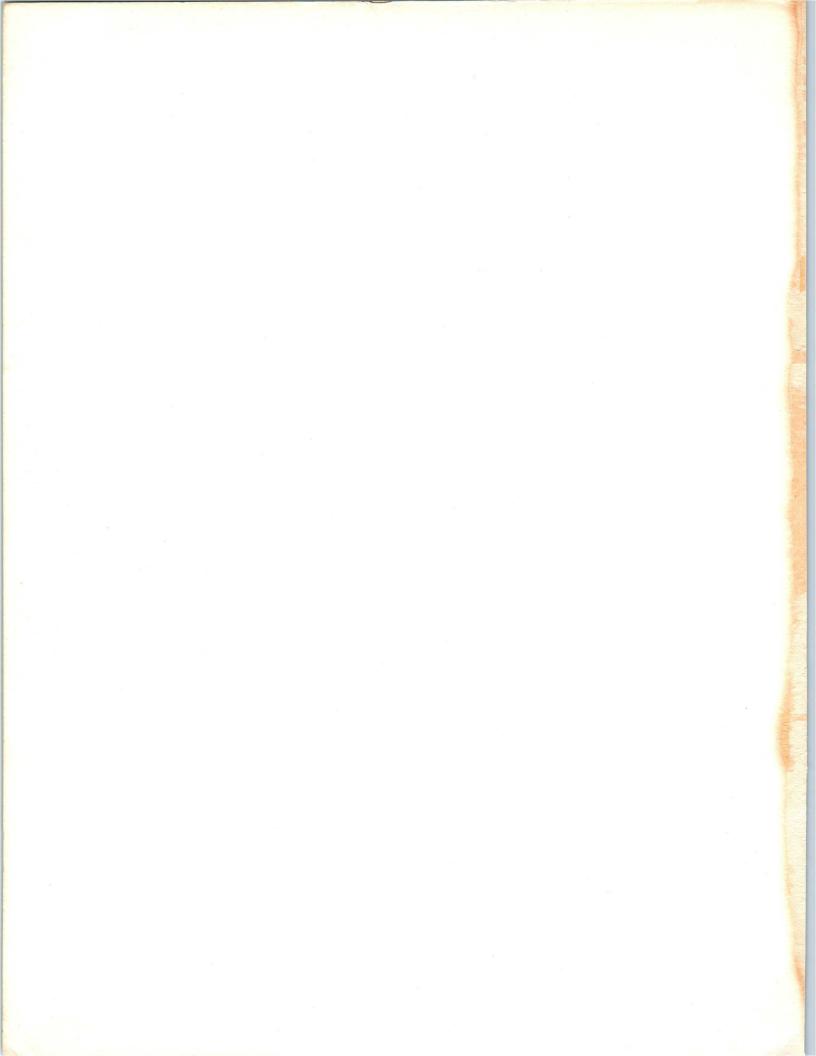
WATKINS-JOHNSON MARCH 1971

MICROWAVE DEVICES TECHNICAL DATA





INTRODUCTION

The Technical Data Sheets in this catalog are arranged in numerical order. Complete specifications, performance curves and mechanical data are provided on a variety of microwave devices.

For your convenience, the contents of this catalog are listed in the Selection Guide by frequency range under one of the following headings:

- 1) Low-Noise Transistor Amplifiers
- 2) Low-Noise TWT Amplifiers
- 3) Power Tubes
- 4) Power Amplifiers
- 5) Solid State Sources
- 6) Backward-Wave Oscillators
- 7) Replacement BWOs
- 8) YIG Filters

The Selection Guide begins on page 4.

Customer Service information is provided on page 2; our local Representatives are shown on page 3. For additional information on the complete line of W-J products, contact our Representative in your area or call Applications Engineering at Watkins-Johnson.

If you wish to remain on our mailing list for revised editions of this catalog, please fill out the attached postage paid card and drop it in the mail. Don't forget to check the box if your address has changed.

Ordering Information-United States

Purchase orders for W-J products may be placed with Applications Engineering or Customer Service at the Palo Alto or Scotts Valley locations, or with one of the local Representatives listed on the opposite page.

Quotations

Customers may obtain quotations on any of W-J's products by contacting Applications Engineering or Customer Service in Palo Alto or Scotts Valley or the local Representative and outlining specific requirements.

Shipping

Shipments are normally made by means of air transportation to the customer's place of business. Surface carriers are not generally used, except in cases where the shipment is too bulky for delivery by air. Premium transportation methods used by W-J ensure safe, quick and dependable service.

Field Returns

If it is necessary to return a product, contact Applications Engineering or Customer Service at Palo Alto or Scotts Valley or our local Representative and give full details. The warranty form enclosed with the product should be completed and included in the package.

Warranties

Customers are protected by the Product Warranties shipped with all W-J products. The warranty period is specified on each Product Service Report.

Service

W-J maintains an experienced group of Applications Engineers at the home office and in the local sales offices to assist in answering technical questions about our products and their application. The services of our engineering and technical staff are also available.

Ordering Information-Overseas

Watkins-Johnson International, a subsidiary of W-J, operates sales offices in Palo Alto, the United Kingdom West Germany and Italy. There are Representatives' offices located throughout Europe, the Mediterranean, Japan and Canada. The locations of these offices are shown on the opposite page. Orders may be placed : with any sales office or the representative office nearest you.

SALES REPRESENTATIVES

Racal Electronics Pty, Ltd. 47 Talavera Road North Ryde, N.S.W. Telephone: 886444 Telex: AA20365

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Allan Crawford Assoc., Ltd. 157 St. Charles Street W.

Longueuil, P.Q. Telephone: (514) 670-1212 TWX: 610-422-3875

Allan Crawford Assoc., Ltd. 376 Churchill Avenue

Ottawa, Ontario Telephone: (613) 725-3354 TWX: 610-562-1670

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OY Hedengren AB Lauttasaarentie 50 00200 Helsinki 20

(P.O. Box 10190 00100 Helsinki 10) Telephone: 670211 Telex: 121110 Cable: HEDOY-HELSINKI

Cable: AIRTRADE-COPENHAGEN

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Gentry Associates, Inc. Rm. 422, 2109 W. Clinton Huntsville 35805 Telephone: (205) 534-9771

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L & M Engineering, Inc. 9911 Inglewood Ave. Inglewood 90301 Telephone: (213) 674-6850

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Bennewitz Associates, Inc. 2801 E. Colfax Ave. Denver 80206 Telephone: (303) 399-1132

DISTRICT OF COLUMBIA

(Government Agencies Only) Watkins-Johnson Company 6006 Executive Blvd. Rockville, Md. 20852 Telephone: (301) 881-3300

Eastern Instrumentation Incorporated 5410 Indian Head Highway Suite 309 Washington, D.C. 20021 Telephone: (301) 839-3801

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Gentry Associates, Inc. 550 N. Bumby Avenue Orlando 32803 Telephone: (305) 841-7740

ILLINOIS

RF Specialists 118 West Higgins Road Park Ridge 60068 Telephone: (312) 698-2044

INDIANA

RF Specialists 6410 Woodwind Drive Indianapolis 46217 Telephone: (317) 783-7630

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S. Sterling Company 17500 W. McNichols Road Detroit 48235 Telephone: (313) 255-1970

MISSOURI

Kemco, Inc. Strother Bldg. Room 15, 6050 Brown Road St. Louis 63134 Telephone: (314) 524-0820

EXPORT

Cable

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Eastern Instrumentation Incorporated 300 Northern Blvd. Great Neck, L.I. 11021 Telephone: (516) 466-9505

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Ossmann Instruments, Inc. 474 Thurston Road Rochester 14619 Telephone: (716) 328-2230

Ossmann Instruments, Inc. 1901 Vestal Parkway East Vestal 13850 Telephone: (607) 785-9947

Ossmann Instruments, Inc. P.O. Box 207 Wappinger Falls 12590 Telephone: (914) 297-7777

NORTH CAROLINA Gentry Associates, Inc. 116 E. O'Neal Ave. Burlington 27215 Telephone: (919) 227-2581

OHIO S. Sterling Company 5827 Mayrield Road Cleveland 44124 Telephone: (216) 442-8080

S. Sterling Company 2673 Culver Avenue Dayton 45429 Telephone: (513) 298-7573

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Eastern Instrumentation Incorporated 613 Cheltenham Avenue Philadelphia 19126 Telepnone: (215) 927-7777

S. Sterling Company No. 2 Parkway Center Pittsburgh 15220 Telepnone: (412) 922-5720

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Кетсо, Inc. P.O. вох 998

Irving 75060

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WASHINGTON

Eastern Instrumentation

Telephone: (703) 644-6622

Rush S. Drake Associates

Incorporated 6133 Maynard Ave. South Seattle 98108 Telephone: (206) 763-2755

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Megex Zürich, GmbH 8048 Zürich Badenerstrasse 582 Telephone: (051) 52-78-00 Telex: 54368 Cable: MEGEXIMPORT-ZURICH

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Watkins-Johnson Internat'l 8 München 2 Maximiliansplatz 12A Telephone: (0811) 29 33 30 Telex: 528401 Cable: WJDBM-MUNCHEN

WEST GERMANY

SELECTION GUIDE

LOW-NOISE TRANSISTOR AMPLIFIERS

Frequency Range	Type Number	Remarks
50–500 MHz	WJ-5030	3.5 dB Noise Figure
0.5– 1.0 GHz	WJ-736	4.0 dB Noise Figure
0.5– 1.0 GHz	WJ-738	4.0 dB Noise Figure
0.5– 1.0 GHz	WJ-740	4.0 dB Noise Figure
1.0– 2.0 GHz	WJ-737	6.0 dB Noise Figure
1.0– 2.0 GHz	WJ-739	6.0 dB Noise Figure
1.0– 2.0 GHz	WJ-741	6.0 dB Noise Figure
1.0- 4.0 GHz	WJ-6007	7.5 dB Noise Figure
2.0- 4.0 GHz	WJ-5004-4	7.0 dB Noise Figure
2.0- 4.0 GHz	WJ-5096	8.5 dB Noise Figure
2.0- 4.5 GHz	WJ-5090-4	7.5 dB Noise Figure

LOW-NOISE TWT AMPLIFIERS

F	requency Range	Type Number	Remarks	
0.	.5– 1.0 GHz .5– 1.0 GHz .5– 2.0 GHz	WJ-278 WJ-404 WJ-397	Standard Series Gain-Matched Ultra-Wide Band	
1. 1. 1. 1. 1. 1.	0- 2.0 GHz 0- 2.0 GHz 0- 2.0 GHz 0- 2.0 GHz 0- 2.0 GHz 0- 2.0 GHz 0- 2.6 GHz 0- 2.6 GHz 0- 4.0 GHz 4- 2.3 GHz	WJ-268 WJ-294 WJ-374 WJ-405 WJ-457 WJ-268-2 WJ-280 WJ-442 WJ-370-3	Standard Series Compact Dual-Helix Gain-Matched Battery-Operable Standard Series Standard Series Ultra-Wide Band Gain- and Phase-Matched	
2. 2. 2.	0– 4.0 GHz 0– 4.0 GHz 0– 4.0 GHz 0– 4.0 GHz 0– 4.0 GHz	WJ-269 WJ-295 WJ-375 WJ-406 WJ-422	Standard Series Compact Dual-Helix Gain-Matched High Dynamic Range/ Ultra-Low Noise	
2. 2. 2. 2. 2. 2. 2. 2. 2. 2. 2. 2. 2. 2	0- 4.0 GHz 0- 4.0 GHz 0- 4.0 GHz 0- 4.0 GHz 0- 4.0 GHz 0- 4.5 GHz 0- 4.5 GHz 2- 2.3 GHz 3- 4.5 GHz 6- 5.2 GHz	WJ-458 WJ-462 WJ-477 WJ-486 WJ-3003 WJ-281 WJ-343 WJ-343 WJ-355 WJ-269-1 WJ-381 WJ-482	Battery-Operable Miniature PPM 100 mW Power TWT Limiter 100 mW Power Standard Series Ultra-Wide Band Ultra-Low Noise Standard Series Compact High Dynamic Range/ Ultra-Low Noise	

LOW-NOISE TWT AMPLIFIERS (Cont'd)

Frequency Range	Type Number	Remarks
4.0- 8.0 GHz 4.0- 8.0 GHz	WJ-271 WJ-271-30 WJ-286 WJ-296 WJ-376 WJ-407 WJ-423 WJ-459 WJ-459 WJ-463 WJ-476	Standard Series Standard Series Standard Series Compact Dual-Helix Gain-Matched High Dynamic Range/ Ultra-Low Noise Battery-Operable Miniature PPM 100 mW Power
4.0– 8.0 GHz 4.0– 8.0 GHz	WJ-485 WJ-3004	TWT Limiter 100 mW Power
7.0–11.0 GHz 7.0–11.0 GHz 7.0–11.0 GHz 8.0–12.0 GHz	WJ-276-2 WJ-396 WJ-484 WJ-276 WJ-363-3 WJ-287 WJ-297 WJ-345 WJ-363 WJ-363 WJ-377 WJ-399 WJ-399-2 WJ-408 WJ-424 WJ-460	Standard Series Ultra-Low Noise TWT Limiter Standard Series Standard Series Compact Ultra-Low Noise Standard Series Dual-Helix Standard Series Standard Series Gain-Matched High Dynamic Range/ Ultra-Low Noise Battery-Operable
8.0–12.0 GHz 8.0–12.0 GHz 8.0–12.0 GHz 8.0–12.0 GHz 8.5– 9.3 GHz 8.5– 9.6 GHz 10.0–12.0 GHz	WJ-464 WJ-472 WJ-3005 WJ-437 WJ-345-7 WJ-345-11 WJ-363-4	Miniature PPM 100 mW Power 100 mW Power Ultra-Wide Band Ultra-Low Noise Ultra-Low Noise Standard Series
12.0–18.0 GHz 12.0–18.0 GHz 12.0–18.0 GHz 12.0–18.0 GHz 12.0–18.0 GHz 12.0–18.0 GHz 12.0–18.0 GHz 12.0–18.0 GHz	WJ-307 WJ-342 WJ-371 WJ-425 WJ-461 WJ-465 WJ-3006	Standard Series Compact Ultra-Low Noise Ultra-Low Noise Battery-Operable Miniature PPM 100 mW Power
18.0–26.5 GHz	WJ-393	Millimeter LNTWA
20.5–40.0 GHz	WJ-338	Millimeter LNTWA

POWER TUBES

Frequency Range	Type Number	Remarks
1.0- 2.0 GHz	WJ-340	1,000 Watts Gridded
1.0- 2.0 GHz	WJ-2500	1 Watt Power
2.0- 2.2 GHz 2.0- 4.0 GHz 2.2- 2.3 GHz 2.2- 2.3 GHz 2.2- 2.3 GHz 2.2- 2.3 GHz 2.2- 2.4 GHz 2.2- 2.4 GHz 2.2- 2.4 GHz 2.5- 3.5 GHz	WJ-445-1 WJ-2501 WJ-395-1 WJ-448-1 WJ-448-2 WJ-274-2 WJ-274-8 WJ-398-1 WJ-368-3	1 Watt Low Distortion 1 Watt Power 100 Watts High Efficiency 50 Watts High Efficiency 15/90 Watts High Efficiency 20 Watts High Efficiency 10/20 Watts High Efficiency 20 Watts High Impact 120/50 Watts Pulsed
4.0- 8.0 GHz	WJ-2502	1 Watt Power
4.0- 8.0 GHz	WJ-3606	3 Watts Low Noise
4.4- 5.8 GHz	WJ-369-3	120/50 Watts Pulsed
5.0- 8.5 GHz	WJ-231-5	35 Watts Wideband
5.4- 5.7 GHz	WJ-346	20,000 Watts Power
5.4- 5.9 GHz	WJ-228	12,000 Watts Power
6.0- 8.0 GHz	WJ-284-5	200 Watts Power
7.0–11.0 GHz	WJ-391	5 Watts Power
7.0–11.0 GHz	WJ-492-1	3 Watts High Gain
7.0–12.0 GHz	WJ-2503	1 Watt Power
8.0–12.4 GHz	WJ-492-2	3 Watts High Gain
11.5–14.0 GHz	WJ-446	5 Watts Low Distortion
12.0–18.0 GHz	WJ-3604	3 Watts Low Noise

POWER AMPLIFIERS

Frequency Range	Type Number	Remarks
1.42–1.6 GHz	WJ-4539	20-Watt CW Cavity
1.435–1.540 GHz	WJ-4540A	100-Watt CW Cavity
2.2–2.3 GHz	WJ-4523	20-Watt CW Cavity
2.2–2.3 GHz	WJ-1171 Series	9 to 24 Watt TWTAs
2.2–2.4 GHz	WJ-1014-1	20-Watt TWTA
5.4–5.9 GHz	WJ-1051-1	45-Watt Pulsed TWTA
5.9–6.45 GHz	WJ-1064-4	35-Watt TWTA
7.0–11.0 GHz	WJ-1115	3-Watt TWTA
12.4–18.0 GHz	WJ-1179	2 Watts with Serrodyne Capability

SOLID STATE SOURCES

Frequency Range	Type Number	Remarks
0.25–0.5 GHz	WJ-2811	100 mW Varactor-Tuned Oscillator
0.5– 1.0 GHz	WJ-571	10 mW YIG-Tuned Transistor Oscillator
0.5– 1.0 GHz 0.5– 1.0 GHz	WJ-700 WJ-2800	+ 5 dBm Harmonic Generator 100 mW Varactor-Tuned Oscillator

SOLID STATE SOURCES (Cont'd)

		•
Frequency Range	Type Number	Remarks
1.0- 2.0 GHz	WJ-569	10 mW YIG-Tuned Transistor Oscillator
1.0– 2.0 GHz 1.0– 2.0 GHz	WJ-701 WJ-2803	+ 3 dBm Harmonic Generator 100 mW Varactor-Tuned Oscillator
1.0- 2.0 GHz	WJ-2803-50	50 mW Varactor-Tuned Oscillator
1.4– 2.4 GHz	WJ-2810	50 mW Varactor-Tuned Oscillator
1.0–12.4 GHz	WJ-5060	4 to 30 mW (unleveled) Local Oscillator
2.4- 4.0 GHz	WJ-572	2 mW YIG-Tuned Transistor Oscillator
2.0– 4.0 GHz 2.0– 4.0 GHz	WJ-702 WJ-2804-10	0 dBm Harmonic Generator 10 mW Varactor-Tuned Oscillator
2.0- 4.0 GHz	WJ-2804-20	20 mW Varactor-Tuned Oscillator
2.0- 4.0 GHz	WJ-2804-40	40 mW Varactor-Tuned Oscillator
4.0- 8.0 GHz	WJ-703	– 25 dBm Harmonic Generator
7.0–12.4 GHz 8.0–12.0 GHz 8.0–12.4 GHz	WJ-760 WJ-704 WJ-5008	10 mW Avalanche Diode Oscillator – 25 dBm Harmonic Generator 8 mW YIG-Tuned Bulk GaAs Oscillator
12.4–18.0 GHz	WJ-5041	1 mW YIG-Tuned Bulk GaAs Oscillator

BACKWARD-WAVE OSCILLATORS

Frequency Range	Type Number	Remarks
0.5- 1.0 GHz	SE-223	30 mW Unshielded
1.0– 2.0 GHz 1.0– 2.6 GHz 1.4– 2.5 GHz 1.4– 2.5 GHz 1.7– 4.2 GHz	SE-214A SE-214 SE-219 SE-219A SE-215	100 mW Unshielded 30 mW Unshielded 100 mW Unshielded 100 mW Unshielded 30 mW Unshielded
2.0- 4.0 GHz 2.0- 4.0 GHz 2.0- 4.0 GHz 2.0- 4.0 GHz 2.0- 4.0 GHz 2.0- 4.0 GHz 2.0- 4.5 GHz 2.0- 4.5 GHz 2.0- 4.5 GHz 2.6- 5.2 GHz	SE-215A SE-310 WJ-2018 WJ-2024 WJ-2040-2 WJ-2051 WJ-2014 WJ-2040 SE-310-3 WJ-2038	75 mW Unshielded 50 mW Compact 70 mW Magnetically/RFI Shielded 50 mW Compact 50 mW Magnetically/RFI Shielded 30 mW Magnetically/RFI Shielded 50 mW Magnetically/RFI Shielded 50 mW Compact 50 mW Magnetically/RFI Shielded
3.5- 6.75 GHz 3.5- 6.75 GHz 3.7- 8.3 GHz 4.0- 8.0 GHz	SE-221 WJ-2049 SE-211B SE-211A SE-304 WJ-2015 WJ-2019 WJ-2025 WJ-2030	40 mW Unshielded 40 mW Unshielded 15 mW Unshielded 30 mW Unshielded 20 mW Compact 50 mW Unshielded 30 mW Magnetically/RFI Shielded 20 mW Compact 50 mW Compact

BACKWARD-WAVE OSCILLATORS (Cont'd)

Frequency Range	Type Number	Remarks
4.0- 8.0 GHz	WJ-2034	60 mW Magnetically/RFI Shielded
4.0- 8.0 GHz	WJ-2047	40 mW Unshielded
4.0- 8.6 GHz	WJ-2050	30 mW Magnetically/RFI Shielded
4.5-10.0 GHz	WJ-2044	25 mW Magnetically/RFI Shielded
5.3- 6.0 GHz	SE-217	100 mW Unshielded
7.0–12.4 GHz 7.0–12.4 GHz 7.0–12.4 GHz 7.5–11.0 GHz 8.0–12.4 GHz 8.0–12.4 GHz 8.0–12.4 GHz 8.0–12.4 GHz 8.0–12.4 GHz 8.0–12.4 GHz 8.0–12.4 GHz 8.0–12.4 GHz 8.0–12.4 GHz 8.2–12.4 GHz 8.2–12.4 GHz 8.2–12.4 GHz 8.2–12.4 GHz 8.2–12.4 GHz 8.2–12.4 GHz	SE-209 WJ-2001 WJ-2039-1 WJ-2042 SE-313 WJ-2006 WJ-2008 WJ-2008 WJ-2008-2 WJ-2020 WJ-2027 WJ-2027 WJ-2033-1 WJ-2039 SE-209A SE-303 WJ-2026 WJ-2004	10 mW Unshielded 25 mW Unshielded 40 mW Magnetically/RFI Shielded 30 mW Magnetically/RFI Shielded 50 mW Compact 50 mW Unshielded 50 mW Magnetically/RFI Shielded 100 mW Unshielded 80 mW Unshielded 50 mW Magnetically/RFI Shielded 50 mW Magnetically/RFI Shielded 80 mW Magnetically/RFI Shielded 20 mW Unshielded 20 mW Compact 20 mW Compact 10 mW Compact
10.0–15.5 GHz 12.4–18.0 GHz 14.0–17.0 GHz 14.0–17.0 GHz	SE-220 SE-216 SE-307 SE-307A WJ-2003 WJ-2007 WJ-2021 WJ-2028 WJ-2043 WJ-2052 WJ-2056 SE-308 SE-308A WJ-2029	10 mW Unshielded 10 mW Unshielded 20 mW Compact 20 mW Compact 40 mW Unshielded 40 mW Magnetically/RFI Shielded 20 mW Compact 40 mW Magnetically/RFI Shielded 20 mW Magnetically/RFI Shielded 40 mW Magnetically/RFI Shielded 10 mW Compact 10 mW Compact 10 mW Compact
18.0–26.5 GHz	SE-218	20 mW Unshielded
18.0–26.5 GHz	WJ-2022	20 mW Magnetically/RFI Shielded
18.0–26.5 GHz	WJ-2057	20 mW Magnetically/RFI Shielded
26.5–40.0 GHz	SE-222	10 mW Unshielded
26.5–40.0 GHz	WJ-2041	10 mW Magnetically/RFI Shielded
26.5–40.0 GHz	WJ-2058	10 mW Magnetically/RFI Shielded

REPLACEMENT BWOs

Frequency Range	Type Number	Remarks
1.0– 2.0 GHz	SE-214A-50	100 mW Unshielded
1.0– 2.6 GHz	SE-214-50	25 mW Unshielded
1.4– 2.5 GHz	SE-219-50	100 mW Unshielded
1.7– 4.2 GHz	SE-215-50	40 mW Unshielded
1.7– 4.2 GHz	WJ-2018-51	30 mW Magnetically/RFI Shielded
2.0– 4.0 GHz	SE-215A-50	80 mW Unshielded
2.0– 4.0 GHz	WJ-2018-50	75 mW Magnetically/RFI Shielded
2.6– 5.2 GHz	WJ-2038-50	50 mW Magnetically/RFI Shielded
3.5– 6.75 GHz	SE-221-50	45 mW Unshielded
3.5– 6.75 GHz	WJ-2049-50	40 mW Unshielded
3.7– 8.3 GHz	SE-211B-50	15 mW Unshielded

REPLACEMENT BWOs (Cont'd)

Frequency Range	Type Number	Remarks
3.7– 8.3 GHz	WJ-2019-51	20 mW Magnetically/RFI Shielded
4.0– 8.0 GHz	SE-211A-50	30 mW Unshielded
4.0– 8.0 GHz	WJ-2019-50	30 mW Magnetically/RFI Shielded
7.0–12.4 GHz 7.0–12.4 GHz 7.0–12.4 GHz 8.0–12.4 GHz 8.0–12.4 GHz 8.0–12.4 GHz 8.0–12.4 GHz 8.0–12.4 GHz 10.0–15.5 GHz	WJ-2001-51 WJ-2020-51 WJ-2039-51 SE-209A-50 WJ-2001-50 WJ-2020-50 WJ-2039-50 SE-220-50	25 mW Unshielded 25 mW Magnetically/RFI Shielded 40 mW Magnetically/RFI Shielded 20 mW Unshielded 50 mW Unshielded 50 mW Magnetically/RFI Shielded 80 mW Magnetically/RFI Shielded 20 mW Unshielded
12.4–18.0 GHz	WJ-2003-50	40 mW Unshielded
12.4–18.0 GHz	WJ-2056-50	50 mW Magnetically/RFI Shielded
12.4–18.0 GHz	WJ-2060-50	50 mW Magnetically/RFI Shielded
18.0–26.5 GHz	SE-218-50	20 mW Unshielded
18.0–26.5 GHz	WJ-2057-50	20 mW Magnetically/RFI Shielded
18.0–26.5 GHz	WJ-2061-50	25 mW Magnetically/RFI Shielded
26.5–40.0 GHz	SE-222-50	10 mW Unshielded
26.5–40.0 GHz	WJ-2058-50	7 mW Magnetically/RFI Shielded
26.5–40.0 GHz	WJ-2062-50	10 mW Magnetically/RFI Shielded

YIG FILTERS

Frequency Range	Type Number	Remarks
0.5- 1.0 GHz	WJ-723	Three-Stage
1.0- 2.0 GHz 1.0- 2.0 GHz	WJ-611 WJ-615 WJ-619 WJ-634 WJ-638 WJ-648 WJ-724	Compact Two-Stage Compact Four-Stage Compact Dual Two-Stage Two-Stage Hybrid Four-Stage Hybrid Dual Two-Stage Hybrid Three-Stage
1.0– 2.3 GHz 1.0– 5.0 GHz 1.0–12.4 GHz 1.0–18.0 GHz	WJ-627 WJ-652 WJ-756 WJ-795	YIG Magnetometer Mechanically Tuned Compact Three-Stage Compact Two-Stage
2.0– 4.0 GHz 2.0– 4.0 GHz 2.0– 4.0 GHz 2.0– 4.0 GHz 2.0– 4.0 GHz 2.0– 4.0 GHz 2.0– 4.0 GHz	WJ-612 WJ-616 WJ-620 WJ-635 WJ-639 WJ-649	Compact Two-Stage Comact Four-Stage Compact Dual Two-Stage Two-Stage Hybrid Four-Stage Hybrid Dual Two-Stage Hybrid
2.0– 4.0 GHz 2.0–12.4 GHz	WJ-725 WJ-623	Three-Stage Multi-Octave Compact
4.0- 8.0 GHz 4.0- 8.0 GHz	WJ-613 WJ-617 WJ-621 WJ-636 WJ-640 WJ-650 WJ-726	Compact Two-Stage Compact Four-Stage Compact Dual Two-Stage Two-Stage Hybrid Four-Stage Hybrid Dual Two-Stage Hybrid Three-Stage

YIG FILTERS (Cont'd)

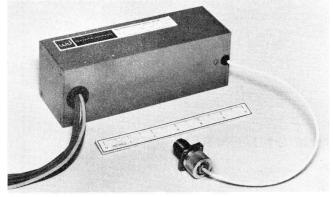
Frequency Range	Type Number	Remarks
8.0–12.4 GHz	WJ-614	Compact Two-Stage
8.0–12.4 GHz	WJ-618	Compact Four-Stage
8.0–12.4 GHz	WJ-622	Compact Dual Two-Stage
8.0–12.4 GHz	WJ-637	Two-Stage Hybrid
8.0–12.4 GHz	WJ-641	Four-Stage Hybrid
8.0–12.4 GHz	WJ-651	Dual Two-Stage Hybrid
8.0–12.4 GHz	WJ-727	Three-Stage

BACKWARD-WAVE O S C I L L A T O R

SE-209

TECHNICAL DATA • September 1965

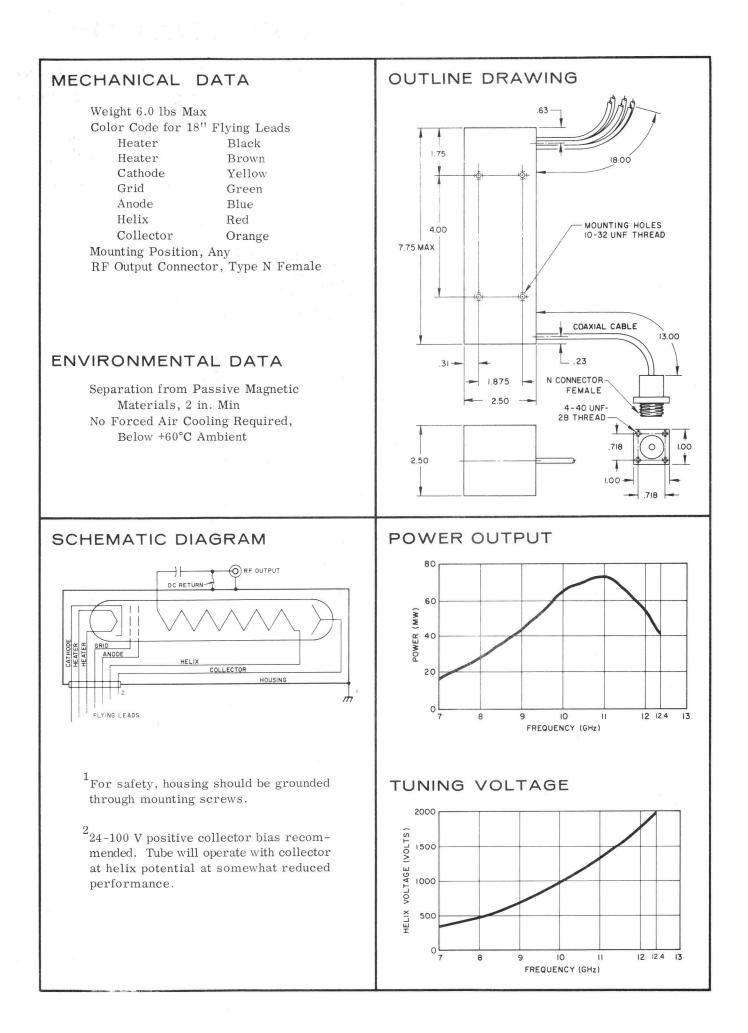
The type SE-209 BWO is a single-helix, voltage tunable oscillator. This permanent-magnetfocused wide band oscillator is well suited for use as a swept signal source in signal generators, particularly in view of its high stability. Other applications include radar receivers (as local oscillator), frequency diversity transmitters (as master oscillator), and ECM equipment. The SE-209 features smooth power over the band, low cathode current, and two control electrodes. The control grid makes possible power cutoff with low negative grid voltage. Power output can be modulated with either the grid or anode, or both. Cathode



modulation with the grid grounded usually reduces FM caused by AM. With all voltages isolated from both tube housing and the r.f. output terminal, packaging problems are simplified, since the tube housing and output connector can be grounded regardless of power supply configuration.

ELECTRICAL (CHARACTERISTICS, (CW		
		Units	Typical	Absolute
			Values	Ratings
Nominal Frequency	Band	GHz	7-12.4	
	Load with VSWR = 1.25:1	mW	12-80	10 Min
Power Output Varia		db		10 Max
Fine Grain Variatio		db/250 MHz	5	3 Max
Tube VSWR				2.5:1 Max
	into 2:1 Load (Any Phase)	MHz	1	2 Max
Spurious Oscillatio			_	
	to Total Spurious Output	db	60	45 Min
	to Noise Power 30 MHz Away	db/MHz	95	85 Min
	vity to Heater Voltage	MHz/V	7.5	10 Max
Sensitivity to Anod		MHz/V	0.5	1 Max
Sensitivity to Grid	-	MHz/V	2	4 Max
Tuning Curve Slope	-			
Low End (7.0		MHz/V	8.5	
Mid-Frequenc		MHz/V	3.9	
High End (12.		MHz/V	1.5	
Grid r.f. Cutoff Vol		V	-10	-20 Max
	de to all other Electrodes,			
including Hea		\mathbf{pf}	28	35 Max
Capacitance; Grid	to all other Electrodes, at			
Power Input C	Connector	\mathbf{pf}	28	35 Max
Capacitance; R.F.	connector center pin and			
housing to all	other Electrodes	pf	135	150 Max
Heater Voltage		Vdc		$6.3 \pm 5\%$
Heater Current		А	0.9	0.6 - 1.2
				Min/Max
Cathode Current		mA	9	12 Max
Helix Voltage Rang	e	V	310-2000	250-2100
				Min/Max
Helix Current		mA	1.5	3 Max
Anode Voltage		V	160	215 Max
Anode Current		mA	1	2 Max

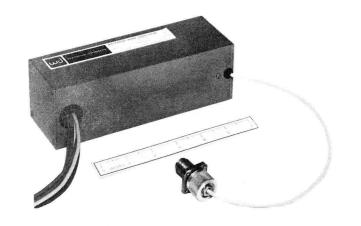
ELECTRICAL CHARACTERISTICS, CW



* MARCH 1969

BACKWARD-WAVE OSCILLATOR SE-209A

The type SE-209A BWO is a single-helix, voltage tunable oscillator. This permanent-magnet focused wideband oscillator is well suited for use as a swept signal source in signal generators, particularly in view of its high stability. Other applications include radar receivers (as local oscillator), frequency diversity transmitters (as master oscillator), and ECM equipment. The SE-209A features smooth power over the band, low cathode current, and two control electrodes. The control grid makes possible power cutoff with low negative grid voltage. Power output can be modulated with either the grid or anode, or both. With all voltages isolated from both tube housing and the RF output terminal, packaging problems are simplified, since the tube housing and output connector



can be grounded regardless of power supply configuration.

		ABSOLUTE	TYPICAL
	UNITS	RATINGS	VALUES
Nominal Frequency Band	GHz		8.0 - 12.4
Power Output Into Load With VSWR=1,25	mW	25 - 50	20 Min
Power Output Variation	dB		6 Max
Fine Grain Variation	dB/250 MHz		3 Max
Tube VSWR			2.5:1 Max
Frequency Pulling Into 2:1 Load			
(Any Phase)	MHz	1	2 Max
Spurious Oscillation			
Ratio of Signal to Total Spurious			
Output	dB	60	45 Min
Ratio of Signal to Noise Power			
30 MHz Away	dB/MHz	95	85 Min
Long-Term Sensitivity to Heater Voltage	MHz/V	7.5	
Sensitivity to Anode Voltage	MHz/V	0.5	
Sensitivity to Grid Voltage	MHz/V	2	
Tuning Curve Slope			
Low End (8.2 GHz)	MHz/V	7.0	
Mid-Frequency (10.3 GHz)	MHz/V	3.5	
High End (12.4 GHz)	MHz/V	1.5	
Grid RF Cutoff Voltage	V	-10	-20 Max
Capacitance; Cathode to All Other			
Electrodes, Including Heater	pF	28	35 Max
Capacitance; Grid to All Other Electrodes	-		
at Power Input Connector	pF	28	35 Max
Capacitance; RF Connector Center Pin and	-		
Housing to All Other Electrodes	pF	135	150 Max
Heater Voltage	V		$6.3 \pm 5\%$
Heater Current	А	0.9	0.6 Min
			1.2 Max
Cathode Current	mA	8	12 Max
Helix Voltage Range	V	480 - 2000	450 Min
			2100 Max
Helix Current	mA	1.5	3 Max
Anode Voltage	V	150	215 Max
Anode Current	mA	0.5	2 Max

SPECIFICATIONS

*Supersedes Technical Data Sheet SE-209A Dated September 1965

SE-209A

OUTLINE DRAWING

MECHANICAL CHARACTERISTICS

Weight, 6.0 lbs Max Color Code for 18" Flying Leads Heater Black

Heater Cathode Grid Anode Helix Collector Mounting Position, Any

Brown

Yellow

Green

Orange

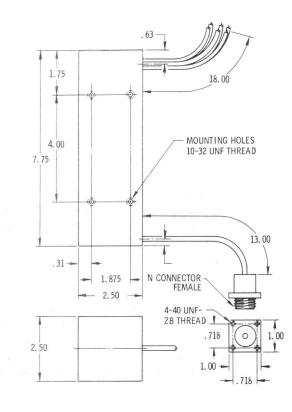
Blue

Red

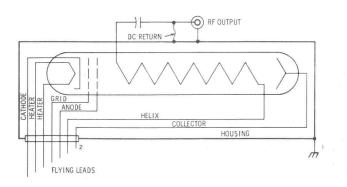
RF Output Connector, Type N Female

ENVIRONMENTAL CHARACTERISTICS

Separation From Passive Magnetic Materials, 2" Min No Forced Air Cooling Required, Below +60⁰ C Ambient

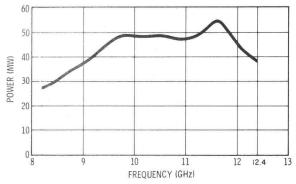


SCHEMATIC DIAGRAM

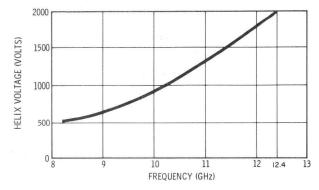


- 1 For safety, Housing should be grounded through mounting screws.
- 2 50-100 V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.
- 3 Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.

POWER OUTPUT



TUNING VOLTAGE



DECEMBER 1970

BACKWARD-WAVE OSCILLATOR SE-209A-50



SPECIFICATIONS

	UNITS	TYPICAL VALUES	ABSOLUTE RATINGS
Nominal Frequency Band Power Output into Load with VSWR = 1.25:1 Power Output Variation Fine Grain Variation Tube VSWR Frequency Pulling Into 2:1 Load (Any Phase)	. mW . dB . dB / 250 MHz		7 Max. 3 Max. 2.5:1 Max.
Spurious Oscillation Ratio of Signal to Noise Power 30 MHz Away Ratio of Signal to Total Spurious Output Long-term Sensitivity to Heater Voltage Sensitivity to Anode Voltage Sensitivity to Grid Voltage Tuning Curve Slope	.dB .MHz/V .MHz/V	60 .7.5 0.5	85 Min. 45 Min.
Low End (8.2 GHz) Mid-Frequency (10.3 GHz) High End (12.4 GHz) Grid RF Cutoff Voltage	.MHz/V	.3.5	. —25 Max.
Capacitance; Cathode to all other Electrodes, including Heater	.pF	.28	35 Max.
Capacitance; Grid to all other Electrodes, at Power Input Plug	рF	28	35 Max
Capacitance; RF Connector Center Pin and Housing to all other Electrodes Heater Voltage Heater Current	.pF	.135	… 150 Max. … 6.3 ± 5% … 0.4−1.2
Cathode Current [*]	.mA	.8 .500–2000	450-2100
Helix Current	.V	.150	215 Max.

*Set cathode current to Final Test Data value furnished with tube.

The SE-209A-50 BWO is a single-helix, voltage tunable oscillator. This permanent-magnet focused wide band oscillator is well suited for use as a swept signal source in signal generators, particularly in view

Other applications include radar receivers (as local oscillator), frequency diversity transmitters (as master

The SE-209A-50 features smooth power over the band, low cathode current, and two control electrodes. The control grid makes possible power cutoff with low negative grid voltage. Power output can be modulated

with either the grid or anode, or both. Cathode modulated lation with the grid grounded usually reduces FM caused by AM. Packaging problems are simplified,

since all voltages are isolated from both tube housing and the RF output terminal. The tube housing and output connector can be grounded regardless of power

of its high stability.

supply configuration.

oscillator), and ECM equipment.

SE-209A-50

MECHANICAL CHARACTERISTICS

Height, 2.5 inches (64 mm) Width, 2.5 inches (64 mm) Length, 7.75 inches (197 mm) max. Weight, 6 lbs. (2.72 Kg) max.

Color Code for 18" Flying Leads

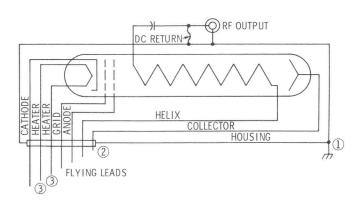
Heater	Black
Heater	Brown
Cathode	Yellow
Grid	Green
Anode	Blue
Helix	Red
Collector	Orange

Mounting Position, Any RF Output Connector, Type N Female on Balun

ENVIRONMENTAL CHARACTERISTICS

Separation from Passive Magnetic Materials, 2 in. Min. No Forced Air Cooling Required Below +60°C Ambient

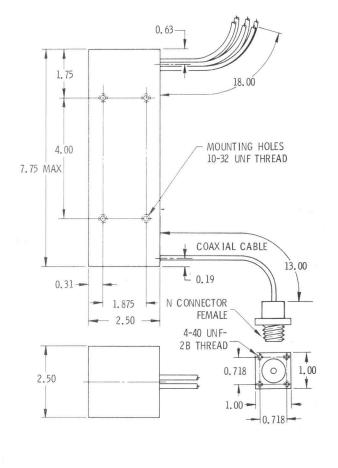
SCHEMATIC DIAGRAM

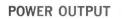


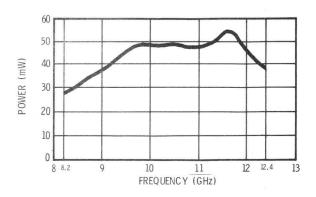
Notes:

- (1) For safety, housing should be grounded through mounting screws.
- (2) 45–150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.
- 3. Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.

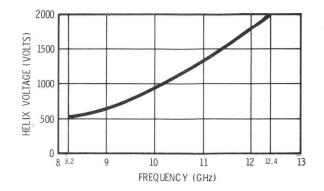
OUTLINE DRAWING







TUNING VOLTAGE



SE-211A

BACKWARD-WAVE

OSCILLATOR

September 1965

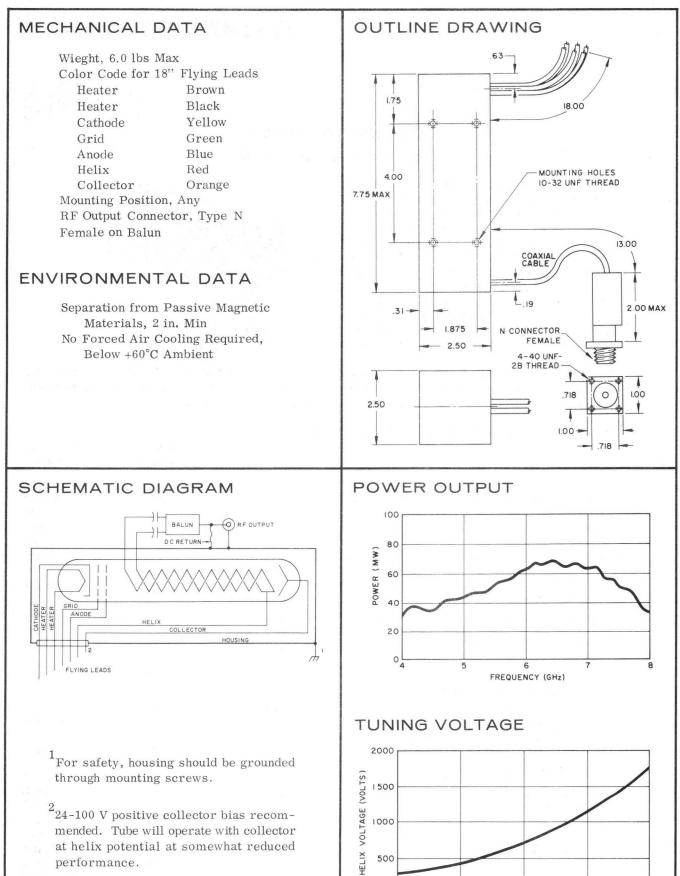
The type SE-211A BWO is a bifilar (dual helix), voltage tunable oscillator. The permanent-magnet focused wide band oscillator is well suited for use as a swept signal source in signal generators, particularly in view of its high stability. Other applications include ECM receivers (as local oscillator), frequency diversity transmitters (as master oscillator), and other electronic equipment. The SE-211A features smooth power over the band, low cathode current, and two control electrodes. The control grid makes possible power cutoff with low negative grid voltage. Power output can be modulated with either the grid or anode, or both.



Cathode modulation with the grid grounded usually reduces FM caused by AM. With all voltages isolated from both tube housing and the r.f. output terminal, packaging problems are simplified, since the tube housing and output connector can be grounded regardless of power supply configuration.

ELECTRICAL CHARACTERISTICS, CW

	Units	Typical Values	Absolute Ratings
		values	Ratings
Nominal Frequency Band	GHz	4-8	
Power Output into a Load with VSWR = 1.25	mW	30-70	30 Min
Power Output Variation	db		6 Max
Fine Grain Variation	db/250 MHz		3 Max
Tube VSWR			2.5:1 Max
Frequency Pulling into 2:1 Load (Any Phase)	MHz	1.5	3 Max
Spurious Oscillation			
Ratio of Signal to 2nd Harmonic Output	db	35	20 Min
Ratio of Signal to Noise Power 30 MHz Away	db/MHz	95	85 Min
Long-term Sensitivity to Heater Voltage	MHz/V	5	10 Max
Sensitivity to Anode Voltage	MHz/V	0.5	1 Max
Sensitivity to Grid Voltage	MHz/V	3	5 Max
Tuning Curve Slope			
Low End (4.0 GHz)	MHz/V	5.9	
Mid-Frequency (6.0 GHz)	MHz/V	2.7	
High End (8.0 GHz)	MHz/V	2.0	
Grid r.f. Cutoff Voltage	V	-7	-20 Max
Capacitance; Cathode to all other Electrodes,			
including Heater	pf	30	45 Max
Capacitance; Grid to all other Electrodes, at			
Power Input Connector	pf	30	45 Max
Capacitance; Helix to all other Electrodes	pf	100	150 Max
Heater Voltage	V		$6.3\pm5\%$
Heater Current	A	0.9	0.6-1.2
			Min/Max
Cathode Current	mA	9	12 Max
Helix Voltage	V	310-1825	250-1900
			Min/Max
Helix Current	mA	1.5	3 Max
Anode Voltage	V	135	215 Max
Anode Current	mA	0.5	2 Max



FREQUENCY (GHz)

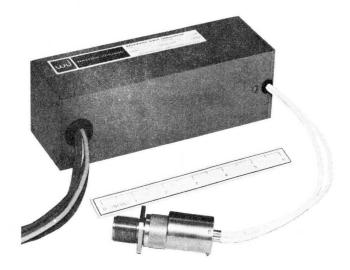
DECEMBER 1970

BACKWARD-WAVE OSCILLATOR SE-211A-50

The SE-211A-50 BWO is a bifilar (dual-helix), voltage tunable oscillator. This permanent-magnet focused wide band oscillator is well suited for use as a swept signal source in signal generators, particularly in view of its high stability.

Other applications include ECM receivers (as local oscillator), frequency diversity transmitters (as master oscillator), and other electronic equipment.

The SE-211A-50 features smooth power over the band, low cathode current, and two control electrodes. The control grid makes possible power cutoff with low negative grid voltage. Power output can be modulated with either the grid or anode, or both. Cathode modulation with the grid grounded usually reduces FM caused by AM. Packaging problems are simplified, since all voltages are isolated from both tube housing and the RF output terminal. The tube housing and output connector can be grounded regardless of power supply configuration.



EV DIO A

SPECIFICATIONS

	UNITS	TYPICAL VALUES	ABSOLUTE RATINGS
Nominal Frequency Band Power Output into Load with VSWR = 1.25:1 Power Output Variation	. mW	.30–70	5 Max.
Fine Grain Variation Tube VSWR Frequency Pulling Into 2:1 Load (Any Phase) Spurious Oscillation	.MHz	.1.5	2.5:1 Max. 3 Max.
Ratio of Signal to Noise Power 30 MHz Away Ratio of Signal to 2nd Harmonic Output Long-term Sensitivity to Heater Voltage Sensitivity to Anode Voltage	.dB	.35 .5	85 Min. 20 Min.
Sensitivity to Grid Voltage Tuning Curve Slope Low End (4.0 GHz)	.MHz/V	.3 .5.9	
Mid-Frequency (6.0 GHz) High End (8.0 GHz) Grid RF Cutoff Voltage Capacitance; Cathode to all other Electrodes,	.MHz/V .V	.2.0 .—7	
including Heater Capacitance; Grid to all other Electrodes,	nF	30	45 Max
Capacitance; Helix to all other Electrodes Heater Voltage Heater Current	.A	.0.9	0.4–1.2 Min./Max.
Cathode Current * Helix Voltage Range Helix Current	.V	.310–1825	12 Max. . 250–1900 Min. /Max.
Anode Voltage	.V	.135	. 215 Max.

*Set cathode current to Final Test Data value furnished with tube.

SE-211A-50

MECHANICAL CHARACTERISTICS

Height, 2.5 inches (64 mm) Width, 2.5 inches (64 mm) Length, 7.75 inches (197 mm) max. Weight, 6.5 lbs. (2.95 Kg) max.

Color Code for 18" Flying Leads

HeaterBlackHeaterBrownCathodeYellowGridGreenAnodeBlueHelixRedCollectorOrange

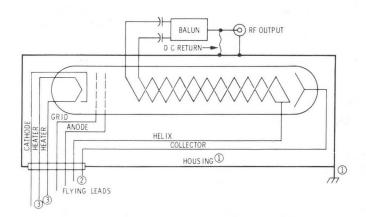
Mounting Position, Any

RF Output Connector, Type N Female on Balun

ENVIRONMENTAL CHARACTERISTICS

Separation from Passive Magnetic Materials, 2 in. Min. No Forced Air Cooling Required Below +60°C Ambient

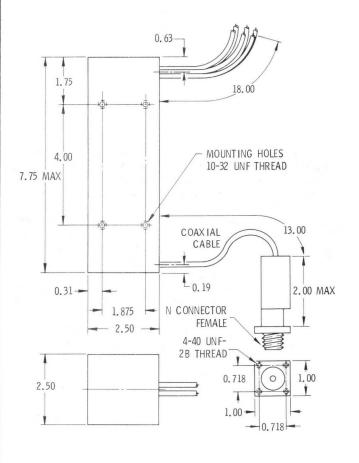
SCHEMATIC DIAGRAM

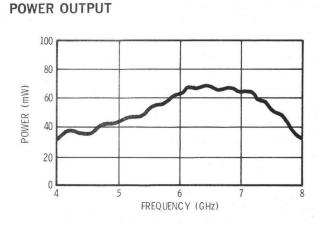


Notes:

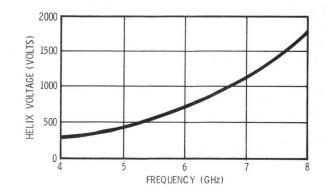
- (1) For safety, housing should be grounded through mounting screws.
- (2) 45–150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.
- (3) Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.

OUTLINE DRAWING





TUNING VOLTAGE

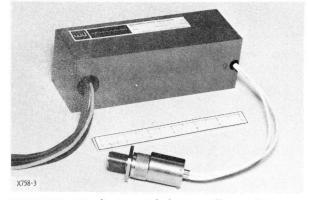


SE-211B

BACKWARD-WAVE OSCILLATOR

November 1968 *

The type SE-211B BWO is a bifilar (dual helix), voltage tunable oscillator. This permanent-magnet focused wide band oscillator is well suited for use as a swept signal source in signal generators, particularly in view of its high stability. Other applications include ECM receivers (as local oscillator), and other electronic equipment. The SE-211B features smooth power over the band, low cathode current, and two control electrodes. The control grid makes possible power cutoff with low negative grid voltage. Power output can be modulated with either the grid or anode, or both. All voltages are isolated from both tube housing and the RF output terminal. Packaging problems are simplified, since the tube housing and output



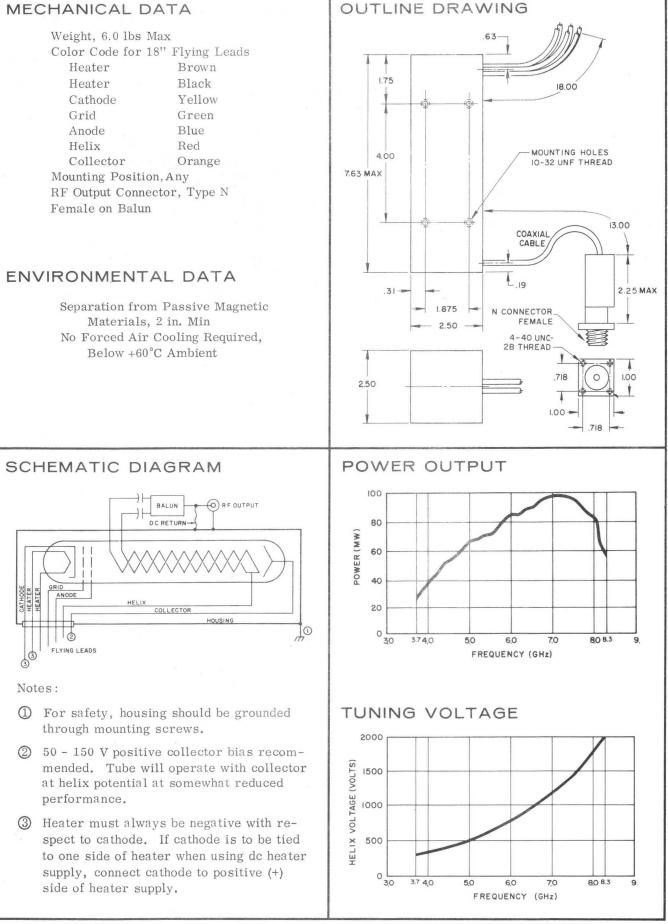
connector can be grounded regardless of power supply configuration.

SPECIFICATIONS

	Units	Typical Values	Absolute Ratings
Nominal Frequency Band	GHz		3.7-8.3
Power Output into a Load with VSWR = 1.25	mW	35-100	15 Min
Power Output Variation	db		8 Max
Fine Grain Variation	db/250 MHz		3 Max
Tube VSWR			2.5:1 Max
Frequency Pulling into 2:1 Load (Any Phase)	MHz	1.5	3 Max
Spurious Oscillation			
Ratio of Signal to 2nd Harmonic Output	db	35	20 Min
Ratio of Signal to all Noise Power 30 MHz Away	db/MHz	95	85 Min
Long-term Sensitivity to Heater Voltage	MHz/V	4	7 Max
Sensitivity to Anode Voltage	MHz/V	0.6	1 Max
Sensitivity to Grid Voltage	MHz/V	3	5 Max
Tuning Curve Slope			
Low End (3.7 GHz)	MHz/V	6.4	
Mid-Frequency (6.0 GHz)	MHz/V	2.7	
High End (8.3 GHz)	MHz/V	1.6	
Grid r.f Cutoff Voltage	V	-7	-20 Max
Capacitance; Cathode to all other Electrodes,			
including Heater	pf	30	45 Max
Capacitance; Grid to all other Electrodes, at			
Power Input Connector	pf	30	45 Max
Capacitance; Helix to all other Electrodes	pf	100	150 Max
Heater Voltage	V		6.3±5%
Heater Current	А	0.75	0.4 - 1.2
			Min/Max
Cathode Current		9	12 Max
Helix Voltage Range	mA	250-2000	200-2100
			Min/Max
Helix Current	mA	1.5	3.0 Max
Anode Voltage	V	150	215 Max
Anode Current	mA	0.1	2.0 Max
	1 1005		

* Supersedes SE-211B Technical Data Sheet dated September 1965.

MECHANICAL DATA



DECEMBER 1970

BACKWARD-WAVE OSCILLATOR SE-211B-50

The SE-211B-50 BWO is a bifilar (dual-helix), voltage tunable oscillator. This permanent-magnet focused wide band oscillator is well suited for use as a swept signal source in signal generators, particularly in view of its high stability.

Other applications include ECM receivers (as local oscillator), frequency diversity transmitters (as master oscillator), and other electronic equipment.

The SE-211B-50 features smooth power over the band, low cathode current, and two control electrodes. The control grid makes possible power cutoff with low negative grid voltage. Power output can be modulated with either the grid or anode, or both. Cathode modulation with the grid grounded usually reduces FM caused by AM. Packaging problems are simplified, since all voltages are isolated from both tube housing and the RF output terminal. The tube housing and output connector can be grounded regardless of power supply configuration.



SPECIFICATIONS

	UNITS	TYPICAL VALUES	ABSOLUTE RATINGS
Nominal Frequency Band Power Output into Load with VSWR = 1.25:1	. mW	.25–100	15 Min.
Power Output Variation	.dB/250 MHz		3 Max.
Tube VSWR Frequency Pulling Into 2:1 Load (Any Phase) Spurious Oscillation	.MHz	.1.5	2.5:1 Max.
Ratio of Signal to Noise Power 30 MHz Away Ratio of Signal to 2nd Harmonic Output	.dB/MHz	.95	85 Min.
Long-term Sensitivity to Heater Voltage	.MHz/V	.4 .0.6	
Sensitivity to Grid Voltage Tuning Curve Slope Low End (3.7 GHz)			
Mid-Frequency (6.0 GHz)	. MHz/V	.2.7	
Grid RF Cutoff Voltage	.V	.—7	
Capacitance; Grid to all other Electrodes, at Power Input Plug	-		
Capacitance; Helix to all other Electrodes Heater Voltage Heater Current	nF	100	150 Max
			Min./Max.
Cathode Current *	.mA	.250–2000	12 Max. 200–2100 Min./Max.
Helix Current	.mA	.1.5	3.Ó Max.
Anode Current	.mA	.0.5	2.0 Max.

*Set cathode current to Final Test Data value furnished with tube.

SE-211B-50

MECHANICAL CHARACTERISTICS

Height, 2.5 inches (64 mm) Width, 2.5 inches (64 mm) Length, 7.75 inches (197 mm) max. Weight, 6.5 lbs. (2.95 Kg) max.

Color Code for 18" Flying Leads Heater Black Heater Brown C

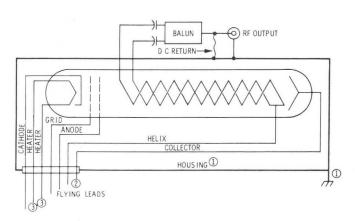
Cathode	Yellow
Grid	Green
Anode	Blue
Helix	Red
Collector	Orange

Mounting Position, Any RF Output Connector, Type N Female on Balun

ENVIRONMENTAL CHARACTERISTICS

Separation from Passive Magnetic Materials, 2 in. Min. No Forced Air Cooling Required Below +60°C Ambient

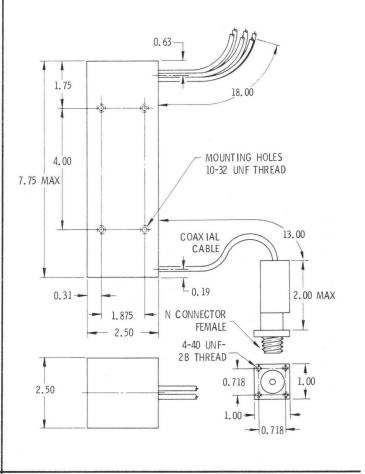
SCHEMATIC DIAGRAM



Notes:

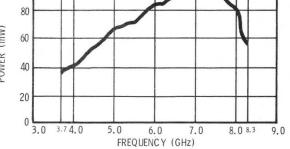
- (1) For safety, housing should be grounded through mounting screws.
- (2) 45-150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.
- (3) Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.

OUTLINE DRAWING

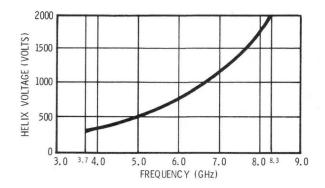




POWER OUTPUT



TUNING VOLTAGE

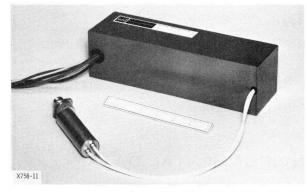


BACKWARD-WAVE OSCILLATOR

SE - 214

December 1967

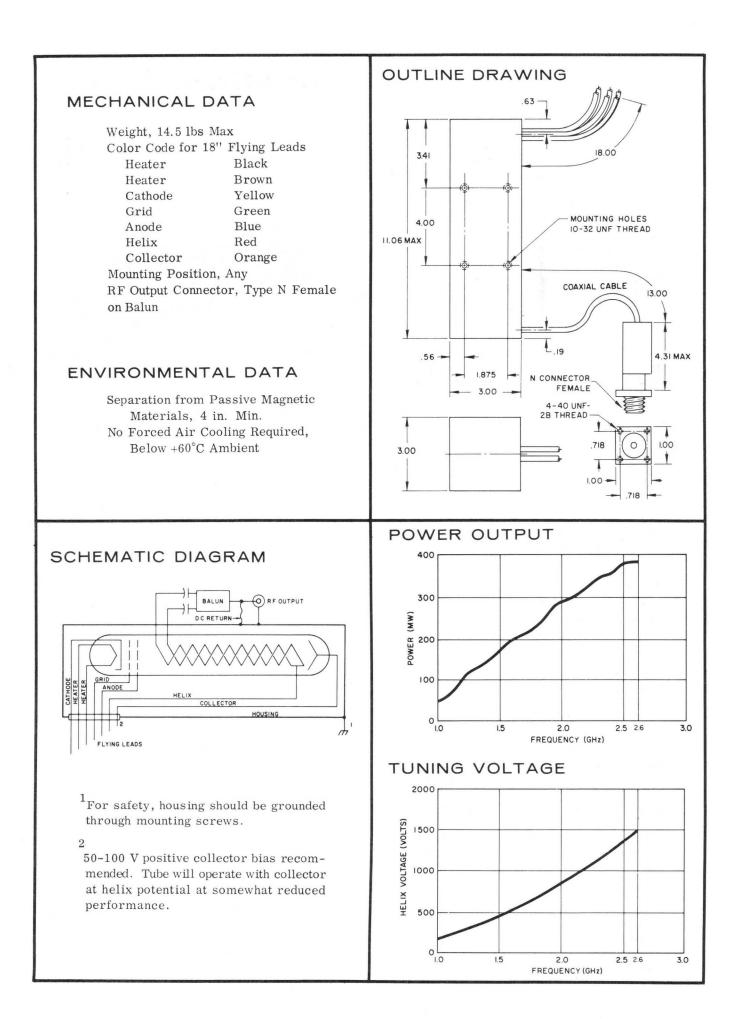
The type SE-214 BWO is a bifilar (dual helix), voltage tunable oscillator. This permanent-magnet focused wide band oscillator is well suited for use as a swept signal source in signal generators, particularly in view of its high stability. Other applications include ECM receivers (as local oscillator), frequency diversity transmitters (as master oscillator), and other electronic equipment. The SE-214 features smooth power over the band, low cathode current, and two control electrodes. The control grid makes possible power cutoff with low negative grid voltage. Power output can be modulated with either the grid or anode,



or both. Cathode modulation with the grid grounded usually reduces FM caused by AM. With all voltages isolated from both tube housing and the r.f. output terminal, packaging problems are simplified, since the tube housing and output connector can be grounded regardless of power supply configuration.

SPECIFICATIONS

	Units	Typical Values	Absolute Ratings
Nominal Frequency Band	GHz	1 - 2.6	
Power Output into Load VSWR = 1.25	mW	50-350	30 Min
Power Output Variation	db		11 Max
Fine Grain Variation	db/40 MHz		3 Max
Tube VSWR			2.5:1 Max
Frequency Pulling into 2:1 Load (Any Phase)	MHz	2	5 Max
Spurious Oscillation			
Ratio of Signal to 2nd Harmonic Output	db	40	20 Min
Ratio of Signal to Noise Power 30 MHz Away	db/MHz	95	85 Min
Long-term Sensitivity to Heater Voltage	MHz/V	5	10 Max
Sensitivity to Anode Voltage	MHz/V	0.2	0.5 Max
Sensitivity to Grid Voltage	MHz/V	5	10 Max
Tuning Curve Slope			
Low End (1.0 GHz)	MHz/V	3.8	
Mid-Frequency (1.8 GHz)	MHz/V	1.4	
High End (2.6 GHz)	MHz/V	0.56	
Grid r.f. Cutoff Voltage		-7	-20 Max
Capacitance; Cathode to all other Electrodes,			
including Heater	pf	15	25 Max
Capacitance; Grid to all other Electrodes at			
Power	\mathbf{pf}	20	25 Max
Capacitance; Helix to all other Electrodes	pf	370	400 Max
Heater Voltage	V		$6.3\pm5\%$
Heater Current	А	0.85	0.4 - 1.2
			Min/Max
Cathode Current	mA	11	17 Max
Helix Voltage Range	V	190-1500	170 - 1600
			Min/Max
Helix Current	mA	1.5	4 Max
Anode Voltage	V	95	215 Max
Anode Current	mA	1	1.5 Max



FEBRUARY 1971

BACKWARD-WAVE OSCILLATOR SE-214-50

The SE-214-50 BWO is a bifilar (dual-helix), voltage tunable oscillator. This permanent-magnet focused wide band oscillator is well suited for use as a swept signal source in signal generators, particularly in view of its high stability.

Other applications include ECM receivers (as local oscillator), frequency diversity transmitters (as master oscillator), and other electronic equipment.

The SE-214-50 features smooth power over the band, low cathode current, and two control electrodes. The control grid makes possible power cutoff with low negative grid voltage. Power output can be modulated with either the grid or anode, or both. Cathode modulation with the grid grounded usually reduces FM caused by AM. Packaging problems are simplified, since all voltages are isolated from both tube housing and the RF output terminal. The tube housing and output connector can be grounded regardless of power supply configuration.

	UNITS	TYPICAL ABSOLUT VALUES RATINGS	_
Nominal Frequency Band Power Output into Load with VSWR = 1.25:1 Power Output Variation Fine Grain Variation Tube VSWR Frequency Fulling Into 2:1 Load (Any Phase)	mW dB dB/50 MHz	50—350 25 Mir 11 Max 3 Max 2.5:1 Max	<. <. <.
Spurious Oscillation Ratio of Signal to Noise Power 30 MHz Away Ratio of Signal to 2nd Harmonic Output Long-term Sensitivity to Heater Voltage Sensitivity to Anode Voltage Sensitivity to Grid Voltage Tuning Curve Slope	dB MHz/V	40 20 Mir 5 0.2	I. 1.
Low End (1.0 GHz) Mid-Frequency (1.8 GHz) High End (2.6 GHz) Grid RF Cutoff Voltage Capacitance; Cathode to all other Electrodes, including Heater	MHz/V MHz/V V	1.4 0.56 —7 —25 Max	
Capacitance; Grid to all other Electrodes, at Power Input Plug Capacitance; Helix to all other Electrodes Heater Voltage Heater Current Cathode Current* Helix Voltage Range	pF pF Vdc A mA V	20	x. x. % x. x.
Helix Current Anode Voltage Anode Current	. V	. 1.5	x. x.

*Set cathode current to final test data value furnished with tube.



SE-214-50

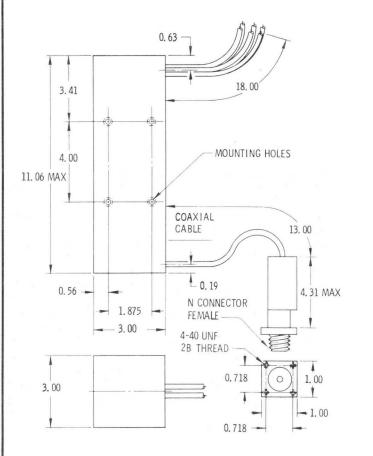
MECHANICAL CHARACTERISTICS

Height, 3 inches (76 mm) Width, 3 inches (76 mm) Length, 11 inches (279 mm) max. Weight, 14.5 lbs. (6.58 Kg) max. Color Code for 18" Flying Leads Heater Black Heater Brown Cathode Yellow Grid Green Anode Blue Helix Red Collector Orange Mounting Position, Any RF Output Connector, Type N Female on Balun

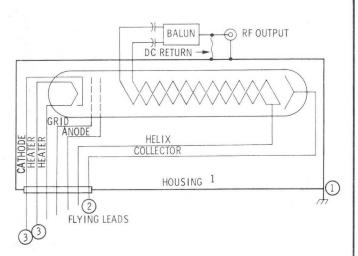
ENVIRONMENTAL CHARACTERISTICS

Separation from Passive Magnetic Materials, 4 in. Min. No Forced Air Cooling Required Below +60°C Ambient.

OUTLINE DRAWING



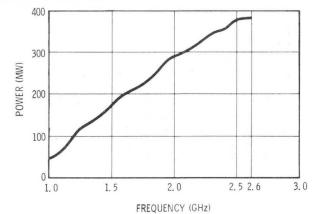
SCHEMATIC DIAGRAM

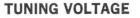


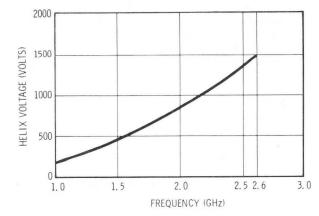
Notes:

- 1. For safety, housing should be grounded through mounting screws.
- 2. 45–150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.
- Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.









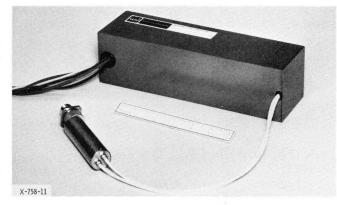
BACKWARD-WAVE OSCILLATOR

TECHNICAL DATA

September 1968 *

SE-214A

The type SE-214A BWO is a bifilar (dual helix), voltage tunable oscillator. This permanent-magnet focused wide band oscillator is well suited for use as a swept signal source in signal generators, particularly in view of its high stability. Other applications include ECM receivers (as local oscillator), frequency diversity transmitters (as master oscillator), and other electronic equipment. The SE-214A features smooth power over the band, low cathode current, and two control electrodes. The control grid makes possible power cutoff with low negative grid voltage. Power output can be modulated with either the grid or anode, or both.

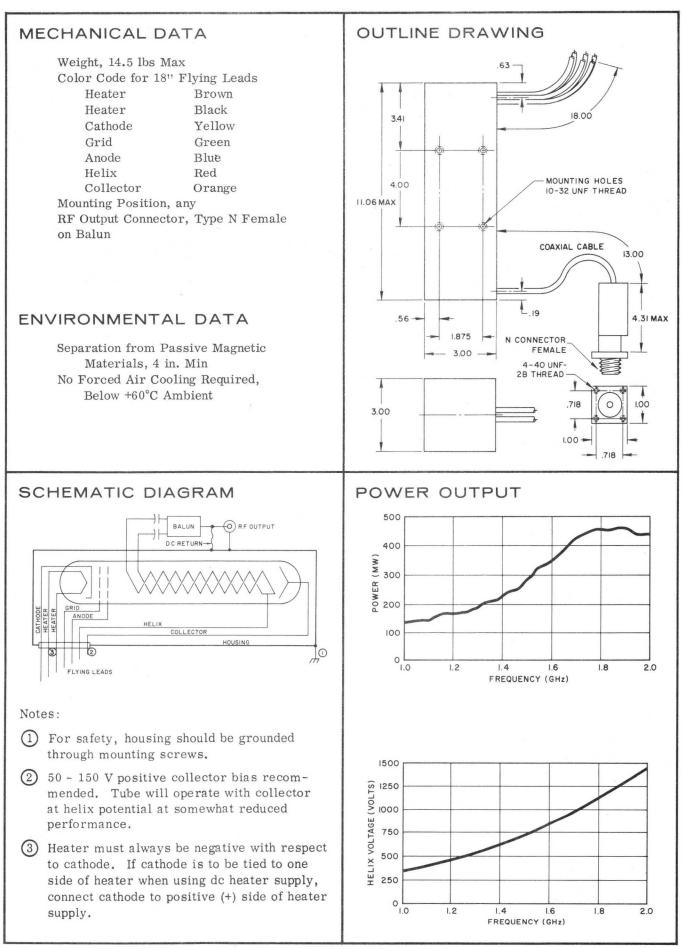


Cathode modulation with the grid grounded usually reduces FM caused by AM. With all voltages isolated from both tube housing and the r.f. output terminal, packaging problems are simplified, since the tube housing and output connector can be grounded regardless of power supply configuration.

ELECTRICAL CHARACTERISTICS, CW

	Units	Typical Values	Absolute Ratings
Nominal Frequency Band	GHz	1-2.0	
Power Output into Load VSWR = 1.25	mW	110-450	100 Min
Power Output Variation	db		8 Max
Fine Grain Variation	db/50MHz		3 Max
Tube VSWR			2.5:1 Max
Frequency Pulling into 2:1 Load (Any Phase)	MHz	2	5 Max
Spurious Oscillation			
Ratio of Signal to 2nd Harmonic Output	db	35	25 Min
Ratio of Signal to Noise Power 30 MHz Away	db/MHz	95	85 Min
Long-term Sensitivity to Heater Voltage	MHz/V	4	8 Max
Sensitivity to Anode Voltage	MHz/V	0.3	0.7 Max
Sensitivity to Grid Voltage	MHz/V	1.5	5 Max
Tuning Curve Slope			
Low End (1.0 GHz)	MHz/V	1.4	
Mid-Frequency (1.5 GHz)	MHz/V	.9	
High End (2.0 GHz)	MHz/V	.7	
Grid r.f. Cutoff Voltage	V	-7	-20 Max
Capacitance; Cathode to all other Electrodes,			
including Heater	pf	15	25 Max
Capacitance; Grid to all other Electrodes, at	-		
Power Input Plug	\mathbf{pf}	20	25 Max
Capacitance; Helix to all other Electrodes	pf	370	400 Max.
Heater Voltage	V		6.3±5%
Heater Current	А	0.72	1.2 Max
Cathode Current	mA	12	17 Max
Helix Voltage Range	V	335-1450	310-1485
0			Min/Max
Helix Current	mA	2	4.0 Max
Anode Voltage	v	100	215 Max
Anode Current	mA	0.8	1.5 Max
	Charle Dated Castantan	10/5	

* Supersedes SE-214 A Technical Data Sheet Dated September 1965



WATKINS = JOHNSON COMPANY 3333 HILLVIEW AVENUE = STANFORD INDUSTRIAL PARK PALO ALTO, CALIFORNIA 94304 TWX 910-373-1253 PHONE (415) 326-8830 Telex: 348-415

DECEMBER 1970

BACKWARD-WAVE OSCILLATOR SE-214A-50

The SE-214A-50 BWO is a bifilar (dual-helix), voltage tunable oscillator. This permanent-magnet focused wide band oscillator is well suited for use as a swept signal source in signal generators, particularly in view of its high stability.

Other applications include ECM receivers (as local oscillator), frequency diversity transmitters (as master oscillator), and other electronic equipment.

The SE-214A-50 features smooth power over the band, low cathode current, and two control electrodes. The control grid makes possible power cutoff with low negative grid voltage. Power output can be modulated with either the grid or anode, or both. Cathode modulation with the grid grounded usually reduces FM caused by AM. Packaging problems are simplified, since all voltages are isolated from both tube housing and the RF output terminal. The tube housing and output connector can be grounded regardless of power supply configuration.

SPECIFICATIONS

	UNITS	TYPICAL VALUES	ABSOLUTE RATINGS
Nominal Frequency Band	GHz	1-2.0	
Power Output into Load with VSWR = 1.25:1 Power Output Variation Fine Grain Variation Tube VSWR Frequency Pulling Into 2:1 Load (Any Phase)	mW dB dB / 50 MHz	110–450	
Spurious Oscillation Ratio of Signal to Noise Power 30 MHz Away Ratio of Signal to 2nd Harmonic Output	dB	35	85 Min.
Long-term Sensitivity to Heater Voltage Sensitivity to Anode Voltage Sensitivity to Grid Voltage	MHz/V	0.3	
Tuning Curve Slope Low End (1.0 GHz) Mid-Frequency (1.5 GHz)	MHz/V		
High End (2.0 GHz) Grid RF Cutoff Voltage Capacitance; Cathode to all other Electrodes,	V		
including Heater	pF		
Capacitance; Grid to all other Electrodes, at Power Input Plug Capacitance; Helix to all other Electrodes			35 Max. 400 Max.
Heater Voltage Heater Current Cathode Current * Helix Voltage Range	A	0.85 12	0.4-1.2 Max.
Helix Voltage Range Helix Current Anode Voltage	mA	2	Min./Max. 4.0 Max.
Anode Current	mA	0.8	1.5 Max.

*Set cathode current to Final Test Data value furnished with tube.

SE-214A-50

MECHANICAL CHARACTERISTICS

Height, 3 inches (76 mm) Width, 3 inches (76 mm) Length, 11 inches (279 mm) max. Weight, 14.5 lbs. (6.58 Kg) max.

Color Code for 18" Flying Leads Heater Black

HeaterBrownCathodeYellowGridGreenAnodeBlueHelixRedCollectorOrange

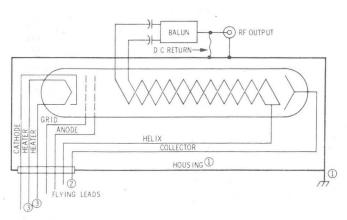
Mounting Position, Any

RF Output Connector, Type N Female on Balun

ENVIRONMENTAL CHARACTERISTICS

Separation from Passive Magnetic Materials, 4 in. Min. No Forced Air Cooling Required Below +60°C Ambient

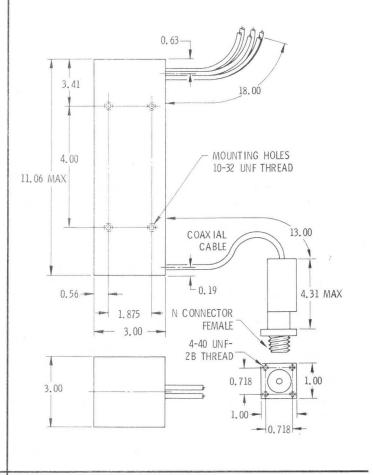
SCHEMATIC DIAGRAM

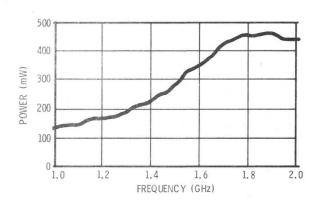


Notes:

- (1) For safety, housing should be grounded through mounting screws.
- (2) 45–150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.
- (3.) Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.

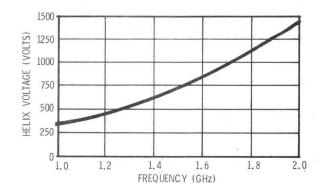
OUTLINE DRAWING





TUNING VOLTAGE

POWER OUTPUT



SE-215

BACKWARD-WAVE OSCILLATOR

September 1968 *

Absolute

The type SE-215 BWO is a bifilar (dual helix), voltage tunable oscillator. This permanent-magnet focused wide band oscillator is well suited for use as a swept signal source in signal generators, particularly in view of its high stability. Other applications include radar receivers (as local oscillator), frequency diversity transmitters (as master oscillator), and ECM equipment. The SE-215 features smooth power over the band, low cathode current, and two control electrodes. The control grid makes possible power cutoff with low negative grid voltage. Power output can be modulated with either the grid or anode, or both. Cathode



Typical

modulation with the grid grounded usually reduces FM caused by AM. With all voltages isolated from both tube housing and the r.f. output terminal, packaging problems are simplified, since the tube housing and output connector can be grounded regardless of power supply configuration.

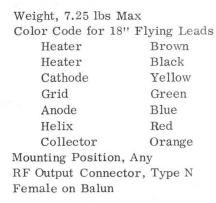
Units

ELECTRICAL CHARICTERISTICS, CW

	Onits	Values	Ratings
Nominal Frequency Band	GHz	1.7-4.2	
Power Output into a Load with $VSWR = 1.25$	mW	40-300	30 Min
Power Output Variation	db		9 Max
Fine Grain Variation	db/250 MHz		3 Max
Tube VSWR			2.5:1 Max
Frequency Pulling into 2:1 Load (Any Phase)	MHz	2	5 Max
Spurious Oscillation			
Ratio of Signal to 2nd Harmonic Output	db	30	20 Min
Ratio of Signal to Noise Power 30 MHz Away	db/MHz	95	85 Min
Long-term Sensitivity to Heater Voltage	MHz/V	2	8 Max
Sensitivity to Anode Voltage	MHz/V	0.25	1 Max
Sensitivity to Grid Voltage	MHz/V	3	6 Max
Tuning Curve Slope			
Low End (1.7 GHz)	MHz/V	2.7	
Mid-Frequency (2.95 GHz)	MHz/V	1.4	
High End (4.2 GHz)	MHz/V	.75	
Grid r.f. Cutoff Voltage	V	-8	-20 Max
Capacitance; Cathode to all other Electrodes,			
including Heater	\mathbf{pf}	18	25 Max
Capacitance; Grid to all other Electrodes at			
Power Input Plug	pf	18	25 Max
Capacitance; Helix to all other Electrodes	\mathbf{pf}	250	300 Max
Heater Voltage	V		$6.3 \pm 5\%$
Heater Current	А	0.72	0.6 - 1.2
			Min/Max
Cathode Current	mA	8	15 Max
Helix Voltage	V	235-2030	200-2150
			Min/Max
Helix Current	mA	2	4 Max
Anode Voltage	V	130	220 Max
Anode Current	mA	0.6	1.5 Max
# Suppresides SE 215 Technical Date	Chaot Dated Contombor 10	CE	

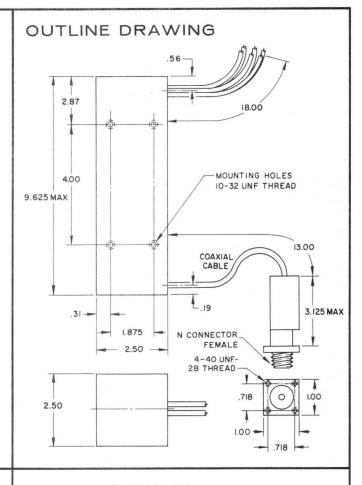
* Supersedes SE-215 Technical Data Sheet Dated September 1965



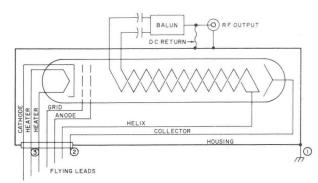


ENVIRONMENTAL DATA

Separation from Passive Magnetic Materials, 4 in. Min No Forced Air Cooling Required, Below +60°C Ambient

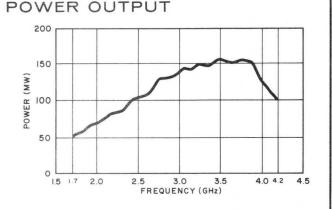


SCHEMATIC DIAGRAM

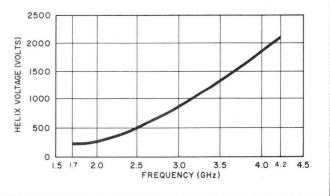


Notes:

- (1) For safety, housing should be grounded through mounting screws.
- 2 50 150 V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.
- (3) Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.



TUNING VOLTAGE



WATKINS = JOHNSON COMPANY 3333 HILLVIEW AVENUE = STANFORD INDUSTRIAL PARK PALO ALTO, CALIFORNIA 94304 TWX 910-373-1253 PHONE (415) 326-8830 Telex: 348-415

The SE-215-50 BWO is a bifilar (dual-helix), voltage tunable oscillator. This permanent-magnet focused wide band oscillator is well suited for use as a swept signal source in signal generators, particularly in view of its high stability.

Other applications include radar receivers (as local oscillator), frequency diversity transmitters (as master oscillator), and ECM equipment.

The SE-215-50 features smooth power over the band, low cathode current, and two control electrodes. The control grid makes possible power cutoff with low negative grid voltage. Power output can be modulated with either the grid or anode, or both. Cathode modulation with the grid grounded usually reduces FM caused by AM. Packaging problems are simplified, since all voltages are isolated from both tube housing and the RF output terminal. The tube housing and output connector can be grounded regardless of power supply configuration.

DECEMBER 1970 BACKWARD-WAVE OSCILLATOR SE-215-50



SPECIFICATIONS

	UNITS	TYPICAL VALUES	ABSOLUTE RATINGS
Frequency Band	GHz		1.7-4.2
Power Output into Load with VSWR = 1.25:1			40 Min.
Power Output Variation	dB		9 Max.
Fine Grain Variation	dB/100 MHz		3 Max.
Tube VSWR			. 2.5:1 Max.
Tube VSWR Frequency Pulling Into 2:1 Load (Any Phase)	MHz	2	5 Max.
Spurious Oscillation			
Ratio of Signal to Noise Power 30 MHz Away	dB/MHz B.W	95	85 Min.
Ratio of Signal to 2nd Harmonic Output			20 Min.
Long-term Sensitivity to Heater Voltage			
Sensitivity to Anode Voltage			
Sensitivity to Grid Voltage	MHz/V	3	
Tuning Curve Slope	A	~ =	
Low End (1.7 GHz)	MHz/V	2.7	
Mid-Frequency (3.0 GHz)	MHZ/V	1.4	
High End (4.2 GHz)	· · IVIHZ/V · · · · · · · · · · · · · · · · · · ·	/5	OF Man
Capacitance; Cathode to all other Electrodes,	· · V · · · · · · · · · · · · · · · · ·		25 Wax.
including Heater and Housing	nF	18	25 Max
Capacitance; Grid to all other Electrodes,	· .pr	10	
including Housing	рF	18	35 Max
Capacitance: Helix and Collector to all other			
Electrodes including Housing	рF	250	300 Max.
Heater Voltage			$6.3 \pm 5\%$
Heater Current	A	0.9	0.4-1.2
			Min /Max
Cathode Current *	mA	8	15 Max.
Helix Voltage Range	V	235–2030	. 200–2150
			Min./Max.
Helix Current		2	4 Max.
Anode Voltage	V	130	215 Max.
Anode Current	mA	0.6	1.5 Max.
* Set cathode current to Final Test Data value furnished with tube			

SE-215-50

OUTLINE DRAWING

MECHANICAL CHARACTERISTICS

Height, 2.5 inches (64 mm) Width, 2.5 inches (64 mm) Length, 9.6 inches (244 mm) max. Weight, 7.25 lbs. (3.29 Kg) max.

Color Code for 18" Flying Leads

Heater	Black
Heater	Brown
Cathode	Yellow
Grid	Green
Anode	Blue
Helix	Red
Collector	Orange

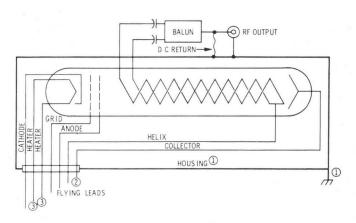
Mounting Position, Any

RF Output Connector, Type N Female on Balun

ENVIRONMENTAL CHARACTERISTICS

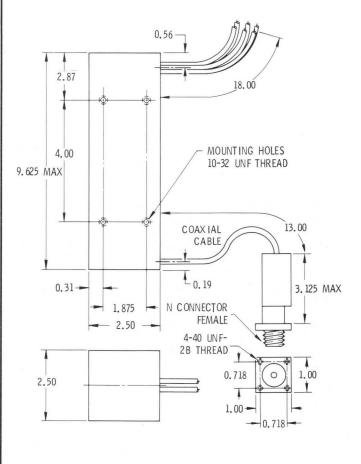
Separation from Passive Magnetic Materials, 4 in. Min. No Forced Air Cooling Required Below +60°C Ambient

SCHEMATIC DIAGRAM

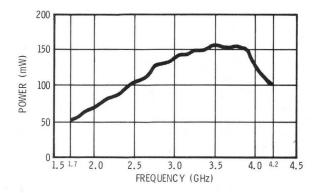


Notes:

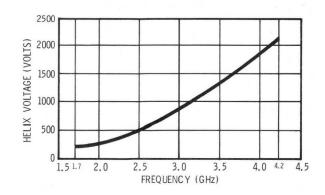
- 1. For safety, housing should be grounded through mounting screws.
- 2. 45–150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.
- Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.



POWER OUTPUT



TUNING VOLTAGE

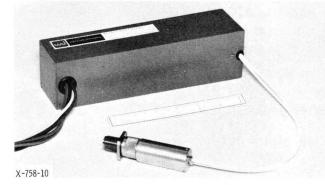


BACKWARD-WAVE OSCILLATOR

SE-215A

September 1968*

The type SE-215A BWO is a bifilar (dual helix), voltage tunable oscillator. This permanent-magnet focused wide band oscillator is well suited for use as a swept signal source in signal generators, particularly in view of its high stability. Other applications include radar receivers (as local oscillator), and ECM equipment. The SE-215A features smooth power over the band, low cathode current, and two control electrodes. The control grid makes possible power cutoff with low negative grid voltage. Power output can be modulated with either the grid or anode, or both. Cathode modulation with the



grid grounded usually reduces FM caused by AM. With all voltages isolated from both tube housing and the r.f. output terminal, packaging problems are simplified, since the tube housing and output connector can be grounded regardless of power supply configuration.

ELECTRICAL CHARACTERISTICS, CW

LECTRICAL CHARACTERISTICS, CV			
	Units	Typical	Absolute
		Values	Ratings
Newinal Engeneers Dand		0.4	
Nominal Frequency Band	GHz	2-4	
Power Output into a Load with VSWR = 1.25	mW	100-300	75 Min
Power Output Variation	db		6 Max
Fine Grain Variation	db/250 MHz		3 Max
Tube VSWR			2.5:1 Max
Frequency Pulling into 2:1 Load (Any Phase)	MHz	2	5 Max
Spurious Oscillation			
Ratio of Signal to 2nd Harmonic Output	db	30	25 Min
Ratio of Signal to Noise Power 30 MHz Away	db/MHz	95	85 Min
Long-term Sensitivity to Heater Voltage	MHz/V	2	8 Max
Sensitivity to Anode Voltage	MHz/V	0.25	1 Max
Sensitivity to Grid Voltage	MHz/V	3	6 Max
Tuning Curve Slope			
Low End (2.0 GHz)	MHz/V	2.5	
Mid-Frequency (3.0 GHz)	MHz/V	1.4	
High End (4.0 GHz)	MHz/V	.85	
Grid r.f. Cutoff Voltage	V V	-8	-20 Max
		0	
Capacitance; Cathode to all other Electrodes,	c	10	05.35
including Heater	pf	18	25 Max
Capacitance; Grid to all other Electrodes at			
Power Input Plug	pf	18	25 Max
Capacitance; Helix to all other Electrodes	\mathbf{pf}	250	300 Max
Heater	V		$6.3\pm5\%$
Heater Current	A	0.72	0.4 - 1.2
			Min/Max
Cathode Current	mA	8	15 Max
Helix Voltage Range	V	330-1800	300-2000
			Min/Max
Helix Current	mA		3.0 Max
Anode Voltage	V	130	215 Max
Anode Current	mA	0.6	1.5 Max
			210 1.1411

* Supersedes SE-215A Technical Data Sheet Dated September 1965

MECHANICAL DATA

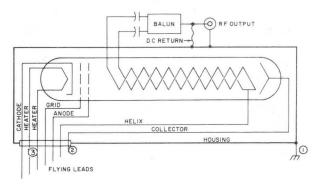
Weight, 7.25 lbs Max Color Code for 18" Flying Leads Heater Brown Heater Black Cathode Yellow Grid Green Anode Blue Helix Red Collector Orange

Mounting Position, Any RF Output Connector, Type N Female on Balun

ENVIRONMENTAL DATA

Separation from Passive Magnetic Materials, 4 in. Min No Forced Air Cooling Required, Below +60°C Ambient

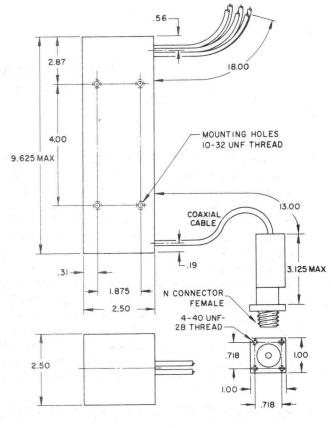
SCHEMATIC DIAGRAM



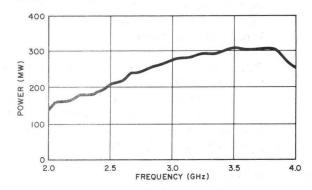
Notes:

- (1) For safety, housing should be grounded through mounting screws.
- 2 50 150 V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.
- (3) Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.

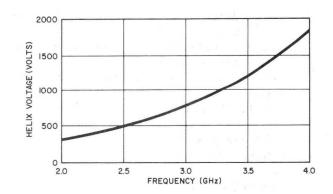
OUTLINE DRAWING



POWER OUTPUT



TUNING VOLTAGE



WATKINS = JOHNSON COMPANY 3333 HILLVIEW AVENUE = STANFORD INDUSTRIAL PARK PALO ALTO, CALIFORNIA 94304 TWX 910-373-1253 PHONE (415) 326-8830 Telex: 348-415

DECEMBER 1970

BACKWARD-WAVE OSCILLATOR SE-215A-50



SPECIFICATIONS

	UNITS	TYPICAL VALUES	ABSOLUTE RATINGS
Frequency Band	GHz		
Power Output into Load with VSWR = 1.25 :1	mW	100-300	80 Min.
Power Output Variation	dB		7 Max.
Fine Grain Variation		• • • • • • • • • • • • • • • • • • • •	2 5.1 Max
Frequency Pulling Into 2:1 Load (Any Phase)		2	5 Max.
Spurious Oscillation			
Ratio of Signal to Noise Power 30 MHz Away	dB/MHz	95	85 Min.
Ratio of Signal to 2nd Harmonic Output	dB		20 Min.
Long-term Sensitivity to Heater Voltage Sensitivity to Anode Voltage			
Sensitivity to Grid Voltage		3	
Tuning Curve Slope			
Low End (2.0 GHz)			
Mid-Frequency (3.0 GHz)			
High End (4.0 GHz)	V	8	-25 Max
Capacitance: Cathode to all other Electrodes.			
including Heater	pF	18	3 5 Max.
Capacitance; Grid to all other Electrodes,	- F	10	OF M
at Power Input Plug Capacitance; Helix to all other Electrodes	pr	250	35 Max.
Heater Voltage	Vdc		$6.3 \pm 5\%$
Heater Voltage	A	0.72	0.4-1.2
			Min /Max
Cathode Current *		8	15 Max.
Helix voltage Range	V		. 300–2000 Min./Max.
Helix Current		0.5	3.0 Max.
Anode Voltage	V		215 Max.
Anode Current	mA	0.6	1.5 Max.

*Set cathode current to Final Test Data value furnished with tube.

The SE-215A-50 BWO is a bifilar (dual-helix), voltage tunable oscillator. This permanent-magnet focused wide band oscillator is well suited for use as a swept signal source in signal generators, particularly in view

Other applications include radar receivers (as local oscillator), frequency diversity transmitters (as master oscillator), and ECM equipment. The SE-215A-50 features smooth power over the band, low cathode current, and two control electrodes. The control grid makes possible power cutoff with low negative grid voltage. Power output can be modulated with either the grid or anode, or both. Cathode modulation with the grid grounded usually reduces FM caused by AM. Packaging problems are simplified, since all voltages are isolated from both tube housing and the RF output terminal. The tube housing and output connector can be grounded regardless of power

of its high stability.

supply configuration.

SE-215A-50

MECHANICAL CHARACTERISTICS

Height, 2.5 inches (64 mm) Width, 2.5 inches (64 mm) Length, 9.6 inches (244 mm) max. Weight, 7.25 lbs. (3.29 Kg) max.

Color Code for 18"	Flying Leads
Heater	Black
Heater	Brown
Cathode	Yellow
Grid	Green
Anode	Blue
Helix	Red
Collector	Orange

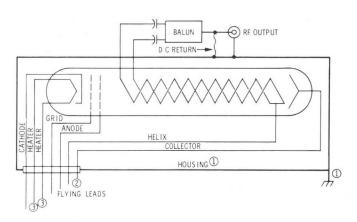
Mounting Position, Any

RF Output Connector, Type N Female on Balun

ENVIRONMENTAL CHARACTERISTICS

Separation from Passive Magnetic Materials, 4 in. Min. No Forced Air Cooling Required Below +60°C Ambient

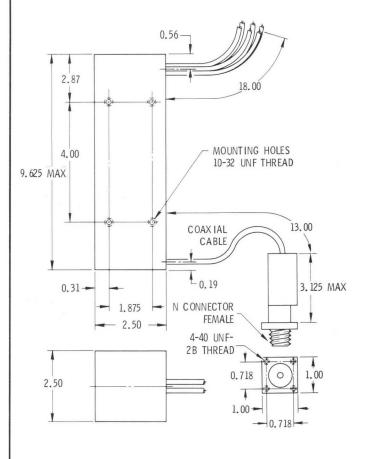
SCHEMATIC DIAGRAM

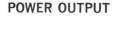


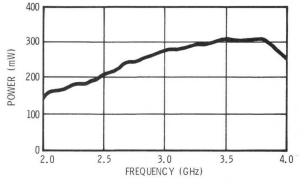
Notes:

- (1.) For safety, housing should be grounded through mounting screws.
- (2.) 45–150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.
- (3.) Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.

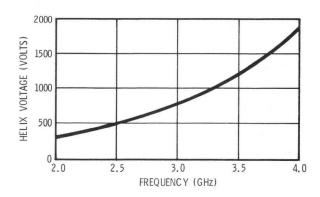
OUTLINE DRAWING







TUNING VOLTAGE



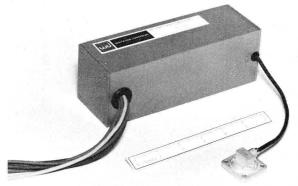
BACKWARD-WAVE

OSCILLATOR

SE-216

TECHNICAL DATA • September 1965

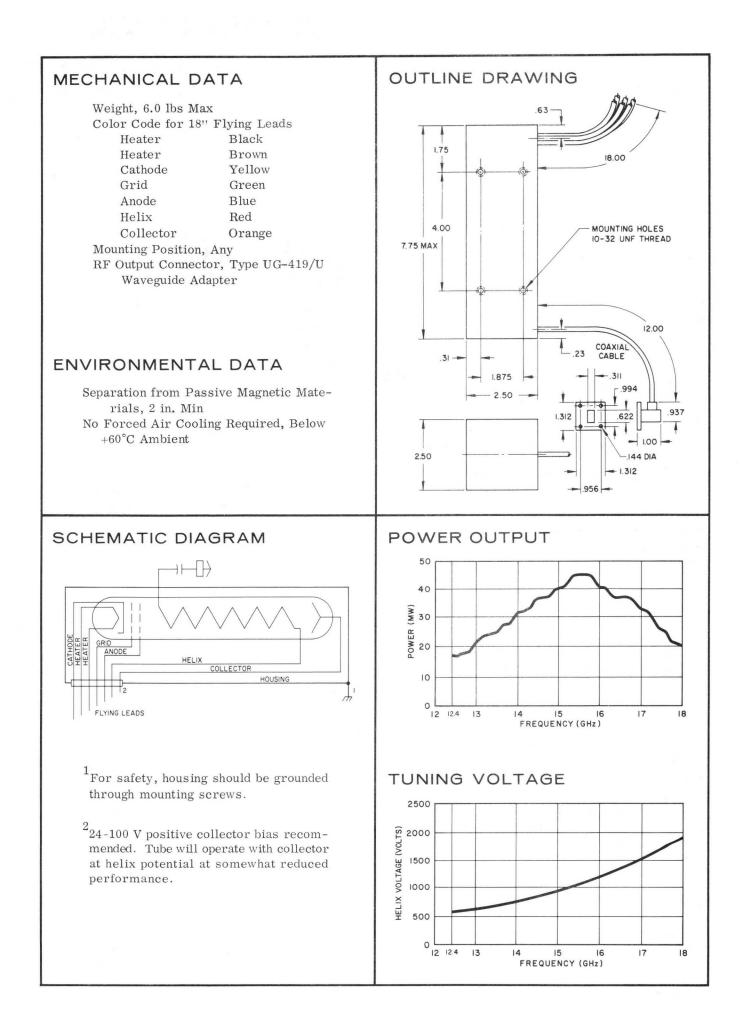
The type SE-216 BWO is a single-helix, voltage tunable oscillator. This permanent-magnet-focused wide band oscillator is well suited for use as a swept signal source in signal generators, particularly in view of its high stability. Other applications include ECM receivers (as local oscillator), frequency diversity transmitters (as master oscillator), and other electronic equipment. The SE-216 features smooth power over the band, low cathode current, and two control electrodes. The control grid makes possible power cutoff with low negative grid voltage. Power output can be modulated with either the grid or anode,



or both. Cathode modulation with the grid grounded usually reduces FM caused by AM. With all voltages isolated from both tube housing and the r.f. output terminal, packaging problems are simplified, since the tube housing and output connector can be grounded regardless of power supply configuration.

CW		
Units	Typical Values	Absolute Ratings
GHz	12 4-18	
mW		10 Min
db		6 Max
db/250 MHz		3 Max
,		3:1 Max
MHz	1	2 Max
db	48	40 Min
db/MHz	95	85 Min
MHz/V	5	10 Max
MHz/V	0.5	1.5 Max
MHz/V	3	6 Max
MHz/V	8.7	
MHz/V	4.4	
MHz/V	2.2	
V	-15	-20 Max
pf	25	40 Max
pf	25	40 Max
pf	100	125 Max
V		6.3±5%
А	0.9	0.6-1.2
		Min/Max
		12 Max
V	530-1900	500-2000
	2	Min/Max
		3 Max
-		215 Max
mA	1	2 Max
	GHz mW db db/250 MHz MHz db db/MHz MHz/V MHz/V MHz/V MHz/V MHz/V V pf pf pf V	Units Typical Values GHz 12.4-18 mW 15-70 db db/250 MHz MHz 1 db 48 db/MHz 95 MHz/V 5 MHz/V 3 MHz/V 3 MHz/V 2.2 V -15 pf 25 pf 25 pf 25 pf 25 pf 0.9 mA 7 V 530-1900 mA 2 V 160

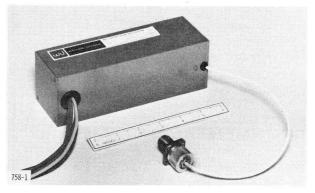
ELECTRICAL CHARACTERISTICS, CW



BACKWARD-WAVE OSCILLATOR SE-217

September 1965

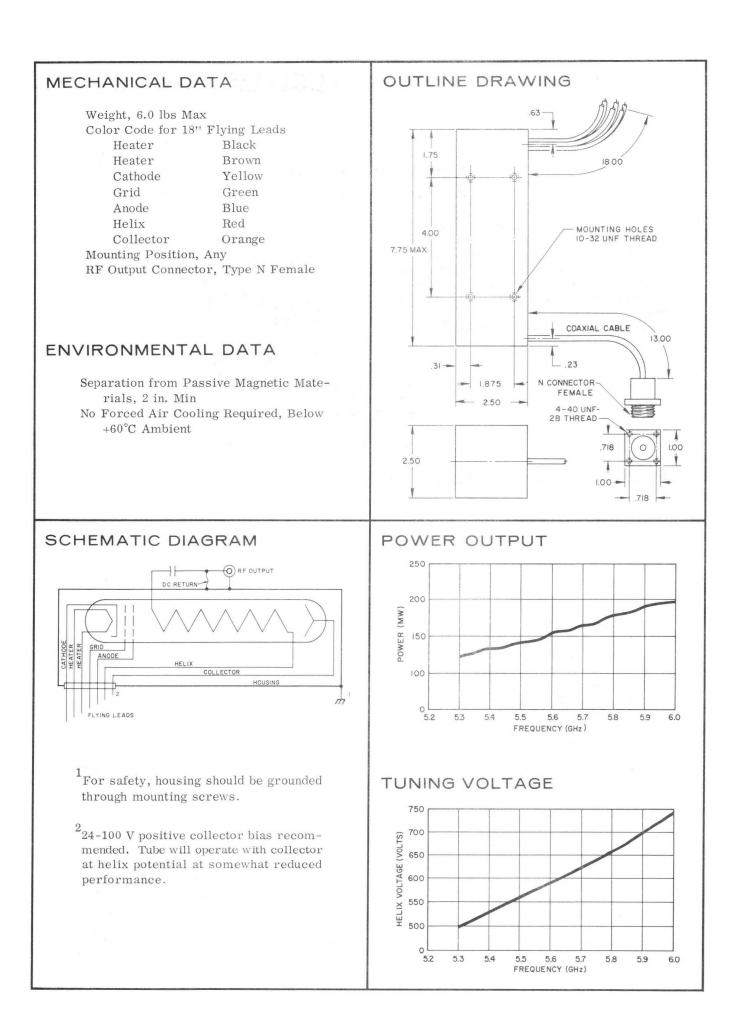
The type SE-217 BWO is a single-helix, voltage tunable oscillator. This permanent-magnet focused wide band oscillator is well suited for use as a swept signal source in signal generators, particularly in view of its high stability. Other applications include ECM receivers (as local oscillator), frequency diversity transmitters (as master oscillator), and other electronic equipment. The SE-217 features smooth power over the band, low cathode current, and two control electrodes. The control grid makes possible power cutoff with low negative grid voltage. Power output can be modulated with either the grid or anode,



or both. Cathode modulation with the grid grounded usually reduces FM caused by AM. With all voltages isolated from both tube housing and the r.f. output terminal, packaging problems are simplified, since the tube housing and output connector can be grounded regardless of power supply configuration.

ELECTRICAL CHARACTERISTICS, CW

	Units	Typical	Absolute
		Values	Ratings
Nominal Frequency Band	GHz	5.3-6.0	
Power Output into Load with VSWR = 1.25	mW	120-160	100 Min
Power Output Variation	db		3 Max
Fine Grain Variation	db/100 MHz		1.5 Max
Tube VSWR			2:1 Max
Frequency Pulling into 2:1 Load (Any Phase)	MHz	2	5 Max
Spurious Oscillation			
Ratio of Signal to Total Spurious Output	db	52	40 Min
Ratio of Signal to Noise Power 30 MHz Away	db/MHz	95	85 Min
Long-term Sensitivity to Heater Voltage	MHz/V	1.5	2 Max
Sensitivity to Anode Voltage	MHz/V	0.5	1 Max
Sensitivity to Grid Voltage	MHz/V	2.5	5 Max
Tuning Curve Slope			
Low End (5.3 GHz)	MHz/V	3.3	
Mid-Frequency (5.65 GHz)	MHz/V	2.8	
High End (6.0 GHz)	MHz/V	2.3	
Grid r.f. Cutoff Voltage	V	-10	-20 Max
Capacitance; Cathode to all other Electrodes,			
including Heater	\mathbf{pf}	18	25 Max
Capacitance; Grid to all other Electrodes, at			
Power Input Connector	pf	12	20 Max
Capacitance; Helix to all other Electrodes and		Δ.	
Housing	pf	135	160 Max
Heater Voltage	V		$6.3 \pm 5\%$
Heater Current	А	1.0	1.2 Max
Cathode Current	mA	14	20 Max
Helix Voltage Range	V	480 - 740	440-800
			Min/Max
Helix Current	mA	5	8 Max
Anode Voltage	V	100	215 Max
Anode Current	mA	0.7	2.0 Max



MAY 1969*

BACKWARD-WAVE OSCILLATOR SE-218

The SE-218 is a single-helix, voltage tunable oscillator utilizing a permanent magnet focusing system. This wide-band oscillator is well suited for use as a swept signal source in highly stable signal generators. Other applications include local oscillators in frequency diversity transmitters and in electronic test sets. The SE-218 delivers smooth power output over the band with low operating cathode current. Power output can be modulated with either the grid or the anode circuits. All voltages are isolated from the tube housing for easy packaging.



SPECIFICATIONS

JE LOIFIC/			
	UNITS	TYPICAL VALUES	ABSOLUTE RATINGS
Nominal Frequency Band Power Output into Load with VSWR = 1.25:1 Power Output Variation Fine Grain Variation Tube VSWR Frequency Pulling into 2:1 Load (Any Phase) Spurious Oscillation	.mW .dB .dB/250 MHz	25-50	20 Min. 6 Max. 3 Max. 2.5:1 Max.
Ratio of Signal to Total Spurious Output Ratio of Signal to Noise Power 30 MHz Away Sensitivity to Heater Voltage Sensitivity to Anode Voltage Sensitivity to Grid Voltage Tuning Curve Slope	.dB/MHz .MHz/V .MHz/V	95 35 1.0	40 Min. 85 Min.
Low End (18 MHz) Mid-Frequency (22.5 MHz) High End (26.5 MHz) Grid RF Cutoff Voltage	.MHz/V	7 3.5	. —20 Max.
Capacitance; Cathode to all other Electrodes including Heater and Housing Capacitance; Grid to all other Electrodes			
and Housing			
Electrodes and Housing Heater Voltage Heater Current	.V	. 0.67	6.3±5% 0.4-1.2
Cathode Current ¹ Helix Voltage Range Helix Current Anode Voltage Anode Current	. V	530-1800 1.5 180	. 450-2000 . 2.5 Max. . 250 Max.

¹Set cathode current to Final Test Data value furnished with tube. *Supersedes SE-218 Technical Data Sheet dated September 1965.

SE-218 MECHANICAL CHARACTERISTICS

Height, 2.5 inches (64 mm) Width, 2.5 inches (64 mm) Length, 5.25 inches (133 mm) Weight, 4 lbs. (1.81 Kg) Max. Color Code for 18" Flying Leads Black Heater Heater Brown Cathode Yellow Green Grid Blue Anode Red Helix Collector Orange

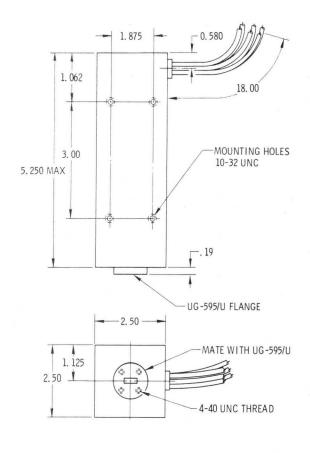
Mounting Position, Any RF Output Connector, UG-595/U Flange

ENVIRONMENTAL CHARACTERISTICS

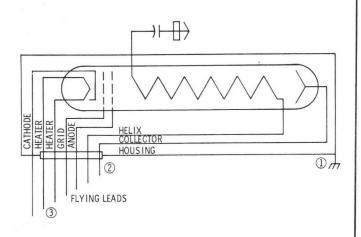
Separation from Passive Magnetic Materials, 2 in. Min.

No Forced Air Cooling Required Below +60°C Ambient

OUTLINE DRAWING



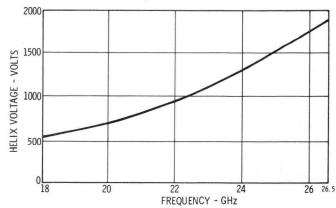
SCHEMATIC DIAGRAM





POWER OUTPUT

60



FREQUENCY - GHz

Notes:

- For safety, housing should be grounded through mounting screws.
- (2) 50-150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.
- (3) Heater must never be positive with respect to cathode.

26 26.5

JANUARY 1971

BACKWARD-WAVE OSCILLATOR SE-218-50



The type SE-218-50 is a single helix, voltage tunable oscillator utilizing a permanent magnet focusing system. This wide-band oscillator is well suited for use as a swept signal source in highly stable signal generators. Other applications include local oscillators in frequency diversity transmitters and in electronic test sets. The SE-218-50 delivers smooth power output over the band with low operating cathode current. Power output can be modulated with either the grid or the anode circuits. All voltages are isolated from the tube housing for easy packaging.

SPECIFICATIONS

		TYPICAL	ADOOLUTE
	UNITS	TYPICAL VALUES	ABSOLUTE RATINGS
Frequency Band	.GHz		18-26.5
Power Output into Load with VSWR = 1.25:1	.mW	25-50	20 Min.
Power Output Variation	.dB		8 Max.
Fine Grain Variation	.dB/250 MHz		З Мах.
Tube VSWR			2.5:1 Max.
Frequency Pulling into 2:1 Load (Any Phase)	.MHz	. 2	6 Max.
Spurious Oscillation			
Ratio of Signal to Total Spurious Output	.dB	. 50	40 Min.
Ratio of Signal to Noise Power 30 MHz Away	.dB/MHz	95	85 Min.
Sensitivity to Heater Voltage			
Sensitivity to Anode Voltage			
Sensitivity to Grid Voltage Tuning Curve Slope	. IVI TIZ/ V	. 10	
Low End (18 MHz)		123	
Mid-Frequency (22.5 MHz)			
High End (26.5 MHz)			
Grid RF Cutoff Voltage	.V	-10	-25 Max.
Capacitance; Cathode to all other Electrodes			
including Heater and Housing	.рF	30	50 Max.
Capacitance: Grid to all other Electrodes			
and Housing	.pF	. 20	50 Max.
Capacitance: Helix and Collector to all other			
Electrodes and Housing	.pF	. 70	. 120 Max.
Heater Voltage	.V		$6.3\pm5\%$
Heater Current	.A	. 0.67	0.4-1.2
Cathode Current ¹			
Helix Voltage Range	· V · · · · · · · · · · · · · · · · · ·	1 5	2.5 May
Anode Voltage	. III/A	180	215 Max
Anode Current	mΔ	0.2	1 Max
Andre Guirent			

'Set cathode current to Final Test Data value furnished with tube.

SE-218-50 MECHANICAL CHARACTERISTICS

Height, 2.5 inches (64 mm) Width, 2.5 inches (64 mm) Length, 6.75 inches (171 mm) Weight, 6 lbs. (2.72 Kg) Max. Color Code for 18" Flying Leads Black Heater Brown Heater Yellow Cathode Grid Green Blue Anode Helix Red Collector Orange

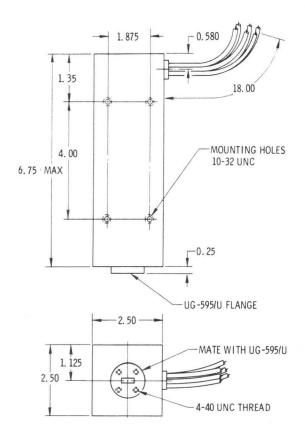
Mounting Position, Any RF Output Connector, UG-595/U Flange

ENVIRONMENTAL CHARACTERISTICS

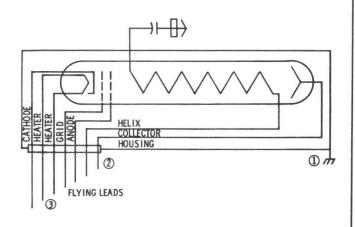
Separation from Passive Magnetic Materials, 2 in. Min.

No Forced Air Cooling Required Below +60°C Ambient

OUTLINE DRAWING

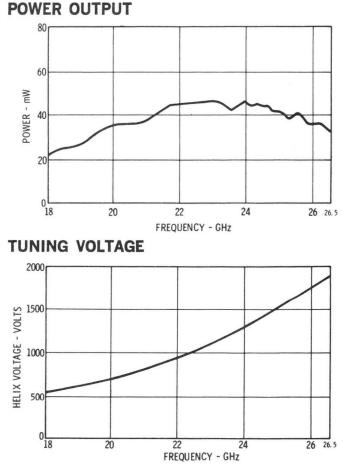


SCHEMATIC DIAGRAM



Notes:

- (1) For safety, housing should be grounded through mounting screws.
- (2) 45-150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.
- (3) Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.



JANUARY 1969

BACKWARD-WAVE OSCILLATOR SE-219

The type SE-219 BWO is a bifilar (dual helix), voltage-tunable oscillator. This permanent-magnet focused wide band oscillator is well suited for use as a swept signal source in signal generators, particularly in view of its high stability. Other applications include ECM receivers (as local oscillator), frequency diversity transmitters (as master oscillator), and other electronic equipment. The SE-219 features smooth power over the band, low cathode current, and two control electrodes. The control grid makes possible power cutoff with low negative grid voltage. Power output can be modulated with either the grid or anode, or both. All voltages are isolated from housing and RF output connector for maximum flexibility in circuit applications.



SPECIFICATIONS

	Units	Typical Values	Absolute Ratings
Frequency Band	GHz		1.4 - 2.5
Power Output into Load VSWR = 1.25	mW	110 - 250	100 Min
Power Output Variation	dB	1542 - 0.3254 (PARCERSEN)	8 Max
Fine Grain Variation	dB/50 MHz		3 Max
Tube VSWR			2.5:1 Max
Frequency Pulling into 2:1 Load (Any Phase)	MHz	2	5 Max
Spurious Oscillation			
Ratio of Signal to 2nd Harmonic Output	dB	40	20 Min
Ratio of Signal to Noise Power 30 MHz Away	dB/MHz	95	85 Min
Long-Term Sensitivity to Heater Voltage	MHz/V	5	10 Max
Sensitivity to Anode Voltage	MHz/V	0.2	0.5 Max
Sensitivity to Grid Voltage	MHz/V	5	10 Max
Tuning Curve Slope			
Low-End (1.4 GHz)	MHz/V	1.8	
Mid-Frequency (1.95 GHz)	MHz/V	1.05	
High-End (2.5 GHz)	MHz/V	0.7	
Grid RF Cutoff Voltage	V	-7	-20 Max
Capacitance; Cathode to all other			
Electrodes, including Heater	pF	15	25 Max
Capacitance; Grid to all other			
Electrodes at Power Input Connector	pF	20	25 Max
Capacitance; Helix to all other Electrodes	pF	440	475 Max
Heater Voltage	V		6.3+5%
Heater Current	А	0.85	0.4-1.2
Cathode Current	mA	11	17 Max
Helix Voltage Range	V	370-1385	350-1450
Helix Current	mA	1.5	4 Max
Anode Voltage	V .	95	215 Max
Anode Current	mA	1	1.5 Max

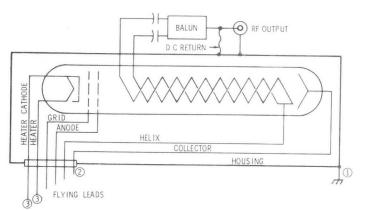
MECHANICAL CHARACTERISTICS

Height, 3 Inches (76 mm) Width, 3 Inches (76 mm) Length, 11 Inches (279 mm) Weight, 14.5 lbs. (6.58 kg.) max. Color Code for 18" Flying Leads Heater Brown Heater Black Cathode Yellow Grid Green Blue Anode Helix Red Orange Collector Mounting Position, any RF Output Connector, Type N Female on Balun

ENVIRONMENTAL CHARACTERISTICS

Separation from Passive Magnetic Materials, 4 in. Min No Forced Air Cooling Required, Below +60°C Ambient

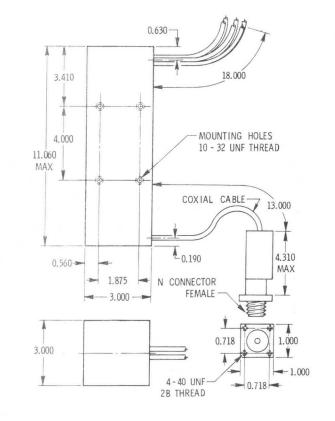
SCHEMATIC DIAGRAM



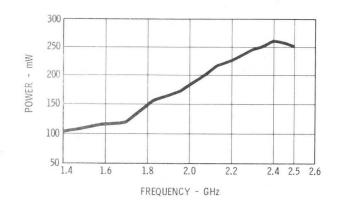
Notes:

- (1) For safety, housing should be grounded through mounting screws.
- (2) 50 150 V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.
- (3) Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.

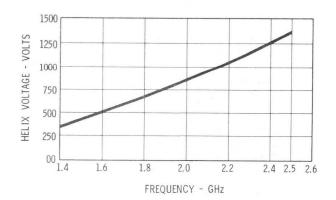
OUTLINE DRAWING







TUNING VOLTAGE



DECEMBER 1970

BACKWARD-WAVE OSCILLATOR SE-219 -50

TVDIOAL

SPECIFICATIONS

	UNITS	TYPICAL VALUES	ABSOLUTE RATINGS
Frequency Band Power Output into Load with VSWR = 1.25:1 Power Output Variation	mW		100 Min.
Fine Grain Variation Tube VSWR Frequency Pulling Into 2:1 Load (Any Phase) Spurious Oscillation			2.5:1 Max
Ratio of Signal to Noise Power 30 MHz Away . Ratio of Signal to 2nd Harmonic Output Long-term Sensitivity to Heater Voltage	dB	40	85 Min. 20 Min.
Sensitivity to Anode Voltage Sensitivity to Grid Voltage Tuning Curve Slope	MHz/V	0.2	
Low End (1.4 GHz) Mid-Frequency (1.95 GHz) High End (2.5 GHz)	MHz/V	1.05	~
Grid RF Cutoff Voltage Capacitance; Cathode to all other Electrodes, including Heater	V		
Capacitance; Grid to all other Electrodes, at Power Input Connector	ρF		35 Max.
Capacitance; Helix to all other Electrodes Heater Voltage Heater Current	Vdc	0.85	6.3 ± 5% 0.4–1.2 Min./Max.
Cathode Current [*]	mA V		17 Max.
Helix Current Anode Voltage Anode Current	V		4 Max. 215 Max.
		· · · · · L · · · · · · · · · · · · · · ·	I.J WIAX.

*Set cathode current to Final Test Data value furnished with tube.

The SE-219-50 BWO is a bifilar (dual-helix), voltage tunable oscillator. This permanent-magnet focused wide band oscillator is well suited for use as a swept signal source in signal generators, particularly in view of its high stability.

Other applications include ECM receivers (as local oscillator), frequency diversity transmitters (as master oscillator), and other electronic equipment.

The SE-219-50 features smooth power over the band, low cathode current, and two control electrodes. The control grid makes possible power cutoff with low negative grid voltage. Power output can be modulated with either the grid or anode, or both. Cathode modulation with the grid grounded usually reduces FM caused by AM. Packaging problems are simplified, since all voltages are isolated from both tube housing and the RF output terminal. The tube housing and output connector can be grounded regardless of power supply configuration.

SE-219-50

MECHANICAL CHARACTERISTICS

Height, 3 inches (76 mm) Width, 3 inches (76 mm) Length, 11 inches (279 mm) max. Weight, 14.5 lbs. (6.58 Kg) max.

Color Code for 18" Flying Leads

HeaterBlackHeaterBrownCathodeYellowGridGreenAnodeBlueHelixRedCollectorOrange

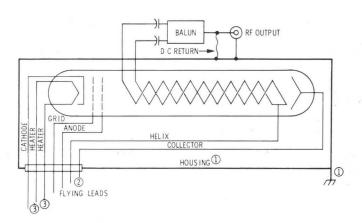
Mounting Position, Any

RF Output Connector, Type N Female on Balun

ENVIRONMENTAL CHARACTERISTICS

Separation from Passive Magnetic Materials, 4 in. Min. No Forced Air Cooling Required Below +60°C Ambient

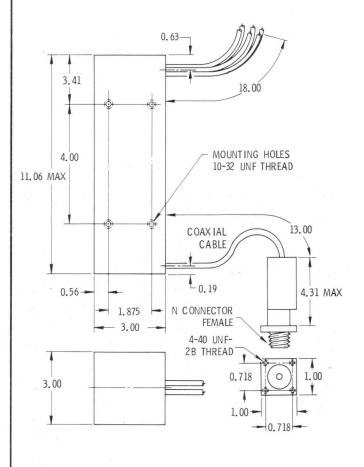
SCHEMATIC DIAGRAM

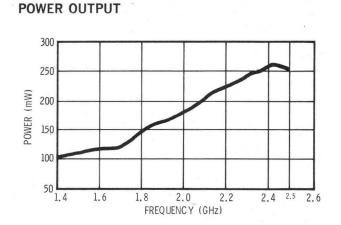


Notes:

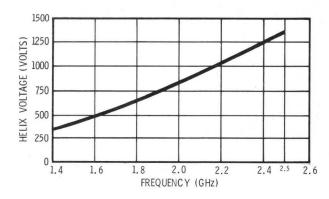
- (1.) For safety, housing should be grounded through mounting screws.
- (2) 45–150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.
- (3) Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.

OUTLINE DRAWING





TUNING VOLTAGE



TECHNICAL DATA BACKWARD-WAVE

OSCILLATOR

SE-219A

TECHNICAL DATA • March 1966

The type SE-219A BWO is a bifilar (dual helix), voltage-tunable oscillator. This permanent-magnet-focused wide-band oscillator is well suited for use as a swept signal source in signal generators, particularly in view of its high stability. Other applications include ECM receivers (as local oscillator), frequency diversity transmitters (as master oscillator), and other electronic equipment. The SE-219A features smooth power over the band, low cathode current, and two control electrodes. The control grid makes possible power cutoff with low negative grid voltage. Power output can be modulated with either the grid or



anode, or both. Cathode modulation with the grid grounded usually reduces FM caused by AM. All voltages are isolated from housing and RF output connector for maximum flexibility in circuit applications.

ELECTRICAL CHARACTERISTICS,	CW Units	Typical Values	Absolute Ratings
Nominal Frequency Band	GHz	1.4-2.5	
Power Output into Load VSWR = 1.25	mW	110-350	100 Min
Power Output Variation	dB		8 Max
Fine Grain Variation	dB/100 MHz		3 Max
Tube VSWR			2.0:1 Max
Frequency Pulling into 2:1 Load (Any Phase)	MHz	2	5 Max
Spurious Oscillation			
Ratio of Signal to 2nd Harmonic Output	dB	40	20 Min
Ratio of Signal to Noise Power 30 MHz Away	dB/MHz	95	85 Min
Long-Term Sensitivity to Heater Voltage	MHz/V	5	10 Max
Sensitivity to Anode Voltage	MHz/V	0.2	0.5 Max
Sensitivity to Grid Voltage	MHz/V	5	10 Max
Tuning Curve Slope			
Low-End (1.4 GHz)	MHz/V	1.8	
Mid-Frequency (1.95 GHz)	MHz/V	1.05	
High-End (2.5 GHz)	MHz/V	0.7	
Grid RF Cutoff Voltage	V	-7	-20 Max
Capacitance; Cathode to all other			
Electrodes, including Heater	pF	15	25 Max
Capacitance; Grid to all other			
Electrodes at Power Input Connector	pF	20	25 Max
Capacitance; Helix to all other Electrodes	pF	440	475 Max
Heater Voltage	V		6.3+5%
Heater Current	A	0.85	0.4-1.2
			Min/Max
Cathode Current	mA	11	17 Max
Helix Voltage Range	V	370-1385	350-1450
			Min/Max
Helix Current	mA	1.5	4 Max
Anode Voltage	V	95	215 Max
Anode Current	mA	1	1.5 Max

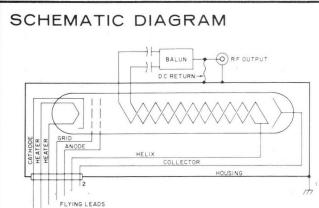
ELECTRICAL CHARACTERISTICS, CW

MECHANICAL DATA

Weight, 14.5 lbs M	ax
Color Code for 18"	Flying Leads
Heater	Black
Heater	Brown
Cathode	Yellow
Grid	Green
Anode	Blue
Helix	Red
Collector	Orange
Mounting Position,	Any
RF Output Connecto	or, Type N Female
on Balun	

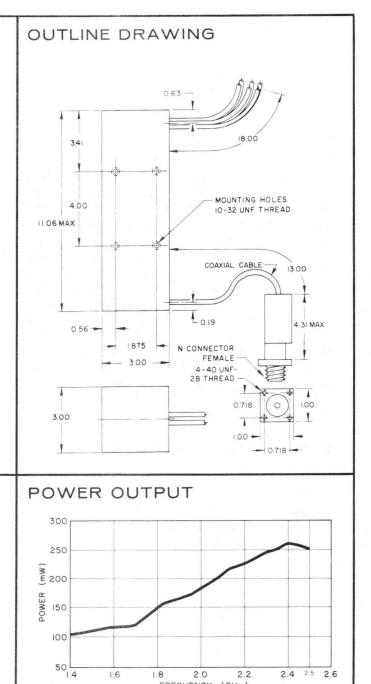
ENVIRONMENTAL DATA

Separation from Passive Magnetic Materials, 4 in. Min No Forced Air Cooling Required Below +60[°]C Ambient

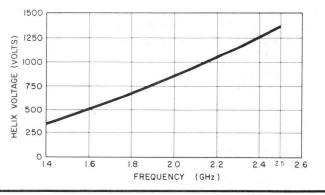


¹For Safety, housing should be grounded through mounting screws.

 2 50-150 V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.







FREQUENCY (GHz)

Printed in U.S.A.

JULY 1967

BACKWARD-WAVE OSCILLATOR SE-220

The type SE-220 is a single helix, voltage tunable oscillator utilizing a permanent magnet focusing system. This wide-band oscillator is well suited for use as a swept signal source in highly stable signal generators. Other applications include local oscillators in frequency diversity transmitters and in electronic test sets. The SE-220 delivers smooth power output over the band with low operating cathode current. Power output can be modulated with either the grid or the anode circuits. All voltages are isolated from the tube housing for easy packing.

SPECIFICATIONS

	UNITS	TYPICAL VALUES	ABSOLUTE RATINGS
Nominal Frequency Band Power Output into Load with VSWR = 1.25:1	.GHz	12-40	. 10.0-15.5
Power Output Variation	.dB		8 Max.
Tube VSWR		1.5	2.5:1 Max. 3 Max.
Ratio of Signal to Noise Power 30 MHz Away Long-term Sensitivity to Heater Voltage Sensitivity to Anode Voltage	.MHz/V	5	85 Min.
Sensitivity to Grid Voltage			
Low End (10.0 GHz)	.MHz/V	7 4	
High End (15.5 GHz)	.MHz/V	2 —10	. —20 Max.
Capacitance; Cathode to all other Electrodes including Heater and Housing			
Capacitance; Grid to all other Electrodes and Housing Capacitance; Helix and Collector to all other			
Electrodes and Housing	.Vdc		$.6.3 \pm 5\%$
Heater Current	.A	0.95	0.4-1.2 Min/Max
Cathode Current			IVIIII/IVIAX
Helix Current Anode Voltage* Anode Current	.νV	150	. 215 Max.

*Set anode voltage to Final Test Data value furnished with tube.

SE-220

MECHANICAL CHARACTERISTICS

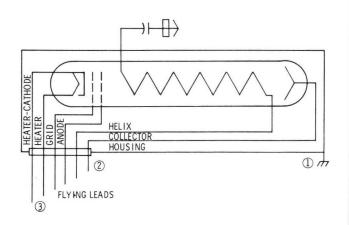
Height, 2.5 inches (64 mm) Width, 2.5 inches (64mm) Length, 7.75 inches (197 mm) Weight, 6.0 lbs. (2.72 Kg) Max. Color Code for 18" Flying Leads Heater Brown Heater Black Grid Green Anode Blue Red Helix Collector Orange Cathode Yellow Mounting Position, any RF Output Connector, WR 75 Waveguide Flange

ENVIRONMENTAL CHARACTERISTICS

Separation from Passive Magnetic Materials 2 in. Min.

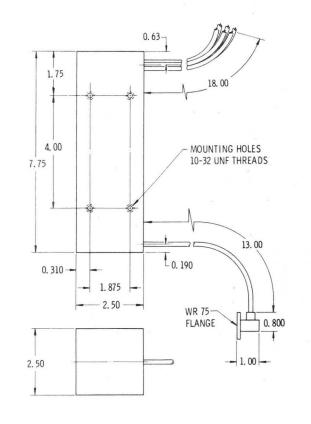
No Forced Air Cooling Required Below 60°C Ambient

SCHEMATIC DIAGRAM

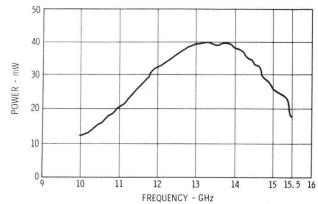


- OFor safety, housing should be grounded through mounting screws.
- ②50-150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.
- Heater must never be positive with respect to cathode.

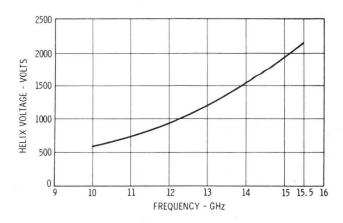
OUTLINE DRAWING



POWER OUTPUT



TUNING VOLTAGE



JANUARY 1971

BACKWARD-WAVE OSCILLATOR SE-220-50



The type SE-220-50 is a single helix, voltage tunable oscillator utilizing a permanent magnet focusing system. This wide-band oscillator is well suited for use as a swept signal source in highly stable signal generators. Other applications include local oscillators in frequency diversity transmitters and in electronic test sets. The SE-220-50 delivers smooth power output over the band with low operating cathode current. Power output can be modulated with either the grid or the anode circuits. All voltages are isolated from the tube housing for easy packaging.

SPECIFICATIONS

	UNITS	TYPICAL	ABSOLUTE RATINGS
Frequency Band Power Output into Load with VSWR = 1.25:1 Power Output Variation	.mW	23.48	20 Min.
Fine Grain Variation Tube VSWR Frequency Pulling into 2:1 Load (Any Phase)		1.5	2.5:1 Max.
Ratio of Signal to Noise Power 30 MHz Away Long-term Sensitivity to Heater Voltage Sensitivity to Anode Voltage Sensitivity to Grid Voltage	.MHz/V	5 0.5	65 141111.
Tuning Curve Slope Low End (10.0 GHz) Mid-Frequency (12.8 GHz)	.MHz/V	7 4	
High End (15.5 GHz) Grid RF Cutoff Voltage Capacitance; Cathode to all other Electrodes including Heater and Housing	.V	—10	
Capacitance; Grid to all other Electrodes and Housing			
Capacitance; Helix and Collector to all other Electrodes and Housing Heater Voltage	.Vdc		$6.3 \pm 5\%$
Cathode Current * Helix Voltage Range	.mA	7	Min/Max . 10 Max. . 550-2250 Min/Max
Helix Current Anode Voltage* Anode Current	.V [*]	150	. 215 Max.

*Set cathode current to Final Test Data value furnished with tube.

SE-220-50

MECHANICAL CHARACTERISTICS

Height, 2.5 inches (64 mm) Width, 2.5 inches (64mm) Length, 7.75 inches (197 mm) Weight, 6.0 lbs. (2.72 Kg) Max. Color Code for 18" Flying Leads Heater Brown Heater Black Grid Green Anode Blue Helix Red Collector Orange Cathode Yellow Mounting Position, any RF Output Connector, WR 75 Waveguide Flange

ENVIRONMENTAL CHARACTERISTICS

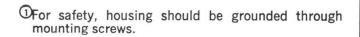
Separation from Passive Magnetic Materials 2 in. Min.

No Forced Air Cooling Required Below 60°C Ambient

SCHEMATIC DIAGRAM

2

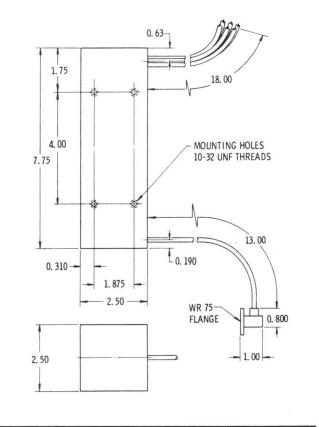
FLYING LEADS



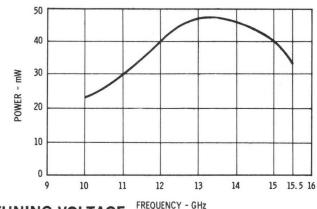
1 1

- @45-150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.
- Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.

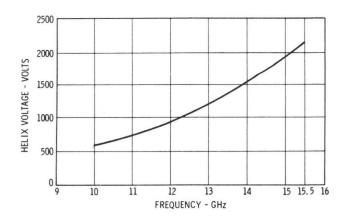
OUTLINE DRAWING



POWER OUTPUT







JANUARY 1971

BACKWARD-WAVE O S C I L L A T O R

SE-221

TECHNICAL DATA • September 1965

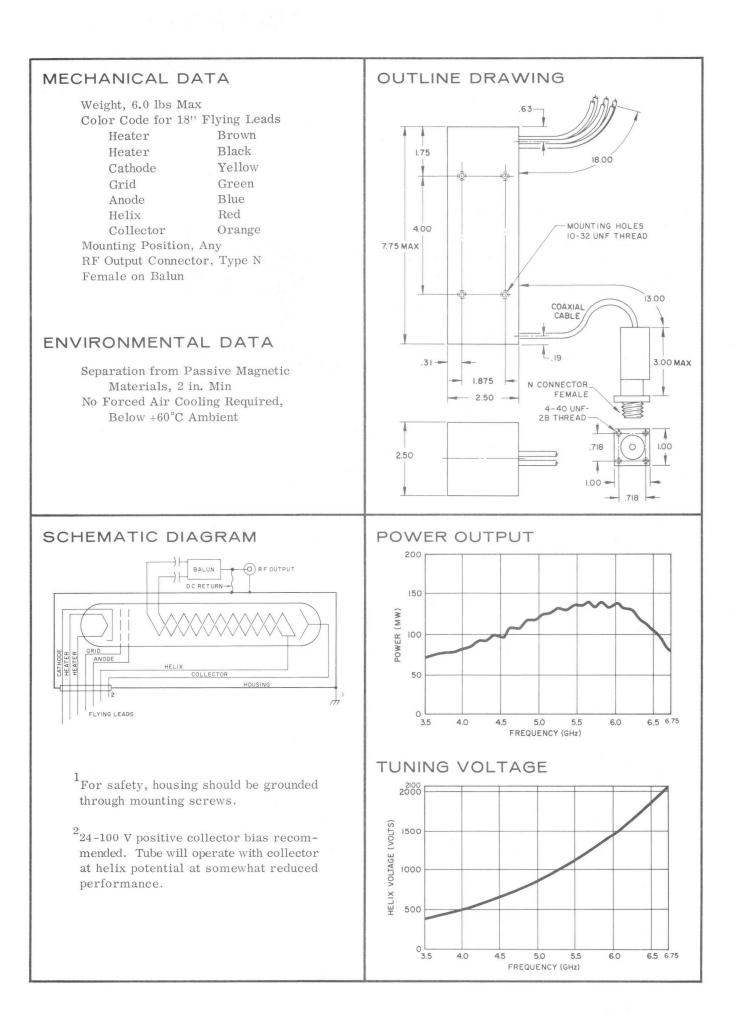
The type SE-221 BWO is a bifilar (dual helix), voltage tunable oscillator. This permanent-magnet focused wide band oscillator is well suited for use as a swept signal source in signal generators, par ticularly in view of its high stability. Other applications include ECM receivers (as local oscillator), frequency diversity transmitters (as master oscillator), and other electronic equipment. The SE-221 features smooth power over the band, low cathode current, and two control electrodes. The control grid makes possible power cutoff with low negative grid voltage. Power output can be modulated with either the grid or anode,



or both. Cathode modulation with the grid grounded usually reduces FM caused by AM. With all voltages isolated from both tube housing and the r.f. output terminal, packaging problems are simplified, since the tube housing and output connector can be grounded regardless of power supply configuration.

ELECTRICAL CHARACTERISTICS, CW

-	LECTRICAL CHARACTERISTICS, CW	Units	Typical Values	Absolute Ratings
	Nominal Frequency Band	GHz	3.5-6.75	
	Power Output into a Load with VSWR = 1.25	mW	50-130	40 Min
	Power Output Variation	db		7 Max
	Fine Grain Variation	db/250 MHz		3 Max
	Tube VSWR	Successive and a successive succe		2.5:1 Max
	Frequency Pulling into 2:1 Load (Any Phase)	MHz	1.5	3 Max
	Spurious Oscillation			
	Ratio of Signal to 2nd Harmonic Output	db	30	20 Min
	Ratio of Signal to Noise Power 30 MHz Away	db/MHz	95	85 Min
	Long-term Sensitivity to Heater Voltage	MHz/V	5	10 Max
	Sensitivity to Anode Voltage	MHz/V	0.5	1 Max
	Sensitivity to Grid Voltage	MHz/V	3	5 Max
	Tuning Curve Slope	1991 1997 1997 1997 1999 1999 1997 1997		
	Low End (3.5 GHz)	MHz/V	5.6	
	Mid-Frequency (5.1 GHz)	MHz/V	2.2	
	High End (6.75 GHz)	MHz/V	1.6	
	Grid r.f. Cutoff Voltage	V	-7	-20 Max
	Collector Voltage Above Helix (Note 1)	V	50-150	300 Max
	Capacitance; Cathode to all other Electrodes,			
	including Heater	pf	30	45 Max
	Capacitance; Grid to all other Electrodes, at	*		
	Power Input Connector	pf	30	45 Max
	Capacitance; Helix to all other Electrodes	pf	100	150 Max
	Heater Voltage	v		6.3=5%
	Heater Current	А	0.85	0.6 - 1.2
				Min/Max
	Cathode Current	mA	8	12 Max
	Helix Voltage Range	V	400-2040	350-2100
				Min/Max
	Helix Current	mA	2	3 Max
	Anode Voltage	V	175	250 Max
	Anode Current	mA	0.5	2 Max



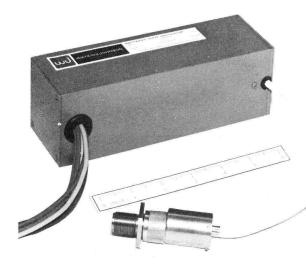
DECEMBER 1970

BACKWARD-WAVE OSCILLATOR SE-221-50

The SE-221-50 BWO is a bifilar (dual-helix), voltage tunable oscillator. This permanent-magnet focused wide band oscillator is well suited for use as a swept signal source in signal generators, particularly in view of its high stability.

Other applications include ECM receivers (as local oscillator), frequency diversity transmitters (as master oscillator), and other electronic equipment.

The SE-221-50 features smooth power over the band, low cathode current, and two control electrodes. The control grid makes possible power cutoff with low negative grid voltage. Power output can be modulated with either the grid or anode, or both. Cathode modulation with the grid grounded usually reduces FM caused by AM. Packaging problems are simplified, since all voltages are isolated from both tube housing and the RF output terminal. The tube housing and output connector can be grounded regardless of power supply configuration.



SPECIFICATIONS

	UNITS	TYPICAL VALUES	ABSOLUTE RATINGS
Frequency Band Power Output into Load with VSWR = 1.25:1 Power Output Variation Fine Grain Variation Tube VSWR Frequency Pulling Into 2:1 Load (Any Phase)	mW		45 Min. 6 Max. 3 Max. . 2.5:1 Max.
Spurious Oscillation Ratio of Signal to Noise Power 30 MHz Away Ratio of Signal to 2nd Harmonic Output Long-term Sensitivity to Heater Voltage Sensitivity to Anode Voltage Sensitivity to Grid Voltage	dB		85 Min. 20 Min.
Tuning Curve Slope Low End (3.5 GHz) Mid-Frequency (5.1 GHz) High End (6.75 GHz) Grid RF Cutoff Voltage Collector Voltage Above Helix Capacitance; Cathode to all other Electrodes,	MHz/V	2.5 1.1	—25 Max. 300 Max.
Capacitance, Cathode to an other Electrodes, including Heater Capacitance; Grid to all other Electrodes, at Power Input Connector Capacitance; Helix to all other Electrodes Heater Voltage Heater Current	nF	30	45 Max
Cathode Current *	mA	8	Min./Max. 12 Max. . 350–2100 Min /Max
Helix Current Anode Voltage Anode Current	V	175	215 Max.

*Set cathode current to Final Test Data value furnished with tube.

SE-221-50

MECHANICAL CHARACTERISTICS

Height, 2.5 inches (64 mm) Width, 2.5 inches (64 mm) Length, 7.75 inches (197 mm) max. Weight, 6 lbs. (2.72 Kg) max.

Color Code for 18" Flying Leads Heater Black

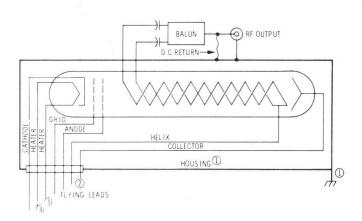
Treater	DIACK
Heater	Brown
Cathode	Yellow
Grid	Green
Anode	Blue
Helix	Red
Collector	Orange

Mounting Position, Any RF Output Connector, Type N Female on Balun

ENVIRONMENTAL CHARACTERISTICS

Separation from Passive Magnetic Materials, 2 in. Min. No Forced Air Cooling Required Below +60°C Ambient

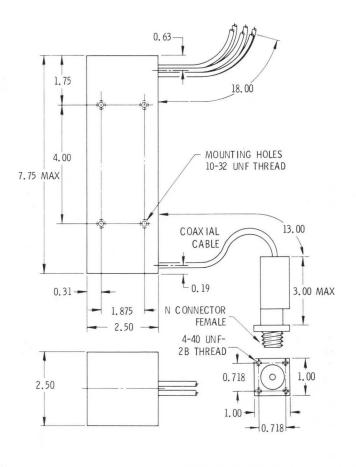
SCHEMATIC DIAGRAM

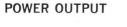


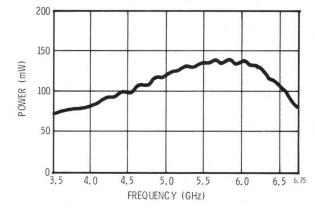
Notes:

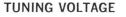
- (1) For safety, housing should be grounded through mounting screws.
- (2) 45–150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.
- (3) Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.

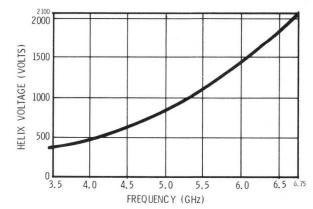
OUTLINE DRAWING











MAY 1969*

BACKWARD-WAVE OSCILLATOR SE-222

The SE-222 is a single-helix, voltage tunable oscillator utilizing a permanent magnet focusing system. This wide-band oscillator is well suited for use as a swept signal source in highly stable signal generators. Other applications include local oscillators in frequency diversity transmitters and in electronic test sets. The SE-222 delivers smooth power output over the band with low operating cathode current. Power output can be modulated with either the grid or the anode circuits. All voltages are isolated from the tube housing for easy packaging.

SPECIFICATIONS

	UNITS	TYPICAL VALUES	ABSOLUTE RATINGS
Nominal Frequency Band	.GHz		26.5-40
Power Output into Load with VSWR = 1.25:1	.mW	10-35	10 Min.
Power Output Variation			
Fine Grain Variation	.dB/500 MHz		З Мах.
Tube VSWR	***************		2.5:1 Max.
Frequency Pulling into 2:1 Load (Any Phase)			
Ratio of Signal to Noise Power 30 MHz Away Long-term Sensitivity to Heater Voltage			65 1/111.
Sensitivity to Anode Voltage			
Sensitivity to Grid Voltage			
Tuning Curve Slope	,		
Low End (26.5 GHz)			
Mid-Frequency (33.25 GHz)			
High End (40 GHz)	. MHz/V	. 6	20 May
Grid RF Cutoff Voltage Capacitance; Cathode to all other Electrodes	· V · · · · · · · · · · · · · · ·	. —/	20 IVIAX.
including Heater and Housing	nE	35	50 Max
Capacitance: Grid to all other Electrodes	.pr	. 55	JU Wax.
Capacitance; Grid to all other Electrodes and Housing	.pF	. 25	50 Max.
Capacitance; Helix and Collector to all other			
Electrodes and Housing			
Heater Voltage	.Vdc		$6.3\pm5\%$
Heater Current	.A	1.65	0.4-1.2 5 May
Cathode Current ¹	.ma	520-1900	500-2100
Helix Current	.mA	1.0	1.5 Max.
Anode Voltage			
Anode Current	.mA	.05	0.7 Max.

¹Set cathode current to Final Test Data value furnished with tube.

*Supersedes SE-222 Technical Data Sheet dated July 1967.



SE-222 MECHANICAL CHARACTERISTICS

Height, 2.5 inches (64 mm) Width, 2.5 inches (64 mm) Length, 5.25 inches (133 mm) Weight, 3.75 lbs. (1.70 Kg) Max. Color Code for 18" Flying Leads Heater Brown Heater Black Grid Green Anode Blue Helix Red Collector Orange Yellow Cathode

Mounting Position, Any

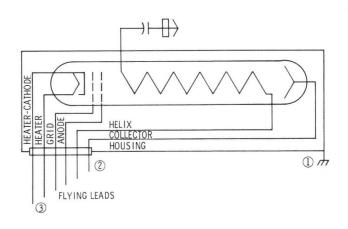
RF Output Connector mates to UG599/U Waveguide Flange

ENVIRONMENTAL CHARACTERISTICS

Separation from Passive Magnetic Materials 4 in. Min.

No Forced Air Cooling Required Below +60°C Ambient

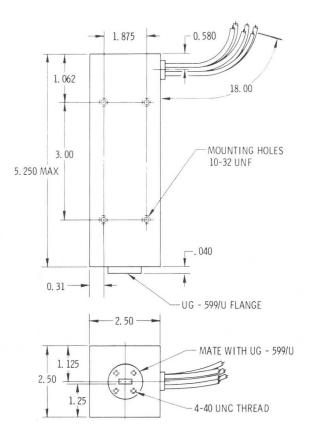
SCHEMATIC DIAGRAM



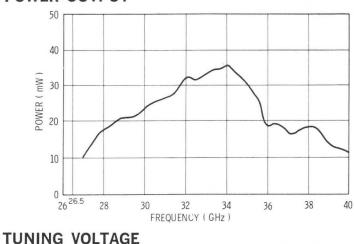
Notes:

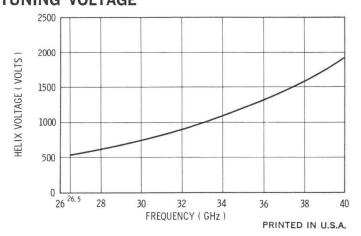
- For safety, housing should be grounded through mounting screws.
- (2) 50-150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.
- (3) Heater must never be positive with respect to cathode.

OUTLINE DRAWING



POWER OUTPUT





X-758-12 MAY 1969

JANUARY 1971

ABSOLUTE

BACKWARD-WAVE OSCILLATOR SE-222-50

The type SE-222-50 is a single helix, voltage tunable oscillator utilizing a permanent magnet focusing system. This wide-band oscillator is well suited for use as a swept signal source in highly stable signal generators. Other applications include local oscillators in frequency diversity transmitters and in electronic test sets. The SE-222-50 delivers smooth power output over the band with low operating cathode current. Power output can be modulated with either the grid or the anode circuits. All voltages are isolated from the tube housing for easy packaging.



TYPICAL

SPECIFICATIONS

	UNITS	VALUES	RATINGS
Frequency Band	.GHz		26.5-40
Power Output into Load with VSWR = 1.25:1	.mW	12-35	10 Min.
Power Output Variation	.dB		8 Max.
Fine Grain Variation	.dB/250 MHz		3 Max.
Tube VSWR			2.5:1 Max.
Frequency Pulling into 2:1 Load (Any Phase)	.MHz	. 6	18 Max.
Ratio of Signal to Noise Power 30 MHz Away			85 Min.
Long-term Sensitivity to Heater Voltage	.MHZ/V	. 30	
Sensitivity to Anode Voltage	.IVITIZ/V	25	
Tuning Curve Slope	. 1911 12/9	. 20	
Low End (26.5 GHz)	MHz/V	20	
Mid-Frequency (33.25 GHz)			
High End (40 GHz)			
Grid RF Cutoff Voltage	.V	—7	
Canacitance: Cathode to all other Electrodes			
including Heater and Housing	.pF	. 35	* 50 Max.
Capacitance: Grid to all other Electrodes			
and Housing	.pF	. 25	50 Max.
Capacitance; Helix and Collector to all other	-	CO	100 14
Electrodes and Housing	.pF	. 60	. 100 Max.
Heater Voltage	.Vdc		$ 0.3 \pm 5\%$
Heater Current	.A	J.05	0.4-1.2 5 May
Cathode Current ¹	.ma	520,1900	480-2050
Helix Current	mA	1.0	1.5 Max.
Anode Voltage	.V	150	215 Max.
Anode Current	.mA	.05	0.7 Max.

'Set cathode current to Final Test Data value furnished with tube.

SE-222-50 MECHANICAL CHARACTERISTICS

Height, 2.5 inches (64 mm) Width, 2.5 inches (64 mm) Length, 6.75 inches (171 mm) Weight, 5.0 lbs. (2.27 Kg) Max. Color Code for 18" Flying Leads

	, 0
Heater	Brown
Heater	Black
Grid	Green
Anode	Blue
Helix	Red
Collector	Orange
Cathode	Yellow

Mounting Position, Any

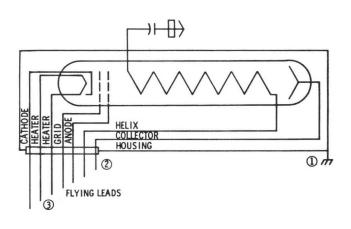
RF Output Connector mates to UG599/U Waveguide Flange

ENVIRONMENTAL CHARACTERISTICS

Separation from Passive Magnetic Materials 4 in. Min.

No Forced Air Cooling Required Below +60°C Ambient

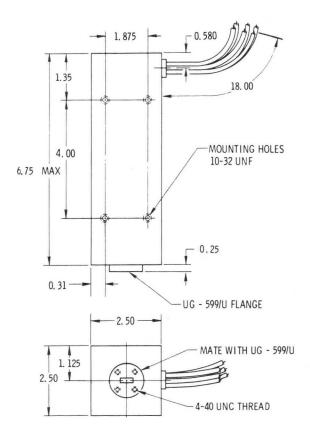
SCHEMATIC DIAGRAM

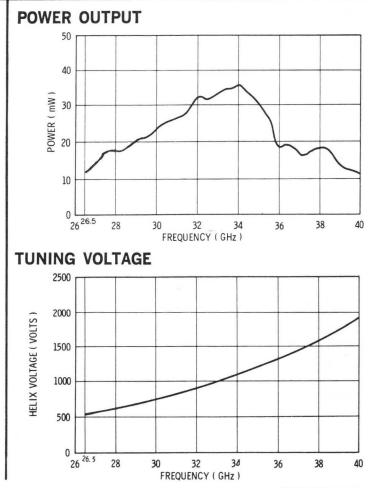


Notes:

- For safety, housing should be grounded through mounting screws.
- (2) 50-150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.
- (3) Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.

