PHILIPS

Data handbook

Electronic components and materials

Semiconductors and integrated circuits

Part 4 December 1971

Transmitting transistors

Microwave devices

Field effect transistors

Dual transistors

Microminiature devices

Photo devices

Accessories

SEMICONDUCTORS AND INTEGRATED CIRCUITS

Part 4 **December 1971**

DATA HANDBOOK SYSTEM

To provide you with a comprehensive source of information on electronic components, subassemblies and materials, our Data Handbook System is made up of three series of handbooks, each comprising several parts.
The three series, identified by the colours noted, are:

ELECTRON TUBES (9 parts)	BLUE
SEMICONDUCTORS AND INTEGRATED CIRCUITS (5 parts)	RED
COMPONENTS AND MATERIALS (7 parts)	GREEN

The several parts contain all pertinent data available at the time of publication, and each is revised and reissued annually; the contents of each series are summarized on the following pages.
We have made every effort to ensure that each series is as accurate, comprehensive and up-to-date as possible, and we hope you will find it to be a valuable source of reference. Where ratings or specifications quoted differ from those published in the preceding edition they will be pointed out by arrows. You will understand that we can not guarantee that all products listed in any one edition of the handbook will remain available, or that their specifications will not be changed, before the next edition is published. If you need confirmation that the pusblished data about any of our products are the latest available, may we ask that you contact our representative. He is at your service and will be glad to answer your inquiries.

May 1971

ELECTRON TUBES (BLUE SERIES)

This series consists of the following parts, issued on the dates indicated.

Part 1 **January 1971**

Transmitting tubes (Tetrodes, Pentodes)
Associated accessories

Part 2 **March 1971**

Tubes for microwave equipment

Part 3 **March 1970**

Special Quality tubes
Miscellaneous devices

Part 4 **April 1971**

Receiving tubes

Part 5 **May 1971**

Cathode-ray tubes
Photo tubes
Camera tubes
Photoconductive devices
Associated accessories

Part 6 **June 1971**

Photomultipliers tubes
Channel electron multipliers
Scintillators
Photoscintillators
Radiation counter tubes
Semiconductor radiation detectors
Neutron generator tubes
Photo diodes
Associated accessories

Part 7 **July 1971**

Voltage stabilizing and reference tubes
Counter, selector, and indicator tubes
Trigger tubes
Switching diodes
Thyratrons
Ignitrons
Industrial rectifying tubes
High-voltage rectifying tubes

Part 8 **August 1971**

T.V. Picture tubes

Part 9 **January 1971**

Transmitting tubes (Triodes)
Tubes for R.F. heating (Triodes)
Associated accessories

August 1971

SEMICONDUCTORS AND INTEGRATED CIRCUITS (RED SERIES)

This series consists of the following parts, issued on the dates indicated.

Part 1 Diodes and Thyristors — September 1971

General
Signal diodes
Variable capacitance diodes
Voltage regulator diodes
Rectifier diodes
Thyristors, diacs, triacs
Rectifier stacks
Accessories
Heatsinks

Part 2 Low frequency; Deflection — October 1971

General
Low frequency transistors (low power)
Low frequency power transistors
Deflection transistors
Accessories

Part 3 High frequency; Switching — November 1971

General
High frequency transistors
Switching transistors
Accessories

Part 4 Special types — December 1971

General
Transmitting transistors
Microwave devices
Field effect transistors
Dual transistors
Microminiature devices for thick- and thin-film circuits
Photoconductive devices
Photodiodes
Phototransistors
Light emitting diodes
Infra-red sensitive devices
Accessories

Part 5 Integrated Circuits — March 1971

General
Digital integrated circuits
  DTL (FC family)
  TTL (FJ family)
  MOS (FD family)
Linear integrated circuits

COMPONENTS AND MATERIALS (GREEN SERIES)

This series consists of the following parts, issued on the dates indicated.

Part 1 Circuit Blocks, Input/Output Devices, Electro-mechanical Components *), Peripheral Devices — October 1971

Circuit blocks 40-Series
Counter modules 50-Series
Norbits 60-Series, 61-Series
Circuit blocks 90-Series
Input/output devices
Electro-mechanical components *)
Peripheral devices

Part 2 Resistors, Capacitors — December 1970

Fixed resistors
Variable resistors
Non-linear resistors
Ceramic capacitors
Polyester, polycarbonate, polystyrene, paper capacitors
Electrolytic capacitors
Variable capacitors

Part 3 Radio, Audio, Television — February 1971

FM tuners
Coils * *)
Piezoelectric ceramic resonators and filters
Loudspeakers
Audio and mains transformers
Television tuners
Components for black and white television
Components for colour television
Deflection assemblies for camera tubes

Part 4 Magnetic Materials, Piezoelectric Ceramics — April 1971

Ferrites for radio, audio and television
Small coils, assemblies and assembling parts
Ferroxcube potcores and square cores
Ferroxcube transformer cores
Piezoxide
Permanent magnet materials

Part 5 Memory Products, Magnetic Heads, Quartz Crystals, Microwave Devices, Variable Transformers — June 1971

Ferrite memory cores
Matrix planes, matrix stacks
Complete memories
Magnetic heads
Quartz crystal units, crystal filters
Isolators, circulators
Variable mains transformers

Part 6 Electric Motors and Accessories, Timing and Control Devices — August 1971

Stepper motors
Small synchronous motors
Asynchronous motors
Small d.c. motors
Tachogenerators and servomotors
Indicators for built-in test equipment

Part 7 Circuit Blocks — September 1971

Circuit blocks 100kHz Series
Circuit blocks 1-Series
Circuit blocks 10-Series
Circuit blocks for ferrite core memory drive

*) From October 1971 published in Part 1 instead of Part 5.

* *) Also included (under "Small coils, etc.") in Part 4.

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General

Type designation
Rating systems
Letter symbols

PRO ELECTRON TYPE DESIGNATION CODE

FOR SEMICONDUCTOR DEVICES

This type designation code applies to discrete devices and to multiple devices 1)

The type designation consists of:

TWO LETTERS FOLLOWED BY A SERIAL NUMBER

The first letter gives an indication of the material

A	Material with a band gap of 0.6 to 1.0 eV, such as germanium
B	Material with a band gap of 1.0 to 1.3 eV, such as silicon
C	Material with a band gap of 1.3 eV and more, such as gallium arsenide
D	Material with a band gap of less than 0.6 eV, such as indium antimonide
R	Compound material as employed in Hall generators and photoconductive cells

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1) A multiple device is defined as a combination of similar or dissimilar active devices, contained in a common encapsulation that cannot be dismantled, and of which all electrodes of the individual devices are accessible from the outside.

Multiples of similar devices as well as multiples consisting of a main device and an auxiliary device are designated according to the code for discrete devices described above.
Multiples of dissimilar devices of other nature are designated by the second letter G.

The second letter indicates primarily the main application respectively main application and construction if a further differentiation is essential

A	Detection diode, switching diode, mixer diode
B	Variable capacitance diode
C	Transistor for a.f. applications ($R_{th\ j\text{-}mb} > 15\ ^{o}C/W$)
D	Power transistor for a.f. applications ($R_{th\ j\text{-}mb} \leq 15\ ^{o}C/W$)
E	Tunnel diode
F	Transistor for h.f. applications ($R_{th\ j\text{-}mb} > 15\ ^{o}C/W$)
G	Multiple of dissimilar devices (see note on page 1); Miscellaneous
H	Magnetic sensitive diode; Field probe
K	Hall generator in an open magnetic circuit, e.g. magnetogram or signal probe
L	Power transistor for h.f. applications ($R_{th\ j\text{-}mb} \leq 15\ ^{o}C/W$)
M	Hall generator in a closed electrically energised magnetic circuit, e.g. Hall modulator or multiplier
P	Radiation sensitive device 1)
Q	Radiation generating device
R	Electrically triggered controlling and switching device having a breakdown characteristic ($R_{th\ j\text{-}mb} > 15\ ^{o}C/W$)
S	Transistor for switching applications ($R_{th\ j\text{-}mb} > 15\ ^{o}C/W$)
T	Electrically, or by means of light, triggered controlling and switching power device having a breakdown characteristic ($R_{th\ j\text{-}mb} \leq 15\ ^{o}C/W$) 1)
U	Power transistor for switching applications ($R_{th\ j\text{-}mb} \leq 15\ ^{o}C/W$)
X	Multiplier diode, e.g. varactor, step recovery diode
Y	Rectifying diode, booster diode, efficiency diode 1)
Z	Voltage reference or voltage regulator diode 1)

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1) For the type designation of a range see page 4.

The serial number consists of:

Three figures for semiconductor devices designed primarily for use in domestic equipment

One letter and two figures for semiconductor devices designed primarily for use in professional equipment

VERSION LETTER

A version letter can be used, for instance, for a diode with up-rated voltage, for a sub-division of a transistor type in different gain ranges, a low noise version of an existing transistor and for a diode, transistor, or thyristor with minor mechanical differences, such as finish of the leads, length of the leads etc. The letters never have a fixed meaning, the only exception being the letter R.

EXAMPLES

AC187	Germanium low power a.f. transistor intended primarily for domestic equipment
BYX27	Silicon rectifying diode intended primarily for professional equipment

TYPE DESIGNATION FOR A RANGE OF RADIATION DETECTORS

The type designation of a range of variants of radiation detectors distinctly belonging to one basic type may be qualified by a suffix part which is clearly seperated from the basic part by a dash (-).

The basic part being the same for the whole range, is in accordance with the designation code for discrete devices.

The suffix part consists of a figure giving the depth of the depletion layer in μm and where appropriate a version letter if there are differences in resolution.

TYPE DESIGNATION FOR A RANGE OF SEMICONDUCTOR DEVICES

The type designation of a range of variants of:

a) voltage reference or voltage regulator diodes (second letter Z)

b) rectifying diodes (second letter Y)

c) thyristors (second letter T)

d) radiation detectors

distinctly belonging to one basic type may be qualified by a suffix part which is clearly separated from the basic part by a dash (-)
The basic part being the same for the whole range, is in accordance with the designation code for discrete devices.

The suffix part consists of:

a) for voltage reference or voltage regulator diodes

one letter followed by the typical zener voltage and where appropriate the letter R [1])
The first letter indicates the nominal tolerance of the zener voltage in %

A	1%
B	2%
C	5%
D	10%
E	15%

The typical zener voltage is related to the nominal current rating for the whole range. The letter V is used to denote the decimal point when this occurs.

b) for rectifying diodes

a number and where appropriate the letter R [1])
The number generally indicates the maximum repetitive peak reverse voltage
For controlled avalanche types it indicates the maximum crest working reverse voltage

c) for thyristors

a number and where appropriate the letter R [1])
The number generally indicates either the maximum repetitive peak reverse voltage or the maximum repetitive peak off-state voltage, whichever is lower
For controlled avalanche types it indicates the maximum crest working reverse voltage

---

[1]) The letter R indicates reverse polarity (anode to stud). The normal polarity (cathode to stud) and symmetrical executions are not specially indicated.

d) for radiation detectors

a figure giving the depth of the depletion layer in μm and where appropriate a version letter if there are differences in resolution.

EXAMPLES

BZY88series	Range of silicon voltage regulator diodes for professional equipment
BZY88-C9V1	The particular type out of the range with a typical zener voltage of 9.1 V ± 5%
BYX13-1200	The particular normal polarity type out of the BYX13series with a maximum repetitive peak reverse voltage of 1200 V
BTW92-800R	The particular reverse polarity type out of the BTW92 thyristor range of which the lower maximum repetitive peak voltage is 800V

RATING SYSTEMS

ACCORDING TO I.E.C. PUBLICATION 134

1. DEFINITIONS OF TERMS USED

1.1 Electronic device. An electronic tube or valve, transistor or other semiconductor device.

Note: This definition excludes inductors, capacitors, resistors and similar components.

1.2 Characteristic. A characteristic is an inherent and measurable property of a device. Such a property may be electrical, mechanical, thermal, hydraulic, electro-magnetic, or nuclear, and can be expressed as a value for stated or recognized conditions. A characteristic may also be a set of related values, usually shown in graphical form.

1.3 Bogey electronic device. An electronic device whose characteristics have the published nominal values for the type. A bogey electronic device for any particular application can be obtained by considering only those characteristics which are directly related to the application.

1.4 Rating. A value which establishes either a limiting capability or a limiting condition for an electronic device. It is determined for specified values of environment and operation, and may be stated in any suitable terms.

Note: Limiting conditions may be either maxima or minima.

1.5 Rating system. The set of principles upon which ratings are established and which determine their interpretation.

Note: The rating system indicates the division of responsibility between the device manufacturer and the circuit designer, with the object of ensuring that the working conditions do not exceed the ratings.

2. ABSOLUTE MAXIMUM RATING SYSTEM

Absolute maximum ratings are limiting values of operating and environmental conditions applicable to any electronic device of a specified type as defined by its published data, which should not be exceeded under the worst probable conditions.

These values are chosen by the device manufacturer to provide acceptable serviceability of the device, taking no responsibility for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the device under consideration and of all other electronic devices in the equipment.

p.t.o.

The equipment manufacturer should design so that, initially and throughout life, no absolute maximum value for the intended service is exceeded with any device under the worst probable operating conditions with respect to supply voltage variation, equipment component variation, equipment control adjustment, load variations, signal variation, environmental conditions, and variations in characteristics of the device under consideration and of all other electronic devices in the equipment.

3. DESIGN MAXIMUM RATING SYSTEM

Design maximum ratings are limiting values of operating and environmental conditions applicable to a bogey electronic device of a specified type as defined by its published data, and should not be exceeded under the worst probable conditions.

These values are chosen by the device manufacturer to provide acceptable serviceability of the device, taking responsibility for the effects of changes in operating conditions due to variations in the characteristics of the electronic device under consideration.

The equipment manufacturer should design so that, initially and throughout life, no design maximum value for the intended service is exceeded with a bogey device under the worst probable operating conditions with respect to supply voltage variation, equipment component variation, variation in characteristics of all other devices in the equipment, equipment control adjustment, load variation, signal variation and environmental conditions.

4. DESIGN CENTRE RATING SYSTEM

Design centre ratings are limiting values of operating and environmental conditions applicable to a bogey electronic device of a specified type as defined by its published data, and should not be exceeded under normal conditions.

These values are chosen by the device manufacturer to provide acceptable serviceability of the device in average applications, taking responsibility for normal changes in operating conditions due to rated supply voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of all electronic devices.

The equipment manufacturer should design so that, initially, no design centre value for the intended service is exceeded with a bogey electronic device in equipment operating at the stated normal supply voltage.

NOTE

It is common use to apply the Absolute Maximum System in semiconductor published data.

LETTER SYMBOLS

LETTER SYMBOLS FOR SEMICONDUCTOR DEVICES
excluding rectifier diodes, thyristors and integrated circuits

This system is based on the Recommendations of the INTERNATIONAL ELECTROTECHNICAL COMMISSION as published in I.E.C. Publication 148.

QUANTITY SYMBOLS

1. Instantaneous values of current, voltage and power, which vary with time are represented by the appropriate lower case letter.

   Examples: i, v, p

2. Maximum (peak), average, d.c. and root-mean-square values are represented by the appropriate upper case letter.

   Examples: I, V, P

SUBSCRIPTS FOR QUANTITY SYMBOLS

1. Total values are indicated by upper case subscripts.

   Examples: I_C, I_{CM}, $I_{C(AV)}$, i_C, V_{EB}

2. Values of varying components are indicated by lower case subscripts.

   Examples: i_c, I_c, v_{eb}, V_{eb}

3. To distinguish between maximum (peak), average, d.c. and root-mean-square values, the following subscripts are added:

   For maximum (peak) values : M or m

   For average values : (AV) or (av) (only if it is necessary to distinguish between d.c. and average)

   For d.c. values : no additional subscript

   For root-mean-square values : (RMS) or (rms)

   Examples: I_C, I_{cm}, $I_{C(AV)}$, $I_{c(rms)}$, $I_{C(RMS)}$

4. List of subscripts (examples, see figure 1)

A, a = Anode terminal
K, k = Cathode terminal
E, e = Emitter terminal
B, b = Base terminal or Substrate for MOS devices
C, c = Collector terminal
D, d = Drain terminal
(BR) = Break-down
X, x = Specified circuit
M, m = Maximum (peak) value
(AV), (av) = Average value
(RMS), (rms) = R.M.S. value
F, f = Forward
G, g = Gate terminal
R, r = As first subscript: Reverse. As second subscript: Repetitive
O, o = As third subscript: The terminal not mentioned is open circuited
S, s = As first or second subscript: Source terminal (for FETS only)
As second subscript: Non-repetitive (not for FETS)
As third subscript : Short circuit between the terminal not mentioned and the reference terminal
Z, z = Zener. (Replaces R to indicate the actual zener voltage, current or power of voltage reference or voltage regulator diodes)

5. Examples of the application of the rules:
Figure 1 represents a transistor collector current, consisting of a direct current and a signal, as a function of time.

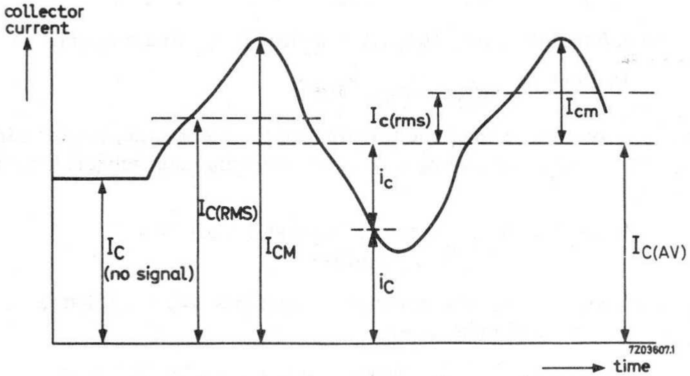

Fig.1

CONVENTIONS FOR SUBSCRIPT SEQUENCE

1. Currents

For transistors	the first subscript indicates the terminal carrying the current (conventional current flow from the external circuit into the terminal is positive)
For diodes	a forward current (conventional current flow into the anode terminal) is represented by the subscript F or f; a reverse current (conventional current flow out of the anode terminal) is represented by the subscript R or r.

2. Voltages

For transistors	normally, two subscripts are used to indicate the points between which the voltage is measured. The first subscript indicates one terminal point and the second the reference terminal. Where there is no possibility of confusion, the second subscript may be omitted.
For diodes	a forward voltage (anode positive with respect to cathode) is represented by the subscript F or f and a reverse voltage (anode negative with respect to cathode) by the subscript R or r.

3. Supply voltages

Supply voltages may be indicated by repeating the terminal subscript.

Examples: V_{EE}, V_{CC}, V_{BB}

The reference terminal may then be indicated by a third subscript.

Examples: V_{EEB}, V_{CCB}, V_{BBC}

4. In devices having more than one terminal of the same type, the terminal subscripts are modified by adding a number following the subscript and on the same line.

Example: V_{B2-E} voltage between second base and emitter

In multiple unit devices, the terminal subscripts are modified by a number preceding the terminal subscripts:

Example: V_{1B-2B} voltage between the base of the first unit and that of the second one.

ELECTRICAL PARAMETER SYMBOLS

1. The values of four pole matrix parameters or other resistances, impedances admittances, etc... inherent in the device, are represented by the lower case symbol with the appropriate subscripts.

Examples: h_{ib}, z_{fb}, y_{oc}, h_{FE}

2. The four pole matrix parameters of external circuits and of circuits in which the device forms only a part are represented by the upper case symbols with the appropriate subscripts.

Examples: H_i, Z_o, H_F, Y_R

SUBSCRIPTS FOR PARAMETER SYMBOLS

1. The static values of parameters are indicated by upper case subscripts.

Examples: h_{IB}, h_{FE}

Note The static value is the slope of the line from the origin to the operating point on the appropriate characteristic curve, i.e. the quotient of the appropriate electrical quantities at the operating point.

2. The small-signal values of parameters are indicated by lower case subscripts.

Examples: h_{ib}, z_{ob}

3. The first subscript, in matrix notation identifies the element of the four pole matrix.

i (for 11) = input
o (for 22) = output
f (for 21) = forward transfer
r (for 12) = reverse transfer

Examples:

$$\begin{aligned} V_1 &= h_i I_1 + h_r V_2 \\ I_2 &= h_f I_1 + h_o V_2 \end{aligned}$$

Notes 1) The voltage and current symbols in matrix notation are indicated by a single digit subscript.
The subscript 1 = input; the subscript 2 = output

2) The voltages and currents in these equations may be complex quantities.

4. The second subscript identifies the circuit configuration.

   e = common emitter
   b = common base
   c = common collector
   j = common terminal, general

   Examples: (common base)

   $$I_1 = y_{ib} V_{1b} + y_{rb} V_{2b}$$

   $$I_2 = y_{fb} V_{1b} + y_{ob} V_{2b}$$

   When the common terminal is understood, the second subscript may be omitted.

5. If it is necessary to distinguish between real and imaginary parts of the four pole parameters, the following notations may be used.

   $Re(h_{ib})$ etc.. for the real part

   $Im(h_{ib})$ etc.. for the imaginary part

LIST OF LETTER SYMBOLS IN ALPHABETICAL ORDER

Letter symbol	Definition
B	Bandwidth
b_{ib}, b_{ie}, b_{is}, b_{fb}, b_{fe}, b_{fs}, b_{ob}, b_{oe}, b_{os}, b_{rb}, b_{re}, b_{rs}	See y parameters
C_c [1]	Collector capacitance (emitter open-circuited to a.c. and d.c.)
C_d [1]	Diode capacitance
C_e [1]	Emitter capacitance (collector open-circuited to a.c. and d.c.)
C_{ib}, C_{ie}, C_{is}, C_{fb} C_{fe}, C_{fs}, C_{ob}, C_{oe} C_{os}, C_{rb}, C_{re}, C_{rs}	See y parameters
d	Distortion
F	Noise figure
f	Frequency
f_{hfb}, f_{hfe}, f_{yfe}	Cut-off frequency (frequency at which the parameter indicated by the subscript is 0.7 of its low frequency value)
f_T	Transition frequency (Gain-bandwidth product)
g_{ie}, g_{ib}, g_{oe}, g_{ob}	See y parameters
G_p	Power gain
G_S	Source conductance
G_{tr}	Transducer gain
G_{UM}	Maximum unilateralised power gain
G_v	Voltage gain

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1) As an exception to the general rule for electrical parameters capacitances are represented by the upper-case letter.

Letter symbol	Definition
h_{FB}, h_{FC}, h_{FE}	D.C. current gain (static value of the forward current transfer ratio; output voltage held constant)
h_{fb}, h_{fc}, h_{fe}	Small-signal current gain (small-signal value of the forward current transfer ratio; output short-circuited to a.c.)
h_{IB}, h_{IC}, h_{IE}	Static value of the input resistance (output voltage held constant)
h_{ib}, h_{ic}, h_{ie}	Small-signal value of the input impedance (output short-circuited to a.c.)
h_{OB}, h_{OC}, h_{OE}	Static value of the output conductance (input current held constant)
h_{ob}, h_{oc}, h_{oe}	Small-signal value of the output admittance (input open-circuited to a.c.)
h_{RB}, h_{RC}, h_{RE}	Static value of the reverse voltage transfer ratio (input current held constant)
h_{rb}, h_{rc}, h_{re}	Small-signal value of the reverse voltage transfer ratio (input open-circuited to a.c.)
I_B, I_C, I_D, I_E, I_G, I_S	Total d.c. (or average) current
I_b, I_c, I_d, I_e, I_g, I_s	Varying component of the current
i_B, i_C, i_D, i_E, i_G, i_S	Instantaneous total value of the current
i_b, i_c, i_d, i_e, i_g, i_s	Instantaneous value of the varying component of the current
$I_{B(AV)}$, $I_{C(AV)}$, $I_{E(AV)}$	Total average current (to distinguish between average and d.c. if necessary)
I_{BEX}, I_{CEX}	Total base, respectively collector current under specified conditions. These symbols are commonly used in case of a reverse biased emitter junction
I_{BM}, I_{CM}, I_{EM}	Maximum (peak) value of the total current
I_{bm}, I_{cm}, I_{em}	Maximum (peak) value of the varying component of the current
I_{CBO}	Collector cut-off current (open emitter)
I_{CEO}	Collector cut-off current (open base)
I_{CBS} or I_{CES}	Collector cut-off current (emitter short-circuited to base)

Letter symbol	Definition
I_{DSS}	Drain current (source short-circuited to gate)
I_{EBO}	Emitter cut-off current (open collector)
I_F	Total forward current of a diode (d.c. or average)
i_F	Instantaneous total value of the forward current of a diode
$I_{F(AV)}$	Total average forward current of a diode (to distinguish between average and d.c. if necessary)
I_{FM}	Peak forward current of a diode
I_{GSS}	Gate cut-off current (source short-circuited to drain)
I_i, I_o	Input, respectively output current of a specified circuit
I_R	Total reverse (cut-off) current of a diode
i_R	Instantaneous total value of the reverse current of a diode
I_{RRM}	Repetitive peak reverse current of a diode
I_{RSM}	Non-repetitive peak reverse current of a diode
I_{SDS}	Source cut-off current (drain short-circuited to gate)
I_Z	Zener current (d.c. or average)
I_{ZM}	Peak zener current
I_{ZS}	Non-repetitive zener current
P_i, P_o	Input, respectively output power of a specified circuit
P_{tot}	Total power dissipation in the device
P_Z	Zener power dissipation
P_{ZM}	Peak zener power dissipation
P_{ZSM}	Non-repetitive peak zener power dissipation
Q_s	Reverse recovery charge

Letter symbol	Definition
r_D	Diode (internal) series resistance
r_{DS}	Drain-source resistance
r_{GS}	Gate-source resistance
R_L	Load resistance
R_S	Source resistance
R_{th}	Thermal resistance
$R_{th\ j\text{-}a}$	Thermal resistance from junction to ambient
$R_{th\ j\text{-}mb}$	Thermal resistance from junction to mounting base
$R_{th\ j\text{-}c}$	Thermal resistance from junction to case
$R_{th\ mb\text{-}h}$	Thermal resistance from mounting base to heatsink (contact thermal resistance)
r_Z	Dynamic-slope resistance of a zener diode
S_Z	Temperature coefficient of the operating voltage of a zener diode
T_{amb}	Ambient temperature
T_{case}	Case temperature
t_d ; t_f	Delay time; fall time
t_{fr}	Forward recovery time of a diode
T_j	Junction temperature
t_{off}	**Turn-off** time ($t_{off} = t_s + t_f$)
t_{on}	**Turn-on** time ($t_{on} = t_d + t_r$)
t_r	Rise time
t_{rr}	Reverse recovery time of a diode
t_s	Storage time
T_{stg}	Storage temperature
V_{BB}, V_{CC}, V_{EE}	Supply voltage
V_{BE}, V_{CB}, V_{CE}, V_{EB}	Total value of the voltage (d.c. or average)
V_{be}, V_{cb}, V_{ce}, V_{eb}	Varying component of the voltage
v_{BE}, v_{CB}, v_{CE}, v_{EB}	Instantaneous value of the total voltage
v_{be}, v_{cb}, v_{ce}, v_{eb}	Instantaneous value of the varying component of the voltage

Letter symbols	Definition
V_{BEfl}	Base-emitter floating voltage (open base)
V_{BEsat}	Saturation voltage at specified bottoming conditions
$V_{(BR)}$	Breakdown voltage
$V_{(BR)CBO}$, $V_{(BR)CEO}$, $V_{(BR)EBO}$	Breakdown voltage between the terminal indicated by the first subscript and the reference terminal (second subscript) when the third terminal is open circuited
$V_{(BR)CER}$	Collector-emitter breakdown voltage with a specified resistance between emitter and base
$V_{(BR)CES}$	Collector-emitter breakdown voltage with the emitter short circuited to the base
V_{CBO}, V_{CEO}, V_{DGO}, V_{EBO}, V_{GSO}	Voltage of the terminal indicated by the first subscript w.r.t. the reference terminal (second subscript) with the third terminal open circuited
V_{CBOM}, V_{CEOM}	Peak value of V_{CBO}, V_{CEO}
V_{CEK}	Knee voltage at specified conditions
V_{CER}	Collector-emitter voltage with a specified resistance between emitter and base
V_{CERM}	Peak value of V_{CER}
V_{CES}	Collector-emitter voltage with the emitter short circuited to the base
V_{CEsat}	Saturation voltage at specified bottoming conditions
$V_{CE.sust}$	Collector-emitter sustaining voltage under the condition, indicated by the third subscript
V_{CEX}	Collector-emitter voltage in a specified circuit. This symbol is commonly used to indicate a reverse biased emitter junction
V_{DSS}	Drain-source voltage with the source short-circuited to the gate
V_{EBfl}	Emitter-base floating voltage (open emitter)
V_F	Continuous forward voltage of a diode
V_{FM}	Peak forward voltage of a diode

Letter symbol	Definition	
V_i, V_o	Input, respectively output voltage of a specified circuit	
$V_{(P)GS}$	Gate-source cut-off voltage	
V_R	Continuous reverse voltage of a diode	
V_{RM}	Peak reverse voltage of a diode	
V_{RSM}	Non-repetitive peak reverse voltage of a diode	
V_Z	Operating voltage (zener voltage) of a zener diode	
y_{ib}, y_{ie}, y_{is}	Input admittance	Output short circuited to a.c.
b_{ib}, b_{ie}, b_{is}		
g_{ib}, g_{ie}, g_{is}	Input conductance	
C_{ib}, C_{ie}, C_{is}	Input capacitance	
φ_{ib}, φ_{ie}, φ_{is}	Phase angle of input admittance	
y_{fb}, y_{fe}, y_{fs}	Transfer admittance	Output short circuited to a.c.
b_{fb}, b_{fe}, b_{fs}		
g_{fb}, g_{fe}, g_{fs}	Transfer conductance	
C_{fb}, C_{fe}, C_{fs}	Transfer capacitance	
φ_{fb}, φ_{fe}, φ_{fs}	Phase angle of transfer admittance	
y_{ob}, y_{oe}, y_{os}	Output admittance	Input short circuited to a.c.
b_{ob}, b_{oe}, b_{os}		
g_{ob}, g_{oe}, g_{os}	Output conductance	
C_{ob}, C_{oe}, C_{os}	Output capacitance	
φ_{ob}, φ_{oe}, φ_{os}	Phase angle of output admittance	
y_{rb}, y_{re}, y_{rs}	Feedback admittance	Input short circuited to a.c.
b_{rb}, b_{re}, b_{rs}		
g_{rb}, g_{re}, g_{rs}	Feedback conductance	
C_{rb}, C_{re}, C_{rs}	Feedback capacitance	
φ_{rb}, φ_{re}, φ_{rs}	Phase angle of feedback admittance	
Z_{th}	Transient thermal impedance	

Transmitting transistors

RULES FOR MOUNTING QUARTER-INCH CAPSTAN HEADERS AS USED FOR R-F POWER TRANSISTORS

A 5 mm thick brass nut is supplied with each transistor for securing it to a heatsink. To ensure optimum heat transfer and avoid damage to the threaded stud of the transistor the following recommendations should be observed:

- Diameter of mounting hole in heatsink: 4.1 mm (+0.05, - 0.00)
- Heatsink to be at least 3 mm thick.
  Attachment to a thinner heatsink may damage the mounting stud.
- Heatsink surfaces at the mounting hole to be flat, parallel, and free of burrs or oxidation.
- Mounting nut torque: 8.0 kg cm (+0.05, - 0.0)
  If security against vibration is required, use a locking compound such as Lock-tite. Do not use washers; they impair the heat transfer.
- Recommend distance from the top surface of heatsink to surface of printed wiring board: 2.9 mm (+0.0, - 0.2)
  Tension in the transistor leads sets the limit on spacing between heatsink and printed wiring board; in general, the leads can withstand more pull in the downward than in the upward direction.
- Solder the leads to the connection pads with resin-cored lead-tin solder, using an iron of normal temperature. Soldering iron temperatures as high as 350 °C are safely tolerable; the transistor can withstand an interior temperature of 250 °C for about ten minutes.
  The leads may be tinned, if required, by dipping them into a solder bath at about 230 °C; each lead may be dipped up to its full length. A flux of the quality of Super-Safe is recommended; after tinning, surplus flux should be rinsed away in tap water.

GERMANIUM ALLOY DIFFUSED TRANSISTOR

P-N-P transistor in a TO-39 metal envelope, primarily intended for use as a power amplifier in transmitting circuits up to frequencies of 180 MHz.

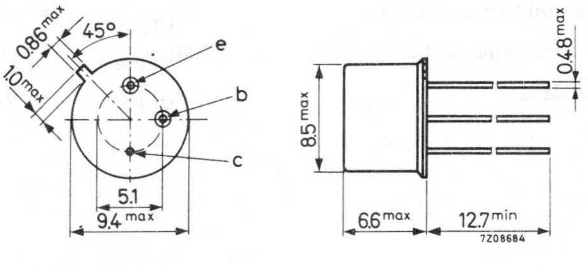
QUICK REFERENCE DATA

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	32	V
Collector-emitter voltage (V_{BE} = 0)	$-V_{CES}$	max.	32	V
Collector current (d.c.)	$-I_C$	max.	150	mA
Total power dissipation up to T_{case} = 65 °C	P_{tot}	max.	800	mW
Junction temperature	T_j	max.	90	°C
Transition frequency				
I_E = 100 mA; $-V_{CB}$ = 5 V	f_T	typ.	350	MHz

MECHANICAL DATA Dimensions in mm

TO-39

Collector connected to case



Accessories available: 56218, 56245, 56265

RATINGS (Limiting values) [1]

Voltages

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	32	V
Collector-emitter voltage (V_{BE} = 0)	$-V_{CES}$	max.	32	V

Currents

Collector current (d.c.)	$-I_C$	max.	150	mA
Collector current (peak value)	$-I_{CM}$	max.	300	mA
Emitter current (d.c.)	I_E	max.	200	mA
Emitter current (peak value)	I_{EM}	max.	350	mA
Reverse emitter current (d.c.)	$-I_E$	max.	10	mA
Reverse emitter current (peak value)	$-I_{EM}$	max.	30	mA

Power dissipation

Total power dissipation up to T_{case} = 65 °C	P_{tot}	max.	800	mW

Temperatures

Storage temperature	T_{stg}		−55 to +75	°C
Junction temperature : continuous	T_j	max.	90	°C
incidentally	T_j	max.	100	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	0.25	°C/mW
on a heatsink of 12.5 cm^2	$R_{th\ j-a}$	=	0.08	°C/mW
From junction to case	$R_{th\ j-c}$	=	0.035	°C/mW

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[1] Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

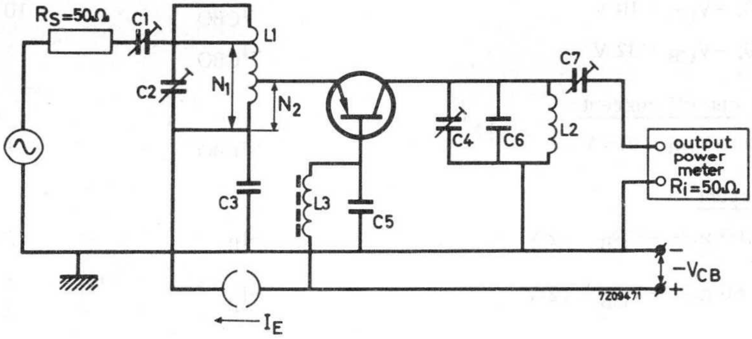
CHARACTERISTICS

T_{amb} = 25 °C unless otherwise specified

Collector cut-off current				
$I_E = 0$; $-V_{CB} = 10$ V	$-I_{CBO}$	<	10	µA
$I_E = 0$; $-V_{CB} = 32$ V	$-I_{CBO}$	<	1	mA
Emitter cut-off current				
$I_C = 0$; $-V_{EB} = 0.5$ V	$-I_{EBO}$	<	1	mA
Base current				
$I_E = 100$ mA; $-V_{CB} = 2$ V	$-I_B$	<	.3	mA
$I_E = 80$ mA; $-V_{CB} = 12$ V	$-I_B$	typ. <</br>	1 2	mA mA
Saturation voltage				
$-I_C = 300$ mA; $-I_B = 20$ mA	$-V_{CE\,sat}$	<	1	V
Collector capacitance at f = 0.5 MHz				
$I_E = I_e = 0$; $-V_{CB} = 10$ V	C_c	typ.	12	pF
Real part of input impedance				
$I_E = 100$ mA; $-V_{CB} = 5$ V; f = 100 MHz	$Re(h_{ie})$	typ.	18	Ω
Transition frequency				
$I_E = 100$ mA; $-V_{CB} = 5$ V	f_T	> typ.	225 350	MHz MHz

APPLICATION INFORMATION

V.H.F. power amplifier circuit at T_{amb} = 25 °C



f	=	80	180 MHz
C1	=	50	15 pF
C2	=	50	15 pF
C3	=	10	1 nF
C4	=	50	15 pF
C5 [1]	=	10	0.12 nF
C6	=	82	0 pF
C7	=	100	15 pF

f	=	80	180 MHz
L1	=	0.1	0.08 μH
L2	=	0.03	0.02 μH
L3	=	h.f. choke	
N_1/N_{tot}	=	1	0.5
N_2/N_{tot}	=	0.5	0.22
Q_1	>	150	200
Q_2	>	150	200

Performance in common base configuration

I_E = 80 mA; $-V_{CB}$ = 12 V

Output power at	f = 80 MHz	P_o	> 500	mW
	f = 180 MHz	P_o	> 400	mW
Power gain at	f = 80 MHz	G_p [2]	> 10	dB
	f = 180 MHz	G_p [2]	> 9	dB

Note

Care should be taken to reduce the case to heatsink capacitance, especially at 180 MHz.

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[1] C_5 should be chosen such that its series conductance can be neglected (e.g. a tubular ceramic capacitor mounted in a copper block).

[2] Without insertion losses and stated minimum P_o.

V.H.F. POWER TRANSISTOR

N-P-N epitaxial planar transistor intended for use in class A, B and C operated mobile, industrial and military transmitters with a supply voltage of 13.5 V. The transistor is resistance stabilized. Every transistor is tested under severe load mismatch conditions with a supply overvoltage to 16.5 V. It has a TO-39 envelope with the collector connected to the case.

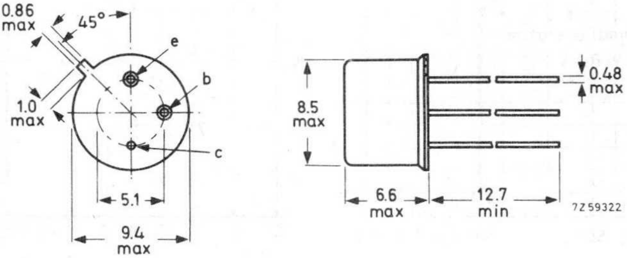
QUICK REFERENCE DATA

R.F. performance up to T_{mb} = 25 ^{o}C in an unneutralised common-emitter class B circuit.

Mode of operation	V_{CC} (V)	f (MHz)	P_S (W)	P_L (W)	I_C (A)	G_p (dB)	η (%)	$\overline{z}_i$ (Ω)	$\overline{Y}_L$ (mA/V)
c.w.	13.5	175	$<$ 0.63	4	$<$ 0.49	$>$ 8	$>$ 60	3.8+j2.2	36-j22
c.w.	12.5	175	typ. 0.63	4	typ. 0.53	typ. 8	typ. 60		

MECHANICAL DATA Dimensions in mm

TO-39
Collector connected to case



Accessories available on request: 56218; 56245; 56265

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltages

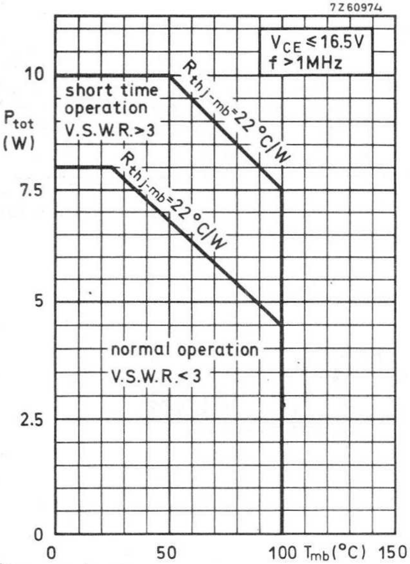
Collector-base voltage (open emitter) peak value	V_{CBOM}	max.	36	V
Collector-emitter voltage (open base)	V_{CEO}	max.	18	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4	V

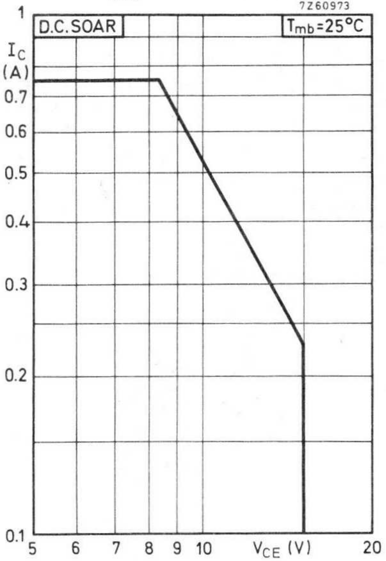
Currents

Collector current (average)	$I_{C(AV)}$	max.	0.75	A
Collector current (peak value) f > 1 MHz	I_{CM}	max.	2.25	A

Power dissipation

Total power dissipation up to T_{mb} = 25 °C f > 1 MHz	P_{tot}	max.	8	W





Temperature

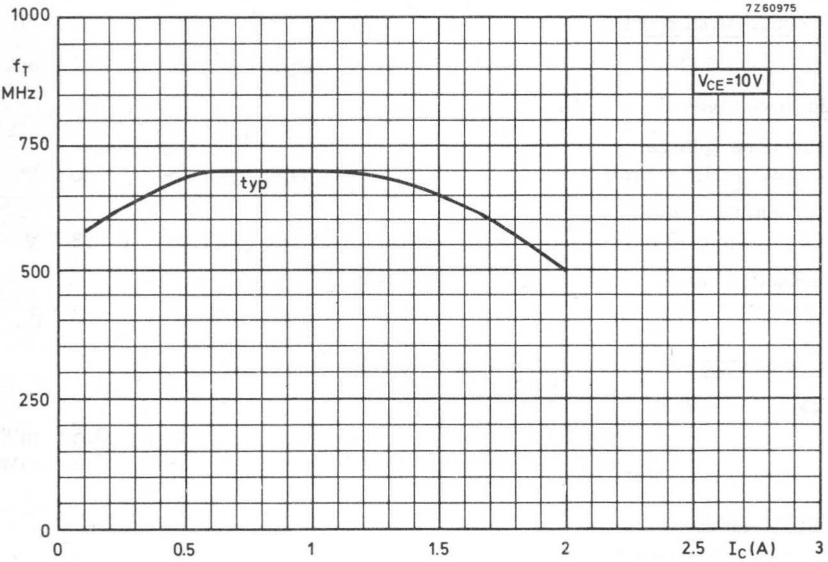
Storage temperature	T_{stg}	-65 to +200	°C
Operating junction temperature	T_j	max. 200	°C

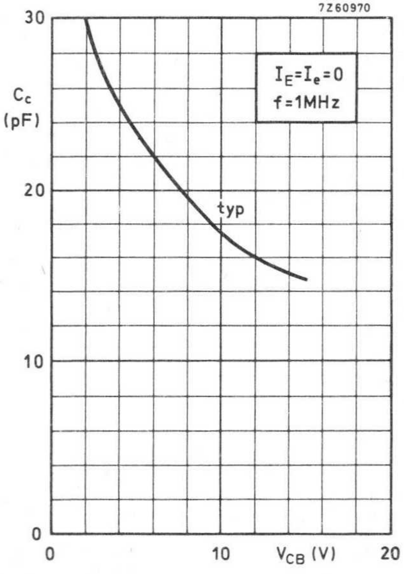
THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	22	°C/W
From mounting base to heatsink with a boron nitride washer for electrical insulation	$R_{th\ mb\text{-}h}$	=	2.5	°C/W

CHARACTERISTICS $T_j = 25\,^{o}C$ unless otherwise specified

Collector cut-off current				
$I_B = 0$; $V_{CE} = 14\,V$	I_{CEO}	<	5	mA
Breakdown voltages				
Collector-base voltage open emitter, $I_C = 1\,mA$	$V_{(BR)CBO}$	>	36	V
Collector-emitter voltage open base, $I_C = 10\,mA$	$V_{(BR)CEO}$	>	18	V
Emitter-base voltage open collector, $I_E = 1\,mA$	$V_{(BR)EBO}$	>	4	V
Transient energy				
$L = 25\,mH$; $f = 50\,Hz$				
open base	E	>	0.5	mWs
$-V_{BE} = 1.5\,V$; $R_{BE} = 33\,\Omega$	E	>	0.5	mWs
D.C. current gain				
$I_C = 500\,mA$; $V_{CE} = 5\,V$	h_{FE}	>	5	
Transition frequency				
$I_C = 350\,mA$; $V_{CE} = 10\,V$	f_T	typ.	700	MHz
Collector capacitance at $f = 1\,MHz$				
$I_E = I_e = 0$; $V_{CB} = 15\,V$	C_c	typ. <	15 20	pF pF
Feedback capacitance at $f = 1\,MHz$				
$I_C = 50\,mA$; $V_{CE} = 15\,V$	$-C_{re}$	typ.	11	pF


7Z60975
1000
f_T
(MHz)
750
500
250
0
0
0.5
1
1.5
2
2.5
I_C (A)
3
V_{CE}=10V
typ


7Z60970
30
C_c
(pF)
20
10
0
0
10
V_{CB} (V)
20
I_E=I_e=0
f=1MHz
typ

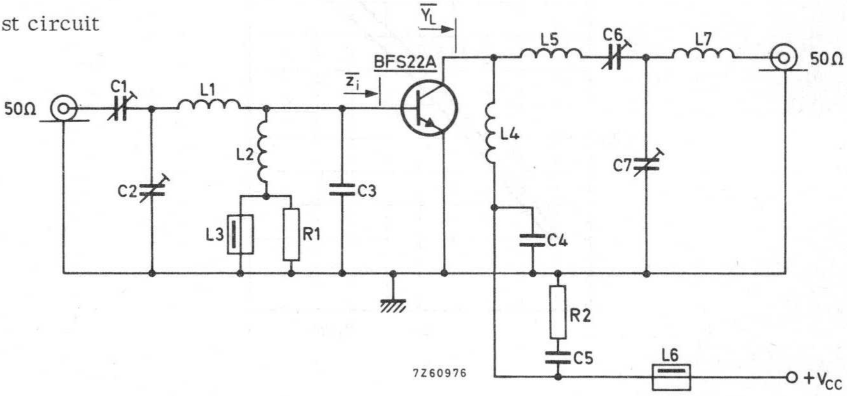
APPLICATION INFORMATION

R. F. performance in c. w. operation (unneutralised common-emitter class B circuit)

f = 175 MHz; T_{mb} up to 25 °C

V_{CC}(V)	P_S(W)	P_L(W)	I_C(A)	G_p(dB)	η(%)	$\overline{z}_i$(Ω)	$\overline{Y}_L$(mA/V)
13.5	< 0.63	4	< 0.49	> 8	> 60	3.8+j2.2	36-j22
12.5	typ. 0.63	4	typ. 0.53	typ. 8	typ. 60		

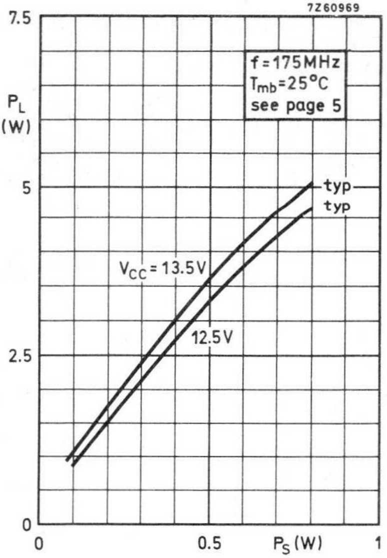
Test circuit

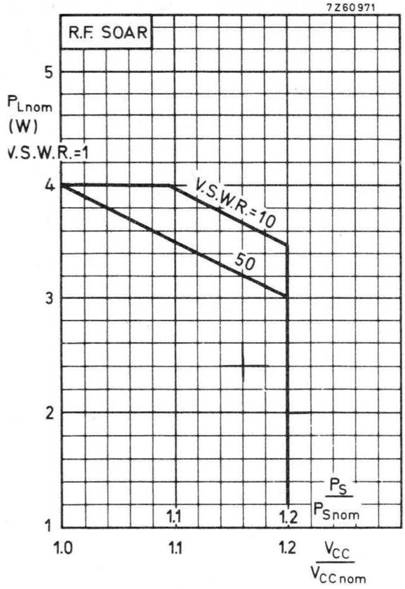


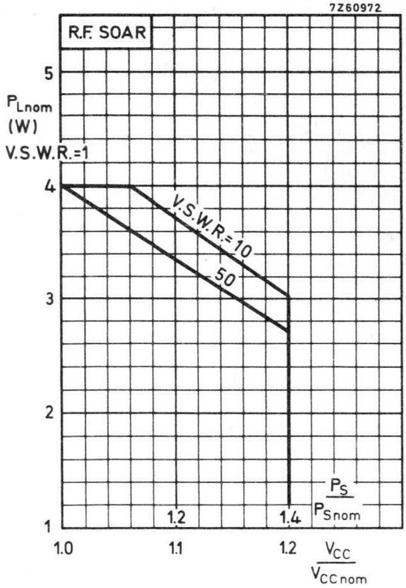
C1 = C6 = 4 to 29 pF air trimmer with insulated rotor
C2 = C7 = 4 to 29 pF air trimmer with non-insulated rotor
C3 = 39 pF ceramic
C4 = 100 pF ceramic
C5 = 15 nF polyester

L1 = 1 turn enamelled Cu wire (1.0 mm); int. diam. 10 mm; leads 2 x 10 mm
L2 = 6 turns enamelled Cu wire (0.7 mm); int. diam. 4 mm; leads 2 x 10 mm
L3 = L6 = ferroxcube choke (code number 4312 020 36640)
L4 = 8 turns enamelled Cu wire (0.7 mm); int. diam. 4 mm; leads 2 x 10 mm
L5 = 5 turns enamelled Cu wire (1.0 mm); winding pitch 1.0 mm; int. diam. 8 mm; leads 2 x 10 mm
L7 = 7 turns enamelled Cu wire (1.0 mm); winding pitch 1.0 mm; int. diam. 6 mm; leads 2 x 5 mm

R1 = R2 = 10 Ω carbon


7Z60969
7.5
5
2.5
0
P_L (W)
0
0.5
1
P_S (W)
f = 175 MHz
T_{mb} = 25 °C
see page 5
V_{CC} = 13.5 V
12.5 V
typ
typ





Conditions for R.F. SOAR:

f = 175 MHz
T_{mb} = 70 °C
V_{CCnom} = 12.5 or 13.5 V

$P_{Snom} = P_S$ at $V_{CC} = V_{CCnom}$ and V.S.W.R. = 1
see also page 5

The transistor has been developed for use with unstabilized supply voltages. As the output power and drive power increase with the supply voltage, the nominal output power must be derated in accordance with the graphs above for safe operation at supply voltages other than the nominal. The graphs show the allowable output power under nominal conditions, as a function of the supply overvoltage ratio, with V. S. W. R. as parameter.
The left hand graph applies to the situation in which the drive (P_S/P_{Snom}) increases linearly with supply overvoltage ratio.
The right hand graph shows the derating factor to be applied when the drive (P_S/P_{Snom}) increases as the square of the supply overvoltage ratio (V_{CC}/V_{CCnom}).
Depending on the operating conditions, the appropriate derating factor may lie in the region between the linear and the square-law functions.

V.H.F. POWER TRANSISTOR

N-P-N epitaxial planar transistor intended for use in class A, B and C operated mobile, industrial and military transmitters with a supply voltage of 28 V. The transistor is resistance stabilized. Every transistor is tested under severe load mismatch conditions. It has a TO-39 envelope with the collector connected to the case.

QUICK REFERENCE DATA

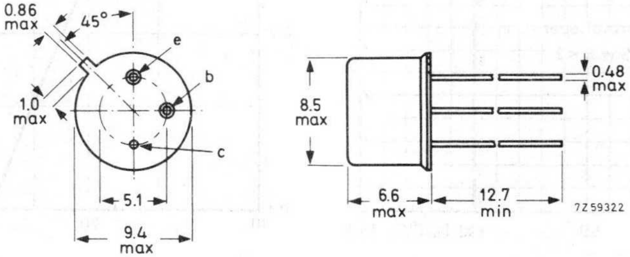
R.F. performance up to T_{mb} = 25 ^oC in an unneutralised common-emitter class B circuit.

Mode of operation	V_{CC} (V)	f (MHz)	P_S (W)	P_L (W)	I_C (A)	G_p (dB)	η (%)	$\overline{z_i}$ (Ω)	$\overline{Y_L}$ (mA/V)
c.w.	28	175	< 0.40	4	< 0.22	> 10	> 65	2.3+j1.6	8.6-j18

MECHANICAL DATA

Dimensions in mm

TO-39
Collector connected
to case



Accessories available on request: 56218; 56245; 56265.

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltages

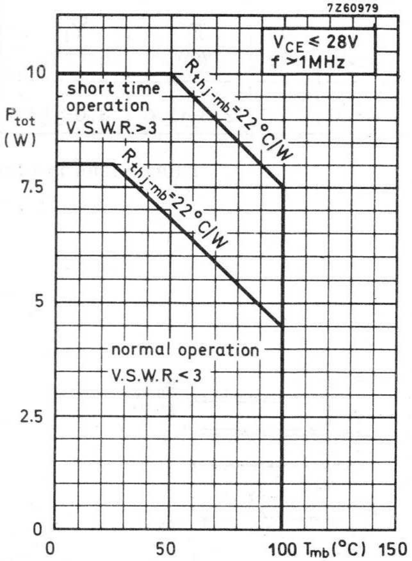
Collector-base voltage (open emitter) peak value	V_{CBOM}	max.	65	V
Collector-emitter voltage (open base)	V_{CEO}	max.	36	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4	V

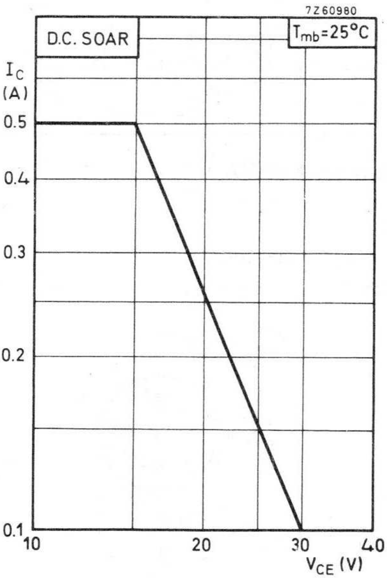
Currents

Collector current (average)	$I_{C(AV)}$	max.	0.5	A
Collector current (peak value) f > 1 MHz	I_{CM}	max.	1.5	A

Power dissipation

Total power dissipation up to T_{mb} = 25 °C f > 1 MHz	P_{tot}	max.	8	W





Temperature

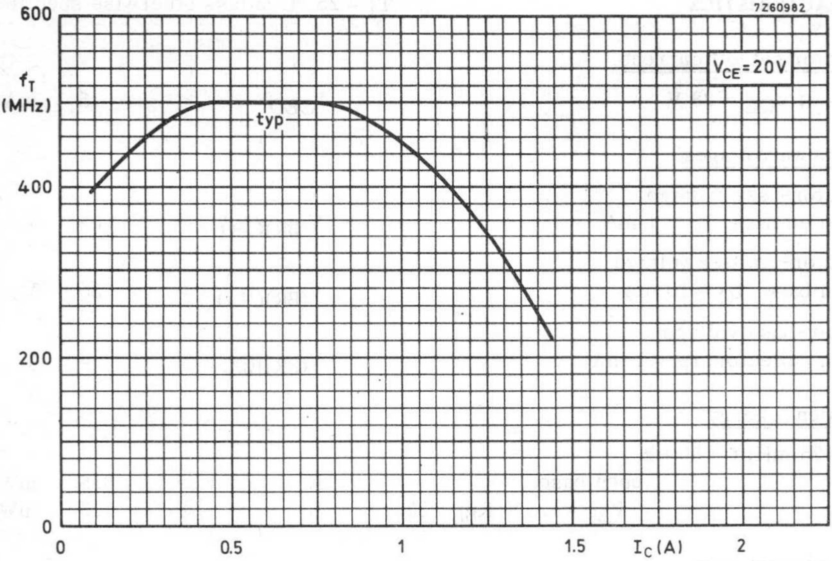
Storage temperature	T_{stg}	−65 to +200		°C
Operating junction temperature	T_j	max.	200	°C

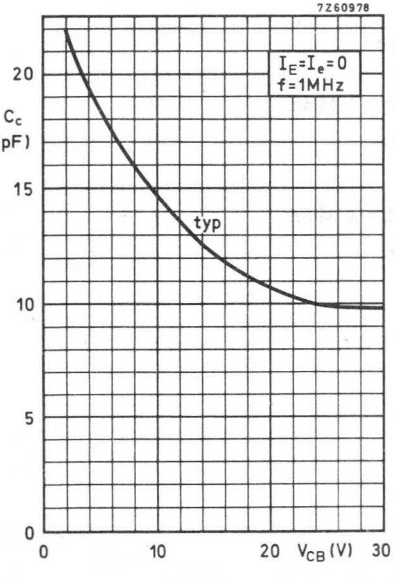
THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j-mb}$	=	22	°C/W
From mounting base to heatsink with a boron nitride washer for electrical insulation	$R_{th\ mb-h}$	=	2.5	°C/W

CHARACTERISTICS $T_j = 25\ ^{o}C$ unless otherwise specified

Collector cut-off current				
$I_B = 0$; $V_{CE} = 28$ V	I_{CEO}	<	5	mA
Breakdown voltages				
Collector-base voltage open emitter, $I_C = 1$ mA	$V_{(BR)CBO}$	>	65	V
Collector-emitter voltage open base, $I_C = 10$ mA	$V_{(BR)CEO}$	>	36	V
Emitter-base voltage open collector; $I_E = 1$ mA	$V_{(BR)EBO}$	>	4	V
Transient energy				
L = 25 mH; f = 50 Hz				
open base	E	>	0.5	mWs
$-V_{BE} = 1.5$ V; $R_{BE} = 33\ \Omega$	E	>	0.5	mWs
D.C. current gain				
$I_C = 500$ mA; $V_{CE} = 5$ V	h_{FE}	>	5	
Transition frequency				
$I_C = 400$ mA; $V_{CE} = 20$ V	f_T	typ.	500	MHz
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; $V_{CB} = 30$ V	C_c	typ. <	10 15	pF pF
Feedback capacitance at f = 1 MHz				
$I_C = 25$ mA; $V_{CE} = 30$ V	$-C_{re}$	typ.	7.5	pF


7Z60982
600
400
200
0
f_T
(MHz)
V_{CE}=20V
typ
0
0.5
1
1.5
I_C (A)
2


7Z60978
20
15
10
5
0
C_c
(pF)
I_E=I_e=0
f=1MHz
typ
0
10
20
V_{CB} (V)
30

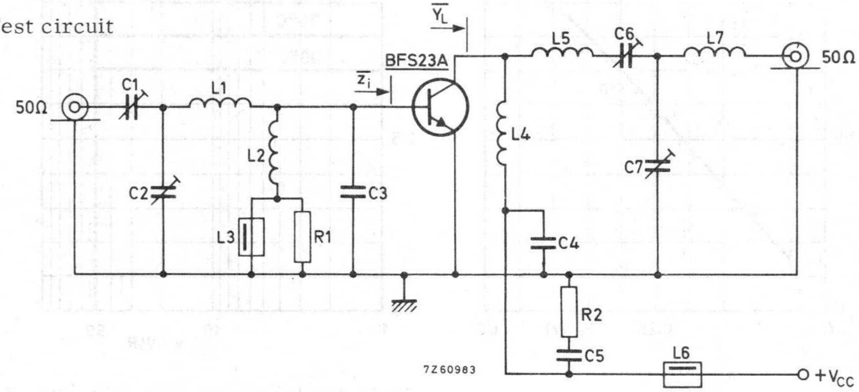
APPLICATION INFORMATION

R.F. performance in c.w. operation (unneutralised common-emitter class B circuit)

V_{CC} = 28 V; T_{mb} up to 25 °C

f(MHz)	P_S (W)	P_L (W)	I_C (A)	G_p (dB)	η (%)	$\overline{z_i}$ (Ω)	$\overline{Y_L}$ (mA/V)
175	< 0.40	4	< 0.22	> 10	> 65	2.3+j1.6	8.6-j18

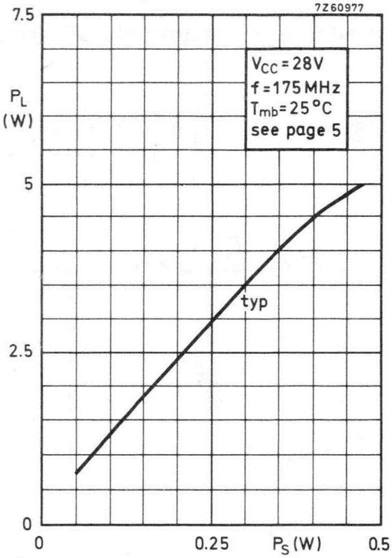
Test circuit

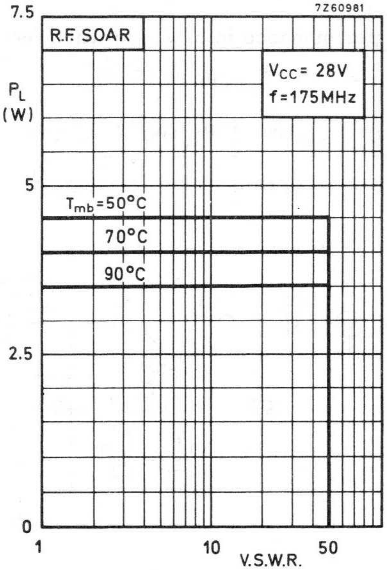


C1 = C6 = 4 to 29 pF air trimmer with insulated rotor
C2 = C7 = 4 to 29 pF air trimmer with non-insulated rotor
C3 = 39 pF ceramic
C4 = 100 pF ceramic
C5 = 15 nF polyester

L1 = 1 turn enamelled Cu wire (1.0 mm); int. diam. 10 mm; leads 2 x 10 mm
L2 = 6 turns enamelled Cu wire (0.7 mm); int. diam. 4 mm; leads 2 x 10 mm
L3 = L6 = ferroxcube choke (code number 4312 020 36640)
L4 = 8 turns enamelled Cu wire (0.7 mm); int. diam. 4 mm; leads 2 x 10 mm
L5 = 5 turns enamelled Cu wire (1.0 mm); winding pitch 1.0 mm; int. diam. 8 mm; leads 2 x 10 mm
L7 = 4 turns enamelled Cu wire (1.0 mm); winding pitch 1.0 mm; int. diam. 6 mm; leads 2 x 5 mm

R1 = R2 = 10 Ω carbon





For high voltage operation, a stabilized power supply is generally used.
The graph shows the allowable output power under nominal conditions as a function of the V.S.W.R., with heatsink temperature as parameter.

SILICON PLANAR EPITAXIAL TRANSISTORS

N-P-N transistors in a TO-39 metal envelope with the collector connected to the case. The BFY44 and BFY70 are primarily intended for use in v.h.f. medium power amplifiers or as output stage in small transmitters or as driver for transmitting tubes.

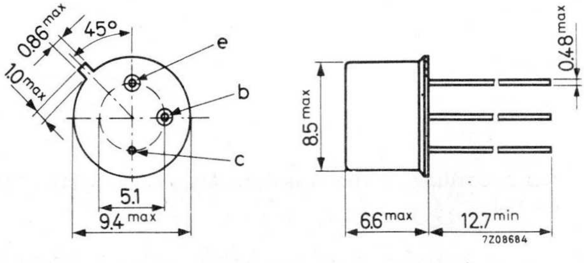
QUICK REFERENCE DATA

			BFY44	BFY70	
Collector-base voltage (open emitter)	V_{CBO}	max.	80	60	V
Collector-emitter voltage (open base)	V_{CEO}	max.	60	40	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4	4	V
Collector current (d.c.)	I_C	max.	1	1	A
Total power dissipation up to T_{case} = 25 °C	P_{tot}	max.	5	5	W
Junction temperature	T_j	max.	200	200	°C
Saturation voltages I_C = 500 mA; I_B = 100 mA	V_{CEsat}	typ.	0.4	0.4	V
Transition frequency I_C = 100 mA; V_{CE} = 10 V	f_T	typ.	210	210	MHz
Performance in a specified circuit at f = 180 MHz					
Output power at V_{CE} = 40 V	P_o	typ.	2.1	-	W
Output power at V_{CE} = 28 V	P_o	typ.	-	1.5	W
Power gain	G_p	typ.	7	7	dB
Collector efficiency	η	typ.	50	50	%

MECHANICAL DATA

Dimensions in mm

Collector connected to case
TO-39



Accessories available: 56218, 56245, 56265

RATINGS (Limiting values)[1]

			BFY44	BFY70	
Voltages					
Collector-base voltage (open emitter)	V_{CBO}	max.	80	60	V
Collector-emitter voltage (open base)	V_{CEO}	max.	60	40	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4	4	V
Currents					
Collector current (d.c.)	I_C	max.	1.0		A
Collector current (peak value)	I_{CM}	max.	1.0		A
Base current (d.c.)	I_B	max.	0.2		A
Base current (peak value)	I_{BM}	max.	0.2		A
Power dissipation					
Total power dissipation up to $T_{case} = 25\,^{\circ}C$	P_{tot}	max.	5		W
Temperatures					
Storage temperature	T_{stg}	-65 to	+200		°C
Junction temperature	T_j	max.	200		°C

THERMAL RESISTANCE

From junction to case	$R_{th\ j\text{-}c}$	=	35	°C/W

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[1] Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

CHARACTERISTICS $T_j = 25\ ^{o}C$ unless otherwise specified

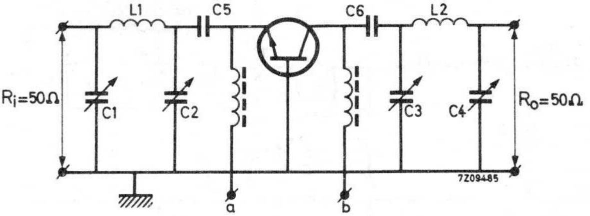
			BFY44	BFY70	
Collector cut-off current					
$I_E = 0;\ V_{CB} = 40\ V$	I_{CBO}	typ.	3	-	nA
		<	500	-	nA
$I_E = 0;\ V_{CB} = 28\ V$	I_{CBO}	typ.	-	3	nA
		<	-	500	nA
$I_E = 0;\ V_{CB} = 40\ V;\ T_j = 150\ ^{o}C$	I_{CBO}	typ.	1.5	-	μA
		<	50	-	μA
$I_E = 0;\ V_{CB} = 28\ V;\ T_j = 150\ ^{o}C$	I_{CBO}	typ.	-	1.5	μA
		<	-	50	μA
Emitter cut-off current					
$I_C = 0;\ V_{EB} = 1\ V$	I_{EBO}	typ.	1	1	nA
		<	500	500	nA
$I_C = 0;\ V_{EB} = 4\ V$	I_{EBO}	<	100	100	μA
Sustaining voltages					
$I_C = 10\ mA;\ I_B = 0$	$V_{CEOsust}$	>	60	40	V
$I_C = 1\ mA;\ R_{BE} = 10\ \Omega$	$V_{CERsust}$	>	80	60	V
$I_C = 0.5\ mA;\ V_{BE} = 0$	$V_{CESsust}$	>	80	60	V
Saturation voltages					
$I_C = 500\ mA;\ I_B = 100\ mA$	V_{CEsat}	typ.	0.4		V
		<	0.7		V
	V_{BEsat}	typ.	1.0		V
		<	1.5		V

CHARACTERISTICS (continued) $T_j = 25\ ^oC$ unless otherwise specified

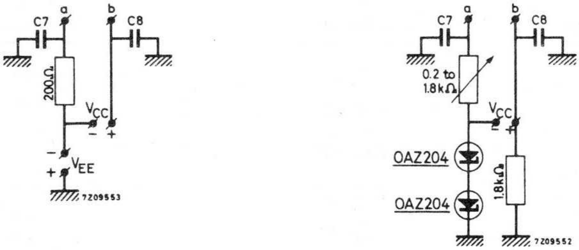
D.C. current gain				
$I_C = 150$ mA; $V_{CE} = 10$ V	h_{FE}	typ.	20	
$I_C = 500$ mA; $V_{CE} = 5$ V	h_{FE}	$>$ typ.	5 20	
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$ BFY44 : $V_{CB} = 40$ V	C_c	typ. $<$	7 12	pF pF
$I_E = I_e = 0$ BFY70 : $V_{CB} = 28$ V	C_c	typ. $<$	7 14	pF pF
Transition frequency				
$I_C = 100$ mA; $V_{CE} = 10$ V	f_T	typ.	210	MHz
Feedback time constant at f = 10.7 MHz				
$-I_E = 30$ mA; $V_{CB} = 20$ V	$\left\lvert \frac{h_{rb}}{\omega} \right\rvert$	typ. $<$	18 35	ps ps
y parameters at f = 180 MHz (common base) $T_{amb} = 25\ ^oC$				
$-I_E = 150$ mA; $V_{CB} = 24$ V				
Input conductance	g_{ib}	typ.	48	$m\Omega^{-1}$
Input capacitance	$-C_{ib}$	typ.	120	pF
Transfer admittance	$\lvert y_{fb} \rvert$	typ.	98	$m\Omega^{-1}$
Phase angle of transfer admittance	φ_{fb}	typ.	62^o	
Output conductance	g_{ob}	typ.	4.3	$m\Omega^{-1}$
Output capacitance	C_{ob}	typ.	13.5	pF
y parameters at f = 180 MHz (common emitter)				
$I_C = 150$ mA; $V_{CE} = 24$ V				
Input conductance	g_{ie}	typ.	96	$m\Omega^{-1}$
Input capacitance	$-C_{ie}$	typ.	32	pF

APPLICATION INFORMATION

A. Amplifier circuit



Different methods of biasing



Components	f = 100 MHz	f = 180 MHz
C1, C2, C4	25 pF variable air capacitor + 22 pF mica	25 pF variable air capacitor
C3	25 pF variable air capacitor	25 pF variable air capacitor
C5, C6, C7, C8	3.3 nF	1 nF
L1	2 turns Cu wire (1 mm); d = 12 mm	1 turn Cu wire (1.2 mm); d = 12 mm
L2	3.5 turns Cu wire (1 mm); d = 12 mm	2 turns Cu wire (1.2 mm); d = 12 mm

Performance in common base configuration

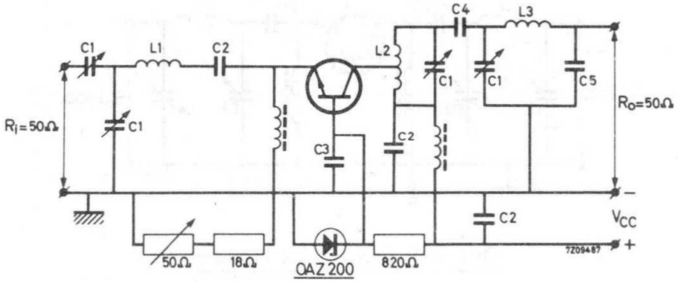
BFY44: V_{CE} = 40 V; P_i = 0.425 W

BFY70: V_{CE} = 28 V; P_i = 0.3 W

			BFY44	BFY70	
Output power	P_o	>	1.7	1.2	W
		typ.	2.1	1.5	W
Power gain	G_p	>	6.0		dB
		typ.	7.0		dB
Collector efficiency	η	>	40		%
		typ.	50		%

APPLICATION **INFORMATION** (continued)

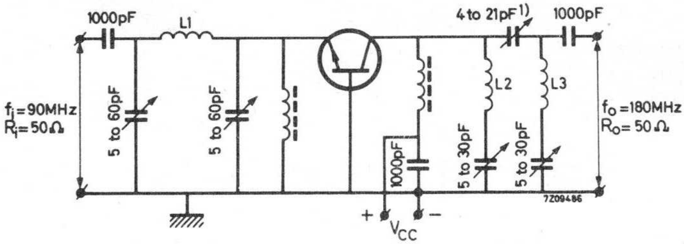
B. Amplifier circuit



Components	f = 80 MHz	f = 165 MHz
C1	60 pF	25 pF
C2	680 pF	100 pF
C3	680 pF	82 pF
C4	4.7 pF	2.2 pF
C5	82 pF	33 pF
L1	2 turns Cu wire (1 mm); d = 10 mm	straight Cu wire (1 mm); length 40 mm
L2	3 turns enamelled Cu wire (1.5 mm); d = 12 mm	2 turns Cu wire (1 mm); d = 10 mm
Tap	1.2 turn from cold side	0.8 turn from cold side
L3	3 turns enamelled Cu wire (1.5 mm); d = 12 mm	2 turns Cu wire (1 mm); d = 10 mm

APPLICATION INFORMATION (continued)

C. Frequency doubler 90-180 MHz



L1 ≈ 70 nH; 1.5 turns
L2 ≈ 90 nH; 2 turns
L3 ≈ 140 nH; 3 turns

Cu wire (1.2 mm); d = 12 mm

Typical performance

V_{CE} (V)	I_C (mA)	P_i = (mW) f_i = 90 MHz	P_o (mW) f_o = 180 MHz	G_p (dB)	η (%)
40[2]	110	130	920	8.5	21
30	94	110	700	8.0	25
20	82	110	460	6.2	28

---

[1] Variable ceramic capacitor
[2] V_{CE} = 40 V is for BFY44 only

TRANSMITTING TRANSISTOR

N-P-N epitaxial planar transistor intended for s.s.b. in class A and AB and in f.m. transmitting applications in class C with a supply voltage up to 28 V. The transistor is resistance stabilized and tested under severe load mismatch conditions. It has a $\frac{1}{4}$" capstan envelope with a moulded cap. All leads are isolated from the stud.

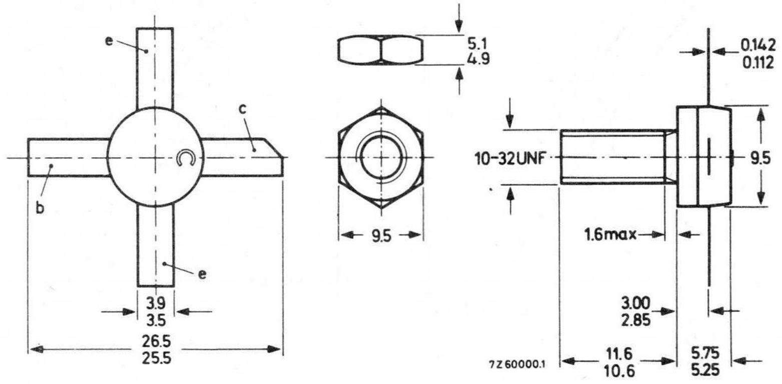
QUICK REFERENCE DATA

Operation	Class	V_{CE} (V)	f_1 (MHz)	f_2 (MHz)	P_L (W)	G_p (dB)	d_3 (dB)	I_C (A)	dt (%)
s.s.b.	A	26	28.000	28.001	0-8(PEP)	>18	< -40	1.2	-
s.s.b.	AB	28	28.000	28.001	25(PEP)	>18	typ. -35	typ. 1.28	typ. 35

Operation	Class	V_{CC} (V)	f (MHz)	P_S (W)	P_L (W)	G_p (dB)	I_C (A)	η (%)	$\overline{z}_i$ (Ω)	$\overline{Y}_L$ (mA/V)
c.w.	B	28	70	typ. 0.5	25	typ. 17	typ. 1.49	typ. 60	0.53-j1.4	42.5-j54

MECHANICAL DATA

Dimensions in mm



Torque on nut: min. 15 kg cm
(1.5 Newton metres)
max. 17 kg cm
(1.7 Newton metres)

Diameter of clearance hole in heatsink: max. 5.0 mm.
Mounting hole to have no burrs at either end. De-burring must leave surface flat; do not chamfer or countersink either end of hole.

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltages

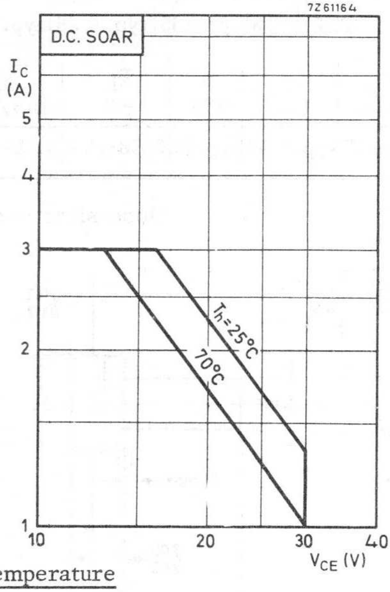
Collector-base voltage (open emitter) peak value	V_{CBOM}	max.	65	V
Collector-emitter voltage (open base)	V_{CEO}	max.	36	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4.0	V

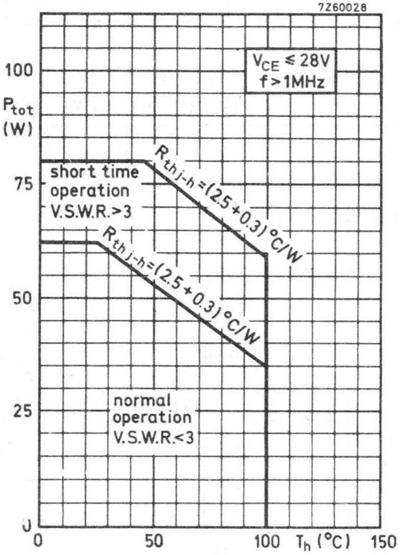
Currents

Collector current (average)	$I_{C(AV)}$	max.	3.0	A
Collector current (peak value) f > 1 MHz	I_{CM}	max.	6	A

Power dissipation

Total power dissipation up to $T_h = 25\ ^oC$ f > 1 MHz	P_{tot}	max.	62.5	W





Temperature

Storage temperature	T_{stg}	−30 to +200		^oC
Operating junction temperature	T_j	max.	200	^oC

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	2.5	$^oC/W$
From mounting base to heatsink	$R_{th\ mb\text{-}h}$	=	0.3	$^oC/W$

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Breakdown voltages

Collector-base voltage open emitter; I_C = 50 mA	$V_{(BR)CBO}$	>	65	V
Collector-emitter voltage open base; I_C = 50 mA	$V_{(BR)CEO}$	>	36	V
Emitter-base voltage open collector; I_E = 10 mA	$V_{(BR)EBO}$	>	4.0	V

Transient energy

L = 25 mH; f = 50 Hz				
open base	E	>	8	mWs
$-V_{BE}$ = 1.5 V; R_{BE} = 33 Ω	E	>	8	mWs

D.C. current gain

I_C = 1.0 A; V_{CE} = 5 V	h_{FE}	typ. 10	50 to 100	

Transition frequency

I_C = 3.0 A; V_{CE} = 20 V	f_T	typ.	500	MHz

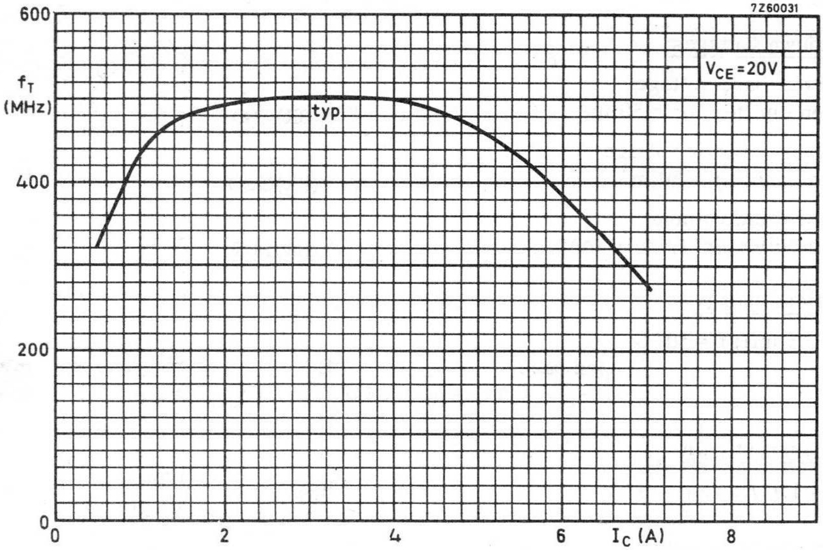
Collector capacitance at f = 1 MHz

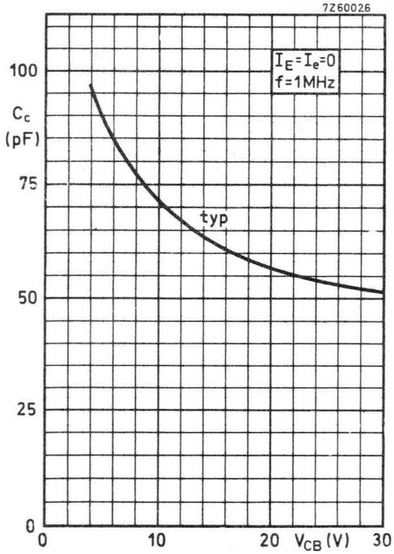
$I_E = I_e = 0$; V_{CB} = 30 V	C_c	typ. <	50 65	pF pF

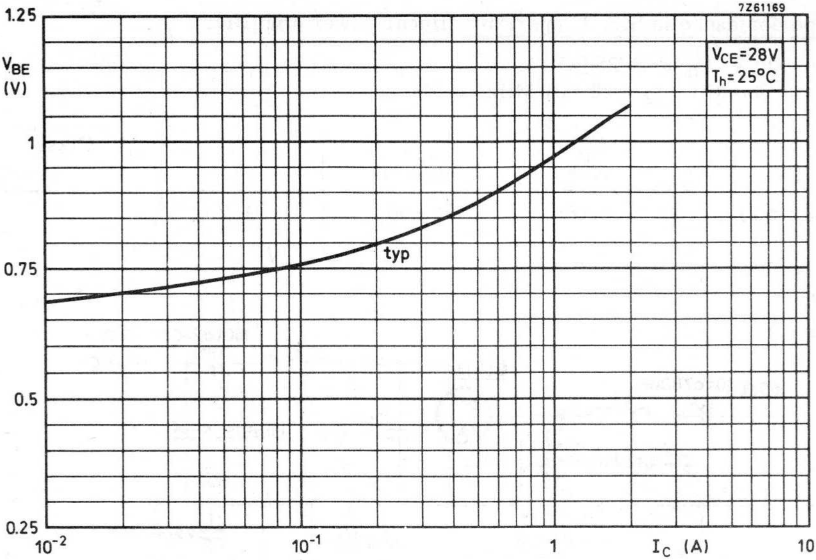
Feedback capacitance

I_C = 100 mA; V_{CE} = 30 V	$-C_{re}$	typ.	31	pF

Collector-stud capacitance	C_{cs}	typ.	2	pF


7Z60031
600
400
200
0
f_T
(MHz)
typ
$V_{CE}=20V$
0
2
4
6
I_C (A)
8


7Z60026
100
75
50
25
0
C_c
(pF)
typ
$I_E=I_e=0$
f=1MHz
0
10
20
V_{CB} (V)
30


7Z61169
V_{BE} (V)
1.25
1
0.75
0.5
0.25
V_{CE}=28V
T_h=25°C
typ
10^{-2}
10^{-1}
1
I_C (A)
10

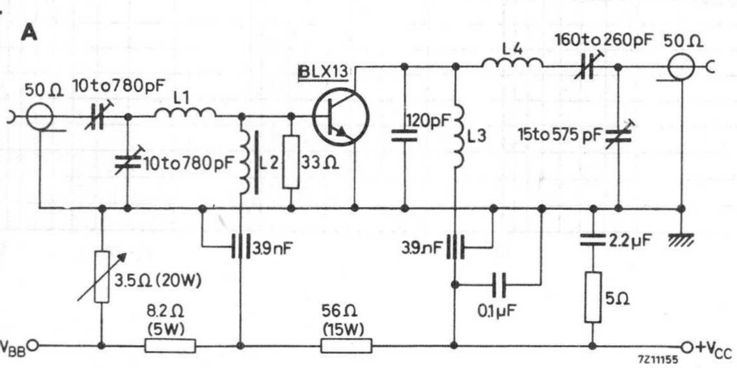
APPLICATION INFORMATION

R.F. performance in S.S.B. operation (linear power amplifier)

V_{CE} = 26 V; T_h up to 25 °C
f_1 = 28.000 MHz; f_2 = 28.001 MHz

output power (W)	G_p (dB)	d_3 (dB) 1)	I_C (A)	Class
0-8 (PEP)	> 18	< -40	1.2	A

Test circuit:

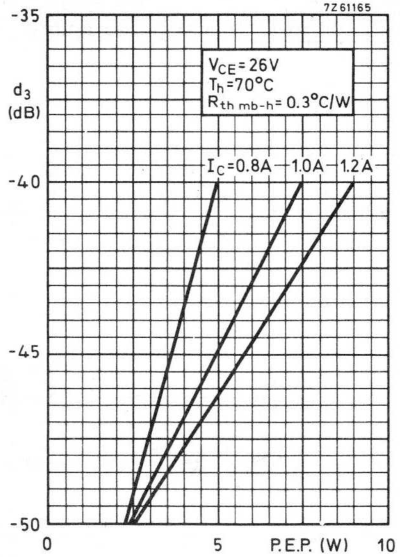


L1 = 3 turns enamelled Cu wire (1.5 mm); winding pitch 2.5 mm; int. diam. 7 mm
leads 50 mm totally
L2 = 7 turns enamelled Cu wire (0.7 mm) on 3H1 toroid; 60 μH
(code number of 3H1: 4322 020 36620)
L3 = 4 turns enamelled Cu wire (1.5 mm); winding pitch 2.5 mm; int. diam. 10 mm
L4 = 7 turns enamelled Cu wire (1.5 mm); winding pitch 2.5 mm; int. diam. 12 mm

Detailed information for a wide band application
1.6 to 28 MHz available on request

---

1) Stated figures are maxima encountered at any driving level between the specified values of PEP and are referred to the according level of either of the equal ampl. tones. Relative to the according peak envelope power these figures should be increased by 6 dB.


7Z61165
-35
d$_3$
(dB)
-40
-45
-50
0
5
P.E.P. (W)
10
V$_{CE}$ = 26V
T$_h$ = 70°C
R$_{th\ mb-h}$ = 0.3°C/W
I$_C$ = 0.8A
1.0A
1.2A

APPLICATION INFORMATION

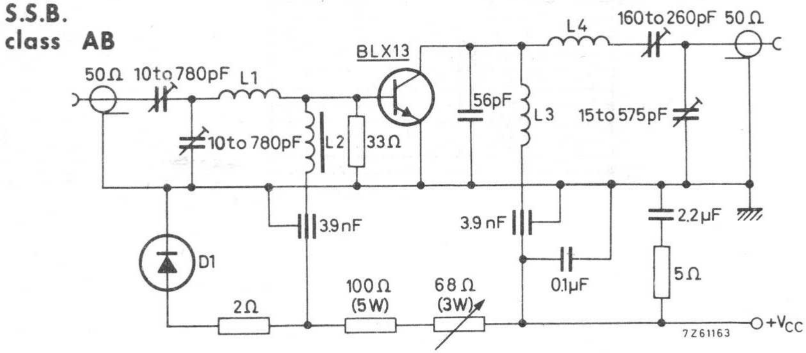
R.F. performance in S.S.B. operation (linear power amplifier)

V_{CC} = 28 V; T_h up to 25 °C

f_1 = 28.000 MHz; f_2 = 28.001 MHz

output power (W)	G_p (dB)	dt (%)	d_3 (dB) 1)	I_{CZS} (mA)	I_C (A)	Class
25 PEP	> 18	typ. 35	typ. −35	25	typ. 1.28	AB

Test circuit:



D1 = AYY10/120

L1 = 3 turns enamelled Cu wire (1.5 mm); winding pitch 2.5 mm; int. diam. 7 mm leads 50 mm totally

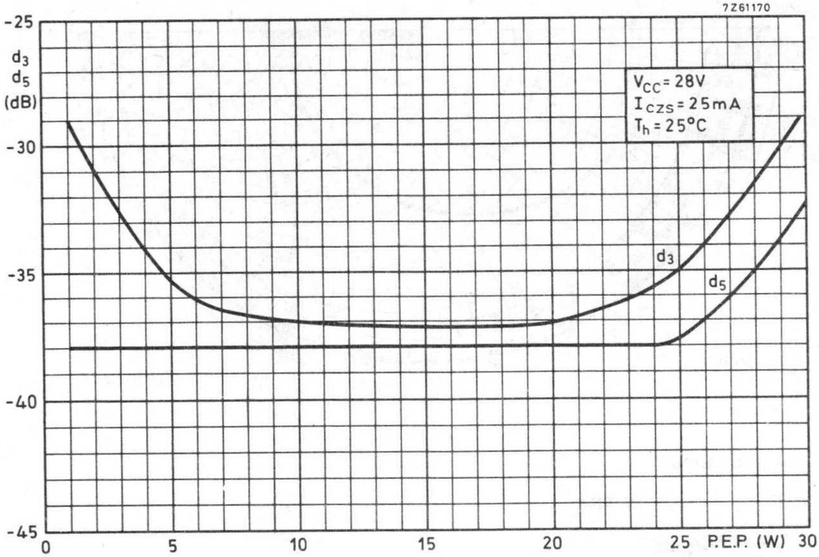
L2 = 7 turns enamelled Cu wire (0.7 mm) on 3H1 toroid; 60 μH (code number of 3H1: 4322 020 36620)

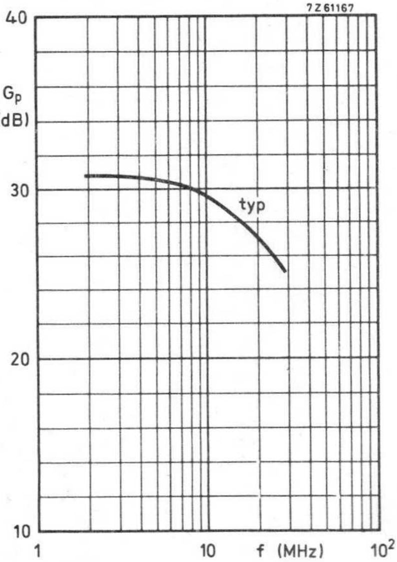
L3 = 4 turns enamelled Cu wire (1.5 mm); winding pitch 2.5 mm; int. diam. 10 mm

L4 = 7 turns enamelled Cu wire (1.5 mm); winding pitch 2.5 mm; int. diam. 12 mm

---

1) Stated intermodulation distortion figures are referred to the according level of either of the equal amplified tones. Relative to the according peak envelope powers these figures should be increased by 6 dB.





Conditions:

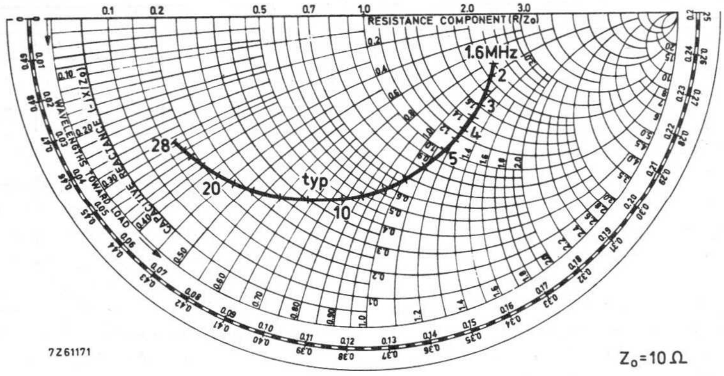
P_L = 25 W PEP

V_{CC} = 28 V

I_{CZS} = 25 mA

Z_L = 12.5 Ω

T_h = 25 °C



Z₀ = 10 Ω

Conditions:

P_L = 25 W PEP

V_{CC} = 28 V

I_{CZS} = 25 mA

Z_L = 12.5 Ω

T_h = 25 °C

APPLICATION INFORMATION

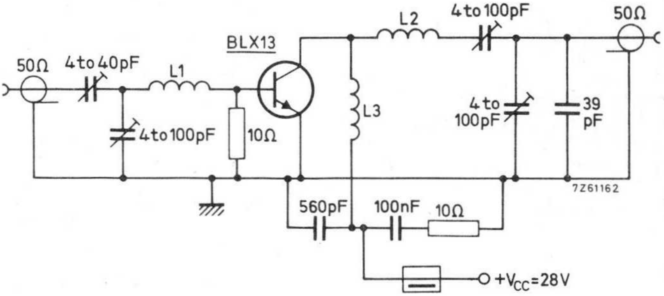
R.F. performance in c.w. operation (class B)

V_{CC} = 28 V; T_h up to 25 °C

f (MHz)	P_S (W)	P_L (W)	I_C (A)	G_p (dB)	η (%)	$\overline{z_i}$ (Ω)	$\overline{Y_L}$ (mA/V)
70	typ. 0.5	25	typ. 1.49	typ. 17	typ. 60	0.53-j1.4	42.5-j54

Test circuit:

C.W.
class B

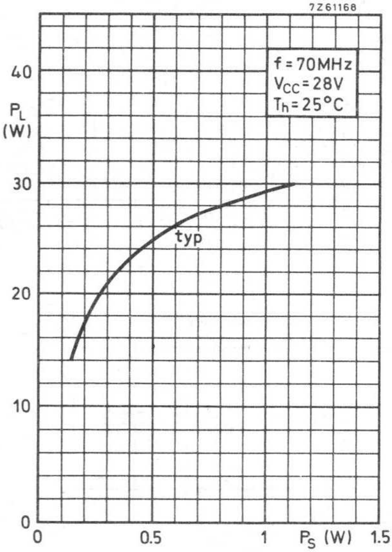


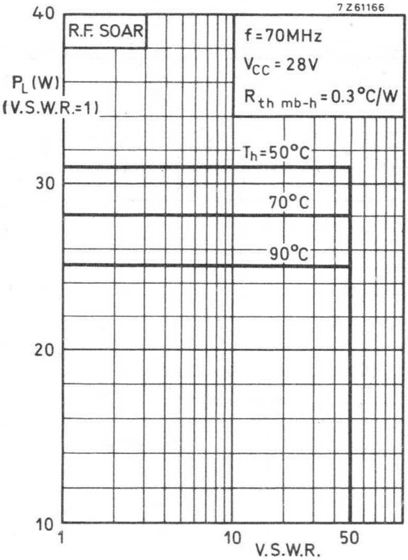
L1 = 93 nH; 3 turns enamelled Cu wire (1.5 mm); int. diam. 10 mm; length 8 mm; leads 2 x 5 mm

L2 = 147 nH; 5 turns enamelled Cu wire (1.5 mm); int. diam. 9 mm; length 14 mm; leads 2 x 5 mm

L3 = 118 nH; 4 turns enamelled Cu wire (1.5 mm); int. diam. 9 mm; length 10.5 mm; leads 2 x 5 mm

L4 = FXC choke (code number 4312 020 36640)





For high voltage operation, a stabilized power supply is generally used.
The graph shows the allowable output power under nominal conditions as a function of the V.S.W.R., with heat-sink temperature as parameter.

TRANSMITTING TRANSISTOR

Silicon n-p-n power transistor for use in industrial and military s.s.b. and c.w. equipment operating in the h.f. and v.h.f. band;

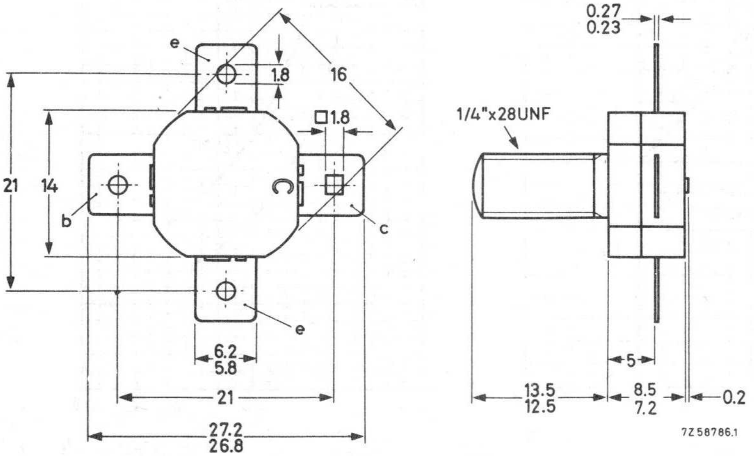
- rated for 50 W PEP at 1.6 MHz to 28 MHz (intermodulation distortion better than 30 dB down); full load mismatch permissible at stud temperatures up to 70 °C
- rated at 50 W for frequencies up to 70 MHz in c.w. operation
- supply voltage 28 V
- plastic stripline package

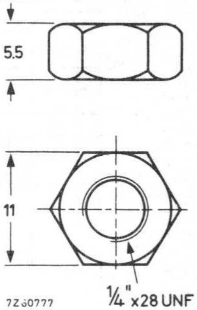
QUICK REFERENCE DATA

Operation	Class	V_{CC} (V)	f (MHz)	P_L (W)	Gp (dB)	d3 (dB)	I_{CZS} (A)
s.s.b.	A	28	1.6 to 28	15 (PEP)	> 13	typ. -40	2.0
s.s.b.	AB	28	1.6 to 28	7.5-50 (PEP)	> 13	< -30	0.1
c.w.	B	28	70	50	> 7.5		
c.w.	B	28	30	50	typ. 16		

MECHANICAL DATA

Dimensions in mm





Torque on nut: min. 23 kg cm
(2.3 Newton metres)
max. 27 kg cm
(2.7 Newton metres)

Diameter of clearance hole in heatsink: max. 6.5 mm.
Mounting hole to have no burrs at either end. De-burring must leave surface flat; do not chamfer or countersink either end of hole.

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltages

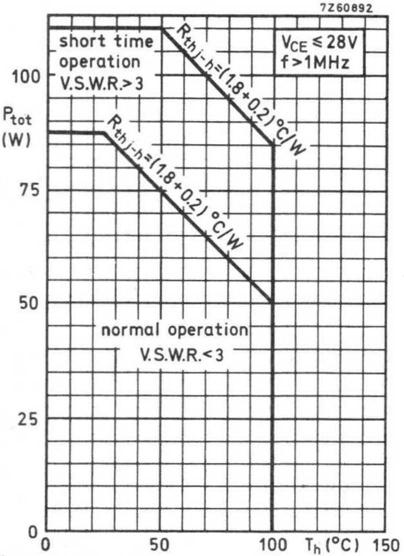
Collector-base voltage (open emitter) peak value	V_{CBOM}	max.	85	V
Collector-emitter voltage (R_{BE} = 10 Ω) peak value	V_{CERM}	max.	85	V
Collector-emitter voltage (open base)	V_{CEO}	max.	36	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4.0	V

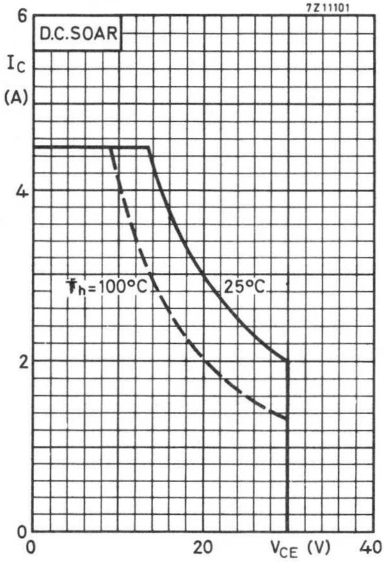
Currents

Collector current (average)	I_{CAV}	max.	4.0	A
Collector current (peak value) f > 1 MHz	I_{CM}	max.	12	A

Power dissipation

Total power dissipation up to T_h = 25 °C f > 1 MHz	P_{tot}	max.	88	W





Temperature

Storage temperature	T_{stg}	−65 to +200	°C
Operating junction temperature	T_j	max. +200	°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j-mb}$	=	1.8	°C/W
From mounting base to heatsink	$R_{th\ mb-h}$	=	0.2	°C/W

CHARACTERISTICS $T_j = 25\ ^{o}C$ unless otherwise specified

Breakdown voltages

Collector-base voltage open emitter; $I_C = 25$ mA	$V_{(BR)CBO}$	>	85	V
Collector-emitter voltage $R_{BE} = 10\ \Omega$; $I_C = 25$ mA	$V_{(BR)CER}$	>	85	V
Collector-emitter voltage open base; $I_C = 50$ mA	$V_{(BR)CEO}$	>	36	V
Emitter-base voltage open collector; $I_E = 10$ mA	$V_{(BR)EBO}$	>	4.0	V

Collector-emitter saturation voltage

$I_C = 0.7$ A; $I_B = 0.14$ A	V_{CEsat}	<	1.0	V

Transient energy

L = 25 mH; f = 50 Hz

open base	E	>	8	mWs
$-V_{BE} = 1.5$ V; $R_{BE} = 33\Omega$	E	>	8	mWs

D.C. current gain

$I_C = 1.4$ A; $V_{CE} = 6$ V	h_{FE}	15 to 100		

Transition frequency

$I_C = 3.0$ A; $V_{CE} = 10$ V	f_T	typ.	250	MHz

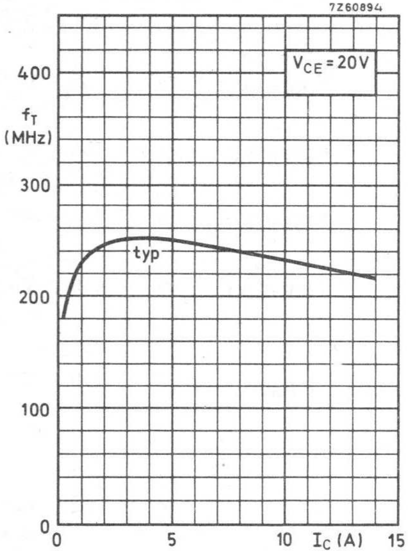
Collector capacitance at f = 1 MHz

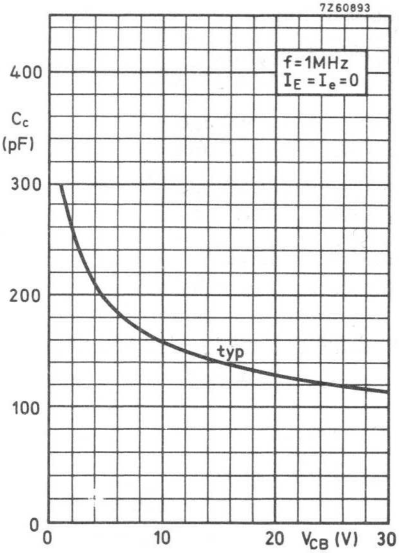
$I_E = I_e = 0$; $V_{CB} = 30$ V	C_c	typ.	115	pF
		<	125	pF

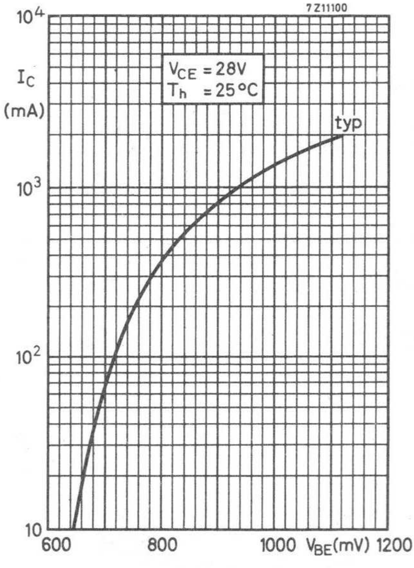
Feedback capacitance at f = 1 MHz

$I_C = 100$ mA; $V_{CE} = 30$ V	$-C_{re}$	typ.	90	pF

Collector-stud capacitance	C_{cs}	typ.	3.5	pF


7Z60894
$V_{CE} = 20V$
f_T (MHz)
400
300
200
100
0
typ
0
5
10
15
I_C (A)


7Z60893
f = 1MHz
$I_E = I_e = 0$
C_c (pF)
400
300
200
100
0
typ
0
10
20
30
V_{CB} (V)


7Z11100
$V_{CE} = 28V$
$T_h = 25°C$
I_C (mA)
10^4
10^3
10^2
10
typ
600
800
1000
1200
V_{BE}(mV)

APPLICATION INFORMATION

R.F. performance in S.S.B. operation (linear power amplifier)

V_{CC} = 28 V; T_h up to 25 °C

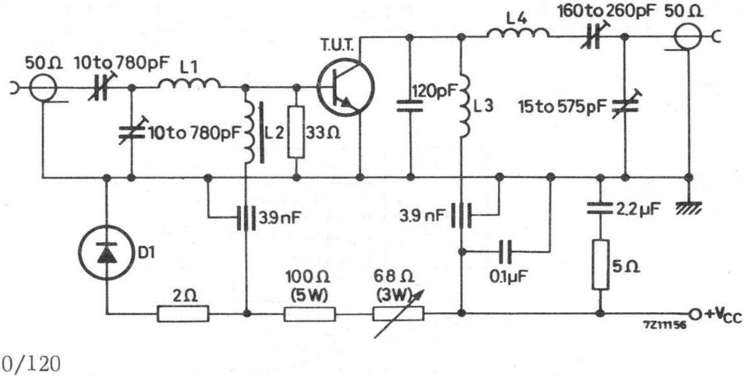
f_1 = 28.000 MHz; f_2 = 28.001 MHz

output power (W)	G_p (dB)	η_{dt} (%)	d_3 (dB) 1)	d_5 (dB) 1)	I_{CZS} (A)	I_C (A)	Class
7.5 to 50 (PEP)	>13	>35	< −30	< −30	0.1	<2.55	AB

At temperatures up to 90 °C the output power relative to that at 25 °C is diminished by a factor −40 mW/°C

The transistor is designed to withstand a full load mismatch operating under 50 W PEP at V_{CC} = 28 V and T_h = 70 °C

Test circuit:
S.S.B.
class A-B



D1 = AYY10/120

L1 = 3 turns enamelled Cu wire (1.5 mm); winding pitch 2.5 mm; int. diam. 7 mm leads 50 mm totally

L2 = 7 turns enamelled Cu wire (0.7 mm) on 3H1 toroid; 60 μH (code number of 3H1: 4322 020 36620)

L3 = 4 turns enamelled Cu wire (1.5 mm); winding pitch 2.5 mm; int. diam. 10mm

L4 = 7 turns enamelled Cu wire (1.5 mm); winding pitch 2.5 mm; int. diam. 12mm

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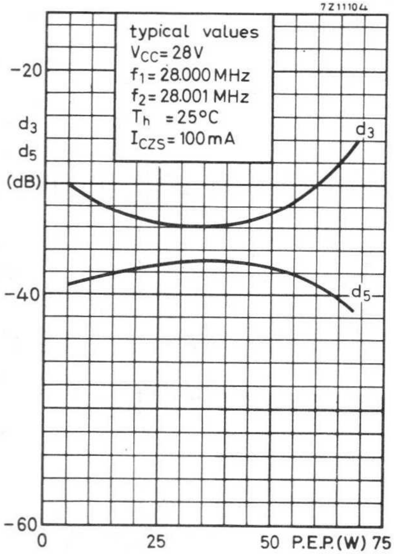
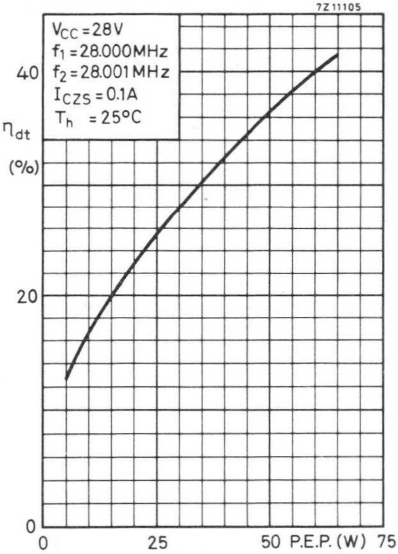
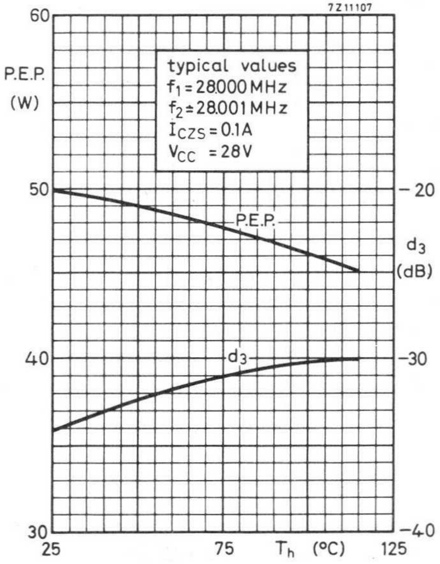
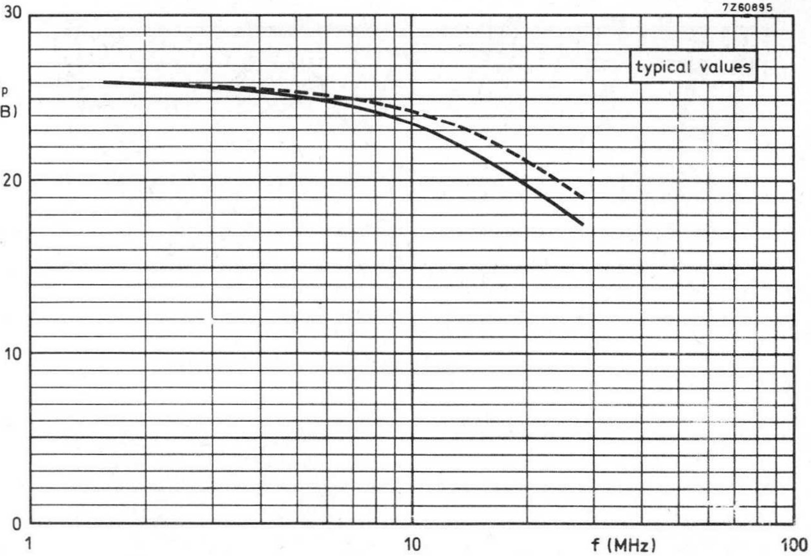
1) Stated figures are maxima encountered at any driving level between the specified values of PEP and are referred to the according level of either of the equal ampl. tones. Relative to the according peak envelope power these figures should be increased by 6 dB.


7Z11104
typical values
V_{CC} = 28 V
f_1 = 28.000 MHz
f_2 = 28.001 MHz
T_h = 25°C
I_{CZS} = 100 mA
-20
-40
-60
d_3
d_5
(dB)
d_3
d_5
0
25
50
P.E.P.(W)
75


7Z11105
V_{CC} = 28 V
f_1 = 28.000 MHz
f_2 = 28.001 MHz
I_{CZS} = 0.1 A
T_h = 25°C
η_{dt}
(%)
40
20
0
0
25
50
P.E.P. (W)
75


7Z11107
typical values
f_1 = 28.000 MHz
f_2 = 28.001 MHz
I_{CZS} = 0.1 A
V_{CC} = 28 V
60
P.E.P.
(W)
50
40
30
P.E.P.
d_3
-20
d_3
(dB)
-30
-40
25
75
T_h (°C)
125

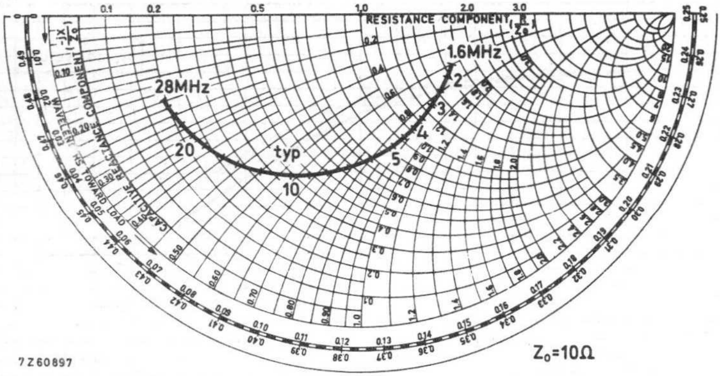


S.S.B. class AB operation

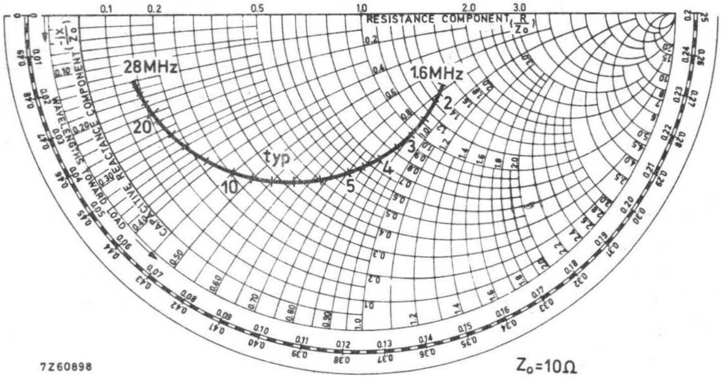
P_L = 50 W PEP
V_{CC} = 28 V
I_C = 100 mA
Z_L = 6.25 Ω
T_h = 25 °C

The drawn curve holds for an unneutralized amplifier.

The dashed curve holds for a push-pull amplifier with cross neutralization.
Collector-base neutralizing capacitor: 82 pF



7Z60897



7Z60898

S.S.B. class AB operation

P_L = 50 W PEP
V_{CC} = 28 V
I_C = 100 mA
Z_L = 6.25 Ω
T_h = 25 °C

The upper graph holds for a push-pull amplifier with cross neutralization.
Collector-base neutralizing capacitor: 82 pF

The lower graph holds for an unneutralized amplifier.

APPLICATION INFORMATION (continued)

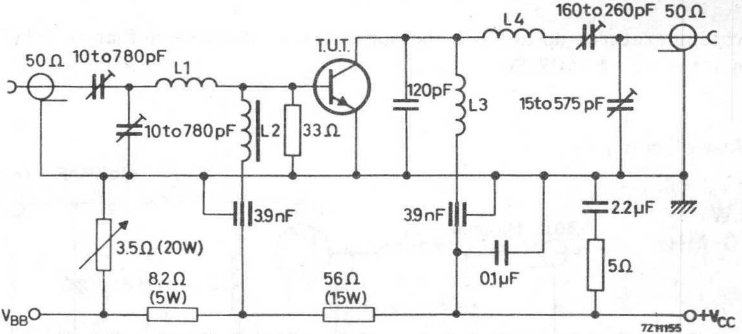
R.F. performance in S.S.B. operation (linear power amplifier)

V_{CC} = 28 V; T_h up to 25 °C
f_1 = 28.000 MHz; f_2 = 28.001 MHz

output power (W)	G_p (dB)	d_3 (dB) 1)	d_5 (dB) 1)	I_C (A)	Class
15 PEP	> 13	typ. −40	typ. −45	2.0	A

Test circuit:

S.S.B. class A

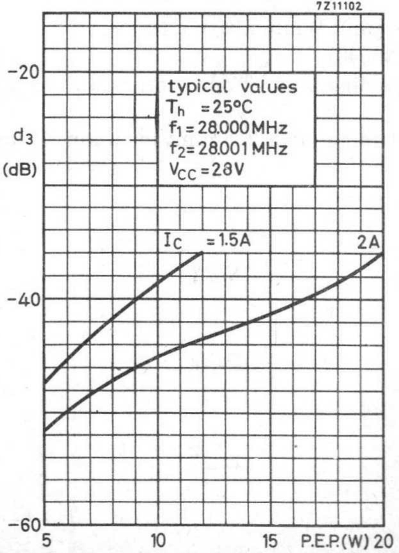


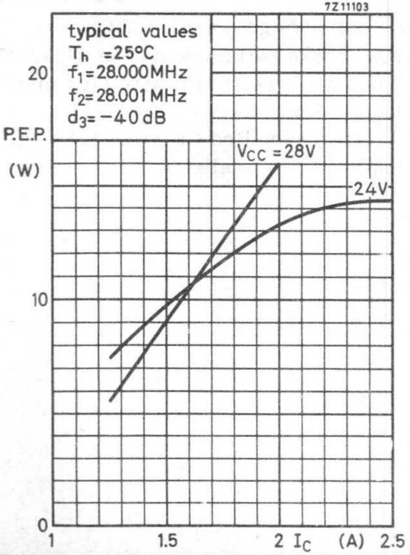
L1 = 3 turns enamelled Cu wire (1.5 mm); winding pitch 2.5 mm; int. diam. 7 mm
leads 50 mm totally

L2 = 7 turns enamelled Cu wire (0.7 mm) on 3H1 toroid; 60 μH
(code number of 3H1: 4322 020 36620)

L3 = 4 turns enamelled Cu wire (1.5 mm); winding pitch 2.5 mm; int. diam. 10 mm

L4 = 7 turns enamelled Cu wire (1.5 mm); winding pitch 2.5 mm; int. diam. 12 mm





APPLICATION INFORMATION

R.F. performance in c.w. operation (class B)

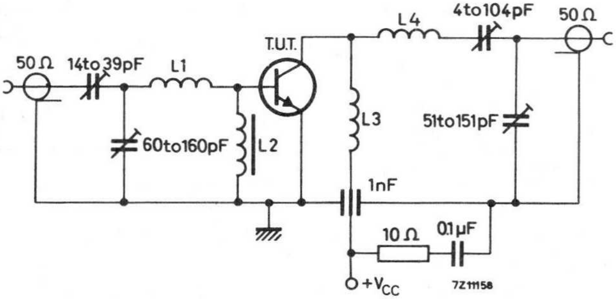
V_{CC} = 28 V; T_h up to 25 °C

f (MHz)	P_S (W)	P_L (W)	I_C (A)	G_p (dB)	η (%)	$\overline{z_i}$ (Ω)	$\overline{Y_L}$ (mA/V)
70	< 8.9	50	< 3.25	> 7.5	> 55	1.0+j0.2	115-j77
50	typ. 4	50	typ. 3.25	typ. 11	typ. 55	0.9-j0.5	104-j85
30	typ. 1.2	50	typ. 3.25	typ. 16	typ. 55	0.75-j1.6	89-j101

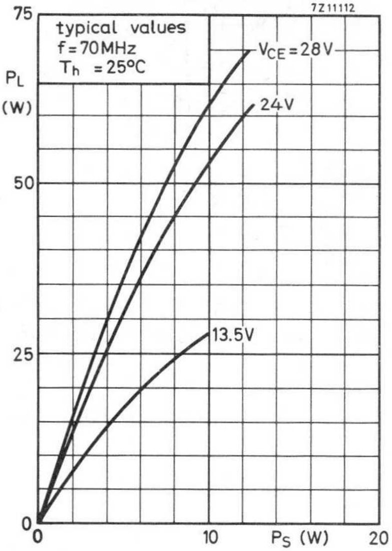
At temperatures up to 90 °C the output power relative to that at 25 °C is diminished by a factor −40 mW/°C.

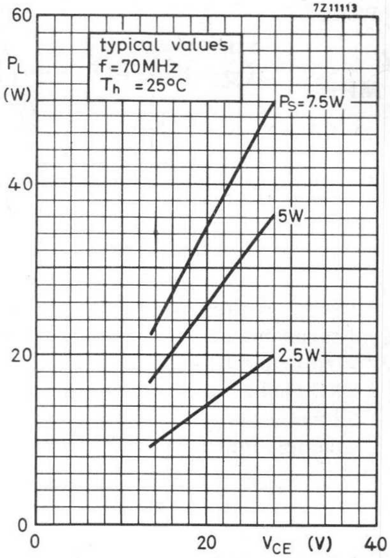
Test circuit:

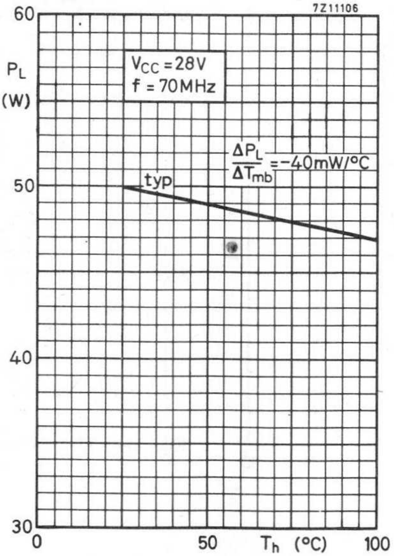
C.W.
70 MHz



L1 = 60 mm straight enamelled Cu wire (1.5 mm); 9 mm above chassis
L2 = FXC choke coil (code number 4322 020 36640)
L3 = 2 turns enamelled Cu wire (1.5 mm); winding pitch 2 mm; int. diam. 10 mm leads 55 mm totally
L4 = 3 turns enamelled Cu wire (1.5 mm); winding pitch 2.5 mm; int. diam. 10 mm leads 50 mm totally


7Z11112
typical values
f = 70 MHz
Th = 25°C
PL (W)
75
50
25
0
VCE = 28 V
24 V
13.5 V
0
10
PS (W)
20

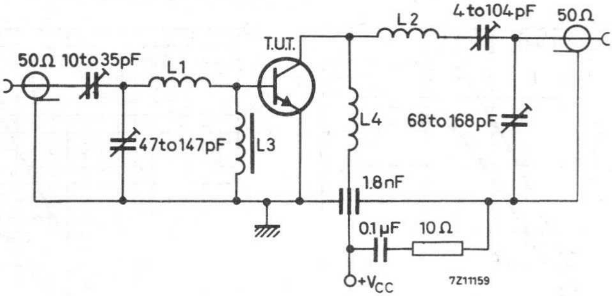

7Z11113
typical values
f = 70 MHz
Th = 25°C
PL (W)
60
40
20
0
PS = 7.5 W
5 W
2.5 W
0
20
VCE (V)
40


7Z11106
VCC = 28 V
f = 70 MHz
PL (W)
60
50
40
30
typ
ΔPL/ΔTmb = -40 mW/°C
0
50
Th (°C)
100

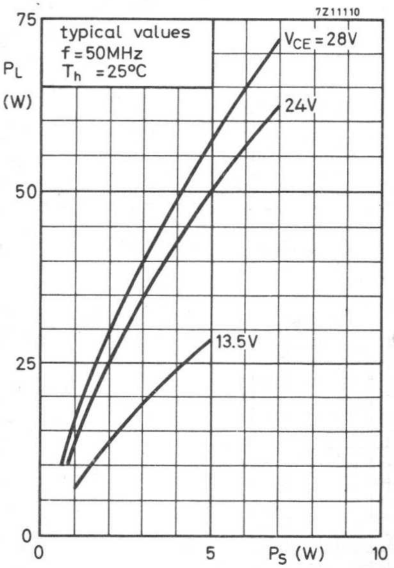
APPLICATION INFORMATION (continued)

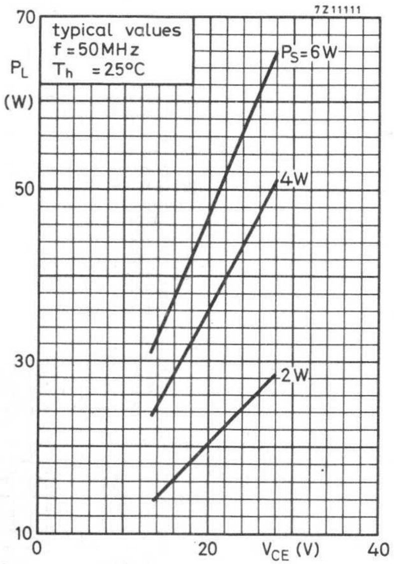
Test circuit:

C.W.
50 MHz



L1 = 1 turn enamelled Cu wire (1.5 mm); int. diam. 10 mm; leads 40 mm totally
L2 = 4 turns enamelled Cu wire (1.5 mm); int. diam. 12 mm; leads 40 mm totally
winding pitch 2 mm
L3 = FXC choke coil (code number 4322 020 36640)
L4 = 3 turns enamelled Cu wire (1.5 mm); int. diam. 10 mm; leads 40 mm totally
winding pitch 2 mm

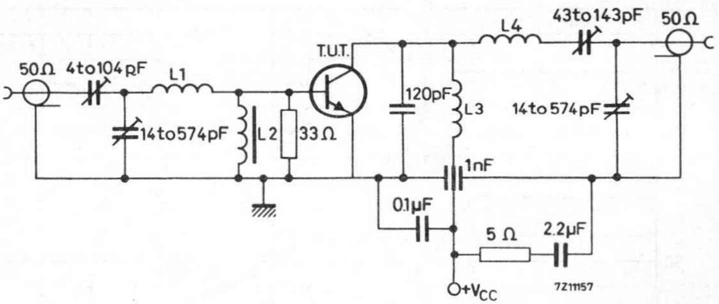




APPLICATION INFORMATION (continued)

Test circuit :

C.W.
30 MHz

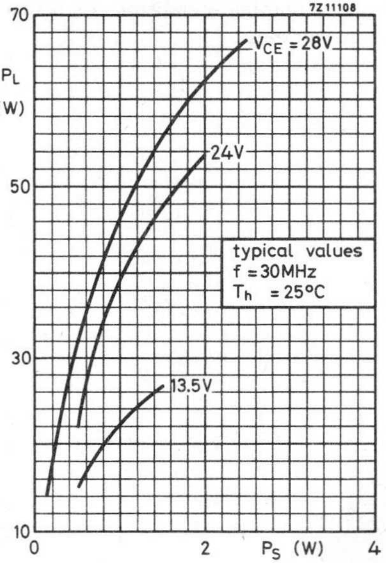


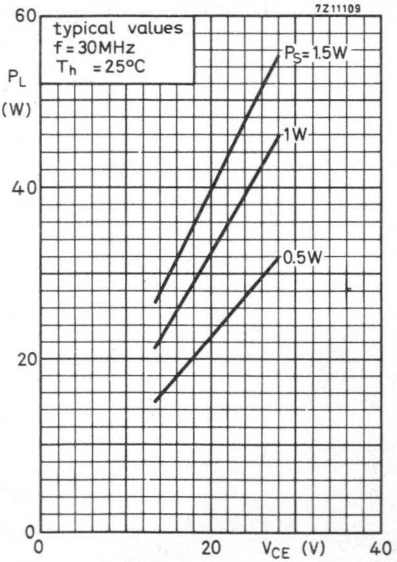
L1 = 2 turns enamelled Cu wire (1.5 mm); winding pitch 2 mm; int. diam. 10 mm leads 60 mm totally

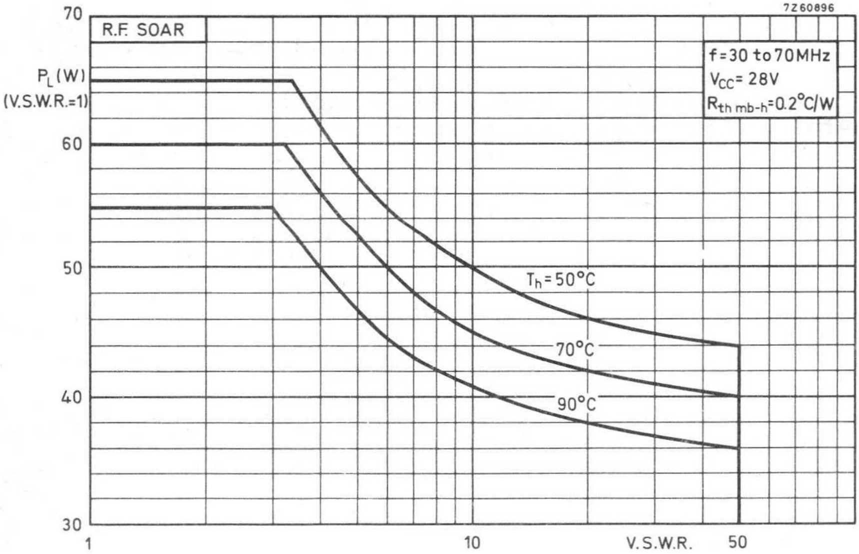
L2 = 7 turns enamelled Cu wire (0.7 mm) on 3H1 toroid; 60 µH (code number of 3H1: 4322 020 36620)

L3 = 4 turns enamelled Cu wire (1.5 mm); winding pitch 2 mm; int. diam. 10 mm leads 50 mm totally

L4 = 6 turns enamelled Cu wire (1.5 mm); winding pitch 2 mm; int. diam. 12 mm leads 50 mm totally







For high voltage operation, a stabilized power supply is generally used.
The graphs shows the allowable output power under nominal conditions as a function of the V.S.W.R., with heatsink temperature as parameter.

U.H.F. POWER TRANSISTOR

N-P-N epitaxial planar transistor intended for use in class A, B and C operated mobile, industrial and military transmitters with a supply voltage of 13.5 V. The transistor is resistance stabilized. Every transistor is tested under severe load mismatch conditions with a supply overvoltage to 16.5 V. It has a capstan envelope with a moulded cap. All leads are isolated from the stud.

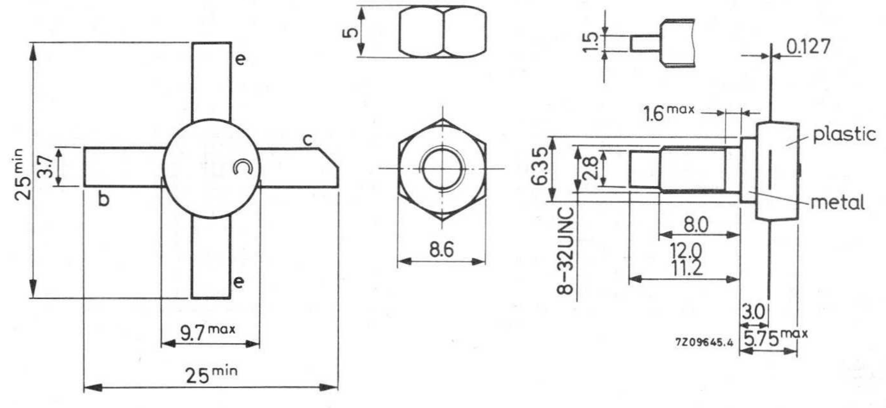
QUICK REFERENCE DATA

R.F. performance up to T_{mb} = 25 ^{o}C in an unneutralised common-emitter class B circuit.

Mode of operation	V_{CC} (V)	f (MHz)	P_S (W)	P_L (W)	I_C (A)	G_p (dB)	η (%)	$\overline{z_i}$ (Ω)	$\overline{Y_L}$ (mA/V)
c.w.	13.5	470	< 8	20	< 2.28	> 4	> 65	1.1 + j4.9	190-j45
c.w.	12.5	470	< 6.8	17	< 2.09	> 4	> 65		

MECHANICAL DATA

Dimensions in mm



Torque on nut: min. 7.5 kg cm
(0.75 Newton metres)
max. 8.5 kg cm
(0.85 Newton metres)

Diameter of clearance hole in heatsink: max. 4.17 mm.
Mounting hole to have no burrs at either end. De-burring must leave surface flat; do not chamfer or countersink either end of hole.

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltages

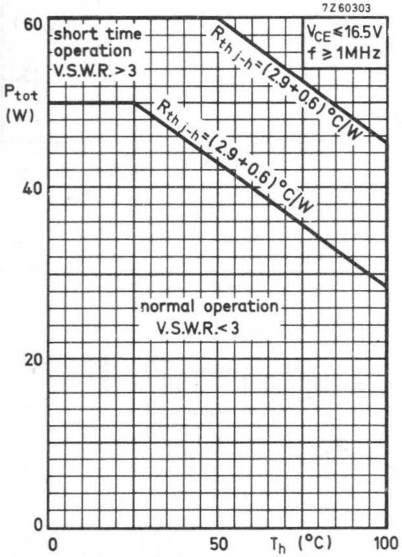
Collector-base voltage (open emitter) peak value	V_{CBOM}	max.	36	V
Collector-emitter voltage (open base)	V_{CEO}	max.	18	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4	V

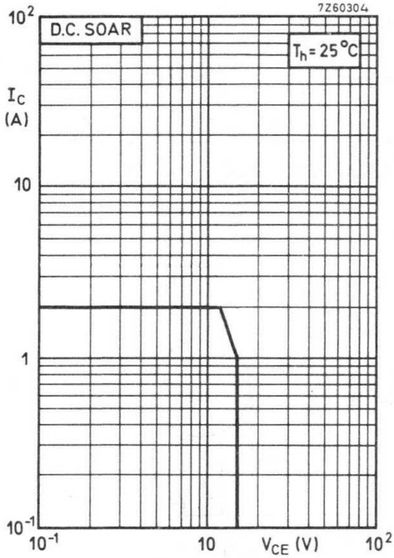
Currents

Collector current (average)	$I_{C(AV)}$	max.	3.5	A
Collector current (peak value) f > 1 MHz	I_{CM}	max.	10	A

Power dissipation

Total power dissipation up to $T_h = 25\ ^{o}C$ f > 1 MHz	P_{tot}	max.	50	W





Temperature

Storage temperature	T_{stg}		−30 to +200	^{o}C
Operating junction temperature	T_j	max.	200	^{o}C

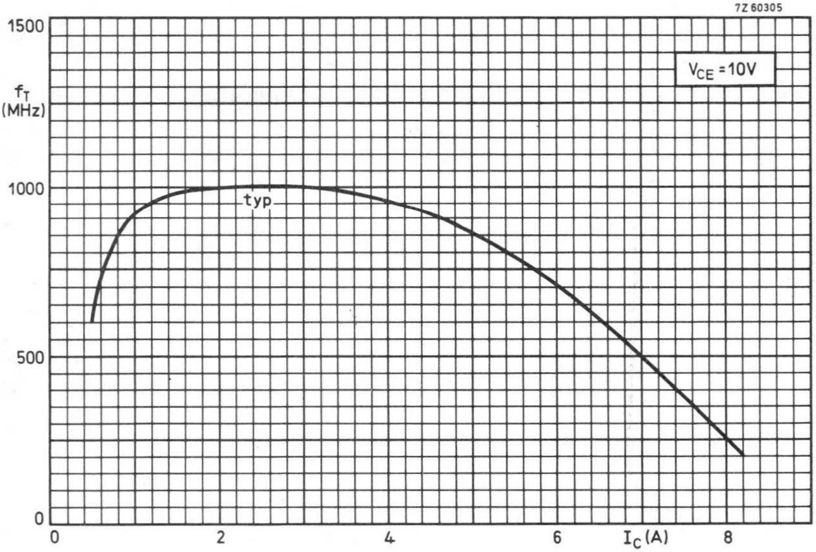
THERMAL RESISTANCE

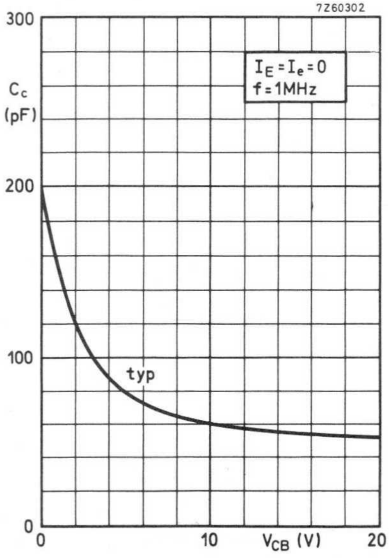
From junction to mounting base	$R_{th\ j-mb}$ =	2.9	$^{o}C/W$
From mounting base to heatsink	$R_{th\ mb-h}$ =	0.6	$^{o}C/W$

CHARACTERISTICS

$T_j = 25\ ^{\circ}C$ unless other wise specified

Breakdown voltages				
Collector-base voltage open emitter, $I_C = 25$ mA	$V_{(BR)CBO}$	>	36	V
Collector-emitter voltage open base, $I_C = 25$ mA	$V_{(BR)CEO}$	>	18	V
Emitter-base voltage open collector; $I_E = 10$ mA	$V_{(BR)EBO}$	>	4	V
Transient energy				
$L = 25$ mH; $f = 50$ Hz				
open base	E	>	3.1	mWs
$-V_{BE} = 1.5$ V; $R_{BE} = 33\ \Omega$	E	>	3.1	mWs
D.C. current gain				
$I_C = 1$ A; $V_{CE} = 5$ V	h_{FE}	>	10	
		typ.	30	
Transition frequency				
$I_C = 2$ A; $V_{CE} = 10$ V	f_T	typ.	1.0	GHz
Collector capacitance at $f = 1$ MHz				
$I_E = I_e = 0$; $V_{CB} = 15$ V	C_c	typ.	55	pF
		<	70	pF
Feedback capacitance				
$I_C = 100$ mA; $V_{CE} = 15$ V	$-C_{re}$	typ.	32	pF
Collector-stud capacitance	C_{cs}	typ.	2	pF


7Z 60305
1500
f_T
(MHz)
1000
500
0
0
2
4
6
I_C (A)
8
V_{CE} = 10V
typ


7Z60302
300
C_c
(pF)
200
100
0
0
10
V_{CB} (V)
20
$I_E = I_e = 0$
f = 1MHz
typ

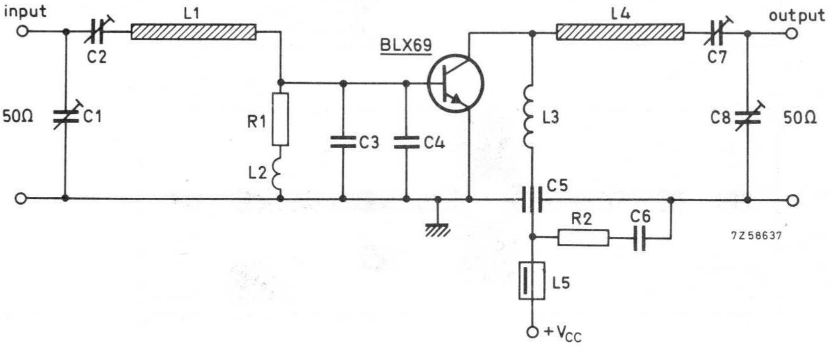
APPLICATION INFORMATION

R. F. performance in c. w. operation (unneutralised common-emitter class B ciruit)

T_{mb} up to 25 °C

f (MHz)	V_{CC} (V)	P_S (W)	P_L (W)	I_C (A)	G_p (dB)	η (%)	$\overline{z_i}$ (Ω)	$\overline{Y_L}$ (mA/V)
470	13.5	< 8	20	< 2.28	> 4	> 65	1.1 + j4.9	190-j45
470	12.5	< 6.8	17	< 2.09	> 4	> 65		
175	12.5	typ. 1.35	17	typ. 2.3	typ. 11	typ. 60	1.5 + j0.6	170-j57

Test circuit for 470 MHz:



List of components:

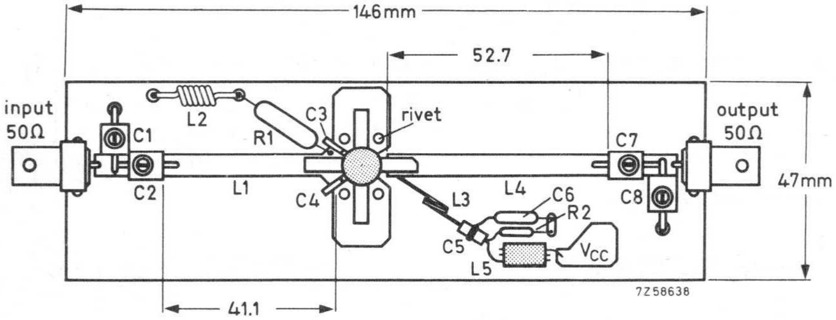
C1=C2=C7=C8=1.8 to 9.0 pF film dielectric trimmer (code number 2222 809 05002)
C3=C4= 15 pF chip capacitor
C5= 100 pF feed through capacitor
C6= 33 nF polyester capacitor
R1= 1 Ω
R2= 10 Ω
L1= strip-line (41.1 mm x 5.0 mm)
L2= 13 turns closely wound enamelled Cu wire (0.5 mm); int.diam. 4.0 mm (0.32 μH)
L3= 2 turns Cu wire (1 mm); winding pitch 1.5 mm; int.diam. 4 mm; leads 2x5 mm
L4= strip-line (52.7 mm x 5.0 mm)
L5= ferroxcube choke coil. Z (at f = 250 MHz) = 400 Ω ± 20 %
(code number 4312 020 36640)

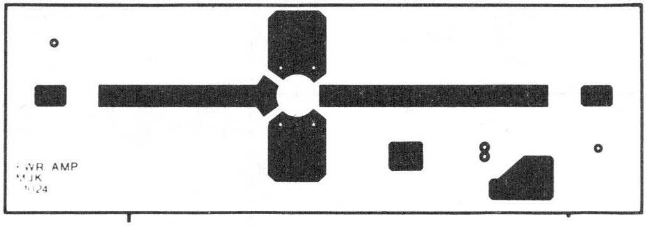
L1 and L4 are strip lines on a double Cu clad print plate with teflon fibre glass dielectric
(ϵ_r = 2.74); thickness 1.45 mm

Component lay-out for 470 MHz: see page 6

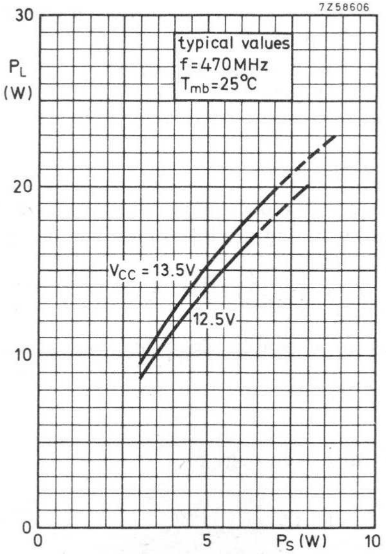
APPLICATION INFORMATION (continued)

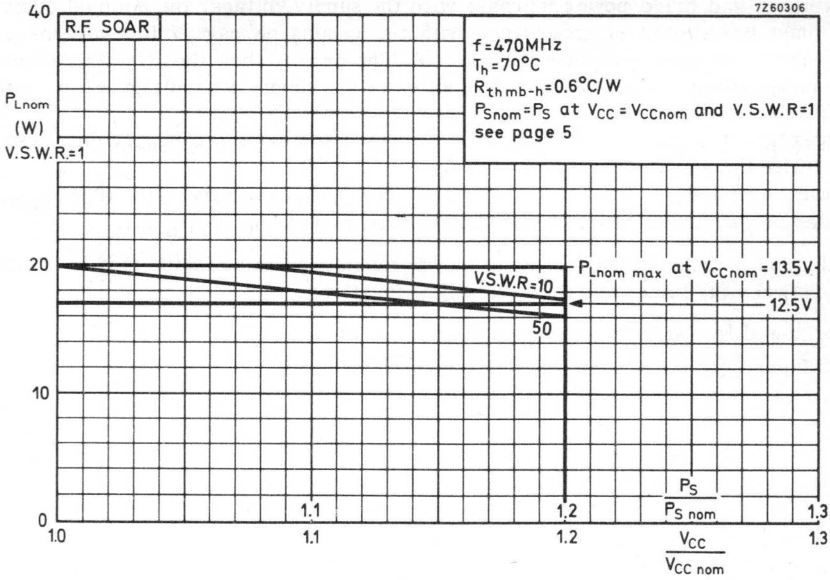
Component lay-out and printed circuit board for 470 MHz test circuit.

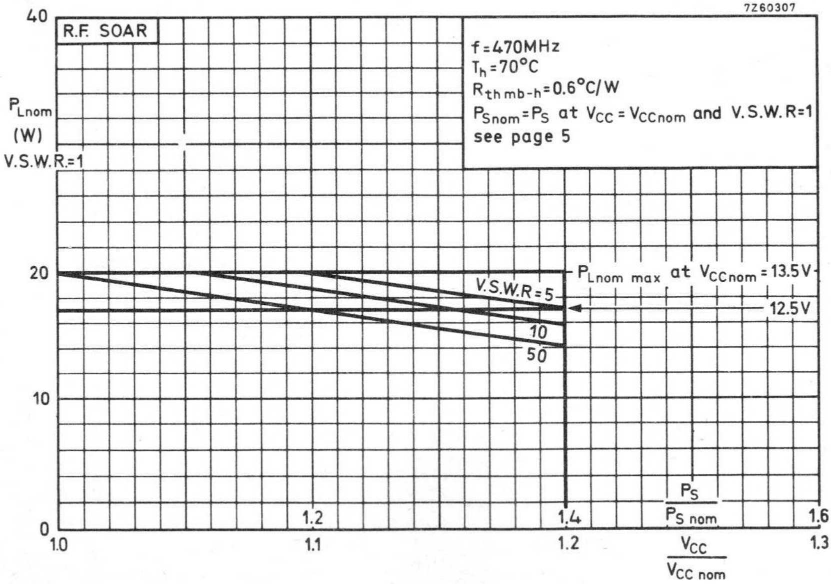




The circuit and the components are situated on one side of the epoxy fibre-glass board, the other side being fully metallised to serve as earth. Earth connections are made by means of hollow rivets.




7Z60306
R.F. SOAR
P_Lnom (W) V.S.W.R.=1
40
20
10
0
f=470MHz
T_h=70°C
R_th mb-h=0.6°C/W
P_Snom=P_S at V_CC=V_CCnom and V.S.W.R=1
see page 5
P_Lnom max at V_CCnom=13.5V
12.5V
V.S.W.R=10
50
P_S / P_S nom
1.1
1.2
1.3
V_CC / V_CC nom
1.0
1.1
1.2
1.3


7Z60307
R.F. SOAR
P_Lnom (W) V.S.W.R.=1
40
20
10
0
f=470MHz
T_h=70°C
R_th mb-h=0.6°C/W
P_Snom=P_S at V_CC=V_CCnom and V.S.W.R=1
see page 5
P_Lnom max at V_CCnom=13.5V
12.5V
V.S.W.R=5
10
50
P_S / P_S nom
1.2
1.4
1.6
V_CC / V_CC nom
1.0
1.1
1.2
1.3

The transistor has been developed for use with unstabilized supply voltages. As the output power and drive power increase with the supply voltage, the nominal output power must be derated in accordance with the graphs on page 7 for safe operation at supply voltages other than the nominal. The graphs show the allowable output power, under nominal conditions, as a function of the supply overvoltage ratio, with V.S.W.R. as parameter.
The upper graph applies to the situation in which the drive (P_S/P_{Snom}) increases linearly with the supply overvoltage ratio.
The lower graph shows the derating factor to be applied when the drive (P_S/P_{Snom}) increases as the square of the supply overvoltage ratio (V_{CC}/V_{CCnom}).

Depending on the operating conditions, the appropriate derating factor may lie in the region between the linear and the square-law functions.

The horizontal line at 20 W applies at V_{CCnom} = 13.5 V.
For V_{CCnom} = 12.5 V, P_L should be derated to 17 W.

SILICON PLANAR EPITAXIAL TRANSISTOR

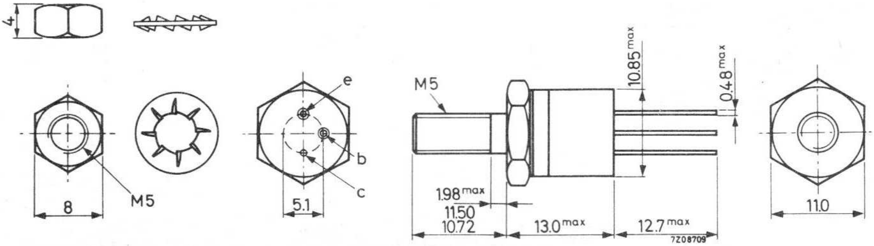
N-P-N transistor in a metal envelope. All electrodes are electrically insulated from the stud.
The BLY14 is intended for high frequency and high power applications, primarily for use in the transmitting field.

QUICK REFERENCE DATA

Collector-base voltage (open emitter)	V_{CBO}	max.	80	V
Collector-emitter voltage (V_{BE} = 0)	V_{CES}	max.	80	V
Collector current (peak value)	I_{CM}	max.	1.0	A
Total power dissipation up to T_{mb} = 25 °C f ≥ 1 MHz	P_{tot}	max.	8.75	W
Junction temperature	T_j	max.	200	°C
D.C. current gain at T_j = 25 °C $-I_E$ = 500 mA; V_{CB} = 10 V	h_{FE}	typ.	11	
Transition frequency I_C = 100 mA; V_{CE} = 10 V	f_T	typ.	190	MHz
Performance in a specified circuit V_{CE} = 40 V; P_i = 0.625 W; f = 180 MHz				
Output power	P_o	>	3	W
Power gain	G_p	>	6.8	dB
Collector efficiency	η	>	40	%

MECHANICAL DATA

Dimensions in mm



Collector is connected to the can (upper part of the envelope)
Torque on nut: max. 18 cm kg

RATINGS (Limiting values) [1]

Voltages

Collector-base voltage (open emitter)	V_{CBO}	max.	80	V
Collector-emitter voltage (V_{BE} = 0)	V_{CES}	max.	80	V
Collector-emitter voltage (open base)	V_{CEO}	max.	55	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4	V

Currents

Collector current (d.c.)	I_C	max.	1.0	A
Collector current (peak value)	I_{CM}	max.	1.0	A
Base current (d.c.)	I_B	max.	0.2	A
Base current (peak value)	I_{BM}	max.	0.2	A

Power dissipation

Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	8.75	W

Temperatures

Storage temperature	T_{stg}		-65 to +200	°C
Junction temperature	T_j	max.	200	°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	20	°C/W

CHARACTERISTICS T_j = 25 °C unless otherwise specified

Collector cut-off current

I_E = 0; V_{CB} = 40 V	I_{CBO}	typ. <	1 500	nA nA
I_E = 0; V_{CB} = 40 V; T_j = 150 °C	I_{CBO}	typ. <	0.8 50	μA μA
V_{CE} = 80 V; R_{BE} = 10 Ω	I_{CER}	<	1	mA
I_B = 0; V_{CE} = 55 V	I_{CEO}	<	10	mA

Emitter cut-off current

I_C = 0; V_{EB} = 1 V	I_{EBO}	typ. <	2 500	nA nA
I_C = 0; V_{EB} = 4 V	I_{EBO}	<	100	μA

---

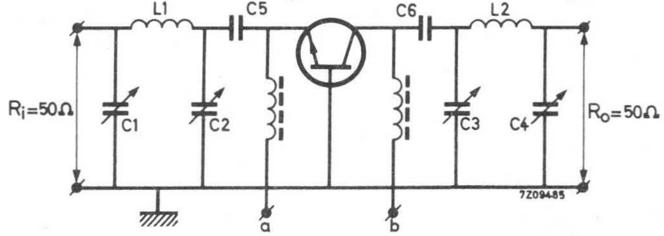
[1] Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

CHARACTERISTICS (continued) T_j = 25 °C unless otherwise specified

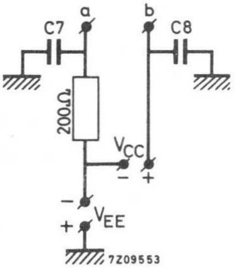
Saturation voltages				
I_C = 500 mA; I_B = 100 mA	V_{CEsat}	typ.	0.3	V
		<	0.7	V
	V_{BEsat}	typ.	1.1	V
		<	1.5	V
D.C. current gain				
$-I_E$ = 10 mA; V_{CB} = 10 V	h_{FE}	typ.	9	
$-I_E$ = 150 mA; V_{CB} = 10 V	h_{FE}	typ.	11	
$-I_E$ = 500 mA; V_{CB} = 10 V	h_{FE}	>	5	
		typ.	11	
Collector capacitance at f = 1 MHz				
I_E = I_e = 0; V_{CB} = 40 V	C_c	typ.	7.5	pF
		<	10	pF
Capacitance between collector and stud		typ.	3.7	pF
		<	5	pF
Transition frequency				
I_C = 100 mA; V_{CE} = 10 V	f_T	typ.	190	MHz
Feedback time constant at f = 10 MHz				
$-I_E$ = 30 mA; V_{CB} = 40 V	$\left\lvert\frac{h_{rb}}{\omega}\right\rvert$	typ.	10.5	ps
		<	35	ps
y parameters in common base configuration				
$-I_E$ = 150 mA; V_{CB} = 24 V; f = 180 MHz				
Input conductance	g_{ib}	typ.	48	$m\Omega^{-1}$
Input capacitance	$-C_{ib}$	typ.	120	pF
Transfer admittance	$\lvert y_{fb}\rvert$	typ.	98	$m\Omega^{-1}$
Phase angle of transfer admittance	φ_{fb}	typ.	62°	
Output conductance	g_{ob}	typ.	4.3	$m\Omega^{-1}$
Output capacitance	C_{ob}	typ.	13.5	pF
y parameters in common emitter configuration				
I_C = 150 mA; V_{CE} = 24 V; f = 180 MHz				
Input conductance	g_{ie}	typ.	96	$m\Omega^{-1}$
Input capacitance	$-C_{ie}$	typ.	32	pF

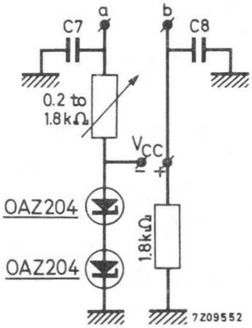
APPLICATION INFORMATION

Amplifier circuit



Different methods of biasing





Components	f = 100 MHz	f = 180 MHz
C1, C2, C3, C4	25 pF	25 pF
C5, C6, C7, C8	3.3 nF	1 nF
L1	2 turns Cu wire (1 mm); d = 12 mm	1 turn Cu wire (1.2 mm); d = 12 mm
L2	3.5 turns Cu wire (1 mm); d = 12 mm	2 turns Cu wire (1.2 mm); d = 12 mm

Performance in common base configuration

V_{CE} = 40 V; P_i = 0.625 W

f = 180 MHz; T_{mb} = 25 °C

Output power	P_o	>	3.0	W
		typ.	3.6	W
Power gain	G_p	>	6.8	dB
		typ.	7.6	dB
Collector efficiency	η	>	40	%
		typ.	48	%

TRIPLE DIFFUSED SILICON PLANAR TRANSISTOR

N-P-N triple diffused transistor in a TO-36 metal envelope.
The BLY17 is intended for high frequency and high power applications, primarily for use in the transmitting field.

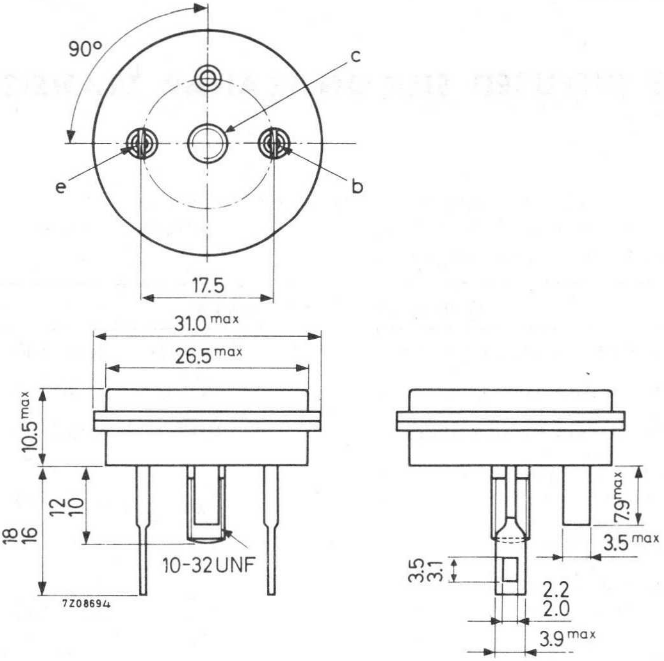
QUICK REFERENCE DATA

Collector-base voltage (open emitter)	V_{CBO}	max.	100	V
Collector-emitter voltage ($R_{BE} \leq 10\ \Omega$)	V_{CER}	max.	100	V
Collector current (peak value)	I_{CM}	max.	10	A
Total power dissipation up to T_{mb} = 25 °C $f \geq 0.5$ MHz	P_{tot}	max.	100	W
Junction temperature	T_j	max.	175	°C
D.C. current gain at T_j = 25 °C $-I_E$ = 1 A; V_{CB} = 0	h_{FE}	typ.	25	
Transition frequency I_C = 1.5 A; V_{CE} = 10 V	f_T	typ.	70	MHz
Performance in a specified circuit at f = 30 MHz V_{CE} = 40 V; V_{BE} = 0; P_i = 7.5 W				
Output power	P_o	>	30	W
Power gain	G_p	>	6	dB
Collector efficiency	η	>	40	%

MECHANICAL DATA See page 2

MECHANICAL DATA Dimensions in mm

TO-36



Diameter of hole in heatsink: max. 5.2 mm
Supplied with device : 56213

Torque on nut: min. 8 cm kg
max. 17 cm kg

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Collector-base voltage (open emitter)	V_{CBO}	max.	100	V
Collector-emitter voltage ($R_{BE} \leq 10\ \Omega$)	V_{CER}	max.	100	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4	V
Collector current (d.c.)	I_C	max.	10	A
Collector current (peak value)	I_{CM}	max.	10	A
Base current (d.c. or average over any 20 ms period)	I_B	max.	2	A
Total power dissipation up to T_{mb} = 25 °C f ≥ 0.5 MHz	P_{tot}	max.	100	W
Storage temperature	T_{stg}	-65 to +175		°C
Junction temperature	T_j	max.	175	°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j-mb}$	=	1.5	°C/W

N-P-N SILICON V.H.F. POWER TRANSISTORS

Silicon high frequency power transistors in a capstan envelope, designed for mobile operation in class B.
The BLY83 is primarily intended for a.m. operation at 13.8 V but is also suitable for f.m. operation at 24 V.
The BLY84 is primarily intended for f.m. operation at 13.8 V.

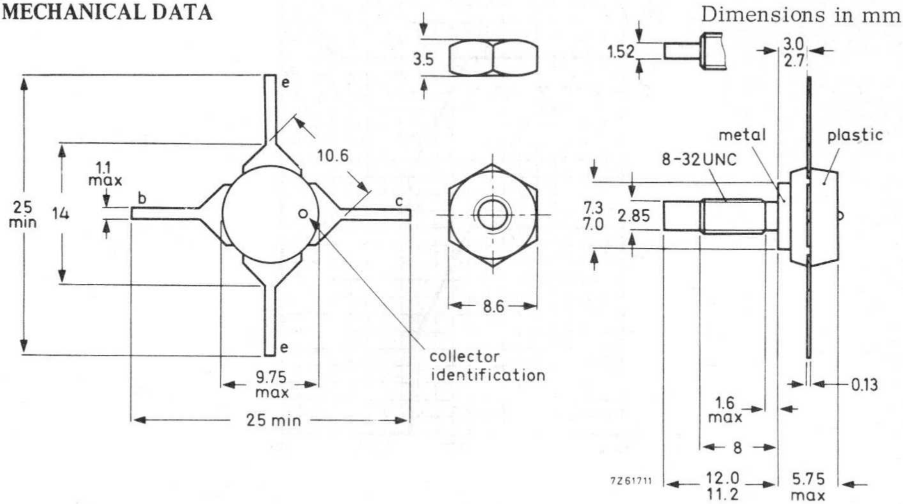
QUICK REFERENCE DATA

R.F. performance up to T_h = 40 °C

Type No.	Mode of operation	V_{CC} (V)	f (MHz)	f_{mod} (kHz)	P_S (W)	P_L (W)	$P_{L(car)}$ (W)	I_C (A)	G_p (dB)	η (%)	d_{tot} (%)	m (%)
BLY83	c.w.	24	175	-	1.35	13	-	0.84	9.8	65	-	-
BLY84	c.w.	13.8	175	-	3.4	13	-	1.2	5.8	79	-	-
BLY84	c.w.	13.8	80	-	0.5	13.25	-	1.2	14.2	80	-	-
BLY83	a.m.	13.8	175	1	0.35	-	7	0.66	13	77	< 5	80
BLY83	a.m.	13.8	80	1	0.06	-	7.5	0.7	21	77	< 5	80

MECHANICAL DATA

Dimensions in mm



Torque on nut: min. 7.5 kg cm
(0.75 Newton-metres)
max. 8.5 kg cm
(0.85 Newton-metres)

Diameter of clearance hole in heatsink: max. 4.17 mm.
Mounting hole to have no burrs at either end.
De-burring must leave surface flat; do not chamfer or coutersink either end of hole.

When locking is required, an adhesive instead of a lock washer is required.

