Mullard **VOLUME 4 (Part III)**

Semiconductor and Photoelectric Devices

transistors (continued)

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HIGH FREQUENCY POWER TRANSISTOR

OC22

High frequency power transistor for use in high speed industrial switching applications, digital computers and high quality audio amplifiers.

PRELIMINARY DATA

ABSOLUTE MAXIMUM RATINGS (limiting values)

The equipment designer must ensure that no transistor exceeds these ratings. In arriving at the actual operating conditions, variation in supply voltages, component tolerances and ambient temperature must also be taken into account.

Collector voltage

†$v_{ce(pk)}$ max.	−32	V
*$V_{ce(av)}$ max.	−24	V
†$V_{ce(d.c.)}$ max.	−24	V
$v_{cb(pk)}$ max.	−47	V
*$V_{cb(av)}$ max.	−36	V
$V_{cb(d.c.)}$ max.	−36	V

†This voltage is limited to small currents as shown on page C3.

Reverse emitter-base voltage

$v_{eb(pk)}$ max.	−15	V
*$V_{eb(av)}$ max.	−12	V
$V_{eb(d.c.)}$ max.	−12	V

Collector current

$i_{c(pk)}$ max.	2.0	A
*I_c max.	1.0	A

Emitter current

$i_{e(pk)}$ max.	2.2	A
*I_e max.	1.2	A

Base current

$i_{b(pk)}$ max.	200	mA
*I_b max.	200	mA

Total dissipation See page C5

$$p_{tot}\ \text{max.} = \frac{T_{junction}\ \text{max.} - T_{ambient}}{\theta}$$

*Averaged over any 20ms period.

Temperature ratings

Storage temperature	–55 to +75	°C
Maximum junction temperature	90	°C
Junction temperature rise above mounting base temperature θ_m	3.0	°C/W

For full information on calculating junction temperature see fig. 2 and operating notes, page D4.

CHARACTERISTICS at $T_{junction} = 25°C$

		Typical production spreads			
Grounded base		*Min.*	*Av.*	*Max.*	
Collector leakage current					
($V_c = -10V$, $I_e = 0mA$)	I_{co}	—	30	100	μA
Emitter leakage current					
($V_e = -10V$, $I_c = 0mA$)	I_{eo}	—	20	100	μA
Grounded emitter					
Collector knee voltage					
$I_c = 400mA$ (see fig. 1)	$V_{c(knee)}$	—	–400	–600	mV
Collector bottoming voltage					
($I_c = 1A$, $I_b = 30mA$)	V_{ce}	—	–600	—	mV
*Base input voltage	V_{be}				
($V_c = -2V$, $I_c = 100mA$)		—	–260	–350	mV
($V_c = -2V$, $I_c = 1A$)		—	–1.0	–2.0	V

*See page C1 for values at other collector currents.

Current amplification factor $\bar{\alpha}' = \frac{I_c - I_{co}}{I_b + I_{co}}$

($V_c = -2V$, $I_c = 100mA$)	—	200	—
($V_c = -2V$, $I_c = 1A$)	50	150	—

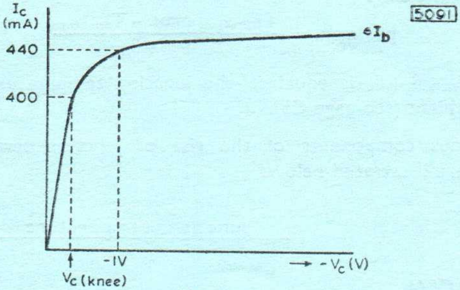


Fig. 1
I_b adjusted such that I_c=440mA with V_c=−1V

BASIC PARAMETERS

Measured at $V_c = -2V$, $I_c = 400mA$, $T_{mounting\ base} = 25°C$

$^*r_e$	0.06	Ω
$r_{bb'}$	100	Ω
c_c (depletion capacitance)	170	pF
f_α	2.0	Mc/s
g_m	16	A/V
α' at low frequencies	180	

*The value of r_e given here is $\frac{kT}{q} \cdot \frac{1}{I_e} \simeq \frac{25}{I_e}\Omega$, where I_e is in mA and T is in °K.

OPERATING NOTES

1. Dissipation and heat sink considerations

The maximum total dissipation p_{tot} max. = $(V_{ce} \times I_c) + (V_{be} \times I_b)$, is given by the relationship

$$p_{tot}\ \text{max.} = \frac{T_{junction}\ \text{max.} - T_{ambient}}{\theta_m + \theta_i + \theta_h}$$

Where $\theta_m + \theta_i + \theta_h$ is equal to the junction temperature rise per watt above ambient (see page C5).

The various components of the rise of junction temperature above ambient are illustrated below:

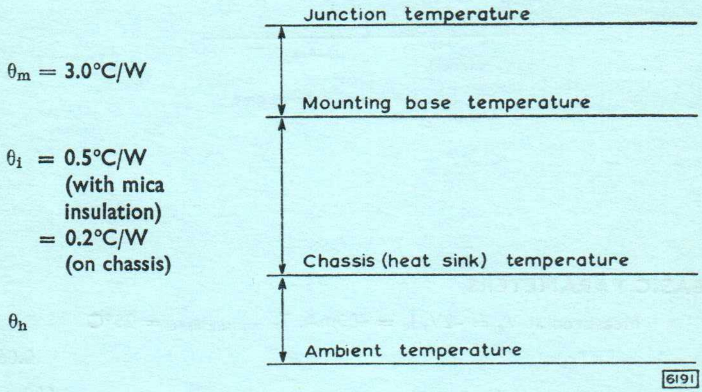


Fig. 2

θ_h depends on the cooling conditions under which the transistor is used, i.e., dimensions, position and surface conditions of heat sink etc. A good air-cooled heat sink will have a value of θ_h = 4°C/W.

θ_h can be determined for a given collector dissipation and ambient temperature by measuring the mounting base temperature

$$\theta_h = \frac{T_{mounting\ base} - T_{ambient}}{P_c} - \theta_i\ ^{\circ}\text{C/W}$$

The following example illustrates the temperatures which occur at various points on the transistor at $p_c = 4W$, $T_{junction} = 90°C$, $\theta_h = 4.0°C/W$ with mica insulation.

Junction temperature	= 90°C
Mounting base temperature	= 90–(4×3.0) = 78°C
Chassis (heat sink) temperature	= 78–(4×0.5) = 76°C
Ambient temperature	= 76–(4×4.0) = 60°C

The suitability of any design can be checked by measuring with a thermocouple the mounting base temperature of the transistor operating at the selected collector dissipation and maximum ambient temperature. The point defined by the mounting base temperature and the total dissipation must lie below the line of the graph on page C6, which results in $T_{junction} \leq 90°C$. If the point lies above the line the design is inadmissible and the dissipation must be reduced or the heat sink improved. The selected total dissipation should be the maximum attained by any transistor in the design being checked.

2. Transistors may be soldered directly into the circuit but the heat conducted to the junction should be kept to a minimum by the use of a thermal shunt.

3. Transistors may be dip soldered at a solder temperature of 240°C for a maximum of 10 seconds up to a point 5mm from the seal.

MECHANICAL DATA

Weight { 0.7 oz / 20 g

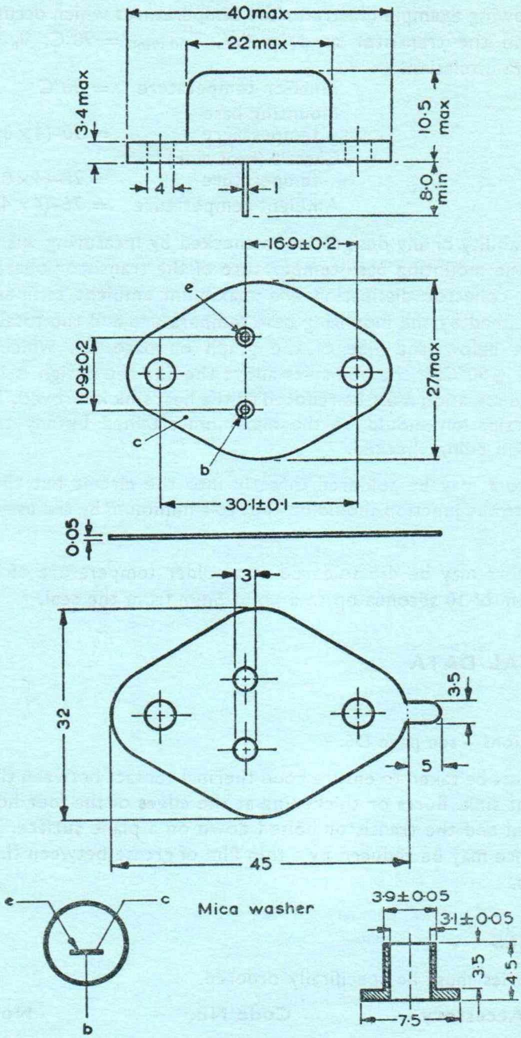
Dimensions – see page D6.

Care must be taken to ensure good thermal contact between the transistor and heat sink. Burrs or thickening at the edges of the four holes must be removed and the transistor bolted down on a plane surface. The thermal resistance may be reduced by a thin film of grease between the contacting surfaces.

ACCESSORIES

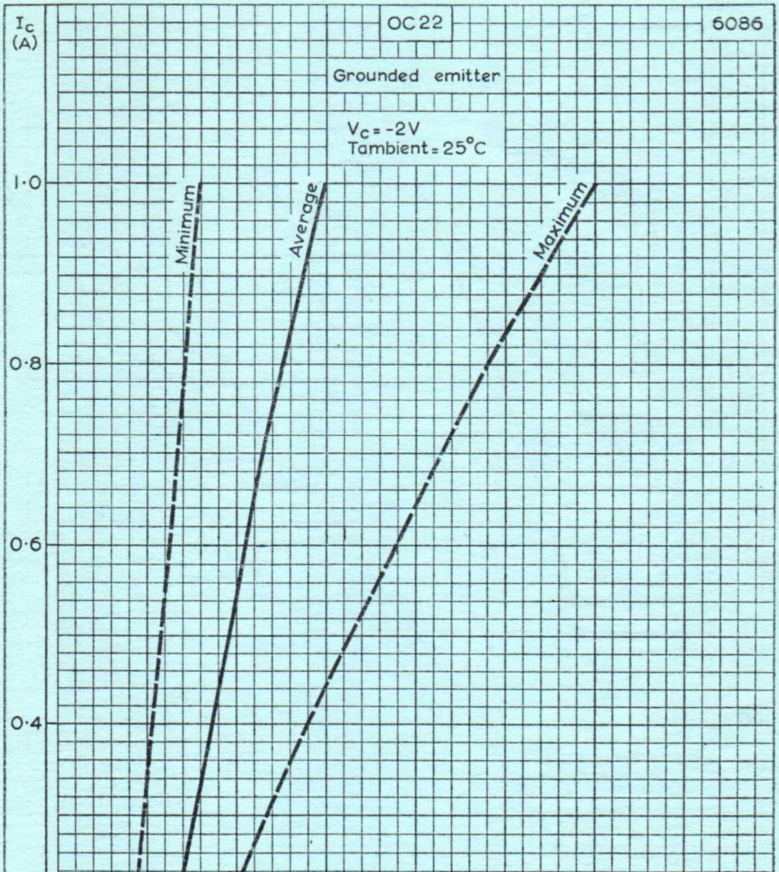
Accessories must be specifically ordered.

Accessory	Code No.	Notes
2 insulating bushes 1 mica washer	56201a 56201b	Obtainable in packs for 10 or 100 transistors.
Set of 2 bushes, 1 washer	56201	Obtainable as a complete set for one transistor.

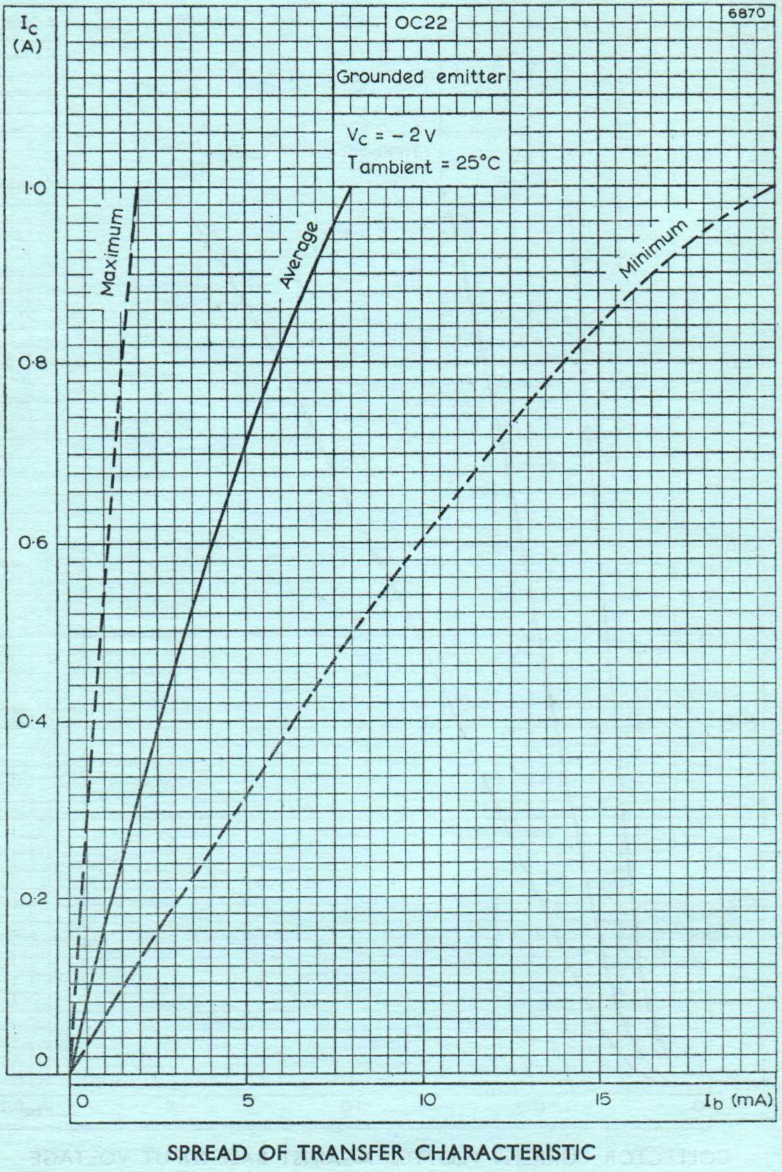


6109

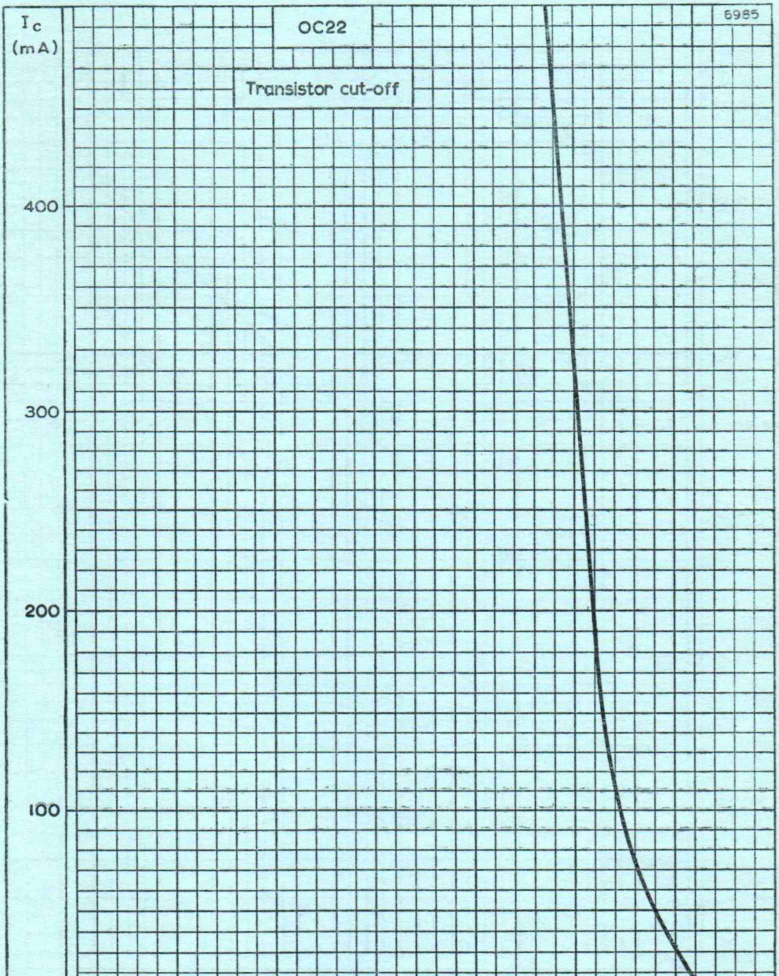
All dimensions in mm



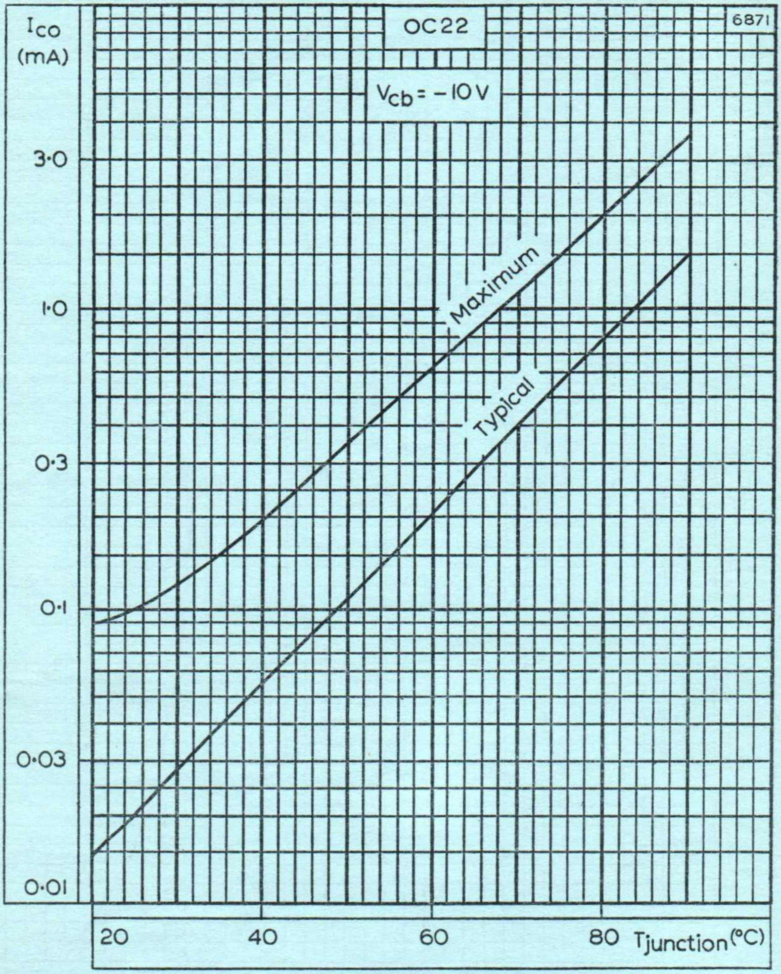
COLLECTOR CURRENT PLOTTED AGAINST BASE INPUT VOLTAGE



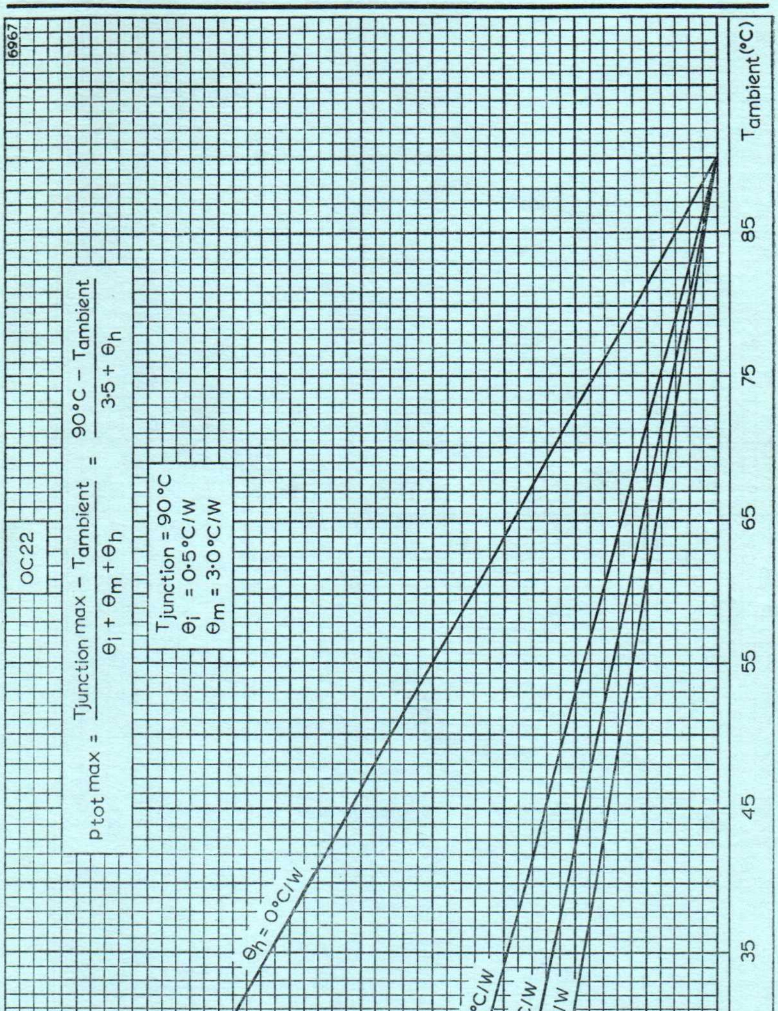
SPREAD OF TRANSFER CHARACTERISTIC



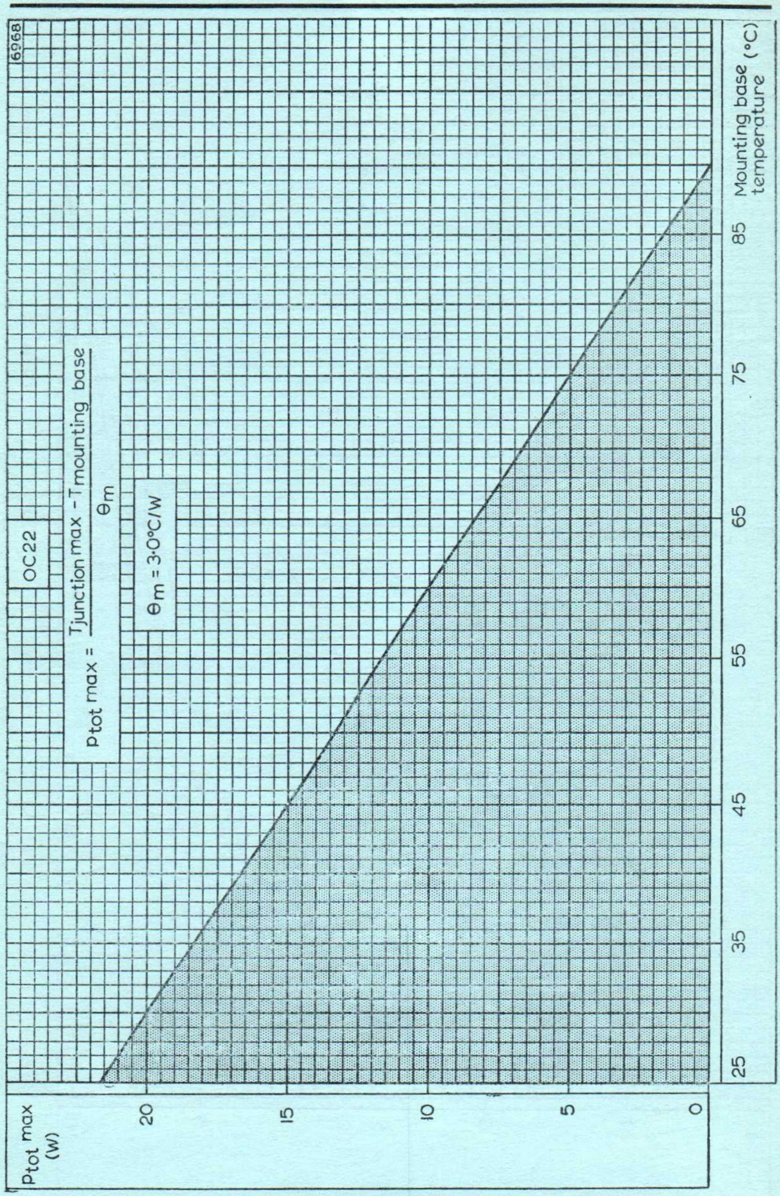
COLLECTOR CURRENT PLOTTED AGAINST ABSOLUTE MAXIMUM
COLLECTOR-EMITTER VOLTAGE



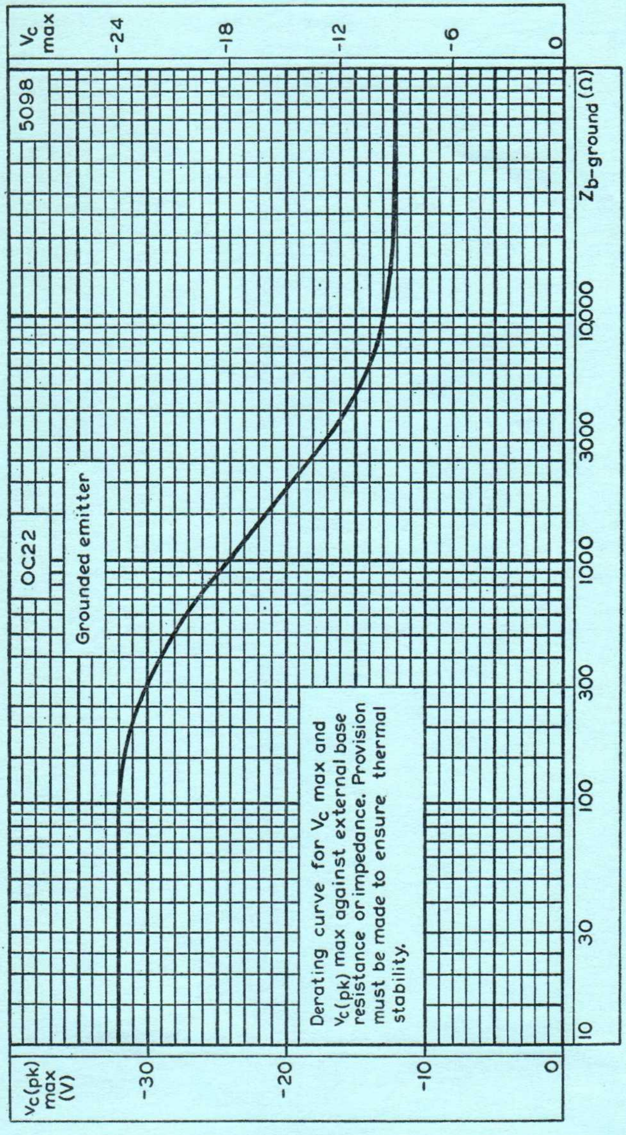
VARIATION OF I_{co} WITH JUNCTION TEMPERATURE



MAXIMUM DISSIPATION PLOTTED AGAINST AMBIENT TEMPERATURE



MAXIMUM DISSIPATION PLOTTED AGAINST MOUNTING BASE TEMPERATURE



MAXIMUM PEAK AND AVERAGE COLLECTOR VOLTAGE PLOTTED AGAINST EXTERNAL BASE-EMITTER IMPEDANCE OR RESISTANCE

HIGH FREQUENCY POWER TRANSISTOR

OC23

High frequency power transistor for use in high speed industrial switching applications and digital computers: particularly suitable as a pulse generator for a ferrite store.

PRELIMINARY DATA

ABSOLUTE MAXIMUM RATINGS (limiting values)

The equipment designer must ensure that no transistor exceeds these ratings. In arriving at the actual operating conditions, variation in supply voltages, component tolerances and ambient temperature must also be taken into account.

Collector voltage

†$v_{ce(pk)}$ max.	−40	V
*$V_{ce(av)}$ max.	−24	V
†$V_{ce(d.c.)}$ max.	−24	V
$v_{cb(pk)}$ max.	−55	V
*$V_{cb(av)}$ max.	−36	V
$V_{cb(d.c.)}$ max.	−36	V

†This voltage is limited to small currents as shown on page C3.

Reverse emitter-base voltage

$v_{eb(pk)}$ max.	−15	V
*$V_{eb(av)}$ max.	−12	V
$V_{eb(d.c.)}$ max.	−12	V

Collector current

$i_{c(pk)}$ max.	2.0	A
*I_c max.	1.0	A

Emitter current

$i_{e(pk)}$ max.	2.2	A
*I_e max.	1.2	A

Base current

$i_{b(pk)}$ max.	200	mA
*I_b max.	200	mA

Total dissipation See page C5

$$p_{tot}\ \text{max.} = \frac{T_{junction}\ \text{max.} - T_{ambient}}{\theta}$$

*Averaged over any 20ms period.

Mullard

Temperature ratings

Storage temperature		−55 to +75	°C
Maximum junction temperature		90	°C
Junction temperature rise above mounting base temperature	θ_m	3.0	°C/W

For full information on calculating junction temperature see fig. 4 and operating notes, page D5.

CHARACTERISTICS at $T_{junction} = 25°C$

		Typical production spreads Min.	Av.	Max.	
Grounded base					
Collector leakage current ($V_c = -10V$, $I_e = 0mA$)	I_{co}	—	30	100	µA
Emitter leakage current ($V_e = -10V$, $I_c = 0mA$)	I_{eo}	—	20	100	µA
Grounded emitter					
Collector current with reversed bias on base ($V_c = -40V$, $V_{be} = +500mV$)	I'_{coo}	—	—	2.0	mA
Collector knee voltage $I_c = 400mA$ (see fig. 1)	$V_{c(knee)}$	—	−350	−600	mV
Collector bottoming voltage ($I_c = 1A$, $I_b = 30mA$)	V_{ce}	—	−400	—	mV
*Base input voltage	V_{be}				
($V_c = -2V$, $I_c = 100mA$)		—	−250	−350	mV
($V_c = -2V$, $I_c = 1A$)		—	−0.8	−2.0	V

*See page C1 for values at other collector currents.

Current amplification factor $\bar{\alpha}' = \frac{I_c - I_{co}}{I_b + I_{co}}$					
($V_c = -2V$, $I_c = 100mA$)		—	200	—	
($V_c = -2V$, $I_c = 1A$)		50	150	—	

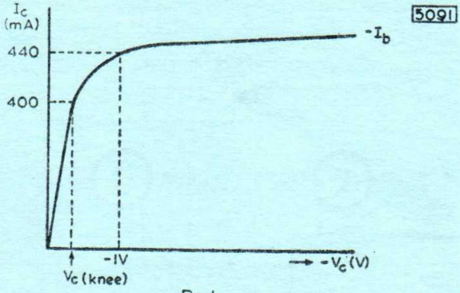


Fig. 1
I_b adjusted such that $I_c = 440mA$ with $V_c = -1V$

BASIC PARAMETERS

Measured at $V_c = -2V$, $I_c = 400mA$, $T_{mounting\ base} = 25°C$

$^*r_e$	0.06	Ω
†$r_{bb'}$	80	Ω
c_c (depletion capacitance)	170	pF
f_α	2.5	Mc/s
g_m	16	A/V
α' at low frequencies	180	

*The value of r_e given here is $\frac{kT}{q} \cdot \frac{1}{Ie} \approx \frac{25}{Ie}\,\Omega$, where I_e is in mA and T is in °K.

†When the transistor is used under pulse conditions the base resistance is considerably reduced.

OPERATING CONDITIONS FOR TYPICAL PULSE AMPLIFIER DRIVING A FERRITE STORE

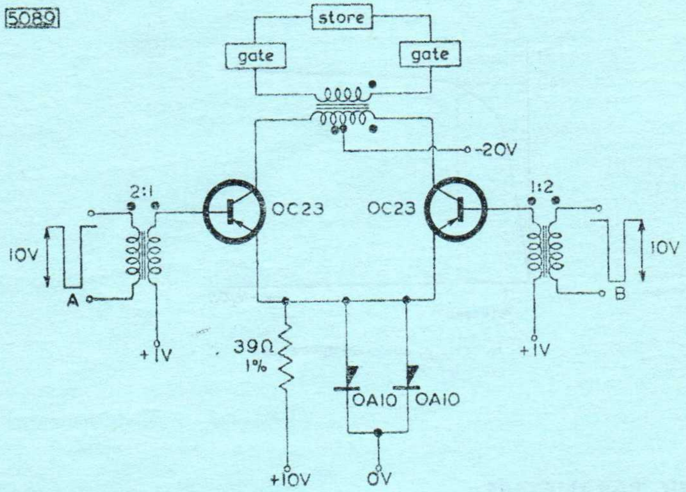


Fig. 2

WAVEFORMS

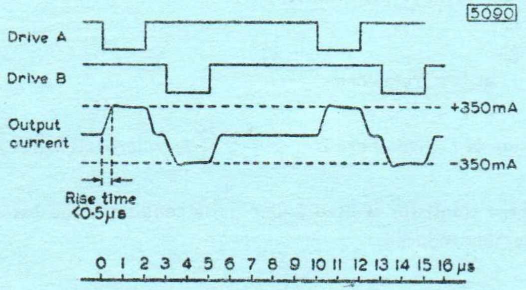


Fig. 3

Output Transformer

Three windings each of 30 turns wound together for minimum leakage inductance on a standard former, enclosed in a pair of Ferroxcube cores FX1561.

OPERATING NOTES

1. Dissipation and heat sink considerations

The maximum total dissipation, p_{tot} max. $= (V_{ce} \times I_c) + (V_{be} \times I_b)$, is given by the relationship

$$p_{tot}\text{ max.} = \frac{T_{junction}\text{ max.} - T_{ambient}}{\theta_m + \theta_i + \theta_h}$$

Where $\theta_m + \theta_i + \theta_h$ is equal to the junction temperature rise per watt above ambient (see page C5).

The various components of the rise of junction temperature above ambient are illustrated below:

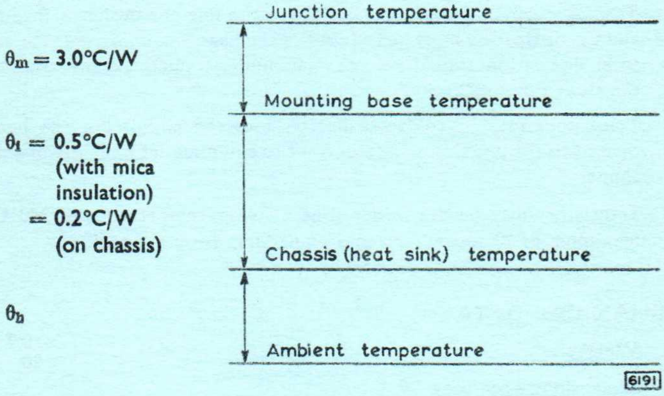


Fig. 4

θ_h depends on the cooling conditions under which the transistor is used, i.e., dimensions, position and surface conditions of heat sink etc. A good air-cooled heat sink will have a value of $\theta_h = 4°C/W$.

θ_h can be determined for a given collector dissipation and ambient temperature by measuring the mounting base temperature

$$\theta_h = \frac{T_{mounting\ base} - T_{ambient}}{p_c} - \theta_i\,°C/W$$

OC23

HIGH FREQUENCY POWER TRANSISTOR

The following example illustrates the temperatures which occur at various points on the transistor at $p_c = 4W$, $T_{junction} = 90°C$, $\theta_h = 4.0°C/W$ with mica insulation.

Junction temperature	= 90°C
Mounting base temperature	= 90–(4×3.0) = 78°C
Chassis (heat sink) temperature	= 78–(4×0.5) = 76°C
Ambient temperature	= 76–(4×4.0) = 60°C

The suitability of any design can be checked by measuring with a thermocouple the mounting base temperature of the transistor operating at the selected collector dissipation and maximum ambient temperature. The point defined by the mounting base temperature and the total dissipation must lie below the line on the graph on page C6 which results in $T_{junction} \leqq 90°C$. If the point lies above the line the design is inadmissible and the dissipation must be reduced or the heat sink improved. The selected total dissipation should be the maximum attained by any transistor in the design being checked.

2. Transistors may be soldered directly into the circuit but the heat conducted to the junction should be kept to a minimum by the use of a thermal shunt.

3. Transistors may be dip soldered at a solder temperature of 240°C for a maximum of 10 seconds up to a point 5mm from the seal.

MECHANICAL DATA

Weight { 0.7 oz / 20 g }

Dimensions – see page D7.

Care must be taken to ensure good thermal contact between the transistor and heat sink. Burrs or thickening at the edges of the four holes must be removed and the transistor bolted down on a plane surface. The thermal resistance may be reduced by a thin film of grease between the contacting surfaces.

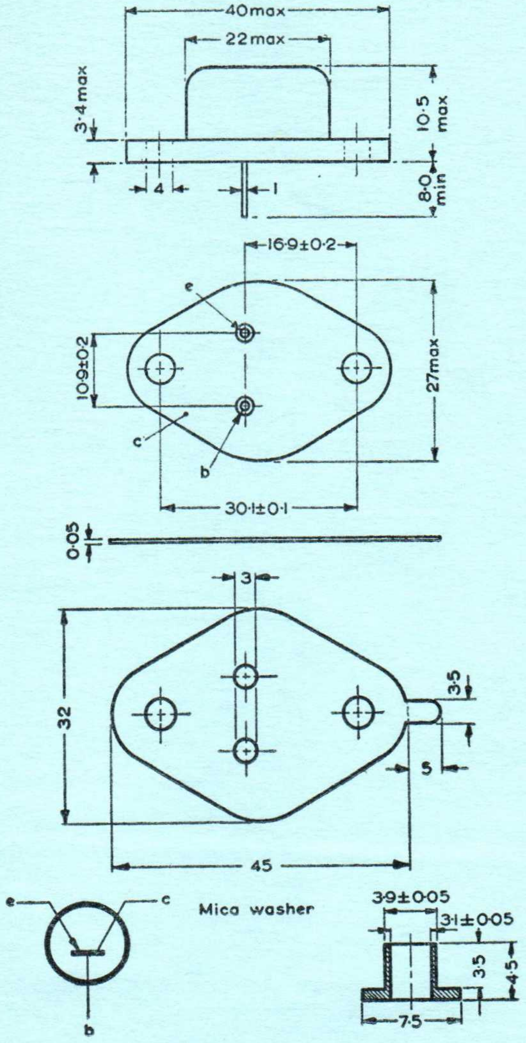
ACCESSORIES

Accessories must be specifically ordered.

Accessory	Code No.	Notes
2 insulating bushes 1 mica washer	56201a 56201b	Obtainable in packs for 10 or 100 transistors.
Set of 2 bushes, 1 washer	56201	Obtainable as a complete set for one transistor.

HIGH FREQUENCY POWER TRANSISTOR

OC23



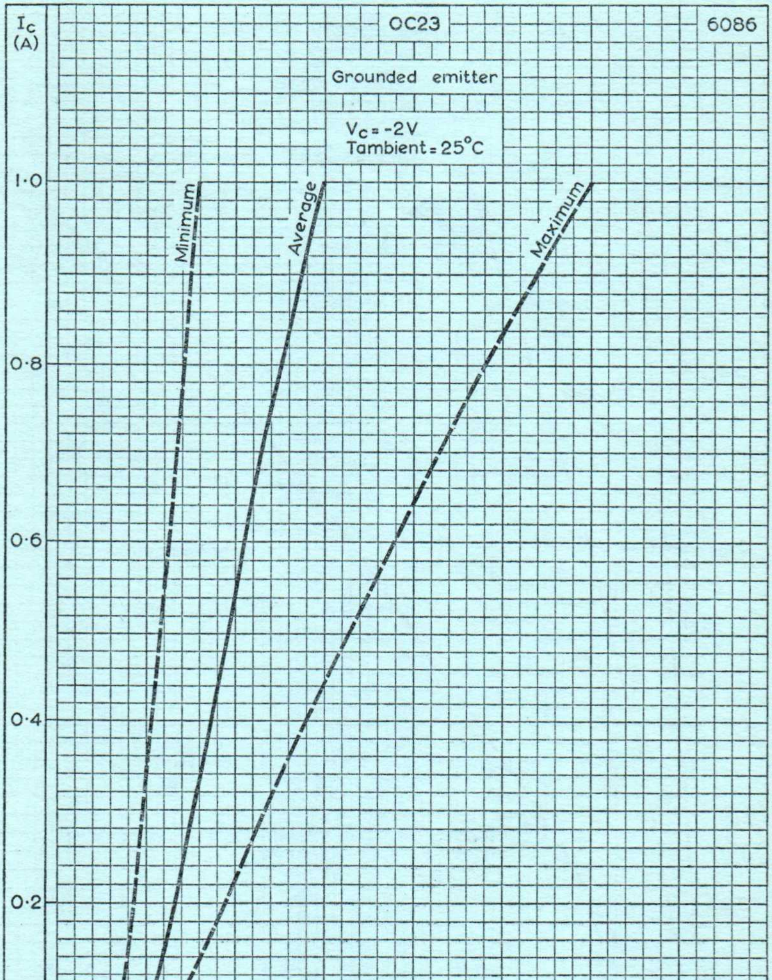
Insulating bush

6109

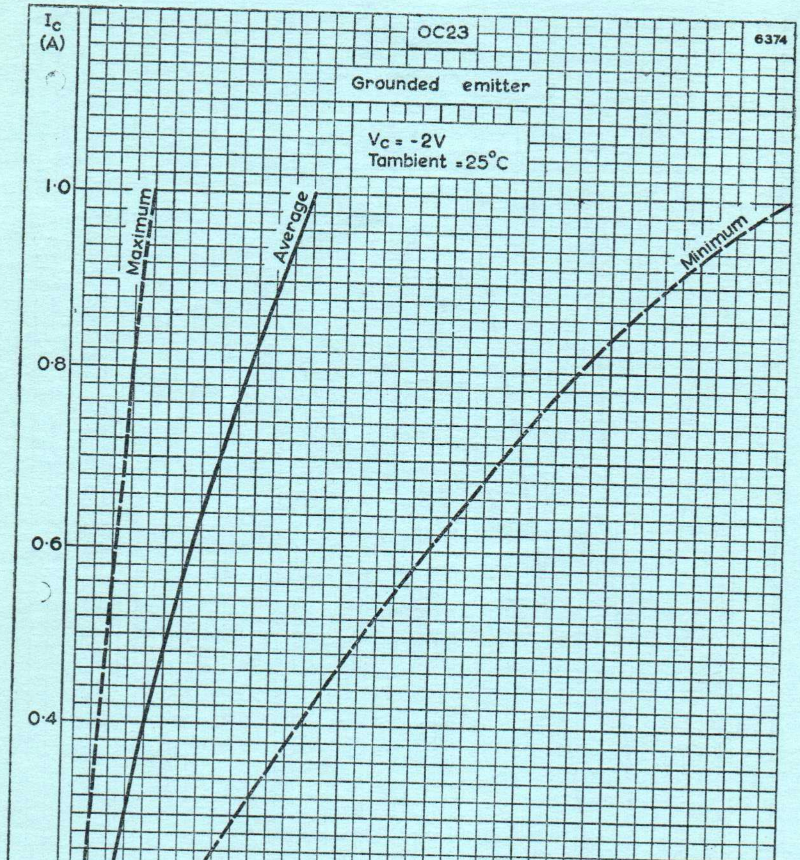
All dimensions in mm

HIGH FREQUENCY POWER TRANSISTOR

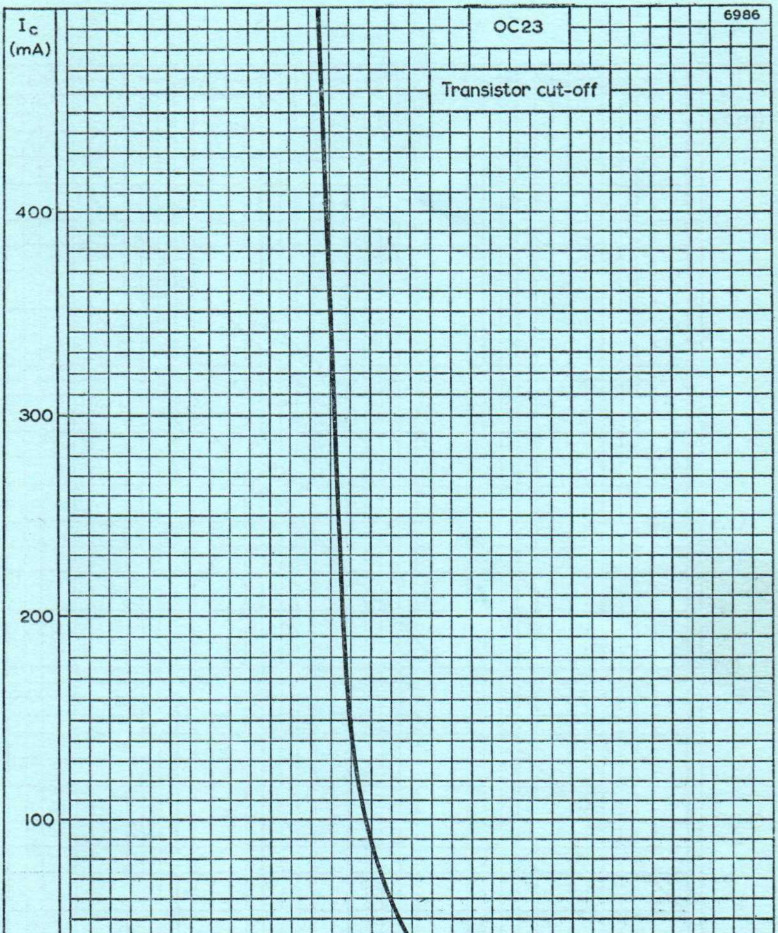
OC23



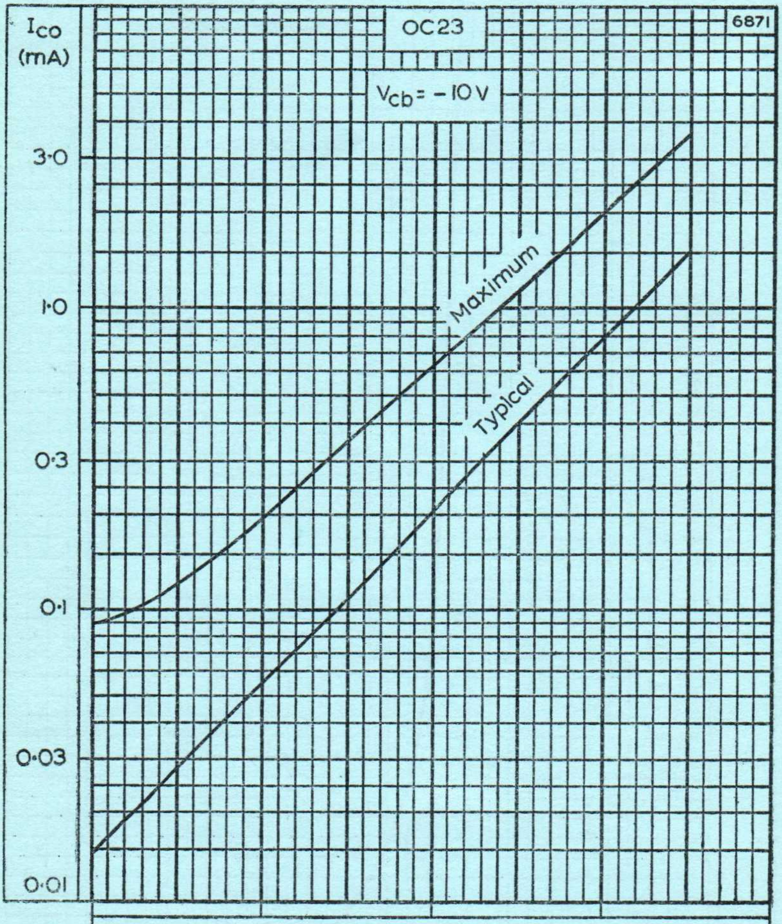
COLLECTOR CURRENT PLOTTED AGAINST BASE INPUT VOLTAGE



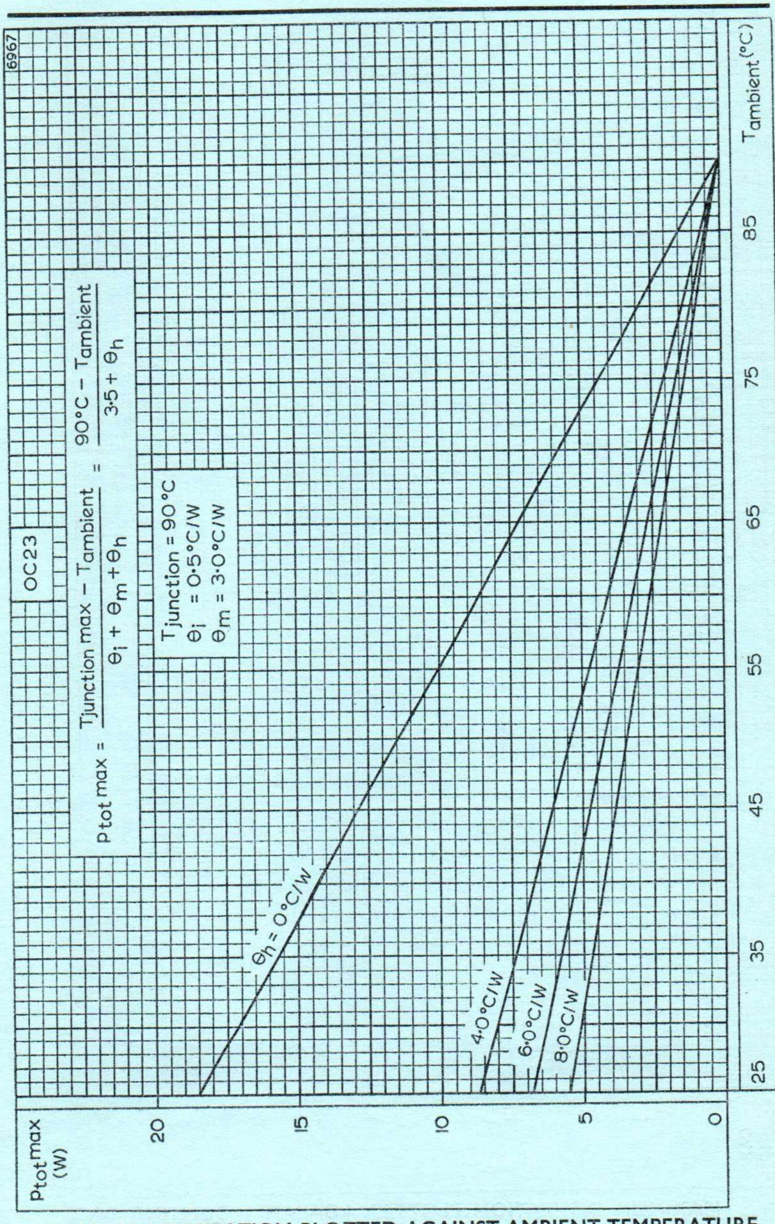
SPREAD OF TRANSFER CHARACTERISTIC



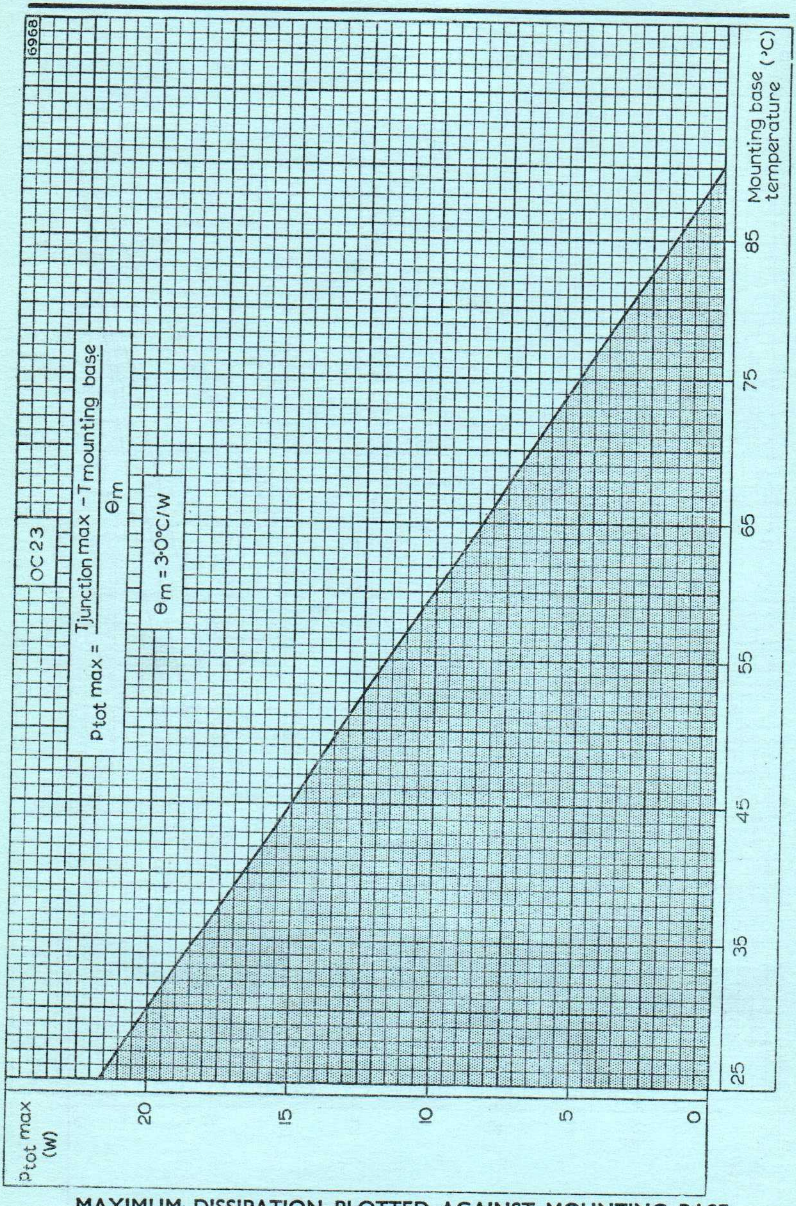
COLLECTOR CURRENT PLOTTED AGAINST ABSOLUTE MAXIMUM COLLECTOR-EMITTER VOLTAGE



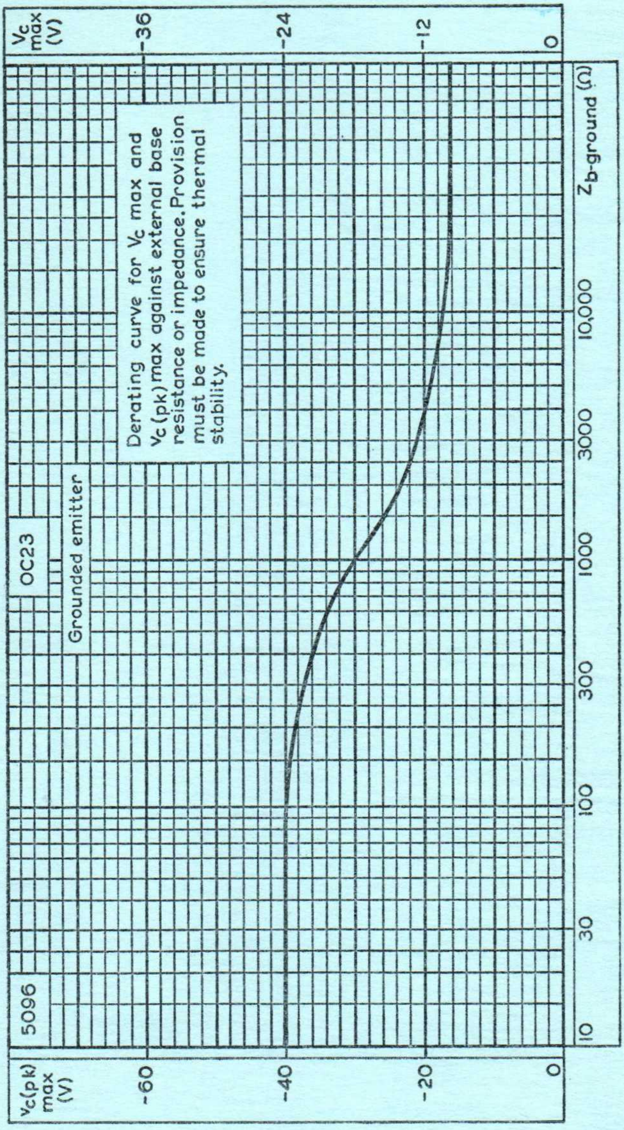
VARIATION OF I_{co} WITH JUNCTION TEMPERATURE



MAXIMUM DISSIPATION PLOTTED AGAINST AMBIENT TEMPERATURE



MAXIMUM DISSIPATION PLOTTED AGAINST MOUNTING BASE TEMPERATURE



MAXIMUM PEAK AND AVERAGE COLLECTOR VOLTAGE PLOTTED AGAINST EXTERNAL BASE-EMITTER IMPEDANCE OR RESISTANCE

HIGH FREQUENCY POWER TRANSISTOR

OC24

High frequency power transistor for use in high speed industrial switching applications and digital computers, and for medium frequency transmitter and carrier telephony applications.

PRELIMINARY DATA

ABSOLUTE MAXIMUM RATINGS (limiting values)

The equipment designer must ensure that no transistor exceeds these ratings. In arriving at the actual operating conditions, variation in supply voltages, component tolerances and ambient temperature must also be taken into account.

Collector voltage

†$v_{ce(pk)}$ max.	−40	V
*$V_{ce(av)}$ max.	−24	V
†$V_{ce(d.c.)}$ max.	−24	V
$v_{cb(pk)}$ max.	−47	V
*$V_{cb(av)}$ max.	−36	V
$V_{cb(d.c.)}$ max.	−36	V

†This voltage is limited to small currents as shown on page C3.

Reverse emitter base-voltage

$v_{eb(pk)}$ max.	−15	V
*$V_{eb(av)}$ max.	−12	V
$V_{eb(d.c.)}$ max.	−12	V

Collector current

$i_{c(pk)}$ max.	2.0	A
*I_c max.	1.0	A

Emitter current

$i_{e(pk)}$ max.	2.2	A
*I_e max.	1.2	A

Base current

$i_{b(pk)}$ max.	200	mA
*I_b max.	200	mA

Total dissipation See page C5

$$p_{tot}\ \text{max.} = \frac{T_{junction}\ \text{max.} - T_{ambient}}{\theta}$$

*Averaged over any 20ms period.

Temperature ratings

Storage temperature		−55 to +75	°C
Maximum junction temperature		90	°C
Junction temperature rise above mounting base temperature	θ_m	3.0	°C/W

For full information on calculating junction temperature see fig.4 and operating notes, page D6.

CHARACTERISTICS at $T_{junction} = 25°C$

Typical production spreads

		Min.	*Av.*	*Max.*	
Grounded base					
Collector leakage current ($V_c = -10V$, $I_e = 0mA$)	I_{co}	—	30	100	µA
Emitter leakage current ($V_e = -10V$, $I_c = 0mA$)	I_{eo}	—	20	100	µA
Grounded emitter					
Collector current with reversed bias on base ($V_c = -40V$, $V_{be} = +500mV$)	I'_{coo}	—	—	2.0	mA
Collector knee voltage $I_c = 400mA$ (see fig. 1)	$V_{ce(knee)}$	—	−350	−600	mV
Collector bottoming voltage ($I_c = 1A$, $I_b = 30mA$)	V_{ce}	—	−400	—	mV
*Base input voltage	V_{be}				
($V_c = -2V$, $I_c = 100mA$)		—	−250	−350	mV
($V_c = -2V$, $I_c = 1A$)		—	−0.8	−2.0	V

*See page C1 for values at other collector currents.

Current amplification factor $\bar{\alpha}' = \frac{I_c - I_{co}}{I_b + I_{co}}$

($V_c = -2V$, $I_c = 100mA$)	—	200	—
($V_c = -2V$, $I_c = 1A$)	50	150	—

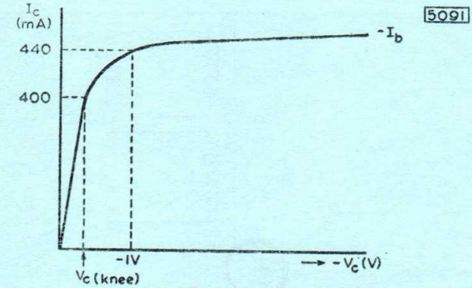


Fig. 1
I_b adjusted such that I_c=440mA with V_c=-1V

BASIC PARAMETERS

Measured at $V_c = -2V$, $I_c = 400mA$, $T_{mounting\ base} = 25°C$

$*r_e$	0.06	Ω
$r_{bb'}$	70	Ω
c_c (depletion capacitance)	170	pF
f_α	2.5	Mc/s
g_m	16	A/V
α′ at low frequencies	180	

*The value of r_e given here is $\frac{kT}{q} \cdot \frac{1}{I_e} \approx \frac{25\Omega}{I_e}$, where I_e is in mA and T is in °K.

HIGH FREQUENCY POWER TRANSISTOR

OPERATING CONDITIONS OF SINGLE TRANSISTOR OC24 AS CLASS 'B' R.F. AMPLIFIER

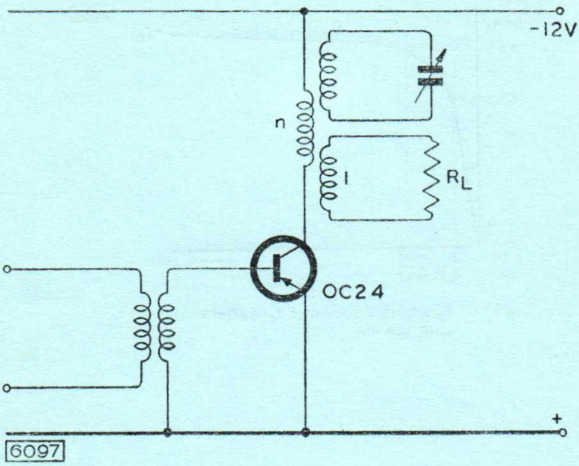


Fig. 2

Typical values at $T_{ambient} = 25°C$

Supply voltage	V_{cc}	–12	V
Signal frequency	f	500	kc/s
Power delivered to load	P_{load}	500	mW
Load	R_L	12	Ω
Output transformer turns ratio	n	3.33 : 1	
D.C. collector current	I_c	90	mA

Drive conditions

The following drive will give 500mW output from an average transistor.

Peak drive voltage	$v_{in(pk)}$	2.1	V
Drive power (r.m.s.)	P_{in}	25	mW

OPERATING CONDITIONS OF MATCHED PAIR 2-OC24 AS CLASS 'B' R.F. AMPLIFIER

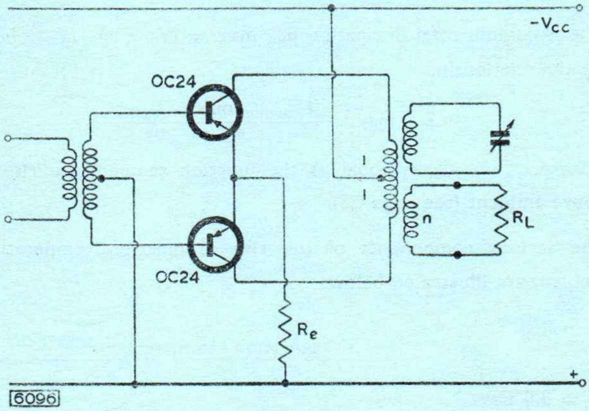


Fig. 3

Typical values at $T_{ambient} = 25°C$*

Supply voltage	V_{cc}	–12	V
Signal frequency	f	500	kc/s
Emitter resistor	R_e	1.0	Ω
Battery current	I	550	mA
Power delivered to load	P_{load}	3.0	W
Load	R_L	90	Ω
R_{load} (collector to collector)	R_{c-c}	90	Ω
R_{load} (per transistor) $(R_c = \frac{R_{c-c}}{4} + R_e)$	R_c	23.5	Ω
Output transformer turns ratio	n	1+1 : 2	

At P_{load} of 3W

Peak collector current	$i_{c(pk)}$	865	mA
Collector current (per transistor)	I_c	275	mA

Drive conditions

The following drive will give 3W output from an average pair of transistors

Peak drive voltage	$v_{in(pk)}$	5.4	V
Drive power (r.m.s.)	P_{in}	325	mW

*For operation up to an ambient temperature of 55°C, the thermal resistance of each heat sink should be ≦4.5°C/W.

OPERATING NOTES

1. Dissipation and heat sink considerations

The maximum total dissipation p_{tot} max. $= (V_{ce} \times I_c) + (V_{be} \times I_b)$, is given by the relationship

$$p_{tot} \text{ max.} = \frac{T_{junction} \text{ max.} - T_{ambient}}{\theta_m + \theta_i + \theta_h}$$

Where $\theta_m + \theta_i + \theta_h$ is equal to the junction temperature rise per watt above ambient (see page C5).

The various components of the rise of junction temperature above ambient are illustrated below:

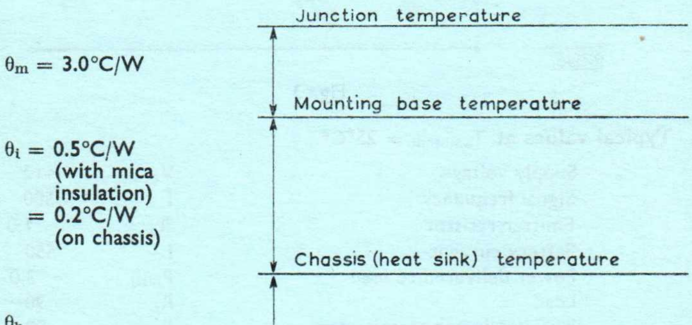


Fig. 4

θ_h depends on the cooling conditions under which the transistor is used i.e., dimensions, position and surface conditions of heat sink etc. A good air-cooled heat sink will have a value of $\theta_h = 4°C/W$.

θ_h can be determined for a given collector dissipation and ambient temperature by measuring the mounting base temperature

$$\theta_h = \frac{T_{mounting\ base} - T_{ambient}}{p_c} - \theta_i \text{°C/W}$$

The following example illustrates the temperatures which occur at various points on the transistor at $p_c = 4W$, $T_{junction} = 90°C$, $\theta_h = 4.0°C/W$ with mica insulation.

Junction temperature	= 90°C
Mounting base temperature	= 90–(4×3.0) = 78°C
Chassis (heat sink) temperature	= 78–(4×0.5) = 76°C
Ambinet temperature	= 76–(4×4.0) = 60°C

The suitability of any design can be checked by measuring with a thermocouple the mounting base temperature of the transistor operating at the selected collector dissipation and maximum ambient temperature. The point defined by the mounting base temperature and the total dissipation must lie below the line on the graph on page C16 which results in $T_{junction} \leqq 90°C$. If the point lies above the line the design is inadmissible and the dissipation must be reduced or the heat sink improved. The selected total dissipation should be the maximum attained by any transistor in the design being checked.

2. Transistors may be soldered directly into the circuit but the heat conducted to the junction should be kept to a minimum by the use of a thermal shunt.

3. Transistors may be dip soldered at a solder temperature of 240°C for a maximum of 10 seconds up to a point 5mm from the seal.

MECHANICAL DATA

Weight	0.7	oz
	20	g

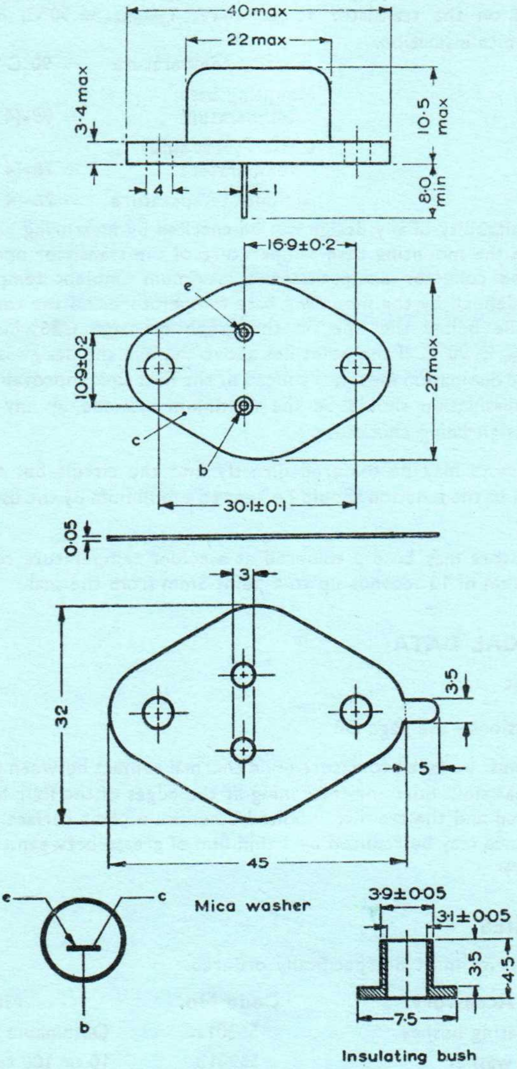
Dimensions – see page D8

Care must be taken to ensure good thermal contact between the transistor and heat sink. Burrs or thickening at the edges of the four holes must be removed and the transistor bolted down on a plane surface. The thermal resistance may be reduced by a thin film of grease between the contacting surfaces.

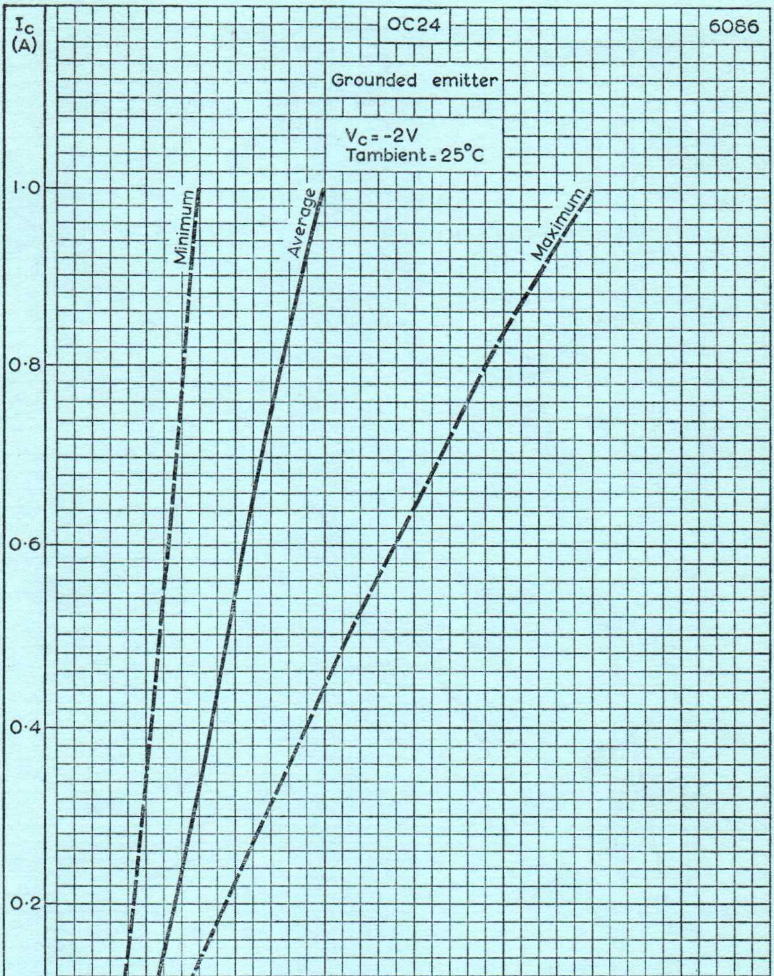
ACCESSORIES

Accessories must be specifically ordered.

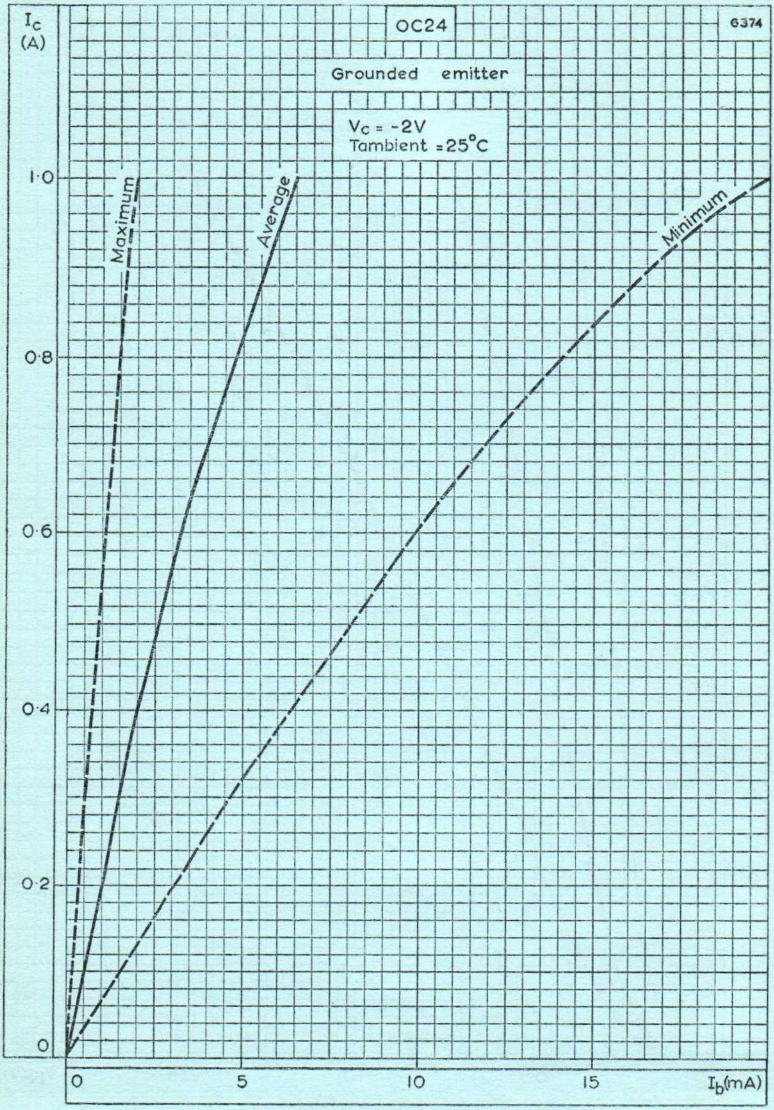
Accessory	Code No.	Notes
2 insulating bushes	56201a	Obtainable in packs for
1 mica washer	56201b	10 or 100 transistors.
Set of 2 bushes, 1 washer	56201	Obtainable as a complete set for one transistor.



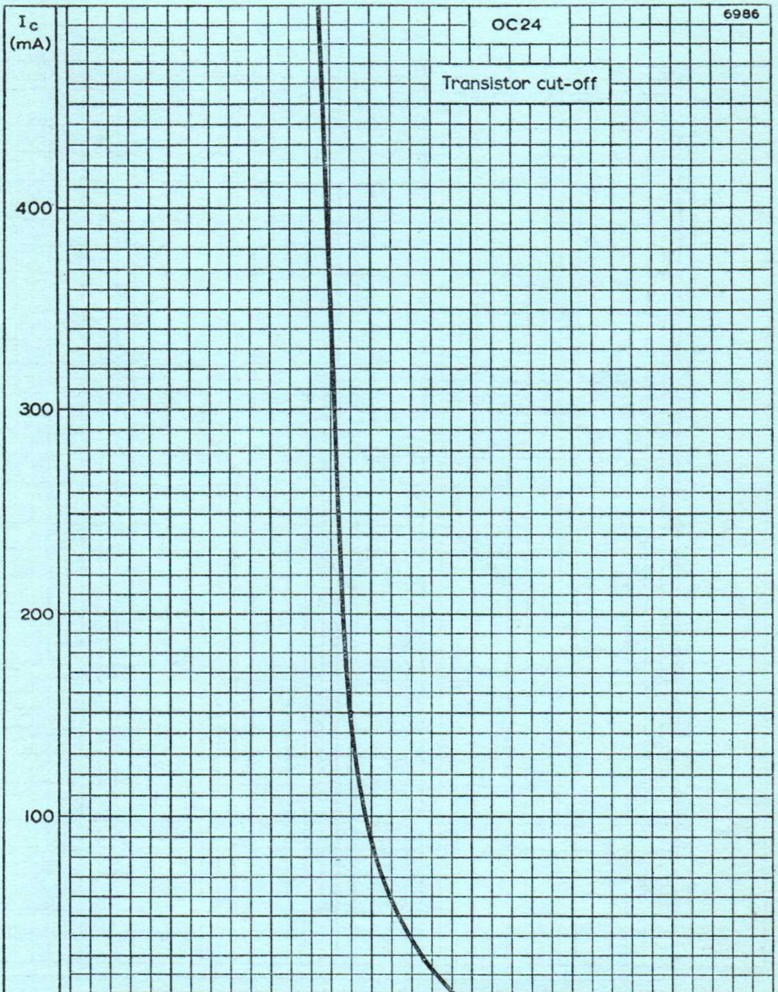
All dimensions in mm



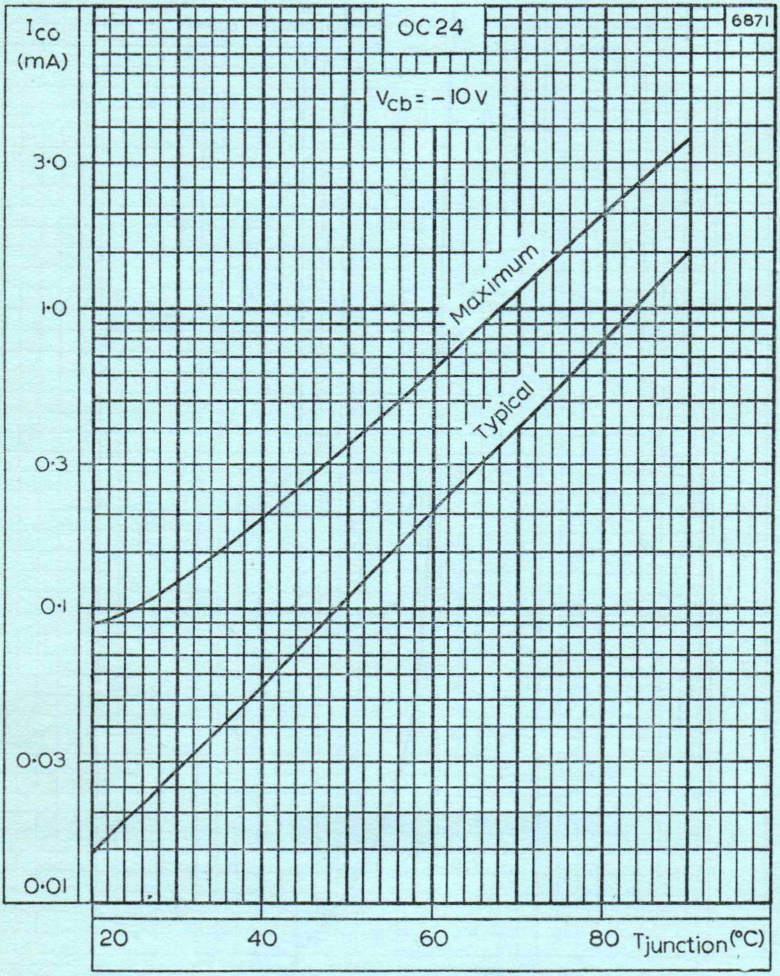
COLLECTOR CURRENT PLOTTED AGAINST BASE INPUT VOLTAGE



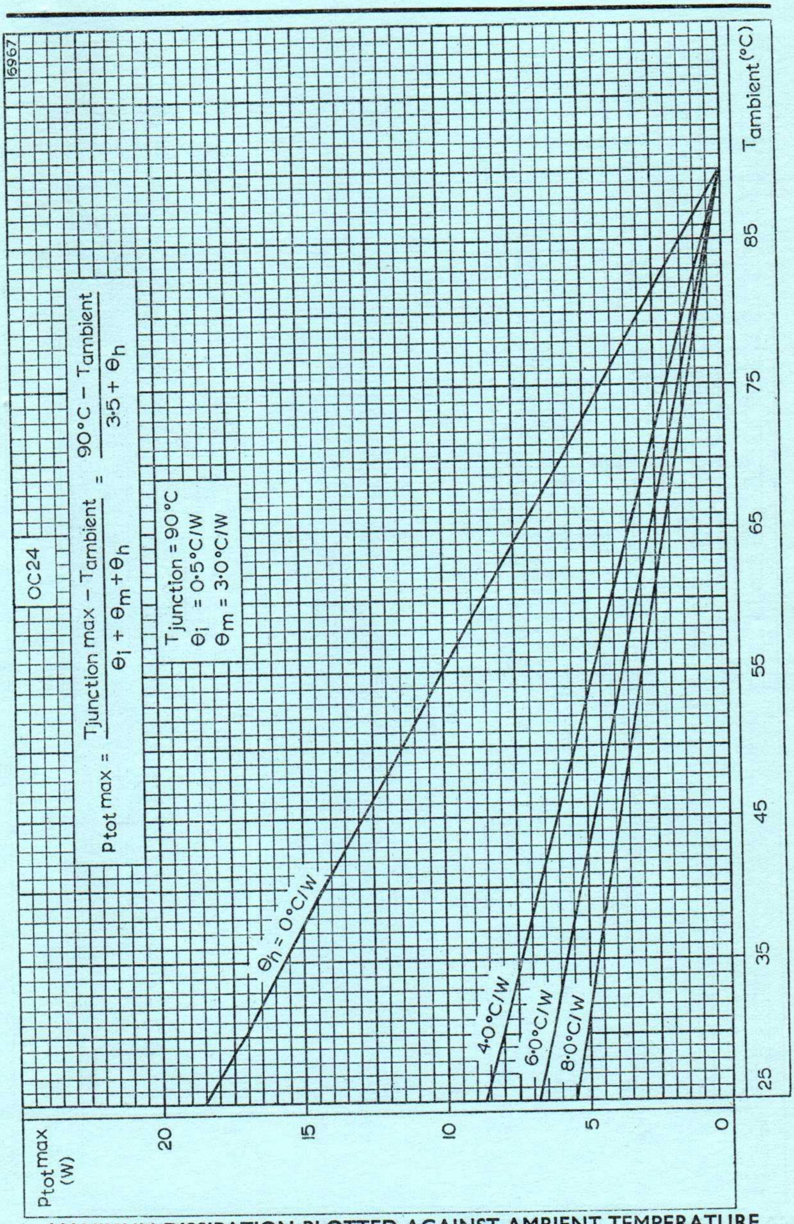
SPREAD OF TRANSFER CHARACTERISTIC



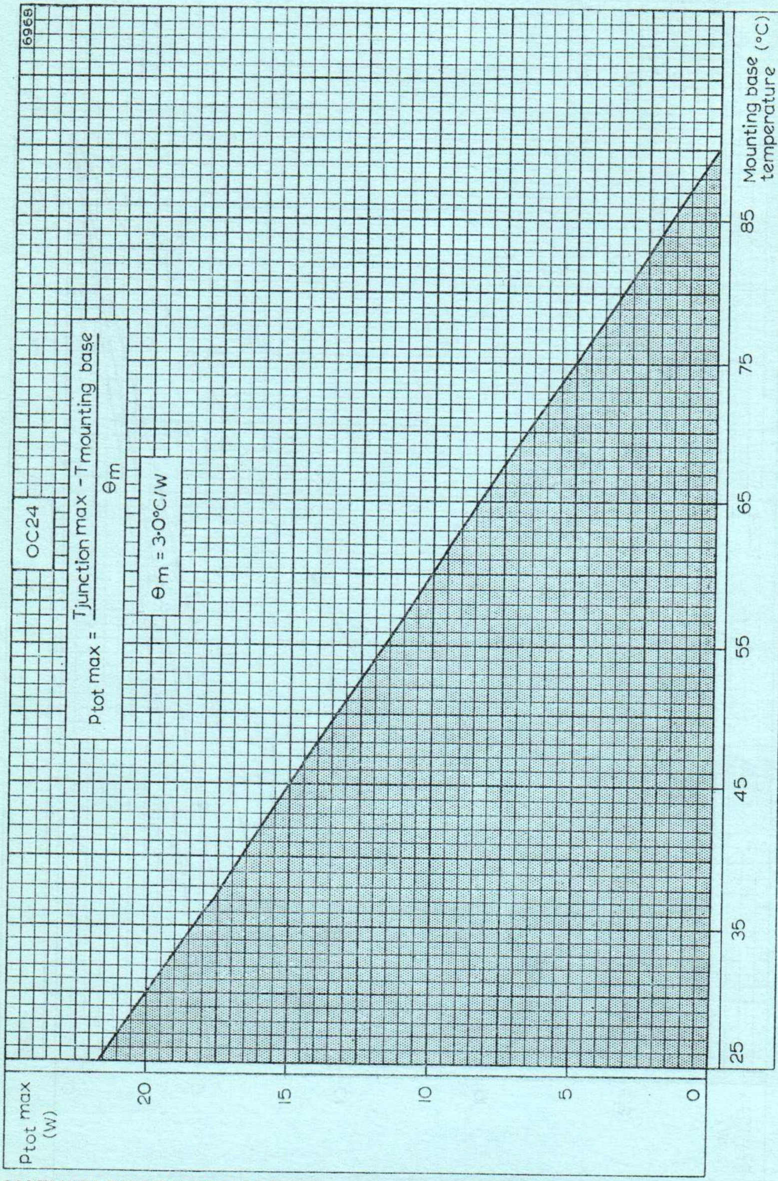
COLLECTOR CURRENT PLOTTED AGAINST ABSOLUTE MAXIMUM COLLECTOR-EMITTER VOLTAGE



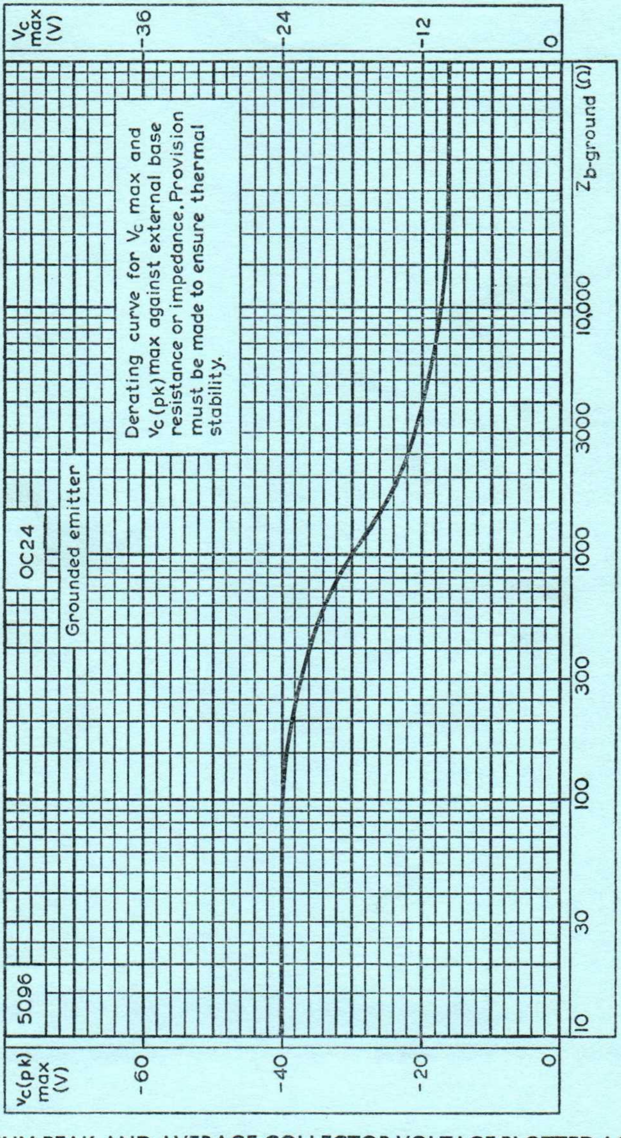
VARIATION OF I_{co} WITH JUNCTION TEMPERATURE



MAXIMUM DISSIPATION PLOTTED AGAINST AMBIENT TEMPERATURE



MAXIMUM DISSIPATION PLOTTED AGAINST MOUNTING BASE TEMPERATURE



MAXIMUM PEAK AND AVERAGE COLLECTOR VOLTAGE PLOTTED AGAINST EXTERNAL BASE-EMITTER IMPEDANCE OR RESISTANCE

JUNCTION TRANSISTOR

0C25

Power Junction transistor of the p-n-p alloy type for general purpose industrial applications.

PRELIMINARY DATA

ABSOLUTE MAXIMUM RATINGS

The equipment designer must ensure that no transistor exceeds these ratings. In arriving at the actual operating conditions, variations in supply voltages, component tolerances and ambient temperature must also be taken into account.

Collector voltage		
V_{cb} max. ($I_e = 0A$)	–40	V
V_{ce} max. ($I_c = 0.5A$)	–40	V
V_{ce} max. ($I_c = 3.0A$)	–40	V
Collector current		
$i_{c(pk)}$ max.	4.0	A
*I_c max.	4.0	A
Emitter current		
$i_{e(pk)}$ max.	4.0	A
*I_e max.	4.0	A
Reverse emitter-base voltage		
$v_{eb(pk)}$ max.	–10	V
*V_{eb} max.	–10	V
Base current		
$i_{b(pk)}$ max.	500	mA
*I_b max.	500	mA

*Averaged over any 20ms period.

Total dissipation at $T_{mounting\ base} \leqslant 45°C$	22.5	W
Temperature ratings		
Storage temperature	–55 to +75	°C
Maximum junction temperature		
Continuous operation	90	°C
‡Intermittent operation (total duration = 200 hours max.)	100	°C
Junction temperature rise above mounting base, θ_{j-mb}	2.0	°C/W

‡Likelihood of full performance of a circuit at this temperature is also dependent on the type of application.

For full information on calculating junction temperature see operating notes, pages D2 and D3.

0C25 JUNCTION TRANSISTOR

CHARACTERISTICS at $T_{mounting\ base} = 25°C$

		Typical production spread *Min.*	*Typ.*	*Max.*	
Grounded base					
Collector leakage current	I_{co}				
($V_{cb} = -500mV$, $I_e = 0mA$)		—	—	100	µA
Grounded emitter					
Base input voltage	V_{be}				
($V_{cb} = 0V$, $I_c = 1A$)		—	—	–750	mV
($V_{cb} = 0V$, $I_c = 4A$)		—	—	–1.5	V

LARGE SIGNAL CHARACTERISTICS

		Min.	Typ.	Max.
Current amplification factor	$\bar{\alpha}' = \frac{I_c - I_{co}}{I_b + I_{co}}$			
($V_{ce} = -1V$, $I_c = 1A$)		15	—	80
($V_{ce} = -1V$, $I_c = 4A$)		12	—	50

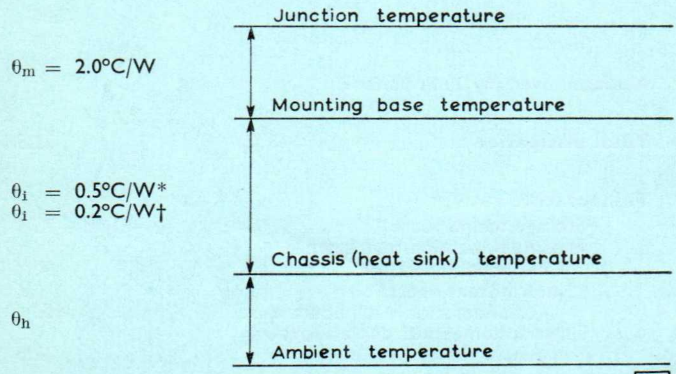
OPERATING NOTES

1. **Dissipation and heat sink considerations.**
The maximum total dissipation (p_{tot} max. $= (V_{ce} \times I_c) + (V_{be} \times I_b)$) is given by the relationship:

$$p_{tot}\ \text{max.} = \frac{T_{junction}\ \text{max.} - T_{ambient}}{\theta_m + \theta_i + \theta_h}$$

Where $\theta_m + \theta_i + \theta_h$ is equal to the junction temperature rise per watt above ambient.

The various components of the rise of junction temperature above ambient are illustrated below:



*With mica insulation.

†Mounted directly on to a chassis with thin film of silicone grease between contacting surfaces.

θ_h depends on the cooling conditions under which the transistor is used i.e., dimensions, position and surface conditions of heat sink, etc.; a good air-cooled heat sink will have an approximate value of $\theta_h = 2.2°C/W$. (7in × 7in × 1/16in blackened aluminium).

θ_h can be determined for a given total dissipation and ambient temperature by measuring the mounting base temperature.

$$\theta_h = \frac{T_{mounting\ base} - T_{ambient}}{p_{tot}} - \theta_i$$

The following example illustrates the temperatures which occur at various points on the transistor at $p_{tot} = 8W$, $T_{junction} = 90°C$ $\theta_h = 2.2°C/W$.

Transistor with mica insulation

Junction temperature	= 90°C
Mounting base temperature	= 90–(8 × 2.0) = 74°C
Chassis (heat sink) temperature	= 74–(8 × 0.5) = 70°C
Ambient temperature	= 70–(8 × 2.2) = 52.4°C

The suitability of any design can be checked by measuring with a thermocouple the mounting base temperature of the transistor operating at the selected collector dissipation and maximum ambient temperature. The point defined by the mounting base temperature and the total dissipation must lie below the line of the curve on page C1 which results in $T_{junction} < 90°C$. If the point lies above the line the design is inadmissible and the dissipation must be reduced or the heat sink impoved. The selected total dissipation should be the maximum attained by any transistor in the design being checked.

2. Transistors may be dip soldered at a solder temperature of 240°C for a maximum of 10 seconds up to a point 2mm from the seal.

3. Care must be taken to ensure good thermal contact between the transistor and heat sink. Burrs or thickening at the edges of the four holes must be removed and the transistor bolted down on a plane surface.

ACCESSORIES

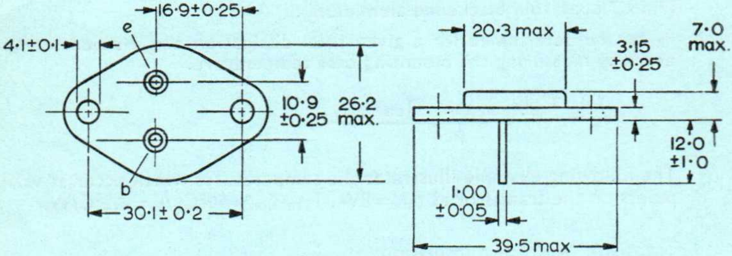
Accessories must be specifically ordered.