OUTLINE DRAWING





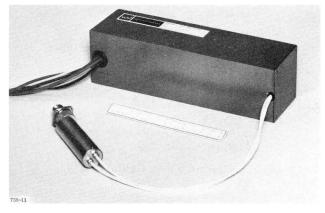
SE-223

BACKWARD-WAVE

OSCILLATOR

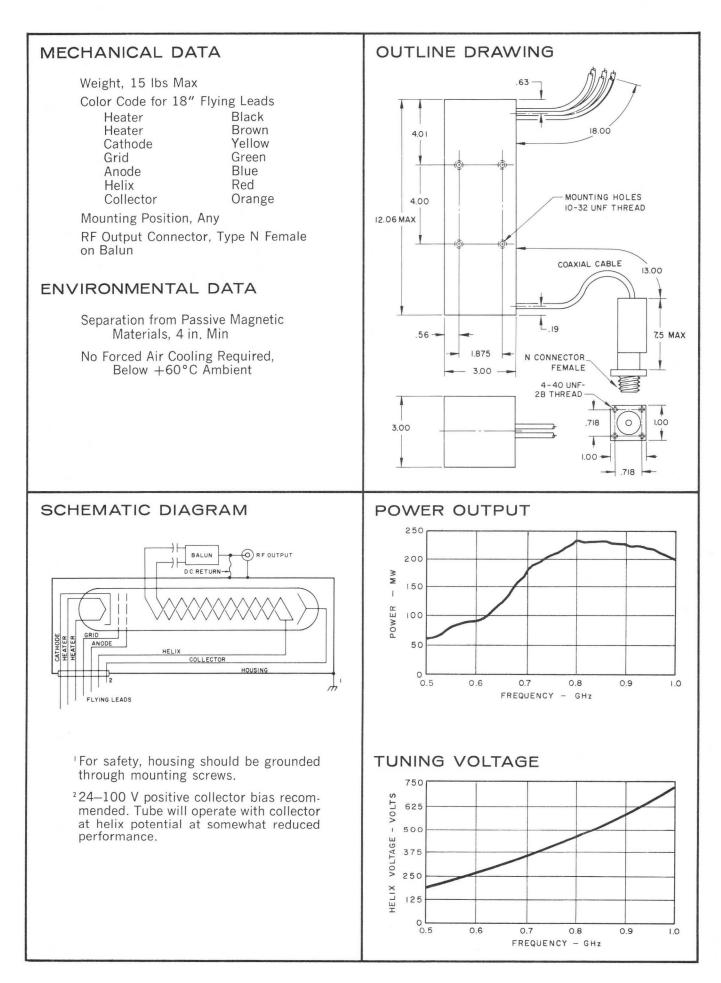
January 1967

The type SE-223 BWO is a bifilar (dual helix), voltage tunable oscillator utilizing a permanent-magnet focusing system. This wide band oscillator is well suited for use as a swept signal source in highly stable signal generators. Other applications include local oscillators in ECM receivers, as master oscillators in frequency diversity transmitters and in electronic test sets. The SE-223 delivers smooth power output over the band with low operating cathode current. Power output can be modulated with either the grid or the anode circuits. All voltages are isolated from the tube housing for easier packaging.



SPECIFICATIONS

	Units	Typical Values	Absolute Ratings
Nominal Frequency Band	GHz	0.5-1.0	
Power Output into Load with VSWR = 1.25	mW	60-230	30 Min
Power Output Variation	dB		10 Max
Fine Grain Variation	dB/25 MHz		3 Max
Tube VSWR			2.5:1 Max
Frequency Pulling into 2:1 Load (Any Phase)	MHz	5	10 Max
Spurious Oscillation			
Ratio of Signal to 2nd Harmonic Output	dB	40	20 Min
Ratio of Signal to Noise Power 30 MHz Away	dB/MHz	95	85 Min
Long-term Sensitivity to Heater Voltage	MHz/V	5	10 Max
Sensitivity to Anode Voltage	MHz/V	0.6	2.0 Max
Sensitivity to Grid Voltage	MHz/V	5	10 Max
Tuning Curve Slope		1.6	
Low End (0.5 GHz)	MHz/V MHz/V	0.9	
High End (1.0 GHz)	MHz/V	0.7	
Grid R. F. Cutoff Voltage		7	-20 Max
Capacitance; Cathode to all other Electrodes,			Lomax
including Heater and Housing	pF	50	60 Max
Capacitance; Grid to all other Electrodes			
including Housing	pF	25	30 Max
Capacitance; Helix to all other Electrodes	pF	250	300 Max
Heater Voltage	V		$6.3 \pm 5\%$
Heater Current	A	1.4	1.0-1.65
			Min/Max
Cathode Current	mA	11	17 Max
Helix Voltage Range	V	170-720	150-750
		0	Min/Max
Helix Current		2	4 Max
Anode Voltage	V	100	215 Max
Anode Current	mA	1	1.5 Max



JANUARY 1971

GRIDDED HIGH-GAIN TRAVELING-WAVE AMPLIFIER WJ-228



The WJ-228 is a high-power, high-gain C-band traveling-wave amplifier for pulsed operation. This tube is of rugged, light-weight construction backed by production experience gained through the manufacture of large quantities of this type. The WJ-228 produces 14 kw power output with 0.5 watt drive. It employs a high-mu grid which permits modulation of the beam by means of a 50C-volt pulse.

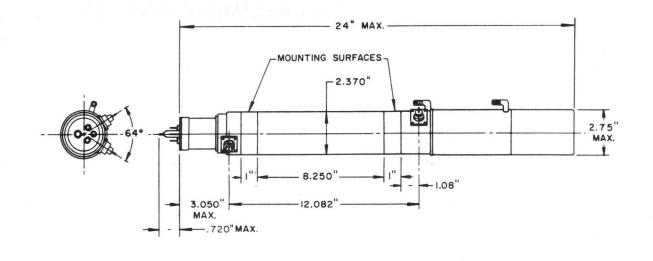
The slow-wave circuit is of the coupled-cavity design which is all metal-ceramic construction. The tube is designed to withstand shock and vibration. A temperature-compensating jacket is employed over the ferrite ppm magnet stack to eliminate any appreciable change in characteristics over a wide range of operating temperatures. By means of a high-convergence gridded gun, the peak cathode loading can be minimized $(2A/cm^2)$ which in turn extends the life of the tube. In addition, the integral focusing system requires no alignment and leakage fields are negligible.

The WJ-228 employs an insulated collector for increased efficiency by means of collector depression. The collector cooling jacket is at ground potential to eliminate electrical insulation in the coolant system. Since the WJ-228 may be operated at duty cycles up to 0.028, average power in excess of 340 watts is available.

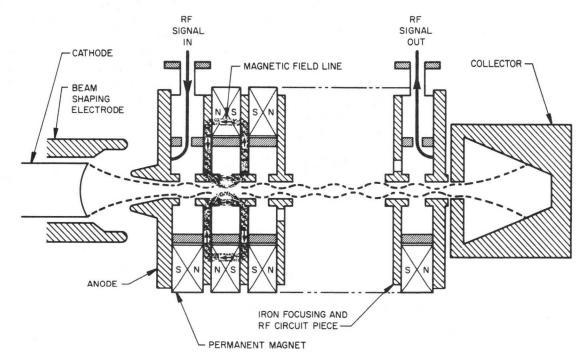
SPECIFICATIONS

PERFORMANCE	
Frequency	5.4 - 5.9 GHz 5.4 - 5.9 GHz
Power output (peak)	
Average of six points ¹	14 kw
Lowest point in band	—
Gain (at 0.5 w drive)	
Average of six points ¹	44.4 dB
	41.2 dB
Gain variation (at 0.5 w drive -6 points)	$\pm 0.6 \; dB$
ELECTRICAL REQUIREMENTS	Typical Range
	23.0 kV
	11.5 kV 12.0 ±0.5 kV
Collector current	
Without drive or depression	3.6 A peak 3.0 A peak min.
With drive, without depression	3.3 A peak 2.9 A peak min.
With drive and depression	2.6 A peak 2.0 A peak min.
* Supersedes WJ-228 Technical Data Sheet dated August 1967.	

¹At equal increments of 100 MHz



RF AND MAGNETIC CIRCUIT



NOTE:

THE MAGNETIC CIRCUIT IS INTEGRAL WITH THE RF CIRCUIT. IT CAN BE SEEN THAT A SECTION OF THE CAVITY WALL ALSO SERVES AS A FLUX GUIDE FOR THE MAGNETIC FOCUSING CIRCUIT.

WJ-228

SPECIFICATIONS (Cont'd)

Body current

Non-depressed.

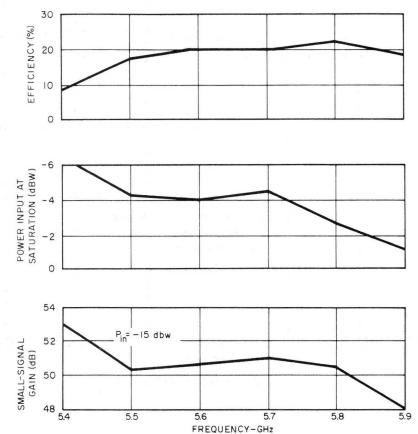
Without drive or depression 0.5 A peak 0.7 A peak max. With drive, without depression 0.8 A peak 1.2 A peak max. With drive and depression 1.7 A peak 2.3 A peak max. Duty cycle 0.024 0.024 Pulse duration 2 µsec 5 µsec max.
Grid pulse voltage
Grid current 0.5 A peak 0.7 A max. Grid capacitance (to all else)
Circuit and anode voltage Ground
Heater voltage 12 V 60 Hz ac 12 V 60 Hz ac 12.5 V max. Heater current 2.3 A 2.3 A 2.5 A max.
Ion pump voltage
MECHANICAL Weight (including ion pump) RF connectors ²
Depressed

. . . . 0.5 gpm of water -

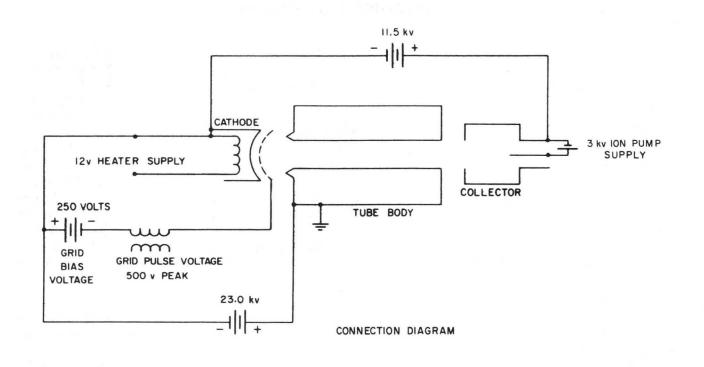
18 psig pressure drop max.

 $^2\text{Coaxial}$ to either ''C'' band waveguide or type N coax adaptors can be provided if desired

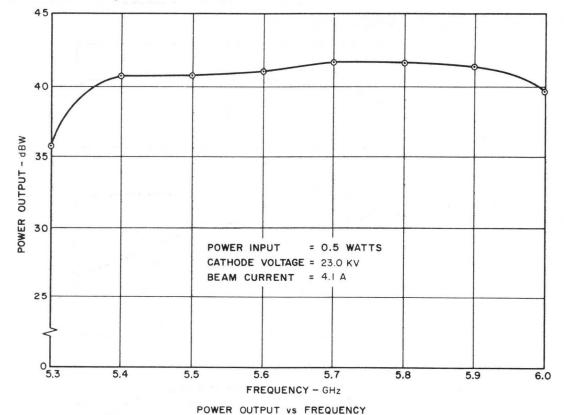
TYPICAL PERFORMANCE CHARACTERISTICS



CONNECTION DIAGRAM



POWER OUTPUT VS. FREQUENCY



JANUARY 1971

September 1968 *

5.0 TO 8.5 GHz 35-WATT CW PPM-FOCUSED TRAVELING-WAVE TUBE WJ-231-5

Watkins-Johnson WJ-231-5 is a versatile, wideband traveling-wave tube employing periodic-permanent-magnet focusing. Providing a guaranteed CW power output of 35 watts from 5.0 to 8.5 GHz, the WJ-231-5 is the basic tube used in the WJ-1015 satellite amplifier and the WJ-364 commercial amplifier. A separate power supply, the WJ-1024, is also available for operating the WJ-231-5. This power supply is available in versions for laboratory or military environments.

This TWT represents the end product of a series of developmental and production units fabricated for a high-reliability space program. Its design employs many of the techniques and components proven successful in earlier models of Watkins-Johnson medium-power traveling-wave tubes, e.g., stacked metal-ceramic electron-gun assembly, precision-aligned PPM focusing components, and beryllia wedge-supported helix structure.

Typical values of overall efficiency, saturation gain, and saturated power output are shown in the specifications below. Although the WJ-231-5 is listed for use between 5.0 and 8.5 GHz, it is capable of operating over an extended frequency range



from 4.0 to 9.0 GHz. In such application, the tube can be expected to produce a typical saturated output power of 35 watts and typical saturation gain of 30 dB. The gain, which is minimum at band edge, may be improved at one end of the band by slight adjustment of anode and helix voltages; this will result in a gain decrease at the opposite band edge. By operating the collector depressed, an overall efficiency of 23% is guaranteed. More than 26% is typical from 4.0 to 9.0 GHz, and, over narrower frequency ranges, efficiencies exceeding 30% can be achieved.

SPECIFICATIONS

PERFORMANCE CHARACTERISTICS Frequency Saturation Gain Saturation Power Output Small Signal Gain Efficiency (with collector depression) Noise Figure	34 dB 38 W 40 dB 26 to 30 %	30 dB, min. 35 W, min. 36 dB, min. 23%, min.
ELECTRICAL REQUIREMENTS Heater Voltage Heater Current Anode Voltage Anode Current Helix Voltage Helix Current Collector Voltage Collector Current Cathode Current	5.5 V 0.8 A .4750 V 0.1 mA .4600 V .2 mA .2000 V .60 mA	1.0 A, max. 4750 ±150 V 1.0 mA, max. 4600 ±150 V

*Supersedes WJ-231-5 Technical Bulletin, Volume 8, No. 11; July 1966

WJ-231-5

FIG. 1. TYPICAL PERFORMANCE CHARACTERISTICS

MECHANICAL CHARACTERISTICS

Height (connectors included) 3.20 inches (81mm)
Width 3.20 inches (81 mm)
Length 12.50 inches (318 mm)
Weight 4.50 lbs. (2.04 Kg)
Cooling Conduction
Focusing PPM
RF Connector TNC, female
DC Connections 12 inch flying leads

ENVIRONMENTAL CHARACTERISTICS

Can be qualified to meet requirements of MIL-E-5400.

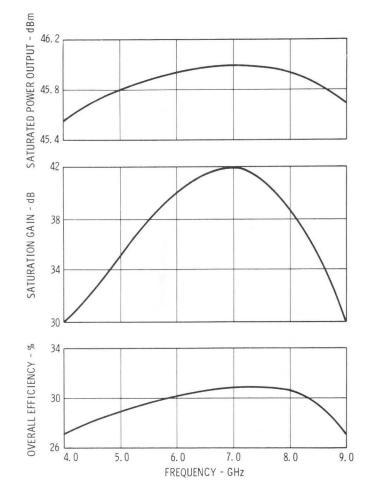
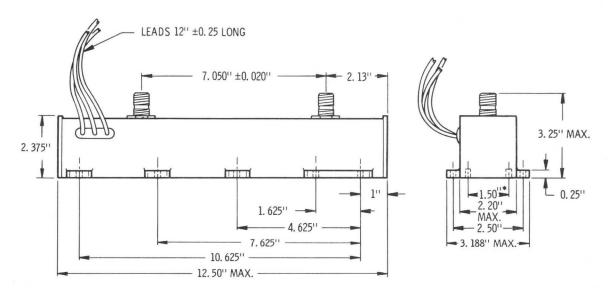


FIG. 2. OUTLINE DRAWING



OPTIONAL MODEL WITHOUT MOUNTING FLANGES ALSO AVAILABLE.

* DISTANCE BETWEEN MOUNTING HOLES WITH 8-32 UNC (SST INSERTS) 1/4" DP (10) PLACES ON MODELS WITHOUT MOUNTING FLANGES. WJ-231-5

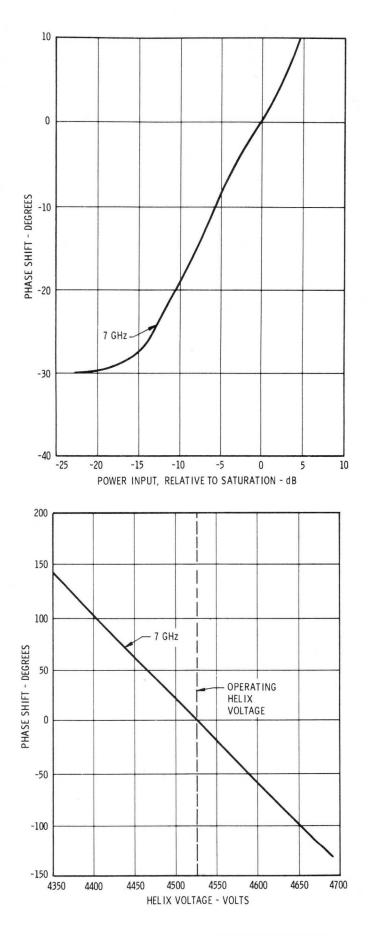
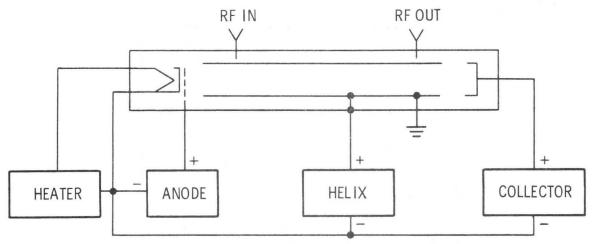


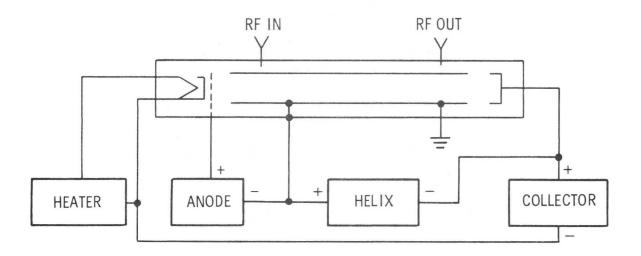
FIG. 3. TYPICAL PHASE CHARACTERISTICS

WJ-231-5



HEATER 0-6 VOLTS AC AT 1 AMPERE MAXIMUM ANODE 0-5000 VOLTS AT 1 mA MAXIMUM HELIX 0-4800 AT 10 mA MAXIMUM COLLECTOR 1800-2200 VOLTS AT 70 mA MAXIMUM

PREFERRED CONNECTION FOR LABORATORY-TYPE POWER SUPPLY CONFIGURATION.



HEATER 0-6 VOLTS AC AT 1A MAXIMUM ANODE 0-200 VOLTS AT 1 mA MAXIMUM HELIX 0-3000 VOLTS AT 10 mA MAXIMUM COLLECTOR 1800-2200 VOLTS AT 70 mA MAXIMUM

NOTE: WITH THIS CONFIGURATION, THE ANODE SUPPLY CANNOT CUT OFF TUBE EMISSION.

CONNECTION FOR HIGH EFFICIENCY POWER SUPPLY DESIGN AS USED IN A TYPICAL WATKINS-JOHNSON POWER SUPPLY.

FIG. 4. SUGGESTED POWER SUPPLY CONNECTION DIAGRAMS

April 1967 *

1.0 TO 2.0 GHz LOW-NOISE TRAVELING-WAVE AMPLIFIER WITH INTEGRAL POWER SUPPLY

- "JUST PLUG IT IN"
- NOISE FIGURE 5.0
 dB MAXIMUM
- PERMANENT-MAGNET FOCUSING
- NO ADJUSTMENTS NEEDED
- MEETS MIL-E-5400, CLASS 2 SPECIFICATION

The WJ-268 is the L-band member of the Watkins-Johnson family of Standard low-noise amplifiers with integral solid-state power supply. When introduced to the microwave industry in 1963, the WJ-268's performance in the 1.0 to 2.0 GHz range was unparalleled by other devices. Today, this performance still remains better than or comparable to any commercially available unit. With hundreds of units in use throughout the world, the WJ-268 provides low noise figure (many production amplifiers exhibit noise figures of less than 4 dB), low cost per-operating-hour, and high field-proven reliability (MTBF's in excess of 20,000 hours with 99% confidence level).

This proven amplifier is completely self-contained,





adjustment-free, and requires only a 115 volt ac linevoltage input (48 to 420 Hz). The completely shielded package may be operated in any orientation, in stacked arrays or adjacent to ferromagnetic material, without adversely affecting the amplifier's performance.

Rugged construction of the tube, magnet, and power supply assembly assures reliable operation under vibrational forces of 10 g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of -54° C to $+71^{\circ}$ C. The environmental characteristics of the WJ-268 meet the corresponding requirements of MIL-E-5400, Class 2 Specification.

SPECIFICATIONS

PERFORMANCE							Typical Guaranteed
Frequency							1.0 to 2.0 GHz 1.0 to 2.0 GHz
							4.5 dB 5.0 db, max.
Gain, Small Signal	÷			÷.,	×		30 dB
							1.5:1 2:1, max.
Power Output, Saturated							— 5 dBm — 10 dBm, min.
ELECTRICAL REQUIREMEN	ITS						Typical Range ¹
Primary Voltage		×.	,	,			115 V ac 115 \pm 10 V ac
Primary Frequency			x				60 Hz
Primary Power	Υ.						~ 25 W

^tThis Technical Data Sheet presents up-to-date information on the WJ-268, first described in Technical Bulletin Volume 5, No. 2; March, 1963.

WJ-268

MECHANICAL CHARACTERISTICS

Height 4.75 inches (121 mm) max. Width 4.75 inches (121 mm) max.
Length (excluding connectors) 12 inches (305 mm) max.
Weight 17 pounds (7.71 Kg) max.
Primary Power Connection, Deutsch Receptacle DM9601-3P
RF Connections (50 ohms, nominal) Type N, jack
Reference Drawing Number 290000

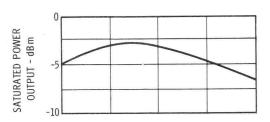
ENVIRONMENTAL CHARACTERISTICS²

Temperature, Operating .		—54°C to +71°C
Vibration		
0.10 Inch Double Amplit	ude	5 to 45 Hz

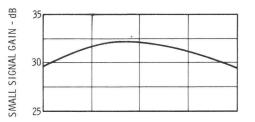
0.10 1	101	, 0	Jui	010	1.11	npi	 auo		. 0 .0 .0
10 g,	Sir	Igle	A	mp	litu	Ide			45 to 500 Hz
Shock									15 g, 11 ms

- 1. Every amplifier will meet the guaranteed performance specifications for any primary voltage and frequency within these ranges.
- 2. These environmental characteristics meet the respective requirements of MIL-E-5400, Class 2 Specification.

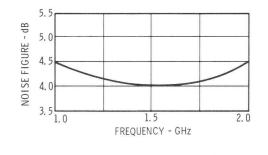
POWER



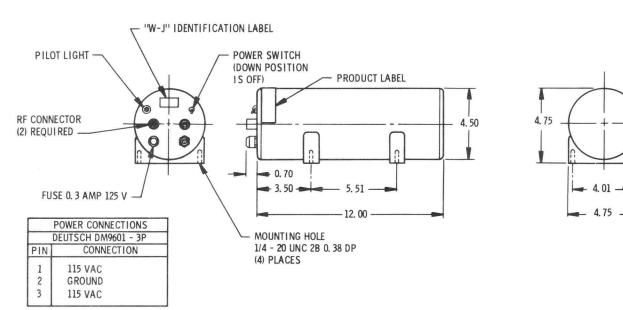
GAIN



NOISE



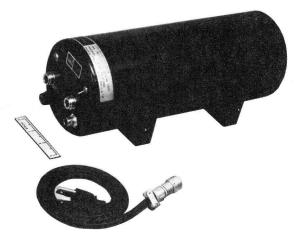
OUTLINE DRAWING



June 1968 ≭

WJ-268-2

1.0 TO 2.6 GHz LOW-NOISE TRAVELING-WAVE AMPLIFIER WITH INTEGRAL POWER SUPPLY



The WJ-268-2 is an extended frequency version of the Watkins-Johnson family of Standard low-noise amplifiers with integral solid-state power supply. When introduced to the microwave industry in 1963, this amplifier's performance in the 1.0 to 2.6 GHz range was unparalleled by other devices. Today, this performance still remains better than or comparable to any commercially available unit. With hundreds of units in use throughout the world, the WJ-268-2 provides low noise figure (many production amplifiers exhibit noise figures of less than 4 dB), low cost per-operating-hour and high field-proven reliability (MTBF's in excess of 20,000 hours with 99% confidence level).

This proven amplifier is completely self-contained,

- "JUST PLUG IT IN"
- NOISE FIGURE 5.5
 dB MAXIMUM
- PERMANENT-MAGNET FOCUSING
- NO ADJUSTMENTS NEEDED
- MEETS MIL-E-5400, CLASS 2 SPECIFICATION

adjustment-free, and requires only 115 volt ac line-voltage input (48 to 420 Hz). The completely shielded package may be operated in any orientation, in stacked arrays or adjacent to ferromagnetic material, without adversely affecting the amplifier's performance.

Rugged construction of the tube, magnet, and power supply assembly assures reliable operation under vibrational forces of 10 g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of -54 °C to +71 °C. The environmental characteristics of the WJ-268-2 meet or exceed the corresponding requirements of MIL-E-5400, Class 2 Specification.

SPECIFICATIONS

PERFORMANCE	Typical	Guaranteed
Frequency	1.0 to 2.6 GHz	1.0 to 2.6 GHz
Noise Figure, Terminal	4.5 dB	5.5 dB, max.
Gain, Small Signal	30 dB	25 dB, min.
VSWR, Input and Output	1.5:1	2:1, max.
Power Output, Saturated	–5 dBm	
ELECTRICAL REQUIREMENTS	Typical	Range
ELECTRICAL REQUIREMENTS Primary Voltage Primary Frequency	115 V ac	115 ±10 V ac
Primary Voltage		115 ±10 V ac
Primary Voltage	115 V ac 	115 ±10 V ac

No. 6; August, 1963.

WJ-268-2

ENVIRONMENTAL CHARACTERISTICS

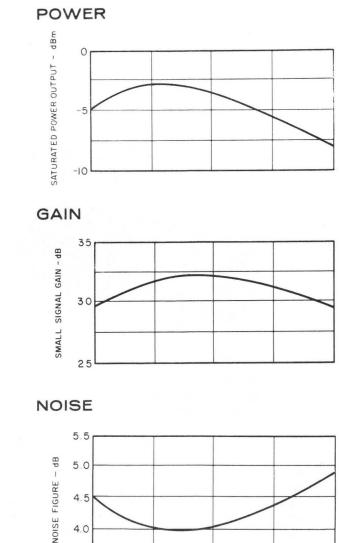
Temperature (Operating)54°C to +71°C
Vibration
0.10 Inch, Double Amplitude 5 to 45 Hz
10 g, Single Amplitude
Shock 15 g, 11 ms

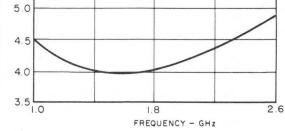
MECHANICAL CHARACTERISTICS

Amplifier Length	
(excluding connectors) 12 inches, max	٢.
Amplifier Height and Width 4.75 inches, max	٢.
Amplifier Weight 17 lbs., max	κ.
Primary Power Connection, Deutsch Receptacle DM9601-3	Ρ
RF Connections (50 ohms, nominal) Type N, jac	
Reference Drawing Number	0

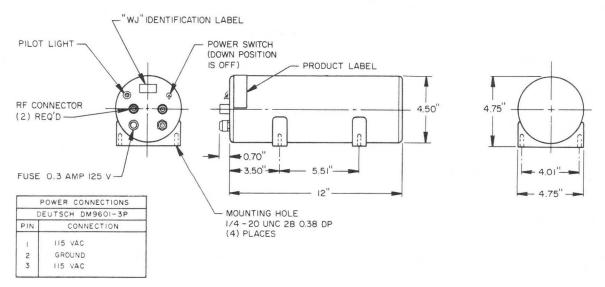
Every amplifier will meet the guaranteed performance specifications for any primary voltage and frequency within these ranges.

These environmental characteristics meet the respective requirements of MIL-E-5400, Class 2 Specification.





OUTLINE DRAWING



3400-1 June 1968

February 1967

2.0 TO 4.0 GHz LOW-NOISE TRAVELING-WAVE AMPLIFIER WITH INTEGRAL POWER SUPPLY WJ-269



The WJ-269 is one of the original members of Watkins-Johnson's family of Standard low-noise amplifiers with integral solid-state power supply. When introduced to the microwave industry in 1963, the WJ-269's performance in the 2.0 to 4.0 GHz range was unparalleled by other devices. Today, this performance still remains better than or comparable to any commercially available unit. With hundreds of units in use throughout the world, the WJ-269 provides low noise figure (many production amplifiers exhibit noise figures of less than 5 dB), low cost peroperating-hour and high field-proven reliability (MTBF's in excess of 20,000 hours with 99% confidence level).

This proven amplifier is completely self-contained,

- "JUST PLUG IT IN"
- NOISE FIGURE 5.5
 dB MAXIMUM
- PERMANENT-MAGNET FOCUSING
- PROVEN RELIABILITY
- NO ADJUSTMENTS NEEDED
- 115 VOLT, 48 TO 420 Hz OPERATION
- MEETS MIL-E-5400, CLASS 2 SPECIFICATION

adjustment-free, and requires only a 115 volt ac linevoltage input (48 to 420 Hz). The completely shielded package may be operated in any orientation, in stacked arrays or adjacent to ferromagnetic material, without adversely affecting the amplifier's performance.

Rugged construction of the tube, magnet, and power supply assembly assures reliable operation under vibrational forces of 10 g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of -54° C to $+71^{\circ}$ C. The environmental characteristics of the WJ-269 meet or exceed the corresponding requirements of MIL-E-5400, Class 2 Specification.

SPECIFICATIONS

PERFORMANCE	ТурісаІ	Guaranteed
Frequency	2.0 to 4.0 GHz	.0 to 4.0 GHz
Noise Figure, Terminal	4.8 dB	5.5 dB, max.
Gain, Small Signal	30 dB	. 25 dB, min.
VSWR, Input and Output	1.5:1	. 2:1, max.
Power Output, Saturated	— 3 dBm	I0 dBm, min.
ELECTRICAL REQUIREMENTS	Typical	Range
Primary Voltage	115 Vac 1	15 ± 10 V ac
Primary Frequency	60 Hz	48 to 420 Hz
Primary Power	25 W	

This Technical Data Sheet presents up-to-date information on the WJ-269, first described in Technical Bulletin Volume 5, No. 3; March, 1963.

WJ-269

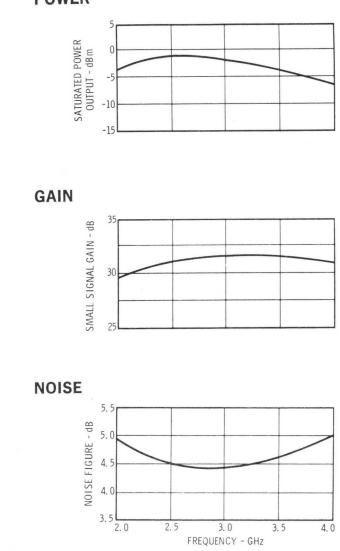
ENVIRONMENTAL CHARACTERISTICS²

Temper	atu	re	(0)	ber	ati	ng)			-	54	°C to +71°C	
Vibratic	n											
0.10	nc	h, I	Doi	ldu	еA	mp	litu	ude			. 5 to 45 Hz	7
10 g,	Si	ngl	еA	mp	olit	ude	è				45 to 500 Hz	7
Shock											15 g, 11 ms	5

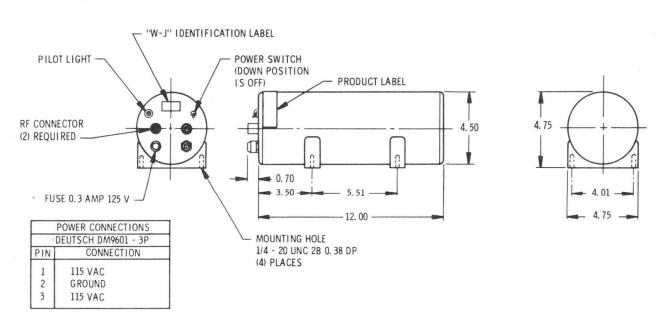
MECHANICAL CHARACTERISTICS

Height
Length (excluding connectors) 12 inches (305 mm) max.
Weight 17 pounds (7.71 Kg) max.
Primary Power Connection, Deutsch Receptacle DM9601-3P
RF Connections (50 ohms, nominal Type N, jack
Reference Drawing Number 290000

- 1. Every amplifier will meet the guaranteed performance specifications for any voltage and frequency lying with in these ranges.
- 2. These environmental characteristics meet the respective requirements of MIL-E-5400, Class 2 Specification.



OUTLINE DRAWING



POWER



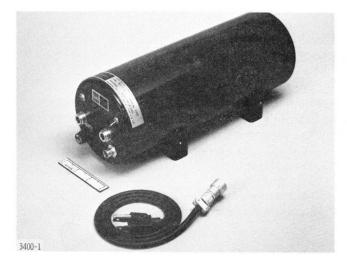
July 1968 ≭

2.3 TO 4.5 GHz LOW-NOISE TRAVELING-WAVE AMPLIFIER WITH INTEGRAL POWER SUPPLY

- "JUST PLUG IT IN"
- NOISE FIGURE 6.0 dB MAXIMUM
- PERMANENT-MAGNET FOCUSING
- PROVEN RELIABILITY
- NO ADJUSTMENTS
 NEEDED
- 115 VOLT, 48 TO 420 Hz OPERATION
- MEETS MIL-E-5400, CLASS 2 ENVIRONMENT

The WJ-269-1 is one of the original members of Watkins-Johnson's family of Standard low-noise amplifiers with integral solid-state power supply. When introduced to the microwave industry in 1963, the performance of the WJ-269-1 in the 2.3 to 4.5 GHz range was unparalleled by other devices. Today, this performance still remains better than any other commercially available unit, and thousands of units are in use throughout the world. The WJ-269-1 provides low noise figures (many production amplifiers exhibit noise figures of less than 5 dB), low cost per-operating-hour and high field-proven reliability (MTBF's in excess of 20,000 hours with 99% confidence level).

This proven amplifier is completely self-contained,



adjustment-free and requires only 115 volt ac line-voltage input (48 to 420 Hz). The completely shielded package may be operated in any orientation, in stacked arrays or adjacent to ferromagnetic material, without adversely affecting the amplifier's performance.

Rugged construction of the tube, magnet, and power supply assembly assures reliable operation under vibrational forces of 10 g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of -54 °C to +71 °C. The environmental characteristics of the WJ-269-1 meet or exceed the corresponding requirements of MIL-E-5400, Class 2 Specification.

SPECIFICATIONS

PERFORMANCE	Typical	Guaranteed
Frequency	.2.3 to 4.5 GHz	2.3 to 4.5 GHz
Noise Figure, Terminal	5.3 dB	6.0 dB, max.
Gain, Small Signal	.28 dB	25 dB, min.
VSWR, Input and Output		
Power Output, Saturated	.—5 dBm	—10 dBm, min.
ELECTRICAL REQUIREMENTS		Range
Primary Voltage	.115 V ac	115 ±10 V ac
Primary Frequency	60 Hz	48 to 420 Hz
Primary Current	.170 mA	
Primary Power		

*This Technical Data Sheet presents up-to-date information on the WJ-269-1 first described in Technical Bulletin Volume 5, No. 7; August, 1963.

WJ-269-1

ENVIRONMENTAL CHARACTERISTICS²

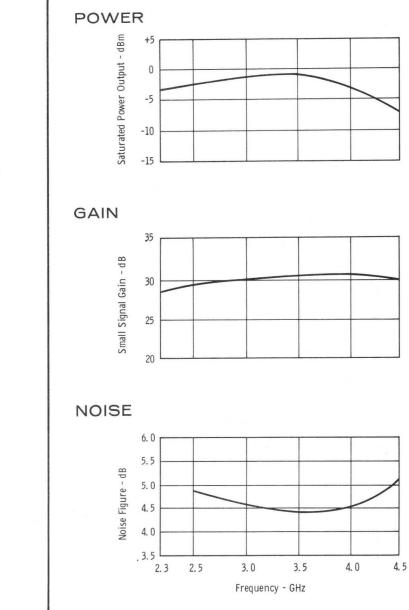
MECHANICAL CHARACTERISTICS

Amplifier Length

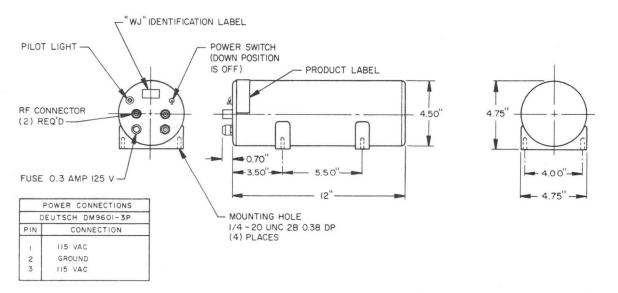
(excluding connectors) 12 inches, max	κ.
Amplifier Height and Width 4.75 inches, max	κ.
Amplifier Weight 17 lbs., max	Χ.
Primary Power Connection,	
Deutsch Receptacle DM9601-3	Ρ
RF Connections	
(50 ohms, nominal) Type N, jac	:k
Reference Drawing Number	0

¹Every amplifier will meet the guaranteed performance specifications for any primary voltage and frequency lying within these ranges.

²These environmental characteristics meet or exceed the respective requirements of MIL-E-5400, Class 2 Specification.



OUTLINE DRAWING



March 1967 *

4.0 TO 8.0 GHz LOW-NOISE TRAVELING-WAVE AMPLIFIER WITH INTEGRAL POWER SUPPLY WJ-271



The WJ-271 is the C-band member of the Watkins-Johnson family of Standard low-noise amplifiers with integral solid-state power supply. When introduced to the microwave industry in 1963, the WJ-271's performance in the 4.0 to 8.0 GHz range was unparalleled by other devices. Today, this performance still remains better than or comparable to any commercially available unit. With hundreds of units in use throughout the world, the WJ-271 provides low noise figure (many production amplifiers exhibit noise figures of less than 6 dB), low cost per-operating-hour, and high field-proven reliability (MTBF's in excess of 20,000 hours with 99% confidence level).

This proven amplifier is completely self-contained,

- "JUST PLUG IT IN"
- NOISE FIGURE 6.5 dB MAXIMUM
- PERMANENT-MAGNET FOCUSING
- PROVEN RELIABILITY
- NO ADJUSTMENTS NEEDED
- 115 VOLT, 48 TO 420 Hz OPERATION
- MEETS MIL-E-5400, CLASS 2 SPECIFICATION

adjustment-free, and requires only a 115 volt ac linevoltage input (48 to 420 Hz). The completely shielded package may be operated in any orientation, in stacked arrays or adjacent to ferromagnetic material, without adversely affecting the amplifier's performance.

Rugged construction of the tube, magnet, and power supply assembly assures reliable operation under vibrational forces of 10 g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of -54° C to $+71^{\circ}$ C. The environmental characteristics of the WJ-271 meet the corresponding requirements of MIL-E-5400, Class 2 Specification.

SPECIFICATIONS

PERFORMANCE	Typical Guaranteed
Frequency	4.0 to 8.0 GHz 4.0 to 8.0 GHz
Noise Figure, Terminal	5.5 dB 6.5 dB, max.
Gain, Small Signal	30 dB
VSWR, Input and Output	1.5:1 2:1, max.
Power Output, Saturated +3	3.0 dBm
ELECTRICAL REQUIREMENTS	Typical Range
Primary Voltage	115 V ac
Primary Frequency	
Primary Power	~ 25 W

★ This Technical Data Sheet presents up-to-date information on the WJ-271, first described in Technical Bulletin Volume 6, No. 2; February, 1964.

WJ-271

ENVIRONMENTAL CHARACTERISTICS

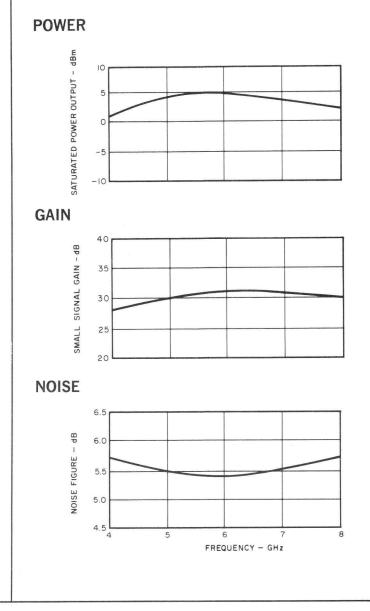
Temperature (Operating) $-54^\circ C$ to $+71^\circ C$
Vibration 0.10 Inch, Double Amplitude 5 to 45 Hz
10 g, Single Amplitude 45 to 500 Hz
Shock

MECHANICAL CHARACTERISTICS

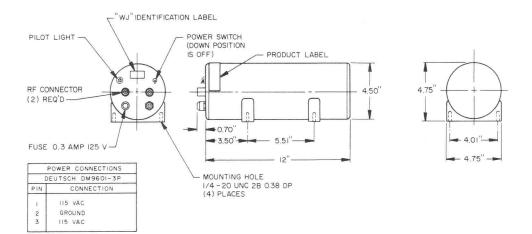
Amplifier Length
(excluding connectors) 12 inches, max.
Amplifier Height and Width . 4.75 inches, max.
Amplifer Weight 17 lbs, max.
Primary Power Connection,
Deutsch Receptacle DM9601-3P
RF Connections
(50 ohms, nominal) Type N, jack

Every amplifer will meet the guaranteed performance specifications for any primary voltage and frequency within these ranges.

These environmental characteristics meet the respective requirements of MIL-E-5400, Class 2 Specification.



OUTLINE DRAWING



3400-1 March 1967

AUGUST 1970*

4.0 TO 8.0 GHz LOW-NOISE TRAVELING-WAVE AMPLIFIER WITH INTEGRAL POWER SUPPLY WJ-271-30



The WJ-271-30 is a full C-band member of the WJ-271 family of Standard low-noise amplifiers with integral solid-state power supply. When introduced to the microwave industry in 1963, the WJ-271's performance in the 4.0 to 8.0 GHz range was unparalleled by other devices. Today, this performance still remains better than or comparable to any commercially available unit. With hundreds of units in use throughout the world, the WJ-271 family provides low noise figure (many production amplifiers exhibit noise figures of less than 6 dB), low cost per-operating-hour, and high field-proven reliability (MTBF's in excess of 20,000 hours with 99% confidence level).

This proven amplifier is completely self-contained,

- "JUST PLUG IT IN"
- NOISE FIGURE 7.0 dB MAXIMUM
- PERMANENT-MAGNET FOCUSING
- PROVEN RELIABILITY
- NO ADJUSTMENTS
 NEEDED
- 115 VOLT, 48 TO 420 Hz OPERATION
- MEETS MIL-E-5400, CLASS 2 SPECIFICATION

adjustment-free, and requires only a 115 volt ac linevoltage input (48 to 420 Hz). The completely shielded package may be operated in any orientation, in stacked arrays or adjacent to ferromagnetic material, without adversely affecting the amplifier's performance.

Rugged construction of the tube, magnet, and power supply assembly assures reliable operation under vibrational forces of 10 g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of -54 °C to +71 °C. The environmental characteristics of the WJ-271-30 meet the corresponding requirements of MIL-E-5400, Class 2 Specification.

PERFORMANCE	Typical Guaranteed
Frequency	4.0 to 8.0 GHz 4.0 to 8.0 GHz
Noise Figure, Terminal	6.3 dB 7.0 dB, max.
Gain, Small Signal	30 dB
VSWR, Input and Output	1.5:1 2:1, max.
Power Output, Saturated	+3.0 dBm
ELECTRICAL REQUIREMENTS	Typical Range ¹
Primary Voltage	115 V ac 115 ± 10 V ac
	60 Hz
Primary Power	· · · 14 W
Primary Current	175 mA

SPECIFICATIONS

1. Every amplifer will meet the guaranteed performance specifications for any primary voltage and frequency within these ranges. *Supersedes WJ-271-30 Technical Data Sheet dated JUNE 1970.

WJ-271-30

ENVIRONMENTAL CHARACTERISTICS²

Temperature (Operating)5	$54^{\circ}C$ to $+71^{\circ}C$
Vibration	
0.10 Inch, Double Amplitude .	. 5 to 45 Hz
10 g, Single Amplitude	45 to 500 Hz
Shock	. 15 g, 11 ms

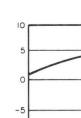
MECHANICAL **CHARACTERISTICS**

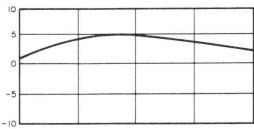
Height 4.75 inches (121 mm) max.
Width 4.75 inches (121 mm) max.
Length (excluding
connectors) 12 inches (305 mm) max.
Weight 17 lbs. (7.71 Kg)
Primary Power Connection Deutsch Receptacle DM9601-3P
RF Connections
(50 ohms, nominal) Type N, jack
Reference Drawing Number 290000

2. These environmental characteristics meet the respective requirements of MIL-E-5400, Class 2 Specification.

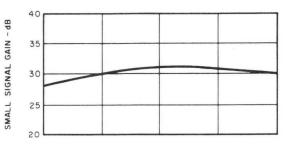
POWER

SATURATED POWER OUTPUT - dBm

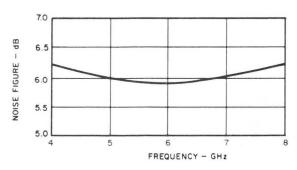




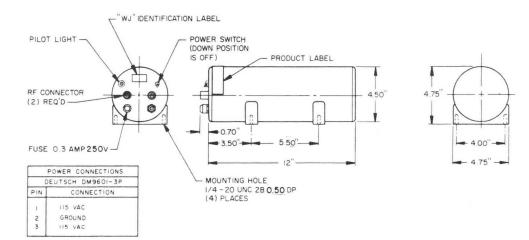
GAIN



NOISE



OUTLINE DRAWING



June 1967

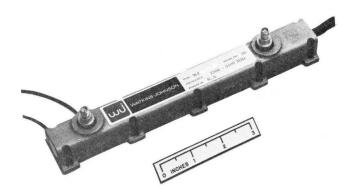
2.2 TO 2.4 GHz COMPACT 20-WATT TRAVELING-WAVE TUBE FOR SPACE COMMUNICATIONS AND TELEMETRY WJ-274-2

The WJ-274-2 is a medium power traveling-wave tube developed to meet the requirements of satellite and deep-space transmitter applications where high reliability, small size, light weight and maximum overall efficiency are essential.

This small, periodic-permanent-magnet focused TWT exhibits an overall efficiency, including heater power, above 30%. The metal-ceramic construction of the WJ-274-2 is just one of the design features used to assure the maximum in reliable, long-life operation. It has the ability to perform during and after extreme temperature, vibration, shock, and static acceleration.

The WJ-274-2 will deliver 20 watts of output power over the frequency range of 2.2 to 2.4 GHz. By operating the tube under different sets of voltage conditions, saturated output levels from 10 to 35 watts can be provided while maintaining a fixed value of gain without significantly affecting efficiency. Therefore, it is necessary to change only the helix, anode, and collector voltages to obtain an optimum condition for any desired power level. Efficiency generally improves with an increased power level for the tube, enabling the user to cover a range of power requirements with one tube.

The power output, gain, and efficiency are very nearly constant over the specified frequency range, as shown in Fig. 1. The noise characteristics of the tube shown in Fig. 3 are for undriven (carrier off)



and saturation drive (carrier on) conditions, with and without a low-pass filter at the tube's output. The power transfer curves of Fig. 4 show that the output power at saturation is relatively unchanged with a substantial change in drive power.

A number of variations of the WJ-274-2 are available which optimize performance at various other frequencies and power levels. The tube can be made to meet environmental conditions more stringent than those described in the Specifications. Manufactured under rigid quality assurance specifications, versions of this tube have also been qualified for space applications.

PERFORM	MANCE							Typical		Guaranteed
	Frequency							2.2-2.4 GHz		2.2-2.4 GHz
	Power Output, Sa									
	Gain, Saturation							35 dB		30 dB, min.
	Efficiency				×			33%		30%, min.
ELECTRI	CAL REQUIREME	NTS	5					Typical		Range
	Heater Voltage							3.0 V .		2.5 to 3.5 V
	Heater Current							0.8 A .		0.7 to 1.0 A
	Anode Voltage							1820 V .		$1820\pm100V$
	Anode Current							0.4 mA .		1.0 mA, max.
	Helix Voltage .							1620 V .		$1620\pm100V$
	Helix Current .							5.6 mA .		10.0 mA, max.
	Collector Voltage).					~	1115V .		$1115\pm55V$
	Collector Current	t.						46 m A .		54 mA, max.
	Cathode Current							52 mA .		54 mA, max.

SPECIFICATIONS

ENVIRONMENTAL CHARACTERISTICS

Heat Sink Temperature Vibration		-20°C to +85°C
a) Sinusoidal (2 min/octave) .		0.5 inch, double amplitude, 5 to 18 Hz, ±20 g peak, 18 to 2000 Hz
b) Random		
(5 min/axis)		0.1 g²/Hz, 20 to
		2000 Hz
Acceleration (1 min/axis))	100 g
Shock		75 g,11 ms

MECHANICAL CHARACTERISTICS

Height

101611
(excluding connectors) 0.9 inches (23 mm) max.
Width 1 inch (25 mm) max.
Length 9.2 inches (234 mm) max.
Weight 18 ounces (510 g)
RF Connectors OSM, female
DC Connectors Flying Leads
Cooling Conduction from bottom surface

¹Efficiency is defined as the minimum RF output power across the band, divided by the total dc power input, including heater power.



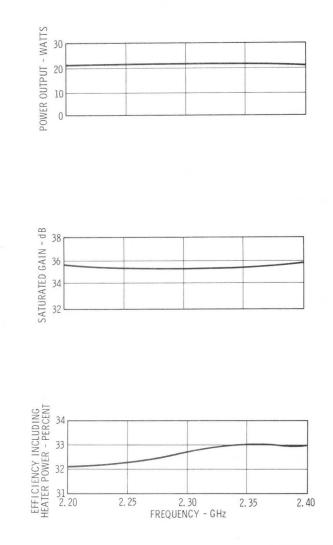


FIG. 2 OUTLINE DRAWING

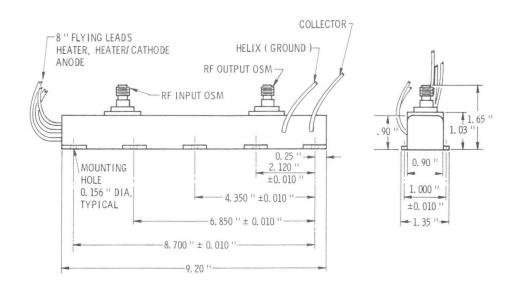
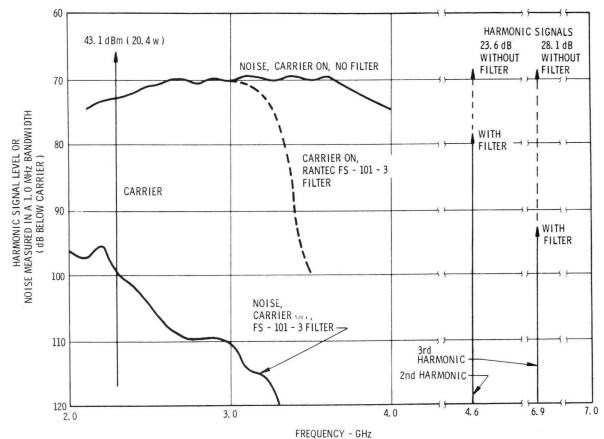
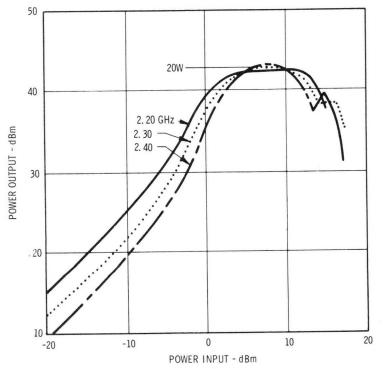


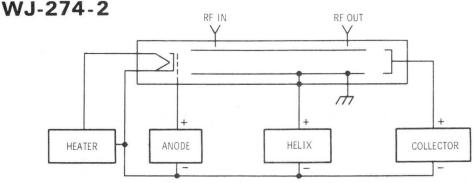
FIG. 3 TYPICAL NOISE AND HARMONIC CHARACTERISTICS



FREQUENCE - GF

FIG. 4 TYPICAL POWER TRANSFER CHARACTERISTICS





HEATER 2.5-3.5 VOLTS AC AT 1 AMPERE MAXIMUM ANODE 1720-1920 VOLTS AT 1 mA MAXIMUM HELIX 1520-1720 AT 10 mA MAXIMUM COLLECTOR 1060-1170 VOLTS AT 54 mA MAXIMUM

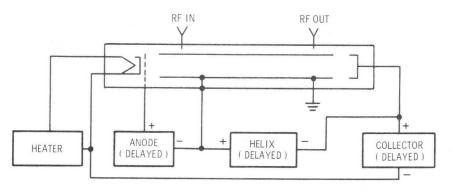
NOTE:

TO ENSURE THAT THE TWT IS OPERATED PROPERLY, IT IS SUGGESTED THAT VOLTAGES BE AP-PLIED AS FOLLOWS:

- 1. SLOWLY APPLY FILAMENT VOLTAGE UNTIL SPECIFIED VALUE IS REACHED, OBSERVING THAT FIL-AMENT CURRENT DOES NOT EXCEED MAXIMUM VALUE. ALLOW AT LEAST 2 MINUTES FOR FILA-MENT VOLTAGE TO STABILIZE.
- 2. SLOWLY APPLY COLLECTOR VOLTAGE UNTIL SPECIFIED VALUE IS REACHED, OBSERVING THAT COLLECTOR CURRENT DOES NOT EXCEED MAXIMUM VALUE.
- 3. SET ADJUSTABLE OVERCURRENT DISCONNECT CIRCUIT FOR MAXIMUM HELIX CURRENT VALUE SPECIFIED, THEN SLOWLY INCREASE HELIX VOLTAGE TO SPECIFIED VALUE.
- 4. SLOWLY INCREASE ANODE VOLTAGE TO SPECIFIED VALUE, OBSERVING THAT CURRENT DOES NOT EXCEED MAXIMUM VALUE.

HELIX DISCONNECT CIRCUIT SHOULD FUNCTION SUCH THAT ALL VOLTAGES WILL BE DISABLED WITHIN 100 #SEC IF HELIX CURRENT EXCEEDS MAXIMUM VALUE.

FIG. 5 PREFERRED CONNECTION FOR LABORATORY-TYPE POWER SUPPLY **CONFIGURATION FOR WJ-274-2**



HEATER 2.5-3.5 VOLTS AC AT 1 AMPERE MAXIMUM.

ANODE 1720-1920 VOLTS AT 1 mA MAXIMUM (SUM OF ANODE, HELIX, AND

COLLECTOR SUPPLIES)

HELIX 1520-1720 VOLTS AT 10 mA MAXIMUM (SUM OF HELIX AND COLLECTOR SUPPLIES)

COLLECTOR 1060-1170 VOLTS AT 54 mA MAXIMUM

NOTE

FIG. 6 PREFERRED CONNECTION FOR HIGH-DENSITY POWER SUPPLY

- WITH THIS CONFIGURATION, ANODE SUPPLY CANNOT CUTOFF TUBE EMISSION. TO PREVENT DAM-AGE TO TWT, VOLTAGES MUST BE APPLIED TO TWT IN THE FOLLOWING SEQUENCE:
- 1. APPLY HEATER VOLTAGE SLOWLY TO ALLOW FILAMENT RESISTANCE CHANGE AS TEMPERA-

- TURE RISES.

- 2. COLLECTOR, HELIX, AND ANODE VOLTAGES MAY BE APPLIED SIMULTANEOUSLY AFTER HEATER VOLTAGE HAS BEEN ON FOR 2 MINUTES MINIMUM.

CAUTION HELIX OVERCURRENT DISCONNECT CIRCUIT MUST BE SET FOR MAXIMUM HELIX CURRENT VALUE SPECIFIED AND MUST DISCONNECT ALL VOLTAGES IN LESS THAN 100 $_{\mu}\text{SEC}$ IF MAXIMUM VALUE IS EXCEEDED.

CONFIGURATION FOR WJ-274-2.



January 1968

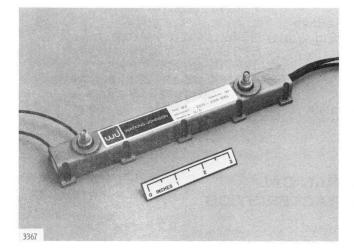
2.2 TO 2.4 GHz COMPACT VARIABLE POWER LEVEL TRAVELING-WAVE TUBE FOR SPACE COMMUNICATIONS AND TELEMETRY

The WJ-274-8 is a medium power traveling-wave tube developed to meet the requirements of satellite and deep-space transmitter applications where high reliability, small size, light weight and maximum overall efficiency are essential.

This small, periodic-permanent-magnet focused TWT exhibits an overall efficiency, including heater power, above 24%. The metal-ceramic construction of the WJ-274-8 is just one of the design features used to assure the maximum in reliable, long-life operation. It has the ability to perform during and after extreme temperature, vibration, shock, and static acceleration.

The WJ-274-8 will deliver 20 watts of output power over the frequency range of 2.2 to 2.4 GHz. By operating the tube under different sets of voltage conditions, saturated output levels from 10 to 35 watts can be provided while maintaining a fixed value of gain without significantly affecting efficiency. Therefore, it is necessary to change only the helix, anode, and collector voltages to obtain an optimum condition for any desired power level. Efficiency generally improves with an increased power level for the tube, enabling the user to cover a range of power requirements with one tube.

The power transfer curves of Fig. 1 show that the output power at saturation is relatively unchanged



with a substantial change in drive power, and for constant drive, the tube can give 11.75 W or 22.3 W at constant efficiency.

A number of variations of the WJ-274-8 are available which optimize performance at various other frequencies and power levels. The tube can be made to meet environmental conditions more stringent than those described in the Specifications. Manufactured under rigid quality assurance specifications, versions of this tube have also been qualified for space applications.

SPECIFICATIONS

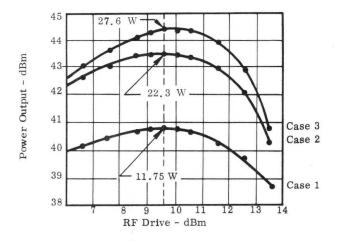
PERFORMANCE Frequency Power Output, Saturated Gain, Saturation Efficiency	Typical . 2.2-2.4 GHz . 11.75 W . 31 dB	MODE Guaranteed 2.2-2.4 GHz 10 W 29 dB 24%	Typical	MODE Guaranteed 2.2-2.4 GHz 20 W 32 dB 24%
ELECTRICAL REQUIREMENTS TWT Voltages Anode (VDC) Helix (VDC) Collector (VDC)	Typical . 1563 . 1515 . 951	/ MODE Range 1563 ±100 1515 ±100 951 ±100 3.5 ±0.5	20 W Typical 2057 1640 1252 3.5	/ MODE Range 2057 ±100 1640 ±100 1252 ±100 3.5 ±0.5
Heater (VRMS) TWT Currents Anode (mA) Helix (mA) Collector (mA) Heater (A)	. 0.4 . 5.0 . 30.8	0.5 max. 10.0 max. 40.0 max. 0.9 max.	0.4 8.0 46.1 0.8	0.5 max. 10.0 max. 60.0 max. 0.9 max.

ENVIRONMENTAL CHARACTERISTICS

Heat Sink Temperature —20°C to +85°C								
Vibration								
a. Sinusoidal								
(2 min/octave) 0.5 inch double amplitude,								
5 to 18 cps \pm 20 g, peak,								
18 to 2000 cps								
b. Random								
(5 min/axis) 20-59 cps at 0. 4 g²/cps								
59-126 cps at 9 dB/octave								
126-700 cps at 0. 4 g ² /cps								
700-900 cps at -18 dB/octave								
900-2000 cps at 0.09 g ² /cps								
Acceleration (1 min/axis) 100 g								
Shock								



Tube Length 9.2 inches, max.
Tube Cross-Section
(excluding connectors 0.95 x 1.35 inch, max.
RF Connectors OSM (Female)
DC Connectors Flying Leads
Tube Weight 20 ounces, max.
Cooling Conduction from bottom surface

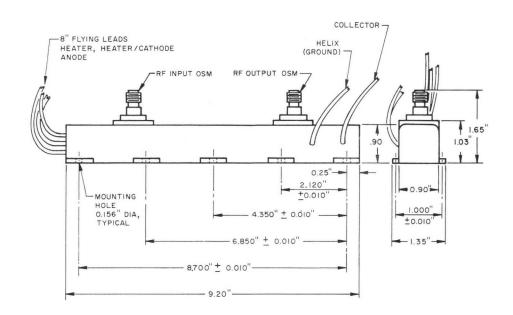


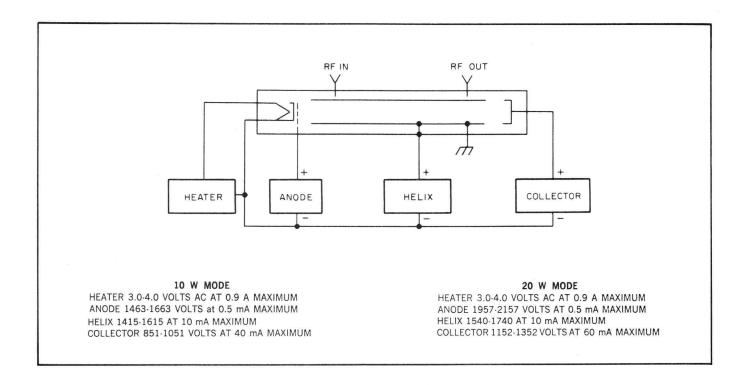
FREQUENCY: 2300 MHz

	Case 1	Case 2	Case 3
Power Output (W) Drive (dBm)	11.75 9.6	22.3 9.6	27.6
Overall Efficiency (%)	28.4	28.9	26.7
Gain (dB)	31.2	33.9	34.8

FIG. 1 PERFORMANCE CHARACTERISTICS

FIG. 2. OUTLINE DRAWING





NOTE:

TO ENSURE THAT THE TWT IS OPERATED PROP-ERLY, IT IS SUGGESTED THAT VOLTAGES BE AP-PLIED AS FOLLOWS:

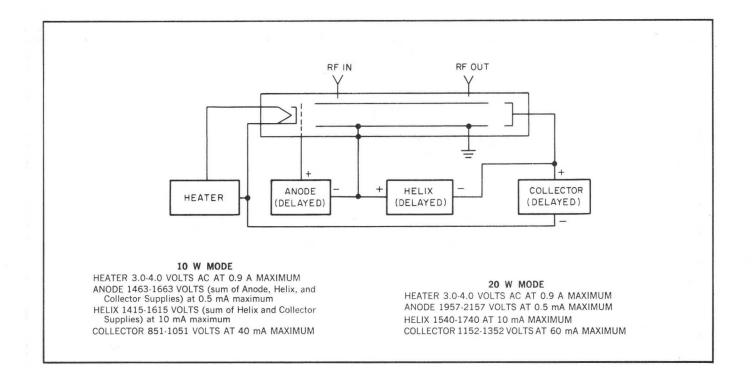
- 1. SLOWLY APPLY FILAMENT VOLTAGE UNTIL SPEC-IFIED VALUE IS REACHED, OBSERVING THAT FILAMENT DOES NOT EXCEED MAXIMUM VALUE. ALLOW AT LEAST 2 MINUTES FOR FILAMENT VOLTAGE TO STABILIZE.
- 2. SLOWLY APPLY COLLECTOR VOLTAGE UNTIL SPECIFIED VALUE IS REACHED.
- 3. SET ADJUSTABLE OVERCURRENT DISCONNECT

CIRCUIT FOR MAXIMUM HELIX CURRENT VALUE SPECIFIED, THEN SLOWLY INCREASE HELIX VOLT-AGE TO SPECIFIED VALUE.

4. SLOWLY INCREASE ANODE VOLTAGE TO SPECI-FIED VALUE, OBSERVING THAT CURRENT DOES NOT EXCEED MAXIMUM VALUE.

HELIX DISCONNECT CIRCUIT SHOULD FUNCTION SUCH THAT ALL VOLTAGES WILL BE DISABLED WITHIN 100 μSEC IF HELIX CURRENT EXCEEDS MAXIMUM VALUE.

FIG. 3. PREFERRED CONNECTION FOR LABORATORY-TYPE POWER SUPPLY CONFIGURATION FOR WJ-274-8.



NOTE:

WITH THIS CONFIGURATION, ANODE SUPPLY CAN NOT CUTOFF TUBE EMISSION. TO PREVENT DAM-AGE TO TWT, VOLTAGES MUST BE APPLIED TO TWT IN THE FOLLOWING SEQUENCE:

- 1. APPLY HEATER VOLTAGE SLOWLY TO ALLOW FIL-AMENT RESISTANCE CHANGE AS TEMPERATURE RISES.
- 2. COLLECTOR, HELIX, AND ANODE VOLTAGES MAY

BE APPLIED SIMULTANEOUSLY AFTER HEATER VOLTAGE HAS BEEN ON FOR 2 MINUTES MINI-MUM.

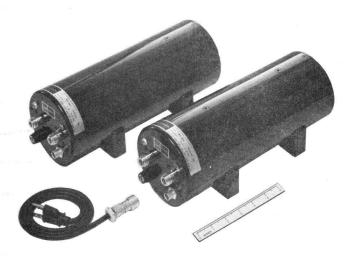
CAUTION

HELIX OVERCURRENT DISCONNECT CIRCUIT MUST BE SET FOR MAXIMUM HELIX CURRENT VALUE SPECIFIED AND MUST DISCONNECT ALL VOLTAGES IN LESS THAN 100 μ SEC IF MAXIMUM VALUE IS EXCEEDED.

FIG. 4. PREFERRED CONNECTION FOR HIGH-DENSITY POWER SUPPLY CONFIGURATION FOR WJ-274-8.

January 1967 ≭

X-BAND LOW-NOISE TWT AMPLIFIERS WITH INTEGRAL POWER SUPPLY WJ-276 AND WJ-276-2



The WJ-276 and WJ-276-2 are the original members of Watkins-Johnson Company's X-band family of low-noise TWT amplifiers with integral power supply operating from 115 volts a.c. The WJ-276 covers 8.0 to 12.0 GHz and the WJ-276-2 covers 7.0 to 11.0 GHz — otherwise both amplifiers have identical electrical and mechanical characteristics.

The same conservative design and careful processing techniques responsible for the long life of other Watkins-Johnson low-noise amplifiers have been extended to the WJ-276 and WJ-276-2. With a proven MTBF in excess of 20,000 hours (99% confidence level), hundreds of these units today are providing reliable operation in widespread application throughout the world. The amplifiers' outstanding electrical performance and long-term reliability have made NOISE FIGURE
 8.5 dB MAXIMUM

 PERMANENT-MAGNET FOCUSING

- PROVEN MTBF 20,000 + HOURS
- NO ADJUSTMENTS REQUIRED
- MEETS MIL-E-5400, CLASS 2

them the standard of the industry.

Both these amplifiers are completely self-contained units. They are adjustment-free and require only an ac line-voltage input. The completely shielded package may be operated in any orientation, in stacked arrays or adjacent to ferromagnetic material without adversely affecting the amplifiers' performance.

Rugged construction of the tube, magnet, and power supply assembly assures reliable operation under vibrational forces of 10 g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of -54° C to $+71^{\circ}$ C. The environmental characteristics of both amplifiers meet or exceed the corresponding requirements of MIL-E-5400, Class 2.

SPECIFICATIONS

Performance TYPICAL **GUARANTEED** Frequency 8.0 to 12.0 GHz WJ-276 8.0 to 12.0 GHz WJ-276-2 7.0 to 11.0 GHz 7.0 to 11.0 GHz 7.5 dB 8.5 dB, max. Noise Figure, Terminal Gain, Small Signal VSWR, Input and Output + 3 dBm · · · · · · · · · · Power Output, Saturated -5.0 dBm TYPICAL RANGE **Electrical Requirements** Primary Voltage Primary Frequency 25 W Primary Power .

* This Technical Data Sheet presents up-to-date information on the WJ-276 and WJ-276-2, first described in Technical Bulletin, Volume 5, No. 9; October 1963.

WJ-276 AND WJ-276-2

ENVIRONMENTAL CHARACTERISTICS²

Temperature, Operating . . -54° to $+71^{\circ}$ C Vibration

a. 0.10 Inch, Double Amplitude								Э	. 5 to 45 Hz		
b. 1	0	g,	Sir	ngl	e A	mp	litu	ıde			45 to 500 Hz
Shock	(÷								15 g, 11 ms

MECHANICAL CHARACTERISTICS

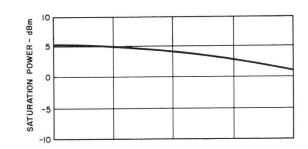
Amplifier Length

(excluding connectors) 12.0 inches, max.
Amplifier Height and Width . 4.75 inches, max.
Weight
Primary Power Connection, Deutsch Receptacle DM9601-3P
RF Connections (50 ohms, nominal) Type N, jack
Reference Drawing No

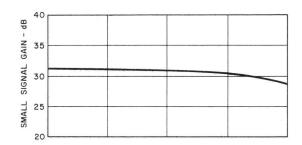
¹ Every amplifier will meet the guaranteed performance specifications for any voltage or frequency lying within these ranges.

²These environmental characteristics meet or exceed the respective requirements of MIL-E-5400, Class 2.

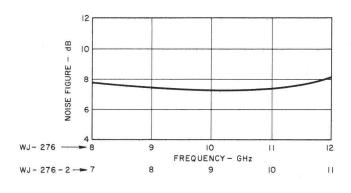
POWER



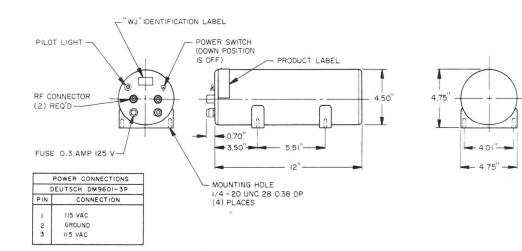
GAIN



NOISE



OUTLINE DRAWING



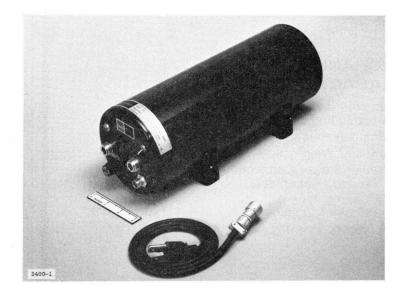


0.5 TO 1.0 GHz LOW-NOISE TRAVELING-WAVE AMPLIFIER WITH INTEGRAL POWER SUPPLY

- "JUST PLUG IT IN"
- NOISE FIGURE 4.5 dB MAXIMUM
- PERMANENT-MAGNET FOCUSING
- PROVEN RELIABILITY
- NO ADJUSTMENTS NEEDED
- 115 VOLT, 48 TO 420 Hz OPERATION
- MEETS MIL-E-5400, CLASS 2 SPECIFICATION

The WJ-278 is the P-band member of the Watkins-Johnson family of Standard low-noise amplifiers with integral solid-state power supply. When introduced to the microwave industry in 1964, the WJ-278's performance in the 0.5 to 1.0 GHz range was unparalleled by other devices. Today, this performance still remains better than or comparable to any commercially available unit. With hundreds of units in use throughout the world, the WJ-278 provides low noise figure (most production amplifiers exhibit noise figures of less than 4 dB), low cost per-operatinghour, and high field-proven reliability (MTBF's in excess of 20,000 hours with 99% confidence level).

This proven amplifier is completely self-contained,



adjustment-free, and requires only a 115 volt ac line-voltage input (48 to 420 Hz). The completely shielded package may be operated in any orientation, in stacked arrays or adjacent to ferromagnetic material, without adversely affecting the amplifier's performance.

Rugged construction of the tube, magnet, and power supply assembly assures reliable operation under vibrational forces of 10 g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of -54° C to $+71^{\circ}$ C. The environmental characteristics of the WJ-278 meet or exceed the corresponding requirements of MIL-E-5400, Class 2 Specification.

SPECIFICATIONS										
PERFORMANCE	Typical Guaranteed									
Frequency	0.5 to 1.0 GHz 0.5 to 1.0 GHz									
Noise Figure, Terminal										
Gain, Small Signal	30 dB									
VSWR, Input and Output										
Power Output, Saturated	-4 dBm 10 dBm, min.									
ELECTRICAL REQUIREMENTS Typical Range										
Primary Voltage	115 V ac									
Primary Frequency	60 Hz									
Primary Power	25 W									

ODFOUTION

* Information on this Technical Data Sheet supercedes information contained in WJ-278 Technical Data Sheet, dated March 1967.

WJ-278

ENVIRONMENTAL CHARACTERISTICS

Temperature (Operating) . . -54°C to $+71^\circ\text{C}$ Vibration

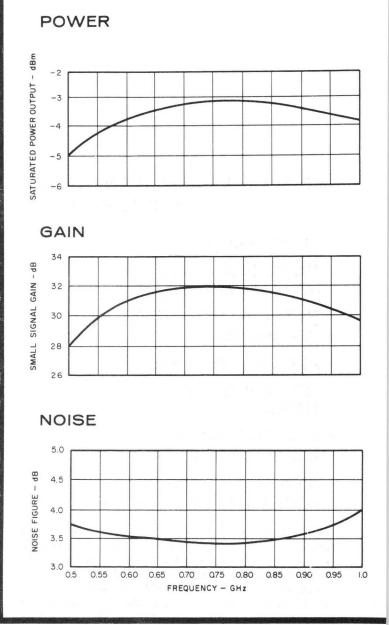
MECHANICAL CHARACTERISTICS

Amplifier Length

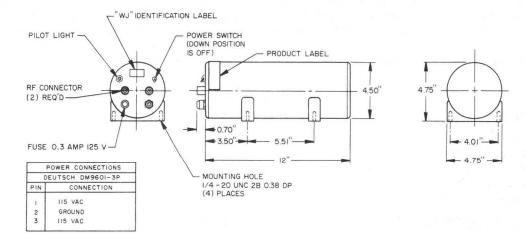
(50 ohms, nominal) Type N, jack Reference Drawing Number 290000

Every amplifier will meet the guaranteed performance specifications for any primary voltage and frequency within these ranges.

These environmental characteristics meet or exceed the respective requirements of MIL-E-5400, Class 2 Specification.



OUTLINE DRAWING



WATKINS - JOHNSON COMPANY 3333 HILLVIEW AVENUE STANFORD INDUSTRIAL PARK PALO ALTO, CALIFORNIA 94304 TWX 910-373-1253 PHONE (415) 326-8830 Telex: 348-415

January 1967

1.0 TO 2.6 GHz LOW-NOISE PERMANENT-MAGNET TRAVELING-WAVE AMPLIFIER WITH INTEGRAL POWER SUPPLY

- NOISE FIGURE
 8.0 dB MAXIMUM
- PERMANENT-MAGNET FOCUSING
- PROVEN MTBF 20,000+ HOURS
- NO ADJUSTMENTS REQUIRED
- MEETS MIL-E-5400, CLASS 2

The WJ-280 extends the Watkins-Johnson Company family of low-noise permanent-magnet traveling-wave amplifiers. The WJ-280, with a typical noise figure of 6.5 dB, has been specially designed for applications where higher gain and increased power output are required over a broader frequency band.

Like other amplifiers in Watkins-Johnson Company's family of low-noise amplifiers, the WJ-280 incorporates an integral power supply, making the unit completely self-contained, adjustment-free and requiring only an ac line-voltage input. This permanent-magnet focused tube has been designed into a completely shielded package which enables side-by-



side operation in stacked arrays or next to ferromagnetic material without any adverse effect.

The tube may be mounted in any orientation without degradation of performance. Rugged construction of the tube, magnet, and power supply assembly assures reliable operation under vibrational forces of 10 g, at frequencies up to 500 Hz. The environmental characteristics of the WJ-280 meet or exceed the corresponding requirements of MIL-E-5400, Class 2.

The same conservative design and careful processing techniques which have given long life in other Watkins-Johnson low-noise tubes have also been extended to this amplifier.

SPECIFICATIONS

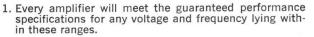
PERFORMANCE	Typical Guarantee	ed
Frequency	1.0–2.6 GHz 1.0–2.6 Gł	١z
Noise Figure, Terminal	6.5 dB 8.0 dB ma	X.
Gain, Small Signal	40 dB	n.
VSWR, Input and Output		
Power Output	— 2 dBm	n.
ELECTRICAL REQUIREMENTS	Typical Rang	e
Primary Voltage	115 V ac $$ 115 \pm 10 V a	ас
Primary Frequency	60 Hz	Ηz
Primary Power	25 W	

* This Technical Data Sheet presents up-to-date information on the WJ-280, first described in Technical Bulletin, Volume 5, No. 11; November 1963.

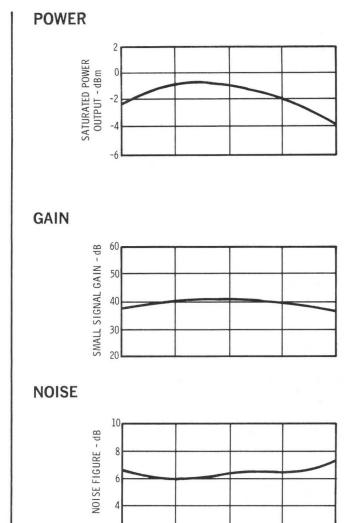


ENVIRONMENTAL CHARACTERISTICS²

MECHANICAL CHARACTERISTICS



2. These environmental characteristics meet or exceed the respective requirements of MIL-E-5400, Class 2.

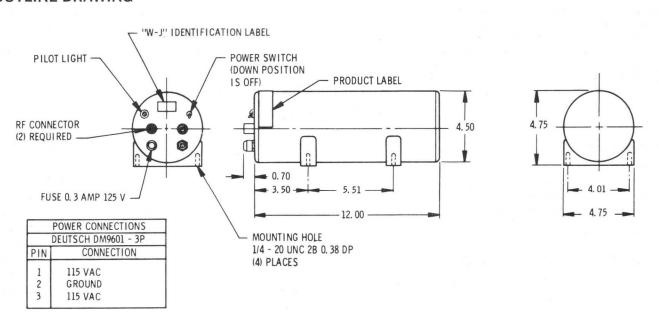


1.4 1.8 FREQUENCY - GHz

2

1.0

OUTLINE DRAWING



2.6

2.2



2.0 TO 4.5 GHz LOW-NOISE PERMANENT-MAGNET TRAVELING-WAVE AMPLIFIER WITH INTEGRAL POWER SUPPLY

- NOISE FIGURE
 8.0 dB MAXIMUM
- PERMANENT-MAGNET FOCUSING
- PROVEN MTBF 20,000+ HOURS
- NO ADJUSTMENTS REQUIRED
- MEETS MIL-E-5400, CLASS 2

The WJ-281 is an extension of Watkins-Johnson Company's family of high gain, low-noise travelingwave amplifiers. This amplifier has a permanentmagnet focused TWT with a typical noise figure of 7.0 dB and a typical small signal gain of 40 dB.

Like other units of the Watkins-Johnson Company family of low-noise amplifiers, the WJ-281 incorporates an integral power supply, making the unit completely self-contained, adjustment-free and requiring only an ac line-voltage input. The permanent-magnet focused TWT has been designed into a completely shielded package which enables sideby-side operation in stacked arrays or placement next to ferromagnetic material without any adverse effect.

The WJ-281 covers a frequency range of 2.0 to 4.5 GHz with a minimum small-signal gain of 35 dB.



The saturated power output of the tube is nominally 1 milliwatt with a guaranteed maximum noise figure of 8.0 dB.

The tube may be mounted in any orientation without degradation of performance. Rugged construction of the tube, magnet, and power supply assembly assures reliable operation under vibrational forces of over 10 g, at frequencies up to 500 Hz. The environmental characteristics of the WJ-281 meet or exceed the corresponding requirements of MIL-E-5400, Class 2.

The same conservative design and rigid manufacturing process control which have given long life in other Watkins-Johnson low-noise tubes have been extended to this amplifier. Tubes of similar design are exceeding operating life times of 20,000 hours.

PERFORMANCE	Typical	Guaranteed
Frequency	2.0–4.5 GHz	2.0–4.5 GHz
Noise Figure, Terminal	6.0 dB	8.0 dB max.
Gain, Small Signal	40 dB	35 dB min.
VSWR, Input and Output	1.5:1	2:1 max.
Power Output	—2 dBm	
	Typical	Range
Primary Voltage	115 V ac	115 \pm 10 V ac
Primary Frequency	60 Hz	48 to 420 Hz
Primary Power		

*This Technical Data Sheet presents up-to-date information on the WJ-281, first described in Technical Bulletin, Volume 6, No. 3; February 1964.

SPECIFICATIONS

WJ-281

ENVIRONMENTAL CHARACTERISTICS

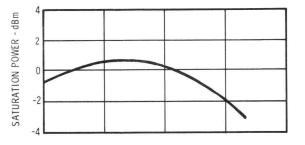
Temperature, Operating . . -54° C to $+71^{\circ}$ C Vibration

MECHANICAL CHARACTERISTICS

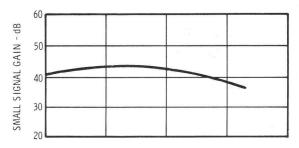
Height 4.75 inches (1	21 mm) max.
Width 4.75 inches (1)	21 mm) max.
Length (excluding connectors) 12 inches (30	5 mm) max.
Weight 17 pounds (7.	
Primary Power Connection,	
Deutsch Receptacle	DM9601-3P

- 1. Every amplifier will meet the guaranteed performance specifications for any voltage and frequency lying with in these ranges.
- 2. These environmental characteristics meet or exceed the respective requirements of MIL-E-5400, Class 2.

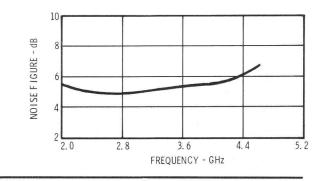




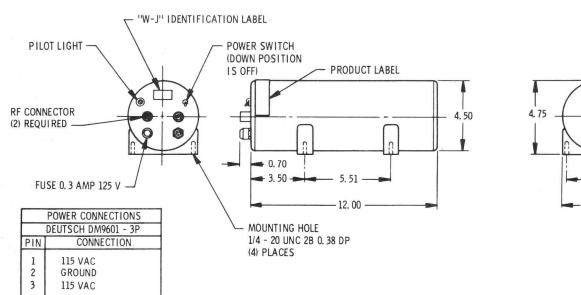
GAIN







OUTLINE DRAWING





4.01

4.75



April 1967

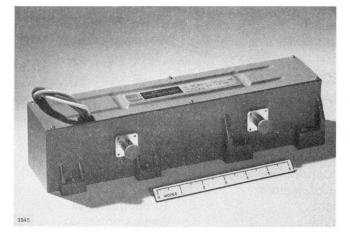
6.0 TO 8.0 GHz, 200 WATT CW, PPM-FOCUSED **TRAVELING-WAVE TUBE**

The WJ-284-5 is a 200 watt CW conduction-cooled traveling-wave tube developed for use in airborne and missile applications. Although the tube is designed for 200 watts output power, it can be operated at power levels as low as 100 watts by means of a simple adjustment that controls the beam current. The saturation gain at the lower power output level is approximately 25 dB.

The WJ-284-5, constructed of metal-ceramic materials, incorporates design features to assure the maximum in reliable, long-life operation. This tube has been qualified for missile and airborne applications, and will meet the environmental conditions given on the Tentative Specification sheet. Outline dimensions for the WJ-284-5 are illustrated in Figure 1. Although the WJ-284-5 guaranteed frequency range is from 6.0 to 8.0 GHz, the tube is capable of being operated at greater bandwidths as shown in Figure 2. Figure 3 illustrates a typical transfer curve for the tube operating at 6.6 GHz.

To illustrate the effect voltage variations have upon the performance of the tube, a curve showing saturated power output and saturation gain versus frequency as a function of helix voltage is contained in Figure 4. Helix voltage is the voltage between the helix and cathode. Note that the power output is relatively insensitive to helix voltage whereas saturation gain is affected. For example, over the frequency range from 6.2 to 7.0 GHz, the saturation gain will change by 0.8 dB for a 1% change in helix voltage.

Helix current, with and without RF drive, versus collector voltage variation is shown in Figure 5. Note that at the nominal operating point the helix current is relatively insensitive to collector voltage variation,



and the RF power output and gain remain unchanged.

Typical power supply configurations that will satisfactorily operate the WJ-284-5 are illustrated in Figures 6 and 7. It is recommended that protection for the helix of the tube be provided by employing "crow-bar" circuitry which will ensure voltage decay within 100 μ sec after either the helix or collector power supply is turned off. Also recommended is an overload current circuit which removes all voltages within 100 μ sec when the helix current exceeds 10 mA. The tube should not be operated into a load with VSWR greater than 1.4, to prevent damage to the helix which might result from the addition of incident and returned power.

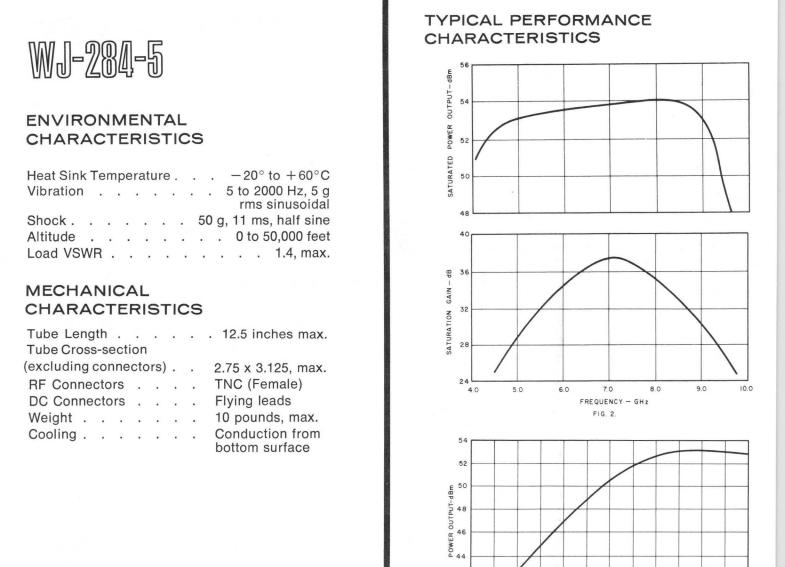
Other versions of the WJ-284-5 are available at reduced power level, with liquid cooling, which meet less critical environmental specifications.

Our sur la sel

*i

SPECIFICATIONS

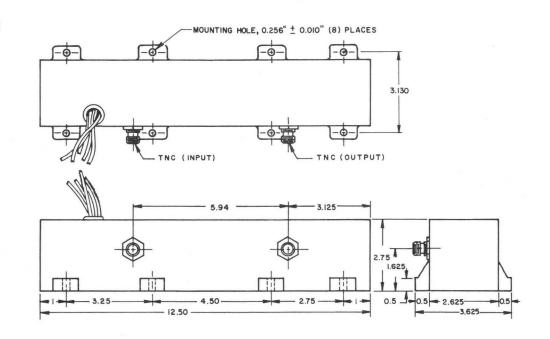
PERFORM	VANCE						Typical	Guaranteed
	Frequency						5.0 to 9.0 GHz	6.0 to 8.0 GHz
	Power Output, Sat							200 W, min. *
	Gain, Saturation						34 dB	30 dB, min.
	Efficiency						25%	23%, min.
ELECTRI	CAL REQUIREMEN	TS					Typical	Range
	Heater Voltage .						7.0 V	6.5 to 8.5 V
	Heater Current .						1.5 A	1.4 to 1.6 A
	Anode Voltage .						6750V	6750 ± 400V
	Anode Current .						0.2 mA	1 mA max.
	Helix Voltage						6750 V	$6750\pm150~V$
	Helix Current						2.8 mA	10.0 mA max.
	Collector Voltage						4200 V	4100-4400 V
into 1.15 max.	Collector Current						197 mA	210 mA max.
VSWR load	Cathode Current .						200 mA	210 mA max.



Efficiency is defined as the minimum RF output power across the band, divided by the total dc power input, including heater power.

OUTLINE DRAWING

FIG.I



42

40

0

14 16 18 20

8 10 12

POWER INPUT-dBm FIG.3.

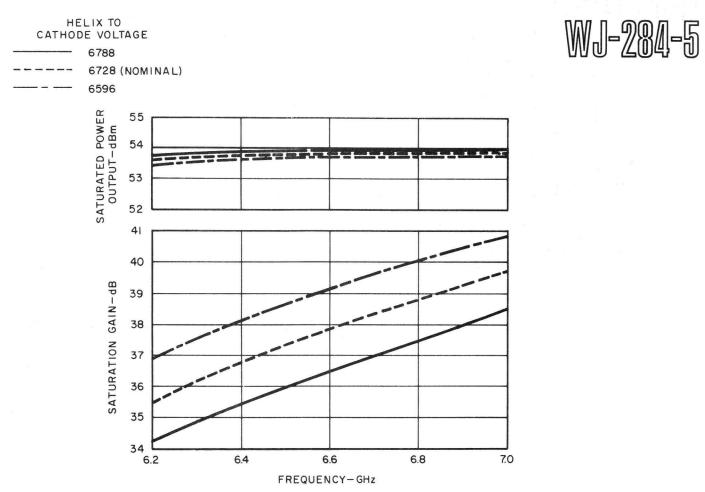


FIG. 4. SATURATION GAIN FOR THE WJ-284-5 VERSUS FREQUENCY AND AS A FUNCTION OF HELIX VOLTAGE.

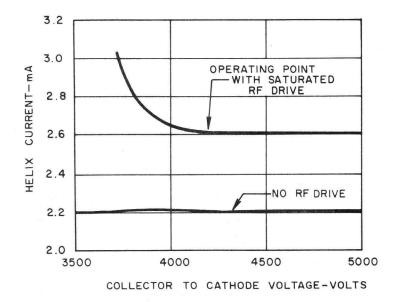
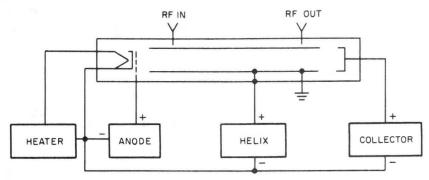


FIG.5. HELIX CURRENT VERSUS COLLECTOR VOLTAGE FOR THE WJ-284-5 T W T. DATA ARE SHOWN WITH AND WITHOUT RF DRIVE. THE RF POWER OUTPUT REMAINS UNCHANGED AS THE COLLECTOR VOLTAGE IS VARIED. THE CATHODE CURRENT IS 200 mA.

WJ-284-5



HEATER 7.0-8.0 VOLTS AC AT 1.6 A MAXIMUM ANODE 6350-7150 VOLTS AT 1 mA MAXIMUM HELIX 6600-6900 VOLTS AT 10 mA MAXIMUM COLLECTOR 4100-4400 VOLTS AT 210 mA MAXIMUM

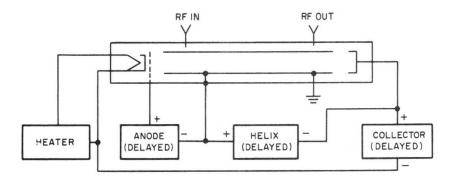
NOTE:

TO ENSURE THAT THE TWT IS OPERATED PROPERLY, IT IS SUGGESTED THAT VOLTAGES BE APPLIED AS FOLLOWS:

- 1. SLOWLY APPLY FILAMENT VOLTAGE UNTIL SPECIFIED VALUE IS REACHED, OBSERVING THAT FILAMENT CURRENT DOES NOT EXCEED MAXIMUM VALUE. ALLOW AT LEAST 2 MINUTES FOR FILAMENT VOLTAGE TO STABILIZE.
- SLOWLY APPLY COLLECTOR VOLTAGE UNTIL SPECIFIED VALUE IS REACHED, OBSERVING THAT COLLECTOR CURRENT DOES NOT EXCEED MAXIMUM VALUE.
- 3. SET ADJUSTABLE OVERCURRENT DISCONNECT CIRCUIT FOR MAXIMUM HELIX CURRENT VALUE SPECIFIED, THEN SLOWLY APPLY HELIX VOLTAGE TO SPECIFIED VALUE.
- 4. SLOWLY APPLY ANODE VOLTAGE TO SPECIFIED VALUE, OBSERVING THAT CURRENT DOES NOT EXCEED MAXIMUM VALUE.

HELIX DISCONNECT CIRCUIT SHOULD FUNCTION SUCH THAT ALL VOLTAGES WILL BE DISABLED WITHIN 100 $_{\mu}\text{SEC}$ if helix current exceeds maximum value.

FIGURE 6. PREFERRED CONNECTION FOR LABORATORY-TYPE POWER SUPPLY CONFIGURATION FOR THE WJ-284-5



HEATER 7.0-8.0 VOLTS AC AT 1.6 A MAXIMUM

ANODE 6350-7150 VOLTS AT 1 MA MAXIMUM (SUM OF ANODE, HELIX, AND COLLECTOR SUPPLIES) HELIX 6600-6900 VOLTS AT 10 MA MAXIMUM (SUM OF HELIX AND COLLECTOR SUPPLIES) COLLECTOR 4100-4400 VOLTS AT 210 MA MAXIMUM

NOTE:

- WITH THIS CONFIGURATION, ANODE SUPPLY CANNOT CUT OFF TUBE EMISSION. TO PREVENT DAMAGE TO TWT, VOLTAGES MUST BE APPLIED TO TWT IN THE FOLLOWING SEQUENCE:
- 1. APPLY HEATER VOLTAGE SLOWLY TO ALLOW FILAMENT RESISTANCE CHANGE AS TEMPERA-TURE RISES.
- 2. COLLECTOR, HELIX, AND ANODE VOLTAGES MAY BE APPLIED SIMULTANEOUSLY AFTER HEATER VOLTAGE HAS BEEN ON FOR 2 MINUTES MINIMUM.

CAUTION

HELIX OVERCURRENT DISCONNECT CIRCUIT MUST BE SET FOR MAXIMUM HELIX CURRENT VALUE SPECIFIED AND MUST DISCONNECT ALL VOLTAGES IN LESS THAN 100 $_{\rm P}$ SEC IF MAXIMUM VALUE IS EXCEEDED.

FIGURE 7. PREFERRED CONNECTION FOR HIGH-DENSITY POWER SUPPLY CONFIGURATION FOR THE WJ-284-5

WATKINS **JOHNSON COMPANY** 3333 HILLVIEW AVENUE **STANFORD INDUSTRIAL PARK** PALO ALTO. CALIFORNIA 94304 TWX 910-373-1253 PHONE (415) 326-8830 Telex: 348-415



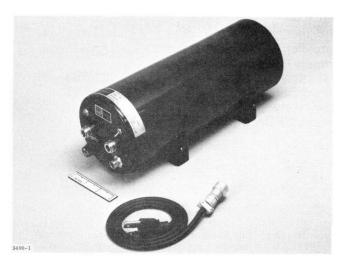
July 1967

4.0 to 8.0 GHz LOW-NOISE TRAVELING-WAVE AMPLIFIER WITH INTEGRAL POWER SUPPLY

- LOW-NOISE FIGURE: 8.0 dB MAXIMUM
- PERMANENT-MAGNET FOCUSING
- INTEGRAL POWER SUPPLY
- C-BAND OPERATION
- LOW-VOLTAGE INPUT
- ADJUSTMENT-FREE PERFORMANCE

The WJ-286 is the C-band member of the Watkins-Johnson family of high-gain low-noise amplifiers with integral solid-state power supply. The same conservative design and rigid manufacturing process control which have given long life in other Watkins-Johnson low-noise tubes have been extended to this amplifier.

Like other units of the Watkins-Johnson Company family of low-noise amplifiers, the WJ-286 incorporates an integral power supply, making the unit completely self-contained, adjustment-free and requiring only an ac line-voltage input. The perma-



nent-magnet focused TWT has been designed into a completely shielded package which enables sideby-side operation in stacked arrays or placement next to ferromagnetic material without any adverse effect.

The tube may be mounted in any orientation without degradation of performance. Rugged construction of the tube, magnet, and power supply assembly assures reliable operation under vibrational forces of over 10 g, at frequencies up to 500 Hz. The environmental characteristics of the WJ- 286 meet the corresponding requirements of MIL-E-5400, Class 2.

SPECIFICATIONS

PERFORMANCE Frequency Noise figure, terminal Gain, Small Signal VSWR, input and output Power output	. 6.5 dB	8.0 dB, max. 35 dB min. 2:1 max.
ELECTRICAL REQUIREMENTS Primary voltage Primary frequency Primary power	. 60 Hz	

ENVIRONMENTAL CHARACTERISTICS

Temperature, Operating . . -54°C to $+71^\circ\text{C}$ Vibration

MECHANICAL CHARACTERISTICS

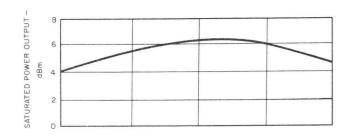
Amplifier Length

Deutsch Receptacle DM9601-3P RF Connections

(50 ohms, nominal) Type N, jack Reference Drawing Number . . . 290000

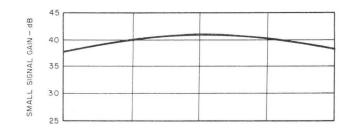
Every amplifier will meet the guaranteed performance specifications for any primary voltage and frequency with in these ranges.

These environmental characteristics meet the respective requirements of MIL-E-5400, Class 2 Specification.



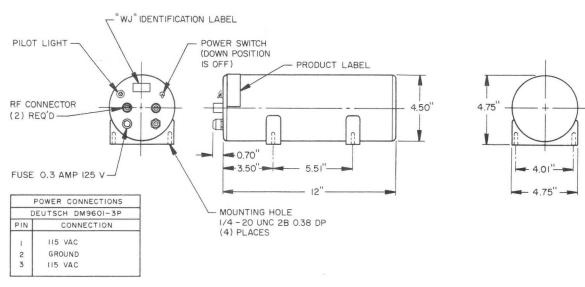
GAIN

POWER



NOISE

RP - HODIL - HZ BP - HDIL - HZ BP - HDIL - HZ FREQUENCY - GHZ



August 1967

8.0 to 12.0 GHz LOW-NOISE TRAVELING-WAVE AMPLIFIER WITH INTEGRAL POWER SUPPLY WJ-287



- LOW-NOISE FIGURE: 10.0 dB MAXIMUM
- X-BAND OPERATION
- PERMANENT-MAGNET FOCUSING
- INTEGRAL POWER SUPPLY
- LOW-VOLTAGE INPUT
- ADJUSTMENT-FREE
 PERFORMANCE

The WJ-287 is the X-band member of the Watkins-Johnson family of high-gain low-noise amplifiers with integral solid-state power supply. The same conservative design and rigid manufacturing process control which have given long life in other Watkins-Johnson low-noise tubes have been extended to this amplifier.

Like other units of the Watkins-Johnson Company family of low-noise amplifiers, the WJ-287 incorporates an integral power supply, making the unit completely self-contained, adjustment-free and requiring only an ac line-voltage input. The permanent-magnet focused TWT has been designed into a completely shielded package which enables sideby-side operation in stacked arrays or placement next to ferromagnetic material without any adverse effect.

The tube may be mounted in any orientation without degradation of performance. Rugged construction of the tube, magnet, and power supply assembly assures reliable operation under vibrational forces of over 10 g, at frequencies up to 500 Hz. The environmental characteristics of the WJ-287 meet the corresponding requirements of MIL-E-5400, Class 2.

SPECIFICATIONS

PERFORMANCE Frequency Noise figure, terminal Gain, Small Signal VSWR, input and output Power output	8.5 dB	10 dB max. 35 dB min. 2:1 max.
ELECTRICAL REQUIREMENTS Primary voltage Primary frequency Primary power	60 Hz	

ENVIRONMENTAL² CHARACTERISTICS

Temperature, operating —54°C to +71°C Vibration

a10 inch, double amplitude	5 to 45 Hz
b. 10 g, single amplitude	45 to 500 Hz
Shock	15 g, 11 ms

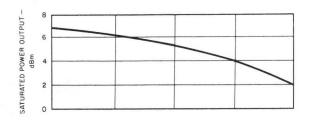
MECHANICAL CHARACTERISTICS

Height 4.75 inches (121 mm) max.
Width 4.75 inches (121 mm) max.
Length (excluding
connectors) 12 inches (305 mm) max.
Weight 17 pounds (7.71 Kg) max.
Primary Power Connection,
Deutsch receptacle DM9601-3P
RF Connections (50 ohms, nominal) Type N, jack
Reference Drawing Number 290000

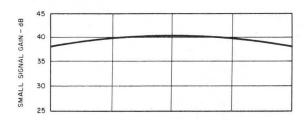
¹Every tube will meet the guaranteed performance specifications for any primary voltage and frequency lying within these ranges.

²These environmental characteristics meet the respective requirements for MIL-E-5400, Class 2.

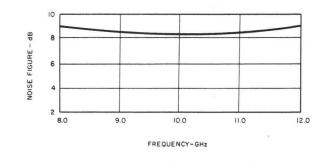
POWER

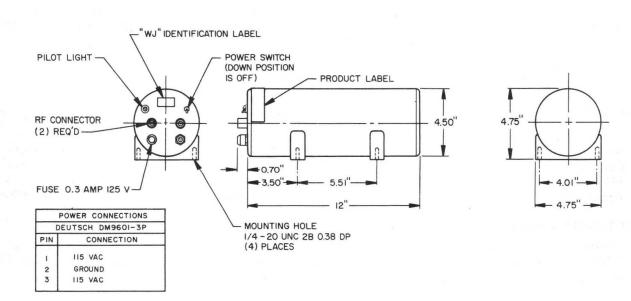


GAIN









February 1967

1.0 TO 2.0 GHz, COMPACT LOW-NOISE PERMANENT-MAGNET TRAVELING-WAVE AMPLIFIER WITH INTEGRAL POWER SUPPLY

WJ-294



The WJ-294 is the L-band member of Watkins-Johnson's family of compact traveling-wave amplifiers. Incorporating many of the time-tested features of its larger predecessors, this amplifier is only 9.5 inches long, 3.4 inches in height and width, and weighs 6.0 pounds. The amplifier is completely adjustment-free and has an integral solid-state power supply which operates from a 115-volt ac, 48 to 420 Hz source. A 28-volt dc version of the WJ-294 is also available on special order.

Although guaranteed to produce a noise figure not exceeding 8.0 dB, a typical WJ-294 production unit can be expected to yield a much lower noise figure over the major segment of the 1.0 to 2.0 GHz frequency range. The typical performance noise figure curve shown represents actual test figures taken from randomly selected amplifiers. Note that most of the curve appears below the 7.0 dB line.

The WJ-294 will meet or exceed respective environmental requirements of MIL-E-5400, Class 2 Specification. Rugged construction of the traveling-wave

- "JUST PLUG IT IN"
- NOISE FIGURE 8.0 dB MAXIMUM
- ADJUSTMENT-FREE
- PERMANENT-MAGNET FOCUSING
- MORE THAN 20 SPECIALIZED VERSIONS AVAILABLE

tube, permanent magnet, and power supply assembly assures reliable operation under vibrational forces of 10 g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of -54° C to $+71^{\circ}$ C.

The same conservative design and careful processing techniques responsible for the long life of other Watkins-Johnson low-noise amplifiers have been extended to the WJ-294. It can be predicted that they will yield an MTBF in excess of 18,500 hours (99% confidence level). The anticipated MTBF is based on extensive tests performed on this and similar tubes and power supply components.

More than twenty specialized versions of the WJ-294 are available on special order. These amplifiers offer a lower noise figure over narrower bandwidths, phase and gain matching, extended and special frequency coverages, rigid differential phase and gain performance, automatic gain control, and inclusion of a unique blanking circuit to permit pulse times of a few nanoseconds. Details are available upon request.

SPECIFICATIONS

PERFORMANCE	Typical Guaranteed
Frequency	1.0 to 2.0 GHz 1.0 to 2.0 GHz
Noise Figure, Terminal	7.0 dB 8.0 dB, max.
Gain, Small Signal	30.0 dB
VSWR, Input and Output	1.5:1
Power Output	+9.0 dBm +7.0 dBm, min.
ELECTRICAL REQUIREMENTS	Typical Range ¹
Primary Voltage	115 V ac 115 ± 10 V ac
Primary Frequency	60 Hz
Primary Power	20 W

MECHANICAL CHARACTERISTICS²

Height 3.4 inches (86 mm) max. Width 3.4 inches (86 mm) max.
Length (excluding connectors) 9.5 inches (241 mm) max.
Weight 6 pounds (2.72 Kg) max.
Primary Power Connection, Deutsch Receptacle
Reference Drawing Number 290003

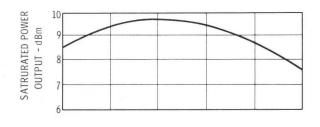
ENVIRONMENTAL CHARACTERISTICS

Temperature, Operating . . $-54^{\circ}C$ to $+71^{\circ}C$ Vibration

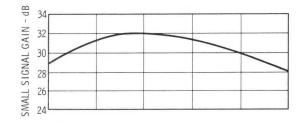
¹Every tube will meet the guaranteed performance specifications within these ranges.

²These environmental characteristics meet or exceed the respective requirements of MIL-E-5400, Class 2 Specification.

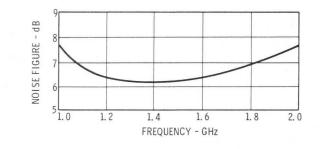
POWER

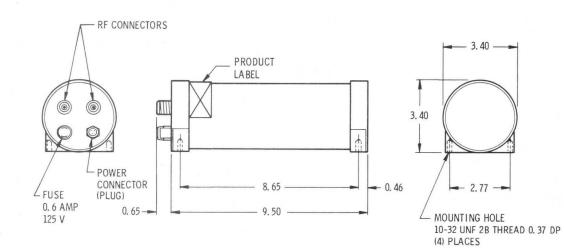


GAIN



NOISE





WJ-295

2.0 TO 4.0 GHz, COMPACT LOW-NOISE February 1967 PERMANENT-MAGNET TRAVELING-WAVE AMPLIFIER WITH INTEGRAL POWER SUPPLY

- "JUST PLUG IT IN"
- NOISE FIGURE 8.5 dB MAXIMUM
- ADJUSTMENT-FREE
- PERMANENT-MAGNET
 FOCUSING
- MORE THAN 20 SPECIALIZED VERSIONS AVAILABLE

The WJ-295 is the S-band member of Watkins-Johnson's family of compact traveling wave amplifiers. Incorporating many of the time-tested features of its larger predecessors, this amplifier is only 9.5 inches long, 3.4 inches in height and width, and weighs 6.0 pounds. The amplifier is completely adjustment-free and has an integral solid-state power supply which operates from a 115-volt ac, 48 to 420 Hz source. A 28-volt dc version of the WJ-295 is also available on special order.

Although guaranteed to produce a noise figure not exceeding 8.5 dB, a typical WJ-295 production unit can be expected to yield a much lower noise figure over the major segment of the 2.0 to 4.0 GHz frequency range. The typical performance noise figure curve shown represents actual test figures taken from randomly selected amplifiers. Note that most of the curve appears below the 7.5 dB line.

The WJ-295 will meet or exceed respective environmental requirements of MIL-E-5400, Class 2 Specification. Rugged construction of the traveling-wave



tube, permanent magnet, and power supply assembly assures reliable operation under vibrational forces of 10 g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of -54° C to $+71^{\circ}$ C.

The same conservative design and careful processing techniques responsible for the long life of other Watkins-Johnson low-noise amplifiers have been extended to the WJ-295. It can be predicted that they will yield an MTBF in excess of 18,500 hours (99% confidence level). The anticipated MTBF is based on extensive tests performed on this and similar tubes and power supply components.

More than twenty specialized versions of the WJ-295 are available on special order. These amplifiers offer a lower noise figure over narrower bandwidths, phase and gain matching, extended and special frequency coverages, rigid differential phase and gain performance, automatic gain control, and inclusion of a unique blanking circuit to permit pulse times of a few nanoseconds. Details are available upon request.

SPECIFICATIONS

PERFORMANCE				Typical Guaranteed
Frequency				2.0 to 4.0 GHz 2.0 to 4.0 GHz
				7.5 dB 8.5 dB, max.
Gain, Small Signal				30.0 dB
VSWR, Input and Output				1.5:1 2:1, max.
Power Output			·	+10.0 dBm +7.0 dBm, min.
ELECTRICAL REQUIREMENTS				Typical Range
Primary Voltage				115 V ac
Primary Frequency				60 Hz
Primary Power				20 W

MECHANICAL CHARACTERISTICS

Primary Power Connection, Deutsch Receptacle . . . DM9601-3P

RF Connections (50 ohms, nominal). Type N, jack

Reference Drawing Number 290003

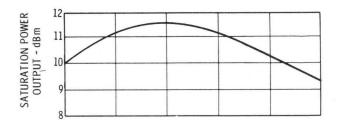
ENVIRONMENTAL CHARACTERISTICS

Temperature, Operating . -54° C to $+71^{\circ}$ C Vibration

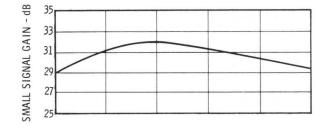
а.	0.	10	Inc	ch,	Do	ubl	e A	\mp	blit	ude	Э	. 5 to 45 Hz
b.	10) g,	Si	ngl	e A	mp	olitu	Jde				45 to 500 Hz
Shoc	k											15 g, 11 ms

- 1. Every tube will meet the guaranteed performance specifications within these ranges.
- 2. These environmental characteristics meet or exceed the respective requirements of MIL-E-5400, Class 2 Specification.

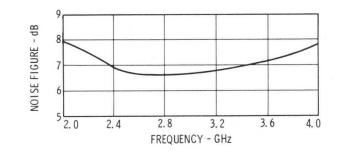
POWER

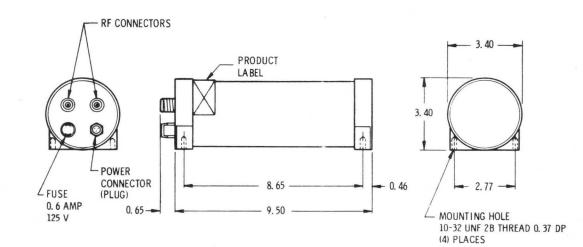


GAIN



NOISE





WJ-296

4.0 TO 8.0 GHz, COMPACT LOW-NOISE February 1967 PERMANENT-MAGNET TRAVELING-WAVE AMPLIFIER WITH INTEGRAL POWER SUPPLY

- "JUST PLUG IT IN"
- NOISE FIGURE
 9.0 dB MAXIMUM
- ADJUSTMENT-FREE
- PERMANENT-MAGNET FOCUSING
- MORE THAN 20 SPECIALIZED VERSIONS AVAILABLE

The WJ-296 is the C-band member of Watkins-Johnson's family of compact traveling-wave amplifiers. Incorporating many of the time-tested features of its larger predecessors, this amplifier is only 9.5 inches long, 3.4 inches in height and width, and weighs 6.0 pounds. The amplifier is completely adjusment-free and has an integral solid-state power supply which operates from a 115-volt ac, 48 to 420 Hz source. A 28-volt dc version of the WJ-296 is also available on special order.

Although guaranteed to produce a noise figure not exceeding 9.0 dB, a typical WJ-296 production unit can be expected to yield a much lower noise figure over the major segment of the 4.0 to 8.0 GHz frequency range. The typical performance noise figure curve shown represents actual test figures taken from randomly selected amplifiers. Note that most of the curve appears below the 8.0 dB line.

The WJ-296 will meet or exceed respective environmental requirements of MIL-E-5400, Class 2 Specification. Rugged construction of the traveling-wave



tube, permanent magnet, and power supply assembly assures reliable operation under vibrational forces of 10 g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of -54° C to $+71^{\circ}$ C.

The same conservative design and careful processing techniques responsible for the long life of other Watkins-Johnson low-noise amplifiers have been extended to the WJ-296. It can be predicted that they will yield an MTBF in excess of 18,500 hours (99% confidence level). The anticipated MTBF is based on extensive tests performed on this and similar tubes and power supply components.

More than twenty specialized versions of the WJ-296 are available on special order. These amplifiers offer a lower noise figure over narrower bandwidths, phase and gain matching, extended and special frequency coverages, rigid differential phase and gain performance, automatic gain control, and inclusion of a unique blanking circuit to permit pulse times of a few nanoseconds. Details are available upon request.

SPECIFICATIONS

PERFORMANCE	Typical Guaranteed	
Frequency	4.0 to 8.0 GHz 4.0 to 8.0 GHz	
Noise Figure, Terminal	8.0 dB 9.0 dB, max.	
Gain, Small Signal	30.0 dB	
VSWR, Input and Output	1.5:1 2:1, max.	
Power Output	+11.0 dBm +7.0 dBm, min.	
ELECTRICAL REQUIREMENTS	51	
Primary Voltage	115 V ac	2
Primary Frequency	60 Hz	1
Primary Power		

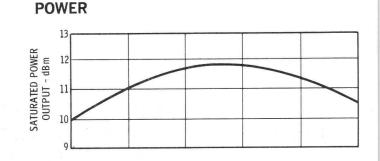
ENVIRONMENTAL CHARACTERISTICS²

Temperature, Operating -54° C to $+71^{\circ}$ C
Vibration
a. 0.10 Inch, Double Amplitude . 5 to 45 Hz
b. 10 g, Single Amplitude 45 to 500 Hz
Shock

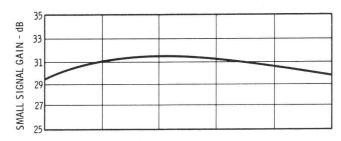
MECHANICAL CHARACTERISTICS

Height3.4 inches (86 mm) max.Width3.4 inches (86 mm) max.
Length (excluding connectors) 9.5 inches (241 mm) max. Weight 6 pounds (2.72 Kg) max.
Primary Power Connection, Deutsch Receptacle DM9601-3P RF Connections (50 ohms, nominal) Type N, jack
Reference Drawing Number

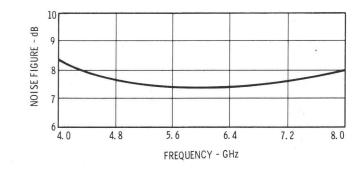
- 1. Every tube will meet the guaranteed performance specifications within these ranges.
- 2. These environmental characteristics meet or exceed the respective requirements of MIL-E-5400, Class 2 Specification.

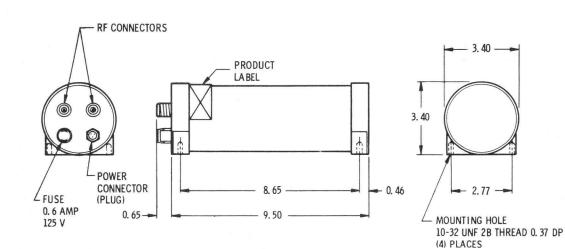






NOISE





WJ-297

8.0 TO 12.0 GHz, COMPACT LOW-NOISE February 1967 PERMANENT-MAGNET TRAVELING-WAVE AMPLIFIER WITH INTEGRAL POWER SUPPLY

- "JUST PLUG IT IN"
- NOISE FIGURE
 10.0 dB MAXIMUM
- ADJUSTMENT-FREE
- PERMANENT-MAGNET FOCUSING
- MORE THAN 20
 SPECIALIZED
 VERSIONS AVAILABLE

The WJ-297 is the X-band member of Watkins-Johnson's family of compact traveling wave amplifiers. Incorporating many of the time-tested features of its larger predecessors, this amplifier is only 9.5 inches long, 3.4 inches in height and width, and weighs 6.0 pounds. The amplifier is completely adjustment-free and has an integral solid-state power supply which operates from a 115-volt ac, 48 to 420 Hz source. A 28-volt dc version of the WJ-297 is also available on special order.

Although guaranteed to produce a noise figure not exceeding 10.0 dB, a typical WJ-297 production unit can be expected to yield a much lower noise figure over the major segment of the 8.0 to 12.0 GHz frequency range. The typical performance noise figure curve shown represents actual test figures taken from randomly selected amplifiers. Note that most of the curve appears below the 9.0 dB line.

The WJ-297 will meet or exceed respective environmental requirements of MIL-E-5400, Class 2 Specification. Rugged construction of the traveling-wave



tube, permanent magnet, and power supply assembly assures reliable operation under vibrational forces of 10 g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of -54° C to $+71^{\circ}$ C.

The same conservative design and careful processing techniques responsible for the long life of other Watkins-Johnson low-noise amplifiers have been extended to the WJ-297. It can be predicted that they will yield an MTBF in excess of 18,500 hours (99% confidence level). The anticipated MTBF is based on extensive tests performed on this and similar tubes and power supply components.

More than twenty specialized versions of the WJ-297 are available on special order. These amplifiers offer a lower noise figure over narrower bandwidths, phase and gain matching, extended and special frequency coverages, rigid differential phase and gain performance, automatic gain control, and inclusion of a unique blanking circuit to permit pulse times of a few nanoseconds. Details are available upon request.

SPECIFICATIONS

PERFORMANCE	Typical Guaranteed
Frequency	8.0 to 12.0 GHz 8.0 to 12.0 GHz
Noise Figure, Terminal	9.0 dB
Gain, Small Signal	30.0 dB
VSWR, Input and Output	1.5:1 2:1, max.
Power Output	+10.0 dBm +7.0 dBm, min.
ELECTRICAL REQUIREMENTS	Typical Range ¹
Primary Voltage	115 V ac
Primary Frequency	60 Hz
Primary Power	20 W

ENVIRONMENTAL CHARACTERISTICS²

Temperature, Operating . $-54^{\circ}C$ to $+71^{\circ}C$ Vibration

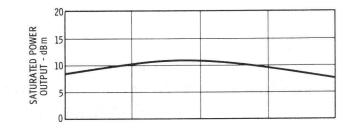
a. (0.1	0	Inc	:h,	Do	ubl	eΑ	mp	oliti	ude	Э	. 5 to 45 Hz
b.	10	g,	Si	ngl	еA	mp	olitu	Jde	١.			45 to 500 Hz
Shock		-		-		-						15 g, 11 ms

MECHANICAL CHARACTERISTICS

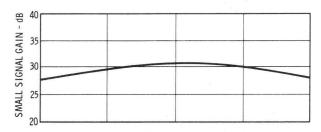
Height3.4 inches (86 mm) max.Width3.4 inches (86 mm) max.
Length (excluding connectors) 9.5 inches (241 mm) max. Weight 6 pounds (2.72 Kg) max.
Primary Power Connection, Deutsch Receptacle DM9601-3P
RF Connections (50 ohms, nominal) Type N, jack Reference Drawing Number 290003

- 1. Every tube will meet the guaranteed performance specifications within these ranges.
- 2. These environmental characteristics meet or exceed the respective requirements of MIL-E-5400, Class 2 Specification.

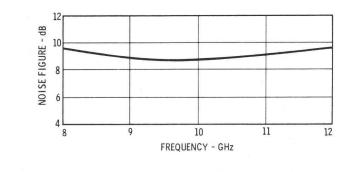
POWER

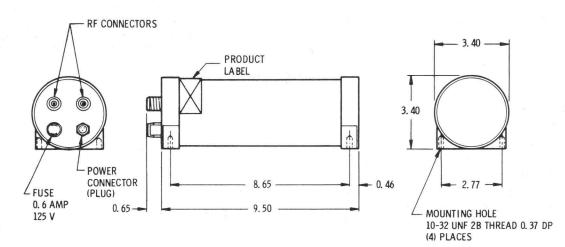


GAIN



NOISE



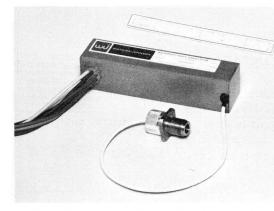


BACKWARD-WAVE O S C I L L A T O R

SE - 303

TECHNICAL DATA • August 1965

The type SE-303 is a single-helix, voltage tunable oscillator utilizing a permanent-magnet focusing system. The miniature square package features rugged construction and capability to withstand severe environmental conditions defined in MIL-E-5400, Class 2. The size and weight of this package are comparable to electrostaticallyfocused BWOs in this band, but with superior performance, reliability and reduced power supply requirements. Thus, it is ideal for space, airborne and shipboard applications as a local oscillator in swept or FM receivers, master oscillator in transmitters and ECM jammers, signal source in generators, etc. Fine grain variation of frequency vs. voltage is extremely low. Power out-



put and tuning curves are uniform and highly reproducible. Power can be modulated and leveled with either grid or anode circuits. All voltages are isolated from the housing and r.f. connector for easier packaging.

ELECTRICAL CHARACTERISTICS, CW

	Units	Typical Values	Absolute Ratings
Nominal Frequency Band	GHz	8.2-12.4	
Power Output into Load with VSWR = 1.25:1	mW	25-100	20 Min
Power Output Variation	db		8 Max
Fine Grain Variation	db/250 MHz		3 Max
Tube VSWR			2.5:1 Max
Frequency Pulling into 2:1 Load (Any Phase)	MHz	0.8	1.5 Max
Ratio of Signal to Noise Power 30 MHz Away	db/MHz	95	85 Min
Long-term sensitivity to Heater Voltage	MHz/V	5.5	10 Max
Sensitivity to Anode Voltage	MHz/V	0.3	1.0 Max
Sensitivity to Grid Voltage	MHz/V	2	4 Max
Tuning Curve Slope			
Low End (8.2 GHz)	MHz/V	6.5	
Mid-Frequency (10.3 GHz)	MHz/V	3.3	
High End (12.4 GHz)	MHz/V	1.7	
Grid r.f. Cutoff Voltage	V	-10	-20 Max
Capacitance; Cathode to all Other Electrodes			
and Case	pf	18	25 Max
Capacitance; Grid to all Other Electrodes			
and Case	\mathbf{pf}	18	25 Max
Capacitance; Helix and Collector to all Other			
Electrodes and Case	pf	70	100 Max
Heater Voltage	Vdc		$6.3 \pm 5\%$
Heater Current	А	.75	0.4-1.2
	· ·		Min/Max
Cathode Current	mA	8	12 Max
Helix Voltage Range	V	485 - 1850	450-2000
			Min/Max
Anode Voltage*	\mathbf{V}	125	200 Max
Anode Current	mA	0.3	2 Max

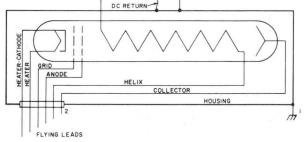
MECHANICAL DATA

Weight, 1.5 lbs Max Color Code for 18" Flying Leads Heater Brown Heater-Cathode Yellow Grid Green Anode Blue Helix Red Collector Orange Mounting Position, Any RF Output Connector, Type N Female

ENVIRONMENTAL DATA

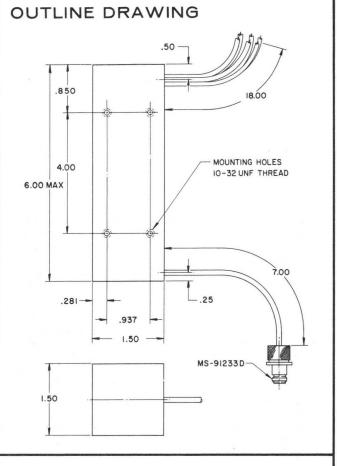
Separation from Passive Magnetic Materials, 2 in. Min Designed to Meet or Exceed MIL-E-5400, Class 2 Environment No Forced Air Cooling Required

SCHEMATIC DIAGRAM

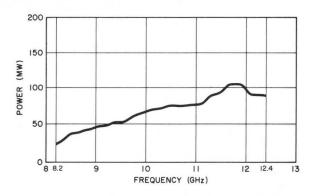


¹For safety, housing should be grounded through mounting screws.

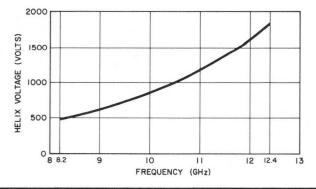
²24-100 V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.



POWER OUTPUT



TUNING VOLTAGE



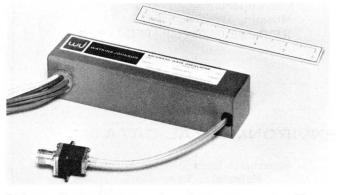
BACKWARD-WAVE

OSCILLATOR

SE-304

August 1965

The type SE - 304 BWO is a bifilar (dual - helix) voltage tunable oscillator utilizing a permanentmagnet focusing system. The miniature square package features rugged construction and capability to withstand severe environmental conditions defined in MIL-E-5400, Class 2. The size and weight of this package are comparable to electrostatically-focused BWOs in this band, but with superior performance, reliability, and reduced power supply requirements. Thus, it is ideal for space, airborne and shipboard applications as a local oscillator in swept or FM receivers, master oscillator in transmitters and ECM jammers, signal source in generators, etc. Fine

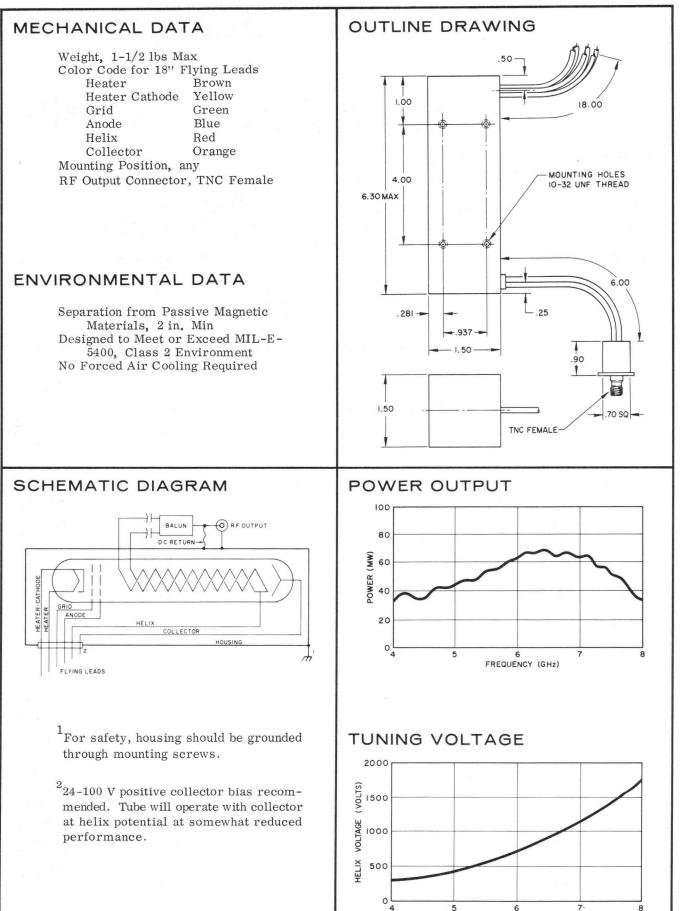


grain variation of frequency vs. voltage is extremely low. Power output and tuning curves are uniform and highly reproducible. Power can be modulated and leveled with either grid or anode circuits. All voltages are isolated from the housing for easier packaging.

ELECTRICAL CHARACTERISTICS, CW

	Units	Typical Values	Absolute Ratings
Nominal Frequency Band	GHz	4.0-8.0	
Power Output into Load with VSWR = 1,25:1	mW	30-70	20 Min
Power Output Variation	db		6 Max
Fine Grain Variation	db/250 MHz		3 Max
Tube VSWR			2.5:1 Max
Frequency Pulling Into 2:1 Load (Any Phase)	MHz	0.6	1.0
Ratio of Signal to Noise Power 30 MHz Away	db/MHz	95	85 Min
Ratio of Signal to 2nd Harmonic Output	db	30	20 Min
Long-term Sensitivity to Heater Voltage at 6 GHz	MHz/V	3.5	6 Max
Sensitivity to Anode Voltage	MHz/V	0.5	1.0 Max
Sensitivity to Grid Voltage	MHz/V	3	5 Max
Tuning Curve Slope			
Low End (4.0 GHz)	MHz/V	6.0	
Mid-Frequency (6.0 GHz)	MHz/V	2.5	
High End (8.0 GHz	MHz/V	1.7	
Grid r.f. Cutoff Voltage	V	-7	-20 Max
Capacitance; Cathode to all other Electrodes,			
inc. Heater	pf	18	25 Max
Capacitance; Grid to all other Electrodes, at			
Power Input Connector	pf	18	25 Max
Capacitance; Helix and Collector to all other			
Electrodes and Case	pf	90	125 Max
Heater Voltage	Vdc		$6.3 \pm 5\%$
Heater Current	А	.75	0.4 - 1.2
			Min/Max
Cathode Current	mA	6	12 Max
Helix Voltage Range	V	280-1710	250-1800
0			Min/Max
Anode Voltage*	V	100	200 Max
Anode Current	mA	0.3	2 Max

*Set anode voltage to Final Test Data value furnished with tube.



6 FREQUENCY (GHz)

FREQ

BACKWARD-WAVE

SE-307

TECHNICAL DATA • August 1965

The type SE-307 is a single-helix, voltage tunable oscillator utilizing a permanent-magnet focusing system. The miniature square package features rugged construction and capability to withstand severe environmental conditions defined in MIL-E - 5400, Class 2. The size and weight of this package are comparable to electrostatically-focused BWOs in this band, but with superior performance, reliability, and reduced power supply requirements. Thus, it is ideal for space, airborne and shipboard applications as a local oscillator in swept or FM receivers, master oscillator in transmitters and ECM jammers, signal source in generators, etc. Fine grain variation of frequency vs. voltage is extremely low. Power out-

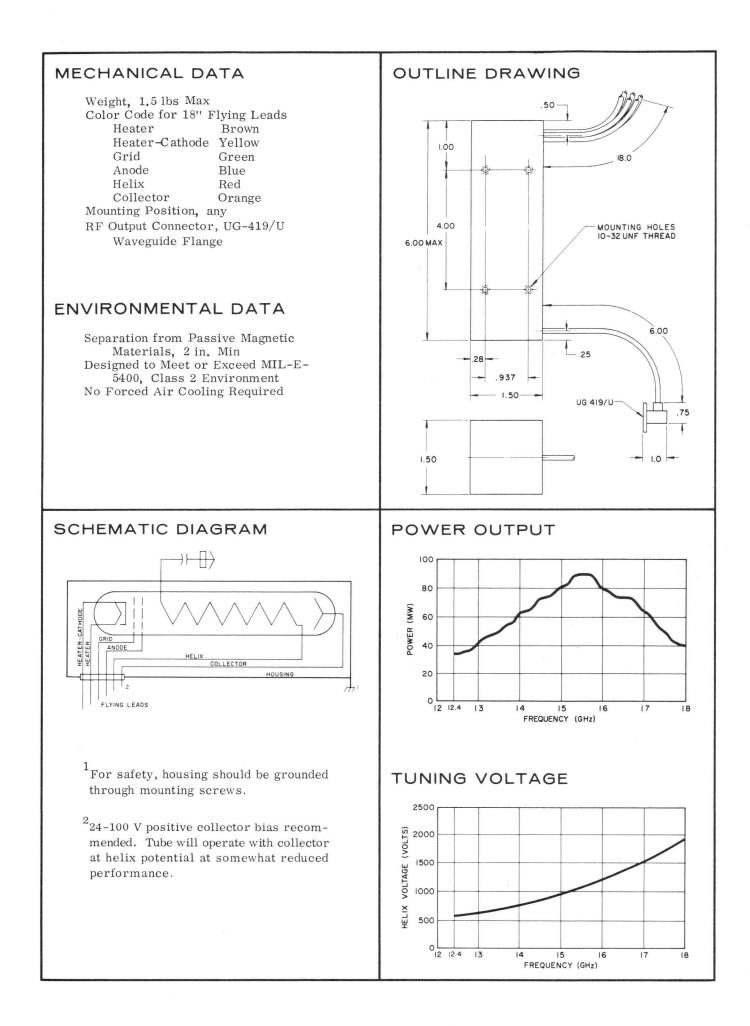


put and tuning curves are uniform and highly reproducible. Power can be modulated and leveled with either grid or anode circuits. All voltages are isolated from the housing and r.f. connector for easier packaging.

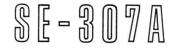
ELECTRICAL CHARACTERISTICS, CW

	Units	Typical Values	Absolute Ratings
Nominal Frequency Band Power Output into Load with VSWR = 1.25:1 Power Output Variation Fine Grain Variation Tube VSWR	GHz mW db db/250 MHz	12.4-18.0 25-85	20 Min 6 Max 3 Max 2.5:1 Max
Frequency Pulling into 2:1 Load (Any Phase) Ratio of Signal to Noise Power 30 MHz Away Long-term Sensitivity to Heater Voltage	MHz db/MHz MHz/V	$1.0 \\ 95 \\ 5$	1.5 Max 85 Min 10 Max
Sensitivity to Anode Voltage Sensitivity to Grid Voltage Tuning Curve Slope	MHz/V MHz/V	0.5 3	1.0 Max 6 Max
Low End (12.4 GHz) Mid-Frequency (15.2 GHz) High End (18.0 GHz)	MHz/V MHz/V MHz/V	8.7 4.4 2.2	20.14
Grid r. f. Cutoff Voltage Capacitance; Cathode to all Other Electrodes including Heater	V	-10 15	-20 Max 20 Max
Capacitance; Grid to all Other Electrodes at Power Input Connector Capacitance; Helix and Collector to all Other	pf	18	25 Max
Electrodes and Case Heater Voltage	pf Vdc	80	110 Max 6.3±5%
Heater Current	A mA	.75	0.4-1.2 Min/Max 12 Max
Helix Voltage Range	V ·	570-1980	500-2100 Min/Max
Anode Voltage* Anode Current	V m A	150 0.5	200 Max 2 Max

*Set anode voltage to Final Test Data value furnished with tube.

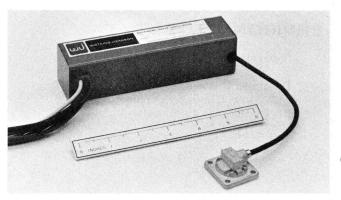


BACKWARD-WAVE



TECHNICAL DATA • August 1965

The type SE-307A is a single-helix, voltage tunable oscillator utilizing a permanent-magnet focusing system. The miniature square package features rugged construction and capability to withstand environmental conditions defined in MIL-E-5400, Class 2. The size and weight of this package is comparable to electrostatically-focused BWOs in this band, but with superior performance, reliability and reduced power supply requirements. Thus, it is ideal for space, airborne and shipboard applications as a local oscillator in swept or FM receivers, master oscillator in transmitters and ECM jammers, signal source in generators, etc. Fine grain variation of frequency vs.



voltage is extremely low. Power output and tuning curves are uniform and highly reproducible. Power can be modulated and leveled with the anode circuit. All voltages are isolated from the housing and r.f. connector for easier packaging.

ELECTRICAL CHARACTERISTICS, CW

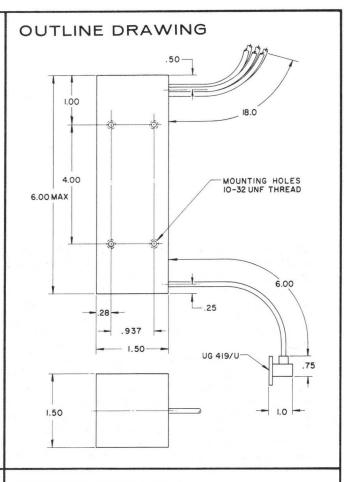
	Units	Typical Values	Absolute Ratings
Nominal Frequency Band	GHz	12.4-18.0	
Power Output into Load with VSWR = 1.25:1	mW	25-85	20 Min
Power Output Variation	db		6 Max
Fine Grain Variation	db/250 MHz		3 Max
Tube VSWR			2.5:1 Max
Frequency Pulling into 2:1 Load (Any Phase)	MHz	1.0	1.5 Max
Ratio of Signal to Noise Power 30 MHz from Carrier	db/MHz	95	85 Min
Long-term sensitivity to Heater Voltage	MHz/V	5	10 Max
Sensitivity to Anode Voltage	MHz/V	0.5	1.0 Max
Tuning Curve Slope			
Low End (12.4 GHz)	MHz/V	8.7	
Mid-Frequency (15.2 GHz)	MHz/V	4.4	
High End (18.0 GHz)	MHz/V	2.2	
Capacitance; Cathode to All Other Electrodes,			
including Heater	pf	15	20 Max
Capacitance; Helix and Collector to All Other	1		
Electrodes and Case	pf	80	110 Max
Heater Voltage	Vde		$6.3 \pm 5\%$
Heater Current	А	0.75	0.4-1.2 Min/Max
Cathode Current	mA	8	12 Max
Helix Voltage Range	V	570 - 1980	500 - 2100
			Min/Max
Anode Voltage*	. V	150	200 Max
Anode Current	mA	0.5	2 Max

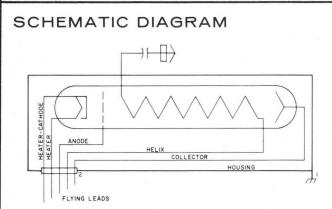
MECHANICAL DATA

Weight, 1-1/2 lbs Max Mounting Position, any Color Code for 18" Flying Leads Heater Brown Heater Cathode Yellow Anode Blue Helix Red Collector Orange RF Output Connector, UG-419/U Waveguide Flange

ENVIRONMENTAL DATA

Separation from Passive Magnetic Materials, 2 in. Min Designed to Meet or Exceed MIL-E-5400, Class 2 Environment No Forced Air Cooling Required

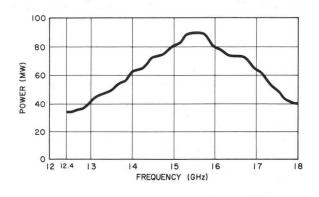




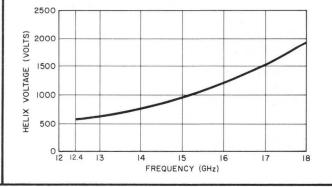
 1 For safety, housing should be grounded through mounting screws.

²24-100 V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.

POWER OUTPUT



TUNING VOLTAGE





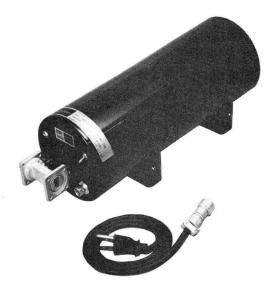
March 1967 X

12 TO 18 GHz LOW-NOISE TRAVELING-WAVE AMPLIFIER WITH INTEGRAL POWER SUPPLY

- "JUST PLUG IT IN"
- NOISE FIGURE 10.0
 dB MAXIMUM
- PERMANENT-MAGNET FOCUSING
- PROVEN RELIABILITY
- NO ADJUSTMENTS
 NEEDED
- 115 VOLT, 48 TO 420 Hz OPERATION
- MEETS MIL-E-5400, CLASS 2 SPECIFICATION

The WJ-307 is one of the original members of Watkins-Johnson's family of Standard low-noise amplifiers with integral solid-state power supply. When introduced to the microwave industry in 1964, the WJ-307's performance in the 12.0 to 18.0 GHz range was unparalleled by other devices. Today, this performance still remains better than or comparable to any commercially available unit. With many units in use throughout the world, the WJ-307 provides low noise figure (many production amplifiers exhibit noise figures of less than 9 dB), low cost per-operating-hour, and high field-proven reliability (MTBF's in excess of 20,000 hours with 99% confidence level).

This proven amplifier is completely self-contained,



adjustment-free, and requires only a 115 volt ac linevoltage input (48 to 420 Hz). The completely shielded package may be operated in any orientation, in stacked arrays or adjacent to ferromagnetic material, without adversely affecting the amplifier's performance.

Rugged construction of the tube, magnet, and power supply assembly assures reliable operation under vibrational forces of 5 g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of -54° C to $+71^{\circ}$ C. The environmental characteristics of the WJ-307 meet or exceed the corresponding requirements of MIL-E-5400: Temperature, Class 2; Vibration, Curve III.

SPECIFICATIONS

PERFORMANCE	Typical	Guaranteed
Frequency	12.0 to 18.0 GHz	.0 to 18.0 GHz
Noise Figure, Terminal		
Gain, Small Signal	30 dB	. 25 dB, min.
VSWR, Input and Output	1.5:1	. 2:1, max.
Power Output, Saturated	+3.0 dBm	—5 dBm, min.
ELECTRICAL REQUIREMENTS	Typical	Range ¹
Primary Voltage	115 V ac	115 ± 10 V ac
Primary Frequency	60 Hz	48 to 420 Hz
Primary Power	25 W	

* This Technical Data Sheet presents up-to-date information on the WJ-307, first described in Technical Bulletin Vol. 6, No. 9; September, 1964.

ENVIRONMENTAL CHARACTERISTICS²

Temperature (Operating) . . -54° C to $+71^{\circ}$ C Vibration

MECHANICAL CHARACTERISTICS

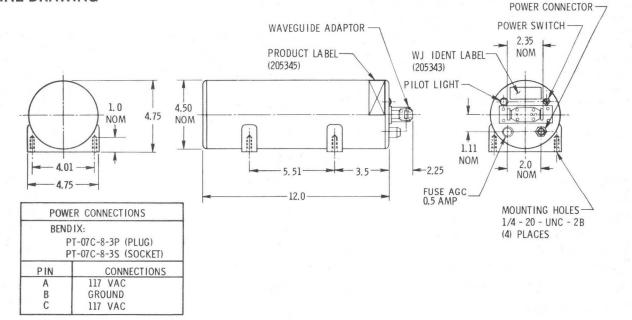
Height 4.75 inches (121 mm) max. Width 4.75 inches (121 mm) max. Length (excluding

connectors) 12 inches (305 mm) max. Weight 18 pounds (8.16 Kg) max. Primary Power Connection.

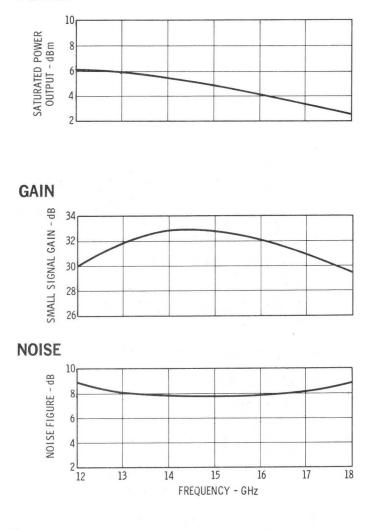
Deutsch Receptacle . . . DM9601-3P RF Connections Waveguide Flange UG-541/U Reference Drawing Number . . . 290027

- Every amplifier will meet the guaranteed performance specifications for any primary voltage and frequency lying within these ranges.
- 2. These environmental charateristics meet or exceed the respective requirements of MIL-E-5400: Temperature, Class 2; Vibration, Curve III.





POWER

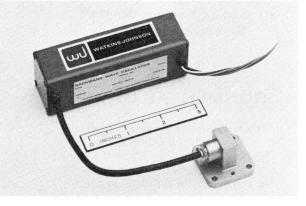


BACKWARD-WAVE O S C I L L A T O R

SE-308

TECHNICAL DATA • August 1965

The type SE-308 is a single-helix, voltage tunable oscillator utilizing a permanent-magnet focusing system. The miniature square package features rugged construction and capability to withstand severe environmental conditions defined in MIL-E-5400, Class 2. The size and weight of this package are comparable to electrostaticallyfocused BWOs in this band, but with superior performance, reliability, and reduced power supply requirements. Thus, it is ideal for space, airborne and shipboard applications as a local oscillator in swept or FM receivers, master oscillator in transmitters and ECM jammers, signal source in generators, etc. Fine grain variation of frequency vs. voltage is extremely low. Power out-

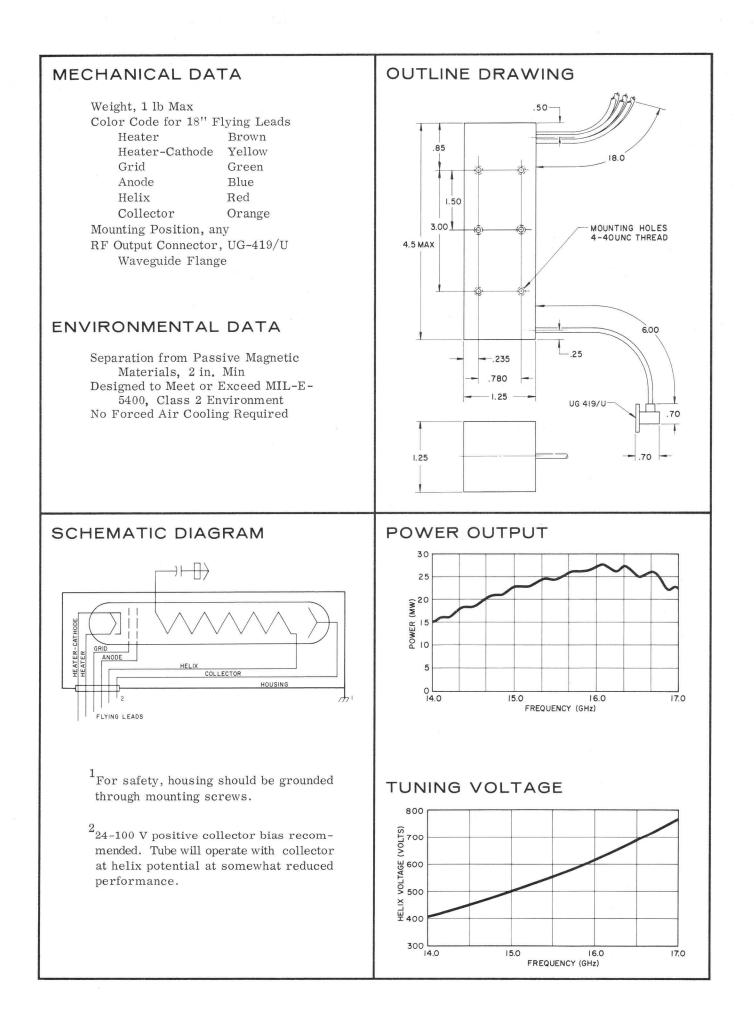


put and tuning curves are uniform and highly reproducible. Power can be modulated and leveled with either grid or anode circuits. All voltages are isolated from the housing and r. f. connector for easier packaging.

ELECTRICAL CHARACTERISTICS, CW

	Units	Typical Values	Absolute Ratings
Nominal Frequency Band	GHz	14.0-17.0	
Power Output into Load with VSWR = 1.25:1	mW	15-30	10 Min
Power Output Variation	db		6 Max
Fine Grain Variation	db/250 MHz		3 Max
Tube VSWR			2.5:1 Max
Frequency Pulling into 2:1 Load (Any Phase)	MHz	0.9	1.5 Max
Ratio of Signal to Noise Power 30 MHz Away	db/MHz	95	85 Min
Long-term Sensitivity to Heater Voltage	MHz/V	5	10 Max
Sensitivity to Anode Voltage	MHz/V	0.5	1.5 Max
Sensitivity to Grid Voltage	MHz/V	3	6 Max
Tuning Curve Slope	N	10 5	
Low End (14 GHz)	MHz/V	10.5	
Mid-Frequency (15.5 GHz)	MHz/V	8.0	
High End (17 GHz)	MHz/V	6.0	0.0.75
Grid r.f. Cutoff Voltage	V	-10	-20 Max
Capacitance; Cathode to all Other Electrodes			
including Heater	pf	15	20 Max
Capacitance; Grid to all Other Electrodes at			
Power Input Connector	pf	18	25 Max
Capacitance; Helix and Collector to all Other			
Electrodes and Case	pf	80	110 Max
Heater Voltage	, Vdc		$6.3 \pm 5\%$
Heater Current	А	.75	0.4-1.2
			Min/Max
Cathode Current	mA	7	12 Max
Helix Voltage Range	V	405 - 760	375-800
		1146 - Marco 1000	Min/Max
Anode Voltage*	V .	150	200 Max
Anode Current	mA	0.5	2 Max

*Set anode voltage to Final Test Data value furnished with tube.



BACKWARD-WAVE O S C I L L A T O R

SE-308A

TECHNICAL DATA • August 1965

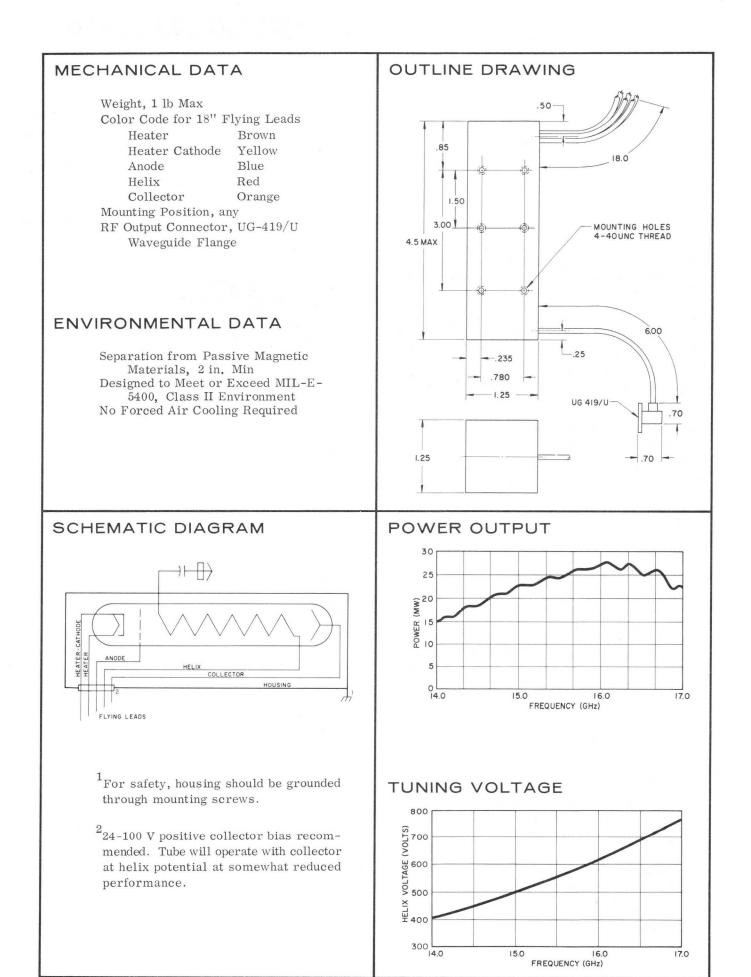
The type SE-308A is a single-helix, voltage tunable oscillator utilizing a permanent-magnet focusing system. The miniature square package features rugged construction and capability to withstand severe environmental conditions defined in MIL-E-5400, Class 2. The size and weight of this package are comparable to electrostaticallyfocused BWOs in this band, but with superior performance, reliability, and reduced power supply requirements. Thus, it is ideal for space, airborne and shipboard applications as a local oscillator in swept or FM receivers, master oscillator in transmitters and ECM jammers, signal source in generators, etc. Fine grain var-



iation of frequency vs. voltage is extremely low. Power output and tuning curves are uniform and highly reproducible. Power can be modulated and leveled with the anode circuit. All voltages are isolated from the housing and r. f. connector for easier packaging.