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

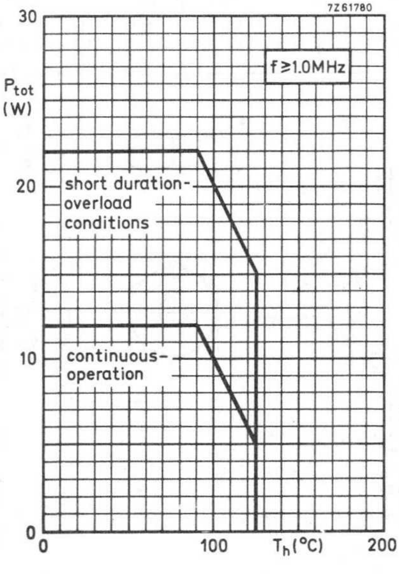
Voltages			BLY83	BLY84	
Collector-base voltage (open emitter) peak value	V_{CBOM}	max.	66	40	V
Collector-emitter voltage (open base)	V_{CEO}	max.	33	20	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4		V

Currents

Collector-current (peak value) f < 1.0 MHz	I_{CM}	max.	2.5	A
Collector-current (peak value) f > 1.0 MHz	I_{CM}	max.	7.5	A

Power dissipation

Total power dissipation up to $T_h = 90\ ^oC$	P_{tot}	max.	12	W



Temperature

Storage temperature	T_{stg}	−65 to +150	^oC

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			BLY83	BLY84	
Breakdown voltages					
Collector-base voltage open emitter; I_C = 10 mA	$V_{(BR)CBO}$	>	66	40	V
Collector-emitter voltage V_{BE} = 0; I_C = 10 mA	$V_{(BR)CES}$	>	66	40	V
Collector-emitter voltage open base; I_C = 50 mA	$V_{(BR)CEO}$	>	33	20	V
Emitter-base voltage open collector; I_E = 1 mA	$V_{(BR)EBO}$	>	4	4	V
D.C. current gain					
I_C = 1.0 A; V_{CE} = 5.0 V	h_{FE}	>	10	10	
		typ.	60	60	
		<	220	–	
Transition frequency					
I_C = 1.0 A; V_{CE} = 5.0 V; f = 100 MHz	f_T	>	250	250	MHz
		typ.	450	450	MHz
Collector capacitance at f = 1 MHz					
$I_E = I_e$ = 0; V_{CB} = 10 V	C_c	typ.	34	37	pF
		<	45	45	pF
Emitter capacitance at f = 1 MHz					
$I_C = I_c$ = 0; V_{EB} = 0	C_e	>	100	100	pF
		typ.	155	155	pF

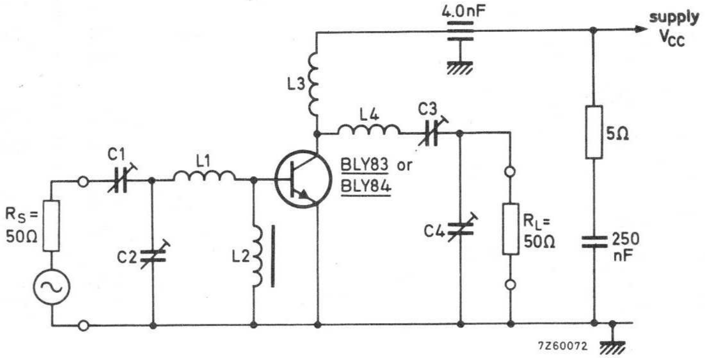
APPLICATION INFORMATION

R.F. performance in c.w. operation at f = 175 MHz

T_h up to 40 ^{o}C

Type No.	V_{CC} (V)	P_S (W)	P_L (W)	I_C (A)	G_p (dB)	η (%)
BLY84	13.8	1.20	7.0	0.66	7.6	77
BLY84	13.8	3.40	13.0	1.20	5.8	79
BLY83	24.0	1.35	13.0	0.84	9.8	65

Test circuit



List of components:

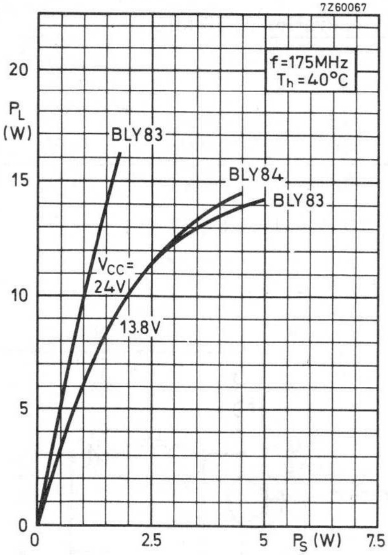
C1 = C3 = C4 = 30 pFmax } air trimmers
C2 = 60 pF max }

L1 = 25.4 mm of straight Cu wire (1 mm)

L2 = 3 turns of Cu wire (0.5 mm) on Ferrite FX1115

L3 = 3 turns of Cu wire (1.3 mm), int. diam. 9.5 mm, 1 = 9.5 mm

L4 = 2 turns of Cu wire (1.6 mm), int. diam. 12.7 mm, 1 = 9.5 mm


7Z60067
f = 175MHz
T_h = 40°C
P_L
(W)
20
15
10
5
0
BLY83
BLY84
BLY83
V_{CC} =
24V
13.8V
0
2.5
5
P_S (W)
7.5

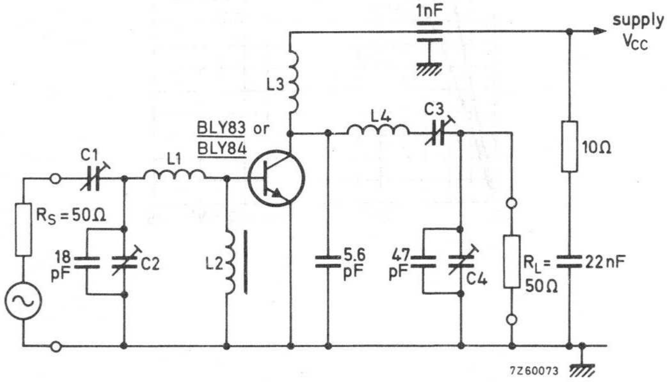
APPLICATION INFORMATION

R.F. performance in c.w. operation at 80 MHz

T_h up to 40 °C

Type No.	V_{CC} (V)	P_S (W)	P_L (W)	I_C (A)	G_P (dB)	η (%)
BLY84	6.9	0.5	5.3	0.96	10.3	80
BLY84	13.8	0.5	13.25	1.2	14.2	80

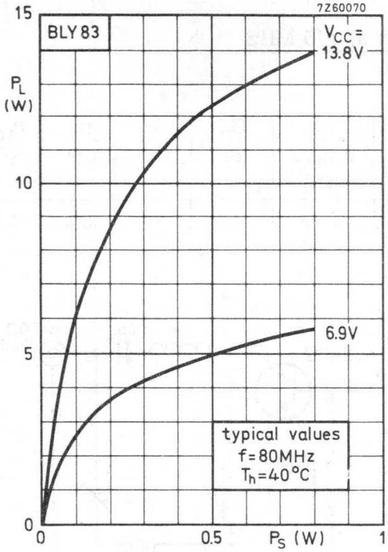
Test circuit

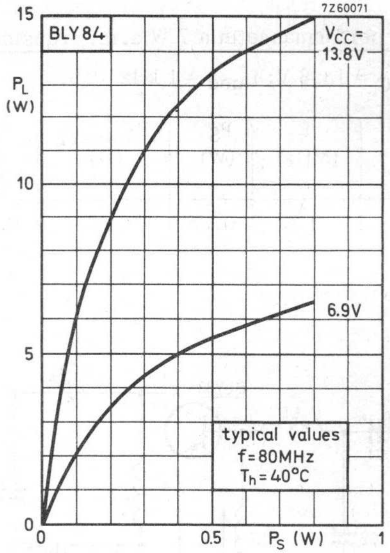


List of components:

C1 = C2 = C3 = C4 = 4 to 29 pF air trimmers

L1 = 4 turns Cu wire (1 mm); int. diam. 6.3 mm; l = 8.0 mm
L2 = 2 turns Cu wire (0.35 mm) on Ferrite bead FX1115
L3 = 5 turns closely wound Cu wire (1 mm); int. diam. 6.3 mm
L4 = 5 turns Cu wire (1.3 mm); int. diam. 9.5 mm; l = 12 mm


7Z60070
BLY83
V_{CC} = 13.8V
6.9V
P_L (W)
15
10
5
0
0
0.5
P_S (W)
1
typical values
f = 80MHz
T_h = 40°C

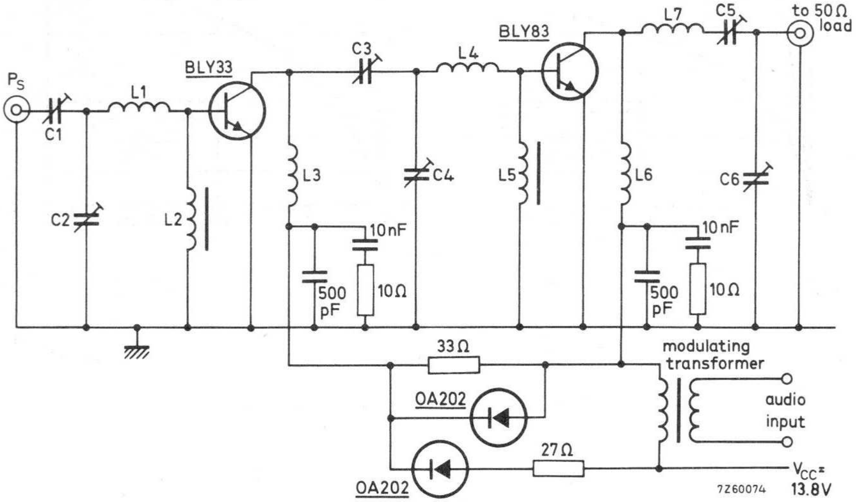

7Z60071
BLY84
V_{CC} = 13.8V
6.9V
P_L (W)
15
10
5
0
0
0.5
P_S (W)
1
typical values
f = 80MHz
T_h = 40°C

APPLICATION INFORMATION

R.F. performance in a 7 W a.m. transmitter at 175 MHz

V_{CC} = 13.8 V; f_{mod} = 1 kHz

Type No.	f (MHz)	P_S (W)	$P_{L\ (car)}$ (W)	I_C dr. (A)	I_C ampl. (A)	G_p (dB)	η (%)	m (%)	d_{tot} (%)
BLY83	175	0.35	7.0	0.22	0.66	13	77	80	< 5



List of components

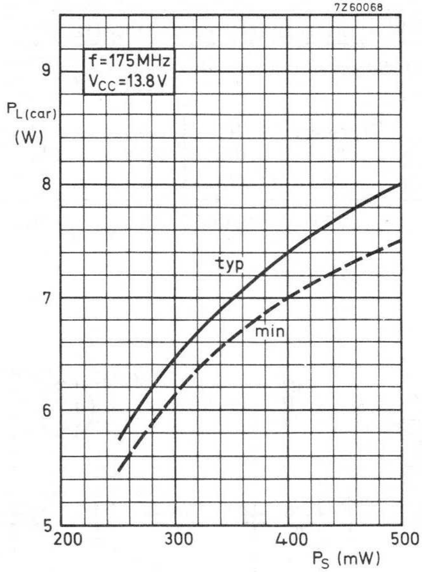
C1 = C2 = C3 = C4 = C5 = C6 = 4 to 29 pF air trimmers

L1 = L4 = 3 turns of 18 s.w.g. en.cu. d = 6.4 mm, l = 5.0 mm

L3 = L6 = 5 turns of 18 s.w.g. en.cu. d = 6.4 mm, l = 10 mm

L7 = 3 turns of 16 s.w.g. en.cu. d = 10 mm, l = 10 mm

L2 = L5 = 2 turns of 26 s.w.g. en.cu. wound on ferrite bead FX1115



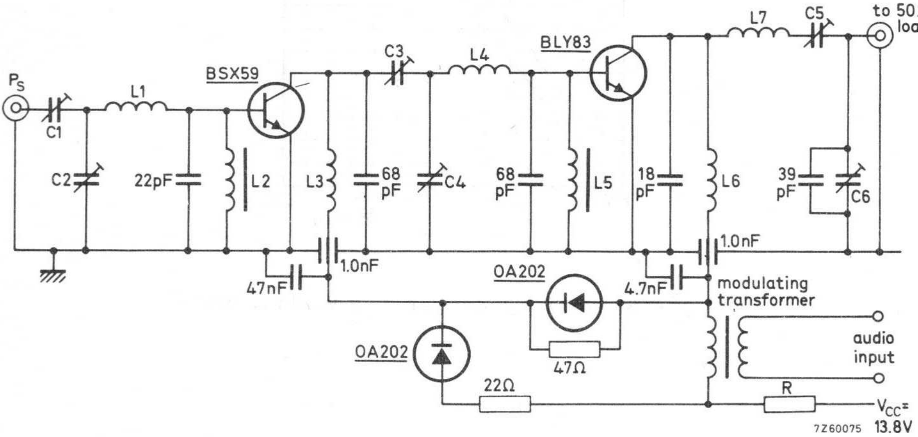
Aerial carrier power versus c.w. drive power

APPLICATION INFORMATION

R.F. performance in a 7 W a.m. transmitter at 80 MHz

$V_{CC} = 13.8$ V; $f_{mod} = 1$ kHz

Type No.	f (MHz)	P_S (W)	$P_{L\,(car)}$ (W)	I_C dr. (A)	I_C ampl. (A)	G_P (dB)	η (%)	m (%)	d_{tot} (%)
BLY83	80	0.06	7.5	0.06	0.7	21	77	80	< 5



List of components:

C1 = C2 = C3 = C4 = C5 = C6 = 4 to 29 pF air trimmers

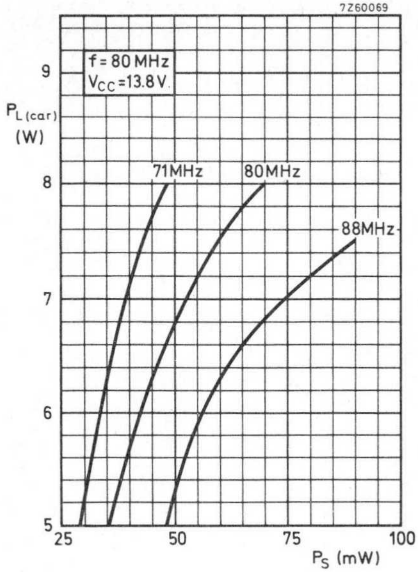
L1 = L4 = 5 turns of 18 s.w.g. en.cu. d = 6.3 mm, l = 9.0 mm

L3 = L6 = 3 turns of 18 s.w.g. en.cu. d = 7.0 mm, l = 6.0 mm

L7 = 6 turns of 14 s.w.g. cu. d = 10 mm, l = 13 mm

L2 = L5 = 1 turn of 26 s.w.g. en.cu. wound on ferrite bead FX1115

R This resistor is incorporated in the equipment to reduce the carrier level to 8 W or below.



Aerial carrier power versus c.w. drive power

V.H.F. POWER TRANSISTOR

N-P-N epitaxial planar transistor intended for use in class A, B and C operated mobile, industrial and military transmitters with a supply voltage of 13.5 V. The transistor is resistance stabilized. Every transistor is tested under severe load mismatch conditions with a supply overvoltage to 16.5 V. It has a $\frac{1}{4}$" capstan envelope with a moulded cap. All leads are isolated from the stud.

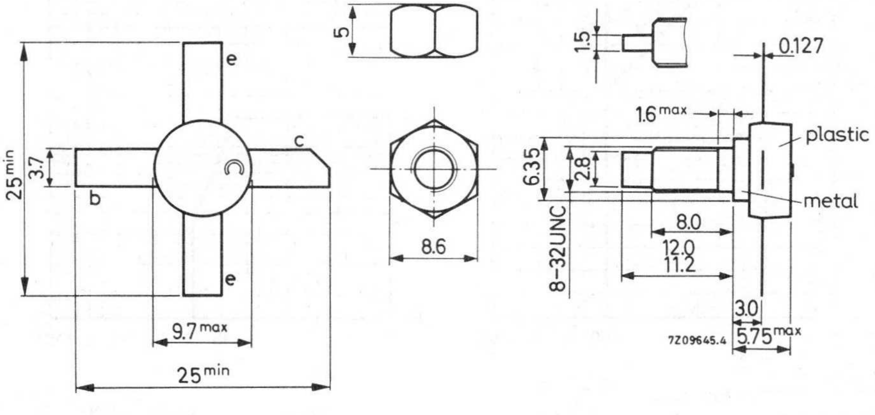
QUICK REFERENCE DATA

R.F. performance up to T_{mb} = 25 °C in an unneutralised common-emitter class B circuit.

Mode of operation	V_{CC} (V)	f (MHz)	P_S (W)	P_L (W)	I_C (A)	G_p (dB)	η (%)	$\overline{z}_i$ (Ω)	$\overline{Y}_L$ (mA/V)
c.w.	13.5	175	< 1.0	8	< 0.85	> 9	> 70	2.75+j1.5	74-j18
c.w.	12.5	175	typ. 1.0	8	typ. 0.91	typ. 9	typ. 70		

MECHANICAL DATA

Dimensions in mm



Torque on nut: min. 7.5 kg cm
(0.75 Newton metres)
max. 8.5 kg cm
(0.85 Newton metres)

Diameter of clearance hole in heatsink: max. 4.17 mm.
Mounting hole to have no burrs at either end. De-burring must leave surface flat; do not chamfer or countersink either end of hole.

When locking is required, an adhesive instead of a lock washer is preferred.

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltages

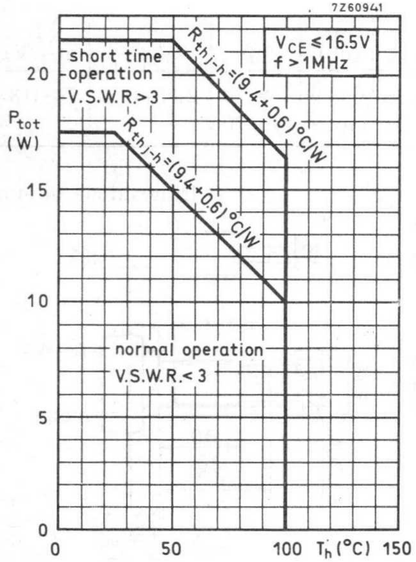
Collector-base voltage (open emitter) peak value	V_{CBOM}	max.	36	V
Collector-emitter voltage (open base)	V_{CEO}	max.	18	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4	V

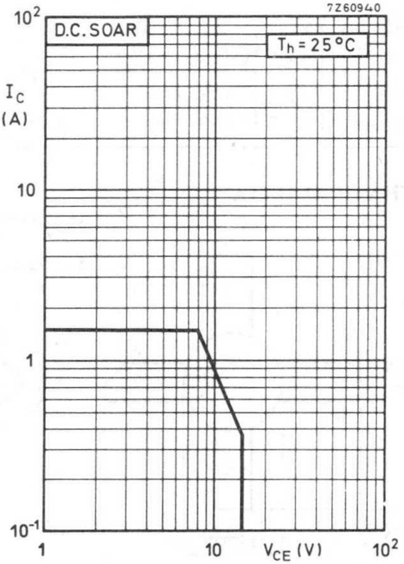
Currents

Collector current (average)	$I_{C(AV)}$	max.	1.25	A
Collector current (peak value) f > 1 MHz	I_{CM}	max.	3.75	A

Power dissipation

Total power dissipation up to T_h = 25 °C f > 1 MHz	P_{tot}	max.	17.5	W





Temperature

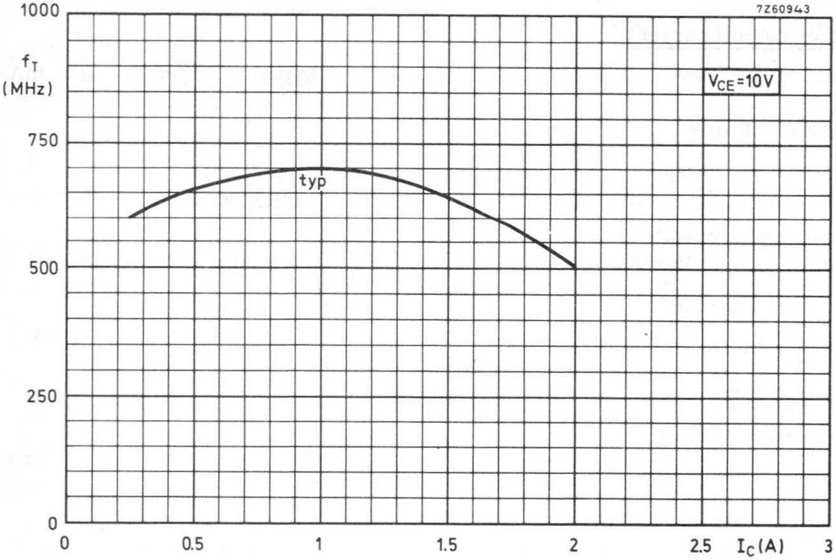
Storage temperature	T_{stg}		-30 to +200	°C
Operating junction temperature	T_j	max.	200	°C

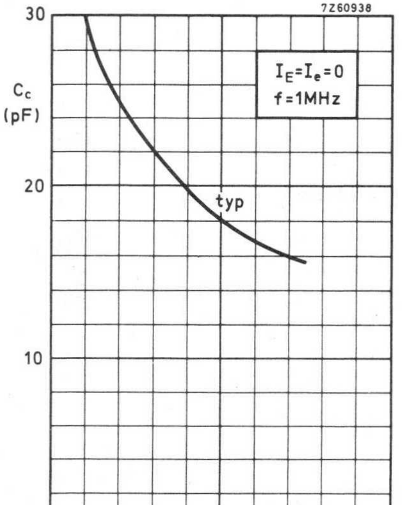
THERMAL RESISTANCE

From junction to mounting base	$R_{th\,j-mb}$	=	9.4	°C/W
From mounting base to heatsink	$R_{th\,mb-h}$	=	0.6	°C/W

CHARACTERISTICS $T_j = 25\,^{\circ}C$ unless otherwise specified

Collector cut-off current				
$I_B = 0$; $V_{CE} = 14\,V$	I_{CEO}	<	5	mA
Breakdown voltages				
Collector-base voltage open emitter, $I_C = 1$ mA	$V_{(BR)CBO}$	>	36	V
Collector-emitter voltage open base, $I_C = 10$ mA	$V_{(BR)CEO}$	>	18	V
Emitter-base voltage open collector, $I_E = 1$ mA	$V_{(BR)EBO}$	>	4	V
Transient energy				
$L = 25$ mH; $f = 50$ Hz				
open base	E	>	0.5	mWs
$-V_{BE} = 1.5\,V$; $R_{BE} = 33\,\Omega$	E	>	0.5	mWs
D.C. current gain				
$I_C = 500$ mA; $V_{CE} = 5$ V	h_{FE}	>	5	
Transition frequency				
$I_C = 500$ mA; $V_{CE} = 10$ V	f_T	typ.	700	MHz
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; $V_{CB} = 15$ V	C_c	typ. <	15 20	pF pF
Feedback capacitance at f = 1 MHz				
$I_C = 100$ mA; $V_{CE} = 15$ V	$-C_{re}$	typ.	11	pF
Collector-stud capacitance	C_{cs}	typ.	2	pF


7Z60943
1000
f_T
(MHz)
750
500
250
0
0
0.5
1
1.5
2
2.5
I_C (A)
3
V_{CE}=10V
typ


7Z60938
30
C_c
(pF)
20
10
0
0
10
V_{CB} (V)
20
I_E=I_e=0
f=1MHz
typ

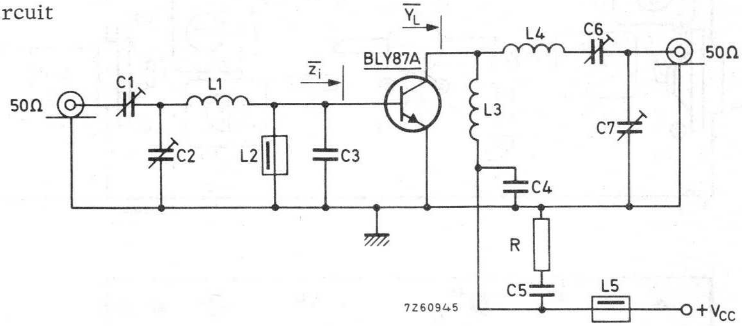
APPLICATION INFORMATION

R. F. performance in c. w. operation (unneutralised common-emitter class B circuit)

f = 175 MHz; T_{mb} up to 25 °C

V_{CC}(V)	P_S(W)	P_L(W)	I_C (A)	G_p(dB)	η(%)	$\overline{z_i}$ (Ω)	$\overline{Y_L}$(mA/V)
13.5	< 1.0	8	< 0.85	> 9	> 70	2.75+j1.5	74-j18
12.5	typ. 1.0	8	typ. 0.91	typ. 9	typ. 70		

Test circuit



C1 = 2.5 to 20 pF film dielectric trimmer (code number 2222 809 07004)
C2 = C6 = C7 = 4 to 40 pF film dielectric trimmer (code number 2222 809 07008)
C3 = 47 pF ceramic
C4 = 100 pF ceramic
C5 = 150 nF polyester

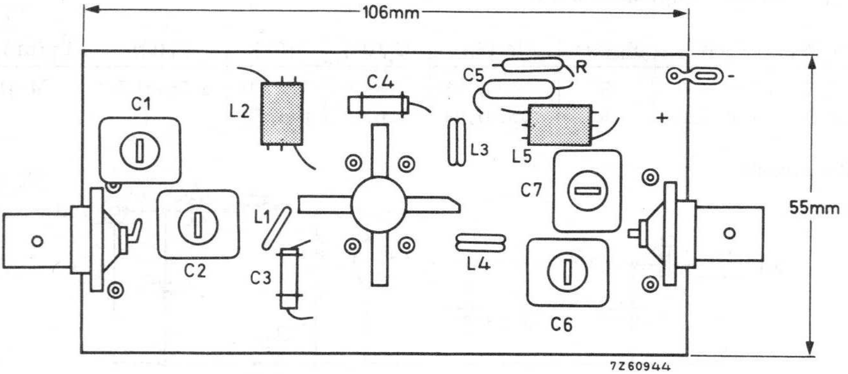
L1 = 0.5 turn enamelled Cu wire (1.5 mm); int. diam. 6 mm; leads 2 x 10 mm
L2 = L5 = ferroxcube choke (code number 4312 020 36640)
L3 = 2.5 turns closely wound enamelled Cu wire (1.5 mm); int. diam. 6 mm; leads 2 x 10 mm
L4 = 4.5 turns enamelled Cu wire (1.5 mm); int. diam. 6 mm; leads 2 x 10 mm

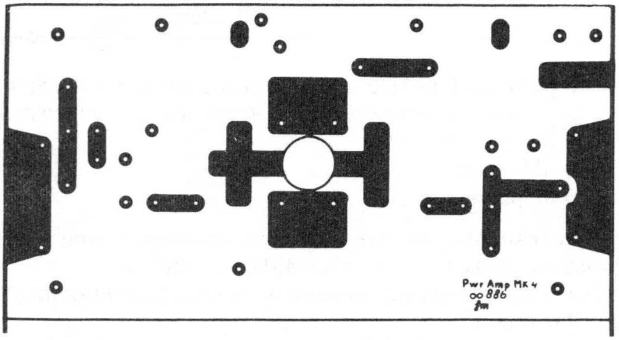
R = 10 Ω carbon

Component lay-out for 175 MHz test circuit see page 6

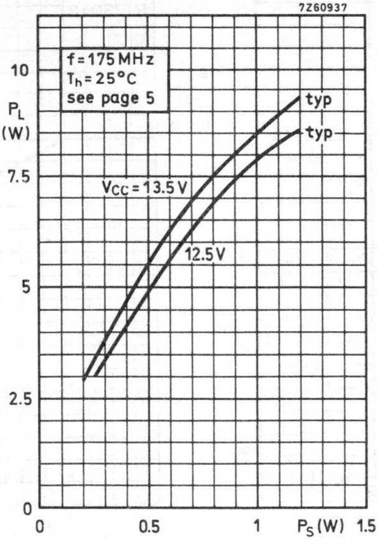
APPLICATION INFORMATION (continued)

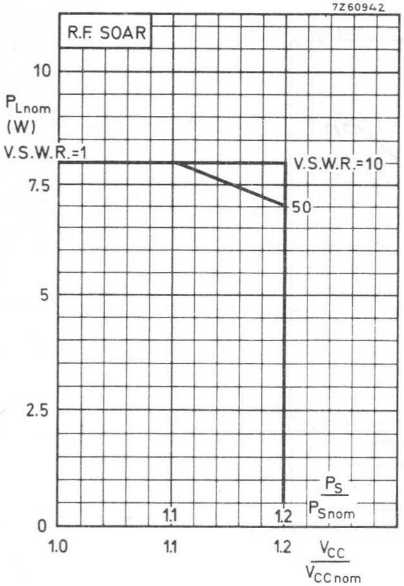
Component lay-out and printed circuit board for 175 MHz test circuit.

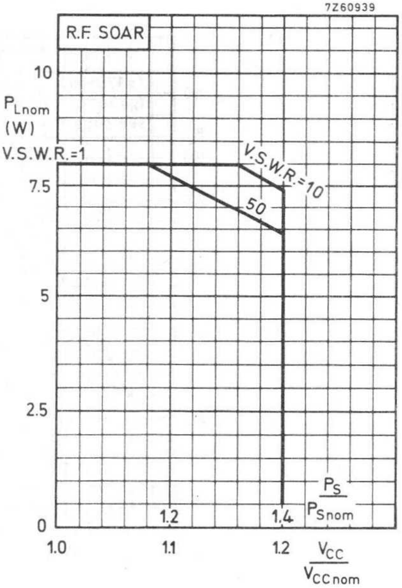




The circuit and the components are situated on one side of the epoxy fibre-glass board, the other side being fully metallised to serve as earth. Earth connections are made by means of hollow rivets.


7Z60937
f = 175 MHz
T_h = 25 °C
see page 5
P_L (W)
10
7.5
5
2.5
0
0
0.5
1
P_S (W)
1.5
typ
typ
V_{CC} = 13.5 V
12.5 V





Conditions for R.F. SOAR:

f = 175 MHz $\quad P_{Snom} = P_S$ at $V_{CC} = V_{CCnom}$ and V.S.W.R. = 1
T_h = 70 °C $\quad R_{th\ mb\text{-}h} = 0.6$ °C/W
V_{CCnom} = 12.5 or 13.5 V see also page 5

The transistor has been developed for use with unstabilized supply voltages. As the output power and drive power increase with the supply voltage, the nominal output power must be derated in accordance with the graphs above for safe operation at supply voltages other than the nominal. The graphs show the allowable output power under nominal conditions, as a function of the supply overvoltage ratio, with V. S. W. R. as parameter.

The left hand graph applies to the situation in which the drive (P_S/P_{Snom}) increases linearly with supply overvoltage ratio.

The right hand graph shows the derating factor to be applied when the drive (P_S/P_{Snom}) increases as the square of the supply overvoltage ratio (V_{CC}/V_{CCnom}).

Depending on the operating conditions, the appropriate derating factor may lie in the region between the linear and the square-law functions.

V.H.F. POWER TRANSISTOR

N-P-N epitaxial planar transistor intended for use in class A, B and C operated mobile, industrial and military transmitters with a supply voltage of 13.5 V. The transistor is resistance stabilized. Every transistor is tested under severe load mismatch conditions with a supply overvoltage to 16.5 V. It has a $\frac{1}{4}$" capstan envelope with a moulded cap. All leads are isolated from the stud.

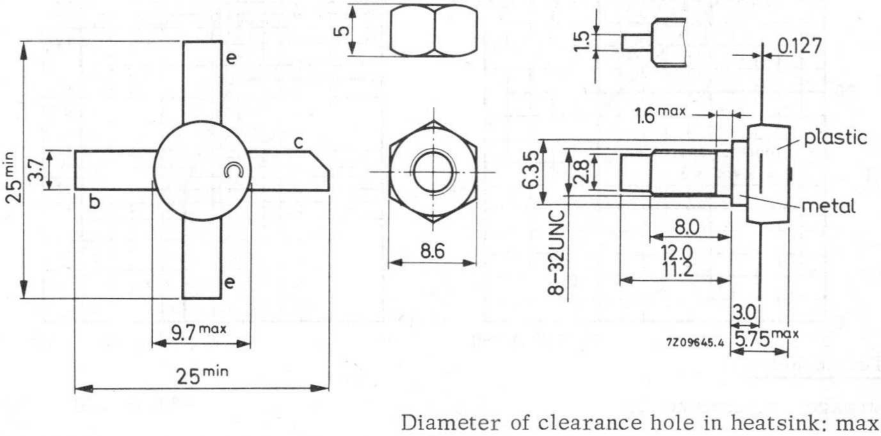
QUICK REFERENCE DATA

R.F. performance up to T_{mb} = 25 °C in an unneutralised common-emitter class B circuit.

Mode of operation	V_{CC} (V)	f (MHz)	P_S (W)	P_L (W)	I_C (A)	G_p (dB)	η (%)	$\overline{z}_i$ (Ω)	$\overline{Y}_L$ (mA/V)
c.w.	13.5	175	< 2.65	15	< 1.71	> 7.5	> 65	2.3+j2.5	120-j7.8
c.w.	12.5	175	typ. 2.65	15	typ. 1.85	typ. 7.5	typ. 65		

MECHANICAL DATA

Dimensions in mm



Torque on nut: min. 7.5 kg cm
(0.75 Newton metres)
max. 8.5 kg cm
(0.85 Newton metres)

Diameter of clearance hole in heatsink: max. 4.17 mm.
Mounting hole to have no burrs at either end. De-burring must leave surface flat; do not chamfer or countersink either end of hole.

When locking is required, an adhesive instead of a lock washer is preferred.

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltages

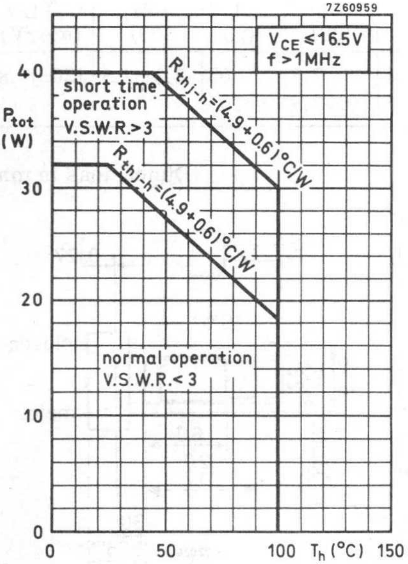
Collector-base voltage (open emitter) peak value	V_{CBOM}	max.	36	V
Collector-emitter voltage (open base)	V_{CEO}	max.	18	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4	V

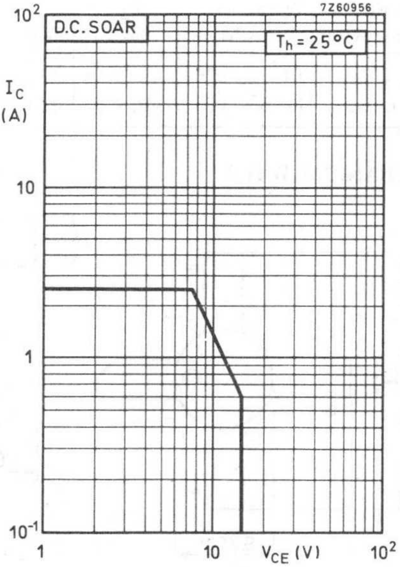
Currents

Collector current (average)	$I_{C(AV)}$	max.	2.5	A
Collector (peak value) f > 1 MHz	I_{CM}	max.	7.5	A

Power dissipation

Total power dissipation up to $T_h = 25\ ^oC$ f > 1 MHz	P_{tot}	max.	32	W





Temperature

Storage temperature	T_{stg}	-30 to +200		^oC
Operating junction temperature	T_j	max.	200	^oC

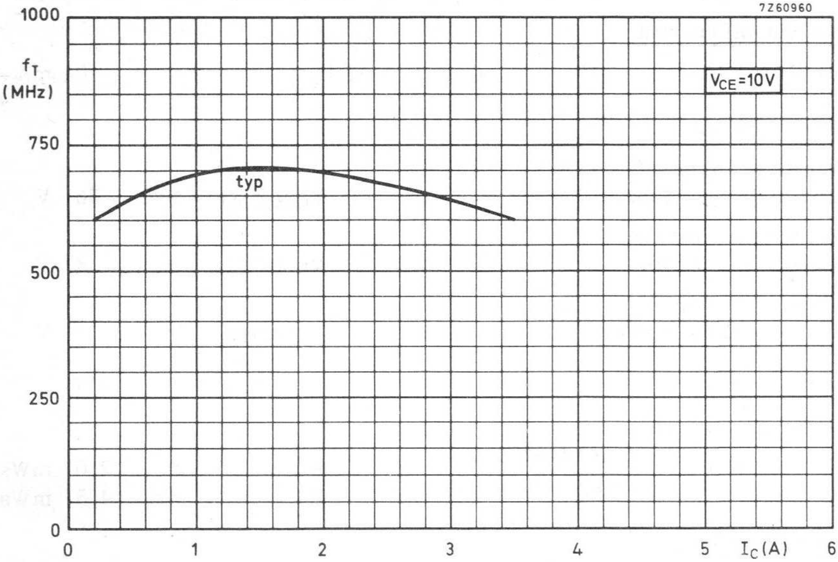
THERMAL RESISTANCE

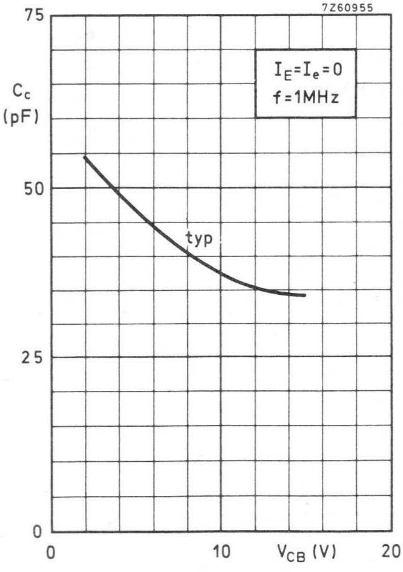
From junction to mounting base	$R_{th\,j-mb}$	=	4.9	$^oC/W$
From mounting base to heatsink	R_{mb-h}	=	0.6	$^oC/W$

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current				
$I_B = 0$; $V_{CE} = 14$ V	I_{CEO}	<	10	mA
Breakdown voltages				
Collector-base voltage open emitter, $I_C = 3$ mA	$V_{(BR)CBO}$	>	36	V
Collector-emitter voltage open base, $I_C = 25$ mA	$V_{(BR)CEO}$	>	18	V
Emitter-base voltage open collector; $I_E = 3$ mA	$V_{(BR)EBO}$	>	4	V
Transient energy				
$L = 25$ mH; $f = 50$ Hz				
open base	E	>	2.0	mWs
$-V_{BE} = 1.5$ V; $R_{BE} = 33\ \Omega$	E	>	4.5	mWs
D.C. current gain				
$I_C = 500$ mA; $V_{CE} = 5$ V	h_{FE}	>	5	
Transition frequency				
$I_C = 1$ A; $V_{CE} = 10$ V	f_T	typ.	700	MHz
Collector capacitance at $f = 1$ MHz				
$I_E = I_e = 0$; $V_{CB} = 15$ V	C_c	typ. <	34 40	pF pF
Feedback capacitance at $f = 1$ MHz				
$I_C = 100$ mA; $V_{CE} = 15$ V	$-C_{re}$	typ.	25	pF
Collector-stud capacitance	C_{cs}	typ.	2	pF


7Z60960
1000
f_T
(MHz)
750
500
250
0
0
1
2
3
4
5
I_C (A)
6
V_{CE}=10V
typ


7Z60955
75
C_c
(pF)
50
25
0
0
10
V_{CB} (V)
20
$I_E = I_e = 0$
f=1MHz
typ

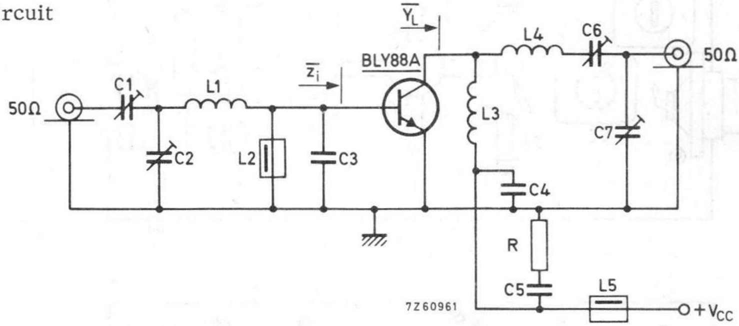
APPLICATION INFORMATION

R.F. performance in c.w. operation (unneutralised common-emitter class B circuit)

f = 175 MHz; T_{mb} up to 25 °C

V_{CC}(V)	P_S(W)	P_L(W)	I_C(A)	G_p(dB)	η(%)	$\overline{z}_i$(Ω)	$\overline{Y}_L$(mA/V)
13.5	< 2.65	15	< 1.71	> 7.5	> 65	2.3+j2.5	120-j7.8
12.5	typ. 2.65	15	typ. 1.85	typ. 7.5	typ. 65		

Test circuit



C1= 2.5 to 20 pF film dielectric trimmer (code number 2222 809 07004)
C2=C6=C7= 4 to 40 pF film dielectric trimmer (code number 2222 809 07008)
C3= 47 pF ceramic
C4= 100 pF ceramic
C5= 150 nF polyester

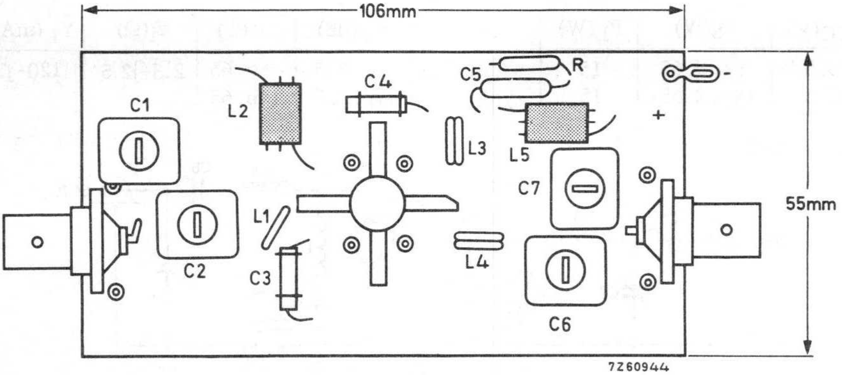
L1= 0.5 turn enamelled Cu wire (1.5 mm); int. diam. 6 mm; leads 2 x 10 mm
L2=L5= ferroxcube choke (code number 4312 020 36640)
L3= 2.5 turns closely wound enamelled Cu wire (1.5 mm); int. diam. 6 mm; leads 2 x 10 mm
L4= 2.5 turns enamelled Cu wire (1.5 mm); int. diam. 6 mm; leads 2 x 10 mm

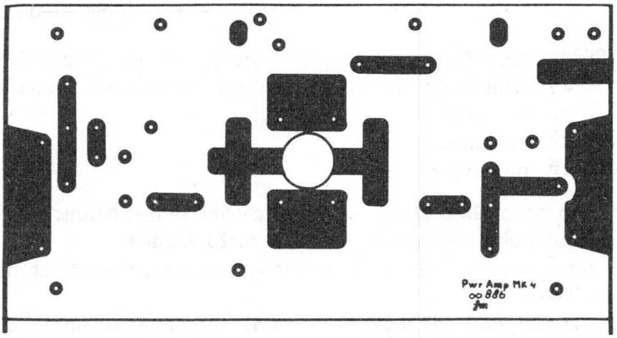
R = 10 Ω carbon

Component lay-out for 175 MHz test circuit see page 6.

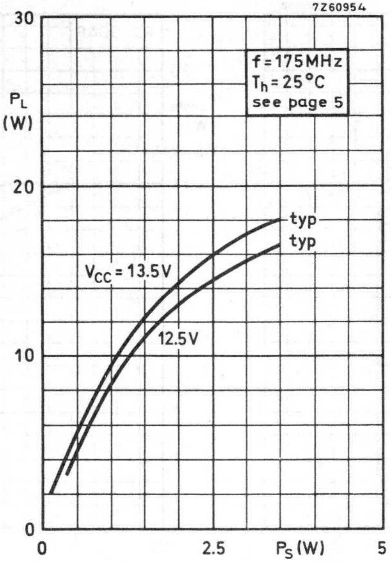
APPLICATION INFORMATION (continued)

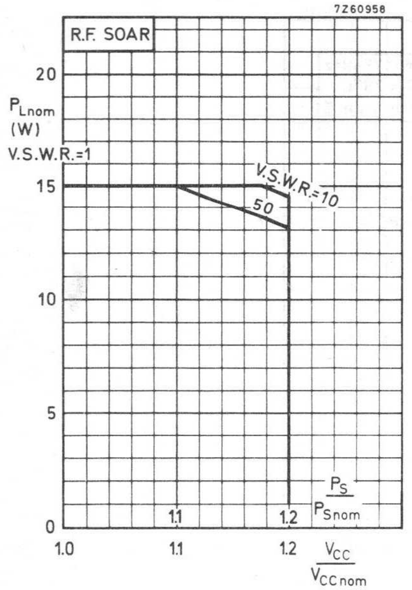
Component lay-out and printed circuit board for 175 MHz test circuit.

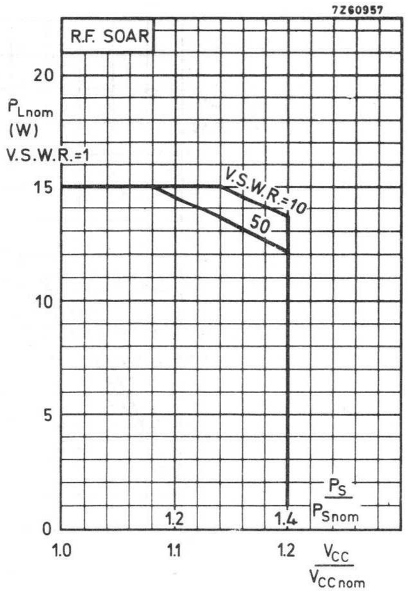




The circuit and the components are situated on one side of the epoxy fibre-glass board, the other side being fully metallised to serve as earth. Earth connections are made by means of hollow rivets.


7Z60954
30
20
10
0
P_L
(W)
f = 175 MHz
T_h = 25 °C
see page 5
typ
typ
V_CC = 13.5 V
12.5 V
0
2.5
P_S (W)
5





Conditions for R.F. SOAR:

f = 175 MHz $P_{Snom} = P_S$ at $V_{CC} = V_{CCnom}$ and V.S.W.R. = 1
T_h = 70 °C $R_{th\,mb\text{-}h}$ = 0.6 °C/W
V_{CCnom} = 12.5 or 13.5 V see also page 5

The transistor has been developed for use with unstabilized supply voltages. As the output power and drive power increase with the supply voltage, the nominal output power must be derated in accordance with the graphs above for safe operation at supply voltages other than the nominal. The graphs show the allowable output power under nominal conditions, as a function of the supply overvoltage ratio, with V.S.W.R. as parameter.
The left hand graph applies to the situation in which the drive (P_S/P_{Snom}) increases linearly with supply overvoltage ratio.
The right hand graph shows the derating factor to be applied when the drive (P_S/P_{Snom}) increases as the square of the supply overvoltage ratio (V_{CC}/V_{CCnom}).
Depending on the operating conditions, the appropriate derating factor may lie in the region between the linear and the square-law functions.

V.H.F. POWER TRANSISTOR

N-P-N epitaxial planar transistor intended for use in class A, B and C operated mobile, industrial and military transmitters with a supply voltage of 13.5 V. The transistor is resistance stabilized. Every transistor is tested under severe load mismatch conditions with a supply overvoltage to 16.5 V. It has a $\frac{1}{4}$" capstan envelope with a moulded cap. All leads are isolated from the stud.

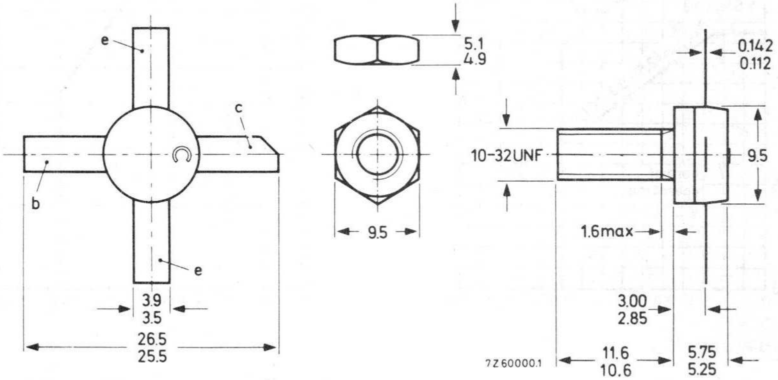
QUICK REFERENCE DATA

R. F. performance up to T_{mb} = 25 °C in an unneutralised common-emitter class B circuit.

Mode of operation	V_{CC} (V)	f (MHz)	P_S (W)	P_L (W)	I_C (A)	G_p (dB)	η (%)	$\overline{z}_i$ (Ω)	$\overline{Y}_L$ (mA/V)
c.w.	13.5	175	< 6.25	25	<2.64	> 6	>70	1.7+j1.4	209+j13.7

MECHANICAL DATA

Dimensions in mm



Torque on nut: min. 15 kg cm
(1.5 Newton metres)
max. 17 kg cm
(1.7 Newton metres)

Diameter of clearance hole in heatsink: max. 5.0 mm.
Mounting hole to have no burrs at either end. De-burring must leave surface flat; do not chamfer or countersink either end of hole.

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltages

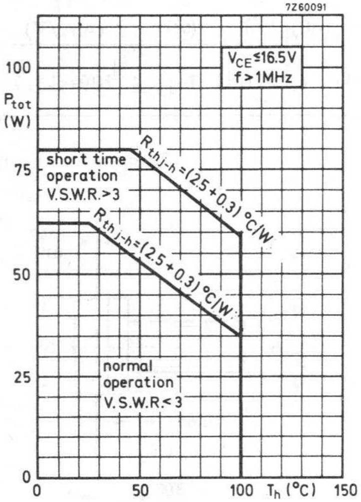
Collector-base voltage (open emitter) peak value	V_{CBOM}	max.	36	V
Collector-emitter voltage (open base)	V_{CEO}	max.	18	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4	V

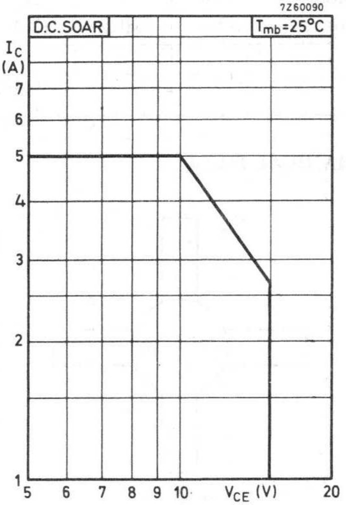
Currents

Collector current (average)	$I_{C(AV)}$	max.	5	A
Collector current (peak value) f > 1 MHz	I_{CM}	max.	10	A

Power dissipation

Total power dissipation up to T_{mb} = 25 °C f > 1 MHz	P_{tot}	max.	70	W





Temperature

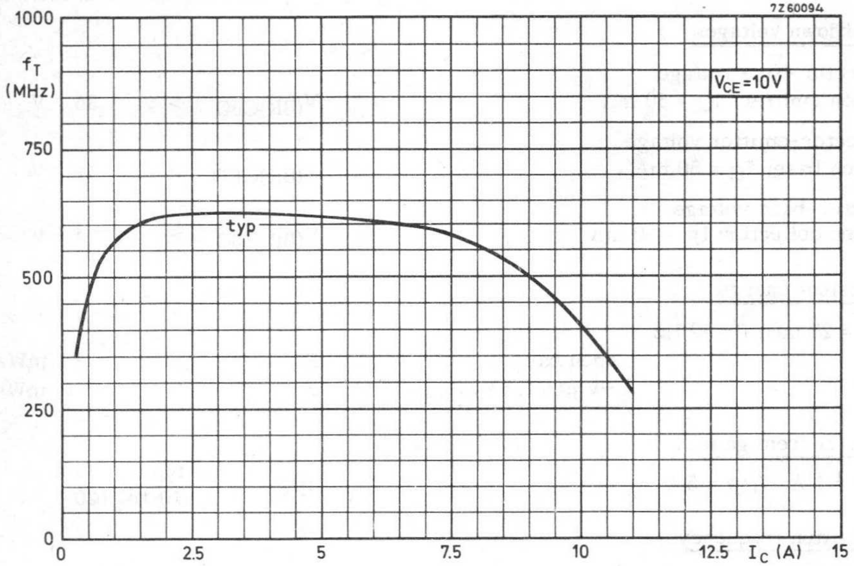
Storage temperature	T_{stg}	−30 to +200	°C
Operating junction temperature	T_j	max. 200	°C

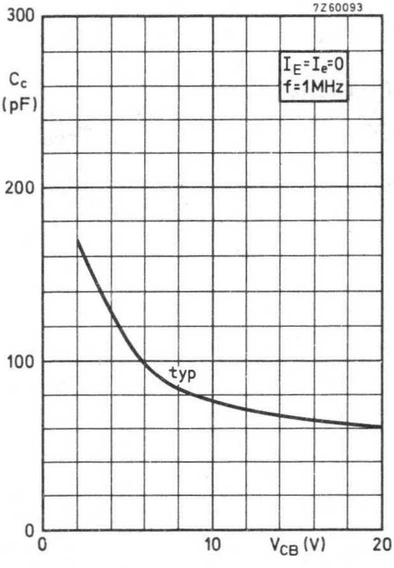
THERMAL RESISTANCE

From junction to mounting base	$R_{th\,j-mb}$	=	2.5	°C/W
From mounting base to heatsink	$R_{th\,mb-h}$	=	0.3	°C/W

CHARACTERISTICS $T_j = 25\,^{o}C$ unless otherwise specified

Breakdown voltages				
Collector-base voltage open emitter, I_C = 50 mA	$V_{(BR)CBO}$	>	36	V
Collector-emitter voltage open base, I_C = 50 mA	$V_{(BR)CEO}$	>	18	V
Emitter-base voltage open collector; I_E = 10 mA	$V_{(BR)EBO}$	>	4	V
Transient energy				
L = 25 mH; f = 50 Hz				
open base	E	>	8	mWs
$-V_{BE}$ = 1.5 V; R_{BE} = 33 Ω	E	>	8	mWs
D.C. current gain				
I_C = 1 A; V_{CE} = 5 V	h_{FE}	typ.	50	
		10 to	120	
Transition frequency				
I_C = 4 A; V_{CE} = 10 V	f_T	typ.	650	MHz
Collector capacitance at f = 1 MHz				
$I_E = I_e$ = 0; V_{CB} = 15 V	C_c	typ.	65	pF
		<	90	pF
Feedback capacitance at f = 1 MHz				
I_C = 100 mA; V_{CE} = 15 V	$-C_{re}$	typ.	41	pF
Collector-stud capacitance	C_{cs}	typ.	2	pF


7Z60094
1000
f_T
(MHz)
750
500
250
0
0
2.5
5
7.5
10
12.5
I_C (A)
15
V_CE=10V
typ


7Z60093
300
C_c
(pF)
200
100
0
0
10
V_CB (V)
20
I_E=I_e=0
f=1MHz
typ

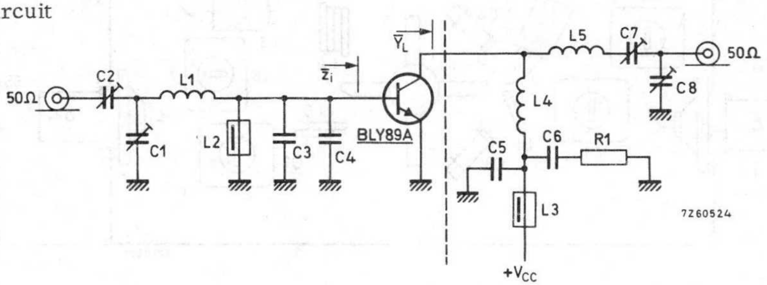
APPLICATION INFORMATION

R. F. performance in c. w. operation (unneutralised common-emitter class B circuit)

V_{CC} = 13.5 V; T_{mb} up to 25 °C

f(MHz)	P_S (W)	P_L (W)	I_C (A)	G_p (dB)	η(%)	$\overline{z}_i$ (Ω)	$\overline{Y}_L$ (mA/V)
175	< 6.25	25	< 2.64	> 6	> 70	1.7+j1.4	209+j13.7

Test circuit



C1 = 4 to 44 pF film dielectric trimmer (code number 2222 809 07008)
C2 = 2 to 22 pF film dielectric trimmer (code number 2222 809 07004)
C3 = C4 = 47 pF ceramic
C5 = 100 pF ceramic
C6 = 150 nF polyester
C7 = 4 to 104 pF film dielectric trimmer (code number 2222 809 07015)
C8 = 4 to 64 pF film dielectric trimmer (code number 2222 809 07011)

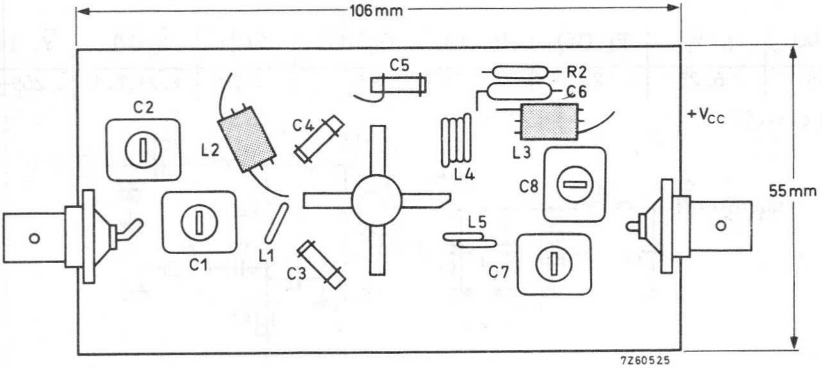
L1 = 0.5 turn enamelled Cu wire (1.5 mm); int.diam. 6 mm; leads 2x6 mm
L2 = L3 = ferroxcube choke (code number 4312 020 36640)
L4 = 3.5 turns closely wound enamelled Cu wire (1.5 mm); int.diam. 6 mm; leads 2x6 mm
L5 = 1 turn enamelled Cu wire (1.5 mm); int.diam. 6 mm; leads 2x6 mm

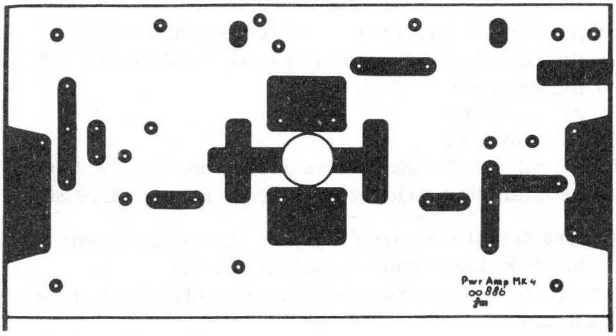
R1 = 10 Ω carbon

Component lay-out for 175 MHz see page 6.

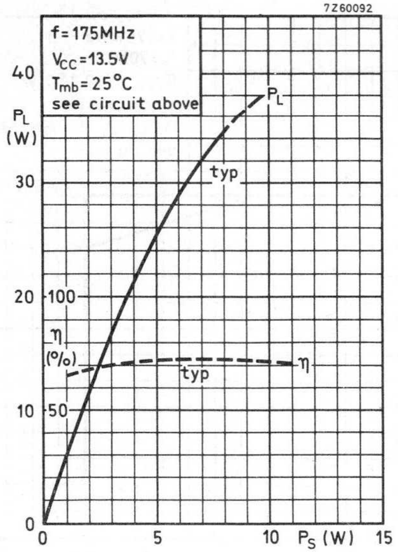
APPLICATION INFORMATION (continued)

Component lay-out and printed circuit board for 175 MHz test circuit.





The circuit and the components are situated on one side of the epoxy fibre-glass board, the other side being fully metallised to serve as earth. Earth connections are made by means of hollow rivets.

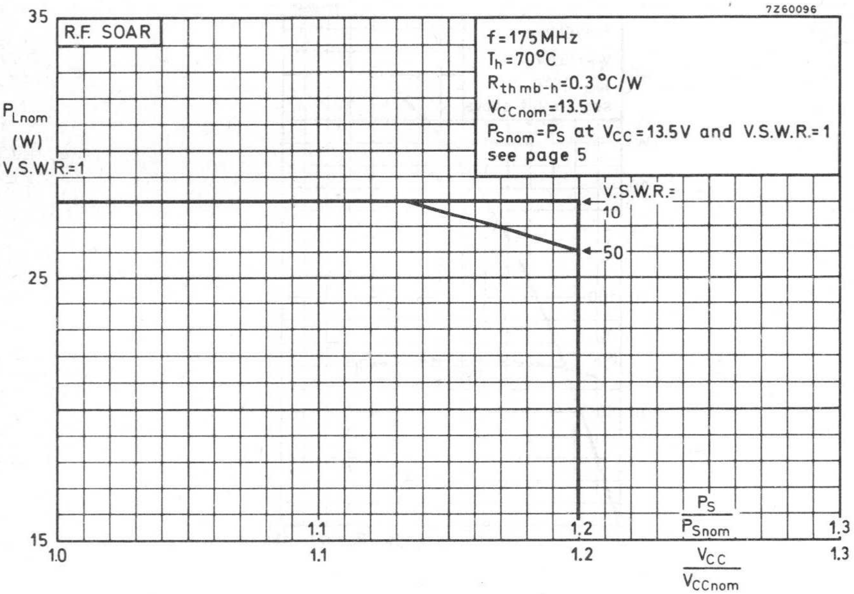


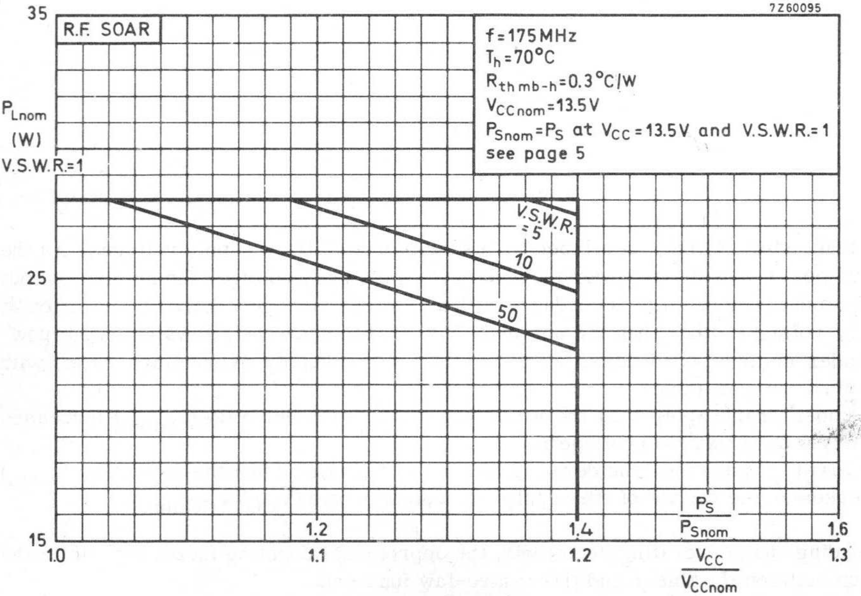
The transistor has been developed for use with unstabilized supply voltages. As the output power and drive power increase with the supply voltage, the nominal output power must be derated in accordance with the graphs on page 7 for safe operation at supply voltages other than the nominal. The graphs show the allowable output power under nominal conditions, as a function of the supply overvoltage ratio, with V.S.W.R. as parameter

The upper graph applies to the situation in which the drive (P_S/P_{Snom}) increases linearly with supply overvoltage ratio.

The lower graph shows the derating factor to be applied when the drive (P_S/P_{Snom}) increases as the square of the supply overvoltage ratio (V_{CC}/V_{CCnom}).

Depending on the operating conditions, the appropriate derating factor may lie in the region between the linear and the square-law functions.


7Z60096
R.F. SOAR
f = 175 MHz
T_h = 70 °C
$R_{th\,mb-h}$ = 0.3 °C/W
V_{CCnom} = 13.5 V
$P_{Snom} = P_S$ at V_{CC} = 13.5 V and V.S.W.R. = 1
see page 5
P_{Lnom}
(W)
V.S.W.R. = 1
35
25
15
V.S.W.R. =
10
50
1.0
1.1
1.2
1.3
$\frac{P_S}{P_{Snom}}$
$\frac{V_{CC}}{V_{CCnom}}$


7Z60095
R.F. SOAR
f = 175 MHz
T_h = 70 °C
$R_{th\,mb-h}$ = 0.3 °C/W
V_{CCnom} = 13.5 V
$P_{Snom} = P_S$ at V_{CC} = 13.5 V and V.S.W.R. = 1
see page 5
P_{Lnom}
(W)
V.S.W.R. = 1
35
25
15
V.S.W.R. = 5
10
50
1.2
1.4
1.6
1.0
1.1
1.2
1.3
$\frac{P_S}{P_{Snom}}$
$\frac{V_{CC}}{V_{CCnom}}$

V.H.F. POWER TRANSISTOR

N-P-N epitaxial planar transistor intended for use in class A, B and C operated mobile, industrial and military transmitters with a supply voltage of 12.5 V. The transistor is resistance stabilized. Every transistor is tested under severe load mismatch conditions with a supply overvoltage to 15 V. It has a plastic encapsulated stripline package. All leads are isolated from the stud.

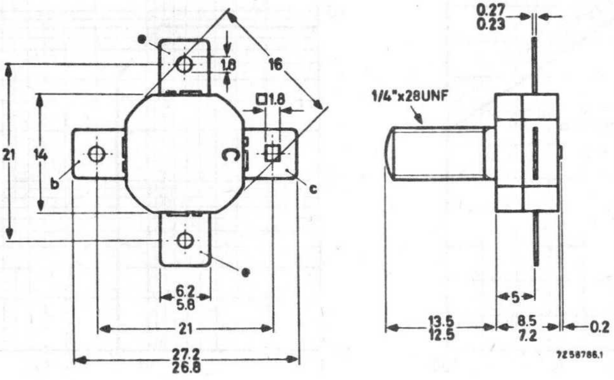
QUICK REFERENCE DATA

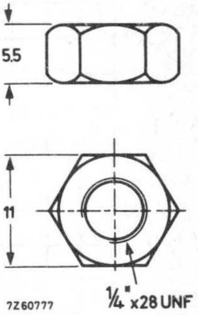
R.F. performance up to T_h = 25 °C in an unneutralised common-emitter class B circuit.

Mode of operation	V_{CC} (V)	f (MHz)	P_S (W)	P_L (W)	I_C (A)	G_p (dB)	η (%)	$\overline{z_i}$ (Ω)	$\overline{Y_L}$ (mA/V)
c.w.	12.5	175	< 15.8	50	< 5.33	> 5.0	> 75	1.3+j1.6	270+j160

MECHANICAL DATA

Dimensions in mm





Torque on nut: min. 23 kg cm
(2.3 Newton metres)
max. 27 kg cm
(2.7 Newton metres)

Diameter of clearance hole in heatsink: max. 6.5 mm.
Mounting hole to have no burrs at either end.
De-burring must leave surface flat; do not chamfer or countersink either end of hole.

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltages

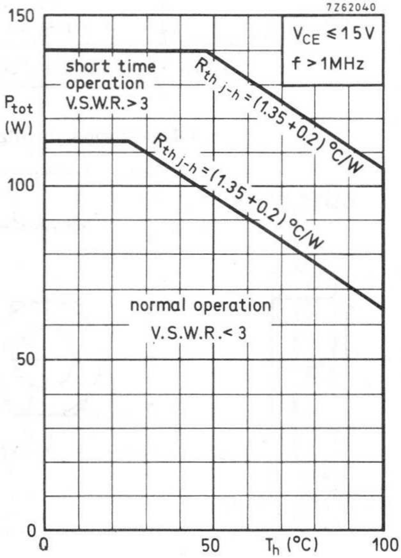
Collector-base voltage (open emitter) peak value	V_{CBOM}	max.	36	V
Collector-emitter voltage (open base)	V_{CEO}	max.	18	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4	V

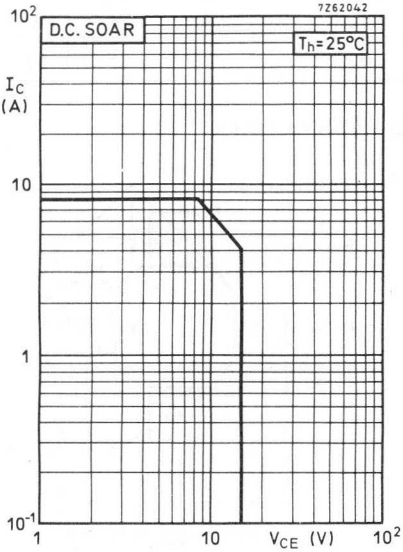
Currents

Collector current (average)	$I_{C(AV)}$	max.	8	A
Collector current (peak value) f > 1 MHz	I_{CM}	max.	20	A

Power dissipation

Total power dissipation up to T_{mb} = 25 °C f > 1 MHz	P_{tot}	max.	130	W





Temperature

Storage temperature	T_{stg}	−65 to +200	°C
Operating junction temperature	T_j	max. 200	°C

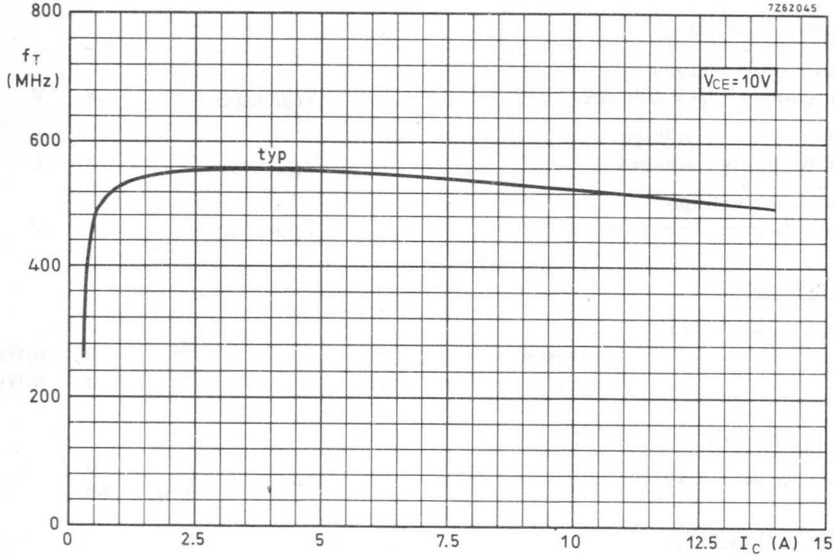
THERMAL RESISTANCE

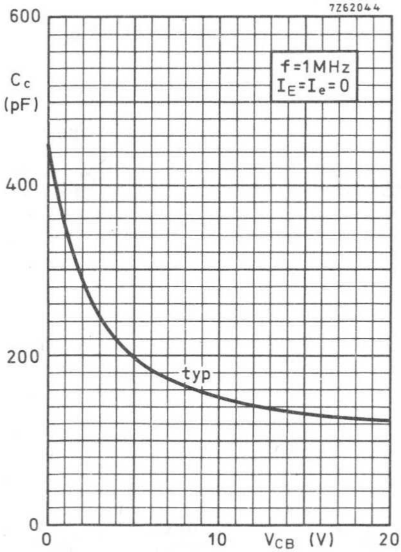
From junction to mounting base	$R_{th\ j-mb}$	=	1.35	°C/W
From mounting base to heatsink	$R_{th\ mb-h}$	=	0.2	°C/W

CHARACTERISTICS

$T_j = 25\ ^oC$ unless otherwise specified

Breakdown voltages				
Collector-base voltage open emitter, $I_C = 100$ mA	$V_{(BR)CBO}$	>	36	V
Collector-emitter voltage open base, $I_C = 100$ mA	$V_{(BR)CEO}$	>	18	V
Emitter-base voltage open collector, $I_E = 25$ mA	$V_{(BR)EBO}$	>	4	V
Transient energy				
L = 25 mH; f = 50 Hz				
open base	E	>	8	mWs
$-V_{BE} = 1.5$ V; $R_{BE} = 33\ \Omega$	E	>	8	mWs
D.C. current gain				
$I_C = 1$ A; $V_{CE} = 5$ V	h_{FE}	> typ.	10 50	
Transition frequency				
$I_C = 6$ A; $V_{CE} = 10$ V	f_T	typ.	550	MHz
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; $V_{CB} = 15$ V	C_c	typ. <	130 160	pF pF
Feedback capacitance				
$I_C = 200$ mA; $V_{CE} = 15$ V	$-C_{re}$	typ.	82	pF
Collector-stud capacitance	C_{cs}	typ.	3.5	pF


7Z62045
800
600
400
200
0
f_T
(MHz)
V_{CE} = 10V
typ
0
2.5
5
7.5
10
12.5
I_C (A)
15


7Z62044
600
400
200
0
C_c
(pF)
f = 1 MHz
I_E = I_e = 0
typ
0
10
V_{CB} (V)
20

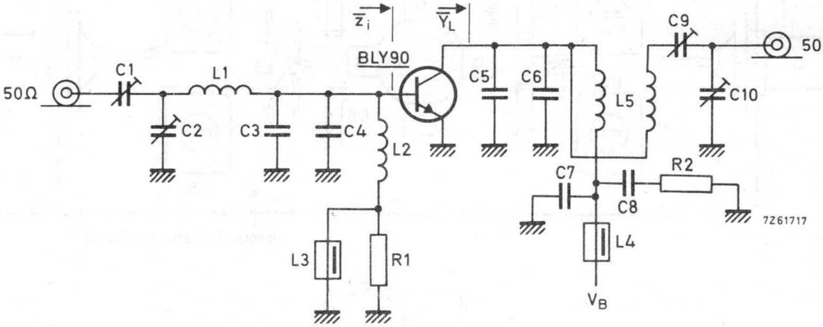
APPLICATION INFORMATION

R. F. performance in c.w. operation (unneutralised common-emitter class B circuit)

f = 175 MHz; T_h up to 25 °C

V_{CC} (V)	P_S (W)	P_L (W)	I_C (A)	G_p (dB)	η (%)	$\overline{z_i}$ (Ω)	$\overline{Y_L}$ (mA/V)
12.5	< 15.8	50	< 5.33	> 5.0	> 75	1.3+j1.6	270+j160

Test circuit for 175 MHz:



C1 = 2 to 20 pF film dielectric trimmer
C2 = 4 to 40 pF film dielectric trimmer
C3 = C4 = C5 = C6 = 56 pF ceramic
C7 = 100 pF ceramic
C8 = 100 nF polyester
C9 = 4 to 80 pF film dielectric trimmer
C10 = 4 to 60 pF film dielectric trimmer

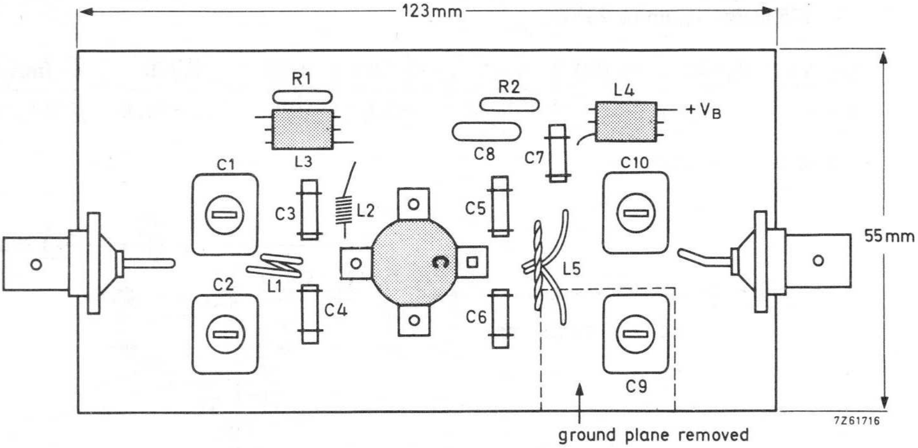
L1 = 1.5 turns enamelled Cu wire (1.5 mm); int. diam. 6 mm; length 4 mm; leads 2 x 5 mm
L2 = 7 turns closely wound enamelled Cu wire (0.5 mm); int. diam. 3 mm; leads 2 x 5 mm
L3 = L4 = ferroxcube choke (code number 4312 020 36640)
L5 = bifilar wound enamelled Cu wire (1.0 mm); see figure on page 6

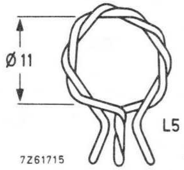
R1 = 10 Ω carbon
R2 = 4.7 Ω carbon

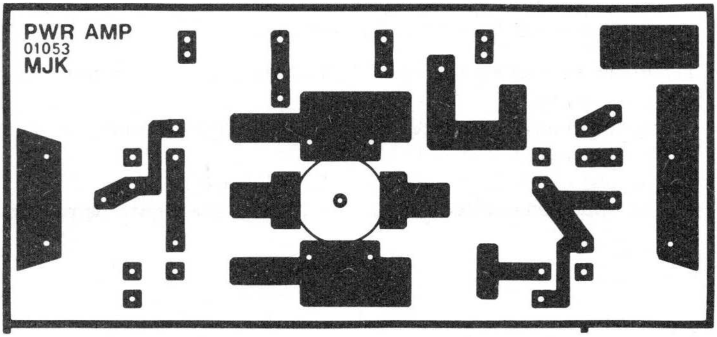
Component lay-out for 175 MHz see page 6.

APPLICATION INFORMATION (continued)

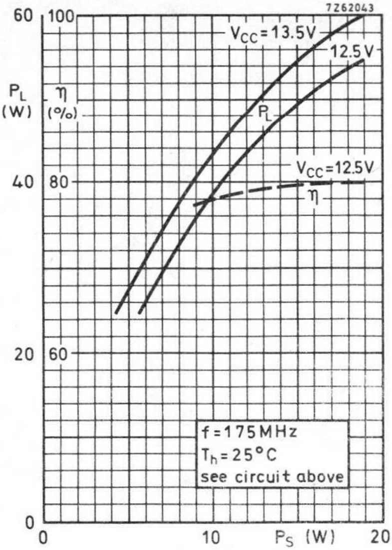
Component lay-out and printed circuit board for 175 MHz test circuit.

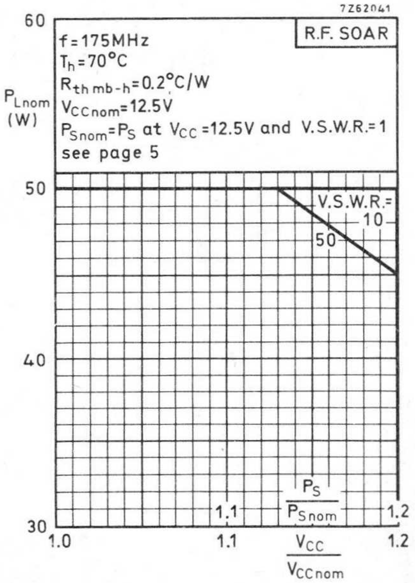






The circuit and the components are situated on one side of the epoxy fibre-glass board, the other side being fully metallized to serve as earth. Earth connections are made by means of hollow rivets.





The transistor has been developed for use with unstabilized supply voltages. As the output power and drive power increase with the supply voltage, the nominal output power (P_{Lnom}) must be derated in accordance with the adjacent graph for safe operation at supply voltage other than the nominal. The graph shows the allowable output power under nominal conditions, as a function of the supply overvoltage ratio with V.S.W.R. as parameter. The graph applies to the situation in which the drive (P_S/P_{Snom}) increases linearly with supply overvoltage ratio ($V_{CC} = V_{CCnom}$).

V.H.F. POWER TRANSISTOR

N-P-N epitaxial planar transistor intended for use in class A, B and C operated mobile, industrial and military transmitters with a supply voltage of 28 V. The transistor is resistance stabilized. Every transistor is tested under severe load mismatch conditions. It has a $\frac{1}{4}$" capstan envelope with a moulded cap. All leads are isolated from the stud.

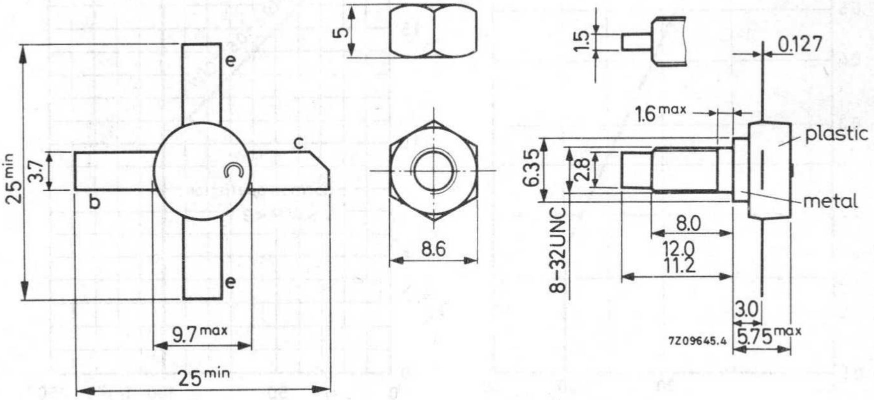
QUICK REFERENCE DATA

R.F. performance up to T_{mb} = 25 °C in an unneutralised common-emitter class B circuit

Mode of operation	V_{CC} (V)	f (MHz)	P_S (W)	P_L (W)	I_C (A)	G_p (dB)	η (%)	$\overline{z_i}$ (Ω)	$\overline{Y_L}$ (mA/V)
c.w.	28	175	< 0.50	8	< 0.44	> 12	> 65	1.8+j1.0	17-j20

MECHANICAL DATA

Dimensions in mm



Torque on nut: min. 7.5 kg cm
(0.75 Newton metres)
max. 8.5 kg cm
(0.85 Newton metres)

Diameter of clearance hole in heatsink: max. 4.17 mm
Mounting hole to have no burrs at either end
De-burring must leave surface flat; do not chamfer or countersink either end of hole.

When locking is required, an adhesive instead of a lock washer is preferred.

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltages

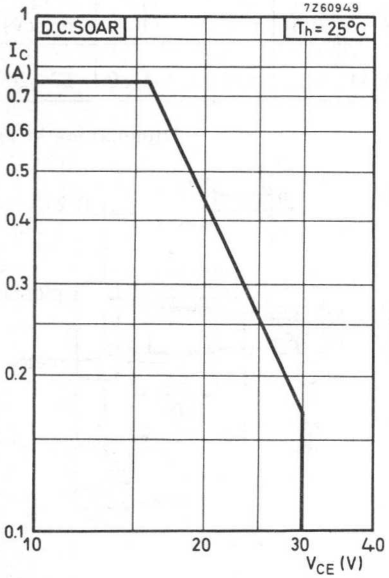
Collector-base voltage (open emitter) peak value	V_{CBOM}	max.	65	V
Collector-emitter voltage (open base)	V_{CEO}	max.	36	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4	V

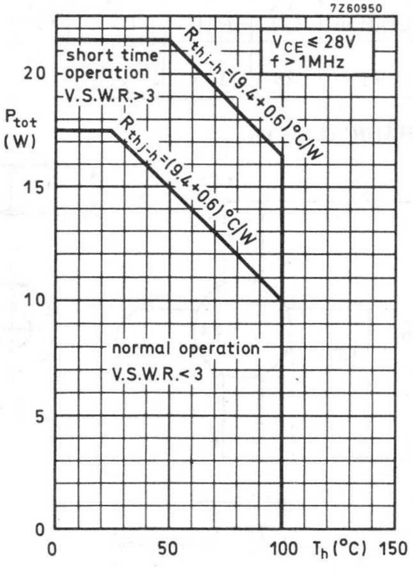
Currents

Collector current (average)	$I_{C(AV)}$	max.	0.75	A
Collector current (peak value) f > 1 MHz	I_{CM}	max.	2.25	A

Power dissipation

Total power dissipation up to T_h = 25 °C f > 1 MHz	P_{tot}	max.	17.5	W





Temperatures

Storage temperature	T_{stg}		−30 to +200	°C
Operating junction temperature	T_j	max.	200	°C

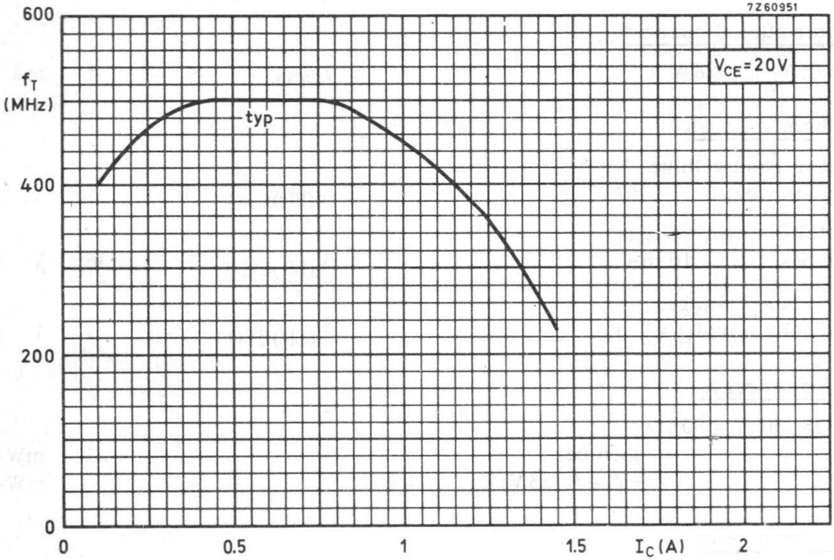
THERMAL RESISTANCE

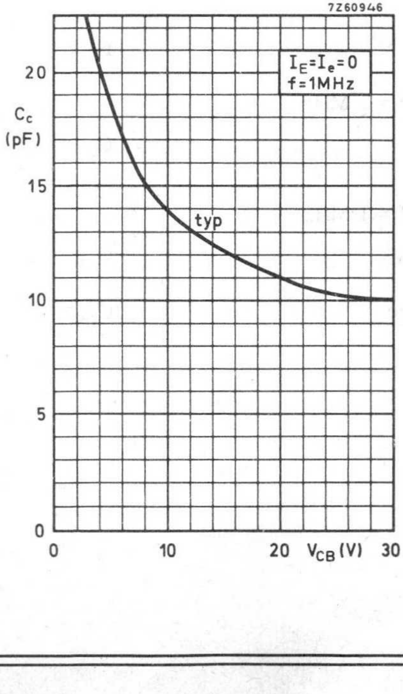
From junction to mounting base	$R_{th\,j\text{-}mb}$	=	9.4	°C/W
From mounting base to heatsink	$R_{th\,mb\text{-}h}$	=	0.6	°C/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current				
$I_B = 0$; $V_{CE} = 28$ V	I_{CEO}	<	5	mA
Breakdown voltages				
Collector-base voltage open emitter; $I_C = 1$ mA	$V_{(BR)CBO}$	>	65	V
Collector-emitter voltage open base, $I_C = 10$ mA	$V_{(BR)CEO}$	>	36	V
Emitter-base voltage open collector; $I_E = 1$ mA	$V_{(BR)EBO}$	>	4	V
Transient energy				
L = 25 mH; f = 50 Hz				
open base	E	>	0.5	mWs
$-V_{BE} = 1.5$ V; $R_{BE} = 33\ \Omega$	E	>	0.5	mWs
D.C. current gain				
$I_C = 500$ mA; $V_{CE} = 5$ V	h_{FE}	>	5	
Transition frequency				
$I_C = 400$ mA; $V_{CE} = 20$ V	f_T	typ.	500	MHz
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; $V_{CB} = 30$ V	C_c	typ. <	10 15	pF pF
Feedback capacitance at f = 1 MHz				
$I_C = 50$ mA; $V_{CE} = 30$ V	$-C_{re}$	typ.	7.5	pF
Collector-stud capacitance	C_{cs}	typ.	2	pF


7Z60951
600
f_T
(MHz)
400
200
0
0
0.5
1
1.5
I_C (A)
2
V_{CE} = 20V
typ


7Z60946
20
C_c
(pF)
15
10
5
0
0
10
20
V_{CB} (V)
30
$I_E = I_e = 0$
f = 1MHz
typ

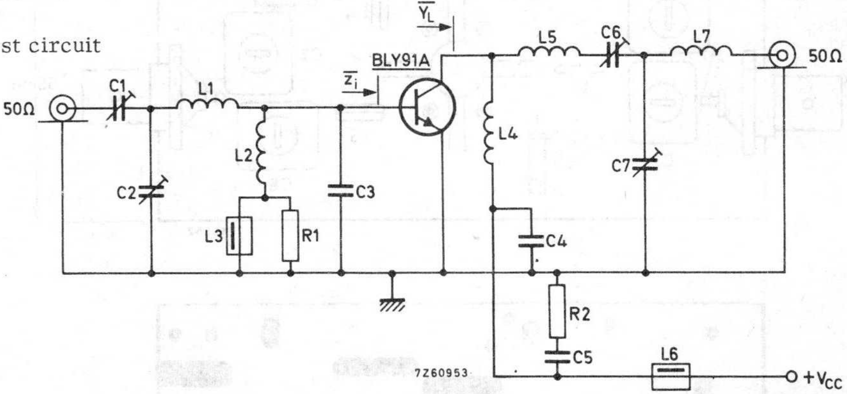
APPLICATION INFORMATION

R.F. performance in c.w. operation (unneutralised common-emitter class B circuit)

V_{CC} = 28 V; T_{mb} up to 25 °C

f(MHz)	P_S (W)	P_L (W)	I_C (A)	G_p (dB)	η(%)	$\overline{z_i}$ (Ω)	$\overline{Y_L}$ (mA/V)
175	< 0.50	8	< 0.44	> 12	> 65	1.8+j1.0	17-j20

Test circuit



C1 = 2.5 to 20 pF film dielectric trimmer (code number 2222 809 07004)
C2 = C6 = C7 = 4 to 40 pF film dielectric trimmer (code number 2222 809 07008)
C3 = 47 pF ceramic
C4 = 100 pF ceramic
C5 = 150 nF polyester

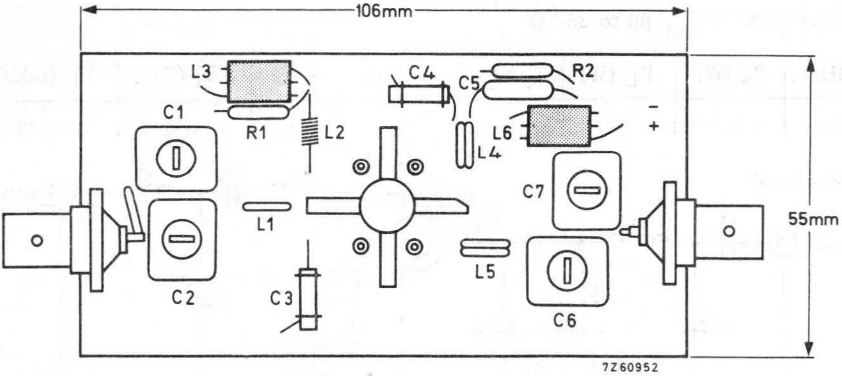
L1 = 0.5 turn enamelled Cu wire (1.5 mm); int. diam. 6 mm; leads 2 x 10 mm
L2 = 6.5 turns closely wound enamelled Cu wire (0.7 mm); int. diam. 4 mm; leads 2 x 5 mm
L3 = L6 = ferroxcube choke (code number 4312 020 36640)
L4 = 7.5 turns enamelled Cu wire (0.7 mm); int. diam. 4 mm; leads 2 x 5 mm
L5 = 4.5 turns enamelled Cu wire (0.7 mm); int. diam. 6 mm; leads 2 x 7 mm
L7 = 3.5 turns enamelled Cu wire (0.7 mm); int. diam. 6 mm; leads 2 x 7 mm

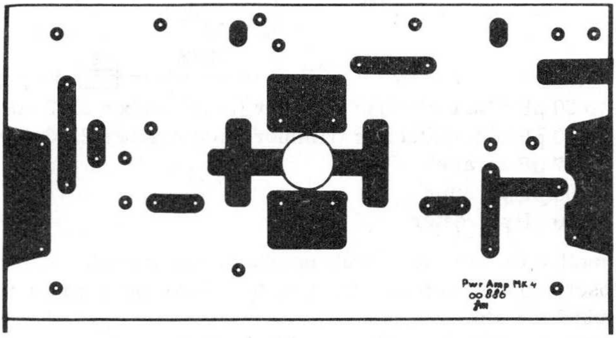
R1 = R2 = 10 Ω carbon

Component lay-out for 175 MHz test circuit see page 6.

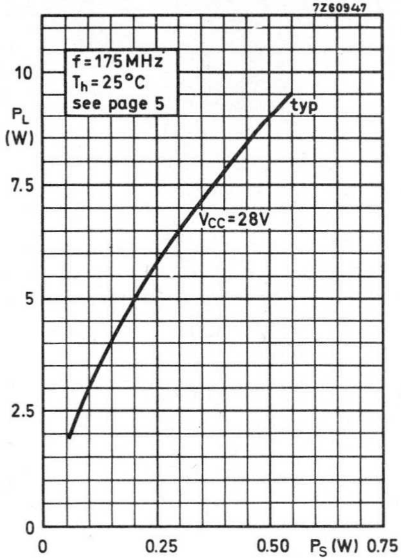
APPLICATION INFORMATION (continued)

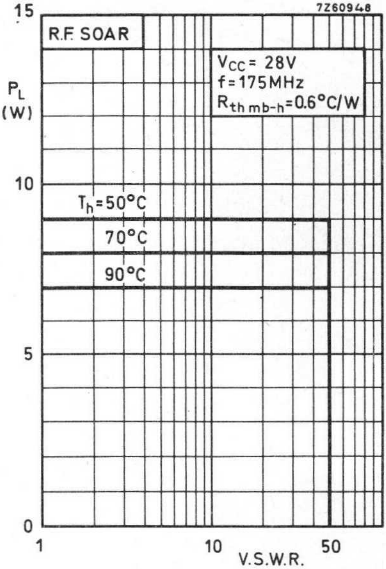
Component lay-out and printed circuit board for 175 MHz test circuit.





The circuit and the components are situated on one side of the epoxy fibre-glass board, the other side being fully metallised to serve as earth. Earth connections are made by means of hollow rivets.





For high voltage operation, a stabilized power supply is generally used.
The graph shows the allowable output power under nominal conditions as a function of the V.S.W.R., with heat-sink temperature as parameter.

V.H.F. POWER TRANSISTOR

N-P-N epitaxial planar transistor intended for use in class A, B and C operated mobile, industrial and military transmitters with a supply voltage of 28 V. The transistor is resistance stabilized. Every transistor is tested under severe load mismatch conditions. It has a $\frac{1}{4}$" capstan envelope with a moulded cap. All leads are isolated from the stud.

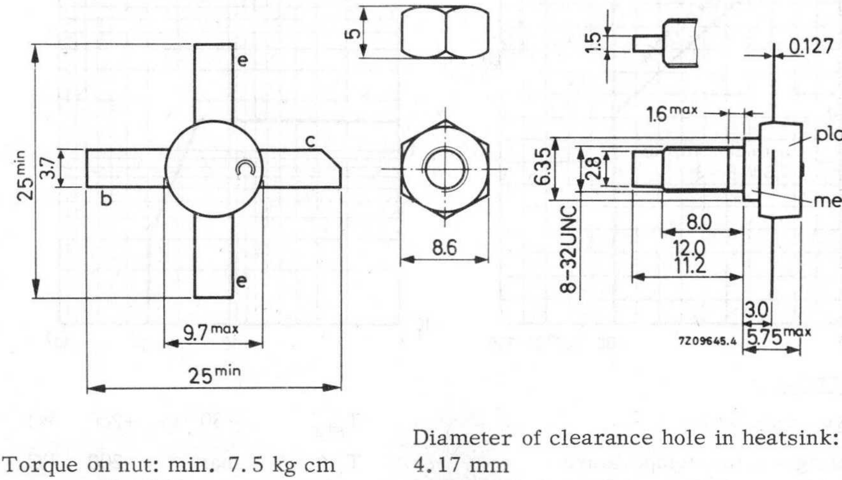
QUICK REFERENCE DATA

R.F. performance up to T_{mb} = 25 °C in an unneutralised common-emitter class B circuit

Mode of operation	V_{CC} (V)	f (MHz)	P_S (W)	P_L (W)	I_C (A)	G_p (dB)	η (%)	$\overline{z_i}$ (Ω)	$\overline{Y_L}$ (mA/V)
c.w.	28	175	< 1.5	15	< 0.83	> 10	> 65	1.4+j2.15	32-j28

MECHANICAL DATA

Dimensions in mm



Torque on nut: min. 7.5 kg cm
(0.75 Newton metres)
max. 8.5 kg cm
(0.85 Newton metres)

Diameter of clearance hole in heatsink: max. 4.17 mm
Mounting hole to have no burrs at either end
De-burring must leave surface flat; do not chamfer or countersink either end of hole.

When locking is required, an adhesive instead of a lock washer is preferred.

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltages

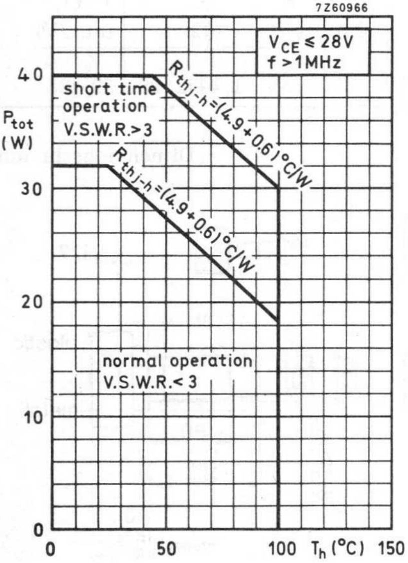
Collector-base voltage (open emitter) peak value	V_{CBOM}	max.	65	V
Collector-emitter voltage (open base)	V_{CEO}	max.	36	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4	V

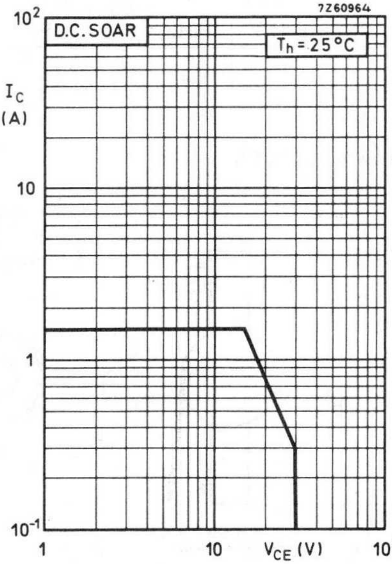
Currents

Collector current (average)	$I_{C(AV)}$	max.	1.5	A
Collector current (peak value) f > 1 MHz	I_{CM}	max.	4.5	A

Power dissipation

Total power dissipation up to T_h = 25 °C f > 1 MHz	P_{tot}	max.	32	W





Temperatures

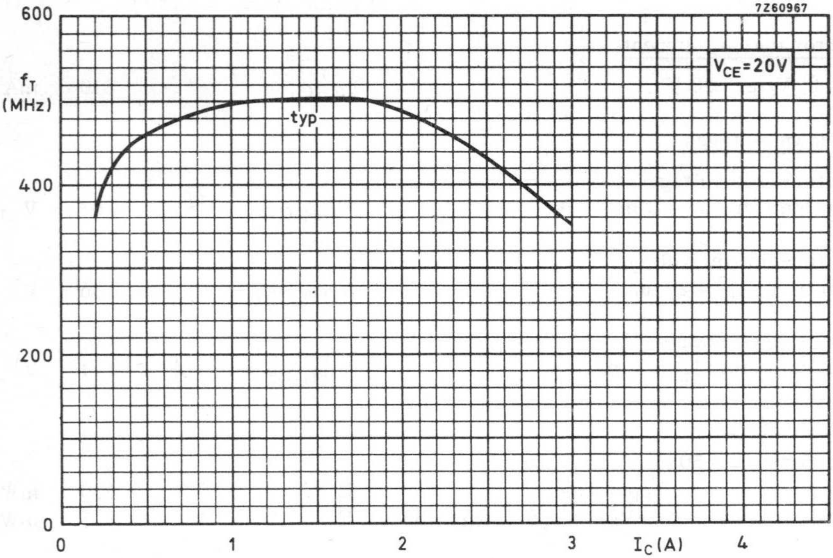
Storage temperature	T_{stg}	−30 to	+200	°C
Operating junction temperature	T_j	max.	200	°C

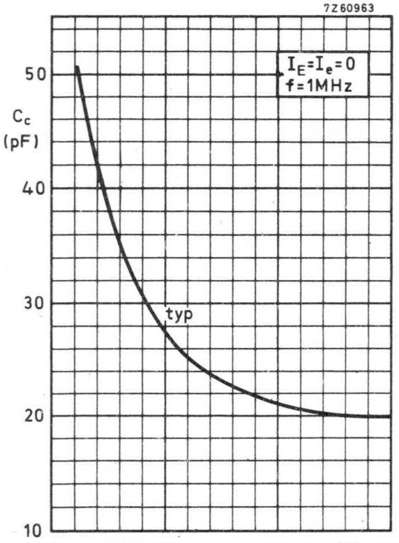
THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j-mb}$	=	4.9	°C/W
From mounting base to heatsink	$R_{th\ mb-h}$	=	0.6	°C/W

CHARACTERISTICS $T_j = 25\ ^{o}C$ unless otherwise specified

Collector cut-off current				
$I_B = 0$; $V_{CE} = 28$ V	I_{CEO}	<	10	mA
Breakdown voltages				
Collector-base voltage open emitter, $I_C = 3$ mA	$V_{(BR)CBO}$	>	65	V
Collector-emitter voltage open base, $I_C = 25$ mA	$V_{(BR)CEO}$	>	36	V
Emitter-base voltage open collector; $I_E = 3$ mA	$V_{(BR)EBO}$	>	4	V
Transient energy				
L = 25 mH; f = 50 Hz				
open base	E	>	2.0	mWs
$-V_{BE} = 1.5$ V; $R_{BE} = 33\ \Omega$	E	>	4.5	mWs
D.C. current gain				
$I_C = 500$ mA; $V_{CE} = 5$ V	h_{FE}	>	5	
Transition frequency				
$I_C = 600$ mA; $V_{CE} = 20$ V	f_T	typ.	500	MHz
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; $V_{CB} = 30$ V	C_c	typ. <	20 30	pF pF
Feedback capacitance at f = 1 MHz				
$I_C = 100$ mA; $V_{CE} = 30$ V	$-C_{re}$	typ.	15	pF
Collector-stud capacitance	C_{cs}	typ.	2	pF


7Z60967
600
f_T
(MHz)
400
200
0
$V_{CE} = 20V$
typ
0
1
2
3
I_C (A)
4


7Z60963
50
C_c
(pF)
40
30
20
10
$I_E = I_e = 0$
f = 1MHz
typ
0
10
20
V_{CB} (V)
30

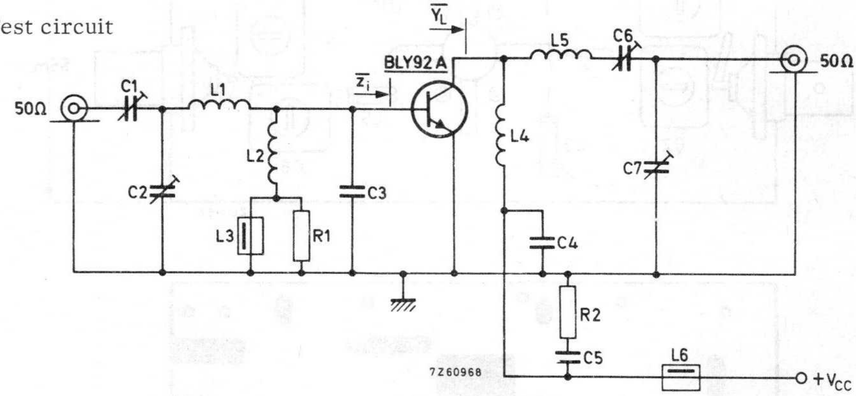
APPLICATION INFORMATION

R.F. performance in c.w. operation (unneutralised common-emitter class B circuit)

V_{CC} = 28 V; T_{mb} up to 25 °C

f(MHz)	P_S (W)	P_L (W)	I_C (A)	G_p (dB)	η(%)	$\overline{z_i}$ (Ω)	$\overline{Y_L}$ (mA/V)
175	< 1.5	15	< 0.83	> 10	> 65	1.4+j2.15	32-j28

Test circuit



C1 = 2.5 to 20 pF film dielectric trimmer (code number 2222 809 07004)
C2 = C6 = C7 = 4 to 40 pF film dielectric trimmer (code number 2222 809 07008)
C3 = 47 pF ceramic
C4 = 100 pF ceramic
C5 = 150 nF polyester

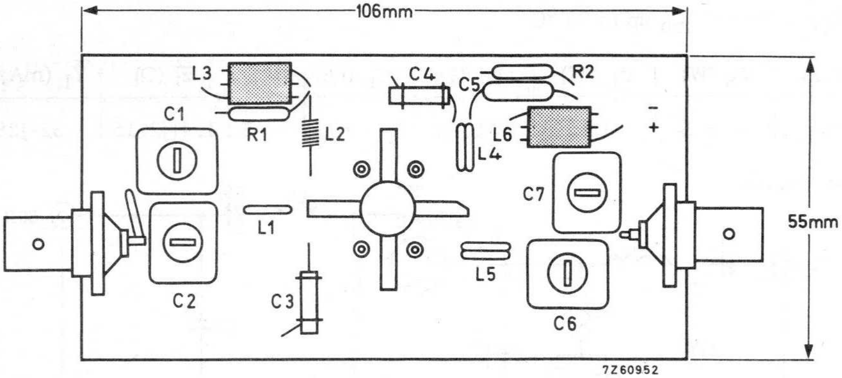
L1 = 0.5 turn enamelled Cu wire (1.5 mm); int. diam. 6 mm; leads 2 x 10 mm
L2 = 6.5 turns closely wound enamelled Cu wire (0.7 mm); int. diam. 4 mm; leads 2 x 5 mm
L3 = L5 = ferroxcube choke (code number 4312 020 36640)
L4 = 2.5 turns enamelled Cu wire (0.7 mm); int. diam. 6 mm; leads 2 x 7 mm
L6 = 4.5 turns enamelled Cu wire (0.7 mm); int. diam. 6 mm; leads 2 x 7 mm

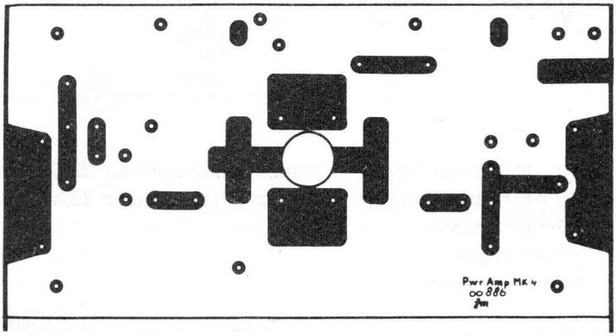
R1 = R2 = 10 Ω carbon

Component lay-out for 175 MHz test circuit see page 6.

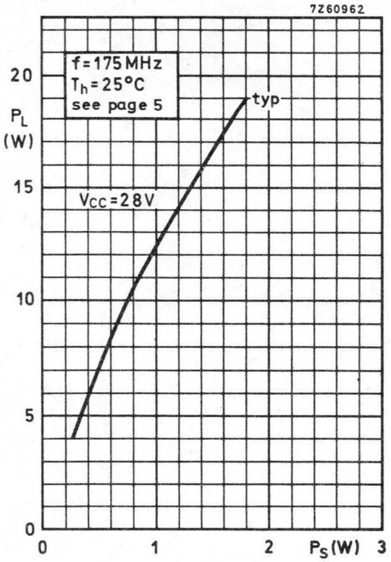
APPLICATION INFORMATION (continued)

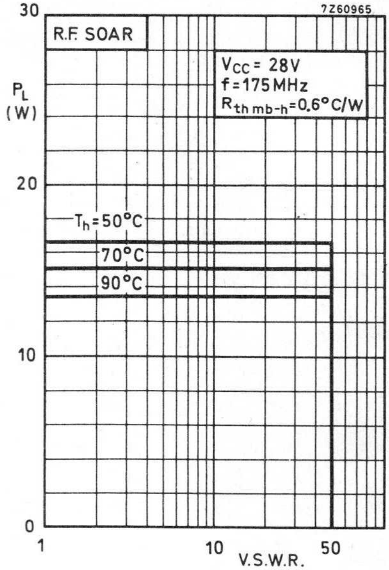
Component lay-out and printed circuit board for 175 MHz test circuit.





The circuit and the components are situated on one side of the epoxy fibre-glass board, the other side being fully metallised to serve as earth. Earth connections are made by means of hollow rivets.





For high voltage operation, a stabilized power supply is generally used.
The graph shows the allowable output power under nominal conditions as a function of the V.S.W.R., with heat-sink temperature as parameter.

V.H.F. POWER TRANSISTOR

N-P-N epitaxial planar transistor intended for use in class A, B and C operated mobile, industrial and military transmitters with a supply voltage of 28 V. The transistor is resistance stabilized. Every transistor is tested under severe load mismatch conditions. It has a $\frac{1}{4}$" capstan envelope with a moulded cap. All leads are isolated from the stud.

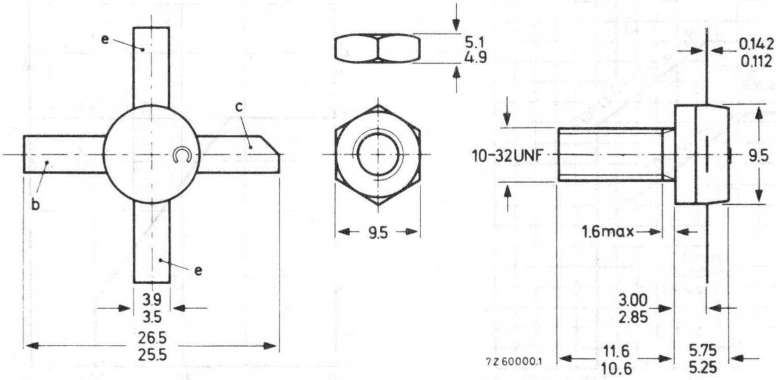
QUICK REFERENCE DATA

R.F. performance up to T_{mb} = 25 °C in an unneutralised common-emitter class B circuit.

Mode of operation	V_{CC} (V)	f (MHz)	P_S (W)	P_L (W)	I_C (A)	G_p (dB)	η (%)	$\overline{z_i}$ (Ω)	$\overline{Y_L}$ (mA/V)
c.w.	28	175	< 3.1	25	< 1.5	> 9	> 60	1.0+j1.2	57.7-j52.7

MECHANICAL DATA

Dimensions in mm



Torque on nut: min. 15 kg cm
(1.5 Newton metres)
max. 17 kg cm
(1.7 Newton metres)

Diameter of clearance hole in heatsink: max. 5.0 mm.
Mounting hole to have no burrs at either end.
De-burring must leave surface flat; do not chamfer or countersink either end of hole.

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC134)

Voltages

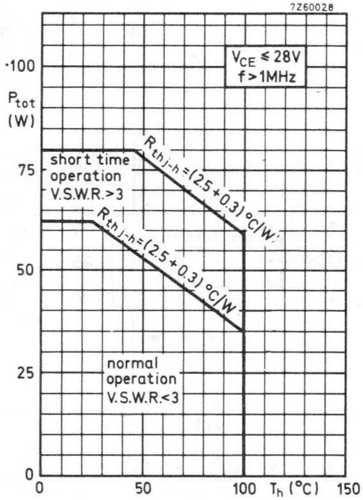
Collector-base voltage (open emitter) peak value	V_{CBOM}	max.	65	V
Collector-emitter voltage (open base)	V_{CEO}	max.	36	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4	V

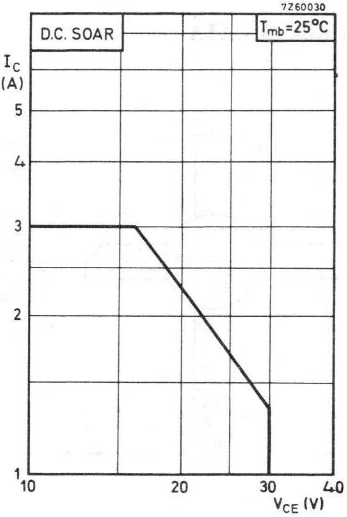
Currents

Collector current (average)	$I_{C(AV)}$	max.	3	A
Collector current (peak value) f > 1 MHz	I_{CM}	max.	9	A

Power dissipation

Total power dissipation up to T_{mb} = 25 °C f > 1 MHz	P_{tot}	max.	70	W





Temperature

Storage temperature	T_{stg}		−30 to +200	°C
Operating junction temperature	T_j	max.	200	°C

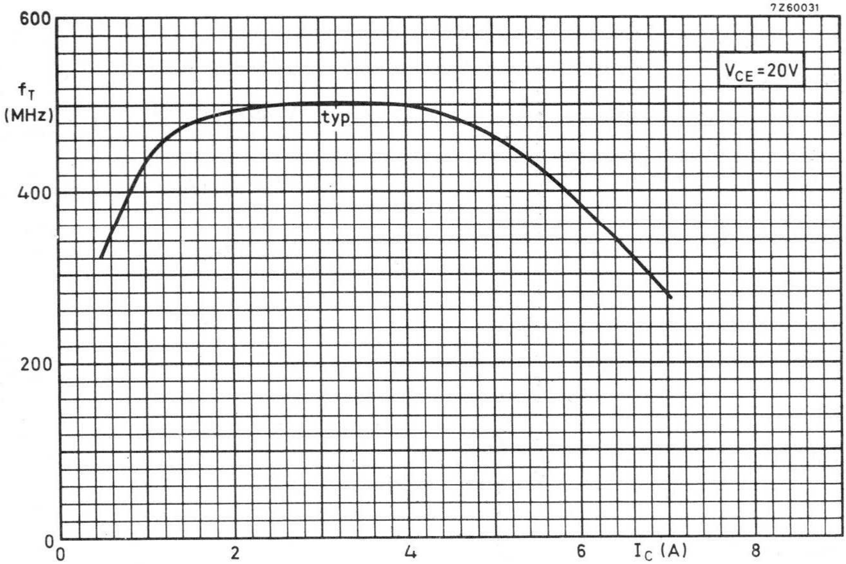
THERMAL RESISTANCE

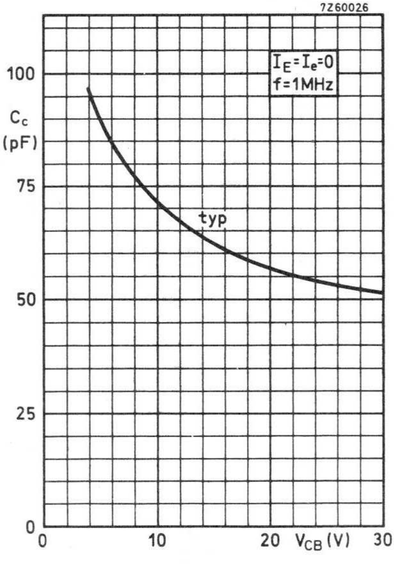
From junction to mounting base	$R_{th\ j-mb}$	=	2.5	°C/W
From mounting base to heatsink	$R_{th\ mb-h}$	=	0.3	°C/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Breakdown voltages				
Collector-base voltage open emitter, I_C = 50 mA	$V_{(BR)CBO}$	>	65	V
Collector-emitter voltage open base, I_C = 50 mA	$V_{(BR)CEO}$	>	36	V
Emitter-base voltage open collector; I_E = 10 mA	$V_{(BR)EBO}$	>	4	V
Transient energy				
L = 25 mH; f = 50 Hz				
open base	E	>	8	mWs
$-V_{BE}$ = 1.5 V; R_{BE} = 33 Ω	E	>	8	mWs
D.C. current gain				
I_C = 1 A; V_{CE} = 5 V	h_{FE}	typ. 10 to	50 120	
Transition frequency				
I_C = 3 A; V_{CE} = 20 V	f_T	typ.	500	MHz
Collector capacitance at f = 1 MHz				
$I_E = I_e$ = 0; V_{CB} = 30 V	C_c	typ. <	50 65	pF pF
Feedback capacitance at f = 1 MHz				
I_C = 100 mA; V_{CE} = 30 V	$-C_{re}$	typ.	31	pF
Collector-stud capacitance	C_{cs}	typ.	2	pF


7Z60031
600
f_T
(MHz)
400
200
0
0
2
4
6
I_C (A)
8
V_{CE} = 20V
typ


7Z60026
100
C_c
(pF)
75
50
25
0
0
10
20
V_{CB} (V)
30
$I_E = I_e = 0$
f = 1MHz
typ

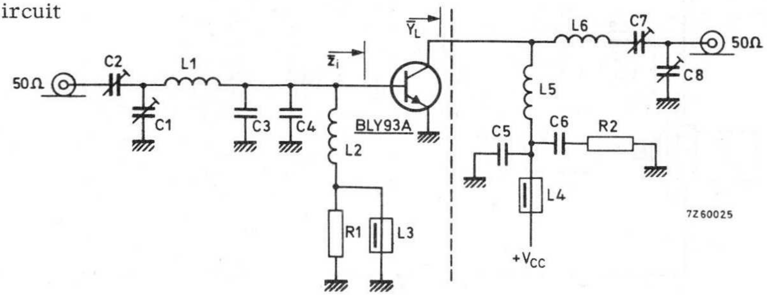
APPLICATION INFORMATION

R.F. performance in c.w. operation (unneutralised common-emitter class B circuit)

V_{CC} = 28 V; T_{mb} = 25 °C

f(MHz)	P_S (W)	P_L (W)	I_C (A)	G_p (dB)	η (%)	$\overline{z}_i$ (Ω)	$\overline{Y}_L$ (mA/V)
175	< 3.1	25	< 1.5	> 9	> 60	1.0+j1.2	57.7-j52.7

Test circuit



C1 = 4 to 44 pF film dielectric trimmer (code number 2222 809 07008)
C2 = 2 to 22 pF film dielectric trimmer (code number 2222 809 07004)
C3 = C4 = 47 pF ceramic
C5 = 100 pF ceramic
C6 = 150 nF polyester
C7 = 4 to 104 pF film dielectric trimmer (code number 2222 809 07015)
C8 = 4 to 64 pF film dielectric trimmer (code number 2222 809 07011)

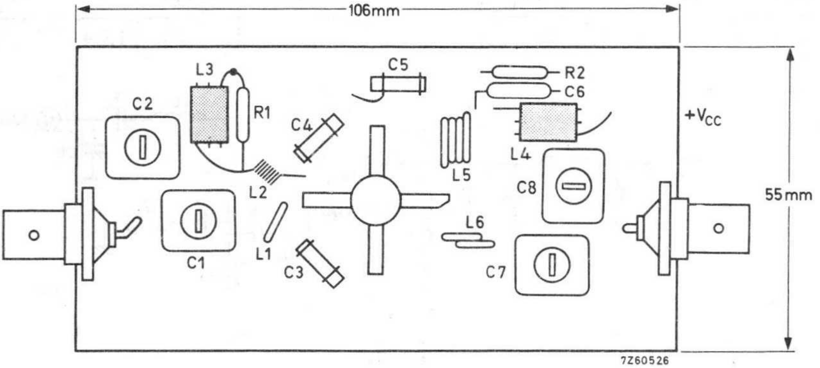
L1 = 0.5 turn enamelled Cu wire (1.5 mm); int.diam.6 mm; leads 2x6 mm
L2 = 6 turns closely wound enamelled Cu wire (0.7 mm); int.diam.4 mm; leads 2x4 mm
L3 = L4 = ferroxcube choke (code number 4312 020 36640)
L5 = 3.5 turns enamelled Cu wire (1.5 mm); int.diam. 6 mm; leads 2x6 mm
L6 = 1.5 turns enamelled Cu wire (1.5 mm); int.diam. 6 mm; leads 2x6 mm

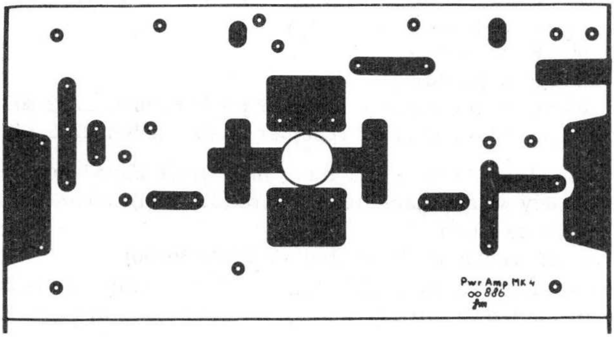
R1 = R2 = 10 Ω carbon

Component lay-out for 175 MHz see page 6.

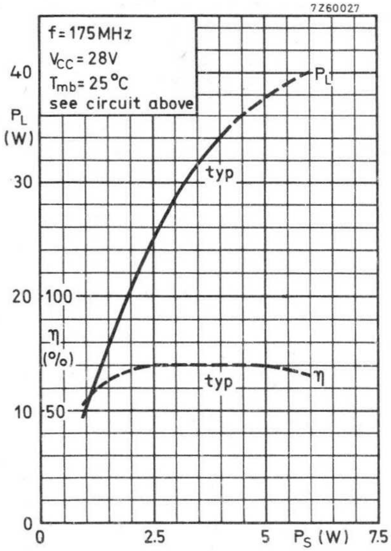
APPLICATION INFORMATION (continued)

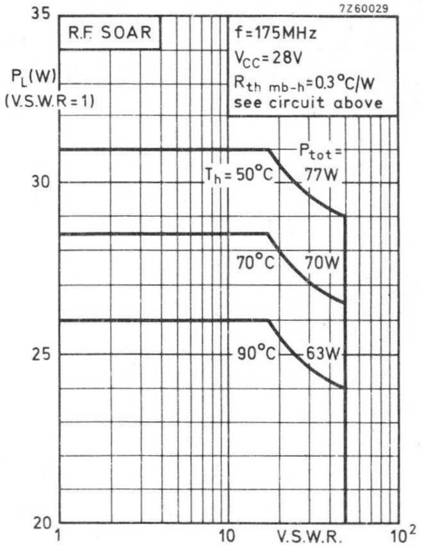
Component lay-out and printed circuit board for 175 MHz test circuit.





The circuit and the components are situated on one side of the epoxy fibre-glass board, the other side being fully metallised to serve as earth. Earth connections are made by means of hollow rivets.





For high voltage operation, a stabilized power supply is generally used.
The graph shows the allowable output power under nominal conditions as a function of the V.S.W.R., with heat-sink temperature as parameter.

V.H.F. POWER TRANSISTOR

N-P-N epitaxial planar transistor intended for use in class A, B and C operated mobile, industrial and military transmitters with a supply voltage of 28 V. The transistor is resistance stabilized. Every transistor is tested under severe load mismatch conditions. It has a plastic encapsulated stripline package. All leads are isolated from the stud.

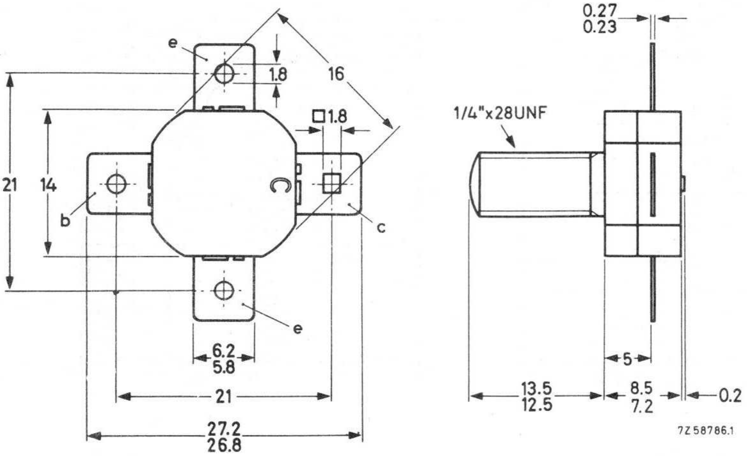
QUICK REFERENCE DATA

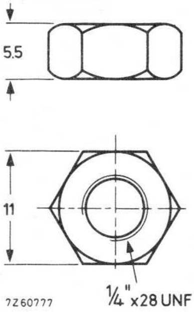
R.F. performance up to T_{mb} = 25 °C in an unneutralised common-emitter class B circuit.

Mode of operation	V_{CC} (V)	f (MHz)	P_S (W)	P_L (W)	I_C (A)	G_p (dB)	η (%)	$\overline{z_i}$ (Ω)	$\overline{Y_L}$ (mA/V)
c.w.	28	175	< 10	50	< 2.75	> 7	> 65	0.7+j1.45	120-j70

MECHANICAL DATA

Dimensions in mm





Torque on nut: min. 23 kg cm
(2.3 Newton metres)
max. 27 kg cm
(2.7 Newton metres)

Diameter of clearance hole in heatsink: max. 6.5 mm.
Mounting hole to have no burrs at either end. De-burring must leave surface flat; do not chamfer or countersink either end of hole.

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltages

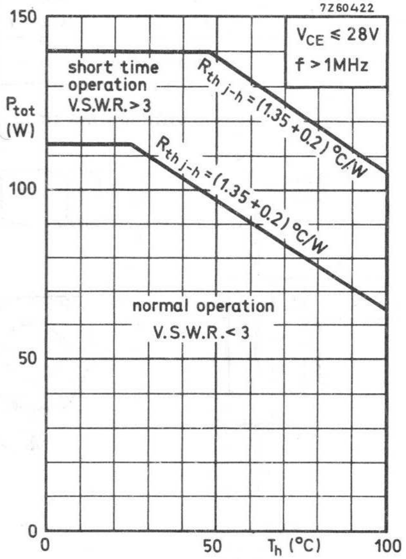
Collector-base voltage (open emitter) peak value	V_{CBOM}	max.	65	V
Collector-emitter voltage (open base)	V_{CEO}	max.	36	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4	V

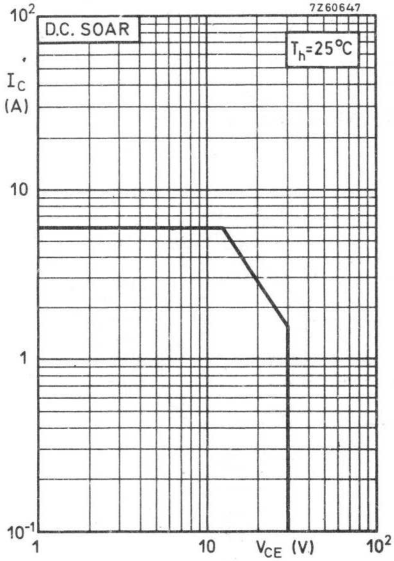
Currents

Collector current (average)	$I_{C(AV)}$	max.	6	A
Collector current (peak value) f > 1 MHz	I_{CM}	max.	12	A

Power dissipation

Total power dissipation up to T_{mb} = 25 °C f > 1 MHz	P_{tot}	max.	130	W





Temperature

Storage temperature	T_{stg}		−65 to +200	°C
Operating junction temperature	T_j	max.	200	°C

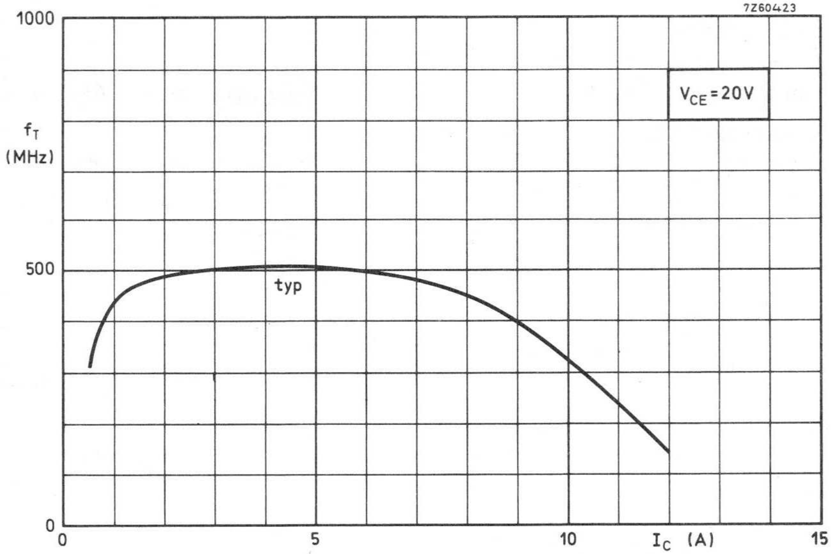
THERMAL RESISTANCE

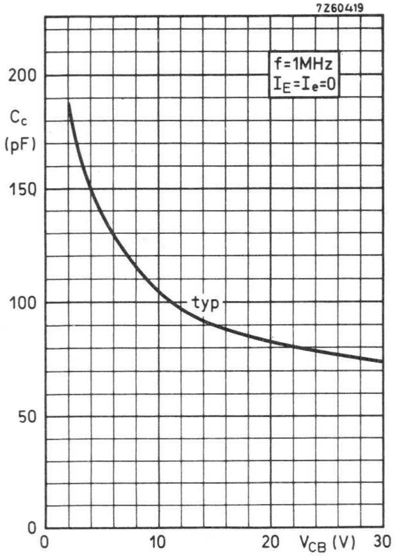
From junction to mounting base	$R_{th\,j\text{-}mb}$	=	1.35	°C/W
From mounting base to heatsink	$R_{th\,mb\text{-}h}$	=	0.2	°C/W

CHARACTERISTICS

$T_j = 25\,^{o}C$ unless otherwise specified

Breakdown voltages				
Collector-base voltage open emitter, $I_C = 100$ mA	$V_{(BR)CBO}$	>	65	V
Collector-emitter voltage open base, $I_C = 100$ mA	$V_{(BR)CEO}$	>	36	V
Emitter-base voltage open collector; $I_E = 25$ mA	$V_{(BR)EBO}$	>	4	V
Transient energy				
L = 25 mH; f = 50 Hz				
open base	E	>	8	mWs
$-V_{BE} = 1.5$ V; $R_{BE} = 33\ \Omega$	E	>	8	mWs
D.C. current gain				
$I_C = 1$ A; $V_{CE} = 5$ V	h_{FE}	10 to 120		
Transition frequency				
$I_C = 6$ A; $V_{CE} = 20$ V	f_T	typ.	500	MHz
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; $V_{CB} = 30$ V	C_c	typ. <	75 130	pF pF
Feedback capacitance				
$I_C = 100$ mA; $V_{CE} = 30$ V	$-C_{re}$	typ.	47	pF
Collector-stud capacitance	C_{cs}	typ.	3.5	pF


7Z60423
1000
500
0
f_T
(MHz)
$V_{CE} = 20V$
typ
0
5
10
I_C (A)
15


7Z60419
200
150
100
50
0
C_c
(pF)
f = 1MHz
$I_E = I_e = 0$
typ
0
10
20
V_{CB} (V)
30

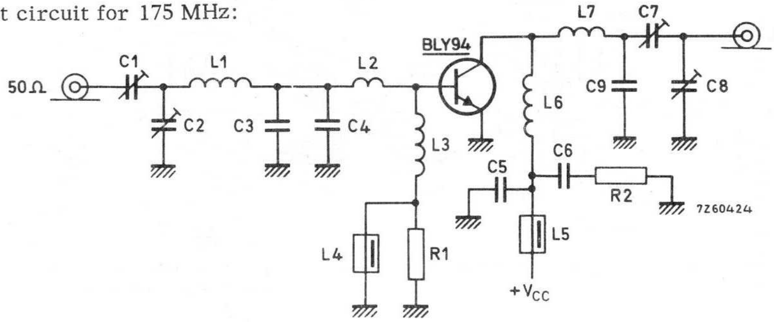
APPLICATION INFORMATION

R.F. performance in c.w. operation (unneutralised common-emitter class Bcircuit)

f = 175 MHz; T_{mb} up to 25 °C

V_{CC} (V)	P_S (W)	P_L (W)	I_C (A)	G_p (dB)	η (%)	$\overline{z_i}$ (Ω)	$\overline{Y_L}$ (mA/V)
28	< 10	50	< 2.75	> 7	> 65	0.7+j1.45	120-j70

Test circuit for 175 MHz:



List of components:

C1 = 2 to 20 pF film dielectric trimmer (code number 2222 809 07004)
C2 = 4 to 40 pF film dielectric trimmer (code number 2222 809 07008)
C3 = C4 = 56 pF ceramic
C5 = 100 pF ceramic
C6 = 100 nF polyester
C7 = 4 to 60 pF film dielectric trimmer (code number 2222 809 07011)
C8 = 4 to 100 pF film dielectric trimmer (code number 2222 809 07015)
C9 = 6.8 pF ceramic

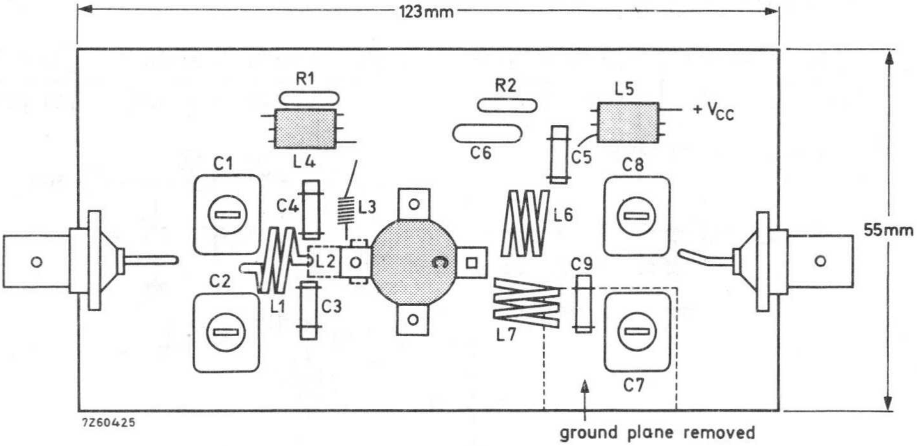
L1 = 36 nH; 2 turns enamelled Cu wire (1.5 mm); int. diam. 7 mm; length 5 mm; lead length 2 x 5 mm
L2 = formed by the metallization on the p.c. board; see component lay-out
L3 = 100 nH; 7 turns closely wound enamelled Cu wire (0.5 mm); int. diam 3 mm; lead length 2 x 5 mm
L4 = L5 = ferroxcube choke (code number 4312 020 36640)
L6 53 nH; 2 turns enamelled Cu wire (1.5 mm); int. diam. 10 mm; length 5.2 mm; lead length 2 x 5 mm
L7 = 46 nH; 2 turns enamelled Cu wire (1.5 mm); int. diam. 9 mm; length 5.4 mm; lead length 2 x 5 mm

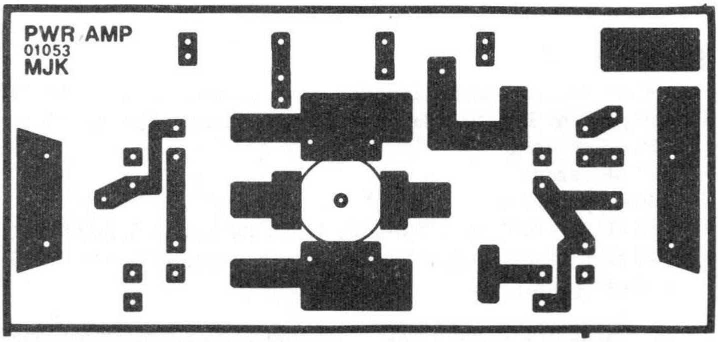
R1 = R2 = 10 Ω carbon

Component lay-out see page 6

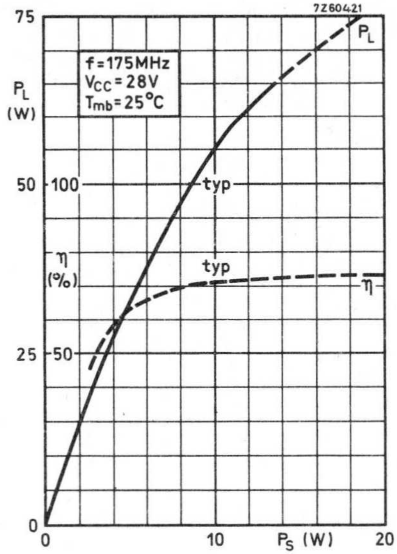
APPLICATION INFORMATION (continued)

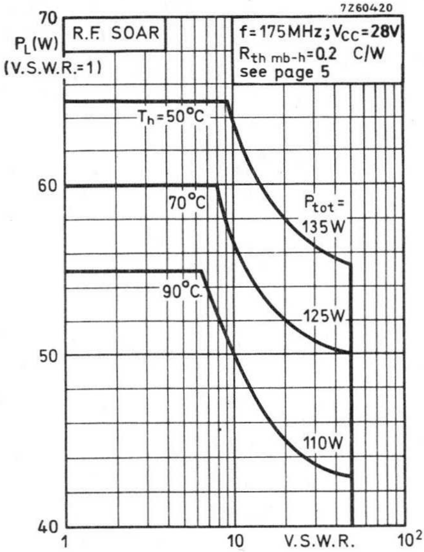
Component lay-out and printed circuit board for 175 MHz test circuit.





The circuit and the components are situated on one side of the epoxy fibre-glass board, the other side being fully metallised to serve as earth. Earth connections are made by means of hollow rivets.





For high voltage operation, a stabilized power supply is generally used.
The graph shows the allowable output power under nominal conditions as a function of the V.S.W.R., with heat-sink temperature as parameter.

SILICON EPITAXIAL PLANAR OVERLAY TRANSISTORS

The 2N3553 is a n-p-n overlay transistor in a TO-39 metal envelope with the collector connected to the case.
The 2N3375 and the 2N3632 are n-p-n overlay transistors in TO-60 metal envelopes with the electrodes insulated from the studs.
The 2N3553 and the 2N3375 are intended for v.h.f./u.h.f. and the 2N3632 for v.h.f. transmitting applications.

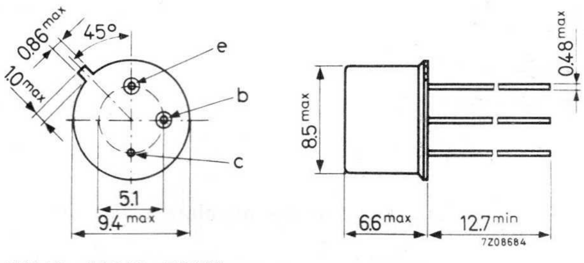
QUICK REFERENCE DATA

			2N3553	2N3375	2N3632	
Collector-emitter voltage $-V_{BE} = 1.5$ V	V_{CEX}	max.	65	65	65	V
Collector-emitter voltage (open base)	V_{CEO}	max.	40	40	40	V
Collector current (peak value)	I_{CM}	max.	1.0	1.5	3.0	A
Total power dissipation up to $T_{mb} = 25$ °C	P_{tot}	max.	7	11.6	23	W
Junction temperature	T_j	max.	200	200	200	°C
Transition frequency						
$I_C = 125$ mA; $V_{CE} = 28$ V	f_T	typ.	500	500		MHz
$I_C = 250$ mA; $V_{CE} = 28$ V	f_T	typ.			400	MHz

R.F. performance at $V_{CE} = 28$ V				
	f (MHz)	P_o (W)	P_i (W)	η (%)
2N3553	175	2.5	< 0.25	> 50
2N3375	100	7.5	< 1	> 65
2N3375	400	> 3	1	> 40
2N3632	175	> 13.5	3.5	> 70

MECHANICAL DATA Dimensions in mm

2N3553
Collector connected to case
TO-39



Accessories available: 56218, 56245, 56265.

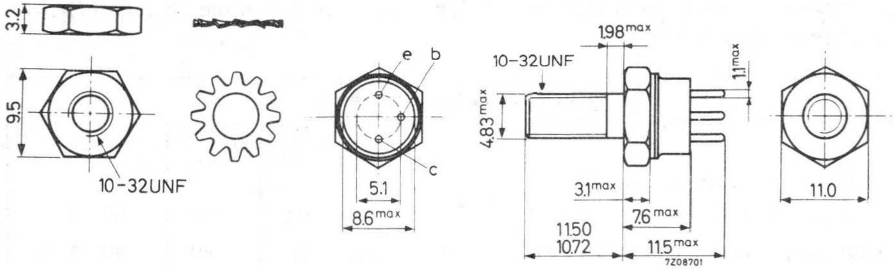
MECHANICAL DATA (continued)

2N3375
2N3632

TO-60
The top pins should not be bent

Dimensions in mm
Torque on nut: min. 8 cm kg
max. 17 cm kg

Diameter of hole in heatsink: 4.8 to 5.2 mm



RATINGS (Limiting values) [1]

Voltages [2]

Collector-base voltage (open emitter)	V_{CBO}	max.	65	V
Collector-emitter voltage I_C up to 200 mA; $-V_{BE}$ = 1.5 V	V_{CEX}	max.	65	V
Collector-emitter voltage (open base) I_C up to 200 mA	V_{CEO}	max.	40	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4	V

Currents [2]			2N3553	2N3375	2N3632	
Collector current (d.c.)	I_C	max.	0.35	0.5	1	A
Collector current (peak value)	I_{CM}	max.	1.0	1.5	3	A
Power dissipation [2]						
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	7	11.6	23	W

Temperatures

Storage temperature	T_{stg}	-65 to +200	°C
Junction temperature	T_j	max. 200	°C

---

[1] Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

[2] See also areas of permissible operation at pages 10 and 11.

THERMAL RESISTANCE

			2N3553	2N3375	2N3632	
From junction to mounting base	$R_{th\ j\text{-}mb}$	=	25	15	7.5	^{o}C/W
From mounting base to heatsink	$R_{th\ mb\text{-}h}$	=		0.6	0.6	^{o}C/W
From mounting base to heatsink mounted with						
top clamping washer of 56218	$R_{th\ mb\text{-}h}$	=	1.0			^{o}C/W
top clamping washer of 56218 and a boron nitride washer for electrical insulation	$R_{th\ mb\text{-}h}$	=	2.5			^{o}C/W

CHARACTERISTICS

T_j = 25 ^{o}C unless otherwise specified

			2N3553	2N3375	2N3632	
Collector cut-off current						
I_B = 0; V_{CE} = 30 V	I_{CEO}	<	100	100	250	μA
Breakdown voltages						
I_E = 0; I_C = 250 μA	$V_{(BR)CBO}$	>	65	65	65	V
I_C up to 200 mA						
$-V_{BE}$ = 1.5 V; R_B = 33 Ω 1)	$V_{(BR)CEX}$	>	65	65	65	V
I_B = 0 1)	$V_{(BR)CEO}$	>	40	40	40	V
I_C = 0; I_E = 250 μA	$V_{(BR)EBO}$	>	4	4	4	V
Base-emitter voltage						
I_C = 250 mA; V_{CE} = 5 V	V_{BE}	<	1.5			V
I_C = 500 mA; V_{CE} = 5 V	V_{BE}	<		1.5		V
I_C = 1000 mA; V_{CE} = 5 V	V_{BE}	<			1.5	V
Saturation voltage						
I_C = 250 mA; I_B = 50 mA	V_{CEsat}	<	1.0			V
I_C = 500 mA; I_B = 100 mA	V_{CEsat}	<		1.0		V
I_C = 1000 mA; I_B = 200 mA	V_{CEsat}	<			1.0	V

---

1) Pulsed through an inductor of 25 mH; δ = 0.5; f = 50 Hz

CHARACTERISTICS (continued)

T_j = 25 °C unless otherwise specified

			2N3553	2N3375	2N3632	
D.C. current gain						
I_C = 125 mA; V_{CE} = 5 V	h_{FE}	>	15	15		
		<	200	200		
I_C = 250 mA; V_{CE} = 5 V	h_{FE}	>	10	10	10	
		<	100	100	150	
I_C = 1000 mA; V_{CE} = 5 V	h_{FE}	>			5	
		<			110	
Collector capacitance at f = 1 MHz						
$I_E = I_e = 0$; V_{CB} = 28 V	C_c	<	10	10	20	pF
Collector-case capacitance		<		6	6	pF
Transition frequency						
I_C = 125 mA; V_{CE} = 28 V	f_T	typ.	500	500		MHz
I_C = 250 mA; V_{CE} = 28 V	f_T	typ.			400	MHz
Real part of input impedance at f = 200 MHz						
I_C = 125 mA; V_{CE} = 28 V	Re(h_{ie})	<	20	20		Ω
I_C = 250 mA; V_{CE} = 28 V	Re(h_{ie})	<			20	Ω

R.F. performance at V_{CE} = 28 V

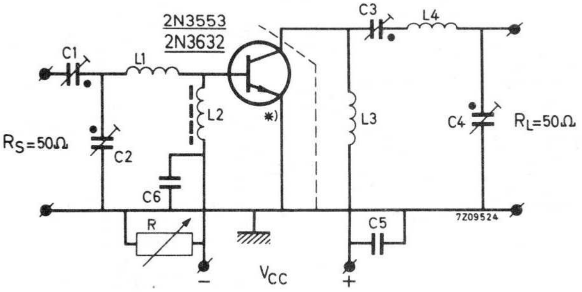
	f (MHz)	P_o (W)	P_i (W)	I_C (mA)	η %	Test circuit at page
2N3553	175	2.5	< 0.25	< 180	> 50	5
2N3375	100	7.5	< 1	< 410	> 65	6
2N3375	400	> 3	1	270	> 40	7
2N3632	175	> 13.5	3.5	690	> 70	5

NOTE

The transistors can withstand an output V.S.W.R. of 3:1 varied through all phases under conditions mentioned in the table above.

CHARACTERISTICS (continued)

Test circuit with the 2N3553 or the 2N3632 at f = 175 MHz



*) The length of the external emitter wire of the 2N3553 is 1.6 mm.
The emitter of the 2N3632 should be connected to the case as short as possible.

Components

C1 = C2 = C3 = C4 = 4 to 29 pF air trimmer

C5 = 10 nF polyester

C6 = 100 pF ceramic

L1 = 1 turn Cu wire (1.0 mm); int. diam. 10 mm; leads 2 x 10 mm

L2 = Ferroxcube choke coil. Z (at f = 175 MHz) = 550 Ω ± 20% (code number 4312 020 36640)

L3 = 15 turns closely wound enamelled Cu wire (0.7 mm); int. diam. 4 mm

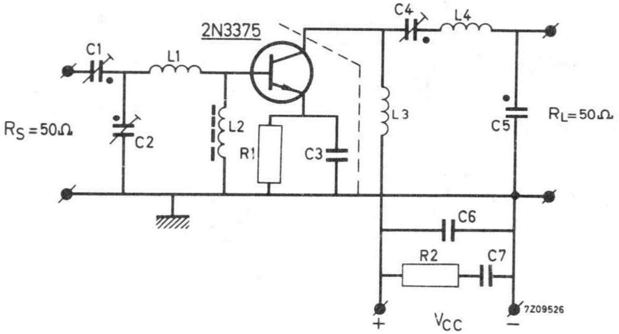
L4 = 3 turns closely wound enamelled Cu wire (1.5 mm); int. diam. 12 mm; leads 2 x 20 mm

R = 0 for the 2N3553

R = 0 to 2 Ω for the 2N3632

CHARACTERISTICS (continued)

Test circuit with the 2N3375 at f = 100 MHz



Components

C1 = C2 = 3.5 to 61.5 pF air trimmer

C3 = 10 nF polyester

C4 = C5 = 4 to 29 pF air trimmer

C6 = 330 pF ceramic

C7 = 10 nF polyester

L1 = 2 turns closely wound enamelled Cu wire (1.5 mm); int. diam. 10 mm; leads 2 x 10 mm

L2 = Ferroxcube choke coil. Z (at f = 100 MHz) = 700 Ω ± 20% (code number 4312 020 36640)

L3 = 23 turns closely wound enamelled Cu wire (0.7 mm); int. diam. 6 mm

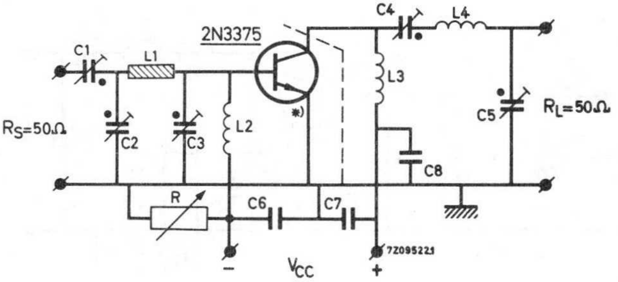
L4 = 5 turns closely wound enamelled Cu wire (1.5 mm); int. diam. 12 mm; leads 2 x 10 mm

R1 = 1.35 Ω carbon

R2 = 10 Ω carbon

CHARACTERISTICS (continued)

Test circuit with the 2N3375 at f = 400 MHz



*) The emitter should be connected to the case as short as possible.

Components

C1 = C2 = 0.7 to 6.7 pF ceramic trimmer

C3 = 0.5 to 3.5 pF ceramic trimmer

C4 = C5 = 3 to 19 pF air trimmer

C6 = C7 = 15 pF ceramic

C8 = 4700 pF ceramic

L1 = 20 mm straight Cu wire; diam. 1.5 mm; spaced 8 mm from chassis

L2 = 17 turns closely wound enamelled Cu wire (0.5 mm); int. diam. 3 mm

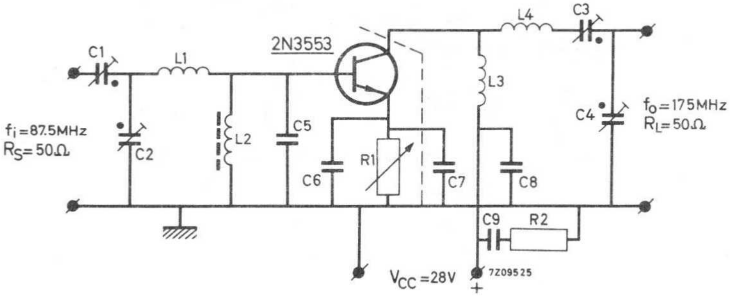
L3 = 7 turns closely wound enamelled Cu wire (0.5 mm); int. diam. 3 mm

L4 = 1 turn Cu wire (1.5 mm); int. diam. 10 mm; leads 2 x 5 mm

R = 0 to 5 Ω

APPLICATION INFORMATION

The 2N3553 used in a frequency doubler circuit 87.5 - 175 MHz



Components

C1 = C2 = C3 = 4 to 29 pF air trimmer
C4 = 3.5 to 61.5 pF air trimmer
C5 = 56 pF ceramic
C6 = 680 pF ceramic
C7 = 150 pF ceramic
C8 = 100 pF ceramic
C9 = 10 nF polyester

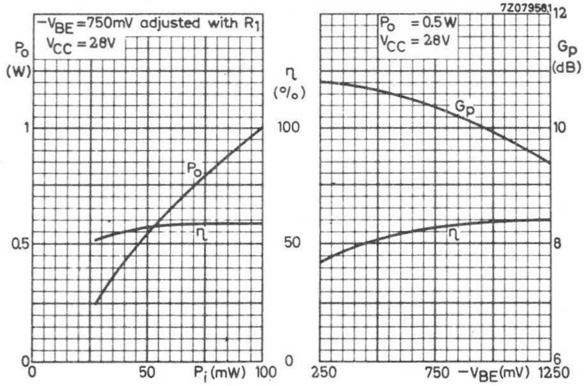
R_1 = 0 to 50 Ω
R_2 = 10 Ω carbon

L1 = 5 turns Cu wire (1 mm); winding pitch 1.5 mm; int. diam. 6 mm; leads 2 x 12 mm

L2 = Ferroxcube choke coil; Z (at f = 87.5 MHz) = 750 Ω ± 20% (code number 4312 020 **36640**)

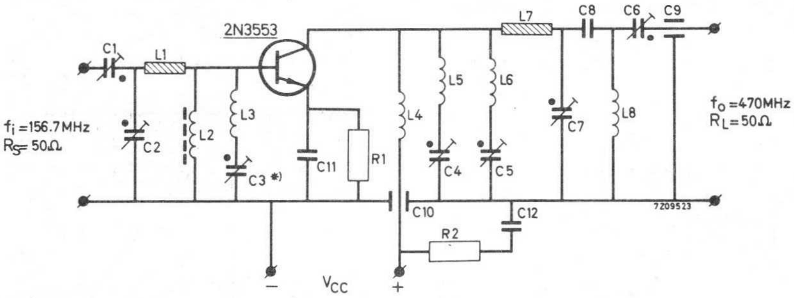
L3 = 15 turns closely wound enamelled Cu wire (0.7 mm); int. diam. 4 mm

L4 = 6 turns Cu wire (1 mm); winding pitch 1.5 mm; int. diam. 6 mm; leads 2 x 12 mm



APPLICATION INFORMATION (continued)

The 2N3553 used in a parametric frequency tripler 156.7 - 470 MHz



*) C3 tuned to second harmonic frequency

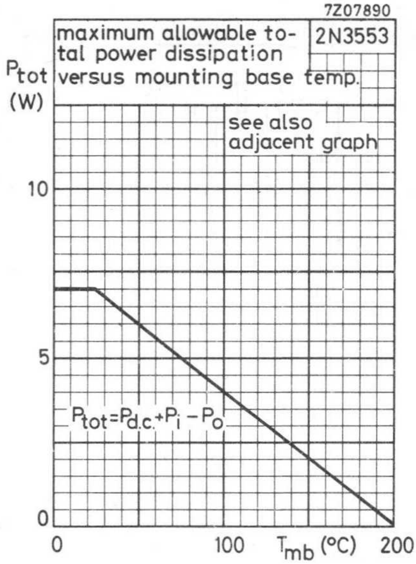
Components

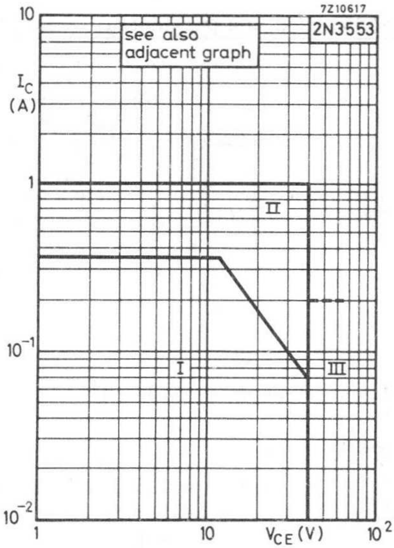
C1 = C2 = C3 = C4 =	4 to 29 pF	air trimmer	R_1 = 2.2 Ω	carbon
C5 = C6 = C7 =	4 to 10.4 pF	air trimmer	R_2 = 10 Ω	carbon
C8 =	1.0 pF	ceramic		
C9 =	12 pF	ceramic; feed through		
C10 =	100 pF	ceramic; feed through		
C11 =	1000 pF	ceramic		
C12 =	15 nF	polyester		

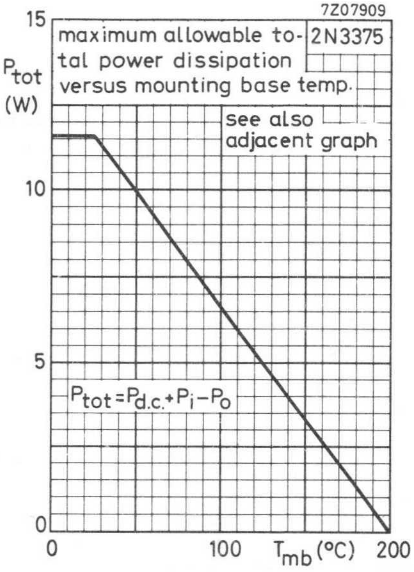
L1 = 35 mm straight Cu wire; diam. 1 mm; spaced 5.5 mm from chassis
L2 = Ferroxcube choke coil; Z (at f = 156.7 MHz) = 600 Ω ± 20%
(code number 4312 020 36640)
L3 = 18 mm straight Cu wire; diam. 1 mm; spaced 5.5. mm from chassis
L4 = 7 turns closely wound enamelled Cu wire (0.5 mm); int. diam. 3.5 mm
L5 = 3 turns Cu wire (1 mm); winding pitch 1.7 mm; int. diam. 8.5 mm; leads 2 x 10 mm
L6 = 2 turns Cu wire (1 mm); winding pitch 1.7 mm; int. diam. 7 mm; leads 2 x 10 mm
L7 = 40 mm straight Cu wire; diam. 1.5 mm; spaced 5.5 mm from chassis
L8 = 1 turn Cu wire; int. diam. 7 mm; leads 2 x 5 mm

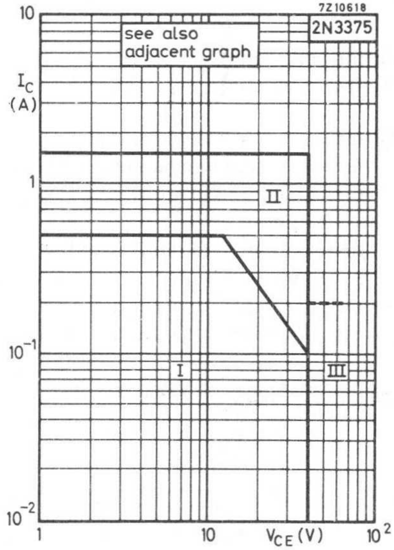
Typical performance at V_{CC} = 28 V

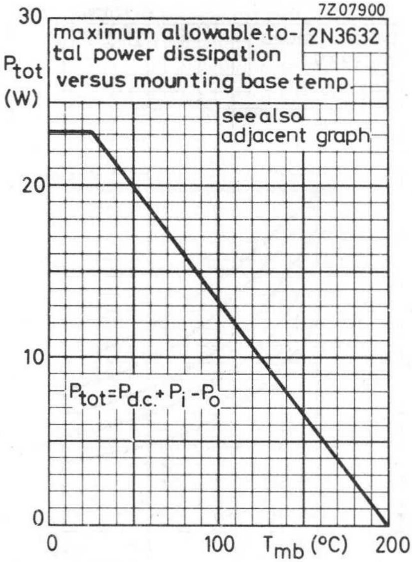
P_o (W)	P_i (W)	G_p (dB)	I_C (mA)	η %
1.5	0.27	7.5	125	43
2.0	0.39	7.1	156	46

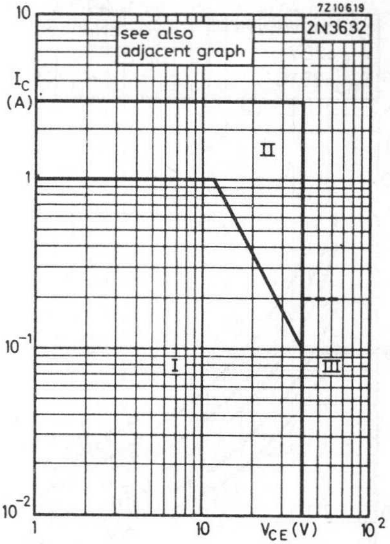

7Z07890
maximum allowable total power dissipation versus mounting base temp.
2N3553
see also adjacent graph
P_{tot} (W)
10
5
0
$P_{tot} = P_{d.c.} + P_i - P_o$
0
100
T_{mb} (°C)
200


7Z10617
2N3553
see also adjacent graph
I_C (A)
10
1
10^{-1}
10^{-2}
I
II
III
1
10
V_{CE} (V)
10^2


7Z07909
maximum allowable total power dissipation versus mounting base temp.
2N3375
see also adjacent graph
P_{tot} (W)
15
10
5
0
$P_{tot} = P_{d.c.} + P_i - P_o$
0
100
T_{mb} (°C)
200


7Z10618
2N3375
see also adjacent graph
I_C (A)
10
1
10^{-1}
10^{-2}
I
II
III
1
10
V_{CE} (V)
10^2

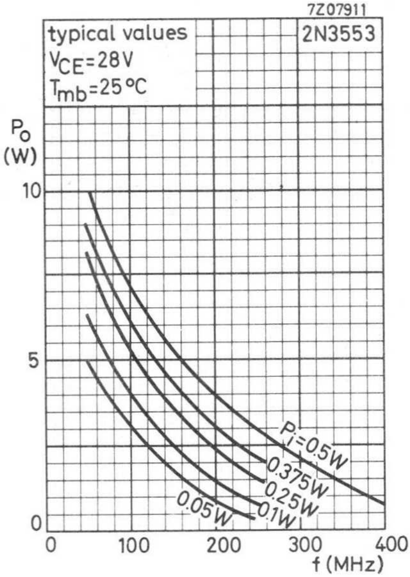


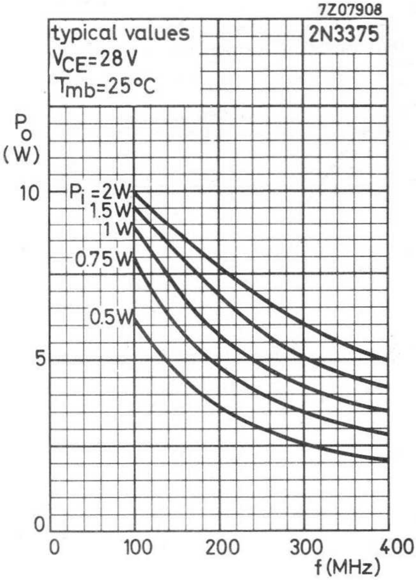


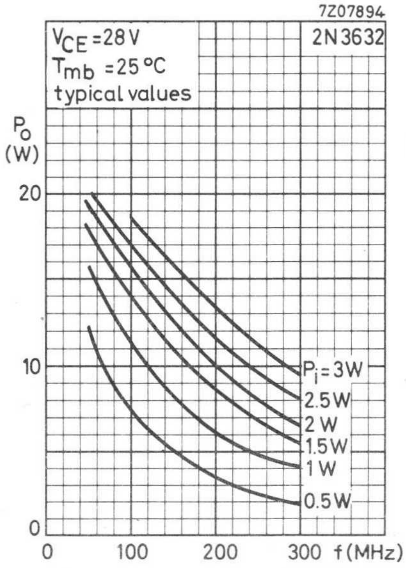
I Region of permissible operation under all base-emitter conditions and at all frequencies, including d.c.

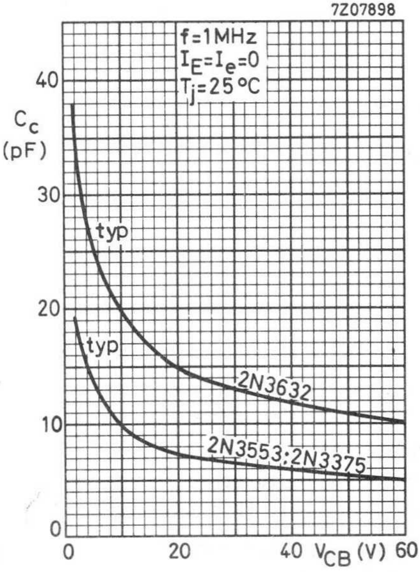
II Additional region of operation at f ≥ 1 MHz.
Care must be taken to reduce the d.c. adjustment to region I before removing the a.c. signal. This may be achieved by an appropriate bias in class A, B or C.

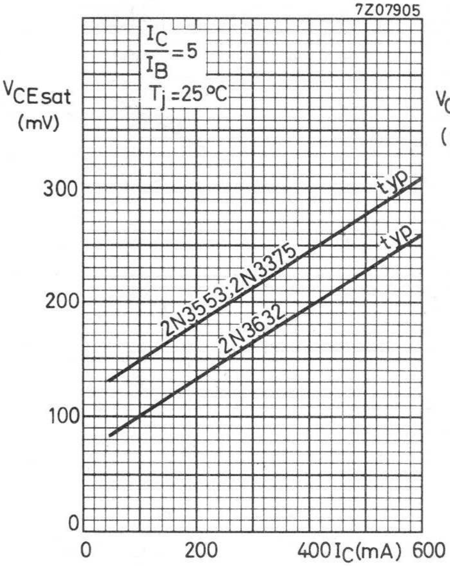
III Operating during switching off in this region is allowed, provided the transistor is cut-off with $-V_{BB} \leq 1.5$ V and $R_{BE} \geq 33\ \Omega$, $I_C \leq 200$ mA and the transient energy does not exceed 0.5 mWs.