Accessory	Code No.	Notes
2 insulating bushes 1 mica washer 1 metal washer	56201a 56201b 56214	Obtainable in packs for 10 or 100 transistors.
Set of 2 insulating bushes 1 mica washer	56201	Obtainable as complete set for one transistor.

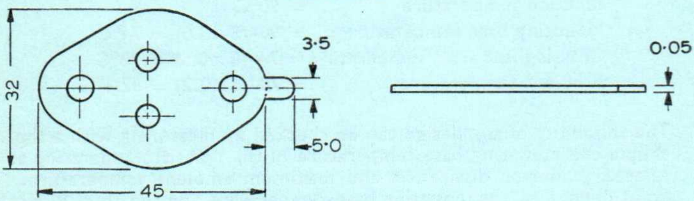
0C25

JUNCTION TRANSISTOR

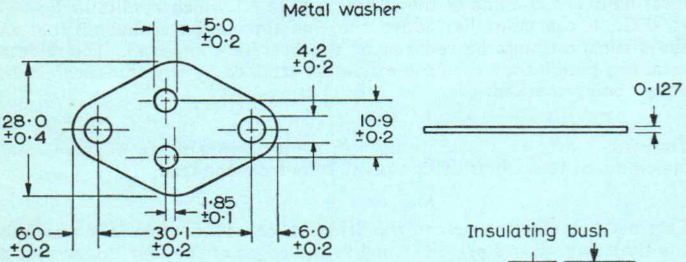
Transistor

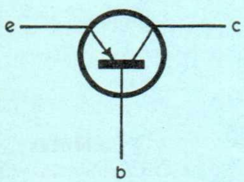


Mica washer

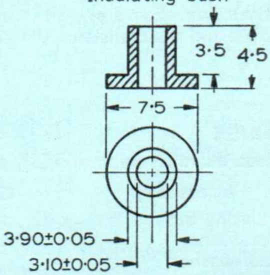


Metal washer





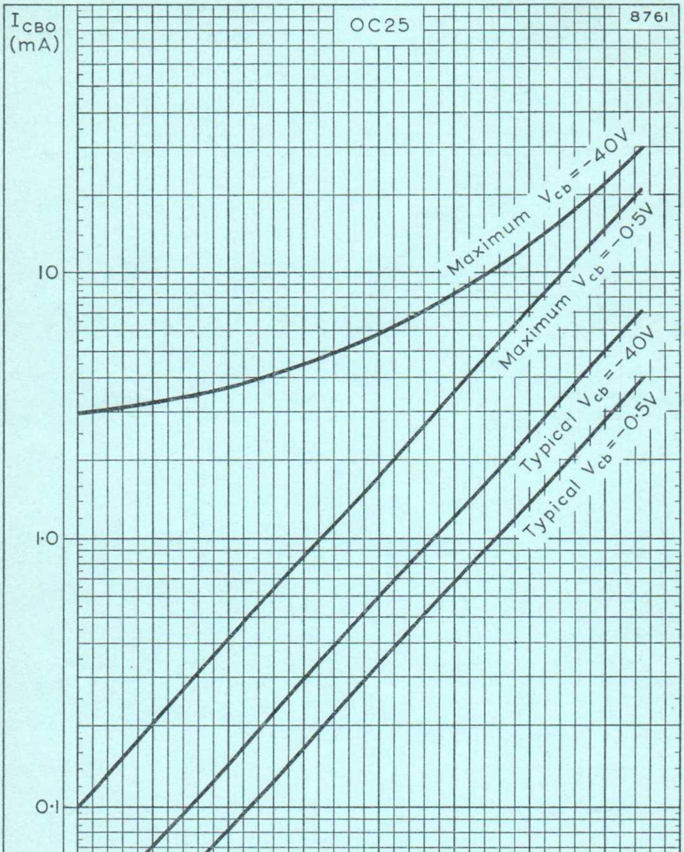
Insulating bush



8484

All dimensions in mm

MAXIMUM TOTAL DISSIPATION PLOTTED AGAINST MOUNTING BASE TEMPERATURE



VARIATION OF LEAKAGE CURRENT WITH JUNCTION TEMPERATURE

P-N-P GERMANIUM JUNCTION TRANSISTOR

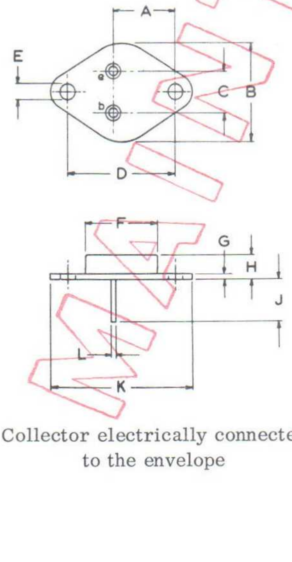
OC26

Power junction transistor of the p-n-p alloy type intended for use in output stages of car radio receivers.

QUICK REFERENCE DATA		
$-V_{CB}$ max. ($Z_{BE} < 200\Omega$)	32	V
$-V_{CE}$ max. ($Z_{BE} < 200\Omega$)	16	V
$-V_{EB}$ max.	10	V
$-I_C$ max.	3.5	A
$-I_B$ max.	0.5	A
P_{tot} max. ($T_{mb} \leq 75^{o}C$)	12.5	W
T_j max.	90	^{o}C
h_{FE} ($-V_{CE} = 14V$, $-I_C = 30mA$)	20 - 80	
($-V_{CE} = 1.0V$, $-I_C = 1.0A$)	20 - 60	
P_{out} typ. ($-V_{CC} = 14V$, $-I_C = 0.5A$, $R_L = 29\Omega$)	3.2	W

OUTLINE AND DIMENSIONS

Conforms to B.S. 3934 SO-5A/SB2-2
J.E.D.E.C. TO-3



Collector electrically connected to the envelope

	Millimetres
A	16.9 typ.
B	26.6 max.
C	10.9 typ.
D	30.1 typ.
E	4.0 to 4.2
F	20.3 max.
G	3.15 typ.
H	10.4 max.
J	9.5 typ.
K	39.5 max.
L	1.0 typ.

OC28 OC29 OC35 OC36

QUICK REFERENCE DATA

Power junction transistors of the p-n-p alloy type intended for use in medium and high voltage and high current switching applications. Matched pairs of each type are available under the type number 2-OC

	OC28	OC29	OC35	OC36	
V_{CB} max. ($I_E = 0A$)	−80	−60	−60	−80	V
V_{CE} max. ($I_E = 0.5A$)	−60	−48	−48	−60	V
V_{CE} max. ($I_E = 6.0A$)	−60	−32	−32	−32	V
h_{FE} ($I_C = 1.0A$)	20–55	45–130	25–75	30–110	

Unless otherwise shown, data is applicable to all types

ABSOLUTE MAXIMUM RATINGS

The equipment designer must ensure that no transistor exceeds these ratings. In arriving at the actual operating conditions, variations in supply voltages, component tolerances and ambient temperatures must also be taken into account.

	OC28	OC29	OC35	OC36	
Collector voltage					
V_{CB} max. ($I_E = 0A$)	−80	−60	−60	−80	V
V_{CE} max. ($I_E = 0.5A$)	−60	−48	−48	−60	V
V_{CE} max. ($I_E = 6.0A$)	−60	−32	−32	−32	V
Collector current					
I_{CM} max.				10	A
†$I_{C(AV)}$ max.				8.0	A
Emitter current					
I_{EM} max.				12	A
†$I_{E(AV)}$ max.				9.0	A
Reverse emitter-base voltage					
V_{EB} max. ($I_C = 0A$)	−40	−20	−20	−40	V ←
Base current					
I_{BM} max.				2.0	A
†$I_{B(AV)}$ max.				1.0	A
Total Dissipation at $T_{case} \leqslant 45°C$				30	W

$T_{case} > 45°C$ $\quad P_{tot}$ max. $= \dfrac{T_j \text{ max} - T_{case}}{\theta_{j-case}}$

†Averaged over any 20ms period.

OC28 Series

JUNCTION TRANSISTORS

Temperature ratings

T_{stg} max.	75	°C
T_{stg} min.	−55	°C
T_j max. (Continuous operation)	90	°C
‡T_j max. (Intermittent operation total duration 200 hours)	100	°C
θ_{j-case} max.	1.5	°C/W
$\theta_{case-heat\ sink}$ max. (when mounted with metal washer 0.127mm thick and with mica washer)	0.5	°C/W

‡Likelihood of full performance of a circuit at this temperature is also dependent on the type of application.

CHARACTERISTICS at T_{case} = 25°C

Common base		Typical production spread Min.	Typ.	Max.	
Collector leakage current	I_{CBO}				
(V_{CB} = −500mV, I_E = 0mA)		—	—	100	µA
(V_{CB} = −14V, I_E = 0mA, T_{case} = 100°C)		—	—	20	mA
(V_{CB} = −60V, I_E = 0mA, T_{case} = 100°C)	OC29, OC35	—	8.5	30	mA←
(V_{CB} = −80V, I_E = 0mA T_{case} = 100°C)	OC28, OC36	—	12	30	mA←
Emitter cut-off voltage (V_{CB} = −48V, I_E = 0mA, T_{case} = 100°C)	V_{EB}	—	—	−500	mV←
Common emitter					
Collector knee voltage at I_C = 6A (see Fig. 1)	$V_{CE(knee)}$	—	−0.5	−1.0	V

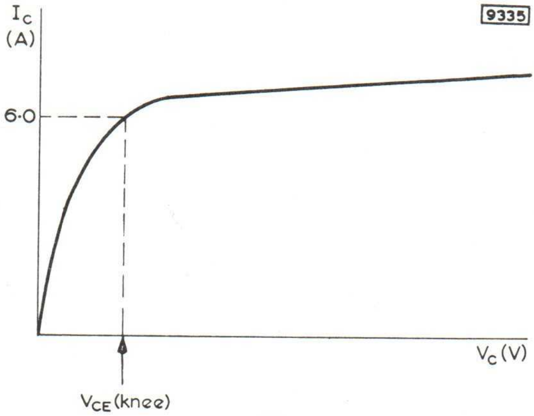


Fig. 1

		OC28 min.	OC28 max.	OC29 min.	OC29 max.	OC35 min.	OC35 max.	OC36 min.	OC36 max.	
Base current	I_B									
(V_{CB} = 0V, I_E = 1A)		17.5	50	7.2	21.5	13	38	9	33	mA
(V_{CB} = 0V, I_E = 6A)		190	375	73	165	130	285	90	285	mA
Base input voltage	V_{BE}									
(V_{CB} = 0V, I_E = 1A)		←			800				→	mV
(V_{CB} = 0V, I_E = 6A)		−0.6	−1.6	—	−1.6	−0.4	−1.4	—	−1.6	V
Current amplification factor	h_{FE}									
(V_{CE} = −14V, I_C = 30mA)		20	—	—		—		—		
(V_{CE} = −1V, I_C = 1A)		20	55	45	130	25	75	30	110	
(V_{CE} = −1V, I_C = 6A)		15	30	35	80	20	45	20	65	

BASIC PARAMETERS

Cut-off frequency					
(V_{CB} = −6V, I_E = 300mA)	f_{hfb}	—	250	—	kc/s
Collector depletion capacitance					
(V_{CB} = −12V, I_E = 0mA)	c_{tc}	—	160	—	pF
Emitter depletion capacitance					
(V_{EB} = −6V, I_E = 0mA)	c_{te}	—	165	—	pF
Time constant, current feed	$\frac{\beta}{\omega 1}$				
(V_{CE} = −4V, I_{CM} = 1A)		—	45	70	µs
(V_{CE} = −4V, I_{CM} = 6A)		—	30	50	µs
Desaturation time constant					
(V_{CE} = 0V, I_{BM} = 50mA)	τ_s	—	30	50	µs

Typical operation in on-off power switching circuit

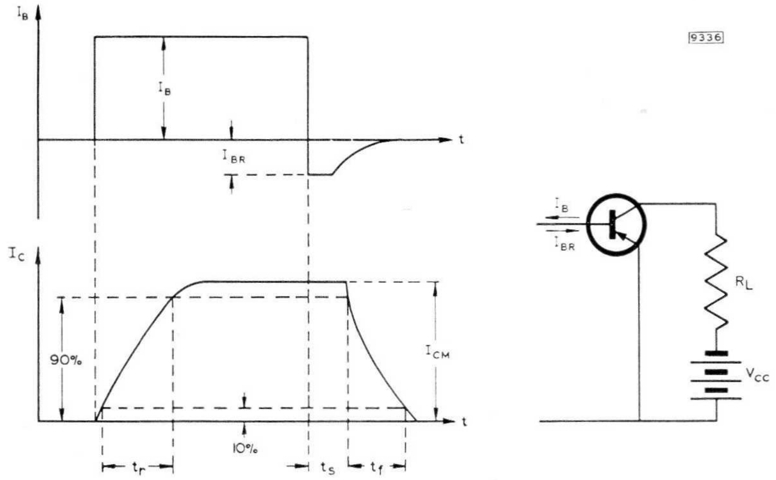


Fig. 2

D.C. supply voltage	V_{CC}	14				28				V
Load resistance	R_L	14		2.3		28		4.7		Ω
peak collector current	I_{CM}	1.0		6.0		1.0		6.0		A
		OC29	OC35	OC29	OC35	OC28	OC36	OC28	OC36	
'Turn On' base current	I_B	35	55	260	400	70	50	480	400	mA
'Reverse' base current	I_{BR}	8.7	13.7	65	100	17.5	12.5	120	100	mA
Switching times										
Rise time	t_r	20		20		20		20		µs
Storage time	t_s	15		15		15		15		µs
Fall time	t_f	40		35		40		35		µs

Rise time $$t_r = \frac{\beta}{\omega 1} \log_e \frac{h_{FE} \mid I_B \mid}{h_{FE} \mid I_B \mid - \mid I_{CM} \mid}$$

Fall time $$t_f = \frac{\beta}{\omega 1} \log_e \left[1 + \frac{\mid I_{CM} \mid}{h_{FE} \mid I_{BR} \mid} \right]$$

Storage time $$t_s = \tau_s \log_e \frac{\mid I_B \mid + \mid I_{BR} \mid}{\frac{\mid I_{CM} \mid}{h_{FE}} + \mid I_{BR} \mid}$$

CHARACTERISTICS OF MATCHED PAIR

(measured at $T_{case} = 25°C$)

Ratio of the current amplification factors of the two transistors

at $V_{CB} = 0V$, $I_C = 300mA$	1.2 : 1
$V_{CB} = 0V$, $I_C = 6A$	1.2 : 1

Difference between the base-emitter voltages of the two transistors

at $V_{CB} = -14V$, $I_C = 30mA$	<35	mV
$V_{CB} = 0V$, $I_C = 6A$	<300	mV

OPERATING NOTES

1. **Dissipation and heat sink considerations**

The maximum total dissipation P_{tot} max. $= (V_{CE} \times I_C) + (V_{BE} \times I_B)$, is given by the relationship:—

$$P_{tot}\ \text{max.} = \frac{T_j\ \text{max.} - T_{amb}}{\theta_m + \theta_i + \theta_h}$$

Where $\theta_m + \theta_i + \theta_h$ is equal to θ_{j-amb}.

The various components of θ_{j-amb} are illustrated below:

$\theta_{j-case} = 1.5°C/W$

$*\theta_i = 0.5°C/W$

$\dagger\theta_i = 0.2°C/W$

θ_h

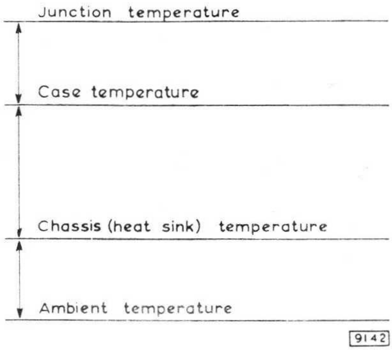


Fig. 3

*When mounted with a metal washer 0.127mm thick and a mica washer, or with a mica washer only and silicone grease, $\theta_i = 0.5°C/W$. This value applies when the transistor is bolted down evenly on a flat heat sink. The metal washer is advantageous in taking up any irregularities in the heat sink surfaces.

†When mounted directly on the chassis with a thin film of silicone grease between the contacting surfaces, $\theta_i = 0.2°C/W$. This value applies when the transistor is bolted down evenly on a flat heat sink.

θ_h depends on the cooling conditions under which the transistor is used, i.e., dimensions, position and surface conditions of heat sink, etc. An air-cooled heat sink (7in. × 7in. × 1/16in. blackened aluminium) will have a value of $\theta_h = 2.2°C/W$.

θ_h can be determined for a given collector dissipation and ambient temperature by measuring the case temperature.

$$\theta_h = \frac{T_{case} - T_{amb}}{P_{tot}} - \theta_i \, ^\circ C/W$$

The following example illustrates the temperatures which occur at various points on the transistor at $p_C = 10W$, $T_j = 90°C$, $\theta_h = 2.2°C/W$.

T_j	= 90°C
T_{case}	= 90–(10 × 1.5) = 75°C
$T_{heat\ sink}$	= 75–(10 × 0.5) = 70°C
T_{amb}	= 70–(10 × 2.2) = 48°C

The suitability of any design can be checked by measuring, with a thermocouple, the case temperature of the transistor operating at the selected collector dissipation and maximum ambient temperature. The point defined by the case temperature and the total dissipation must lie within the shaded area shown on the graph on page C10. If the point lies outside the shaded area the design is inadmissible and the dissipation must be reduced or the heatsink improved. The selected total dissipation should be the maximum attained by any transistor in the design being checked. ←

2. Transistors may be soldered directly into the circuit but the heat conducted to the junction should be kept to a minimum by the use of a thermal shunt.

3. Transistors may be dip soldered at a solder temperature of 240°C for a maximum of 10 seconds up to a point 2mm from the seal.

4. Care must be taken to ensure good thermal contact between the transistor and heat sink. Burrs or thickening at the edges of the four holes must be removed and the transistor bolted down on a plane surface.

MECHANICAL DATA

Dimensions – see page D8.

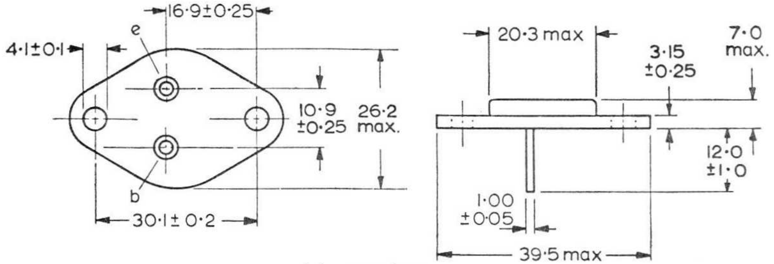
Average weight: 0.66 oz / 18.6 g

ACCESSORIES

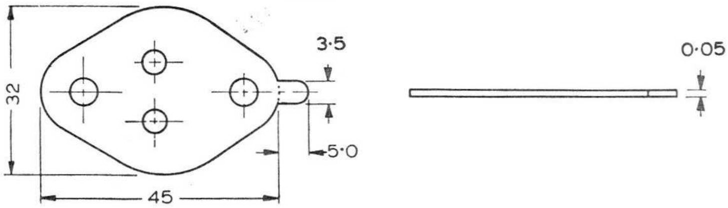
Accessories must be specifically ordered.

Accessory	Code No.	Notes
2 insulating bushes	56201a	Obtainable in packs for
1 mica washer	56201b	10 or 100 transistors.
1 metal washer	56214	
Set of 2 insulating bushes	56201	Obtainable as complete
1 mica washer		set for one transistor.

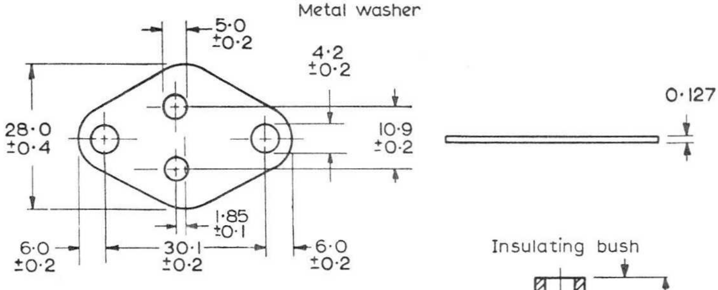
Transistor

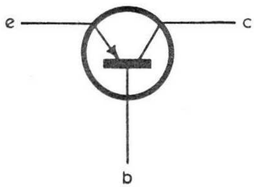


Mica washer

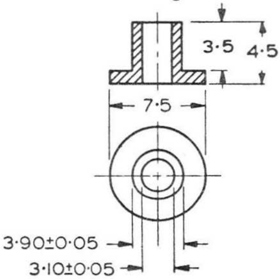


Metal washer



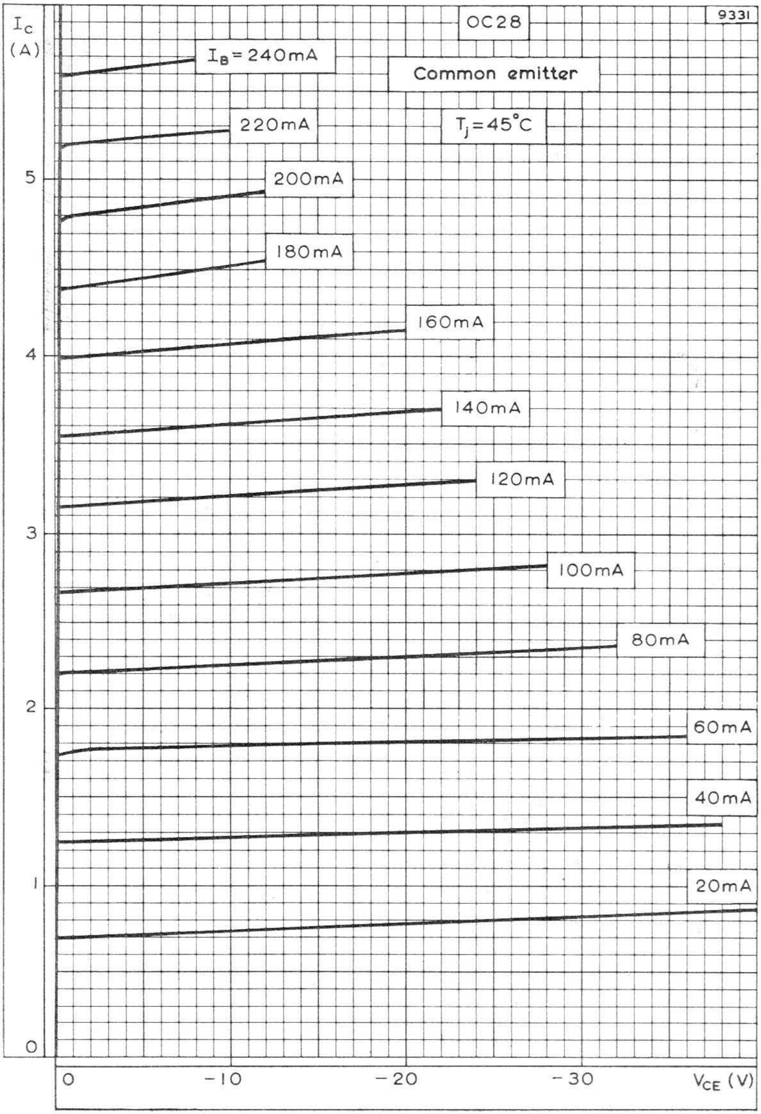


Insulating bush

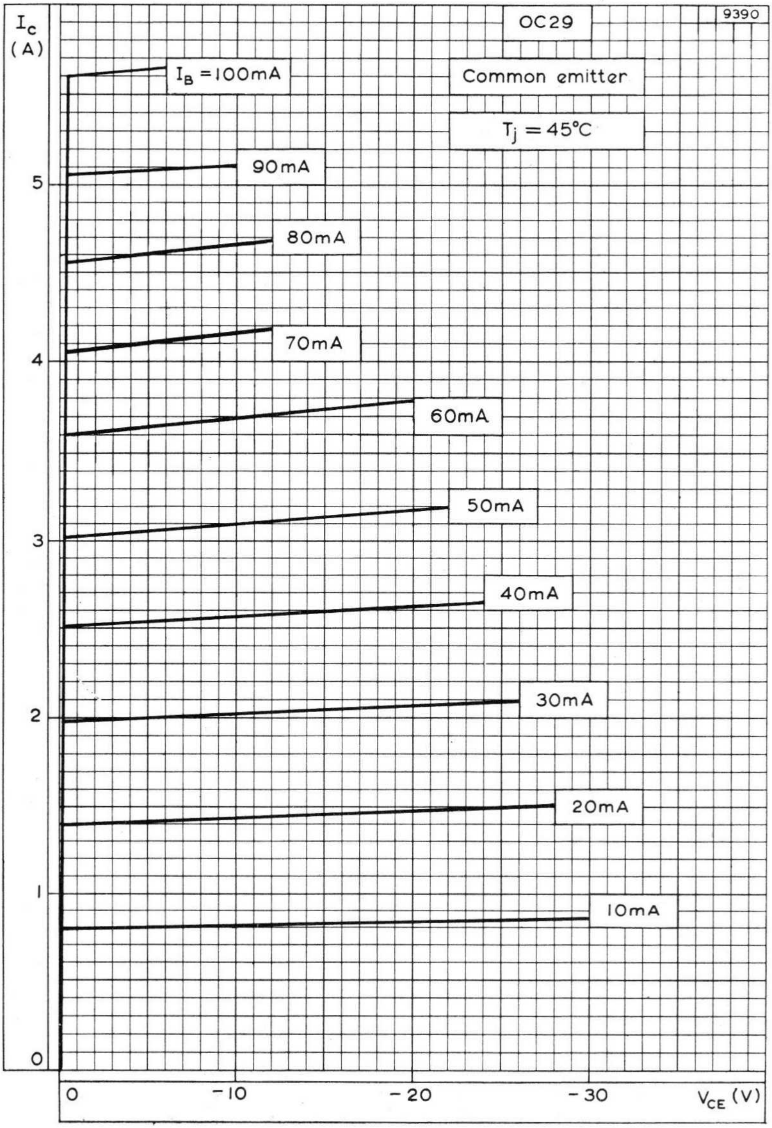


8484

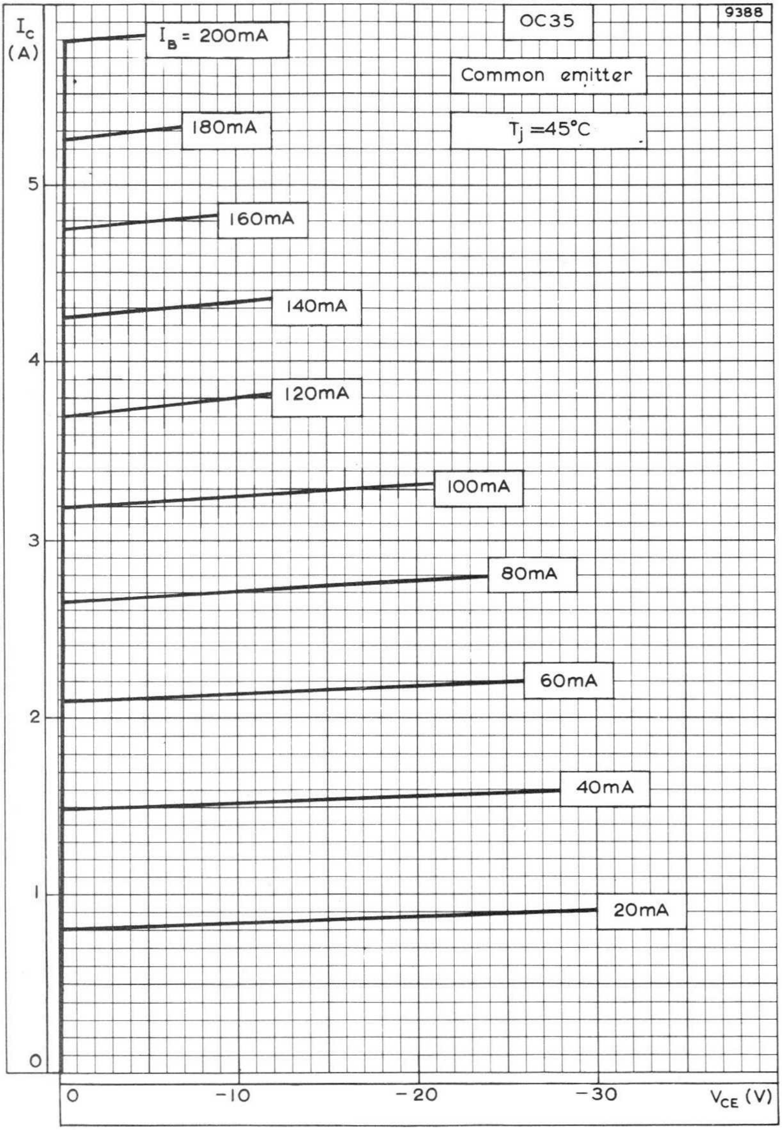
All dimensions in mm



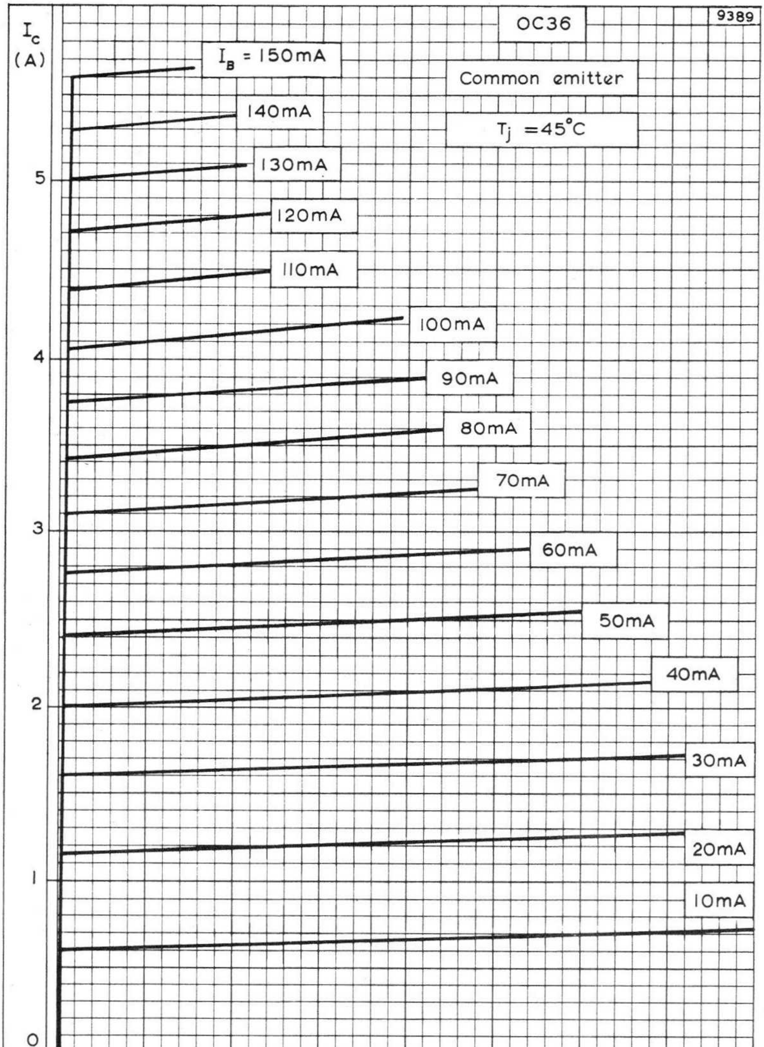
OUTPUT CHARACTERISTIC FOR OC28. COMMON EMITTER



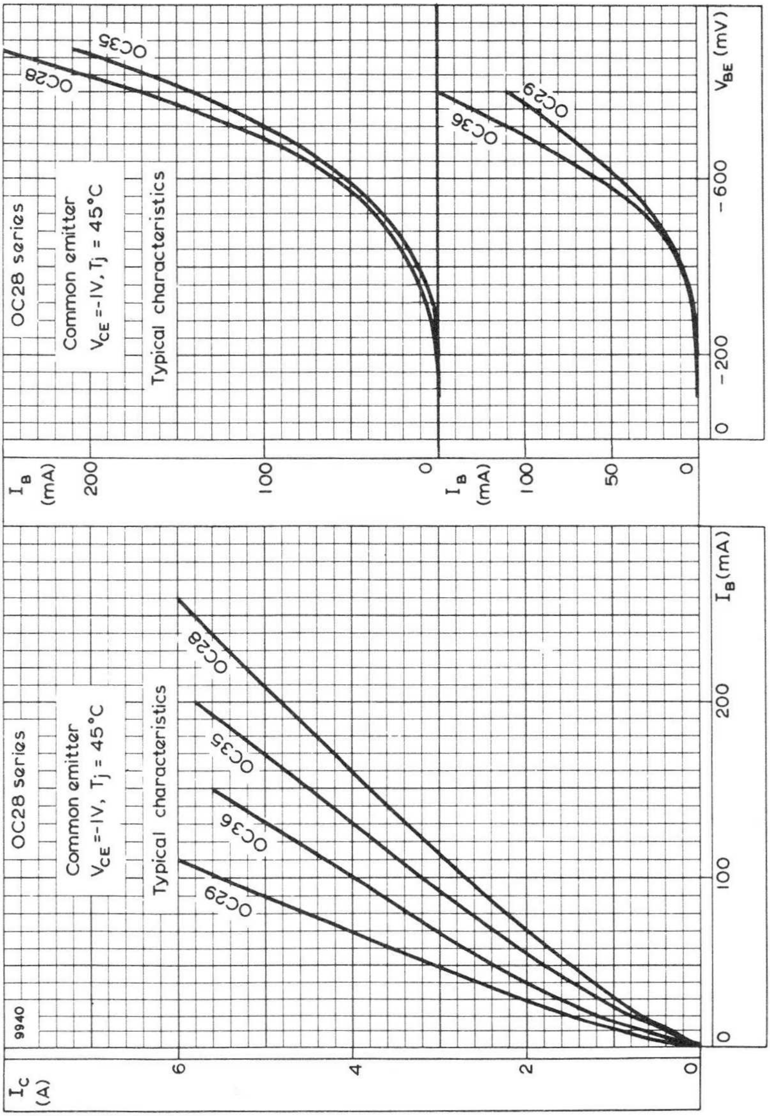
OUTPUT CHARACTERISTIC FOR OC29. COMMON EMITTER



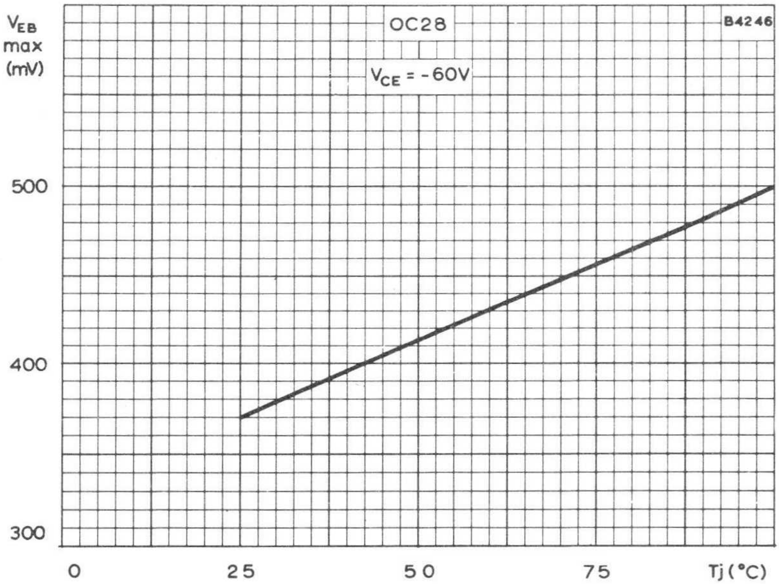
OUTPUT CHARACTERISTIC FOR OC35. COMMON EMITTER

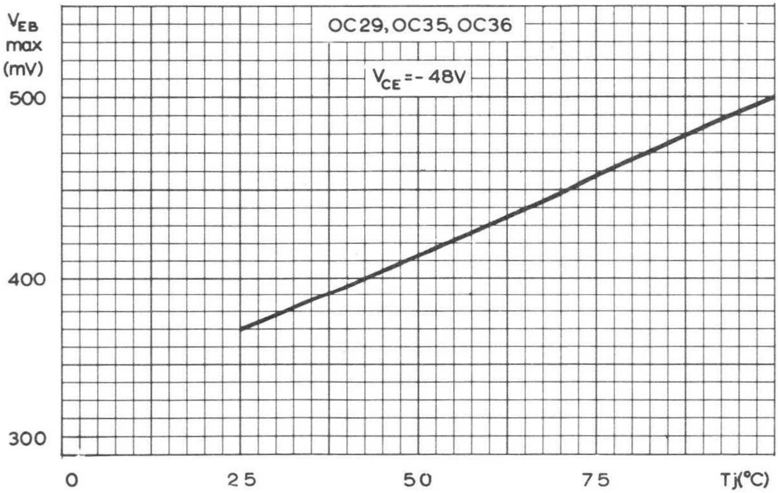


OUTPUT CHARACTERISTIC FOR OC36. COMMON EMITTER

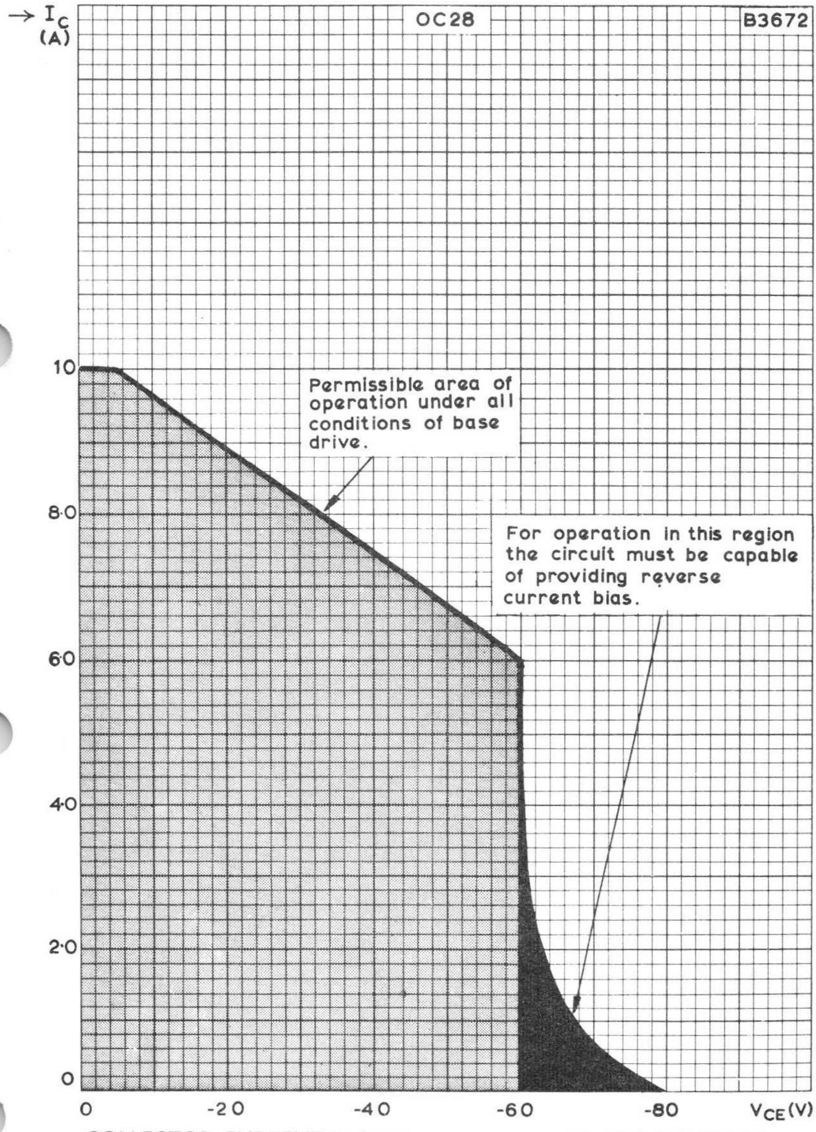


TRANSFER AND INPUT CHARACTERISTICS. COMMON EMITTER

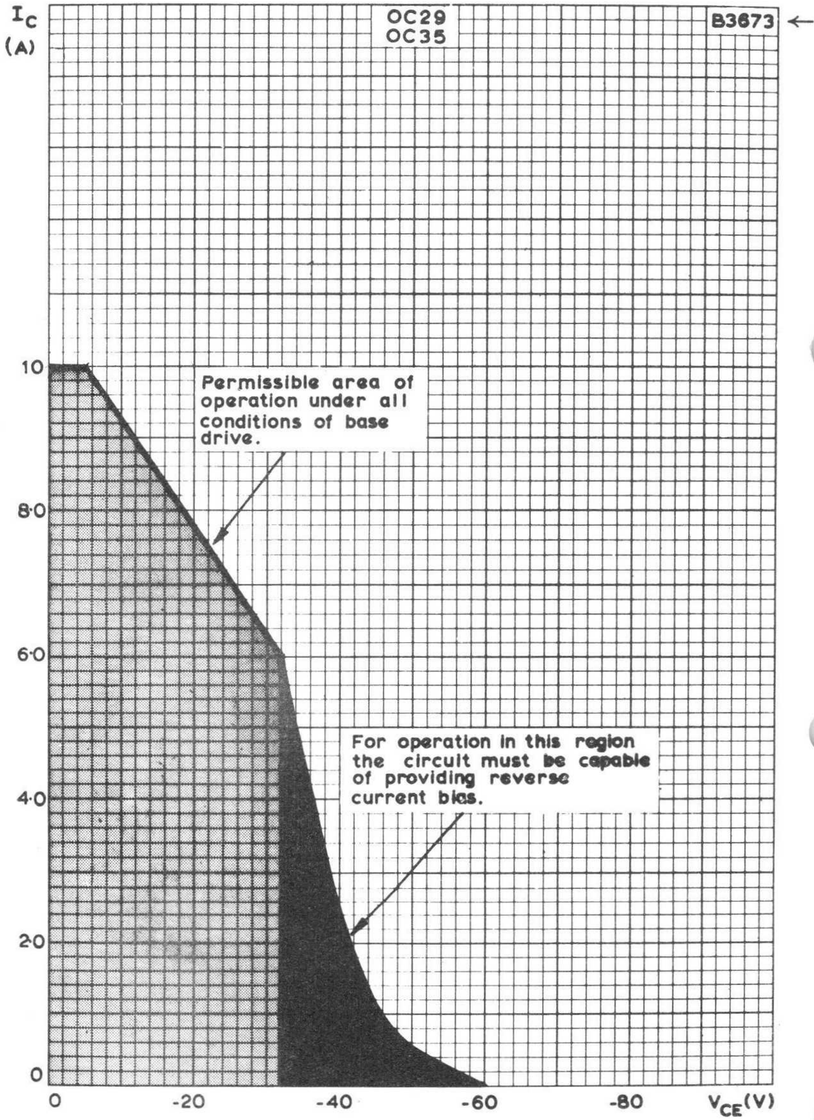




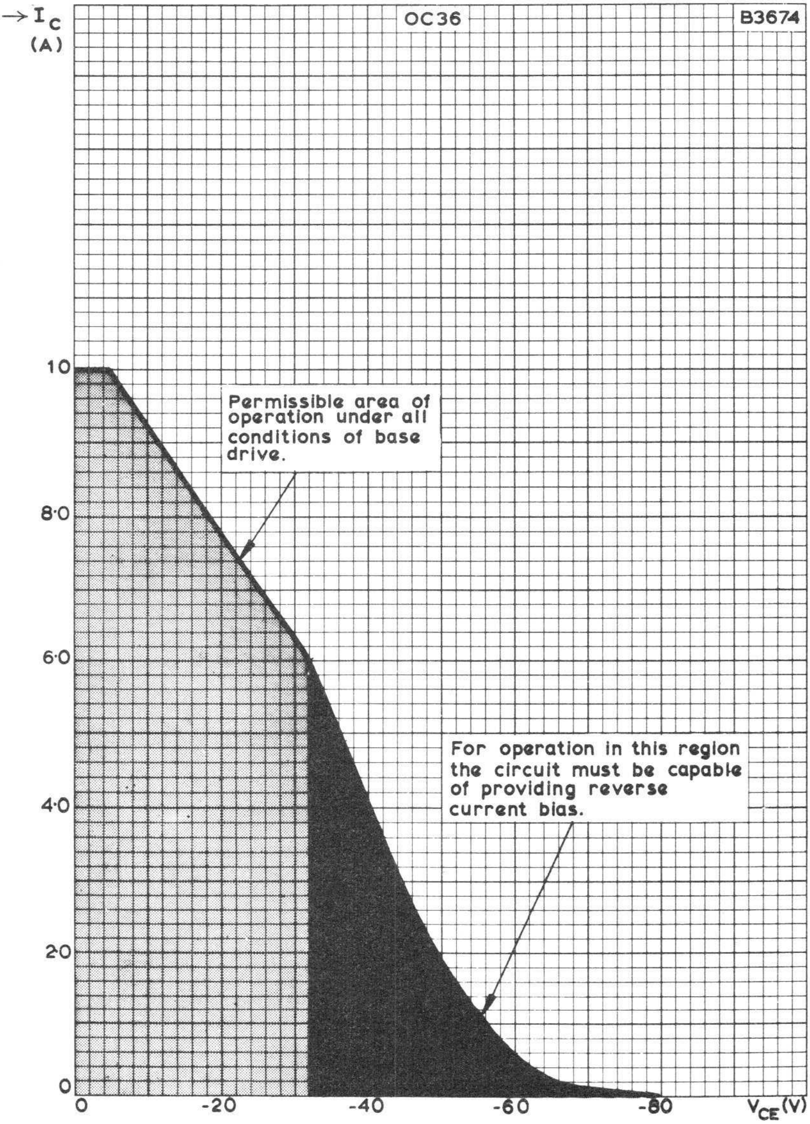
VARIATION OF MAXIMUM EMITTER-BASE CUT-OFF VOLTAGE WITH JUNCTION TEMPERATURE



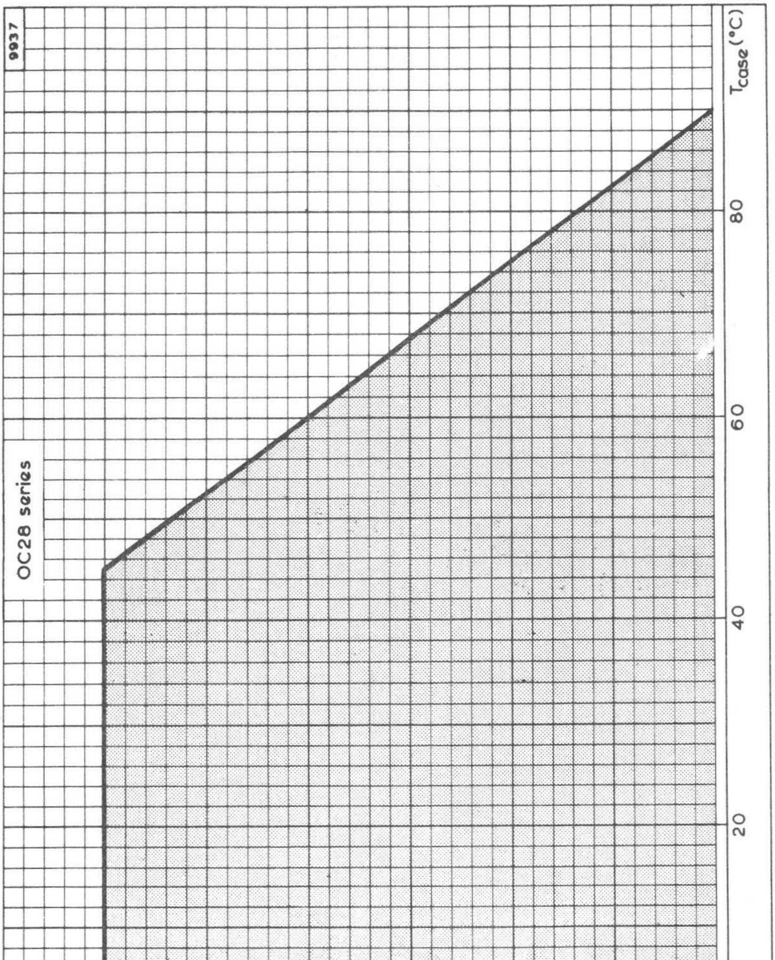
COLLECTOR CURRENT PLOTTED AGAINST ABSOLUTE MAXIMUM COLLECTOR-EMITTER VOLTAGE. OC28



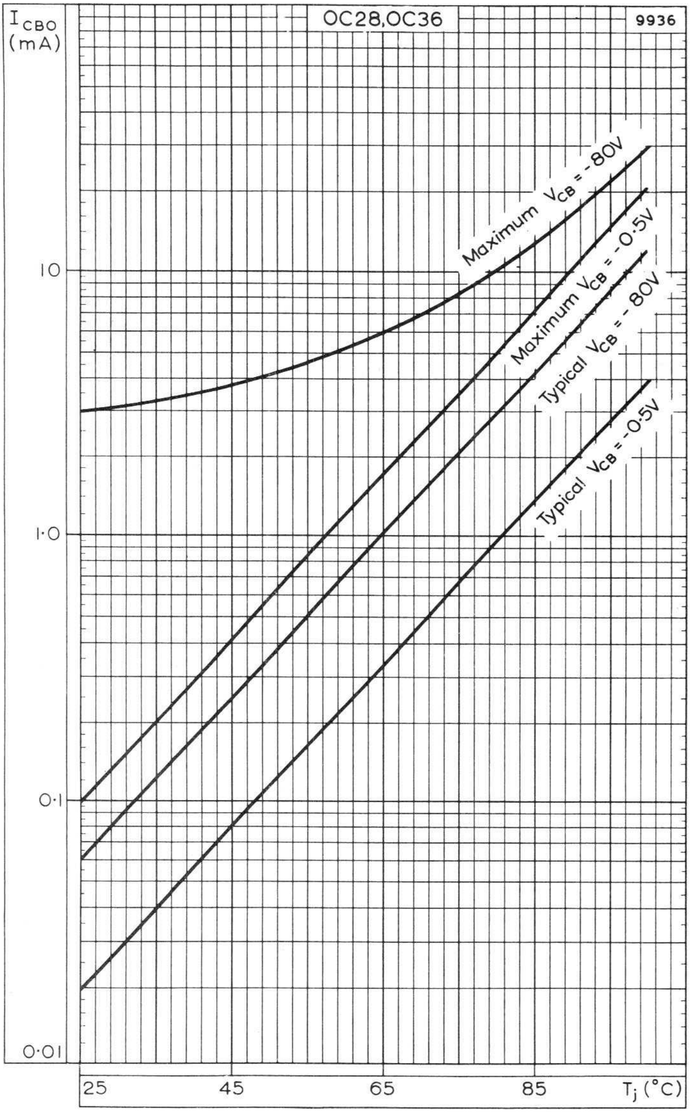
COLLECTOR CURRENT PLOTTED AGAINST ABSOLUTE MAXIMUM COLLECTOR-EMITTER VOLTAGE. OC29, OC35



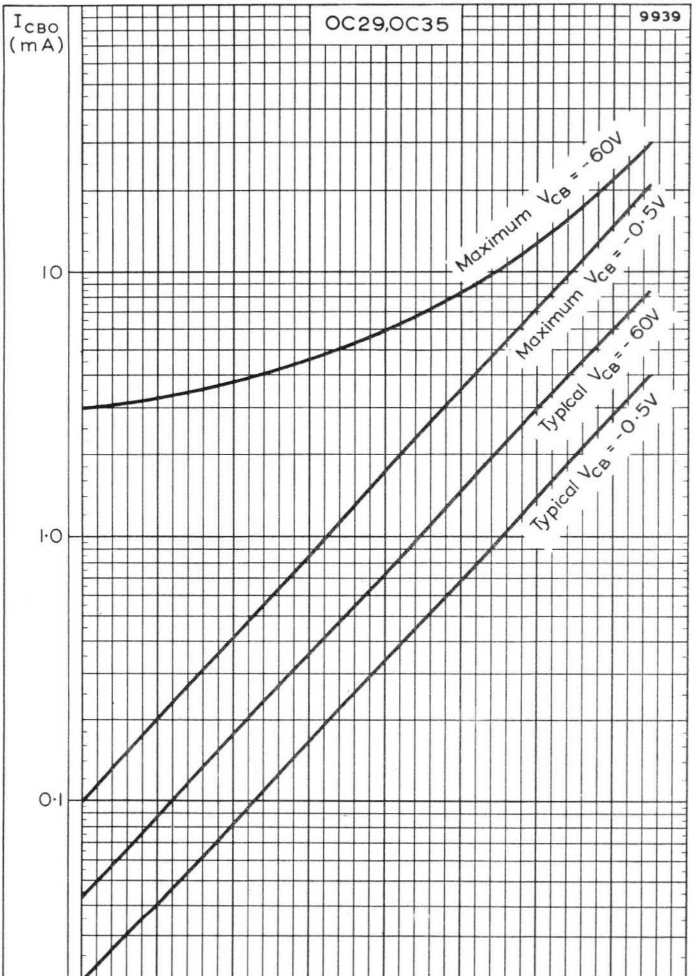
COLLECTOR CURRENT PLOTTED AGAINST ABSOLUTE MAXIMUM COLLECTOR-EMITTER VOLTAGE. OC36



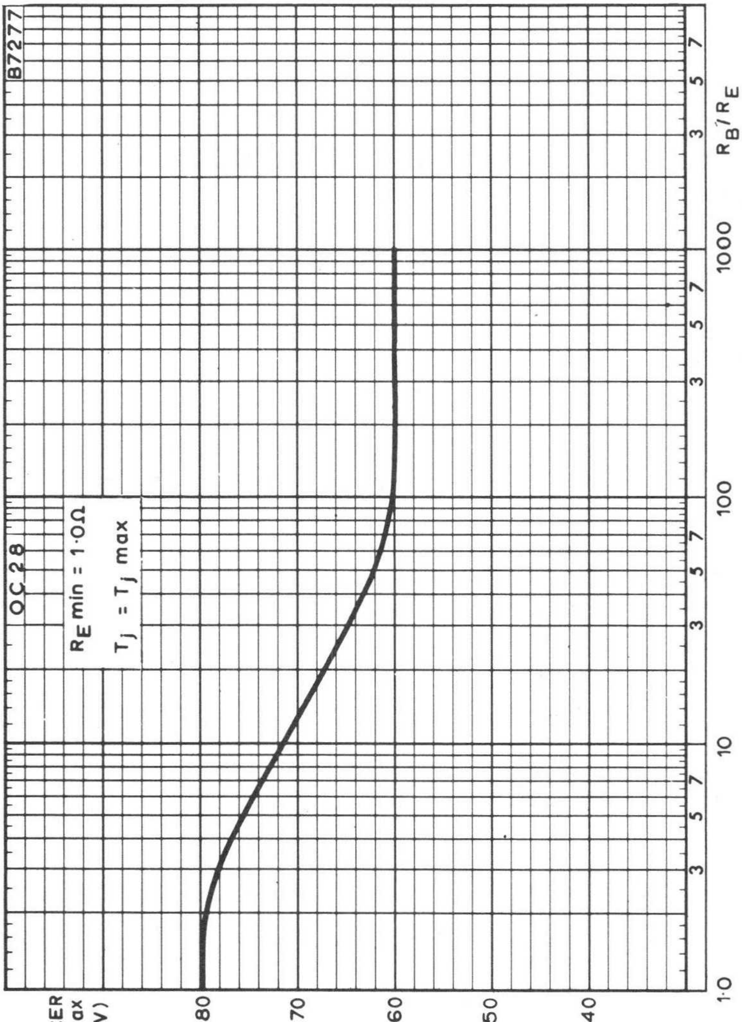
MAXIMUM TOTAL DISSIPATION PLOTTED AGAINST CASE TEMPERATURE



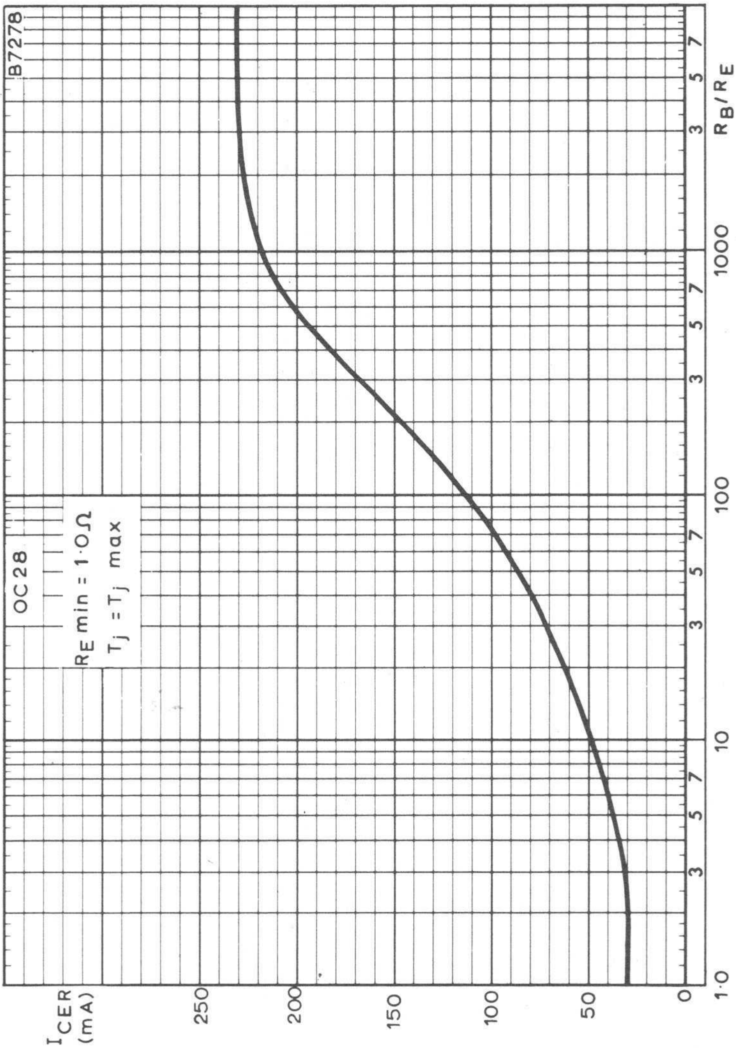
VARIATION OF I_{CBO} WITH JUNCTION TEMPERATURE. OC28, OC36



VARIATION OF I_{CBO} WITH JUNCTION TEMPERATURE. OC29, OC35



MAXIMUM PERMISSIBLE COLLECTOR-EMITTER VOLTAGE PLOTTED AGAINST RATIO OF R_B/R_E



TYPICAL VARIATION OF I_{CER} WITH RATIO OF R_B/R_E

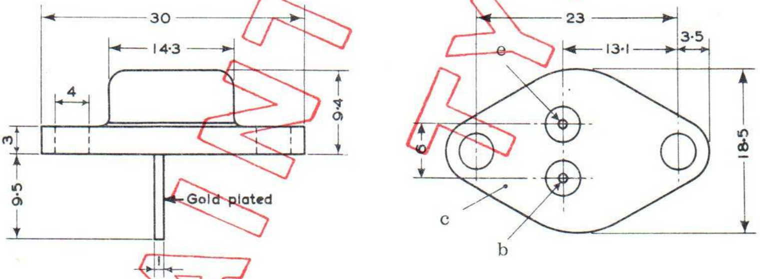
P-N-P GERMANIUM JUNCTION TRANSISTOR

OC30

Medium power junction transistor of the p-n-p alloy type intended for use in output stages and switching circuits.

QUICK REFERENCE DATA		
$-V_{CB}$ max. ($Z_{BE} \leq 500\Omega$)	16	V
$-V_{CE}$ max. ($Z_{BE} \leq 500\Omega$)	16	V
$-V_{EB}$ max.	10	V
$-I_C$ max.	1.4	A
$-I_B$ max.	0.25	A
P_{tot} max. ($T_{mb} = 25^{o}C$)	6.7	W
T_j max.	75	^{o}C
h_{FE} typ. ($-V_{CE} = 14V$, $-I_C = 10mA$)	32	
($-V_{CE} = 7V$, $-I_C = 100mA$)	36	
($-V_{CE} = 1V$, $-I_C = 800mA$)	28	
f_{hfe} typ. ($-V_{CE} = 7V$, $-I_C = 100mA$)	9.0	kHz

OUTLINE AND DIMENSIONS



All dimensions in millimetres

JUNCTION TRANSISTOR

0C41

Junction transistor of the p-n-p alloy type intended for industrial switching applications.

ABSOLUTE MAXIMUM RATINGS

The equipment designer must ensure that no transistor exceeds these ratings. In arriving at the actual operating conditions, variations in supply voltages, component tolerances and ambient temperature must also be taken into account.

Collector voltage		
V_{cb} max. ($I_e = 0$mA)	–16	V
V_{ce} max. ($+V_{be} > 300$mV)	–15	V
Collector current		
$i_{c(pk)}$ max.	150	mA
*I_c max.	50	mA
Emitter current		
$i_{e(pk)}$ max.	150	mA
*I_e max.	50	mA
Reverse emitter-base voltage		
V_{eb} max. ($I_c = 0$mA)	–12	V
Base current		
$i_{b(pk)}$ max.	125	mA
*I_b max.	15	mA
Total dissipation	See page C4	
$\left(p_{tot}\text{ max.} = \frac{T_{junction}\text{ max.} - T_{ambient}}{\theta}\right)$		
Temperature ratings		
Storage temperature limits	–55 to +75	°C
Maximum junction temperature		
Continuous operation	75	°C
Intermittent operation (total duration = 200 hours max.)	90	°C
Junction temperature rise above ambient with transistor in free air, θ		
Without cooling clip	0.6	°C/mW
With type 'a' or extended type 'b' cooling clip (see outline drawing and page D4)	0.5	°C/mW
With standard cooling clip type 'b' on a heat sink 3.5cm × 3.5cm 16s.w.g. aluminium	0.45	°C/mW

*Averaged over any 20ms period.

OC41

JUNCTION TRANSISTOR

CHARACTERISTICS at $T_{ambient} = 25°C$

		Typical production spreads			
		Min.	*Typ.*	*Max.*	
Grounded base					
Collector leakage current ($V_{cb} = -15V$, $I_e = 0mA$, $T_{ambient} = 60°C$)	I_{co}	—	10	30	μA
Emitter leakage current ($V_{eb} = -12V$, $I_c = 0mA$)	I_{eo}	—	2.0	10	μA
Grounded emitter					
Collector leakage current with reversed bias on base	I_{coo}				
($V_{ce} = -15V$, $V_{be} = +500mV$)		—	2.0	10	μA
($V_{ce} = -15V$, $V_{be} = +500mV$, $T_{ambient} = 60°C$)		—	10	30	μA
Collector knee voltage at $I_c = 50mA$ (see fig. 1)	$V_{c(knee)}$	—	-200	—	mV
Collector bottoming voltage	V_{ce}				
($I_c = 10mA$, $I_b = 600\mu A$)		-40	-70	-140	mV
($I_c = 50mA$, $I_b = 3mA$)		-60	-100	-200	mV
($I_c = 125mA$, $I_b = 14mA$)		-60	-120	-280	mV
Current amplification factor $\bar{\alpha}' = \frac{I_c - I_{co}}{I_b + I_{co}}$					
($V_{cb} = 0V$, $I_c = 10mA$)		20	40	90	
($V_{cb} = 0V$, $I_c = 50mA$)		20	35	80	
($V_{cb} = 0V$, $i_{c(pk)} = 125mA$)		10	25	60	

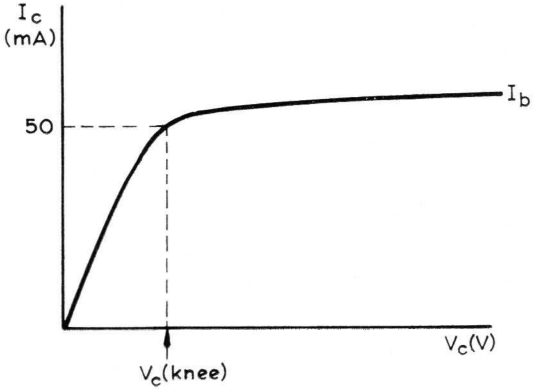


Fig. 1

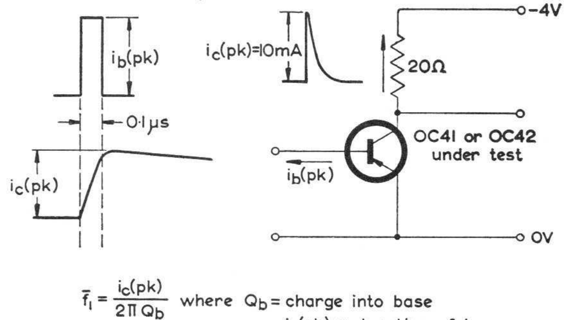
5872

BASIC PARAMETERS

		Typical productions spreads Min.	Typ.	Max.	
Collector depletion capacitance (V_{cb} = −6V)	$c_{c(dep)}$	—	9.0	14	pF
Typical parameters for pulse operation					
Large signal cut-off frequency (see fig. 2)	$\bar{f}_1$	3.0	4.0	—	Mc/s
On demand current gain	β_s				
($i_{c(pk)}$ = 5mA, $v_{ce(pk)}$ = −5V, $v_{ce(pk)}$ = −200mV)		10	25	—	
($i_{c(pk)}$ = 10mA, $v_{ce(pk)}$ = −10V, $v_{ce(pk)}$ = −200mV)		15	30	—	
Desaturation time constant (I_c = 50mA)	τ_s	0.4	1.0	1.7	µs
Current drive time constant $\tau_c = \frac{\alpha'}{\omega_1}$	τ_c				
($i_{c(pk)}$ = 10mA, $v_{ce(pk)}$ = −750mV)		0.5	1.5	3.0	µs
($i_{c(pk)}$ = 125mA, $v_{ce(pk)}$ = −750mV)		0.3	1.3	2.8	µs
Voltage drive time constant ($i_{c(pk)}$ = 1mA, $v_{ce(pk)}$ = −1.5V)	τ_v	50	100	150	ns
*Figure of merit	$\frac{\omega_1}{r_{bb'}}$		0.4×10^6		rad/Ω

*The value of $\frac{\omega_1}{r_{bb'}}$ is the reciprocal of the product of r_e and the voltage drive time constant, τ_v

MEASUREMENT OF $\bar{f}_l$



$$\bar{f}_l = \frac{i_c(pk)}{2\pi Q_b}$$ where Q_b = charge into base = $i_b(pk)$ x duration of base current pulse.

6193

Fig. 2

SOLDERING AND WIRING RECOMMENDATIONS

1. When using a soldering iron, transistors may be soldered directly into the circuit, but heat conducted to the junction should if possible be kept to a minimum by the use of a thermal shunt.
2. Transistors may be dip-soldered at a solder temperature of 245°C for a maximum soldering time of 5 seconds. The case temperature during dip-soldering may exceed the maximum storage temperature for a period not greater than 2 minutes, provided that it at no time exceeds 115°C. These recommendations apply to a transistor mounted flush on a board having punched-through holes, or spaced at least 1.5mm away from a board having plated-through holes.
3. Care should be taken not to bend the leads nearer than 1.5mm from the seal.

COOLING CLIPS

Type 'a'

Intended for operation in free air and not recommended for bolting on to a heat sink.

Type 'b'

Extended version.–Intended for operation in free air but may be bolted on to such materials as paxolin without deterioration in the thermal resistance.

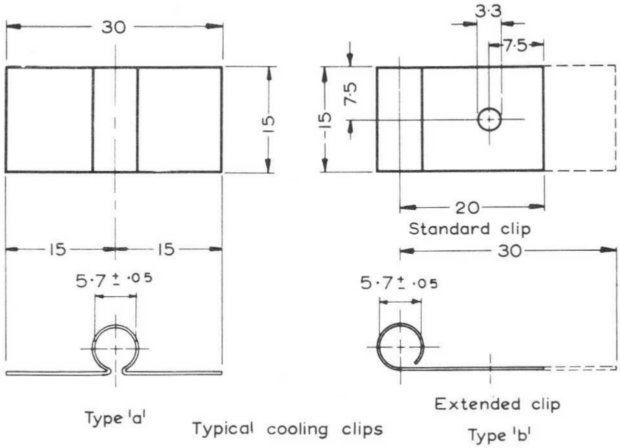
Standard version.–Intended to be bolted on to a heat sink.

ACCESSORIES

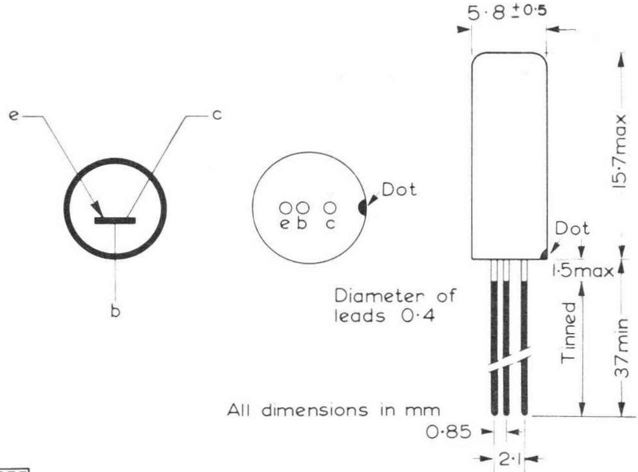
Accessory	*Code No.*	*Notes*
Cooling clip type 'a'	56209	Must be
Cooling clip type 'b'		specifically
standard version	56210	ordered

The extended version of the cooling clip type 'b' is not supplied by Mullard Limited.

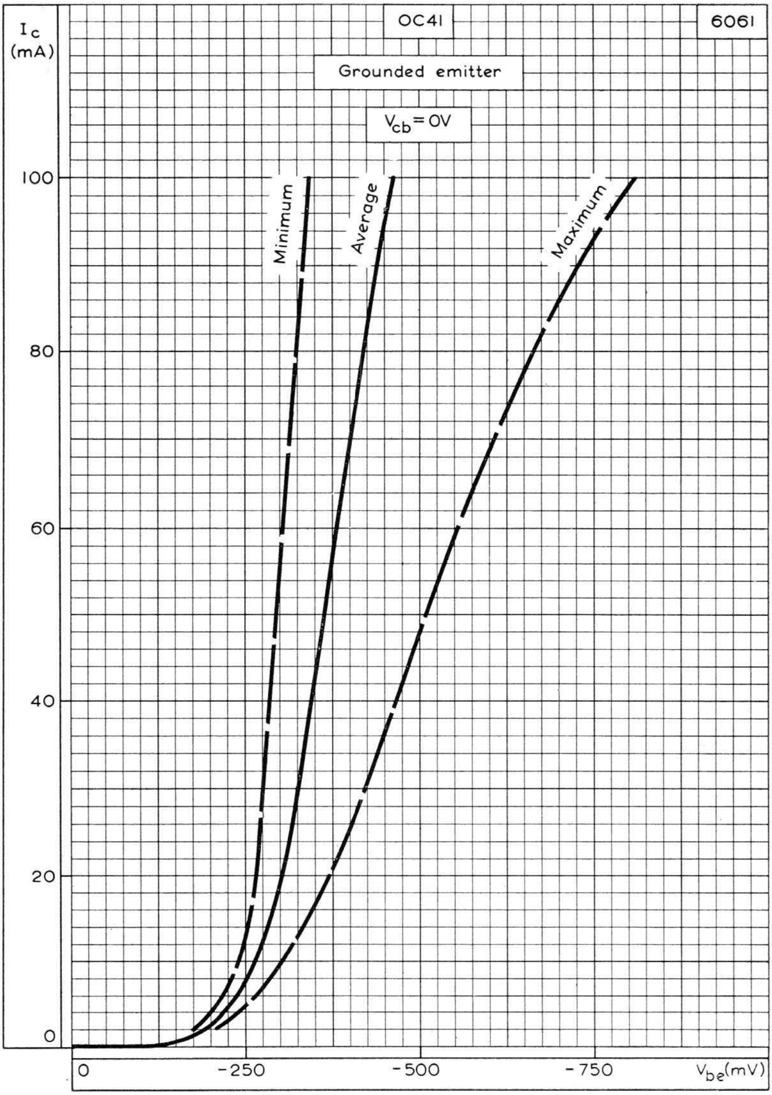
B044



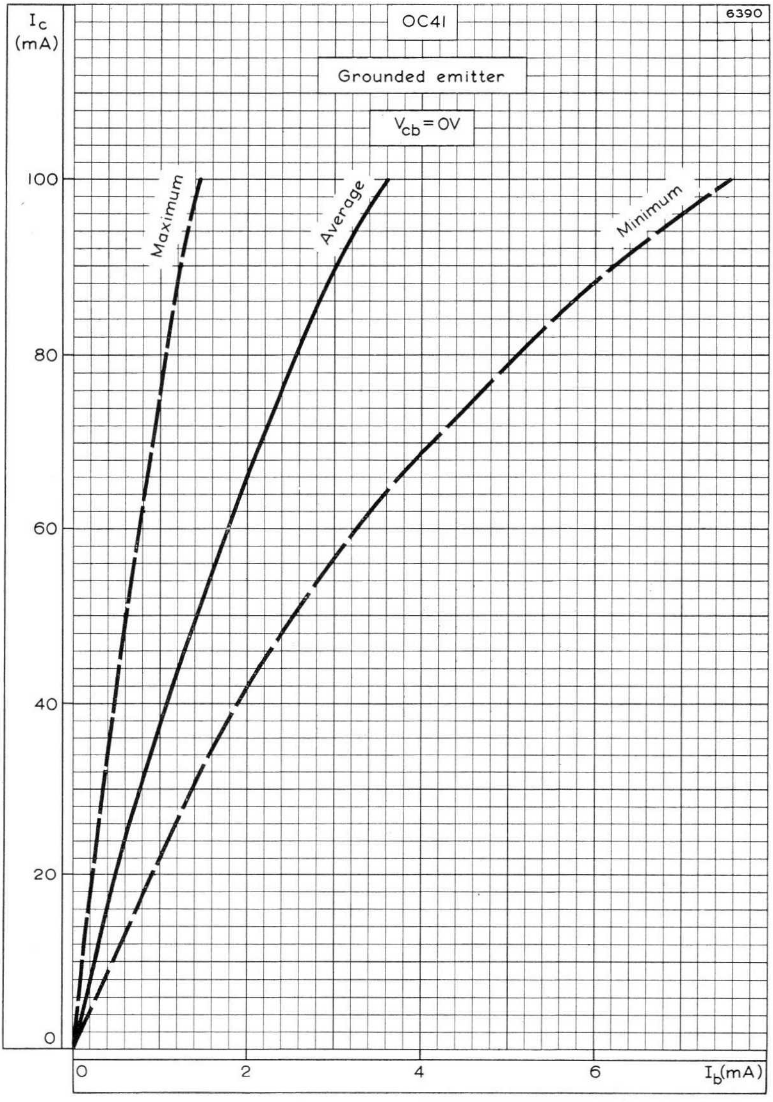
Material: 0·5mm copper strip commercial half-hard BS899



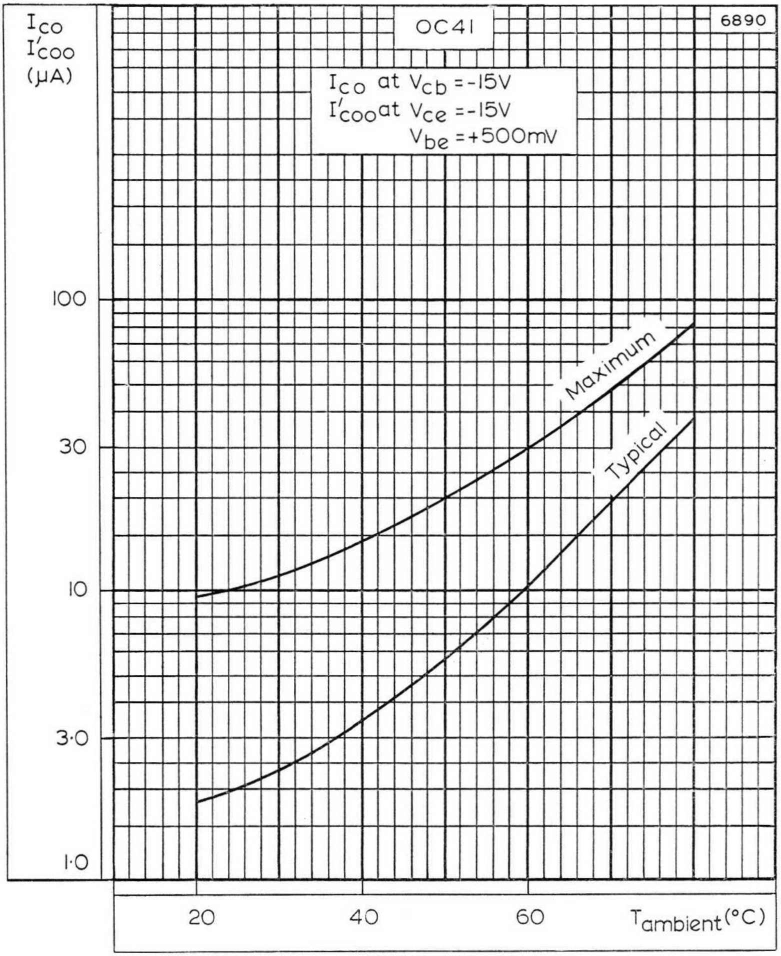
B3377



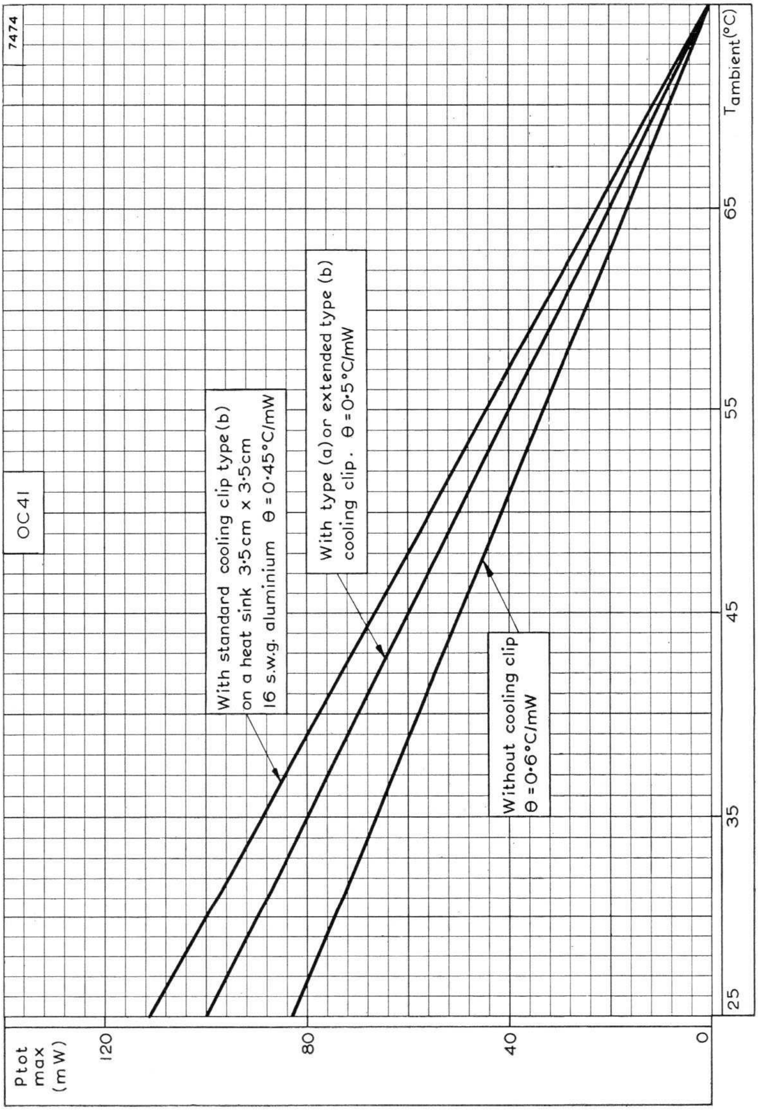
SPREAD OF BASE-EMITTER VOLTAGE PLOTTED AGAINST COLLECTOR CURRENT



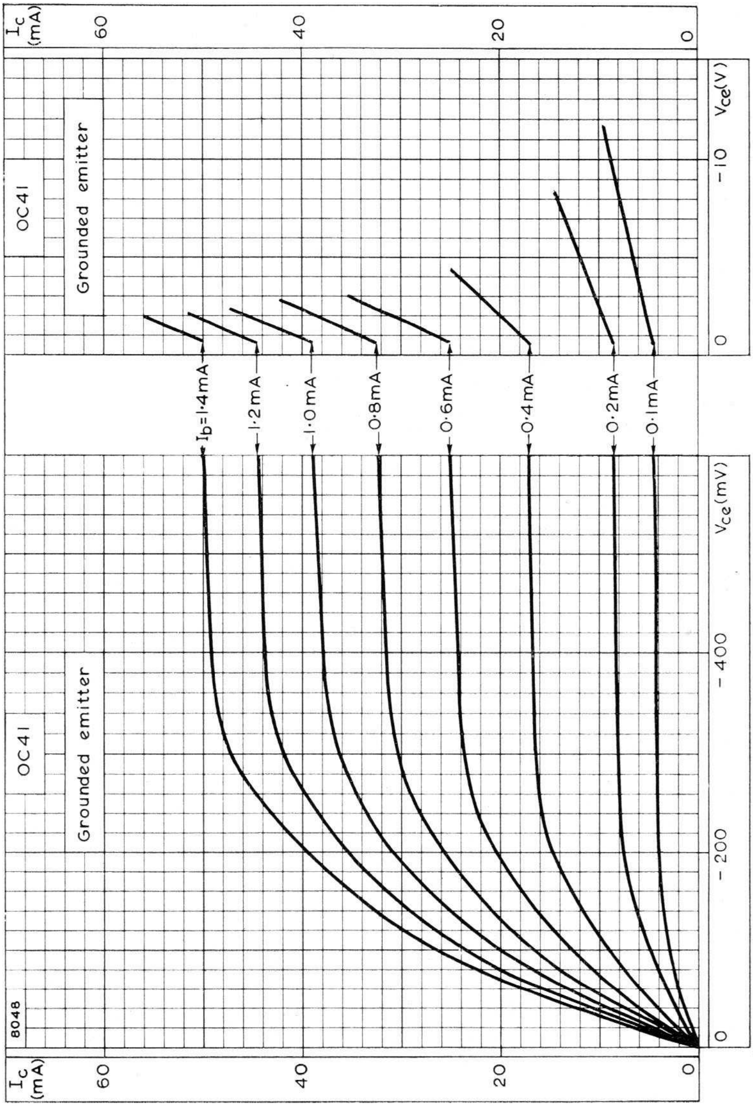
SPREAD OF TRANSFER CHARACTERISTIC



COLLECTOR LEAKAGE CURRENT AND COLLECTOR LEAKAGE CURRENT WITH REVERSED BIAS ON THE BASE PLOTTED AGAINST AMBIENT TEMPERATURE



MAXIMUM TOTAL DISSIPATION PLOTTED AGAINST AMBIENT TEMPERATURE



OUTPUT CHARACTERISTICS. GROUNDED EMITTER

JUNCTION TRANSISTOR

0C42

Junction transistor of the p-n-p alloy type intended for industrial switching applications.

ABSOLUTE MAXIMUM RATINGS

The equipment designer must ensure that no transistor exceeds these ratings. In arriving at the actual operating conditions, variations in supply voltages, component tolerances and ambient temperature must also be taken into account.

Collector voltage		
V_{cb} max. ($I_e = 0$mA)	–16	V
V_{ce} max. ($+V_{be} > 300$mV)	–15	V
Collector current		
$i_{c(pk)}$ max.	150	mA
*I_c max.	50	mA
Emitter current		
$i_{e(pk)}$ max.	150	mA
*I_e max.	50	mA
Reverse emitter-base voltage		
V_{eb} max. ($I_c = 0$mA)	–12	V
Base current		
$i_{b(pk)}$ max.	125	mA
*I_b max.	15	mA
Total dissipation	See page C4	
$\left(p_{tot}\text{ max.} = \dfrac{T_{junction}\text{ max.} - T_{ambient}}{\theta}\right)$		
Temperature ratings		
Storage temperature limits	–55 to +75	°C
Maximum junction temperature		
Continuous operation	75	°C
Intermittent operation (total duration = 200 hours max.)	90	°C
Junction temperature rise above ambient with transistor in free air, θ		
Without cooling clip	0.6	°C/mW
With type 'a' or extended type 'b' cooling clip (see outline drawing and page D4)	0.5	°C/mW
With standard cooling clip type 'b' on a heat sink 3.5cm × 3.5cm 16s.w.g. aluminium	0.45	°C/mW

*Averaged over any 20ms period.

0C42 JUNCTION TRANSISTOR

CHARACTERISTICS at $T_{ambient} = 25°C$

		Typical production spreads			
Grounded base		*Min.*	*Typ.*	*Max.*	
Collector leakage current ($V_{cb} = -15V$, $I_e = 0mA$, $T_{ambient} = 60°C$)	I_{co}	—	10	30	µA
Emitter leakage current ($V_{eb} = -12V$, $I_c = 0mA$)	I_{eo}	—	2.0	10	µA
Grounded emitter					
Collector leakage current with reversed bias on base	I_{coo}				
($V_{ce} = -15V$, $V_{be} = +500mV$)		—	2.0	10	µA
($V_{ce} = -15V$, $V_{be} = +500mV$, $T_{ambient} = 60°C$)		—	10	30	µA
Collector knee voltage at $I_c = 50mA$ (see fig. 1)	$V_{c(knee)}$	—	−200	—	mV
Collector bottoming voltage	V_{ce}				
($I_c = 10mA$, $I_b = 300\mu A$)		−40	−70	−140	mV
($I_c = 50mA$, $I_b = 1.5mA$)		−60	−100	−200	mV
($I_c = 125mA$, $I_b = 7mA$)		−60	−120	−280	mV
Current amplification factor $\bar{\alpha}' = \frac{I_c - I_{co}}{I_b + I_{co}}$					
($V_{cb} = 0V$, $I_c = 10mA$)		40	80	—	
($V_{cb} = 0V$, $I_c = 50mA$)		40	70	—	
($V_{cb} = 0V$, $i_{c(pk)} = 125mA$)		20	50	—	

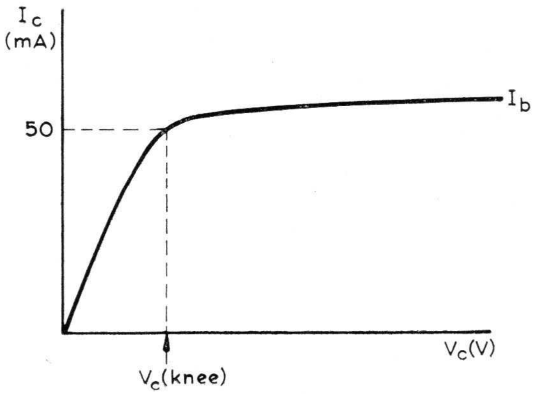


Fig. 1

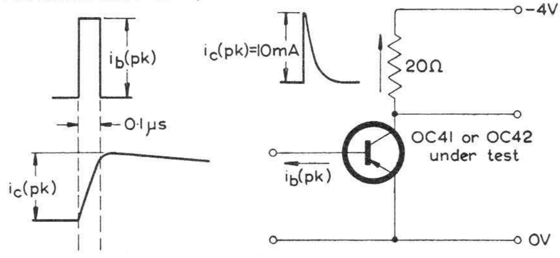
5872

BASIC PARAMETERS

		Min.	Typ.	Max.	
		Typical production spreads			
Collector depletion capacitance ($V_{cb} = -6V$)	$c_{c(dep)}$	—	9.0	14	pF
Typical parameters for pulse operation					
Large signal cut-off frequency (see fig. 2)	$\bar{f}_1$	5.5	7.0	—	Mc/s
On demand current gain	β_s				
($i_{c(pk)} = 5mA$, $v_{cc(pk)} = -5V$, $v_{ce(pk)} = -200mV$)		10	30	—	
($i_{c(pk)} = 10mA$, $v_{cc(pk)} = -10V$, $v_{ce(pk)} = -200mV$)		15	40	—	
Desaturation time constant ($I_c = 50mA$)	τ_s	0.2	0.7	1.7	μs
Current drive time constant $\tau_c = \frac{\alpha'}{\bar{\omega}_1}$	τ_c				
($i_{c(pk)} = 10mA$, $v_{ce(pk)} = -750mV$)		0.3	1.2	2.5	μs
($i_{c(pk)} = 125mA$, $v_{ce(pk)} = -750mV$)		0.3	1.0	2.0	μs
Voltage drive time constant ($i_{c(pk)} = 1mA$, $v_{ce(pk)} = -1.5V$)	τ_v	20	70	130	ns
*Figure of merit	$\frac{\omega_1}{r_{bb'}}$		0.57×10^6		rad/Ω

*The value of $\frac{\omega_1}{r_{bb'}}$ is the reciprocal of the product of r_e and the voltage drive time constant, τ_v

MEASUREMENT OF $\bar{f}_1$



$\bar{f}_1 = \frac{i_c(pk)}{2\pi Q_b}$ where Q_b = charge into base
= $i_b(pk)$ x duration of base current pulse.

6193

Fig. 2

SOLDERING AND WIRING RECOMMENDATIONS

1. When using a soldering iron, transistors may be soldered directly into the circuit, but heat conducted to the junction should if possible be kept to a minimum by the use of a thermal shunt.
2. Transistors may be dip-soldered at a solder temperature of 245°C for a maximum soldering time of 5 seconds. The case temperature during dip-soldering may exceed the maximum storage temperature for a period not greater than 2 minutes, provided that it at no time exceeds 115°C. These recommendations apply to a transistor mounted flush on a board having punched-through holes, or spaced at least 1.5mm away from a board having plated-through holes.
3. Care should be taken not to bend the leads nearer than 1.5mm from the seal.

COOLING CLIPS

Type 'a'

Intended for operation in free air and not recommended for bolting on to a heat sink.

Type 'b'

Extended version.–Intended for operation in free air but may be bolted on to such materials as paxolin without deterioration in the thermal resistance.

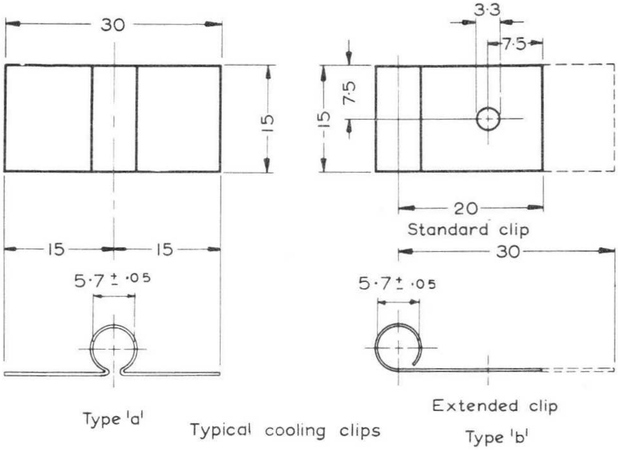
Standard version.–Intended to be bolted on to a heat sink.

ACCESSORIES

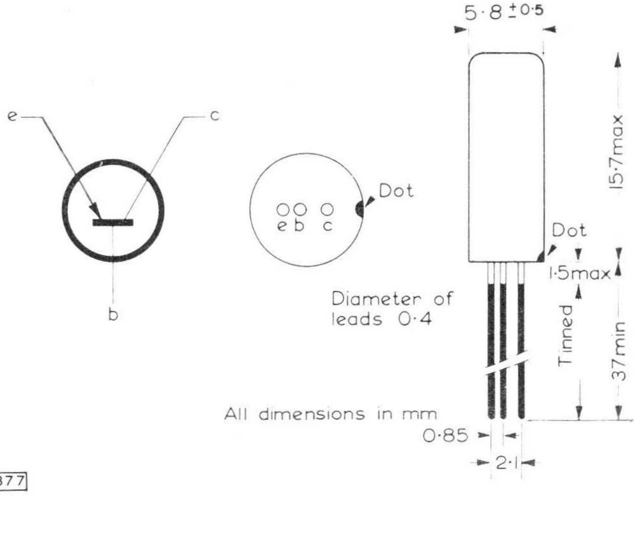
Accessory	*Code No.*	*Notes*
Cooling clip type 'a'	56209	Must be
Cooling clip type 'b'		specifically
standard version	56210	ordered

The extended version of the cooling clip type 'b' is not supplied by Mullard Limited.