ELECTRICAL CHARACTERISTICS, CW

Nominal Frequency Band GHz $14.0-17.0$ Power Output into Load with VSWR = 1.25:1mW $15-30$ 10 MinPower Output Variationdb 6 MaxFine Grain Variationdb/ 250 MHz 3 MaxTube VSWR $2.5:1$ Max $2.5:1$ MaxFrequency Pulling into 2:1 Load (Any Phase)MHz 0.9 Ratio of Signal to Noise Power 30 MHz Awaydb/MHz 95 Long-term Sensitivity to Heater VoltageMHz/V 5 Sensitivity to Anode VoltageMHz/V 0.5 Low End (14 GHz)MHz/V 10.5 Mid-Frequency (15.5 GHz)MHz/V 6.0 Capacitance; Cathode to all Other Electrodes pf inc. Heater pf 15 Capacitance; Helix and Collector to all Other pf Electrodes and Case pf 80 Heater Voltage Vdc A $.75$ $0.4-1.2$ Min/Max		Units	Typical Values	Absolute Ratings
Power Output Variationdb6 MaxPower Output Variationdb/250 MHz3 MaxTube VSWR2.5:1 MaxFrequency Pulling into 2:1 Load (Any Phase)MHz0.9Ratio of Signal to Noise Power 30 MHz Awaydb/MHz95Ratio of Signal to Noise Power 30 MHz Awaydb/MHz95Long-term Sensitivity to Heater VoltageMHz/V5Low End (14 GHz)MHz/V0.5Mid-Frequency (15.5 GHz)MHz/V10.5Mid-Frequency (15.5 GHz)MHz/V8.0High End (17 GHz)MHz/V6.0Capacitance; Cathode to all Other Electrodespf15Inc. Heaterpf80110 MaxCapacitance; Helix and Collector to all Otherpf80Lectrodes and Casepf80110 MaxHeater VoltageVdc6,3±5%Heater CurrentA.750.4-1.2	Nominal Frequency Band	GHz	14.0-17.0	
Fine Grain Variationdb/250 MHz3 MaxFullTube VSWR2.5:1 MaxFrequency Pulling into 2:1 Load (Any Phase)MHz0.9Ratio of Signal to Noise Power 30 MHz Awaydb/MHz95Long-term Sensitivity to Heater VoltageMHz/V5Long-term Sensitivity to Heater VoltageMHz/V5Low End (14 GHz)MHz/V0.5Mid-Frequency (15.5 GHz)MHz/V8.0High End (17 GHz)MHz/V6.0Capacitance; Cathode to all Other Electrodespf15Electrodes and Casepf80110 MaxHeater VoltageVdc6.3±5%Heater CurrentA.750.4-1.2	Power Output into Load with VSWR = $1.25:1$	mW	15-30	10 Min
Tube VSWR2.5:1 MaxFrequency Pulling into 2:1 Load (Any Phase)MHz 0.9 1.5 MaxRatio of Signal to Noise Power 30 MHz Awaydb/MHz 95 85 MinLong-term Sensitivity to Heater VoltageMHz/V 5 10 MaxSensitivity to Anode VoltageMHz/V 0.5 1.5 MáxTuning Curve SlopeMHz/V 0.5 1.5 MáxLow End (14 GHz)MHz/V 10.5 Mid-Frequency (15.5 GHz)Mid-Frequency (15.5 GHz)MHz/V 8.0 High End (17 GHz)MHz/V 6.0 Capacitance; Cathode to all Other Electrodes pf 15 Low End Case pf 80 110 MaxHeater VoltageVdc $6.3\pm5\%$ Heater CurrentA $.75$ $0.4-1.2$	Power Output Variation	db		6 Max
Frequency Pulling into 2:1 Load (Any Phase)MHz 0.9 1.5 MaxRatio of Signal to Noise Power 30 MHz Awaydb/MHz95 85 MinLong-term Sensitivity to Heater VoltageMHz/V5 10 MaxSensitivity to Anode VoltageMHz/V 0.5 1.5 MáxTuning Curve SlopeMHz/V 0.5 1.5 MáxLow End (14 GHz)MHz/V 10.5 1.5 MáxMid-Frequency (15.5 GHz)MHz/V 8.0 110 MaxHigh End (17 GHz)MHz/V 6.0 6.0 Capacitance; Cathode to all Other Electrodes inc. Heaterpf 15 20 MaxCapacitance; Helix and Collector to all Other Electrodes and Casepf 80 110 MaxHeater VoltageVdc $6.3\pm5\%$ $6.3\pm5\%$ Heater CurrentA.75 $0.4-1.2$	Fine Grain Variation	db/250 MHz		3 Max
Ratio of Signal to Noise Power 30 MHz Awaydb/MHz9585 MinLong-term Sensitivity to Heater VoltageMHz/V510 MaxSensitivity to Anode VoltageMHz/V0.51.5 MaxTuning Curve SlopeMHz/V10.51.5 MaxLow End (14 GHz)MHz/V10.510 MaxMid-Frequency (15.5 GHz)MHz/V8.010 MaxHigh End (17 GHz)MHz/V6.010 MaxCapacitance; Cathode to all Other Electrodes inc. Heaterpf1520 MaxCapacitance; Helix and Collector to all Other Electrodes and Casepf80110 MaxHeater VoltageVdc6.3±5%6.3±5%Heater CurrentA.750.4-1.2	Tube VSWR			2.5:1 Max
Long-term Sensitivity to Heater VoltageMHz/V510 MaxSensitivity to Anode VoltageMHz/V0.51.5 MaxTuning Curve SlopeImage: Sensitivity to Anode VoltageMHz/V0.51.5 MaxLow End (14 GHz)MHz/V10.5Mid-Frequency (15.5 GHz)MHz/V8.0Mid-Frequency (15.5 GHz)MHz/V6.06.0Capacitance; Cathode to all Other Electrodesinc. Heaterpf1520 MaxCapacitance; Helix and Collector to all Otherpf80110 MaxHeater VoltageVdc6.3±5%6.3±5%Heater CurrentA.750.4-1.2	Frequency Pulling into 2:1 Load (Any Phase)	MHz	0.9	1.5 Max
Sensitivity to Anode VoltageMHz/V0.51.5 MaxTuning Curve SlopeImage: Stress of the stre	Ratio of Signal to Noise Power 30 MHz Away	db/MHz	95	85 Min
Tuning Curve Slope Low End (14 GHz) Mid-Frequency (15.5 GHz)MHz/V10.5Mid-Frequency (15.5 GHz) High End (17 GHz)MHz/V8.0Capacitance; Cathode to all Other Electrodes inc. Heaterpf1520 MaxCapacitance; Helix and Collector to all Other Electrodes and Casepf80110 MaxHeater VoltageVdc6.3±5%6.3±5%Heater CurrentA.750.4-1.2	Long-term Sensitivity to Heater Voltage	MHz/V	5	10 Max
Low End (14 GHz)MHz/V10.5Mid-Frequency (15.5 GHz)MHz/V8.0High End (17 GHz)MHz/V6.0Capacitance; Cathode to all Other ElectrodesInc. Heaterinc. Heaterpf1520 MaxCapacitance; Helix and Collector to all OtherInto MaxElectrodes and Casepf80110 MaxHeater VoltageVdc6.3±5%Heater CurrentA.750.4-1.2	Sensitivity to Anode Voltage	MHz/V	0.5	1.5 Max
Mid-Frequency (15.5 GHz)MHz/V8.0High End (17 GHz)MHz/V6.0Capacitance; Cathode to all Other Electrodes inc. Heaterpf1520 MaxCapacitance; Helix and Collector to all Other Electrodes and Casepf80110 MaxHeater VoltageVdc6.3±5%Heater CurrentA.750.4-1.2	Tuning Curve Slope			
High End (17 GHz)MHz/V6.0Capacitance; Cathode to all Other Electrodes inc. Heaterpf1520 MaxCapacitance; Helix and Collector to all Other Electrodes and Casepf80110 MaxHeater VoltageVdc6.3±5%Heater CurrentA.750.4-1.2	Low End (14 GHz)			
Capacitance; Cathode to all Other Electrodes inc. Heaterpf1520 MaxCapacitance; Helix and Collector to all Other Electrodes and Casepf80110 MaxHeater VoltageVdc6.3±5%Heater CurrentA.750.4-1.2			17.	
inc. Heater pf 15 20 Max Capacitance; Helix and Collector to all Other Electrodes and Case pf 80 110 Max Heater Voltage Vdc 6.3±5% Heater Current A .75 0.4-1.2	High End (17 GHz)	MHz/V	6.0	
Capacitance; Helix and Collector to all Other Electrodes and Casepf80110 MaxHeater VoltageVdc $6.3\pm5\%$ Heater CurrentA.75 $0.4-1.2$	Capacitance; Cathode to all Other Electrodes			
Electrodes and Casepf80110 MaxHeater VoltageVdc $6.3\pm5\%$ Heater CurrentA.75 $0.4-1.2$	inc. Heater	pf	15	20 Max
Heater VoltageVdc $6.3\pm5\%$ Heater CurrentA.75	Capacitance; Helix and Collector to all Other			
Heater Current A .75 0.4-1.2	Electrodes and Case		80	
noutor ourront	Heater Voltage	Vdc		
Min/Max	Heater Current	А	.75	
Cathode Current mA 7 12 Max				
Helix Voltage Range V 405-760 375-800	Helix Voltage Range	, V	405-760	
Min/Max			150	
Anode Voltage* V 150 200 Max				
Anode Current mA 0.5 2 Max	Anode Current	mA	0.5	2 Max

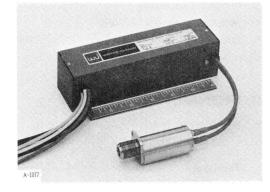


BACKWARD-WAVE OSCILLATOR

SE-310

September 1967

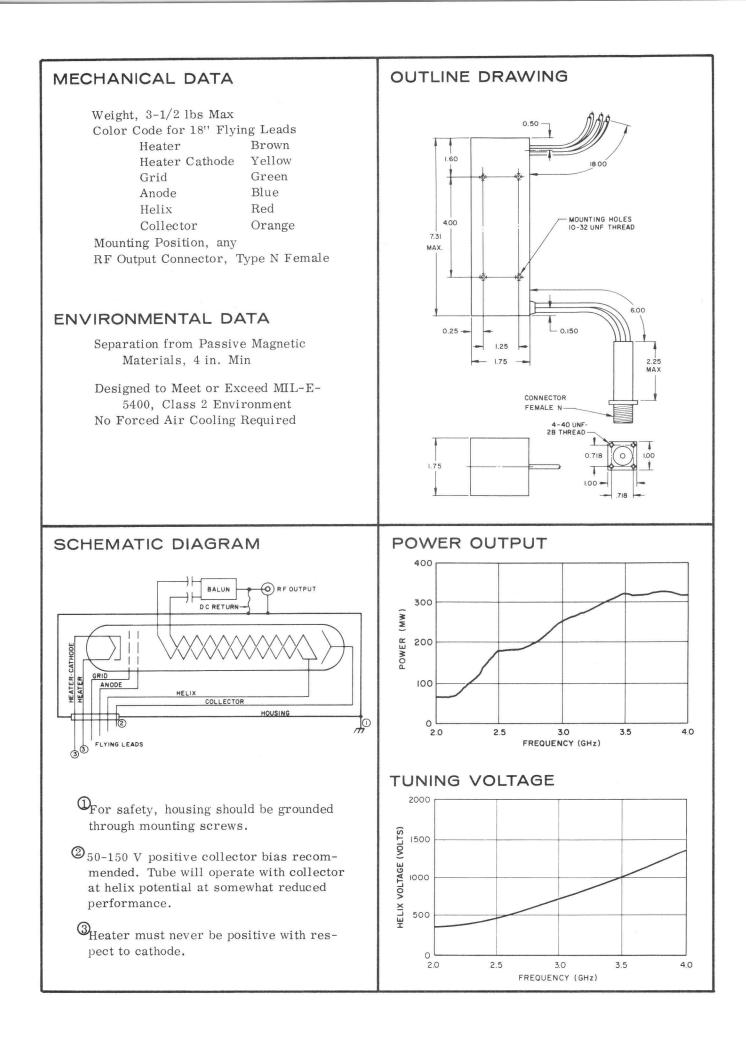
The SE 310 is a bifilar (dual) helix, voltage tunable oscillator utilizing a permanent magnet focusing system. The miniature square package features rugged construction and capability to withstand severe environmental conditions defined in MIL-E-5400, Class 2. The SE-310 is ideal for space, airborne and shipboard applications as a local oscillator in swept or FM receivers, master oscillator in transmitters and ECM jammers, signal source in signal generators. Fine grain variation of frequency versus voltage is extremely low. The SE-310 delivers smooth power output over the band with low operating cathode current. Power can be



modulated and leveled with either grid or anode circuits. All voltages are isolated from the housing and RF output connector for maximum flexibility in circuit applications.

SPECIFICATIONS						
	UNITS	TYPICAL	ABSOLU	TE		
		VALUES	RATIN	GS		
Nominal Frequency Band	GHz	2.0 - 4.0				
Power Output into Load with VSWR = 1.25:1	mW	60 - 330	50	Min		
Power Output Variation	dB		9	Max		
Fine Grain Variation	dB/250 M	Hz		Max		
Tube VSWR			2.5:1	Max		
Frequency Pulling Into 2:1 Load (Any Phase)	MHz	4	6			
Ratio of Signal to Noise Power 30 MHz Away	dB/MHz	95	85	Min		
Ratio of Signal to 2nd Harmonic Output	dB	30	20	Min		
Long-term Sensitivity to Heater Voltage at 3 GHz	MHz/V	5				
Sensitivity to Anode Voltage	MHz/V	1				
Sensitivity to Grid Voltage	MHz/V	6				
Tuning Curve Slope						
Low End (2.0 GHz)	MHz/V	4.5				
Mid-Frequency (3.0 GHz)	MHz/V	2.5				
High End (4.0 GHz)	MHz/V	1				
Grid r.f. Cutoff Voltage	V	-8	-20	Max		
Capacitance: Cathode to all other Electrodes						
and Housing	pF	20	30	Max		
Capacitance: Grid to all other Electrodes						
and Housing	\mathbf{pF}	16	25	Max		
Capacitance; Helix and Collector to all other						
Electrodes and Housing	pF	230		Max		
Heater Voltage	Vdc			$\pm 5\%$		
Heater Current	А	.75		4-1.2		
				/Max		
Cathode Current*	mA	12.5	15	Max		
Helix Voltage Range	V	290-1320		-1400		
		2		/Max		
Anode Voltage	V	130		Max		
Anode Current	mA	0.1		Max		
Helix Current	mA	1.8	3	Max		

* Set Cathode current to Final Test Data value furnished with tube.

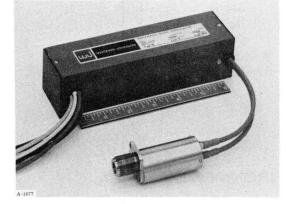


BACKWARD-WAVE OSCILLATOR

September 1967

SE-310-3

The SE-310-3 is a bifilar (dual) helix, voltage tunable oscillator utilizing a permanent magnet focusing system. The miniature square package features rugged construction and capability to withstand severe environmental conditions defined in MIL-E-5400, Class 2. The SE-310-3 is ideal for space, airborne and shipboard applications as a local oscillator in swept or FM receivers, master oscillator in transmitters and ECM jammers, and as a signal source in signal generators. Fine grain variation of frequency versus voltage is extremely low. The SE-310-3 delivers smooth power output over the band with low operating cathode



current. Power can be modulated and leveled with either grid or anode circuit. All voltages are isolated from the housing and RF output connector for maximum flexibility in circuit applications.

SPECIFICATIONS

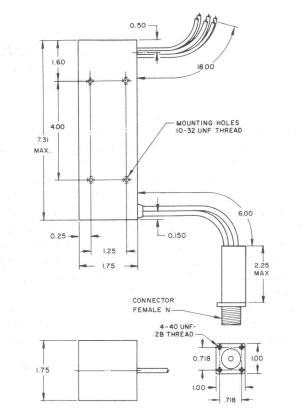
SPECIFICATIONS						
	Units	Typical	Absolute			
		Values	Ratings			
Nominal Frequency Band	GHz	2.6-5.2				
Power Output into Load with VSWR = 1.25:1	mW	65-230	50 Min			
Power Output Variation	dB		8 Max			
Fine Grain Variation	dB/250 MHz		3 Max			
Tube VSWR			2.5:1 Max			
Frequency Pulling Into 2:1 Load (Any Phase)	MHz	3	6			
Ratio of Signal to Noise Power 30 MHz Away	dB/MHz	95	85 Min			
Ratio of Signal to 2nd Harmonic Output	dB	30	20 Min			
Long-term Sensitivity to Heater Voltage at 6 GHz	MHz/V	3.0				
Sensitivity to Anode Voltage	MHz/V	0.8				
Sensitivity to Grid Voltage	MHz/V	8				
Tuning Curve Slope						
Low End (2.6 GHz)	MHz/V	4.2				
Mid-Frequency (3.9 GHz)	MHz/V	2				
High End (5.2 GHz)	MHz/V	1				
Grid r.f. Cutoff Voltage	V	-5	-20 Max			
Capacitance: Cathode to all other Electrodes						
and Housing	\mathbf{pF}	20	30 Max			
Capacitance: Grid to all other Electrodes						
and Housing	\mathbf{pF}	20	30 Max			
Capacitance; Helix and Collector to all other						
Electrodes and Housing	\mathbf{pF}	230	260 Max			
Heater Voltage	Vdc		$6.3\pm 5\%$			
Heater Current	А	. 75	0.4 - 1.2			
			Min/Max			
Cathode Current*	mA	10	15 Max			
Helix Voltage Range	V	365-1830	345-1920			
			Min/Max			
Helix Current	mA	1.3	3 Max			
Anode Voltage	V	110	215 Max			
Anode Current	mA	0.1	2 Max			

* Set Cathode current to Final Test Data value furnished with tube.

MECHANICAL DATA

OUTLINE DRAWING

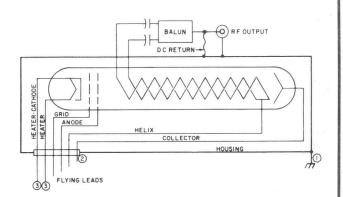
Weight, 3-1/2 lbs Max Color Code for 18'' Flying Leads Heater Brown Heater Cathode Yellow Grid Green Anode Blue Helix Red Collector Orange Mounting Position, any RF Output Connector, Type N Female



ENVIRONMENTAL DATA

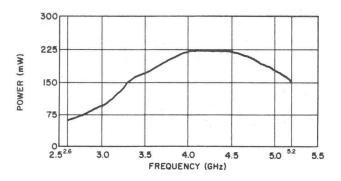
Separation from Passive Magnetic Materials, 4 in. Min Designed to Meet or Exceed MIL-E-5400, Class 2 Environment No Forced Air Cooling Required

SCHEMATIC DIAGRAM

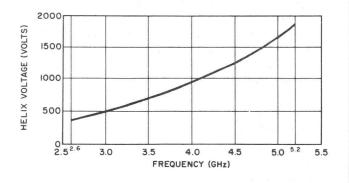


- ⁽¹⁾For safety, housing should be grounded through mounting screws.
- ② 50-150 V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.
- ³Heater must always be negative with respect to cathode.

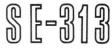
POWER OUTPUT



TUNING VOLTAGE



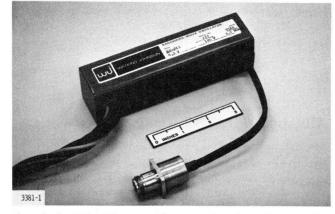
WATKINS = JOHNSON COMPANY 3333 HILLVIEW AVENUE = STANFORD INDUSTRIAL PARK PALO ALTO, CALIFORNIA 94304 TWX 910-373-1253 PHONE (415) 326-8830 Telex: 348-415



BACKWARD-WAVE OSCILLATOR

November 1968*

The type SE-313 BWO is a bifilar (dual helix) voltage tunable oscillator utilizing permanent-magnet focusing. The miniature square package features rugged construction and capability to withstand severe environmental conditions. The size and weight of this package are comparable to electrostatically-focused BWO's in this band, but with superior performance, reliability, and reduced power supply requirements. Thus, it is ideal for space, airborne, and shipboard applications as a local oscillator in swept or FM receivers, master oscillator in transmitters and ECM jammers, signal source in generators, etc. Fine grain variation of frequency versus voltage is extremely low. Power output and tuning curves are uniform and highly reproducible. Power can be modulated and



leveled with either grid or anode circuits. Helix and collector should be grounded to the housing for high altitude operation.

	Units	Typical Values	Absolute Ratings
Nominal Frequency Band Power Output into Load with VSWR = 1.25:1 Power Output Variation Fine Grain Variation Tube VSWR	GHz mW db db/250 MHz	60-150	8.0-12.4 50 Min 6 Max 3 Max 2.5:1 Max
Frequency Pulling into 2:1 Load (Any Phase) Ratio of Signal to 2nd Harmonic Output Ratio of Signal to Noise Power 30 MHz Away Long-term Sensitivity to Heater Voltage Sensitivity to Anode Voltage Sensitivity to Grid Voltage	MHz db db/MHz MHz/V MHz/V MHz/V	0.6 30 95 5 0.6 3	2.01 Max 2.0 Max 20 Min 85 Min 10 Max 1.0 Max 5 Max
Tuning Curve Slope Low End (8.0 GHz) Mid-Frequency (10.0 GHz) High End (12.4 GHz) Grid r.f. Cutoff Voltage	MHz/V MHz/V MHz/V V	7.2 4.6 2.7 -7	-20 Max
Capacitance; Cathode and Grid to all Other Electrodes and Case Capacitance; Helix and Collector to all Other	pf	40	50 Max
Electrodes and Case Heater Voltage Heater Current	pf Vdc A	150 0.75	175 Max 6.3±5% 0.4-1.2
Cathode Current Helix Voltage Range	m A V	8 450-1495	Min/Max 12 Max 425-1600 Min/Max
Anode Voltage ¹ Anode Current	V mA	150 0.1	250 Max 2 Max

SPECIFICATIONS

 1 Set Anode Voltage to Final Test Data value furnished with tube.

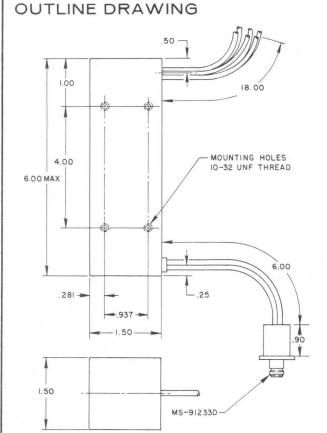
* Supersedes SE-313 Technical Data Sheet dated August 1965.

MECHANICAL DATA

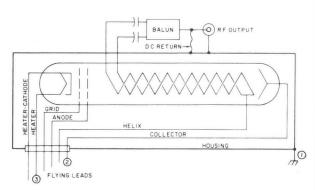
Weight, 1-1/2 lbs Max Color Code for 18" Flying Leads Heater Brown Heater Cathode Yellow Grid Green Blue Anode Helix Red Collector Orange Mounting Position, any RF Output Connector, Type N Female

ENVIRONMENTAL DATA

Separation from Passive Magnetic Materials, 2 in. Min Designed to Meet or Exceed MIL-E-5400, Class 2 Environment No Forced Air Cooling Required



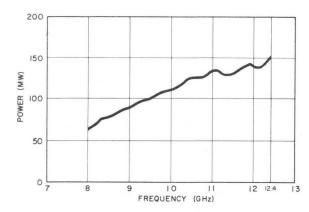
SCHEMATIC DIAGRAM



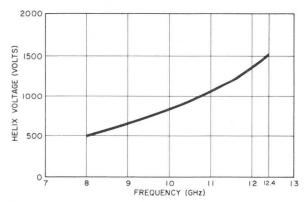
Notes:

- (1) For safety, housing should be grounded through mounting screws.
- (2) 50 150 V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.
- ③ Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.

POWER OUTPUT



TUNING VOLTAGE



WATKINS = JOHNSON COMPANY 3333 HILLVIEW AVENUE = STANFORD INDUSTRIAL PARK PALO ALTO, CALIFORNIA 94304 TWX 910-373-1253 PHONE (415) 326-8830 Telex: 348-415

DECEMBER 1970 *

26.5 TO 40.0 GHz LOW-NOISE TRAVELING-WAVE AMPLIFIER WITH INTEGRAL POWER SUPPLY WJ-338

- "JUST PLUG IT IN"
- NOISE FIGURE: 14.5 dB MAXIMUM
- PERMANENT-MAGNET FOCUSING
- NO ADJUSTMENTS
 NEEDED

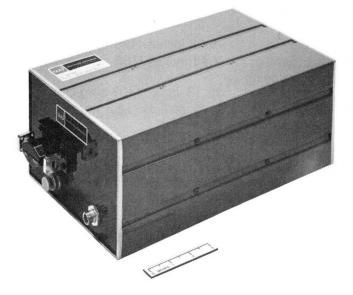
The WJ-338 is the first of a new family of standard low-noise TWA's developed by Watkins-Johnson Company for use in K_a -band. Users can expect long life and trouble-free performance from this amplifier, which exhibits the same conservative design and rigid manufacturing process control as other members of the standard series. Permanent-magnet focusing allows side-by-side operation in stacked arrays or next to ferromagnetic material without adverse effect. The integral power supply, which requires only an ac line-voltage input, makes the amplifier a completely self-contained unit. The WJ-338 may be mounted in any orientation without degradation of performance. Rugged construction of the tube, magnet, and power supply assembly ensures reliable operation under vibrational forces of over 2 g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of 0°C to 50°C.

Other members of the WJ-338 family are also available with higher gain and/or noise figure over a narrow frequency band.

SPECIFICATIONS

PERFORMANCE	Typical	Guaranteed
Frequency		26.5 to 40.0 GHz
Noise Figure, Terminal ¹	.13.5 dB	14.5 dB, max.
Gain, Small Signal	.28 dB	25 dB, min.
VSWR, Input and Output	.1.5:1	2.5:1, max.
Power Output	.10 dBm	5 dBm, min.
ELECTRICAL REQUIREMENTS	Typical	Range ²
Primary Voltage	.115 V ac	\ldots 115 \pm 10 V ac
Primary Frequency	.60 Hz	48 to 420 Hz
Primary Power	.20 W	30 W, max.

¹Noise figure is as read on a standard HP 340B Meter utilizing a standard AIL 07096 noise source. ²Every tube will meet the guaranteed performance specifications for any voltage lying within these ranges. *Supersedes WJ-338 Technical Data Sheet dated January 1969.



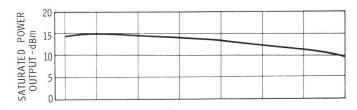
ENVIRONMENTAL CHARACTERISTICS

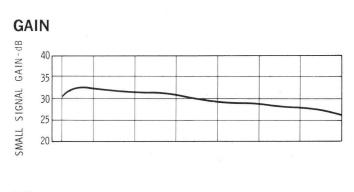
a. 0.01 Inch, Double Amplitude 5 to 63 Hz b. 2 g, Single Amplitude 63 to 500 Hz

MECHANICAL CHARACTERISTICS

Height 5.08 inches (129 mm) max.	
Width 7.45 inches (189 mm) max.	
Length (excluding	
connectors) 12.18 inches (309 mm) max.	
Weight 27 pounds (12.2 Kg) max.	
Primary Power Connection,	
Bendix Receptacle PT07C-8-3P	
RF Connectors	
(WR-42 Waveguide) UG 599/U flange	

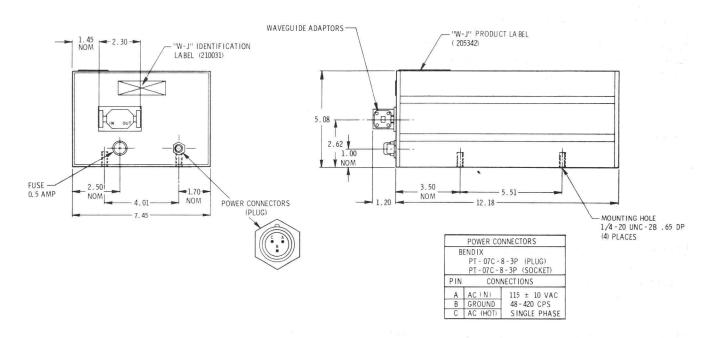
POWER





NOISE

P 20 20 15 10 5 26 26.5 28 30 32 34 36 38 40 FREQUENCY - GHz



September 1968 *

1.0 TO 2.0 GHz **GRIDDED 1-KILOWATT TRAVELING-WAVE TUBE** WJ-340

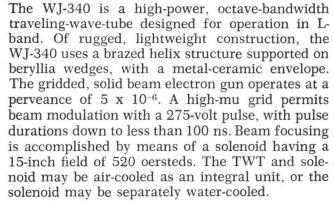


SPECIFICATIONS

PERFORMANCE CHARACTERISTICS	Typical	Guaranteed
Frequency	1.0 to 2.0 GHz	1.0 to 2.0 GHz
Power output (pulsed)	1.2 kW	1.0 kW, min.
Gain at saturation		30 dB, min.
Load VSWR		2:1, max.
Duty Cycle		0.01, max.

ELECTRICAL REQUIREMENTS

Cathode voltage	.5.0 kV 4.7 to 5.2 kV
Beam current	.1.8 amps 1.7 to 2.0 amps
Heater voltage	.7.5 volts
Heater current	.2.2 amps 2.0 to 2.4 amps
Grid pulse voltage	.275 volts
Grid bias voltage	200 volts
Grid current	.0.5 amps 0.4 to 0.6 amps
Grid capacitance	.50 pF
Circuit voltage, anode and collector	.Ground Ground
Pulse duration	.5 μ sec 0.1 to 10 μ sec
Magnetic field	.525 gauss 600 gauss max.
Solenoid voltage	.60 volts
Solenoid current	.8.0 amps 7.5 to 8.5 amps



Tube performance can be altered somewhat by variation of the voltages and currents. Although the basic WJ-340 is designed for operation at a duty cycle of 0.01, factory modified versions with higher duty cycle capability are available on special order. These special tubes have slightly modified collectors which may, or may not, require water cooling, depending on the specific duty cycle.

MECHANICAL **CHARACTERISTICS**

7.5 V HEATER SUPPLY

GRID PULSE

VOLTAGE in

2. 75V PEAK

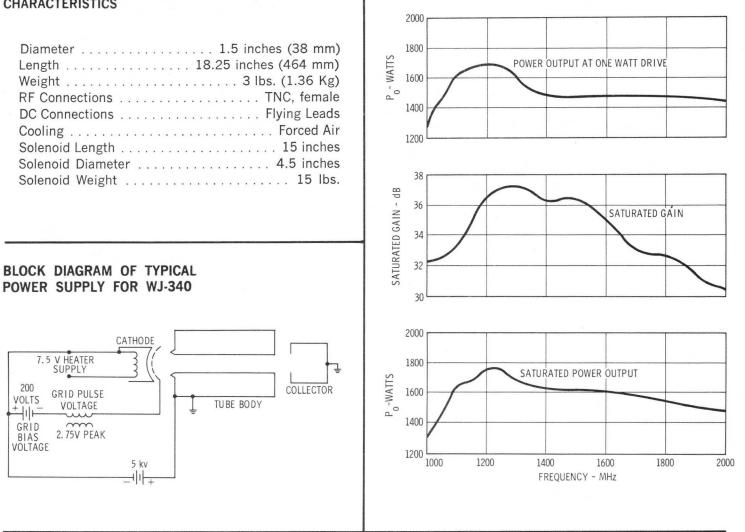
200

VOLTS +

GRID BIAS

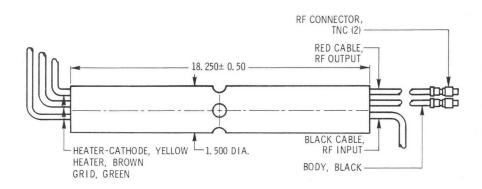
Diameter 1.5 inches (38 mm)
Length 18.25 inches (464 mm)
Weight 3 lbs. (1.36 Kg)
RF Connections TNC, female
DC Connections Flying Leads
Cooling Forced Air
Solenoid Length 15 inches
Solenoid Diameter 4.5 inches
Solenoid Weight 15 lbs.

TYPICAL POWER OUTPUT AND GAIN CURVES



OUTLINE DRAWING OF WJ-340, **EXCLUDING SOLENOID**

5 kv



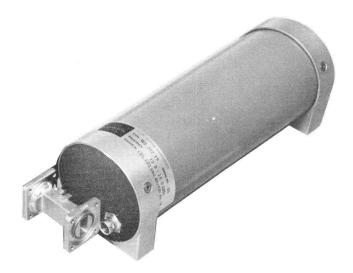
February 1967

12.0 TO 18.0 GHz COMPACT LOW-NOISE TRAVELING-WAVE AMPLIFIER WITH INTEGRAL POWER SUPPLY M 1_9/19

- "JUST PLUG IT IN"
- NOISE FIGURE 12
 dB MAXIMUM
- PERMANENT-MAGNET FOCUSING
- PROVEN RELIABILITY
- NO ADJUSTMENTS NEEDED
- 115 VOLT, 48 TO 420 Hz OPERATION
- MEETS MIL-E-5400, CLASS 2 SPECIFICATION

The WJ-342, a compact and wide dynamic range Ku-band amplifier, is the latest addition to the Watkins-Johnson family of PM-focused integral power supply traveling-wave amplifiers.

This compact amplifier has a typical noise figure of 10 dB and saturated power output of +10 dBm. Weighing less than 6.5 pounds, the WJ-342 measures less than 12 inches long, including waveguide adaptors. Typical power drain from a 115-volt ac source is 20 watts. The WJ-342 offers a guaranteed noise figure of 12 dB over the 12.0 to 18.0 GHz band at 25



dB minimum gain with +7.0 dBm minimum output power.

Reliable operation is achieved in any orientation. The environmental characteristics of the WJ-342 meet the requirements of MIL-E-5400 Specification. Like other members of its family, the WJ-342 is conservatively designed for long-life and trouble-free performance. Various versions of the standard model are available offering improved narrow-band performance, wider frequency coverage, and lower power drain.

SPECIFICATIONS

PERFORMANCE Frequency	Typical 12.0–18.0 GHz				
Noise Figure, Terminal					
Gain, Small Signal					
VSWR, Input and Output					
Power Output	+10 dBm	. +7 dBm, min.			
ELECTRICAL REQUIREMENTS Typical Range 1					
Primary Voltage	115 V ac	. 115 \pm 10 V ac			
Primary Frequency	60 Hz	. 48 to 420 Hz			
Primary Power	20 W				



ENVIRONMENTAL CHARACTERISTICS²

Temperature (Operating) . . -54° C to $+71^{\circ}$ C Vibration

MECHANICAL CHARACTERISTICS

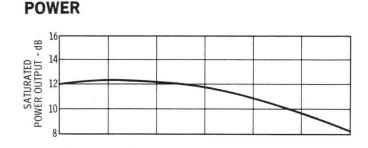
Height 3.4 inches (86 mm) max. Width 3.4 inches (86 mm) max. Length (excluding

connectors) 9.5 inches (241 mm) max. Weight 6.5 pounds (2.95 Kg) max.

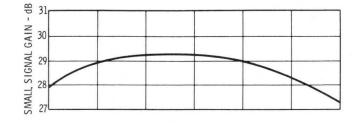
Primary Power Connection, Deutsch Receptacle . . . DM9601-3P RF Connections

(Waveguide) . . UG-541/U Choke Flange Reference Drawing Number 290034

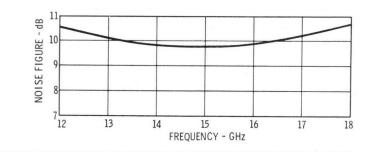
- 1. Every tube will meet the guaranteed performance specifications within these ranges.
- 2. These environmental characteistics meet or exceed the respective requirements of MIL-E-5400 temperature Class 2, Vibration Curve III.



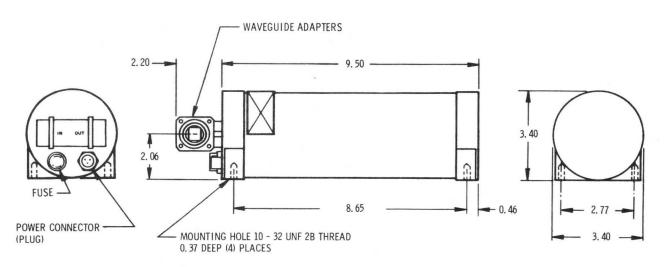
GAIN



NOISE



OUTLINE DRAWING



February 1967

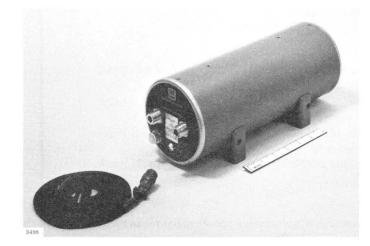
WJ-343

August 1968 *

2.0 to 8.0 GHz LOW-NOISE, TRAVELING-WAVE TUBE AMPLIFIER WITH INTEGRAL POWER SUPPLY

- "JUST PLUG IT IN"
- NOISE FIGURE 7.5 dB
- S-C BANDS RANGE
- ADJUSTMENT-FREE
 OPERATION
- PERMANENT MAGNET FOCUSING
- MEETS MIL-E-5400, CLASS 2 SPECIFICATION

The WJ-343 is one of a series of ultra-wide band LNTWAs developed by Watkins-Johnson Company for use in sensitive, ultra-wide-bandwidth receiver equipments. It offers economy of space, weight and price over two single-octave amplifiers covering the same frequency range. It features the same long-life design, rugged construction and adjustment-free operation characteristics of Wat-



kins-Johnson's line of octave-band, low-noise amplifiers.

The WJ-343 may be mounted in any orientation and is built to withstand the shock, vibration, and temperature specifications of MIL-E-5400, Class 2. Magnetic shielding allows operation next to similar units, or to ferromagnetic material, without degredation of performance.

SPECIFICATIONS

PERFORMANCE	Typical	Guaranteed
Frequency		
Noise figure, terminal	6.0 dB	7.5 dB max.
Gain, small signal		25 dB
Gain variation, small signal	±3 dB	
VSWR, input and output		2.5:1 max.
Power output	+5 dBm	0 dBm
ELECTRICAL REQUIREMENTS	Typical	Range ¹
Primary voltage		\dots 115 ±10 V ac
Primary frequency	60 Hz	48 to 420 Hz
Primary power	. 25 watts	

* Supersedes WJ-343 Technical Data Sheet dated November 1967

ENVIRONMENTAL CHARACTERISTICS²

Temperature
Vibration
a. 0.10 inch, double amplitude 5 to 45 Hz
b. 5 g, single amplitude 45 to 500 Hz
Shock 15 g, 11 ms

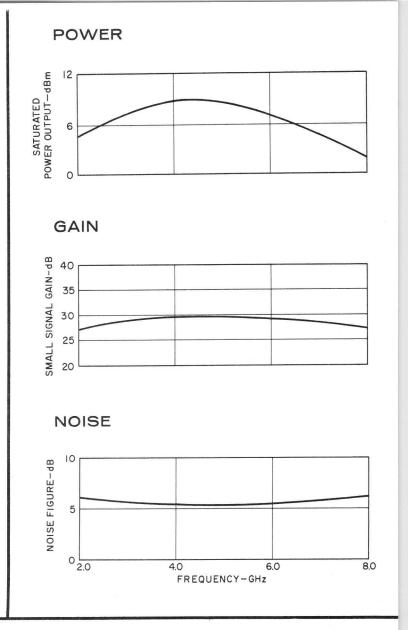
MECHANICAL CHARACTERISTICS

Amplifier length

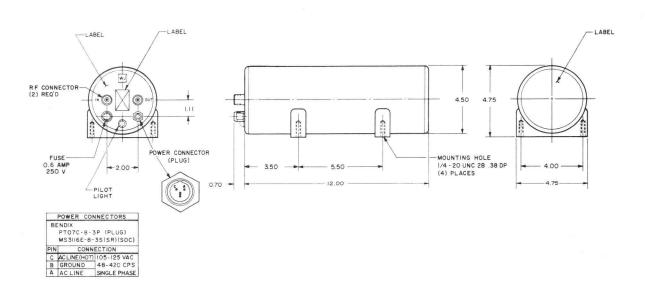
(excluding connectors) 12 inches, max.
Amplifier height and width4.75 inches, max.
Weight 18 lbs., max.
Primary power connection, Bendix receptacle PT07C-8-3P
RF connections (50 ohms nominal) Type N, jack

¹Meets guaranteed performance specifications for any voltage within these ranges.

²Environmental characteristics meet or exceed respective requirements for MIL-E-5400, Class 2.



OUTLINE DRAWING



WJ-345,-7,-11

8 TO 12 GHz, ULTRA LOW-NOISE TRAVELING-WAVE AMPLIFIER WITH INTEGRAL POWER SUPPLY

- "JUST PLUG IT IN"
- NOISE FIGURE 7.0 dB MAXIMUM OVER FULL FREQUENCY BAND
- NOISE FIGURE 5.5 dB MAXIMUM OVER SELECTED FREQUENCY RANGES
- PROVEN RELIABILITY

PERFORMANCE

 MEETS MIL-E-5400, CLASS 2 SPECIFICATION

The WJ-345 is the X-band member of a family of PM-focused amplifiers providing ultra-low-noise capability in a completely self-contained, adjustment-free package. Its only requirement is a 115 volt AC line voltage input (48 to 420 Hz). Other versions of this amplifier provide guaranteed noise figures ranging from 5.5 dB to 7.0 dB depending on the specified bandwidth. Helix gain control, anode blanking and other special applications can be provided on all models.

All versions of this amplifier family may be oper-



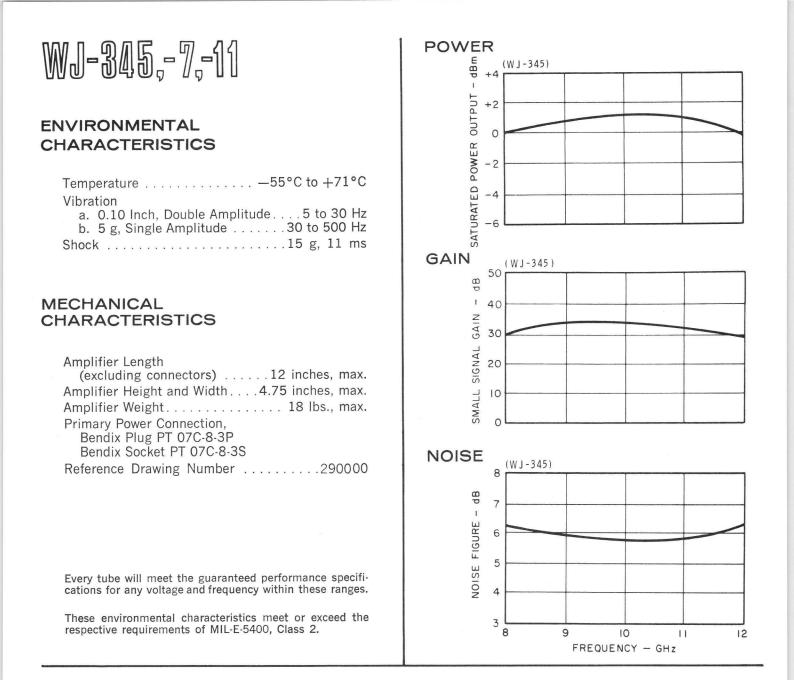
ated in any orientation, in stacked arrays or adjacent to ferromagnetic material without degradation of performance.

Rugged construction of the tube, magnet, and power supply assembly assures reliable operation under vibrational forces of 5 g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of -54° to $+71^{\circ}$ C. The environmental characteristics of the WJ-345 family meet or exceed the corresponding requirements of MIL-E-5400, Class 2.

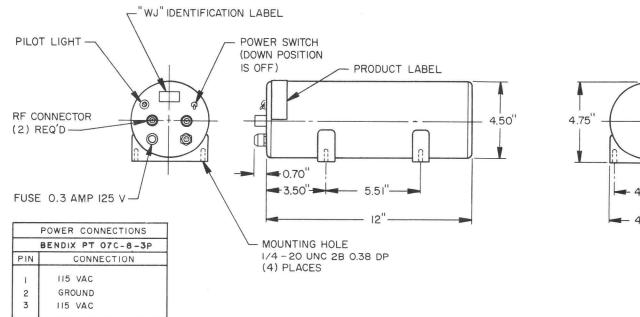
SPECIFICATIONS Typical

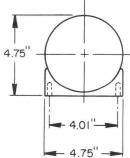
Guaranteed

WJ-345-7	.8 to 12 GHz
WJ-345-7	.6.0 dB 7.0 dB 7.0 dB 5.5 dB 5.5 dB 6.0 dB 6.0 dB
Gain, Small SignalVSWR, Input and Output	.30 dB 25 dB, min. .1.5:1 2:1, max.
Power Output: WJ-345 WJ-345-7	.0 dBm
ELECTRICAL REQUIREMENTS Primary Voltage Primary Frequency Primary Power	.115 V ac



OUTLINE DRAWING





September 1967

The WJ-346 is a high-power, high-gain, C-band traveling-wave amplifier designed for pulsed operation. It produces 20 kW power with a minimum of 50 dB gain, and employs a high-mu grid which permits modulation of the beam by means of a 550-volt pulse.

The slow-wave circuit is of coupled-cavity design, which includes all metal-ceramic construction. A temperature-compensating jacket is employed over the ferrite PPM magnetic stack to eliminate any appreciable change in characteristics over a wide range of operating temperatures. Minimization of peak cathode loading $(2A/cm^2)$, by means of a high-convergence gridded gun, extends the life of the tube. In addition, the integral focusing system requires no alignment and leakage fields are negligible.

The WJ-346 employs a forced air-cooled collector which may be run at ground potential or insulated for collector current measurement. The tube is

GRIDDED HIGH-GAIN C-BAND **TRAVELING-WAVE AMPLIFIER** WJ-346



also equipped with an ion pump which prolongs tube life during long-term storage and aids in lengthening overall tube life.

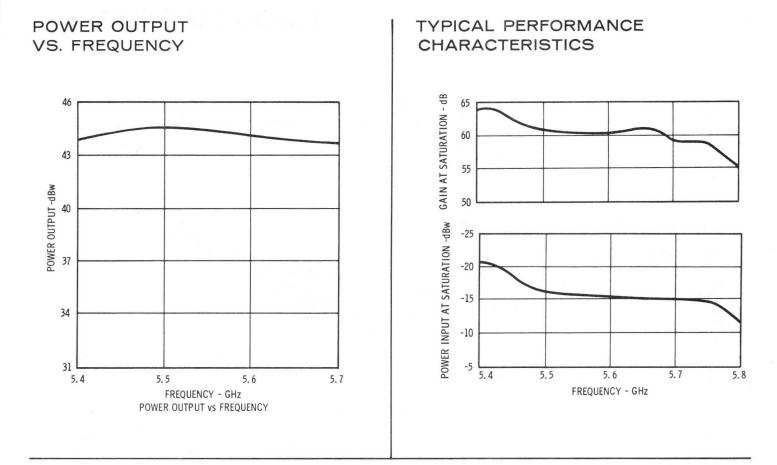
PERFORMANCE	Typical	Guaranteed
Frequency	. 5.35-5.75 GHz	. 5.4-5.7 GHz
Power output (peak)		
Average of four points ¹	. 22 kW	20 kW
Lowest point in band		16 kW
Gain		
Average of six points ¹	.57 dB	50 dB
ELECTRICAL REQUIREMENTS	Typical	Range
Cathode voltage	. 26.0 kV	26.0 ±1.0 kV
Collector current		
Without drive	. 5.0 A peak 5	5.5 A peak min.
With drive	4.4 A peak 4.4 A peak 4	1.0 A peak min.
Body current		
Without drive	.1.0 A peak 1	.4 A peak max.
With drive	. 1.6 A peak	2.0 A peak max.
Duty cycle	. 0.003	005 max.
Pulse duration	500 V pock	100 to 600 V
Grid pulse voltageGrid bias voltage	200 V	-200 + 5 V
Grid current	0.8 A neak	12 A max
Grid capacitance (to all else)	35 nF	45 pF max.
Circuit and anode voltage	Ground	Ground
Heater voltage	. 12 V 60 Hz ac	12.5 V max.
Heater current		2.5 A max.
Ion pump voltage	+3.0 kV to collector	. 3.0 ±0.15 kV
lon pump current, operating	1.0 μΑ	20 μA max.
MECHANICAL CHARACTERISTICS		
Weight (including ion-pump)	18.5	5 lbs. (8.39 Kg)
RF connectors ²		ed 50-ohm coax

Forced air

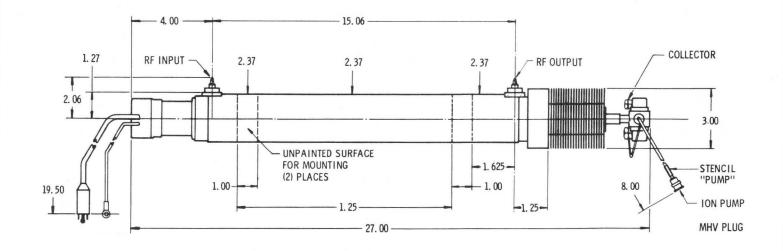
SPECIFICATIONS

Coolant

¹At equal increments of 100 MHz ²Coaxial to either "C" band waveguide or type N coax adaptors can be provided if desired

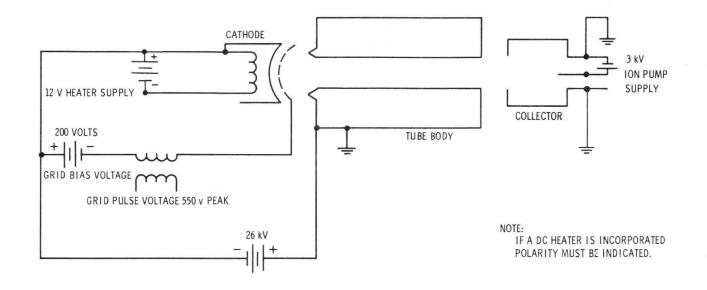


OUTLINE DRAWING

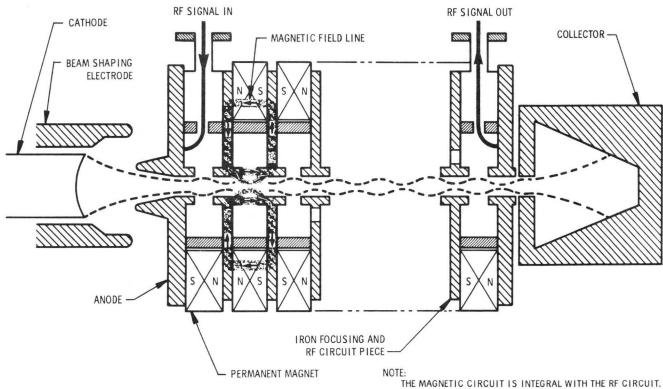


September 1967

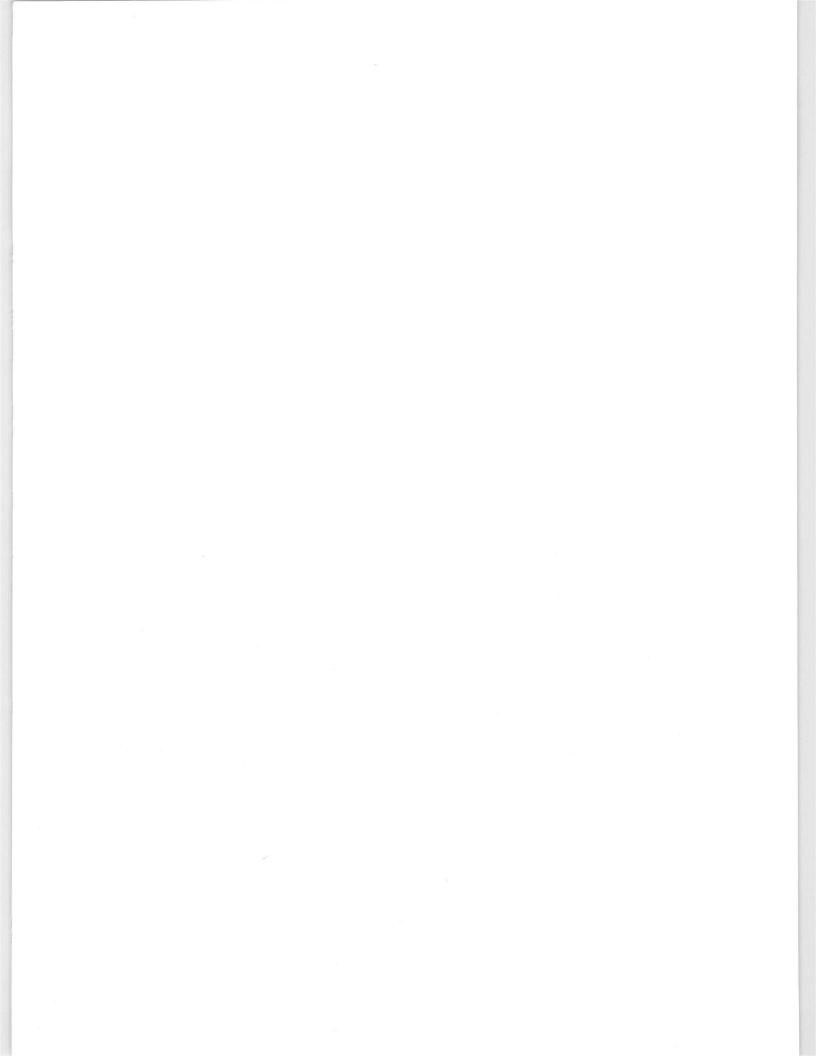
CONNECTION DIAGRAM



RF AND MAGNETIC CIRCUIT



THE MAGNETIC CIRCUIT IS INTEGRAL WITH THE RF CIRCUIT. IT CAN BE SEEN THAT A SECTION OF THE CAVITY WALL ALSO SERVES AS A FLUX GUIDE FOR THE MAGNETIC FOCUSING CIRCUIT.





September 1968 *

4.5 TO 6.5 GHz LOW-NOISE PERMANENT-MAGNET TRAVELING-WAVE AMPLIFIERS WITH INTEGRAL POWER SUPPLY

- "JUST PLUG IT IN"
- NOISE FIGURE 5.0 dB MAXIMUM
- PERMANENT-MAGNET
 FOCUSING
- NO ADJUSTMENTS
 NEEDED
- MEETS MIL-E-5400, CLASS 2 ENVIRONMENT

The WJ-349 series of low-noise traveling-wave amplifiers is an extension of the standard family of Watkins-Johnson TWA's. The series provides exceptionally low noise figure through the center portion of the C-band, including the important bands of 4.5 to 5.0 GHz and 5.4 to 5.9 GHz. Each member of the family requires only an ac line-voltage input for operation and is adjustment-free.

The WJ-349 amplifier package includes a shielded permanent-magnet that is not adversely affected by adjacent PM tubes or ferromagnetic material. Also integral with the package is a factory-set pow-



er supply whose total power consumption from the 115-volt ac source is less than 20 watts. All components are regulated or compensated for full specification performance from -54° C to $+71^{\circ}$ C.

Installation and operation are simplified by the rugged construction of each amplifier. When any of them is mounted in any orientation by its four threaded mounting holes, it can withstand vibrational forces of over 10 g at frequencies up to 500 Hz and shock in any plane of over 15 g, 11 millisecond duration. These environmental characteristics meet or exceed the corresponding requirements of MIL-E-5400, Class 2.

SPECIFICATIONS

Guaranteed Typical PERFORMANCE Frequency: Noise figure, terminal: WJ-349 Range Typical ELECTRICAL REQUIREMENTS Primary power14 watts

*Supersedes WJ-349, WJ-349-2, WJ-349-3 Technical Bulletin, Volume 8, No. 6; March, 1966



ENVIRONMENTAL CHARACTERISTICS

Temperature
Vibration
a10 inch, double amplitude 5 to 45 Hz
b. 10 g, single amplitude 45 to 500 Hz
Shock 15 g, 11 ms

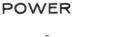
MECHANICAL CHARACTERISTICS

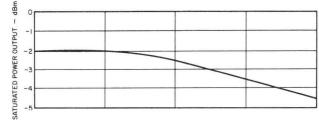
Amplifier length

(excluding connectors) 12.0 inches, max.
Amplifier height and width 4.75 inches, max.
Weight 17 pounds, max.
Primary power connection, Deutsch receptacle DM9601-3P
RF connections (50 ohms, nominal) Type N, jack
Outline Drawing No 290000

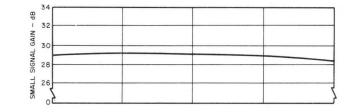
Every amplifier will meet the guaranteed performance specifications for any voltage lying within these ranges.

These environmental characteristics meet or exceed the respective requirements of MIL-E-5400, Class 2.

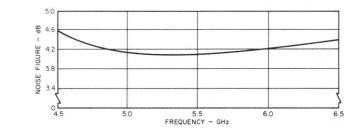




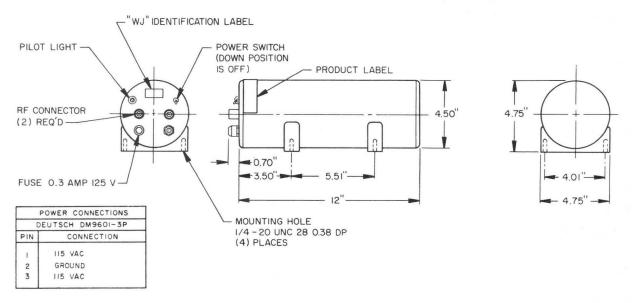
GAIN



NOISE



OUTLINE DRAWING





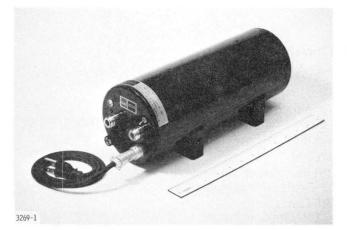
July 1968 *

2.2 TO 2.3 GHz LOW-NOISE PERMANENT-MAGNET TRAVELING-WAVE AMPLIFIER WITH INTEGRAL POWER SUPPLY

- "JUST PLUG IT IN"
- NOISE FIGURE 3.7 dB MAXIMUM
- PERMANENT-MAGNET FOCUSING
- NO ADJUSTMENTS NEEDED
- MEETS MIL-E-5400, CLASS 2 ENVIRONMENT

Designed especially for space communication and telemetry applications, the WJ-355 exhibits one of the lowest noise figures of any traveling-wave amplifier currently available in a completely packaged unit. Although guaranteed not to exceed 3.7 dB, the WJ-355 typically exhibits less than 3.4 dB noise figure across the 2.2 to 2.3 GHz spectrum for which it is designed to operate. This amplifier, like most Watkins-Johnson low-noise amplifiers, comes in a single package complete with its own integral 115 volt ac power supply, which operates equally well from commercial 60 Hz power or from 400 Hz power characteristically available in aircraft.

This is a ready-to-operate amplifier. No adjustments are required upon receipt, nor are readjustments required during the amplifier's long life.



Other low-noise units, similar to the WJ-355, are attaining MTBF's in excess of 20,000 hours with a 99 percent confidence level. This long life, which gives the WJ-355 an extremely low cost per operating hour, is a result of the advanced design and careful processing techniques for which the Watkins-Johnson Company is noted.

The amplifier may be mounted in any orientation without degradation of performance. Rugged construction of the tube, magnet, and power supply assembly assures reliable operation under vibrational forces of 10 g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of -54 °C to +71 °C. The environmental characteristics of the WJ-355 meet or exceed the corresponding requirements of MIL-E-5400, Class 2.

SPECIFICATIONS

PERFORMANCE	Typical	Guaranteed
Frequency	. 2.2 to 2.3 GHz	2.2 to 2.3 GHz
Noise Figure, Terminal	. 3.4 dB	3.7 dB max.
Gain, Small Signal	.30 dB	25 dB min.
VSWR, Input and Output	. 1.5:1	2:1 max.
Power Output	.—3.0 dBm	—5.0 dBm
ELECTRICAL REQUIREMENTS	Typical	Range
Primary Voltage	.115 V ac	\ldots 115 ±10 V ac
Primary Frequency	.60 Hz	48 to 420 Hz
Primary Current	.170 mA	
Primary Power	. 14 watts	

*Supersedes WJ-355 Technical Bulletin, Volume 8, No. 4; January, 1966

ENVIRONMENTAL CHARACTERISTICS

Temperature
Vibration
a10 inch, double amplitude 5 to 45 Hz
b. 10 g, single amplitude 45 to 500 Hz
Shock 15 g, 11 ms

MECHANICAL CHARACTERISTICS

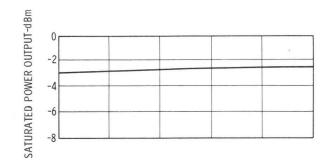
Amplifier Length

(excluding connectors) 12 inches, max.
Amplifier Height and Width 4.75 inches, max.
Weight 17 pounds
Primary Power Connection, Deutsch Receptacle DM9601-3P
RF Connectors (50 ohms, nominal) Type N jack
Reference Drawing Number

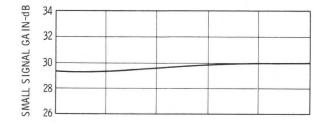
Every amplifier will meet the guaranteed performance specifications for any voltage lying within these ranges.

These environmental characteristics meet or exceed the respective requirements of MIL-E-5400, Class 2.

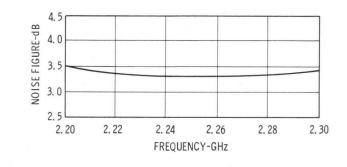








NOISE



POWER CONNECTOR

OUTLINE DRAWING

POWER CONNECTIONS

CONNECTION

DEUTSCH DM9601-3P

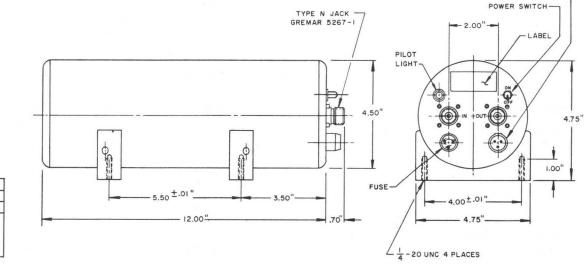
115 VAC

GROUND

PIN

1

23





March 1967

8 TO 12 GHz, 20 MILLIWATT LOW-NOISE TRAVELING-WAVE AMPLIFIER WITH INTEGRAL POWER SUPPLY

- "JUST PLUG IT IN"
- NOISE FIGURE
 8.0 dB MAXIMUM
- PERMANENT-MAGNET FOCUSING
- PROVEN RELIABILITY
- NO ADJUSTMENTS REQUIRED
- MEETS MIL-E-5400, CLASS 2 SPECIFICATION

The WJ-363 is one of the original members of Watkins-Johnson's family of PM-focused integral power supply amplifiers. Like its lower-power predecessors, the WJ-363 is completely self-contained, adjustment-free, and requires only a 115-volt ac line-voltage input (48 to 420 Hz).

This proven amplifier, with a typical noise figure of 7 dB, may be operated in any orientation, in stacked arrays, or adjacent to ferromagnetic material with-



out degradation of performance.

Rugged construction of the tube, magnet, and power supply assembly assures reliable operation under vibrational forces of 5 g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of -54° to $+71^{\circ}$ C. The environmental characteristics of the WJ-363 meet or exceed the corresponding requirements of MIL-E-5400, Class 2.

SPECIFICATIONS

PERFORMANCE	Typical Guaranteed
Frequency	8 to 12 GHz 8 to 12 GHz
Noise Figure, Terminal	7 dB 8 dB, max.
	35 dB
VSWR, Input and Output	1.5:1
Power Output	16 dBm 13 dBm
ELECTRICAL REQUIREMENTS	TypicalRange115 V ac115 ±10 V ac
Primary Voltage	48 to 420 Hz
Primary Voltage	00 HZ
Primary Power	20 W



ENVIRONMENTAL CHARACTERISTICS ²

Temperature
Vibration
a) 0.10 Inch, Double Amplitude . 5 to 30 Hz
b) 5 g, Single Amplitude 30 to 500 Hz
Shock 15 g, 11 ms

MECHANICAL CHARACTERISTICS

Height	4.75 inches (121 mm) max.
Width	4.75 inches (121 mm) max.
Length (excluding	

connectors) 12 inches (305 mm) max. Weight 18 pounds (8.16 Kg) max. Primary Power Connection,

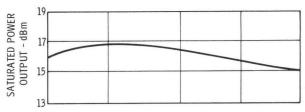
Bendix Plug PT 07C-8-3P Bendix Socket PT 07C-8-3S

Reference Drawing Number 290121

1. Every tube will meet the guaranteed performance speci-

fications for any voltage and frequency within these

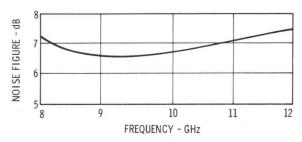
POWER



GAIN



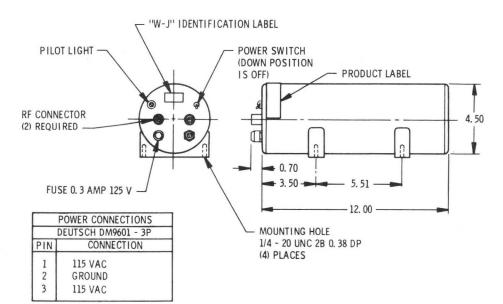
NOISE

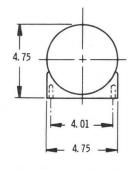


2. These environmental characteristics meet or exceed the respective requirements of MIL-E-5400, Class 2.

OUTLINE DRAWING

ranges.







March 1967

8 TO 10 GHz, 20 MILLIWATT LOW-NOISE TRAVELING-WAVE AMPLIFIER WITH INTEGRAL POWER SUPPLY

- "JUST PLUG IT IN"
- NOISE FIGURE
 7 dB MAXIMUM
- PERMANENT-MAGNET FOCUSING
- PROVEN RELIABILITY
- NO ADJUSTMENTS REQUIRED
- MEETS MIL-E-5400, CLASS 2 SPECIFICATION

With the addition of the WJ-363-3 to its family of PM-focused integral power supply amplifiers, Watkins-Johnson Company increases the dynamic range of its X-Band low-noise amplifiers. Like its lowerpower predecessors, the WJ-363-3 is completely selfcontained, adjustment-free, and requires only a 115volt ac line voltage input (48 to 420 Hz).

This amplifier, with a typical noise-figure of 6 dB, may be operated in any orientation, in stacked ar-

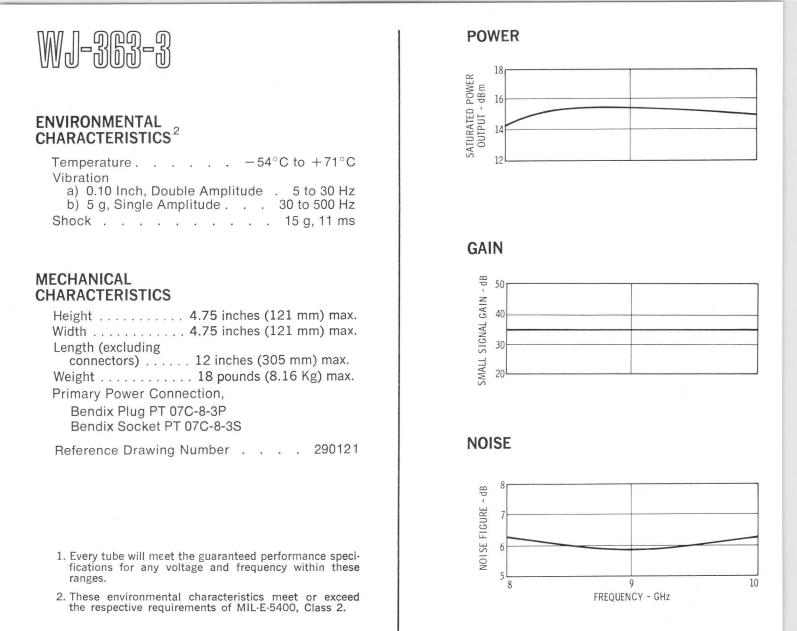


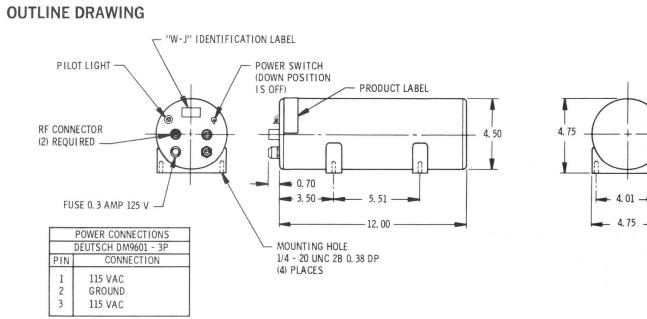
rays, or adjacent to ferromagnetic materials without degradation of performance.

Rugged construction of the tube, magnet, and power supply assembly assures reliable operation under vibrational forces of 5 g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of -54° to $+71^{\circ}$ C. The environmental characteristics of the WJ-363-3 meet or exceed the corresponding requirements of MIL-E-5400, Class 2.

PERFORMANCE	Typical Guaranteed			
Frequency	8 to 10 GHz 8 to 10 GHz			
Noise Figure, Terminal	6 dB 7 dB, max.			
Gain, Small Signal	35 dB			
VSWR, Input and Output	1.5:1			
Power Output	16 dBm 13 dBm			
ELECTRICAL REQUIREMENTS Typical Range ¹				
Primary Voltage	115 V ac			
Primary Frequency	60 Hz			
Primary Power	20 W			

SPECIFICATIONS





WJ-363-4

April 1967

10 TO 12 GHz, 20 MILLIWATT LOW-NOISE TRAVELING-WAVE AMPLIFIER WITH INTEGRAL POWER SUPPLY

- "JUST PLUG IT IN"
- NOISE FIGURE
 7.5 dB MAXIMUM
- PERMANENT-MAGNET FOCUSING
- PROVEN RELIABILITY
- NO ADJUSTMENTS REQUIRED
- MEETS MIL-E-5400, CLASS 2 SPECIFICATION

With the addition of the WJ-363-4 to its family of low-noise amplifiers with integral solid-state power supplies, Watkins-Johnson Company increases the dynamic range of its X-Band low-noise amplifiers. Like its lower-power predecessors, the WJ-363-4 is completely self-contained, adjustment-free, and requires only a 115-volt ac line-voltage input (48 to 420 Hz).

The same conservative design and careful processing techniques responsible for the long life of other Watkins-Johnson low-noise amplifiers have been extended to the WJ-363-4. It can be predicted that they will yield an MTBF in excess of 18,500 hours (99% confidence level). The anticipated MTBF is



based on extensive tests performed on this and similar tubes and power supply components.

This amplifier, with a typical noise figure of 6.5 dB, may be operated in any orientation, in stacked arrays, or adjacent to ferromagnetic materials without degradation of performance.

Rugged construction of the tube, magnet, and power supply assembly assures reliable operation under vibrational forces of 5 g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of -54° to $+71^{\circ}$ C. The environmental characteristics of the WJ-363-4 meet or exceed the corresponding requirements of MIL-E-5400, Class 2.

SPECIFICATIONS

PERFORMANCE	Typical Guaranteed				
Frequency	10 to 12 GHz 10 to 12 GHz				
Noise Figure, Terminal	6.5 dB 7.5 dB, max.				
Gain, Small Signal	35 dB				
VSWR, Input and Output	1.5:1				
Power Output	16 dBm 13 dBm				
ELECTRICAL REQUIREMENTS Typical Range ¹					
Primary Voltage	115 V ac				
Primary Frequency	60 Hz				
Primary Power	20 W				



ENVIRONMENTAL CHARACTERISTICS²

Temperature	5°C to +71°C
Vibration	
a) 0.10 Inch, Double Amplitude	. 5 to 30 Hz
b) 5 g, Single Amplitude	30 to 500 Hz

Shock 15 g, 11 ms

MECHANICAL CHARACTERISTICS

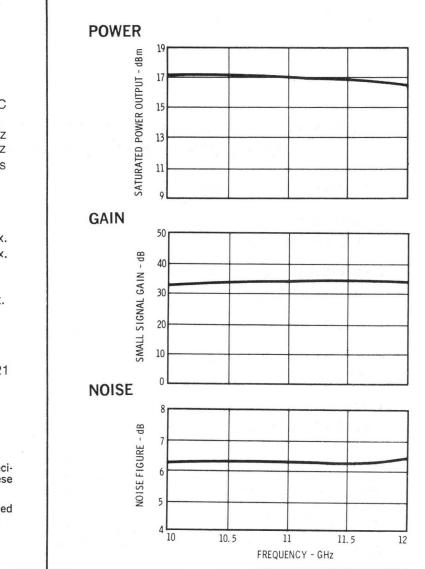
Height 4.75 inches (121 mm) max. Width 4.75 inches (121 mm) max. Length (excluding

connectors) 12 inches (305 mm) max. Weight 18 pounds (8.16 Kg) max. Primary Power Connection,

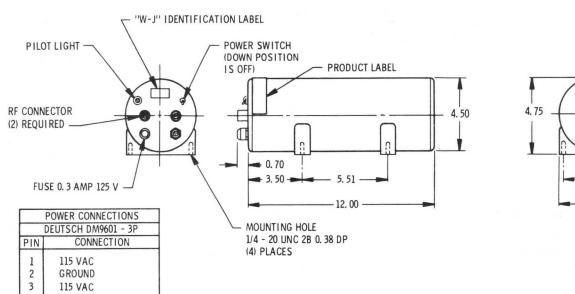
Bendix Plug PT 07C-8-3P Bendix Socket PT 07C-8-3S

Reference Drawing Number 290121

- Every tube will meet the guaranteed performance specifications for any voltage and frequency within these ranges.
- 2. These environmental characteristics meet or exceed the respective requirements of MIL-E-5400, Class 2.



OUTLINE DRAWING



4.01 -

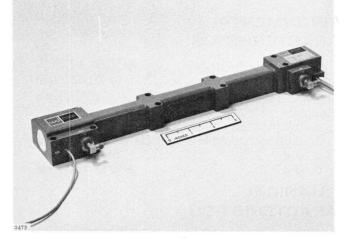
4.75 -

WJ-368-3

2.5 to 3.5 GHz 120/50 WATT (PULSED) February 1968 GRIDDED DUAL-MODE TRAVELING WAVE TUBE

The WJ-368-3 is a PPM-focused, helix-type, traveling-wave tube designed to operate at 15% duty cycle with 120 watts output power and 5 mW RF drive power. It can, however, be used over a wide range of power levels, pulse lengths, frequencies, and duty cycles.

The high-mu gridded gun, wide-band helix interaction structure, and high average power capability of the WJ-368-3 allow a variety of applications. It may, for example, be used as a high-gain driver for high-power radar transmitters, as a high-gain driver or transmitter for ECM equipment, or as a radar transponder transmitter. In addition, it has been qualified for severe airborne environmental applications.



SPECIFICATIONS

	Typical	Guaranteed
Frequency	2.5 - 4.0 GHz	2.5 - 3.5 GHz
Power Output (Pulsed)		
Mode A	140 W	120 W, min.
Gain at Rated Output Power		
Mode A	42 dB	40 dB, min. 38 dB, min.
Duty Cycle Mode A		15% max
Mode B		
Pulse Length		\ldots 100 μ sec. max.
ELECTRICAL REQUIREMENTS	Typical	Range ³ or Maximum
Cathode Voltage ¹	1050.1/	4050 L 4450 V
Mode A	. – 4350 V	-4250 to -4450 V -3850 to -4050 V
Beam Pulse Current		
Mode A	. 240 mA	275 mA max.
Mode B		
Grid Bias Voltage ²	. – 100 V	75 to - 100 V
Grid Pulse Voltage ²		
Mode A	. +70 V	+40 to +100 V
Mode B	. +40 V	+25 to +80 V
Grid Pulse Current		
Mode A	.35 mA	50 mA max.
Mode B		
Helix Voltage	.Ground	Ground
Helix Pulse Current		
Mode A		
Mode B	10 mA	50 mA max.

WJ-**360**-3

Collector Valtage?

SPECIFICATIONS (Cont'd)

Mode A	+3000 V	
Heater Voltage	5.6 V	
Heater Current		
Relative to ground	3Eveny tube will most the guaranteed performance speci	

¹Relative to ground. ²Relative to cathode. ³Every tube will meet the guaranteed performance specifications for a voltage and current lying in this range.

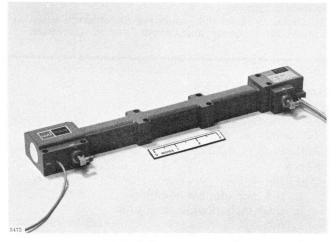
ENVIRONMENTAL POWER CHARACTERISTICS 54 dBm MODE A 52 ۱ Altitude 0 to 70,000 feet OUTPUT 50 Shock 10 g, 11 ms MODE B Vibration POWER 48 a. 0.3 inch, double amplitude 5 to 23 Hz b. 0.06 inch, double amplitude . . . 23 to 55 Hz 46 GAIN MECHANICAL 46 **CHARACTERISTICS** đВ MODE A 44 GAIN Cross Section (excluding 42 SATURATED connectors) 1.25 x 2.0 inches, max. MODE B Weight 2.2 lbs., max. 40 RF Connectors OSM Power Connections Flying Leads 38 2.8 3.2 3.4 3.6 2.6 3.0 Cooling Heat Sink Focusing PPM FREQUENCY-GHz OUTLINE DRAWING SCHEMATIC DIAGRAM RF IN RE OUT RF OUTPUT RF INPUT + Ò 1.25 1 0.625 0 GRID PULSE VOLTAGE ູ AD WIRE 1.3125 GRID, HEATER AND HEATER CATHODE LEAD WIRES COLLECTOR HEATER GRID HELIX COLLECTOR 0.875 2.00 1.6125 0.1875-VOLTAGE MODE A MODE B - 1.625 HEATER 5.3 to 5.8 5.3 to 5.8 4.625 GRID BIAS GRID PULSE - 7.625 75 to 100 75 to 100 - 10 625 40 to 100 25 to 80 HELIX 3850 to 4050 4250 to 4450 - 12,750 COLLECTOR 2800 to 3300 2400 to 3300 Preferred Power Supply Configuration for WJ-368-3

4.4 to 5.8 GHz 120/50 WATT (PULSED) GRIDDED DUAL-MODE TRAVELING-WAVE TUBE

February 1968

The WJ-369-3 is a PPM-focused, helix type, traveling-wave tube produced by Watkins-Johnson Company for use over a wide range of power levels, pulse lengths, frequencies, and duty cycles. It is designed to operate at 15% duty cycle with 120 watts output power and 5 mW RF drive power. Various other performance levels can be achieved by varying the specified voltages and currents. At low duty, for example, 100 watts output power can be achieved from 4.0 to 8.0 GHz with greater than 30 dB gain.

The high-mu gridded gun, wide-band helix interaction structure, and high average power capability of the WJ-369-3 allow several different applications. It may, for example, be used as a high-gain driver for high-power radar transmitters, as a highgain driver or transmitter for ECM equipment, or as a radar transponder transmitter. In addition,



it has been qualified for severe airborne environmental applications.

SPECIFICATIONS

PERFORMANCE Frequency	Typical	Guaranteed
Power Output (Pulsed) Mode A		
Mode B		
Gain at Rated Output Power Mode A	42 dB	40 dB min
Mode B	40 dB	38 dB, min.
Duty Cycle Mode A		15%, max.
Mode B		40%, max.
Pulse Length		\ldots 100 μ sec. max.
ELECTRICAL REQUIREMENTS	Typical	Range ³ or Maximum
Cathode Voltage ¹ Mode A	5450 \/	
Mode B		
Beam Pulse Current		
Mode A		
Grid Bias Voltage ²	-100 V	75 to -100 V
Grid Pulse Voltage ²		
Mode A		
Grid Pulse Current		
Mode A		
Helix Voltage	Ground	Ground
Helix Pulse Current Mode A	30 mA may	50 mA max.
Mode B		



SPECIFICATIONS (Cont'd)

Collector Voltag	je ²	
Mode A	+3300 V	
Heater Voltage		
Heater Current	1.2 A 1.2 A 1.4 A max.	
WARRAN INC. INC.		

¹Relative to ground.

²Relative to cathode.

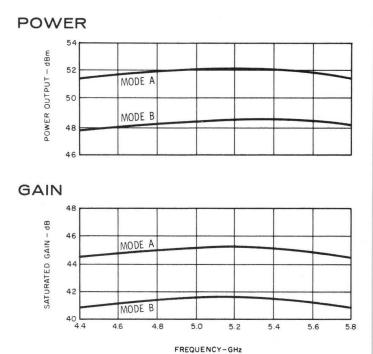
³Every tube will meet the guaranteed performance specifications for a voltage and current lying in this range.

ENVIRONMENTAL **CHARACTERISTICS**

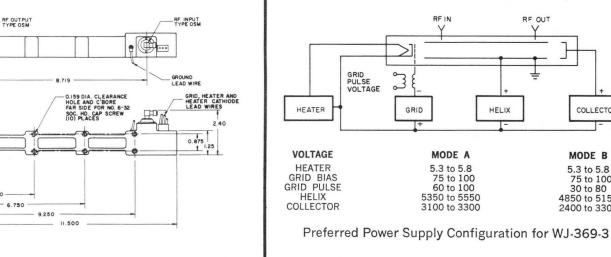
Altitude 0 to 70,000 feet Vibration a. 0.3 inch, double amplitude 5 to 23 Hz b. 0.06 inch, double amplitude . . . 23 to 55 Hz c. 6 g 55 to 200 Hz d. 3 g 200 to 1500 Hz

MECHANICAL **CHARACTERISTICS**

Length 11.5 inches, max.
Cross Section (excluding
connectors) 1.25 x 2.0 inches, max.
Weight 1.8 lbs., max.
RF Connectors OSM
Power Connections Flying Leads
Cooling Heat Sink
Focusing PPM



SCHEMATIC DIAGRAM



OUTLINE DRAWING

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1.3125

- 1.625-

4.250

1

0.625

COLLECTOR

2.00 1.6125

0.1875-

COLLECTOR

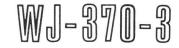
MODE B

5.3 to 5.8

4850 to 5150 2400 to 3300

75 to 100 30 to 80

RF OUT



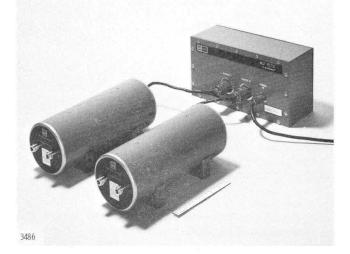
February 1968

1.4 to 2.3 GHz GAIN- AND PHASE-MATCHED DUAL TRAVELING-WAVE AMPLIFIERS WITH POWER SUPPLY

- NOISE FIGURE: 4.5 dB
- GAIN TRACKING ±0.5 dB MAX.
- PHASE TRACKING ±5° MAX.
- SMALL SIGNAL GAIN: 20 dB MIN.
- PERMANENT MAGNET FOCUSING
- ADJUSTMENT-FREE PERFORMANCE

WJ-370-3 is one of a new series of gain- and phase-matched low-noise traveling-wave amplifier packages developed by Watkins-Johnson Company for use in mono-pulse tracking receivers. The package is comprised of a pair of low-noise permanentmagnet amplifiers, gain- and phase-matched across the operating frequency range, and a power supply.

Because the amplifiers are operated from a single helix supply, they will track as specified with a voltage input of 115 ± 10 Vac, 55 to 65 Hz, even when minor power supply variations (such as reg-



ulation, ripple, and long term drift) and changes in temperature occur. Gain tracking is guaranteed to be within ± 0.5 dB maximum, and phase tracking is guaranteed to be within $\pm 5^{\circ}$ maximum over the full operating temperature range.

Other versions of this package are available for specific applications, and still others are under development. Performance specifications, electrical requirements, environmental characteristics, and mechanical characteristics for these packages may be varied to meet specific requirements.

SPECIFICATIONS

PERFORMANCE Frequency Noise figure, terminal Small signal gain Small signal gain variation VSWR, input and output Power output Small signal gain tracking between two amplifiers ¹ Phase tracking between two amplifiers in environment ^{1,2}	1.4 - 2.3 GHz 4.0 dB 21.5 dB 1 dB 1.3:1 10 dBm ±0.4 dB	
ELECTRICAL REQUIREMENTS ¹ Primary voltage Primary frequency Primary power	115 Vac	Range 105 - 125 Vac 55 - 65 Hz

NOTES:

¹These specifications are for a matched pair, both operating from one WJ-1072 power supply.

²This specification applies for all conditions listed under "Environmental Characteristics" for any 100 hour operating period within the warranty period (1000 hours) when the amplifiers are operated as follows: A coaxial line stretcher or equivalent phase shifter having a minimum range of 90°C at 2.3 GHz must be placed in series with one amplifier and used to phase match the two amplifiers within $\pm 1^{\circ}$ at one frequency within the operating band at the beginning of the 100 hour period.

WJ-370-3

ENVIRONMENTAL

CHARACTERISTICS

Temperature, operating0°C to 35°C

MECHANICAL CHARACTERISTICS

Amplifier

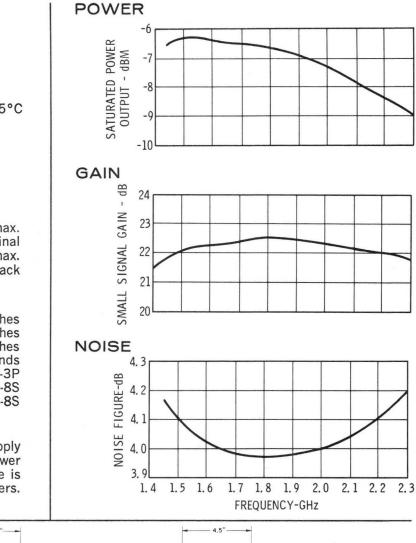
Amplifier length
(excluding connectors) 11.5 inches, max.
Amplifier diameter 4.5 inches, nominal
Amplifier weight
RF connections Type N, jack

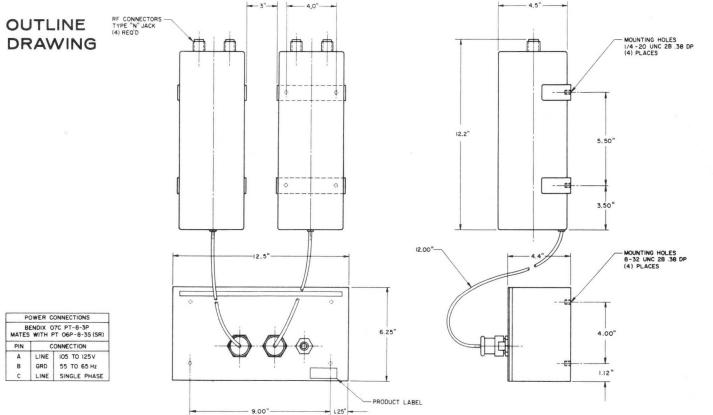
Power Supply

s
S
S
s
Ρ
S
S

Interconnection

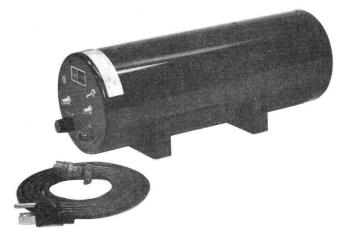
Interconnection between tube and power supply is via Bendix PT series connector at the power supply. A one (1) foot interconnecting cable is provided as an integral part of the amplifiers.





NOVEMBER 1969

12 TO 18 GHz LOW-NOISE TRAVELING-WAVE AMPLIFIER WITH INTEGRAL POWER SUPPLY WJ-371



- "JUST PLUG IT IN"
- NOISE FIGURE
 9.0 dB MAXIMUM
- PERMANENT-MAGNET FOCUSING
- PROVEN RELIABILITY
- NO ADJUSTMENTS NEEDED
- 115 VOLT, 48 TO 420 Hz OPERATION

WJ-371 is one of a family of PM-focused amplifiers developed by Watkins-Johnson for applications where wide dynamic range is required. The amplifier features the lowest guaranteed noise figure of any Ku-band unit plus a saturated power output of +12 dBm minimum, making it the amplifier with the widest dynamic range of any presently available commercial unit. Narrowband applications of 1 to 2 GHz can be provided with guaranteed noise figures approximately 1 dB less than the wideband version.

This proven amplifier is completely self-contained, adjustment-free, and requires only a 115 volt ac line-

voltage input (48 to 420 Hz). The completely shielded package may be operated in any orientation, in stacked arrays or adjacent to ferromagnetic material, without adversely affecting the amplifier's performance.

Rugged construction of the tube, magnet, and power supply assembly assures reliable operation under vibrational forces of 5g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of -54°C to +71°C. The environmental characteristics of the WJ-371 meet or exceed the corresponding requirements of MIL-E-5400: Temperature, Class 2; Vibration, Curve III.

	SPECIFICATIONS	
PERFORMANCE	Typical	Guaranteed
Frequency	12.0 to 18.0 GHz	12.0 to 18.0 GHz
Gain, Small Signal	30 dB	25 dB, min.
VSWR, Input and Output		2:1, max.
	+15 dBm	
ELECTRICAL REQUIREMENTS	Typical	Range ¹
Primary Voltage		
Primary Frequency	60 Hz	48 to 420 Hz
Primary Power		
· · · · · · · · · · · · · · · · · · ·		

R GROUND 48-420 Hz A AC SINGLE PLASE

ENVIRONMENTAL CHARACTERISTICS²

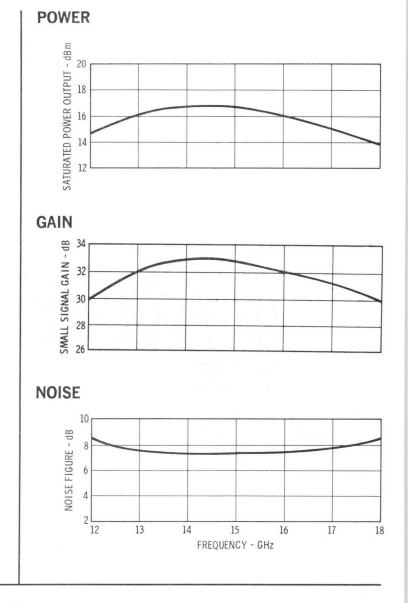
Temperature (Operating) -54°C to +71°C Vibration 0.10 Inch Double Amplitude 5 to 30 Hz 5g, Single Amplitude 30 to 500 Hz Shock 15 g, 11ms

MECHANICAL CHARACTERISTICS

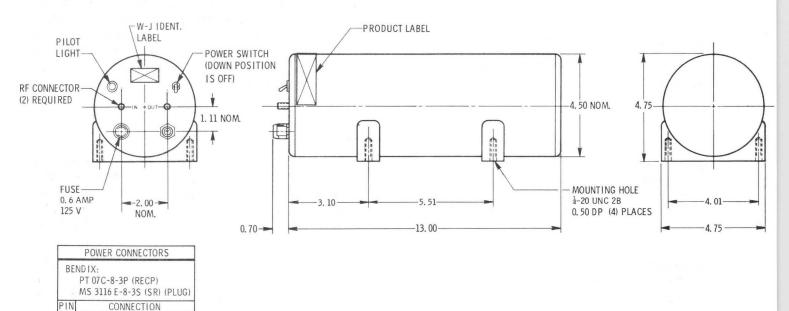
Height 4.75 inches (121 mm) max.
Width 4.75 inches (121 mm) max.
Length (excluding connectors) 13 inches (330 mm) max.
Weight 18 pounds (8.16 Kg) max.
Primary Power Connection, Bendix Receptacle PTO7C-8-3P
RF Connections OSM Jack
Reference Drawing Number 290240

¹Every amplifier will meet the guaranteed performance specifications for any primary voltage and frequency lying within these ranges.

²These environmental characteristics meet or exceed the respective requirements of MIL-E-5400K (dated 24 May1968) : Temperature, Class 2; Vibration, Curve III.



OUTLINE DRAWING



С

В

A

AC (HOT)

GROUND

AC

105-125 VAC

48-420 Hz

SINGLE PHASE

APRIL 1970*

1.0 TO 2.0 GHz DUAL-HELIX LOW-NOISE TRAVELING-WAVE AMPLIFIER WITH INTEGRAL POWER SUPPLY • "JUST PLUG IT IN" WJ-374

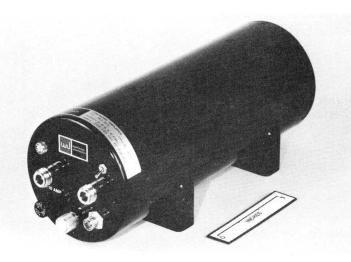
- NEGLIGIBLE PERFORMANCE
 VARIATION DURING
- NOISE FIGURE
 5.5 dB MAXIMUM

GAIN ADJUSTMENT

- POWER OUTPUT
 O dBm MINIMUM
- PERMANENT-MAGNET FOCUSING
- MEETS MIL-E-5400, CLASS 2 SPECIFICATION

The WJ-374 is one of a new series of dual-helix LNTWAs developed by Watkins-Johnson for use in systems where small signal gain may be adjusted without significant loss in power output or increase in noise figure. Application of a negative dc voltage allows reduction of gain from 25 to 0 dB while power output and noise figure remain relatively constant. In addition, the gain curve is extremely flat under reduced gain conditions.

The WJ-374 is completely self-contained, adjustment-free, and requires only a 115 volt ac linevoltage input (48 to 420 Hz). The completely



shielded package may be operated in any orientation, in stacked arrays or adjacent to ferromagnetic material, without adversely affecting the amplifier's performance.

Rugged construction of the tube, magnet, and power supply assembly assures reliable operation under vibrational forces of 10 g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of -54 °C to +71 °C. The environmental characteristics of the WJ-374 meet the corresponding requirements of MIL-E-5400, Class 2 Specification.

SPECIFICATIONS

PERFORMANCE		
Frequency		1.0 to 2.0 GHz
Noise Figure, Terminal		5.5 dB, max.
Gain, Small Signal		
VSWR, Input and Output		
Power Output, Saturated		
ELECTRICAL REQUIREMENTS		Range ¹
Primary Voltage		115 ±10 V ac
Primary Frequency	60 Hz	48 to 420 Hz
Primary Power		
AGC Voltage		

*Supersedes WJ-374 Technical Data Sheet dated January 1969.

ENVIRONMENTAL CHARACTERISTICS²

Temperature, Operating . . -54° to $+71^\circ\text{C}$ Vibration

MECHANICAL CHARACTERISTICS

Height 4.75 inches (121 mm) max.	
Width 4.75 inches (121 mm) max.	
Length (excluding connectors) 12 inches (305 mm) max. Weight 17 pounds (7.71 Kg) max.	
Primary Power Connection, Deutsch Receptacle DM9601-3P	
RF Connections (50 ohms, nominal) Type N, jack	
AGC Connector Type TNC, Jac	k
Reference Drawing No	2

¹Every tube will meet the guaranteed performance specifications for any voltage and frequency within these ranges.

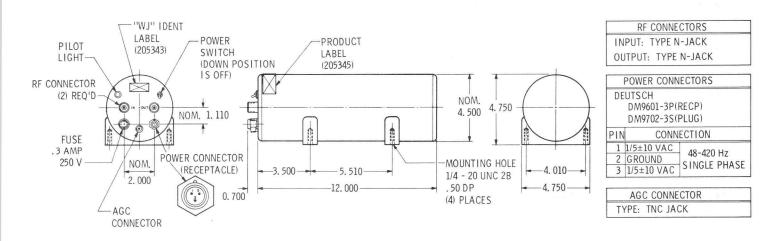
²These environmental characteristics meet or exceed the respective requirements of MIL-E-5400, Class 2.

FULL SATURATED POWER OUTPUT - dBm 2 GAIN 0 AT 20 d B GAIN REDUCTION -2 GAIN 35 FULL GAIN 30 - dB 25 GAIN 20 SMALL SIGNAL 15 GAIN DURING 10 AGC 5 0 -5 NOISE 7.5 dB AT 20 dB 1 7.0 GAIN REDUCTION NOISE FIGURE 6.5 6.0 FULL 5.5 GAIN 5.0 1.0 1.5 2.0 FREQUENCY - GHz NOTE: THE AGC CURVES AT REDUCED GAIN LEVELS ARE TYPICAL CURVES.

POWER

3

OUTLINE DRAWING



APRIL 1970*

2.0 TO 4.0 GHz **DUAL-HELIX LOW-NOISE TRAVELING-WAVE AMPLIFIER** WITH INTEGRAL POWER SUPPLY WJ-375

- "JUST PLUG IT IN"
- NEGLIGIBLE PERFORMANCE VARIATION DURING GAIN ADJUSTMENT
- NOISE FIGURE 5.5 dB MAXIMUM
- POWER OUTPUT O dBm MINIMUM
- PERMANENT-MAGNET FOCUSING
- MEETS MIL-E-5400, CLASS 2 SPECIFICATION

The WJ-375 is one of a new series of dual-helix LNTWAs developed by Watkins-Johnson for use in systems where small signal gain may be adjusted without significant loss in power output or increase in noise figure. Application of a negative dc voltage allows reduction of gain from 25 to 0 dB while power output and noise figure remain relatively constant. In addition, the gain curve is extremely flat under reduced gain conditions.

The WJ-375 is completely self-contained, adjustment-free, and requires only a 115 volt ac linevoltage input (48 to 420 Hz). The completely



shielded package may be operated in any orientation, in stacked arrays or adjacent to ferromagnetic material, without adversely affecting the amplifier's performance.

Rugged construction of the tube, magnet, and power supply assembly assures reliable operation under vibrational forces of 10 g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of -54 °C to +71 °C. The environmental characteristics of the WJ-375 meet the corresponding requirements of MIL-E-5400, Class 2 Specification.

SPECIFICATIONS

PERFORMANCE	Typical	Guaranteed
Frequency		2.0 to 4.0 GHz
Noise Figure, Terminal	. 5.0 dB	5.5 dB, max.
Gain, Small Signal	. 30 dB	25 dB, min.
VSWR, Input and Output	. 1.5:1	2:1, max.
Power Output, Saturated	.+1 dBm	0 dBm, min.
ELECTRICAL REQUIREMENTS		
Primary Voltage		
Primary Frequency	.60 Hz	48 to 420 Hz
Primary Power	. 25 W	
AGC Voltage	.0 to -25 V dc	0 to —30 V dc

*Supersedes WJ-375 Technical Data Sheet dated January 1969.

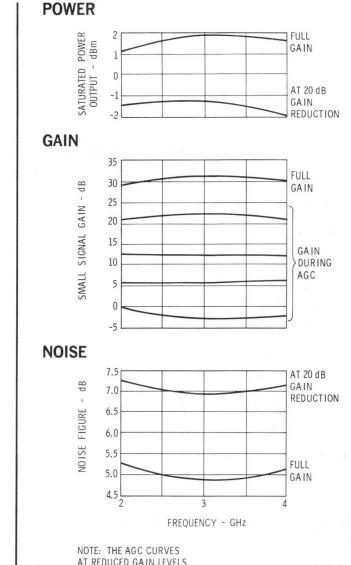
ENVIRONMENTAL CHARACTERISTICS²

MECHANICAL CHARACTERISTICS

Height
Length (excluding connectors) 12 inches (305 mm) max.
Weight 17 pounds (7.71 Kg) max.
Primary Power Connection, Deutsch Receptacle DM9601-3P
RF Connections
(50 ohms, nominal) Type N, jack
AGC Connector Type TNC, Jack
Reference Drawing No 290012

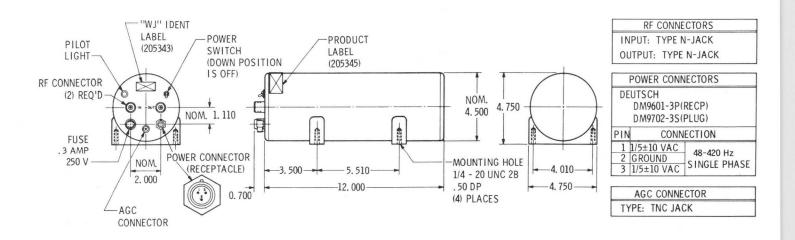
¹Every tube will meet the guaranteed performance specifica-tions for any primary voltage and frequency within these ranges.

²These environmental characteristics meet the respective requirements of MIL-E-5400, Class 2.



AT REDUCED GAIN LEVELS ARE TYPICAL CURVES.

OUTLINE DRAWING



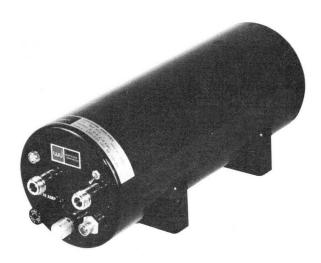
APRIL 1970 *

4.0 TO 8.0 GHz DUAL-HELIX LOW-NOISE TRAVELING-WAVE AMPLIFIER WITH INTEGRAL POWER SUPPLY WJ-376

- "JUST PLUG IT IN"
- NEGLIGIBLE PERFORMANCE VARIATION DURING GAIN ADJUSTMENT
- NOISE FIGURE
 6.5 dB MAXIMUM
- POWER OUTPUT O dBm MINIMUM
- PERMANENT-MAGNET FOCUSING
- MEETS MIL-E-5400, CLASS 2 SPECIFICATION

The WJ-376 is one of a new series of dual-helix LNTWAs developed by Watkins-Johnson for use in systems where small signal gain may be adjusted without significant loss in power output or increase in noise figure. Application of a negative dc voltage allows reduction of gain from 25 to 0 dB while power output and noise figure remain relatively constant. In addition, the gain curve is extremely flat under reduced gain conditions.

The WJ-376 is completely self-contained, adjustment-free, and requires only a 115 volt ac linevoltage input (48 to 420 Hz). The completely



shielded package may be operated in any orientation, in stacked arrays or adjacent to ferromagnetic material, without adversely affecting the amplifier's performance.

Rugged construction of the tube, magnet, and power supply assembly assures reliable operation under vibrational forces of 10 g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of -54°C to +71°C. The environmental characteristics of the WJ-376 meet the corresponding requirements of MIL-E-5400, Class 2 Specification.

SPECIFICATIONS

PERFORMANCE	Typical	Guaranteed
Frequency		4.0 to 8.0 GHz
Noise Figure, Terminal	6.0 dB	6.5 dB, max.
Gain, Small Signal		
VSWR, Input and Output	1.5:1	2:1, max.
Power Output, Saturated	+2 dBm	0 dBm min.
ELECTRICAL REQUIREMENTS	Typical	Range ¹
ELECTRICAL REQUIREMENTS Primary Voltage		5
	115 V ac	115 ±10 V ac
Primary Voltage		115 ±10 V ac
Primary Voltage	115 V ac	115 ±10 V ac 48 to 420 Hz

*Supersedes WJ-376 Technical Data Sheet dated January 1969.

ENVIRONMENTAL CHARACTERISTICS²

Temperature, Operating $... -54^{\circ}$ to $+71^{\circ}$ C Vibration

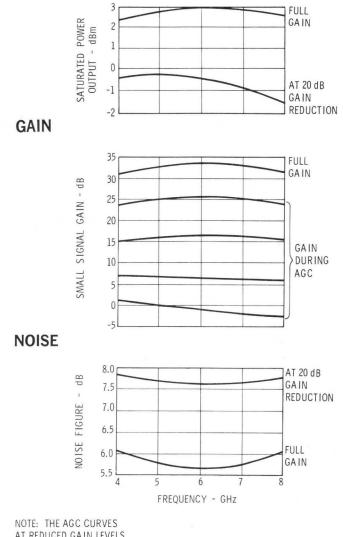
MECHANICAL CHARACTERISTICS

ack
12

Every tube will meet the guaranteed performance specifications for any primary voltage and frequency within these ranges.

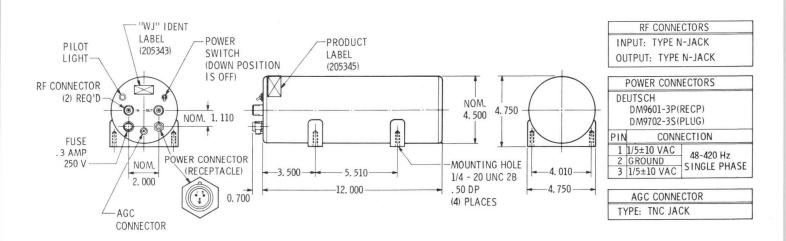
²These environmental characteristics meet the respective requirements of MIL-E-5400, Class 2.





AT REDUCED GAIN LEVELS ARE TYPICAL CURVES.

OUTLINE DRAWING



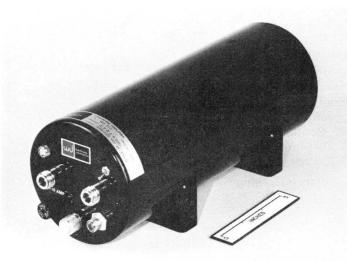
APRIL 1970 *

8.0 TO 12.0 GHz DUAL-HELIX LOW-NOISE TRAVELING-WAVE AMPLIFIER WITH INTEGRAL POWER SUPPLY WJ-377

- "JUST PLUG IT IN"
- NEGLIGIBLE PERFORMANCE VARIATION DURING GAIN ADJUSTMENT
- NOISE FIGURE
 8.0 dB MAXIMUM
- POWER OUTPUT
 O dBm MINIMUM
- PERMANENT-MAGNET FOCUSING
- MEETS MIL-E-5400, CLASS 2 SPECIFICATION

The WJ-377 is one of a new series of dual-helix LNTWAs developed by Watkins-Johnson for use in systems where small signal gain may be adjusted without significant loss in power output or increase in noise figure. Application of a negative dc voltage allows reduction of gain from 25 to 0 dB while power output and noise figure remain relatively constant. In addition, the gain curve is extremely flat under reduced gain conditions.

The WJ-377 is completely self-contained, adjustment-free, and requires only a 115 volt ac linevoltage input (48 to 420 Hz). The completely



shielded package may be operated in any orientation, in stacked arrays or adjacent to ferromagnetic material, without adversely affecting the amplifier's performance.

Rugged construction of the tube, magnet, and power supply assembly assures reliable operation under vibrational forces of 10 g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of -54 °C to +71 °C. The environmental characteristics of the WJ-377 meet the corresponding requirements of MIL-E-5400, Class 2 Specification.

SPECIFICATIONS

PERFORMANCE	Typical	Guaranteed
Frequency		8.0 to 12.0 GHz
Noise Figure, Terminal	7.5 dB	8.0 dB, max.
Gain, Small Signal	30 dB	25 dB, min.
VSWR, Input and Output	1.5:1	2:1, max.
Power Output, Saturated	+2 dBm	0 dBm min.
ELECTRICAL REQUIREMENTS	Typical	Range
ELECTRICAL REQUIREMENTS Primary Voltage		
	115 V ac	115 ±10 V ac
Primary Voltage	115 V ac 60 Hz	115 ±10 V ac

*Supersedes WJ-377 Technical Data Sheet dated January 1969.

ENVIRONMENTAL CHARACTERISTICS²

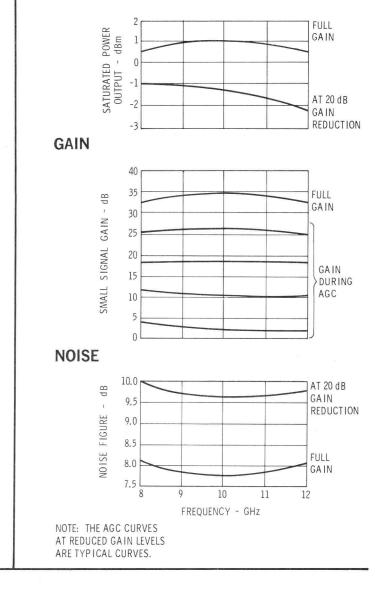
Temperature, Operating \cdot . -54° to $+71^{\circ}$ C Vibration
a. 0.10 Inch, Double Amplitude . 5 to 45 Hz b. 10 g, Single Amplitude 45 to 500 Hz Shock
MECHANICAL CHARACTERISTICS
Height
connectors) 12 inches (305 mm) max.
Weight
Primary Power Connection,

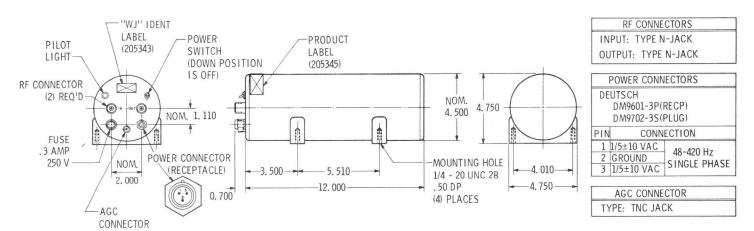
Deutsch Receptacle DM9601-3P
RF Connections
(50 ohms, nominal) Type N, jack
AGC Connector Type TNC, Jack
Reference Drawing No

¹Every tube will meet the guaranteed performance specifications for any primary voltage and frequency within these ranges.

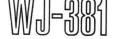
²These environmental characteristics meet the respective requirements of MIL-E-5400, Class 2.







2.6 TO 5.2 GHz, COMPACT LOW-NOISE PERMANENT-MAGNET TRAVELING-WAVE AMPLIFIER WITH INTEGRAL POWER SUPPLY



March 1967

- "JUST PLUG IT IN"
- NOISE FIGURE 9.5 dB MAXIMUM
- ADJUSTMENT FREE
- PERMANENT-MAGNET FOCUSING

SPECIALIZED VERSIONS **AVAILABLE**

The WJ-381 is one of the Watkins-Johnson family of compact traveling-wave amplifiers designed to fill the increasing requirements for a "straddle-band" amplifier covering portions of S and C bands in a single device. Incorporating many of the time-tested features of its larger predecessors, this amplifier is only 9.5 inches long, 3.4 inches in height and width, and weighs 6.0 pounds. The amplifier is completely adjustment-free and has an integral solid-state power supply which operates from a 115-volt ac, 48 to 420 Hz source.

Although guaranteed to produce a noise figure not exceeding 9.5 dB, a typical WJ-381 production unit can be expected to yield a much lower noise figure over the major segment of the 2.6 to 5.2 GHz frequency range. The typical performance noise figure curve shown represents actual test figures taken from randomly selected amplifiers. Note that most of the curve appears below 8.5 dB.

The WJ-381 will meet or exceed environmental requirements of MIL-E-5400, Class 2 Specification. Rugged construction of the traveling-wave tube, per-



manent magnet, and power supply assembly assures reliable operation under vibrational forces of 10 g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of -54° C to $+71^{\circ}C.$

The same conservative design and careful processing techniques responsible for the long life of other Watkins-Johnson low-noise amplifiers have been extended to the WJ-381. It can be predicted that they will yield an MTBF in excess of 18,500 hours (99%confidence level). The anticipated MTBF is based on extensive tests performed on this and similar tubes and power supply components.

Several specialized versions of the WJ-381 are available on special order. These amplifiers offer a lower noise figure over narrower bandwidths, phase and gain matching, extended and special frequency coverages, rigid differential phase and gain performance, automatic gain control, and inclusion of a unique blanking circuit to permit pulse times of a few nanoseconds. Details are available upon request.

PERFORMANCE Typical Guaranteed Noise Figure, Terminal 8.5 dB 9.5 dB, max. Gain, Small Signal 1.5:1 2:1, max. Power Output +10.0 dBm +7.0 dBm, min. ELECTRICAL REQUIREMENTS Typical Range Primary Power 20 W



ENVIRONMENTAL CHARACTERISTICS

Tem	nper	atı	Ire	, O	per	ati	ng			-	54	$^{\circ}$ C to $+71^{\circ}$ C
Vibr	ratio	n										
a	. 0.1	0	Inc	h,	Do	ubl	e A	\m	plit	ude	Э	. 5 to 45 Hz
	. 10											45 to 500 Hz
		-		-								15 a. 11 ms

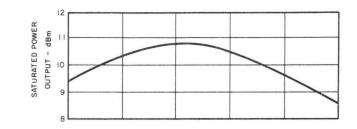
MECHANICAL CHARACTERISTICS

Amplifier Length
(excluding connectors) 9.5 inches, max.
Amplifier Height and Width 3.4 inches, max.
Amplifier Weight 6.0 pounds
Primary Power Connection, Deutsch Receptacle DM9601-3P
RF Connections (50 ohms, nominal) Type N, jack
Reference Drawing Number 290003

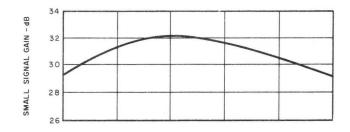
Every tube will meet the guaranteed performance specifications within these ranges.

These environmental characteristics meet or exceed the respective requirements of MIL-E-5400, Class 2 Specification.

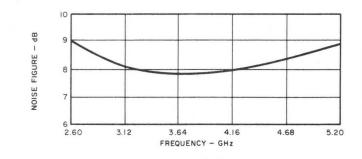
POWER



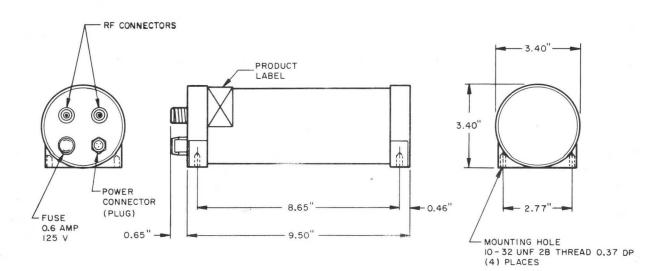
GAIN



NOISE



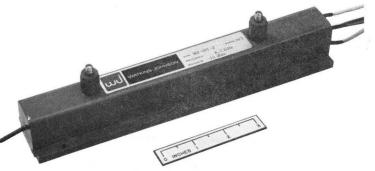
OUTLINE DRAWING



WATKINS - JOHNSON COMPANY 3333 HILLVIEW AVENUE STANFORD INDUSTRIAL PARK PALO ALTO, CALIFORNIA 94304 TWX 910-373-1253 PHONE (415) 326-8830 Telex: 348-415

July 1969*

7.0 TO 11.0 GHz, 5-WATT TRAVELING-WAVE TUBE WJ-391



The WJ-391 is a medium-power traveling-wave tube for use in the 7.0 to 11.0 GHz frequency range. This tube provides 5 watts power output and 42 dB small signal gain. A unique feature of the WJ-391 is its very low fine structure gain variation, making it especially suitable for applications where gain variation and phase linearity are important. The use of periodicpermanent-magnet focusing and metal-ceramic construction results in a compact, lighweight tube that is especially suitable for use in airborne and space applications.

This traveling-wave tube is one of a family of space and missile qualified medium-power tubes, all of which use similar construction techniques. The com-

- OUTPUT POWER 5 WATTS MINIMUM
- PPM FOCUSING
- ESPECIALLY SUITABLE FOR AIRBORNE/SPACE APPLICATION
- EXTREMELY LOW FINE-STRUCTURE GAIN VARIATION

pact, all metal-ceramic assembly provides a unit that can easily withstand the shock, vibration and temperature extremes that are encountered in missile launchings.

The PPM focusing system uses Alnico-8 magnets which make it insensitive to temperature variations over its operating range. Cooling of the tube is by conduction through the baseplate of the capsule.

Operating efficiency of the WJ-391 can be improved by depressing the collector voltage below the helix voltage.

In addition the WJ-391 may also be supplied with an integral power supply, resulting in a fully integrated TWT amplifier.

PERFORMANCE	Typical	Guaranteed
Frequency		
Saturated Power Output		
Small Signal Gain		
Small Signal Gain Variation		
Gross Fine Structure Small Signal Gain Variation	±0.2 dB	±0.5 dB
AM-PM Conversion (At 5 watts)	4.5°/dB	5°/dB, max.
Noise Figure	27 dB	30 dB. max.
0		
ELECTRICAL REQUIREMENTS	TYPICAL	RANGE
ELECTRICAL REQUIREMENTS Heater Voltage	TYPICAL	RANGE 6.0 to 6.6 volts
ELECTRICAL REQUIREMENTS Heater Voltage	TYPICAL 6.3 volts	RANGE
ELECTRICAL REQUIREMENTS Heater Voltage Anode Voltage Helix Voltage	TYPICAL 6.3 volts +50 volts 3100 volts	RANGE
ELECTRICAL REQUIREMENTS Heater Voltage Anode Voltage Helix Voltage Collector Voltage	TYPICAL 6.3 volts +50 volts 3100 volts	RANGE
ELECTRICAL REQUIREMENTS Heater Voltage Anode Voltage Helix Voltage Collector Voltage Cathode Current	TYPICAL 	RANGE
ELECTRICAL REQUIREMENTS Heater Voltage Anode Voltage Helix Voltage Collector Voltage Cathode Current Helix Current	TYPICAL 	RANGE
ELECTRICAL REQUIREMENTS Heater Voltage Anode Voltage Helix Voltage Collector Voltage	TYPICAL 	RANGE

SPECIFICATIONS

*Supersedes WJ-391 Technical Data Sheet Dated April 1969

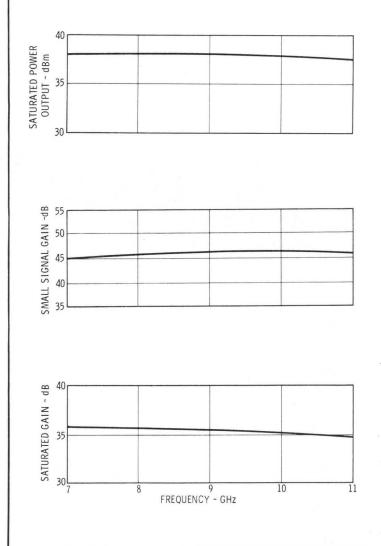
MECHANICAL CHARACTERISTICS

Cooling Conduction through baseplate
Height 1.25 inches (32 mm) max.
Width 1.85 inches (47 mm) max.
Length 10.86 inches (276 mm) max.
Weight 1.5 pounds (680 g) max.
Connectors OSM
Focusing PPM

ENVIRONMENTAL CAPABILITY¹

Temperature	-54°C to +85°C (baseplate)
Vibration (120-2000	0 cycles) 5 Grms
Shock	20 G
Altitude	Any

RF ELECTRICAL PERFORMANCE CHARACTERISTICS



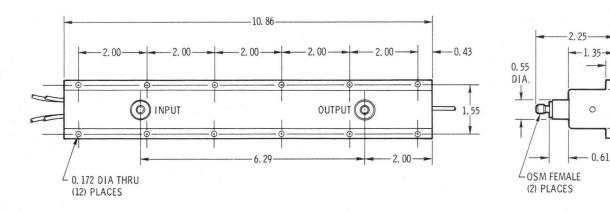
0.25

4

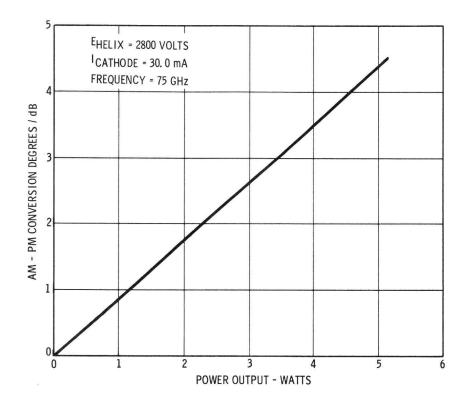
1. 19

1.80

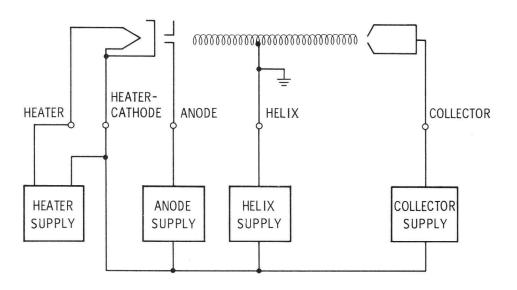
 $^{1}\text{Every}$ tube can be qualified to meet requirements of MIL-E-5400.



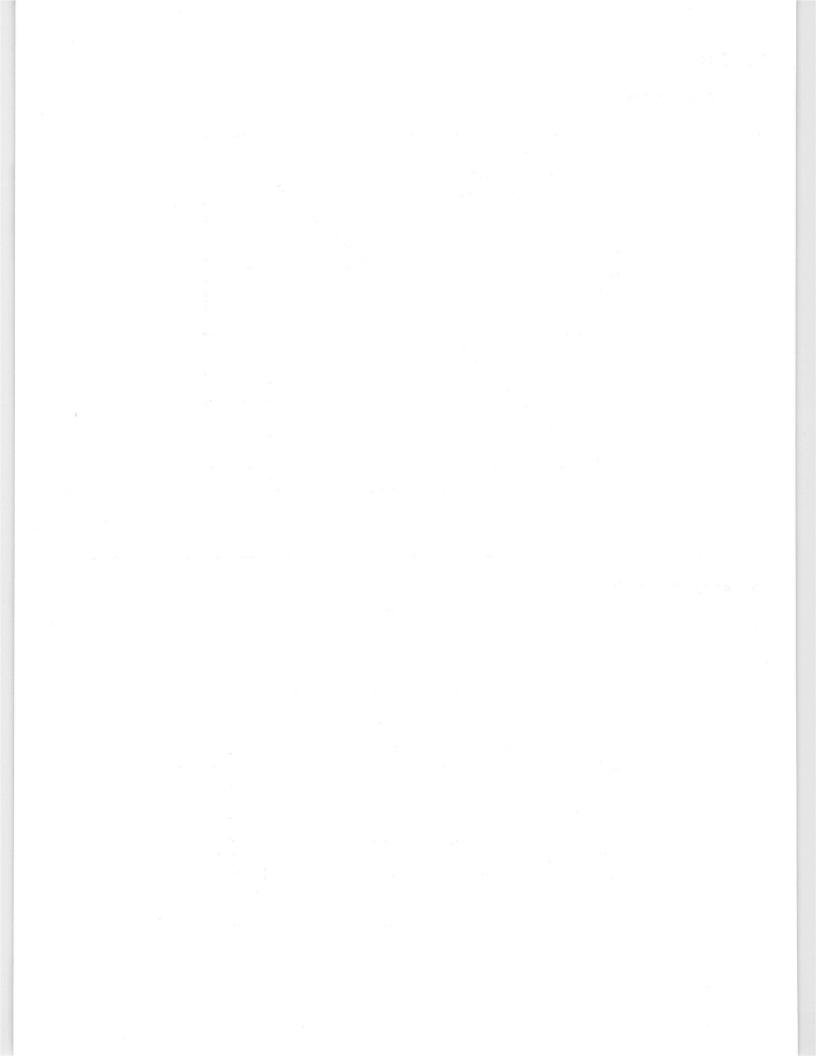
AM-PM CONVERSION



SCHEMATIC DIAGRAM



JULY 1969



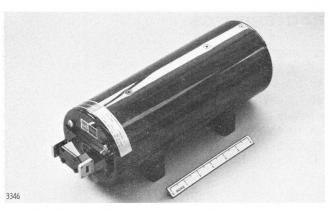


18.0 TO 26.5 GHz, LOW-NOISE PERMANENT-MAGNET TRAVELING-WAVE AMPLIFIER WITH INTEGRAL POWER SUPPLY

- "JUST PLUG IT IN"
- NOISE FIGURE 13 dB MAXIMUM
- PERMANENT-MAGNET FOCUSING
- NO ADJUSTMENTS NEEDED

The WJ-393 extends the Watkins-Johnson family of low-noise integral power supply permanentmagnet focused traveling-wave amplifiers into the millimeter wavelength region. This K-band amplifier offers a guaranteed maximum noise figure of 13 dB over the 18.0 to 26.5 GHz frequency range, but typically can be expected to yield a noise figure of less than 11 dB over much of the range. Saturated power output is 0 dBm minimum, and small signal gain is 25 dB minimum.

The WJ-393 amplifier package includes a shielded permanent magnet that is not adversely affected by adjacent PM tubes or ferromagnetic material. Also integral with the package is a factory-set power supply whose total power consumption from the 115-volt ac source is typically 5 watts. All components are regulated or compensated for full



specification performance over the specified temperature range.

The same conservative design and careful processing techniques which are responsible for long life in other Watkins-Johnson low-noise amplifiers, have been extended to this amplifier. Similar amplifiers of this type have attained MTBF's in excess of 15,000 hours (99% confidence level). This low-cost-per-operating-hour performance is characteristic of the WJ-393 and all other amplifiers in this rugged family.

Installation and operation of the WJ-393 are simplified by rugged construction. When mounted in any orientation by the four threaded mounting holes, the WJ-393 can withstand vibrational forces of over 5 g at frequencies up to 500 Hz, and shock in any plane of over 15 g, 11 millisecond duration.

PERFORMANCE	Typical	Gauraneova
Frequency	.18.0 to 26.5 GHz	18.0 to 26.5 GHz
Noise Figure, Terminal ¹		
Gain, Small Signal	.28 dB	25 dB, min.
VSWR, Input and Output		
Power Output		
ELECTRICAL REQUIREMENTS	Typical	Range ²
Primary Voltage	.115 V ac	115 ±10 V ac
Primary Frequency	.60 Hz	48 to 420 Hz
Primary Power	.5 W	10 W, max.
*Supersedes WJ-393 Technical Bulletin, Volume 8, No. 14, October	r, 1966	

ENVIRONMENTAL CHARACTERISTICS

D. 3)	g	,	0	11	Ig	ie	2	A	11	ιŀ	וו	ιι	u	u	e			٠	٠	50	ιυ	-	000	ΠZ
Shock	ş					•	•	•		•				•		•	•	•			15	jg	57	11	ms

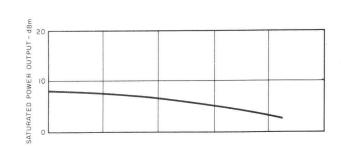
MECHANICAL CHARACTERISTICS

Amplifier Length

(excluding connectors) 12 inches, max.
Amplifier Cross Section 4.75 inches, max.
Amplifier Weight 18 pounds, max.
Primary Power Connection Bendix receptacle PT-07C-8-3P
RF Connectors (WR-42 Waveguide) UG-595/U flange

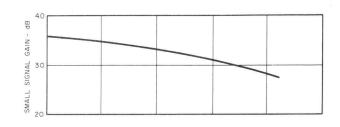
¹Noise Figure is as read on a standard Hewlett-Packard Model <u>340B</u> Noise Figure Meter utilizing a standard AIL 07053 noise source.

²Every amplifier will meet the guaranteed performance specifications for any voltage lying within these ranges.

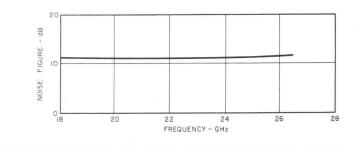




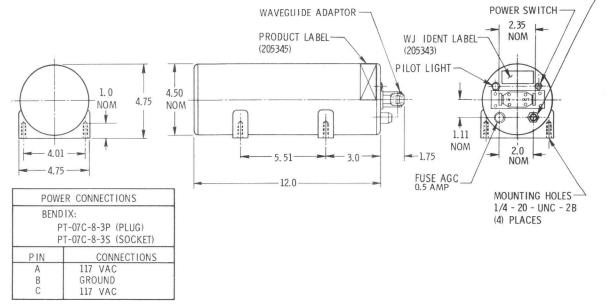
POWER







POWER CONNECTOR -





September 1968 *

2.2 TO 2.3 GHz

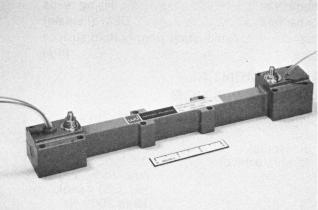
COMPACT, HIGH-EFFICIENCY, 100 WATT TRAVELING-WAVE TUBE FOR SPACE COMMUNICATIONS AND TELEMETRY

The WJ-395-1 traveling-wave tube is designed to meet the power amplifier requirements of earth orbit and deep-space missions where high reliability, small size, light weight and maximum overall efficiency are essential.

This small, periodic-permanent-magnet focused TWT exhibits an overall efficiency, including heater power, above 44%. The metal-ceramic construction of the WJ-395-1 is just one of the design features used to assure the maximum in reliable, long-life operation. It has the ability to perform during and after extreme temperature, vibration, shock, and static acceleration.

The WJ-395-1 will deliver 100 watts of output power over the frequency range of 2.2 to 2.3 GHz. By operating the tube under different sets of voltage conditions, saturated output levels from 60 to 120 watts can be provided while maintaining a fixed value of rf drive without significantly affecting efficiency. This is shown in Fig. 4. Therefore, it is necessary to change only the helix, anode, and collector voltages to obtain near optimum performance for any desired power level.

The power output, gain, and overall efficiency are very nearly constant over the guaranteed frequency range as shown in Fig. 1. Fig. 3 shows the rf performance characteristics as a function of helix voltage for various values of beam current. Note



3819

that beam efficiency, not overall efficiency, is plotted in the lower curve. The points for maximum beam efficiency also correspond to maximum overall efficiency. These maximum efficiency points are indicated on the middle curve.

A number of variations of the WJ-395-1 are available which optimize performance at various other frequencies and power levels. The tube can be made to meet environmental conditions more stringent than those described in the Specifications. Manufactured under rigid quality assurance specifications, versions of this tube have also been qualified for space applications.

PERFORMANCE CHARACTERISTICS Guaranteed Typical ELECTRICAL REQUIREMENTS Typical Range

SPECIFICATIONS

¹These voltages are referenced to the cathode. Helix is operated at ground potential. ²Overall efficiency is defined as the RF output power, divided by the total dc input, including heater power.

* Supersedes WJ-395-1 Technical Data Sheet Dated July 1968

WJ-395-1

MECHANICAL CHARACTERISTICS

Tube length
Tube width 1.8 inches max.
Tube height, excluding connectors 1.6 inches max.
Tube weight 2.8 pounds max.
DC connectors Flying leads
RF connectors OSM (Female)
Cooling Conduction from bottom surface
Focusing PPM
ENVIRONMENTAL
CHARACTERISTICS

Heat Sink Temperature-20°C to +85°C Vibration

a. Sinusoidal
(2 min/octave) 0.5 inch, double
amplitude, 5 to 18
Hz, ±20 g peak,
18 to 2000 Hz
b. Random $(5 \text{ min} (avia)) = 0.1 \sigma^2 (11 - 20 \text{ to})$
(5 min/axis) 0.1 g²/Hz, 20 to 2000 Hz
Acceleration (1 min/axiş) 100 g
Shock

FIG. 1 — SATURATION POWER OUTPUT, GAIN, AND OVERALL EFFICIENCY.

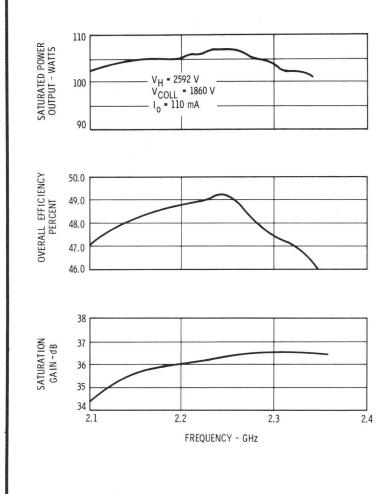
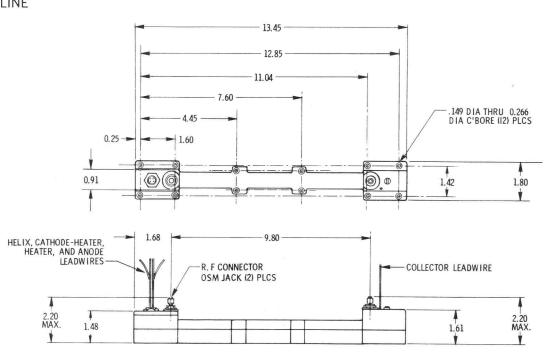


FIG. 2 — OUTLINE DRAWING



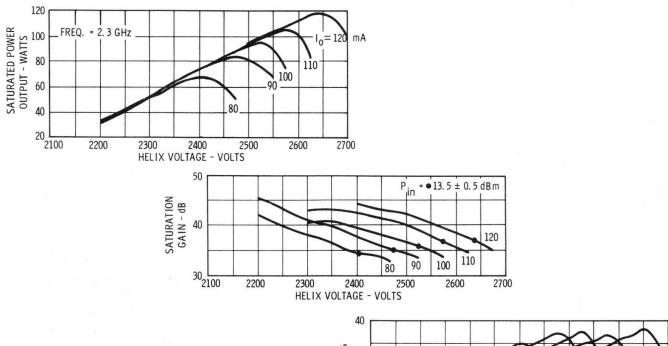
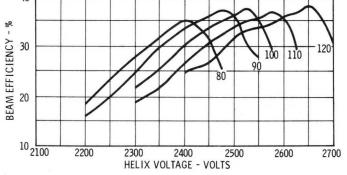


FIG. 3 — SATURATION POWER OUTPUT, SATURATION GAIN AND BEAM EFFICIENCY FOR VARIATION IN ELECTRODE VOLTAGES



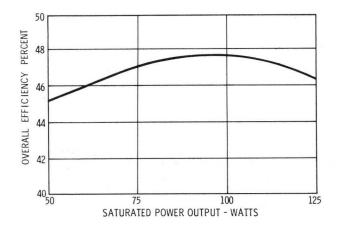
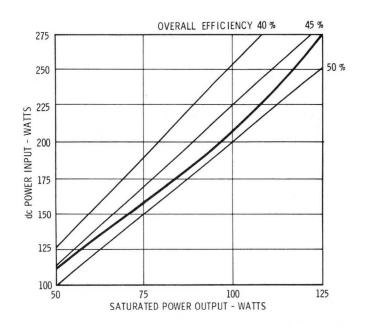
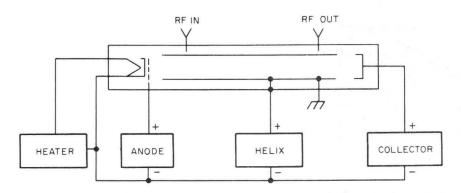


FIG. 4 — OVERALL EFFICIENCY AND TOTAL DC INPUT POWER AS A FUNCTION OF SATURATED POWER OUTPUT



Note: These curves represent constant RF input drive power and programmed anode, helix and collector voltages.



3.5-4.5 VOLTS AC AT 1 AMPERE MAXIMUM HEATER 3300-3800 VOLTS AT 1 mA MAXIMUM ANODE 2500-2800 VOLTS AT 18 mA MAXIMUM HELIX 1800-2300 VOLTS AT 115 mA MAXIMUM COLLECTOR

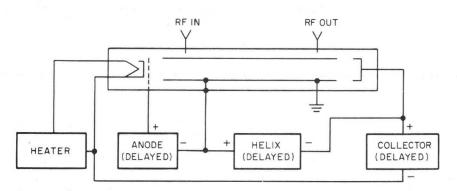
NOTE

TO ENSURE THAT THE TWT IS OPERATED PROPERLY, IT IS SUGGESTED THAT VOLTAGES BE AP-PLIED AS FOLLOWS:

- 1. SLOWLY APPLY FILAMENT VOLTAGE UNTIL SPECIFIED VALUE IS REACHED, OBSERVING THAT FIL-AMENT CURRENT DOES NOT EXCEED MAXIMUM VALUE. ALLOW AT LEAST 2 MINUTES FOR FILA-MENT VOLTAGE TO STABILIZE.
- 2. SLOWLY APPLY COLLECTOR VOLTAGE UNTIL SPECIFIED VALUE IS REACHED, OBSERVING THAT COLLECTOR CURRENT DOES NOT EXCEED MAXIMUM VALUE.
- 3. SET ADJUSTABLE OVERCURRENT DISCONNECT CIRCUIT FOR MAXIMUM HELIX CURRENT VALUE SPECIFIED, THEN SLOWLY APPLY HELIX VOLTAGE TO SPECIFIED VALUE.
- 4. SLOWLY APPLY ANODE VOLTAGE TO SPECIFIED VALUE, OBSERVING THAT CURRENT DOES NOT EXCEED MAXIMUM VALUE.

HELIX DISCONNECT CIRCUIT SHOULD FUNCTION SUCH THAT ALL VOLTAGES WILL BE DISABLED WITHIN 100 $_{\rm F}{\rm SEC}$ if Helix current exceeds maximum value.

FIG. 5 PREFERRED CONNECTION FOR LABORATORY-TYPE POWER SUPPLY CONFIGURATION FOR WJ-395-1



3.5 VOLTS AC (TYPICAL) AT 1 A MAXIMUM HEATER ANODE 1050 VOLTS (TYPICAL) AT 1 mA MAXIMUM 630 VOLTS (TYPICAL) AT 18 mA MAXIMUM HELIX 1960 VOLTS (TYPICAL) AT 115 mA MAXIMUM COLLECTOR

WITH THIS CONFIGURATION, ANODE SUPPLY CANNOT CUTOFF TUBE EMISSION. TO PREVENT DAM-AGE TO TWT, VOLTAGES MUST BE APPLIED TO TWT IN THE FOLLOWING SEQUENCE:

1. APPLY HEATER VOLTAGE SLOWLY TO ALLOW FILAMENT RESISTANCE CHANGE AS TEMPERA-TURE RISES.

2. COLLECTOR, HELIX, AND ANODE VOLTAGES MAY BE APPLIED SIMULTANEOUSLY AFTER HEATER VOLTAGE HAS BEEN ON FOR 2 MINUTES MINIMUM.

CAUTION

HELIX OVERCURRENT DISCONNECT CIRCUIT MUST BE SET FOR MAXIMUM HELIX CURRENT VALUE SPECIFIED AND MUST DISCONNECT ALL VOLTAGES IN LESS THAN 100 $_{\mu}$ SEC IF MAXIMUM VALUE IS EXCEEDED.

FIG. 6 PREFERRED CONNECTION FOR HIGH-DENSITY POWER SUPPLY CONFIGURATION FOR WJ-395-1

FEBRUARY 1970*

7 TO 11 GHz ULTRA LOW-NOISE TWT AMPLIFIER WITH INTEGRAL POWER SUPPLY WJ-396

- "JUST PLUG IT IN"
- GUARANTEED 6.0 dB
 NOISE FIGURE
- SMALL SIZE 3.4 x 3.4 x 10.0 INCHES
- WEIGHT: 8.5 POUNDS
- MEETS MIL-E-5400, CLASS || ENVIRONMENT

WJ-396 is the first of a new series of small, lightweight, ultra-low-noise traveling-wave amplifiers developed by Watkins-Johnson Company. Designed and built for long life with optimum performance, this amplifier is expected to attain an MTBF similar to that exhibited by certain of W-J's LNTWAs (over 15,000 hours at 99% confidence level). For special applications, the guaranteed noise figure can be lowered over the selected portions of the band. Rugged construction allows the WJ-396 to withstand vibrational forces of over 5 g at frequencies up to 500 Hz, and over 15 g of shock in any plane for 11 millisecond duration. Shielded permanent-magnet focusing is unaffected by adjacent PM tubes or ferromagnetic material. An integral power supply consumes less than 10 watts of power from the 115-volt ac source. All components are regulated or compensated for full specification performance from -54° C to $+71^{\circ}$ C.

SPECIFICATIONS

PERFORMANCE	Typical	Guaranteed
Frequency	7.0 to 11.0 GHz	7.0 to 11.0 GHz
Noise figure, terminal (8.0 to 10.0 GHz) ¹		6.0 dB
(7.0 to 8.0 GHz; 10.0 to 12.0 GHz)	.6.0 dB	6.5 dB
Gain, small signal		
VSWR, input and output	.1.5:1	2:1 max.
Power output	—5. 0 dBm	
ELECTRICAL REQUIREMENTS		Range ²
Primary voltage		115 ±10 V ac
Primary frequency	60 Hz	48 to 420 Hz
Primary power	10 watts	

1. Noise figure is as read on an HP Noise Figure Meter model 340 B, using HP Noise Sources model H 347 A and model X 347 A.

2. Every tube will meet the guaranteed performance specifications for any primary voltage and frequency lying within these ranges.

*Supersedes WJ-396 Technical Data Sheet dated March 1968.



ENVIRONMENTAL³ CHARACTERISTICS

Temperature
Vibration
a10 inch, double amplitude 5 to 30 Hz
b. 5 g, single amplitude 30 to 2,000 Hz
Shock 15 g, 11 ms

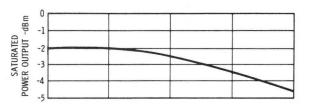
MECHANICAL CHARACTERISTICS

Height 3.	
Width 3.	4 inches (86 mm) max.
Length (excluding	
connectors) 10	
Weight 8	3.5 lbs. (3.86 Kg) max.

Primary power connection, Bendix PT-07C-8-3P RF connectors (input and output) Type N Jack

3. These environmental characteristics meet or exceed the respective requirements for MIL-E-5400, Class 2.

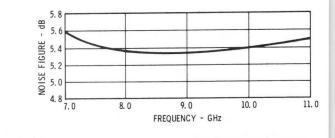


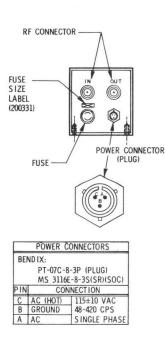


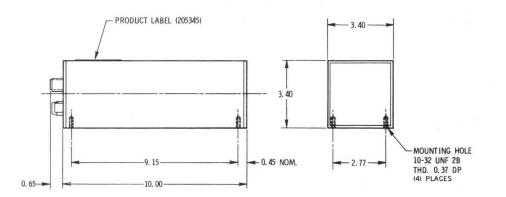
GAIN



NOISE







WJ-397

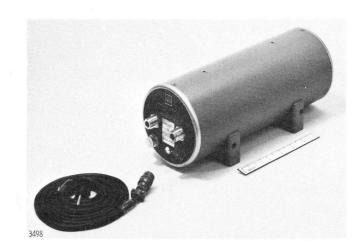
March 1968

0.5 TO 2.0 GHz LOW-NOISE, DOUBLE-OCTAVE PERMANENT-MAGNET TRAVELING-WAVE AMPLIFIER WITH INTEGRAL POWER SUPPLY

- NOISE FIGURE
 7 dB MAXIMUM
- PERMANENT-MAGNET FOCUSING
- PROVEN RELIABILITY
- NO ADJUSTMENTS
 REQUIRED
- MEETS MIL-E-5400, CLASS 2 SPECIFICATION

The WJ-397 is the first of another new series of low-noise traveling-wave amplifiers developed by Watkins-Johnson Company. Featuring an ultralow noise figure (7.0 dB max.) across the P- and L-band frequency spectrum, this double-octave amplifier is ideal for use in sensitive, ultra-wide bandwidth receiver equipment applications. A guaranteed power output of 0 dBm adds to the overall capability of this amplifier. The WJ-397 has the same long-life design, rugged construction, and adjustment-free operation characteristics of Watkins-Johnson's other octaveband, low-noise amplifiers. Magnetic shielding allows operation next to similar units or to ferromagnetic materials without degradation of performance. The amplifier may be mounted in any orientation, and is built to withstand the shock, vibration, and temperature specifications of MIL-E-5400, Class 2.

PERFORMANCE	Typical	Guaranteed
Frequency	. 0.5-2.0 GHz	0.5-2.0 GHz
Noise figure, terminal		
Gain, small signal		
Gain variation, small signal	. ±2 dB	
VSWR, input and output	. 1.5:1	2.5:1 max.
Power output	. +5 dBm	0 dBm
ELECTRICAL REQUIREMENTS	Typical	Range
Primary voltage	.115 V ac	. 115 ± 10 V ac
Primary frequency	. 60 Hz	48 to 420 Hz
Primary power	. 6 watts	10 watts



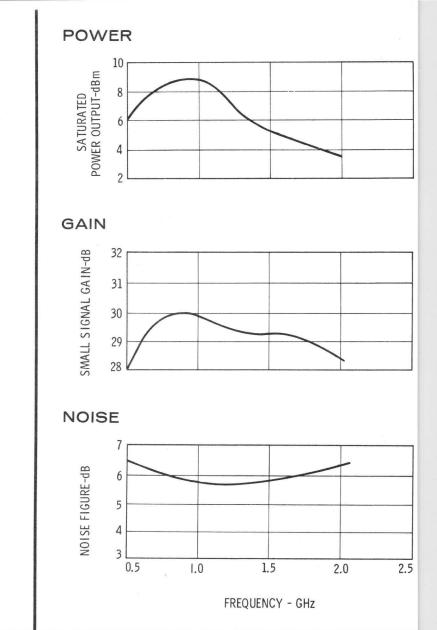
ENVIRONMENTAL CHARACTERISTICS

Temperature $\dots \dots \dots$
Vibration
a. 0.10 inch, double amplitude 5 to 45 Hz
b. 5g, single amplitude 45 to 500 Hz
Shock 15 g, 11 ms

MECHANICAL CHARACTERISTICS

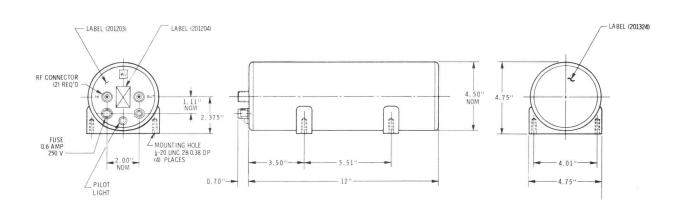
Amp	lifier	length	

(excluding connectors) 12 inches, max.
Amplifier height and width 4.75 inches, max.
Weight 17 lbs, max.
Primary power connection, Bendix receptacle PT-07C-8-3P
RF connections (50 ohms, nominal) Type N, jack



¹Every tube will meet the guaranteed performance specifications for any voltage within these ranges.

 $^{2}\mbox{These}$ environmental characteristics meet or exceed the respective requirements for MIL-E-5400, Class 2.



January 1968

2.2 TO 2.4 GHz COMPACT 20-WATT TRAVELING-WAVE TUBE FOR SATELLITE APPLICATION AND HIGH IMPACT SHOCK LEVEL

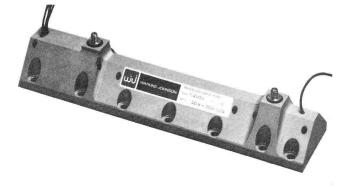
WJ-398-1

The WJ-398-1 is a medium power traveling-wave tube developed to meet the requirements of satellite and deep-space transmitter applications where high reliability, small size, light weight and maximum overall efficiency are essential.

This small, periodic-permanent-magnet focused TWT exhibits an overall efficiency, including heater power, above 25%. The metal-ceramic construction of the WJ-398-1 is just one of the design features used to assure the maximum in reliable, long-life operation. It has the ability to perform during and after extreme temperature, vibration, static acceleration, and high impact shock levels, to 5,000 G, for 0.5 ms duration (such as may be experienced in a planetary hard-landing vehicle).

The WJ-398-1 will deliver 20 watts of output power over the frequency range of 2.2 to 2.4 GHz. By operating the tube under different sets of voltage conditions, saturated output levels from 10 to 25 watts can be provided while maintaining a fixed value of gain without significantly affecting efficiency. Therefore, it is necessary to change only the helix, anode, and collector voltages to obtain an optimum condition for any desired power level.

Efficiency generally improves with an increased power level for the tube, enabling the user to cover



a range of power requirements with one tube.

The power output, gain, and efficiency are very nearly constant over the specified frequency range, as shown in Fig. 1. The power transfer curves of Fig. 3 show that the output power at saturation is relatively unchanged with a substantial change in drive power.

A number of variations of the WJ-398-1 are available which optimize performance at various other frequencies and power levels. The tube can be made to meet environmental conditions more stringent than those described in the Specifications; for example, engineering models have been tested to shock levels as high as 9500 G for 0.7 ms duration.

PERFORMANCEFrequency rangeRF power outputRF input for saturationRF gain	.22.4 watts	20 watts min. 8 dBm max. 35 dB min.
Primary power		
ELECTRICAL REQUIREMENTS Heater Voltage	Typical 6.5 V	Range
Heater Current Anode Voltage	.1.0 A	0.8-1.2 A
Anode Current	.0.1 mA	1.0 mA, max.
Helix Current Collector Voltage		10.0 mA, max.
Collector Current	52 mA	60 mA. max.

WJ-398-1

ENVIRONMENTAL CHARACTERISTICS

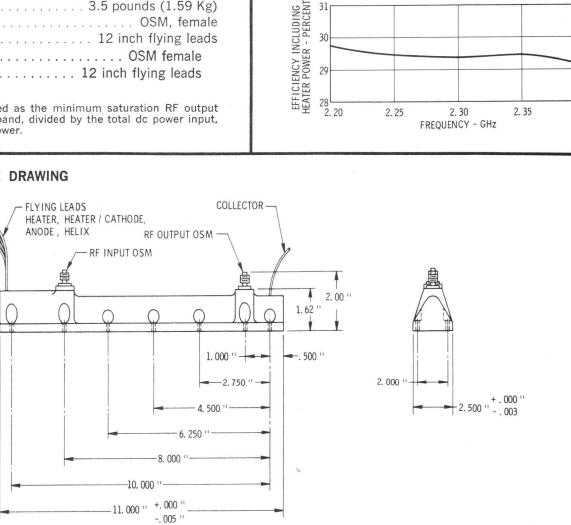
Shock 5,000 G average, 0.5 ms duration Acceleration 14 G, 5 minutes Vibration, complex. . Superimposed 14 G rms noise (18 sec.) 5.0 G rms noise (600 sec.) 2.0 G rms sine 15-40 Hz (600 sec.) 9.0 G rms sine 40-250 Hz (600 sec.) 4.5 G rms sine 250-2000 Hz (600 sec.) 14 G rms noise (18 sec.) Temperature -10°C to +75°C

MECHANICAL **CHARACTERISTICS**

Height (including connectors) 2 inches (51 mm)
Width 2.5 inches (64 mm)
Length 11 inches (279 mm)
Weight 3.5 pounds (1.59 Kg)
RF Connector OSM, female
DC Connections 12 inch flying leads
RF connector OSM female
DC connections 12 inch flying leads

¹Efficiency is defined as the minimum saturation RF output power across the band, divided by the total dc power input, including heater power.

FIG. 2. OUTLINE DRAWING



POWER OUTPUT - WATTS

30

20

10

0

43 - dB

42

41

40

31

30

SATURATED GAIN

FIG. 1. **RF PERFORMANCE** CHARACTERISTICS vs. FREQUENCY

2.40

FIG. 3. TYPICAL POWER TRANSFER CHARACTERISTICS

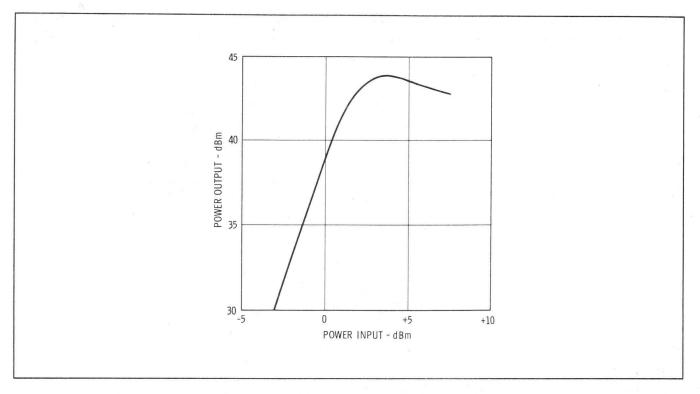
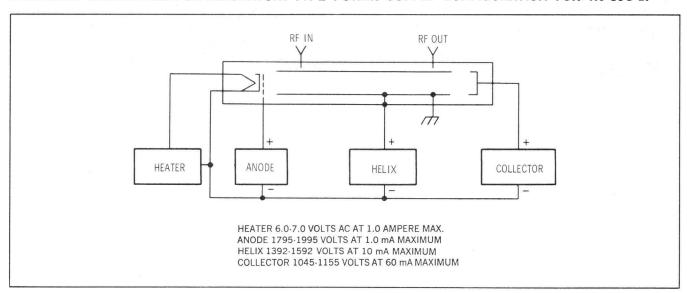


FIG. 4. PREFERRED CONNECTION FOR LABORATORY-TYPE POWER SUPPLY CONFIGURATION FOR WJ-398-1.



NOTE:

TO ENSURE THAT THE TWT IS OPERATED PROP-ERLY, IT IS SUGGESTED THAT VOLTAGES BE AP-PLIED AS FOLLOWS:

- 1. SLOWLY APPLY FILAMENT VOLTAGE UNTIL SPEC-IFIED VALUE IS REACHED, OBSERVING THAT FILAMENT DOES NOT EXCEED MAXIMUM VALUE. ALLOW AT LEAST 2 MINUTES FOR FILAMENT VOLTAGE TO STABILIZE.
- 2. SLOWLY APPLY COLLECTOR VOLTAGE UNTIL SPECIFIED VALUE IS REACHED.
- 3. SET ADJUSTABLE OVERCURRENT DISCONNECT

CIRCUIT FOR MAXIMUM HELIX CURRENT VALUE SPECIFIED, THEN SLOWLY INCREASE HELIX VOLT-AGE TO SPECIFIED VALUE.

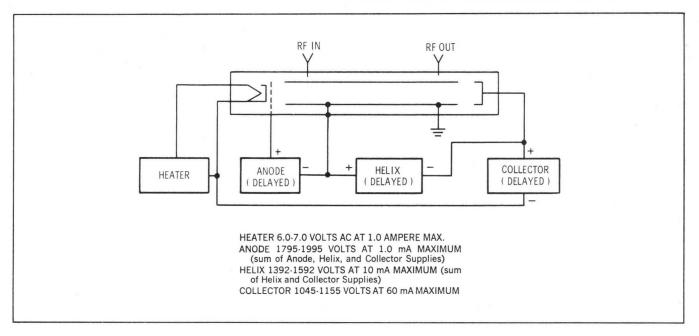
4. SLOWLY INCREASE ANODE VOLTAGE TO SPECI-FIED VALUE, OBSERVING THAT CURRENT DOES NOT EXCEED MAXIMUM VALUE.

HELIX DISCONNECT CIRCUIT SHOULD FUNCTION SUCH THAT ALL VOLTAGES WILL BE DISABLED WITHIN 100 μSEC IF HELIX CURRENT EXCEEDS MAXIMUM VALUE.

WJ-398-1

WJ-398-1

FIG. 5. PREFERRED CONNECTION FOR HIGH-DENSITY POWER SUPPLY CONFIGURATION FOR WJ-398-1.



NOTE:

WITH THIS CONFIGURATION, ANODE SUPPLY CAN NOT CUTOFF TUBE EMISSION. TO PREVENT DAM-AGE TO TWT, VOLTAGES MUST BE APPLIED TO TWT IN THE FOLLOWING SEQUENCE:

- 1. APPLY HEATER VOLTAGE SLOWLY TO ALLOW FIL-AMENT RESISTANCE CHANGE AS TEMPERATURE RISES.
- 2. COLLECTOR, HELIX, AND ANODE VOLTAGES MAY BE APPLIED SIMULTANEOUSLY AFTER HEATER

VOLTAGE HAS BEEN ON FOR 2 MINUTES MINI-MUM.

CAUTION

HELIX OVERCURRENT DISCONNECT CIRCUIT MUST BE SET FOR MAXIMUM HELIX CURRENT VALUE SPECIFIED AND MUST DISCONNECT ALL VOLTAGES IN LESS THAN 100 μSEC IF MAXIMUM VALUE IS EXCEEDED.

W J-399

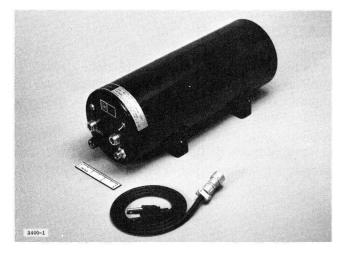
July 1967

8 TO 12 GHz, 40 MILLIWATT LOW-NOISE TRAVELING-WAVE AMPLIFIER WITH INTEGRAL POWER SUPPLY

- "JUST PLUG IT IN"
- NOISE FIGURE
 10 dB MAXIMUM
- PERMANENT-MAGNET FOCUSING
- PROVEN RELIABILITY
- NO ADJUSTMENTS REQUIRED
- MEETS MIL-E-5400, CLASS 2 SPECIFICATION

The WJ-399 is one of the original members of Watkins-Johnson's family of PM-focused integral power supply amplifiers. Like its lower-power predecessors, the WJ-399 is completely self-contained, adjustment-free, and requires only a 115-volt ac line-voltage input (48 to 420 Hz).

This proven amplifier, with a typical noise figure of 9 dB, may be operated in any orientation, in stacked arrays, or adjacent to ferromagnetic ma-



terial without degradation of performance.

Rugged construction of the tube, magnet, and power supply assembly assures reliable operation under vibrational forces of 5 g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of -54° to $+71^{\circ}$ C. The environmental characteristics of the WJ-399 meet or exceed the corresponding requirements of MIL-E-5400, Class 2.

SPECIFICATIONS

PERFORMANCE	Typical	Guaranteed
Frequency	8 to 12 GHz	8 to 12 GHz
Noise Figure, Terminal	9 dB	10 dB, max.
Gain, Small Signal		30 dB, min.
VSWR, Input and Output	1.5:1	2:1, max.
Power Output	18 dBm	16 dBm
ELECTRICAL REQUIREMENTS	Typical	Range
Primary Voltage		115 ±10 V ac
Primary Frequency	60 Hz	48 to 420 Hz
Primary Power		

*This Technical Data Sheet presents up-to-date information on the WJ-399 first described in Technical Bulletin, Volume 8, No. 13; September 1966.

WJ-399

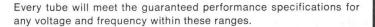
ENVIRONMENTAL CHARACTERISTICS

MECHANICAL CHARACTERISTICS

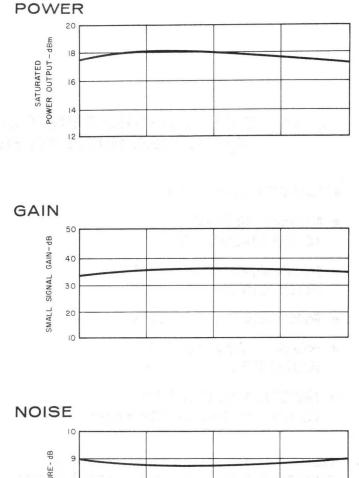
Amplifier Length

Bendix Plug PT 07C-8-3P Bendix Socket PT 07C-8-3S

Reference Drawing Number 290121



These environmental characteristics meet or exceed the respective requirements of MIL-E-5400, Class 2.

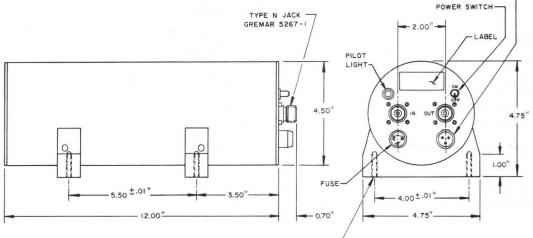


- 1 - 20 UNC 4 PLACES

POWER CONNECTOR

12

OUTLINE DRAWING



 POWER
 CONNECTORS

 BENDIX:
 PT 07C-8-3P
 (PLUG)

 PT 07C-8-3S
 (SOCKET)

 PIN
 CONNECTION

 A
 115± IO VAC

 B
 GROUND

 C
 115± IO VAC

 SINGLE PHASE

WATKINS ■ JOHNSON COMPANY 3333 HILLVIEW AVENUE ■ STANFORD INDUSTRIAL PARK PALO ALTO, CALIFORNIA 94304 TWX 910-373-1253 PHONE (415) 326-8830 Telex: 348-415

July 1967 *

8 TO 12 GHz, 60 MILLIWATT LOW-NOISE TRAVELING-WAVE AMPLIFIER WITH INTEGRAL POWER SUPPLY WJ-399-2



The WJ-399-2 is a higher output power version of the WJ-399 with a typical output power of 80 mW. Like its lower-power predecessors, the WJ-399-2 is completely self-contained, adjustment-free, and requires only a 115-volt ac line-voltage input (48 to 420 Hz).