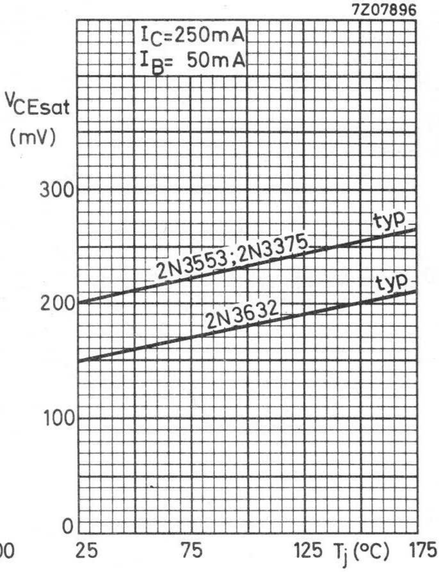

7Z07911
typical values
V_{CE}=28V
T_{mb}=25 °C
2N3553
P_o (W)
10
5
0
0
100
200
300
400
f (MHz)
P_i=0.5W
0.375W
0.25W
0.1W
0.05W

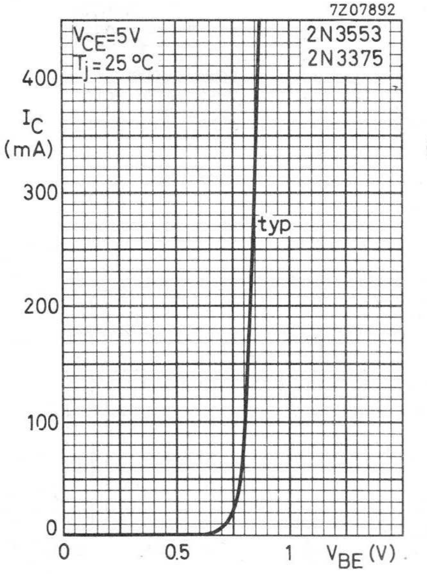

7Z07908
typical values
V_{CE}=28 V
T_{mb}=25 °C
2N3375
P_o (W)
10
5
0
P_i =2W
1.5W
1W
0.75W
0.5W
0
100
200
300
400
f (MHz)

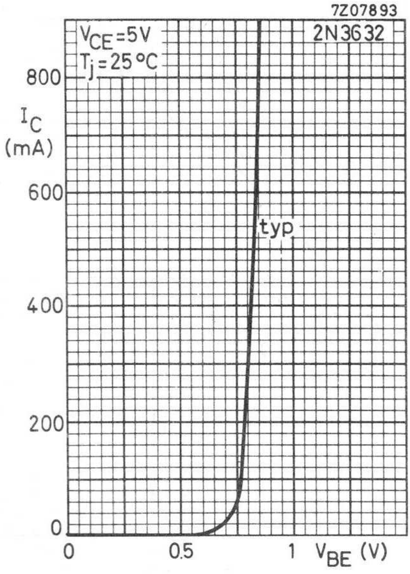

7Z07894
V_{CE} =28 V
T_{mb} =25 °C
typical values
2N3632
P_o (W)
20
10
0
P_i= 3W
2.5W
2 W
1.5W
1 W
0.5W
0
100
200
300
f (MHz)

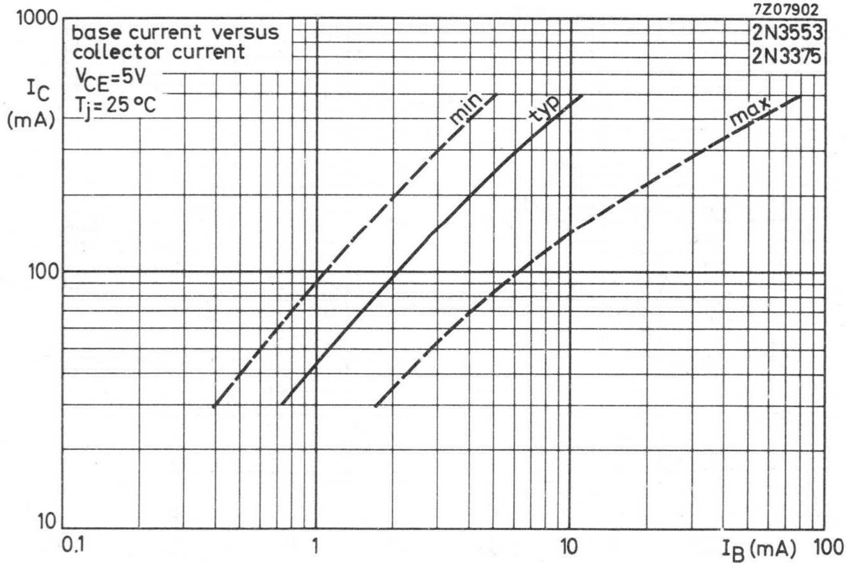

7Z07898
f=1MHz
I_E=I_e=0
T_j= 25 °C
C_c (pF)
40
30
20
10
0
typ
typ
2N3632
2N3553;2N3375
0
20
40
V_{CB} (V)
60

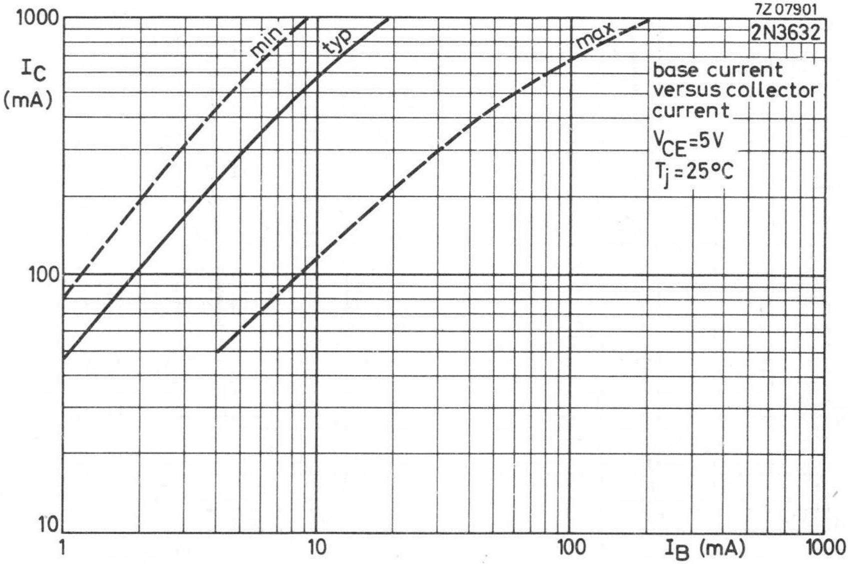

7Z07905
$\frac{I_C}{I_B} = 5$
$T_j = 25\,^\circ C$
V_{CEsat} (mV)
300
200
100
0
0
200
400
I_C (mA)
600
typ
typ
2N3553;2N3375
2N3632

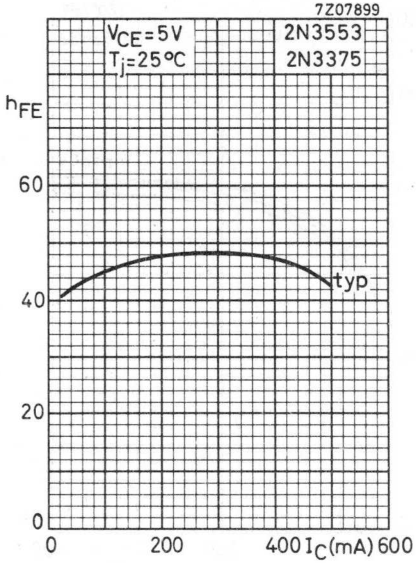

7Z07896
$I_C = 250\,mA$
$I_B = 50\,mA$
V_{CEsat} (mV)
300
200
100
0
25
75
125
T_j (°C)
175
typ
typ
2N3553;2N3375
2N3632

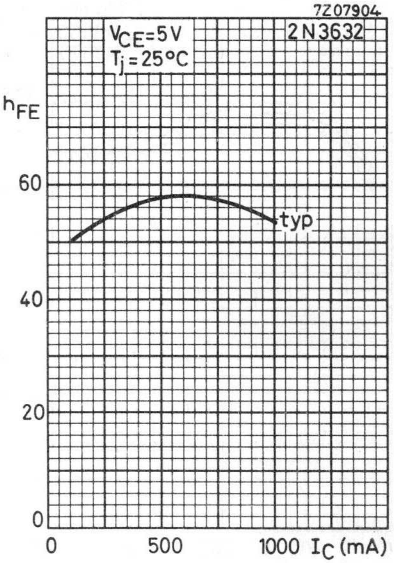

7Z07892
2N3553
2N3375
$V_{CE} = 5V$
$T_j = 25\,^\circ C$
400
I_C (mA)
300
200
100
0
0
0.5
1
V_{BE} (V)
typ

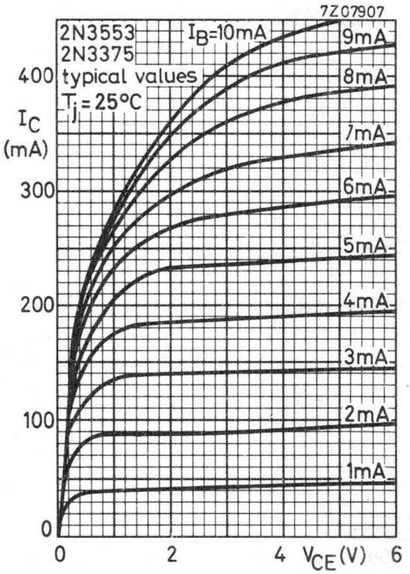

7Z07893
2N3632
$V_{CE} = 5V$
$T_j = 25\,^\circ C$
800
I_C (mA)
600
400
200
0
0
0.5
1
V_{BE} (V)
typ

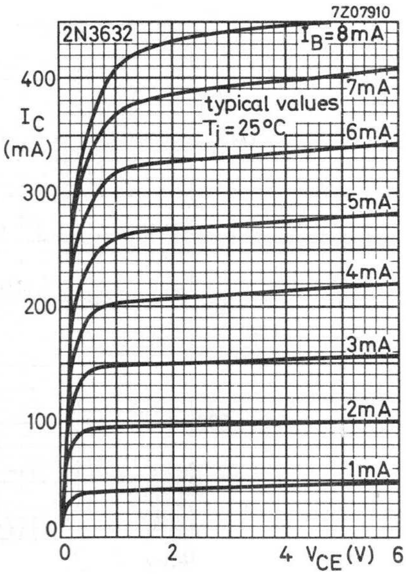

7Z07902
2N3553
2N3375
base current versus collector current
V_{CE}=5V
T_j= 25 °C
I_C (mA)
1000
100
10
0.1
1
10
I_B (mA)
100
min
typ
max

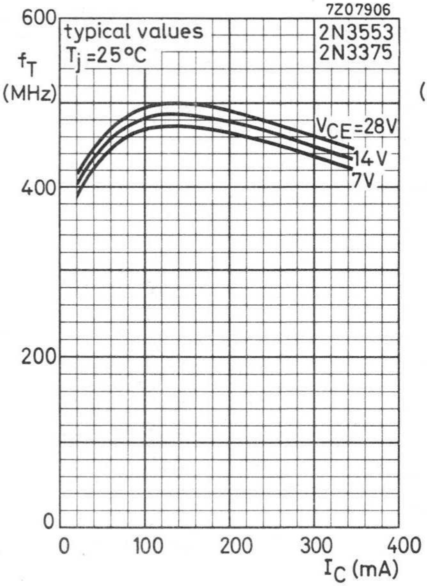

7Z07901
2N3632
base current versus collector current
V_{CE}=5V
T_j =25°C
I_C (mA)
1000
100
10
1
10
100
I_B (mA)
1000
min
typ
max

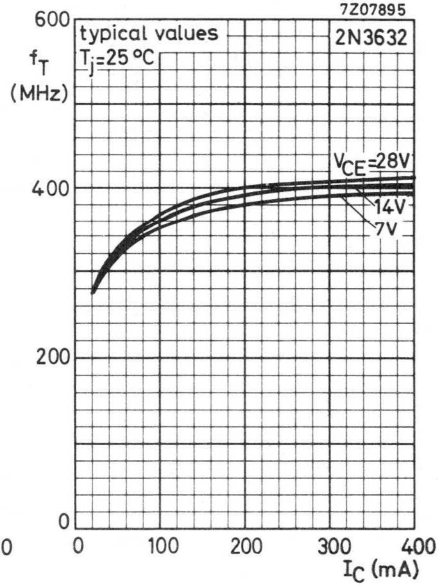

7Z07899
VCE=5V
Tj=25°C
2N3553
2N3375
hFE
60
40
20
0
typ
0
200
400 IC(mA) 600

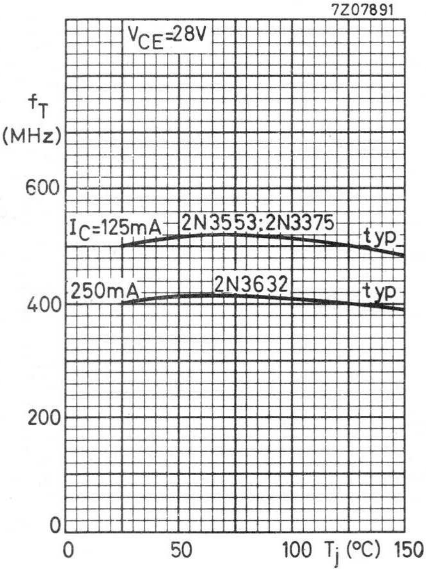

7Z07904
VCE=5V
Tj=25°C
2N3632
hFE
60
40
20
0
typ
0
500
1000 IC (mA)

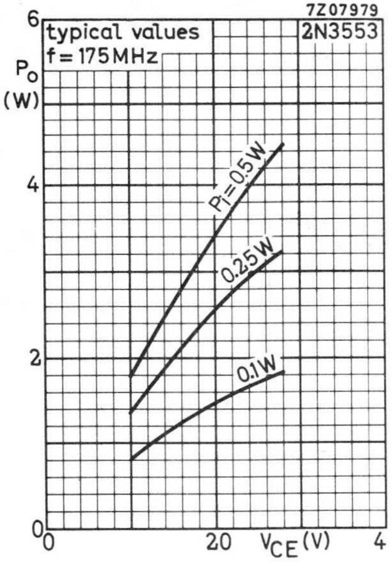

7Z07907
2N3553
2N3375
typical values
Tj=25°C
IB=10mA
9mA
8mA
7mA
6mA
5mA
4mA
3mA
2mA
1mA
400
300
200
100
0
IC (mA)
0
2
4 VCE(V) 6

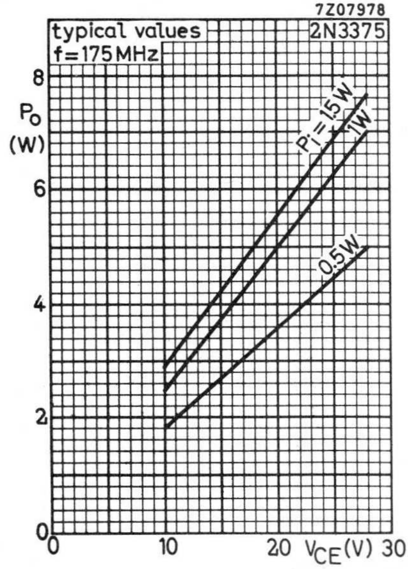

7Z07910
2N3632
IB=8mA
7mA
6mA
5mA
4mA
3mA
2mA
1mA
typical values
Tj=25°C
400
300
200
100
0
IC (mA)
0
2
4 VCE(V) 6

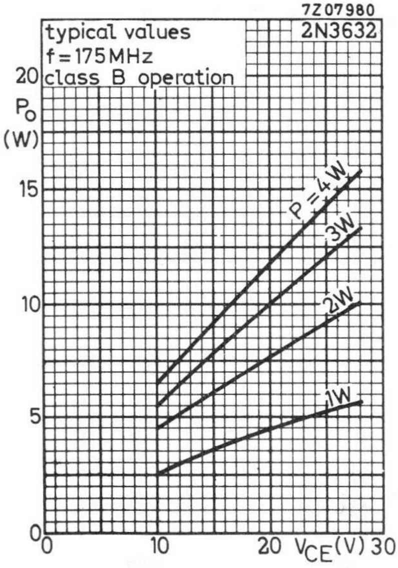

7Z07906
typical values
T_j = 25 °C
2N3553
2N3375
f_T (MHz)
600
400
200
0
V_{CE} = 28V
14 V
7V
0
100
200
300
400
I_C (mA)


7Z07895
typical values
T_j = 25 °C
2N3632
f_T (MHz)
600
400
200
0
V_{CE} = 28V
14V
7V
0
100
200
300
400
I_C (mA)


7Z07891
V_{CE} = 28V
f_T (MHz)
600
400
200
0
I_C = 125mA
2N3553; 2N3375
typ
250mA
2N3632
typ
0
50
100
T_j (°C)
150


7Z07979
typical values
f = 175 MHz
2N3553
P_o
(W)
6
4
2
0
0
20
V_{CE} (V)
4
P_i = 0.5 W
0.25 W
0.1 W


7Z07978
typical values
f = 175 MHz
2N3375
P_o
(W)
8
6
4
2
0
0
10
20
V_{CE} (V)
30
P_i = 1.5 W
1 W
0.5 W


7Z07980
typical values
f = 175 MHz
class B operation
2N3632
P_o
(W)
20
15
10
5
0
0
10
20
V_{CE} (V)
30
P_i = 4 W
3 W
2 W
1 W

SILICON EPITAXIAL PLANAR OVERLAY TRANSISTORS

N-P-N overlay transistors in a TO-39 metal envelope with the collector connected to the case. The devices are primarily intended for class A, B or C amplifiers, frequency multiplier- and oscillator circuits.
The transistors are suitable in output, driver or pre-driver stages in v.h.f. and u.h.f. equipment.

QUICK REFERENCE DATA

			2N3866	2N4427	
Collector-emitter voltage R_{BE} = 10 Ω	V_{CER}	max.	55	40	V
Collector-emitter voltage (open base)	V_{CEO}	max.	30	20	V
Collector current (d.c. or averaged over any 20 ms period)	I_C	max.	0.4	0.4	A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	5	3.5	W
Junction temperature	T_j	max.	200	200	°C
Transition frequency					
I_C = 25 mA; V_{CE} = 15 V; f = 100 MHz	f_T	typ.	700		MHz
I_C = 25 mA; V_{CE} = 10 V; f = 100 MHz	f_T	typ.		700	MHz

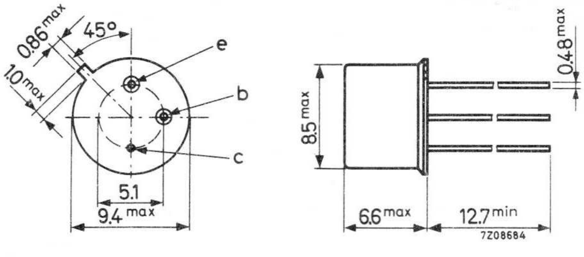
R.F. performance

Type	f (MHz)	V_{CE} (V)	P_o (W)	P_i (W)	η (%)
2N3866	400	28	1	< 0.1	> 45
2N4427	175	12	1	< 0.1	> 50

MECHANICAL DATA

Dimensions in mm

Collector connected to case
TO-39



Accessories available: 56218; 56245; 56265

RATINGS **Limiting values** in accordance with the Absolute Maximum System (IEC134)

			2N3866	2N4427	
Voltages [1]					
Collector-base voltage (open emitter)	V_{CBO}	max.	55	40	V
Collector-emitter voltage $R_{BE} = 10\ \Omega$	V_{CER}	max.	55	40	V
Collector-emitter voltage (open base)	V_{CEO}	max.	30	20	V
Emitter-base voltage (open collector)	V_{EBO}	max.	3.5	2.0	V
Currents [1]					
Collector current (d.c. or averaged over any 20 ms period)	I_C	max.	0.4	0.4	A
Collector current (peak value)	I_{CM}	max.	0.4	0.4	A
Power dissipation [1]					
Total power dissipation up to $T_{mb} = 25\ ^oC$	P_{tot}	max.	5	3.5	W

Temperatures

Storage temperature	T_{stg}		−65 to +200	°C
Junction temperature	T_j	max.	200	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	200	°C/W
From junction to mounting base	$R_{th\ j\text{-}mb}$	=	35	°C/W
From mounting base to heatsink mounted with top clamping washer of 56218	$R_{th\ mb\text{-}h}$	=	1.0	°C/W
top clamping washer of 56218 **and a boron nitride washer** for electrical insulation	$R_{th\ mb\text{-}h}$	=	**2.5**	°C/W

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[1] See also areas of permissible operation on page 6 .

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			2N3866	2N4427	
Collector cut-off current					
$I_B = 0$; $V_{CE} = 28$ V	I_{CEO}	<	20		μA
$I_B = 0$; $V_{CE} = 12$ V	I_{CEO}	<		20	μA
Breakdown voltages					
$I_E = 0$; $I_C = 100$ μA	$V_{(BR)CBO}$	>	55	40	V
$I_C = 5$ mA; $R_{BE} = 10\ \Omega$	$V_{(BR)CER}$	>	55	40	V
$I_B = 0$; $I_C = 5$ mA	$V_{(BR)CEO}$	>	30	20	V
$I_C = 0$; $I_E = 100$ μA	$V_{(BR)EBO}$	>	3.5	2	V
Collector-emitter saturation voltage					
$I_C = 100$ mA; $I_B = 20$ mA	V_{CEsat}	<	1.0	0.5	V
D.C. current gain					
$I_C = 50$ mA; $V_{CE} = 5$ V	h_{FE}		10 to 200		
$I_C = 100$ mA; $V_{CE} = 5$ V	h_{FE}			10 to 200	
$I_C = 360$ mA; $V_{CE} = 5$ V	h_{FE}	>	5	5	
Transition frequency					
$I_C = 25$ mA; $V_{CE} = 15$ V; f = 100 MHz	f_T	typ.	700		MHz
$I_C = 25$ mA; $V_{CE} = 10$ V; f = 100 MHz	f_T	typ.		700	MHz
Collector capacitance					
$V_{CB} = 28$ V; $I_E = I_e = 0$; f = 1 MHz	C_c	<	3		pF
$V_{CB} = 12$ V; $I_E = I_e = 0$; f = 1 MHz	C_c	<		4	pF

R.F. performance at T_{mb} = 25 °C

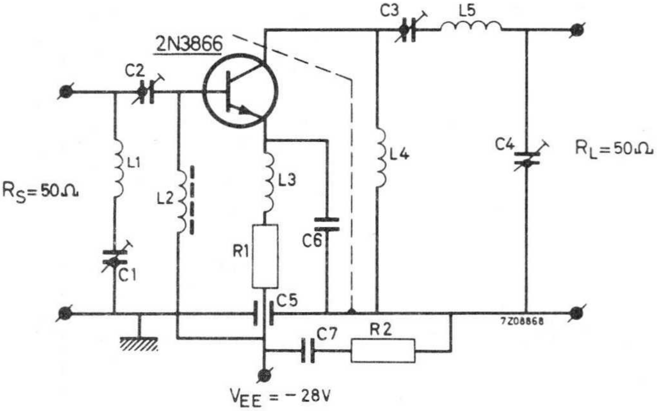
	f (MHz)	V_{CE} (V)	P_o (W)	P_i (W)	I_C (mA)	η (%)	Test circuit on page
2N3866	100	28	1.8	0.05	< 107	> 60	
2N3866	250	28	1.5	0.1	< 107	> 50	
2N3866	400	28	1.0	< 0.1	< 79	> 45	4 *
2N4427	175	12	1.0	< 0.1	< 167	> 50	5 *
2N4427	470	12	0.4	0.1	67	50	

---

*) The transistor can withstand an output V.S.W.R. of 3 : 1 varied through all phases for conditions, mentioned in the table above.

CHARACTERISTICS (continued)

Test circuit with the 2N3866 at f = 400 MHz



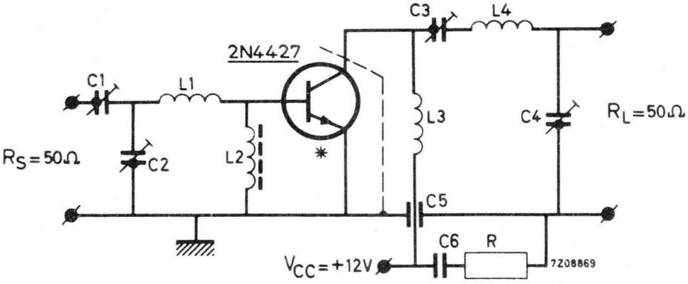
C1 = C2 = C3 = 4 to 29 pF air trimmer
C4 = 4 to 14 pF air trimmer
C5 = 1 nF feed through
C6 = 12 pF
C7 = 12 nF

R1 = 5.6 Ω
R2 = 10 Ω

L1 = 2 turns Cu wire (1 mm); int. diam. 6 mm; winding pitch 3 mm
L2 = Ferroxcube choke coil; Z (at f = 250 MHz) = 450 Ω (code number 4312 020 36690)
L3 = L4 = 6 turns enamelled Cu wire (0.5 mm); int. diam. 3.5 mm (100 nH)
L5 = 2 turns Cu wire (1 mm); int. diam. 7 mm; winding pitch 2.5 mm; leads 2x15 mm.

CHARACTERISTICS (continued)

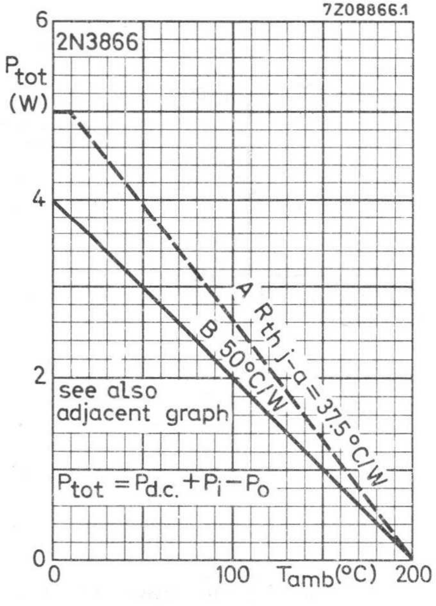
Test circuit with the 2N4427 at f = 175 MHz

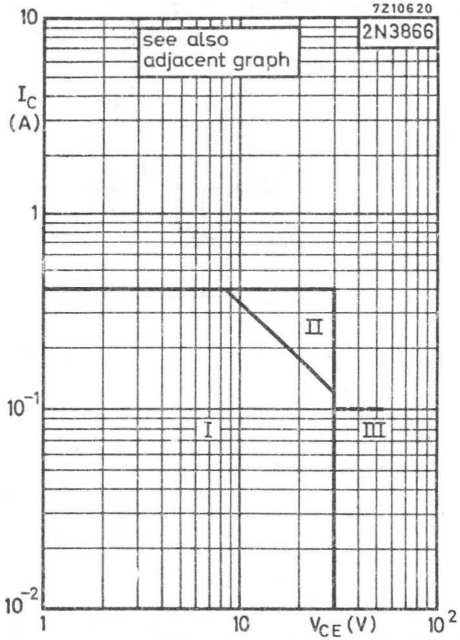


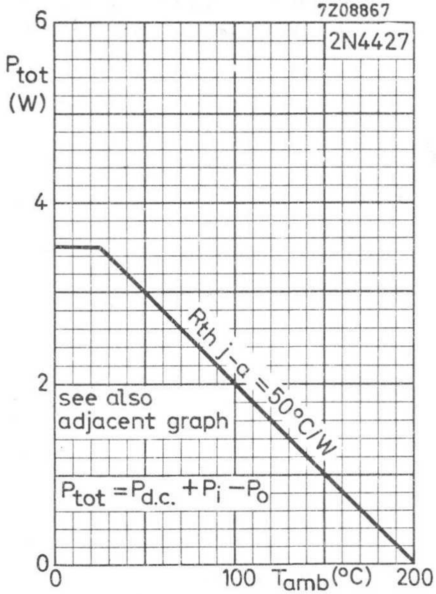
*) The length of the external emitter wire is 1.6 mm

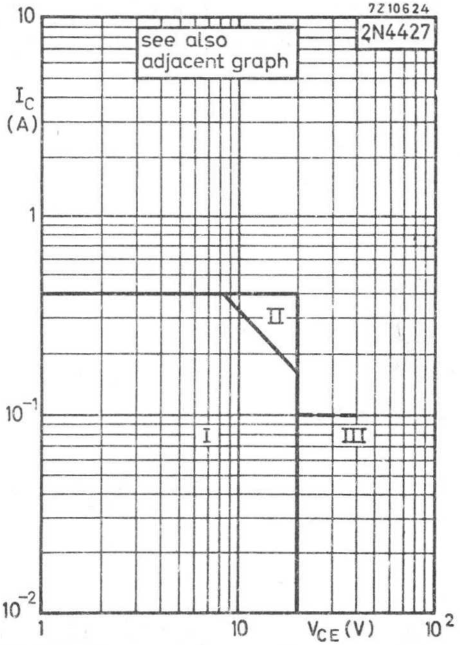
C1 = C2 = C3 = C4 =	4 to 29 pF	air trimmer
C5 =	1 nF	feed through
C6 =	12 nF	
R =	10 Ω	

L1 = 2 turns Cu wire (1 mm); int. diam. 6 mm; winding pitch 2 mm; leads 2x10 mm
L2 = Ferroxcube choke coil; Z (at f = 175 MHz) = 550 Ω (code number 4312 020 **36640**)
L3 = 2 turns Cu wire (1 mm); int. diam. 5 mm; winding pitch 2 mm; leads 2x10 mm
L4 = 3 turns Cu wire (1.5 mm); int. diam. 10 mm; winding pitch 2 mm; leads 2x15 mm


7Z08866.1
2N3866
P_{tot} (W)
6
4
2
0
0
100
200
T_{amb} (°C)
A $R_{th\ j-a}$ = 37.5 °C/W
B 50°C/W
see also adjacent graph
$P_{tot} = P_{d.c.} + P_i - P_o$


7Z10620
2N3866
see also adjacent graph
I_C (A)
10
1
10^{-1}
10^{-2}
1
10
10^2
V_{CE} (V)
I
II
III

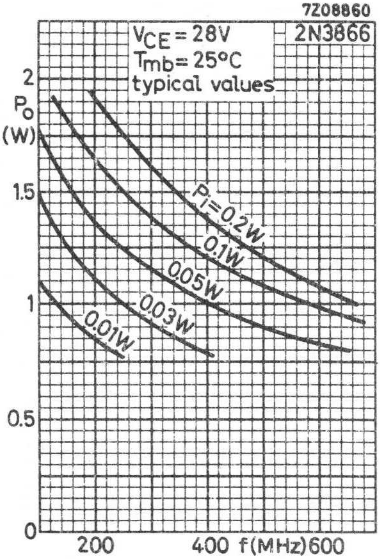

7Z08867
2N4427
P_{tot} (W)
6
4
2
0
0
100
200
T_{amb} (°C)
$R_{th\ j-a}$ = 50°C/W
see also adjacent graph
$P_{tot} = P_{d.c.} + P_i - P_o$

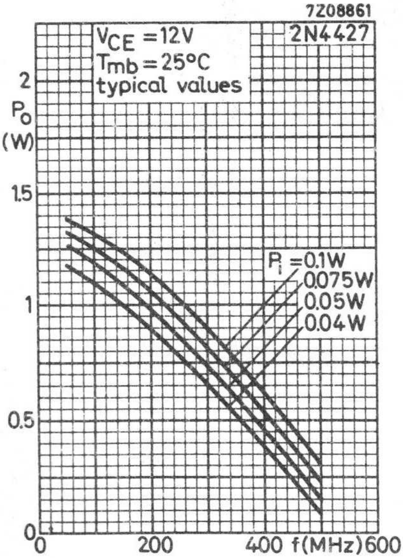

7Z10624
2N4427
see also adjacent graph
I_C (A)
10
1
10^{-1}
10^{-2}
1
10
10^2
V_{CE} (V)
I
II
III

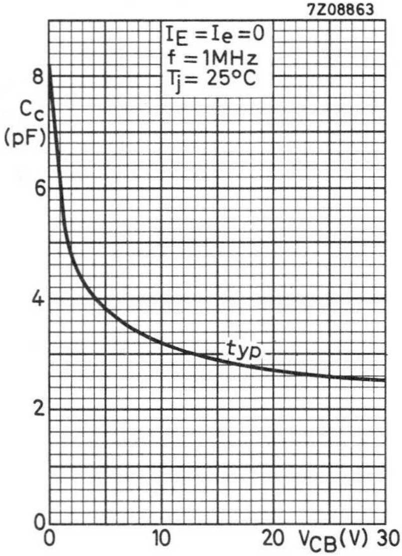
I Region of permissible operation under all base-emitter conditions and at all frequencies, including d.c.

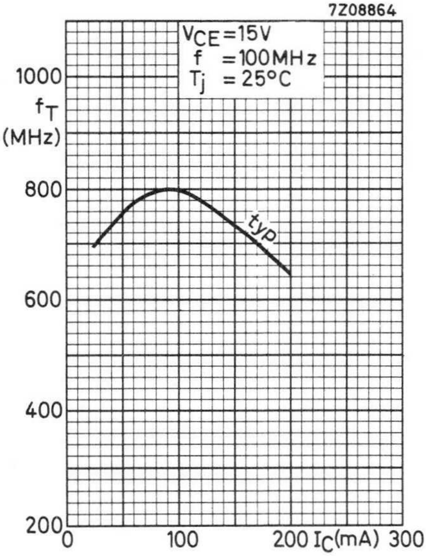
II Additional region of operation at f ≥ 1 MHz.
Care must be taken to reduce the d.c. adjustment to region I before removing the a.c. signal. This may be achieved by an appropriate bias in class A, B or C.

III Operating during switching off in this region is allowed, provided the transistor is cut-off with $-V_{BB} \leq 1.5$ V and $R_{BE} \geq 33\ \Omega$, $I_C \leq 100$ mA and the transient energy does not exceed 0.125 mWs.






7Z08863
$I_E = I_e = 0$
f = 1MHz
T_j = 25°C
C_c
(pF)
8
6
4
2
0
typ
0
10
20
V_{CB}(V)
30


7Z08864
V_{CE} = 15V
f = 100MHz
T_j = 25°C
f_T
(MHz)
1000
800
600
400
200
typ
0
100
200
I_C(mA)
300

SILICON EPITAXIAL PLANAR OVERLAY TRANSISTORS

The 2N3924 is a n-p-n overlay transistor in a TO-39 metal envelope with the collector connected to the case.
The 2N3926 and the 2N3927 are n-p-n overlay transistors in TO-60 metal envelopes with the emitter connected to the case.
The transistors are intended for v.h.f. transmitting applications.

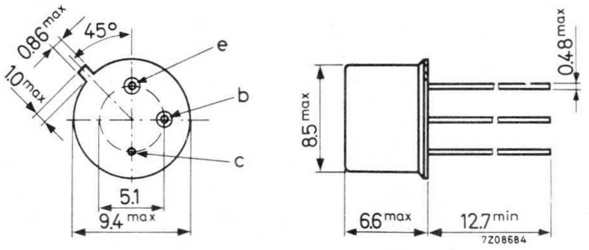
QUICK REFERENCE DATA

			2N3924	2N3926	2N3927	
Collector-emitter voltage $-V_{BE}$ = 1.5 V	V_{CEX}	max.	36	36	36	V
Collector-emitter voltage (open base)	V_{CEO}	max.	18	18	18	V
Collector current (peak value)	I_{CM}	max.	1.5	3.0	4.5	A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	7	11.6	23	W
Junction temperature	T_j	max.	200	200	200	°C
Transition frequency I_C = 100 mA; V_{CE} = 13.5 V	f_T	>	250	250		MHz
I_C = 200 mA; V_{CE} = 13.5 V	f_T	>			200	MHz

R.F. performance at V_{CE} = 13.5 V; f = 175 MHz			
	P_o (W)	P_i (W)	η (%)
2N3924	4	< 1	> 70
2N3926	7	< 2	> 70
2N3927	12	< 4	> 80

MECHANICAL DATA Dimensions in mm

2N3924
Collector connected to case
TO-39



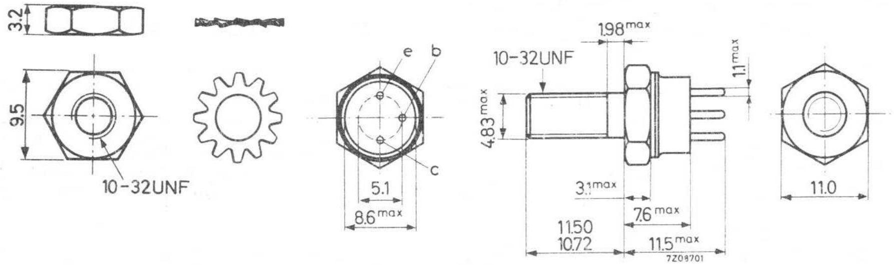
Accessories available: 56218, 56245, 56265.

MECHANICAL DATA (continued) Dimensions in mm

2N3926
2N3927
TO-60
The emitter connected to the case
The top pins should not be bent

Diameter of hole in heatsink: 4.8 to 5.2 mm
The device is supplied with nut and lock washer

Torque on nut: min. 8 cm kg
max. 17 cm kg



RATINGS (Limiting values) [1]

Voltages [2]

Collector-base voltage (open emitter)	V_{CBO}	max.	36	V
Collector-emitter voltage I_C up to 400 mA; $-V_{BE}$ = 1.5 V	V_{CEX}	max.	36	V
Collector-emitter voltage (open base) I_C up to 400 mA	V_{CEO}	max.	18	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4	V

			2N3924	2N3926	2N3927	
Currents [2]						
Collector current (d.c.)	I_C	max.	0.5	1.0	1.5	A
Collector current (peak value)	I_{CM}	max.	1.5	3.0	4.5	A
Power dissipation [2]						
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	7	11.6	23	W

Temperatures

Storage temperature	T_{stg}		-65 to +200	°C
Junction temperature	T_j	max.	200	°C

---

[1] Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

[2] See also areas of permissible operation at pages 8 and 9.

THERMAL RESISTANCE

			2N3924	2N3926	2N3927	
From junction to mounting base	$R_{th\ j\text{-}mb}$	=	25	15	7.5	°C/W
From mounting base to heatsink	$R_{th\ mb\text{-}h}$	=		0.6	0.6	°C/W
From mounting base to heatsink mounted with						
top clamping washer of 56218	$R_{th\ mb\text{-}h}$	=	1.0			°C/W
top clamping washer of 56218 and a boron nitride washer for electrical insulation	$R_{th\ mb\text{-}h}$	=	2.5			°C/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			2N3924	2N3926	2N3927	
Collector cut-off current						
$I_B = 0$; $V_{CE} = 15$ V	I_{CEO}	<	100	100	250	μA
$I_B = 0$; $V_{CE} = 15$ V; $T_j = 150$ °C	I_{CEO}	<	5	5	5	mA
Breakdown voltages						
$I_E = 0$; $I_C = 250$ μA	$V_{(BR)CBO}$	>	36	36	36	V
I_C up to 400 mA						
$-V_{BE} = 1.5$ V; $R_B = 33\ \Omega$ [1])	$V_{(BR)CEX}$	>	36	36	36	V
$I_B = 0$ [1])	$V_{(BR)CEO}$	>	18	18	18	V
$I_C = 0$; $I_E = 250$ μA	$V_{(BR)EBO}$	>	4	4	4	V
Base-emitter voltage						
$I_C =$ 250 mA; $V_{CE} = 5$ V	V_{BE}	<	1.5			V
$I_C =$ 500 mA; $V_{CE} = 5$ V	V_{BE}	<		1.5		V
$I_C =$ 1000 mA; $V_{CE} = 5$ V	V_{BE}	<			1.5	V
Saturation voltage						
$I_C =$ 250 mA; $I_B =$ 50 mA	V_{CEsat}	<	0.75			V
$I_C =$ 500 mA; $I_B =$ 100 mA	V_{CEsat}	<		0.75		V
$I_C =$ 1000 mA; $I_B =$ 200 mA	V_{CEsat}	<			1.0	V

---

[1]) Pulsed through an inductor of 25 mH; $\delta = 0.5$; f = 50 Hz

CHARACTERISTICS (continued) T_j = 25 °C unless otherwise specified

			2N3924	2N3926	2N3927	
D.C. current gain						
I_C = 250 mA; V_{CE} = 5 V	h_{FE}	>	10			
		<	150			
I_C = 500 mA; V_{CE} = 5 V	h_{FE}	>		5		
		<		150		
I_C = 1000 mA; V_{CE} = 5 V	h_{FE}	>			5	
		<			150	
Collector capacitance at f = 1 MHz						
$I_E = I_e = 0$; V_{CB} = 13.5 V	C_c	<	20	20	45	pF
Transition frequency						
I_C = 100 mA; V_{CE} = 13.5 V	f_T	>	250	250		MHz
I_C = 200 mA; V_{CE} = 13.5 V	f_T	>			200	MHz
Real part of input impedance at f = 200 MHz						
I_C = 100 mA; V_{CE} = 13.5 V	$Re(h_{ie})$	<	20	20		Ω
I_C = 200 mA; V_{CE} = 13.5 V	$Re(h_{ie})$	<			20	Ω

R.F. performance at V_{CE} = 28 V; f = 175 MHz

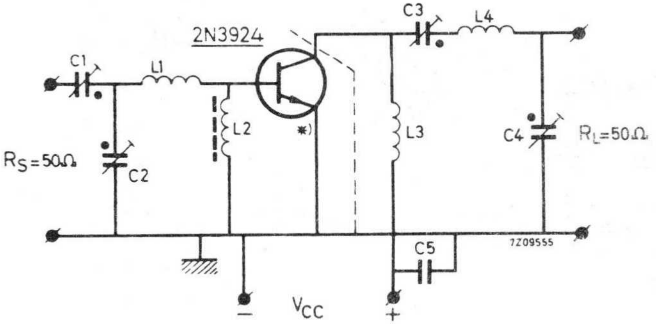
	P_o (W)	P_i (W)	I_C (mA)	η %	Test circuit at page
2N3924	4	< 1	< 420	> 70	5
2N3926	7	< 2	< 740	> 70	6
2N3927	12	< 4	< 1100	> 80	6

NOTE

The transistors can withstand an output V.S.W.R. of 3 : 1 varied through all phases under conditions mentioned in the table above.

CHARACTERISTICS (continued)

Test circuit with the 2N3924 at f = 175 MHz



*) The length of the external emitter wire of the 2N3924 is 1.6 mm.

Components

C1 = C2 = C3 = C4 = 4 to 29 pF air trimmer

C5 = 10 nF polyester

L1 = 1 turn Cu wire (1.0 mm); int. diam. 10 mm; leads 2 x 10 mm

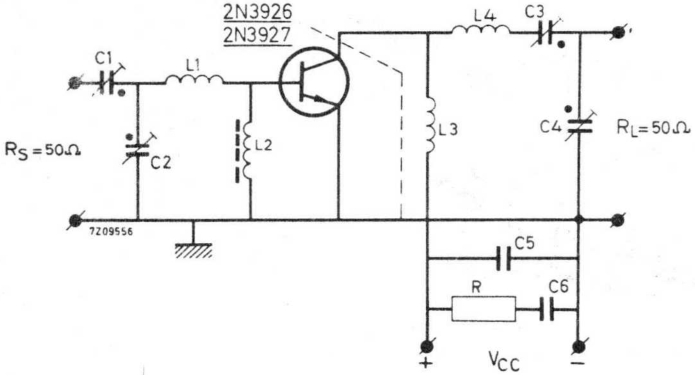
L2 = Ferroxcube choke coil. Z (at f = 175 MHz) = 550 Ω ± 20%
(code number 4312 020 36640)

L3 = 15 turns closely wound enamelled Cu wire (0.7 mm); int. diam. 4 mm

L4 = 3 turns closely wound enamelled Cu wire (1.5 mm); int. diam. 12 mm; leads 2 x 20 mm

CHARACTERISTICS (continued)

Test circuit with the 2N3926 or 2N3927 at f = 175 MHz



Components

C1 = C2 = C3 = C4 = 4 to 29 pF air trimmer

C5 = 100 pF ceramic

C6 = 10 nF polyester

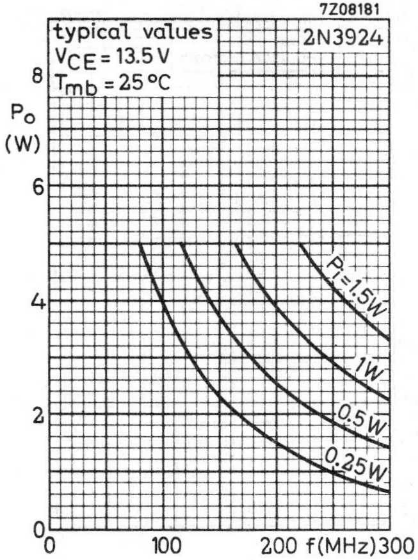
L1 = 1 turn Cu wire (1.0 mm); int. diam. 10 mm; leads 2 x 10 mm

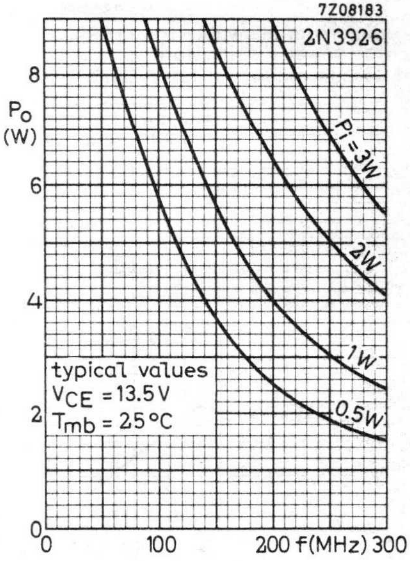
L2 = Ferroxcube choke coil. Z (at f = 175 MHz) = 550 Ω ± 20% (code number 4312 020 36640)

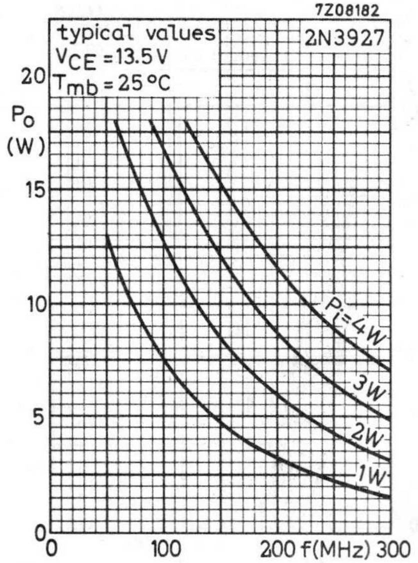
L3 = 15 turns closely wound enamelled Cu wire (0.7 mm); int. diam. 4 mm

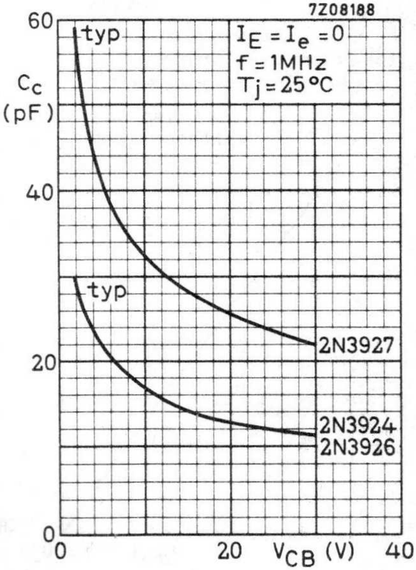
L4 = 2 turns closely wound enamelled Cu wire (1.5 mm); int. diam. 8.5 mm; leads 2 x 20 mm

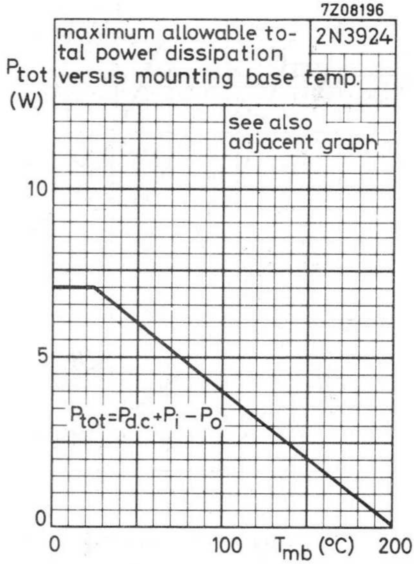
R = 10 Ω carbon

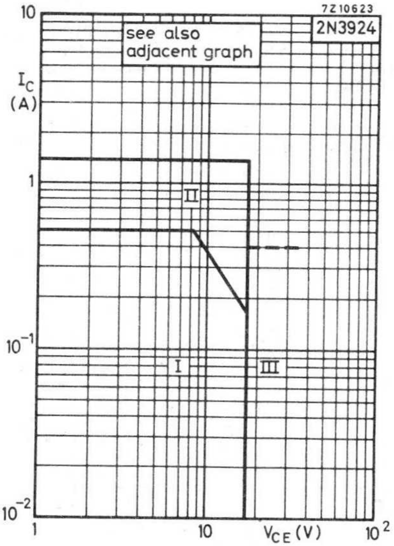

7Z08181
typical values
V_{CE} = 13.5 V
T_{mb} = 25 °C
2N3924
P_o (W)
0
2
4
6
8
0
100
200
f(MHz)
300
P_i = 1.5W
1W
0.5 W
0.25 W

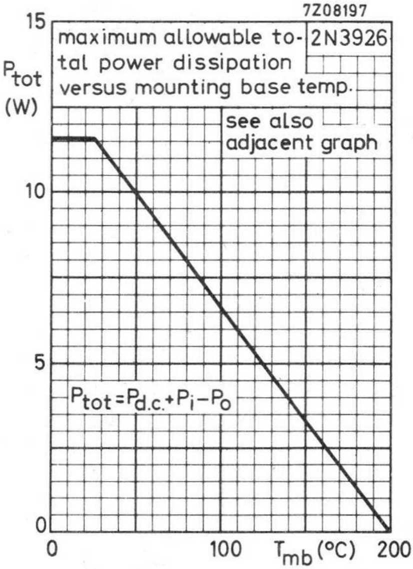

7Z08183
2N3926
P_o (W)
0
2
4
6
8
0
100
200
f(MHz)
300
P_i = 3W
2W
1W
0.5W
typical values
V_{CE} = 13.5 V
T_{mb} = 25 °C

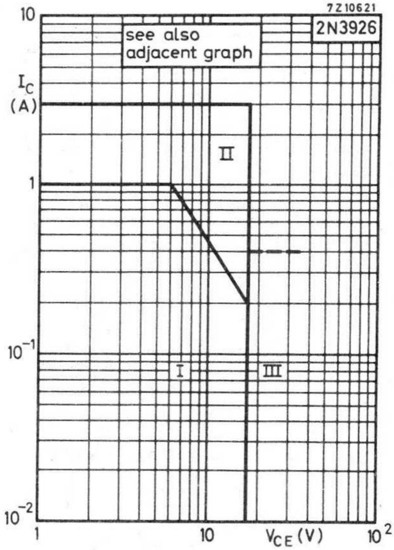

7Z08182
typical values
V_{CE} = 13.5 V
T_{mb} = 25 °C
2N3927
P_o (W)
0
5
10
15
20
0
100
200
f(MHz)
300
P_i = 4W
3W
2W
1W

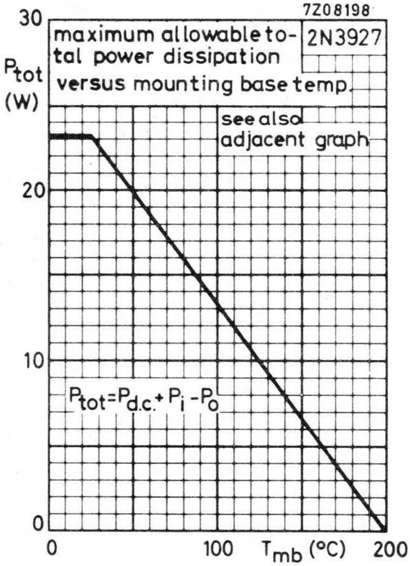

7Z08188
C_c (pF)
0
20
40
60
typ
typ
$I_E = I_e = 0$
f = 1MHz
T_j = 25 °C
2N3927
2N3924
2N3926
0
20
V_{CB} (V)
40

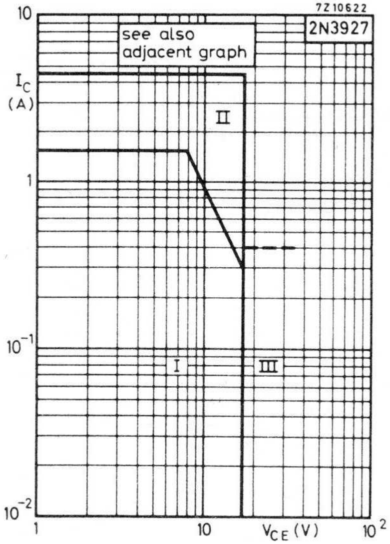

7Z08196
maximum allowable total power dissipation versus mounting base temp.
2N3924
see also adjacent graph
P_{tot} (W)
10
5
0
$P_{tot}=P_{d.c.}+P_i-P_o$
0
100
T_{mb} (°C)
200


7Z10623
2N3924
see also adjacent graph
I_C (A)
10
1
10^{-1}
10^{-2}
II
I
III
1
10
V_{CE} (V)
10^2


7Z08197
maximum allowable total power dissipation versus mounting base temp.
2N3926
see also adjacent graph
15
P_{tot} (W)
10
5
0
$P_{tot}=P_{d.c.}+P_i-P_o$
0
100
T_{mb} (°C)
200


7Z10621
2N3926
see also adjacent graph
I_C (A)
10
1
10^{-1}
10^{-2}
II
I
III
1
10
V_{CE} (V)
10^2

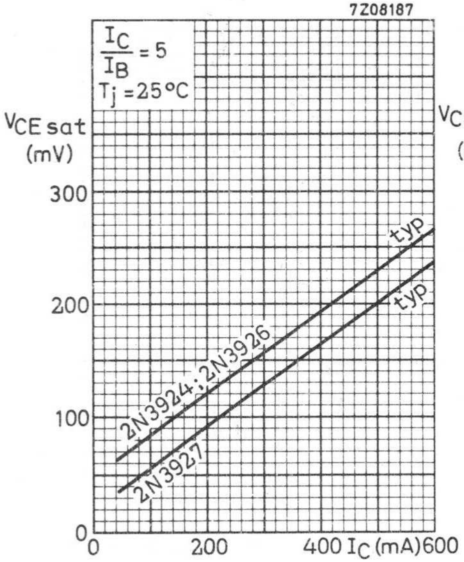


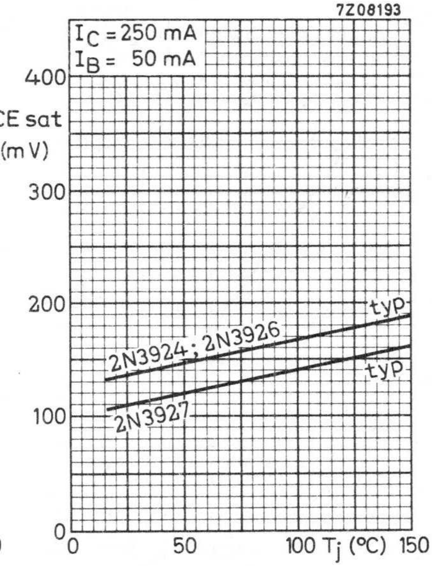


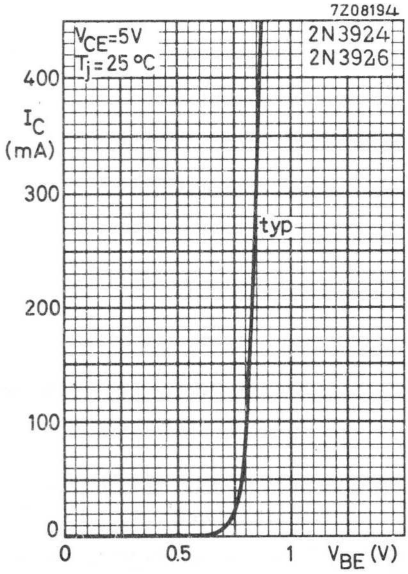
I Region of permissible operation under all base-emitter conditions and at all frequencies, including d.c.

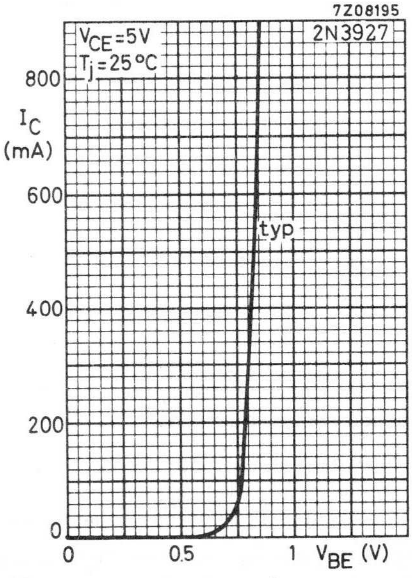
II Additional region of operation at f ≥ 1 MHz.
Care must be taken to reduce the d.c. adjustment to region I before removing the a.c. signal. This may be achieved by an appropriate bias in class A, B or C.

III Operating during switching off in this region is allowed, provided the transistor is cut-off with $-V_{BB} \leq 1.5$ V and $R_{BE} \geq 33\ \Omega$, $I_C \leq 400$ mA and the transient energy does not exceed 2 mWs.

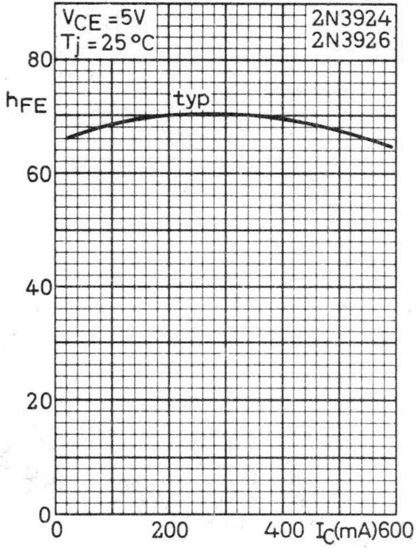

7Z08187
$\frac{I_C}{I_B} = 5$
$T_j = 25\,°C$
$V_{CE\,sat}$ (mV)
300
200
100
0
0
200
400 I_C (mA) 600
typ
typ
2N3924; 2N3926
2N3927


7Z08193
$I_C = 250$ mA
$I_B = 50$ mA
400
$V_{CE\,sat}$ (mV)
300
200
100
0
0
50
100 T_j (°C) 150
typ
2N3924; 2N3926
typ
2N3927

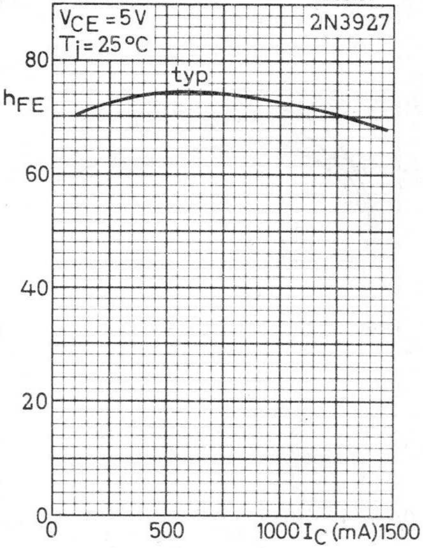

7Z08194
$V_{CE} = 5$ V
$T_j = 25\,°C$
2N3924
2N3926
400
I_C (mA)
300
200
100
0
0
0.5
1 V_{BE} (V)
typ


7Z08195
$V_{CE} = 5$ V
$T_j = 25\,°C$
2N3927
800
I_C (mA)
600
400
200
0
0
0.5
1 V_{BE} (V)
typ

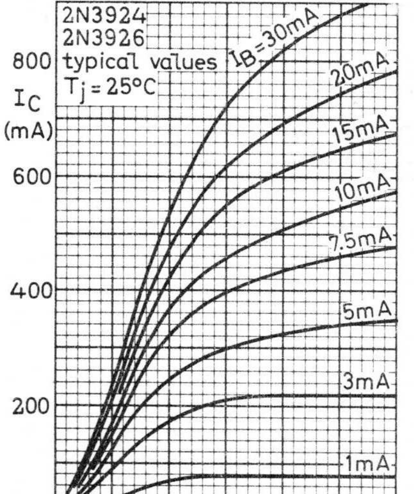
7Z08189



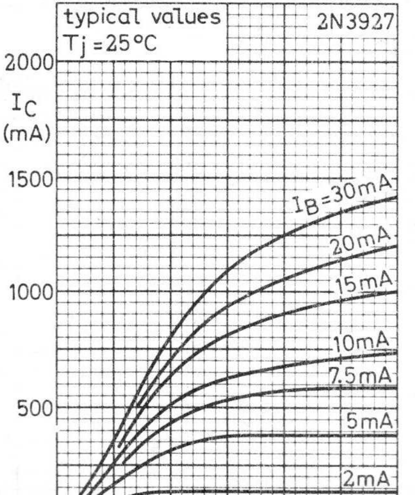
7Z08191

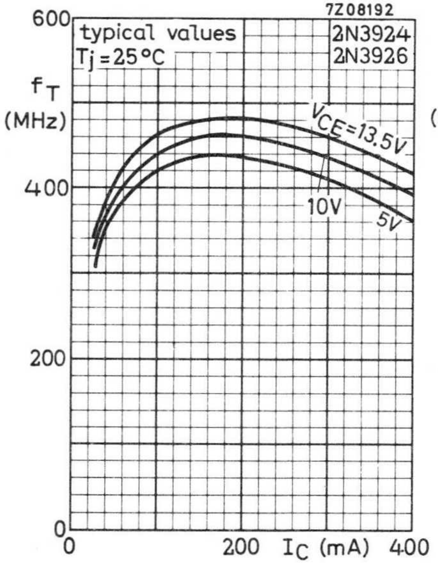


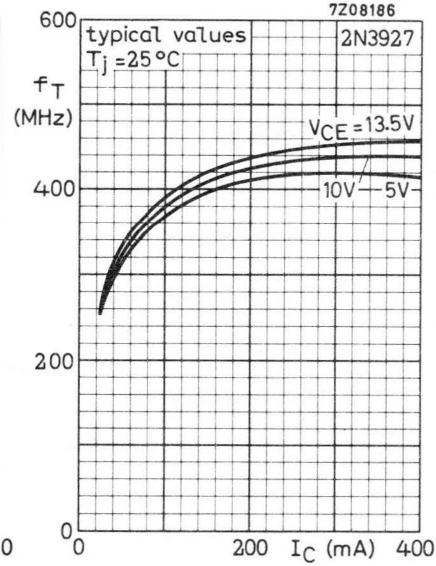
7Z08184

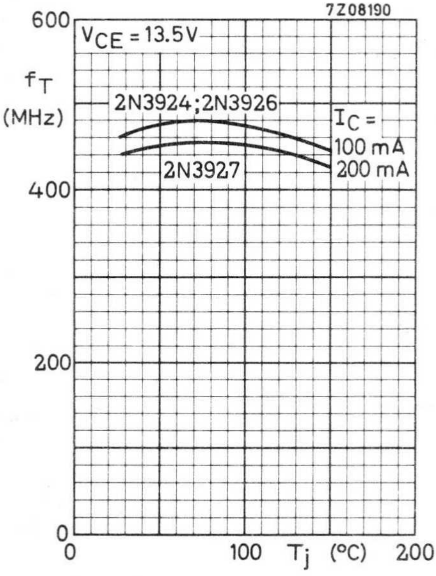


7Z08185




7Z08192
typical values
Tj = 25 °C
2N3924
2N3926
fT
(MHz)
600
400
200
0
0
200
IC (mA)
400
VCE = 13.5V
10V
5V


7Z08186
typical values
Tj = 25 °C
2N3927
fT
(MHz)
600
400
200
0
0
200
IC (mA)
400
VCE = 13.5V
10V
5V


7Z08190
VCE = 13.5V
fT
(MHz)
600
400
200
0
0
100
Tj (°C)
200
2N3924;2N3926
2N3927
IC =
100 mA
200 mA

SILICON EPITAXIAL PLANAR OVERLAY TRANSISTOR

For data of this transistor please refer to type 2N3866

Microwave devices

MICROWAVE MIXER DIODES

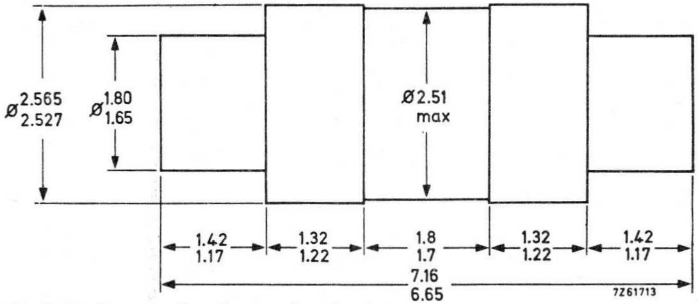
Subminiature germanium point-contact mixer diodes primarily intended for low noise mixer applications at X-band.

QUICK REFERENCE DATA

Frequency range		f		1.0 to 18	GHz
Noise figure	AAY39	F	typ.	6.0	dB
	AAY39A	F	typ.	7.0	dB

MECHANICAL DATA

Dimensions in mm



The cathode indicates the electrode which becomes positive in an a.c. rectifier circuit.

The cathode is marked red

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Burn-out				
D.C. spike		max.	0.1	erg
R.F. spike		max.	0.05	erg
Pulse peak power (t_p = 0.5 μs)		max.	0.5	W
Temperatures				
Storage temperature	T_{stg}		−55 to +100	°C
Operating ambient temperature	T_{amb}		−55 to +100	°C

CHARACTERISTICS T_{amb} = 25 °C

Reverse current at V_R = 0.5 V		I_R	typ.	3.0	μA
Forward current at V_F = 0.5 V		I_F	typ.	5.0	mA
Overall noise figure [1]	AAY39	F	typ.	6.0	dB
				5.5 to 6.5	dB
	AAY39A	F	typ.	7.0	dB
			<	7.5	dB
Conversion loss	AAY39		typ.	4.2	dB
	AAY39A		typ.	5.0	dB
Noise temperature ratio					
i.f. = 45 MHz	AAY39		typ.	1.1 : 1	
	AAY39A		typ.	1.2 : 1	
Voltage standing wave ratio		V.S.W.R.	<	1.43 : 1	
Intermediate frequency impedance		Z_{if}		250 to 450	Ω
Operating frequency range		f		1.0 to 18	GHz

NOTE

Optimum performance is obtained when the oscillator drive is adjusted to give a diode rectified current of 1.0 mA and the load resistance is restricted to max. 100 Ω

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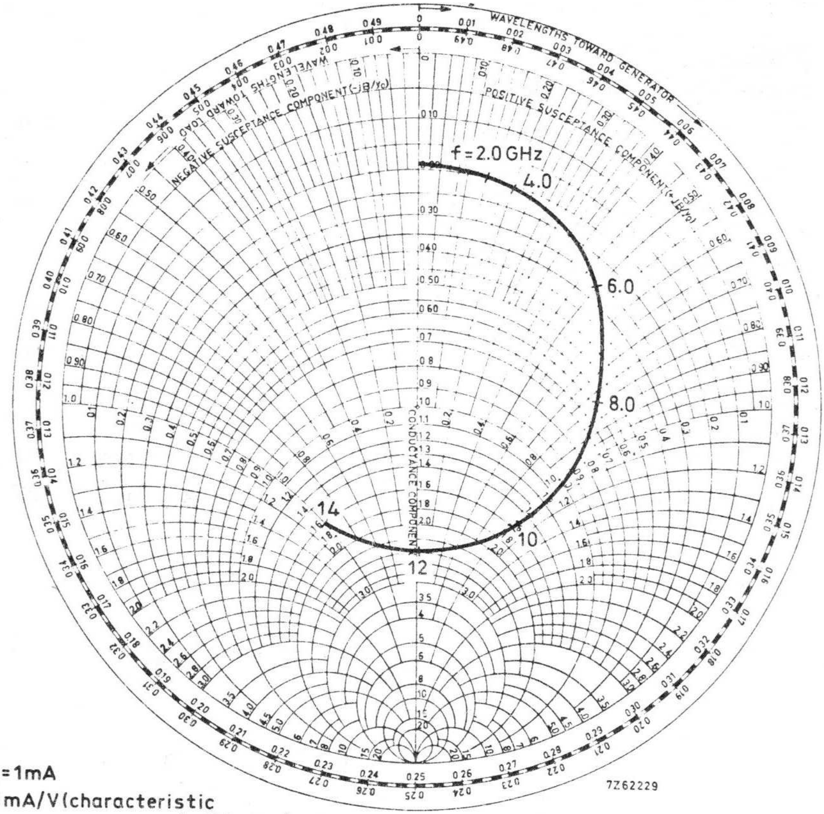
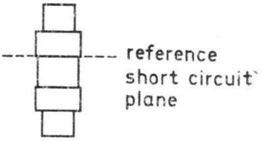
[1] Measured at 9.375 GHz, 1.0 mA diode rectified current, R_L = 15 Ω, this value includes i.f. noise of 1.5 dB.



$I_{F(AV)} = 1\text{mA}$
$y_0 = 20\text{mA/V}$ (characteristic admittance)

7Z62229



7Z62230

APPLICATION INFORMATION

1. Mixer performance

Measured overall noise figure

f = 16.5 GHz; F_{if} = 1.5 dB; i.f. = 45 MHz	F	typ.	7.0	dB
f = 3.0 GHz; F_{if} = 1.5 dB; i.f. = 45 MHz	F	typ.	5.5	dB
f = 9.5 GHz; i.f. = 3.0 kHz	F	typ.	29	dB

2. Signal/Flicker noise ratio at 9.5 GHz

measured at 2.0 kHz from carrier in a 70 Hz bandwidth			131	dB

3. Detector performance

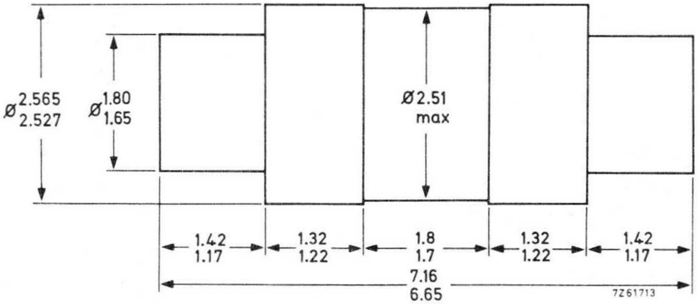
Tangential sensitivity f = 9.375 GHz; B = 1.0 MHz; I_F = 50 μA		typ.	−52	dBm
Video impedance; I_F = 50 μA	Z_{iv}	typ.	800	Ω

MICROWAVE MIXER DIODE

Subminiature germanium point-contact mixer diode for use at Q-band (Ka-band)

QUICK REFERENCE DATA			
Frequency range		26 to 40	GHz
Noise figure	typ.	8.5	dB

MECHANICAL DATA Dimensions in mm



The cathode is marked red

The cathode indicates the electrode which becomes positive in an a.c. rectifier circuit.

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Burn-out			
R.F. spike		max.	0.03 erg
Pulse peak power ($t_p = 0.2\ \mu s$)		max.	0.5 W
Temperatures			
Storage temperature	T_{stg}		-55 to +100 °C
Operating ambient temperature	T_{amb}		-55 to +100 °C

CHARACTERISTICS $T_{amb} = 25$ °C

Reverse current at $V_R = 0.5$ V	I_R	typ.	2.0 μA
Forward current at $V_F = 0.5$ V	I_F	typ.	2.0 mA
Overall noise figure [1]	F	typ. <	8.5 dB 10 dB
Conversion loss		typ.	5.5 dB
Noise temperature ratio; i.f. = 45 MHz			1.6 : 1
Voltage standing wave ratio [2]	V.S.W.R.	typ. <	1.4 : 1 1.8 : 1
Intermediate frequency impedance	Z_{if}	typ.	1000 Ω 700 to 1400 Ω
Operating frequency range			26 to 40 GHz

MATCHED PAIRS

The diodes can be supplied in matched pairs under the typenumber 2-AAY59M.
The diodes are matched to ±10% on rectified current and within 150 Ω i.f. impedance

---

[1] Measured at 34.86 GHz, 0.5 mA diode rectified current, this value includes i.f. noise of 1.5 dB

[2] With respect to standard test holder

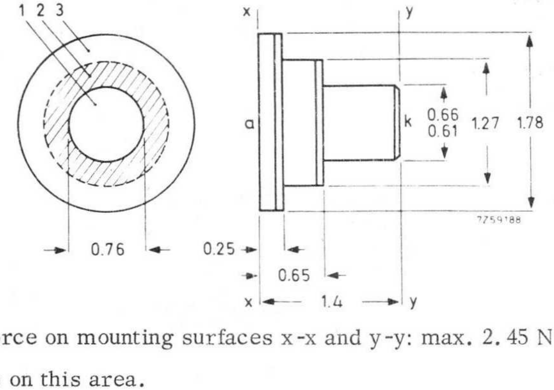
GERMANIUM TUNNEL DIODES

Germanium tunnel diodes for use as low noise microwave amplifiers in S-band. The device is mounted in a small ceramic-metal case with hermetic welded seal.

QUICK REFERENCE DATA

			AEY13	AEY15	AEY16	
Resistive cut-off frequency	f_r	>	6	8	10	GHz
Noise measure	N_S	typ.	1. 3	1. 3	1. 3	
Peak point current	I_P	>	1. 8	1. 8	1. 8	mA
Peak point voltage	V_P	typ.	50	50	50	mV
Valley point voltage	V_V	typ.	300	300	300	mV
Peak to valley point current ratio	I_P/I_V	typ.	10	10	10	

MECHANICAL DATA Dimensions in mm



Compression force on mounting surfaces x-x and y-y: max. 2. 45 N

1. Do not press on this area.
2. Preferred area of pressure.
3. Take care not to flex the flange.

Contact to the diode should be made by means of a resilient arrangement so that it is not possible to apply undue force. If for example, in a microwave circuit contact is made between a plunger and a flat surface then the plunger should be actuated through a spring.

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Junction temperature	T_j	-40 to $+70$	^oC

CHARACTERISTICS $T_{amb} = 25^oC$ unless otherwise specified

Peak point voltage	V_P	typ.	50	mV
Valley point voltage	V_V	typ.	300	mV
Peak point current	I_P		1.8 to 2.3	mA
Peak-valley current ratio	I_P/I_V	typ.	10	

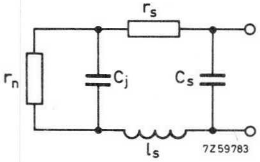
Resistive cut-off frequency

$$f_r = \frac{1}{2\pi . r_n . C_j}\sqrt{\frac{r_n}{r_s} - 1}$$

			AEY13	AEY15	AEY16	
	f_r	>	6	8	10	GHz
		typ.	7	9	11	GHz
		<	14	14	14	GHz
Junction capacitance at V_V	C_j	typ.	3.2	2.5	2.0	pF

Stray capacitance	C_s	typ.	0.3	pF
Series inductance	l_s	typ.	120	pH
Series resistance	r_s	typ.	1.0	Ω
		<	2.0	Ω
Negative resistance at inflexion point	r_n	typ.	50	Ω
Noise measure ¹)	N_s	typ.	1.3	

EQUIVALENT CIRCUIT



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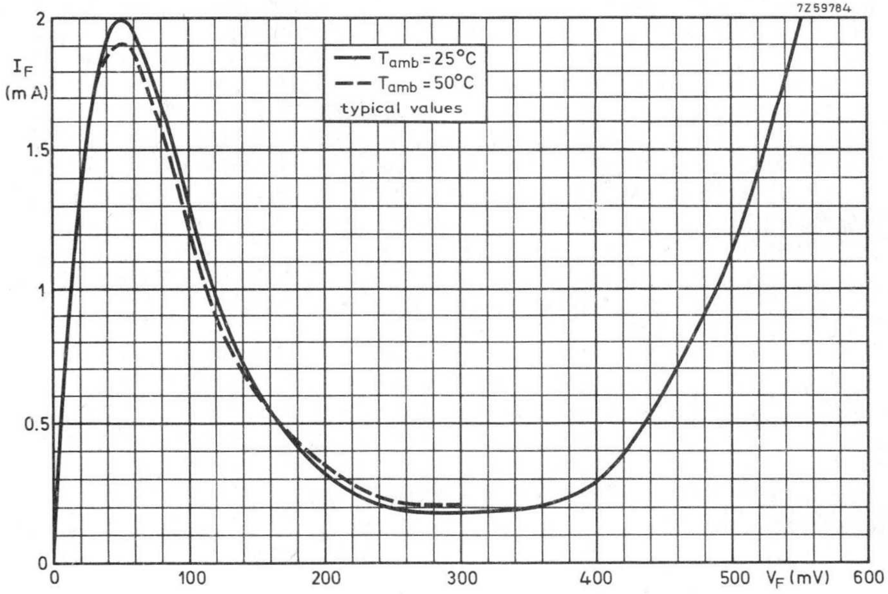
¹) $N_S \approx 20\ I_F . r_n$ if biased in the negative resistance region.


7Z59784
I_F (mA)
2
1.5
1
0.5
0
$T_{amb} = 25°C$
$T_{amb} = 50°C$
typical values
0
100
200
300
400
500
V_F (mV)
600

MICROWAVE MIXER DIODES

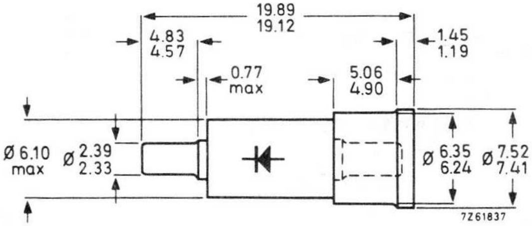
Silicon Schottky barrier mixer diodes in a DO-23 envelope.

QUICK REFERENCE DATA				
Noise figure in X-band	BAW95D:	F	$<$ 8.2	dB
	BAW95E:	F	$<$ 7.5	dB
	BAW95F:	F	$<$ 7.0	dB

MECHANICAL DATA

Dimensions in mm

DO-23



Symbol indicates polarity

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC134)

Total power dissipation (peak value)

f = 9.375 GHz; t_p = 0.5 μs	P_{tot}	max.	1	W

Burn-out

Multiple r.f. spike; ΔF = 1 dB		max.	2×10^{-8}	J
		max.	0.2	erg

Temperatures

Storage temperature	T_{stg}	−55 to +150	°C
Ambient temperature	T_{amb}	−55 to +150	°C

CHARACTERISTICS T_{amb} = 25 °C

Overall noise figure at f = 9.375 GHz

$I_{F(AV)}$ = 1 mA; R_L = 15 Ω

F includes F_{if} = 1.5 dB with 45 MHz i.f.

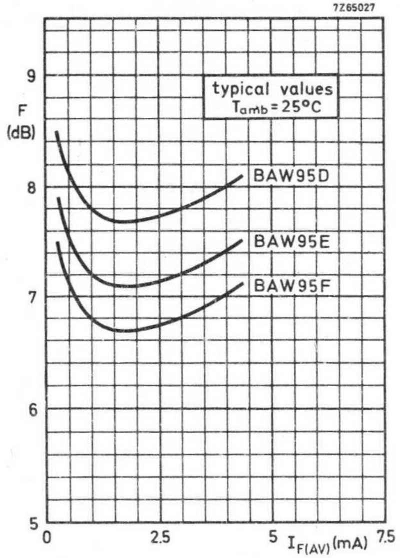
BAW95D:	F	typ.	7.8	dB
		<	8.2	dB
BAW95E:	F	typ.	7.2	dB
		<	7.5	dB
BAW95F:	F	typ.	6.8	dB
		<	7.0	dB

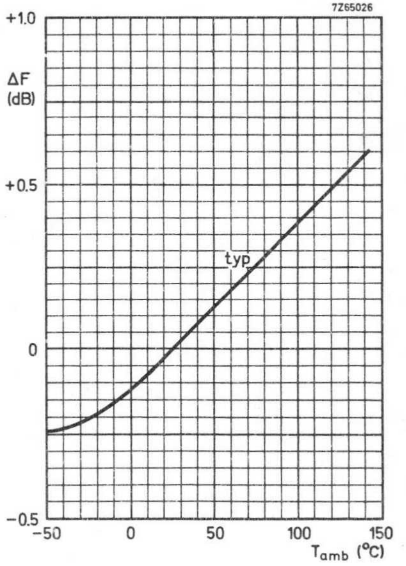
Voltage standing wave ratio at f = 9.375 GHz

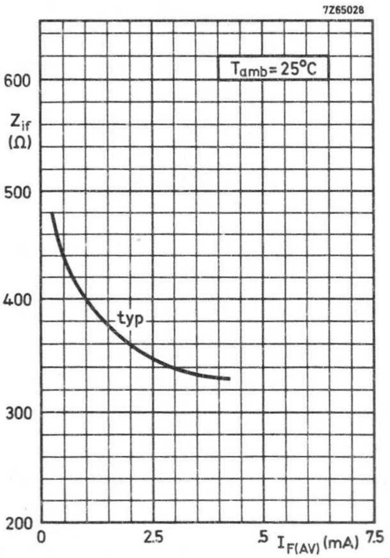
$I_{F(AV)}$ = 1 mA; R_L = 15 Ω; socket: JAN-106	V.S.W.R.	<	1.3

Intermediate frequency impedance	Z_{if}	typ.	400	Ω
			250 to 500	Ω

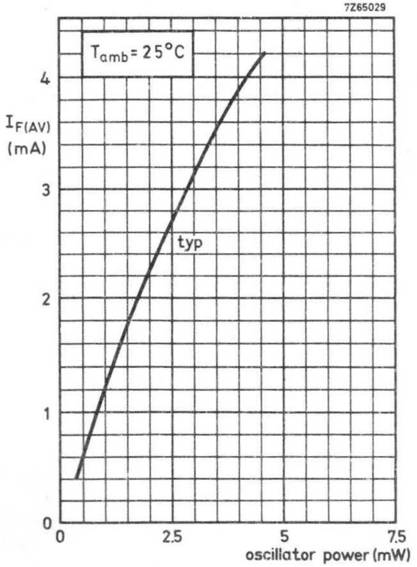
for use in an adjustable JAN106 holder







this graph holds for a pretuned holder



SILICON DOUBLE DIFFUSED VARACTOR DIODE

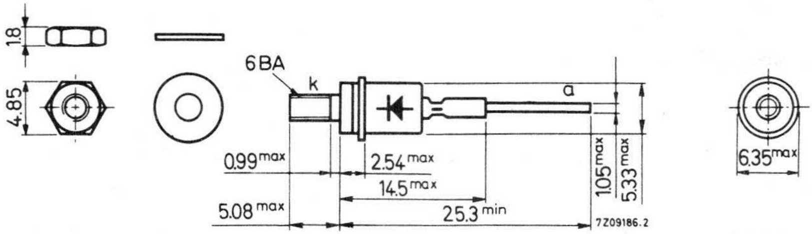
Varactor diode in a metal envelope primarily intended for use in frequency multiplier circuits with output frequencies up to 1000 MHz.

QUICK REFERENCE DATA

Continuous reverse voltage	V_R	max.	100	V
Total power dissipation up to T_{mb} = 30 °C	P_{tot}	max.	12	W
Junction temperature	T_j	max.	150	°C
Total capacitance at f = 10 MHz V_R = 100 V	C_d		4.0 to 6.0	pF
Diode series resistance at f = 250 MHz V_R = 48 V	r_D	max.	1.3	Ω
Cut-off frequency $\frac{1}{2\pi r_D (C_d \text{ at } V_{Rmax})}$	f_{co}	> typ.	20 25	GHz GHz

MECHANICAL DATA Dimensions in mm

Supplied with the device: Nut and lock washer



Diameter of hole in heatsink: 2.87 mm

RATINGS (Limiting values) [1]

Voltage				
Continuous reverse voltage	V_R	max.	100	V
Current				
Repetitive peak forward current	I_{FRM}	max.	400	mA
Power dissipation				
Total power dissipation up to T_{mb} = 30 °C	P_{tot}	max.	12	W
T_{amb} = 30 °C	P_{tot}	max.	1	W
Temperatures				
Storage temperature	T_{stg}		−55 to +150	°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	120	°C/W
From junction to mounting base	$R_{th\ j\text{-}mb}$	=	10	°C/W

CHARACTERISTICS T_j = 25 °C unless otherwise specified

Reverse current (d.c.)				
V_R = 100 V	I_R	typ.	0.1	μA
		<	10	μA
V_R = 100 V; T_j = 150 °C	I_R	typ.	8	μA
		<	200	μA
Total capacitance at f = 10 MHz				
V_F = 0.5 V	C_d	typ.	65	pF
V_R = 0	C_d	typ.	25	pF
V_R = 100 V	C_d		4 to 6	pF
Stray capacitance	C_s	typ.	1.4	pF
Diode series inductance	L_d	typ.	13	nH
Diode series resistance at f = 250 MHz				
V_R = 48 V	r_D	typ.	1.3	Ω
		<	2.0	Ω
Cut-off frequency $\frac{1}{2\pi r_D(C_d \text{ at } V_{Rmax})}$	f_{co}	>	20	GHz
		typ.	25	GHz

---

[1] Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

SILICON PLANAR EPITAXIAL VARACTOR DIODE

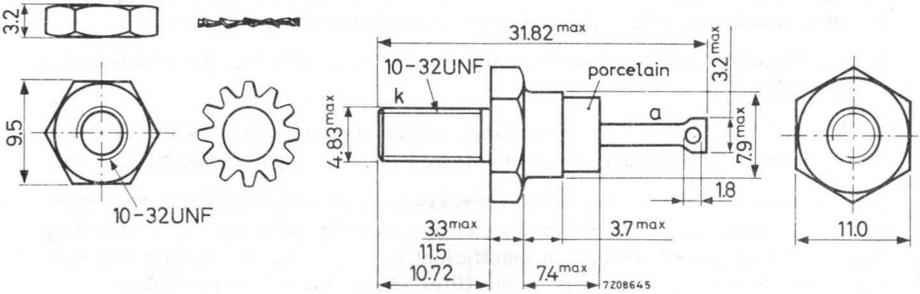
Varactor diode with a very low series resistance, in a low inductance, hermetically sealed, welded ceramic-metal DO-4 envelope.
The BAY96 is a high efficiency frequency multiplier designed for use in the v.h.f. and u.h.f. regions.
With the reverse voltage rating of 120 V, it can handle an input power up to 40 W.

QUICK REFERENCE DATA

Continuous reverse voltage	V_R	max.	120	V
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	20	W
Junction temperature	T_j	max.	175	°C
Total capacitance at f = 1 MHz				
V_R = 6 V	C_d		28 to 39	pF
Diode series resistance at f = 400 MHz				
V_R = 6 V	r_D	max.	1.2	Ω
Cut-off frequency $\frac{1}{2\pi r_D C_d}$ at V_R = 120 V	f_{co}	typ.	25	GHz

MECHANICAL DATA Dimensions in mm

DO-4



Diameter of hole in heatsink: max. 5.2 mm
Accessories available: 56295 (56262A)

Torque on nut: min. 8 cm kg
max. 17 cm kg

RATINGS (Limiting values) [1]

Voltage

Continuous reverse voltage	V_R	max.	120	V

Power dissipation

Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	20	W

Temperatures

Storage temperature	T_{stg}	-65 to +175		°C
Junction temperature	T_j	max.	175	°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	7.5	°C/W

CHARACTERISTICS

Total capacitance at f = 1 MHz				
V_R = 6 V	C_d	28 to	39	pF
Diode series resistance at f = 400 MHz				
V_R = 6 V	r_D	typ. <	0.9 1.2	Ω Ω
Cut-off frequency $\frac{1}{2\pi r_D C_d}$ at V_R = 120 V	f_{co}	typ.	25	GHz

APPLICATION INFORMATION

Frequency tripler 150 to 450 MHz

The tripler circuit at page 3 consists of a parallel connection of the varactor, the input and output circuits, and the idler circuits. This shunt configuration has two outstanding advantages for high power harmonic generation.

1. The varactor can be grounded on one side, thus utilizing the chassis as a heatsink.
2. The varactor, being a low impedance device, operates best in a circuit that requires a low impedance coupling element between input and output circuits.

The function of the input and output networks is to provide impedance matching, and at the same time eliminate undesired r.f. current components, minimizing losses. A single tuned circuit is insufficient for the reduction of spurious response and therefore, a suitable output filter should follow the multiplier.

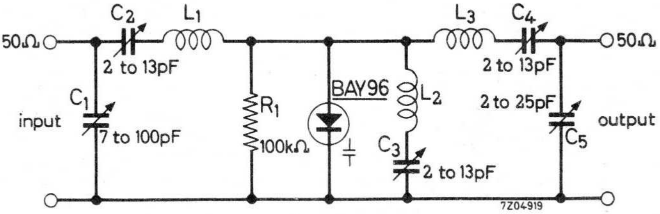
---

[1] Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

APPLICATION INFORMATION (continued)

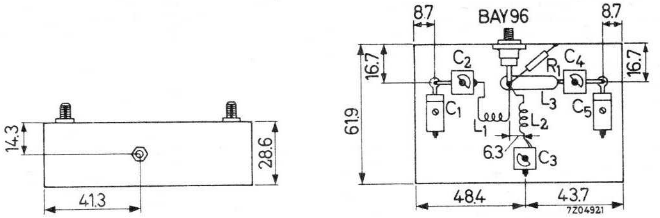
140 to 450 MHz tripler circuit

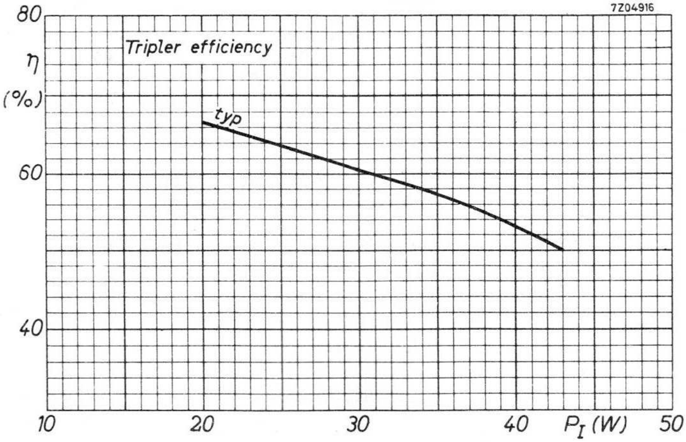
Efficiency at P_I = 25 W	η	>	60	%
		typ.	64	%

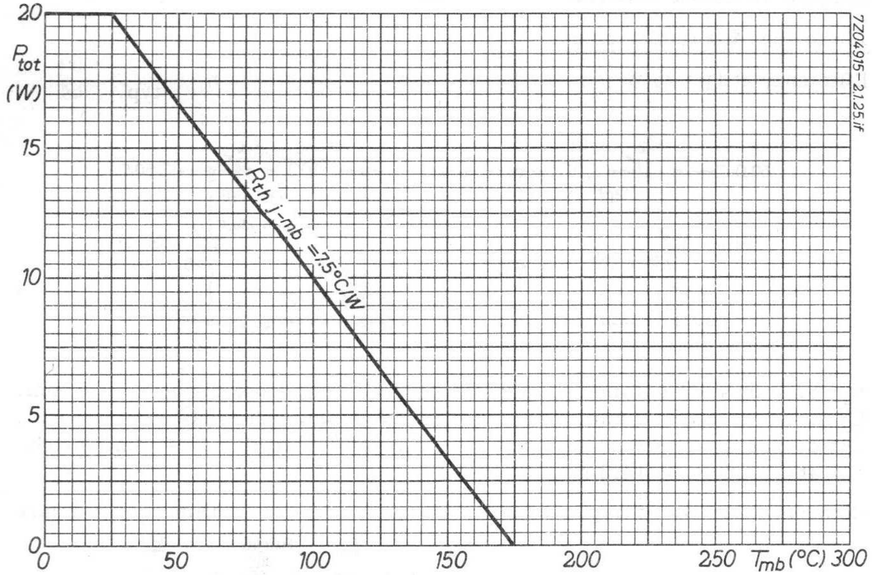


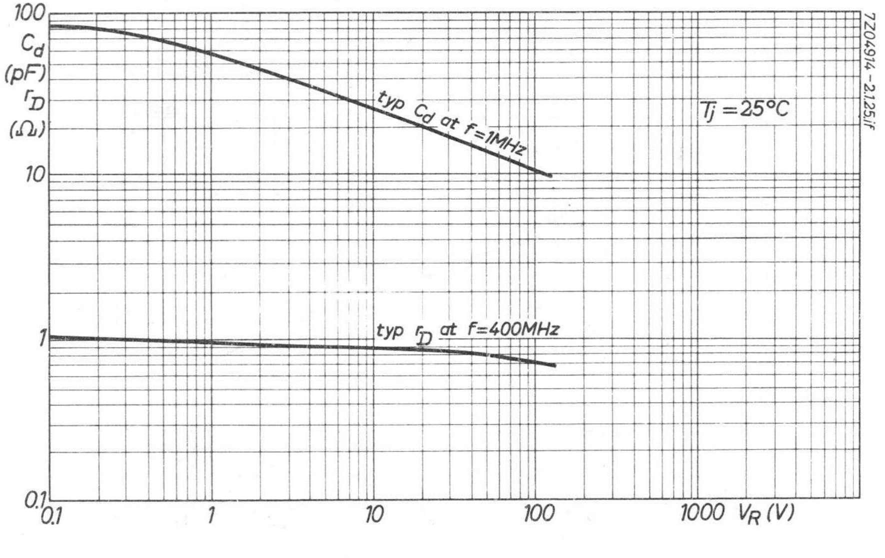
L_1 = 6.5 turns; d = 1.3 mm. Length of coil: 14.3 mm, inner diameter: 7.5 mm.
L_2 = 2 turns; d = 2 mm. Length of coil: 7.9 mm, inner diameter: 6.7 mm.
L_3 = copper strip, cross section 6.3 x 0.5 mm^2, length: 25.4 mm, height above chassis: 14.3 mm.

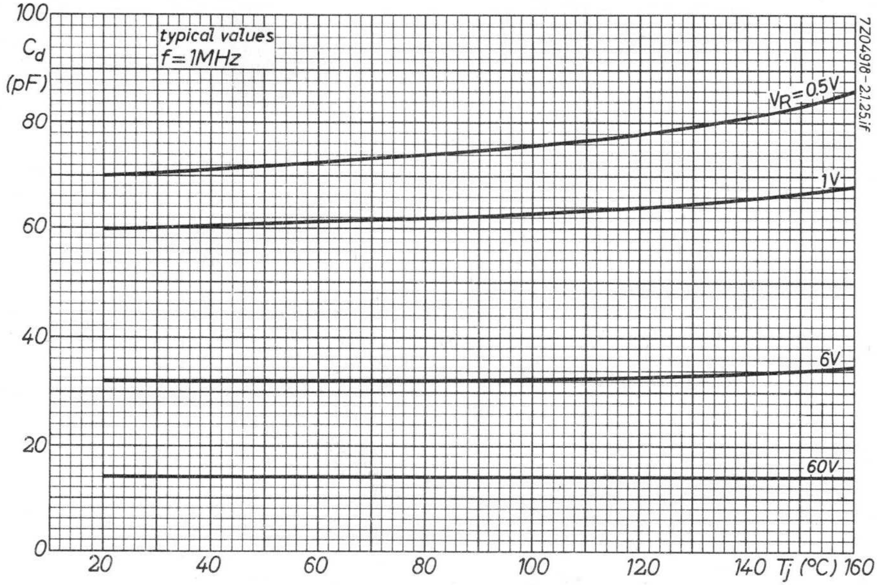
Component lay-out of tripler circuit: Dimensions in mm

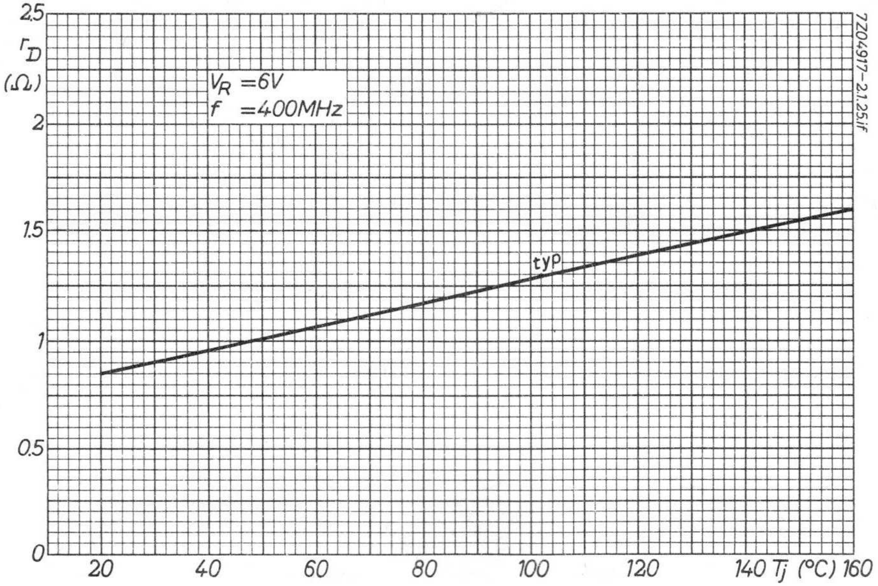





20
P_{tot}
(W)
15
10
5
0
0
50
100
150
200
250
T_{mb} (°C)
300
$R_{th\ j-mb}$ =7,5°C/W
7Z04915-2.1.25.if


100
C_d
(pF)
r_D
(Ω)
10
1
0.1
0.1
1
10
100
1000
V_R (V)
typ C_d at f=1MHz
typ r_D at f=400MHz
T_j =25°C
7Z04914-2.1.25.if


100
C_d
(pF)
80
60
40
20
0
typical values
f=1MHz
V_R=0.5V
1V
6V
60V
20
40
60
80
100
120
140 T_j (°C) 160
7Z04918-2.1.25.if


2.5
r_D
(Ω)
2
1.5
1
0.5
0
V_R =6V
f =400MHz
typ
20
40
60
80
100
120
140 T_j (°C) 160
7Z04917-2.1.25.if

SILICON VARACTOR DIODE

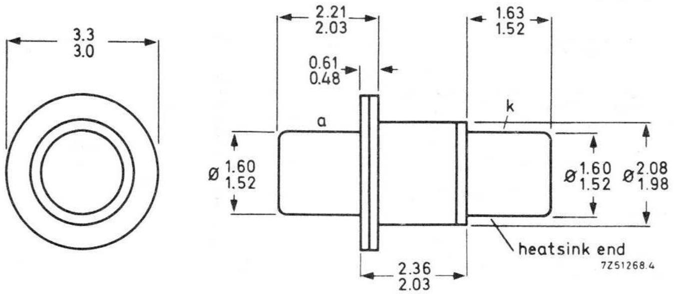
The BXY27 is a silicon planar epitaxial varactor diode exhibiting step recovery characteristics, especially suitable for use in frequency multiplier circuits up to S-band output frequency and 10 W input power.
The device is mounted in a small double ended ceramic-metal case with hermetic seal. The diode is packed in a container.

QUICK REFERENCE DATA

Input power (doubler 1 to 2 GHz)	P_i	<	10	W
Output power (doubler 1 to 2 GHz)	P_o	>	5	W
Junction temperature	T_j	max.	175	°C
Cut-off frequency	f_c	typ.	100	GHz
Diode capacitance	C_d	typ.	4.5	pF

MECHANICAL DATA

Dimensions in mm



Type marking on the container

The heat should be transferred via the cathode pin.

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Reverse voltage	V_R	max.	55	V
Total power dissipation up to T_{pin} = 95 °C	P_{tot}	max.	4	W
Storage temperature	T_{stg}	-65 to +175		°C
Junction temperature	T_j	max.	175	°C

THERMAL RESISTANCE

From junction to pin	$R_{th\ j\text{-}pin}$	=	20	°C/W

CHARACTERISTICS

T_{amb} = 25 °C unless otherwise specified

Reverse current at V_R = 6 V

	I_R	typ. <	1 1	nA μA

Cut-off frequency at V_R = 6 V

$$f_c = \frac{1}{2\pi r_d(C_d - C_{str})}$$

	f_c	> typ.	50 100	GHz GHz

Diode capacitance at f = 1 MHz

V_R = 6 V(C_d includes C_{str})	C_d	typ. 3.0 to	4.5 6.5	pF pF
Stray capacitance	C_{str}	typ.	0.25	pF
Diode series inductance	L_d	typ.	650	pH

Diode series resistance at f = 2 GHz

V_R = 6 V	r_d	typ.	0.4	Ω

Overall efficiency in frequency doubler circuit on page 3

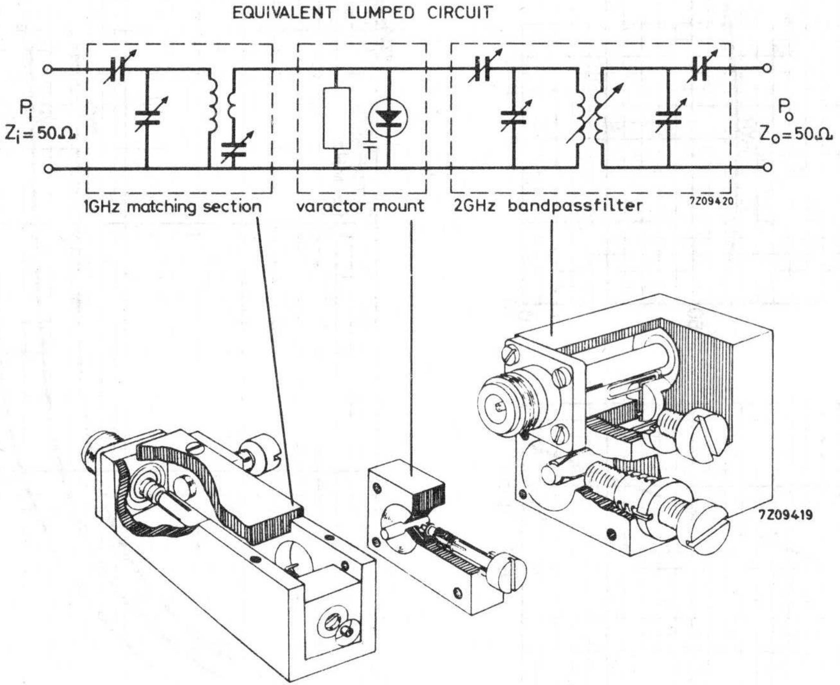
P_i = 10 W: f_i = 1 GHz	η	> typ.	50 60	% %

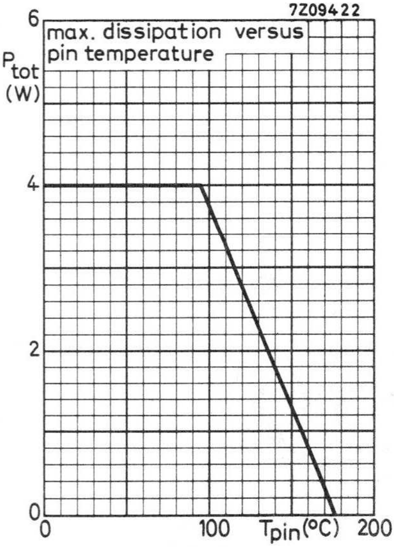
Overall efficiency in frequency tripler circuit

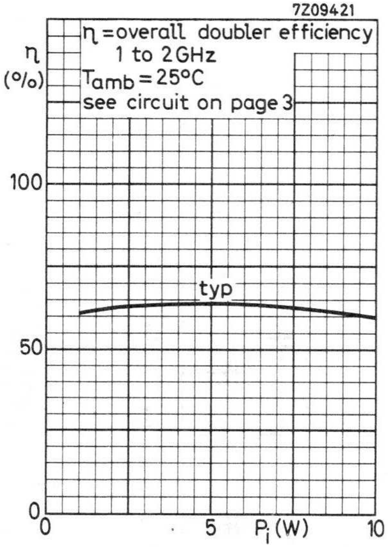
P_i = 10 W: f_i = 1 GHz	η	typ.	40	%

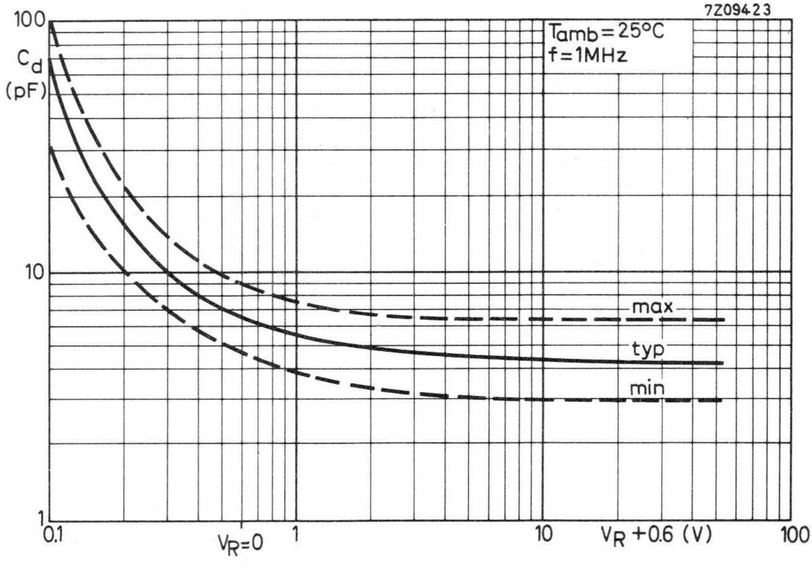
CHARACTERISTICS

Test circuit




7Z09422
max. dissipation versus pin temperature
P_tot (W)
6
4
2
0
0
100
T_pin (°C)
200


7Z09421
η = overall doubler efficiency 1 to 2 GHz
T_amb = 25°C
see circuit on page 3
η (%)
100
50
0
typ
0
5
P_i (W)
10


7Z09423
T_amb = 25°C
f = 1MHz
C_d (pF)
100
10
1
max
typ
min
0.1
V_R = 0
1
10
V_R + 0.6 (V)
100

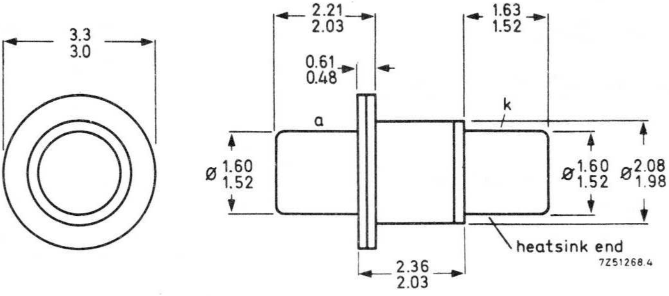
SILICON VARACTOR DIODE

The BXY28 is a silicon planar epitaxial varactor diode exhibiting step recovery characteristics, especially suitable for use in frequency multiplier circuits up to C-band output frequency and 7 W input power.
The device is mounted in a small double ended ceramic-metal case with hermetic seal. The diode is packed in a container.

QUICK REFERENCE DATA

Input power (doubler 2 to 4 GHz)	P_i	<	7	W
Output power (doubler 2 to 4 GHz)	P_o	>	3.5	W
Junction temperature	T_j	max.	175	°C
Cut-off frequency	f_c	typ.	100	GHz
Diode capacitance	C_d	typ.	1.5	pF

MECHANICAL DATA Dimensions in mm



Type marking on the container

The heat should be transferred via the cathode pin.

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Reverse voltage	V_R	max.	45	V
Total power dissipation up to T_{pin} = 70 °C	P_{tot}	max.	3.5	W
Storage temperature	T_{stg}		−65 to +175	°C
Junction temperature	T_j	max.	175	°C

THERMAL RESISTANCE

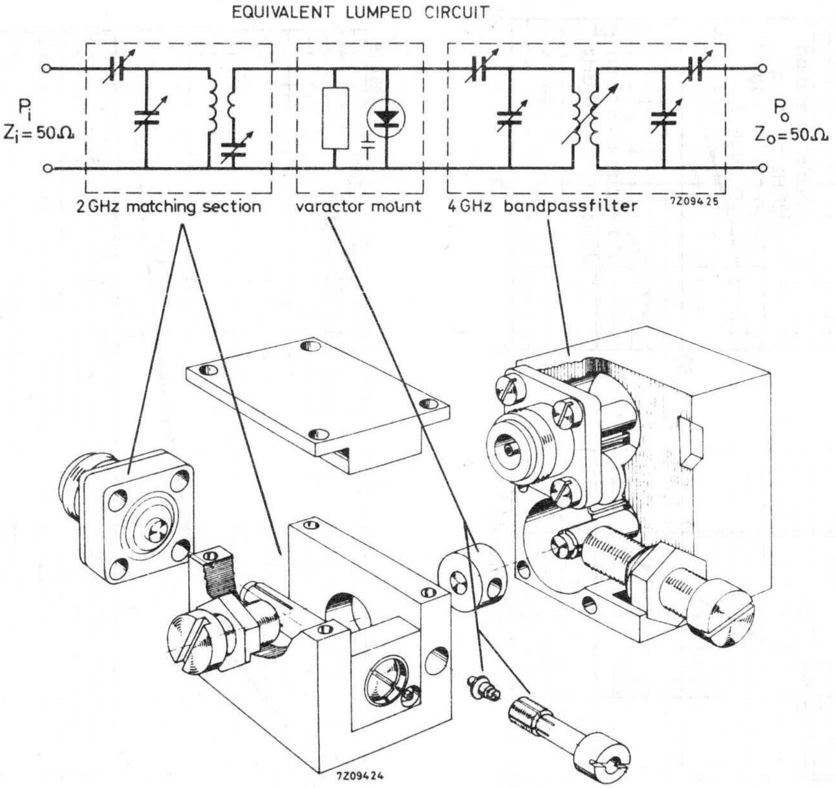
From junction to pin	$R_{th\ j\text{-}pin}$	=	30	°C/W

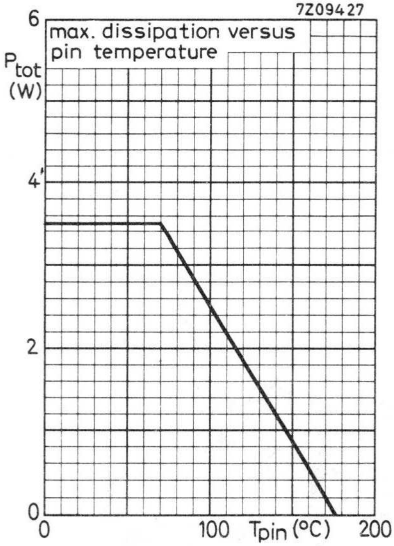
CHARACTERISTICS T_{amb} = 25 °C unless otherwise specified

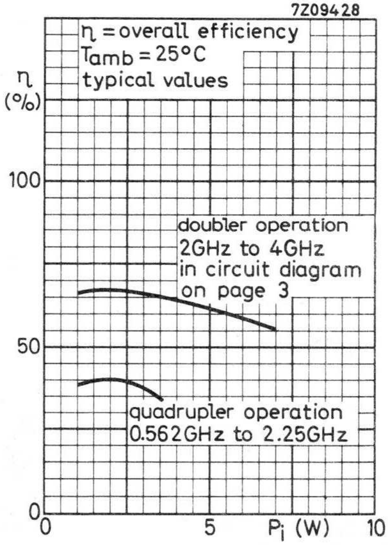
Reverse current at V_R = 6 V	I_R	typ.	1	nA
		<	1	µA
Cut-off frequency at V_R = 6 V				
$f_c = \frac{1}{2\pi r_d(C_d - C_{str})}$	f_c	>	80	GHz
		typ.	100	GHz
Diode capacitance at f = 1 MHz				
V_R = 6 V (C_d includes C_{str})	C_d	typ.	1.5	pF
		1.0 to	2.5	pF
Stray capacitance	C_{str}	typ.	0.25	pF
Diode series inductance	L_d	typ.	650	pH
Diode series resistance at f = 2 GHz				
V_R = 6 V	r_d	typ.	0.9	Ω
Overall efficiency in frequency doubler circuit of page 3				
P_i = 7 W; f_i = 2 GHz	η	>	50	%
		typ.	55	%
Overall efficiency in frequency quadrupler circuit				
P_i = 2 W; f_i = 0.56 GHz	η	typ.	40	%

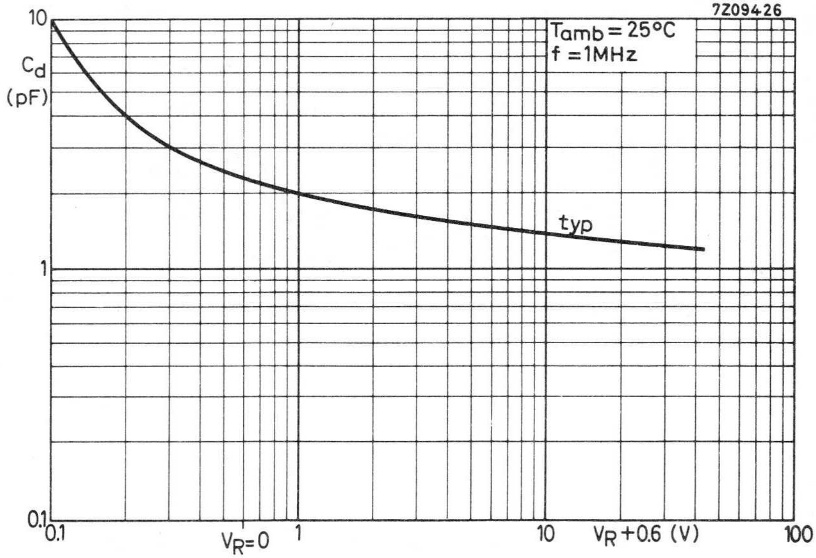
CHARACTERISTICS

Test circuit




7Z09427
max. dissipation versus pin temperature
6
P_{tot} (W)
4
2
0
0
100
T_{pin} (°C)
200


7Z09428
η = overall efficiency
T_{amb} = 25°C
typical values
η (%)
100
50
0
0
5
P_i (W)
10
doubler operation 2GHz to 4GHz in circuit diagram on page 3
quadrupler operation 0.562GHz to 2.25GHz


7Z09426
T_{amb} = 25°C
f = 1MHz
10
C_d (pF)
1
0.1
0.1
V_R=0
1
10
V_R + 0.6 (V)
100
typ

SILICON VARACTOR DIODE

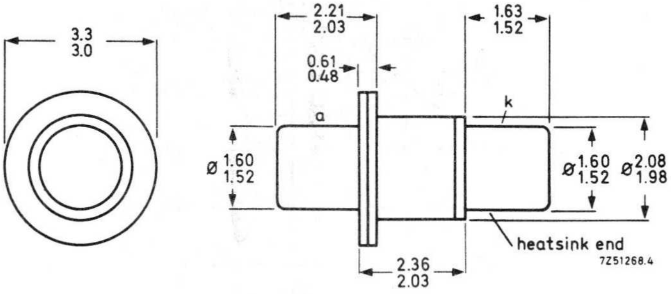
Silicon planar epitaxial varactor diode exhibiting step recovery characteristics, especially suitable for use in frequency multiplier circuits up to X-band output frequency.
The device is mounted in a small double ended ceramic-metal case with hermetic seal.

QUICK REFERENCE DATA

Output power (quadrupler 2.25 to 9.0 GHz)				
at P_i = 1.0 W	P_o	>	0.3	W
Resistive cut-off frequency at V_R = 6 V	f_c	typ.	120	GHz
Diode capacitance at V_R = 6 V	C_d	typ.	1.0	pF
Junction temperature	T_j	max.	150	^oC

MECHANICAL DATA

Dimensions in mm



Type marking on the container
The heat should be transferred via the cathode pin

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Reverse voltage	V_R	max.	25	V
Total power dissipation up to T_{pin} = 70 °C	P_{tot}	max.	1	W
Storage temperature	T_{stg}		-55 to +150	°C
Junction temperature	T_j	max.	150	°C

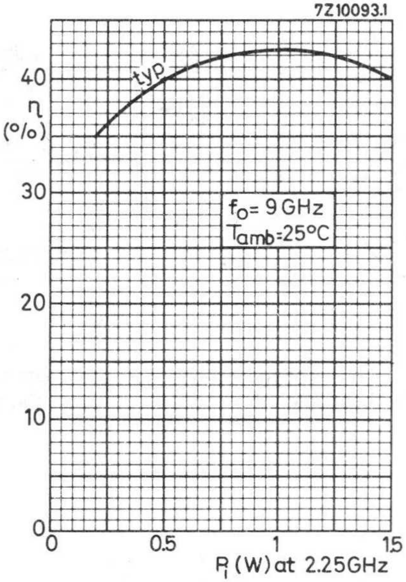
THERMAL RESISTANCE

From junction to pin	$R_{th\ j\text{-}pin}$	=	50	°C/W

CHARACTERISTICS

T_{amb} = 25 °C

Reverse current at V_R = 6 V	I_R	typ. <	1,0 1,0	nA μA
Cut-off frequency at V_R = 6 V $f_c = \frac{1}{2\pi r_D(C_d - C_{str})}$	f_c	> typ.	90 120	GHz GHz
Diode capacitance at V_R = 6 V; f = 1 MHz	C_d	typ. 0,8 to	1,0 1,5	pF pF
Stray capacitance	C_{str}	typ.	0,25	pF
Diode series inductance	L_d	typ.	650	pH
Overall efficiency in quadrupler circuit P_i = 1,0 W; f_i = 2,25 GHz	η	>	30	%



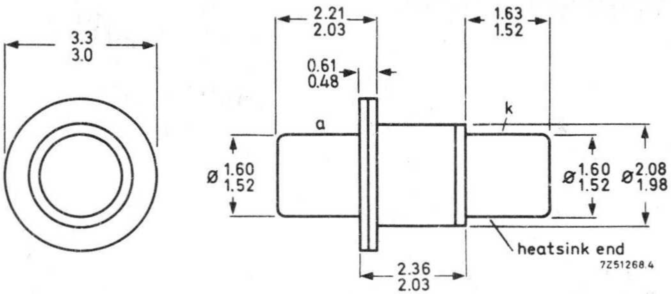
SILICON VARACTOR DIODE

Silicon planar epitaxial varactor diode exhibiting step recovery characteristics, especially suitable for use in high order frequency multiplier circuits up to X-band output frequency.
The device is mounted in a small double ended ceramic-metal case with hermetic seal.

QUICK REFERENCE DATA

Output power (frequency multiplier 1 to 10 GHz)				
at P_i = 500 mW	P_o	typ.	20	mW
Resistive cut-off frequency at V_R = 6 V	f_c	typ.	150	GHz
Diode capacitance at V_R = 6 V	C_d	typ.	0.75	pF
Junction temperature	T_j	max.	150	°C

MECHANICAL DATA Dimensions in mm



Type marking on container.
The heat should be transferred via the cathode pin.

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Reverse voltage	V_R	max.	20	V
Total power dissipation up to T_{pin} = 70 °C	P_{tot}	max.	1	W
Storage temperature	T_{stg}	−55 to +150		°C
Junction temperature	T_j	max.	150	°C

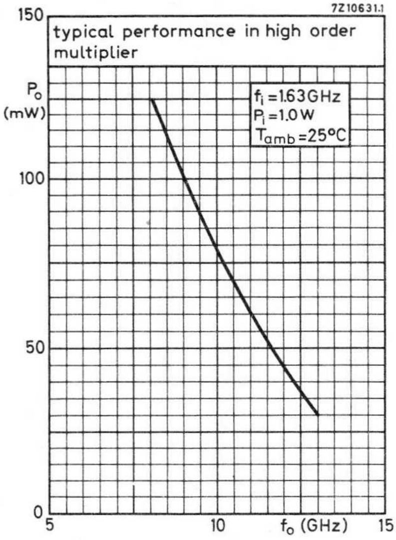
THERMAL RESISTANCE

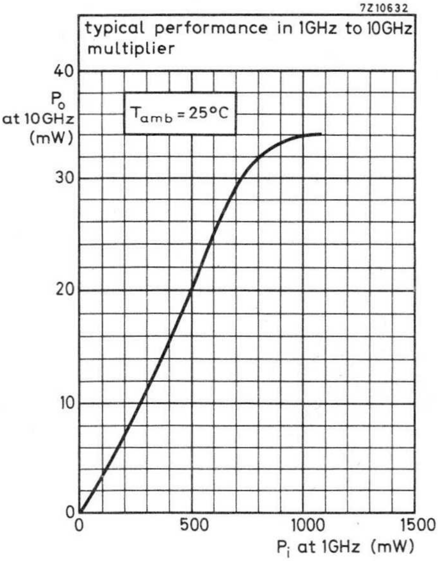
From junction to pin	$R_{th\ j\text{-}pin}$	=	50	°C/W

CHARACTERISTICS

T_{amb} = 25 °C

Reverse current at V_R = 6 V	I_R	typ. <	1 1	nA μA
Cut-off frequency at V_R = 6 V $f_c = \frac{1}{2\pi r_D(C_d - C_{str})}$	f_c	> typ.	100 150	GHz GHz
Diode capacitance at V_R = 6 V; f = 1 MHz	C_d	typ. 0.5 to	0.75 1	pF pF
Stray capacitance	C_{str}	typ.	0.25	pF
Diode series inductance	L_d	typ.	650	pH
Transition time	t_t	<	150	ps
Storage time	t_s	typ.	50	ns
Multiplier performance Output power at P_i = 500 mW (frequency multiplier 1 to 10 GHz)	P_o	> typ.	15 20	mW mW


7Z10631.1
typical performance in high order multiplier
P_o (mW)
f_i =1.63GHz
P_i =1.0W
T_{amb} =25°C
150
100
50
0
5
10
f_o (GHz)
15


7Z10632
typical performance in 1GHz to 10GHz multiplier
P_o at 10GHz (mW)
T_{amb} = 25°C
40
30
20
10
0
0
500
1000
1500
P_i at 1GHz (mW)

GALLIUM ARSENIDE VARACTOR DIODE

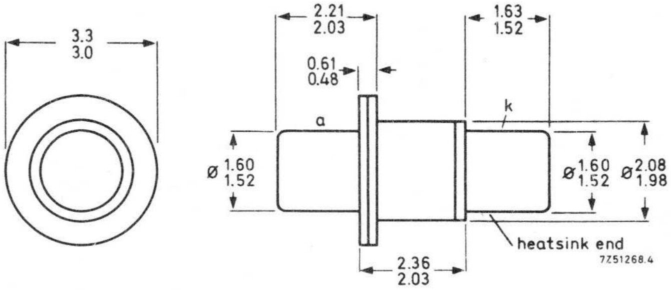
Diffused mesa varactor diode with a high cut-off frequency for use in parametric amplifiers, frequency multipliers and switches.
The device is mounted in a small double ended ceramic-metal case with hermetic seal.

QUICK REFERENCE DATA

Reverse voltage	V_R	max.	6.0	V
Average forward current	I_{FAV}	max.	70	mA
Total power dissipation up to T_{pin} = 107 °C	P_{tot}	max.	50	mW
Operating ambient temperature	T_{amb}	−196 to +150		°C
Cut-off frequency; V_R = 6 V	f_c	typ.	240	GHz

MECHANICAL DATA

Dimensions in mm



RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltage

Continuous reverse voltage	V_R	max.	6.0	V

Current

Average forward current	I_{FAV}	max.	70	mA

Power dissipation

Total power dissipation up to T_{pin} = 107 °C	P_{tot}	max.	50	mW

Temperatures

Storage temperature	T_{stg}	−196 to +150		°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

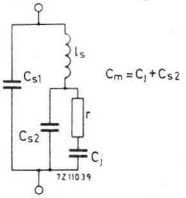
From junction to pin	$R_{th\ j-pin}$	=	0.9	°C/mW

CHARACTERISTICS T_{amb} = 25 °C unless otherwise specified

Reverse current					
$V_R = 6.0$ V	I_R	typ.		0.1	μA
		<		1.0	μA
Forward voltage					
$I_F = 1.0$ μA	V_F	typ.		0.9	V
Effective diode capacitance 1) $C_m = \frac{1}{4\pi^2 f_{res}^2 l_s}$					
$V_R = 0$	C_m	typ.		0.4	pF
		0.3	to	0.5	pF
Stray capacitance 1)	Cs1	typ.		0.10	pF
	Cs2	typ.		0.15	pF
Series inductance 1)	l_s	typ.		625	pH
Cut-off frequency 2) at $V_R = 0$	f_{co}	>		125	GHz
		typ.		150	GHz
$V_R = 6$ V	f_{co}	typ.		240	GHz
Capacitance variation coefficient 3)	γ	>		0.12	
		typ.		0.15	
Series resonant frequency at $V_R = 0$ 2)	f_{res}	typ.		10	GHz
		8.9	to	11.6	GHz

---

1) A suitable lumped circuit equivalent may be drawn as follows:



2) Measurements at and about f_{res}, in a suitable waveguide holder, enable the values of f_{res} and the diode Q factor to be determined. The effective diode capacitance and the cut-off frequency can be calculated taking l_s to be the typical value. $f_{co} = Q_o f_{res}$ where Q_o is the Q factor at zero bias.

3) $$\gamma = \frac{C_{m\,max} - C_{m\,min}}{2\,(C_{m\,max} + C_{m\,min})} = \frac{(1-V)^{-1/3} - 2^{-1/3}}{2\left\{(1-V)^{-1/3} + 2^{-1/3}\right\} + \frac{4\,C_{s2}}{C_j}}$$

where $C_{m\,max}$ = effective capacitance at I_F = 1.0 μA
$C_{m\,min}$ = effective capacitance at V_R 1.0 V
$V = V_F$ at 1.0 μA
$C_j = C_m - C_{s2}$

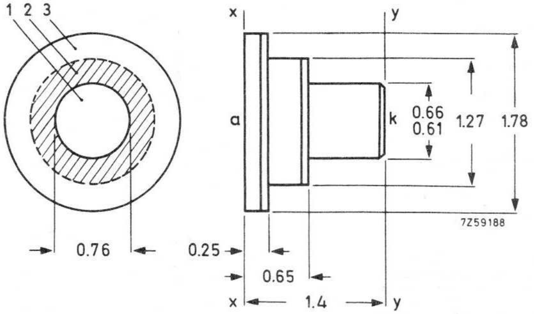
GALLIUM ARSENIDE DIFFUSED MESA VARACTOR DIODE

Varactor diode with a high cut-off frequency, primarily intended for use in microwave parametric amplifiers. The device is mounted in a small ceramic-metal case with hermetic welded seal.

QUICK REFERENCE DATA				
Continuous reverse voltage	V_R	max.	6	V
Total power dissipation up to T_{mb} = 25 ^oC	P_{tot}	max.	50	mW
Junction temperature	T_j		−196 to +135	^oC
Cut-off frequency ; V_R = 0	f_{co}	typ.	350	GHz

MECHANICAL DATA

Dimensions in mm



Compression force on mounting surfaces x-x and y-y: max. 2.45 N

1. Do not press on this area.
2. Preferred area of pressure.
3. Take care not to flex the flange

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC134)

Voltage				
Continuous reverse voltage	V_R	max.	6.0	V
Power dissipation				
Total power dissipation up to $T_{mb} = 25\ ^oC$	P_{tot}	max.	50	mW
Temperatures				
Storage temperature	T_{stg}	−196 to +175		^oC
Junction temperature	T_j	max.	135	^oC

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	0.9	$^oC/mW$

CHARACTERISTICS $T_{amb} = 25\ ^oC$ unless otherwise specified

Reverse current				
$V_R = 6.0$ V	I_R	typ. <	0.1 1.0	μA μA
Capacitance $\frac{1}{2\pi r_D f_{co}}$				
$V_R = 0$	C_d	typ.	0.2	pF
Stray capacitance	C_s	typ.	0.3	pF
Diode series resistance				
$V_R = 0$	r_D	typ. 1 to	2.25 3.0	Ω Ω
Series inductance $\frac{1}{4\pi^2 f_{res}{}^2 C_d}$	l_s	typ.	140	pH
Cut-off frequency ; $V_R = 0$	f_{co}	> typ.	200 350	GHz GHz
Product of capacitance variation coefficient and cut-off frequency; $V_R = 0$ 1)	γf_{co}	> typ.	35 40	GHz GHz
Series resonant frequency ; $V_R = 0$	f_{res}	typ. 27 to	30 34	GHz GHz

---

1)
$$\gamma = \frac{C_{d\,max} - C_{d\,min}}{2\,(C_{d\,max} + C_{d\,min})} = \frac{\frac{1}{f_{res\,min}{}^2} - \frac{1}{f_{res\,max}{}^2}}{2\,(\frac{1}{f_{res\,min}{}^2} + \frac{1}{f_{res\,max}{}^2})}$$

where $C_{d\,max}$ = capacitance at $I_F = 1.0\ \mu A$

$C_{d\,min}$ = capacitance at $V_R = 1.0$ V

$f_{res\,min}$ and $f_{res\,max}$ are the corresponding resonant frequencies assuming a constant inductance. Hence it is directly measurable in the transmission loss system.

Remark

The dynamic parameters are quoted using a holder which takes the form of a double four-section, wide band, low v.s.w.r. Q-band 26 to 40 GHz waveguide transformer to a reduced height of 0.25 mm. The transformer is step down followed by step up in order to use standard Q-band components on either side. A d.c. isolated choke system allows the diode to be inserted across the 0.25 mm reduced height section and to be biased.

Using a swept frequency transmission loss measuring system the f_{co}, the Q and γ of the diode-holder system can be measured ($f_{co} = Q \times f_{res}$).

Separately, by measuring the transmission loss past the diode at resonance, r_D can be found.

OPERATING NOTES

The CXY10 varactor diode will give excellent noise performance in a parametric amplifier of suitable design.

For instance, at a signal frequency of 8.5GHz in an amplifier having an over-coupled ratio of 4dB to 5dB with a pump frequency at 35GHz and an idler frequency of 26.5GHz, the effective input noise temperature of the amplifier less the contribution due to the circulator would be typically 200°K and a maximum of 250°K with the amplifier at room temperature. In cooled paramps, due to its low temperature working capability, the device would give appropriately lower effective input noise temperatures.

GUNN EFFECT DIODES

Gallium arsenide Gunn effect diodes for c.w. oscillations up to X-band frequencies. The devices are mounted in a small double ended ceramic-metal case with hermetic seal suitable for mounting in various types of cavity.

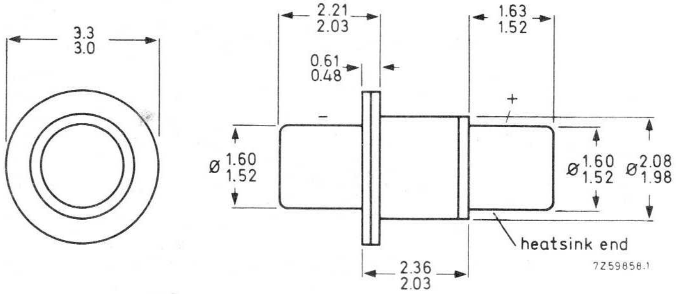
The main types CXY11A to C will oscillate throughout X-band, the actual frequency depending on the cavity used. The sub-types 8.5, 10.5 and 11.5 are only specified in a 1 GHz band centred on 8.5, 10.5 and 11.5 GHz respectively (see table 1 on page 2)

QUICK REFERENCE DATA

Operating voltage		V	typ.	7	V
Total power dissipation up to T_{pin} = 35 °C		P_{tot}	max.	1.0	W
Operating frequency			X-band		
Output power at f = 9.5 GHz	CXY11A	P_o	>	5	mW
	CXY11B	P_o	>	10	mW
	CXY11C	P_o	>	15	mW

MECHANICAL DATA

Dimensions in mm



Type marking on the container

The heat should be transferred via the flangeless pin

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltage [1]	V	max.	7.0	V
Total power dissipation up to T_{pin} = 35 °C	P_{tot}	max.	1.0	W
Storage temperature	T_{stg}	max.	175	°C

CHARACTERISTICS T_{pin} = 35 °C

Current at V = 7.0 V	I	typ.	140	mA
Operating frequency [2]	f		8.0 to 12	GHz
Output power [3]				
CXY11A	P_o	> typ.	5 8	mW mW
CXY11B	P_o	> typ.	10 12	mW mW
CXY11C	P_o	> typ.	15 20	mW mW

---

[1] Bias must always be applied in such a way that the flanged end of the device is negative. Reversing polarity or exceeding maximum rating may cause permanent damage. Care should be taken not to exceed voltage transients of 8 V.

[2] The frequency is governed by the choise of cavity to which the device is coupled. For frequency coverage see table 1.

[3] P_o is measured in a coaxial cavity at the test frequency given in table 1.

Table 1.	Test frequency and frequency coverage in GHz			
	8.5	9.5	10.5	11.5
	8 to 9	8 to 12	10 to 11	11 to 12
P_o > 5 mW typ. 8 mW	CXY11A$_{8.5}$	CXY11A	CXY11A$_{10.5}$	CXY11A$_{11.5}$
P_o > 10 mW typ. 12 mW	CXY11B$_{8.5}$	CXY11B	CXY11B$_{10.5}$	CXY11B$_{11.5}$
P_o > 15 mW typ. 20 mW	CXY11C$_{8.5}$	CXY11C	CXY11C$_{10.5}$	CXY11C$_{11.5}$

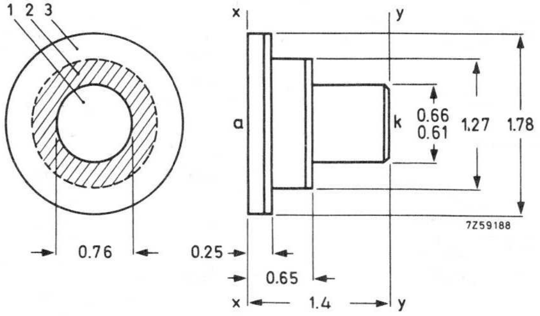
GALLIUM ARSENIDE DIFFUSED MESA VARACTOR DIODE

Diffused mesa varactor diode suitable for use in frequency multiplier circuits up to Q-band output frequency. The device is mounted in a small ceramic-metal case with hermetic welded seal.

QUICK REFERENCE DATA

Output power (quadrupler 9.0 to 36 GHz) at P_i = 500 mW	P_o	>	50	mW
Resistive cut-off frequency at V_R = 6 V	f_c	typ.	500	GHz
Junction temperature	T_j	max.	175	°C

MECHANICAL DATA Dimensions in mm



Compression force on mounting surfaces x-x and y-y: max. 2.45 N

1. Do not press on this area.
2. Preferred area of pressure.
3. Take care not to flex the flange.

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltage				
Continuous reverse voltage	V_R	max.	10	V
Power dissipation				
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	300	mW
R.F. input power	P_i	max.	500	mW
Temperatures				
Storage temperature	T_{stg}	-55 to +175		°C
Junction temperature	T_j	max.	175	°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	0.5	°C/mW

CHARACTERISTICS T_{amb} = 25 °C unless otherwise specified

Reverse current				
V_R = 6.0 V	I_R	typ. <	0.001 1.0	µA µA
Capacitance $\frac{1}{2\pi r_D f_{co}}$				
V_R = 6.0 V	C_d	typ.	0.25	pF
Stray capacitance	C_s	typ.	0.3	pF
Diode series resistance				
V_R = 6.0 V	r_D	typ.	1.3	Ω
Series inductance $\frac{1}{4\pi^2 f_{res}^2 C_d}$	l_s	typ.	120	pH
Cut-off frequency ; V_R = 6.0 V	f_{co}	> typ.	300 500	GHz GHz
Series resonant frequency ; V_R = 6.0 V	f_{res}	typ. 27 to	29 35	GHz GHz

Remark

The dynamic parameters are quoted using a holder which takes the form of a double four-section, wide band, low v.s.w.r. Q-band 26 to 40 GHz waveguide transformer to a reduced height of 0.25 mm. The transformer is step down followed by step up in order to use standard Q-band components on either side. A d.c. isolated choke system allows the diode to be inserted across the 0.25 mm reduced height section and to be biased.

Using a swept frequency transmission loss measuring system the f_{co}, the Q of the diode-holder system can be measured ($f_{co} = Q \times f_{res}$).

Separately, by measuring the transmission loss past the diode at resonance, r_D can be found.

SILICON VARACTOR DIODES

Siliçon planar epitaxial varactor diodes exhibiting step recovery characteristics, especially suitable for use in frequency multiplier circuits up to S - band output frequency.

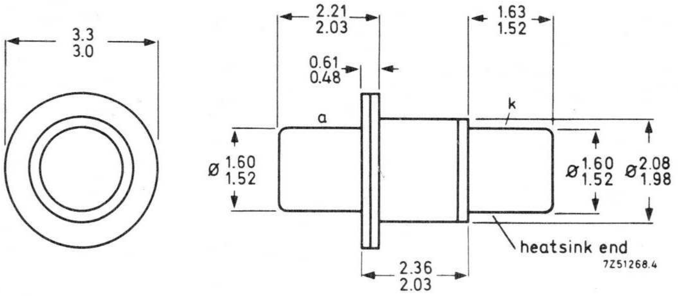
QUICK REFERENCE DATA

Ouput power (doubler 1.0 to 2.0 GHz) at P_i = 12 W	P_o	>	6.0	W
Resistive cut-off frequency at V_R = 6 V	f_c	typ.	100	GHz
Diode capacitance at V_R = 6 V	C_d	typ.	6.0	pF

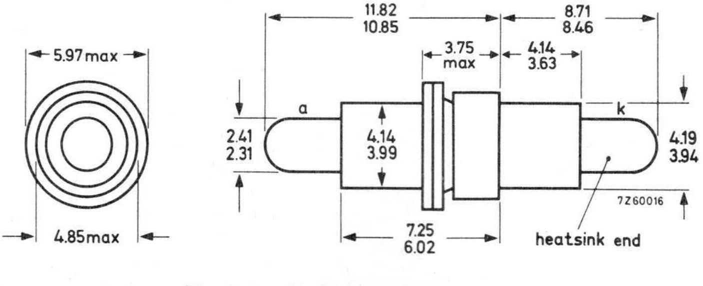
MECHANICAL DATA

Dimensions in mm

1N5152



1N5153



Type marking on container
The heat should be transferred via the cathode pin

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Reverse voltage	V_R	max.	75	V
Total power dissipation up to T_{pin} = 70 °C	P_{tot}	max.	5	W
Storage temperature	T_{stg}		-55 to +175	°C
Junction temperature	T_j	max.	175	°C

THERMAL RESISTANCE

From junction to pin	$R_{th\ j\text{-}pin}$	=	20	°C/W

CHARACTERISTICS at T_{amb} = 25 °C

Reverse breakdown voltage I_R = 10 μA	$V_{(BR)R}$	>	75	V
Forward voltage I_F = 10 mA	V_F	<	1.0	V
Reverse current at V_R = 60 V	I_R	typ. <	1.0 1.0	nA μA
Resistive cut-off frequency at V_R = 6 V; f = 2.0 GHz	f_c	> typ.	55 100	GHz GHz
Diode capacitance at V_R = 6 V; f = 1 MHz	C_d	5.0 to	7.5	pF
Overall efficiency in doubler circuit P_i = 12 W; f_i = 1.0 GHz	η	> typ.	50 60	% %

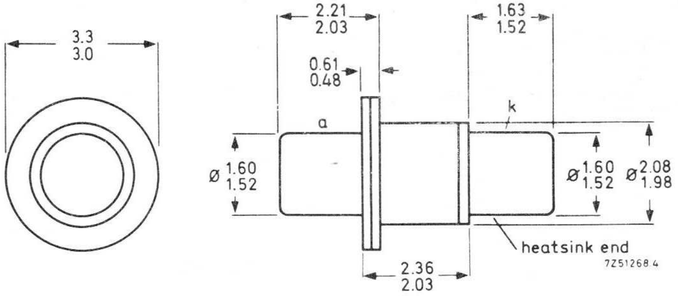
SILICON VARACTOR DIODE

Silicon planar epitaxial varactor diode exhibiting step recovery characteristics, especially suitable for use in frequency multiplier circuits up to C-band output frequency.

QUICK REFERENCE DATA

Output power (tripler 2.0 to 6.0 GHz) at P_i = 5 W	P_o	>	2.0	W
Resistive cut-off frequency at V_R = 6 V	f_c	typ.	120	GHz
Diode capacitance at V_R = 6 V	C_d	typ.	2.0	pF

MECHANICAL DATA Dimensions in mm



Type marking on container
The heat should be transferred via the cathode pin

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Reverse voltage	V_R	max.	35	V
Total power dissipation up to T_{pin} = 70 °C	P_{tot}	max.	3	W
Storage temperature	T_{stg}	-55 to +175		°C
Junction temperature	T_j	max.	175	°C

THERMAL RESISTANCE

From junction to pin	$R_{th\ j\text{-}pin}$	=	35	°C/W

CHARACTERISTICS at T_{amb} = 25 °C

Reverse breakdown voltage I_R = 10 µA	$V_{(BR)R}$	>	35	V
Forward voltage I_F = 10 mA	V_F	<	1.0	V
Reverse current at V_R = 26 V	I_R	typ. <	1.0 1.0	nA µA
Resistive cut-off frequency at V_R = 6 V; f = 2.0 GHz	f_c	> typ.	100 120	GHz GHz
Diode capacitance at V_R = 6 V; f = 1 MHz	C_d	1.0 to	3.0	pF
Overall efficiency in tripler circuit P_i = 5 W; f_i = 2.0 GHz	η	>	40	%

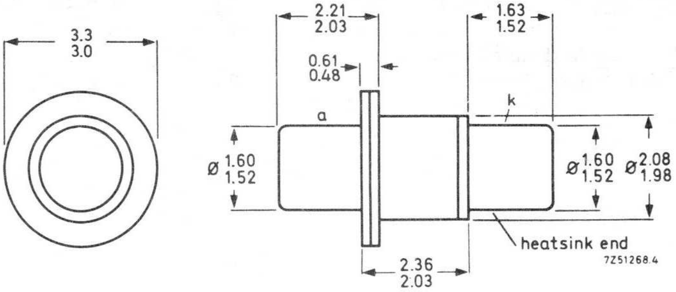
SILICON VARACTOR DIODE

Silicon planar epitaxial varactor diode exhibiting step recovery characteristics, especially suitable for use in frequency multiplier circuits up to X-band output frequency.

QUICK REFERENCE DATA

Output power (doubler 5.0 to 10 GHz) at P_i = 2.6 W	P_o	>	1.0	W
Resistive cut-off frequency at V_R = 6 V	f_c	typ.	200	GHz
Diode capacitance at V_R = 6 V	C_d	typ.	0.8	pF

MECHANICAL DATA Dimensions in mm



Type marking on container
The heat should be transferred via the cathode pin

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Reverse voltage	V_R	max.	20	V
Total power dissipation up to T_{pin} = 70 °C	P_{tot}	max.	2.5	W
Storage temperature	T_{stg}	-55 to +175		°C
Junction temperature	T_j	max.	175	°C

THERMAL RESISTANCE

From junction to pin	$R_{th\ j\text{-}pin}$	=	38.5	°C/w

CHARACTERISTICS at T_{amb} = 25 °C

Reverse breakdown voltage I_R = 10 μA	$V_{(BR)R}$	>	20	V
Forward voltage I_F = 10 mA	V_F	<	1.0	V
Reverse current at V_R = 16 V	I_R	<	0.1	μA
Resistive cut-off frequency at V_R = 6 V; f = 8 GHz	f_c	> typ.	180 200	GHz GHz
Diode capacitance at V_R = 6 V; f = 1 MHz	C_d	0.6 to	1.0	pF
Overall efficiency in doubler circuit P_i = 2.6 W; f_i = 5.0 GHz	η	>	38	%

Field effect transistors

N-CHANNEL INSULATED GATE FIELD EFFECT TRANSISTOR

Depletion type insulated gate field effect transistor in a TO-72 metal envelope with the substrate connected to the case.
It is intended for linear applications in the audio as well as the i.f. and v.h.f. frequency region, and in cases where high input impedance, low gate leakage currents and low noise figures are of importance.

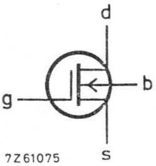
QUICK REFERENCE DATA

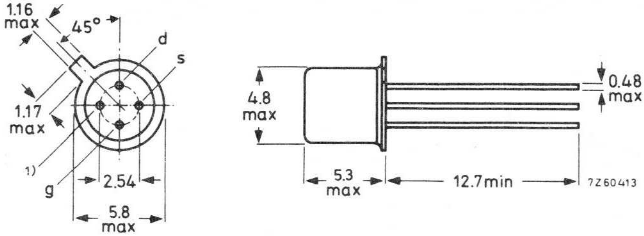
Drain-substrate voltage	V_{DB}	max.	30	V
Gate-substrate voltage	V_{GB}	max.	10	V
		min.	−10	V
Drain current V_{DS} = 15 V; V_{GS} = 0	I_{DSS}	10 to	40	mA
Transfer admittance I_D = 5 mA; V_{DS} = 15 V; f = 1 kHz	$\lvert y_{fs} \rvert$	>	6	mA/V
Feedback capacitance I_D = 5 mA; V_{DS} = 15 V; f = 1 MHz	C_{rs}	<	0.7	pF
Noise figure at f = 200 MHz ; T_{amb} = 25 °C I_D = 5 mA; V_{DS} = 15 V G_S = 1 mΩ^{-1}; B_S = B_{Sopt}	F	<	5	dB
Equivalent noise voltage ; T_{amb} = 25 °C I_D = 5 mA; V_{DS} = 15 V; f = 1 kHz	$V_n/\sqrt{B}$	typ.	100	nV/$\sqrt{\text{Hz}}$

MECHANICAL DATA see page 2

MECHANICAL DATA

TO-72





Note: To safeguard the gates against damage due to accumulation of static charge during transport or handling, the leads are encircled by a ring of conductive rubber which should be removed just after the transistor is soldered into the circuit.

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltages

Drain-substrate voltage	V_{DB}	max.	30	V
Source-substrate voltage	V_{SB}	max.	30	V
Gate-substrate voltage (continuous)	V_{GB}	max. min.	10 −10	V V
Repetitive peak gate to all other terminals voltage $V_{SB} = V_{DB} = 0$; f > 100 Hz	$V_{G\text{-}N}$	max. min.	15 −15	V V

Currents

Drain current (d.c.)	I_D	max.	20	mA
Drain current (peak value) t_r = 20 ms; δ = 0.1	I_{DM}	max.	50	mA

Power dissipation

Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	200	mW

Temperatures

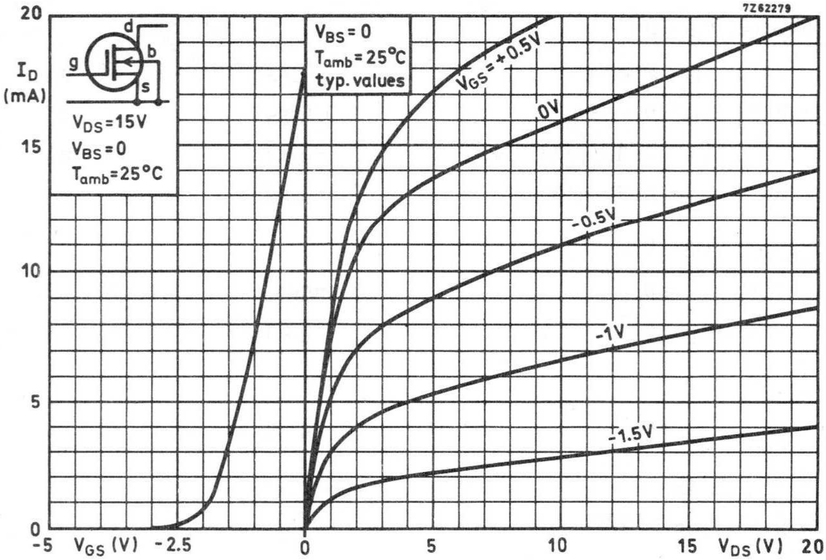
Storage temperature	T_{stg}		−65 to +125	°C
Junction temperature	T_j	max.	125	°C

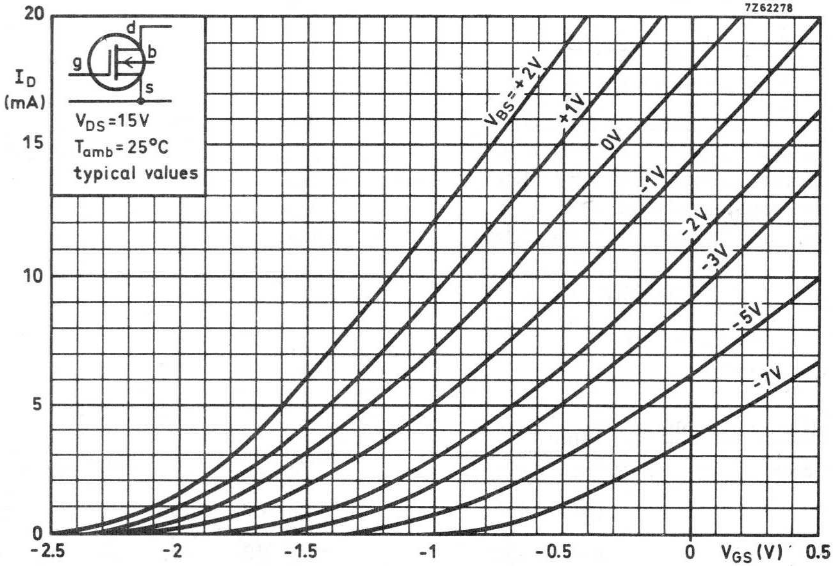
THERMAL RESISTANCE

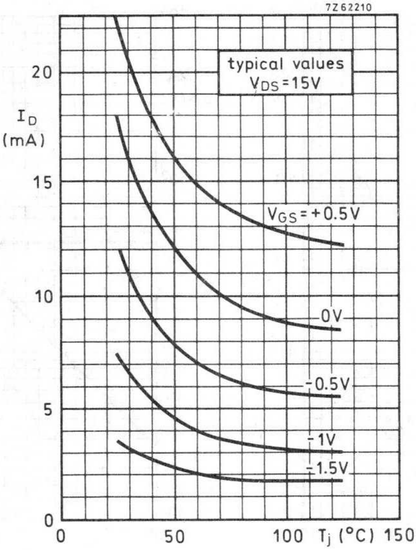
From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	0.5	°C/mW

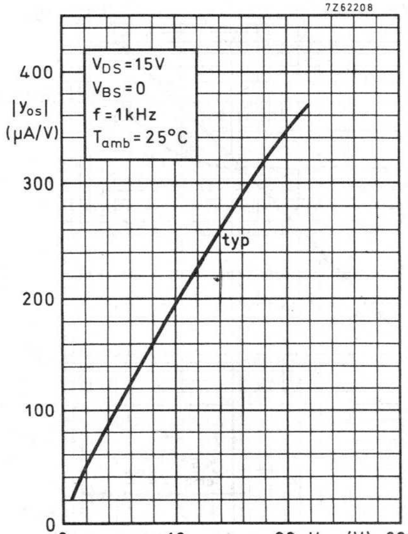
CHARACTERISTICS T_j = 25 °C unless otherwise specified

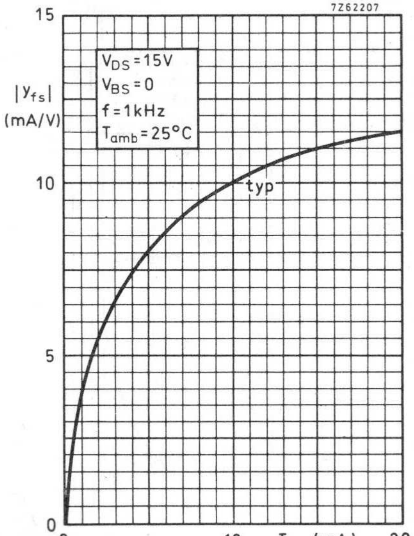
Gate currents; $V_{BS} = 0$				
$-V_{GS} = 10$ V; $V_{DS} = 0$	$-I_{GSS}$	<	10	pA
$V_{GS} = 10$ V; $V_{DS} = 0$	I_{GSS}	<	10	pA
$-V_{GS} = 10$ V; $V_{DS} = 0$; $T_j = 125$ °C	$-I_{GSS}$	<	200	pA
$V_{GS} = 10$ V; $V_{DS} = 0$; $T_j = 125$ °C	I_{GSS}	<	200	pA
Bulk currents; $V_{GB} = 0$				
$-V_{BD} = 30$ V; $I_S = 0$	$-I_{BDO}$	<	10	µA
$-V_{BS} = 30$ V; $I_D = 0$	$-I_{BSO}$	<	10	µA
Drain current				
$V_{DS} = 15$ V; $V_{GS} = 0$	I_{DSS}		10 to 40	mA
Gate-source voltage				
$I_D = 100$ nA; $V_{DS} = 15$ V	$-V_{GS}$		0.5 to 3.5	V
Gate-source cut-off voltage				
$I_D = 100$ nA ; $V_{DS} = 15$ V	$-V_{(P)GS}$	<	4	V
y parameters $T_{amb} = 25$ °C				
$I_D = 5$ mA; $V_{DS} = 15$ V				
Transfer admittance at f = 1 kHz	$\lvert y_{fs} \rvert$	>	6	mA/V
Output admittance at f = 1 kHz	$\lvert y_{os} \rvert$	<	0.4	mA/V
Input capacitance at f = 1 MHz	C_{is}	<	5	pF
Feedback capacitance at f = 1 MHz	C_{rs}	<	0.7	pF
Output capacitance at f = 1 MHz	C_{os}	<	3	pF
Noise figure at f = 200 MHz $T_{amb} = 25$ °C				
$I_D = 5$ mA; $V_{DS} = 15$ V				
$G_S = 1\ m\Omega^{-1}$; $B_S = B_{Sopt}$	F	<	5	dB
Equivalent noise voltage $T_{amb} = 25$ °C				
$I_D = 5$ mA; $V_{DS} = 15$ V; f = 120 Hz	$V_n/\sqrt{B}$	typ.	300	nV/$\sqrt{\text{Hz}}$
f = 1 kHz	$V_n/\sqrt{B}$	typ.	100	nV/$\sqrt{\text{Hz}}$
f = 10 kHz	$V_n/\sqrt{B}$	typ.	35	nV/$\sqrt{\text{Hz}}$

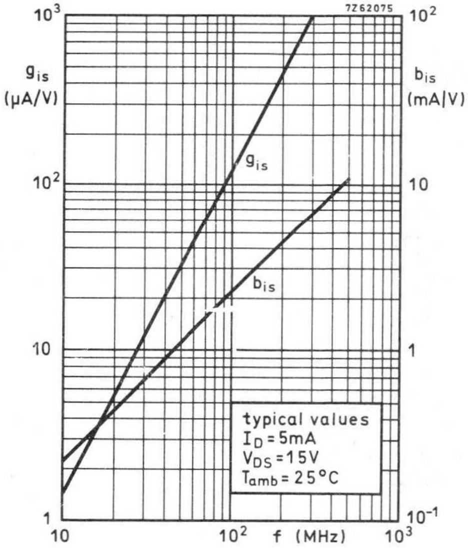

7Z62279
20
I_D
(mA)
15
10
5
0
d
g
b
s
V_DS=15V
V_BS=0
T_amb=25°C
V_BS = 0
T_amb = 25°C
typ. values
V_GS = +0.5V
0V
-0.5V
-1V
-1.5V
-5
V_GS (V)
-2.5
0
5
10
15
V_DS (V)
20

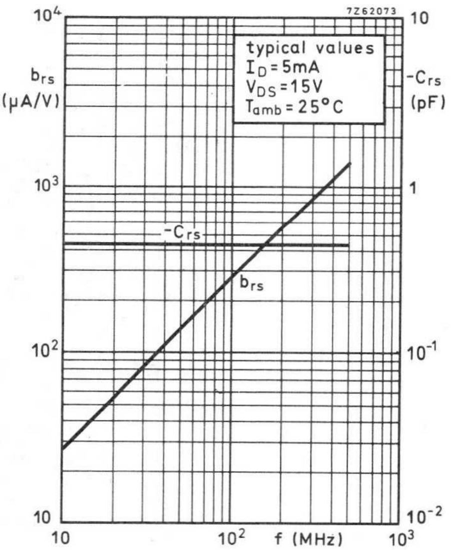

7Z62278
20
I_D
(mA)
15
10
5
0
d
g
b
s
V_DS=15V
T_amb=25°C
typical values
V_BS=+2V
+1V
0V
-1V
-2V
-3V
-5V
-7V
-2.5
-2
-1.5
-1
-0.5
0
V_GS (V)
0.5

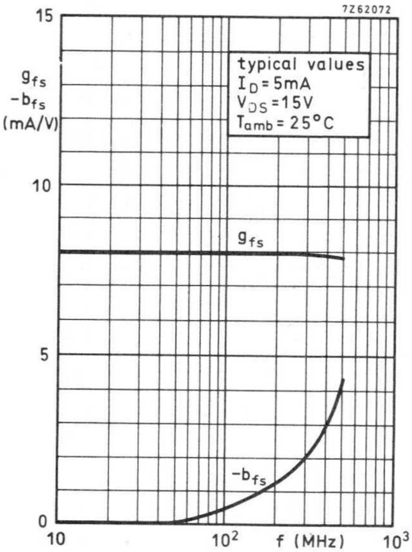

7Z62210
typical values
$V_{DS}=15V$
I_D (mA)
20
15
10
5
0
$V_{GS}=+0.5V$
0V
-0.5V
-1V
-1.5V
0
50
100
T_j (°C)
150

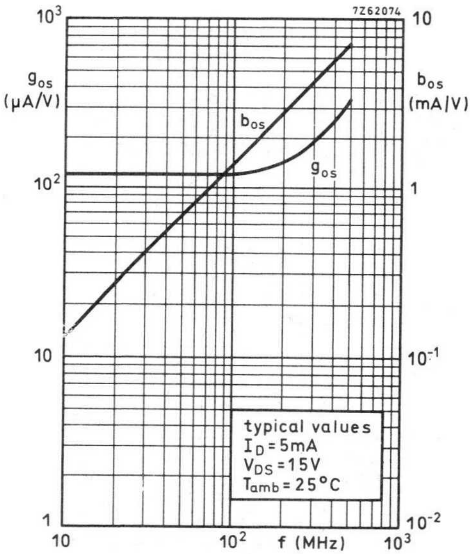

7Z62208
$V_{DS}=15V$
$V_{BS}=0$
f = 1kHz
$T_{amb}=25°C$
$|y_{os}|$ (μA/V)
400
300
200
100
0
typ
0
10
20
V_{DS} (V)
30

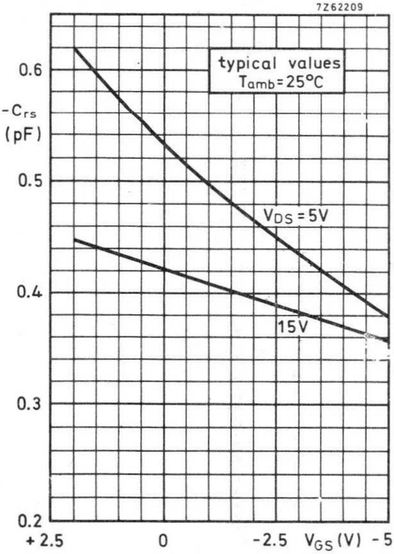

7Z62207
15
$V_{DS}=15V$
$V_{BS}=0$
f = 1kHz
$T_{amb}=25°C$
$|y_{fs}|$ (mA/V)
10
5
0
typ
0
10
I_D (mA)
20

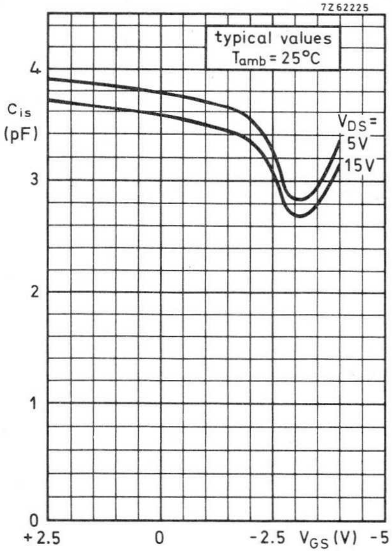

7Z62075
10^3
10^2
10
1
g_{is} (μA/V)
b_{is} (mA/V)
10^2
10
1
10^{-1}
g_{is}
b_{is}
typical values
$I_D = 5mA$
$V_{DS} = 15V$
$T_{amb} = 25°C$
10
10^2
f (MHz)
10^3


7Z62073
10^4
10^3
10^2
10
b_{rs} (μA/V)
$-C_{rs}$ (pF)
10
1
10^{-1}
10^{-2}
typical values
$I_D = 5mA$
$V_{DS} = 15V$
$T_{amb} = 25°C$
$-C_{rs}$
b_{rs}
10
10^2
f (MHz)
10^3


7Z62072
15
10
5
0
g_{fs}
$-b_{fs}$
(mA/V)
typical values
$I_D = 5mA$
$V_{DS} = 15V$
$T_{amb} = 25°C$
g_{fs}
$-b_{fs}$
10
10^2
f (MHz)
10^3


7Z62074
10^3
10^2
10
1
g_{os} (μA/V)
b_{os} (mA/V)
10
1
10^{-1}
10^{-2}
b_{os}
g_{os}
typical values
$I_D = 5mA$
$V_{DS} = 15V$
$T_{amb} = 25°C$
10
10^2
f (MHz)
10^3


7Z62209
typical values
$T_{amb} = 25^\circ C$
$-C_{rs}$
(pF)
0.6
0.5
0.4
0.3
0.2
$V_{DS} = 5V$
15V
+ 2.5
0
-2.5
V_{GS} (V)
- 5


7Z62225
typical values
$T_{amb} = 25^\circ C$
C_{is}
(pF)
4
3
2
1
0
$V_{DS} =$
5V
15V
+ 2.5
0
-2.5
V_{GS} (V)
-5

- -

For data and curves of these types please refer to section
Microminiature devices for thick- and thin-film circuits

- -

MATCHED N-CHANNEL FET's

Matched pair of n-channel silicon epitaxial planar junction field effect transistors in TO-72 metal envelopes held together by a metal S-clip.
It is intended for low level differential amplifiers.

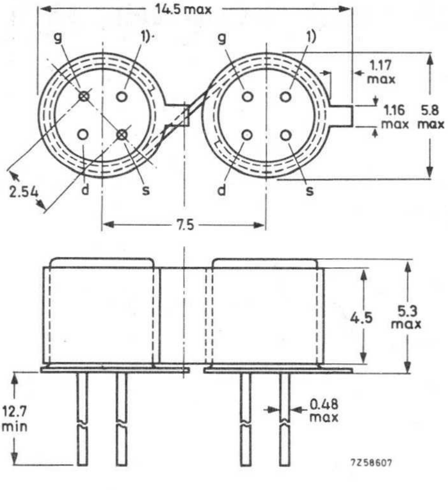
QUICK REFERENCE DATA

Characteristics $T_{amb} = 25\ ^oC$; $V_{DG} = 15$ V; $I_D = 0.5$ mA			BFS21	BFS21A	
Gate cut-off current	I_G	<	0.5	0.5	nA
Gate-source voltage difference	$\lvert \Delta V_{GS} \rvert$	<	20	10	mV
Thermal drift of gate-source voltage difference	$\left\lvert \frac{d\ \Delta V_{GS}}{dT} \right\rvert$	<	75	40	$\mu V/^oC$
Difference of penetration factor	$\left\lvert \Delta \frac{g_{os}}{g_{fs}} \right\rvert$	<	1	0.5	10^{-3}
Difference of transfer impedance	$\left\lvert \Delta \frac{1}{g_{fs}} \right\rvert$	<	15	7.5	Ω
Common mode rejection ratio	CMRR	>	60	66	dB

TOTAL DEVICE

MECHANICAL DATA

Dimensions in mm



1) = shield lead (connected to case)

max. lead diameter is guaranteed only for 12.7 mm

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltage				
Voltage between any 2 terminals	V	max.	30	V
Currents				
Drain current	I_D	max.	4	mA
Gate current	I_G	max.	0.5	mA
Power dissipation				
Total power dissipation up to T_{amb} = 100 °C	P_{tot}	max.	30	mW
Temperature				
Operating ambient temperature	Tamb	-20 to + 100 °C		

CHARACTERISTICS (total device) T_{amb} = 25 °C unless otherwise specified

		BFS21	BFS21A	
Drain current ratio				
V_{DG} = 15 V; V_{GS} = 0; T_j = 25 °C	$\frac{I_{D1-S1S}}{I_{D2-S2S}}$	> 0.95 < 1.05	0.95 1.05	
Gate-source voltage difference				
I_D = 500 µA; V_{DG} = 15 V	$\lvert\Delta V_{GS}\rvert$	< 20	10	mV
I_D = 100 µA; V_{DG} = 15 V	$\lvert\Delta V_{GS}\rvert$	< 20	10	mV
Thermal drift of gate-source voltage difference				
I_D = 500 µA; V_{DG} = 15 V	$\left\lvert\frac{d\ \Delta V_{GS}}{dT}\right\rvert$	< 75	40	µV/°C
I_D = 100 µA; V_{DG} = 15 V	$\left\lvert\frac{d\ \Delta V_{GS}}{dT}\right\rvert$	< 75	40	µV/°C
Change of gate-source voltage difference with ambient temperature				
T_{amb} = 25 to 100 °C				
I_D = 500 µA; V_{DG} = 15 V	$\lvert\Delta V_{GS}(T_{amb2}) - \Delta V_{GS}(T_{amb1})\rvert$	< 6	3	mV
I_D = 100 µA; V_{DG} = 15 V	$\lvert\Delta V_{GS}(T_{amb2}) - \Delta V_{GS}(T_{amb1})\rvert$	< 6	3	mV
Difference of penetration factors 1)				
I_D = 500 µA; V_{DG} = 15 V	$\left\lvert\Delta\frac{g_{os}}{g_{fs}}\right\rvert$	< 1	0.5	10^{-3}
I_D = 100 µA; V_{DG} = 15 V	$\left\lvert\Delta\frac{g_{os}}{g_{fs}}\right\rvert$	< 1	0.5	10^{-3}
Difference of transfer impedances 2)				
I_D = 500 µA; V_{DG} = 15 V	$\left\lvert\Delta\frac{1}{g_{fs}}\right\rvert$	< 15	7.5	Ω
I_D = 100 µA; V_{DG} = 15 V	$\left\lvert\Delta\frac{1}{g_{fs}}\right\rvert$	< 75	37.5	Ω

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1) The difference between the penetration factors is equal to the ratio of the change of the gate-source voltage difference to the change of drain-gate voltage, at constant drain current.

$$(\Delta\frac{g_{os}}{g_{fs}} = \frac{d\ \Delta V_{GS}}{d\ V_{DG}} \text{ at } I_D = \text{constant})$$

2) The difference between the transfer impedances is equal to the ratio of the change of the gate-source voltage difference to the change of drain current, at constant drain-gate voltage.

$$(\Delta\frac{1}{g_{fs}} = \frac{d\ \Delta V_{GS}}{d\ I_D} \text{ at } V_{DG} = \text{constant})$$

CHARACTERISTICS (continued) (total device)

Common mode rejection ratio [1]			BFS21	BFS21A	
I_D = 500 μA; V_{DG} = 15 V	CMRR	>	60	66	dB
I_D = 100 μA; V_{DG} = 15 V	CMRR	>	60	66	dB

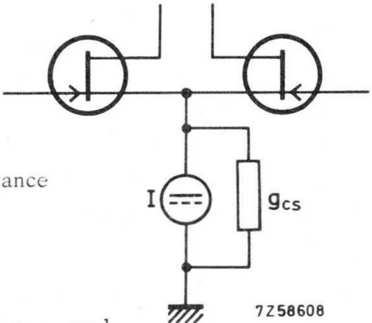
INDIVIDUAL TRANSISTOR

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltages				
Drain-source voltage	$\pm V_{DS}$	max.	30	V
Drain-gate voltage (open source)	V_{DGO}	max.	30	V
Gate-source voltage (open drain)	$-V_{GSO}$	max.	30	V
Currents				
Drain current	I_D	max.	20	mA
Gate current	I_G	max.	10	mA
Power dissipation				
Total power dissipation up to $T_{amb} = 25^o$	P_{tot}	max.	300	mW
Temperatures				
Storage temperature	T_{stg}		-65 to +200	^oC
Junction temperature	T_j	max.	200	^oC

THERMAL RESISTANCE

From junction to ambient in free air (for individual transistor without S-clip)	$R_{th\ j-a}$	=	0.59	$^oC/mW$



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[1] Common mode rejection ratio

$$(C\,M\,R\,R)^{-1} = \Delta \frac{g_{os}}{g_{fs}} + \tfrac{1}{2}\, g_{cs}\, \Delta \frac{1}{g_{fs}}$$

where g_{cs} in this formula is the output conductance of the summing current source.