B044

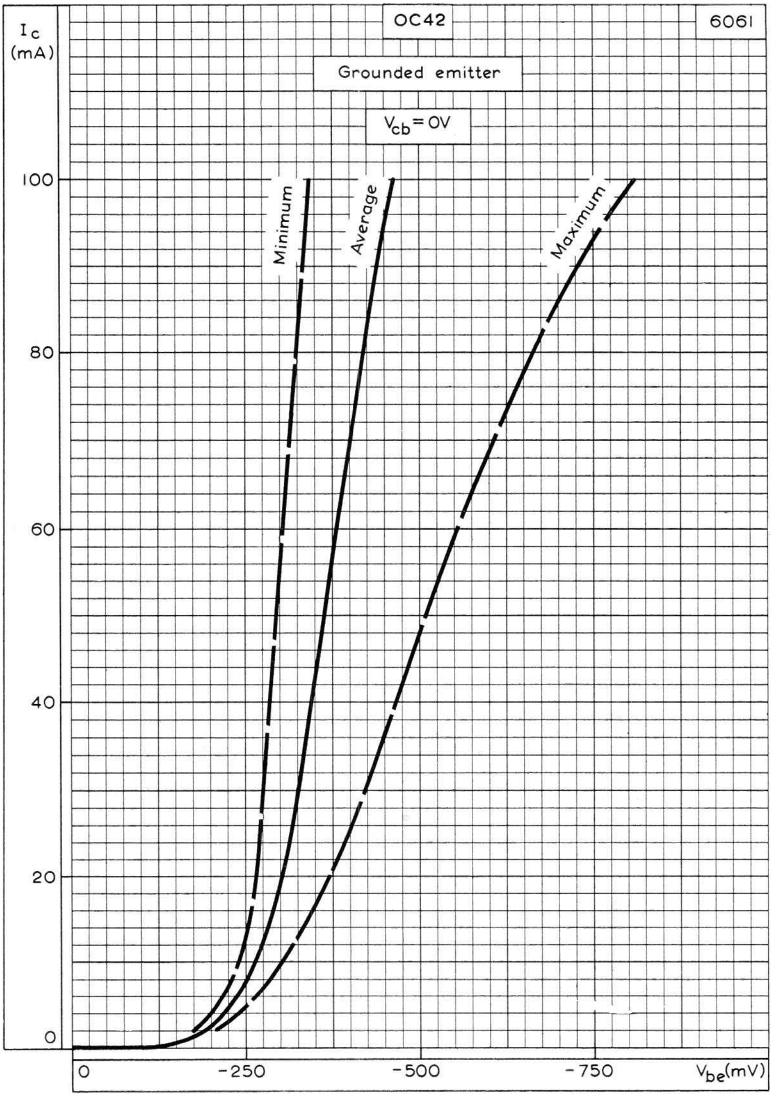


Material: 0·5mm copper strip commercial half-hard BS899

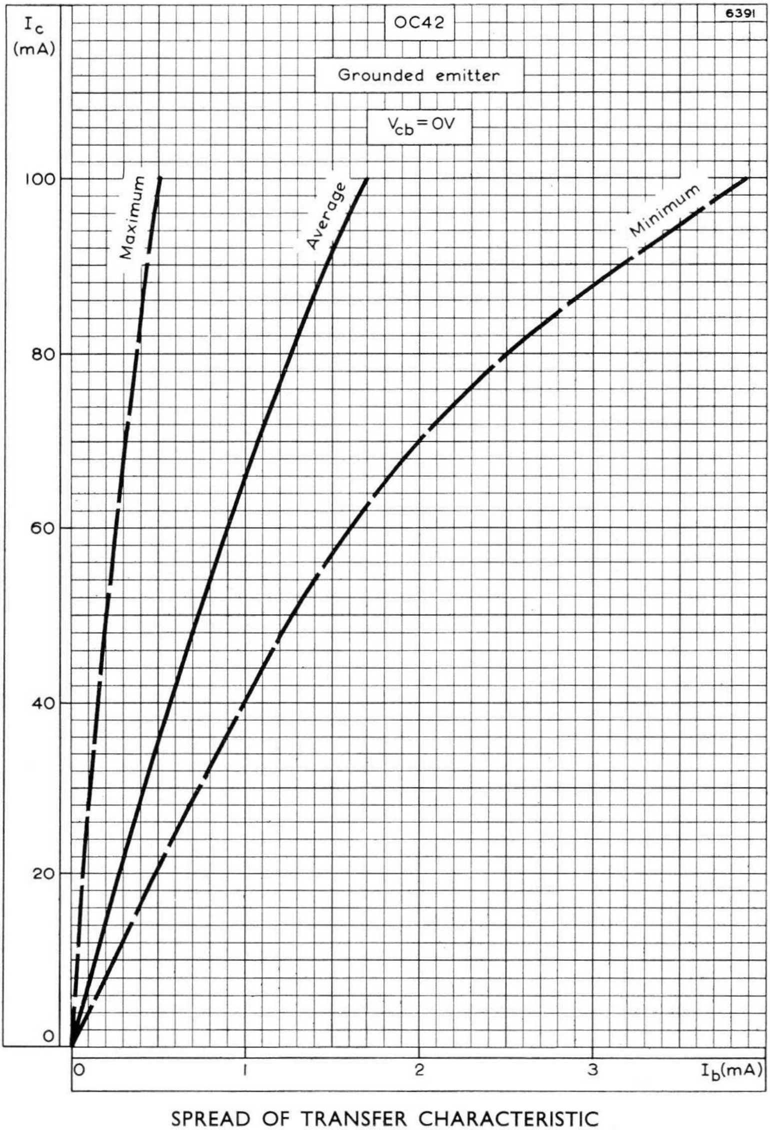


All dimensions in mm

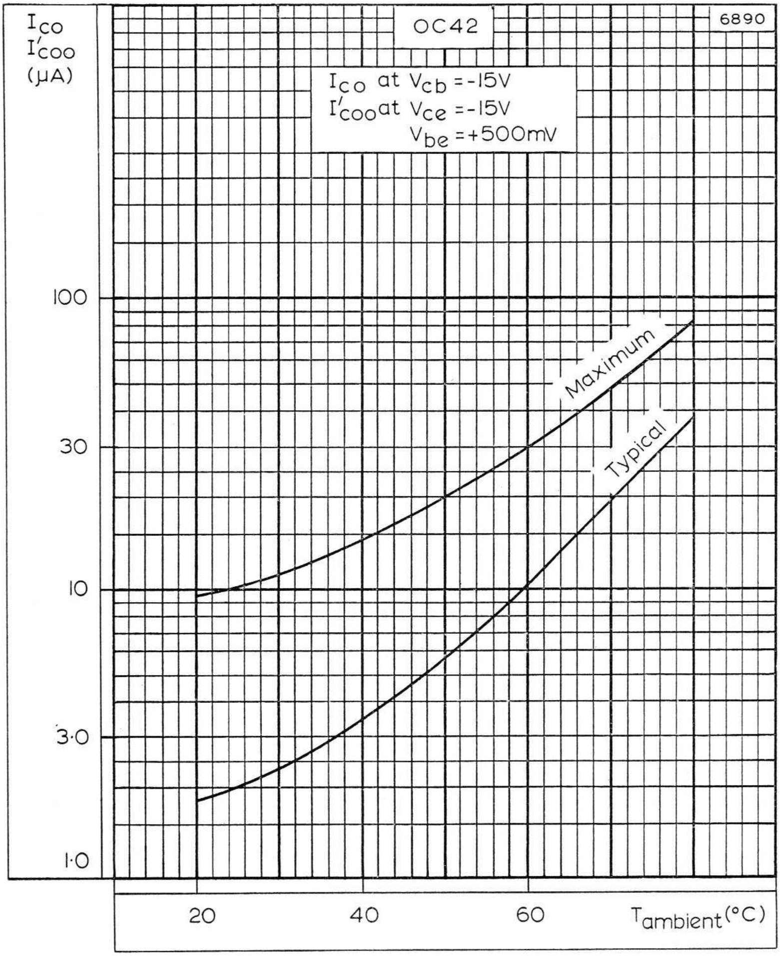
B3377



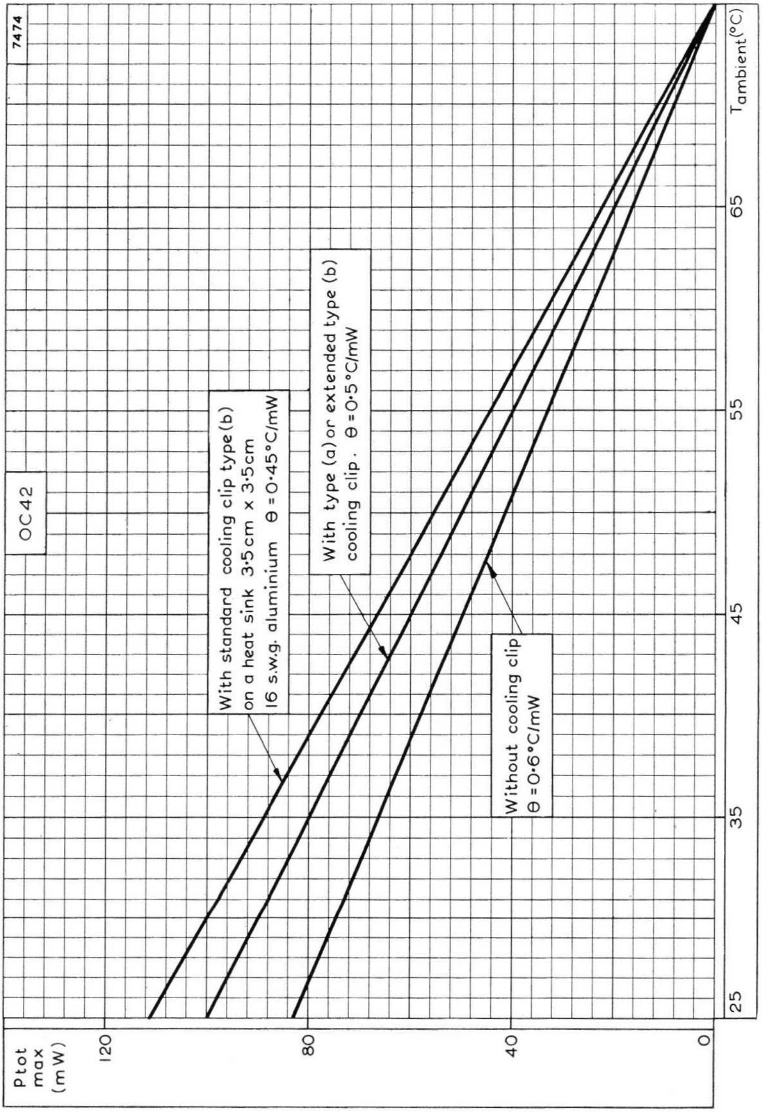
SPREAD OF BASE-EMITTER VOLTAGE PLOTTED AGAINST COLLECTOR CURRENT



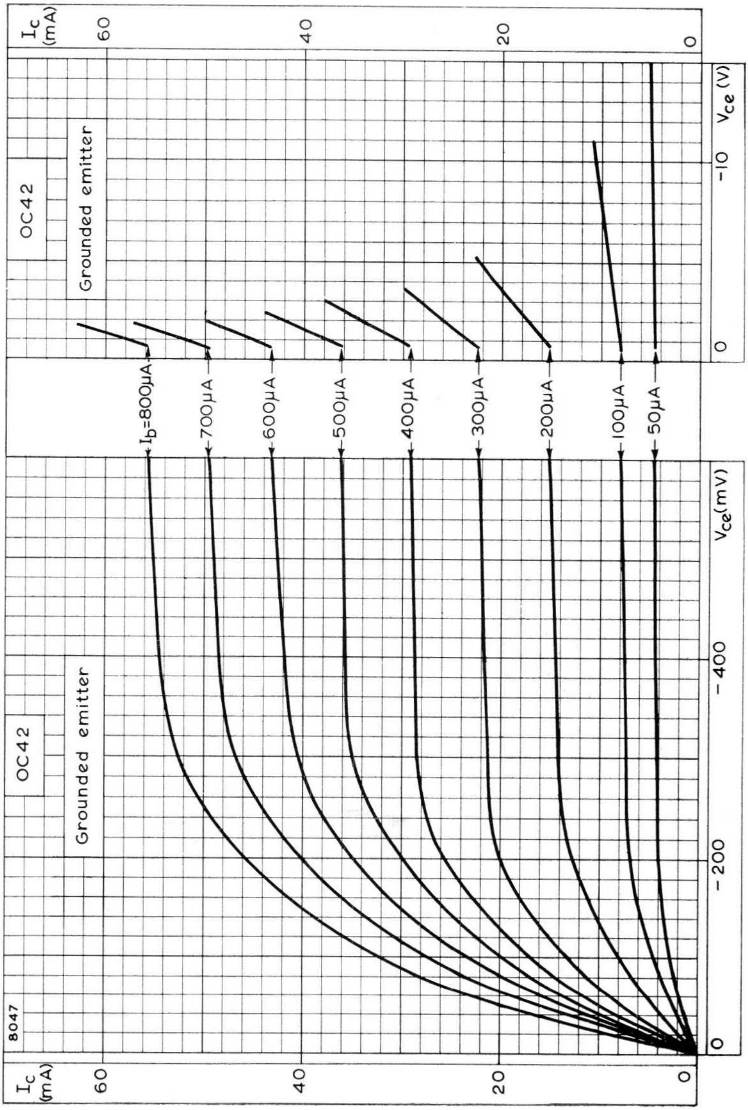
SPREAD OF TRANSFER CHARACTERISTIC



COLLECTOR LEAKAGE CURRENT AND COLLECTOR LEAKAGE CURRENT WITH REVERSED BIAS ON THE BASE PLOTTED AGAINST AMBIENT TEMPERATURE



MAXIMUM TOTAL DISSIPATION PLOTTED AGAINST AMBIENT TEMPERATURE



OUTPUT CHARACTERISTICS. GROUNDED EMITTER

JUNCTION TRANSISTOR OC43

Junction transistor of the p-n-p alloy type intended for industrial switching applications.

ABSOLUTE MAXIMUM RATINGS (limiting values)

The equipment designer must ensure that no transistor exceeds these ratings. In arriving at the actual operating conditions, variations in supply voltages, component tolerances and ambient temperatures must also be taken into account.

Collector voltage		
V_{cb} max. ($I_e = 0$mA)	−15	V
V_{ce} max. ($+V_{be} > 500$mV)	−15	V
Collector current		
$i_{c(pk)}$ max.	150	mA
*I_c max.	50	mA
Emitter current		
$i_{e(pk)}$ max.	150	mA
*I_e max.	50	mA
Reverse emitter-base voltage		
V_{eb} max. ($I_c = 0$mA)	−12	V
Base current		
$i_{b(pk)}$ max.	125	mA
*I_b max.	15	mA
Temperature ratings		
Storage temperature limits	−55 to +75	°C
Maximum junction temperature		
Continuous operation	75	°C
Intermittent operation (total duration = 200 hours max.)	90	°C
Junction temperature rise above ambient with transistor in free air, θ		
Without cooling clip	0.6	°C/mW
With type 'a' or extended type 'b' cooling clip (see outline drawing and page D3)	0.5	°C/mW
With standard cooling clip type 'b' on a heat sink 3.5cm × 3.5cm 16 s.w.g. aluminium	0.45	°C/mW

*Averaged over any 20ms period

CHARACTERISTICS at $T_{ambient}=25°C$

		Typical production spreads Min.	Typ.	Max.	
Grounded base					
Collector leakage current	I_{co}				
($V_{cb}=-15V$, $I_e=0mA$)		—	2.0	10	µA
($V_{cb}=-15V$, $I_e=0mA$, $T_{ambient}=60°C$)		—	10	30	µA
Emitter leakage current ($V_{eb}=-12V$, $I_c=0mA$, $T_{junction}=25°C$)	I_{eo}	—	1.5	10	µA
Grounded emitter					
Collector current with reversed bias on base ($V_{ce}=-15V$, $V_{be}=+500mV$)	I_{coo}	—	2.0	10	µA
Collector bottoming voltage ($i_{c(pk)}=125mA$, $I_b=7mA$)	V_{ce}	-60	-120	-280	mV
Base input voltage ($V_{cb}=0V$, $I_c=50mA$)	V_{be}	—	-360	—	mV
Current amplification factor $\bar{\alpha}'=\frac{I_c - I_{co}}{I_b + I_{co}}$					
($V_{cb}=0V$, $I_c=50mA$)		50	100	200	
($V_{cb}=0V$, $i_{c(pk)}=150mA$)		30	60	120	

BASIC PARAMETERS

Measured at $V_c=-6V$, $I_c=1mA$, $T_{junction}=25°C$

	Min.	Typ.	Max.	
*r_e	—	25	—	Ω
$r_{bb'}$	—	120	—	Ω
$c_{c(dep)}$ ($I_e=0mA$)	—	9.0	14	pF

*The value of r_e given here is $\frac{kT}{q} \cdot \frac{1}{I_e} \simeq \frac{25}{I_e}$, where I_e is in mA and T is in °K.

Typical parameters for pulse operation

		Typical production spreads Min.	*Typ.*	*Max.*	
Current amplification cut-off frequency at $V_{ce}=-6V$, $I_e=1mA$ ($\|\alpha'\|=1$)	f_1	12	18	—	Mc/s
On demand current gain	β_s				
($i_{c(pk)}=5mA$, $v_{cc(pk)}=-5V$, $v_{ce(pk)}=-200mV$)		20	60	—	
($i_{c(pk)}=10mA$, $v_{cc(pk)}=-10V$, $v_{ce(pk)}=-200mV$)		25	75	—	
Desaturation time constant ($I_c=50mA$)	τ_s	—	1.0	1.7	µs
Current drive time constant $\tau_e=\frac{\alpha'}{\omega_1}$	τ_e				
($i_{c(pk)}=10mA$, $v_{ce(pk)}=-750mV$)		—	1.2	2.5	µs
($i_{c(pk)}=125mA$, $v_{ce(pk)}=-750mV$)		—	0.75	1.5	µs
†Figure of merit	$\frac{\omega_1}{r_{bb'}}$		0.7×10^6		rad/Ω

†The value of $\frac{\omega_1}{r_{bb'}}$ is the reciprocal of the product of r_e and the voltage drive time constant, τ_v.

SOLDERING AND WIRING RECOMMENDATIONS

1. When using a soldering iron, transistors may be soldered directly into the circuit, but heat conducted to the junction should if possible be kept to a minimum by the use of a thermal shunt.
2. Transistors may be dip-soldered at a solder temperature of 245°C for a maximum soldering time of 5 seconds. The case temperature during dip-soldering may exceed the maximum storage temperature for a period not greater than 2 minutes, provided that it at no time exceeds 115°C. These recommendations apply to a transistor mounted flush on a board having punched-through holes, or spaced at least 1.5mm away from a board having plated-through holes.
3. Care should be taken not to bend the leads nearer than 1.5mm from the seal.

COOLING CLIPS

Type 'a' Intended for operation in free air and not recommended for bolting on to a heat sink.

Type 'b' *Extended version.* Intended for operation in free air but may be bolted on to such materials as paxolin without deterioration in the thermal resistance.

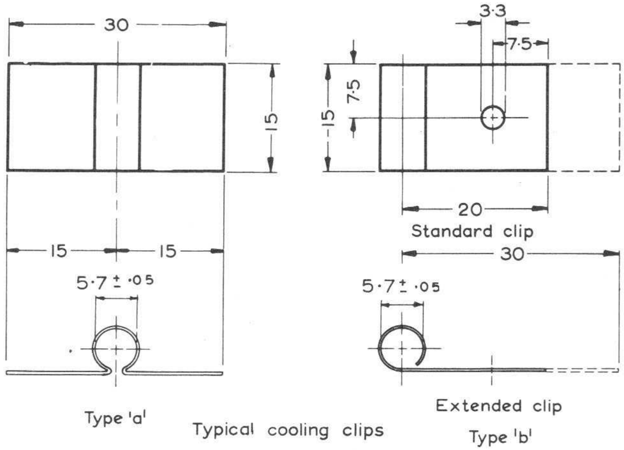
Standard version. Intended to be bolted on to a heat sink.

ACCESSORIES

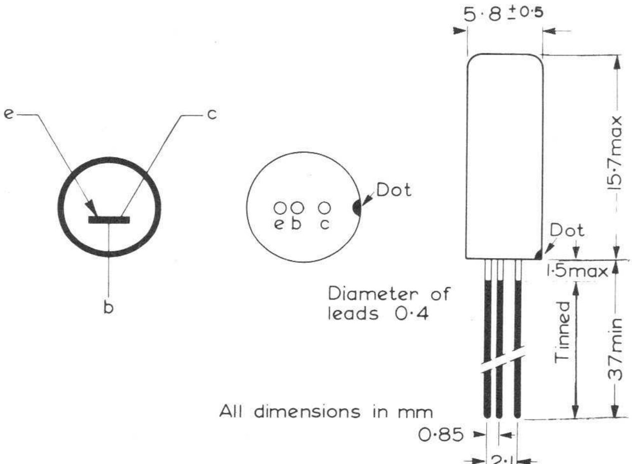
Accessory	*Code No.*	*Notes*
Cooling clip type 'a'	56209	Must be specifically ordered
Cooling clip type 'b' standard version	56210	

The extended version of the cooling clip type 'b' is not supplied by Mullard Ltd.

B044



Material: 0·5mm copper strip commercial half-hard BS899



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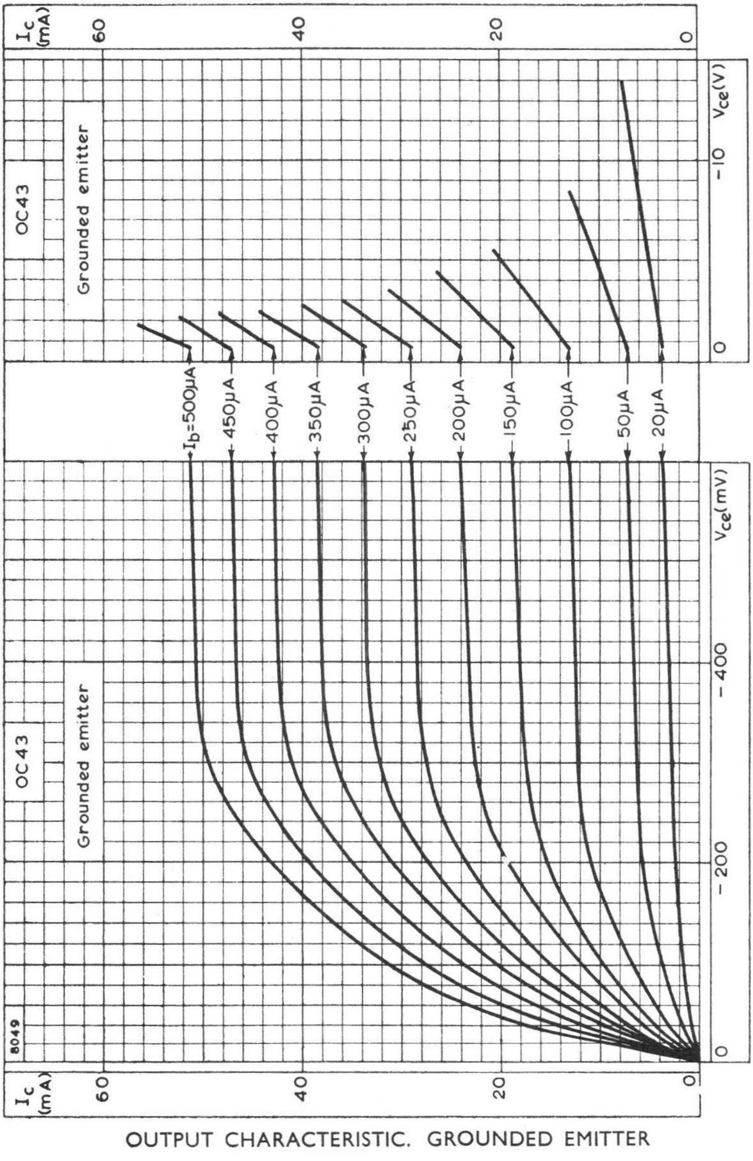
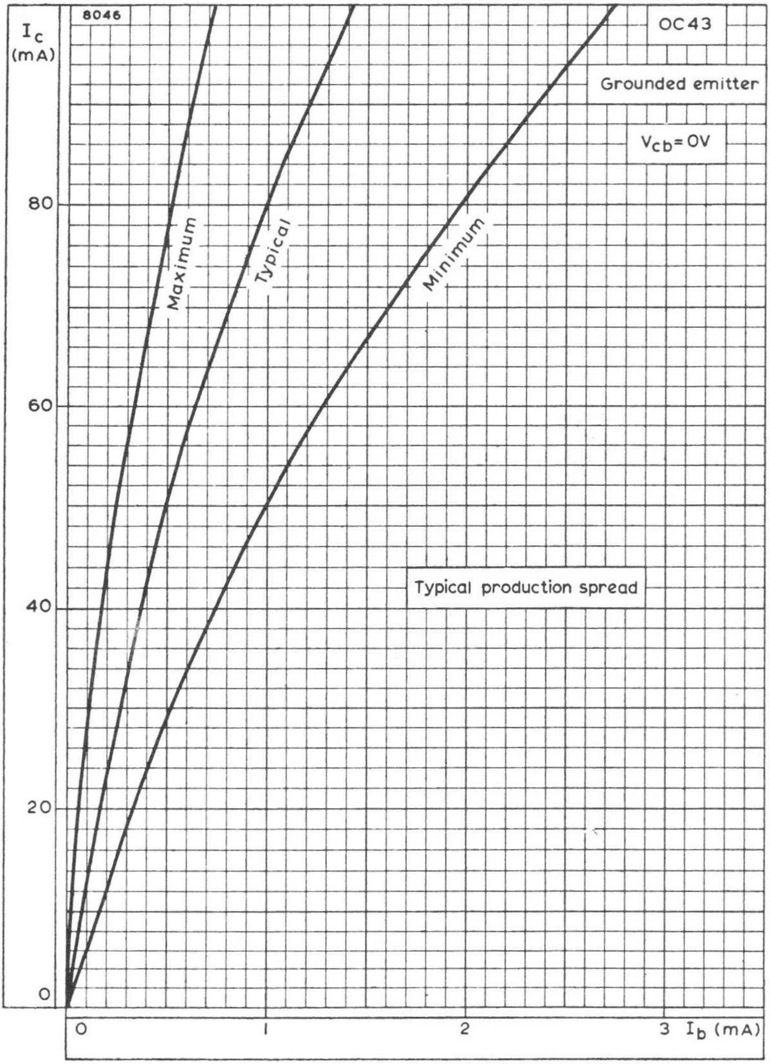
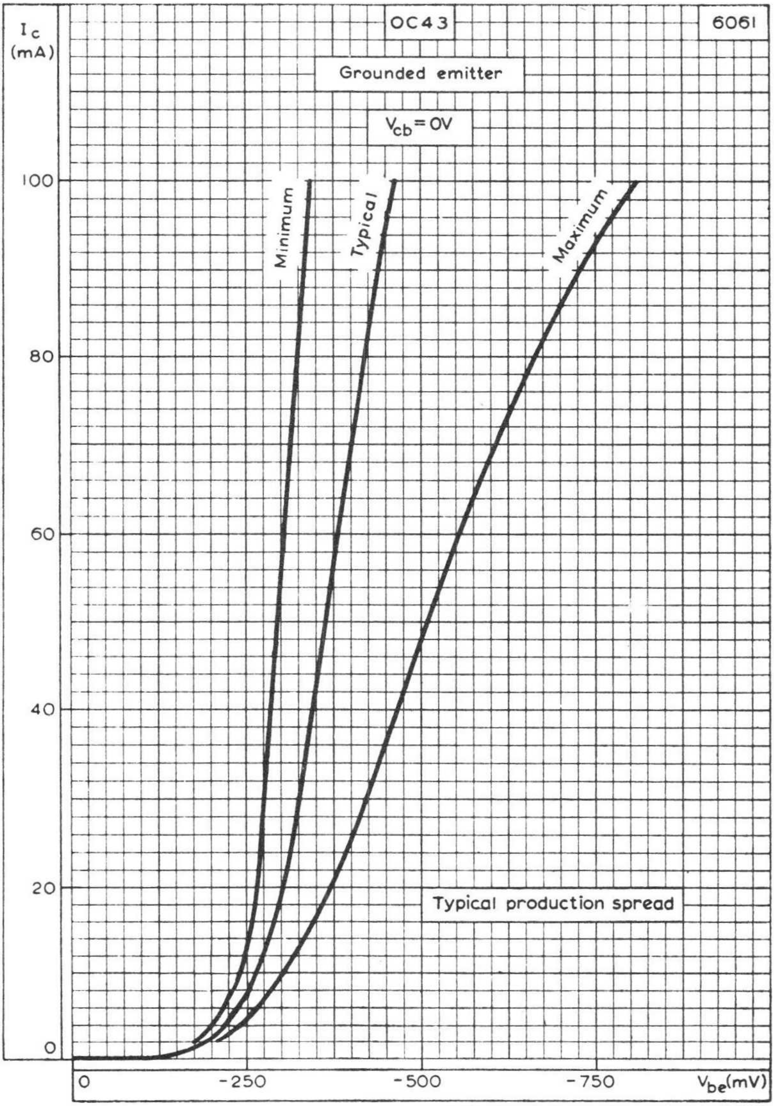


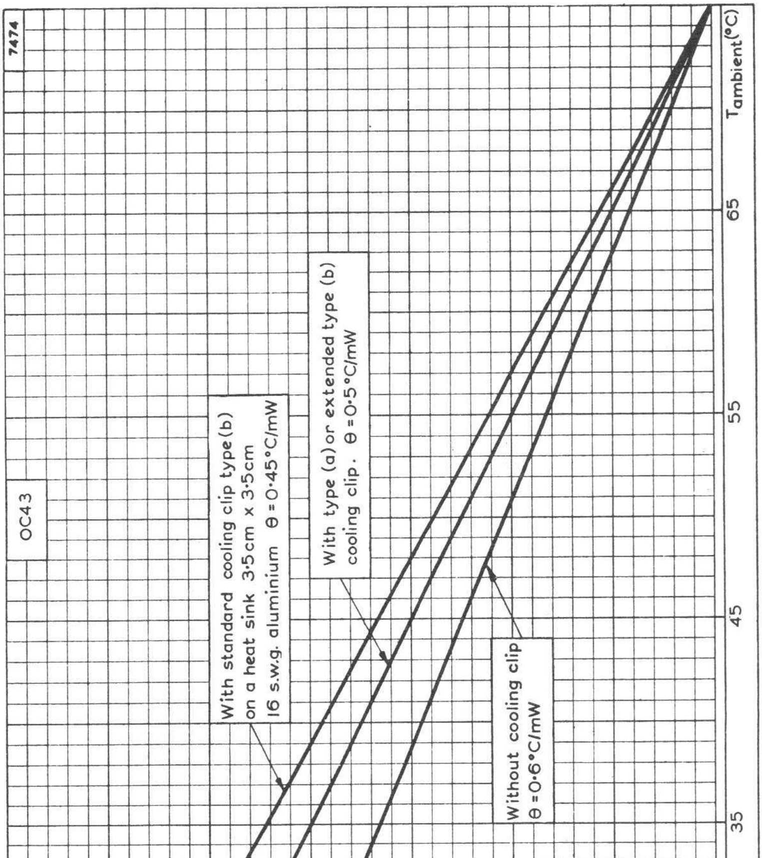
OUTPUT CHARACTERISTIC. GROUNDED EMITTER



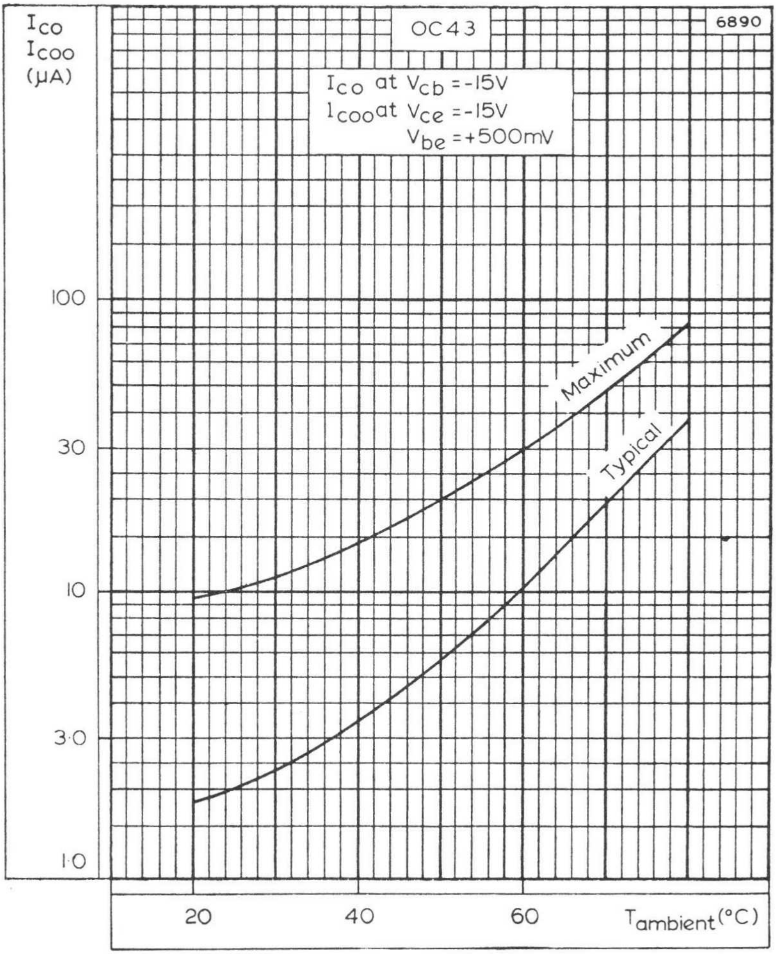
SPREAD OF TRANSFER CHARACTERISTIC. GROUNDED EMITTER



SPREAD OF BASE-EMITTER VOLTAGE PLOTTED AGAINST COLLECTOR CURRENT. GROUNDED EMITTER



MAXIMUM TOTAL DISSIPATION PLOTTED AGAINST AMBIENT TEMPERATURE



COLLECTOR LEAKAGE CURRENT AND COLLECTOR LEAKAGE CURRENT WITH REVERSED BIAS ON THE BASE PLOTTED AGAINST AMBIENT TEMPERATURE

R.F. JUNCTION TRANSISTOR

OC44

R.F. junction transistor of the p-n-p alloy type in all-glass construction intended for use in converters and mixer-oscillator circuits.

ABSOLUTE MAXIMUM RATINGS (limiting values)

The equipment designer must ensure that no transistor exceeds these ratings. In arriving at the actual operating conditions, variations in supply voltages, component tolerances and ambient temperature must also be taken into account.

Collector voltage

Grounded base

$v_{cb(pk)}$ max.	–15	V
*$V_{cb(av)}$ max.	–10	V
$V_{cb(d.c.)}$ max.	–10	V

Grounded emitter

$v_{ce(pk)}$ max.	–15	V
*$V_{ce(av)}$ max.	–10	V
$V_{ce(d.c.)}$ max.	–10	V

These figures apply with an external base-ground circuit impedance of less than 1kΩ, or providing $+V_{be} > 300$mV (i.e. transistor cut-off).

For other values of impedance see curve on page C4.

Collector current

$i_{c(pk)}$ max.	10	mA
*I_c max.	5.0	mA

Emitter current

$i_{e(pk)}$ max.	10	mA
*I_e max.	5.0	mA

Reverse emitter-base voltage

$v_{eb(pk)}$ max.	12	V
*$V_{eb(av)}$ max.	8.0	V
$V_{eb(d.c.)}$ max.	8.0	V

Base current

$i_{b(pk)}$ max.	1.0	mA
I_b max.	1.0	mA

Total dissipation

See page C5

$$\left(p_{tot} \text{ max.} = \frac{T_{junction} \text{ max.} - T_{ambient}}{\theta} \right)$$

Temperature ratings

Storage temperature limits	–55 to +75	°C
Maximum junction temperature		
Continuous operation	75	°C
‡Intermittent operation (total duration = 200 hours max.)	90	°C
Junction temperature rise above ambient, θ	0.7°C/mW	

*Averaged over any 20ms period.

‡Likelihood of full performance of a circuit at this temperature is also dependent on the type of application.

OC44

R.F. JUNCTION TRANSISTOR

CHARACTERISTICS at $T_{junction} = 25°C$

		Typical production spreads			
		Min.	*Typ.*	*Max.*	
Grounded base					
Collector leakage current	I_{co}				
(V_{cb} = −2V, I_e = 0mA)		—	0.5	2.0	μA
(V_{cb} = −15V, I_e = 0mA)		—	—	10	μA
Emitter leakage current	I_{eo}				
(V_{eb} = −2V, I_c = 0mA)		—	0.4	2.0	μA
(V_{eb} = −12V, I_c = 0mA)		—	—	40	μA
Grounded emitter					
Collector leakage current (V_{ce} = −2V, I_b = 0mA)	I'_{co}	—	25	75	μA
Collector current with reversed bias on base (V_{ce} = −15V, V_{be} = +500mV)	I'_c	—	1.0	50	μA
Collector knee voltage at I_c = 5mA (see fig. 1)	$V_{ce(knee)}$	−80	−140	−200	mV
Collector bottoming voltage (I_c = 8mA, I_b = 500μA)	V_{ce}	−20	−45	−150	mV
*Base input voltage (V_{ce} = −6V, I_c = 1mA)	V_{be}	−125	−150	−185	mV

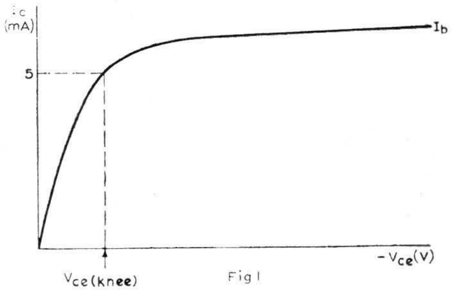


Fig I

Ib adjusted such that Ic=6mA with Vce=-1V

For information on changes in characteristics with change in temperature, see page C6.

*The base input voltage V_{be} changes by approx. −2mV/°C change in junction temperature.

SMALL SIGNAL CHARACTERISTICS at $T_{junction} = 25°C$

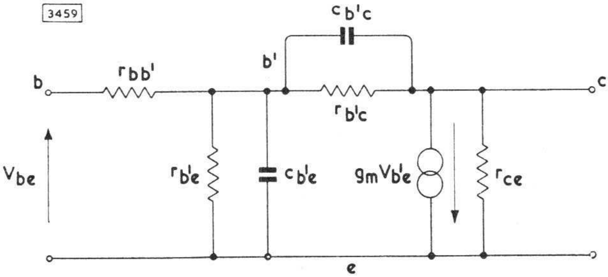
Basic parameters

Measured at $V_c = -6V$, $I_c = 1mA$

	Typical production spreads Min.	Typ.	Max.	
$*r_e$	—	25	—	Ω
$r_{bb'}$	40	110	250	Ω
$c_{c(dep)}$	6.5	10	13.5	pF
μ	—	10×10^{-4}	—	
f_α	7.5	15	30	Mc/s
g_m	—	39	—	mA/V
α' (at 1kc/s)	40	100	225	

*The value of r_e given here is $\frac{kT}{q} \cdot \frac{1}{I_e} \simeq \frac{25}{I_e}$, where I_e is in mA and T is in °K.

Equivalent circuit parameters (hybrid π network)

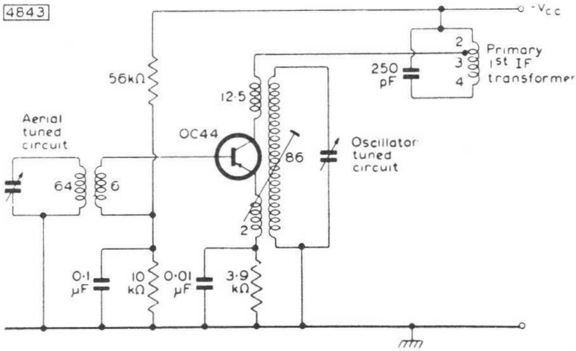


b' indicates the internal base connection

Measured at $V_{ce} = -6V$, $I_e = 1mA$

		Min.	Typ.	Max.	
Collector-to-base capacitance	$c_{b'c}$	7.0	10.5	14	pF
Base-to-emitter capacitance	$c_{b'e}$	—	410	—	pF
Collector-to-emitter conductance	g_{ce}	—	40	100	µmhos
Collector-to-emitter resistance	r_{ce}	10	25	—	kΩ
Collector-to-base conductance	$g_{b'c}$	—	—	0.5	µmhos
Collector-to-base resistance	$r_{b'c}$	2.0	—	—	MΩ
Base-to-emitter conductance	$g_{b'e}$	—	390	—	µmhos
Base-to-emitter resistance	$r_{b'e}$	—	2.5	—	kΩ
Internal base resistance	$r_{bb'}$	40	110	250	Ω
Internal transconductance	g_m	—	39	—	mA/V
Figure of merit	$\frac{f_\alpha}{r_{bb'}}$	50	137	286	kc/s per Ω

OPERATING CONDITIONS AS A FREQUENCY CHANGER



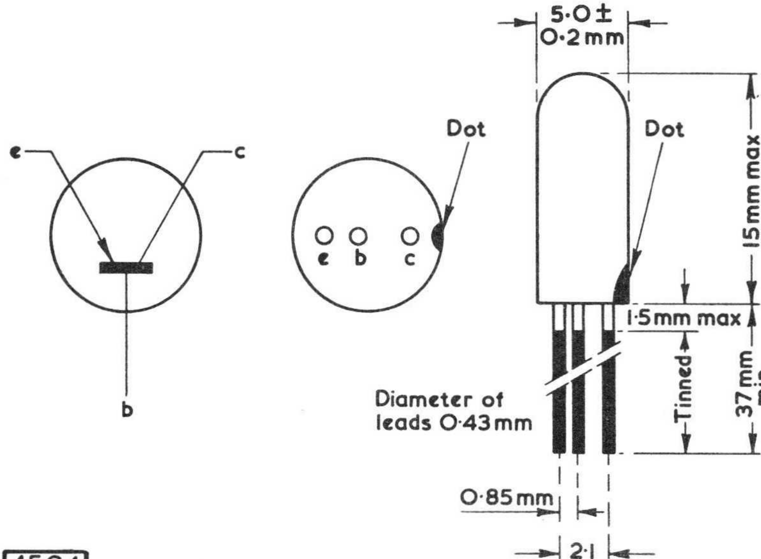
V_{cc}	-7.0	V
I_e	0.3	mA
Conversion gain (at f = 1Mc/s)	27	dB
R_{in} At f = 1Mc/s	5	kΩ
At f = 200kc/s	10	kΩ

→ ### SOLDERING AND WIRING RECOMMENDATIONS

1. When using a soldering iron, transistors may be soldered directly into the circuit, but heat conducted to the junction should if possible be kept to a minimum by the use of a thermal shunt.
2. Transistors may be dip-soldered at a solder temperature of 245°C for a maximum soldering time of 5 seconds. The case temperature during dip-soldering may exceed the maximum storage temperature for a period not greater than 2 minutes, provided that it at no time exceeds 115°C. These recommendations apply to a transistor mounted flush on a board having punched-through holes, or spaced at least 1.5mm away from a board having plated-through holes.
3. Care should be taken not to bend the leads nearer than 1.5mm from the seal.

→ **OUTLINE AND DIMENSIONS**

Conforming to V.A.S.C.A. SO-2/SB3-2



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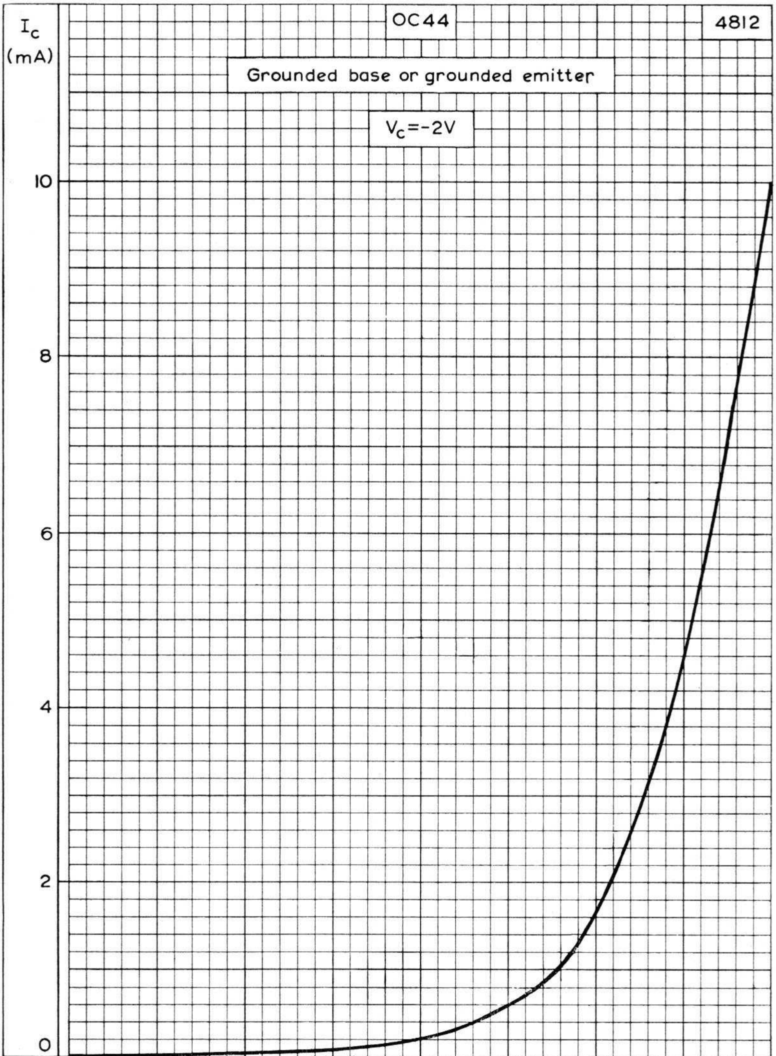
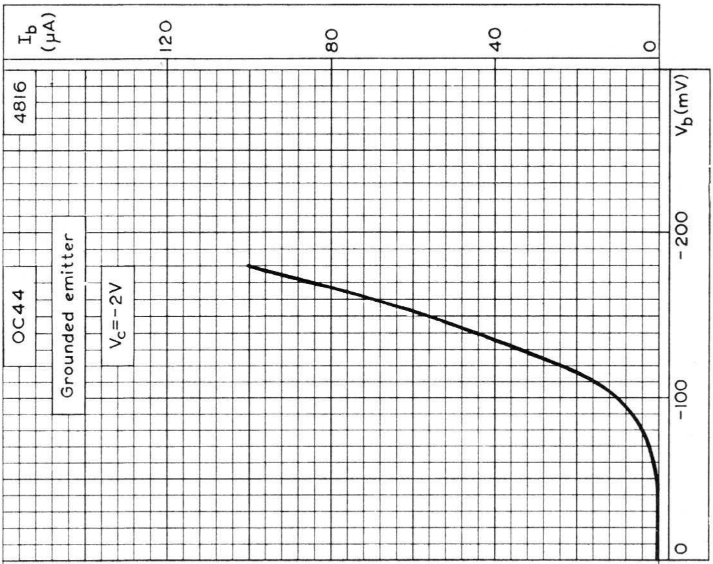
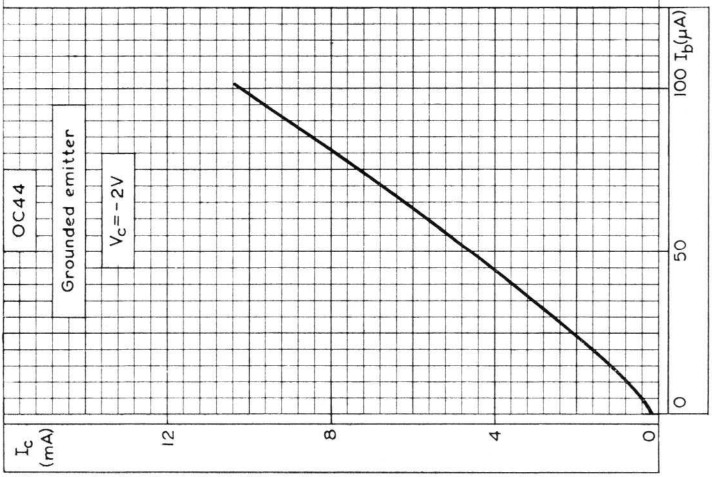


COLLECTOR CURRENT PLOTTED AGAINST BASE-EMITTER VOLTAGE
(Grounded base or grounded emitter)

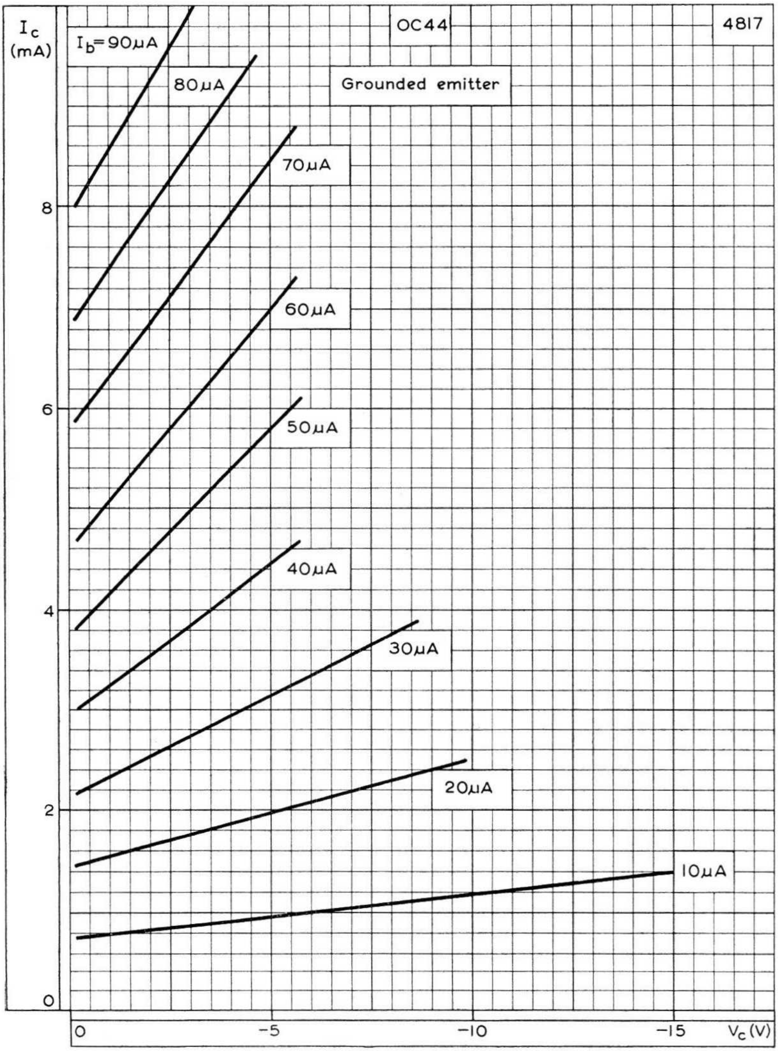
OC44

R.F. JUNCTION TRANSISTOR

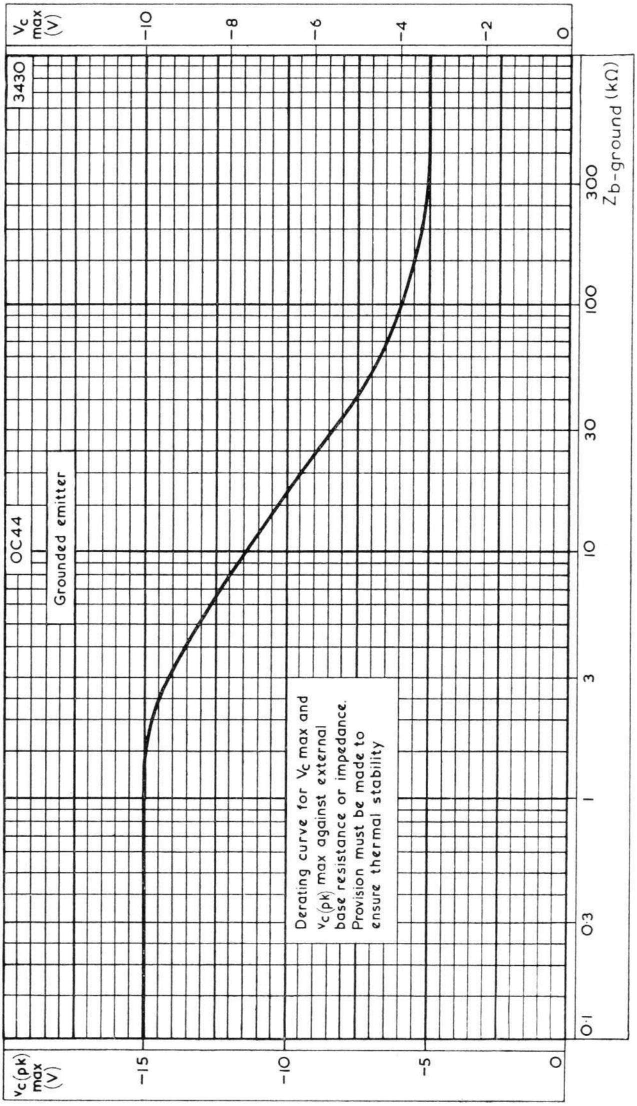




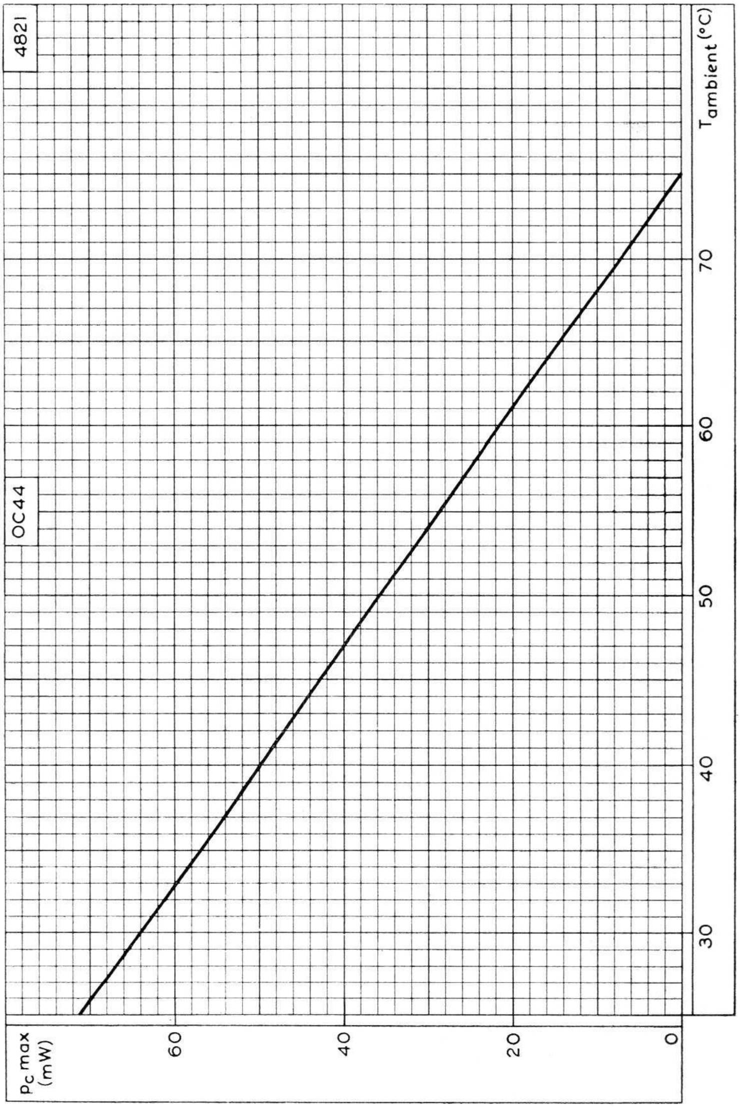
TRANSFER AND INPUT CHARACTERISTICS. GROUNDED EMITTER



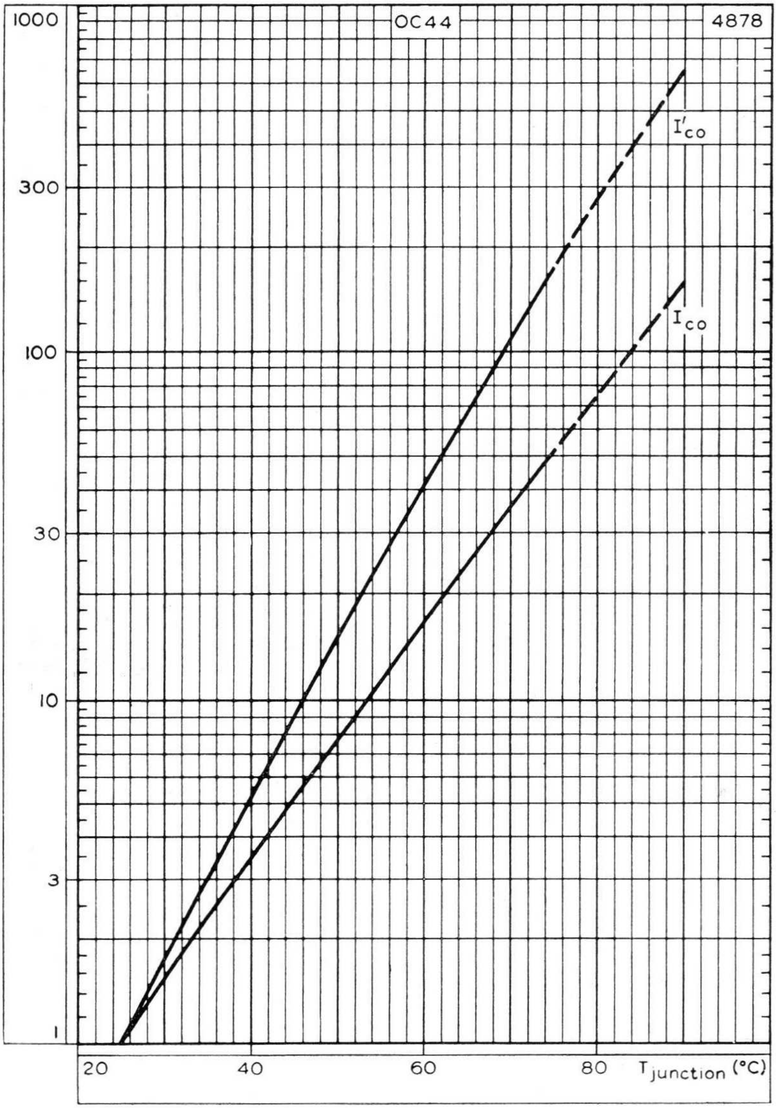
OUTPUT CHARACTERISTICS. GROUNDED EMITTER



MAXIMUM PEAK AND AVERAGE COLLECTOR VOLTAGE PLOTTED AGAINST EXTERNAL BASE-EMITTER IMPEDANCE OR RESISTANCE



MAXIMUM COLLECTOR DISSIPATION PLOTTED AGAINST AMBIENT TEMPERATURE



VARIATION OF I_{co} AND I'_{co} WITH TEMPERATURE

R.F. JUNCTION TRANSISTOR

0C45

R.F. junction transistor of the p-n-p alloy type in all-glass construction for use in i.f. amplifier stages.

ABSOLUTE MAXIMUM RATINGS (limiting values)

The equipment designer must ensure that no transistor exceeds these ratings. In arriving at the actual operating conditions, variations in supply voltages, component tolerances and ambient temperature must also be taken into account.

Collector voltage

Grounded base

$v_{cb(pk)}$ max.	−15	V
*$V_{cb(av)}$ max.	−10	V
$V_{cb(d.c.)}$ max.	−10	V

Grounded emitter

$v_{ce(pk)}$ max.	−15	V
*$V_{ce(av)}$ max.	−10	V
$V_{ce(d.c.)}$ max.	−10	V

These figures apply with an external base-ground circuit impedance of less than 1kΩ, or providing $+V_{be} > 300$mV (i.e. transistor cut-off).

For other values of impedance see curve on page C4.

Collector current

$i_{c(pk)}$ max.	10	mA
*I_c max.	5.0	mA

Emitter current

$i_{e(pk)}$ max.	10	mA
*I_e max.	5.0	mA

Reverse emitter-base voltage

$v_{eb(pk)}$ max.	12	V
*$V_{eb(av)}$ max.	8.0	V
$V_{eb(d.c.)}$ max.	8.0	V

Base current

$i_{b(pk)}$ max.	1.0	mA
I_b max.	1.0	mA

Total dissipation See page C5

$$\left(p_{tot}\ \text{max.} = \frac{T_{junction}\ \text{max.} - T_{ambient}}{\theta}\right)$$

Temperature ratings

Storage temperature limits	−55 to +75	°C
Maximum junction temperature		
Continuous operation	75	°C
‡Intermittent operation (total duration = 200 hours max.)	90	°C
Junction temperature rise above ambient, θ	0.7°C/mW	

*Averaged over any 20ms period.

‡Likelihood of full performance of a circuit at this temperature is also dependent on the type of application.

CHARACTERISTICS at $T_{junction} = 25°C$

		Typical production spreads			
		Min.	*Typ.*	*Max.*	
Grounded base					
Collector leakage current	I_{co}				
($V_{cb} = -2V$, $I_e = 0mA$)		—	0.5	2.0	μA
($V_{cb} = -15V$, $I_e = 0mA$)		—	—	10	μA
Emitter leakage current	I_{eo}				
($V_{eb} = -2V$, $I_c = 0mA$)		—	0.4	2.0	μA
($V_{eb} = -12V$, $I_c = 0mA$)		—	—	40	μA
Grounded emitter					
Collector leakage current ($V_{ce} = -2V$, $I_b = 0mA$)	I'_{co}	—	12	40	μA
Collector current with reversed bias on base ($V_{ce} = -15V$, $V_{be} = +500mV$)	I'_c	—	1.0	50	μA
Collector knee voltage at $I_c = 5mA$ (see fig. 1)	$V_{ce(knee)}$	−80	−140	−200	mV
Collector bottoming voltage ($I_c = 8mA$, $I_b = 500\mu A$)	V_{ce}	−20	−60	−150	mV
Base input voltage ($V_{ce} = -6V$, $I_c = 1mA$)	V_{be}	−145	−170	−195	mV

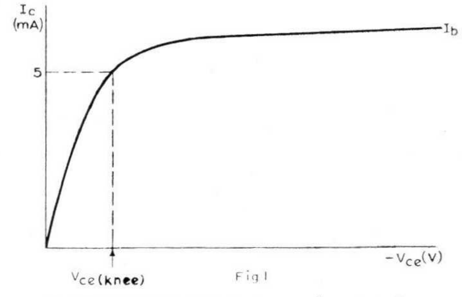


Fig 1

Ib adjusted such that Ic=6mA with Vce=-1V

For information on changes in characteristics with change in temperature see page C6.

*The base input voltage V_{be} changes by approx. −2mV/°C change in junction temperature.

SMALL SIGNAL CHARACTERISTICS at $T_{junction} = 25°C$

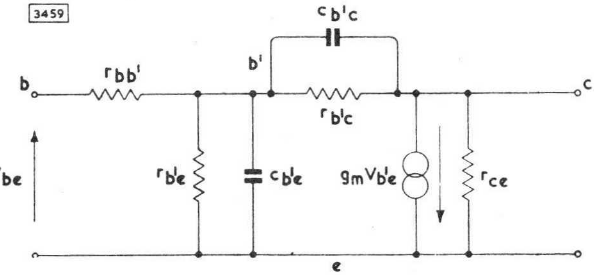
Basic parameters

Measured at $V_c = -6V$, $I_c = 1mA$

	Typical production spreads Min.	Typ.	Max.	
$*r_e$	—	25	—	Ω
$r_{bb'}$	35	75	200	Ω
$c_{c(dep)}$	6.5	10	13.5	pF
μ	—	3.8×10^{-4}	—	
f_α	3	6	12	Mc/s
g_m	—	39	—	mA/V
α' (at 1kc/s)	25	50	125	

*The value of r_e given here is $\frac{kT}{q}\cdot\frac{1}{I_e} \simeq \frac{25}{I_e}$, where I_e is in mA and T is in °K.

Equivalent circuit parameters (hybrid π network)

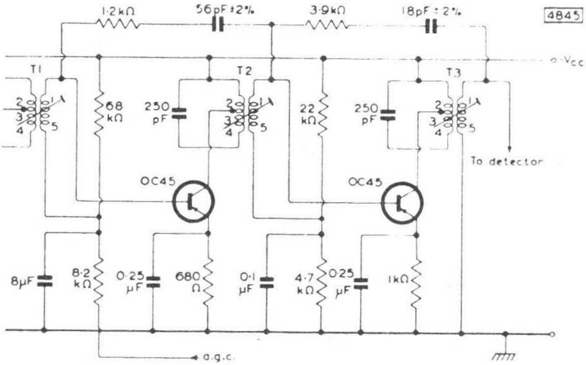


b' indicates the internal base connection

Measured at $V_{ce} = -6V$, $I_c = 1mA$

		Typical production spreads Min.	Typ.	Max.	
Collector-to-base capacitance	$c_{b'c}$	7.0	10.5	14	pF
Base-to-emitter capacitance	$c_{b'e}$	—	1000	—	pF
Collector-to-emitter conductance	g_{ce}	—	15	40	μmhos
Collector-to-emitter resistance	r_{ce}	25	66.7	—	kΩ
Collector-to-base conductance	$g_{b'c}$	—	—	0.5	μmhos
Collector-to-base resistance	$r_{b'c}$	2.0	—	—	MΩ
Base-to-emitter conductance	$g_{b'e}$	—	760	—	μmhos
Base-to-emitter resistance	$r_{b'e}$	—	1.3	—	kΩ
Internal base resistance	$r_{bb'}$	35	75	200	Ω
Internal transconductance	g_m	—	39	—	mA/V
Figure of merit	$\frac{f_\alpha}{r_{bb'}}$	33	80	200	kc/s per Ω

OPERATING CONDITIONS AS AN I.F. AMPLIFIER



f	470	kc/s
V_{cc}	−7.0	V
I_e	1.0	mA
Typical power gain per stage	30	dB

I.F. transformer winding data

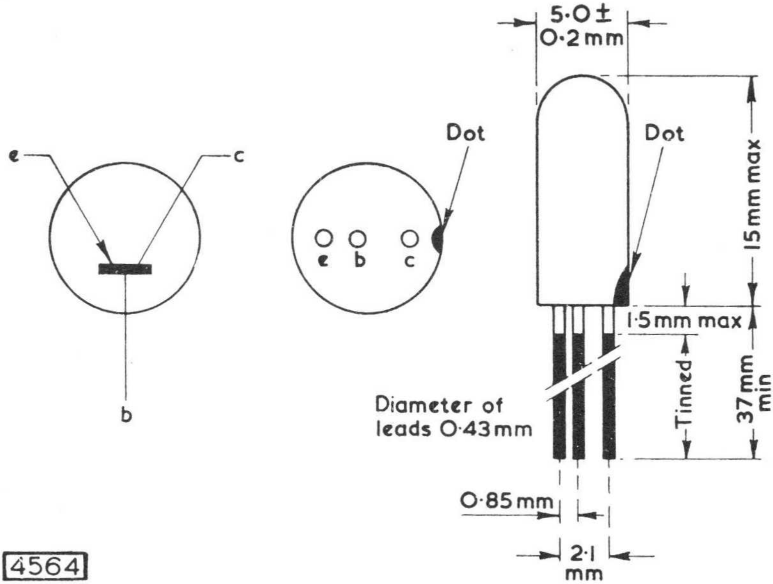
	T1, T2	*T3*
Coil pin nos.	*No. of turns*	*No. of turns*
2–3	45	29
3–4	105	89
1–5	7.5	16

→ SOLDERING AND WIRING RECOMMENDATIONS

1. When using a soldering iron, transistors may be soldered directly into the circuit, but heat conducted to the junction should if possible be kept to a minimum by the use of a thermal shunt.
2. Transistors may be dip-soldered at a solder temperature of 245°C for a maximum soldering time of 5 seconds. The case temperature during dip-soldering may exceed the maximum storage temperature for a period not greater than 2 minutes, provided that it at no time exceeds 115°C. These recommendations apply to a transistor mounted flush on a board having punched-through holes, or spaced at least 1.5mm away from a board having plated-through holes.
3. Care should be taken not to bend the leads nearer than 1.5mm from the seal.

→ OUTLINE AND DIMENSIONS

Conforming to V.A.S.C.A. SO-2 SB3-2



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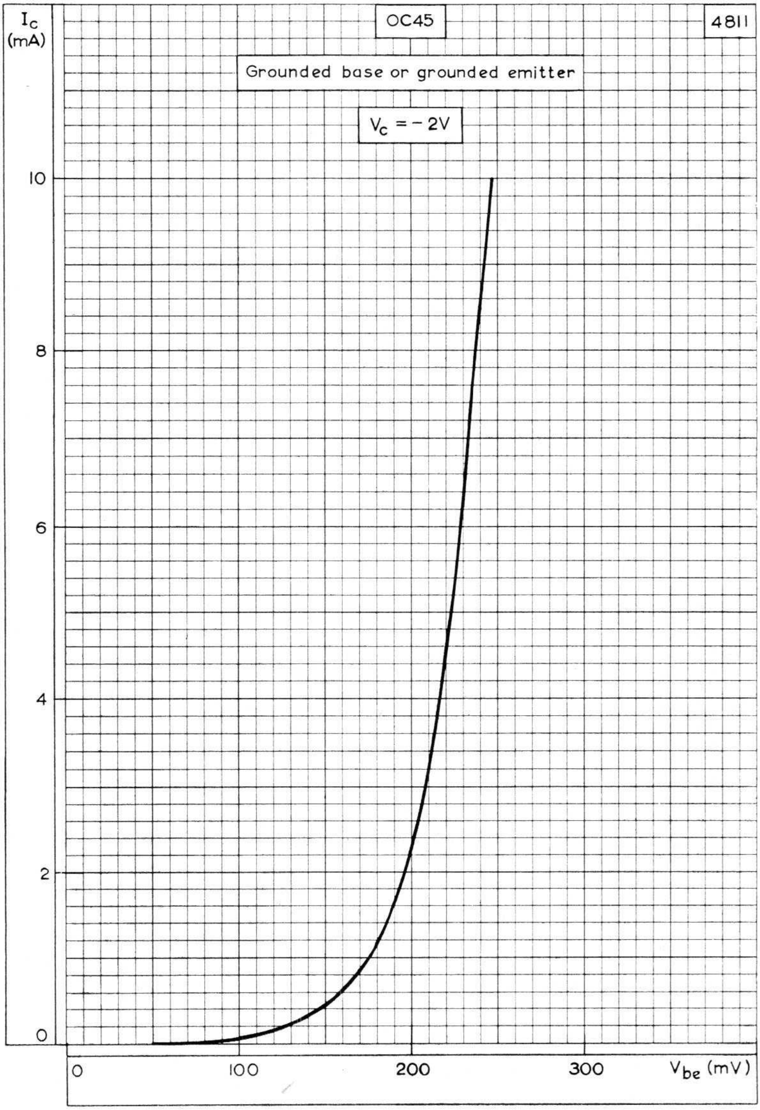
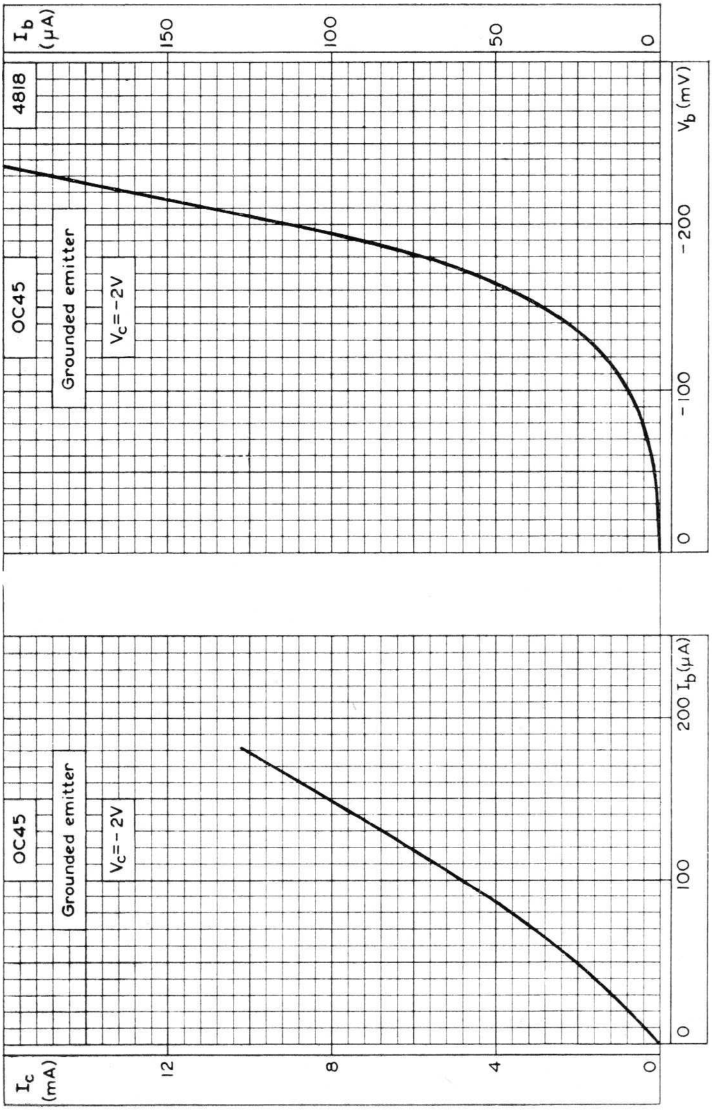
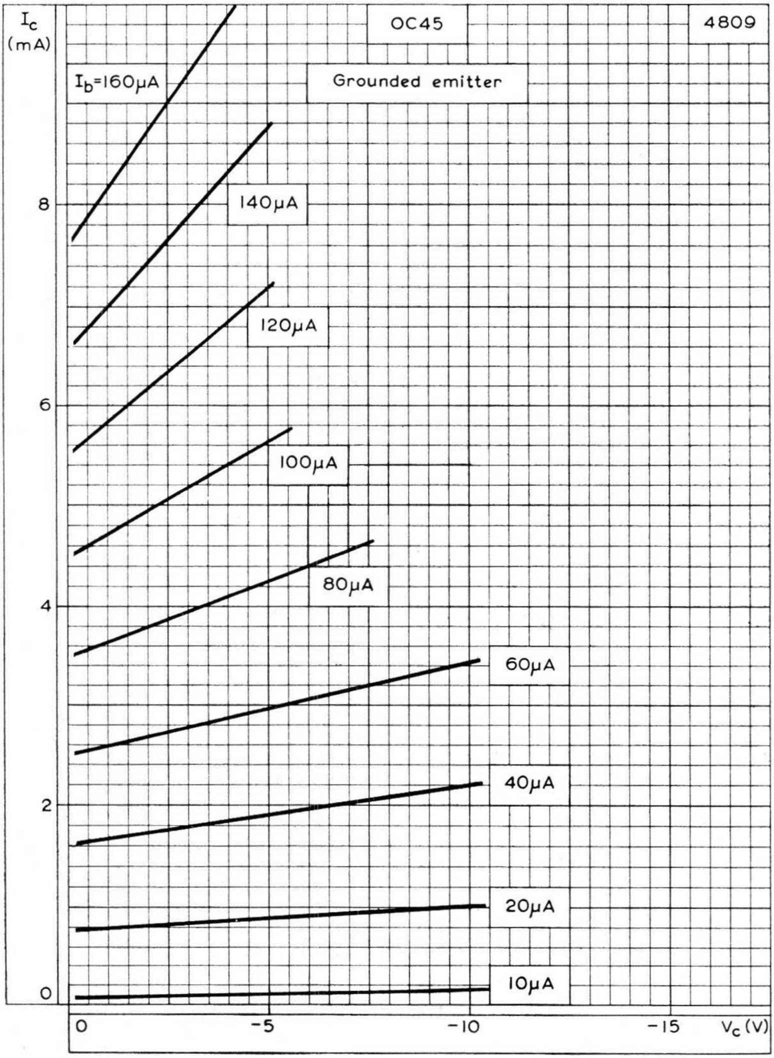


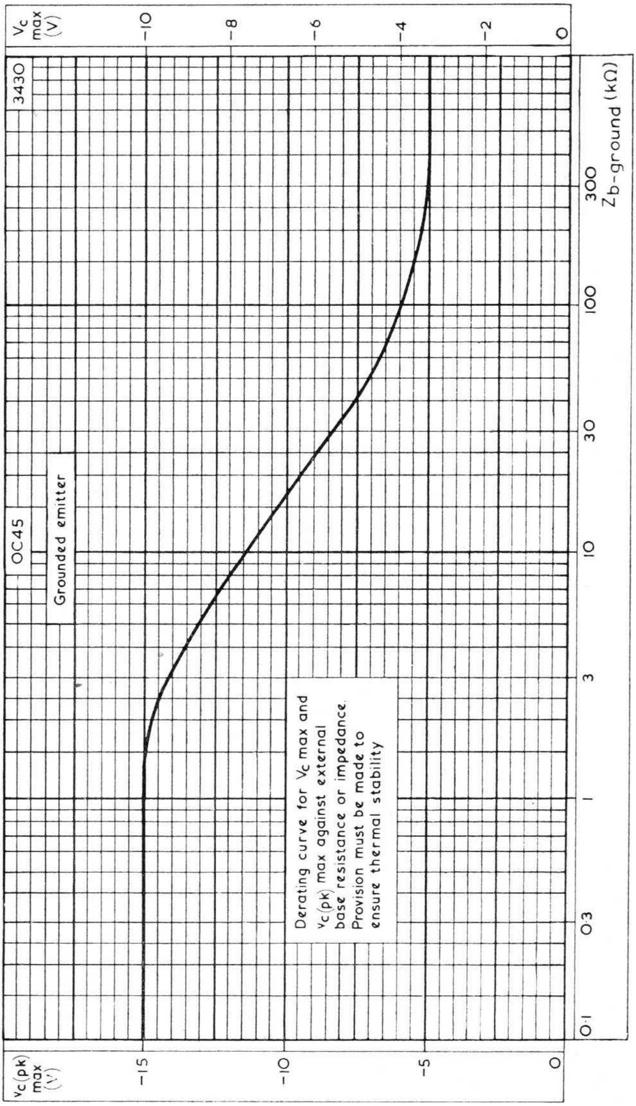
COLLECTOR CURRENT PLOTTED AGAINST BASE-EMITTER VOLTAGE
(Grounded base or grounded emitter)



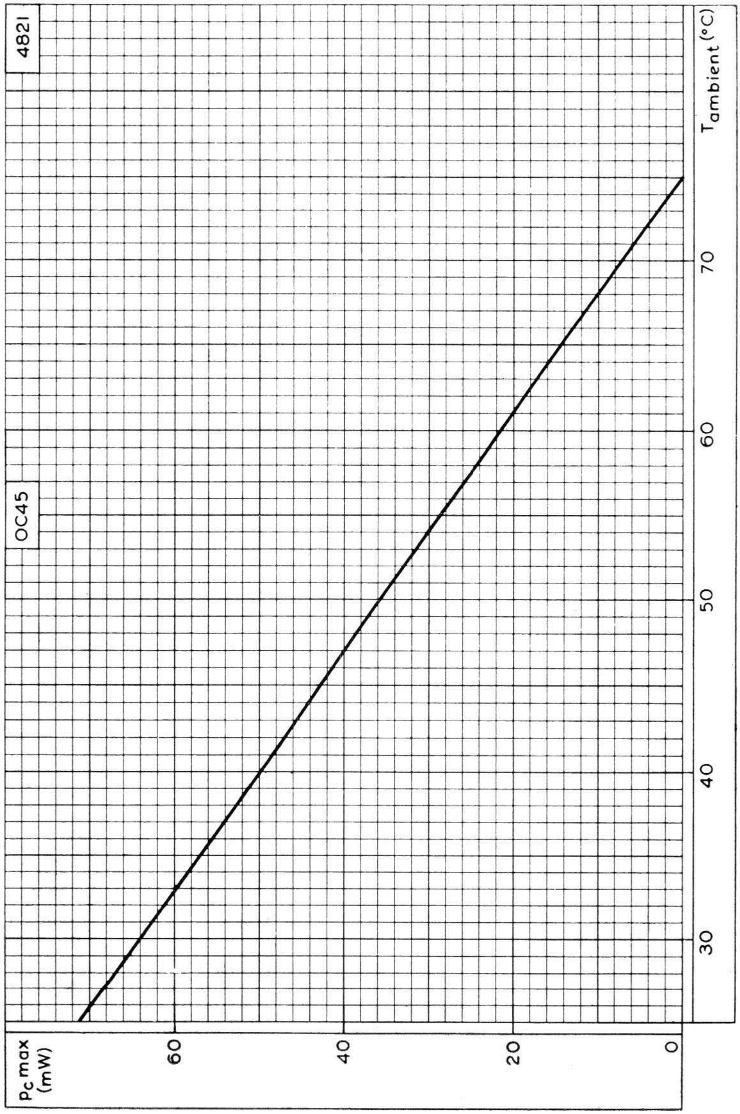
TRANSFER AND INPUT CHARACTERISTICS. GROUNDED EMITTER



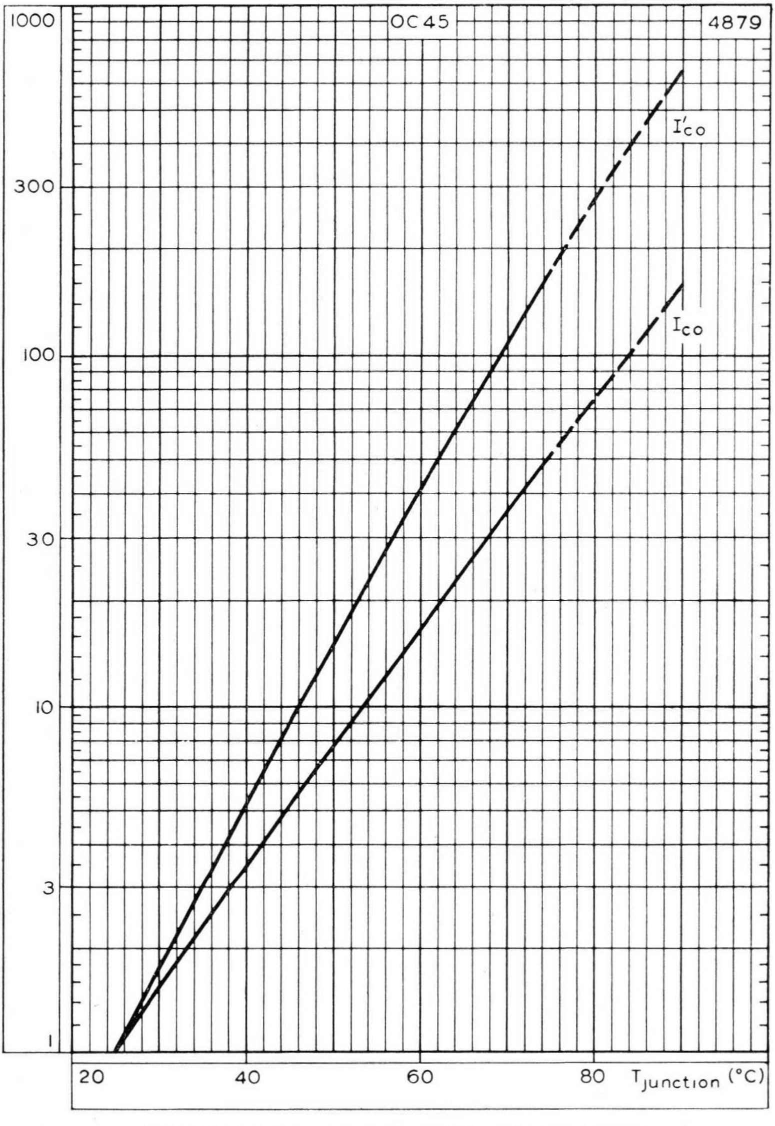
OUTPUT CHARACTERISTICS. GROUNDED EMITTER



MAXIMUM PEAK AND AVERAGE COLLECTOR VOLTAGE PLOTTED AGAINST EXTERNAL BASE-EMITTER IMPEDANCE OR RESISTANCE



MAXIMUM COLLECTOR DISSIPATION PLOTTED AGAINST AMBIENT TEMPERATURE



VARIATION OF I_{co} AND I'_{co} WITH TEMPERATURE

GERMANIUM P-N-P ALLOY JUNCTION TRANSISTORS

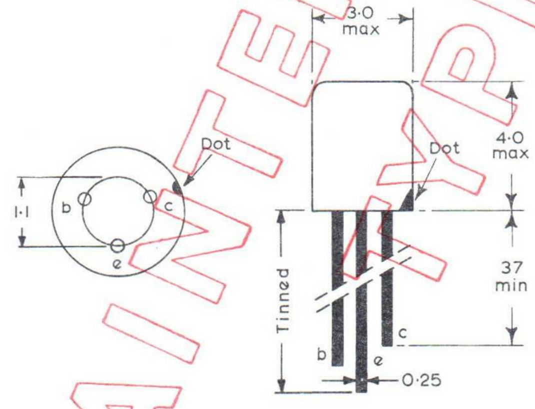
OC57 OC58 OC59 OC60

Germanium junction transistors of the p-n-p alloy type in metal construction, suitable for use in hearing aids and special low frequency applications.

QUICK REFERENCE DATA

	OC57	OC58	OC59	OC60	
$-V_{CBO}$ max.	7.0	7.0	7.0	7.0	V
$-V_{CEO}$ max.	3.0	3.0	3.0	3.0	V
$-I_C$ max.	5.0	5.0	5.0	5.0	mA
$-I_{CM}$ max.	10	10	10	10	mA
h_{fe} typ. $-I_C = 0.25$mA	35	55	80	-	
$-I_C = 0.5$mA	-	-	-	60	
P_{tot} max. ($T_{amb} \leq 45^{o}C$)	20	20	20	20	mW
T_j max.	75	75	75	75	^{o}C

OUTLINE AND DIMENSIONS



All dimensions in mm

JUNCTION TRANSISTOR

OC70

Junction transistor of the p-n-p alloy type in all glass construction especially suitable for use in low consumption audio amplifier circuits.

LIMITING VALUES (absolute ratings)

The equipment designer must ensure that no transistor exceeds these ratings. In arriving at the actual operating conditions, variations in supply voltages, component tolerances and ambient temperature must also be taken into account.

Collector voltage		
Grounded base		
$v_{c(pk)}$ max.	−30	V
*$V_{c(av.)}$ max.	−20	V
V_c max. (d.c.)	−20	V
Grounded emitter		
$v_{c(pk)}$ max.	−30	V
*$V_{c(av.)}$ max.	−20	V
V_c max. (d.c.)	−20	V

These figures apply with an external base-ground circuit impedance of less than 500Ω, or providing $+V_{be} > 500mV$ (i.e. transistor cut-off). For other values of impedance see curve on page 14.

Collector current		
**$i_{c(pk)}$ max.	50	mA
*I_c max.	10	mA
Emitter current		
**$i_{e(pk)}$ max.	55	mA
*I_e max.	12	mA
Reverse base emitter voltage		
$v_{be(pk)}$ max.	10	V
V_{be} max.	10	V
Base current		
$i_{b(pk)}$ max.	5.0	mA
*I_b max.	2.0	mA
Total dissipation	See page 15	

$$\left(P_{tot} = \frac{T_{junction}\ \text{max.} - T_{ambient}}{\theta}\right)$$

Temperature ratings		
Storage temperature	−55 to +75	°C
Maximum junction temperature ($T_{junction}$ max.)		
Continuous operation	75	°C
‡Intermittent operation (total duration = 200 hrs. max.)	90	°C
Junction temperature rise above ambient (θ)	0.4	°C/mW

*Averaged over any 20ms period

**Owing to linearity considerations it is inadvisable to design for peak currents greater than 25mA where low distortion is required.

‡Likelihood of full performance of a circuit at this temperature is also dependent on the type of application.

OC70

JUNCTION TRANSISTOR

Junction transistor of the p-n-p alloy type in all glass construction especially suitable for use in low consumption audio amplifier circuits.

CHARACTERISTICS AT $T_{junction} = 25°C$

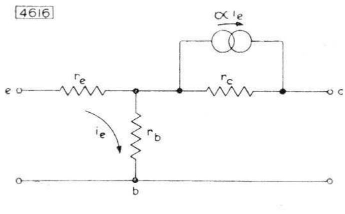
		Min.	Av.	Max.	
Grounded base					
Collector leakage current ($V_c = -4.5V$, $I_e = 0mA$)	I_{co}	—	5.0	13	μA
Emitter leakage current ($V_e = -4.5V$, $I_c = 0mA$)	I_{eo}	—	3.0	13	μA
Grounded emitter					
Collector leakage current ($V_c = -4.5V$, $I_b = 0mA$)	I'_{co}	—	110	225	μA
Collector bottoming voltage ($I_c = 9mA$, $I_b = 0.5mA$)	V_{ce}	—	−100	−330	mV
Base input voltage ($V_c = -4.5V$, $I_c = 1mA$)	V_{be}	−120	−145	−170	mV
Noise figure ($f = 1kc/s$, $R_{source} = 500\Omega$, $V_c = -2V$, $I_c = 0.5mA$)		—	10	16	dB

For information on changes in characteristics with change in temperature see page 16.

SMALL SIGNAL CHARACTERISTICS

Equivalent circuit parameters (T-network)

Measured at: $f = 1kc/s$, $V_c = -2V$, $I_c = 0.5$ mA, $T_{ambient} = 25°C$



r_e	39	Ω
r_b	1.0	kΩ
r_c	1.43	MΩ
α	0.968	

		Min.	Av.	Max.	
Grounded base cut-off frequency ($V_c = -6V$, $I_c = 1mA$)	f_α	200	500	1000	kc/s
Grounded emitter cut-off frequency ($V_c = -6V$, $I_c = 1mA$)	f_α'	5	15	26	kc/s

JUNCTION TRANSISTOR

OC70

Junction transistor of the p-n-p alloy type in all glass construction especially suitable for use in low consumption audio amplifier circuits.

SMALL SIGNAL CHARACTERISTICS measured at $V_c = -2V$, $I_c = 0.5mA$

Grounded base

Hybrid matrix

		Typical production spreads *Min.*	*Av.*	*Max.*	
Input impedance (with output short circuited to a.c.)	h_{11}	58	71	88	Ω
Current amplification (with output short circuited to a.c.)	$-h_{21}$	0.952	0.968	0.976	
Output admittance (with input open circuited to a.c.)	h_{22}	—	0.7	1.3	μmhos
Voltage feedback ratio (with input open circuited to a.c.)	h_{12}	—	7×10^{-4}	—	

Mullard system

		Min.	Av.	Max.	
Current amplification (with output short circuited to a.c.)	α	0.952	0.968	0.976	
Input resistance (with output short circuited to a.c.)	r_{in}	58	71	88	Ω
Input resistance (with output open circuited to a.c.)	r_{11}	—	1.0	—	kΩ
Output resistance (with input short circuited to a.c.)	r_{out}	—	100	—	kΩ
Output resistance (with input open circuited to a.c.)	r_{22}	0.77	1.4	—	MΩ

Grounded emitter

Hybrid matrix

		Min.	Av.	Max.	
Input impedance (with output short circuited to a.c.)	h'_{11}	1.2	2.2	3.6	kΩ
Current amplification (with output short circuited to a.c.)	h'_{21}	20	30	40	
Output admittance (with input open circuited to a.c.)	h'_{22}	—	22	53	μmhos
Voltage feedback ratio (with input open circuited to a.c.)	h'_{12}	—	9×10^{-4}	27×10^{-4}	

Mullard system

		Min.	Av.	Max.	
Current amplification (with output short circuited to a.c.)	α'	20	30	40	
Input resistance (with output short circuited to a.c.)	r'_{in}	1.2	2.2	3.6	kΩ
Input resistance (with output open circuited to a.c.)	r'_{11}	—	1.0	—	kΩ
Output resistance (with input short circuited to a.c.)	r'_{out}	—	100	—	kΩ
Output resistance (with input open circuited to a.c.)	r'_{22}	18.8	45	—	kΩ

OC70

JUNCTION TRANSISTOR

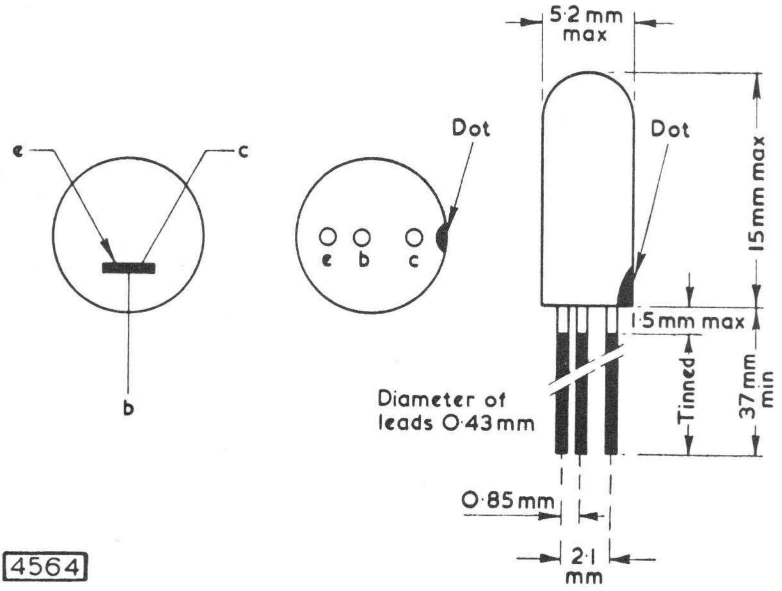
Junction transistor of the p-n-p alloy type in all glass construction especially suitable for use in low consumption audio amplifier circuits

SOLDERING AND WIRING RECOMMENDATIONS

1. When using a soldering iron, transistors may be soldered directly into the circuit, but heat conducted to the junction should if possible be kept to a minimum by the use of a thermal shunt.
2. Transistors may be dip-soldered at a solder temperature of 245°C for a maximum soldering time of 5 seconds. The case temperature during dip-soldering may exceed the maximum storage temperature for a period not greater than 2 minutes, provided that it at no time exceeds 115°C. These recommendations apply to a transistor mounted flush on a board having punched-through holes, or spaced at least 1.5mm away from a board having plated-through holes.
3. Care should be taken not to bend the leads nearer than 1.5mm from the seal.

OUTLINE AND DIMENSIONS

Conforming to V.A.S.C.A. SO-2/SB3-2



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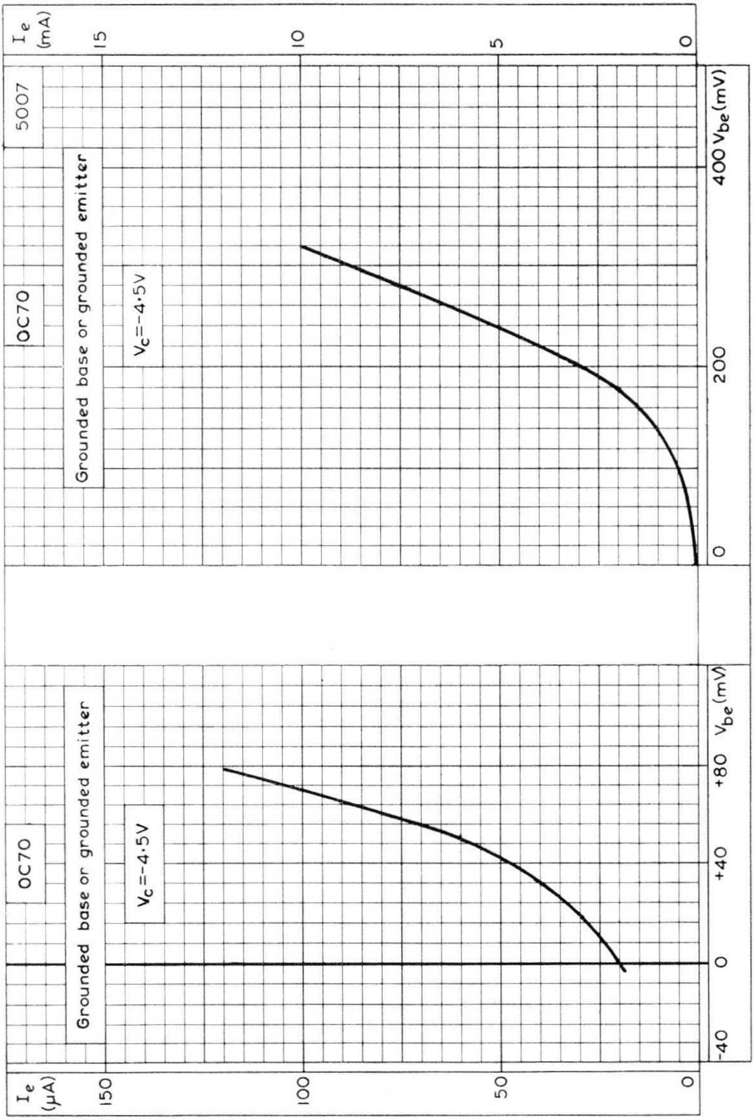
JUNCTION TRANSISTOR

OC70

Junction transistor of the p-n-p alloy type in all glass construction especially suitable for use in low consumption audio amplifier circuits.