This proven amplifier, with a typical noise figure of 10 dB, may be operated in any orientation, in stacked arrays, or adjacent to ferromagnetic ma"JUST PLUG IT IN"

NOISE FIGURE
 11.0 dB MAXIMUM

- PERMANENT-MAGNET FOCUSING
- PROVEN RELIABILITY
- NO ADJUSTMENTS REQUIRED
- MEETS MIL-E-5400, CLASS 2 SPECIFICATION

terial without degradation of performance. Rugged construction of the tube, magnet, and power supply assembly assures reliable operation under vibrational forces of 5 g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of -54° to $+71^{\circ}$ C. The environmental characteristics of the WJ-399-2 meet or exceed the corresponding requirements of MIL-E-5400, Class 2.

SPECIFICATIONS

PERFORMANCE	Typical	Guaranteed
Frequency	8 to 12 GHz	8 to 12 GHz
Noise Figure, Terminal	10 dB	11 dB, max.
Gain, Small Signal		30 dB, min.
VSWR, Input and Output	. 1.5:1	2:1, max.
Power Output	.19 dBm	18 dBm
ELECTRICAL REQUIREMENTS	Typical	Range ¹
Primary Voltage	115 V ac	115 ±10 V ac
Primary Frequency	60 Hz	48 to 420 Hz
Primary Power	20 W	

*This Technical Data Sheet presents up-to-date information on the WJ-399 first described in Technical Bulletin, Volume 8, No. 13; September 1966.

WJ-399-2

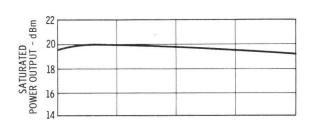
ENVIRONMENTAL CHARACTERISTICS²

Temperature -55° C to $+71^{\circ}$ C
Vibration
a) 0.10 Inch, Double Amplitude . 5 to 30 Hz
b) 5 g, Single Amplitude 30 to 500 Hz
Shock

MECHANICAL CHARACTERISTICS

Height 4.75 inches (121 mm) max.
Width 4.75 inches (121 mm) max.
Length (excluding
connectors) 12 inches (305 mm) max.
Weight 18 pounds (8.16 Kg) max.
Primary Power Connection,
Bendix Plug PT 07C-8-3P
Bendix SocketPT 07C-8-3S
Reference Drawing Number 290121

¹Every tube will meet the guaranteed performance specifications for any voltage and frequency within these ranges. ²These environmental characteristics meet or exceed the respective requirements of MIL-E-5400, Class 2.

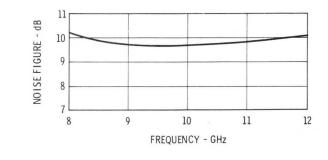


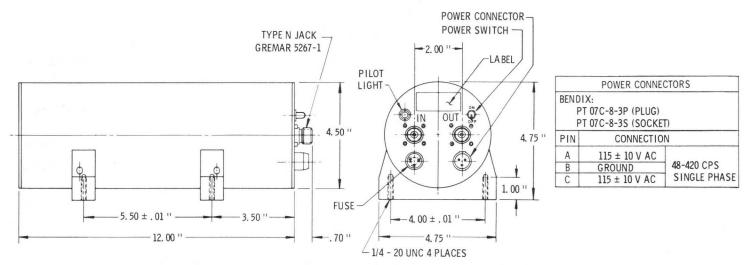
GAIN

POWER



NOISE





W J - 404

0.5 to 1.0 GHz LOW-NOISE TWT DUAL August 1967 AMPLIFIER WITH INTEGRAL POWER SUPPLY

- MATCHED GAIN: 2.0 dB max.
- NOISE FIGURE: 8.5 dB max.
- POWER OUTPUT: + 5 dBm
- PERMANENT MAGNET FOCUSING
- ADJUSTMENT FREE OPERATION
- "JUST PLUG IT IN"

The WJ-404 is the P-band member of Watkins-Johnson's newest family of low-noise dual amplifiers with PM focusing and integral power supply. A low noise figure combined with high power output and small size are standard features of this amplifier. Its outstanding feature is gain matching between channels to provide a guaranteed maximum gain difference of 2.0 dB at any frequency within the operating range, and over the tempera<image><image>

ture range of -54° C to $+55^{\circ}$ C.

The WJ-404 is well suited for airborne military systems applications. Rugged construction of the tube, magnet, and power supply ensures reliable operation under vibrational forces of 5g at frequencies up to 500 Hz. Performance is unaffected by operation in stacked arrays or adjacent to ferromagnetic materials.

PERFORMANCE (Each Channel) Frequency Noise figure, terminal Gain, small signal Gain, matching Warm-up time VSWR, input and output Power output	.0.5-1.0 GHz .7.0 dB .28 dB .1.0 dB .1.5:1	0.5-1.0 GHz 8.5 dB max. 25 dB min. 2.0 dB max. 15 minutes max. 2:1 max.
ELECTRICAL REQUIREMENTS Primary Voltage Primary Frequency Primary Power	Typical . 115 Vac . 60 Hz	Range

ENVIRONMENTAL CHARACTERISTICS

Temperature,	operating	54°C to +5	5°C
Temperature,	non-operating	62°C to +8	5°C
Vibration			
a. 0.10 in	ch, double amplit	tude 5 to 45	5 Hz

b. 5G, single amplitude 45 to 500 Hz
Shock
Altitude 50,000 feet
Humidity 95%

MECHANICAL CHARACTERISTICS

Amplifier length

(excluding connectors)10.0 inches, max.
Amplifier height
Amplifier width
Weight 14.5 pounds, max.
Primary power connection, Bendix PT-07C-8-3P RF connections
(50 ohm, nominal)

Each tube of the dual-amplifier package shall meet the performance specifications listed.

At any frequency within the band, the difference in small signal gain between the two channels shall not exceed the specified limit.

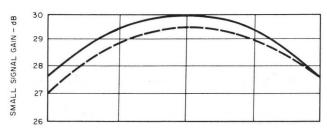
The amplifier shall meet all guaranteed parameters within the specified time.

Each tube shall meet the guaranteed performance specifications within these primary voltage and frequency ranges.

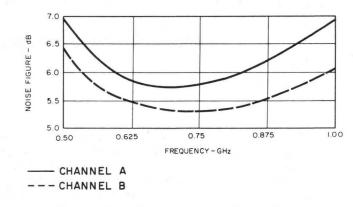
All performance specifications shall be met over the specified temperature range.

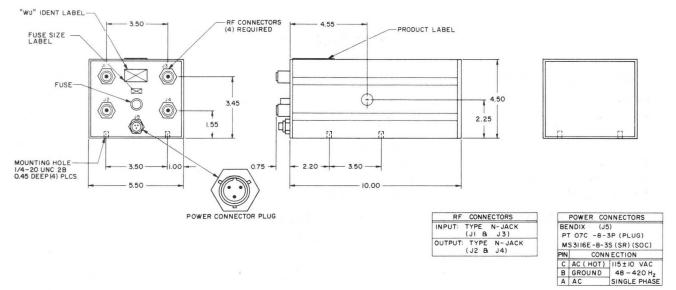






NOISE



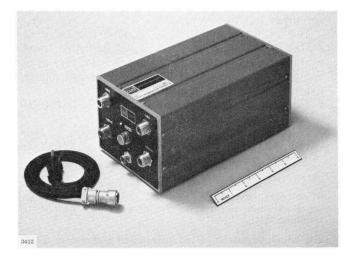


WJ-405

1 to 2 GHz LOW-NOISE TWT DUAL August 1967 AMPLIFIER WITH INTEGRAL POWER SUPPLY

- MATCHED GAIN: 2.0 dB max.
- NOISE FIGURE: 8.5 dB max.
- POWER OUTPUT: + 7 dBm min.
- PERMANENT MAGNET FOCUSING
- ADJUSTMENT FREE OPERATION
- "JUST PLUG IT IN"

The WJ-405 is the L-band member of Watkins-Johnson's newest family of low-noise dual amplifiers with PM focusing and integral power supply. Its outstanding feature is gain matching between channels to provide a guaranteed maximum gain difference of 2.0 dB at any frequency within the operating range, and over the temperature range of -54 °C to +55 °C. Standard features include a low noise figure combined with high power output



and small size.

Performance of the WJ-405 is unaffected by operation in stacked arrays or adjacent to ferromagnetic materials. Rugged construction of the tube, magnet, and power supply ensures reliable operation under vibrational forces of 5g at frequencies up to 500 Hz. The WJ-405 is well suited for airborne military systems applications.

PERFORMANCE (Each Channel)	Typical	Guaranteed
Frequency	1.0-2.0 GHz	1.0-2.0 GHz
Noise figure, terminal	7.0 dB	8.5 dB max.
Gain, small signal	30 dB	25 dB min.
Gain, matching	1.0 dB	2.0 dB max.
Warm-up time		
VSWR, input and output		
Power output	+9 dBm	+7 dBm min.
ELECTRICAL REQUIREMENTS	Typical	Range
Primary Voltage	115 Vac	
Primary Frequency	60 Hz	48 to 420 Hz
Primary Power	25 watts	

ENVIRONMENTAL CHARACTERISTICS

Temperature, operating $\dots -54^{\circ}$ C to $+55^{\circ}$ C Temperature, non-operating $\dots -62^{\circ}$ C to $+85^{\circ}$ C Vibration

b. 5G, single amplitude
Shock
Altitude 50,000 feet
Humidity 95%

MECHANICAL CHARACTERISTICS

Amplifier length

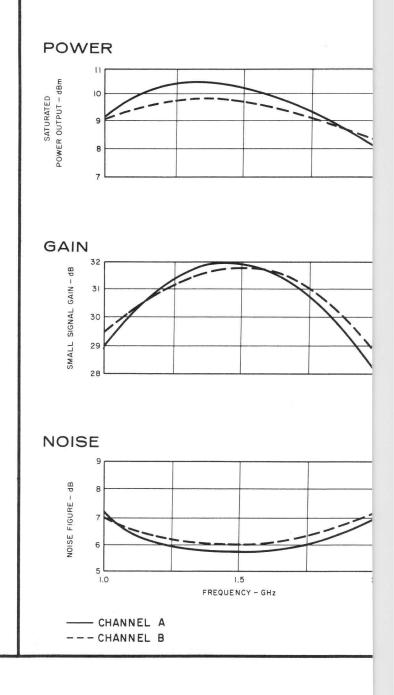
Each tube of the dual-amplifier package shall meet the performance specifications listed.

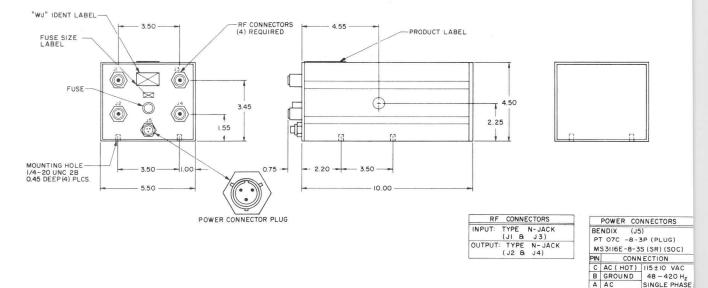
At any frequency within the band, the difference in small signal gain between the two channels shall not exceed the specified limit.

The amplifier shall meet all guaranteed parameters within the specified time.

Each tube shall meet the guaranteed performance specifications within these primary voltage and frequency ranges.

All performance specifications shall be met over the specified temperature range.







August 1967

2 to 4 GHz LOW-NOISE TWT DUAL AMPLIFIER WITH INTEGRAL POWER SUPPLY

- MATCHED GAIN: 2.0 dB max.
- NOISE FIGURE: 8.5 dB max.
- POWER OUTPUT: + 7 dBm min.
- PERMANENT MAGNET FOCUSING
- ADJUSTMENT FREE OPERATION
- "JUST PLUG IT IN"

The WJ-406 is the S-band member of Watkins-Johnson's newest family of low-noise dual amplifiers with PM focusing and integral power supply. It combines the standard features (low noise figure/high power output/small size) of all W-J lownoise amplifiers with a special feature of this family: gain matching between channels to provide a guaranteed maximum gain difference of 2.0 dB at any frequency within the operating range, and over the temperature range of -54° to $+55^{\circ}$ C.



Rugged construction of the tube, magnet, and power supply ensures reliable operation under vibrational forces of 5g at frequencies up to 500 Hz. In addition to these features, performance is unaffected by operation in stacked arrays or adjacent to ferromagnetic materials, making the WJ-406 well suited for airborne military systems applications.

PERFORMANCE (Each Channel) ¹	Typical	Guaranteed
Frequency ²	2.0-4.0 GHz	2.0-4.0 GHz
Noise figure, terminal		
Gain, small signal	30 dB	25 dB min.
Gain, matching	1.0 dB	2.0 dB max.
Warm-up time ³		15 minutes max.
VSWR, input and output		
Power output	+10 dBm	+7 dBm min.
ELECTRICAL REQUIREMENTS	Typical	Range ⁴
Primary Voltage	115 Vac	
Primary Frequency	60 Hz	48 to 420 Hz
Primary Power	25 watts	

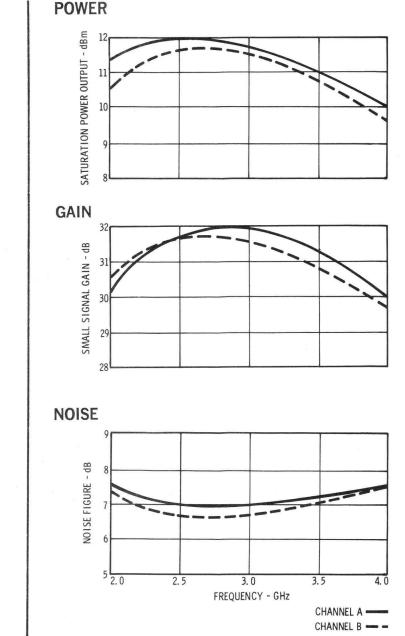
ENVIRONMENTAL CHARACTERISTICS⁵

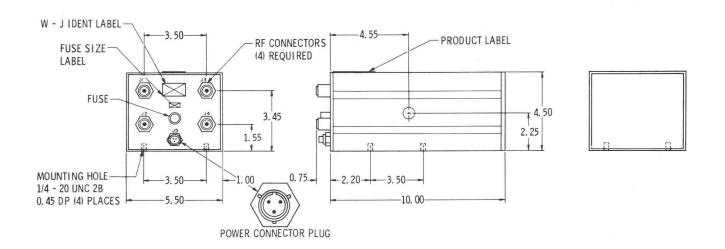
011001																			
Altitude													5	50).	0	00	feet	t
Humidity																			

MECHANICAL CHARACTERISTICS

Height 4.5 inches (114 mm) max.
Width 5.5 inches (140 mm) max.
Length (excluding connectors) 10 inches (254 mm) max.
Weight 14.5 pounds (6.58 Kg) max.
Primary power connection,
Bendix PT-07C-8-3P
RF connections
(50 ohm, nominal) Type N, Jack Watkins-Johnson Outline Drawing 290058

- 1. Each tube of the dual-amplifier package shall meet the performance specifications listed.
- 2. At any frequency within the band, the difference in small signal gain between the two channels shall not exceed the specified limit.
- 3. The amplifier shall meet all guaranteed parameters within the specified time.
- 4. Each tube shall meet the guaranteed performance specifications within these primary voltage and frequency ranges.
- All performance specifications shall be met over the specified temperature range.





WJ-407

August 1967

4 to 8 GHz LOW-NOISE TWT DUAL AMPLIFIER WITH INTEGRAL POWER SUPPLY

- MATCHED GAIN: 2.0 dB max.
- NOISE FIGURE: 9.0 dB max.
- POWER OUTPUT: + 7 dBm
- PERMANENT MAGNET FOCUSING
- ADJUSTMENT FREE OPERATION
- "JUST PLUG IT IN"

The WJ-407, C-band member of Watkins-Johnson's newest family of low-noise dual amplifiers with PM focusing and integral power supply, features gain matching between channels to provide a guaranteed maximum gain difference of 2.0 dB at any frequency within the operating range, and over the temperature range of -54° C to $+55^{\circ}$ C. Additional features, which are standard on all W-J low-noise amplifiers, include a low noise figure, high power output, and small size.

Performance of the WJ-407 is unaffected by operation in stacked arrays or adjacent to ferromagnetic materials. Reliable operation under vibrational forces of 5g at frequencies up to 500 Hz is ensured by rugged construction of tube, magnet, and power supply. These operational features make the WJ-407 particularly suitable for airborne military systems applications.

PERFORMANCE (Each Channel)	Typical	Guaranteed
Frequency	4.0-8.0 GHz	4.0-8.0 GHz
Noise figure, terminal	7.5 dB	9.0 dB max.
Gain, small signal	29 dB	25 dB min.
Gain, matching	1.0 dB	2.0 dƁ max.
Warm-up time		15 minutes max.
VSWR, input and output	1.5:1	2:1 max.
Power output	+10 dBm	+7 dBm min.
ELECTRICAL REQUIREMENTS	Typical	Range
Primary Voltage	115 Vac	
Primary Frequency	60 Hz	
Primary Power	25 watts	



ENVIRONMENTAL CHARACTERISTICS

Temperature, operating \ldots -54°C to +55°C Temperature, non-operating \ldots -62°C to +85°C Vibration

a. 0.10 inch, double amplitude 5 to 45 Hz
b. 5G, single amplitude
Shock
Altitude 50,000 feet
Humidity 95%

MECHANICAL

CHARACTERISTICS

Amplifier length

(excluding connectors)10.0 inches, max.
Amplifier height
Amplifier width
Weight 14.5 pounds, max.
Primary power connection,
Bendix PT-07C-8-3P
RF connections
(50 ohm, nominal) Type N, Jack
Watkins-Johnson Outline Drawing
0

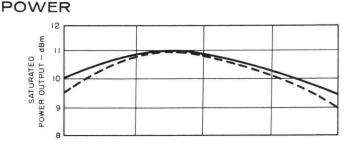
Each tube of the dual-amplifier package shall meet the performance specifications listed.

At any frequency within the band, the difference in small signal gain between the two channels shall not exceed the specified limit.

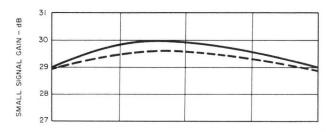
The amplifier shall meet all guaranteed parameters within the specified time.

Each tube shall meet the guaranteed performance specifications within these primary voltage and frequency ranges.

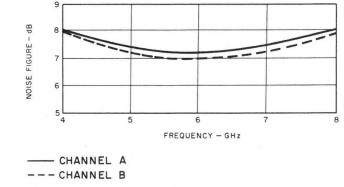
All performance specifications shall be met over the specified temperature range.

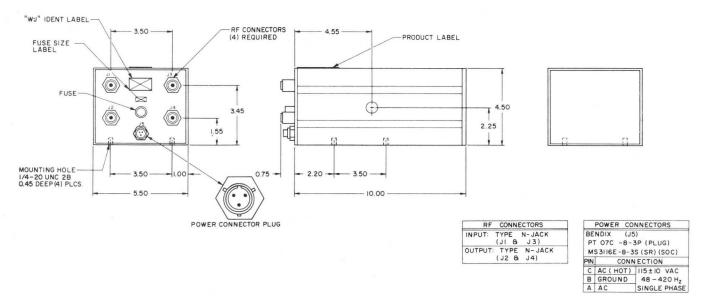


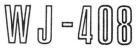












8 to 12 GHz LOW-NOISE TWT DUAL August 1967 AMPLIFIER WITH INTEGRAL POWER SUPPLY

• MATCHED GAIN: 2.0 dB max.

- NOISE FIGURE: 9.5 dB max.
- POWER OUTPUT: + 7 dBm min.
- PERMANENT MAGNET FOCUSING
- ADJUSTMENT FREE OPERATION
- "JUST PLUG IT IN"

The X-band member of Watkins-Johnson's newest family of low-noise dual amplifiers with PM focusing and integral power supply is designated WJ-408. Its outstanding feature is gain matching between channels to provide a guaranteed maximum difference of 2.0 dB at any frequency within the operating range and over the temperature range of -54° C to $+55^{\circ}$ C. Standard features include a low noise figure combined with high power



output and small size.

The WJ-408 is well suited for airborne military systems applications. Rugged consruction of the tube, magnet, and power supply ensures reliable operation under vibrational forces of 5g at frequencies up to 500 Hz. Performance is unaffected by operation in stacked arrays or adjacent to ferromagnetic materials.

SPECIFICATIONS

PERFORMANCE (Each Channel)

Frequency
Noise figure, terminal
Gain, small signal
Gain, matching
Warm-up time
VSWR, input and ouput
Power output

ELECTRICAL REQUIREMENTS

Primary	Voltage							•			•		•	i.					•	•		ŝ	
Primary	Frequenc	;y	•		•	•	•	•	•	•	•	•	•	•	•	•	•	•		•	•	•	
Primary	Power .			•	×	•	•	•	•	•	•	•	•		•	•	•	•	•	•	•	•	

Typical	Guaranteed
8.0-12.0 GHz	. 8.0-12.0 GHz
8.5 dB	9.5 dB max.
30 dB	25 dB min.
1.0 dB	2.0 dB max.
	5 minutes max.
1.5:1	2:1 max.
+10 dBm	. +7 dBm min.
Typical	Range

.)p.o														mango
115 Vac .	•													115 ± 10 Vac
60 Hz							•	÷			3	0.8	8.6	48 to 420 Hz
25 watts														

ENVIRONMENTAL CHARACTERISTICS

Temperature, operating —54°C to +55°C
Temperature, non-operating—62°C to +85°C
Vibration
a10 inch, double amplitude 5 to 45 Hz

b. 5G, single amplitude45 to 500 H	Z
Shock	IS
Altitude 50,000 fee	et
Humidity	

MECHANICAL CHARACTERISTICS

Amplifier length

(excluding connectors)10.0 inches, max.
Amplifier height
Amplifier width
Weight 14.5 pounds, max.
Primary power connection,
Bendix PT-07C-8-3P
RF connections
50 ohm, nominal) Type N, jack Watkins-Johnson Outline Drawing 290058

Each tube of the dual-amplifier package shall meet the performance specifications listed.

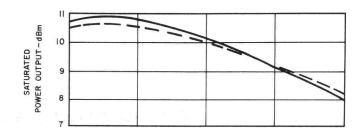
At any frequency within the band, the difference in small signal gain between the two channels shall not exceed the specified limit.

The amplifier shall meet all guaranteed parameters within the specified time.

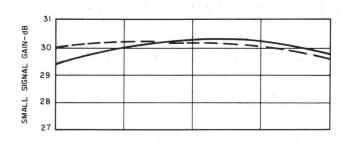
Each tube shall meet the guaranteed performance specifications within these primary voltage and frequency ranges.

All performance specifications shall be met over the specified temperature range.

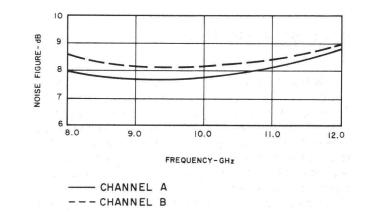
POWER

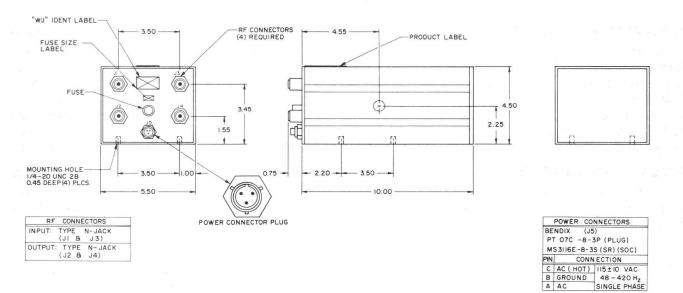


GAIN



NOISE





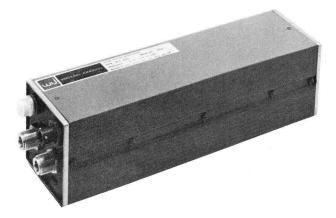
WJ-422

APRIL 1970 *

2 to 4 GHz LOW-NOISE TWT AMPLIFIER WITH INTEGRAL POWER SUPPLY

- "JUST PLUG IT IN"
- GUARANTEED +10 dBm POWER OUTPUT
- GUARANTEED 7.5 dB NOISE
 FIGURE ACROSS FULL S-BAND
- SMALL SIZE: 3x3x10.5 INCHES
- MEETS MIL-E-5400
 CLASS II ENVIRONMENT

The WJ-422 is one of a family of single-reversal permanent-magnet TWT amplifiers developed by Watkins-Johnson Company to meet the increasing demand for reliable microwave devices. No other S-band low-noise TWT amplifier on the market today can match the power output/noise figure/ size combination offered by this amplifier. It is completely self-contained, and adjustment-free, operating with only an ac line voltage input.



The WJ-422 may be mounted in any orientation without degradation of performance. Rugged construction of the tube, magnet, and power supply ensures reliable operation under vibrational forces of 10g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of -54° to $+71^{\circ}$ C. These environmental characteristics of the WJ-422 meet the corresponding requirements of MIL-E-5400, Class 2.

SPECIFICATIONS

PERFORMANCE	Typical	Guaranteed
Frequency	2.0 to 4.0 GHz	2.0 to 4.0 GHz
Noise figure, terminal	.7.0 dB	7.5 dB max.
Gain, Small Signal	. 32 dB	25 dB min.
VSWR, input and output	.1.5:1	2:1 max.
Power output	.+12 dBm	+10 dBm min.
ELECTRICAL REQUIREMENTS	Typical	Range
Primary voltage	.115 Vac	115 ±10 Vac
Primary Current	. 120 mA	
Primary frequency	.60 Hz	48 to 420 Hz
Primary power	.10 watts	

*Supersedes WJ-422 Technical Data Sheet dated February 1968.

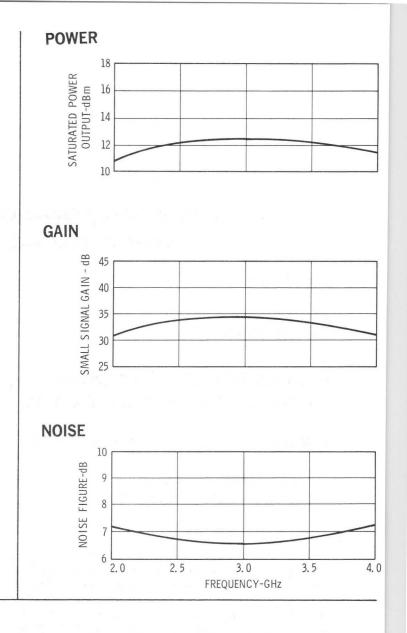
ENVIRONMENTAL CHARACTERISTICS²

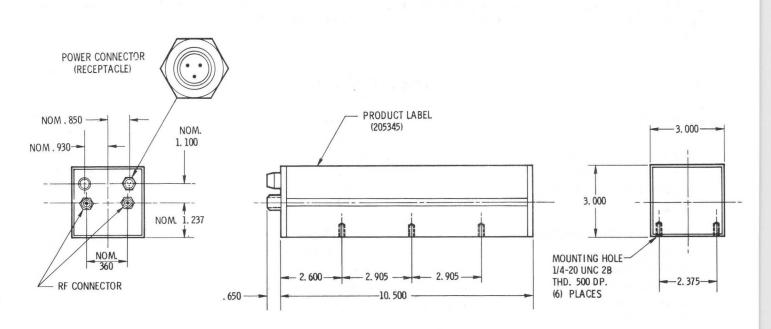
Temperature
Vibration
a10 inch, double amplitude 5 to 45 Hz
b. 10 g, single amplitude 45 to 500 Hz
Shock 15 G, 11 ms

MECHANICAL CHARACTERISTICS

Height Max. 3inches (76 mm) max.
Width 3 inches (76 mm) max.
Length (excluding
connectors 10.5 inches (267mm) max.
Weight 6.5 pounds (2.95 Kg) max.
Primary power connection,
Bendix receptacle PT07C-8-3p
RF connections
(50 ohms, nominal) Type N, jack

- 1. Every tube will meet the guaranteed performance specifications for any primary voltage and frequency within these ranges.
- 2. These environmental characteristics meet the respective requirements of MIL-E-5400, Class 2 Specification.





WJ-423

APRIL 1970 *

4 to 8 GHz LOW-NOISE TWT AMPLIFIER WITH INTEGRAL POWER SUPPLY

- "JUST PLUG IT IN"
- GUARANTEED 7.5 dB NOISE
 FIGURE ACROSS FULL C-BAND
- GUARANTEED +10 dBm POWER OUTPUT
- SMALL SIZE: 3x3x10.5 INCHES
- MEETS MIL-E-5400 CLASS II ENVIRONMENT

The WJ-423 is one of a family of single-reversal permanent-magnet TWT amplifiers developed by Watkins-Johnson Company to meet the increasing demand for reliable microwave devices. Featuring a wide dynamic range in a rugged and compact configuration, this tube produces 20 mW output power with 6.5 dB noise figure over half of the Cband frequency range. In addition, it is completely self-contained and adjustment-free, operating with only an ac line voltage input. and a second sec

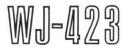
The WJ-423 may be mounted in any orientation without degradation of performance. Rugged construction of the tube, magnet, and power supply ensures reliable operation under vibrational forces of 10g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of -54° to $+71^{\circ}$ C. These environmental characteristics of the WJ-423 meet the corresponding requirements of MIL-E-5400, Class 2.

SPECIFICATIONS

PERFORMANCE	Typical	Guaranteed
Frequency Noise figure, terminal Gain, Small Signal VSWR, input and output Power output		
ELECTRICAL REQUIREMENTS	Typical	Range
Primary voltage		115 ±10 Vac

Primary	voltage		 				• •						110 Vac
Primary	frequen	су	 										60 Hz
Primary	power		 										10 watts
Primary	current												120 mA

*Supersedes WJ-423 Technical Data Sheet dated January 1968.



ENVIRONMENTAL CHARACTERISTICS²

MECHANICAL CHARACTERISTICS

Height 3inches (76 mm) max.
Width 3 inches (76 mm) max.
Length (excluding
connectors 10.5 inches (267mm) max.
Weight 6.5 pounds (2.95 Kg) max.
Primary power connection,
Bendix receptacle PT07C-8-3p
RF connections
(50 ohms, nominal) Type N, jack

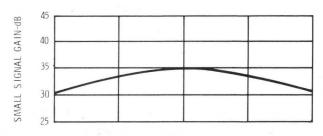
Every tube will meet the guaranteed performance specifications for any primary voltage and frequency lying within these ranges.

These environmental characteristics meet the respective requirements for MIL-E-5400, Class 2.

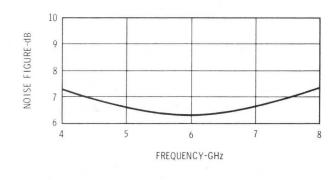
POWER



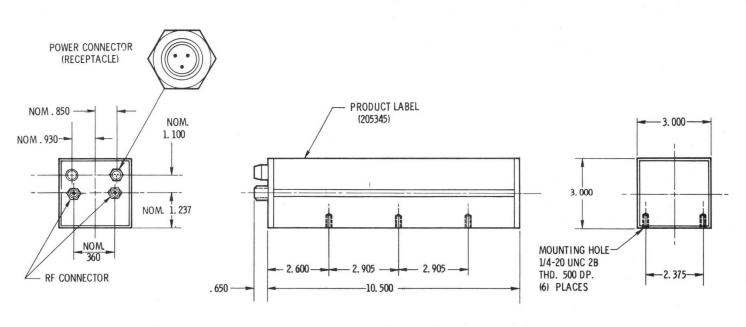
GAIN



NOISE



OUTLINE DRAWING



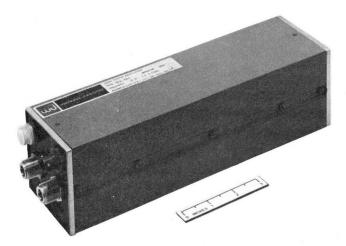
WATKINS = JOHNSON COMPANY 3333 HILLVIEW AVENUE = STANFORD INDUSTRIAL PARK PALO ALTO, CALIFORNIA 94304 TWX 910-373-1253 PHONE (415) 326-8830 Telex: 348-415

APRIL 1970 *

8 TO 12 GHz LOW-NOISE TWT AMPLIFIER WITH INTEGRAL POWER SUPPLY WJ-424

- "JUST PLUG IT IN"
- GUARANTEED 7.5 dB NOISE
 FIGURE ACROSS FULL X-BAND
- GUARANTEED +10 dBm POWER OUTPUT
- SMALL SIZE: 3x3x10.5 INCHES
- MEETS MIL-E-5400 CLASS II ENVIRONMENT

The WJ-424 is the first of a family of singlereversal permanent-magnet TWT amplifiers developed by Watkins-Johnson Company to meet the increasing demand for reliable microwave devices. No other X-band low-noise TWT amplifier on the market today can match the power output/noise figure/size combination offered by this amplifier. It is completely self-contained, and adjustmentfree, operating with only an ac line voltage input.



The WJ-424 may be mounted in any orientation without degradation of performance. Rugged construction of the tube, magnet, and power supply ensures reliable operation under vibrational forces of 10g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of -54° to $+71^{\circ}$ C. These environmental characteristics of the WJ-424 meet the corresponding requirements of MIL-E-5400, Class 2.

SPECIFICATIONS

PERFORMANCE	Typical	Guaranteed
Frequency		
Noise figure, terminal	.7.0 dB	7.5 dB max.
Gain, Small Signal	.32 dB	25 dB min.
VSWR, input and output	.1.5:1	2:1 max.
Power output		
ELECTRICAL REQUIREMENTS	Typical	Range ¹
Primary voltage	.115 Vac	115 ±10 Vac
Primary frequency	.60 Hz	48 to 420 Hz
Primary current		
Primary power	10 watts	

*Supersedes WJ-424 Technical Data Sheet dated January 1969.

ENVIRONMENTAL CHARACTERISTICS²

Temperature
Vibration a10 inch, double amplitude 5 to 45 Hz
b. 10 g, single amplitude 45 to 500 Hz
Shock 15 G, 11 ms

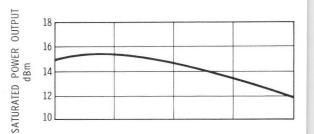
MECHANICAL CHARACTERISTICS

Height 3inches (76 mm) max. Width 3 inches (76 mm) max.
Length (excluding connectors 10.5 inches (267mm) max. Weight 6.5 pounds (2.95 Kg) max.
Primary power connection, Bendix receptacle PT07C-8-3p
RF connections (50 ohms, nominal) Type N, jack

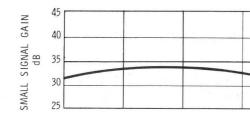
¹Every tube will meet the guaranteed performance specifications for any primary voltage and frequency within these ranges.

²These environmental characteristics meet the respective requirements of MIL-E-5400, Class 2.

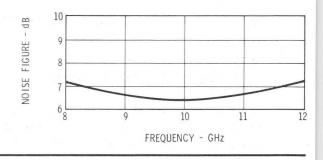


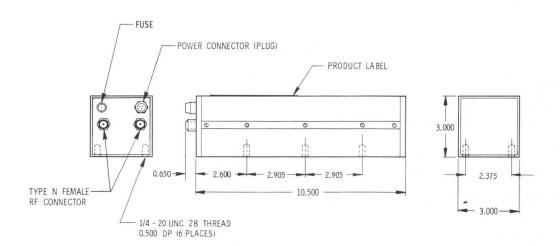


GAIN



NOISE





JANUARY 1970

12 TO 18 GHz LOW-NOISE TWT AMPLIFIER WITH INTEGRAL POWER SUPPLY WJ-425

- "JUST PLUG IT IN"
- GUARANTEED 10 dB NOISE FIGURE ACROSS FULL Ku-BAND
- GUARANTEED +10 dBm POWER OUTPUT
- SMALL SIZE: 3 x 3 x 10.5 INCHES
- MEETS MIL-E-5400
 CLASS II ENVIRONMENT

The WJ-425 is one of a family of single-reversal permanent-magnet TWT amplifiers developed by Watkins-Johnson to meet the increasing demand for reliable microwave devices. No other Ku-band low-noise TWT amplifier on the market today can match the power output/noise figure/size combination offered by this amplifier. It is completely self-contained, and adjustment-free, operating with only an ac line voltage input.

The WJ-425 may be mounted in any orientation with-



out degradation of performance. Rugged construction of the tube, magnet, and power supply ensures reliable operation under vibrational forces of 10g, at frequencies up to 500 Hz.Full specifications are met over the operating temperature range of -54° to $+71^{\circ}$ C. These environmental characteristics of the WJ-425 meet the corresponding requirements of MIL-E-5400, Class 2.

SPECIFICATIONS

PERFORMANCE Frequency		Guaranteed 12.0 to 18.0 GHz
Noise figure, terminal ¹		
Gain, Small Signal		
VSWR, input and output	1.5:1	2:1 max.
Power output	13 dBm	10 dBm min.
ELECTRICAL REQUIREMENTS	Typical	Range ²
Primary voltage		115 ±10 Vac
Primary frequency	60 Hz	
Primary current		
Primary power	17 watts	

ENVIRONMENTAL³ CHARACTERISTICS

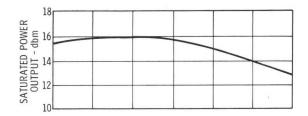
Temperature
Vibration
a. 0.10 inch, double amplitude 5 to 45 Hz
b. 10 g, single amplitude 45 to 500 Hz
Shock

MECHANICAL CHARACTERISTICS

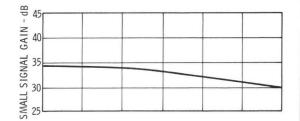
Height	۲.
Width 3 inches (76 mm) max	κ.
Length (excluding	
connectors) 10.5 inches (267 mm) max	
Weight7 pounds (3.18 kg) max	ζ.
Primary power connection, Bendix receptaclePT07C-8-3	р
RF connections (50 ohms, nominal) Type OSM, Jac	k

- 1. Noise figure is as read on an HP Noise Figure Meter model 340 B, using HP Noise Sources model H 347 A and model X 347 A.
- 2. Every tube will meet the guaranteed performance specifications for any primary voltage and frequency lying within these ranges.
- **3.** These environmental characteristics meet or exceed the respective requirements of MIL-E-5400K (dated 24 May 1968), Class 2.

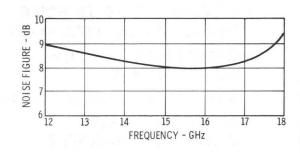
POWER

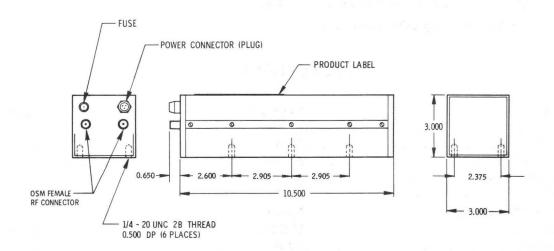


GAIN



NOISE





DECEMBER 1970 *

8 TO 18 GHz LOW-NOISE TRAVELING-WAVE AMPLIFIER WITH INTEGRAL POWER SUPPLY WJ-437

- "JUST PLUG IT IN"
- NOISE FIGURE
 9.5 dB MAXIMUM
- PERMANENT-MAGNET FOCUSING
- NO ADJUSTMENTS
 NEEDED
- MEETS MIL-E-5400, CLASS 2 ENVIRONMENT

WJ-437, a compact ultra-wide band amplifier, is the latest addition to the Watkins-Johnson family of PM focused integral power supply traveling wave amplifiers.

Covering all of X-Band and Ku-Band, this amplifier typically exhibits a noise figure below 8.0 dB, a saturated power output above +5 dBm, and a small signal gain better than 30 dB across the band. Clearly, this kind of performance represents a significant advance in the state of the art in low noise broadband amplifiers. This performance cannot even be challenged by any of the narrower band counterparts in Ku-Band. (Some WJ-437's have exhibited noise figures below 8.5 dB across the 8-18 GHz band.)



The amplifier is completely self-contained, adjustment free, and requires only a 115 volt ac line voltage input (48 to 420 Hz). The completely shielded package may be operated in any orientation, in stacked arrays or adjacent to ferromagnetic material, without adversely affecting the amplifier's performance.

With assurance of reliable operation under MIL-E-5400 (Temperature, Class 2; Vibration, Curve III), this new broadband low noise amplifier opens up an entirely new area for unique applications as well as considerably enhancing prospects for existing ones.

SPECIFICATIONS

	Typical	Guaranteed
Frequency	.8.0 to 18.0 GHz	8.0 to 18.0 GHz
Noise Figure, Terminal	.8.0 dB	9.5 dB, max.
Gain, Small Signal	.30 dB	25 dB, min.
VSWR, Input and Output	.1.5:1	2.5:1, max.
Power Output, Saturated	.+5 dBm	. +3 dBm, min.

ELECTRICAL REQUIREMENTS	Typical	Range ¹
Primary Voltage		\ldots 115 ±10 V ac
Primary Frequency		
Primary Power	5 W	
	1000	

*Supersedes WJ-437 Technical Data Sheet dated February 1969

ENVIRONMENTAL CHARACTERISTICS²

Temperature (Operating)54°C to +71°C
Vibration
0.10 Inch Double Amplitude 5 to 30 Hz
5 g, Single Amplitude 30 to 500 Hz
Shock 15 g, 11 ms

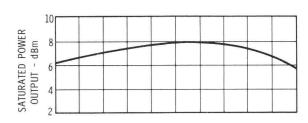
MECHANICAL CHARACTERISTICS

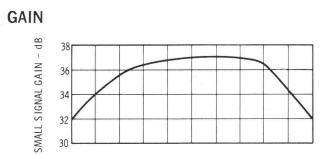
Height 4.75 inches (121 mm) max.
Width 4.75 inches (121 mm) max.
Length (excluding
connectors) 12 inches (305 mm) max.
Weight
Primary Power Connection,
Bendix PTO 7C-8-3P
RF Connections OSM

¹Every amplifier will meet the guaranteed performance specifications for any primary voltage and frequency lying within these ranges.

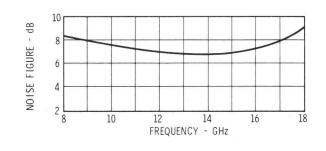
²These environmental characteristics meet or exceed the respective requirements of MIL-E-5400: Temperature, Class 2; Vibration, Curve III.

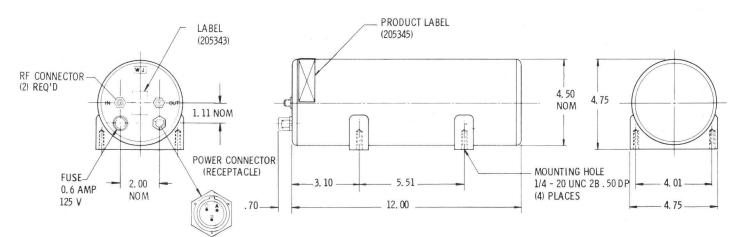






NOISE





POWER CONNECTORS		
BEND	IX	
P	T 07C-8-3P	(PLUG)
٨	AS 3116 E-8-	3S (SR) (SOC)
PIN CONNECTION		
C	AC (HOT)	105 - 125 V ac
B	GROUND	48 - 420 Hz
A	AC	SINGLE PHASE

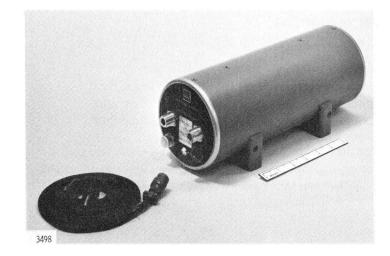
WJ-442

October 1968

1.0 to 4.0 GHz LOW-NOISE, TRAVELING-WAVE TUBE AMPLIFIER WITH INTEGRAL POWER SUPPLY

- "JUST PLUG IT IN"
- NOISE FIGURE 7.0 dB
- L-S BANDS RANGE
- ADJUSTMENT-FREE OPERATION
- PERMANENT MAGNET FOCUSING
- MEETS MIL-E-5400, CLASS 2 SPECIFICATION

The WJ-442 is one of a series of ultra-wide band LNTWAs developed by Watkins-Johnson Company for use in sensitive, ultra-wide-bandwidth receiver equipments. It offers economy of space, weight and price over two single-octave amplifiers covering the same frequency range. It features the same long-life design, rugged construction and adjustment-free operation characteristics of Wat-



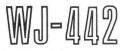
kins-Johnson's line of octave-band, low-noise amplifiers.

The WJ-442 may be mounted in any orientation and is built to withstand the shock, vibration, and temperature specifications of MIL-E-5400, Class 2. Magnetic shielding allows operation next to similar units, or to ferromagnetic material, without degradation of performance.

SPECIFICATIONS

PERFORMANCE	Typical	Guaranteed
Frequency	.6.0 dB	7.0 dB max.
VSWR, input and output Power output	.1.5:1	
ELECTRICAL REQUIREMENTS Primary voltage Primary frequency Primary power	.60 Hz	

¹Every amplifier will meet the guaranteed performance specifications within these ranges.



ENVIRONMENTAL CHARACTERISTICS²

Temperature (Operating) $\dots -54$ °C to +71 °C Vibration

0.10 Inch, Double Amplitude 5 to 45 Hz 10 g, Single Amplitude 45 to 500 Hz Shock 15 g, 11 ms

MECHANICAL CHARACTERISTICS

Amplifier Length

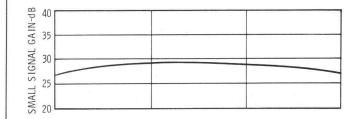
(excluding connectors) 12 inches, max.
Amplifier Cross Section 4.75 inches, max.
Amplifier Weight 18 pounds, max.
Primary Power Connection Bendix receptacle PT-07C-8-3P
RF Connections (50 ohms, nominal)

²These environmental characteristics meet or exceed the respective requirements of MIL-E-5400, Class 2.

SATURATED POWER OUTPUT -dBm

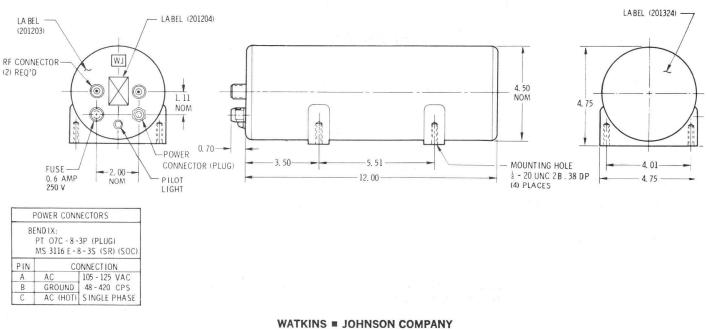
GAIN

POWER



NOISE

8P-3H00 5 0 1.0 2.0 FREQUENCY-GHz 4.0



WJ-445-1

May 1968

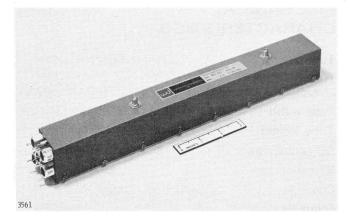
2.0 TO 2.2 GHz, 1 WATT TRAVELING-WAVE TUBE

- OUTPUT POWER
 1 WATT MINIMUM
- PPM FOCUSING
- EXTREMELY LOW DIFFERENTIAL TIME DELAY
- EXTREMELY LOW FINE-STRUCTURE GAIN VARIATION
- VERY LOW PHASE NOISE

The WJ-445-1 medium power traveling-wave tube provides nearly distortionless power amplification of microwave signals in the frequency range of 2.0 to 2.2 GHz. The differential time delay and gain variations are extremely small when operated either at saturation or in the small signal region. In addition the AM/PM conversion coefficient can be reduced to a neglible value by operating down from saturation. As an example, AM/PM is typically less than 0.15°/dB at 17 dBm output, or less than 0.03°/dB at 10 dBm output.

The tube has been designed so as to introduce negligible spurious phase noise into the amplifying system. Positive ion drainage is provided effectively by operating the anode above and the collector below helix potential. This reduces both the AM and PM ion noise to an undetectable level.

The heater is isolated electrically from the cathode;



with dc power to the filament the only phase noise introduced, even very close to the RF carrier is due to the inherent noise character of the tube and is related to its noise figure. This small residual PM is "white" in character, that is it is essentially independent of frequency.

The PPM focusing system uses Alnico-8 magnets which make it insensitive to temperature variations over its operating range. Cooling of the tube is by conduction through the baseplate of the capsule.

Operating efficiency of the WJ-445-1 is improved by depressing the collector voltage below the helix voltage.

In addition the WJ-445-1 may also be supplied with a very compact integral power supply, resulting in a fully integrated TWT amplifier.

PERFORMANCE CHARACTERISTICS Frequency range Saturation power output Saturation gain Small signal gain Gross small signal gain variation Fine structure small signal gain variation Differential time delay AM-PM conversion (at 1 watt) Noise figure	2 watts 31 dB 36 dB 0.2 dB Less than .05 dB ±0.1 ns 3.0°/dB	1 watt, min. 30 dB, min. 35 dB, min. 0.5 dB, max. 0.5 dB, max. ±0.2 ns, max. 4.0°/dB, max.
ELECTRICAL REQUIREMENTS Heater voltage Heater current Anode voltage ¹	0.8 A	A max.

SPECIFICATIONS

WJ-445-1

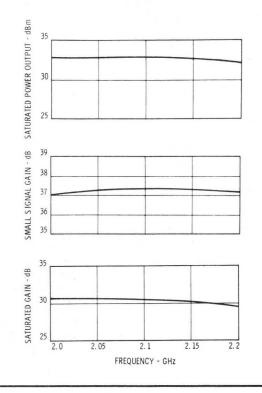
SPECIFICATIONS (Cont'd)	Typical	Range
Anode current	Less than 0.1 mA	1 mA, max.
Helix voltage ¹	+950 volts	850 to 1050 volts
Helix current	1.0 mA	3 mA max.
Collector voltage ¹	+700 volts	650 to 750 volts
Collector current		25 mA max.
NOTES: ¹ These voltages are referenced to the cathode. Collect	ctor is operated at ground potential.	

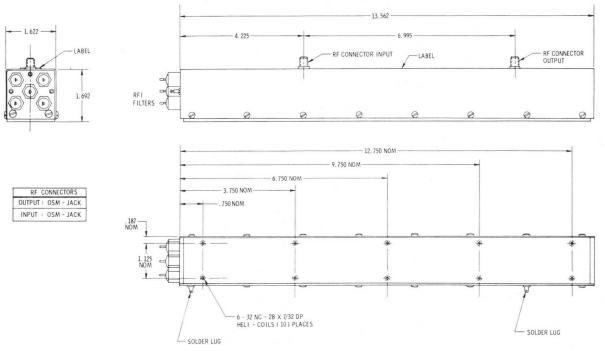
MECHANICAL CHARACTERISTICS

ENVIRONMENTAL CHARACTERISTICS

Temperature	0°C to 65°C (baseplate)
Vibration (120-2000 cycl	es) 4 G rms
Shock	20 G for 5 ms
Altitude	0 to 12,000 ft.

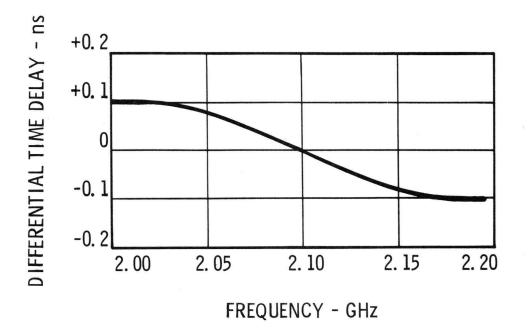
RF ELECTRICAL PERFORMANCE CHARACTERISTICS



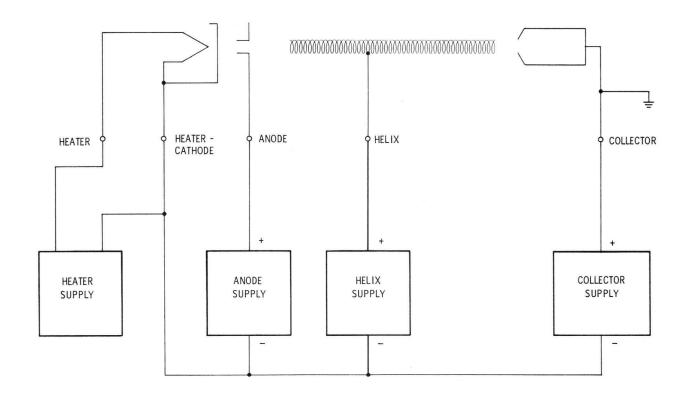


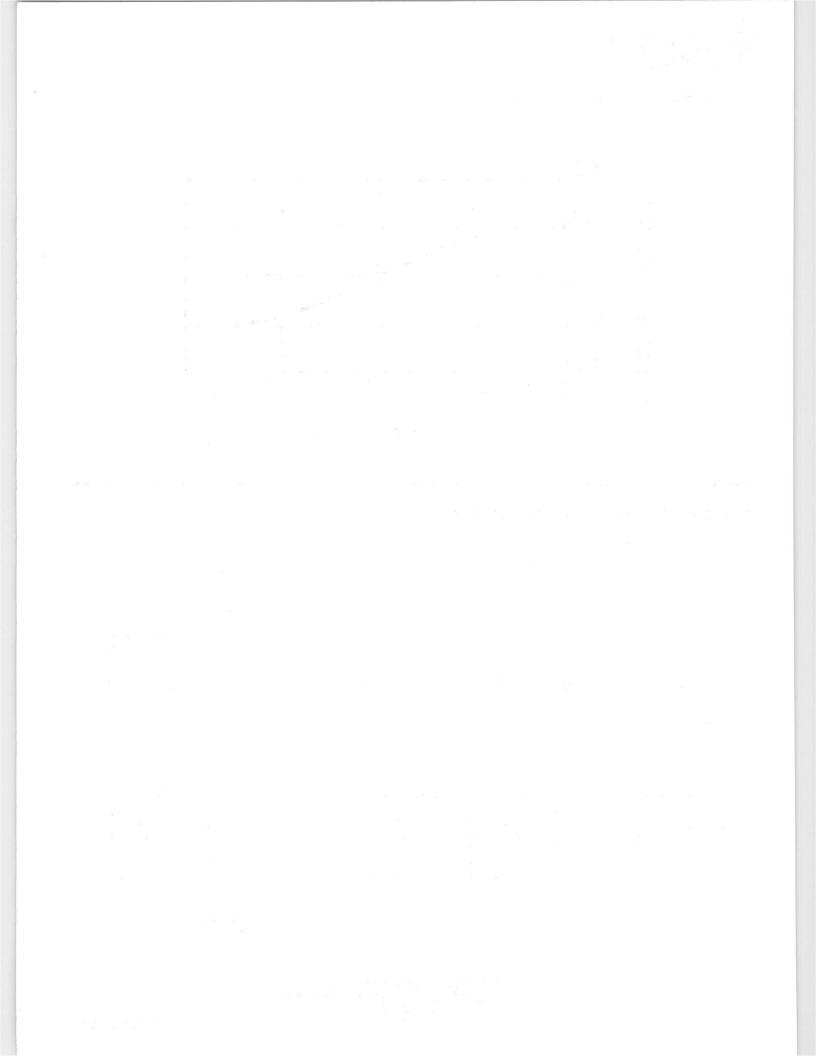
WJ-445-1

DIFFERENTIAL TIME DELAY



TYPICAL POWER SUPPLY CONNECTIONS





WJ-446

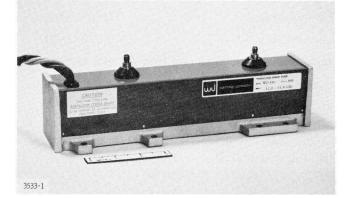
April 1968

11.5 TO 14.0 GHz 5 WATT CW TRAVELING WAVE TUBE

- OUTPUT POWER
 5 WATTS MINIMUM
- PPM FOCUSING
- LOW PHASE AND GAIN VARIATION

The WJ-446 is one of a family of medium-power traveling-wave tubes designed by Watkins-Johnson Company for microwave amplification with a minimum of distortion.

The use of periodic-permanent-magnet focusing and metal-ceramic construction results in long life with trouble free operation. Ion drainage is provided to minimize the effects of aging during the life of the tube. The PPM-focusing system is temperature-compensated to make it insensitive to



temperature variations over the operating range. The tube itself is cooled by conduction through the baseplate of the capsule.

The WJ-446 incorporates several special features. Operating efficiency, for instance, can be improved by depressing the collector voltage below the helix voltage. In addition, the tube may be supplied with an integral power supply, resulting in a fully integrated TWT amplifier.

SPECIFICATIONS

PERFORMANCE CHARACTERISTICS	Typical	Guaranteed
Frequency Range	. 11.5 to 14.0 GHz 11	5 to 14.0 GHz
Saturation Power Output	. 6 watts	. 5 watts, min.
Saturation Gain	.34 dB	32 dB, min.
Small Signal Gain	. 41 dB	39 dB, min.
Small Signal Gain Variation	. ±0.5 dB	. ±1 dB, max.

ELECTRICAL REQUIREMENTS	Typical	Range
Heater Voltage	. 6.3 volts	6.0 to 6.6 volts
Heater Current	.0.8 A	1.0 A max.
Anode Voltage ¹	.3000 volts	2800 to 3500 volts
Anode Current	.0.1 mA	1.0 mA max.
Helix Voltage ¹	.4000 volts	3800 to 4200 volts
Helix Current	.0.5 mA	3 mA max.
Collector Voltage ¹	.2200 volts	2000 to 4000 volts
Collector Current	.35 mA	40 mA max.

Notes: ¹All voltages are referenced to the cathode. Helix is operated at ground potential.

MECHANICAL CHARACTERISTICS

Tube Length 10.5 inches, max.
Tube Height, excluding connectors, 2.5 inch, max.
Tube Width 2.5 inch, max.
Tube Weight 4.0 lbs. max.
DC Connectors Flying Leads
RF Connectors OSM (female)
Cooling Conduction from bottom surface
Focusing PPM

Can be qualified to meet requirements of MIL-E-5400.

TYPICAL POWER SUPPLY CONNECTIONS

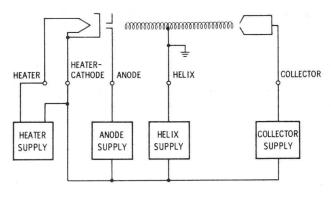
OUTLINE

DRAWING

FLYING LEADS

204547

CAUTION LABEL



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+0/

ntin

ntin

5. 430

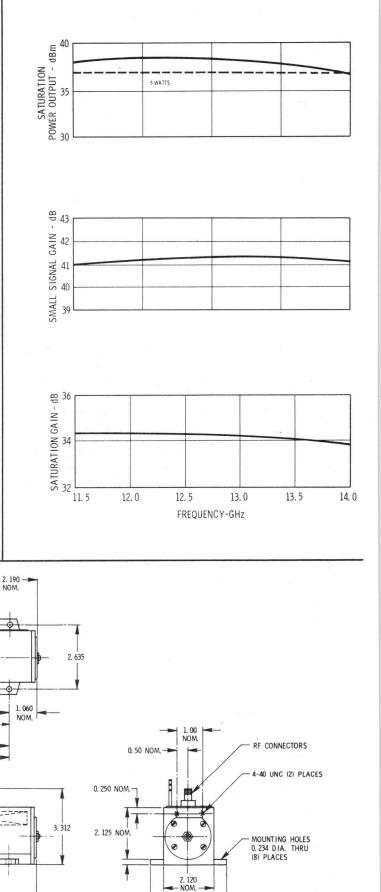
- 5. 885

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10.825

PRODUCT LABEL 205344

RF ELECTRICAL PERFORMANCE CHARACTERISTICS



- 3. 188

WATKINS = JOHNSON COMPANY 3333 HILLVIEW AVENUE = STANFORD INDUSTRIAL PARK PALO ALTO, CALIFORNIA 94304 TWX 910-373-1253 PHONE (415) 326-8830 Telex: 348-415

- 1. 635 -

WJ-448-1

June 1968

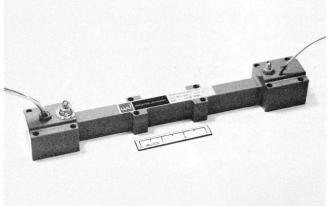
2.2 TO 2.3 GHz COMPACT, HIGH-EFFICIENCY, 50 WATT TRAVELING-WAVE TUBE FOR SPACE COMMUNICATIONS AND TELEMETRY

WJ-448-1 is a traveling-wave tube designed to meet the power amplifier requirements of earth-orbit and deep-space missions where high reliability, small size, light weight and maximum overall efficiency are essential.

This small, periodic-permanent-magnet focused TWT exhibits an overall efficiency, including heater power, above 40%. The metal-ceramic construction of the WJ-448-1 is just one of the design features used to assure the maximum in reliable, long-life operation. It has the ability to perform during and after extreme temperature, vibration, shock, and static acceleration.

The WJ-448-1 will deliver 50 watts of output power over the frequency range of 2.2 to 2.3 GHz. By operating the tube under different sets of voltage conditions, saturated output levels from 40 to 60 watts can be provided while maintaining a fixed value of rf drive without significantly affecting efficiency. Therefore, it is necessary to change only the helix, anode, and collector voltages to obtain near optimum performance for any desired power level.

The power output, gain, and efficiency are very nearly constant over the specified frequency range, as shown in Fig. 1. The power transfer curves of



3557-1

Fig. 3 and Fig. 4 show that the output power at saturation is relatively unchanged with a substantial change in drive power.

A number of variations of the WJ-448-1 are available which optimize performance at various other frequencies and power levels. The tube can be made to meet environmental conditions more stringent than those described in the Specifications. Versions of this tube can be manufactured and qualified to different levels of life and reliability for space applications.

SPECIFICATIONS

PERFORMANCE CHARACTERISTICS	Typical	Guaranteed
Frequency range	2.2 to 2.3 GHz	2.2 to 2.3 GHz
Saturation power output		
Saturation gain		27 dB min.
Overall efficiency, including heater ¹	43 percent	40 percent, min.
		_
ELECTRICAL CHARACTERISTICS	Typical	Range
Heater voltage	3.8 volts	3.5 to 4.5 volts
Heater current	0.73 amps	0.9 amps max.
Anode voltage ²	2500 volts	2300 to 2700 volts
Anode current		
Helix voltage ²	2280 volts	2150 to 2350 volts
Helix current		10 mA max.
Collector voltage ²		
Collector current		

NOTES:

¹Overall efficiency is defined as the RF output power divided by the total dc power input, including heater power. ²These voltages are referenced to the cathode. Helix is operated at ground potential.

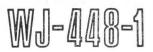


Fig. 1. WJ-448-1 Broadband Performance Characteristic.

MECHANICAL CHARACTERISTICS

Tube length 12.7 inches max.
Tube height, excluding
connectors 1.7 inches max.
Tube width 1.9 inches max.
Tube weight
DC connectors Flying leads
RF connectors OSM (Female)
Cooling Conduction from bottom surface
Focusing PPM

ENVIRONMENTAL CHARACTERISTICS

Heat Sink Temperature	 -20°C to	+85°C
Vibration		
a Cinuanidal		

a.	Sinusoidal	
	(2 min/octave).	. 0.5 inch, double amplitude,
		5 to 18 cycles, ± 20 g peak,
		18 to 2000 cycles
h	Pandom	

p. Random
(5 min/axis). 0.1 g ² /cycles, 20 to 2000 cycles
Acceleration (1 min/axis) 100 g
Shock 75 g, 11 ms

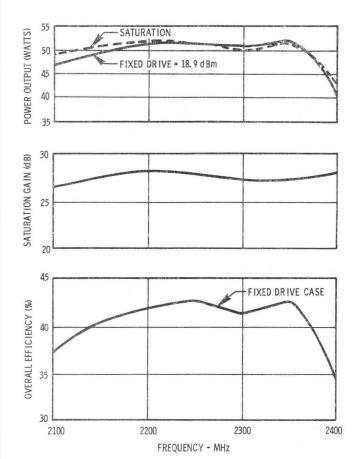
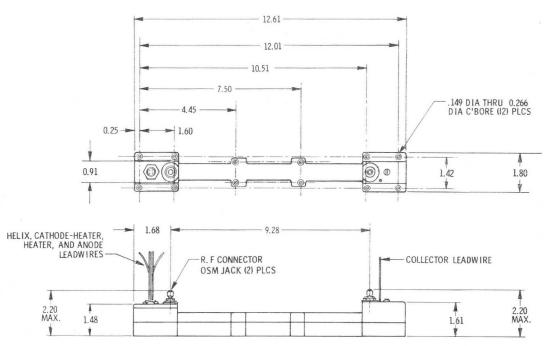
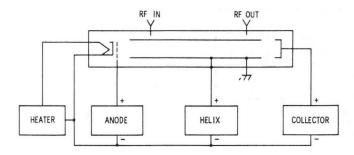


Fig. 2. Outline Drawing.





Heater 3.5-4.5 volts ac at 0.9 ampere maximum Anode 2300-2700 volts at 1 mA maximum Helix 2150-2350 at 10 mA maximum Collector 1400-1650 volts at 75 mA maximum

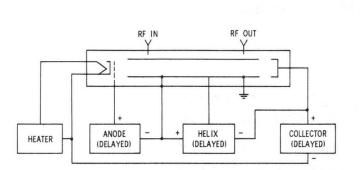
NOTE:

To ensure that the TWT is operated properly, it is

suggested that voltages be applied as follows:

- 1. Slowly apply filament voltage until specified value is reached, observing that filament current does not exceed maximum value. Allow at least 2 minutes for filament voltage to stabilize.
- 2. Slowly apply collector voltage until specified value is reached.
- Set adjustable overcurrent disconnect circuit for maximum helix current value specified, then slowly increase helix voltage to specified value.
- Slowly increase anode voltage to specified value, observing that current does not exceed maximum value.

Helix disconnect circuit should function such that all voltages will be disabled within 100 μ sec if helix current exceeds maximum value.



Heater 3.5-4.5 volts ac at 0.9 ampere maximum Anode 0-550 volts at 1 mA maximum Helix 500-950 volts at 10 mA maximum Collector 1400-1650 volts at 75 mA maximum NOTE:

With this configuration, anode supply cannot cutoff tube emission. To prevent damage to TWT, voltages must be applied to TWT in the following sequence:

- 1. Apply heater voltage slowly to allow filament resistance change as temperature rises.
- 2. Collector, helix, and anode voltages may be applied simultaneously after heater voltage has been on for 2 minutes minimum.

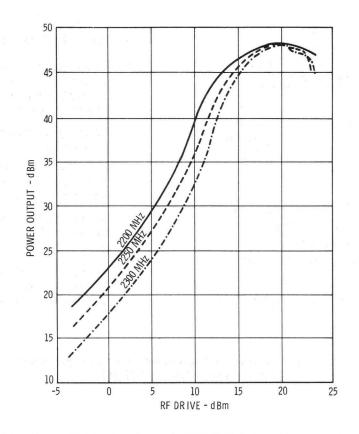
CAUTION

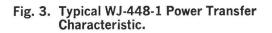
Helix overcurrent disconnect circuit must be set for maximum helix current value specified and must disconnect all voltages in less than 100 μ sec if maximum value is exceeded.

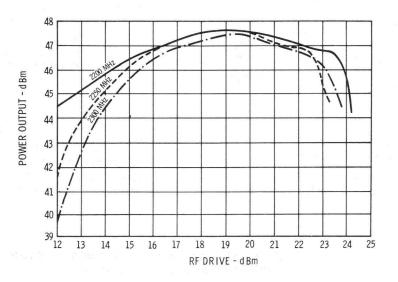
Fig. 6. Preferred connection for high-density power supply configuration for WJ-448-1.

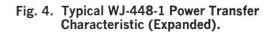
Fig. 5. Preferred connection for laboratory-type power supply configuration for WJ-448-1

WJ-448-1









DECEMBER 1969

2.2 TO 2.3 GHz HIGH-EFFICIENCY TRAVELING- WAVE TUBE WITH VARIABLE POWER OUTPUT WJ-448-2

- 44% EFFICIENCY AT 50-WATT POWER LEVEL
- 15 TO 90 WATTS VARIABLE POWER
 OPERATION
- SUITABLE FOR AIRBORNE/SPACE APPLICATIONS
- SPACE-QUALIFIED MODEL AVAILABLE

Maximum efficiency (44%) of the WJ-448-2 occurs at the 50-watt level. The efficiency is greater than 40% over the range from 30 watts to 65 watts, and is greater than 30% over the extended range from 15 watts to 90 watts. It is important to note that the total saturation power range from 10 watts to 90 watts was obtained at a fixed RF input drive level of 17.5 dBm. Figure 3 shows the typical variations in electrode voltages necessary to achieve the different levels of RF output power.

The power output, gain and efficiency at a particular power output level are very nearly constant over the specified frequency range, as shown in figure 4 for the 50-watt level. The power transfer curves of figures 5 and 6 show that the output power at saturation is relatively unchanged with a substantial change in drive power.

Variations of the WJ-448 family of TWTs are available to optimize performance at other frequencies and power levels. Each tube can be made to meet environmental conditions more stringent than those described in the specifications. Manufactured under rigid quality assurance specifications, one version of this tube has been qualified for space applications; WJ-448-2 is also suitable for ground, airborne and shipboard applications.



WJ-448-2 is a high-efficiency TWT designed for use in systems where various power output levels may be required. High efficiency is maintained at the various power levels by operating the tube at saturation; the RF drive power remains at a fixed value while the three principal dc voltages applied to the tube are changed, allowing operation over a power output range as wide as 8 dB. Varying the power output of the system thus becomes a matter of programming the power supply voltages applied to the tube.

WJ-448-2 satisfies the power amplifier requirements of earth-orbit and deep-space missions where high reliability, small size, maximum overall efficiency and long life operation are essential. High performance is maintained during and after extreme temperature, vibration, shock and static acceleration. Its unique highefficiency, variable-power features make it suitable for multi-power level and fixed-output requirements.

Figure 2 shows typical variable power performance of the WJ-448-2. The upper plot shows the overall efficiency that can be obtained as a function of RF output power. The lower plot shows the relationship between total dc input and RF output power; the diagonal lines represent lines of constant overall efficiency. From this plot, a systems designer can readily determine the input power required for a given output power.

SPECIFICATIONS

	Typic	al	
PERFORMANCE CHARACTERISTICS	Wide Range	Reduced Range	Guaranteed ¹
Frequency Range	. 2.2-2.3 GHz	2.2-2.3 GHz	2.2-2.3 GHz
Saturation Power Output			
Variable Power Output Range			
Drive Power for Saturation			
Saturation gain			. 27 dB, min.
Overall Efficiency, Including Heater ²			
ELECTRICAL CHARACTERISTICS ^{3, 4}			Typical⁵
Heater Voltage	. 3.5-4.5 volts	. 3.5-4.5 volts	3.8 volts
Control Anode Voltage	. 1300-3500 volts .	. 1800-2800 volts	. 2500 volts
Blocking Anode Voltage	. 1450-3650 volts .	. 1950-2950 volts	. 2430 volts
Helix Voltage			
Collector Voltage	. 1000-2300 volts .	. 1300-1750 volts	. 1530 volts
Heater Current	. 0.9 A max	. 0.9 A max	0.7 A
Control Anode Current	. 1.0 mA max	. 1.0 mA max	0.2 mA
Blocking Anode Current	. 1.0 mA max	. 1.0 mA max	0.5 mA
Helix Current	. 13 mA max	. 10 mA max	7.0 mA
Collector Current	. 125 mA max	. 95 mA max	65 mA

1. Guaranteed performance is over the frequency range and at the power level shown.

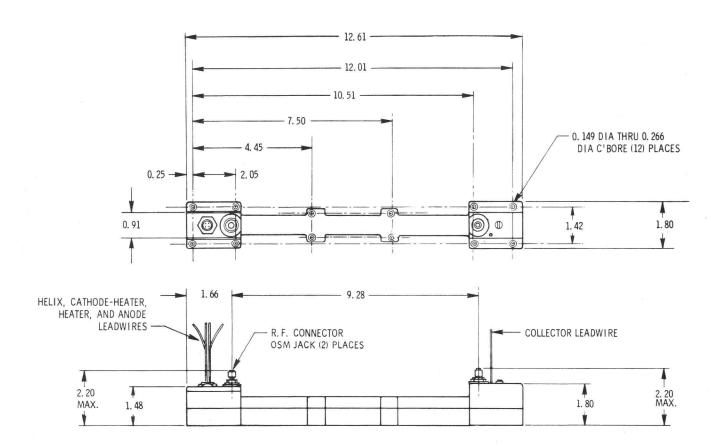
2. Overall efficiency is defined as the RF output power divided by the total dc power input, including heater power.

3. All voltages referenced to the cathode. Helix is operated at ground potential. Blocking anode is operated at a fixed +150 volts above helix potential (ground).

4. The voltage ranges are the extremes required to adjust the tube over the power output range shown. Each power level requires a particular set of anode, helix, and collector voltages.

5. At the 50 watt power level.

FIG. 1. OUTLINE DRAWING



ENVIRONMENTAL CHARACTERISTICS

Heat Sink Temperature —20°C to +85° Vibration a. Sinusoidal (2 min/octave 0.5 inch, double amplitude 5 to 18 cycles, ±20 g peak 18 to 2000 cycle b. Random	, , S
(5 min/axis) 0.1 g²/cycles, 20 to 2000 cycle Acceleration (1min/axis)	g
MECHANICAL CHARACTERISTICS	
Tube length 12.7 inches max Tube height, excluding connectors 1.9 inches max Tube width 1.9 inches max Tube weight 36 ounces max DC connectors Flying lead RF connectors OSM (Jack Cooling Conduction from bottom surfact Focusing PPI Color Code for 18" Flying Leads Helix Orang Cathode Heater Yellor Heater Brow Control Anode Gree Blocking Anode Blu	α. α. s) e M e w n n e



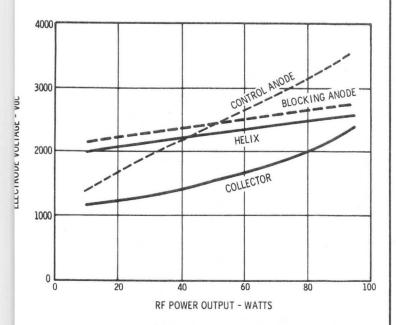


FIG. 2. TYPICAL WJ-448-2 VARIABLE POWER OUTPUT PERFORMANCE

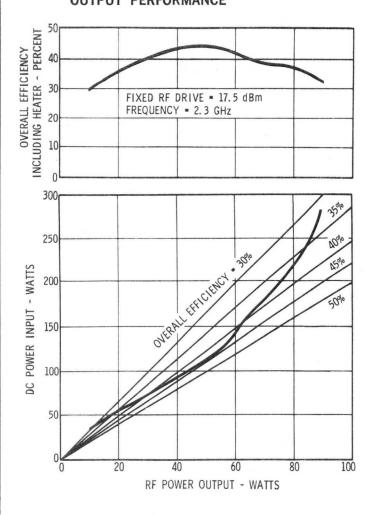


FIG. 4. WJ-448-2 BROADBAND PERFORMANCE CHARACTERISTICS

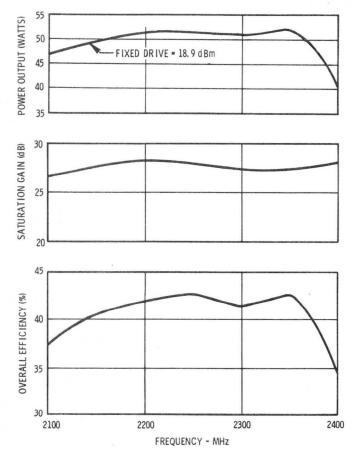


FIG. 5. TYPICAL WJ-448-2 POWER TRANSFER CHARACTERISTIC

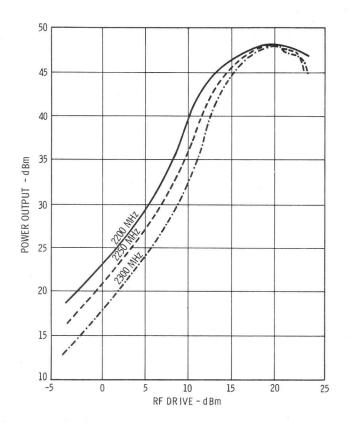


FIG. 6. TYPICAL WJ-448-2 POWER TRANSFER CHARACTERISTIC (EXPANDED)

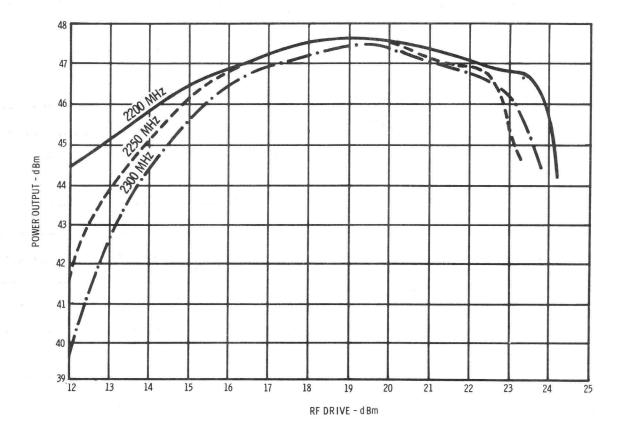
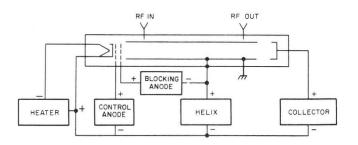


FIG. 7. PREFERRED CONNECTION FOR LABORATORY-TYPE POWER SUPPLY CONFIGURATION FOR WJ-448-2



Heater 3.5-4.5 volts at 0.9 ampere maximum Blocking Anode 150 volts above helix at 1 mA maximum

Control Anode . . 1300-3500 volts at 1 mA maximum Helix 1900-2600 volts at 13 mA maximum Collector 1000-2300 volts at 125 mA maximum

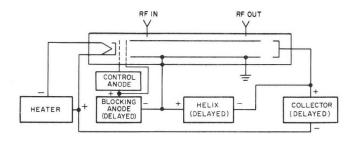
NOTE:

To ensure that the TWT is operated properly, it is suggested that voltages be applied as follows:

- 1. Slowly apply filament voltage until specified value is reached, observing that filament current does not exceed maximum value. Allow at least 2 minutes for filament voltage to stabilize.
- Slowly apply collector voltage until specified value is reached, observing that collector current does not exceed maximum value.
- 3. Set adjustable overcurrent disconnect circuit for maximum helix current value specified, then slowly increase helix voltage to specified value.
- Slowly increase anode voltages to specified value, observing that current does not exceed maximum value.

Helix disconnect circuit should function such that all voltages will be disabled within 100 μ sec if helix current exceeds maximum value.

FIG. 8. PREFERRED CONNECTION FOR HIGH-DENSITY POWER SUPPLY CONFIGURA-TION FOR WJ-448-2



Heater ... 3.5-4.5 volts ac at 0.9 ampere maximum Control Anode ... 1300-3500 volts at 1 mA maximum Blocking Anode 150 volts above helix at 1 mA maximum

Helix 1900-2600 volts at 13 mA maximum Collector 1000-2300 volts at 125 mA maximum

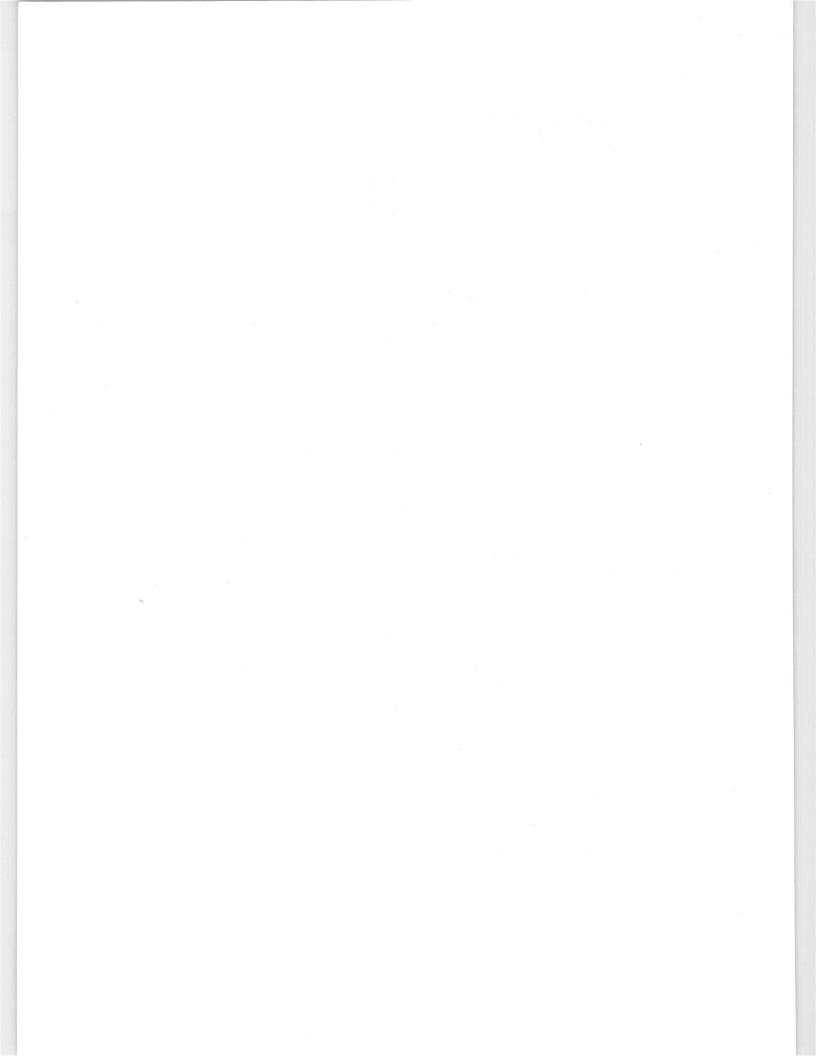
NOTE:

With this configuration, anode supply cannot cut off tube emission. To prevent damage to TWT, voltages must be applied to TWT in the following sequence:

- 1. Apply heater voltage slowly to allow filament resistance change as temperature rises.
- 2. Collector, helix, and anode voltages may be applied simultaneously after heater voltage has been on for 2 minutes minimum.

CAUTION

Helix overcurrent disconnect circuit must be set for maximum helix current value specified and must disconnect all voltages in less than 100 μ sec if maximum value is exceeded.



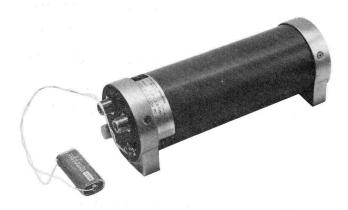
FEBRUARY 1970

1.0 TO 2.0 GHz, COMPACT LOW-NOISE PERMANENT-MAGNET TRAVELING-WAVE AMPLIFIER WITH BATTERY-OPERABLE INTEGRAL POWER SUPPLY WJ-457

- "JUST PLUG IT IN"
- POWER DRAIN 3.0 WATTS MAXIMUM
- NOISE FIGURE
 8.0 dB MAXIMUM
- SMALL SIZE: 3.4 x 9.5 INCHES
- WEIGHT: 6.0 LBS.
- ADJUSTMENT-FREE
- PERMANENT-MAGNET FOCUSING
- MORE THAN 20
 SPECIALIZED
 VERSIONS AVAILABLE

WJ-457 is the L-band member of a new series of compact LNTWAs incorporating the Battery Operable, Integral Power Supply (BOIPS) feature. The introduction of BOIPS as a standard option allows W-J's compact amplifiers to be competitive with solid state amplifiers, particularly in size and power drain specifications, with the added advantage of production experience in all the popular microwave bands.

The WJ-457 is completely self-contained and adjustment-free, and requires only 20 to 28 V dc input for



operation. It may be operated in any orientation. Rugged construction of the tube, magnet, and power supply assembly ensures reliable operation under vibrational forces of 10 g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of -54 °C to +71 °C. The environmental characteristics of the WJ-457 meet or exceed the corresponding requirements of MIL-E-5400, class 2 specification.

SPECIFICATIONS

PERFORMANCE Frequency Noise Figure, Terminal Gain, Small Signal VSWR, Input and Output Power Output	7.0 dB 30.0 dB 1.5:1	1.0 to 2.0 GHz 8.0 dB, max. 25.0 dB, min. 2:1, max.
ELECTRICAL REQUIREMENTS Primary Voltage Primary Power	23 V dc	
✤ Supersedes WJ-457 Technical Data Sheet dated October 1968.		

ENVIRONMENTAL CHARACTERISTICS²

Temperature, Operating54°C to +71°C
Vibration
a. 0.10 Inch, Double Amplitude 5 to 45 Hz
b. 10 g, Single Amplitude 45 to 500 Hz
Shock 15 g, 11 ms

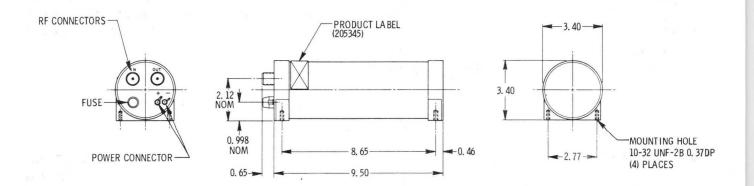
MECHANICAL CHARACTERISTICS

Height 3.4 inches (86 mm) max.
Width 3.4 inches (86 mm) max.
Length (excluding connectors) 9.5 inches (241 mm) max.
Weight 6 lbs. (2.72 Kg) max.
Primary Power Connection, Erie Feedthrough 1200-094, 1215-094
RF Connections (50 ohms, nominal) Type N, Jack
Reference Drawing Number 290197

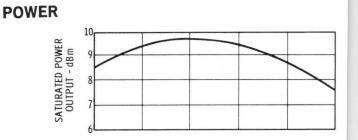
 $^{1}\!\text{Every}$ tube will meet the guaranteed performance specifications within these ranges.

²These environmental characteristics meet or exceed the respective requirements of MIL-E-5400, Class 2 Specification.

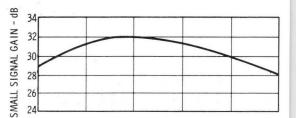
OUTLINE DRAWING



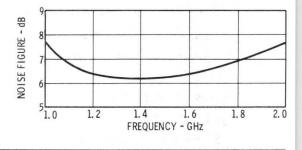
FEBRUARY 1970



GAIN







FEBRUARY 1970*

2.0 TO 4.0 GHz, COMPACT LOW-NOISE PERMANENT-MAGNET TRAVELING-WAVE AMPLIFIER WITH BATTERY-OPERABLE INTEGRAL POWER SUPPLY WJ-458

- "JUST PLUG IT IN"
- POWER DRAIN 3.0 WATTS MAXIMUM
- NOISE FIGURE 8.5 dB MAXIMUM
- SMALL SIZE:
 3.4 x 9.5 INCHES
- WEIGHT: 6.0 LBS.
- ADJUSTMENT-FREE
- PERMANENT-MAGNET FOCUSING
- MORE THAN 20
 SPECIALIZED
 VERSIONS AVAILABLE

WJ-458 is the S-band member of a new series of compact LNTWAs incorporating the Battery Operable, Integral Power Supply (BOIPS) feature. The introduction of BOIPS as a standard option allows W-J's compact amplifiers to be competitive with solid state amplifiers, particularly in size and power drain specifications, with the added advantage of production experience in all the popular microwave bands.

The WJ-458 is completely self-contained and adjustment-free, and requires only 20 to 28 V dc input for



operation. It may be operated in any orientation. Rugged construction of the tube, magnet, and power supply assembly ensures reliable operation under vibrational forces of 10 g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of -54 °C to +71 °C. The environmental characteristics of the WJ-458 meet or exceed the corresponding requirements of MIL-E-5400, class 2 specification.

SPECIFICATIONS

PERFORMANCE Frequency Noise Figure, Terminal Gain, Small Signal VSWR, Input and Output Power Output	7.5 dB 30.0 dB 1.5:1	
ELECTRICAL REQUIREMENTS Primary Voltage Primary Power	23 V dc	

*Supersedes WJ-458 Technical Data Sheet dated October 1968.

ENVIRONMENTAL CHARACTERISTICS²

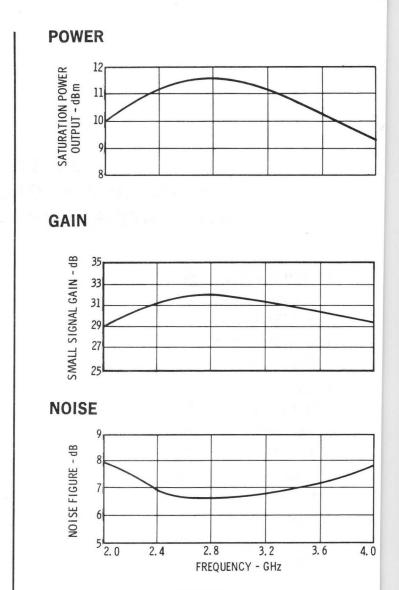
Temperature, Operating —54°C to +71°C
Vibration
a. 0.10 Inch, Double Amplitude 5 to 45 Hz
b. 10 g, Single Amplitude 45 to 500 Hz
Shock 15 g, 11 ms

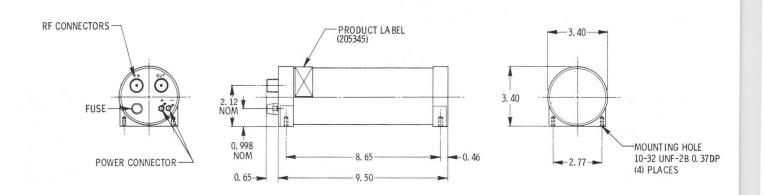
MECHANICAL CHARACTERISTICS

Height 3.4 inches (86 mm) max.
Width 3.4 inches (86 mm) max.
Length (excluding connectors) 9.5 inches (241 mm) max.
Weight 6 lbs. (2.72 Kg) max.
Primary Power Connection, Erie Feedthrough 1200-094, 1215-094
RF Connections (50 ohms, nominal) Type N, Jack
Reference Drawing Number 290197

¹Every tube will meet the guaranteed performance specifications within these ranges.

²These environmental characteristics meet or exceed the respective requirements of MIL-E-5400, Class 2 Specification.





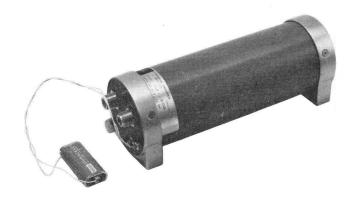
FEBRUARY 1970

4.0 TO 8.0 GHz, COMPACT LOW-NOISE PERMANENT-MAGNET TRAVELING-WAVE AMPLIFIER WITH BATTERY-OPERABLE INTEGRAL POWER SUPPLY WJ-459

- "JUST PLUG IT IN"
- POWER DRAIN
 3.0 WATTS MAXIMUM
- NOISE FIGURE
 9.0 dB MAXIMUM
- SMALL SIZE: 3.4 x 9.5 INCHES
- WEIGHT: 6.0 LBS.
- ADJUSTMENT-FREE
- PERMANENT-MAGNET FOCUSING
- MORE THAN 20
 SPECIALIZED
 VERSIONS AVAILABLE

WJ-459 is the C-band member of a new series of compact LNTWAs incorporating the Battery Operable, Integral Power Supply (BOIPS) feature. The introduction of BOIPS as a standard option allows W-J's compact amplifiers to be competitive with solid state amplifiers, particularly in size and power drain specifications, with the added advantage of production experience in all the popular microwave bands.

The WJ-459 is completely self-contained and adjustment-free, and requires only 20 to 28 V dc input for



operation. It may be operated in any orientation. Rugged construction of the tube, magnet, and power supply assembly ensures reliable operation under vibrational forces of 10 g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of -54 °C to +71 °C. The environmental characteristics of the WJ-459 meet or exceed the corresponding requirements of MIL-E-5400, class 2 specification.

SPECIFICATIONS

PERFORMANCE Frequency Noise Figure, Terminal Gain, Small Signal VSWR, Input and Output Power Output	8.0 dB .30.0 dB .1.5:1	9.0 dB, max. 25.0 dB, min. 2:1, max.
ELECTRICAL REQUIREMENTS Primary Voltage Primary Power		

★Supersedes WJ-459 Technical Data Sheet dated October 1968.

ENVIRONMENTAL CHARACTERISTICS²

Temperature, Operating54°C to +71°C
Vibration
a. 0.10 Inch, Double Amplitude 5 to 45 Hz
b. 10 g, Single Amplitude 45 to 500 Hz
Shock 15 g, 11 ms

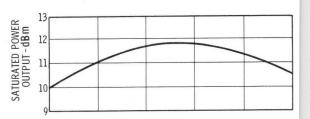
MECHANICAL CHARACTERISTICS

Height 3.4 inches (86 mm) max.
Width 3.4 inches (86 mm) max.
Length (excluding connectors) 9.5 inches (241 mm) max.
Weight 6 lbs. (2.72 Kg) max.
Primary Power Connection, Erie Feedthrough 1200-094, 1215-094
RF Connections (50 ohms, nominal) Type N, Jack Reference Drawing Number 290197
-

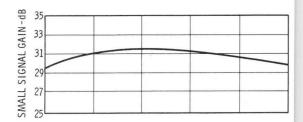
¹Every tube will meet the guaranteed performance specifications within these ranges.

²These environmental characteristics meet or exceed the respective requirements of MIL-E-5400, Class 2 Specification.

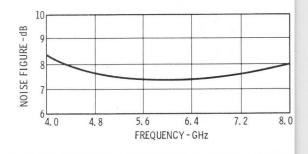
POWER

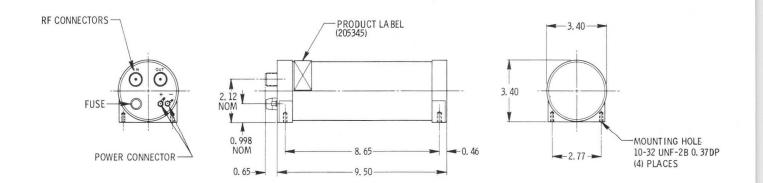


GAIN



NOISE





FEBRUARY 1970*

8.0 TO 12.0 GHz, COMPACT LOW-NOISE PERMANENT-MAGNET TRAVELING-WAVE AMPLIFIER WITH BATTERY-OPERABLE INTEGRAL POWER SUPPLY WJ-460

- "JUST PLUG IT IN"
- POWER DRAIN 3.0 WATTS MAXIMUM
- NOISE FIGURE
 10.0 dB MAXIMUM
- SMALL SIZE: 3.4 x 9.5 INCHES
- WEIGHT: 6.0 LBS.
- ADJUSTMENT-FREE
- PERMANENT-MAGNET FOCUSING
- MORE THAN 20
 SPECIALIZED
 VERSIONS AVAILABLE

WJ-460 is the X-band member of a new series of compact LNTWAs incorporating the Battery Operable, Integral Power Supply (BOIPS) feature. The introduction of BOIPS as a standard option allows W-J's compact amplifiers to be competitive with solid state amplifiers, particularly in size and power drain specifications, with the added advantage of production experience in all the popular microwave bands.

The WJ-460 is completely self-contained and adjustment-free, and requires only 20 to 28 V dc input for



operation. It may be operated in any orientation. Rugged construction of the tube, magnet, and power supply assembly ensures reliable operation under vibrational forces of 10 g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of -54 °C to +71 °C. The environmental characteristics of the WJ-460 meet or exceed the corresponding requirements of MIL-E-5400, class 2 specification.

SPECIFICATIONS

PERFORMANCE Frequency Noise Figure, Terminal Gain, Small Signal VSWR, Input and Output Power Output	.9.0 dB .30.0 dB .1.5:1	10.0 dB, max. 25.0 dB, min. 2:1, max.
ELECTRICAL REQUIREMENTS Primary Voltage Primary Power		

*Supersedes WJ-460 Technical Data Sheet dated October 1968.

ENVIRONMENTAL CHARACTERISTICS²

Temperature, Operating54°C to +71°C
Vibration
a. 0.10 Inch, Double Amplitude 5 to 45 Hz
b. 10 g, Single Amplitude 45 to 500 Hz
Shock 15 g, 11 ms

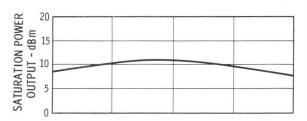
MECHANICAL CHARACTERISTICS

Height 3.4 inches (86 mm) max.
Width 3.4 inches (86 mm) max.
Length (excluding connectors) 9.5 inches (241 mm) max.
Weight 6 lbs. (2.72 Kg) max.
Primary Power Connection, Erie Feedthrough 1200-094, 1215-094
RF Connections (50 ohms, nominal) Type N, Jack
Reference Drawing Number 290197

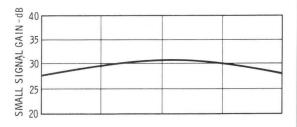
¹Every tube will meet the guaranteed performance specifications within these ranges.

²These environmental characteristics meet or exceed the respective requirements of MIL-E-5400, Class 2 Specification.

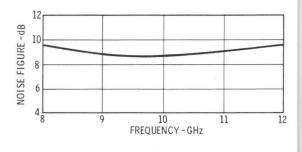
POWER

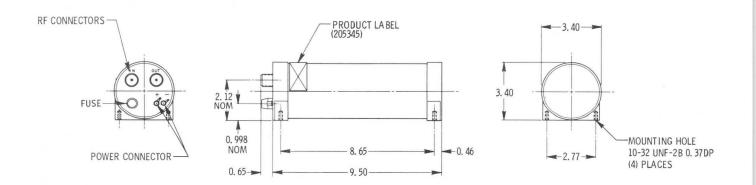






NOISE





FEBRUARY 1970 *

12.0 TO 18.0 GHz, COMPACT LOW-NOISE PERMANENT-MAGNET TRAVELING-WAVE AMPLIFIER WITH BATTERY-OPERABLE INTEGRAL POWER SUPPLY WJ-461

- "JUST PLUG IT IN"
- POWER DRAIN 3.0 WATTS MAXIMUM
- NOISE FIGURE
 12.0 dB MAXIMUM
- SMALL SIZE: 3.4 x 9.5 INCHES
- WEIGHT: 6.5 LBS.
- ADJUSTMENT-FREE
- PERMANENT-MAGNET FOCUSING
- MORE THAN 20
 SPECIALIZED
 VERSIONS AVAILABLE

WJ-461 is the Ku-band member of a new series of compact LNTWAs incorporating the Battery Operable, Integral Power Supply (BOIPS) feature. The introduction of BOIPS as a standard option allows W-J's compact amplifiers to be competitive with solid state amplifiers, particularly in size and power drain specifications, with the added advantage of production experience in all the popular microwave bands.

The WJ-461 is completely self-contained and adjustment-free, and requires only 20 to 28 V dc input for



operation. It may be operated in any orientation. Rugged construction of the tube, magnet, and power supply assembly ensures reliable operation under vibrational forces of 10 g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of -54 °C to +71 °C. The environmental characteristics of the WJ-461 meet or exceed the corresponding requirements of MIL-E-5400, class 2 specification.

PERFORMANCE Frequency Noise Figure, Terminal Gain, Small Signal VSWR, Input and Output Power Output	.10.0 dB .28 dB .1.5:1	12.0 dB, max. 25 dB, min. 2:1, max.
ELECTRICAL REQUIREMENTS	Typical	Range ¹
Primary Voltage Primary Power *Supersedes WJ-461 Technical Data Sheet dated October 1968.	.23 V ac	20 to 28 V dc 3 W, max.

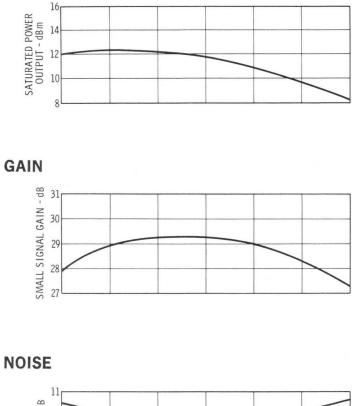
ENVIRONMENTAL CHARACTERISTICS²

Temperature, Operating54°C to +71°C
Vibration
a. 0.10 Inch, Double Amplitude 5 to 30 Hz
b. 5 g, Single Amplitude 30 to 500 Hz
Shock 15 g. 11 ms

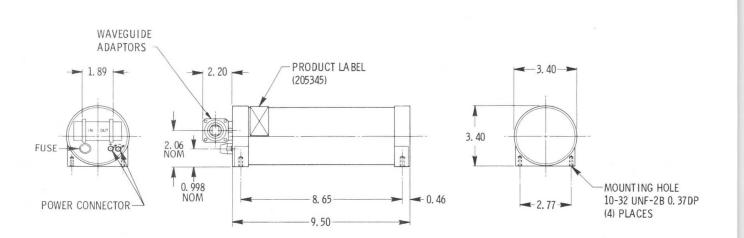
MECHANICAL CHARACTERISTICS

Height 3.4 inches (86 mm) max.
Width 3.4 inches (86 mm) max.
Length (excluding connectors 9.5 inches (241 mm) max.
Weight 6.5 lbs (2.95 Kg) max.
Primary Power Connection, Erie Feedthrough 1200-094, 1215-094
RF Connections (Waveguide) UG-541/U Choke Flange
Reference Drawing Number 290196

- ¹ Every tube will meet the guaranteed performance specifications within these ranges.
- ² These environmental characteristics meet or exceed the respective requirements of MIL-E-5400 temperature Class 2, Vibration Curve III.



OUTLINE DRAWING



POWER

OCTOBER 1969 *

2 TO 4 GHz MINIATURE PPM-FOCUSED LOW-NOISE TWT AMPLIFIER WITH INTEGRAL POWER SUPPLY WJ-462



The WJ-462 is one of a family of periodic-permanent-magnet low-noise TWT amplifiers developed by Watkins-Johnson Company to meet the increasing demand for reliable microwave devices. No other S-band PPM low-noise TWT amplifier on the market today can match the power output/noise figure/gain/size combination offered by this amplifier. It is completely self-contained, and adjustment-free, operating with only an ac line voltage input. • "JUST PLUG IT IN"

- GUARANTEED 10.0 dB NOISE FIGURE ACROSS FULL S-BAND
- GUARANTEED +10 dBm POWER OUTPUT
- SMALL SIZE: 2x2x11 INCHES
- MEETS MIL-E-5400 CLASS II ENVIRONMENT

The WJ-462 may be mounted in any orientation without degradation of performance. Rugged construction of the tube, magnet, and power supply ensures reliable operation under vibrational forces of 10g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of -54° to $+71^{\circ}$ C. These environmental characteristics of the WJ-462 meet the corresponding requirements of MIL-E-5400, Class 2.

SPECIFICATIONS

PERFORMANCE		Guaranteed
Frequency	2.0 to 4.0 GHz	2.0 to 4.0 GHz
Noise figure, terminal		
Gain, small signal	45 dB	
VSWR, input and output	1.5:1	2:1 max.
Power output	+16 dBm	+10 dBm min.
ELECTRICAL REQUIREMENTS	Typical	Range ¹
Primary voltage	115 Vac	115 ±10 Vac
Primary frequency	60 Hz	48 to 420 Hz
Primary power	10 watts	

*Supersedes WJ-462 Technical Data Sheet dated November, 1968.

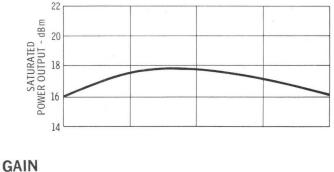
ENVIRONMENTAL CHARACTERISTICS²

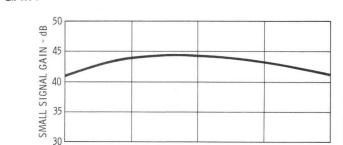
Temperature
Vibration
a10 inch, double amplitude 5 to 45 Hz
b. 10 g, single amplitude 45 to 500 Hz
Shock 15 G, 11 ms

MECHANICAL CHARACTERISTICS

Height (excluding

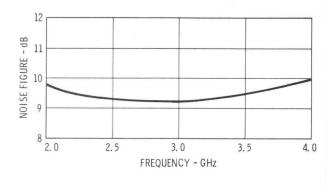
connectors) 2 inches (51 mm) max.
Width 2 inches (51 mm) max.
Length 11 inches (279 mm) max.
Weight 3.5 pounds (1.56 Kg) max.
Primary Power Connection,
Bendix receptacle PT 07C-8-3P
RF Connections (50 ohms, nominal) OSM, jack





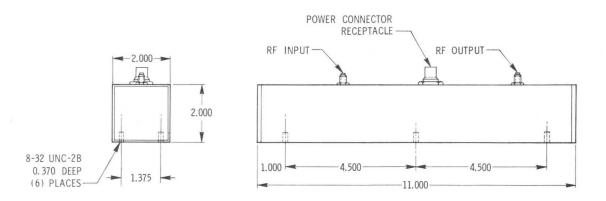
NOISE

POWER



 $^1\!Every$ tube will meet the guaranteed performance specifications for any primary voltage and frequency within these ranges.

 $^{2}\mbox{These}$ environmental characteristics meet the respective requirements of MIL-E-5400, Class 2.



November 1968

4 TO 8 GHz MINIATURE PPM-FOCUSED LOW-NOISE TWT AMPLIFIER WITH INTEGRAL POWER SUPPLY WJ-463

- "JUST PLUG IT IN"
- GUARANTEED +10 dBm POWER OUTPUT
- GUARANTEED 10.0 dB NOISE FIGURE ACROSS FULL C-BAND
- SMALL SIZE: 2x2x11 INCHES
- MEETS MIL-E-5400 CLASS II ENVIRONMENT

The WJ-463 may be mounted in any orientation without degradation of performance. Rugged construction of the tube, magnet, and power supply ensures reliable operation under vibrational forces of 10g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of -54° to $+71^{\circ}$ C. These environmental characteristics of the WJ-463 meet the corresponding requirements of MIL-E-5400, Class 2.

SPECIFICATIONS

PERFORMANCE	Typical	Guaranteed
Frequency	4.0 to 8.0 GHz	4.0 to 8.0 GHz
Noise figure, terminal	9.0 dB	10.0 dB max.
Gain, small signal	45 dB	40 dB min.
VSWR, input and output	1.5:1	2:1 max.
Power output	+15 dBm	. +10 dBm min.
ELECTRICAL REQUIREMENTS	Typical	Range ¹
Primary voltage		115 ±10 Vac
Primary frequency	60 Hz	48 to 420 Hz
Primary power	17 watts	



The WJ-463 is one of a family of periodic-perma-

nent-magnet low noise TWT amplifiers developed

by Watkins-Johnson Company to meet the increas-

ing demand for reliable microwave devices. No

other C-band PPM low noise TWT amplifier on the

market today can match the power output/noise

figure/gain/size combination offered by this am-

plifier. In addition it is completely self-contained

and adjustment-free, operating with only an ac

line voltage input.

ENVIRONMENTAL CHARACTERISTICS²

Temperature
Vibration
a10 inch, double amplitude 5 to 45 Hz
b. 10 g, single amplitude 45 to 500 Hz
Shock 15 G, 11 ms

MECHANICAL CHARACTERISTICS

Height (excluding

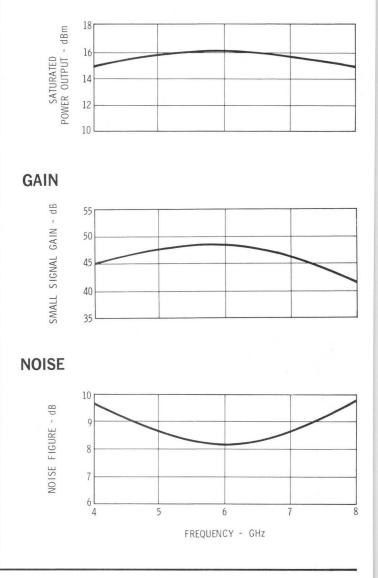
connectors)	2 inches (51 mm) max.
Width	2 inches (51 mm) max.
Length	l inches (279 mm) max.
Weight 4	pounds (1.81 Kg) max.
Primary Power Connection,	
Bendix receptacle	PT 07C-8-3P

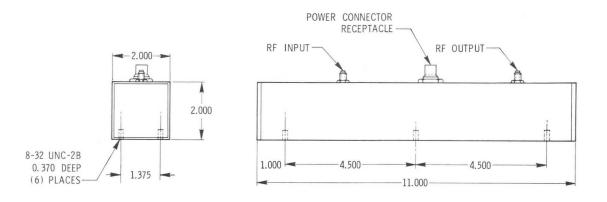
RF Connections (50 ohms, nominal) OSM, jack

¹Every tube will meet the guaranteed performance specifications for any primary voltage and frequency within these ranges.

²These environmental characteristics meet the respective requirements of MIL-E-5400, Class 2.







AUGUST 1970 *

8 TO 12 GHz MINIATURE PPM-FOCUSED LOW-NOISE TWT AMPLIFIER WITH INTEGRAL POWER SUPPLY WJ-464

- "JUST PLUG IT IN"
- GUARANTEED 10.0 dB NOISE
 FIGURE ACROSS FULL X-BAND
- GUARANTEED +10 dBm POWER OUTPUT
- SMALL SIZE: 2x2x11 INCHES
- MEETS MIL-E-5400
 CLASS II ENVIRONMENT

The WJ-464 may be mounted in any orientation without degradation of performance. Rugged construction of the tube, magnet, and power supply ensures reliable operation under vibrational forces of 10g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of -54° to $+71^{\circ}$ C. These environmental characteristics of the WJ-464 meet the corresponding requirements of MIL-E-5400, Class 2.

SPECIFICATIONS

PERFORMANCE	Typical	Guaranteed
Frequency	8.0 to 12.0 GHz	8.0 to 12.0 GHz
Noise figure, terminal	9.0 dB	10.0 dB max.
Gain, small signal		
VSWR, input and output	1.5:1	
Power output	15 dBm	10 dBm min
		10 ubin min.
ELECTRICAL REQUIREMENTS		Range ¹
ELECTRICAL REQUIREMENTS	Typical	Range ¹
	Typical 115 Vac	Range ¹ 115 ±10 Vac
ELECTRICAL REQUIREMENTS Primary voltage	Typical 115 Vac	Range ¹ 115 ±10 Vac

* Supersedes WJ-464 Technical Data Sheet dated September 1969.



nent-magnet low noise TWT amplifiers developed by Watkins-Johnson Company to meet the increasing demand for reliable microwave devices. No other X-band PPM low-noise TWT amplifier on the market today can match the power output/noise figure/gain/size combination offered by this amplifier. It is completely self-contained, and adjustment-free, operating with only an ac line voltage input.

The WJ-464 is one of a family of periodic-perma-

ENVIRONMENTAL CHARACTERISTICS²

Temperature
Vibration
a. 0.10 inch, double amplitude5 to 45 Hz
b. 10 g, single amplitude 45 to 500 Hz
Shock

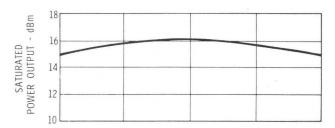
MECHANICAL CHARACTERISTICS

Height (excluding

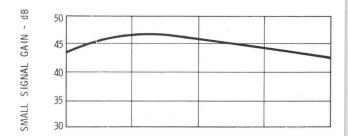
connectors)
Width2 inches (51 mm) max.
Length
Weight
Primary Power Connection,
Bendix receptacle PT 07-C-8-3P
RF Connections (50 ohms, nominal)OSM, jack
Outline Drawing Number

- 1. Every tube will meet the guaranteed performance specifications for any primary voltage and frequency lying within these ranges.
- 2. These environmental characteristics meet the respective requirements for MIL-E-5400, Class 2.

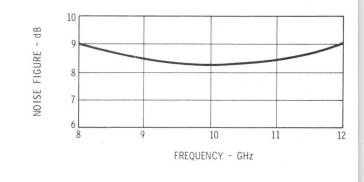


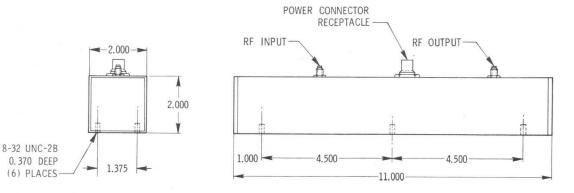


GAIN



NOISE





OCTOBER 1969

12 TO 18 GHz MINIATURE PPM-FOCUSED LOW-NOISE TWT AMPLIFIER WITH INTEGRAL POWER SUPPLY WJ-465

- "JUST PLUG IT IN"
- GUARANTEED 12.5 dB NOISE FIGURE ACROSS FULL Ku-BAND
- GUARANTEED +13 dBm POWER OUTPUT
- SMALL SIZE: 3x3x11 INCHES
- MEETS MIL-E-5400
 CLASS II ENVIRONMENT

The WJ-465 is one of a family of periodic-permanentmagnet low-noise TWT amplifiers developed by Watkins-Johnson Company to meet the increasing demand for reliable microwave devices. No other Ku-band PPM low-noise TWT amplifier on the market today can match the power output/noise figure/gain/size combination offered by this amplifier. It is completely self-contained, and adjustment-free, operating with only an ac line voltage input.

Primary Power 15 watts

The WJ-465 may be mounted in any orientation without degradation of performance. Rugged construction of the tube, magnet, and power supply ensures reliable operation under vibrational forces of 10g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of -54° to $+71^{\circ}$ C. These environmental characteristics of the WJ-465 meet the corresponding requirements of MIL-E-5400, Class 2.

PERFORMANCE	TYPICAL	GUARANTEED
Frequency	. 12 to 18 GHz	12 to 18 GHz
Noise figure, terminal	. 11.5 dB	12.5dB max.
Gain, small signal	. 40 dB	35 dB min.
VSWR, input and output	. 1.5:1	2:1 max.
Power output (saturation)	. 14 dBm	. +13 dBm min.
ELECTRICAL REQUIREMENTS	TYPICAL	RANGE ¹
Primary Voltage	. 115 Vac	115 ±10 Vac
Primary Frequency	. 60 Hz	48 to 420 Hz



ENVIRONMENTAL CHARACTERISTICS²

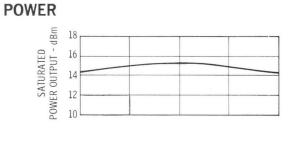
Temperature
Vibration
a10 inch, double amplitude 5 to 45 Hz
b. 10 g, single amplitude 45 to 500 Hz
Shock 15 G, 11 ms

MECHANICAL CHARACTERISTICS

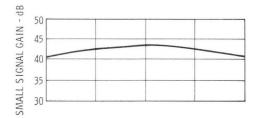
Height 3 inches (76 mm) max.
Width
(excluding connectors) 3 inches (76 mm) max.
Length 11 inches (279 mm) max.
Weight 5 pounds (2.27 Kg) max.
Primary power connection,
Bendix receptacle PT07C-8-3p
RF Connections (Waveguide) UG 541/U, RG 91/U
Primary power connection, Bendix receptacle PT07C-8-3p

¹Every tube will meet the guaranteed performance specifications for any primary voltage and frequency within these ranges.

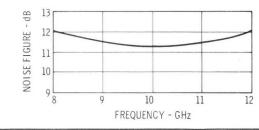
²These environmental characteristics meet the respective requirements of MIL-E-5400, Class 2.

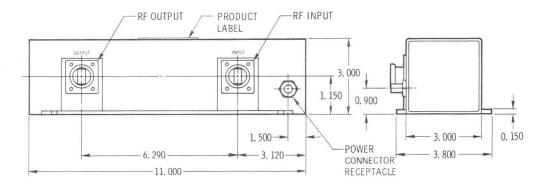


GAIN



NOISE





NOVEMBER 1969

8 TO 12 GHz 100 MILLIWATT LOW-NOISE TWT AMPLIFIER WITH INTEGRAL POWER SUPPLY WJ-472



"JUST PLUG IT IN"

- GUARANTEED 100 mW
 POWER OUTPUT
- MAXIMUM 12 dB NOISE
 FIGURE ACROSS FULL X-BAND
- SMALL SIZE: 3x3x10.5 INCHES

The WJ-472 is one of a family of 100-milliwatt singlereversal permanent-magnet TWT amplifiers developed by Watkins-Johnson for applications where increased dynamic range is desired. No other X-band low-noise TWT amplifier on the market today can match the power output/noise figure/size combination offered by this amplifier. It is completely self-contained, and adjustment-free, operating with only an ac line voltage input. The WJ-472 may be mounted in any orientation without degradation of performance. Rugged construction of the tube, magnet, and power supply ensures reliable operation under vibrational forces of 5g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of -54° to $+71^{\circ}$ C. These environmental characteristics of the WJ-472 meet the corresponding requirements of MIL-E-5400, Class 2.

PERFORMANCE Frequency	Typical	Guaranteed
Noise figure, terminal		
Gain, Small Signal		
VSWR, input and output	1.5:1	2:1 max.
Power output		
ELECTRICAL REQUIREMENTS	Typical	Range ¹
Primary voltage	115 Vac	$\dots \dots \dots \dots \dots \dots 115 \pm 10$ Vac
Primary frequency	60 Hz	
Primary current	220 mA	
Primary power	20 watts	

ENVIRONMENTAL CHARACTERISTICS²

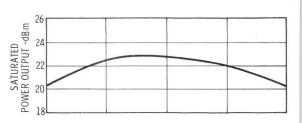
Temperature
Vibration
a. 0.10 inch, double amplitude 5 to 30 Hz
b. 5 g, single amplitude
Shock

MECHANICAL CHARACTERISTICS

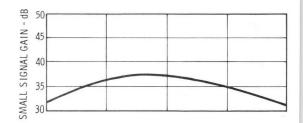
....

Height
Width 3 inches (76 mm) max.
Length (excluding
connectors) 10.5 inches (267 mm) max.
Weight7 pounds (3.18 kg) max.
Primary power connection,
Bendix receptaclePT07C-8-3p
RF connections
(50 ohms, nominal)

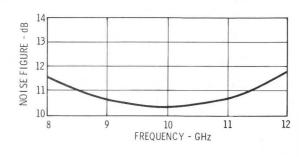




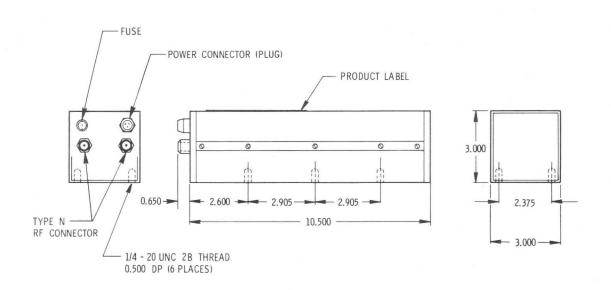
GAIN



NOISE

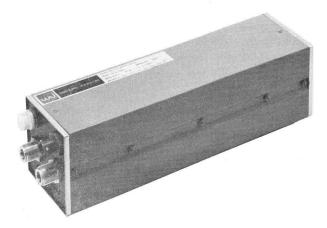


- 1. Every tube will meet the guaranteed performance specifications for any primary voltage and frequency lying within these ranges.
- 2. These environmental characteristics meet or exceed the respective requirements of MIL-E-5400K (dated 24 May 1968), Class 2.



NOVEMBER 1969

4 TO 8 GHz 100 MILLIWATT LOW-NOISE TWT AMPLIFIER WITH INTEGRAL POWER SUPPLY WJ-476



• "JUST PLUG IT IN"

- GUARANTEED 100 mW
 POWER OUTPUT
- MAXIMUM 12 dB NOISE
 FIGURE ACROSS FULL C-BAND
- SMALL SIZE: 3 x 3 x 10.5 INCHES

The WJ-476 is one of a family of 100-milliwatt singlereversal permanent-magnet TWT amplifiers developed by Watkins-Johnson for applications where increased dynamic range is desired. Featuring a wide dynamic range in a rugged and compact configuration, this tube produces 100 mW output power with 12 dB noise figure. In addition, it is completely self-contained and adjustment-free, operating with only an ac line voltage input. The WJ-476 may be mounted in any orientation without degradation of performance. Rugged construction of the tube, magnet, and power supply ensures reliable operation under vibrational forces of 5g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of -54° to $+71^{\circ}$ C. These environmental characteristics of the WJ-476 meet the corresponding requirements of MIL-E-5400, Class 2.

PERFORMANCE	Typical	Guaranteed
Frequency		
Noise figure, terminal	11 dB	
Gain, Small Signal		
VSWR, input and output	1.5:1	
Power output	+21 dBm	+20 dBm min.
ELECTRICAL REQUIREMENTS	Typical	Range ¹
Primary voltage		115 ±10 Vac
Primary frequency	60 Hz	
Primary current		
Primary power	20 watts	

ENVIRONMENTAL CHARACTERISTICS

Temperature
Vibration
a. 0.10 inch, double amplitude5 to 30 Hz
b. 5 g, single amplitude
Shock15 G, 11 ms

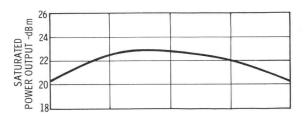
MECHANICAL CHARACTERISTICS

leight	6
Vidth	c.
ength (excluding	
connectors) 10.5 inches (267 mm) max.	
Veight	
Primary power connection, Bendix receptaclePTO7C-8-3p)
RF connections (50 ohms, nominal)	K

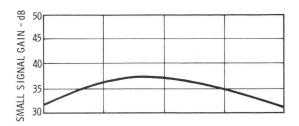
NOTE:

- 1. Every tube will meet the guaranteed performance specifications for any primary voltage and frequency within these ranges.
- 2. These environmental characteristics meet the respective requirements of MIL-E-5400K, dated 24 May 68, class 2.

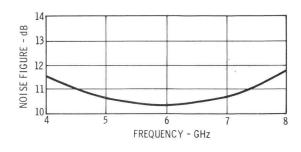


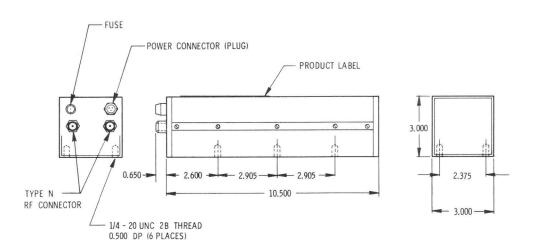


GAIN



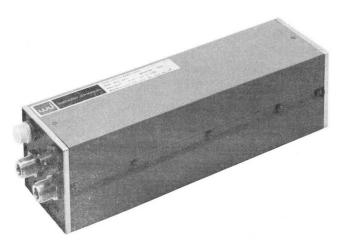
NOISE





NOVEMBER 1969

2 TO 4 GHz 100 MILLIWATT LOW-NOISE TWT AMPLIFIER WITH INTEGRAL POWER SUPPLY WJ-477



• "JUST PLUG IT IN"

- GUARANTEED 100 mW
 POWER OUTPUT
- MAXIMUM 12 dB NOISE FIGURE ACROSS FULL S-BAND
- SMALL SIZE: 3 x 3 x 10.5 INCHES

The WJ-477 is one of a family of 100-milliwatt singlereversal permanent-magnet TWT amplifiers developed by Watkins-Johnson for applications where increased dynamic range is desired. No other S-band low-noise TWT amplifier on the market today can match the power output/noise figure/size combination offered by this amplifier. It is completely self-contained, and adjustment-free, operating with only an ac line voltage input. The WJ-477 may be mounted in any orientation without degradation of performance. Rugged construction of the tube, magnet, and power supply ensures reliable operation under vibrational forces of 5g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of -54° to $+71^{\circ}$ C. These environmental characteristics of the WJ-477 meet the corresponding requirements of MIL-E-5400, Class 2.

PERFORMANCE	Typical	Guaranteed
Frequency		2.0 to 4.0 GHz
Noise figure, Terminal	.11 dB	12 dB max.
Gain, Small Signal	.30 dB	25 dB, min.
VSWR, input and output	.1.5:1	2:1 max.
Power output	.+21 dBm	+20 dBm min.
ELECTRICAL REQUIREMENTS	Typical	Range ¹
Primary voltage	.115 Vac	115 ±10 Vac
Primary frequency	.60 Hz	48 to 420 Hz
Primary current		
Primary power	.20 watts	

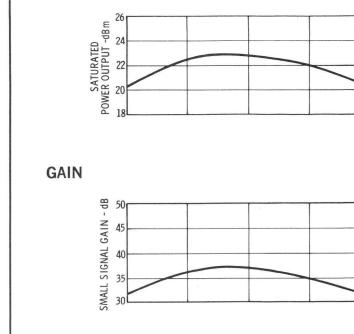
ENVIRONMENTAL CHARACTERISTICS²

Temperature
Vibration
a) 0.10 Inch, Double Amplitude 5 to 30 Hz
b) 5 g, Single Amplitude
Shock

MECHANICAL CHARACTERISTICS

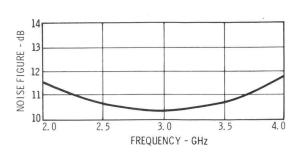
Height 3 inches (76 mm) max.
Width 3 inches (76 mm) max.
Length (excluding
connectors)
Weight
Primary power connection,
Bendix receptaclePT07C-8-3p
RF conections
(50 ohms, nominal)Type N, jack

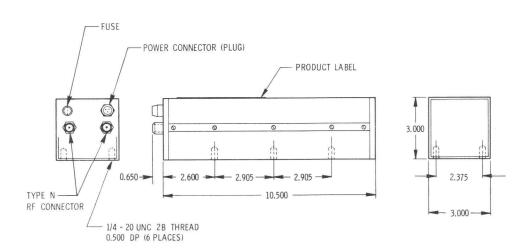
- 1. Every tube will meet the guaranteed performance specifications for any voltage and frequency within these ranges.
- These environmental characteristics meet or exceed the respective requirements of MIL-E-5400K (dated 24 May 1968), Class 2.



NOISE

POWER





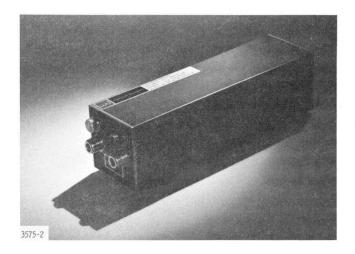
WJ-482

September 1968

2.6 TO 5.2 GHz LOW-NOISE TWT AMPLIFIER WITH INTEGRAL POWER SUPPLY

- "JUST PLUG IT IN"
- GUARANTEED +10 dBm POWER OUTPUT
- GUARANTEED 7.5 dB NOISE FIGURE
- SMALL SIZE: 3 x 3 x 11.25 INCHES
- MEETS MIL-E-5400, CLASS 2 ENVIRONMENT

The WJ-482 is one of a family of single-reversal permanent-magnet TWT amplifiers developed by Watkins-Johnson Company to meet the increasing demand for reliable microwave devices. No other 2.6 to 5.2 GHz low-noise TWT amplifier on the market today can match the power output/noise figure/size combination offered by this amplifier. It is completely self-contained, and adjustmentfree, operating with only an ac line voltage input.



The WJ-482 may be mounted in any orientation without degradation of performance. Rugged construction of the tube, magnet, and power supply ensures reliable operation under vibration forces of 10g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of -54° to $+71^{\circ}$ C. These environmental characteristics of the WJ-482 meet the corresponding requirements of MIL-E-5400, Class 2.

PERFORMANCE	Typical	Guaranteed
Frequency	.2.6 to 5.2 GHz	2.6 to 5.2 GHz
Noise Figure, terminal		
Gain, Small Signal	.30 dB	25 dB min.
VSWR, input and output	.1.5:1	2:1 max.
Power output	.+12 dBm	+10 dBm min.
ELECTRICAL REQUIREMENTS	Typical	Range ¹
Primary voltage	.115 Vac	115 ±10 Vac
Primary current	.150 mA	
Primary current		48 to 420 Hz

ENVIRONMENTAL CHARACTERISTICS²

Temperature, Operating54°C to +71°C
Vibration
a. 0.10 Inch, Double Amplitude 5 to 45 Hz
b. 10 g, Single Amplitude 45 to 500 Hz
Shock 15 g, 11 ms

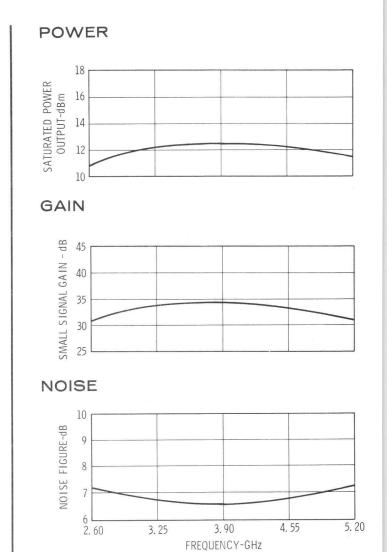
MECHANICAL CHARACTERISTICS

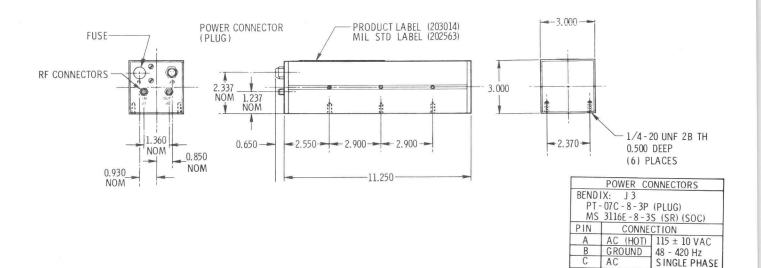
Amplifier length

(excluding connectors) 11.25 inches, max.	
Amplifier height 3 inches, max.	
Amplifier width 3 inches, max.	ł
Weight 7.5 pounds, max.	
Primary power connection, Bendix receptacle PT07C-8-3p)
RF connections	
(50 ohms, nominal) Type N, jack	<
Reference Drawing Number 290229)

Every tube will meet the guaranteed performance specifications for any primary voltage and frequency within these ranges.

These environmental characteristics meet the respective requirements of MIL-E-5400, Class 2 Specification.





APRIL 1970 *

7 TO 11 GHz PPM-FOCUSED LOW-NOISE TWT LIMITER WITH INTEGRAL POWER SUPPLY WJ-484



The WJ-484 is one of a family of periodic-permanentmagnet low noise TWT limiters developed by Watkins-Johnson Company to meet the increasing demand for reliable microwave devices. It is completely self-contained, and adjustment free, operating with only an ac line voltage input.

The WJ-484 may be mounted in any orientation

"JUST PLUG IT IN"

- GUARANTEED 10.0 dB VARIATION IN POWER OUTPUT OVER 35 dB POWER INPUT RANGE
- GUARANTEED +10 dBm POWER OUTPUT
- SMALL SIZE: 2x2x11 INCHES
- MEETS MIL-E-5400 CLASS II ENVIRONMENT AS SPECIFIED

without degradation of performance. Rugged construction of the tube, magnet, and power supply ensures reliable operation under vibrational forces of 10g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of -54° to $+71^{\circ}$ C. These environmental characteristics of the WJ-484 meet the corresponding requirements of MIL-E-5400, Class 2.

SPECIFICATIONS

PERFORMANCE	Typical	Guaranteed
Frequency		
Noise figure, terminal	11.0 dB	
Gain, small signal	40 dB	
VSWR, input and output	1.5:1	
Saturation Power Output		
Power Output Variation/35 dB Input Power		
Range (up to +0 dBm)	9 dB	
ELECTRICAL REQUIREMENTS ¹		Range
Primary voltage	115 Vac	
Primary frequency	60 Hz	
Primary power		
Primary current	145 mA	

* Supersedes WJ-484 Technical Data Sheet dated September 1969.

ENVIRONMENTAL CHARACTERISTICS²

Temperature
Vibration
a. 0.10 inch, double amplitude5 to 45 Hz
b. 10 g, single amplitude
Shock

MECHANICAL CHARACTERISTICS

Height (excluding

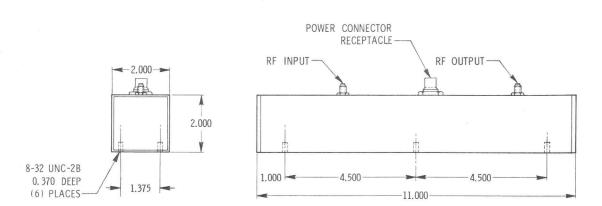
connectors)2 inches (51 mm) max.
Width2 inches (51 mm) max.
Length 11 inches (279 mm) max.
Weight
Primary power connection,
Bendix receptacle PT07C-8-3p

Bollan 1000	praoio		
RF connection	(50 ohms,	nominal)	OSM, jack
Outline Drawir	ıg	W.	No. 290238

NOTE:

- 1. Every tube will meet the guaranteed performance specifications for any primary voltage and frequency within these ranges.
- 2. These environmental characteristics meet the respective requirements of MIL-E-5400K, dated 24 May 68, class 2.

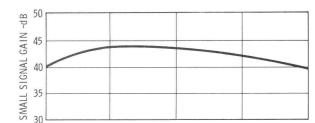
OUTLINE DRAWING



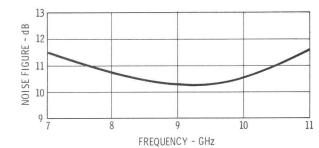
20 ج		
dBm D - 18		
URATE UTPUT		
SATURAT POWER OUTPU 91		
AO 12		

GAIN

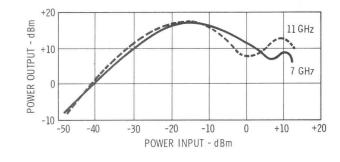
POWER



NOISE



OVERDRIVE



NOVEMBER 1969

4.0 TO 8.0 GHz PPM-FOCUSED LOW-NOISE TWT LIMITER WITH INTEGRAL POWER SUPPLY WJ-485

- "JUST PLUG IT IN"
- MAXIMUM 10.0 dB VARIATION IN POWER OUTPUT OVER 35 dB POWER INPUT RANGE
- GUARANTEED +12 dBm SATURATED POWER OUTPUT
- SMALL SIZE: 2 x 2 x 11 INCHES
- DESIGNED TO MEET MIL-E-5400 CLASS II ENVIRONMENT AS SPECIFIED

The WJ-485 is one of a family of periodic-permanentmagnet low noise TWT limiters developed by Watkins-Johnson Company to meet the increasing demand for reliable microwave devices. It is completely self-contained, and adjustment free, operating with only an ac line voltage input.

The WJ-485 may be mounted in any orientation with-



out degradation of performance. Rugged construction of the tube, magnet, and power supply ensures reliable operation under vibrational forces of 10g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of -54° to $+71^{\circ}$ C. These environmental characteristics of the WJ-485 meet the corresponding requirements of MIL-E-5400, Class 2.

PERFORMANCE Frequency	Typical	Guaranteed
Noise figure, terminal	13.0 dB	15.0 dB max.
VSWR, input and output	1.5:1	2:1 max.
Power Output Overdrive Power Output Variation for	14 dBm	+12 dBm min.
Input Variation of 35 dB		10 dB max.
ELECTRICAL REQUIREMENTS ¹	Typical	Range
Primary Voltage	115 V ac	115 ±10 V ac
Primary Frequency	60 Hz	48 to 420 Hz
Primary Power		

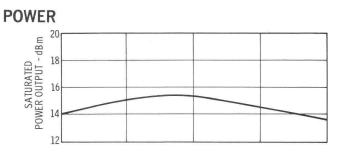
ENVIRONMENTAL CHARACTERISTICS²

Temperature
Vibration
a10 inch, double amplitude 5 to 45 Hz
b. 10 g, single amplitude 45 to 500 Hz
Shock 15 g, 11 ms

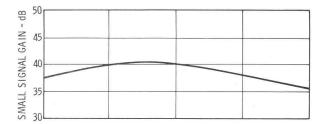
MECHANICAL CHARACTERISTICS

Height

(excluding connectors) 2 inches (51 mm) max.
Width 2 inches (51 mm) max.
Length 11 inches (279 mm) max.
Weight 3¾ pounds (1.70 Kg) max.
Primary power connection, Bendix receptacle PT07C-8-3p
RF connection (50 ohms, nominal) OSM, jack
Outline Drawing No WJ-290238



GAIN



NOISE

10

0

-10∟ -50

-30

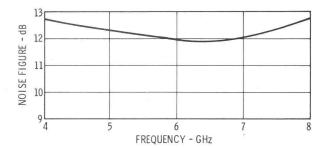
-40

-20

-10

POWER INPUT - dBm

POWER OUTPUT - dBm

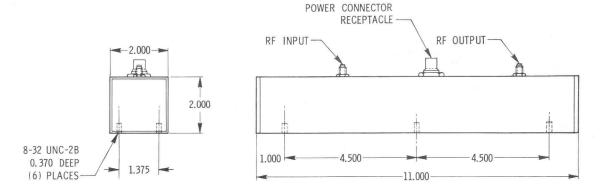


NOTE:

¹Every tube will meet the guaranteed performance specifications for any primary voltage and frequency within these ranges.

 $^2 These environmental characteristics meet the respective requirements of MIL-E-5400K, dated 24 May 68, class 2.$

OUTLINE DRAWING



4 GHz

1

8 GHz

10

0

20

NOVEMBER 1969

2 TO 4 GHz PPM-FOCUSED LOW-NOISE TWT LIMITER WITH INTEGRAL POWER SUPPLY WJ-486

- "JUST PLUG IT IN"
- MAXIMUM 10.0 dB VARIATION IN POWER OUTPUT OVER 35 dB POWER INPUT RANGE
- GUARANTEED +13 dBm POWER OUTPUT
- SMALL SIZE: 2x2x11 INCHES
- MEETS MIL-E-5400
 CLASS II ENVIRONMENT

The WJ-486 is one of a family of periodic-permanentmagnet low noise TWT limiters developed by Watkins-Johnson Company to meet the increasing demand for reliable microwave devices. It is completely self-contained, and adjustment free, operating with only an ac line voltage input.

The WJ-486 may be mounted in any orientation with-



out degradation of performance. Rugged construction of the tube, magnet, and power supply ensures reliable operation under vibrational forces of 10g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of -54° to $+71^{\circ}$ C. These environmental characteristics of the WJ-486 meet the corresponding requirements of MIL-E-5400, Class 2.

PERFORMANCE Frequency	Typical	Guaranteed
Noise figure, terminal		
Gain, small signal	.43 dB	40 dB min.
VSWR, input and output	.1.5:1	2:1 max.
Power Output	.+17 dBm +	13 dBm min.
Overdrive Power Output Variation for Input Variation of 35 dB	. 7 dB	10 dB max.
ELECTRICAL REQUIREMENTS ¹	Typical	Range
Primary voltage	.115 Vac	115 ±10 Vac
Primary frequency	.60 Hz	48 to 420 Hz
Primary Power		

ENVIRONMENTAL CHARACTERISTICS²

Temperature	-54°C to +71°C
Vibration	
a10 inch, double amplitude	
b. 10 g, single amplitude	45 to 500 Hz
Shock	15 g, 11 ms

MECHANICAL CHARACTERISTICS

Height (excluding

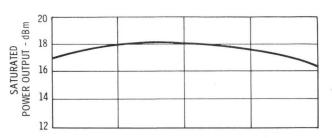
connectors)
Width2 inches (51 mm) max.
Length11 inches (279 mm) max.
Weight 3.5 pounds (1.59 Kg) max.
Primary power connection,
Bendix receptaclePT07C-8-3p
RF connection (50 ohms, nominal)OSM, jack
Outline Drawing No WJ-290238

NOTE:

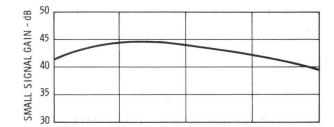
¹Every tube will meet the guaranteed performance specifications for any primary voltage and frequency within these ranges.

²These environmental characteristics meet the respective requirements of MIL-E-5400K, dated 24 May 68, class 2.

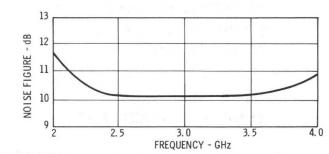




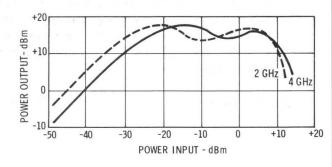
GAIN

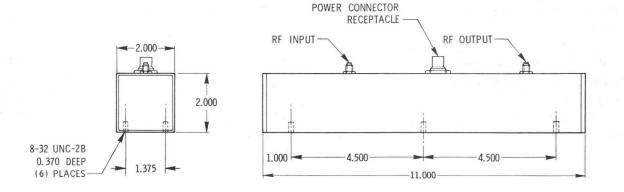


NOISE



OVERDRIVE





AUGUST 1969 🗱

7 TO 11 GHz MEDIUM-POWER LOW-NOISE TRAVELING-WAVE TUBE WJ-492-1



WJ-492-1 is a medium-power low-noise traveling-wave tube designed for use in airborne and space applications. It is particularly suitable for applications where gain variation and phase linearity are important (the tube provides fine structure gain variation of ± 0.5 dB). A unique feature of the tube is its low cathode current density: a W-J innovation in low-noise electron gun design allows cathode loading of only 0.8 A/cm². This feature ensures the user of extremely long tube life.

The use of Periodic-Permanent-Magnet (PPM) focus-

- OUTPUT POWER 3 WATTS MINIMUM
- PPM FOCUSING
- ESPECIALLY SUITABLE FOR AIRBORNE/SPACE APPLICATION
- EXTREMELY LOW FINE-STRUCTURE GAIN VARIATION

ing and metal-ceramic construction results in a compact, lightweight configuration. Alnico-8 magnets are used in the PPM-focusing system, making it insensitive to temperature variations over the operating range. Cooling of the tube is by conduction through the baseplate of the capsule.

Operating efficiency of the WJ-492-1 can be improved by depressing the collector voltage below the helix voltage. The tube may also be supplied with an integral power supply, resulting in a fully integrated TWT amplifier.

SPECIFICATIONS

PERFORMANCE	Typical	Guaranteed
Frequency		7.0 to 11.0 GHz
Saturated Power Output	.4 watts	3 watts, min.
Small Signal Gain	.45 dB	42 dB, min.
Small Signal Gain Variation		
Gross Fine Structure Small Signal Gain Variation	.±0.2 dB	±0.5 dB
Noise Figure	.20 dB	22 dB, max.

ELECTRICAL REQUIREMENTS	Typical	Range
Heater Voltage	.6.3 volts	6.0 to 6.6 volts
Grid Voltage ¹	.140 volts	120 to 150 volts
Helix Voltage ¹	.3100 volts	2900 to 3300 volts
Collector Voltage ¹	.1800 volts	1700 to 1900 volts
Cathode Current	.26 mA	23 to 30 mA
Helix Current	.0.5 mA	0.2 to 3 mA
Heater Current	.0.4 A	0.3 to 0.5 A

NOTE 1. Voltage with respect to cathode. 2. Helix is grounded to tube capsule. *Supersedes WJ-492-1 Technical Data Sheet Dated December 1968

WJ-492-1

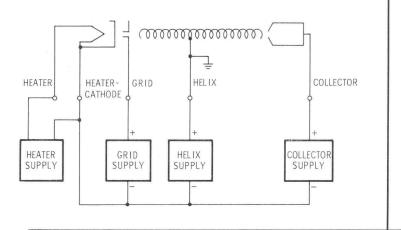
MECHANICAL CHARACTERISTICS

Cooling Conduction through baseplate ³
Length 12 inches, max.
Height 1.90 inch, max.
Width 1.40 inch, max.
Weight 2.0 lbs. max.
Connectors OSM, Jack
Focusing PPM

ENVIRONMENTAL CAPABILITY

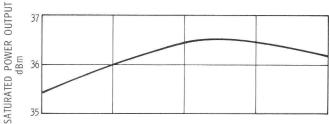
Temperature —54°C to 85°C (baseplate)
Vibration (120-2000 cycles) 5 Grms
Shock
Altitude Any
³ Air cooling available upon request.

SCHEMATIC DIAGRAM

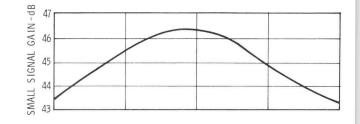


RF ELECTRICAL PERFORMANCE CHARACTERISTICS

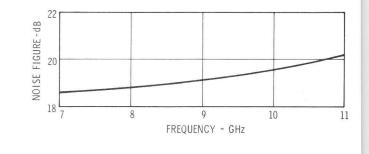


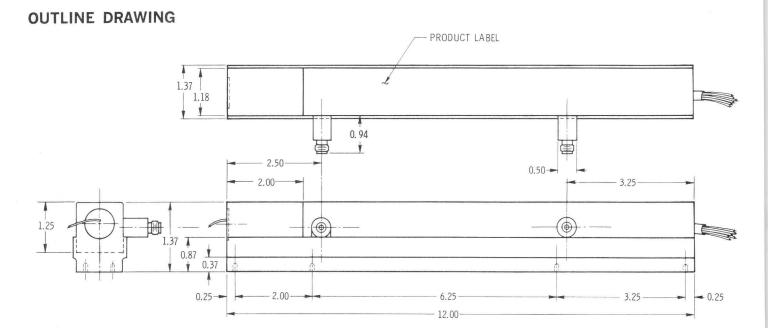


GAIN



NOISE





APRIL 1969

8 TO 12.4 GHz HIGH-GAIN **MEDIUM-POWER LOW-NOISE** TRAVELING-WAVE TUBE WJ-492-2

- SMALL SIGNAL GAIN 60 dB MINIMUM
- OUTPUT POWER **3 WATTS MINIMUM**
- PPM FOCUSING
- ESPECIALLY SUITABLE FOR AIRBORNE/SPACE APPLICATION

pact, lightweight configuration. Alnico-8 magnets are used in the PPM-focusing system, making it insensitive to temperature variations over the operating range. Cooling of the tube is by conduction through the baseplate of the capsule.

Operating efficiency of the WJ-492-2 can be improved by depressing the collector voltage below the helix voltage. The tube may also be supplied with an integral power supply, resulting in a fully integrated TWT amplifier.

SPECIFICATIONS

PERFORMANCE	Typical	Guaranteed
Frequency		8.0 to 12.4 GHz
Saturated Power Output	.4 watts	3 watts, min.
Small Signal Gain	.62 dB	60 dB, min.
Small Signal Gain Variation	. ±2.0 dB	. ±3.0 dB, max.
Gross Fine Structure Small Signal Gain Variation	. ±1.0 dB	±1.5 dB
Noise Figure	.20 dB	22 dB, max.

ELECTRICAL REQUIREMENTS	Typical	Range
Heater Voltage	.6.3 volts	6.0 to 6.6 volts
Grid Voltage ¹	25 volts	
Helix Voltage ¹	.3100 volts	2800 to 3200 volts
Collector Voltage ¹	.1800 volts	1700 to 3200 volts
Cathode Current	.37 mA	35 to 40 mA
Helix Current	.0.5 mA	0.2 to 4.0 mA
Heater Current	.0.4 A	0.3 to 0.5 A

NOTE 1. Voltage with respect to cathode.

2. Helix is at ground potential.

WJ-492-2 is a medium-power low-noise traveling-wave

tube designed for use in airborne and space applica-

tions. It is particularly suitable for applications where

high gain and low noise are important. A unique

feature of the tube is its low cathode current density:

a W-J innovation in low-noise electron gun design al-

lows cathode loading of only 1.5 A/cm². This feature

The use of Periodic-Permanent-Magnet (PPM) focus-

ing and metal-ceramic construction results in a com-

ensures the user of long tube life.

WJ-492-2

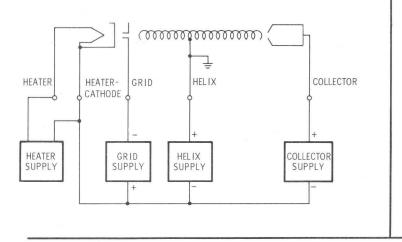
MECHANICAL CHARACTERISTICS

Cooling Conduction through baseplate ³
Length 12 inches, max.
Height 1.90 inch, max.
Width 1.40 inch, max.
Weight 2.0 lbs. max.
Connectors OSM, Jack
Focusing PPM

ENVIRONMENTAL CAPABILITY

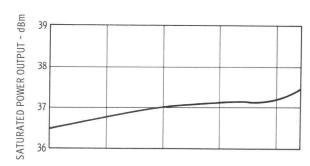
Temperature54°C to 85°C (baseplate)
Vibration (120-2000 cycles) 5 Grms
Shock
Altitude Any
³ Air cooling available upon request.

SCHEMATIC DIAGRAM

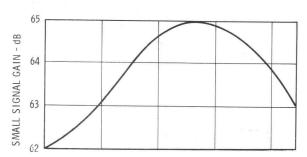


RF ELECTRICAL PERFORMANCE CHARACTERISTICS

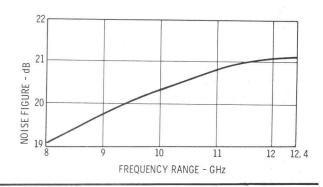
POWER

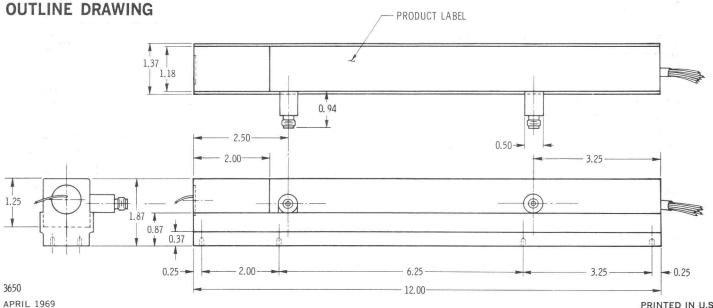


GAIN



NOISE





YIG-TUNED L-BAND TRANSISTOR OSCILLATOR

September 1968 *

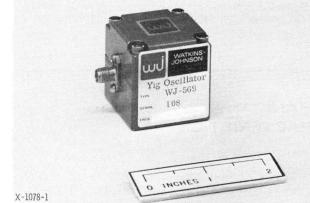
WJ-569

The WJ-569 is one of a family of lightweight, electronically tuned, transistor oscillators produced by Watkins-Johnson Company. YIG tuning provides excellent linearity over the full octave for this solid-state, microwave signal source. The use of high "Q" YIG spheres for frequency control ensures an extremely clean output spectrum.

The WJ-569 is designed for substantial derating of power dissipation in the transistor, resulting in extremely high reliability. All power input lines are isolated by low pass filters to prevent RFI. The RF circuit is isolated from the dc circuit, thus enabling the input voltages to be common to other circuit voltages if desired.

Complex auxiliary electrical circuitry is eliminated in the WJ-569. A self-regulating, proportionalcontrolled heater, which stabilizes the temperature of the YIG sphere, requires only the application of unregulated power for operation. The built-in dc biasing network, which provides over-voltage and reverse-polarity protection, requires only one voltage to drive the transistor.

Frequency tuning of the WJ-569 is accomplished by changing the current which flows through the



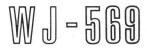
tuning coils, producing a magnetic bias for the YIG resonator. Since the WJ-569 is magnetically shielded, it produces negligible stray magnetic fields and remains unaffected by moderate magnetic environments.

YIG-tuned oscillators with wider bandwidth, higher outputs, lower power variation, higher sweep rate, and different tuning sensitivity can be made to order.

SPECIFICATIONS

RF PERFORMANCE Nominal Frequency Band	Typical	Guaranteed
Power Output into Load VSWR = 1.25 Power Output Variation (matched load) Fine Grain Variation (matched load)	.15 to 30 mW	10 mW, min.
Spurious Oscillation Ratio of Signal to 2nd Harmonic Output Ratio of Signal to all other Spurious Outputs Output Impedance	.20 dB	13 dB, min. 50 dB, min.¹
Sensitivity to Supply Voltage Frequency Drift, —30°C to 65°C Pulling Figure, VSWR 1.5:1 at any phase Residual FM, Peak to Peak	.0.3 MHz/V	10 MHz, max.
TUNING CHARACTERISTICSSweep Rate (Sawtooth)Tuning LinearityHysteresis (maximum)Tuning SensitivityTuning Coil ResistanceTuning Coil Inductance	.±0.1% .2 MHz .5.7 MHz/mA .5 ohm	
*Supersedes WJ-569 Data Sheet dated May, 1968		

¹Measured for design verification only

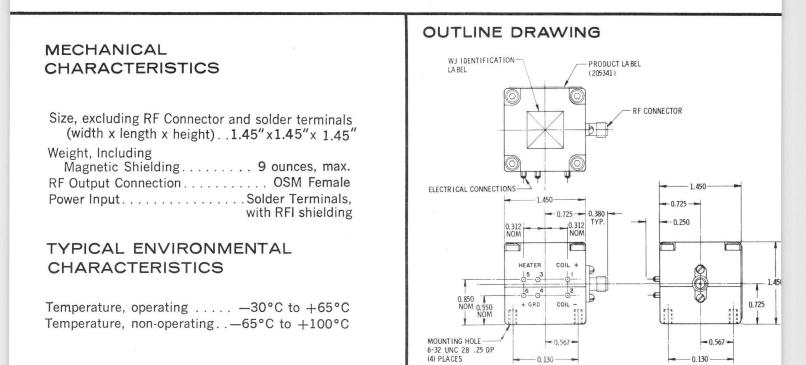


SPECIFICATIONS (Cont'd)

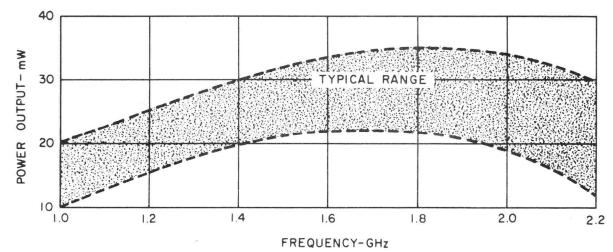
ELECTRICAL REQUIREMENTS

*Oscillator Voltage, negative side ground	15 ±0.2 Vdc	
Oscillator Current		
**YIG Heater Power at -30°C, Steady State	1.5 W	
Voltage		28 Volts, max.

*Protective biasing circuit employed to prevent transistor damage from over-voltage or reverse voltages. **YIG heater is self-regulating, proportional-controlled, temperature-sensitive resistor.



TUNING CURVE



YIG-TUNED P-BAND TRANSISTOR OSCILLATOR



May 1968 *

The WJ-571 is one of a family of lightweight, electronically tuned, transistor oscillators produced by Watkins-Johnson Company. YIG tuning provides excellent linearity over the full octave for this solid-state, microwave signal source. The use of high "Q" YIG spheres for frequency control ensures an extremely clean output spectrum.

The WJ-571 is designed for substantial derating of power dissipation in the transistor, resulting in extremely high reliability. All power input lines are isolated by low pass filters to prevent RFI. The RF circuit is isolated from the dc circuit, thus enabling the input voltages to be common to other circuit voltages if desired.

Complex auxiliary electrical circuitry is eliminated in the WJ-571. A self-regulating, proportionalcontrolled heater, which stabilizes the temperature of the YIG sphere, requires only the application of unregulated power for operation. The built-in dc biasing network, which provides over-voltage and reverse-polarity protection, requires only one voltage to drive the transistor.

Frequency tuning of the WJ-571 is accomplished by changing the current which flows through the



3550

tuning coils, producing a magnetic bias for the YIG resonator. Since the WJ-571 is magnetically shielded, it produces negligible stray magnetic fields and remains unaffected by moderate magnetic environments.

YIG-tuned oscillators with wider bandwidth, higher outputs, lower power variation, higher sweep rate, and different tuning sensitivity can be made to order.