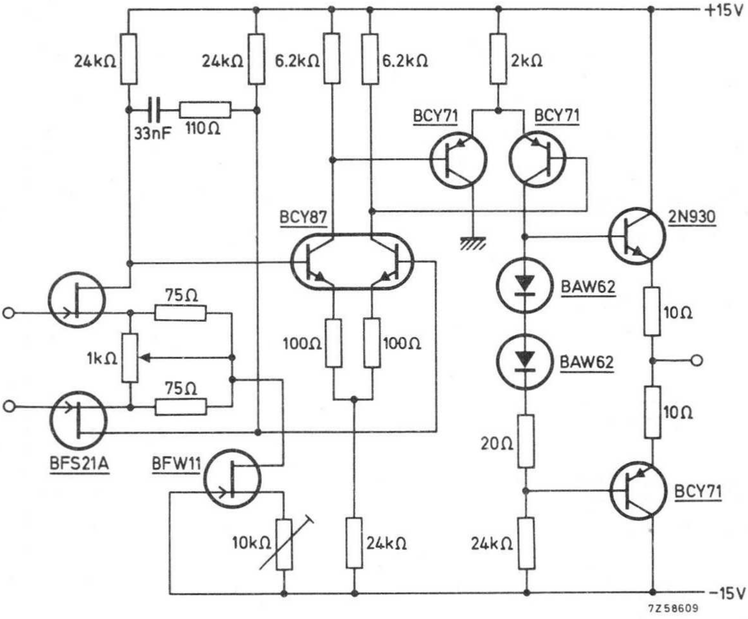
The guaranteed values of CMRR apply at $g_{cs} = 0.1\ \mu\Omega^{-1}$

CHARACTERISTICS (individual transistor) $T_{amb} = 25\,^{o}C$ unless otherwise specified

Gate cut-off current				
$I_D = 500\,\mu A;\ V_{DS} = 15\ V$	I_G	$<$	0.5	nA
$I_D = 500\,\mu A;\ V_{DS} = 15\ V;\ T_{amb} = 100\ ^{o}C$	I_G	$<$	25	nA
Drain current				
$V_{DS} = 15\ V,\ V_{GS} = 0,\ T_j = 25\ ^{o}C$	I_{DSS}	$>$	1	mA
Gate-source cut-off voltage				
$I_D = 0.5\ nA,\ V_{DS} = 15\ V$	$-V_{(P)GS}$	$<$	6	V
Transfer conductance at f = 1 kHz				
$I_D = 500\,\mu A;\ V_{DS} = 15\ V$	g_{fs}	$>$	1.0	$m\Omega^{-1}$
Output conductance at f = 1 kHz				
$I_D = 500\,\mu A;\ V_{DS} = 15\ V$	g_{os}	$<$	15	$\mu\Omega^{-1}$
Input capacitance at f = 1 MHz				
$I_D = 500\,\mu A;\ V_{DS} = 15\ V$	C_{is}	$<$	5	pF
Feedback capacitance at f = 1 MHz				
$I_D = 500\,\mu A;\ V_{DS} = 15\ V$	C_{rs}	$<$	0.75	pF
Equivalent noise voltage				
f = 10 Hz				
$I_D = 500\,\mu A;\ V_{DS} = 15\ V$	$V_n/\sqrt{B}$	$<$	200	$nV/\sqrt{Hz}$
$V_{DS} = 15\ V,\ V_{GS} = 0$	$V_n/\sqrt{B}$	$<$	75	$nV/\sqrt{Hz}$

APPLICATION INFORMATION

Operational amplifier



APPLICATION INFORMATION (continued)

Input voltages

Initial off-set voltage	<	10	mV
Differential off-set voltage change with temperature	<	40	μV/^{o}C
Differential off-set voltage change with time	<	40	μV/day
Noise voltage (B = 100 kHz)	<	2	μV
Common mode rejection ratio	>	65	dB
Supply rejection ratio	<	500	10^{-6}
Input voltage range	±	10	V

Input currents

Input bias current; T_{amb} = 25 ^{o}C	typ.	50	pA
; T_{amb} = 100 ^{o}C	<	25	nA
Off-set current ; T_{amb} = 25 ^{o}C	typ.	20	pA
; T_{amb} = 100 ^{o}C	<	25	nA

Input impedance

Input resistance	typ.	100	GΩ
Input resistance (common mode)	typ.	100	GΩ
Input capacitance	typ.	3	pF
Input capacitance (common mode)	typ.	3	pF

Frequency response

Bandwidth (G_V = 1)	typ.	10	MHz
Slewing rate	typ.	10	V/μs

Output voltage range	±	10	V
Output current range	±	10	mA
Output resistance	typ.	300	Ω

SILICON N-CHANNEL DUAL INSULATED GATE FIELD EFFECT TRANSISTOR

Depletion type field effect transistor in a TO-72 metal envelope with source and substrate connected to the case.

This M.O.S.-tetrode is intended for a wide range of applications in communication, instrumentation and control.

The tetrode configuration, a series arrangement of two gate controlled channels offers:

a. very low feedback capacitance providing the possibility of more than 40 dB gain control in r.f. amplifiers requiring negligible a.g.c. power.

b. excellent signal handling capability over the entire gain control range.

c. low noise figure combined with high gain.

QUICK REFERENCE DATA

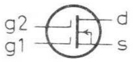
Drain-source voltage	V_{DSX}	max.	20	V
Gate 1-source voltage	$\pm V_{G1-S}$	max.	8	V
Gate 2-source voltage	$\pm V_{G2-S}$	max.	8	V
Drain current	I_D	max.	20	mA
Total power dissipation up to $T_{amb} = 25^oC$	P_{tot}	max.	200	mW
Junction temperature	T_j	max.	135	^oC
Transfer admittance at f = 1 kHz $I_D = 10$ mA; $V_{DS} = 13$ V; $+V_{G2-S} = 4$ V	$\|y_{fs}\|$	> typ.	8 13	mA/V mA/V
Feedback capacitance at f = 10 MHz $I_D = 10$ mA; $V_{DS} = 13$ V; $+V_{G2-S} = 4$ V	$-C_{rs}$	typ.	25	fF
Transducer gain at f = 200 MHz $I_D = 10$ mA; $V_{DS} = 13$ V; $+V_{G2-S} = 4$ V B_S and B_L tuned for maximum gain	G_{tr}	typ.	18	dB
Noise figure at optimum source admittance $I_D = 10$ mA; $V_{DS} = 13$ V; $+V_{G2-S} = 4$ V; f = 200 MHz	F_{min}	typ. <	3 4	dB dB

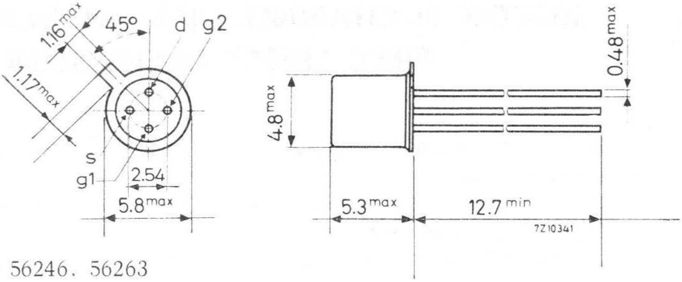
MECHANICAL DATA see page 2.

MECHANICAL DATA

Dimensions in mm

TO-72
Source and substrate
connected to the case





Accessories available: 56246, 56263

Note: To safeguard the gates against damage due to accumulation of static charge during transport or handling, the leads are encircled by a ring of conductive rubber which should be removed just after the transistor is soldered into the circuit.

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltages				
Drain-source voltage	V_{DSX}	max.	20	V
Gate 1-source voltage	$\pm V_{G1-S}$	max.	8	V
Gate 2-source voltage	$\pm V_{G2-S}$	max.	8	V
Non repetitive peak voltage ($t \leq 10$ ms)				
gate 1-source voltage	$\pm V_{G1-SM}$	max.	50	V
gate 2-source voltage	$\pm V_{G2-SM}$	max.	50	V
Current				
Drain current	I_D	max.	20	mA
Power dissipation				
Total power dissipation up to $T_{amb} = 25\,^{o}C$	P_{tot}	max.	200	mW
Temperatures				
Storage temperature	T_{stg}	-65 to +135		^{o}C
Junction temperature	T_j	max.	135	^{o}C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	0.55	$^{o}C/mW$

CHARACTERISTICS T_j = 25 °C unless otherwise specified

Gate 1 cut-off current

$\pm V_{G1-S}$ = 8 V; V_{G2-S} = 0; V_{DS} = 0; T_j = 135 °C $\pm I_{G1-SS}$ < 1 nA

Gate 2 cut-off current

$\pm V_{G2-S}$ = 8 V; V_{G1-S} = 0; V_{DS} = 0; T_j = 135 °C $\pm I_{G2-SS}$ < 1 nA

Gate 1-source voltage

I_D = 10 mA; V_{DS} = 13 V; + V_{G2-S} = 4 V $-V_{G1-S}$ 0.6 to 2.8 V

Gate 1-source cut-off voltage

I_D = 100 μA; V_{DS} = 20 V; + V_{G2-S} = 4 V $-V_{G1-S}$ < 5 V

Gate 2-source cut-off voltage

I_D = 50 μA; V_{DS} = 20 V; V_{G1-S} = 0 $-V_{G2-S}$ < 4 V

y parameters (common source)

I_D = 10 mA; V_{DS} = 13 V; + V_{G2-S} = 4 V; T_{amb} = 25 °C

Transfer admittance f = 1 kHz $|y_{fs}|$ > 8 mA/V; typ. 13 mA/V

f = 200 MHz $|y_{fs}|$ typ. 12.1 mA/V

f = 500 MHz $|y_{fs}|$ typ. 11.2 mA/V

Feedback capacitance f = 10 MHz $-C_{rs}$ typ. 25 fF

Transducer gain at f = 200 MHz

I_D = 10 mA; V_{DS} = 13 V; + V_{G2-S} = 4 V

G_S = 1.3 mA/V; G_L = 1 mA/V; T_{amb} = 25 °C

B_S and B_L tuned for maximum gain G_{tr} typ. 18 dB

Maximum unilateralised power gain at T_{amb} = 25 °C

$$G_{UM} \text{ in dB} = 10 \log \frac{|y_{fs}|^2}{4 g_{is} g_{os}}$$

I_D = 10 mA; V_{DS} = 13 V; + V_{G2-S} = 4 V; f = 200 MHz G_{UM} typ. 21.3 dB

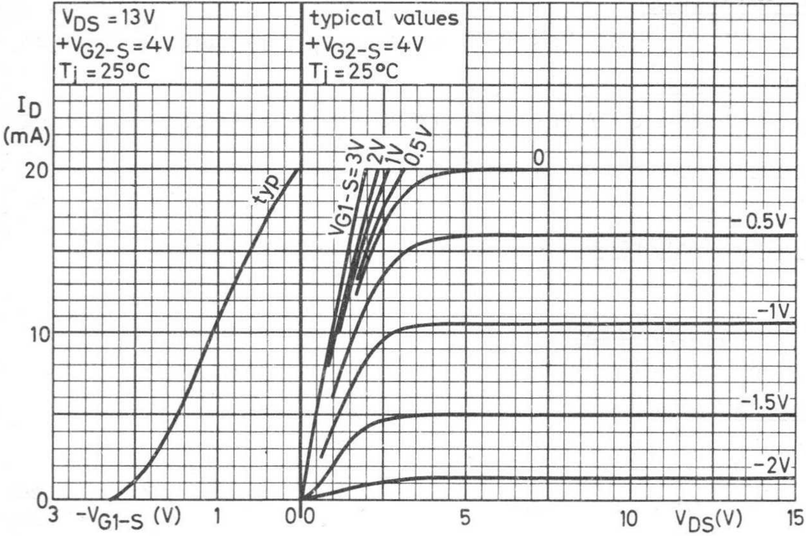
f = 500 MHz G_{UM} typ. 7.3 dB

Noise figure at optimum source admittance at f = 200 MHz

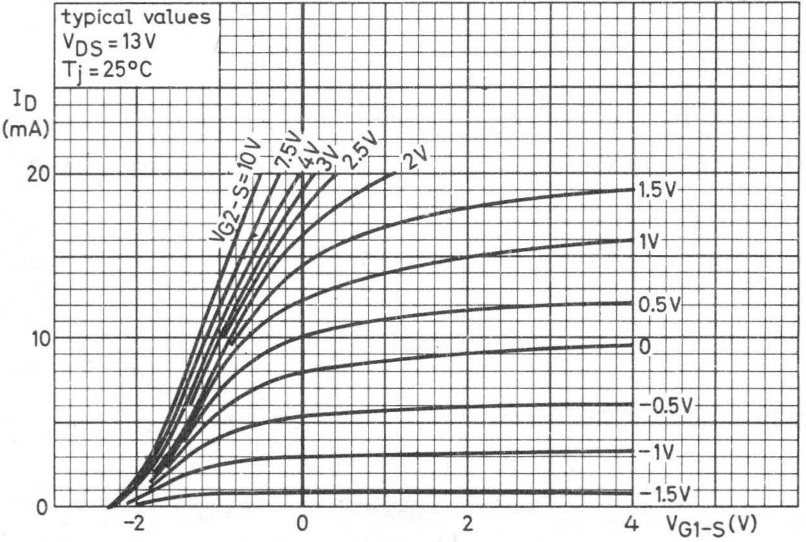
I_D = 10 mA; V_{DS} = 13 V; + V_{G2-S} = 4 V

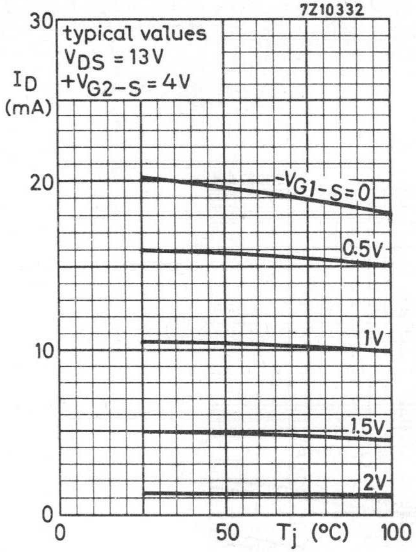
G_{Sopt} = 1.4 mA/V; B_{Sopt} = 5.5 mA/V; T_{amb} = 25 °C F_{min} typ. 3 dB; < 4 dB

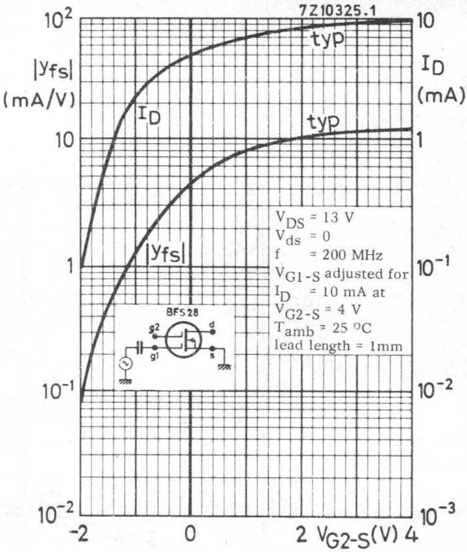
7Z10323

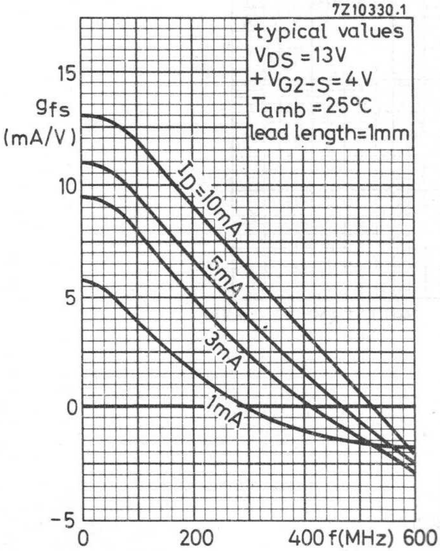


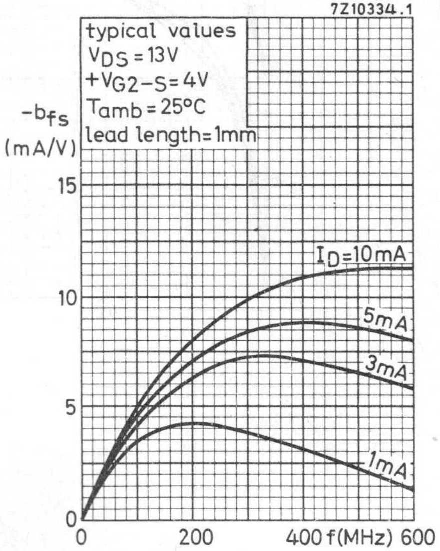
7Z10329

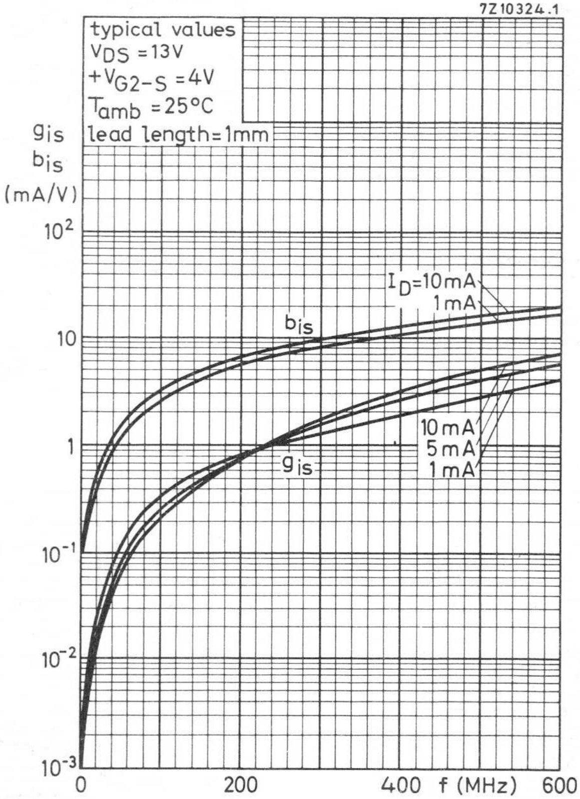


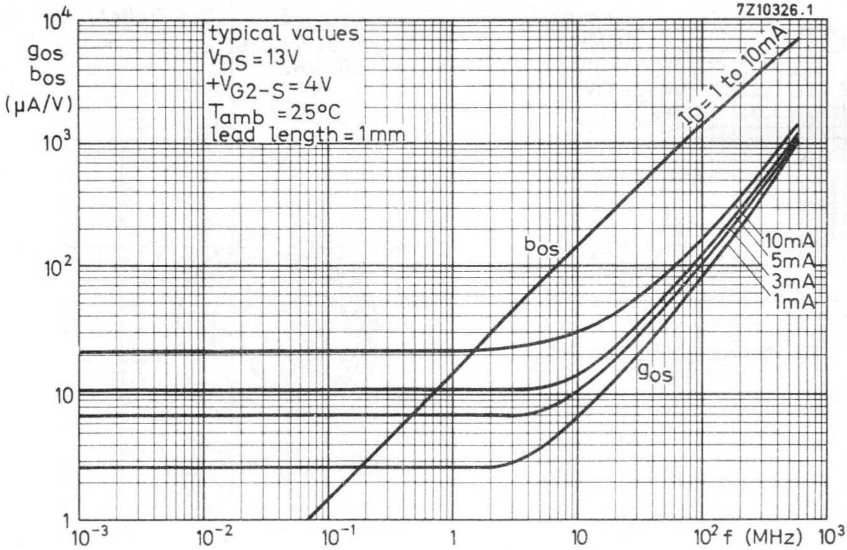

7Z10332
typical values
V_{DS} = 13V
$+V_{G2-S}$ = 4V
I_D
(mA)
30
20
10
0
$-V_{G1-S}$=0
0.5V
1V
1.5V
2V
0
50
T_j (°C)
100

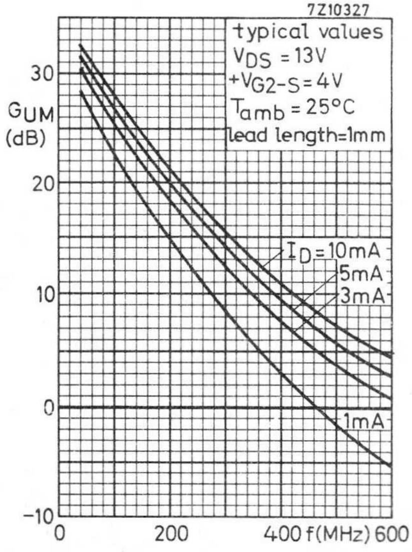

7Z10325.1
10^2
$|y_{fs}|$
(mA/V)
10
1
10^{-1}
10^{-2}
typ
I_D
typ
$|y_{fs}|$
10
I_D
(mA)
1
10^{-1}
10^{-2}
10^{-3}
V_{DS} = 13 V
V_{ds} = 0
f = 200 MHz
V_{G1-S} adjusted for
I_D = 10 mA at
V_{G2-S} = 4 V
T_{amb} = 25 °C
lead length = 1mm
BFS28
g2
d
g1
s
-2
0
2 V_{G2-S}(V) 4

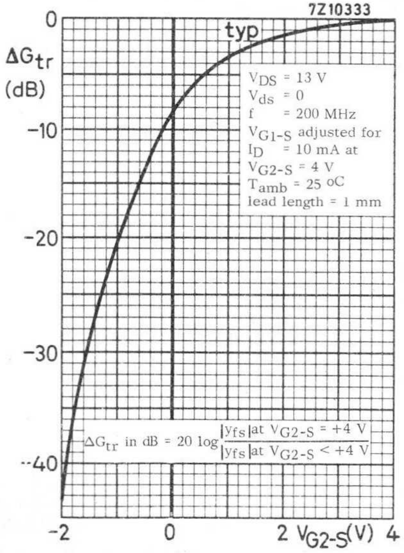

7Z10330.1
typical values
V_{DS} = 13V
$+V_{G2-S}$ = 4V
T_{amb} = 25°C
lead length=1mm
15
g_{fs}
(mA/V)
10
5
0
-5
I_D=10mA
5mA
3mA
1mA
0
200
400 f(MHz) 600

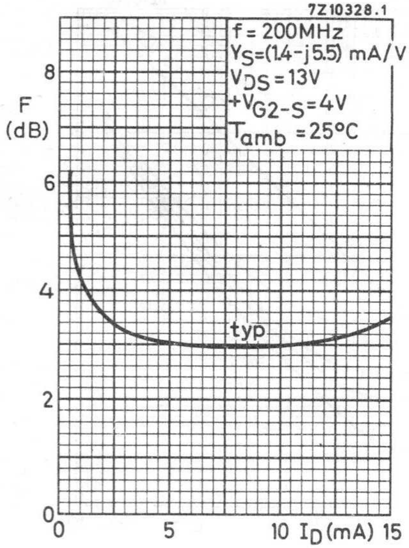

7Z10334.1
typical values
V_{DS} = 13V
$+V_{G2-S}$ = 4V
T_{amb} = 25°C
lead length=1mm
$-b_{fs}$
(mA/V)
15
10
5
0
I_D=10mA
5mA
3mA
1mA
0
200
400 f(MHz) 600

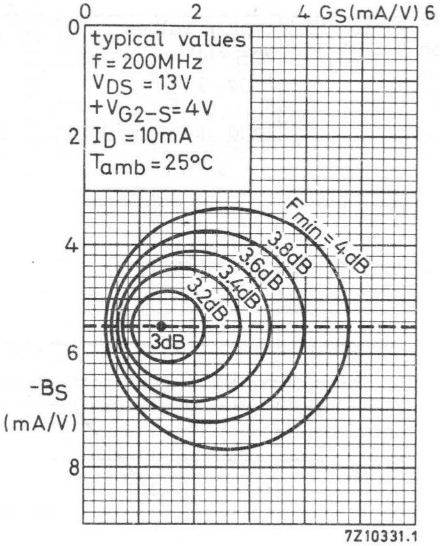

7Z10324.1
typical values
V_{DS} = 13 V
$+V_{G2-S}$ = 4 V
T_{amb} = 25 °C
lead length = 1 mm
g_{is}
b_{is}
(mA/V)
10^2
10
1
10^{-1}
10^{-2}
10^{-3}
I_D=10 mA
1 mA
b_{is}
10 mA
5 mA
1 mA
g_{is}
0
200
400
f (MHz)
600


7Z10326.1
typical values
$V_{DS} = 13V$
$+V_{G2-S} = 4V$
$T_{amb} = 25°C$
lead length = 1mm
g_{os}
b_{os}
(μA/V)
10^4
10^3
10^2
10
1
$I_D = 1$ to 10mA
b_{os}
10mA
5mA
3mA
1mA
g_{os}
10^{-3}
10^{-2}
10^{-1}
1
10
10^2
f (MHz)
10^3


7Z10327
typical values
$V_{DS} = 13V$
$+V_{G2-S} = 4V$
$T_{amb} = 25°C$
lead length=1mm
G_{UM}
(dB)
30
20
10
0
−10
$I_D = 10mA$
5mA
3mA
1mA
0
200
400 f(MHz) 600


7Z10333
ΔG_{tr}
(dB)
0
-10
-20
-30
-40
typ
V_{DS} = 13 V
V_{ds} = 0
f = 200 MHz
V_{G1-S} adjusted for
I_D = 10 mA at
V_{G2-S} = 4 V
T_{amb} = 25 oC
lead length = 1 mm
ΔG_{tr} in dB = 20 log $\frac{|y_{fs}| \text{at } V_{G2-S} = +4 \text{ V}}{|y_{fs}| \text{at } V_{G2-S} < +4 \text{ V}}$
-2
0
2 V_{G2-S}(V) 4


7Z10328.1
f = 200MHz
Y_S=(1.4−j5.5) mA/V
V_{DS} = 13V
+V_{G2-S}=4V
T_{amb} = 25°C
F
(dB)
8
6
4
2
0
typ
0
5
10
I_D(mA)
15


0
2
4
G_S(mA/V)
6
typical values
f = 200MHz
V_{DS} = 13V
+V_{G2-S}=4V
I_D = 10mA
T_{amb} = 25°C
0
2
4
6
8
$-B_S$
(mA/V)
F_{min} = 4dB
3.8dB
3.6dB
3.4dB
3.2dB
3dB
7Z10331.1

N-CHANNEL SILICON FIELD EFFECT TRANSISTORS

N-channel silicon epitaxial planar junction field effect transistors in a TO-72 metal envelope with the shield lead connected to the case.
The transistors are designed for broad band amplifiers (0 to 300 MHz).
Their very low noise at low frequencies makes these devices very suitable for differential amplifiers, electro-medical and nuclear detector pre-amplifiers.

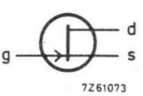
QUICK REFERENCE DATA

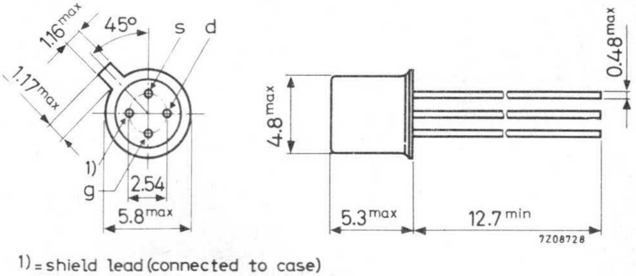
			BFW10	BFW11	
Drain-source voltage	$\pm V_{DS}$	max.	30		V
Gate-source voltage (open drain)	$-V_{GSO}$	max.	30		V
Total power dissipation up to $T_{amb} = 25\ ^{o}C$	P_{tot}	max.	300		mW
Drain current $V_{DS} = 15$ V; $V_{GS} = 0$	I_{DSS}	>	8	4	mA
		<	20	10	mA
Gate-source cut-off voltage $I_D = 0.5$ nA; $V_{DS} = 15$ V	$-V_{(P)GS}$	<	8	6	V
Feedback capacitance at f = 1 MHz $V_{DS} = 15$ V; $V_{GS} = 0$	$-C_{rs}$	<	0.80	0.80	pF
Transfer admittance (common source) $V_{DS} = 15$ V; $V_{GS} = 0$; f = 200 MHz	$\lvert y_{fs} \rvert$	>	3.2	3.2	mA/V
Noise figure at $V_{DS} = 15$ V; $V_{GS} = 0$ f = 100 MHz; $R_G = 1\ k\Omega$	F	<	2.5	2.5	dB
Equivalent noise voltage f = 10 Hz	$V_n/\sqrt{B}$	<	75	75	$nV/\sqrt{Hz}$

MECHANICAL DATA

Dimensions in mm

TO-72
Insulated electrodes





1) = shield lead (connected to case)

Accessories available: 56246, 56263.

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltages

Drain-source voltage	$\pm V_{DS}$	max.	30	V
Drain-gate voltage (open source)	V_{DGO}	max.	30	V
Gate-source voltage (open drain)	$-V_{GSO}$	max.	30	V

Currents

Drain current	I_D	max.	20	mA
Gate current	I_G	max.	10	mA

Power dissipation

Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	300	mW

Temperatures

Storage temperature	T_{stg}	-65 to +200		°C
Junction temperature	T_j	max.	200	°C

THERMAL RESISTANCE

From junction to ambient	$R_{th\ j-a}$	=	0.59	°C/mW

CHARACTERISTICS T_j = 25 °C unless otherwise specified

			BFW10	BFW11	
Gate cut-off current					
$-V_{GS}$ = 20 V; V_{DS} = 0	$-I_{GSS}$	<	0.1	0.1	nA
$-V_{GS}$ = 20 V; V_{DS} = 0; T_j = 150 °C	$-I_{GSS}$	<	0.5	0.5	μA
Drain current [1]					
V_{DS} = 15 V; V_{GS} = 0	I_{DSS}	>	8	4	mA
		<	20	10	mA
Gate-source voltage					
I_D = 400 μA; V_{DS} = 15 V	$-V_{GS}$	>	2.0		V
		<	7.5		V
I_D = 50 μA; V_{DS} = 15 V	$-V_{GS}$	>		1.25	V
		<		4.0	V
Gate-source cut-off voltage					
I_D = 0.5 nA; V_{DS} = 15 V	$-V_{(P)GS}$	<	8	6	V
y parameters					
V_{DS} = 15 V; V_{GS} = 0; T_{amb} = 25 °C f = 1 kHz Transfer admittance	$\lvert y_{fs} \rvert$	>	3.5	3.0	mA/V
		<	6.5	6.5	mA/V
Output admittance	$\lvert y_{os} \rvert$	<	85	50	μA/V
f = 1 MHz Input capacitance	C_{is}	typ.	4	4	pF
		<	5	5	pF
Feedback capacitance	$-C_{rs}$	typ.	0.6	0.6	pF
		<	0.80	0.80	pF
f = 200 MHz Transfer admittance	$\lvert y_{fs} \rvert$	>	3.2	3.2	mA/V
Input conductance	g_{is}	<	800	800	μA/V
Output conductance	g_{os}	<	200	100	μA/V
Noise figure at f = 100 MHz; R_G = 1 kΩ					
V_{DS} = 15 V; V_{GS} = 0 ; T_{amb} = 25 °C input tuned to minimum noise	F	<	2.5	2.5	dB
Equivalent noise voltage					
V_{DS} = 15 V; V_{GS} = 0; T_{amb} = 25 °C					
f = 10 Hz	$V_n/\sqrt{B}$	<	75	75	nV/$\sqrt{\text{Hz}}$

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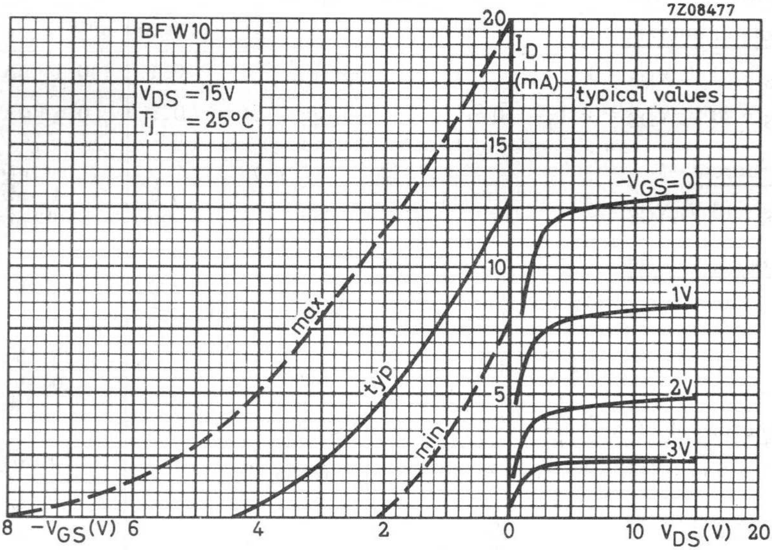
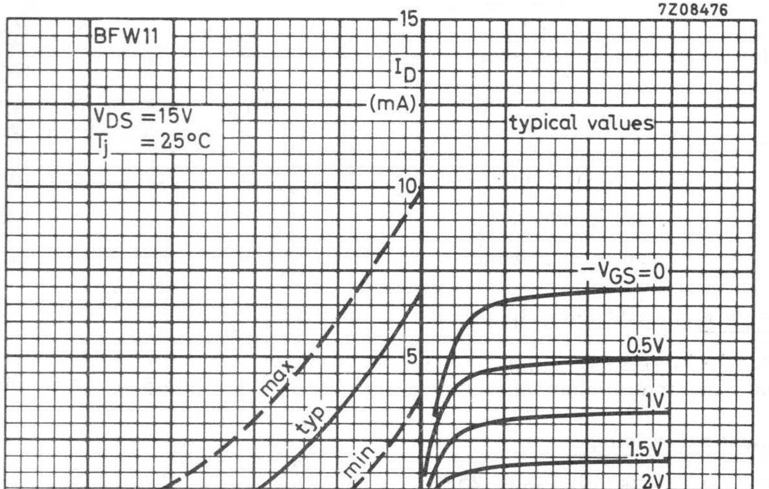
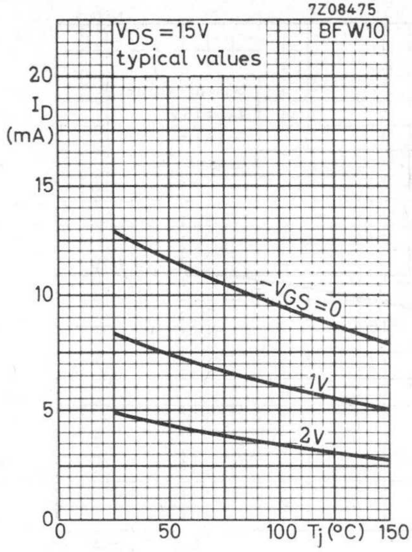
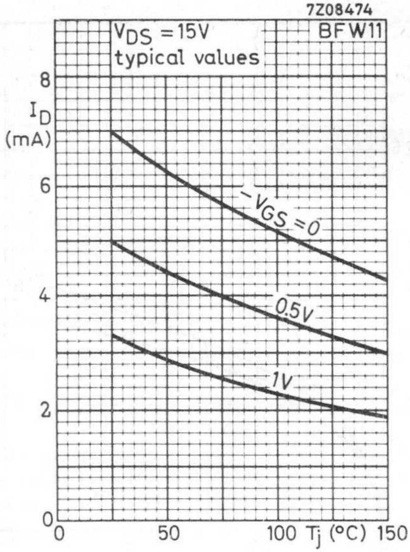
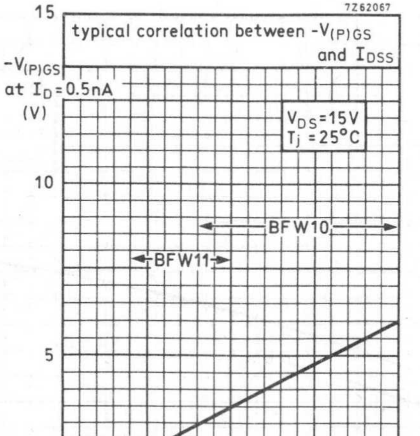
[1] Measured under pulsed conditions.

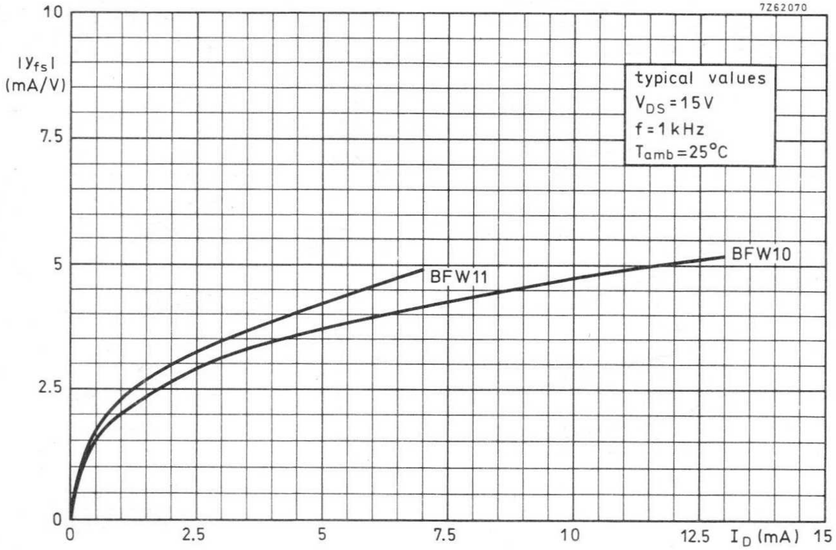

7Z08477
BFW10
V_{DS} = 15V
T_j = 25°C
max
typ
min
I_D (mA)
typical values
$-V_{GS}$ = 0
1V
2V
3V
20
15
10
5
8
$-V_{GS}$ (V)
6
4
2
0
10
V_{DS} (V)
20

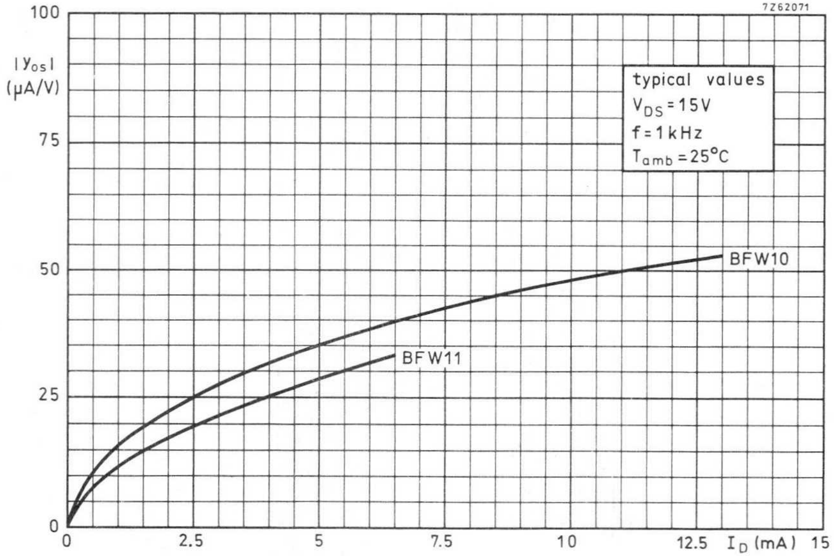

7Z08476
BFW11
V_{DS} = 15V
T_j = 25°C
max
typ
min
I_D (mA)
typical values
$-V_{GS}$ = 0
0.5V
1V
1.5V
2V
15
10
5
4
$-V_{GS}$ (V)
2
0
10
V_{DS} (V)
20

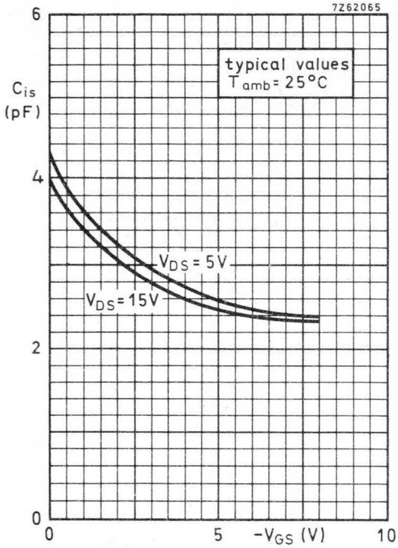

7Z08475
$V_{DS} = 15V$
typical values
BFW10
I_D
(mA)
20
15
10
5
0
0
50
100
T_j (°C)
150
$-V_{GS} = 0$
1V
2V

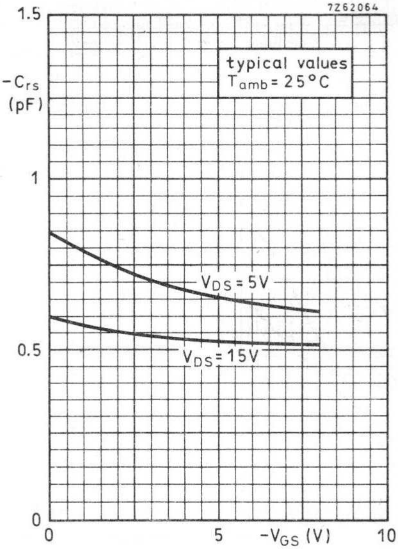

7Z08474
$V_{DS} = 15V$
typical values
BFW11
I_D
(mA)
8
6
4
2
0
0
50
100
T_j (°C)
150
$-V_{GS} = 0$
0.5V
1V

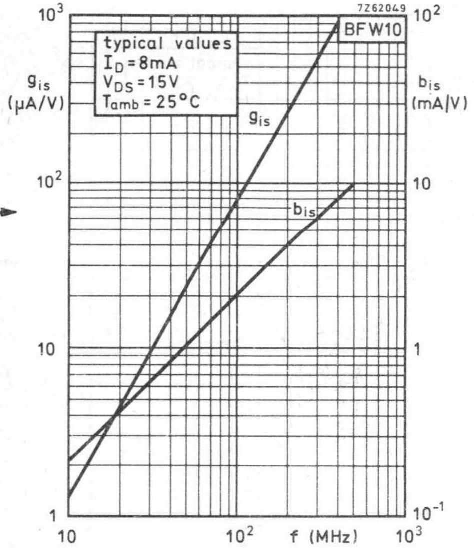

7Z62067
typical correlation between $-V_{(P)GS}$ and I_{DSS}
$-V_{(P)GS}$
at $I_D = 0.5nA$
(V)
15
10
5
0
$V_{DS} = 15V$
$T_j = 25°C$
BFW10
BFW11
0
10
20
I_{DSS} at $V_{GS} = 0$ (mA)

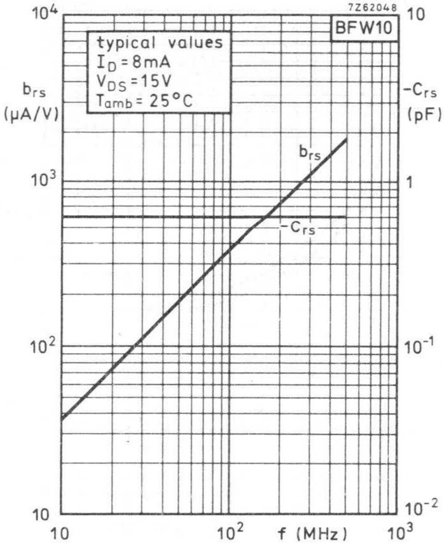

7Z62070
|yfs|
(mA/V)
10
7.5
5
2.5
0
typical values
V_{DS} = 15 V
f = 1 kHz
T_{amb} = 25 °C
BFW11
BFW10
0
2.5
5
7.5
10
12.5
I_D (mA)
15

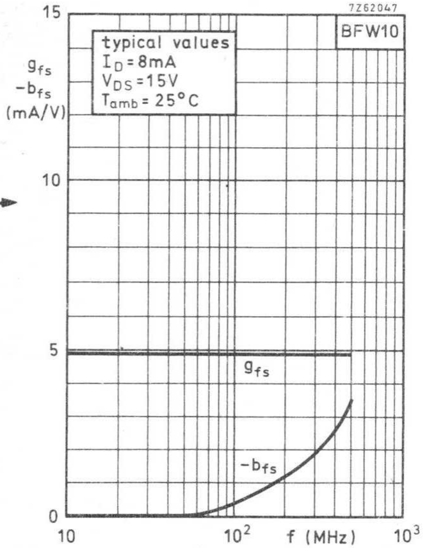

7Z62071
|yos|
(µA/V)
100
75
50
25
0
typical values
V_{DS} = 15 V
f = 1 kHz
T_{amb} = 25 °C
BFW10
BFW11
0
2.5
5
7.5
10
12.5
I_D (mA)
15

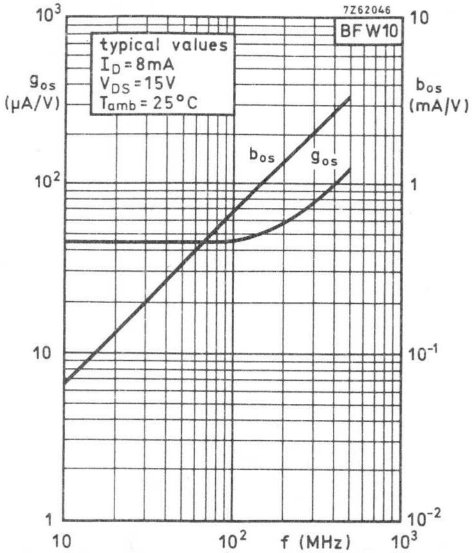

7Z62065
C_{is}
(pF)
6
4
2
0
typical values
T_{amb} = 25°C
V_{DS} = 5V
V_{DS} = 15V
0
5
$-V_{GS}$ (V)
10

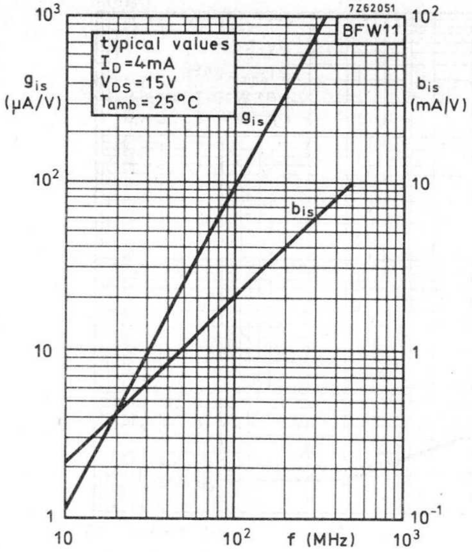

7Z62064
$-C_{rs}$
(pF)
1.5
1
0.5
0
typical values
T_{amb} = 25°C
V_{DS} = 5V
V_{DS} = 15V
0
5
$-V_{GS}$ (V)
10

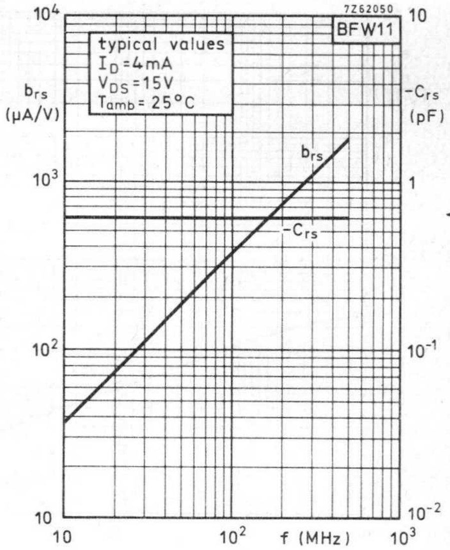

7Z62049
BFW10
typical values
$I_D = 8mA$
$V_{DS} = 15V$
$T_{amb} = 25°C$
g_{is} (μA/V)
b_{is} (mA/V)
g_{is}
b_{is}
10^3
10^2
10
1
10^2
10
1
10^{-1}
10
10^2
f (MHz)
10^3

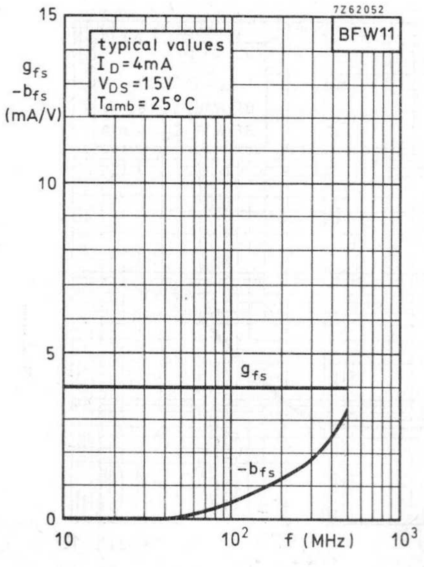

7Z62048
BFW10
typical values
$I_D = 8mA$
$V_{DS} = 15V$
$T_{amb} = 25°C$
b_{rs} (μA/V)
$-C_{rs}$ (pF)
b_{rs}
$-C_{rs}$
10^4
10^3
10^2
10
10
1
10^{-1}
10^{-2}
10
10^2
f (MHz)
10^3

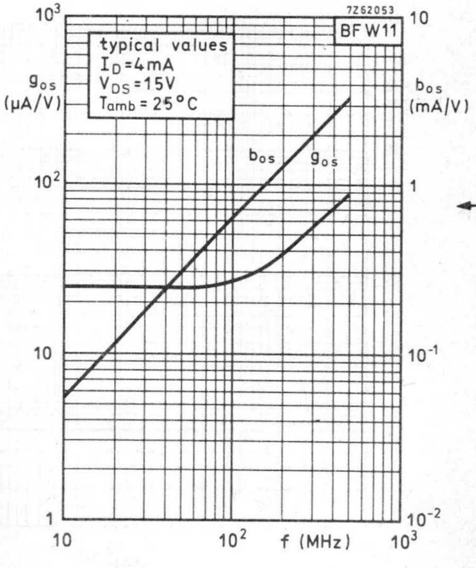

7Z62047
BFW10
typical values
$I_D = 8mA$
$V_{DS} = 15V$
$T_{amb} = 25°C$
g_{fs}
$-b_{fs}$
(mA/V)
g_{fs}
$-b_{fs}$
15
10
5
0
10
10^2
f (MHz)
10^3

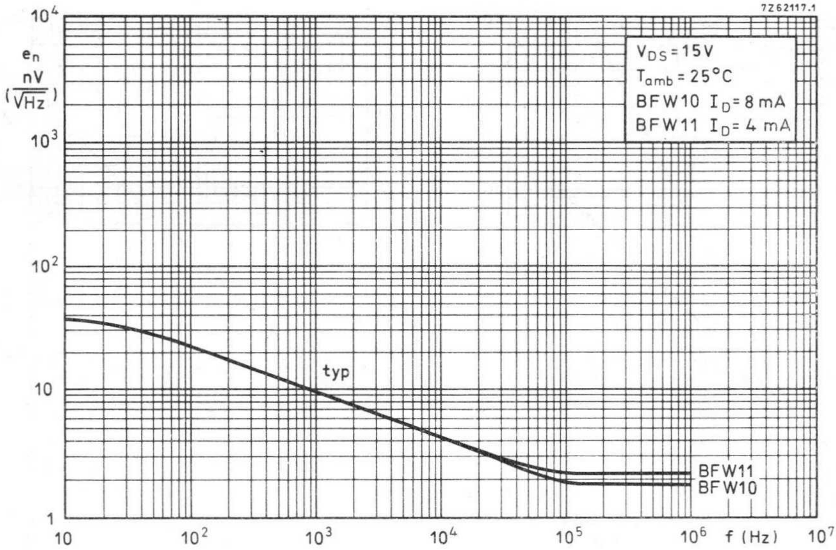

7Z62046
BFW10
typical values
$I_D = 8mA$
$V_{DS} = 15V$
$T_{amb} = 25°C$
g_{os} (μA/V)
b_{os} (mA/V)
b_{os}
g_{os}
10^3
10^2
10
1
10
1
10^{-1}
10^{-2}
10
10^2
f (MHz)
10^3

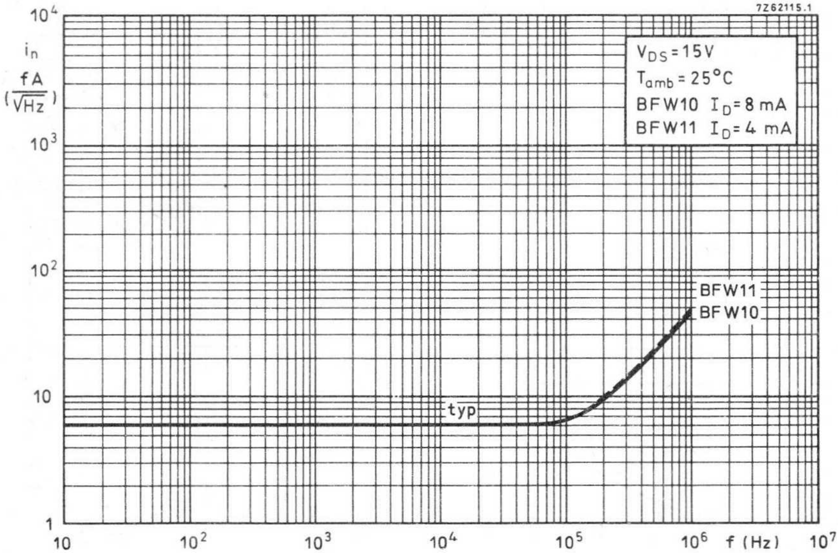

7Z62051
BFW11
typical values
I_D = 4 mA
V_{DS} = 15 V
T_{amb} = 25 °C
g_{is} (μA/V)
b_{is} (mA/V)
g_{is}
b_{is}
10^3
10^2
10
1
10^2
10
1
10^{-1}
10
10^2
f (MHz)
10^3

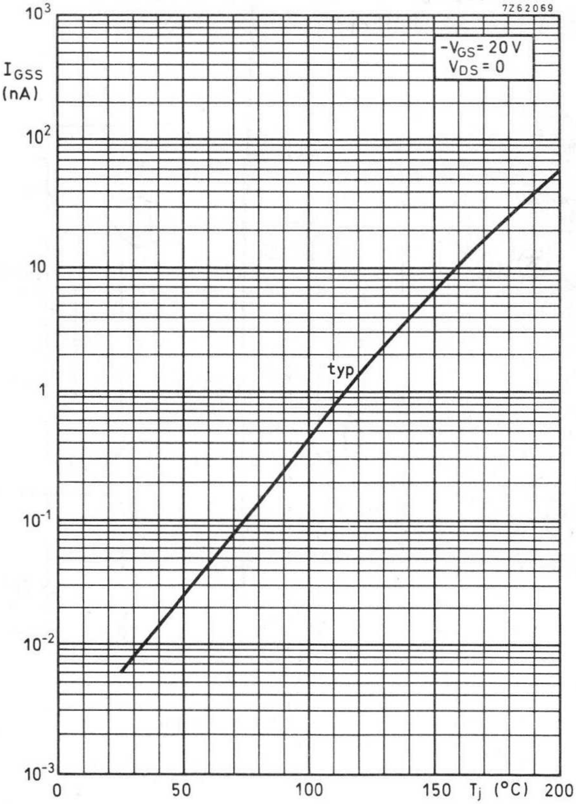

7Z62050
BFW11
typical values
I_D = 4 mA
V_{DS} = 15 V
T_{amb} = 25 °C
b_{rs} (μA/V)
$-C_{rs}$ (pF)
b_{rs}
$-C_{rs}$
10^4
10^3
10^2
10
10
1
10^{-1}
10^{-2}
10
10^2
f (MHz)
10^3


7Z62052
BFW11
typical values
I_D = 4 mA
V_{DS} = 15 V
T_{amb} = 25 °C
g_{fs}
$-b_{fs}$
(mA/V)
g_{fs}
$-b_{fs}$
15
10
5
0
10
10^2
f (MHz)
10^3


7Z62053
BFW11
typical values
I_D = 4 mA
V_{DS} = 15 V
T_{amb} = 25 °C
g_{os} (μA/V)
b_{os} (mA/V)
b_{os}
g_{os}
10^3
10^2
10
1
10
1
10^{-1}
10^{-2}
10
10^2
f (MHz)
10^3

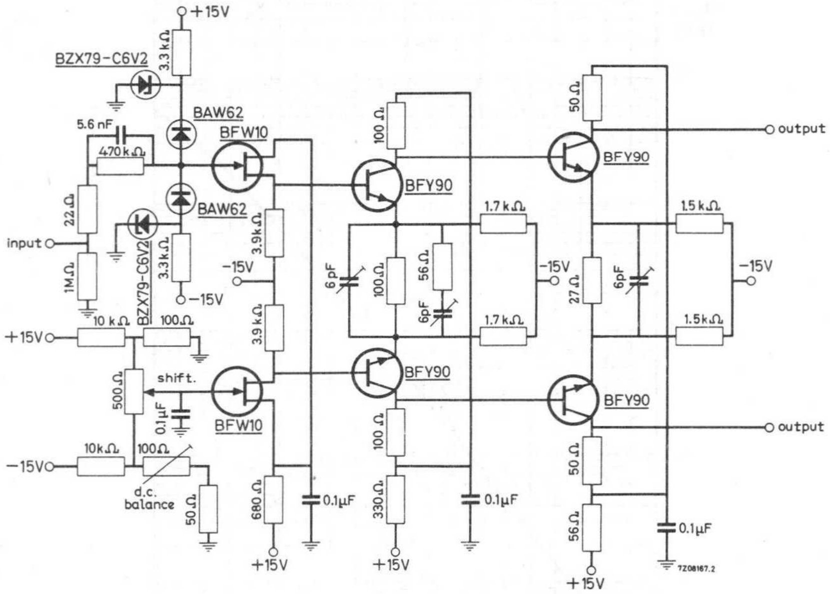

7Z62117.1
e_n
$(\frac{nV}{\sqrt{Hz}})$
10^4
10^3
10^2
10
1
$V_{DS} = 15V$
$T_{amb} = 25°C$
BFW10 $I_D = 8$ mA
BFW11 $I_D = 4$ mA
typ
BFW11
BFW10
10
10^2
10^3
10^4
10^5
10^6
f (Hz)
10^7


7Z62115.1
i_n
$(\frac{fA}{\sqrt{Hz}})$
10^4
10^3
10^2
10
1
$V_{DS} = 15V$
$T_{amb} = 25°C$
BFW10 $I_D = 8$ mA
BFW11 $I_D = 4$ mA
BFW11
BFW10
typ
10
10^2
10^3
10^4
10^5
10^6
f (Hz)
10^7


7Z62069
I_{GSS} (nA)
10^3
10^2
10
1
10^{-1}
10^{-2}
10^{-3}
$-V_{GS} = 20$ V
$V_{DS} = 0$
typ
0
50
100
150
T_j (°C)
200

APPLICATION INFORMATION

Input amplifier circuit for an oscilloscope.

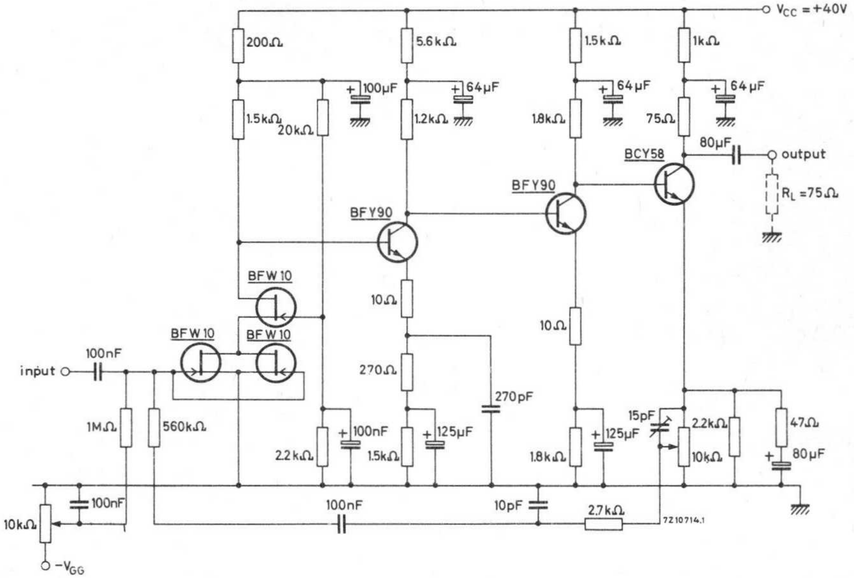


Performance:

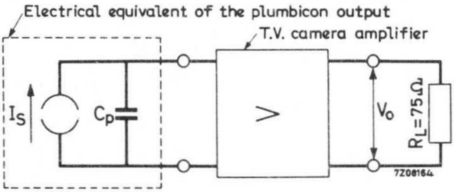
Input resistance	1 MΩ
Input capacitance	7.5 pF
Bandwidth	From d.c. to 300 MHz
Rise time	< 1 ns
Voltage gain	3.6
R.M.S. noise voltage (B = 300 MHz)	≤ 0.2 mV (input short-circuited)
Input sensitivity	This input amplifier is intended for an oscilloscope with a maximum input sensitivity of 5 or 10 mV/cm and a total bandwidth of 150 MHz
Input voltage	Max. permissible input voltage: peak to peak 600 V d.c. 300 V

APPLICATION INFORMATION (continued)

Television camera amplifier with BFW10



The circuit is designed for the Plumbicon Television Camera tube No. 55876. The electrical behaviour of this tube can be described as consisting of a current source I_S, shunted by a capacitance C_p ($C_p \approx 12$ pF).



Performance:

Transfer impedance (40 Hz to 5 MHz)	$\frac{V_O}{I_S}$	=	10^6 V/A
Output resistance	R_o	=	75 Ω
Output voltage (peak to peak) ($d \leq 5\%$)	V_O	<	1.3 V
Signal-noise ratio			
Ratio of V_O p-p (at I_S p-p = 0.3 µA) and the effective output noise voltage V_n (f from 40 Hz to 5 MHz)	$\frac{V_{O\,p\text{-}p}}{V_n}$	=	46 dB

N-CHANNEL SILICON FIELD EFFECT TRANSISTORS

N-channel silicon epitaxial planar junction field effect transistors in a TO-72 metal envelope with the shield lead connected to the case.
The transistors are intended for battery powered equipment and other low current/low voltage applications.

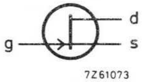
QUICK REFERENCE DATA

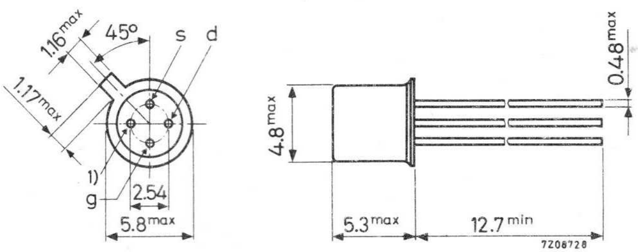
Drain-source voltage	$\pm V_{DS}$	max.	30		V
Gate-source voltage (open drain)	$-V_{GSO}$	max.	30		V
Total power dissipation up to $T_{amb} = 110\,^{0}C$	P_{tot}	max.	150		mW
			BFW12	BFW13	
Drain current $V_{DS} = 15$ V; $V_{GS} = 0$	I_{DSS}	>	1	0.2	mA
		<	5	1.5	mA
Gate-source cut-off voltage $I_D = 0.5$ nA; $V_{DS} = 15$ V	$-V_{(P)GS}$	<	2.5	1.2	V
Feedback capacitance at f = 1 MHz $V_{DS} = 15$ V; $V_{GS} = 0$	$-C_{rs}$	<	0.80	0.80	pF
Transfer admittance (common source) $V_{DS} = 15$ V; $I_D = 200\ \mu A$; f = 1 kHz	$\lvert y_{fs} \rvert$	>	0.5	0.5	mA/V
Equivalent noise voltage $V_{DS} = 15$ V; $I_D = 200\ \mu A$ B = 0.6 to 100 Hz	V_n	<	0.5	0.5	μV

MECHANICAL DATA

Dimensions in mm

TO-72
Insulated electrodes





1) = shield lead (connected to case)

Accessories supplied on request: 56246, 56263

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltages				
Drain-source voltage	$\pm V_{DS}$	max.	30	V
Drain-gate voltage (open source)	V_{DGO}	max.	30	V
Gate-source voltage (open drain)	$-V_{GSO}$	max.	30	V
Currents				
Drain current	I_D	max.	10	mA
Gate current	I_G	max.	5	mA
Power dissipation				
Total power dissipation up to T_{amb} = 110 °C	P_{tot}	max.	150	mW
Temperatures				
Storage temperature	T_{stg}	-65 to	+200	°C
Junction temperature	T_j	max.	200	°C

THERMAL RESISTANCE

From junction to ambient	$R_{th\ j-a}$	=	0.59	°C/mW

CHARACTERISTICS T_j = 25 °C unless otherwise specified

			BFW12	BFW13	
Gate cut-off current					
$-V_{GS}$ = 10 V; V_{DS} = 0	$-I_{GSS}$	<	0.1	0.1	nA
$-V_{GS}$ = 10 V; V_{DS} = 0; T_j = 150 °C	$-I_{GSS}$	<	0.1	0.1	μA
Drain current [1]					
V_{DS} = 15 V; V_{GS}= 0	I_{DSS}	>	1	0.2	mA
		<	5	1.5	mA
Gate-source voltage					
I_D = 50 μA; V_{DS} = 15 V	$-V_{GS}$	>	0.5	0.1	V
		<	2.0	1.0	V
Gate-source cut-off voltage					
I_D = 0.5 nA; V_{DS} = 15 V	$-V_{(P)GS}$	<	2.5	1.2	V
y parameters at f = 1 kHz; T_{amb} = 25 °C					
V_{DS} = 15 V; V_{GS} = 0					
Transfer admittance	$\|y_{fs}\|$	>	2.0	1.0	mA/V
Output admittance	$\|y_{os}\|$	<	30	10	μA/V
V_{DS} = 15 V; I_D = 500 μA					
Transfer admittance	$\|y_{fs}\|$	>	1.5	-	mA/V
Output admittance	$\|y_{os}\|$	<	10	-	μA/V
V_{DS} = 15 V; I_D = 200 μA					
Transfer admittance	$\|y_{fs}\|$	>	0.5	0.5	mA/V
Output admittance	$\|y_{os}\|$	<	5	5	μA/V
f = 1 MHz; T_{amb} = 25 °C					
V_{DS} = 15 V; V_{GS} = 0					
Input capacitance	C_{iss}	<	5	5	pF
Feedback capacitance	$-C_{rs}$	<	0.80	0.80	pF
Equivalent noise voltage					
V_{DS} = 15 V; I_D = 200 μA; T_{amb} = 25 °C B = 0.6 to 100 Hz	V_n	<	0.5	0.5	μV

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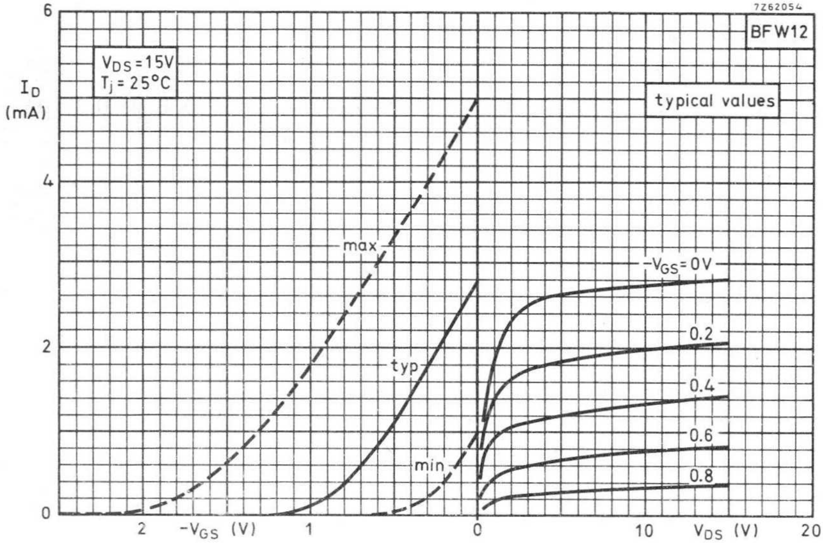
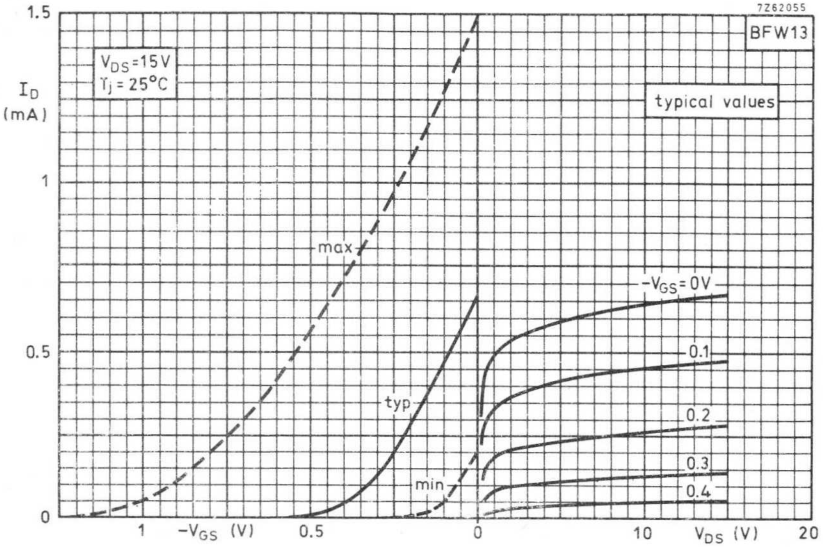
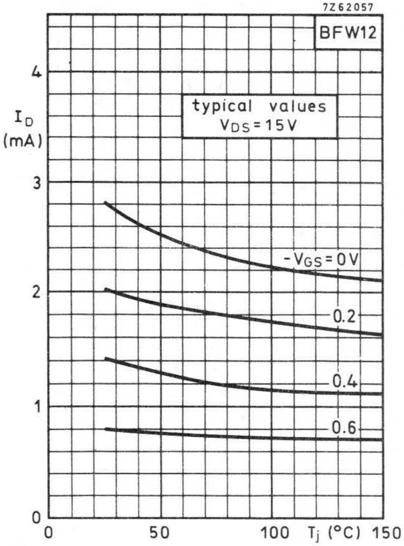
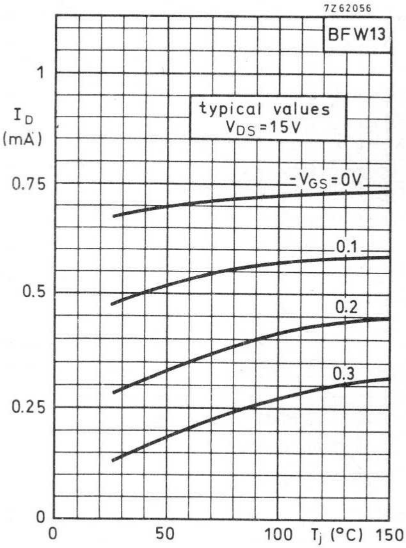
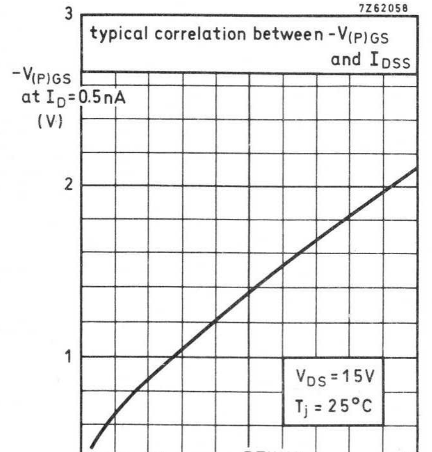
[1] Measured under pulsed conditions.

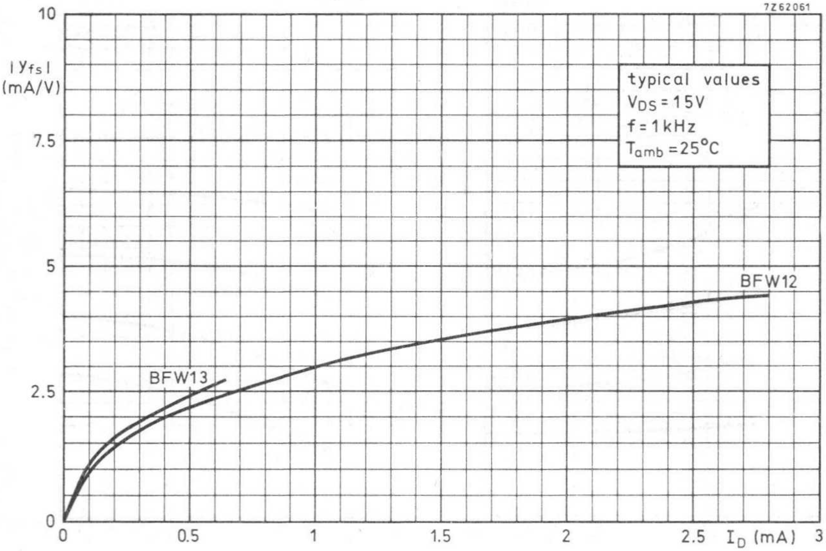

7Z62054
BFW12
V_{DS} = 15V
T_j = 25°C
I_D (mA)
typical values
max
typ
min
$-V_{GS}$ = 0V
0.2
0.4
0.6
0.8
6
4
2
0
2
$-V_{GS}$ (V)
1
0
10
V_{DS} (V)
20

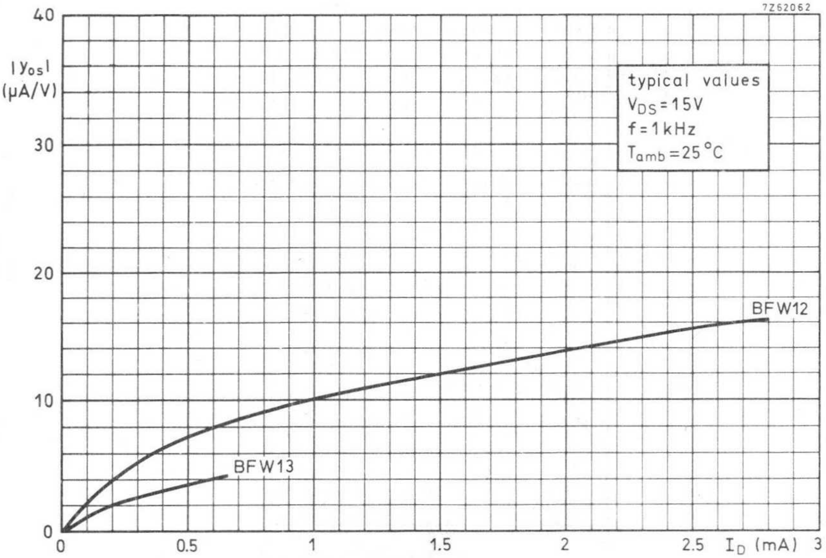

7Z62055
BFW13
V_{DS} = 15V
T_j = 25°C
I_D (mA)
typical values
max
typ
min
$-V_{GS}$ = 0V
0.1
0.2
0.3
0.4
1.5
1
0.5
0
1
$-V_{GS}$ (V)
0.5
0
10
V_{DS} (V)
20

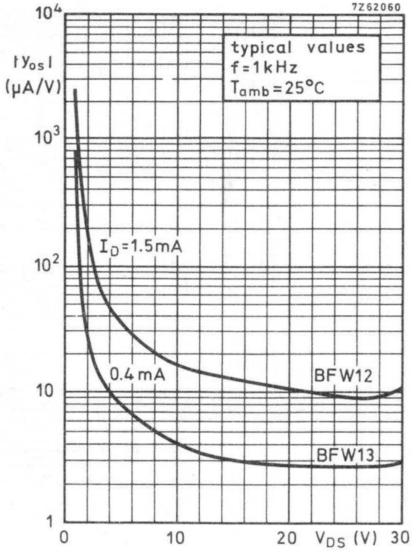

7Z62057
BFW12
typical values
$V_{DS}=15V$
I_D (mA)
4
3
2
1
0
$-V_{GS}=0V$
0.2
0.4
0.6
0
50
100
T_j (°C)
150

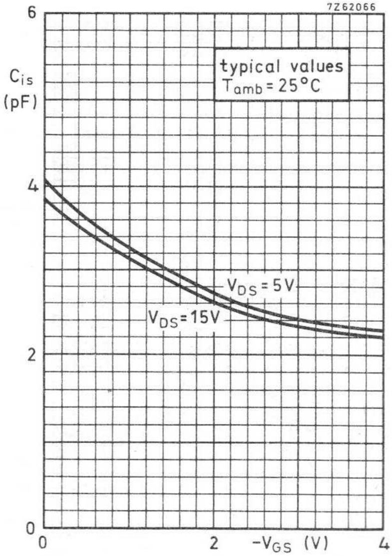

7Z62056
BFW13
typical values
$V_{DS}=15V$
I_D (mA)
1
0.75
0.5
0.25
0
$-V_{GS}=0V$
0.1
0.2
0.3
0
50
100
T_j (°C)
150

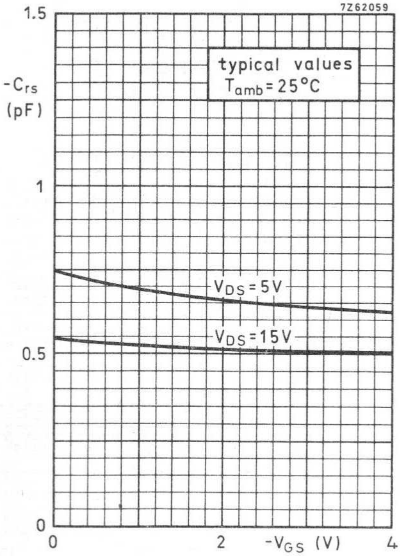

7Z62058
typical correlation between $-V_{(P)GS}$ and I_{DSS}
$-V_{(P)GS}$ at $I_D=0.5nA$ (V)
3
2
1
0
$V_{DS}=15V$
$T_j=25°C$
BFW12
BFW13
0
2.5
5
I_{DSS} at $V_{GS}=0$ (mA)

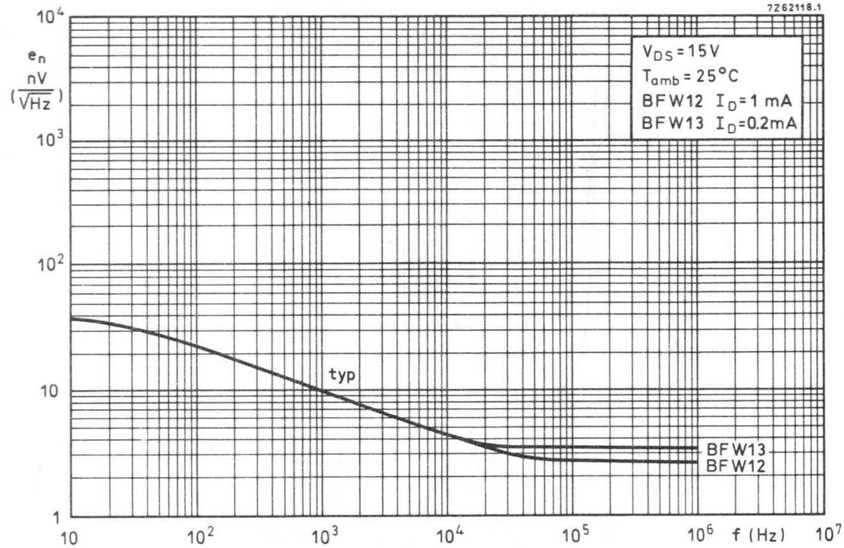

7Z62061
|y_{fs}|
(mA/V)
10
7.5
5
2.5
0
0
0.5
1
1.5
2
2.5
3
I_D (mA)
typical values
V_{DS} = 15V
f = 1kHz
T_{amb} = 25°C
BFW13
BFW12

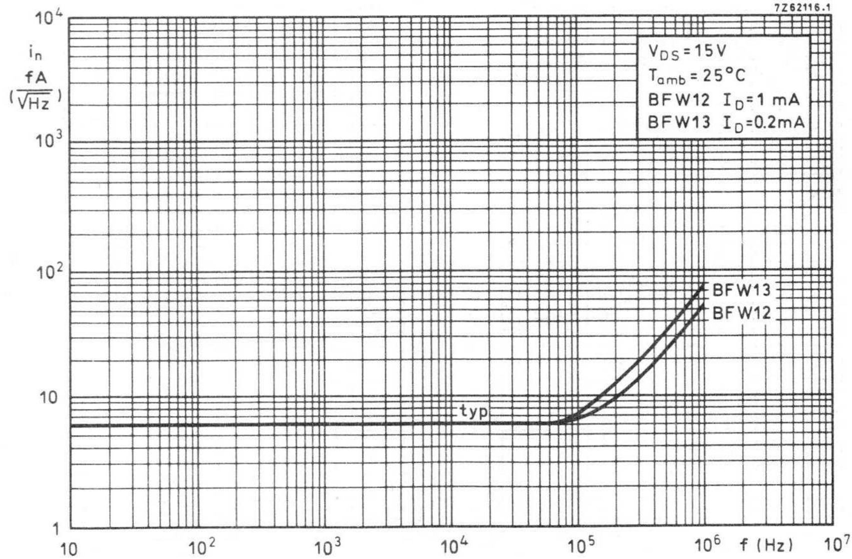

7Z62062
|y_{os}|
(μA/V)
40
30
20
10
0
0
0.5
1
1.5
2
2.5
3
I_D (mA)
typical values
V_{DS} = 15V
f = 1kHz
T_{amb} = 25°C
BFW12
BFW13

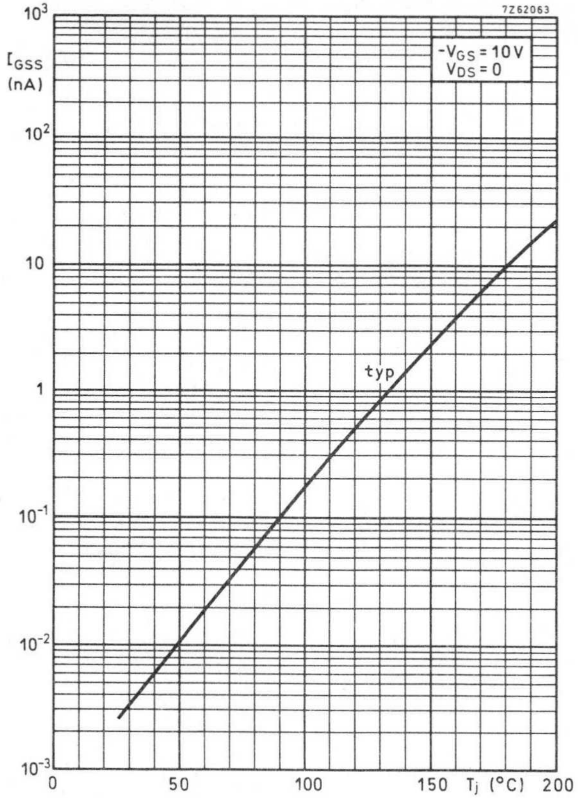

7Z62060
$|y_{os}|$ (μA/V)
10^4
10^3
10^2
10
1
typical values
f = 1 kHz
T_{amb} = 25°C
I_D = 1.5 mA
0.4 mA
BFW12
BFW13
0
10
20
V_{DS} (V)
30


7Z62066
C_{is} (pF)
6
4
2
0
typical values
T_{amb} = 25 °C
V_{DS} = 5 V
V_{DS} = 15 V
0
2
$-V_{GS}$ (V)
4


7Z62059
$-C_{rs}$ (pF)
1.5
1
0.5
0
typical values
T_{amb} = 25 °C
V_{DS} = 5 V
V_{DS} = 15 V
0
2
$-V_{GS}$ (V)
4


7Z62118.1
e_n
nV/√Hz
10^4
10^3
10^2
10
1
V_{DS} = 15 V
T_{amb} = 25 °C
BFW12 I_D = 1 mA
BFW13 I_D = 0.2 mA
typ
BFW13
BFW12
10
10^2
10^3
10^4
10^5
10^6
f (Hz)
10^7


7Z62116.1
i_n
fA/√Hz
10^4
10^3
10^2
10
1
V_{DS} = 15 V
T_{amb} = 25 °C
BFW12 I_D = 1 mA
BFW13 I_D = 0.2 mA
typ
BFW13
BFW12
10
10^2
10^3
10^4
10^5
10^6
f (Hz)
10^7


7Z62063
I_{GSS} (nA)
10^3
10^2
10
1
10^{-1}
10^{-2}
10^{-3}
$-V_{GS} = 10\,V$
$V_{DS} = 0$
typ
0
50
100
150
T_j (°C)
200

N-CHANNEL SILICON FIELD EFFECT TRANSISTOR

N-channel silicon epitaxial planar junction field effect transistor in a TO-72 metal envelope with the shield lead connected to the case.
The transistor is designed for general purpose amplifiers.

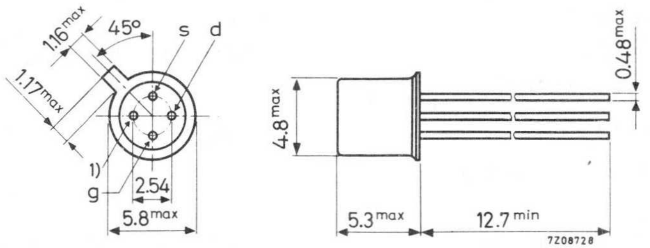
QUICK REFERENCE DATA

Drain-source voltage	$\pm V_{DS}$	max.	25	V
Gate-source voltage (open drain)	$-V_{GSO}$	max.	25	V
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	300	mW
Drain current V_{DS} = 15 V; V_{GS} = 0	I_{DSS}		2 to 20	mA
Gate-source cut-off voltage I_D = 1.0 nA; V_{DS} = 15 V	$-V_{(P)GS}$	<	8	V
Feedback capacitance at f = 1 MHz V_{DS} = 15 V; V_{GS} = 0	$-C_{rs}$	<	2.0	pF
Transfer admittance (common source) V_{DS} = 15 V; V_{GS} = 0; f = 10 MHz	$\lvert y_{fs} \rvert$	>	1.6	$m\Omega^{-1}$

MECHANICAL DATA

Dimensions in mm

TO-72



1) = shield lead (connected to case)

Accessories available: 56246, 56263.

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC134)

Voltages

Drain-source voltage	$\pm V_{DS}$	max.	25	V
Drain-gate voltage (open source)	V_{DGO}	max.	25	V
Gate-source voltage (open drain)	$-V_{GSO}$	max.	25	V

Currents

Drain current	I_D	max.	20	mA
Gate current	I_G	max.	10	mA

Power dissipation

Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	300	mW

Temperatures

Storage temperature	T_{stg}		-65 to +200	°C
Junction temperature	T_j	max.	200	°C

THERMAL RESISTANCE

From junction to ambient	$R_{th\ j\text{-}a}$	=	0.59	°C/mW

CHARACTERISTICS T_j = 25 °C unless otherwise specified

Gate cut-off current

$-V_{GS}$ = 20 V; V_{DS} = 0	$-I_{GSS}$	<	1.0	nA
$-V_{GS}$ = 20 V; V_{DS} = 0; T_j = 150 °C	$-I_{GSS}$	<	1.0	μA

Drain current [1]

V_{DS} = 15 V; V_{GS} = 0	I_{DSS}	2 to	20	mA

Gate-source voltage

I_D = 200 μA; V_{DS} = 15 V	$-V_{GS}$	0.5 to	7.5	V

Gate-source cut-off voltage

I_D = 1.0 nA; V_{DS} = 15 V	$-V_{(P)GS}$	<	8	V

y parameters (common source)

V_{DS} = 15 V; V_{GS} = 0

f = 1 kHz Transfer admittance	$\lvert y_{fs} \rvert$	2.0 to	6.5	$m\Omega^{-1}$
Output admittance	$\lvert y_{os} \rvert$	<	85	$\mu\Omega^{-1}$
f = 1 MHz Input capacitance	C_{is}	<	6	pF
Feedback capacitance	$-C_{rs}$	<	2.0	pF
f = 10 MHz Transfer admittance	$\lvert y_{fs} \rvert$	>	1.6	$m\Omega^{-1}$

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[1] Measured under pulsed conditions.

N-CHANNEL FIELD EFFECT TRANSISTORS

Silicon N-channel junction field effect transistors in a TO-18 metal envelope with the gate connected to the case. The transistors are intended for switching applications. The devices are symmetrical and have the feature: low "on" resistance at zero gate voltage.

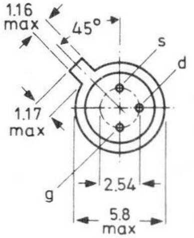
QUICK REFERENCE DATA

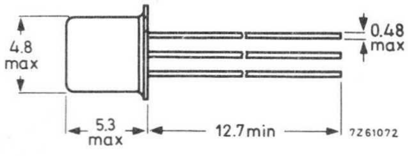
Drain-source voltage	V_{DS}	max.	40			V
Total power dissipation up to $T_{amb} = 25\ ^{o}C$	P_{tot}	max.	350			mW
			BSV78	BSV79	BSV80	
Drain current $V_{DS} = 15\ V$; $V_{GS} = 0$	I_{DSS}	>	50	20	10	mA
Gate-source cut-off voltage $I_D = 1\ nA$; $V_{GS} = 15\ V$	$-V_{(P)GS}$	>	3.75	2.0	1.0	V
		<	11	7.0	5.0	V
Drain-source resistance (on) at f = 1 kHz $I_D = 0$; $V_{GS} = 0$	$r_{ds\ on}$	<	25	40	60	Ω
Feedback capacitance at f = 1 MHz $V_{DS} = 0$; $-V_{GS} = 10\ V$	$-C_{rs}$	<	5	5	5	pF
Turn on time	t_{on}	<	10	15	15	ns
Turn off time	t_{off}	<	10	15	25	ns

MECHANICAL DATA

Dimensions in mm

Gate connected to case
TO-18





RATINGS Limiting values in accordance with the Absolute Maximum System (IEC134)

Voltages

Drain-source voltage	V_{DS}	max.	40	V
Drain-gate voltage (open source)	V_{DGO}	max.	40	V
Gate-source voltage (open drain)	$-V_{GSO}$	max.	40	V

Current

Forward gate current	I_G	max.	50	mA

Power dissipation

Total power dissipation up to $T_{amb} = 25\ ^{o}C$	P_{tot}	max.	350	mW

Temperatures

Storage temperature	T_{stg}	-65 to +200		^{o}C
Junction temperature	T_j	max.	175	^{o}C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	0.43	$^{o}C/mW$

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Gate cut-off current

$-V_{GS}$ = 20 V; V_{DS} = 0	$-I_{GSS}$	<	0.25	nA
$-V_{GS}$ = 20 V; V_{DS} = 0; T_j = 150 °C	$-I_{GSS}$	<	0.5	μA

Drain cut-off current

V_{DS} = 15 V; $-V_{GS}$ = 12 V	I_{DSX}	<	0.25	nA
V_{DS} = 15 V; $-V_{GS}$ = 12 V; T_j = 150 °C	I_{DSX}	<	0.5	μA

			BSV78	BSV79	BSV80	
Drain current						
V_{DS} = 15 V; V_{GS} = 0	I_{DSS}	>	50	20	10	mA
Gate-source cut-off voltage						
I_D = 1 nA; V_{DS} = 15 V	$-V_{(P)GS}$	>	3.75	2.0	1.0	V
		<	11	7.0	5.0	V
Gate-source voltage						
I_D = 1.5 μA; V_{DS} = 15 V	$-V_{GS}$	>	3.5	1.75	0.75	V
		<	10	6.0	4.0	V
Drain-source voltage (on)						
I_D = 20 mA; V_{GS} = 0	V_{DSon}	<	500			mV
I_D = 10 mA; V_{GS} = 0	V_{DSon}	<		400		mV
I_D = 5 mA; V_{GS} = 0	V_{DSon}	<			325	mV
Drain-source resistance (on) at f = 1 kHz						
I_D = 0; V_{GS} = 0	$r_{ds\ on}$	<	25	40	60	Ω
y parameters at f = 1 MHz (common source)						
$-V_{GS}$ = 10 V; V_{DS} = 0						
Input capacitance	C_{is}	<	10	10	10	pF
Feedback capacitance	$-C_{rs}$	<	5	5	5	pF

CHARACTERISTICS (continued)

T_j = 25 °C unless otherwise specified

Turn on time when switched from

$-V_{GS}$ = 11 V to I_D = 20 mA: BSV78
$-V_{GS}$ = 7 V to I_D = 10 mA: BSV79
$-V_{GS}$ = 5 V to I_D = 5 mA: BSV80
} at V_{DD} = 10 V

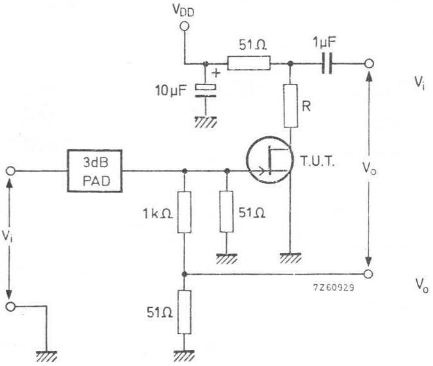
			BSV78	BSV79	BSV80	
delay time	t_d	<	5	10	8	ns
rise time	t_r	<	5	5	7	ns
turn on time	t_{on}	<	10	15	15	ns

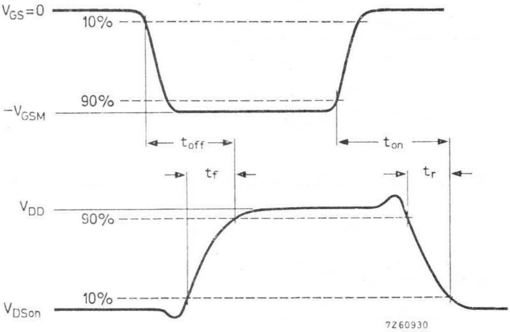
Turn off time when switched from

I_D = 20 mA to $-V_{GS}$ = 11 V (BSV78)
I_D = 10 mA to $-V_{GS}$ = 7 V (BSV79)
I_D = 5 mA to $-V_{GS}$ = 5 V (BSV80)
} at V_{DD} = 10 V

			BSV78	BSV79	BSV80	
fall time	t_f	<	6	10	20	ns
storage time	t_s	<	4	5	5	ns
turn off time	t_{off}	<	10	15	25	ns

Test circuit:





$$R_L = \frac{10 - V_{DSon}}{I_{Don}} - 51 \quad \Omega$$

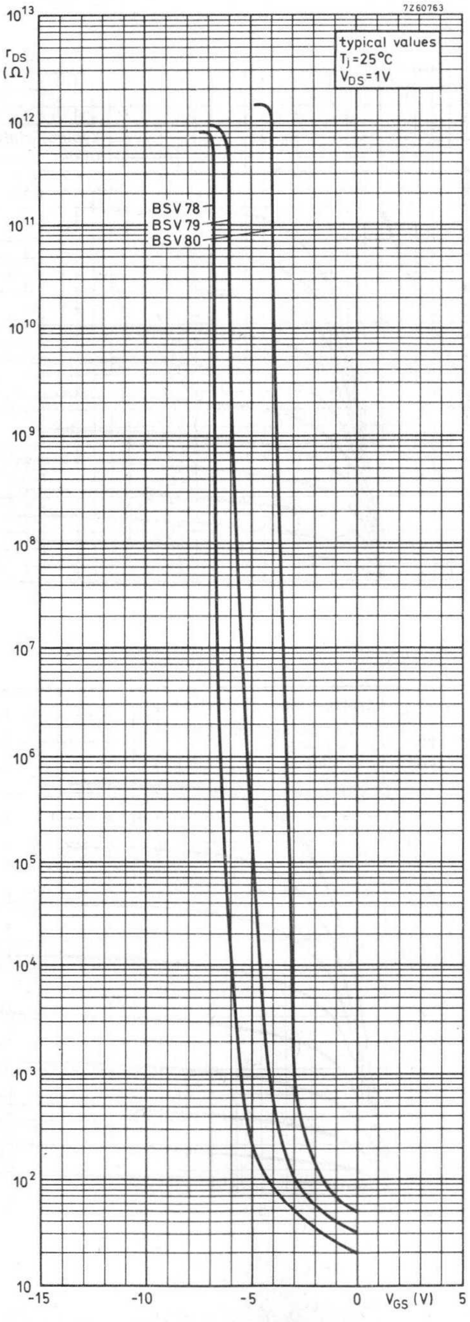
	BSV78	BSV79	BSV80	
R_L =	424	909	1885	Ω

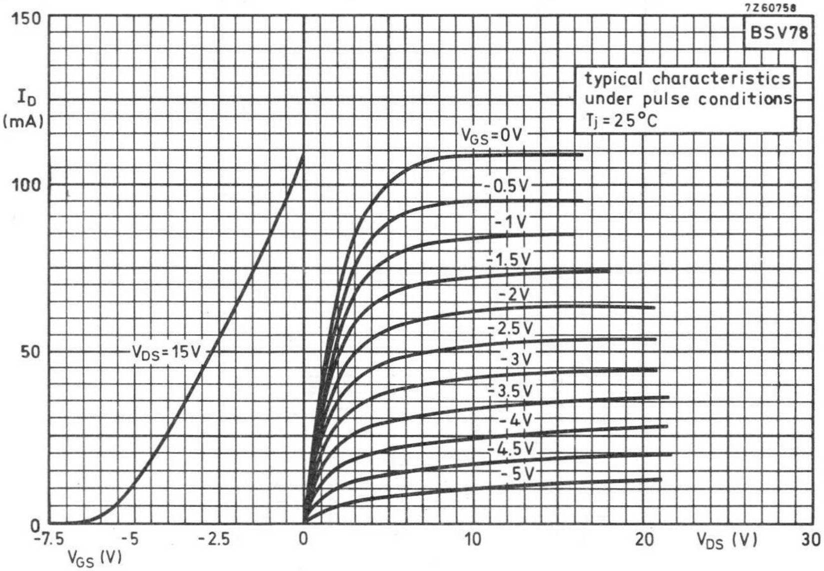
Pulse generator:

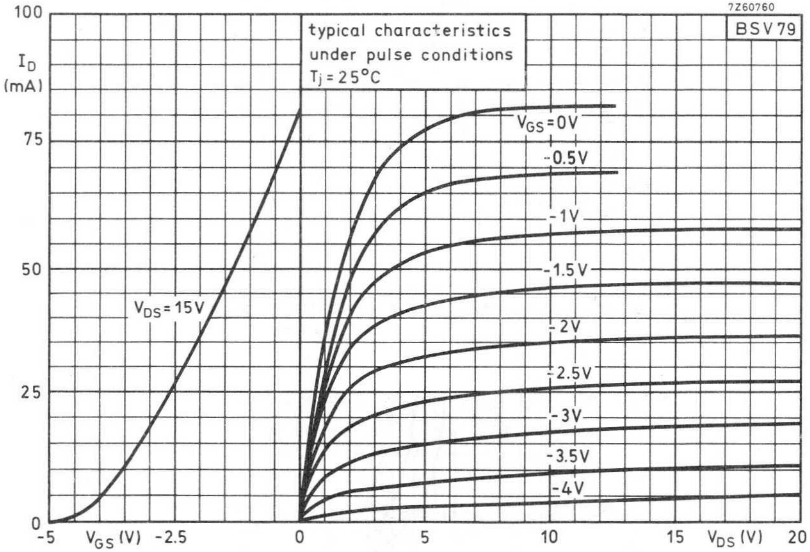
R_i = 50 Ω
t_r < 0.5 ns
t_f < 5 ns

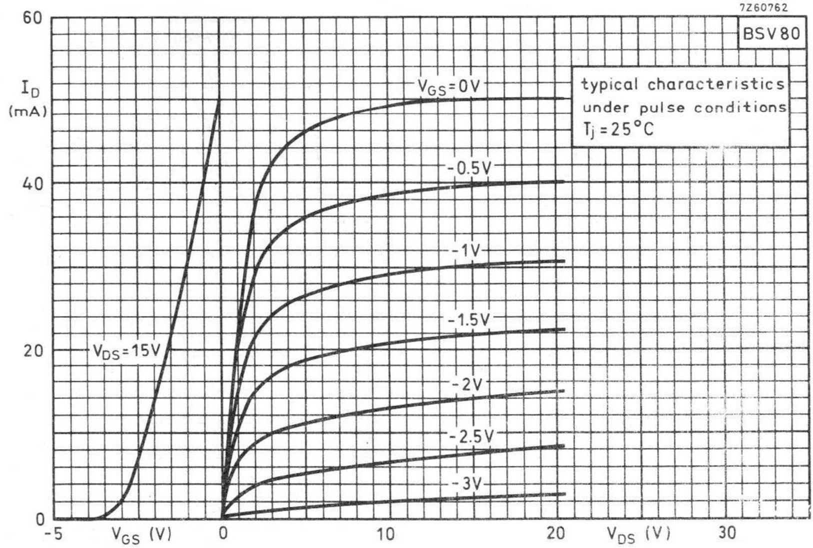
Oscilloscope:

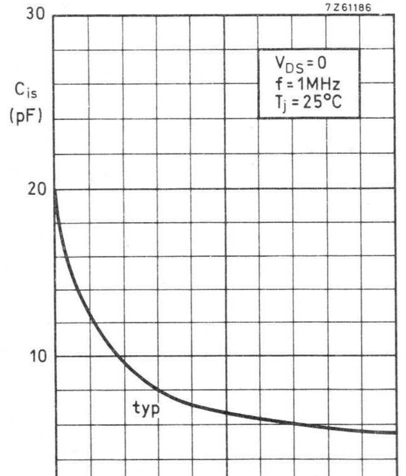
R_i = 50 Ω
t_r < 1 ns
t_f < 1 ns

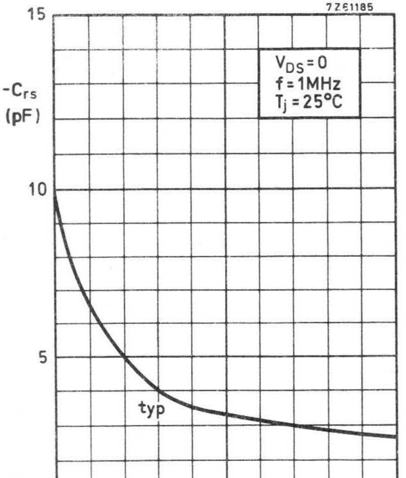

7Z60763
10^{13}
r_{DS}
(Ω)
10^{12}
10^{11}
10^{10}
10^9
10^8
10^7
10^6
10^5
10^4
10^3
10^2
10
typical values
$T_j = 25°C$
$V_{DS} = 1V$
BSV 78
BSV 79
BSV 80
−15
−10
−5
0
V_{GS} (V)
5

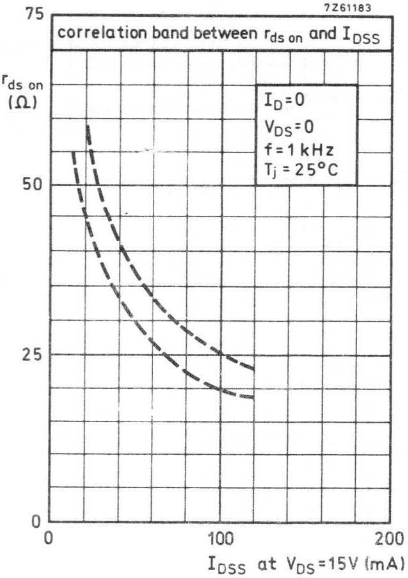

7Z60758
BSV78
typical characteristics
under pulse conditions
$T_j = 25°C$
I_D (mA)
150
100
50
0
-7.5
-5
-2.5
0
10
20
30
V_{GS} (V)
V_{DS} (V)
$V_{DS} = 15 V$
$V_{GS} = 0 V$
-0.5 V
-1 V
-1.5 V
-2 V
-2.5 V
-3 V
-3.5 V
-4 V
-4.5 V
-5 V

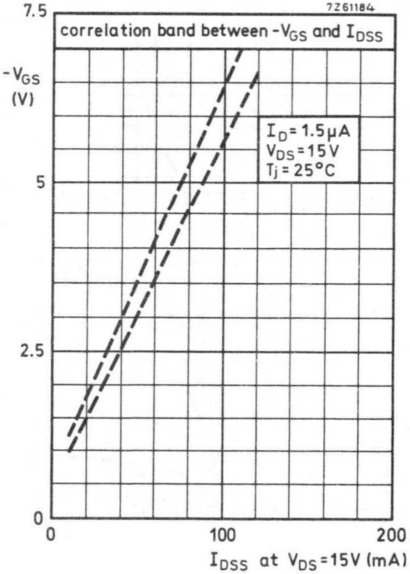

7Z60760
BSV 79
typical characteristics
under pulse conditions
$T_j = 25°C$
I_D (mA)
100
75
50
25
0
-5
-2.5
0
5
10
15
20
V_{GS} (V)
V_{DS} (V)
$V_{DS} = 15 V$
$V_{GS} = 0 V$
-0.5 V
-1 V
-1.5 V
-2 V
-2.5 V
-3 V
-3.5 V
-4 V


7Z60762
BSV80
typical characteristics
under pulse conditions
$T_j = 25\,°C$
I_D
(mA)
60
40
20
0
-5
V_{GS} (V)
0
10
20
V_{DS} (V)
30
$V_{DS} = 15V$
$V_{GS} = 0V$
-0.5V
-1V
-1.5V
-2V
-2.5V
-3V


7Z61186
$V_{DS} = 0$
f = 1MHz
$T_j = 25°C$
C_{is}
(pF)
30
20
10
0
0
10
$-V_{GS}$ (V)
20
typ

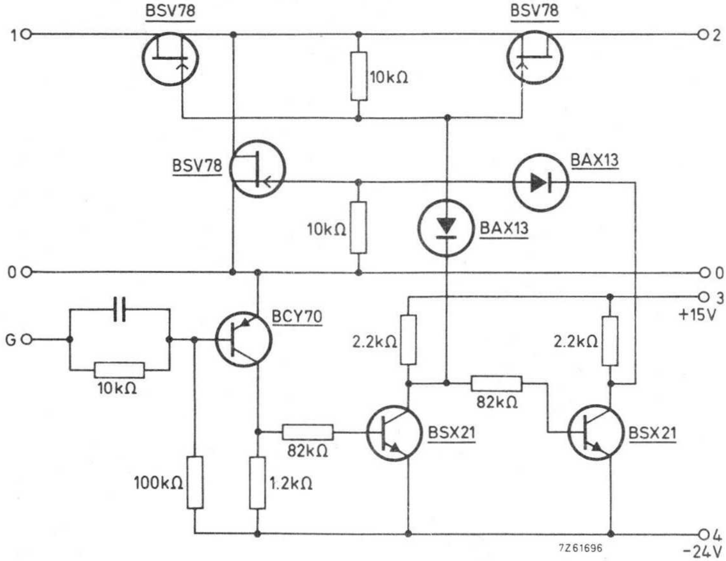

7Z61185
$V_{DS} = 0$
f = 1MHz
$T_j = 25°C$
$-C_{rs}$
(pF)
15
10
5
0
0
10
$-V_{GS}$ (V)
20
typ


7Z61183
correlation band between $r_{ds\ on}$ and I_{DSS}
$r_{ds\ on}$ (Ω)
75
50
25
0
$I_D = 0$
$V_{DS} = 0$
f = 1 kHz
$T_j = 25°C$
0
100
200
I_{DSS} at $V_{DS} = 15V$ (mA)


7Z61184
correlation band between $-V_{GS}$ and I_{DSS}
$-V_{GS}$ (V)
7.5
5
2.5
0
$I_D = 1.5 \mu A$
$V_{DS} = 15 V$
$T_j = 25°C$
0
100
200
I_{DSS} at $V_{DS} = 15V$ (mA)

APPLICATION INFORMATION

Floating bidirectional 50 mA switch with BSV78



Maximum allowable voltages:

V_{10}	max.	±	15	V
V_{20}	max.	±	15	V
V_{12}	max.	±	30	V

Maximum allowable current to be switched:

I_{12}	max.	±	50	mA

Supply currents:	on-state	I_3 = 20 mA	off-state	I_3 =	20 mA
		I_4 = 20 mA		I_4 =	40 mA

Performance:		on-state	off-state	
Gate voltage	typ.	6	0	V
Resistance between terminals 1 and 2	typ.	50	10^{10}	Ω
terminals 1 and 0	>	10^{10}	10^{10}	Ω
terminals 2 and 0	>	10^{10}	10^{10}	Ω

Switching times with R_L = 1 kΩ, when

switched to $V_{G\,on}$ = 6 V	t_{on}	< 50	ns
switched to $V_{G\,off}$ = 0	t_{off}	< 50	ns

N-CHANNEL INSULATED GATE FIELD EFFECT TRANSISTOR

Depletion type insulated gate field effect transistor in a TO-72 metal envelope with the substrate connected to the case.
It is intended for chopper and other special switching applications, e.g. timing circuits, multiplex circuits, etc. The features are a very low drain-source 'on' resistance, a very high drain-source 'off' resistance and low feedback capacitances.

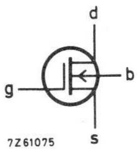
QUICK REFERENCE DATA

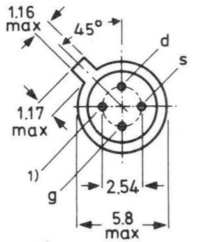
Drain-source resistance (on) at f = 1 kHz				
$V_{DS} = 0$; $V_{GS} = 5$ V; $V_{BS} = 0$	$r_{ds\,on}$	<	50	Ω
Drain-source resistance (off)				
$V_{DS} = 10$ V; $-V_{GS} = 5$ V; $V_{BS} = 0$	r_{DSoff}	>	10	GΩ
Feedback capacitances at f = 1 MHz				
$-V_{GS} = 5$ V; $V_{DS} = 0$; $I_B = 0$	$-C_{rs}$	<	0.5	pF
$-V_{GD} = 5$ V; $V_{SD} = 0$; $I_B = 0$	$-C_{rd}$	<	1.2	pF

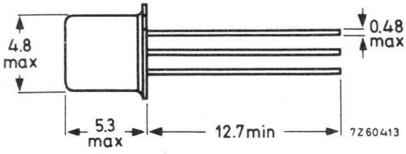
MECHANICAL DATA

Dimensions in mm

TO-72







1) Substrate connected to case

Note: To safeguard the gates against damage duo to accumulation of static charge during transport or handling, the leads are encircled by a ring of conductive rubber which should be removed just after the transistor is soldered into the circuit.

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltages

Drain-substrate voltage	V_{DB}	max.	30	V
Source-substrate voltage	V_{SB}	max.	30	V
Gate-substrate voltage (continuous)	V_{GB}	max. min.	10 −10	V V
Repetitive peak gate to all other terminals voltage $V_{SB} = V_{DB} = 0$; $f > 100$ Hz	V_{G-N}	max. min.	15 −15	V V
Non repetitive peak gate to all other terminals voltage $V_{SB} = V_{DB} = 0$; $t < 10$ ms	V_{G-N}	max. min.	50 −50	V V

Currents

Drain current (peak value) $t_r = 20$ ms; $d = 0.1$	I_{DM}	max.	50	mA
Source current (peak value) $t_r = 20$ ms; $d = 0.1$	I_{SM}	max.	50	mA

Power dissipation

Total power dissipation up to $T_{amb} = 25$ °C	P_{tot}	max.	200	mW

Temperatures

Storage temperature	T_{stg}		−65 to +125	°C
Junction temperature	T_j	max.	125	°C

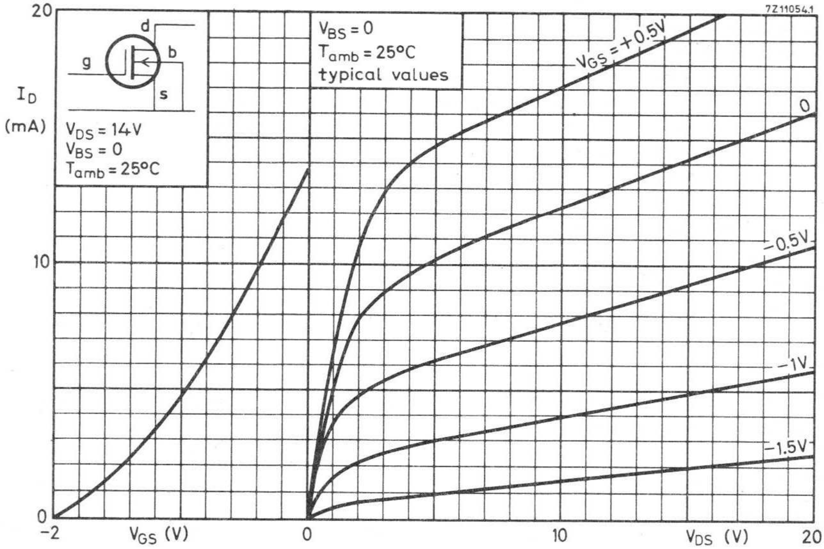
THERMAL RESISTANCE

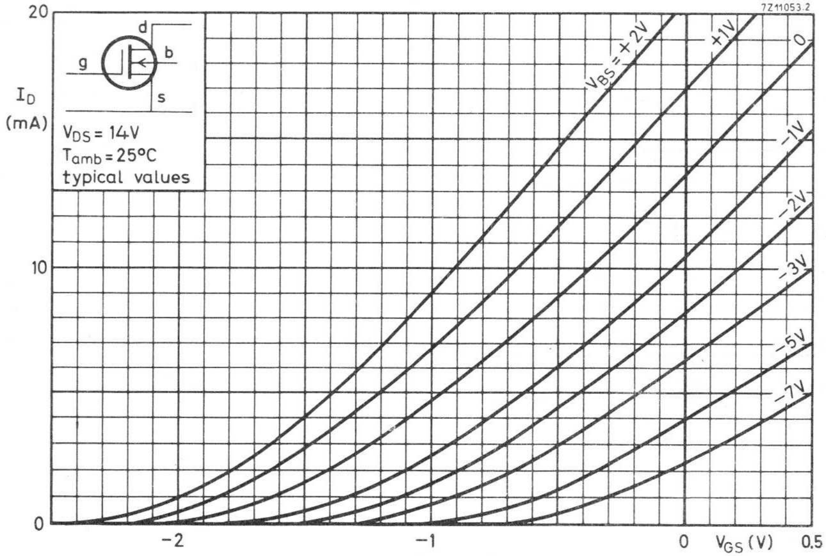
From junction to ambient in free air $R_{th\ j-a}$ = 0.5 °C/mW

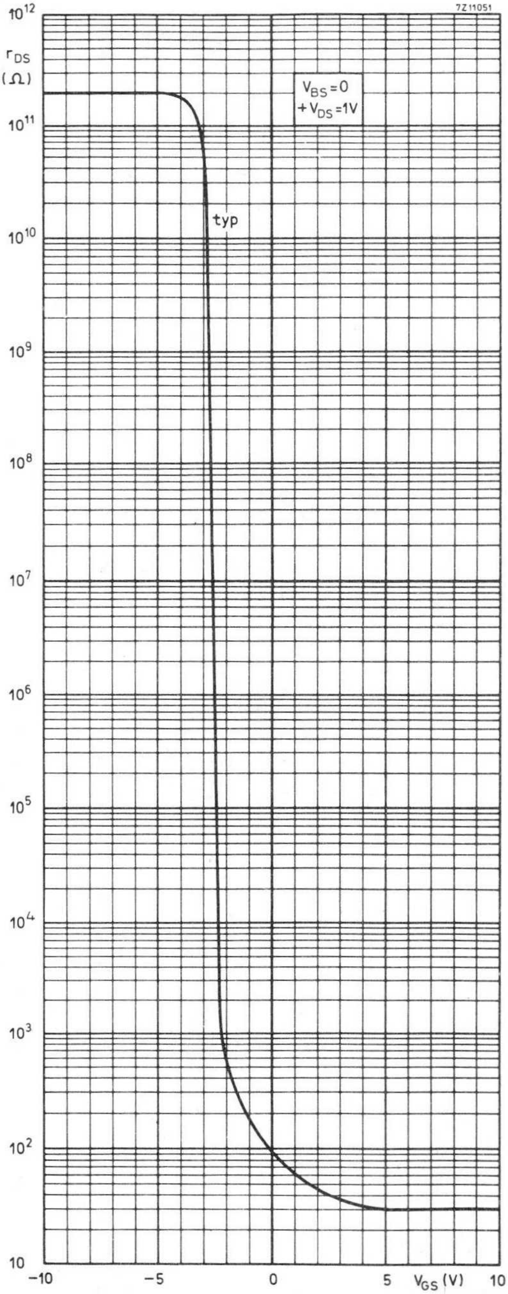
CHARACTERISTICS

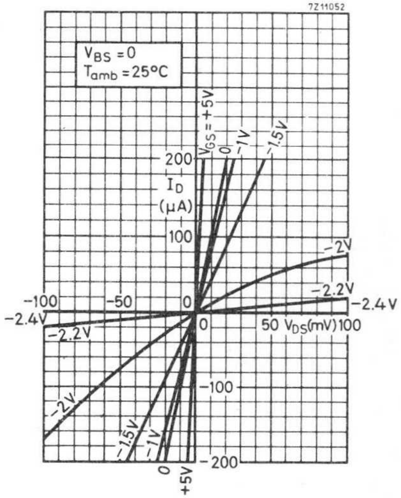
T_j = 25 °C unless otherwise specified

Drain cut-off currents; V_{BS} = 0				
V_{DS} = 10 V; $-V_{GS}$ = 5 V	I_{DSX}	<	1	nA
V_{DS} = 10 V; $-V_{GS}$ = 5 V; T_j = 125 °C	I_{DSX}	<	1	μA
Source cut-off currents; V_{BD} = 0				
V_{SD} = 10 V; $-V_{GD}$ = 5 V	I_{SDX}	<	1	nA
V_{SD} = 10 V; $-V_{GD}$ = 5 V; T_j = 125 °C	I_{SDX}	<	1	μA
Gate currents; V_{BS} = 0				
$-V_{GS}$ = 10 V; V_{DS} = 0	$-I_{GSS}$	<	10	pA
V_{GS} = 10 V; V_{DS} = 0	I_{GSS}	<	10	pA
$-V_{GS}$ = 10 V; V_{DS} = 0; T_j = 125 °C	$-I_{GSS}$	<	200	pA
V_{GS} = 10 V; V_{DS} = 0; T_j = 125 °C	I_{GSS}	<	200	pA
Bulk currents; V_{GB} = 0				
$-V_{BD}$ = 30 V; I_S = 0	$-I_{BDO}$	<	10	μA
$-V_{BS}$ = 30 V; I_D = 0	$-I_{BSO}$	<	10	μA
Drain-source resistance (on) at f = 1 kHz; V_{BS} = 0				
V_{GS} = 0 ; V_{DS} = 0	r_{dson}	<	100	Ω
V_{GS} = 0 ; V_{DS} = 0; T_j = 125 °C	r_{dson}	<	150	Ω
$+V_{GS}$ = 5 V; V_{DS} = 0	r_{dson}	<	50	Ω
Drain-source resistance (off)				
$-V_{GS}$ = 5 V; V_{DS} = 10 V; V_{BS} = 0	r_{DSoff}	>	10	GΩ
Feedback capacitances at f = 1 MHz				
$-V_{GS}$ = 5 V; V_{DS} = 0; I_B = 0	C_{rs}	<	0.5	pF
$-V_{GD}$ = 5 V; V_{SD} = 0; I_B = 0	C_{rd}	<	1.2	pF
Gate to all other terminals capacitance at f = 1 MHz				
$-V_{GB}$ = 5 V; V_{SB} = V_{DB} = 0	C_{g-n}	<	5	pF


7Z11054.1
I_D (mA)
20
10
0
d
g
b
s
V_DS = 14V
V_BS = 0
T_amb = 25°C
V_BS = 0
T_amb = 25°C
typical values
V_GS = +0.5V
0
−0.5V
−1V
−1.5V
−2
V_GS (V)
0
10
V_DS (V)
20


7Z11053.2
I_D (mA)
20
10
0
d
g
b
s
V_DS = 14V
T_amb = 25°C
typical values
V_BS = +2V
+1V
0
−1V
−2V
−3V
−5V
−7V
−2
−1
0
V_GS (V)
0.5


7Z11051
r_{DS} (Ω)
10^{12}
10^{11}
10^{10}
10^{9}
10^{8}
10^{7}
10^{6}
10^{5}
10^{4}
10^{3}
10^{2}
10
$V_{BS} = 0$
$+V_{DS} = 1V$
typ
−10
−5
0
5
V_{GS} (V)
10


7Z11052
$V_{BS} = 0$
$T_{amb} = 25°C$
$V_{GS} = +5V$
0
−1V
−1.5V
−2V
−2.2V
−2.4V
200
I_D (μA)
100
0
−100
−200
−100
−50
0
50
V_{DS}(mV)
100
−2.4V
−2.2V
−2V
−1.5V
−1V
0
+5V

N-CHANNEL SILICON FIELD EFFECT TRANSISTOR

Silicon N-channel depletion type junction-triode field effect transistor in a TO-72 metal envelope, primarily intended for depletion mode operation in low power i.f.-r.f. amplifiers for industrial applications.

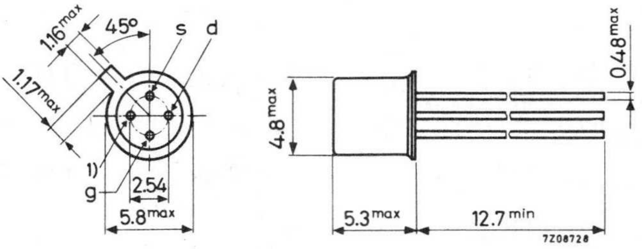
QUICK REFERENCE DATA

Drain-source voltage	V_{DS}	max.	30	V
Gate-source voltage	$-V_{GS}$	max.	30	V
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	300	mW
Gate cut-off current $-V_{GS}$ = 20 V; V_{DS} = 0	$-I_{GSS}$	<	0.5	nA
Feedback capacitance at f = 1 MHz V_{DS} = 15 V; V_{GS} = 0	$-C_{rs}$	<	2	pF
Transfer admittance (common source) V_{DS} = 15 V; V_{GS} = 0; f = 200 MHz T_{amb} = 25 °C	$\|y_{fs}\|$	>	3.2	$m\Omega^{-1}$

MECHANICAL DATA

Dimensions in mm

TO-72



1) = shield lead (connected to case)

Accessories available: 56246; 56263

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltages

Drain-source voltage	V_{DS}	max.	30	V
Drain-gate voltage	V_{DG}	max.	30	V
Gate-source voltage	$-V_{GS}$	max.	30	V

Current

Gate current	I_G	max.	10	mA

Power dissipation

Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	300	mW
Linear derating factor			2	mW/°C

Temperatures

Storage temperature	T_{stg}	-65 to	+200	°C
Junction temperature	T_j	max.	200	°C

CHARACTERISTICS T_j = 25 °C unless otherwise specified

Gate cut-off current

$-V_{GS}$ = 20 V; V_{DS} = 0	$-I_{GSS}$	<	0.5	nA
$-V_{GS}$ = 20 V; V_{DS} = 0; T_j = 150 °C	$-I_{GSS}$	<	0.5	μA

Drain current [1]

V_{DS} = 15 V; V_{GS} = 0	I_{DSS}	4 to	20	mA

Gate-source voltage

I_D = 400 μA; V_{DS} = 15 V	$-V_{GS}$	1 to	7.5	V

Gate-source cut-off voltage

I_D = 0.5 nA; V_{DS} = 15 V	$-V_{(P)GS}$	<	8	V

Gate-source breakdown voltage

$-I_G$ = 1 μA; V_{DS} = 0	$-V_{(BR)GSS}$	>	30	V

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[1] Measured under pulsed conditions; pulse duration t = 100 ms; duty cycle $\delta \leq 0.1$.

CHARACTERISTICS (continued)

y parameters (common source)

$V_{DS} = 15$ V; $V_{GS} = 0$ $T_{amb} = 25$ °C

f = 1 kHz	Transfer admittance [1]	$\|y_{fs}\|$		3.5 to 6.5	$m\Omega^{-1}$
	Output admittance [1]	$\|y_{os}\|$	$<$	35	$\mu\Omega^{-1}$
f = 1 MHz	Input capacitance	C_{is}	$<$	6	pF
	Feedback capacitance	$-C_{rs}$	$<$	2	pF
f = 200 MHz	Transfer admittance	$\|y_{fs}\|$	$>$	3.2	$m\Omega^{-1}$
	Real part of input conductance	$R_e(y_{is})$	$<$	0.8	$m\Omega^{-1}$
	Real part of output conductance	$R_e(y_{os})$	$<$	0.2	$m\Omega^{-1}$

Noise figure at f = 100 MHz $T_{amb} = 25$ °C

$V_{DS} = 15$ V; $V_{GS} = 0$; $R_G = 1$ kΩ input tuned to minimum noise	F	$<$	2.5	dB

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[1] Measured under pulsed conditions; Pulse duration t = 100 ms; duty cycle $\delta \leq 0.1$

N-CHANNEL SILICON FIELD EFFECT TRANSISTOR

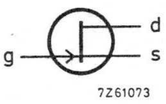
N-channel silicon epitaxial planar junction field effect transistor in a TO-72 metal envelope with the shield lead connected to the case.
The transistor is suitable in a variety of low power switching applications, e.g. in multiplexing systems.

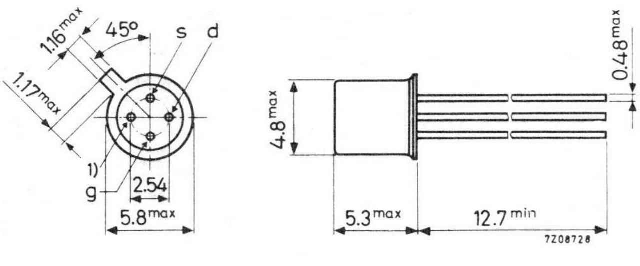
QUICK REFERENCE DATA

Drain-source voltage	$\pm V_{DS}$	max.	30	V
Gate-source voltage (open drain)	$-V_{GSO}$	max.	30	V
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	300	mW
Drain current V_{DS} = 20 V; V_{GS} = 0	I_{DSS}	>	2	mA
Gate-source cut-off voltage I_D = 10 nA; V_{DS} = 10 V	$-V_{(P)GS}$		4 to 6	V
Feedback capacitance at f = 1 MHz V_{DS} = 0; V_{GS} = 7 V	$-C_{rs}$	<	1.5	pF
Drain-source resistance (on) at f = 1 kHz V_{GS} = 0; I_D = 0	$r_{ds\ on}$	<	220	Ω

MECHANICAL DATA

TO-72
Insulated electrodes





1) = shield lead (connected to case)

Accessories available: 56246, 56263.

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltages				
Drain-source voltage	$\pm V_{DS}$	max.	30	V
Drain-gate voltage (open source)	V_{DGO}	max.	30	V
Gate-source voltage (open drain)	$-V_{GSO}$	max.	30	V
Current				
Gate current	I_G	max.	10	mA
Power dissipation				
Total power dissipation up to $T_{amb} = 25\ ^{\circ}C$	P_{tot}	max.	300	mW
Temperatures				
Storage temperature	T_{stg}		−55 to +200	°C
Junction temperature	T_j	max.	200	°C

THERMAL RESISTANCE

From junction to ambient	$R_{th\ j\text{-}a}$	=	0.59	°C/mW

CHARACTERISTICS $T_j = 25\ ^{o}C$ unless otherwise specified

Gate cut-off current				
$-V_{GS} = 20$ V; $V_{DS} = 0$	$-I_{GSS}$	<	0.1	nA
Drain current				
$V_{DG} = 20$ V; $I_S = 0$	I_{DGO}	<	0.1	nA
$V_{DG} = 20$ V; $I_S = 0$; $T_{amb} = 150\ ^{o}C$	I_{DGO}	<	0.2	µA
Drain current [1])				
$V_{DS} = 20$ V; $V_{GS} = 0$	I_{DSS}	>	2	mA
Gate-source breakdown voltage				
$-I_G = 1.0\ \mu A$; $V_{DS} = 0$	$-V_{(BR)GS}$	>	30	V
Gate-source voltage				
$I_D = 10$ nA; $V_{DS} = 10$ V	$-V_{(P)GS}$		4 to 6	V
Drain-source voltage				
$I_D = 1.0$ mA; $V_{GS} = 0$	V_{DS}	<	0.25	V
Drain cut-off current				
$V_{DS} = 10$ V; $-V_{GS} = 7.0$ V	I_D	<	1.0	nA
$V_{DS} = 10$ V; $-V_{GS} = 7.0$ V; $T_{amb} = 150\ ^{o}C$	I_D	<	2.0	µA
Drain-source resistance (on) at f = 1 kHz				
$V_{GS} = 0$; $I_D = 0$	$r_{ds\ on}$	<	220	Ω
Input capacitance at f = 1 MHz				
$V_{DS} = 20$ V; $V_{GS} = 0$	C_{is}	<	6	pF
Feedback capacitance at f = 1 MHz				
$V_{DS} = 0$; $V_{GS} = 7$ V	$-C_{rs}$	<	1.5	pF
Switching times				
$V_{DD} = 1.5$ V; $I_{D\ on} = 1.0$ mA				
$V_{GS\ on} = 0$; $-V_{GS\ off} = 6$ V				
delay time	t_d	<	20	ns
rise time	t_r	<	100	ns
turn off time	t_{off}	<	100	ns

CHARACTERISTICS (continued)

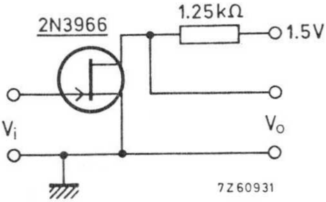
Switching times

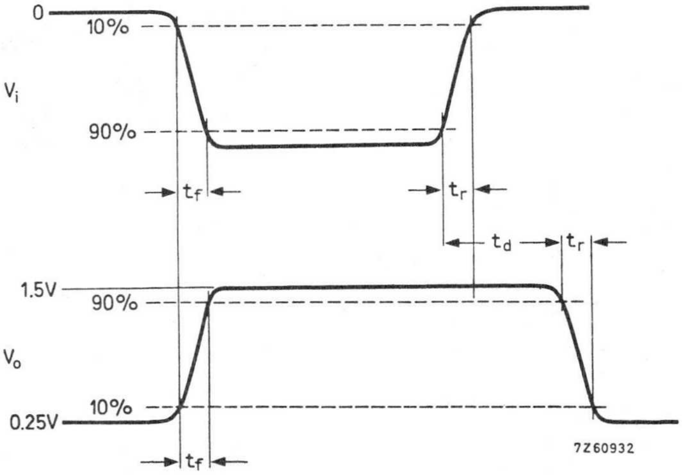
$V_{DD} = 1.5$ V; $I_{D\,on} = 1.0$ mA

$V_{GS\,on} = 0$; $-V_{GS\,off} = 6$ V

delay time	t_d	<	20	ns
rise time	t_r	<	100	ns
turn off time	t_{off}	<	100	ns

Test circuit:





Pulse generator:

$t_r < 1.0$ ns
$t_f < 1.0$ ns
$t_p = 1.0$ µs
$\delta < 0.5$
$R_S = 50\ \Omega$

Oscilloscope:

$t_r < 10$ ns
$R_i > 5$ MΩ
$C_i < 10$ pF

N-CHANNEL FIELD EFFECT TRANSISTORS

Silicon N-channel depletion type junction-triode field effect transistors in a TO-18 metal envelope with the gate connected to the case. The transistors are intended for low power switching applications in industrial service.

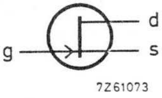
QUICK REFERENCE DATA

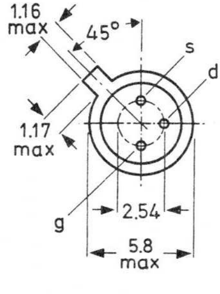
Drain-source voltage		$\pm V_{DS}$	max.	40			V
Total power dissipation up to $T_{case} = 25\,^oC$		P_{tot}	max.	1.8			W
				2N4091	2N4092	2N4093	
Drain current $V_{DS} = 20$ V; $V_{GS} = 0$		I_{DSS}	>	30	15	8	mA
Gate-source cut-off voltage $I_D = 1$ nA; $V_{DS} = 20$ V		$-V_{(P)GS}$	>	5.0	2.0	1.0	V
			<	10	7.0	5.0	V
Drain-source resistance (on) at f = 1 kHz $I_D = 0$; $V_{GS} = 0$		$r_{ds\ on}$	<	30	50	80	Ω
Feedback capacitance at f = 1 MHz $V_{DS} = 0$; $-V_{GS} = 20$ V		$-C_{rs}$	<	5.0			pF
Turn off time $V_{DD} = 3.0$ V; $V_{GS} = 0$							
$I_D = 6.6$ mA; $-V_{GSM} = 12$ V	2N4091	t_{off}	<	40			ns
$I_D = 4.0$ mA; $-V_{GSM} = 8$ V	2N4092	t_{off}	<	60			ns
$I_D = 2.5$ mA; $-V_{GSM} = 6$ V	2N4093	t_{off}	<	80			ns

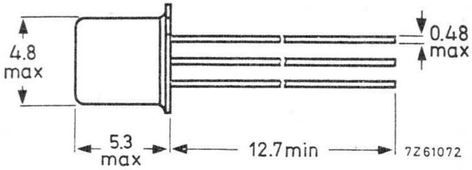
MECHANICAL DATA Dimensions in mm

Gate connected to case

TO-18







Accessories supplied on request: 56246, 56263.

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltages				
Drain-source voltage	$\pm V_{DS}$	max.	40	V
Drain-gate voltage (open source)	V_{DGO}	max.	40	V
Gate-source voltage (open drain)	$-V_{GSO}$	max.	40	V
Current				
Forward gate current (d.c.)	I_G	max.	10	mA
Power dissipation				
Total power dissipation up to T_{case} = 25 °C	P_{tot}	max.	1.8	W
Temperatures				
Storage temperature	T_{stg}	-55 to	+200	°C
Junction temperature	T_j	max.	200	°C

THERMAL RESISTANCE

From junction to case in free air	$R_{th\ j-c}$	=	0.1	°C/mW

CHARACTERISTICS T_{amb} = 25 °C unless otherwise specified

Drain current				
V_{DG} = 20 V; I_S = 0	I_{DGO}	<	0.2	nA
V_{DG} = 20 V; I_S = 0; T_{amb} = 150 °C	I_{DGO}	<	0.4	μA
Source current				
V_{SG} = 20 V; I_D = 0	I_{SGO}	<	0.2	nA

			2N4091	2N4092	2N4093	
Drain cut-off current						
V_{DS} = 20 V; $-V_{GS}$ = 12 V	I_{DSX}	<	0.2	–	–	nA
V_{DS} = 20 V; $-V_{GS}$ = 8 V	I_{DSX}	<	–	0.2	–	nA
V_{DS} = 20 V; $-V_{GS}$ = 6 V	I_{DSX}	<	–	–	0.2	nA
V_{DS} = 20 V; $-V_{GS}$ = 12 V; T_{amb} = 150 °C	I_{DSX}	<	0.4	–	–	μA
V_{DS} = 20 V; $-V_{GS}$ = 8 V; T_{amb} = 150 °C	I_{DSX}	<	–	0.4	–	μA
V_{DS} = 20 V; $-V_{GS}$ = 6 V; T_{amb} = 150 °C	I_{DSX}	<	–	–	0.4	μA
Gate-source breakdown voltage						
$-I_G$ = 1.0 μA; V_{DS} = 0	$-V_{(BR)GSS}$	>	40	40	40	V
Drain current [1]						
V_{DS} = 20 V; V_{GS} = 0	I_{DSS}	>	30	15	8	mA
Gate-source voltage						
I_D = 1 mA; V_{DS} = 20 V	$-V_{GS}$	>	5.0	2.0	1.0	V
		<	10	7.0	5.0	V
Drain-source voltage (on)						
I_D = 6.6 mA; V_{GS} = 0	V_{DSon}	<	0.2	–	–	V
I_D = 4.0 mA; V_{GS} = 0	V_{DSon}	<	–	0.2	–	V
I_D = 2.5 mA; V_{GS} = 0	V_{DSon}	<	–	–	0.2	V
Drain-source resistance (on)						
I_D = 1.0 mA; V_{GS} = 0	r_{DSon}	<	30	50	80	Ω
Drain-source resistance (on) at f = 1 kHz						
I_D = 0; V_{GS} = 0	$r_{ds\ on}$	<	30	50	80	Ω

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[1] Measured under pulsed conditions: $t_p \leq 300\ \mu s$; $\delta \leq 0.03$

CHARACTERISTICS (continued) T_{amb} = 25 °C unless otherwise specified

y-parameters at f = 1 MHz (common source)

$V_{DS} = 20\,V;\ V_{GS} = 0$

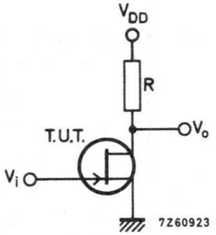
Input capacitance	C_{is}	<	16	pF
Feedback capacitance	$-C_{rs}$	<	5	pF

Switching times

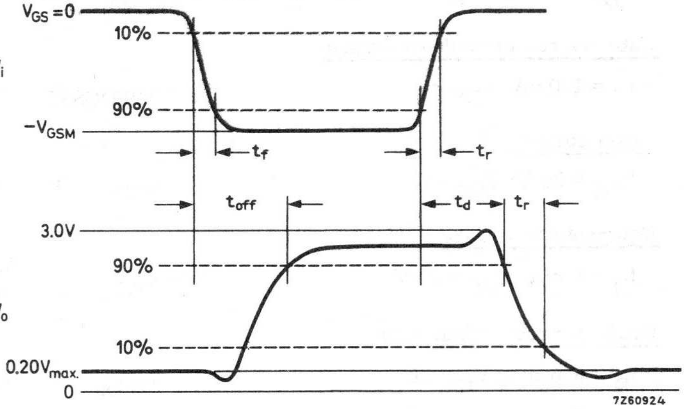
$V_{DD} = 3.0\,V;\ V_{GS} = 0$

			2N4091	2N4092	2N4093	
	I_D	=	6.6	4.0	2.5	mA
	$-V_{GSM}$	=	12	8	6	V
Delay time	t_d	<	15	15	20	ns
Rise time	t_r	<	10	20	40	ns
Turn off time	t_{off}	<	40	60	80	ns

Test circuit:



$$R = \frac{2.8}{I_D}$$



Pulse generator:

t_r	<	1	ns
t_f	<	1	ns
t_p	=	1.0	μs
δ	=	0.1	
R_S	=	50	Ω

Oscilloscope:

t_r	<	0.4	ns
R_i	>	9.8	MΩ
Z_i	<	1.7˙	pF

N-CHANNEL FIELD EFFECT TRANSISTORS

Silicon N-channel depletion type junction-triode field effect transistors in a TO-18 metal envelope with the gate connected to the case. The transistors are intended for low power, chopper or switching, application in industrial service.

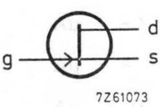
QUICK REFERENCE DATA

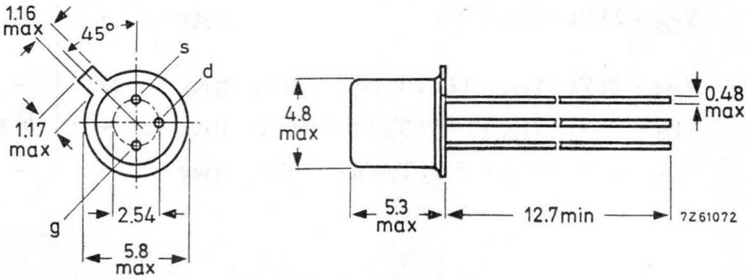
Drain-source voltage	$\pm V_{DS}$	max.	40			V
Total power dissipation up to $T_{case} = 25\ ^{o}C$	P_{tot}	max.	1.8			W
			2N4391	2N4392	2N4393	
Drain current $V_{DS} = 20$ V; $V_{GS} = 0$	I_{DSS}	>	50	25	5	mA
Gate source cut-off voltage $I_D = 1$ nA; $V_{DS} = 20$ V	$-V_{(P)GS}$	>	4.0	2.0	0.5	V
		<	10	5.0	3.0	V
Drain-source resistance (on) at f = 1 kHz $I_D = 1$ mA; $V_{GS} = 0$	r_{dson}	<	30	60	100	Ω
Feedback capacitance at f = 1 MHz $V_{DS} = 0$; $-V_{GS} = 12$ V (2N4391) $V_{DS} = 0$; $-V_{GS} = 7$ V (2N4392) $V_{DS} = 0$; $-V_{GS} = 5$ V (2N4393)	$-C_{rs}$	<	3.5	3.5	3.5	pF
Turn-off time $V_{DD} = 10$ V; $V_{GS} = 0$ $I_D = 12$ mA; $-V_{GSM} = 12$ V (2N4391)	t_{off}	<	20	–	–	ns
$I_D = 6.0$ mA; $-V_{GSM} = 7$ V (2N4392)	t_{off}	<	–	35	–	ns
$I_D = 3.0$ mA; $-V_{GSM} = 5$ V (2N4393)	t_{off}	<	–	–	50	ns

MECHANICAL DATA Dimensions in mm

Gate connected to case

TO-18





Accessories supplied on request: 56246, 56263

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltages

Drain-source voltage	$\pm V_{DS}$	max.	40	V
Drain-gate voltage (open source)	V_{DGO}	max.	40	V
Gate-source voltage	$-V_{GSO}$	max.	40	V

Current

Gate current (d.c.)	I_G	max.	50	mA

Power dissipation

Total power dissipation up to $T_{case} = 25\,^oC$	P_{tot}	max.	1.8	W

Temperatures

Storage temperature	T_{stg}	-65 to	200	^oC
Junction temperature	T_j	max.	200	^oC

Thermal resistance

From junction to case in free air	$R_{th\,j\text{-}c}$	=	0.1	$^oC/mW$

CHARACTERISTICS $T_{amb} = 25\,^oC$ unless otherwise specified

Gate cut-off current

$-V_{GS} = 20$ V; $V_{DS} = 0$	$-I_{GSS} <$	0.1	nA
$-V_{GS} = 20$ V; $V_{DS} = 0$; $T_{amb} = 150\,^oC$	$-I_{GSS} <$	0.2	μA

Drain cut-off current		2N4391	2N4392	2N4393	
$V_{DS} = 20$ V; $-V_{GS} = 12$ V	$I_{DSX} <$	0.1	-	-	nA
$V_{DS} = 20$ V; $-V_{GS} = 7$ V	$I_{DSX} <$	-	0.1	-	nA
$V_{DS} = 20$ V; $-V_{GS} = 5$ V	$I_{DSX} <$	-	-	0.1	nA
$V_{DS} = 20$ V; $-V_{GS} = 12$ V; $T_{amb} = 150\,^oC$	$I_{DSX} <$	0.2	-	-	μA
$V_{DS} = 20$ V; $-V_{GS} = 7$ V; $T_{amb} = 150\,^oC$	$I_{DSX} <$	-	0.2	-	μA
$V_{DS} = 20$ V; $-V_{GS} = 5$ V; $T_{amb} = 150\,^oC$	$I_{DSX} <$	-	-	0.2	μA

CHARACTERISTICS (continued) T_{amb} = 25 °C unless otherwise specified

			2N4391	2N4392	2N4393	
Drain current [1]						
V_{DS} = 20 V; V_{GS} = 0	I_{DSS}	>	50	–	–	mA
		<	150	–	–	mA
V_{DS} = 20 V; V_{GS} = 0	I_{DSS}	>	–	25	–	mA
		<	–	75	–	mA
V_{DS} = 20 V; V_{GS} = 0	I_{DSS}	>	–	–	5	mA
		<	–	–	30	mA
Gate-source breakdown voltage						
$-I_G$ = 1 μA; V_{DS} = 0	$-V_{(BR)GSS}$	>	40	40	40	V
Gate-source voltage						
I_G = 1 mA; V_{DS} = 0	V_{GSon}	<	1.0	1.0	1.0	V
Gate-source cut-off voltage						
I_D = 1 nA; V_{DS} = 0	$-V_{(P)GS}$	>	4.0	2.0	0.5	V
		<	10	5.0	3.0	V
Drain-source voltage (on)						
I_D = 12 mA; V_{GS} = 0	V_{DSon}	<	0.4	–	–	V
I_D = 6.0 mA; V_{GS} = 0	V_{DSon}	<	–	0.4	–	V
I_D = 3.0 mA; V_{GS} = 0	V_{DSon}	<	–	–	0.4	V
Drain-source resistance (on)						
I_D = 1 mA; V_{GS} = 0	r_{DSon}	<	30	60	100	Ω
Drain-source resistance (on) at f = 1 kHz						
I_D = 0; V_{GS} = 0	r_{dson}	<	30	60	100	Ω
y parameters at f = 1 MHz (common source)						
Input capacitance						
V_{DS} = 20 V; V_{GS} = 0	C_{is}	<	14	14	14	pF
Feedback capacitance						
$-V_{GS}$ = 12 V; V_{DS} = 0	$-C_{rs}$	<	3.5	–	–	pF
$-V_{GS}$ = 7 V; V_{DS} = 0	$-C_{rs}$	<	–	3.5	–	pF
$-V_{GS}$ = 5 V; V_{DS} = 0	$-C_{rs}$	<	–	–	3.5	pF

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[1] measured under pulsed conditions: t_p = 100 μs; δ = 0.01

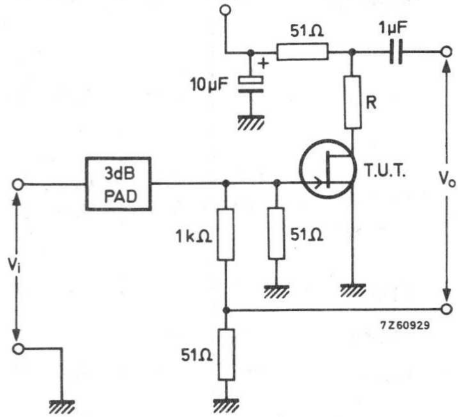
CHARACTERISTICS (continued) T_{amb} = 25 °C unless otherwise specified

Switching times

V_{DD} = 10 V; V_{GS} = 0

			2N4391	2N4392	2N4393	
	I_D	=	12	6.0	3.0	mA
	$-V_{GSM}$	=	12	7	5	V
Rise time	t_r	<	5	5	5	ns
Turn on time	t_{on}	<	15	15	15	ns
Fall time	t_f	<	15	20	30	ns
Turn off time	t_{off}	<	20	35	50	ns

Test circuit:



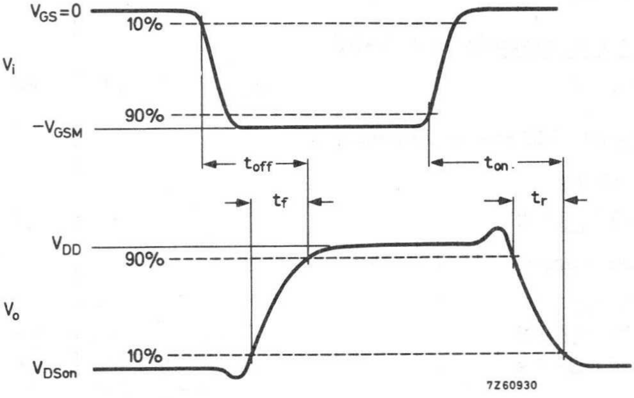
$$R = \frac{9.6}{I_D} - 51\,\Omega$$

Pulse generator:

t_r < 0.5 ns
t_f < 0.5 ns
t_p = 100 µs
δ = 0.01

Oscilloscope:

R_i = 50 Ω



N-CHANNEL FIELD EFFECT TRANSISTORS

Silicon N-channel depletion type junction-triode field effect transistors in a TO-18 metal envelope with the gate connected to the case. The transistors are intended for low power, chopper or switching, applications in industrial service.

QUICK REFERENCE DATA

Drain-source voltage 2N4856 to 2N4858	$\pm V_{DS}$	max.	40			V
Drain-source voltage 2N4859 to 2N4861	$\pm V_{DS}$	max.	30			V
Total power dissipation up to $T_{amb} = 25\ ^{o}C$	P_{tot}	max.	360			mW
			2N4856 2N4859	2N4857 2N4860	2N4858 2N4861	
Drain current $V_{DS} = 15\ V$; $V_{GS} = 0$	I_{DSS}	>	50	20	8	mA
Gate-source cut-off voltage $I_D = 0.5\ nA$; $V_{DS} = 15\ V$	$-V_{(P)GS}$	>	4	2	0.8	V
	$-V_{(P)GS}$	<	10	6	4	V
Drain-source resistance (on) at f = 1 kHz $I_D = 0$; $V_{GS} = 0$	r_{dson}	<	25	40	60	Ω
Feedback capacitance at f = 1 MHz $V_{DS} = 0$; $-V_{GS} = 10\ V$	$-C_{rs}$	<		8		pF

Turn off time

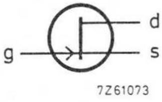
$V_{DD} = 10\ V$; $V_{GS} = 0$

$I_D = 20\ mA$; $-V_{GSM} = 10\ V$	2N4856; 2N4859	t_{off}	<	25	ns
$I_D = 10\ mA$; $-V_{GSM} = 6\ V$	2N4857; 2N4860	t_{off}	<	50	ns
$I_D = 5\ mA$; $-V_{GSM} = 4\ V$	2N4858; 2N4861	t_{off}	<	100	ns

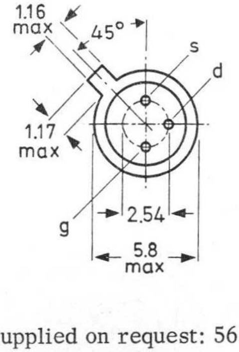
MECHANICAL DATA

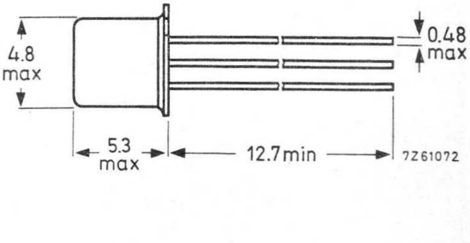
Dimensions in mm

Gate connected to case
TO-18



7Z61073





7Z61072

Accessories supplied on request: 56246; 56263

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltages			2N4856 2N4857 2N4858	2N4859 2N4860 2N4861	
Drain-source voltage	$\pm V_{DS}$	max.	40	30	V
Drain-gate voltage (open source)	V_{DGO}	max.	40	30	V
Gate-source voltage (open drain)	$-V_{GSO}$	max.	40	30	V

Current				
Gate current (d.c.)	I_G	max.	50	mA
Power dissipation				
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	360	mW
Temperatures				
Storage temperature	T_{stg}	-65 to +200		°C
Junction temperature	T_j	max.	200	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\,j\text{-}a}$	=	0.49	°C/mW

CHARACTERISTICS

T_{amb} = 25 °C unless otherwise specified

			2N4856 2N4857 2N4858	2N4859 2N4860 2N4861	
Gate cut-off current					
$-V_{GS}$ = 20 V; V_{DS} = 0	$-I_{GSS}$	$<$	0.25	–	nA
$-V_{GS}$ = 15 V; V_{DS} = 0	$-I_{GSS}$	$<$	–	0.25	nA
$-V_{GS}$ = 20 V; V_{DS} = 0; T_{amb} = 150 °C	$-I_{GSS}$	$<$	0.5	–	µA
$-V_{GS}$ = 15 V; V_{DS} = 0; T_{amb} = 150 °C	$-I_{GSS}$	$<$	–	0.5	µA
Drain cut-off current					
V_{DS} = 15 V; $-V_{GS}$ = 10 V	I_{DSX}	$<$	0.25	0.25	nA
V_{DS} = 15 V; $-V_{GS}$ = 10 V; T_{amb} = 150 °C	I_{DSX}	$<$	0.5	0.5	µA

			2N4856 2N4859	2N4857 2N4860	2N4858 2N4861	
Drain current [1]						
V_{DS} = 15 V; V_{GS} = 0	I_{DSS}	$>$	50	20	8	mA
	I_{DSS}	$<$	–	100	80	mA

		2N4856 2N4857 2N4858	2N4859 2N4860 2N4861	
Gate-source breakdown voltage				
$-I_G$ = 1 µA; V_{DS} = 0	$-V_{(BR)GSS}$	40	30	V

			2N4856 2N4859	2N4857 2N4860	2N4858 2N4861	
Gate-source cut-off voltage						
I_D = 0.5 nA; V_{DS} = 15 V	$-V_{(P)GS}$	$>$	4	2	0.8	V
		$<$	10	6	4	V
Drain-source voltage (on)						
I_D = 20 mA; V_{GS} = 0	V_{DSon}	$<$	0.75	–	–	V
I_D = 10 mA; V_{GS} = 0	V_{DSon}	$<$	–	0.50	–	V
I_D = 5 mA; V_{GS} = 0	V_{DSon}	$<$	–	–	0.50	V
Drain-source resistance (on) at f = 1 kHz						
I_D = 0; V_{GS} = 0	r_{dson}	$<$	25	40	60	Ω

---

[1] measured under pulsed conditions: t_p = 100 ms; $\delta \leq 0.1$

CHARACTERISTICS (continued) $T_{amb} = 25\ ^{o}C$ unless otherwise specified

y-parameters at f = 1 MHz (common source)

$-V_{GS} = 10\,V;\ V_{DS} = 0$

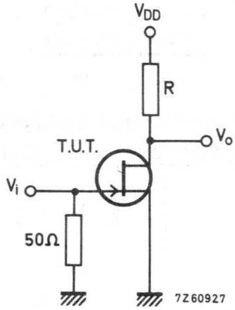
Input capacitance	C_{is}	<	18	pF
Feedback capacitance	$-C_{rs}$	<	8	pF

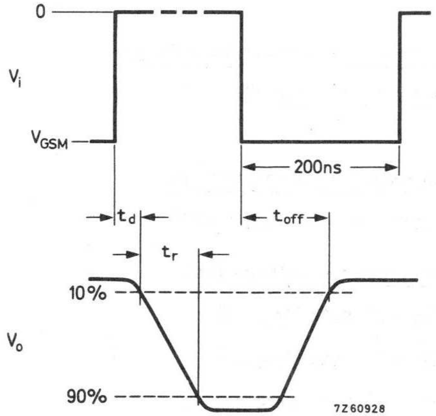
Switching times

$V_{DD} = 10\,V;\ V_{GS} = 0$

			2N4856 2N4859	2N4857 2N4860	2N4858 2N4861	
	I_D	=	20	10	5	mA
	$-V_{GSM}$	=	10	6	4	V
Delay time	t_d	<	6	6	10	ns
Rise time	t_r	<	3	4	10	ns
Turn off time	t_{off}	<	25	50	100	ns

Test circuit:





		2N4856 2N4859	2N4857 2N4860	2N4859 2N4861	
R	=	464	953	1910	Ω

Pulse generator:

$t_r \leq 1$ ns
$t_f \leq 1$ ns
$\delta = 0.02$
$Z_o = 50\ \Omega$

Oscilloscope:

$t_r \leq 0.75$ ns
$R_i \geq 1$ MΩ
$C_i \leq 2.5$ pF

Dual transistors

N-P-N SILICON PLANAR LOW-LEVEL DUAL TRANSISTORS FOR DIFFERENTIAL AMPLIFIERS

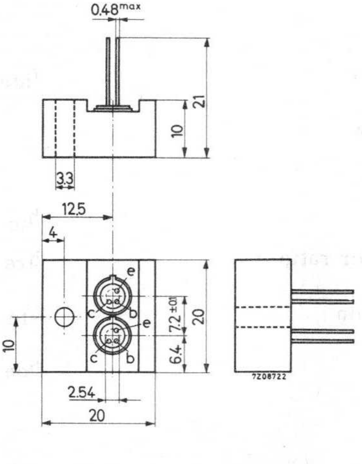
Two special matched transistors in a TO-18 metal envelope, housed together in an aluminium cube.

The BCY55 is intended for very low level, low noise and low drift differential amplifiers.

QUICK REFERENCE DATA

Equivalent differential voltage change referred to the input $\left\| I_{1E} + I_{2E} \right\| \leq 200\ \mu A$ $V_{1C\text{-}1E} = V_{2C\text{-}2E} \leq 20\ V$ $\left\| V_{1B\text{-}1E} - V_{2B\text{-}2E} \right\| \leq 100\ \mu V$ T_{amb}: -20 to +90 °C	$\left\| \frac{\Delta V}{\Delta T} \right\|$	typ. <	1 $\mu V/^{o}C$ 3 $\mu V/^{o}C$
Equivalent differential current change referred to the input $I_{1C} + I_{2C} = 100\ \mu A$ T_{amb}: -20 to +90 °C	$\left\| \frac{\Delta I}{\Delta T} \right\|$	typ. <	0.5 $nA/^{o}C$ 1.5 $nA/^{o}C$

MECHANICAL DATA Dimensions in mm



CHARACTERISTICS of the individual transistors T_j = 25 °C unless otherwise specified

Collector cut-off current				
$I_E = 0$; $V_{CB} = 45$ V	I_{CBO}	<	10	nA
$I_E = 0$; $V_{CB} = 20$ V; $T_{amb} = 90$ °C	I_{CBO}	<	5	nA
Emitter cut-off current				
$I_C = 0$; $V_{EB} = 5$ V	I_{EBO}	<	10	nA
Emitter-base voltage				
$-I_E = 0.5$ mA; $V_{CB} = 5$ V	$-V_{EB}$		600 to 800	mV
Saturation voltages				
$I_C = 10$ mA; $I_B = 0.5$ mA	V_{CEsat}	<	1.0	V
	V_{BEsat}		0.6 to 1.0	V
D.C. current gain				
$I_C = 10$ μA; $V_{CE} = 5$ V	h_{FE}		100 to 300	
$I_C = 10$ mA; $V_{CE} = 5$ V	h_{FE}		200 to 600	
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; $V_{CB} = 5$ V	C_c	<	8	pF
Transition frequency				
$I_C = 0.5$ mA; $V_{CE} = 5$ V	f_T	>	50	MHz
		typ.	80	MHz
Cut-off frequency				
$I_C = 0.5$ mA; $V_{CE} = 5$ V	f_{hfe}	>	100	kHz
h parameters at f = 1 kHz				
$I_C = 1$ mA; $V_{CE} = 5$ V				
Input impedance	h_{ie}	typ.	10.0	kΩ
Reverse voltage transfer ratio	h_{re}	typ.	5.5	10^{-4}
Small signal current gain	h_{fe}	typ.	350	
			150 to 600	
Output admittance	h_{oe}	typ.	25	$\mu\Omega^{-1}$
Noise figure				
$I_C = 10$ μA; $V_{CE} = 5$ V $R_S = 10$ kΩ; B = 10 to 15000 Hz	F	typ.	2	dB
		<	3	dB

CHARACTERISTICS of the complete device

Ratio of collector currents

$V_{1B-1E} = V_{2B-2E}$
Emitter currents of each transistor up to 100 μA

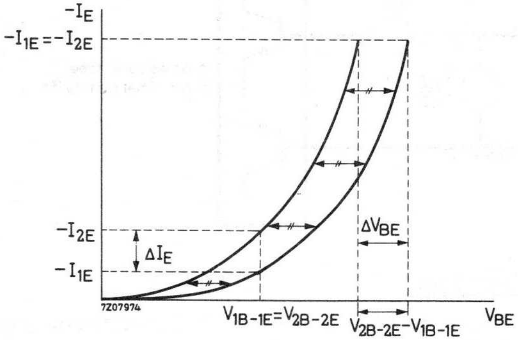
$$\frac{I_{1C}}{I_{2C}} \quad 0.85 \text{ to } 1 \quad \text{typ. } 0.93$$

Difference of base-emitter voltages

$-I_{1E} = -I_{2E}$ up to 100 μA
T_{amb}: −20 to +90 °C

$|V_{1B-1E} - V_{2B-2E}|$ typ. 2 mV
< 4 mV

Illustration of matching characteristics:



$$\frac{I_{2E}}{I_{1E}} = \exp. \frac{q}{kT} \cdot \Delta V_{BE}$$

$\frac{I_{2E}}{I_{1E}}$ measured at $\Delta V_{BE} = 0$

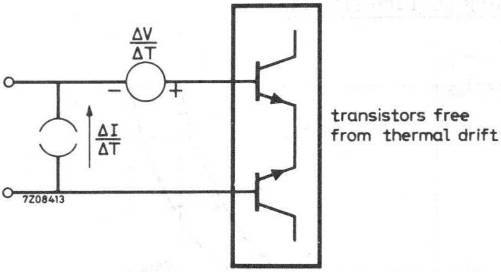
ΔV_{BE} measured at $\frac{I_{2E}}{I_{1E}} = 1$

CHARACTERISTICS of the complete device (continued)

Equivalent circuit for drift

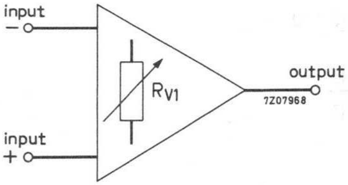
In the equivalent circuit the transistors are considered to be drift free. All temperature coefficients are concentrated in the voltage source $\frac{\Delta V}{\Delta T}$ and in the current source $\frac{\Delta I}{\Delta T}$.

It should be noted that the differential current change given is only valid when the source resistances are almost equal; the differential voltage change only when the base-emitter voltages are almost equal.



Block symbol of test amplifier

The test amplifier, used in the tests on page 5, is described on pages 6 and 7. It is represented by the following amplifier symbol:



CHARACTERISTICS of the complete device (continued)

Equivalent differential voltage change with temperature referred to the input.

$|I_{1E} + I_{2E}| \leq 200\ \mu A$; $V_{1C-1E} = V_{2C-2E} \leq 20$ V

$|V_{1B-1E} - V_{2B-2E}| \leq 100\ \mu V$; T_j: −20 to +90 °C

BCY55 unit (wires included) mounted in a small metal or plastic box for shielding against direct heat radiation.

$\left|\frac{\Delta V}{\Delta T}\right|$ typ. 1 $\mu V/^{\circ}C$
< 3 $\mu V/^{\circ}C$

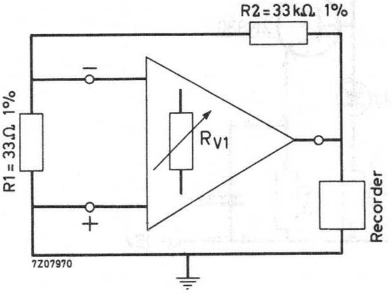
Equivalent differential current change with temperature referred to the input.