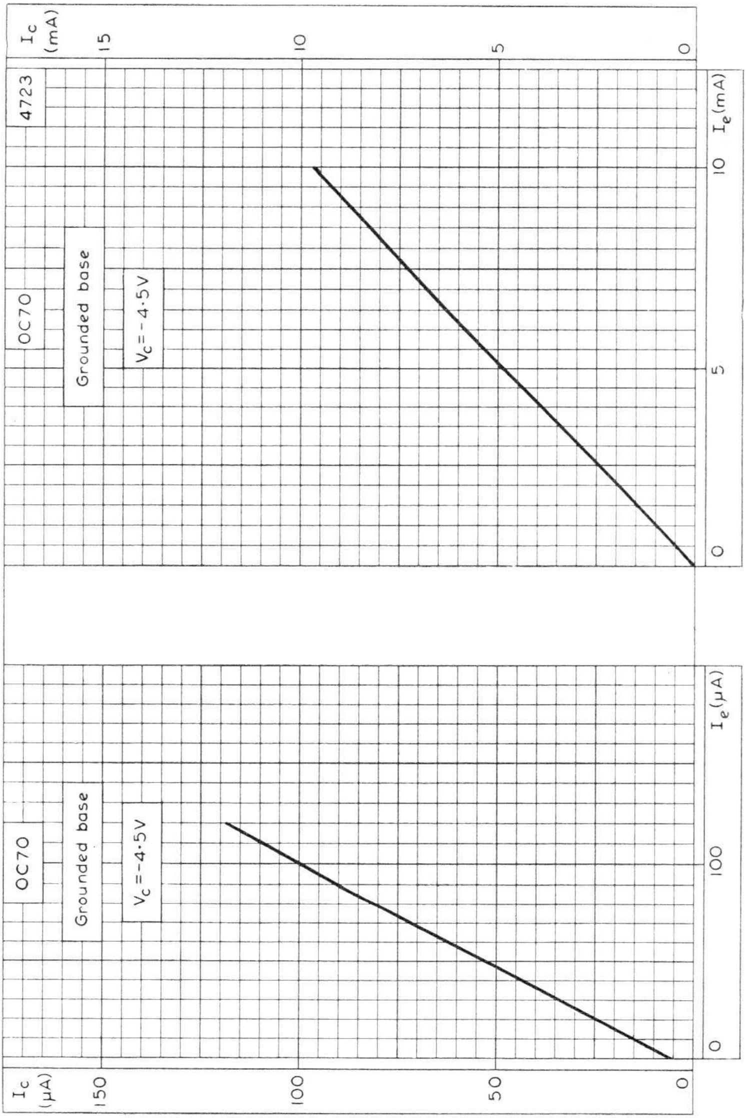


EMITTER CURRENT PLOTTED AGAINST EMITTER-BASE VOLTAGE
(Grounded base or grounded emitter)

OC70

JUNCTION TRANSISTOR

Junction transistor of the p-n-p alloy type in all glass construction especially suitable for use in low consumption audio amplifier circuits.

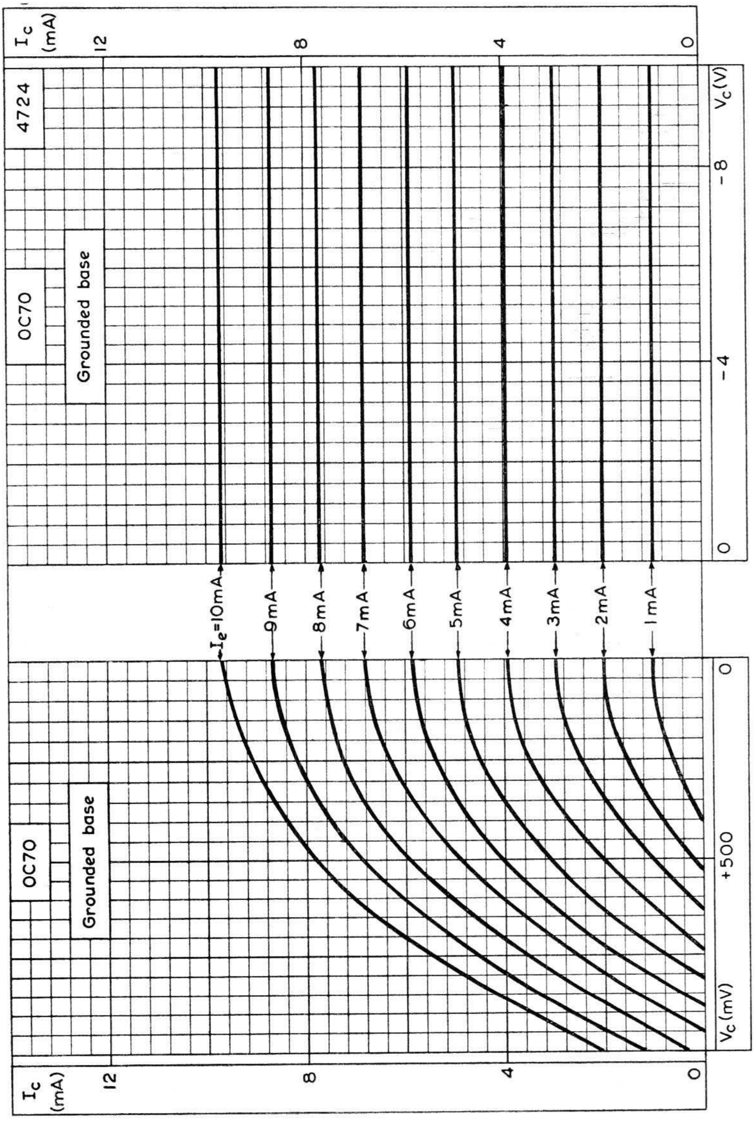


TRANSFER CHARACTERISTIC. GROUNDED BASE.

JUNCTION TRANSISTOR

OC70

Junction transistor of the p-n-p alloy type in all glass construction especially suitable for use in low consumption audio amplifier circuits.

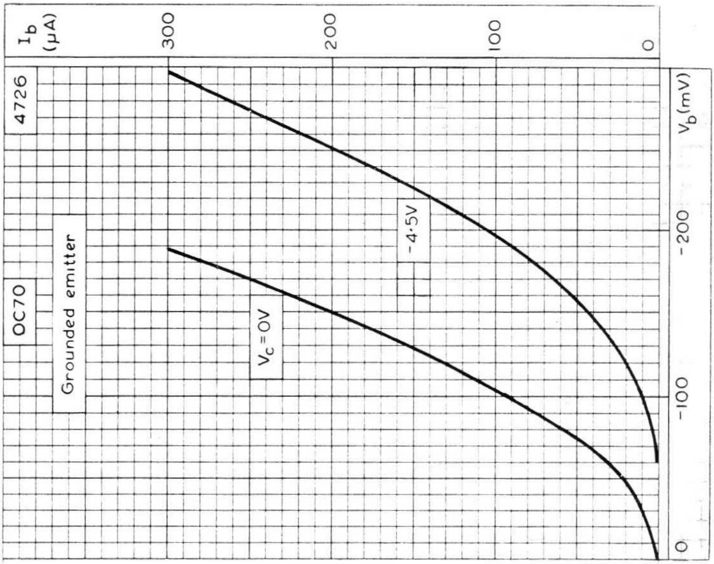


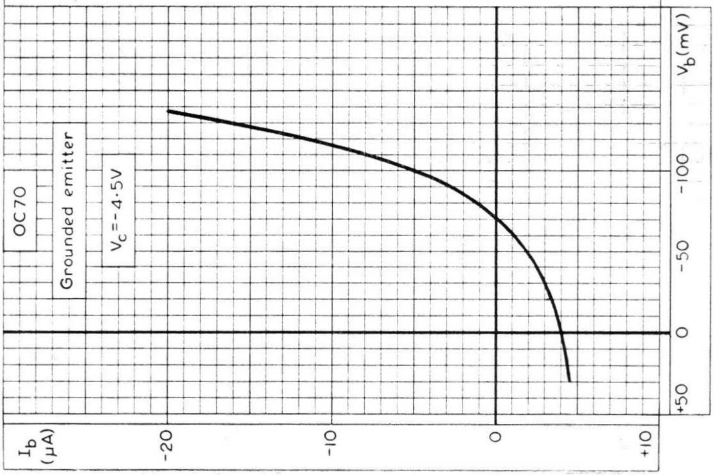
OUTPUT CHARACTERISTIC. GROUNDED BASE.

OC70

JUNCTION TRANSISTOR

Junction transistor of the p-n-p alloy type in all glass construction especially suitable for use in low consumption audio amplifier circuits.



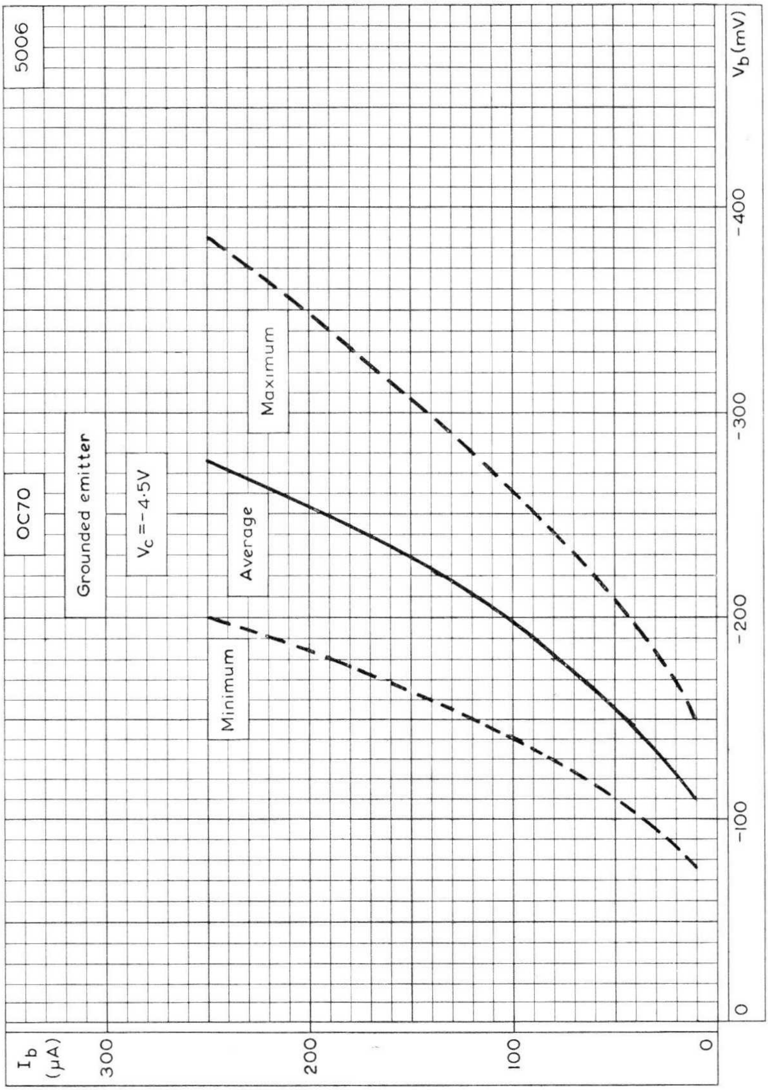


INPUT CHARACTERISTIC. GROUNDED EMITTER.

JUNCTION TRANSISTOR

OC70

Junction transistor of the p-n-p alloy type in all glass construction especially suitable for use in low consumption audio amplifier circuits.

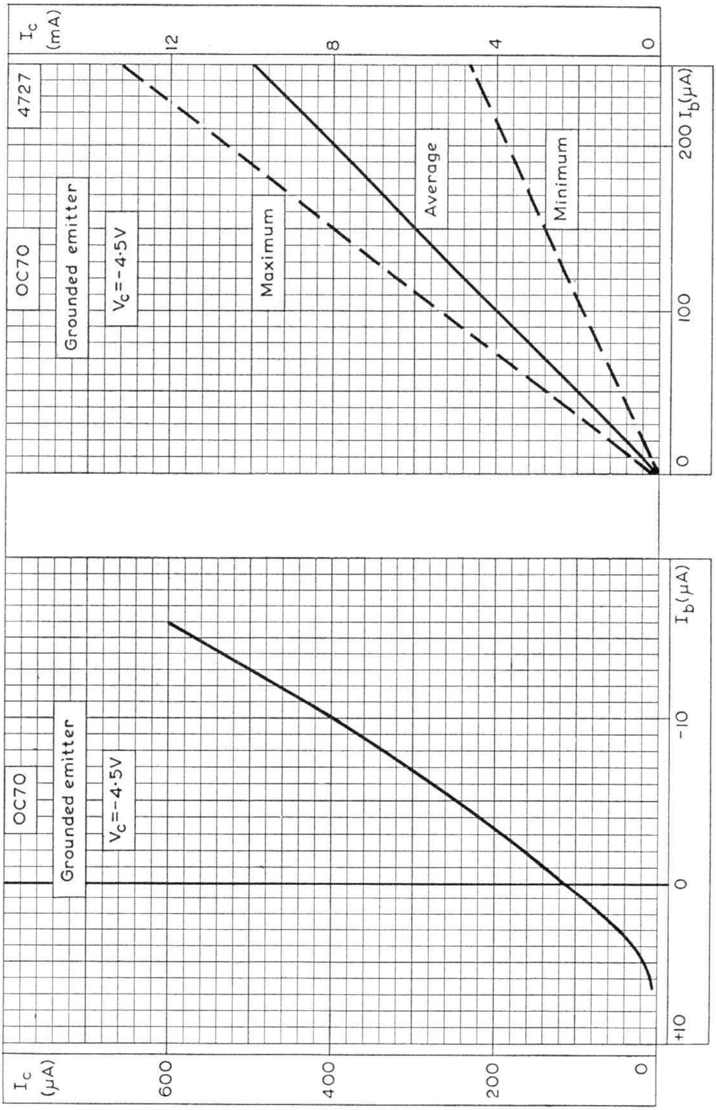


SPREAD OF INPUT CHARACTERISTIC. GROUNDED EMITTER.

OC70

JUNCTION TRANSISTOR

Junction transistor of the p-n-p alloy type in all glass construction especially suitable for use in low consumption audio amplifier circuits.

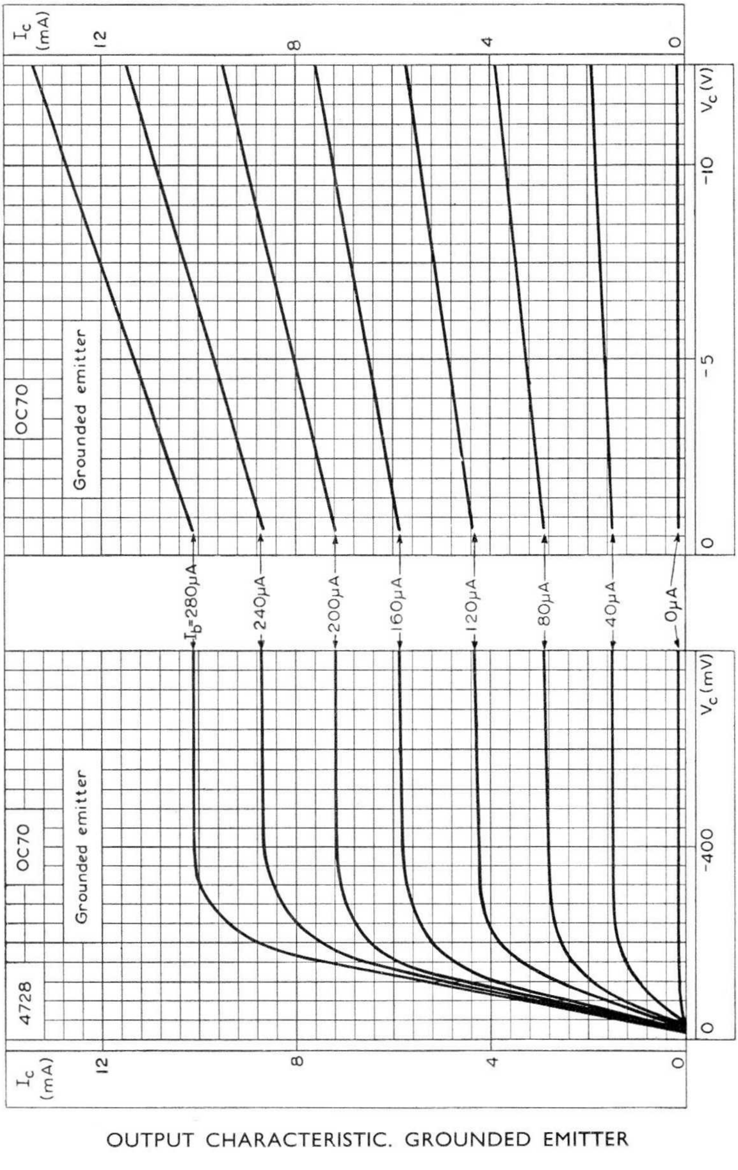


TRANSFER CHARACTERISTIC WITH SPREADS. GROUNDED EMITTER.

JUNCTION TRANSISTOR

OC70

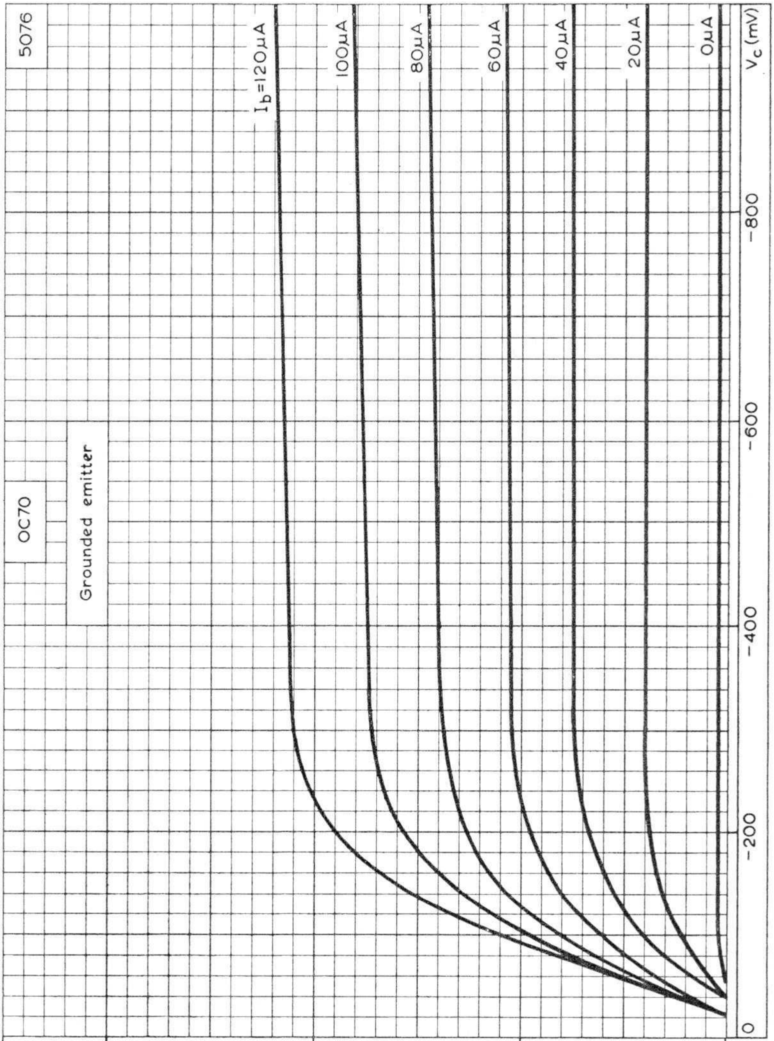
Junction transistor of the p-n-p alloy type in all glass construction especially suitable for use in low consumption audio amplifier circuits.



OUTPUT CHARACTERISTIC. GROUNDED EMITTER

JUNCTION TRANSISTOR

Junction transistor of the p-n-p alloy type in all glass construction especially suitable for use in low consumption audio amplifier circuits.

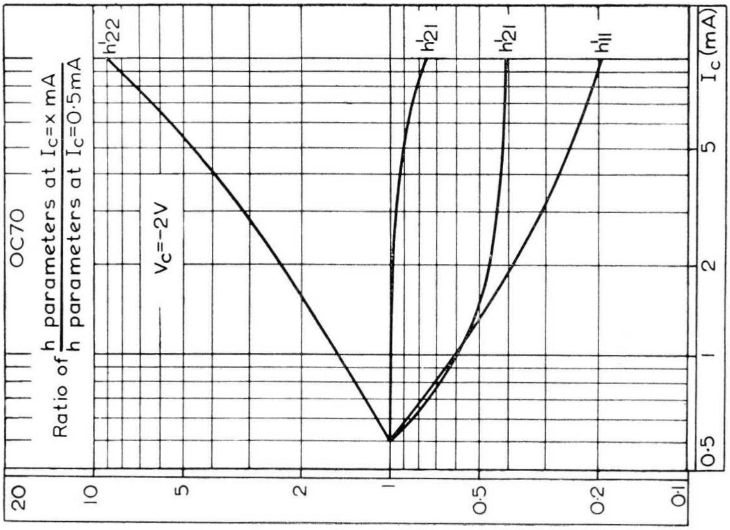


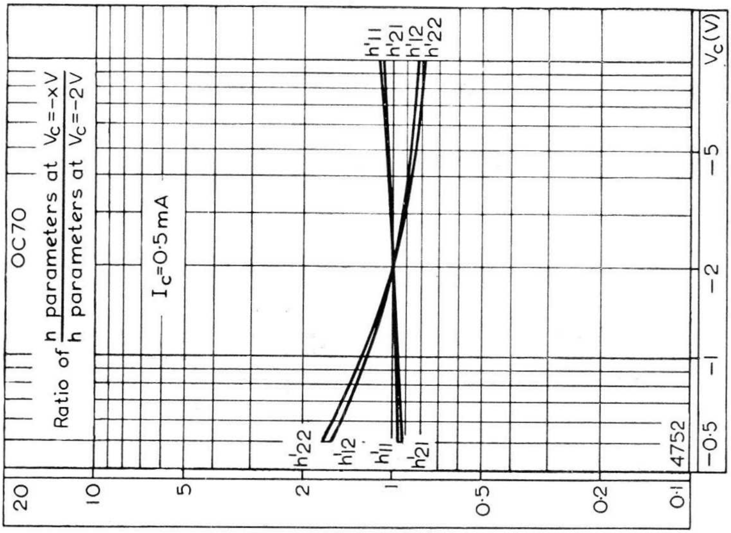
OUTPUT CHARACTERISTIC OVER CURRENT RANGE 0 TO 3mA AND VOLTAGE RANGE 0 TO −1V. GROUNDED EMITTER

JUNCTION TRANSISTOR

OC70

Junction transistor of the p-n-p alloy type in all glass construction especially suitable for use in low consumption audio amplifier circuits.



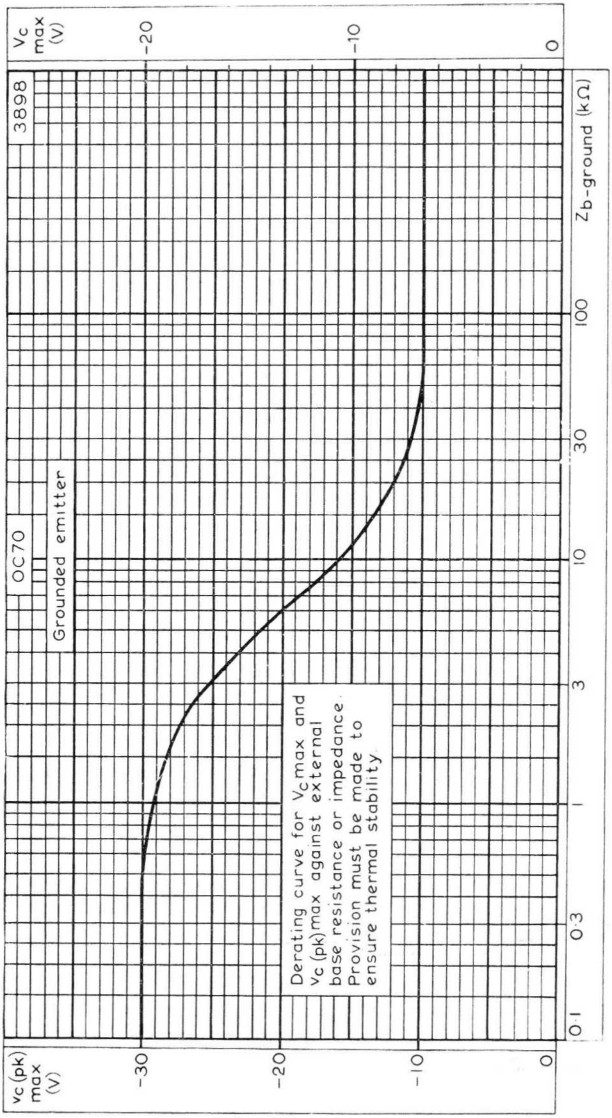


VARIATION OF h PARAMETERS WITH WORKING POINT. GROUNDED EMITTER

OC70

JUNCTION TRANSISTOR

Junction transistor of the p-n-p alloy type in all glass construction especially suitable for use in low consumption audio amplifier circuits.

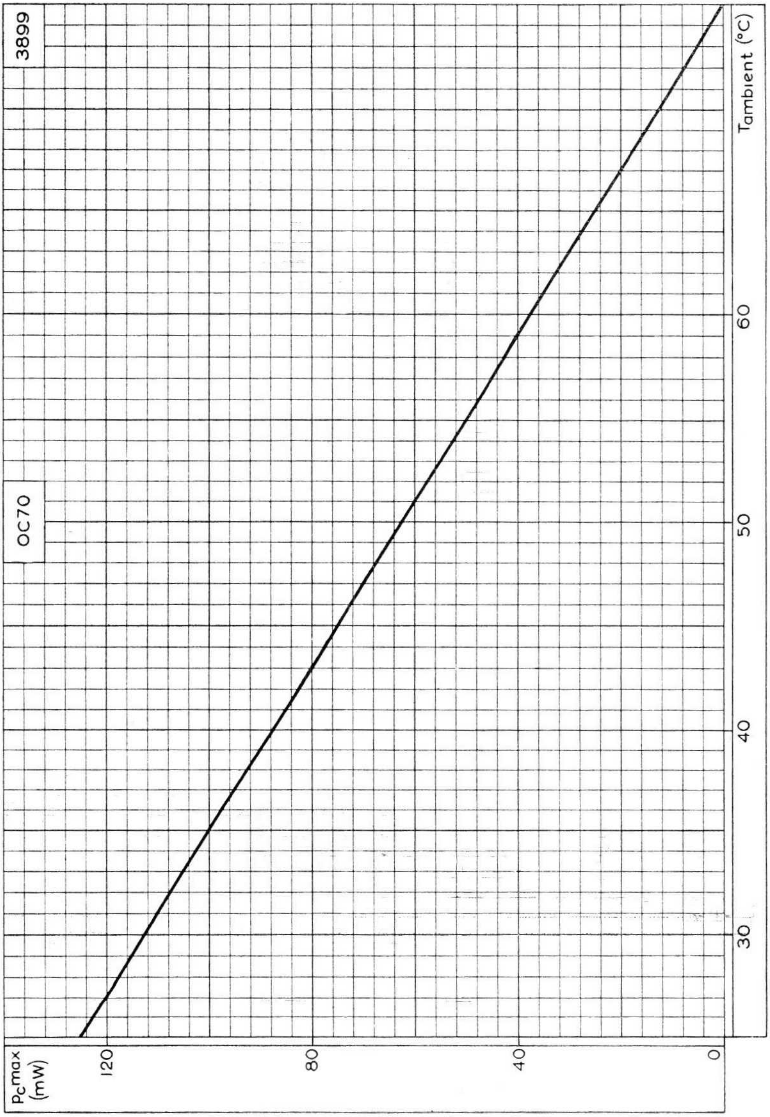


MAXIMUM PEAK AND AVERAGE COLLECTOR VOLTAGE PLOTTED AGAINST EXTERNAL BASE-EMITTER IMPEDANCE OR RESISTANCE

JUNCTION TRANSISTOR

OC70

Junction transistor of the p-n-p alloy type in all glass construction especially suitable for use in low consumption audio amplifier circuits.

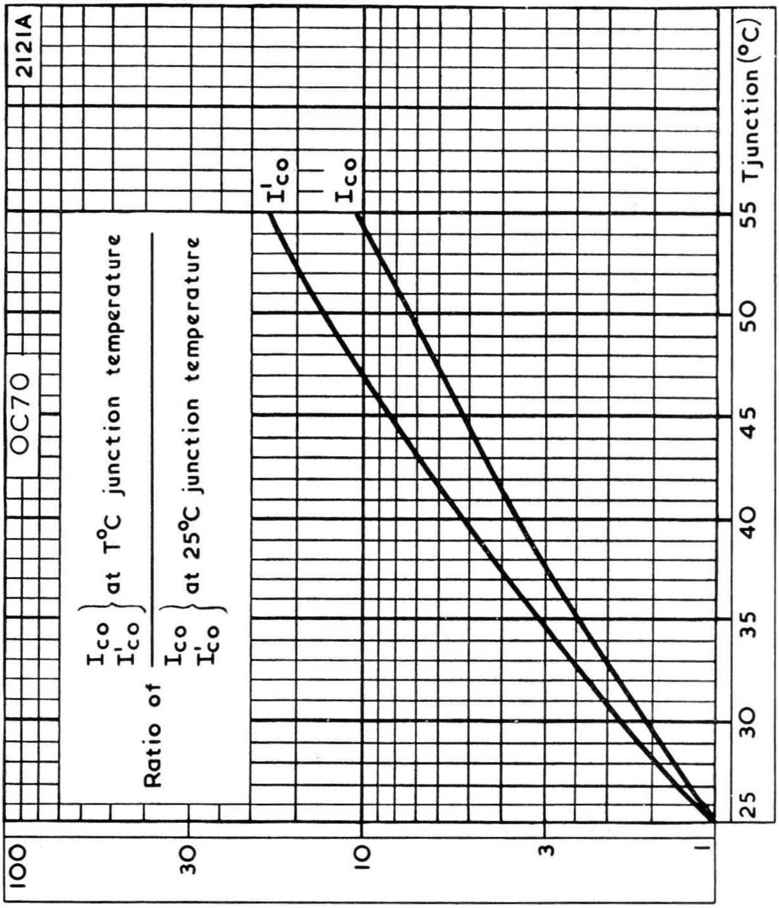


COLLECTOR DISSIPATION PLOTTED AGAINST AMBIENT TEMPERATURE

OC70

JUNCTION TRANSISTOR

Junction transistor of the p-n-p alloy type in all glass construction especially suitable for use in low consumption audio amplifier circuits.

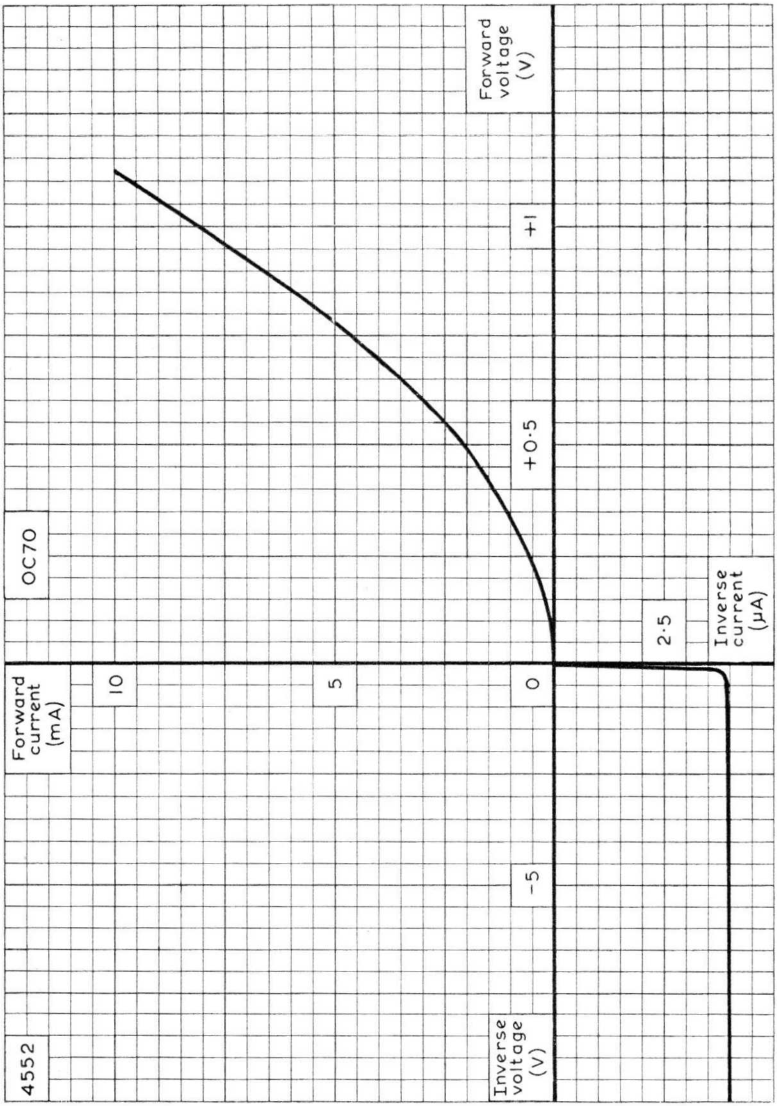


VARIATION OF I_{co} AND I'_{co} WITH TEMPERATURE

JUNCTION TRANSISTOR

OC70

Junction transistor of the p-n-p alloy type in all glass construction especially suitable for use in low consumption audio amplifier circuits.



CHARACTERISTICS OF EMITTER-BASE DIODE

JUNCTION TRANSISTOR

OC71

Junction transistor of the p-n-p alloy type in all glass construction, especially suitable for use in low-consumption audio amplifier circuits.

LIMITING VALUES (absolute ratings)

The equipment designer must ensure that no transistor exceeds these ratings. In arriving at the actual operating conditions, variation in supply voltages, component tolerances and ambient temperature must also be taken into account.

Collector voltage

Grounded base

$v_{c(pk)}$ max.	−30	V
*$V_{c(av.)}$ max.	−20	V
V_c max. (d.c.)	−20	V

Grounded emitter

$v_{c(pk)}$ max.	−30	V
*$V_{c(av.)}$ max.	−20	V
V_c max. (d.c.)	−20	V

These figures apply with an external base-ground circuit impedance of less than 500Ω, or providing $+V_{be} > 500$mV.
For other values of impedance see curve on page 17.

Collector current

**$i_{c(pk)}$ max.	50	mA
*I_c max.	10	mA

Emitter current

**$i_{e(pk)}$ max.	55	mA
*I_e max.	12	mA

Reverse base emitter voltage

$v_{be(pk)}$ max.	10	V
V_{be} max.	10	V

Base current

$i_{b(pk)}$ max.	5.0	mA
*I_b max.	2.0	mA

Total dissipation

See page 18

$$\left(P_{tot} = \frac{T_{junction}\ \text{max.} - T_{ambient}}{\theta}\right)$$

Temperature ratings

Storage temperature	−55 to +75	°C
Maximum junction temperature ($T_{junction}$ max.)		
Continuous operation	75	°C
‡Intermittent operation (total duration = 200hrs. max.)	90	°C
Junction temperature rise above ambient (θ)	0.4	°C/mW

*Averaged over any 20ms period

**Owing to linearity considerations it is inadvisable to design for peak currents greater than 25mA where low distortion is required.

‡Likelihood of full performance of a circuit at this temperature is also dependent on the type of application.

OC71

JUNCTION TRANSISTOR

Junction transistor of the p-n-p alloy type in all glass construction, especially suitable for use in low-consumption audio amplifier circuits.

CHARACTERISTICS AT $T_{junction} = 25°C$

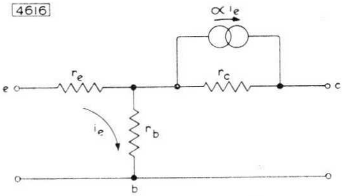
		Min.	Av.	Max.	
Grounded base					
Collector leakage current ($V_c = -4.5V$, $I_e = 0mA$)	I_{co}	—	4.5	13	μA
Emitter leakage current ($V_e = -4.5V$, $I_c = 0mA$)	I_{eo}	—	3.5	13	
Grounded emitter					
Collector leakage current ($V_c = -4.5V$, $I_b = 0mA$)	I'_{co}	—	150	325	μA
Collector bottoming voltage ($I_c = 9mA$, $I_b = 0.5mA$)	V_{ce}	—	−80	−210	mV
Base input voltage ($V_c = -4.5V$, $I_c = 1mA$)	V_{be}	−115	−135	−155	mV
Noise figure ($f = 1kc/s$, $R_{source} = 500\Omega$, $V_c = -2V$, $I_c = 0.5mA$)		—	10	16	dB

For information on changes in characteristics with change in temperature see page 19.

SMALL SIGNAL CHARACTERISTICS

Equivalent circuit parameters (Tnetwork)

Measured at: $f = 1kc/s$, $V_c = -2V$, $I_c = 3mA$, $T_{ambient} = 25°C$



r_e	6.5	Ω
r_b	500	Ω
r_c	625	kΩ
α	0.979	

		Min.	Av.	Max.	
Grounded base cut-off frequency ($V_c = -6V$, $I_c = 1mA$)	f_α	300	600	1000	kc/s
Grounded emitter cut-off frequency ($V_c = -6V$, $I_c = 1mA$)	f_α'	5	11	26	kc/s
Typical parameters for the full equivalent circuit					
Collector to base capacitance ($V_c = -6V$)	c_c	—	40	—	pF
Internal base resistance ($V_c = -6V$, $I_c = 1mA$)	$r_{bb'}$	—	300	—	Ω

JUNCTION TRANSISTOR

OC71

Junction transistor of the p-n-p alloy type in all glass construction, especially suitable for use in low-consumption audio amplifier circuits.

SMALL SIGNAL CHARACTERISTICS measured at $V_c = -2V$, $I_c = 1mA$

Grounded base

Hybrid matrix

Input impedance (with output short circuited to a.c.)	h_{11}	35	Ω
Current amplification (with output short circuited to a.c.)	$-h_{21}$	0.976	
Output admittance (with input open circuited to a.c.)	h_{22}	1.0	μmhos
Voltage feedback ratio (with input open circuited to a.c.)	h_{12}	7×10^{-4}	

Mullard system

Current amplification (with output short circuited to a.c.)	α	0.976	
Input resistance (with output short circuited to a.c.)	r_{in}	35	Ω
Input resistance (with output open circuited to a.c.)	r_{11}	720	Ω
Output resistance (with input short circuited to a.c.)	r_{out}	50	kΩ
Output resistance (with input open circuited to a.c.)	r_{22}	1.0	MΩ

Grounded emitter

Hybrid matrix

Input impedance (with output short circuited to a.c.)	h'_{11}	1.45	kΩ
Current amplification (with output short circuited to a.c.)	h'_{21}	41	
Output admittance (with input open circuited to a.c.)	h'_{22}	42	μmhos
Voltage feedback ratio (with input open circuited to a.c.)	h'_{12}	7.6×10^{-4}	

Mullard system

Current amplification (with output short circuited to a.c.)	α'	41	
Input resistance (with output short circuited to a.c.	r'_{in}	1.45	kΩ
Input resistance (with output open circuited to a.c.)	r'_{11}	720	Ω
Output resistance (with input short circuited to a.c.)	r'_{out}	50	kΩ
Output resistance (with input open circuited to a.c.)	r'_{22}	25	kΩ

OC71

JUNCTION TRANSISTOR

Junction transistor of the p-n-p alloy type in all glass construction, especially suitable for use in low-consumption audio amplifier circuits.

SMALL SIGNAL CHARACTERISTICS measured at $V_c = -2V$, $I_c = 3mA$

Grounded base

Hybrid matrix

		Typical production spreads Min.	Av.	Max.	
Input impedance (with output short circuited to a.c.)	h_{11}	10	17	25	Ω
Current amplification (with output short circuited to a.c.)	$-h_{21}$	0.968	0.979	0.987	
Output admittance (with input open circuited to a.c.)	h_{22}	—	1.6	2.7	μmhos
Voltage feedback ratio (with input open circuited to a.c.)	h_{12}	—	8×10^{-4}	—	

Mullard System

		Min.	Av.	Max.	
Current amplification (with output short circuited to a.c.)	α	0.968	0.979	0.987	
Input resistance (with output short circuited to a.c.)	r_{in}	10	17	25	Ω
Input resistance (with output open circuited to a.c.)	r_{11}	—	500	—	Ω
Output resistance (with input short circuited to a.c.)	r_{out}	—	21	—	kΩ
Output resistance (with input open circuited to a.c.)	r_{22}	370	625	—	kΩ

Grounded emitter

Hybrid matrix

		Min.	Av.	Max.	
Input impedance (with output short circuited to a.c.)	h'_{11}	0.4	0.8	1.5	kΩ
Current amplification (with output short circuited to a.c.)	h'_{21}	30	47	75	
Output admittance (with input open circuited to a.c.)	h'_{22}	—	80	200	μmhos
Voltage feedback ratio (with input open circuited to a.c.)	h'_{12}	—	5.4×10^{-4}	17×10^{-4}	

Mullard system

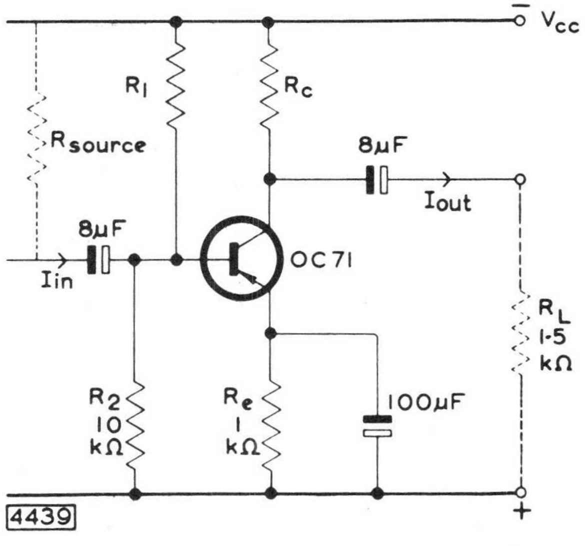
		Min.	Av.	Max.	
Current amplification (with output short circuited to a.c.)	α'	30	47	75	
Input resistance (with output short circuited to a.c.)	r'_{in}	0.4	0.8	1.5	kΩ
Input resistance (with output open circuited to a.c.)	r'_{11}	—	500	—	Ω
Output resistance (with input short circuited to a.c.)	r'_{out}	—	21	—	kΩ
Output resistance (with input open circuited to a.c.)	r'_{22}	5.0	12.5	—	kΩ

JUNCTION TRANSISTOR

OC71

Junction transistor of the p-n-p alloy type in all glass construction, especially suitable for use in low-consumption audio amplifier circuits.

OPERATING CONDITIONS AS R.C. COUPLED AMPLIFIER



V_{cc} (V)	I_c (mA)	R1 (kΩ)	R_e (kΩ)	$\frac{I_{out}}{I_{in}}$	I_{out} for $D_{tot} = 5\%$ (µA r.m.s.)
6	1.0	39	2.2	23	200
6	1.5	22	1.5	18.5	290
9	1.0	62	3.9	28	260
9	1.5	39	2.7	24	430
12	1.0	82	5.6	31	270
12	1.5	56	4.7	30	535

The source impedance R_{source} is equal to R_c , and the resistance R_L is equivalent to the input impedance of the following stage. The gain and distortion figures are therefore typical of one OC71 in a series of identical stages in cascade.

OC71

JUNCTION TRANSISTOR

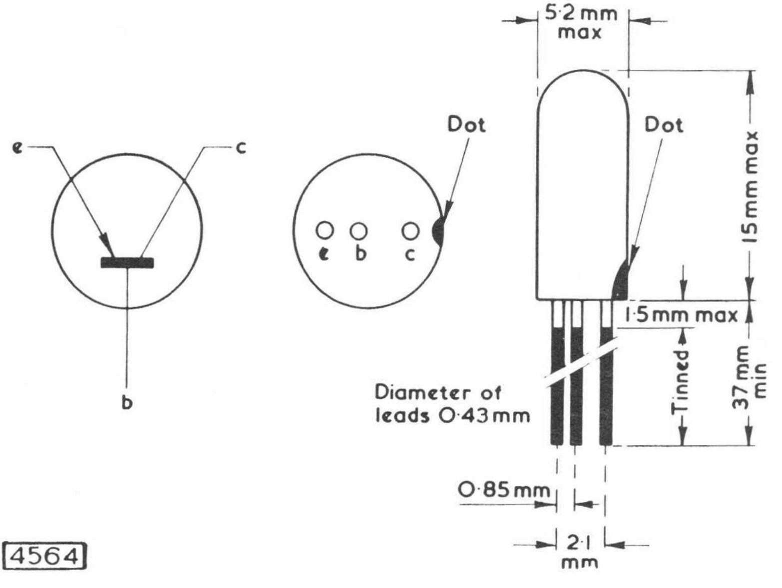
Junction transistor of the p-n-p alloy type in all glass construction, especially suitable for use in low-consumption audio amplifier circuits.

> SOLDERING AND WIRING RECOMMENDATIONS

1. When using a soldering iron, transistors may be soldered directly into the circuit, but heat conducted to the junction should if possible be kept to a minimum by the use of a thermal shunt.
2. Transistors may be dip-soldered at a solder temperature of 245°C for a maximum soldering time of 5 seconds. The case temperature during dip-soldering may exceed the maximum storage temperature for a period not greater than 2 minutes, provided that it at no time exceeds 115°C. These recommendations apply to a transistor mounted flush on a board having punched-through holes, or spaced at least 1.5mm away from a board having plated-through holes.
3. Care should be taken not to bend the leads nearer than 1.5mm from the seal.

OUTLINE AND DIMENSIONS ←

Conforming to V.A.S.C.A. SO-2/SB3-2

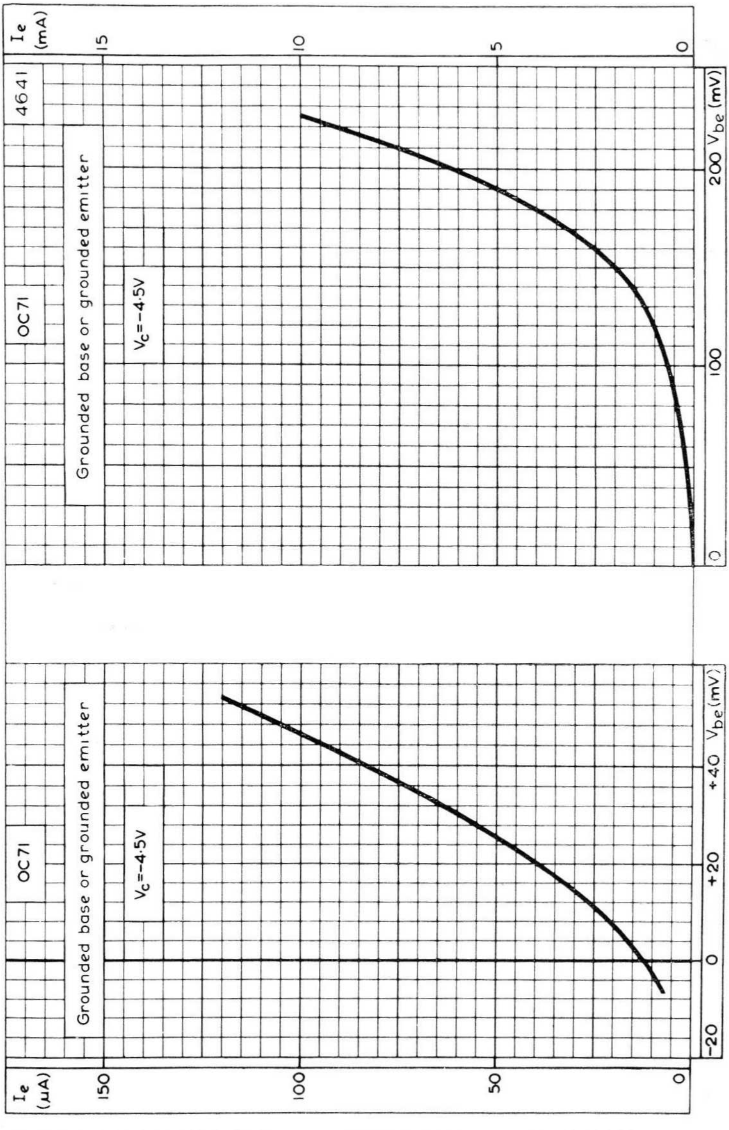


4564

JUNCTION TRANSISTOR

OC71

Junction transistor of the p-n-p alloy type in all glass construction, especially suitable for use in low-consumption audio amplifier circuits.

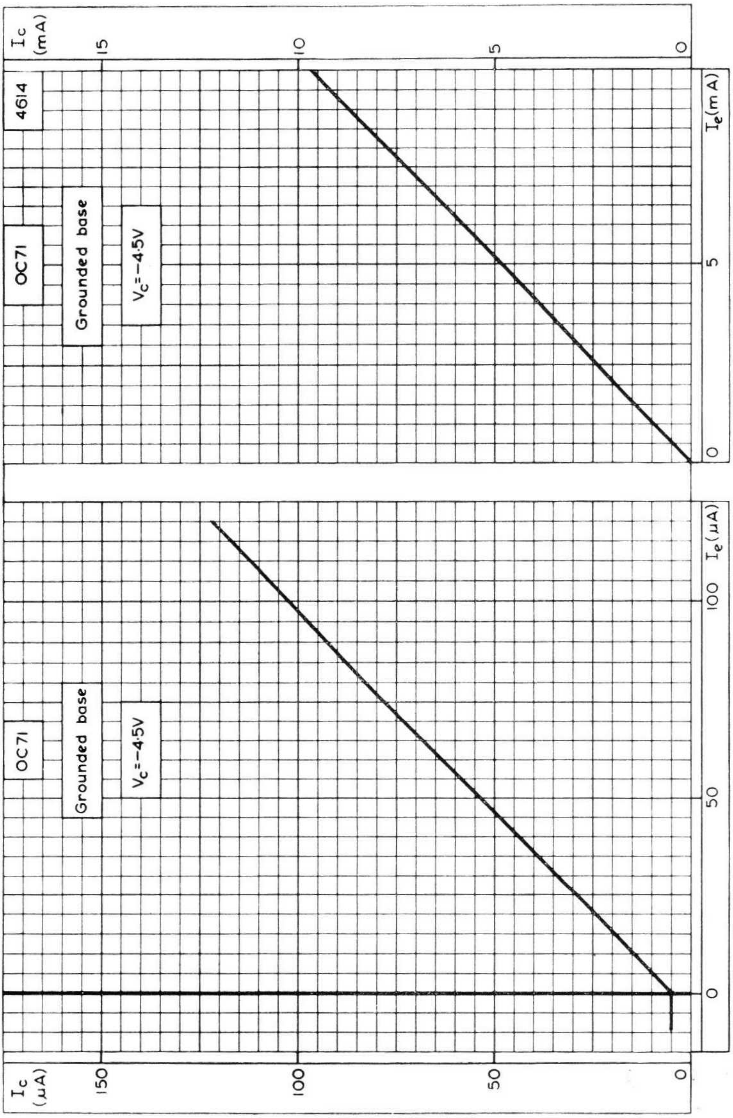


EMITTER CURRENT PLOTTED AGAINST EMITTER-BASE VOLTAGE
(Grounded base or grounded emitter)

OC71

JUNCTION TRANSISTOR

Junction transistor of the p-n-p alloy type in all glass construction, especially suitable for use in low-consumption audio amplifier circuits.

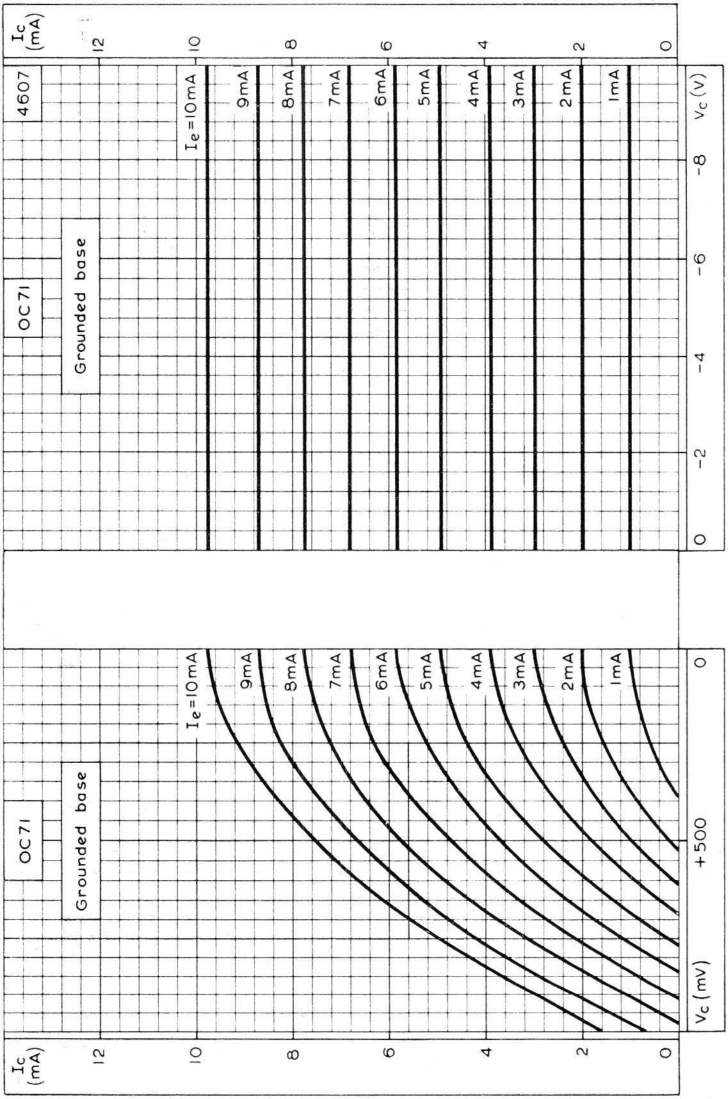


TRANSFER CHARACTERISTIC. GROUNDED BASE

JUNCTION TRANSISTOR

OC71

Junction transistor of the p-n-p alloy type in all glass construction, especially suitable for use in low-consumption audio amplifier circuits.

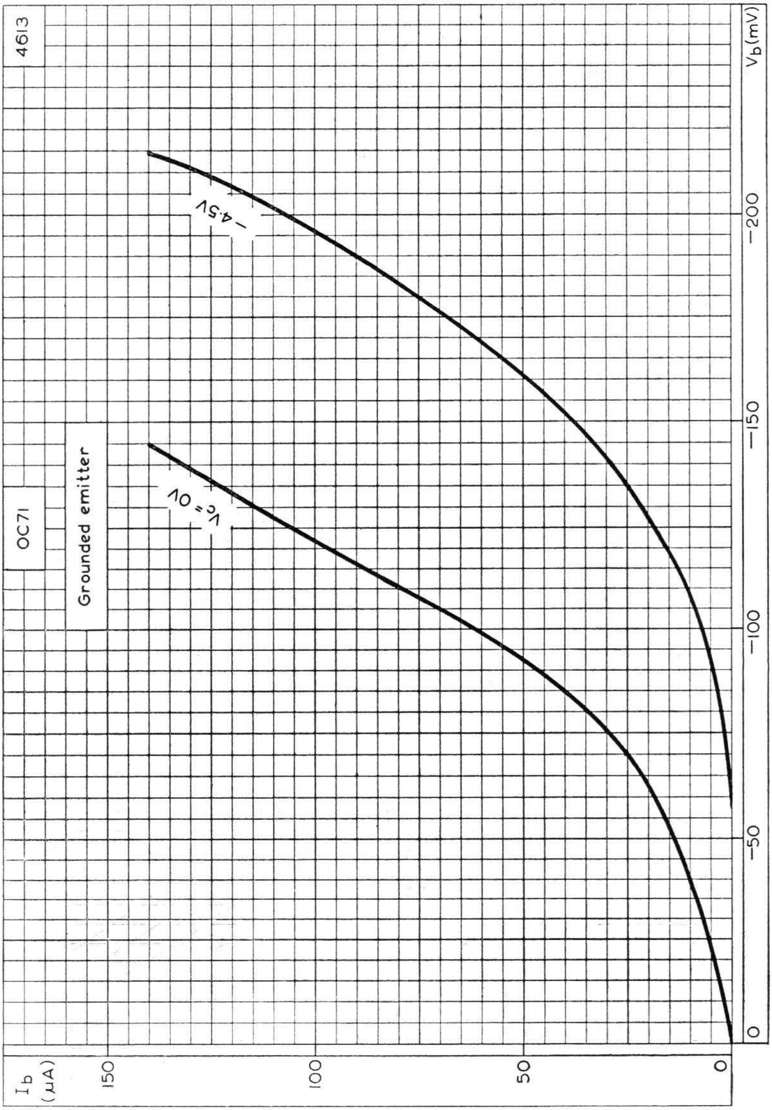


OUTPUT CHARACTERISTIC. GROUNDED BASE

OC71

JUNCTION TRANSISTOR

Junction transistor of the p-n-p alloy type in all glass construction, especially suitable for use in low-consumption audio amplifier circuits.

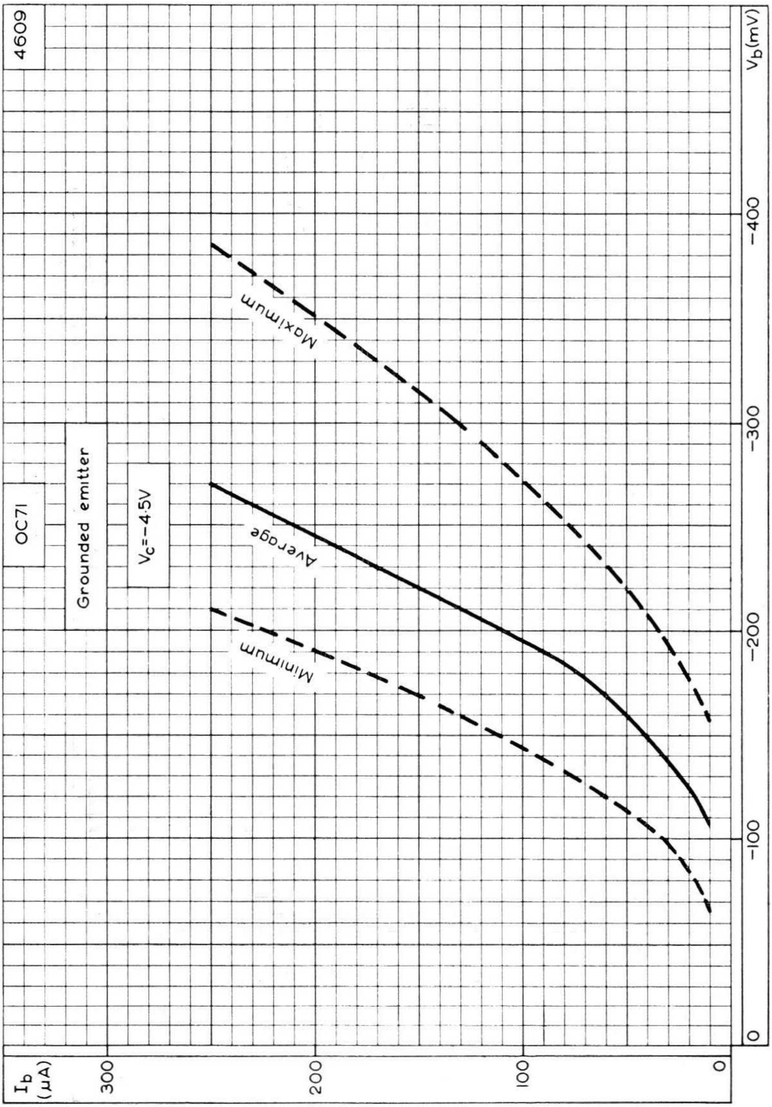


INPUT CHARACTERISTIC. GROUNDED EMITTER

JUNCTION TRANSISTOR

OC71

Junction transistor of the p-n-p alloy type in all glass construction, especially suitable for use in low-consumption audio amplifier circuits.

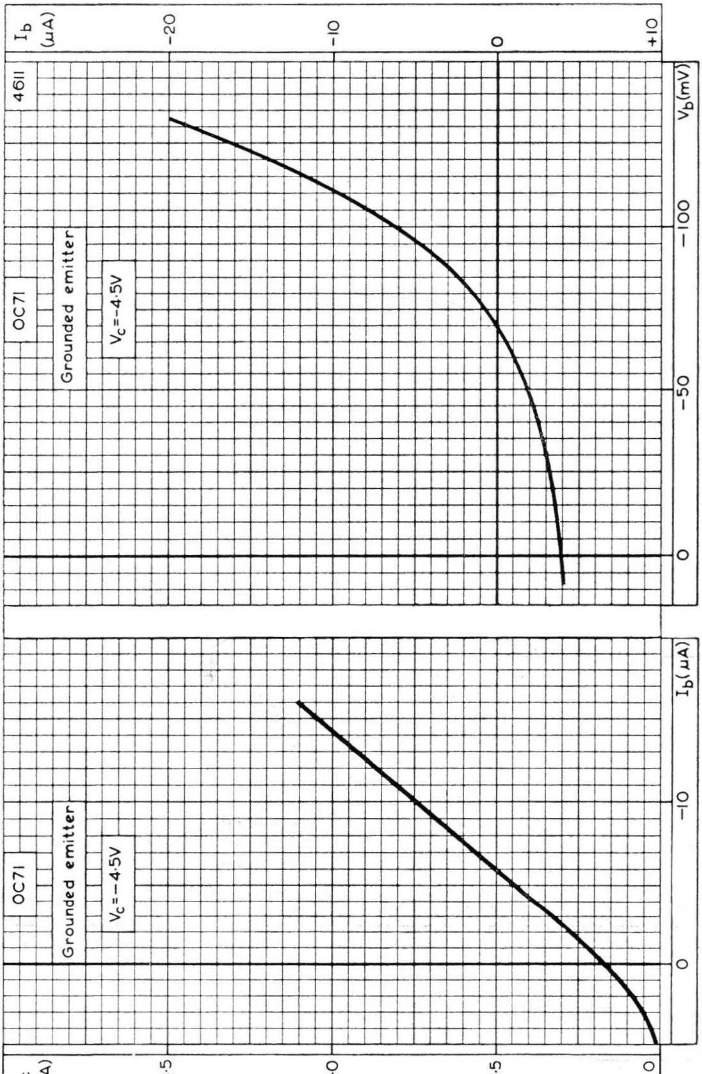


SPREAD OF INPUT CHARACTERISTIC. GROUNDED EMITTER

OC71

JUNCTION TRANSISTOR

Junction transistor of the p-n-p alloy type in all glass construction, especially suitable for use in low-consumption audio amplifier circuits.

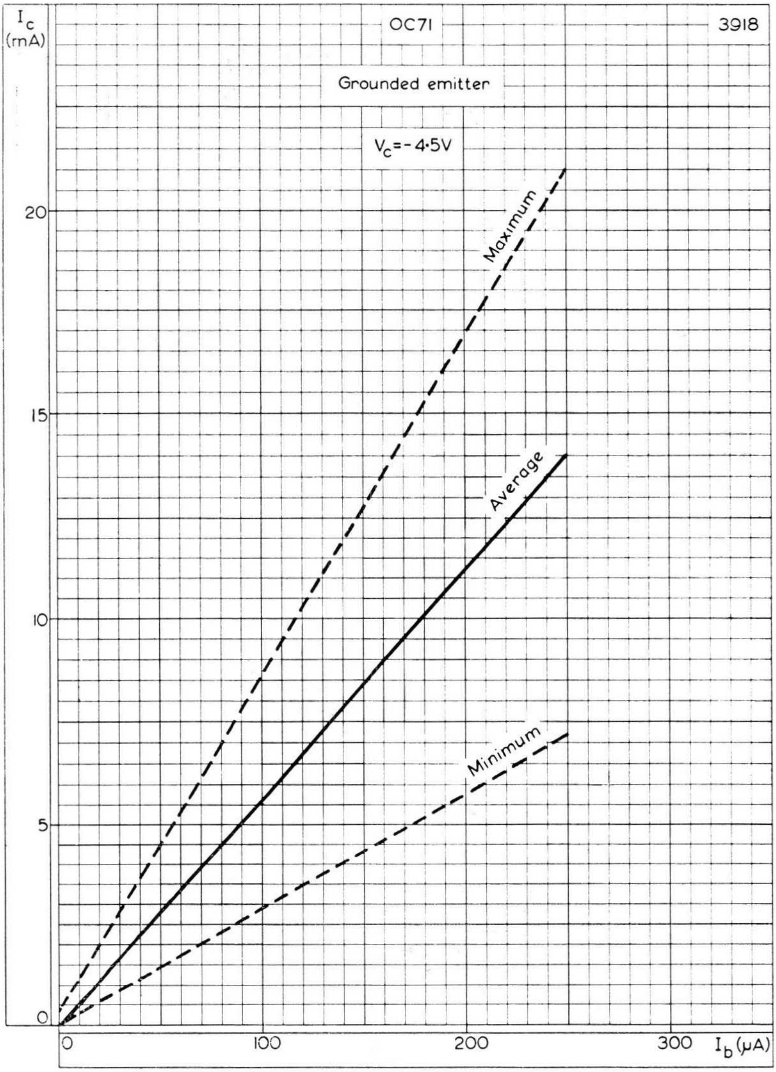


INPUT CHARACTERISTIC (I_b = +10 TO −20μA) AND TRANSFER CHARACTERISTIC. GROUNDED EMITTER

JUNCTION TRANSISTOR

OC71

Junction transistor of the p-n-p alloy type in all glass construction, especially suitable for use in low-consumption audio amplifier circuits.

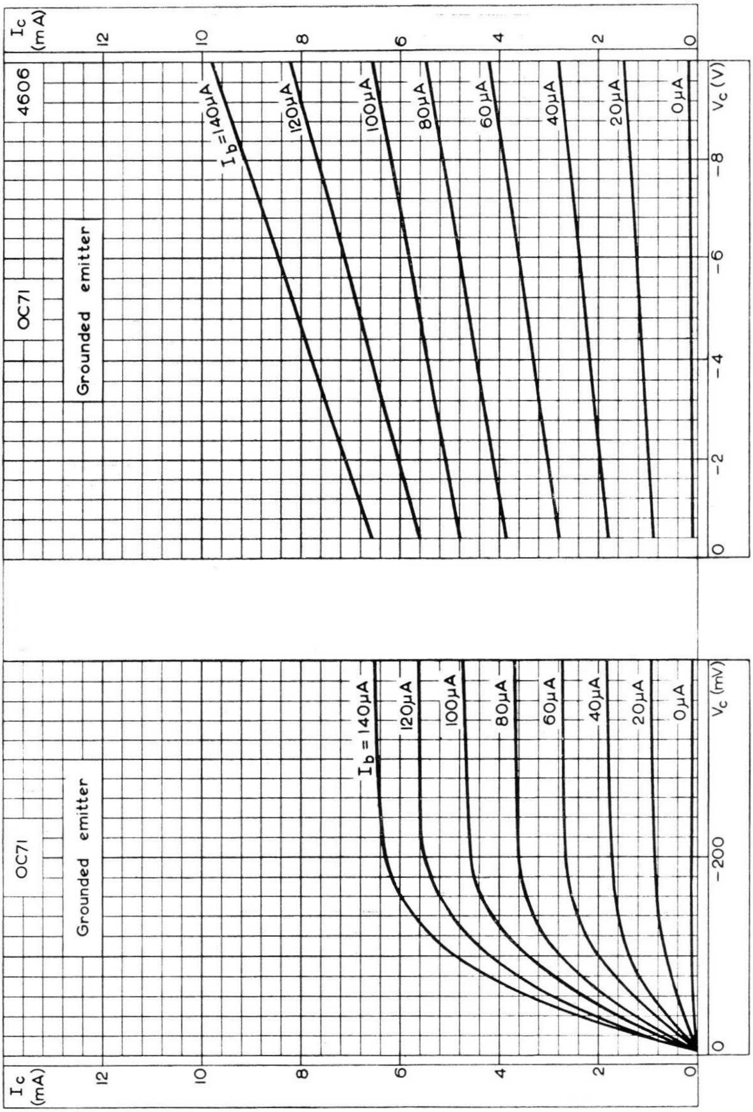


SPREAD OF TRANSFER CHARACTERISTIC. GROUNDED EMITTER

OC71

JUNCTION TRANSISTOR

Junction transistor of the p-n-p alloy type in all glass construction, especially suitable for use in low-consumption audio amplifier circuits.

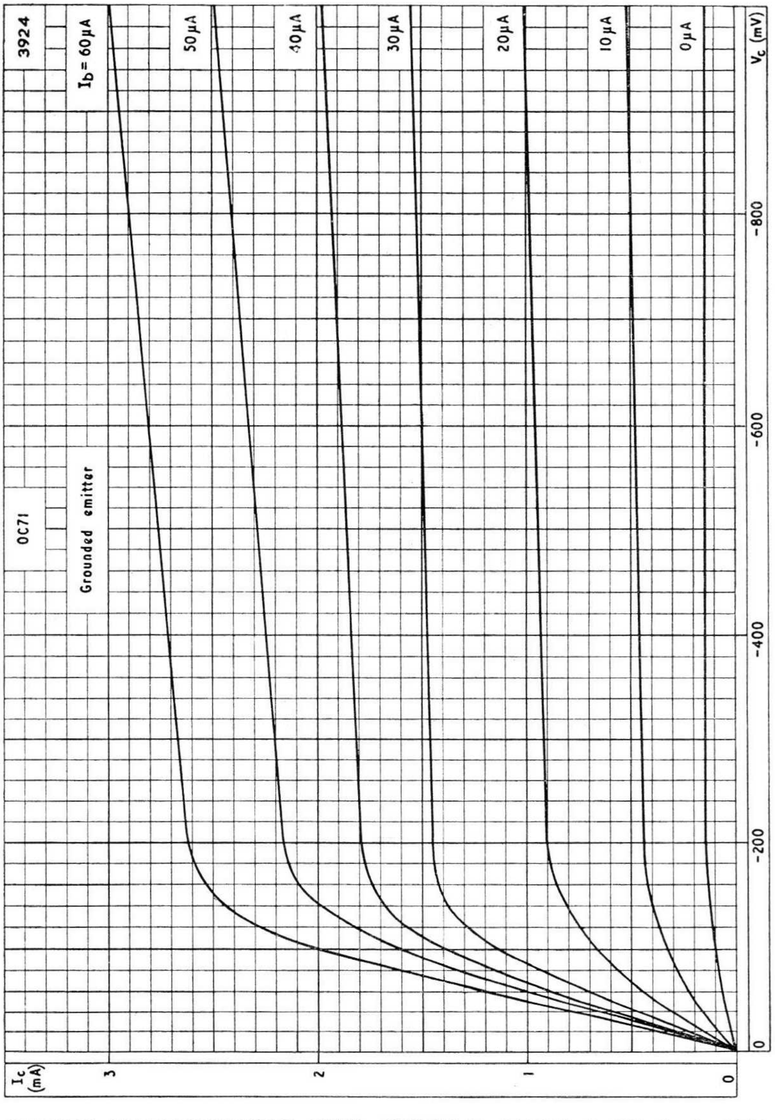


OUTPUT CHARACTERISTIC. GROUNDED EMITTER

JUNCTION TRANSISTOR

0C71

Junction transistor of the p-n-p alloy type in all glass construction, especially suitable for use in low-consumption audio amplifier circuits.

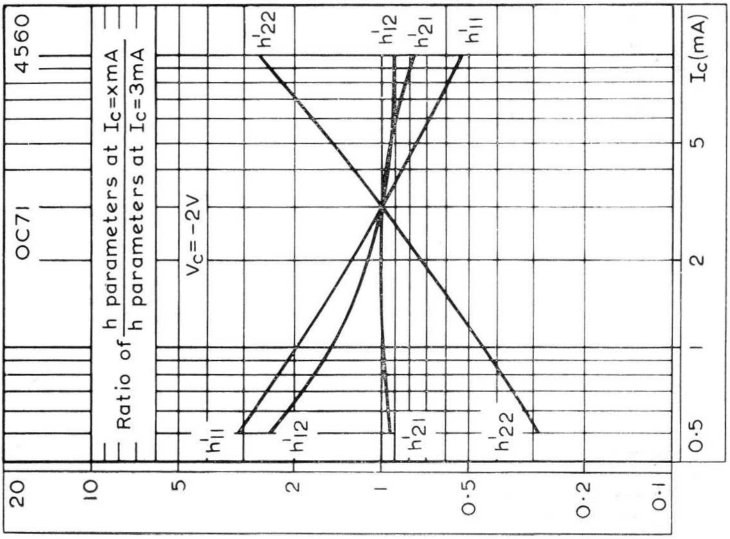


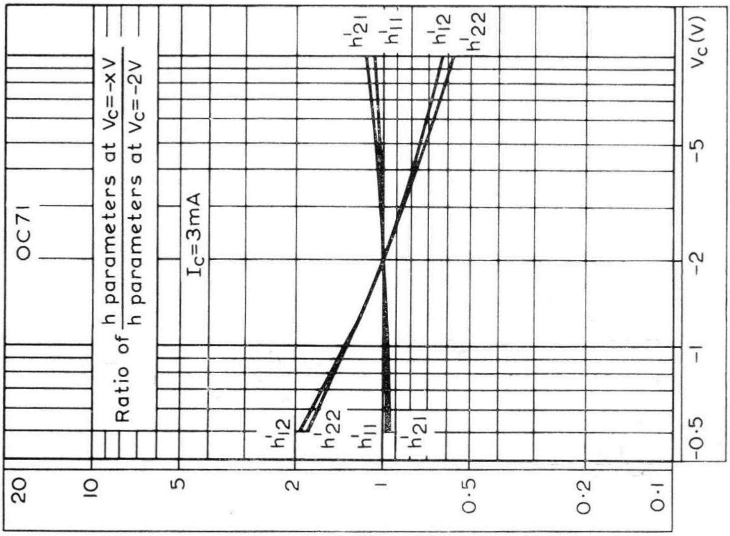
OUTPUT CHARACTERISTIC OVER CURRENT RANGE 0 TO 3mA AND VOLTAGE RANGE 0 TO –1V. GROUNDED EMITTER

OC71

JUNCTION TRANSISTOR

Junction transistor of the p-n-p alloy type in all glass construction, especially suitable for use in low-consumption audio amplifier circuits.



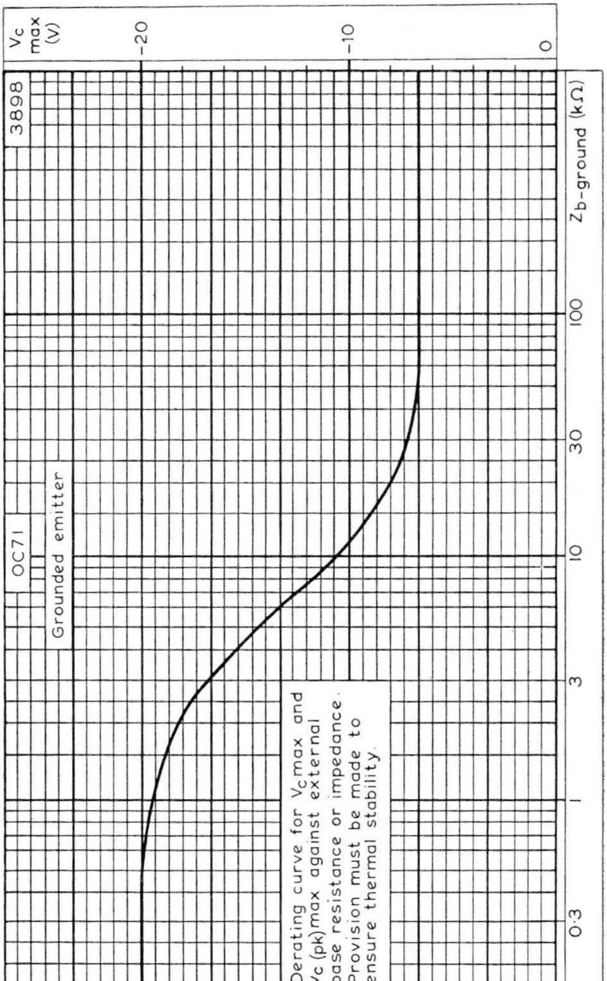


VARIATION OF h PARAMETERS WITH WORKING POINT. GROUNDED EMITTER

JUNCTION TRANSISTOR

OC71

Junction transistor of the p-n-p alloy type in all glass construction, especially suitable for use in low-consumption audio amplifier circuits.

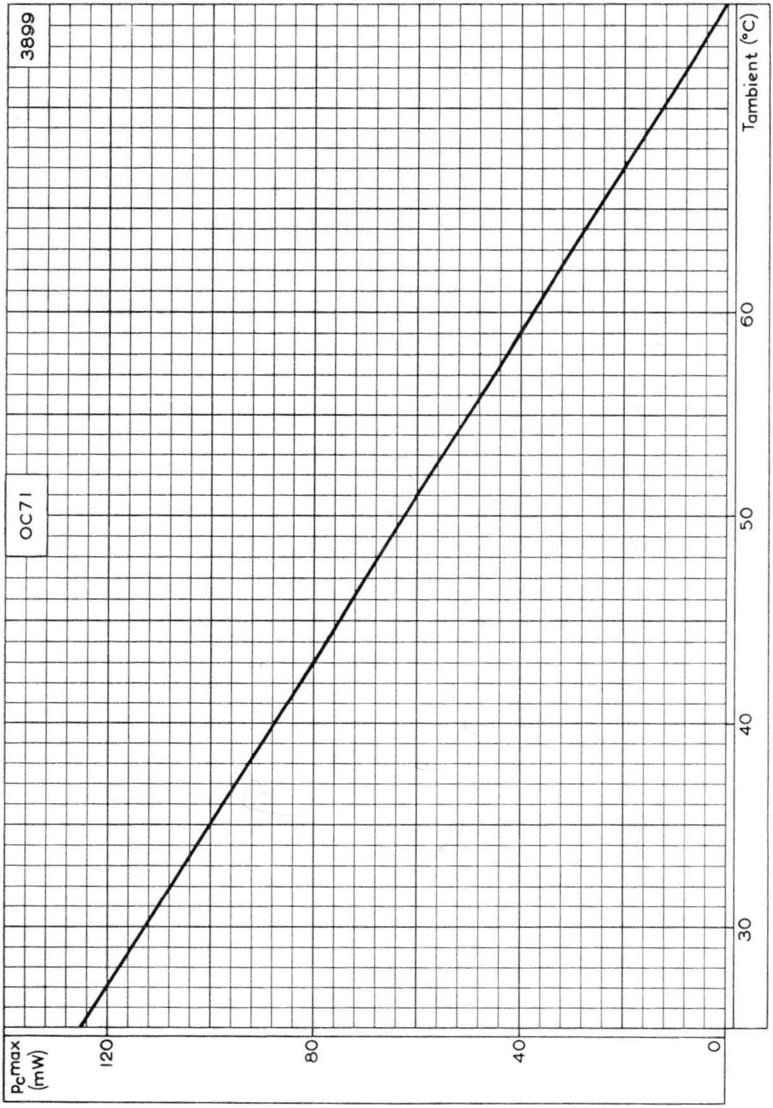


MAXIMUM PEAK AND AVERAGE COLLECTOR VOLTAGE PLOTTED AGAINST EXTERNAL BASE-EMITTER IMPEDANCE OR RESISTANCE

OC71

JUNCTION TRANSISTOR

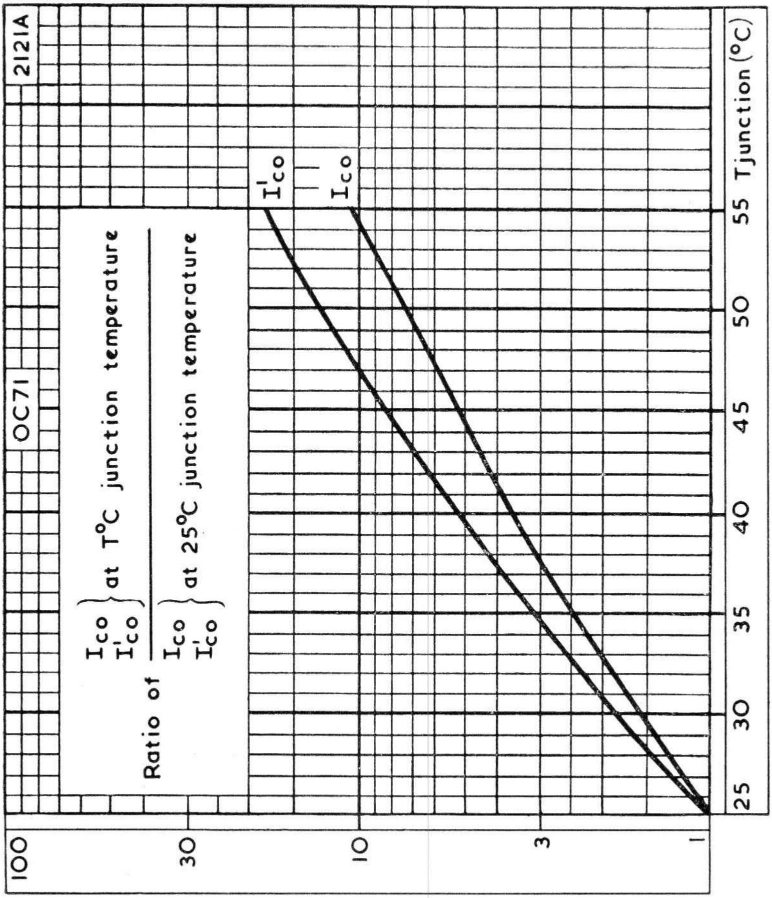
Junction transistor of the p-n-p alloy type in all glass construction, especially suitable for use in low-consumption audio amplifier circuits.



COLLECTOR DISSIPATION PLOTTED AGAINST AMBIENT TEMPERATURE

JUNCTION TRANSISTOR

Junction transistor of the p-n-p alloy type in all glass construction, especially suitable for use in low-consumption audio amplifier circuits.

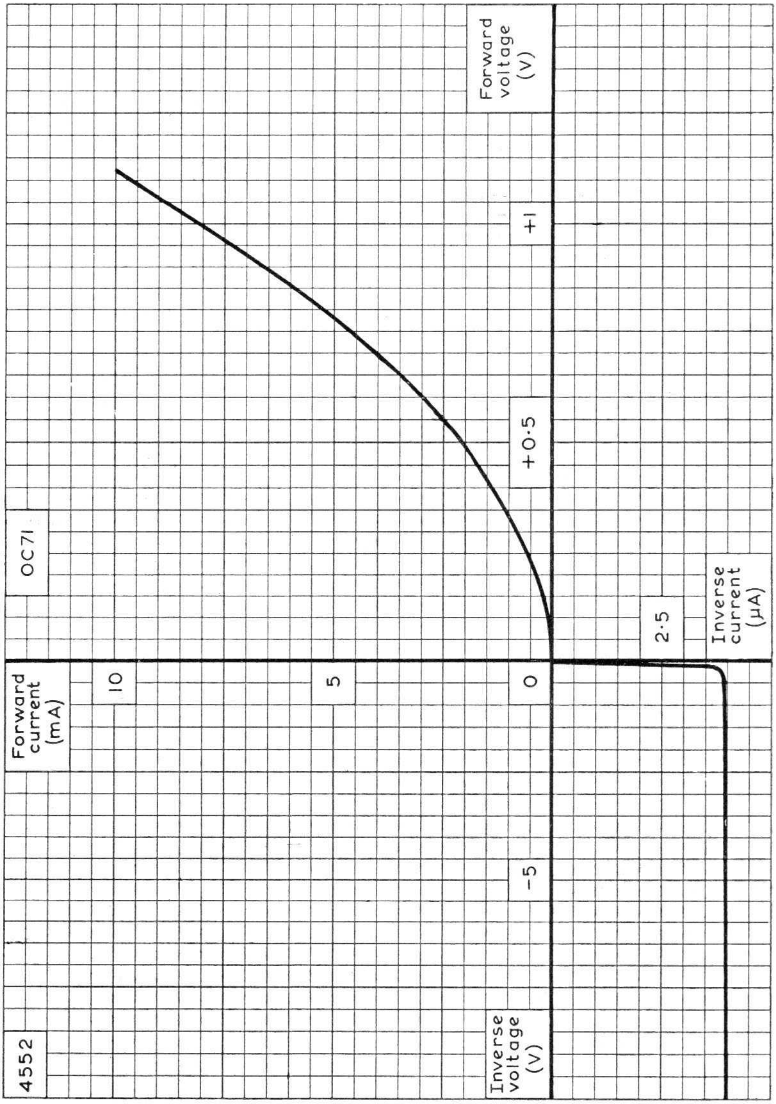


VARIATION OF I_{co} AND I'_{co} WITH TEMPERATURE

OC71

JUNCTION TRANSISTOR

Junction transistor of the p-n-p alloy type in all glass construction, especially suitable for use in low-consumption audio amplifier circuits.



CHARACTERISTICS OF EMITTER-BASE DIODE

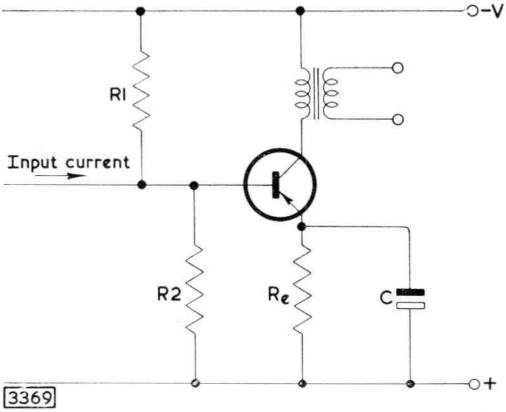
JUNCTION TRANSISTOR

OC72
2-OC72

Junction transistor of the p-n-p alloy type for use in class 'B' output stages, oscillator and switching circuits and d.c. converters.

OPERATING CONDITIONS OF SINGLE TRANSISTOR OC72 AS CLASS 'A' AMPLIFIER

The values of the emitter resistance in the circuits below are based upon full interchangeability of the transistors and such a stabilisation of the currents that the maximum junction temperature is not exceeded up to an ambient temperature of 45°C.



With a cooling fin in free air on a heat sink of 3.5 × 3.5cm or equivalent

Supply voltage	V	−6.0	−9.0	−12	V
D.C. collector current	I_c	16.3	10.6	8.2	mA
Bias resistors	R_1	3.3	8.2	18	kΩ
	R_2	1.0	2.2	4.7	kΩ
*Emitter resistor	R_e	62	140	280	Ω
Emitter capacitor	C	250	250	250	μF
Power delivered to transformer primary	P_{out}	38	38	38	mW
Load impedance	R_{load}	300	680	1150	Ω
Source impedance	R_{source}	>3.0	>3.0	>3.0	kΩ
At P_{out} max.					
Base current	i_b	160	110	90	μA
*Input current	i_{in}	220	130	90	μA
Distortion	D_{tot}	3.6	3.8	3.6	%

*In order to take into account the spread of transistors an increase in input current of 50% should be allowed for in the design.

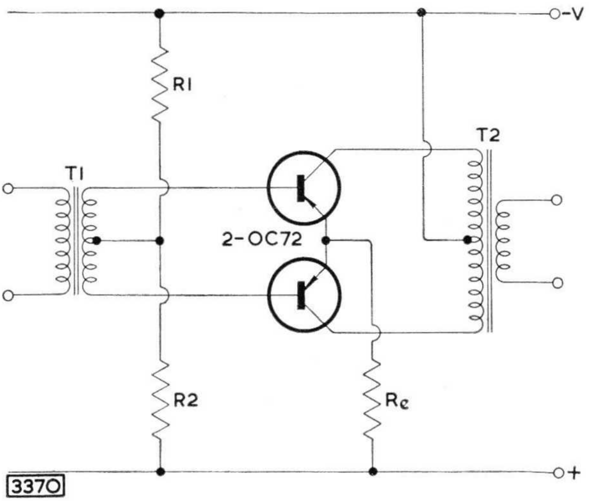
OC72
2-OC72

JUNCTION TRANSISTOR

Junction transistor of the p-n-p alloy type for use in class 'B' output stages, oscillator and switching circuits and d.c. converters.

OPERATING CONDITIONS OF MATCHED PAIR 2-OC72 AS CLASS 'B' AMPLIFIER

The circuits below are designed for stable operation up to an ambient temperature of 45°C.



Without cooling fin

Supply voltage	V	−4.5	−6.0	V
Quiescent current	$I_{c1}+I_{c2}$	3.0	3.0	mA
Bias resistors	R_1	2.7	3.3	kΩ
	R_2	100	100	Ω
*Emitter resistor	R_e	5.0	10	Ω
Power delivered to transformer primary	P_{out}	220	275	mW
R_{load} (collector to collector)	R_{c-c}	115	140	Ω
R_{load} (per transistor) $(R_c = \frac{R_{c-c}}{4} + R_e)$	R_c	34	45	Ω
At P_{out} max.				
Collector current (peak)	$i_{c(pk)}$	125	125	mA
Collector current (per transistor)	I_c	40	40	mA
Distortion	D_{tot}	9.0	9.5	%

*If a resistor is incorporated in each emitter the value of each resistor must be 1.15 times the value of the common emitter resistor to ensure the same thermal stability.

JUNCTION TRANSISTOR

OC72
2-OC72

Junction transistor of the p-n-p alloy type for use in class 'B' output stages, oscillator and switching circuits and d.c. converters.

Drive conditions

The following drive must be available in the transformer secondary to give full output from all transistors. This allows for losses in R2 and in a transformer secondary resistance of 50Ω.

Peak drive current	4.9	4.9	mA
Peak drive voltage	1.9	2.6	V
$P_{drive(r.m.s.)}$	4.6	6.4	mW

With cooling fin in free air mounted on a heat sink of 3.5×3.5cm or equivalent.

Supply voltage	V	−6.0	−6.0	−9.0	−9.0	−12	V
Quiescent current	$I_{c1}+I_{c2}$	3.0	3.0	3.0	2.5	3.0	mA
Bias resistors	R_1	3.3	†3	4.7	5.1	4.7	kΩ
	R_2	100	†	100	100	100	Ω
*Emitter resistor	R_e	5.0	0	14	10	30	Ω
Power delivered to transformer primary	P_{out}	310	240	355	220	390	mW
R_{load} (collector to collector)	R_{c-c}	160	280	305	600	430	Ω
R_{load} (per transistor) $(R_c = \frac{R_{c-c}}{4} + R_e)$	R_c	45	70	90	160	138	Ω
At P_{out} max.							
Collector current (peak)	$i_{c(pk)}$	125	85	100	56	85	mA
Collector current (per transistor)	I_c	40	27	32	18	27	mA
Distortion	D_{tot}	9.5	8.5	8.5	8.5	8.5	%

*If a resistor is incorporated in each emitter the value of each resistor must be 1.15 times the value of the common emitter resistor to ensure the same thermal stability.

Drive conditions

The following drive must be available in the transformer secondary to give full output from all transistors. This allows for losses in R2 and in a transformer secondary resistance of 50Ω.

Peak drive current	4.9	2.8	3.2	1.7	2.8	mA
Peak drive voltage	1.9	0.6	2.3	1.1	3.3	V
$P_{drive(r.m.s.)}$	4.6	0.84	3.7	0.95	4.6	mW

†R_1 = 1 to 3 kΩ variable.

R_2 = 85Ω resistor in parallel with a Varite resistor type VA1040 (130Ω at 25°C, B = 4500°K).

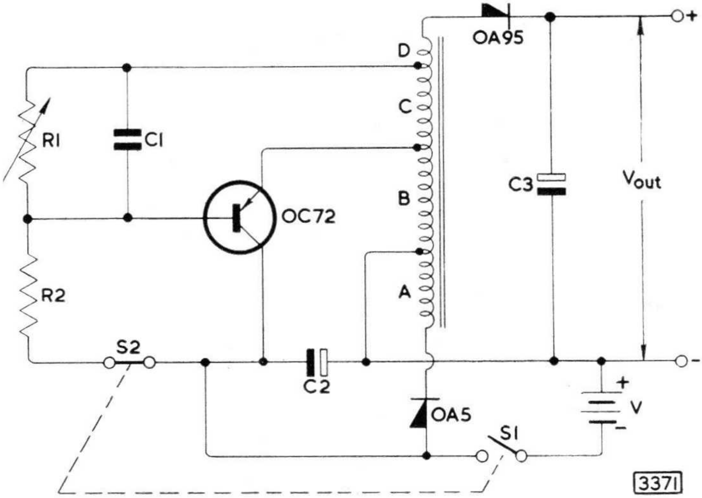
OC72
2-OC72

JUNCTION TRANSISTOR

Junction transistor of the p-n-p alloy type for use in class 'B' output stages, oscillator and switching circuits and d.c. converters.

OPERATING CONDITIONS AS A D.C. CONVERTER

Single transistor (without cooling fin)



Note: S_1 and S_2 are mechanically coupled, so that S_2 opens after S_1 has been closed.