SPECIFICATIONS

RF PERFORMANCE Nominal Frequency Band Power Output into Load VSWR = 1.25 Power Output Variation (matched load) Fine Grain Variation (matched load)	.3 dB	Guaranteed . 0.5 to 1.0 GHz 10 mW min. 6 dB max.
Spurious Oscillation Ratio of Signal to 2nd Harmonic Output Ratio of Signal to all Other Spurious Outputs Output Impedance Sensitivity to Supply Voltage Frequency Drift, —30°C to 65°C Pulling Figure, VSWR 1.5:1 at any phase Residual FM, Peak to Peak	.60 dB .50 Ohms .0.3 MHz/V .5 MHz .5 MHz	1 MHz/V max. ¹ 12 MHz max.
TUNING CHARACTERISTICS Sweep Rate (Sawtooth) Tuning Linearity Hysteresis (maximum) Tuning Sensitivity Tuning Coil Resistance Tuning Coil Inductance	.±0.2% .2 MHz .5.5 MHz/mA .9.5 Ohm	±0.3% max. 3 MHz max. ¹

*Supersedes WJ-571 Data Sheet dated March 1968 ¹Measured for design verification only



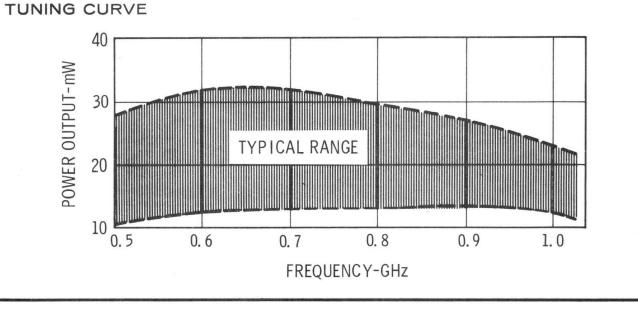
SPECIFICATIONS (Cont'd)

ELECTRICAL REQUIREMENTS

*Oscillator Voltage, positive side ground	.—24 ±0.2 Vdc
Oscillator Current	45 mA
**YIG Heater Power at —30°C, Steady State	1.5 W
YIG Heater Voltage	

*Protective biasing circuit employed to prevent transistor damage from over-voltage or reverse voltages. **YIG heater is self-regulating, proportional-controlled, temperature-sensitive resistor.

MECHANICAL OUTLINE DRAWING **CHARACTERISTICS** - 0.35 NOM. WJ IDENTIFICATION Size excluding RF Connector and Solder Terminals LABEL (205579). ELECTRICAL CONNECTIONS (width x length x height). . . . 1.4" x 1.4" x 1.4" WJ PRODUCT Weight, including LABEL (205339) Magnetic Shielding 9 ounces, max. RF Output Connection OSM Female DC Input Connection Solder Terminals with RFI Shielding 1.45 1.45 MAX 0.380-MAX 0.725 **RF CONNECTOR** 0.280 NOM. TYPICAL ENVIRONMENTAL ¥. Ø CHARACTERISTICS 1.45 0.560 MAX I NOM. 0.72 Temperature, operating-30°C to +65°C Temperature, non-operating ... -65°C to +100°C MOUNTING HOLE 6-32 UNC 2B 0.38 0.567 0.375 DP (4) PLACES - 1. 130 ----NOM. 0.750



YIG-TUNED S-BAND TRANSISTOR OSCILLATOR

October 1968

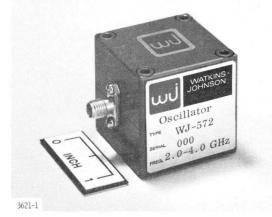
Guaranteed

The WJ-572 is one of a family of lightweight, electronically tuned, transistor oscillators produced by Watkins-Johnson Company. YIG tuning provides excellent linearity over the full octave for this solid-state, microwave signal source. The use of high "Q" YIG spheres for frequency control ensures an extremely clean output spectrum.

The WJ-572 is designed for substantial derating of power dissipation in the transistor, resulting in extremely high reliability. All power input lines are isolated by low pass filters to prevent RFI. The RF circuit is isolated from the dc circuit, thus enabling the input voltages to be common to other circuit voltages if desired.

Complex auxiliary electrical circuitry is eliminated in the WJ-572. A self-regulating, proportionalcontrolled heater, which stabilizes the temperature of the YIG sphere, requires only the application of unregulated power for operation. The built-in dc biasing network, which provides over-voltage and reverse-polarity protection, requires only one voltage to drive the transistor.

Frequency tuning of the WJ-572 is accomplished by changing the current which flows through the tuning coils, producing a magnetic bias for the YIG resonator. Since the WJ-572 is magnetically



shielded, it produces negligible stray magnetic fields and remains unaffected by moderate magnetic environments.

YIG-tuned oscillators with wider bandwidth, higher outputs, lower power variation, higher sweep rate, and different tuning sensitivity can be made to order. For example, a slightly modified version of the WJ-572 capable of delivering a minimum of 10 mW power over the frequency band extending from 2 to 3 GHz is available.

RF PERFORMANCE

•••		<i>,</i> ,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,			
	Nominal Frequency Band				
	Power Output into Load VSWR = 1.25	.3-5 mW	2 mW, min.		
	Power Output variation (matched load)	.4 dB	6 dB, max.		
	Fine Grain Variation (matched load)	.1.5 dB/50 MHz			
	Spurious Oscillation				
	Ratio of Signal to 2nd Harmonic Output	.20 dB	10 dB, min.		
	Ratio of Signal to all other Spurious Outputs	.60 dB	50 dB, min. ¹		
	Output Impedance	. 50 ohms			
	Sensitivity to Supply Voltage	.0.3 MHz/V	1 MHz/V, max. ¹		
	Frequency Drift,	.10 MHz	. 20 MHz, max.		
	Pulling Figure, VSWR 1.5:1 at any phase	.3 MHz	6 MHz, max. ¹		
	Residual FM, Peak to Peak	.5 kHz			
Т	TUNING CHARACTERISTICS				
	Sweep Rate (Sawtooth)	.100 Hz			
	Tuning Linearity		±0.4%, max.		
	Hysteresis (maximum)				
	Tuning Sensitivity	.11.5 MHz/mA			

SPECIFICATIONS

Typical

¹Measured for design verification only.

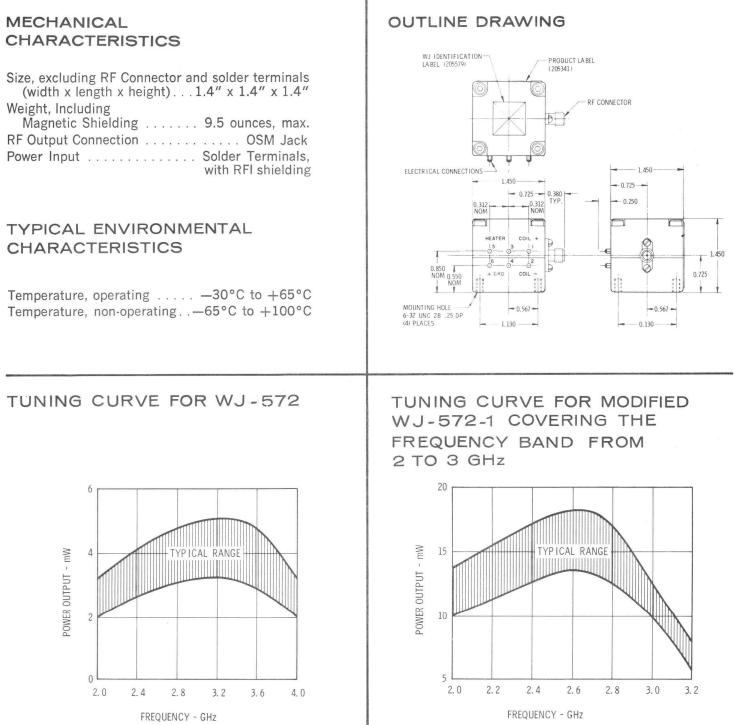
Tuning Coil Resistance8 ohm

SPECIFICATIONS (Cont'd)



ELECTRICAL REQUIREMENTS	Typical	Guaranteed
*Oscillator Voltage, negative side ground	15 ±0.2 Vdc	
Oscillator Current		60 mA, max.
**YIG Heater Power at -30°C, Steady State .		1.5 W, max.
Voltage		28 Volts, max.

*Protective biasing circuit employed to prevent transistor damage from over-voltage or reverse voltages. **YIG heater is self-regulating, proportional-controlled, temperature-sensitive resistor.



1 TO 2 GHz COMPACT TWO-STAGE YIG FILTER

WJ-611

September 1968

The WJ-611 is one of a family of compact YIG filters incorporating a self-shielding magnetic circuit. Features of this electronically tuned YIG filter include high reliability, long life, ruggedness, small size, and high thermal stability. In addition, the tuning power requirement is less than ¼ watt.

For specific requirements, the WJ-611 can be produced to cover any frequency range in the L-band up to 1.2 octaves. Optional bandwidths are available for specific requirements between 8 and 40 MHz. In addition, the tuning sensitivity may be changed to 9 MHz/mA without increasing the tuning power requirement.



SPECIFICATIONS

RF PERFORMANCE	Typical	Nominal	Guaranteed
Frequency Range			
Bandwidth (3 dB) (minimum)			20 MHz
Insertion Loss (maximum)	2.5 dB		3.0 dB
Off Resonance Isolation (minimum)	50 dB		40 dB
Off Resonance Spurious (minimum)			25 dB
Directivity	Reciprocal		
Passband Ripple (maximum)	0.5 dB		1.0 dB
Passband Spurious (maximum)	1.0 dB		2.0 dB
Passband VSWR (maximum)	1.5:1		2.0:1
Limiting Level (minimum)	+20 dBm		+10 dBm
Selectivity (per octave)	12 dB		

TUNING CHARACTERISTICS

Sensitivity	17 MHz/mA
Coil Resistance	10 ohms
Coil Inductance	110 mH
Time Constant	1.0 ms
Deviation from Linear	±2 MHz
Hysteresis	
Frequency Drift over Temp. Range 0-60°C	8 MHz
Zero Current Frequency	Not Biased

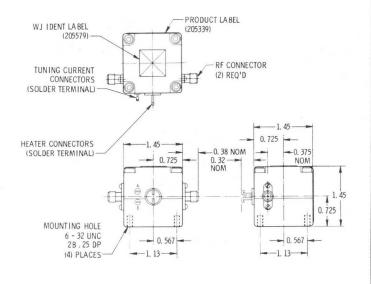
MECHANICAL CHARACTERISTICS

Size (excluding connectors) 1.4 x 1.4 x 1.4 inches
Weight
RF Connectors OSM Jack
Outline Drawing No

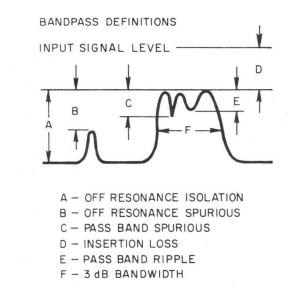
HEATER CHARACTERISTICS

Operating Voltage	22 to 30 Volts
Operating Current:	
Surge at 0°C	750 mA
Steady State at 0°C	250 mA

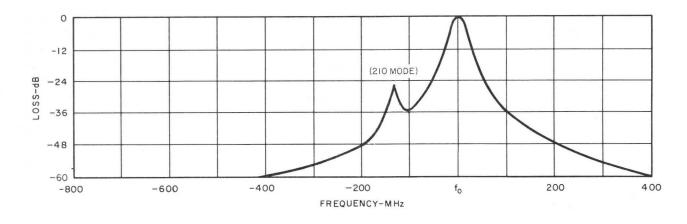
OUTLINE DRAWING



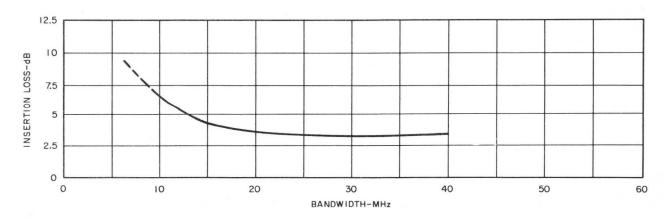
MEASUREMENT DEFINITIONS



SELECTIVITY CURVE



BANDWIDTH vs. LOSS





2 TO 4 GHz COMPACT TWO-STAGE YIG FILTER

September 1968

The WJ-612, one of a family of electronically tuned compact YIG filters produced by Watkins-Johnson Company, offers high reliability, long life, ruggedness, and high thermal stability in a small package. These features are primarily the result of a built-in self-shielding magnetic circuit. The tuning power requirement is less than 1 watt for this YIG filter.

The WJ-612 is available with several options. It can be produced to cover any frequency range in the S-band up to 1.2 octaves. Bandwidths other than specified are available between 10 and 50 MHz. The tuning sensitivity may be changed to 9 MHz/mA without increasing the tuning power requirement.



SPECIFICATIONS

RF PERFORMANCE	Typical	Nominal	Guaranteed
Frequency Range			2.0 to 4.0 GHz
Bandwidth (3 dB) (minimum)			20 MHz
Insertion Loss (maximum)	2.5 dB		3.0 dB
Off Resonance Isolation (minimum)	60 dB		50 dB
Off Resonance Spurious (minimum)			25 dB
Directivity	Reciprocal		
Passband Ripple (maximum)			1.0 dB
Passband Spurious (maximum)			1.0 dB
Passband VSWR (maximum)	1.5:1		2.0:1
Limiting Level (minimum)	+20 dBm		+10 dBm
Selectivity (per octave)	12 dB		

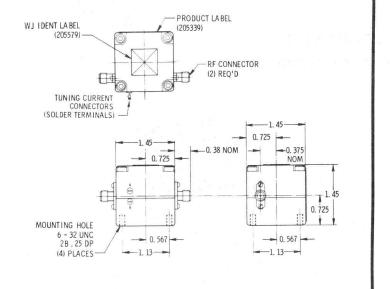
TUNING CHARACTERISTICS

Sensitivity	17 MHz/mA
Coil Resistance	10 ohms
Coil Inductance	110 mH
Time Constant	1 ms
Deviation from Linear	. ±3 MHz
Hysteresis	. 10 MHz
Frequency Drift over Temp. Range 0-60°C	8 MHz
Zero Current Frequency	Not Biased

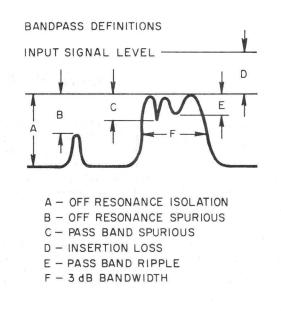
MECHANICAL CHARACTERISTICS

Size (excluding connectors) 1.4 x 1.4 x 1.4 inches
Weight 12 ounces
RF Connectors OSM Jack
Outline Drawing No

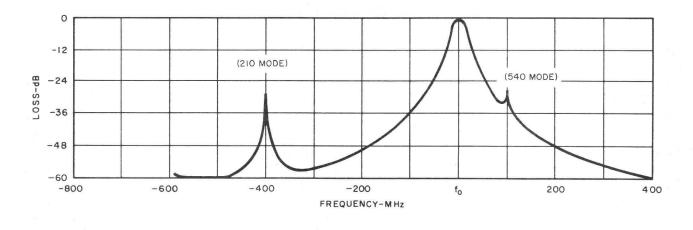
WJ-612 outline drawing

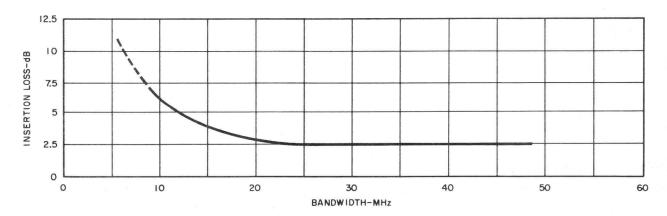


MEASUREMENT DEFINITION



SELECTIVITY CURVE







4 TO 8 GHz COMPACT TWO-STAGE YIG FILTER

September 1968

The WJ-613 is one of a family of electronically tuned, compact YIG filters produced by Watkins-Johnson Company. A self-shielding magnetic circuit built into the WJ-613 ensures high reliability, long life, ruggedness, and high thermal stability in a compact filter. A low tuning power requirement (less than 2 watts) is also featured in this YIG filter.

For specific requirements, the WJ-613 can be produced to cover any frequency range in the C-band up to 1.2 octaves. Optional bandwidths are available for specific requirements between 10 and 60 MHz. In addition, the tuning sensitivity may be changed to 9 MHz/mA without increasing the tuning power requirement.



SPECIFICATIONS

RF PERFORMANCE	Typical	Nominal	Guaranteed
Frequency Range			
Bandwidth (3 dB) (minimum)	.2.5 dB		25 MHz
Off Resonance Isolation (minimum)	60 dB		50 dB
Off Resonance Spurious (minimum)			25 dB
Directivity	. Reciprocal		
Passband Ripple (maximum)	.0.5 dB		1.0 dB
Passband Spurious (maximum)	.0.5 dB		1.0 dB
Passband VSWR (maximum)	1.5:1		2.0:1
Limiting Level (minimum)	+20 dBm		+10 dBm
Selectivity (per octave)	12 dB		

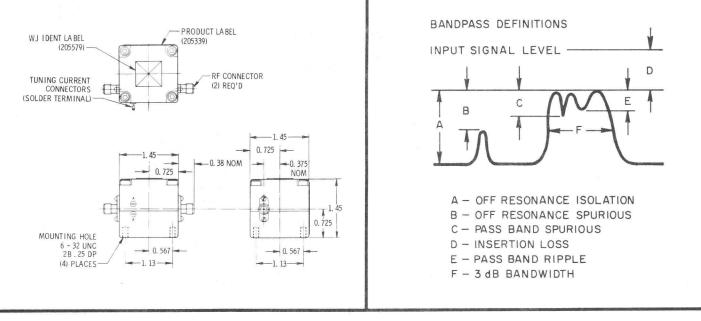
TUNING CHARACTERISTICS

Sensitivity	7 MHz/mA
Coil Resistance	10 ohms
Coil Inductance	110 mH
Time Constant	. 1 ms
Deviation from Linear	. ±5 MHz
Hysteresis	
Frequency Drift over Temp. Range 0-60°C	
Zero Current Frequency	Not Biased

MECHANICAL CHARACTERISTICS

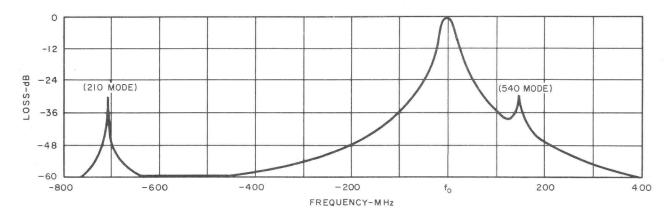
Size (excluding connectors) 1.4 x 1.4 x 1.4 inches
Weight
RF Connectors OSM Jack
Outline Drawing No

OUTLINE DRAWING

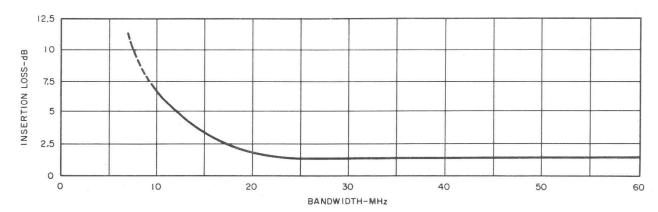


MEASUREMENT DEFINITION

SELECTIVITY CURVE



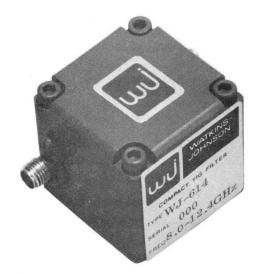
BANDWIDTH vs. LOSS



WATKINS = JOHNSON COMPANY 3333 HILLVIEW AVENUE = STANFORD INDUSTRIAL PARK PALO ALTO, CALIFORNIA 94304 TWX 910-373-1253 PHONE (415) 326-8830 Telex: 348-415

FEBRUARY 1970 *

8 TO 12 GHz COMPACT TWO-STAGE YIG FILTER WJ-614



SPECIFICATIONS

RF PERFORMANCE Frequency Range Bandwidth (3 dB) (minimum)	Typical	Nominal	8.0 to 12.4 GHz
Insertion Loss (maximum) Off Resonance Isolation (minimum) Off Resonance Spurious (minimum)	.2.0 dB		3.0 dB 50 dB
Directivity	. Reciprocal . 0.5 dB		1.0 dB
Passband Spurious (maximum) Passband VSWR (maximum) Limiting Level (minimum)	. 1.5:1		2.0:1
Selectivity (per octave)			1
Sensitivity Coil Resistance Coil Inductance Time Constant Deviation from Linear Hysteresis Frequency Drift over Temperature Range 0-60°C		5.5 ohms 60 mH 1.0 ms ±8 MHz 15 MHz	
Zero Current Frequency			6 x 26 x 26 mm)
Size (excluding connectors)			ounces (340 g)
* Supersedes WJ-614 Technical Data Sheet dated September 1968.			

* Supersedes WJ-614 Technical Data Sheet dated September 1968.

The WJ-614, one of a family of compact YIG filters incorporating a self-shielding magnetic circuit, features high reliability, long life,ruggedness, small size, and high thermal stability. The tuning power requirement for this electronically tuned YIG filter is less than 3.0 watts. The WJ-614 can be produced to cover any frequency range in the X-band up to 5 GHz. Bandwidths other than specified are available between

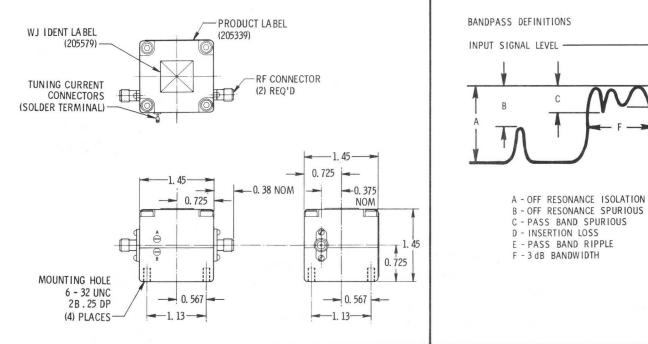
15 and 100 MHz.

OUTLINE DRAWING

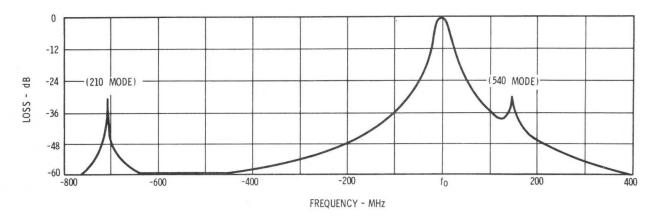
MEASUREMENT DEFINITIONS

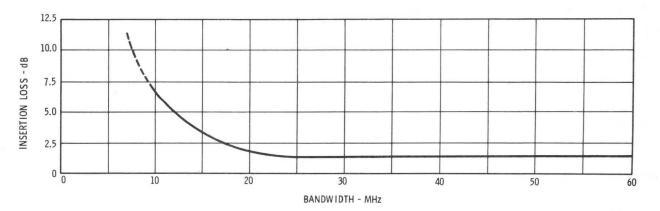
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SELECTIVITY CURVE







1 TO 2 GHz COMPACT FOUR-STAGE YIG FILTER

The WJ-615 is one of a family of compact YIG filters incorporating a self-shielding magnetic circuit. Features of this electronically tuned YIG filter include high reliability, long life, ruggedness, small size, and high thermal stability. In addition, the tuning power requirement is less than 1/4 watt.

For specific requirements, the WJ-615 can be produced to cover any frequency range in the L-band up to 1.2 octaves. Optional bandwidths are available for specific requirements between 8 and 50 MHz. In addition, the tuning sensitivity may be changed to 9 MHz/mA without increasing the tuning power requirement.



SPECIFICATIONS

RF PERFORMANCE	Typical	Nominal	Guaranteed
Frequency Range Bandwidth (3 dB) (minimum)		1.0	to 2.0 GHz
Insertion Loss (maximum)	. 3.0 dB		6.0 dB
Off Resonance Isolation (minimum)	. 80 dB		70 dB
Off Resonance Spurious (minimum)			50 dB
Directivity			
Passband Ripple (maximum)			
Passband Spurious (maximum)	. 1.0 dB		1.5 dB
Passband VSWR	. 1.5:1		2:1
Limiting Level (minimum)	. +20 dBm		. +10 dBm
Selectivity (per octave)			

TUNING CHARACTERISTICS

Sensitivity	17 MHz/mA
Coil Resistance	10 ohms
Coil Inductance	110 mH
Time Constant	1.0 ms
Deviation from Linear	±2 MHz
Hysteresis	4 MHz
Frequency Drift over Temp. Range 0-60°C	8 MHz
Zero Current Frequency	. Not Biased

MECHANICAL CHARACTERISTICS

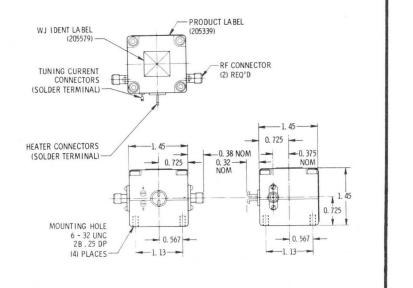
Size (excluding connectors) 1.4 x 1.4 x 1.4 inches	
Weight	
RF Connectors OSM Jack	
Outline Drawing No. 290050	

HEATER CHARACTERISTICS

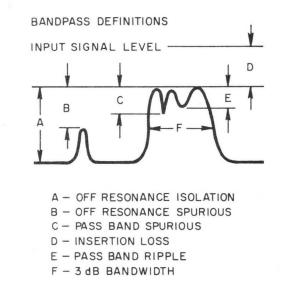
Operating Voltage	2 to 30 Volts
Operating Current:	
Surge at 0°C	750 mA
Steady State at 0°C	250 mA

*Supersedes WJ-615 Data Sheet dated May 1968

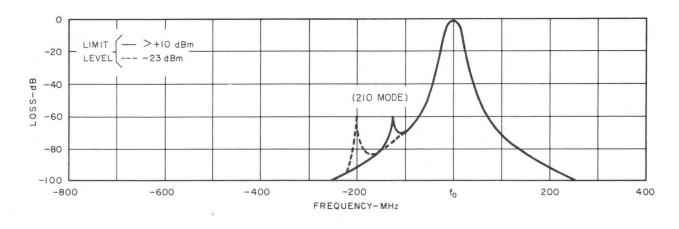
OUTLINE DRAWING



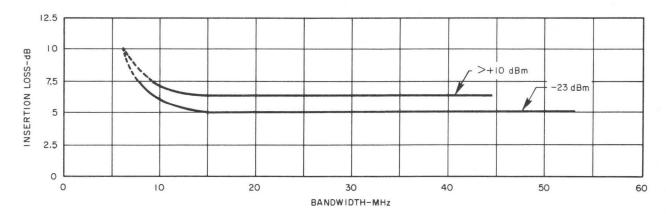




SELECTIVITY CURVE









September 1968

2 TO 4 GHz FOUR-STAGE COMPACT YIG FILTER

The WJ-616, one of a family of electronically tuned compact YIG filters produced by Watkins-Johnson Company, offers high reliability, long life, ruggedness, and high thermal stability in a small package. These features are primarily the result of a built-in self-shielding magnetic circuit. The tuning power requirement is less than 1 watt for this compact YIG filter.

The WJ-616 is available with several options. It can be produced to cover any frequency range in the S-band up to 1.2 octaves. Bandwidths other than specified are available between 8 and 50 MHz. The tuning sensitivity may be changed to 9 MHz/mA without increasing the tuning power requirement.



SPECIFICATIONS

RF PERFORMANCE	Typical	Nominal	Guaranteed
Frequency Range			2.0 to 4.0 GHz
Bandwidth (3 dB) (minimum)			20 MHz
Insertion Loss (maximum)	3.5 dB		5.0 dB
Off Resonance Isolation (minimum)			
Off Resonance Spurious (minimum)			
Directivity	Reciprocal		
Passband Ripple (maximum)	0.5 dB		1.0 dB
Passband Spurious (maximum)	1.0 dB		1.5 dB
Passband VSWR (maximum)	1.5:1		2.0:1
Limiting Level (minimum)	+20 dBm		+10 dBm
Selectivity (per octave)			

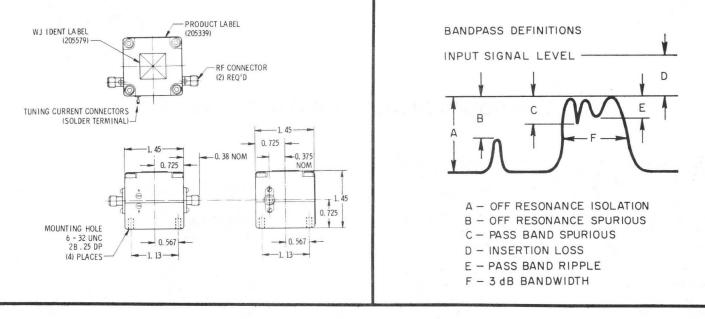
TUNING CHARACTERISTICS

Sensitivity	17 MHz/mA
Coil Resistance	. 10 ohms
Coil Inductance	110 mH
Time Constant	. 1.0 ms
Deviation from Linear	±3 MHz
Hysteresis	10 MHz
Frequency Drift over Temp. Range 0-60°C	8 MHz
Zero Current Frequency	

MECHANICAL CHARACTERISTICS

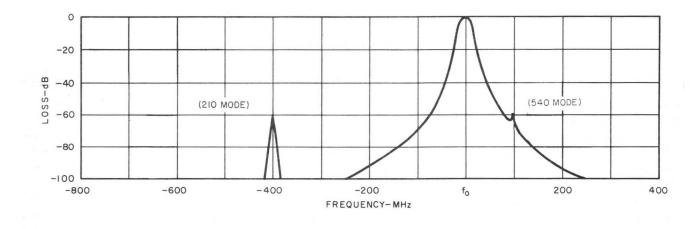
Size (excluding connectors) 1.4 x 1.4 x 1.4 inche	S
Weight	
RF Connectors OSM Jack	
Outline Drawing No	

OUTLINE DRAWING

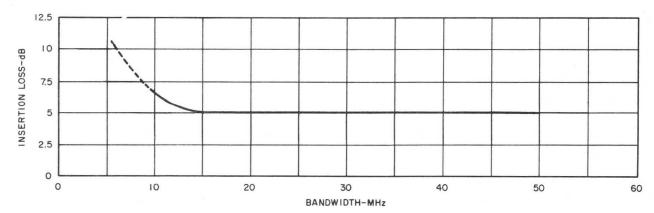


MEASUREMENT DEFINITIONS

SELECTIVITY CURVE



BANDWIDTH vs. LOSS



WATKINS = JOHNSON COMPANY 3333 HILLVIEW AVENUE = STANFORD INDUSTRIAL PARK PALO ALTO, CALIFORNIA 94304 TWX 910-373-1253 PHONE (415) 326-8830 Telex: 348-415

WJ-617

September 1968

4 TO 8 GHz COMPACT FOUR-STAGE YIG FILTER

The WJ-617 is one of a family of electronically tuned compact YIG filters produced by Watkins-Johnson Company. A self-shielding magnetic circuit built into the WJ-617 ensures high reliability, long life, ruggedness, and high thermal stability in a compact filter. A low tuning power requirement (less than 2 watts) is also featured in this YIG filter

For specific requirements, the WJ-617 can be produced to cover any frequency range in the C-band up to 1.2 octaves. Optional bandwidths are available for specific requirements between 10 and 50 MHz. In addition, the tuning sensitivity may be changed to 9 MHz/mA without increasing the tuning power requirement.



SPECIFICATIONS

RF PERFORMANCE	Typical	Nominal	Guaranteed
Frequency Range			4.0 to 8.0 GHz
Bandwidth (3 dB) (minimum)			20 MHz
Insertion Loss (maximum)	3.5 dB		5.0 dB
Off Resonance Isolation (minimum)	80 dB		70 dB
Off Resonance Spurious (minimum)			50 dB
Directivity	Reciprocal		
Passband Ripple (maximum)	0.5 dB		1.0 dB
Passband Spurious (maximum)			
Passband VSWR	1.5:1		2.0:1
Limiting Level (minimum)	+20 dBm		+10 dBm
Selectivity (per octave)	24 dB		

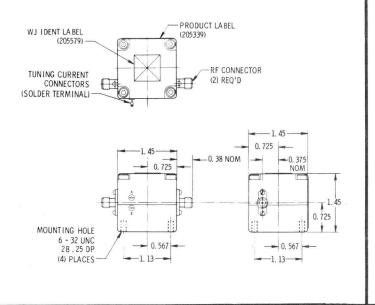
TUNING CHARACTERISTICS

Sensitivity
Coil Resistance
Coil Inductance 110 mH
Time Constant 1.0 ms
Deviation from Linear±5 MHz
Hysteresis
Frequency Drift over Temp. Range 0-60°C
Zero Current Frequency Not Biased

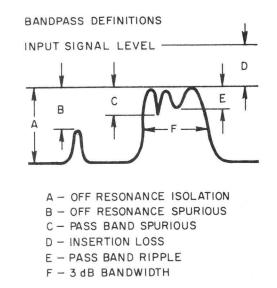
MECHANICAL CHARACTERISTICS

Size (excluding connectors) 1.4 x 1.4 x 1.4 inches
Weight
RF Connectors OSM Jack
Outline Drawing No

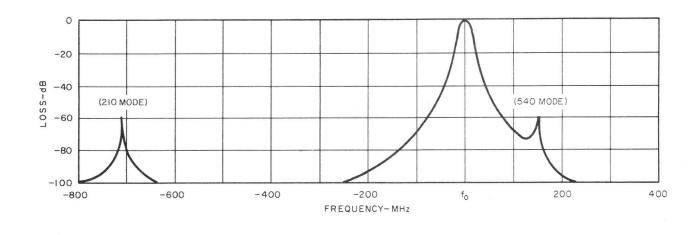
OUTLINE DRAWING



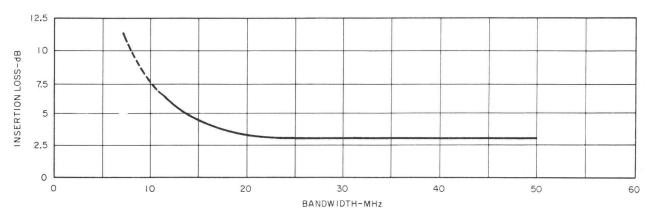
MEASUREMENT DEFINITIONS



SELECTIVITY CURVE



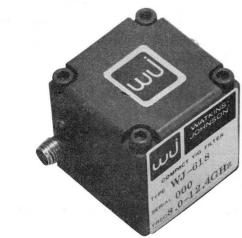
BANDWIDTH vs. LOSS



WATKINS **■** JOHNSON COMPANY 3333 HILLVIEW AVENUE **■** STANFORD INDUSTRIAL PARK PALO ALTO, CALIFORNIA 94304 TWX 910-373-1253 PHONE (415) 326-8830 Telex: 348-415

FEBRUARY 1970*

8 TO 12 GHz COMPACT FOUR-STAGE YIG FILTER WJ-618



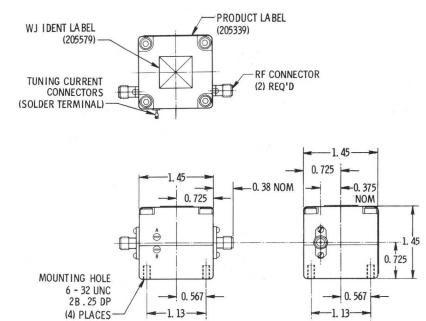
The WJ-618, one of a family of compact YIG filters incorporating a self-shielding magnetic circuit, features high reliability, long life ruggedness, small size, and high thermal stability. The tuning power requirement for this electronically tuned YIG filter is less than 3.0 watts. The WJ-618 can be produced to cover any frequency range in the X-band up to 5 GHz. Bandwidths other than specified are available between 15 and 60 MHz.

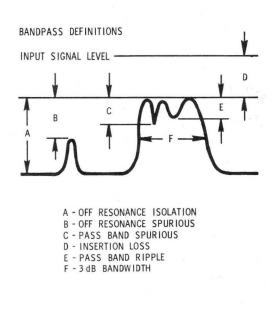
SPECIFICATIONS

RF PERFORMANCE Frequency Range Bandwidth (3 dB) (minimum) Insertion Loss (maximum) Off Resonance Isolation (minimum)	. 3.5 dB		8.0 to 12.4 GHz 20 MHz 5.0 dB 70 dB
Off Resonance Spurious (minimum)DirectivityPassband Ripple (maximum)Passband Spurious (maximum)Passband VSWR (maximum)Limiting Level (minimum)Selectivity (per octave)	. Reciprocal .0.5 dB .1.5 dB .1.5:1 .+20 dBm		1.0 dB 2.0 dB 2.0:1
TUNING CHARACTERISTICS Sensitivity Coil Resistance Coil Inductance Time Constant Deviation from Linear Hysteresis Frequency Drift over Temperature Range 0-60°C Zero Current Frequency		5.5 ohms 60 mH 1.0 ms ±8 MHz 15 MHz 12 MHz	
MECHANICAL CHARACTERISTICS Size (excluding connectors) Weight RF Connectors Outline Drawing No. * Supersedes WJ-618 Technical Data Sheet dated September 1968.			12 ounces (340 g) SMA Jack

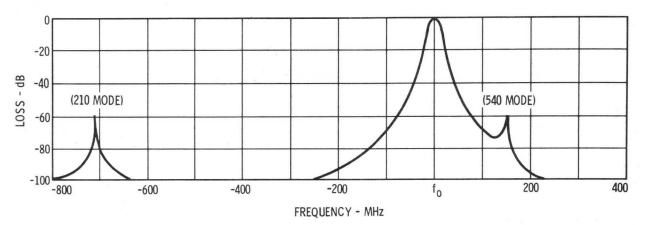
MEASUREMENT DEFINITIONS

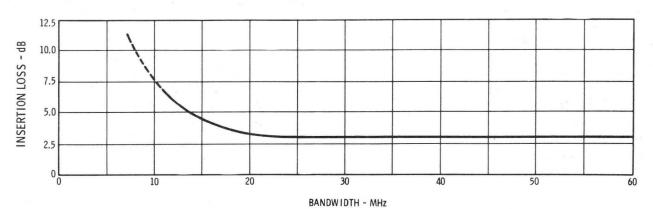
OUTLINE DRAWING





SELECTIVITY CURVE







1 TO 2 GHz COMPACT DUAL-CHANNEL TWO-STAGE YIG FILTER

The WJ-619 is one of a family of compact YIG filters incorporating a self-shielding magnetic circuit. Features of this electronically tuned YIG filter include high reliability, long life, ruggedness, small size, and high thermal stability. In addition, the tuning power requirement is less than ¹/₄ watt.

For specific requirements, the WJ-619 can be produced to cover any frequency range in the L-band up to 1.2 octaves. Optional bandwidths are available for specific requirements between 8 and 60 MHz. In addition, the tuning sensitivity may be changed to 9 MHz/mA without increasing the tuning power requirement.



SPECIFICATIONS

RF PERFORMANCE (per channel)			Guaranteed
Frequency Range			1.0 to 2.0 GHz
Bandwidth (3 dB) (minimum)			20 MHz
Insertion Loss (maximum)	2.0 dB		3.0 dB'
Off Resonance Isolation (minimum)	50 dB		40 dB
Off Resonance Spurious (minimum)			25 dB
Directivity	Reciprocal		
Passband Ripple (maximum)	0.5 dB		1.0 dB
Passband Spurious (maximum)	1.0 dB		2.0 dB
Passband VSWR (maximum)	1.5:1		2:1
Limiting Level (minimum)	+20 dBm		+10 dBm
Selectivity (per octave)	12 dB		
Isolation Between Channels (minimum)	50 dB		40 dB
Frequency Tracking Between Channels	4 MHz		6 MHz

TUNING CHARACTERISTICS

Sensitivity	17 MHz/mA
Coil Resistance	10 ohms
Coil Inductance	110 mH
Time Constant	1.0 ms
Deviation from Linear	agentes from the test
Hysteresis	4 MHz
Frequency Drift over Temp. Range 0-60°C	8 MHz
Zero Current Frequency	Not Biased

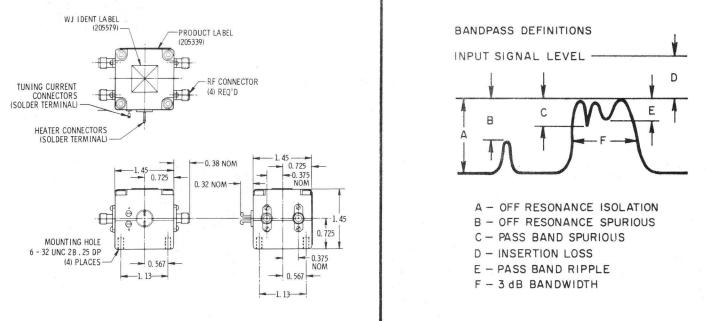
MECHANICAL CHARACTERISTICS

Size (excluding connectors)1.4 x 1.4 x 1.4 incheWeight12 ouncesRF ConnectorsOSM JackOutline Drawing No.290051	S
HEATER CHARACTERISTICS Operating Voltage	
Operating Current: Surge at 0°C	

¹Total of insertion loss of combined channels, passband spurious, and passband ripple not to exceed 8 db at any point of band.

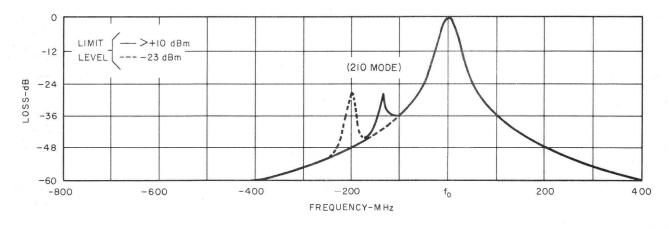
*Supersedes WJ-619 Data Sheet dated May 1968

OUTLINE DRAWING

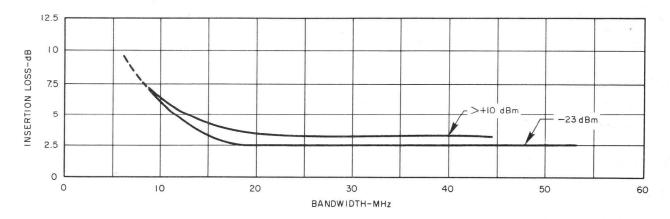


MEASUREMENT DEFINITIONS

SELECTIVITY CURVE







WATKINS = JOHNSON COMPANY 3333 HILLVIEW AVENUE = STANFORD INDUSTRIAL PARK PALO ALTO, CALIFORNIA 94304 TWX 910-373-1253 PHONE (415) 326-8830 Telex: 348-415

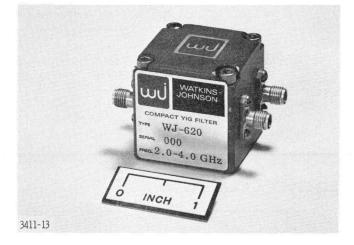


September 1968

2 TO 4 GHz COMPACT DUAL-CHANNEL TWO-STAGE YIG FILTER

The WJ-620, one of a family of electronically tuned compact YIG filters produced by Watkins-Johnson Company, offers high reliability, long life, ruggedness, small size, and high thermal stability. These features are primarily attributed to a built-in selfshielding magnetic circuit. The tuning power requirement is less than 1 watt for this YIG filter.

The WJ-620 is available with several options. It can be produced to cover any frequency range in the S-band up to 1.2 octaves. Bandwidths other than specified are available between 10 and 70 MHz. The tuning sensitivity may be changed to 9 MHz/mA without increasing the tuning power requirement.



SPECIFICATIONS

RF_PERFORMANCE (per channel)		Guaranteed
Frequency Range Bandwidth (3 dB) (minimum)		 20 MHz
Insertion Loss (maximum)	. 60 dB	 50 dB
Off Resonance Spurious (minimum)	. Reciprocal	
Passband Ripple (maximum)	. 1.0 dB	 1.5 dB
Passband VSWR (maximum)	. +20 dBm	 +10 dBm
Selectivity (per octave) Isolation Between Channels Frequency Tracking Between Channels	.50 dB	 40 dB 6 MHz

TUNING CHARACTERISTICS

onnia onniatorenao	
Sensitivity	Ą
Coil Resistance	
Coil Inductance	
Time Constant	
Deviation from Linear ±3 MHz	
Hysteresis	
Frequency Drift over Temp. Range 0-60°C8 MHz	
Zero Current Frequency Not Biased	1

MECHANICAL CHARACTERISTICS

Size (excluding connectors)	1.4 x 1.4 x 1.4 inches
Weight	12 ounces
RF Connectors	OSM Jack
Outline Drawing No.	

'Total of insertion loss of combined channels, passband spurious, and passband ripple not to exceed 8 db at any point of band.

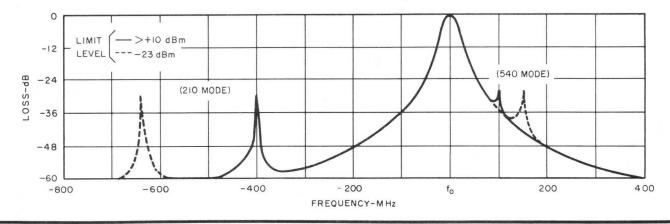
*Supersedes WJ-620 Data Sheet dated May 1968

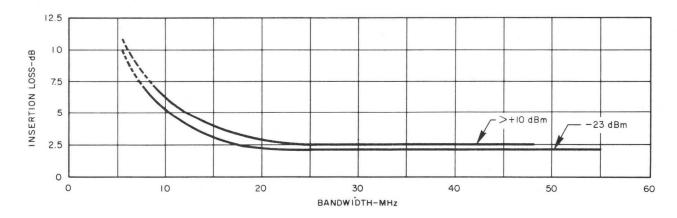
OUTLINE DRAWING

WJ I DENT LA BEL (205579) PRODUCT LABEL BANDPASS DEFINITIONS (205339) INPUT SIGNAL LEVEL ſ¢ Ð D RF CONNECTOR TUNING CURRENT (4) REQ'D CONNECTORS (SOLDER TERMINAL) Ε С В 1.45 -0.38 NOM 0.725 -0. 375 0.725 NOM 17 す A - OFF RESONANCE ISOLATION 1 1-1.45 **B - OFF RESONANCE SPURIOUS** 3 Ē 0. 725 C - PASS BAND SPURIOUS MOUNTING HOLE : . 6 - 32 UNC 28.25 DP D - INSERTION LOSS - 0.375 NOM (4) PLACES -0, 567 E - PASS BAND RIPPLE -1. 13---0.567 -F-3dB BANDWIDTH -1.13-

MEASUREMENT DEFINITIONS

SELECTIVITY CURVE





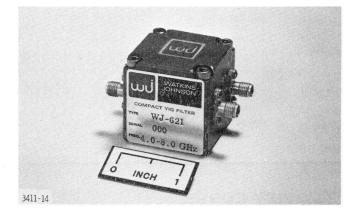


September 1968 *

4 TO 8 GHz COMPACT DUAL-CHANNEL TWO-STAGE YIG FILTER

The WJ-621 is one of a family of electronically tuned, compact YIG filters produced by Watkins-Johnson Company. A self-shielding magnetic circuit built into the WJ-621 results in high reliability, long life, ruggedness, small size, and high thermal stability. A low tuning power requirement (less than 4 watts) is also a feature of this YIG filter.

For specific requirements, the WJ-621 can be produced to cover any frequency range in the C-band up to 1.2 octaves. Optional bandwidths are available for specific requirements between 10 and 80 MHz. In addition, the tuning sensitivity may be changed to 9 MHz/mA without increasing the tuning power requirement.



SPECIFICATIONS

RF PERFORMANCE (per channel)	Typical	Nominal	Guaranteed
Frequency Range Bandwidth (3 dB) (minimum) Insertion Loss (maximum) Off Resonance Isolation (minimum) Off Resonance Spurious (minimum)	. 2.0 dB		25 MHz 3.0 dB ¹ 50 dB
Directivity Passband Ripple (maximum) Passband Spurious (maximum) Passband VSWR (maximum) Limiting Level (minimum) Selectivity (per octave)	.0.5 dB 0.5 dB 1.5:1 +20 dBm		1.5 dB 2:1
Isolation Between Channels	.50 dB		

TUNING CHARACTERISTICS

Sensitivity	. 17 MHz/mA
Coil Resistance	10 ohms
Coil Inductance	110 mH
Time Constant	1.0 ms
Deviation from Linear	±5 MHz
Hysteresis	20 MHz
Frequency Drift over Temp. Range 0-60°C	10 MHz
Zero Current Frequency	Not Biased

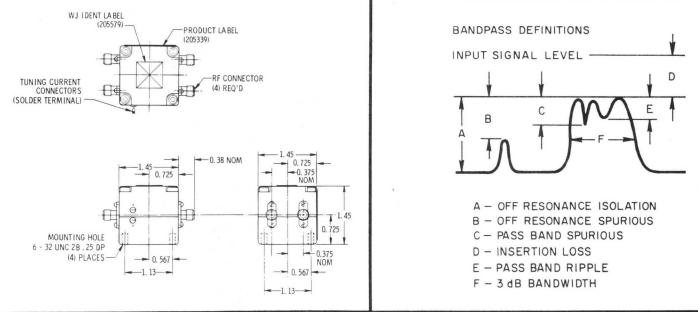
MECHANICAL CHARACTERISTICS

Size (excluding connectors)	
Weight	
RF Connectors OSM Jack	
Outline Drawing No	

¹Total of insertion loss of combined channels, passband spurious, and passband ripple not to exceed 8 db at any point of band.

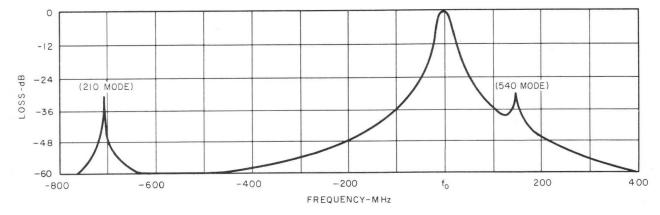


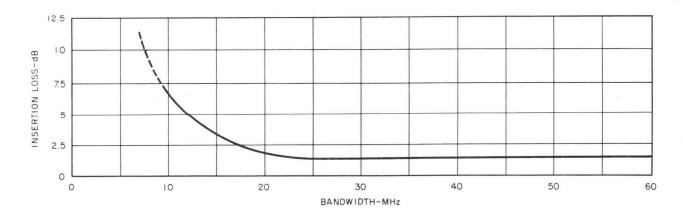
OUTLINE DRAWING



MEASUREMENT DEFINITIONS

SELECTIVITY CURVE





FEBRUARY 1970*

8 TO 12.4 GHz COMPACT DUAL-CHANNEL TWO-STAGE YIG FILTER WJ-622

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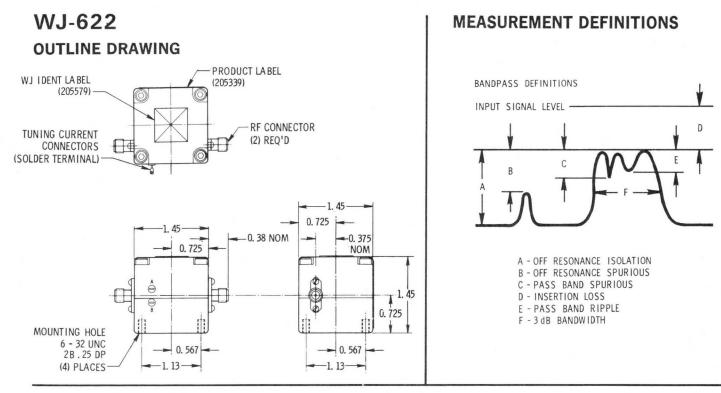
SPECIFICATIONS

RF PERFORMANCE (per channel) Frequency Range	Typical		
Bandwidth (3 dB) (minimum) Insertion Loss (maximum) Off Resonance Isolation (minimum) Off Resonance Spurious (minimum)	. 1.5 dB		20 MHz 3.0 dB ¹ 50 dB
Directivity	. Reciprocal . 0.5 dB		1.0 dB
Passband Spurious (maximum) Passband VSWR (maximum)	. 1.5:1		2:1
Limiting Level (minimum)	. 12 dB		
Isolation Between Channels Frequency Tracking Error Between Channels (maximum)			
TUNING CHARACTERISTICS			
Sensitivity Coil Resistance Coil Inductance Time Constant Deviation from Linear Hysteresis	· · · · · · · · · · · · · · · · · · ·	5.5 ohms 60 mH 1.0 ms ±8 MHz 15 MHz	
Frequency Drift over Temperature Range 0-60°C Zero Current Frequency			
MECHANICAL CHARACTERISTICS Size (excluding connectors) Weight RF Connectors Outline Drawing No.		12 ou	unces (340 g) SMA Jack

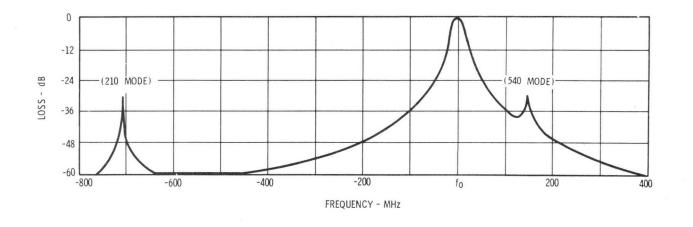
* Supersedes WJ-622 Technical Data Sheet dated September 1968.

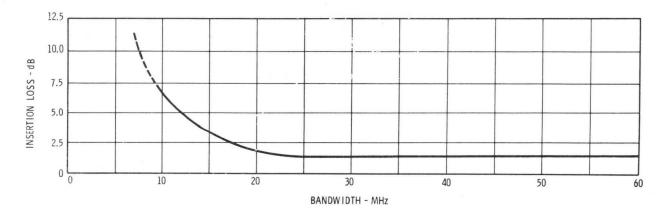
The WJ-622, one of a family of compact YIG filters which incorporate a self-shielding magnetic circuit, features high reliability, long life ruggedness, small size and high thermal stability. The tuning power requirement for this electronically tuned YIG filter is less than 3 watts. The WJ-622 can be produced to cover any frequency range in the X-band up to 5 GHz. Bandwidths other than specified are available between

15 and 100 MHz.



SELECTIVITY CURVE





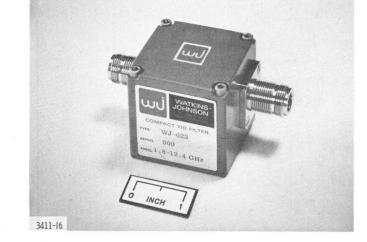


2.0 to 12.4 GHz TWO-STAGE MULTI-OCTAVE COMPACT YIG FILTER

October 1968 *

Watkins-Johnson Company has developed a multioctave (2.0 to 12.4 GHz) YIG filter which adds a wide tuning range capability to the compact filter line. The WJ-623 is an electronically tuned YIG filter that features high reliability, long life, ruggedness, small size, and a low tuning power requirement (less than 3 watts). These features are primarily attributable to a self-shielded magnetic circuit built into the filter structure.

The WJ-623 is particularly suited for ultra-wideband receiving and frequency measuring applications. For specific requirements, the tuning sensitivity may be changed to 9 MHz/mA without increasing the tuning power requirements. In addition, optional bandwidths are available for specific requirements between 15 and 80 MHz.



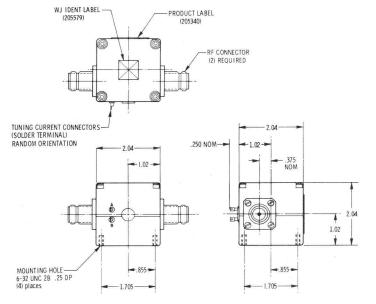
SPECIFICATIONS

RF PERFORMANCE Frequency range	Typical .1.8 to 12.4 GHz	Nominal	Guaranteed 2.0 to 12.4 GHz
Bandwidth (3 dB)	.35 MHz	25 (m	in) 70 (max) MHz
Insertion loss			
			60 dB, 1-4 GHz
			55 dB, 4-8 GHz 50 dB, 8-10 GHz
Discriticity	Designed	47	' dB, 10-12.4 GHz
Directivity Passband ripple and spurious			3.0 dB (max)
VSWR, input and output, max.			
Limiting level, min	• • • • • • • • • • • • • • • • • • • •		n (2.0 - 12.4 GHz) 3m (1.8 - 2.0 GHz)
Selectivity	12 dB/octave	-23 de	5111 (1.8 - 2.0 GHZ)
Off resonance spurious— other than 210 mode			50 dB down min
210 mode			
TUNING CHARACTERISTICS			
Tuning current			740 mA, max.
Coil resistance			
Coil inductance		112 millihen	ries, ±10 percent
Deviation from linear			0.5 percent max.
Temperature drift (0 to 55°C)			
Hysteresis			30 MHz max.
MECHANICAL CHARACTERISTICS			
Size			
Weight			
RF connector		ype iv temale	
Outline Drawing No			
Superseues w3.625 reclinical Data Sheet dated Apr			I down the 2

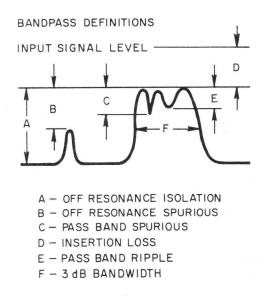
NOTE 1—At any frequency within the specified tuning range, temperature drift must not exceed the difference between the 3 dB bandwidth (in MHz) and 19 MHz. This measurement will be made for design verification only.

WJ -623

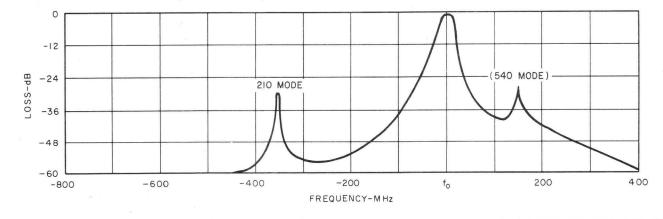
OUTLINE DRAWING



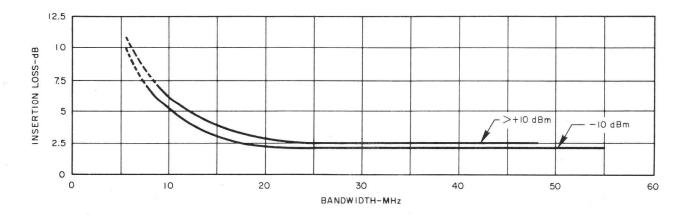
MEASUREMENT DEFINITION



SELECTIVITY CURVE (TYPICAL)



BANDWIDTH vs. LOSS (TYPICAL)



WATKINS **S JOHNSON COMPANY** 3333 HILLVIEW AVENUE **S** STANFORD INDUSTRIAL PARK PALO ALTO, CALIFORNIA 94304 TWX 910-373-1253 PHONE (415) 326-8830 Telex: 348-415



YIG MAGNETOMETER

November 1968

The WJ-627 magnetometer is a specialized application of the YIG tuned microwave transistor oscillators produced by the Watkins-Johnson Company. The magnetometer is capable of measuring pulsed and continuous wave magnetic fields of complex waveforms. The frequency response of the magnetometer extends to 100 MHz.

A change in magnetic field strength is translated directly to a shift of the oscillator frequency. The oscillator frequency can then be converted to an amplitude modulated signal by a suitable frequency discriminator.

Since the WJ-627 itself is magnetically shielded, the field to be measured is sampled with an external coil. The induced current created by a change in magnetic flux through the external sensor coil is fed to an internal driving coil which is in close proximity to a YIG resonator. The field induced in the internal coil modulates the oscillator frequency by changing the resonant frequency of the YIG. The zero field oscillator frequency is set with a biasing magnet.

At the option of the customer, the external sensor coil and a transmission line type microwave discriminator can be supplied to be used in conjunction with the WJ-627 magnetometer.

The YIG magnetometer can be adapted to measure



small magnetic fields of one gauss or less; it may also be adapted to measure large magnetic fields of several hundred gauss. Typical dynamic range is 100:1.

Built-in tuning coils are provided to sweep the oscillator for power output and frequency linearity measurements. The power output variation is small enough to allow direct detection with a microwave discriminator without amplitude limiting.

Since the magnetic field modulates a microwave frequency source, direct transmission of the information through space is possible.

MAGNETOMETER PERFORMANCE Sensitivity range (direct)	0.5 to	
Dynamic range		100:1
Frequency response	60 Hz to 100 MHz	
Sensitivity range of internal driving coil		
Temperature Coefficient of biasing magnet,		
0°C to 50°C	.0.02%/°C	
RF PERFORMANCE		
Center frequency	1.0 t	o 2.3 GHz
Frequency deviation		-100 MHz
Power output		. 10 mW
Power variations over ±100 MHz		1 dB
Frequency drift —30°C to 65°C	5 MHz 10	MHz max.
Sensitivity to supply voltage		
Pulling figure (1.5:1 VSWR)		
Linearity of frequency deviation		

SPECIFICATIONS

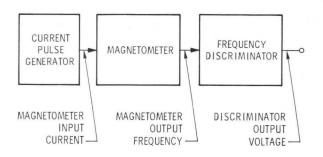
ELECTRICAL REQUIREMENTS

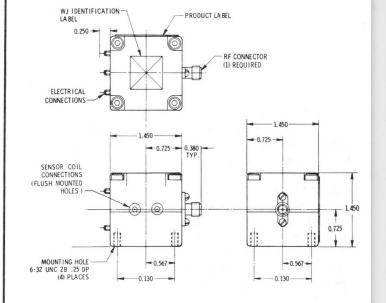
Oscillator	voltage	•			•	•	•	•	•	•]	15	5	+	:0).2	Vdd	C
Oscillator	current			•								•	•			50	m	A

MECHANICAL CHARACTERISTICS

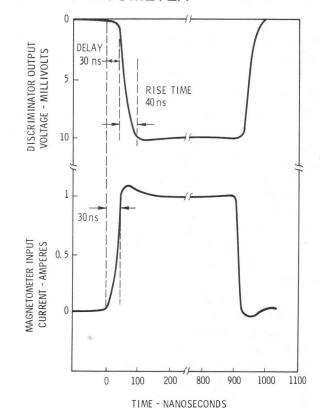
Size, excluding RF Connector
and solder terminals 1.45 x 1.45 x 1.45 in.
Weight 9 ounces
RF output connector OSM, jack
Power input Solder terminals with
RFI shielding
Sensor coil 2 pin Jack

BLOCK DIAGRAM OF SYSTEM USED TO MEASURE THE MAGNETOMETER PULSE RESPONSE





RESPONSE OF DISCRIMINATOR OUTPUT VOLTAGE TO A 1 MICROSECOND CURRENT PULSE INTO THE MAGNETOMETER



WATKINS ■ JOHNSON COMPANY 3333 HILLVIEW AVENUE ■ STANFORD INDUSTRIAL PARK PALO ALTO, CALIFORNIA 94304 TWX 910-373-1253 PHONE (415) 326-8830 Telex: 348-415

OUTLINE DRAWING



September 1968

1 to 2 GHz TWO-STAGE HYBRID YIG FILTER

The WJ-634 is one of the two-stage members of a family of hybrid YIG-filters developed by Watkins-Johnson Company. It provides faster switching capability than the compact filter line, and has lower coil resistance and inductance, thereby simplifying driver design. The WJ-634 also features high tuning rate, low tuning power and high RF performance.

For specific requirements, the WJ-634 can be produced to cover any frequency range in the L-band up to 1.2 octaves. Optional bandwidths are available for specific requirements between 8 and 40 MHz.



3411-21

SPECIFICATIONS

RF PERFORMANCE	Typical	Nominal	Guaranteed
Frequency Range		1.	0 to 2.0 GHz
Bandwidth (3 dB) (minimum)			
Insertion Loss (maximum)			
Off Resonance Isolation (minimum)	.50 dB		40 dB
Off Resonance Spurious (minimum)			25 dB
Directivity	. Reciprocal		
Passband Ripple (maximum)	.0.5 dB		1.0 dB
Passband Spurious (maximum)	.1.0 dB		2.0 dB
Passband VSWR (maximum)	. 1.5:1		2.0:1
Limiting Level (minimum)	. +20 dBm		+10 dBm
Selectivity (per octave)			

TUNING CHARACTERISTICS

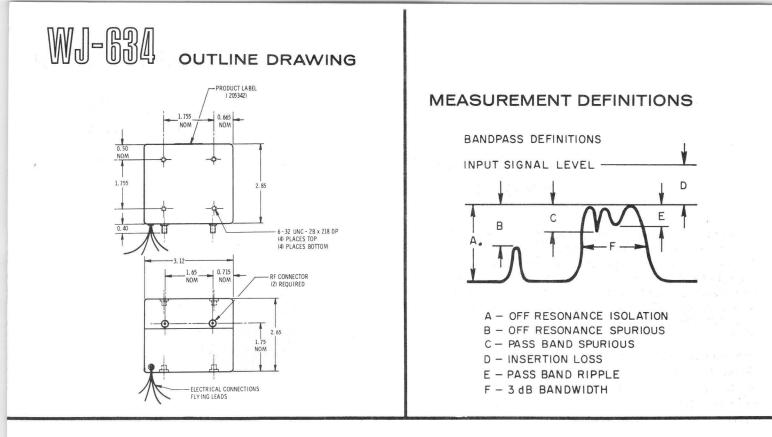
Sensitivity	6 MHz/mA
Coil Resistance	2.5 ohms
Coil Inductance	. 12 mH
Time Constant	0.2 ms
Deviation from Linear	. ±2 MHz
Hysteresis	5 MHz
Frequency Drift over Temp. Range 0-60°C	10 MHz
Zero Current Frequency	.0.95 GHz

MECHANICAL CHARACTERISTICS

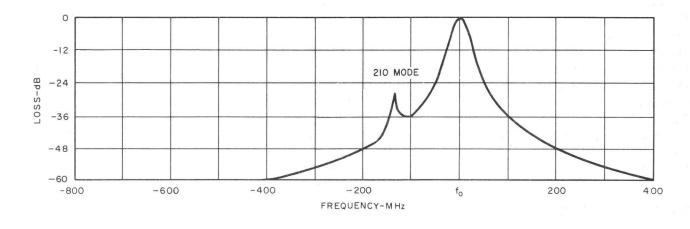
Size (excluding connectors)	. 2.65	x 3.12 x 2.85 inches
Weight		. 30 ounces
RF Connectors		. OSM Jack
Outline Drawing No		. 290096

HEATER CHARACTERISTICS

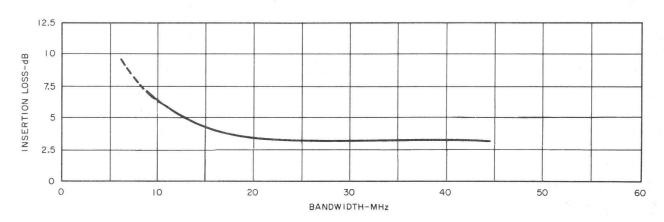
Operating Voltage	2 to 30 Volts
Operating Current:	
Surge at 0°C	. 750 mA
Steady State at 0°C	. 250 mA



SELECTIVITY CURVE



BANDWIDTH vs. LOSS



WATKINS = JOHNSON COMPANY 3333 HILLVIEW AVENUE = STANFORD INDUSTRIAL PARK PALO ALTO, CALIFORNIA 94304 TWX 910-373-1253 PHONE (415) 326-8830 Telex: 348-415

MARCH 1969

2 TO 4 GHz TWO-STAGE HYBRID YIG FILTER WJ-635

The WJ-635 is one of the two-stage members of a family of hybrid YIG filters developed by Watkins-Johnson Company. It provides faster switching capability than the compact filter line, and has lower coil resistance and inductance, thereby simplifying driver design. The WJ-635 also features high tuning rate, low tuning power and high RF performance.

For specific requirements, the WJ-635 can be produced to cover any frequency range in the S-band up to 1.2 octaves. Optional bandwidths are available for specific requirements between 8 and 40 MHz.

SPECIFICATIONS

RF PERFORMANCE Frequency Range Bandwidth (3 dB) (minimum)		
Insertion Loss (maximum)		 3.5 dB
Off Resonance Isolation (minimum) Off Resonance Spurious (minimum)		
Directivity Passband Ripple (maximum)		 1.0 dB
Passband Spurious (maximum) Passband VSWR (maximum)		
Limiting Level (minimum) Selectivity (per octave)	.+20 dBm	

TUNING CHARACTERISTICS

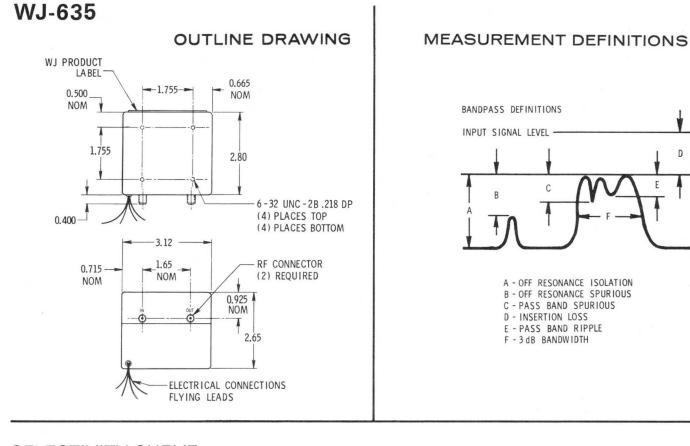
Sensitivity	6 MHz/mA	
Coil Resistance		
Coil Inductance	12 mH	
Time Constant	0.2 ms	
Deviation from Linear	±4 MHz	
Hysteresis	8 MHz	
Zero Current Frequency	1.95 GHz	

MECHANICAL CHARACTERISTICS

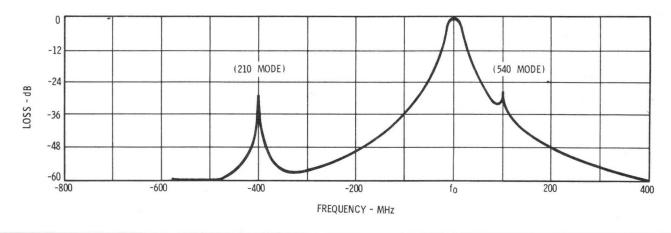
Size (excluding connectors)	2.65 x 3.12 x 2.80 in.
Weight	30 ounces
RF Connectors	OSM Jack
Outline Drawing No	290096

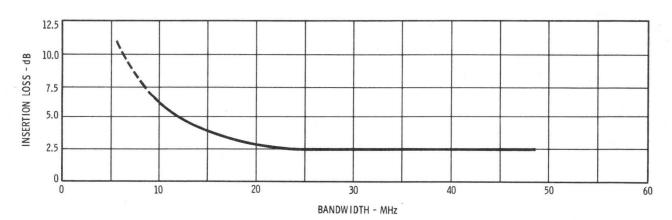


3411-22



SELECTIVITY CURVE





MARCH 1969

4 TO 8 GHz TWO-STAGE HYBRID YIG FILTER WJ-636

The WJ-636 is one of the two-stage members of a family of hybrid YIG filters developed by Watkins-Johnson Company. It provides faster switching capability than the compact filter line, and has lower coil resistance and inductance, thereby simplifying driver design. The WJ-636 also features high tuning rate, low tuning power and high RF perform-For specific requirements, the WJ-636 can be pro-

duced to cover any frequency range in the C-band up to 1.2 octaves. Optional bandwidths are available for specific requirements between 8 and 40 MHz.

SPECIFICATIONS

3411-23

RF PERFORMANCE	Typical	Nominal	Guaranteed
Frequency Range			4.0 to 8.0 GHz
Bandwidth (3 dB) (minimum)			25 MHz
Insertion Loss (maximum)	.2.5 dB		3.0 dB
Off Resonance Isolation (minimum)	.60 dB		50 dB
Off Resonance Spurious (minimum)			25 dB
Directivity	.Reciprocal		
Passband Ripple (maximum)	.0.5 dB		1.0 dB
Passband Spurious (maximum)	.0.5 dB		1.5 dB
Passband VSWR (maximum)	.1.5:1		2.0:1
Limiting Level (minimum)	.+20 dBm		+10 dBm
Selectivity (per octave)			

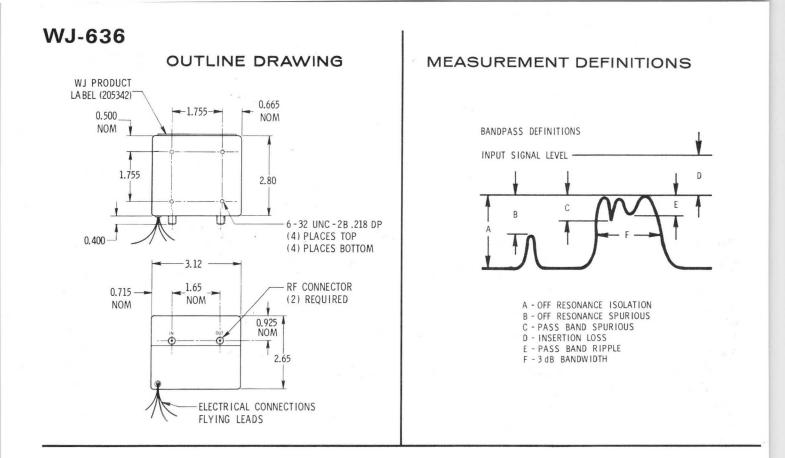
TUNING CHARACTERISTICS

ance.

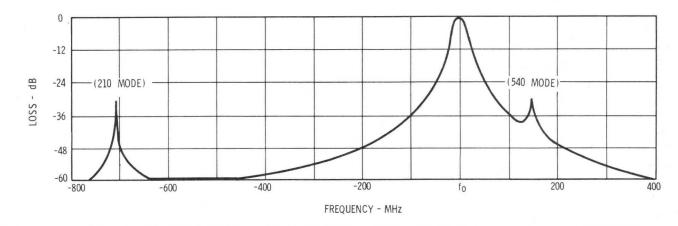
Sensitivity	6 MHz/mA
Coil Resistance	2.5 ohms
Coil Inductance	12 mH
Time Constant	0.2 ms
Deviation from Linear	±8 MHz
Hysteresis	20 MHz
Zero Current Frequency	3.9 GHz

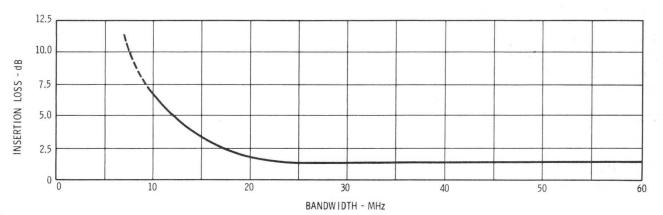
MECHANICAL CHARACTERISTICS

Size (excluding connectors)	2.65 x 3.12 x 2.80 in.
Weight	30 ounces
RF Connectors	
Outline Drawing No.	290096



SELECTIVITY CURVE





APRIL 1969

8 TO 12.4 GHz TWO-STAGE HYBRID YIG FILTER WJ-637

The WJ-637 is one of the two-stage members of a family of hybrid YIG filters developed by Watkins-Johnson Company. It provides faster switching capability than the compact filter line, and has lower coil resistance and inductance, thereby simplifying driver design. The WJ-637 also features high tuning rate, low tuning power and high RF performance.

For specific requirements, the WJ-637 can be modified to cover up to a 5000 MHz frequency range in the X-band. Optional bandwidths are available for specific requirements between 8 and 40 MHz.

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SPECIFICATIONS

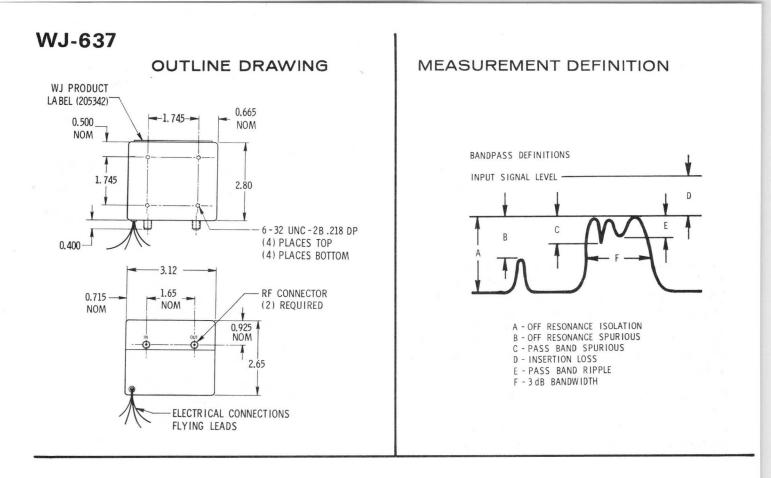
RF PERFORMANCE Frequency Range	Typical	Guaranteed 3.0 to 12.4 GHz
Bandwidth (3 dB) (minimum)		
Insertion Loss (maximum)		
Off Resonance Isolation (minimum)	60 dB	 50 dB
Off Resonance Spurious (minimum)		 25 dB
Directivity	Reciprocal	
Passband Ripple (maximum)	0.5 dB	 1.0 dB
Passband Spurious (maximum)	1.0 dB	 1.5 dB
Passband VSWR (maximum)	1.5:1	 2.0:1
Limiting Level (minimum)	+20 dBm	 +10 dBm
Selectivity (per octave)	12 dB	

TUNING CHARACTERISTICS

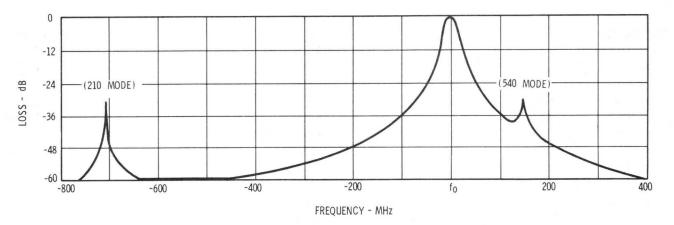
Sensitivity	6 MHz/mA
Coil Resistance	2.5 ohms
Coil Inductance	12 mH
Time Constant	
Deviation from Linear	±12 MHz
Hysteresis	35 MHz
Zero Current Frequency	7.9 GHz

MECHANICAL CHARACTERISTICS

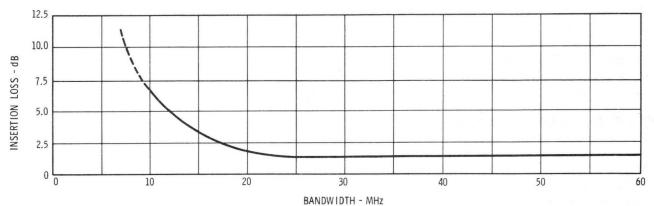
Size (excluding connectors)	2.65 x 3.12 x 2.80 in.
	(67 x 79 x 72 mm)
Weight	30 ounces (850 g)
RF Connectors	OSM Jack
Outline Drawing No	290096



SELECTIVITY CURVE







3411-24 APRIL 1969

MARCH 1969

1 TO 2 GHz FOUR-STAGE HYBRID YIG FILTER WJ-638

The WJ-638 is one of the four-stage members of a family of hybrid YIG filters developed by Watkins-Johnson Company. It provides faster switching capability than the compact filter line, and has lower coil resistance and inductance, thereby simplifying driver design. The WJ-638 also features high tuning rate, low tuning power and high RF performance.

For specific requirements, the WJ-638 can be produced to cover any frequency range in the L-band up to 1.2 octaves. Optional bandwidths are available for specific requirements between 8 and 40 MHz.

SPECIFICATIONS

RF PERFORMANCE Frequency Range	Typical	
Bandwidth (3 dB) (minimum)		
Insertion Loss (maximum)	4.5 dB	 6.0 dB
Off Resonance Isolation (minimum)		
Off Resonance Spurious (minimum)		 50 dB
Directivity	Reciprocal	
Passband Ripple (maximum)	0.5 dB	 I.O dB
Passband Spurious (maximum)	1.0 dB	 2.0 dB
Passband VSWR (maximum)	1.5:1	 2.0:1
Limiting Level (minimum)	+20 dBm	 +10 dBm
Selectivity (per octave)	24 dB	

TUNING CHARACTERISTICS

Sensitivity	6 MHz/mA
Coil Resistance	
Coil Inductance	
Time Constant	
Deviation from Linear	
Hysteresis	
Zero Current Frequency	0.95 GHz

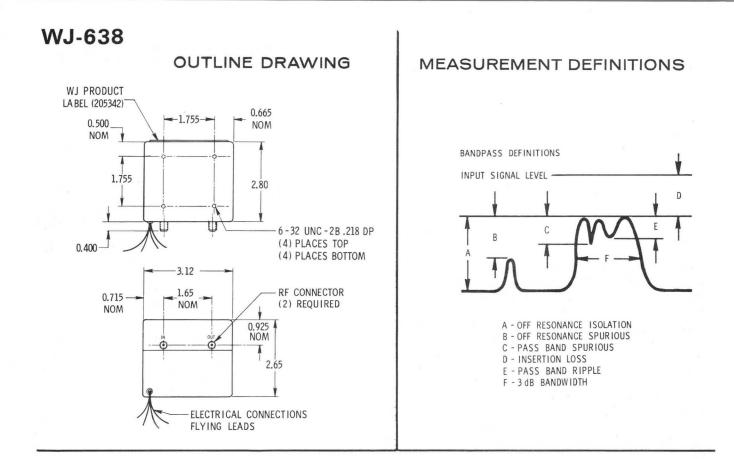
MECHANICAL CHARACTERISTICS

Size (excluding connectors)	 2.65 x 3.12 x 2.80 in.
Weight	 30 ounces
RF Connectors	

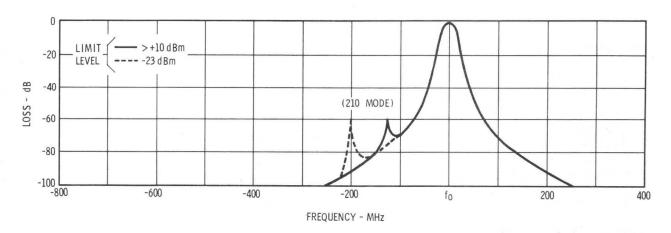
HEATER CHARACTERISTICS

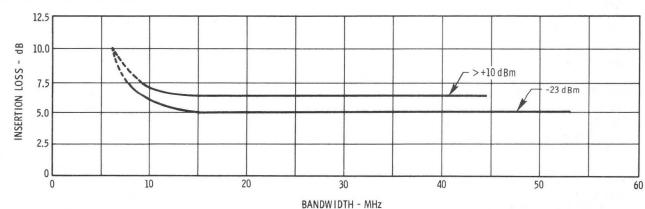
Operating Voltage	 .22 to 30 Volts
Operating Current:	
Surge at 0°C	 .750 mA
Steady State at 0°C	 .250 mA





SELECTIVITY CURVE





MARCH 1969

2 TO 4 GHz FOUR-STAGE HYBRID YIG FILTER WJ-639

The WJ-639 is one of the four-stage members of a family of hybrid YIG filters developed by Watkins-Johnson Company. It provides faster switching capability than the compact filter line, and has lower coil resistance and inductance, thereby simplifying driver design. The WJ-639 also features high tuning rate, low tuning power and high RF performance.

For specific requirements, the WJ-639 can be produced to cover any frequency range in the S-band up to 1.2 octaves. Optional bandwidths are available for specific requirements between 8 and 40 MHz.

SPECIFICATIONS

3411-26

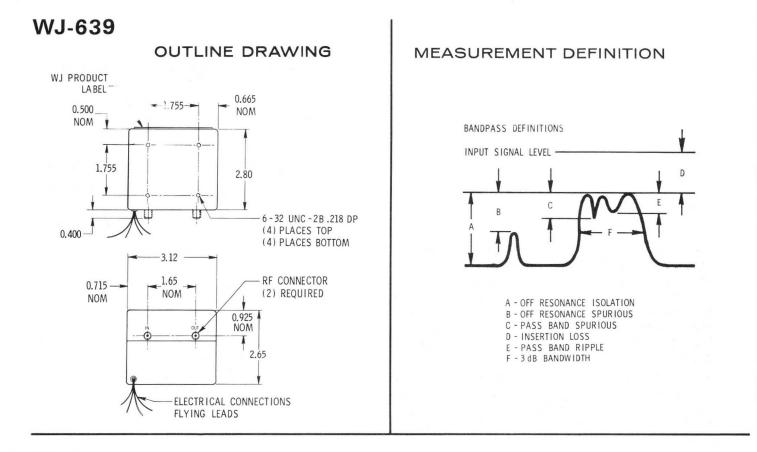
RF PERFORMANCE Frequency Range			
Bandwidth (3 dB) (minimum) Insertion Loss (maximum)	3.5 dB		5.0 dB
Off Resonance Isolation (minimum) Off Resonance Spurious (minimum)			
Directivity	Reciprocal		
Passband Ripple (maximum)	0.5 dB		1.0 dB
Passband Spurious (maximum)	1.0 dB		1.5 dB
Passband VSWR (maximum)	1.5:1		2.0:1
Limiting Level (minimum)		*******	+10 dBm
Selectivity (per octave)	24 dB		

TUNING CHARACTERISTICS

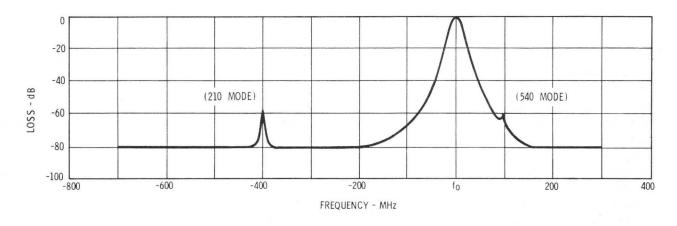
Sensitivity	6 MHz/mA
Coil Resistance	2.5 ohms
Coil Inductance	12 mH
Time Constant	0.2 ms
Deviation from Linear	±4 MHz
Hysteresis	8 MHz
Zero Current Frequency	1.95 GHz

MECHANICAL CHARACTERISTICS

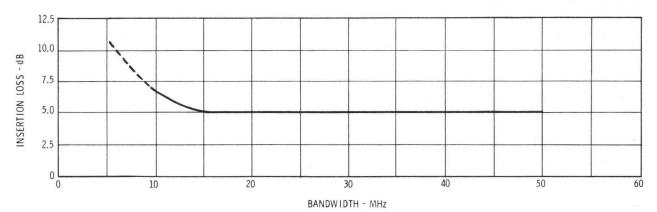
Size (excluding connectors)	. 2.65 x 3.12 x 2.80 in.
Weight	. 30 ounces
RF Connectors	. OSM Jack
Outline Drawing No	. 290096



SELECTIVITY CURVE



BANDWIDTH vs. LOSS



MARCH 1969

4 TO 8 GHz FOUR-STAGE HYBRID YIG FILTER WJ-640

The WJ-640 is one of the four-stage members of a family of hybrid YIG filters developed by Watkins-Johnson Company. It provides faster switching capability than the compact filter line, and has lower coil resistance and inductance, thereby simplifying driver design. The WJ-640 also features high tuning rate, low tuning power and high RF performance.

For specific requirements, the WJ-640 can be produced to cover any frequency range in the C-band up to 1.2 octaves. Optional bandwidths are available for specific requirements between 8 and 40 MHz.

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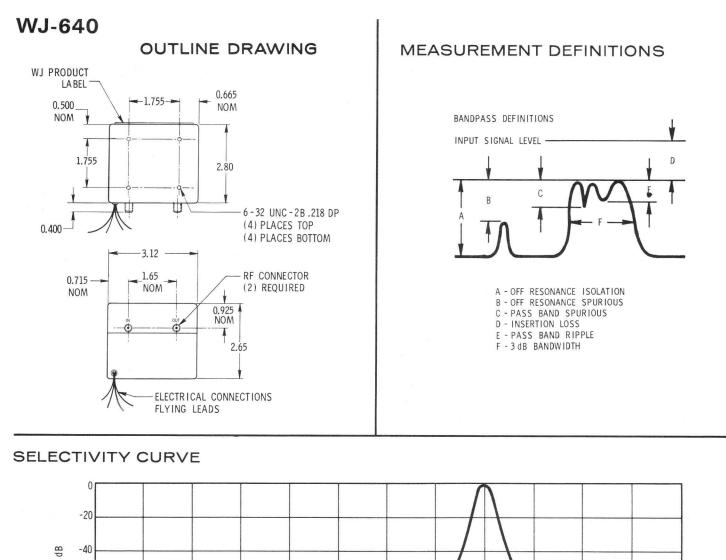
RF PERFORMANCE	Typical	
Frequency Range		 4.0 to 8.0 GHz
Bandwidth (3 dB) (minimum)		 20 MHz
Insertion Loss (maximum)		
Off Resonance Isolation (minimum)	80 dB	 70 dB
Off Resonance Spurious (minimum)		 50 dB
Directivity	Reciprocal	
Passband Ripple (maximum)	0.5 dB	 1.0 dB
Passband Spurious (maximum)	1.0 dB	 1.5 dB
Passband VSWR (maximum)		
Limiting Level (minimum)		
Selectivity (per octave)	24 dB	

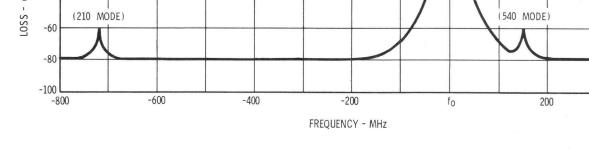
TUNING CHARACTERISTICS

Sensitivity	. 6 MHz/mA
Coil Resistance	. 2.5 ohms
Coil Inductance	. 12 mH
Time Constant	. 0.2 ms
Deviation from Linear	. ±8 MHz
Hysteresis	
Zero Current Frequency	

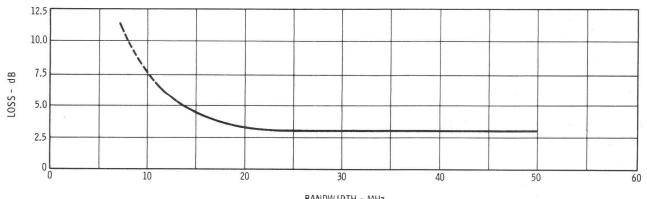
MECHANICAL CHARACTERISTICS

Size (excluding connectors)	2.65 x 3.12 x 2.80 in.
Weight	30 ounces
RF Connectors	OSM Jack
Outline Drawing No	290096





BANDWIDTH vs. LOSS



400

APRIL 1969

8 TO 12.4 GHz FOUR-STAGE HYBRID YIG FILTER WJ-641

The WJ-641 is one of the four-stage members of a family of hybrid YIG filters developed by Watkins-Johnson Company. It provides faster switching capability than the compact filter line, and has lower coil resistance and inductance, thereby simplifying driver design. The WJ-641 also features high tuning rate, low tuning power and high RF performance.

For specific requirements, the WJ-641 can be modified to cover up to a 5000 MHz frequency range in the X-band. Optional bandwidths are available for specific requirements between 8 and 40 MHz.

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SPECIFICATIONS

RF PERFORMANCE Frequency Range	Typical	Nominal 8.	s.
Bandwidth (3 dB) (minimum)			20 MHz
Insertion Loss (maximum)	.3.5 dB		5.0 dB
Off Resonance Isolation (minimum)	80 dB		70 dB
Off Resonance Spurious (minimum)			50 dB
Directivity	.Reciprocal		
Passband Ripple (maximum)			1.0 dB
Passband Spurious (maximum)			1.5 dB
Passband VSWR (maximum)	.1.5:1		2.0:1
Limiting Level (minimum)	.+20 dBm		+10 dBm
Selectivity (per octave)	.24 dB		

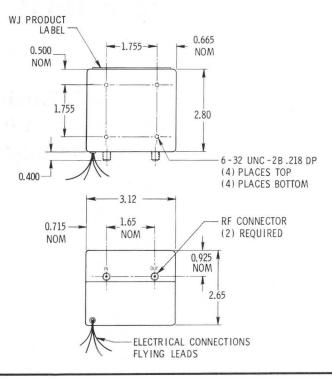
TUNING CHARACTERISTICS

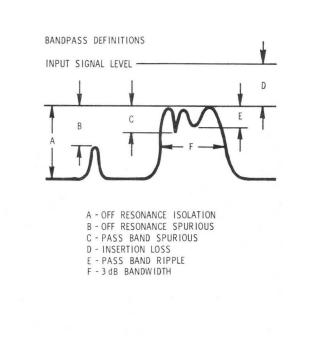
Coil Resistance	ł
Coil Inductance 12 mH	
Time Constant 0.2 ms	
Deviation from Linear ±12 MHz	
Hysteresis	
Zero Current Frequency	

MECHANICAL CHARACTERISTICS

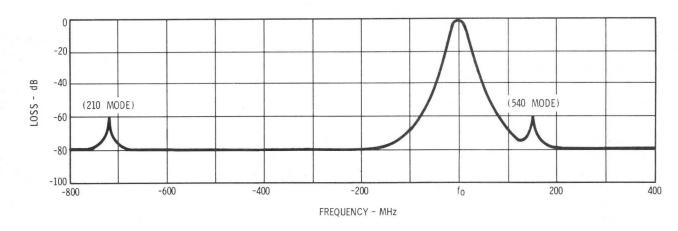
Size (excluding connectors)	. 2.65 x 3.12 x 2.80 in.
Weight	30 ounces
RF Connectors	. OSM Jack
Outline Drawing No.	290096

OUTLINE DRAWING

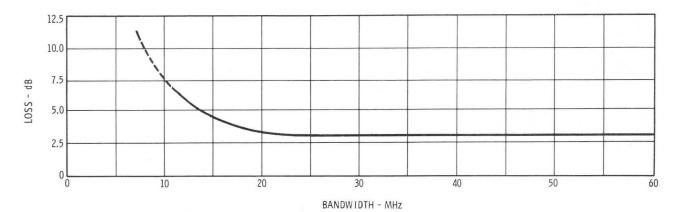




SELECTIVITY CURVE



BANDWIDTH vs. LOSS



MEASUREMENT DEFINITIONS

MARCH 1969

1 TO 2 GHz DUAL TWO-STAGE HYBRID YIG FILTER WJ-648

The WJ-648 is one of the dual two-stage members of a family of hybrid YIG filters developed by Watkins-Johnson Company. It provides faster switching capability than the compact filter line, and has lower coil resistance and inductance, thereby simplifying driver design. The WJ-648 also features high tuning rate, low tuning power and high RF performance.

For specific requirements, the WJ-648 can be produced to cover any frequency range in the L-band up to 1.2 octaves. Optional bandwidths are available for specific requirements between 8 and 40 MHz.



SPECIFICATIONS

RF PERFORMA Frequency Ra	NCE (per channel)	Typical	Nominal	Guaranteed
Bandwidth (3	dB) (minimum)			20 MHz
Off Resonance	s (maximum)			3.5 dB' 40 dB
Off Resonance	e Spurious (minimum)			25 dB
Passband Rig	ple (maximum)			1.0 dB
Passband Sp	urious (maximum)	1.0 dB		2.0 dB
	WR (maximum)			
Selectivity (p	er octave)	12 dB		
Isolation Betw Tracking Erro	veen Channels (minimum) or Between Channels (maximum)			40 dB

TUNING CHARACTERISTICS

Sensitivity	. 6 MHz/mA
Coil Resistance	. 2.5 ohms
Coil Inductance	. 12 mH
Time Constant	
Deviation from Linear	. ±2 MHz
Hysteresis	
Zero Current Frequency	. 0.95 GHz

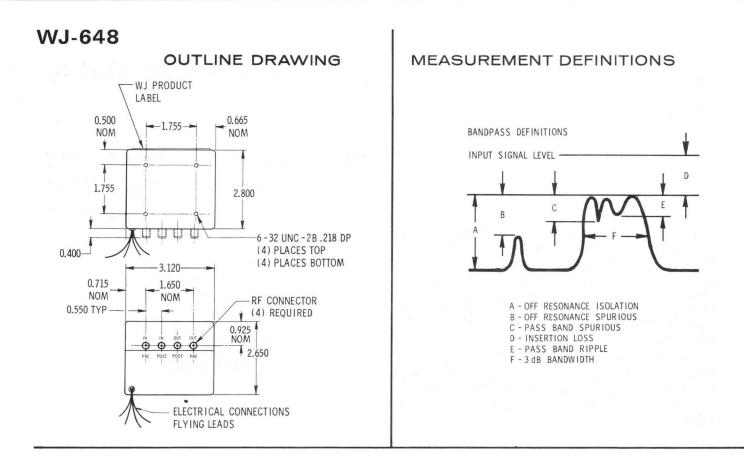
MECHANICAL CHARACTERISTICS

Size (excluding connectors	s)	
Weight		

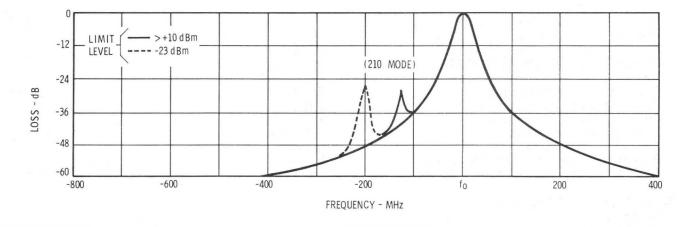
HEATER CHARACTERISTICS

Operating Voltage	
Operating Current:	
Surge at 0°C	
Steady State at 0°C	

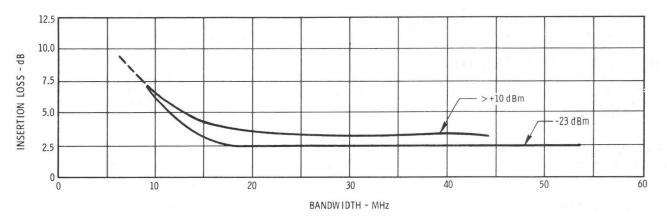
¹Total of combined channels insertion loss, passband spurious, and passband ripple not to exceed 8 dB at any point in band.



SELECTIVITY CURVE



BANDWIDTH vs. LOSS



MARCH 1969

2 TO 4 GHz DUAL TWO-STAGE HYBRID YIG FILTER WJ-649

The WJ-649 is one of the dual two-stage members of a family of hybrid YIG filters developed by Watkins-Johnson Company. It provides faster switching capability than the compact filter line, and has lower coil resistance and inductance, thereby simplifying driver design. The WJ-649 also features high tuning rate, low tuning power and high RF performance.

For specific requirements, the WJ-649 can be produced to cover any frequency range in the S-band up to 1.2 octaves. Optional bandwidths are available for specific requirements between 8 and 40 MHz.



SPECIFICATIONS

RF PERFORMANCE (per channel) Frequency Range	Typical	Nominal	Guaranteed
Bandwidth (3 dB) (minimum)			
Insertion Loss (maximum)	2.5 dB		3.5 dB ¹
Off Resonance Isolation (minimum)	60 dB		50 dB
Off Resonance Spurious (minimum)			25 dB
Directivity	. Reciprocal		
Passband Ripple (maximum)	0.5 dB		1.0 dB
Passband Spurious (maximum)	1.0 dB		1.5 dB
Passband VSWR (maximum)	1.5:1		2.0:1
Limiting Level (minimum)	. + 20 dBm		+10 dBm
Selectivity (per octave)	.12 dB		
Isolation Between Channels (minimum)			
Tracking Error Between Channels (maximum)	.4 MHz		6 MHz

TUNING CHARACTERISTICS

Sensitivity	. 6 MHz/mA
Coil Resistance	. 2.5 ohms
Coil Inductance	. 12 mH
Time Constant	. 0.2 ms
Deviation from Linear	. ±4 MHz
Hysteresis	. 8 MHz
Zero Current Frequency	. 1.95 GHz

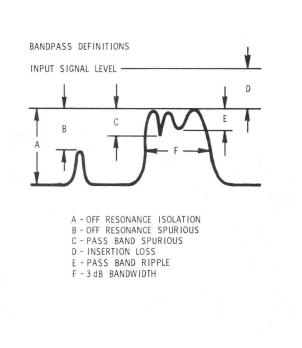
MECHANICAL CHARACTERISTICS

Size (excluding connectors)	. 2.65 x 3.12 x 2.80 in.
Weight	. 30 ounces
RF Connectors	
Outline Drawing No	. 290122

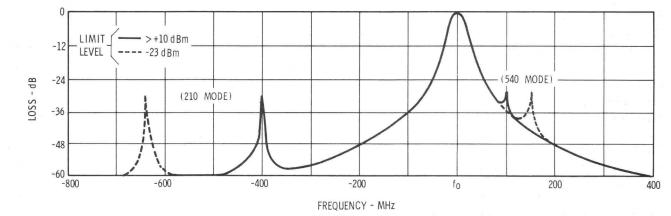
'Total of combined channels insertion loss, passband spurious, and passband ripple not to exceed 8 dB at any point in band.

OUTLINE DRAWING

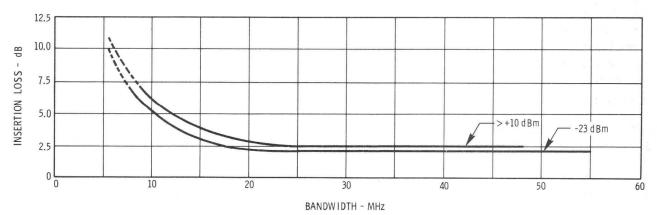
WJ PRODUCT LABEL 0.500 0.665 -1.755---NOM NOM 1 T 1.755 2.800 1 ΨΨ U Ψ -6-32 UNC-2B.218 DP 0.400-(4) PLACES TOP (4) PLACES BOTTOM 3.12 -0.715 1.650 NOM NOM -RF CONNECTOR 0.550 TYP (4) REQUIRED -0.925 NOM $\phi \phi \phi \phi$ 2.65 POST POST PRE PRE ELECTRICAL CONNECTIONS FLYING LEADS



SELECTIVITY CURVE



BANDWIDTH vs. LOSS



ING MEASUREMENT DEFINITIONS

MARCH 1969

4 TO 8 GHz DUAL TWO-STAGE HYBRID YIG FILTER WJ-650

The WJ-650 is one of the dual two-stage members of a family of hybrid YIG filters developed by Watkins-Johnson Company. It provides faster switching capability than the compact filter line, and has lower coil resistance and inductance, thereby simplifying driver design. The WJ-650 also features high tuning rate, low tuning power and high RF performance.

For specific requirements, the WJ-650 can be produced to cover any frequency range in the C-band up to 1.2 octaves. Optional bandwidths are available for specific requirements between 8 and 40 MHz.



SPECIFICATIONS

RF PERFORMANCE (per channel) Frequency Range	Typical	 Guaranteed
Bandwidth (3 dB) (minimum)		
Insertion Loss (maximum)	2.0 dB	 3.0 dB ¹
Off Resonance Isolation (minimum)	60 dB	 50 dB
Off Resonance Spurious (minimum)		 25 dB
Directivity	Reciprocal	
Passband Ripple (maximum)	0.5 dB	 1.0 dB
Passband Spurious (maximum)	0.5 dB	 1.5 dB
Passband VSWR (maximum)	1.5:1	 2.0:1
Limiting Level (minimum)	+20 dBm	 +10 dBm
Selectivity (per octave)	12 dB	
Isolation Between Channels (minimum)	50 dB	 40 dB
Tracking Error Between Channels (maximum)	4 MHz	 8 MHz

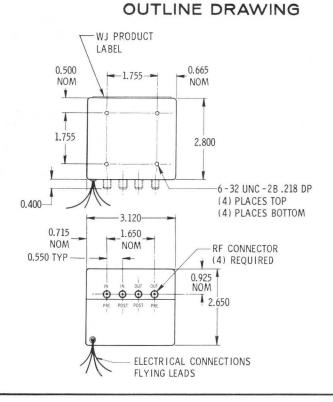
TUNING CHARACTERISTICS

Sensitivity	6 MHz/mA
Coil Resistance	2.5 ohms
Coil Inductance	12 mH
Time Constant	0.2 ms
Deviation from Linear	±8 MHz
Hysteresis	20 MHz
Zero Current Frequency	3.90 GHz

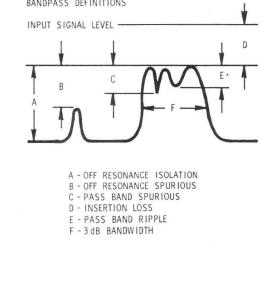
MECHANICAL CHARACTERISTICS

Size (excluding connectors)	2.65 x 3.12 x 2.80 in.
Weight	30 ounces
RF Connectors	OSM Jack
Outline Drawing No.	290122

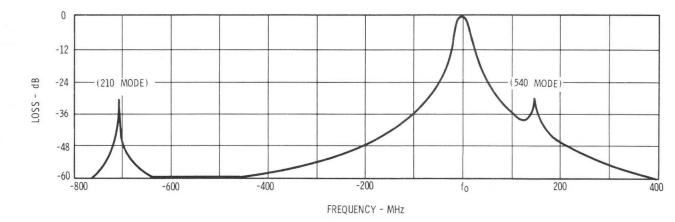
'Total of combined channels insertion loss, passband spurious, and passband ripple not to exceed 8 dB at any point in band.



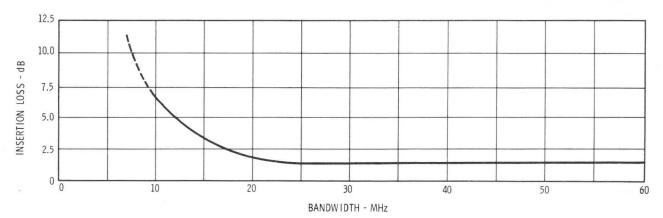
BANDPASS DEFINITIONS



SELECTIVITY CURVE



BANDWIDTH vs. LOSS



APRIL 1969

8 TO 12.4 GHz DUAL TWO-STAGE HYBRID YIG FILTER WJ-651

The WJ-651 is one of the dual two-stage members of a family of hybrid YIG filters developed by Watkins-Johnson Company. It provides faster switching capability than the compact filter line, and has lower coil resistance and inductance, thereby simplifying driver design. The WJ-651 also features high tuning rate, low tuning power and high RF performance.

For specific requirements, the WJ-651 can be produced to cover up to a 5000 MHz frequency range in the X-band. Optional bandwidths are available for specific requirements between 8 and 40 MHz.



SPECIFICATIONS

Denduidth (2 dD) (minimum)	dB1
Bandwidth (3 dB) (minimum) 20 M	
Insertion Loss (maximum)	dB
Off Resonance Isolation (minimum) 60 dB 60 dB 50	ab
Off Resonance Spurious (minimum) 25	dB
Directivity	
Passband Ripple (maximum) 1.0	dB
Passband Spurious (maximum) 1.5	dB
Passband VSWR (maximum)	0:1
Limiting Level (minimum) +10 dBm	Bm
Selectivity (per octave)	
Isolation Between Channels (minimum)	dB
Tracking Error Between Channels (maximum)5 MHz	

TUNING CHARACTERISTICS

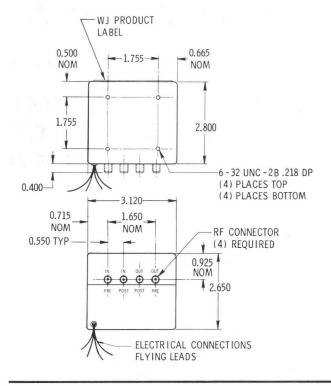
Sensitivity	Hz/mA
Coil Resistance	ohms
Coil Inductance	nH
Time Constant	ms
Deviation from Linear ±12	2 MHz
Hysteresis	ИHz
Zero Current Frequency	GHz

MECHANICAL CHARACTERISTICS

Size (excluding connectors)	2.65 x 3.12 x 2.80 in.
Weight	30 ounces
RF Connectors	OSM Jack
Outline Drawing No.	290122

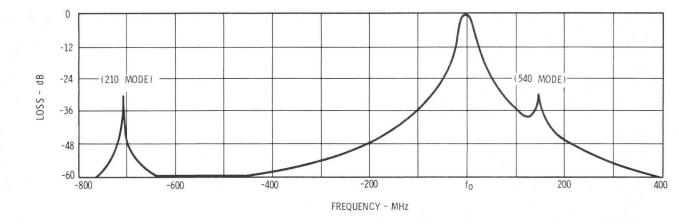
¹Total of combined channels insertion loss, passband spurious, and passband ripple not to exceed 8 dB at any point in band.

OUTLINE DRAWING

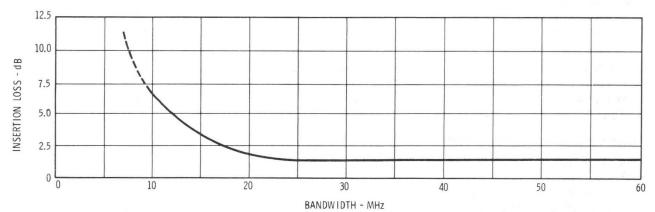


BANDPASS DEFINITIONS	L
INPUT SIGNAL LEVEL	
+ + +	D
	1
A - OFF RESONANCE ISOLATION B - OFF RESONANCE SPURIOUS C - PASS BAND SPURIOUS	
D - INSERTION LOSS E - PASS BAND RIPPLE F - 3 dB BANDWIDTH	

SELECTIVITY CURVE



BANDWIDTH vs. LOSS



3411-32 APRIL 1969

MEASUREMENT DEFINITION



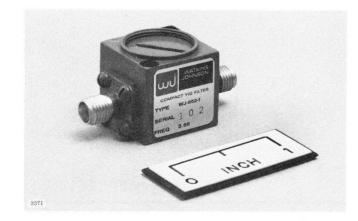
April 1967

MECHANICALLY TUNED MINIATURE TWO-STAGE YIG FILTER

The WJ-652 is the first of a new family of Watkins-Johnson Company mechanically-tuned microwave YIG filters produced in a miniature, lightweight configuration to meet rugged environmental requirements. Measuring only $\frac{3}{4}$ -inch cubed, this unit is tuned by means of a simple screwdriver adjustment. The WJ-652 and other members of this family of YIG filters have a tuning range of 500 MHz and are available with center frequencies of from 1 to 5 GHz.

The miniaturized design of the WJ-652 makes it particularly suitable for applications where space is at a premium. A large number of these filters can be physically stacked together to provide front-end multi-channel receiver configurations for various combinations of fixed frequencies with excellent channel isolation.

The WJ-652 filter may also be used in fixed-tuned



limiter applications, offering either low or high level cutoff at -23 dBm or +18dBm, respectively.

SPECIFICATIONS

RF PERFORMANCE	Typical Guaranteed	
Center Frequency	*1.0–5.0 GHz	1
Bandwidth at 3 dB		
Insertion Loss		
Limiting: Low Level (1.0-3.3 GHz)		
High Level (1.0-5.0 GHz)		
Off Resonance Isolation	. 30 dB, min 25 dB, min. . 1.5:1 2.0:1 . 12 dB/Octave	•

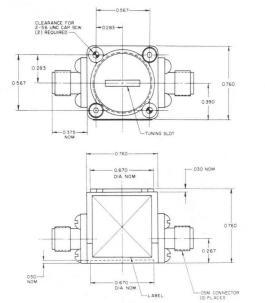
MECHANICAL CHARACTERISTICS

* Tuning Range					×.										f_{c}	± 25	50 MHz
Dimensions .										÷			3⁄4	"	X	3⁄4 ″	× 3⁄4″
Weight																	1 oz.
RF Connector	Тур	се															OSM

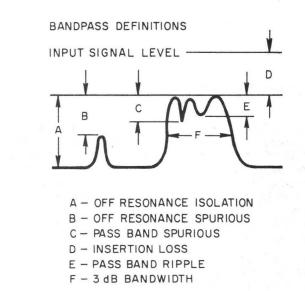
* The mechanical tuning adjustment allows for a tuning range of ±250 MHz anywhere over the frequency range. Center frequency requirement should be specified when unit is ordered.



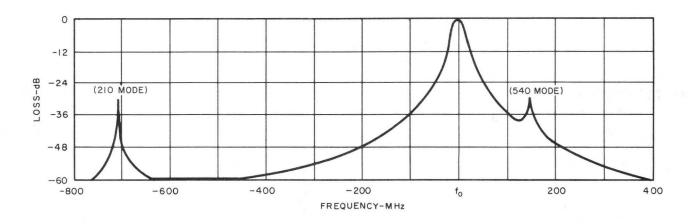
OUTLINE DRAWING



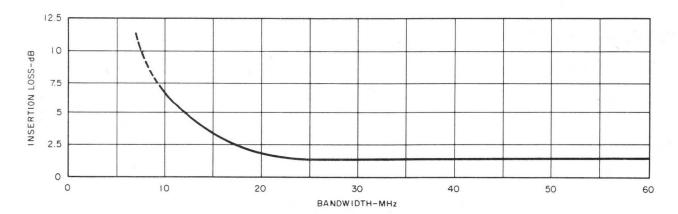
MEASUREMENT DEFINITIONS



SELECTIVITY CURVE



BANDWIDTH vs. LOSS



WATKINS **=** JOHNSON COMPANY 3333 HILLVIEW AVENUE **=** STANFORD INDUSTRIAL PARK PALO ALTO, CALIFORNIA 94304 TWX 910-373-1253 PHONE (415) 326-8830 Telex: 348-415

WJ-700

September 1968*

0.5 TO 1.0 GHz YIG - TUNED HARMONIC GENERATOR

The WJ-700 is one of a new family of solid state, electronically-tuned, harmonic generators developed by Watkins-Johnson Company. This generator, which is driven by a 100 MHz signal source, produces high output power at any one of the 100 MHz harmonics in P-band. In fact, its power output is approximately 5 dB above that of an untuned comb generator at comparable frequencies. Fast switching makes it ideal for use as a first local oscillator in digitally tuned microwave receivers, or as a frequency-stable, digitally tuned microwave source.

The output frequency of the WJ-700 is selected by changing (in discrete, equally spaced steps) the current in the tuning coils, thus producing a magnetic bias for the YIG resonators. Stray magnetic fields are negligible, and the generator remains unaffected by moderate magnetic environments. For specific requirements, the WJ-700 may be varied to cover offset frequency ranges, alternate input drive frequencies, or changes in ambient temperatures between -55° C and $+80^{\circ}$ C. A self-regulating, proportional controlled heater, requiring only the application of unregulated power for operation, stabilizes the temperatures of the YIG spheres in the three-stage filter circuit.



A special feature of the WJ-700 is its compatibility with the WJ-723 three-stage YIG filter. The resulting harmonic generator filter chain provides microwave harmonic energy with over 100 dB suppression of harmonics spaced ± 200 MHz or more from the tuned harmonic when driven by less than one watt of 100 MHz fundamental signal.

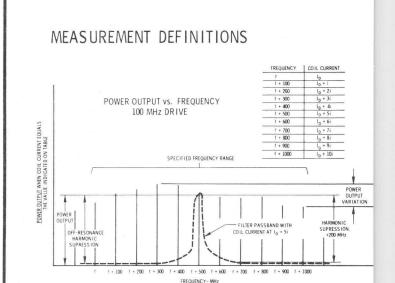
SPECIFICATIONS

RF PERFORMANCE Frequency range Power output, min. Output impedance Harmonic suppression ±100 MHz Harmonic suppression, ±200 MHz and above Input VSWR	. +10 dBm . 50 ohms . 50 dB . 70 dB	+ 5 dBm, Note 2
ENVIRONMENTAL CHARACTERISTICS Operating Temperature		—20° to +55°C
TUNING CHARACTERISTICS Sensitivity Coil resistance Coil inductance Time Constant	. 120 mm	

* Supersedes WJ-700 Technical Data Sheet Dated December 1967

RF INPUT CHARACTERISTICS POWER OUTPUT - dBm TYPICAL RANGE Drive power +30 dBm max. 10 **D.C. INPUT CHARACTERISTICS** Heater voltage 24 ±4 volts Heater current: 5 MECHANICAL CHARACTERISTICS Dimensions 3.11" x 2.85" x 3.7" Weight 35 ounces 0.5 0.6 0.7 0.8 RF connectors OSM female FREQUENCY - GHz Outline drawing number 290160 Notes:

- 1. This measurement will be made for design verification only.
- 2. Maximum power output variation is 6 dB.



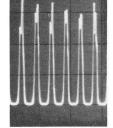
0.9

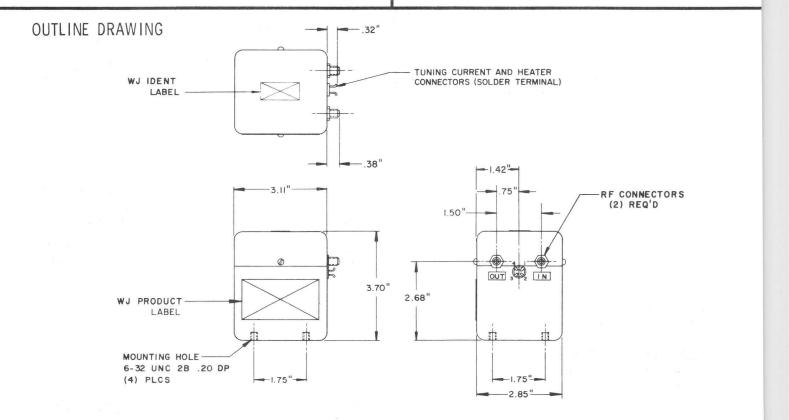
1.0

POWER OUTPUT

15

100 MHZ HARMONICS DISPLAY





WJ-701

September 1968 *

1.0 TO 2.0 GHz YIG -TUNED HARMONIC GENERATOR

The WJ-701 is one of a new family of solid state, electronically-tuned, harmonic generators developed by Watkins-Johnson Company. This generator, which is driven by a 100 MHz signal source, produces high output power at any one of the 100 MHz harmonics in L-band. In fact, its power output is approximately 5 dB above that of an untuned comb generator at comparable frequencies. Fast switching makes it ideal for use as a first local oscillator in digitally tuned microwave receivers, or as a frequency-stable, digitally tuned microwave source.

The output frequency of the WJ-701 is selected by changing (in discrete, equally spaced steps) the current in the tuning coils, thus producing a magnetic bias for the YIG resonators. Stray magnetic fields are negligible, and the generator remains unaffected by moderate magnetic environments. For specific requirements, the WJ-701 may be varied to cover offset frequency ranges, alternate input drive frequencies, or changes in ambient temperatures between -55° C and $+80^{\circ}$ C. A self-regulating, proportional controlled heater, requiring only the application of unregulated power for operation, stabilizes the temperatures of the YIG spheres in the three-stage filter circuit.



3507-6

A special feature of the WJ-701 is its compatibility with the WJ-724 three-stage YIG filter. The resulting harmonic generator filter chain provides microwave harmonic energy with over 100 dB suppression of harmonics spaced ± 200 MHz or more from the tuned harmonic when driven by less than one watt of 100 MHz fundamental signal.

SPECIFICATIONS

RF PERFORMANCE Frequency range	Typical	Guaranteed
Power output, min.	. +8 dBm	dBm, Note 2
Harmonic suppression ±100 MHz Harmonic suppression, ±200 MHz and above Input VSWR	. 50 dB	35 dB 50 dB
ENVIRONMENTAL CHARACTERISTICS Operating Temperature		0° to +55°C
TUNING CHARACTERISTICS		
Sensitivity	. o onms	
Coil inductance	. 120 mH . 50 μs 100 μs	s max., Note 1
*		

Supersedes WJ-701 Technical Data Sheet Dated December 1967

RF INPUT CHARACTERISTICS

Drive freque	n	сy					i.						ž.	100	MHZ
Drive power		,		•	•						+	3	0	dBm	max.

D.C. INPUT CHARACTERISTICS

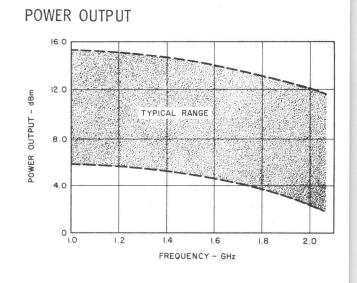
Heater voltage	. 24 ±4 volts
Heater current:	
Surge at -20°C	750 mA max.
Steady state at -20°C	1 5 0

MECHANICAL CHARACTERISTICS

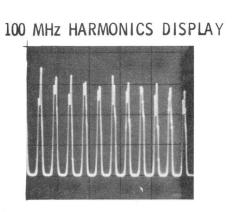
Dimensions	 3.11″ x	2.85" x 3.7"
Weight	 	35 ounces
RF connectors	 	OSM female
Outline drawing n		

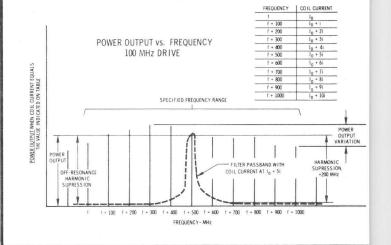
Notes:

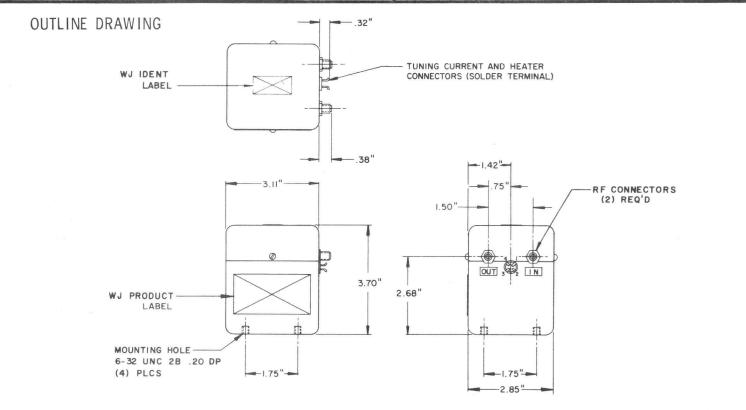
- 1. This measurement will be made for design verification only.
- 2. Maximum power output variation is 6 dB.



MEASUREMENT DEFINITIONS









September 1968

2.0 TO 4.0 GHz YIG - TUNED HARMONIC GENERATOR

The WJ-702 is one of a new family of solid state, electronically-tuned, harmonic generators developed by Watkins-Johnson Company. This generator, which is driven by a 100 MHz signal source, produces high output power at any one of the 100 MHz harmonics in S-band. In fact, its power output is approximately 5 dB above that of an untuned comb generator at comparable frequencies. Fast switching makes it ideal for use as a first local oscillator in digitally tuned microwave receivers, or as a frequency-stable, digitally tuned microwave source.

The output frequency of the WJ-702 is selected by changing (in discrete, equally spaced steps) the current in the tuning coils, thus producing a magnetic bias for the YIG resonators. Stray magnetic fields are negligible, and the generator remains unaffected by moderate magnetic environments. For specific requirements, the WJ-702 may be varied to cover offset frequency ranges, alternate input drive frequencies, or changes in ambient temperatures between -55° C and $+80^{\circ}$ C. A self-regulating, proportional controlled heater, requiring only the application of unregulated power for operation, stabilizes the temperatures of the YIG spheres in the three-stage filter circuit.



3507-9

A special feature of the WJ-702 is its compatibility with the WJ-725 three-stage YIG filter. The resulting harmonic generator filter chain provides microwave harmonic energy with over 100 dB suppression of harmonics spaced ± 200 MHz or more from the tuned harmonic when driven by less than one watt of 100 MHz fundamental signal.

SPECIFICATIONS

RF PERFORMANCE Frequency range Power output, min.	. +5 dBm	
Harmonic suppression ±100 MHz Harmonic suppression, ±200 MHz and above Input VSWR	. 50 dB	35 dB 50 dB
ENVIRONMENTAL CHARACTERISTICS Operating Temperature		20° to +55°C
TUNING CHARACTERISTICS Sensitivity Coil resistance Coil inductance Time Constant	.6 ohms .120 mH	100 μ s max., Note 1

* Supersedes WJ-702 Technical Data Sheet Dated December 1967

RF INPUT CHARACTERISTICS

Drive frequency		•	•				,				100	MHz
Drive power									.3	0	dBm	max.

D.C. INPUT CHARACTERISTICS

Heater voltage	24	± 4 volts
Heater current:		
Surge at -20°C	750	mA max.
Steady state at -20°C	150	mA max.

MECHANICAL CHARACTERISTICS

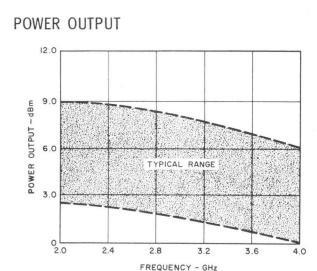
Dimensions											3.	1	1	"	Х	2.	85	"	x 3.7"
Weight										•							3	5	ounces
RF connecto	ors															C	SN	N	female
Outline drav	vin	g	r	IL	In	١Ł	De	er										2	290160

Notes:

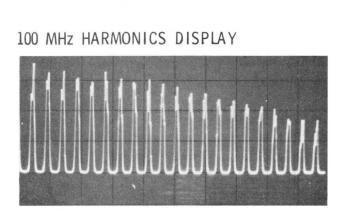
OUTLINE DRAWING

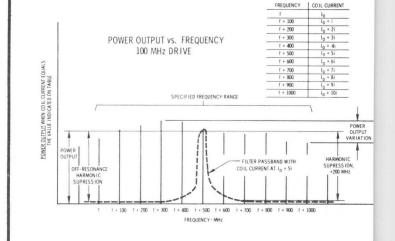
WJ IDENT

1. This measurement will be made for design verification only. 2. Maximum power output variation to be 8 dB.

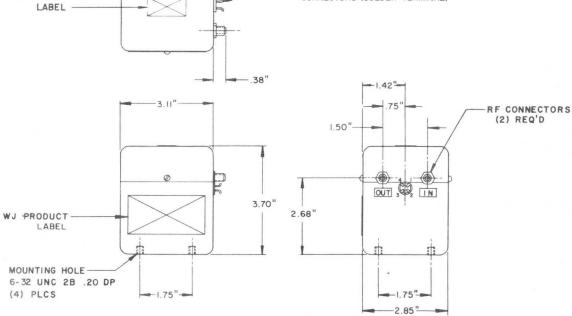


MEASUREMENT DEFINITIONS

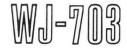




 TUNING CURRENT AND HEATER CONNECTORS (SOLDER TERMINAL)



-.32"



November 1968

4.0 TO 8.0 GHz YIG-TUNED HARMONIC GENERATOR

The WJ-703 is one of a new family of solid state, electronically-tuned, harmonic generators developed by Watkins-Johnson Company. This generator, which is driven by a 100-MHz signal source, produces output power at any one of the 100-MHz harmonics in C-band. In fact, its power output is approximately 5 dB above that of an untuned comb generator at comparable frequencies. Fast switching makes it ideal for use as a first local oscillator in digitally tuned microwave receivers, or as a frequency-stable, digitally tuned microwave source.

The output frequency of the WJ-703 is selected by changing (in discrete, equally spaced steps) the current in the tuning coils, thus producing a magnetic bias for the YIG resonators. Stray magnetic fields are negligible, and the generator remains unaffected by moderate magnetic environments. For specific requirements, the WJ-703 may be varied to cover offset frequency ranges, alternate input drive frequencies, or changes in ambient temperatures between -55° C and $+80^{\circ}$ C. A selfregulating, proportional controlled heater, requiring only the application of unregulated power for operation, stabilizes the temperatures of the YIG



spheres in the three-stage filter circuit.

A special feature of the WJ-703 is its compatibility with the WJ-726 three-stage YIG filter. The resulting harmonic generator filter chain provides microwave harmonic energy with over 100 dB suppression of harmonics spaced ± 200 MHz or more from the tuned harmonic when driven by less than one watt of 100 MHz fundamental signal.

SPECIFICATIONS

RF PERFORMANCE Frequency range Power output, min		
Output impedance	.50 ohms	
Harmonic suppression ±200 MHz		
Off-resonance harmonic suppression,		
ENVIRONMENTAL CHARACTERISTICS		
Operating Temperature		10°C to 55°C
TUNING CHARACTERISTICS		
Sensitivity		
Coil resistance		

Notes:

1. This measurement will be made for design verifica-

tion only.

2. Maximum power output variation to be 15 dB.

RF INPUT CHARACTERISTICS

Drive frequency 100 MHz Drive power +30 dBm max.

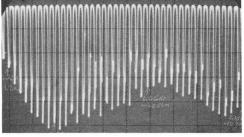
D.C. INPUT CHARACTERISTICS

Heater voltage	24 ±4 volts
Heater current:	
Surge at 10°C	750 mA max.
Steady state at 10°C	150 mA max.

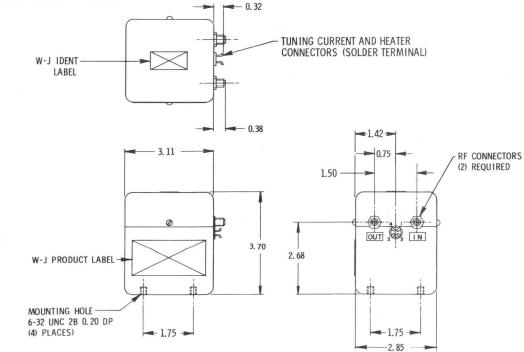
MECHANICAL CHARACTERISTICS

Dimensions	3.11 x 2.85 x 3.7 inches
Weight	35 ounces
RF connectors	OSM jack
Outline drawing number	er 290160

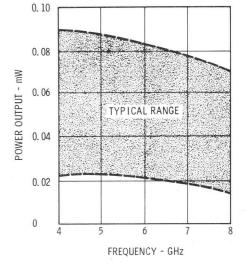
100 MHz HARMONICS DISPLAY



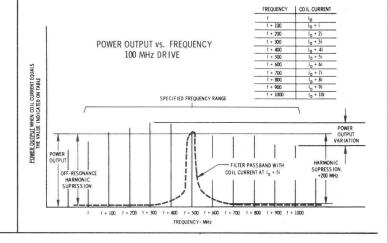
OUTLINE DRAWING



POWER OUTPUT



MEASUREMENT DEFINITIONS



WJ-704

November 1968

8.0 TO 12.0 GHz YIG-TUNED HARMONIC GENERATOR

The WJ-704 is one of a new family of solid state, electronically-tuned, harmonic generators developed by Watkins-Johnson Company. This generator, which is driven by a 100-MHz signal source, produces output power at any one of the 100-MHz harmonics in X-band. In fact, its power output is approximately 5 dB above that of an untuned comb generator at comparable frequencies. Fast switching makes it ideal for use as a first local oscillator in digitally tuned microwave receivers, or as a frequency-stable, digitally tuned microwave source.

The output frequency of the WJ-704 is selected by changing (in discrete, equally spaced steps) the current in the tuning coils, thus producing a magnetic bias for the YIG resonators. Stray magnetic fields are negligible, and the generator remains unaffected by moderate magnetic environments. For specific requirements, the WJ-704 may be varied to cover offset frequency ranges, alternate input drive frequencies, or changes in ambient temperatures between -55° C and $+80^{\circ}$ C. A self-regulating, proportional controlled heater, requiring only the application of unregulated power for operation, stabilizes the temperatures of the YIG



spheres in the three-stage filter circuit.

A special feature of the WJ-704 is its compatibility with the WJ-727 three-stage YIG filter. The resulting harmonic generator filter chain provides microwave harmonic energy with over 100 dB suppression of harmonics spaced ± 200 MHz or more from the tuned harmonic when driven by less than one watt of 100 MHz fundamental signal.

SPECIFICATIONS

RF PERFORMANCE Frequency range Power output, min.		Guaranteed 8.0 to 12.0 GHz 25 dBm, Note 2
Output impedance		
Off-resonance harmonic suppression,	.70 dB	60 dB
Input VSWR	.1.5:1	2.0:1, Note 1
ENVIRONMENTAL CHARACTERISTICS Operating Temperature		10°C to 55°C
TUNING CHARACTERISTICS		
Sensitivity	12.5 MHz/mA	
Coil resistance		
Coil inductance		
Time Constant	50 μs	100 μ s max., Note 1
Notes:	be made for design verifica-	

1. This measurement will be made for design verifica-

tion only.

2. Maximum power output variation to be 15 dB.

RF INPUT CHARACTERISTICS

Drive frequency		100 MHz
Drive power	+30 (dBm max.

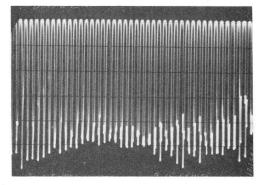
D.C. INPUT CHARACTERISTICS

Heater voltage 24 :	±4 volts
Heater current:	
Surge at 10°C 750 r	mA max.
Steady state at 10°C 150 r	mA max.

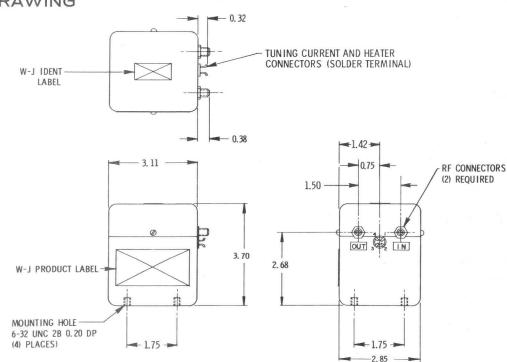
MECHANICAL CHARACTERISTICS

Dimensions	3.11" x 2.85" x 3.7"
Weight	35 ounces
RF connectors	OSM jack
Outline drawing number	

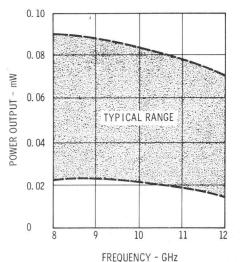
100 MHz HARMONICS DISPLAY



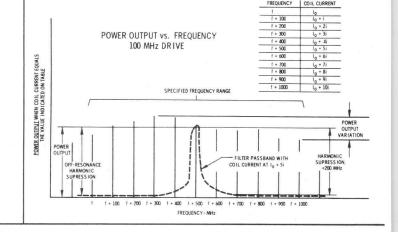
OUTLINE DRAWING



POWER OUTPUT



MEASUREMENT DEFINITIONS





0.5 TO 1.0 GHz THREE-STAGE YIG FILTER

September 1968

The WJ-723 is one of a new family of YIG filters designed for applications requiring electronicallycontrolled, fast switching from one frequency to another. Featuring high reliability, long life, rugged construction, and low insertion loss, this filter can be tuned to frequencies several hundred MHz apart in less than 100 microseconds. The three-resonator circuit provides a high selectivity figure of 18 dB per octave.

Accurate linear tuning of the WJ-723 is accomplished by changing the current in the tuning coils, thus altering the magnetic field at the YIG resonators. Stray magnetic fields are negligible, and the filter remains unaffected by moderate magnetic environments. For specific requirements, the WJ-723 may be varied to cover offset frequency ranges, to provide different values of instantaneous bandwidth and frequency stability over changes in ambient temperatures between -55 °C and +80 °C. A self-regulating, proportionally controlled heater, requiring only the application of unregulated power for operation, stabilizes the temperature of the YIG spheres. This feature minimizes spurious responses



and bandwidth variation over wide environmental temperature ranges.

A special feature of the WJ-723 is its compatibility with the WJ-700 YIG-tuned harmonic generator. The resulting harmonic generator filter chain provides microwave harmonic energy with over 100 dB suppression of harmonics spaced ± 200 MHz or more from the tuned harmonic when driven by less than one watt of 100 MHz fundamental signal.

SPECIFICATIONS

		Guaranteed
Frequency range		 0.5 to 1.0 GHz
Bandwidth, 3 db		
Insertion loss		
Off-Resonance isolation	.70 dB	 60 dB min.
Off-Resonance spurious	.50 dB	 45 dB min.
Directivity		
Passband ripple	.0.5 dB	 Note 2
Passband spurious	.1.0 dB	 Note 2
Passband VSWR	.1.5:1	 2.0:1 max., Note 3
Limiting level	.+20 dBm	 >+10 dBm
Selectivity	.18 dB/octave	

TUNING CHARACTERISTICS

Sensitivity	12.5 MHz/mA
Coil resistance	
Coil inductance	75 mH
Frequency deviation 10°C to 50°C	±2 MHz Note 1

 Bandwidth will be adequate to provide insertion loss below the specified value. The insertion loss measurement includes passband ripple and spurious modes (per Note 2), as well as the effects of temperature changes and non-linearities. Equally spaced tuning current steps will be used. The insertion loss will be measured at the worst point within ±5 MHz of the linearly calculated frequency corresponding to a particular tuning current.

2. Maximum combined insertion loss plus ripple and spurious shall not exceed 8 dB within ± 5 MHz of center frequency.

3. This measurement will be made for design verification only.

WJ-723

SPECIFICATIONS (Cont'd)

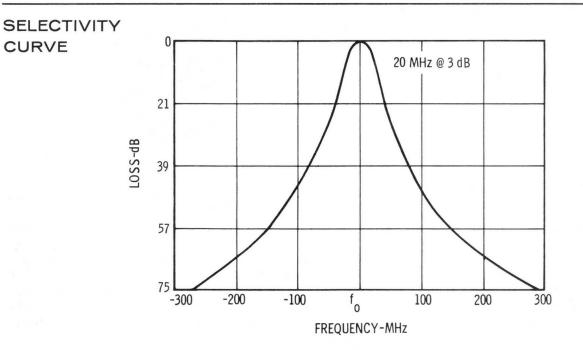
MECHANICAL CHARACTERISTICS

Dimensions	
Weight	
RF connector	M Jack
Outline drawing number	290161

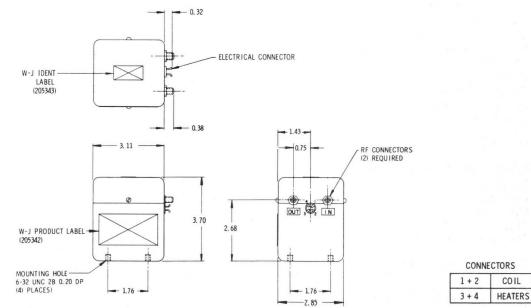
..... 24 ±4 volts

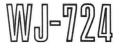
HEATER CHARACTERISTICS

Operating current:		
Surge at 10°C		A
Steady state at	10°C150 m/	A



OUTLINE DRAWING





1.0 TO 2.0 GHz THREE-STAGE YIG FILTER September 1968

3507-3

The WJ-724 is one of a new family of YIG filters designed for applications requiring electronicallycontrolled, fast switching from one frequency to another. Featuring high reliability, long life, rugged construction, and low insertion loss, this filter can be tuned to frequencies several hundred MHz apart in less than 100 microseconds. The three-resonator circuit provides a high selectivity figure of 18 dB per octave.

Accurate linear tuning of the WJ-724 is accomplished by changing the current in the tuning coils, thus altering the magnetic field at the YIG resonators. Stray magnetic fields are negligible, and the filter remains unaffected by moderate magnetic environments. For specific requirements, the WJ-724 may be varied to cover offset frequency ranges, to provide different values of instantaneous bandwidth and frequency stability over changes in ambient temperatures between -55° C and $+80^{\circ}$ C. A self-regulating, proportionally controlled heater, requiring only the application of unregulated power for operation, stabilizes the temperature of the YIG spheres. This feature minimizes spurious responses



and bandwidth variation over wide environmental temperature ranges.

A special feature of the WJ-724 is its compatibility with the WJ-701 YIG-tuned harmonic generator. The resulting harmonic generator filter chain provides microwave harmonic energy with over 100 dB suppression of harmonics spaced ± 200 MHz or more from the tuned harmonic when driven by less than one watt of 100 MHz fundamental signal.

SPECIFICATIONS

RF_PERFORMANCE	Typical	Guaranteed
Frequency range Bandwidth, 3 db Insertion loss		Note 1
Off-Resonance isolation	70 dB	60 dB min.
Directivity	Reciprocal 0.5 dB	Note 2
Passband spurious	1.0 dB	
Limiting level	+20 dBm	>+10 dBm
TUNING CHARACTERISTICS		

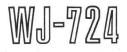
TUNING CHARACTERISTICS

Sensitivity	12.5 MHz/mA
Coil resistance	
Coil inductance	75 mH
Time constant	$50 \ \mu s$
Frequency deviation 10°C to 50°C	±3 MHz Note 1

 Bandwidth will be adequate to provide insertion loss below the specified value. The insertion loss measurement includes passband ripple and spurious modes (per Note 2), as well as the effects of temperature changes and non-linearities. Equally spaced tuning current steps will be used. The insertion loss will be measured at the worst point within ±5 MHz of the linearly calculated frequency corresponding to a particular tuning current.

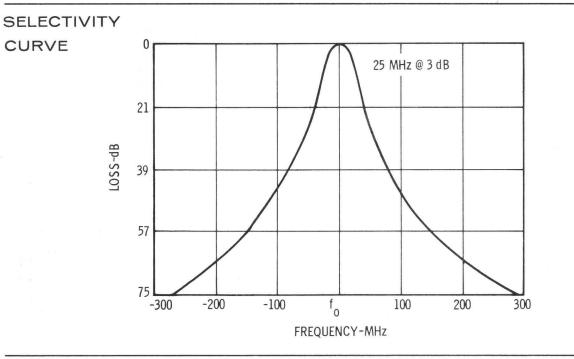
2. Maximum combined insertion loss plus ripple and spurious shall not exceed 6 dB.

3. This measurement will be made for design verification only.

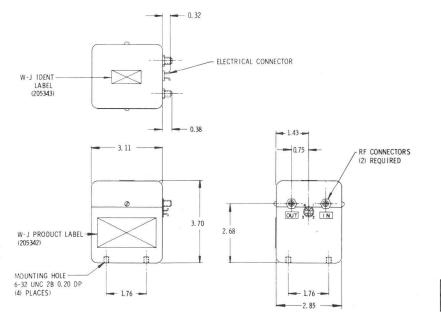


SPECIFICATIONS (Cont'd)

MECHANICAL CHARACTERISTICS Dimensions	35 ounces
RF connector	OSM Jack 290161
HEATER CHARACTERISTICS	
Operating voltage	24 ±4 volts
Surge at 10°C	



OUTLINE DRAWING



COIL

HEATERS

CONNECTORS

1 + 2

3 + 4

2.0 TO 4.0 GHz THREE-STAGE YIG FILTER

September 1968

The WJ-725 is one of a new family of YIG filters designed for applications requiring electronicallycontrolled, fast switching from one frequency to another. Featuring high reliability, long life, rugged construction, and low insertion loss, this filter can be tuned to frequencies several hundred MHz apart in less than 100 microseconds. The three-resonator circuit provides a high selectivity figure of 18 dB per octave.

Accurate linear tuning of the WJ-725 is accomplished by changing the current in the tuning coils, thus altering the magnetic field at the YIG resonators. Stray magnetic fields are negligible, and the filter remains unaffected by moderate magnetic environments. For specific requirements, the WJ-725 may be varied to cover offset frequency ranges, to provide different values of instantaneous bandwidth and frequency stability over changes in ambient temperatures between -55° C and $+80^{\circ}$ C. A self-regulating, proportionally controlled heater, requiring only the application of unregulated power for operation, stabilizes the temperature of the YIG spheres. This feature minimizes spurious responses



and bandwidth variation over wide environmental temperature ranges.

A special feature of the WJ-725 is its compatibility with the WJ-702 YIG-tuned harmonic generator. The resulting harmonic generator filter chain provides microwave harmonic energy with over 100 dB suppression of harmonics spaced ± 200 MHz or more from the tuned harmonic when driven by less than one watt of 100 MHz fundamental signal.

SPECIFICATIONS

RF PERFORMANCE	Typical	Guaranteed
Frequency rangeBandwidth, 3 db		Note 1
Insertion loss		
Off-Resonance spurious		
Directivity	0.5 dB	
Passband spurious Passband VSWR	1.5:1	2.0:1 max., Note 3
Limiting level		>+10 dBm

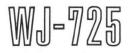
TUNING CHARACTERISTICS

Sensitivity	12.5 MHz/mA
Coil resistance	3 ohms
Coil inductance	75 mH
Time constant	
Frequency deviation 10°C to 50°C	±4 MHz Note 1

 Bandwidth will be adequate to provide insertion loss below the specified value. The insertion loss measurement includes passband ripple and spurious modes (per Note 2), as well as the effects of temperature changes and non-linearities. Equally spaced tuning current steps will be used. The insertion loss will be measured at the worst point within ±5 MHz of the linearly calculated frequency corresponding to a particular tuning current.

2. Maximum combined insertion loss plus ripple and spurious shall not exceed 6 dB.

3. This measurement will be made for design verification only.



SPECIFICATIONS (Cont'd)

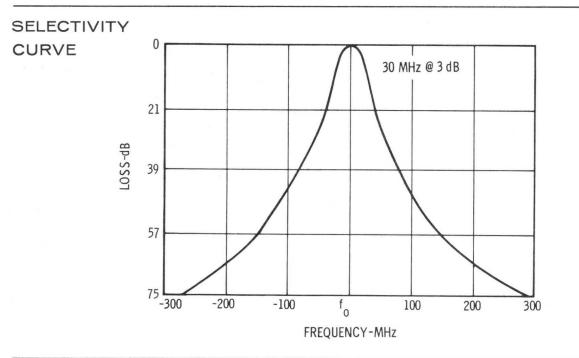
MECHANICAL CHARACTERISTICS

Dimensions	hes
Weight	ces
Outline drawing number	161

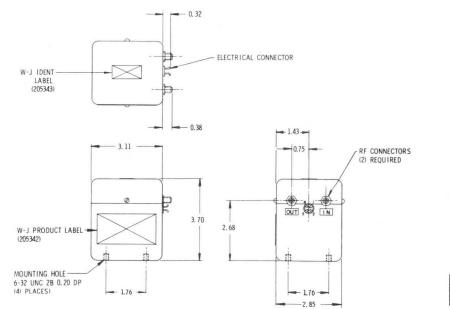
...... 24 ±4 volts

HEATER CHARACTERISTICS

Operating voltage		•					 		•								
Operating current:																	
Surge at 10°C							 				. 7	5	0	n	n	Ą	
Steady state at	10°C						 				. 1	5	0	n	n/	Ą	



OUTLINE DRAWING



CONNECTORS

COIL

HEATERS

1 + 2

3+4

WJ-726

4.0 TO 8.0 GHz THREE-STAGE YIG FILTER September 1968

The WJ-726 is one of a new family of YIG filters designed for applications requiring electronicallycontrolled, fast switching from one frequency to another. Featuring high reliability, long life, rugged construction, and low insertion loss, this filter can be tuned to frequencies several hundred MHz apart in less than 100 microseconds. The three-resonator circuit provides a high selectivity figure of 18 dB per octave.

Accurate linear tuning of the WJ-726 is accomplished by changing the current in the tuning coils, thus altering the magnetic field at the YIG resonators. Stray magnetic fields are negligible, and the filter remains unaffected by moderate magnetic environments. For specific requirements, the WJ-726 may be varied to cover offset frequency ranges, to provide different values of instantaneous bandwidth and frequency stability over changes in ambient temperatures between -55° C and $+80^{\circ}$ C. A self-regulating, proportionally controlled heater, requiring only the application of unregulated power for operation, stabilizes the temperature of the YIG spheres. This feature minimizes spurious responses



3507-7

and bandwidth variation over wide environmental temperature ranges.

A special feature of the WJ-726 is its compatibility with the WJ-703 YIG-tuned harmonic generator. The resulting harmonic generator filter chain provides microwave harmonic energy with over 100 dB suppression of harmonics spaced ± 200 MHz or more from the tuned harmonic when driven by less than one watt of 100 MHz fundamental signal.

SPECIFICATIONS

RF PERFORMANCE	Typical	Guaranteed
Frequency range		
Bandwidth, 3 db	.35 MHz	Note 1
Insertion loss	.3 dB	Note 2
Off-Resonance isolation		
Off-Resonance spurious		. 45 dB min.
Directivity		
Passband ripple	.0.5 dB	Note 2
Passband spurious	.1.0 dB	Note 2
Passband VSWR		
Limiting level		>+10 dBm
Selectivity	.18 dB/octave	

TUNING CHARACTERISTICS

Sensitivity	12.5 MHz/mA
Coil resistance	
Coil inductance	
Time constant	$50 \ \mu s$ Note 3
Frequency deviation 10°C to 50°C	±6 MHz Note 1

1. Bandwidth will be adequate to provide insertion loss below the specified value. The insertion loss measurement includes passband ripple and spurious modes (per Note 2), as well as the effects of temperature changes and non-linearities. Equally spaced tuning current steps will be used. The insertion loss will be measured at the worst point within ±5 MHz of the linearly calculated frequency corresponding to a particular tuning current.

2. Maximum combined insertion loss plus ripple and spurious shall not exceed 6 dB.

3. This measurement will be made for design verification only.



SPECIFICATIONS (Cont'd)

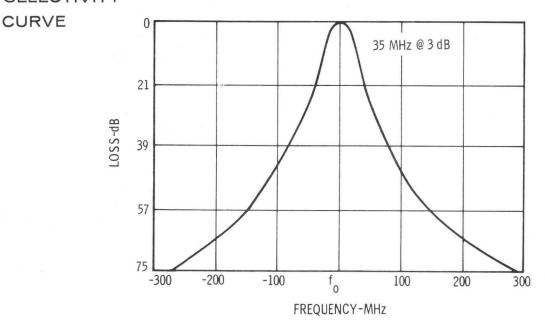
MECHANICAL CHARACTERISTICS

Dimensions	
Weight	35 ounces
RF connector	OSM Jack
Outline drawing number	

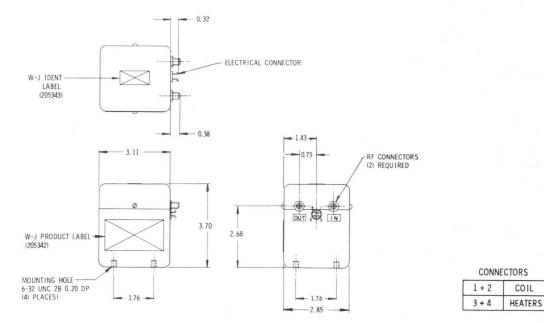
HEATER CHARACTERISTICS

Operating voltage Operating current:			•	•	•			• •			•	•	•	•	•	•						 	
Surge at 10°C						•				63			•			7!	50)	m	hA	A		
Steady state at	10°C									8.5						1!	50)	m	١A	ł		

SELECTIVITY



OUTLINE DRAWING



..... 24 ±4 volts

.

WJ-727

8.0 TO 12.0 GHz THREE-STAGE YIG FILTER

September 1968

The WJ-727 is one of a new family of YIG filters designed for applications requiring electronicallycontrolled, fast switching from one frequency to another. Featuring high reliability, long life, rugged construction, and low insertion loss, this filter can be tuned to frequencies several hundred MHz apart in less than 100 microseconds. The three-resonator circuit provides a high selectivity figure of 18 dB per octave.

Accurate linear tuning of the WJ-727 is accomplished by changing the current in the tuning coils, thus altering the magnetic field at the YIG resonators. Stray magnetic fields are negligible, and the filter remains unaffected by moderate magnetic environments. For specific requirements, the WJ-727 may be varied to cover offset frequency ranges, to provide different values of instantaneous bandwidth and frequency stability over changes in ambient temperatures between -55 °C and +80 °C. A self-regulating, proportionally controlled heater, requiring only the application of unregulated power for operation, stabilizes the temperature of the YIG spheres.



3507-2

A special feature of the WJ-727 is its compatibility with the WJ-704 YIG-tuned harmonic generator. The resulting harmonic generator filter chain provides microwave harmonic energy with over 100 dB suppression of harmonics spaced ± 200 MHz or more from the tuned harmonic when driven by less than one watt of 100 MHz fundamental signal.

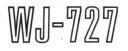
SPECIFICATIONS

RF PERFORMANCE		
Frequency range		8.0 to 12.0 GHz
Bandwidth, 3 db		
Insertion loss		
Off-Resonance isolation	.70 dB	60 dB min.
Off-Resonance spurious	.50 dB	45 dB min.
Directivity	Reciprocal	
Passband ripple	.0.5 dB	Note 2
Passband spurious	.1.0 dB	Note 2
Passband VSWR	.1.5:1	2.0:1 max., Note 3
Limiting level	.+20 dBm	$\dots \dots >+10 \text{ dBm}$
Selectivity	.18 dB/octave	
TUNING CHARACTERISTICS		

1. Bandwidth will be adequate to provide insertion loss below the specified value. The insertion loss measurement includes passband ripple and spurious modes (per Note 2), as well as the effects of temperature changes and non-linearities. Equally spaced tuning current steps will be used. The insertion loss will be measured at the worst point within ±5 MHz of the linearly calculated frequency corresponding to a particular tuning current.

2. Maximum combined insertion loss plus ripple and spurious shall hot exceed 6 dB.

3. This measurement will be made for design verification only.



SPECIFICATIONS (Cont'd)

MECHANICAL CHARACTERISTICS

Dimensions
Weight
RF connector
Outline drawing number

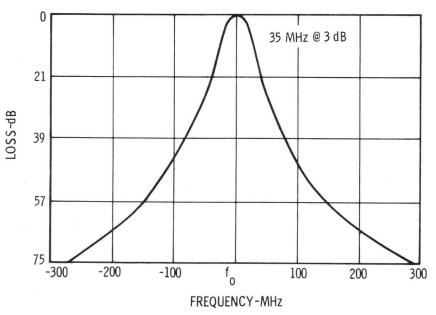
..... 24 ±4 volts

HEATER CHARACTERISTICS

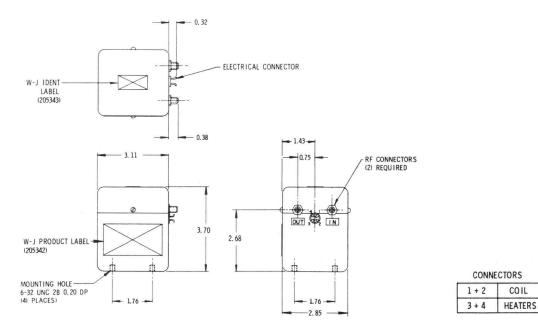
Operating voltage Operating current:	•••.••	• •	 •••	 •••	 • • •	 • • • •		•
Surge at 10°C			 	 	 	 .750	mA	
Steady state at	10°C		 	 	 	 .150	mA	

SELECTIVITY

CURVE



OUTLINE DRAWING



APRIL 1970 *

0.5 TO 1.0 GHz LOW-NOISE MICROWAVE TRANSISTOR AMPLIFIER WJ-736

- SMALL SIZE: 1.0 x 1.3 x 2.9 INCHES
- GUARANTEED 4.0 dB NOISE FIGURE
- GUARANTEED -3 dBm POWER OUTPUT
- MEETS MIL-E-16400 AND MIL-E-5400 CLASS II ENVIRONMENT
- NO ADJUSTMENTS REQUIRED

The WJ-736 is one of a new series of low-noise microwave transistor amplifiers developed by Watkins-Johnson Company to complement an existing line of ultra-low-noise TWAs. Featuring all solid state components, this miniaturized amplifier offers a guaranteed noise figure of 4.0 dB and -3 dBm saturated power output. No other P-band amplifier on the market can match the power output/noise figure/size combination offered by this amplifier. Modular construction ensures high reliability under adverse operating conditions. Calculated MTBF for this amplifier exceeds 250,000 hours. The microstripline circuit configuration employs integrated circuit biasing and bypass modules for consistently high performance. The overall design of the WJ-736 is consistent with the general requirements of MIL-E-16400 and MIL-E-5400, class II. Since the amplifier is tested and set for operation prior to shipment, no adjustments are necessary by the user.