$I_{1C} + I_{2C} = 100\ \mu A$

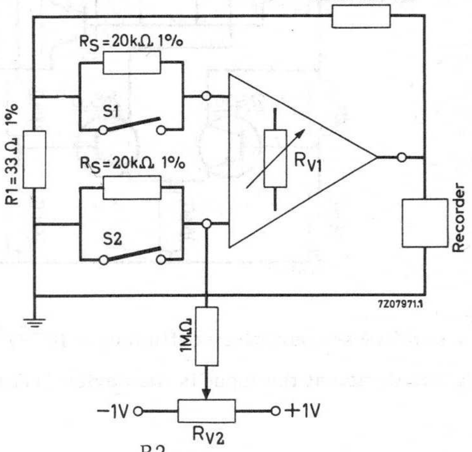
$\frac{\Delta I}{\Delta T}$ typ. 0.5 $nA/^{\circ}C$
< 1.5 $nA/^{\circ}C$

Test methods

$\boxed{\frac{\Delta V}{\Delta T}}$



$\boxed{\frac{\Delta I}{\Delta T}}$



NOTE

To prevent contact potentials, connections should be soldered.

Amplification factor determined by feedback circuit: $\frac{R2}{R1} = 1000$

Output voltage against time is recorded.

The temperature of the amplifier is adjusted to T_1 between −20 and +90 °C. When it has stabilized, the output voltage is brought to zero ($|V_{T1}| < 100$ mV)[1]. The amplifier temperature is then adjusted to T_2 between −20 and +90 °C. When it has stabilized the output voltage can be read off.

Then: $\frac{\Delta V}{\Delta T} = \frac{V_{T2} - V_{T1}}{T_2 - T_1} \cdot \frac{R1}{R2}$ or $\frac{\Delta I}{\Delta T} = \frac{V_{T2} - V_{T1}}{T_2 - T_1} \cdot \frac{R1}{R2} \cdot \frac{1}{2R_S}$

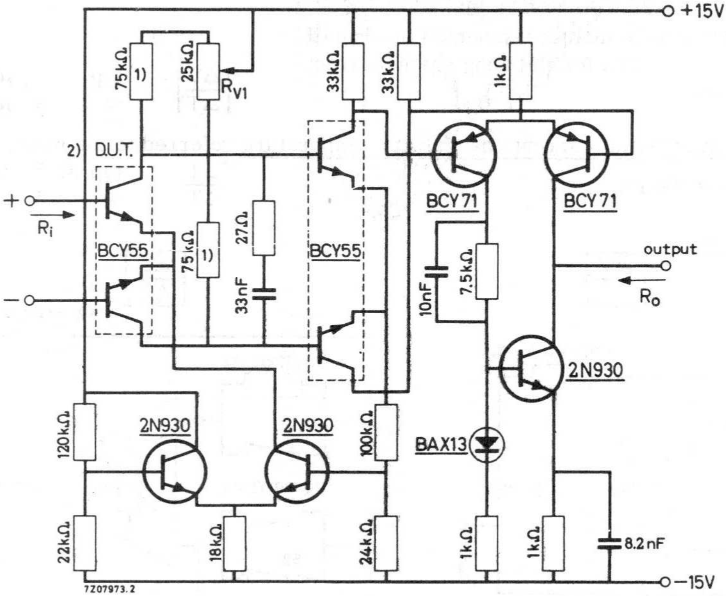
---

[1] For $\frac{\Delta V}{\Delta T}$: adjusted by R_{V1}

For $\frac{\Delta I}{\Delta T}$: first by R_{V1} with S1 and S2 closed, then by R_{V2} with the switches open.

Differential test-amplifier

The test amplifier (including feedback resistors, source-resistors and biasing-resistors) should be mounted in a small box to ensure a uniform temperature throughout.



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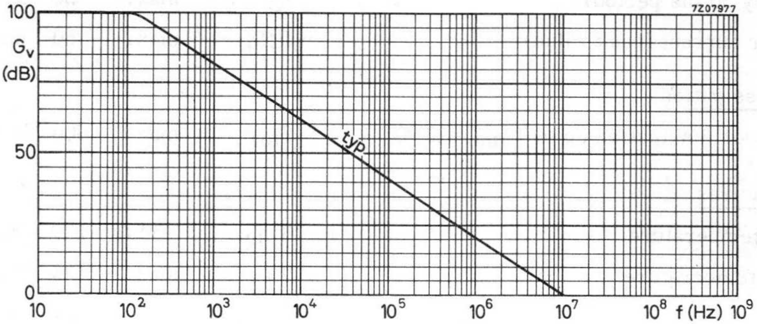
[1]) Relative temperature coefficient $< 10^{-5}/^{o}C$

2) The device at the input is the device under test

Performance of the test amplifier

Open loop voltage gain (Z_L = 10 kΩ)	G_V	typ.	10^5	
Frequency at which G_V = 1	f_1	typ.	10	MHz
Max. common mode input voltage range			±10	V
Max. output current			±2.5	mA
Max. output voltage			±10	V
Input resistance	R_i	≥	100	kΩ
Output resistance	R_o	typ.	20	kΩ



RATINGS of the individual transistors (Limiting values) [1]

Voltages

Collector-base voltage (open emitter)	V_{CBO}	max.	45	V
Collector-emitter voltage (open base)	V_{CEO}	max.	45	V
Collector-emitter voltage with V_{BE} = 0	V_{CES}	max.	45	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	V

Currents

Collector currents (d.c. or average over any 50 ms period)	I_C	max.	30	mA
Collector current (peak value)	I_{CM}	max.	60	mA

Power dissipation

Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	300	mW

Temperatures

Storage temperature	T_{stg}		-50 to +125	°C
Junction temperature	T_j	max.	125	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	0.33	°C/mW

(This value applies to one transistor at equal dissipation or difference in dissipation < 20% in both transistors of the unit)

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[1] Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

N-P-N SILICON PLANAR DUAL TRANSISTORS FOR DIFFERENTIAL AMPLIFIERS

Matched dual n-p-n transistors in a TO-71 metal envelope with all leads insulated from the case. They are primarily intended for differential amplifier applications in general industrial service; e.g. instrumentation and control.
The product is divided in three types according to their matching accuracy.
The BCY87 and BCY88 are intended for applications in prestages of differential amplifiers where low offset, drift and noise are of prime importance. The BCY89 is for second stages, long tail pairs and more general purposes.

QUICK REFERENCE DATA

Ratings

Collector-base voltage (open emitter)	V_{CBO}	max.	45	V
Collector-emitter voltage (open base)	V_{CEO}	max.	40	V
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	150	mW
Junction temperature	T_j	max.	175	°C

Characteristics of the complete device with collector-base voltage of 10 V and sum of emitter currents from 10 to 100 μA.

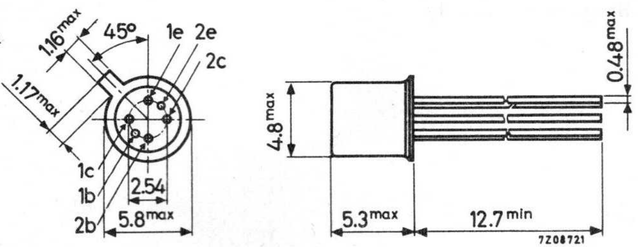
		BCY87	BCY88	BCY89	
Ratio of collector currents at $V_{1B-1E} = V_{2B-2E}$	I_{1C}/I_{2C}	0.9-1.11	0.8-1.25	0.67-1.5	
Base current difference at $V_{1B-1E} = V_{2B-2E}$	$\lvert I_{1B}-I_{2B}\rvert$	< 25	80	300	nA
Equivalent differential voltage change with temperature	$\left\lvert\frac{\Delta V}{\Delta T}\right\rvert$ 1)	< 3	6	10	μV/°C
Equivalent differential current change with temperature	$\left\lvert\frac{\Delta I}{\Delta T}\right\rvert$ 1)	< 0.5	2	10	nA/°C

MECHANICAL DATA

Dimensions in mm

TO-71
All leads insulated from the case

Accessories available:
56263



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1) T_{amb} = -20 to +90 °C

RATINGS see page 7

CHARACTERISTICS of the individual transistors

T_{amb} = 25 °C unless otherwise specified

			BCY87	BCY88	BCY89	
Collector cut-off currents						
$I_E = 0$; $V_{CB} = 20$ V; $T_{amb} = 90$ °C	I_{CBO}	$<$	5	20	–	nA
$I_E = 0$; $V_{CB} = 20$ V	I_{CBO}	$<$	–	–	10	nA
D.C. current gain						
$I_C = 5\ \mu A$; $V_{CB} = 10$ V	h_{FE}	$>$	80	–	–	
$I_C = 50\ \mu A$; $V_{CB} = 10$ V	h_{FE}	$>$	100	100	100	
		$<$	450	450	450	
$I_C = 500\ \mu A$; $V_{CB} = 10$ V	h_{FE}	$>$	–	120	–	
		$<$	–	600	–	
$I_C = 10$ mA; $V_{CB} = 10$ V	h_{FE}	$>$	–	–	100	
		$<$	–	–	600	
Transition frequency						
$-I_E = 50\ \mu A$; $V_{CB} = 10$ V	f_T	$>$	10	10	10	MHz
$-I_E = 500\ \mu A$; $V_{CB} = 10$ V	f_T	$>$	50	50	50	MHz
Collector capacitance at f = 1 MHz						
$I_E = I_e = 0$; $V_{CB} = 10$ V	C_c	$<$	3.5	3.5	3.5	pF
Noise figures						
$I_C = 50\ \mu A$; $V_{CE} = 5$ V; $R_S = 10\ k\Omega$ Bandwidth 10 Hz to 15 kHz	F	$<$	3	4	4	dB
1 kHz spot noise figure $I_C = 50\ \mu A$; $V_{CE} = 5$ V; R_S = opt. Bandwidth = 200 Hz	F	$<$	4	5	5	dB

CHARACTERISTICS of the complete device.

These characteristics are valid under the following conditions:

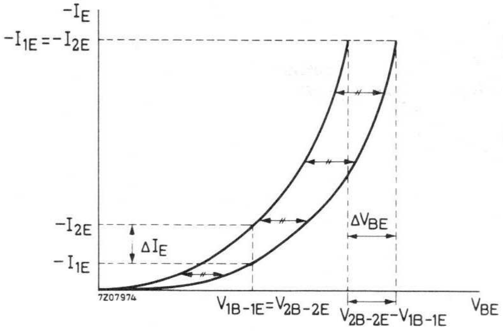
a. Collector-base voltage of both transistors not exceeding 10 V ($V_{1C-1B} = V_{2C-2B} \leq 10$ V)

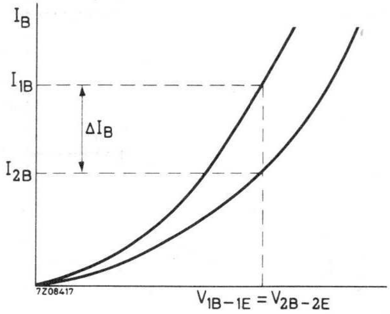
b. Sum of the emitter currents from 10 to 100 μA
$-(I_{1E} + I_{2E}) = 10$ to 100 μA

MATCHING CHARACTERISTICS

		BCY87	BCY88	BCY89	
Ratio of collector currents					
$V_{1B-1E} = V_{2B-2E}$	I_{1C}/I_{2C}	0.9-1.11	0.8-1.25	0.67-1.5	
Difference between base-emitter voltages					
$I_{1C} = I_{2C}$	$\lvert V_{1B-1E} - V_{2B-2E} \rvert$	< 3	6	10	mV
Difference between base currents					
$V_{1B-1E} = V_{2B-2E}$	$\lvert I_{1B} - I_{2B} \rvert$	< 25	80	300	nA
D.C. current gain ratio					
$I_{1C} = I_{2C}$	h_{1FE}/h_{2FE}	0.9-1.11	0.8-1.25	-	

Illustration of matching characteristics:





$$\frac{I_{2E}}{I_{1E}} = \exp. \frac{q}{KT} \cdot \Delta V_{BE}$$

$\frac{I_{2E}}{I_{1E}}$ measured at $\Delta V_{BE} = 0$

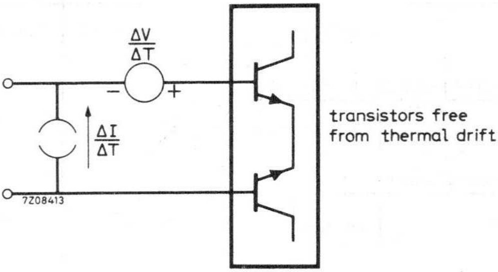
ΔV_{BE} measured at $\frac{I_{2E}}{I_{1E}} = 1$

CHARACTERISTICS of the complete device (continued)

Equivalent circuit for drift

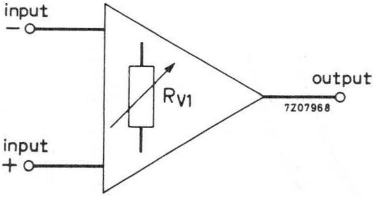
In the equivalent circuit the transistors are considered to be drift free. All temperature coefficients are concentrated in the voltage source $\frac{\Delta V}{\Delta T}$ and in the current source $\frac{\Delta I}{\Delta T}$.

It should be noted that the differential current change given is only valid when the source resistances are almost equal; the differential voltage change only when the base-emitter voltages are almost equal.



Block symbol of test amplifier

The test amplifier, used in the tests on page 5, is described on pages 6 and 7. It is represented by the following amplifier symbol:



CHARACTERISTICS of the complete device (continued)

Equivalent differential voltage change with temperature

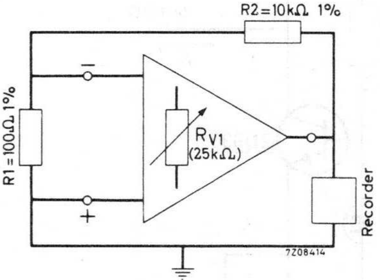
			BCY87	BCY88	BCY89	
Tamb = −20 to +90 °C	$\left\lvert\frac{\Delta V}{\Delta T}\right\rvert$	typ.	1	2	4	μV/°C
		<	3	6	10	μV/°C

Equivalent differential current change with temperature

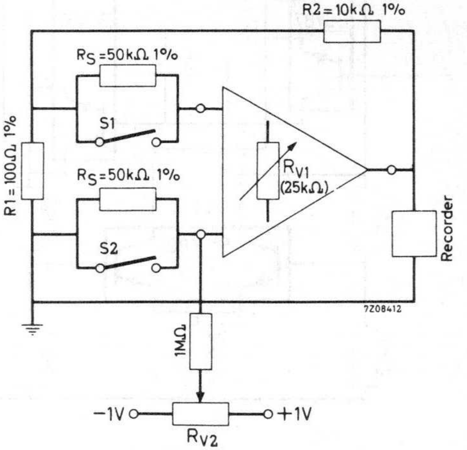
			BCY87	BCY88	BCY89	
Tamb = −20 to +90 °C	$\left\lvert\frac{\Delta I}{\Delta T}\right\rvert$	<	0.5	2	10	nA/°C

Test methods

$\boxed{\frac{\Delta V}{\Delta T}}$



$\boxed{\frac{\Delta I}{\Delta T}}$



NOTE

To prevent contact potentials, connections should be soldered.

Amplification factor determined by feedback circuit: $\frac{R2}{R1} = 100$

Output voltage against time is recorded.

The temperature of the amplifier is adjusted to T_1 between −20 and +90 °C. When it has stabilized, the output voltage is brought to zero ($|V_{T1}| < 1$ mV)[1]. The amplifier temperature is then adjusted to T_2 between −20 and +90 °C. When it has stabilized the output voltage can be read off.

Then: $\frac{\Delta V}{\Delta T} = \frac{V_{T2} - V_{T1}}{T_2 - T_1} \cdot \frac{R1}{R2}$ or $\frac{\Delta I}{\Delta T} = \frac{V_{T2} - V_{T1}}{T_2 - T_1} \cdot \frac{R1}{R2} \cdot \frac{1}{2R_S}$

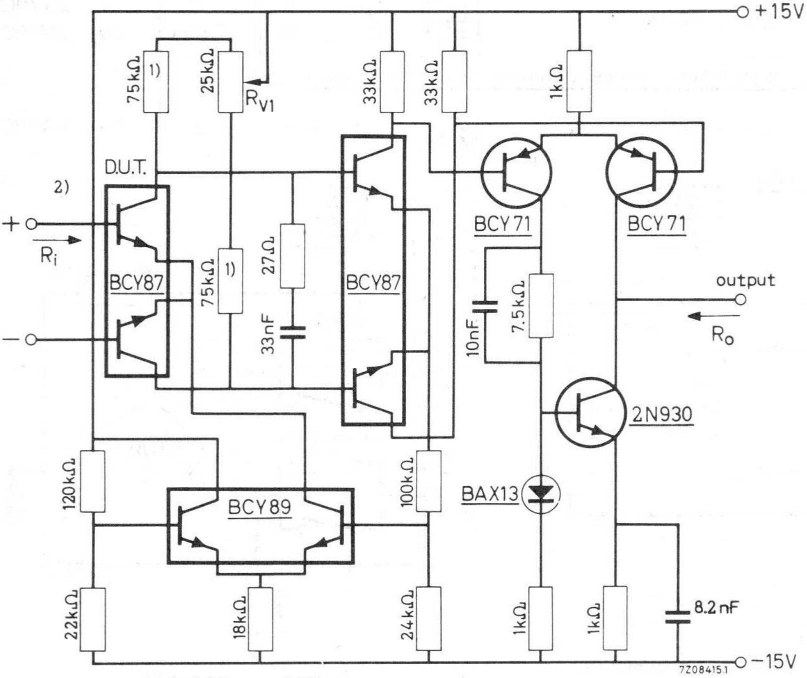
---

[1] For $\frac{\Delta V}{\Delta T}$: adjusted by R_{V1}

For $\frac{\Delta I}{\Delta T}$: first by R_{V1} with S1 and S2 closed, then by R_{V2} with the switches open.

Differential test-amplifier

The test amplifier (including feedback resistors, source-resistors and biasing-resistors) should be mounted in a small box to ensure a uniform temperature throughout.



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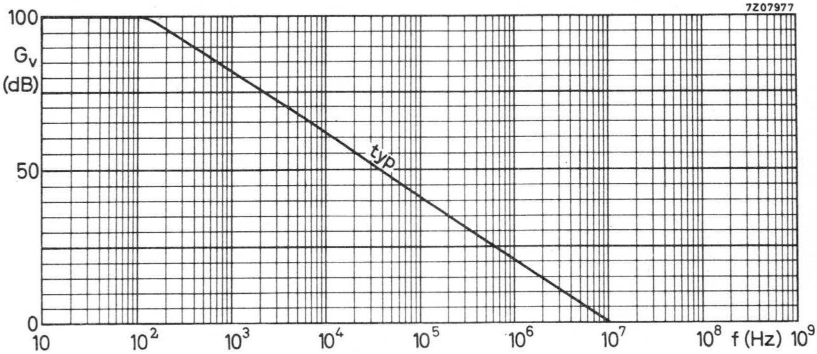
1) Relative temperature coefficient < $10^{-5}/{}^{\circ}C$

2) The device at the input is the device under test

Performance of the test amplifier

Open loop voltage gain (Z_L = 10 kΩ)	G_v	typ.	10^5	
Frequency at which G_v = 1	f_1	typ.	10	MHz
Max. common mode input voltage range			±10	V
Max. output current			±2.5	mA
Max. output voltage			±10	V
Input resistance	R_i		100	kΩ
Output resistance	R_o	typ.	20	kΩ
Common mode rejection ratio			10^5	



RATINGS (Limiting values) 1)

Voltages (each transistor)

Collector-base voltage (open emitter)	V_{CBO}	max.	45	V
Collector-emitter voltage (open base) I_C = 10 mA	V_{CEO}	max.	40	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	V

Currents (each transistor)

Collector current (d.c.)	I_C	max.	30	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	150	mW

Temperatures

Storage temperature	T_{stg}	max.	175	°C
Junction temperature	T_j	max.	175	°C

THERMAL RESISTANCE

From junction to ambient	$R_{th\ j\text{-}a}$	=	1	°C/mW

---

1) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

For data and curves of these types please refer to section Field effect transistors

Microminiature devices for thick- and thin-film circuits

SOLDERING RECOMMENDATIONS

The gold-plated fernico tags are pre-tinned with a solder that melts at 185 °C. The following recommendations are for soldering the semiconductors to glass substrates having vapour deposited resistors and tin-lead covered conductive patterns. To get reliable connections, keep the following points in mind:

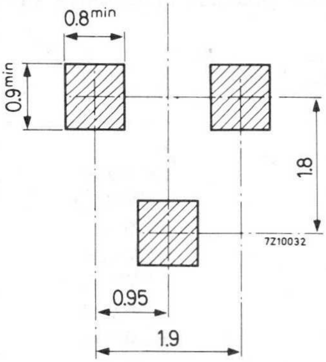
1. The maximum solder temperature and the proper flux are important.
   The flux must not affect the resistors, and its residue must be easy to remove. Use only rosin flux, which can be easily removed with butylacetate or xylene.
2. The temperature change during soldering must not be so severe as to strain the substrate.
3. The semiconductors must be accurately positioned on the substrate. The soldering tags must coincide exactly with the deposited conductors to avoid cracking the glass at high spots where the heated tags come in contact with it.
4. The softening point of the plastic encapsulation is 150 °C; take care to avoid damaging it during the soldering procedure.
5. Use micro-soldering irons of 18-8 stainless steel. They should be designed so as to concentrate heat at the tip.
6. With the tags at the maximum permissible temperature (250 °C) the maximum permissible soldering time is 10 s. The maximum permissible rate of temperature change is 25 °C/s.

Procedure

Pre-heat the substrate to 100 °C (on a heating table). Pick up the semiconductor with a vacuum needle. Using a magnifier and a micromanupilator position it exactly in the required place and alignment, and deposit it on the substrate. Bring the three micro-soldering irons into contact with the soldering tags and press them down firmly to ensure good heat transfer. Apply 20 W to each iron for 8 seconds.
This is sufficient to make the solder fluid for 3 seconds and assure good electrical contact; the junction temperature reaches 250 °C. To cool the solder below its melting point, allow a 3 to 5 second pause before removing the soldering irons.

With this method the encapsulation gets no hotter that the heating table (100 °C) and, if the soldering time is not less than 8 seconds, there is little risk of damage to the substrate. The method is also recommended for replacing semiconductors.

Minimum required dimensions of metal connection pads on thick-and thin-film substrates



Hand soldering

It is possible to replace semiconductors with a hand-held miniature soldering iron, but the procedure has the following disadvantages:

- It is expensive and time consuming.
- The semiconductors cannot be positioned accurately, and therefore the connecting tags may come into contact with the substrate and damage it.
- There is a high risk of breaking either the substrate or the connections inside the encapsulation; the encapsulation may also be damaged by the iron.

The transistors in this chapter are also available with the base and emitter connections interchanged. These types are indicated by the letter R following the type number: e.g. BCW29R.

Type No.	Marking code	Type No.	Marking code
BAW56	A1		
BCW29	C1	BCW29R	C4
BCW30	C2	BCW30R	C5
BCW31	D1	BCW31R	D4
BCW32	D2	BCW32R	D5
BCW33	D3	BCW33R	D6
BCW69	H1	BCW69R	H4
BCW70	H2	BCW70R	H5
BCW71	K1	BCW71R	K4
BCW72	K2	BCW72R	K5
BFR30	M1		
BFR31	M2		
BFS17	E1	BFS17R	E4
BFS18	F1	BFS18R	F4
BFS19	F2	BFS19R	F5
BFS20	G1	BFS20R	G4
BSV52	B2	BSV52R	B4
BZX84-C4V7	Z1		
BZX84-C5V1	Z2		
BZX84-C5V6	Z3		
BZX84-C6V2	Z4		
BZX84-C6V8	Z5		
BZX84-C7V5	Z6		
BZX84-C8V2	Z7		
BZX84-C9V1	Z8		
BZX84-C10	Z9		
BZX84-C11	Y1		
BZX84-C12	Y2		

SILICON PLANAR EPITAXIAL HIGH SPEED DIODES

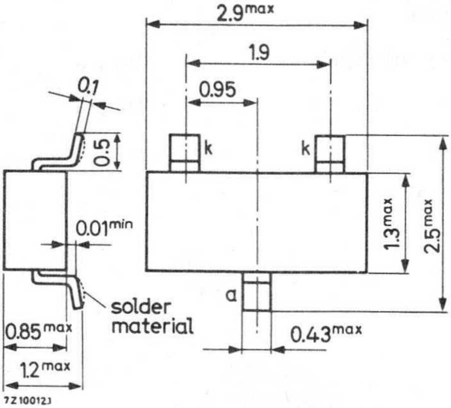
The BAW56 consists of two diodes in a micro miniature plastic envelope. The anodes are commoned and the unit is intended for high speed switching in thick and thin film circuits.

QUICK REFERENCE DATA (per diode)

Continuous reverse voltage	V_R	max.	25	V
Repetitive peak reverse voltage	V_{RRM}	max.	50	V
Repetitive peak forward current	I_{FRM}	max.	100	mA
Junction temperature	T_j		−65 to +125	^oC
Forward voltage at I_F = 50 mA	V_F	<	1.1	V
Reverse recovery time when switched from I_F = 10 mA to V_R = 1 V; R_L = 100 Ω measured at I_R = 1 mA	t_{rr}	<	6	ns
Recovered charge when switched from I_F = 10 mA to V_R = 5 V; R_L = 500 Ω	Q_s	<	45	pC

MECHANICAL DATA Dimensions in mm

Code: A1



RATINGS (per diode) Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltages

Continuous reverse voltage	V_R	max.	25	V
Repetitive peak reverse voltage	V_{RRM}	max.	50	V

Currents

Averaged rectified forward current (averaged over any 20 ms period)	I_{FAV}	max.	50	mA
Forward current (d.c.)	I_F	max.	50	mA
Repetitive peak forward current	I_{FRM}	max.	100	mA

Temperatures

Storage temperature	T_{stg}		−65 to +125	°C
Junction temperature	T_j	max.	125	°C [1]

THERMAL RESISTANCE (per diode)

From junction to ambient
mounted on a glass substrate
of 5 mm x 5 mm x 1 mm

both diodes loaded simultaneously	$R_{th\ j\text{-}a}$	=	1.4	°C/mW
one diode loaded	$R_{th\ j\text{-}a}$	=	0.9	°C/mW

mounted on a **ceramic substrate of 7 mm x 5 mm x 0.5 mm**

both diodes loaded simultaneously	$R_{th\ j\text{-}a}$	=	1.1	°C/mW
one diode loaded	$R_{th\ j\text{-}a}$	=	0.67	°C/mW

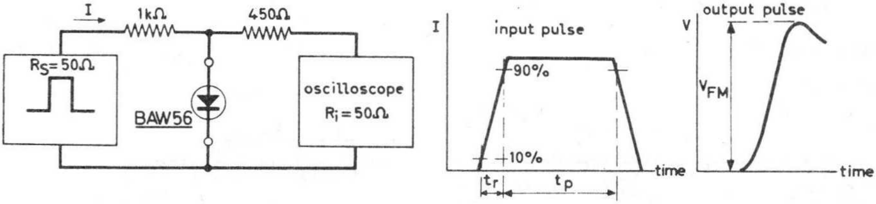
---

[1] For highly professional applications it is advisable not to exceed a max. junction temperature of 100 °C.

CHARACTERISTICS (per diode) T_j = 25 °C unless otherwise specified

Forward voltage				
I_F = 1 mA	V_F	<	715	mV
I_F = 10 mA	V_F	<	855	mV
I_F = 50 mA	V_F	<	1100	mV
I_F = 100 mA	V_F	<	1300	mV
Reverse current				
V_R = 10 V; T_j = 125 °C	I_R	<	8	μA
V_R = 25 V	I_R	<	30	nA
V_R = 25 V; T_j = 125 °C	I_R	<	10	μA
Diode capacitance at f = 1 MHz; V_R = 0	C_d	<	2	pF
Forward recovery voltage				
I_F = 10 mA; t_r = 20 ns	V_{FM}	<	1.75	V

Test circuit:



Current pulse: Rise time t_r = 20 ns Oscilloscope: Rise time t_r = 0.35 ns

Pulse duration t_p = 120 ns

Duty cycle δ = 0.01

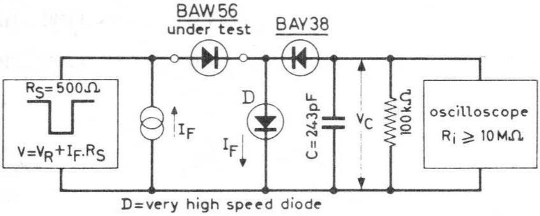
Circuit capacitance C < 1 pF (C = Oscilloscope + parasitical capacitance)

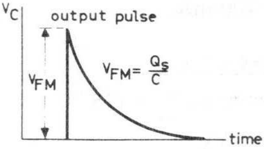
CHARACTERISTICS (continued) $T_j = 25\ ^{o}C$ unless otherwise specified

Recovered charge when switched from

$I_F = 10$ mA to $V_R = 5$ V; $R_L = 500\ \Omega$ Q_s < 45 pC

Test circuit:





Reverse pulse: Rise time $t_r = 2$ ns

Pulse duration $t_p = 400$ ns

Duty cycle $\delta = 0.02$

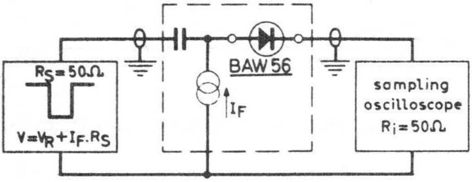
Circuit capacitance C < 7 pF (C = Oscilloscope + parasitical capacitance)

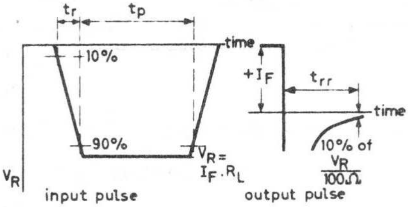
Reverse recovery time when switched from

$I_F = 10$ mA to $V_R = 1$ V; $R_L = 100\ \Omega$

measured at $I_R = 1$ mA t_{rr} < 6 ns

Test circuit:



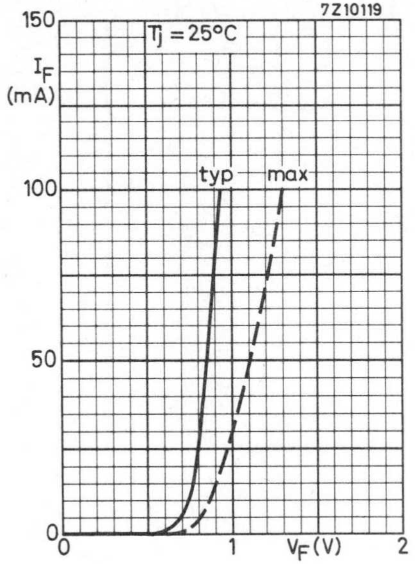


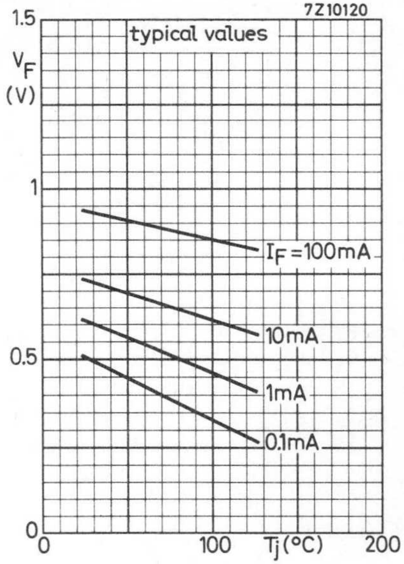
Reverse pulse: Rise time $t_r = 0.6$ ns Oscilloscope: Rise time $t_r = 0.35$ ns

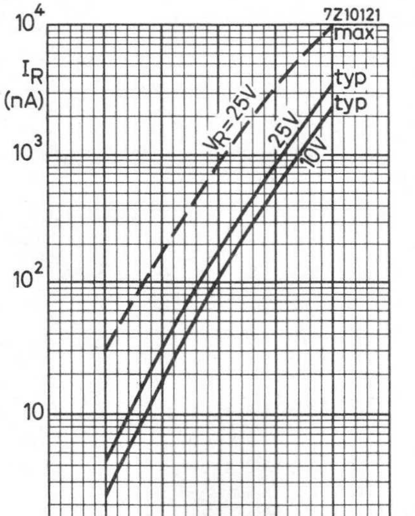
Pulse duration $t_p = 100$ ns

Duty cycle $\delta = 0.05$

Circuit capacitance C < 1 pF (C = Oscilloscope + parasitical capacitance)


7Z10119
150
I_F
(mA)
$T_j = 25°C$
typ
max
100
50
0
0
1
V_F (V)
2


7Z10120
1.5
V_F
(V)
typical values
1
I_F =100mA
10mA
0.5
1mA
0.1mA
0
0
100
T_j (°C)
200


7Z10121
10^4
max
I_R
(nA)
typ
typ
V_R=25V
25V
10V
10^3
10^2
10
1
0
50
100
T_j (°C)
150

A.F. SILICON PLANAR EPITAXIAL TRANSISTORS

P-N-P transistors in a micro miniature plastic envelope.
They are intended for low level general purpose applications in thick and thin film circuits.

QUICK REFERENCE DATA

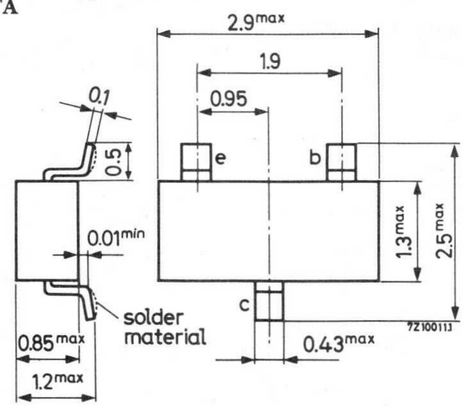
			BCW29	BCW30	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	30	30	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	20	20	V
Collector current (peak value)	$-I_{CM}$	max.	200	200	mA
Total power dissipation up to $T_{amb} = 25\ ^{o}C$	P_{tot}	max.	150	150	mW
Junction temperature	T_j	max.	125	125	^{o}C
D.C. current gain at $T_j = 25\ ^{o}C$ $-I_C = 2$ mA; $-V_{CE} = 5$ V	h_{FE}	> <	120 260	215 500	
Transition frequency at f = 35 MHz $-I_C = 10$ mA; $-V_{CE} = 5$ V	f_T	typ.	150	150	MHz
Noise figure at $R_S = 2\ k\Omega$ $-I_C = 200\ \mu A$; $-V_{CE} = 5$ V f = 1 kHz; B = 200 Hz	F	<	10	10	dB

MECHANICAL DATA

Dimensions in mm

Code:

BCW29	C1
BCW30	C2



RATINGS Limiting values in accordance with the Absolute Maximum System (IEC134)

Voltages

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	30	V
Collector-emitter voltage (V_{BE} = 0)	$-V_{CES}$	max.	30	V
Collector-emitter voltage (open base) $-I_C$ = 2 mA	$-V_{CEO}$	max.	20	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5	V

Currents

Collector current (d.c.)	$-I_C$	max.	50	mA
Collector current (peak value)	$-I_{CM}$	max.	200	mA

Power dissipation

Total power dissipation up to T_{amb} = 25 °C mounted on a **ceramic substrate** of **7 mm x 5 mm x 0.5 mm**	P_{tot}	max.	150	mW

Temperatures

Storage temperature	T_{stg}	-65 to +125		°C
Junction temperature	T_j	max.	125	°C [1]

THERMAL RESISTANCE

From junction to ambient

mounted on a glass substrate of 5 mm x 5 mm x 1 mm	$R_{th\ j\text{-}a}$	=	0.9	°C/mW
mounted on **ceramic substrate** of **7 mm x 5 mm x 0.5 mm**	$R_{th\ j\text{-}a}$	=	0.67	°C/mW

CHARACTERISTICS

Collector cut-off current

I_E = 0; $-V_{CB}$ = 20 V; T_j = 25 °C	$-I_{CBO}$	<	100	nA
T_j = 100 °C	$-I_{CBO}$	<	10	μA

Base-emitter voltage

$-I_C$ = 2 mA; $-V_{CE}$ = 5 V; T_j = 25 °C	$-V_{BE}$	600 to 750		mV

---

[1] For highly professional applications it is advisable not to exceed a maximum junction temperature of 100 °C.

CHARACTERISTICS (continued) T_j = 25 °C unless otherwise specified

Saturation voltages

$-I_C$ = 10 mA; $-I_B$ = 0.5 mA	$-V_{CEsat}$	typ.	80	mV
		<	300	mV
	$-V_{BEsat}$	typ.	720	mV
$-I_C$ = 50 mA; $-I_B$ = 2.5 mA	$-V_{CEsat}$	typ.	180	mV
	$-V_{BEsat}$	typ.	810	mV

D.C. current gain

			BCW29	BCW30
$-I_C$ = 10 µA; $-V_{CE}$ = 5 V	h_{FE}	typ.	90	150
$-I_C$ = 2 mA; $-V_{CE}$ = 5 V	h_{FE}	>	120	215
		<	260	500

Collector capacitance at f = 1 MHz

$I_E = I_e = 0$; $-V_{CB}$ = 10 V	C_c	<	7.0	pF

Transition frequency at f = 35 MHz

$-I_C$ = 10 mA; $-V_{CE}$ = 5 V	f_T	typ.	150	MHz

Noise figure at R_S = 2 kΩ

$-I_C$ = 200 µA; $-V_{CE}$ = 5 V f = 1 kHz; B = 200 Hz	F	<	10	dB[1]

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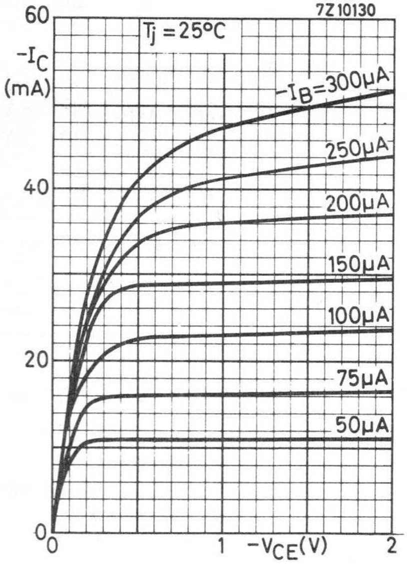
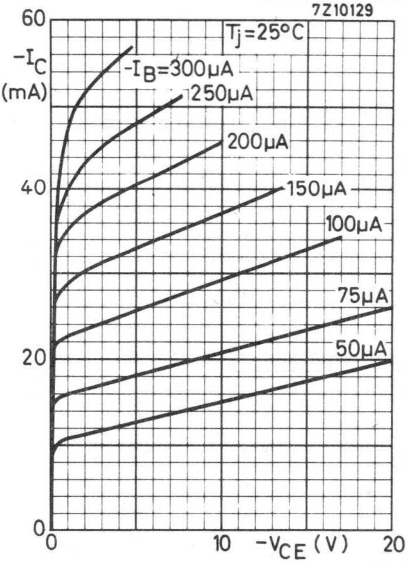
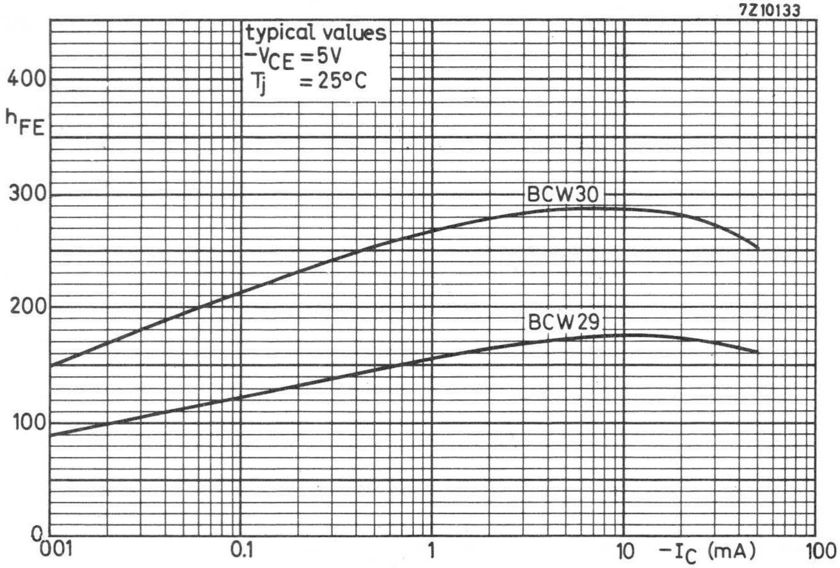
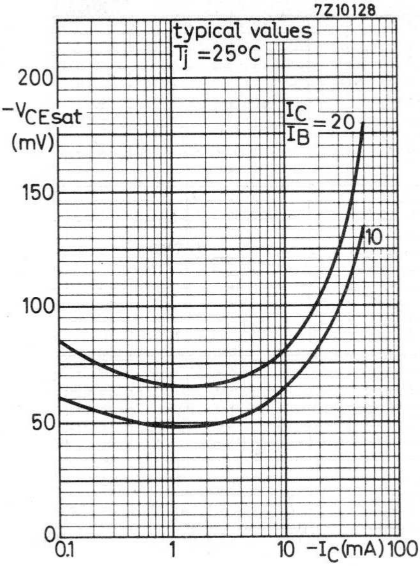
[1] Crystal mounted in a BC177 envelope.

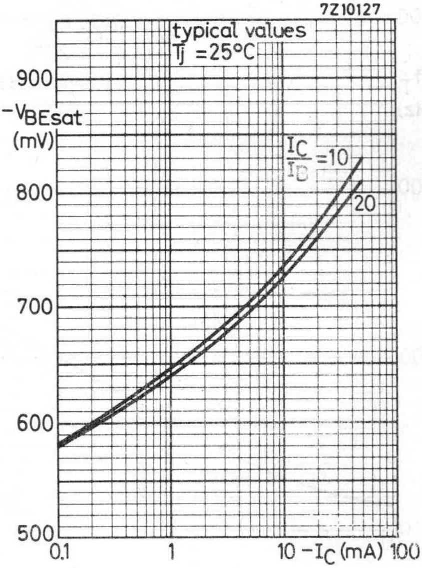
Typical behaviour of collector current versus collector-emitter voltage

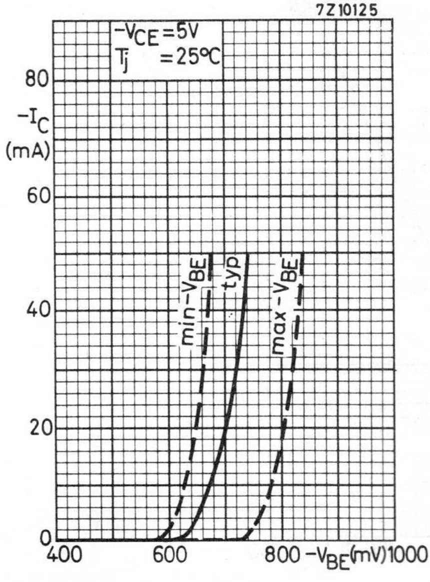


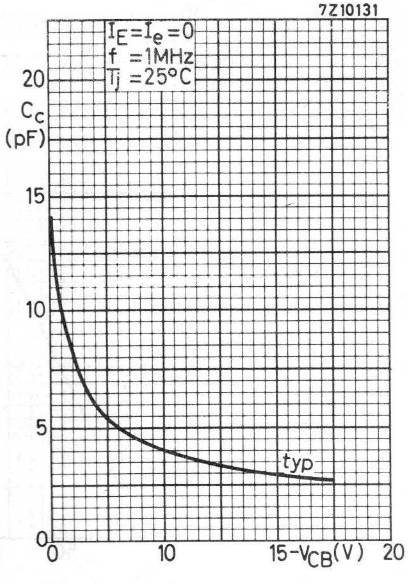


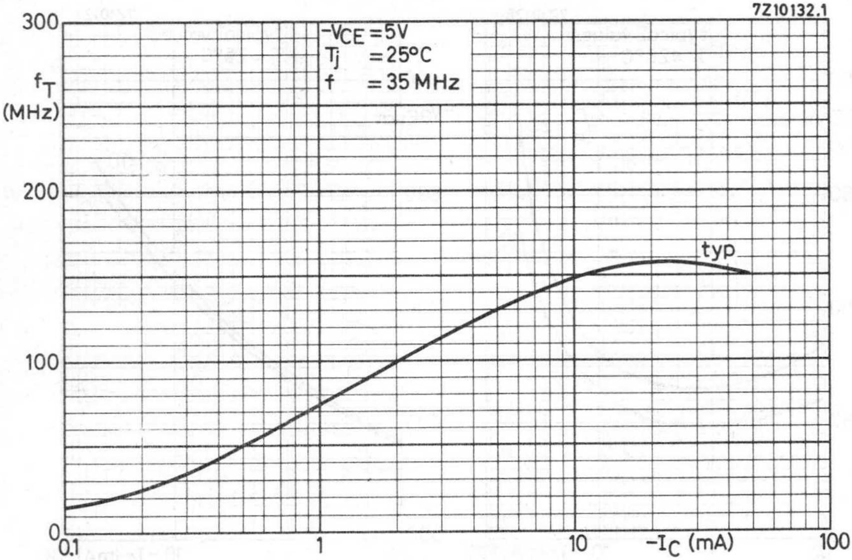


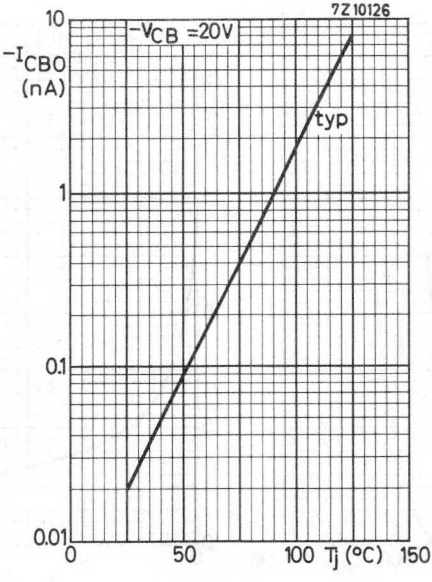

7Z10128
typical values
T_j = 25°C
$-V_{CEsat}$ (mV)
$\frac{I_C}{I_B}$ = 20
10
200
150
100
50
0
0.1
1
10
$-I_C$ (mA)
100


7Z10127
typical values
T_j = 25°C
$-V_{BEsat}$ (mV)
$\frac{I_C}{I_B}$ = 10
20
900
800
700
600
500
0.1
1
10
$-I_C$ (mA)
100


7Z10125
$-V_{CE}$ = 5V
T_j = 25°C
$-I_C$ (mA)
min $-V_{BE}$
typ
max $-V_{BE}$
80
60
40
20
0
400
600
800
$-V_{BE}$ (mV)
1000


7Z10131
$I_E = I_e = 0$
f = 1MHz
T_j = 25°C
C_c (pF)
typ
20
15
10
5
0
0
10
15
$-V_{CB}$ (V)
20


7Z10132.1
300
200
100
0
f_T
(MHz)
−V_CE = 5V
T_j = 25°C
f = 35 MHz
typ
0.1
1
10
−I_C (mA)
100


7Z10126
10
1
0.1
0.01
−I_CBO
(nA)
−V_CB = 20V
typ
0
50
100
T_j (°C)
150

A.F. SILICON PLANAR EPITAXIAL TRANSISTORS

N-P-N transistors in a micro miniature plastic envelope.
They are intended for low level general purpose applications in thick and thin film circuits.

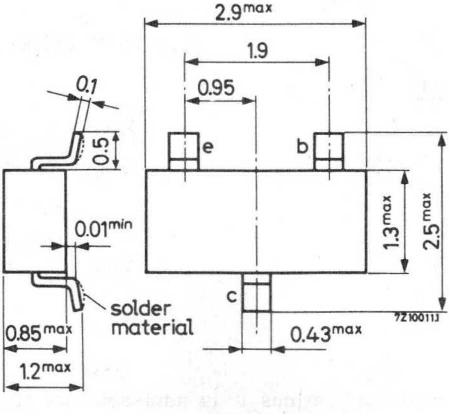
QUICK REFERENCE DATA

			BCW31	BCW32	BCW33	
Collector-base voltage (open emitter)	V_{CBO}	max.	30	30	30	V
Collector-emitter voltage (open base)	V_{CEO}	max.	20	20	20	V
Collector current (peak value)	I_{CM}	max.	200	200	200	mA
Total power dissipation up to $T_{amb} = 25\ ^oC$	P_{tot}	max.	150	150	150	mW
Junction temperature	T_j	max.	125	125	125	^oC
D.C. current gain at $T_j = 25\ ^oC$ $I_C = 2$ mA: $V_{CE} = 5$ V	h_{FE}	>	110	200	420	
		<	220	450	800	
Transition frequency at f = 35 MHz $I_C = 10$ mA; $V_{CE} = 5$ V	f_T	typ.	300	300	300	MHz
Noise figure at $R_S = 2\ k\Omega$ $I_C = 200\ \mu A$; $V_{CE} = 5$ V f = 1 kHz; B = 200 Hz	F	<	10	10	10	dB

MECHANICAL DATA

Dimensions in mm

Code:
BCW31 D1
BCW32 D2
BCW33 D3



RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltages

Collector-base voltage (open emitter)	V_{CBO}	max.	30	V
Collector-emitter voltage (open base) I_C = 2 mA	V_{CEO}	max.	20	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	V

Currents

Collector current (d.c.)	I_C	max.	50	mA
Collector current (peak value)	I_{CM}	max.	200	mA

Power dissipation

Total power dissipation up to T_{amb} = 25 °C mounted on a **ceramic substrate of 7 mm x 5 mm x 0.5 mm**	P_{tot}	max.	**150**	mW

Temperatures

Storage temperature	T_{stg}	-65 to	+125	°C
Junction temperature	T_j	max.	125	°C 1)

THERMAL RESISTANCE

From junction to ambient mounted on a **glass substrate of** 5 mm x 5 mm x 1 mm	$R_{th\ j\text{-}a}$	=	0.9	°C/mW
mounted on **ceramic substrate of 7 mm x 5 mm x 0.5 mm**	$R_{th\ j\text{-}a}$	=	**0.67**	°C/mW

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current

I_E = 0; V_{CB} = 20 V	I_{CBO}	<	100	nA
I_E = 0; V_{CB} = 20 V; T_j = 100 °C	I_{CBO}	<	10	μA

Base-emitter voltage

I_C = 2 mA; V_{CE} = 5 V	V_{BE}	550 to	700	mV

---

1) For highly professional applications it is advisable not to exceed a maximum junction temperature of 100 °C.

CHARACTERISTICS (continued) T_j = 25 °C unless otherwise specified

Saturation voltages

I_C = 10 mA; I_B = 0.5 mA	V_{CEsat}	typ. <	120 250	mV mV
	V_{BEsat}	typ.	750	mV
I_C = 50 mA; I_B = 2.5 mA	V_{CEsat}	typ.	230	mV
	V_{BEsat}	typ.	870	mV

D.C. current gain

			BCW31	BCW32	BCW33
I_C = 10 μA; V_{CE} = 5 V	h_{FE}	typ.	90	150	270
I_C = 2 mA; V_{CE} = 5 V	h_{FE}	> <	110 220	200 450	420 800

Collector capacitance at f = 1 MHz

I_E = I_e = 0; V_{CB} = 10 V	C_c	<	4.0	pF

Transition frequency at f = 35 MHz

I_C = 10 mA; V_{CE} = 5 V	f_T	typ.	300	MHz

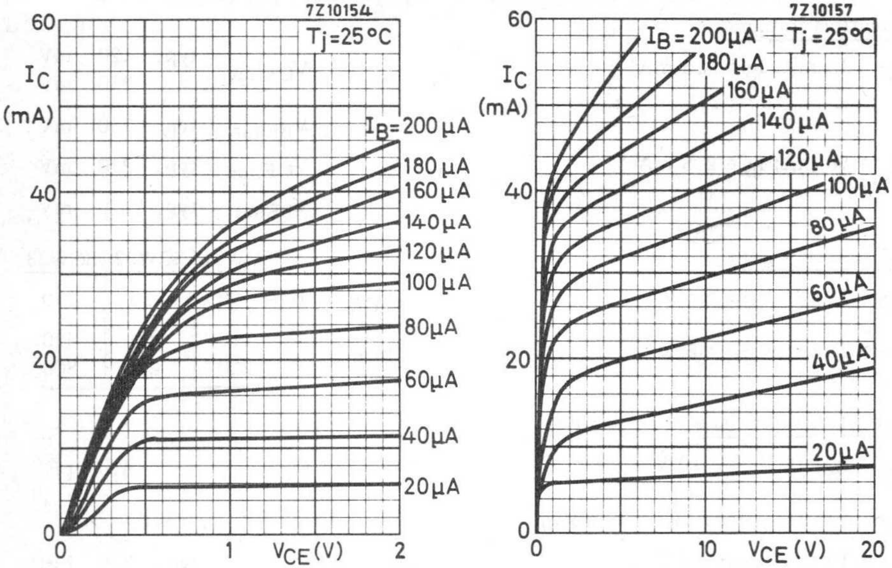
Noise figure at R_S = 2 kΩ

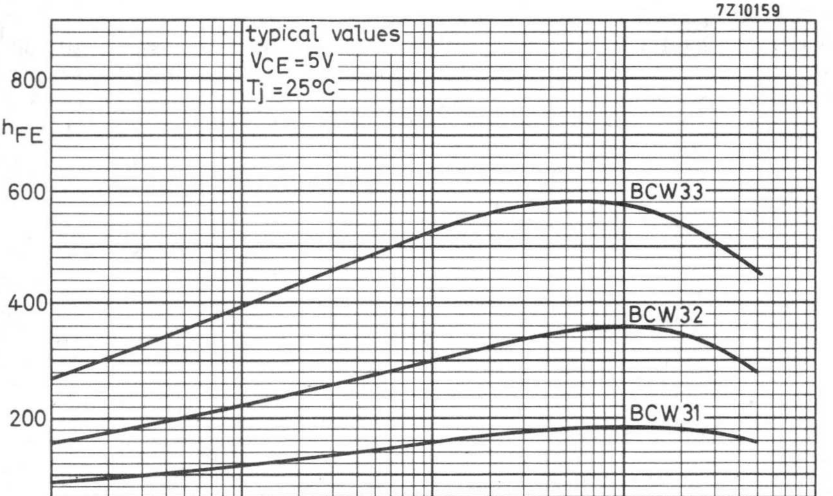
I_C = 200 μA; V_{CE} = 5 V f = 1 kHz; B = 200 Hz	F	<	10	dB 1)

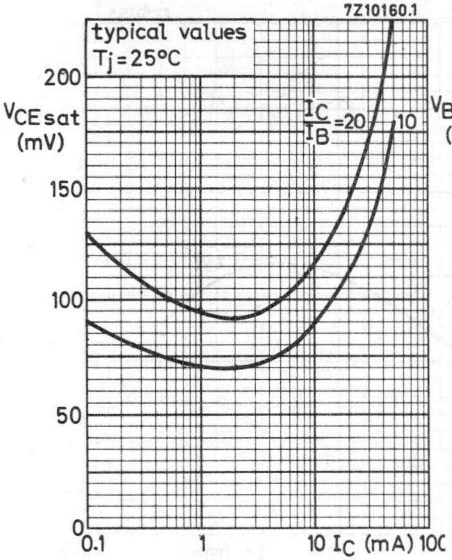
---

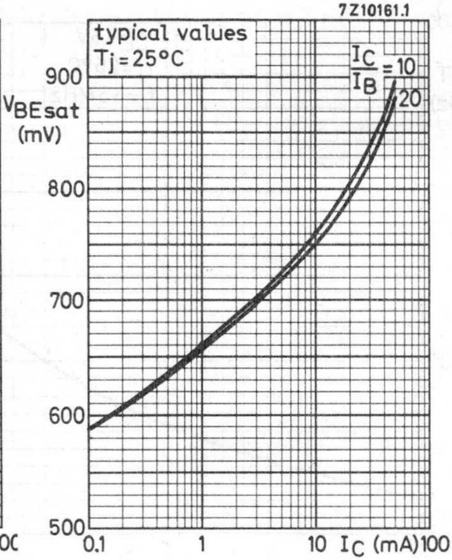
1) Crystal mounted in a BC107 envelope.

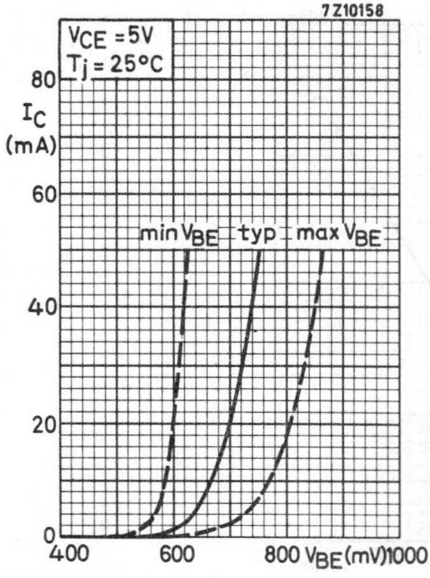
Typical behaviour of collector current versus collector-emitter voltage

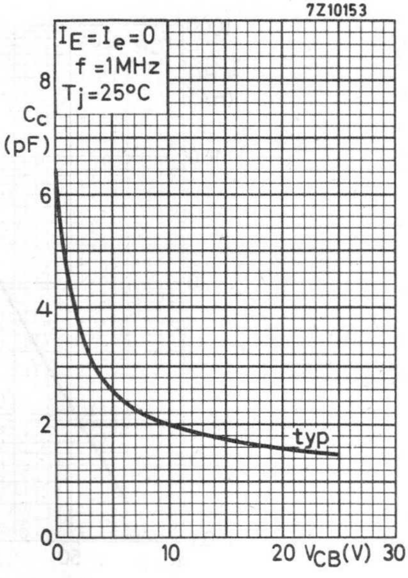


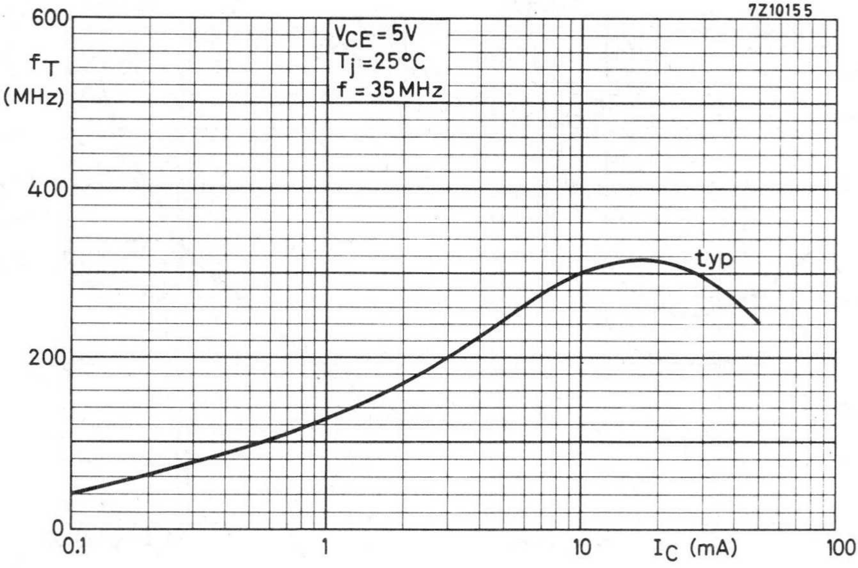


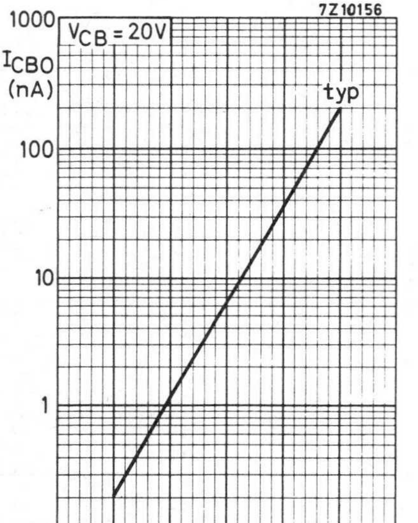

7Z10160.1
typical values
Tj=25°C
VCEsat
(mV)
IC/IB=20
10
200
150
100
50
0
0.1
1
10 IC (mA) 100


7Z10161.1
typical values
Tj=25°C
VBEsat
(mV)
IC/IB=10
20
900
800
700
600
500
0.1
1
10 IC (mA)100


7Z10158
VCE =5V
Tj = 25°C
IC
(mA)
min VBE
typ
max VBE
80
60
40
20
0
400
600
800 VBE(mV)1000


7Z10153
IE = Ie = 0
f =1MHz
Tj=25°C
Cc
(pF)
typ
8
6
4
2
0
0
10
20 VCB(V) 30


7Z10155
600
400
200
0
f_T
(MHz)
V_{CE} = 5V
T_j = 25 °C
f = 35 MHz
typ
0.1
1
10
I_C (mA)
100


7Z10156
1000
100
10
1
0.1
I_{CBO}
(nA)
V_{CB} = 20V
typ
0
50
100
T_j (°C)
150

A.F. SILICON PLANAR EPITAXIAL TRANSISTORS

P-N-P transistors in a micro miniature plastic envelope.
They are intended for low level general purpose applications in thick and thin film circuits.

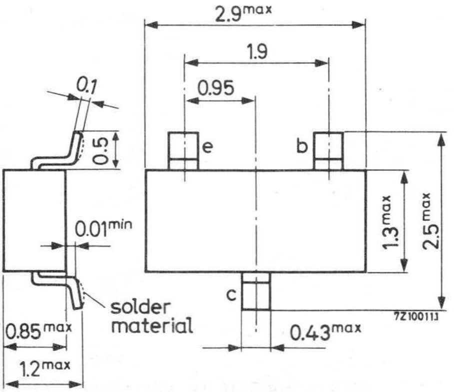
QUICK REFERENCE DATA

			BCW69	BCW70	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	50	50	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	45	45	V
Collector current (peak value)	$-I_{CM}$	max.	200	200	mA
Total power dissipation up to $T_{amb} = 25\ ^oC$	P_{tot}	max.	150	150	mW
Junction temperature	T_j	max.	125	125	^oC
D.C. current gain at $T_j = 25\ ^oC$ $-I_C = 2$ mA; $-V_{CE} = 5$ V	h_{FE}	$>$ $<$	120 260	215 500	
Transition frequency at f = 35 MHz $-I_C = 10$ mA; $-V_{CE} = 5$ V	f_T	typ.	150	150	MHz
Noise figure at $R_S = 2$ kΩ $-I_C = 200\ \mu A$; $-V_{CE} = 5$ V f = 1 kHz; B = 200 Hz	F	$<$	10	10	dB

MECHANICAL DATA

Dimensions in mm

Code:
BCW69 H1
BCW70 H2



RATINGS Limiting values in accordance with the Absolute Maximum System (IEC134)

Voltages

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	50	V
Collector-emitter voltage (V_{BE} = 0)	$-V_{CES}$	max.	50	V
Collector-emitter voltage (open base) $-I_C$ = 2 mA	$-V_{CEO}$	max.	45	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5	V

Currents

Collector current (d.c.)	$-I_C$	max.	50	mA
Collector current (peak value)	$-I_{CM}$	max.	200	mA

Power dissipation

Total power dissipation up to T_{amb} = 25 °C mounted on a ceramic substrate of 7 mm x 5 mm x 0.5 mm	P_{tot}	max.	150	mW

Temperatures

Storage temperature	T_{stg}	-65 to	+125	°C
Junction temperature	T_j	max.	125	°C [1]

THERMAL RESISTANCE

From junction to ambient

mounted on a glass substrate of 5 mm x 5 mm x 1 mm	$R_{th\ j-a}$	=	0.9	°C/mW
mounted on a ceramic substrate of 7 mm x 5 mm x 0.5 mm	$R_{th\ j-a}$	=	0.67	°C/mW

CHARACTERISTICS

Collector cut-off current

$I_E = 0$; $-V_{CB}$ = 20 V; T_j = 25 °C	$-I_{CBO}$	<	100	nA
T_j = 100 °C	$-I_{CBO}$	<	10	μA

Base-emitter voltage

$-I_C$ = 2 mA; $-V_{CE}$ = 5 V; T_j = 25 °C	$-V_{BE}$	600 to	750	mV

---

[1] For highly professional applications it is advisable not to exceed a maximum junction temperature of 100 °C.

CHARACTERISTICS (continued) $T_j = 25\ ^{o}C$ unless otherwise specified

Saturation voltages

$-I_C = 10$ mA; $-I_B = 0.5$ mA	$-V_{CEsat}$	typ.	80	mV
		<	300	mV
	$-V_{BEsat}$	typ.	720	mV
$-I_C = 50$ mA; $-I_B = 2.5$ mA	$-V_{CEsat}$	typ.	180	mV
	$-V_{BEsat}$	typ.	810	mV

D. C. current gain

			BCW69	BCW70
$-I_C = 10\ \mu A$; $-V_{CE} = 5$ V	h_{FE}	typ.	90	150
$-I_C = 2$ mA; $-V_{CE} = 5$ V	h_{FE}	>	120	215
		<	260	500

Collector capacitance at f = 1 MHz

$I_E = I_e = 0$; $-V_{CB} = 10$ V	C_c	<	7.0	pF

Transition frequency at f = 35 MHz

$-I_C = 10$ mA; $-V_{CE} = 5$ V	f_T	typ.	150	MHz

Noise figure at $R_S = 2\ k\Omega$

$-I_C = 200\ \mu A$; $-V_{CE} = 5$ V f = 1 kHz; B = 200 Hz	F	<	10	dB[1]

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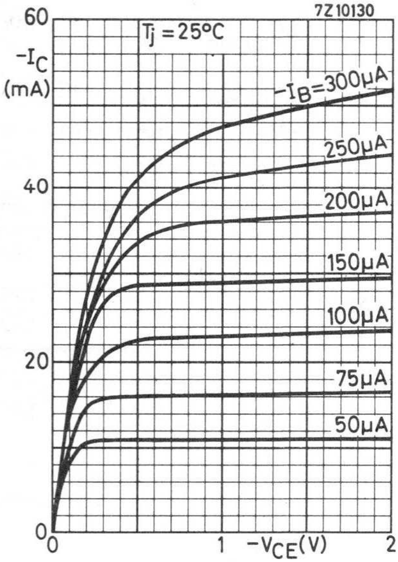
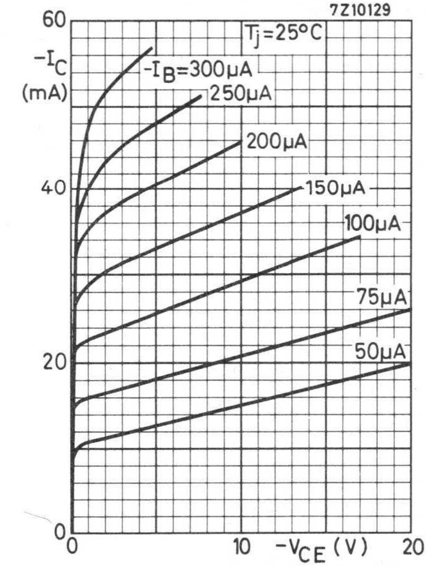
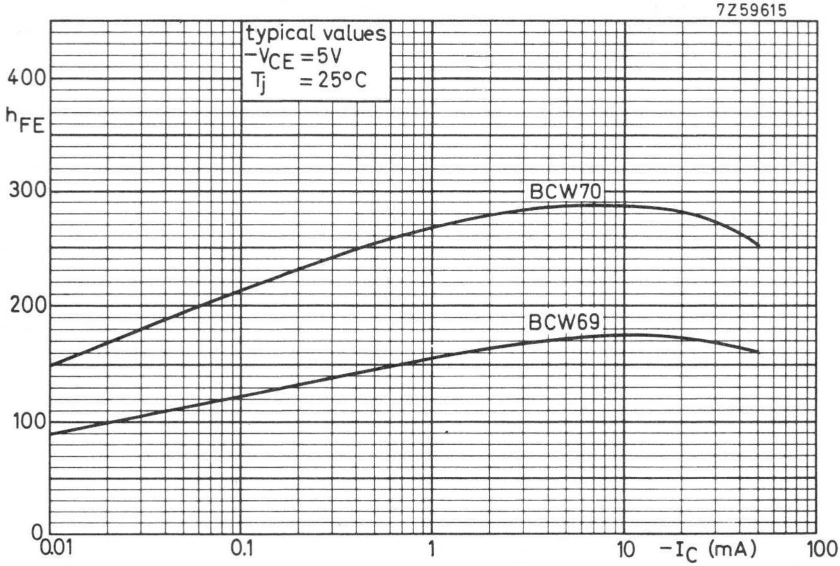
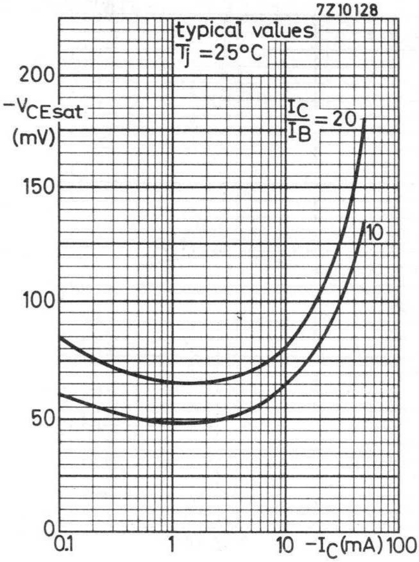
[1] Crystal mounted in a BC177 envelope.

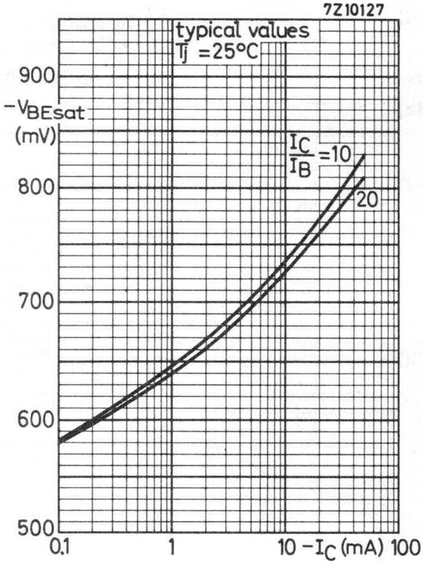
Typical behaviour of collector current versus collector-emitter voltage

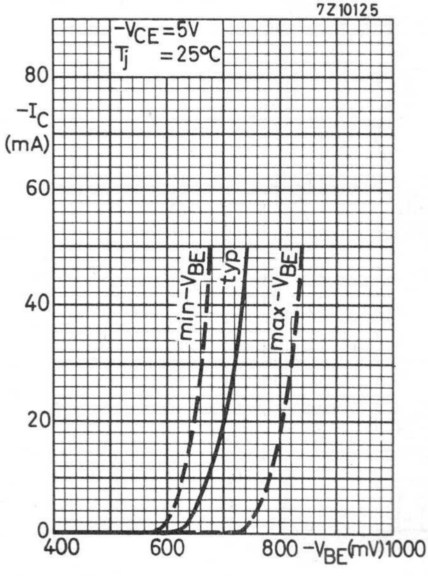


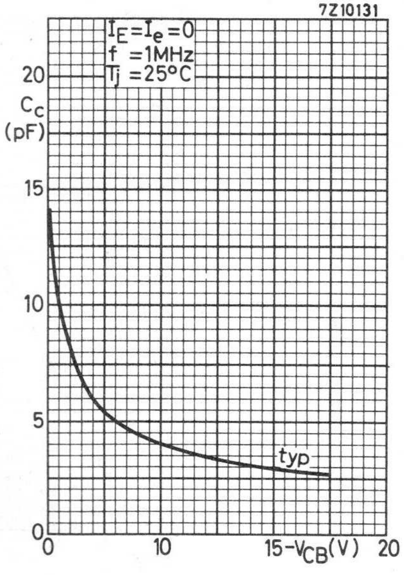


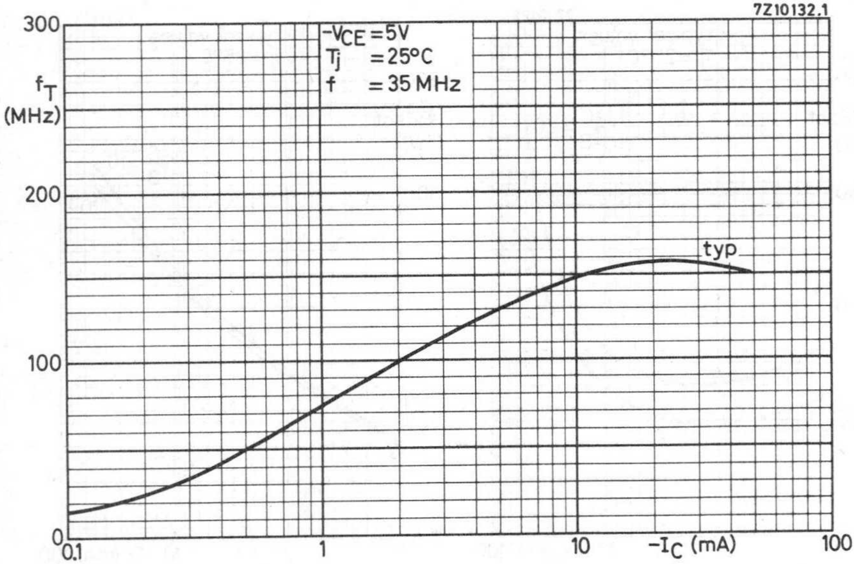


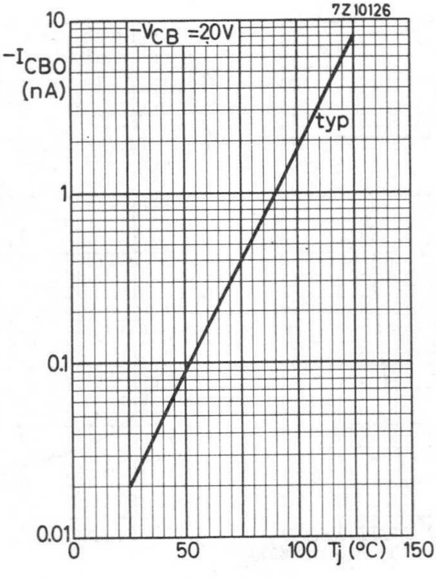

7Z10128
typical values
Tj = 25°C
$-V_{CEsat}$ (mV)
200
150
100
50
0
$\frac{I_C}{I_B}$ = 20
10
0.1
1
10
$-I_C$ (mA)
100


7Z10127
typical values
Tj = 25°C
$-V_{BEsat}$ (mV)
900
800
700
600
500
$\frac{I_C}{I_B}$ = 10
20
0.1
1
10
$-I_C$ (mA)
100


7Z10125
$-V_{CE}$ = 5V
Tj = 25°C
$-I_C$ (mA)
80
60
40
20
0
min $-V_{BE}$
typ
max $-V_{BE}$
400
600
800
$-V_{BE}$ (mV)
1000


7Z10131
$I_E = I_e = 0$
f = 1MHz
Tj = 25°C
C_c (pF)
20
15
10
5
0
typ
0
10
15
$-V_{CB}$ (V)
20


7Z10132.1
300
f_T
(MHz)
200
100
0
0.1
1
10
$-I_C$ (mA)
100
$-V_{CE}$ = 5V
T_j = 25°C
f = 35 MHz
typ


7Z10126
10
$-I_{CBO}$
(nA)
1
0.1
0.01
0
50
100
T_j (°C)
150
$-V_{CB}$ = 20V
typ

A.F. SILICON PLANAR EPITAXIAL TRANSISTORS

N-P-N transistors in a micro miniature plastic envelope.
They are intended for low level general purpose applications in thick and thin film circuits.

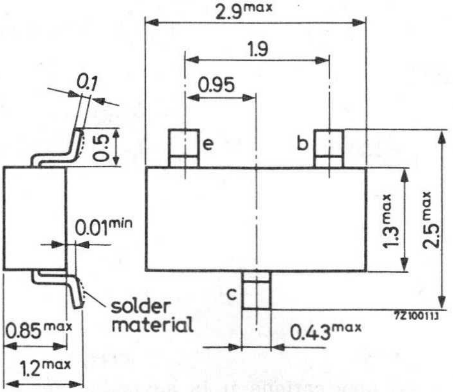
QUICK REFERENCE DATA

			BCW71	BCW72	
Collector-base voltage (open emitter)	V_{CBO}	max.	50	50	V
Collector-emitter voltage (open base)	V_{CEO}	max.	45	45	V
Collector current (peak value)	I_{CM}	max.	200	200	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	150	150	mW
Junction temperature	T_j	max.	125	125	°C
D.C. current gain at T_j = 25 °C I_C = 2 mA; V_{CE} = 5 V	h_{FE}	> <	110 220	200 450	
Transition frequency at f = 35 MHz I_C = 10 mA; V_{CE} = 5 V	f_T	typ.	300	300	MHz
Noise figure at R_S = 2 kΩ I_C = 200 μA; V_{CE} = 5 V f = 1 kHz; B = 200 Hz	F	<	10	10	dB

MECHANICAL DATA

Dimensions in mm

Code:
BCW71 K1
BCW72 K2



RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltages

Collector-base voltage (open emitter)	V_{CBO}	max.	50	V
Collector-emitter voltage (open base) I_C = 2 mA	V_{CEO}	max.	45	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	V

Currents

Collector current (d.c.)	I_C	max.	50	mA
Collector current (peak value)	I_{CM}	max.	200	mA

Power dissipation

Total power dissipation up to T_{amb} = 25 °C mounted on a ceramic substrate of 7 mm x 5 mm x 0.5 mm	P_{tot}	max.	150	mW

Temperatures

Storage temperature	T_{stg}	-65 to	+125	°C
Junction temperature	T_j	max.	125	°C [1]

THERMAL RESISTANCE

From junction to ambient

mounted on a glass substrate of 5 mm x 5 mm x 1 mm	$R_{th\ j-a}$	=	0.9	°C/mW
mounted on a ceramic substrate of 7 mm x 5 mm x 0.5 mm	$R_{th\ j-a}$	=	0.67	°C/mW

CHARACTERISTICS T_j = 25 °C unless otherwise specified

Collector cut-off current

$I_E = 0$; V_{CB} = 20 V	I_{CBO}	<	100	nA
$I_E = 0$; V_{CB} = 20 V; T_j = 100 °C	I_{CBO}	<	10	µA

Base emitter voltage

I_C = 2 mA; V_{CE} = 5 V	V_{BE}	550 to	700	mV

---

[1] For highly professional applications it is advisable not to exceed a maximum junction temperature of 100 °C.

CHARACTERISTICS (continued) T_j = 25 °C unless otherwise specified

Saturation voltages

I_C = 10 mA; I_B = 0.5 mA	V_{CEsat}	typ.	120	mV
		<	250	mV
	V_{BEsat}	typ.	750	mV
I_C = 50 mA; I_B = 2.5 mA	V_{CEsat}	typ.	230	mV
	V_{BEsat}	typ.	870	mV

D.C. current gain

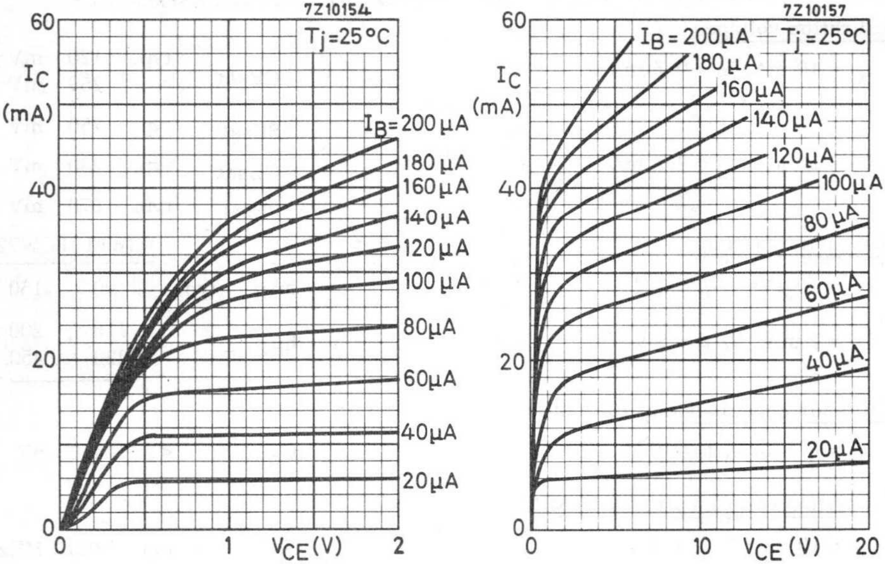
			BCW71	BCW72
I_C = 10 µA; V_{CE} = 5 V	h_{FE}	typ.	90	150
I_C = 2 mA; V_{CE} = 5 V	h_{FE}	>	110	200
		<	220	450

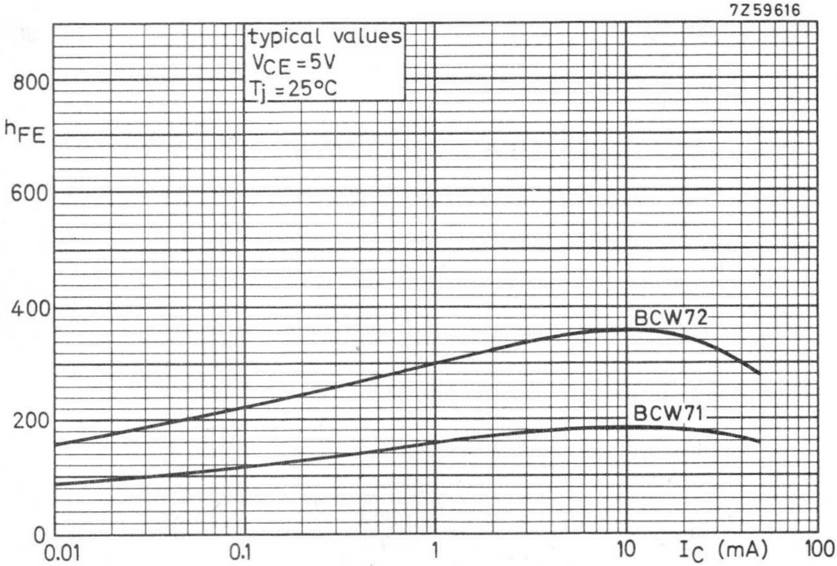
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; V_{CB} = 10 V	C_c	<	4.0	pF
Transition frequency at f = 35 MHz				
I_C = 10 mA; V_{CE} = 5 V	f_T	typ.	300	MHz
Noise figure at R_S = 2 kΩ				
I_C = 200 µA; V_{CE} = 5 V f = 1 kHz; B = 200 Hz	F	<	10	dB 1)

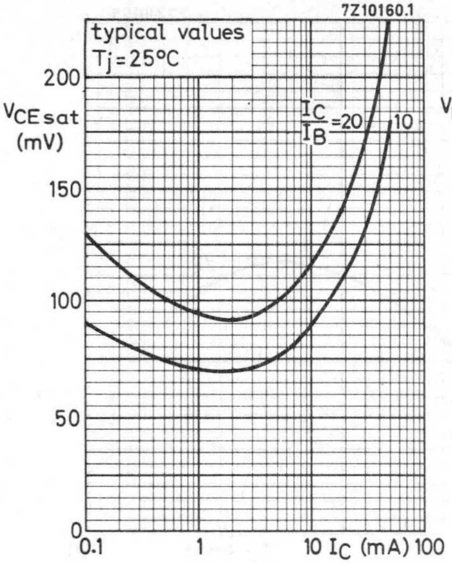
---

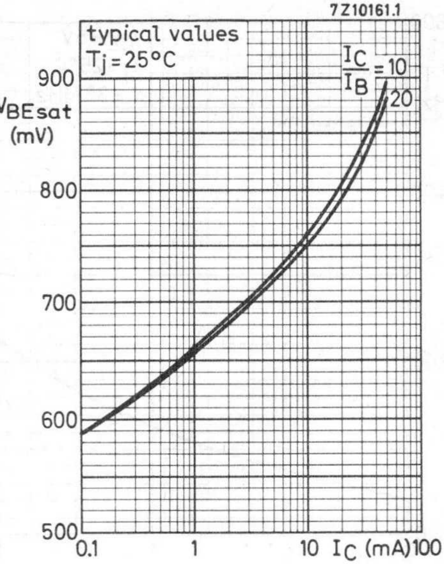
1) Crystal mounted in a BC107 envelope.

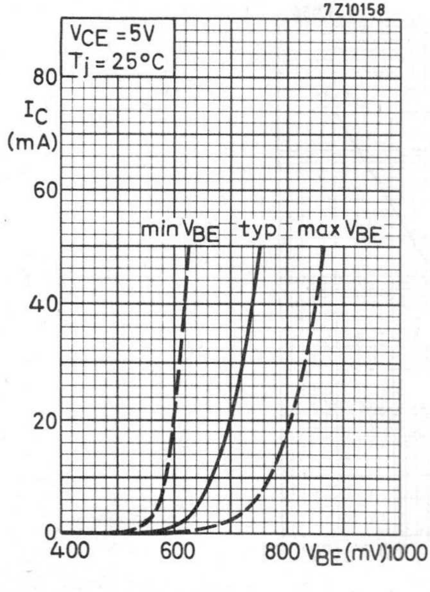
Typical behaviour of collector current versus collector-emitter voltage

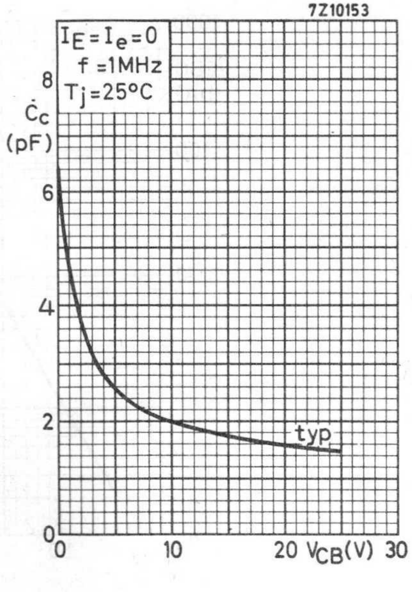


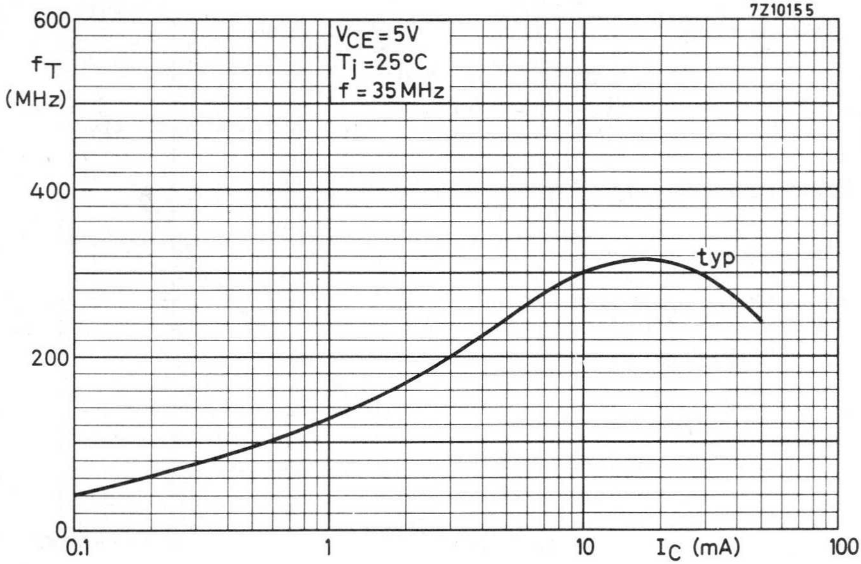


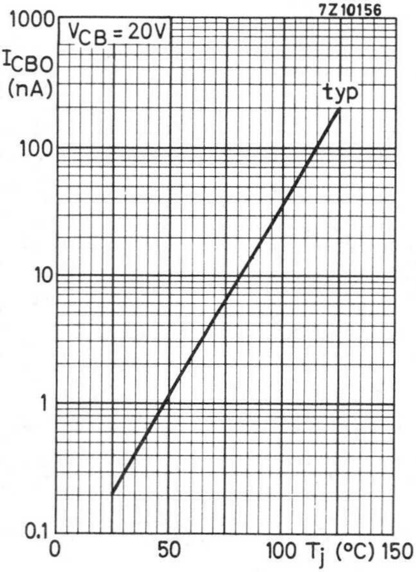

7Z10160.1
typical values
Tj = 25°C
VCEsat
(mV)
200
150
100
50
0
IC/IB = 20
10
0.1
1
10 IC (mA) 100


7Z10161.1
typical values
Tj = 25°C
IC/IB = 10
20
VBEsat
(mV)
900
800
700
600
500
0.1
1
10 IC (mA) 100


7Z10158
VCE = 5V
Tj = 25°C
IC
(mA)
80
60
40
20
0
min VBE
typ
max VBE
400
600
800 VBE (mV) 1000


7Z10153
IE = Ie = 0
f = 1MHz
Tj = 25°C
Cc
(pF)
8
6
4
2
0
typ
0
10
20 VCB (V) 30


7Z10155
600
f_T
(MHz)
400
200
0
V_{CE} = 5V
T_j = 25°C
f = 35 MHz
typ
0.1
1
10
I_C (mA)
100


7Z10156
1000
I_{CBO}
(nA)
100
10
1
0.1
V_{CB} = 20V
typ
0
50
100 T_j (°C) 150

N-CHANNEL SILICON FIELD EFFECT TRANSISTOR

Planar epitaxial junction field effect transistor in a micro miniature plastic envelope. It is intended for low level general purpose amplifiers in thick- and thin-film circuits.

QUICK REFERENCE DATA

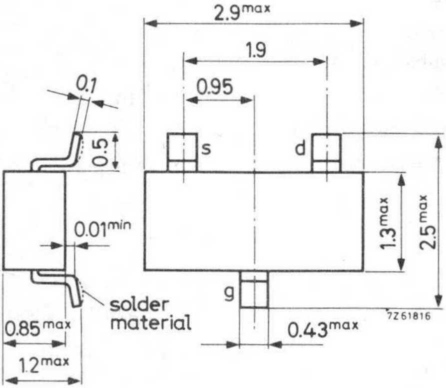
Drain-source voltage	$\pm V_{DS}$	max.	25		V
Gate-source voltage (open drain)	$-V_{GSO}$	max.	25		V
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	150		mW
Drain current			BFR30	BFR31	
V_{DS} = 10 V; V_{GS} = 0	I_{DSS}	>	4	1	mA
		<	10	5	mA
Transfer admittance (common source) I_D = 1 mA; V_{DS} = 10 V; f = 1 kHz	$\|y_{fs}\|$	>	1.0	1.5	mA/V
		<	4.0	4.5	mA/V

MECHANICAL DATA

Dimensions in mm

Code:

BFR30	M1
BFR31	M2



MOUNTING METHODS see page 4.

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltages

Drain-source voltage	$\pm V_{DS}$	max.	25	V
Drain-gate voltage (open source)	V_{DGO}	max.	25	V
Gate-source voltage (open drain)	$-V_{GSO}$	max.	25	V

Current

Drain current	I_D	max.	10	mA
Gate current	I_G	max.	5	mA

Power dissipation

Total power dissipation up to T_{amb} = 25 °C mounted on a ceramic substrate of 7 mm x 5 mm x 0.5 mm	P_{tot}	max.	150	mW

Temperatures

Storage temperature	T_{stg}	−65 to	+125	°C
Junction temperature	T_j	max.	125	°C [1]

THERMAL RESISTANCE

From junction to ambient

mounted on a glass substrate of 5 mm x 5 mm x 1 mm	$R_{th\ j\text{-}a}$	=	0.9	°C/mW
mounted on a ceramic substrate of 7 mm x 5 mm x 0.5 mm	$R_{th\ j\text{-}a}$	=	0.67	°C/mW

---

[1] For highly professional applications it is advisable not to exceed a maximum junction temperature of 100 °C.

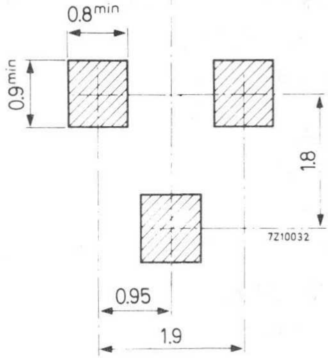
CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			BFR30	BFR31	
Gate cut-off current					
$-V_{GS}$ = 10 V; V_{DS} = 0	$-I_{GSS}$	<	0.2	0.2	nA
Drain current					
V_{DS} = 10 V; V_{GS} = 0	I_{DSS}	>	4	1	mA
		<	10	5	mA
Gate-source voltage					
I_D = 1 mA; V_{DS} = 10 V	$-V_{GS}$	>	0.7	0	V
		<	3.0	1.3	V
I_D = 50 μA; V_{DS} = 10 V	$-V_{GS}$	<	4.0	2.0	V
Gate-source cut-off voltage					
I_D = 0.5 nA; V_{DS} = 10 V	$-V_{(P)GS}$	<	5	2.5	V
y parameters					
Transfer admittance at f = 1 kHz; T_{amb} = 25 °C					
I_D = 1 mA; V_{DS} = 10 V	$\|y_{fs}\|$	>	1.0	1.5	mA/V
		<	4.0	4.5	mA/V
I_D = 200 μA; V_{DS} = 10 V	$\|y_{fs}\|$	>	0.5	0.75	mA/V
Output admittance at f = 1 kHz					
I_D = 1 mA; V_{DS} = 10 V	$\|y_{os}\|$	<	40	25	μA/V
I_D = 200 μA; V_{DS} = 10 V	$\|y_{os}\|$	<	20	15	μA/V
Input capacitance at f = 1 MHz					
I_D = 1 mA; V_{DS} = 10 V	C_{is}	<	4	4	pF
I_D = 200 μA; V_{DS} = 10 V	C_{is}	<	4	4	pF
Feedback capacitance at f = 1 MHz; T_{amb} = 25 °C					
I_D = 1 mA; V_{DS} = 10 V	C_{rs}	<	1.5	1.5	pF
I_D = 200 μA; V_{DS} = 10 V	C_{rs}	<	1.5	1.5	pF
Equivalent noise voltage					
I_D = 200 μA; V_{DS} = 10 V B = 0.6 to 100 Hz	V_n	<	0.5	0.5	μV

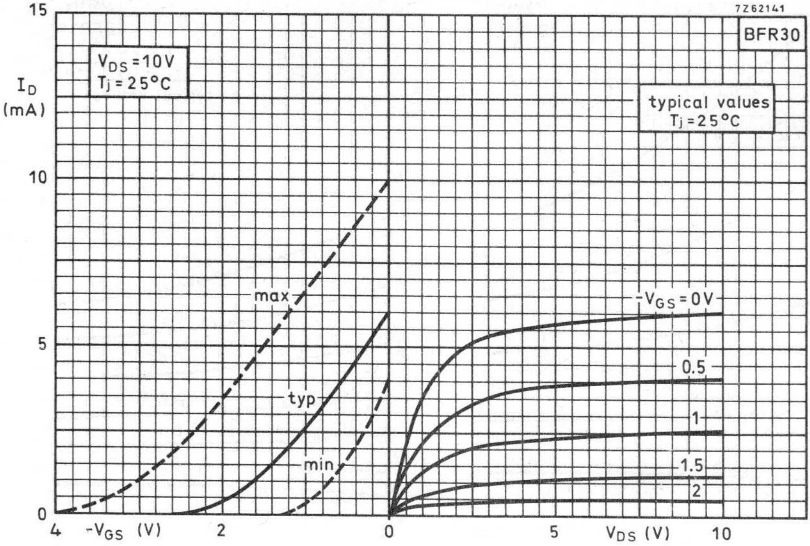
MOUNTING METHODS

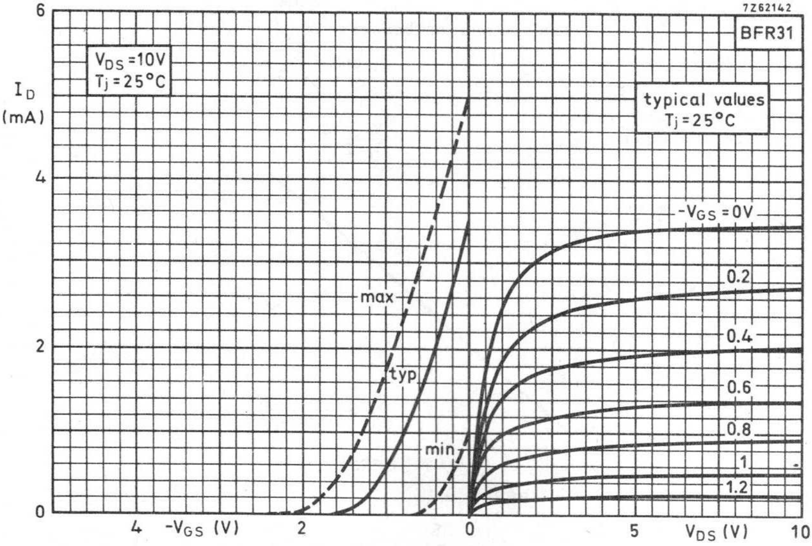
Minimum required dimensions of metal connection pads on thick- and thin-film substrates.

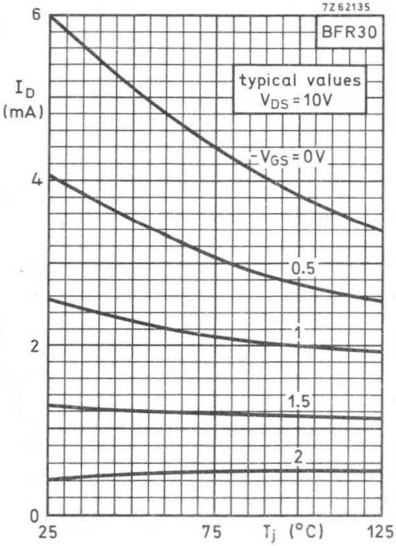


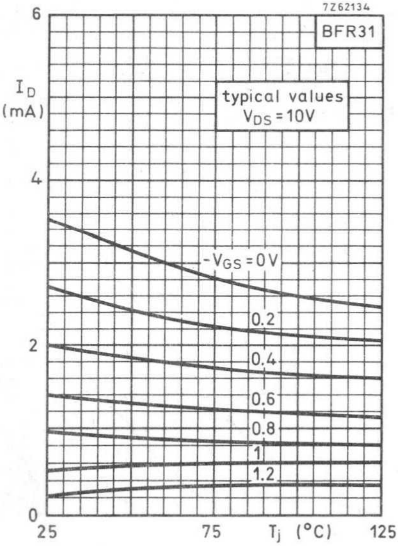
Soldering

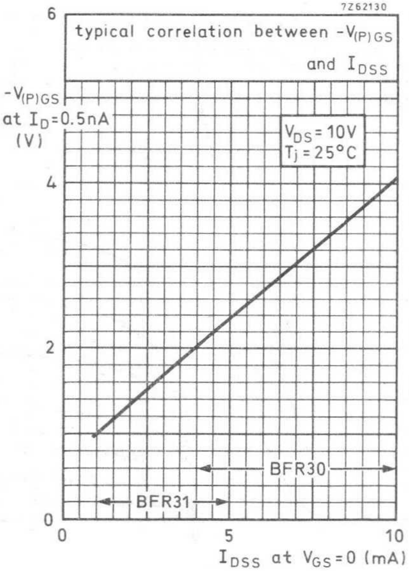
The leads are covered with a solder material of which the melting point is 185 °C. At a maximum lead temperature of 250 °C, the maximum permissible soldering time is 10 s.
The maximum temperature gradient is 25 °C/s.

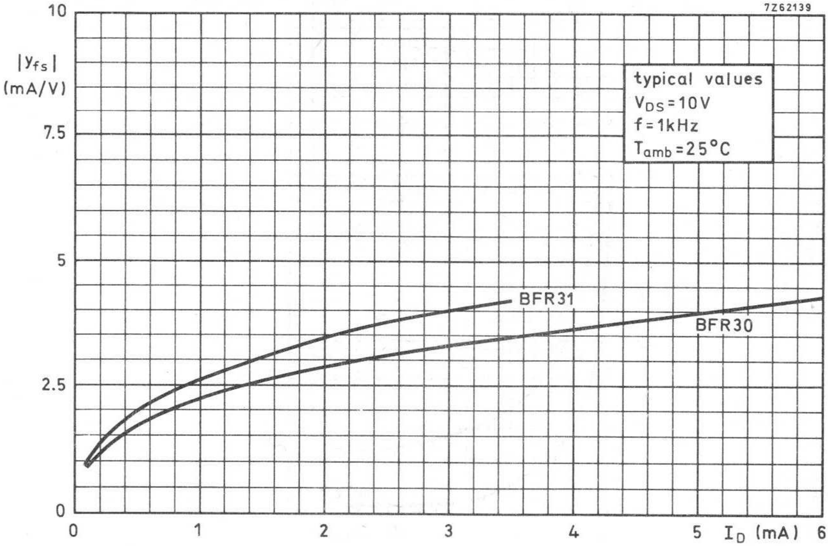

7Z62141
BFR30
V_{DS} = 10 V
T_j = 25 °C
I_D (mA)
15
10
5
0
typical values
T_j = 25 °C
max
typ
min
$-V_{GS}$ = 0 V
0.5
1
1.5
2
4
$-V_{GS}$ (V)
2
0
5
V_{DS} (V)
10

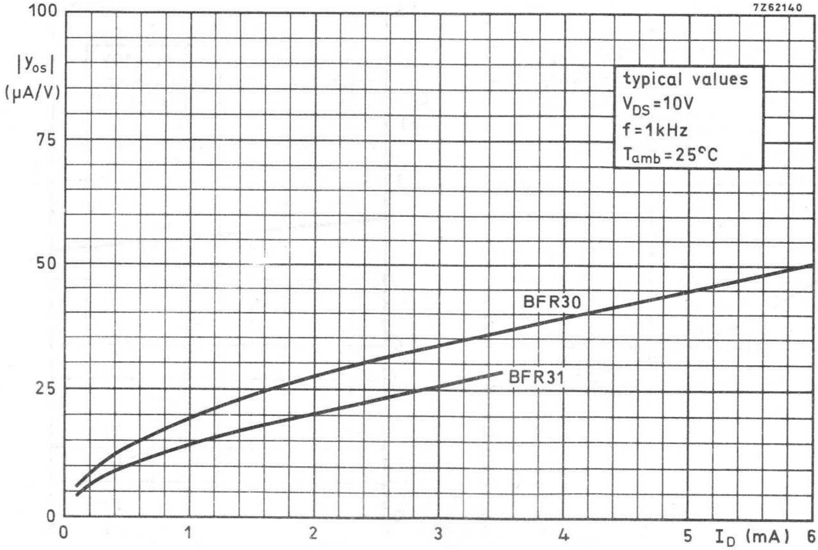

7Z62142
BFR31
V_{DS} = 10 V
T_j = 25 °C
I_D (mA)
6
4
2
0
typical values
T_j = 25 °C
max
typ
min
$-V_{GS}$ = 0 V
0.2
0.4
0.6
0.8
1
1.2
4
$-V_{GS}$ (V)
2
0
5
V_{DS} (V)
10

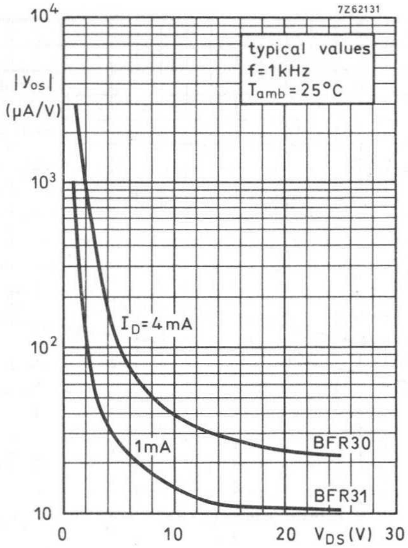

7Z62135
BFR30
typical values
V_{DS} = 10V
I_D
(mA)
$-V_{GS}$ = 0V
0.5
1
1.5
2
6
4
2
0
25
75
T_j (°C)
125

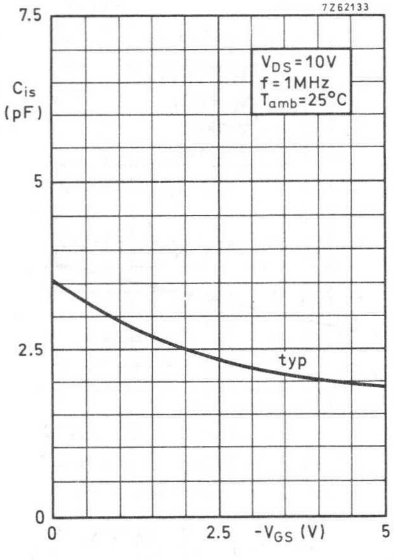

7Z62134
BFR31
typical values
V_{DS} = 10V
I_D
(mA)
$-V_{GS}$ = 0V
0.2
0.4
0.6
0.8
1
1.2
6
4
2
0
25
75
T_j (°C)
125

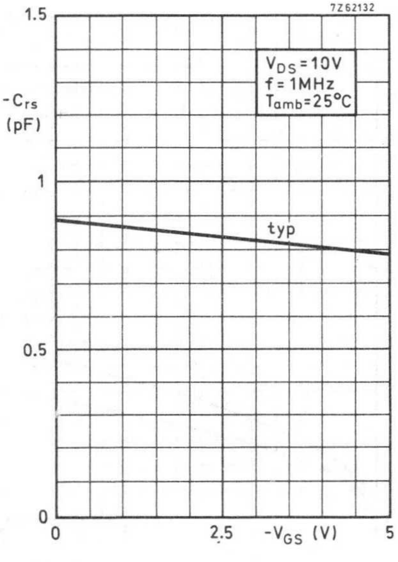

7Z62130
typical correlation between $-V_{(P)GS}$ and I_{DSS}
$-V_{(P)GS}$
at I_D = 0.5nA
(V)
V_{DS} = 10V
T_j = 25°C
BFR30
BFR31
6
4
2
0
0
5
10
I_{DSS} at V_{GS} = 0 (mA)

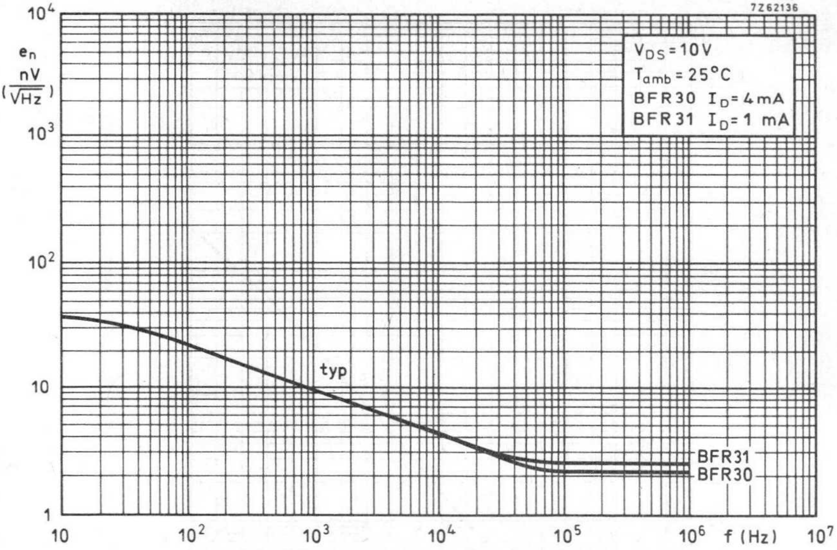

7Z62139
|yfs|
(mA/V)
10
7.5
5
2.5
0
0
1
2
3
4
5
ID (mA)
6
typical values
VDS = 10 V
f = 1 kHz
Tamb = 25 °C
BFR31
BFR30

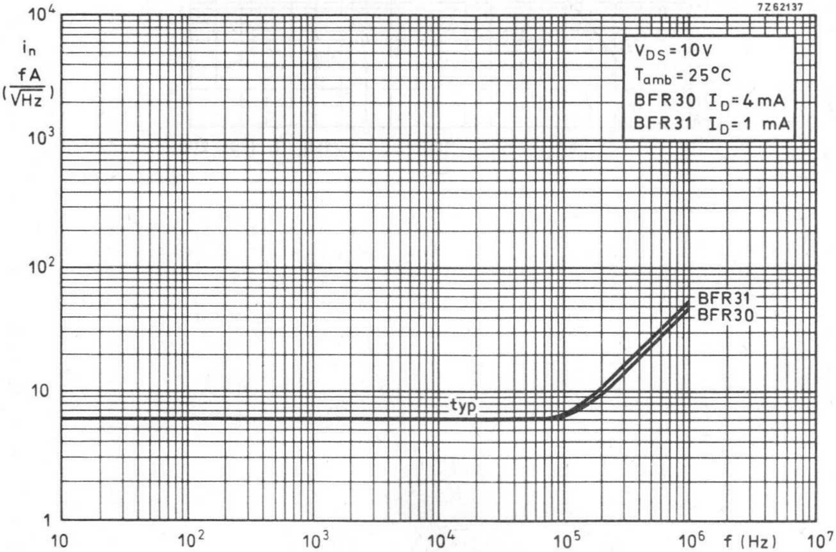

7Z62140
|yos|
(μA/V)
100
75
50
25
0
0
1
2
3
4
5
ID (mA)
6
typical values
VDS = 10 V
f = 1 kHz
Tamb = 25 °C
BFR30
BFR31

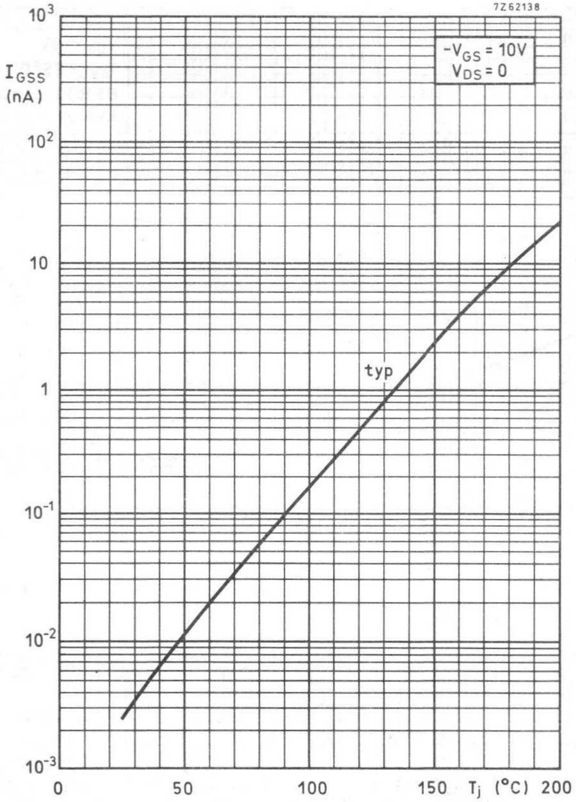

7Z62131
10^4
10^3
10^2
10
$|y_{os}|$
(μA/V)
typical values
f = 1 kHz
T_{amb} = 25 °C
I_D = 4 mA
1 mA
BFR30
BFR31
0
10
20
V_{DS} (V)
30


7Z62133
7.5
5
2.5
0
C_{is}
(pF)
V_{DS} = 10 V
f = 1 MHz
T_{amb} = 25 °C
typ
0
2.5
$-V_{GS}$ (V)
5


7Z62132
1.5
1
0.5
0
$-C_{rs}$
(pF)
V_{DS} = 10 V
f = 1 MHz
T_{amb} = 25 °C
typ
0
2.5
$-V_{GS}$ (V)
5


7Z62136
e_n
$(\frac{nV}{\sqrt{Hz}})$
10^4
10^3
10^2
10
1
10
10^2
10^3
10^4
10^5
10^6
f (Hz)
10^7
V_{DS} = 10 V
T_{amb} = 25 °C
BFR30 I_D = 4 mA
BFR31 I_D = 1 mA
typ
BFR31
BFR30


7Z62137
i_n
$(\frac{fA}{\sqrt{Hz}})$
10^4
10^3
10^2
10
1
10
10^2
10^3
10^4
10^5
10^6
f (Hz)
10^7
V_{DS} = 10 V
T_{amb} = 25 °C
BFR30 I_D = 4 mA
BFR31 I_D = 1 mA
typ
BFR31
BFR30


7Z62138
I_{GSS}
(nA)
10^3
10^2
10
1
10^{-1}
10^{-2}
10^{-3}
$-V_{GS} = 10V$
$V_{DS} = 0$
typ
0
50
100
150
T_j (°C)
200

SILICON PLANAR EPITAXIAL TRANSISTOR

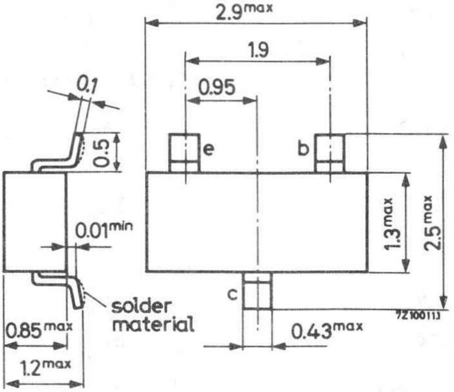
N-P-N transistor in a micro miniature plastic envelope.
It is intended for a wide range of v.h.f. and u.h.f. applications in thick and thin film circuits.

QUICK REFERENCE DATA

Collector-base voltage (open emitter; peak value)	V_{CBOM}	max.	25	V
Collector-emitter voltage (open base)	V_{CEO}	max.	15	V
Collector current (peak value)	I_{CM}	max.	50	mA
Total power dissipation up to $T_{amb} = 25\ ^oC$	P_{tot}	max.	**150**	mW
Junction temperature	T_j	max.	125	^oC
D.C. current gain $I_C = 2$ mA; $V_{CE} = 1$ V	h_{FE}		20 to 150	
Transition frequency $I_C = 25$ mA; $V_{CE} = 5$ V; f = 500 MHz	f_T	typ.	1.3	GHz
Noise figure $I_C = 2$ mA; $V_{CE} = 5$ V $R_S = 50\ \Omega$; f = 500 MHz	F	typ.	4.5	dB

MECHANICAL DATA Dimensions in mm

Code: E1



RATINGS Limiting values in accordance with the Absolute Maximum System (IEC134)

Voltages

Collector-base voltage (open emitter; peak value)	V_{CBOM}	max.	25	V
Collector-emitter voltage (open base) I_C = 10 mA	V_{CEO}	max.	15	V
Emitter-base voltage (open collector)	V_{EBO}	max.	2.5	V

Currents

Collector current (d.c.)	I_C	max.	25	mA
Collector current (peak value)	I_{CM}	max.	50	mA

Power dissipation

Total power dissipation up to T_{amb} = 25 °C mounted on a **ceramic substrate of 7 mm x 5 mm x 0.5 mm**	P_{tot}	max.	**150**	mW

Temperatures

Storage temperature	T_{stg}		-65 to +125	°C
Junction temperature	T_j	max.	125	°C 1)

THERMAL RESISTANCE

From junction to ambient mounted on a glass substrate of 5 mm x 5 mm x 1 mm	$R_{th\ j-a}$	=	0.9	°C/mW
mounted on a **ceramic substrate of 7 mm x 5 mm x 0.5 mm**	$R_{th\ j-a}$	=	**0.67**	°C/mW

CHARACTERISTICS T_j = 25 °C unless otherwise specified

Collector cut-off current

$I_E = 0$; V_{CB} = 10 V	I_{CBO}	<	10	nA
$I_E = 0$; V_{CB} = 10 V; T_j = 100 °C	I_{CBO}	<	10	μA

D.C. current gain

I_C = 2 mA; V_{CE} = 1 V	h_{FE}	20 to	150	
I_C = 25 mA; V_{CE} = 1 V	h_{FE}	>	20	

---

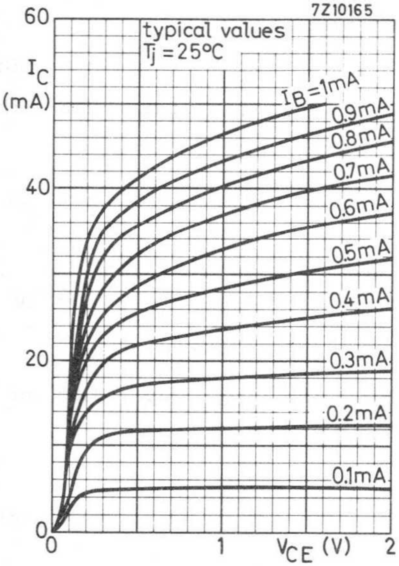
1) For highly professional applications it is advisable not to exceed a maximum junction temperature of 100 °C.

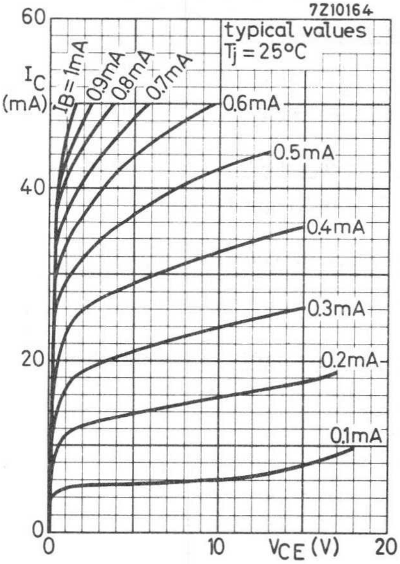
CHARACTERISTICS (continued) T_j = 25 °C unless otherwise specified

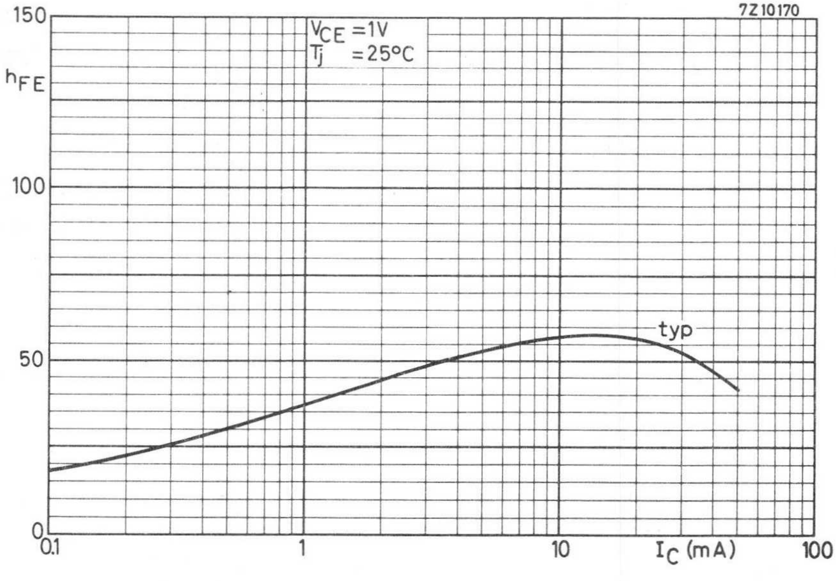
Transition frequency				
I_C = 2 mA; V_{CE} = 5 V; f = 500 MHz	f_T	typ.	1.0	GHz
I_C = 25 mA; V_{CE} = 5 V; f = 500 MHz	f_T	typ.	1.3	GHz
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; V_{CB} = 10 V	C_c	<	1.5	pF
Emitter capacitance at f = 1 MHz				
$I_C = I_c = 0$; V_{EB} = 0.5 V	C_e	<	2.0	pF
Feedback capacitance at f = 1 MHz				
I_C = 2 mA; V_{CE} = 5 V	$-C_{re}$	typ.	0.65	pF
Noise figure				
I_C = 2 mA; V_{CE} = 5 V f = 500 MHz; R_S = 50 Ω	F	typ.	4.5	dB[1]
Intermodulation distortion				
I_C = 10 mA; V_{CE} = 6 V; R_L = 37.5 Ω; T_{amb} = 25 °C V_o = 100 mV at f_p = 183 MHz V_o = 100 mV at f_q = 200 MHz measured at $f_{(2q-p)}$ = 217 MHz	d_{im}	typ.	-45	dB

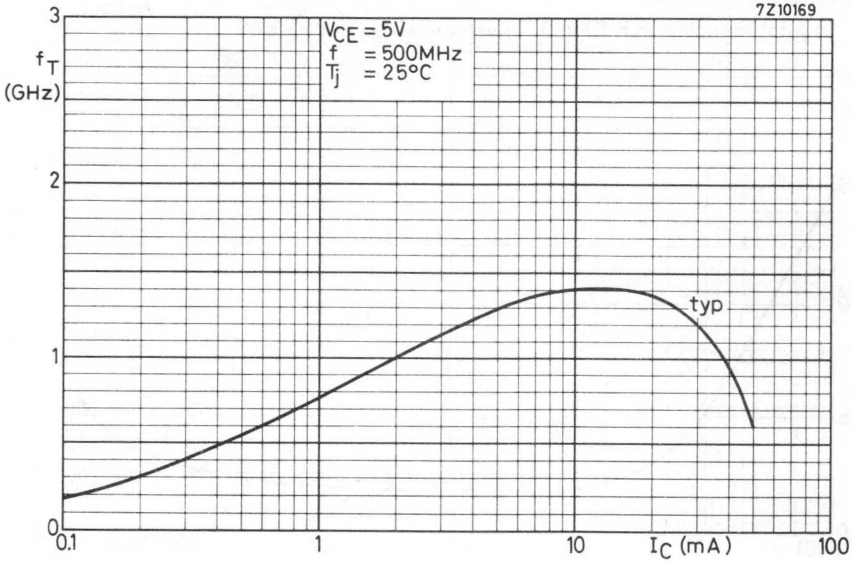
---

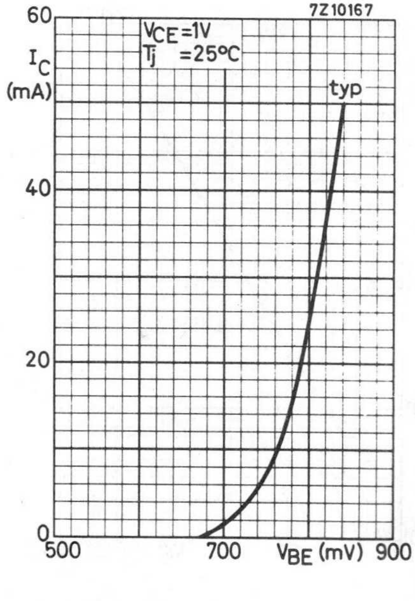
[1] Crystal mounted in a BFY90 envelope.

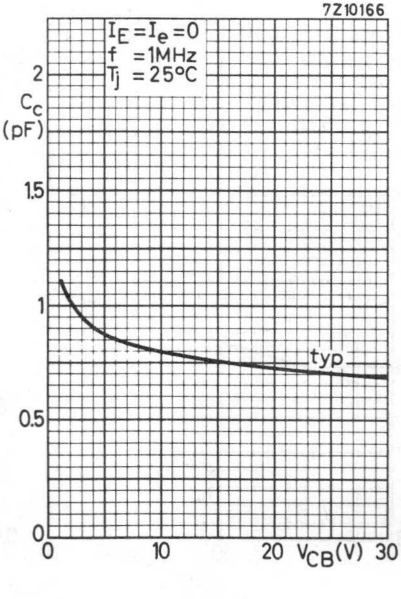

7Z10165
typical values
Tj = 25°C
IC (mA)
60
40
20
0
IB=1mA
0.9mA
0.8mA
0.7mA
0.6mA
0.5mA
0.4mA
0.3mA
0.2mA
0.1mA
0
1
VCE (V)
2

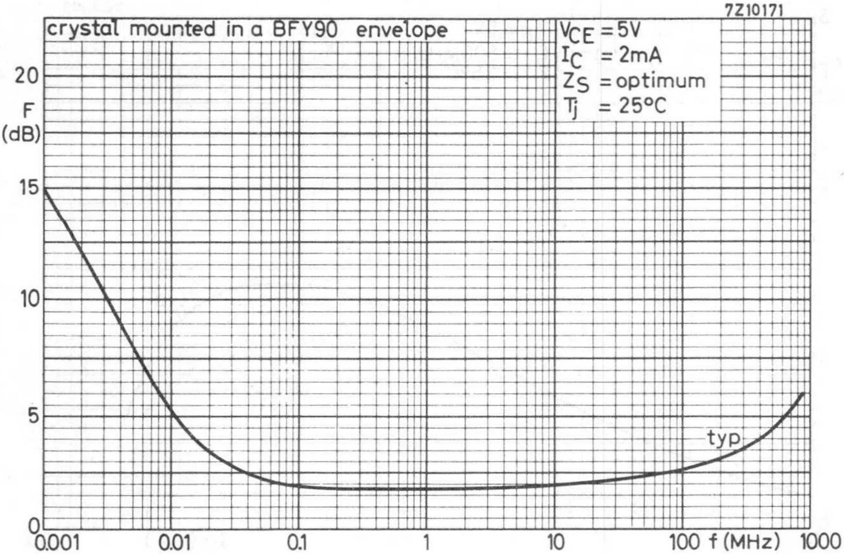

7Z10164
typical values
Tj = 25°C
IC (mA)
60
40
20
0
IB=1mA
0.9mA
0.8mA
0.7mA
0.6mA
0.5mA
0.4mA
0.3mA
0.2mA
0.1mA
0
10
VCE (V)
20

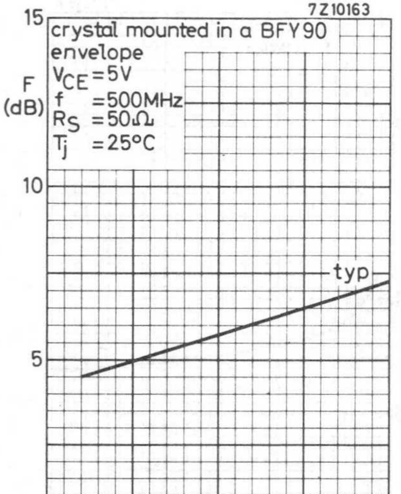

7Z10170
VCE = 1V
Tj = 25°C
hFE
150
100
50
0
typ
0.1
1
10
IC (mA)
100

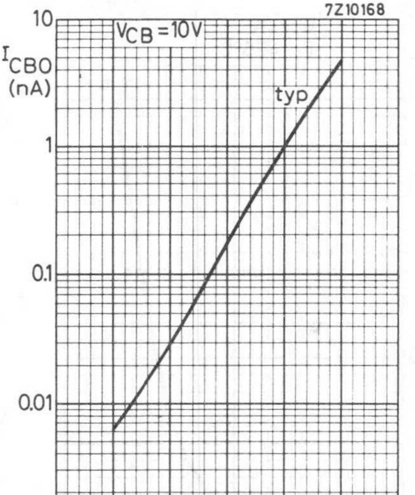

7Z10169
V_{CE} = 5V
f = 500MHz
T_j = 25°C
f_T
(GHz)
3
2
1
0
0.1
1
10
100
I_C (mA)
typ


7Z10167
V_{CE} =1V
T_j =25°C
I_C
(mA)
60
40
20
0
500
700
900
V_{BE} (mV)
typ


7Z10166
$I_E = I_e = 0$
f = 1MHz
T_j = 25°C
C_c
(pF)
2
1.5
1
0.5
0
10
20
30
V_{CB}(V)
typ


7Z10171
crystal mounted in a BFY90 envelope
V_{CE} = 5V
I_C = 2mA
Z_S = optimum
T_j = 25°C
F (dB)
20
15
10
5
0
typ
0.001
0.01
0.1
1
10
100
f (MHz)
1000


7Z10163
crystal mounted in a BFY90 envelope
V_{CE}=5V
f =500MHz
R_S =50Ω
T_j =25°C
F (dB)
15
10
5
0
typ
0
10
I_C(mA)
20


7Z10168
V_{CB}=10V
I_{CBO} (nA)
10
1
0.1
0.01
0.001
typ
0
50
100
T_j(°C)
150

SILICON PLANAR EPITAXIAL TRANSISTORS

N-P-N transistors in a micro miniature plastic envelope.
They are intended for general purpose and h.f. applications in thick and thin film circuits.

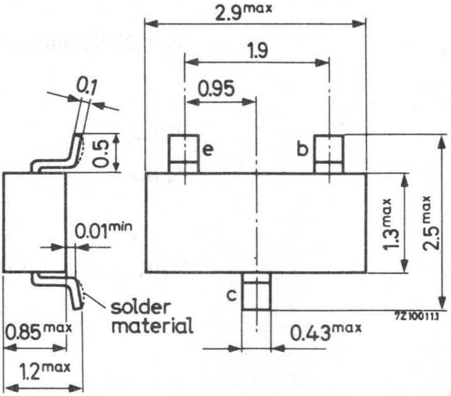
QUICK REFERENCE DATA

Collector-base voltage (open emitter)	V_{CBO}	max.	30		V
Collector-emitter voltage (open base)	V_{CEO}	max.	20		V
Collector current (d.c.)	I_C	max.	30		mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	150		mW
Junction temperature	T_j	max.	125		°C
D.C. current gain			BFS18	BFS19	
I_C = 1 mA; V_{CE} = 10 V	h_{FE}		35 to 125	65 to 225	
Transition frequency at f = 100 MHz					
I_C = 1 mA; V_{CE} = 10 V	f_T	typ.	200	260	MHz
Noise figure at f = 100 MHz					
I_C = 1 mA; V_{CE} = 10 V; G_S = 10 mΩ^{-1}	F	typ.	4		dB

MECHANICAL DATA

Dimensions in mm

Code:
BFS18 F1
BFS19 F2



RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltages

Collector-base voltage (open emitter)	V_{CBO}	max.	30	V
Collector-emitter voltage (open base) I_C = 2 mA	V_{CEO}	max.	20	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	V

Currents

Collector current (d.c.)	I_C	max.	30	mA
Colector current (peak value)	I_{CM}	max.	30	mA

Power dissipation

Total power dissipation up to T_{amb} = 25 °C mounted on a **ceramic substrate of 7 mm x 5 mm x 0.5 mm**	P_{tot}	max.	**150**	mW

Temperatures

Storage temperature	T_{stg}		-65 to +125	°C
Junction temperature	T_j	max.	125	°C [1]

THERMAL RESISTANCE

From junction to ambient mounted on a glass substrate of 5 mm x 5 mm x 1 mm	$R_{th\ j-a}$	=	0.9	°C/mW
mounted on a **ceramic substrate of 7 mm x 5 mm x 0.5 mm**	$R_{th\ j-a}$	=	**0.67**	°C/mW

CHARACTERISTICS T_j = 25 °C unless otherwise specified

Collector cut-off current

I_E = 0; V_{CB} = 20 V	I_{CBO}	<	100	nA
I_E = 0; V_{CB} = 20 V; T_j = 100 °C	I_{CBO}	<	10	μA

Base-emitter voltage

I_C = 1 mA; V_{CE} = 10 V	V_{BE}	0.65 to 0.74	V

---

1) For highly professional applications it is advisable not to exceed a maximum junction temperature of 100 °C.

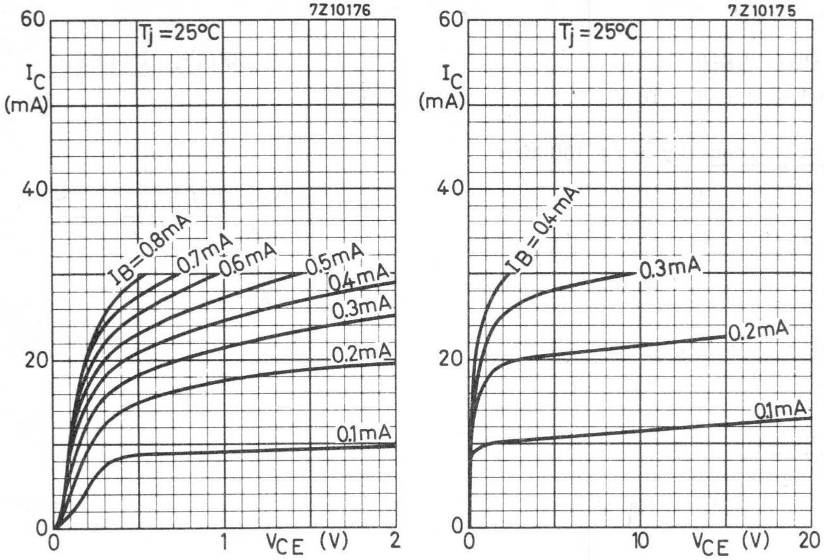
CHARACTERISTICS (continued) T_j = 25 °C unless otherwise specified

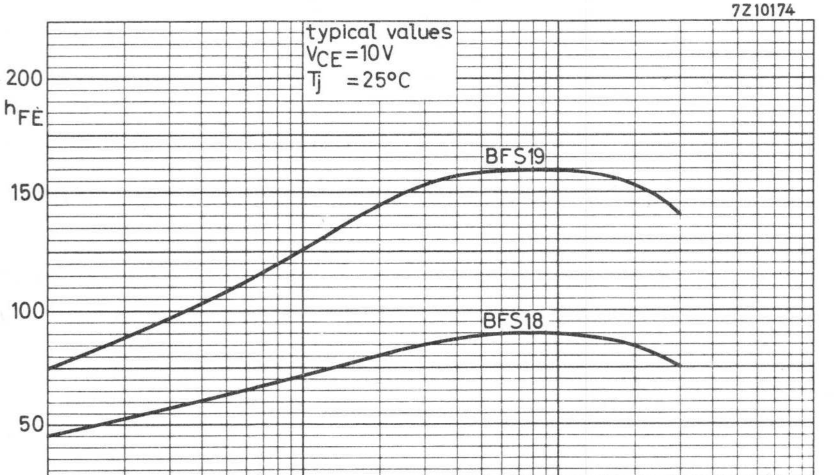
			BFS18	BFS19	
D.C. current gain					
I_C = 1 mA; V_{CE} = 10 V	h_{FE}		35 to 125	65 to 225	
Transition frequency at f = 100 MHz					
I_C = 1 mA; V_{CE} = 10 V	f_T	typ.	200	260	MHz
Collector capacitance at f = 1 MHz					
$I_E = I_e = 0$; V_{CB} = 10 V	C_c	typ.	1		pF
Feedback capacitance at f = 1 MHz					
I_C = 1 mA; V_{CE} = 10 V	$-C_{re}$	typ.	0.85		pF
Noise figure					
I_C = 1 mA; V_{CE} = 10 V G_S = 10 mΩ^{-1}; f = 100 MHz	F	typ.	4		dB 1)

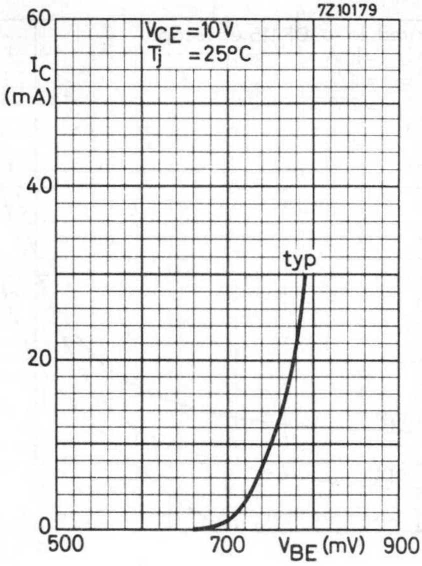
---

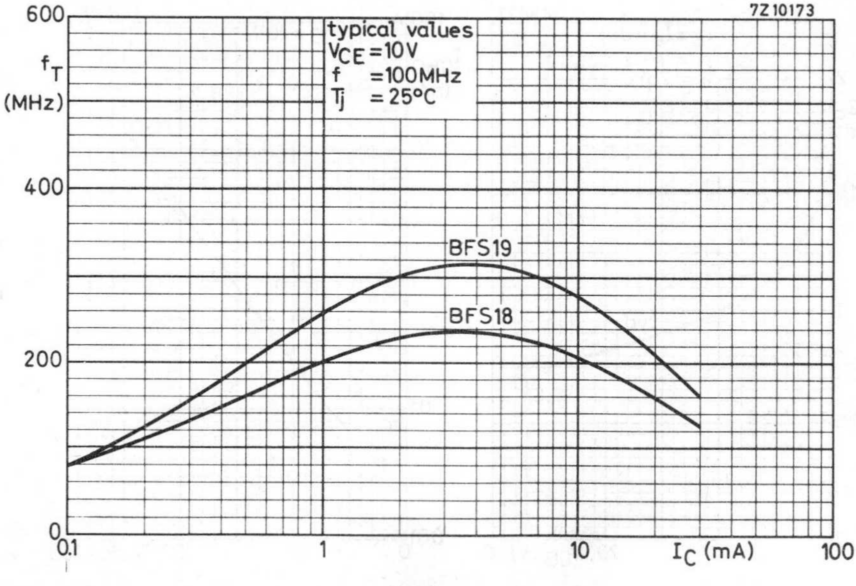
1) Crystal mounted in a BF115 envelope.

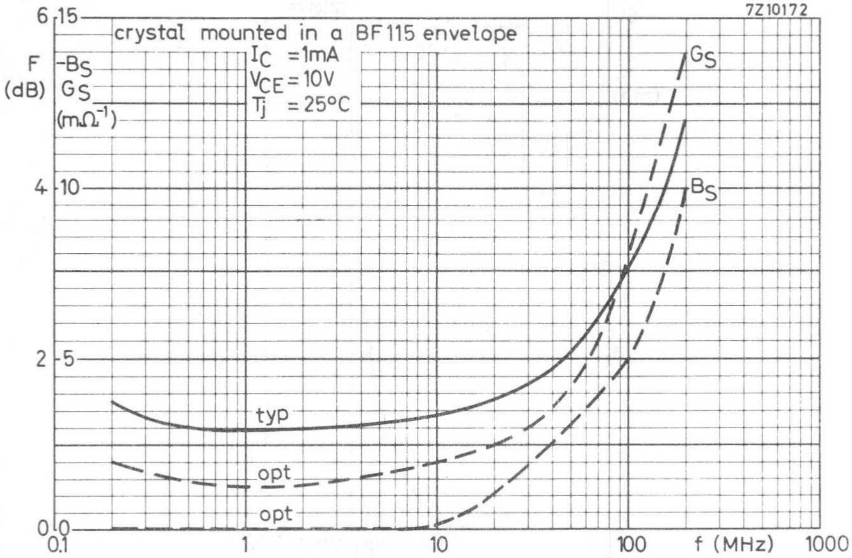
Typical behaviour of collector current versus collector-emitter voltage

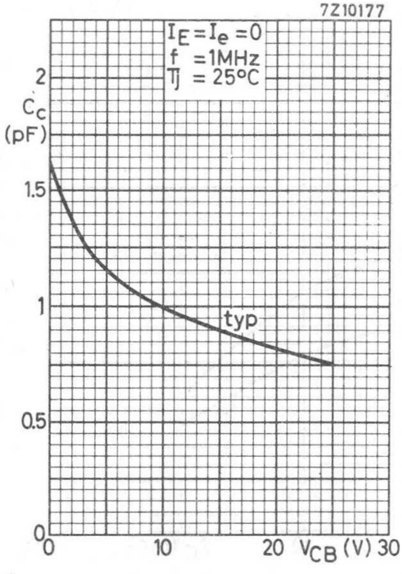


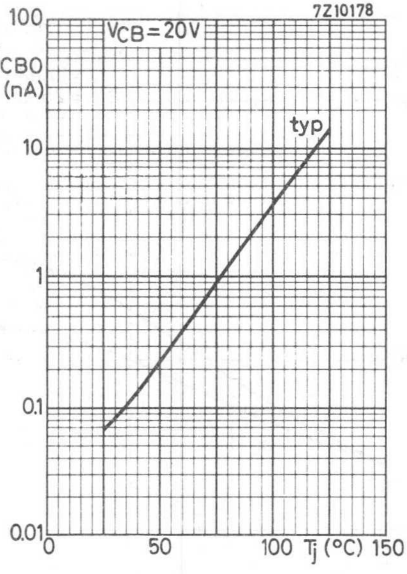



7Z10179
V_{CE} = 10 V
T_j = 25 °C
I_C (mA)
60
40
20
0
typ
500
700
V_{BE} (mV)
900


7Z10173
typical values
V_{CE} = 10 V
f = 100 MHz
T_j = 25 °C
f_T (MHz)
600
400
200
0
BFS19
BFS18
0.1
1
10
I_C (mA)
100


7Z10172
crystal mounted in a BF115 envelope
I_C = 1mA
V_{CE} = 10V
T_j = 25°C
F (dB)
$-B_S$
G_S (mΩ^{-1})
6 15
4 10
2 5
0 0
0.1
1
10
100
f (MHz)
1000
G_S
B_S
typ
opt
opt


7Z10177
$I_E = I_e = 0$
f = 1MHz
T_j = 25°C
C_c (pF)
2
1.5
1
0.5
0
0
10
20
V_{CB} (V)
30
typ


7Z10178
V_{CB} = 20V
I_{CBO} (nA)
100
10
1
0.1
0.01
0
50
100
T_j (°C)
150
typ

SILICON PLANAR EPITAXIAL TRANSISTOR

N-P-N transistor in a micro miniature plastic envelope.
It has a very low feedback capacitance and is intended for i.f. and v.h.f. applications in thick and thin film circuit.

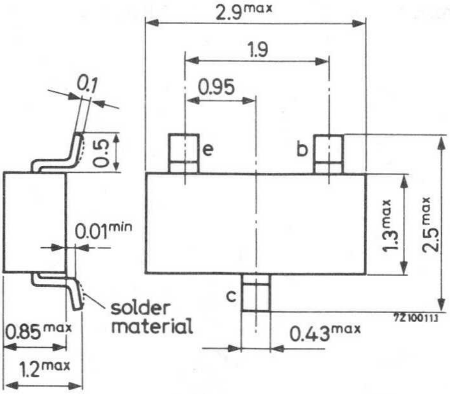
QUICK REFERENCE DATA

Collector-base voltage (open emitter)	V_{CBO}	max.	30	V
Collector-emitter voltage (open base)	V_{CEO}	max.	20	V
Collector current (d.c.)	I_C	max.	25	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	150	mW
Junction temperature	T_j	max.	125	°C
D.C. current gain I_C = 7 mA; V_{CE} = 10 V	h_{FE}	>	40	
Transition frequency at f = 100 MHz I_C = 5 mA; V_{CE} = 5 V	f_T	typ.	450	MHz
Feedback capacitance at f = 1 MHz I_C = 1 mA; V_{CE} = 10 V	$-C_{re}$	typ.	400	fF

MECHANICAL DATA

Dimensions in mm

Code: G1



RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltages				
Collector-base voltage (open emitter)	V_{CBO}	max.	30	V
Collector-emitter voltage (open base) I_C = 2 mA	V_{CEO}	max.	20	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4	V
Currents				
Collector current (d.c.)	I_C	max.	25	mA
Collector current (peak value)	I_{CM}	max.	25	mA
Power dissipation				
Total power dissipation up to T_{amb} = 25 °C mounted on a **ceramic substrate of 7 mm x 5 mm x 0.5 mm**	P_{tot}	max.	**150**	mW
Temperatures				
Storage temperature	T_{stg}		-65 to +125	°C
Junction temperature	T_j	max.	125	°C [1]

THERMAL RESISTANCE

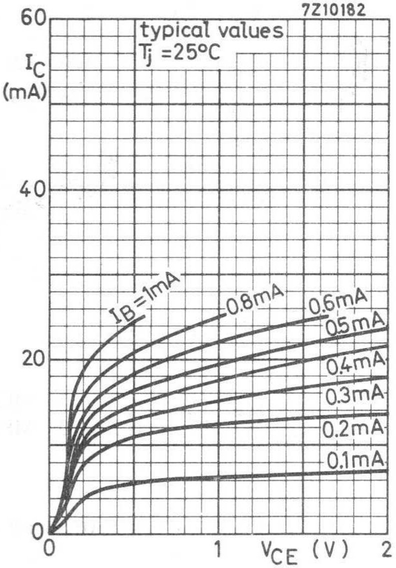
From junction to ambient mounted on a glass substrate of 5 mm x 5 mm x 1 mm	$R_{th\ j-a}$	=	0.9	°C/mW
mounted on a **ceramic substrate of 7 mm x 5 mm x 0.5 mm**	$R_{th\ j-a}$	=	**0.67**	°C/mW

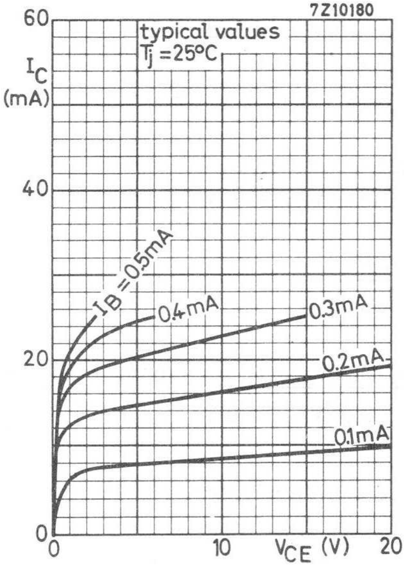
---

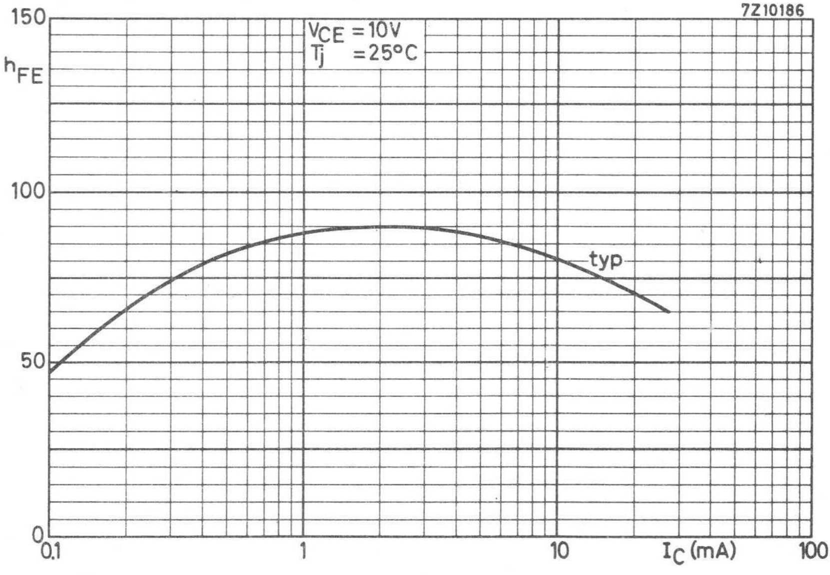
[1] For highly professional applications it is advisable not to exceed a maximum junction temperature of 100 °C

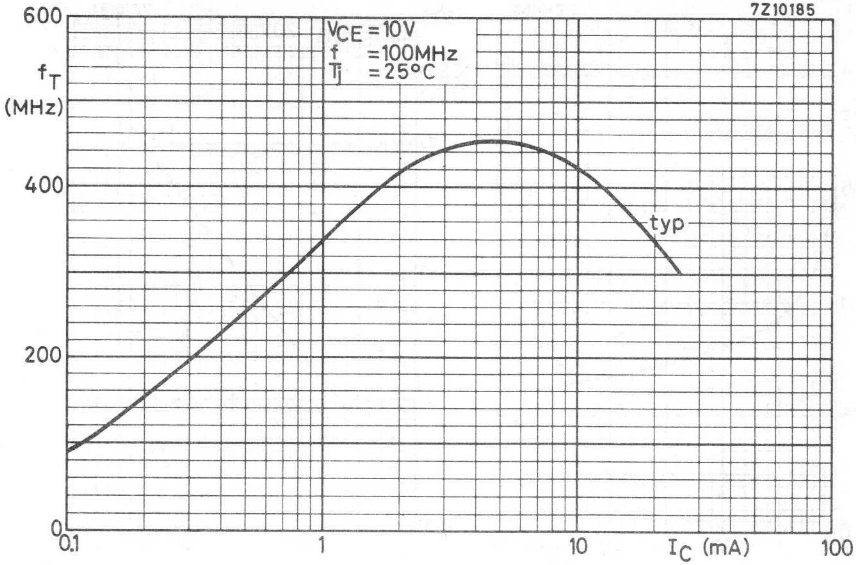
CHARACTERISTICS T_j = 25 °C unless otherwise specified

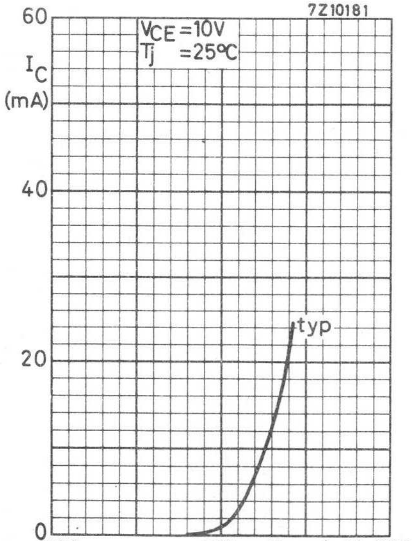
Collector cut-off current				
$I_E = 0$; $V_{CB} = 20$ V	I_{CBO}	<	100	nA
$I_E = 0$; $V_{CB} = 20$ V; $T_j = 100$ °C	I_{CBO}	<	10	μA
Base-emitter voltage				
$I_C = 7$ mA; $V_{CE} = 10$ V	V_{BE}	typ. <	740 900	mV mV
D.C. current gain				
$I_C = 7$ mA; $V_{CE} = 10$ V	h_{FE}	> typ.	40 85	
Transition frequency at f = 100 MHz				
$I_C = 5$ mA; $V_{CE} = 10$ V	f_T	> typ.	275 450	MHz MHz
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; $V_{CB} = 10$ V	C_c	typ.	0.8	pF
Feedback capacitance at f = 1 MHz				
$I_C = 1$ mA; $V_{CE} = 10$ V	$-C_{re}$	typ.	350	fF

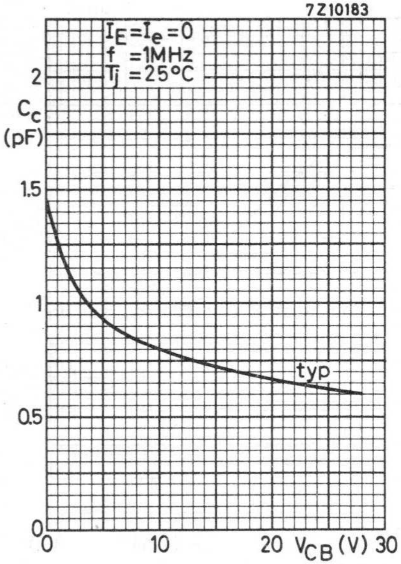

7Z10182
typical values
T_j =25°C
I_C (mA)
60
40
20
0
0
1
V_{CE} (V)
2
I_B=1mA
0.8mA
0.6mA
0.5mA
0.4mA
0.3mA
0.2mA
0.1mA

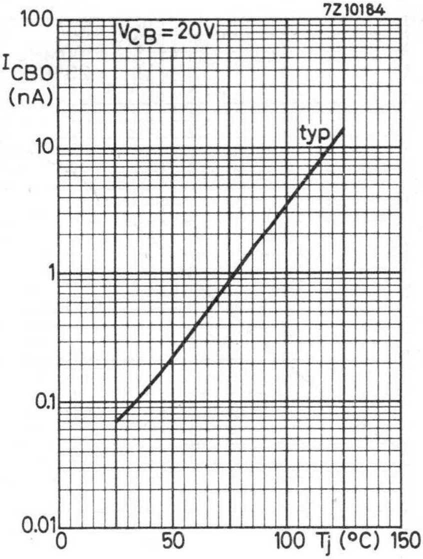

7Z10180
typical values
T_j =25°C
I_C (mA)
60
40
20
0
0
10
V_{CE} (V)
20
I_B=0.5mA
0.4mA
0.3mA
0.2mA
0.1mA


7Z10186
V_{CE} =10V
T_j =25°C
h_{FE}
150
100
50
0
0.1
1
10
I_C (mA)
100
typ


7Z10185
V_{CE} = 10V
f = 100MHz
T_j = 25°C
f_T (MHz)
600
400
200
0
0.1
1
10
100
I_C (mA)
typ


7Z10181
V_{CE} = 10V
T_j = 25°C
I_C (mA)
60
40
20
0
500
700
900
V_{BE} (mV)
typ


7Z10183
$I_E = I_e = 0$
f = 1MHz
$T_j = 25°C$
C_c (pF)
2
1.5
1
0.5
0
typ
0
10
20
30
V_{CB} (V)


7Z10184
$V_{CB} = 20V$
I_{CBO} (nA)
100
10
1
0.1
0.01
typ
0
50
100
150
T_j (°C)

SILICON PLANAR EPITAXIAL
HIGH SPEED SWITCHING TRANSISTOR

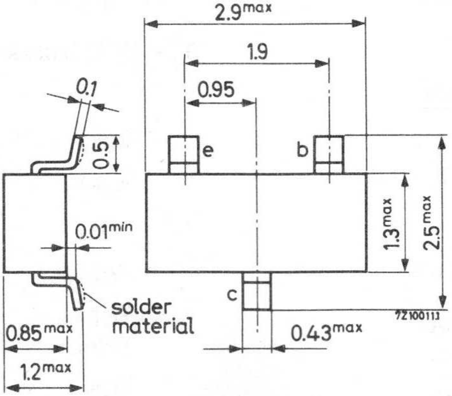
N-P-N transistor in a microminiature plastic envelope. It is intended for very high-speed saturated switching in thick and thin film circuits.

QUICK REFERENCE DATA

Collector-base voltage (open emitter)	V_{CBO}	max.	20	V
Collector-emitter voltage ($V_{BE} = 0$)	V_{CES}	max.	20	V
Collector-emitter voltage (open base)	V_{CEO}	max.	12	V
Collector current (peak value)	I_{CM}	max.	200	mA
Total power dissipation up to $T_{amb} = 25\ ^{o}C$	P_{tot}	max.	**150**	mW
Junction temperature	T_j	-65 to +125		^{o}C
D.C. current gain				
$I_C = 10$ mA; $V_{CE} = 1$ V	h_{FE}	40 to	120	
$I_C = 50$ mA; $V_{CE} = 1$ V	h_{FE}	>	25	
Transition frequency at f = 100 MHz				
$I_C = 10$ mA; $V_{CE} = 10$ V	f_T	> typ.	400 500	MHz MHz
Storage time				
$I_C = I_B = -I_{BM} = 10$ mA	t_s	<	13	ns

MECHANICAL DATA Dimensions in mm

Code: B2



RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltages

Collector-base voltage (open emitter)	V_{CBO}	max.	20	V
Collector-emitter voltage ($V_{BE} = 0$)	V_{CES}	max.	20	V
Collector-emitter voltage (open base) $I_C = 10$ mA	V_{CEO}	max.	12	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	V

Currents

Collector current (d.c.)	I_C	max.	50	mA
Collector current (peak value)	I_{CM}	max.	200	mA

Power dissipation

Total power dissipation up to $T_{amb} = 25$ °C mounted on a **ceramic substrate of 7 mm x 5 mm x 0.5 mm**	P_{tot}	max.	**150**	mW

Temperatures

Storage temperature	T_{stg}		−65 to +125	°C
Junction temperature	T_j	max.	125	°C 1)

THERMAL RESISTANCE

From junction to ambient mounted on a glass substrate of 5 mm x 5 mm x 1 mm	$R_{th\ j\text{-}a}$	=	0.9	°C/mW
mounted on a **ceramic substrate of 7 mm x 5 mm x 0.5 mm**m	$R_{th\ j\text{-}a}$	=	**0.67**	°C/mW

CHARACTERISTICS $T_j = 25$ °C unless otherwise specified

Collector cut-off current

$I_E = 0$; $V_{CB} = 10$ V	I_{CBO}	<	100	nA
$I_E = 0$; $V_{CB} = 10$ V; $T_j = 125$ °C	I_{CBO}	<	5	µA

Saturation voltages

$I_C = 10$ mA; $I_B = 300$ µA	V_{CEsat}	<	300	mV
$I_C = 10$ mA; $I_B = 1$ mA	V_{CEsat}	<	250	mV
	V_{BEsat}		700 to 850	mV
$I_C = 50$ mA; $I_B = 5$ mA	V_{CEsat}	<	400	mV
	V_{BEsat}	<	1200	mV

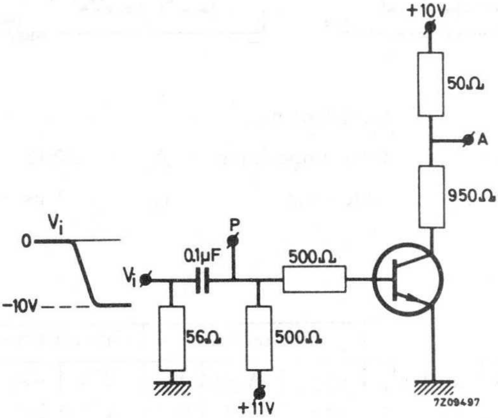
---

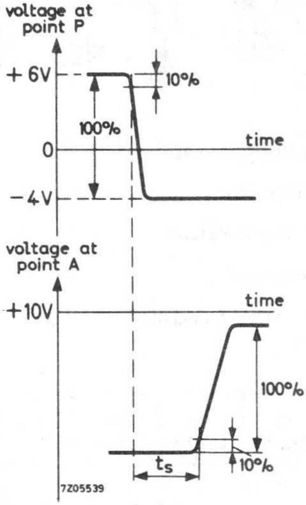
1) For highly professional applications it is advisable not to exceed a max. junction temperature of 100 °C.

CHARACTERISTICS (continued)

D.C. current gain				
I_C = 1 mA; V_{CE} = 1 V	h_{FE}	>	25	
I_C = 10 mA; V_{CE} = 1 V	h_{FE}		40 to 120	
I_C = 50 mA; V_{CE} = 1 V	h_{FE}	>	25	
Transition frequency at f = 100 MHz				
I_C = 10 mA; V_{CE} = 10 V	f_T	> typ.	400 500	MHz MHz
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; V_{CB} = 5 V	C_c	<	4	pF
Emitter capacitance at f = 1 MHz				
$I_C = I_c = 0$; V_{EB} = 1 V	C_e	<	4.5	pF
Switching times				
Storage time $I_C = I_B = -I_{BM}$ = 10 mA	t_s	<	13	ns

Test circuit:





Pulse generator:			
Rise time	t_r	<	1 ns
Pulse duration	t	>	300 ns
Duty cycle	δ	<	0.02
Source impedance	R_S	=	50 Ω

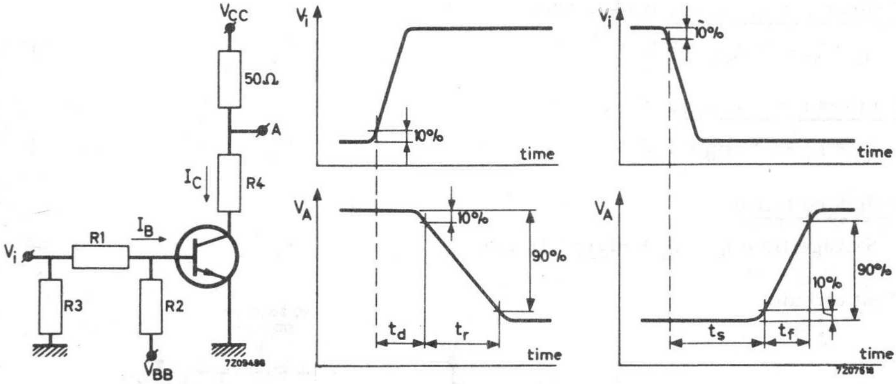
Oscilloscope:			
Input impedance	R_i	=	50 Ω
Rise time	t_r	<	1 ns

CHARACTERISTICS (continued) T_j = 25 °C unless otherwise specified

Switching times

Turn on time when switched from $-V_{BE}$ = 1.5 V to I_C = 10 mA; I_B = 3 mA	t_{on}	<	12	ns
Turn off time when switched from I_C = 10 mA; I_B = 3 mA to cut-off with $-I_{BM}$ = 1.5 mA	t_{off}	<	18	ns

Test circuit:



Pulse generator:

Rise time	t_r	<	1 ns
Pulse duration	t	>	300 ns
Duty cycle	δ	<	0.02
Source impedance	R_S	=	50 Ω

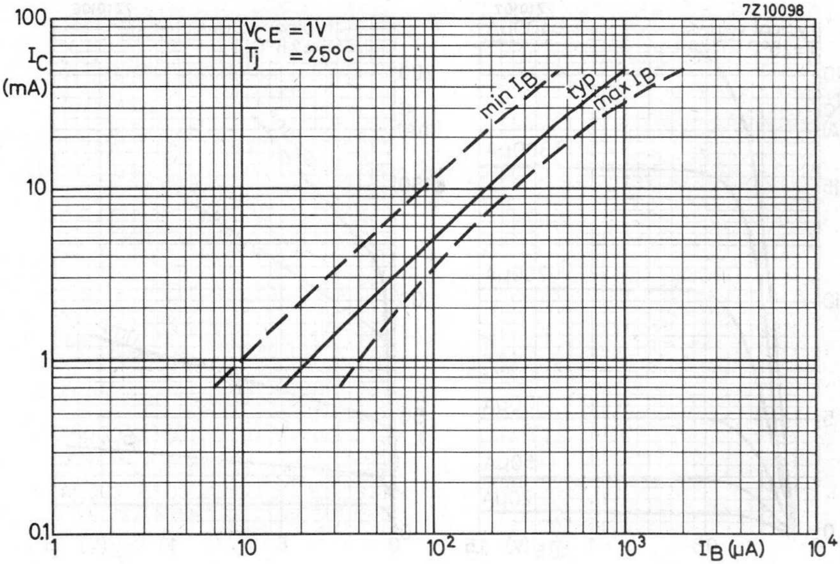
Oscilloscope:

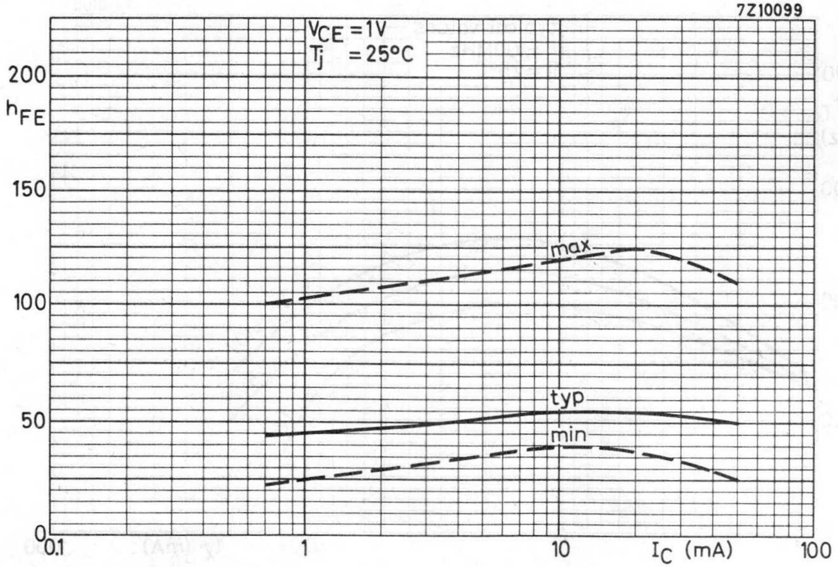
Input impedance	R_i	=	50 Ω
Rise time	t_r	<	1 ns

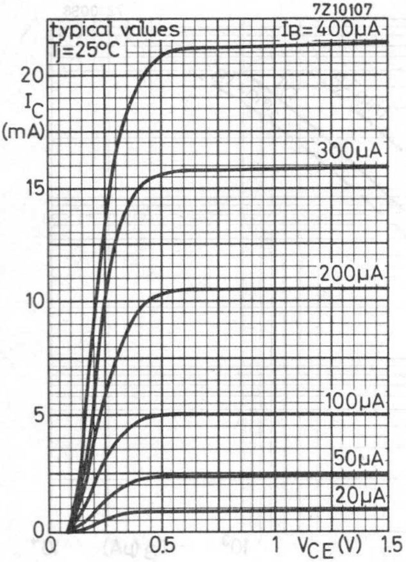
							turn on time			turn off time	
I_C (mA)	I_B (mA)	$-I_{BM}$ (mA)	V_{CC} (V)	R_1;R_2 (kΩ)	R_3 (Ω)	R_4 (Ω)	$-V_{BB}$ (V)	$-V_{BE}$ (V)	V_i (V)	$-V_{BB}$ (V)	$-V_i$ (V)
10	3	1.5	3	3.3	50	220	3.0	1.5	15	12.0	15

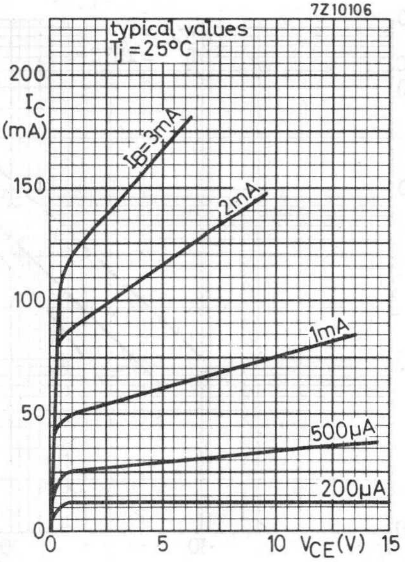
Note

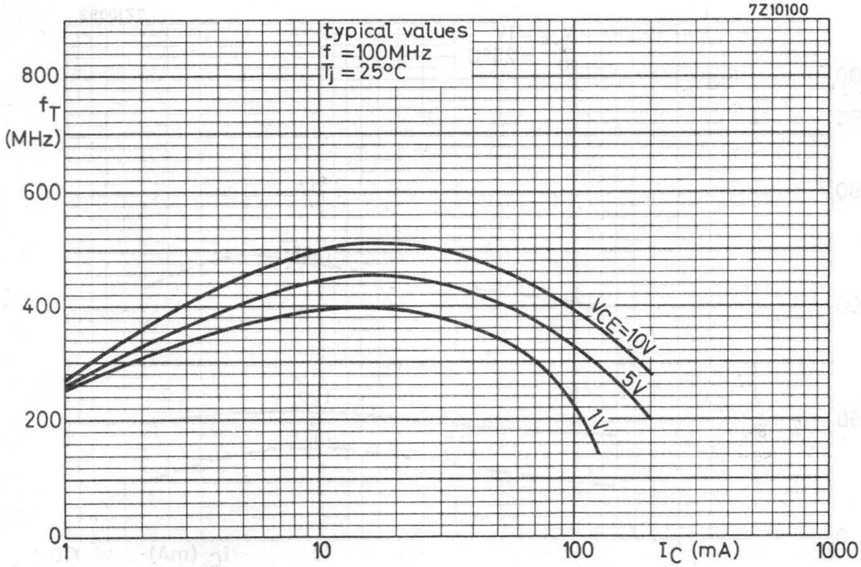
$-I_{BM}$ is the reverse current that can flow during switching off. The indicated $-I_{BM}$ is determined and limited by the applied cut-off voltage and series resistance.