Transformer tappings: A = 12%, B = 32%, C = 6%, D = 50%

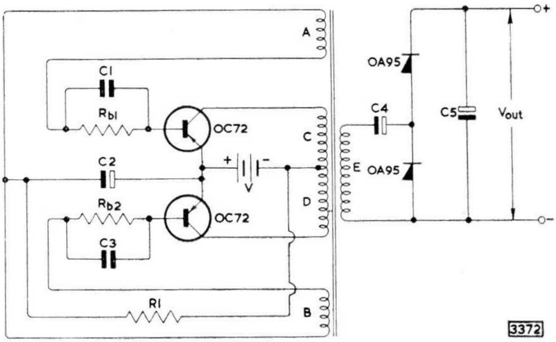
Supply voltage	V	6.0	V
Battery current	I	28	mA
Input power	P_{in}	168	mW
Output voltage	V_{out}	45	V
Output current	I_{out}	3.0	mA
Output power	P_{out}	135	mW
Efficiency	η	81	%
Total transistor dissipation		11.7	mW
Total diode losses		6.1	mW
Total transformer losses		14.3	mW
Total resistor losses		0.9	mW
Output resistance		2.0	kΩ
Component values:			
	R_1	1.0	kΩ
	R_2	2.7	kΩ
	C_1	0.03	μF
	C_2	100	μF
	C_3	3.2	μF

JUNCTION TRANSISTOR

OC72
2-OC72

Junction transistor of the p-n-p alloy type for use in class 'B' output stages, oscillator and switching circuits and d.c. converters.

Two transistors in push-pull d.c. converter



Supply voltage	V	6.0	V
Battery current	I	154	mA
Input power	P_{in}	924	mW
Output voltage	V_{out}	75.5	V
Output current	I_{out}	9.4	mA
Output power	P_{out}	710	mW
Efficiency	η	77	%
Total transistor dissipation		86	mW
Total diode losses		39	mW
Total resistor losses		54	mW
Total transformer losses		35	mW
Output resistance		<1.4	kΩ
Component values:			
	R_{b1}	270	Ω
	R_{b2}	270	Ω
	R_1	820	Ω
	C_1	0.047	µF
	C_2	16	µF
	C_3	0.047	µF
	C_4	8.0	µF
	C_5	8.0	µF

Transformer ratio
A : C = B : D = 1 : 2.7   E : C = 1 : 0.137

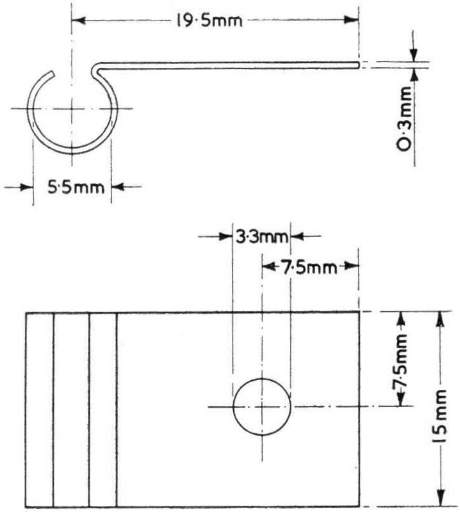
OPERATING NOTES

1. The transistor may be soldered directly into the circuit but heat conducted to the junction should be kept to a minimum by the use of a thermal shunt.
2. Care should be taken not to bend the leads nearer than 1.5mm to the seal.

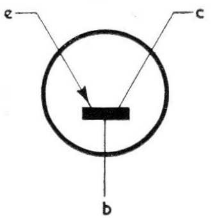
OC72
2-OC72

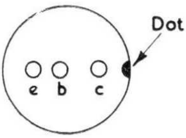
JUNCTION TRANSISTOR

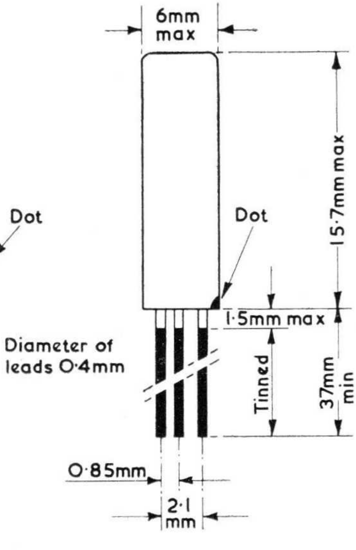
Junction transistor of the p-n-p alloy type for use in class 'B' output stages, oscillator and switching circuits and d.c. converters.



Dimensions of cooling fin





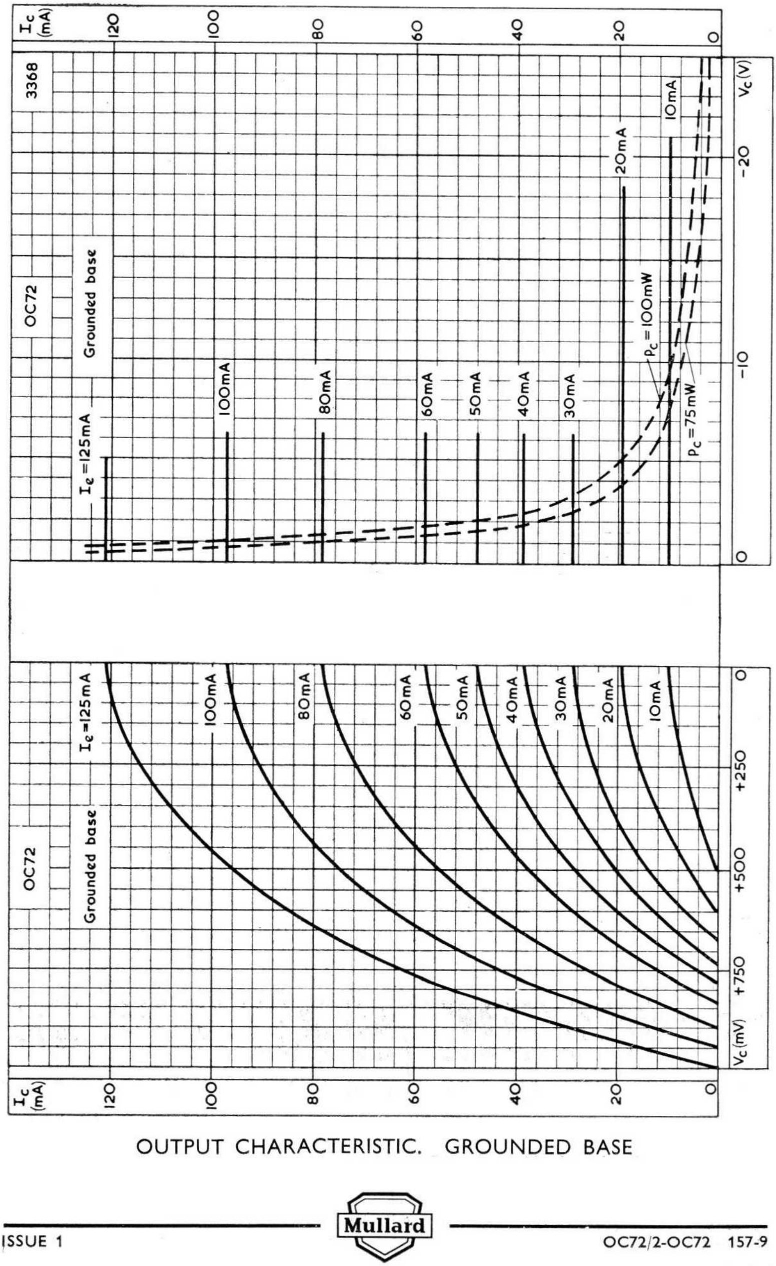


3219

JUNCTION TRANSISTOR

OC72
2-OC72

Junction transistor of the p-n-p alloy type for use in class 'B' output stages, oscillator and switching circuits and d.c. converters.

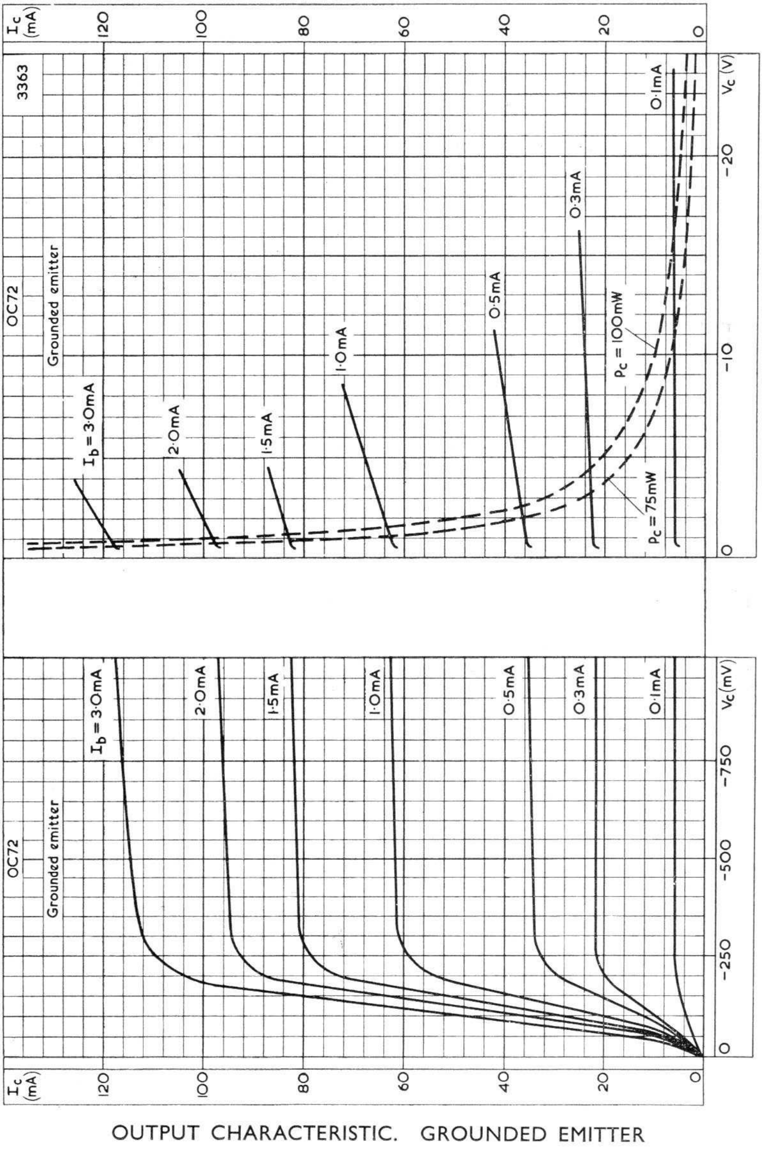


OUTPUT CHARACTERISTIC. GROUNDED BASE

OC72
2-OC72

JUNCTION TRANSISTOR

Junction transistor of the p-n-p alloy type for use in class 'B' output stages, oscillator and switching circuits and d.c. converters.

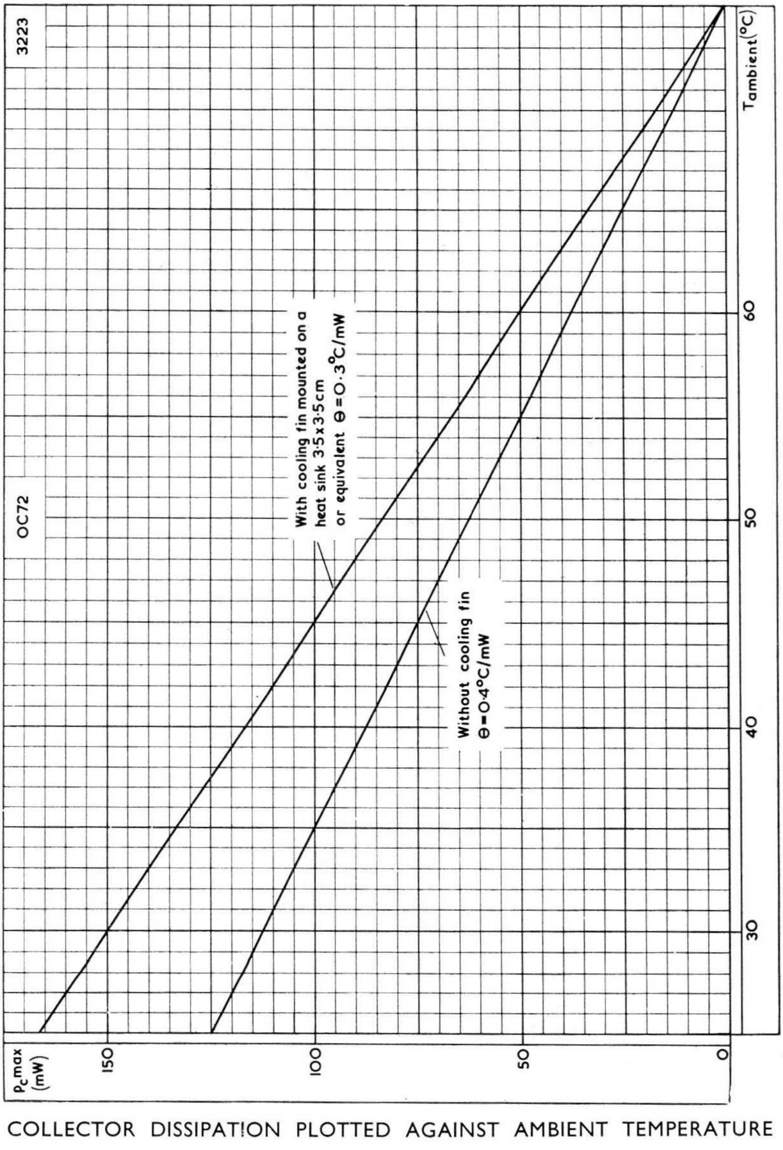


OUTPUT CHARACTERISTIC. GROUNDED EMITTER

JUNCTION TRANSISTOR

OC72
2-OC72

Junction transistor of the p-n-p alloy type for use in class 'B' output stages, oscillator and switching circuits and d.c. converters.

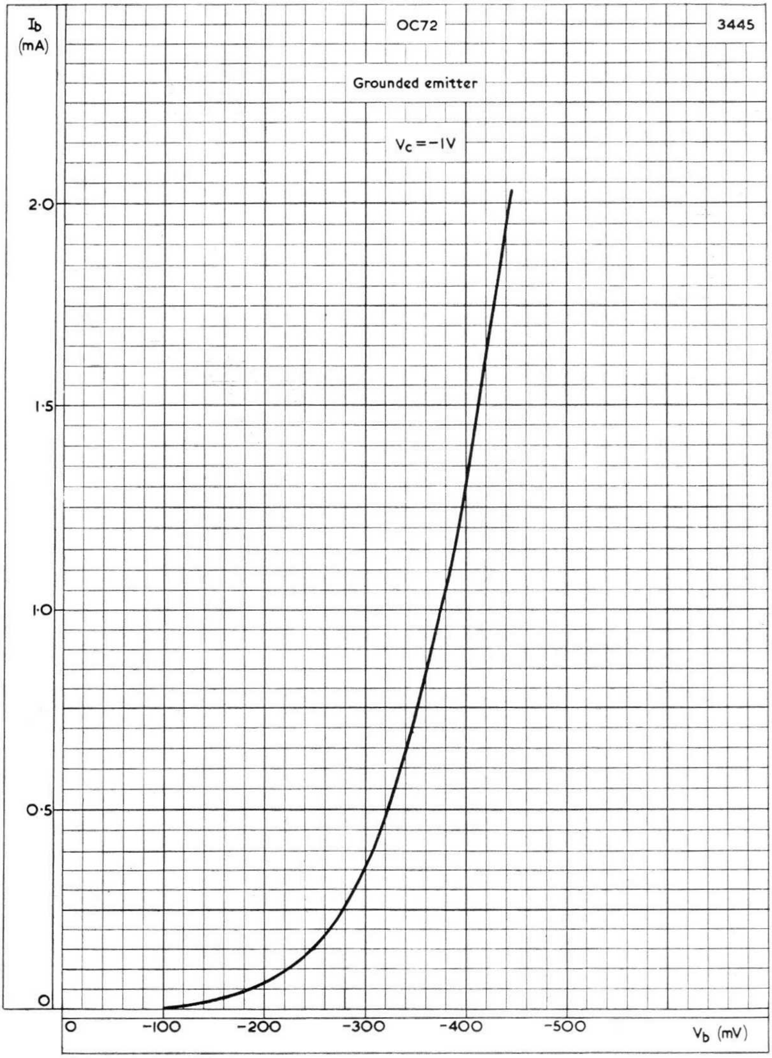


COLLECTOR DISSIPATION PLOTTED AGAINST AMBIENT TEMPERATURE

OC72
2-OC72

JUNCTION TRANSISTOR

Junction transistor of the p-n-p alloy type for use in class 'B' output stages, oscillator and switching circuits and d.c. converters.

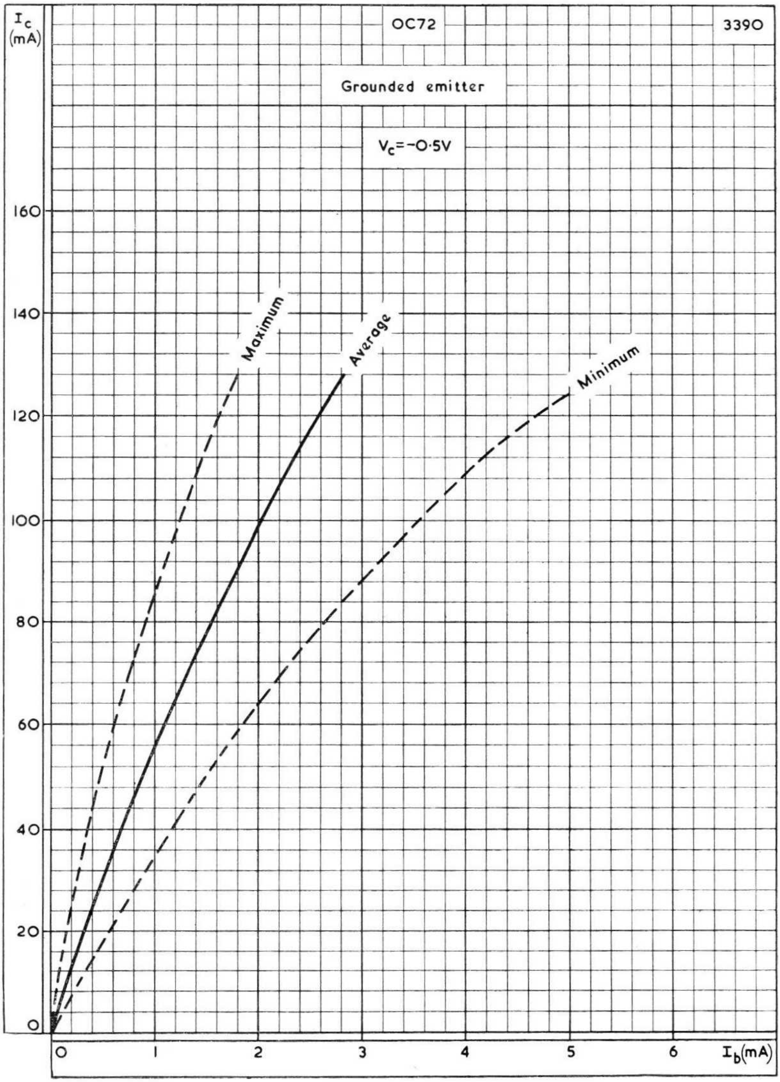


INPUT CHARACTERISTIC. GROUNDED EMITTER

JUNCTION TRANSISTOR

Junction transistor of the p-n-p alloy type for use in class 'B' output stages, oscillator and switching circuits and d.c. converters.

OC72
2-OC72

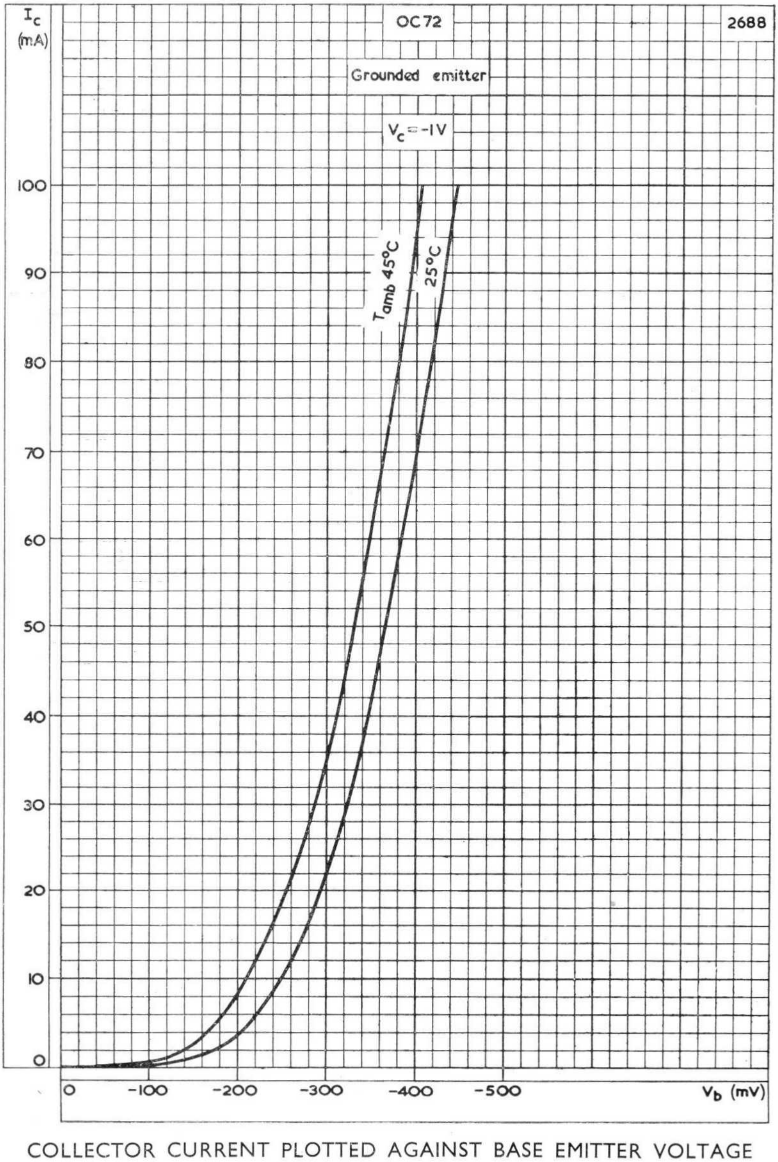


SPREAD OF TRANSFER CHARACTERISTIC. GROUNDED EMITTER

OC72
2-OC72

JUNCTION TRANSISTOR

Junction transistor of the p-n-p alloy type for use in class 'B' output stages, oscillator and switching circuits and d.c. converters.

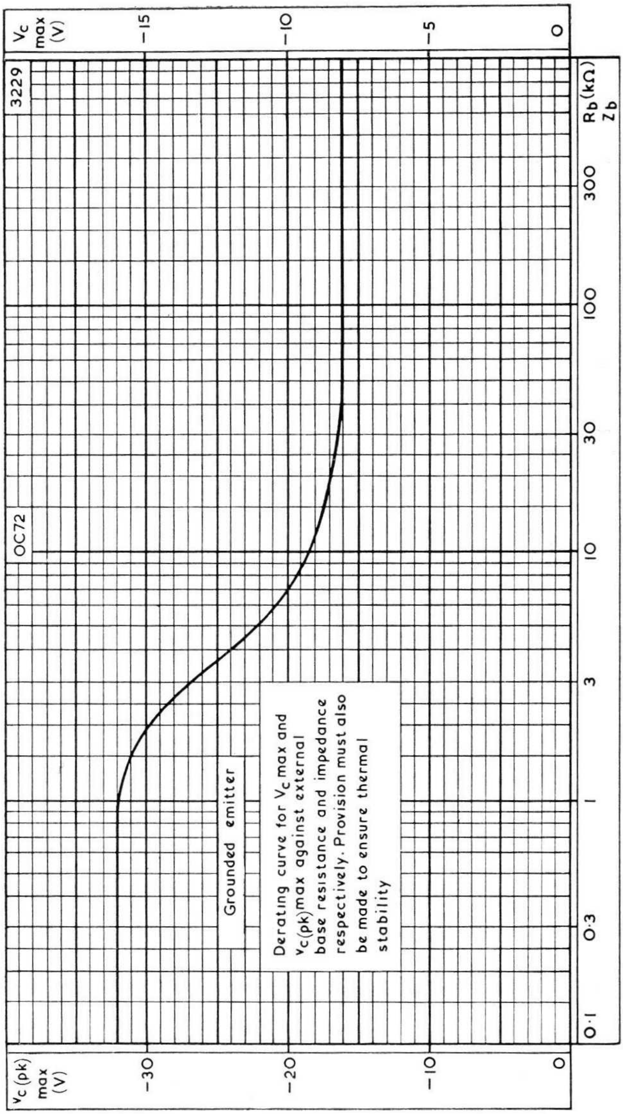


COLLECTOR CURRENT PLOTTED AGAINST BASE EMITTER VOLTAGE

JUNCTION TRANSISTOR

OC72
2-OC72

Junction transistor of the p-n-p alloy type for use in class 'B' output stages, oscillator and switching circuits and d.c. converters.

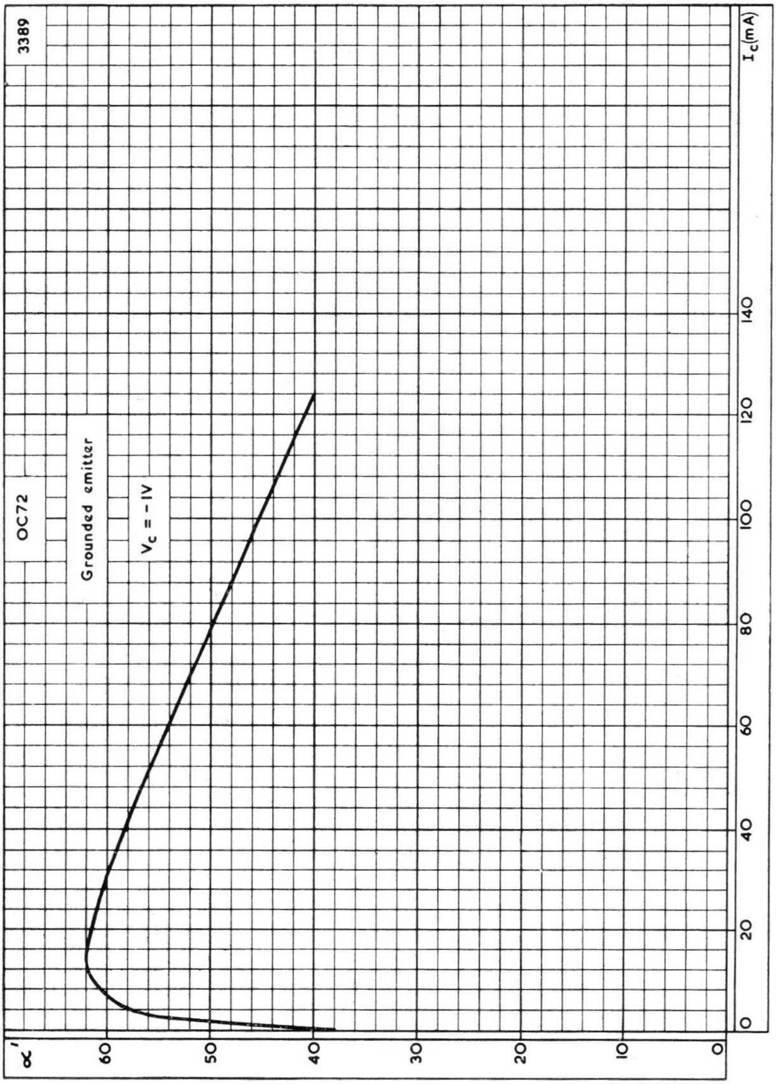


MAXIMUM PEAK AND AVERAGE COLLECTOR VOLTAGE PLOTTED AGAINST EXTERNAL BASE-EMITTER IMPEDANCE OR RESISTANCE

OC72
2-OC72

JUNCTION TRANSISTOR

Junction transistor of the p-n-p alloy type for use in class 'B' output stages, oscillator and switching circuits and d.c. converters

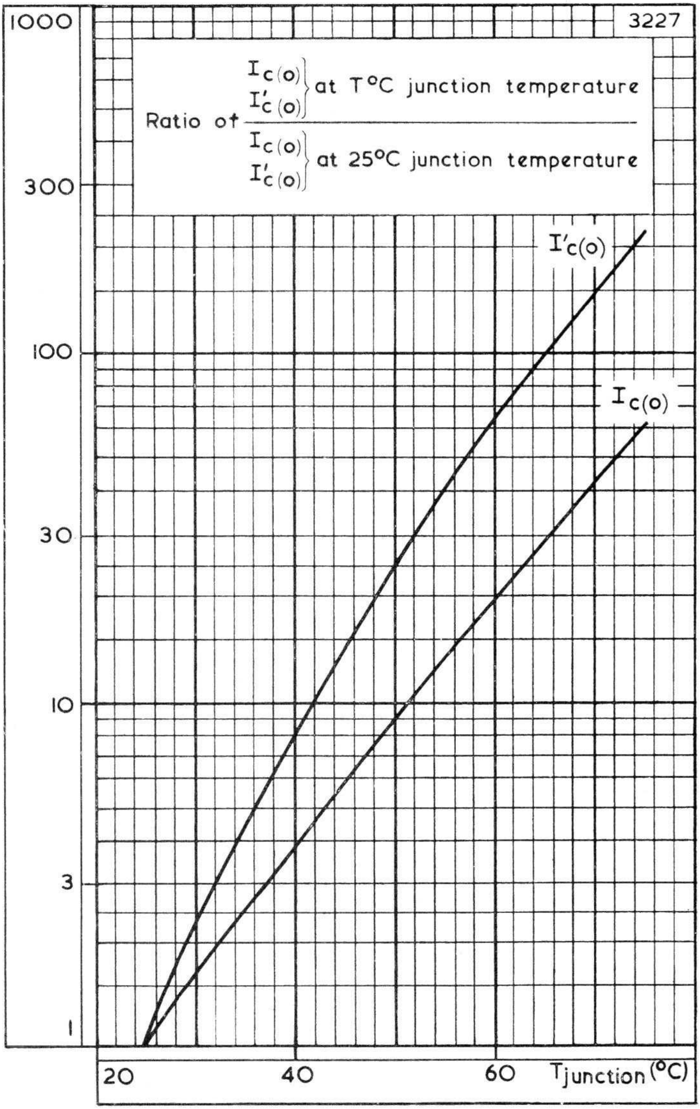


CURRENT AMPLIFICATION FACTOR PLOTTED AGAINST COLLECTOR CURRENT

JUNCTION TRANSISTOR

OC72
2-OC72

Junction transistor of the p-n-p alloy type for use in class 'B' output stages, oscillator and switching circuits and d.c. converters.



VARIATION OF $I_{c(o)}$ $I'_{c(o)}$ PLOTTED AGAINST JUNCTION TEMPERATURE

JUNCTION TRANSISTOR

OC72
2-OC72

Junction transistor of the p-n-p alloy type for use in class 'B' output stages, oscillator and switching circuits and d.c. converters.

CHARACTERISTICS OF OC72 (measured at $T_{ambient} = 25°C$)

Grounded base		Min.	Av.	Max.	
Collector leakage current ($V_c = -10V$)	$I_{c(o)}$		4.5	10	μA
Emitter leakage current ($V_e = -10V$)	$I_{e(o)}$		4.5	15	μA
Current amplification cut-off frequency ($V_c = -6V$, $I_c = 10mA$)	f_α	350			kc/s
Grounded emitter					
Collector leakage current ($V_c = -6V$)	$I'_{c(o)}$	50	125	300	μA
Collector current ($V_c = -30V$, $V_{b-e} > +0.1V$)	I_c		7.5	15	μA
Collector knee voltage at $I_c = 125mA$ (see fig. 1)	$V_{c(knee)}$			-400	mV

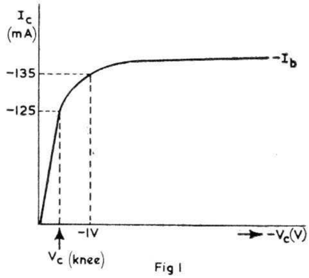


Fig 1

I_b adjusted such that $I_c = -135mA$ with $V_c = -1V$

Static characteristics

Current amplification factor $\bar{\alpha}' = \frac{I_c - I'_{c(o)}}{I_b}$

		Min.	Av.	Max.	
at $V_c = -5.4V$, $I_c = 10mA$	$\bar{\alpha}'$	45	70	120	
$V_c = -0.7V$, $I_c = 80mA$	$\bar{\alpha}'$	30	50	90	
$V_c = -0.7V$, $I_c = 125mA$	$\bar{\alpha}'$	25			
$V_c = -1.0V$, $I_c = 250mA$	$\bar{\alpha}$	15			
Base input voltage					
at $V_c = -6.0V$, $I_c = 1.5mA$	V_{b-e}	130		170	mV
$V_c = -0.7V$, $I_c = 80$ mA	V_{b-e}			450	mV
$V_c = -0.7V$, $I_c = 125$ mA	V_{b-e}			700	mV
Noise figure ($f = 1kc/s$, $R_{source} = 500\Omega$, $V_c = -2V$, $I_c = 0.5mA$)				15	dB

OC72
2-OC72

JUNCTION TRANSISTOR

Junction transistor of the p-n-p alloy type for use in class 'B' output stages, oscillator and switching circuits and d.c. converters.

CHARACTERISTICS OF MATCHED PAIR 2-OC72
(measured at $T_{ambient} = 25°C$)

Ratio of the current amplification factors of the two transistors both at $I_c = 80mA$ and at $I_c = 10mA$	$<1.3 : 1$

LIMITING VALUES (absolute ratings)

The equipment designer must ensure that no transistor exceeds these ratings and in arriving at the actual operating conditions, variations in supply voltages, component tolerances and ambient temperature must also be taken into account.

Grounded base		
$v_{c(pk)}$ max.	−32	V
V_c max. (average or d.c.)	−16	V
Grounded emitter		
$v_{c(pk)}$ max.	−32V See fig. 7	
V_c max. (average or d.c.)	−16V See fig. 7	
Collector current		
†$i_{c(pk)}$ max.	±250	mA
*I_c max.	125	mA
Reverse emitter voltage		
$v_{e(pk)}$ max	−10	V
V_e max.	−10	V
Emitter current		
†$i_{e(pk)}$ max.	±250	mA
*I_e max.	125	mA
Base current		
$i_{b(pk)}$ max.	±125	mA
*I_b max.	20	mA
Collector dissipation	See fig. 3	

*Averaged over any 20ms period.

†Owing to linearity considerations it is inadvisable to design for peak currents greater than 125mA where low distortion is required.

TEMPERATURE RATINGS

Storage temperature	−55 to +75	°C
Max. junction temperature	75	°C
Junction temperature rise above ambient (without cooling fin, in free air)	0.4	°C/mW
Junction temperature rise above ambient (with cooling fin, mounted in free air on a heat sink of 3.5 × 3.5cm or equivalent)	0.3	°C/mW

JUNCTION TRANSISTOR

OC75

Junction transistor of the p-n-p alloy type in all-glass construction especially suitable for use in high gain amplifiers.

LIMITING VALUES (absolute ratings)

The equipment designer must ensure that no transistor exceeds these ratings. In arriving at the actual operating conditions, variations in supply voltages, component tolerances and ambient temperature must also be taken into account.

Collector voltage

Grounded base		
$v_{c(pk)}$ max.	−30	V
*$V_{c(av.)}$ max.	−20	V
V_c max. (d.c.)	−20	V
Grounded emitter		
†$v_{c(pk.)}$ max.	−30	V
*$V_{c(av.)}$ max.	−20	V
V_c max. (d.c.)	−20	V

†These figures apply with an external base-ground circuit impedance of less than 500Ω, or providing $+V_{be} > 500mV$. (i.e., transistor cut-off). For other values of impedance see curve on page C9.

Collector Current

**$i_{c(pk)}$ max.	50	mA
*I_c max.	10	mA

Emitter Current

**$i_{e(pk)}$ max.	55	mA
*I_e max.	12	mA

Reverse emitter base voltage

$v_{eb(pk)}$ max.	−10	V
V_{eb} max. (d.c.)	−10	V

Base current

$i_{b(pk)}$ max.	5·0	mA
*I_b max.	2·0	mA

Total dissipation

$$\left(p_{tot} = \frac{T_{junction}\ \text{max.} - T_{ambient}}{\theta}\right)$$

See page C10.

Temperature ratings

Storage temperature	−55 to +75	°C
Maximum junction temperature ($T_{junction}$ max.)		
Continuous operation	75	°C
‡Intermittent operation (total duration = 200 hours max.)	90	°C
Junction temperature rise above ambient θ	<0.4	°C/mW

*Averaged over any 20ms period

**Owing to linearity considerations it is inadvisable to design for peak currents greater than 25mA where low distortion is required.

‡Likelihood of full performance of a circuit at this temperature is also dependent on the type of application.

CHARACTERISTICS AT $T_{junction} = 25°C$

Grounded base

		Typical production spreads Min.	Av.	Max.	
Collector leakage current ($V_c = -4.5V$, $I_e = 0mA$)	I_{co}	—	4.5	14	µA
Emitter leakage current ($V_e = -4.5V$, $I_c = 0mA$)	I_{eo}	—	3.5	13	µA

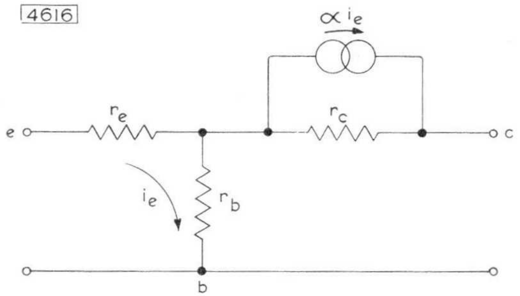
Grounded emitter

		Min.	Av.	Max.	
Collector bottoming voltage ($I_c = 9mA$, $I_b = 0.5mA$)	V_{ce}	—	−90	−210	mV
Base input voltage ($V_c = -4.5V$, $I_c = 3mA$)	V_{be}	−100	−140	−210	mV
Noise figure ($f = 1kc/s$, $R_{source} = 500\Omega$, $V_c = -2V$, $I_c = 0.5mA$)		—	10	16	dB

SMALL SIGNAL CHARACTERISTICS AT $T_{junction} = 25°C$

Equivalent circuit parameters (T-network)

Measured at:		
f	1	kc/s
V_c	−2	V
I_c	3	mA



r_e	6.4	Ω
r_b	720	Ω
r_c	715	kΩ
α	0.989	

Typical parameters for the full equivalent circuit

(Measured at: $V_c = -2V$, $I_c = 3mA$)

	Typical production spreads Min.	Av.	Max.	
α' (at low frequencies)	60	90	130	
$f_{\alpha'}$	—	8	—	kc/s
f_α (measured at $V_c = -6V$, $I_c = 1mA$)	—	900	—	kc/s

Grounded base

Measured at $V_c = -2V$, $I_c = 3mA$, $f = 1kc/s$

Hybrid matrix — *Typical production spreads*

		Min.	Av.	Max.	
Input impedance (with output short circuited to a.c.)	h_{11}	—	14	—	Ω
Current amplification (with output short circuited to a.c.)	$-h_{21}$	—	0.989	—	
Output admittance (with input open circuited to a.c.)	h_{22}	—	1.4	—	μmhos
Voltage feedback ratio (with input open circuited to a.c.)	h_{12}	—	10×10^{-4}	—	

Mullard system

		Min.	Av.	Max.	
Current amplification (with output short circuited to a.c.)	α	—	0.989	—	
Input resistance (with output short circuited to a.c.)	r_{in}	—	14	—	Ω
Input resistance (with output open circuited to a.c.)	r_{11}	—	720	—	Ω
Output resistance (with input short circuited to a.c.)	r_{out}	—	14	—	kΩ
Output resistance (with input open circuited to a.c.)	r_{22}	—	715	—	kΩ

Grounded emitter

Measured at $V_c = -2V$, $I_c = 3mA$, $f = 1kc/s$

Hybrid matrix

		Min.	Av.	Max.	
Input impedance (with output short circuited to a.c.)	h'_{11}	—	1.3	—	kΩ
Current amplification (with output short circuited to a.c.)	h'_{21}	60	90	130	
Output admittance (with input open circuited to a.c.)	h'_{22}	—	125	—	μmhos
Voltage feedback ratio (with input open circuited to a.c.)	h'_{12}	—	8×10^{-4}	—	

Mullard system

		Min.	Av.	Max.	
Current amplification (with output short circuited to a.c.)	α'	60	90	130	
Input resistance (with output short circuited to a.c.)	r'_{in}	—	1.3	—	kΩ
Input resistance (with output open circuited to a.c.)	r'_{11}	—	720	—	Ω
Output resistance (with input short circuited to a.c.)	r'_{out}	—	14	—	kΩ
Output resistance (with input open circuited to a.c.)	r'_{22}	—	7.8	—	kΩ

OC75

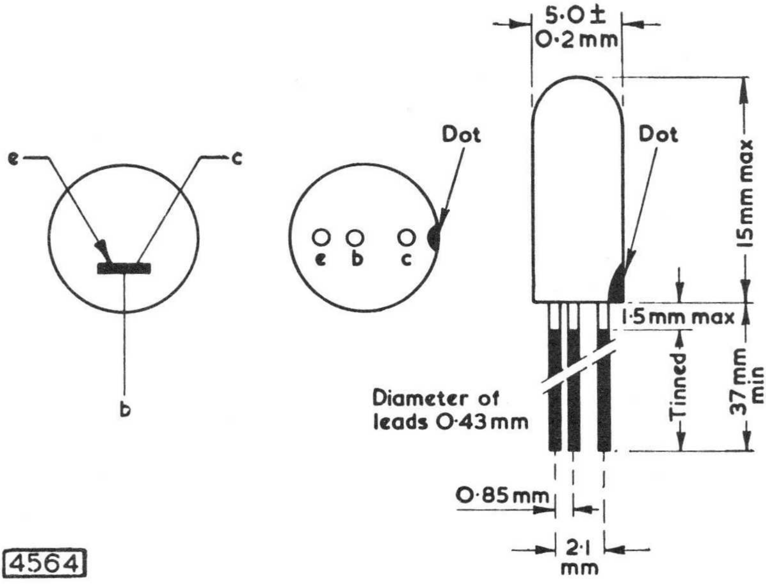
JUNCTION TRANSISTOR

→ SOLDERING AND WIRING RECOMMENDATIONS

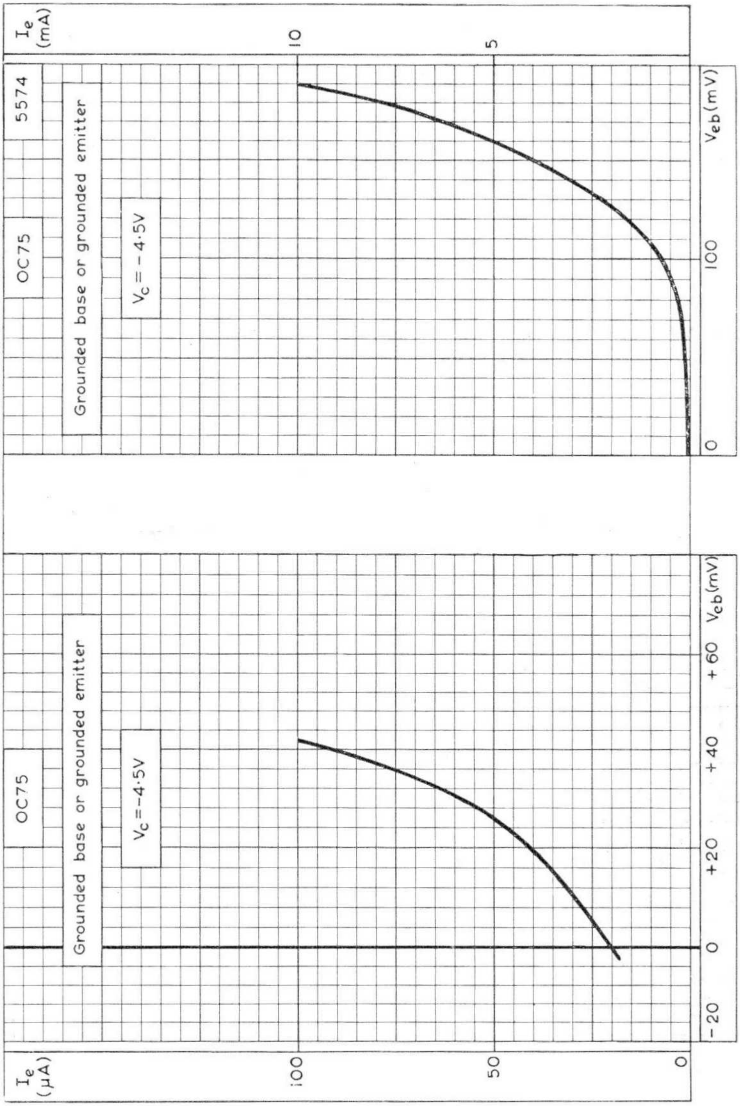
1. When using a soldering iron, transistors may be soldered directly into the circuit, but heat conducted to the junction should if possible be kept to a minimum by the use of a thermal shunt.
2. Transistors may be dip-soldered at a solder temperature of 245°C for a maximum soldering time of 5 seconds. The case temperature during dip-soldering may exceed the maximum storage temperature for a period not greater than 2 minutes, provided that it at no time exceeds 115°C. These recommendations apply to a transistor mounted flush on a board having punched-through holes, or spaced at least 1.5mm away from a board having plated-through holes.
3. Care should be taken not to bend the leads nearer than 1.5mm from the seal.

OUTLINE AND DIMENSIONS ←

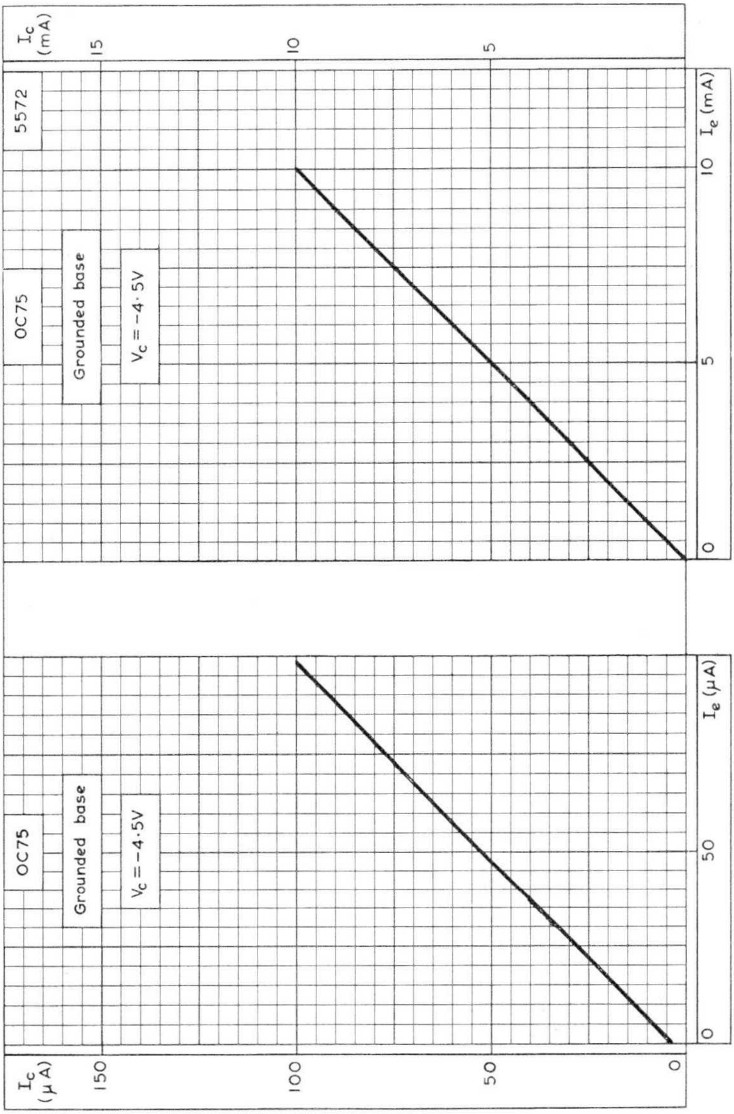
Conforming to V.A.S.C.A. SO-2/SB3-2



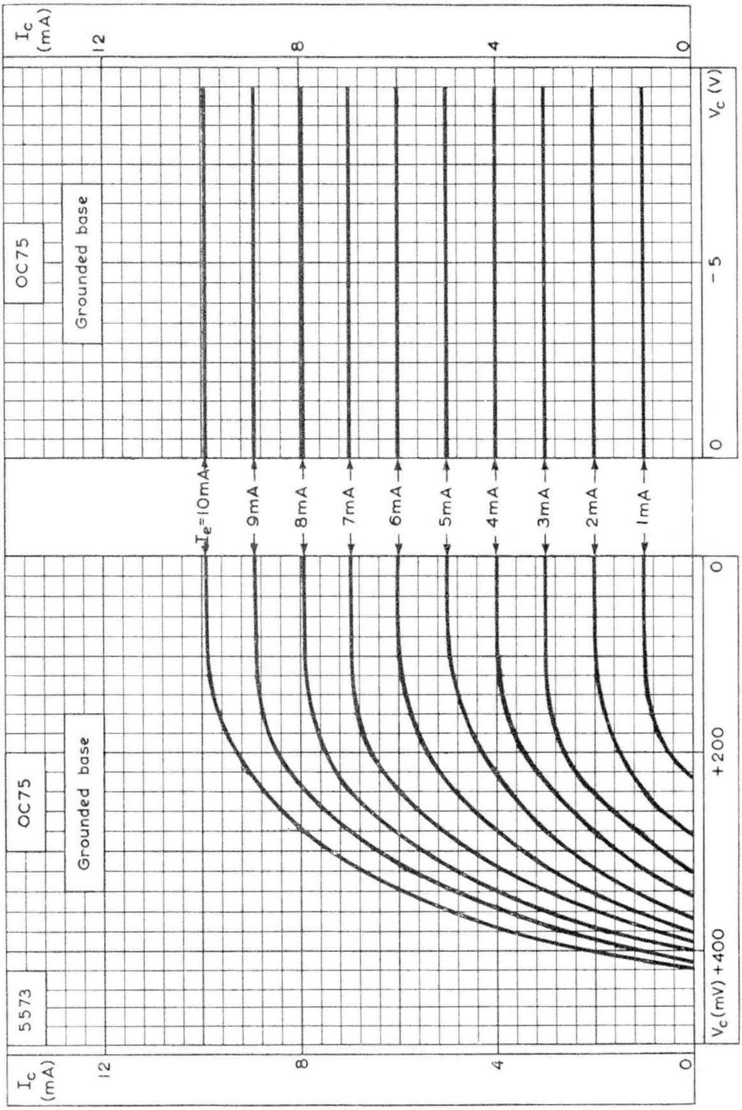
4564



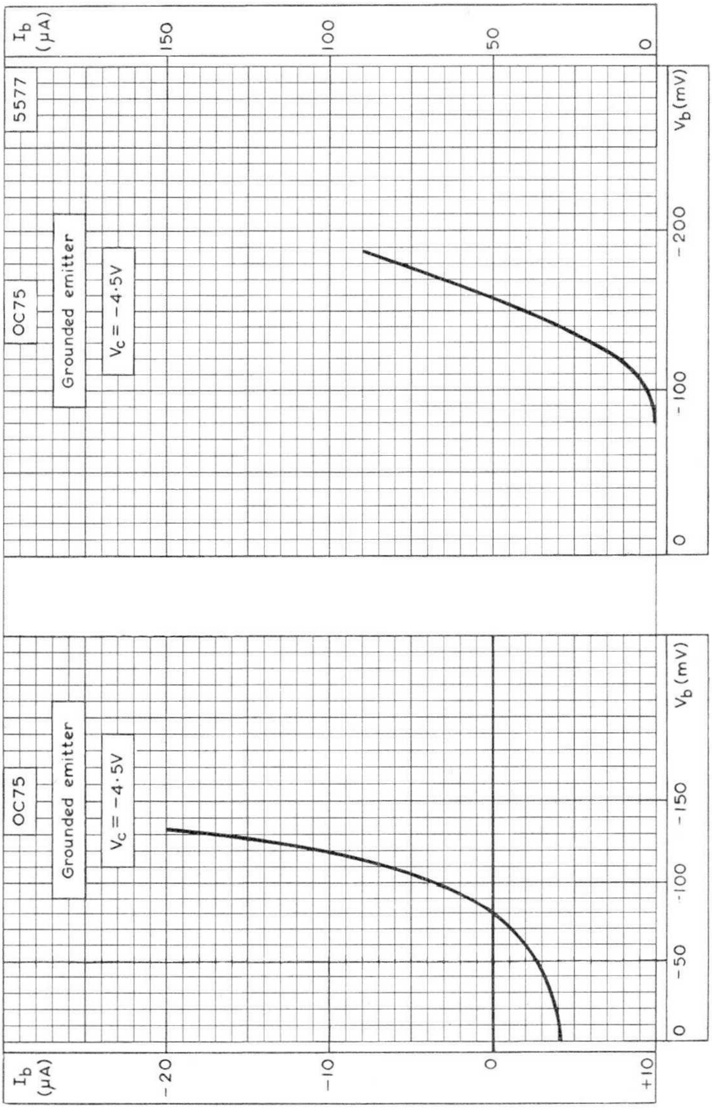
EMITTER CURRENT PLOTTED AGAINST EMITTER-BASE VOLTAGE
(Grounded base or grounded emitter)



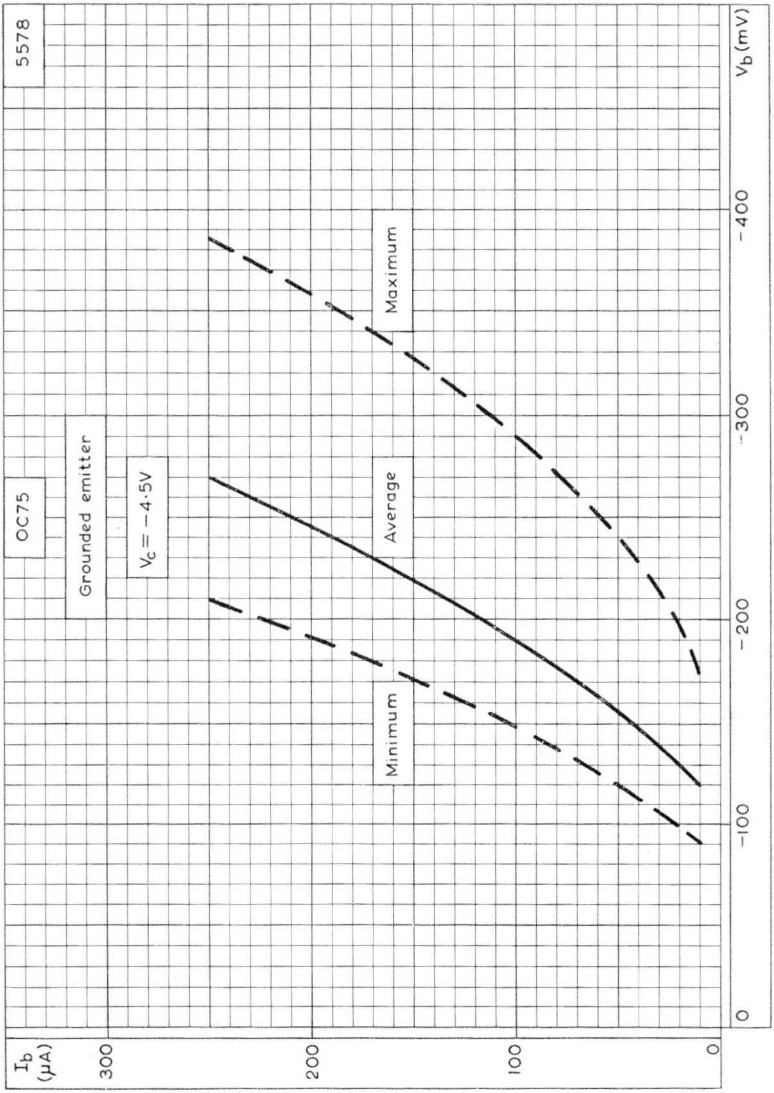
TRANSFER CHARACTERISTIC, GROUNDED BASE



OUTPUT CHARACTERISTIC. GROUNDED BASE



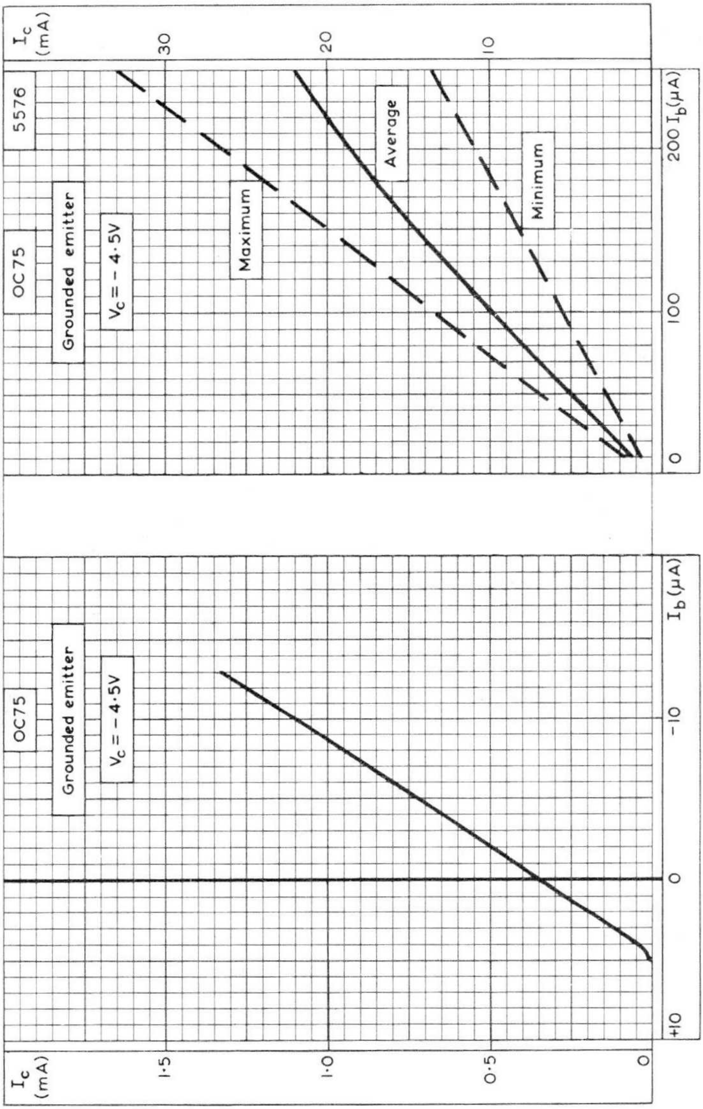
INPUT CHARACTERISTIC AND INPUT CHARACTERISTIC (I_b = +10 to −20 μA).
GROUNDED EMITTER



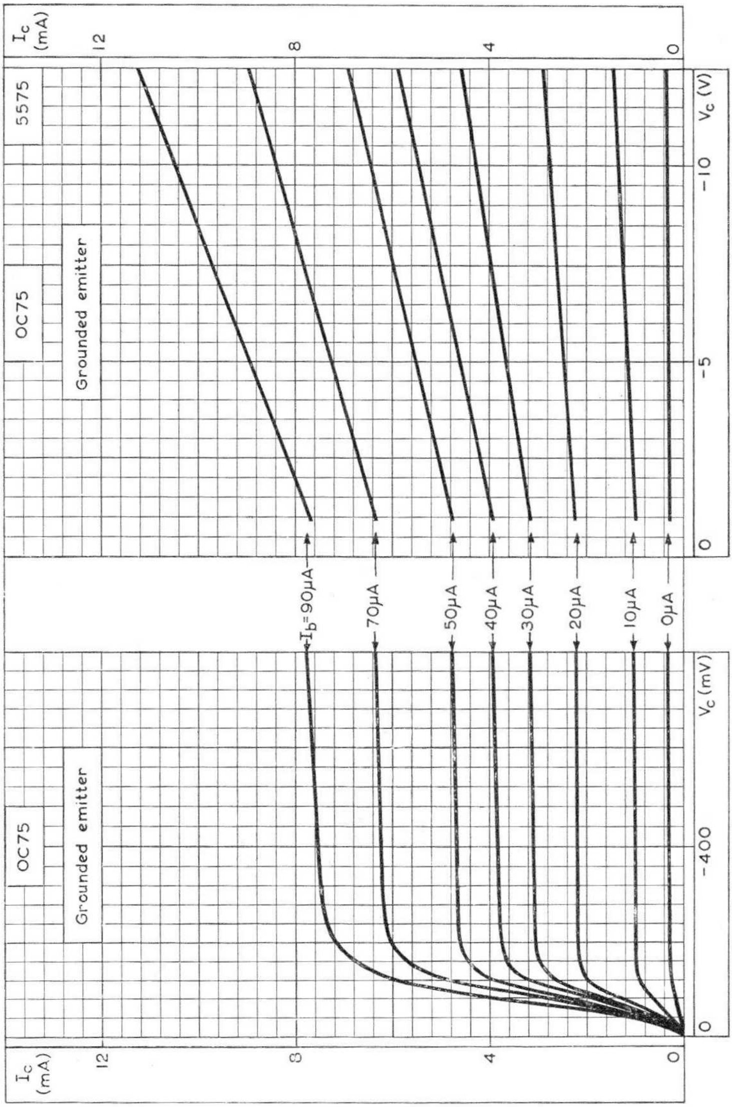
SPREAD OF INPUT CHARACTERISTIC. GROUNDED EMITTER.

OC75

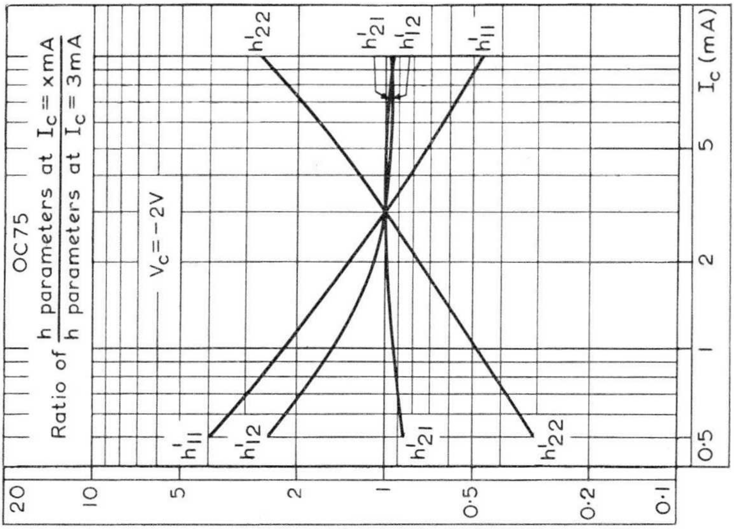
JUNCTION TRANSISTOR

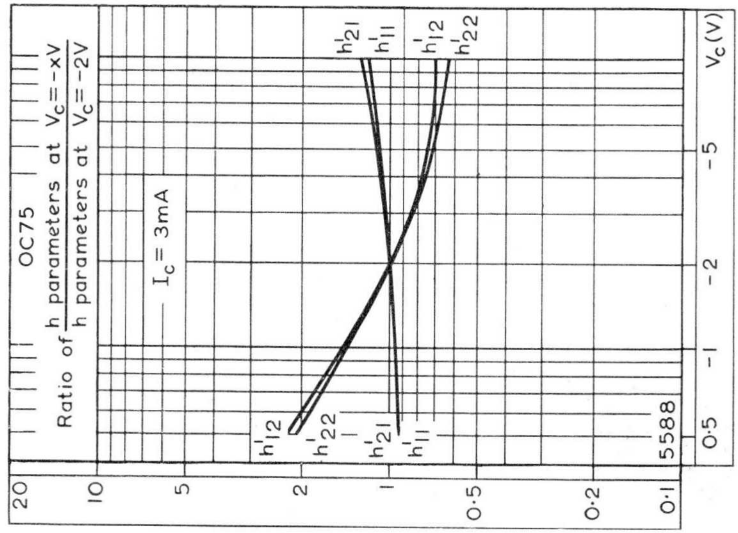


TRANSFER CHARACTERISTIC AND SPREAD OF TRANSFER CHARACTERISTIC
GROUNDED EMITTER

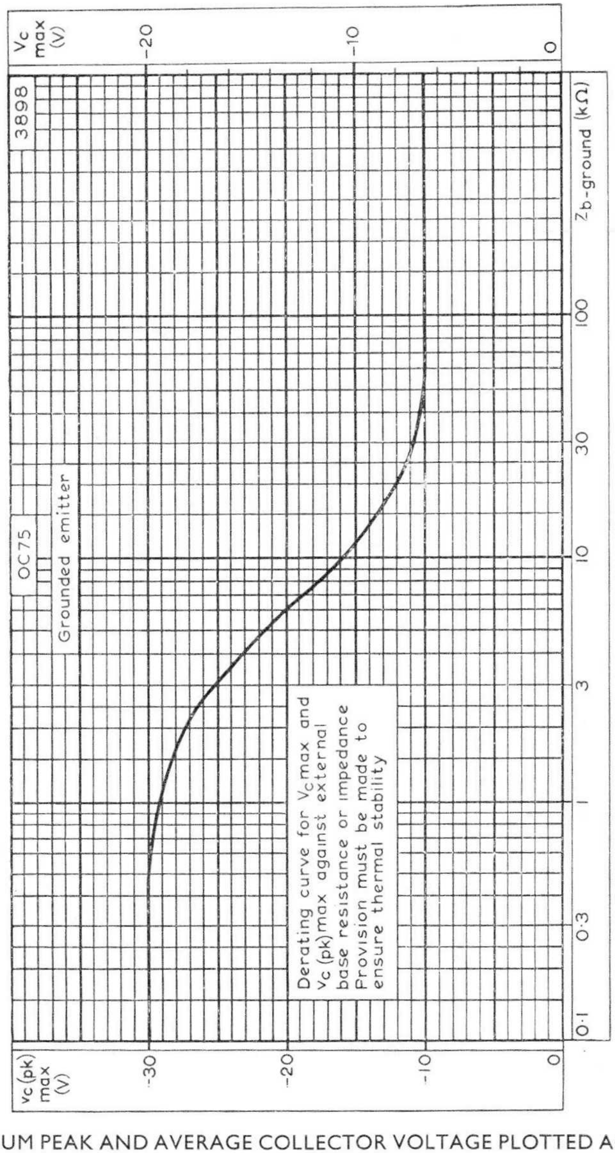


OUTPUT CHARACTERISTIC. GROUNDED EMITTER

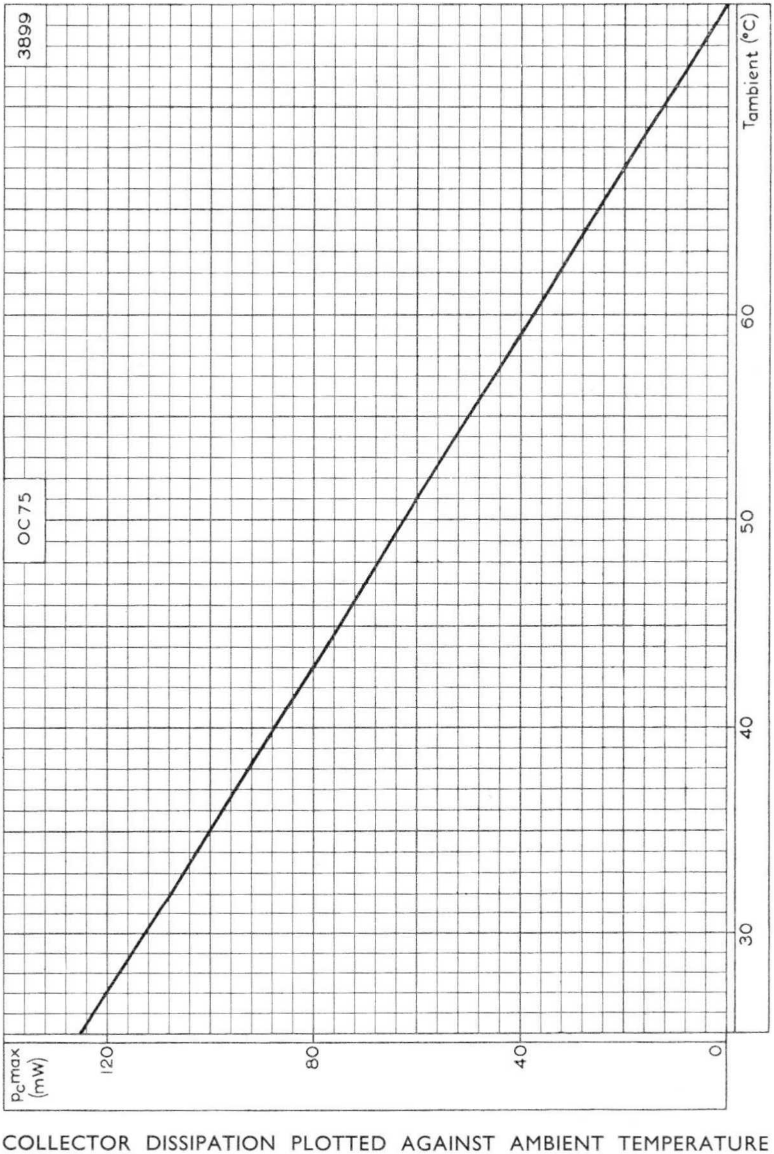




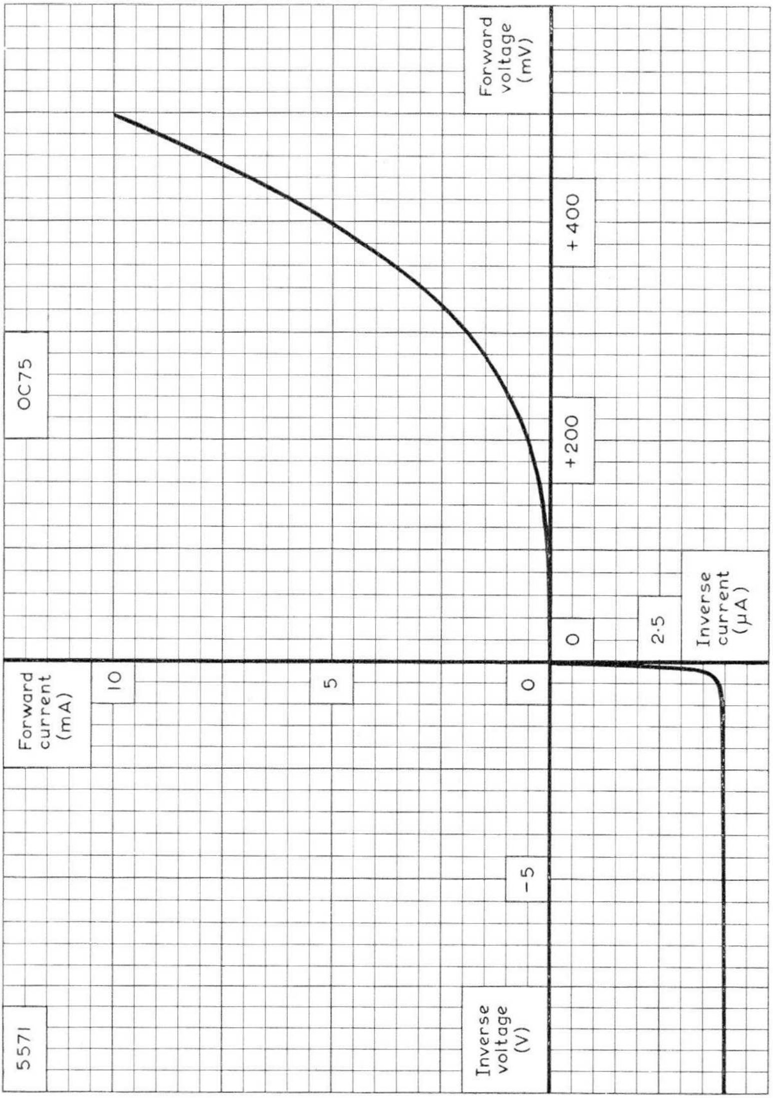
VARIATION OF h PARAMETERS WITH WORKING POINT. GROUNDED EMITTER



MAXIMUM PEAK AND AVERAGE COLLECTOR VOLTAGE PLOTTED AGAINST EXTERNAL BASE-EMITTER IMPEDANCE OR RESISTANCE



COLLECTOR DISSIPATION PLOTTED AGAINST AMBIENT TEMPERATURE



CHARACTERISTIC OF EMITTER-BASE DIODE

OC76

Junction transistor of the p-n-p alloy type suitable for use in switching and pulse oscillating circuits and as a d.c. converter.

CHARACTERISTICS (measured at $T_{ambient} = 25°C$)

		Min.	Av.	Max.	
Grounded base					
Collector leakage current ($V_c = -10V$)	$I_{c(o)}$	—	4.5	10	µA
Emitter leakage current ($V_e = -10V$)	$I_{e(o)}$	—	4.5	10	µA
Current amplification cut-off frequency ($V_c = -6V$, $I_e = 10mA$)	f_α	350	—	—	kc/s
Grounded emitter					
Collector leakage current ($V_c = -6V$)	$I'_{c(o)}$	—	200	600	µA
Collector current ($V_c = -30V$, $V_{b-e} > +0.5V$)	I_c	—	7.5	15	µA
Collector knee voltage at $I_c = 125mA$ (see fig. 1)	$V_{c(knee)}$	—	—	-400	mV

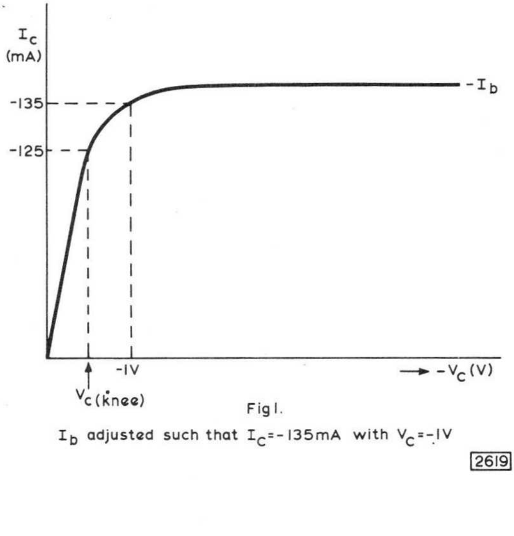


Fig 1.

I_b adjusted such that $I_C = -135mA$ with $V_C = -1V$

Static characteristics

		Min.	Max.	
Current amplification factor	$\bar{\alpha}' = \frac{I_c - I'_{c(o)}}{I_b}$			
at $V_c = -5.4V$, $I_c = 10mA$	$\bar{\alpha}'$	45	—	
$V_c = -0.7V$, $I_c = 80mA$	$\bar{\alpha}'$	30	—	
$V_c = -0.7V$, $I_c = 125mA$	$\bar{\alpha}'$	25	—	
$V_c = -1.0V$, $I_c = 250mA$	$\bar{\alpha}'$	15	—	
Base input voltage				
at $V_c = -0.7V$, $I_c = 80mA$	V_{b-e}	—	450	mV
$V_c = -0.7V$, $I_c = 125mA$	V_{b-e}	—	700	mV
Noise figure ($f = 1kc/s$, $R_{source} = 500\Omega$, $V_c = -2V$, $I_c = 0.5mA$)		—	15	dB

LIMITING VALUES (absolute ratings)

The equipment designer must ensure that no transistor exceeds these ratings and in arriving at the actual operating conditions, variations in supply voltages, component tolerances and ambient temperatures must also be taken into account.

Grounded base		
$v_{c(pk)}$ max.	-32	V
V_c max. (average or d.c.)	-32	V
Grounded emitter		
$v_{c(pk)}$ max.	See page C7	
V_c max. (average or d.c.)	See page C7	
Collector current		
$i_{c(pk)}$ max.	±250	mA
*I_c max.	125	mA
Reverse emitter voltage		
$v_{e(pk)}$ max.	-10	V
V_e max.	-10	V
Emitter current		
$i_{e(pk)}$ max.	±250	mA
*I_e max.	125	mA
Base current		
$i_{b(pk)}$ max.	±125	mA
*I_b max.	20	mA
Collector dissipation	See page C3	

*Averaged over any 20ms period.

TEMPERATURE RATINGS

Storage temperature	−55 to +75	°C
Max. junction temperature for continuous operation	75	°C
†Max. junction temperature for intermittent operation (total duration = 200 hours max.)	90	°C
Max. junction temperature rise above ambient (without cooling fin, in free air)	0.4	°C/mW
Max. junction temperature rise above ambient (with cooling fin, mounted in free air on a heat sink of 3.5 × 3.5cm or equivalent)	0.3	°C/mW

†Likelihood of full performance of a circuit at this temperature is also dependent upon the type of application.

OPERATING CONDITIONS AS A D.C. CONVERTER

Single transistor (without cooling fin)

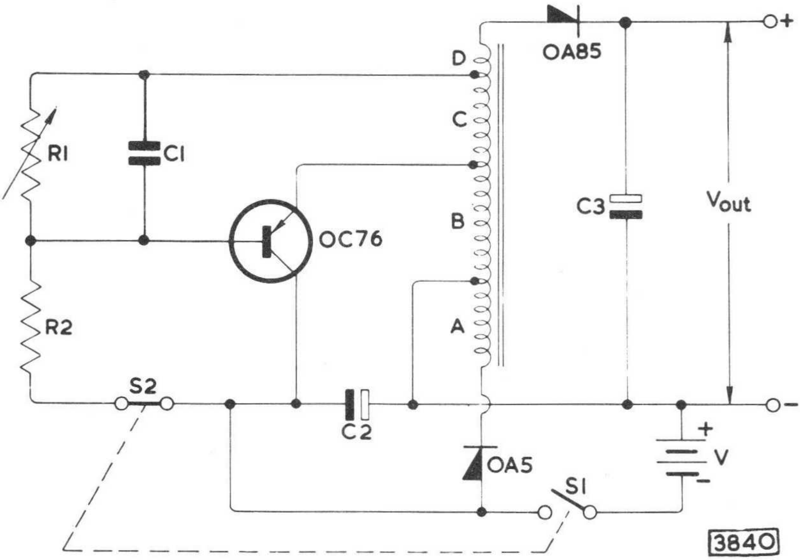


Fig. 2.

Note: S1 and S2 are mechanically coupled, so that S2 opens after S1 has been closed.

Transformer tappings: A = 12%, B = 32%, C = 6%, D = 50%.

Supply voltage	V	6.0	V
Battery Current	I	28	mA
Input power	P_{in}	168	mW
Output voltage	V_{out}	45	V
Output current	I_{out}	3.0	mA
Output power	P_{out}	135	mW
Efficiency	η	81	%
Total transistor dissipation		11.7	mW
Total diode losses		6.1	mW
Total transformer losses		14.3	mW
Total resistor losses		0.9	mW
Output resistance		2.0	kΩ
Component values:			
	R1	1.0	kΩ
	R2	2.7	kΩ
	C1	0.03	μF
	C2	100	μF
	C3	3.2	μF

Two transistors in push-pull d.c. converter.

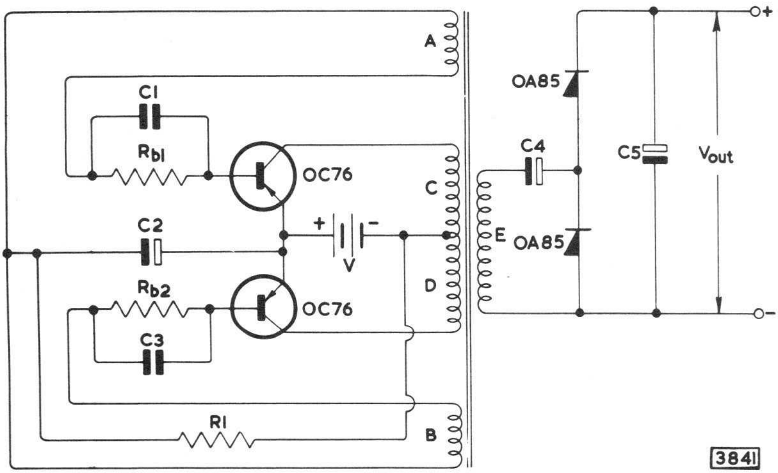


Fig. 3.

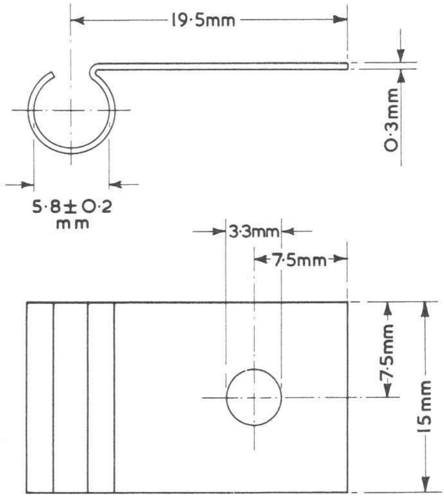
Supply voltage	V	6.0	V
Battery current	I	154	mA
Input power	P_{in}	924	mW
Output voltage	V_{out}	75.5	V
Output current	I_{out}	9.4	mA
Output power	P_{out}	710	mW
Efficiency		77	%
Total transistor dissipation		86	mW
Total diode losses		39	mW
Total resistor losses		54	mW
Total transformer losses		35	mW
Output resistance		$\approx$1.4	kΩ
Component values:			
	R_{b1}	270	Ω
	R_{b2}	270	Ω
	R_1	820	Ω
	C_1	0.047	μF
	C_2	16	μF
	C_3	0.047	μF
	C_4	8.0	μF
	C_5	8.0	μF

Transformer ratio

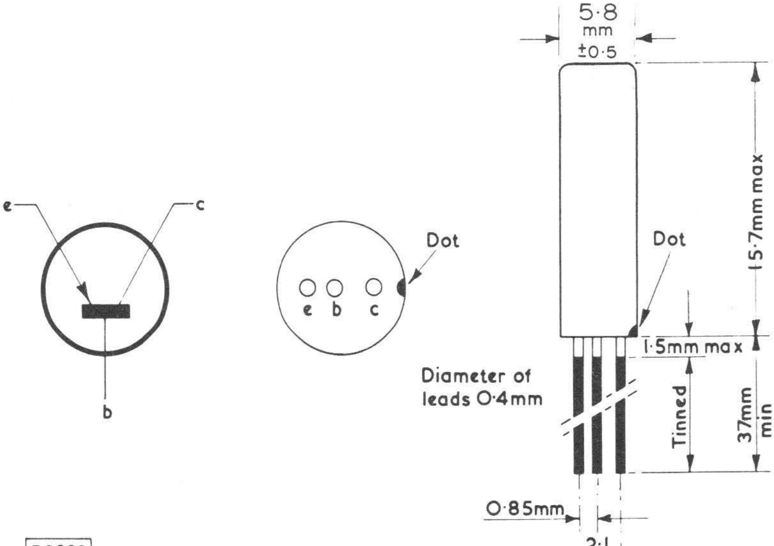
A : C = B : D = 1 : 2.7 E : C = 1 : 0.137

OPERATING NOTES

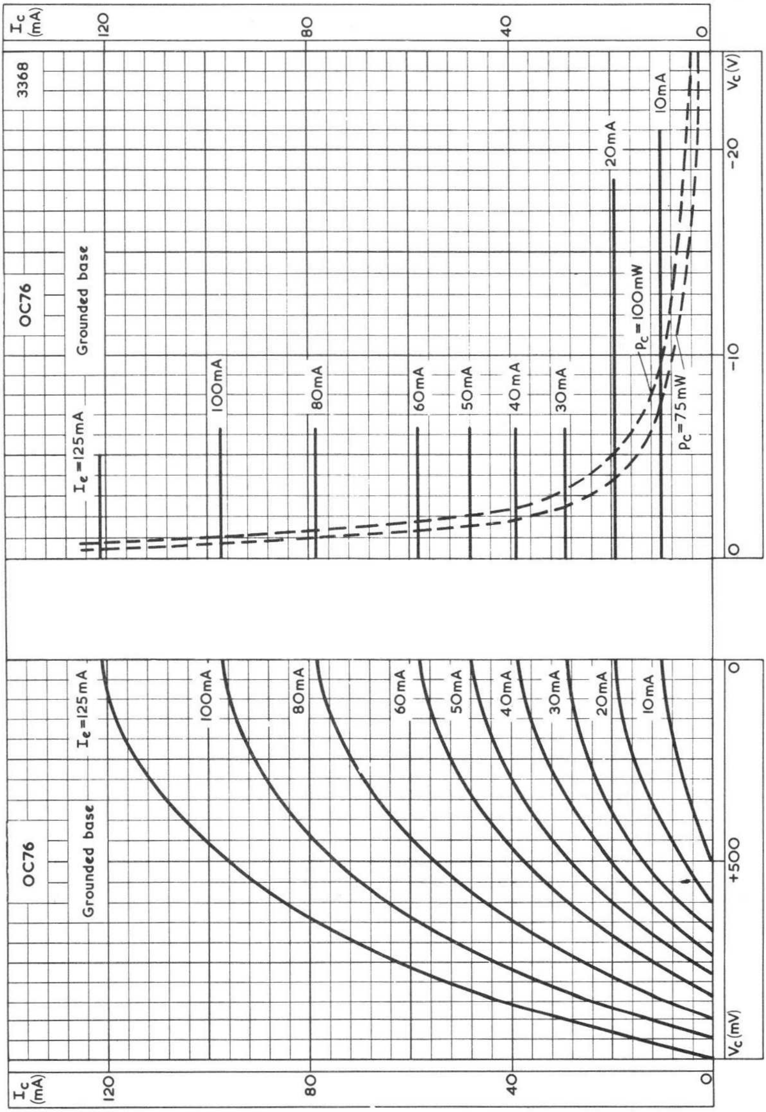
1. The transistor may be soldered directly into the circuit but heat conducted to the junction should be kept to a minimum by the use of a thermal shunt.
2. Care should be taken not to bend the leads nearer than 1.5mm to the seal.



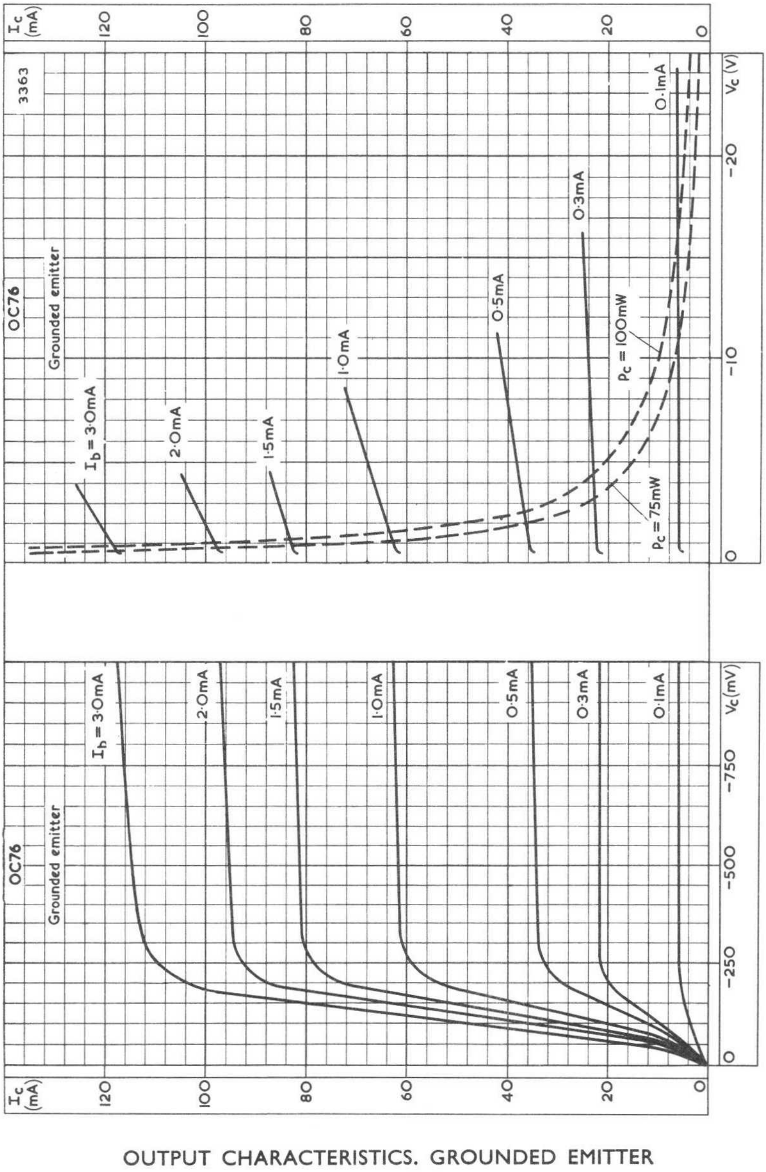
Dimensions of cooling fin



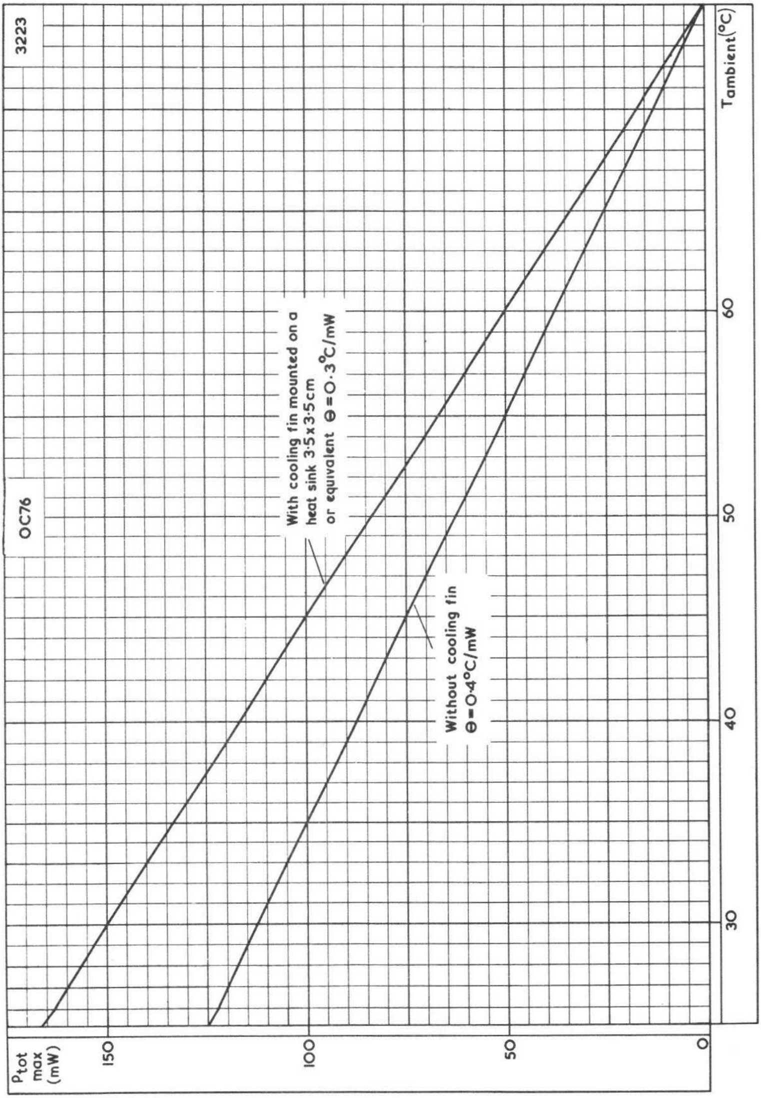
B3603



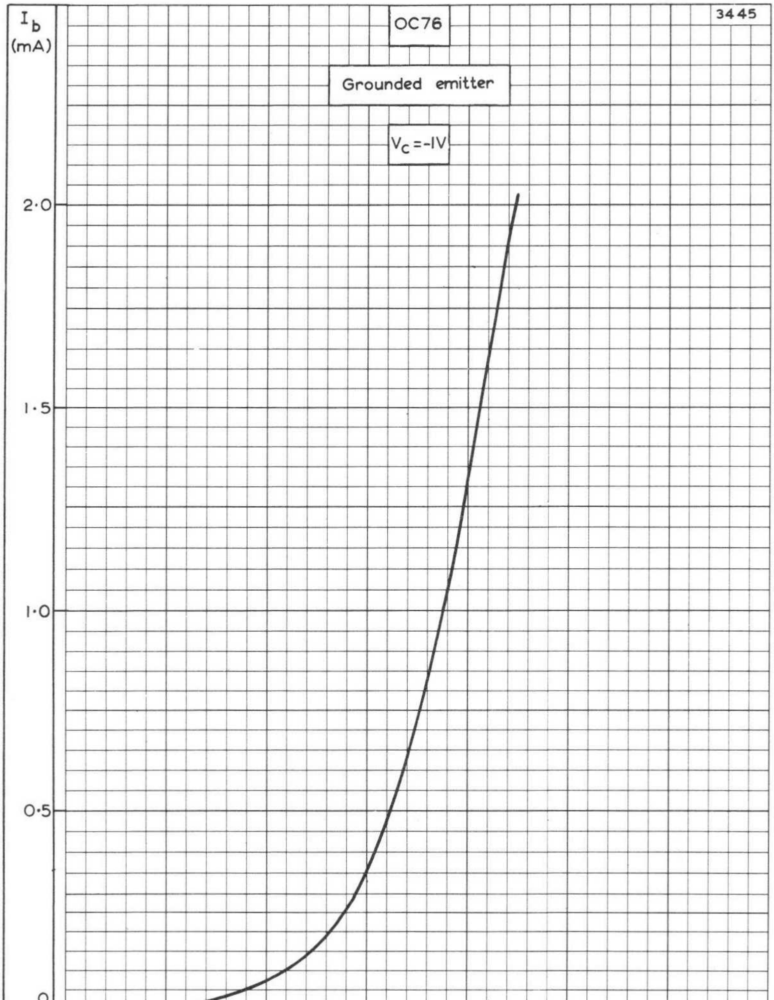
OUTPUT CHARACTERISTICS. GROUNDED BASE



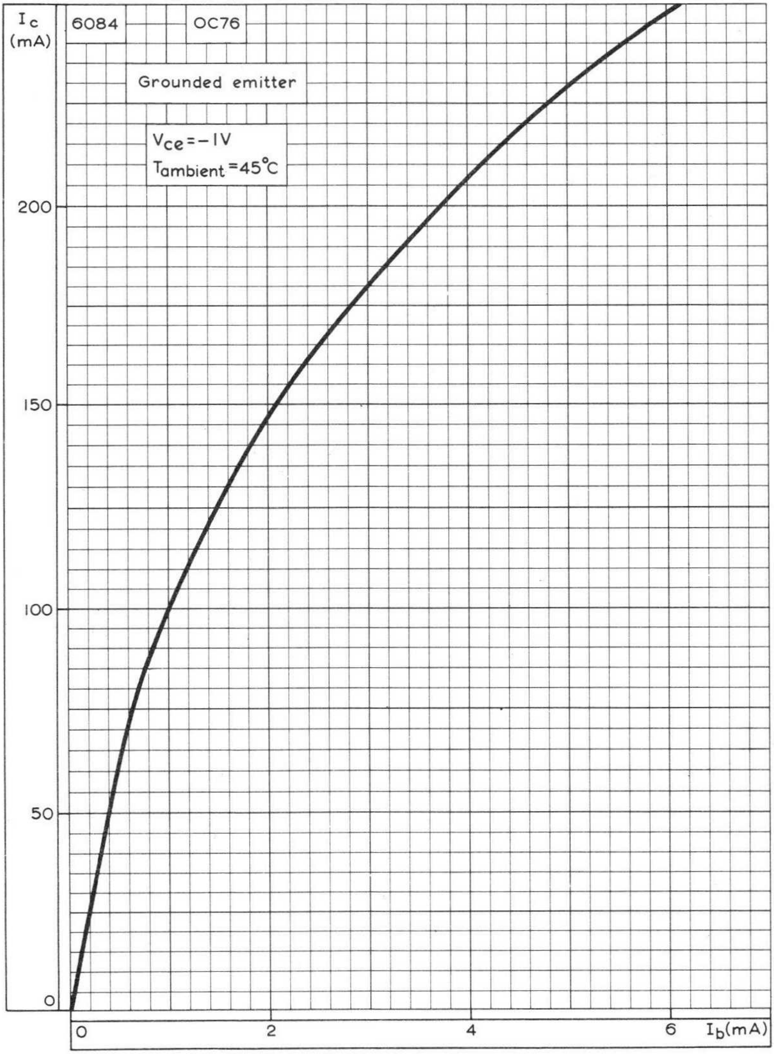
OUTPUT CHARACTERISTICS. GROUNDED EMITTER



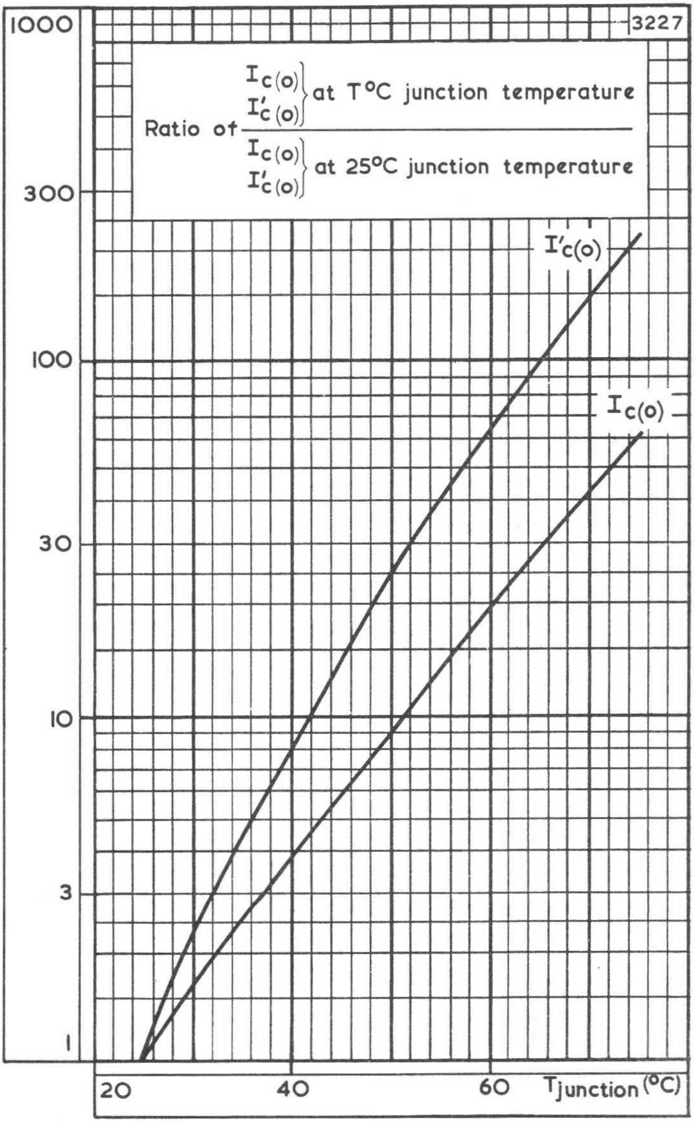
COLLECTOR DISSIPATION PLOTTED AGAINST AMBIENT TEMPERATURE



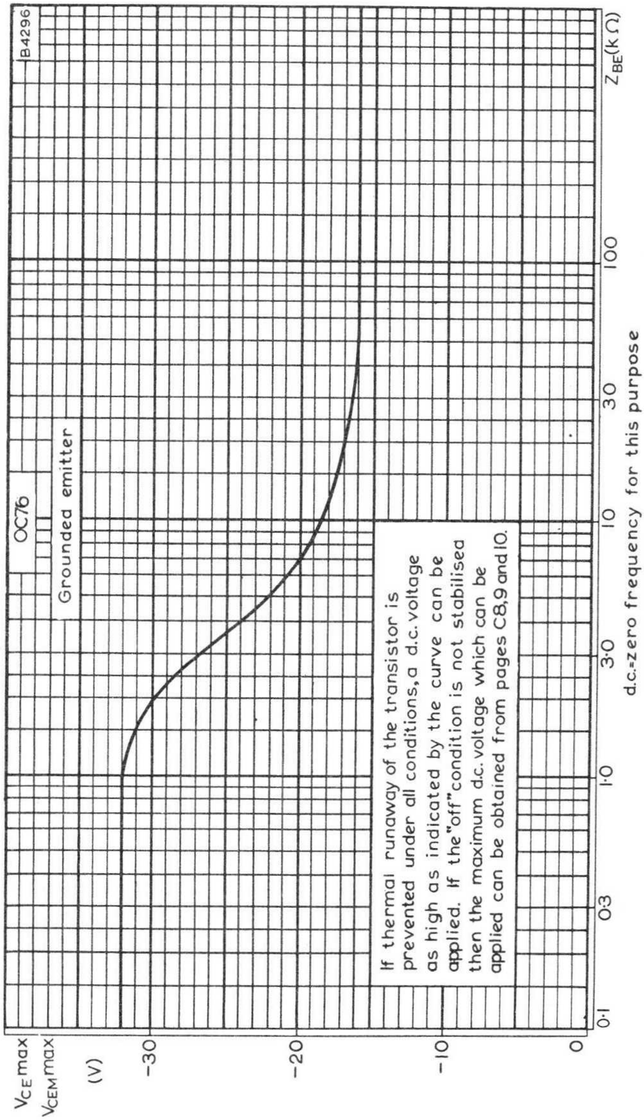
INPUT CHARACTERISTIC. GROUNDED EMITTER.