SPECIFICATIONS

PERFORMANCE	Typical	
Frequency	0.5 to 1.0 GHz	0.5 to 1.0 GHz
Noise Figure (terminal)		4.0 dB max.
Gain, Small Signal		25 dB min.
Gain Variation	±0.7 dB	±1.0 dB max.
VSWR, Input and Output	1.5:1	2.0:1 max.
Power Output, Saturated ¹	0 dBm	—3 dBm min.
Impedance, Input and Output		50 ohms
Intercept Point for Third Order IM	+7 dBm	
PRIMARY FLECTRICAL REQUIREMENTS		

PRIMARY ELECTRICAL REQUIREMENTS

						~																	
Primary	Voltage			8	•		•					0.0		ŝ			•		•	-15	vol	lts	
Primary	Power											 								 0.5	watt	S	

ENVIRONMENTAL CHARACTERISTICS

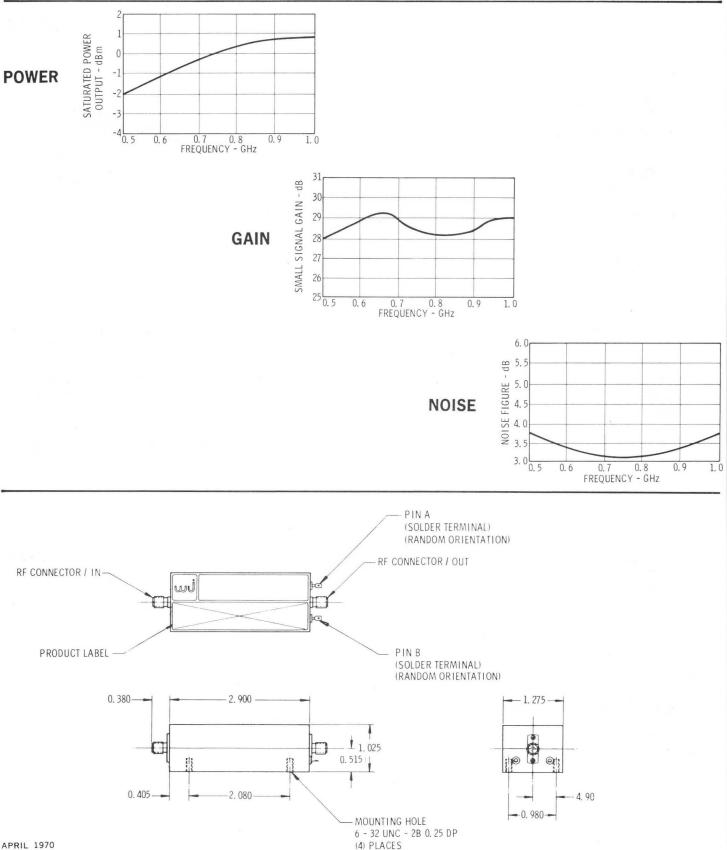
Designed to meet the general requirements of MIL-E-16400 and MIL-E-5400 Class II.

1. For 1 dB gain compression.

*Supersedes WJ-736 Technical Data Sheet dated March 1968.



MECHANICAL CHARACTERISTICS Height 1.0 inches (25 mm) Width 1.3 inches (33 mm) Length (less connectors) 2.9 inches (74 mm) RF Connectors OSM jack



APRIL 1970 *

1.0 TO 2.0 GHz LOW-NOISE MICROWAVE TRANSISTOR AMPLIFIER WJ-737

- SMALL SIZE: 1.0 x 1.3 x 2.9 INCHES
- GUARANTEED 6.0 dB
 NOISE FIGURE
- GUARANTEED 0 dBm
 POWER OUTPUT
- MIL-E-5400 AND MIL-E-16400 CLASS II ENVIRONMENT DESIGN
- NO ADJUSTMENTS REQUIRED

The WJ-737 is one of a new series of low-noise microwave transistor amplifiers developed by Watkins-Johnson Company to complement an existing line of ultra-low-noise TWAs. Featuring all solid state components, this miniaturized amplifier offers a guaranteed noise figure of 6.0 dB and 0 dBm power output.¹ No other L-band amplifier on the market can match the power output/noise figure/size combination offered by this amplifier.



Modular construction ensures high reliability under adverse operating conditions. Calculated MTBF for this amplifier exceeds 225,000 hours. The microstripline circuit configuration employs integrated circuit biasing and bypass modules for consistently high performance. The overall design of the WJ-737 is consistent with the general requirements of MIL-E-16400 and MIL-E-5400, class II. Since the amplifier is tested and set for operation prior to shipment, no adjustments are necessary by the user.

SPECIFICATIONS

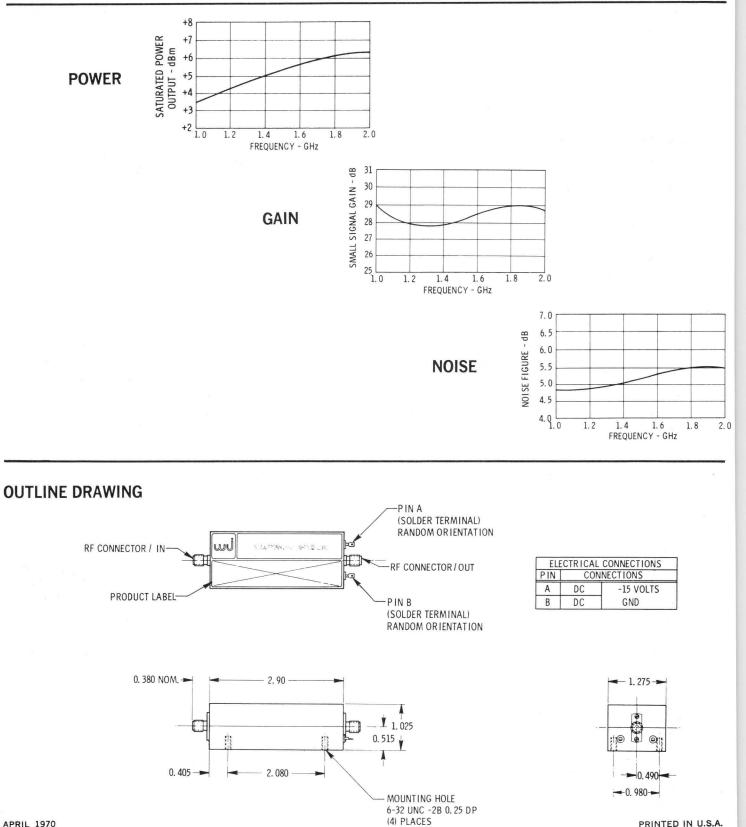
PERFORMANCE Frequency	Typical . 1.0 to 2.0 GHz	Guaranteed
Noise Figure	. 5.0 dB	6.0 dB min.
Gain, Small Signal		
VSWR, Input and Output		
Power Output ¹		
Impedance, Input and Output		50 ohms
	. +10 dBill	
PRIMARY ELECTRICAL REQUIREMENTS Primary Voltage	-15 volts	
Primary Power		
ENVIRONMENTAL CHARACTERISTICS Designed to meet the general requirements of MIL-E-1	6400 and MIL-E-5400 Class II.	

1. For 1 dB gain compression.

*Supersedes WJ-737 Technical Data Sheet dated May 1968.

MECHANICAL CHARACTERISTICS

Height 1 inch (25 mm)
Width 1.3 inches (33 mm)
Length (less connectors) 2.9 inches (74 mm)
Weight 3 ounces (85 g)
RF Connectors OSM Jack



PRINTED IN U.S.A.

APRIL 1970*

0.5 TO 1.0 GHz LOW-NOISE MICROWAVE TRANSISTOR AMPLIFIER WITH INTEGRAL POWER SUPPLY WJ-738

- SMALL SIZE: 1.3 x 2.3 x 2.9 INCHES
- GUARANTEED 4.0 dB NOISE FIGURE
- GUARANTEED -3 dBm POWER OUTPUT
- MEETS MIL-E-16400 AND MIL-E-5400 CLASS II ENVIRONMENT DESIGN
- "JUST PLUG IT IN"

Modular construction ensures high reliability under adverse operating conditions. Calculated MTBF for this amplifier exceeds 200,000 hours. The microstripline circuit configuration employs integrated circuit biasing and bypass modules for consistently high performance. The overall design of the WJ-738 is consistent with the general requirements of MIL-E-16400 and MIL-E-5400, class II. Since the amplifier is tested and set for operation prior to shipment, no adjustments are necessary by the user.

SPECIFICATIONS

PERFORMANCE Frequency Noise Figure (terminal) Gain, Small Signal Gain Variation VSWR, Input and Output Power Output ¹ Impedance, Input and Output Intercept Point for Third Order IM	.3.5 dB .28 dB .±0.7 dB .1.5:1 .0 dBm .50 ohms	. 0.5 to 1.0 GHz 4.0 dB max. 25 dB min. ±1.0 dB max. 2.0:1 max. —3 dBm min.
Intercept Point for Third Order IM		

PRIMARY ELECTRICAL REQUIREMENTS

Primary Voltage115 ±	LO volt ac
Primary Power2.5 wat	ts max.
Primary Frequency	20 Hz

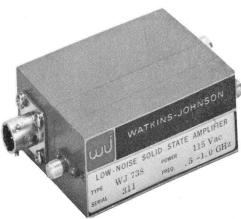
ENVIRONMENTAL CHARACTERISTICS

Designed to meet the general requirements of MIL-E-16400 and MIL-E-5400 Class II.

1. For 1 dB gain compression.

for operation.

*Supersedes WJ-738 Technical Data Sheet dated May 1968.



The WJ-738 is one of a new series of low-noise microwave transistor amplifiers developed by Watkins-

Johnson Company to complement an existing line of

ultra-low-noise TWAs. Featuring all solid state com-

ponents, this miniaturized amplifier offers a guaran-

teed noise figure of 4.0 dB and -3 dBm saturated

power output. No other P-band amplifier (with integral power supply) on the market can match the power

output/noise figure/size combination offered by this amplifier. Plug it into most 115 volt ac power outlets

MECHANICAL CHARACTERISTICS

Height 1.3 inches (33 mm)
Width 2.3 inches (58 mm)
Length (less connectors) 2.9 inches (74 mm)
Weight 6.0 ounces (170g)
RF Connectors OSM Jack

0.525

....

- -

0.165-

POWER CONNECTOR

0.485

MOUNTING HOLE 6-32 THREADED INSERTS .50 DP (4) PLACES 2.90

2.56

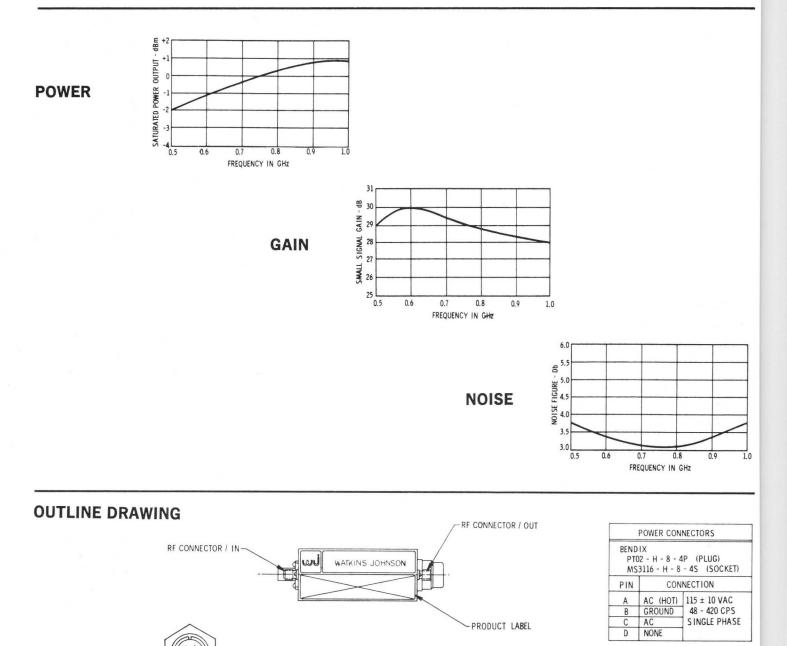
0.68

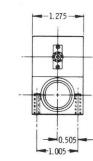
1.90

1.39

- FUSE

Γ





JULY 1970 *

1.0 TO 2.0 GHz LOW-NOISE MICROWAVE TRANSISTOR AMPLIFIER WITH INTEGRAL POWER SUPPLY WJ-739



The WJ-739 is one of a new series of low-noise microwave transistor amplifiers developed by Watkins-Johnson Company to complement an existing line of ultra-low-noise TWA's. Featuring all solid state components, this miniaturized amplifier offers a guaranteed noise figure of 6.0 dB and 0 dBm power output.¹ No other L-band amplifier (with integral power supply) on the market can match the power output/noise figure/size combination offered by this amplifier. Plug it into most 115 volt ac power outlets for operation.

- SMALL SIZE: 1.3 x 2.3 x 2.9 INCHES
- GUARANTEED 6.0 dB NOISE FIGURE
- GUARANTEED 0 dBm
 POWER OUTPUT
- MIL-E-16400 AND MIL-E-5400 CLASS II ENVIRONMENT DESIGN
- "JUST PLUG IT IN"

Modular construction ensures high reliability under adverse operating conditions. Calculated MTBF for this amplifier exceeds 200,000 hours. The microstripline circuit configuration employs integrated circuit biasing and bypass modules for consistently high performance. The overall design of the WJ-739 is consistent with the general requirements of MIL-E-16400 and MIL-E-5400, class II. Since the amplifier is tested and set for operation prior to shipment, no adjustments are necessary by the user.

SPECIFICATIONS

Intercept Point for United Urger IVI +10.0BM	PERFORMANCE Frequency Noise Figure Gain, Small Signal Gain Variation VSWR, Input and Output Power Output ¹ Impedance, Input and Output Intercept Point for Third Order IM	5.0 dB	1.0 to 2.0 GHz 6.0 dB min. 25 dB min. ±1.0 dB max. 2.0:1 max. 0 dBm min.
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PRIMARY ELECTRICAL REQUIREMENTS

Primary	Voltage										•	 1			$.115 \pm 10$ volt ac	
Primary	Power						•								. 2.5 watts max.	
Primary	Frequer	ICY	١.												.48 to 420 Hz	

ENVIRONMENTAL CHARACTERISTICS

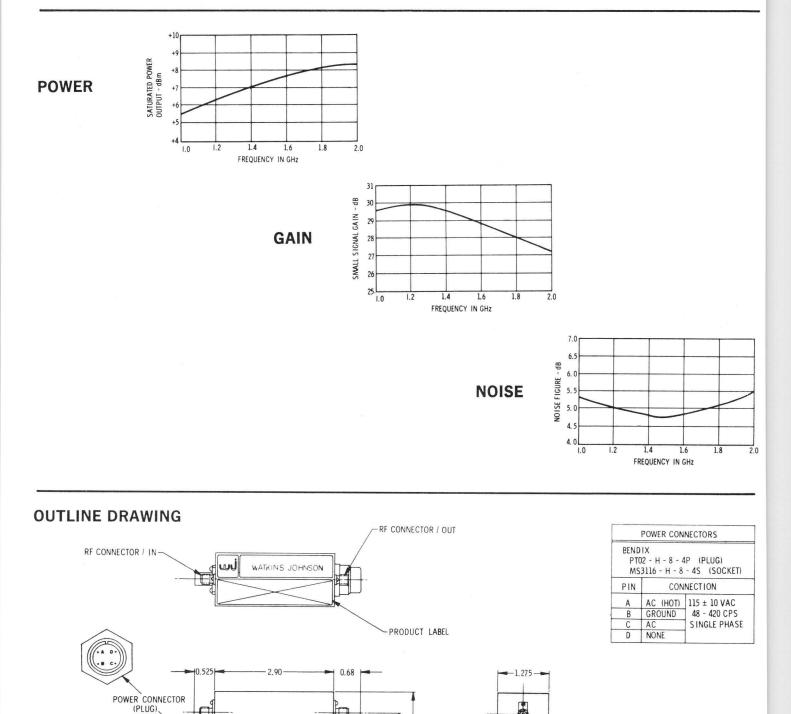
Designed to meet the general requirements of MIL-E-16400 and MIL-E-5400 Class II.

1. For 1 dB gain compression.

*Supersedes WJ-739 Technical Data Sheet dated May 1968.

MECHANICAL CHARACTERISTICS

Height 1.3 inches (33 mm)
Width 2.3 inches (58 mm)
Length (less connectors) 2.9 inches (74 mm)
Weight 6.0 ounces (170g)
RF Connectors OSM Jack



-

4

1.39

-FUSE

1.90

1

0.485

0.165-

- 2.56 -

MOUNTING HOLE 6-32 THREADED INSERTS . 50 DP (4) PLACES

WJ-740

May 1968

0.5 to 1.0 GHz LOW-NOISE MICROWAVE TRANSISTOR AMPLIFIER WITH INTEGRAL POWER SUPPLY

- "JUST PLUG IT IN"
- GUARANTEED 4.0 dB NOISE FIGURE
- GUARANTEED -3 dBm POWER OUTPUT

PERFORMANCE

- MEETS MIL-E-16400 AND MIL-E-5400 CLASS II ENVIRONMENT
- DIRECT TWA REPLACEMENT

The WJ-740 is one of a new series of low-noise microwave transistor amplifiers developed by Watkins-Johnson Company for TWA replacement. Featuring all solid state components, this miniaturized amplifier offers a guaranteed noise figure of 4.0 dB and -3 dBm saturated power output. The power output/noise figure/size combination offered by this L-band amplifier is unmatched by standard TWAs. Plug it into most 115 volt ac power outlets for operation.



Modular construction ensures high reliability under adverse operating conditions. The microstripline circuit configuration employs integrated circuit biasing and bypass modules for consistently high performance. The overall design of the WJ-740 is consistent with the general requirements of MIL-E-16400 and MIL-E-5400, class II. Since the amplifier is tested and set for operation prior to shipment, no adjustments are necessary by the user.

SPECIFICATIONS

Guaranteed

	51	
Frequency	0.5 - 1.0 GHz	. 0.5 - 1.0 GHz
Noise figure (terminal)	3.5 dB	4.0 dB max.
Gain, small signal		
VSWR, input and output		
*Power output		
Impedance, input and output	50 Onins	

Typical

PRIMARY ELECTRICAL REQUIREMENTS

Primary voltage	
Primary power1.5 watts max.	
Primary frequency	

ENVIRONMENTAL CHARACTERISTICS

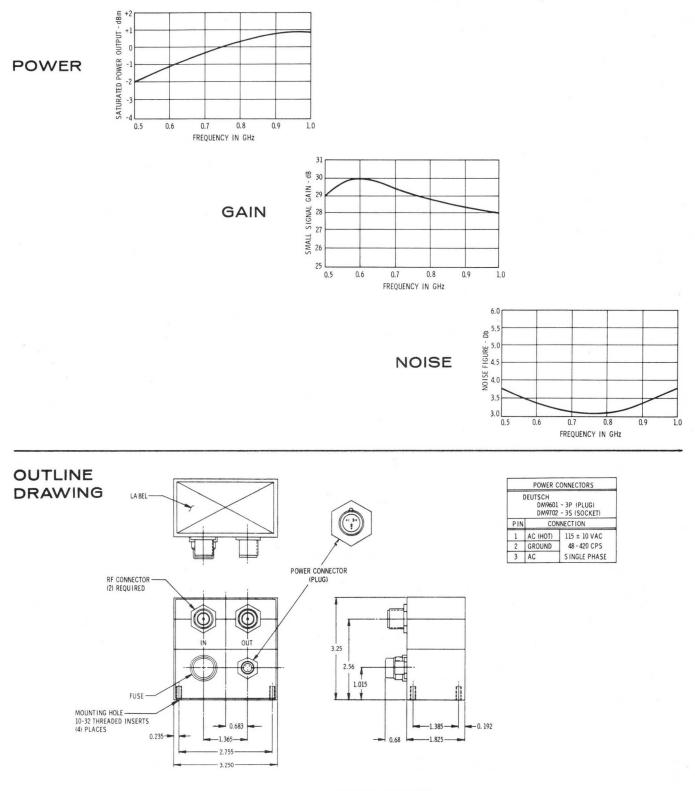
Designed to meet the general requirements of MIL-E-16400 and MIL-E-5400, Class II.

*For 1 dB gain compression.

WJ-740

MECHANICAL CHARACTERISTICS

Length1.825 inches (less connectors)Height3.250 inchesWidth3.250 inchesWeight10 ouncesRF connectorsN jack



WATKINS = JOHNSON COMPANY 3333 HILLVIEW AVENUE = STANFORD INDUSTRIAL PARK PALO ALTO, CALIFORNIA 94304 TWX 910-373-1253 PHONE (415) 326-8830 Telex: 348-415

W J - 741

May 1968

1. 0 to 2. 0 GHz LOW-NOISE MICROWAVE TRANSISTOR AMPLIFIER WITH INTEGRAL POWER SUPPLY

- "JUST PLUG IT IN"
- GUARANTEED 6.0 dB NOISE FIGURE
- GUARANTEED 0 dBm POWER OUTPUT
- MEETS MIL-E-16400 AND MIL-E-5400 CLASS II ENVIRONMENT

DIRECT TWA REPLACEMENT

The WJ-741 is one of a new series of low-noise microwave transistor amplifiers developed by Watkins-Johnson Company for TWA replacement. Featuring all solid state components, this miniaturized amplifier offers a guaranteed noise figure of 6.0 dB and 0 dBm saturated power output. The power output/noise figure/size combination offered by this L-band amplifier is unmatched by standard TWAs. Plug it into most 115 volt ac power outlets for operation.



Modular construction ensures high reliability under adverse operating conditions. The microstripline circuit configuration employs integrated circuit biasing and bypass modules for consistently high performance. The overall design of the WJ-741 is consistent with the general requirements of MIL-E-16400 and MIL-E-5400, class II. Since the amplifier is tested and set for operation prior to shipment, no adjustments are necessary by the user.

SPECIFICATIONS

PERFORMANCE

Typical

Guaranteed

Frequency	1.0 to 2.0 GHz	1.0 to 2.0 GHz
Noise figure		
Gain, small signal		
VSWR, input and output	1.5:1	2.0:1 max.
* Power output	+6 dBm	0 dBm min.
Impedance, input and output		50 ohms

PRIMARY ELECTRICAL REQUIREMENTS

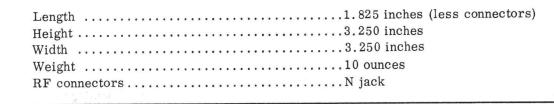
Primary voltage $115 \pm 10^{\circ}$	volt ac
Primary power1.5 watts	max.
Primary frequency	Hz

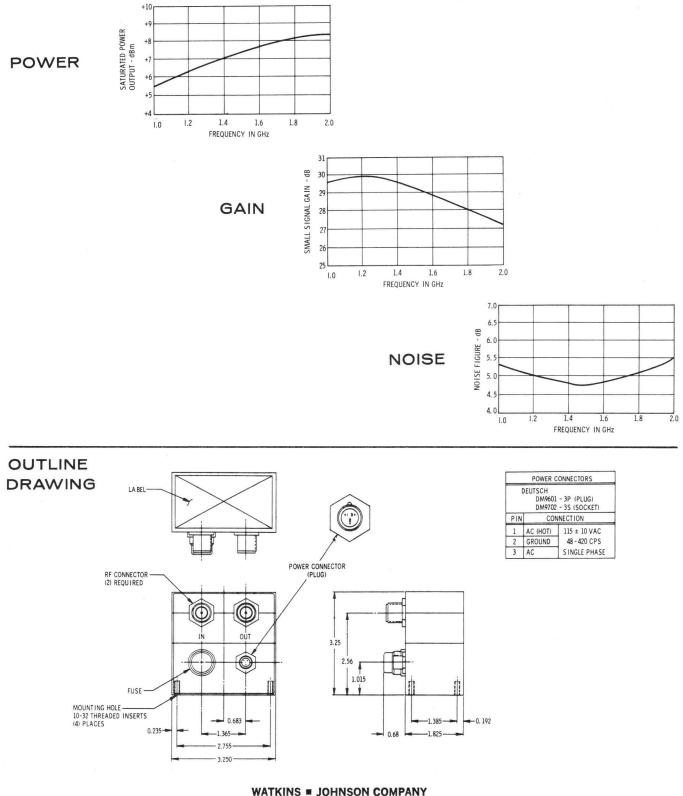
ENVIRONMENTAL CHARACTERISTICS

Designed to meet the general requirements of MIL-E-16400 and MIL-E-5400, Class II. *For 1 dB gain compression.

WJ-741

MECHANICAL CHARACTERISTICS





3333 HILLVIEW AVENUE ■ STANFORD INDUSTRIAL PARK PALO ALTO, CALIFORNIA 94304 TWX 910-373-1253 PHONE (415) 326-8830 Telex: 348-415

OCTOBER 1969

1 TO 12.4 GHz THREE-STAGE MULTI-OCTAVE COMPACT YIG FILTER WJ-756

Watkins-Johnson has added a three-stage device to its multi-octave compact YIG filter line. This device offers increased off-resonance isolation (typically 75 dB) in a unit covering the 1 to 12.4 GHz frequency range. The compact magnetic design of this filter ensures high reliability, long life, ruggedness, small size, and a low tuning power requirement (less than 3 watts).

WJ-756 is particularly suited for ultra-wide bandwidth receiving and frequency measuring applications. For specific requirements, the tuning sensitivity may be changed to 9 MHz/mA without increasing the tuning power requirements. In addition, optional bandwidths are available for special applications.



SPECIFICATIONS

RF PERFORMANCE	Typical		Guaranteed
Frequency Range			. 1.0 to 12.4 GHz
Bandwidth (3dB) (minimum)			20 MHz
Insertion Loss (maximum)	4.0 dB		7.5 dB
Off Resonance Isolation (minimum)			
Off Resonance Spurious (minimum)			15 dB
Directivity	Reciprocal		
Passband Ripple and Spurious (maximum)	1.5 dB		2.0 dB
VSWR Input and Output (maximum)	1.5:1		2.0:1
Limiting Level (minimum)		+10	dBm (2-12.4 GHz)
Selectivity			-23 dBm (1-2 GHz)

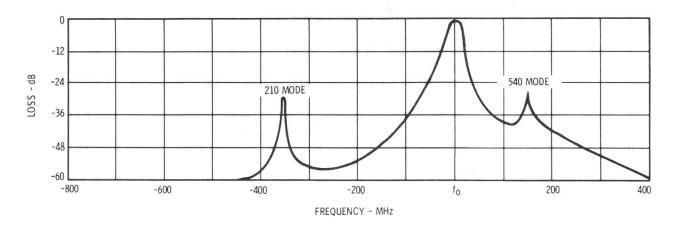
TUNING CHARACTERISTICS

offind officience	
Sensitivity	MHz/mA
Coil Resistance	5.5 ohms
Coil Inductance	.112 mH
Time Constant	5 ms
Deviation from Linear (maximum)±0.2	5 percent
Hysteresis	. 30 MHz
Frequency Drift over Temp. Range +10°C to +30°C	. 15 MHz

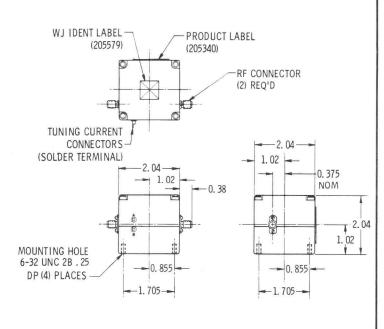
SPECIFICATIONS (Cont'd)

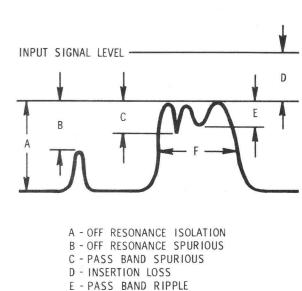
MECHANICAL CHARACTERISTICS Size (excluding connectors) Weight RF Connectors Outline Drawing No.	30 ounces (850 g) OSM Jack
HEATER CHARACTERISTICS Operating Voltage Operating Current: Surge at +10°C Steady State at +10°C	

SELECTIVITY CURVE (TYPICAL)



OUTLINE DRAWING





MEASUREMENT DEFINITIONS

F - 3 dB BANDWIDTH

7.0 TO 12.4 GHz AVALANCHE DIODE OSCILLATOR

November 1968

- SMALL SIZE: 1x1x1.1 INCHES
- BURNOUT PROTECTION CIRCUIT
- SOLID STATE RELIABILITY

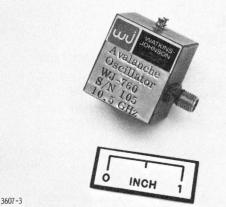
• DIRECT D.C. TO R.F. CONVERSION

WJ-760 is one of a new family of solid state microwave oscillators featuring direct d.c. to r.f. conversion through a single active device. These oscillators may be used as receiver local oscillators, laboratory signal sources, low power transmitters, doppler radar devices, microwave relays, or in any application where small size and high reliability are essential.

A silicon avalanche transit-time diode manufactured by Watkins-Johnson is used as the active element in a coaxial resonant circuit to produce microwave oscillations. Since the WJ-760 is a fundamental mode oscillator, it is inherently free of spurious oscillations.

For high stability, this unit may easily be injectionlocked to an external source. Locking over a 25 MHz range may be accomplished with only -20dB of injected power. The stability and spectral properties of the unit under phase-locked operation are identical to that of the locking signal.

A transistorized current limiting bias circuit is built into the WJ-760 to prevent over-driving of the avalanche diode. This enables the user to bias the device with a d.c. source of any value from



100 to 150 volts without overdriving it. AM and FM modulation may be accomplished by biasing the unit with a small series resistance below the point of current limited operation in the 70-80 volt range, where the limiter is not functioning and the current voltage characteristics of the circuit is that of the avalanche diode.

Forward voltage protection is also featured up to 150 volts in the event the user inadvertantly interchanges the bias leads. The bias circuitry also contains an externally accessible trimmer pot which varies the diode bias current while maintaining its current limited operation. This enables the user to adjust to the desired output power level.

Other features include mechanical tuning of typically ± 100 MHz through the use of a cavity perturbing screw, a grounded case (only the positive bias terminal is hot), and a female output connector (type OSM). Output to waveguide can be obtained through the use of a simple waveguide to coaxial adaptor. Avalance diode oscillators with broader mechanical tuning, electronic tuning, and higher output power can be provided on special order.

SPECIFICATIONS

RF PERFORMANCE	Typical	Guaranteed
Center Frequency		7 to 12.4 GHz, Note 1
Power Output	.25 mW	10 mW
Mechanical Tuning Range	.±100 MHz	
Spurious Oscillations at or greater than ±500 KHz	.50 dB	
Pulling Factor (1.2 VSWR)	.3 parts/1000	
Output Impedance	.50 ohms	

ELECTRICAL REQUIREMENTS

D.C.	Input Current	, Note 2	 		 	 •				 . :	20	m/	A ma	ax.	
D.C.	Input Voltage,	Note 2	 	 •••	 •	 	 •	•••	•	• •	 			100) V

TEMPERATURE

Operating Case Temperature ... -55°C to 55°C Storage Temperature -70°C to 85°C

MECHANICAL

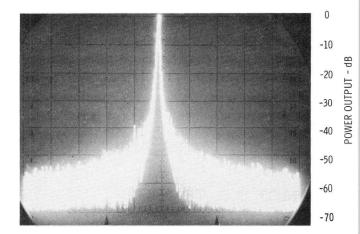
CHARACTERISTICS

Size 1.1 inch cube
Weight 4 oz.
RF Connector OSM Jack
D.C. Connector Solder Lugs
Outline Drawing No

NOTES:

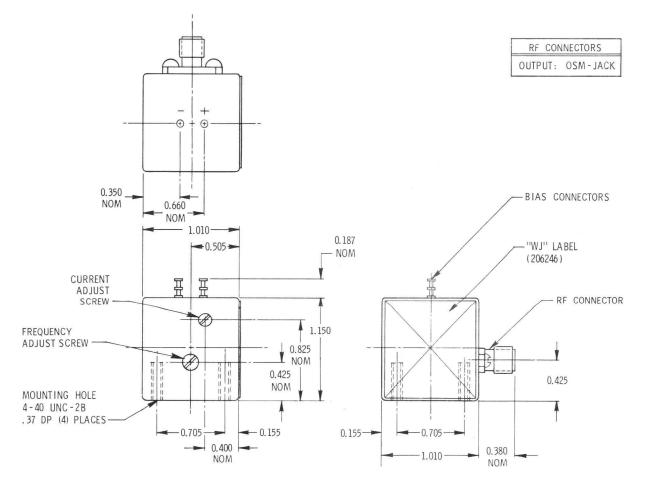
- 1. To be specified by customer as any frequency in increments of 200 MHz; ie: 7.0, 7.2, 7.4, . . . 12.0, 12.2, 12.4 GHz.
- 2. This unit is supplied with a current limiter which allows operation at any D.C. voltage from 100 to 150 volts.

TYPICAL OUTPUT POWER SPECTRUM



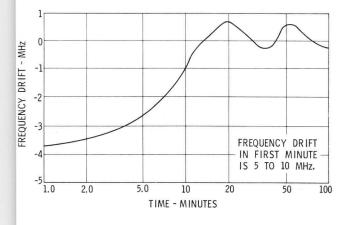
300 KHz / DIVISION

OUTLINE DRAWING

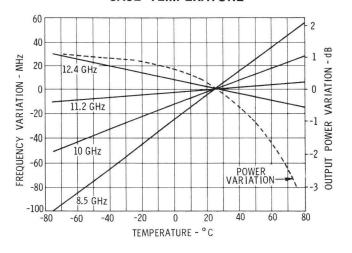


WJ-760

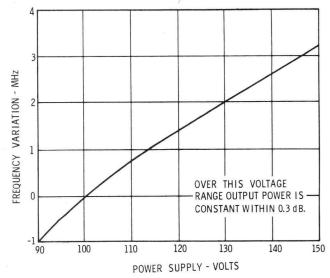
TYPICAL PLOT OF FREQUENCY DRIFT AS FUNCTION OF WARM-UP TIME



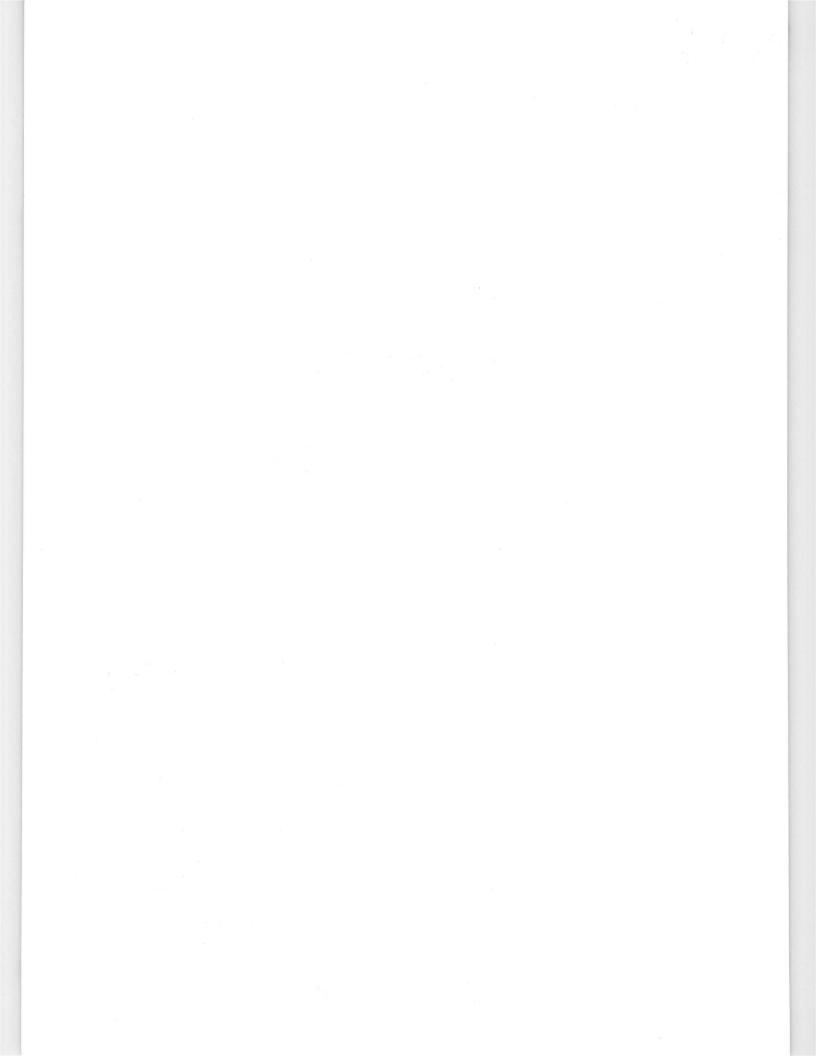
TYPICAL FREQUENCY AND POWER VARIATION AS A FUNCTION OF CASE TEMPERATURE



TYPICAL FREQUENCY VARIATION AS A FUNCTION OF POWER SUPPLY VOLTAGE



WATKINS ■ JOHNSON COMPANY 3333 HILLVIEW AVENUE ■ STANFORD INDUSTRIAL PARK PALO ALTO, CALIFORNIA 94304 TWX 910-373-1253 PHONE (415) 326-8830 Telex: 348-415



JULY 1970 *

1 TO 18 GHz TWO-STAGE MULTI-OCTAVE COMPACT YIG FILTER WJ-795

Watkins-Johnson has developed a multi-octave (1 to 18 GHz) YIG filter that adds a wide tuning range capability to the compact filter line. WJ-795 is an electronically tuned YIG filter that features high reliability, long life, ruggedness, small size, and a low tuning power requirement (less than 6 watts). These features are primarily attributable to a self-shielded magnetic circuit built into the filter structure.

WJ-795 is particularly suited for ultra-wide band receiving and frequency measuring applications. For specific requirements, the tuning sensitivity may be changed to 12 MHz/mA without increasing the tuning power requirements.



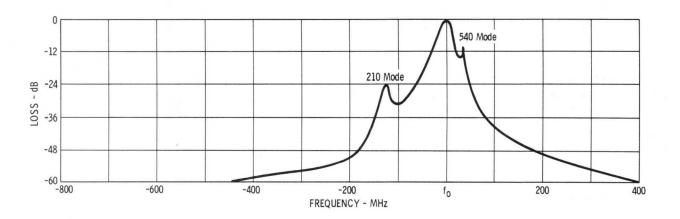
SPECIFICATIONS

RF PERFORMANCE Frequency Range	Typical		
Bandwidth (3dB) (minimum)			
Insertion Loss (maximum)			
Off Resonance Isolation (minimum)			
Off Resonance Spurious (minimum) (-210 mode) .			20 dB
Directivity	· · · · · · · · · · · · · · · · · · ·		
Passband Ripple and Spurious (maximum)	. 1.0 dB		2.0 dB
VSWR Input and Output (maximum)	. 1.5:1		2.0:1
Limiting Level (minimum)			+10 dBm
Selectivity		. 12 dB/Octave	
TUNING CHARACTERISTICS			
Sensitivity		24 MHz/mA	
Coil Resistance		7 ohms	
Coil Inductance		200 mH	
Time Constant		10 ms	
Deviation from Linear		±15 MHz	
Hysteresis		45 MHz	
Frequency Drift over Temp. Range +10°C to +30°C		15 MHz	

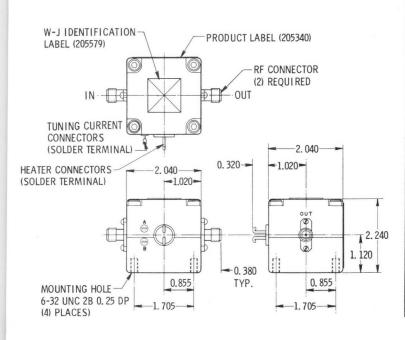
¹ Insertion loss variation shall not exceed 4 dB. * Supersedes WJ-795 Technical Data Sheet dated October 1969.

MECHANICAL CHARACTERISTICS Size (excluding connectors) Weight RF Connectors Outline Drawing No.	 •	 •	 •••	 40 	οι 	 ces	s (x 50 1.1 DSN	6 m L3 M J	Kg) ack	
HEATER CHARACTERISTICS Operating Voltage Operating Current: Surge at +10°C Steady State at +10°C			 	 		 		75	50	mA	

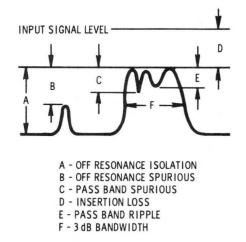
SELECTIVITY CURVE (TYPICAL)



OUTLINE DRAWING



MEASUREMENT DEFINITIONS



WJ-1014-1

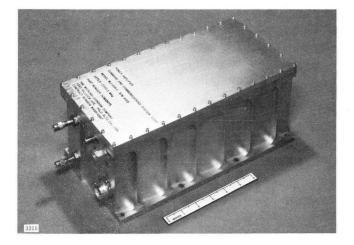
March 1967

2.2 TO 2.4 GHz, SPACE QUALIFIED, 20 WATT MICROWAVE AMPLIFIER WITH INTEGRAL SOLID-STATE POWER SUPPLY

The WJ-1014-1 is a medium power, telemetry, microwave amplifier operating in S-band. It is a fully integrated package complete with traveling-wave tube, all solid-state power supply, RFI filtering, and telemetry output circuitry for monitoring the amplifier's operation. Originally developed for NASA for use in Saturn V vehicles, the WJ-1014-1 is environmentally qualified, both electrically and mechanically, for satellite and deep space probe applications where absolute reliability, small size, lightweight, and maximum overall efficiency are essential.

The amplifier package is designed to accept Watkins-Johnson's WJ-274 series of traveling-wave tubes, or other tubes of similar size and performance. The integral RF filter components provide high attenuation of spurious and harmonic outputs, but exhibit relatively low insertion loss. Units can be supplied without the band reject/harmonic filter and isolator components. In such case, a 15% increase in saturated power output can be expected.

The power output, gain, and efficiency are very nearly constant over the frequency range from 2.2 to 2.4 GHz. The power transfer curves show that the



output power at saturation is relatively unchanged with a substantial change in drive power. Typically, output saturation can be realized with only 75 milliwatts of drive power. The noise characteristics of the amplifier are given for undriven and saturation drive conditions, with and without the RFI network at the tube's output.

SPECIFICATIONS

PERFORMANCE					Ту	pical	Guaranteed
Frequency Range						2.2 to 2.4 GHz .	2.2 to 2.4 GHz
Power Output, Saturated .							
Efficiency							
Overall Amplifier						22%	20%, min.
Traveling-Wave Tube							
Power Supply							
Power Output Variation							
dB per 100 MHz						±0.2	± 0.4
dB per 10 MHz							
RF Drive for Saturated Outpu							
Maximum Load VSWR							
Duty Cycle							
Phase Linearity							
Harmonic and Spurious Outp							
Spurious Coherent						.70 dB	65 dB
In-band Spurious						65 dB	60 dB
2nd and 3rd Harmonic .						65 dB	60 dB
4th Harmonic						85 dB	80 dB
Noise Power Output (2.2-10	G⊦	łz)				70 dB/MHz BW	65 dB/MHz BW
On-Off Cycling	•						10,000, min.

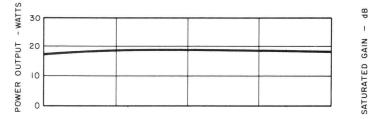


ELECTRICAL CHARACTERISTICS Typical	Range
Primary Voltage	28 ± 4 V dc
Telemetry Outputs a) Regulator Voltage b) High Voltage Status	
c) Helix Current	0 to 5 V dc
Filament Time Delay	

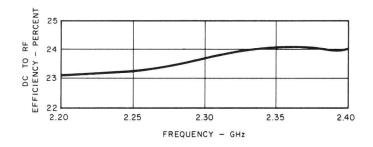
MECHANICAL CHARACTERISTICS

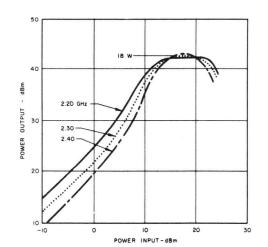
Base Plate Dimensions		•		:									. 5.375 inches . 19 lbs. . 4.25 lbs.
Connectors a) RF Input b) RF Output c) Power and Telemetry c)	•	:	•	•	•	:	:	•					. TNC . Type N

TYPICAL PERFORMANCE CHARACTERISTICS



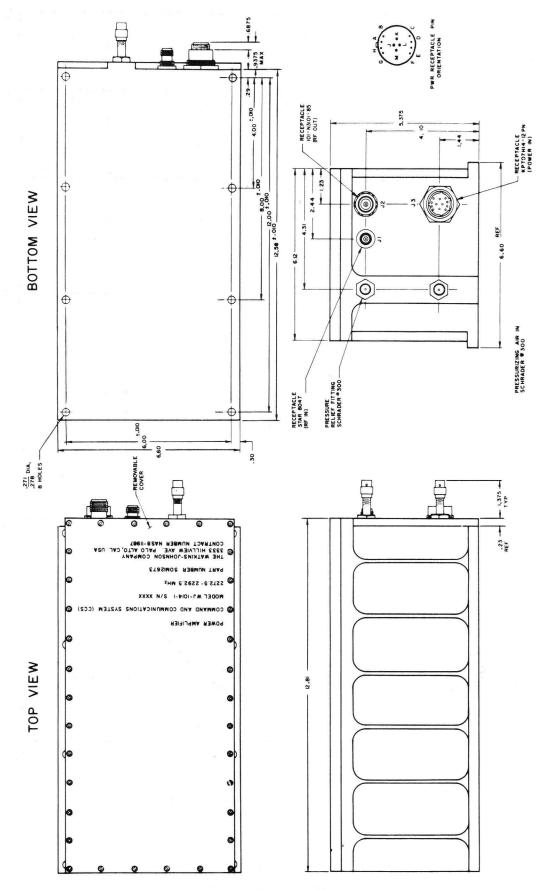
P	25	[]
GAIN -	24	
RATED (23	
SATUF	22	



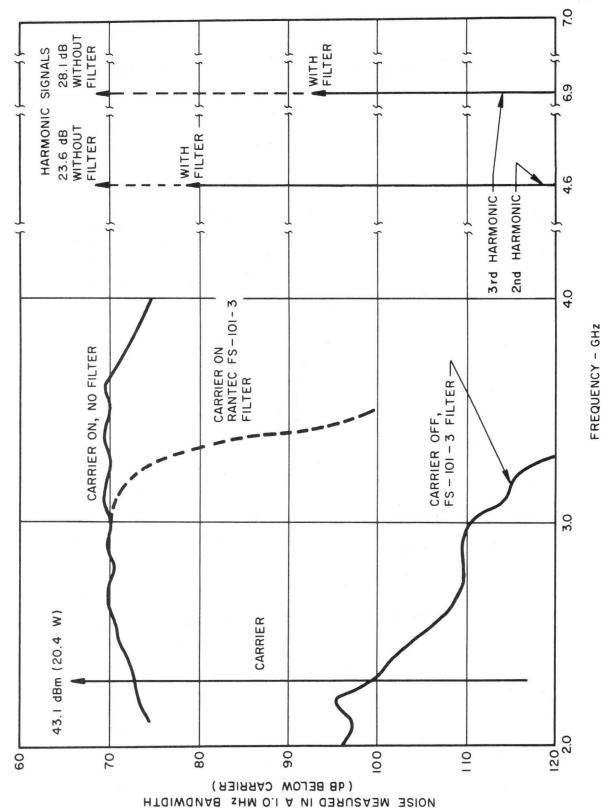


WJ-1014-1

OUTLINE DRAWING



TYPICAL NOISE AND HARMONIC CHARACTERISTICS



WATKINS – JOHNSON COMPANY 3333 HILLVIEW AVENUE STANFORD INDUSTRIAL PARK PALO ALTO, CALIFORNIA 94304 TWX 910-373-1253 PHONE (415) 326-8830 Telex: 348-415

SEPTEMBER 1970

5.4 TO 5.9 GHz 45-WATT PULSED TWT AMPLIFIER WJ-1051-1



WJ-1051-1 is a broadband TWT amplifier designed for applications where stringent pulse characteristics are required. It is particularly suited for sophisticated, coherent, frequency-agile communication and navigation systems. In addition, it may be used either as a driver or as the output stage in advanced radar applications.

Pulse characteristics provided by the WJ-1051-1 include phase and amplitude stability during the entire pulse duration and extremely fast rise and fall times. These characteristics are obtained through the use of a hi-mu gridded traveling-wave tube (WJ-369) and a highly regulated grid modulator. The amplifier contains its own forced air cooling and protective overload features.

WJ-1051-1 can operate either as a fixed-pulse-length amplifier or as a pulse follower. It may be easily adapted to accommodate W-J TWTs other than WJ-369 to provide a wide range of allowable power outputs, duty cycles, and pulse widths over different frequency bands.

SPECIFICATIONS

ELECTRICAL PERFORMANCEGuaranteedFrequency5.4 to 5.9 GHzPower Output45 watts min.Gain at Rated Power45 dB, min.Duty Factor5% max.Phase Shift10° max., during 30 µsec pulsePulse Length30 µsecPulse Length Adjustability±2.0 µsecPulse Length Stability±0.1 µsecPulse Rise and Fall Time50 nanoseconds max.Pulse Droop0.1 dB, max.Modulator Input Impedance93 ±10 ohmsProtective InterlockTWT grid pulse removed on absence of a 50 Vdc signal	AHz nin. nin. nax. ilse sec sec sec nax. nax.
ELECTRICAL REQUIREMENTS Range Input Voltage 105 to 125 Vac, 47 to 68 Hz (380 Hz to 440 Hz optional) Modulator Trigger 60.0 ±10 V positive trigger, 1.0 ±0.5 µsec wide	nal)
ENVIRONMENTAL CHARACTERISTICS Temperature +50°F to +100°F Altitude Normal ground Vibration Laboratory environment Humidity Room ambient	und ent

Note 1: For extended performance in full C-band (4 to 8 GHz), power output is 25 watts, gain at rated power is 40 dB, and duty factor is 1.5%.

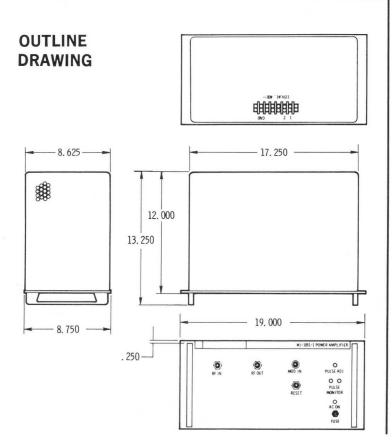
- POWER OUTPUT 50 WATTS MIN.
- GAIN AT RATED POWER 45 dB MIN.
- PULSE LENGTH STABILITY $\pm 0.1 \,\mu$ SEC
- PULSE RISE AND FALL TIME 50 NANOSECONDS

WJ-1051-1

MECHANICAL CHARACTERISTICS

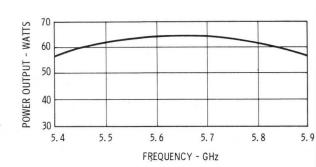
Size 8.75 x 12.25 x 19 inches (222 x 311 x 483 mm)
Weight 50 pounds (22.7 Kg)
Cooling No external cooling required
Connectors .a. Primary power — Terminal block
 b. Trigger input — Type BNC
c. RF output — Type N

- d. RF input Type N
- e. Bus interrupt Terminal block

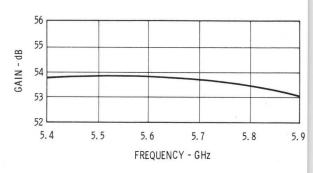


TYPICAL PERFORMANCE CHARACTERISTICS

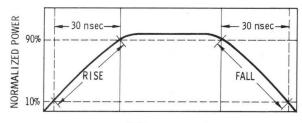








RISE AND FALL TIME



TIME - nanoseconds

WJ-1064-4

5.9 to 6.45 GHz MEDIUM POWER TRAVELING-WAVE AMPLIFIER

June 1968

WJ-1064-4 is one of a family of medium power integrated amplifier packages developed by Watkins-Johnson Company for satellite communication applications. It combines a periodic-permanentmagnet (PPM) focused traveling-wave tube with an all-solid-state regulated power supply. The combination is packaged in a rugged cabinet designed for rack or bench mounting.

Simplicity and reliability have been stressed in the design of this amplifier package. Modular construction is used throughout, all internal circuitry has been preadjusted, and only two external controls are used: the low- and high-voltage on-off switches. The TWT is safeguarded by a number of automatic protective circuits, which ensure that maximum life is attained.

The tube is directly coupled to the RF input and output connectors and an associated power supply. The power supply circuitry provides all the voltages and currents necessary to power the tube. In addition, the power supply is capable of generating



highly filtered, well-regulated voltages, thus making it superior in performance to laboratory supplies many times its size and weight.

Other members of this family of amplifier packages are currently in production or under development. For special applications requiring specifications different from those listed below, contact Applications Engineering for Systems products at Watkins-Johnson Company or our representative in your area.

SPECIFICATIONS

PERFORMANCE Frequency Saturation power output Saturation gain Noise figure Gain slope	5.9 to 6.5 GHz .38 watts 40 dB 30 dB	
ELECTRICAL REQUIREMENTS Primary voltage Primary frequency	Typical 115 Vac	Range²
Primary frequencyPrimary power	60 Hz	48 to 63 Hz
ENVIRONMENTAL CHARACTERISTICS		
Temperature, operating Vibration, 3 G, single amplitude Shock, 15 G, 11 ms Altitude, operating		10 to 500 Hz

¹ To meet the guaranteed performance limits, the amplifier must be terminated in a load whose VSWR is 1.5:1 maximum. A mismatch exceeding 2.5:1 at the output terminal could result in permanent damage to the traveling-wave tube.
² Every amplifier will meet the guaranteed specifications within these ranges.



MECHANICAL CHARACTERISTICS

Amplifier width 17 inches, max.
Amplifier height 7 inches, max.
Amplifier depth,
excluding connectors
Weight 40 pounds, max.
RF connections.
input and output Type N Female
CoolingNote 3
Front Panel Note 4

³ Cooling is by forced air convection provided integrally within the amplifier.

⁴ Front panel includes:

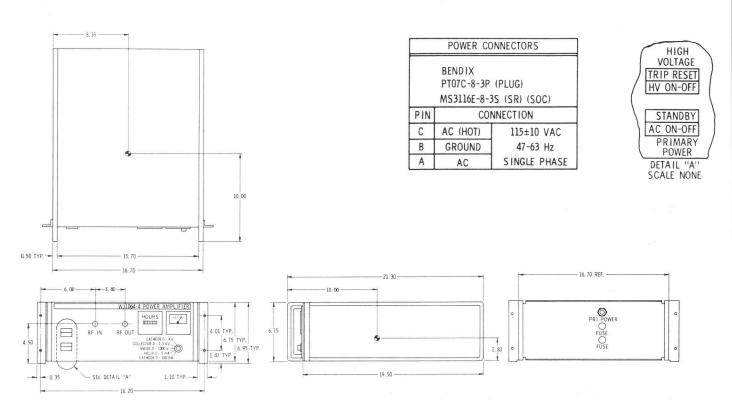
- a. AC power dual lighted push button switch b. HV dual lighted push button switch

- c. RF input Type N Female d. RF output Type N Female e. Elapsed time meter —TWT Heater "on" hours f. Monitor meter and selector switch to show:

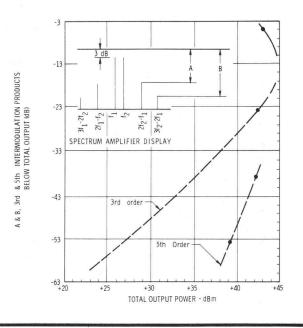
 - 1. V helix cathode
 - 2. V helix anode 3. V helix collector

 - 4. I helix 5. I Cathode

OUTLINE DRAWING

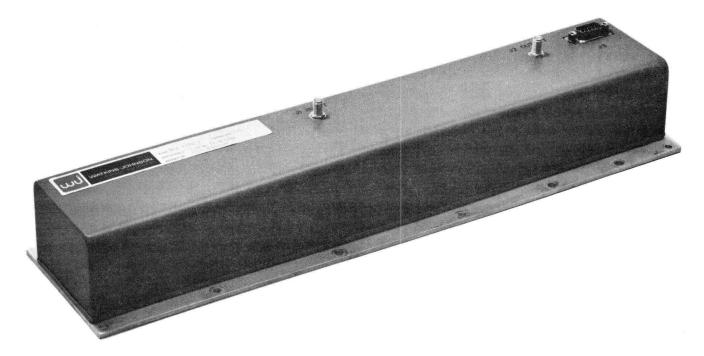


TYPICAL THIRD & FIFTH ORDER INTERMODULATION DISTORTION AS A FUNCTION OF OUTPUT LEVEL (FOR TWO EQUAL SIGNALS 25 MHz APART)



OCTOBER 1969

7 TO 11 GHz MEDIUM-POWER MICROWAVE AMPLIFIER WJ-1115



- INTEGRAL POWER SUPPLY
- SMALL SIZE
- HIGH POWER OUTPUT
- LOW NOISE FIGURE
- WIDE-BAND OPERATION

Watkins-Johnson has developed a microwave amplifier with integral power supply for use in airborne ECM or data link systems. Designated WJ-1115, this amplifier provides 3 watts power output, 45 dB small signal gain, and 22 dB max. noise figure in X-band.

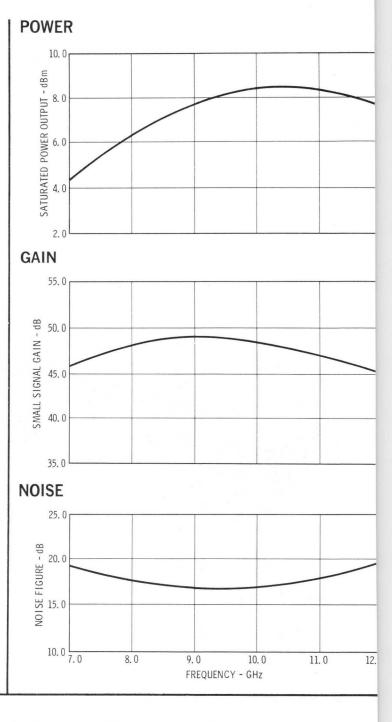
WJ-1115 weighs less than 6.5 lbs. and comes in a 2.3 x 3.0 x 16 inches package. In addition, it meets or exceeds the environmental requirements of MIL-E-5400, class II.

SPECIFICATIONS

PERFORMANCETypicalFrequency7.0 to 12.4 C	Guaranteed
Saturation Output	
Small Signal Gain 48.0 dB	
Gain Variation	
Fine Grain Variation B.5 dB	1.0 dB
Noise Figure 19.0 dB	22 dB max.
Warm up Time	3.0 - 4.0 minutes
ELECTRICAL CHARACTERISTICS	Nominal
Primary Power	
Voltage	115/200 Vac, 3-phase, WYE connection
Frequency	400 Hz ±20 Hz
Voltage Variation	±10 volts, line to neutral
Power	

MECHANICAL CHARACTERISTICS

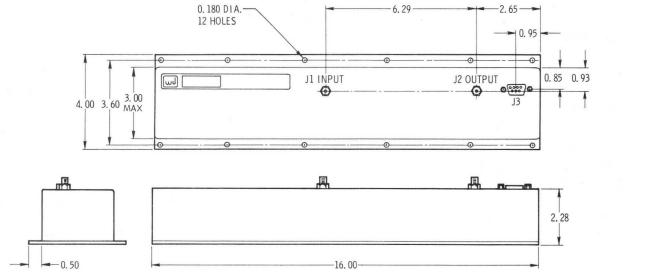
Ler	gth 16 inches (406 mm)
Cro	ss-section, excluding connectors 2.3 x 3 inches (58 x 76 mm)
We	ght 6.5 pounds (2.95 Kg)
Pov	ver Connection Cannon, DEM-9p
RF	Connectors OSM, Jack
Cod	ling Conduction



ENVIRONMENTAL CHARACTERISTICS

Exceeds the environmental requirements of MIL-E-5400, class II.

OUTLINE DRAWING



OCTOBER 1969

SEPTEMBER 1970

WJ-1165 SERIES MICRO-SOURCES

- ALL SOLID STATE
- FREQUENCY COVERAGE TO 18 GHz
- SMALL SIZE AND WEIGHT
- LOCAL OR REMOTE PROGRAMMING
- PHASE-LOCK CAPABILITY
- CW OR FM OPERATION

Watkins-Johnson has developed a new series of compact, lightweight signal sources covering the 0.5 to 18 GHz frequency range in six bands. Designed for applications where size and weight are primary considerations, the WJ-1165 micro-sources feature all solid state construction for trouble-free performance, instant RF power of greater than 5 mW (up to 30 mW in some bands), low residual FM, excellent linearity and high frequency accuracy.

The micro-sources may be programmed manually to any discrete frequency (in 1 MHz increments) in the band by means of a thumbwheel switch on the front panel. An optional remote BCD control is also available for discrete frequency selection. The capability to internally sweep each micro-source over the entire



frequency band is also optional. A standard external sweep mode is available to accommodate sawtooth and triangular waveforms. An optional error voltage input for phase locking may be provided where extreme frequency accuracies are required.

Each micro-source in the WJ-1165 series incorporates one of a family of electronically tuned transistor or bulk GaAs oscillators built by Watkins-Johnson. These oscillators utilize high "Q" YIG spheres for frequency control, thus ensuring an extremely clean output spectrum and providing excellent linearity over the entire frequency range. The oscillators are driven by extremely well-regulated power supplies that provide power with low ripple content for maximum performance.

SPECIFICATIONS

RF PERFORMANCE Nominal Frequency Band (GHz) ¹ Power Output into Load VSWR 1.25:1 Min Power Output Variation (Matched Load) Max Spurious Oscillation	. 30 mW	WJ-1165-2 1.0-2.0 30 mW 6 dB	WJ-1165-3 2.0-4.0 5 mW 6 dB	WJ-1165-5 8.0-12.4 10 mW 6 dB	WJ-1165-6 12.4-18.0 8 mW 8 dB
Ratio of Signal to 2nd Harmonic Output Ratio of Signal to all other Spurious Output Frequency Drift, 0.50°C, Max Pulling Figure, Any Phase Residual FM, Peak to Peak	. 50 dB . 6 MHz . 6 MHz @ 1.5:1 VSWR	13 dB 50 dB 6 MHz 4 MHz @ 1.5:1 VSWR 100 KHz	10 dB 50 dB 10 MHz 6 MHz @ 1.5:1 VSWR 150 KHz	30 dB 60 dB 20 MHz 15 MHz @ 2:1 VSWR 200 KHz	30 dB 60 dB 30 MHz 20 MHz @ 2:1 VSWR 200 KHz
TUNING CHARACTERISTICS Sweep Rate (Saw Tooth) Tuning Linearity dc @ 30°C Max. Frequency Accuracy Output Impedance Incremental Frequency Steps	. ±0.25% . ±0.3% . 50 ohm s	100 Hz ±0.25% ±0.3% 50 ohms 1 MHz	100 Hz ±0.25% ±0.3% 50 ohms 1 MHz	100 Hz ±0.20% ±0.3% 50 ohms 1 MHz	100 Hz ±0.20% ±0.3% 50 ohms 1 MHz

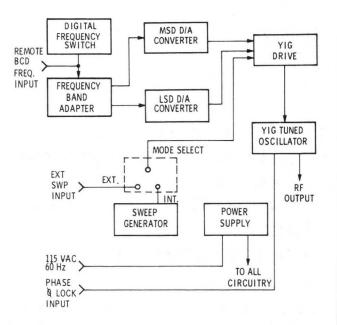
PRIMARY ELECTRICAL REQUIREMENTS

1. WJ-1165-4 (4.0-8.0 (GHz) under development.

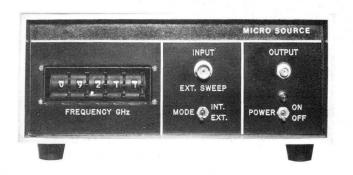
MECHANICAL CHARACTERISTICS

Size 4.0 x 10.75 x 12 inches (102 x 273 x 305 mm) Weight ... Approximately 13 lbs. (5.9 kg)

SCHEMATIC DIAGRAM



FRONT PANEL



JANUARY 1971

HIGH-EFFICIENCY TWT AMPLIFIERS FOR DEEP-SPACE & SATELLITE APPLICATIONS WJ-1171 SERIES

- dc to RF Efficiency > 36 %
- Ultra-High Reliability
- Lightweight
- Space-Qualified

The WJ-1171 series of TWT amplifiers was developed by Watkins-Johnson to meet the advanced telemetry and communication requirements of orbital and deepspace missions. Designed to survive severe environmental conditions with no degradation of performance, these rugged TWTAs exhibit long life, high efficiency, ultra-high reliability and extremely light weight.

One version of the basic amplifier, the WJ-1171-1, was developed specifically for use in the Pioneer F/G spacecraft, scheduled for launch in 1973-74. This TWTA will provide a minimum 24,000-hour mission life with high dc to RF efficiency and absolute mini-

In the following tables, the RF power output is specified into a 1:1 load. Cold (non-operating) output VSWR is included to allow calculation of maximum power transfer into other than 1:1 loads. Additionally, it should be noted that no RF components, such as power monitors and filters, are included. An accurate estimate of the RF power output available when such components are included may be obtained by subtracting from the specified power output 0.3 dB for a power monitor alone, or 0.45 dB for a power monitor/harmonic filter combination.

The WJ-1171-1 is designed for operation from a moderately well-regulated buss. It requires only the



mum weight. It also features minimum residual and stray magnetic fields.

Other versions of the basic WJ-1171 are available; several are listed on the following pages. These TWTAs may be used in applications requiring higher or lower RF power, dual-mode operation, or unregulated dc input power operation. A variety of power monitor and filter combinations are also available. Options for all versions include extended temperature ranges, increased vibration and shock levels, magnetic cleanliness, telemetry outputs up to 10 V full scale, and extended frequency ranges.

APPLICATIONS NOTES

use of a series dissipative helix regulator to achieve optimum performance. However, many spacecraft power systems employ unregulated busses. A version of the WJ-1171, employing a switching pre-regulator, is offered for such applications. In deciding which amplifier will afford maximum efficiency for a given power buss, the following guide-lines are helpful. A switching regulator has a fairly constant efficiency of approximately 90%. Therefore, if buss excursions of 10% or greater are to be encountered, a dissipative regulator will consume more power at "high line" than a switching regulator. Conversely, if less than 10% buss excursions are anticipated, a dissipative regulator will afford the most overall efficiency.

WJ-1171 SERIES

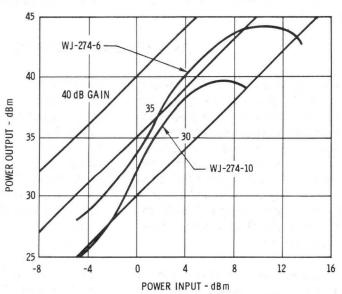
SPECIFICATIONS

TWTA Model No. — (Associated TWT) —	WJ-1171-1 (WJ-274-10)	WJ-117 1-2 (WJ-274-6)	WJ-1171-3 (WJ-274-9)	WJ-1171-4 (WJ-274-6)
PERFORMANCE CAPABILITIES:				
Frequency	2.2-2.3 GHz	2.2-2.3 GHz	2.2-2.3 GHz	2.2-2.3 GHz
Sat. Power Output ¹	9 watts	24 watts	12/24 watts	24 watts
Efficiency Overall ²	33.6%	36.8%	30.6%/34.9%	33.4%
Sat. Gain	33 dB	31 dB	28/31 dB	31 dB
Output VSWR (Cold)	1.25:1	1.25:1	1.25:1	1.25:1
ELECTRICAL CHARACTERISTIC	S:			
Primary Voltage	+28 vdc ±3%	+28 vdc ±3%	$+28 \text{ vdc} \pm 3\%$	+24 to 32 vdc
Primary Power	26 w @ 28 v - 3%	65.2 w @ 28 v - 3%	39.2/68.7 @ 28v - 3%	
	26.8 w @ 28v	67.2w @ 28v	40.4/70.7 @ 28 v	72 w @ 24 - 32 v
	27.6w @ 28v +3%	69.1w @ 28v +3%	41.6/72.8 @ 28 v +3%	primary input
Telemetry Outputs:		C		
Cathode and Helix Currents,				
and Collector Temperature	0 to ± 3 vdc	0 to ± 3 vdc	0 to ± 3 vdc	0 to ± 3 vdc
Delay Time Before 100%				
Carrier Power	90 to 150 sec	90 to 150 sec	 90 to 150 sec 	90 to 150 sec
MECHANICAL CHARACTERISTI	ICS:			
Baseplate Dimensions	4.44 x 11.00 in.	4.44 x 11.00 in.	4.58 x 12.00 in.	5.40 x 11.00 in.
	(113 x 279 mm)	(113 x 279 mm)	(123 x 305 mm)	(137 x 279 mm)
Height (excluding connectors)	3 in. (76 mm)	3 in. (76 mm)	3 in. (76 mm)	3 in. (76 mm)
Weight	3.8 lbs.	4.2 lbs.	4.55 lbs.	5.0 lbs.
	(1.72 Kg)	(1.91 Kg)	(2.06 Kg)	(2.27 Kg)
Connector Types	TNC or	TNC or	TNC or	TNC or
RF In and Out	3 mm female	3 mm female	3 mm female	3 mm female
Power/TLM/CMD	Cannon Golden "D"	Cannon Golden "D"	Cannon Golden "D"	Cannon Golden "D"

1. Power Output is specified into 1:1 load. Output VSWR is included in table to allow calculation in other than 1:1 loads.

Efficiency is specified at 28 v — 3%. Since the regulators are dissipative (except for WJ-1171-4 which
is a switching regulator design) power consumption and, therefore, efficiency vary with line voltage.
See Electrical Characteristics.

PERFORMANCE CHARACTERISTICS

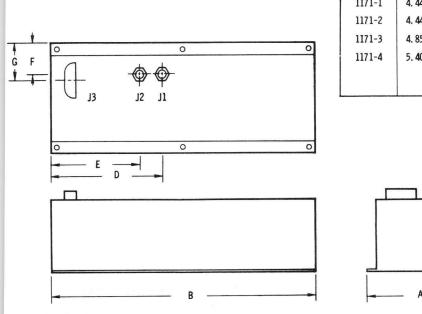


Transfer curve of WJ-274-6 and WJ-274-10

WJ-1171 SERIES

BLOCK DIAGRAM RF INPUT J1 LOW-VOLTAGE HIGH-VOLTAGE CONVERTER CONVERTER MODULE J3 MODULE ANODE PRIMARY 1 ANODE POWER (+) RECTIFIER/ FILTER FILTER HIGH-VOLTAGE CONVERTER TRANSFORMER PRIMARY POWER 9 > **RETURN** (-) HELIX CONVERTER HELIX 11 LOW-SWITCHING HELIX RECTIFIER/ VOLTAGE 11 TRANSISTOR REGULATOR FILTER TRAVELING-WAVE TUBE CONVERTER COLLECTOR HEAT SINK COLLECTOR 3 "ON-OFF" (CMD) > **RECTIFIER**/ COMMAND CATHODE FILTER INTERFACE RFI MODULE CONVERTER HEATER 13 REFERENCE VOLTS (TLM) CONVERTER TEMPERATURE (TLM) > 14 TELEMETRY < CIRCUITRY $\frac{\text{TWT}}{\text{TEMPERATURE (TLM)}} > \frac{15}{2}$ (FT 4 CHASSIS GRD. > E RF OUTPUT POWER MONITOR POWER 6 <€ MONITOR << (OPTION) HELIX CURRENT (TLM) 7 > $\lambda \lambda$ CATHODE RF OUTPUT 8 > CURRENT (TLM) J2

OUTLINE DRAWING



DIMENSIONS IN INCHES								OVERALL
MODEL NO.	Α	В	C	D	E	F	G	WEIGHT (lbs.)
1171-1	4.44	11.00	3.00	5.00	3.75	1.00	1.500	3.8
1171-2	4. 44	12.00	3.00	5.00	3.75	1.00	1.500	4.2
1171-3	4. 85	12.00	3.00	5.00	3.75	1.00	1.500	4. 55
1171-4	5.40	12.00	3.00	5.00	3.75	1.00	1.500	5.0
11/1-4	5.40	12.00	5.00	5.00	3.13	1.00	1.500	5.0

С

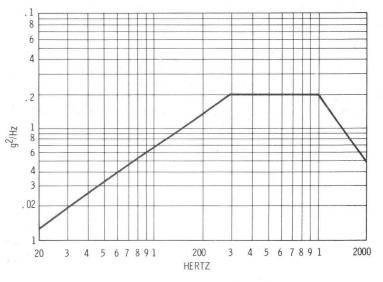
WJ-1171 SERIES

ENVIRONMENTAL CAPABILITIES

1. Operating Temperature Range:

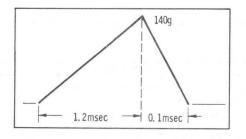
-25°C to +70°C (baseplate temp.)

2. Vibration

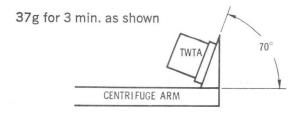


Random vibration spectrum

3. Shock



4. Sustained Acceleration:



5. Operating Pressure:

All models can operate without damage over an indefinite period at pressures from 2 atmospheres to 10⁻⁵ Torr. JANUARY 1971 PRINTED IN U.S.A.

FEBRUARY 1971

MICROWAVE RF AMPLIFIER WITH SERRODYNE CAPABILITY WJ-1179

Watkins-Johnson has developed a traveling-wave tube amplifier for applications such as Doppler return simulation and voltage-controlled phase or frequency shifting. Incorporating integral power, monitoring, control and modulation circuitry, this amplifier features the capability for serrodyne operation. A number of W-J power tubes may be adapted for use in the serrodyne system, giving users a wide choice of frequency band and RF power output.

Serrodyne operation denotes the ability of travelingwave devices to shift the frequency of an input signal (in addition to amplification) by use of the phase shift versus circuit (helix to cathode) voltage inherent in such devices. Briefly, the operation is as follows: a modulating sawtooth voltage of proper amplitude is applied to the helix of the TWT. Depending on the polarity of the voltage, the output frequency of the TWT is shifted up or down, with respect to the input carrier, by an amount equal to the frequency of the sawtooth.



Provision has been made within this amplifier for logic input or switch-controlled optimization of the amplitude and dc level of the sawtooth voltage in order to allow operation over a wide RF range with fixed amplitude sawtooth voltage drive. A number of options are available which allow logic level or switch programming of other amplifier features up to and including a fully remote programming capability.

SPECIFICATIONS

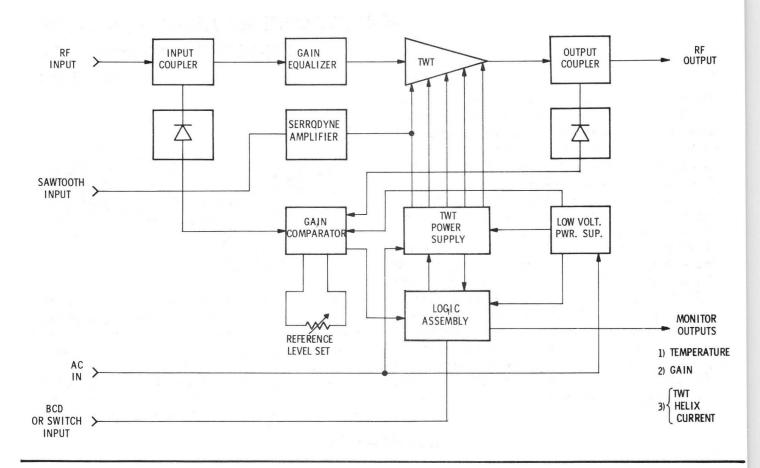
PERFORMANCE

Frequency 12.4 to 18 GHz
Power Output, CW
Small Signal Gain
Gain Flatness (full band) ±2.5 dE
Doppler Frequency Shift 10 Hz to 25 kHz
Voltage Controlled Phase Shift
ELECTRICAL REQUIREMENTS
Input Power 200 v, 3-phase, 400 Hz (optional inputs available
Modulating Sawtooth for Serrodyning
Phase Shift Control Voltage 0 to 5 volt
MECHANICAL CHARACTERISTICS
Height
Width 19 inches (483 mm), rack moun
Length
Weight
Power and RF Connectors As required
Cooling Internal Forced Ai
ENVIRONMENTAL CHARACTERISTICS (Operating)
Temperature
Altitude
Shock
Vibration
RFI
RELIABILITY MTBF greater than 3,000 hours per MIL HDBK 217

Notes: 1. TWTAs available in octave bands from 2 to 18 GHz.

WJ-1179

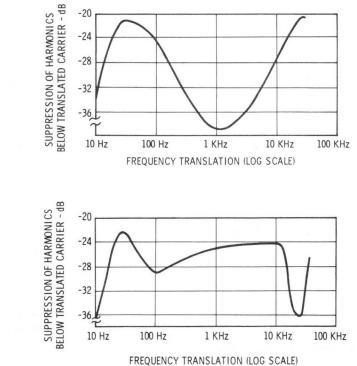
SCHEMATIC DIAGRAM



SERRODYNE OPERATION



SUPPRESSION OF SERRODYNE FREQUENCY HARMONICS IN OUTPUT SPECTRUM



B. Down-Translation

WJ-2001

TECHNICAL DATA • March 1966

The type WJ-2001 BWO is a bifilar (dual-helix), voltage-tunable oscillator. This permanent-magnet-focused wide-band oscillator is well suited for use as a swept signal source in signal generators, particularly in view of its high stability. Other applications include radar receivers (as local oscillator), frequency diversity transmitters (as master oscillator), and ECM equipment. The WJ-2001 features smooth power over the band, low cathode current, and two control electrodes. The control grid makes possible power cutoff with low negative grid voltage. Power output can be modulated with either the grid or anode, or both.



Cathode modulation with the grid grounded usually reduces FM caused by AM. Packaging problems are simplified, since all voltages are isolated from both tube housing and the RF output terminal. The tube housing and output connector can be grounded regardless of power supply configuration.

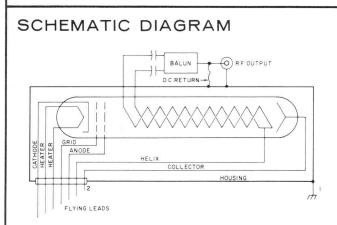
ELECTRICAL CHARACTERISTICS,	CW Units	Typical	Absolute
		Values	Ratings
Nominal Frequency Band	GHz	7.0-12.4	
Power Output (Load VSWR=1.25)	mW	35 - 175	25 Min
Power Output Variation	dB		10 Max
Fine Grain Variation	dB/250 MHz		3 Max
Tube VSWR			2.5:1 Max
Frequency pulling into 2:1 Load	MHz	1.5	3 Max
Spurious Oscillation			
Ratio of Signal to Noise Power 30 MHz Away	dB/MHz	95	85 Mi n
Ratio of Signal to Second Harmonic Output	dB	30	25 Min
Long-term Sensitivity to Heater Voltage	MHz/V	5	10 Max
Sensitivity to Anode Voltage	MHz/V	0.6	1 Max
Sensitivity to Grid Voltage	MHz/V	3	5 Max
Tuning Curve Slope			
Low-End (7.0 GHz)	MHz/V	9.2	
Mid-Frequency (9.7 GHz)	MHz/V	4.8	
High-End (12.4 GHz)	MHz/V	2.7	
Grid RF Cutoff Voltage	V	-7	-20 Max
Capacitance; Cathode & Grid to all other			
Electrodes and Case	\mathbf{pF}	40	50 Max
Capacitance; Grid to all other Electrodes			
and Case	рF	20	25 Max
Capacitance; Helix and Collector to all other			
Electrodes and Case	pF	150	175 Max
Heater Voltage	V		6.3+5%
Heater Current	А	0.75	0.4-1.2
			Min/Max
Cathode Current	mA	8	12 Max
Helix Voltage Range	V	330-1495	300-1600
			Min/Max
Helix Current	mA	1.5	3 Max
Anode Voltage	V	160	215 Max
Anode Current	mA	0.5	2 Max

MECHANICAL DATA

Weight, 3.0 lbs Max Color Code for 18" Flying Leads Heater Black Brown Heater Yellow Cathode Green Grid Blue Anode Helix Red Orange Collector Mounting Position, Any RF Output Connector, Type N Female on Balun

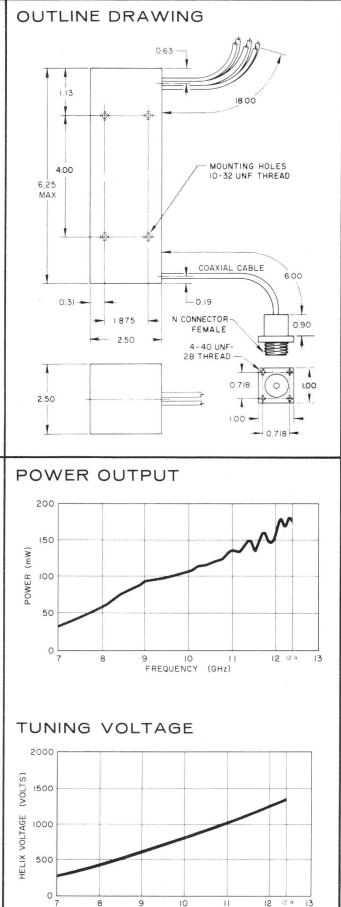
ENVIRONMENTAL DATA

Separation from Passive Magnetic Materials, 2 in. Min No Forced Air Cooling Required Below +60⁰C Ambient



¹For safety, housing should be grounded through mounting screws.

 2 50-150 V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.



FREQUENCY

(GHz)

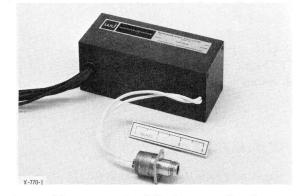
BACKWARD-WAVE

September 1965

Absolute

₩Ĵ-2001-1

The type WJ-2001-1 BWO is a bifilar (dual-helix), voltage tunable oscillator. This permanent-magnet-focused wide band oscillator is well suited for use as a swept signal source in signal generators, particularly in view of its high stability. Other applications include radar receivers (as local oscillator), frequency diversity transmitters (as master oscillator), and ECM equipment. The WJ-2001-1 features smooth power over the band, low cathode current, and two control electrodes. The control grid makes possible power cutoff with low negative grid voltage. Power output can be modulated with either the grid or anode, or both. Cathode modulation with the grid



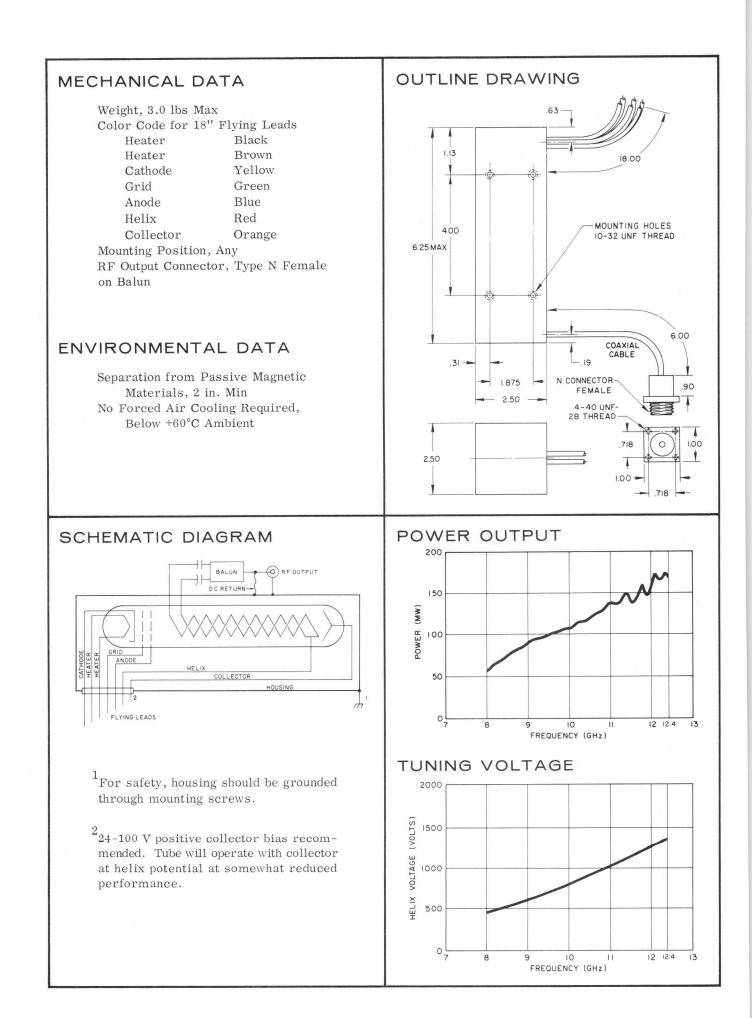
Typical

grounded usually reduces FM caused by AM. Packaging problems are simplified, since all voltages are isolated from both tube housing and the r.f. output terminal. The tube housing and output connector can be grounded regardless of power supply configuration

Unite

ELECTRICAL CHARACTERISTICS, CW

	Units	Values	Ratings
Nominal Frequency Band	GHz	8-12.4	
Power Output (Load VSWR = 1.25)	mW	60-175	50 Min
Power Output Variation	db		6 Max
Fine grain Variation	db/250 MHz		3 Max
Tube VSWR			2.5:1 Max
Frequency pulling into 2:1 Load		1.5	3 Max
Spurious Oscillation			
Ratio of Signal to Noise Power 30 MHz Away	db/MHz	95	85 Min
Ratio of Signal to Second Harmonic Output	db	30	25 Min
Long-term Sensitivity to Heater Voltage	MHz/V	5	10 Max
Sensitivity to Anode Voltage	MHz/V	0.6	1 Max
Sensitivity to Grid Voltage	MHz/V	3	5 Max
Tuning Curve Slope			
Low End (8.0 GHz)	MHz/V	7.2	
Mid-Frequency (10.2 GHz)	MHz/V	4.6	
High End (12.4 GHz)	MHz/V	2.7	
Grid r.f. Cutoff Voltage	V	-7	-20 Max
Capacitance; Cathode & Grid to all other Electrodes and Case	pf	40	50 Max
Capacitance; Grid to all other Electrodes and Case	pf	20	25 Max
Capacitance; Helix and Collector to all other Electrodes and Case	pf	150	175 Max
Heater Voltage	V		$6.3 \pm 5\%$
Heater Current	А	0.9	0.6-1.2
			Min/Max
Cathode Current	mA	8	12 Max
Helix Voltage Range	V	450-1495	427-1600
			Min/Max
Helix Current	mA	1.5	3 Max
Anode Voltage	V	160	215 Max
Anode Current	mA	0.5	2 Max



DECEMBER 1970

BACKWARD-WAVE OSCILLATOR WJ-2001-50

The WJ-2001-50 BWO is a bifilar (dual-helix), voltage tunable oscillator. This permanent-magnet focused wide band oscillator is well suited for use as a swept signal source in signal generators, particularly in view of its high stability.

Other applications include radar receivers (as local oscillator), frequency diversity transmitters (as master oscillator), and ECM equipment.

The WJ-2001-50 features smooth power over the band, low cathode current, and two control electrodes. The control grid makes possible power cutoff with low negative grid voltage. Power output can be modulated with either the grid or anode, or both. Cathode modulation with the grid grounded usually reduces FM caused by AM. Packaging problems are simplified, since all voltages are isolated from both tube housing and the RF output terminal. The tube housing and output connector can be grounded regardless of power supply configuration.



SPECIFICATIONS

	UNITS	TYPICAL VALUES	ABSOLUTE RATINGS
Frequency Band . Power Output into Load with VSWR = 1.25:1 Power Output Variation Fine Grain Variation Tube VSWR Frequency Pulling Into 2:1 Load (Any Phase)	. mW	60–175	50 Min. 6 Max. 3 Max.
Spurious Oscillation Ratio of Signal to Noise Power 30 MHz Away Ratio of Signal to 2nd Harmonic Output Long-term Sensitivity to Heater Voltage Sensitivity to Anode Voltage Sensitivity to Grid Voltage Tuning Curve Slope	dB MHz/V MHz/V	30 5 0.6	85 Min. 20 Min.
Low End (8.0 GHz) Mid-Frequency (10.2 GHz) High End (12.4 GHz) Grid RF Cutoff Voltage	MHz/V		
including Housing Capacitance: Grid to all other Electrodes.			
including Housing Capacitance; Helix and Collector to all other Electrodes including Housing Heater Voltage Heater Current	pF Vdc		175 Max. 6.3 ± 5% 0.4−1.2
Cathode Current [*]		8	Min./Max. 12 Max. . 427–1600
Helix Current Anode Voltage Anode Current	V		215 Max.

*Set cathode current to Final Test Data value furnished with tube.

WJ-2001-50

MECHANICAL CHARACTERISTICS

Height, 2.5 inches (64 mm) Width, 2.5 inches (64 mm) Length, 6.25 inches (159 mm) max. Weight, 6 lbs. (2.72 Kg) max.

Color Code for 18" Flying Leads

Heater	Black
Heater	Brown
Cathode	Yellow
Grid	Green
Anode	Blue
Helix	Red
Collector	Orange

Mounting Position, Any

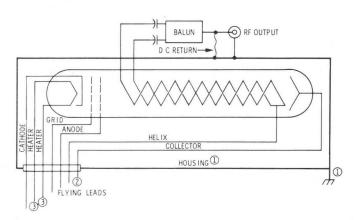
RF Output Connector, Type N Female on Balun

ge

ENVIRONMENTAL CHARACTERISTICS

Separation from Passive Magnetic Materials, 2 in. Min. No Forced Air Cooling Required Below +60°C Ambient

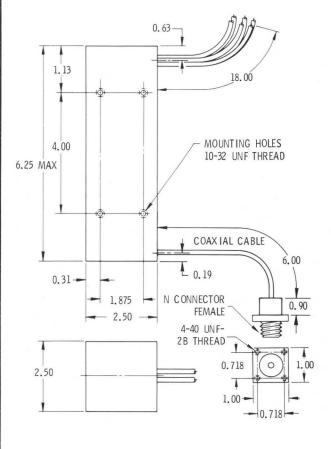
SCHEMATIC DIAGRAM



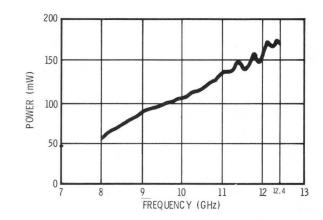
Notes:

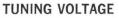
- 1. For safety, housing should be grounded through mounting screws.
- 2. 45-150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.
- 3. Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.

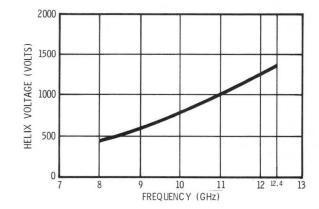
OUTLINE DRAWING











DECEMBER 1970

BACKWARD-WAVE OSCILLATOR WJ-2001-51

The WJ-2001-51 BWO is a bifilar (dual-helix), voltage tunable oscillator. This permanent-magnet focused wide band oscillator is well suited for use as a swept signal source in signal generators, particularly in view of its high stability.

Other applications include radar receivers (as local oscillator), frequency diversity transmitters (as master oscillator), and ECM equipment.

The WJ-2001-51 features smooth power over the band, low cathode current, and two control electrodes. The control grid makes possible power cutoff with low negative grid voltage. Power output can be modulated with either the grid or anode, or both. Cathode modulation with the grid grounded usually reduces FM caused by AM. Packaging problems are simplified, since all voltages are isolated from both tube housing and the RF output terminal. The tube housing and output connector can be grounded regardless of power supply configuration.



SPECIFICATIONS

	UNITS	TYPICAL VALUES	ABSOLUTE RATINGS
Frequency Band Power Output into Load with VSWR = 1.25:1 Power Output Variation Fine Grain Variation Tube VSWR Frequency Pulling Into 2:1 Load (Any Phase)	. mW	.35–175	25 Min. 10 Max. 3 Max.
Spurious Oscillation Ratio of Signal to Noise Power 30 MHz Away Ratio of Signal to 2nd Harmonic Output Long-term Sensitivity to Heater Voltage Sensitivity to Anode Voltage Sensitivity to Grid Voltage Tuning Curve Slope	.dB .MHz/V .MHz/V	.30 .5 .0.6	85 Min. 20 Min.
Low End (7.0 GHz) Mid-Frequency (9.7 GHz) High End (12.4 GHz) Grid RF Cutoff Voltage Capacitance: Cathoda to all other Electrodes	.MHz/V .MHz/V .V	.4.8 .2.7 7	
Capacitance; Galiloue to all other Electrodes, including Housing Capacitance; Grid to all other Electrodes,	.pF	.40	50 Max.
including Housing			
Electrodes including Housing	.Vdc		$6.3 \pm 5\%$ 0.4 - 1.2
Cathode Current * Helix Voltage Range	.mA	.8 .330–1495	300-1600
Helix Current	.V	.160	215 Max.

*Set cathode current to Final Test Data value furnished with tube.

WJ-2001-51

MECHANICAL CHARACTERISTICS

Height, 2.5 inches (64 mm) Width, 2.5 inches (64 mm) Length, 6.25 inches (159 mm) max. Weight, 6 lbs. (2.72 Kg) max.

Color Code for 18" Flying Leads Heater Black

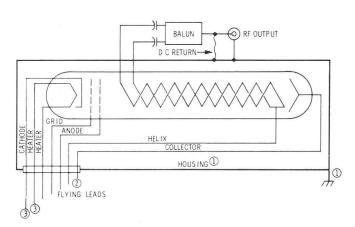
Heater	Brown
Cathode	Yellow
Grid	Green
Anode	Blue
Helix	Red
Collector	Orange

Mounting Position, Any RF Output Connector, Type N Female on Balun

ENVIRONMENTAL CHARACTERISTICS

Separation from Passive Magnetic Materials, 2 in. Min. No Forced Air Cooling Required Below +60°C Ambient

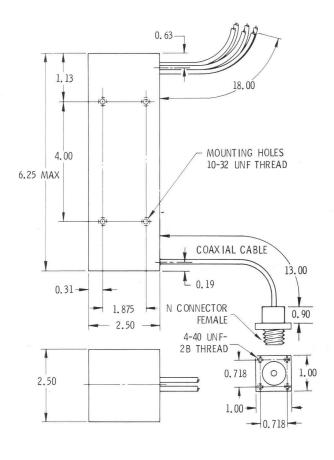
SCHEMATIC DIAGRAM

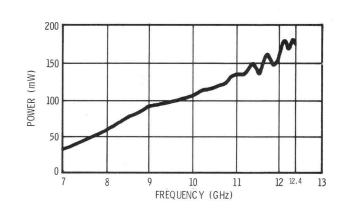


Notes:

- (1) For safety, housing should be grounded through mounting screws.
- (2) 45–150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.
- (3) Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.

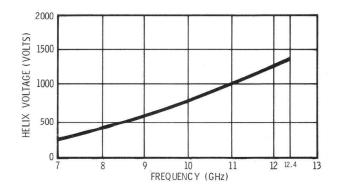
OUTLINE DRAWING





TUNING VOLTAGE

POWER OUTPUT

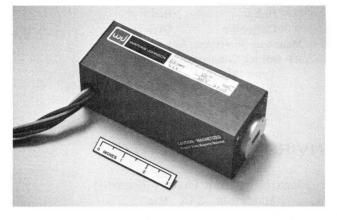


WJ-2003

BACKWARD-WAVE OSCILLATOR

December 1966

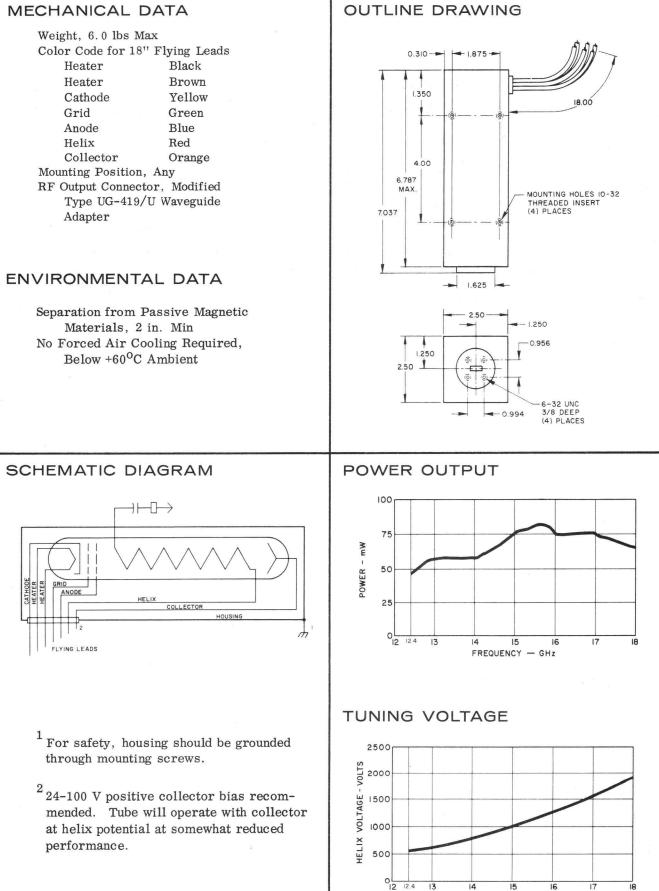
The type WJ-2003 is a single-helix voltage tunable oscillator utilizing a permanent-magnet focusing system. This wide band oscillator is well suited for use as a swept signal source in highly stable signal generators. Other applications include local oscillators in ECM receivers, as master oscillators in frequency diversity transmitters, and in electronic test sets. The WJ-2003 delivers smooth power output over the band with low operating cathode current. Power output can be modulated with either the grid or the anode circuits . All voltages are isolated from the tube housing for easier packaging.



SPECIFICATIONS

	Units	Typical Values	Absolute Ratings
Nominal Frequency Band	GHz	12.4-18	
Power Output into Load VSWR=1.25	mW	45-90	40 Min
Power Output Variation	dB		6 Max
Fine Grain Variation	dB/250 MHz		3 Max
Tube VSWR			3:1 Max
Frequency Pulling into 2:1 Load (Any Phase) MHz	1	2 Max
Ratio of Signal to Noise Power 30 MHz Away	dB/MHz	95	85 Min
Long-term Sensitivity to Heater Voltage	MHz/V	5	10 Max
Sensitivity to Anode Voltage	MHz/V	0.5	1.5 Max
Sensitivity to Grid Voltage	MHz/V	3	6 Max
Tuning Curve Slope			
Low End (12.4 GHz)	MHz/V	8.5	
Mid-Frequency (15.2 GHz)	MHz/V	5.0	
High End (18.0 GHz)	MHz/V	2.3	
Grid r.f. Cutoff Voltage	V	-8	-20 Max
Capacitance; Cathode to all other Electrodes	3		
including Heater and Housing	pf	30	40 Max
Capacitance; Grid to all other Electrodes			
including Housing	pf	30	40 Max
Capacitance; Helix and Collector to all other			
Electrodes and Housing	pf	125	165 Max
Heater Voltage	V		6.3±5%
Heater Current	А	.75	.4-1.2
			Min/Max
Cathode Current	mA	7	12 Max
Helix Voltage Range	V	560-1925	530-2020
			Min/Max
Helix Current	mA	2	3 Max
Anode Voltage	V	100	215 Max
Anode Current	mA	.1	2 Max

MECHANICAL DATA



14 15 FREQUENCY - GHz

DECEMBER 1970

BACKWARD-WAVE OSCILLATOR WJ-2003-50

The WJ-2003-50 BWO is a single-helix, voltage tunable oscillator. This permanent-magnet focused wide band oscillator is well suited for use as a swept signal source in signal generators, particularly in view of its high stability.

Other applications include ECM receivers (as local oscillator), frequency diversity transmitters (as master oscillator), and other electronic equipment.

The WJ-2003-50 features smooth power over the band, low cathode current, and two control electrodes. The control grid makes possible power cutoff with low negative grid voltage. Power output can be modulated with either the grid or anode, or both. Cathode modulation with the grid grounded usually reduces FM caused by AM. Packaging problems are simplified, since all voltages are isolated from both tube housing and the RF output terminal. The tube housing and output connector can be grounded regardless of power supply configuration.



SPECIFICATIONS

	UNITS	TYPICAL VALUES	ABSOLUTE RATINGS
Nominal Frequency Band Power Output into Load with VSWR = 1.25:1 Power Output Variation Fine Grain Variation Tube VSWR Frequency Pulling Into 2:1 Load (Any Phase)	.mW .dB .dB/250 MHz		40 Min. 6 Max. 3 Max. 3.1 Max.
Ratio of Signal to Noise Power 30 MHz Away. Long-term Sensitivity to Heater Voltage Sensitivity to Anode Voltage Sensitivity to Grid Voltage Tuning Curve Slope Low End (12.4 GHz) Mid-Frequency (15.2 GHz)	. MHz/V	.5 .0.5 .3 .8.5 .5.0	
High End (18.0 GHz) Grid RF Cutoff Voltage Capacitance; Cathode to all other Electrodes,			
including Heater and Housing Capacitance; Grid to all other Electrodes, including Housing			
Capacitance; Helix and Collector to all other Electrodes and Housing Heater Voltage Heater Current	рF	125	. 165 Max. . 6.3 ±5% 4-1.2
Cathode Current * Helix Voltage Range	.V	.560–1925	530-2020
Helix Current Anode Voltage Anode Current	.V	.100	. 215 Max.

* Set cathode current to Final Test Data value furnished with tube.

WJ-2003-50

MECHANICAL **CHARACTERISTICS**

Height, 2.5 inches (64 mm) Width, 2.5 inches (64 mm) Length, 7 inches (178 mm) Max. Weight, 6 lbs. (2.72 Kg) Max.

Color Code for 18" Flying Leads

Heater	Black
Heater	Brown
Cathode	Yellow
Grid	Green
Anode	Blue
Helix	Red
Collector	Orange

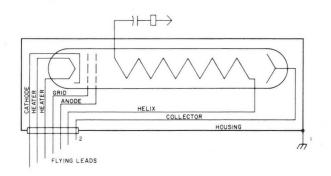
Mounting Position, Any

RF Output Connector, Modified Type UG-419/U Waveguide Adapter

ENVIRONMENTAL CHARACTERISTICS

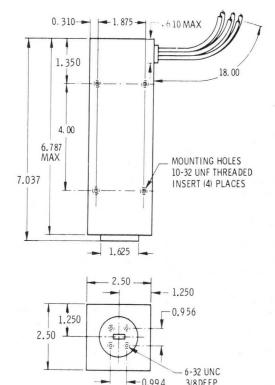
Separation from Passive Magnetic Materials, 2 in. Min. No Forced Air Cooling Required Below +60°C Ambient

SCHEMATIC DIAGRAM

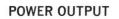


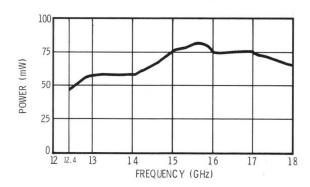
Notes:

- (1) For safety, housing should be grounded through mounting screws.
- (2) 45–150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.
- (3) Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.



OUTLINE DRAWING

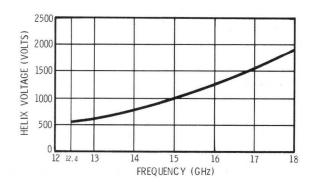




3/8DEEP

(4) PLACES

TUNING VOLTAGE



W J - 2

BACKWARD-WAVE O S C I L L A T O R

March 1966

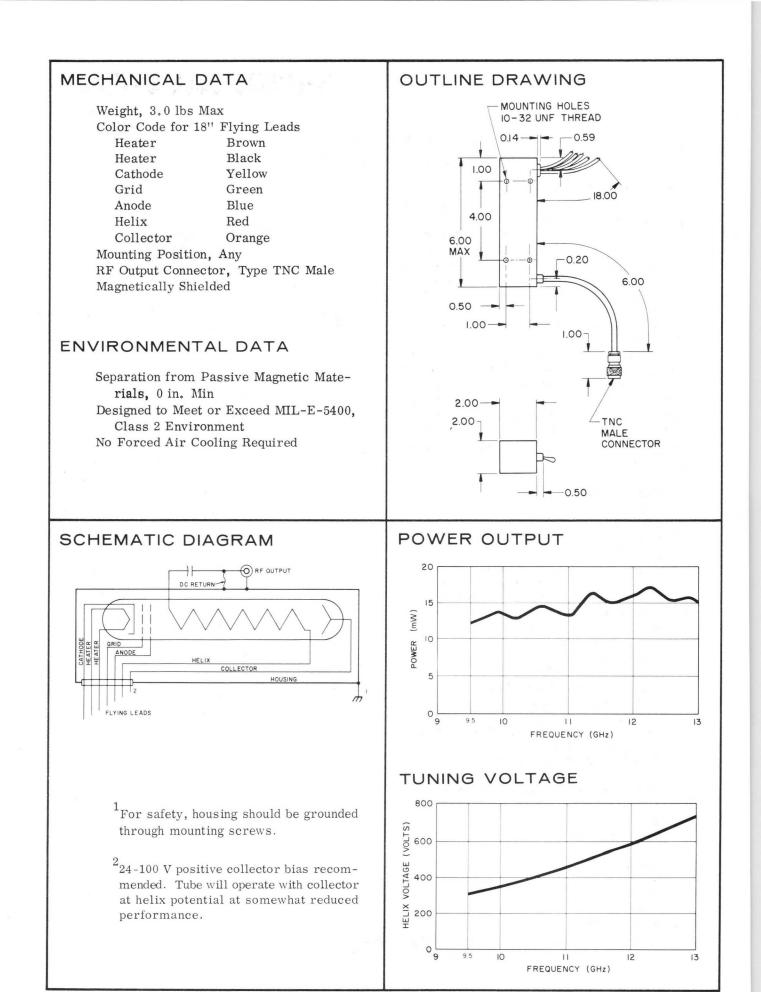
The type WJ-2004 BWO is a magnetically shielded voltage tunable oscillator. Its miniature square package features rugged construction and capability to withstand the severe environmental conditions defined in MIL-E-5400, Class 2. Magnetic shielding reduces the external magnetic field strength to a level that allows normal operation of two BWO's side by side or directly on a steel plate. The tube's immunity to external ac or dc magnetic fields, together with minimal stray magnetic field makes the WJ-2004 ideal for signal generating and sweeping equipment, for use in radar receivers (as local oscillator), and in frequency diversity



transmitters in ECM equipment (as master oscillator). Fine grain variation of frequency versus voltage is extremely low. Power output and tuning curves are uniform and highly reproducible. Power can be modulated and leveled with either grid or anode circuits. All voltages are isolated from housing and RF output connector for maximum flexibility in circuit applications.

ELECTRICAL CHARACTERISTICS, CW	Units	Typical Values	Absolute Ratings
Nominal Frequency Band	GHz	9.5-13.0	
Power Output into Load with VSWR = 1.25:1	mW	12-30	10 Min
Power Output Variation	dB		5 Max
Fine Grain Variation	dB/250 MHz		3 Max
Tube VSWR			3:1 Max
Frequency Pulling into 2:1 Load (Any Phase)	MHz	1.5	4 Max
Ratio of Signal to Noise Power 30 MHz Away	dB/MHz	95	85 Min
Ratio of Signal to 2nd Harmonic Output	dB	25	15 Min
Long-term Sensitivity to Heater Voltage	MHz/V	5	10 Max
Sensitivity to Anode Voltage	MHz/V	1	2 Max
Sensitivity to Grid Voltage	MHz/V	2	5 Max
Tuning Curve Slope			
Low End (9.5 GHz)	MHz/V	13	
Mid-Frequency (11.0 GHz)	MHz/V	9	
High End (13.0 GHz)	MHz/V	6	
Grid RF Cutoff Voltage	V	-10	-20 Max
Capacitance; Cathode to all other Electrodes,			
including Heater	pF	20	25
Capacitance; Grid to all other Electrodes, at			
Power Input Connector	pF	20	25
Capacitance; Helix and Collector to all other			
Electrodes and Case	pF	100	120
Heater Voltage	V dc		6.3+5%
Heater Current	А	0.75	0.4 to 1.2
			Min/Max
Cathode Current	mA	5	10
Helix Voltage Range	V	310/750	295/800
			Min/Max
Anode Voltage *	V	95	200 Max
Anode Current	mA	0.3	2.0 Max

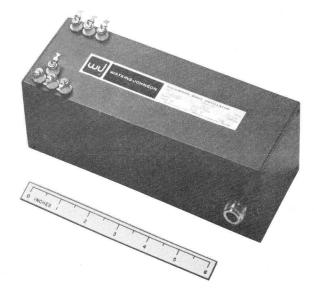
* Set anode voltage to Final Test Data value furnished with tube.



JULY 1967

BACKWARD-WAVE OSCILLATOR WJ-2006

The WJ-2006 is a shielded, voltage tunable oscillator utilizing a bifilar (dual) helix and a permanent-magnet focusing system. Unsaturated magnetic shielding reduces the magnetic field strength to less than 5 gauss 1/2 inch away from any point in the housing. RFI shielding and filtering allow the WJ-2006 to meet both MIL-I-26600, Class 1, and MIL-I-6181D. An im-munity to external ac or dc magnetic fields, together with minimal stray magnetic fields and low RF radiation, makes the WJ-2006 ideal for signal generating and sweeping equipment, for use in radar receivers (as local oscillator), in frequency diversity transmitters (as master oscillator), and in ECM equipment. Fine grain variation of frequency versus voltage is extremely low. The WJ-2006 delivers smooth power output over the band with low operating cathode current. Power can be modulated and leveled with either grid or anode circuits. All voltages are isolated from the housing and RF output connector for maximum flexibility in circuit applications.



SPECIFICATIONS

	SPECIFICATIONS	TYPICAL	ABSOLUTE
	UNITS		
Nominal Frequency Band	GHz		8.0-12.4
Power Output into Load with VSWR = $1.25:1$		60-175	50 Min.
Power Output Variation	dB		6 Max.
Fine Grain Variation	dB/250 MHz		З Мах.
Tube VSWR			2.5:1 Max.
Frequency Pulling into 2:1 Load (Any Phase)	MHz	0.6	1.5 Max.
Ratio of Signal to Noise Power 30 MHz Away	dB/MHz	95	85 Min.
Ratio of Signal to 2nd Harmonic Output Long-term Sensitivity to Heater Voltage			20 Min.
Sensitivity to Anode Voltage	MHz/V	. 0.6	
Sensitivity to Grid Voltage		3	
Tuning Curve Slope			
Low End (8.0 GHz)		7.2	
Mid-frequency (10.0 GHz)	MHz/V	4.6	
High End (12.4 GHz)	MHz/V	2.7	00.14
Grid RF Cutoff Voltage	· · · · · · · · · · · · · · · · · · ·	—/	—20 Max.
Capacitance; Cathode to all other Electrodes including Heater and Housing	рF	36	50
including Housing	pF	34	50
Canaaitanaay Ulaliy and Callactor to all other			
Electrodes and Housing	pF	160	
Heater Voltage	Vdc		$ 6.3 \pm 5\%$
Heater Current	A	0./5	0.4-1.2
Cathode Current	0	0	Min/Max
	· · · · · · · · · · · · · · · · · · ·	450 1405	12 IVIAX.
Helix Voltage Range	· · · · · · · · · · · · · · · · · · ·	450-1495	Min/Max
Helix Current	mA	1.3	
Anode Voltage*	V	150	200 Max.
Anode Current	mA	0.5	2 Max.
and the second sec	d with turks		

*Set anode voltage to Final Test Data value furnished with tube.

WJ-2006

MECHANICAL CHARACTERISTICS

Height, 3 inches (76 mm) Width, 3 inches (76 mm) Length, 8 inches (203 mm) Weight, 6.0 lbs. (2.72 Kg) Max. DC Terminal Connections

A — Anode

- B Collector
- C Helix
- D Grid
- E Cathode
- F Heater
- G --- Heater

Mounting Position, Any

RF Output Connector, Type N Female Magnetically Shielded

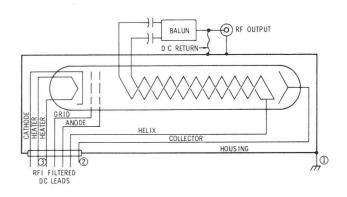
ENVIRONMENTAL CHARACTERISTICS

Separation from Passive Magnetic Materials, None Required

No Forced Air Cooling Required

RFI Shielded and Filtered to Meet MIL-D-26600 Line I or MIL-I-6181D

SCHEMATIC DIAGRAM



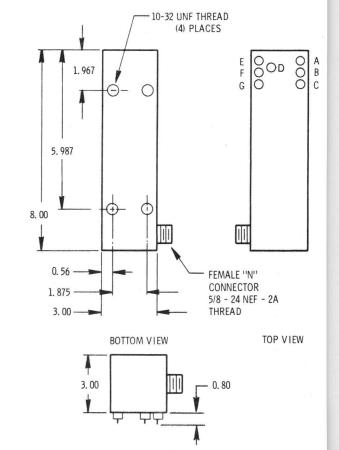
NOTES:

OFor safety, housing should be grounded through mounting screws.

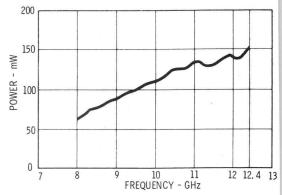
②24-100V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.

Heater must never be positive with respect to cathode.

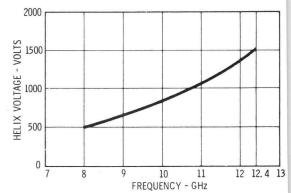
OUTLINE DRAWING



POWER OUTPUT



TUNING VOLTAGE



WJ-2007

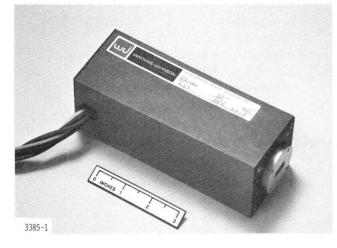
BACKWARD-WAVE OSCILLATOR

November 1968

The WJ-2007 is a magnetically and RFI shielded voltage tunable oscillator utilizing a single helix and permanent magnet focusing system to cover the frequency range from 12.4 to 18.0 GHz. Unsaturated magnetic shielding reduces the magnetic field strength at any point, 1/2 inch from the housing, to a value of less than 10 gauss. Interference requirements of MIL-STD-461 are met or exceeded by integral RFI shielding and filtering.

The combination of immunity to external ac or dc magnetic fields, minimal stray generated magnetic fields, and extremely low RF radiation, makes the WJ-2007 ideal for a number of applications, including the following: signal generating and sweeping equipment, radar receivers (as local oscillator), frequency diversity transmitters, and ECM equipment (as master oscillator).

The fine grain variation of frequency versus voltage is extremely low. The WJ-2007 delivers



smooth power output over the band with low operating cathode current. Power can be modulated and leveled with either grid or anode circuits. All voltages are isolated from the housing for maximum flexibility in circuit applications.

SPECIFICATIONS

	TYPICAL ABSOLUTE VALUES RATINGS	
Power Output VariationdBFine Grain VariationdB/250 MHzTube VSWR	50 - 110 40 Min. 6 Max. 	
Sensitivity to Grid Voltage MHz/V Tuning Curve Slope	. 5	
Low End (12.4 GHz) MHz/V MHz/V Mid-Frequency (15.2 GHz) MHz/V MHz/V High End (18.0 GHz) MHz/V MHz/V	2.6	
Including Housing pF	40 75 Max.	
Capacitance; Helix and Collector to All Other Electrodes and Housing	$6.3 \ldots 6.3 \pm 5\%$	•
Cathode Current mA Helix Voltage Range V		
Helix Current mA mA Anode Voltage* V V Anode Current mA mA * Set anode voltage to Final Test Data value furnished with tube.	130	

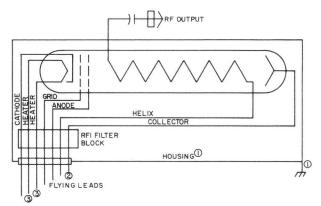
MECHANICAL DATA

Weight, 6.0 lbs. Max. Color Code for 18" Flying Leads Heater Black Brown Heater Cathode Yellow Grid Green Anode Blue Helix Red Collector Orange Mounting Position, Any RF Output Connector, Mate With UG 419/U Waveguide Flange Magnetically Shielded

ENVIRONMENTAL DATA

 Separation From Passive Magnetic Materials, None Required
 No Forced Air Cooling Required Below +60° C Ambient
 RFI Shielded and Filtered to Meet or Exceed MIL-STD-461

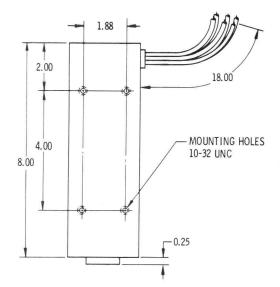
SCHEMATIC DIAGRAM

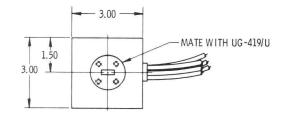


Notes:

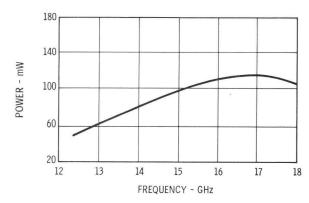
- (1) For safety, housing should be grounded through mounting screws.
- (2) 50 150 V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.
- (3) Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.

OUTLINE DRAWING

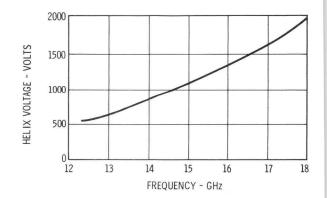




POWER OUTPUT



TUNING VOLTAGE



WATKINS = JOHNSON COMPANY 3333 HILLVIEW AVENUE = STANFORD INDUSTRIAL PARK PALO ALTO, CALIFORNIA 94304. TWX 910-373-1253 PHONE (415) 326-8830 Telex: 348-415

JULY 1969*

BACKWARD-WAVE OSCILLATOR WJ-2008

The WJ-2008 is a bifilar (dual) helix, voltage tunable oscillator utilizing a permanent magnet focusing system. This wide band oscillator is well-suited for use as a swept signal source in highly stable signal generators. Other applications include local oscillators in ECM receivers and master oscillators in frequency diversity transmitters and electronic test sets. Fine grain variation of frequency versus voltage is extremely low. The WJ-2008 delivers smooth power output over the band with low operating cathode current. Power can be modulated and leveled with either grid or anode circuits. All voltages are isolated from the housing and RF output connector for maximum flexibility in circuit applications.

SPECIFICATIONS

	UNITS	TYPICAL VALUES	ABSOLUTE RATINGS
Nominal Frequency Band Power Output into Load with VSWR = 1.25:1 Power Output Variation Fine Grain Variation Tube VSWR	.mW .dB .dB/250 MHz	. 120-225	100 Min. 6 Max. 3 Max.
Frequency Pulling into 2:1 Load (Any Phase) Ratio of Signal to Noise Power 30 MHz Away Ratio of Signal to 2nd Harmonic Output Long-term Sensitivity to Heater Voltage Sensitivity to Anode Voltage Sensitivity to Grid Voltage	. MHz . dB/MHz . dB . MHz/V . MHz/V	. 1.5 . 95 . 30 . 7 . 1.5	3 Max. 85 Min.
Tuning Curve Slope Low End (8.0 GHz) Mid-Frequency (10.2 GHz) High End (12.4 GHz) Grid RF Cutoff Voltage Capacitance; Cathode to all other Electrodes	. MHz/V	. 3 . 2	. —20 Max.
Capacitance, Cathole to an other Electrodes including Heater and Housing Capacitance; Grid to all other Electrodes including Housing			
Capitance; Helix and Collector to all other Electrodes and Housing Heater Voltage Heater Current			
Cathode Current ¹	.V	. 630-2075	. 14 Max. 600-2150
Anode Voltage Anode Current Helix Current	mA	0.1	. 215 Max.

¹Set cathode current to Final Test Data value furnished with tube. *Supersedes WJ-2008 Technical Data Sheet dated November 1967.

WJ-2008

MECHANICAL CHARACTERISTICS

Height, 2.5 inches (64 mm) Width, 2.5 inches (64mm) Length, 6.25 inches (159 mm) max. Weight, 3 lbs. (1.36 Kg) Max.

Color Code for 18"	Flying Leads
Heater	Black
Heater	Brown
Cathode	Yellow
Grid	Green
Anode	Blue
Helix	Red

Helix Red Collector Orange

Mounting Position, Any

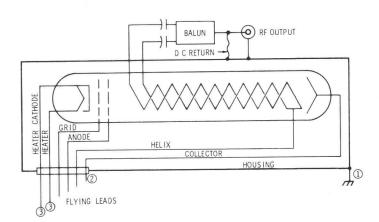
RF Output Connector, Type N Female

ENVIRONMENTAL CHARACTERISTICS

Separation from Passive Magnetic Materials, 2 in. Min.

No Forced Air Cooling Required Below +60°C Ambient

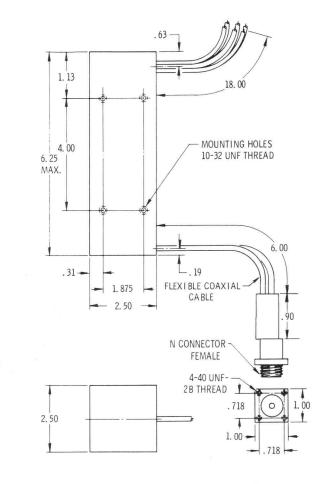
SCHEMATIC DIAGRAM



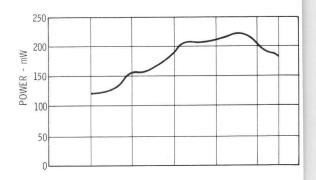
Notes:

- (1) For safety, housing should be grounded through mounting screws.
- (2) 50-150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.
- (3) Heater must always be negative with respect to cathode. One heater lead may be tied to cathode.

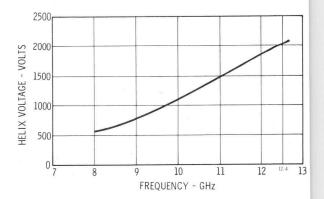
OUTLINE DRAWING



POWER OUTPUT



TUNING VOLTAGE



BACKWARD-WAVE OSCILLATOR

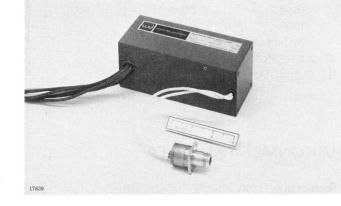
TECHNICAL DATA

WJ-2008-2

November 1967

A DOOT LUTE

The WJ 2008-2 is a bifilar (dual) helix, voltage tunable oscillator utilizing a permanent magnet focusing system. This wide band oscillator is well-suited for use as a swept signal source in highly stable signal generators. Other applications include local oscillators in ECM receivers and master oscillators in frequency diversity transmitters and electronic test sets. Fine grain variation of frequency versus voltage is extremely low. The WJ 2008-2 delivers smooth power output over the band with low operating cathode current. Power can be modulated and leveled with either grid or anode circuits. All voltages are



TYDICAT

isolated from the housing and RF output connector for maximum flexibility in circuit applications.

SPECIFICATIONS

	UNITS	TYPICAL	ABSOLUTE
	ONTE	VALUES	RATINGS
Nominal Frequency Band	GHz	8.0-12.4	
Power Output into Load with VSWR = 1.25:1	mW	85-135	80 Min
Power Output Variation	$d\mathbf{B}$		6 Max
Fine Grain Variation	dB/250 MHz		3 Max
Tube VSWR			2.5:1 Max
Frequency Pulling Into 2:1 Load (Any Phase)	MHz	1.5	3 Max
Ratio of Signal to Noise Power 30 MHz Away	dB/MHz B.W.	95	85 Min
Ratio of Signal to 2nd Harmonic Output	dB	30	20 Min
Long-term Sensitivity to Heater Voltage	MHz/V	7	
Sensitivity to Anode Voltage	MHz/V	1.7	
Sensitivity to Grid Voltage	MHz/V	7	
Tuning Curve Slope			
Low End (8.0 GHz)	MHz/V	5.5	
Mid-Frequency (10.2 GHz)	MHz/V	3.5	
High End (12.4 GHz)	MHz/V	2	
Grid r.f. Cutoff Voltage	V	-15	-20 Max
Capacitance; Cathode to all other Electrodes			
incl. Heater and Housing	\mathbf{pF}	40	55 Max
Capacitance; Grid to all other Electrodes,			
incl. Housing	\mathbf{pF}	20	35 Max
Capacitance; Helix and Collector to all other			
Electrodes and Housing	\mathbf{pF}	150	175 Max
Heater Voltage	Vdc		$6.3 \pm 5\%$
Heater Current	А	0.7	0.4 to 1.2
			Min/Max
Cathode Current*	mA	8	12 Max
Helix Voltage Range	V	630-2075	600-2150
			Min/Max
Anode Voltage	V	120	215 Max
Anode Current	mA	0.05	2 Max
Helix Current	mA	1.2	3 Max

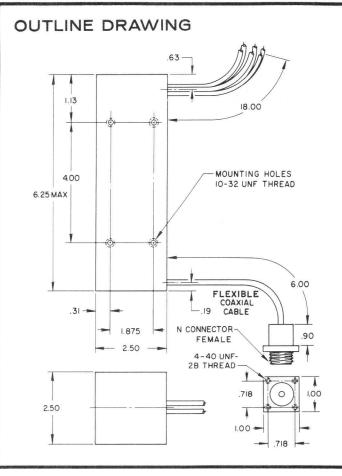
*Set cathode current to Final Test Data value furnished with tube

MECHANICAL DATA

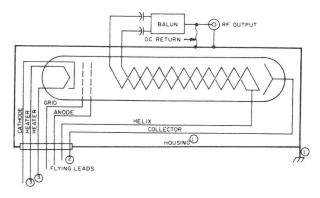
Weight, 3.0 lbs Max Color Code for 18" Flying Leads Heater Black Heater Brown Cathode Yellow Grid Green Blue Anode Red Helix Collector Orange Mounting Position, Any RF Output Connector, Type N Female

ENVIRONMENTAL DATA

Separation from Passive Magnetic Materials, 2 in. Min No Forced Air Cooling Required, Below +60^oC Ambient



SCHEMATIC DIAGRAM

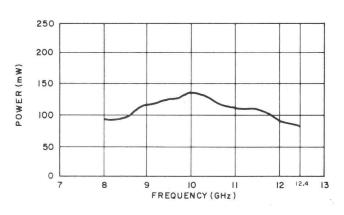


D_{For safety, housing should be grounded through mounting screws.}

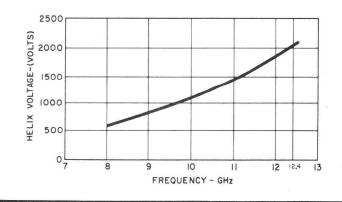
250-150 V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.

⁽³⁾Heater must always be negative with respect to cathode. One heater lead may be tied to cathode.

POWER OUTPUT



TUNING VOLTAGE



WATKINS ■ JOHNSON COMPANY 3333 HILLVIEW AVENUE ■ STANFORD INDUSTRIAL PARK PALO ALTO, CALIFORNIA 94304 TWX 910-373-1253 PHONE (415) 326-8830 Telex: 348-415

AUGUST 1967

BACKWARD-WAVE OSCILLATOR WJ-2014

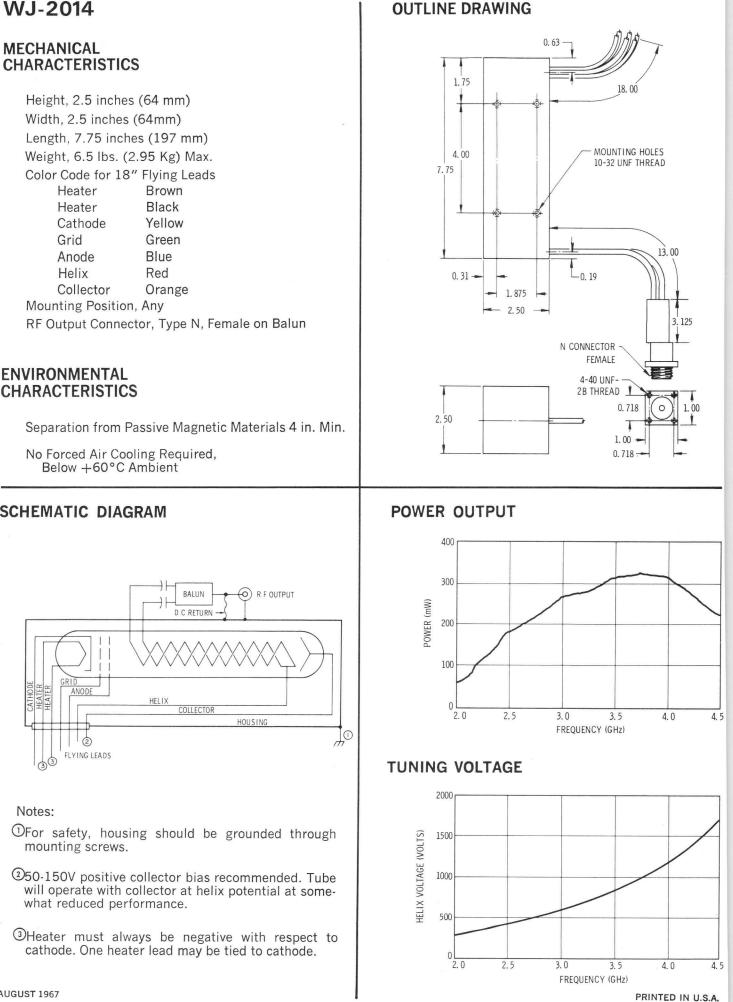
The WJ-2014 is a 50 mW, 2.0 to 4.5 GHz voltage tunable oscillator utilizing a bifilar (dual) helix and a permanent magnet focusing system. This wide band oscillator is well suited for use as a swept signal source in highly stable signal generators. Other applications include local oscillators in ECM receivers, master oscillators in frequency diversity transmitters and electronic test sets. Fine grain variation of frequency versus voltage is extremely low. The WJ-2014 delivers smooth power output over the band with low operating cathode current. Power can be modulated and leveled with either grid or anode circuits. All voltages are isolated from the hounsing and RF output connector for maximum flexibility in circuit applications.



SPECIFICATIONS

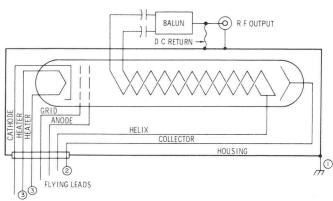
	UNITS	TYPICAL VALUES	ABSOLUTE RATINGS
Nominal Frequency Band Power Output into Load with VSWR = 1.25 Power Output Variation Fine Grain Variation Tube VSWR Frequency Pulling into 2:1 Load (Any Phase)	.mW .dB .dB/250 MHz	60-350	50 Min. 9 Max. 4 Max. 2.5:1 Max.
Spurious Oscillation Ratio of Signal to 2nd Harmonic Output Ratio of Signal to Noise Power 30 MHz Away Long-term Sensitivity to Heater Voltage @ 3 GHz Sensitivity to Anode Voltage Sensitivity to Grid Voltage Tuning Curve Slope	.dB/MHz .MHz/V .MHz/V	95 5 1	20 Min. 85 Min.
Low End (2.0 GHz) Mid-Frequency (3.25 GHz) High End (4.5 GHz) Grid RF Cutoff Voltage	.MHz/V	2.0 0.8	. —20 Max.
Capacitance; Cathode to all other Electrodes including Heater and Housing			
Capacitance; Grid to all other Electrodes including Housing			
Capacitance; Helix and Collector to all other Electrodes including Housing Heater Voltage Heater Current			
Cathode Current*	.mA	12.5 290-1750	15 [°] Max. . 275-1800
Helix Current Anode Voltage Anode Current	.V	130	. 215 Max.

*Set cathode current to Final Test Data value furnished with tube.



CHARACTERISTICS

SCHEMATIC DIAGRAM



Notes:

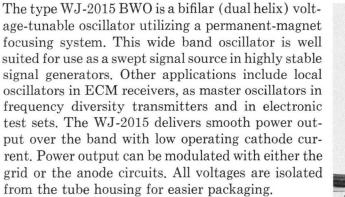
- mounting screws.
- 250-150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.
- 3Heater must always be negative with respect to cathode. One heater lead may be tied to cathode.

BACKWARD-WAVE *

OSCILLATOR

WJ-2015

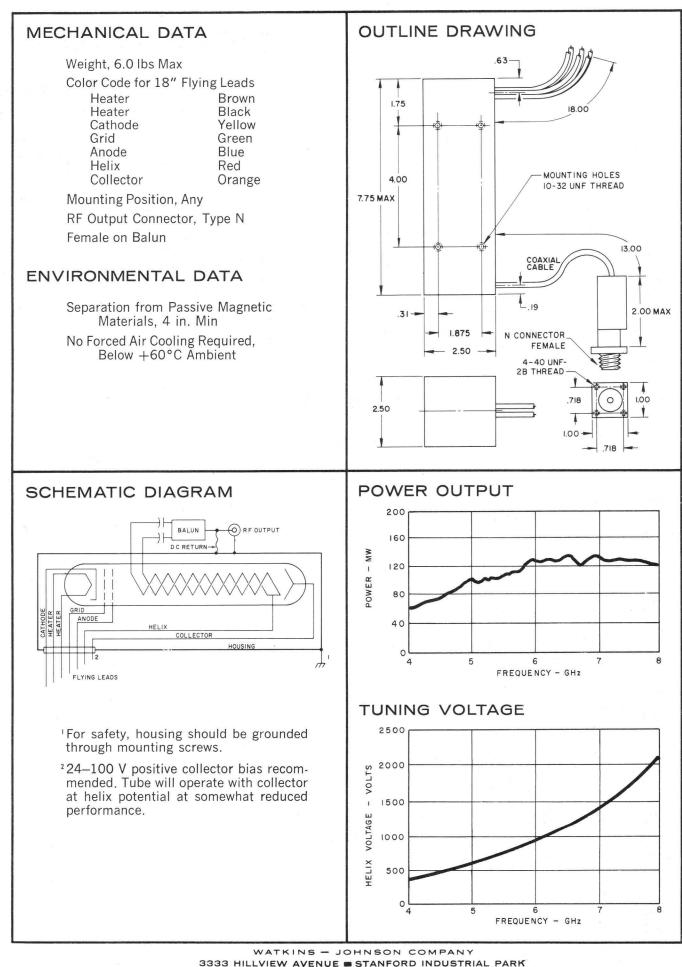
TECHNICAL DATA • March 1967



753

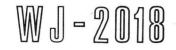
SPECIFICATIONS

	Units	Typical Values	Absolute Ratings
Nominal Frequency Band	GHz	4-8	
Power Output into Load with VSWR = 1.25	mW	60-150	60 Min
Power Output Variation	dB		6 Max
Fine Grain Variation	dB/250 MHz		3 Max
Tube VSWR	and the second second second second		2.5:1 Max
Frequency Pulling into 2:1 Load (Any Phase)	MHz	1.5	3 Max
Spurious Oscillation			
Ratio of Signal to 2nd Harmonic Output	dB	35	20 Min
Ratio of Signal to Noise Power 30 MHz Away	dB/MHz	95	85 Min
Long-term Sensitivity to Heater Voltage	MHz/V	5	10 Max
Sensitivity to Anode Voltage	MHz/V	0.5	1 Max
Sensitivity to Grid Voltage	MHz/V	3	5 Max
Tuning Curve Slope			
Low End (4.0 GHz)	MHz/V	5.4	
Mid-Frequency (6.0 GHz)	MHz/V	2.5	
High End (8.0 GHz)	MHz/V	1.9	00 Ман
Grid R F Cutoff Voltage	V	—7	—20 Max
Capacitance; Cathode to all other Electrodes, including Heater and Housing	pF	30	45 Max
Capacitance; Grid to all other Electrodes	рі	50	+5 Max
including Housing	рF	30	45 Max
Capacitance; Helix to all other Electrodes	pF	100	150 Max
Heater Voltage		100	$6.3 \pm 5\%$
Heater Current	A	0.9	0.6-1.2
	Л	0.5	Min/Max
Cathode Current	mA	8.5	15 Max
Helix Voltage	V .	345-2085	330-2150
			Min/Max
Helix Current	mA	1.5	3 Max
Anode Voltage	V	135	215 Max
Anode Current	mA	0.5	2 Max



3333 HILLVIEW AVENUE STANFORD INDUSTRIAL PARK PALO ALTO, CALIFORNIA 94304 TWX 910-373-1253 PHONE (415) 326-8830 Telex: 348-415

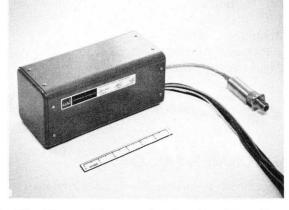
Printed in U.S.A.



June 1967

BACKWARD-WAVE O S C I L L A T O R

The WJ-2018 is a magnetically shielded and RFI shielded voltage tunable oscillator utilizing a bifilar (dual) helix and a permanent-magnet focusing system. An immunity to external ac or dc magnetic fields,together with a minimal stray magnetic field and low RF radiation, makes the WJ -2018 ideal for signal generating and sweeping equipment, for use in radar receivers (aslocal) oscillator), in frequency diversity transmitters (as master oscillator), and in ECM equipment. Fine grain variation of frequency versus voltage is extremely low. The WJ-2018 delivers smooth power output over the band with low operating

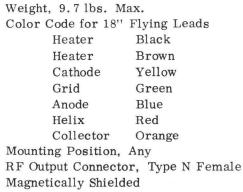


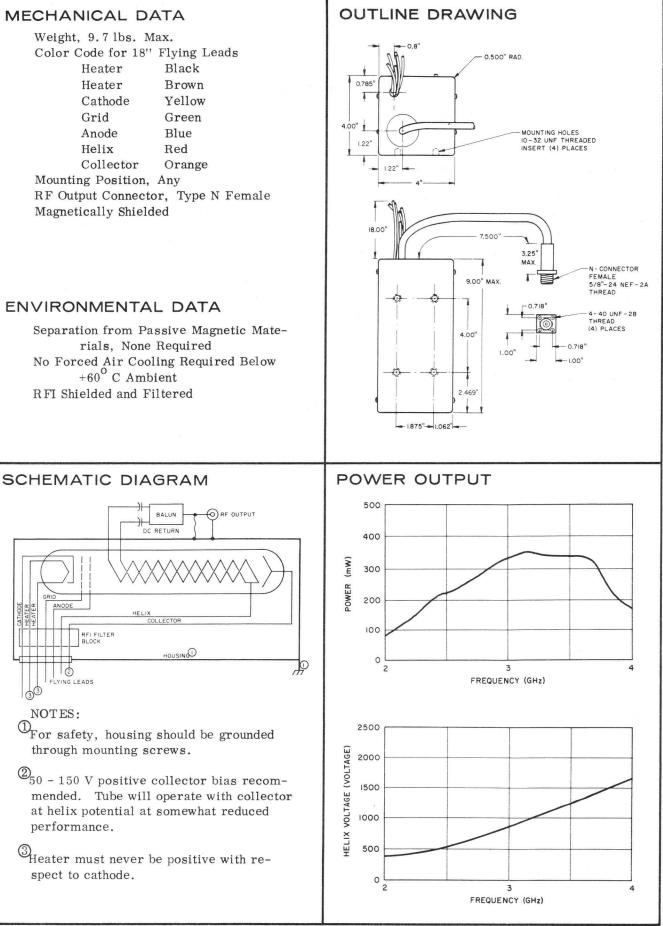
cathode current. Power can be modulated and leveled with either grid or anode circuit. All voltages are isolated from housing and RF output connector for maximum flexibility in circuit applications.

SPECIFIC	ATIONS		
	UNITS	TYPICAL VALUES	ABSOLUTE RATINGS
Nominal Frequency Band	GHz	2.0-4.0	
Power Output into Load with VSWR = 1.25:1	mW	90-360	70 Min
Power Output Variation	dB		8 Max
Fine Grain Variation	dB/100 MHz		3 Max
Tube VSWR			2.5:1 Max
Frequency Pulling Into 2:1 Load (Any Phase)	MHz	4	8 Max
Ratio of Signal to Noise Power 30 MHz Away	dB/MHz B.W.	95	85 Min
Ratio of Signal to 2nd Harmonic Output	dB	30	20 Min
Long-term Sensitivity to Heater Voltage	MHz/V	5	
Sensitivity to Anode Voltage	MHz/V	0.4	
Sensitivity to Grid Voltage	MHz/V	2	
Tuning Curve Slope			
Low End (2.0 GHz)	MHz/V	. 3	
Mid-Frequency (3.0 GHz)	MHz/V	1.7	
High End (4.0 GHz)	MHz/V	1	
Grid RF Cutoff Voltage	V	-7	-20 Max
Capacitance; Cathode to all other Electrodes,			
including Heater and Housing	\mathbf{pF}	55	75 Max
Capacitance; Grid to all other Electrodes,			
including Housing	pF	55	75 Max
Capacitance; Helix and Collector to all other			
Electrodes and Housing	\mathbf{pF}	245	275 Max
Heater Voltage	Vdc	6.3	$6.3 \pm 5\%$
Heater Current	А	0.75	0.4 - 1.2
			Min/Max
Cathode Current	mA	11	15 Max
Helix Voltage Range	V	375-1735	308-2000
			Min / Max
Helix Current	mA	1.5	3 Max
Anode Voltage*	V	150	215 Max
Anode Current	mA	0.1	2 Max
* Set anode voltage to Final Test Data value furnish	ed with tube		

* Set anode voltage to Final Test Data value furnished with tube.

MECHANICAL DATA





10 FLYING LEADS

NOTES:

33

BACKWARD-WAVE OSCILLATOR WJ-2018-50

SPECIFICATIONS

	UNITS	TYPICAL VALUES	ABSOLUTE RATINGS
Frequency Band Power Output into Load with VSWR = 1.25:1 Power Output Variation Fine Grain Variation Tube VSWR Frequency Pulling Into 2:1 Load (Any Phase)	. mW		75 Min. 8 Max. 3 Max. 2.5:1 Max.
Spurious Oscillation Ratio of Signal to Noise Power 30 MHz Away Ratio of Signal to 2nd Harmonic Output Long-term Sensitivity to Heater Voltage Sensitivity to Anode Voltage Sensitivity to Grid Voltage Tuning Curve Slope	.dB .MHz/V .MHz/V .MHz/V .MHz/V	30 5 0.4 4	85 Min. 20 Min.
Low End (2.0 GHz) Mid-Frequency (3.0 GHz) High End (4.0 GHz) Grid RF Cutoff Voltage Capacitance; Cathode to all other Electrodes,	. MHz/V	.1.7	. — 25 Max.
including Heater and Housing Capacitance: Grid to all other Electrodes.			
including Housing Capacitance; Helix and Collector to all other Electrodes including Housing Heater Voltage Heater Current	nF	245	275 Max. 6.3 ± 5% 0.4−1.2
Cathode Current * Helix Voltage Range	.mA	.11 .375–1735	. 308–2000
Helix Current Anode Voltage Anode Current	.V .mA		215 Max.

* Set cathode current to Final Test Data value furnished with tube.

The WJ-2018-50 is a magnetically shielded and RFI shielded voltage tunable oscillator utilizing a bifilar (dual helix) and a permanent-magnet focusing system. An immunity to external ac or dc magnetic fields, together with a minimal stray magnetic field and low RF radiation, makes the WJ-2018-50 ideal for signal generating and sweeping equipment, for use in radar

receivers (as local oscillator), in frequency diversity

transmitters (as master oscillator), and in ECM equipment. Fine grain variation of frequency versus voltage

The WJ-2018-50 delivers smooth power output over the band with low operating cathode current. Power can be modulated and leveled with either grid or anode circuits. All voltages are isolated from housing and RF output connector for maximum flexibility in circuit

is extremely low.

applications.

WJ-2018-50

MECHANICAL CHARACTERISTICS

Height, 4 inches (102 mm) Width, 4 inches (102 mm) Length, 9 inches (229 mm) max. Weight, 11.3 lbs. (5.13 Kg) max.

Color Code for 18" Flying Leads

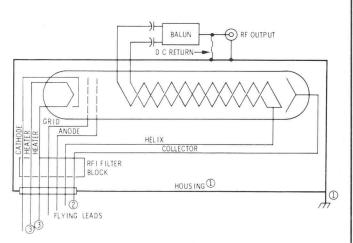
Heater	Black
Heater	Brown
Cathode	Yellow
Grid	Green
Anode	Blue
Helix	Red
Collector	Orange

Mounting Position, Any RF Output Connector, Type N Female on Balun

ENVIRONMENTAL CHARACTERISTICS

Magnetically Shielded Separation from Passive Magnetic Materials, None Required No Forced Air Cooling Required Below +60°C Ambient RFI Shielded and Filtered

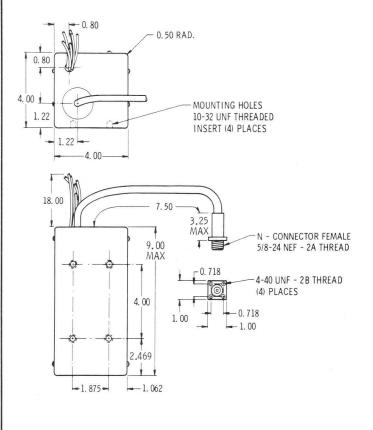
SCHEMATIC DIAGRAM

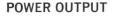


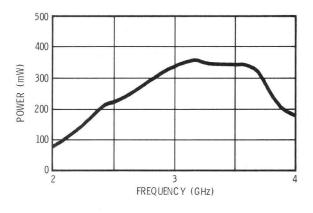
Notes:

- For safety, housing should be grounded through mounting screws.
- (2) 45–150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.
- (3) Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.

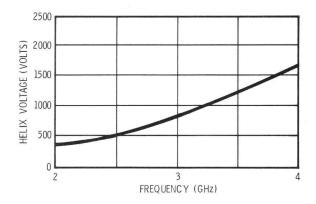
OUTLINE DRAWING







TUNING VOLTAGE



DECEMBER 1970

BACKWARD-WAVE OSCILLATOR WJ-2018-51

anode circuits. All voltages are isolated from housing and RF output connector for maximum flexibility in circuit applications.

SPECIFICATIONS

	UNITS	TYPICAL VALUES	ABSOLUTE RATINGS
Frequency Band Power Output into Load with VSWR = 1.25:1 Power Output Variation Fine Grain Variation Tube VSWR Frequency Pulling Into 2:1 Load (Any Phase) Spurious Oscillation	. mW	.90–360	30 Min. 10 Max. 3 Max.
Ratio of Signal to Noise Power 30 MHz Away Ratio of Signal to 2nd Harmonic Output Long-term Sensitivity to Heater Voltage Sensitivity to Anode Voltage Sensitivity to Grid Voltage Tuning Curve Slope	.dB .MHz/V .MHz/V	.30 .5 .0.4	85 Min. 20 Min.
Low End (1.7 GHz) Mid-Frequency (3.0 GHz) High End (4.2 GHz) Grid RF Cutoff Voltage	.MHz/V	.1.7	. —25 Max.
Capacitance; Cathode to all other Electrodes, including Heater and Housing Capacitance; Grid to all other Electrodes,			
including Housing	•		
Electrodes including Housing	.Vdc	. 6.3	$6.3 \pm 5\%$ 0.4 - 1.2
Cathode Current [*]	.mA .V	.11 .270–1950	Min./Max. 15 Max. 257–2200 Min./Max.
Helix Current	.V	.150	3 Max. 215 Max.

* Set cathode current to Final Test Data value furnished with tube.



The WJ-2018-51 is a magnetically shielded and RFI shielded voltage tunable oscillator utilizing a bifilar (dual helix) and a permanent-magnet focusing system. Unsaturated magnetic shielding reduces the magnetic field strength along the outside of the housing. RFI

shielding and filtering enables this tube to meet MIL-I-6181D. An immunity to external ac or dc magnetic fields, to-

gether with a minimal stray magnetic field and low RF radiation, makes the WJ-2018-51 ideal for signal generating and sweeping equipment, for use in radar receivers (as local oscillator), in frequency diversity transmitters (as master oscillator), and in ECM equipment. Fine grain variation of frequency versus voltage is extremely low. Power output and tuning curves are uniform and highly reproducible.

The WJ-2018-51 delivers smooth power output over the band with low operating cathode current. Power can be modulated and leveled with either grid or

WJ-2018-51

MECHANICAL CHARACTERISTICS

Height, 4 inches (102 mm) Width, 4 inches (102 mm) Length, 9 inches (229 mm) max. Weight, 11.3 lbs. (5.13 Kg) max.

Color Code for 18" Flying Leads

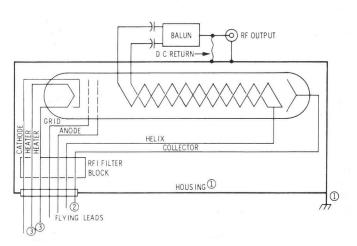
Heater	Black
Heater	Brown
Cathode	Yellow
Grid	Green
Anode	Blue
Helix	Red
Collector	Orange

Mounting Position, Any RF Output Connector, Type N Female on Balun

ENVIRONMENTAL CHARACTERISTICS

Magnetically Shielded Separation from Passive Magnetic Materials, None Required No Forced Air Cooling Required Below +60°C Ambient RFI Shielded and Filtered

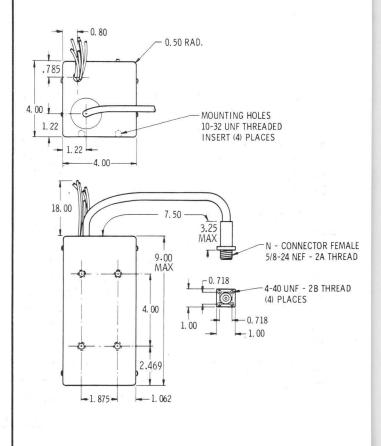
SCHEMATIC DIAGRAM



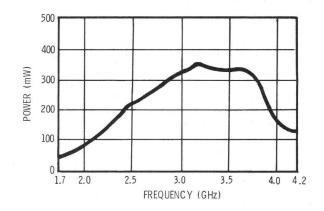
Notes:

- (1.) For safety, housing should be grounded through mounting screws.
- (2) 45–150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.
- (3) Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.

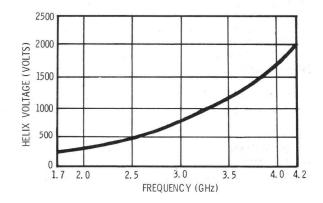
OUTLINE DRAWING







TUNING VOLTAGE

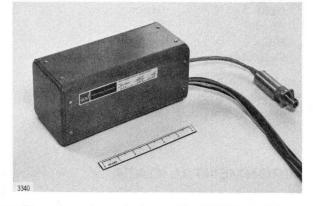




BACKWARD-WAVE O S C I L L A T O R

September 1968 *

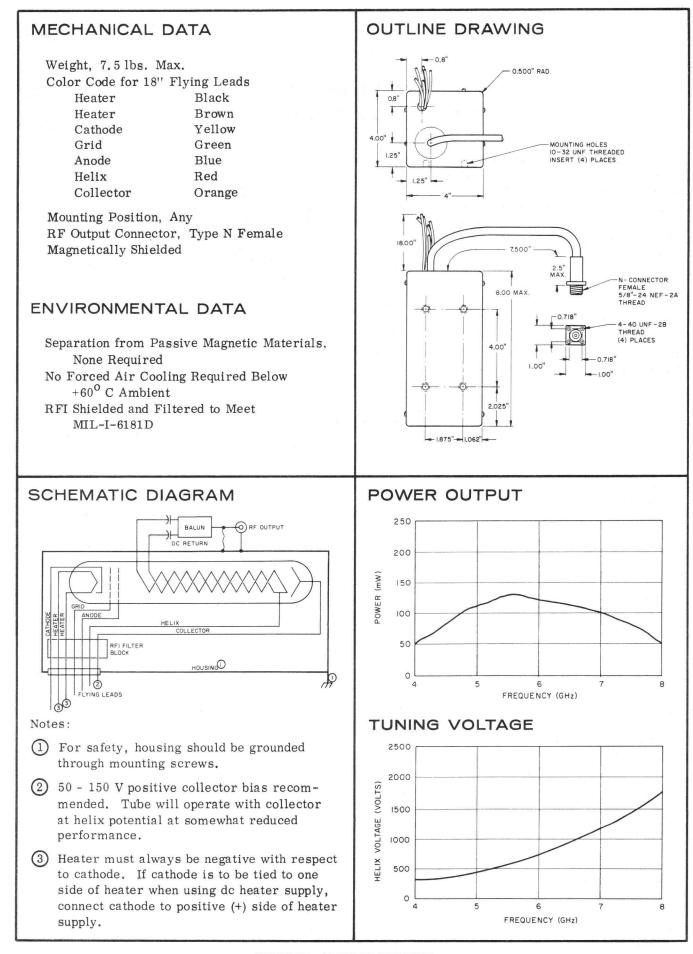
The WJ-2019 is a shielded, voltage tunable oscillator utilizing a bifilar (dual) helix and a permanent-magnet focusing system. Unsaturated magnetic shielding reduces the magnetic field strength to less than 15 gauss 1-inch from any point of the housing. RFI shielding and filtering allow the WJ-2019 to meet MIL-I-6181D. An immunity to external ac or dc magnetic fields together with a minimal stray magnetic field and low RF radiation, makes the WJ-2019 ideal for signal generating and sweeping equipment, for use in radar receivers (as local oscillator), in frequency diversity transmitters (as master oscillator) and in ECM



equipment. Fine grain variation of frequency versus voltage is extremely low. The WJ-2019 delivers smooth power output over the band with low operating cathode current. Power can be modulated and leveled with either grid or anode circuits. All voltages are isolated from housing and RF output connector for maximum flexibility in circuit applications.

SPECIFICA	TIONS		
	UNITS	TYPICAL	ABSOLUTE
		VALUES	RATINGS
Nominal Frequency Band	GHz	4.0-8.0	
Power Output into Load with VSWR = 1.25:1	mW	50-120	30 Min
Power Output Variation	dB		7 Max
Fine Grain Variation	dB/250 MHz		3 Max
Tube VSWR			2.5:1 Max
Frequency Pulling Into 2:1 Load (Any Phase)	MHz	1	3 Max
Ratio of Signal to Noise Power 30 MHz Away	dB/MHz B.W.	95	85 Min
Ratio of Signal to 2nd Harmonic Output	dB	30	20 Min
Long-term Sensitivity to Heater Voltage	MHz/V	3	
Sensitivity to Anode Voltage	MHz/V	0.9	
Sensitivity to Grid Voltage	MHz/V	7	
Tuning Curve Slope			
Low End (4.0 GHz)	MHz/V	6	
Mid-Frequency (6.0 GHz)	MHz/V	3	
High End (8.0 GHz)	MHz/V	1.5	
Grid RF Cutoff Voltage	V	-11	-20 Max
Capacitance; Cathode to all other Electrodes,			
including Heater and Housing	pF	55	70 Max
Capacitance; Grid to all other Electrodes,	1 -		
including Housing	pF	55	70 Max
Capacitance; Helix and Collector to all other	*		
Electrodes and Housing	рF	210	250 Max
Heater Voltage	Vdc	6.3	$6.3 \pm 5\%$
Heater Current	А	0.75	0.4-1.2
			Min/Max
Cathode Current	mA	9	13 Max
Helix Voltage Range	V	302-1805	280-1900
			Min/Max
Helix Current	mA	1.2	3 Max
Anode Voltage ¹	V	120	215 Max
Anode Current	mA	0.1	2 Max
¹ Set anode voltage to Final Test Data value furnishe	d with tube.		

* Supersedes WJ-2019 Technical Data Sheet Dated June 1967



DECEMBER 1970

BACKWARD-WAVE OSCILLATOR WJ-2019-50



anode circuits. All voltages are isolated from housing and RF output connector for maximum flexibility in circuit applications.