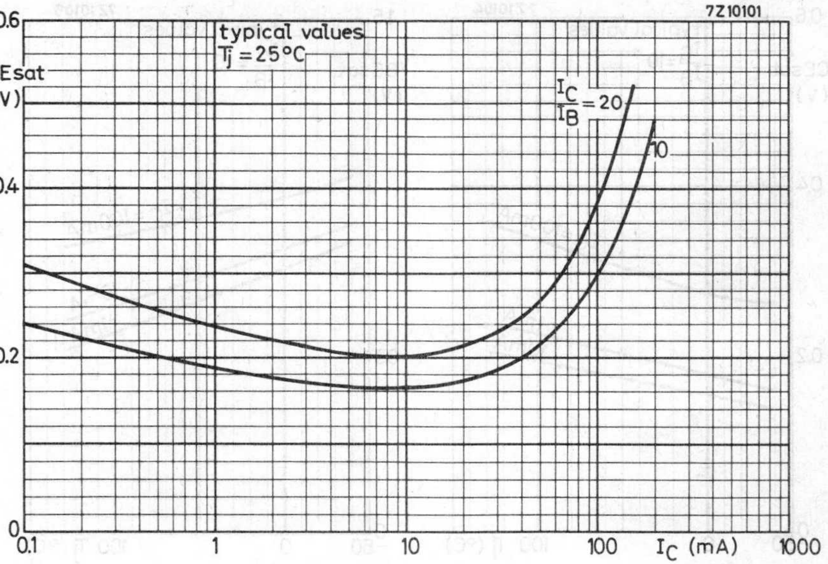

7Z10098
100
I_C
(mA)
10
1
0.1
V_{CE} = 1V
T_j = 25°C
min I_B
typ
max I_B
1
10
10^2
10^3
I_B (μA)
10^4

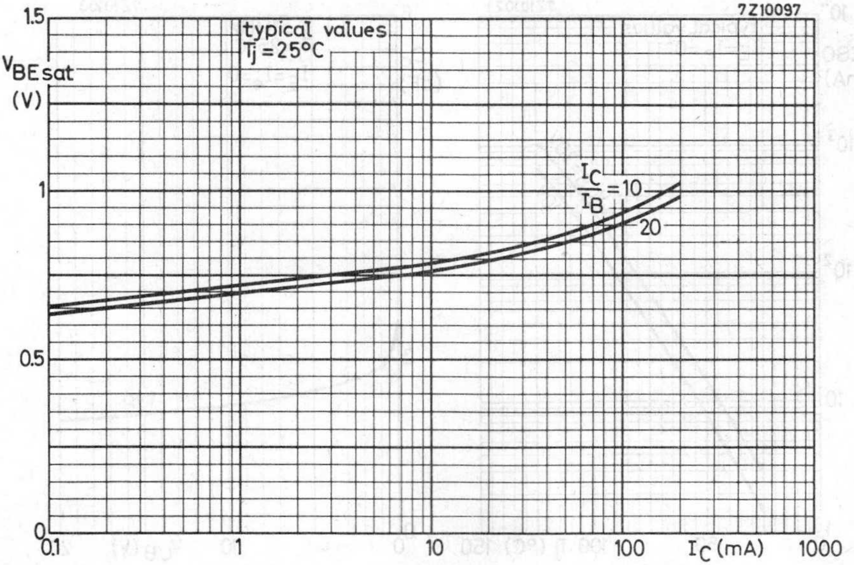

7Z10099
200
h_{FE}
150
100
50
0
V_{CE} = 1V
T_j = 25°C
max
typ
min
0.1
1
10
I_C (mA)
100

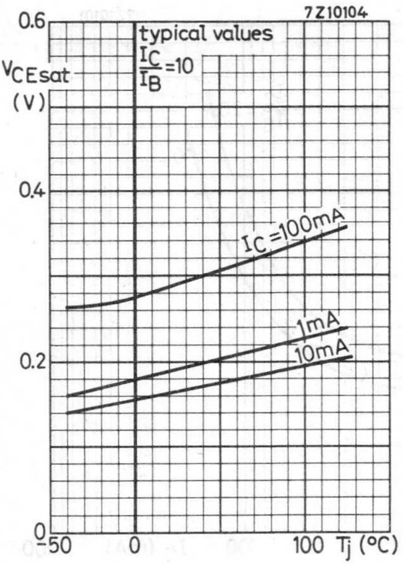

7Z10107
typical values
Tj=25°C
IB=400μA
300μA
200μA
100μA
50μA
20μA
IC
(mA)
20
15
10
5
0
0
0.5
1
1.5
VCE(V)

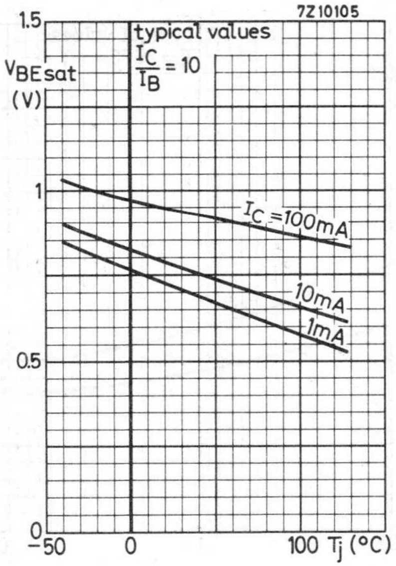

7Z10106
typical values
Tj=25°C
IB=3mA
2mA
1mA
500μA
200μA
IC
(mA)
200
150
100
50
0
0
5
10
15
VCE(V)

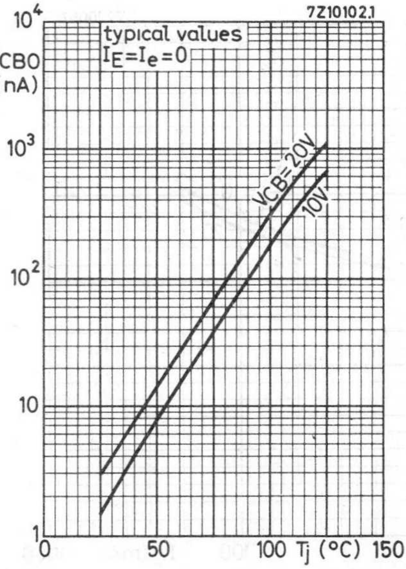

7Z10100
typical values
f =100MHz
Tj = 25°C
fT
(MHz)
800
600
400
200
0
1
10
100
1000
IC (mA)
VCE=10V
5V
1V

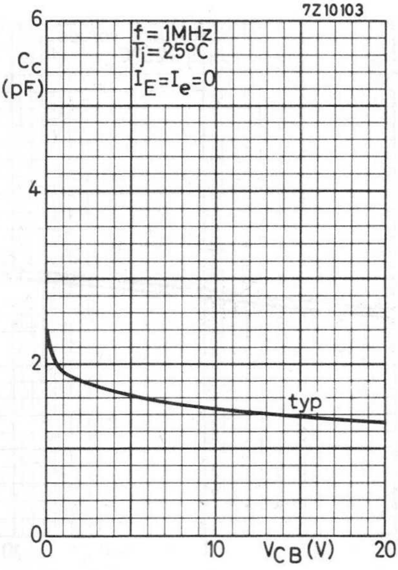

7Z10101
0.6
0.4
0.2
0
V_{CEsat}
(V)
typical values
$T_j = 25°C$
$\frac{I_C}{I_B} = 20$
10
0.1
1
10
100
I_C (mA)
1000


7Z10097
1.5
1
0.5
0
V_{BEsat}
(V)
typical values
$T_j = 25°C$
$\frac{I_C}{I_B} = 10$
20
0.1
1
10
100
I_C (mA)
1000


7Z10104
typical values
$\frac{I_C}{I_B}=10$
V_{CEsat} (V)
0.6
0.4
0.2
0
$I_C=100mA$
1mA
10mA
-50
0
100
T_j (°C)


7Z10105
typical values
$\frac{I_C}{I_B}=10$
V_{BEsat} (V)
1.5
1
0.5
0
$I_C=100mA$
10mA
1mA
-50
0
100
T_j (°C)


7Z10102.1
typical values
$I_E=I_e=0$
I_{CBO} (nA)
10^4
10^3
10^2
10
1
$V_{CB}=20V$
10V
0
50
100
T_j (°C)
150


7Z10103
f = 1MHz
$T_j=25°C$
$I_E=I_e=0$
C_c (pF)
6
4
2
0
typ
0
10
V_{CB} (V)
20

SILICON PLANAR VOLTAGE REFERENCE DIODES

Low power general purpose voltage reference diodes in a micro miniature plastic envelope intended for application in thick- and thin-film circuits.
The series covers the whole normalized range of nominal zener voltages from 4.7 V to 12 V with a tolerance of ± 5%.

QUICK REFERENCE DATA

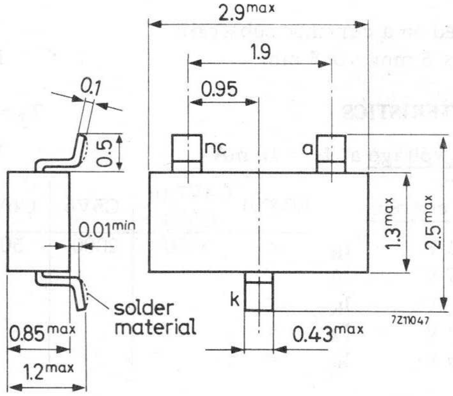
Zener voltage range		nom.	4.7 to 12 V
Zener voltage tolerance			± 5 %
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	150 mW
Junction temperature	T_j	max.	125 °C

MECHANICAL DATA

Dimensions in mm

Code:

BZX84-C4V7	Z1
BZX84-C5V1	Z2
BZX84-C5V6	Z3
BZX84-C6V2	Z4
BZX84-C6V8	Z5
BZX84-C7V5	Z6
BZX84-C8V2	Z7
BZX84-C9V1	Z8
BZX84-C10	Z9
BZX84-C11	Y1
BZX84-C12	Y2



RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Currents

Repetitive peak forward current	I_{FRM}	max.	100	mA
Repetitive peak zener current	I_{ZRM}	max.	100	mA

Power dissipation

Total power dissipation up to T_{amb} = 25 °C mounted on a glass substrate of 5 mm x 5 mm x 1 mm	P_{tot}	max.	110	mW
mounted on a ceramic substrate of 7 mm x 5 mm x 0.5 mm	P_{tot}	max.	150	mW

Temperatures

Storage temperature	T_{stg}		−65 to +125	°C
Junction temperature	T_j	max.	125	°C [1]

THERMAL RESISTANCE

From junction to ambient mounted on a glass substrate of 5 mm x 5 mm x 1 mm	$R_{th\ j\text{-}a}$	=	0.9	°C/mW
mounted on a ceramic substrate 7 mm x 5 mm x 0.5 mm	$R_{th\ j\text{-}a}$	=	0.67	°C/mW

CHARACTERISTICS T_j = 25 °C unless otherwise specified

Forward voltage at I_F = 10 mA V_F < 0.9 V

Reverse current		BZX84-	C4V7 to C5V1	C5V6	C6V2	C6V8 to C8V2	C9V1	C10 C11	C12	
V_R = 2 V	I_R	<	3000	2000	500					nA
V_R = 3 V	I_R	<				100				nA
V_R = 5 V	I_R	<					100			nA
V_R = 7 V	I_R	<						100		nA
V_R = 8 V	I_R	<							100	nA

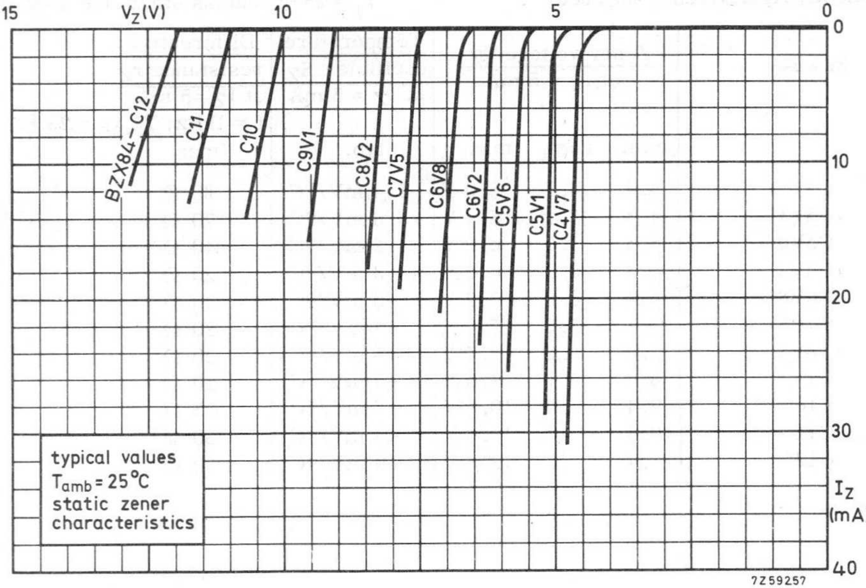
---

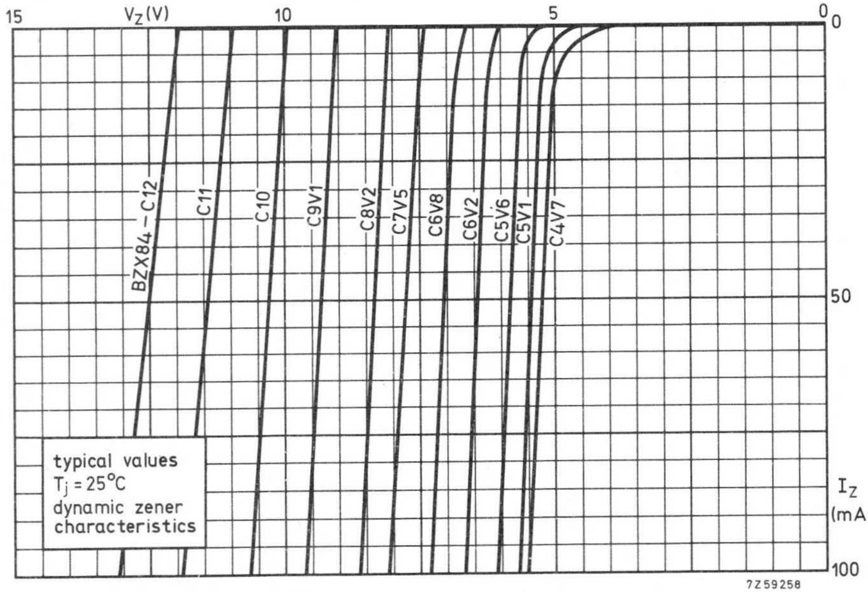
[1] For highly professional applications it is advisable not to exceed a maximum junction temperature of 100 °C.

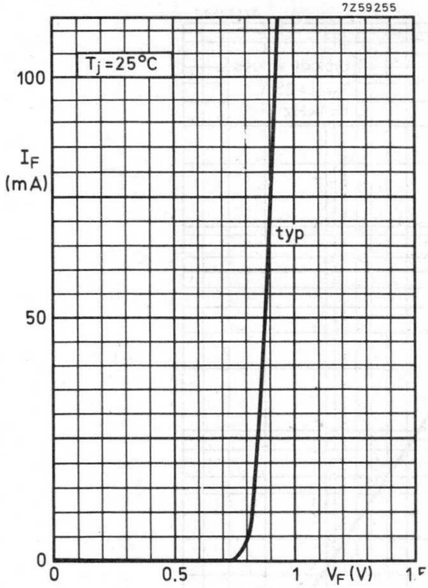
CHARACTERISTICS (continued)

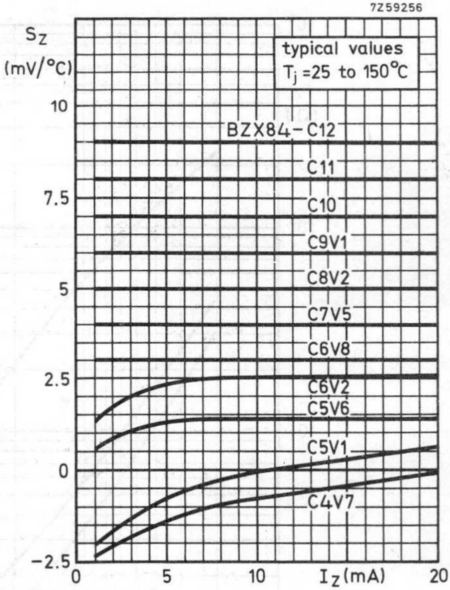
T_j = 25 °C unless otherwise specified

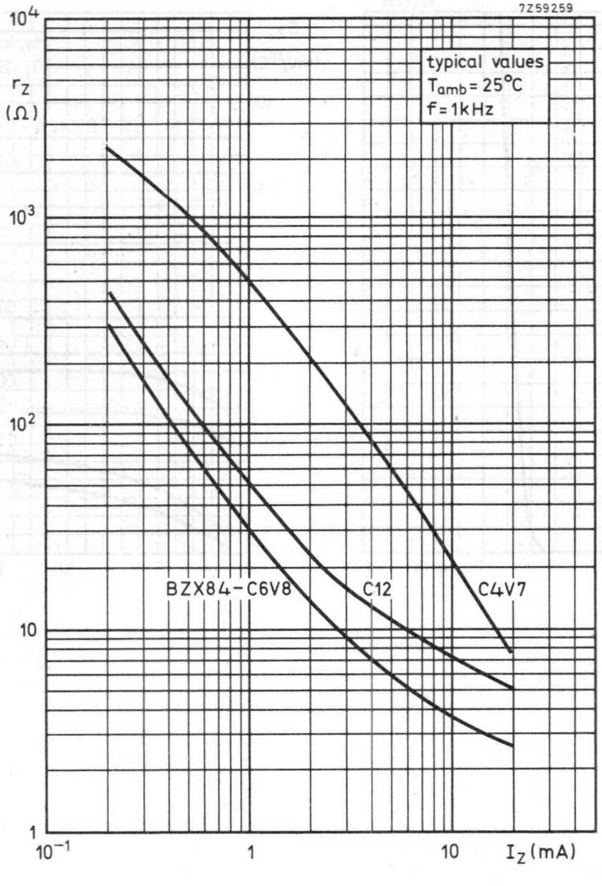
BZX84-...	Zener voltage V_Z at I_Z = 5 mA			Temperature coefficient S_Z at I_Z = 5 mA	Differential resistance r_Z at I_Z = 5 mA f = 1kHz; T_{amb} = 25 °C
	min.	nom.	max.	typ.	max.
C4V7	4.4	4.7	5.0 V	−1.4 mV/°C	80 Ω
C5V1	4.8	5.1	5.4 V	−0.8 mV/°C	70 Ω
C5V6	5.3	5.6	6.0 V	+1.2 mV/°C	40 Ω
C6V2	5.8	6.2	6.6 V	+2.3 mV/°C	20 Ω
C6V8	6.4	6.8	7.2 V	+3 mV/°C	20 Ω
C7V5	7.1	7.5	7.9 V	+4 mV/°C	20 Ω
C8V2	7.8	8.2	8.7 V	+5 mV/°C	20 Ω
C9V1	8.6	9.1	9.6 V	+6 mV/°C	20 Ω
C10	9.4	10	10.6 V	+7 mV/°C	25 Ω
C11	10.4	11	11.6 V	+8 mV/°C	30 Ω
C12	11.4	12	12.6 V	+9 mV/°C	30 Ω


15
V_Z(V)
10
5
0
0
10
20
30
40
I_Z
(mA)
BZX84-C12
C11
C10
C9V1
C8V2
C7V5
C6V8
C6V2
C5V6
C5V1
C4V7
typical values
T_{amb} = 25°C
static zener characteristics
7Z59257


15
V_Z(V)
10
5
0
0
50
100
I_Z
(mA)
BZX84-C12
C11
C10
C9V1
C8V2
C7V5
C6V8
C6V2
C5V6
C5V1
C4V7
typical values
T_j = 25°C
dynamic zener characteristics
7Z59258


7Z59255
$T_j = 25°C$
I_F (mA)
100
50
0
typ
0
0.5
1
V_F (V)
1.5


7Z59256
S_Z (mV/°C)
typical values
T_j = 25 to 150°C
10
7.5
5
2.5
0
−2.5
BZX84−C12
C11
C10
C9V1
C8V2
C7V5
C6V8
C6V2
C5V6
C5V1
C4V7
0
5
10
I_Z (mA)
20


7Z59259
10^4
r_Z
(Ω)
10^3
10^2
10
1
10^{-1}
1
10
I_Z(mA)
typical values
T_{amb} = 25°C
f = 1kHz
BZX84-C6V8
C12
C4V7

Photoconductive devices

TYPE SELECTION CHART

	hermetically sealed					lacquered	
	P_{tot} max (mW)					P_{tot} max.(mW)	
	70	100	225	500	1000	200	750
on-off services	ORP60 ORP61 ORP63	ORP62 ORP69	RPY41	RPY18 RPY19	ORP90 RPY20 RPY27 RPY55	RPY58	RPY43
measuring purposes	P_{tot} max. 10 mW RPY33			P_{tot} max. 50 mW RPY71		P_{tot} max. 50 mW RPY58	

GENERAL OPERATIONAL RECOMMENDATIONS
PHOTOCONDUCTIVE DEVICES

1. GENERAL

1.1 These application directions are valid for all types of photoconductive cells, unless otherwise stated on the individual technical data sheets.

1.2 A photoconductive device is a light-sensitive device whose resistance varies with the illumination on the device.

1.3 Where the term illumination is used in the following sections it shall be taken to mean the radiant energy which is normally used to excite the device.

1.4 Also in the following sections, history is taken to mean the duration of the specified conditions plus a sufficient description of previous conditions.

2. OPERATING CHARACTERISTICS

2.1 The data given on the individual technical data sheets are based on the devices being uniformly illuminated.

2.2 The illumination resistance is the ratio of the voltage across the device to the current through the device when illumination is applied to the device.

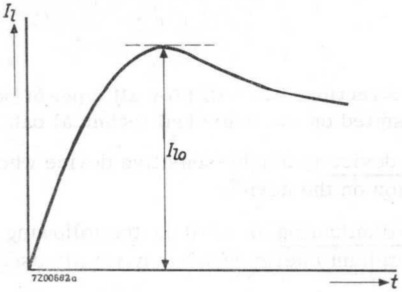
2.2.1 For a particular set of conditions the equilibrium illumination resistance is the illumination resistance after such a time under these conditions that the rate of change of the illumination resistance is less than 1% per 5 minutes.

2.2.2 For a particular set of conditions the initial illumination resistance is the first virtually constant value of the illumination resistance after a period of storage or other operating conditions.
The initial illumination resistance usually occurs after a few seconds under the specified conditions.

2.3 The illumination current is the current which passes when a voltage and illumination are applied to the device.

2.3.1 For a particular set of conditions the equilibrium illumination current is the illumination current after such a time under these conditions that the rate of change of the illumination current is less than 1% per 5 minutes.

2.3.2 For a particular set of conditions the initial illumination current is the first virtually constant value of the illumination current after a period of storage or other operating conditions.
The initial illumination current usually occurs after a few seconds under the specified conditions.



2.4 The dark resistance is the resistance of the device in the absence of illumination.

2.4.1 For a particular set of conditions the equilibrium dark resistance is the dark resistance after such a time under these conditions that the rate of change of the dark resistance is less than 2% per 5 minutes.

2.4.2 For a particular set of conditions the initial dark resistance is the dark resistance after a specified time under these conditions following a specified history.

2.5 The dark current is the current which passes when a voltage is applied to the device in the absence of illumination.

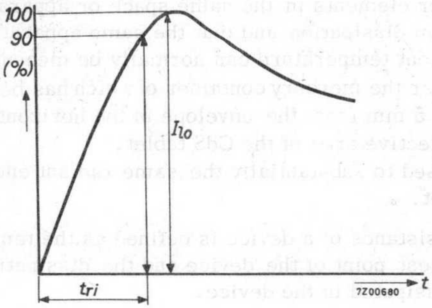
2.5.1 For a particular set of conditions the equilibrium dark current is the dark current after such a time under these conditions that the rate of change of the dark current is less than 2% per 5 minutes.

2.5.2 For a particular set of conditions the initial dark current is the dark current after a specified time under these conditions immediately following a specified history.

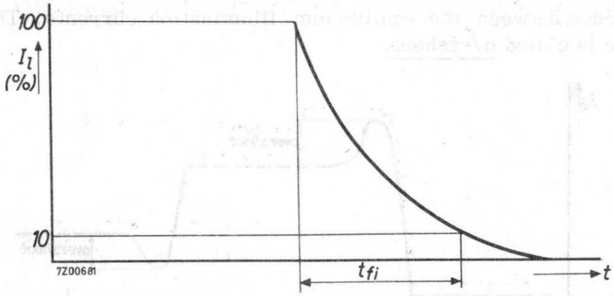
2.6.1 For a particular set of conditions and history the resistance decay time is the time taken for the resistance of the device to fall to a specified value measured from the instant of starting the illumination.

2.6.2 For a particular set of conditions and history the resistance rise time is the time taken for the resistance of the device to rise to a specified value measured from the instant of stopping the illumination.

2.7.1 For a particular set of conditions and history the current rise time is the time taken for the current through the device to rise to 90% ot its initial illumination current measured from the instant of starting the illumination.



2.7.2 For a particular set of conditions and history the current decay time is the time taken for the current through the device to fall to 10% of its value at the instant of stopping the illumination, measured from that instant.



2.8 The illumination sensitivity is the quotient of illumination current by the incident illumination.

2.9 The illumination resistance (current) temperature response is the relationship between the illumination resistance (current) and the ambient temperature of the device under constant illumination and voltage conditions.

2.10 For a particular set of conditions the initial drift is the difference between the equilibrium and initial illumination current, expressed as a percentage of the initial illumination current.

2.11 The illumination response is the relationship between the initial illumination resistance and the illumination, defined as $\frac{\Delta \log r_{lo}}{\Delta \log E}$

3. THERMAL DATA

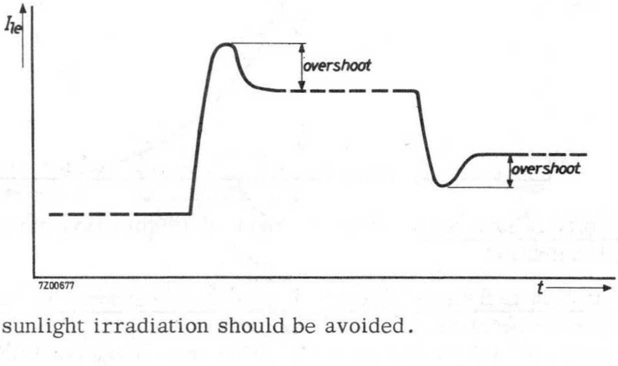
3.1 Ambient temperature. The ambient temperature of a device is the temperature of the surrounding air of that device in its practical situation, which means that other elements in the same space or apparatus must have their normal maximum dissipation and that the same apparatus envelope must be used. This ambient temperature can normally be measured by using a mercury thermometer the mercury container of which has been blackened, placed at a distance of 5 mm from the envelope in the horizontal plane through the centre of the effective area of the CdS tablet.

It shall be exposed to substantially the same radiant energy as that incident on the CdS tablet.

3.2 The thermal resistance of a device is defined as the temperature difference between the hottest point of the device and the dissipating medium, divided by the power dissipated in the device.

4. OPERATIONAL NOTES

4.1 When a photoconductive device is subjected to a change of operating conditions there may be a transient change of current in excess of that due to the difference between the equilibrium illumination currents. This transient change is called overshoot.



4.2 Direct sunlight irradiation should be avoided.

5. MOUNTING

5.1 If no restrictions are made on the individual published data sheets, the device may be mounted in any position.

5.2 Most of the photoconductive devices may be soldered directly into the circuit, which is indicated on the individual published data sheets. However, the heat conducted to the seal of the device should be kept to a minimum by the use of a thermal shunt. If not otherwise indicated, the device may be dip-soldered at a solder temperature of 240 °C for a maximum of 10 seconds up to a point 5 mm from the seals.

6. STORAGE

It is recommended that the devices be stored in the dark. At any rate direct sunlight irradiation should be avoided.

7. LIMITING VALUES

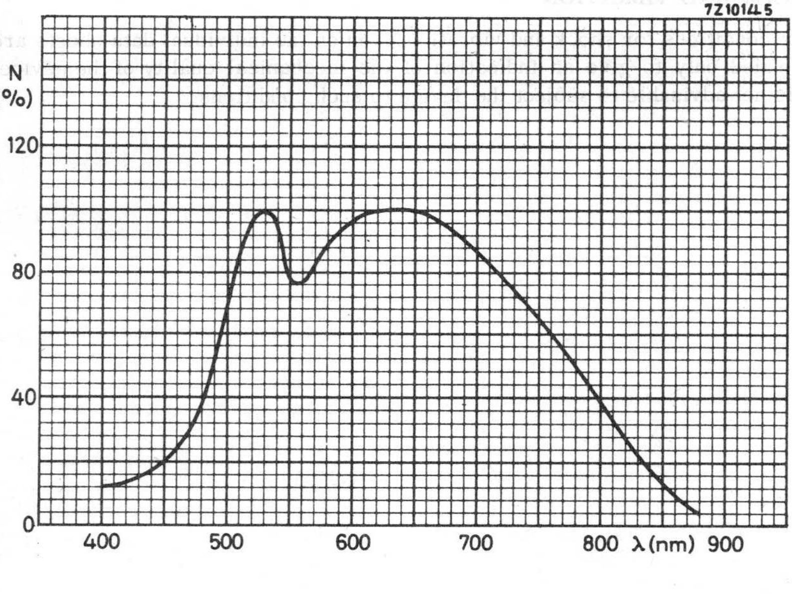
The limiting values of photoconductive devices are given in the absolute maximum rating system.

8. OUTLINE DIMENSIONS

The outline dimensions are given in mm.

9. SHOCK AND VIBRATION

The conditions for shock and vibration given on the individual data sheets are intended only to give an indication of the mechanical quality of the device. It is not advisable to subject the device to such conditions.



TYPE D

CADMIUM SULPHIDE PHOTOCONDUCTIVE DEVICES

LIST OF SYMBOLS

Cell voltage	V
Cell current	I
Illumination current	I_l
Initial illumination current	I_{lo}
Equilibrium illumination current	I_{le}
Dark current	I_d
Initial dark current	I_{do}
Equilibrium dark current	I_{de}
Illumination resistance	r_l
Initial illumination resistance	r_{lo}
Equilibrium illumination resistance	r_{le}
Dark resistance	r_d
Initial dark resistance	r_{do}
Equilibrium dark resistance	r_{de}
Current rise time	t_{ri}
Current decay time	t_{fi}
Resistance rise time	t_{rr}
Resistance decay time	t_{fr}
Pulse time	t_{imp}
Averaging time	t_{av}
Pulse repetition rate	p_{rr}

Illumination sensitivity	N
Illumination response	γ
Voltage response	α
Ambient temperature	T_{amb}
Thermal resistance	K
Temperature of CdS tablet	T_{tablet}
Colour temperature	T_K
Dissipation	P
Illumination	E
Initial drift	D_o

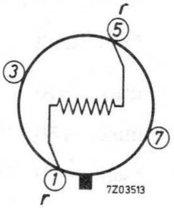
CADMIUM SULPHIDE PHOTOCONDUCTIVE CELL

Cadmium sulphide photoconductive cell with top sensitivity intended for use in flame control, smoke detection and industrial on-off switching applications.

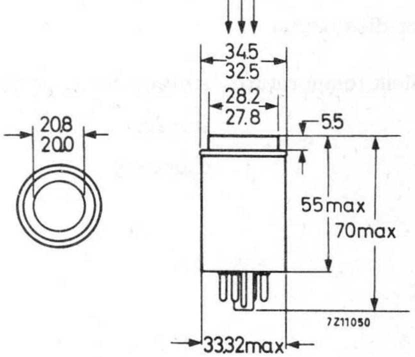
QUICK REFERENCE DATA				
Power dissipation at $T_{amb} = 25\,^{o}C$	P	max.	1.5	W
Cell voltage, d.c.and repetitive peak	V	max.	350	V
Cell resistance at 50 lux, 2700 ^{o}K colour temperature	$r_{\ell o}$		330	Ω
Spectral response curve		type D		
Outline dimensions		max. 34.5 dia. x 70		mm

MECHANICAL DATA

Dimensions in mm



Base: Octal



ELECTRICAL DATA

General

The electrical properties of CdS cells are dependent on many factors such as illumination, colour temperature of the light source, voltage, current, temperature, total time of operation in the circuit and time of operation during the last 24 hours prior to the measurement. The following basic characteristics are therefore only checkpoints of the electrical properties of these devices measured with defined values of the various conditions and at delivery.

Basic characteristics at T_{amb} = 25 °C, illumination with colour temperature of 2700 °K and at delivery

	symbol	min.	typical	max.	unit
Equilibrium dark current measured with 300 V d.c. applied via 1 MΩ, 30 minutes after switching off the illumination	I_{de}			6	μA
Initial illumination current measured at 10 V d.c. and illumination = 50 lux, after 16 hrs in darkness [1]	I_{lo}	11	30	47	mA
Initial illumination current measured at 10 V d.c. illumination = 50 lux and colour temperature = 1500 °K, after 16 hrs in darkness	I_{lo}	24	60	96	mA
Sensitivity at 50 lux, with 10 V d.c. applied	N		0.6		mA/lux

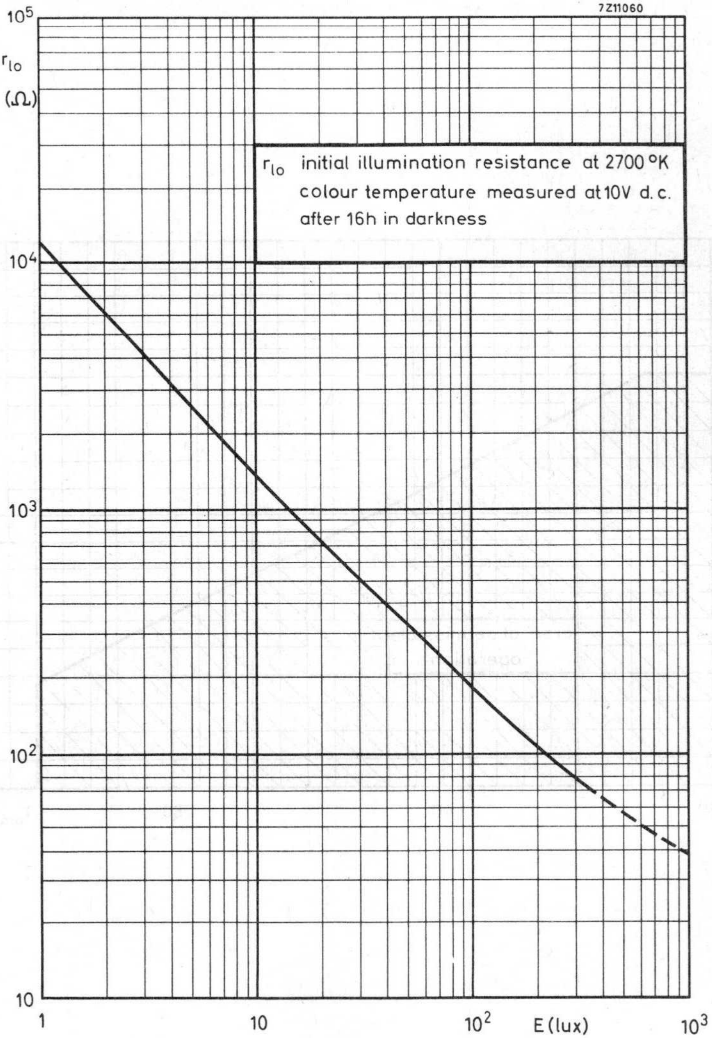
LIMITING VALUES (Absolute max.rating system)

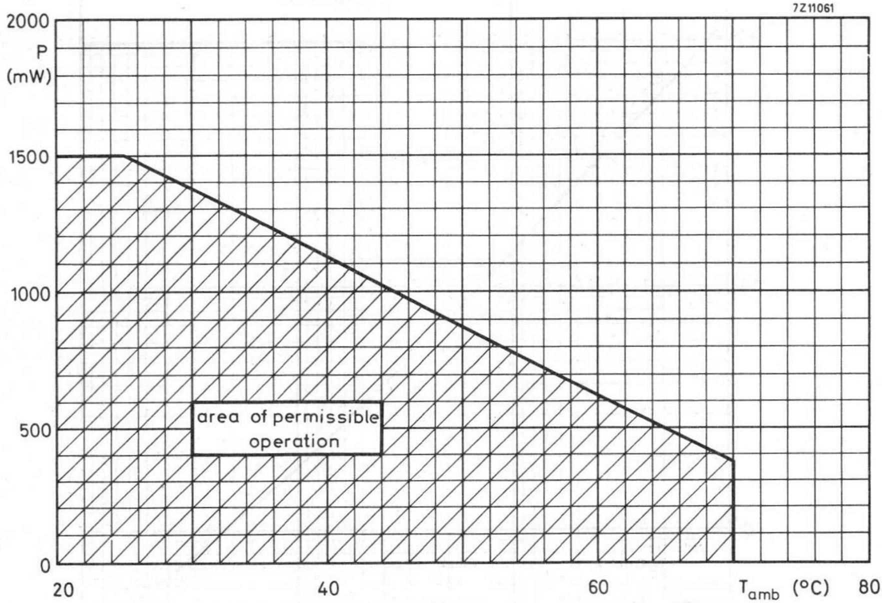
Cell voltage, d.c. and repetitive peak	V	max.	350	V
Power dissipation		see page 4		
Ambient temperature, storage and operating	T_{amb}	min.	-40	°C
storage	T_{amb}	max.	+50	°C [2]
operating	T_{amb}	max.	+70	°C

---

[1] After 16 hours in darkness changes in the CdS material are still occurring, but have only insignificant effect on the illumination resistance and on the resistance decay time.

[2] Operation of the cell counteracts the deteriorating effect of long periods at high temperature. The maximum operating temperature is therefore higher than the maximum storage temperature.


7Z11060
10^5
r_{lo}
(Ω)
r_{lo} initial illumination resistance at 2700 °K colour temperature measured at 10V d.c. after 16h in darkness
10^4
10^3
10^2
10
1
10
10^2
E (lux)
10^3


7Z11061
2000
P
(mW)
1500
1000
500
0
20
40
60
80
T_{amb} (°C)
area of permissible operation

CADMIUM SULPHIDE PHOTOCONDUCTIVE CELL

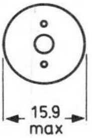
Cadmium sulphide photoconductive cell with top and side sensitivity.

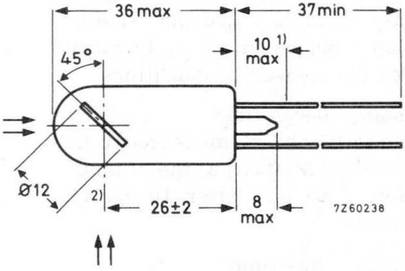
QUICK REFERENCE DATA

Power dissipation at T_{amb} = 25 °C	P	max.	360	mW
Cell voltage, d.c. and repetitive peak	V	max.	300	V
Cell resistance at 50 lux, 2700 °K colour temperature	r_{lo}		2700	Ω
Spectral response curve		type	D	
Outline dimensions		max.	15.9 dia. x 44	mm

MECHANICAL DATA

Dimensions in mm





Soldering

The cell may be soldered directly into the circuit but heat conducted to the seal should be kept to a minimum by the use of a thermal shunt. The cell may be dip-soldered at a solder temperature of 240 °C for a maximum of 10 s up to a point 10 mm from the seals.

---

1) Not tin plated

2) Centre of sensitive area

ELECTRICAL DATA

General

The electrical properties of CdS cells are dependent on many factors such as illumination, colour temperature of the light source, voltage, current, temperature, total time of operation in the circuit and time of operation during the last 24 hours prior to the measurement. The following basic characteristics are therefore only checkpoints of the electrical properties of these devices measured with defined values of the various conditions and at delivery.

Basic characteristics at T_{amb} = 25 °C, illumination with colour temperature of 2700 °K and at delivery.

	symbol	min.	typical	max.	unit
Equilibrium dark resistance measured with 300 V d.c. applied via 1 MΩ, 30 minutes after switching off the illumination	r_{de}	8			MΩ
Initial illumination resistance measured at 20 V d.c. and illumination = 50 lux, after 16 hrs in darkness [1]	r_{lo}	1300	2700	6200	Ω
Equilibrium illumination resistance measured at 20 V d.c. and illumination = 50 lux, after 15 minutes under the measuring conditions	r_{le}		3400		Ω
Resistance decay time Time to reach 7 kΩ measured from the instant of starting the illumination of 50 lux, after 16 hrs in darkness	t_{fr}		350		ms
Resistance rise time Time to reach 25 kΩ measured from the instant of stopping the illumination, after 15 minutes or longer illumination of 50 lux	t_{rr}		75		ms

---

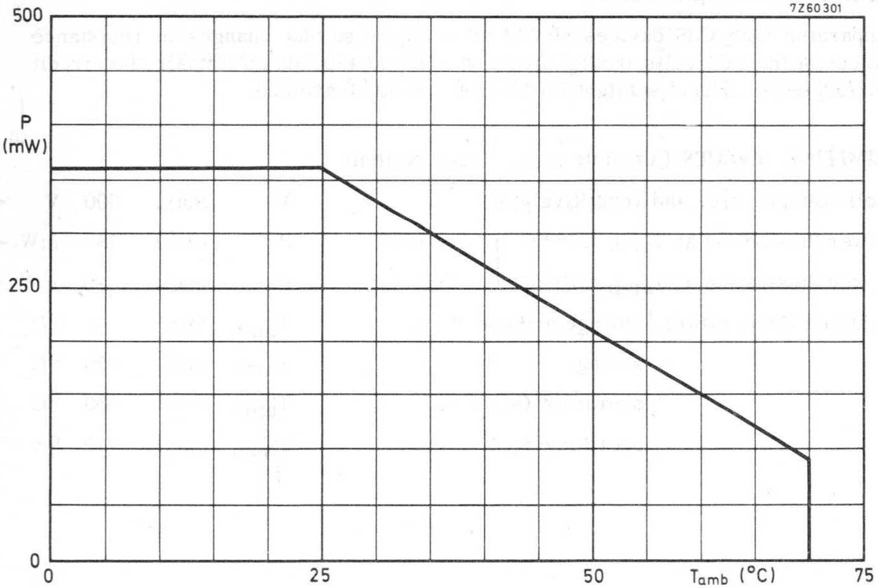
[1] After 16 hours in darkness changes in the CdS material are still occurring, but have only insignificant effect on the illumination resistance and on the resistance decay time.

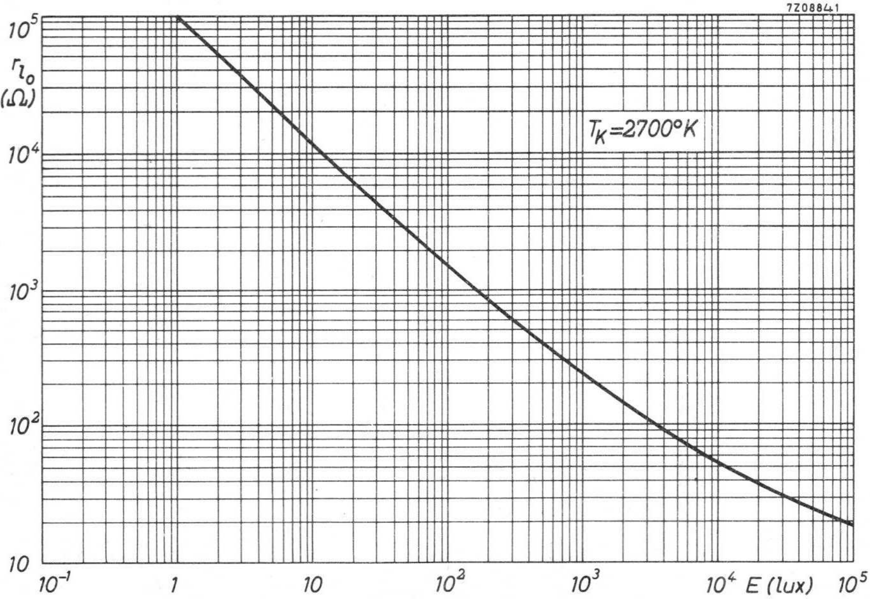
DESIGN CONSIDERATIONS

Apparatus with CdS devices should be designed so that changes in resistance values of the CdS cells during life from -30% to +70% do not impair the circuit performance. Direct sunlight irradiation should be avoided.

LIMITING VALUES (Absolute max. rating system)

Cell voltage, d.c. and repetitive peak		V	max.	300	V	←
Power dissipation at T_{amb} = 25 °C	See also	P	max.	360	mW	←
Power dissipation at T_{amb} = 70 °C	sheet 4	P	max.	90	mW	←
Ambient temperature, storage and operating		T_{amb}	min.	-40	°C	
storage		T_{amb}	max.	+50	°C	
operating (< 1 lux)		T_{amb}	max.	+50	°C	
operating (≥ 1 lux)		T_{amb}	max.	+70	°C	


7Z60301
P
(mW)
500
250
0
0
25
50
Tamb (°C)
75

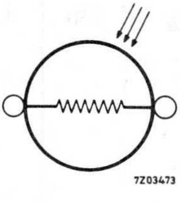

7Z08841
10^5
r_{l_0}
(Ω)
10^4
10^3
10^2
10
T_K=2700°K
10^{-1}
1
10
10^2
10^3
10^4 E (lux)
10^5

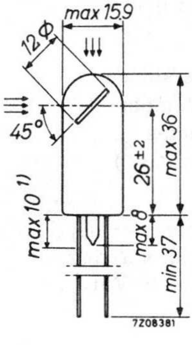
CADMIUM SULPHIDE PHOTOCONDUCTIVE CELL

Cadmium sulphide photoconductive cell with top and side sensitivity intended for use in industrial on-off applications such as flame failure equipment. The cell is tropic proof, shock and vibration resistant.

QUICK REFERENCE DATA				
Power dissipation at T_{amb} = 25 °C	P	max.	400	mW
Cell voltage, d.c. and repetitive peak	V	max.	200	V
Cell resistance at 50 lux, 2700 °K colour temperature	r_{l_0}		1200	Ω
Spectral response curve		type D		
Outline dimensions		max. 15.9 dia x 44		mm

MECHANICAL DATA Dimensions in mm





Soldering

The cell may be soldered directly into the circuit but heat conducted to the seal should be kept to a minimum by the use of a thermal shunt. The cell may be dip-soldered at a solder temperature of 240 °C for a maximum of 10 s up to a point 10 mm from the seals.

---

1) Not tinned.

ELECTRICAL DATA

General

The electrical properties of CdS cells are dependent on many factors such as illumination, colour temperature of the light source, voltage, current, temperature, total time of operation in the circuit and time of operation during the last 24 hours prior to the measurement. The following basic characteristics are therefore only checkpoints of the electrical properties of these devices measured with defined values of the various conditions and at delivery.

Basic characteristics at T_{amb} = 25 °C, illumination with colour temperature of 2700 °K and at delivery

	symbol	min.	typical	max.	unit
Initial dark resistance measured with 200 V d.c. applied via 1 MΩ, 20 s after switching off the illumination	r_{do}	4		1)	MΩ
Equilibrium dark resistance measured with 200 V d.c. applied via 1 MΩ, 30 minutes after switching off the illumination	r_{de}	100		1)	MΩ
Initial illumination resistance measured at 10 V d.c., illumination = 50 lux, after 16 hours in darkness 2) 3)	r_{lo}	750	1200	3000	Ω
Equilibrium illumination resistance measured at 10 V d.c., illumination = 50 lux, after 15 minutes under the measuring conditions 3)	r_{le}	750	1500	4100	Ω
Current rise time Time to reach 90% of the max. value, measured from the instant of starting the illumination of 50 lux, at 10 V d.c. after 16 hours in darkness	t_{ri}			2	s

1) The spread of the dark resistance is large and values higher than 100 MΩ and 10 000 MΩ are possible for the initial dark resistance and the equilibrium dark resistance respectively.

2) After 16 hours in darkness changes in the CdS material are still occurring, but have only insignificant effect on the illumination resistance and on the resistance decay time.

3) Measured at top sensitivity.

Basic characteristics at T_{amb} = 25 °C, illumination with colour temperature of 2700 °K and at delivery (continued)

	symbol	min.	typical	max.	unit
Current decay time Time to reach 10% of the max. value, measured from the instant of stopping the illumination after 16 hours darkness and 10 sec. illumination of 50 lux, at 10 V d.c.	t_{f_1}			0.2	s
Sensitivity at 50 lux, with 10 V d.c. applied	N		0.17		mA/lux
Negative temperature response of illumination resistance	$\Delta rl/\Delta T$		0.2	0.5	%/°C
Voltage response $\frac{\text{r at } 0.5\ \text{V}}{\text{r at } 10\ \text{V}}$	α		1.05		

THERMAL DATA

Continuous temperature of CdS tablet	T_{tablet}	max.	+85	°C
Thermal resistance from CdS tablet to ambient, device free in air	K		150	°C/W

DESIGN CONSIDERATIONS

Apparatus with CdS cells should be designed so that changes in resistance values of the cells during life from −30% to +70% do not impair the circuit performance. Direct sunlight irradiation should be avoided.

SHOCK AND VIBRATION

An indication for the ruggedness of the cell is the following:
Samples taken from normal production are submitted to shock and vibration tests mentioned below. More than 95% of the devices pass these tests without perceptible damage.

Shock

25 g_{peak}, 10 000 shocks in one of the three positions of the cell.

Vibration

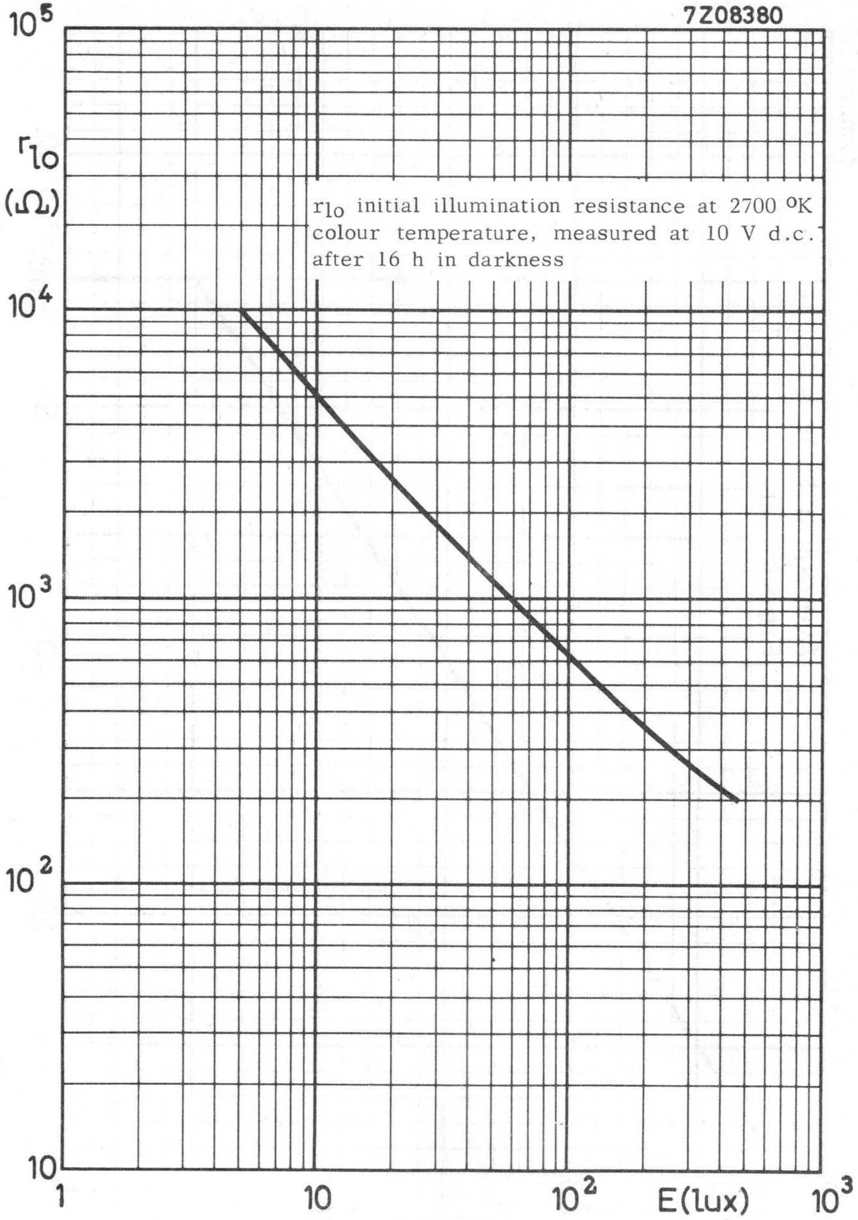
2.5 g_{peak}, 50 Hz, during 32 hours in each of the three positions of the cell.

LIMITING VALUES (Absolute max. rating system)

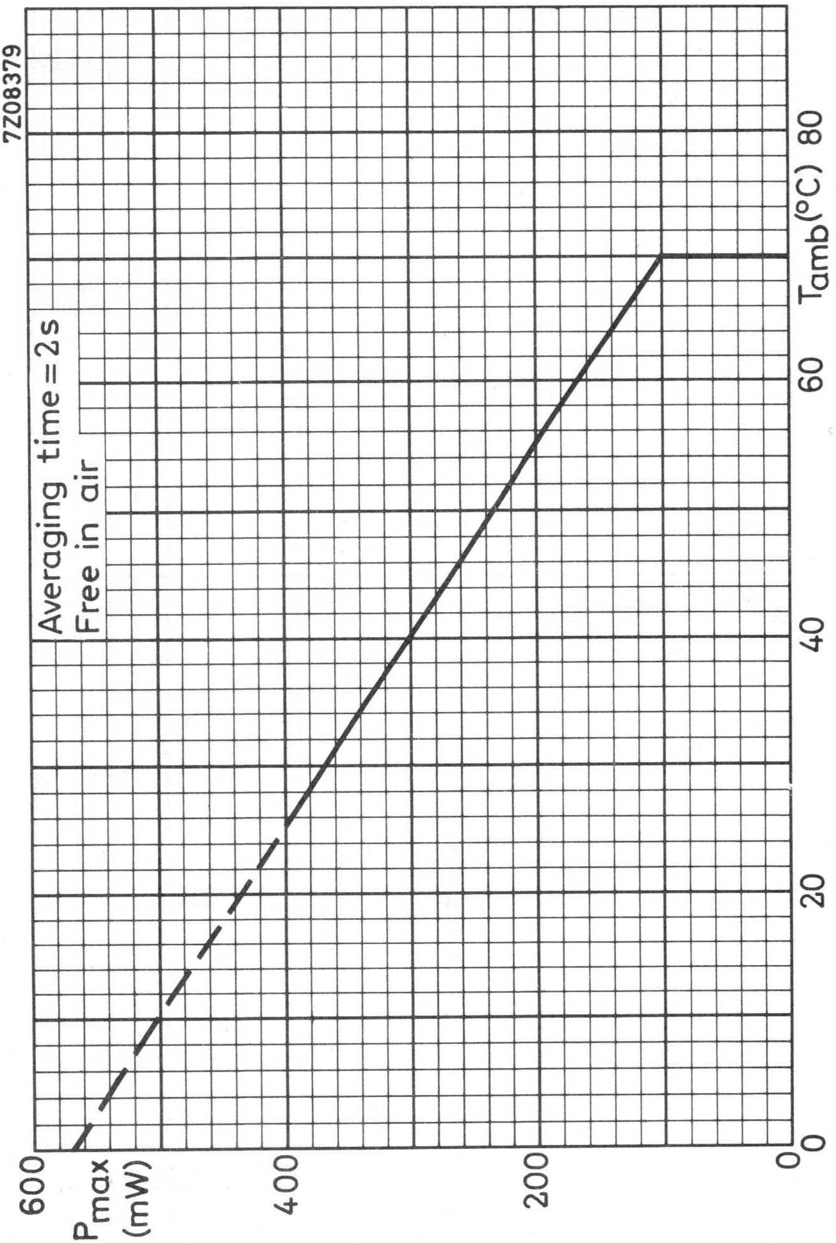
Cell voltage, d.c. and repetitive peak	V	max.	200	V
Cell voltage, pulse, t_{imp} = max. 5 ms p.r.r. = max. once per minute	V_p	max.	500	V
Power dissipation, t_{av} = 2 s	P	See sheet 6		
Power dissipation, pulse	P_p	max.	5xP	
Cell current, d.c. and repetitive peak	I	max.	100	mA
Illumination	E	max.	50 000	lux
Temperature CdS tablet, operating	T_{tablet}	max.	85	°C
Ambient temperature, storage and operating	T_{amb}	min.	-40	°C
storage	T_{amb}	max.	+50	°C [1]
operating	T_{amb}	max.	+70	°C

---

[1] Operation of the cell counteracts the deteriorating effect of long periods at high temperature. The maximum operating temperature is therefore higher than the maximum storage temperature.



r_{lo} initial illumination resistance at 2700 °K colour temperature, measured at 10 V d.c. after 16 h in darkness


7Z08379
Averaging time = 2s
Free in air
P_{max} (mW)
600
400
200
0
T_{amb} (°C)
0
20
40
60
80

CADMIUM SULPHIDE PHOTOCONDUCTIVE CELL

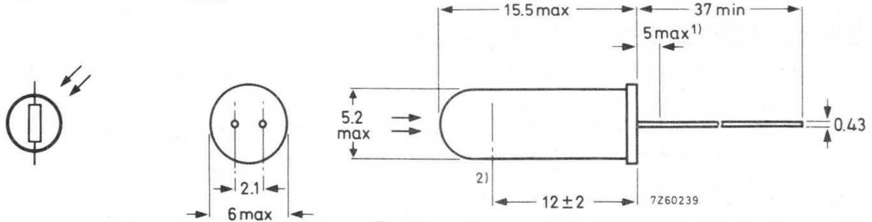
Cadmium sulphide photoconductive cell with top sensitivity intended for use in flame control and other industrial applications as well as for automatic brightness and contrast control in TV receivers.
The cell is shock and vibration resistant.

QUICK REFERENCE DATA

Power dissipation at T_{amb} = 25 °C	P	max.	70	mW
Cell voltage, d.c. and repetitive peak	V	max.	350	V
Cell resistance at 50 lux, 2700 °K colour temperature	r_{lo}		60	kΩ
Spectral response curve		type D		
Outline dimensions		max. 6 dia. x 15.5		mm

MECHANICAL DATA

Dimensions in mm



Sensitive area 0.25 mm^2

Soldering

The cell may be soldered directly into the circuit but heat conducted to the seal should be kept to a minimum by the use of a thermal shunt. The cell may be dip-soldered at a solder temperature of 240 °C for a maximum of 10 s up to a point 5 mm from the seals.

---

1) Not tin plated

2) Centre of sensitive area

ELECTRICAL DATA

General

The electrical properties of CdS cells are dependent on many factors such as illumination, colour temperature of the light source, voltage, current, temperature, total time of operation in the circuit and time of operation during the last 24 hours prior to the measurement. The following basic characteristics are therefore only checkpoints of the electrical properties of these devices measured with defined values of the various conditions and at delivery.

Basic characteristics at T_{amb} = 25 °C, illumination with colour temperature of 2700 °K and at delivery

	symbol	min.	typical	max.	unit
Initial dark current measured at 300 V d.c. applied via 1 MΩ, 20 s after switching off the illumination	I_{do}			1.5	μA
Initial illumination current measured at 30 V d.c. and illumination = 50 lux, after 16 hrs in darkness [1])	I_{lo}	200	500	800	μA
Sensitivity at 50 lux, with 30 V d.c. applied	N		10		μA/lux

End of life characteristics at T_{amb} = 25 °C

Life test conditions: Illumination 50 to 100 lux, colour temperature about 2500 °K, P = 60 mW, T_{amb} = 35 °C

None of the end of life values stated under this heading are expected to be reached before 2500 operating hours under the following conditions:

Initial dark current measured at 300 V d.c., 20 s after switching off the illumination	I_{do}	max. 3 μA
Change of initial illumination current during life measured at 30 V d.c., illumination = 50 lux and colour temperature = 2700 °K, after 16 hrs in darkness	ΔI_{lo}	max. 60 %

---

1) After 16 hours in darkness changes in the CdS material are still occurring, but have only insignificant effect on the illumination resistance and on the resistance decay time.

SHOCK AND VIBRATION

An indication for the ruggedness of the device is the following:
Samples taken from normal production are submitted to shock and vibration tests mentioned below. More than 95% of the devices pass these tests without perceptible damage.

Shock

25 g_{peak}, 3000 shock in one of the three positions of the cell.

Vibration

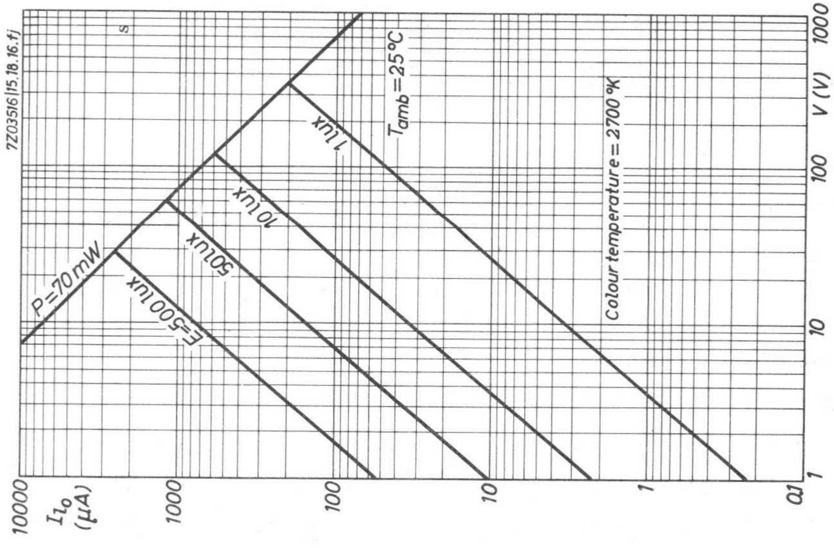
2.5 g_{peak}, 50 Hz during 32 hours in each of the three positions of the cell.

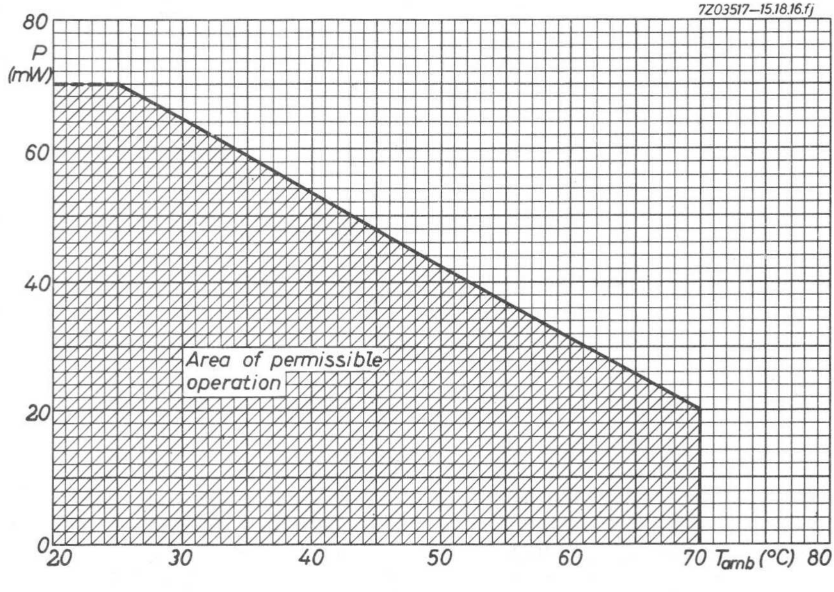
LIMITING VALUES (Absolute max. rating system)

Cell voltage, d.c. and repetitive peak		V	max.	350	V
Power dissipation at T_{amb} = 25 °C	See also sheet 4	P	max.	70	mW
Power dissipation at T_{amb} = 70 °C		P	max.	20	mW
Cell current, d.c. and repetitive peak		I	max.	7.5	mA
Ambient temperature, storage and operating		T_{amb}	min.	-40	°C
storage		T_{amb}	max.	+50	°C [1]
operating		T_{amb}	max.	+70	°C

---

[1] Operation of the cell counteracts the deteriorating effect of long periods at high temperature. The maximum operating temperature is therefore higher than the maximum storage temperature.


7Z03516|15.18.16.fj
P=70mW
E=5000 lux
50 lux
10 lux
1 lux
T_{amb}=25 °C
Colour temperature = 2700 °K
V (V)
1000
100
10
1
I_{l_0} (μA)
10000
1000
100
10
1
0.1


7Z03517–15.18.16.fj
P (mW)
80
60
40
20
0
Area of permissible operation
20
30
40
50
60
70
80
T_{amb} (°C)

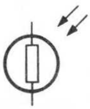
CADMIUM SULPHIDE PHOTOCONDUCTIVE CELL

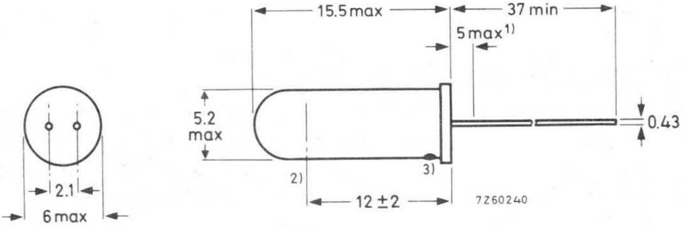
Cadmium sulphide photoconductive cell with side sensitivity intended for use in flame control and other industrial applications as well as for automatic brightness and contrast control in TV receivers.
The cell is shock and vibration resistant.

QUICK REFERENCE DATA				
Power dissipation at T_{amb} = 25 °C	P	max.	70	mW
Cell voltage, d.c. and repetitive peak	V	max.	350	V
Cell resistance at 50 lux, 2700 °K colour temperature	r_{lo}		60	kΩ
Spectral response curve		type D		
Outline dimensions		max. 6 dia. x	15.5	mm

MECHANICAL DATA

Dimensions in mm





Sensitive area 0.25 mm²

Soldering

The cell may be soldered directly into the circuit but heat conducted to the seal should be kept to a minimum by the use of a thermal shunt. The cell may be dip-soldered at a solder temperature of 240 °C for a maximum of 10 s up to a point 5 mm from the seals.

---

1) Not tin plated

2) Centre of sensitive area

3) Brown dot

ELECTRICAL DATA

General

The electrical properties of CdS cells are dependent on many factors such as illumination, colour temperature of the light source, voltage, current, temperature, total time of operation in the circuit and time of operation during the last 24 hours prior to the measurement. The following basic characteristics are therefore only checkpoints of the electrical properties of these devices measured with defined values of the various conditions and at delivery.

Basic characteristics at T_{amb} = 25 °C, illumination with colour temperature of 2700 °K and at delivery

	symbol	min.	typical	max.	unit
Initial dark current measured at 300 V d.c. applied via 1 MΩ, 20 s after switching off the illumination	I_{do}			1.5	μA
Initial illumination current measured at 30 V d.c. and illumination = 50 lux, after 16 hrs in darkness [1])	I_{lo}	200	500	800	μA
Sensitivity at 50 lux, with 30 V d.c. applied	N		10		μA/lux

End of life characteristics at T_{amb} = 25 °C

Life test conditions: Illumination 50 to 100 lux, colour temperature about 2500 °K, P = 60 mW, T_{amb} = 35 °C

None of the end of life values stated under this heading are expected to be reached before 2500 operating hours under the following conditions:

Initial dark current measured at 300 V d.c., 20 s after switching off the illumination	I_{do}	max. 3	μA
Change of initial illumination current during life measured at 30 V d.c., illumination = 50 lux and colour temperature = 2700 °K, after 16 hrs in darkness	ΔI_{lo}	max. 60	%

---

[1]) After 16 hours in darkness changes in the CdS material are still occurring, but have only insignificant effect on the illumination resistance and on the resistance decay time.

SHOCK AND VIBRATION

An indication for the ruggedness of the device is the following:
Samples taken from normal production are submitted to shock and vibration tests mentioned below. More than 95% of the devices pass these tests without perceptible damage.

Shock

25 g_{peak}, 3000 shocks in one of the three positions of the cell.

Vibration

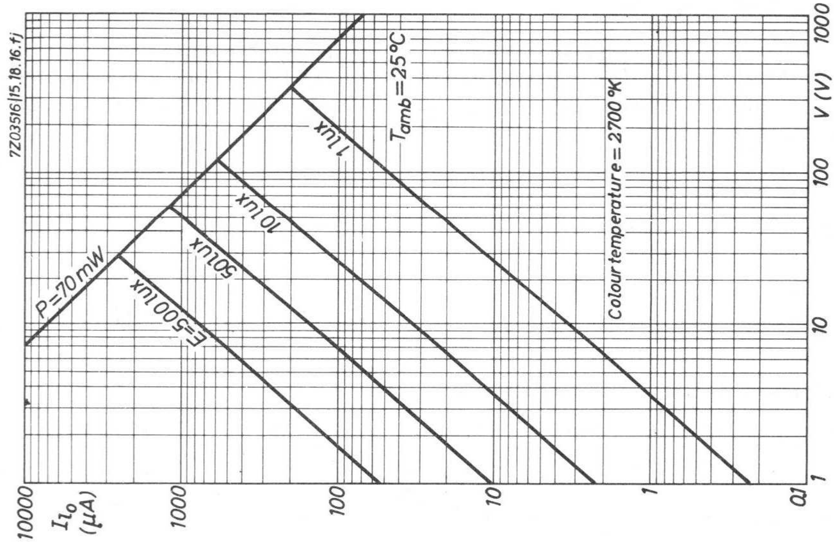
2.5 g_{peak}, 50 Hz during 32 hours in each of the three positions of the cell.

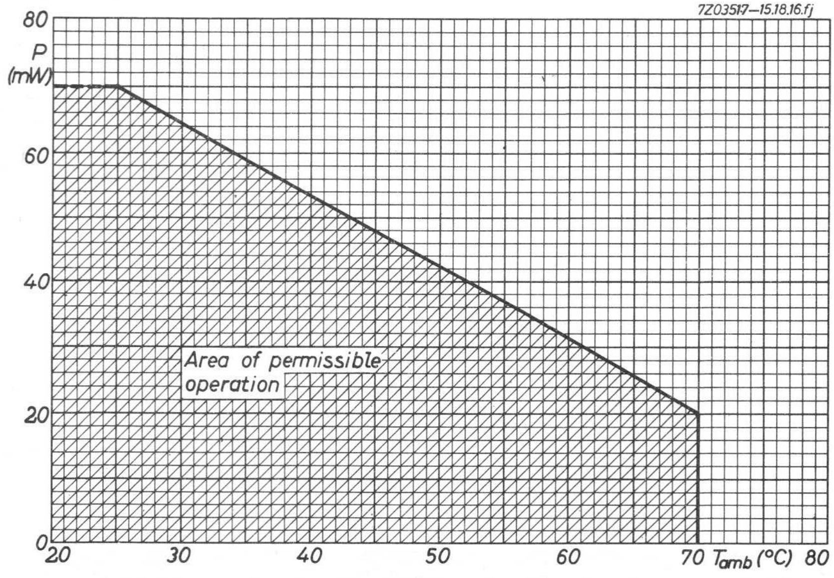
LIMITING VALUES (Absolute max. rating system)

Cell voltage, d.c. and repetitive peak		V	max.	350	V
Power dissipation at T_{amb} = 25 ^{o}C	See also sheet 4	P	max.	70	mW
Power dissipation at T_{amb} = 70 ^{o}C		P	max.	20	mW
Cell current, d.c. and repetitive peak		I	max.	7.5	mA
Ambient temperature,	storage and operating	T_{amb}	min.	-40	^{o}C
	storage	T_{amb}	max.	+50	^{o}C [1]
	operating	T_{amb}	max.	+70	^{o}C

---

[1] Operation of the cell counteracts the deteriorating effect of long periods at high temperature. The maximum operating temperature is therefore higher than the maximum storage temperature.


7Z03516|15.18.16.fj
T_{amb}=25°C
Colour temperature = 2700 °K
1 lux
10 lux
50 lux
E=500 lux
P=70 mW
V (V)
1000
100
10
1
I_{Lo} (μA)
10000
1000
100
10
1
0.1


7Z03517–15.18.16.fj
80
P (mW)
60
40
20
0
20
30
40
50
60
70
T_{amb} (°C)
80
Area of permissible operation

CADMIUM SULPHIDE PHOTOCONDUCTIVE CELL

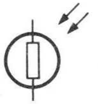
Cadmium sulphide photoconductive cell with side sensitivity intended for use in industrial on-off applications such as flame failure circuits.
The cell is tropic proof, shock and vibration resistant.

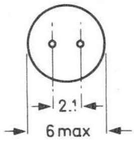
QUICK REFERENCE DATA

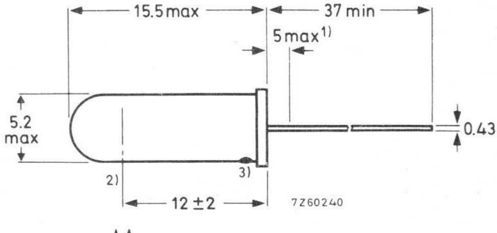
Power dissipation at T_{amb} = 25 °C	P	max.	100	mW
Cell voltage, d.c. and repetitive peak	V	max.	350	V
Cell resistance at 50 lux, 2700 °K colour temperature	r_{l_0}		45	kΩ
Spectral response curve		type D		
Outline dimensions		max. 6 dia x 15.5		mm

MECHANICAL DATA

Dimensions in mm







Soldering

The cell may be soldered directly into the circuit but heat conducted to the seal should be kept to a minimum by the use of a thermal shunt. The cell may be dip-soldered at a solder temperature of 240 °C for a maximum of 10 s up to a point 5 mm from the seals.

---

1) Not tinned

2) Centre of sensitive area

3) Red dot

ELECTRICAL DATA

General.

The electrical properties of CdS cells are dependent on many factors such as illumination, colour temperature of the light source, voltage, current, temperature, total time of operation in the circuit and time of operation during the last 24 hours prior to the measurement. The following basic characteristics are therefore only checkpoints of the electrical properties of these devices measured with defined values of the various conditions and at delivery.

Basic characteristics at T_{amb} = 25 °C, illumination with colour temperature of 2700 °K and at delivery.

	symbol	min.	typical	max.	unit
Initial dark resistance measured with 300 V d.c. applied via 1 MΩ, 20 s after switching off the illumination	r_{d_o}	150		1)	MΩ
Initial illumination resistance measured at 30 V d.c., illumination 50 lux, after 16 h in darkness 2)	r_{l_o}	30	45	100	kΩ
Equilibrium illumination resistance measured at 30 V d.c., illumination 50 lux, after 15 min. under the measuring conditions	r_{l_e}	30	60	170	kΩ
Current rise time	t_{r_i}		see page 6		
Current decay time	t_{f_i}		see page 6		
Sensitivity at 50 lux, with 30 V d.c. applied	N		13		μA/lux
Negative temperature response of illumination resistance	$\Delta r_l/\Delta T$		0.2	0.5	%/°C
Voltage respons $\frac{r \text{ at } 0.5 \text{ V d.c.}}{r \text{ at } 30 \text{ V d.c.}}$			1.4		

---

1) The spread of the dark resistance is large and values higher than 1000 MΩ are possible for the initial dark resistance.

2) After 16 hours in darkness changes in the CdS material are still occurring, but have only insignificant effect on the illumination resistance and on the current rise time.

THERMAL DATA

Continuous temperature of CdS tablet	T_{tablet}	max. + 85	°C
Thermal resistance from CdS tablet to ambient, device free in air	K	600	°C/W

DESIGN CONSIDERATIONS

Apparatus with CdS cells should be designed so that changes in resistance values of the cells during life from -30 % to + 70 % do not impair the circuit performance. Direct sunlight irradiation should be avoided.

SHOCK AND VIBRATION

An indication for the ruggedness of the cell is the following:
Samples taken from normal production are submitted to shock and vibration tests mentioned below. More than 95% of the devices pass these tests without perceptible damage.

Shock

25 g_{peak}, 10000 shocks in one of the three positions of the cell.

Vibration

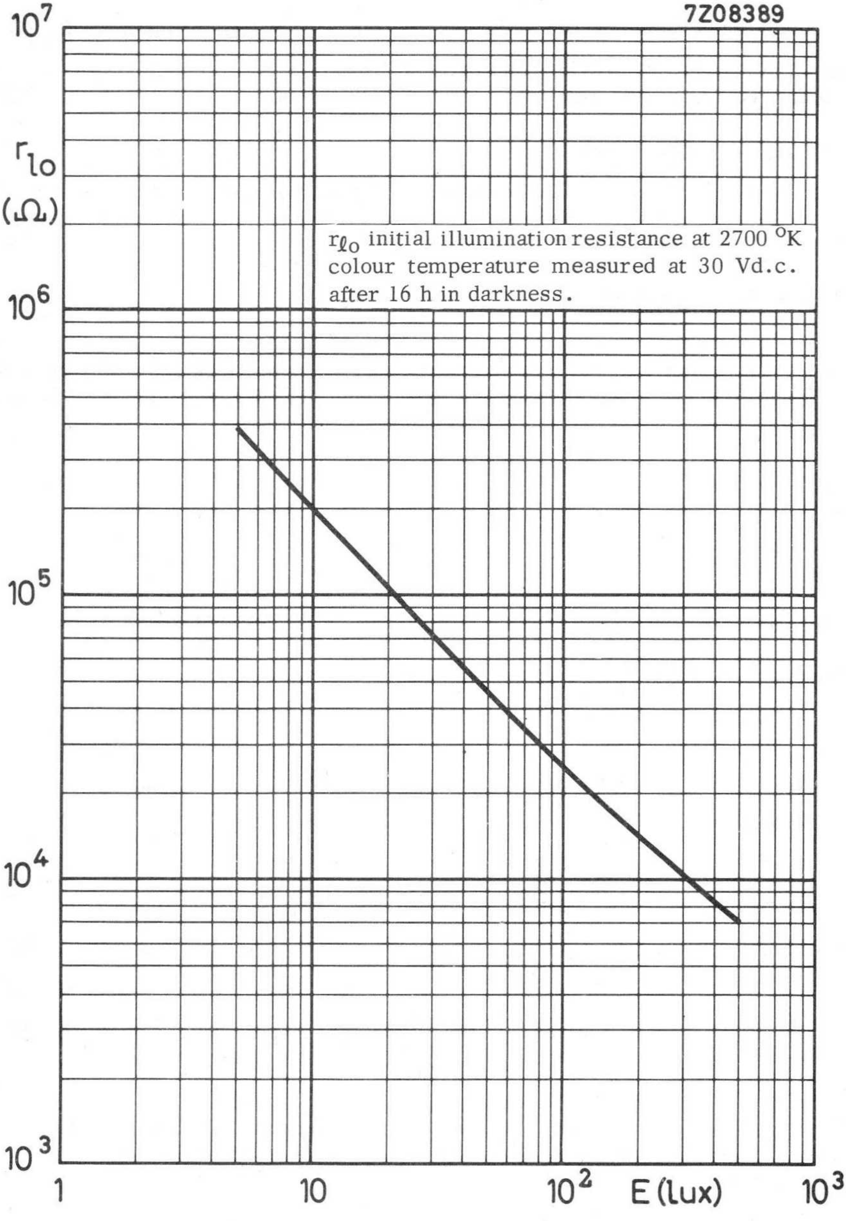
2.5 g_{peak}, 50 Hz, during 32 hours in each of the three positions of the cell.

LIMITING VALUES (Absolute max. rating system)

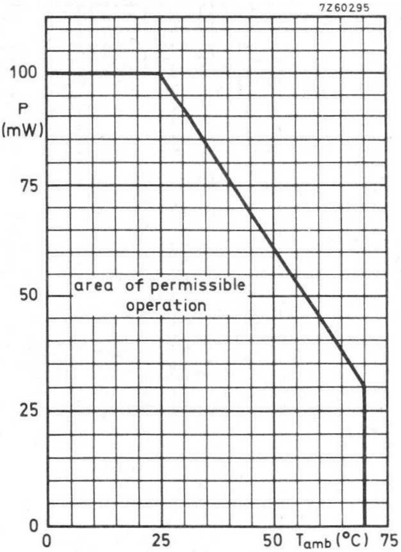
Cell voltage, d.c. and repetitive peak	V	max.	350	V
Cell voltage, pulse, t_{imp} = max. 5 ms p.r.r. max. once per minute	V_p	max.	1000	V
Power dissipation, t_{av} = 2 s	P	see page 5		
Power dissipation, pulse	P_p	max.	5 x P	
Temperature CdS tablet, operating	T_{tablet}	max.	85	°C
Ambient temperature, storage and operating	T_{amb}	min.	-40	°C
storage	T_{amb}	max.	+50	°C 1)
operating	T_{amb}	max.	+70	°C

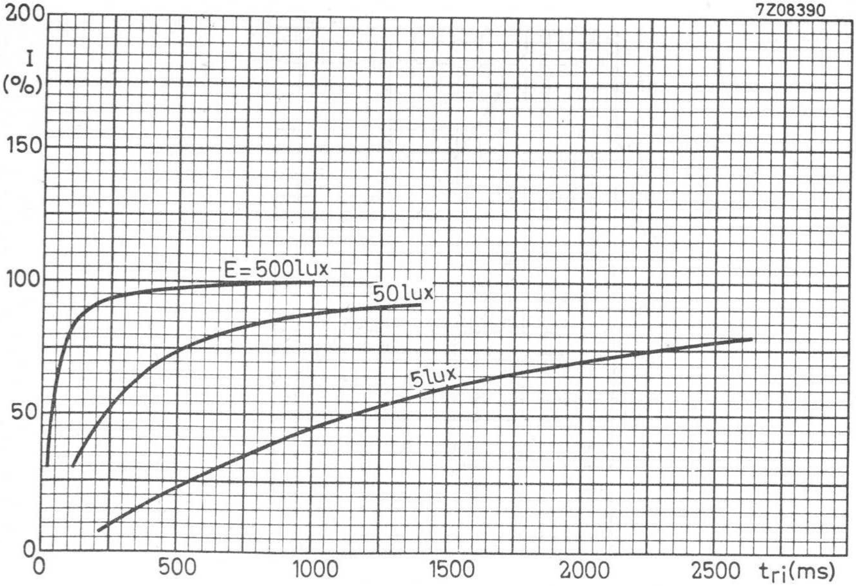
---

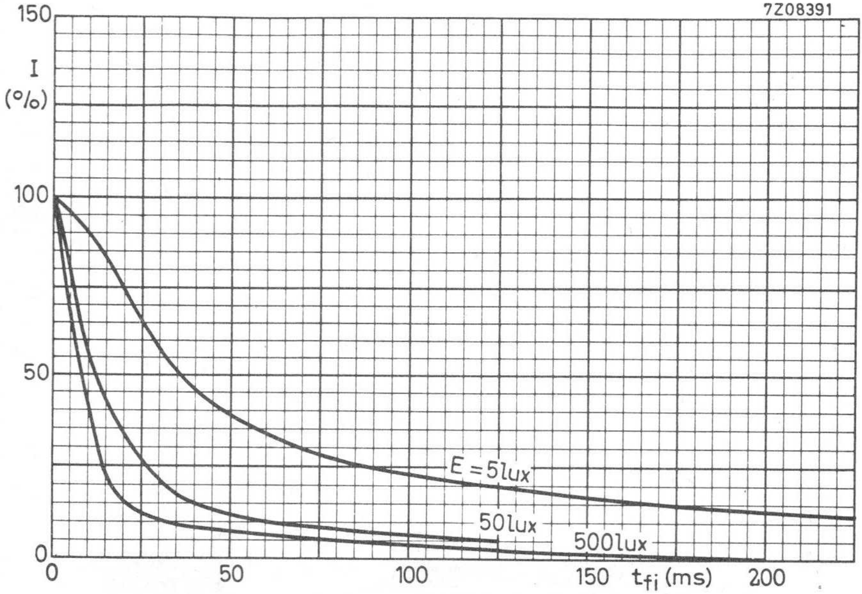
1) Operation of the cell counteracts the deteriorating effect of long periods at high temperature. The maximum operating temperature is therefore higher than the maximum storage temperature.



$r_{\ell o}$ initial illumination resistance at 2700 °K colour temperature measured at 30 Vd.c. after 16 h in darkness.


7Z60295
100
P
(mW)
75
50
25
0
0
25
50
T_{amb} (°C)
75
area of permissible
operation


7Z08390
200
I
(%)
150
100
50
0
0
500
1000
1500
2000
2500
t_{ri}(ms)
E=500lux
50lux
5lux


7Z08391
150
I
(%)
100
50
0
0
50
100
150
t_{fi} (ms)
200
E = 5lux
50lux
500lux

CADMIUM SULPHIDE PHOTOCONDUCTIVE CELL

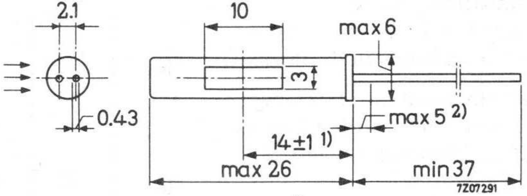
Cadmium sulphide photoconductive cell with side sensitivity.
The cell is tropic proof, shock- and vibration resistant.

QUICK REFERENCE DATA

Power dissipation	P	max.	75	mW
Cell voltage, d.c. and repetitive peak	V	max.	100	V
Cell resistance at 50 lux, 2700 °K colour temperature	r_{lo}		1600	Ω
Spectral response		type D		
Outline dimensions			6 dia. x 26	mm

MECHANICAL DATA

Dimensions in mm



Total area to be illuminated	0.3	cm^2
Sensitive part of this area	0.15	cm^2

Soldering

The cell may be soldered directly into the circuit but heat conducted to the seal should be kept to a minimum by the use of a thermal shunt. The cell may be dip-soldered at a solder temperature of 240 °C for a maximum of 10 s up to a point 5 mm from the seal.

---

1) Centre of sensitive area.

2) Not tin plated.
Care should be taken not to bend the leads nearer than 1.5 mm to the seal.

ELECTRICAL DATA

General

The electrical properties of CdS cells are dependent on many factors such as illumination, colour temperature of the light source, voltage, current, temperature, total time of operation in the circuit and time of operation during the last 24 hours prior to the measurement. The following basic characteristics are therefore only checkpoints of the electrical properties of these devices measured with defined values of the various conditions and at delivery.

Basic characteristics at T_{amb} = 25 °C, illumination with colour temperature = 2700 °K and at delivery

	Symbol	min.	typical	max.	unit
Initial dark resistance measured with 100 V d.c. applied via 1 MΩ 20 s after switching off the illumination	r_{do}	9		1)	MΩ
Equilibrium dark resistance measured with 100 V d.c. applied via 1 MΩ, 30 min. after switching off the illumination	r_{de}	250		1)	MΩ
Initial illumination resistance measured at V = 10 V, illumination 50 lux, after 16 hours in darkness 2)	r_{lo}	750	1600	2500	Ω
Equilibrium illumination resistance measured at V = 10 V, illumination 50 lux, after 15 minutes under the measuring conditions	r_{le}	750	1920	3250	Ω
Current rise time Time to reach 90% of its initial illumination current, measured from the instant of starting the illumination of 50 lux, at V = 10 V, after 16 hours in darkness	t_{ri}		1000		ms

---

1) The spread of the dark resistance is large and values higher than 30 MΩ and 2000 MΩ are possible for the initial dark resistance and the equilibrium dark resistance respectively.

2) After 16 hours in darkness changes in the CdS material are still occurring, but have only insignificant effect on the illumination resistance and on the resistance decay time.

ELECTRICAL DATA (continued)

	Symbol	min.	typical	max.	unit
Current decay time Time to reach 10% of its initial illumination current, measured from the instant of stopping the illumination of 50 lux, at V = 10 V, after 16 hours in darkness	t_{fi}		75		ms
Sensitivity at 50 lux, with V = 10 V d.c. applied	N		0.15		mA/lux
Negative temperature response of the illumination resistance			0.2	0.5	%/°C
Voltage response $\frac{\text{r at 0.5 V}}{\text{r at 10 V}}$	α		1.5		

DESIGN CONSIDERATIONS

It should be noted that this cell is designed for very high typical sensitivity with respect to its sensitive area, but that it may be expected that a high sensitivity will only be maintained if the dissipation averaged over 2 s is kept below 20 mW at 25 °C. Higher dissipations will accelerate the aging process which lowers sensitivity.

SHOCK AND VIBRATION

An indication for the ruggedness of the cell is the following:
Samples taken from normal production are submitted to shock and vibration tests mentioned below: More than 95% of the devices pass these tests without perceptible damage.

Shock

25 g_{peak}, 10000 shocks in one of the three positions of the cell.

Vibration

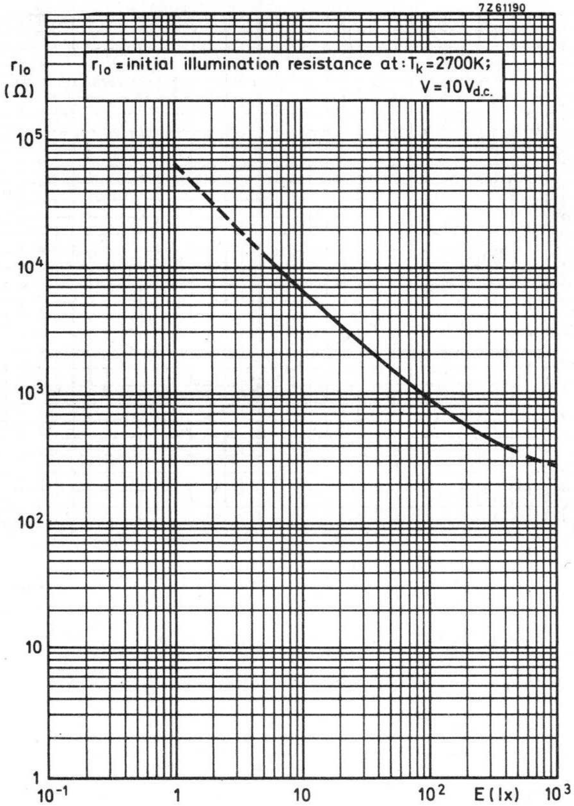
2.5 g_{peak}, 50 Hz, during 32 hours in each of the three positions of the cell.

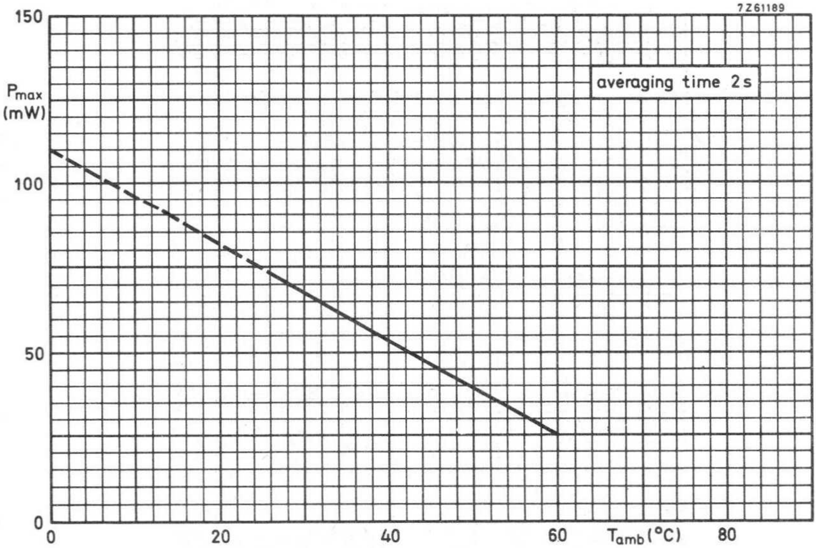
LIMITING VALUES (Absolute max. rating system)

Cell voltage, d.c. and repetitive peak		V	max.	100	V
Power dissipation, t_{av} = 2 s		P	see sheet 5		
Ambient temperature,	storage and operating	T_{amb}	min.	-40	°C
	Storage	T_{amb}	max.	+40	°C [1]
	Operating	T_{amb}	max.	+70	°C

---

[1] Operation of the cell counteracts the deteriorating effect of long periods at the high temperature. The maximum operating temperature is therefore higher than the maximum storage temperature.


7Z61190
r_{lo} (Ω)
r_{lo} = initial illumination resistance at: T_k = 2700K; $V = 10\,V_{d.c.}$
10^5
10^4
10^3
10^2
10
1
10^{-1}
1
10
10^2
E (lx)
10^3


7Z61189
150
P_{max}
(mW)
100
50
0
averaging time 2 s
0
20
40
60
T_{amb} (°C)
80

CADMIUM SULPHIDE PHOTOCONDUCTIVE CELL

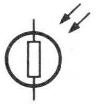
Cadmium sulphide photoconductive cell with side andtop sensitivity for use in flame control and other industrial on off applications.
The cell is tropic proff, shock and vibration resistant.

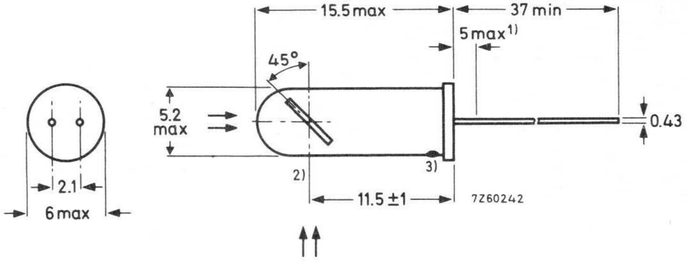
QUICK REFERENCE DATA

Power dissipation at T_{amb} = + 25 °C	P	max.	100	mW
Cell voltage, d.c. and repetitive peak	V	max.	350	V
Cell resistance top sensitivity at 50 lux, 2700 °K colour temperature	r_{lo}		30	kΩ
Spectral response curve		type D		
Outline dimensions		max. 6 dia x	15.5	mm

MECHANICAL DATA

Dimensions in mm





Soldering

The cell may be soldered directly into the circuit but heat conducted to the seal should be kept to a minimum by the use of a thermal shunt. The cell may be dip-soldered at a solder temperature of 240 °C for a maximum of 10 s up to a point 5 mm from the seals.

---

1) Not tin plated
2) Centre of sensitive area
3) White dot

ELECTRICAL DATA

General

The electrical properties of CdS cells are dependent on many factors such as illumination, colour temperature of the light source, voltage, current, temperature, total time of operation in the circuit and time of operation during the last 24 hours prior to the measurement. The following basic characteristics are therefore only checkpoints of the electrical properties of these devices measured with defined values of the various conditions and at delivery.

Basic characteristics at T_{amb} = 25 °C, illumination with colour temperature of 2700 °K and at delivery

	symbol	min.	typical	max.	unit
Initial dark resistance measured with 300 V d.c. applied via 1 MΩ, 20 s after switching off the illumination	r_{do}	100		[1])	MΩ
Initial illumination resistance measured at 30 V d.c., illumination = 50 lux, after 16 hours in darkness 2) 3)	r_{lo}	20	30	60	kΩ
Ratio side/top sensitivity	r_{le}side/top	0.7	1.0	1.8	
Equilibrium illumination resistance measured at 30 V d.c. illumination = 50 lux, after 15 minutes under the measuring conditions 3)	r_{le}	27	46	115	kΩ
Current rise time	t_{ri}	see	sheet 7		
Current decay time	t_{fi}	see	sheet 7		

---

[1]) The spread of the dark resistance is large and values higher than 1000 MΩ are possible for the initial dark resistance.

[2]) After 16 hours in darkness changes in the CdS material are still occurring, but have only insignificant effect on the illumination resistance and on the resistance decay time.

[3]) Measured at top sensitivity.

Basic characteristics at T_{amb} = 25 °C , illumination with colour temperature of 2700 °K and at delivery (continued)

	symbol	min.	typical	max.	unit
Sensitivity at 50 lux, with 30 V d.c. applied 3)	N		20		μA/lux
Negative temperature response of illumination resistance	$\Delta r_l/\Delta T$		0.2	0.5	%/ °C
Voltage response $\frac{\text{r at 0.5 V d.c.}}{\text{r at 30 V d.c.}}$	α		1.4		

THERMAL DATA

Continous temperature of CdS tablet	T_{tablet}	max. + 85 °C
Thermal resistance from CdS tablet to ambient, device free in air	K	600 °C/W

DESIGN CONSIDERATIONS

Apparatus with CdS cells should be designed so that changes in resistance values of the cells during life from −30% to +70 % do not impair the circuit performance. Direct sunlight irradiation should be avoided.

SHOCK AND VIBRATION

An indication for the ruggedness of the cell is the following:
Samples taken from normal production are submitted to shock and vibration tests mentioned below. More than 95% of the devices pass these tests without perceptible damage.

Shock

25 g_{peak}, 10 000 shocks in one of the three positions of the cell.

Vibration

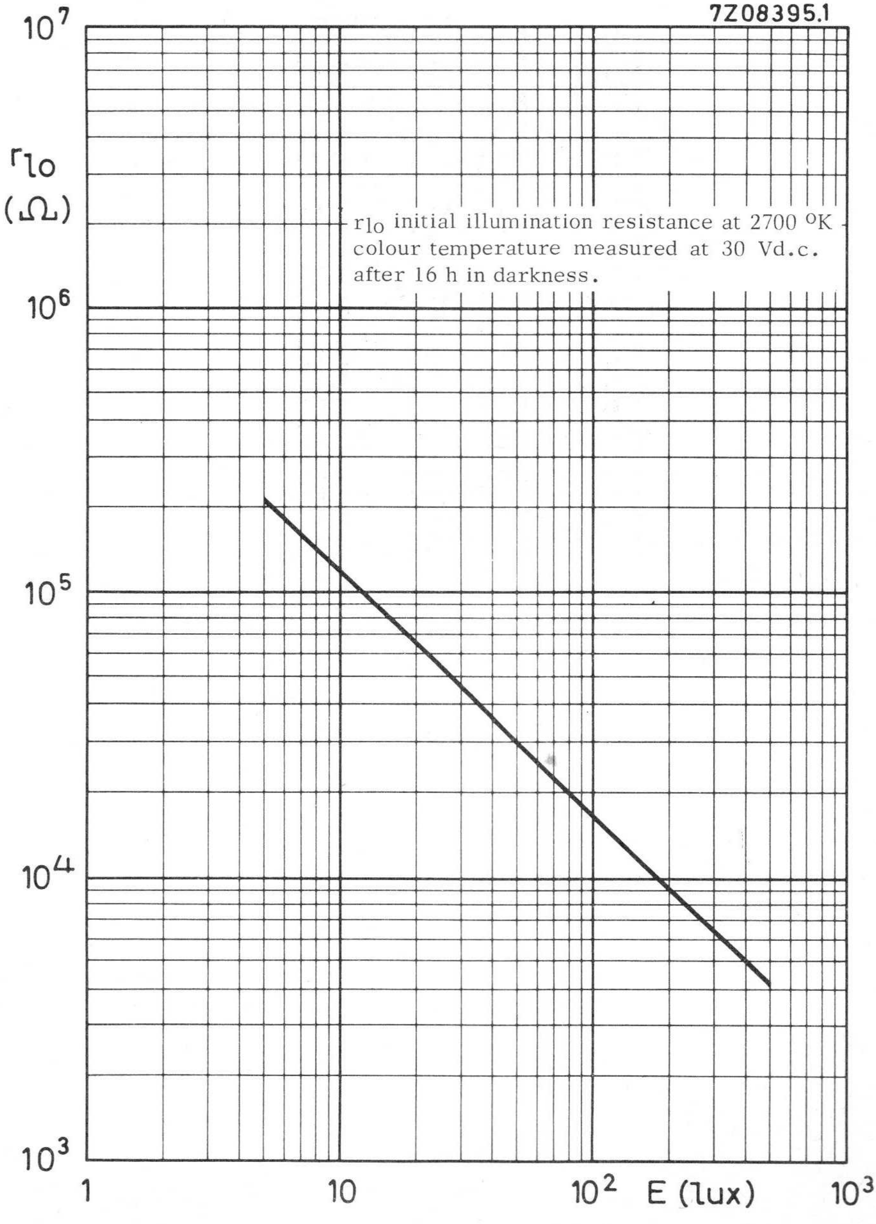
2.5 g_{peak}, 50 Hz, during 32 hours in each of the three positions of the cell.

LIMITING VALUES Absolute max. rating system)

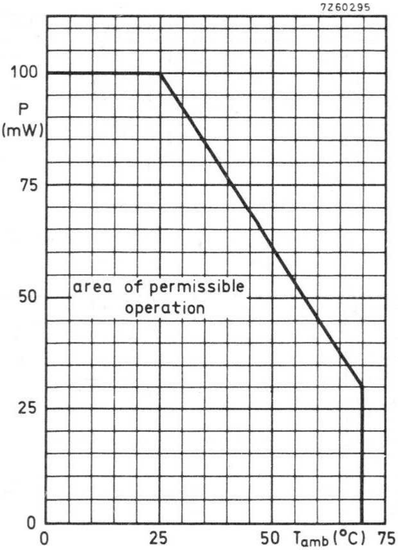
Cell voltage, d.c. and repetitive peak	V	max.	350	V
Cell voltage, pulse, t_{imp} = max. 5 ms p.r.r. = max. once per minute	V_p	max.	700	V
Power dissipation, t_{av} = 2 s	P	See sheet 6		
Power dissipation, pulse	P_p	max.	5xP	
Temperature CdS tablet, operating	T_{tablet}	max.	+85	°C
Ambient temperature, storage and operating	T_{amb}	min.	-40	°C
storage	T_{amb}	max.	+50	°C 1)
operating	T_{amb}	max.	+70	°C

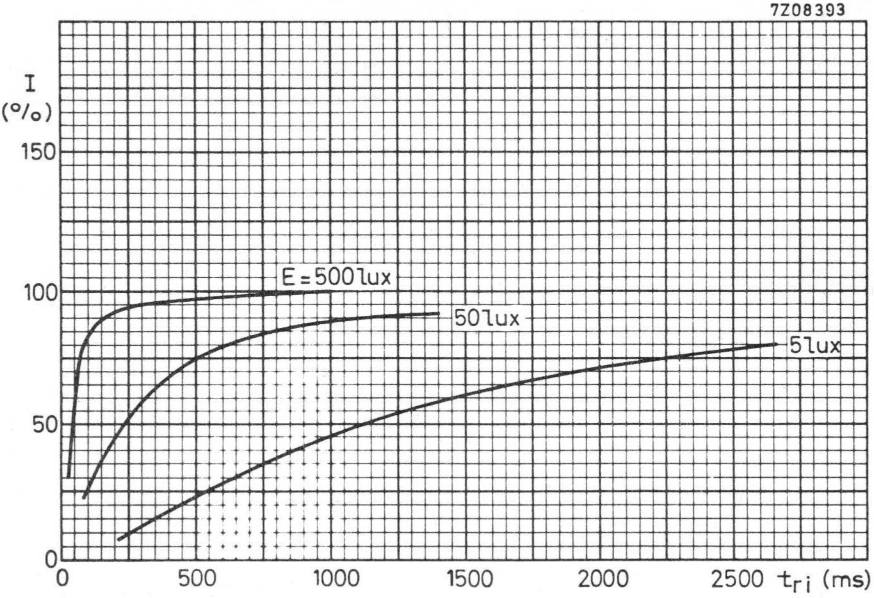
---

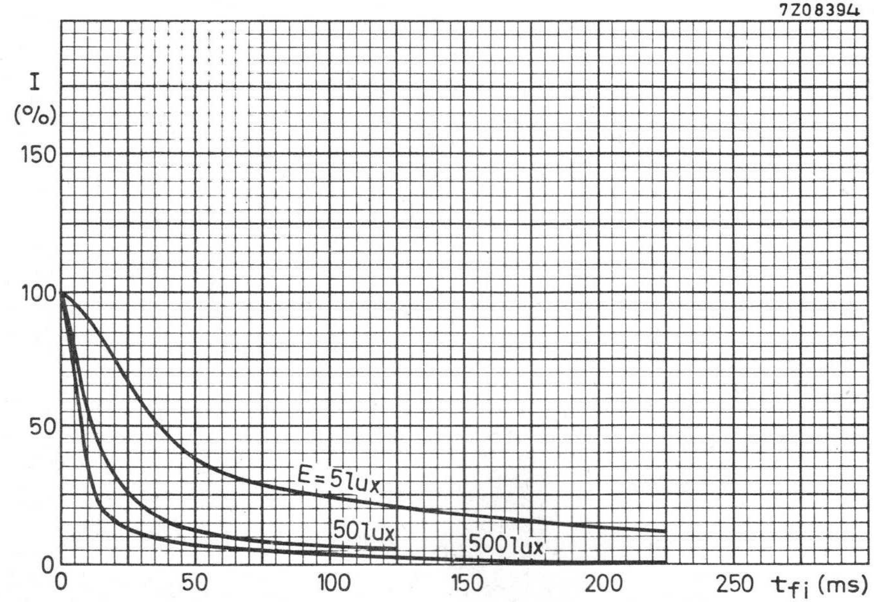
1) Operation of the cell counteracts the deteriorating effect of long periods at high temperature. The maximum operating temperature is therefore higher than the maximum storage temperature.



r_{lo} initial illumination resistance at 2700 °K colour temperature measured at 30 Vd.c. after 16 h in darkness.


7Z60295
100
P
(mW)
75
50
25
0
0
25
50
T_{amb} (°C)
75
area of permissible operation


7Z08393
I
(%)
150
100
50
0
0
500
1000
1500
2000
2500
t_{ri} (ms)
E = 500lux
50lux
5lux


7Z08394
I
(%)
150
100
50
0
0
50
100
150
200
250
t_{fi} (ms)
E = 5lux
50lux
500lux

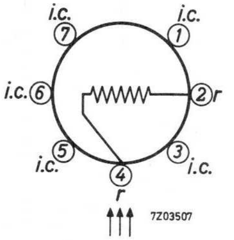
CADMIUM SULPHIDE PHOTOCONDUCTIVE CELL

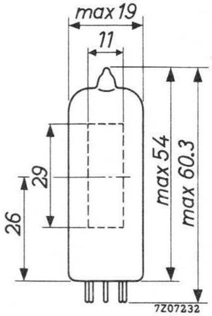
Cadmium sulphide photoconductive cell with side sensitivity intended for use in flame control, smoke detector or industrial on-off switching applications. The cell is shock and vibration resistant.

QUICK REFERENCE DATA				
Power dissipation at T_{amb} = 25 °C	P	max.	1	W
Cell voltage, d.c. and repetitive peak	V	max.	350	V
Cell resistance at 50 lux, 2700 °K colour temperature	r		1000	Ω
Spectral response curve		type D		
Outline dimensions		max. 19 dia. x 60.3		mm

MECHANICAL DATA

Dimensions in mm





Base: 7 p. miniature

Total area to be illuminated 1.1 x 2.9 cm^2

ELECTRICAL DATA

General

The electrical properties of CdS cells are dependent on many factors such as illumination, colour temperature of the light source, voltage current, temperature, total time of operation in the circuit and time of operation during the last 24 hours prior to the measurement. The following basic characteristics are therefore only checkpoints of the electrical properties of these devices measured with defined values of the various conditions and at delivery.

Basic characteristics at T_{amb} = 25 °C, illumination with colour temperature of 2700 °K and at delivery.

	symbol	min.	typical	max.	unit
Initial dark current measured with 300 V d.c. applied via 1 MΩ, 20 s after switching off the illumination	I_{do}			70	μA
Equilibrium dark current measured with 300 V d.c. applied via 1 MΩ, 15 minutes after switching off the illumination	I_{do}			2.5	μA
Initial illumination current measured at 10 V d.c. and illumination = 50 lux, after 16 hrs in darkness [1]	I_{lo}	3	10	15	mA
Initial illumination current measured at 10 V d.c., illumination = 50 lux and colour temperature = 1500 °K, after 16 hrs in darkness	I_{lo}	6	20	31	mA
Sensitivity at 50 lux, with 10 V d.c. applied	N		0.2		mA/lux
Current rise time	t_{ri}		see sheet 5		
Current decay time	t_{fi}		see sheet 5		

---

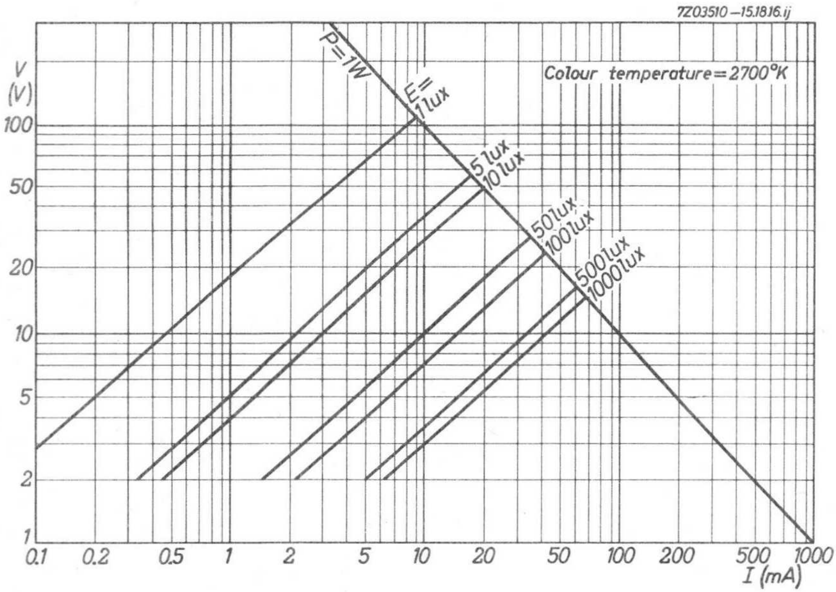
[1] After 16 hours in darkness changes in the CdS material are still occurring, but have only insignificant effect on the illumination resistance and on the resistance decay time.

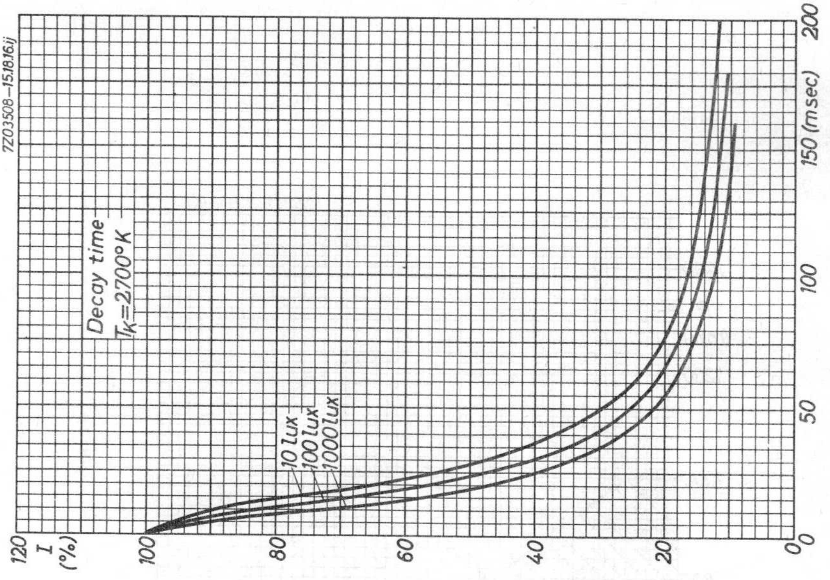
LIMITING VALUES (Absolute max. rating system)

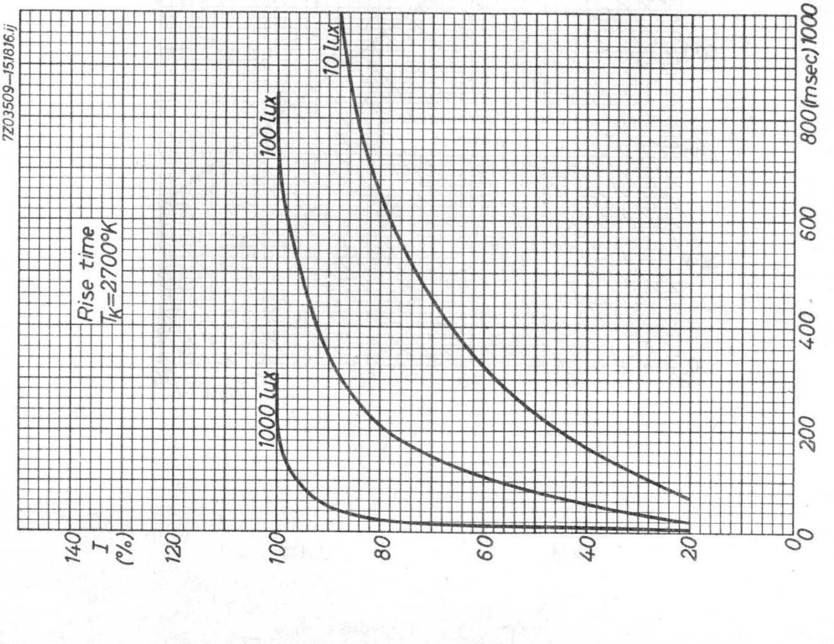
Cell voltage, d.c. and repetitive peak		V	max.	350	V
Power dissipation at T_{amb} = 25 °C	See also sheet 6	P	max.	1.0	W
Power dissipation at T_{amb} = 70 °C		P	max.	0.3	W
Ambient temperature, storage and operating		T_{amb}	min.	-40	°C
storage		T_{amb}	max.	+50	°C (1)
operating		T_{amb}	max.	+70	°C

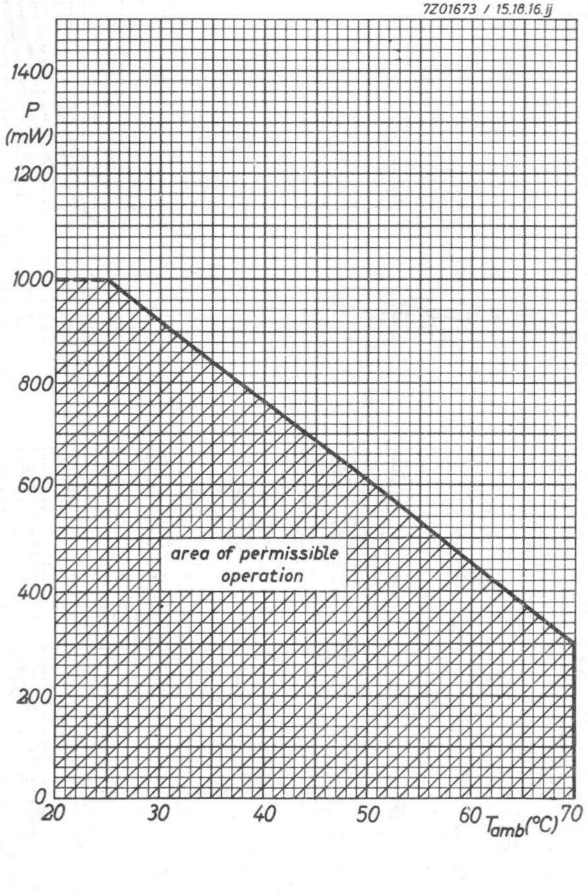
---

(1) Operation of the cell counteracts the deteriorating effect of long periods at high temperature. The maximum operating temperature is therefore higher than the maximum storage temperature.


7Z03510 –15.18.16.ij
V
(V)
100
50
20
10
5
2
1
0.1
0.2
0.5
1
2
5
10
20
50
100
200
500
1000
I (mA)
P=1W
E=
1 lux
5 lux
10 lux
50 lux
100 lux
500 lux
1000 lux
Colour temperature=2700°K


7Z03508–15.18.16.ij
Decay time
T_K=2700°K
10 lux
100 lux
1000 lux
I
(%)
120
100
80
60
40
20
0
0
50
100
150 (msec)
200


7Z03509–15.18.16.ij
Rise time
T_K=2700°K
1000 lux
100 lux
10 lux
140
I
(%)
120
100
80
60
40
20
0
0
200
400
600
800 (msec) 1000


7Z01673 / 15.18.16.ij
1400
P
(mW)
1200
1000
800
600
400
200
0
20
30
40
50
60
70
T_{amb}(°C)
area of permissible operation

LAMP CdS CELLS-COMBINATION

Combination of four cadmium sulphide photoconductive cells and a small incandescent lamp in a Noval envelope for use in relais circuits with low output resistance, control circuits and logic circuits.

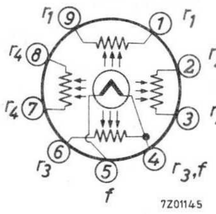
QUICK REFERENCE DATA

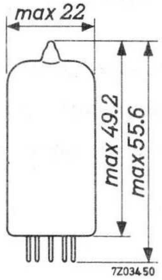
Power dissipation, each cell, at T_{amb} = 25 °C	P	max.	150	mW
Cell voltage, d.c. and repetitive peak	V	max.	200	V
Cell resistance	r		15	Ω
Outline dimensions		max. 22 dia. x 55.6		mm

MECHANICAL DATA

Dimensions in mm

Base: Noval





ELECTRICAL DATA

Basic characteristics at T_{amb} = 25 °C, and at delivery

	symbol	min.	typical	max.	unit
Lamp filament voltage	V_f		24		V 2)
Lamp filament current at V_f = 24 V	I_f	54	60	66	mA
Initial dark current measured in the circuit of fig.1	I_{do}			15	μA

Basic characteristics at T_{amb} = 25 °C, and at delivery (continued)

	symbol	min.	typical	max.	unit
Initial illumination resistance measured in the circuit of fig.1 after 16 hrs in darkness 1)	r_{lo}		15	25	Ω
Resistance decay time Time to reach 400 Ω in circuit of fig.2, measured from the instant of starting the illumination after 16 hrs in darkness	t_{fr}		20		ms
Resistance rise time Time to reach 300 kΩ in circuit of fig.2, measured from the instant of stopping the illumination after 5 minutes or longer illumination	t_{rr}			1.7	s
Insulation resistance between two cells or between cell and filament measured at 300 V d.c.	r_{ins}	200			MΩ

CAPACITANCES measured at filament voltage V_f = 0 V

Between the terminals of each cell	C_r		9.5	pF
Between any cell terminal and the filament (except pins 4 and 6)	C_{rf}	max.	1	pF

REMARK

Shock and vibration should be avoided.

LIMITING VALUES (Absolute max. rating system)

Filament voltage (d.c. or r.m.s.)	V_f	max.	25.2	V	2)
Cell voltage, d.c. and repetitive peak	V	max.	200	V	
Power dissipation of each cell at T_{amb} = 25 °C	P	max.	150	mW	3)
Power dissipation of each cell at T_{amb} = 55 °C	P	max.	85	mW	3)
Voltage between any pair of cells	V_{ri}-V_{rj}	max.	350	V	
Ambient temperature, operating	T_{amb}	min.	-40	°C	
		max.	+55	°C	3)

Measuring circuit for r_{lo} and I_{do}

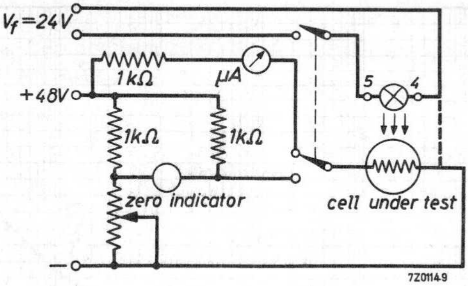


Fig.1

Measuring circuit t_{fr} and t_{rr}

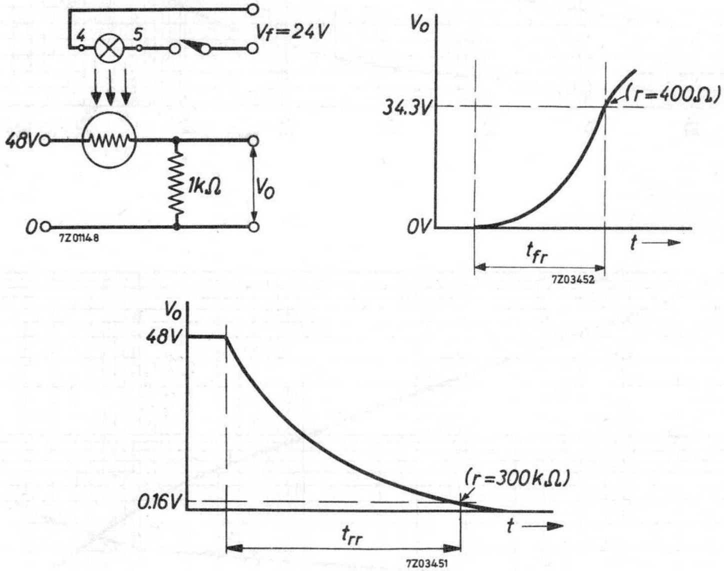


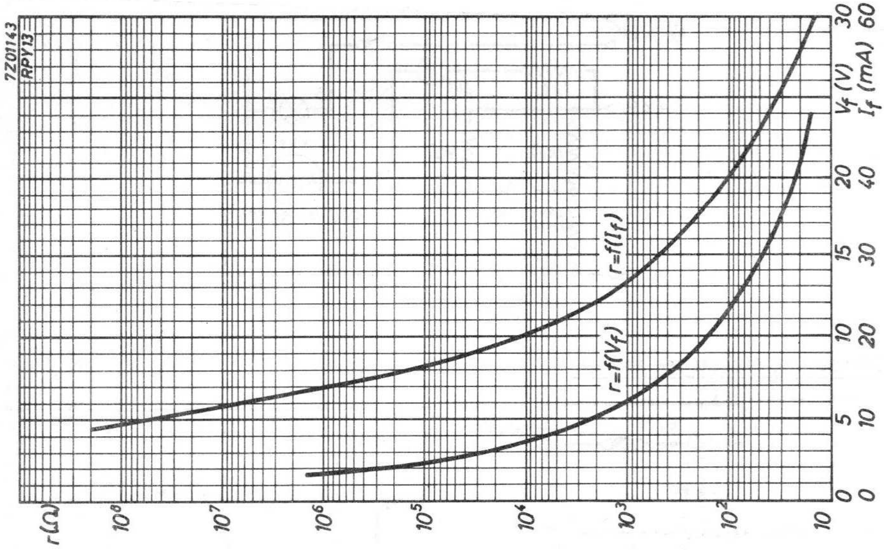
Fig.2

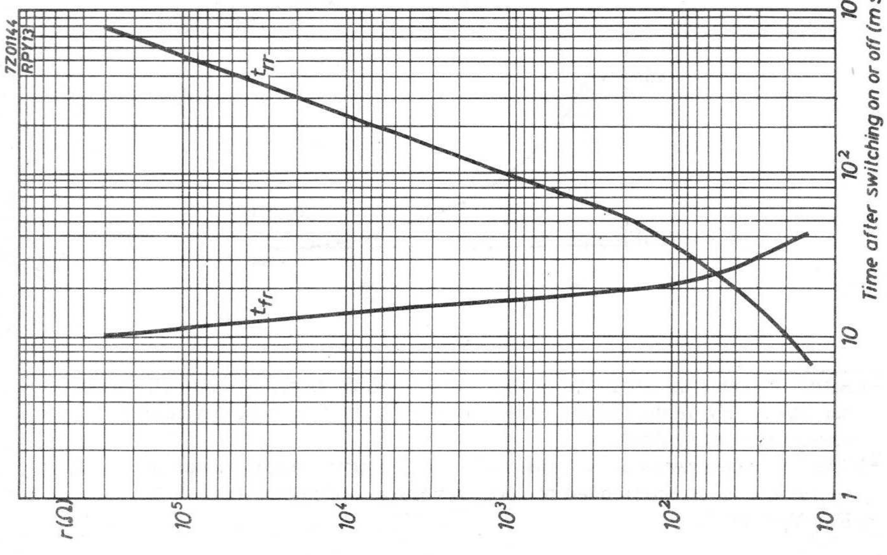
---

[1] After 16 hours in darkness changes in the CdS material are still occurring, but have only insignificant effect on the illumination resistance and on the resistance decay time.

[2] The life expectancy is considerably longer with lower values of V_f. In this respect it is recommended to apply a voltage not higher than 20 V.

[3] For V_f = 24 V.


7Z01143
RPY13
r(Ω)
10^8
10^7
10^6
10^5
10^4
10^3
10^2
10
r=f(I_f)
r=f(V_f)
V_f (V)
I_f (mA)
0 5 10 15 20 30
0 10 20 30 40 60


7Z01144
RPY13
r(Ω)
10^5
10^4
10^3
10^2
10
t_rr
t_fr
1
10
10^2
10^3
Time after switching on or off (m sec)

CADMIUM SULPHIDE PHOTOCONDUCTIVE CELL

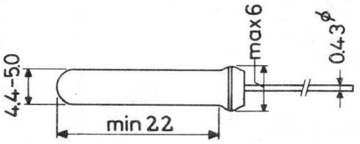
Cadmium sulphide photoconductive cell with side sensitivity intended for use in general control circuits. The cell is tropic proof, shock and vibration resistant.

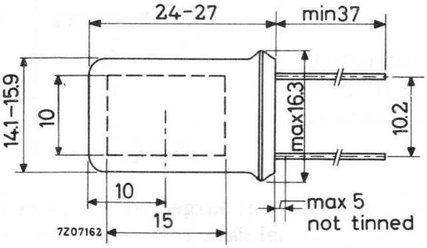
QUICK REFERENCE DATA

Power dissipation at T_{amb} = 25 ^{o}C	P	max.	0.5	W
Power dissipation, with a heatsink with K = 5 ^{o}C/W and T_{amb} = 25 ^{o}C	P	max.	2	W
Cell voltage, d.c. and repetitive peak	V	max.	100	V
Cell resistance at 5000 lux, 2700 ^{o}K colour temperature	r		25	Ω
Spectral response curve		type D		
Outline dimensions		max.	27 x 16.3 x 6	mm

MECHANICAL DATA

Dimensions in mm





The centre distance of the leads is compatible with the IEC standard raster for printed wiring (0.1 inch).

Soldering

The cell may be soldered directly into the circuit but heat conducted to the seal should be kept to a minimum by the use of a thermal shunt. The cell may be dip-soldered at a solder temperature of 240 °C for a maximum of 10 s up to a point 5 mm from the seals.

ELECTRICAL DATA

General

The electrical properties of CdS cells are dependent on many factors such as illumination, colour temperature of the light source, voltage, current, temperature, total time of operation in the circuit and time of operation during the last 24 hours prior to the measurement. The following basic characteristics are therefore only checkpoints of the electrical properties of these devices measured with defined values of the various conditions and at delivery.

Basic characteristics at T_{amb} = 25 °C, illumination with colour temperature of 2700 °K and at delivery.

	symbol	min.	typical	max.	unit
Initial dark resistance measured with 100 V d.c. applied via 1 MΩ, 20 s after switching off the illumination	r_{do}	5.6		[1]	MΩ
Equilibrium dark resistance measured with 100 V d.c. applied via 1 MΩ, 30 minutes after switching off the illumination	r_{de}	50		[1]	MΩ
Initial illumination resistance (1) measured at 10 V d.c., illumination = 50 lux, after 16 hrs in darkness. [2]	r_{lo} (1)	235	400	1200	Ω
Initial illumination resistance (2) measured at 1 V d.c., illumination = 5000 lux, after 16 hrs in darkness [2][3]	r_{lo} (2)		25	35	Ω

---

[1] The spread of the dark resistance is large and values higher than 15 MΩ and 2000 MΩ are possible for the initial dark resistance and the equilibrium dark resistance respectively.

[2] After 16 hours in darkness changes in the CdS material are still occurring, but have only insignificant effect on the illumination resistance and on the resistance decay time.

[3] Maximum during life 40 Ω.

DESIGN CONSIDERATIONS

Apparatus with CdS cells should be designed so that changes in resistance values of the cells during life from -30% to +70% do not impair the circuit performance. Direct sunlight irradiation should be avoided.

SHOCK AND VIBRATION

An indication for the ruggedness of the cell is the following:
Samples taken from normal production are submitted to shock and vibration tests mentioned below. More than 95% of the devices pass these tests without perceptible damage.

Shock

25 g_{peak}, 10 000 shocks in one of the three positions of the cell.

Vibration

2,5 g_{peak}, 50 Hz, during 32 hours in each of the three positions of the cell.

N.B. These conditions are used solely to assess the mechanical quality of the cell. It is not advisable to subject the cell to such conditions.

LIMITING VALUES (Absolute max. rating system)

Cell voltage, d.c. and repetitive peak	V	max.	100	V
Cell voltage, pulse, t_{imp} = max. 5 ms prr = max. once per minute	V_p	max.	250	V
Power dissipation, t_{av} = 2 s	P	see sheet C		
Power dissipation, pulse	P_p	max.	5 x P	
Cell current, d.c. and repetitive peak	I	max.	250	mA
Illumination	E	max.	50000	lux
Temperature CdS tablet, operating	T_{tablet}	max.	+85	°C [1]
Ambient temperature, storage and operating	T_{amb}	min.	-40	°C
storage	T_{amb}	max.	+50	°C [2]
operating	T_{amb}	max.	+70	°C

---

[1] If no forced air cooling is used, the envelope temperature opposite the centre of the sensitive area is about 83 °C when the CdS tablet temperature is 85 °C. This temperature can be determined e.g. with a thermocouple fastened on the envelope.

[2] Operation of the cell counteracts the deteriorating effect of long periods at high temperature. The maximum operating temperature is therefore higher than the maximum storage temperature.

Basic characteristics at T_{amb} = 25 °C, illumination with colour temperature of 2700 °K and at delivery. (continued)

	symbol	min.	typical	max.	unit
Equilibrium illumination resistance (1) measured at 10 V d.c., illumination = 50 lux, after 15 minutes under the measuring conditions	r_{le} (1)	235	480	1560	Ω
Equilibrium illumination resistance (2) measured at 1 V d.c., illumination = 5000 lux, after 15 minutes under the measuring conditions. [2]	r_{le} (2)			35	Ω
Resistance decay time Time to reach 50 Ω, measured from the instant of starting the illumination of 5000 lux, after 16 hrs in darkness. [1]	t_{fr}		5	25	ms
Resistance rise time Time to reach 2 kΩ, measured from the instant of stopping the illumination after 5 minutes or longer illumination of 5000 lux	t_{rr}		40	200	ms
Sensitivity at 50 lux, with 10 V d.c. applied	N		0.5		mA/lux
Negative temperature response of illumination resistance			0.2	0.5	%/°C
Voltage response $\frac{\text{r at 0.5 V d.c.}}{\text{r at 10 V d.c.}}$	α		1.1		

THERMAL DATA

Continuous temperature of CdS tablet	T_{tablet}	max. +85	°C
Thermal resistance from CdS tablet to ambient, device free in air	K	120	°C/W
Thermal resistance from CdS tablet to heatsink (temperature of heatsink measured near the centre of the cell), when the cell is properly clamped on a heatsink as described on sheet 5	K	25	°C/W

---

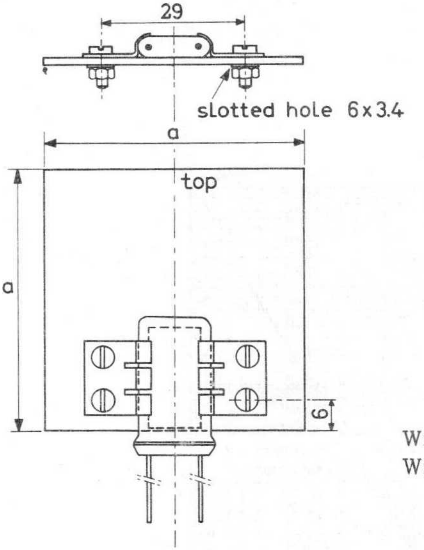
1) After 16 hours in darkness changes in the CdS material are still occurring, but have only insignificant effect on the illumination resistance and on the resistance decay time.

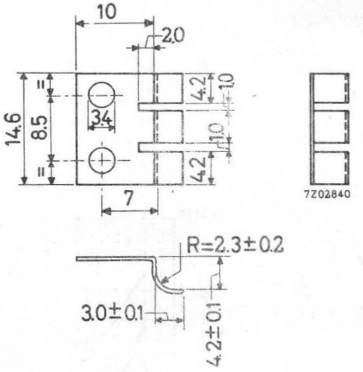
2) Maximum during life 40 Ω.

MECHANICAL DATA (continued)

Dimensions in mm

RPY18 MOUNTED ON HEATSINK



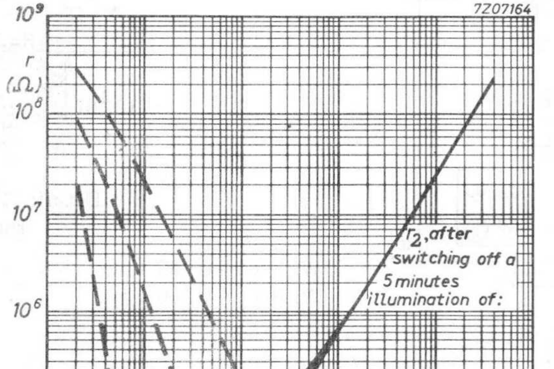


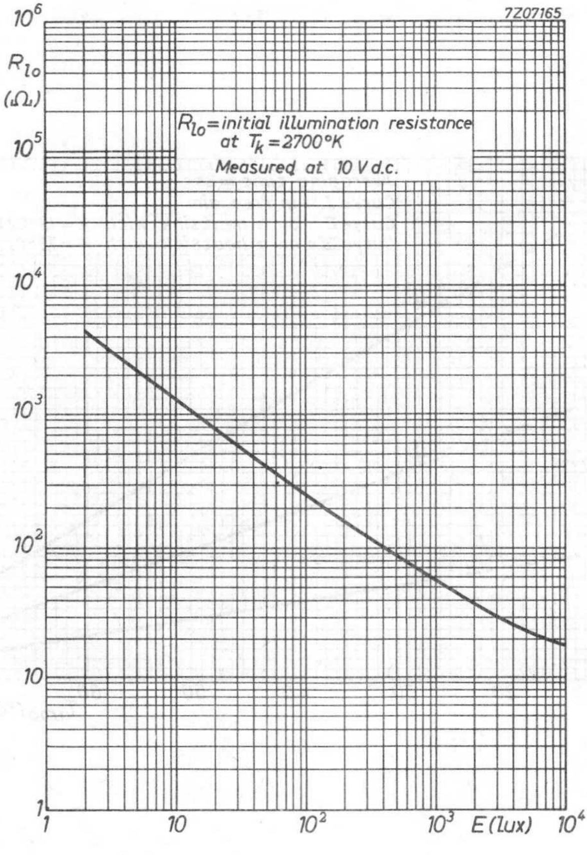
Detail: Clamping strip
tombac 0.3 mm

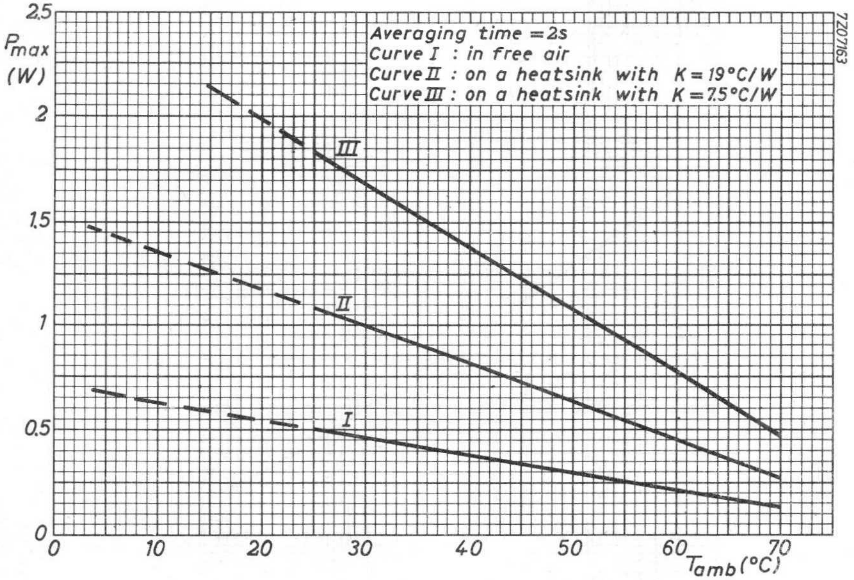
With a = 50 mm K = 19 °C/W
With a = 100 mm K = 7.5 °C/W

Mounting instructions

1. Mount one clamp on the heatsink, using the side with round holes.
2. Push the RPY18 under than clamp.
3. Press the second clamp firmly against the RPY18, using the slot holes.


7Z07164
r
(Ω)
10
10^2
10^3
10^4
10^5
10^6
10^7
10^8
10^9
1
10
10^2
10^3
10^4 t(msec) 10^5
r_2,after switching off a 5 minutes illumination of:
r_1,after 16hrs of darkness and switching on an illumination of:
5 lux
50 lux
500 lux
5000 lux
5 lux
50 lux
500 lux
5000 lux


7Z07165
10^6
R_{lo}
(Ω)
10^5
10^4
10^3
10^2
10
1
1
10
10^2
10^3
E (lux)
10^4
R_{lo} = initial illumination resistance at T_k = 2700 °K
Measured at 10 V d.c.



2.5
P_{max}
(W)
2
1.5
1
0.5
0
0
10
20
30
40
50
60
70
T_{amb}(°C)
Averaging time = 2s
Curve I : in free air
Curve II : on a heatsink with K = 19°C/W
Curve III : on a heatsink with K = 7.5°C/W
III
II
I
7Z07163

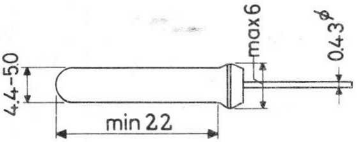
CADMIUM SULPHIDE PHOTOCONDUCTIVE CELL

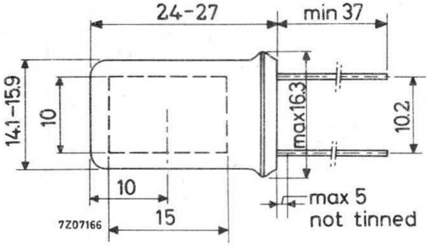
Cadmium sulphide photoconductive cell with side sensitivity intended for use in general control circuits.
The cell is tropic proof, shock and vibration resistant.

QUICK REFERENCE DATA				
Power dissipation at T_{amb} = 25 °C	P	max.	0.5	W
Power dissipation, with a heatsink with K = 5 °C/W and T_{amb} = 25 °C	P	max.	2	W
Cell voltage, d.c. and repetitive peak	V	max.	400	V
Cell resistance at 50 lux, 2700 °K colour temperature	r		3000	Ω
Spectral response curve		type D		
Outline dimensions		max. 27 x 16.3 x 6		mm

MECHANICAL DATA

Dimensions in mm





Soldering

The cell may be soldered directly into the circuit but heat conducted to the seal should be kept to a minimum by the use of a thermal shunt. The cell may be dip-soldered at a solder temperature of 240 °C for a maximum of 10 s up to a point 5 mm from the seals.

ELECTRICAL DATA

General

The electrical properties of CdS cells are dependent on many factors such as illumination, colour temperature of the light source, voltage, current, temperature, total time of operation in the circuit and time of operation during the last 24 hours prior to the measurement. The following basic characteristics are therefore only checkpoints of the electrical properties of these devices measured with defined values of the various conditions and at delivery.

Basic characteristics at T_{amb} = 25 °C, illumination with colour temperature of 2700 °K and at delivery

	symbol	min.	typical	max.	unit
Initial dark resistance measured with 300 V d.c. applied via 1 MΩ, 20 s after switching off the illumination	r_{do}	10		1)	MΩ
Equilibrium dark resistance measured with 300 V d.c. applied via 1 MΩ, 30 minutes after switching off the illumination	r_{de}	200		1)	MΩ
Initial illumination resistance measured at 10 V d.c. illumination = 50 lux, after 16 hrs in darkness 2)	r_{lo}	1400	3000	6600	Ω
Equilibrium illumination resistance measured at 10 V d.c. illumination = 50 lux, after 15 minutes under the measuring conditions	r_{le}	1400	3800	9000	Ω
Resistance decay time Time to reach 20 kΩ, measured from the instant of starting the illumination of 50 lux, at 10 V d.c. after 16 hours in darkness	t_{fr}			0.2	s

---

1) The spread of the dark resistance is large and values higher than 100 MΩ and 10 000 MΩ are possible for the initial dark resistance and the equilibrium dark resistance respectively.

2) After 16 hours in darkness changes in the CdS material are still occurring, but have only insignificant effect on the illumination resistance and on the resistance decay time.

Basic characteristics at T_{amb} = 25 °C, illumination with colour temperature of 2700 °K and at delivery (continued)

	symbol	min.	typical	max.	unit
Resistance rise time Time to reach 1 MΩ, measured from the instant of stopping the illumination after 5 minutes or longer illumination of 50 lux, at 10 V d.c.	t_{rr}		0.6	1.25	s
Sensitivity	N		0.07		mA/lux
Negative temperature response of illumination resistance			0.2	0.5	%/°C
Voltage response $\frac{\text{r at 0.5 V d.c.}}{\text{r at 10 V d.c.}}$	α		1.1		

THERMAL DATA

Continuous temperature of CdS tablet	T_{tablet}	max. +85	°C
Thermal resistance from CdS tablet to ambient, device free in air	K	120	°C/W
Thermal resistance from CdS tablet to heatsink (temperature of heatsink measured near the centre of the cell), when the cell is properly clamped on a heatsink as described on sheet 5	K	25	°C/W

DESIGN CONSIDERATIONS

Apparatus with CdS cells should be designed so that changes in resistance values of the cells during life from −30% to +70% do not impair the circuit performance. Direct sunlight irradiation should be avoided.

SHOCK AND VIBRATION

An indication for the ruggedness of the cell is the following:
Samples taken from normal production are submitted to shock and vibration tests mentioned below. More than 95% of the devices pass these tests without perceptible damage.

Shock

25 g_{peak}, 10 000 shocks in one of the three positions of the cell.

Vibration

2.5 g_{peak}, 50 Hz, during 32 hours in each of the three positions of the cell.

LIMITING VALUES (Absolute max. rating system)

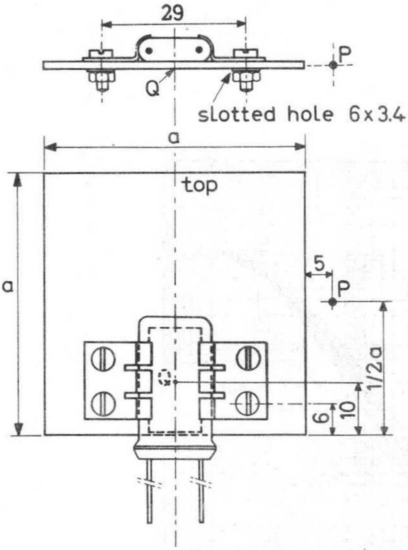
Cell voltage, d.c. and repetitive peak	V	max.	400	V
Cell voltage, pulse, T_{imp} = max. 5 ms p_{rr} = max. once per minute	V_p	max.	1000	V
Power dissipation, t_{av} = 1 s	P	See sheet 8		
Power dissipation, pulse	P_p	max.	5xP	
Cell current, d.c. and repetitive peak	I	max.	250	mA
Illumination	E	max.	50000	lux
Temperature CdS tablet, operating	T_{tablet}	max.	+85	^oC 1)
Ambient temperature, storage and operating	T_{amb}	min.	-40	^oC
storage	T_{amb}	max.	+50	^oC 2)
operating	T_{amb}	max.	+70	^oC

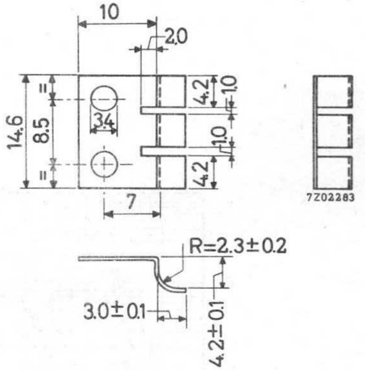
---

1) If no forced air cooling is used, the envelope temperature opposite the centre of the sensitive area is about 83 ^oC when the CdS tablet temperature is 85 ^oC. This temperature can be determined e.g. with a thermocouple fastened on the envelope.

2) Operation of the cell counteracts the deteriorating effect of long periods at high temperature. The maximum operating temperature is therefore higher than the maximum storage temperature.

RPY19 MOUNTED ON HEATSINK





Detail: Clamping strip
tombac 0.3 mm

The heat resistance K of the heatsink is defined as the temperature difference between the point Q at the backside of the heatsink, and ambient at point P, per Watt dissipation in the device, the heatsink being placed in an enclosure as given below.

Enclosure: cubical with internal edges 5 x a mm.
Place : point Q in the centre of the cubic, plane of heatsink vertical, top upside.

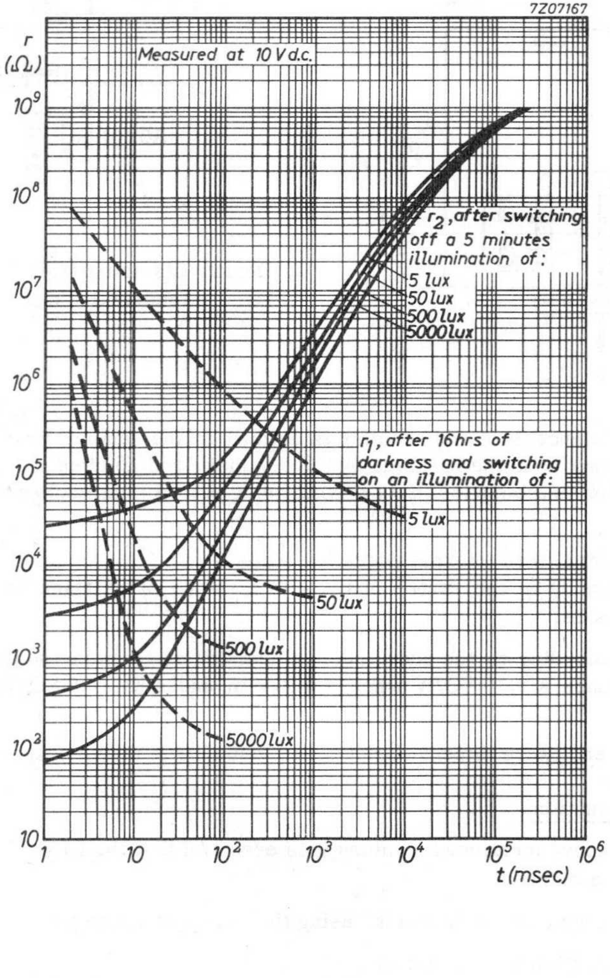
Determined according to the above rules a heatsink as given in the drawing has a heat resistance K = 19 °C/W when a = 50 mm and a K = 7.5 °C/W when a = 100 mm.

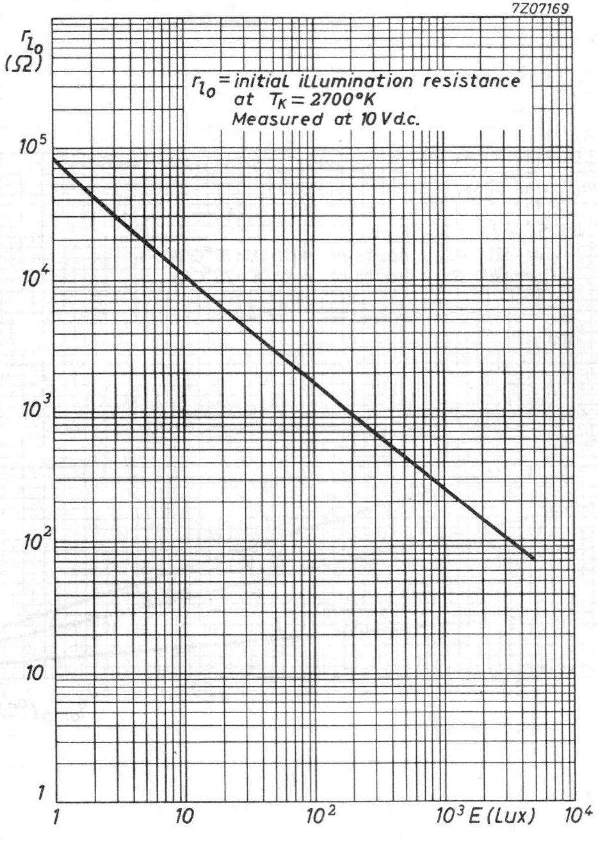
With smaller enclosure dimensions a higher value for K may be expected.

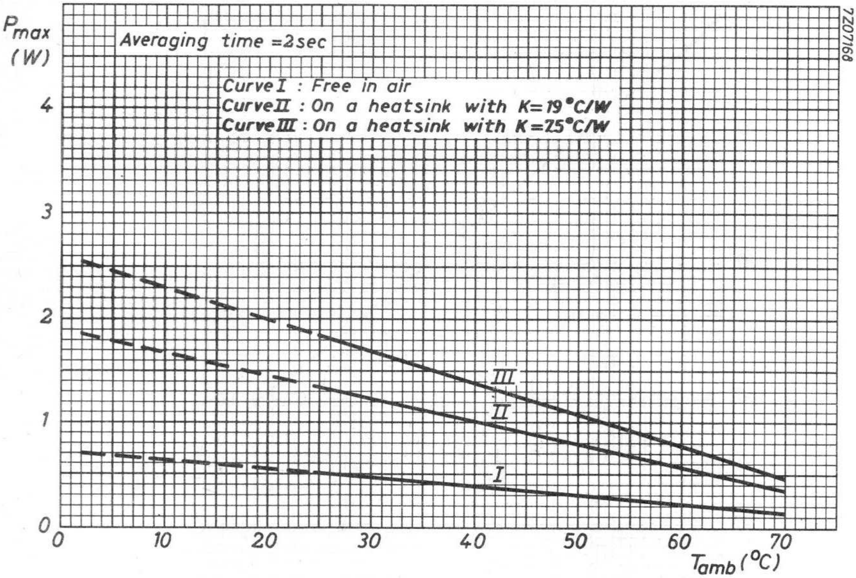
Mounting instructions

To reach the above mentioned K values it is essential that the RPY19 be installed in the following manner:

1. Mount one clamp on the heatsink, using the side with round holes.
2. Push the RPY19 under that clamp.
3. Press the second clamp firmly against the RPY19, using the slot holes.


7Z07167
r
(Ω)
Measured at 10 V d.c.
10^9
10^8
10^7
10^6
10^5
10^4
10^3
10^2
10
1
10
10^2
10^3
10^4
10^5
10^6
t (msec)
r_2, after switching off a 5 minutes illumination of:
5 lux
50 lux
500 lux
5000 lux
r_1, after 16 hrs of darkness and switching on an illumination of:
5 lux
50 lux
500 lux
5000 lux


7Z07169
r_{l_0} (Ω)
r_{l_0} = initial illumination resistance at T_K = 2700°K Measured at 10 Vd.c.
10^5
10^4
10^3
10^2
10
1
1
10
10^2
10^3 E (Lux)
10^4


P_{max}
(W)
Averaging time =2sec
Curve I : Free in air
Curve II : On a heatsink with K=19°C/W
Curve III : On a heatsink with K=7.5°C/W
7Z07168
0
1
2
3
4
0
10
20
30
40
50
60
70
T_{amb} (°C)
III
II
I

CADMIUM SULPHIDE PHOTOCONDUCTIVE CELL

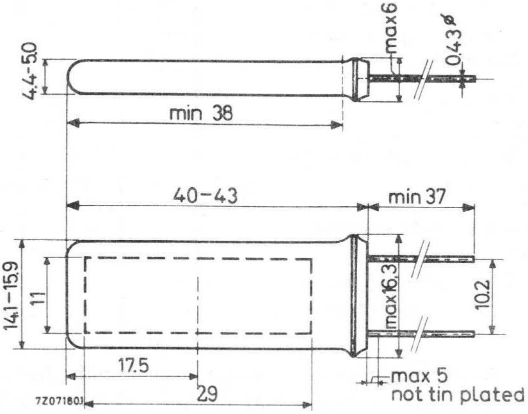
Cadmium sulphide photoconductive cell with side sensitivity intended for use in general control circuits such as twilight switches and flame failure equipment. The cell is tropic proof, shock and vibration resistant.

QUICK REFERENCE DATA

Power dissipation at T_{amb} = 25 °C	P	max.	1	W
Power dissipation, with a heatsink with K = 5 °C/W and T_{amb} = 25 °C	P	max.	3	W
Cell voltage, d.c. and repetitive peak	V	max.	400	V
Cell resistance at 50 lux, 2700 °K colour temperature	r		1500	Ω
Spectral response curve		type D		
Outline dimensions		max. 43 x 16.3 x 6		mm

MECHANICAL DATA

Dimensions in mm



The centre distance of the leads is compatible with the standard raster for printed wiring (0.1 inch)

Soldering

The cell may be soldered directly into the circuit but heat conducted to the tablet should be kept to a minimum by the use of a thermal shunt. The cell may be dip-soldered at a solder temperature of 240 °C for a maximum of 10 s up to a point 5 mm from the seals.

ELECTRICAL DATA

General

The electrical properties of CdS cells are dependent on many factors such as illumination, colour temperature of the light source, voltage, current, temperature, total time of operation in the circuit and time of operation during the last 24 hours prior to the measurement. The following basic characteristics are therefore only checkpoints of the electrical properties of these devices measured with defined values of the various conditions and at delivery.

Basic characteristics at T_{amb} = 25 °C, illumination with colour temperature of 2700 °K and at delivery

	symbol	min.	typical	max.	unit
Initial dark resistance measured with 300 V d.c. applied via 1 MΩ, 20 s after switching off the illumination	r_{do}	6.5		1)	MΩ
Equilibrium dark resistance measured with 300 V d.c. applied via 1 MΩ, 30 minutes after switching off the illumination	r_{de}	120		1)	MΩ
Initial illumination resistance measured at 10 V, d.c. illumination = 50 lux, after 16 hrs in darkness 2)	r_{lo}	700	1500	3300	Ω
Equilibrium illumination resistance measured at 10 V, d.c. illumination = 50 lux, after 15 minutes under the measuring conditions	r_{le}	700	1900	4500	Ω

---

1) The spread of the dark resistance is large and values higher than 100 MΩ and 10 000 MΩ are possible for the initial dark resistance and the equilibrium dark resistance respectively.

2) After 16 hours in darkness changes in the CdS material are still occurring, but have only insignificant effect on the illumination resistance and on the resistance decay time.

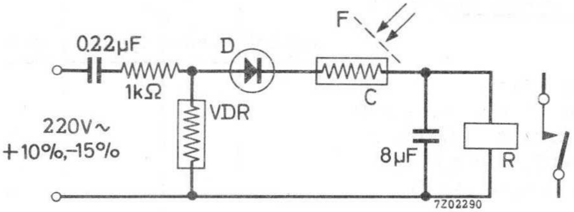
Basic characteristics at T_{amb} = 25 °C, illumination with colour temperature of 2700 °K and at delivery (continued)

	symbol	min.	typical	max.	unit
Resistance decay time Time to reach 10 kΩ, measured from the instant of starting the illumination of 50 lux, at 10 V d.c. after 16 hours in darkness 2)	t_{fr}			0.2	s
Resistance rise time Time to reach 1 MΩ, measured from the instant of stopping the illumination after 5 minutes or longer illumination of 50 lux, at 10 V d.c.	t_{rr}		0.9	1.5	s
Sensitivity at 50 lux, with 10 V d.c. applied	N		0.15		mA/lux
Negative temperature response of illumination resistance			0.2	0.5	%/°C
Voltage response $\frac{\text{r at 0.5 V d.c.}}{\text{r at 10 V d.c.}}$	α		1.05		

THERMAL DATA

Continuous temperature of CdS tablet	T_{tablet}	max.	+85	°C
Thermal resistance from CdS tablet to ambient, device free in air	K		60	°C/W
Thermal resistance from CdS tablet to heatsink (temperature of heatsink measured near the centre of the cell), when the cell is properly clamped on a heatsink as described on sheet 6.	K		15	°C/W

OPERATING CONDITIONS in a typical twilight switching circuit.



C = CdS cell RPY20

R = D.C. Relay 20 kΩ with I_e < 2.7 e.g. energizing current I_e of 2 mA and release current I_r of 0.8 mA.

VDR = voltage dependent resistor 10 mA at 180 V, 2 W e.g. type E299DG/P248

F = Absorption filter to be used to correct spread of the circuit and to adjust the switching level (10 to 70 lux).
Light transmission 5 to 20 %.

D = Diode V_{inv_p} > 500 V

DESIGN CONSIDERATIONS

Apparatus with CdS cells should be designed so that changes in resistance values of the cells during life from −30 % to +70 % do not impair the circuit performance. Direct sunlight irradiation should be avoided.

SHOCK AND VIBRATION

An indication for the ruggedness of the cell is the following:
Samples taken from normal production are submitted to shock and vibration tests mentioned below. More than 95 % of the devices pass these tests without perceptible damage.

Shock

25 g_{peak}, 10 000 shocks in one of the three positions of the cell.

Vibration

2.5 g_{peak}, 50 Hz, during 32 hours in each of the three positions of the cell.

LIMITING VALUES (Absolute max. rating system)

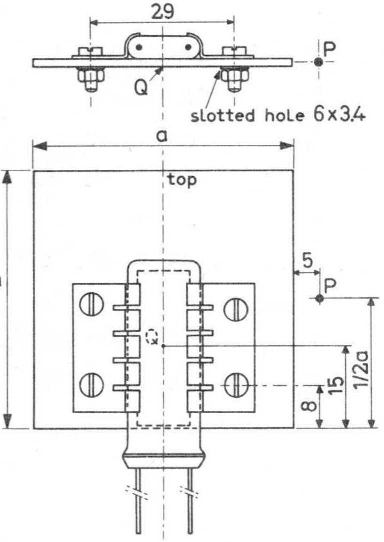
Cell voltage, d.c. and repetitive peak	V	max.	400	V
Cell voltage, pulse, t_{imp} = max. 5 ms p_{rr} = max. once per minute	V_p	max.	1000	V
Power dissipation, t_{av} = 2 s	P	See sheet 8		
Power dissipation, pulse	P_p	max.	5xP	
Cell current, d.c. and repetitive peak	I	max.	500	mA
Illumination	E	max.	50 000	lux
Temperature CdS tablet, operating	T_{tablet}	max.	+85	^{o}C [1]
Ambient temperature, storage and operating	T_{amb}	min.	-40	^{o}C
storage	T_{amb}	max.	+50	^{o}C [2]
operating	T_{amb}	max.	+70	^{o}C

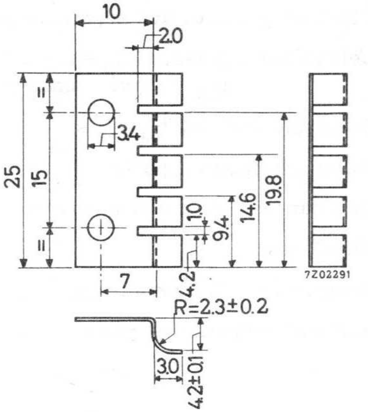
---

[1] If no forced air cooling is used, the envelope temperature opposite the centre of the sensitive area is about 83 ^{o}C when the CdS tablet temperature is 85 ^{o}C. This temperature can be determined e.g. with a thermocouple fastened on the envelope.

[2] Operation of the cell counteracts the deteriorating effect of long periods at high temperature. The maximum operating temperature is therefore higher than the maximum storage temperature.

RPY20 MOUNTED ON HEATSINK





Detail: clamping strip
tombac 0.3 mm

The heat resistance K of the heatsink is defined as the temperature difference between the point Q at the backside of the heatsink, and ambient at point P, per Watt dissipation in the device, the heatsink being placed in an enclosure as given below.

Enclosure: cubical with internal edges 5 x a mm
Place : point Q in the centre of the enclosure, plane of heatsink vertical, "top" up

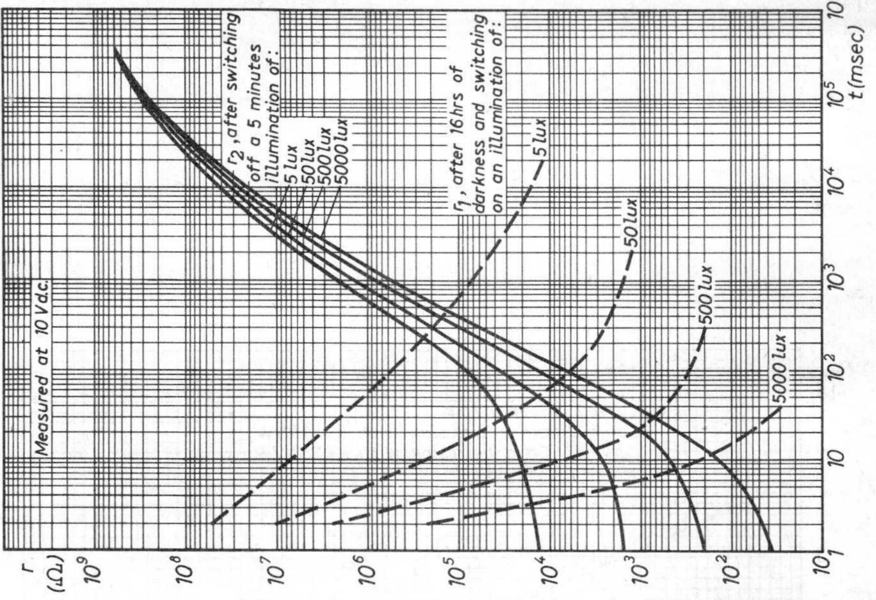
Determined according to the above rules a heatsink as given in the drawing has a heat resistance K = 19 °C/W when a = 50 mm and K = 7.5 °C/W when a = 100 mm.