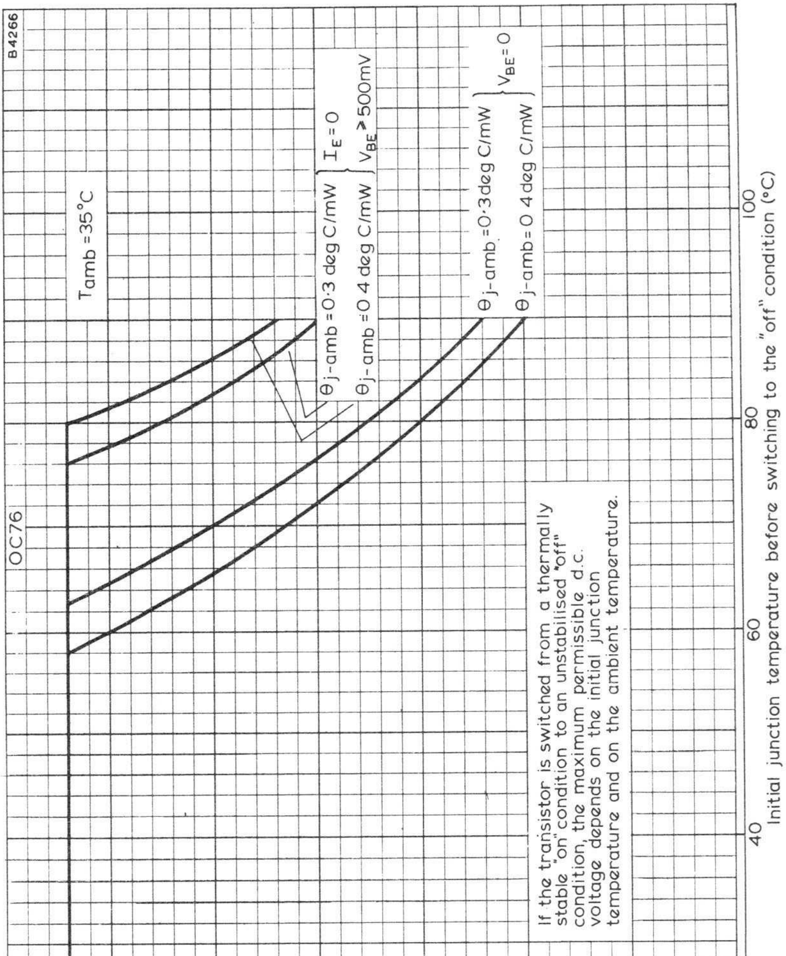
TRANSFER CHARACTERISTIC. GROUNDED EMITTER



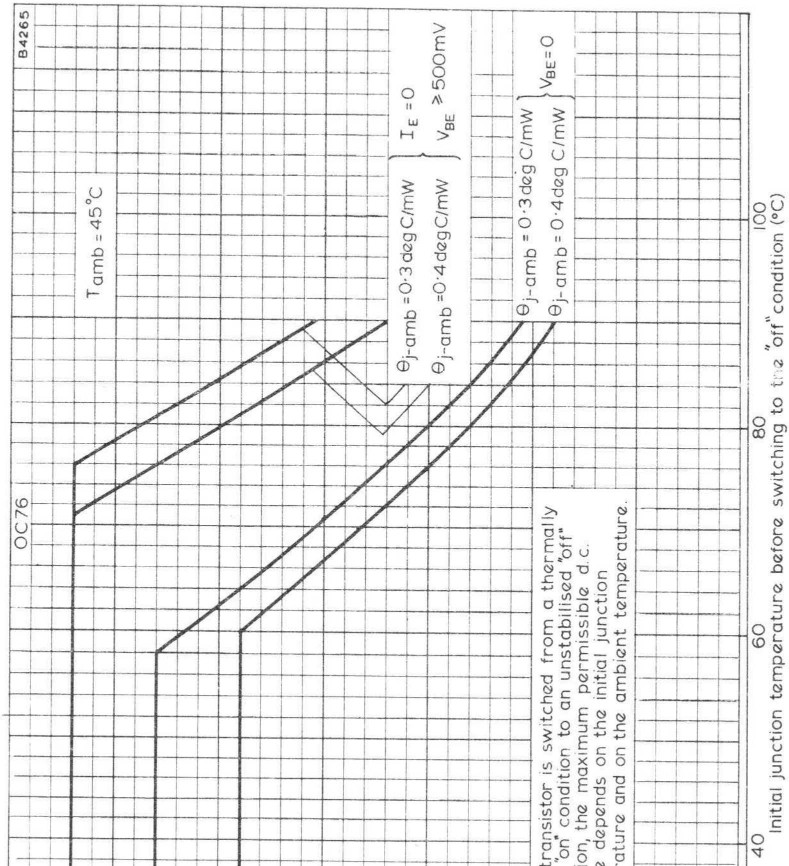
VARIATION OF $I_{c(o)}$ $I'_{c(o)}$ PLOTTED AGAINST JUNCTION TEMPERATURE



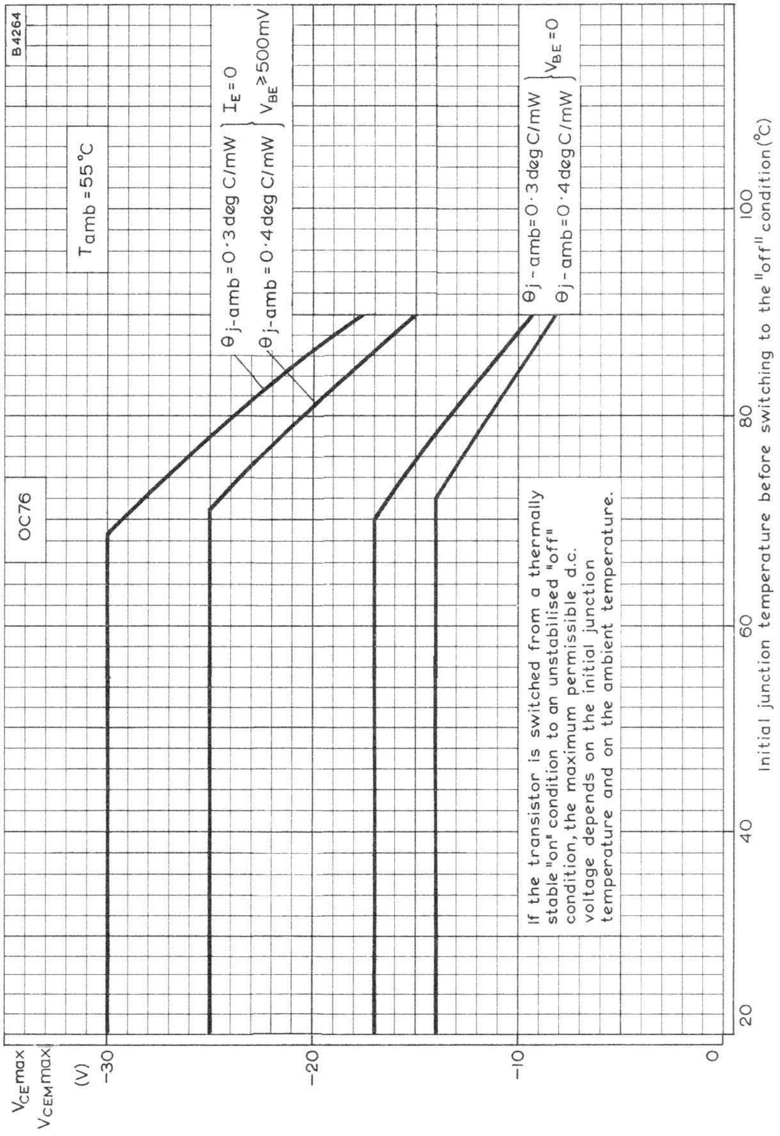
MAXIMUM PEAK AND AVERAGE COLLECTOR VOLTAGE PLOTTED AGAINST EXTERNAL BASE-EMITTER IMPEDANCE



MAXIMUM PEAK AND AVERAGE COLLECTOR VOLTAGE PLOTTED AGAINST INITIAL JUNCTION TEMPERATURE. $T_{amb} = 35°C$



MAXIMUM PEAK AND AVERAGE COLLECTOR VOLTAGE PLOTTED AGAINST INITIAL JUNCTION TEMPERATURE. $T_{amb} = 45°C$



MAXIMUM PEAK AND AVERAGE COLLECTOR VOLTAGE PLOTTED AGAINST INITIAL JUNCTION TEMPERATURE. $T_{amb} = 55°C$

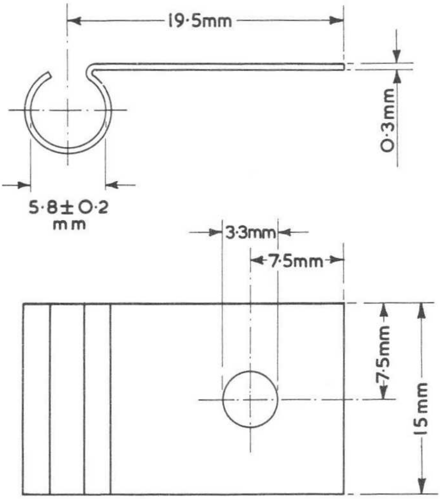
TEMPERATURE RATINGS

Storage temperature	−55 to +75	°C
Max. junction temperature for continuous operation	75	°C
†Max. junction temperature for intermittent operation (total duration = 200 hours max.)	90	°C
Max. junction temperature rise above ambient (without cooling fin, in free air)	0.4	°C/mW
Max. junction temperature rise above ambient (with cooling fin, mounted in free air on a heat sink of 3.5 × 3.5cm or equivalent)	0.3	°C/mW

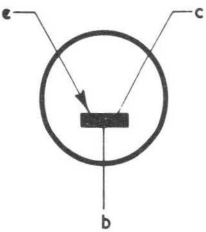
†Likelihood of full performance of a circuit at this temperature is also dependent upon the type of application.

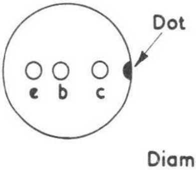
OPERATING NOTES

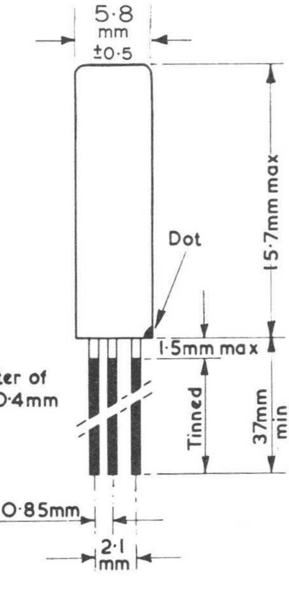
1. The transistor may be soldered directly into the circuit but heat conducted to the junction should be kept to a minimum by the use of a thermal shunt.
2. Care should be taken not to bend the leads nearer than 1.5mm to the seal.



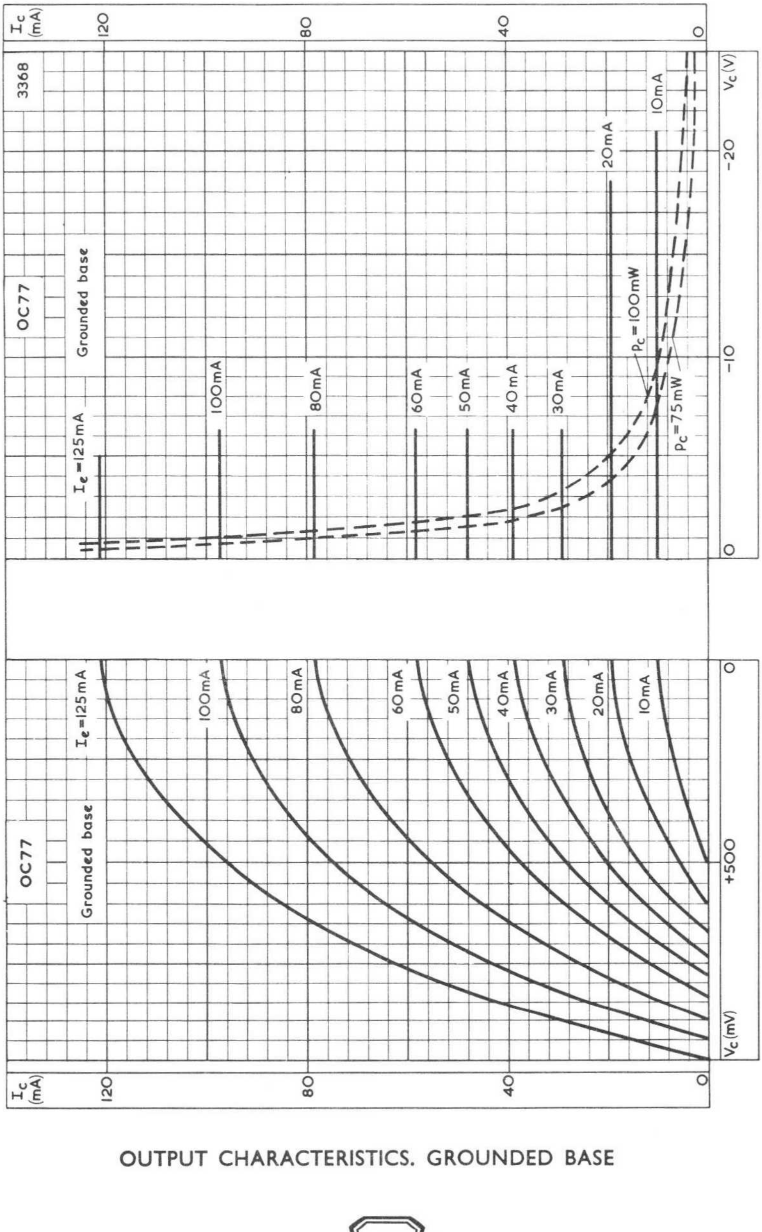
Dimensions of cooling fin



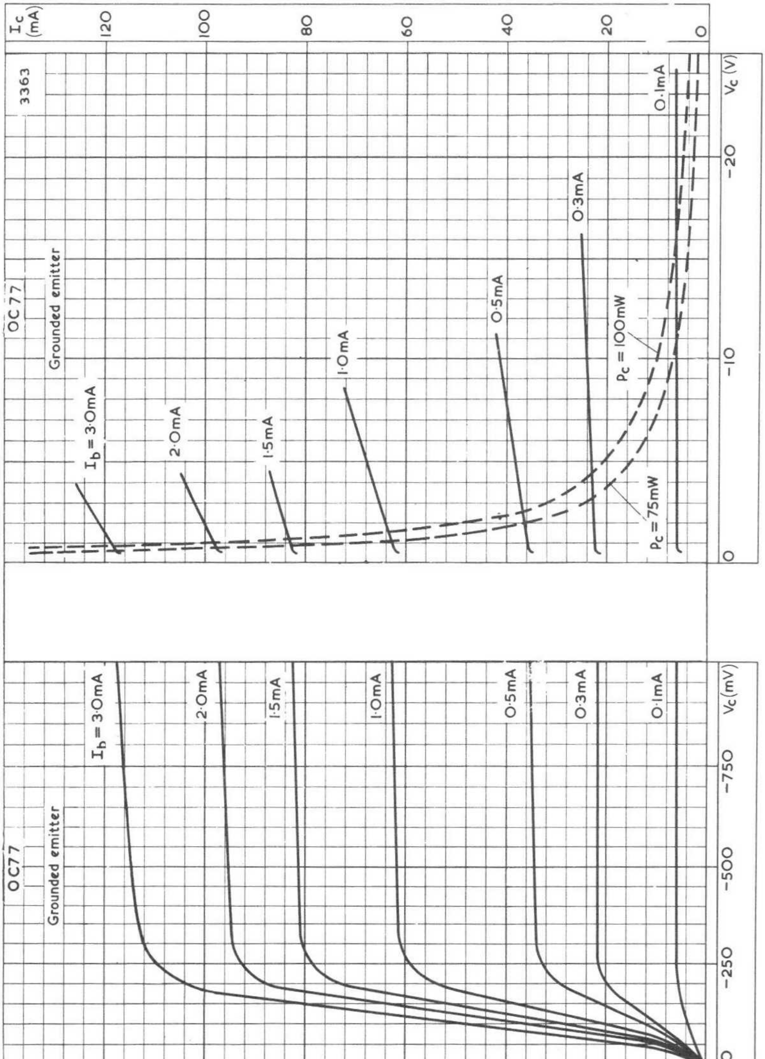




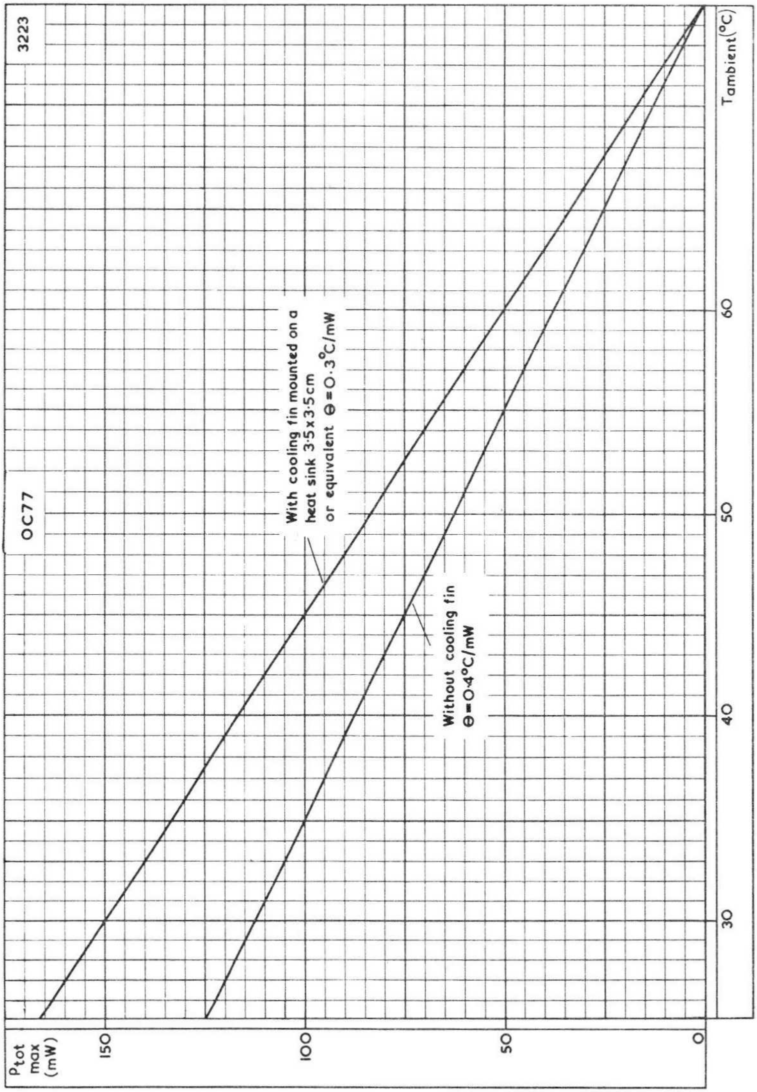
B3603



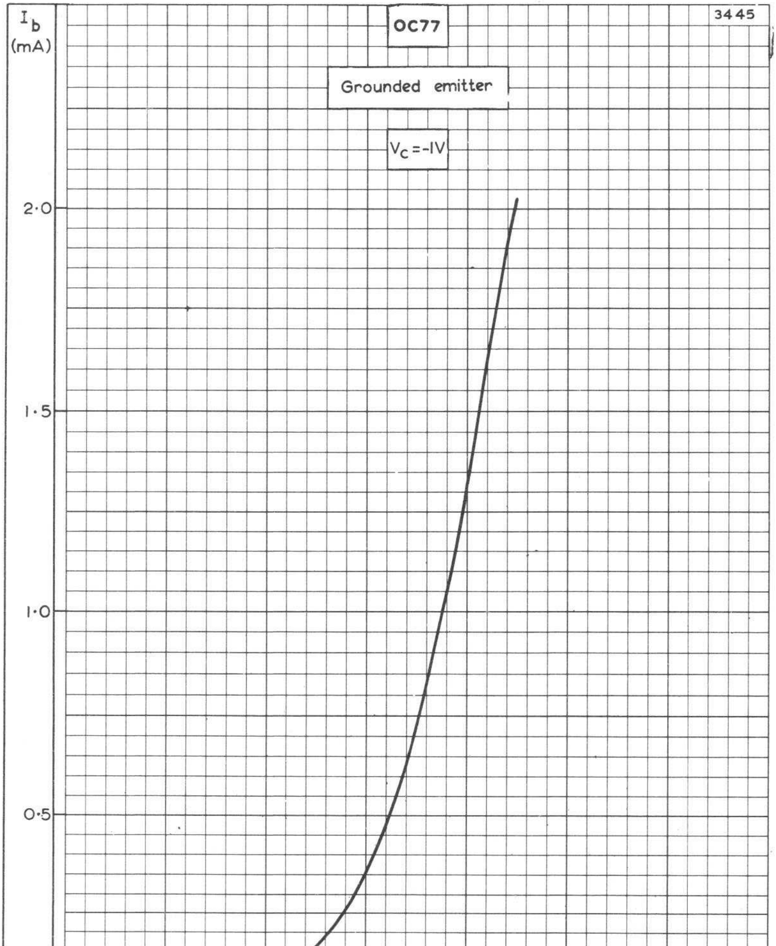
OUTPUT CHARACTERISTICS. GROUNDED BASE



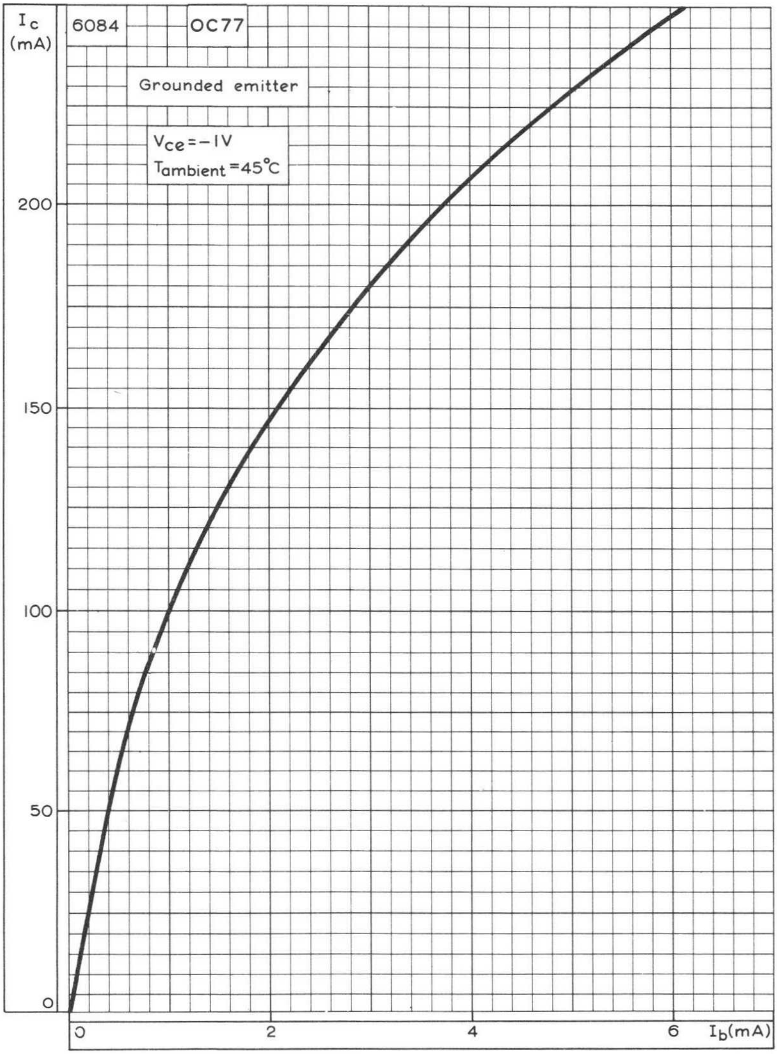
OUTPUT CHARACTERISTICS. GROUNDED EMITTER



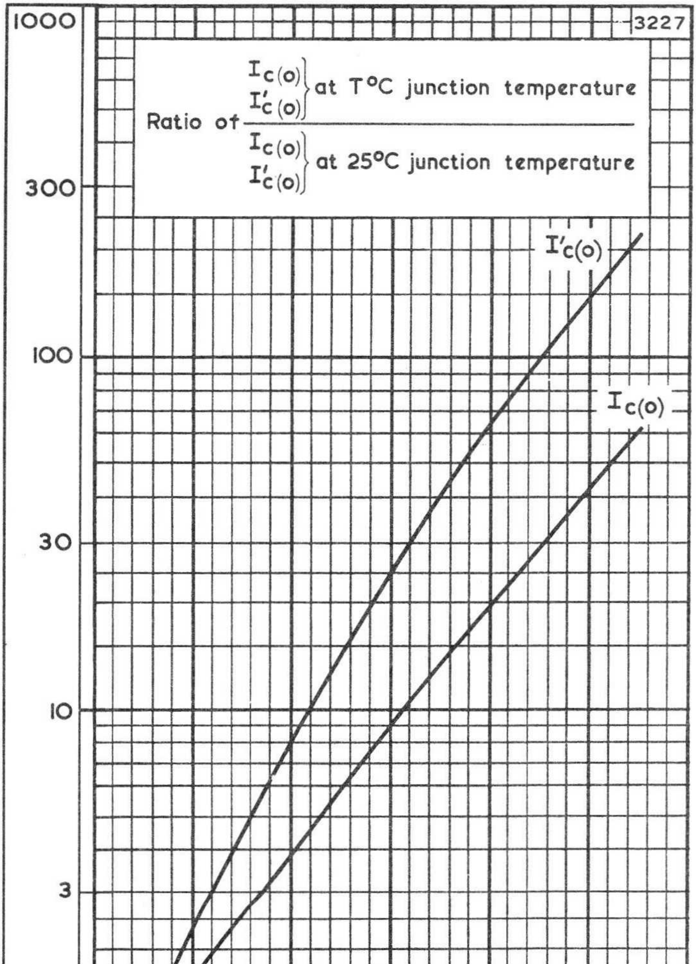
COLLECTOR DISSIPATION PLOTTED AGAINST AMBIENT TEMPERATURE



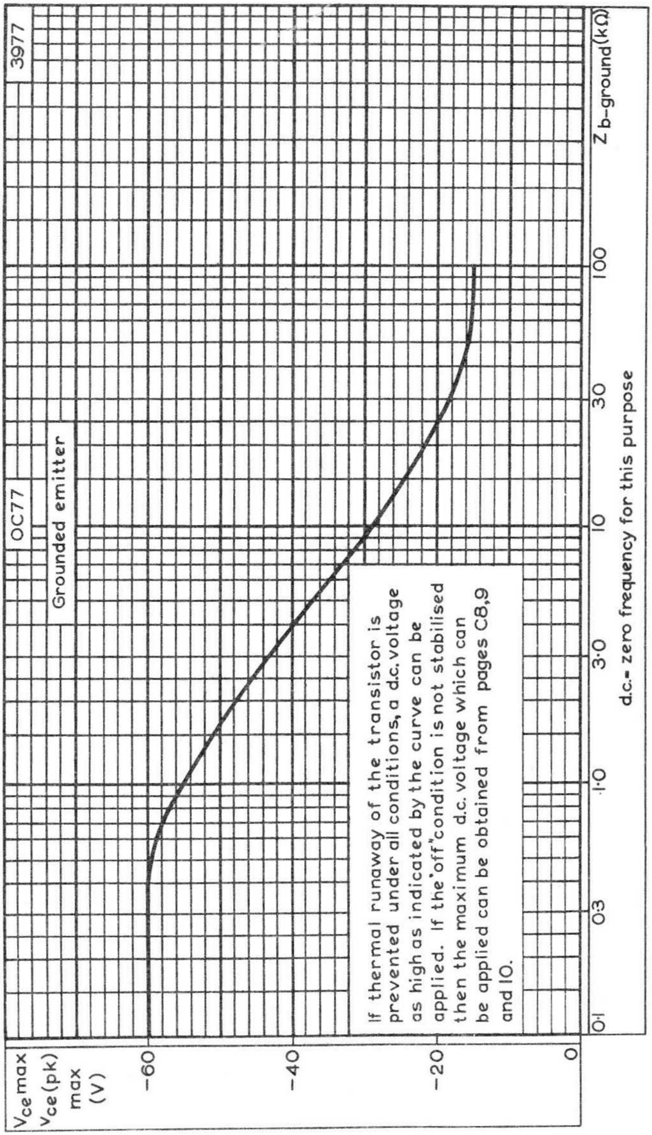
INPUT CHARACTERISTIC. GROUNDED EMITTER



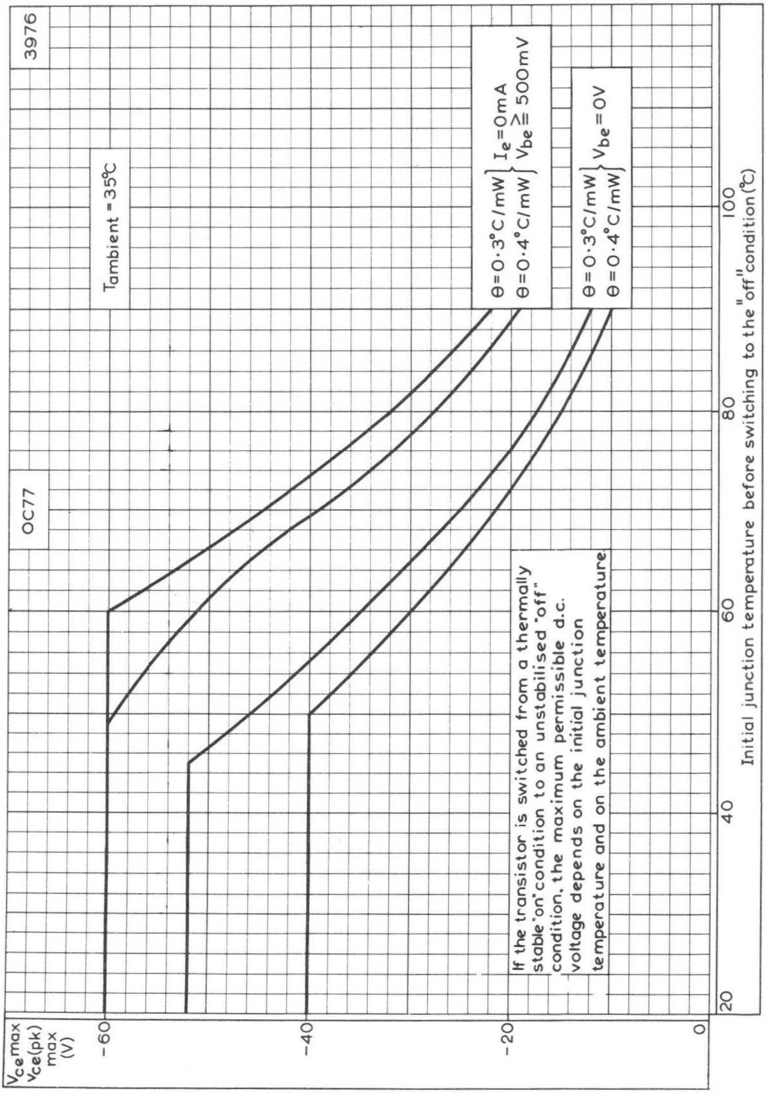
TRANSFER CHARACTERISTIC. GROUNDED EMITTER



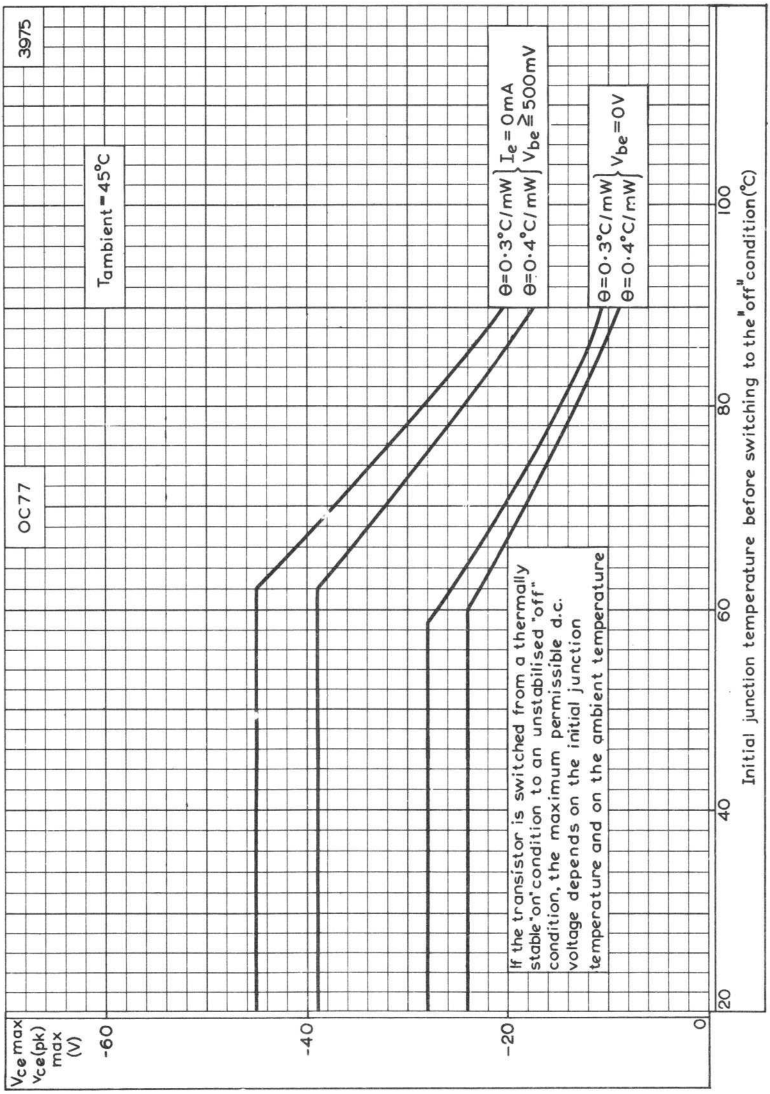
VARIATION OF $I_{c(o)}$, $I'_{c(o)}$ PLOTTED AGAINST JUNCTION TEMPERATURE



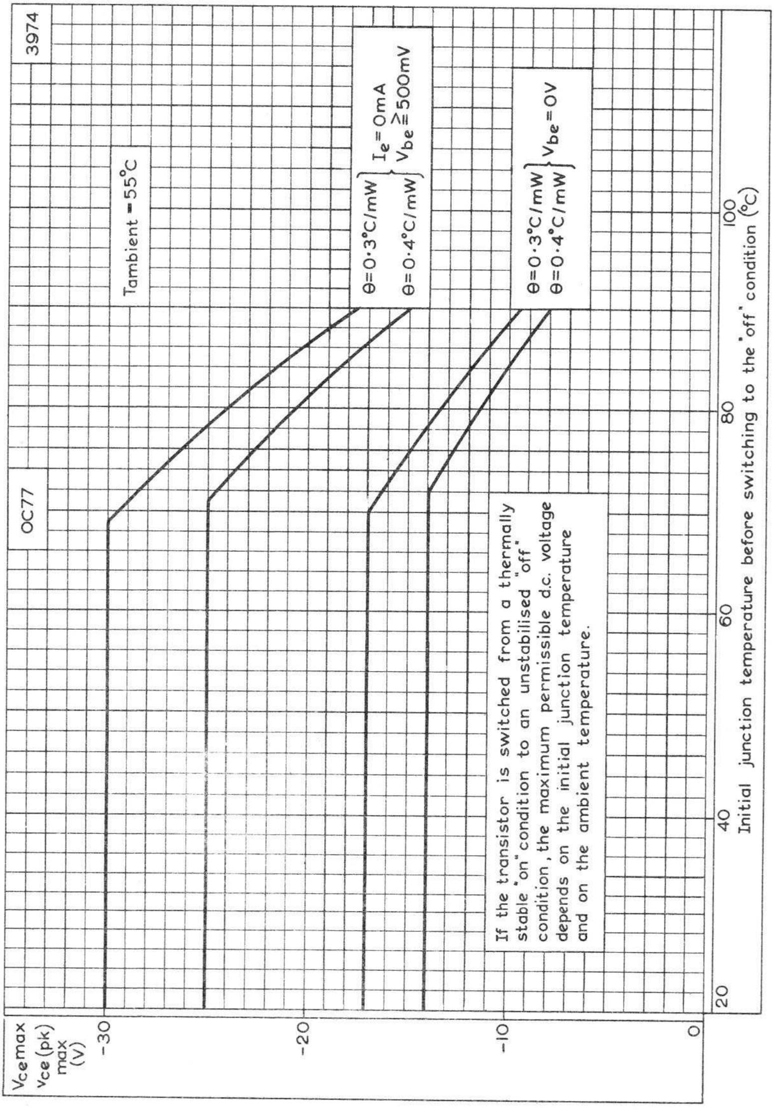
MAXIMUM PEAK AND AVERAGE COLLECTOR VOLTAGE PLOTTED AGAINST EXTERNAL BASE-EMITTER IMPEDANCE



MAXIMUM PEAK AND AVERAGE COLLECTOR VOLTAGE PLOTTED AGAINST INITIAL JUNCTION TEMPERATURE. $T_{ambient} = 35°C$



MAXIMUM PEAK AND AVERAGE COLLECTOR VOLTAGE PLOTTED AGAINST INITIAL JUNCTION TEMPERATURE. $T_{ambient} = 45°C$



MAXIMUM PEAK AND AVERAGE COLLECTOR VOLTAGE PLOTTED AGAINST INITIAL JUNCTION TEMPERATURE. $T_{ambient} = 55°C$

JUNCTION TRANSISTORS

OC83
OC84

Junction transistors of the p-n-p alloy type intended for general purpose switching, pulse oscillatory and large signal applications. Matched pairs are available under the typenumber 2-OC. TO-1 construction, envelope isolated.

QUICK REFERENCE DATA

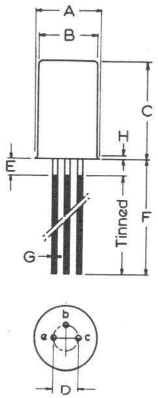
<table>
<tr><th></th><th>OC83</th><th>OC84</th><th></th></tr>
<tr><td>V_{CB} max. ($I_E = 0$)</td><td colspan="2">-32</td><td>V</td></tr>
<tr><td>V_{CE} max. ($+V_{BE} > 1.0V$)</td><td colspan="2">-32</td><td>V</td></tr>
<tr><td>I_{CM} max.</td><td colspan="2">1.0</td><td>A</td></tr>
<tr><td>P_{tot} max. ($T_{amb} = 25^{o}C$)</td><td colspan="2">600</td><td>mW</td></tr>
<tr><td>h_{FE} ($I_C = 300mA$)</td><td>40 to 200</td><td>50 to 160</td><td></td></tr>
<tr><td>f_T typ.</td><td>0.85</td><td>1.0</td><td>MHz</td></tr>
</table>

Unless otherwise shown data is applicable to both types

OUTLINE AND DIMENSIONS

Conforming to J.E.D.E.C. TO-1

B.S.3934 SO-21/SB3-10



Millimetres

	Min.	Typ.	Max.
A	-	-	6.5
B	-	-	6.1
C	-	-	9.4
D	-	1.8	-
E	-	-	1.5
F	38	-	-
G	-	0.43	-

RATINGS

Limiting values of operation according to the absolute maximum system as defined in publication 134 of the International Electrotechnical Commission.

Electrical

	OC83	OC84	
V_{CB} max. (I_E=0)	-32	-32	V
V_{CE} max. (+V_{BE}>1V)	-32	-32	V
V_{CE} max. (I_C≤300mA)	-20	-32	V
I_{CM} max.		1.0	A
*$I_{C(AV)}$ max.		500	mA
I_{EM} max.		1.05	A
*$I_{E(AV)}$ max.		520	mA
V_{EB} max. (I_C=0)	-3.0	-10	V
I_{BM} max.		50	mA
*$I_{B(AV)}$ max.		20	mA
P_{tot} max. (T_{amb} = 25°C)		600	mW
		See page C13	

$$P_{tot}\text{ max.} = \frac{T_j - T_{amb}}{\Theta}$$

*Averaged over any 20ms period.

Thermal

T_j max.	85	°C
T_{stg} max.	85	°C
T_{stg} min.	-55	°C

THERMAL CHARACTERISTICS

Θ_{j-amb} without cooling clip in free air	0.25	degC/mW
Θ_{j-amb} with type (a) or extended type (b) cooling clip see page D6	0.15	degC/mW
Θ_{j-amb} with standard clip type (b) on a heatsink 7cm x 7cm 16 s.w.g. aluminium	0.1	degC/mW

MAJOR CHARACTERISTICS $T_j = 25^oC$

		Min.	Max.	
Collector-base breakdown voltage	$V_{(BR)CBO}$			
I_C=100µA, I_E=0		32	-	V
Collector cut-off current	I_{CBO}			
V_{CB}=-10V, I_E=0		-	10	µA
Collector-emitter saturation voltage	$V_{CE(sat)}$			
I_C=300mA, I_B=9mA		-	-500	mV
Base voltage	V_{BE}			
V_{CB}=0, I_E=300mA		-	-750	mV
Base current	I_B			
V_{CB}=0, I_E=300mA	OC83	1.5	7.5	mA
	OC84	1.8	6.0	mA

TYPICAL CHARACTERISTIC SPREADS $T_{amb} = 25^oC$ unless otherwise stated.

		Typ.	Range
Collector cut-off current	I_{CBO}		
I_E=0, V_{CB}=-10V		4.5	- to 10 µA
V_{CB}=-32V		-	- to 100 µA
V_{CB}=-10V, T_{amb}=85°C		300	- to 500 µA
Emitter cut-off current	I_{EBO}		
I_C=0, V_{EB}=-10V		-	- to 100 µA
Collector-emitter saturation voltage	$V_{CE(sat)}$		
I_C=300mA, I_B=9mA		-300	- to-500 mV
Base voltage	V_{BE}		
V_{CB}=0, I_E=300mA		-475	- to -750 mV
Noise figure			
R_s = 500Ω, V_{CE}=-2V, I_C=0.5mA	OC83	8.0	- to 33 dB ←

Large signal forward current transfer ratio	h_{FEL}	Typ.	Range
V_{CE}=-1V, I_C=50mA	OC83	-	50 to 280
	OC84	-	60 to 200
V_{CE}=-1V, I_C=300mA	OC83	-	40 to 200
	OC84	-	50 to 160

Typical basic parameters. V_{CE}=-6V, I_C = 1mA

$*r_e$		25		Ω
$r_{bb'}$		60		Ω
c_{tc}		40		pF
h_{fe}		90		
		Typ.	Range	
f_T	OC83	0.65	- to 1.0	Mc/s
	OC84	850	-	kc/s

*The value of r_e given here is $\frac{kT}{q}\cdot\frac{1}{I_E} \approx \frac{25}{I_E}$ where I_E is in mA and T is in ^oK.

CHARACTERISTICS OF MATCHED PAIR 2-OC83 / 2-OC84 (T_j = 25°C)

Ratio of the large signal forward current transfer ratios of the two transistors at: -

I_C = 50mA	<1.2 : 1
I_C = 300mA	<1.2 : 1

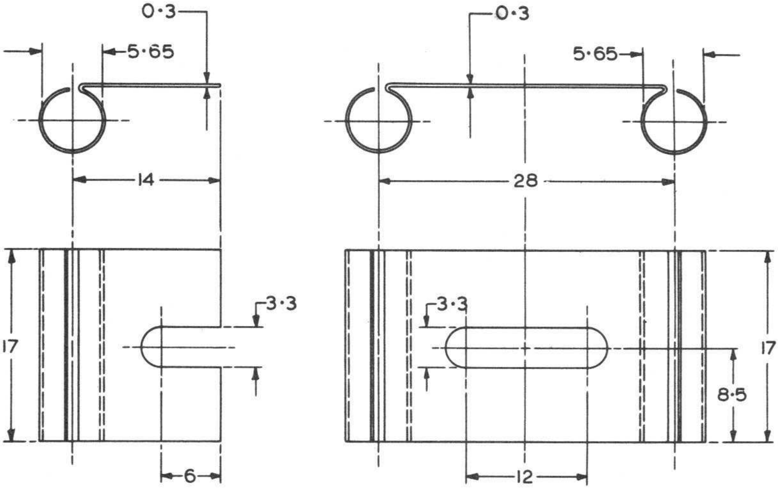
SOLDERING AND WIRING RECOMMENDATIONS

1. Transistors may be soldered directly into the circuit but heat conducted to the junction should be kept to a minimum by use of a thermal shunt.

2. Transistors may be dip soldered at a solder temperature of 245°C for a maximum soldering time of 5 seconds. The case temperature may exceed the maximum storage temperature for a period of not greater than 2 minutes provided that it at no time exceeds 115°C. These recommendations apply to a transistor mounted flush on board with punched through holes or spaced 1.5mm above a board with plated through holes.

3. Care should be taken not to bend the leads nearer than 1.5mm from the seal.

OUTLINE AND DIMENSIONS OF COOLING CLIPS



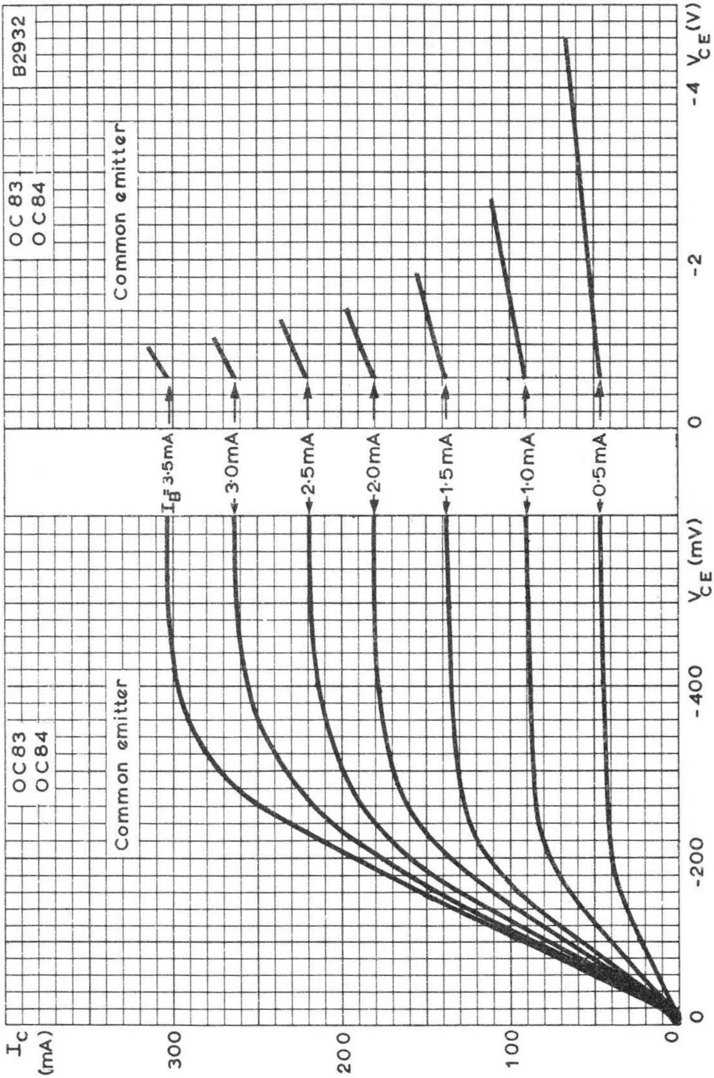
Nominal dimensions in mm

Type a.
Part No. 56227

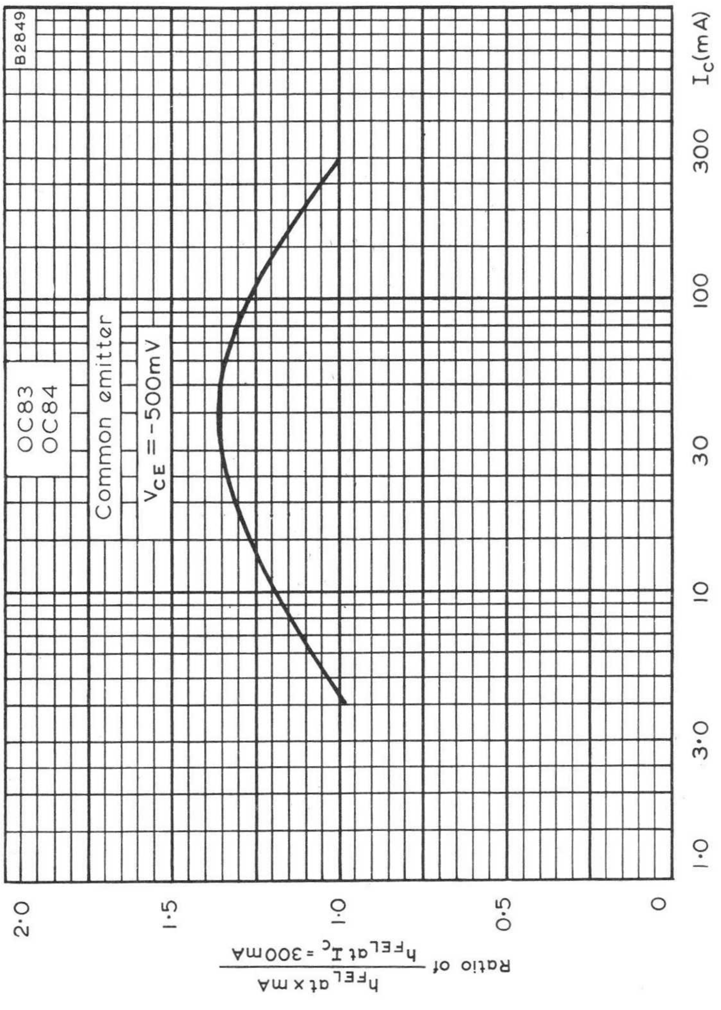
Type b.
Part No. 56226

NOTE - Fitting of cooling clip

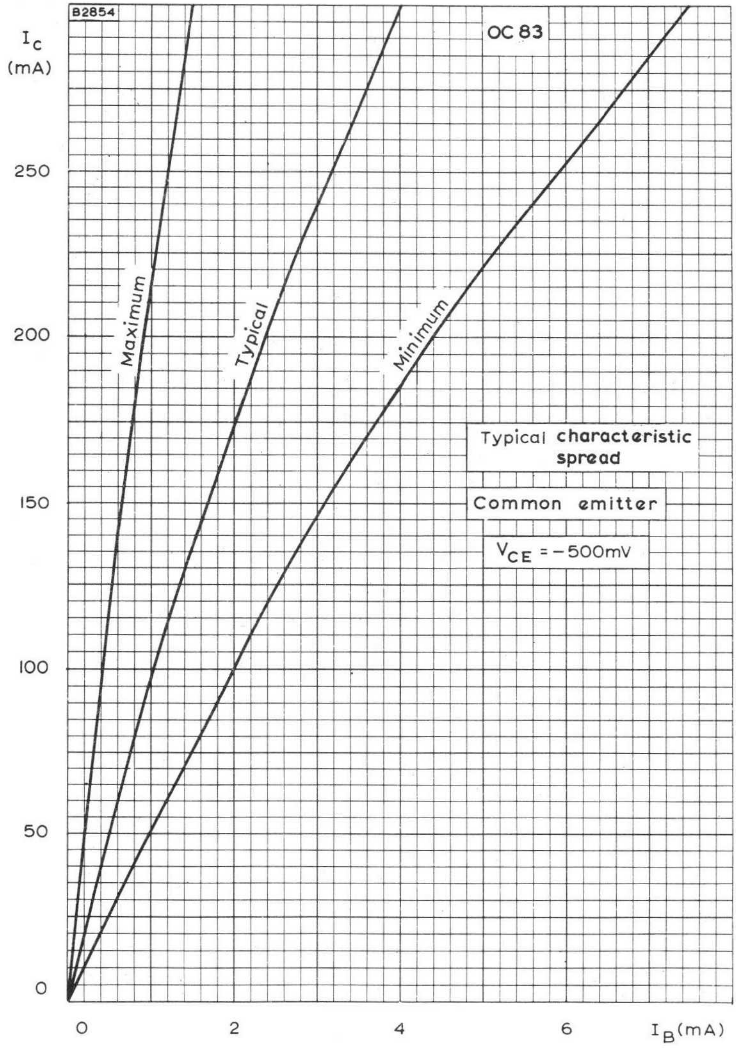
To ensure good thermal contact with the transistor envelope, the cooling clips should not be distorted by forcing it over the "belling" at the base of the transistor.



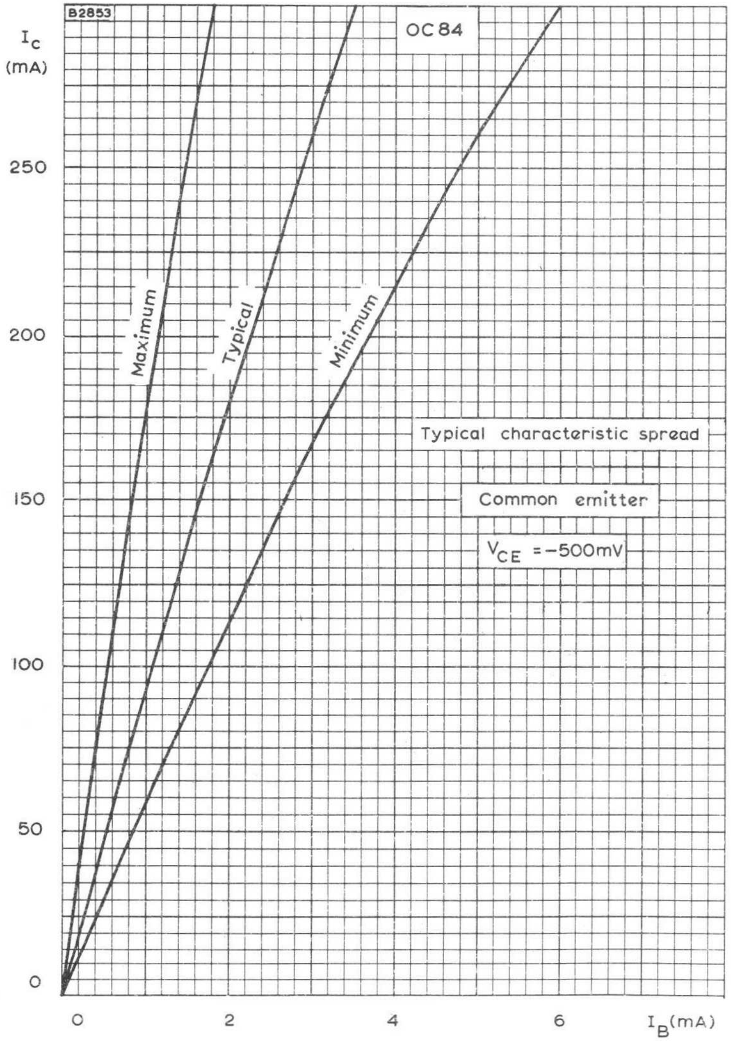
OUTPUT CHARACTERISTICS. COMMON EMITTER



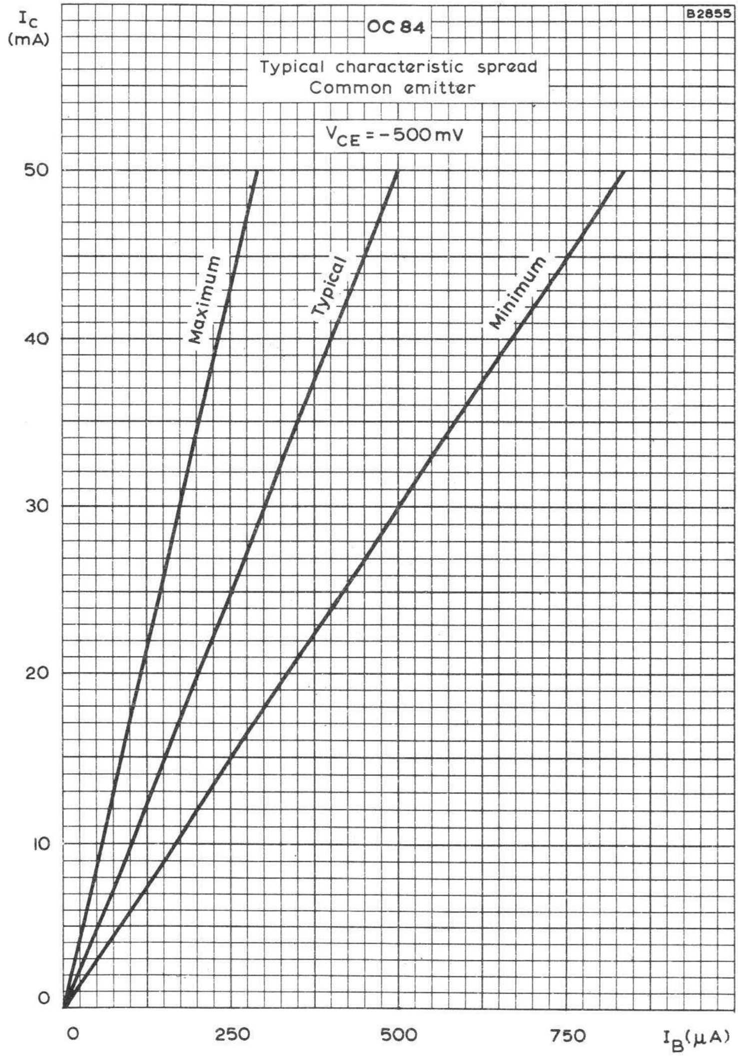
LARGE SIGNAL FORWARD CURRENT TRANSFER RATIO PLOTTED
AGAINST COLLECTOR CURRENT



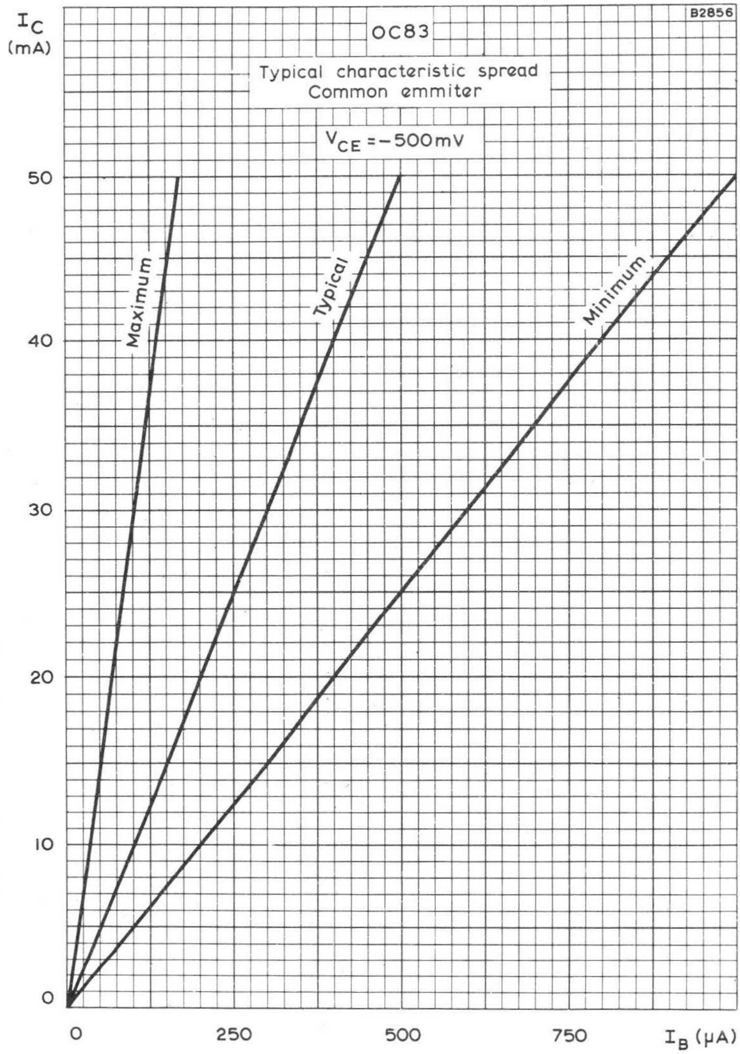
SPREAD OF TRANSFER CHARACTERISTIC. COMMON EMITTER



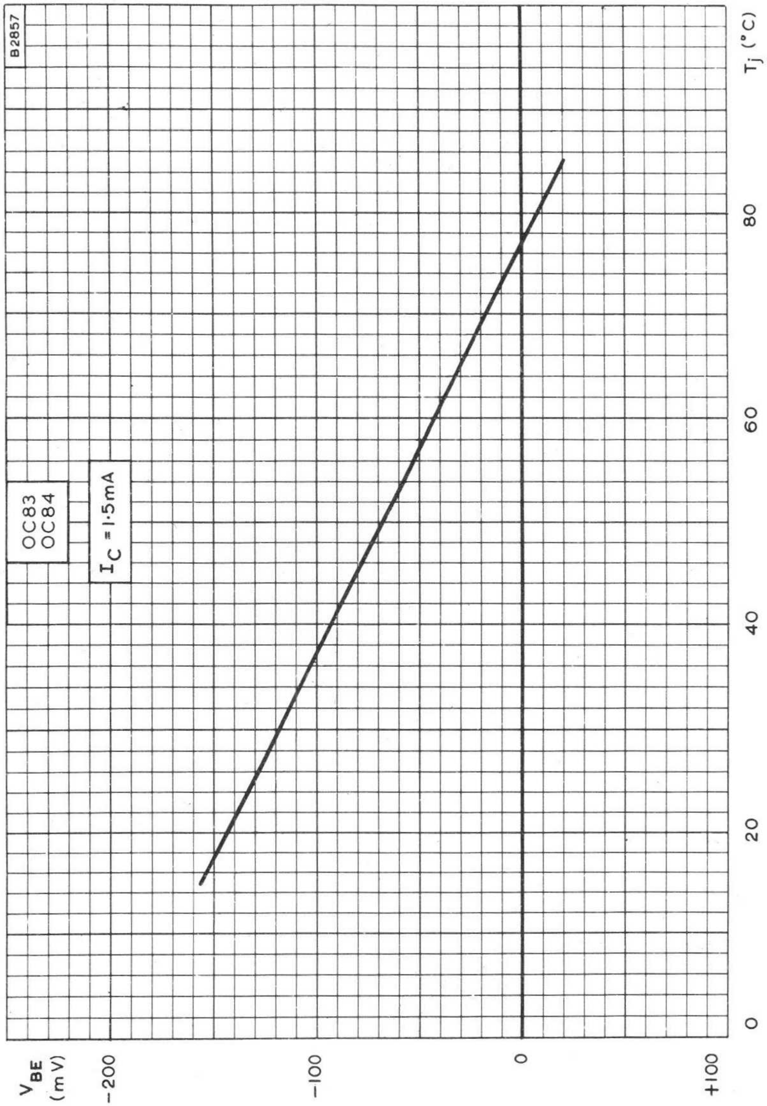
SPREAD OF TRANSFER CHARACTERISTIC. COMMON EMITTER



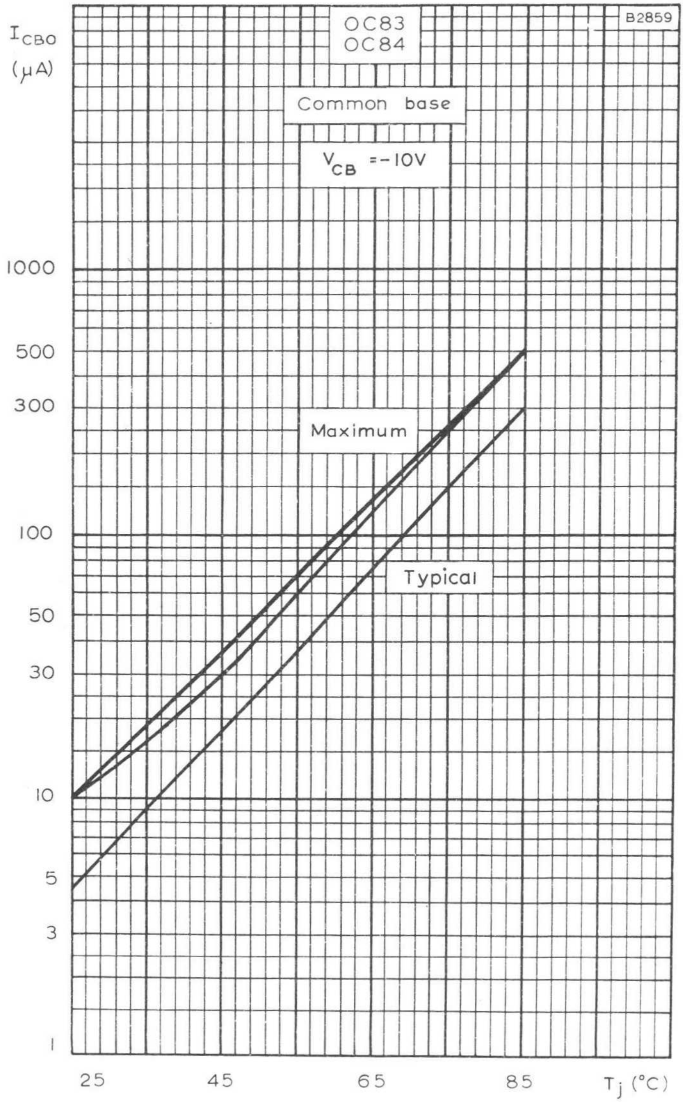
SPREAD OF LOW LEVEL TRANSFER CHARACTERISTICS.
COMMON EMITTER



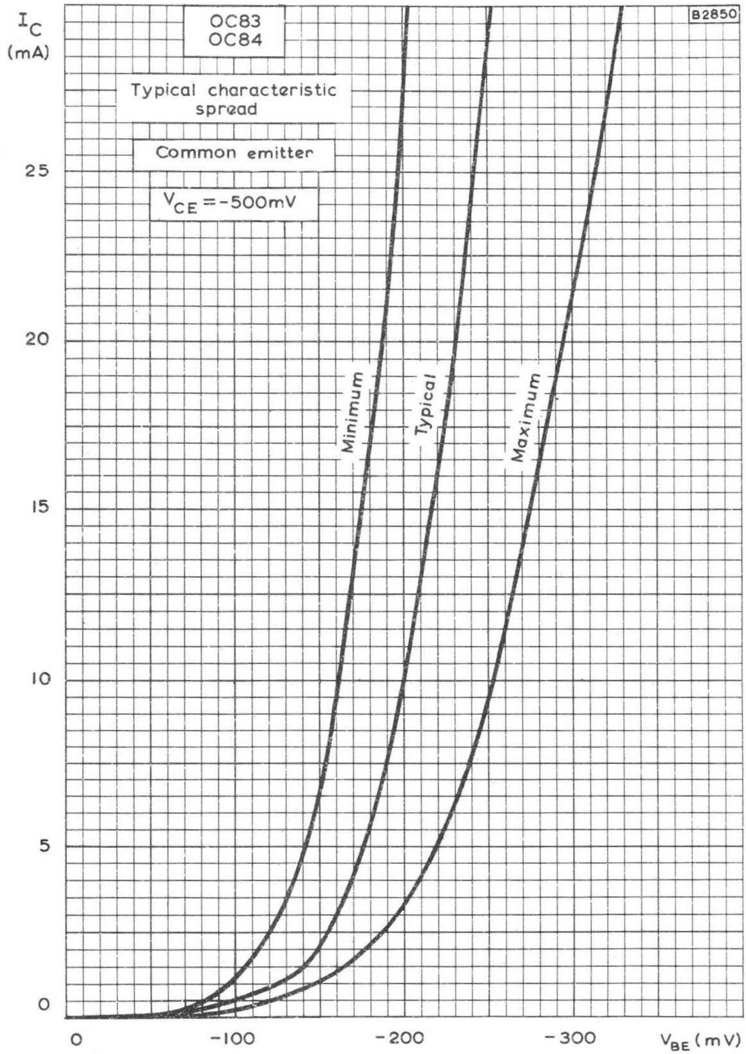
SPREAD OF LOW LEVEL TRANSFER CHARACTERISTICS.
COMMON EMITTER



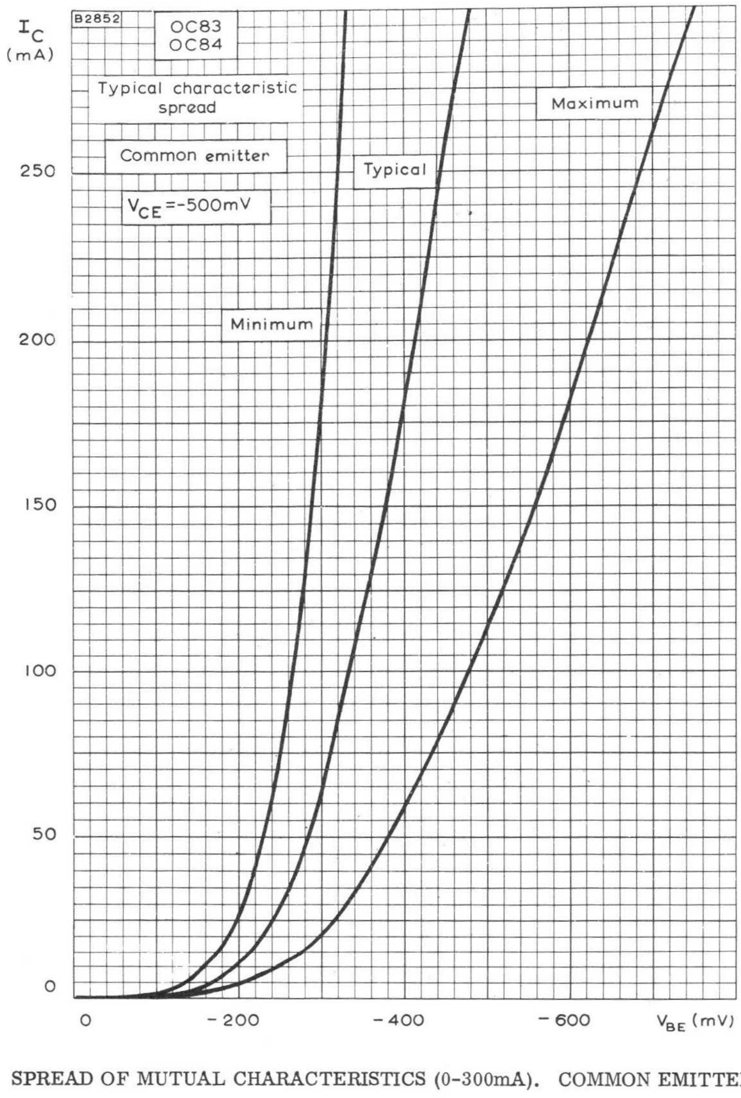
TYPICAL BASE-EMITTER VOLTAGE PLOTTED AGAINST JUNCTION TEMPERATURE



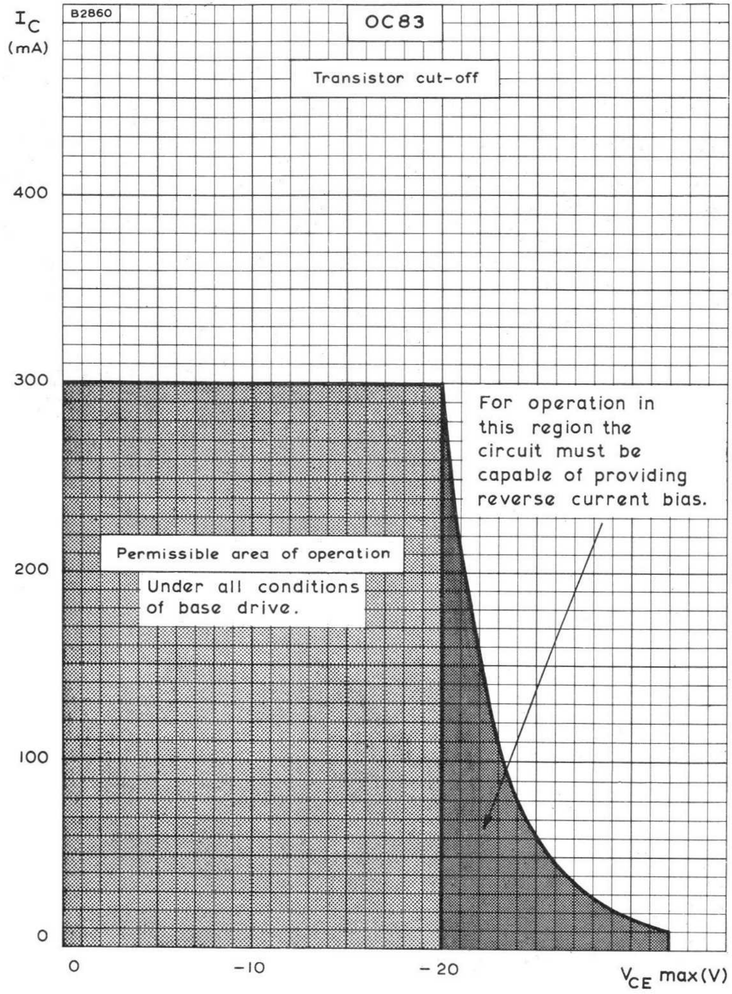
TYPICAL COLLECTOR CUT-OFF CURRENT PLOTTED AGAINST JUNCTION TEMPERATURE



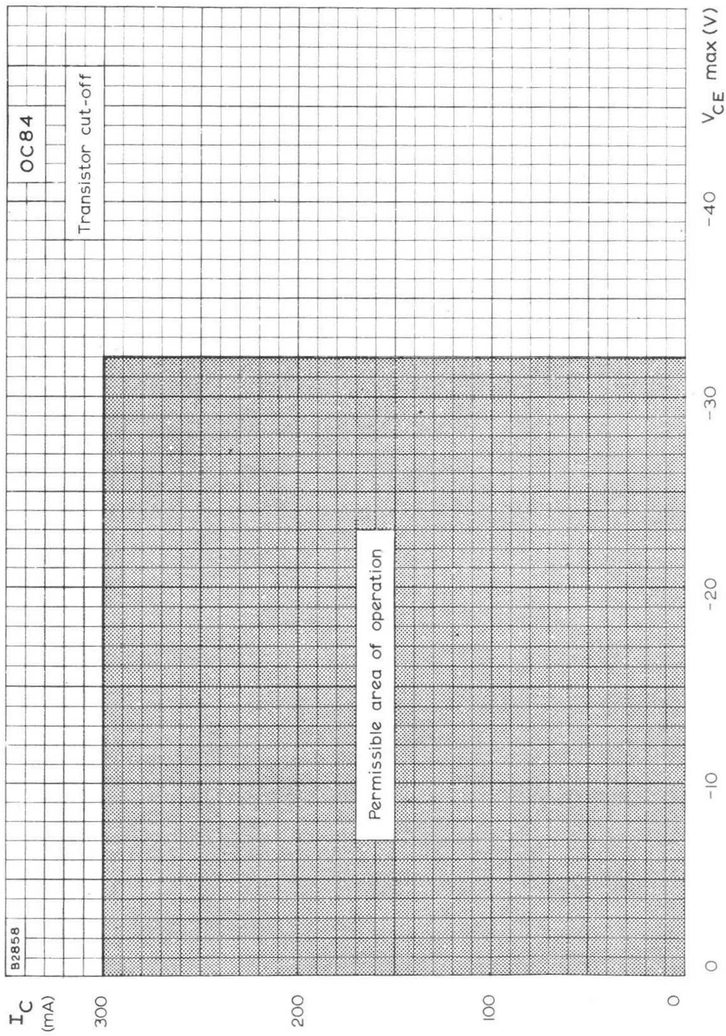
SPREAD OF MUTUAL CHARACTERISTICS (0-30mA). COMMON EMITTER



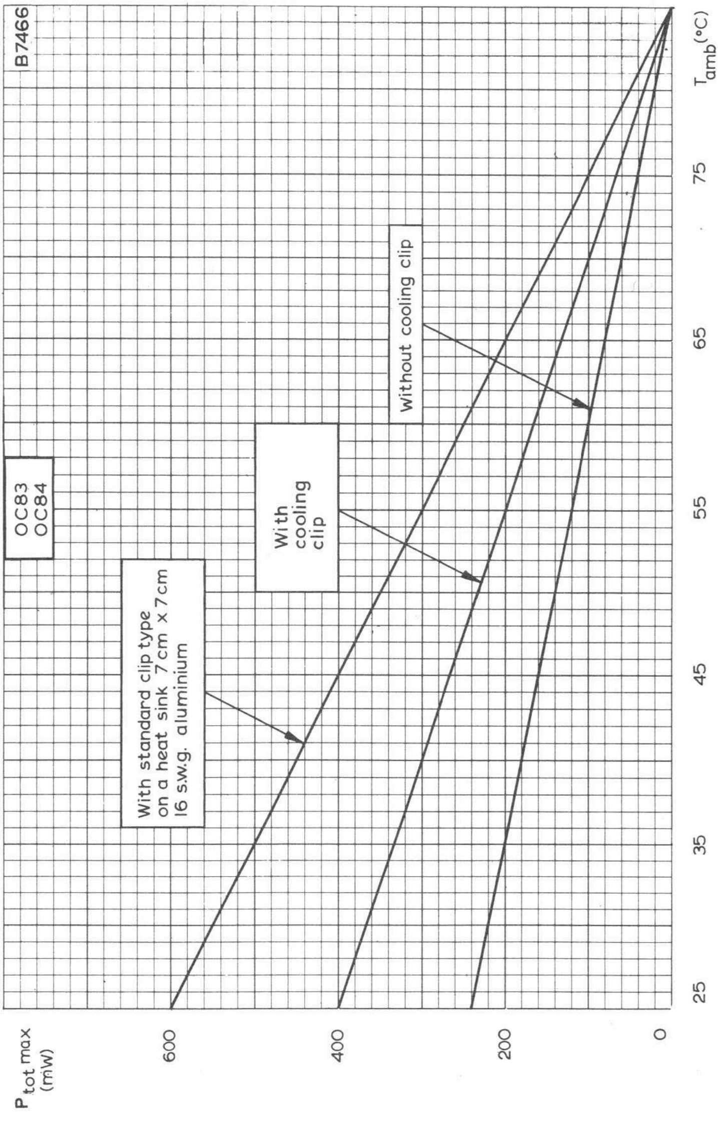
SPREAD OF MUTUAL CHARACTERISTICS (0-300mA). COMMON EMITTER



COLLECTOR CURRENT PLOTTED AGAINST MAXIMUM COLLECTOR-EMITTER VOLTAGE



COLLECTOR CURRENT PLOTTED AGAINST MAXIMUM
COLLECTOR-EMITTER VOLTAGE



MAXIMUM TOTAL DISSIPATION PLOTTED AGAINST AMBIENT TEMPERATURE

GERMANIUM P-N-P ALLOY JUNCTION TRANSISTORS

OC122 OC123

MAINTENANCE TYPE

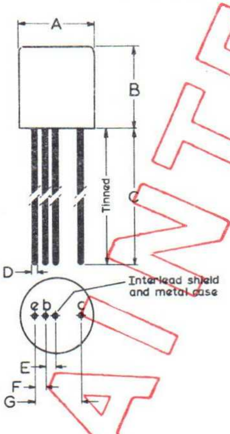
Germanium junction transistors of the p-n-p alloy type intended for use in industrial switching applications and digital computers.

QUICK REFERENCE DATA

	OC122	OC123	
$-V_{CBO}$ max.	32	50	V
$-V_{CE}$ max. ($+V_{BE} > 0.5V$)	32	50	V
$-I_{CM}$ max.	2.0	2.0	A
P_{tot} max. ($T_{amb} = 25^{o}C$)	295	295	mW
T_j max.	90	90	^{o}C
h_{FE} typ. ($-I_C = 100mA$)	180	160	
f_T typ.	1.3	1.5	MHz

OUTLINE AND DIMENSIONS

Conforming to B.S. 3934 SO-23/SB4-4
J.E.D.E.C. TO-7



	Millimetres		
	Min.	Nom.	Max.
A	-	-	9.1
B	-	-	9.5
C	37	-	-
D	-	0.45	-
E	-	1.22	-
F	-	1.22	-
G	-	4.88	-

OC139
OC140
OC141

QUICK REFERENCE DATA

Symmetrical germanium n-p-n junction transistors designed for high current, high speed computer switching applications.

	OC139	OC140	OC141	
V_{CB} max. ($I_C = 3mA$)	+20	+20	+20	V
I_{CM} max.	250	400	400	mA
f_1	> 3.5	> 4.5	> 9.0	Mc/s
h_{FE} ($I_E = 15mA$)	20 to 84	50 to 150	80 to 200	
θ_{j-amb}	←———	0.35°C/mW	———→	

Unless otherwise shown data is applicable to all types

ABSOLUTE MAXIMUM RATINGS

The equipment designer must ensure that no transistor exceeds these ratings. In arriving at the actual operating conditions, variations in supply voltages, component tolerances and ambient temperatures must be taken into account.

	OC139		
Collector voltage			
V_{CB} max. ($I_E = 0mA$)		+20	V
V_{CE} max. ($-V_{BE} > 200mV$)		+20	V
Collector current			
I_{CM} max.	250	400	mA←
*$I_{C(AV)}$ max.	250	400	mA
Emitter current			
I_{EM} max.	250	400	mA←
*$I_{E(AV)}$ max.	250	400	mA
Reverse emitter-base voltage			
V_{EB} max.		+20	V
Base current			
I_{BM} max.	250	400	mA←
*$I_{B(AV)}$ max.	40	40	mA

Total dissipation See page 12

$$\left(P_{tot}\ \text{max.} = \frac{T_j\ \text{max.} - T_{amb}}{\theta}\right)$$

*Averaged over any 20ms period.

Mullard

Temperature ratings

T_{stg} min.	-55	°C
T_{stg} max.	+75	°C
T_j max. (continuous operation)	75	°C
‡T_j max. (intermittent operation) (total duration = 200 hours max.)	90	°C
θ_{j-amb}	0.35	°C/mW←
θ_{j-case}	0.2	°C/mW

‡Likelihood of full performance of a circuit at this temperature is also dependent on the type of application.

CHARACTERISTICS at T_{amb} = 25°C (unless otherwise specified)

Common base

		Typ.	Max.	
Collector leakage current	I_{CBO}			
(V_{CB} = +5V, I_E = 0mA)		0.3	3.0	μA
(V_{CB} = +5V, I_E = 0mA, T_j = 60°C)		6.0	35	μA
(V_{CB} = +20V, I_E = 0mA, T_j = 60°C)		7.0	100	μA

		Typ.	Max.	
Emitter leakage current	I_{EBO}			
(V_{EB} = +5V, I_C = 0mA)		0.3	3.0	μA
(V_{EB} = +5V, I_C = 0mA, T_j = 60°C)		6.0	35	μA
(V_{EB} = +20V, I_C = 0mA, T_j = 60°C)		7.0	100	μA

Maximum emitter input voltage V_{EB}
(V_{CB} = 0V, I_C = 200mA)

	Typ.	Max.	
OC139	–350	–750	mV
OC140	–320	–600	mV
OC141	–320	–450	mV

	Typ.	Max.	
Noise figure			
(V_{CB} = 5V, I_E = 1mA, f = 1kc/s)	5.0	18	dB

Common emitter

		Collector saturation voltage $V_{CE(sat)}$ Typ.	Max.	Base input voltage V_{BE} Typ.	Max.	
I_C = 7.5mA, I_B = 380μA	OC139	+50	+175	+200	+300	mV
165μA	OC140	+60	+175	+200	+250	mV
94μA	OC141	+60	+175	+180	+250	mV
I_C = 50mA, I_B = 3.1mA	OC139	+60	+220	+300	+500	mV
1.25mA	OC140	+70	+220	+250	+380	mV
750μA	OC141	+70	+220	+230	+340	mV

Current amplification factor h_{FE}

		Min.	Typ.	Max.
V_{CB} = 0V, I_E = 15mA	OC139	20	43	84
	OC140	50	75	150
	OC141	80	150	200

		Min.	Typ.
V_{CB} = 0V, I_E = 200mA	OC139	15	33
	OC140	36	67
	OC141	50	134

Bidirectional operation (collector as emitter)

		h_{FE} Min.	Typ.
V_{EB} = 0V, I_C = 200mA	OC140 } OC141 }	21	40

BASIC PARAMETERS

			Typ.	Max.	
Collector-to-base capacitance (V_{CE} = +5V, I_C = 3mA)	$c_{b'c}$		20	30	pF
			Min.	*Typ.*	
Frequency at which $\|h_{fe}\|$ = 1 (V_{CB} = +5V, I_C = 3mA)	f_1	OC139	3.5	6.0	Mc/s
		OC140	4.5	12	Mc/s
		OC141	9.0	20	Mc/s

Typical parameters for pulse operation

Current drive time constant for normal and inverted connections

		Typ.	Max.	
(V_{CE} = +750mV, I_{CM} = 200mA)	β/ω_1	1.3	1.75	µs

→ SOLDERING AND WIRING RECOMMENDATIONS

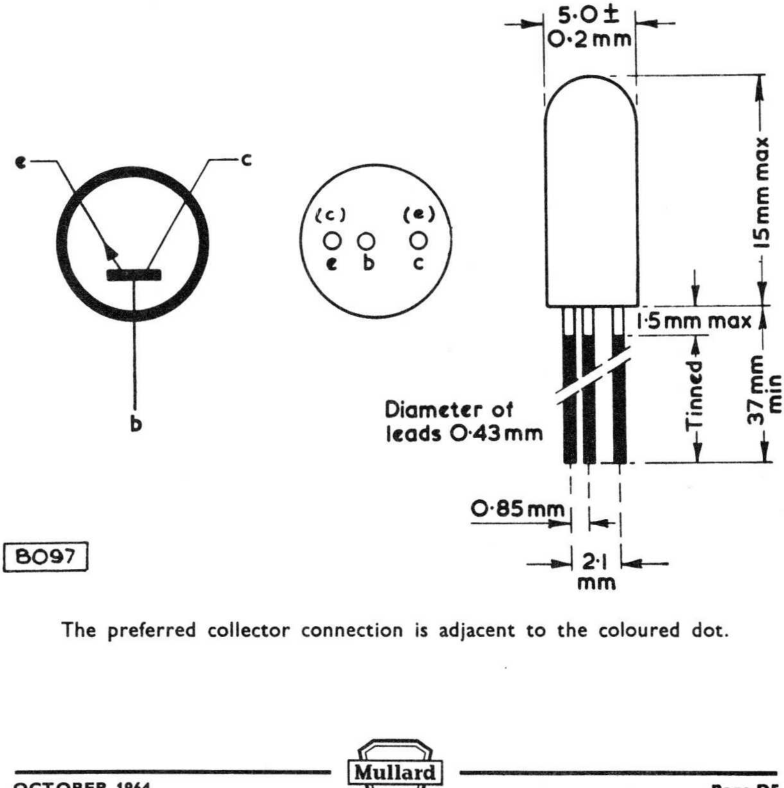
1. When using a soldering iron, transistors may be soldered directly into the circuit, but heat conducted to the junction should if possible be kept to a minimum by the use of a thermal shunt.
2. Transistors may be dip-soldered at a solder temperature of 245°C for a maximum soldering time of 5 seconds. The case temperature during dip-soldering may exceed the maximum storage temperature for a period not greater than 2 minutes, provided that it at no time exceeds 115°C. These recommendations apply to a transistor mounted flush on a board having punched-through holes, or spaced at least 1.5mm away from a board having plated-through holes.
3. Care should be taken not to bend the leads nearer than 1.5mm from the seal.