SPECIFICATIONS										
	UNITS	TYPICAL VALUES	ABSOLUTE RATINGS							
Frequency Band Power Output into Load with VSWR = 1.25:1 Power Output Variation Fine Grain Variation Tube VSWR Frequency Pulling Into 2:1 Load (Any Phase)	.mW .dB .dB / 250 MHz	.50–120	7 Max. 3 Max. 2.5:1 Max.							
Spurious Oscillation Ratio of Signal to Noise Power 30 MHz Away Ratio of Signal to 2nd Harmonic Output Long-term Sensitivity to Heater Voltage Sensitivity to Anode Voltage Sensitivity to Grid Voltage Tuning Curve Slope	.dB .MHz/V .MHz/V	30 3 0.9	85 Min. 20 Min.							
Low End (4.0 GHz) Mid-Frequency (6.0 GHz) High End (8.0 GHz) Grid RF Cutoff Voltage Capacitance: Cathode to all other Electrodes.	.MHz/V .MHz/V .V	3 1.5 —11								
including Heater and Housing	.pF		70 Max.							
Electrodes including Housing Heater Voltage Heater Current Cathode Current *	*		IVIIn. / IVIax.							
Helix Voltage Range Helix Current Anode Voltage Anode Current	.V		. 280–1900 Min./Max. 3 Max. 215 Max.							

*Set cathode current to Final Test Data value furnished with tube.

SPECIFICATIONS

The WJ-2019-50 is a magnetically shielded and RFI shielded voltage tunable oscillator utilizing a bifilar (dual helix) and a permanent-magnet focusing system. Unsaturated magnetic shielding reduces the magnetic field strength along the outside of the housing. RFI shielding and filtering enables this tube to meet MIL-I-6181D.

An immunity to external ac or dc magnetic fields, together with a minimal stray magnetic field and low RF radiation, makes the WJ-2019-50 ideal for signal generating and sweeping equipment, for use in radar receivers (as local oscillator), in frequency diversity transmitters (as master oscillator), and in ECM equipment. Fine grain variation of frequency versus voltage is extremely low. Power output and tuning curves are uniform and highly reproducible.

The WJ-2019-50 delivers smooth power output over the band with low operating cathode current. Power can be modulated and leveled with either grid or

WJ-2019-50

MECHANICAL CHARACTERISTICS

Height, 4 inches (102 mm) Width, 4 inches (102 mm) Length, 8 inches (203 mm) max. Weight, 8 lbs. (3.63 Kg) max.

Color Code for 18" Flying Leads

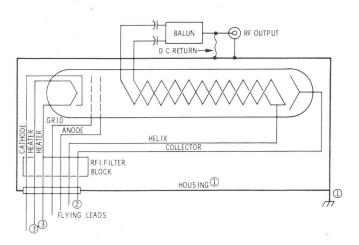
HeaterBlackHeaterBrownCathodeYellowGridGreenAnodeBlueHelixRedCollectorOrange

Mounting Position, Any RF Output Connector, Type N Female on Balun

ENVIRONMENTAL CHARACTERISTICS

Magnetically Shielded Separation from Passive Magnetic Materials, None Required No Forced Air Cooling Required Below +60°C Ambient RFI Shielded and Filtered

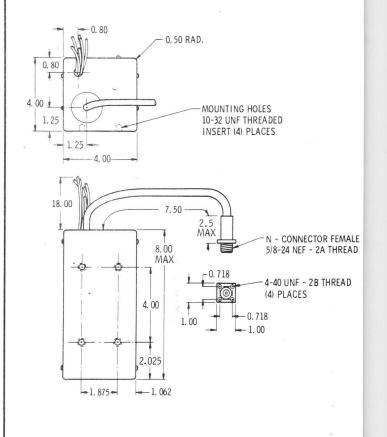
SCHEMATIC DIAGRAM

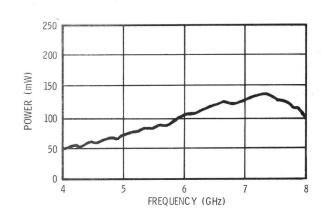


Notes:

- (1) For safety, housing should be grounded through mounting screws.
- (2) 45–150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.
- (3) Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.

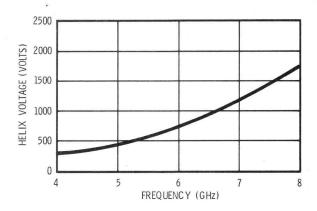






TUNING VOLTAGE

POWER OUTPUT



DECEMBER 1970

BACKWARD-WAVE OSCILLATOR WJ-2019-51

The WJ-2019-51 is a magnetically shielded and RFI shielded voltage tunable oscillator utilizing a bifilar (dual helix) and a permanent-magnet focusing system. Unsaturated magnetic shielding reduces the magnetic field strength along the outside of the housing. RFI shielding and filtering enables this tube to meet MIL-I-6181D.

An immunity to external ac or dc magnetic fields, together with a minimal stray magnetic field and low RF radiation, makes the WJ-2019-51 ideal for signal generating and sweeping equipment, for use in radar receivers (as local oscillator), in frequency diversity transmitters (as master oscillator), and in ECM equipment. Fine grain variation of frequency versus voltage is extremely low. Power output and tuning curves are uniform and highly reproducible.

The WJ-2019-51 delivers smooth power output over the band with low operating cathode current. Power can be modulated and leveled with either grid or



anode circuits. All voltages are isolated from housing and RF output connector for maximum flexibility in circuit applications.

	SPEC	UNITS	TYPICAL VALUES	ABSOLUTE RATINGS
Power (Power (Fine Gr Tube V Frequer	ncy Band Dutput into Load with VSWR = 1.25:1 Dutput Variation ain Variation SWR ncy Pulling Into 2:1 Load (Any Phase)	dB dB		
Rat Rat Long-te Sensitiv Sensitiv	IS Oscillation io of Signal to Noise Power 30 MHz Away io of Signal to 2nd Harmonic Output rm Sensitivity to Heater Voltage vity to Anode Voltage	dB MHz/V MHz/V	30 3 0.9	85 Min. 20 Min.
Low Mid Hig Grid RF	/ End (3.7 GHz) I-Frequency (6.0 GHz) h End (8.3 GHz) Cutoff Voltage	MHz/V MHz/V V	3 0.9 11	
Capacit incl	uding Heater and Housing			
Capacit Elec Heater Heater	ance; Helix and Collector to all other ctrodes including Housing Voltage Current	pF Vdc A		
Helix Vo	e Current [*] oltage Range	V	265–2050	13 Max. 243–2150 Min /Max
Anode \ Anode (urrent . /oltage Current .	V mA		215 Max.
* Cat ant	had a summer to Final Test Data value furnished with	h tubo		

SPECIFICATIONS

* Set cathode current to Final Test Data value furnished with tube.

WJ-2019-51

MECHANICAL CHARACTERISTICS

Height, 4 inches (102 mm) Width, 4 inches (102 mm) Length, 8 inches (204 mm) max. Weight, 8 lbs. (3.63 Kg) max.

Color Code for 18" Flying Leads

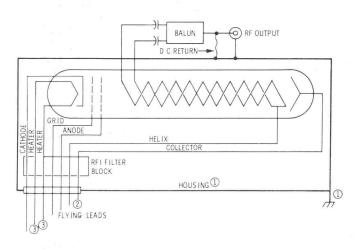
Heater	Black
Heater	Brown
Cathode	Yellow
Grid	Green
Anode	Blue
Helix	Red
Collector	Orange

Mounting Position, Any RF Output Connector, Type N Female on Balun

ENVIRONMENTAL CHARACTERISTICS

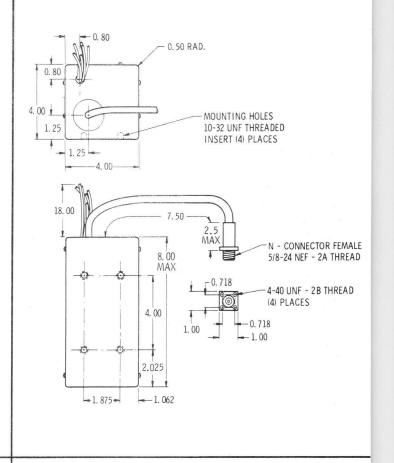
Magnetically Shielded Separation from Passive Magnetic Materials, None Required No Forced Air Cooling Required Below +60°C Ambient RFI Shielded and Filtered

SCHEMATIC DIAGRAM

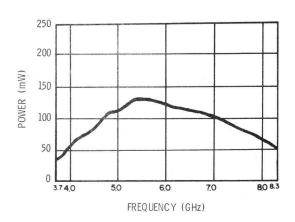


Notes:

- (1) For safety, housing should be grounded through mounting screws.
- 2 45–150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.
- (3) Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.

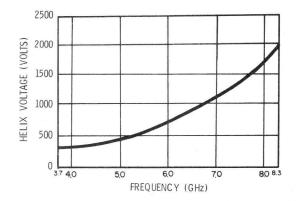


OUTLINE DRAWING



TUNING VOLTAGE

POWER OUTPUT



WJ-2020

BACKWARD-WAVE OSCILLATOR

July 1966

The type WJ-2020 is a magnetically shielded and RFI shielded voltage tunable oscillator utilizing a bifilar helix. Unsaturated magnetic shielding reduces the magnetic field strength to less than 5 gauss ½-inch away from any point of the capsule. RFI shielding and filtering enables this tube to meet MIL-I-6181D. Its immunity to external ac or dc magnetic fields, together with minimal stray magnetic field and low RF radiation, makes the WJ-2020 ideal for signal generating and sweeping equipment, for use in radar receivers (as local oscillator), in frequency diversity transmitters (as master oscillator), and in ECM equipment, Fine

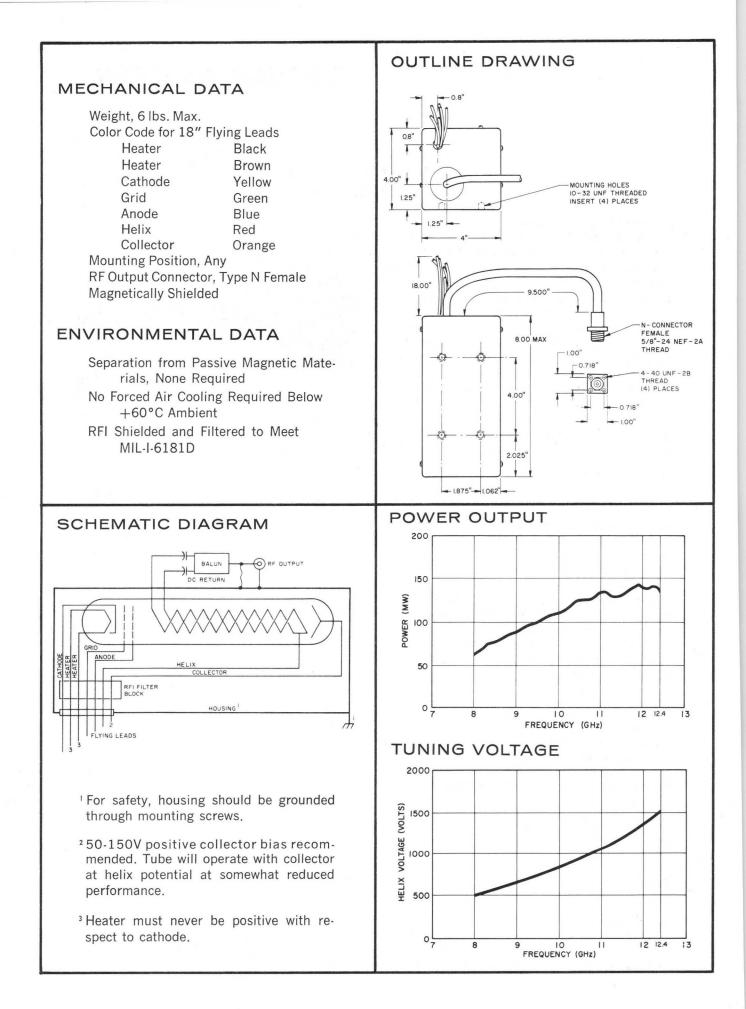


grain variation of frequency versus voltage is extremely low. Power output and tuning curves are uniform and highly reproducible. Power can be modulated and leveled with either grid or anode circuits. All voltages are isolated from housing and RF output connector for maximum flexibility in circuit applications.

ELECTRICAL CHARACTERISTICS, CW

				UNITS	TYPICAL VALUES	ABSOLUTE RATINGS
Nominal Frequency Band				GHz	8.0-12.4	
Power Output into Load with VSWR = 1.25:1				mW	60-175	50 Min.
Power Output Variation				dB		6 Max.
Fine Grain Variation				dB/250 MHz		3 Max.
Tube VSWR						2.5:1 Max.
Frequency Pulling Into 2:1 Load (Any Phase)				MHz	1.5	3 Max.
Ratio of Signal to Noise Power 30 MHz Away	λ.			dB/MHz B.W.	95	85 Min.
Ratio of Signal to 2nd Harmonic Output .				dB	30	20 Min.
Long-term Sensitivity to Heater Voltage .				MHz/V	3	10 Max.
Sensitivity to Anode Voltage				MHz/V	0.6	1 Max.
Sensitivity to Grid Voltage				MHz/V	3	5 Max.
Tuning Curve Slope						
Low End (8.0 GHz)					7.2	
Mid-Frequency (10.2 GHz)	•		•	MHz/V	4.6 2.7	
High End (12.4 GHz) . . . Grid r.f. Cutoff Voltage 					-7	—20 Max.
Capacitance; Grid to all other Electrodes,	•	•	•	V	/	-20 Max.
incl. Heater and Housing			101	pf	45	55 Max.
Capacitance; Gride to all other Electrodes,				þi	40	00 max.
incl. Housing				pf	45	55 Max.
Capacitance; Helix and Collector to all other				L.		
Electrodes and Housing				pf	230	250 Max.
Heater Voltage				Vdc	6.3	$6.3 \pm 5\%$
Heater Current					0.75	0.4 to 1.2 Min./Max.
Cathode Current				mA	8	12 Max.
Helix Voltage Range	·		•	V	450-1495	425-1600 Min./Max.
Anode Voltage*				V	150	215 Max.
Anode Current				mA	0.5	2 Max.

*Set anode voltage to Final Test Data value furnished with tube.



The WJ-2020-50 is a magnetically shielded and RFI shielded voltage tunable oscillator utilizing a bifilar (dual helix) and a permanent-magnet focusing system. Unsaturated magnetic shielding reduces the magnetic field strength along the outside of the housing. RFI shielding and filtering enables this tube to meet MIL-I-6181D.

An immunity to external ac or dc magnetic fields, together with a minimal stray magnetic field and low RF radiation, makes the WJ-2020-50 ideal for signal generating and sweeping equipment, for use in radar receivers (as local oscillator), in frequency diversity transmitters (as master oscillator), and in ECM equipment. Fine grain variation of frequency versus voltage is extremely low. Power output and tuning curves are uniform and highly reproducible.

The WJ-2020-50 delivers smooth power output over the band with low operating cathode current. Power can be modulated and leveled with either grid or anode circuits. All voltages are isolated from housing and RF output connector for maximum flexibility in circuit applications.

JANUARY 1971

BACKWARD-WAVE OSCILLATOR WJ-2020-50



SPECIFICATIONS

	UNITS	TYPICAL VALUES	ABSOLUTE RATINGS
Nominal Frequency Band Power Output into Load with VSWR = 1.25:1 Power Output Variation Fine Grain Variation Tube VSWR	mW dB dB/250 MHz		50 Min. 6 Max. 3 Max. 2.5:1 Max.
Frequency Pulling Into 2:1 Load (Any Phase) Spurious Oscillation Ratio of Signal to Noise Power 30 MHz Away Ratio of Signal to 2nd Harmonic Output Long-term Sensitivity to Heater Voltage Sensitivity to Anode Voltage Sensitivity to Grid Voltage	. dB / MHz B. W . dB	95	85 Min.
Tuning Curve Slope Low End (7.0 GHz) Mid-Frequency (9.7 GHz) High End (12.4 GHz) Grid RF Cutoff Voltage	MHz/V MHz/V MHz/V	· · 7.2 · · 4.6 · · 2.7	. —20 Max.
Capacitance; Cathode to all other Electrodes, including Heater and Housing Capacitance; Grid to all other Electrodes,			
including Housing Capacitance; Helix and Collector to all other Electrodes including Housing Heater Voltage Heater Current	рF	230	250 Max. 6.3 ± 5% 0.4 to 1.2
Cathode Current*	.mA	8	Min./Max. 12 Max. . 425–1600 Min./Max
Helix Current Anode Voltage Anode Current	.V		215 Max.

* Set cathode current to Final Test Data value furnished with tube.

WJ-2020-50

MECHANICAL CHARACTERISTICS

Height, 4 inches (102 mm) Width, 4 inches (102 mm) Length, 8 inches (204 mm) max. Weight, 9.5 lbs. (4.31 Kg) max.

Color Code for 18" Flying Leads

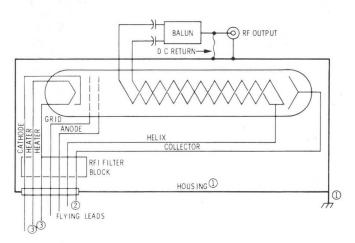
HeaterBlackHeaterBrownCathodeYellowGridGreenAnodeBlueHelixRedCollectorOrange

Mounting Position, Any RF Output Connector, Type N Female on Balun

ENVIRONMENTAL CHARACTERISTICS

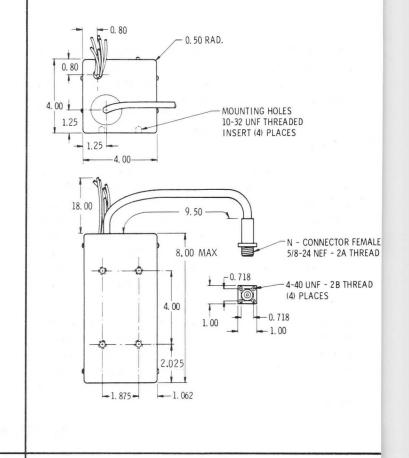
Magnetically Shielded Separation from Passive Magnetic Materials, None Required No Forced Air Cooling Required Below +60°C Ambient RFI Shielded and Filtered

SCHEMATIC DIAGRAM

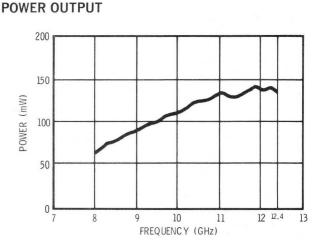


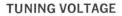
Notes:

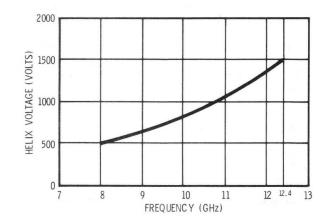
- 1. For safety, housing should be grounded through mounting screws.
- 45–150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.
- Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.



OUTLINE DRAWING







DECEMBER 1970

BACKWARD-WAVE OSCILLATOR WJ-2020-51



SPECIFICATIONS

	UNITS	TYPICAL VALUES	ABSOLUTE RATINGS
Nominal Frequency Band Power Output into Load with VSWR = 1.25:1 Power Output Variation Fine Grain Variation Tube VSWR Frequency Pulling Into 2:1 Load (Any Phase)	. mW .dB .dB/250 MHz	.30–175	25 Min. 8 Max. 3 Max.
Spurious Oscillation Ratio of Signal to Noise Power 30 MHz Away Ratio of Signal to 2nd Harmonic Output Long-term Sensitivity to Heater Voltage Sensitivity to Anode Voltage Sensitivity to Grid Voltage Tuning Curve Slope	.dB/MHz B.W .dB .MHz/V	.95 .30	85 Min.
Low End (7.0 GHz) Mid-Frequency (9.7 GHz) High End (12.4 GHz) Grid RF Cutoff Voltage	. MHz/V	.4.2	—25 Max
Capacitance; Cathode to all other Electrodes, including Heater and Housing Capacitance: Grid to all other Electrodes.	.pF	.45	55 Max.
including Housing Capacitance; Helix and Collector to all other Electrodes including Housing Heater Voltage Heater Current	.pF	.230	. 250 Max. . 6.3 ± 5% 0.4−1.2
Cathode Current*			
Helix Current	.v		. 215 Max.

* Set cathode current to Final Test Data value furnished with tube.

The WJ-2020-51 is a magnetically shielded and RFI

shielded voltage tunable oscillator utilizing a bifilar (dual helix) and a permanent-magnet focusing system.

Unsaturated magnetic shielding reduces the magnetic field strength along the outside of the housing. RFI shielding and filtering enables this tube to meet

An immunity to external ac or dc magnetic fields, to-

gether with a minimal stray magnetic field and low RF radiation, makes the WJ-2020-51 ideal for signal generating and sweeping equipment, for use in radar receivers (as local oscillator), in frequency diversity transmitters (as master oscillator), and in ECM equipment. Fine grain variation of frequency versus voltage is extremely low. Power output and tuning curves are

The WJ-2020-51 delivers smooth power output over the band with low operating cathode current. Power can be modulated and leveled with either grid or anode circuits. All voltages are isolated from housing and RF output connector for maximum flexibility in circuit

uniform and highly reproducible.

MIL-I-6181D.

applications.

WJ-2020-51

MECHANICAL CHARACTERISTICS

Height, 4 inches (102 mm) Width, 4 inches (102 mm) Length, 8 inches (204 mm) max. Weight, 9.5 lbs. (4.31 Kg) max.

Color Code for 18" Flying Leads

HeaterBlackHeaterBrownCathodeYellowGridGreenAnodeBlueHelixRedCollectorOrange

Mounting Position, Any RF Output Connector, Type N Female on Balun Magnetically Shielded

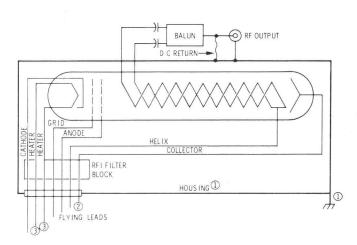
ENVIRONMENTAL CHARACTERISTICS

1

Separation from Passive Magnetic Materials, None Required

No Forced Air Cooling Required Below +60°C Ambient RFI Shielded and Filtered to Meet MIL-I-6181D

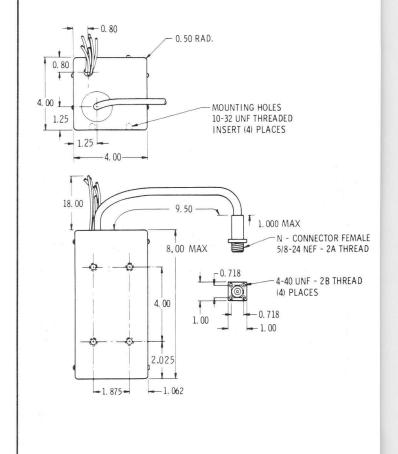
SCHEMATIC DIAGRAM

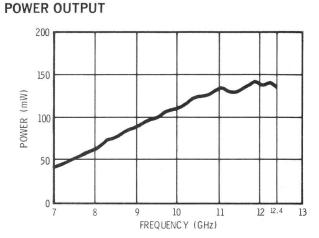


Notes:

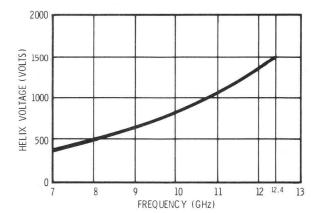
- 1. For safety, housing should be grounded through mounting screws.
- 45–150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.
- Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.











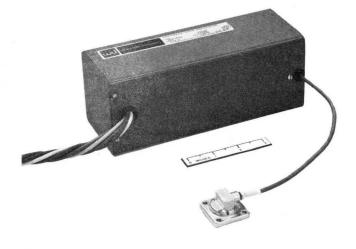
AUGUST 1969

The WJ-2021 is a miniature magnetically and RFI shielded, voltage tunable oscillator, utilizing a single helix and permanent magnet focusing system to cover the frequency range from 12.4 to 18.0 GHz. Interference requirements of MIL-STD-461 are met or exceeded by the integral RFI shielding and filtering.

The combination of immunity to external ac or dc magnetic fields, minimal stray generated magnetic fields and very low RF radiation make the WJ-2021 ideal for a number of applications, including the following: signal generating and sweeping equipment, radar receivers (as local oscillator), frequency diversity transmitters and ECM equipment (as master oscillator.).

The fine grain variation of frequency versus voltage is extemely low. The WJ-2021 delivers smooth power output over the band with low operating cathode current. Power can be modulated and leveled with either grid or anode circuits. All voltages are isolated from the housing for maximum flexibility in circuit applications.

BACKWARD-WAVE OSCILLATOR WJ-2021



	SPECIFICATIONS UNITS	TYPICAL VALUES	ABSOLUTE RATINGS
Frequency Band Power Output into Load with VSWR = 1.25:1 Power Output Variation Fine Grain Variation		50 - 100	40 Min. 6 Max.
Tube VSWR Frequency Pulling into 2:1 Load (Any Phase) Ratio of Signal to Noise Power 30 MHz Away Long-term Sensitivity to Heater Voltage		1	2.5:1 Max.
Sensitivity to Anode Voltage Sensitivity to Grid Voltage Tuning Curve Slope Low End (12.4 GHz)	MHz/V	8	
Mid-Frequency (15.2 GHz) High End (18.0 GHz) Grid RF Cutoff Voltage		4.4	—20 Max.
Capacitance; Cathode to all other Electrodes including Heater and Housing Capacitance; Grid to all other Electrodes including Housing			
Capitance; Helix and Collector to all other Electrodes and Housing Heater Voltage Heater Current	V dc	6.3	6.3 ±5%
Cathode Current ¹	V		500 - 2100 Min./Max.
Helix Current	V	130	3 Max. 215 Max.

¹Set cathode current to Final Test Data value furnished with tube.

*Supersedes WJ-2021 Technical Data Sheet dated April 1969.

WJ-2021

MECHANICAL CHARACTERISTICS

Height	•							•			 . 3 inches (76 mm) max	5
Width .					,					•	3 inches (76 mm) max	
Length										1	8 inches (203 mm) max	
Weight	÷		•	•	•	÷	÷		×		6 pounds (2.72 Kg) max	

Color Code for 18" Flying Leads

Heater	Black
Heater	Brown
Cathode	Yellow
Grid	Green
Anode	Blue
Helix	Red
Collector	Orange

Mounting Position, Any

RF Output Connector, Mate with UG 419/U

Separation from Passive Magnetic Materials, None Required

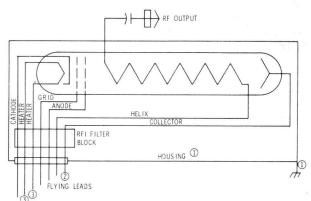
ENVIRONMENTAL CHARACTERISTICS

Magnetically Shielded

No Forced Air Cooling Required Below +60°C Ambient

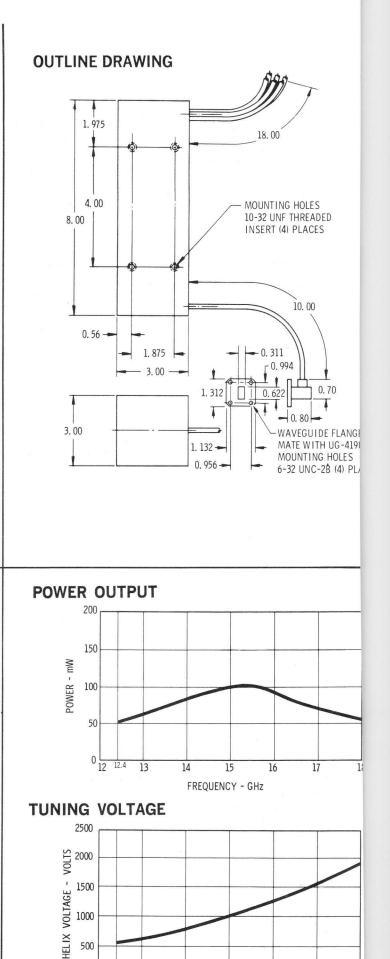
RFI Shielded and Filtered to Meet or Exceed MIL-STD-461

SCHEMATIC DIAGRAM



Notes:

- (1.) For safety, housing should be grounded through mounting screws.
- (2) 50-150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.
- (3.) Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc supply, connect cathode to positive (+) side of heater supply.



500

0∟ 12 12.4 13

14

15

FREQUENCY - GHz

16

18

17

APRIL 1969 *

The WJ-2022 is a magnetically shielded and RFI shielded, voltage tunable oscillator, utilizing a single helix and a permanent-magnet focusing system. Unsaturated magnetic shielding reduces the magnetic field strength to less than 10 gauss, 1/2 inch from any point of the housing. RFI shielding and filtering allow the WJ-2022 to meet levels of MIL-I-6181D. An immunity to external ac or dc magnetic fields, together with minimal stray magnetic fields and low RF radiation, makes the WJ-2022 ideal for signal generating and sweeping equipment, for use in radar receivers (as local oscillator), in frequency diversity transmitters (as master oscillator), and in ECM equipment. Fine grain variation of frequency versus voltage is extremely low. The WJ-2022 delivers smooth power output over the band with low operating cathode current. Power can be modulated and leveled with either grid or anode circuits. All

BACKWARD-WAVE OSCILLATOR WJ-2022



voltages are isolated from the housing for maximum flexibility in circuit applications.

SPECIFICATIONS	TIDICAL	ADGOLUTE
		ABSOLUTE
UNITS	VALUES	RATINGS
GHz		18.0 - 26.5
mW	22 - 70	20 Min.
dB		6 Max.
dB/250 MHz		3 Max.
		2.5:1 Max.
MHz	2	6 Max.
dB	50	40 Min.
dB/MHz	90	80 Min.
MHz/V	35	
MHz/V	1	
MHz/V	10	
MHz/V	12	
MHz/V	6.5	
MHz/V	4	
V	-10	-20 Max.
pf	35	50 Max.
pf	35	50 Max.
pf	90	130 Max.
V		$6.3\pm5\%$
A	0.67	0.4-1.2
mA	6	10 Max.
• 05		450-2000
		3 Max.
		250 Max.
mA	0.2	1 Max.
	UNITS GHz mW dB dB/250 MHz MHz MHz MHz/V MHz/V MHz/V MHz/V MHz/V V pf pf pf V A	UNITS VALUES GHz mW 22 - 70 dB 22 - 70 dB dB dB/250 MHz MHz MHz 2 dB 50 dB/MHz 90 MHz/V 35 MHz/V 1 MHz/V 10 MHz/V 12 MHz/V 6.5 MHz/V 4 V -10 pf 35 pf 35 pf 90 V A 0.67 6 WA 0.67 mA 6 V 530-1820 mA 1.5 V 115

1. Set Cathode Current to Final Test Data furnished with tube.

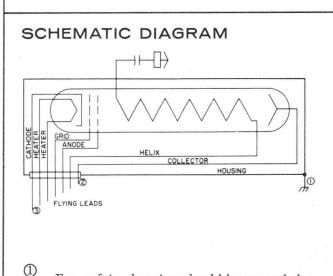
* Supersedes WJ-2022 Technical Data Sheet dated February 1968.

MECHANICAL DATA

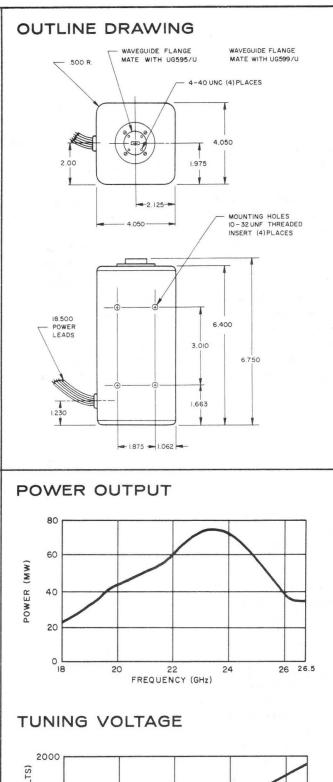
Weight, 6.5 lbs. Max. Color Code for 18" Flying Leads Heater Black (neg) Heater Brown Cathode Yellow Grid Green Blue Anode Helix Red Collector Orange Mounting Position, Any RF Output Connector, UG-595/U Flange Magnetically Shielded

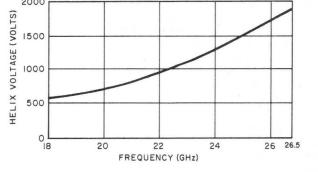
ENVIRONMENTAL DATA

- Separation from Passive Magnetic Materials, None Required No Forced Air Cooling Required, Below
- No Forced Air Cooling Required, Below $+ 60^{\circ}$ C Ambient
- RFI Shielded and Filtered to Meet Levels of MIL-I-6181D



- For safety, housing should be grounded through mounting screws.
- 50-150 V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.
- Heater must always be negative with respect to cathode. One heater lead may be tied to cathode.





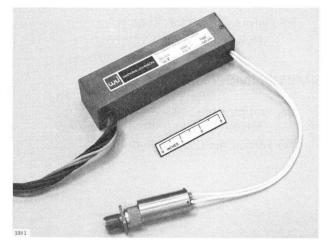
2

(3)

BACKWARD-WAVE OSCILLATOR WJ-2024

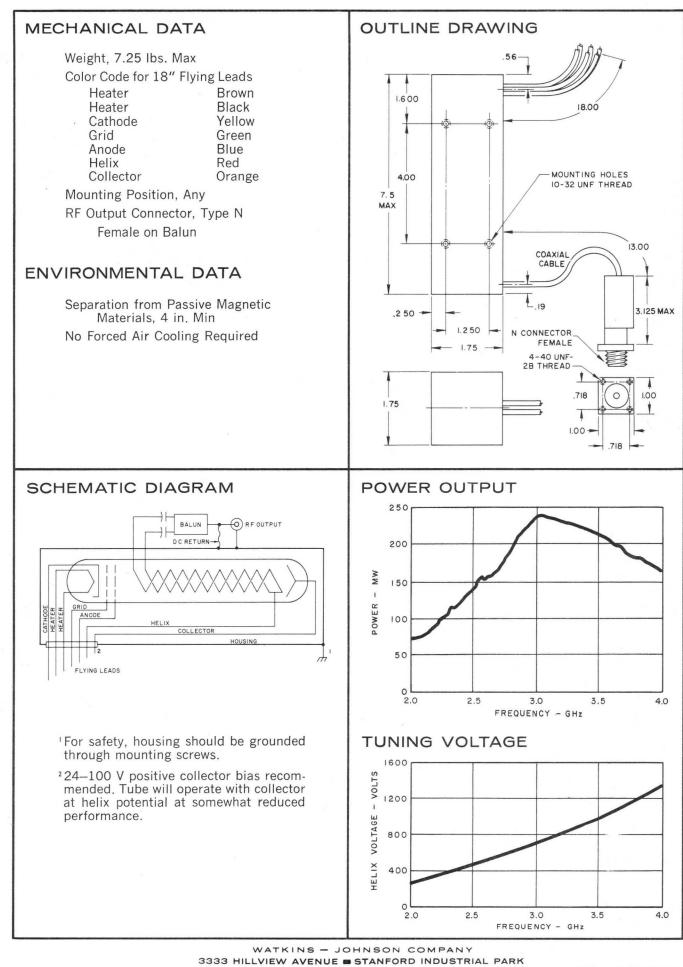
TECHNICAL DATA • January 1967

The WJ-2024 is a miniature square packaged voltage-tunable oscillator utilizing a bifilar (dual-helix) slow-wave structure and a permanent magnet focusing system. The size and weight of this package make it suitable for high density packaging in airborne, shipboard and plug-in sweeper applications. It is used as a local oscillator in swept or FM receivers, master oscillator in transmitters and ECM jammers, signal source in generators and spectrum analyzers. Frequency versus voltage curves are monotonic, making the tubes ideal for linearizing. Power output can be modulated with either grid or anode circuits. All voltages are isolated from the housing for easier packaging.



SPECIFICATIONS

	Units	Typical Values	Absolute Ratings
Nominal Frequency Band	GHz	2-4	
Power Output into Load with VSWR = 1.25	mW	60-250	50 Min
Power Output Variation	dB		8 Max
Fine Grain Variation	dB/250 MHz		3 Max
	ab/ 100 mm		2.5:1 Max
Frequency Pulling into 2:1 Load (Any Phase)	MHz	2	5 Max
Spurious Oscillation	IVIT IZ		JIMAX
Ratio of Signal to 2nd Harmonic Output	dB	25	20 Min
Ratio of Signal to Noise Power 30 MHz Away .	dB/MHz	95	85 Min
Long-term Sensitivity to Heater Voltage	MHz/V	2	8 Max
Sensitivity to Anode Voltage	MHz/V	0.25	1 Max
Sensitivity to Grid Voltage	MHz/V	3	6 Max
Tuning Curve Slope		5	0 Max
Low End (2.0 GHz)	MHz/V	3.2	
Mid-Frequency (3.0 GHz)	MHz/V	2.3	
High End (4.0 GHz)	MHz/V	1.2	
Grid R. F. Cutoff Voltage	V	-8	-20 Max
Capacitance; Cathode to all other Electrodes,			
including Heater and Housing	pF	18	25 Max
Capacitance; Grid to all other Electrodes			
including Housing	pF	18	25 Max
Capacitance; Helix and Collector to all other			
Electrodes and Housing	pF	150	200 Max
Heater Voltage	V		$6.3 \pm 5\%$
Heater Current	A	0.8	0.4-1.2
			Min/Max
Cathode Current	mA	8	15 Max
Helix Voltage Range	V	290-1290	270-1350
			Min/Max
Helix Current	mA	2	3 Max
Anode Voltage	V	130	215 Max
Anode Current	mA	0.6	1.5 Max



333 HILLVIEW AVENUE ■ STANFORD INDUSTRIAL PA PALO ALTO, CALIFORNIA 94304 TWX 910-373-1253 PHONE (415) 326-8830 Telex: 348-415

Printed in U.S.A.

TECHNICAL DATA BACKWARD-WAVE

WJ-2025

TECHNICAL DATA . January 1967

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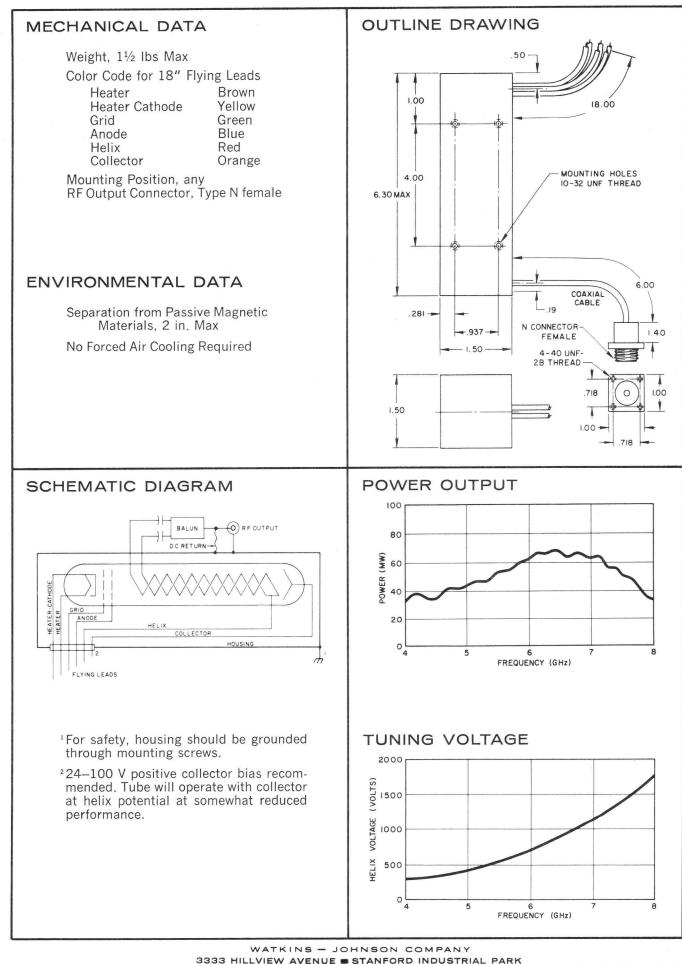
SPECIFICATIONS

3369

The WJ-2025 is a miniature square packaged voltage-tunable oscillator utilizing a bifilar (dual-helix) slow-wave structure and a permanent magnet focusing system. The size and weight of this package make it suitable for high density packaging in airborne, shipboard and plug-in sweeper applications. It is used as a local oscillator in swept or FM receivers, master oscillator in transmitters and ECM jammers, signal source in generators and spectrum analyzers. Frequency versus voltage curves are monotonic, making the tubes ideal for linearizing. Power output can be modulated with either grid or anode circuits. All voltages are isolated from the housing for easier

packaging.

	Units	Typical Values	Absolute Ratings
Nominal Frequency Band	GHz	4.0-8.0	
Power Output into Load with VSWR = $1.25:1$	mW	30-70	20 Min
Power Output Variation			6 Max
Fine Grain Variation	dB/250 MHz		3 Max
Tube VSWR			2.5:1 Max
Frequency Pulling into 2:1 Load (Any Phase)	MHz	0.6	1.0
Ratio of Signal to Noise Power 30 MHz Away	dB/MHz	95	85 Min
Ratio of Signal to 2nd Harmonic Output	dB	30	20 Min
Long-term Sensitivity to Heater Voltage at 6 GHz		3.5	6 Max
Sensitivity to Anode Voltage		0.5	1.0 Max
Sensitivity to Grid Voltage	MHz/V	3	5 Max
Tuning Curve Slope		K 5	
Low End (4.0 GHz)	MHz/V	6.0	
Mid-Frequency (6.0 GHz)		2.5 1.7	
Grid R. F. Cutoff Voltage		-7	—20 Max
Capacitance; Cathode to all other Electrodes.	v		20 1110
including Heater and Housing	P	18	25 Max
Capacitance; Grid to all other Electrodes	1		
including Housing	pF	18	25 Max
Capacitance; Helix and Collector to all other	_		105 14
Electrodes and Housing	pF	90	125 Max
Heater Voltage		0.75	$6.3 \pm 5\%$
Heater Current	A	0.75	0.4–1.2 Min/Max
Cathode Current	mA	8.5	15 Max
	V	280-1710	250-1800
Helix Voltage Range	V	200-1/10	Min Max
Helix Current	mA	2	3 Max
Anode Voltage	V	100	200 Max
Anode Current	mA	0.3	2 Max



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Printed in U.S.A.

BACKWARD-WAVE OSCILLATOR

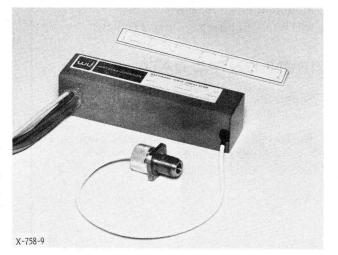


WJ-2026

September 1968 *

Absolute

The WJ-2026 is a miniature square packaged voltage-tunable oscillator utilizing a monofilar (singlehelix) slow-wave structure and a permanent magnet focusing system. The size and weight of this package make it suitable for high density packaging in airborne, shipboard and plug-in sweeper applications. It is used as a local oscillator in swept or FM receivers, master oscillator in transmitters and ECM jammers, signal source in generators and spectrum analyzers. Frequency versus voltage curves are monotonic, making the tubes ideal for linearizing. Power output can be modulated with either grid or anode circuits. All voltages are isolated from the housing for easier packaging.

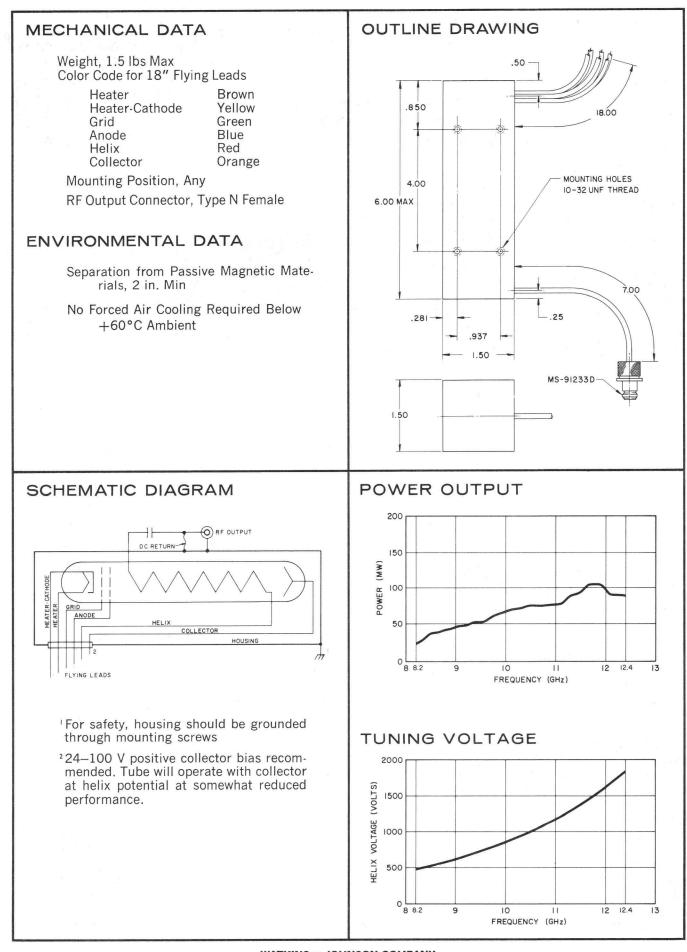


Typical

SPECIFICATIONS

	Units	l ypical Values	Ratings
Nominal Frequency Band	GHz	8.2-12.4	
Power Output into Load with VSWR = 1.25:1 .	mW	25-100	20 Min
Power Output Variation	dB		8 Max
Fine Grain Variation	dB/250 MHz		3 Max
Tube VSWR	,		2.5:1 Max
Frequency Pulling into 2:1 Load (Any Phase)	MHz	0.8	1.5 Max
Ratio of Signal to Noise Power 30 MHz Away	dB/MHz	95	85 Min
Long-term Sensitivity to Heater Voltage	MHz/V	5.5	05 14111
Sensitivity to Anode Voltage	MHz/V	0.3	
Sensitivity to Grid Voltage	MHz/V	2	
Tuning Curve Slope		-	
Low End (8.2 GHz)	MHz/V	6.5	
Mid-Frequency (10.3 GHz)	MHz/V	3.3	
High End (12.4 GHz)	MHz/V	1.7	
Grid R. F. Cutoff Voltage	V	-10	—20 Max
Capacitance; Cathode to all other Electrodes			
Including Heater and Housing	pF	18	25 Max
Capacitance; Grid to all other Electrodes	F	10	
Including Housing	рF	18	25 Max
Capacitance; Helix and Collector to all other Electrodes and Housing	pF	70	100 Max
-		70	
Heater Voltage	A	0.75	6.3±5% 0.4–1.2
Heater Current	A	0.75	Min/Max
Cathode Current	mA	8	12 Max
Helix Voltage Range	V	485-1850	450-2000
Helix Current	mA	2	430–2000 3 Max
Anode Voltage	V	125	200 Max
Anode Current	mA	0.3	2 Max

* Supersedes WJ-2026 Technical Data Sheet Dated January 1967



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BACKWARD-WAVE OSCILLATOR



WJ-2027

September 1968 *

The WJ-2027 is a miniature square packaged voltage-tunable oscillator utilizing a bifilar (dual-helix) slow-wave structure and a permanent magnet focusing system. The size and weight of this package make it suitable for high density packaging in airborne, shipboard and plug-in sweeper applications. It is used as a local oscillator in swept or FM receivers, master oscillator in transmitters and ECM jammers, signal source in generators and spectrum analyzers. Frequency versus voltage curves are monotonic, making the tubes ideal for linearizing. Power output can be modulated with either grid or anode circuits. All voltages are isolated from the housing for easier packaging.

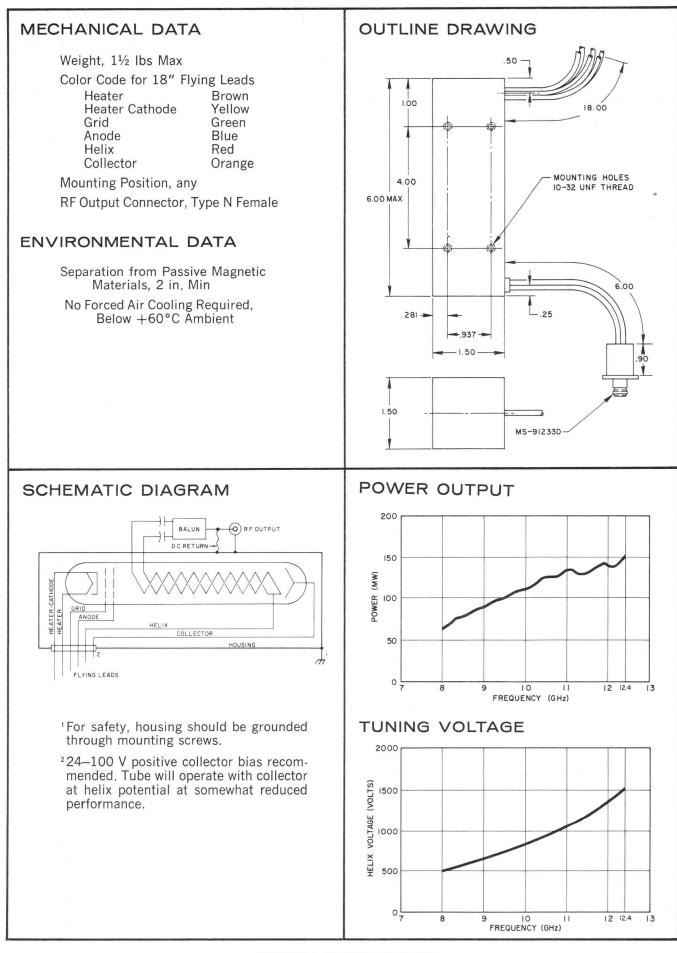


3381-1

SPEC	;IFIC/	ATIO	NS

511	LOII	10/			
			Units	Typical Values	Absolute Ratings
Nominal Frequency Band			GHz	8.0-12.4	
Power Output into Load with VSWR = $1.25:1$.			mW	60-175	50 Min
Power Output Variation			dB		6 Max
Fine Grain Variation			dB/250 MHz		3 Max
			UD/200 MI12		2.5:1 Max
			NALL-	0.6	1.5 Max
Frequency Pulling into 2:1 Load (Any Phase) .			MHz		
Ratio of Signal to 2nd Harmonic Output			dB	30	20 Min
Ratio of Signal to Noise Power 30 MHz Away .			dB/MHz	95	85 Min
Long-term Sensitivity to Heater Voltage			MHz/V	5	
Sensitivity to Anode Voltage			MHz/V	0.6	
Sensitivity to Grid Voltage			MHz/V	3	
Tuning Curve Slope					
Low End (8.0 GHz)			MHz/V	7.2	
Mid-Frequency (10.0 GHz)			MHz/V	4.6	
High End (12.4 GHz)			MHz/V	2.7	00.14
Grid R. F. Cutoff Voltage			V	—7	—20 Max
Capacitance; Cathode to all other Electrodes,			-	20	45 Max
and Housing	•	÷.,	pF	30	45 Wax
Capacitance; Cathode and Grid to all other			рF	40	50 Max
Electrodes and Housing		•	μr	40	50 Max
Capacitance; Helix to all other Electrodes and Housing			рF	150	175 Max
			Vdc	100	$6.3 \pm 5\%$
Heater Voltage				0.75	0.4-1.2
Heater Current			A	0.75	Min/Max
				0	
Cathode Current			mA	8	12 Max
Helix Voltage Range			V	450-1495	425–1600 Min Max
				2	3 Max
Helix Current			mA		
Anode Voltage			V	150	200 Max
Anode Current			mA	0.5	2 Max

* Supersedes WJ-2027 Technical Data Sheet Dated January 1967



WATKINS = JOHNSON COMPANY 3333 HILLVIEW AVENUE = STANFORD INDUSTRIAL PARK PALO ALTO, CALIFORNIA 94304 TWX 910-373-1253 PHONE (415) 326-8830 Telex: 348-415

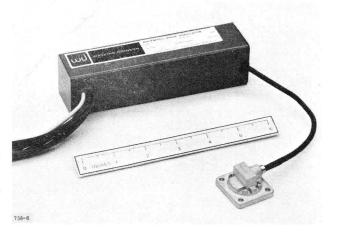
BACKWARD-WAVE O S C I L L A T O R



TECHNICAL DATA

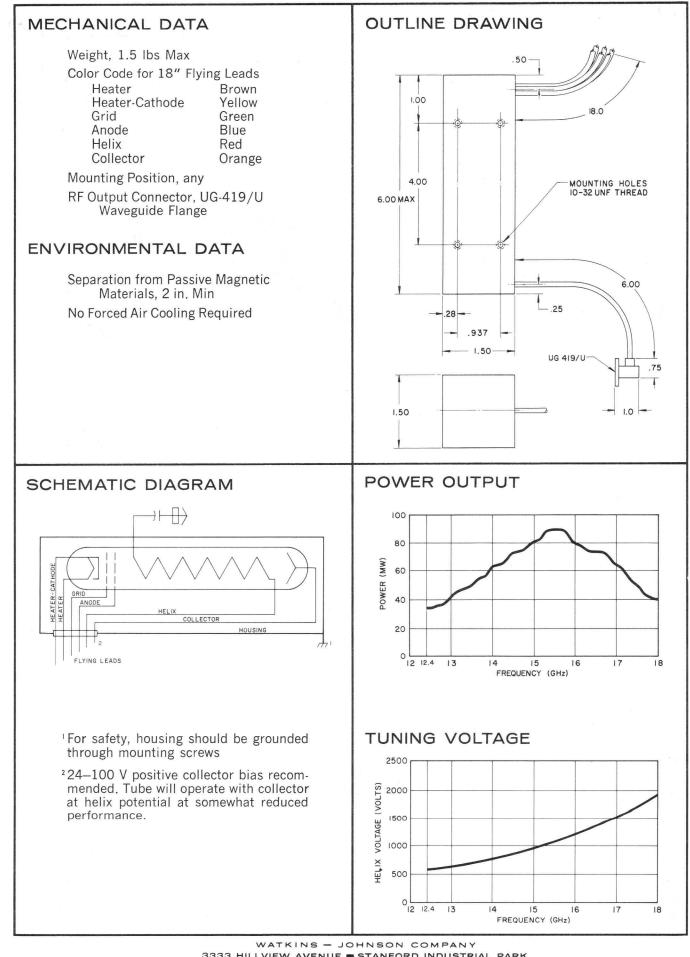
December 1967 *

The WJ-2028 is a miniature square packaged voltage-tunable oscillator utilizing a monofilar (singlehelix) slow-wave structure and a permanent magnet focusing system. The size and weight of this package make it suitable for high density packaging in airborne, shipboard and plug-in sweeper applications. It is used as a local oscillator in swept or FM receivers, master oscillator in transmitters and ECM jammers, signal source in generators and spectrum analyzers. Frequency versus voltage curves are monotonic, making the tubes ideal for linearizing. Power output can be modulated with either grid or anode circuits. All voltages are isolated from the housing for easier packaging.



SPECIFICATIONS

	Units	Typical Values	Absolute Ratings
Nominal Frequency Band	GHz	12.4-18.0	
Power Output into Load with VSWR = 1.25:1	mW	25-85	20 Min
Power Output Variation	dB		6 Max
Fine Grain Variation	dB/250 MHz		3 Max
Tube VSWR			2.5:1 Max
Frequency Pulling into 2:1 Load (Any Phase)	MHz	1.0	1.5 Max
Ratio of Signal to Noise Power 30 MHz Away	dB/MHz	95	85 Min
Long-term Sensitivity to Heater Voltage	MHz/V	5	10 Max
Sensitivity to Anode Voltage	MHz/V	0.5	1.0 Max
Sensitivity to Grid Voltage	MHz/V	3	6 Max
Tuning Curve Slope			
Low End (12.4 GHz)	MHz/V	8.7	
Mid-Frequency (15.2 GHz)	MHz/V	4.4 2.2	
High End (18.0 GHz)	MHz/V		20 May
Grid R. F. Cutoff Voltage	V	-10	—20 Max
Capacitance; Cathode to all other Electrodes, including Heater and Housing	pF	15	20 Max
Capacitance; Grid to all other Electrodes			
including Housing	pF	18	25 Max
Capacitance; Helix and Collector to all other		00	110 14
Electrodes and Case	pF	80	110 Max
Heater Voltage	Vdc		$6.3 \pm 5\%$
Heater Current	A	0.75	0.4–1.2 Min/Max
Cathode Current	mA	8	12 Max
Helix Voltage Range	V	570-1980	500-2100
	e		Min/Max
Helix Current	mA	2	3 Max
Anode Voltage	V	150	200 Max
Anode Current	mA	0.5	2 Max



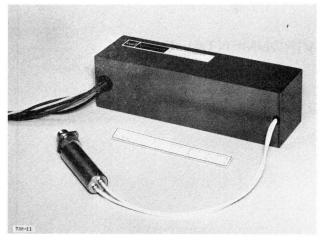
WATKINS – JOHNSON COMPANY 3333 HILLVIEW AVENUE STANFORD INDUSTRIAL PARK PALO ALTO, CALIFORNIA 94304 TWX 910-373-1253 PHONE (415) 326-8830 Telex: 348-415

BACKWARD-WAVE O S C I L L A T O R

WJ-2029

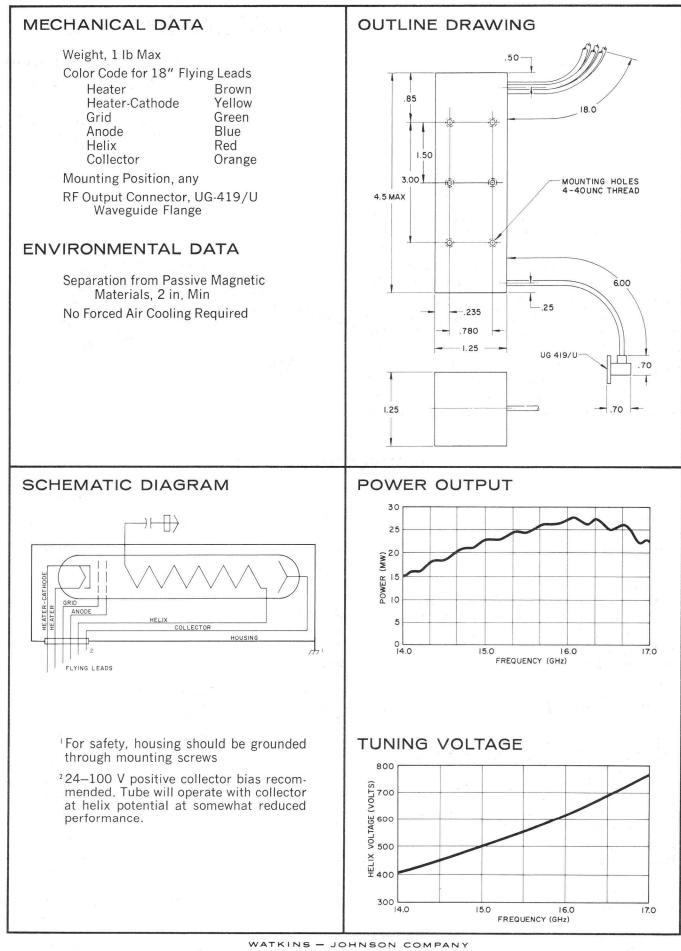
TECHNICAL DATA . January 1967

The WJ-2029 is a miniature square packaged voltage-tunable oscillator utilizing a monofilar (singlehelix) slow-wave structure and a permanent magnet focusing system. The size and weight of this package make it suitable for high density packaging in airborne, shipboard and plug-in sweeper applications. It is used as a local oscillator in swept or FM receivers, master oscillator in transmitters and ECM jammers, signal source in generators and spectrum analyzers. Frequency versus voltage curves are monotonic, making the tubes ideal for linearizing. Power output can be modulated with either grid or anode circuits. All voltages are isolated from the housing for easier packaging.



SPECIFICATIONS

				Units	Typical Values	Absolute Ratings
Nominal Frequency Band				GHz	14.0-17.0	
Power Output into Load with VSWR = 1.25:1				mW	15-30	10 Min
Power Output Variation				dB		6 Max
Fine Grain Variation				dB/250 MHz	15-30	3 Max
Tube VSWR						2.5:1 Max
Frequency Pulling into 2:1 Load (Any Phase)				MHz	0.9	1.5 Max
Ratio of Signal to Noise Power 30 MHz Away				dB/MHz	95	85 Min
Long-term Sensitivity to Heater Voltage				MHz/V	5	10 Max
Sensitivity to Anode Voltage				MHz/V	0.5	1.5 Max
Sensitivity to Grid Voltage				MHz/V	3	6 Max
Tuning Curve Slope						
Low End (14 GHz)				MHz/V	10.5	
Mid-Frequency (15.5 GHz) High End (17 GHz)	•	•		MHz/V MHz/V	8.0 6.0	
Grid R. F. Cutoff Voltage					-10	-20 Max
Capacitance; Cathode to all other Electrodes,		•	•	V	-10	-20 Max
including Heater and Housing				pF	15	20 Max
Capacitance; Grid to all other Electrodes	1	•	•	P1	10	20
including Housing				рF	18	25 Max
Capacitance; Helix and Collector to all other				F .		
Electrodes and Housing				pF	80	110 Max
Heater Voltage				Vdc		$6.3 \pm 5\%$
Heater Current				A	0.75	0.4-1.2
					_	Min/Max
Cathode Current					7	12 Max
Helix Voltage Range	·	•	•	V	405–760	375–800 Min/Max
Helix Current				mA	2	3 Max
Anode Voltage				V	150	200 Max
Anode Current				mA	0.5	2 Max



WATKINS - JOHNSON COMPANY 3333 HILLVIEW AVENUE STANFORD INDUSTRIAL PARK PALO ALTO, CALIFORNIA 94304 TWX 910-373-1253 PHONE (415) 326-8830 Telex: 348-415

TECHNICAL DATA BACKWARD-WAVE OSCILLATOR

WJ-2030

TECHNICAL DATA • January 1967

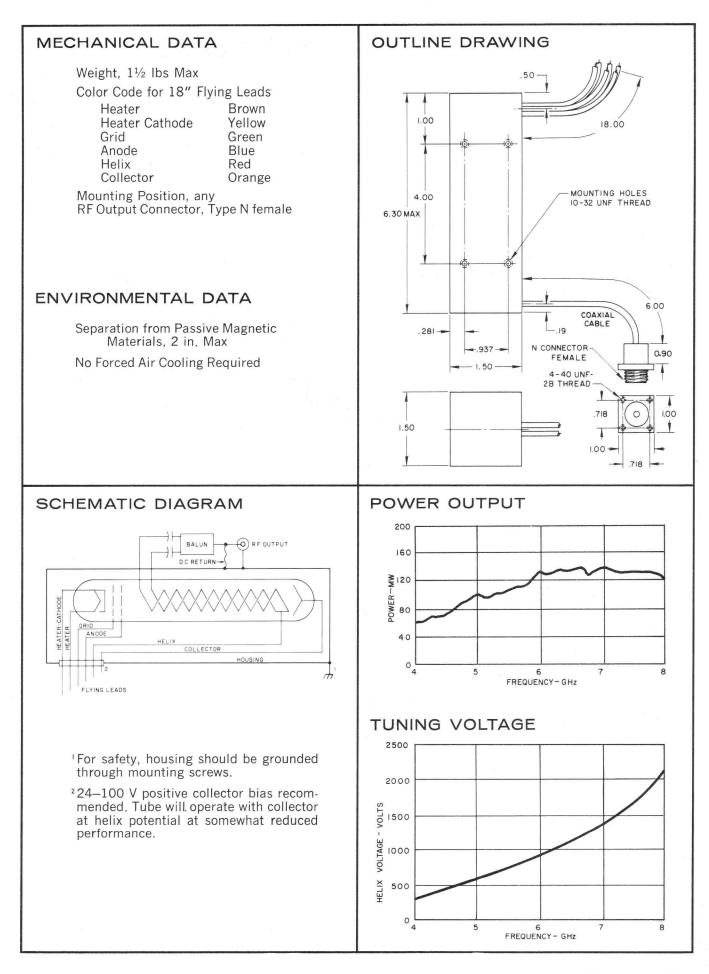
Abaaluta

The WJ-2030 is a miniature square packaged voltage-tunable oscillator utilizing a bifilar (dual-helix) slow-wave structure and a permanent magnet focusing system. The size and weight of this package make it suitable for high density packaging in airborne, shipboard and plug-in sweeper applications. It is used as a local oscillator in swept or FM receivers, master oscillator in transmitters and ECM jammers, signal source in generators and spectrum analyzers. Frequency versus voltage curves are monotonic, making the tubes ideal for linearizing. Power output can be modulated with either grid or anode circuits. All voltages are isolated from the housing for easier packaging.



SPECIFICATIONS

	Units	Typical Values	Absolute Ratings
Nominal Frequency Band	GHz	4.0-8.0	
Power Output into Load with VSWR = 1.25:1		60-150	50 Min
Power Output Variation	dB		6 Max
Fine Grain Variation			3 Max
Tube VSWR			2.5:1 Max
Frequency Pulling into 2:1 Load (Any Phase)	MHz	0.6	2.0
Ratio of Signal to Noise Power 30 MHz Away		95	85 Min
Ratio of Signal to 2nd Harmonic Output	dB	30	20 Min
Long-term Sensitivity to Heater Voltage at 6 GHz	MHz/V	3.5	6 Max
Sensitivity to Anode Voltage	MHz/V	0.5	1.0 Max
Sensitivity to Grid Voltage	MHz/V	3	5 Max
Tuning Curve Slope			
Low End (4.0 GHz)	MHz/V	5.4	
Mid-Frequency (6.0 GHz)		2.5	
High End (8.0 GHz)		1.9	—20 Max
Grid R. F. Cutoff Voltage	V	7	-20 Max
Capacitance; Cathode to all other Electrodes, including Heater and Housing	рĘ	18	25 Max
Capacitance; Grid to all other Electrodes	pF	10	20 1010
Including Housing	pF	18	25 Max
Capacitance; Helix and Collector to all other	þi	10	20
Electrodes and Housing	pF	90	125 Max
Heater Voltage			$6.3 \pm 5\%$
Heater Current		0.75	0.4-1.2
			Min/Max
Cathode Current	mA	8.5	15 Max
Helix Voltage Range	V	345-2085	330-2150
Helix Current	mA	2	3 Max
Anode Voltage	V	100	200 Max
Anode Current	mA	0.3	2 Max



Printed in U.S.A.

BACKWARD-WAVE OSCILLATOR

WJ-2033-1

July 1967

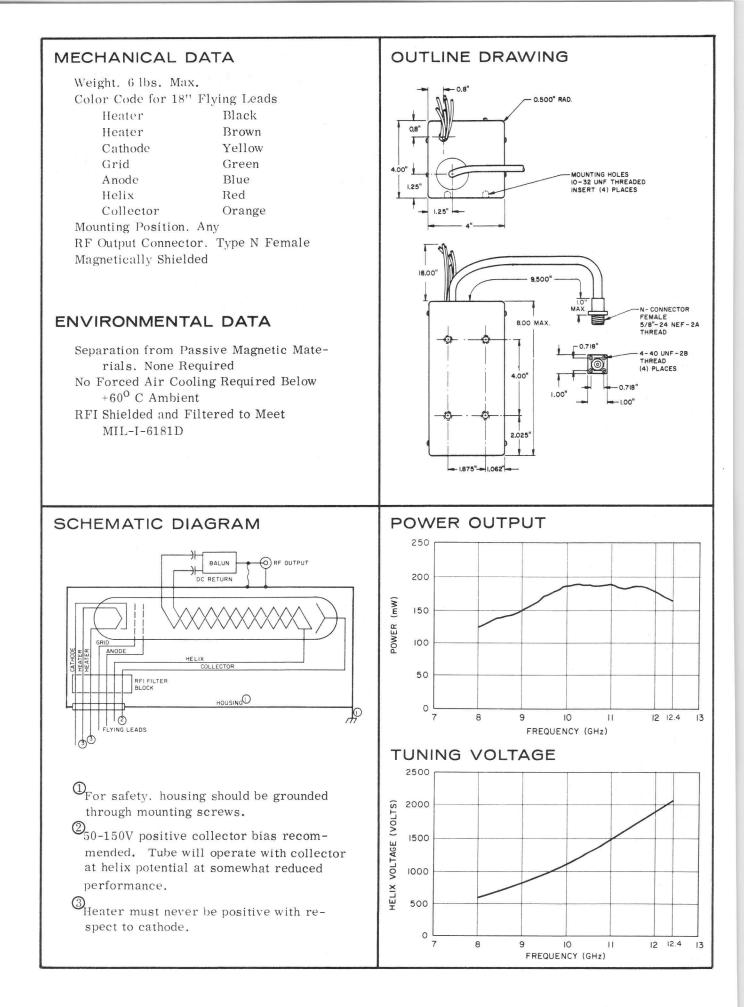
The WJ-2033-1 has a minimum power output of 100 milliwatts and is a shielded, voltage tunable oscillator utilizing a bifilar (dual) helix and a permanent-magnet focusing system. Unsaturated magnetic shielding reduces the magnetic field strength to less than 5 gauss 1/2-inch from any point of the housing. RFI shielding and filtering allow the WJ-2033-1 to meet MIL-I-6181D. An immunity to external ac or dc magnetic fields, together with minimal stray magnetic fields and low RF radiation, makes the WJ-2033-1 ideal for signal generating and sweeping equipment, for use in radar receivers (as local oscillator),



in frequency diversity transmitters (as master oscillator), and in ECM equipment. Fine grain variation of frequency versus voltage is extremely low. The WJ-2033-1 delivers smooth power output over the band with low operating cathode current. Power can be modulated and leveled with either grid or anode circuits. All voltages are isolated from housing and RF output connector for maximum

flexibility in circuit applications. SPECIFICATIONS				
		TYPICAL	ABSOLUTE	
	UNITS	VALUES	RATINGS	
Nominal Frequency Band	GHz	8.0-12.4		
Power Output into Load with $VSWR = 1.25:1$	mW	125-200	100 Min	
Power Output Variation	dB		6 Max	
Fine Grain Variation	dB/250 MHz		3 Max	
Tube VSWR			2.5:1 Max	
Frequency Pulling Into 2:1 Load (Any Phase)	MHz	1	3 Max	
Ratio of Signal to Noise Power 30 MHz Away	dB/MHz B.W.	95	85 Min	
Ratio of Signal to 2nd Harmonic Output	dB	30	20 Min	
Long-term Sensitivity to Heater Voltage	MHz/V	7		
Sensitivity to Anode Voltage	MHz/V	1.5		
Sensitivity to Grid Voltage	MHz/V	6		
Tuning Curve Slope				
Low End (8.0 GHz)	MHz/V	5		
Mid-Frequency (10.2 GHz)	MHz/V	3		
High End (12.4 GHz)	MHz/V	2		
Grid RF Cutoff Voltage	V	-15	-20 Max	
Capacitance; Cathode to all other Electrodes,				
including Heater and Housing	pF	55	75 Max	
Capacitance; Grid to all other Electrodes,				
including Housing	pF	55	75 Max	
Capacitance; Helix and Collector to all other				
Electrodes and Housing	pF	220	250 Max	
Heater Voltage	Vdc	6.3	$6.3 \pm 5 \%$	
Heater Current	А	0.7	0.4 to 1.2	
			Min/ Max	
Cathode Current	mA	8	12 Max	
Helix Voltage Range	V	630-2075	600-2150	
			Min/ Max	
Helix Current	mA	1.3	3 Max	
Anode Voltage*	V	130	215 Max	
Anode Current	mA	0.05	2 Max	

* Set anode voltage to Final Test Data value furnished with tube.

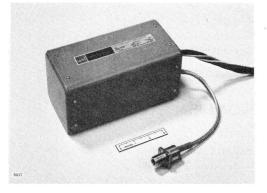


BACKWARD-WAVE O S C I L L A T O R



May 1967

The WJ-2034 is a voltage tunable oscillator utilizing a bifilar helix. Unsaturated magnetic shielding reduces the external magnetic fields strength to less than 5 gauss 1/2-inch from any point of the housing. RFI shielding and filtering allows the WJ-2034 to meet MIL-I-6181D. An immunity to external ac or dc magnetic fields, together with minimal stray magnetic fields and low RF radiation, makes the WJ-2034 ideal for signal generating and sweeping equipment, for use in radar receivers (as local oscillator), in frequency diversity transmitters (as master oscillator, and in ECM equipment. Fine grain



variation of frequency versus voltage is extremely low. Power output and tuning curves are uniform and highly reproducible. Power can be modulated and leveled with either grid or anode circuits. All voltages are isolated from housing and RF output connector for maximum flexibility in circuit applications. **SPECIFICATIONS**

	UNITS	TYPICAL VALUES	ABSOLUTE RATINGS		
Nominal Frequency Band	GHz	4.0-8.0			
Power Output into Load with VSWR = 1.25:1	mW	65-170	60 Min		
Power Output Variation	dB		7 Max		
Fine Grain Variation	dB/250 MHz		3 Max		
Tube VSWR			2.5:1 Max		
Frequency Pulling into 2:1 Load (Any Phase)	MHz	1.5	3 Max		
Ratio of Signal to Noise Power 30 MHz Away	dB/MHz B.W.	95	85 Min		
Ratio of Signal to 2nd Harmonic Output	dB	30	20 Min		
Long-term Sensitivity to Heater Voltage	MHz/V	5			
Sensitivity to Anode Voltage	MHz/V	5			
Sensitivity to Grid Voltage	MHz/V	3			
Tuning Curve Slope					
Low End (4.0 GHz)	MHz/V	6			
Mid-Frequency (6.0 GHz)	MHz/V	2.5			
High End (8.0 GHz)	MHz/V	1			
Grid r.f. Cutoff Voltage	V	-13	-20 Max		
Capacitance; Cathode to all other Electrodes,					
incl. Heater and Housing	pf	60	80 Max		
Capacitance; Grid to all other Electrodes,					
incl. Housing	pf	50	70 Max		
Capacitance; Helix and Collector to all other					
Electrodes and Housing	pf	230	260 Max		
Heater Voltage	Vdc	6.3	$6.3 \pm 5\%$		
Heater Current	А	0.72	0.4 to 1.2		
			Min / Max		
Cathode Current	mA	9.5	15 Max		
Helix Voltage Range	V	350-2100	325-2200		
			Min / Max		
Anode Voltage *	V	125	215 Max		
Anode Current	mA	0.05	2 Max		
Helix Current	mA	1.2	3 Max		
* Set anode voltage to Final Test Data value furnis	shed with tube.				

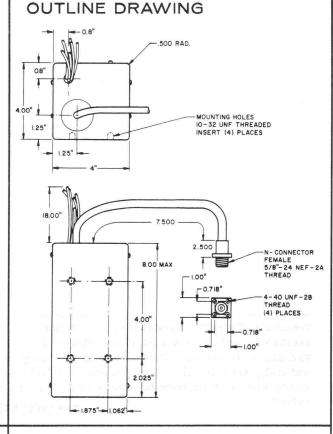
* Set anode voltage to Final Test Data value furnished with tube.

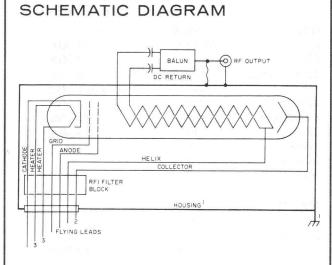


Weight, 6.5 lbs. Max. Color Code for 18" Flying Leads Heater Black Heater Brown Yellow Cathode Green Grid Blue Anode Red Helix Collector Orange Mounting Position, Any RF Output Connector, Type N Female Magnetically Shielded

ENVIRONMENTAL DATA

Separation from Passive Magnetic Materials, None Required No Forced Air Cooling Required Below +60[°] C Ambient RFI Shielded and Filtered to Meet MIL-I-6181D



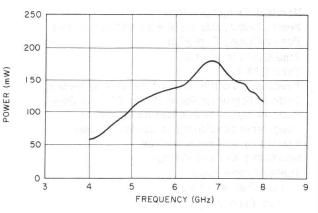


¹For safety, housing should be grounded through mounting screws.

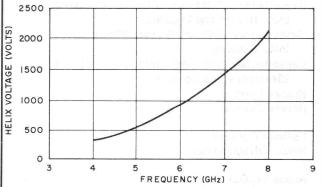
² 50 - 150 V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.

³Heater must never be positive with respect to cathode.

POWER OUTPUT



TUNING VOLTAGE





December 1967 *

BACKWARD-WAVE OSCILLATOR

The WJ-2038 is a magnetically shielded and RFI shielded voltage tunable oscillator utilizing a bifilar (dual) helix and a permanent magnet focusing system. Minimal stray magnetic field, low RF radiation, and an immunity to external ac or dc magnetic fields make the WJ-2038 ideal for use in signal generating and sweeping equipment. The WJ-2038 is also well suited for use in radar receivers (as local oscillator), in frequency diversity transmitters (as master oscillator), and in ECM equipment. Fine grain variation of frequency versus voltage is extremely low. The WJ-2038 delivers smooth power output over the band with



low operating cathode current. Power can be modulated and leveled with either grid or anode circuits. All voltages are isolated from housing and RF output connector for maximum flexibility incircuit applications. **SPECIFICATIONS**

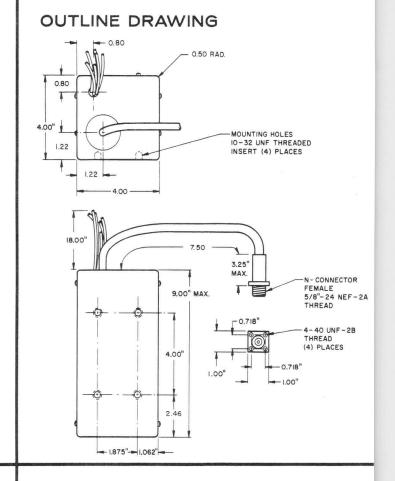
SFECIFICATIONS					
	Units	Typical Values	Absolute Ratings		
Nominal Frequency Band	GHz	2.6-5.2			
Power Output into Load with VSWR = 1.25:1	mW	65-230	50 Min		
Power Output Variation	dB		8 Max		
Fine Grain Variation	dB/250 MHz		3 Max		
Tube VSWR			2.5:1 Max		
Frequency Pulling Into 2:1 Load (Any Phase)	MHz	3	8 Max		
Ratio of Signal to Noise Power 30 MHz Away	dB/MHz B.W.	95	85 Min		
Ratio of Signal to 2nd Harmonic Output	dB	30	20 Min		
Long-Term Sensitivity to Heater Voltage @ 4 GHz	MHz/V	3			
Sensitivity to Anode Voltage @ 4 GHz	MHz/V	0.5			
Sensitivity to Grid Voltage @ 4 GHz	MHz/V	10			
Tuning Curve Slope					
Low End (2.6 GHz)	MHz/V	3.2			
Mid-Frequency (3.9 GHz)	MHz/V	2			
High End (5.2 GHz)	MHz/V	1			
Grid r.f. Cutoff Voltage	V	-10	-20 Max		
Capacitance; Cathode to all other Electrodes,					
incl. Heater and Housing	pF	55	75 Max		
Capacitance; Grid to all other Electrodes					
incl. Housing	pF	55	75 Max		
Capacitance; Helix and Collector to all other			1 (1997)		
Electrodes and Housing	\mathbf{pF}	245	290 Max		
Heater Voltage	Vdc	6.3	$6.3\pm5\%$		
Heater Current	А	0.75	0.4 to 1.2		
			Min/Max		
Cathode Current ¹	mA	10	15 Max		
Helix Voltage Range	V	365-1830	345-1920		
		1 0	Min/Max		
Helix Current	mA V	1.3	3 Max 215 Max		
Anode Voltage		110 0.1	215 Max 2 Max		
Anode Current	mA	0.1	2 WIAX		

Set Cathode Current to Final Test Data value furnished with tube.

*Revision of Technical Data Sheet issued in September 1967.

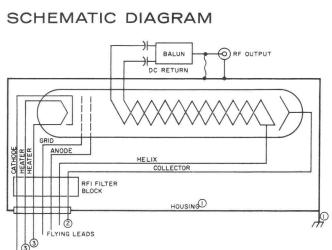
MECHANICAL DATA

Weight, 9.7 lbs. M	lax.
Color Code for 18"	Flying Leads
Heater	Black
Heater	Brown
Cathode	Yellow
Grid	Green
Anode	Blue
Helix	Red
Collector	Orange
Mounting Position,	Any
RF Output Connecto	or, Type N Female
Magnetically Shield	led



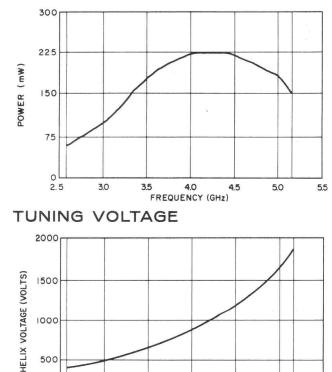
ENVIRONMENTAL DATA Separation from Passive Magnetic Mate-

- rials, None Required
- No Forced Air cooling Required Below +60°C Ambient
- RFI Shielded and Filtered



- ^①For safety, housing should be grounded through mounting screws.
- ²50-150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.
- **③**Heater must always be negative with respect to cathode. One heater lead may be tied to cathode.





5 4.0 4 FREQUENCY (GHz)

4.5

3.5

2.5 2.6

30

5.5

5.0 5.2

NOVEMBER 1970

BACKWARD-WAVE OSCILLATOR WJ-2038-50

The WJ-2038-50 is a magnetically shielded and RFI shielded voltage tunable oscillator utilizing a bifilar (dual helix) and a permanent-magnet focusing system. An immunity to external ac or dc magnetic fields, together with a minimal stray magnetic field and low RF radiation, makes the WJ-2038-50 ideal for signal generating and sweeping equipment, for use in radar receivers (as local oscillator), in frequency diversity transmitters (as master oscillator), and in ECM equipment. Fine grain variation of frequency versus voltage is extremely low.

The WJ-2038-50 delivers smooth power output over the band with low operating cathode current. Power can be modulated and leveled with either grid or anode circuits. All voltages are isolated from housing and RF output connector for maximum flexibility in circuit applications.



SPECIFICATIONS

	UNITS	TYPICAL VALUES	ABSOLUTE RATINGS
Frequency Band . Power Output into Load with VSWR = 1.25:1 Power Output Variation . Fine Grain Variation . Tube VSWR Frequency Pulling Into 2:1 Load (Any Phase)	.mW .dB .dB / 250 MHz	65–230	50 Min. 8 Max. 3 Max.
Spurious Oscillation Ratio of Signal to Noise Power 30 MHz Away Ratio of Signal to 2nd Harmonic Output Long-term Sensitivity to Heater Voltage Sensitivity to Anode Voltage Sensitivity to Grid Voltage Tuning Curve Slope	.dB .MHz/V .MHz/V	30	85 Min. 20 Min.
Low End (2.6 GHz) Mid-Frequency (3.9 GHz) High End (5.2 GHz) Grid RF Cutoff Voltage	.MHz/V	.2	. —25 Max.
Capacitance; Cathode to all other Electrodes, including Heater and Housing	.pF		75 Max.
Capacitance; Grid to all other Electrodes, including Housing Capacitance; Helix and Collector to all other	.pF	.55	75 Max.
Electrodes including Housing	.Vdc	6.3	$6.3 \pm 5\%$
Cathode Current*	.V	.365–1830	15 Max. . 345–1920 Min./Max.
Helix Current	.V		215 Max.
* Set cathode current to Final Test Data value furnished with tube			

* Set cathode current to Final Test Data value furnished with tube.

WJ-2038-50

MECHANICAL CHARACTERISTICS

Height, 4 inches (102 mm) Width, 4 inches (102 mm) Length, 9 inches (229 mm) max. Weight,11.3 lbs.(5.13 Kg) max.

Color Code for 18" Flying Leads

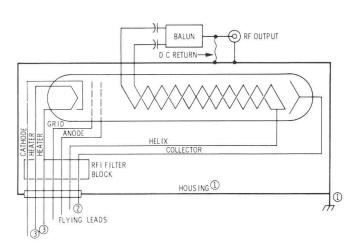
Heater	Black
Heater	Brown
Cathode	Yellow
Grid	Green
Anode	Blue
Helix	Red
Collector	Orange

Mounting Position, Any RF Output Connector, Type N Female on Balun

ENVIRONMENTAL CHARACTERISTICS

Magnetically Shielded Separation from Passive Magnetic Materials, None Required No Forced Air Cooling Required Below +60°C Ambient RFI Shielded and Filtered

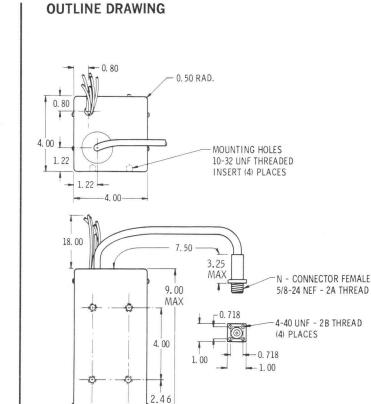
SCHEMATIC DIAGRAM



Notes:

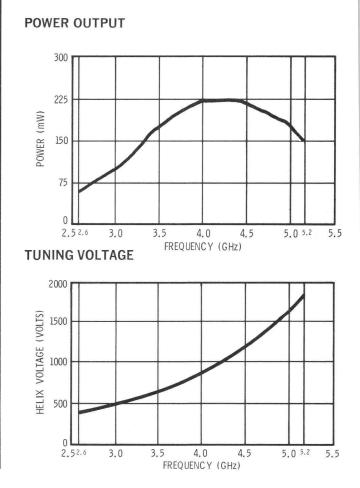
(1) For safety, housing should be grounded through mounting screws.

- (2) 45–150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.
- (3.) Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.



-1.875-

-1.062

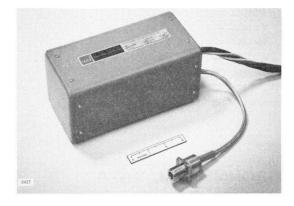




May 1967

BACKWARD-WAVE O S C I L L A T O R

The WJ-2039 is a voltage tunable oscillator with a bifilar helix. An immunity to external ac or dc magnetic fields, plus minimal stray magnetic fields and low RF radiation, makes the WJ-2039 ideal for use in signal generating and sweeping equipment, for use in radar receivers (as local oscillator), in frequency diversity transmitters (as master oscillator), and in ECM equipment. Unsaturated magnetic shielding reduces the external magnetic field strength to less than 5 gauss 1/2-inch from any point of the housing. RFI shielding and filtering allows the WJ-2039 to meet the specifications of MIL-I-6181D. Fine grain varia-

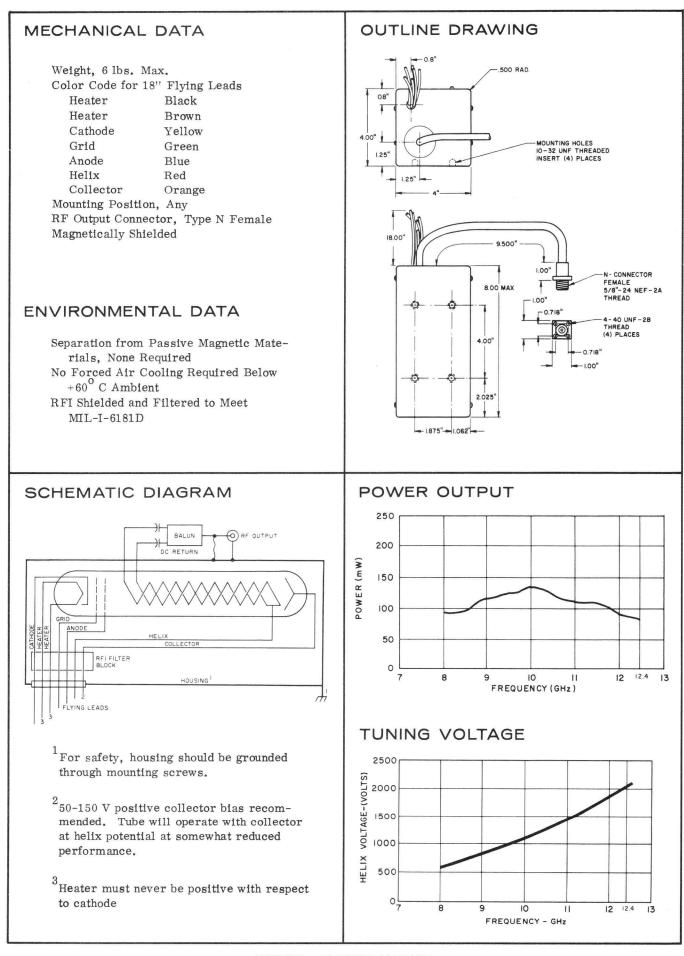


tion of frequency versus voltage is extremely low. Power output and tuning curves are uniform and highly reproducible. Power can be modulated and leveled with either grid or anode circuits. All voltages are isolated from housing and RF output connector for maximum flexibility incircuit applications.

SPECIFICAT	IUNS		
	UNITS	TYPICAL VALUES	ABSOLUTE RATINGS
Nominal Frequency Band	GHz	8.0-12.4	
Power Output into Load with VSWR = 1.25:1	mW	85 - 135	80 Min
Power Output Variation	dB		6 Max
Fine Grain Variation	dB/250 MHz		3 Max
Tube VSWR			2.5:1 Max
Frequency Pulling Into 2:1 Load (Any Phase)	MHz	1	3 Max
Ratio of Signal to Noise Power 30 MHz Away	dB/MHz B.W.	95	85 Min
Ratio of Signal to 2nd Harmonic Output	dB	30	20 Min
Long-term Sensitivity to Heater Voltage	MHz/V	7	
Sensitivity to Anode Voltage	MHz/V	1.7	
Sensitivity to Grid Voltage	MHz/V	7	
Tuning Curve Slope			
Low End (8.0 GHz)	MHz/V	5	
Mid-Frequency (10.2 GHz)	MHz/V	3	
High End (12.4 GHz)	MHz/V	2	
Grid r.f. Cutoff Voltage	V	-15	-20 Max
Capacitance; Cathode to all other Electrodes,			
incl. Heater and Housing	pf	55	75 Max
Capacitance; Grid to all other Electrodes,			
incl. Housing	pf	55	75 Max
Capacitance; Helix and Collector to all other	<u>^</u>		
Electrodes and Housing	pf	220	250 Max
Heater Voltage	Vdc		$6.3 \pm 5\%$
Heater Current	А	0.7	0.4 to 1.2
			Min/Max
Cathode Current	mA	8	12 Max
Helix Voltage Range	V	630-2075	600-2150
			Min/Max
Anode Voltage *	V	120	215 Max
Anode Current	mA	0.05	2 Max
Helix Current	mA	1.2	3 Max

SPECIFICATIONS

* Set anode voltage to Final Test Data value furnished with tube.



WATKINS = JOHNSON COMPANY 3333 HILLVIEW AVENUE = STANFORD INDUSTRIAL PARK PALO ALTO, CALIFORNIA 94304 TWX 910-373-1253 PHONE (415) 326-8830 Telex: 348-415

SEPTEMBER 1967

BACKWARD-WAVE OSCILLATOR WJ-2039-1

The WJ-2039-1 is a 7.0 to 12.4 GHz wide band, magnetic and RFI shielded, voltage tunable oscillator utilizing a bifilar (dual) helix and a permanent-magnet focusing system. Unsaturated magnetic shielding reduces the magnetic field strength to less than 5 gauss $^{1\!/_{\! 2}}$ inch away from any point in the housing. RFI shielding and filtering allow the WJ-2039-1 to meet MIL-I-6181D. Minimal stray magnetic field, low RF radiation, and an immunity to external ac or dc magnetic fields make the WJ-2039-1 ideal for use in signal generating and sweeping equipment. The WJ-2039-1 is also well suited for use in radar receivers (as local oscillator), in frequency diversity transmitters (as master oscillator), and in ECM equipment. Fine grain variation of frequency versus voltage is extremely low. The WJ-2039-1 delivers smooth power output over the band with low operating cathode current. Power can be modulated and leveled with either grid or anode circuit. All voltages are isolated from the housing and RF output connector for maximum flexibility in circuit applications.

C End Concernant	
•	to more i

	UNITS	TYPICAL VALUES	ABSOLUTE RATINGS
Nominal Frequency Band Power Output into Load with VSWR = 1.25:1 Power Output Variation Fine Grain Variation Tube VSWR	dB		8 Max. 3 Max.
Frequency Pulling into 2:1 Load (Any Phase) . Ratio of Signal to Noise Power 30 MHz Away . Ratio of Signal to 2nd Harmonic Output Long-term Sensitivity to Heater Voltage		1	З Мах.
Sensitivity to Anode Voltage Sensitivity to Grid Voltage Tuning Curve Slope Low End (7.0 GHz)		1.7 7 7	
Mid-Frequency (9.7 GHz) High End (12.4 GHz) Grid RF Cutoff Voltage Capacitance; Cathode to all other Electrodes	MHz/V	2 —15	
including Heater and Housing Capacitance; Grid to all other Electrodes including Housing Capacitance; Helix and Collector to all other			
Electrodes including Housing Heater Voltage Heater Current	Vdc	6.3	6.3 ±5% 0.4-1.2
Cathode Current*			12 Max. 430-2150 Min/Max
Anode Voltage Anode Current		120	215 Max.
Set cathous current to rindi rest bata value furnishe			

SPECIFICATIONS

WJ-2039-1

MECHANICAL CHARACTERISTICS

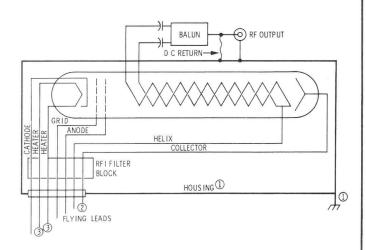
Height, 4 inches (102 mm) Width, 4 inches (102 mm) Length, 8 inches (203 mm) Weight, 6 lbs. (2.72 Kg) Max. Color Code for 18" Flying Leads Heater Black Heater Brown Cathode Yellow Grid Green Anode Blue Helix Red Collector Orange Mounting Position, Any RF Output Connector, Type N, Female Magnetically Shielded

ENVIRONMENTAL CHARACTERISTICS

Separation from Passive Magnetic Materials, None Required No Forced Air Cooling Required Below +60°C Ambient

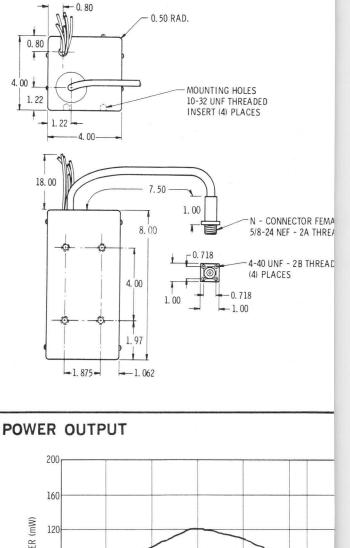
RFI Shielded and Filtered to Meet MIL-I-6181D

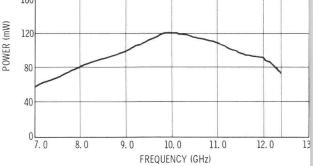
SCHEMATIC DIAGRAM



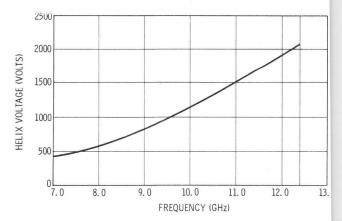
- ①For safety, housing should be grounded through mounting screws.
- ②50-150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.
- ^③Heater must always be negative with respect to cathode. One heater lead may be tied to cathode.

OUTLINE DRAWING





TUNING VOLTAGE



BACKWARD-WAVE OSCILLATOR WJ-2039-50

The WJ-2039-50 is a 7.0 to 12.4 GHz wide band, magnetic and RFI shielded, voltage tunable oscillator utilizing a bifilar (dual) helix and a permanent-magnet focusing system. Unsaturated magnetic shielding reduces the magnetic field strength along the outside of the housing. RFI shielding and filtering allow the WJ-2039-50 to meet MIL-I-6181D. Minimal stray magnetic field, low RF radiation, and an immunity to external ac or dc magnetic fields make the WJ-2039-50 ideal for use in signal generating and sweeping equipment. The WJ-2039-50 is also well suited for use in radar receivers (as local oscillator), in frequency diversity transmitters (as master oscillator), and in ECM equipment. Fine grain variation of frequency versus voltage is extremely low. The WJ-2039-50 delivers smooth power output over the band with low operating cathode current. Power can be modulated and leveled with either grid or anode circuit. All voltages are isolated from the housing and RF output connector for maximum flexibility in circuit applications.



SPECIFICATIONS

	UNITS	TYPICAL VALUES	ABSOLUTE RATINGS
Nominal Frequency Band	GHz		80-124
Power Output into Load with VSWR = 1.25:1		60-125	80 Min.
Power Output Variation	dB		6 Max.
Fine Grain Variation		• • • • • • • • • • • • • • • • •	2.5.1 Max.
Frequency Pulling into 2:1 Load (Any Phase)	MHz	1	3 Max
Ratio of Signal to Noise Power 30 MHz Away	. dB/MHz B. W	95	85 Min.
Long-term Sensitivity to Heater Voltage	.dB	30	20 Min.
Sensitivity to Anode Voltage	MHz/V	1.7	
Sensitivity to Grid Voltage		7	
Tuning Curve Slope		F 7	
Low End (8.0 GHz) Mid-Frequency (10.2 GHz)	. IVIHZ/V	5./	
High End (12.4 GHz)	.MHz/V	2.4	
Grid RF Cutoff Voltage	V	—15	. —25 Max.
Capacitance; Cathode to all other Electrodes	- F	FF	75.14
including Heater and Housing			
including Housing		55	75 Max.
Capacitance: Helix and Collector to all other			
Electrodes including Housing	.pF	63	. 250 Max.
Heater Current	.A	0.75	0.4-1.2
			Min/Max
Cathode Current*	.mA	8	12 Max.
Helix Voltage Range			Min /Max
Helix Current	.mA	1.2	3 Max.
Anode Voltage	.V	120	. 215 Max.
Anode Current		0.1	2 Iviax.

*Set cathode current to Final Test Data value furnished with tube.

WJ-2039-50

MECHANICAL CHARACTERISTICS

Height, 4 inches (102 mm) Width, 4 inches (102 mm) Length, 8 inches (203 mm) Weight, 9.5 lbs. (4.31 Kg) Max. Color Code for 18" Flying Leads Heater Black Heater Brown Cathode Yellow Grid Green Anode Blue Helix Red Collector Orange Mounting Position, Any RF Output Connector, Type N, Female Magnetically Shielded

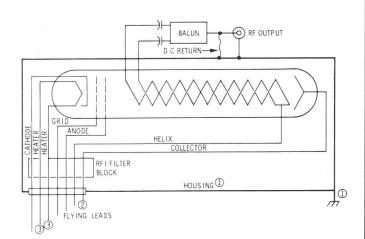
ENVIRONMENTAL CHARACTERISTICS

Separation from Passive Magnetic Materials, None Required

No Forced Air Cooling Required Below +60°C Ambient

RFI Shielded and Filtered to Meet MIL-I-6181D

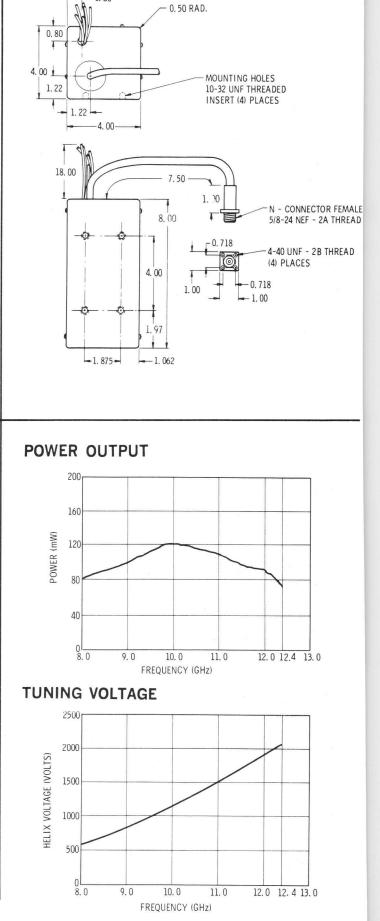
SCHEMATIC DIAGRAM



- (1) For safety, housing should be grounded through mounting screws.
- (2) 45-150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.
- (3) Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.

OUTLINE DRAWING

0.80



DECEMBER 1970

BACKWARD-WAVE OSCILLATOR WJ-2039-51

The WJ-2039-51 is a magnetically shielded and RFI shielded voltage tunable oscillator utilizing a bifilar (dual helix) and a permanent-magnet focusing system. Unsaturated magnetic shielding reduces the magnetic field strength along the outside of the housing. RFI shielding and filtering enables this tube to meet MIL-I-6181D.

An immunity to external ac or dc magnetic fields, together with a minimal stray magnetic field and low RF radiation, makes the WJ-2039-51 ideal for signal generating and sweeping equipment, for use in radar receivers (as local oscillator), in frequency diversity transmitters (as master oscillator), and in ECM equipment. Fine grain variation of frequency versus voltage is extremely low. Power output and tuning curves are uniform and highly reproducible.

The WJ-2039-51 delivers smooth power output over the band with low operating cathode current. Power can be modulated and leveled with either grid or



anode circuits. All voltages are isolated from housing and RF output connector for maximum flexibility in circuit applications.

SPECIFIC	ATIONS UNITS	TYPICAL VALUES	ABSOLUTE RATINGS
Nominal Frequency Band Power Output into Load with VSWR = $1.25:1 \cdot .7 - 8$ GHz 8 - 12.4 GHz	mW	60-125	40 Min.
Power Output Variation Fine Grain Variation Tube VSWR Frequency Pulling into 2:1 Load (Any Phase)	.dB	• • • • • • • • • • • • • • • •	9 Max. 3 Max
Ratio of Signal to Noise Power 30 MHz Away	. dB/MHz B. W . dB	95	3 Max. 85 Min. 20 Min.
Long-term Sensitivity to Heater Voltage Sensitivity to Anode Voltage Sensitivity to Grid Voltage Tuning Curve Slope	.MHz/V	1.7	
Low End (7.0 GHz) Mid-Frequency (9.7 GHz) High End (12.4 GHz) Grid RF Cutoff Voltage	.MHz/V	3.5	25 May
including Heater and Housing			
Capacitance; Grid to all other Electrodes including Housing Capacitance; Helix and Collector to all other			
Electrodes including Housing Heater Voltage Heater Current	.pF .Vdc .A	220	250 Max. 6.3 ±5% 0.4-1.2 Min/Max
Cathode Current*	.V	455-2065	12 Max. . 430-2150 Min/Max
Helix Current Anode Voltage Anode Current	.V	120	3 [°] Max. . 215 Max.
*Set cathode current to Final Test Data value furnished with tube			

*Set cathode current to Final Test Data value furnished with tube.

WJ-2039-51

MECHANICAL CHARACTERISTICS

Height, 4 inches (102 mm) Width, 4 inches (102 mm) Length, 8 inches (203 mm) Weight, 9.5 lbs. (4.31 Kg) Max. Color Code for 18" Flying Leads Heater Black Heater Brown Cathode Yellow Grid Green Blue Anode Helix Red Collector Orange Mounting Position, Any RF Output Connector, Type N, Female

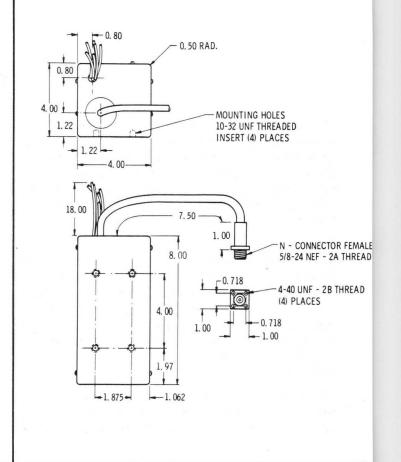
Magnetically Shielded

ENVIRONMENTAL CHARACTERISTICS

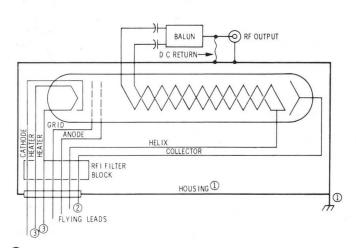
Separation from Passive Magnetic Materials, None Required

No Forced Air Cooling Required Below +60°C Ambient RFI Shielded and Filtered

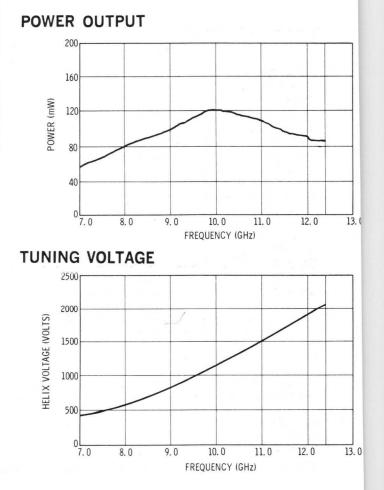
OUTLINE DRAWING



SCHEMATIC DIAGRAM



- OFor safety, housing should be grounded through mounting screws.
- ②45.150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.
- ③ Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.



W J - 2040

BACKWARD-WAVE OSCILLATOR

January 1968 *

The WJ-2040 is a magnetically shielded and RFI shielded voltage tunable oscillator utilizing a bifilar (dual) helix and a permanent-magnet focusing system. Minimal stray magnetic field, low RF radiation, and an immunity to external ac or dc magnetic fields make the WJ-2040 ideal for use in signal generating and sweeping equipment. The WJ-2040 is also well suited for use in radar receivers (as local oscillator), in frequency diversity transmitters (as master oscillator), and in ECM equipment. Fine grain variation of frequency versus voltage is extremely low. The WJ-2040 delivers smooth power output over the band with

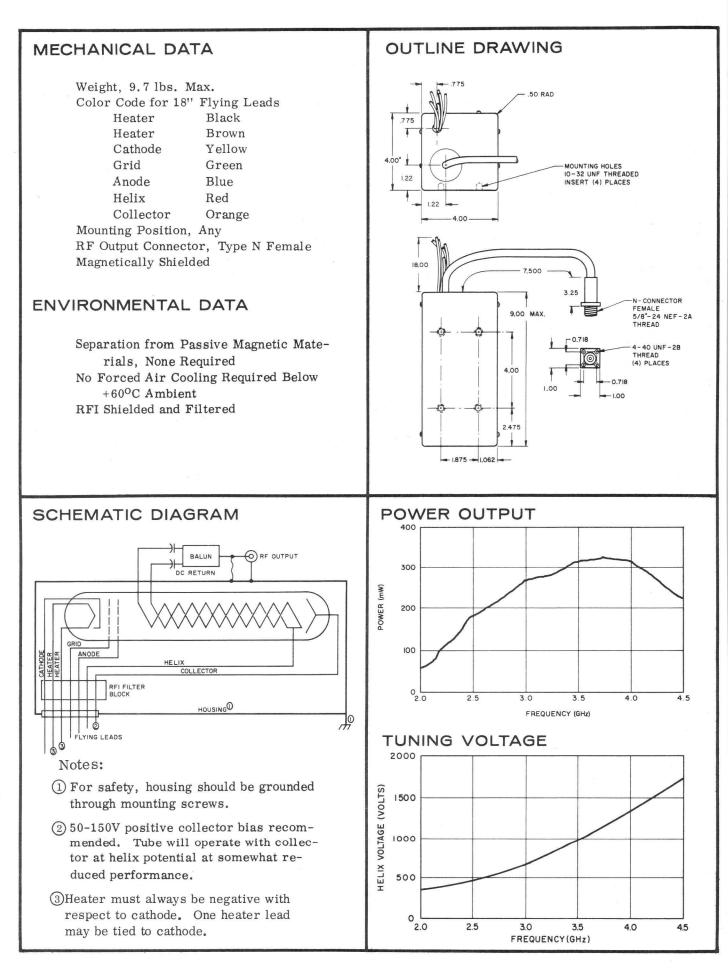


low operating cathode current. Power can be modulated and leveled with either grid or anode circuit. All voltages are isolated from housing and RF output connector for maximum flexibility in circuit applications.

SPECIFICAT	IONS			
	UNITS	TYPICAL	ABSC	LUTE
		VALUES	RAT	INGS
Nominal Frequency Band	GHz	2.0-4.5		
Power Output into Load with VSWR $= 1.25:1$	mW	60 - 350	50	Min.
Power Output Variation	dB		9	Max.
Fine Grain Variation	dB/250 MHz		4	Max.
Tube VSWR			2.5:1	Max.
Frequency Pulling into 2:1 Load (Any Phase)	MHz	4	10	Max.
Ratio of Signal to Noise Power 30 MHz Away	dB/MHz B.W.	95	85	Min.
Ratio of Signal to 2nd Harmonic Output	dB	30	20	Min.
Long-Term Sensitivity to Heater Voltage at 3.25 GHz	MHz/V	5		
Sensitivity to Anode Voltage	MHz/V	1		
Sensitivity to Grid Voltage	MHz/V	6		
Tuning Curve Slope				
Low End (2.0 GHz)	MHz/V	3.5		
Mid-Frequency (3.25 GHz)	MHz/V	1.6		
High End (4.5 GHz)	MHz/V	1		
Grid RF Cutoff Voltage at 3,25 GHz	V	-10	-20	Max.
Capacitance; Cathode to all other Electrodes,	pF	55	75	Max.
including Heater and Housing	-			
Capacitance; Grid to all other Electrodes,	pF	55	75	Max.
including Housing				
Capacitance; Helix and Collector to all other	\mathbf{pF}	245	300	Max.
Electrodes and Housing				
Heater Voltage	Vdc	6.3	6.3	± 5%
Heater Current	А	0.75	0.4-	
				Max
Cathode Current	mA	12.5		Max.
Helix Voltage Range	V	290-1750	275-1	
			Min	/Max
Helix Current		1.8	3	Max.
Anode Voltage	V	130	215	Max.
Anode Current	mA	0.1	2	Max.

¹Set Cathode Current to Final Test Data value furnished with tube.

* This is a revised version of Technical Data Sheet issued September 1967.



WATKINS = JOHNSON COMPANY 3333 HILLVIEW AVENUE = STANFORD INDUSTRIAL PARK PALO ALTO, CALIFORNIA 94304 TWX 910-373-1253 PHONE (415) 326-8830 Telex: 348-415

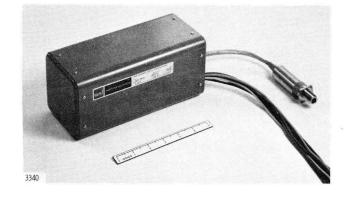
BACKWARD-WAVE OSCILLATOR

February 1968

WJ-2040-2

TECHNICAL DATA

The WJ-2040-2 is a magnetically shielded and
I shielded voltage tunable oscillator utilizing bifilar (dual) helix and a permanent-magnet ocusing system. Minimal stray magnetic field, ow RF radiation, and an immunity to external ac r dc magnetic fields make the WJ-2040-2 ideal or use in signal generating and sweeping equiphent. The WJ-2040-2 is also well suited for use n radar receivers (as local oscillator), in freuency diversity transmitters (as master oscillaor), and in ECM equipment. Fine grainvariation f frequency versus voltage is extremely low.
The WJ-2040-2 delivers smooth power output over



he band with low operating cathode current. Power can be modulated and leveled with either grid or node circuit. All voltages are isolated from housing and RF output connector for maximum flexibility n circuit applications.

SPECIFICATIONS						
	UNITS	TY PICAL VALUES	A BSOLUTE RA TINGS			
Nominal Frequency Band	GHz	2.0 - 4.0				
Power Output into Load with VSWR = 1.25:1	mW	60-330	50 Min.			
Power Output Variation	dB		8 Max.			
Fine Grain Variation	dB/250 MHz		4 Max.			
Tube VSWR			2.5:1 Max.			
Frequency Pulling into 2:1 Load (Any Phase)	MHz	4	6 Max.			
Ratio of Signal to Noise Power 30 MHz Away	dB/MHz B.W.	95	85 Min.			
Ratio of Signal to 2nd Harmonic Output	dB	30	20 Min.			
Long-term Sensitivity to Heater Voltage at 3GHz	MHz/V	5				
Sensitivity to Anode Voltage	MHz/V	1				
Sensitivity to Grid Voltage	MHz/V	6	J			
Tuning Curve Slope						
Low End (2.0 GHz)	MHz/V	3.5				
Mid-Frequency (3.0 GHz)	MHz/V	1.6				
High End (4.0 GHz)	MHz/V	1				
Grid r.f. Cutoff Voltage	V	-8	-20 Max.			
Capacitance; Cathode to all other Electrodes						
incl. Heater and Housing	pf	55	75 Max.			
Capacitance; Grid to all other Electrodes,						
incl. Housing	pf	55	75 Max.			
Capacitance; Helix and Collector to all other						
Electrodes and Housing	pf	245	300 Max.			
Heater Voltage	Vdc	6.3	$6.3 \pm 5\%$			
Heater Current	А	0.75	0.4 to 1.2			
			Min./Max.			
Cathode Current *	mA	12.5	15 Max.			
Helix Voltage Range	V	290-1320	275-1400			
			Min./Max.			
Helix Current		1.8	3 Max.			
Anode Voltage	V	130	215 Max.			
Anode Current	mA	0.1	2 Max.			

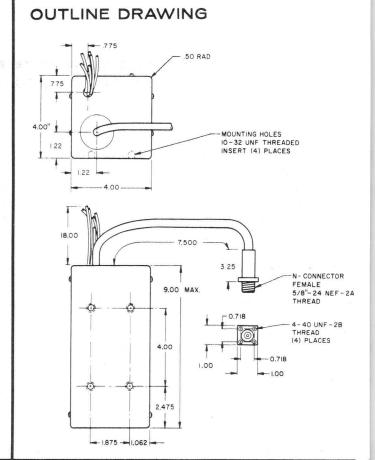
* Set cathode current to Final Test Data value furnished with tube.

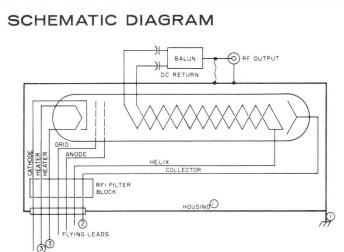
SPECIFICATIONS

Weight, 9.7 lbs. Max. Color Code for 18" Flying Leads Heater Black Heater Brown Cathode Yellow Green Grid Blue Anode Helix Red Collector Orange Mounting Position, Any RF Output Connector, Type N Female Magnetically Shielded

ENVIRONMENTAL DATA

Separation from Passive Magnetic Materials, None Required No Forced Air Cooling Required Below +60°C Ambient RFI Shielded and Filtered





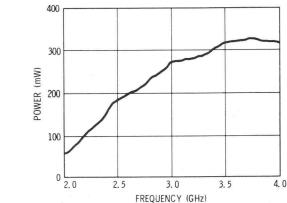
Notes:

()For safety, housing should be grounded through mounting screws.

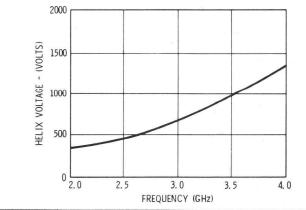
(250-150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.

Heater must always be negative with respect to cathode. One heater lead may be tied to cathode.





TUNING VOLTAGE



WATKINS = JOHNSON COMPANY 3333 HILLVIEW AVENUE = STANFORD INDUSTRIAL PARK PALO ALTO, CALIFORNIA 94304 TWX 910-373-1253 PHONE (415) 326-8830 Telex: 348-415

APRIL 1969 *

BACKWARD-WAVE OSCILLATOR WJ-2041

The WJ-2041 is a magnetically shielded and RFI shielded, voltage tunable oscillator, utilizing a single helix and a permanent-magnet focusing system. Unsaturated magnetic shielding reduces the magnetic field strength to less than 10 gauss, 1/2 inch from any point of the housing. RFI shielding and filtering allow the WJ-2041 to meet levels of MIL-I-6181D. An immunity to external ac or dc magnetic fields, together with minimal stray magnetic fields and low RF radiation, makes the WJ-2041 ideal for signal generating and sweeping equipment, for use in radar receivers (as local oscillator), in frequency diversity transmitters (as master oscillator), and in ECM equipment. Fine grain variation of frequency versus voltage is extremely low. The WJ-2041 delivers smooth power output over the band with low operating cathode current. Power can be modulated and



leveled with either grid or anode circuits. All voltages are isolated from the housing for maximum flexibility in circuit applications.

	SPECIFICATIONS	TYPICAL	ABSOLUTE
	UNITS	VALUES	RATINGS
Nominal Frequency Band	GHz	VALUES	26.5 - 40.0
Power Output into Load with VSWR = 1.25:1	mW	12 - 35	10 Min.
Power Output Into Boad with VBWIT = 1.20.1	dB	11 00	8 Max.
Fine Grain Variation	dB/500 MHz		3 Max.
Tube VSWR			2.5:1 Max.
Frequency Pulling into 2:1 Load (Any Phase)	MHz	6	10 Max.
Ratio of Signal to Noise Power 30 MHz Away	dB/MHz	95	85 Max.
Long-term Sensitivity to Heater Voltage	MHz/V	30	00 111011
Sensitivity to Anode Voltage	MHz/V	2	
Sensitivity to Grid Voltage	MHz/V	25	
Tuning Curve Slope			
Low End (26.5 GHz)	MHz/V	20	
Mid-Frequency (33.25 GHz)	MHz/V	10	
High End (40 GHz)	MHz/V	6	
Grid RF Cutoff Voltage	V	-7	-20 Max.
Capacitance; Cathode to all other Electrodes			
including Heater and Housing	pf	35	50 Max.
Capacitance; Grid to all other Electrodes			
and Housing	pf	25	50 Max.
Capacitance; Helix and Collector to all other			
Electrodes and Housing	pf	60	100 Max.
Heater Voltage	Vde		$6.3 \pm 5\%$
Heater Current 1	A	.65	0.4-1.2
Cathode Current	mA	4	5 Max.
Helix Voltage Range	V	520-1940	500-2100
Helix Current	mA	1.0	1.5 Max.
Anode Voltage	V	150	250 Max.
Anode Current	mA	. 05	.5 Max.
	1 6 1 1 1 1 1		

LOATIONO

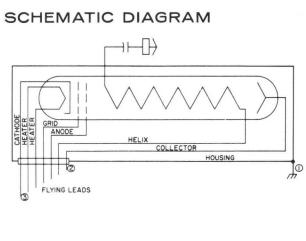
1. Set Cathode Current to Final Test Data value furnished with tube.

* Supersedes WJ-2041 Technical Data Sheet dated February 1968.

Weight, 6.5 lbs. Max. Color Code for 18" Flying Leads Heater Brown Heater Black (neg) Grid Green Anode Blue Helix Red Collector Orange Cathode Yellow Mounting Position, any RF Output Connector mates to UG599/U Waveguide Flange Magnetically Shielded

ENVIRONMENTAL DATA

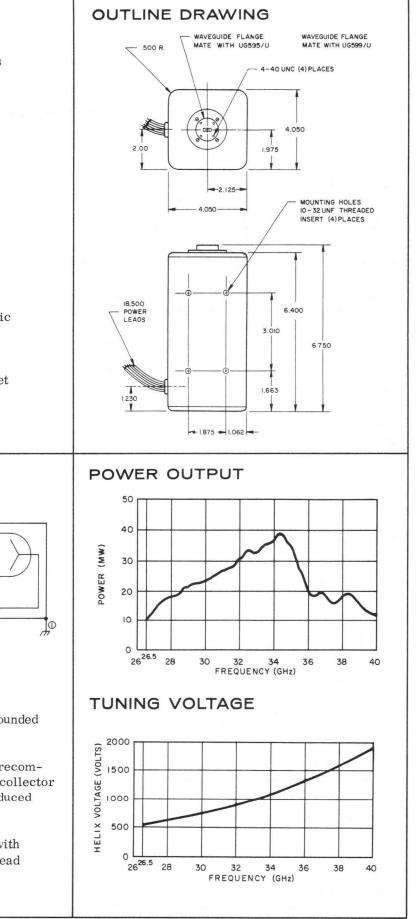
Separation from Passive Magnetic Materials - None Required No Forced Air Cooling Required Below +60^o C Ambient RFI Shielded and Filtered to Meet Levels of MIL-I-6181D



For safety, housing should be grounded through mounting screws.

50-150 V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.

Heater must always be negative with respect to cathode. One heater lead may be tied to cathode.



(1)

(2)

(3)

WJ-2042

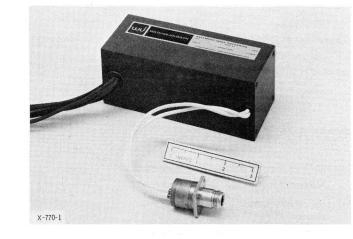
BACKWARD-WAVE OSCILLATOR

September 1968

he WJ-2042 is a magnetically and RFI shielded oltage tunable oscillator utilizing a single helix nd permanent magnet focusing system to cover he frequency range from 12.4 to 18.0 GHz. Unaturated magnetic shielding reduces the magnetic eld strength at any point, 1/2 inch from the housig, to a value of less than 10 gauss. Interference equirements of MIL-STD-461 are met or exceeded y integral RFI shielding and filtering.

he combination of immunity to external ac or de lagnetic fields, minimal stray generated magnetic elds, and extremely low RF radiation, makes the 'J-2042 ideal for a number of applications, includig the following: signal generating and sweeping quipment, radar receiver (as local oscillator), requency diversity transmitters, and ECM equipient (as master oscillator).

he fine grain variation of frequency versus voltage s extremely low. The WJ-2042 delivers smooth



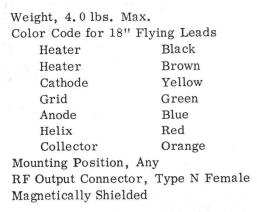
power output over the band with low operating cathode current. Power can be modulated and leveled with either grid or anode circuits. All voltages are isolated from the housing for maximum flexibility in circuit applications.

SPECIFICA	TYPICAL ABSOLUTE	
UNI	ITS VALUES RATINGS	
Power Output Into Load With VSWR = 1.25:1 mW Power Output Variation dB Fine Grain Variation dB Tube VSWR	Hz	
Ratio of Signal to Noise Power 30 MHz Away dB	Hz 1.5	
2	Hz/V 1	
Mid-Frequency (9.25 GHz) MH	Hz/V 13.5	
Grid RF Cutoff Voltage V Capacitance; Cathode to All Other Electrodes,	1020 Max.	
Including Heater and Housing pF Capacitance; Grid to All Other Electrodes,		
Including Housing		
	F	
	0.75 0.4 Min. 1.2 Max.	
Cathode Current*	A 10 12 Max. 	

SPECIFICATIONS

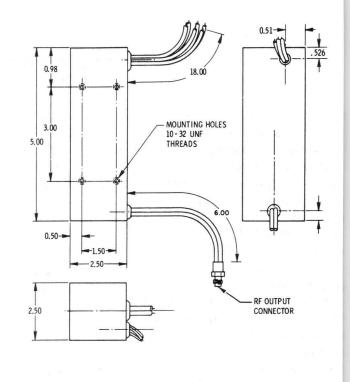
* Set cathode current to Final Test Data value furnished with tube.

OUTLINE DRAWING

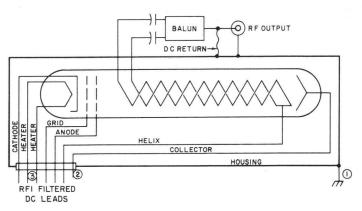


ENVIRONMENTAL DATA

Separation From Passive Magnetic Materials, None Required No Forced Air Cooling Required Below +60⁰ C Ambient RFI Shielded and Filtered to Meet or Exceed MIL-STD-461



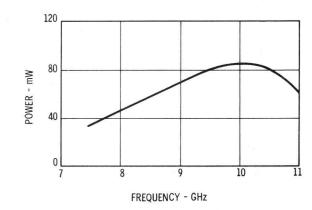
SCHEMATIC DIAGRAM



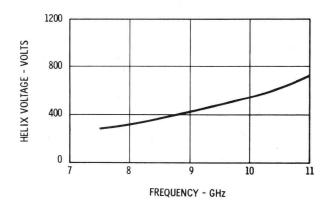
Notes:

- (1) For safety, housing should be grounded through mounting screws.
- (2) 50 150 V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.
- (3) Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.

POWER OUTPUT



TUNING VOLTAGE



WATKINS ■ JOHNSON COMPANY 3333 HILLVIEW AVENUE ■ STANFORD INDUSTRIAL PARK PALO ALTO, CALIFORNIA 94304 TWX 910-373-1253 PHONE (415) 326-8830 Telex: 348-415

SEPTEMBER 1969 *

BACKWARD-WAVE OSCILLATOR WJ-2043

The WJ-2043 is a magnetically and RFI shielded voltage tunable oscillator utilizing a single helix and permanent magnet focusing system to cover the frequency range from 12.4 to 18.0 GHz. Interference requirements of MIL-STD-461 are met or exceeded by integral RFI shielding and filtering.

The combination of immunity to external ac or dc magnetic fields, minimal stray generated magnetic fields and very low RF radiation, makes the WJ-2043 ideal for a number of applications, including the following: signal generating and sweeping equipment, radar receivers (as local oscillator), in frequency diversity transmitters and ECM equipment (as master oscillator).

The fine grain variation of frequency versus voltage is extremely low. The WJ-2043 delivers smooth power output over the band with low operating cathode current. Power can be modulated and leveled with either grid or anode circuits. All voltages are isolated from the housing for maximum flexibility in circuit applications.



SPECIFICATIONS

	UNITS	TYPICAL VALUES	ABSOLUTE RATINGS
Frequency Band	.GHz		. 12.4-18.0
Power Output into Load with VSWR = $1.25:1$. mW	50-100	40 Min.
Power Output Variation	.dB		6 Max.
Fine Grain Variation	.0B/250 MHZ		2.5.1 Max
Frequency Pulling into 2:1 Load (Any Phase)	MHz	1	15 Max.
Ratio of Signal to Noise Power 30 MHz Away	.dB/MHz BW	95	85 Min.
Long-term Sensitivity to Heater Voltage	.MHz/V	15	
Sensitivity to Anode Voltage	.MHZ/V	2	
Tuning Curve Slope		0	
Low End (12.4 GHz)	.MHz/V	7.5	
Mid-Frequency (15.2 GHz)	.MHz/V	4.4	
High End (18.0 GHz)	.MHz/V	2.2	20 Max
Grid RF Cutoff VoltageCapacitance; Cathode to all other Electrodes	· · · · · · · · · · · · · · · · · · ·	. —10	. —20 Iviax.
including Heater and Housing	.pF	. 50	90 Max.
Capacitance: Grid to all other Electrodes			
including Housing	.pF	. 40	80 Max.
Capacitance; Helix and Collector to all other Electrodes and Housing	nF	130	170 Max
Heater Voltage	.V dc	6.3	$6.3 \pm 5\%$
Heater Voltage	.A	. 0.75	. 0.4 to 1.2
			Min./Max.
Cathode Current ¹	.mA	570,1020	15 Max.
			Blim /Blow
Helix Current	.mA	1.8	3 Max.
Anode Voltage Anode Current	.V	. 130	. 215 Max.
Anode Current	.mA	0.1	1 Max.

¹Set cathode current to Final Test Data value furnished with tube. *Supersedes WJ-2043 Technical Data Sheet dated June 1968.

WJ-2043

OUTLINE DRAWING

0.825

1. 220 NOM.

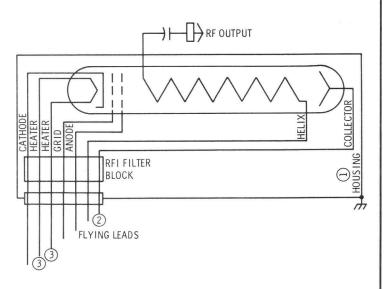


Height	4 inches (102 mm) max.
	4 inches (102 mm) max.
	8 inches (203 mm) max.
	5.5 pounds (2.49 Kg) max.
Color Code for 18"	Flying Leads
Heater	Black
Heater	Brown
Cathode	Yellow
Grid	Green
Anode	Blue
Helix	Red
Collector	Orange
Mounting Position,	Any
RF Output Connect	or, Coaxial Type APC-7
Magnetically Shield	ed
-	

ENVIRONMENTAL CHARACTERISTICS

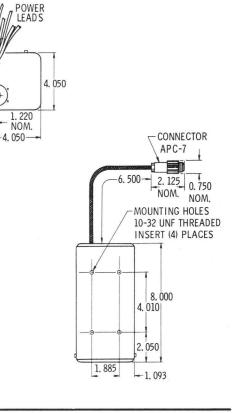
Separation from Passive Magnetic Materials, None Required No Forced Air Cooling Required Below —60°C Ambient RFI Shielded and Filtered

SCHEMATIC DIAGRAM

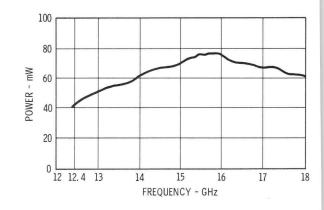


Notes:

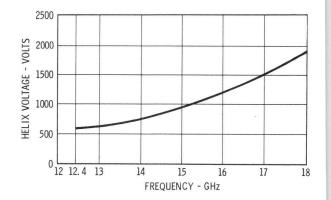
- ¹ For safety, housing should be grounded through mounting screws.
- ² 50-150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.
- ³ Heater must always be negative with respect to cathode. One heater lead may be tied to cathode.



POWER OUTPUT



TUNING VOLTAGE





BACKWARD-WAVE OSCILLATOR

November 1968

The WJ-2044 is a magnetically and RFI shielded voltage tunable oscillator utilizing a single helix and permanent magnet focusing system to cover the frequency range from 4.5 to 10.0 GHz. Unsaturated magnetic shielding reduces the magnetic field strength at any point, 1/2 inch from the housing, to a value of less than 10 gauss. Interference requirements of MIL-STD-461 are met or exceeded by integral RFI shielding and filtering.

The combination of immunity to external ac or dc magnetic fields, minimal stray generated magnetic fields, and extremely low RF radiation, makes the WJ-2044 ideal for a number of applications, including the following: signal generating and sweeping equipment, radar receivers (as local oscillator), frequency diversity transmitters, and ECM equipment (as master oscillator).

The fine grain variation of frequency versus voltage is extremely low. The WJ-2044 delivers a



smooth power output over the band with low operating cathode current. Power can be modulated and leveled with either grid or anode circuits. All voltages are isolated from the housing for maximum flexibility in circuit applications.

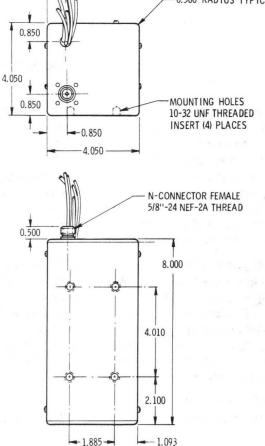
SPECIFICATIONS

	TYPICAL ABSOLUTE	
	UNITS VALUES RATINGS	
Frequency Band	GHz	
Power Output Into Load With VSWR = 1.25:1	mW	
Power Output Variation	dB	
Fine Grain Variation	dB/250 MHz	
Frequency Pulling Into 2 : 1 Load (Any Phase)	MHz 1.2	
Ratio of Signal to Noise Power 30 MHz Away	dB/MHz	
Long-Term Sensitivity to Heater Voltage		
0		
Sensitivity to Anode Voltage	MHz/V 1	
Sensitivity to Grid Voltage	MHz/V 5	
Tuning Curve Slope		
Low End (4.5 GHz)	MHz/V 8.0	
Mid-Frequency (7.25 GHz)	MHz/V 3.5	
High End (10.0 GHz)	MHz/V 2.0	
Grid RF Cutoff Voltage	V820 Max.	
Capacitance; Cathode to All Other Electrodes,		
Including Heater and Housing	pF 55 75 Max.	
Capacitance; Grid to All Other Electrodes,		
Including Housing	pF 55 75 Max.	
Capacitance; Helix and Collector to All Other		
Electrodes and Housing	pF 190 250 Max.	
Heater Voltage	V dc 6.3 6.3 ± 5%	
Heater Current	A 0.75 0.4 Min.	
	1.2 Max.	
Cathode Current	mA 10 15 Max.	
Helix Voltage Range	V 288 - 1970 250 Min.	
	2000 Max.	
Helix Current	mA 1.8 3 Max.	
	V 130 215 Max.	
8	mA 0.1 1 Max.	
Anode Current	mA	

* Set anode voltage to Final Test Data value furnished with tube.

Weight, 6.0 lbs. M	ax.
Color Code for 18"	Flying Leads
Heater	Black
Heater	Brown
Cathode	Yellow
Grid	Green
Anode	Blue
Helix	Red
Collector	Orange
Mounting Position,	Any
RF Output Connecto	or, Type N Female
Magnetically Shield	ed

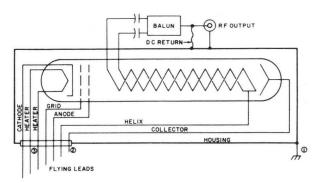
OUTLINE DRAWING



ENVIRONMENTAL DATA

Separation From Passive Magnetic Materials, None Required No Forced Air Cooling Required Below +60° C Ambient RFI Shielded and Filtered to Meet or Exceed MIL-STD-461

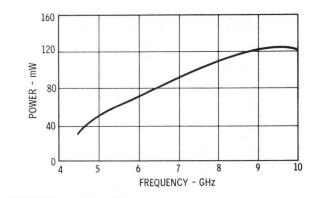
SCHEMATIC DIAGRAM



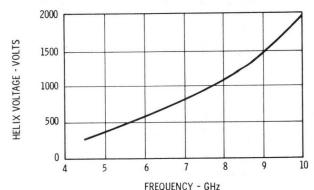
Notes:

- For safety, housing should be grounded through mounting screws.
- 2 50 150 V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.
- ③ Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.

POWER OUTPUT



TUNING VOLTAGE



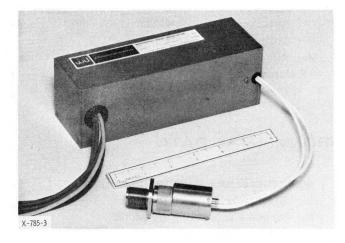
WATKINS ■ JOHNSON COMPANY 3333 HILLVIEW AVENUE ■ STANFORD INDUSTRIAL PARK PALO ALTO, CALIFORNIA 94304 TWX 910-373-1253 PHONE (415) 326-8830 Telex: 348-415 Printed in U.S.A



November 1968

BACKWARD-WAVE OSCILLATOR

The type WJ-2047 is a bifilar (dual-helix), voltage tunable oscillator utilizing permanent magnet focusing. This wide band oscillator is well suited for use as a swept signal source in highly stable signal generators. Other applications include local oscillators in ECM receivers, master oscillators in frequency diversity transmitters, and electronic test sets. The WJ-2047 delivers smooth power output over the band with low operating cathode current. Power output can be modulated with either the grid or the anode circuits. All voltages are isolated from the tube housing for maximum flexibility in circuit applications.



SPECIFICATIONS

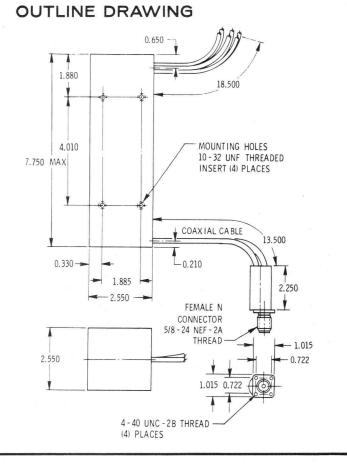
SFECIFI	CATIONS	TYPICAL	ABSOLUTE
	UNITS	VALUES	RATINGS
Frequency Pulling Into 2 : 1 Load (Any Phase)Ratio of Signal to Noise Power 30 MHz AwayLong-Term Sensitivity to Heater VoltageSensitivity to Anode VoltageSensitivity to Grid Voltage	mW	. 95 . 5 1	40 Min. 6 Max. 3 Max. 2.5:1 Max.
Tuning Curve Slope Low End (4.0 GHz)	MHz/V	. 7.5	
Mid-Frequency (6.0 GHz)	MHz/V		
High End (8.0 GHz)	MHz/V		
Grid RF Cutoff Voltage	V	8	20 Max.
Capacitance; Cathode to All Other Electrodes, Including Heater and Housing Capacitance; Grid to All Other Electrodes,	pF	. 22	. 50 Max.
Including Housing	pF	. 20	. 50 Max.
Electrodes and Housing	pF	. 230	. 300 Max.
Heater Voltage	V dc		
Heater Current	Α	. 0.75	. 0.4 Min.
			1.2 Max.
Cathode Current	mA	. 10	. 15 Max.
Helix Voltage Range	v	290 - 1430	. 270 Min. 1500 Max.
Helix Current	mA	. 1.8	3 Max.
Anode Voltage*	V		. 215 Max.
Anode Current	mA	. 0.1	1 Max.

* Set anode voltage to Final Test Data value furnished with tube.

ax.
Flying Leads
Black
Brown
Yellow
Green
Blue
Red
Orange
Any
or, Type N Female

ENVIRONMENTAL DATA

Separation From Passive Magnetic Materials, 2 in. Min. No Forced Air Cooling Required Below +60° C Ambient

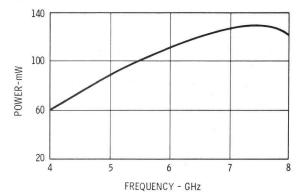


SCHEMATIC DIAGRAM

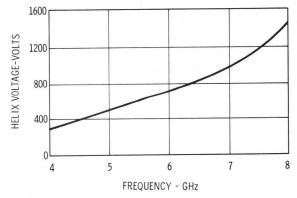
Notes:

- (1) For safety, housing should be grounded through mounting screws.
- (2) 50 150 V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.
- (3) Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.

POWER OUTPUT



TUNING VOLTAGE



WATKINS = JOHNSON COMPANY 3333 HILLVIEW AVENUE = STANFORD INDUSTRIAL PARK PALO ALTO, CALIFORNIA 94304 TWX 910-373-1253 PHONE (415) 326-8830 Telex: 348-415

JUNE 1970

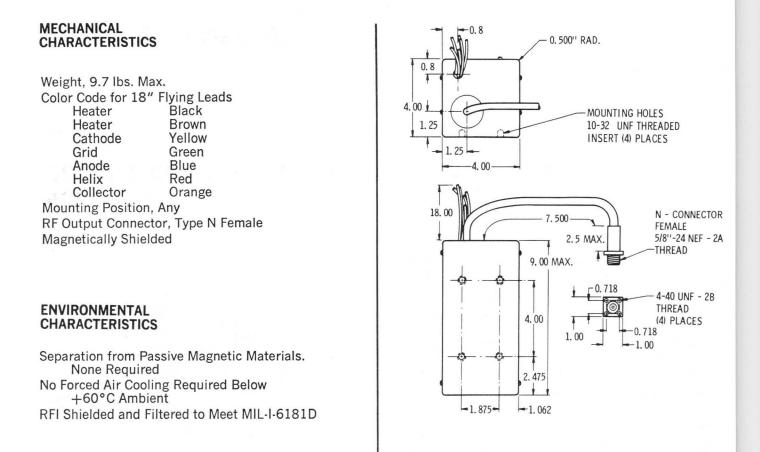
BACKWARD-WAVE OSCILLATOR WJ-2049

The WJ-2049 is a magnetically shielded and RFI shielded voltage tunable oscillator utilizing a bifilar (dual) helix and a permanent magnet focusing system. Minimal stray magnetic field, low RF radiation, and an immunity to external ac or dc magnetic fields make the WJ-2049 ideal for use in signal generating and sweeping equipment. The WJ-2049 is also well suited for use in radar receivers (as local oscillator), in frequency diversity transmitters (as master oscillator), and in ECM equipment. Fine grain variation of frequency versus voltage is extremely low. The WJ-2049 delivers smooth power output over the band with low operating cathode current. Power can be modulated and leveled with either grid or anode circuits. All voltages are isolated from housing and RF output connector for maximum flexibility in circuit applications.

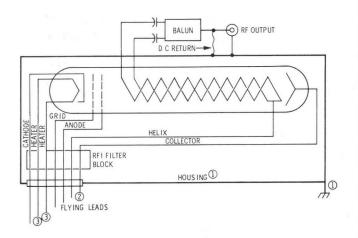


SPECIFICATIONS

Nominal Frequency Band Power Output into Load with VSWR = 1.25:1 Power Output Variation Fine Grain Variation Tube VSWR	. mW .dB .dB/250 MHz	TYPICAL VALUES 3.5-6.75 50-120	ABSOLUTE RATINGS 40 Min. 8 Max. 3 Max. 2.5:1 Max.
Frequency Pulling into 2:1 Load (Any Phase) Ratio of Signal to Noise Power 30 MHz Away Ratio of Signal to 2nd Harmonic Output Long-term Sensitivity to Heater Voltage Sensitivity to Anode Voltage Sensitivity to Grid Voltage Tuning Curve Slope	. MHz . dB/MHz B. W. . dB . MHz/V . MHz/V	1.5 95 30 3 0.9 7	3 Max. 85 Min. 20 Min.
Low End (3.500 GHz) Mid-Frequency (5.125 GHz) High End (6.750 GHz) Grid RF Cutoff Voltage Capacitance; Cathode to all other Electrodes,	. MHz/V . MHz/V	4.7 2.2 1.1 —11	—20 Max.
including heater and housing Capacitance; Grid to all other Electrodes;	·рF	55	70 Max.
including Housing	.pF	55	70 Max.
Electrodes and Housing Heater Voltage	. Vdc	210 6.3 0.75	250 Max. 6.3 ±5% 0.4-1.2 Min./Max.
Cathode Current	. mA . V	9	13 Max. 380-2050 Min./Max.
Helix Current Anode Voltage* Anode Current *Set anode voltage to Final Test Data value furnished with tube.	. V	1.2 120 0.1	3 Max. 215 Max. 2 Max.



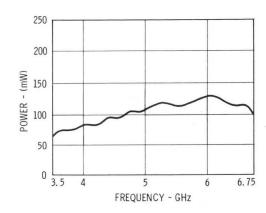
SCHEMATIC DIAGRAM



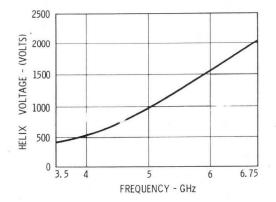
Notès:

- 1) For safety, housing should be grounded through mounting screws.
- (2) 50-150 V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.
- (3.) Heater must always be negative with respect to cathode. Positive heater lead may be tied to cathode.

POWER OUTPUT



TUNING VOLTAGE



DECEMBER 1970

BACKWARD-WAVE OSCILLATOR WJ-2049-50

The WJ-2049-50 is a magnetically shielded and RFI shielded voltage tunable oscillator utilizing a bifilar (dual) helix and a permanent magnet focusing system. Minimal stray magnetic field, low RF radiation, and an immunity to external ac or dc magnetic fields make the WJ-2049-50 ideal for use in signal generating and sweeping equipment. The WJ-2049-50 is also well suited for use in radar receivers (as local oscillator), in frequency diversity transmitters (as master oscillator), and in ECM equipment. Fine grain variation of frequency versus voltage is extremely low. The WJ-2049-50 delivers smooth power output over the band with low operating cathode current. Power can be modulated and leveled with either grid or anode circuits. All voltages are isolated from housing and RF output connector for maximum flexibility in circuit applications.



SPECIFICATIONS

	UNITS	TYPICAL VALUES	ABSOLUTE RATINGS
Frequency Band Power Output into Load with VSWR = 1.25:1 Power Output Variation Fine Grain Variation Tube VSWR	mW dB dB/250 MHz	50-130	3.5-6.75 40 Min. 7 Max. 3 Max. 2.5:1 Max.
Frequency Pulling into 2:1 Load (Any Phase) Ratio of Signal to Noise Power 30 MHz Away Ratio of Signal to 2nd Harmonic Output Long-term Sensitivity to Heater Voltage Sensitivity to Anode Voltage Sensitivity to Grid Voltage Tuning Curve Slope	MHz dB/MHz B. W. dB MHz/V MHz/V	1.5 95 30 5 0.5 3	3 Max. 85 Min. 20 Min.
Low End (3.500 GHz) Mid-Frequency (5.125 GHz) High End (6.750 GHz) Grid RF Cutoff Voltage	MHz/V · · MHz/V	3.5 2.5 1.1 -7	—25 Max.
Capacitance; Cathode to all other Electrodes, including heater and housing	· · pF	30	45 Max.
Capacitance; Grid to all other Electrodes; including Housing Capacitance; Helix and collector to all other	pF	30	45 Max.
Electrodes and Housing	· · pF	100	150 Max. 6.3 ±5%
Heater Voltage	A	0.85	0.3 ± 5 /₀ 0.4-1.2 Min./Max.
Cathode Current [*] Helix Voltage Range		8 40 0-2040	12 Max. 350-2100 Min./Max.
Helix Current Anode Voltage Anode Current	V mA	2 175 0.5	3 Max. 215 Max. 2.0 Max.
* Set cathode current to Final Test Data value furnished with tu	be.		

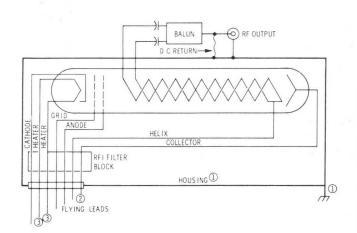
WJ-2049-50

MECHANICAL

OUTLINE DRAWING

CHARACTERISTICS -0.8 0.500" RAD. Height 4 inches (102 mm) Width 0.8 Weight 11.3 pounds (5.13 Kg) Max. Color Code for 18" Flying Leads 4.00 MOUNTING HOLES Heater Black (neg) 10-32 UNF THREADED 1.25 INSERT (4) PLACES Heater Brown 1.25 Cathode Yellow -4 00 Grid Green Blue Anode Helix Red 18.00 N - CONNECTOR 7.500 Collector Orange FEMALE 5/8"-24 NEF - 2A 2.5 MAX Mounting Position, Any THREAD Ā 9.00 MAX RF Output Connector, Type N Female 0.718 Magnetically Shielded 4-40 UNF - 2B THREAD **ENVIRONMENTAL** 4.00 (4) PLACES 0.718 **CHARACTERISTICS** 1.00 -1.00 Separation from Passive Magnetic Materials, None Required 2.475 No Forced Air Cooling Required Below +60°C Ambient -1. 875--1.062 **RFI** Shielded and Filtered

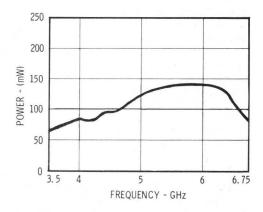
SCHEMATIC DIAGRAM



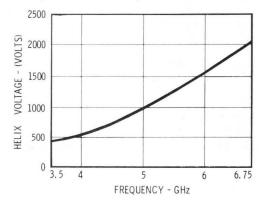
Notes:

- (1) For safety, housing should be grounded through mounting screws.
- (2) 45-150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.
- (3) Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.





TUNING VOLTAGE



BACKWARD-WAVE OSCILLATOR

WJ-2050

APRIL 1969

The WJ-2050 is a magnetically shielded and RFI shielded voltage tunable oscillator utilizing a bifilar (dual) helix and a permanent-magnet focusing system. Minimal stray magnetic field, low RF radiation, and an immunity to external ac or dc magnetic fields make the WJ-2050 ideal for use in signal generating and sweeping equipment. The WJ-2050 is also well suited for use in radar receivers (as local oscillator), in frequency diversity transmitters (as master oscillator), and in ECM equipment. Fine grain variation of frequency versus voltage is extremely low. The WJ-2050 delivers smooth power output over the band with low operating cathode current. Power can be modulated and leveled with either grid or anode



circuit. All voltages are isolated from housing and RF output connector for maximum flexibility in circuit applications.

	SPECIFICATIONS		
	UNITS	TYPICAL VALUES	ABSOLUTE RATINGS
Nominal Frequency Band	GHz	4.0 - 8.0	
Power Output into Load with VSWR = 1.	.25:1 mW	40 - 100	30 Min.
Power Output Variation	dB		8 Max.
Fine Grain Variation	dB/200 MHz		3 Max.
Tube VSWR			2.5:1 Max.
Frequency Pulling into 2:1 Load (Any	Phase) MHz	2	4 Max.
Ratio of Signal to Noise Power 30 MHz		95	85 Min.
Ratio of Signal to 2nd Harmonic Output	dB	30	20 Min.
Long-term Sensitivity to Heater Voltag	e MHz/V	3	
Sensitivity to Anode Voltage	MHz/V	0.9	
Sensitivity to Grid Voltage	MHz/V	7	
Tuning Curve Slope			
Low End (4.0 GHz)	MHz/V	6	
Mid-Frequency (6.0 GHz)	MHz/V	3	
High End (8.0 GHz)	MHz/V	1.5	
Grid RF Cutoff Voltage	V	-11	-20 Max.
Capacitance; Cathode to all other Elec	trodes,		
including Heater and Housing	pF	55	70 Max.
Capacitance; Grid to all other Electro	des,		
including Housing	pF	55	70 Max.
Capacitance; Helix and Collector to all	lother		
Electrodes and Housing	pF	210	250 Max.
Heater Voltage	V dc	6.3	$6.3 \pm 5\%$
Heater Current	А	0.75	0.4 - 1.2
			Min./Max.
Cathode Current	mA	6	10 Max.
Helix Voltage Range	V	302 - 1805	275 - 1900
			Min./Max.
Helix Current	mA	1.2	3 Max.
Anode Voltage*	V	110	215 Max.
Anode Current	mA	0.1	2 Max.
	1 (1 1 1 1 1		

SPECIFICATIONS

* Set anode voltage to Final Test Data value furnished with tube.

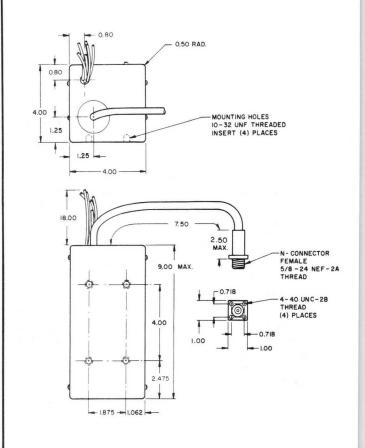
Weight, 9.5 lbs. Max. Color Code for 18" Flying Leads Heater Black Brown Heater Yellow Cathode Grid Green Anode Blue Red Helix Collector Orange

Mounting Position, Any RF Output Connector, Type N Female Magnetically Shielded

ENVIRONMENTAL DATA

Separation from Passive Magnetic Materials, None Required No Forced Air Cooling Required Below +60⁰ C Ambient RFI Shielded and Filtered

OUTLINE DRAWING

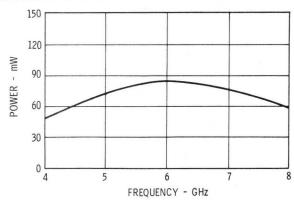


SCHEMATIC DIAGRAM

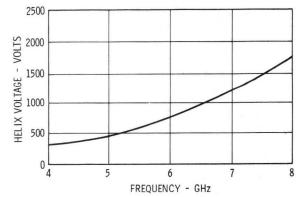
Notes:

- (1) For safety, housing should be grounded through mounting screws.
- 2 50 150 V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.
- (3) Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.

POWER OUTPUT



TUNING VOLTAGE



WATKINS = JOHNSON COMPANY 3333 HILLVIEW AVENUE = STANFORD INDUSTRIAL PARK PALO ALTO, CALIFORNIA 94304 TWX 910-373-1253 PHONE (415) 326-8830 Telex: 348-415

BACKWARD-WAVE OSCILLATOR



APRIL 1969

The WJ-2051 is a magnetically shielded and RFI shielded voltage tunable oscillator utilizing a bifilar (dual) helix and a permanent-magnet focusing system. Minimal stray magnetic field, low RF radiation, and an immunity to external ac or dc magnetic fields make the WJ-2051 ideal for use in signal generating and sweeping equipment. The WJ-2051 is also well suited for use in radar receivers (as local oscillator), in frequency diversity transmitters (as master oscillator), and in ECM equipment. Fine grain variation of frequency versus voltage is extremely low. The WJ-2051 delivers smooth power output over the band with low operating cathode current. Power can be modulated and leveled with either grid or anode



circuit. All voltages are isolated from housing and RF output connector for maximum flexibility in circuit applications.

	UNITS	TYPICAL VALUES	ABSOLUTE RATINGS
Nominal Frequency Band	GHz	2.0 - 4.0	
Power Output into Load with VSWR = 1.25:1	mW	40 - 100	30 Min.
Power Output Variation	dB		8 Max.
Fine Grain Variation	dB/100 MHz		3 Max.
Tube VSWR			2.5:1 Max.
Frequency Pulling into 2 : 1 Load (Any Phase)	MHz	3	6 Max.
Ratio of Signal to Noise Power 30 MHz Away	dB/MHz BW	95	85 Min.
Ratio of Signal to 2nd Harmonic Output	dB	30	20 Min.
Long-term Sensitivity to Heater Voltage	MHz/V	5	
Sensitivity to Anode Voltage	MHz/V	1.0	
Sensitivity to Grid Voltage	MHz/V	6	
Tuning Curve Slope			
Low End (2.0 GHz)	MHz/V	3.5	
Mid-Frequency (3.0 GHz)	MHz/V	2.2	
High End (4.0 GHz)	MHz/V	1.3	
Grid RF Cutoff Voltage	V	-7	-20 Max.
Capacitance; Cathode to all other Electrodes,			
including Heater and Housing	pF	55	75 Max.
Capacitance; Grid to all other Electrodes,			
including Housing	pF	55	75 Max.
Capacitance; Helix and Collector to all other			
Electrodes and Housing	pF	245	275 Max.
Heater Voltage	V dc	6.3	6.3 ±5%
Heater Current	Α	0.75	0.4 - 1.2
			Min./Max.
Cathode Current	mA	8	10 Max.
Helix Voltage Range	V	285 - 1310	250 - 1500
			Min./Max.
Helix Current	mA	1.5	3 Max.
Anode Voltage*	V	110	215 Max.
Anode Current	mA	0.1	2 Max.
	ale and southly have a		

* Set anode voltage to Final Test Data value furnished with tube.

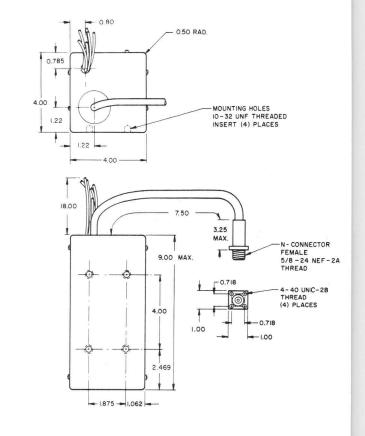
SPECIFICATIONS

Weight, 11.0 lbs. Max. Color Code for 18" Flying Leads Heater Black Heater Brown Cathode Yellow Grid Green Anode Blue Helix Red Collector Orange Mounting Position, Any RF Output Connector, Type N Female Magnetically Shielded

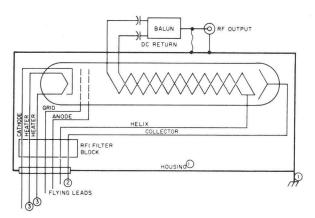
ENVIRONMENTAL DATA

Separation from Passive Magnetic Materials, None Required No Forced Air Cooling Required Below +60⁰ C Ambient RFI Shielded and Filtered

OUTLINE DRAWING



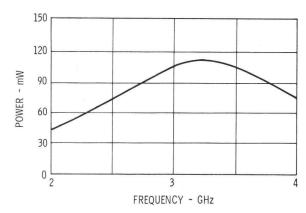
SCHEMATIC DIAGRAM



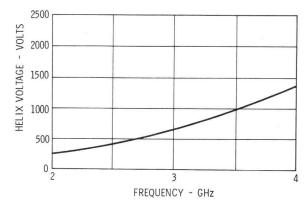
Notes:

- (1) For safety, housing should be grounded through mounting screws.
- (2) 50 150 V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.
- (3) Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.