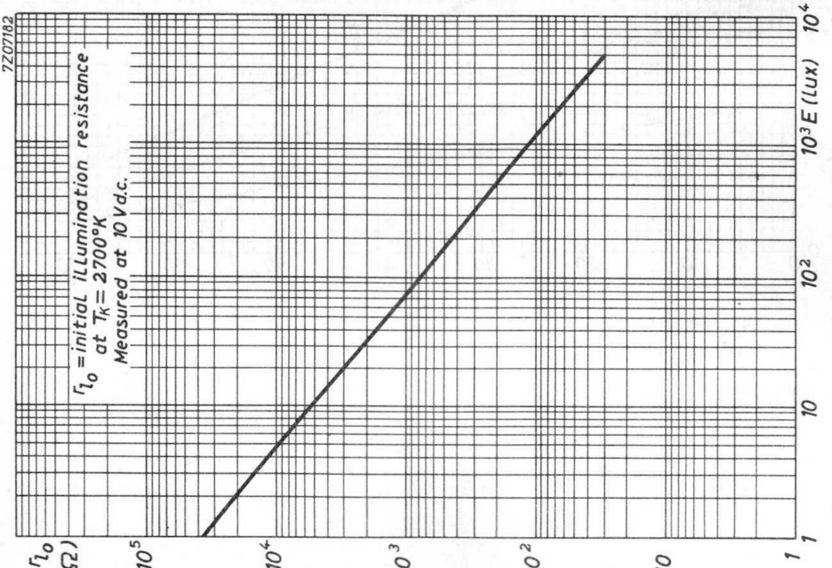
With smaller enclosure dimensions a higher value for K may be expected.

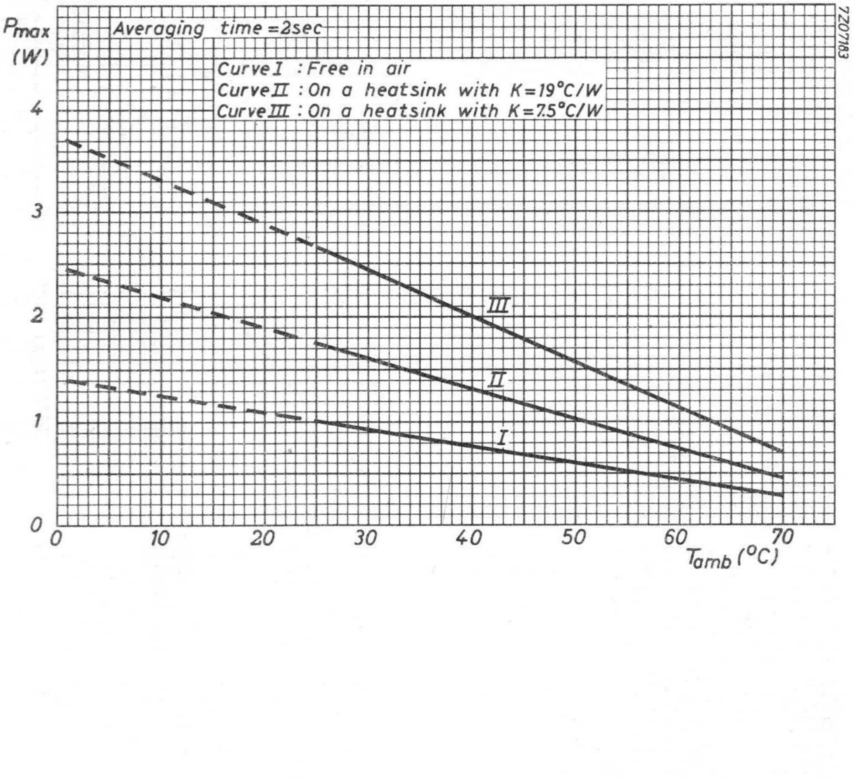
Mounting instructions

To reach the above mentioned K values it is essential that the RPY20 be installed in the following manner:

1. Mount one clamp on the heatsink, using the side with round holes.
2. Push the RPY20 under that clamp.
3. Press the second clamp firmly against the RPY20, using the slot holes.


7Z07181
Measured at 10 V d.c.
r₂, after switching off a 5 minutes illumination of:
5 lux
50 lux
500 lux
5000 lux
r₁, after 16 hrs of darkness and switching on an illumination of:
5 lux
50 lux
500 lux
5000 lux
r (Ω)
10⁹
10⁸
10⁷
10⁶
10⁵
10⁴
10³
10²
10
1
10
10²
10³
10⁴
10⁵
10⁶
t (msec)


7Z07182
r_Lo = initial illumination resistance at T_K = 2700°K
Measured at 10 V d.c.
r_Lo (Ω)
10⁵
10⁴
10³
10²
10
1
1
10
10²
10³
10⁴
E (lux)

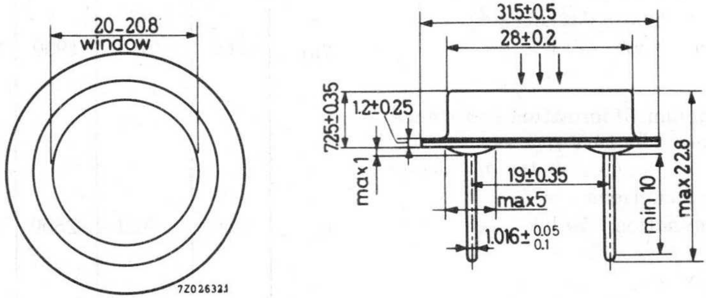

P_{max}
(W)
4
3
2
1
0
Averaging time = 2sec
Curve I : Free in air
Curve II : On a heatsink with K=19°C/W
Curve III : On a heatsink with K=7.5°C/W
III
II
I
0
10
20
30
40
50
60
70
T_{amb} (°C)
7Z07183

CADMIUM SULPHIDE PHOTOCONDUCTIVE CELL

Cadmium sulphide photoconductive cell with top sensitivity intended for use in general control circuits such as twilight switches and flame failure equipment. The cell is tropic proof, shock and vibration resistant.

QUICK REFERENCE DATA				
Power dissipation at Tamb = 25 °C	P	max.	1	W
Cell voltage, d.c. and repetitive peak	V	max.	400	V
Cell resistance at 50 lux, 2700 °K colour temperature	r		650	Ω
Spectral response curve		type D		
Outline dimensions		max. 32 dia.	x 7.6	mm

MECHANICAL DATA



Accessories

Contact springs	type 55561

ELECTRICAL DATA

General

The electrical properties of CdS cells are dependent on many factors such as illumination, colour temperature of the light source, voltage, current, temperature, total time of operation in the circuit and time of operation during the last 24 hours prior to the measurement. The following basic characteristics are therefore only checkpoints of the electrical properties of these devices measured with defined values of the various conditions and at delivery.

Basic characteristics at T_{amb} = 25 °C, illumination with colour temperature of 2700 °K and at delivery

	symbol	min.	typical	max.	unit
Initial dark resistance measured with 400 V d.c. applied via 1 MΩ, 20 s after switching off the illumination	r_{do}	6.0		[1]	MΩ
Equilibrium dark resistance measured with 400 V d.c. applied via 1 MΩ, 30 minutes after switching of the illumination	r_{de}	100		[1]	MΩ
Initial illumination resistance measured at 10 V d.c. after 16 hrs in darkness [2] illumination 50 lux	r_{lo}	380	650	1900	Ω
Equilibrium illumination resistance measured at 10 V d.c. after 15 minutes under the measuring conditions illumination 50 lux	r_{le}	380	820	2600	Ω

---

[1] The spread of the dark resistance is large and values higher than 100 MΩ and 10 000 MΩ are possible for the initial dark resistance and the equilibrium dark resistance respectively.

[2] After 16 hours in darkness changes in the CdS material are still occurring, but have only insignificant effect on the illumination resistance and on the resistance decay time.

Basic characteristics at T_{amb} = 25 °C, illumination with colour temperature of 2700 °K and at delivery (continued)

	symbol	min.	typical	max.	unit
Resistance decay time Time to reach 10 kΩ, measured from the instant of starting the illumination of 50 lux, at 10 V d.c. after 16 hours in darkness 2)	t_{fr}			0.2	s
Resistance rise time Time to reach 1 MΩ, measured from the instant of stopping the illumination after 5 minutes or longer illumination with 50 lux, at 10 V d.c.	t_{rr}		1.0	1.5	s
Sensitivity at 50 lux, with 10 V d.c. applied	N		0.3		mA/lux
Negative temperature response of illumination resistance			0.2	0.5	%/°C
Voltage response $\frac{\text{r at 0.5 V d.c.}}{\text{r at 10 V d.c.}}$	α		1.05		

THERMAL DATA

Continuous temperature of CdS tablet	T_{tablet}	max.	+85	°C
Thermal resistance from CdS tablet to ambient, device free in air	K		60	°C/W

DESIGN CONSIDERATIONS

Apparatus with CdS cells should be designed so that changes in resistance values of the cells during life from -30 % to +70 % do not impair the circuit performance. Direct sunlight irradiation should be avoided.

SHOCK AND VIBRATION

An indication for the ruggedness of the cell is the following:
Samples taken from normal production are submitted to shock and vibration tests mentioned below. More than 95 % of the devices pass these tests without perceptible damage.

Shock

25 g_{peak}, 10 000 shocks in one of the three positions of the cell.

Vibration

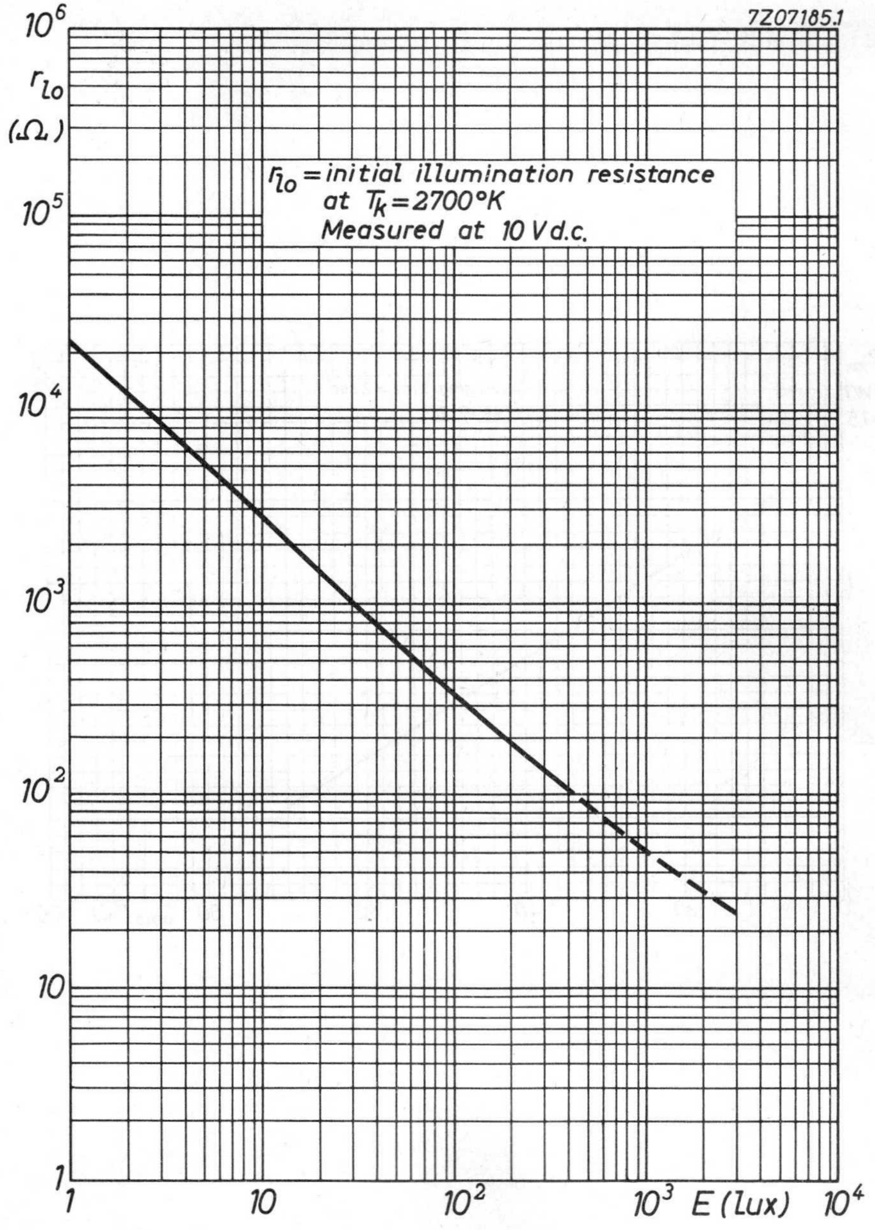
2.5 g_{peak}, 50 Hz, during 32 hours in each of the three positions of the cell.

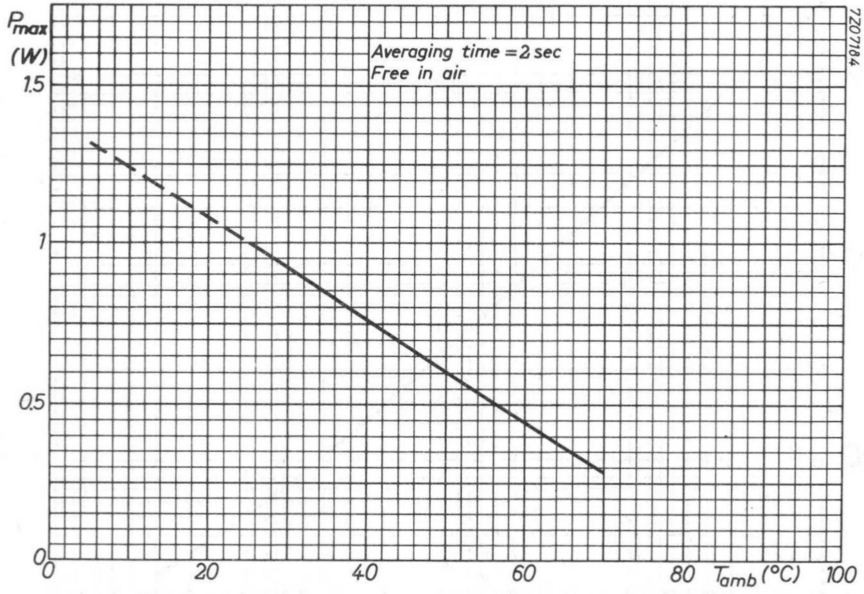
LIMITING VALUES (Absolute max. rating system)

Cell voltage, d.c. and repetitive peak	V	max.	400	V
Cell voltage, pulse, t_{imp} = max. 5 ms p_{rr} = max. once per minute	V_p	max.	1000	V
Power dissipation, t_{av} = 2 s	P	See sheet 6		
Power dissipation, pulse	P_p	max.	5xP	
Cell current, d.c. and repetitive peak	I	max.	250	mA
Illumination	E	max.	50 000	lux
Temperature CdS tablet, operating	T_{tablet}	max.	+85	°C
Ambient temperature, storage and operating	T_{amb}	min.	−40	°C
storage	T_{amb}	max.	+50	°C [1]
operating	T_{amb}	max.	+70	°C

---

[1] Operation of the cell counteracts the deteriorating effect of long periods at high temperature. The maximum operating temperature is therefore higher than the maximum storage temperature.


7Z07185.1
10^6
r_{lo}
(Ω)
10^5
10^4
10^3
10^2
10
1
r_{lo} = initial illumination resistance
at T_k = 2700°K
Measured at 10 V d.c.
1
10
10^2
10^3
E (lux)
10^4



P_{max}
(W)
1.5
1
0.5
0
0
20
40
60
80
T_{amb} (°C)
100
Averaging time = 2 sec
Free in air
7Z07184

CADMIUM SULPHO-SELENIDE PHOTOCONDUCTIVE CELL

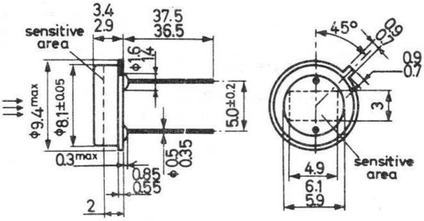
Cadmium sulpho-selenide photoconductive device with top sensitivity intended for use in exposure meters, light-control equipment and for general industrial use. The device is tropic proof, shock and vibration resistant. The envelope is hermetically sealed and has a plane glass window.

QUICK REFERENCE DATA

Power dissipation, as measuring device	P	max.	10	mW
for general use	P	max.	75	mW
Cell voltage, d.c. and repetitive peak	V	max.	50	V
Outline dimensions	max. 3.4 xdia 9.4			mm
Light sensitive area	4.9 mm x 3 mm			

MECHANICAL DATA

Dimensions in mm



Soldering

The device may be soldered direct into the circuit but heat conducted to the seals should be kept at a minimum by the use of a thermal shunt. Dipsoldering at a solder temperature of 245 °C may be employed for a maximum of 10 s up to a point 5 mm from the seals of for maximum 3 s up to a point 1.5 mm from the seals. At a solder temperature between 245 °C and 400 °C the soldering time is maximum 5 s up to a point 5 mm from the seals.
The leads should not be bent less than 1.5 mm from the seals.

Data based on pre-production.

ELECTRICAL DATA

Basic characteristics at T_{amb} = 25 °C

Pre-conditioning > 1 h illumination with 300 lx (fluorescent light)

	symbol	min.	typical	max.	unit
Initial dark resistance measured at 50 $V_{d.c.}$, 20 s after stopping the illumination of 25.6 lx	r_{do}	100			kΩ
Initial illumination resistance measured at 1 $V_{d.c.}$, illumination 25.6 lx, colour temperature **4700** °K	r_{lo}	**1.65**		**5.1**	kΩ
Current decay time: time to reach 10% of the current at the instant of stopping the illumination of 5 lx	t_{fi}		3		s
Gamma between E_1 = 0.4 lx and E_2 = 25.6 lx [1]	γ	**0.60**	0.75	**0.84**	
Shift in illumination current, measured with E = 50 lx, t = 10 min				10	
Pre-conditioning factor [2]		0.9		1.2	
Actinism $\frac{\text{Illumination at 2700 °K}}{\text{Illumination at 4700 °K}}$ (referred to the same cell current)			0.9		

---

[1] $$\gamma = \frac{\log r1 - \log r2}{\log E_2 - \log E_1}$$

[2] $$\text{Pre-conditioning factor} = \frac{\text{Cell current at 0.4 lx, after 3 days in darkness}}{\text{Cell current at 0.4 lx after 1 h pre-conditioning at 300 lx (fluorescent light)}}$$

SHOCK AND VIBRATION

An indication of the ruggedness of the device is the following:
Samples taken from normal production are submitted to shock and vibration tests mentioned below. More than 95% of the devices pass these tests without perceptible damage.

Shock

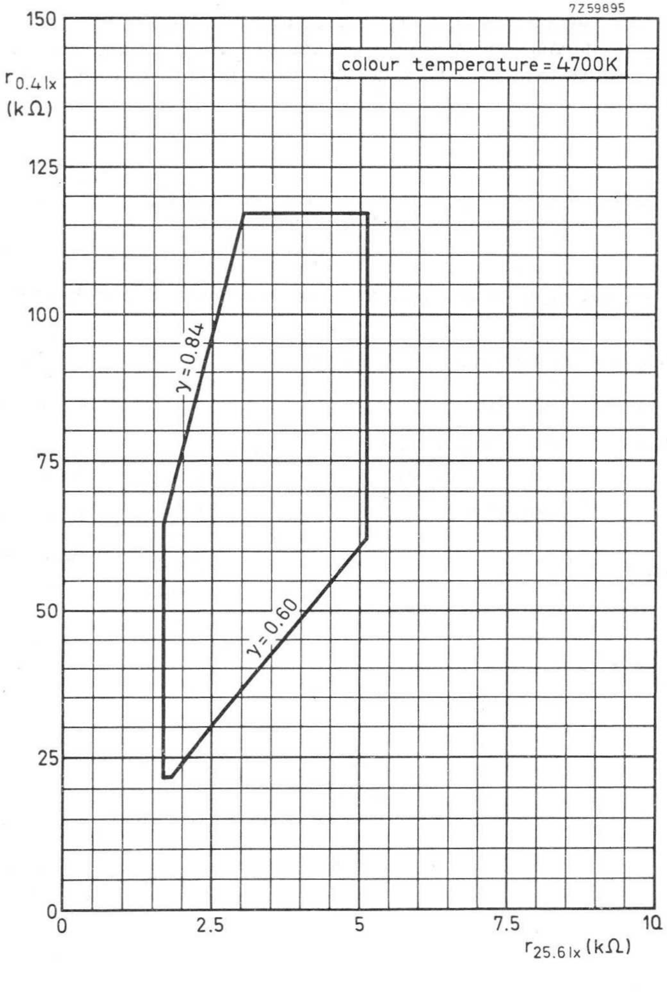
50 g_{peak}, 5 shocks in each of the four positions of the device.

Vibration

2.5 g_{peak}, 50 Hz, during 32 hours in each of the three positions of the device.

LIMITING VALUES (Absolute max. rating system)

Cell voltage, d.c. and repetitive peak	V	max.	50	V
Power dissipation, for use as measuring device	P	max.	10	mW
for general use	P	max.	75	mW
Ambient temperature	T_{amb}	max.	+60	°C
	T_{amb}	min.	-40	°C



Area of illumination resistance ratio

CADMIUM SULPHIDE PHOTOCONDUCTIVE CELL

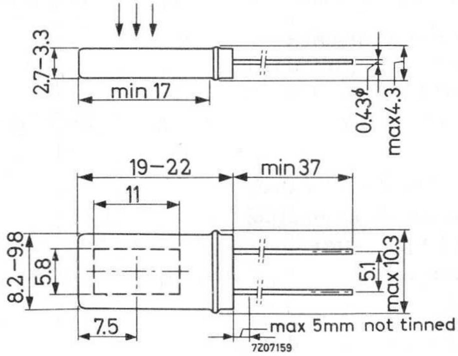
Cadmium sulphide photoconductive cell with side sensitivity intended for use in general control circuits.
The cell is tropic proof, shock and vibration resistant.

QUICK REFERENCE DATA

Power dissipation at T_{amb} = 25 °C	P	max.	225	mW
Cell voltage, d.c. and repetitive peak	V	max.	100	V
Cell resistance at 50 lux, 2700 °K colour temperature	r_{lo}		1.6	kΩ
Spectral response curve		type D		
Outline dimensions		max.22x10.3x4.3		mm

MECHANICAL DATA

Dimensions in mm



Soldering

The cell may be soldered directly into the circuit but heat conducted to the seal should be kept to a minimum by the use of a thermal shunt. The cell may be dip-soldered at a solder temperature of 240 °C for a maximum of 10 s up to a point 5 mm from the seals.

ELECTRICAL DATA

General

The electrical properties of CdS cells are dependent on many factors such as illumination, colour temperature of the light source, voltage current, temperature, total time of operation in the circuit and time of operation during the last 24 hours prior to the measurement. The following basic characteristics are therefore only checkpoints of the electrical properties of these devices measured with defined values of the various conditions and at delivery.

Basic characteristics at T_{amb} = 25 °C, illumination with colour temperature of 2700 °K and at delivery

	symbol	min.	typical	max.	unit
Initial dark resistance measured with 100 V d.c. applied via 1 MΩ, 20 s after switching off the illumination	r_{do}	9		1)	MΩ
Equilibrium dark resistance measured with 100 V d.c. applied via 1 MΩ, 30 minutes after switching off the illumination	r_{de}	100		1)	MΩ
Initial illumination resistance measured at V = 10 V d.c., illumination 50 lux, after 16 hours in darkness 2)	r_{lo}	950	1600	4800	Ω
Equilibrium illumination resistance measured at V = 10 V d.c., illumination 50 lux, after 15 minutes under the measuring conditions	r_{le}	950	1900	6200	Ω
Resistance decay time Time to reach 20 kΩ at V = 10 V d.c. measured from the instant of starting the illumination of 50 lux, after 16 hours in darkness. 2)	t_{fr}			0.2	s
Resistance rise time Time to reach 1 MΩ at V = 10 V d.c. measured after 5 minutes or longer illumination of 50 lux	t_{rr}		1.0	1.5	s
Sensitivity, at V = 10 V d.c. and 50 lux	N		0.12		mA/lux
Negative temperature response of illumination resistance			0.2	0.5	%/°C
Voltage response $\frac{\text{r at 0.5 V d.c.}}{\text{r at 10 V d.c.}}$	α		1.1		

---

1)2) See page 4

THERMAL DATA

Continuous temperature of CdS tablet	T_{tablet}	+85	°C
Thermal resistance from CdS tablet to ambient, device free in air	K	265	°C/W

DESIGN CONSIDERATIONS

Apparatus with CdS cells should be designed so that changes in resistance values of the CdS cells during life from -30% to +70% do not impair the circuit performance. Direct sunlight irradiation should be avoided.

SHOCK AND VIBRATION

An indication for the ruggedness of the cell is the following:
Samples taken from normal production are submitted to shock and vibration tests mentioned below. More than 95% of the devices pass these tests without perceptible damage.

Shock

25 g_{peak}, 10000 shocks in one of the three positions of the cell.

Vibration

2.5 g_{peak}, 50 Hz, during 32 hours in each of the three positions of the cell.

LIMITING VALUES (Absolute max. rating system)

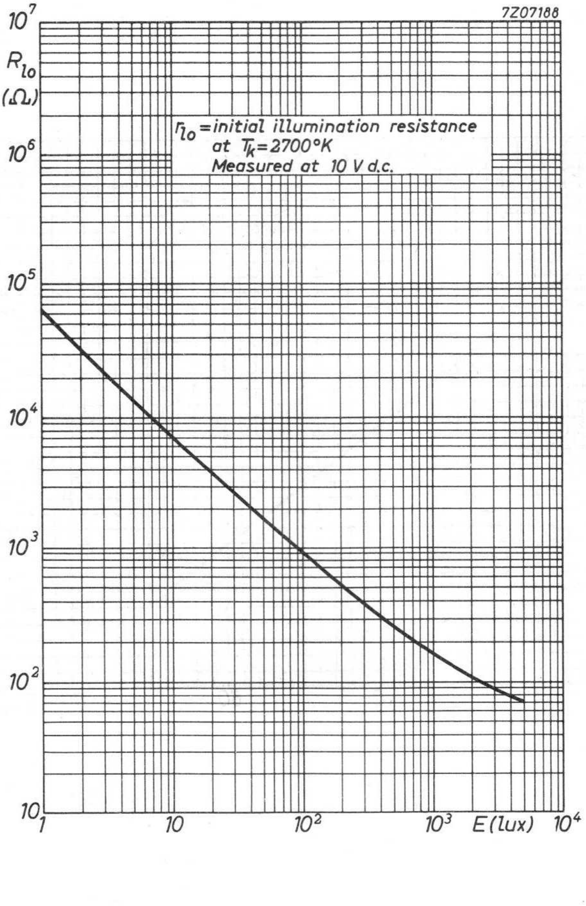
Cell voltage, d.c. and repetitive peak	V	max.	100	V
Cell voltage, pulse, T_{imp} = max. 5 ms P_{rr} = max. once per minute	V_p	max.	250	V
Power dissipation, t_{av} = 2 s	P	See sheet 6		
Power dissipation, pulse	P_p	max.	5 x P	W
Cell current, d.c. and repetitive peak	I	max.	100	mA
Illumination	E	max.	50000	lux
Temperature CdS tablet, operating	T_{tablet}	max.	+85	°C 3)
Ambient temperature, storage and operating	T_{amb}	min.	-40	°C
storage	T_{amb}	max.	+50	°C 4)
operating	T_{amb}	max.	+70	°C

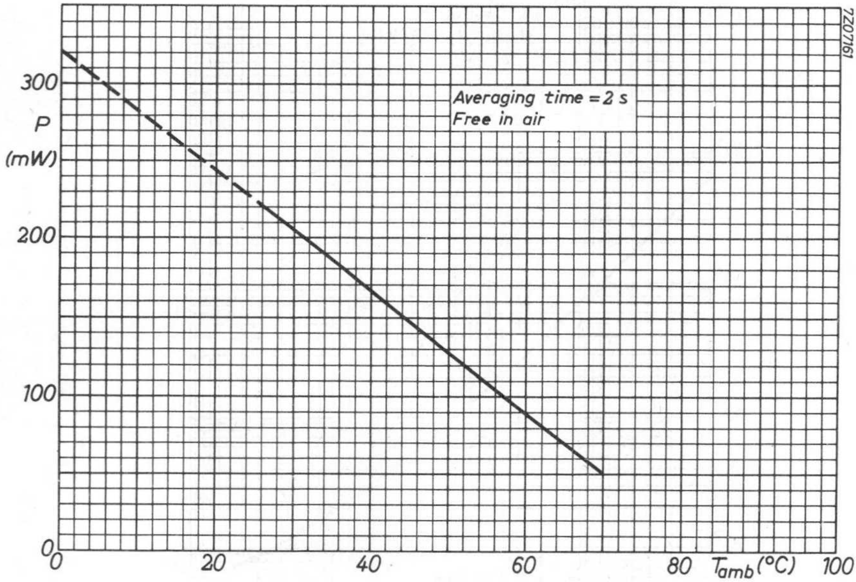
---

3)4) See page 4.

NOTES

1. The spread of the dark resistance is large and values higher than 30 MΩ and 2000 MΩ are possible for the initial dark resistance and the equilibrium dark resistance respectively.
2. After 16 hours in darkness changes in the CdS material are still occurring, but have only insignificant effect on the illumination resistance and on the resistance decay time.
3. If no forced air cooling is used, the envelope temperature opposite the centre of the sensitive area is about 83 °C when the CdS tablet temperature is 85 °C. This temperature can be determined e.g. with a thermocouple fastened on the envelope.
4. Operation of the cell counteracts the deteriorating effect of long periods at high temperature. The maximum operating temperature is therefore higher than the maximum storage temperature.


7Z07188
10^7
R_{lo}
(Ω)
10^6
10^5
10^4
10^3
10^2
10
r_{lo} = initial illumination resistance
at T_k = 2700°K
Measured at 10 V d.c.
1
10
10^2
10^3
E (lux)
10^4


7207161
Averaging time = 2 s
Free in air
P
(mW)
300
200
100
0
0
20
40
60
80
T_{amb} (°C)
100

CADMIUM SULPHIDE PHOTOCONDUCTIVE CELL

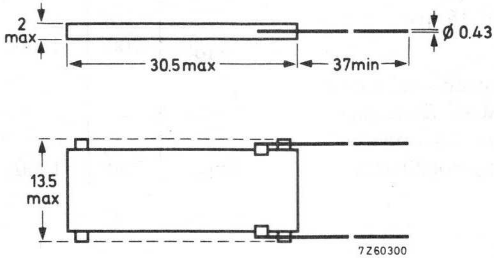
Cadmium sulphide photoconductive cell with side sensitivity.
The device satisfies Test C: Damp heat test (long term exposure), severity IV (56 days exposure) of Publication 68-2 of the International Electrotechnical Commission (IEC).

QUICK REFERENCE DATA

Power dissipation at T_{amb} = 25 ^{o}C	P	max.	0.75	W
Cell voltage, d.c. and repetitive peak	V	max.	400	V
Cell resistance at 50 lux, 2700 ^{o}K colour temperature	r		1500	Ω
Spectral response curve		type D		
Outline dimensions		max. 30.5x13.5x2		mm

MECHANICAL DATA

Dimensions in mm



Soldering

The cell may be soldered directly into the circuit but heat conducted to the tablet should be kept to a minimum by the use of a thermal shunt. The cell may be dip-soldered at a solder temperature of 240 ^{o}C for a maximum of 10 s up to a point 5 mm from the seal.

Mounting

The cell is not insulated electrically and should be mounted accordingly.
Contact the manufacturer when it is desired to envelope the cell.

Warning

To avoid damaging the cell, ask us for special instructions before attempting to encapsulate it in epoxy resin.

ELECTRICAL DATA

General

The electrical properties of CdS cells are dependent on many factors such as illumination, colour temperature of the light source, voltage, current, temperature, total time of operation in the circuit and time of operation during the last 24 hours prior to the measurement. The following basic characteristics are therefore only checkpoints of the electrical properties of these devices measured with defined values of the various conditions and at delivery.

Basic characteristics at T_{amb} = 25 °C, illumination with colour temperature of 2700 °K and at delivery

	symbol	min.	typical	max.	unit
Initial dark resistance measured with 300 V d.c. applied via 1 MΩ, 20 s after switching off the illumination	r_{do}	10		1)	MΩ
Equilibrium dark resistance measured with 400 V d.c. applied via 1 MΩ, 30 minutes after switching off the illumination	r_{de}	200		1)	MΩ
Initial illumination resistance measured at 10 V d.c. illumination = 50 lux, after 16 hrs in darkness 2)	r_{lo}	700	1500	3300	Ω
Equilibrium illumination resistance measured at 10 V d.c. illumination = 50 lux, after 15 minutes under the measuring conditions	r_{le}	700	1900	4500	Ω

---

1) The spread of the dark resistance is large and values higher than 100 MΩ and 10 000 MΩ are possible for the intial dark resistance and the equilibrium dark resistance respectively.

2) After 16 hours in darkness changes in the CdS material are still occurring, but have only insignificant effect on the illumination resistance and on the resistance decay time.

Basic characteristics at T_{amb} = 25 °C, illumination with colour temperature of 2700 °K and at delivery (continued)

	symbol	min.	typical	max.	unit
Resistance decay time Time to reach 10 kΩ, measured from the instant of starting the illumination of 50 lux at 10 V d.c. after 16 hrs in darkness [2]	t_{fr}			0.2	s
Resistance rise time Time to reach 1 MΩ, measured from the instant of stopping the illumination after 5 minutes or longer illumination of 50 lux, at 10 V d.c.	t_{rr}		0.9	1.5	s
Sensitivity at 50 lux, with 10 V d.c. applied	N		0.15		mA/lux
Negative temperature response of illumination resistance			0.2	0.5	%/°C
Voltage response $\frac{\text{r at 0.5 V d.c.}}{\text{r at 10 V d.c.}}$	α		1.05		

THERMAL DATA

Continuous temperature of CdS tablet	T_{tablet}	+85	°C

CLIMATIC DATA

The device satisfies under no load conditions:
Damp heat, steady state test Ca of the I.E.C. publication 68-2-3. Severity 56 days.

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[2] After 16 hours in darkness changes in the CdS material are still occurring, but have only insignificant effect on the illumination resistance and on the resistance decay time.

LIMITING VALUES (Absolute maximum rating system)

Cell voltage, d.c. and repetitive peak	V	max.	400	V
Cell voltage, pulse, t_{imp} = max. 5 ms p_{rr} = max. once per minute	V_p	max.	1000	V
Power dissipation, t_{av} = 2 s	P	see sheet 6		
Power dissipation, pulse	P_p	max.	5xP	
Cell current, d.c. and repetitive peak	I	max.	500	mA
Illumination	E	max.	50 000	lux
Temperature CdS tablet, operating	T_{tablet}	max.	+85	°C
Ambient temperature, storage and operating	T_{amb}	min.	-40	°C
storage	T_{amb}	max.	+50	°C [1]
operating	T_{amb}	max.	+70	°C

DESIGN CONSIDERATIONS

Apparatus with CdS cells should be designed so that changes in resistance values of the cells during life from -30% to +70% do not impair the circuit performance. Direct sunlight irradiation should be avoided.

SHOCK AND VIBRATION

An indication for the ruggedness of the cell is the following:
Samples taken from normal production are submitted to shock and vibration tests mentioned below. More than 95% of the devices pass these tests without perceptible damage.

Shock

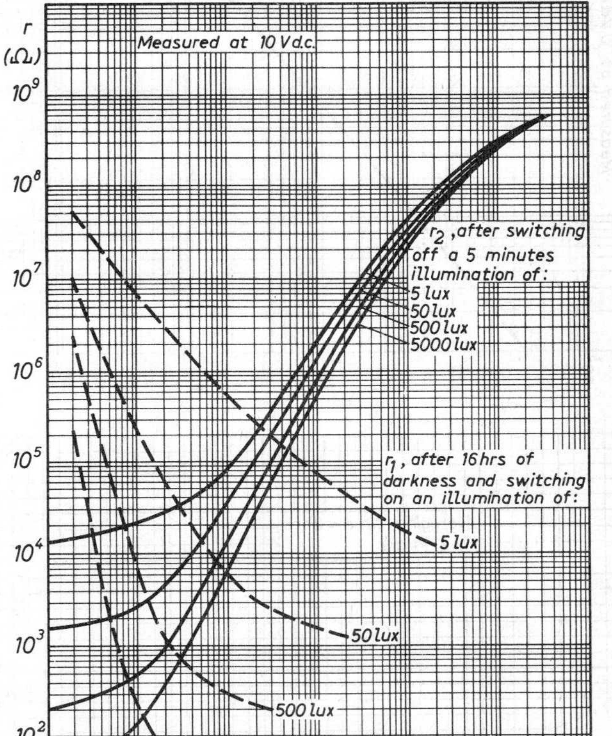
25 g_{peak}, 10 000 shocks in one of the three positions of the cell.

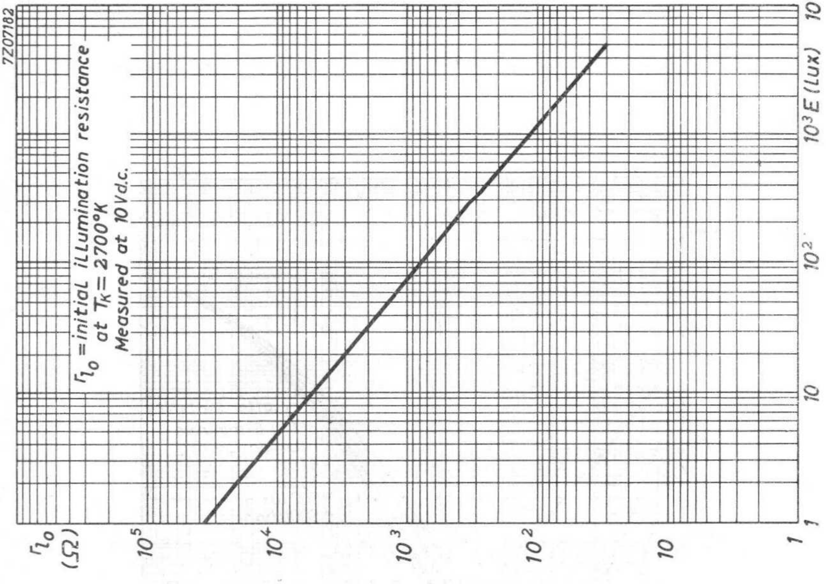
Vibration

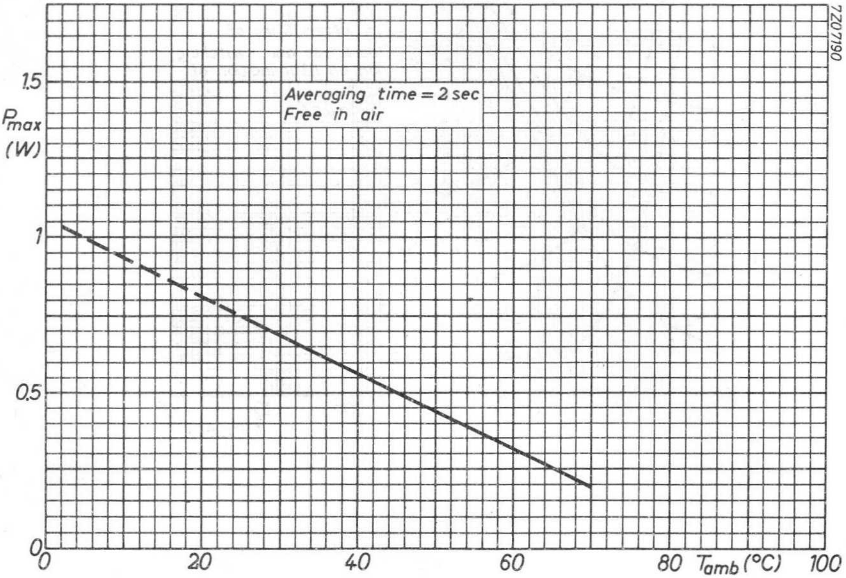
2.5 g_{peak}, 50 Hz, during 32 hours in each of the three positions of the cell.

---

1) Operating of the cell counteracts the deteriorating effect of long periods at high temperature. The maximum operating temperature is therefore higher than the maximum storage temperature


7Z07181
Measured at 10 V d.c.
r
(Ω)
10⁹
10⁸
10⁷
10⁶
10⁵
10⁴
10³
10²
10
1
10
10²
10³
10⁴
10⁵
10⁶
t (msec)
r₂ , after switching off a 5 minutes illumination of:
5 lux
50 lux
500 lux
5000 lux
r₁ , after 16 hrs of darkness and switching on an illumination of:
5 lux
50 lux
500 lux
5000 lux


7Z07182
r_{l_o} = initial illumination resistance
at T_K = 2700°K
Measured at 10 V d.c.
r_{l_o}
(Ω)
10^5
10^4
10^3
10^2
10
1
10^4
10^3 E (lux)
10^2
10
1


7Z07190
1.5
P_{max}
(W)
1
0.5
0
Averaging time = 2 sec
Free in air
0
20
40
60
80
T_{amb} (°C)
100

CADMIUM SULPHIDE PHOTOCONDUCTIVE CELL

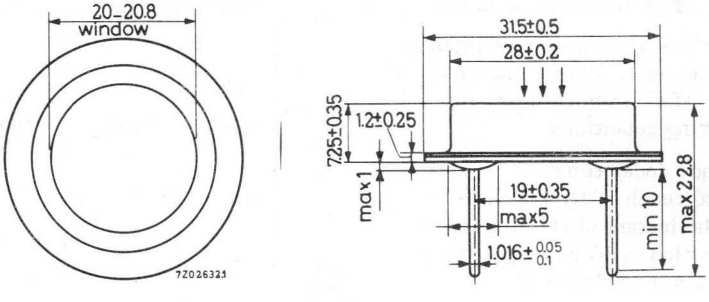
Cadmium sulphide photoconductive cell with top sensitivity intended for use in general control circuits such as twilight switches and flame failure equipment. The cell is tropic proof, shock and vibration resistant.

QUICK REFERENCE DATA

Power dissipation at T_{amb} = 25 °C	P	max.	1	W
Cell voltage, d.c. and repetitive peak	V	max.	200	V
Cell resistance at 50 lux, 2700 °K c.t.	r_{lo}		420	Ω
Spectral response curve			type D	
Outline dimensions		max.	32 dia x 7.6	mm

MECHANICAL DATA

Dimensions in mm



Accessories

Contact springs	type 55561

ELECTRICAL DATA

General

The electrical properties of CdS cells are dependent on many factors such as illumination colour temperature of the light source, voltage, current, temperature, total time of operation in the circuit and time of operation during the last 24 hours prior to the measurement. The following basic characteristics are therefore only checkpoints of the electrical properties of these devices measured with defined values of the various conditions and at delivery.

Basic characteristics at T_{amb} = 25 °C, illumination with colour temperature of 2700 °K and at delivery

	symbol	min.	typical	max.	unit
Initial dark resistance measured with 200 Vd.c. applied via 1 MΩ, 20 s after switching off the illumination	r_{do}	3		1)	MΩ
Equilibrium dark resistance measured with 200 Vd.c. applied via 1 MΩ, 30 min. after switching off the illumination	r_{de}	50		1)	MΩ
Initial illumination resistance measured at 10 Vd.c., illumination 50 lux, after 16 h in darkness 2)	r_{lo}	250	420	1250	Ω
Wquilibrium illumination resistance measured at 10 Vd.c., illumination 50 lux, after 15 min. under the measuring conditions	r_{le}	250	530	1700	Ω
Resistance decay time Time to reach 5 kΩ, measured from the instant of starting the illumination of 50 lux, at 10 Vd.c. after 16 h in darkness 2)	t_{fr}			0.3	s

---

1) the spread of the dark resistance is large and values higher than 50 MΩ and 5000 MΩ are possible for the initial dark resistance and the equilibrium dark resistance respectively.

2) After 16 h in darkness changes in the CdS material are still occurring, but have only insignificant effect on the illumination resistance and on the resistance decay time.

Basic characteristics at T_{amb} = 25 °C, illumination with colour temperature of 2700 °K and at delivery.

	symbol	min.	typical	max.	unit
Resistance rise time Time to reach 1 MΩ, measured from the instant of stopping the illumination, after 5 min. or longer illumination of 50 lux at 10 Vd.c.	t_{rr}			2	s
Sensitivity at 50 lux, with 10 Vd.c. applied	N		0.5		mA/lux
Negative temperature response of illumination resistance	$\Delta r_l/\Delta T$		0.2	0.5	% / °C
Voltage response $\frac{\text{r at 0.5 V}}{\text{r at 10 V}}$			1.05		

THERMAL DATA

Continuous temperature of CdS tablet	T_{tablet}	max.	+ 85	°C
Thermal resistance from CdS tablet to ambient, device free in air	K		60	°C/W

DESIGN CONSIDERATIONS

Apparatus with CdS cells should be designed so that changes in resistance values of the cells during life from - 30 % to + 70 % do not impair the circuit performance. Direct sunlight irradiation should be avoided.

SHOCK AND VIBRATION

An indication for the ruggedness of the cell is the following:
Samples taken from normal production are submitted to shock and vibration tests More than 95 % of the devices pass these tests without perceptible damage.

Shock

25 g_{peak}, 10000 shocks in one of the three positions of the cell.

Vibration

2.5 g_{peak}, 50 Hz, during 32 hours in each of the three positions of the cell.

LIMITING VALUES (Absolute max. rating system)

Cell voltage, d.c. and repetitive peak	V	max.	200	V
Cell voltage, pulse, t_{imp}=max. 5 ms p.r.r. = max. once per minute	V_P	max.	500	V
Power dissipation, t_{av} = 2 s	P	See	page	6
Power dissipation, pulse	P_p	max.	5 x	P
Cell current, d.c. and repetitive peak	I	max.	250	mA
Illumination	E	max.	50000	lux
Temperature Cds tablet, operating	T_{tablet}	max.	85	°C
Ambient temperature, storage and operating	T_{amb}	min.	- 40	°C
storage	T_{amb}	max.	+ 50	°C 1)
operating	T_{amb}	max.	+ 70	°C

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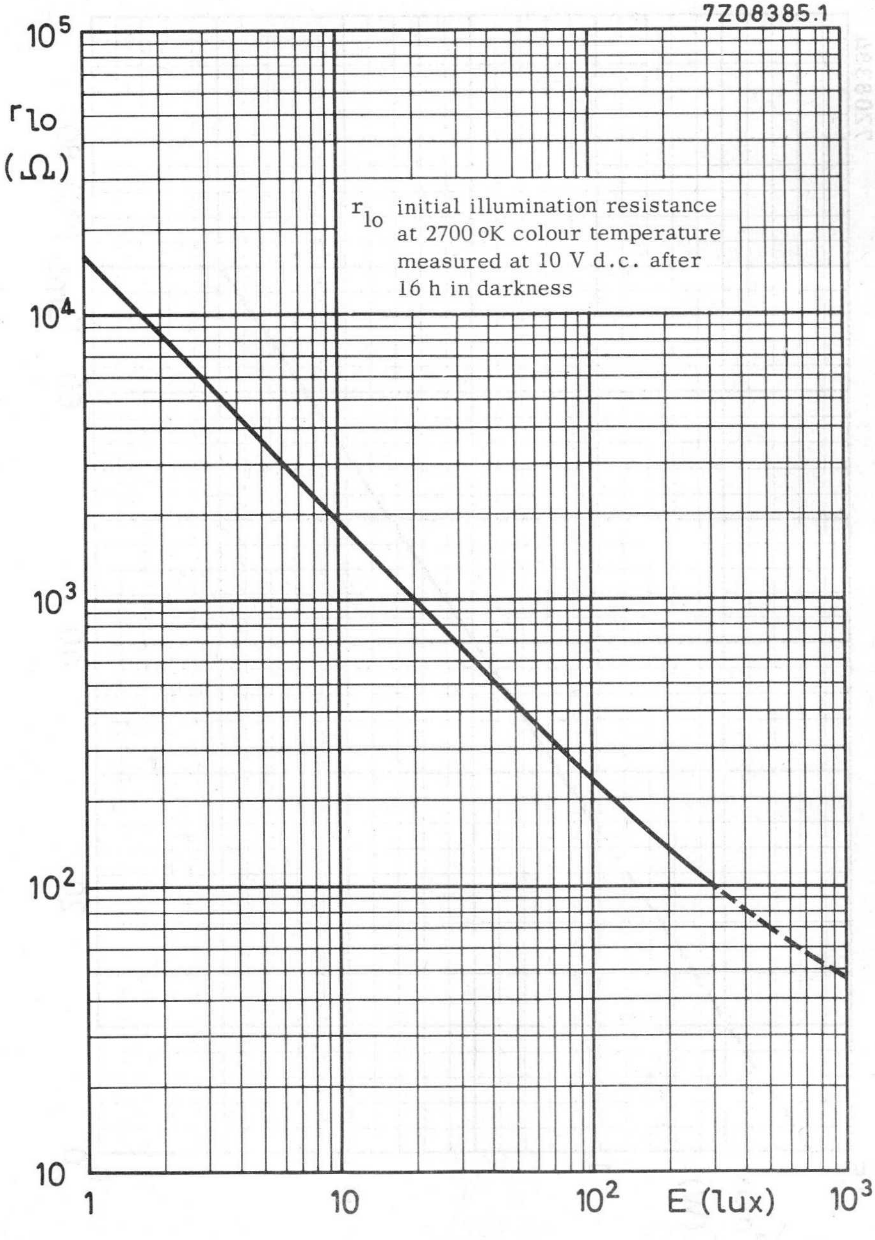
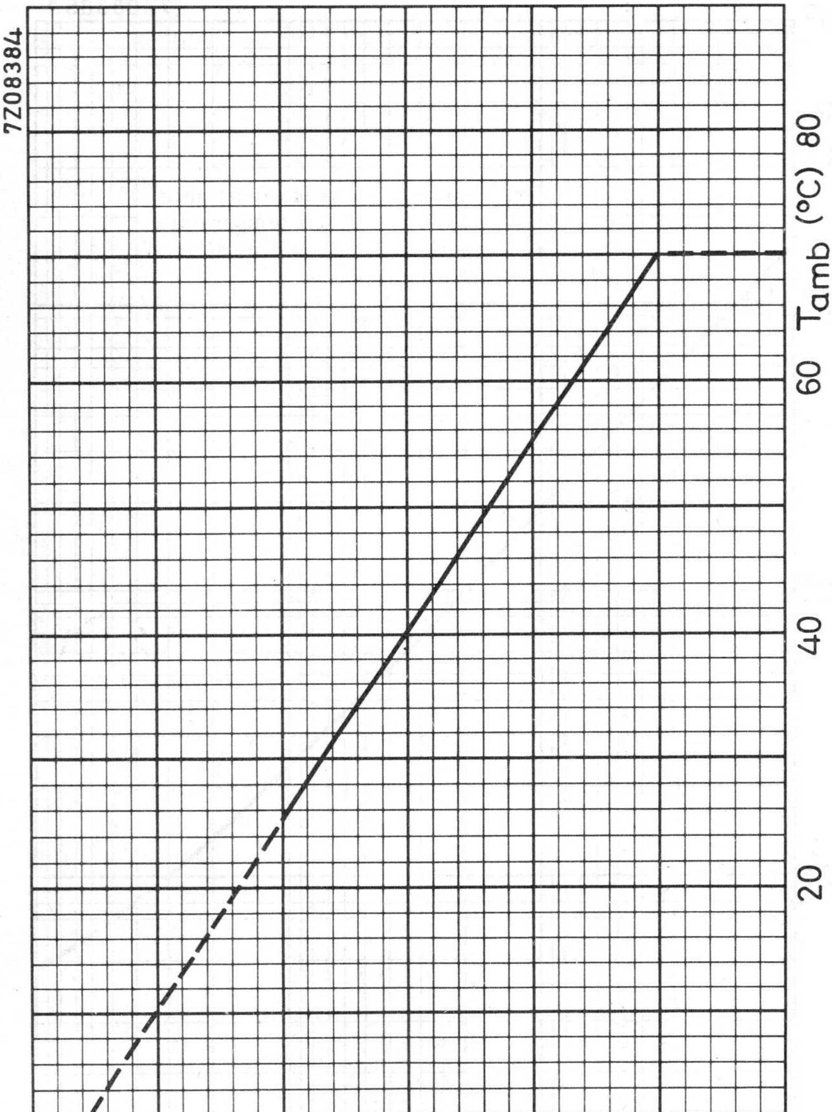
1) Operation of the cell counteracts the deteriorating effect of long periods at high temperature. The maximum operating temperature is therefore higher than the maximum storage temperature.


7Z08385.1
10^5
r_{lo}
(Ω)
10^4
10^3
10^2
10
1
10
10^2
E (lux)
10^3
r_{lo} initial illumination resistance at 2700 °K colour temperature measured at 10 V d.c. after 16 h in darkness


7Z08384
1.5
P_{max}
(W)
1
0.5
0
0
20
40
60
80
T_{amb} (°C)

CADMIUM SULPHIDE PHOTOCONDUCTIVE DEVICE

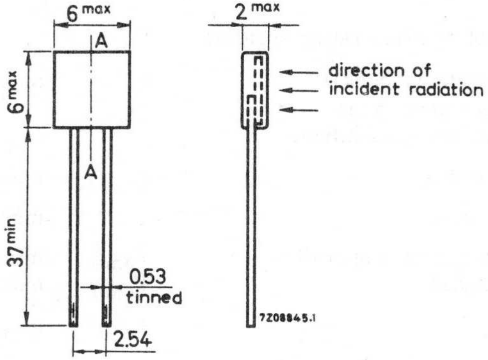
Cadmium sulphide photoconductive device with side sensitivity in plastic encapsulation. The device consists of two cells connected in series and is intended for general applications.

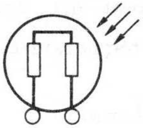
QUICK REFERENCE DATA

Power dissipation at T_{amb} = 40 °C 1)	P		200	mW
Voltage, d.c. and repetitive peak	V	max.	50	V
Resistance at 50 lux, 2700 °K colour temperature	r_{l_o}		600	Ω
Spectral response curve		see page 4		
Outline dimensions		max.	6 x 6 x 2	mm

MECHANICAL DATA

Dimensions in mm





Soldering

The device may be soldered direct into the circuit but heat conducted to the tablet should be kept to a minimum by the use of a thermal shunt.
It may be dip-soldered at a solder temperature of 270 °C for a maximum of 2 s up to a point 6 mm from the envelope.

---

1) See Operating Note 2

ELECTRICAL DATA

Preconditioning > 1 h illumination with 300 lx (fluorescent light)

	symbol	min.	typical	max.	unit
Initial dark resistance, measured with 50 $V_{d.c.}$ applied via 1 MΩ, 20 s after switching off the illumination	r_{do}	200			kΩ
Initial illumination resistance measured at 1 $V_{d.c.}$, illumination 50 lux	r_{lo}	0.35	0.6	1.4	kΩ
Initial drift	D_o		0		%
F_{4700} (= $\frac{r_l \text{ at } 4700\ ^{o}K}{r_l \text{ at } 2700\ ^{o}K}$ at constant illumination)			1.2		

THERMAL DATA

Cell temperature	T_{cell}	max.	60	^{o}C
Thermal resistance from cell to a point on the leads 2 mm from the cell	K		35	$^{o}C/W$

LIMITING VALUES (Absolute max. rating system)

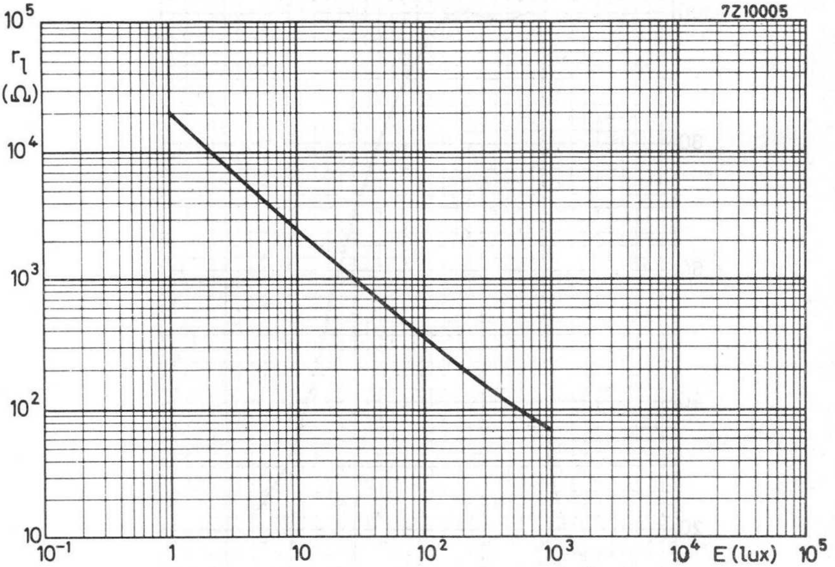
Cell voltage, d.c. and repetitive peak pulse, t_{imp} = max. 5 ms p r r = max. once per minute	V	max.	50	V
Power dissipation, t_{av} = 0.5 s	P	max.	300	mW
Cell current, d.c. and r.m.s.	I	max.	25	mA
Ambient temperature, storage and operating	T_{amb}	min.	−40	^{o}C
storage	T_{amb}	max.	+50	^{o}C
Cell temperature	T_{cell}	max.	+60	^{o}C

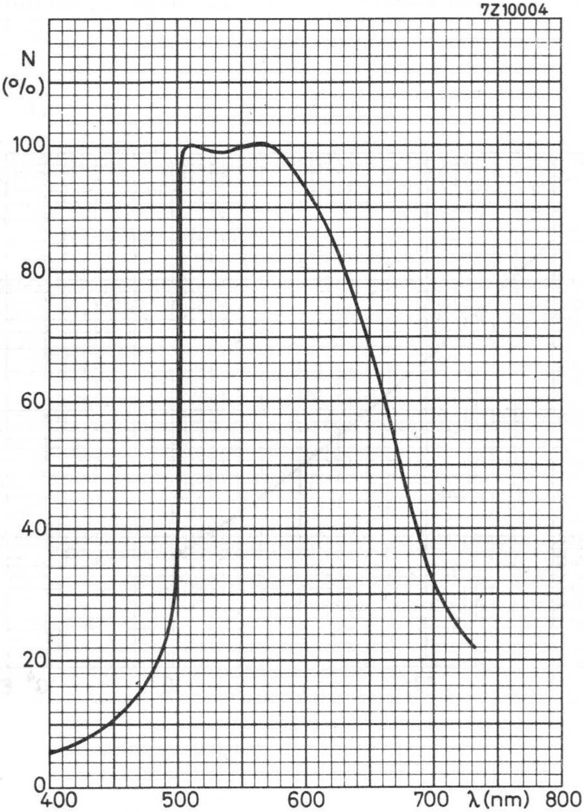
OPERATING NOTES

1. The device consists of two photoconductive cells connected in series. The resistance of the device is mainly governed by the resistance of that cell receiving the lowest luminous flux.
   If it is essential for the application that the device is partly shaded off, the shadow line should be perpendicular to the axis A-A of the device.
2. By clamping the leads at 2 mm from the body of the device, and making sure that the thermal resistance between clamping point and ambient is 50 $^{o}C/W$, one obtains an allowable dissipation of 200 mW at an ambient temperature of 40 ^{o}C; the temperature difference between clamping point and ambient then is 10 ^{o}C and the cell temperature 60 ^{o}C.

CLIMATIC DATA

After exposure to test C: Damp heat test (long term exposure): temperature 40 °C ± 2 °C; relative humidity between 90% and 95%, severity VII of Publication 68-2 of the International Electrotechnical Commission (IEC) the changes in illumination resistance are within +50% and -30%.
A high humidity does not harm the cell. Yet care should be taken not to put the cell into operation when wet. Four hours under normal room conditions make it sufficiently dry, also after it has been exposed to high humidity conditions for a long time.




7Z10004
N
(%)
100
80
60
40
20
0
400
500
600
700
λ(nm)
800

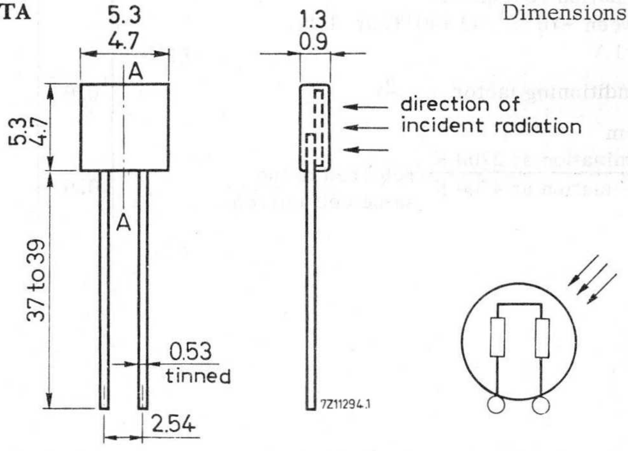
CADMIUM SULPHIDE PHOTOCONDUCTIVE DEVICE

Cadmium sulphide photoconductive cell with side sensitivity in a plastic encapsulation. The device consists of two cells in series and is intended for use in cameras, exposure meters, light control equipment and for general industrial use.

QUICK REFERENCE DATA				
Power dissipation	P	max.	50	mW
Cell voltage, d.c. and repetitive peak	V	max.	50	V
Cell resistance at 10 lux, 2700 °K	r_{lo}		3 to 6	kΩ
Outline dimensions			5 mm x 5 mm x 1	mm

MECHANICAL DATA

Dimensions in mm



Soldering

The device may be soldered direct into the circuit but heat conducted to the seals should be kept at a minimum by the use of a thermal shunt. Dip soldering at a solder temperature of 270 °C may be employed for a maximum of 2 s up to a point 6 mm from the seals.

ELECTRICAL DATA

Basic characteristics at T_{amb} = 25 °C, illumination with 2700 K c.t.

Pre-conditioning 1 h illumination with 300 lx (fluorescent light)

	symbol	min.	typical	max.	unit
Initial dark resistance measured with 50 $V_{d.c.}$ applied via 1 MΩ, 20 s after stopping the illumination of 10 lx	r_{do}	0.6			MΩ
Initial illumination resistance measured at V = 1 $V_{d.c.}$, illumination 10 lx	r_{lo}	2.4		6.0	kΩ
Illumination response [1] measured at 1 $V_{d.c.}$ between 0.1 lx and 10 lx	$\gamma_{0.1-10}$	0.94		1.12	
Negative temperature response of illumination resistance between −10 °C and +40 °C at 1 lx, V = 1 V	$r_l/\Delta T$			0.5	%/°C
Pre-conditioning factor [2]		0.9		1.1	
Actinism $\frac{\text{Illumination at 2700 K}}{\text{Illumination at 4700 K}}$ (referred to the same cell current)		0.9		1.1	

---

[1] $$\gamma = \frac{\log r1 - \log r2}{\log E2 - \log E1}$$ where E1 = 0.1 lx and E2 = 10 lx

[2] $$\text{Pre-conditioning factor} = \frac{\text{Cell current at 1 lx, after 3 days in darkness}}{\text{Cell current at 1 lx, after 1 h pre-conditioning at 300 lx (fluorescent light)}}$$

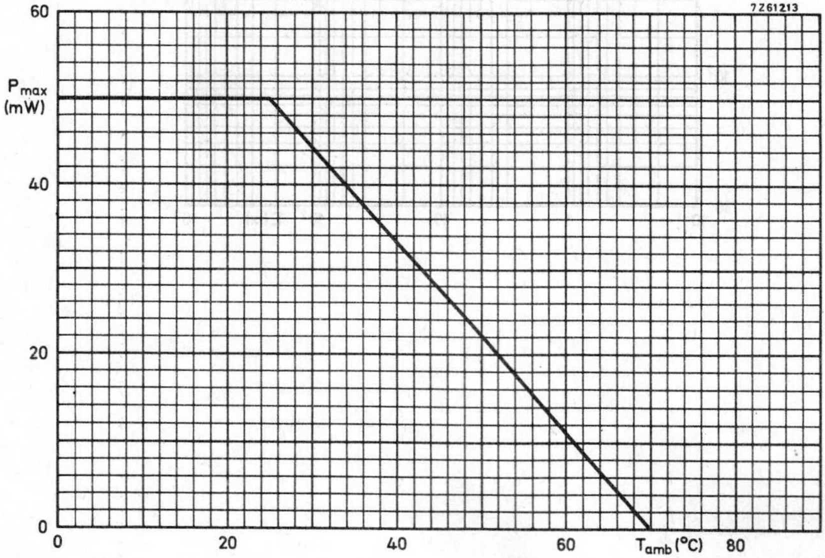
measured when a stable current is reached

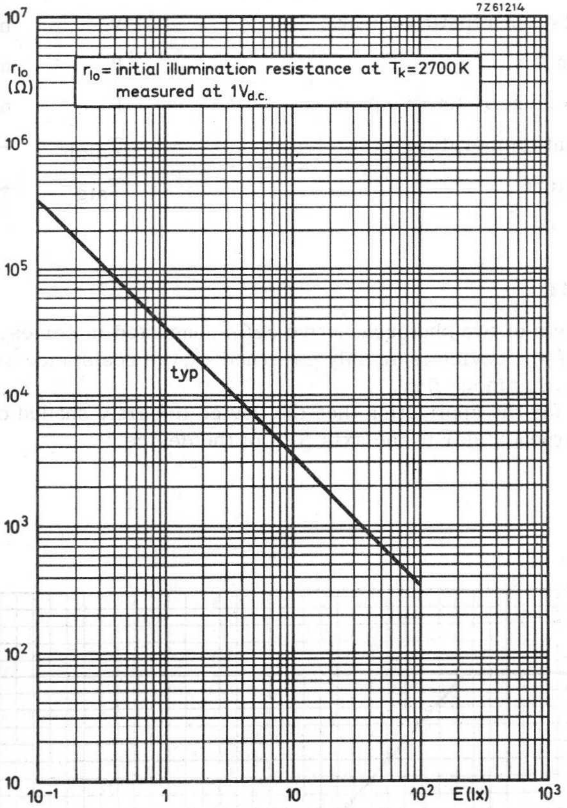
LIMITING VALUES (Absolute max. rating system)

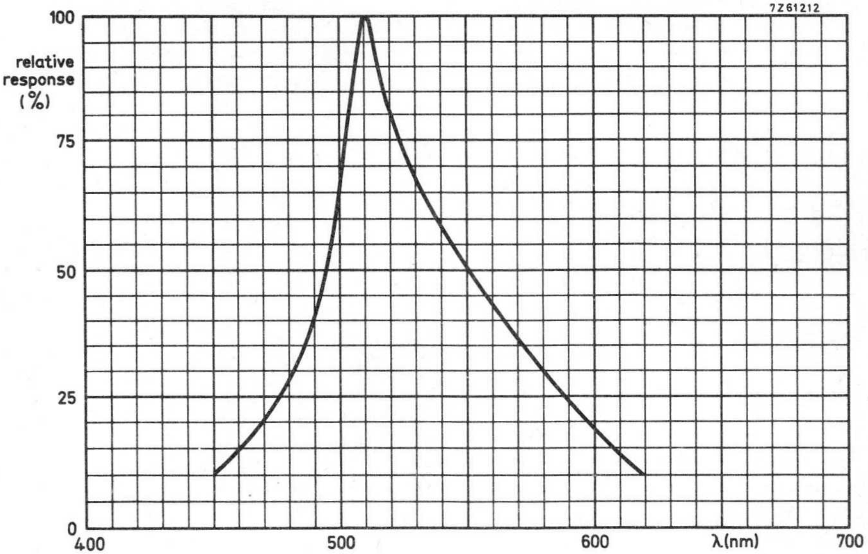
Cell voltage, d.c. and repetitive peak	V	max.	50	V
Power dissipation	P	max.	50	mW
Cell current, d.c. and repetitive peak	I	max.	20	mA
Operating ambient temperature	T_{amb}		-40 to +70	^oC
Storage temperature	T_{stg}		-40 to +70	^oC

OPERATING NOTE

The device consists of two photoconductive cells connected in series.
The resistance of the device is mainly governed by the resistance of that cell receiving the lowest luminous flux.
If it is essential for the application that the device is partly shaded off, the shadow line should be perpendicular to the axis A-A of the device.




7Z61214
r_{lo} (Ω)
r_{lo} = initial illumination resistance at T_k = 2700 K measured at 1 $V_{d.c.}$
typ
10^7
10^6
10^5
10^4
10^3
10^2
10
10^{-1}
1
10
10^2
E (lx)
10^3


7Z61212
100
relative
response
(%)
75
50
25
0
400
500
600
λ(nm)
700

Photodiodes
Phototransistors

PHOTO-DETECTORS

	Type No.	Sensitivity	voltage max.	Outline (dimensions in mm)	Rise time
Ge diode	OAP12	5 μA/mW/cm^2	30 V	sealed diameter 2.8	
Si diodes	BPX40	8 μA/mW/cm^2	18 V	unencapsulated 1.25 x 3.35 x 0.27	
	BPX41	25 μA/mW/cm^2	18 V	unencapsulated 2.15 x 4.7 x 0.27	
	BPX42	100 μA/mW/cm^2	12 V	unencapsulated 5.0 x 7.0 x 0.27	
	BPY10	13 μA/mW/cm^2	1 V	special encapsulation 2.2 x 2.5 x 7.6	
	BPY68	400 μA/mW/cm^2	60 V	diameter 2.8	17 μs
	BPY69	300 μA/mW/cm^2	60 V	diameter 2.2	16 μs
	BPY77	7.5 μA/mW/cm^2	100 V	sealed TO-18 with lens	0.5 ns
Si transistors	BPX25	7 mA/mW/cm^2	32 V	sealed TO-18 with lens	1.8 μs
	BPX29	0.7 mA/mW/cm^2	32 V	sealed TO-18 with flat window	2.4 μs
	BPY76	0.3 mA/mW/cm^2	35 V	sealed diameter 1.75	2.3 μs

INFRA-RED EMITTER

GaAs transistor	CQY11B	3.5 mW/A	2 V	sealed TO-18 with flat window	1 ns

Sensitivity, as measured on the axis of the cell, is stated in mA/mW/cm^2 for radiation of 875 nm wavelength; multiply by 1.2 to obtain the corresponding sensitivity to 1000 lux visible light at 2854 K. Example: sensitivity (875 nm) = 0.6 mA/mW/cm^2; sensitivity (2854 K) = 1.2 x 0.6 = 0.72 mA/1000 lux.
The factor 1.2 is merely approximate. In practice, differences in spectral response between cells, and differences in the infra-red content of 2854 K light, account for some variation.

DEFINITIONS APPLYING TO PHOTOSENSITIVE DEVICES to IEC 306

DEFINITIONS AND UNITS OF RADIATION AND LIGHT QUANTITIES

Radiant flux; radiant power

Power emitted, transferred or received in the form of radiation.

Symbols: ϕ_e, ϕ, P $\phi_e = \frac{dQ_e}{dt}$; unit: watt, W.

Radant intensity

The radiant intensity of a source in a given direction is the quotient of (1) the radiant flux leaving the source propagated in an element of solid angle containing the given direction, by (2) the element of solid angle.

Symbols: I_e, I $I_e = \frac{d\phi_e}{d\Omega}$; unit: watt per steradian, W/sr.

Irradiance

The irradiance at a point of a surface is the quotient of (1) the radiant flux incident on an element of the surface containing the point, by (2) the area of that element.

Symbols: E_e, E $E_e = \frac{d\phi_e}{dA}$; unit: watt per square metre, W/m^2.

Light

Radiation capable of stimulating the organ of vision.

Luminous flux

Quantity derived from radiant flux by evaluating the radiation according to its action upon a selective receptor, the spectral sensitivity of which is defined by the standard spectral luminous efficiency.

Symbols: ϕ_v, ϕ; unit: lumen, 1m.

Lumen

SI unit of luminous flux: luminous flux emitted within unit solid angle (one steradian) by a point source having a uniform intensity of 1 candela.

Symbol: 1m.

Note: – SI stands for "Système International".

Luminous intensity

The luminous intensity of a source in a given direction is the quotient of (1) the luminous flux leaving the source propagated in an element of solid angle containing the given direction, by (2) the element of solid angle.

Symbols: I_V, I $\qquad I_V = \frac{d\phi_V}{d\Omega}$; unit: candela, cd.

Candela

SI unit of luminous intensity: Luminous intensity, in the perpendicular direction, of a surface of 1/600 000 square metre of a black body at the temperature of freezing platinum under a pressure of 101 235 newtons per square metre.

Symbols: cd; 1 cd = 1 lm/sr.

Illuminance

At a point of a surface, the quotient of (1) the luminous flux incident on an element of the surface containing the point, by (2) the area of that element.

Symbols: E_V, E $\qquad E_V = \frac{d\phi_V}{dA}$; unit: lux, lx.

Lux; lumen per square metre

SI unit of illuminance: illuminance produced by a luminous flux of 1 lumen uniformly distributed over a surface of area 1 square metre.

Symbol: lx ; 1 lx = 1 lm/m^2.

Distribution temperature

Temperature of the full radiator for which the ordinates of the spectral distribution curve of its radiance are proportional, in the visible region, to those of the distribution curve of the radiation cosidered.

The unit of measurement is degree Kelvin (K).

Colour temperature

For the purpose of this Recommendation, colour temperature is the distribution temperature of the radiation source.

The unit of measurement is degree Kelvin.

DEFINITIONS OF ELECTRICAL QUANTITIES

Photocurrent

The change in output current from the photocathode caused by incident radiation.

Frequency response characteristic

Relation, usually shown by a graph, between the radiant (or luminous) dynamic sensitivity and the modulation frequency of the incident radiation.

Dark current

The current flowing in a photoelectric device in the absence of irradiation.

Equivalent dark-current irradiation

The incident radiation required to give a d.c. signal output current equal to the dark current.

Equivalent noise irradiation

The value of incident radiation which, when modulated in a stated manner, produces a signal output power equal to the noise power, both in a stated bandwidth.

Quantum efficiency

The ratio of (1) the number of emitted photoelectrons to (2) the number of incident photons.

Quantum efficiency (Q.E.) at a given wavelength of incident radiation may be computed from:

$$\text{Q.E.} = \frac{\text{const.} \times s_k}{\lambda}$$

where:

s_k = spectral sensitivity (amperes per watt) at wavelength λ

λ = wavelength of incident radiation (nanometres)

const. = hc_0/e = 1.24×10^3 W.nm/A

h = Planck constant

c_0 = speed of propagation of electromagnetic waves in vacuo

e = elementary charge

Saturation voltage

The lowest operating voltage which causes no change, or only a slight change, of the photocurrent when this voltage is increased under conditions of given constant radiation.

Saturation current

The output current of a photosensitive device which is not changed, or only insignificantly changed, by an increase of either:

a) the irradiance under constant operating conditions; or

b) the operating voltage under constant irradiance.

Note. – The context should make clear which definition is applicable.

DEFINITIONS OF SENSITIVITY

These definitions apply more directly to photocathode sensitivity. For devices in which it is necessary to define the anode (over-all) sensitivity, signal output current should be considered instead of photocurrent.

Radiant sensitivity

a) The quotient of (1) the photocurrent of the device by (2) the incident radiant power, expressed in amperes per watt.

b) The quotient of (1) the photocurrent of the device by (2) the incident irradiance, expressed in amperes per watt/m^2.

Absolute spectral sensitivity

The radiant sensitivity for monochromatic radiation of a stated wavelength.

Relative spectral sensitivity

The ratio of (1) the radiant sensitivity at any considered wavelength to (2) the radiant sensitivity at a certain wavelength taken as reference, usually the wavelength of maximum response.

Note. – For non-linear detectors, it is neccessary to refer to constant photocurrent at all wavelengths.

Luminous sensitivity

a) The quotient of (1) the photocurrent of the device by (2) the incident luminous flux, expressed in amperes per lumen.

b) The quotient of (1) the photocurrent of the device by (2) the incident illuminance, expressed in amperes per lux.

Dynamic sensitivity

Under stated conditions of operation, the quotient of (1) the variation of the photocurrent of the device by (2) the initiating small variation of the incident radiant power (or luminous)

Note. – Distinction is made between "luminous dynamic sensitivity" and "radiant sensitivity."

Spectral sensitivity characteristic

The relation, usually shown by a graph, between wavelength and absolute or relative spectral sensitivity.

Absolute spectral sensitivity characteristic

The relation, usually shown by a graph, between wavelength and absolute spectral sensitivity.

Relative spectral sensitivity characteristic

The relation between wavelength and relative spectral sensitivity.

Quantum efficiency characteristic

The relation, usually shown by a graph, between wavelength and quantum efficiency.

DEFINITIONS OF TIME QUANTITIES

Rise time

The time required for the photocurrent to rise from a stated low percentage to a stated higher percentage of the maximum value when a steady state of radiation is instantaneously applied.

It is usual to consider the 10 % and 90 % levels.

Fall time

The time required for the photocurrent to fall from a stated high percentage to a stated lower percentage of the maximum value when the steady state of radiation is instantaneously removed.

It is usual to consider the 90 % and 10 % levels.

SILICON PLANAR EPITAXIAL PHOTO-TRANSISTORS

General purpose n-p-n silicon photo-transistors in TO-18.
The window of the BPX25 is a lens, that of the BPX29 is plane.

QUICK REFERENCE DATA

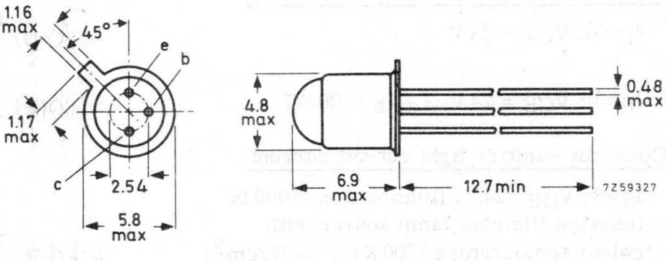
Collector-emitter voltage (open base)	V_{CEO}	max.	32		V
Collector current (peak value)	I_{CM}	max.	200		mA
Junction temperature	T_j	max.	150		°C
Collector-emitter dark cut-off current $I_B = 0$; $V_{CE} = 24$ V	$I_{CEO(D)}$	<	1.0		μA
			BPX25	BPX29	
Collector-emitter light cut-off current $I_B = 0$; $V_{CE} = 24$ V; at 1000 lx	$I_{CEO(L)}$	typ.	8.0	0.8	mA
Peak spectral response	λ_m	typ.	800		nm

MECHANICAL DATA

Dimensions in mm

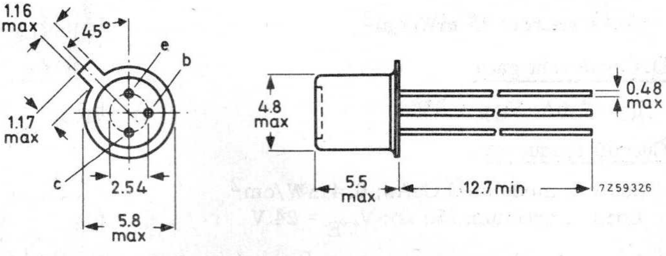
BPX25

TO-18, except for lens
Collector connected to case



BPX29

TO-18, except for window
Collector connected to case



RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltages				
Collector-base voltage (open emitter)	V_{CBO}	max.	32	V
Collector-emitter voltage (open base)	V_{CEO}	max.	32	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	V
Current				
Collector current (d.c.)	I_C	max.	100	mA
Collector current (peak value)	I_{CM}	max.	200	mA
Power dissipation				
Total power dissipation up to $T_{amb} = 25^oC$	P_{tot}	max.	300	mW
Temperatures				
Storage temperature	T_{stg}		-65 to +150	^oC
Junction temperature	T_j	max.	150	^oC

THERMAL RESISTANCE

From junction to ambient	$R_{th\ j\text{-}a}$	=	0.4	$^oC/mW$
From junction to case	$R_{th\ j\text{-}c}$	=	0.15	$^oC/mW$

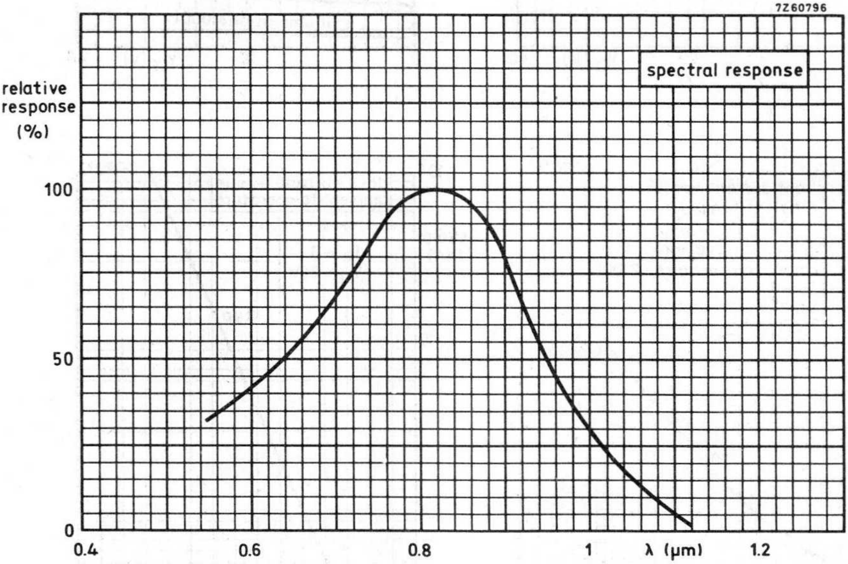
CHARACTERISTICS T_{amb} = 25 ^oC unless otherwise specified

Collector-emitter dark cut-off current				
$I_B = 0$; $V_{CE} = 24\,V$	$I_{CEO(D)}$	typ. <	0.2 1.0	μA μA
$I_B = 0$; $V_{CE} = 24\,V$; $T_{amb} = 100\,^oC$	$I_{CEO(D)}$	typ. <	30 200	μA μA

			BPX25	BPX29	
Collector-emitter light cut-off current					
$I_B = 0$; $V_{CE} = 24\,V$; illumination: 1000 lx tungsten filament lamp source with colour temperature 2700 K (7.7 mW/cm^2)	$I_{CEO(L)}$	> typ.	2.5 8.0	0.25 0.8	mA mA
GaAs source; 15 mW/cm^2	$I_{CEO(L)}$	typ.	13	1.3	mA
D.C. current gain					
$I_C = 2\,mA$; $V_{CE} = 5\,V$	h_{FE}	typ.	250	250	
Cut-off frequency					
Source: modulated GaAs; 0.4 mW/cm^2 Load : optimum (50 Ω); V_{CE} = 24 V	f_{co}	typ.	200	150	kHz

CHARACTERISTICS (continued)

			BPX25	BPX29	
Switching times [1]					
Delay time	t_d	typ.	1.0	2.5	µs
		<	3.0	5.0	µs
Rise time	t_r	typ.	1.5	2.5	µs
		<	3.0	5.0	µs
Storage time	t_s	typ.	0.2	0.2	µs
		<	0.4	0.4	µs
Fall time	t_f	typ.	1.5	3.5	µs
		<	4.0	8.0	µs
Peak spectral response	λ_m	typ.	800	800	nm
Equivalent noise illumination at f = 800 Hz [2]					
V_{CE} = 5 V; illumination: 1000 lx		typ.	0.5	1.5	$\frac{\text{mlx}}{\sqrt{\text{Hz}}}$



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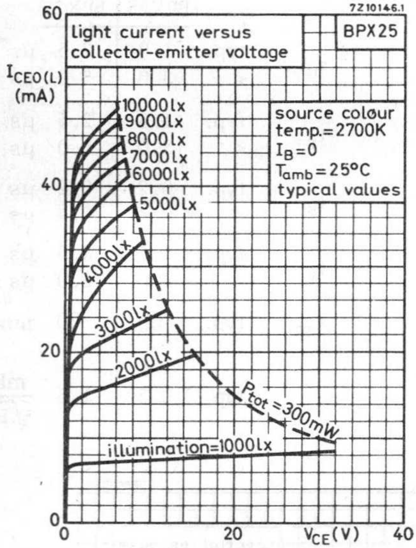
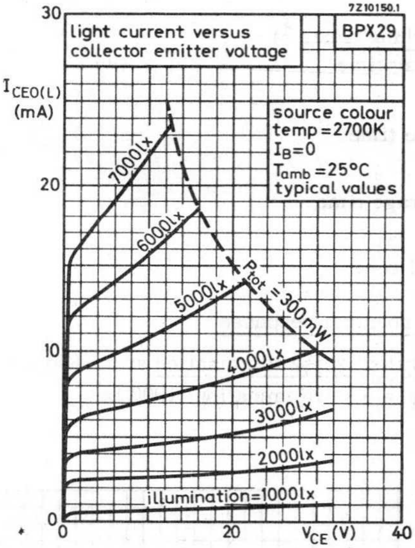
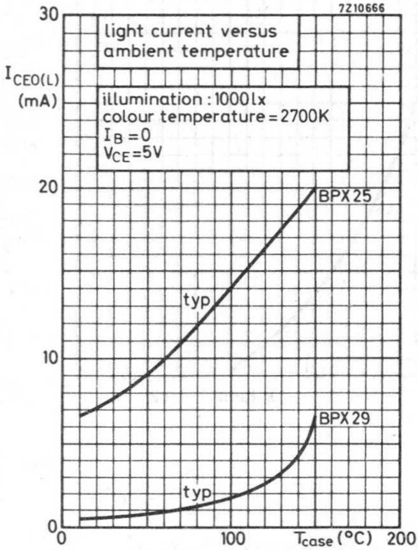
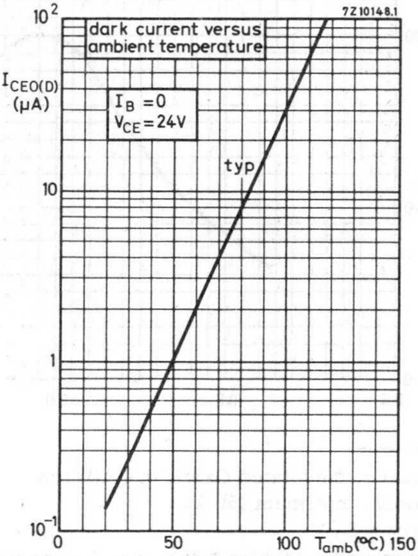
[1] Source: modulated GaAs: 0.4 mW/cm^2
Load: optimum (50 Ω)
V_{CE} = 24 V
Improved switching times can be obtained by a quiescent bias current.
I.e. I_B = 2 µA: t_d < 0.2 µs.

[2] At this and lower frequencies, $\frac{1}{f}$ noise predominates.

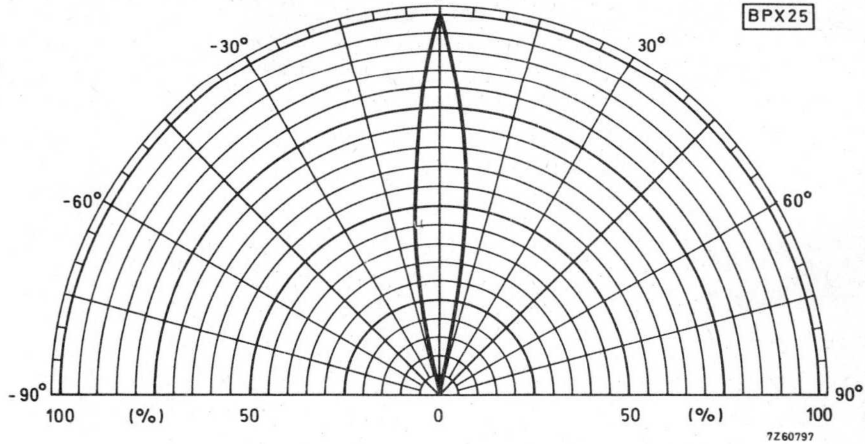

7Z10146.1
light current versus
collector-emitter voltage
BPX25
$I_{CEO(L)}$
(mA)
source colour
temp.=2700K
I_B=0
T_{amb}=25°C
typical values
10000 lx
9000 lx
8000 lx
7000 lx
6000 lx
5000 lx
4000 lx
3000 lx
2000 lx
illumination=1000 lx
P_{tot}=300mW
60
40
20
0
0
20
40
V_{CE}(V)


7Z10150.1
light current versus
collector emitter voltage
BPX29
$I_{CEO(L)}$
(mA)
source colour
temp=2700K
I_B=0
T_{amb}=25°C
typical values
7000 lx
6000 lx
5000 lx
4000 lx
3000 lx
2000 lx
illumination=1000 lx
P_{tot}=300mW
30
20
10
0
0
20
40
V_{CE}(V)

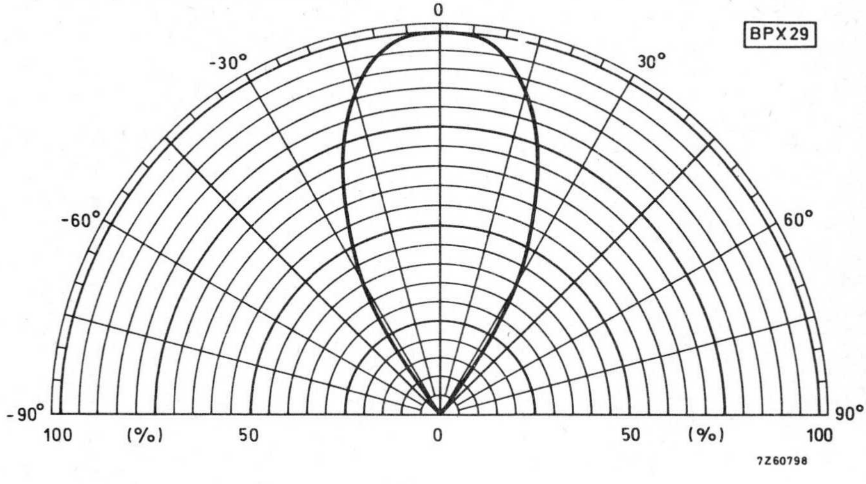

7Z10666
light current versus
ambient temperature
$I_{CEO(L)}$
(mA)
illumination : 1000 lx
colour temperature=2700K
I_B=0
V_{CE}=5V
BPX25
typ
BPX29
typ
30
20
10
0
0
100
200
T_{case}(°C)


7Z10148.1
dark current versus
ambient temperature
$I_{CEO(D)}$
(μA)
I_B=0
V_{CE}=24V
typ
10^2
10
1
10^{-1}
0
50
100
150
T_{amb}(°C)

polar response of relative sensitivity



polar response of relative sensitivity



SILICON PLANAR PHOTO-DIODE

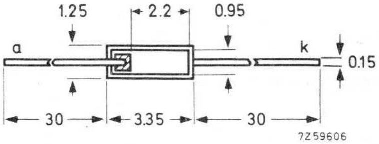
Unencapsulated photo-diode for general purpose applications.

QUICK REFERENCE DATA

Reverse voltage	V_R	max.	18	V
Light sensitivity V_R = 15 V; E = 1000 lx	N	typ.	10	nA/lx
Dark reverse current at V_R = 15 V	I_d	<	0.5	μA
Peak spectral response	λ_m	typ.	800	nm

MECHANICAL DATA

Dimensions in mm



Slice thickness 0.27 mm

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltage			
Reverse voltage	V_R	max.	18 V
Currents			
Forward current	I_F	max.	5 mA
Dark reverse current	I_R	max.	2 mA
Temperatures			
Storage temperature	T_{stg}		−65 to +125 °C
Junction temperature	T_j	max.	125 °C

THERMAL RESISTANCE

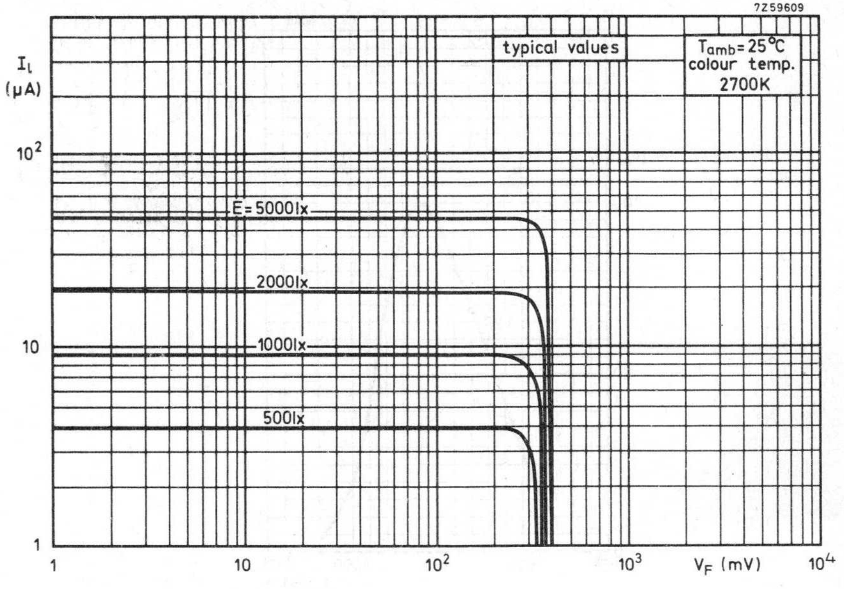
From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	0.5 °C/mW

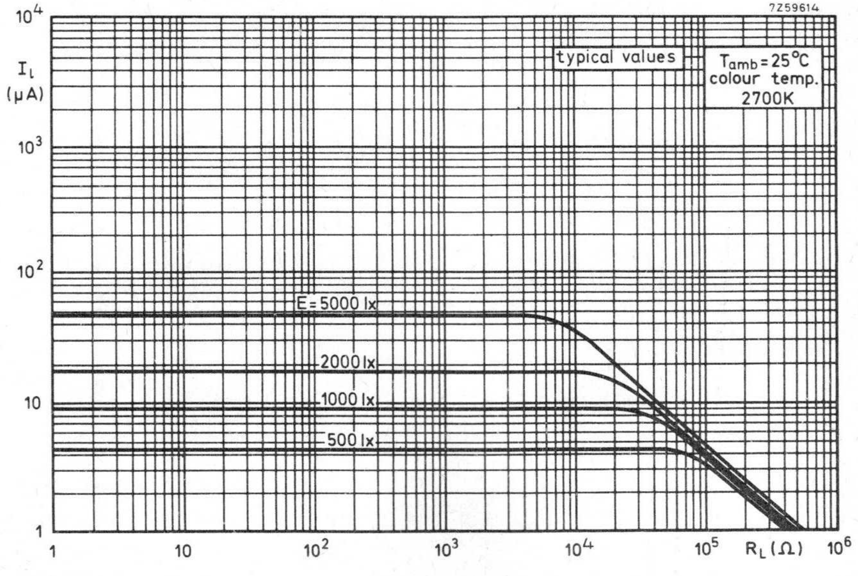
CHARACTERISTICS T_{amb} = 25 °C unless otherwise specified

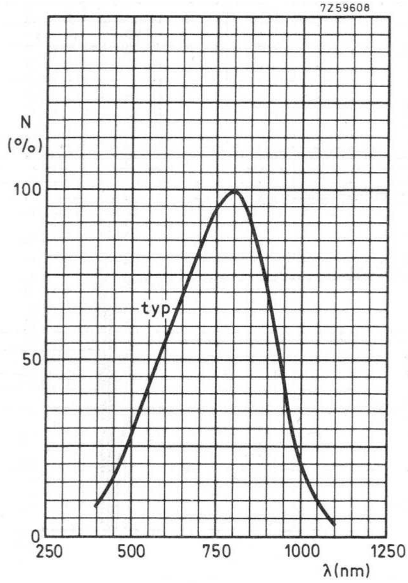
Dark reverse current			
V_R = 15 V	I_d	typ. <	0.01 µA 0.5 µA
→ V_R = 15 V; T_{amb} = 100 °C	I_d	typ. <	0.6 µA 4.0 µA
Light reverse current; V = 0			
E = 1000 lx; colour temperature = 2700 K	I_1	> typ.	7.5 µA 9 µA
Forward voltage; I = 0			
E = 1000 lx; colour temperature = 2700 K	V_F	> typ.	330 mV 350 mV
Light sensitivity [1]			
V_R = 15 V; E = 1000 lx colour temperature = 2700 K	N	> typ.	8.5 nA/lx 10 nA/lx
Peak spectral response	λ_m	typ.	800 nm
Diode capacitance; f = 500 kHz			
V_R = 15 V	C_d	typ.	90 pF
V_R = 0	C_d	typ.	300 pF

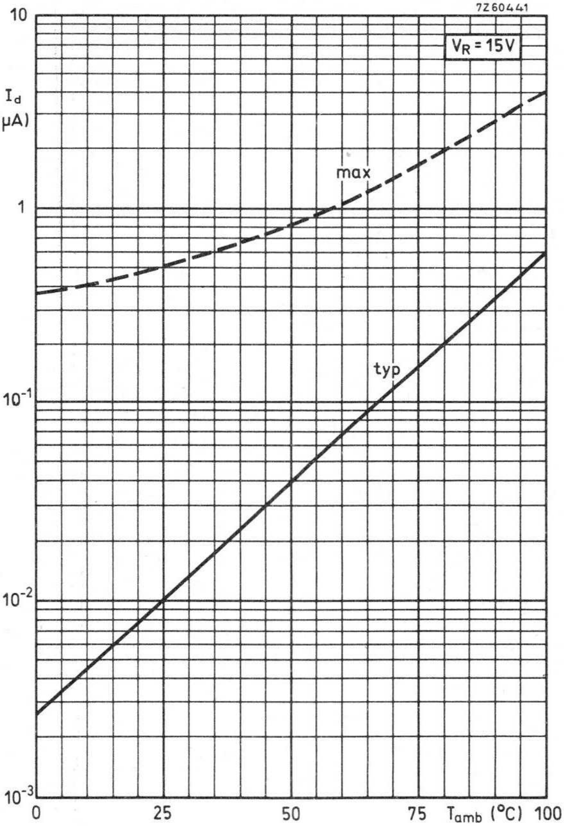
---

[1] The value of light current increases with temperature equal to the increase in dark current.


7Z59609
typical values
T_{amb} = 25 °C
colour temp.
2700K
I_L
(μA)
10^2
10
1
E = 5000 lx
2000 lx
1000 lx
500 lx
1
10
10^2
10^3
V_F (mV)
10^4


7Z59614
typical values
T_{amb} = 25 °C
colour temp.
2700K
I_L
(μA)
10^4
10^3
10^2
10
1
E = 5000 lx
2000 lx
1000 lx
500 lx
1
10
10^2
10^3
10^4
10^5
R_L (Ω)
10^6


7Z59608
N
(%)
100
50
0
250
500
750
1000
1250
λ(nm)
typ


7Z60441
$V_R = 15V$
I_d (μA)
10
1
10^{-1}
10^{-2}
10^{-3}
max
typ
0
25
50
75
T_{amb} (°C)
100

←

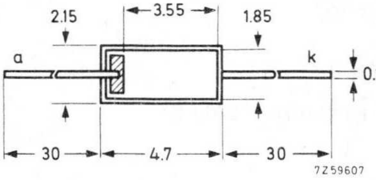
SILICON PLANAR PHOTO-DIODE

Unencapsulated photo-diode for general purpose applications.

QUICK REFERENCE DATA				
Reverse voltage	V_R	max.	18	V
Light sensitivity V_R = 15 V; E = 1000 lx	N	typ.	30	nA/lx
Dark reverse current at V_R = 15 V	I_d	<	1.0	µA
Peak spectral response	λ_m	typ.	800	nm

MECHANICAL DATA

Dimensions in mm



Slice thickness 0.27 mm

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltage				
Reverse voltage	V_R	max.	18	V
Currents				
Forward current	I_F	max.	10	mA
Dark reverse current	I_R	max.	5	mA
Temperatures				
Storage temperature	T_{stg}	-65 to	+125	°C
Junction temperature	T_j	max.	125	°C

THERMAL RESISTANCE

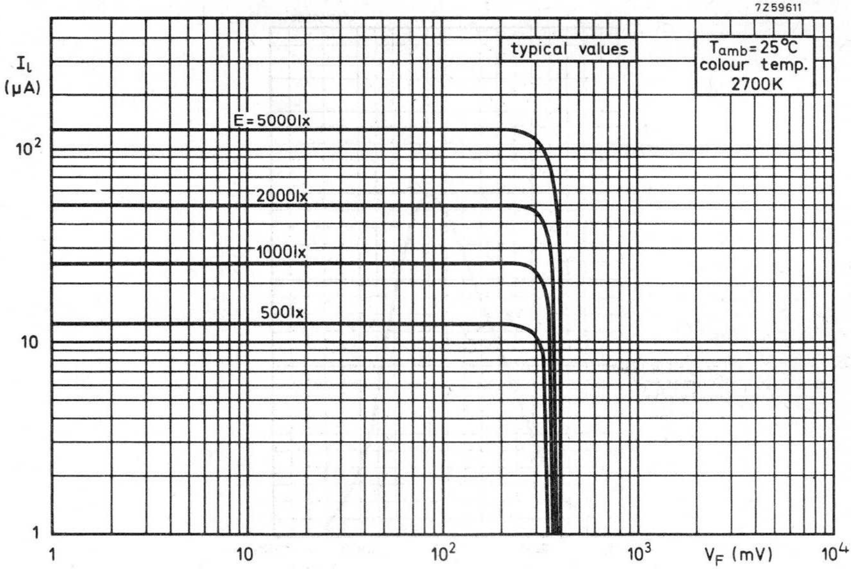
From junction to ambient in free air	$R_{th\ j-a}$	=	0.5	°C/mW

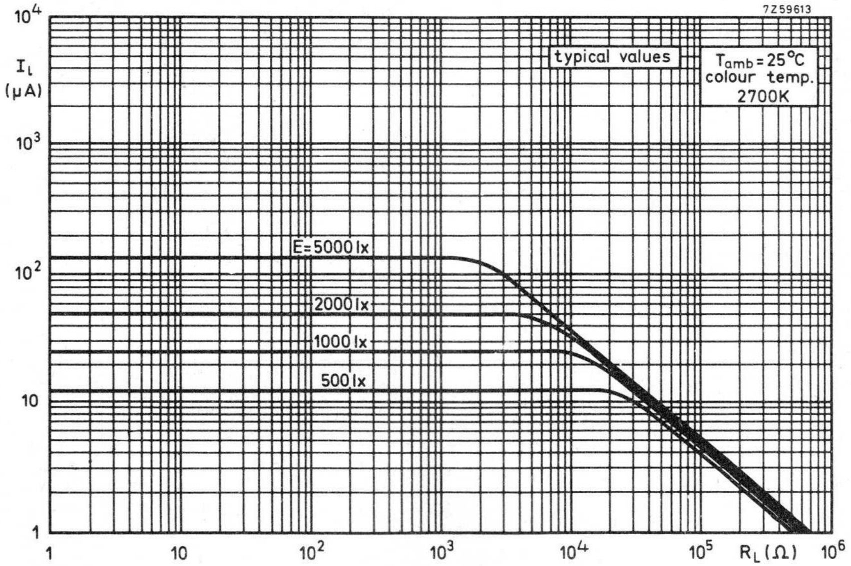
CHARACTERISTICS T_{amb} = 25 °C unless otherwise specified

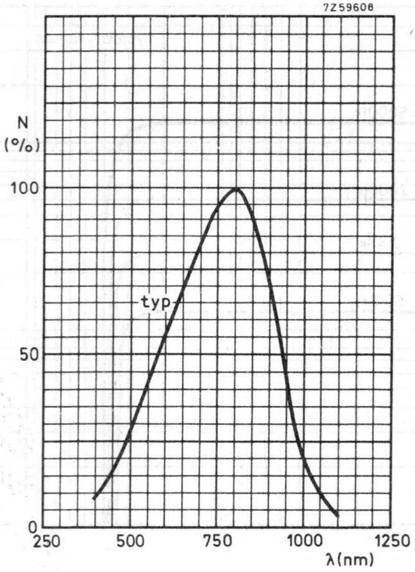
Dark reverse current				
V_R = 15 V	I_d	typ. <	0.02 1.0	µA µA
→ V_R = 15 V; T_{amb} = 100 °C	I_d	typ. <	1.2 8.0	µA µA
Light reverse current; V = 0				
E = 1000 lx; colour temperature = 2700 K	I_l	> typ.	20 25	µA µA
Forward voltage; I = 0				
E = 1000 lx; colour temperature = 2700 K	V_F	> typ.	330 350	mV mV
Light sensitivity [1]				
V_R = 15 V; E = 1000 lx colour temperature = 2700 K	N	> typ.	25 30	nA/lx nA/lx
Peak spectral response	λ_m	typ.	800	nm
Diode capacitance; f = 500 kHz				
V_R = 15 V	C_d	typ.	250	pF
V_R = 0	C_d	typ.	800	pF

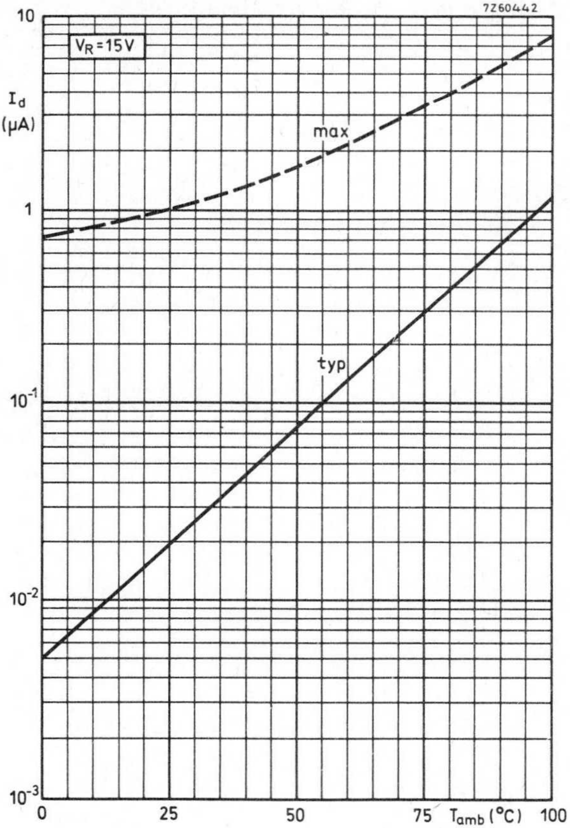
---

[1] The value of light current increases with temperature equal to the increase in dark current.


7Z59611
I_L
(μA)
typical values
$T_{amb} = 25°C$
colour temp.
2700K
E = 5000 lx
2000 lx
1000 lx
500 lx
10^2
10
1
1
10
10^2
10^3
V_F (mV)
10^4


7Z59613
10^4
I_L
(μA)
typical values
$T_{amb} = 25°C$
colour temp.
2700K
10^3
E = 5000 lx
2000 lx
1000 lx
500 lx
10^2
10
1
1
10
10^2
10^3
10^4
10^5
R_L (Ω)
10^6


7Z59608
N
(%)
100
50
0
250
500
750
1000
1250
λ(nm)
typ


7Z60442
$V_R = 15V$
I_d
(μA)
10
1
10^{-1}
10^{-2}
10^{-3}
max
typ
0
25
50
75
T_{amb} (°C)
100

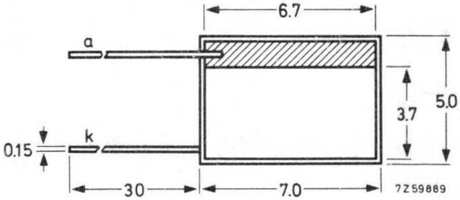
SILICON PLANAR PHOTO-DIODE

Unencapsulated photo-diode for general purpose applications.

QUICK REFERENCE DATA				
Reverse voltage	V_R	max.	12	V
Light sensitivity V_R = 10 V; E = 1000 lx	N	typ.	120	nA/lx
Dark reverse current at V_R = 10 V	I_d	<	5	μA
Peak spectral response	λ_m	typ.	800	nm

MECHANICAL DATA

Dimensions in mm



Slice thickness 0.27 mm

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltage

Reverse voltage	V_R	max.	12	V

Currents

Forward current	I_F	max.	50	mA
Dark reverse current	I_R	max.	20	mA

Temperatures

Storage temperature	T_{stg}	-65 to	+125	°C
Junction temperature	T_j	max.	125	°C

THERMAL RESISTANCE

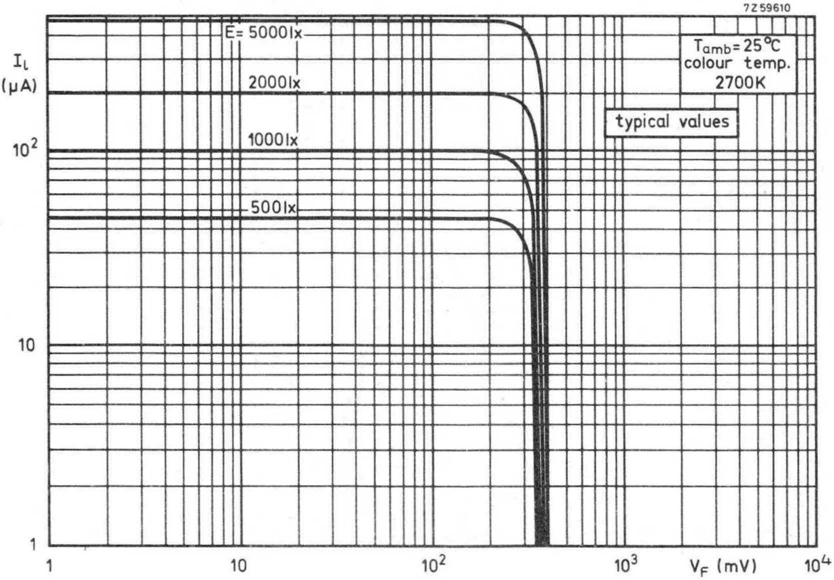
From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	0.3	°C/mW

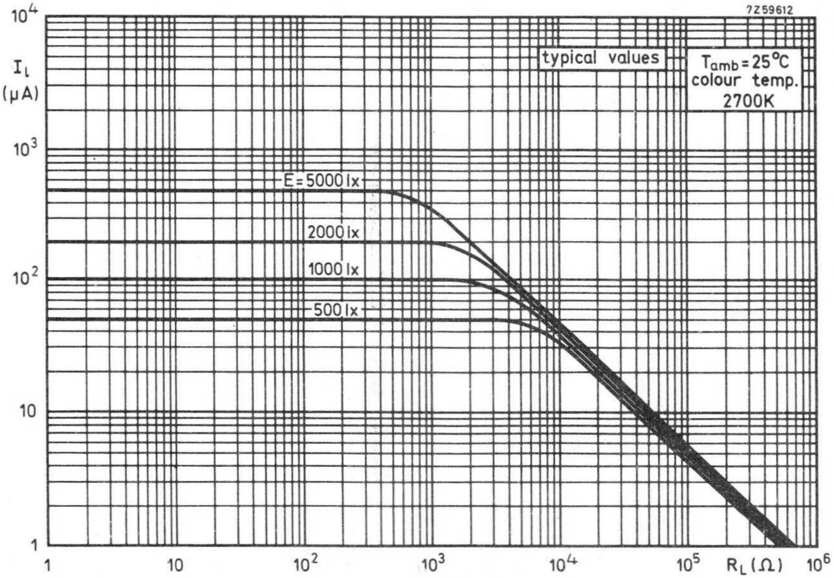
CHARACTERISTICS T_{amb} = 25 °C unless otherwise specified

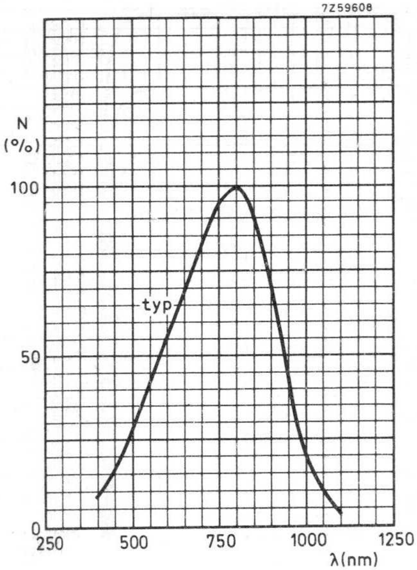
Dark reverse current				
V_R = 10 V	I_d	typ. <</br>	0.1 5.0	µA µA
→ V_R = 10 V; T_{amb} = 100 °C	I_d	typ. <	6.0 40	µA µA
Light reverse current; V = 0				
E = 1000 lx; colour temperature = 2700 K	I_l	> typ.	80 100	µA µA
Forward voltage; I = 0				
E = 1000 lx; colour temperature = 2700 K	V_F	> typ.	330 350	mV mV
Light sensitivity [1]				
V_R = 10 V; E = 1000 lx colour temperature = 2700 K	N	> typ.	100 120	nA/lx nA/lx
Peak spectral response	λ_m	typ.	800	nm
Diode capacitance; f = 500 kHz				
V_R = 10 V	C_d	typ.	1000	pF
V_R = 0	C_d	typ.	3000	pF

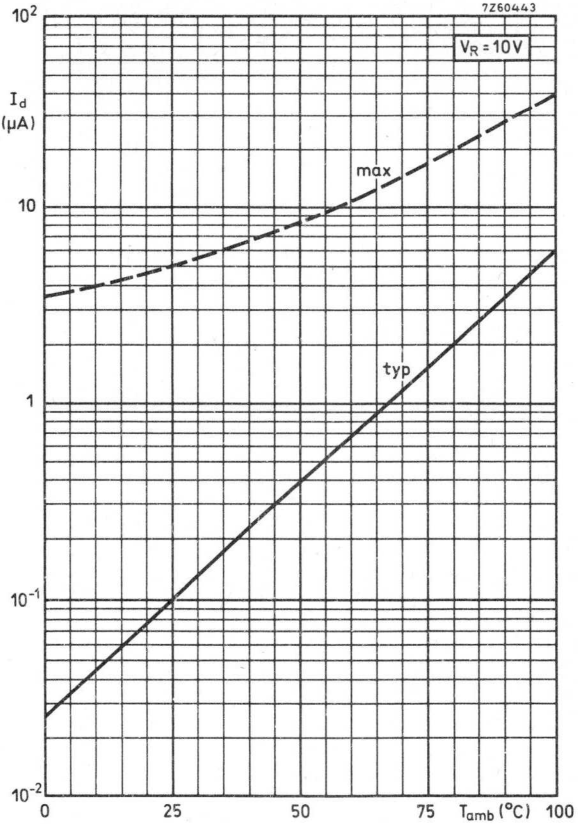
---

1) The value of light current increases with temperature equal to the increase in dark current.


7Z59610
I_L
(μA)
10^2
10
1
1
10
10^2
10^3
V_F (mV)
10^4
E= 5000 lx
2000 lx
1000 lx
500 lx
T_{amb} = 25 °C
colour temp.
2700K
typical values


7Z59612
10^4
I_L
(μA)
10^3
10^2
10
1
1
10
10^2
10^3
10^4
10^5
R_L (Ω)
10^6
E = 5000 lx
2000 lx
1000 lx
500 lx
typical values
T_{amb} = 25 °C
colour temp.
2700K


7Z59608
N
(%)
100
50
0
250
500
750
1000
1250
λ(nm)
typ


7Z60443
$V_R = 10V$
I_d (μA)
10^2
10
1
10^{-1}
10^{-2}
max
typ
0
25
50
75
T_{amb} (°C)
100

←

LIGHT ACTIVATED SCS

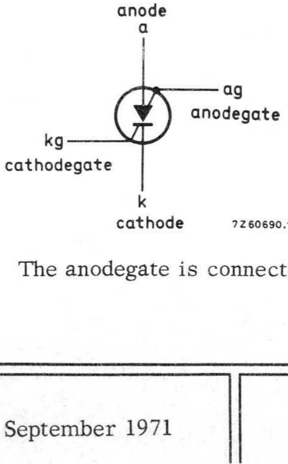
Planar p-n-p-n light activated SCS in a hermetically sealed metal envelope corresponding to TO-72 but with flat glass window. It is capable of switching currents up to 10 A.
With this component it is possible to build relatively simple circuits which will trigger at a light intensity of 100 lux.
The device is an integrated pnp-npn transistor of which all electrodes are accessible.

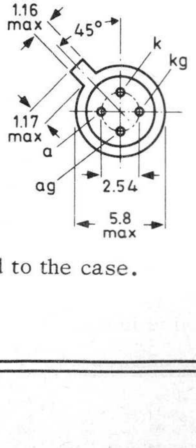
QUICK REFERENCE DATA

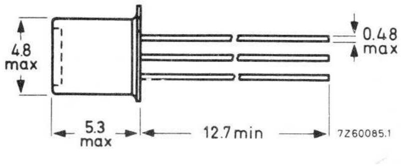
Anode-cathode voltage (forward and reverse)	$V_D = V_R$	max.	70	V
D.C. on-state current	I_T	max.	150	mA
Repetitive peak on-state cathode current $t_p = 1\ \mu s$; $\delta = 10^{-6}$	I_{TRM}	max.	10	A
Spread The ratio of minimum light level at which any specimen is ON to maximum light level at which any specimen is OFF			3	
Irradation level to trigger all devices $V_D = 70$ V; $I_{AG} = 0$; $T_j = 25\ ^oC$ $R_{KG-K} = 1\ M\Omega$; $\lambda = 800$ nm	E_e	>	1.5	mW/cm^2
Irradiation level not to trigger any device $V_D = 70$ V; $I_{AG} = 0$; $T_j = 25\ ^oC$ $R_{KG-K} = 1\ M\Omega$; $\lambda = 800$ nm	E_e	<	0.5	mW/cm^2
Peak spectral response	λ_m	typ.	800	nm

MECHANICAL DATA

Dimensions in mm







The anodegate is connected to the case.

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltage				
Anode-cathode voltage (forward and reverse)	$V_D = V_R$	max.	70	V
Reverse cathodegate-cathode voltage (peak value)	V_{RGKM}	max.	5	V
Reverse anode-anodegate voltage (peak value)	V_{RAGM}	max.	70	V
Currents				
D.C. on-state current	I_T	max.	150	mA
Repetitive peak on-state current				
$t \leq 10\ \mu s$, $\delta = 0.01$	I_{TRM}	max.	2.5	A
$t \leq 1\ \mu s$, $\delta = 10^{-6}$	I_{TRM}	max.	10	A [1]
Anodegate current (peak value)	I_{FGAM}	max.	100	mA
Power dissipation				
Total power dissipation up to $T_{amb} = 25\ ^oC$	P_{tot}	max.	250	mW
Temperatures				
Storage temperature	T_{stg}		-65 to +100	^oC
Junction temperature	T_j	max.	150	^oC

THERMAL RESISTANCE

From junction to ambient	$R_{th\ j-a}$	=	0.5	$^oC/mW$

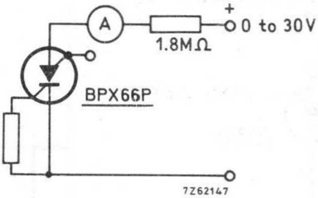
---

[1] This value holds for the use of the device in circuit 1b on page 9

CHARACTERISTICS T_{amb} = 25 °C unless otherwise specified

Forward on-state voltage				
I_T = 100 mA; R_{KG-K} = 1 MΩ; I_{AG} = 0	V_T	<	1.5	V
Dark current (cathodegate current)				
V_D = 70 V; I_{AG} = 0; $V_{KG-K} \leq$ 25 mV; T_j = 25 °C	$I_{KG(d)}$	<	1	nA
V_D = 15 V; I_{AG} = 0; $V_{KG-K} \leq$ 25 mV; T_j = 25 °C	$I_{KG(d)}$	<	0.3	nA
V_D = 70 V; I_{AG} = 0; $V_{KG-K} \leq$ 25 mV; T_j = 100 °C	$I_{KG(d)}$	<	100	nA
Cathodegate trigger voltage				
V_D = 70 V; I_{AG} = 0; R_{KG-K} = 1 MΩ; T_j = 25 °C	V_{GKT}		200 to 500	mV
Holding current (anode current)				
I_{AG} = 0; R_{KG-K} = 1 MΩ	I_H	<	10	µA

Test circuit:



Light current (cathodegate current)				
V_D = 70 V; I_{AG} = 0; T_j = 25 °C				
E_e = 1.5 mW/cm^2; λ = 800 nm	$I_{KG(\ell)}$		400 to 1200	nA
Irradiation level to trigger all devices				
V_D = 70 V; I_{AG} = 0; T_j = 25 °C				
R_{KG-K} = 1 MΩ; λ = 800 nm	E_e	>	1.5	mW/cm^2
Irradation level not to trigger any device				
V_D = 70 V; I_{AG} = 0; T_j = 25 °C				
R_{KG-K} = 1 MΩ; λ = 800 nm	E_e	<	0.5	mW/cm^2

CHARACTERISTICS (continued)

Turn-on time

V_D = 70 V, I_{AG} = 0; R_{KG-K} = 1 MΩ

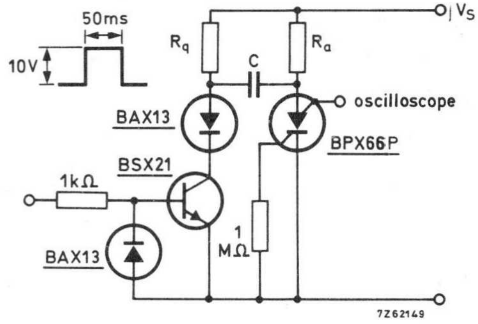
The irradiation level is switched from E_e = 0 to E_e = 1.5 mW/cm^2; λ = 800 nm	t_{on}	typ.	30	µs
E_e = 0 to E_e = 2.5 mW/cm^2; λ = 800 nm	t_{on}	typ. <	20 50	µs µs

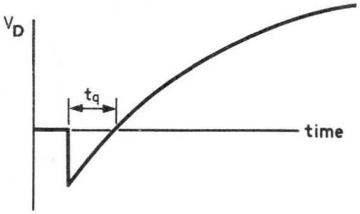
Turn-off time

I_{AG} = 0; R_{KG-K} = 1 MΩ; E_e = 0

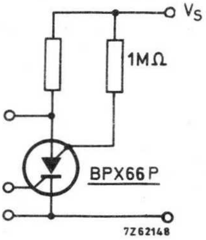
V_S = 70 V; R_a = 50 kΩ; R_q = 3.9 kΩ	t_q	typ.	450	µs
V_S = 12 V; R_a = 10 kΩ; R_q = 2.7 kΩ	t_q	typ.	100	µs

Test circuit:





The turn-off time decreases a factor 10 by connecting the anodegate to the supply voltage via 1 MΩ. See adjacent figure



Peak spectral response	λ_m	typ.	800	nm

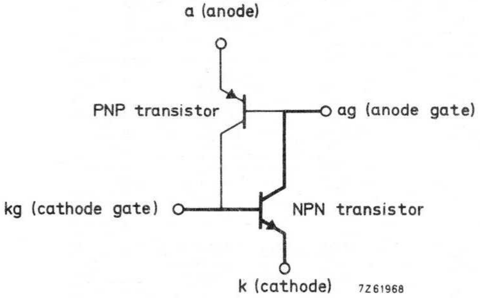
Conversion of lux into mW/cm^2

Each 1000 lux may be substituted by 1.2 mW/cm^2 with 800 nm

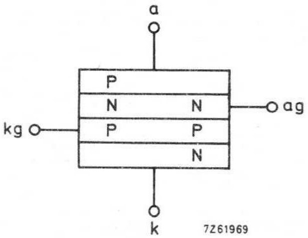
OPERATING PRINCIPLE

The BPX66P can be thought of as two transistors connected as shown below. It will trigger when the forward cathodegate-cathode voltage has a sufficient high value (approx. 0.3 V)

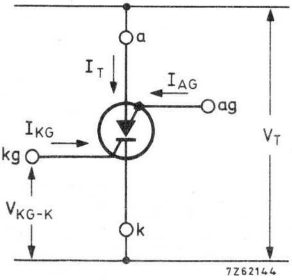
2 transistors equivalent circuit



p-n-p-n SCS equivalent circuit



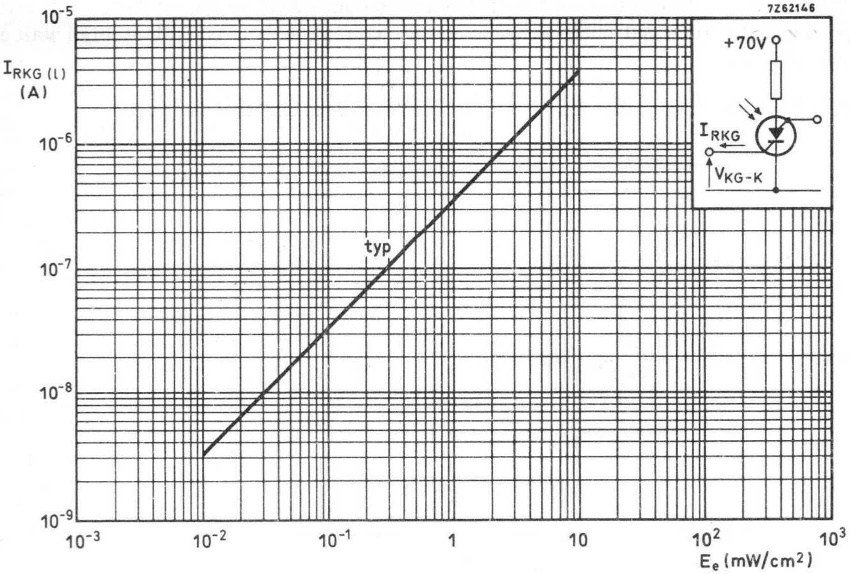
Symbol



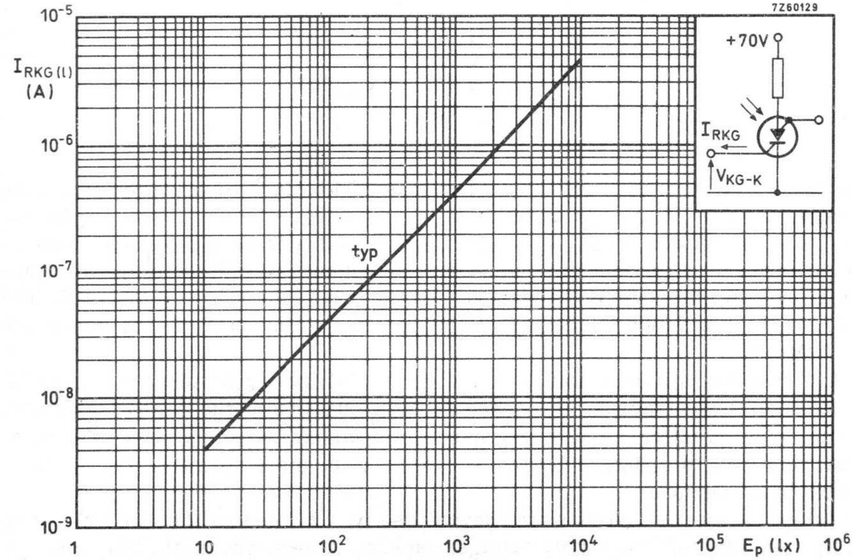
Consider the situation in which the anodegate is left floating. Illumination gives rise to a photocurrent in the p-n-p transistor which will trigger the device into conduction unless there is a bypass (e.g. a resistor) between cathodegate and cathode. If there is such a bypass, triggering will occur when the photocurrent is sufficient to cause a voltage drop across it corresponding to the triggering voltage of 0.3 to 0.4 V. The irradiation value at which the device will trigger varies inversely as the impedance of the bypass.

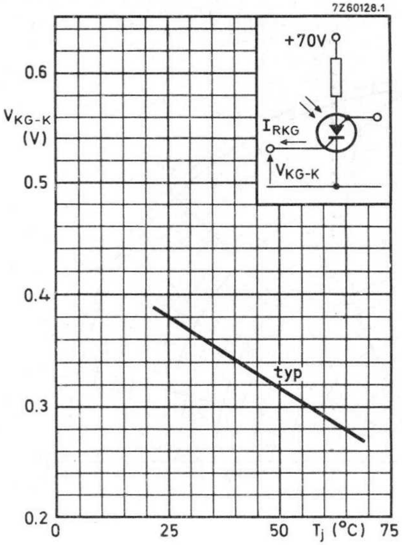
Two factors set a practical limit to the minimum triggering irradiation threshold:
- the leakage current across the base-collector junction of the p-n-p transistor;
- the maximum practical bypass impedance (the higher the impedance, the more vulnerable it is to moisture contamination, and the more sensitive the circuit is to switching transients).

Once triggered into conduction, the device can be returned to the non-conducting state by switching-off the supply voltage, an a.c. voltage reversal, or a negative voltage pulse on the anode.

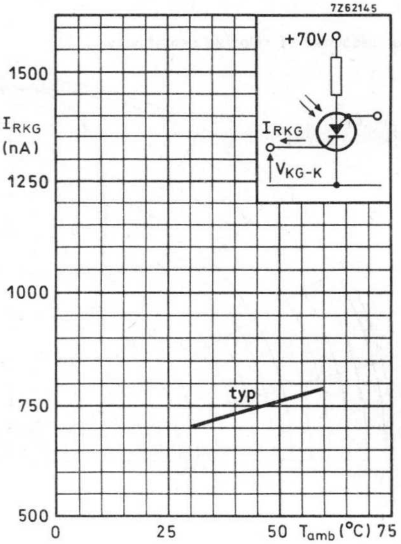


Light current as a function of illumination level measured with an incandescent lamp at a colour temperature of 2854 K.

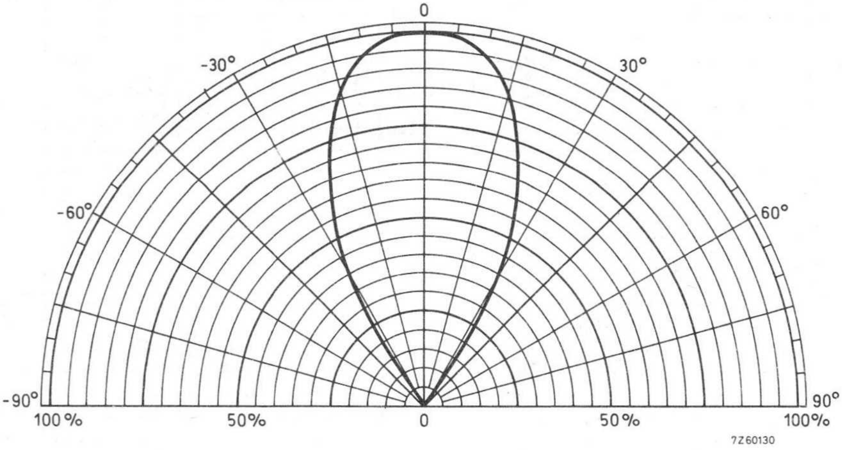


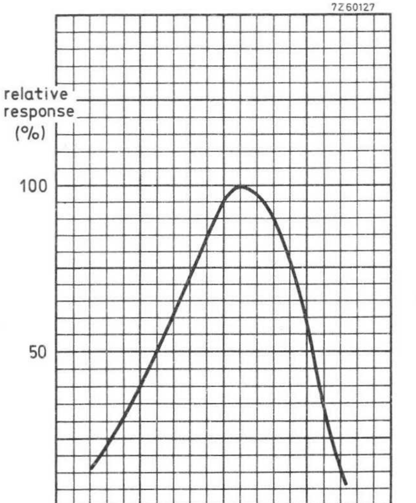


Trigger voltage as a function
of junction temperature



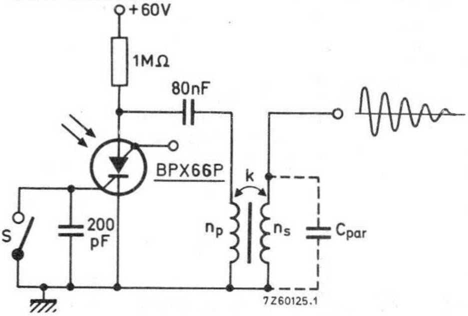
polar response of relative sensitivity





APPLICATION INFORMATION

1. D.C. supply-Circuit for igniting a quench tube in photoflash equipment



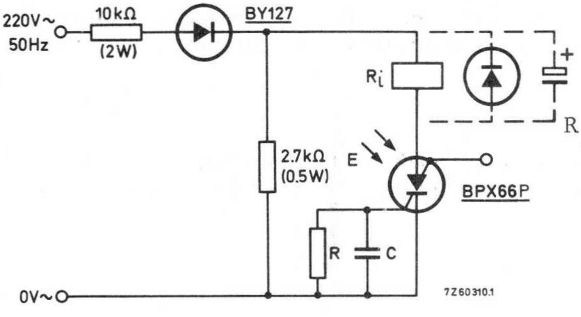
Transformer data:
n_p = 15 turns (2 μH)
n_s = 1215 turns (13.1 mH)
k = 0.68
C_{par} = 10.6 pF

Performance:
repetition frequency 1 Hz
number of discharges $> 10^4$

Switch S should open when the photoflash is fired. As soon as it opens, the BPX66P starts to register the incident illumination E. When $\int E\,dt$ reaches a predetermined value, the BPX66P is triggered and feeds a 1 μs pulse of 10 A through the primary of the transformer; the resulting high voltage across the secondary triggers the quench tube, extinguishing the photoflash tube.

2. A.C. supply - light activated relay circuits

a. 220 V



R_ℓ = d.c. relay

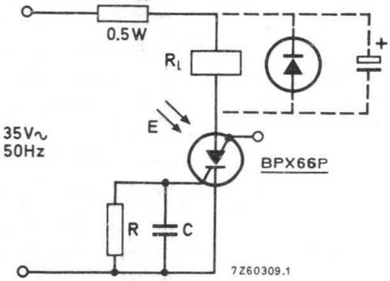
Coil resistance		12 kΩ
I_{on}	<	3 mA
I_{off}		1 mA

R and C must be chosen to meet requirements as to illumination levels E_{in} and E_{out}. The values are practically the same as in the table below.

For gradually changing light levels the relay should be shunted by a capacitor (e.g. 10 μF, 64 V) to prevent chatter; for suddenly changing light levels (on-off) it may be shunted by a diode.

APPLICATION INFORMATION (continued)

b. 35 V



R_ℓ = d.c. relay

Coil resistance	2 kΩ
I_{on}	8.5 mA
I_{off}	2.2 mA

R and C must be choosen to meet requirements as to illumination levels E_{in} and E_{out}; see table below.
For gradually changing light levels the relay should be shunted by a capacitor (e.g. 100 μF, 40 V); for suddenly changing light levels (on-off) it may be shunted by a diode.

R (MΩ)	C(nF)	E_{in}(lx)	E_{out}(lx)
3.3	10	1150	750
3.3	1	450	400
1	0.5	820	800

The values are average values that can be expected at a colour temperature of 2854 K; at other colour temperatures large deviations from these values may be observed.

Caution:

To avoid difficulties with temperature dependence it is generally advantageous to design a circuit for higher values of E_{in} and E_{out}, for then R can be given a lower value.

PHOTO-TRANSISTOR

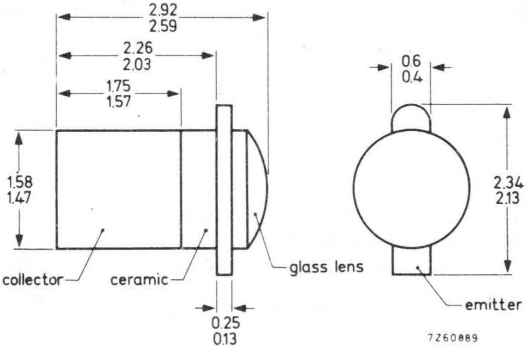
General purpose n-p-n silicon photo-transistor with a glass lens.

QUICK REFERENCE DATA

Collector-emitter voltage (open base)	V_{CEO}	max.	50	V
Collector current (peak value) $t_p < 50\ \mu s$; $\delta < 0.1$	I_{CM}	max.	50	mA
Junction temperature	T_j	max.	150	^oC
Collector-emitter dark current $V_{CE} = 30$ V	I_d	<	25	nA
Collector-emitter light current $V_{CE} = 5$ V; $E = 20$ mW/cm^2	I_ℓ	0.75 to	15	mA
Peak spectral response	λ_m	typ.	800	nm

MECHANICAL DATA

Dimensions in mm



RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltages				
Collector-emitter voltage (open base)	V_{CEO}	max.	50	V
Emitter-collector voltage (open base)	V_{ECO}	max.	7	V
Current				
Collector current (d. c.)	I_C	max.	20	mA
Collector current (peak value) $t_p < 50\ \mu s;\ \delta < 0.1$	I_{CM}	max.	50	mA
Power dissipation				
Total power dissipation up to $T_{amb} = 50\ ^oC$	P_{tot}	max.	50	mW
up to $T_{mb} = 55\ ^oC$	P_{tot}	max.	100	mW
Temperatures				
Storage temperature	T_{stg}		-65 to +150	^oC
Junction temperature	T_j	max.	150	^oC

THERMAL RESISTANCE

From junction to ambient	$R_{th\ j-a}$	=	2	$^oC/mW$
From junction to mounting base	$R_{th\ j-mb}$	=	0.95	$^oC/mW$

CHARACTERISTICS $T_{amb} = 25\ ^oC$ unless otherwise specified

Colllector-emitter dark current				
$V_{CE} = 30$ V	I_d	<	25	nA
$V_{CE} = 30$ V; $T_{amb} = 100\ ^oC$	I_d	<	100	μA
Collector-emitter light current				
$V_{CE} = 5$ V; tungsten filament lamp source with colour temperature 2854K irradiation: $4.75\ mW/cm^2$	I_ℓ	typ.	1	mA
$20\ mW/cm^2$	I_ℓ	typ.	5	mA
			0.75 to 15	mA
Breakdown voltages				
Collector-emitter voltage $E = 0;\ I_C = 0.5$ mA	$V_{(BR)CEO}$	>	50	V
Emitter-collector voltage $E = 0;\ I_C = 0.1$ mA	$V_{(BR)ECO}$	>	7	V
Collector-emitter saturation voltage				
$I_C = 0.4$ mA; $E = 20\ mW/cm^2$ colour temperature: 2854 K	V_{CEsat}	typ.	150	mV
		<	400	mV

CHARACTERISTICS (continued)

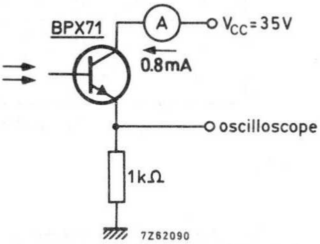
Switching times

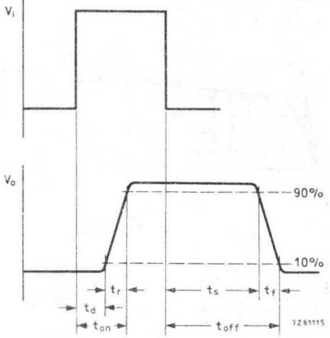
$I_C = 0.8$ mA; $V_{CC} = 35$ V; $R_L = 1$ kΩ

Delay time	t_d	typ.	2.0	µs
		<	20	µs
Rise time	t_r	typ.	3.0	µs
		<	30	µs
Storage time	t_s	typ.	0.1	µs
		<	2.0	µs
Fall time	t_f	typ.	2.5	µs
		<	20	µs

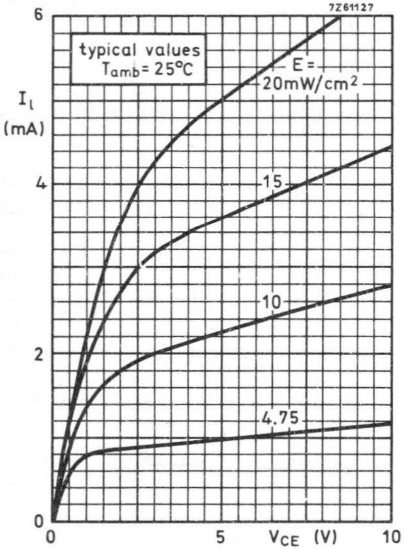
Light input pulse:

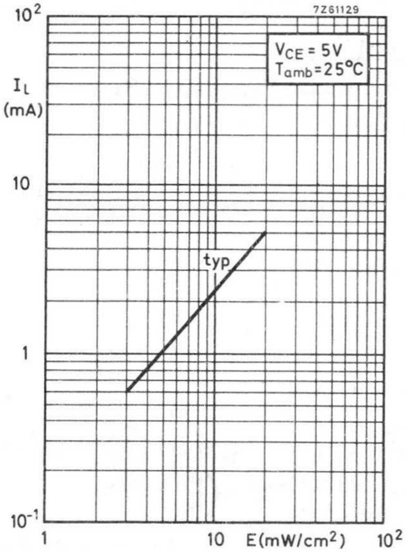
$t_r = t_f = 20$ ns
$t_p = 20\ \mu$s
$f = 500$ Hz
$\lambda = 800$ nm

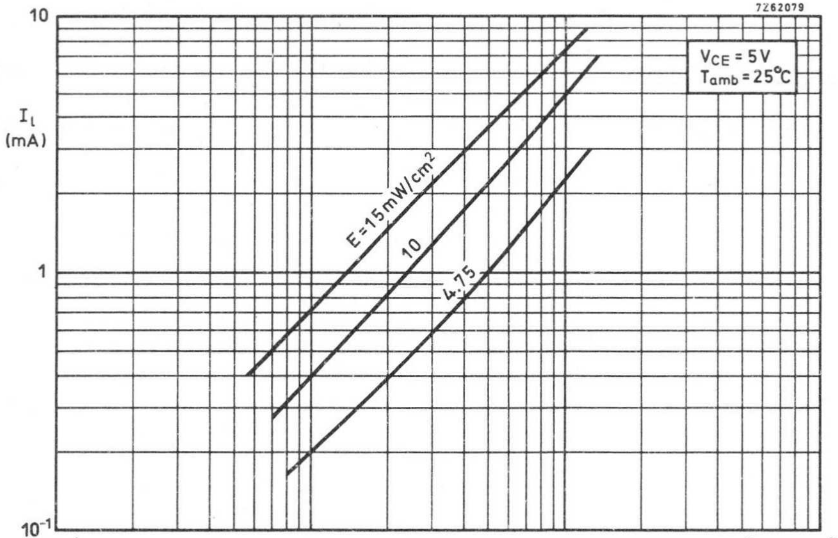


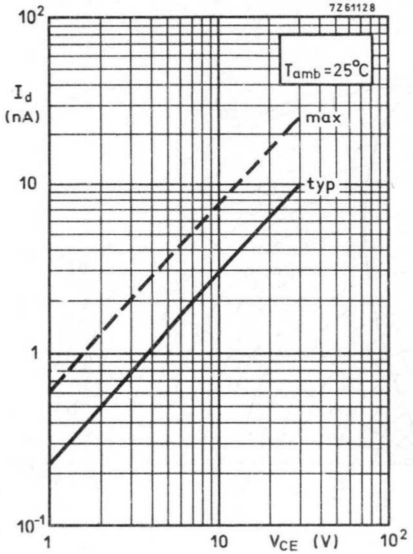


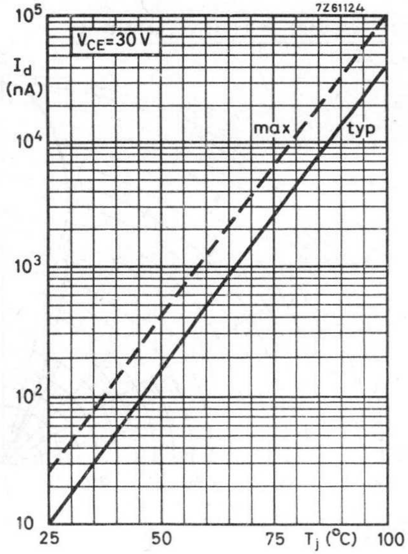
Peak spectral response	λ_m	typ.	800	nm
Bandwidth at half height	$\Delta\lambda_m$	typ.	400	nm

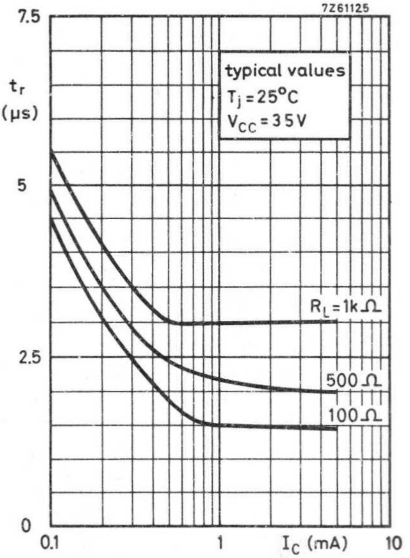

7Z61127
typical values
Tamb = 25°C
E = 20mW/cm²
15
10
4.75
IL (mA)
6
4
2
0
0
5
VCE (V)
10

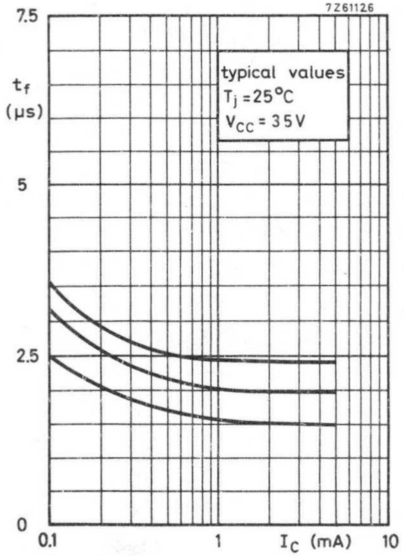

7Z61129
VCE = 5V
Tamb = 25°C
typ
IL (mA)
10²
10
1
10⁻¹
1
10
E(mW/cm²)
10²


7Z62079
VCE = 5V
Tamb = 25°C
E = 15 mW/cm²
10
4.75
IL (mA)
10
1
10⁻¹
10⁻¹
1
10
IL at E = 20mW/cm² (mA)
10²


7Z61128
10^2
I_d
(nA)
$T_{amb} = 25^\circ C$
max
typ
10
1
10^{-1}
1
10
V_{CE} (V)
10^2

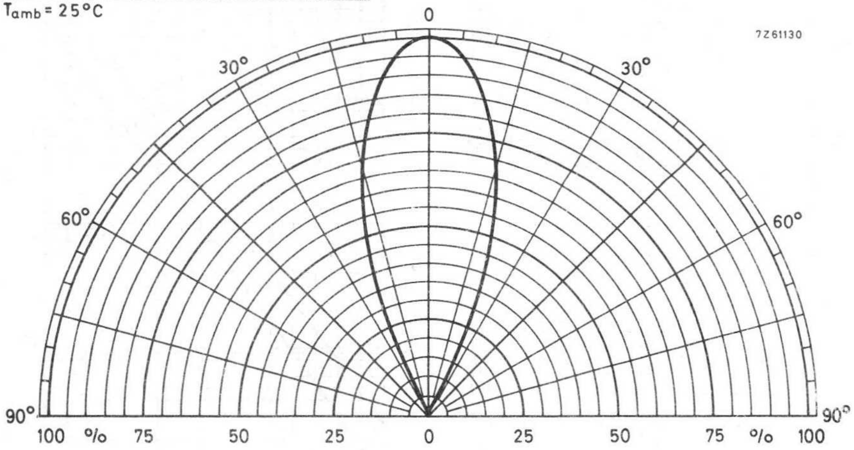

7Z61124
10^5
$V_{CE} = 30 V$
I_d
(nA)
max
typ
10^4
10^3
10^2
10
25
50
75
T_j (°C)
100


7Z61125
7.5
t_r
(μs)
typical values
$T_j = 25^\circ C$
$V_{CC} = 35 V$
5
$R_L = 1 k\Omega$
2.5
500 Ω
100 Ω
0
0.1
1
I_C (mA)
10


7Z61126
7.5
t_f
(μs)
typical values
$T_j = 25^\circ C$
$V_{CC} = 35 V$
5
2.5
0
0.1
1
I_C (mA)
10

polar response of relative sensitivity

$T_{amb} = 25\,°C$



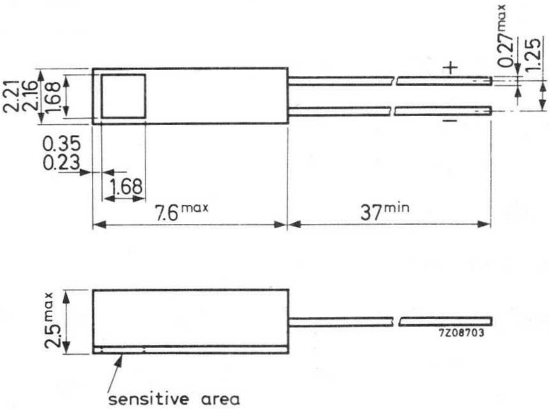
SILICON PHOTOVOLTAIC CELL

Planar photovoltaic cell for use in tape and card readers.

QUICK REFERENCE DATA				
Reverse voltage	V_R	max.	1.0	V
Light reverse current V = 0; E = 1000 lx	I_l	typ.	16	μA
Dark reverse current at V_R = 1.0 V	I_d	<	5.0	μA
Peak spectral response	λ_m	typ.	800	nm

MECHANICAL DATA

Dimensions in mm



RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

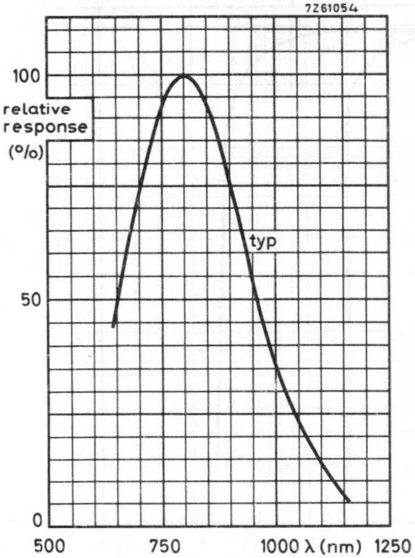
Voltage				
Reverse voltage	V_R	max.	1.0	V
Currents				
Forward current	I_F	max.	10	mA
Temperatures				
Storage temperature	T_{stg}		-20 to +100	^oC
Junction temperature	T_j	max.	100	^oC

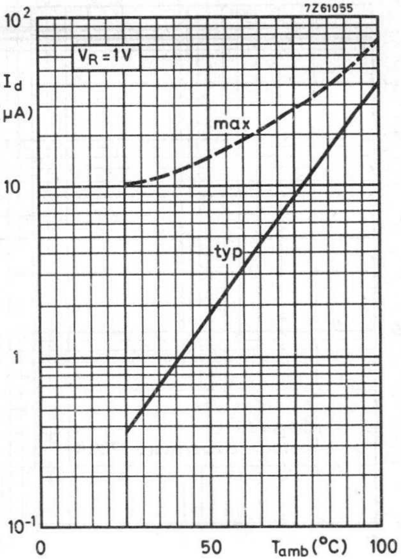
THERMAL RESISTANCE

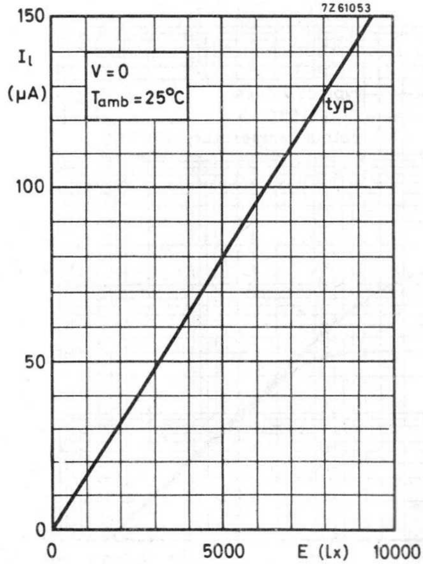
From junction to ambient in free air	$R_{th\ j-a}$	=	0.6	$^oC/mW$

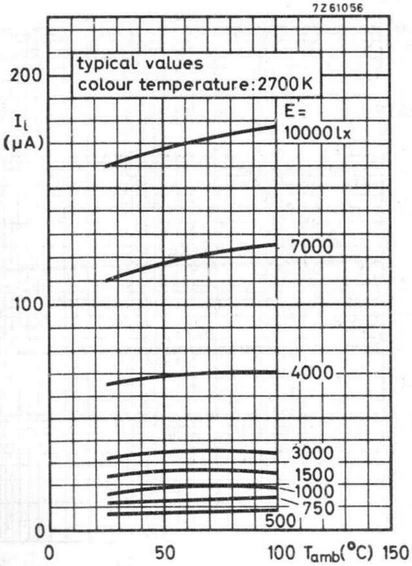
CHARACTERISTICS $T_{amb} = 25\,^oC$ unless otherwise specified

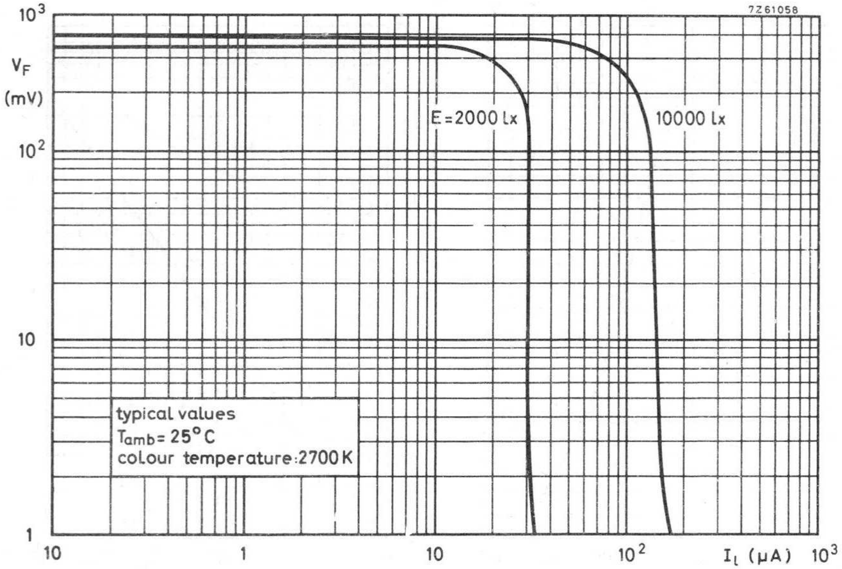
Dark reverse current				
→ $V_R = 1.0$ V	I_d	typ. <	0.35 5.0	μA μA
$V_R = 1.0$ V; $T_{amb} = 75\,^oC$	I_d	<	30	μA
Light reverse current; V = 0				
E = 1000 lx; colour temperature = 2700 K	I_l	typ. 7.5 to	16 30	μA μA
Forward voltage; I = 0				
E = 1000 lx; colour temperature = 2700 K	V_F	typ.	350	mV
Peak spectral response	λ_m	typ.	800	nm
Diode capacitance; f = 500 kHz				
$V_R = 0$	C_d	typ. <	700 1000	pF pF

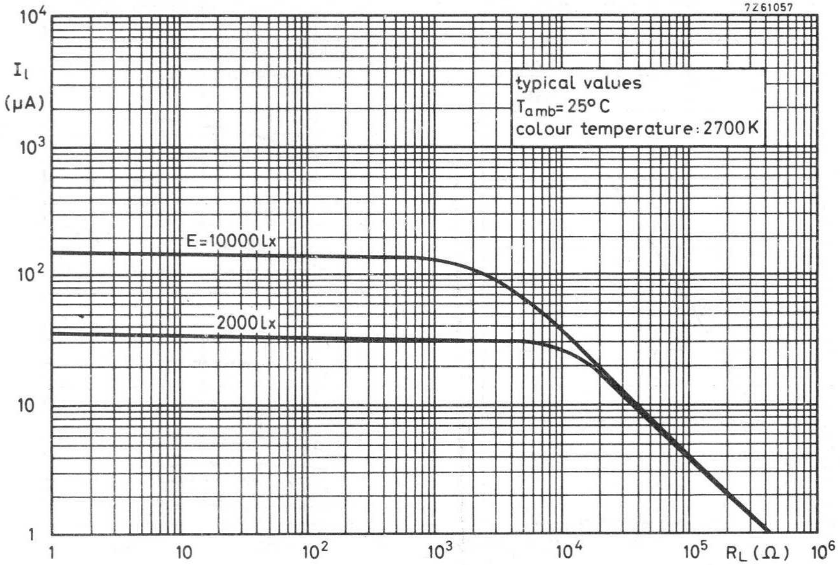

7Z61054
100
relative
response
(%)
50
0
typ
500
750
1000 λ (nm)
1250


7Z61055
10^2
$V_R = 1V$
I_d
(μA)
max
10
typ
1
10^{-1}
0
50
T_{amb} (°C)
100


7Z61053
150
I_l
(μA)
V = 0
T_{amb} = 25°C
typ
100
50
0
0
5000
E (lx)
10000


7Z61056
typical values
colour temperature: 2700 K
200
I_l
(μA)
E =
10000 lx
7000
100
4000
3000
1500
1000
750
500
0
0
50
100 T_{amb}(°C) 150


7Z61058
10^3
V_F
(mV)
10^2
10
1
E=2000 lx
10000 lx
typical values
T_amb = 25° C
colour temperature: 2700 K
10
1
10
10^2
I_l (µA)
10^3


7Z61057
10^4
I_l
(µA)
10^3
10^2
10
1
typical values
T_amb = 25° C
colour temperature: 2700 K
E=10000 lx
2000 lx
1
10
10^2
10^3
10^4
10^5
R_L (Ω)
10^6

SILICON DUO PHOTO-DIODE

Silicon diffused photo-diode in a 2.8 mm diameter envelope with a glass lens. The duo-diode construction makes this device independent of voltage polarity.

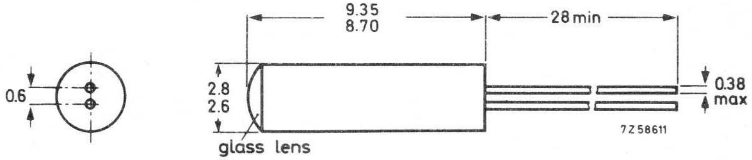
QUICK REFERENCE DATA

Diode voltage (bidirectional)	V	max.	60	V
Dark current at V = 50 V; T_j = 25 °C	I_d	<	50	nA
Sensitivity at V = 50 V	N	typ.	0.5	μA/lx
Current rise time	t_{ri}	typ.	17	μs
Peak spectral response	λ_m	typ.	980	nm

MECHANICAL DATA

Dimensions in mm

7Z58612



7Z58611

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

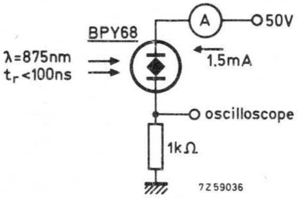
Voltage				
Diode voltage (bidirectional)	V	max.	60	V
Power dissipation				
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	80	mW
Temperatures				
Storage temperature	T_{stg}		-65 to +125	°C
Junction temperature	T_j	max.	125	°C

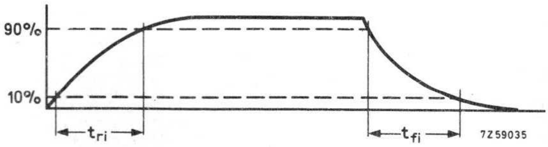
THERMAL RESISTANCE

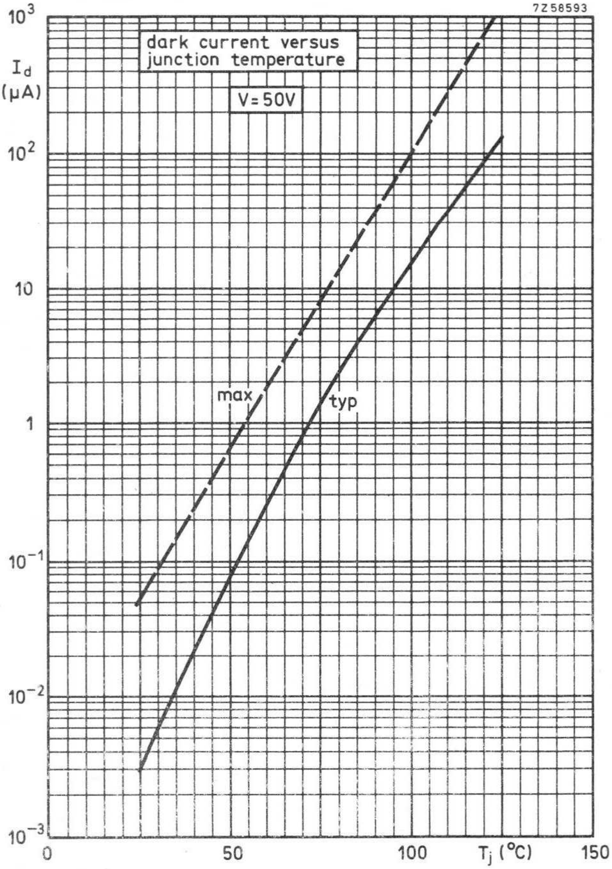
From junction to ambient	$R_{th\ j\text{-}a}$	=	1.25	°C/mW
From junction to case	$R_{th\ j\text{-}c}$	=	0.40	°C/mW

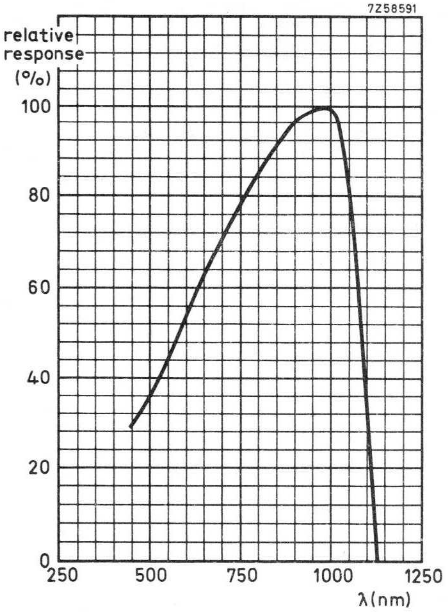
CHARACTERISTICS T_j = 25 °C unless otherwise specified

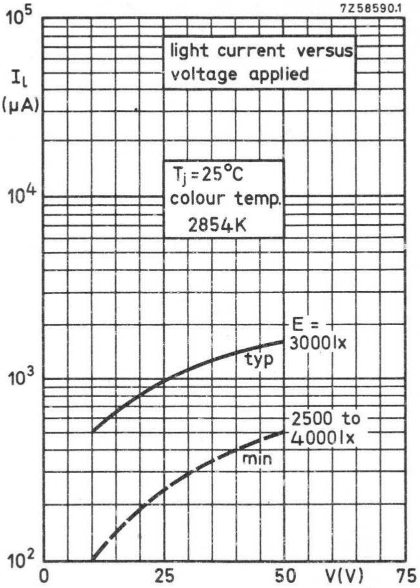
Dark current				
V = 60 V	I_d	typ. <	3.5 10	nA µA
V = 50 V	I_d	typ. <	3 50	nA nA
V = 50 V; T_j = 100 °C	I_d	typ. <	15 100	µA µA
V = 50 V; T_j = 125 °C	I_d	typ.	120	µA
Light current				
V = 50 V; colour temperature = 2854 K				
E = 2500 to 4000 lx	I_l	>	0.5	mA
E = 3000 lx	I_l	typ.	1.5	mA
Capacitance				
V = 0	C	typ.	12	pF
V = 50 V	C	typ.	3.5	pF
Sensitivity				
V = 50 V; colour temperature = 2854 K				
E = 2500 to 4000 lx	N	>	0.20	µA/lx
E = 3000 lx	N	typ.	0.50	µA/lx
Current rise time see drawings below				
V = 50 V	t_{ri}	typ.	17	µs
Current fall time see drawings below				
V = 50 V	t_{fi}	typ.	10	µs

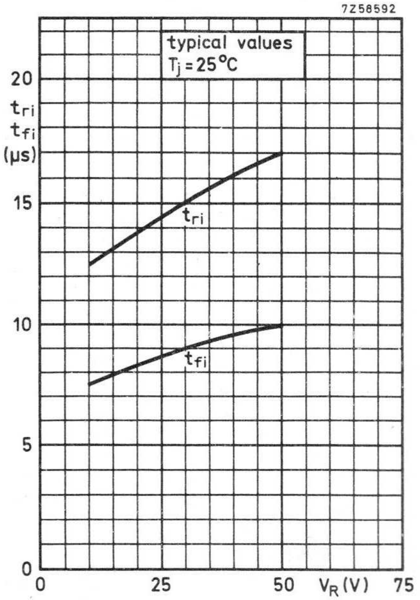


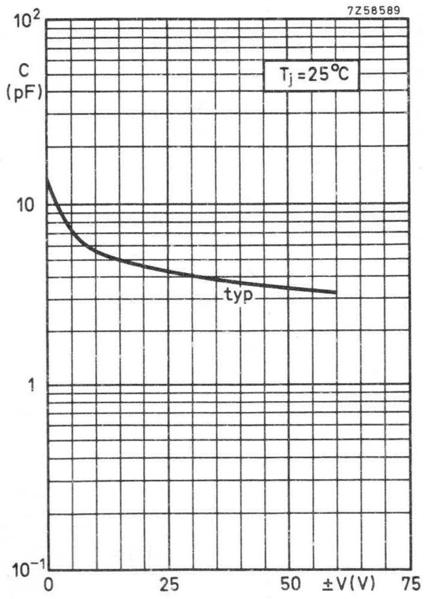



7Z58593
dark current versus
junction temperature
V = 50V
I_d
(µA)
10^3
10^2
10
1
10^{-1}
10^{-2}
10^{-3}
max
typ
0
50
100
T_j (°C)
150


7Z58591
relative response (%)
100
80
60
40
20
0
250
500
750
1000
1250
λ(nm)


7Z58590.1
10^5
I_L (μA)
light current versus voltage applied
T_j = 25°C
colour temp. 2854K
10^4
10^3
10^2
E = 3000 lx
typ
2500 to 4000 lx
min
0
25
50
V(V)
75


7Z58592
typical values
T_j = 25°C
20
t_{ri}
t_{fi}
(μs)
15
10
5
0
t_{ri}
t_{fi}
0
25
50
V_R (V)
75

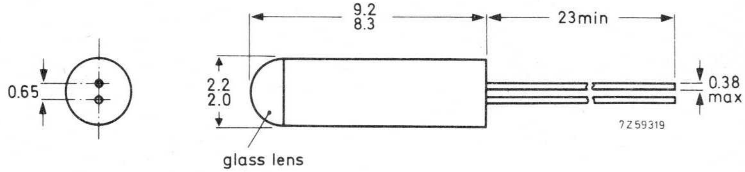

7Z58589
10^2
C (pF)
T_j = 25°C
10
1
10^{-1}
typ
0
25
50
±V(V)
75

SILICON DUO PHOTO-DIODE

Silicon diffused photo-diode in a 2.2 mm diameter envelope with a glass lens. The duo-diode construction makes this device independent of voltage polarity.