MECHANICAL DATA

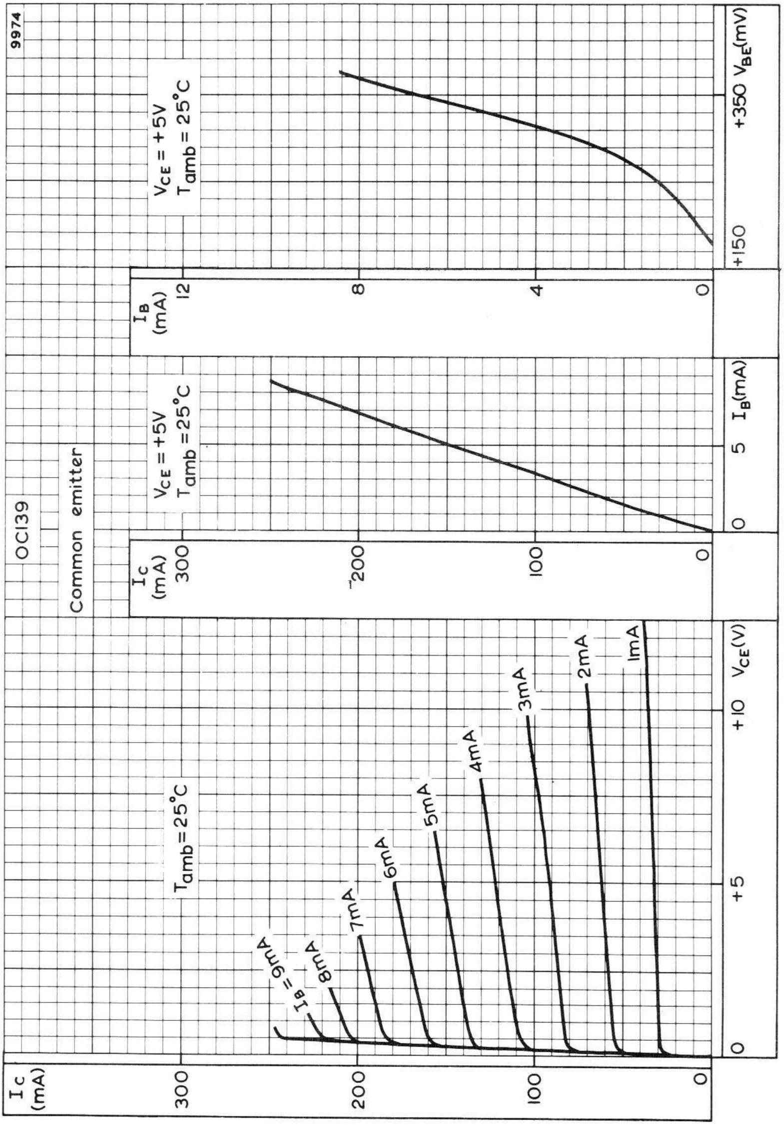
Average weight { 0.023 oz / 0.65 g }

OUTLINE AND DIMENSIONS

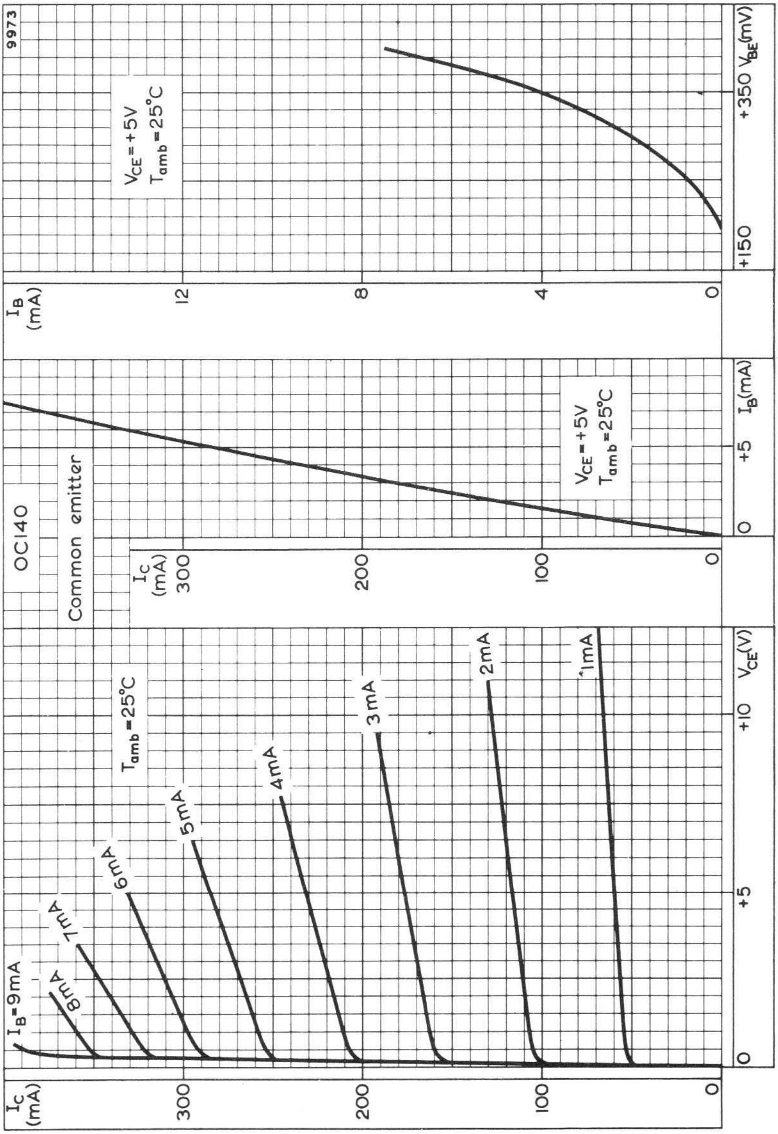
Conforming to V.A.S.C.A. SO-2/SB3-2



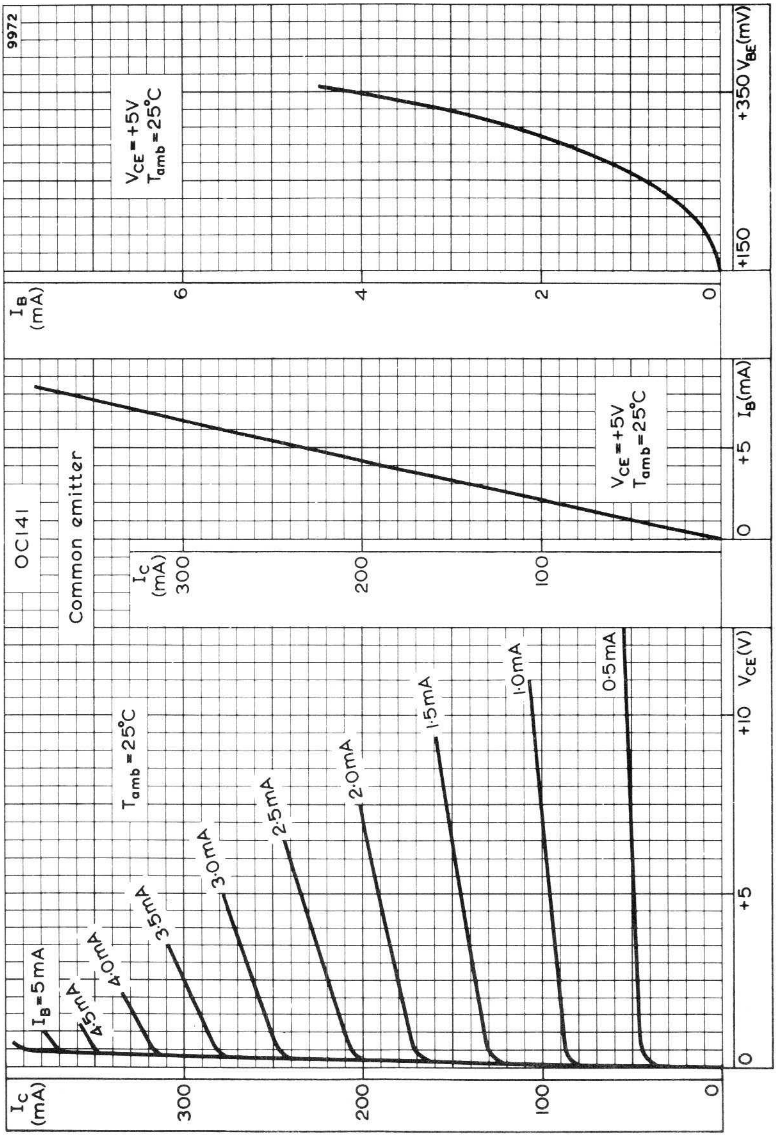
The preferred collector connection is adjacent to the coloured dot.



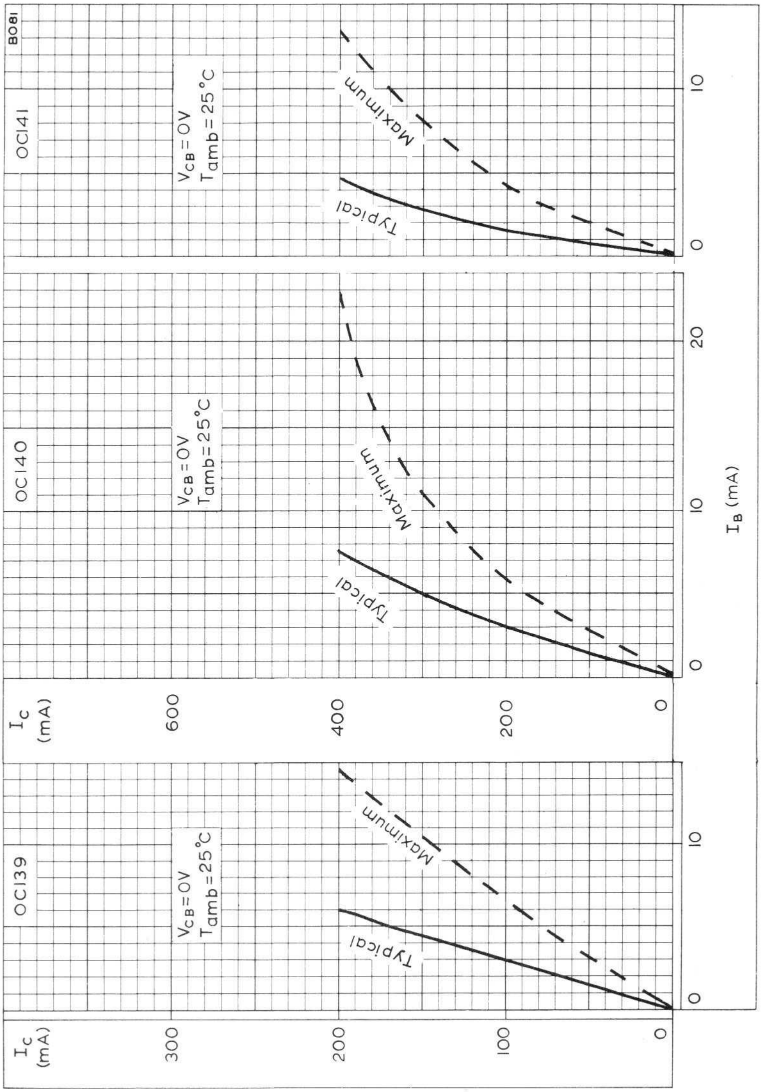
INPUT, TRANSFER AND OUTPUT CHARACTERISTICS FOR OC139. COMMON EMITTER



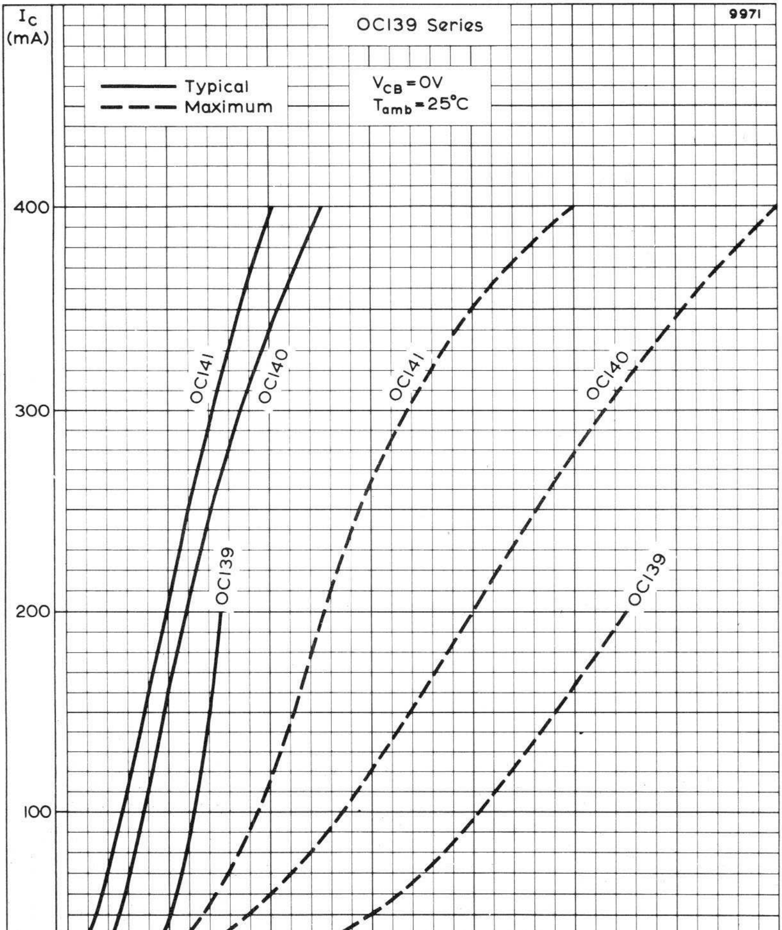
INPUT, TRANSFER AND OUTPUT CHARACTERISTICS FOR OC140.
COMMON EMITTER



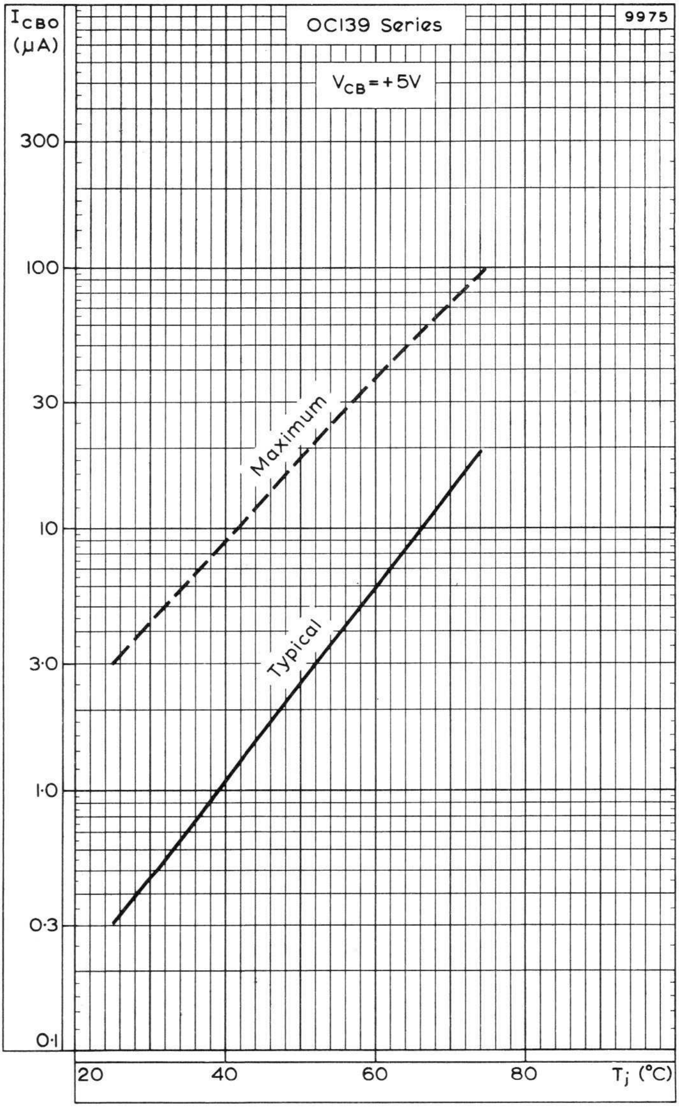
INPUT, TRANSFER AND OUTPUT CHARACTERISTICS FOR OC141.
COMMON EMITTER



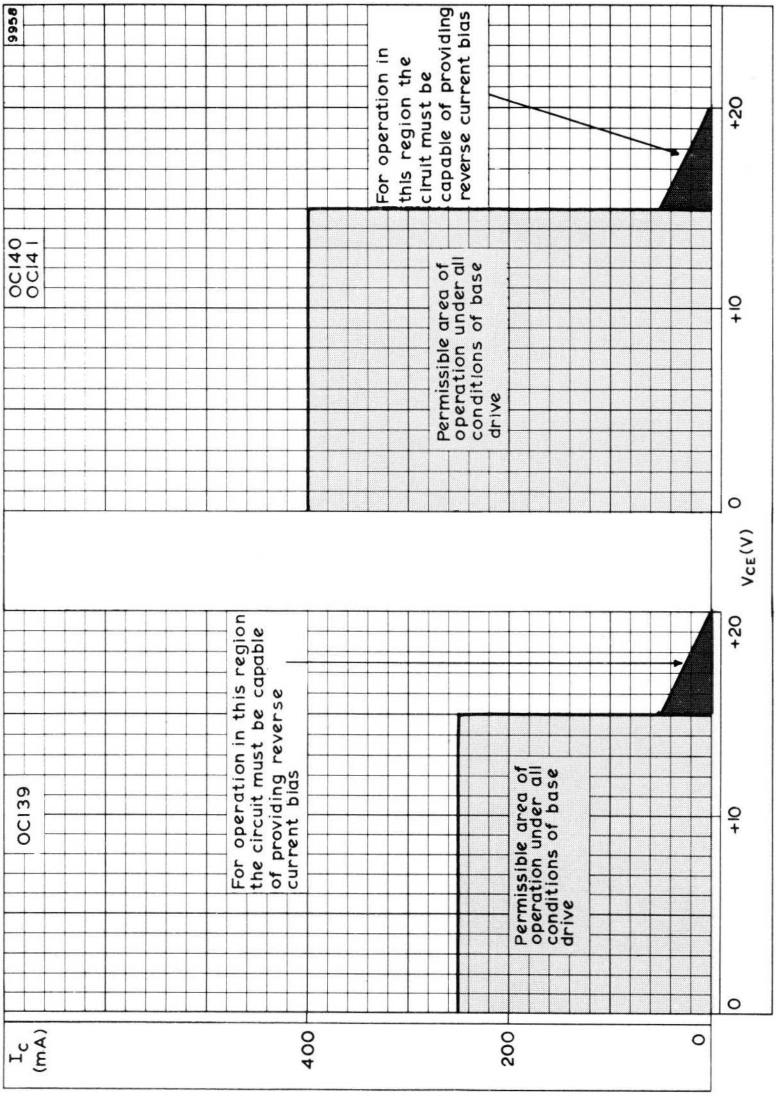
COLLECTOR CURRENT PLOTTED AGAINST BASE CURRENT



COLLECTOR CURRENT PLOTTED AGAINST BASE INPUT VOLTAGE



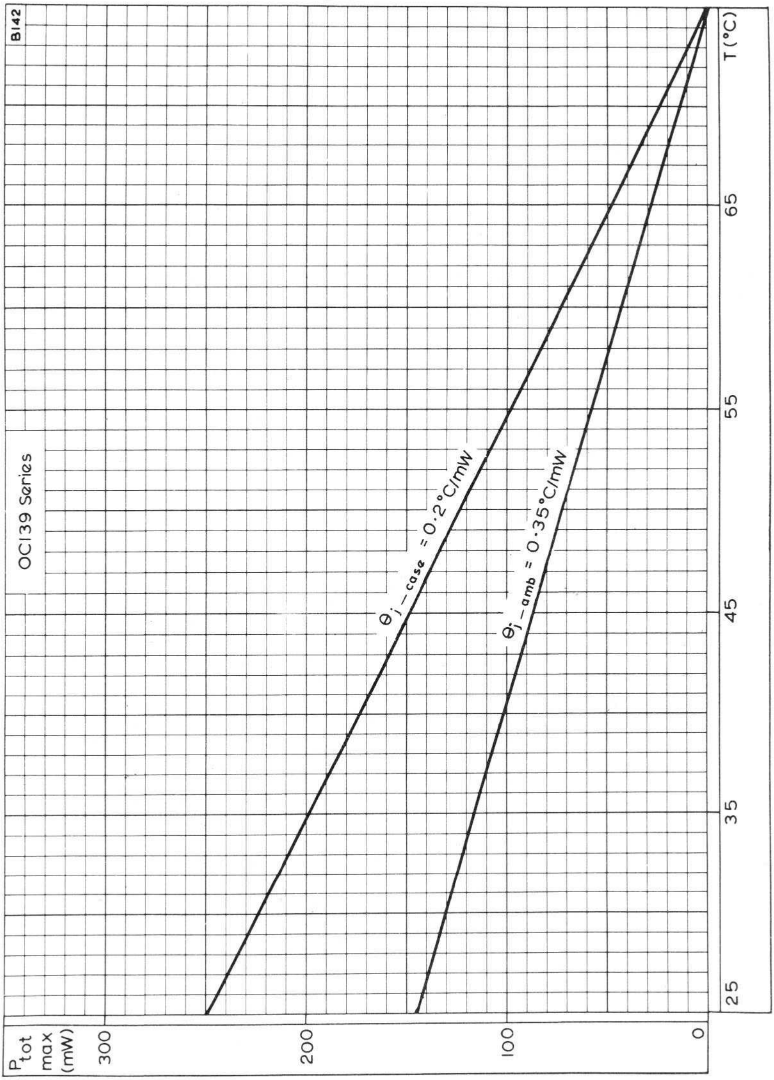
VARIATION OF I_{CBO} WITH JUNCTION TEMPERATURE



COLLECTOR CURRENT PLOTTED AGAINST ABSOLUTE MAXIMUM COLLECTOR EMITTER VOLTAGE

OC139 Series

JUNCTION TRANSISTORS



MAXIMUM TOTAL DISSIPATION PLOTTED AGAINST CASE AND AMBIENT TEMPERATURE

OC170
OC171

QUICK REFERENCE DATA

Germanium junction transistors of the p-n-p alloy diffused type in TO-7 construction. Intended for use in r.f. and mixer oscillator circuits in f.m. receivers.

V_{CB} max. (I_E=0mA)	–20	V
V_{CE} max.	–20	V
I_{CM} max.	10	mA
P_{tot} max. (T_{amb} = 45°C)	50	mW

	TYPICAL POWER GAIN (dB)	at	f (Mc/s)
OC170	25		10
OC171	14		100

Unless otherwise shown data is applicable to both types.

ABSOLUTE MAXIMUM RATINGS

The equipment designer must ensure that no transistor exceeds these ratings. In arriving at the actual operating conditions, variation in supply voltages, component tolerances and the ambient temperature must also be taken into account.

Collector voltage		
V_{CB} max. (I_E = 0mA)	–20	V
†V_{CE} max.	–20	V

†This value applies when $\frac{R_B}{R_E} < 100$ and $R_E > 200\Omega$

Collector current		
I_{CM} max.	10	mA
*$I_{C(AV)}$ max	10	mA
Emitter current		
I_{EM} max.	11	mA
*$I_{EM\ (AV)}$ max.	11	mA
Base current		
I_{BM} max.	1.0	mA
*$I_{B(AV)}$ max.	1.0	mA
†Reverse emitter current		
I_E max.	1.0	mA
*$I_{E(AV)}$ max.	1.0	mA

†When the reverse emitter current is not limited $-V_{EBM}$ must not exceed 0.5V.

*Averaged over any 50ms period.

OC170 OC171

R.F. TRANSISTORS

Total dissipation (at $T_{amb} = 45°C$) 50 mW (see curve on page C3)

$$\left(P_{tot}\ max. = \frac{T_j\ max. - T_{amb}}{\theta}\right)$$

Temperature ratings

T_{stg} max.	+75	°C
T_{stg} min.	−55	°C
T_j max. (continuous operation)	75	°C
‡T_j max. (intermittent operation, total duration 200 hrs)	90	°C
θ_{j-amb}	⩽0.6	°C/mW

‡Likelihood of full performance of a circuit at this temperature is also dependent on the type of application.

CHARACTERISTICS (at $T_{amb} = 25°C$)

		Typical production spread Min.	Typ.	Max.	
Common base					
Collector leakage current ($V_{CB} = -6V, I_E = 0mA$)	I_{CBO}	—	1.2	8	µA
Emitter leakage current ($V_{EB} = 500mV, I_C = 0mA$)	I_{EBO}	—	—	50	µA
Common emitter					
Base current ($V_{CB} = -6V, I_E = 1mA$)	I_B	—	7.0	25	µA
Base voltage ($V_{CB} = -6V, I_E = 1mA$)	V_{BE}	−210	−260	−330	mV
Small signal characteristics					
Frequency at which $\lvert h_{fe}\rvert = 1$ ($V_{CB} = -6V, I_E = 1mA$)	f_1	—	75	—	Mc/s
Current amplification factor ($V_{CE} = -6V, I_E = 1mA, f = 1kc/s$)	h_{fe}	40	150	—	
Intrinsic Base Impedance ($V_{CE} = -6V, I_E = 1mA, f = 2Mc/s$)	$\lvert z_{rb}\rvert$	—	25	45	Ω

Noise figure		OC171	OC170	
($V_{CE} = -6V, I_E = 1mA$)				
R_s 200Ω, f= 500kc/s	*Typ.*	—	3.0	dB
	Max.	—	8.0	dB
R_s 150Ω, f = 10Mc/s	*Typ.*	4.0	4.0	dB
	Max.	8.0	8.0	dB
R_s 68Ω, f = 100Mc/s	*Typ.*	8.0	—	dB
	Max.	9.5	—	dB
($V_{CB} = -6V, I_E = 1mA$)				
R_s = 500Ω, f = 1Kc/s	*Typ.*	15	18	dB
	Max.	40	33	dB

Dynamic Performance

Power Gain $\left(\frac{V_{out}}{V_{in}}\right)^2 \frac{4R_s}{R_L}$ at f =		100	10	Mc/s ←
	Min.	12.5	19.0	dB
	Typ.	14.0	25.0	dB

Typical y-parameters

The y-parameters are measured with an effective lead length of 5 mm.

Measured at $V_C = -6V$, $I_E = 1mA$

		Common Base OC171		Common Emitter OC170		
	f =	100		0.5	10	Mc/s
Input conductance (with output short circuited to a.c.)	g_{ib}	23	g_{ie}	0.4	2.5	mmhos
Input capacitance (with output short circuited to a.c.)	c_{ib}	−6	c_{ie}	80	65	pF
Transfer admittance (with output short circuited to a.c.)	$\lvert y_{fb}\rvert$	14	$\lvert y_{fe}\rvert$	37	32	mA/V
Phase angle of transfer admittance (with output short circuited to a.c.)	ϕ_{fb}	90	ϕ_{fe}	0	335	deg
Output conductance (with input short circuited to a.c.)	g_{ob}	350	g_{oe}	1.0	60	μmhos
Output capacitance (with input short circuited to a.c.)	c_{obs}	2.5	c_{oes}	5.0	4.5	pF
Feedback admittance (with input short circuited to a.c.)	$\lvert y_{rb}\rvert$	600	$\lvert y_{re}\rvert$	4.0	100	μmhos
Phase angle of feedback admittance (with input short circuited to a.c.)	ϕ_{rb}	275	ϕ_{re}	270	260	deg

Measured at $V_{CE} = -6V$, $I_E = 1mA$

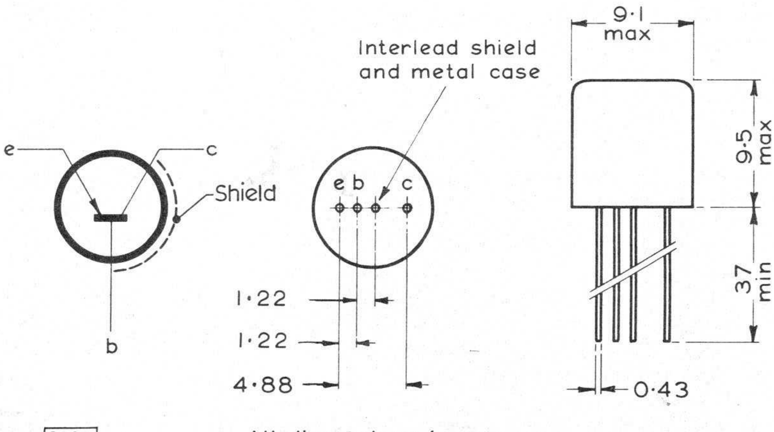
Feedback capacitance (with input short circuited to a.c.)	c_{re}	−1.8	−1.8	pF

OC170
OC171

R.F. TRANSISTORS

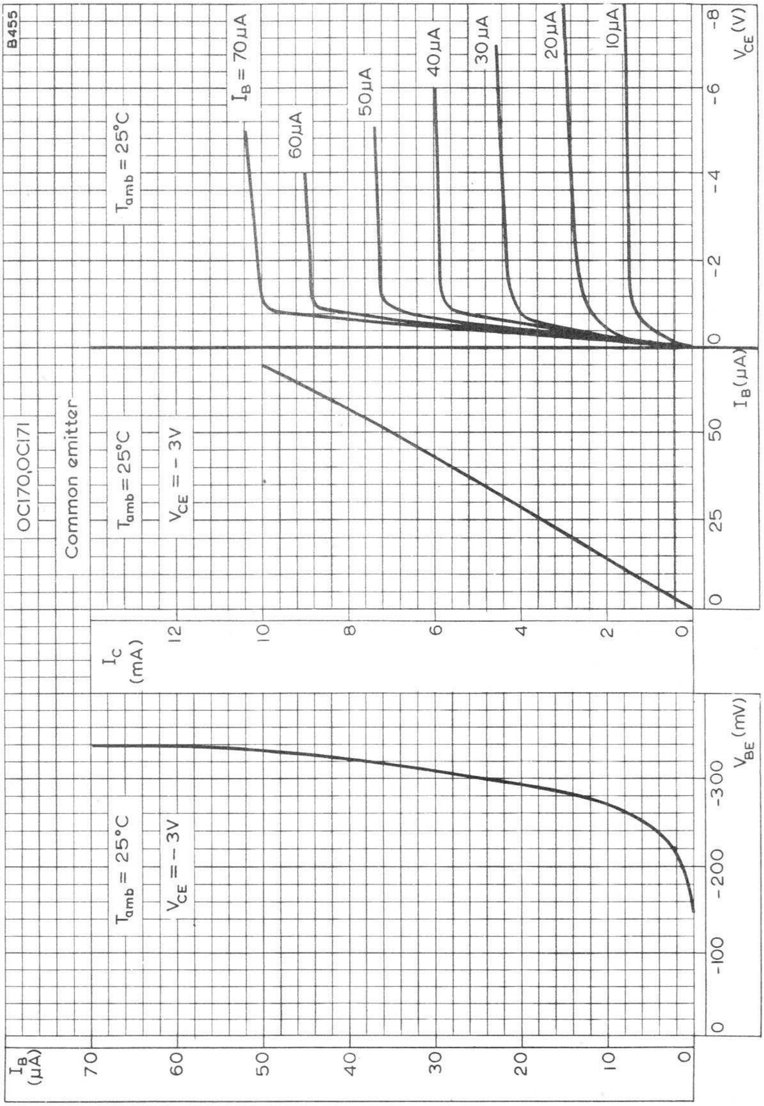
OPERATING NOTES

1. The transistor may be soldered into the circuit but heat conducted to the junction should be kept to a minimum by the use of a thermal shunt.
2. Transistors may be dip soldered at a solder temperature of 245°C for a maximum of 5 seconds up to a point 1.5mm from the seal.
3. Care should be taken not to bend the leads nearer than 1.5mm from the seal.

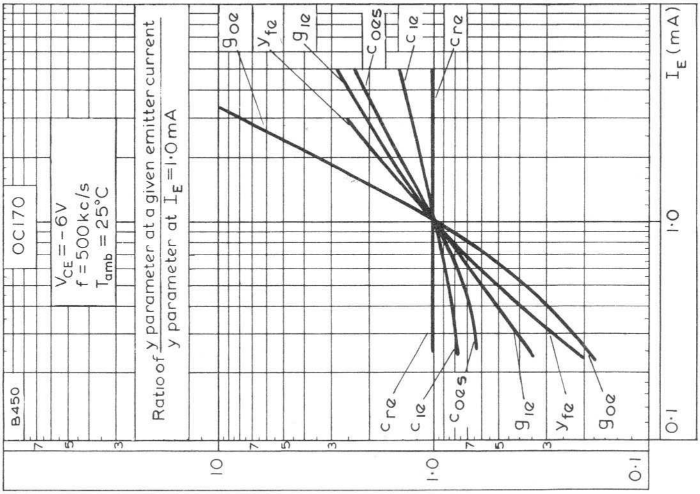


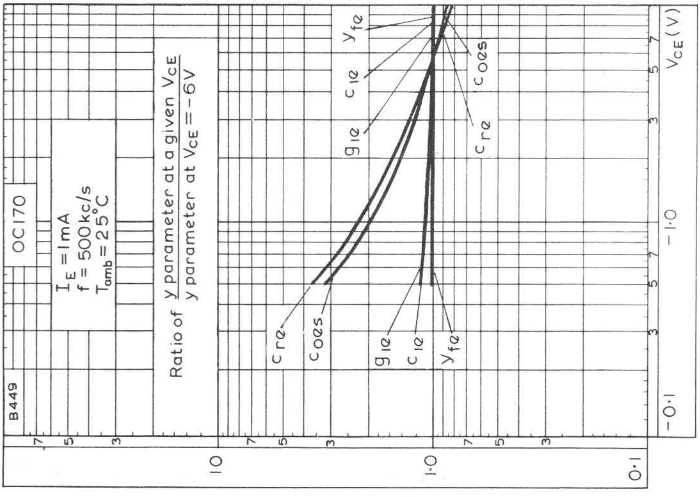
All dimensions in mm

(TO-7 construction)

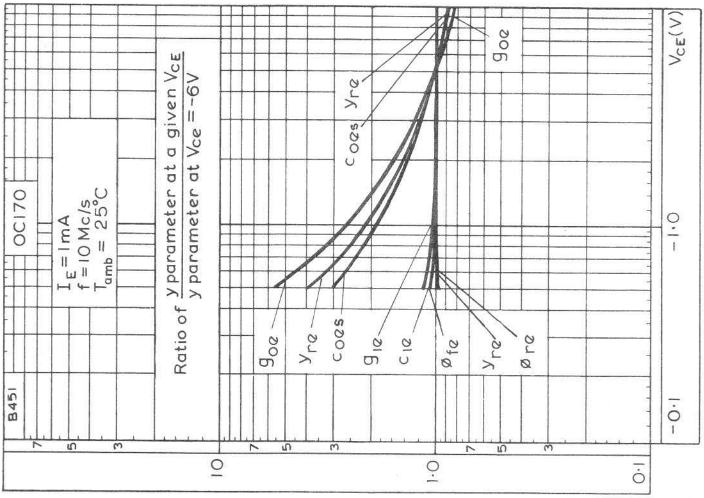


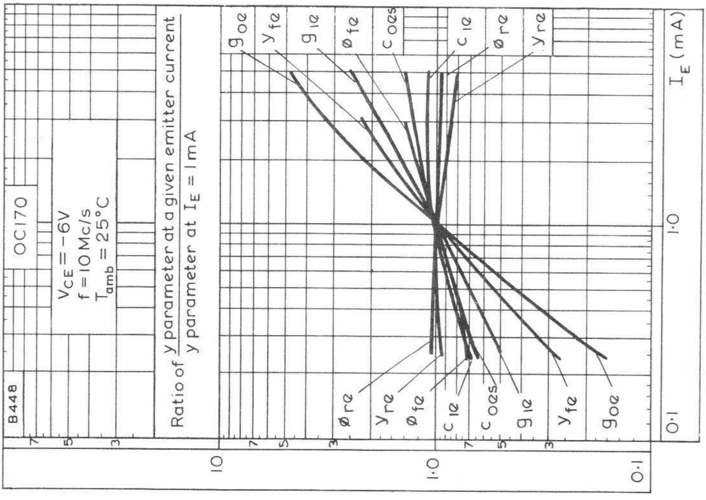
INPUT, OUTPUT AND TRANSFER CHARACTERISTICS
COMMON EMITTER





RATIOS OF Y PARAMETERS PLOTTED AGAINST
(i) COLLECTOR-EMITTER VOLTAGE (ii) EMITTER CURRENT
f = 500kc/s

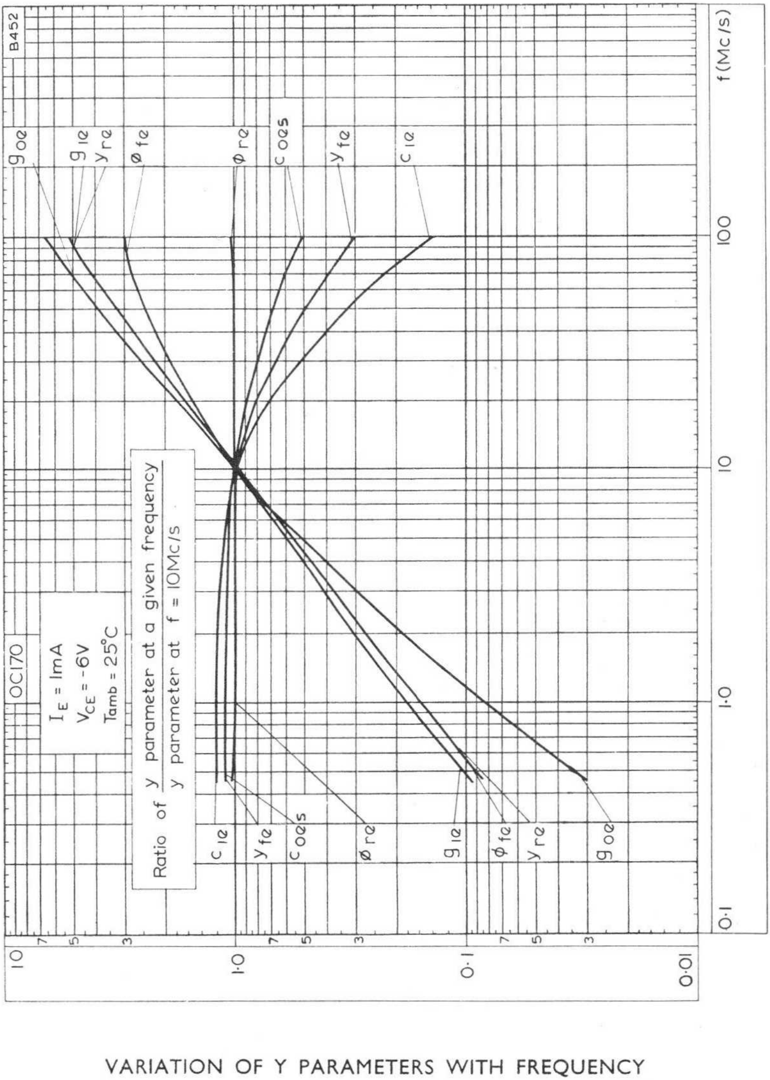




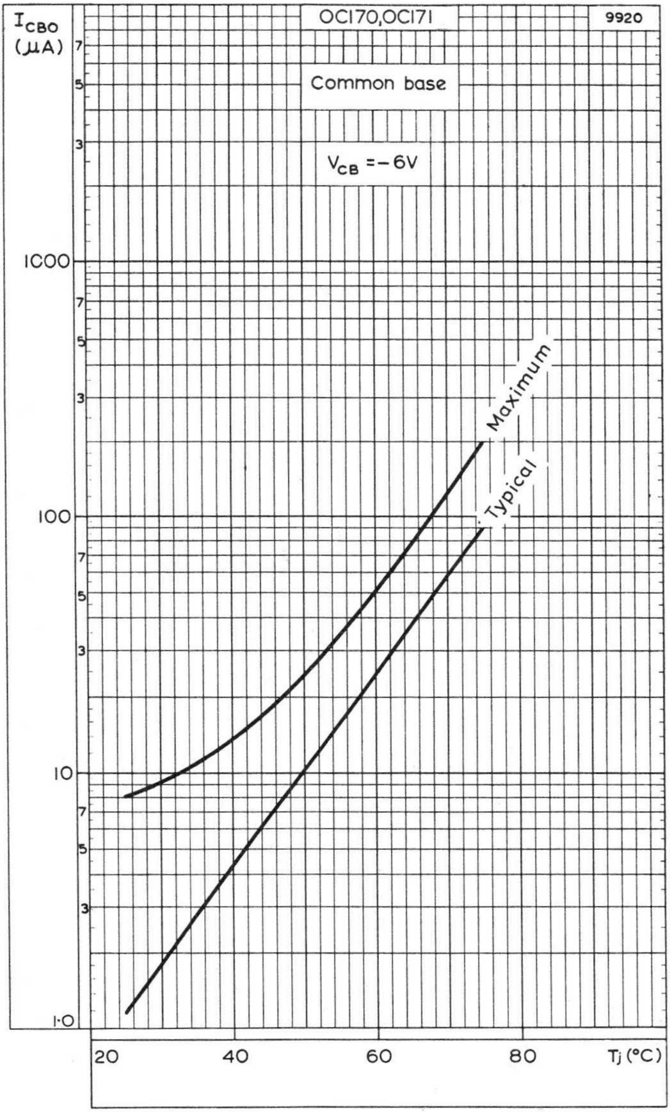
RATIOS OF Y PARAMETERS PLOTTED AGAINST
(i) COLLECTOR-EMITTER VOLTAGE (ii) EMITTER CURRENT
$f = 10$ Mc/s

OC170
OC171

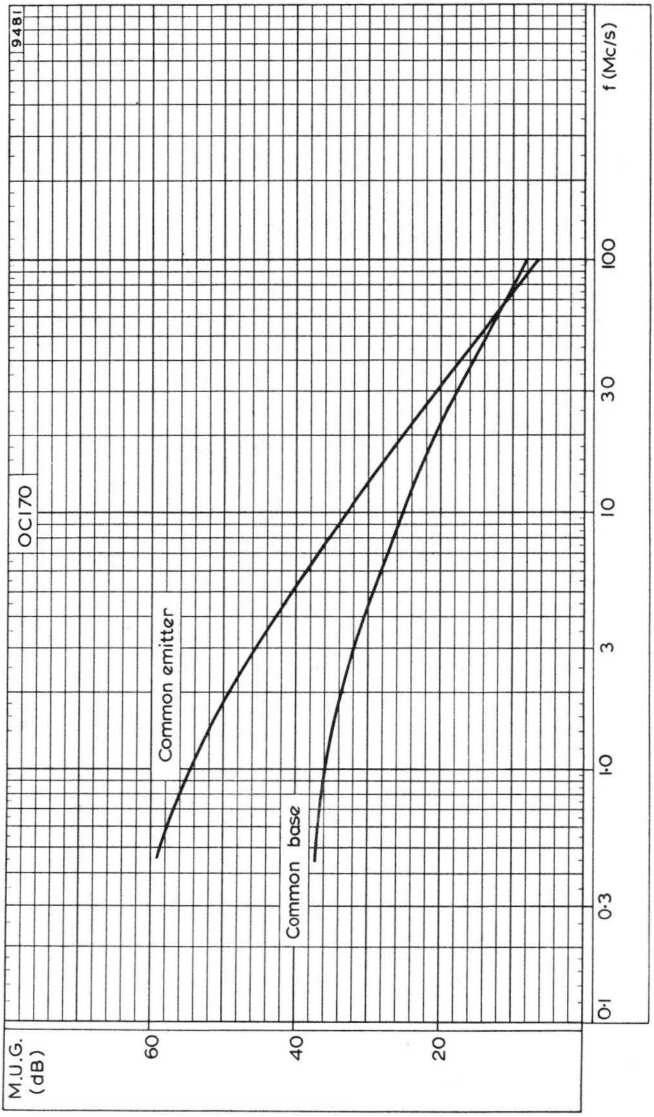
R.F. TRANSISTORS



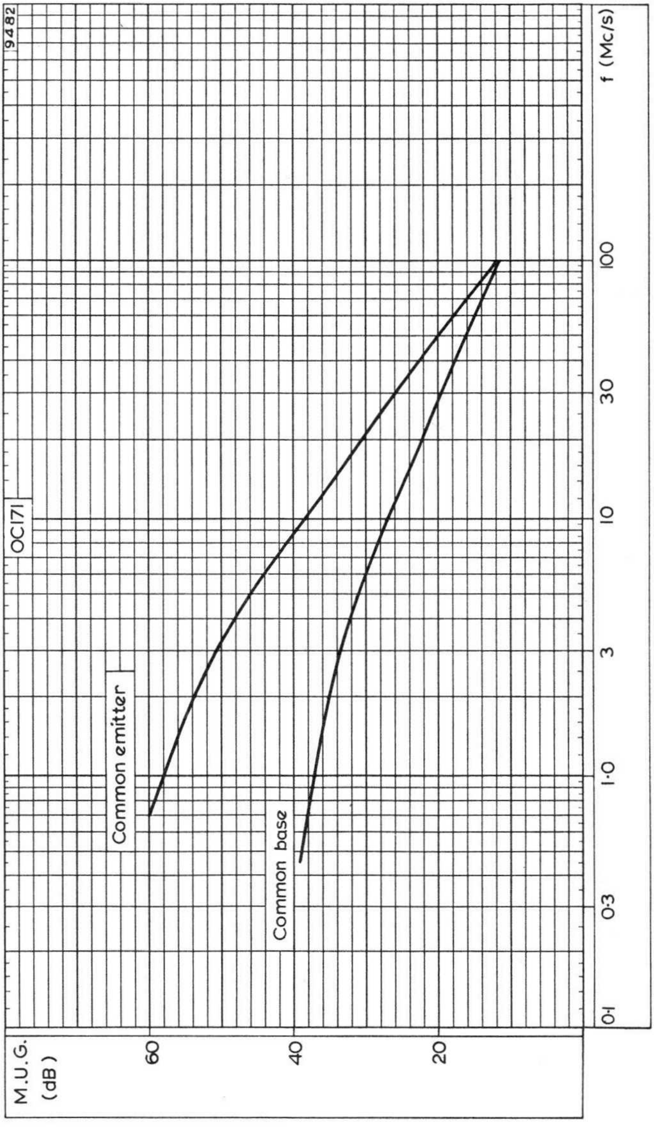
VARIATION OF Y PARAMETERS WITH FREQUENCY



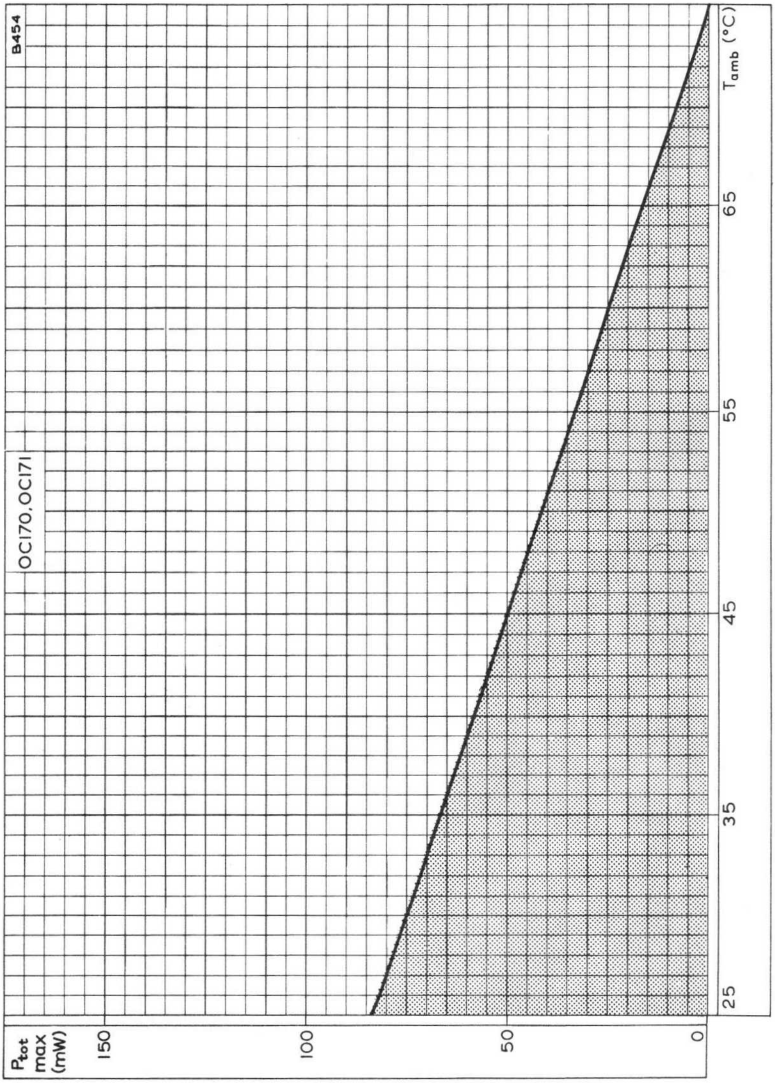
VARIATION OF I_{CBO} WITH JUNCTION TEMPERATURE



MAXIMUM UNILATERALISED GAIN PLOTTED AGAINST FREQUENCY.
OC170



MAXIMUM UNILATERALISED GAIN PLOTTED AGAINST FREQUENCY.
OC171



MAXIMUM TOTAL DISSIPATION PLOTTED AGAINST AMBIENT TEMPERATURE

R.F. JUNCTION TRANSISTOR

OC171

R.F. junction transistor of the p-n-p alloy-diffused type intended for use in r.f. and mixer oscillator circuits in f.m. receivers.

PRELIMINARY DATA

ABSOLUTE MAXIMUM RATINGS (limiting values)

The equipment designer must ensure that no transistor exceeds these ratings. In arriving at the actual operating conditions, variations in supply voltages, component tolerances and ambient temperature must also be taken into account.

Collector voltage

$v_{cb(pk)}$ max.	−20	V
V_{cb} max.	−20	V
*$v_{ce(pk)}$ max.	−20	V
*V_{ce} max.	−20	V

*These values apply when $\frac{R_b}{R_e} < 100$ and $R_e > 200\Omega$.

Collector current

$i_{c(pk)}$ max.	10	mA
I_c max.	10	mA

Emitter current

$i_{e(pk)}$ max.	10	mA
$I_e$max.	10	mA

Reverse emitter-base voltage

$v_{eb(pk)}$ max.	−500	mV
V_{eb} max.	−500	mV

Reverse emitter current

$i_{e(pk)}$ max.	1.0	mA
I_e max.	1.0	mA

Total dissipation See page C5

$$\left(p_{tot}\ \text{max.} = \frac{T_{junction}\ \text{max.} - T_{ambient}}{\theta}\right)$$

Temperature ratings

Storage temperature	−55 to +75	°C
Maximum junction temperature		
Continuous operation	75	°C
†Intermittent operation (total duration = 200hrs max.)	90	°C
Maximum junction temperature rise above ambient, θ	0.6°C/mW	

†Likelihood of full performance of a circuit at this temperature is also dependent on the type of application.

CHARACTERISTICS at $T_{ambient} = 25°C$

		Typical production spreads			
		Min.	*Typ.*	*Max.*	
Collector leakage current	I_{co}				
($V_{cb} = -6V$, $I_e = 0mA$)		—	1.5	13	µA
($V_{cb} = -20V$, $I_e = 0mA$)		—	—	50	µA
Emitter leakage current ($V_{eb} = -500mV$, $I_c = 0mA$)	I_{eo}	—	—	50	µA
Base current ($V_{cb} = -6V$, $I_e = 1mA$)	I_b	—	15	50	µA
Base input voltage ($V_{cb} = -6V$, $I_e = 1mA$)	V_{be}	–210	–260	–330	mV
Current amplification cut-off frequency at $V_{cb} = -6V$, $I_e = 1mA$ ($\lvert\alpha'\rvert = 1$)	f_1	—	70	—	Mc/s
Current amplification factor ($V_{ce} = -6V$, $I_e = 1mA$, $f = 1kc/s$)	α'	20	100	—	
Intrinsic base impedance ($V_{ce} = -6V$, $I_e = 1mA$, $f = 2Mc/s$)	$\lvert Z_{12}\rvert$	—	25	45	Ω
Noise figure ($V_{ce} = -6V$, $I_e = 1mA$)					
$R_{source} = 150\Omega$, $f = 10.7Mc/s$		—	4.0	8.0	dB
$R_{source} = 68\Omega$, $f = 100Mc/s$		—	9.0	11	dB
($V_{cb} = -6V$, $I_e = 1mA$)					
$R_{source} = 500\Omega$, $f = 1kc/s$		—	15	40	dB

y-parameters

Grounded base

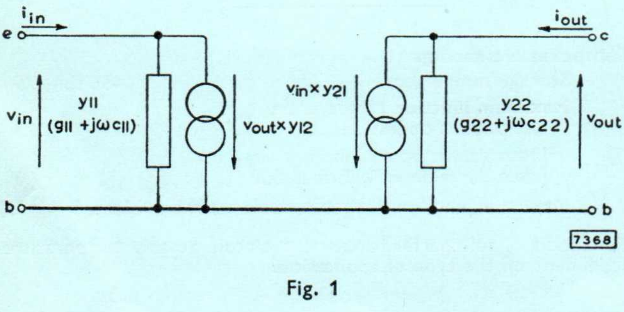


Fig. 1

Measured at V_{cb}=–6V, I_c=1mA, f=100Mc/s

		Typical production spreads Min.	Typ.	Max.	
Input conductance (with output short circuited to a.c.)	g_{11}	—	23	45	mmhos
Input capacitance (with output short circuited to a.c.)	c_{11}	—	–6.0	–18	pF
Transfer admittance (with output short circuited to a.c.)	$\|y_{21}\|$	9.0	14	—	mA/V
Phase angle of transfer admittance (with output short circuited to a.c.)	ϕ_{21}	70	90	110	deg
Output conductance (with input short circuited to a.c.)	g_{22}	—	350	600	µmhos
Output capacitance (with input short circuited to a.c.)	c_{22}	—	2.6	4.0	pF
Feedback admittance (with input short circuited to a.c.)	$\|y_{12}\|$	—	0.6	1.0	mmhos
Phase angle of feedback admittance (with input short circuited to a.c.)	ϕ_{12}	—	–85	—	deg

Grounded emitter

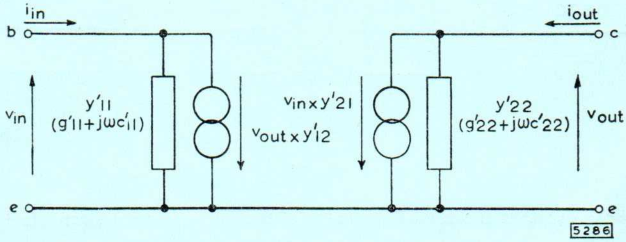


Fig. 2

Measured at $V_{ce}=-6V$, $I_c=1mA$, $f=450kc/s$					
Feedback capacitance	c'_{12}	—	−1.8	−2.4	pF
Measured at $V_{ce}=-6V$, $I_c=1mA$, $f=10.7Mc/s$					
Output conductance	g'_{22}	—	20	65	µmhos

DYNAMIC CHARACTERISTICS in measuring circuit at f=100Mc/s

*Power gain	$\left(\frac{V_{out}}{V_{in}}\right)^2 \frac{4 R_{source}}{R_{load}}$	>10	dB

*The insertion losses of both tuned circuits are inclusive.

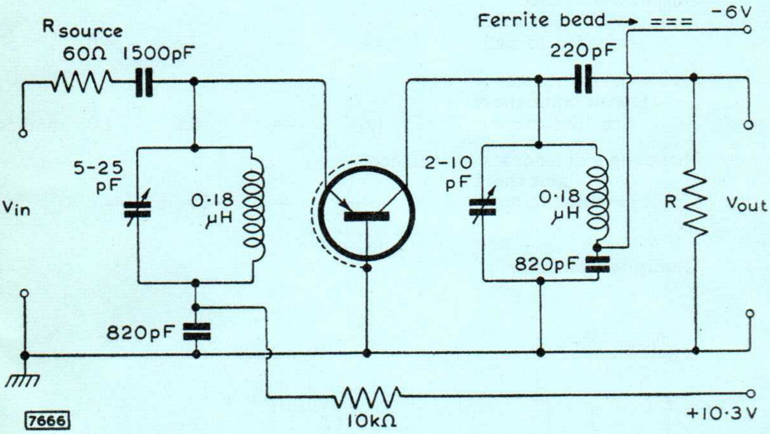
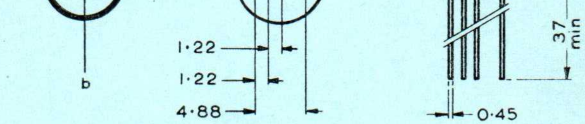


Fig. 3

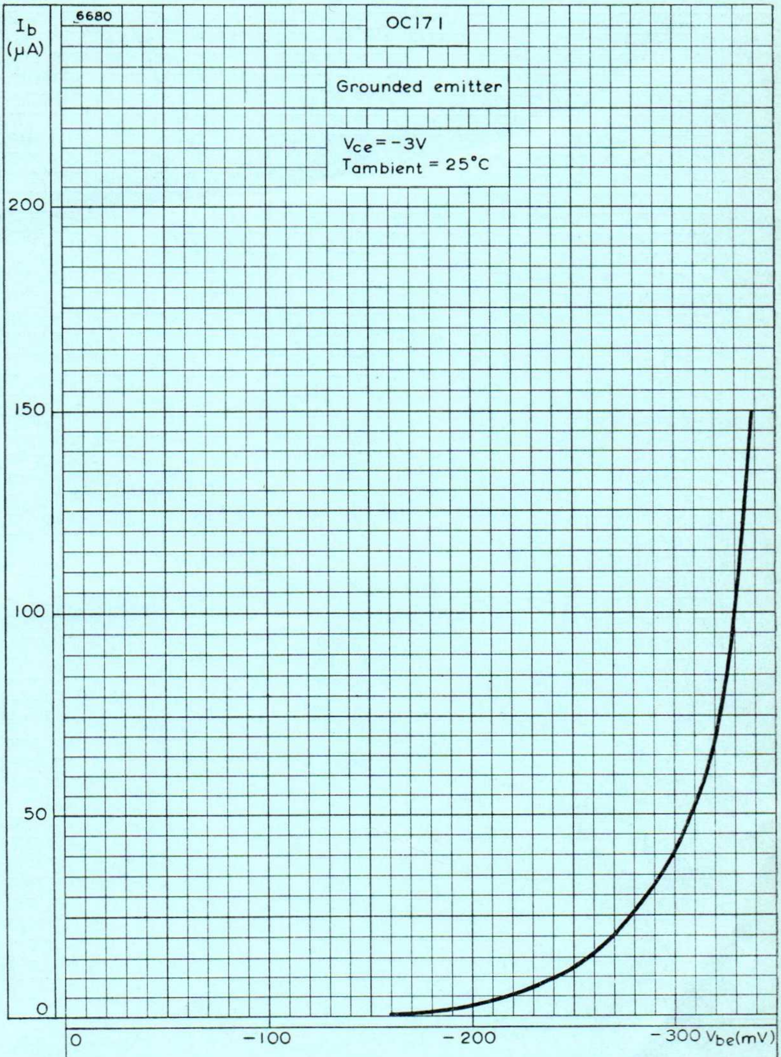
R is chosen so that the total impedance of the output tuned circuit is 3·3 kΩ

OPERATING NOTES

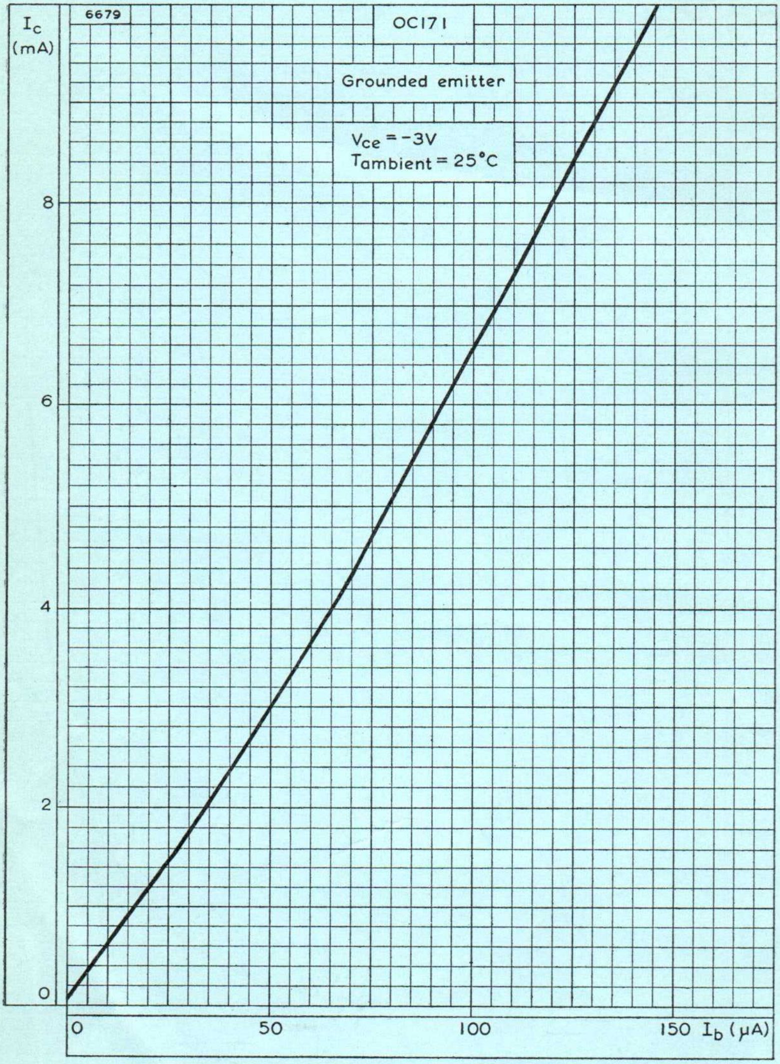
1. The transistors may be soldered directly into the circuit but heat conducted to the junction should be kept to a minimum by the use of a thermal shunt.
2. Transistors may be dip soldered at a solder temperature of 240°C for a maximum of 10 seconds up to a point 5mm from the seal.
3. Care should be taken not to bend the leads nearer than 1.5 mm to the seal.



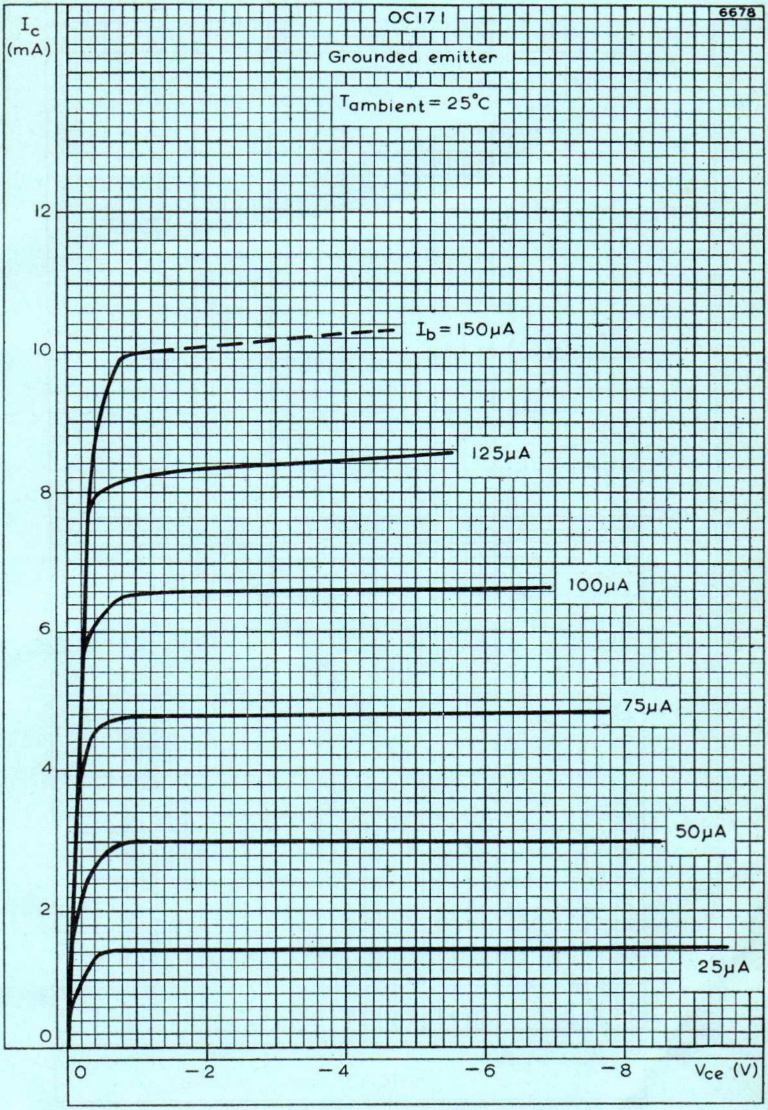
All dimensions in mm



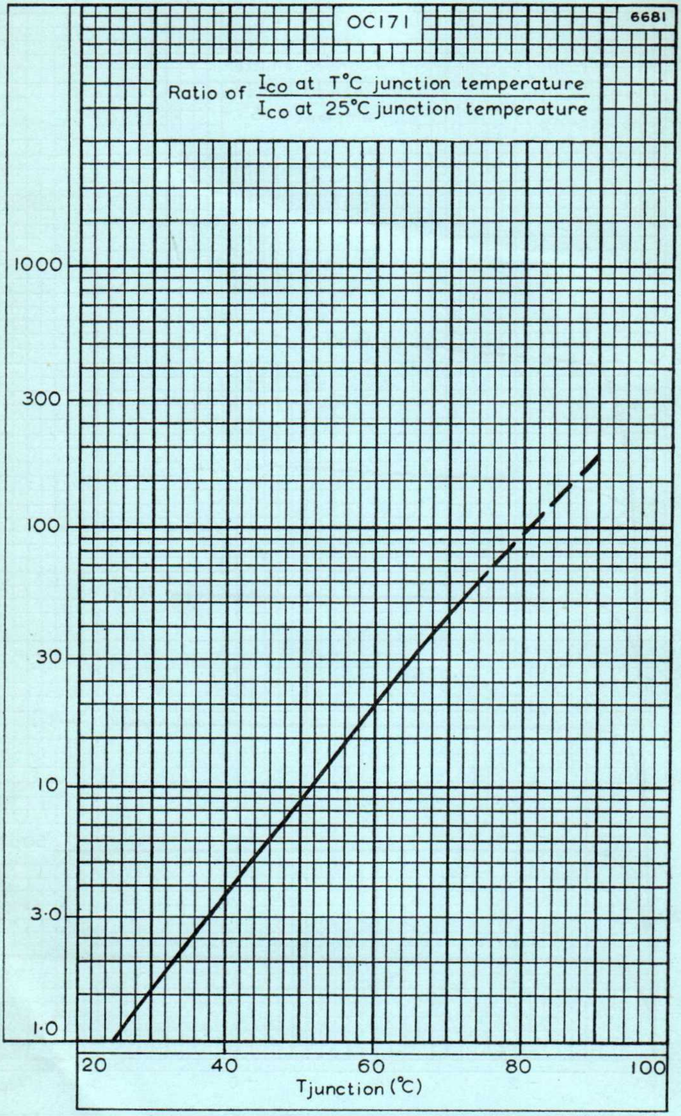
INPUT CHARACTERISTIC. GROUNDED EMITTER



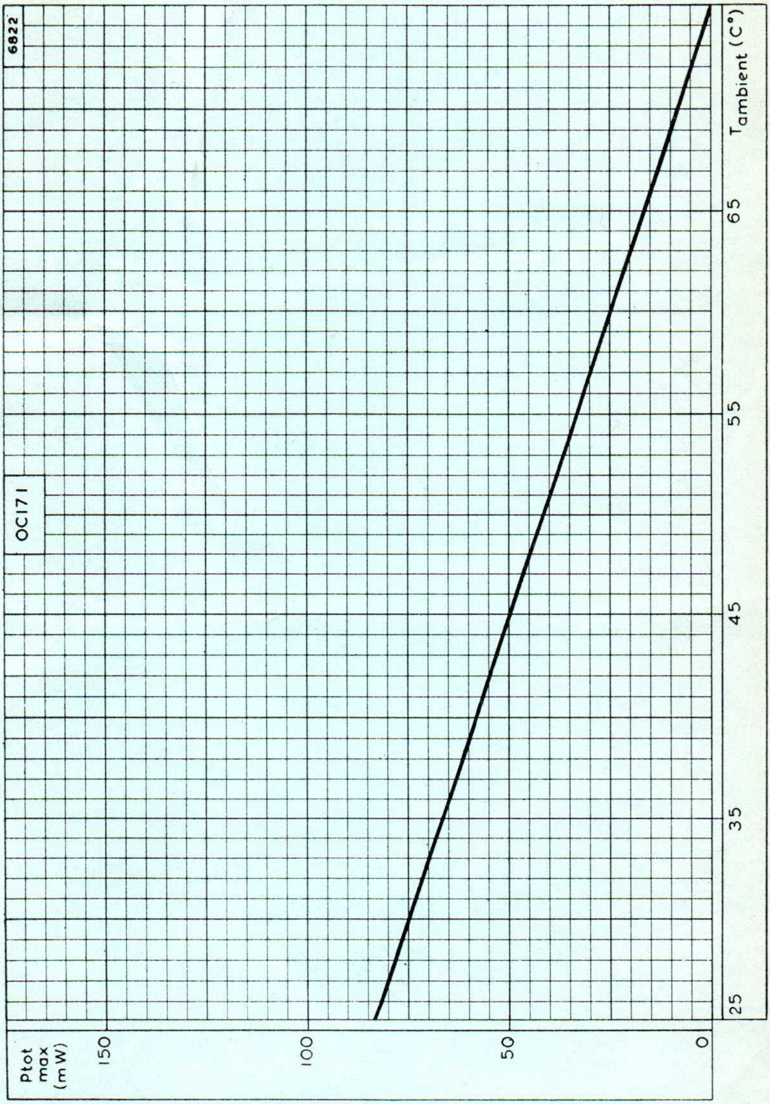
TRANSFER CHARACTERISTIC. GROUNDED EMITTER



OUTPUT CHARACTERISTIC. GROUNDED EMITTER



VARIATION OF I_{co} WITH JUNCTION TEMPERATURE



MAXIMUM TOTAL DISSIPATION PLOTTED AGAINST AMBIENT TEMPERATURE

SILICON P-N-P JUNCTION TRANSISTORS

OC200 OC201 BCZ11 OC202 OC203

Silicon p-n-p junction transistors intended for general purpose industrial applications.

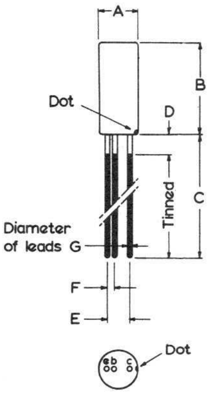
QUICK REFERENCE DATA

	OC200	OC201	BCZ11	OC202	OC203	
$-V_{CBO}$ max.	30	25	30	15	60	V
$-V_{(BR)CEO}$ max. ($-I_C$ = 100mA)	25	20	25	10	50	V
$-I_{CM}$ max.					100	mA
P_{tot} max. (T_{amb} = 25 °C)					250	mW
T_j max.					150	°C
h_{fe} typ. ($-I_C$ = 1.0mA)	15-60	20-80	25-60	40-120	10-60	
f_T typ. ($-I_C$ = 1.0mA)	1.2	3.2	1.5	3.2	1.2	Mc/s

Unless otherwise stated data is applicable to all types in the series

OUTLINE AND DIMENSIONS

Conforms to B.S. 3934 SO-2/SB3-2



	Min.	Nom.	Max.
A	5.75	5.8	5.85
B	-	-	15.7
C	37	-	-
D	-	-	1.5
E	-	2.1	-
F	-	0.85	-
G	-	0.4	-

All dimensions in mm.

RATINGS

Limiting values of operation according to the absolute maximum system.

Electrical

	OC200	OC201	BCZ11	OC202	OC203	
$-V_{CBO}$ max.	30	25	30	15	60	V
$-V_{CEX}$ max.						
($+V_{BE} > 500$mV)	30	25	30	15	60	V
$-V_{(BR)CEO}$ max.						
($-I_C = 100$mA)	25	20	25	10	50	V
$-V_{EBO}$ max.	20	20	20	10	30	V
$-I_{CM}$ max.					100	mA
$*-I_{C(AV)}$ max.					50	mA
I_{EM} max.					100	mA
$*I_{E(AV)}$ max.					65	mA
$-I_{BM}$ max.					50	mA
$*-I_{B(AV)}$ max.					15	mA
P_{tot} max.						
$T_{case} = 25^{o}C$					300	mW
$T_{case} = 100^{o}C$					140	mW
$T_{amb} = 25^{o}C$					250	mW

For other values see curve on page C19

*Averaged over any 20ms period.

Thermal

T_{stg} max.	150	^{o}C
T_{stg} min.	-55	^{o}C
T_j max.	150	^{o}C
T_j min.	-55	^{o}C

THERMAL CHARACTERISTICS

Θ_{j-case}	0.35 degC/mW
Θ_{j-amb}	0.5 degC/mW

SILICON P-N-P JUNCTION TRANSISTORS

OC200 OC201 BCZ11 OC202 OC203

OC200

ELECTRICAL CHARACTERISTICS ($T_{amb}=25^{o}C$ unless otherwise stated)

		Min.	Typ.	Max.	
$-I_{CBO}$	Collector cut-off current				
	$-V_{CB}=6.0V,\ I_E=0$	-	1.0	100*	nA
	$-V_{CB}=6.0V,\ I_E=0$				
	$T_{amb}=100^{o}C$	-	0.1	2.5	μA
	$-V_{CB}=30V,\ I_E=0$	-	10	500	nA
	$-V_{CB}=30V,\ I_E=0,$				
	$T_{amb}=100^{o}C$	-	0.5	10	μA
$-I_{EBO}$	Emitter cut-off current				
	$-V_{EB}=6.0V,\ I_C=0$	-	1.0	100*	nA
	$-V_{EB}=6.0V,\ I_C=0,$				
	$T_{amb}=100^{o}C$	-	0.1	2.5	μA
$-V_{BE}$	Base-emitter voltage				
	$-V_{CE}=4.5V,\ -I_C=20mA$	0.55	0.8	1.25	V
$-V_{CE(sat)}$	Collector-emitter saturation voltage				
	$-I_C=20mA,\ -I_B=3.0mA$	50	170	550*	mV
	$-I_C=7.0mA,\ -I_B=1.0mA$	-	130	320	mV
$-V_{BE(sat)}$	Base-emitter saturation voltage				
	$-I_C=20mA,\ -I_B=3.0mA$	0.6	0.9	1.25	V
h_{fe}	Small signal forward current transfer ratio				
	$-V_{CE}=6.0V,\ -I_C=1.0mA,$				
	$f=1.0kc/s$	15*	-	60*	
h_{FE}	Large signal forward current transfer ratio				
	$-V_{CE}=4.5V,\ -I_C=20mA$	10	20	50	
	$-V_{CE}=4.5V,\ -I_C=50mA$	7.0	15	50	
f_T	Transition frequency				
	$-V_{CE}=6.0V,\ -I_C=1.0mA$	0.45*	1.2	3.5*	Mc/s

*These are the characteristics which are recommended for acceptance testing purposes.

		Min.	Typ.	Max.	
c_{tc}	Collector depletion capacitance $-V_{CB}=6.0V$, $I_E=I_e=0$, $f=500kc/s$	-	30	60	pF
c_{te}	Emitter depletion capacitance $-V_{EB}=6.0V$, $I_C=I_c=0$, $f=500kc/s$	-	15	30	pF
NF	Noise figure $-V_{CB}=2.0V$, $I_E=0.5mA$, $f=1.0kc/s$, $R_s=500\Omega$	-	8.0	17	dB
†r_e	Emitter resistance $-V_{CE}=6.0V$, $-I_C=1.0mA$	-	25	-	Ω
μ	Voltage feedback factor $-V_{CE}=6.0V$, $-I_C=100\mu A$	-	2.0	-	$\times 10^{-4}$

†The value of r_e given here is $\frac{kT}{q}\cdot\frac{1}{I_E} \approx \frac{25}{I_E}$ where I_E is in mA and T is in ^oK.

EQUIVALENT CIRCUIT PARAMETERS - COMMON EMITTER $T_{amb}=25^oC$

Hybrid π network (See also page D13)

Measured at $-V_{CE}=6.0V$, $-I_C=1.0mA$, $\omega=10^4$ rad/s

	Min.	Typ.	Max.	
$r_{bb'}$ (f=500kc/s)	15	180	350	Ω
g_m	-	39	-	mA/V
$r_{b'e}$	-	0.7	-	kΩ
r_{ce}	-	125	-	kΩ
$r_{b'c}$	-	3.5	-	MΩ
$c_{b'c}$	-	36	-	pF
$c_{b'e}$	-	10	-	nF

Hybrid matrix

	Min.	Typ.	Max.	
h_{ie}	0.35	0.9	2.5	kΩ
h_{fe}	15	28	60	
h_{fe} ($T_{amb}=-50^oC$)	10	-	-	
h_{oe}	-	24	55	μmho
h_{re}	-	3	7	$\times 10^{-4}$

OC201

ELECTRICAL CHARACTERISTICS (T_{amb} = 25°C unless otherwise stated)

		Min.	Typ.	Max.	
$-I_{CBO}$	Collector cut-off current				
	$-V_{CB}$ = 6.0V, I_E = 0	-	1.0	100*	nA
	$-V_{CB}$ = 6.0V, I_E = 0, T_{amb} = 100°C	-	0.1	2.5	μA
	$-V_{CB}$ = 25V, I_E = 0	-	10	500	nA
	$-V_{CB}$ = 25V, I_E = 0, T_{amb} = 100°C	-	0.5	10	μA
$-I_{EBO}$	Emitter cut-off current				
	$-V_{EB}$ = 6.0V, I_C = 0	-	1.0	100*	nA
	$-V_{EB}$ = 6.0V, I_C = 0, T_{amb} = 100°C	-	0.1	2.5	μA
$-V_{BE}$	Base-emitter voltage				
	$-V_{CE}$ = 4.5V, $-I_C$ = 20mA	0.55	0.8	1.25	V
$-V_{CE(sat)}$	Collector-emitter saturation voltage				
	$-I_C$ = 20mA, $-I_B$ = 3.0mA	50	140	550*	mV
	$-I_C$ = 7.0mA, $-I_B$ = 1.0mA	-	105	320	mV
$-V_{BE(sat)}$	Base-emitter saturation voltage				
	$-I_C$ = 20mA, $-I_B$ = 3.0mA	0.6	0.9	1.25	V
h_{fe}	Small signal forward current transfer ratio				
	$-V_{CE}$ = 6.0V, $-I_C$ = 1.0mA, f = 1.0kc/s	20*	-	80*	
h_{FE}	Large signal forward current transfer ratio				
	$-V_{CE}$ = 4.5V, $-I_C$ = 20mA	10	40	70	
	$-V_{CE}$ = 4.5V, $-I_C$ = 50mA	10	30	62	
	$-V_{CE}$ = 6.0V, $-I_C$ = 10μA	4	15	55	
	$-V_{CE}$ = 6.0V, $-I_C$ = 100μA	8	20	60	

*These are the characteristics which are recommended for acceptance testing purposes.

		Min.	Typ.	Max.	
f_T	Transition frequency $-V_{CB}=6.0V$, $-I_C=1.0mA$	2.0*	3.2	11*	Mc/s
c_{tc}	Collector depletion capacitance $-V_{CB}=6.0V$, $I_E=I_e=0$, f=500kc/s	-	30	60	pF
c_{te}	Emitter depletion capacitance $-V_{EB}=6.0V$, $I_C=I_e=0$, f=500kc/s	-	15	30	pF
NF	Noise figure $-V_{CB}=2.0V$, $I_E=0.5mA$ f=1.0kc/s, $R_s=500\Omega$	-	8.0	17	dB
†r_e	Emitter resistance $-V_{CE}=6.0V$, $-I_C=1.0mA$	-	25	-	Ω
μ	Voltage feedback factor $-V_{CE}=6.0V$, $-I_C=100\mu A$	-	6.5	-	$\times10^{-4}$

†The value of r_e given here is $\frac{kT}{q}.\frac{1}{I_E} \approx \frac{25}{I_E}$ where I_E is in mA and T is in ^{o}K.

*These are the characteristics which are recommended for acceptance testing purposes.

EQUIVALENT CIRCUIT PARAMETERS - COMMON EMITTER $T_{amb}=25^{o}C$

Hybrid π network (See also page D13)

Measured at $-V_{CE}=6.0V$, $-I_C=1.0mA$, $\omega=10^{-4}$ rad/s

	Min.	Typ.	Max.	
$r_{bb'}$ (f=500kc/s)	90	230	350	Ω
g_m	-	39	-	mA/V
$r_{b'e}$	-	1.2	-	kΩ
r_{ce}	-	40	-	kΩ
$r_{b'c}$	-	1.7	-	MΩ
$c_{b'c}$	-	31.5	-	pF
$c_{b'e}$	-	2.0	-	pF

Hybrid matrix

h_{ie}	0.7	-	2.5	kΩ
h_{fe}	20	40	80	
h_{oe}	-	-	80	μmho
h_{re}	-	-	7	$\times10^{-4}$

BCZ11

ELECTRICAL CHARACTERISTICS ($T_{amb}=25^{o}C$ unless otherwise stated)

		Min.	Typ.	Max.	
$-I_{CBO}$	Collector cut-off current				
	$-V_{CB}=6.0V$, $I_E=0$	-	1.0	100*	nA
	$-V_{CB}=6.0V$, $I_E=0$, $T_{amb}=100^{o}C$	-	0.1	2.5	μA
	$-V_{CB}=30V$, $I_E=0$	-	10	500	nA
	$-V_{CB}=30V$, $I_E=0$, $T_{amb}=100^{o}C$	-	0.5	10	μA
$-I_{EBO}$	Emitter cut-off current				
	$-V_{EB}=6.0V$, $I_C=0$	-	1.0	100*	nA
	$-V_{EB}=6.0V$, $I_C=0$, $T_{amb}=100^{o}C$	-	0.1	2.5	μA
$-V_{BE}$	Base-emitter voltage				
	$-V_{CE}=4.5V$, $-I_C=20mA$	0.55	0.8	1.25	V
$-V_{CE(sat)}$	Collector-emitter saturation voltage				
	$-I_C=20mA$, $-I_B=3.0mA$	50	150	550*	mV
	$-I_C=7.0mA$, $-I_B=1.0mA$	-	110	320	mV
$-V_{BE(sat)}$	Base-emitter saturation voltage				
	$-I_C=20mA$, $-I_B=3.0mA$	0.6	0.9	1.25	V
h_{fe}	Small signal forward current transfer ratio				
	$-V_{CE}=6.0V$, $-I_C=1.0mA$, f=1.0kc/s	25*	-	60*	
h_{FE}	Large signal forward current transfer ratio				
	$-V_{CE}=4.5V$, $-I_C=20mA$	15	30	50	
	$-V_{CE}=4.5V$, $-I_C=50mA$	10	23	50	
	$-V_{CE}=6.0V$, $-I_C=10\mu A$	5	10	25	
	$-V_{CE}=6.0V$, $-I_C=100\mu A$	10	15	30	

*These are the characteristics which are recommended for acceptance testing purposes.

		Min.	Typ.	Max.	
f_T	Transition frequency $-V_{CE}=6.0V$, $-I_C=1.0mA$	0.9*	1.5	3.0*	Mc/s
c_{tc}	Collector depletion capacitance $-V_{CB}=6.0V$, $I_E=I_e=0$, f=500kc/s	-	30	60	pF
c_{te}	Emitter depletion capacitance $-V_{EB}=6.0V$, $I_C=I_c=0$, f=500kc/s	-	15	30	pF
NF	Noise figure $-V_{CB}=2.0V$, $I_E=0.5mA$, f=1.0kc/s, $R_s=500\Omega$	-	8.0	17	dB
†r_e	Emitter resistance $-V_{CE}=6.0V$, $-I_C=1.0mA$	-	25	-	Ω
μ	Voltage feedback factor $-V_{CE}=6.0V$, $-I_C=100\mu A$	-	4.0	-	$\times 10^{-4}$

†The value of r_e given here is $\frac{kT}{q} \cdot \frac{1}{I_E} \approx \frac{25}{I_E}$ where I_E is in mA and T is in ^oK.

*These are the characteristics which are recommended for acceptance testing purposes.

EQUIVALENT CIRCUIT PARAMETERS - COMMON EMITTER $T_{amb}=25^oC$

Hybrid π network (See also page D13)

Measured at $-V_{CE}=6.0V$, $-I_C=1.0mA$, $\omega=10^4$ rad/s

	Min.	Typ.	Max.	
$r_{bb'}$ (f=500kc/s)	100	200	350	Ω
g_m	-	39	-	mA/V
$r_{b'e}$	-	0.9	-	kΩ
r_{ce}	-	65	-	kΩ
$r_{b'c}$	-	2.6	-	MΩ
$c_{b'c}$	-	31.5	-	pF
$c_{b'e}$	-	4.0	-	nF

Hybrid matrix

	Min.	Typ.	Max.	
h_{ie}	0.8	1.1	3.0	kΩ
h_{fe}	25	35	60	
h_{fe} ($T_{amb}=-50^oC$)	18	-	-	
h_{oe}	-	23	40	µmho
h_{re}	-	3	10	$\times 10^{-4}$

OC202

ELECTRICAL CHARACTERISTICS (T_{amb} = 25°C unless otherwise stated)

		Min.	Typ.	Max.	
$-I_{CBO}$	Collector cut-off current				
	$-V_{CB}$ = 6.0V, I_E = 0	-	1.0	100*	nA
	$-V_{CB}$ = 6.0V, I_E = 0, T_{amb} = 100°C	-	0.1	2.5	μA
	$-V_{CB}$ = 15V, I_E = 0	-	10	500	nA
	$-V_{CB}$ = 15V, I_E = 0, T_{amb} = 100°C	-	0.5	10	μA
$-I_{EBO}$	Emitter cut-off current				
	$-V_{EB}$ = 6.0V, I_C = 0	-	1.0	100*	nA
	$-V_{EB}$ = 6.0V, I_C = 0, T_{amb} = 100°C	-	0.1	2.5	μA
$-V_{BE}$	Base-emitter voltage				
	$-V_{CE}$ = 4.5V, $-I_C$ = 20mA	0.55	0.8	1.25	V
$-V_{CE(sat)}$	Collector-emitter saturation voltage				
	$-I_C$ = 20mA, $-I_B$ = 3.0mA	50	130	550*	mV
	$-I_C$ = 7.0mA, $-I_B$ = 1.0mA	-	105	320	mV
$-V_{BE(sat)}$	Base-emitter saturation voltage				
	$-I_C$ = 20mA, $-I_B$ = 3.0mA	0.6	0.9	1.25	V
h_{fe}	Small signal forward current transfer ratio				
	$-V_{CE}$ = 6.0V, $-I_C$ = 1.0mA, f = 1.0kc/s	45*	-	120*	
	$-V_{CE}$ = 6.0V, $-I_C$ = 10μA, f = 1.0kc/s	7	20	40	
	$-V_{CE}$ = 6.0V, $-I_C$ = 100μA, f = 1.0kc/s	25	42	85	

*These are the characteristics which are recommended for acceptance testing purposes.

		Min.	Typ.	Max.	
h_{FE}	Large signal forward current transfer ratio				
	$-V_{CE}=4.5V,\ -I_C=20mA$	24	50	125	
	$-V_{CE}=4.5V,\ -I_C=50mA$	20	40	100	
f_T	Transition frequency				
	$-V_{CE}=6.0V,\ -I_C=1.0mA$	1.4*	3.2	11*	Mc/s
c_{tc}	Collector depletion capacitance				
	$-V_{CB}=6.0V,\ I_E=I_e=0,$				
	f=500kc/s	-	30	60	pF
c_{te}	Emitter depletion capacitance				
	$-V_{EB}=6.0V,\ I_C=I_c=0,$				
	f=500kc/s	-	15	30	pF
NF	Noise figure				
	$-V_{CB}=2.0V,\ I_E=0.5mA$				
	$f=1.0kc/s,\ R_s=500\Omega$	-	8.0	17	dB
†r_e	Emitter resistance				
	$-V_{CE}=6.0V,\ I_C=1.0mA$	-	25	-	Ω
μ	Voltage feedback factor				
	$-V_{CE}=6.0V,\ -I_C=100\mu A$	-	7.5	-	$\times 10^{-4}$

†The value of r_e given here is $\frac{kT}{q} \cdot \frac{1}{I_E} \approx \frac{25}{I_E}$ where I_E is in mA and T is in $^{\circ}$K.

*These are the characteristics which are recommended for acceptance testing purposes.

EQUIVALENT CIRCUIT PARAMETERS - COMMON EMITTER $T_{amb}=25^{\circ}C$

Hybrid π network (See also page D13)

Measured at $-V_{CE}=6.0V,\ -I_C=1.0mA,\ \omega=10^{-4}$ rad/s

	Min.	Typ.	Max.	
$r_{bb'}$ (f=500kc/s)	100	250	550	Ω
g_m	-	39	-	mA/V
$r_{b'e}$	-	1.8	-	kΩ
r_{ce}	-	35	-	kΩ
$r_{b'c}$	-	2.1	-	MΩ
$c_{b'c}$	-	29.5	-	pF
$c_{b'e}$	-	2.0	-	nF

Hybrid matrix

	Min.	Typ.	Max.	
h_{ie}	1.5	2.1	3.3	kΩ
h_{fe}	45	70	120	
h_{fe} ($T_{amb}=-50^{\circ}C$)	30	-	-	
h_{oe}	-	42	80	µmho
h_{re}	-	6	-	$\times 10^{-4}$

OC203

ELECTRICAL CHARACTERISTICS ($T_{amb} = 25^{o}C$ unless otherwise stated)

Symbol	Parameter	Min.	Typ.	Max.	Unit
$-I_{CBO}$	Collector cut-off current				
	$-V_{CB} = 6.0V$, $I_E = 0$	-	1.0	100*	nA
	$-V_{CB} = 6.0V$, $I_E = 0$, $T_{amb} = 100^{o}C$	-	0.1	2.5	μA
	$-V_{CB} = 60V$, $I_E = 0$	-	10	1500	nA
	$-V_{CB} = 60V$, $I_E = 0$, T $T_{amb} = 100^{o}C$	-	0.5	20	μA
$-I_{EBO}$	Emitter cut-off current				
	$-V_{EB} = 6.0V$, $I_C = 0$	-	1.0	100*	nA
	$-V_{EB} = 6.0V$, $I_C = 0$, $T_{amb} = 100^{o}C$	-	0.1	2.5	μA
$-V_{BE}$	Base-emitter voltage				
	$-V_{CE} = 4.5V$, $-I_C = 20mA$	0.55	0.8	1.25	V
$-V_{CE(sat)}$	Collector-emitter saturation voltage				
	$-I_C = 20mA$, $-I_B = 3.0mA$	50	170	550*	mV
	$-I_C = 7.0mA$, $-I_B = 1.0mA$	-	130	320	mV
$-V_{BE(sat)}$	Base-emitter saturation voltage voltage				
	$-I_C = 20mA$, $-I_B = 3.0mA$	0.6	0.9	1.25	V
h_{fe}	Small signal forward current transfer ratio				
	$-V_{CE} = 6.0V$, $-I_C = 1.0mA$, f=1.0kc/s	10*	-	60*	
h_{FE}	Large signal forward current transfer ratio				
	$-V_{CE} = 4.5V$, $-I_C = 20mA$	10	20	50	
	$-V_{CE} = 4.5V$, $-I_C = 50mA$	10	15	50	
f_T	Transition frequency				
	$-V_{CE} = 6.0V$, $-I_C = 1.0mA$	0.3*	1.2	3.5*	Mc/s

*These are the characteristics which are recommended for acceptance testing purposes.

		Min.	Typ.	Max.	
c_{tc}	Collector depletion capacitance $-V_{CB}=6.0V,\ I_E=I_e=0,$ $f=500kc/s$	-	30	60	pF
c_{tc}	Emitter depletion capacitance $-V_{EB}=6.0V,\ I_C=I_c=0,$ $f=500kc/s$	-	15	30	pF
NF	Noise figure $-V_{CB}=2.0V,\ I_E=0.5mA$ $f=1.0kc/s,\ R_s=500\Omega$	-	8.0	17	dB
†r_e	Emitter resistance $-V_{CE}=6.0V,\ -I_C=1.0mA$	-	25	-	Ω
μ	Voltage feedback factor $-V_{CE}=6.0V,\ -I_C=100\mu A$	-	2.0	-	$\times 10^{-4}$

†The value of r_e given here is $\frac{kT}{q} \cdot \frac{1}{I_E} \approx \frac{25}{I_E}$ where I_E is in mA and T is in ^oK.

EQUIVALENT CIRCUIT PARAMETERS - COMMON EMITTER $T_{amb}=25^oC$.