POWER OUTPUT



TUNING VOLTAGE



WATKINS ■ JOHNSON COMPANY 3333 HILLVIEW AVENUE ■ STANFORD INDUSTRIAL PARK PALO ALTO, CALIFORNIA 94304 TWX 910-373-1253 PHONE (415) 326-8830 Telex: 348-415



November 1968

BACKWARD-WAVE OSCILLATOR

The WJ-2052 is a magnetically and RFI shielded oltage tunable oscillator utilizing a single helix nd permanent magnet focusing system to cover he frequency range from 12.4 to 18.0 GHz. Unaturated magnetic shielding reduces the magnetic ield strength at any point, 1/2 inch from the housng, to a value of less than 10 gauss. Interference equirements of MIL-STD-461 are met or exceeded y integral RFI shielding and filtering.

'he combination of immunity to external ac or dc nagnetic fields, minimal stray generated magnetic ields, and extremely low RF radiation, makes the VJ-2052 ideal for a number of applications, includng the following: signal generating and sweeping quipment, radar receivers (as local oscillator), requency diversity transmitters, and ECM equipnent (as master oscillator).

The fine grain variation of frequency versus voltige is extremely low. The WJ-2052 delivers mooth power output over the band with low oper-



ating cathode current and low electrode voltages. Power can be modulated and leveled with either grid or anode circuits. All voltages are isolated from the housing for maximum flexibility in circuit applications.

SPECIFICATIONS

ŭ		YPICAL VALUES	ABSOLUTE RATINGS
Power Output Into Load With VSWR = 1.25:1 n Power Output Variation . Fine Grain Variation . Tube VSWR . Frequency Pulling Into 2:1 Load (Any Phase) . Ratio of Signal to Noise Power 30 MHz Away . Long-Term Sensitivity to Heater Voltage . Sensitivity to Anode Voltage .	MHz/V	0 - 100	20 Min. 8 Max. 3 Max. 2.5:1 Max.
Tuning Curve Slope Low End (12.4 GHz) Mid-Frequency (15.2 GHz) High End (18.0 GHz) Grid RF Cutoff Voltage Capacitance; Cathode to All Other Electrodes Including Heater and Housing Capacitance; Grid to All Other Electrodes and Housing and Housing		$\begin{array}{cccccccccccccccccccccccccccccccccccc$	20 Max.
Heater Voltage Y Heater Current Y Cathode Current* Y	DF	0.67	6.3 ± 5% 0.4 Min. 1.2 Max. 15 Max.
Anode Voltage	nA	$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	3 Max. 215 Max.

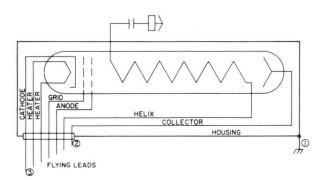
* Set cathode current to Final Test Data value furnished with tube.

Weight, 6.5 lbs. Max. Color Code for 18" Flying Leads Heater Black Heater Brown Cathode Yellow Grid Green Anode Blue Helix Red Collector Orange Mounting Position, Any RF Output Connector, Mate With UG 419/U Waveguide Flange Magnetically Shielded

ENVIRONMENTAL DATA

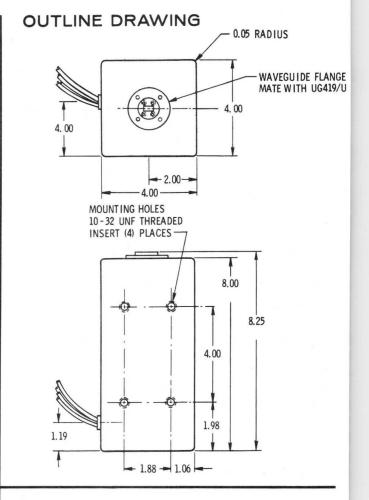
Separation From Passive Magnetic Materials, None Required No Forced Air Cooling Required Below +60^o C Ambient RFI Shielded and Filtered to Meet or Exceed MIL-STD-461

SCHEMATIC DIAGRAM

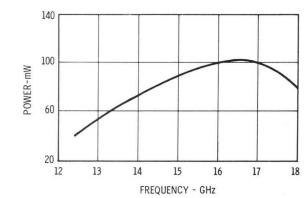


Notes:

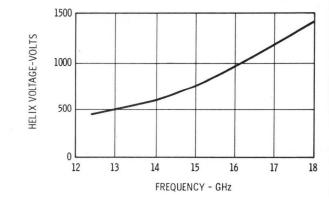
- (1) For safety, housing should be grounded through mounting screws.
- (2) 50 150 V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.
- (3) Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.



POWER OUTPUT



TUNING VOLTAGE



WATKINS ■ JOHNSON COMPANY 3333 HILLVIEW AVENUE ■ STANFORD INDUSTRIAL PARK PALO ALTO, CALIFORNIA 94304 TWX 910-373-1253 PHONE (415) 326-8830 Telex: 348-415

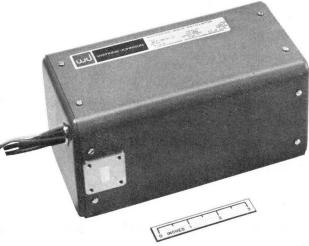
APRIL 1969

The WJ-2056 is a magnetically and RFI shielded, voltage tunable oscillator, utilizing a single helix and permanent magnet focusing system to cover the frequency range from 12.4 to 18.0 GHz. Interference requirements of MIL-STD-461 are met or exceeded by the integral RFI shielding and filtering.

The combination of immunity to external ac or dc magnetic fields, minimal stray generated magnetic fields and very low RF radiation make the WJ-2056 ideal for a number of applications, including the following: signal generating and sweeping equipment, radar receivers (as local oscillator), frequency diversity transmitters and ECM equipment (as master oscillator.).

The fine grain variation of frequency versus voltage is extremely low. The WJ-2056 delivers smooth power output over the band with low operating cathode current. Power can be modulated and leveled with either grid or anode circuits. All voltages are isolated from the housing for maximum flexibility in circuit applications.

BACKWARD-WAVE OSCILLATOR WJ-2056



SPECIF	ICATIONS		
		TYPICAL VALUES	
Frequency Band	GHz		12.4 - 18.0
Power Output into Load with VSWR = 1.25:1 Power Output Variation	mw	50 - 100	40 Min. 6 Max
Fine Grain Variation	dB/250 MHz .		3 Max.
Tube VSWR			2.5:1 Max.
Frequency Pulling into 2:1 Load (Any Phase) Ratio of Signal to Noise Power 30 MHz Away	dB/MHz BW	1	15 Max. 85 Min.
Long-term Sensitivity to Heater Voltage	MHz/V	15	
Sensitivity to Anode Voltage	MHz/V	2	
Sensitivity to Grid Voltage	IVIHZ/V	8	
Low End (12.4 GHz)	MHz/V	7.5	
Mid-Frequency (15.2 GHz)	MHz/V	4.4	
High End (18.0 GHz) Grid RF Cutoff Voltage	IVIHZ/V V	2.2	
Capacitance: Cathode to all other Electrodes			
including Heater and Housing	pF	50	90 Max.
Capacitance; Grid to all other Electrodes	pF		
Capitance: Helix and Collector to all other			
Electrodes and Housing	pF	130	170 Max.
Heater Voltage	V ac	0.75	0.4 to 1.2
			Min./Max.
Cathode Current*	mA		15 Max.
			Min /Max
Helix Current	mA	1.8	3 Max.
Anode Voltage			
*Cot asthede surrent to Einel Test Data value furnished with tube			

*Set cathode current to Final Test Data value furnished with tube.

WJ-2056

MECHANICAL CHARACTERISTICS

Weight, 9 lbs. Max.

Color Code for 18" Flying Leads

Heater Black Heater Brown Cathode Yellow Grid Green Anode Blue Helix Red Collector Orange

Mounting Position, Any

RF Output Connector, Mate with UG 419/U

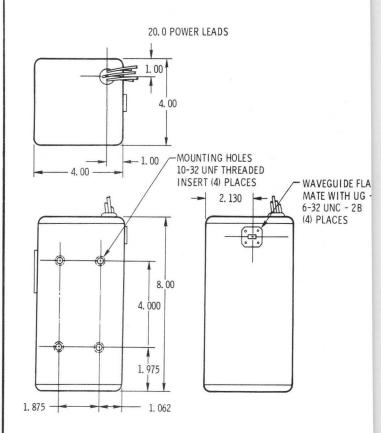
Separation from Passive Magnetic Materials, None Required

ENVIRONMENTAL CHARACTERISTICS

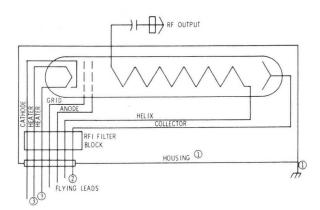
Magnetically Shielded

- No Forced Air Cooling Required Below +60°C Ambient
- RFI Shielded and Filtered to Meet or Exceed MIL-STD-461

OUTLINE DRAWING



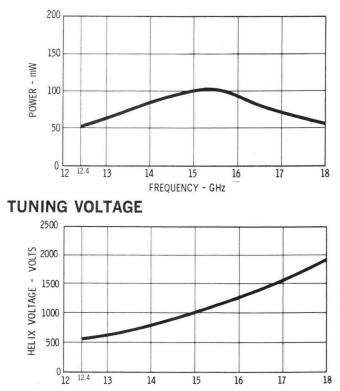
SCHEMATIC DIAGRAM



Notes:

- For safety, housing should be grounded through mounting screws.
- 2. 50-150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.
- (3) Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc supply, connect cathode to positive (+) side of heater supply.

POWER OUTPUT



FREQUENCY - GHz

DECEMBER 1970

BACKWARD-WAVE OSCILLATOR WJ-2056-50

The WJ-2056-50 is a magnetically and RFI shielded, voltage-tunable oscillator, utilizing a single helix and permanent-magnet focusing system to cover the fre-quency range from 12.4 to 18.0 GHz. Interference requirements of MIL-STD-461 are met or exceeded by the integral RFI shielding and filtering.

The combination of immunity to external ac or dc magnetic fields, minimal stray generated magnetic fields and very low RF radiation make the WJ-2056-50 ideal for a number of applications, including the following: signal generating and sweeping equipment, radar receivers (as local oscillator), frequency diversity transmitters and ECM equipment (as master oscillator).

The fine grain variation of frequency versus voltage is extremely low. The WJ-2056-50 delivers smooth power output over the band with low operating cathode current. Power can be modulated and leveled with either grid or anode circuits. All voltages are isolated from the housing for maximum flexibility in circuit applications.



SPECIFICATIONS

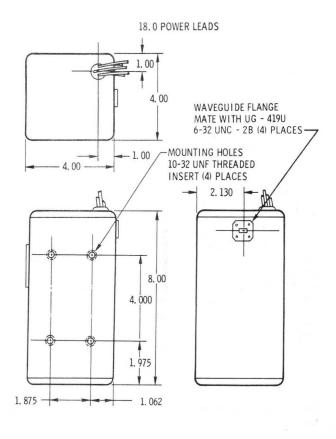
SFEGIFICA	ATIONS	TUDIOAL	ADCOLUTE
Frequency Dond	onno	TYPICAL VALUES	
 Frequency Band	.GПZ	EQ 100	12.4 · 10.0
Power Output into Load with VSWR = 1.25:1		.50 - 100	· · · 50 Win.
Power Output Variation	-UD	*************	2 Max
Fine Grain Variation			
Tube VSWR	•••••••••••••••••••••••••••••••••••••	1	2.3.1 Max.
Frequency Pulling into 2:1 Load (Any Phase)		.1	IS Wax.
Ratio of Signal to Noise Power 30 MHz Away		.90	65 1/111.
Long-term Sensitivity to Heater Voltage			
Sensitivity to Anode Voltage			
Sensitivity to Grid Voltage Tuning Curve Slope		.0	
Low End (12.4 GHz)		75	
Mid-Frequency (15.2 GHz)	MHz/V	1 1	
High End (18.0 GHz)	MHz/V	22	
Grid RF Cutoff Voltage	V	-10	-25 Max
Canaditance: Cathodo to all other Electrodes			
including Heater and Housing	nF	50	90 Max
Capacitance; Grid to all other Electrodes	pr		
including Housing	nF	40	80 Max
Capitaneas Halix and Callector to all other			
Electrodes and Housing	nF	130	
Heater Voltage	V dc	6.3	6.3 ±5%
Heater Current	Α	.0.75	0.4 to 1.2
			Min./Max.
Cathode Current*	.mA	10.0	15 Max.
Helix Voltage Range	.V	570 - 1930	. 500 - 2100
Helix Current	.mA	1.8	З Мах.
Anode Voltage	.V	130	215 Max.
Anode Current	.mA	0.1	1 Max.
*Set cathode current to Final Test Data value furnished with tube.			

WJ-2056-50

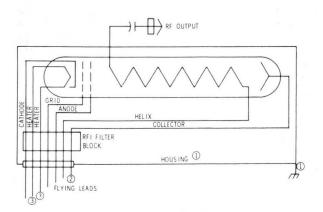
OUTLINE DRAWING

MECHANICAL CHARACTERISTICS

Height 4 inches (102 mm) Width 4 inches (102 mm) Length 8 inches (203 mm) Weight 9 pounds (4.08 Kg) max.
Color Code for 18" Flying Leads
Heater Black
Heater Brown Cathode Yellow
Grid Green
Anode Blue
Helix Red
Collector Orange
Mounting Position, Any
RF Output Connector, Mate with UG 419/U
Separation from Passive Magnetic Materials, None Required
ENVIRONMENTAL CHARACTERISTICS
Magnetically Shielded
No Forced-Air Cooling Required Below +60°C Ambient
RFI Shielded and Filtered



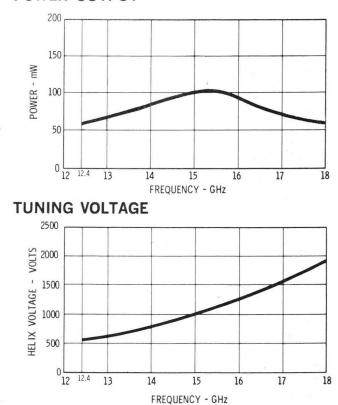
SCHEMATIC DIAGRAM



Notes:

- (1) For safety, housing should be grounded through mounting screws.
- (2) 45-150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.
- (3.) Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc supply, connect cathode to positive (+) side of heater supply.

POWER OUTPUT



APRIL 1969

ARSOLUTE

BACKWARD-WAVE OSCILLATOR WJ-2057



TYPICAL

The WJ-2057 is a magnetically shielded and RFI shielded, voltage tunable oscillator, utilizing a single helix and a permanent-magnet focusing system. Unsaturated magnetic shielding reduces the magnetic field strength to less than 10 gauss, 1/2 inch from any point of the housing. RFI shielding and filtering allow the WJ-2057 to meet levels of MIL-I-6181D. An immunity to external ac or dc magnetic fields, together with minimal stray magnetic fields and low RF radiation, makes the WJ-2057 ideal for signal generating and sweeping equipment, for use in radar receivers (as local oscillator), in frequency diversity transmitters (as master oscillator), and in ECM equipment. Fine grain variation of frequency versus voltage is extremely low. The WJ-2057 delivers smooth power output over the band with low operating cathode current. Power can be modulated and leveled with either grid or anode circuits. All voltages are isolated from the housing for maximum flexibility in circuit applications.

SPECIFICATIONS

	UNITS		RATINGS
Nominal Frequency Band Power Output into Load with VSWR = 1.25 Power Output Variation Fine Grain Variation Tube VSWR Frequency Pulling into 2:1 Load (Any Phase) Spurious Oscillation	.mW .dB .dB/250 MHz .		20 Min. 6 Max. 3 Max. 2.5:1 Max.
Ratio of Signal to Total Spurious Output	.dB/MHz .MHz/V .MHz/V		40 Min. 80 Min.
Tuning Curve Slope Low End (18 MHz) Mid-Frequency (22.5 MHz) High End (26.5 MHz) Grid r.f. Cutoff Voltage	MHz/V MHz/V	6.5	—20 Max.
Capacitance; Cathode to all other Electrodes including Heater and Housing	pF		50 Max.
Capitance; Helix and Collector to all other Electrodes including Heater and Housing Heater Voltage Heater Current	pF	90	130 Max. 6.3 ±5% 0.4 - 1.2
Cathode Current*	V	530 - 1820 .	450 - 2000 Min./Max.
Helix Current	V	115	250 Max.

*Set cathode current to Final Test Data value furnished with tube.

WJ-2057

MECHANICAL CHARACTERISTICS

Weight, 6.5 lbs. Max.

Color Code for 18" Flying Leads Heater Black (neg) Heater Brown Cathode Yellow Grid Green Anode Blue Helix Red Collector Orange

Mounting Position, Any

RF Output Connector, UG-595/U Flange

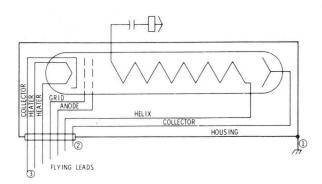
Magnetically Shielded

ENVIRONMENTAL CHARACTERISTICS

- Separation from Passive Magnetic Materials, None Required
- No Forced Air Cooling Required Below +60°C Ambient

RFI Shielded and Filtered to Meet Levels of MIL-I-6181D

SCHEMATIC DIAGRAM

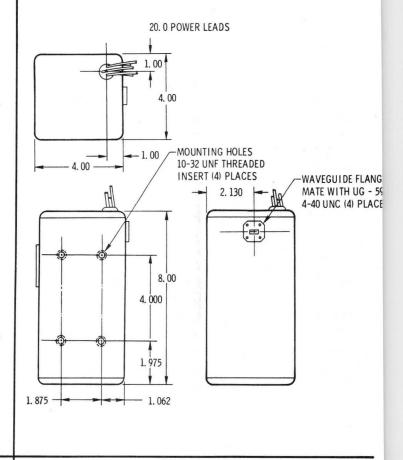


Notes:

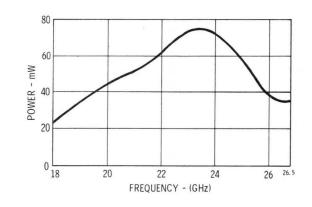
 For safety, housing should be grounded through mounting screws.

- 2. 50-150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.
- (3) Heater must always be negative with respect to cathode One heater lead may be tied to cathode.

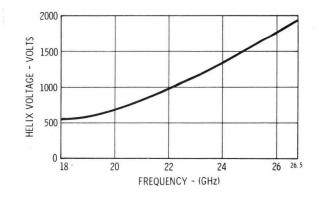
OUTLINE DRAWING



POWER OUTPUT



TUNING VOLTAGE



DECEMBER 1970

BACKWARD-WAVE OSCILLATOR WJ-2057-50

The WJ-2057-50 is a magnetically shielded and RFI shielded voltage tunable oscillator utilizing a single helix and a permanent-magnet focusing system. Unsaturated magnetic shielding reduces the magnetic field strength along the outside of the housing. RFI shielding and filtering enables this tube to meet MIL-I-6181D.

An immunity to external ac or dc magnetic fields, together with a minimal stray magnetic field and low RF radiation, makes the WJ-2057-50 ideal for signal generating and sweeping equipment, for use in radar receivers (as local oscillator), in frequency diversity transmitters (as master oscillator), and in ECM equipment. Fine grain variation of frequency versus voltage is extremely low. Power output and tuning curves are uniform and highly reproducible.

The WJ-2057-50 delivers smooth power output over the band with low operating cathode current. Power can be modulated and leveled with either grid or



anode circuits. All voltages are isolated from housing and RF output connector for maximum flexibility in circuit applications.

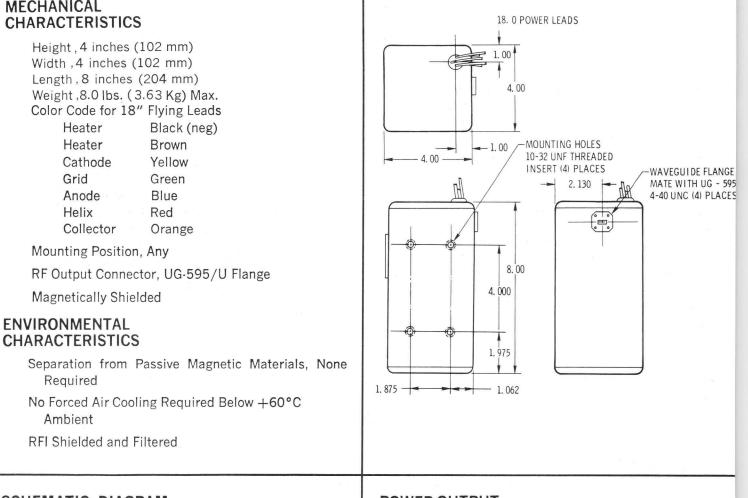
SPECIFICA	TIONS		
	UNITS	TYPICAL VALUES	ABSOLUTE RATINGS
Frequency Band Power Output into Load with VSWR = 1.25:1 Power Output Variation Fine Grain Variation Tube VSWR Frequency Pulling into 2:1 Load (Any Phase) Spurious Oscillation	mW dB dB/250 MHz	.22 - 70	20 Min. 8 Max. 3 Max. 2.5:1 Max
Ratio of Signal to Total Spurious Output	ЫВ/МНz МНz/V	.90	40 Min. 80 Min.
Sensitivity to Grid Voltage Tuning Curve Slope Low End (18 MHz) Mid-Frequency (22.5 MHz) High End (26.5 MHz)	MHz/V MHz/V MHz/V MHz/V	.10 .12 .6.5 .4	
Grid r.f. Cutoff Voltage Capacitance; Cathode to all other Electrodes including Heater and Housing	/	.—10	
Capacitance; Grid to all other Electrodes including Heater and Housing Capitance; Helix and Collector to all other Electrodes			
including Heater and Housing	/ A	.0.67	. 6.3 ±5% . 0.4 - 1.2 Min /Max
Cathode Current*	mA	.6 .520–1800	10 Max.
Helix Current	/	.115	3 Max. 215 Max.

*Set cathode current to Final Test Data value furnished with tube.

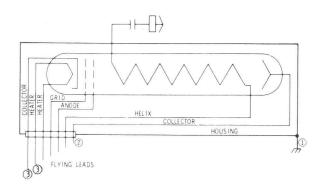
WJ-2057-50

MECHANICAL **CHARACTERISTICS**

OUTLINE DRAWING



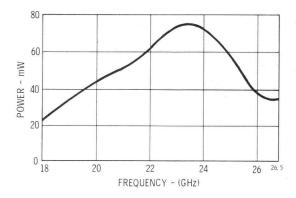
SCHEMATIC DIAGRAM



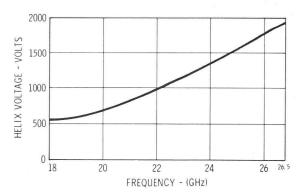
Notes:

- (1) For safety, housing should be grounded through mounting screws.
- (2) 45-150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.
- (3) Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.





TUNING VOLTAGE



APRIL 1969

BACKWARD-WAVE OSCILLATOR WJ-2058



	UNITS	TYPICAL VALUES	ABSOLUTE RATINGS
Nominal Frequency Band Power Output into Load with VSWR = 1.25:1 Power Output Variation Fine Grain Variation Tube VSWR	.mW .dB .dB/500 MHz	12-35	10 Min. 8 Max. 3 Max.
Frequency Pulling into 2:1 Load (Any Phase)Ratio of Signal to Noise Power 30 MHz AwayLong-term Sensitivity to Heater VoltageSensitivity to Anode VoltageSensitivity to Grid Voltage	.MHz	6	10 Max.
Tuning Curve Slope Low End (26.5 GHz) Mid-Frequency (33.25 GHz) High End (40 GHz) Grid RF Cutoff Voltage	.MHz/V	10	. —20 Max.
Capacitance; Cathode to all other Electrodes including Heater and Housing	.pF	.35	50 Max.
including Housing			
Electrodes and Housing Heater Voltage Heater Current Heater Current	.V dc		$0.3 \pm 5\%$
Cathode Current*	.V	520-1940	5 Max. . 500-2100 Min /Max.
Helix Current Anode Voltage Anode Current	.V	. 150	250 Max.

*Set cathode current to Final Test Data value furnished with tube.

The WJ-2058 is a magnetically shielded and RFI

shielded, voltage tunable oscillator, utilizing a single

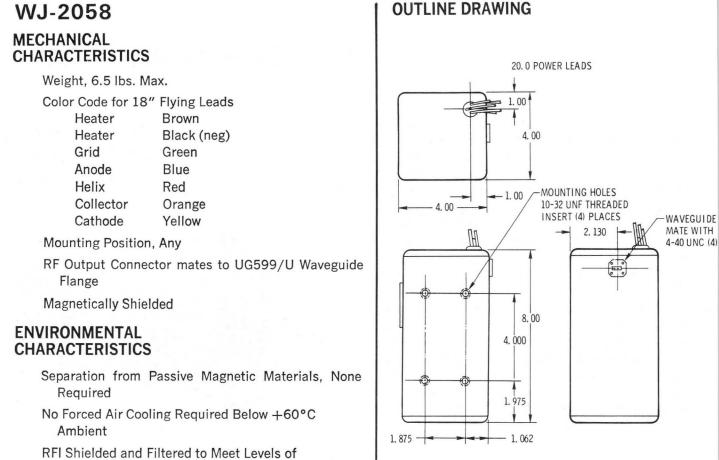
helix and a permanent-magnet focusing system. Unsaturated magnetic shielding reduces the magnetic

field strength to less than 10 gauss, 1/2 inch from any point of the housing. RFI shielding and filtering allow the WJ-2058 to meet levels of MIL-I-6181D. An im-

munity to external ac or dc magnetic fields, together with minimal stray magnetic fields and low RF radiation, makes the WJ-2058 ideal for signal generating and sweeping equipment, for use in radar receivers (as local oscillator), in frequency diversity transmitters (as master oscillator), and in ECM equipment. Fine grain variation of frequency versus voltage is extremely low. The WJ-2058 delivers smooth power output over the band with low operating cathode current. Power can be modulated and leveled with either grid

or anode circuits. All voltages are isolated from the housing for maximum flexibility in circuit applications.

SPECIFICATIONS



POWER OUTPUT

50

40

≥ ≣ 30

POWER .

10

0

2500

2000 S110/

1500 VOLTAGE

1000

500

0 26 26.5 28

HELIX \

26.5 26

TUNING VOLTAGE

28

30

30

32

34

FREQUENCY - GHz

36

34

FREQUENCY - GHz

32

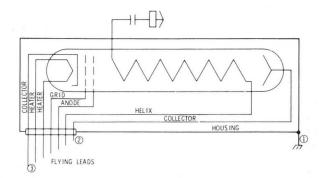
36

40

38

MIL-I-6181D

SCHEMATIC DIAGRAM



Notes:

- (1.) For safety, housing should be grounded through mounting screws.
- (2.)50-150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.
- (3.) Heater must always be negative with respect to cathode One heater lead may be tied to cathode.

PRINTED IN U.S.A.

40

38

DECEMBER 1970

BACKWARD-WAVE OSCILLATOR WJ-2058-50

The WJ-2058-50 is a magnetically shielded and RFI shielded voltage tunable oscillator utilizing a bifilar (dual helix) and a permanent-magnet focusing system. Unsaturated magnetic shielding reduces the magnetic field strength along the outside of the housing. RFI shielding and filtering enables this tube to meet MIL-I-6181D.

An immunity to external ac or dc magnetic fields, together with a minimal stray magnetic field and low RF radiation, makes the WJ-2058-50 ideal for signal generating and sweeping equipment, for use in radar receivers (as local oscillator), in frequency diversity transmitters (as master oscillator), and in ECM equipment. Fine grain variation of frequency versus voltage is extremely low. Power output and tuning curves are uniform and highly reproducible.

The WJ-2058-50 delivers smooth power output over the band with low operating cathode current. Power can be modulated and leveled with either grid or



anode circuits. All voltages are isolated from housing and RF output connector for maximum flexibility in circuit applications.

	SPECIFICATIONS UNITS	TYPICAL VALUES	ABSOLUTE RATINGS
Frequency Band Power Output into Load with VSWR = 1.25:1 Power Output Variation		12-35	7 Min. 8 Max.
Fine Grain Variation Tube VSWR Frequency Pulling into 2:1 Load (Any Phase)			. 2.5:1 Max.
Ratio of Signal to Noise Power 30 MHz Away Long-term Sensitivity to Heater Voltage	dB/MHz 	95 30	
Sensitivity to Anode Voltage Sensitivity to Grid Voltage Tuning Curve Slope	MHz/V	2 25	
Low End (26.5 GHz)		10	
Grid RF Cutoff Voltage	V	—7	—25 Max.
Capacitance; Cathode to all other Electrodes including Heater and Housing	pF	.35	50 Max.
Capacitance; Grid to all other Electrodes including Housing	pF	.25	50 Max.
Capitance; Helix and Collector to all other Electrodes and Housing	pF	.60	100 Max.
Heater Voltage Heater Current	V dc	.65	6.3 ±5% 0.4 to 1.2 Min./Max.
Cathode Current*		4 520-1940	5 Max. 480-2050 Min./Max.
Helix Current Anode Voltage Anode Current		150	1.5 Max. 215 Max.
*Set asthade surrant to Final Test Data value furnished with			

*Set cathode current to Final Test Data value furnished with tube.

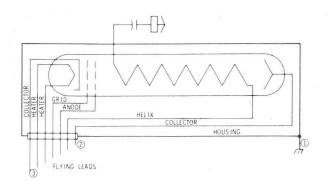
OUTLINE DRAWING

WJ-2058-50 MECHANICAL CHARACTERISTICS

Width	4 inches (102 mm) 4 inches (102 mm) 8 inches (204 mm) 8.0 lbs. (3.63 Kg) Max. Flying Leads Black (neg) Brown				
Cathode	Yellow				
Grid	Green				
Anode	Blue				
Helix	Red				
Collector	Orange				
Mounting Position,	Any				
RF Output Connector mates to UG599/U Waveguide Flange Magnetically Shielded					
ENVIRONMENTAL CHARACTERISTICS					
Separation from P Required	assive Magnetic Materials, None				

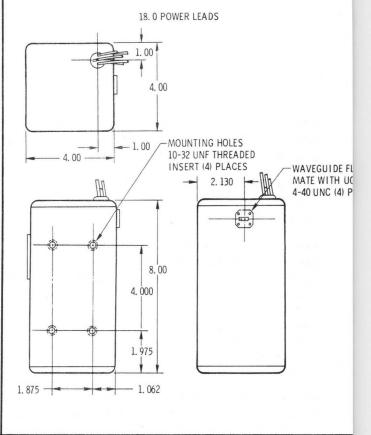
No Forced Air Cooling Required Below +60°C Ambient RFI Shielded and Filtered

SCHEMATIC DIAGRAM

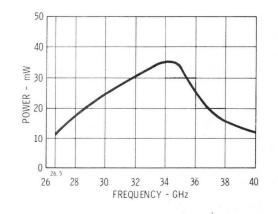


Notes:

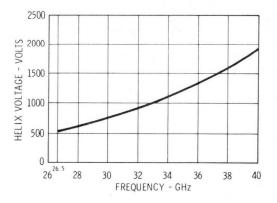
- For safety, housing should be grounded through mounting screws.
- (2) 45-150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.
- (3) Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.



POWER OUTPUT



TUNING VOLTAGE



The WJ-2060-50 is a magnetically and RFI shielded, voltage-tunable oscillator, utilizing a single helix and permanent-magnet focusing system to cover the frequency range from 12.4 to 18.0 GHz. Interference requirements of MIL-STD-461 are met or exceeded by the integral RFI shielding and filtering.

The combination of immunity to external ac or dc magnetic fields, minimal stray generated magnetic fields and very low RF radiation make the WJ-2060-50 ideal for a number of applications, including the following: signal generating and sweeping equipment, radar receivers (as local oscillator), frequency diversity transmitters and ECM equipment (as master oscillator).

The fine grain variation of frequency versus voltage is extremely low. The WJ-2060-50 delivers smooth power output over the band with low operating cathode curent. Power can be modulated and leveled with either grid or anode circuits. All voltages are isolated from the housing for maximum flexibility in circuit applications. DECEMBER 1970

ABSOLUTE

BACKWARD-WAVE OSCILLATOR WJ-2060-50



TYDICAL

SPECIFICATIONS

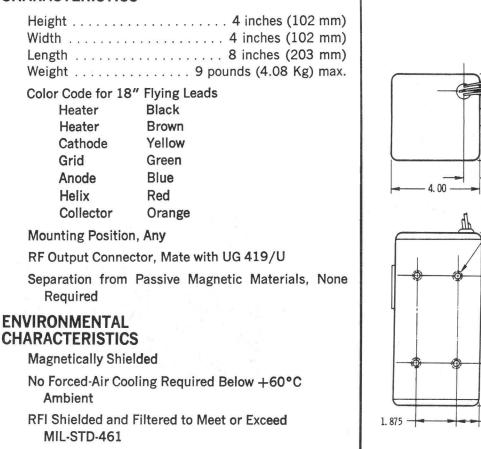
	UNITS	VALUES	RATINGS
Frequency Band	GHz		. 12.4 - 18.0
Power Output into Load with VSWR = 1.25:1	mW	50 - 100	50 Min.
Power Output Variation	dB		8 Max.
Fine Grain Variation			
Tube VSWR			. 2.5:1 Max.
Frequency Pulling into 2:1 Load (Any Phase)	MHz	1	15 Max.
Ratio of Signal to Noise Power 30 MHz Away	dB/MHz BW	95	85 Min.
Long-term Sensitivity to Heater Voltage	MHz/V	15	
Sensitivity to Anode Voltage			
Sensitivity to Grid Voltage	VIHZ/V	8	
Tuning Curve Slope Low End (12.4 GHz)	MHz /V	75	
Mid-Frequency (15.2 GHz)	MHz/V	44	
High End (180 GHz)	MHz /V	22	
Grid RF Cutoff Voltage	V		
including Heater and Housing ,	. ρF	50	90 Max.
L'anacitance' larid to all other Flectrodes			
including Housing	. pF	40	80 Max.
Electrodes and Housing	. pF	130	170 Max.
Heater Voltage	V dc	6.3	$ 6.3 \pm 5\%$
Heater Current	A	0./ 5	Min./Max.
Cathode Current*	mΛ	10.0	15 Max
Helix Voltage Range	V .	570 - 1930	500 - 2100
			Min./Max.
Helix Current	mA	1.8	
Anode Voltage	V		215 Max.
Anode Current		0.1	1 Max.
*Set cathode current to Final Test Data value furnished with tube.			

*Set cathode current to Final Test Data value furnished with tube.

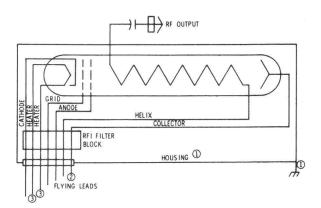
WJ-2060-50

MECHANICAL CHARACTERISTICS

OUTLINE DRAWING

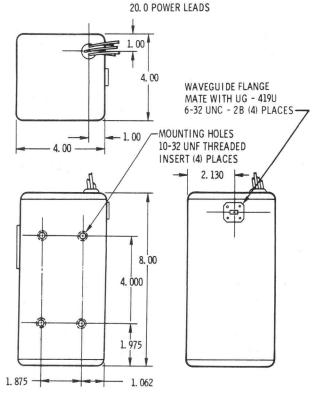


SCHEMATIC DIAGRAM

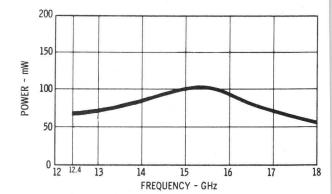


Notes:

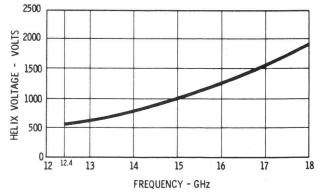
- 1) For safety, housing should be grounded through mounting screws.
- (2) 45.150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.
- (3) Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc supply, connect cathode to positive (+) side of heater supply.



POWER OUTPUT



TUNING VOLTAGE



DECEMBER 1970

BACKWARD-WAVE OSCILLATOR WJ-2061-50



SPECIFICATIONS

	UNITS	TYPICAL VALUES	ABSOLUTE RATINGS
Frequency Band	GHz		. 18.0–26.5
Power Output into Load with VSWR = 1.25	mW		25 Min.
Power Output Variation	dB / 250 MHz		8 Max.
Tube VSWR			2.5:1 Max.
Frequency Pulling Into 2:1 Load (Any Phase)	MHz	2	6 Max.
Spurious Oscillation	dD	50	40 Min
Ratio of Signal to Total Spurious Output Ratio of Signal to Noise Power 30 MHz Away	dB/MHz	90	80 Min
Long-term Sensitivity to Heater Voltage	MHz/V		
Sensitivity to Anode Voltage	MHz/V	1	
Sensitivity to Grid Voltage Tuning Curve Slope	IVIHZ/V	10	
Low End (18 MHz)	MHz/V	12	
Mid-Frequency (22.5 MHz)	MHz/V	6.5	
High End (26.5 MHz) Grid RF Cutoff Voltage	MHZ/V	4	25 Max
Capacitance: Cathode to all other Electrodes			
including Heater and Housing	pF		50 Max.
Capacitance; Grid to all other Electrodes, including Heater and Housing			
Capacitance: Helix and Collector to all other			
Electrodes including Heater and Housing	pF		130 Max.
Heater Voltage	Vdc		$. 6.3 \pm 5\%$
Heater Current	A		Min /Max
Cathode Current*		6	10 Max.
Helix Voltage Range	V		480-2050
Helix Current	mΔ	15	Min./Max.
Anode Voltage			
Anode Current		0.2	1 Max.

* Set cathode current to Final Test Data value furnished with tube.

The WJ-2061-50 is a magnetically shielded and RFI

shielded voltage tunable oscillator utilizing a singlehelix and a permanent-magnet focusing system.

Unsaturated magnetic shielding reduces the magnetic field strength along the outside of the housing. RFI shielding and filtering enables this tube to meet

An immunity to external ac or dc magnetic fields, together with a minimal stray magnetic field and low RF radiation, makes the WJ-2061-50 ideal for signal generating and sweeping equipment, for use in radar receivers (as local oscillator), in frequency diversity transmitters (as master oscillator), and in ECM equip-

ment. Fine grain variation of frequency versus voltage is extremely low. Power output and tuning curves are uniform and highly reproducible.

The WJ-2061-50 delivers smooth power output over the band with low operating cathode current. Power can be modulated and leveled with either grid or anode circuits. All voltages are isolated from housing and RF output connector for maximum flexibility in circuit

MIL-I-6181D.

applications.

WJ-2061-50

OUTLINE DRAWING

MECHANICAL CHARACTERISTICS

Height, 4 inches (102 mm) Width, 4 inches (102 mm) Length, 8 inches (204 mm) max. Weight, 8 lbs. (3.63 Kg) max.

Color Code for 18" Flying Leads

Heater	Black
Heater	Brown
Cathode	Yellow
Grid	Green
Anode	Blue
Helix	Red
Collector	Orange

Mounting Position, Any

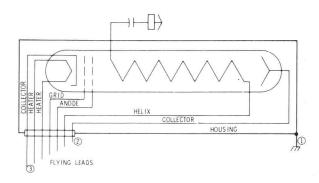
RF Output Connector, UG-595/U Flange

Magnetically Shielded

ENVIRONMENTAL CHARACTERISTICS

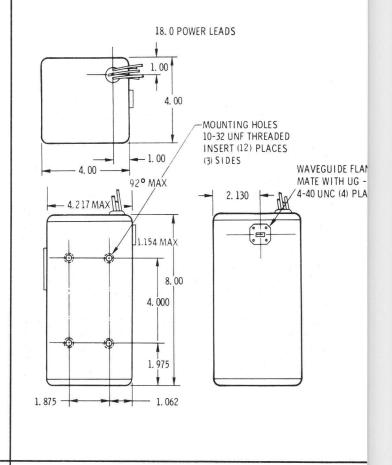
Separation from Passive Magnetic Materials, None Required No Forced Air Cooling Required Below +60°C Ambient RFI Shielded and Filtered to Meet MIL-I-6181D

SCHEMATIC DIAGRAM

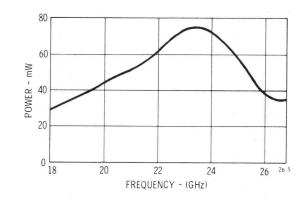


Notes:

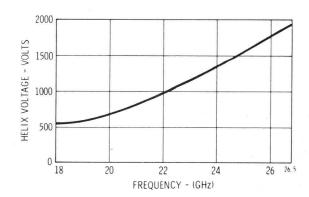
- 1. For safety, housing should be grounded through mounting screws.
- 2. 45–150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.
- Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.



POWER OUTPUT



TUNING VOLTAGE



DECEMBER 1970

ABSOLUTE

BACKWARD-WAVE OSCILLATOR WJ-2062-50

The WJ-2062-50 is a magnetically shielded and RFI shielded voltage tunable oscillator utilizing a single helix and a permanent-magnet focusing system.

Unsaturated magnetic shielding reduces the magnetic field strength along the outside of the housing. RFI shielding and filtering enables this tube to meet MIL-I-6181D.

An immunity to external ac or dc magnetic fields, together with a minimal stray magnetic field and low RF radiation, makes the WJ-2062-50 ideal for signal generating and sweeping equipment, for use in radar receivers (as local oscillator), in frequency diversity transmitters (as master oscillator), and in ECM equipment. Fine grain variation of frequency versus voltage is extremely low. Power output and tuning curves are uniform and highly reproducible.

The WJ-2062-50 delivers smooth power output over the band with low operating cathode current. Power can be modulated and leveled with either grid or



anode circuits. All voltages are isolated from housing and RF output connector for maximum flexibility in circuit applications.

TYPICAL

SPECIFICATIONS	SF	PE	CI	FI	CA	TI	0	NS
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	UNITS	VALUES	RATINGS
Frequency Band Power Output into Load with VSWR = 1.25:1 Power Output Variation Fine Grain Variation	mW	12-35	10 Min. 8 Max.
Tube VSWR Frequency Pulling into 2:1 Load (Any Phase) Ratio of Signal to Noise Power 30 MHz Away Long-term Sensitivity to Heater Voltage		6	2.5:1 Max.
Sensitivity to Anode Voltage Sensitivity to Grid Voltage Tuning Curve Slope Low End (26.5 GHz)	MHz/V MHz/V	2 25	
Mid-Frequency (33.25 GHz) High End (40 GHz) Grid RF Cutoff Voltage Capacitance; Cathode to all other Electrodes	.MHz/V	10	. —25 Max.
Capacitance, Cathode to all other Electrodes including Heater and Housing Capacitance; Grid to all other Electrodes including Housing	pF	.35	50 Max.
Capitance; Helix and Collector to all other Electrodes and Housing Heater Voltage Heater Current	pF	.60	100 Max. . 6.3 ±5%
Cathode Current*		4	Min./Max.
Helix Current Anode Voltage Anode Current	V	150	1.5 Max. 215 Max.

*Set cathode current to Final Test Data value furnished with tube.

WJ-2062-50

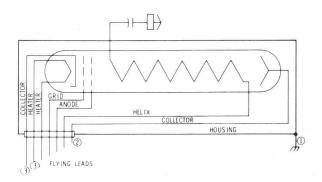
OUTLINE DRAWING

10 O DOWED LEADS

MECHANICAL CHARACTERISTICS

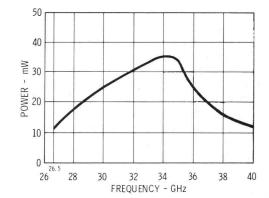
OTTAINOTERIOTIOO	18. 0 POWER LEADS
Height	
Width (102 mm)	1.00
Length	
Weight	
Color Code for 18" Flying Leads	4.00
Heater Black (neg)	
Heater Brown	
Cathode Yellow	
Grid Green	4.00
Anode Blue	INSERT (4) PLACES
Helix Red	A 2. 130 A MATE WITH U 4-40 UNC (4) I
Collector Orange	
Mounting Position, Any	
RF Output Connector mates to UG599/U Waveguide	
Flange	8.00
Magnetically Shielded	4.000
ENVIRONMENTAL	
CHARACTERISTICS	
Separation from Passive Magnetic Materials, None	1. 975
Required	
No Forced Air Cooling Required Below +60°C	1. 875
Ambient	
RFI Shielded and Filtered	

SCHEMATIC DIAGRAM



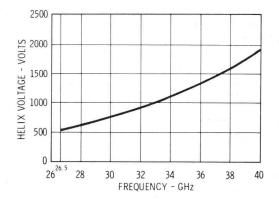
Notes:

- 1) For safety, housing should be grounded through mounting screws.
- 2 45-150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.
- (3) Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.



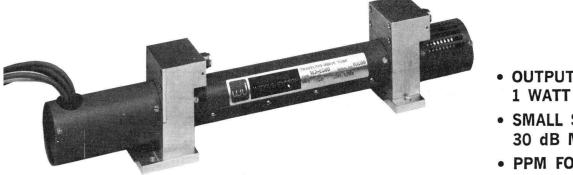
TUNING VOLTAGE

POWER OUTPUT



* JANUARY 1971

1 TO 2 GHz 1-WATT **TRAVELING-WAVE TUBE** WJ-2500



- OUTPUT POWER **1 WATT MINIMUM**
- SMALL SIGNAL GAIN 30 dB MINIMUM
- PPM FOCUSING

WJ-2500 is the 1 to 2 GHz unit in a series of mediumpower traveling-wave tubes developed by Watkins-Johnson for commercial application. It is intended for new or replacement use in one-watt amplifiers for laboratory work and driver applications.

This PPM-focused TWT offers the same performance

and high reliability found in all W-J power tubes. All voltages are isolated from housing and connectors for maximum flexibility in power supply configurations. The normal cooling requirement is 5 cfm over the collector heat exchanger; heat sink cooling can be provided upon special request.

SPECIFICATIONS

PERFORMANCE Frequency Saturated Power Output Small Signal Gain Total Gain Variation Noise Figure	1.25 to 2.50 watts 33 to 40 dB 7 dB	1 watt min. 30 dB min. 11 dB
ELECTRICAL REQUIREMENTS		RANGE
Heater Voltage	. 6.3 volts	. 6.2 to 6.4 volts
Heater Current	. 0.7 A	0.4 to 1.2 A
Cathode Voltage	. 0v	
Cathode Current		30 mA max.
Anode Voltage		
Helix Voltage		
Helix Current		
Grid Voltage		
Collector Voltage		
Collector Current		

*Supersedes WJ-2500-3 Technical Data Sheet dated July 1969.

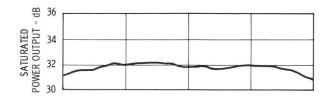
WJ-2500

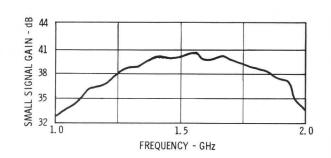
MECHANICAL CHARACTERISTICS

Height
Width 2.30 inches (58 mm) max.
Length 13.0 inches (330 mm) max.
Weight 3.5 pounds (1.59 Kg) max.
DC Connectors Flying Leads
RF Connectors Type "TNC" Female
Cooling Air Cooled
Focusing PPM

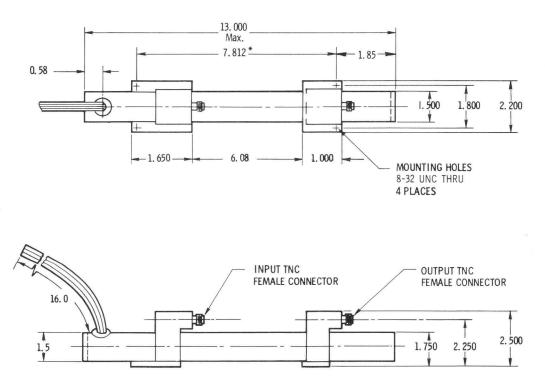
SCHEMATIC DIAGRAM RF INPUT **RF OUTPUT** ()ļ 1 1 HEATER HEATER -CATHODE ANODE HELIX COLLECTOR HEATER GRID SUPPLY SUPPLY SUPPLY SUPPLY SUPPLY

RF ELECTRICAL PERFORMANCE CHARACTERISTICS





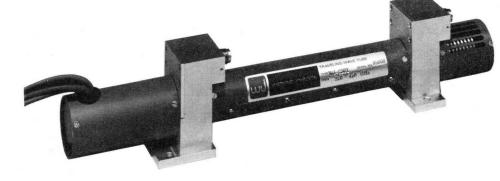
OUTLINE DRAWING



* VARIOUS MOUNTING CONFIGURATIONS AVAILABLE TO MEET CUSTOMER REQUIREMENTS.

* JANUARY 1971

2 TO 4 GHz 1-WATT TRAVELING-WAVE TUBE WJ-2501



- OUTPUT POWER 1 WATT MINIMUM
- SMALL SIGNAL GAIN 30 dB MINIMUM
- PPM FOCUSING

WJ-2501 is the 2 to 4 GHz unit in a series of mediumpower traveling-wave tubes developed by Watkins-Johnson for commercial application. It is intended for new or replacement use in one-watt amplifiers for laboratory work and driver applications. This PPM-fo cused TWT offers the same performance and high reliability found in all W-J power tubes. All voltages are isolated from housing and connectors for maximum flexibility in power supply configurat ions. The normal cooling requirement is 5 cfm over the collector heat exchanger; heat sink cooling can be provided upon special request.

SPECIFICATIONS

PERFORMANCE	TYPICAL	GUARANTEED
Frequency	1.9 to 4.1 GHz	2 to 4 GHz
Saturated Power Output	1.25 to 2.50 watts	1 watt min.
Small Signal Gain		30 dB min.,
Total Gain Variation	7 dB	
Noise Figure		30 dB max.
ELECTRICAL REQUIREMENTS	TYPICAL	RANGE
	6.3 volts	
Heater Current	0.7 A	0.4 to 1.2 A
Cathode Voltage	Ov	
Cathode Current	20 mA	30 mA max.
	375 volts	
	950 volts	
	1.0 mA	
	950 volts	
Collector Current	20 mA	30 mA max.

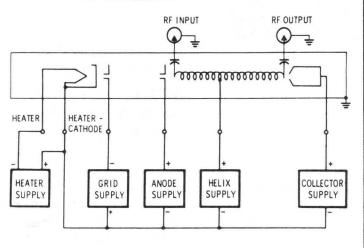
*Supersedes WJ-2501-3 Technical Data Sheet dated April 1970.

WJ 2501

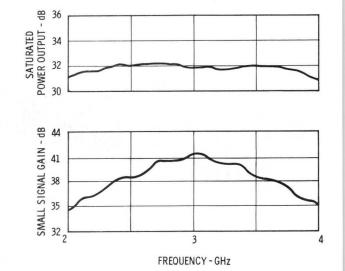
MECHANICAL CHARACTERISTICS

Height 2.6 inches (66 mm) max.
Width 2.30 inches (58 mm) max.
Length 13.0 inches (330 mm) max.
Weight
DC Connectors Flying Leads
RF Connectors
Cooling Air Cooled

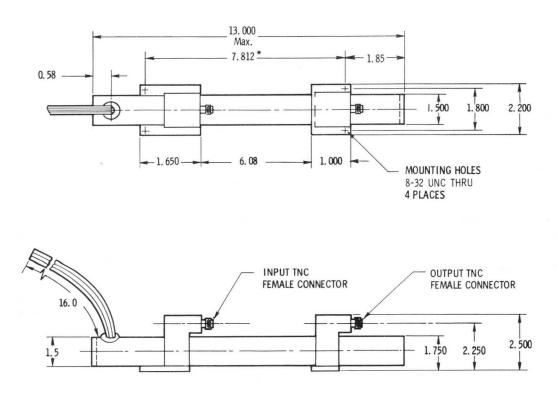
SCHEMATIC DIAGRAM



RF ELECTRICAL PERFORMANCE CHARACTERISTICS



OUTLINE DRAWING



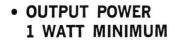
* VARIOUS MOUNTING CONFIGURATIONS AVAILABLE TO MEET CUSTOMER REQUIREMENTS.

JANUARY 1971

PRINTED IN U.S.A.

* JANUARY 1971

4 TO 8 GHz 1-WATT TRAVELING-WAVE TUBE WJ-2502



- SMALL SIGNAL GAIN 30 dB MINIMUM
- PPM FOCUSING

WJ-2502 is the 4 to 8 GHz unit in a series of mediumpower traveling-wave tubes developed by Watkins-Johnson for commercial application. It is intended for new or replacement use in one-watt amplifiers for laboratory work and driver applications. This PPM-focused TWT offers the same performance and high reliability found in all W-J power tubes. All voltages are isolated from housing and connectors for maximum flexibility in power supply configurations.

SPECIFICATIONS

PERFORMANCE Frequency Saturated Power Output Small Signal Gain Total Gain Variation Noise Figure	. 1.25 to 2.50 watts	4 to 8 GHz 1 watt min. 30 dB min. 11 dB
ELECTRICAL REQUIREMENTS	Typical	Range
Heater Voltage		6.2 to 6.4 volts
Heater Current		
Cathode Voltage		
Cathode Current		20 mA max.
Anode Voltage	.700 volts 50	00 to 1000 volts
Helix Voltage	. 2200 volts	00 to 2400 volts
Helix Current		
Grid Voltage		
Collector Voltage		
Collector Current	.16 mA	20 mA max.

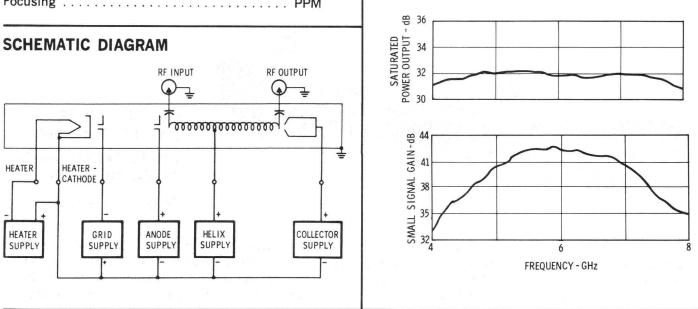
*Supersedes WJ-2502-3 Technical Data Sheet dated June 1970.

WJ 2502

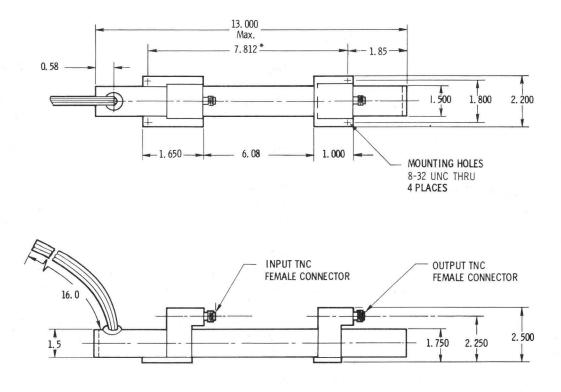
MECHANICAL CHARACTERISTICS

Height 2.6 inches (66 mm) max.
Width 2.30 inches (58 mm) max.
Length 13.0 inches (330 mm) max.
Weight 3.5 pounds (1.59 Kg) max.
DC Connectors Flying Leads
RF Connectors Type "TNC" Female
Cooling 10 cfm, Air Cooled
Focusing PPM

RF ELECTRICAL PERFORMANCE CHARACTERISTICS



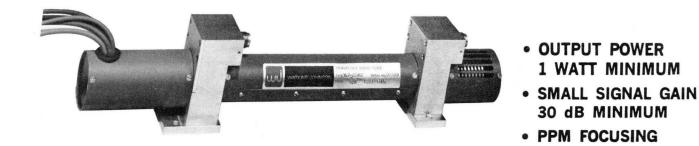
OUTLINE DRAWING



* VARIOUS MOUNTING CONFIGURATIONS AVAILABLE TO MEET CUSTOMER REQUIREMENTS.

* JANUARY 1971

7 TO 12.4 GHz 1-WATT TRAVELING-WAVE TUBE WJ-2503



WJ-2503 is the 7 to 12.4 GHz unit in a series of medium power traveling-wave tubes developed by Watkins-Johnson for commercial applications. It is intended for new or replacement use in one-watt amplifiers for laboratory work or driver applications. This PPM-focused TWT offers the same performance and high reliability found in all W-J power tubes. All voltages are isolated from housing and connectors for maximum flexibility in power supply configurations.

SPECIFICATIONS

PERFORMANCE	TYPICAL	GUARANTEED
Frequency	6.9 to 12.5 GHz	7.0 to 12.4 GHz
Saturated Power Output	1.15 to 2.5 watts	1 watt min.
Small Signal Gain	35 to 41 dB	30 dB min.
Total Gain Variation	4 dB	6 dB
Noise Figure		30 dB max.

ELECTRICAL REQUIREMENTS	TYPICAL	RANGE
Heater Voltage	6.3 volts	6.2 to 6.4 volts
Heater Current	0.7 A	0.4 to 1.2 A
Cathode Voltage	Ov	
Cathode Current		20 mA max.
Anode Voltage		500 to 1000 volts
Helix Voltage		
Helix Current		3 mA max.
Grid Voltage	0 volts	—0 to —70 volts
Collector Voltage		
Collector Current		

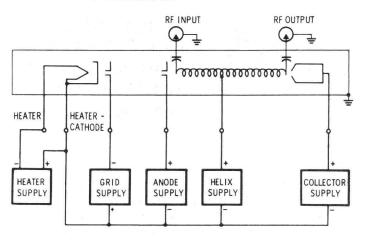
*Supersedes WJ-2503-3 Technical Data Sheet dated June 1970

WJ-2503

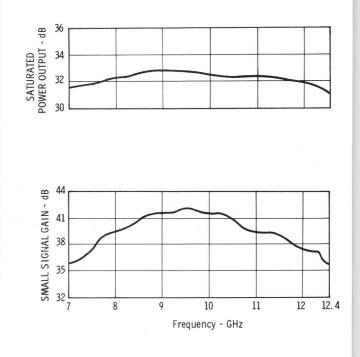
MECHANICAL CHARACTERISTICS

Height 2.6 inches (66 mm) max.
Width 2.30 inches (58 mm) max.
Length 13.0 inches (330 mm) max.
Weight 3.5 pounds (1.59 Kg) max.
DC Connectors Flying Leads
RF Connectors Type "TNC" Female
Cooling
Focusing PPM

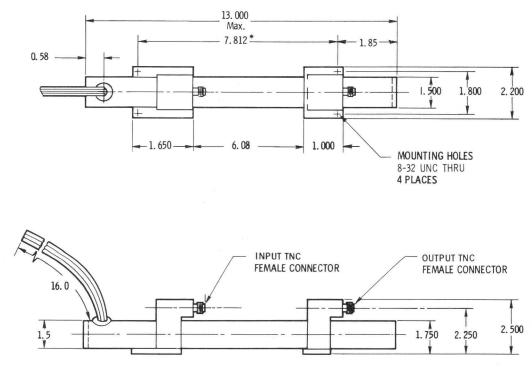
SCHEMATIC DIAGRAM



R F ELECTRICAL PERFORMANCE CHARACTERISTICS



OUTLINE DRAWING



* VARIOUS MOUNTING CONFIGURATIONS AVAILABLE TO MEET CUSTOMER REQUIREMENTS.

APRIL 1969

0.5 TO 1.0 GHz VOLTAGE-TUNED SOLID STATE OSCILLATOR WJ-2800

- VOLTAGE-TUNABLE OVER FULL OCTAVE
- SUPERIOR PULLING CHARACTERISTICS
- NO IN-BAND HARMONICS
- LOW OUT-OF-BAND HARMONICS
- MONOTONIC TUNING CURVE

WJ-2800 is a voltage-tuned transistor oscillator designed to provide fundamental microwave power over the 0.5 to 1.0 GHz range. Varactor tuning ensures a high tuning input impedance characteristic for the device. Since it is a fundamental oscillator, no inband harmonics are exhibited. WJ-2800 is c than its rated tuning voltage exponential a tion. The devise small size, low

WJ-2800 is capable of supplying considerably more than its rated output power in some applications. Its tuning voltage vs. frequency curve is approximately exponential and monotonic, allowing easy linearization. The device is well suited for applications where small size, low input requirements and high reliability are essential.

SPECIFICATIONS

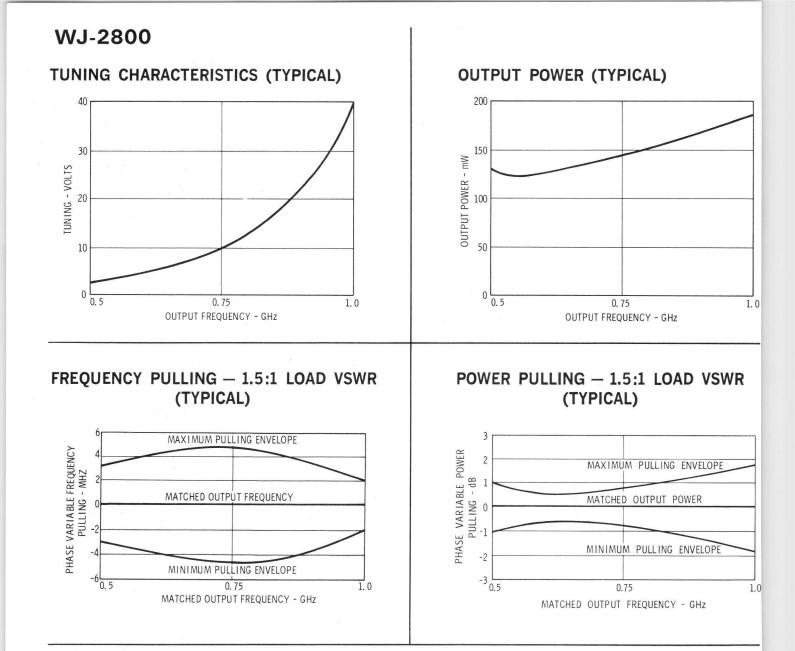
OUTPUT CHARACTERISTICS Frequency Range Power Output (50Ω load) Power Output (1.5:1 load VSWR) Frequency Pulling (1.25:1 load VSWR) Frequency Pulling (1.5:1 load VSWR) Residual FM (peak)	.125 mW .125 mW	100 mW min. 100 mW min. ±1% max. ±2% max.
Harmonic Rejection ¹		
Non-Harmonic Spurious Rejection ²		60 dB min.
Frequency Pushing (supply variations) Operating Temperature Range (heat sink temperature) Frequency Drift with Temperature		0 to 55°C
INPUT REQUIREMENTS		
Transistor Supply Voltage Tuning Voltage at 0.5 GHz Tuning Voltage at 1.0 GHz	+1.5 V dc	min. at -3 mA max.
MECHANICAL CHARACTERISTICS		
Dimensions Weight Connector, RF Connectors, dc		6 oz. (170 g) max. niniature coaxial jack

NOTES:

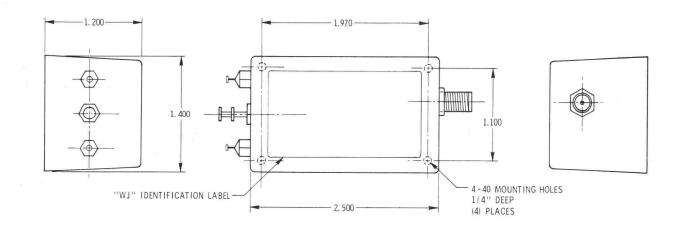
¹The WJ-2800 is a fundamental oscillator and has no in-band harmonics.

²Measured on a spectrum analyzer with approximately 60 dB dynamic range. Only signals greater than 10 kHz from the main signal are specified.





OUTLINE DRAWING



APRIL 1969 *



1 TO 2 GHz VOLTAGE-TUNED SOLID STATE OSCILLATOR WJ-2803

- VOLTAGE-TUNABLE **OVER FULL OCTAVE**
- SUPERIOR PULLING **CHARACTERISTICS**
- NO IN-BAND HARMONICS
- LOW OUT-OF-BAND HARMONICS
- MONOTONIC TUNING CURVE

WJ-2803 is a voltage-tuned transistor oscillator designed to provide fundamental microwave power over the 1 to 2 GHz range. Varactor tuning ensures a high tuning input impedance characteristic for the device. Two transistors in a push-pull configuration provide superior out-of-band harmonics rejection. Since the device is a fundamental oscillator, no inband harmonics are exhibited.

WJ-2803 is capable of supplying considerably more than its rated output power in some applications. Its tuning voltage vs. frequency curve is approximately exponential and monotonic, allowing easy linearization. The device is well suited for applications where small size, low input requirements and high reliability are essential.

SPECIFICATIONS

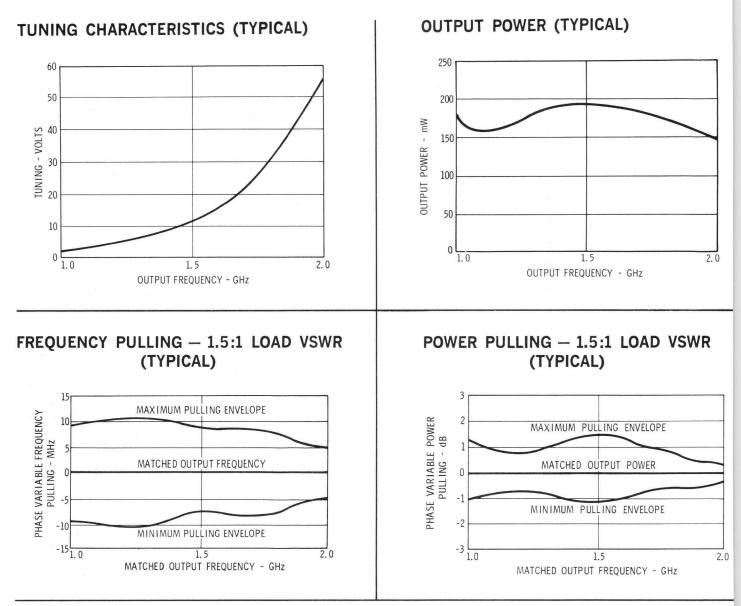
OUTPUT CHARACTERISTICS Frequency Range Power Output (50Ω load) Power Output (1.5:1 load VSWR) Frequency Pulling (1.25:1 load VSWR) Frequency Pulling (1.5:1 load VSWR) Frequency Pulling (1.5:1 load VSWR) Residual FM (peak) Harmonic Rejection ¹ Non-Harmonic Spurious Rejection ² Frequency Pushing (supply variations) Operating Temperature Range (heat sink temperature)	.150 mW .150 mW .±0.5% .±1% .1 kHz .30 dB .±1% per volt±1%	. 100 mW min. . 100 mW min. . ±1% max. . ±2% max. 5 kHz max. 20 dB min. 60 dB min. 2% per volt max. 0 to 55°C
Frequency Drift with Temperature	+15 V dc +1.5 V dc min +60 V dc ma 1.2 x 1.4 x 2.5 inches (30 x 30 6 minia	at 250 mA max. at3 mA max. x. at 1 mA max. 6 x 64 mm) max. oz. (170 g) max. ature coaxial jack

NOTES

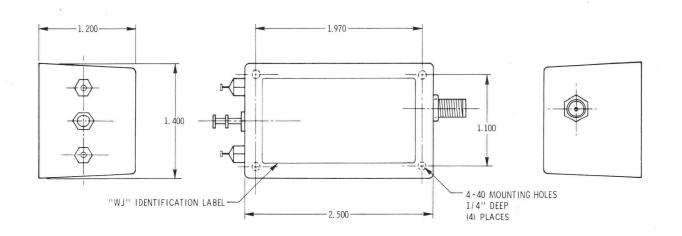
The WJ-2803 is a fundamental oscillator and has no in-band harmonics. ²Measured on a spectrum analyzer with approximately 60 dB dynamic range. Only signals greater than 10 kHz from the main signal are specified.

*Supersedes WJ-2803 Technical Data Sheet dated November 1968.

WJ-2803



OUTLINE DRAWING



3687-1 APRIL 1969

FEBRUARY 1971



WJ-2804-10 is a voltage-tuned transistor oscillator designed to provide fundamental microwave power over the 2 to 4 GHz range. Varactor tuning ensures a high tuning input impedance characteristic for the device. Two transistors in a push-pull configuration provide superior out-of-band harmonics rejection. Since the device is a fundamental oscillator, no inband harmonics are exhibited.

2 TO 4 GHz VOLTAGE-TUNED SOLID STATE OSCILLATOR WJ-2804-10

- VOLTAGE-TUNABLE OVER FULL OCTAVE
- SUPERIOR PULLING CHARACTERISTICS
- NO IN-BAND HARMONICS
- LOW OUT-OF-BAND HARMONICS
- MONOTONIC TUNING CURVE

WJ-2804-10 is capable of supplying considerably more than its rated output power in some applications. Its tuning voltage vs. frequency curve is approximately exponential and monotonic, allowing easy linearization. The device is well suited for applications where small size, low input requirements and high reliability are essential.

SPECIFICATIONS

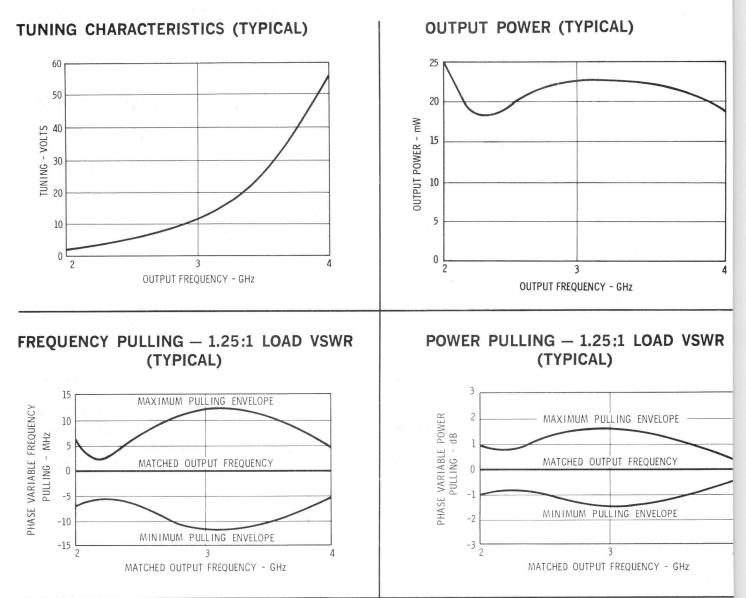
OUTPUT CHARACTERISTICS Frequency Range Power Output (50Ω load) Power Output (1.25:1 load VSWR) Frequency Pulling (1.25:1 load VSWR) Residual FM (peak) Harmonic Rejection ¹ Non-Harmonic Spurious Rejection ² Frequency Pushing (supply variations) Operating Temperature Range (heat sink temperature) Frequency Drift with Temperature	1.95 to 4.05 GHz .20 mW .20 mW .±1% .1 kHz .30 dB .±1% per volt ±:	10 mW min. 10 mW min. ±2% max. 10 kHz max. 20 dB min. 60 dB min. 2% per volt max. 0 to 55°C
INPUT REQUIREMENTS Transistor Supply Voltage Tuning Voltage at 2.0 GHz Tuning Voltage at 4.0 GHz MECHANICAL CHARACTERISTICS Dimensions Weight Connector, RF Connectors, dc	+15 V do +1.5 V dc mir +60 V dc mi 1.2 x 1.4 x 2.5 inches (30 x 3 6 mini	c at 200 mA max. a. at —3 mA max. ax. at 1 mA max. 6 x 64 mm) max. oz. (170 g) max. ature coaxial jack

NOTES:

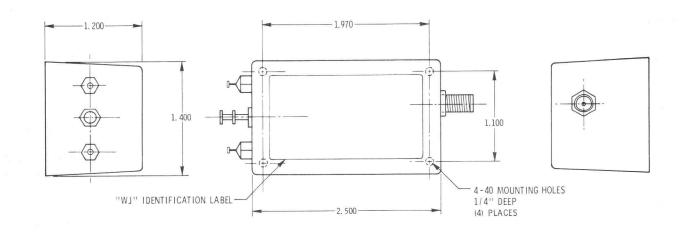
¹The WJ-2804·10 is a fundamental oscillator and has no in-band harmonics. ²Measured on a spectrum analyzer with approximately 60 dB dynamic range. Only signals greater than 10 kHz from the main

signal are specified.

WJ-2804-10



OUTLINE DRAWING



FEBRUARY 1971

FEBRUARY 1971



2 TO 4 GHz VOLTAGE-TUNED SOLID STATE OSCILLATOR WJ-2804-20

- VOLTAGE-TUNABLE OVER FULL OCTAVE
- SUPERIOR PULLING CHARACTERISTICS
- NO IN-BAND HARMONICS
- LOW OUT-OF-BAND HARMONICS
- MONOTONIC TUNING CURVE

WJ-2804-20 is a voltage-tuned transistor oscillator designed to provide fundamental microwave power over the 2 to 4 GHz range. Varactor tuning ensures a high tuning input impedance characteristic for the device. Two transistors in a push-pull configuration provide superior out-of-band harmonics rejection. Since the device is a fundamental oscillator, no inband harmonics are exhibited. WJ-2804-20 is capable of supplying considerably more than its rated output power in some applications. Its tuning voltage vs. frequency curve is approximately exponential and monotonic, allowing easy linearization. The device is well suited for applications where small size, low input requirements and high reliability are essential.

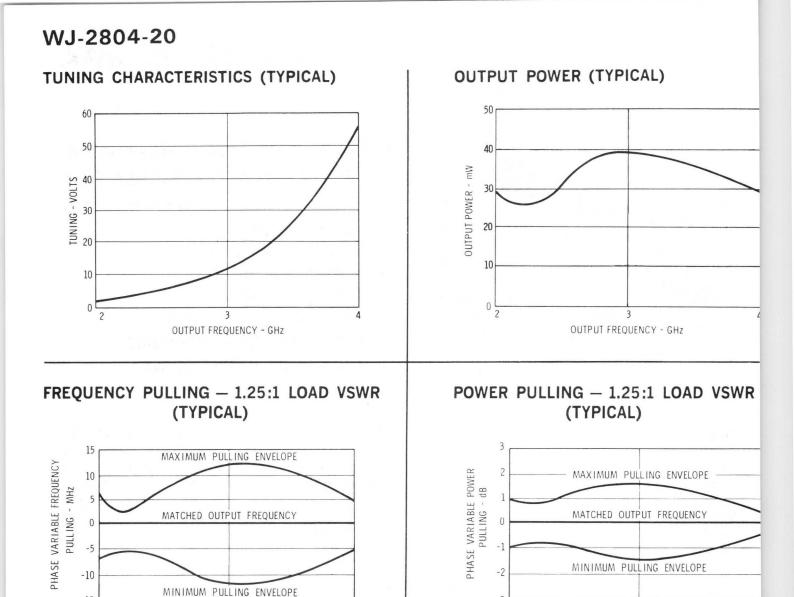
SPECIFICATIONS

OUTPUT CHARACTERISTICSFrequency RangePower Output (50Ω load)Power Output (1.25:1 load VSWR)Frequency Pulling (1.25:1 load VSWR)Residual FM (peak)Harmonic Rejection ¹ Non-Harmonic Spurious Rejection ² Frequency Pushing (supply variations)Operating Temperature Range (heat sink temperature)Frequency Drift with Temperature	.25 mW .25 mW .±1% .1 kHz .30 dB .±1% per volt	20 mW min. 20 mW min. ±2% max. 10 kHz max. 20 dB min. 60 dB min. ±2% per volt max. 0 to 55°C
INPUT REQUIREMENTS Transistor Supply Voltage Tuning Voltage at 2.0 GHz Tuning Voltage at 4.0 GHz MECHANICAL CHARACTERISTICS	+1.5 V dc	: min. at —3 mA max. Ic max. at 1 mA max.
Dimensions Weight Connector, RF Connectors, dc		6 oz. (170 g) max. miniature coaxial jack

NOTES:

¹The WJ-2804-20 is a fundamental oscillator and has no in-band harmonics.

²Measured on a spectrum analyzer with approximately 60 dB dynamic range. Only signals greater than 10 kHz from the main signal are specified.



OUTLINE DRAWING

3

MATCHED OUTPUT FREQUENCY - GHz

-15

2

1.200 1.200 1.400 WJ" IDENTIFICATION LABEL 2.500 1.400 4-40 MOUNTING HOLES 1/4" DEEP (4) PLACES

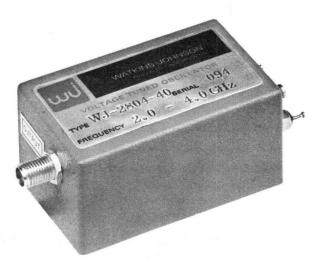
4

-3 L

3

MATCHED OUTPUT FREQUENCY - GHz

FEBRUARY 1971



2 TO 4 GHz VOLTAGE-TUNED SOLID STATE OSCILLATOR WJ-2804-40

- VOLTAGE-TUNABLE OVER FULL OCTAVE
- SUPERIOR PULLING CHARACTERISTICS
- NO IN-BAND HARMONICS
- LOW OUT-OF-BAND HARMONICS
- MONOTONIC TUNING CURVE

WJ-2804-40 is a voltage-tuned transistor oscillator designed to provide fundamental microwave power over the 2 to 4 GHz range. Varactor tuning ensures a high tuning input impedance characteristic for the device. Two transistors in a push-pull configuration provide superior out-of-band harmonics rejection. Since the device is a fundamental oscillator, no inband harmonics are exhibited. WJ-2804-40 is capable of supplying considerably more than its rated output power in some applications. Its tuning voltage vs. frequency curve is approximately exponential and monotonic, allowing easy linearization. The device is well suited for applications where small size, low input requirements and high reliability are essential.

SPECIFICATIONS

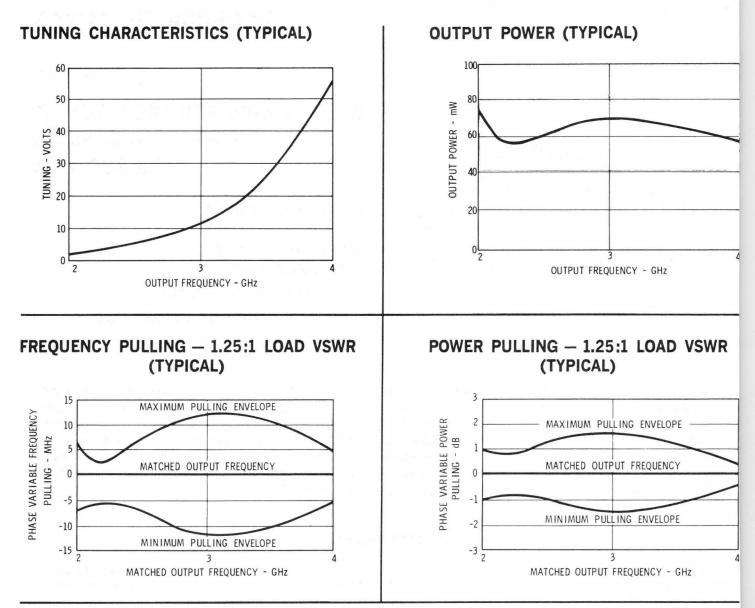
OUTPUT CHARACTERISTICS Frequency Range Power Output (50Ω load) Power Output (1.25:1 load VSWR) Frequency Pulling (1.25:1 load VSWR) Residual FM (peak) Harmonic Rejection ¹ Non-Harmonic Spurious Rejection ² Frequency Pushing (supply variations) Operating Temperature Range (heat sink temperature)	.1.95 to 4.05 GHz .50 mW .50 mW .±1% .1 kHz .30 dB .±1% per volt	
Frequency Drift with Temperature	+1 +1.5 V (+60 V 	5 V dc at 200 mA max. dc min. at —3 mA max. dc max. at 1 mA max. 30 x 36 x 64 mm) max. 6 oz. (170 g) max. miniature coaxial jack

NOTES

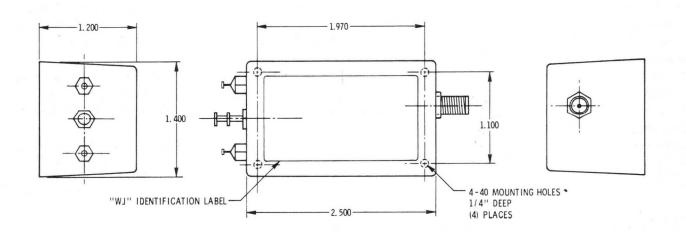
The WJ-2804-40 is a fundamental oscillator and has no in-band harmonics.

²Measured on a spectrum analyzer with approximately 60 dB dynamic range. Only signals greater than 10 kHz from the main signal are specified.

WJ-2804-40



OUTLINE DRAWING



APRIL 1970

1.4 TO 2.4 GHz VOLTAGE-TUNED SOLID STATE OSCILLATOR WJ-2810



VOLTAGE-TUNABLE
 OVER FULL RANGE

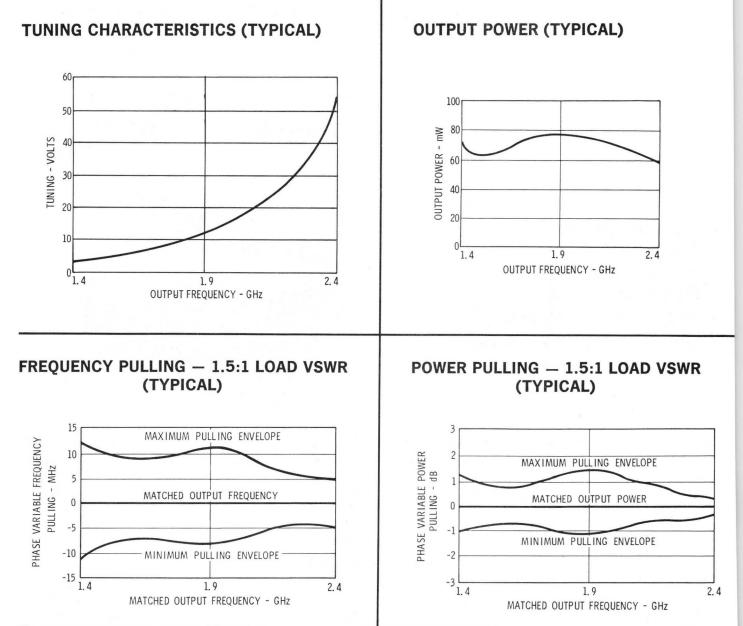
- SUPERIOR PULLING CHARACTERISTICS
- NO IN-BAND HARMONICS
- LOW OUT-OF-BAND HARMONICS
- MONOTONIC TUNING CURVE

WJ-2810 is a voltage-tuned transistor oscillator designed to provide fundamental microwave power over the 1.4 to 2.4 GHz range. Varactor tuning ensures a high tuning input impedance characteristic for the device. Since it is a fundamental oscillator, no in-band harmonics are exhibited. WJ-2810 is capable of supplying considerably more than its rated output power in some applications. Its tuning voltage vs. frequency curve is approximately exponential and monotonic, allowing easy linearization. The device is well suited for applications where small size, low input requirements and high reliability are essential.

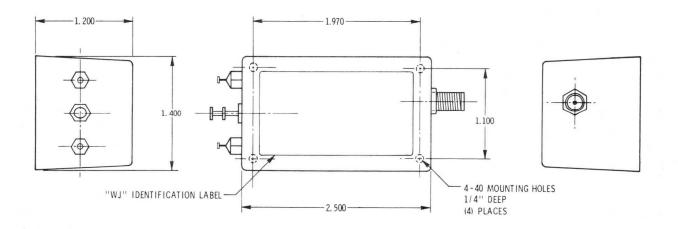
SPECIFICATIONS

OUTPUT CHARACTERISTICS	Typical	Guaranteed
Frequency Range Power Output (50Ω load)		
Power Output (1.5:1 load VSWR)	60 mW	50mW min.
Frequency Pulling (1.25:1 load VSWR)		
Frequency Pulling (1.5:1 load VSWR)	$\ldots \pm 1\%$ \ldots \ldots \ldots \ldots \ldots \ldots	±2% max.
Residual FM (peak)		
Harmonic Rejection ¹		
Non-Harmonic Spurious Rejection ²		
Frequency Pushing (supply variations)		
Operating Temperature Range (heat sink temperatur		
Frequency Drift with Temperature		300 ppm/ °C max.
INPUT REQUIREMENTS		
Transistor Supply Voltage		
Tuning Voltage at 1.0 GHz		
Tuning Voltage at 2.0 GHz	+60 \	dc max. at 1 mA max.
MECHANICAL CHARACTERISTICS		
Dimensions		
Weight		
Connector, RF		
Connectors, dc		soluer lugs
 Measured on a spectrum analyzer with approximately 60 dB dynamic r. 		m the main signal are specified.

WJ-2810



OUTLINE DRAWING



APRIL 1970

APRIL 1969



WJ-2811 is a voltage-tuned transistor oscillator designed to provide fundamental microwave power over the 0.25 to 0.5 GHz range. Varactor tuning ensures a high tuning input impedance characteristic for the device. Since it is a fundamental oscillator, no inband harmonics are exhibited.

0.25 TO 0.5 GHz VOLTAGE-TUNED SOLID STATE OSCILLATOR WJ-2811

- VOLTAGE-TUNABLE OVER FULL OCTAVE
- SUPERIOR PULLING CHARACTERISTICS
- NO IN-BAND HARMONICS
- LOW OUT-OF-BAND HARMONICS
- MONOTONIC TUNING CURVE

WJ-2811 is capable of supplying considerably more than its rated output power in some applications. Its tuning voltage vs. frequency curve is approximately exponential and monotonic, allowing easy linearization. The device is well suited for applications where small size, low input requirements and high reliability are essential.

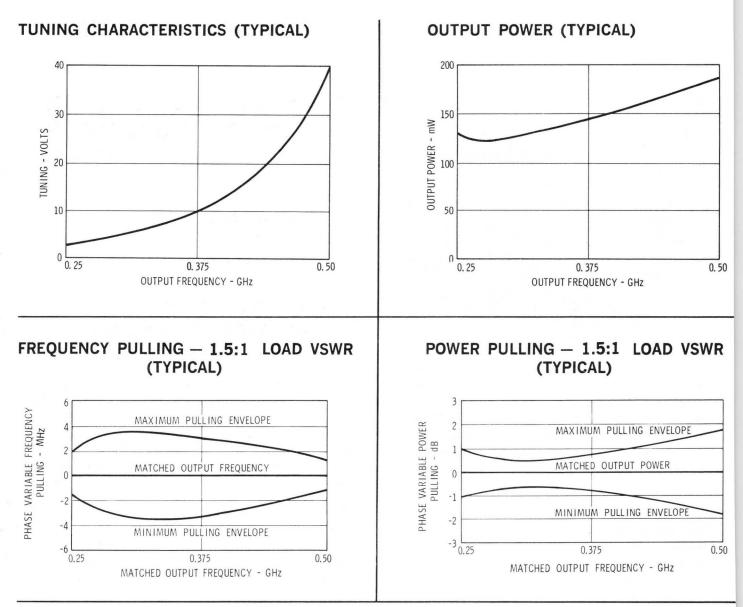
SPECIFICATIONS

OUTPUT CHARACTERISTICS Frequency Range Power Output (50Ω load) Power Output (1.5:1 load VSWR) Frequency Pulling (1.25:1 load VSWR) Frequency Pulling (1.5:1 load VSWR) Frequency Pulling (1.5:1 load VSWR) Residual FM (peak) Harmonic Rejection ¹ Non-Harmonic Spurious Rejection ² Frequency Pushing (supply variations)		100 mW min.
Operating Temperature Range (heat sink temperature) Frequency Drift with Temperature		
INPUT REQUIREMENTS Transistor Supply Voltage Tuning Voltage at 0.25 GHz Tuning Voltage at 0.5 GHz	+24 +1.5 V do	V dc at 200 mA max. min. at —3 mA max.
MECHANICAL CHARACTERISTICS Dimensions Weight Connector, RF Connectors, dc	· · · · · · · · · · · · · · · · · · ·	6 oz. (170 g) max. niniature coaxial jack

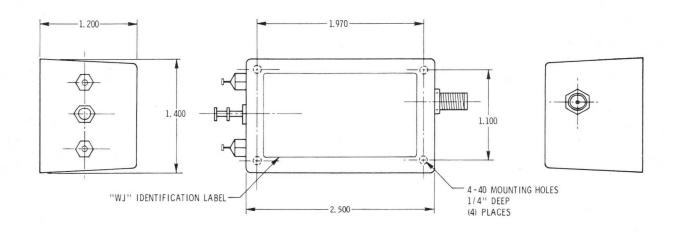
NOTES:

¹The WJ-2811 is a fundamental oscillator and has no in-band harmonics. ²Measured on a spectrum analyzer with approximately 60 dB dynamic range. Only signals greater than 10 kHz from the main signal are specified.

WJ-2811



OUTLINE DRAWING



3671-3 APRIL 1969

AUGUST 1969

2 TO 4 GHz, 100 MILLIWATT LOW-NOISE TRAVELING-WAVE AMPLIFIER WITH INTEGRAL POWER SUPPLY WJ-3003

- POWER OUTPUT 100 mW MINIMUM
- NOISE FIGURE 10 dB MAXIMUM
- "JUST PLUG IT IN"
- PROVEN RELIABILITY
- NO ADJUSTMENTS REQUIRED
- MEETS MIL-E-5400, CLASS 2 SPECIFICATION



WJ-3003 is an S-band amplifier that provides 100 mW power output for applications where increased dynamic range is desired. The amplifier is completely self-contained, adjustment-free, and requires only a 115-volt ac line voltage input (48 to 420 Hz). In addition, it may be operated in any orientation, in stacked arrays, or adjacent to ferromagnetic materials without degradation of performance.

Rugged construction of the tube, magnet, and power supply assembly assures reliable operation under vibrational forces of 5 g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of -54° to $+71^{\circ}$ C. The environmental characteristics of the WJ-3003 meet or exceed the corresponding requirements of MIL-E-5400, Class 2.

SPECIFICATIONS

PERFORMANCE	Typical	Guaranteed
Frequency		
Gain, small signal	35 dB	30 dB, min.
VSWR, input and output	.1.5:1	2:1, max.
Power Output	.21 dBm	20 dBm
ELECTRICAL REQUIREMENTS	Typical	Range ¹
Primary voltage	.115 V ac	115 ±10 V ac
Primary frequency	.60 Hz	48 to 420 Hz
Primary power	.20 W	

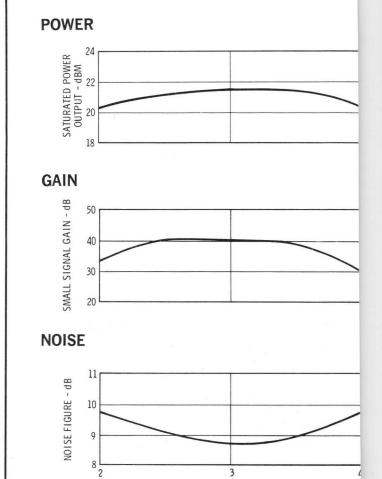
ENVIRONMENTAL CHARACTERISTICS²

Temperature
Vibration
a) 0.10 Inch, Double Amplitude 5 to 30 Hz
b) 5 g, Single Amplitude 30 to 500 Hz
Shock 15 g, 11 ms

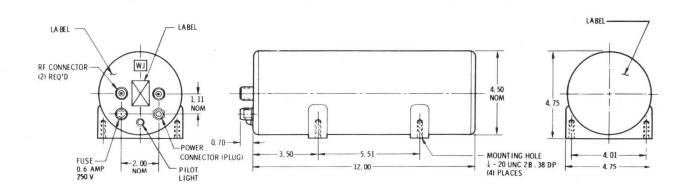
MECHANICAL CHARACTERISTICS

Height 4.75 inches (121 mm) max	
Width 4.75 inches (121 mm) max	
Length (excluding connectors) 12 inches (305 mm) max	
Weight 18 pounds (8.16 Kg) max	
Primary Power Connection Bendix Receptacle PT 07C-8-31	0
RF Connectors Type N, Jac	K
Reference Drawing Number 290029	Э

- 1. Every tube will meet the guaranteed performance specifications for any voltage and frequency within these ranges.
- 2. These environmental characteristics meet or exceed the respective requirements of MIL-E-5400K (dated 24 May 1968), Class 2.



FREQUENCY - GHz



P	OWER CONN	ECTORS	
	ND IX: PT 07C - 8 -	3P (PLUC)	
		3-35 (SR) (SOC)	
PIN	CONNECTION		
A	AC	105 - 125 VAC	
B	GROUND	48-420 CPS	
C	AC (HOT)	SINGLE PHASE	

AUGUST 1969

4 TO 8 GHz, 100 MILLIWATT LOW-NOISE TRAVELING-WAVE AMPLIFIER WITH INTEGRAL POWER SUPPLY WJ-3004

- POWER OUTPUT 100 mW MINIMUM
- NOISE FIGURE 10 dB MAXIMUM
- "JUST PLUG IT IN"
- PROVEN RELIABILITY
- NO ADJUSTMENTS REQUIRED
- MEETS MIL-E-5400, CLASS 2 SPECIFICATION

WJ-3004 is a C-band amplifier that provides 100 mW power ouput for applications where increased dynamic range is desired. The amplifier is completely self-contained, adjustment-free, and requires only a 115-volt ac line voltage input (48 to 420 Hz). In addition, it may be operated in any orientation, in stacked arrays, or adjacent to ferromagnetic materials without degradation of performance.

Rugged construction of the tube, magnet, and power supply assembly assures reliable operation under vibrational forces of 5 g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of -54° to $+71^{\circ}$ C. The environmental characteristics of the WJ-3004 meet or exceed the corresponding requirements of MIL-E-5400, Class 2.

SPECIFICATIONS

PERFORMANCE	Typical	Guaranteed
Frequency		4 to 8 GHz
Noise figure, terminal	.9 dB	10 dB, max.
Gain, small signal	.35 dB	30 dB, min.
VSWR, input and output	.1.5:1	2:1, max.
Power Output	.21 dBm	20 dBm

ELECTRICAL REQUIREMENTS	Typical	Range ¹
Primary voltage		115 ±10 V ac
Primary frequency		
Primary power	20 W	



ENVIRONMENTAL CHARACTERISTICS²

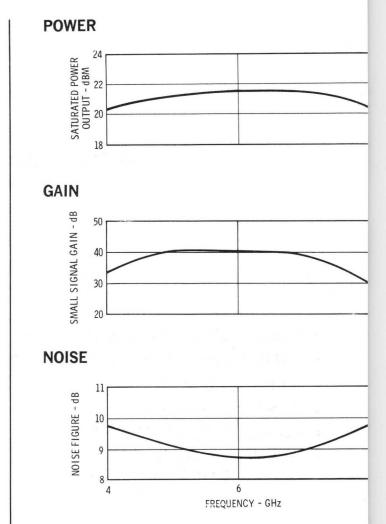
Temperature
Vibration
a) 0.10 Inch, Double Amplitude 5 to 30 Hz
b) 5 g, Single Amplitude 30 to 500 Hz
Shock 15 g, 11 ms

MECHANICAL CHARACTERISTICS

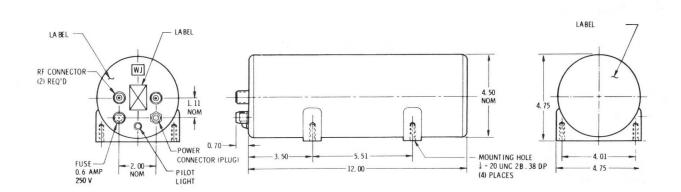
Height
Length (excluding connectors) 12 inches (305 mm) max.
Weight 18 pounds (8.16 Kg) max.
Primary Power Connection Bendix Receptacle PT 07C-8-3P
RF Connectors Type N, Jack
Reference Drawing Number 290029

1. Every tube will meet the guaranteed performance specifications for any voltage and frequency within these ranges.

2. These environmental characteristics meet or exceed the respective requirements of MIL-E-5400K (dated 24 May 1968), Class 2.



OUTLINE DRAWING



	POWER CONN	ECTORS	
BI	ENDIX: PT 07C-8- MS 3116 E-1	3P (PLUG) 8-3S (SR) (SOC	
PIN	CONNECTION		
A	AC	105 - 125 VAC	
В	GROUND	48-420 CPS	
С	AC (HOT)	SINGLE PHASE	

AUGUST 1969

* DECEMBER 1970

8 TO 12 GHz, 100 MILLIWATT LOW-NOISE TRAVELING-WAVE AMPLIFIER WITH INTEGRAL POWER SUPPLY WJ-3005

- POWER OUTPUT 100 mW MINIMUM
- NOISE FIGURE 10 dB MAXIMUM
- "JUST PLUG IT IN"
- PROVEN RELIABILITY
- NO ADJUSTMENTS REQUIRED
- MEETS MIL-E-5400, CLASS 2 SPECIFICATION



WJ-3005 is an X-band amplifier that provides 100 mW power output for applications where increased dynamic range is desired. The amplifier is completely self-contained, adjustment-free, and requires only a 115-volt ac line voltage input (48 to 420 Hz). In addition, it may be operated in any orientation, in stacked arrays, or adjacent to ferromagnetic materials without degradation of performance.

Rugged construction of the tube, magnet, and power supply assembly assures reliable operation under vibrational forces of 5 g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of -54° to $+71^{\circ}$ C. The environmental characteristics of the WJ-3005 meet or exceed the corresponding requirements of MIL-E-5400, Class 2.

SPECIFICATIONS

PERFORMANCE	Typical	Guaranteed
Frequency		8 to 12 GHz
Noise figure, terminal		
Gain, small signal	.35 dB	30 dB, min.
VSWR, input and output	.1.5:1	2:1, max.
Power Output	.21 dBm	20 dBm

ELECTRICAL REQUIREMENTS	Typical	Range ¹
Primary voltage		
Primary frequency		
Primary power		

*Supersedes WJ-3005 Data Sheet dated August 1970

ENVIRONMENTAL CHARACTERISTICS²

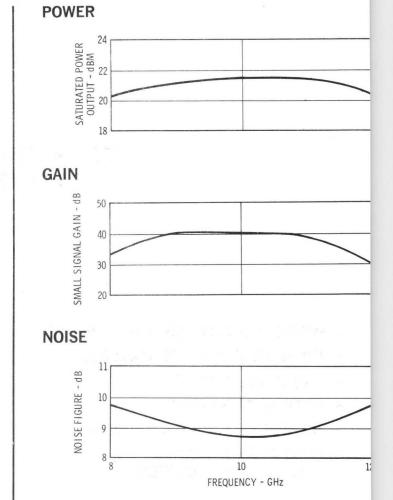
Temperature	+71°C
Vibration	
a) 0.10 Inch, Double Amplitude 5 to	o 30 Hz
b) 5 g, Single Amplitude 30 to	
Shock 15 g,	11 ms

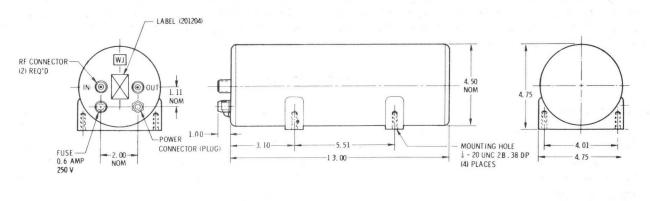
MECHANICAL CHARACTERISTICS

Height 4.75 inches (121 mm) max.
Width 4.75 inches (121 mm) max.
Length (excluding connectors) 13 inches (330 mm) max.
Weight 20 pounds (9.06 Kg) max.
Primary Power Connection Bendix Receptacle PT 07C-8-3P
RF Connectors Type N, Jack
Reference Drawing Number 290299

1. Every tube will meet the guaranteed performance specifications for any voltage and frequency within these ranges.

 These environmental characteristics meet or exceed the respective requirements of MIL-E-5400K (dated 24 May 1968), Class 2.

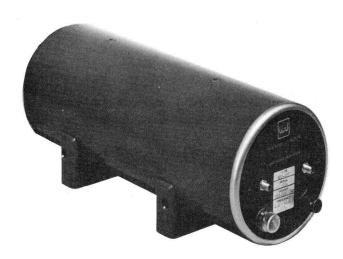




F	OWER CONN	ECTORS
	NDIX: PT 07C-8- MS 3116 E-8	3P (PLUG) 3-3S (SR) (SOC)
PIN	CC	NNECTION
A	AC	105 - 125 VAC
В	GROUND	48-420 CPS
C	AC (HOT)	SINGLE PHASE

DECEMBER 1970

12 TO 18 GHz, 100 MILLIWATT LOW-NOISE TRAVELING-WAVE AMPLIFIER WITH INTEGRAL POWER SUPPLY WJ-3006



- POWER OUTPUT 100 mW MINIMUM
- NOISE FIGURE 13 dB MAXIMUM
- "JUST PLUG IT IN"
- PROVEN RELIABILITY
- NO ADJUSTMENTS REQUIRED
- MEETS MIL-E-5400, CLASS 2 SPECIFICATION

WJ-3006 is a Ku-band amplifier that provides 100 mW power output for applications where increased dynamic range is desired. The amplifier is completely self-contained, adjustment-free, and requires only a 115-volt ac line voltage input (48 to 420 Hz). In addition, it may be operated in any orientation, in stacked arrays, or adjacent to ferromagnetic materials without degradation of performance.

Rugged construction of the tube, magnet, and power supply assembly assures reliable operation under vibrational forces of 5 g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of -54° to $+71^{\circ}$ C. The environmental characteristics of the WJ-3006 meet or exceed the corresponding requirements of MIL-E-5400, Class 2.

SPECIFICATIONS

PERFORMANCE	Typical	Guaranteed
Frequency		12 to 18 GHz
Noise figure, terminal	12 dB	13 dB, max.
Gain, small signal	35 dB	30 dB, min.
VSWR, input and output	1.5:1	2:1, max.
Power Output		
ELECTRICAL REQUIREMENTS	Typical	Range
Primary voltage	115 V ac	115 ±10 V ac
Primary frequency		
Primary power	20 W	

*Supersedes WJ-3006 Technical Data Sheet dated November 1969.

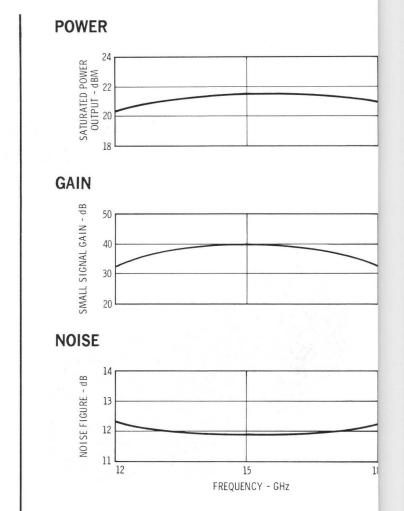
ENVIRONMENTAL CHARACTERISTICS²

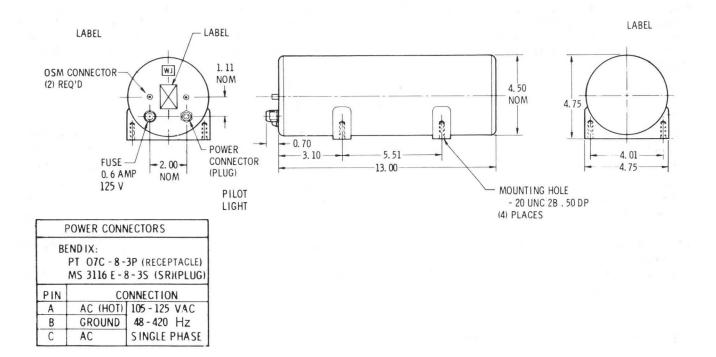
Temperature $\dots \dots \dots$
Vibration
a) 0.10 Inch, Double Amplitude 5 to 30 Hz
b) 5 g, Single Amplitude 30 to 500 Hz
Shock 15 g, 11 ms

MECHANICAL CHARACTERISTICS

Height 4.75 inches (121 mm) max.
Width 4.75 inches (121 mm) max.
Length (excluding connectors) 13 inches (330 mm) max.
Weight 18 pounds (8.16 Kg) max.
Primary Power Connection Bendix Receptacle PT 07C-8-3P
RF Connectors Type OSM, Jack
Reference Drawing Number 290240

- 1. Every tube will meet the guaranteed performance specifications for any voltage and frequency within these ranges.
- 2. These environmental characteristics meet or exceed the respective requirements of MIL-E-5400K (dated 24 May 1968), Class 2.





APRIL 1970

12.0 TO 18 GHz MEDIUM-POWER LOW-NOISE TRAVELING-WAVE TUBE WJ-3604

- OUTPUT POWER 3 WATTS MINIMUM
- PPM FOCUSING
- ESPECIALLY SUITABLE FOR AIRBORNE/SPACE APPLICATION
- LOW FINE-STRUCTURE GAIN VARIATION

WJ-3604 is a medium-power low-noise traveling-wave tube designed for use in airborne and space applications. It is particularly suitable for applications where gain variation and phase linearity are important (the tube provides fine structure gain variation of ± 0.75 dB across Ku-band). The helix may be isolated from ground for serrodyne operation.

The use of Periodic-Permanent-Magnet (PPM) focusing and metal-ceramic construction results in a compact, lightweight configuration. Alnico-8 magnets are



used in the PPM-focusing system, making it insensitive to temperature variations over the operating range. Cooling of the tube is by conduction through the baseplate of the capsule.

Operating efficiency of the WJ-3604 can be improved by depressing the collector voltage below the helix voltage. The tube may also be supplied with an integral power supply, resulting in a fully integrated TWT amplifier.

SPECIFICATIONS

PERFORMANCE Frequency	Typical	Guaranteed
Saturated Power Output		
Small Signal Gain	.38 dB	37 dB, min.
Small Signal Gain Variation	.±1.5 dB	±2.5 dB, max.
Gross Fine Structure Small Signal Gain Variation	.±0.2 dB	±0.75 dB
Noise Figure	.26 dB	28 dB, max.
FLEATDIGAL DECUIDEMENTS	Transform	D
ELECTRICAL REQUIREMENTS		Range
Heater Voltage	6.0 volts	5.0 to 7.0 volts
Heater Voltage	6.0 volts	5.0 to 7.0 volts —110 to —130 volts
Heater Voltage Grid Voltage ¹	6.0 volts	5.0 to 7.0 volts
Heater Voltage Grid Voltage ¹ Helix Voltage ²	6.0 volts	5.0 to 7.0 volts
Heater Voltage Grid Voltage ¹ Helix Voltage ² Collector Voltage ¹	6.0 volts	5.0 to 7.0 volts

1. Voltage with respect to cathode.

2. Helix is grounded to tube capsule.

MECHANICAL CHARACTERISTICS

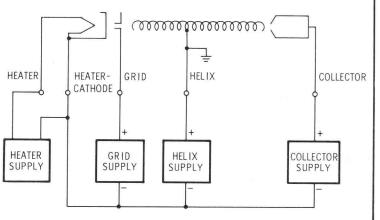
Cooling Conduction through baseplate ³
Height (excluding
connectors) 1.85 inches (47 mm) max.
Width 1.40 inches (36 mm) max.
Length 9.00 inches (229 mm) max.
Weight 2.0 lbs. (910 g) max.
Connectors OSM, Jack
Focusing PPM

ENVIRONMENTAL CHARACTERISTICS

Temperature	0°C to 75°C (baseplate)
Vibration (120-2000 cycles)	5 Grms
Shock	
Altitude	Any

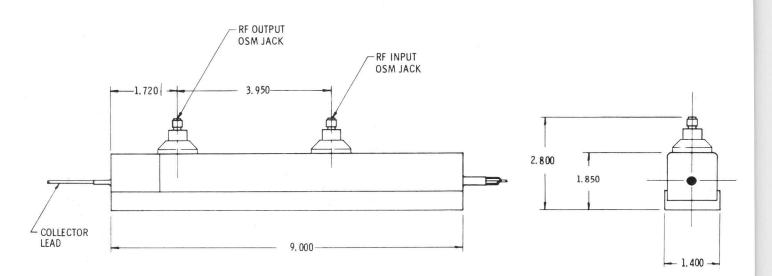
3. Air cooling available upon request.

SCHEMATIC DIAGRAM



POWER 39 SATURATED POWER OUTPUT - dBm 38 37 36 35 GAIN SMALL SIGNAL GAIN - dB 41 40 39 38 37 NOISE 28 NOISE FIGURE - dB 27 26

OUTLINE DRAWING



25 24∟ 12

13

14

15

FREQUENCY - GHz

16

17

1

JULY 1970

4 TO 8 GHz MEDIUM-POWER LOW-NOISE **TRAVELING-WAVE TUBE** WJ-3606

 OUTPUT POWER **3 WATTS MINIMUM**

PPM FOCUSING

- ESPECIALLY SUITABLE FOR AIRBORNE/SPACE APPLICATION
- EXTREMELY LOW FINE-STRUCTURE GAIN VARIATION

WJ-3606 is a medium-power low-noise traveling-wave tube designed for use in airborne and space applications. It is particularly suitable for applications where gain variation and phase linearity are important (the tube provides fine structure gain variation of ± 0.5 dB). A unique feature of the tube is its low cathode current density: a W-J innovation in low-noise electron gun design allows cathode loading of only 1.0 A/cm². This feature ensures the user of extremely long tube life.

The use of Periodic-Permanent-Magnet (PPM) focus-



ing and metal-ceramic construction results in a compact, lightweight configuration. Alnico-8 magnets are used in the PPM-focusing system, making it insensitive to temperature variation over the operating range. Cooling of the tube is by conduction through the baseplate of the capsule.

Operating efficiency of the WJ-3606 can be improved by depressing the collector voltage below the helix voltage. The tube may also be supplied with an integral power supply, resulting in a fully integrated TWT amplifier.

SPECIFICATIONS

PERFORMANCE	Typical	Guaranteed
Frequency		4.0 to 8.0 GHz
Saturated Power Output		
Small Signal Gain	42 dB	40 dB, min.
Small Signal Gain Variation	±2.5 dB	±3 dB, max.
Gross Fine Structure Small Signal Gain Variation	±0.2 dB	±0.5 dB
Noise Figure	20 dB	22 dB, max.
ELECTRICAL REQUIREMENTS	Typical	Range
ELECTRICAL REQUIREMENTS Heater Voltage		0
	6.3 volts	6.0 to 6.6 volts
Heater Voltage		6.0 to 6.6 volts 18 to -22 volts
Heater Voltage Grid Voltage ¹	6.3 volts	6.0 to 6.6 volts 18 to -22 volts 2600 to 3000 volts
Heater Voltage Grid Voltage ¹ Helix Voltage ¹ Collector Voltage ¹ Cathode Current	6.3 volts	6.0 to 6.6 volts 18 to -22 volts 2600 to 3000 volts 1400 to 1800 volts 30 to 40 mA
Heater Voltage Grid Voltage ¹ Helix Voltage ¹ Collector Voltage ¹	6.3 volts	6.0 to 6.6 volts 18 to -22 volts 2600 to 3000 volts 1400 to 1800 volts 30 to 40 mA 0.2 to 3 mA

NOTE 1. Voltage with respect to cathode. 2. Helix is grounded to tube capsule.

SPECIFICATIONS (Cont'd)

MECHANICAL CHARACTERISTICS

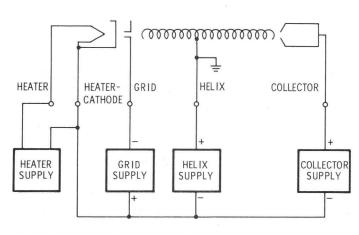
Cooling Conduction through baseplate ³
Length
Height
(excluding connectors) 1.25 inch, (32 mm) max.
Width
Weight 2.5 lbs., 1.13 kg) max.
Connectors OSM, Jack
Focusing PPM

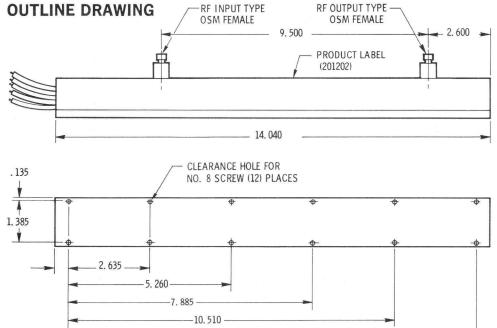
ENVIRONMENTAL CAPABILITY

Temperature54°C to 85°C (baseplate)
Vibration (120-2000 cycles) 5 Grms
Shock
Altitude Any

³Air cooling available upon request.

SCHEMATIC DIAGRAM

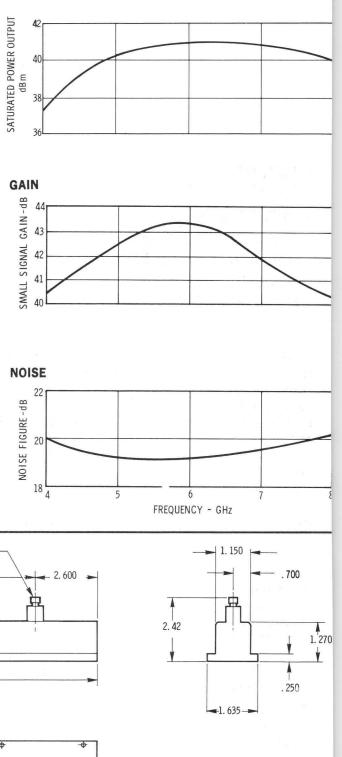




-13. 135 -

RF ELECTRICAL PERFORMANCE CHARACTERISTICS





MARCH 1970

2200 TO 2300 MHz 20-WATT CW CAVITY AMPLIFIER WJ-4523



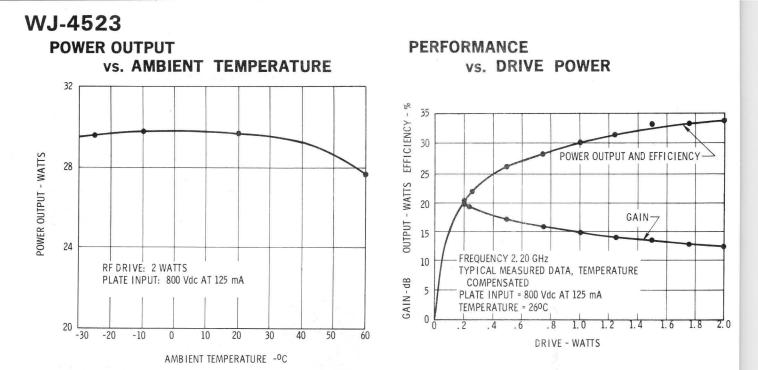
The WJ-4523 cavity amplifier is a compact modular amplifier readily adaptable to airborne or ground support telemetry and communications systems. It is an optimum combination of the tube configuration with the associated rf circuit. Maximum efficiency and rf output from a very small package are outstanding features offered by this amplifier. Tuning can be accomplished with a minimum of test equipment.

SPECIFICATIONS

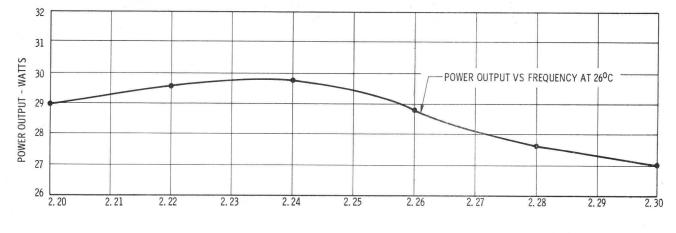
ELECTRICAL

Tuning Range
Tube Type
Power Supply Requirements:
Anode Voltage
Anode Current
Heater Voltage
Heater Current
Operating Characteristics:
Power Input (Nominal)
Power Output, Minimum
Modulation CW/FM
Bandwidth, 3 dB points
Frequency Stability
Load Impedance
Load VSWR
MECHANICAL
Connectors
Cooling Conduction to Heat Sink
Maximum Overall Dimensions 1.25 x 1.25 x 4.38 inches (32 x 32 x 111 mm.)
Net Weight
ENVIRONMENTAL
Mounting Surface Temperature

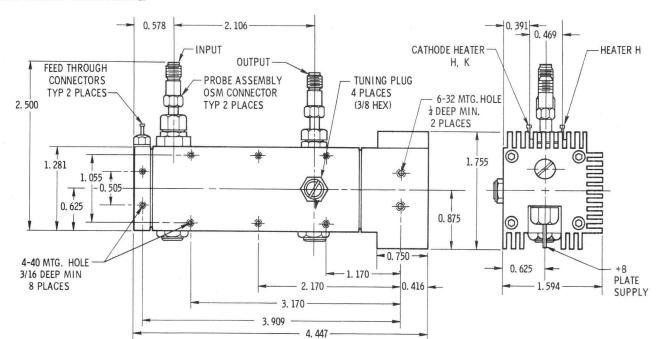
Vibration	10g, 5-500 cycles, 15 minutes in 3 mutually perpendicular planes
Shock	15g for 11 milliseconds in 3 mutually perpendicular planes



POWER OUTPUT vs. FREQUENCY

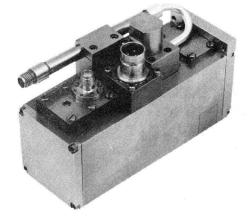






MAY 1969

1420 TO 1600 MHz CAVITY AMPLIFIER WJ-4539



WJ-4539 is a miniaturized, 20-watt cavity amplifier incorporating a ceramic-metal planar triode. It is intended for use in aerospace telemetry transmitters and special aerospace transmitters.

A recommended DC-EC converter for use with this amplifier is WJ-4590.

DEDEODMANICE

SPECIFICATIONS

PERFORMANCE	
Frequency, ¹ continuously tunable	Ηz
Rf power ² output (with 2 watts drive)	
at 1420-1435 MHz 15 watts, C	W
at 1435-1535 MHz 20 watts, C	W
at 1535-1600 MHz 15 watts, C	
Input Signals for the standard FM telemetry signal formats, per IRIG 106-6	56
Bandwidth, Minimum, 3 dB points	Ηz
Gain, Minimum, 1435-1535 MHz 10 d	IB
Load Impedance, nominal	ns
VSWR, Maximum,	
for full rated output	
without damage	
Efficiency, ² Overall, Minimum	
Phase jitter, Maximum, between input and output	ak
Power Supply Requirements ³	
Anode Voltage	
Current	
Heater Voltage	ts
Current 1.0 Ampere	
Harmonic Suppression (2nd, 3rd and 4th of 1435-1535 MHz)	
Warm-up Time	es

1. Also available with similar performance characteristics for other frequencies in the 900-2500 MHz range.

2. Under worst combination of specified environmental conditions. Output and efficiency are higher under optimum conditions. See curves for typical output and efficiency with other drive levels.

3. A separate DC-DC converter package, WJ-4590, operating from 28 +8/-4 Vdc, is available from Watkins-Johnson. Power supplies for operation from other primary sources are available on special order.

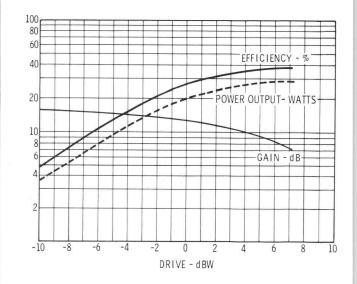
MECHANICAL CHARACTERISTICS

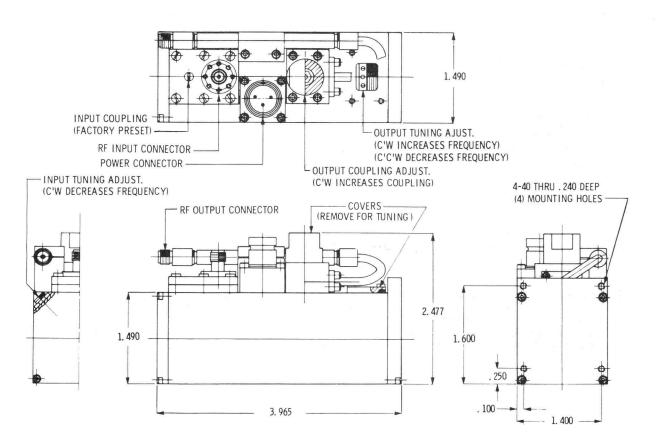
Size, Overall
(including protrusions) $4'' \ge 2\frac{1}{2}'' \ge 1\frac{1}{2}''$
Weight 1.1 pounds
Mounting To Heat Sink (not included)
Tuning Controls Three (all on same surface)
Cooling Conduction to Heat Sink at -54°C to +95°C
Connectors: rf input OSM rf ouput OSM Power Deutsch #DM 5300-3P-643

ENVIRONMENTAL CHARACTERISTICS

Temperature, heat sink, for continuous operation54°C to +95	۰c
Altitude	-
Vibration 20g, 20-2000 cps, 3 major as	
Other Per MIL-E-54	00

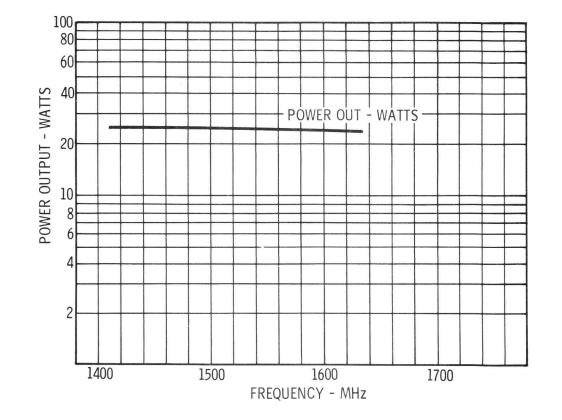
FIG. 1 TYPICAL DATA FOR EFFICIENCY, POWER OUTPUT AND GAIN OF WJ-4539 OPERATING AT 1485 MHz



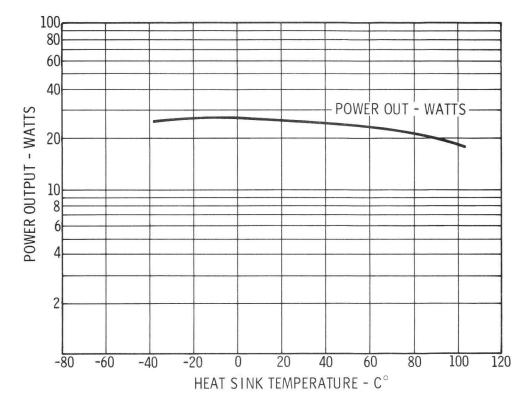


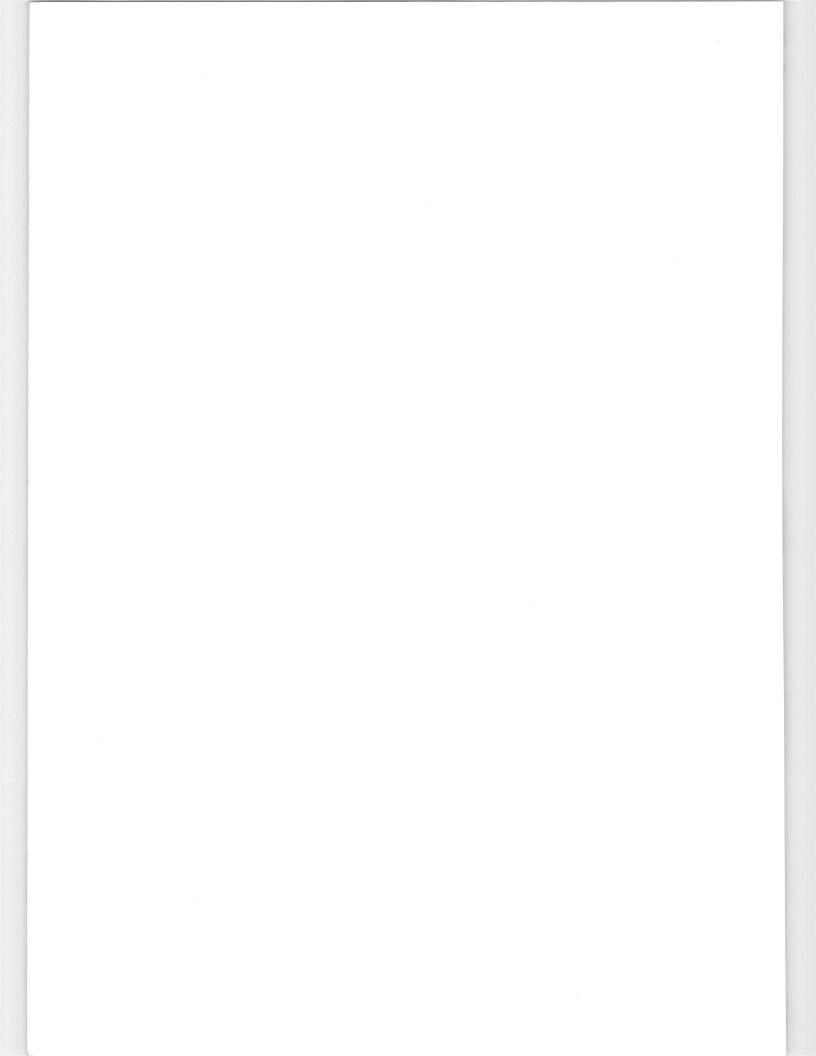
NJ-4539

IG. 2 TUNING RANGE OF WJ-4539 WITH 2 WATTS DRIVE



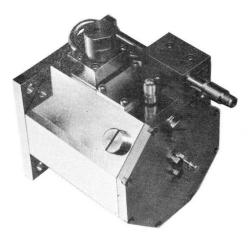
IG. 3 TEMPERATURE EFFECT OF WJ-4539 WITH 8 WATTS DRIVE AT 1482 MHz





MAY 1969

1435-1540 MHz CAVITY AMPLIFIER WJ-4540A



WJ-4540A is a grounded-grid cavity amplifier incorporating a stable-anode planar triode. Recommended for use in missile and aircraft telemetry transmitters, its small size, light weight and sturdy construction make it ideal for airborne systems.

SPECIFICATIONS

ELECTRICAL

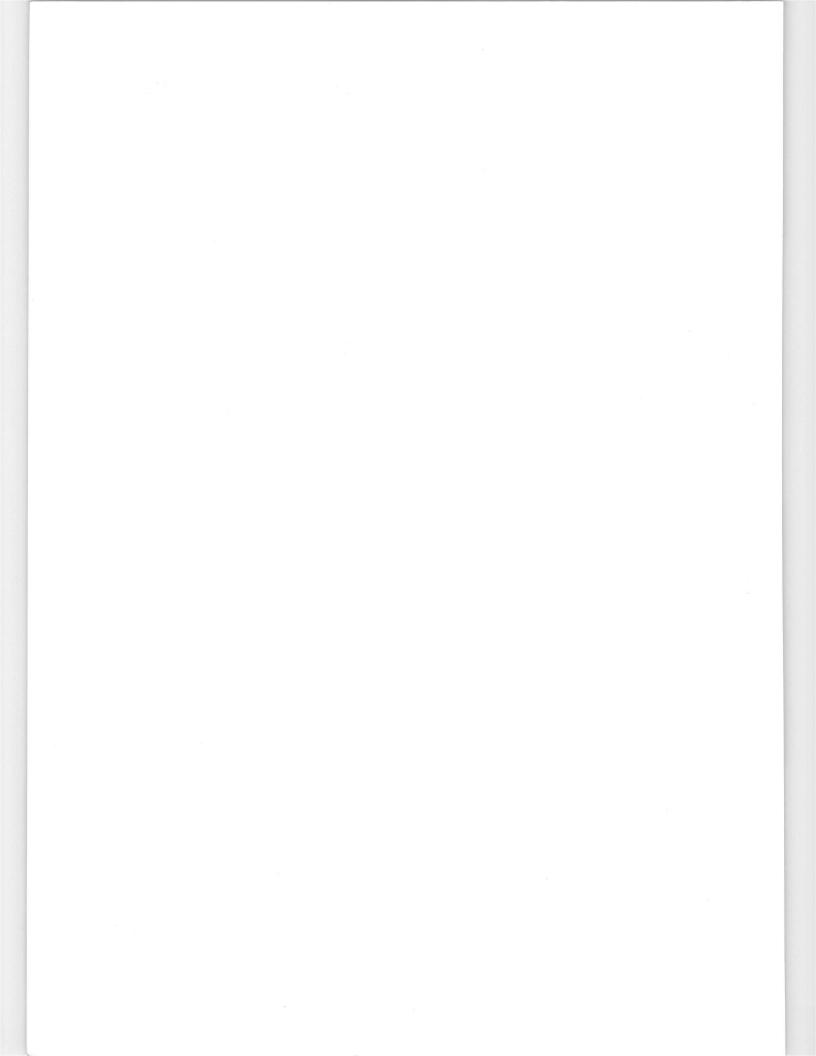
Frequency, tunable	1435-1540 MHz
Power Output, Minimum, with 10 W drive	100 Watts
with 5 W drive	
with 3 W drive	65 Watts
Bandwidth, Minimum (3 dB), with 10 W drive	15 MHz
VSWR, Maximum, for full rated output	
Efficiency, overall, minimum (at 100W)	30%
Harmonic suppression (2nd, 3rd & 4th)	
Warm-up Time	
Power Supply Requirements: Anode:	
Heater:	

MECHANICAL

Size, overall (including connectors)	2.25 Pounds
Connectors: RF Input and Output	OSM Female Special (Mating connector included)

ENVIRONMENT

Temperature, heat sink, continuous operation	—54°C to +95°C	
Altitude	Any	
Vibration, sinusoidal	20g, 20-2000 Hz	
Other	Per MIL-E-5400	
Recommended power supply (DC-DC converter) is WJ-4541. AC supplies also available.		



FEBRUARY 1970*

2.0 TO 4.0 GHz LOW-NOISE MICROWAVE TRANSISTOR AMPLIFIER WITH INTEGRAL POWER SUPPLY WJ-5004-4



SMALL SIZE: 1.3 x 2.3 x 2.9 INCHES

GUARANTEED 7.0 dB
 NOISE FIGURE

- GUARANTEED +5 dBm POWER OUTPUT
- MEETS MIL-E-16400 AND MIL-E-5400 CLASS II ENVIRONMENT
- "JUST PLUG IT IN"

The WJ-5004-4 is one of a new series of low-noise microwave transistor amplifiers developed by Watkins-Johnson Company to complement an existing line of ultra-low-noise TWAs. Featuring all solid state components, this miniaturized amplifier offers a guaranteed noise figure of 7.0 dB and +5 dBm power output.¹ This high-performance S-band amplifier (with integral power supply) offers a power output/noise figure/size combination that is intended to satisfy most design requirements. Plug it into 115 volt ac power outlets for operation.

Modular construction ensures high reliability under adverse operating conditions. The microstripline circuit configuration employs integrated circuit biasing and bypass modules for consistently high performance. The overall design of the WJ-5004-4 is consistent with the general requirements of MIL-E-16400 and MIL-E-5400, class II. Since the amplifier is tested and set for operation prior to shipment, no adjustments are necessary by the user.

SPECIFICATIONS

Frequency Noise Figure Gain, Small Signal VSWR, Input and Output Power Output ¹ Impedance, Input and Output	.6.0 dB .27 dB .1.7:1 .+7 dBm .50 ohms	7.0 dB max. . 25 dB min. . 2.0:1 max. ⊢5 dBm min.
Intercept Point for 3rd Order IM	. +15 dBm	

PRIMARY ELECTRICAL REQUIREMENTS

Primary Voltage	olt ac
Primary Power	nax.
Primary Frequency	

ENVIRONMENTAL CHARACTERISTICS

Designed to meet the respective requirements of MIL-E-16400 F, including Amendment 4 dated 15 May 1968, and MIL-E-5400K, class 2.

¹For 1 dB gain compression.

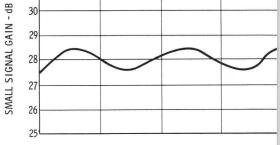
*Supersedes WJ-5004-4 Technical Data Sheet dated October 1969.

WJ-5004-4

POWER

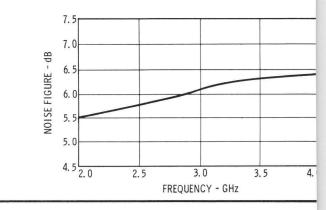
MECHANICAL CHARACTERISTICS

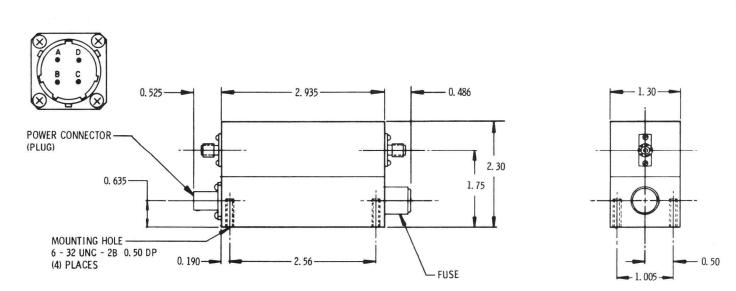
Height 2.3 inches (58 mm)
Width 1.3 inches (33 mm)
Length 2.9 inches (74 mm) (less connectors)
Weight 6.0 ounces (170 g)
RF Connectors OSM Jack



NOISE

GAIN





* NOVEMBER 1970

YIG-TUNED BULK GaAs OSCILLATOR WJ-5008

WJ-5008 is one of a family of lightweight, electronically tuned solid state oscillators produced by Watkins-Johnson Company. YIG tuning provides excellent linearity over the full microwave band for this microwave signal source. The use of high "Q" YIG spheres for frequency control ensures an extremely clean output spectrum.

The dc bias terminal for this oscillator is isolated by low pass filters to prevent RFI. The RF circuit is isolated from the dc circuit, thus enabling the input voltages to be common to other circuit voltages if desired.

Frequency tuning of the WJ-5008 is accomplished by changing the current which flows through the tuning coils, producing a magnetic bias for the YIG resonator. Since the WJ-5008 is magnetically self-shielding, it produces negligible stray magnetic fields and remains unaffected by moderate magnetic environments.

YIG-tuned oscillators with wider bandwidth, higher outputs, lower power variation, higher sweep rate, and different tuning sensitivity can be made to order.



SPECIFICATIONS

RF PERFORMANCE Nominal Frequency Band	Typical	Guaranteed
Power Output into Load VSWR =1.25:1 (50 ohm) Power Output Variation (matched load) Spurious Oscillation	10 mW 5 dB	
Ratio of Signal to 2nd Harmonic Output Ratio of Signal to all other Spurious Outputs in the Nominal Frequency Band		
Sensitivity to Supply Voltage Frequency Drift, 10° to 50°C Pulling Figure, VSWR 2:1 at any phase Residual FM, Peak to Peak	20 MHz 20 MHz	
TUNING CHARACTERISTICSSweep Rate (Sawtooth)Tuning LinearityHysteresisTuning SensitivityTuning Coil ResistanceTuning Coil Inductance	±0.1% 10 MHz 16 MHz/mA 5 Ohm	

*Supersedes WJ-5008 Technical Data Sheet dated January 1970.

SPECIFICATIONS (Cont'd)

ELECTRICAL REQUIREMENTS

*Oscillator Bias Voltage, (typical) 10 Vdc Oscillator Current (typical) 500 mA

*Positive side ground.

MECHANICAL **CHARACTERISTICS**

Size excluding RF Connector and Solder Terminals (width x length x height) 2 x 2 x 2.2 inches (51 x 51 x 56 mm) Weight, including Magnetic Shielding 34 ounces (952 g) max.

RF Output Connection SMA Jack

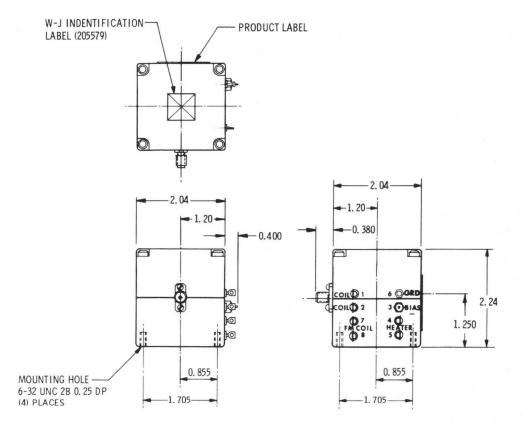
OUTLINE DRAWING

†DC Input Connections Solder Terminals

ENVIRONMENTAL CHARACTERISTICS

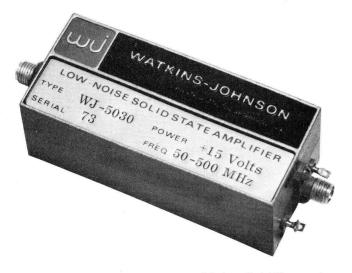
Temperature, operating 10° to 50°C Temperature, non-operating ... -55°C to +85°C

+GaAs Oscillator Solder Terminal connections have RFI shielding.



JANUARY 1970

50 TO 500 MHz LOW-NOISE VHF/UHF TRANSISTOR AMPLIFIER WJ-5030



• SMALL SIZE: 1.0 x 1.3 x 2.9 INCHES

- GUARANTEED 3.5 dB
 NOISE FIGURE
- GUARANTEED -3 dBm POWER OUTPUT*
- MIL-E-16400 AND MIL-E-5400 CLASS II ENVIRONMENT DESIGN
- NO ADJUSTMENTS REQUIRED

The WJ-5030 is one of a new series of low-noise VHF/UHF transistor amplifiers developed by Watkins-Johnson Company to complement an existing line of ultra-low-noise microwave amplifiers. Featuring all solid state components, this miniaturized amplifier offers a guaranteed noise figure of 3.5 dB and -3 dBm power^{*}output over a full decade frequency band.

This high-performance amplifier offers a power output/noise figure/size combination that is intended to satisfy most design requirements. Modular construction ensures high reliablility under adverse operating conditions. The microstripline circuit configuration employs integrated circuit biasing and bypass modules for consistently high performance. The overall design of the WJ-5030 is consistent with the general requirements of MIL-E-16400 and MIL-E-5400, class II. Since the amplifier is tested and set for operation prior to shipment, no adjustments are necessary by the user.

SPECIFICATIONS

PERFORMANCE

Typical

.

Guaranteed

Frequency	50 to 500 MHz	50 to 500 MHz
Noise Figure		
Gain, Small Signal		
Gain Variation	±0.7 dB	±1.0 dB max.
VSWR, Input and Output	2.0:1/1.5:1	2.5:1/2.0:1 max.
Power Output*		
Impedance, Input and Output		50 ohms
Intercept Point for 3rd Order IM	+5 dBm	

PRIMARY ELECTRICAL REQUIREMENTS

Primary																			
Primary	Power .										 						1	watt max	х.

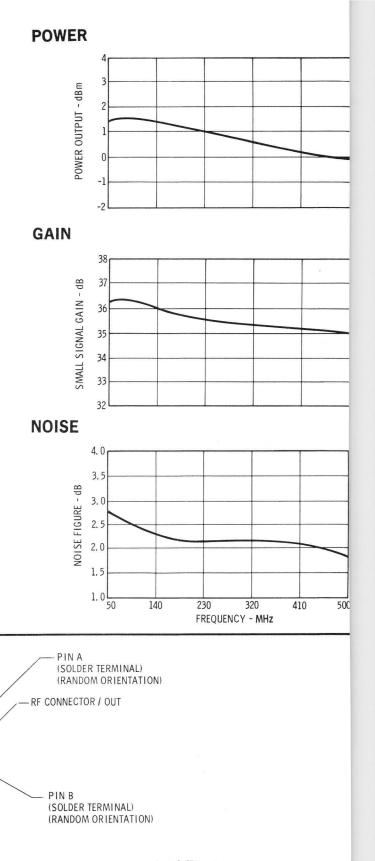
ENVIRONMENTAL CHARACTERISTICS

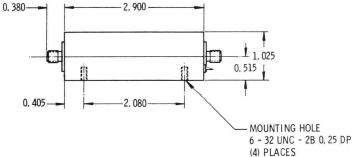
Designed to meet the respective requirements of MIL-E-16400 F, including Amendment 4 dated 15 May 1968, and MIL-E-5400K, class 2.

*For 1 dB gain compression.

MECHANICAL CHARACTERISTICS

Height 1.0 inch (25 mm)
Width 1.3 inches (33 mm)
Length 2.9 inches (74 mm) (less connectors)
Weight 3.0 ounces (85 g)
RF Connectors OSM Jack



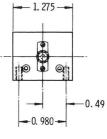


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JANUARY 1970

OUTLINE DRAWING

RF CONNECTOR / IN-

PRODUCT LABEL

* NOVEMBER 1970

YIG-TUNED BULK GaAs OSCILLATOR WJ-5041

WJ-5041 is one of a family of lightweight, electronically tuned solid state oscillators produced by Watkins-Johnson Company. YIG tuning provides excellent linearity over the full microwave band for this microwave signal source. The use of high "Q" YIG spheres for frequency control ensures an extremely clean output spectrum.

The dc bias terminal for this oscillator is isolated by low pass filters to prevent RFI. The RF circuit is isolated from the dc circuit, thus enabling the input voltages to be common to other circuit voltages if desired.

Frequency tuning of the WJ-5041 is accomplished by changing the current which flows through the tuning coils, producing a magnetic bias for the YIG resonator. Since the WJ-5041 is magnetically self-shielding, it produces negligible stray magnetic fields and remains unaffected by moderate magnetic environments.



YIG-tuned oscillators with wider bandwidth, higher ouputs, lower power variation, higher sweep rate, and different tuning sensitivity can be made to order.

SPECIFICATIONS

RF PERFORMANCE Nominal Frequency Band Power Output into Load VSWR = 1.2:1 Power Output Variation (matched load) Spurious Oscillation	3 mW	Guaranteed 12.4 to 18 GHz 1 mW min.
Ratio of Signal to 2nd Harmonic Output Ratio of Signal to all Other Spurious Outputs		
in the Nominal Frequency Band	50 Ohms	
Sensitivity to Supply Voltage Frequency Drift, 10° to 50°C Pulling Figure, VSWR 2:1 at any phase	30 MHz	
Residual FM, Peak to Peak		
TUNING CHARACTERISTICS		
Sweep Rate (Sawtooth)		
Tuning Linearity, dc at 30°C		
Hysteresis, dc at 30°C	40 MHz	
Tuning Sensitivity	17 MHz/mA	
Tuning Coil Resistance	5 Ohms	
Tuning Coil Inductance	110 mH	

*Supersedes WJ-5041 Technical Data Sheet dated December 1969.

SPECIFICATIONS (Cont'd)

ELECTRICAL REQUIREMENTS

*Oscillator Bias Voltage, (typical) 4.0 Vdc Oscillator Current (typical) 500 mA •Negative side ground

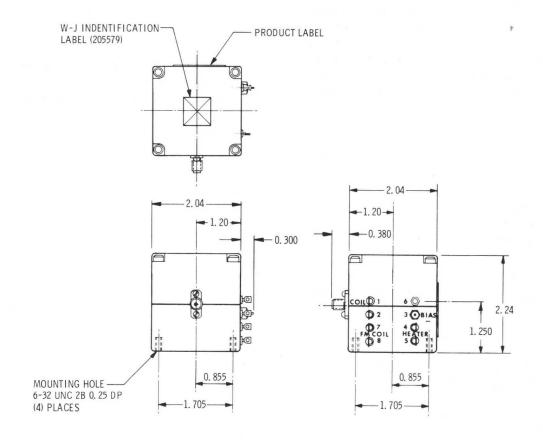
MECHANICAL CHARACTERISTICS

Size excluding RF Connector and Solder Terminals (width x length x height) 2 x 2 x 2.2 inches Weight, including (51 x 51 x 56 mm) Magnetic Shielding 34 ounces (952 g) max. RF Output Connection SMA Jack †DC Input Connections Solder Terminals

ENVIRONMENTAL CHARACTERISTICS

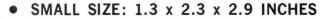
Temperature, operating10° to 50°C Temperature, non-operating -55°C to +85°C

†GaAs Oscillator Solder Terminal connections have RFI shielding.



IANUARY 1971

2.0 TO 4.5 GHz LOW-NOISE MICROWAVE TRANSISTOR AMPLIFIER WITH INTEGRAL POWER SUPPLY WJ-5090-4



- GUARANTEED 7.5 dB NOISE FIGURE
- GUARANTEED +5 dBm POWER OUTPUT
- DESIGNED TO MIL-E-16400 AND MIL-E-5400 CLASS II ENVIRONMENT
- "JUST PLUG IT IN"

The WJ-5090-4 is one of a new series of low-noise microwave transistor amplifiers developed by Watkins-Johnson Company to complement an existing line of ultra-low-noise TWAs. Featuring all solid state components, this miniaturized amplifier offers a guaranteed noise figure of 7.5 dB and +5 dBm power output.¹ This high-performance S-band amplifier (with integral power supply) offers a power output/noise figure/size combination that is intended to satisfy most design requirements. Plug it into 115 volt ac power outlets for operation.

Modular construction ensures high reliability under adverse operating conditions. The microstripline circuit configuration employs integrated circuit biasing and bypass modules for consistently high performance. The overall design of the WJ-5090-4 is consistent with the general requirements of MIL-E-16400 and MIL-E-5400, class II. Since the amplifier is tested and set for operation prior to shipment, no adjustments are necessary by the user.

SPECIFICATIONS

PERFORMANCE Typical Guaranteed Intercept Point for 3rd Order IM + 17 dBm

PRIMARY ELECTRICAL REQUIREMENTS

Primary Voltage								•		•	÷	115 ± 10 volt ac
Primary Power									•			3.0 watts max.
Primary Frequency												48 to 420 Hz

ENVIRONMENTAL CHARACTERISTICS

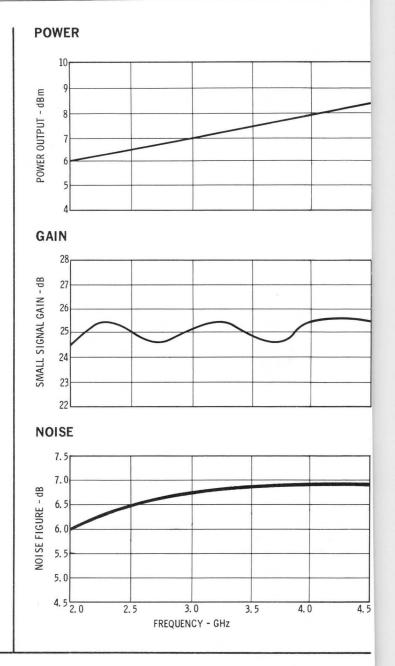
Designed to meet the respective requirements of MIL-E-16400 F, including Amendment 4 dated 15 May 1968, and MIL-E-5400K, class 2.



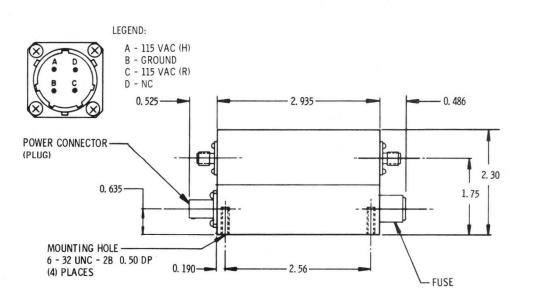
WJ-5090-4

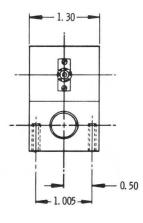
MECHANICAL CHARACTERISTICS

Height 2.3 inches (58 mm)
Width 1.3 inches (33 mm)
Length 2.9 inches (74 mm) (less connectors)
Weight 6.0 ounces (170 g)
RF Connectors OSM Jack



OUTLINE DRAWING

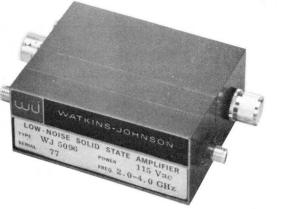




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JULY 1970

2.0 TO 4.0 GHz LOW-NOISE MICROWAVE TRANSISTOR AMPLIFIER WITH INTEGRAL POWER SUPPLY WJ-5096



- SMALL SIZE: 1.3 x 2.3 x 2.9 INCHES
- GUARANTEED 8.5 dB NOISE FIGURE
- GUARANTEED +5 dBm POWER OUTPUT
- MEETS MIL-E-16400 AND MIL-E-5400 CLASS II ENVIRONMENT
- "JUST PLUG IT IN"

The WJ-5096 is one of a new series of low-noise microwave transistor amplifiers developed by Watkins-Johnson Company to complement an existing line of ultra-low-noise TWAs. Featuring all solid state components, this miniaturized amplifier offers a guaranteed noise figure of 8.5 dB and +5 dBm power output.¹ This high-performance S-band amplifier (with integral power supply) offers a power output/noise figure/size combination that is intended to satisfy most design requirements. Plug it into 115 volt ac power outlets for operation.

Modular construction ensures high reliability under adverse operating conditions. The microstripline circuit configuration employs integrated circuit biasing and bypass modules for consistently high performance. The overall design of the WJ-5096 is consistent with the general requirements of MIL-E-16400 and MIL-E-5400, class II. Since the amplifier is tested and set for operation prior to shipment, no adjustments are necessary by the user.

SPECIFICATIONS

PERFORMANCE	Typical	Guaranteed
Frequency	 . 2.0 to 4.0 GHz	. 2.0 to 4.0 GHz
Noise Figure	 . 8.0 dB	8.5 dB max.
Gain, Small Signal	 . 27 dB	25 dB min.
VSWR, Input and Output	 . 1.7:1	2.5:1 max.
Power Output ¹	 . + 7 dBm	+ 5 dBm min.
Impedance, Input and Output	 . 50 ohms	50 ohms
Gain Flatness	 $. \pm 1.0 \text{ dB}$	
Reverse Isolation	 . 50 dB	
Intercept Point for 3rd Order IM	 . +12 dBm	

PRIMARY ELECTRICAL REQUIREMENTS

Primary Voltage											115 ± 10 volt ac
Primary Power											3.0 watts max.
Primary Frequency	÷					i.					48 to 420 Hz

ENVIRONMENTAL CHARACTERISTICS

Designed to meet the respective requirements of MIL-E-16400 F, including Amendment 4 dated 15 May 1968, and MIL-E-5400K, class 2.

¹For 1 dB gain compression.

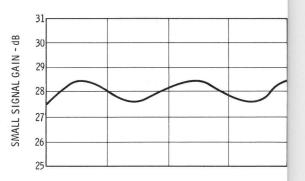
POWER

POWER OUTPUT - dBm

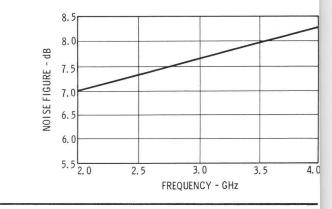


Height 2.3 inches (58 mm)
Width 1.3 inches (33 mm)
Length 2.9 inches (74 mm) (less connectors)
Weight 6.0 ounces (170 g)
RF Connectors OSM Jack

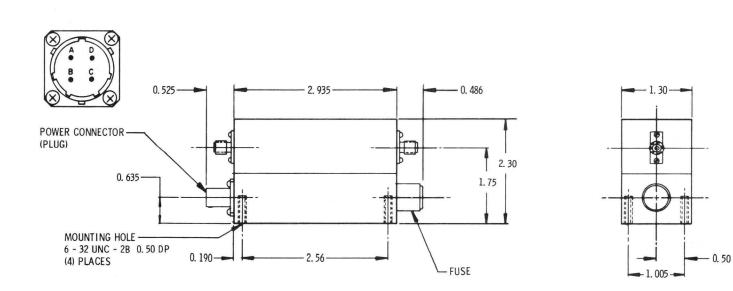








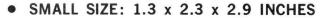
OUTLINE DRAWING



JULY 1970

JANUARY 1971

1.0 TO 4.0 GHz LOW-NOISE MICROWAVE TRANSISTOR AMPLIFIER WITH INTEGRAL POWER SUPPLY WJ-6007



- GUARANTEED 7.5 dB NOISE FIGURE
- GUARANTEED +5 dBm POWER OUTPUT
- DESIGNED TO MIL-E-16400 AND MIL-E-5400 CLASS II ENVIRONMENT
- "JUST PLUG IT IN"

The WJ-6007 is one of a new series of low-noise microwave transistor amplifiers developed by Watkins-Johnson Company to complement an existing line of ultra-low-noise TWAs. Featuring all solid state components, this miniaturized amplifier offers a guaranteed noise figure of 7.5 dB and +5 dBm power output.¹ This high-performance double-octave amplifier (with integral power supply) offers a power output/noise figure/size combination that is intended to satisfy most design requirements. Plug it into 115 volt ac power outlets for operation.

Modular construction ensures high reliability under adverse operating conditions. The microstripline circuit configuration employs integrated circuit biasing and bypass modules for consistently high performance. The overall design of the WJ-6007 is consistent with the general requirements of MIL-E-16400 and MIL-E-5400, class II. Since the amplifier is tested and set for operation prior to shipment, no adjustments are necessary by the user.

SPECIFICATIONS

PERFORMANCE

Typical

Guaranteed

Frequency	1.0 to 4.0 GHz	
Noise Figure	6.0 dB	
	28 dB	
VSWR, Input and Output	1.7:1	
Power Output (For 1 dB gain compression.)	+ 7 dBm+ 5 dBm min.	
Impedance, Input and Output	50 ohms	
Intercept Point for 3rd Order IM	+17 dBm	

PRIMARY ELECTRICAL REQUIREMENTS

Primary Voltage			÷		÷	÷	÷	÷		÷	•	•		115 ± 10 volt ac
Primary Power	i,		ł	Ì.		į.		i.	÷					3.0 watts max.
Primary Frequency														48 to 420 Hz

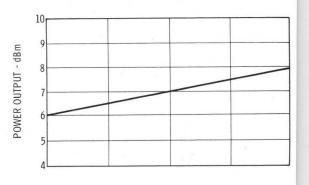
ENVIRONMENTAL CHARACTERISTICS

Designed to meet the respective requirements of MIL-E-16400 F, including Amendment 4 dated 15 May 1968, and MIL-E-5400K, class 2.

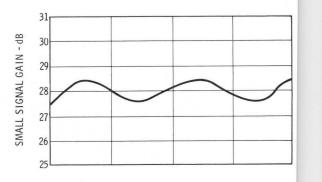


MECHANICAL CHARACTERISTICS

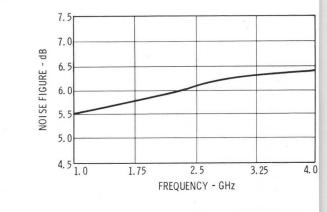
POWER



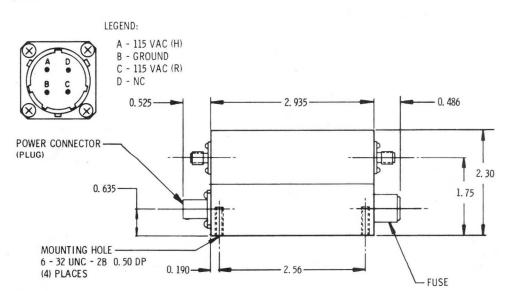
GAIN

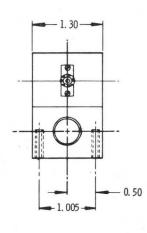






OUTLINE DRAWING





JANUARY 1971

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