QUICK REFERENCE DATA				
Diode voltage (bidirectional)	V	max.	60	V
Dark current at V = 50 V; T_j = 25 °C	I_d	<	50	nA
Sensitivity at V = 50 V	N	typ.	0.37	µA/lx
Current rise time	t_{ri}	typ.	16	µs
Peak spectral response	λ_m	typ.	980	nm

MECHANICAL DATA Dimensions in mm



RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltage

Diode voltage (bidirectional)	V	max.	60	V

Power dissipation

Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max	80	mW

Temperatures

Storage temperature	T_{stg}		−65 to +125	°C
Junction temperature	T_j	max.	125	°C

THERMAL RESISTANCE

From junction to ambient	$R_{th\ j\text{-}a}$	=	1.25	°C/mW
From junction to case	$R_{th\ j\text{-}c}$	=	0.40	°C/mW

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Dark current

V = 60 V	I_d	typ.	7	nA
		<	10	µA
V = 50 V	I_d	typ.	6	nA
		<	50	nA
V = 50 V; T_j = 100 °C	I_d	typ.	20	µA
		<	100	µA
V = 50 V; T_j = 125 °C	I_d	typ.	200	µA

Light current

V = 50 V; colour temperature = 2854 K

E = 2500 to 4000 lx	I_l	>	275	µA
E = 3000 lx	I_l	typ.	1.1	mA

Capacitance

V = 0	C	typ.	11.5	pF
V = 50 V	C	typ.	3.6	pF

Sensitivity

V = 50 V; colour temperature = 2854 K

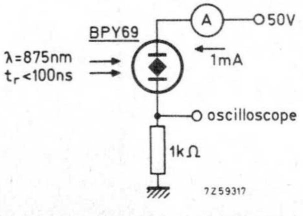
E = 2500 to 4000 lx	N	>	0.11	µA/lx
E = 3000 lx	N	typ.	0.37	µA/lx

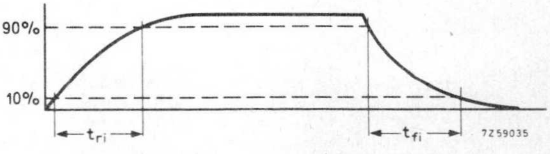
Current rise time see drawings below

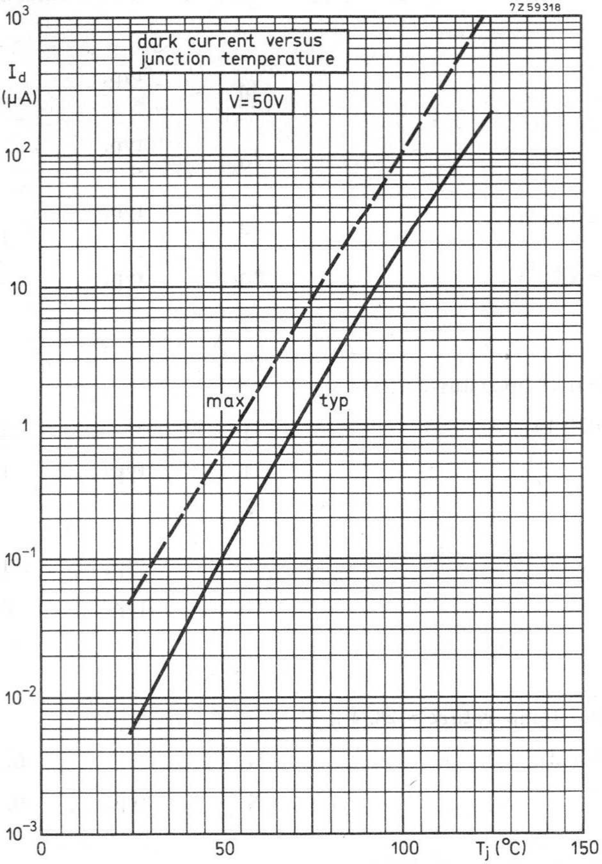
V = 50 V	t_{ri}	typ.	16	µs

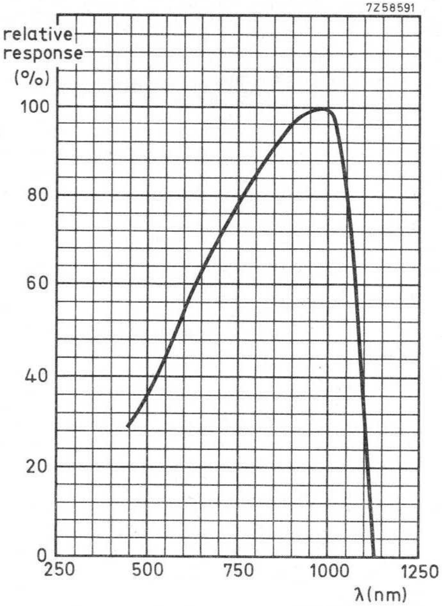
Current fall time see drawings below

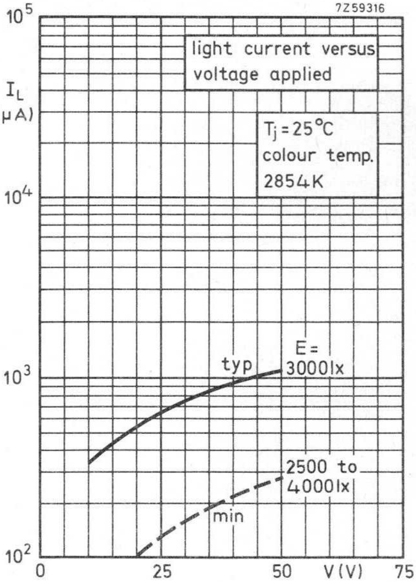
V = 50 V	t_{fi}	typ.	10	µs

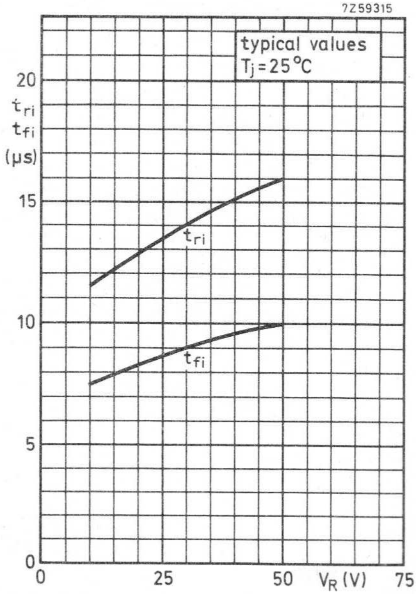


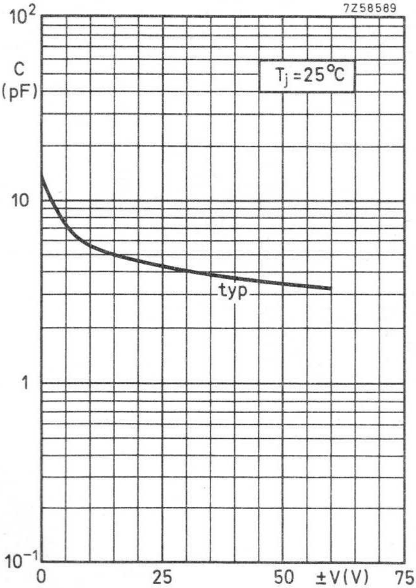



7Z59318
dark current versus
junction temperature
V=50V
I_d
(μA)
10^3
10^2
10
1
10^{-1}
10^{-2}
10^{-3}
max
typ
0
50
100
T_j (°C)
150


7Z58591
relative response (%)
100
80
60
40
20
0
250
500
750
1000
1250
λ(nm)


7Z59316
light current versus voltage applied
$T_j = 25\,^\circ C$
colour temp.
2854K
I_L (μA)
10^5
10^4
10^3
10^2
typ
E = 3000lx
2500 to 4000lx
min
0
25
50
V(V)
75


7Z59315
typical values
$T_j = 25\,^\circ C$
t_{ri}
t_{fi}
(μs)
20
15
10
5
0
t_{ri}
t_{fi}
0
25
50
V_R (V)
75


7Z58589
$T_j = 25\,^\circ C$
C (pF)
10^2
10
1
10^{-1}
typ
0
25
50
±V(V)
75

PLANAR EPITAXIAL PHOTO-TRANSISTOR

N-P-N silicon photo-transistor in a miniature envelope with a lens. It is intended for use as a high sensitive detector in the visible and infra-red wavelengths.

QUICK REFERENCE DATA

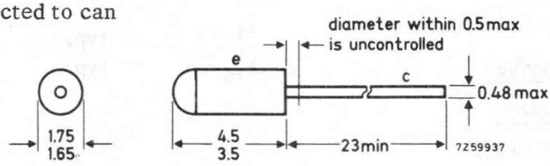
Collector-emitter dark voltage	V_d	max.	35	V
Collector current (peak value)	I_{CM}	max.	10	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	70	mW
Collector-emitter dark cut-off current at V_{CC} = 30 V	I_d	<	100	nA
Light current at 2854 K V_{CE} = 30 V; E = 1 mW/cm^2	I_l	typ.	0.3	mA
Peak spectral response	λ_m	typ.	800	nm

MECHANICAL DATA

Dimensions in mm

Base lead omitted

Emitter connected to can



RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltage				
Collector-emitter dark voltage	V_d	max.	35	V
Current				
Collector current (peak value)	I_{CM}	max.	10	mA
Power dissipation				
Total power dissipation up to $T_{amb} = 25\ ^oC$	P_{tot}	max.	70	mW
Temperatures				
Storage temperature	T_{stg}		−55 to +125	^oC
Junction temperature	T_j	max.	125	^oC

THERMAL RESISTANCE

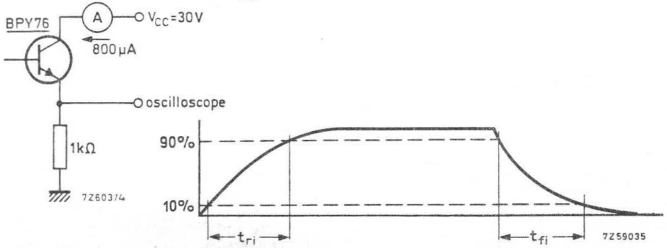
From junction to ambient	$R_{th\ j\text{-}a}$	=	1.4	$^oC/mW$

CHARACTERISTICS $T_{amb} = 25^oC$ unless otherwise specified

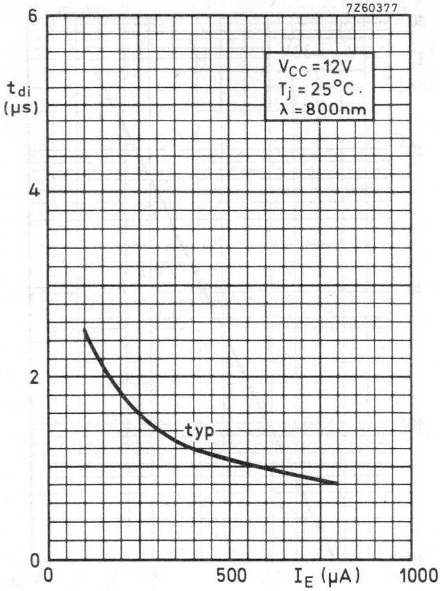
Collector-emitter dark cut-off current				
$V_{CE} = 30$ V	I_d	<	100	nA
Light current at 2854 K				
$V_{CE} = 30$ V; $E = 1$ mW/cm^2	I_l	> typ.	0.1 0.3	mA mA
Peak spectral response	λ_m	typ.	800	nm
Noise equivalent power				
$I_E = 1$ mA; $R_E = 10$ kΩ				
f = 200 kHz; Δ f = 10 kHz	N.E.P.	typ.	2.5×10^{-11}	W
Current delay time 1)	t_{di}	typ.	0.8	μs
Current rise time 1)	t_{ri}	typ.	2.3	μs
Current fall time 1)	t_{fi}	typ.	1.3	μs

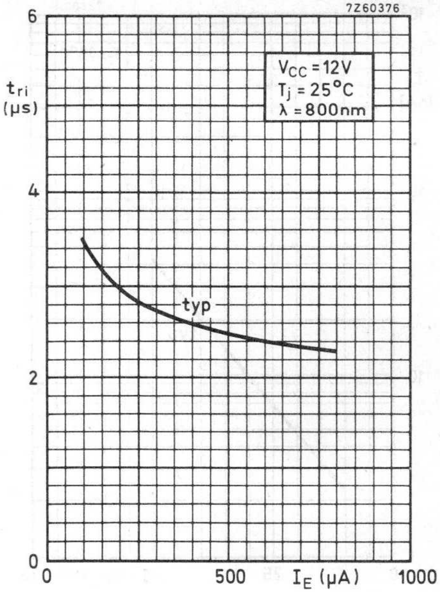
---

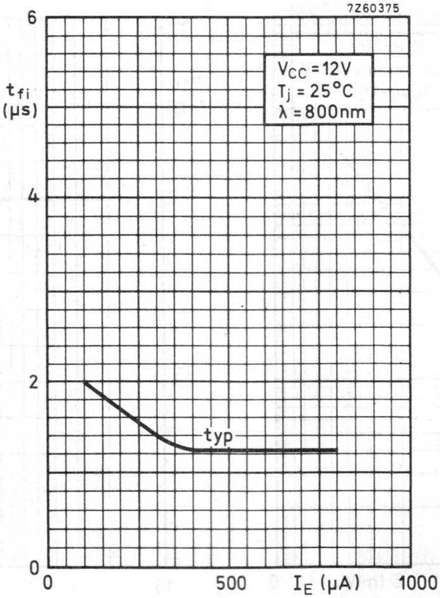
1) Source modulated GaAs

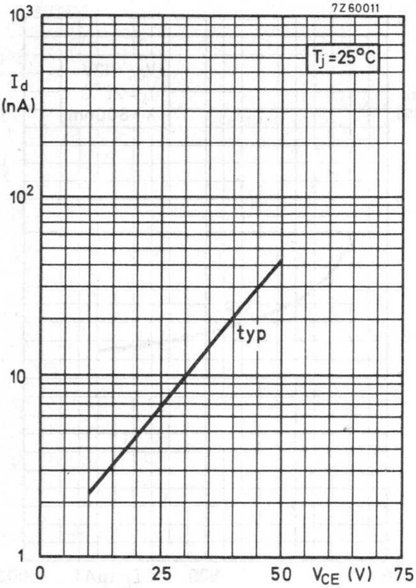


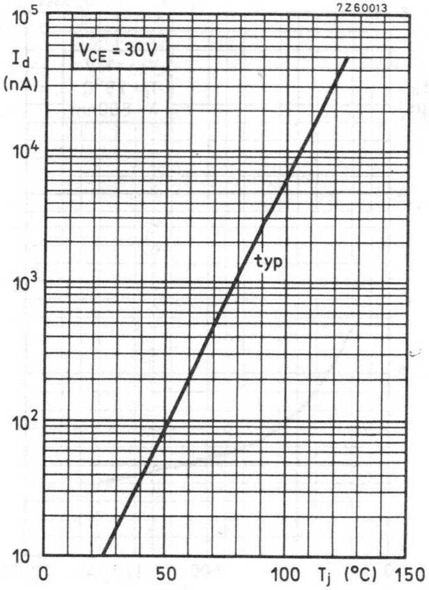
Light pulses:
f = 5 kHz
λ = 800 nm
t_p = 20 μs
$t_f = t_r$ = 20 ns

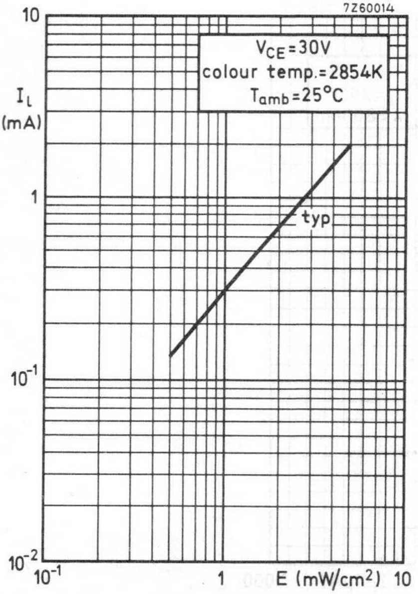

7Z60377
t_{di} (µs)
V_{CC} = 12V
T_j = 25°C
λ = 800nm
typ
6
4
2
0
0
500
I_E (µA)
1000

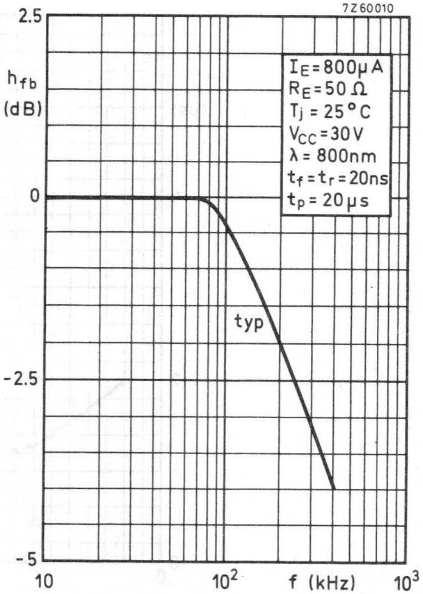

7Z60376
t_{ri} (µs)
V_{CC} = 12V
T_j = 25°C
λ = 800nm
typ
6
4
2
0
0
500
I_E (µA)
1000

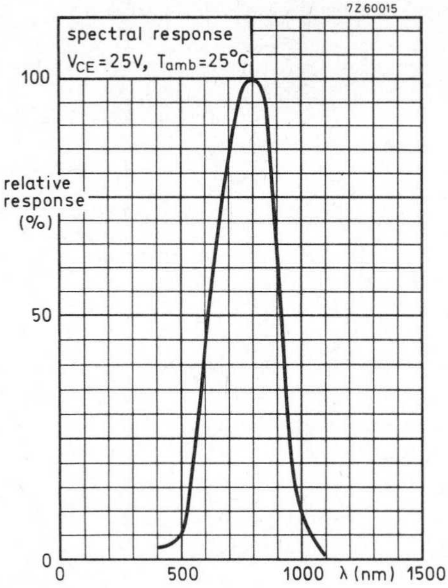

7Z60375
t_{fi} (µs)
V_{CC} = 12V
T_j = 25°C
λ = 800nm
typ
6
4
2
0
0
500
I_E (µA)
1000

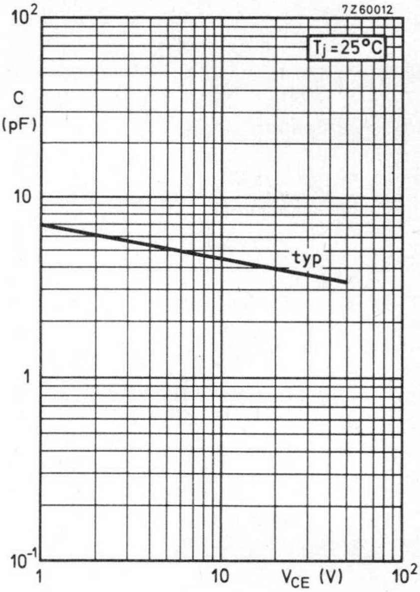

7Z60011
10^3
I_d (nA)
$T_j = 25°C$
10^2
typ
10
1
0
25
50
V_{CE} (V)
75


7Z60013
10^5
I_d (nA)
$V_{CE} = 30V$
10^4
typ
10^3
10^2
10
0
50
100
T_j (°C)
150


7Z60014
10
I_L (mA)
$V_{CE} = 30V$
colour temp.=2854K
$T_{amb} = 25°C$
1
typ
10^{-1}
10^{-2}
10^{-1}
1
E (mW/cm^2)
10


7Z60010
2.5
h_{fb} (dB)
$I_E = 800 \mu A$
$R_E = 50 \Omega$
$T_j = 25°C$
$V_{CC} = 30V$
$\lambda = 800nm$
$t_f = t_r = 20ns$
$t_p = 20 \mu s$
0
typ
-2.5
-5
10
10^2
f (kHz)
10^3


7Z60015
spectral response
V_{CE} = 25V, T_{amb} = 25°C
relative response (%)
100
50
0
0
500
1000
λ (nm)
1500


7Z60012
10^2
T_j = 25°C
C (pF)
10
1
10^{-1}
typ
1
10
V_{CE} (V)
10^2

SILICON PHOTO-DIODE

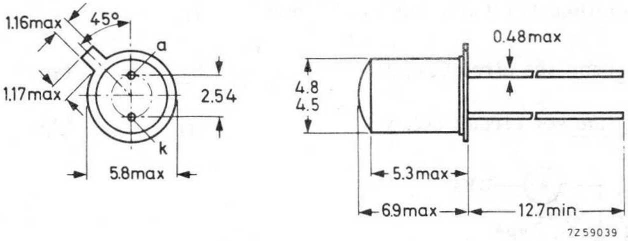
Photo-diode sensitive to visible and infra-red radiation. It is intended for applications up to 1 GHz. The diode is provided with a glass lens.

QUICK REFERENCE DATA

Reverse voltage	V_R	max.	100	V
Total power dissipation up to T_{case} = 25 °C	P_{tot}	max.	0.5	W
Light current at V_R = 10 V incident radiation: E = 1 mW/cm^2 λ = 770 nm	I_l	typ.	7.5	μA
Dark reverse current at V_R = 10 V	I_d	<	2.0	nA
Current rise time	t_{ri}	typ.	0.5	ns

Dimensions in mm

MECHANICAL DATA



max. lead diameter is guaranteed only for 12.7 mm

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

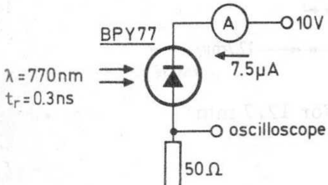
Reverse voltage	V_R	max.	100	V
Total power dissipation up to T_{case} = 25 °C	P_{tot}	max.	0.5	W
Temperatures				
Storage temperature	T_{stg}		−55 to +200	°C
Junction temperature	T_j	max.	200	°C

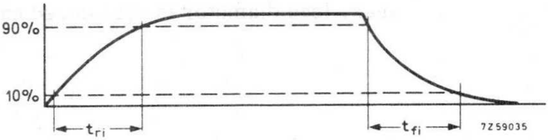
THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	700	°C/W
From junction to case	$R_{th\ j\text{-}c}$	=	350	°C/W

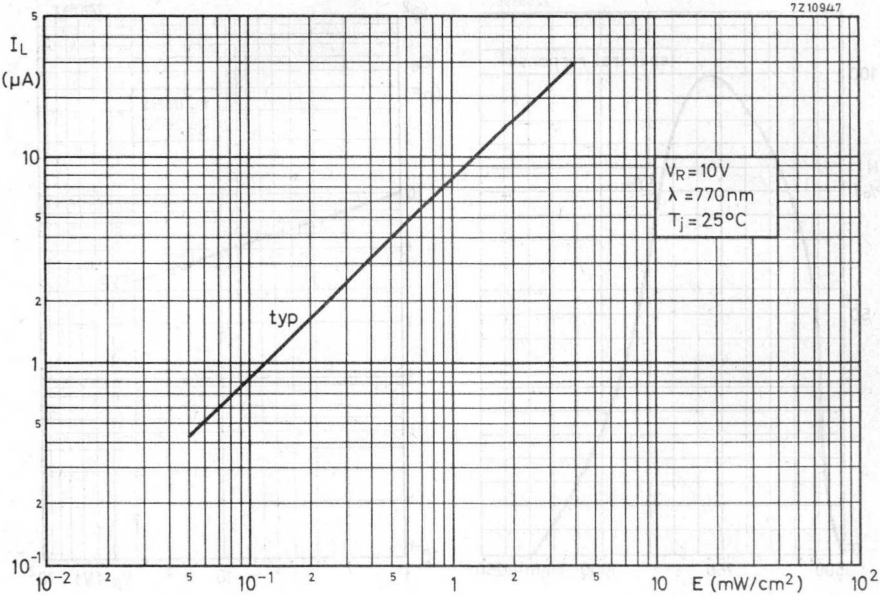
CHARACTERISTICS T_j = 25 °C unless otherwise specified

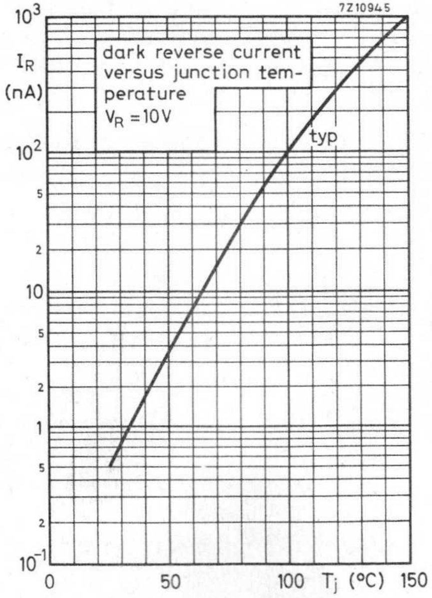
Forward voltage at I_F = 25 mA	V_F	typ. <	0.75 1.0	V V
Dark reverse current at V_R = 10 V	I_d	typ. <	0.5 2.0	nA nA
Light reverse current at V_R = 10 V incident radiation: E = 1 mW/cm²; λ = 770 nm	I_l	> typ.	1.0 7.5	μA μA
Current rise time see circuit below	t_{ri}	typ.	0.5	ns
Current fall time see circuit below	t_{fi}	typ.	0.6	ns



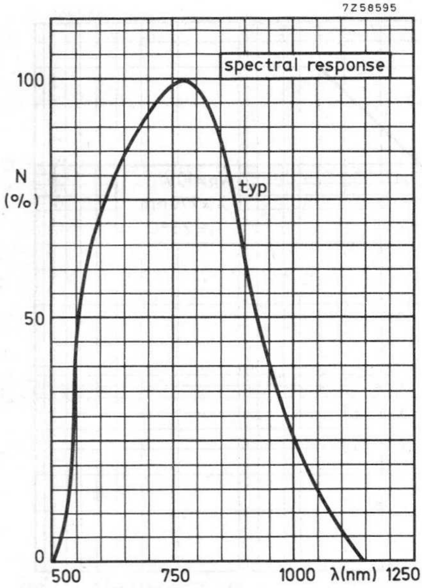


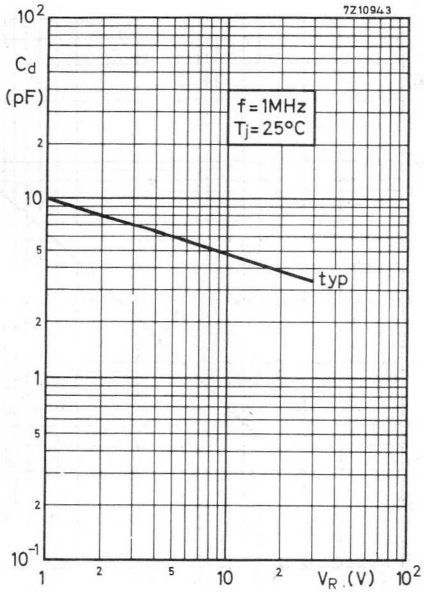
Peak spectral response	λ_m	typ.	770	nm
Diode capacitance at V_R = 10 V; f = 1 MHz	C_d	typ.	4.8	pF





dark reverse current versus junction temperature
$V_R = 10V$


7Z58595
spectral response
N
(%)
100
50
0
typ
500
750
1000
λ(nm)
1250


7Z10943
10^2
C_d
(pF)
f = 1MHz
T_j = 25°C
2
10
5
2
1
5
2
10^{-1}
typ
1
2
5
10
2
V_R (V)
10^2

GERMANIUM PHOTO-DIODE

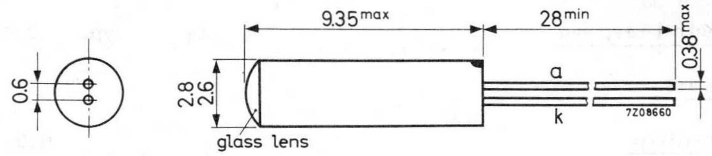
Germanium general purpose photo-diode in a metal envelope.

QUICK REFERENCE DATA

Sensitive area			1	mm^2
Light sensitivity			0.05	μA/lux
Ambient temperature	T_{amb}	max.	60	°C
Peak spectral response	λ_m	typ.	1.55	μm

MECHANICAL DATA

Dimensions in mm



The coloured dot indicates the anode

RATINGS (Limiting values) [1]

Reverse voltage	V_R	max.	30	V
Reverse current	I_R	max.	3	mA
Total power dissipation	P_{tot}	max.	30	mW

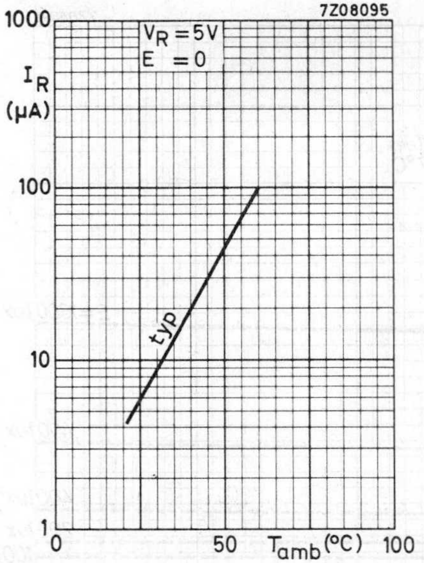
CHARACTERISTICS T_{amb} = 25 °C and using a lamp of colour temperature 2500 °K

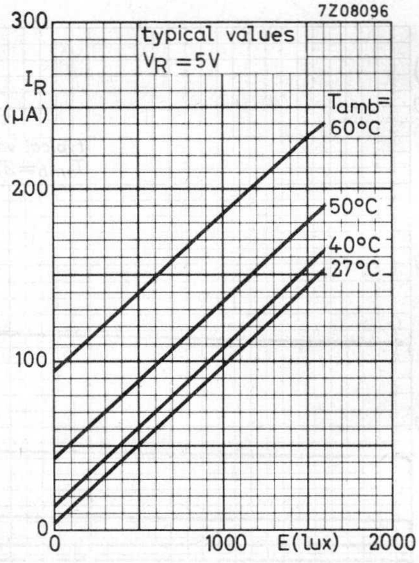
Dark reverse current at $V_R = 10$ V	I_R	<	15	μA
Noise of the dark current (r.m.s. value) $V_R = 10$ V; f = 10 kHz; B = 1 Hz		<	3	pA
Diode resistance ($V_R = 0.5$ to 30 V)	r_D	>	3	MΩ
Cut-off frequency at $V_R = 10$ V [2]	f_c	typ.	50	kHz
Peak spectral response	λ_m	typ.	1.55	μm
Zero spectral response	λ_0	typ.	2.0	μm
Sensitive area			1	mm^2
Light sensitivity			0.05	μA/lux

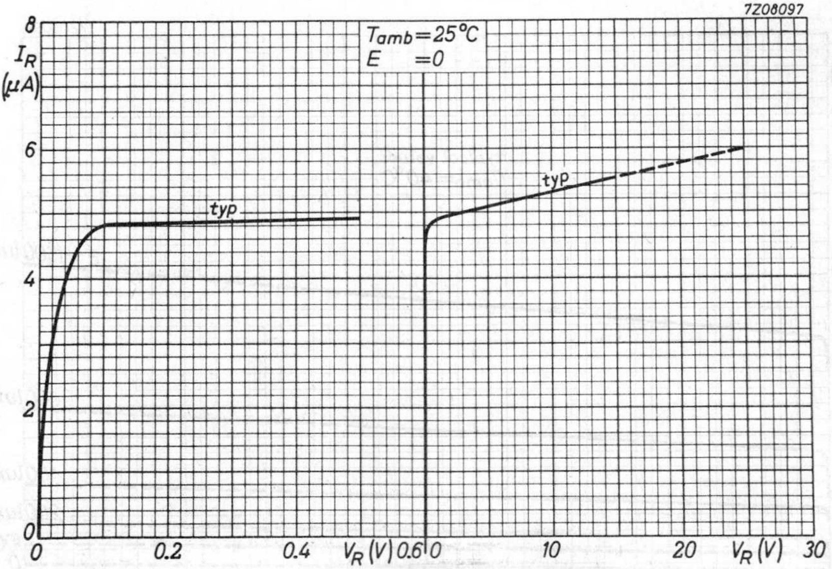
---

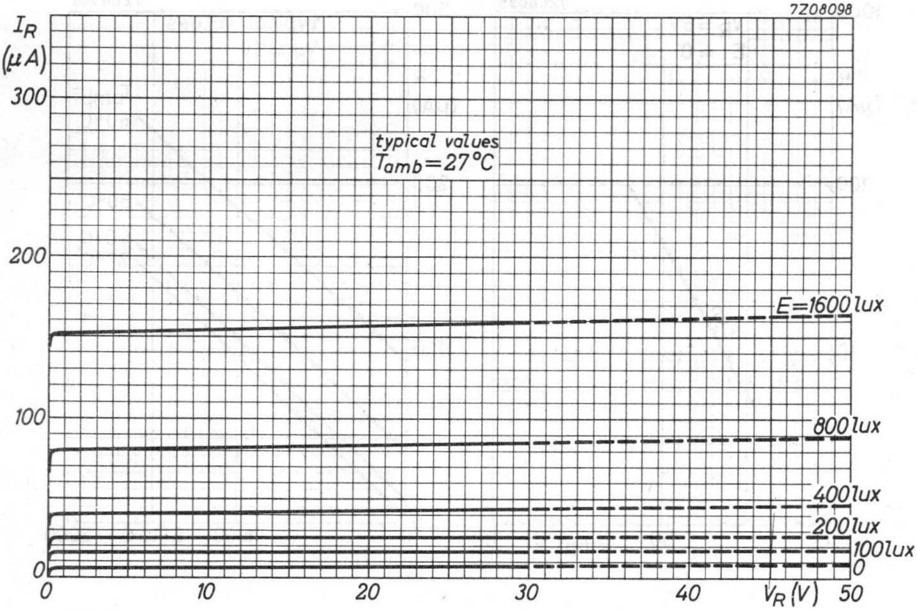
[1] Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

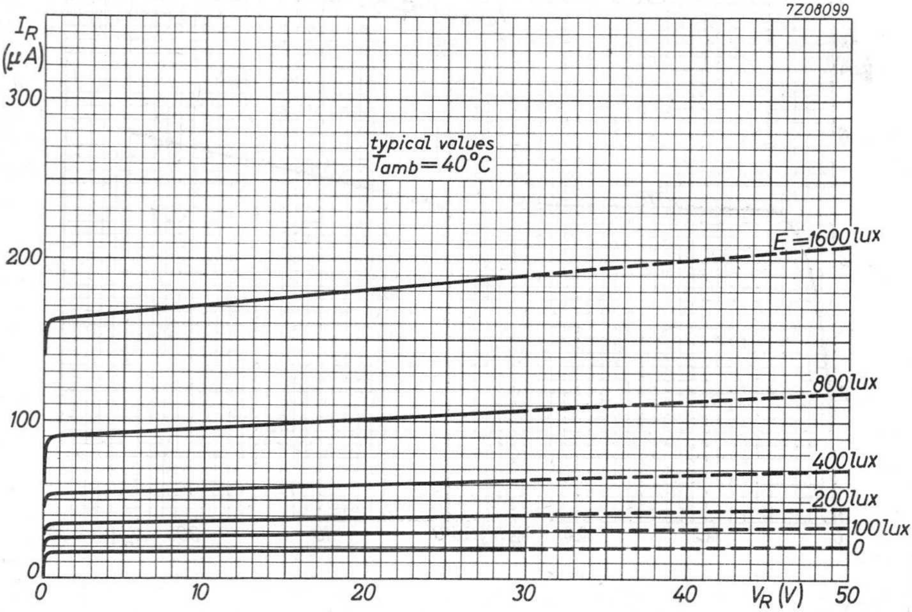
[2] Frequency at which the sensitivity is 3 dB below the reference sensitivity, the latter being measured at $V_R = 10$ V; f = 1 kHz; T_{amb} = 20 °C.

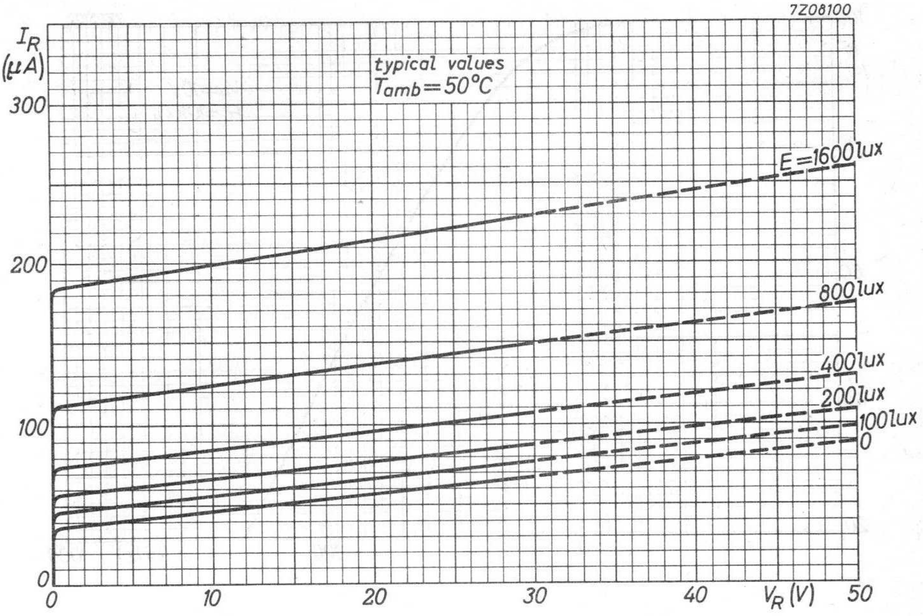

7Z08095
$V_R = 5V$
$E = 0$
I_R (μA)
1000
100
10
1
typ
0
50
T_{amb} (°C)
100

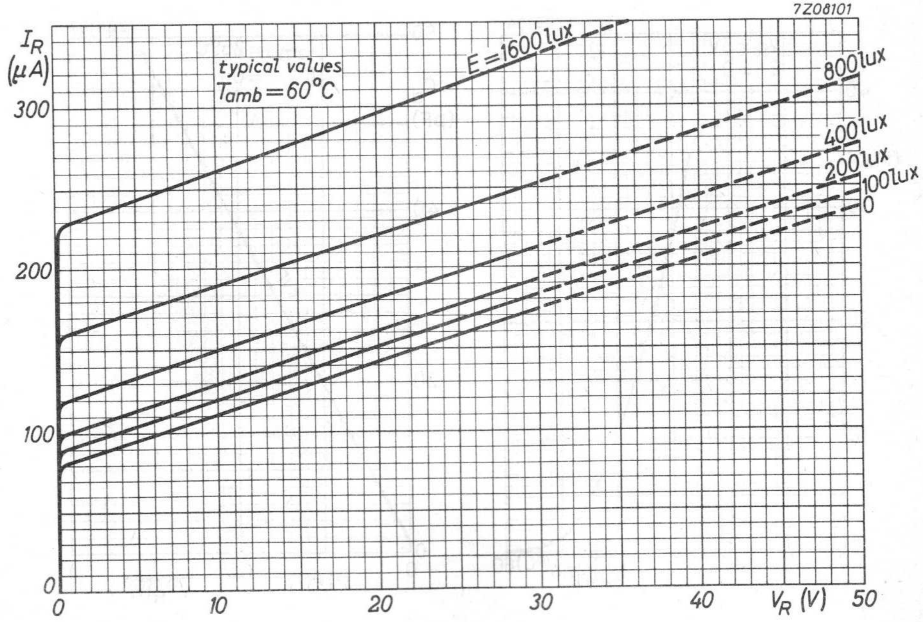

7Z08096
typical values
$V_R = 5V$
I_R (μA)
300
200
100
0
T_{amb}=
60°C
50°C
40°C
27°C
0
1000
E (lux)
2000

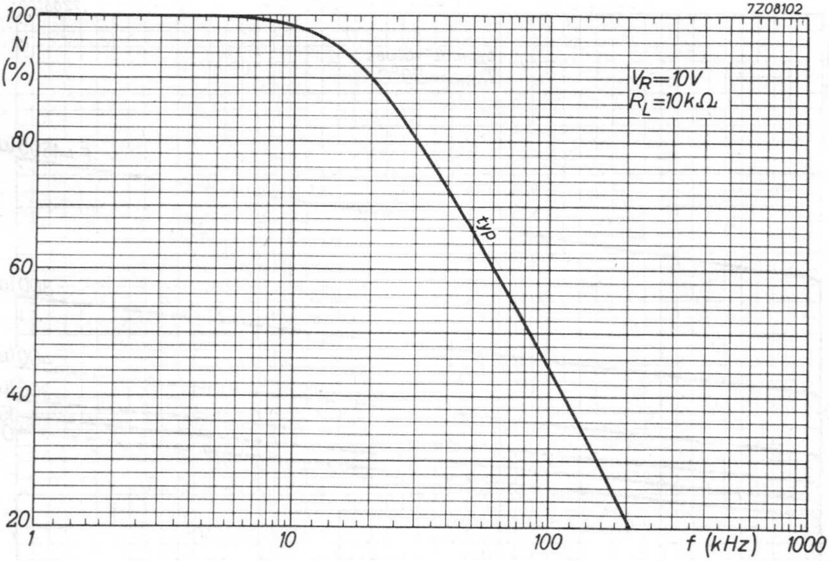

7Z08097
T_{amb}=25°C
E =0
I_R (μA)
8
6
4
2
0
typ
typ
0
0.2
0.4
V_R (V) 0.6
0
10
20
V_R (V)
30

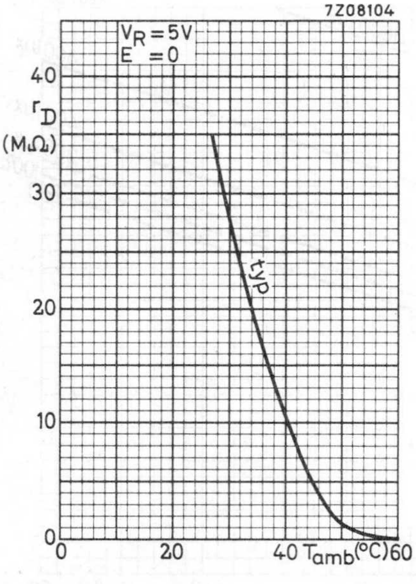

7Z08098
I_R
(μA)
300
200
100
0
typical values
T_{amb}=27°C
E=1600 lux
800 lux
400 lux
200 lux
100 lux
0
0
10
20
30
40
V_R (V)
50

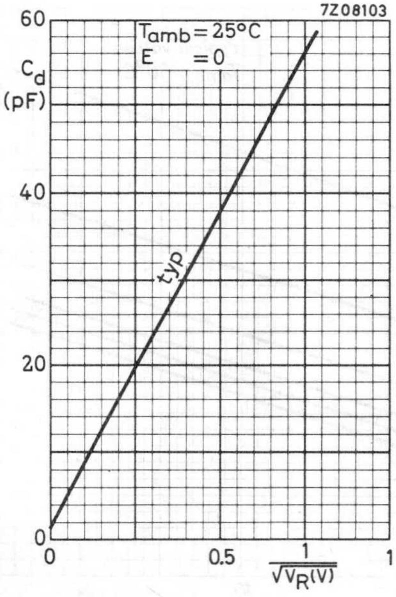

7Z08099
I_R
(μA)
300
200
100
0
typical values
T_{amb}=40°C
E=1600 lux
800 lux
400 lux
200 lux
100 lux
0
0
10
20
30
40
V_R (V)
50


7Z08100
I_R (μA)
300
200
100
0
typical values
$T_{amb} = 50°C$
E = 1600 lux
800 lux
400 lux
200 lux
100 lux
0
0
10
20
30
40
V_R (V)
50


7Z08101
I_R (μA)
300
200
100
0
typical values
$T_{amb} = 60°C$
E = 1600 lux
800 lux
400 lux
200 lux
100 lux
0
0
10
20
30
40
V_R (V)
50


7Z08102
100
N
(%)
80
60
40
20
1
10
100
f (kHz)
1000
$V_R = 10V$
$R_L = 10k\Omega$
typ


7Z08104
$V_R = 5V$
$E = 0$
40
r_D
(MΩ)
30
20
10
0
0
20
40 T_{amb} (°C) 60
typ


7Z08103
60
C_d
(pF)
40
20
0
0
0.5
$\frac{1}{\sqrt{V_R(V)}}$
1
$T_{amb} = 25°C$
$E = 0$
typ

GERMANIUM PHOTO-TRANSISTOR

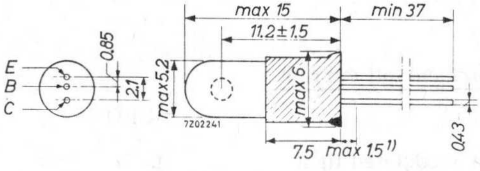
P-N-P germanium photo-transistor intended for general purposes.

QUICK REFERENCE DATA

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	15	V
Collector-emitter voltage ($R_{BE} \leq 1$ kΩ)	$-V_{CER}$	max.	15	V
Collector current (d.c. or average)	$-I_C$	max.	20	mA
Total power dissipation up to $T_{amb} = 25$ °C	P_{tot}	max.	100	mW
Junction temperature	T_j	max.	65	°C
Light sensitivity (area 7 mm^2)	N	>	130	mA/lumen
Peak spectral response	λ_m	typ.	1.43	μm

MECHANICAL DATA

Dimensions in mm



The coloured dot indicates the collector

The preferred direction of incident light is perpendicular to the plane of the leads, and is on the side of the bulb bearing the type number.

---

1) Not tinned.

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltages

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	15	V
Collector-base voltage (peak value)	$-V_{CBM}$	max.	15	V
Collector-emitter voltage ($R_{BE} \leq 1$ kΩ)	$-V_{CER}$	max.	15	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	7.5	V
Collector-emitter voltage (peak value)	$-V_{CEM}$	max.	7.5	V

Currents

Collector current (d.c. or average)	$-I_C$	max.	20	mA
Collector current (peak value)	$-I_{CM}$	max.	20	mA

Power dissipation

Total power dissipation up to $T_{amb} = 25$ °C	P_{tot}	max.	100	mW

Temperatures

Storage temperature	T_{stg}	max.	65	°C
Junction temperature	T_j	max.	65	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	0.4	°C/mW

CHARACTERISTICS

Collector-emitter dark cut-off current $I_B = 0$; $-V_{CE} = 4.5$ V	$-I_{CEO}$	<	325	μA
Cut-off frequency for modulated light	f_c	>	3	kHz
Collector current $-V_{CE} = 2$ V with uniform illumination of 75 ft. candle (807 lux) with preferred direction of incident light, colour temperature of the light source 2700 °K	$-I_C$	>	750	μA
Light sensitivity (area 7 mm^2)	N	>	130	mA/lumen
Peak spectral response	λ_m	typ.	1.43	μm
Zero spectral response	λ_0	typ.	1.9	μm

CHARACTERISTICS (continued)

Circuit diagram

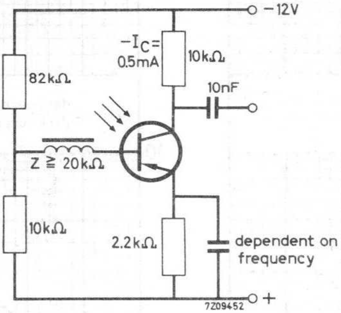
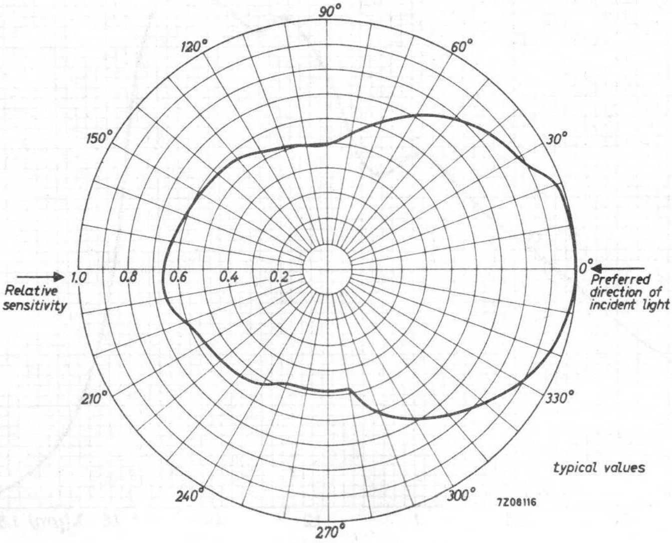
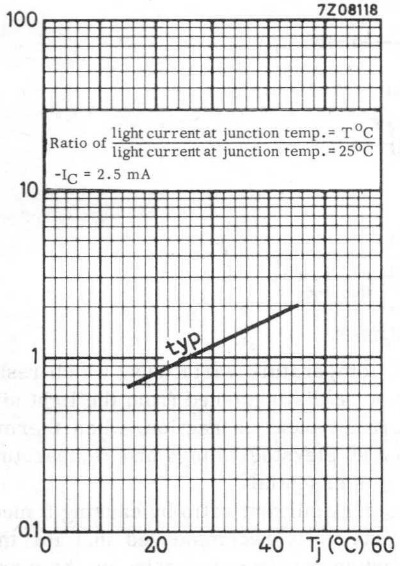
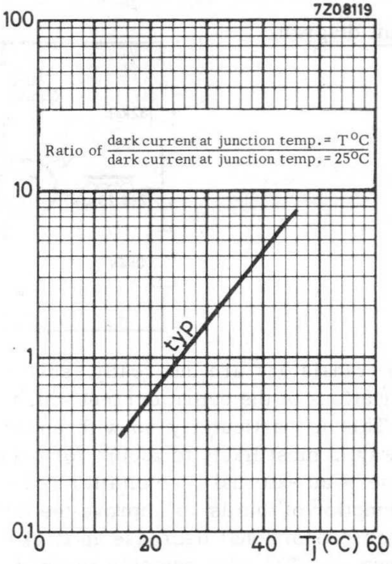


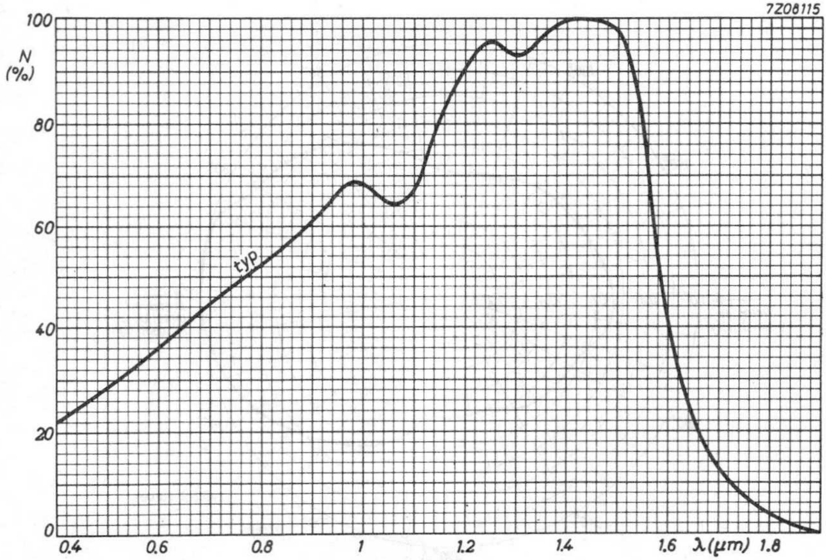
Photo-transistors are inherently sensitive to temperature variations, which result in variations of the output current which cannot be distinguished from the light signal. This is particularly so with an open circuit base connection, when thermal runaway is most likely to occur; for operation at elevated voltage and temperature the use of an external base emitter resistance is essential.

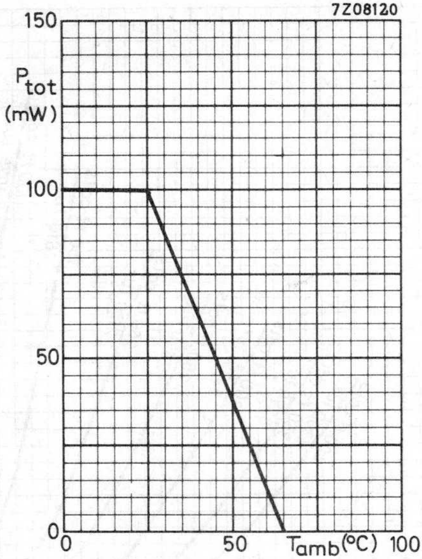
The function of this is to improve the light to dark current ratio by causing a much greater proportional decrease in dark current. It is recommended that for this purpose an NTC type resistor is used, the value required depending on the maximum ambient temperature and light level.

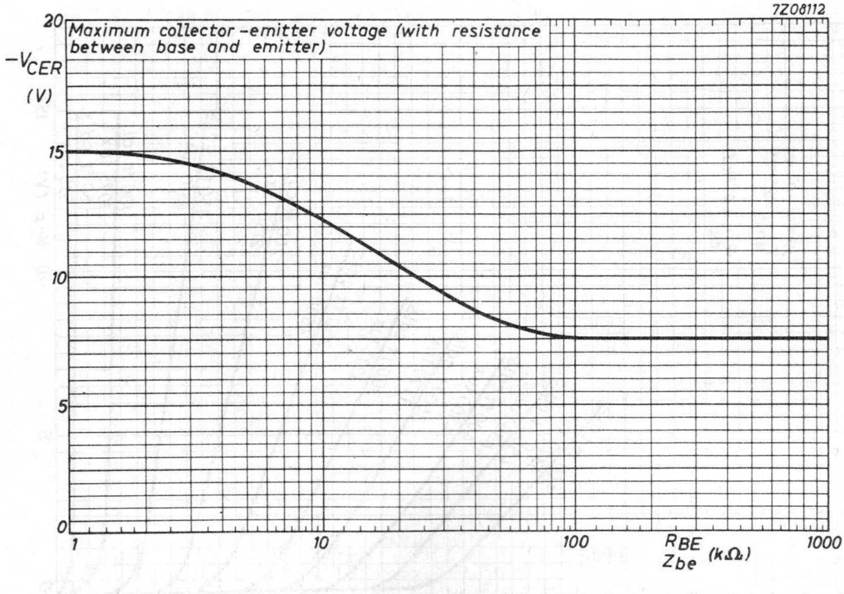


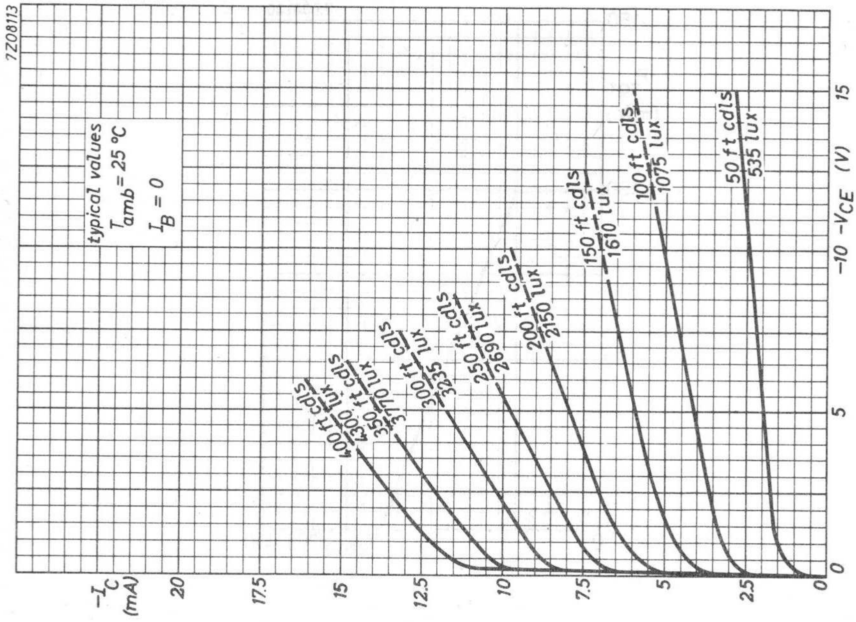

7Z08118
Ratio of $\frac{\text{light current at junction temp.} = T\,^{\circ}\text{C}}{\text{light current at junction temp.} = 25^{\circ}\text{C}}$
$-I_C$ = 2.5 mA
typ
100
10
1
0.1
0
20
40
T_j (°C) 60

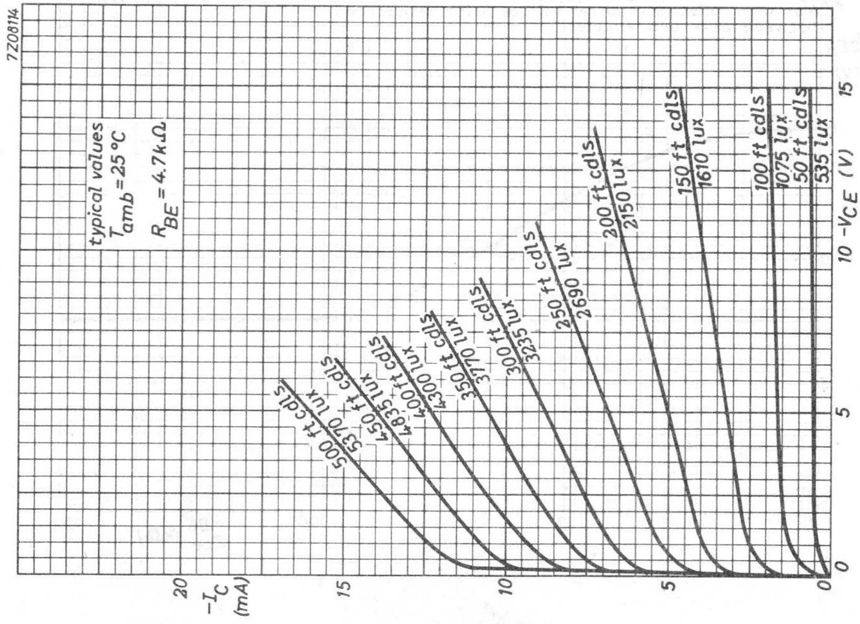

7Z08119
Ratio of $\frac{\text{dark current at junction temp.} = T\,^{\circ}\text{C}}{\text{dark current at junction temp.} = 25^{\circ}\text{C}}$
typ
100
10
1
0.1
0
20
40
T_j (°C) 60


7Z08115
N
(%)
100
80
60
40
20
0
typ
0.4
0.6
0.8
1
1.2
1.4
1.6
λ(μm)
1.8


7Z08120
150
P_{tot}
(mW)
100
50
0
0
50
T_{amb}(°C)
100


7Z08112
Maximum collector-emitter voltage (with resistance between base and emitter)
20
$-V_{CER}$
(V)
15
10
5
0
1
10
100
1000
R_{BE}
Z_{be}
(kΩ)


7Z08113
typical values
T_{amb} = 25 °C
I_B = 0
$-I_C$ (mA)
0
2.5
5
7.5
10
12.5
15
17.5
20
$-V_{CE}$ (V)
0
5
10
15
400 ft cdls
4300 lux
350 ft cdls
3770 lux
300 ft cdls
3235 lux
250 ft cdls
2690 lux
200 ft cdls
2150 lux
150 ft cdls
1610 lux
100 ft cdls
1075 lux
50 ft cdls
535 lux


7Z08114
typical values
T_{amb} = 25 °C
R_{BE} = 4.7 kΩ
$-I_C$ (mA)
0
5
10
15
20
$-V_{CE}$ (V)
0
5
10
15
500 ft cdls
5370 lux
450 ft cdls
4835 lux
400 ft cdls
4300 lux
350 ft cdls
3770 lux
300 ft cdls
3235 lux
250 ft cdls
2690 lux
200 ft cdls
2150 lux
150 ft cdls
1610 lux
100 ft cdls
1075 lux
50 ft cdls
535 lux

Light emitting diodes

GALLIUM ARSENIDE LIGHT EMITTING DIODE

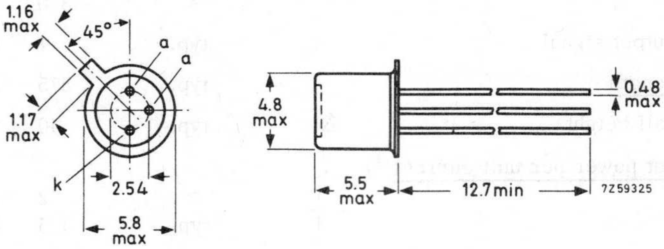
GaAs diode which emit radiation of a narrow spectral band in the near infrared region when forward biased. The device is intended for applications in optical transmission of information in opto-electronic couplers, etc. The diode is provided with a flat glass window.

QUICK REFERENCE DATA				
Forward current (d.c.)	I_F	max.	30	mA
Forward current (peak value)	I_{FM}	max.	0.5	A
Radiation output power per unit current	$\frac{P}{I}$	>	2	mW/A
Rise time of output signal	t_r	typ.	1	ns
Emitted wavelength	λ	typ.	875	nm

MECHANICAL DATA

Dimensions in mm

TO-18, except for window



max. lead diameter is guaranteed only for 12.7 mm.

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltage

Reverse voltage	V_R	max.	2	V

Currents

Forward curent (d.c.)	I_F	max.	30	mA
Forward current (peak value)	I_{FM}	max.	0.5	A

Temperatures

Storage temperature	T_{stg}	−196 to +200	^oC
Junction temperature	T_j	−196 to +200	^oC

THERMAL RESISTANCE

From junction to ambient	$R_{th\ j\text{-}a}$	=	570	$^oC/W$
From junction to case	$R_{th\ j\text{-}c}$	=	220	$^oC/W$

CHARACTERISTICS

$T_{case} = 25\ ^oC$ unless otherwise specified

Forward voltage (single pulse < 10 ms)				
$I_F = 30$ mA	V_F	typ. <	1.2 1.4	V V
$I_F = 0.5$ A	V_F	typ. <	1.5 3.0	V V
Rise time of output signal	t_r	typ.	1	ns
Emitted wavelength	λ	typ.	875	nm
Bandwidth at half height	$\Delta\lambda$	typ.	40	nm
Radiation output power per unit current [1]				
$I_F = 0.5$ A	$\frac{P}{I}$	> typ.	2 3.5	mW/A mW/A
Brightness of crystal at $I_F = 30$ mA		> typ.	300 450	mW/cm^2 mW/cm^2
Aperture angle at half height		typ.	20	^{o}
Emissive area of crystal		typ.	10^{-4}	cm^2

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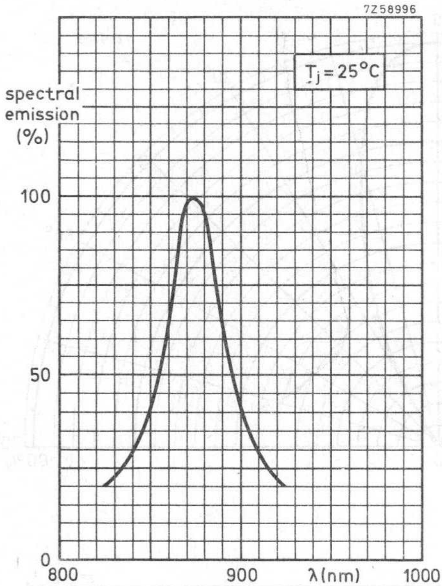
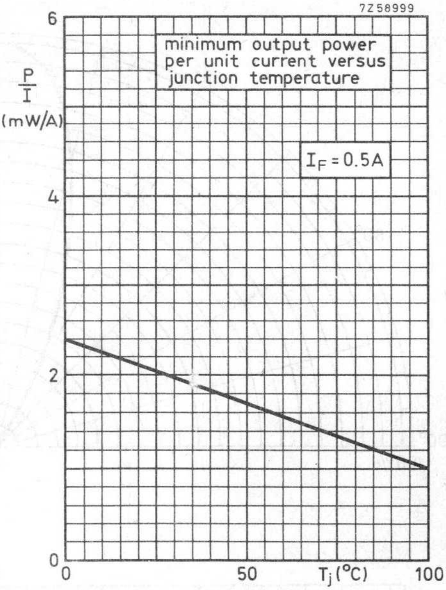
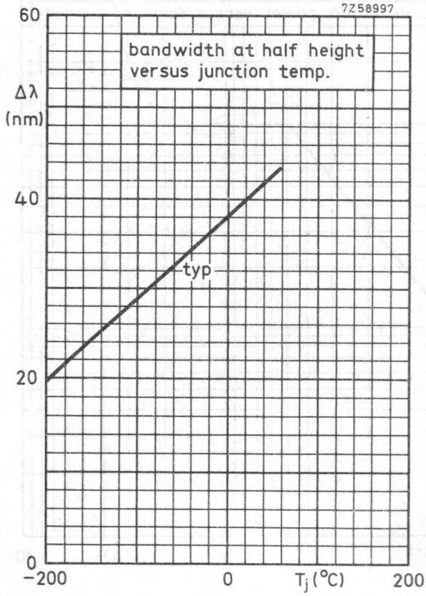
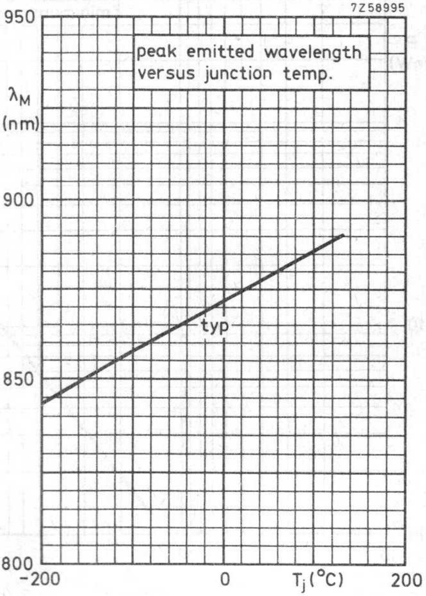
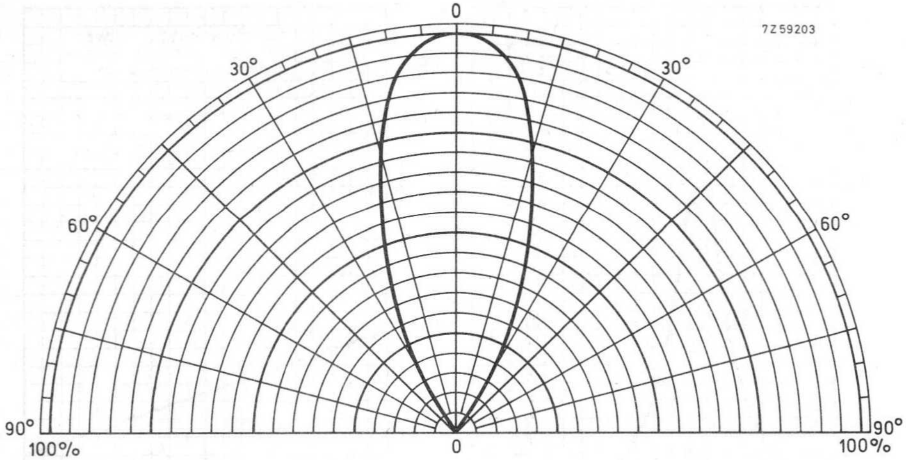
[1] Measured under pulsed conditions, $t_p = 10\ \mu s$; $\delta = 0.01$

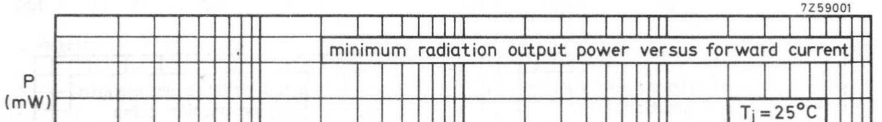

7Z58996
spectral emission (%)
$T_j = 25°C$
100
50
0
800
900
λ(nm)
1000


7Z58999
minimum output power per unit current versus junction temperature
P/I (mW/A)
$I_F = 0.5A$
6
4
2
0
0
50
T_j (°C)
100


7Z58997
bandwidth at half height versus junction temp.
Δλ (nm)
typ
60
40
20
0
−200
0
T_j (°C)
200


7Z58995
peak emitted wavelength versus junction temp.
$λ_M$ (nm)
typ
950
900
850
800
−200
0
T_j (°C)
200


7Z59203
0
30°
30°
60°
60°
90°
90°
100%
0
100%


7Z59001
minimum radiation output power versus forward current
P
(mW)
$T_j = 25°C$
1
10^{-1}
10^{-2}
10^{-3}
10^{-2}
10^{-1}
1
I_F (A)
10

Dissipation and heatsink considerations

The graph on page 6 can be used to determine the peak power dissipation and the thermal resistance of the heatsink required under pulse operation of the diode, when the peak pulse current, duty cycle, pulse duration and permissible temperature rise are known.

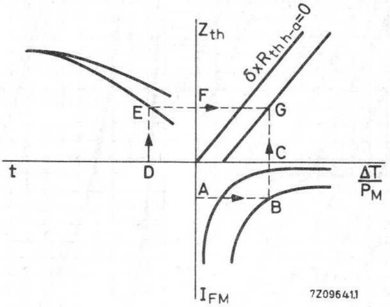


Fig. 1

The thermal relationship under pulse conditions is:

$$\frac{\Delta T}{P_M} = Z_{th} + \delta . R_{th\ h-a}$$

where ΔT = permissible temperature rise = $T_{j\ max.} - T_{amb}$

P_M = peak power dissipation

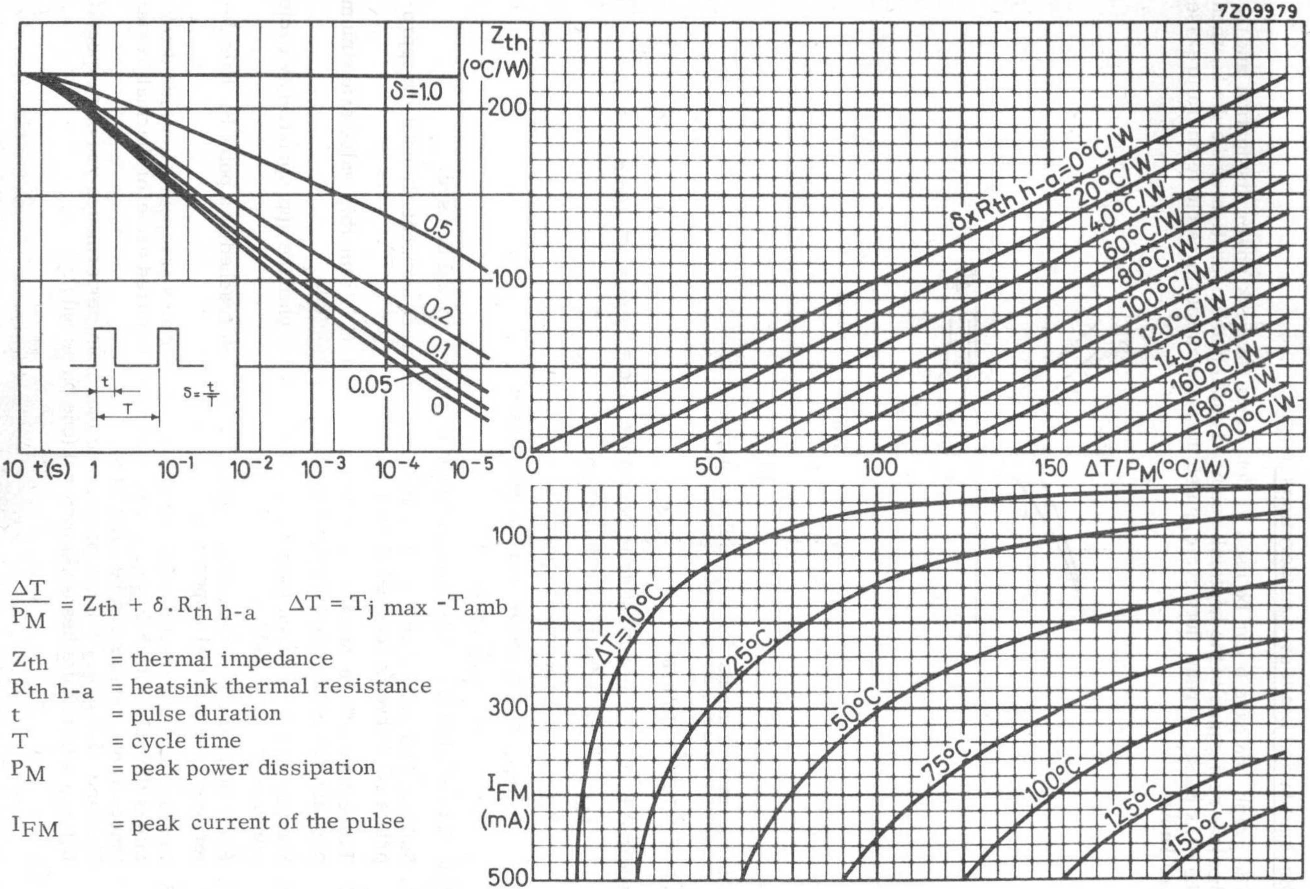
Z_{th} = thermal impedance

$R_{th\ h-a}$ = heatsink thermal resistance

δ = duty cycle

Fig. 1 is used to illustrate how the graph on page 6 should be used.

1. Starting at a point A in Fig. 1 on the I_{FM} axis trace horizontally until the appropriate ΔT curve is reached at point B.
2. Trace upwards to meet $\Delta T/P_M$ axis at a point C. From this value a maximum permissible peak power dissipation can be calculated.
3. Starting at a point D, on the t axis, trace upwards until the appropriate duty cycle curve is met at a point E.
4. From point E trace horizontally until Z_{th} axis is reached at a point F. This determines the thermal impedance.
5. Finally, produce the lines BC and EF until they cross at a point G, which determines the value of $\delta . R_{th\ h-a}$. From this the required value of thermal resistance of the heatsink can be calculated.
   The line $\delta . R_{th\ h-a} = 0$ can provide the maximum performance you can expect if $R_{th\ h-a} = 0$ (infinite heatsink) or $\delta = 0$ (one pulse only).



$\frac{\Delta T}{P_M} = Z_{th} + \delta . R_{th\ h\text{-}a}$ $\Delta T = T_{j\ max} - T_{amb}$

Z_{th} = thermal impedance
$R_{th\ h\text{-}a}$ = heatsink thermal resistance
t = pulse duration
T = cycle time
P_M = peak power dissipation

I_{FM} = peak current of the pulse

Infra-red sensitive devices

PHOTOCONDUCTIVE CELL

Indium antimonide photoconductive element mounted on a copper heatsink, recommended for operation at a temperature of 20 °C.
Sensitive to infra-red radiation extending to 7.5 μm and intended for use with modmodulated or pulsed radiation.

RATINGS (Limiting values) [1]

Bias current at T_{amb} = 20 °C	I	max.	100	mA
Temperatures				
Operating ambient temperature	T_{amb}	max.	70	°C
Storage temperature	T_{stg}		- 50 to + 70	°C

CHARACTERISTICS T_{amb} = 20 °C unless otherwise specified

Peak spectral response	λ		6.0 to 6.3	μm
Spectral response range	from visible to		7.5	μm
Cell resistance	r_1		30 to 120	Ω
Time constant			0.1	μs
Sensitive area			6.0 x 0.5	mm^2
Sensitivity (6.0 μm radiation)		>	0.4	μV/μW
		typ.	1.0	μV/μW
(500 °K radiation)		typ.	0.3	μV/μW
D * (6.0 μm, 800 Hz, 1 Hz)	see notes 1 and 2	>	8.5×10^7	cm$\sqrt{Hz}$/W
		typ.	2.0×10^8	cm$\sqrt{Hz}$/W
(500 °K, 800 Hz, 1 Hz)		typ.	6.0×10^7	cm$\sqrt{Hz}$/W
Noise equivalent power (N.E.P.)				
(6.0 μm, 800 Hz, 1 Hz)	see notes 1 and 2	typ.	8.6×10^{-10}	W
		<	2.0×10^{-9}	W
(500 °K, 800 Hz, 1 Hz)		typ.	2.5×10^{-9}	W

MECHANICAL DATA (see page 2)

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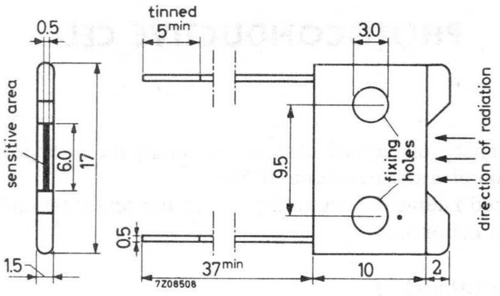
[1] Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

MECHANICAL DATA Dimensions in mm



NOTES

1. Measuring conditions.

The detector is attached to a heatsink which is maintained at a temperature of 20 °C and a bias current of 50 mA is applied. A parallel beam of monochromatic radiation of wavelength 4.4 μm, which would produce a steady irradiance of 68 μW/cm^2 at the sensitive element, is chopped at 800 Hz, giving an actual r.m.s. power at the element which amounts to

$$\frac{68}{2.2} = 31\ \mu\text{W/cm}^2$$

Measurements of the detector output are made with an amplifier tuned to 800 Hz and with a bandwidth of 50 Hz, and are referred to open circuit conditions i.e. correction is made for the shunting effects of the bias supply impedance and the amplifier input impedance. Under these test conditions, the ORP10 will exhibit a minimum signal-to-noise ratio of 45 and typical of 105. The sensitivities quoted at the wavelength of peak response and under black body conditions are calculated from these measurements, assuming the detector to have a typical response curve.

2. D* and N.E.P.

These are figures of merit for the materials of detectors.
D* is defined in the expression:

$$D^* = \frac{\frac{V_s}{V_n} \times \sqrt{A(\Delta f)}}{W}$$

where: V_s = signal voltage across detector terminals
V_n = noise voltage across detector terminals
A = detector area
(Δf) = bandwidth of measuring amplifier
W = radiation power incident on detector sensitive element in watts.

NOTES (continued)

The figures in brackets which follow D* refer to the measuring conditions e.g. D* (5.3 μm, 800 Hz, 1 Hz) denotes monochromatic radiation incident on the detector of wavelength 5.3 μm, chopping frequency 800 Hz, bandwidth 1 Hz.

The Noise Equivalent Power (N.E.P.) is related to D* by the expression:

$$\text{N.E.P.} = \frac{\sqrt{A}}{D^*}.$$

3. Variation of performance with bias current.

Both signal and noise vary with bias current. Typical curves are shown on page 5. At high currents the noise increases more rapidly than the signal, and therefore the signal-to-noise ratio has a peak value at some optimum current, which will vary slightly from cell to cell. A typical value is 50 mA. In addition the ohmic heating caused by bias currents above 60 mA causes the temperature of the element to become significantly greater than the substrate so that the signal decreases as described in note 4.

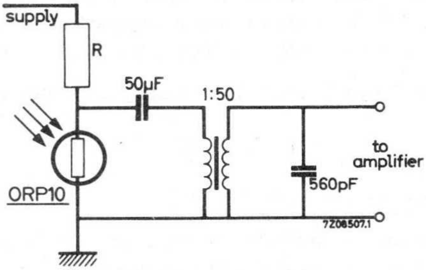
4. Variation of performance with element temperature.

As with all semiconductor photocells, the performance depends on the temperature of the sensitive element. In the case of the ORP10 this is influenced by the ambient temperature and ohmic heating caused by the d.c. bias current. To minimise fluctuations, the element is mounted on a copper base from which it is insulated by a layer of aluminium oxide, and can readily be attached to a large heatsink.
A typical variation of performance with temperature is given on page 5. The curve on page 5 shows the decrease in signal caused by the high current raising the temperature of the element.
On cooling, indium antimonide exhibits improved sensitivity and increased resistance. Below 15 °C this is impractical with the ORP10 unless special precautions are taken to prevent condensation and icing on the exposed element.

5. Warning.

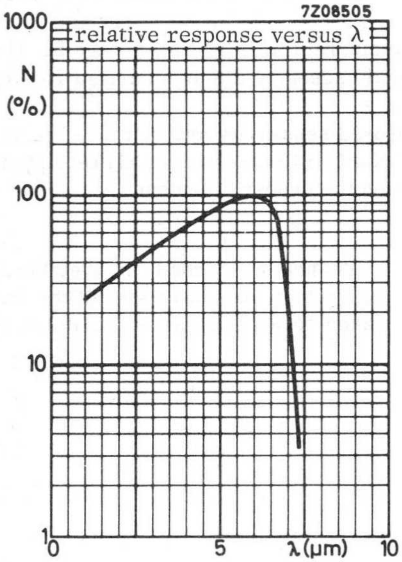
The sensitive surface is unprotected and should not be touched. It is stable in normal atmospheres but should not be exposed to high concentrations of the vapours of organic solvents. Care should be taken to avoid strain when attaching cells to heatsinks.

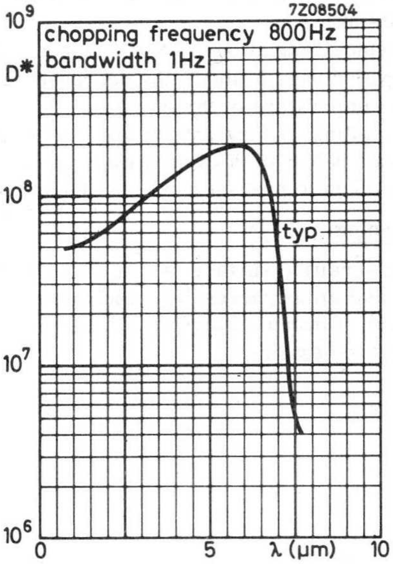
Recommended circuit for use with radiation chopped at 800 Hz.

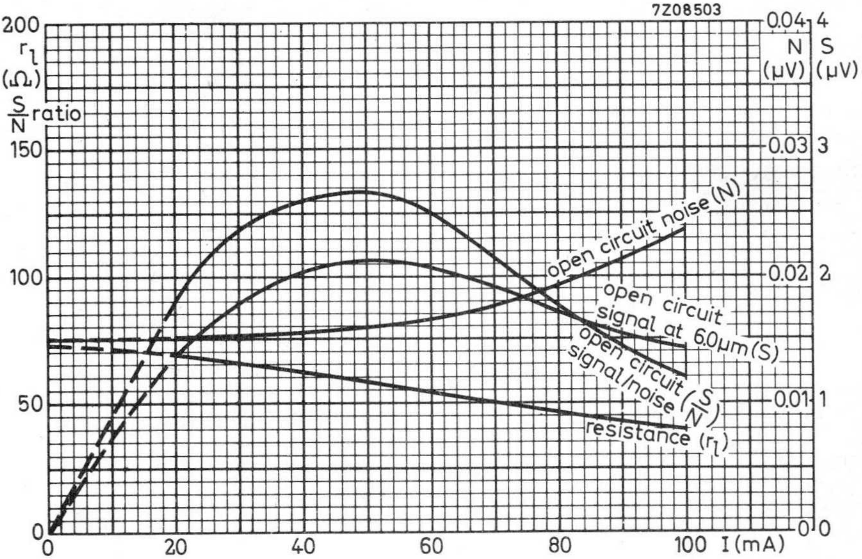


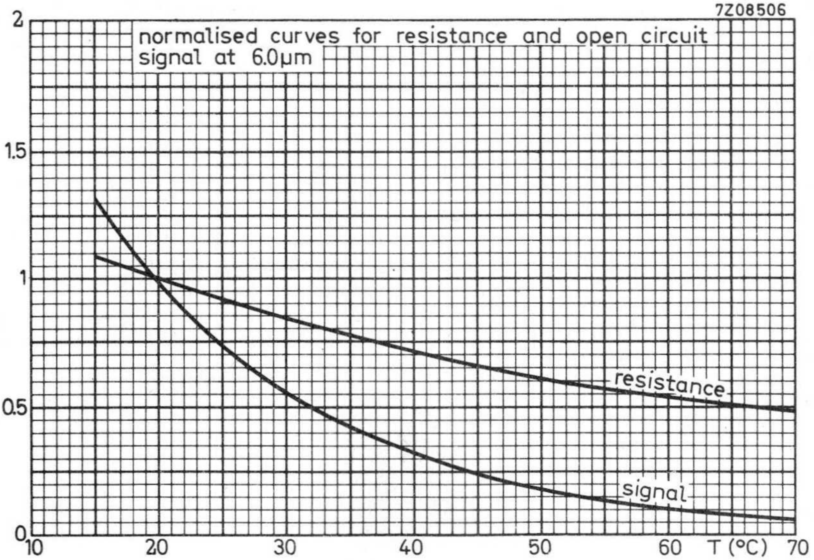
CIRCUIT NOTES

The transformer should be adequately screened to prevent stray pick-up.
The resistor R should be wire wound to minimise noise. It must be substantially larger than the cell resistance and its actual value will depend upon the supply voltage and the cell currents required. The 560 pF capacitor tunes the secondary to 800 Hz.






7Z08503
200
r_l
(Ω)
$\frac{S}{N}$ ratio
150
100
50
0
0
20
40
60
80
100 I (mA)
0.04
N
(μV)
0.03
0.02
0.01
0
4
S
(μV)
3
2
1
0
open circuit noise (N)
open circuit signal at 6.0μm (S)
open circuit signal/noise ($\frac{S}{N}$)
resistance (r_l)


7Z08506
normalised curves for resistance and open circuit signal at 6.0μm
2
1.5
1
0.5
0
10
20
30
40
50
60 T (°C)
70
resistance
signal

PHOTOCONDUCTIVE CELL

Indium antimonide photoconductive element mounted in a glass dewar vessel and cooled by liquid nitrogen or liquid air. Sensitive to infrared radiation extending to 5.6μm an intended for use with modulated or pulsed radiation.

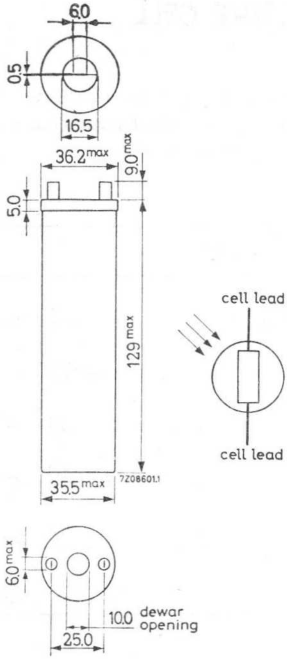
QUICK REFERENCE DATA

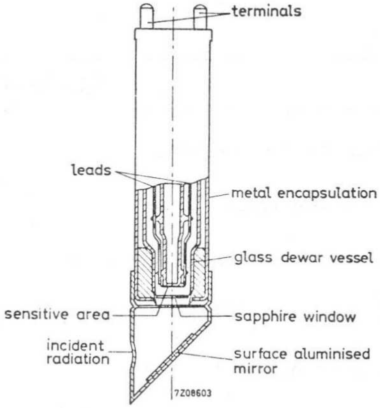
Peak spectral response	λ_m		5.3	μm
Operating temperature	T		77	K
Responsivity (5.3 μm, 800 Hz)		typ.	35	mV/μW
D^* (5.3 μm, 800 Hz, 1 Hz)		typ.	5.5×10^{10}	cm $\sqrt{Hz}$/W
Time constant		typ.	5	μs
Sensitive area			6.0 x 0.5	mm^2

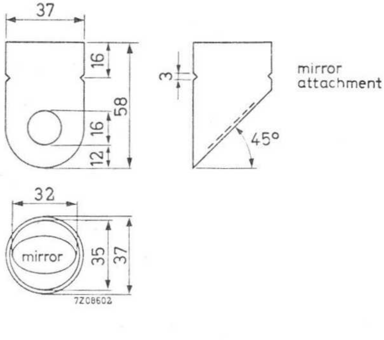
MECHANICAL DATA see page 2

MECHANICAL DATA

Dimensions in mm







RATINGS Limiting values in accordance with the Absolute Maximum System (IEC134)

Bias current at T_{amb} = 77 K	I	max.	30	mA
Temperatures				
Storage temperature	T_{stg}		−55 to +55	°C

CHARACTERISTICS (see note 1 on page 4)

Peak spectral response	λ_m		5.3	μm
Spectral response range		from visible to	5.6	μm
Cell resistance	r_ℓ		20 to 60	kΩ
Time constant		typ.	5	μs
→ Boil-off time of bulk liquid nitrogen		>	90	min
		typ.	120	min

Performance

1. Black body source measurement

colour temperature : 500 K
chopping frequency : 800 Hz
bandwidth : 1 Hz

→ Responsivity	>	4	mV/μW
	typ.	7	mV/μW
→ D*	>	5×10^9	cm $\sqrt{Hz}$/W
	typ.	7.5×10^9	cm $\sqrt{Hz}$/W
→ N.E.P.	typ.	16	pW
	<	35	pW

2. Monochromatic source measurement

radiation : 5.3 μm
chopping frequency : 800 Hz
bandwidth : 1 Hz

Responsivity	typ.	35	mV/μW
D*	typ.	55×10^9	cm $\sqrt{Hz}$/W
N.E.P.	typ.	3.2	pW

NOTES

→ 1. Test conditions

The detector is cooled to 77K by filling the dewar vessel with liquid nitrogen, or by use of a liquid transfer system. An optimum bias of 250 to 500μA is applied. The sensitive element is situated at a distance of 264mm from a black body source limited by an aperture of 3mm diameter.

The radiation path is interrupted at 800Hz by a chopper blade at ambient temperature. Under these conditions the r.m.s. power at the element (chopping factor 2.2) is 4.5μW/cm^2.

Measurements of the detector output are made with an amplifier tuned to 800Hz with a bandwidth of 50Hz, and referred to open-circuit conditions, i.e., correction is made for the shunting effects of the bias supply impedance and the amplifier impedance.

2. D* and N.E.P.

These are figures of merit for the materials of detectors.

The detectivity D* is defined in the expression:

$$D^* = \frac{\frac{V_s}{V_n}\sqrt{A(\Delta f)}}{W}$$

where: V_s = signal voltage across detector terminals
V_n = noise voltage across detector terminals
A = detector area
(Δf) = bandwidth of measuring amplifier
W = radiation power incident on detector sensitive element in r.m.s. watts.

The Noise Equivalent Power (N.E.P.) is related to D* by the expression:

$$N.E.P. = \frac{\sqrt{A}}{D^*}$$

3. Time constant

Detector time constant figures are based on the response to a step function in the incident radiation. Quoted times indicate the interval between the moment the radiation is cut off and the output falling to 63% of its peak value.

4. Variation of performance with bias current

Both signal and noise vary with current in this type of cell. At high currents the noise increases more rapidly than the signal, and therefore the signal-to-noise ratio has a peak value at some optimum current, which will vary slightly from cell to cell.

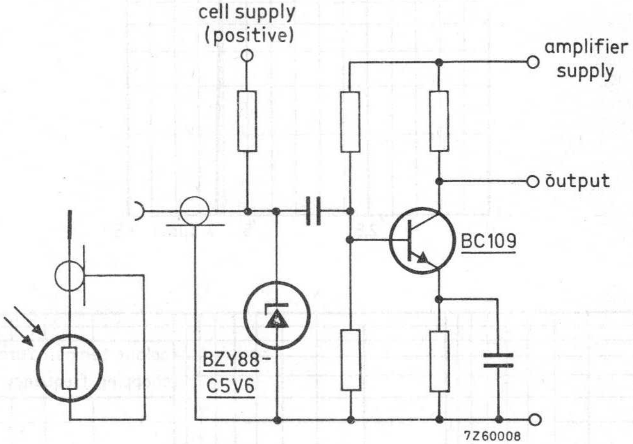
NOTES (continued)

5. Warnings

a. The resistance of the cell at room temperature is three orders of magnitude less than at the operating temperature (77K). Care should therefore be taken to ensure that the device is not allowed to reach room temperature while still biased, if any form of low impedance biasing is employed.

b. If provision is made for cells to be plugged into the bias current and amplifier, steps must be taken to limit the current available from the amplifier input capacitor. This current can be excessive at the instant of plugging in the cell.

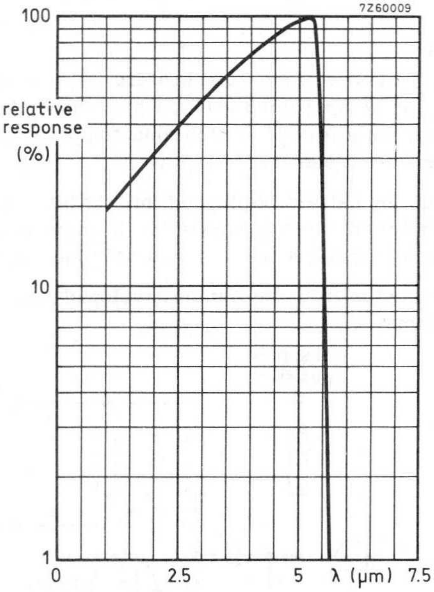
A zener diode can be used to limit the voltage developed across the input capacitor as shown in the diagram.

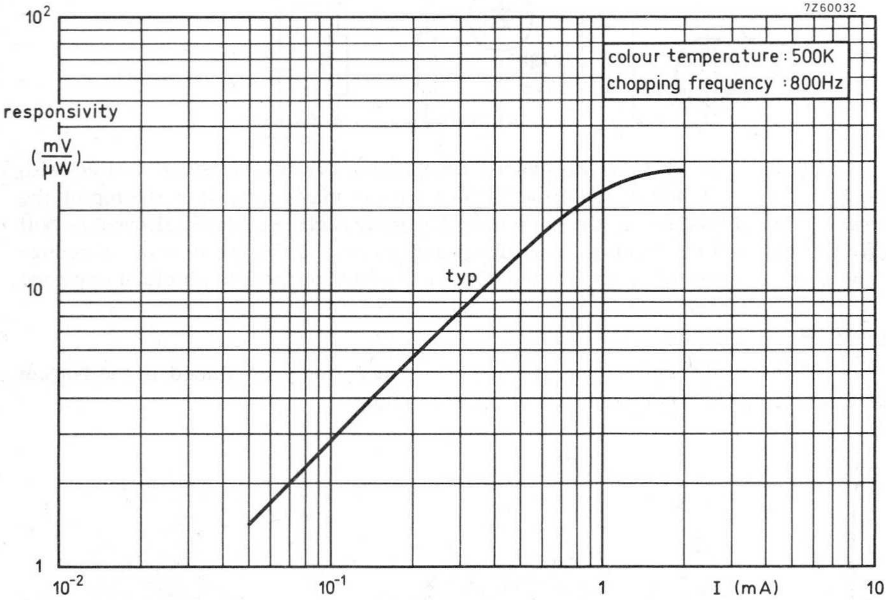


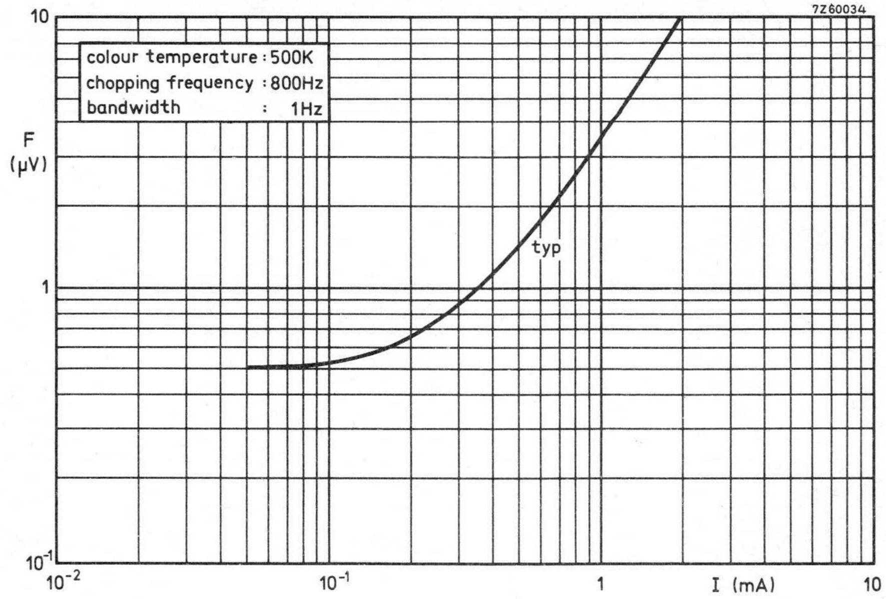
c. The dewar vessel must always be completely dry before being refilled with liquid nitrogen. In humid conditions, water vapour may condense at the top of the dewar. Should this occur, the remaining liquid nitrogen should be allowed to boil off, the ice should be removed carefully and precautions taken to avoid a recurrence. In very humid conditions the window should be purged with a claen dry gas.

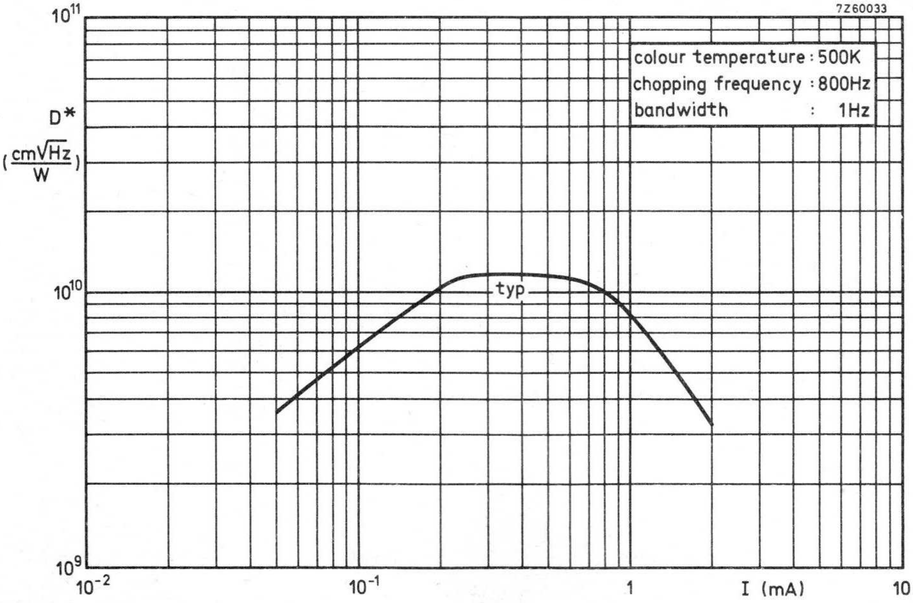
6. Low frequency noise

This will be minimised by use of non-absorbent cotton wool placed in the bottom of the dewar. The recommended quantity is 40mg.


7Z60009
100
relative
response
(%)
10
1
0
2.5
5
λ (μm)
7.5


7Z60032
10^2
colour temperature : 500K
chopping frequency : 800Hz
responsivity
($\frac{mV}{\mu W}$)
typ
10
1
10^{-2}
10^{-1}
1
I (mA)
10


7Z60034
10
1
10⁻¹
F
(μV)
colour temperature : 500K
chopping frequency : 800Hz
bandwidth : 1Hz
typ
10⁻²
10⁻¹
1
I (mA)
10


7Z60033
10¹¹
10¹⁰
10⁹
D*
(cm√Hz / W)
colour temperature : 500K
chopping frequency : 800Hz
bandwidth : 1Hz
typ
10⁻²
10⁻¹
1
I (mA)
10

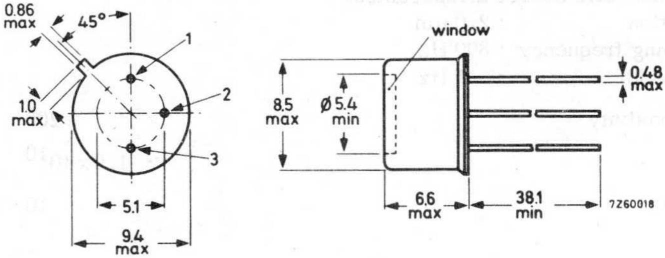
PHOTOCONDUCTIVE CELL

Lead sulphide, chemically deposited, photoconductive cell recommended for room temperature operation.
It is encapsulated in a hermetically sealed TO-5 envelope with an end viewing window.
It has a germanium filter to cut off radiation below 1.5 μm and therefore it may be exposed continuously to visible radiation.

QUICK REFERENCE DATA

Peak spectral response	λ_m	typ.	1.9	μm
Spectral response range	$\Delta\lambda$		1.5 to 3.0	μm
Responsivity (2.0μm, 800 Hz)		>	200	mA/W
Responsivity (500K, 800 Hz)		>	2.0	mA/W
D* (500K, 800 Hz, 1 Hz)			$>1.0 \times 10^8$	$\text{cm}\sqrt{\text{Hz}}/\text{W}$
Time constant		typ.	250	μs
Sensitive area			1.0 x 1.0	mm^2

MECHANICAL DATA



RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Power dissipation	P	max.	20	mW
Temperatures				
Storage temperature	T_{stg}		−20 to +50	°C
Operating ambient temperature	T_{amb}	max.	50	°C

CHARACTERISTICS at $T_{amb} = 20\ ^{o}C$ (see notes on pages 3 and 4)

Peak spectral response	λ_m	typ.	1.9	µm
Spectral response range	$\Delta\lambda$		1.5 to 3.0	µm
Cell resistance	r_ℓ	>	200	kΩ
		typ.	600	kΩ
Time constant		typ.	250	µs
		<	400	µs

Performance

1. Black body source measurement
   colour temperature : 500 K
   chopping frequency : 800 Hz
   bandwidth : 1 Hz

Responsivity	>	2.0	mA/W
D*	>	1.0×10^8	$cm\sqrt{Hz}/W$
N.E.P.	<	1.0	nW

2. Monochromatic source measurement
   radiation : 2.0 µm
   chopping frequency : 800 Hz
   bandwidth : 1 Hz

Responsivity	>	200	mA/W
D*	>	1.0×10^{10}	$cm\sqrt{Hz}/W$
N.E.P.	<	10	pW

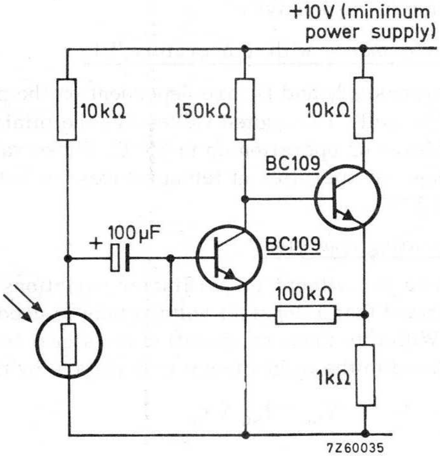
NOTES

1. Test conditions

The cell is operated at a temperature of 20 °C. The sensitive element is situated at a distance of 264 mm from a black body source limited by an aperture of 3 mm diameter.

The radiation path is interrupted at 800 Hz by a chopper blade at ambient temperature. Under these conditions the r.m.s. power at the element (chopping factor 2.2) is 4.5 μW/cm^2.

A bias voltage of 24 V is applied to the cell. Measurements of the detector output are made using a low value resistive load, followed by a current pre-amplifier, as shown below. The output is fed into an amplifier tuned to 800 Hz with a bandwidth of 50 Hz.



2. D* and N.E.P.

These are figures of merit for the materials of detectors.
The detectivity D* is defined in the expression:

$$D^* = \frac{\frac{V_s}{V_n} \sqrt{A(\Delta f)}}{W}$$

where: V_s = signal voltage across detector terminals
V_n = noise voltage across detector terminals
A = detector area
(Δf) = bandwidth of measuring amplifier
W = radiation power incident on detector sensitive element in r.m.s. watts.

The Noise Equivalent Power (N.E.P.) is related to D* by the expression:

$$\text{N.E.P.} = \frac{\sqrt{A}}{D^*}$$

NOTES (continued)

3. Time constant

Detector time constant figures are based on the response to a step function in the incident radiation. Quoted times indicate the interval between the moment the radiation is cut off and the output falling to 63% of its peak value.

4. a. Variation of performance with bias

Both signal and noise vary with bias in this type of cell. At bias levels at which the cell dissipation is less than 2.5 mW the maximum level of D* is maintained. At higher levels the noise increases more rapidly than the signal so that although the responsivity increases, D* falls. The maximum responsivity typically occurs at a dissipation level of 10 mW, beyond which heating occurs with a consequent reduction in responsivity.

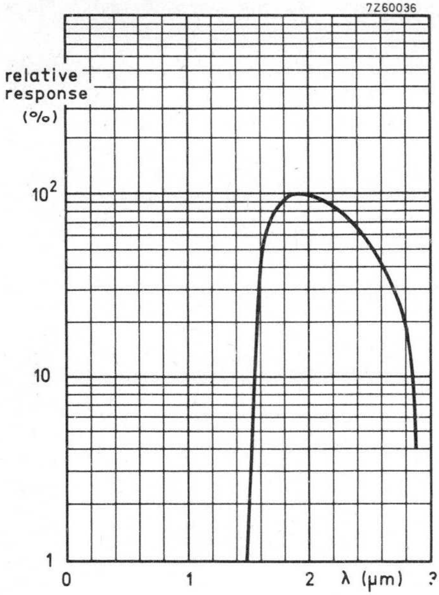
b. Variation of performance with temperature/life

Resistance, responsivity and D* are dependent on the previous temperature/life history of the cell. The quoted values are the minimum which may be expected after storage or operation up to 35 °C. These values may decrease by 50% after storage or operation at temperatures up to the absolute maximum temperature of 50 °C.

5. Recommended operating conditions

In order to minimise the effects of parameter variations with temperature and life it is recommended that a constant voltage bias is used. A suitable circuit is shown on page 3. With this mode of operation the signal is the short-circuit current, which is related to the open-circuit cell voltage by the expression:

$$V_{oc} = I_{sc} \times r_{\ell}$$


7Z60036
relative response (%)
10^2
10
1
0
1
2
λ (μm)
3

PHOTOCONDUCTIVE CELL

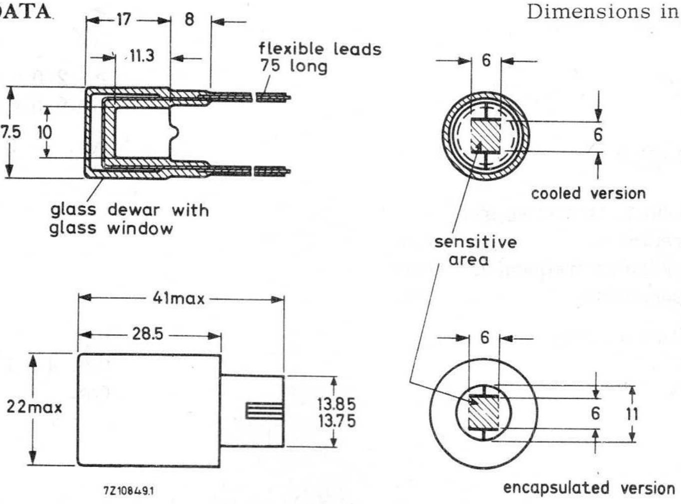
Evaporated lead sulphide photoconductive cells with sensitive element mounted in a glass dewar, encapsulated in an envelope for room temperature operation.
Also available without envelope for cooled operation.
The cells are intended for use with pulsed or modulated radiation.

QUICK REFERENCE DATA

Peak spectral response	λ_m		2.2	µm
Spectral response range	$\Delta\lambda$		0.3 to 3.5	µm
Internal resistance	r_i	typ.	1.5	MΩ
Responsivity (radiation 2.0 µm)		typ.	80	mV/µW
D^* (2.0 µm, 800 Hz, 1 Hz)		typ.	4×10^{10}	cm $\sqrt{Hz}$/W
Time constant		typ.	100	µs
Sensitive area			6.0 x 6.0	mm^2

MECHANICAL DATA

Dimensions in mm



Accessory: socket for encapsulated version: Belling-Lee type 789/CS.

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltage (bidirectional)		V	max.	250	V
Current (bidirectional)		I	max.	0.5	mA
Temperatures					
Storage temperature	encapsulated version	T_{stg}		-55 to +60	^{o}C
	cooled version	T_{stg}		-80 to +60	^{o}C
Operating ambient temperature		T_{amb}	max.	60	^{o}C

CHARACTERISTICS at T_{amb} = 20 ^{o}C (see note 1 on page 3)

Peak spectral response	λ_m		2.2	μm
Spectral response range	$\Delta\lambda$		0.3 to 3.5	μm
Internal resistance	r_i	typ.	1.5	MΩ
			1.0 to 4.0	MΩ
Time constant		typ.	100	μs
Noise voltage		typ.	8.5	μV

Performance

1. Black body source
   colour temperature : 500 K
   chopping frequency : 800 Hz
   bandwidth : 1 Hz

→ Responsivity	>	0.2	mV/μW
	typ.	1.3	mV/μW
→ D^*	>	2.0×10^8	cm $\sqrt{Hz}$/W
	typ.	6.5×10^8	cm $\sqrt{Hz}$/W
→ N.E.P.	typ.	0.92	nW
	<	3.0	nW

2. Monochromatic source
   radiation : 2.0 μm
   chopping frequency: 800 Hz
   bandwidth : 1 Hz

Responsivity	typ.	80	mV/μW
D^*	typ.	4×10^{10}	cm $\sqrt{Hz}$/W
N.E.P.	typ.	15	pW

NOTES

1. Test conditions

The characteristics are measured with the cell biased from a 200 V d.c. supply in series with a 1.0 MΩ load resistor. No correction is made for the loading effect of the 1.0 MΩ resistor, i.e. open circuit characteristics are not given. The sensitive element is situated at a distance of 264 mm a black body source limited by an aperture of 3 mm. The radiation path is interrupted at 800 Hz by a chopper blade at ambient temperature. Under these conditions the r.m.s. power at the element (chopping factor 2.2) is 4.5 μW/cm^2.

Measurements of the detector output are made with an amplifier tuned to 800 Hz with a bandwidth of 50 Hz.

2. D^* and N.E.P.

These are figures of merit for the materials of detectors.

The detectivity D^* is defined in the expression:

$$D^* = \frac{\frac{V_s}{V_n}\sqrt{A(\Delta f)}}{W}$$

where: V_s = signal voltage across detector terminals
V_n = noise voltage across detector terminals
A = detector area
(Δf) = bandwidth of measuring amplifier
W = radiation power incident on detector sensitive element in r.m.s. watts.

The Noise Equivalent Power (N.E.P.) is related to D^* by the expression:

$$\text{N.E.P.} = \frac{\sqrt{A}}{D^*}$$

3. Time constant

Detector time constant figures are based on the response to a step function in the incident radiation. Quoted times indicate the interval between the moment the radiation is cut off and the output falling to 63% of its peak value.

4. Variation of performance with bias current.

Both signal and noise vary with current in this type of cell. At high currents the noise increases more rapidly than the signal, and therefore the signal-to-noise ratio has a peak value at some optimum current, which will vary slightly from cell to cell.

NOTES (continued)

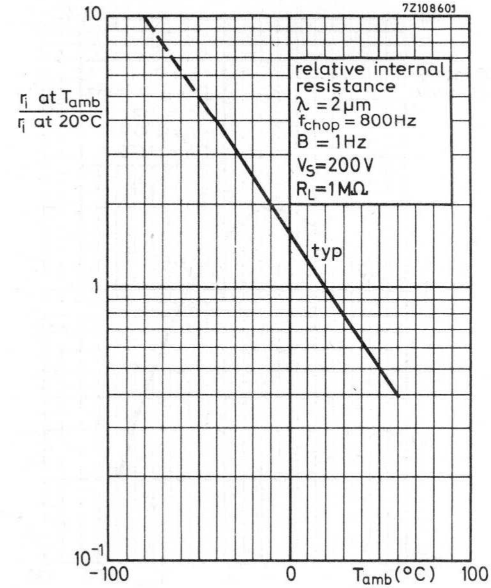
5. Effect of ambient radiation

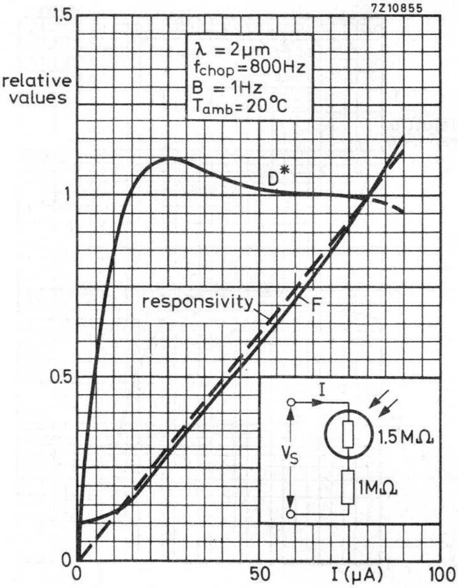
Care should be taken to avoid the incidence on the cell of appreciable radiation in the visible range. Such radiation will cause a decrease in the cell resistance and signal as long as the cell is kept cool. Normal daylight can cause this effect if seen for more than a few minutes. Precautions should be taken to prevent visible light reaching the sensitive element via the liquid nitrogen compartment.

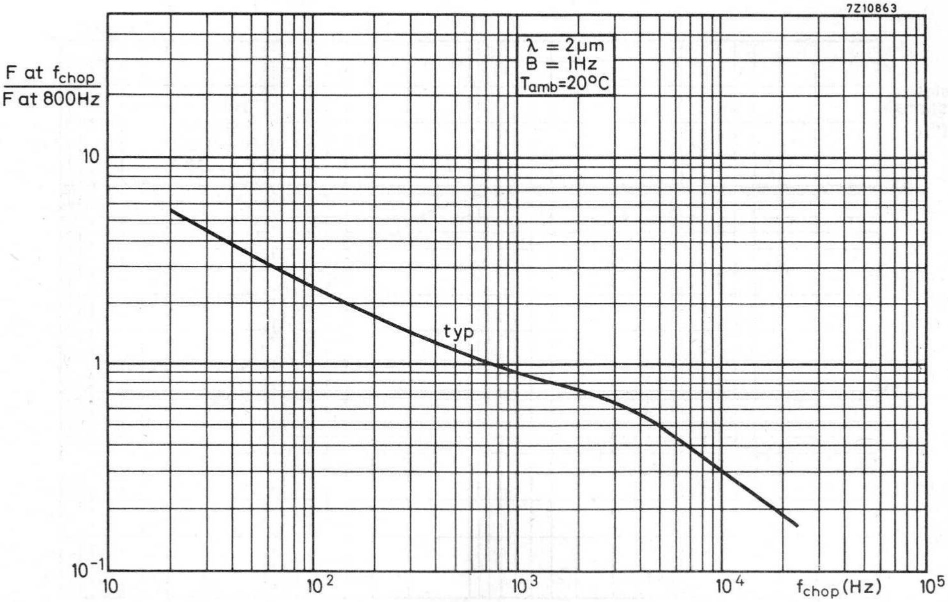
6. Warning

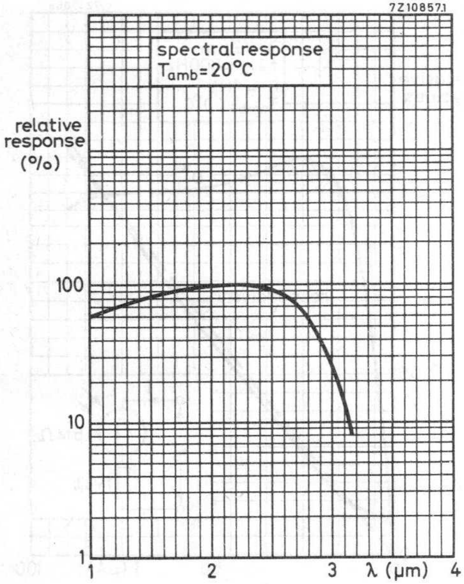
Care should be taken to ensure that the device is not allowed to reach room temperature while still biased.

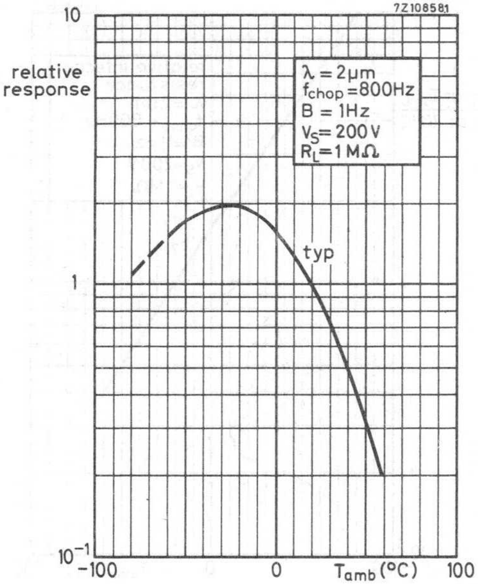
The dewar vessel must always be completely dry before being refilled with liquid nitrogen. In very humid conditions, water vapour may condense at the top of the dewar vessel. Should this occur, the remaining liquid nitrogen should be allowed to boil off, the ice should be removed and precautions taken to avoid a recurrence.

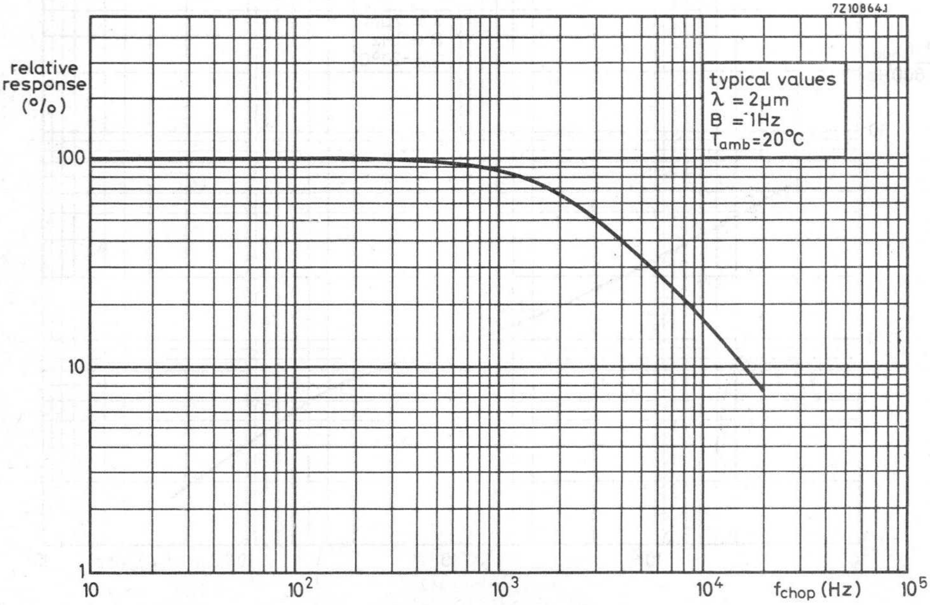

7Z108601
10
1
10^{-1}
$\frac{r_i \text{ at } T_{amb}}{r_i \text{ at } 20°C}$
relative internal resistance
λ = 2 μm
f_{chop} = 800 Hz
B = 1 Hz
V_S = 200 V
R_L = 1 MΩ
typ
-100
0
T_{amb} (°C)
100

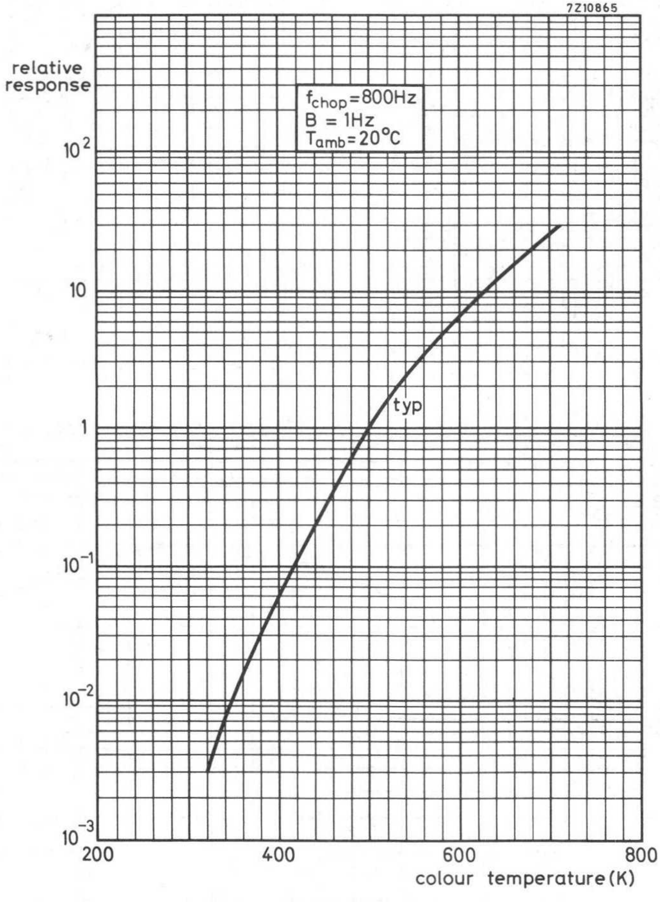

7Z10855
1.5
1
0.5
0
relative values
λ = 2 μm
f_{chop} = 800 Hz
B = 1 Hz
T_{amb} = 20 °C
D*
responsivity
F
I
V_S
1.5 MΩ
1 MΩ
0
50
I (μA)
100

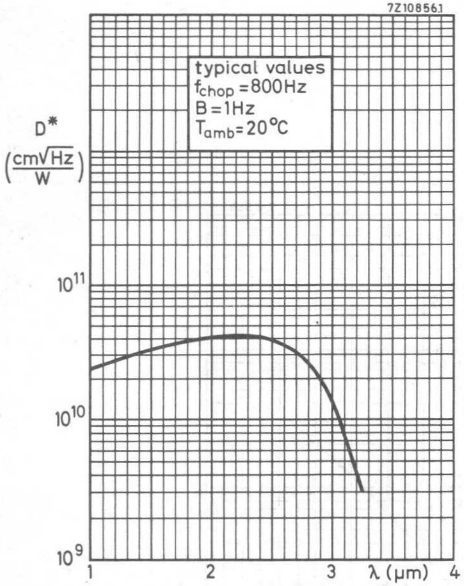

7Z10863
$\frac{F \text{ at } f_{chop}}{F \text{ at } 800 Hz}$
λ = 2 μm
B = 1 Hz
T_{amb} = 20 °C
10
1
10^{-1}
typ
10
10^2
10^3
10^4
f_{chop} (Hz)
10^5

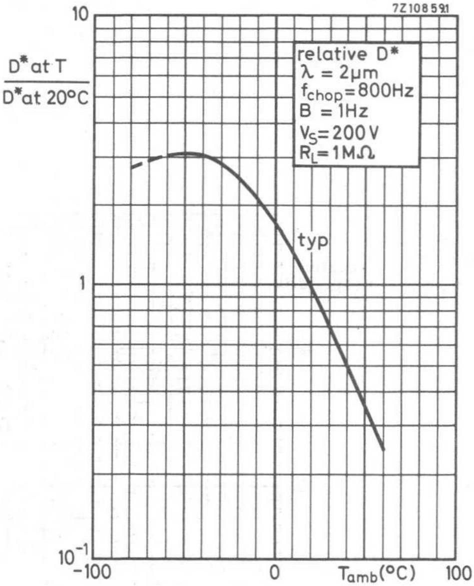

7Z10857.1
spectral response
T_amb = 20°C
relative response (%)
100
10
1
1
2
3
λ (µm)
4

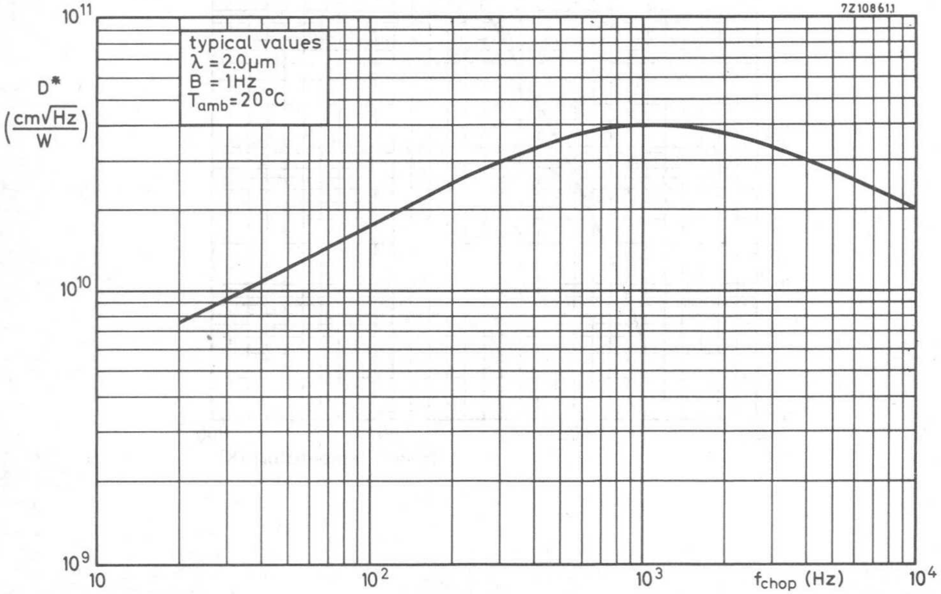

7Z10858.1
10
relative response
λ = 2µm
f_chop = 800Hz
B = 1Hz
V_S = 200 V
R_L = 1 MΩ
typ
1
10^-1
-100
0
T_amb (°C)
100

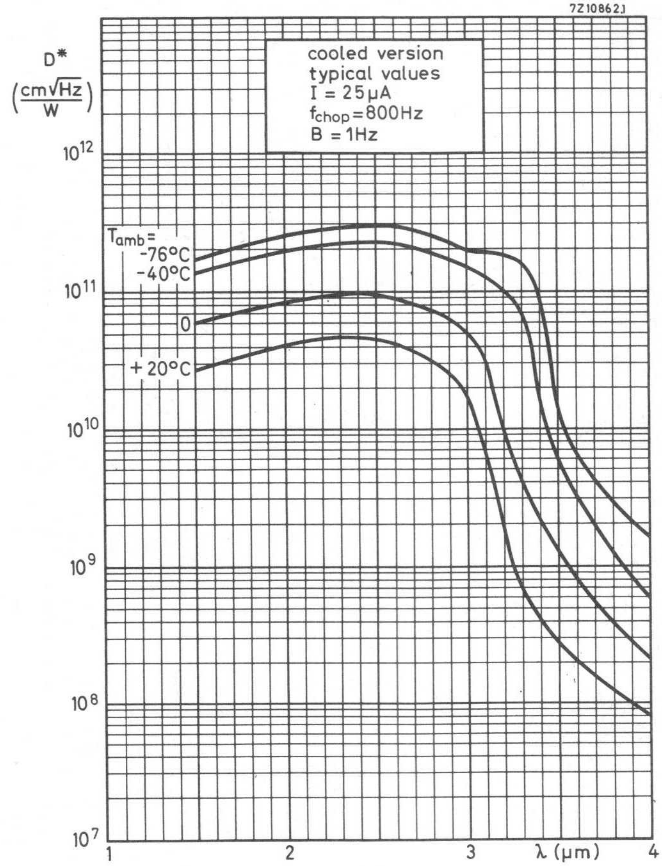

7Z10864.1
relative response (%)
typical values
λ = 2µm
B = 1Hz
T_amb = 20°C
100
10
1
10
10^2
10^3
10^4
f_chop (Hz)
10^5


7Z10865
relative response
10^2
10
1
10^{-1}
10^{-2}
10^{-3}
200
400
600
800
colour temperature (K)
f_{chop}=800Hz
B = 1Hz
T_{amb}=20°C
typ


7Z10856.1
typical values
f_{chop} = 800Hz
B = 1Hz
T_{amb} = 20°C
D*
$\left(\frac{cm\sqrt{Hz}}{W}\right)$
10^{11}
10^{10}
10^{9}
1
2
3
λ (μm)
4


7Z10859.1
10
$\frac{D^* \text{ at } T}{D^* \text{ at } 20°C}$
relative D*
λ = 2μm
f_{chop} = 800Hz
B = 1Hz
V_S = 200 V
R_L = 1MΩ
typ
1
10^{-1}
−100
0
T_{amb}(°C)
100


7Z10861.1
10^{11}
typical values
λ = 2.0μm
B = 1Hz
T_{amb} = 20°C
D*
$\left(\frac{cm\sqrt{Hz}}{W}\right)$
10^{10}
10^{9}
10
10^{2}
10^{3}
f_{chop} (Hz)
10^{4}


7Z10862.1
D*
$\left(\frac{cm\sqrt{Hz}}{W}\right)$
cooled version
typical values
I = 25 µA
f_{chop} = 800 Hz
B = 1 Hz
T_{amb} =
-76 °C
-40 °C
0
+ 20 °C
10^{12}
10^{11}
10^{10}
10^{9}
10^{8}
10^{7}
1
2
3
λ (µm)
4

Accessories

Introduction

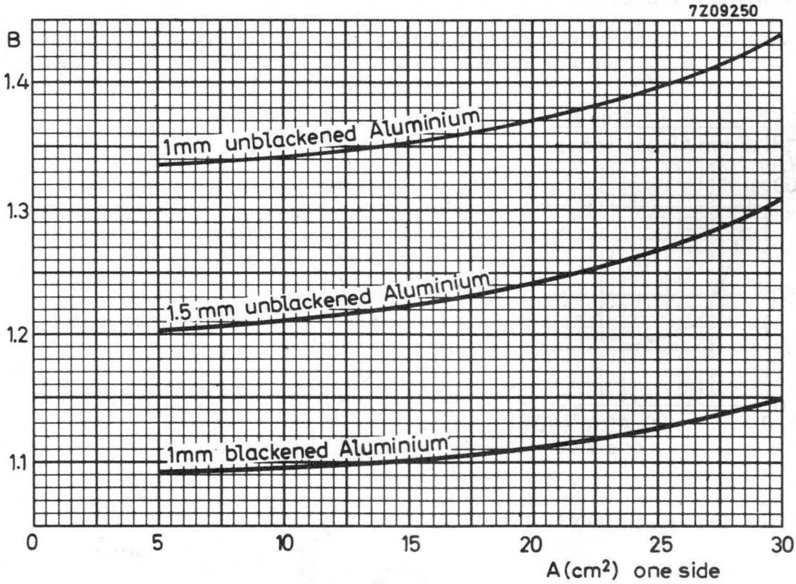
All information on thermal resistances of the accessories combined with flat heatsinks is valid for square heatsinks of 1.5 mm blackened aluminium.
For a few variations the thermal resistance may be derived as follows:

a. Rectangular heatsinks (sides a and 2a)

When mounted with long side horizontal, multiply by 0.95.
When mounted with short side horizontal, multiply by 1.10.

b. Unblackened or thinner heatsinks

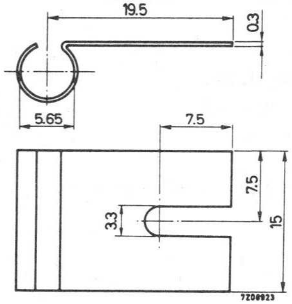
Multiply by the factor B given below as a function of the heatsink size A.



COOLING FIN

MECHANICAL DATA

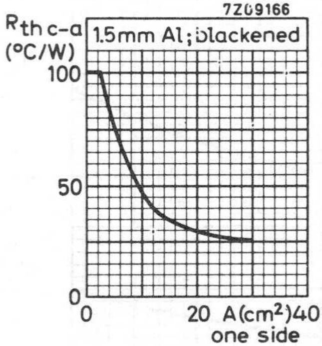
Dimensions in mm



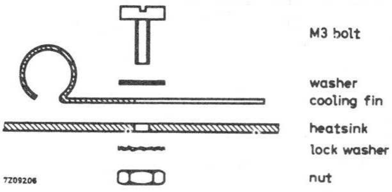
Fin material: brass, nickel plated

THERMAL RESISTANCE

From case to ambient with cooling fin only	$R_{th\ c\text{-}a}$	= 100 °C/W
with heatsink		see graph



MOUNTING INSTRUCTIONS

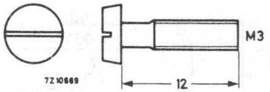


Torque on nut for good heat transfer: 5 cm kg

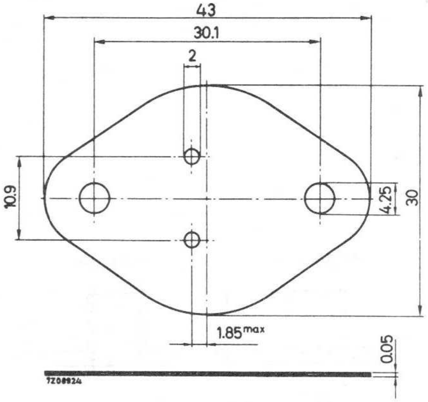
MOUNTING ACCESSORIES

MECHANICAL DATA

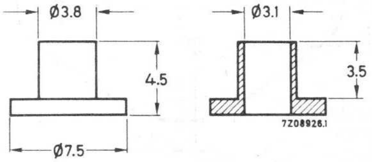
Dimensions in mm



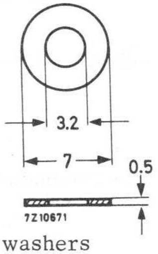
2 cheese head screws, slotted
material: brass, nickel plated



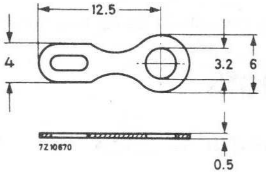
mica washer



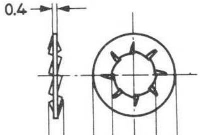
2 insulating bushes



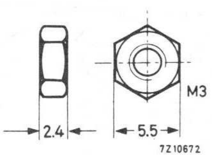
3 plain washers
material: brass, nickel plated



soldering tag



2 lock washers, internal teeth
material: steel, nickel plated



2 hexagon nuts
material: brass, nickel plated

THERMAL RESISTANCE

From mounting base to heatsink with mica washer $R_{th\ mb\text{-}h}$ = 1.0 °C/W

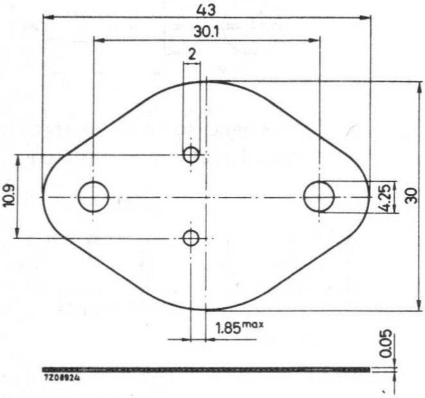
TEMPERATURES

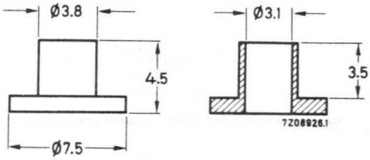
Maximum allowable temperature T_{max} = 150 °C

56201a MICA WASHER AND 2 INSULATING BUSHES

MECHANICAL DATA

Dimensions in mm





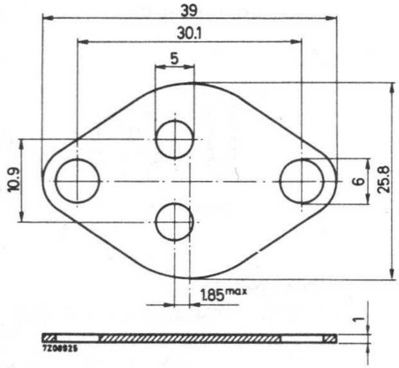
THERMAL RESISTANCE

From mounting base to heatsink $R_{th\ mb\text{-}h}$ = 1.0 ^{o}C/W

56201b LEAD WASHER

MECHANICAL DATA

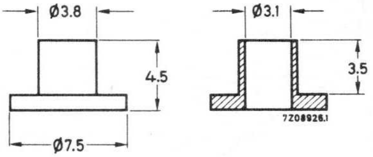
Dimensions in mm



56201c INSULATING BUSH

MECHANICAL DATA

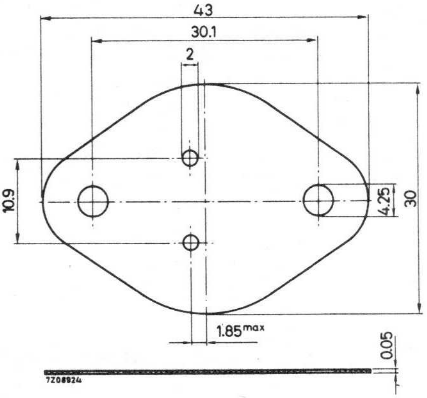
Dimensions in mm



56201d MICA WASHER

MECHANICAL DATA

Dimensions in mm



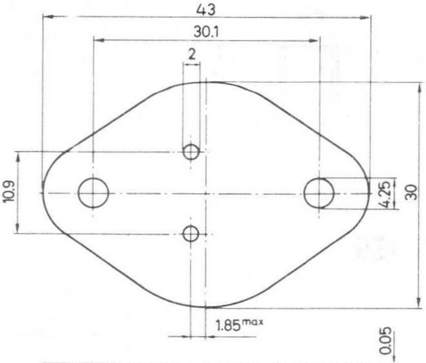
THERMAL RESISTANCE

From mounting base to heatsink $R_{th\,mb\text{-}h}$ = 1.0 °C/W

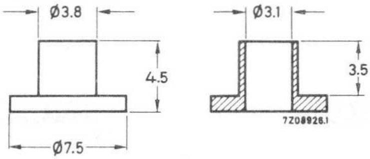
MOUNTING ACCESSORIES

MECHANICAL DATA

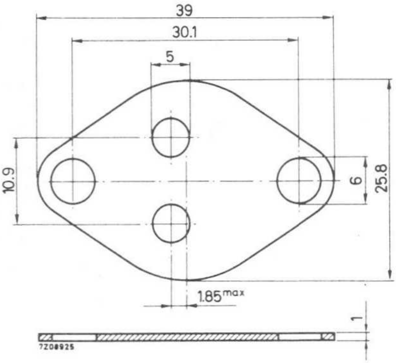
Dimensions in mm



mica washer



2 insulating bushes



lead washer

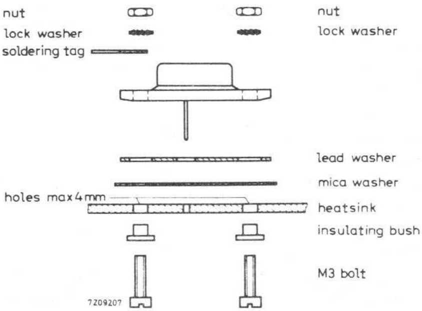
THERMAL RESISTANCE

From mounting base to heatsink				
with mica washer only	$R_{th\ mb-h}$	=	1.0	$^{o}C/W$
with mica washer and lead washer	$R_{th\ mb-h}$	=	0.75	$^{o}C/W$

TEMPERATURE

Maximum allowable temperature	T_{max}	=	150	^{o}C

MOUNTING INSTRUCTIONS



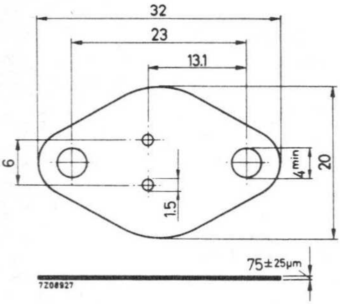
Torque on nut for good heat transfer : 5 cm kg

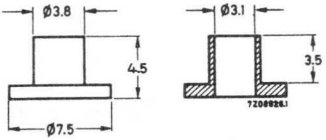
Warning: A plain washer shall be inserted between M3 bolt and insulating bush to ← prevent this insulating bush from being damaged.

MICA WASHER AND 2 INSULATING BUSHES

MECHANICAL DATA

Dimensions in mm





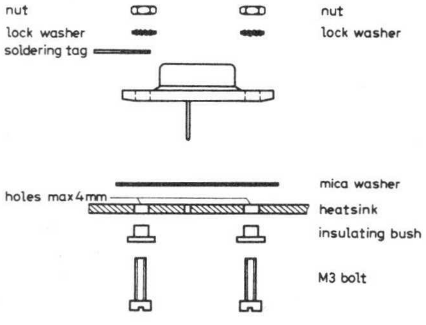
THERMAL RESISTANCE

From mounting base to heatsink $R_{th\ mb\text{-}h}$ = 1.5 °C/W

TEMPERATURE

Maximum allowable temperature T_{max} = 150 °C

MOUNTING INSTRUCTIONS



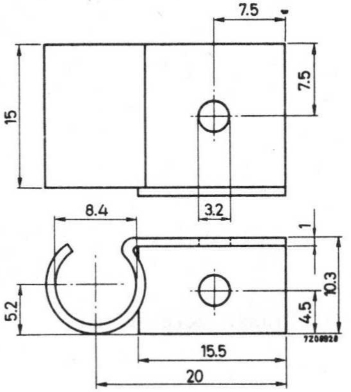
Torque on nut for good heat transfer: 5 cm kg

→ Warning: A plain washer shall be inserted between M3 bolt and insulating bush to prevent this insulating bush from being damaged.

COOLING FIN

MECHANICAL DATA

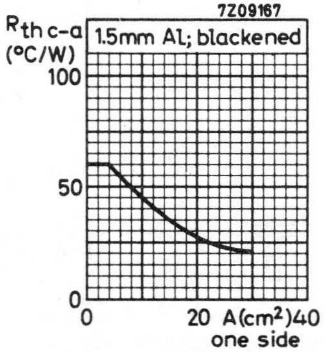
Dimensions in mm



Fin material: aluminium, blackened

THERMAL RESISTANCE

From case to ambient with cooling fin only	$R_{th\ c-a}$	= 60 °C/W
with heatsink		see graph



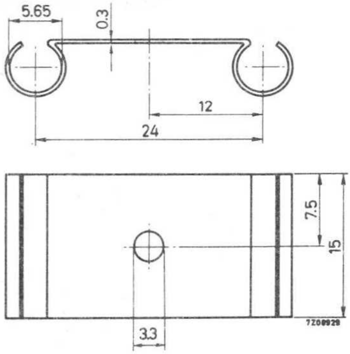
MOUNTING INSTRUCTIONS

Torque on M3 bolts for good heat transfer: 5 cmkg

COOLING FIN

MECHANICAL DATA

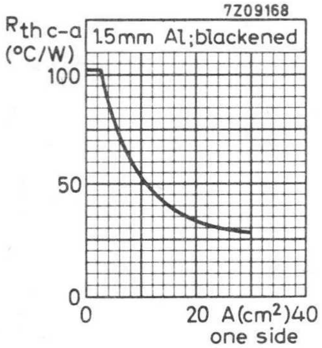
Dimensions in mm



Fin material: brass, nickel plated

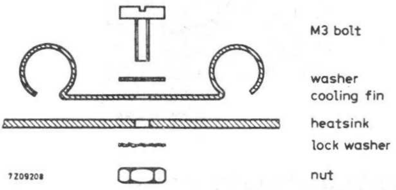
THERMAL RESISTANCE

From case to ambient with cooling fin only	$R_{th\ c\text{-}a}$	= 102 °C/W
with heatsink		see graph



R_{th} values apply to each transistor, provided the two transistors have been mounted so that the heat flow from each is equal.

MOUNTING INSTRUCTIONS

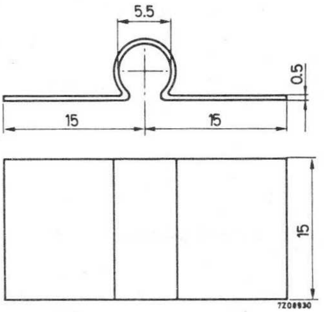


Torque on nut for good heat transfer: 5 cmkg

COOLING FIN

MECHANICAL DATA

Dimensions in mm



Fin material: brass, nickel plated

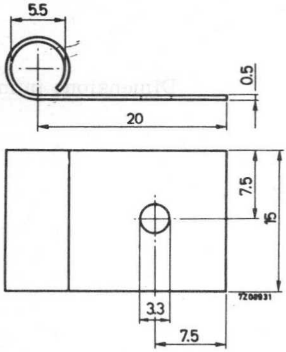
THERMAL RESISTANCE

From case to ambient with cooling fin only $R_{th\ c-a}$ = 75 °C/W

COOLING FIN

MECHANICAL DATA

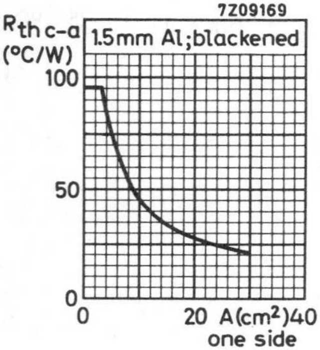
Dimensions in mm



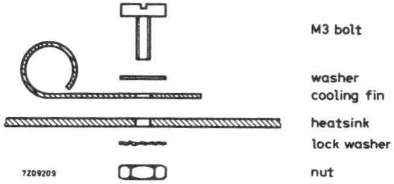
Fin material: brass, nickel plated

THERMAL RESISTANCE

From case to ambient with cooling fin only $R_{th\ c\text{-}a}$ = 95 °C/W
with heatsink see graph



MOUNTING INSTRUCTIONS

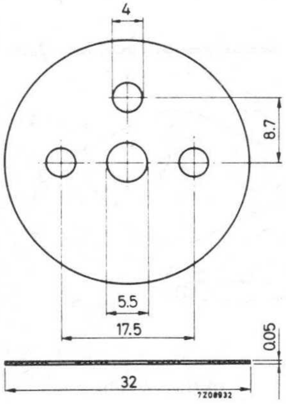


Torque on nut for good heat transfer: 5 cm kg

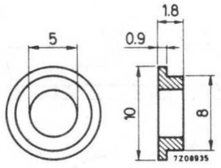
MOUNTING ACCESSORIES

MECHANICAL DATA

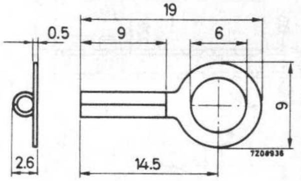
Dimensions in mm



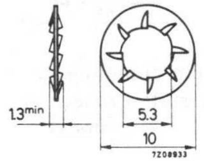
mica washer



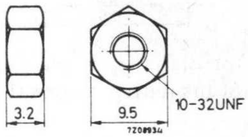
insulating ring



cable lug
material: brass, nickel plated



lock washer internal teeth
material: steel, nickel plated



hexagon nut
material: brass, nickel plated

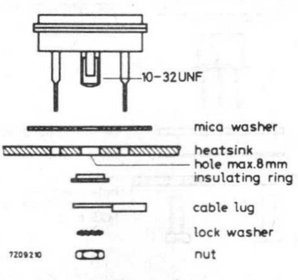
THERMAL RESISTANCE

From mounting base to heatsink $R_{th\ mb-h}$ = 1 °C/W

TEMPERATURE

Maximum allowable temperature T_{max} = 125 °C

MOUNTING INSTRUCTIONS



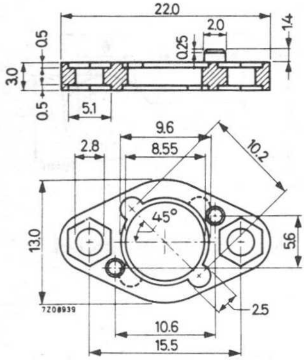
Torque on nut for good heat transfer: 17 cm kg

Non insulated mounting; without items 1, 2 and 3. (3 if necessary)

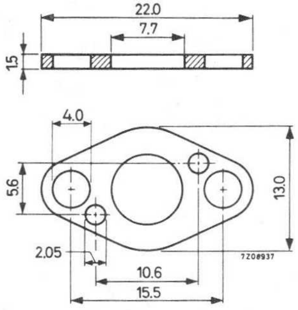
MOUNTING ACCESSORIES

MECHANICAL DATA

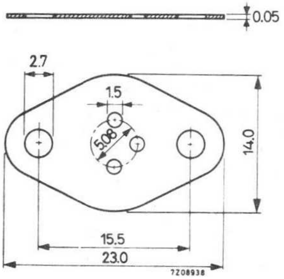
Dimensions in mm



top clamping washer
of insulating material



bottom clamping washer
material: brass, tin
plated



mylar washer

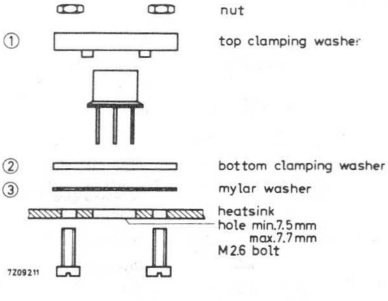
THERMAL RESISTANCE

From mounting base to heatsink non insulated mounting $R_{th\ mb\text{-}h}$ = 3 °C/W
insulated mounting $R_{th\ mb\text{-}h}$ = 6 °C/W

TEMPERATURE

Maximum allowable temperature T_{max} = 100 °C

MOUNTING INSTRUCTIONS

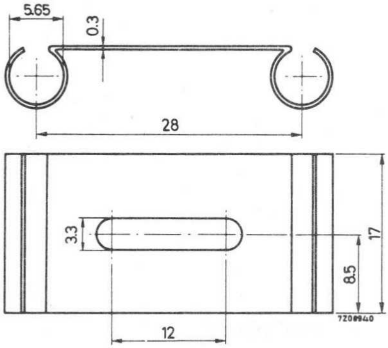


Non insulated mounting; without items 2 and 3. (Note: item 1 must than be mounted up-side down)

COOLING FIN

MECHANICAL DATA

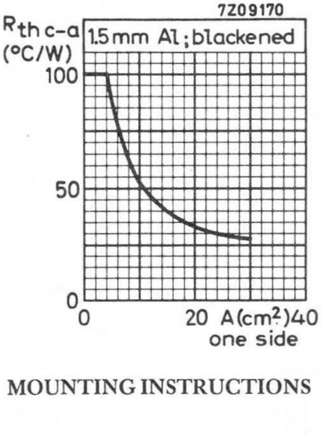
Dimensions in mm



Fin material: brass, nickel plated

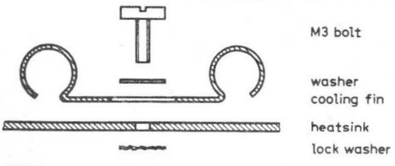
THERMAL RESISTANCE

From case to ambient with cooling fin only	$R_{th\ c\text{-}a}$	= 100 °C/W
with heatsink		see graph



R_{th} values apply to each transistor, provided the two transistors have been mounted so that the heat flow from each is equal.

MOUNTING INSTRUCTIONS

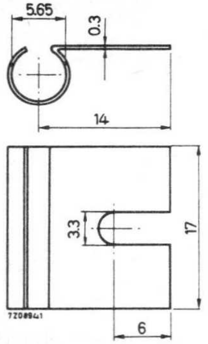


Torque on nut for good heat transfer: 5 cmkg

COOLING FIN

MECHANICAL DATA

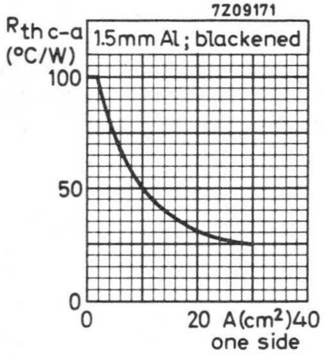
Dimensions in mm



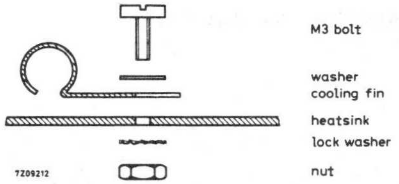
Fin material: brass, nickel plated

THERMAL RESISTANCE

From case to ambient with cooling fin only	$R_{th\ c\text{-}a}$	= 100 °C/W
with heatsink		see graph



MOUNTING INSTRUCTIONS



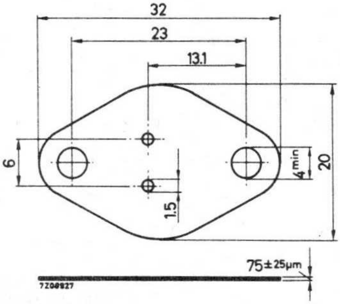
Torque on nut for good heat transfer: 5 cm kg

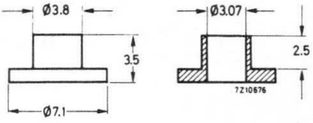
MICA WASHER AND 2 INSULATING BUSHES

56239

MECHANICAL DATA

Dimensions in mm





THERMAL RESISTANCE

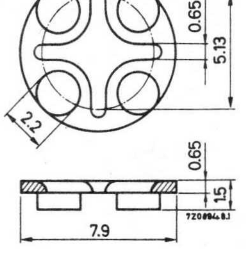
From mounting base to heatsink $R_{th\ mb\text{-}h}$ = 1.5 °C/W

TEMPERATURE

Maximum allowable temperature T_{max} = 150 °C

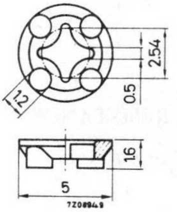
DISTANCE DISCS

56245



Insulating material

56246



Insulating material

TEMPERATURE

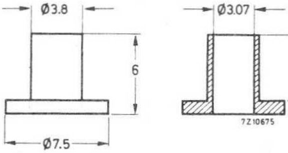
Maximum allowable temperature T_{max} = 100 °C

2 INSULATING BUSHES

56261

MECHANICAL DATA

Dimensions in mm

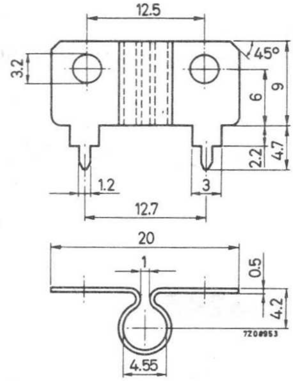


56263

COOLING FIN

MECHANICAL DATA

Dimensions in mm



Fin material: copper, tin plated

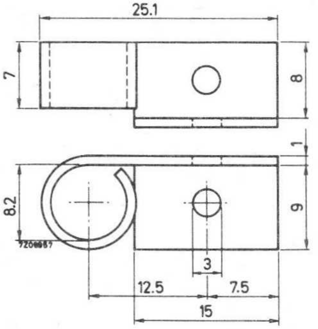
THERMAL RESISTANCE

From case to ambient	$R_{th\ c-a}$ = 100 °C/W

COOLING FIN

MECHANICAL DATA

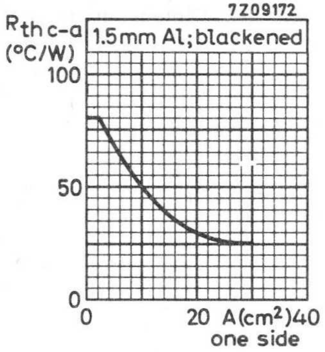
Dimensions in mm



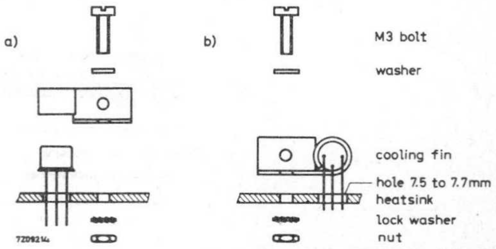
Fin material: aluminium, blackened

THERMAL RESISTANCE

From case to ambient with cooling fin only	$R_{th\ c-a}$	= 80 °C/W
with heatsink		see graph



MOUNTING INSTRUCTIONS

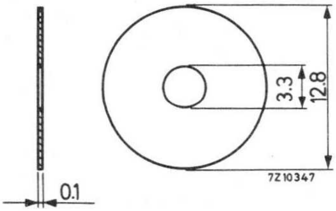


Torque on nut for good heat transfer: 5 cm kg

56302 MICA WASHER

MECHANICAL DATA

Dimensions in mm



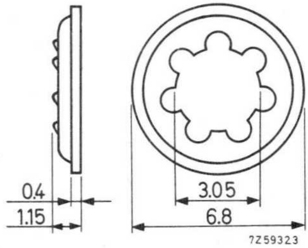
THERMAL RESISTANCE

From mounting base to heatsink $R_{th\ mb-h}$ = 6 °C/W

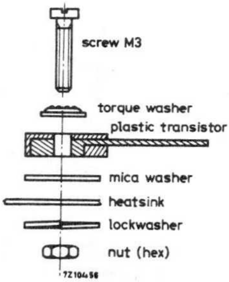
56303 TORQUE WASHER

MECHANICAL DATA

Dimensions in mm



MOUNTING INSTRUCTIONS



Torque on nut: min. 8 cm kg
max. 9 cm kg

INDEX OF TYPE NUMBERS

The inclusion of a type number in this publication does not necessarily imply its availability.

D = Signal diodes
HF = High frequency transistors
LF = Low frequency transistors
Mm = Microminiature devices for thick- and thin-film circuits
Mw = Microwave devices
P = Low frequency power transistors
R = Rectifier diodes
Sw = Switching transistors
Tr = Transmitting transistors
Var = Variable capacitance diodes

INDEX

D = Signal diodes
Dual = Dual transistors
LF = Low frequency transistors
Mm = Microminiature devices for thick- and thin-film circuits

Mw = Microwave devices
P = Low frequency power devices
Var = Variable capacitance diodes

Type No.	Part	Section	Type No.	Part	Section	Type No.	Part	Section
BF115	3	HF	BFS20	4	Mm	BLY83	4	Tr
BF167	3	HF	BFS21	4	FET	BLY84	4	Tr
BF173	3	HF	BFS21A	4	FET	BLY87A	4	Tr
BF177	3	HF	BFS22A	4	Tr	BLY88A	4	Tr
BF178	3	HF	BFS23A	4	Tr	BLY89A	4	Tr
BF179	3	HF	BFS28	4	FET	BLY90	4	Tr
BF180	3	HF	BFS92	3	HF	BLY91A	4	Tr
BF181	3	HF	BFS93	3	HF	BLY92A	4	Tr
BF182	3	HF	BFS94	3	HF	BLY93A	4	Tr
BF183	3	HF	BFS95	3	HF	BLY94	4	Tr
BF184	3	HF	BFW10	4	FET	BPX25; 29	4	PhDT
BF185	3	HF	BFW11	4	FET	BPX40	4	PhDT
BF194	3	HF	BFW12	4	FET	BPX41	4	PhDT
BF195	3	HF	BFW13	4	FET	BPX42	4	PhDT
BF196	3	HF	BFW16A	3	HF	BPX66P	4	PhDT
BF197	3	HF	BFW17A	3	HF	BPX71	4	PhDT
BF198	3	HF	BFW30	3	HF	BPY10	4	PhDT
BF199	3	HF	BFW45	2	Defl	BPY68	4	PhDT
BF200	3	HF	BFW61	4	FET	BPY69	4	PhDT
BF254	3	HF	BFW92	3	HF	BPY76	4	PhDT
BF255	3	HF	BFX34	3	Sw	BPY77	4	PhDT
BF334	3	HF	BFX44	3	HF	BR100	1	Thyr
BF335	3	HF	BFX89	3	HF	BRY39	1	Thyr
BF336	3	HF	BFY44	4	Tr	BRY39(SCS)	3	Sw
BF337	3	HF	BFY50	3	HF	BRY39(PUT)	3	Sw
BF338	3	HF	BFY51	3	HF	BSS27	3	Sw
BFR29	4	FET	BFY52	3	HF	BSS28	3	Sw
BFR30	4	Mm	BFY55	3	HF	BSS29	3	Sw
BFR31	4	Mm	BFY70	4	Tr	BSV52	4	Mm
BFR63	3	HF	BFY90	3	HF	BSV64	3	Sw
BFR64	3	HF	BLX13	4	Tr	BSV68	3	Sw
BFR65	3	HF	BLX14	4	Tr	BSV78	4	FET
BFS17	4	Mm	BLX69	4	Tr	BSV79	4	FET
BFS18	4	Mm	BLY14	4	Tr	BSV80	4	FET
BFS19	4	Mm	BLY17	4	Tr	BSV81	4	FET

Defl = Deflection transistors
FET = Field effect transistors
HF = High frequency transistors
Mm = Microminiature devices for thick- and thin-film circuits
PhDT = Photodiodes and phototransistors
Sw = Switching transistors
Thyr = Thyristors, diacs, triacs
Tr = Transmitting transistors

Defl = Deflection transistors

Mm = Microminiature devices for thick- and thin-film circuits

Mw = Microwave devices

R = Rectifier diodes

Sw = Switching transistors

Thyr = Thyristors, diacs, triacs

Z = Voltage regulator diodes

D = Signal diodes
I = Infrared devices
L = Light emitting devices
Mw = Microwave devices
PhC = Photoconductive devices
PhDT = Photodiodes and phototransistors
St = Rectifier stacks
Sw = Switching transistors
Z = Voltage regulator diodes

INDEX

D = Signal diodes

HF = High frequency transistors

LF = Low frequency transistors

Mw = Microwave devices

P = Low frequency power transistors

Sw = Switching transistors

Tr = Transmitting transistors

Z = Voltage regulator diodes

A = Accessories
DH = Diecast heatsinks
FET = Field effect transistors
HE = Heatsink extrusions
HF = High frequency transistors
I = Infrared devices
LF = Low frequency transistors
P = Low frequency power transistors
Sw = Switching transistors
Tr = Transmitting transistors
WH = Water cooled heatsinks

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