Hybrid π network (See also page D13)

Measured at $-V_{CE}=6.0V,\ -I_C=1.0mA,\ \omega=10^4$ rad/s

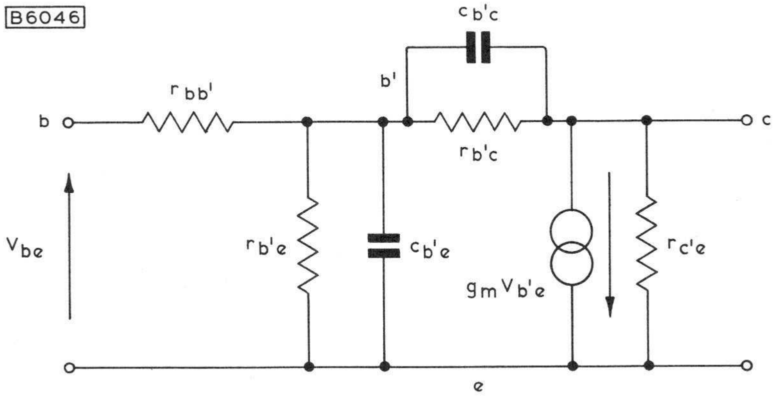
	Min.	Typ.	Max.	
$r_{bb'}$ (f=500kc/s)	50	125	350	Ω
g_m	-	39	-	mA/V
$r_{b'e}$	-	0.5	-	kΩ
r_{ce}	-	125	-	kΩ
$r_{b'c}$	-	2.5	-	MΩ
$c_{b'c}$	-	41.5	-	pF
$c_{b'e}$	-	7.5	-	nF

Hybrid matrix

	Min.	Typ.	Max.
h_{fe}	10	20	60

Hybrid π Network

B6046

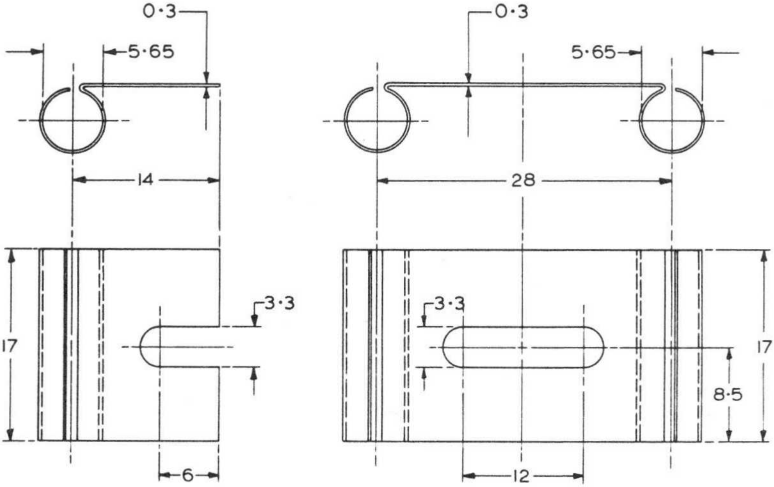


b' indicates the internal base connection

SOLDERING AND WIRING RECOMMENDATIONS

1. When using a soldering iron, transistors may be soldered directly into the circuit, but heat conducted to the junction should if possible be kept to a minimum by the use of a thermal shunt.
2. Transistors may be dip-soldered at a solder temperature of 245°C for a maximum soldering time of 5 seconds. The case temperature during soldering must not at any time exceed the maximum storage temperature. These recommendations apply to a transistor mounted flush on a board having punched-through holes, or spaced at least 1.5mm above a board having plated-through holes.
3. Care should be taken not to bend the leads nearer than 1.5mm from the seal.
4. If devices are stored above 100°C before incorporation into equipment, some deterioration of the external surface is likely to occur which may make soldering into the circuit difficult. Under these circumstances the leads should be retinned using a suitable activated flux.

OUTLINE AND DIMENSIONS OF COOLING CLIPS



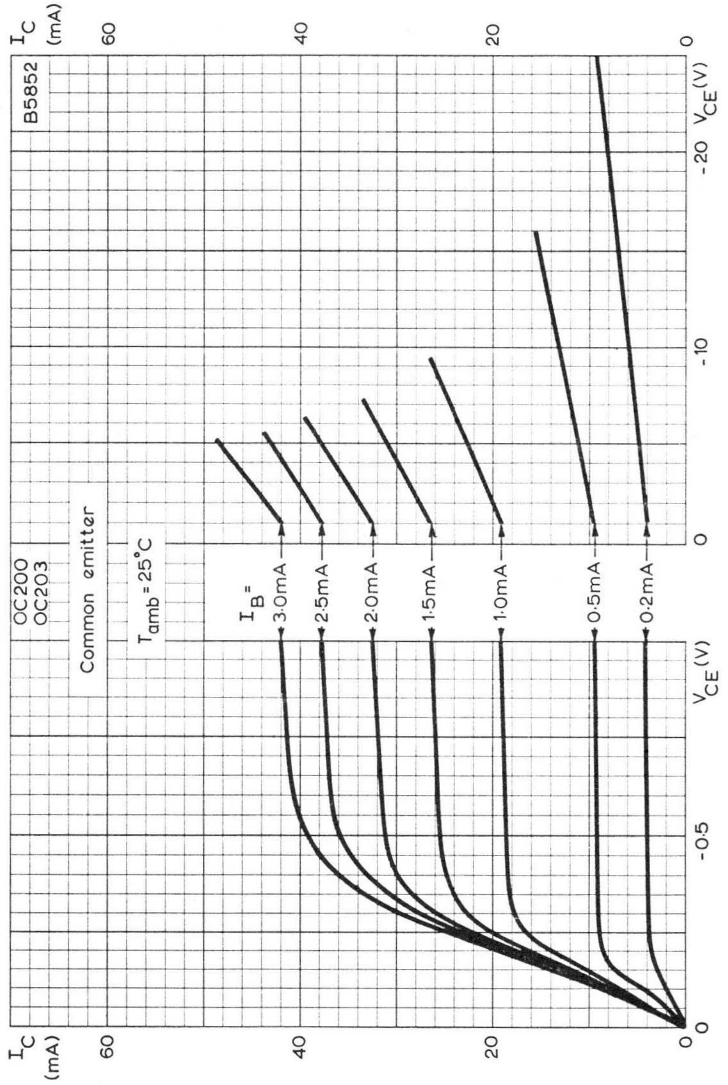
Nominal dimensions in mm

Type a.

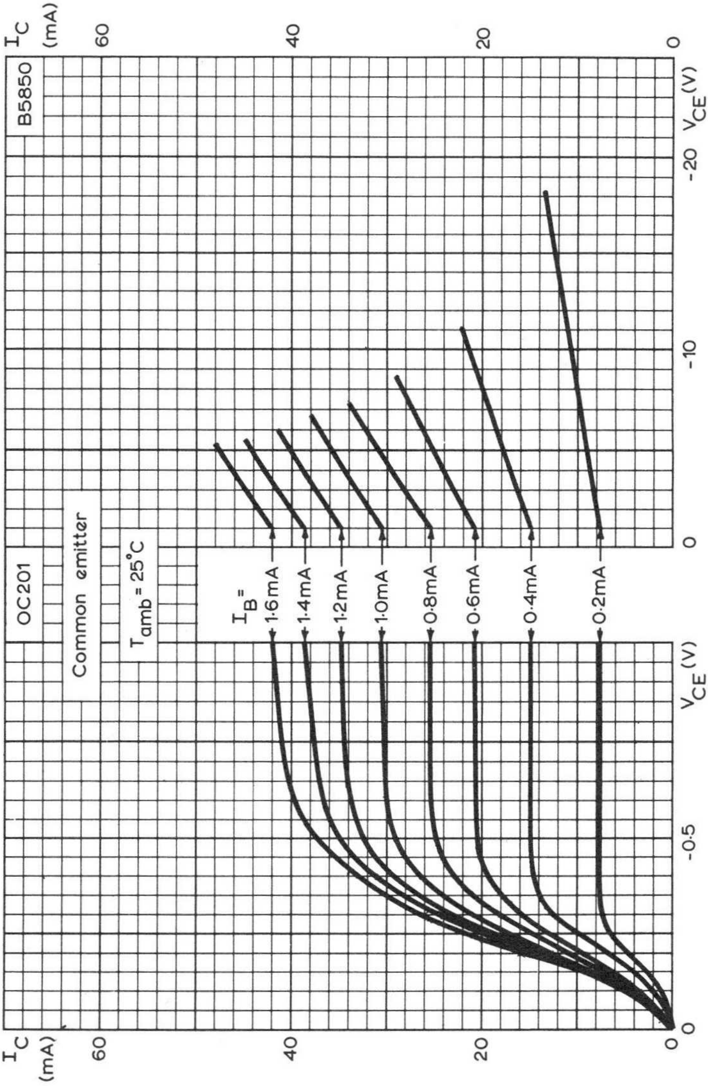
Part No. 56227

Type b.

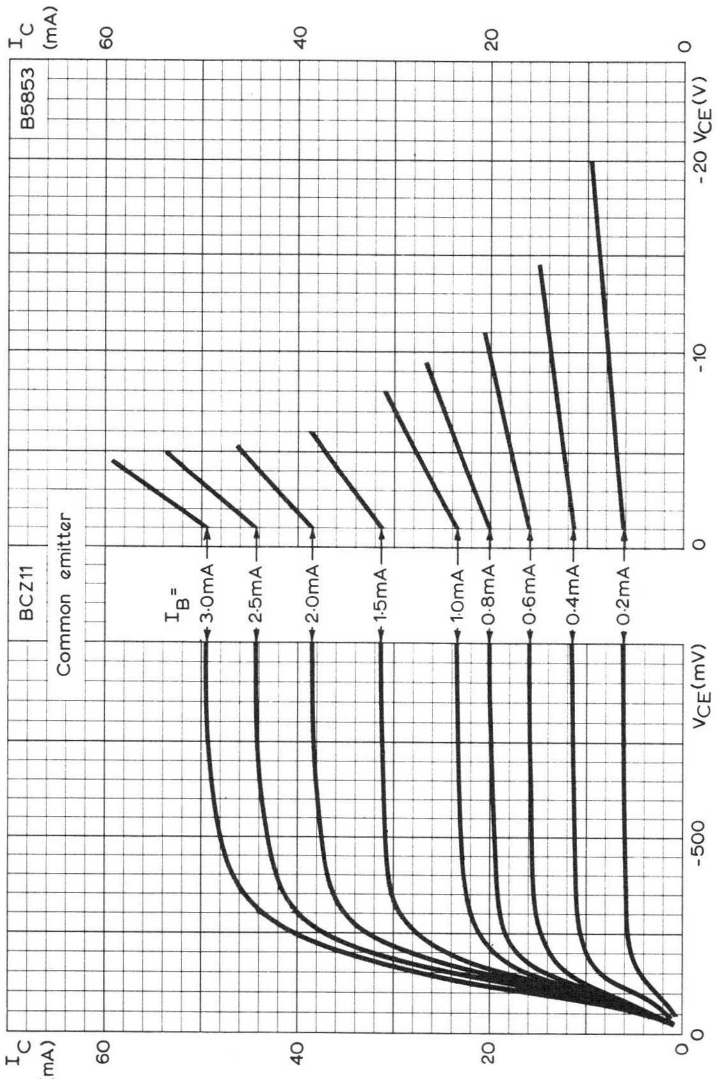
Part No. 56226



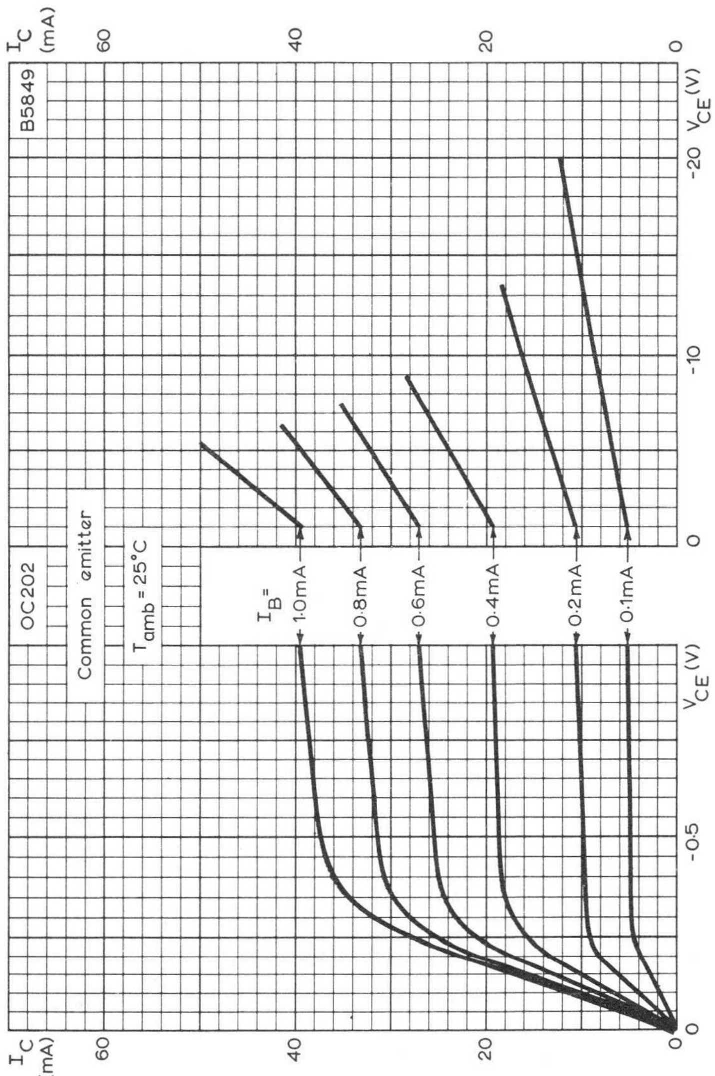
OUTPUT CHARACTERISTICS. COMMON EMITTER



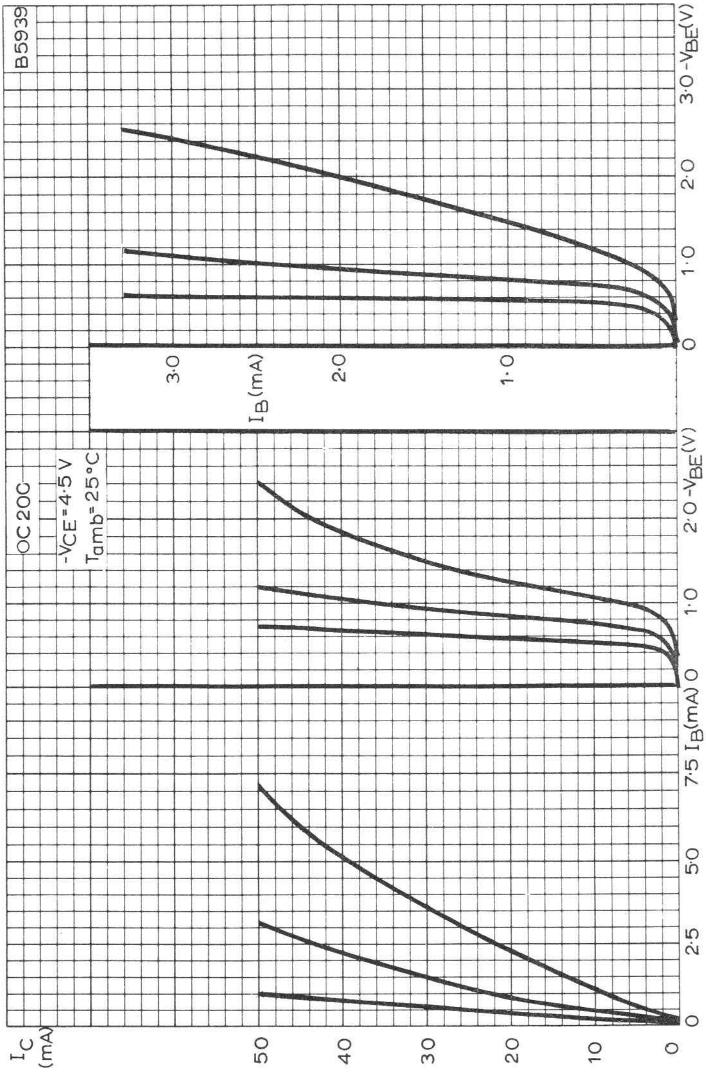
OUTPUT CHARACTERISTICS. COMMON EMITTER



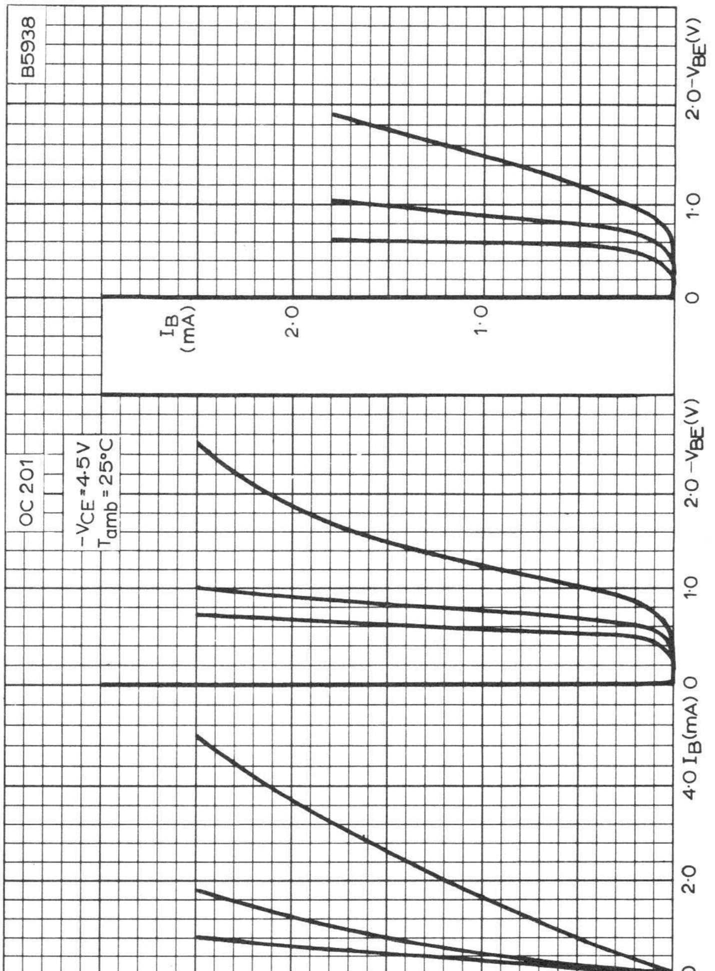
OUTPUT CHARACTERISTICS. COMMON EMITTER



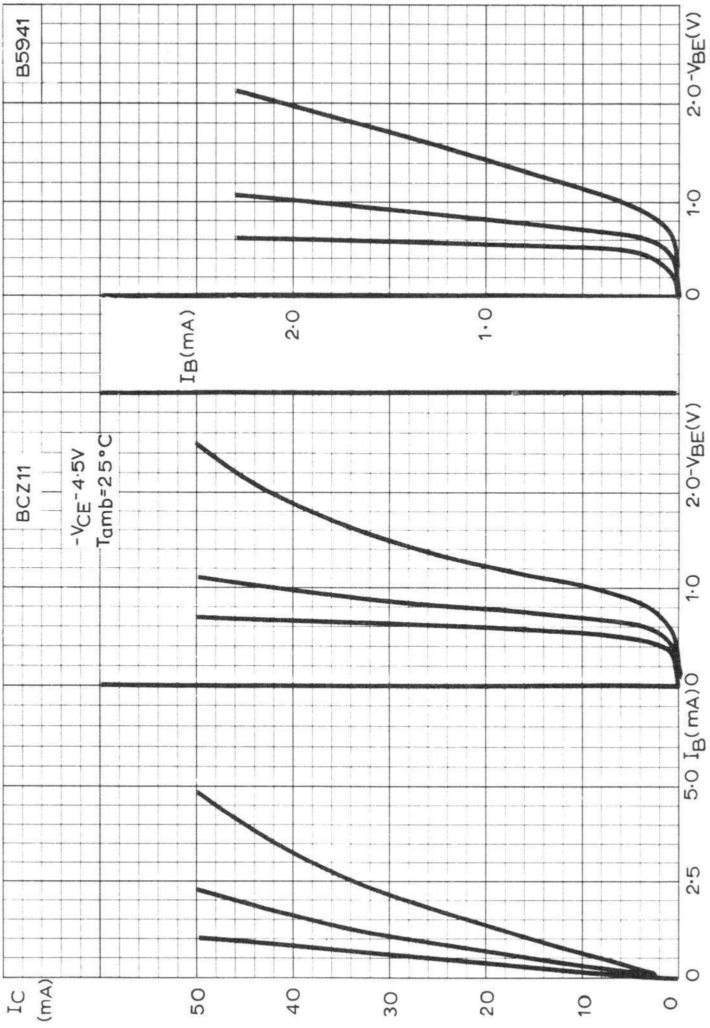
OUTPUT CHARACTERISTICS. COMMON EMITTER



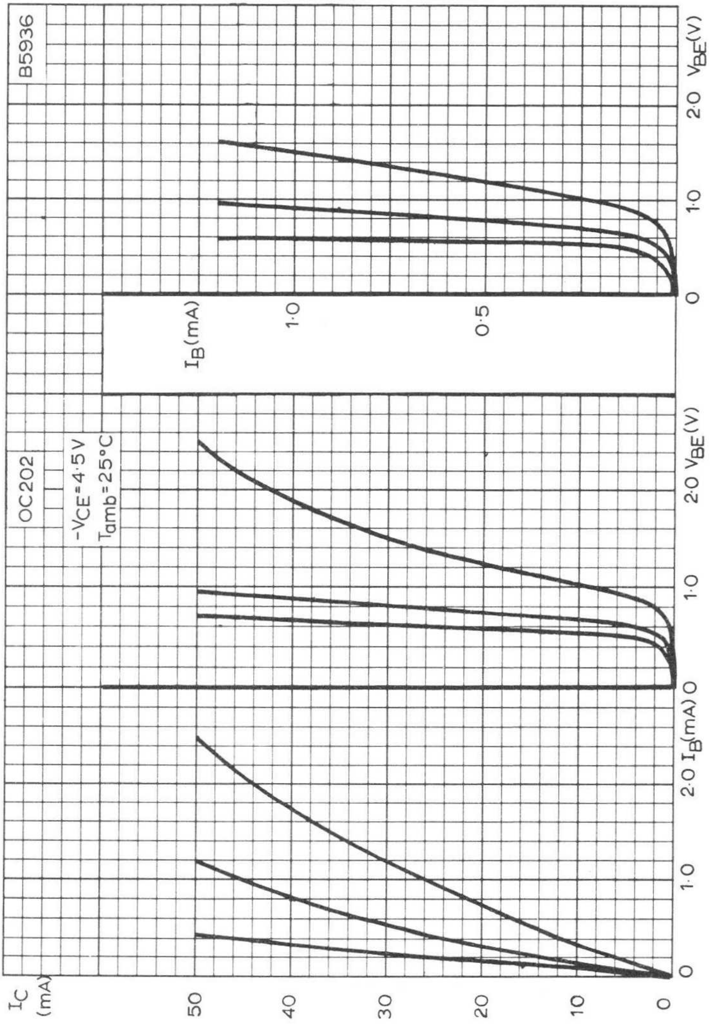
TRANSFER, MUTUAL AND INPUT CHARACTERISTICS.
COMMON EMITTER



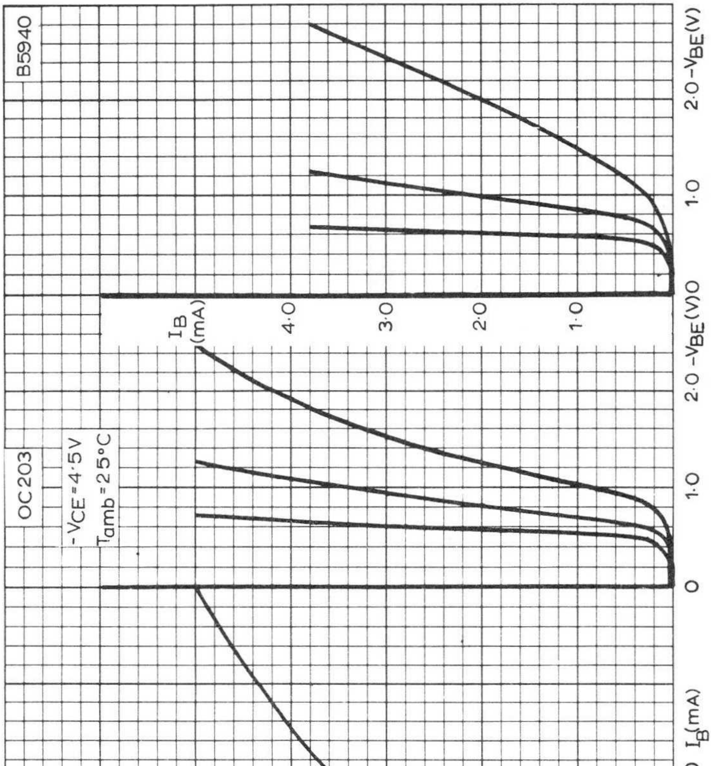
TRANSFER, MUTUAL AND INPUT CHARACTERISTICS
COMMON EMITTER



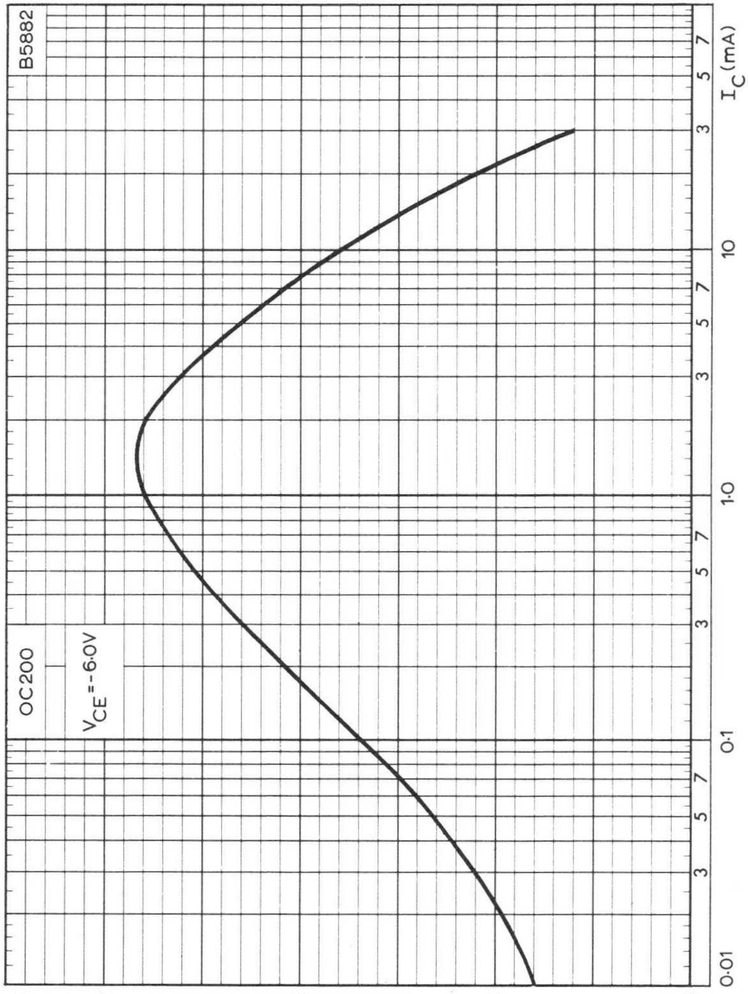
TRANSFER, MUTUAL AND INPUT CHARACTERISTICS.
COMMON EMITTER



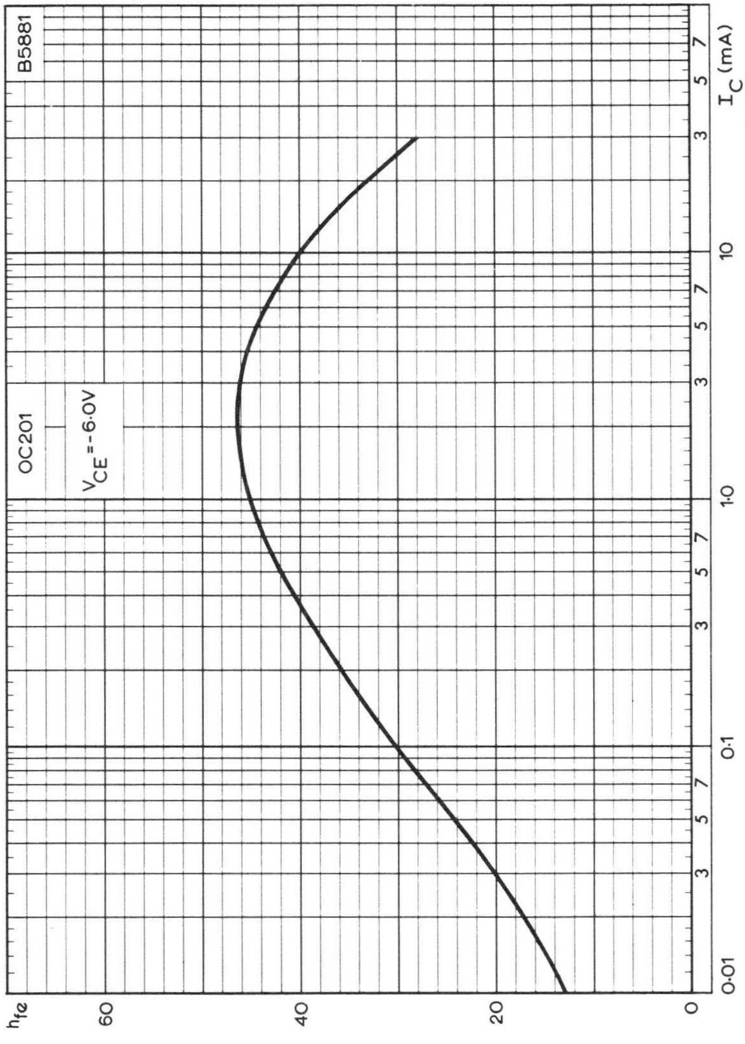
TRANSFER, MUTUAL AND INPUT CHARACTERISTICS.
COMMON EMITTER



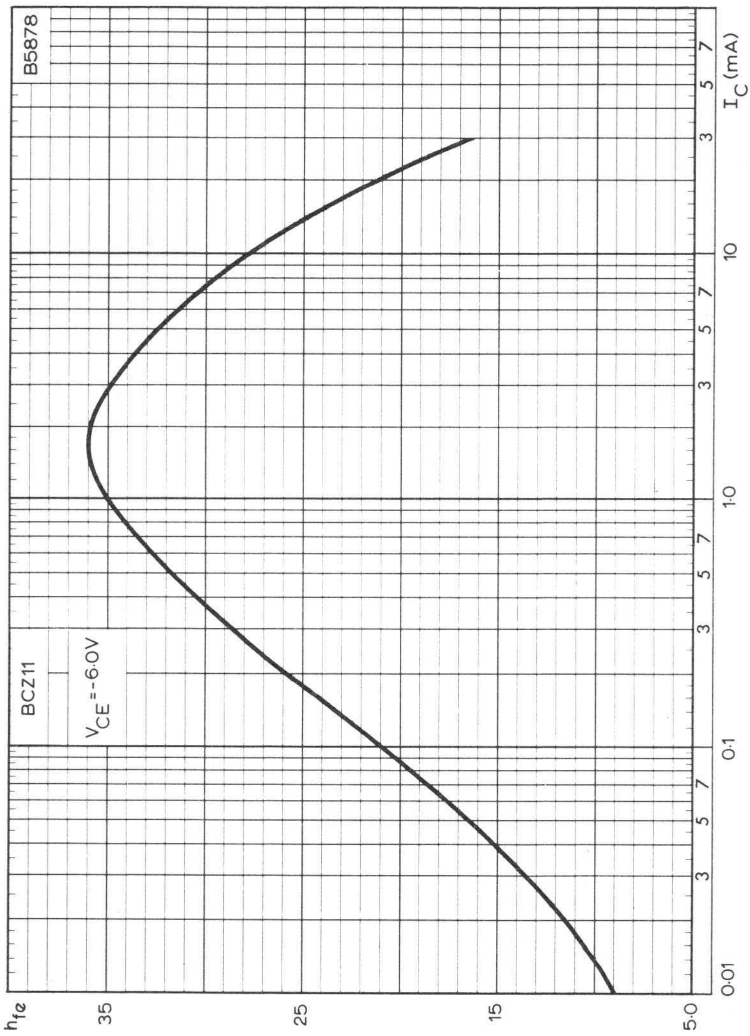
TRANSFER, MUTUAL AND INPUT CHARACTERISTICS.
COMMON EMITTER



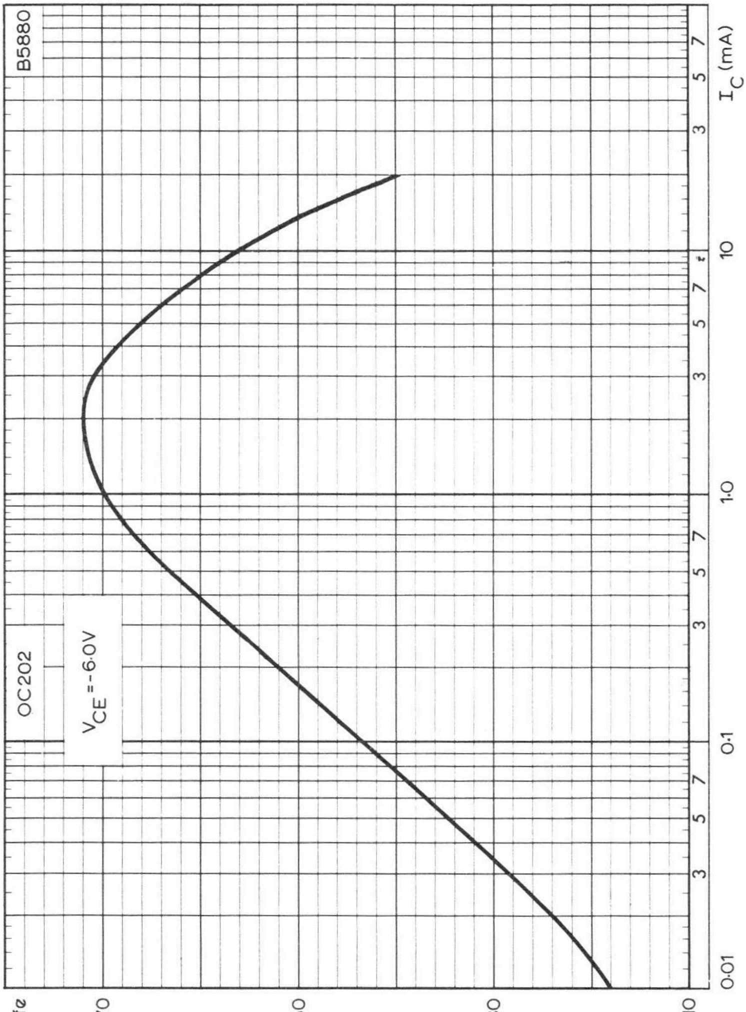
SMALL SIGNAL FORWARD CURRENT TRANSFER RATIO PLOTTED AGAINST COLLECTOR CURRENT



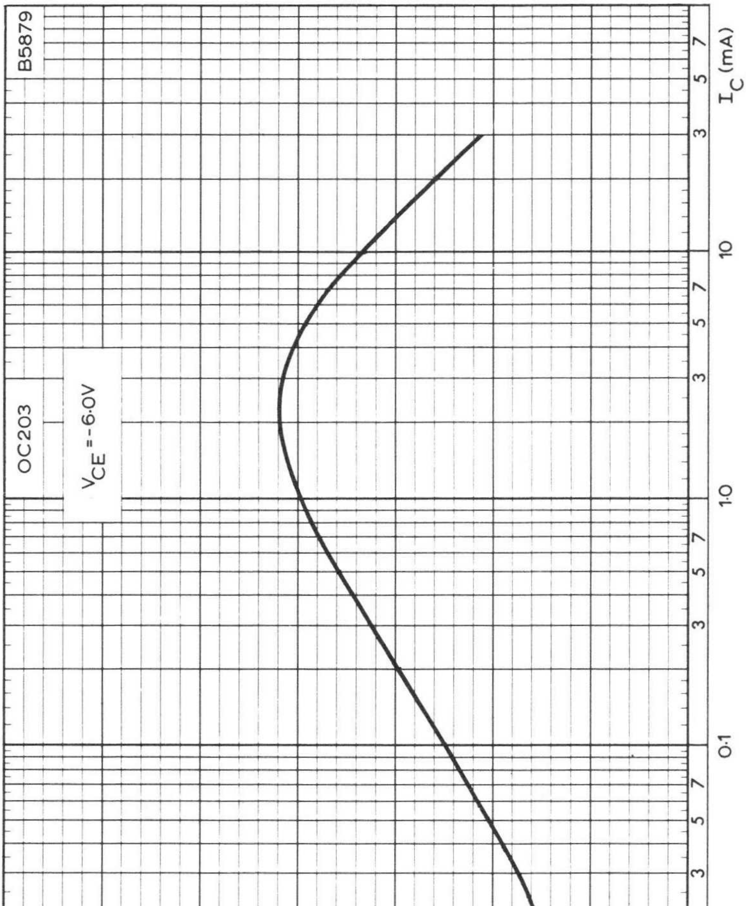
SMALL SIGNAL FORWARD CURRENT TRANSFER RATIO PLOTTED AGAINST COLLECTOR CURRENT



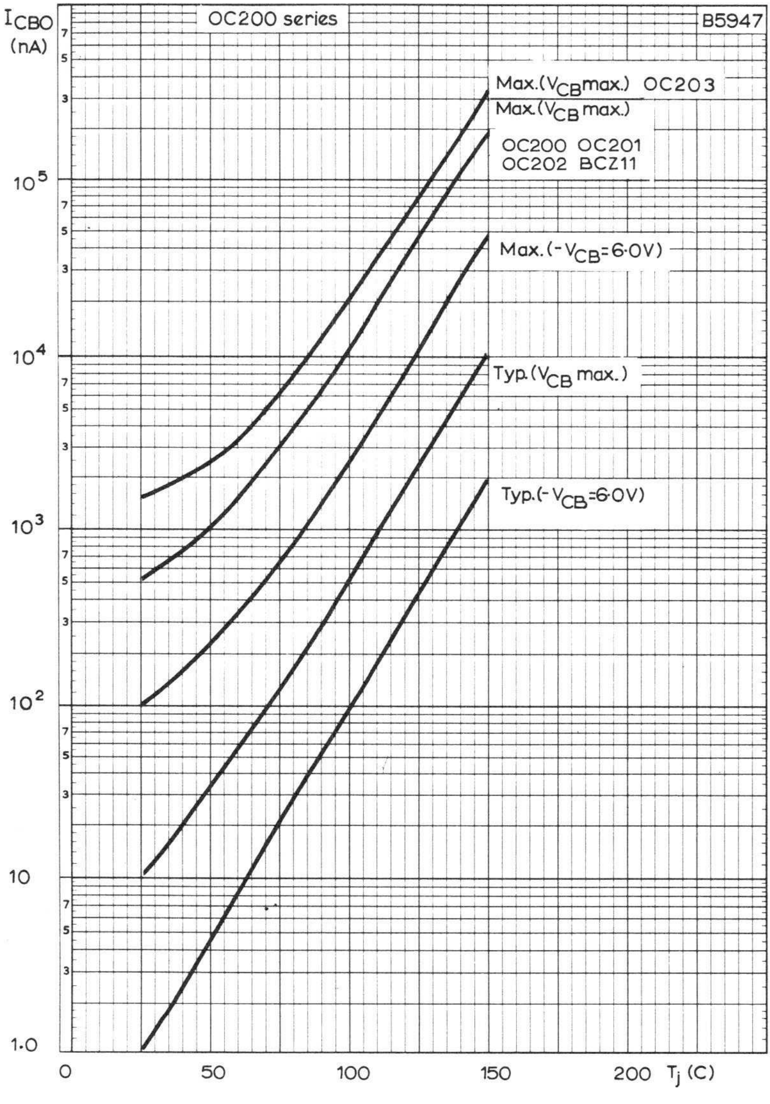
SMALL SIGNAL FORWARD CURRENT TRANSFER RATIO PLOTTED
AGAINST COLLECTOR CURRENT



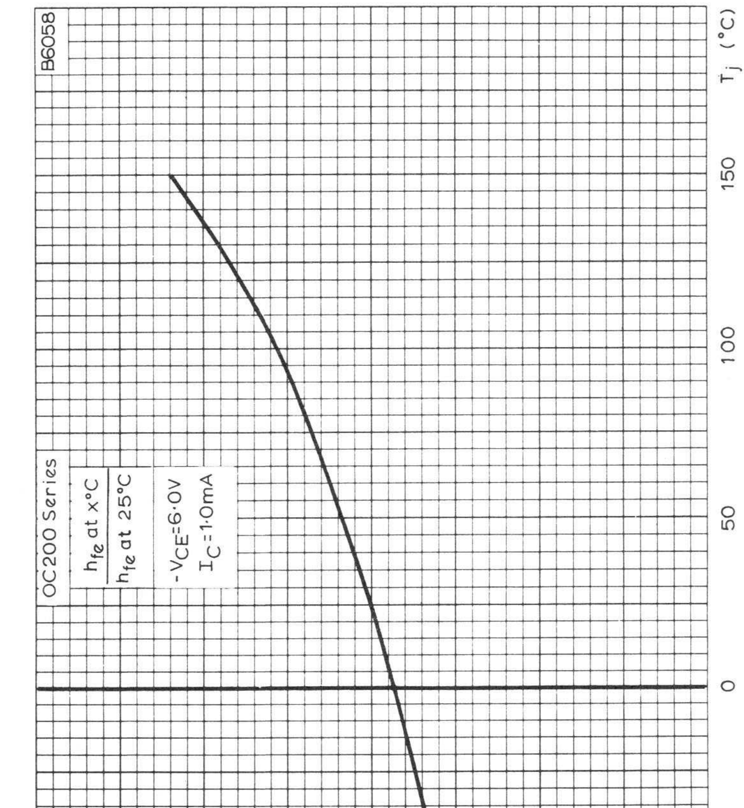
SMALL SIGNAL FORWARD CURRENT TRANSFER RATIO PLOTTED AGAINST COLLECTOR CURRENT



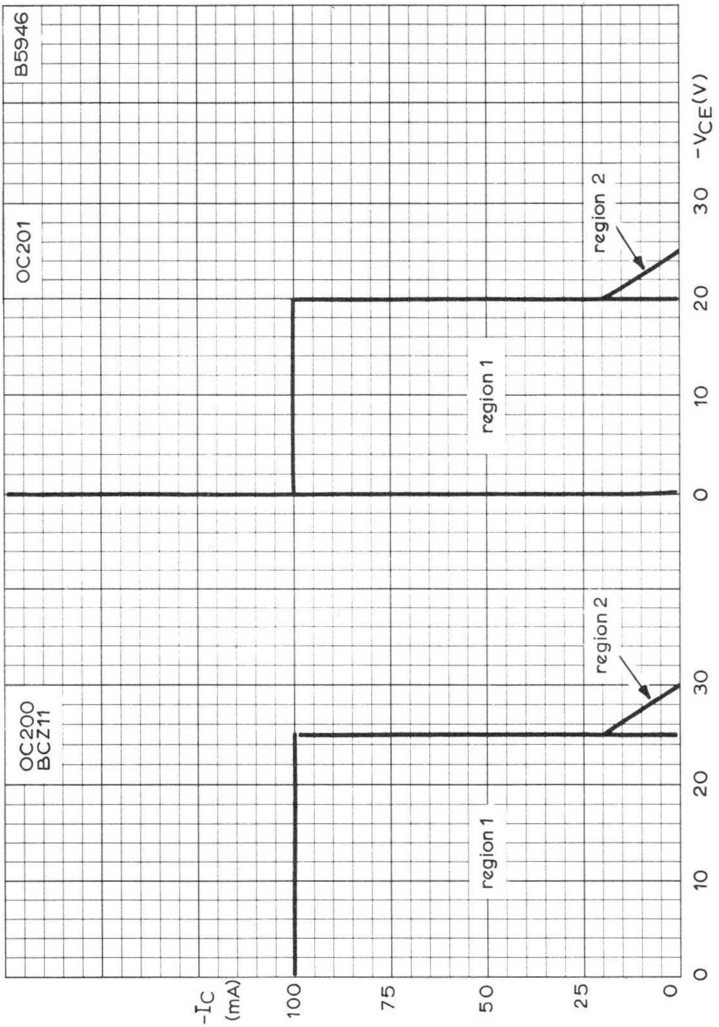
SMALL SIGNAL FORWARD CURRENT TRANSFER RATIO PLOTTED AGAINST COLLECTOR CURRENT



COLLECTOR CUT-OFF CURRENT PLOTTED AGAINST
JUNCTION TEMPERATURE



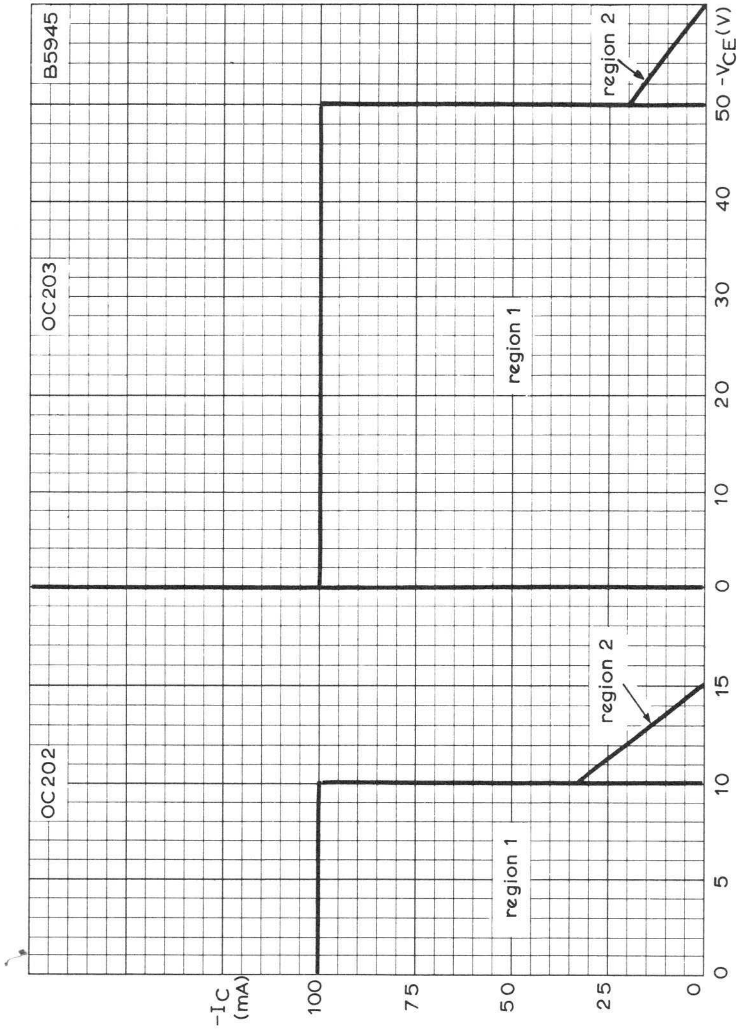
VARIATION OF SMALL SIGNAL FORWARD CURRENT TRANSFER RATIO
WITH JUNCTION TEMPERATURE. NORMALISED AT $T_j = 25^oC$



ABSOLUTE MAXIMUM COLLECTOR-EMITTER VOLTAGE PLOTTED AGAINST COLLECTOR CURRENT

Region 1. Permissible area of operation under all conditions of base drive

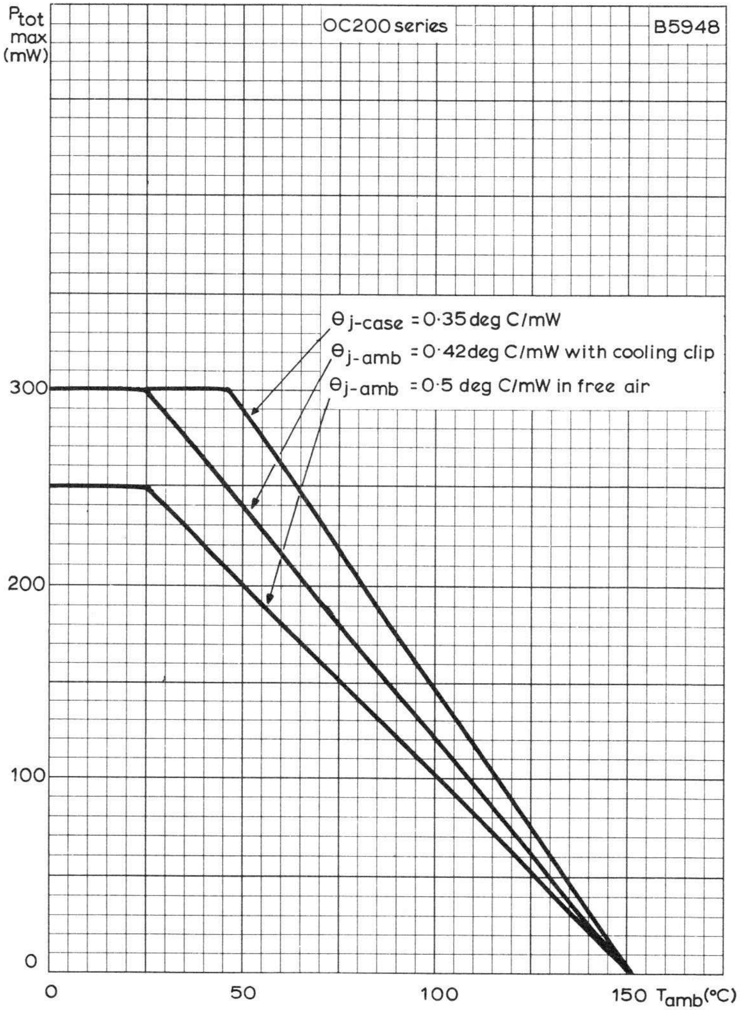
Region 2. For operation in this region the circuit must be capable of providing reverse current bias.



ABSOLUTE MAXIMUM COLLECTOR-EMITTER VOLTAGE PLOTTED AGAINST COLLECTOR CURRENT

Region 1. Permissible area of operation under all conditions of base drive.

Region 2. For operation in this region the circuit must be capable of providing reverse current bias.



MAXIMUM TOTAL DISSIPATION PLOTTED AGAINST AMBIENT TEMPERATURE

SILICON JUNCTION TRANSISTORS

OC204
OC205
OC206

QUICK REFERENCE DATA

Silicon p-n-p alloy junction medium power transistors intended for general purpose industrial applications.

	OC204	OC205	OC206	
V_{CB} max. ($I_E = 0$mA) / V_{CE} max. ($+V_{BE} > 500$mV)	−32	−60	−32	V
V_{EB} max. ($I_C = 0$mA)	←	−12	→	V
I_{CM} max.	←	500	→	mA
P_{tot} max. ($T_{amb} = 100$°C)	←	125	→	mW
h_{FE} ($I_C = 150$mA)	10–30	10–50	16–120	
f_1	>0.45	>0.45	>0.85	Mc/s

Unless otherwise shown data is applicable to all types

ABSOLUTE MAXIMUM RATINGS

The equipment designer must ensure that no transistor exceeds these ratings. In arriving at the actual operating conditions, variations in supply voltages, component tolerances and ambient temperature must also be taken into account.

	OC204	OC205	OC206	
Collector voltage				
V_{CB} max. ($I_E = 0$mA) / V_{CE} max. ($+V_{BE} > 500$mV)	−32	−60	−32	V
V_{CE} max. ($I_C = 200$mA)	−24	−60	−24	V
Reverse emitter-base voltage				
V_{EB} max. ($I_C = 0$mA)			−12	V
Collector current				
I_{CM} max.			500	mA
*$I_{C(AV)}$ max.			250	mA
Emitter current				
I_{EM} max.			500	mA
*$I_{E(AV)}$ max.			250	mA
Base current				
I_{BM} max.			125	mA
*$I_{B(AV)}$ max.			125	mA

*Averaged over any 20ms period.

OC204 Series

SILICON JUNCTION TRANSISTORS

Total dissipation see curve on page C14

$$\left(P_{tot}\ \text{max.} = \frac{T_j\ \text{max.} - T_{amb}}{\theta}\right)$$

Temperature ratings

T_{stg} max.	+150	°C
T_{stg} min.	–55	°C
T_j max.	150	°C
θ_{j-amb}		
Without cooling clip in free air	0.4	°C/mW
With cooling clip (type 56210) on a heat sink 7 × 7cm 16 s.w.g. aluminium	0.3	°C/mW
θ_{j-case}	0.25	°C/mW

BASIC PARAMETERS (measured at V_{CE} = –6V, I_C = 1mA)

		*r_e (Ω)	$r_{bb'}$ (Ω)	c_{tc} (I_E = 0mA) (pF)	h_{fe} (I_C = 10mA) T_{amb} = 25°C	h_{fe} (I_C = 10mA) T_{amb} = –55°C	f_1 (Mc/s)
OC204	Min.	—	20	50	15	10	0.45
	Typ.	25	60	80	30	20	1.0
	Max.	—	120	120	45	35	—
OC205	Min.	—	30	50	15	10	0.45
	Typ.	25	90	65	45	30	1.0
	Max.	—	250	100	100	70	—
OC206	Min.	—	50	50	30	20	0.85
	Typ.	25	110	75	60	40	2.0
	Max.	—	250	110	160	115	—

*The value of r_e given here is $\frac{kT}{q} \cdot \frac{1}{I_E} \approx \frac{25}{I_E}$ where I_E is in mA and T is in °K.

ACCESSORY

Accessory	Code No.	Notes
Cooling clip	56210	Must be specifically ordered

OPERATING NOTES

1. Transistors may be soldered directly into the circuit but heat conducted to the junction should be kept to a minimum by the use of a thermal shunt.
2. Care should be taken not to bend the leads nearer than 1.5mm to the seal.

CHARACTERISTICS (at $T_{amb} = 25°C$)

Common emitter

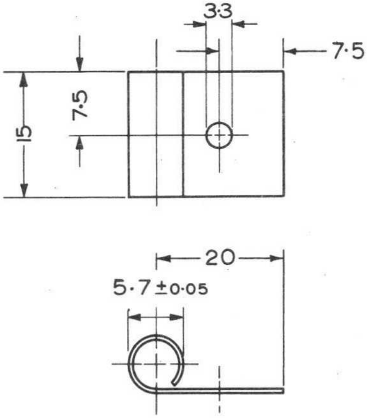
Typical production spread

		Current amplification factor h_{FE} —			Collector bottoming voltage $V_{CE(sat)}$ (mV)	Base input voltage V_{BE} (V)	Noise figure (dB)	Collector leakage current ($I_E = 0mA$) I_{CBO}	(nA)		(µA)	
		$V_{CE} = -2V$, $I_C = 30mA$	$V_{CE} = -1V$, $I_C = 150mA$	$V_{CE} = -6V$, $I_{CM} = 300mA$	$I_C = 125mA$, $I_B = 17mA$	$V_{CB} = 0V$, $I_C = 150mA$	$V_{CE} = -2V$, $f = 1kc/s$, $R_s = 500\Omega$, $I_E = 0.5mA$	$V_{CB}(V)$ / $T_j(°C)$	−6 / 25	−32 / 25	−6 / 100	−32 / 100
OC204	*Min.*	12	10	—	—	−0.8	—		—	—	—	—
	Typ.	24	15	10	−280	−1.2	7		1	10	0.1	0.5
	Max.	—	30	—	−560	−1.6	20		100	500	2.5	10
OC205	*Min.*	13	10	—	—	−0.8	—		—	—	—	—
	Typ.	32	20	10	−280	−1.2	7		1	*10	0.1	*0.5
	Max.	100	50	—	−560	−1.6	20		100	*1500	2.5	*20
OC206	*Min.*	25	16	10	—	−0.7	—		—	—	—	—
	Typ.	50	30	15	−220	−1.05	7		1	10	0.1	0.5
	Max.	150	120	—	−550	−1.6	20		100	500	2.5	10

*$V_{CB} = -60V$

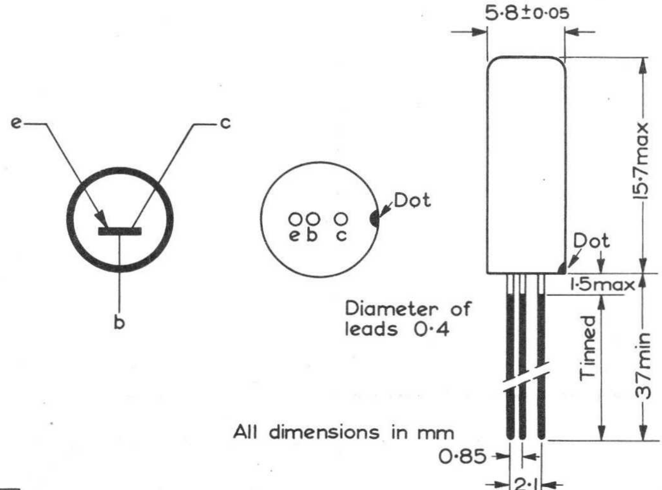
OC204 Series

SILICON JUNCTION TRANSISTORS



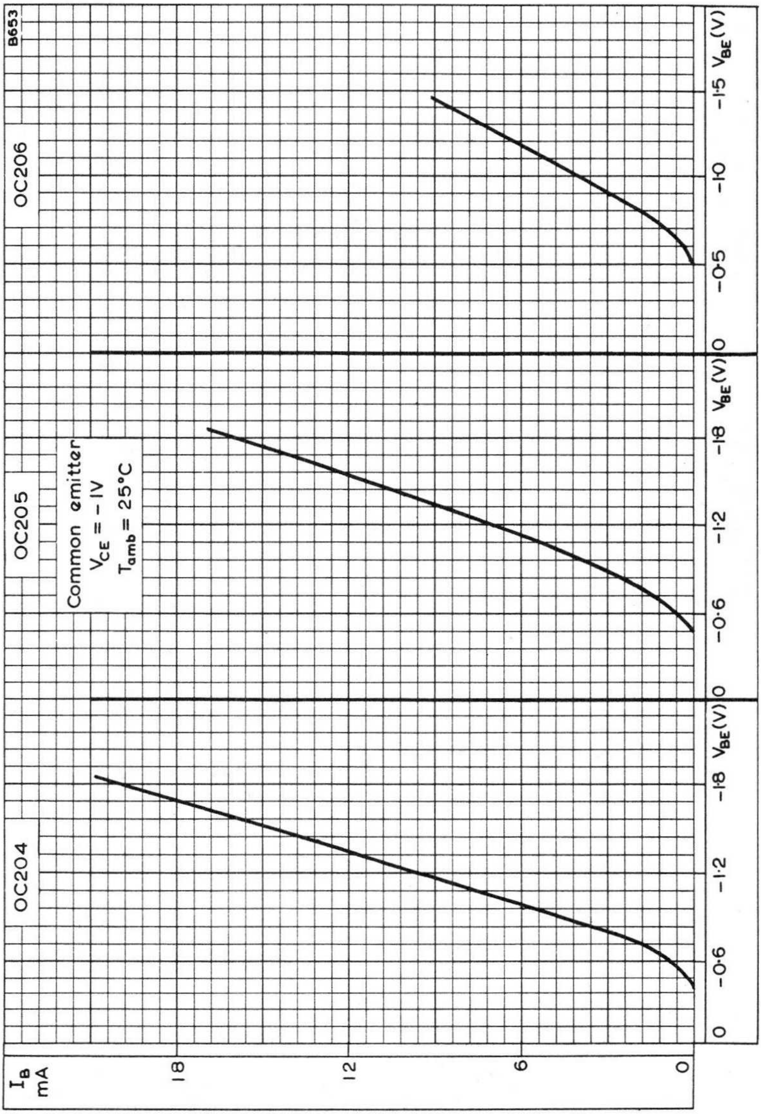
Cooling clip

Material: 0·5mm copper strip commercial half-hard BS899



All dimensions in mm

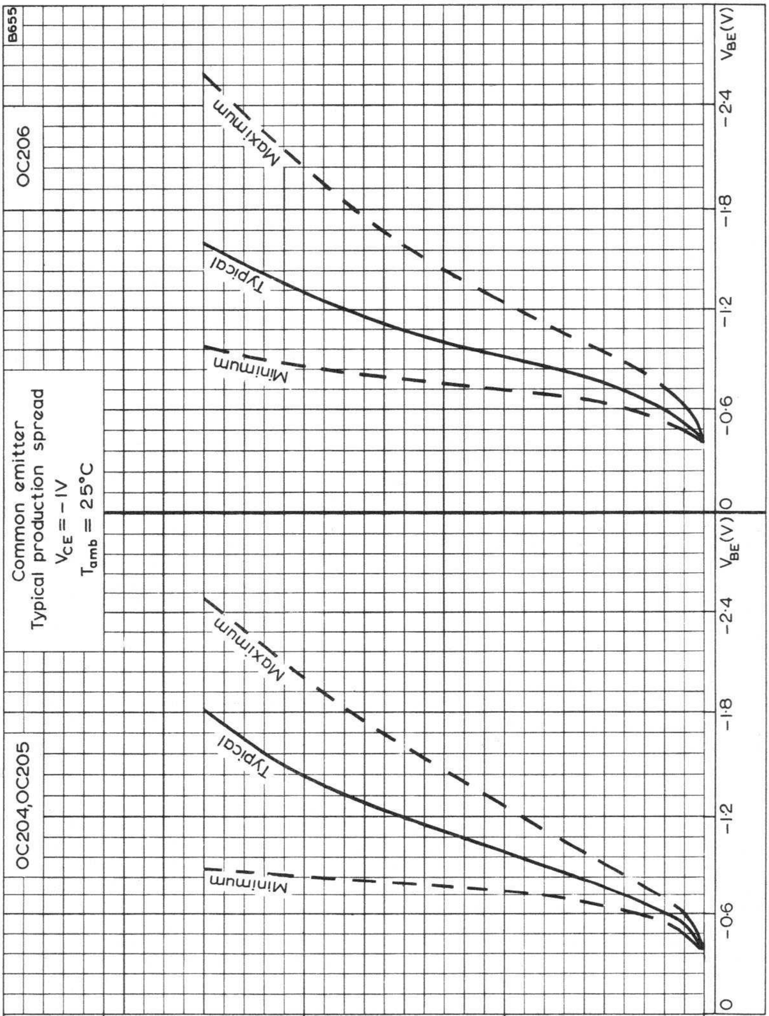
7729



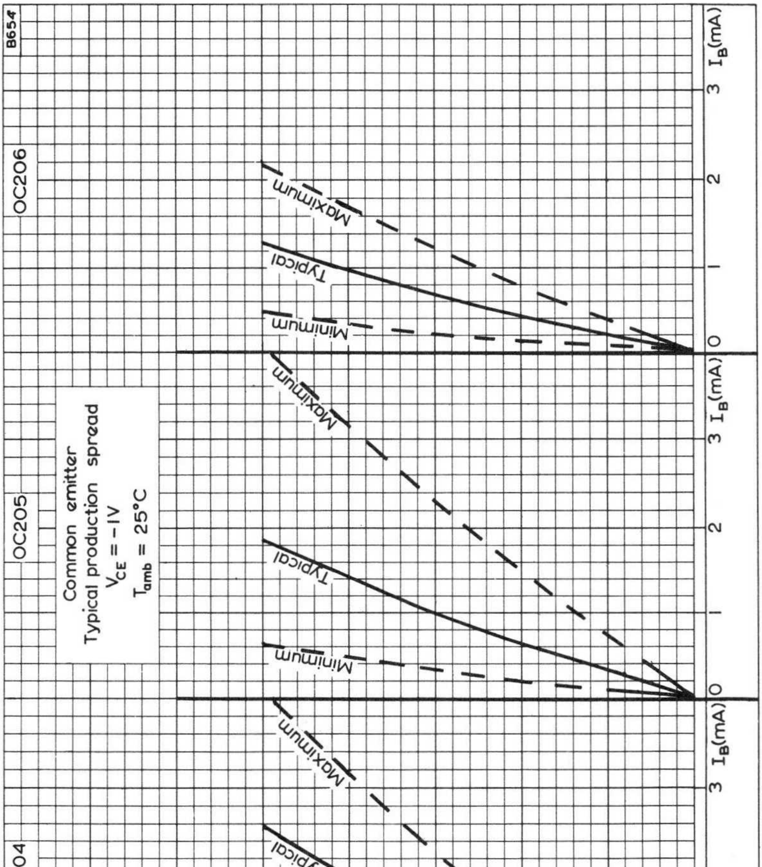
TYPICAL INPUT CHARACTERISTICS

OC204 Series

SILICON JUNCTION TRANSISTORS



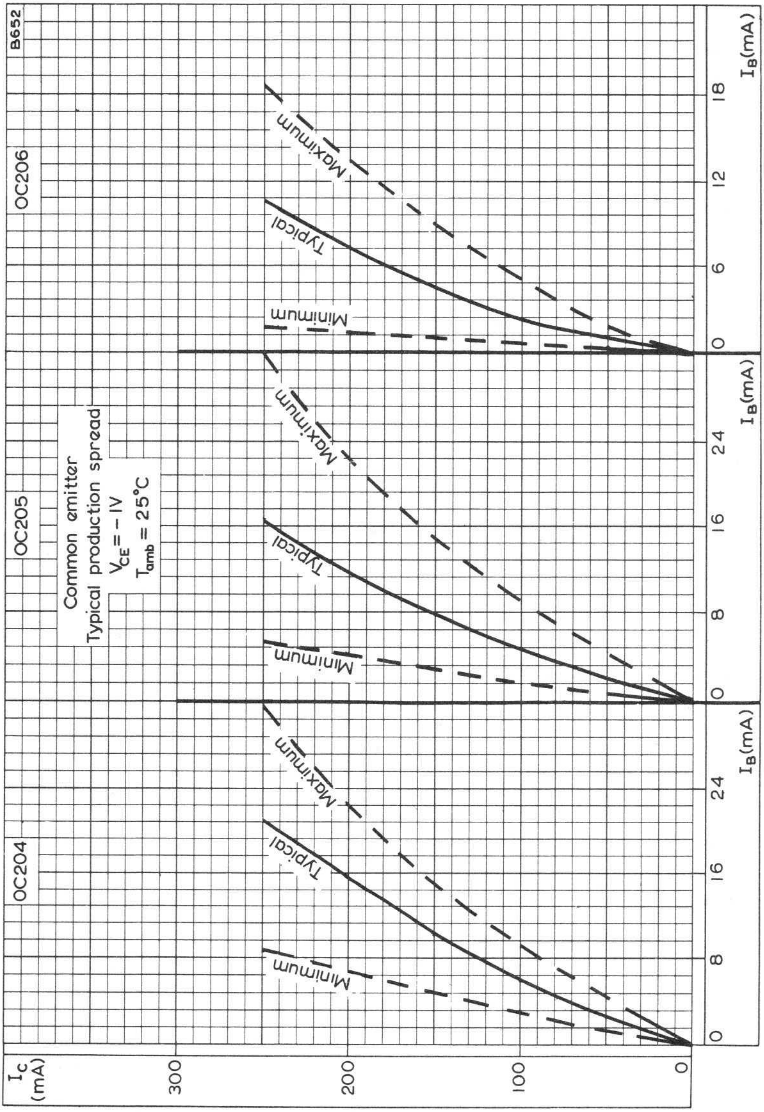
SPREAD OF COLLECTOR CURRENT PLOTTED AGAINST INPUT VOLTAGE



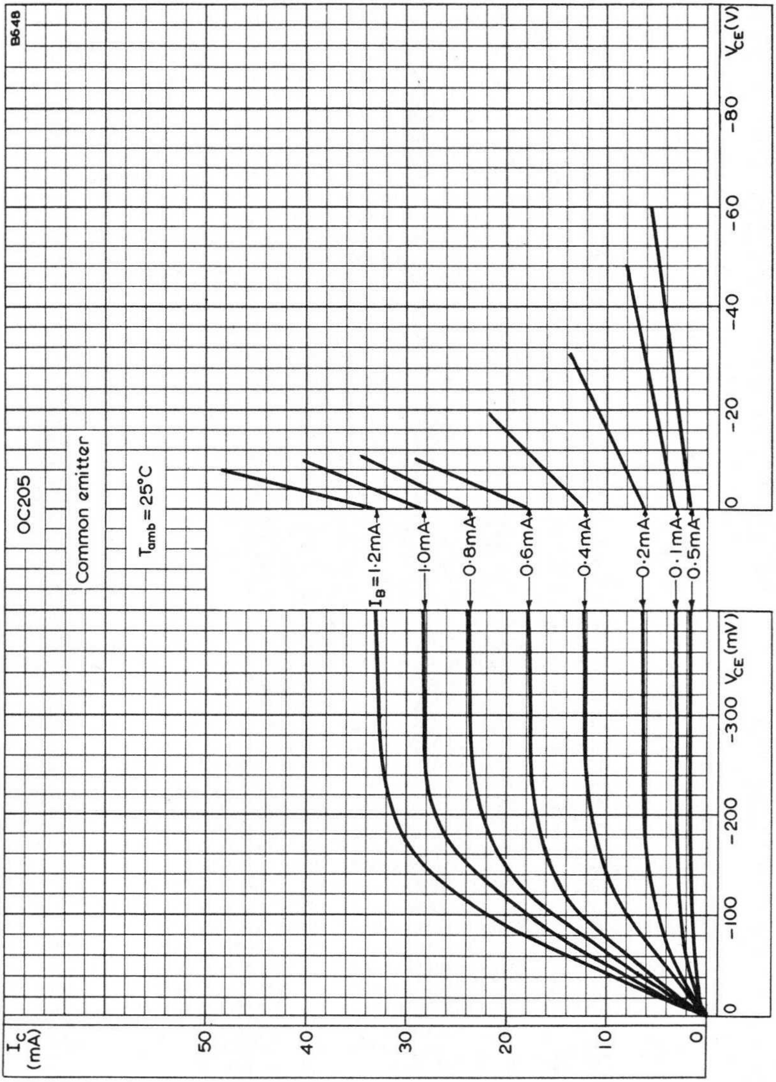
SPREAD OF TRANSFER CHARACTERISTICS AT LOW CURRENTS

OC204 Series

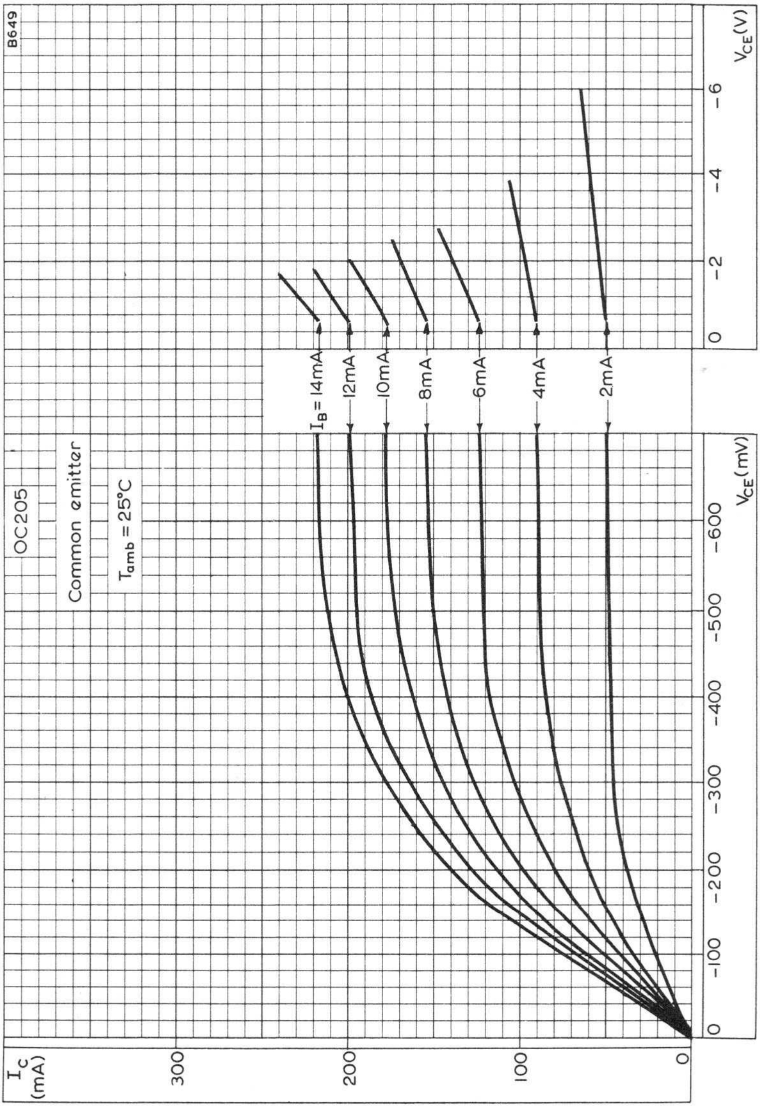
SILICON JUNCTION TRANSISTORS



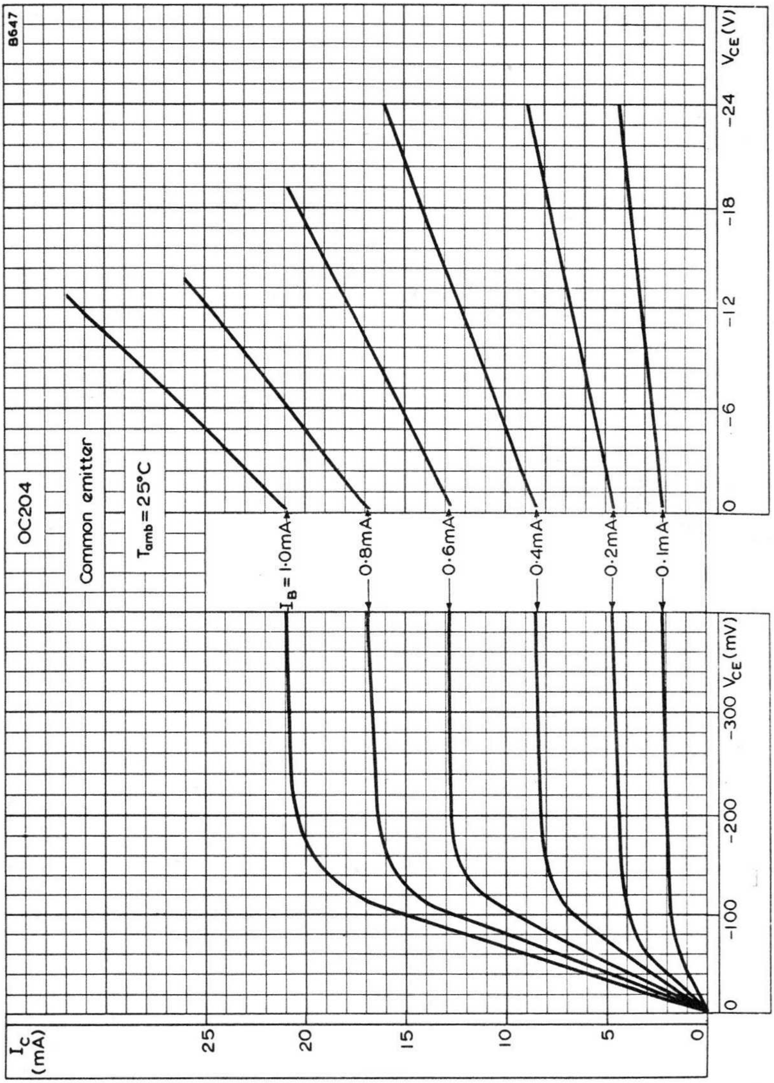
SPREAD OF TRANSFER CHARACTERISTICS AT HIGH CURRENTS



OUTPUT CHARACTERISTICS AT LOW CURRENTS
OC205



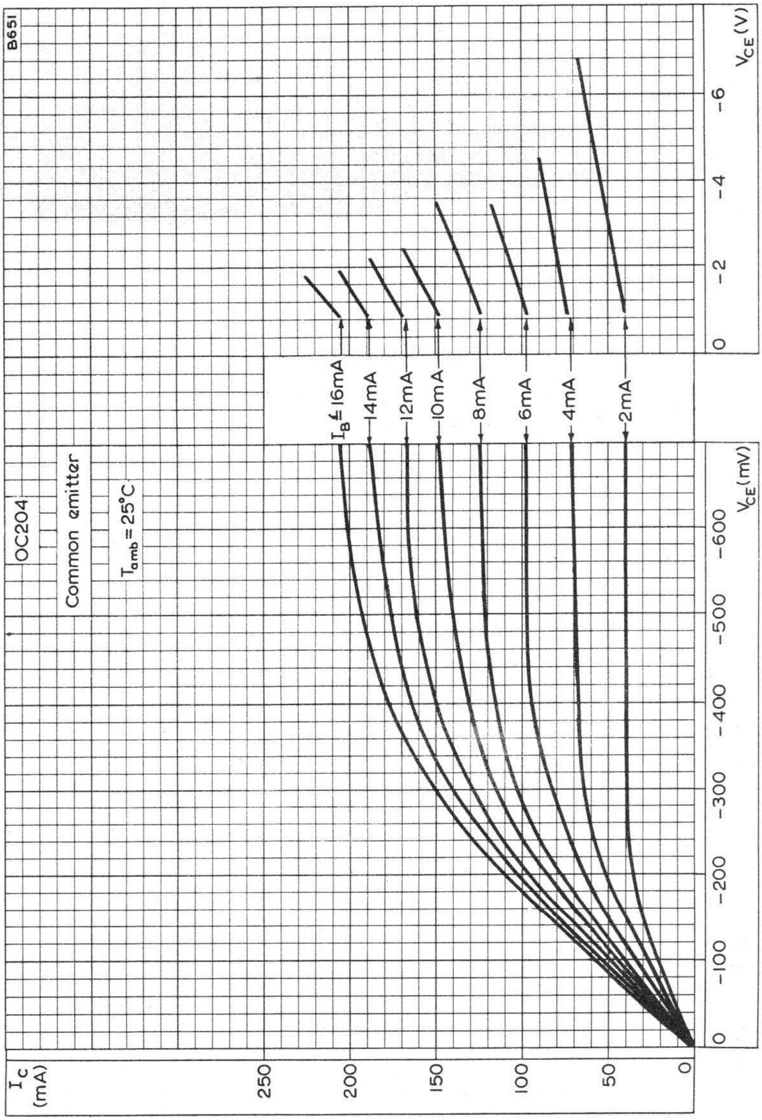
OUTPUT CHARACTERISTICS AT HIGH CURRENTS
OC205



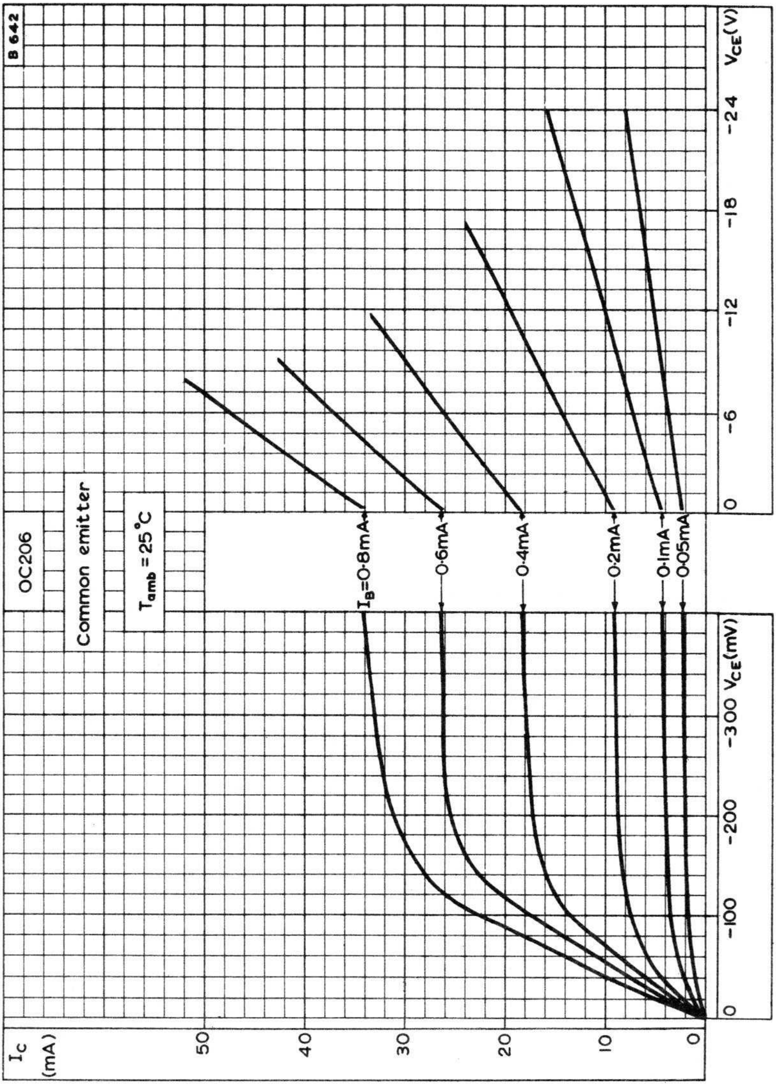
OUTPUT CHARACTERISTICS AT LOW CURRENTS
OC204

OC204 Series

SILICON JUNCTION TRANSISTORS



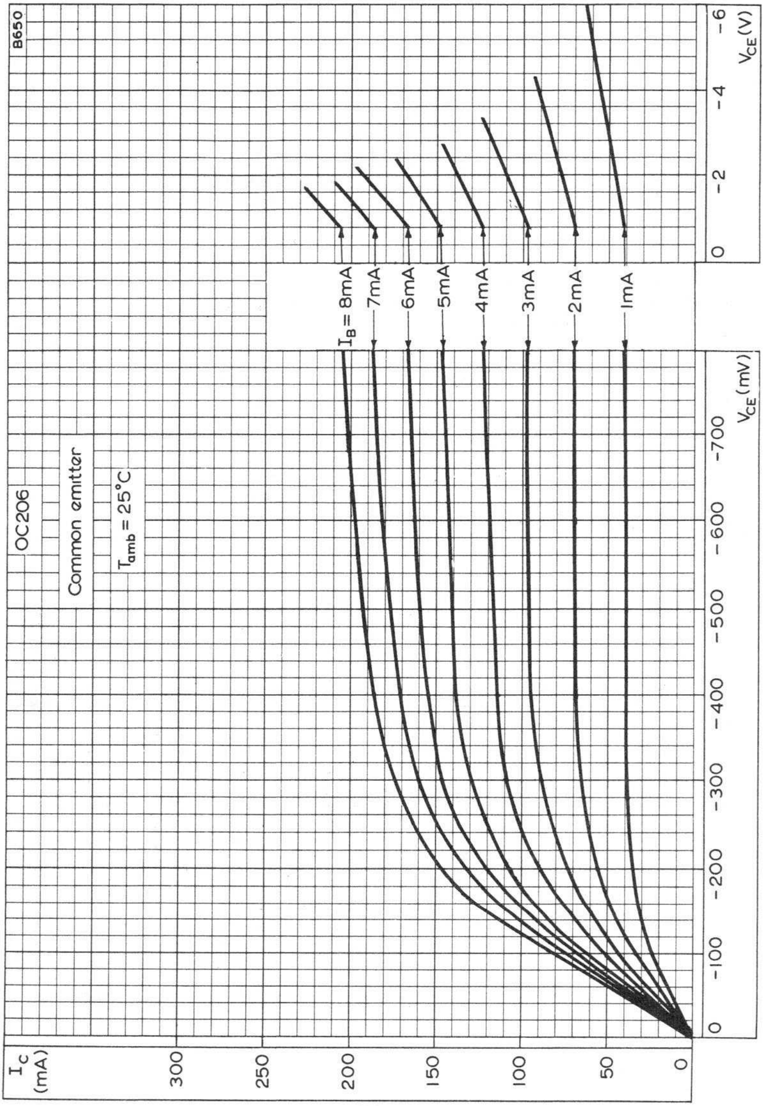
OUTPUT CHARACTERISTICS AT HIGH CURRENTS
OC204



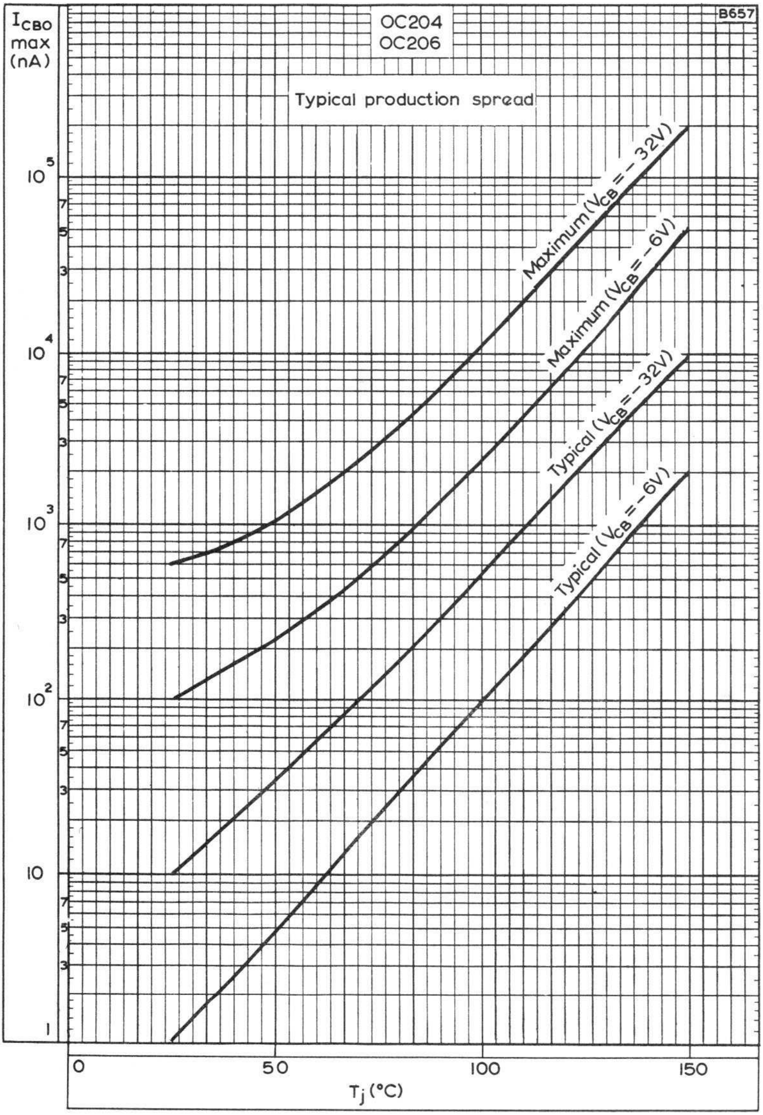
OUTPUT CHARACTERISTICS AT LOW CURRENTS
OC206

OC204 Series

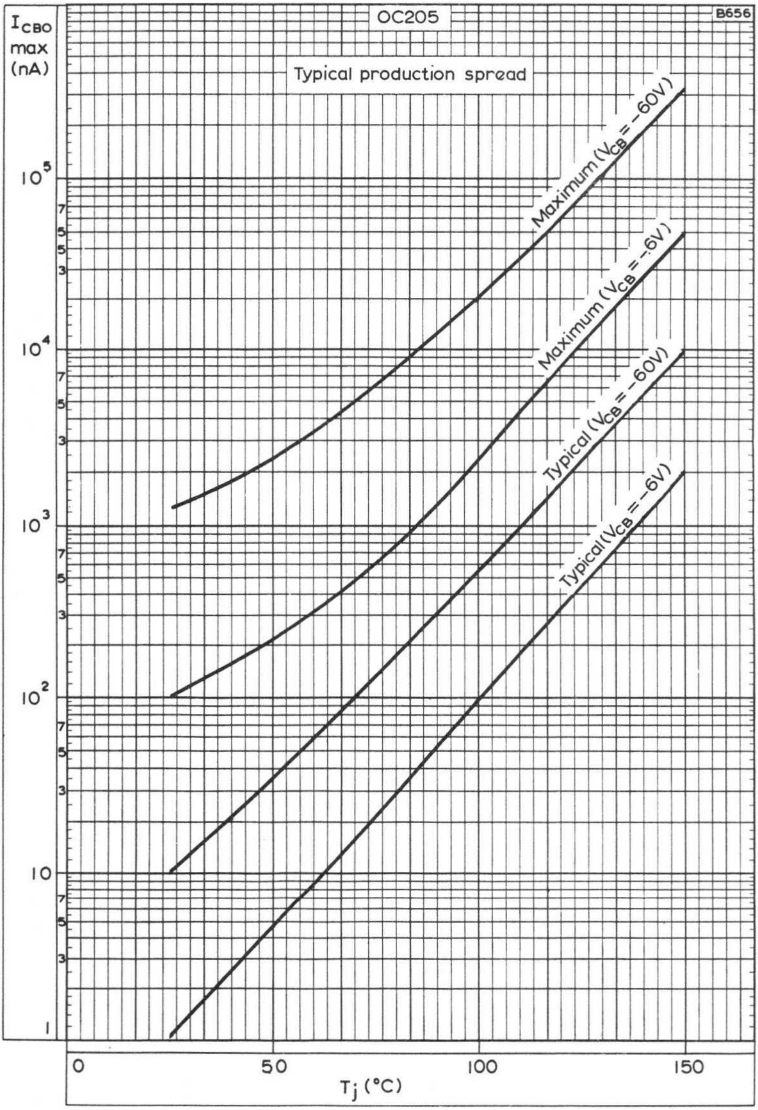
SILICON JUNCTION TRANSISTORS



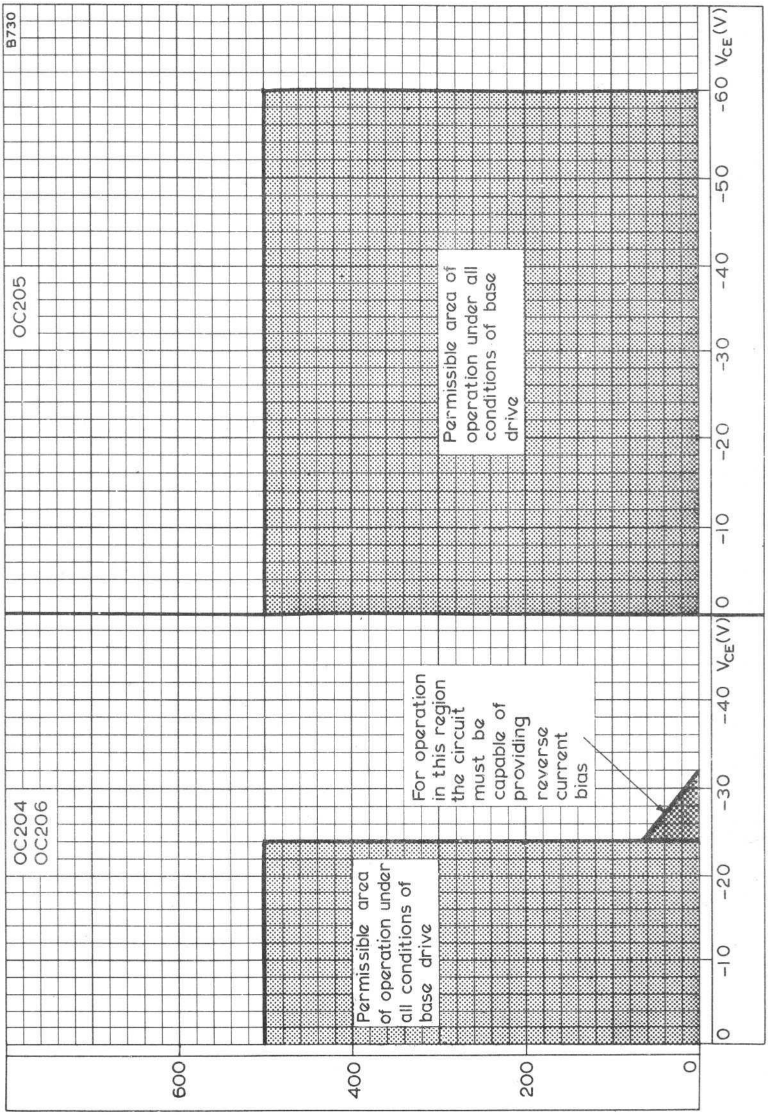
OUTPUT CHARACTERISTICS AT HIGH CURRENTS
OC206



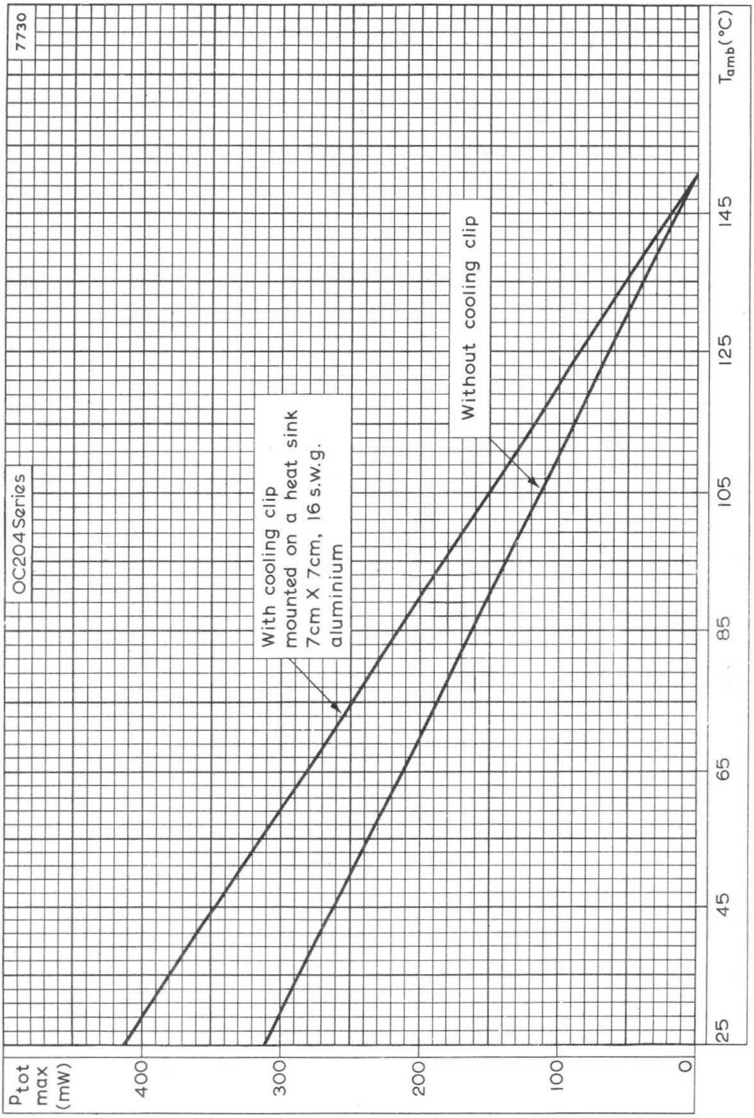
SPREAD OF COLLECTOR LEAKAGE CURRENT PLOTTED AGAINST JUNCTION TEMPERATURE. OC204, 206



SPREAD OF COLLECTOR LEAKAGE CURRENT PLOTTED AGAINST JUNCTION TEMPERATURE. OC205



COLLECTOR CURRENT PLOTTED AGAINST ABSOLUTE MAXIMUM COLLECTOR-EMITTER VOLTAGE



MAXIMUM TOTAL DISSIPATION PLOTTED AGAINST AMBIENT TEMPERATURE

SILICON JUNCTION TRANSISTOR

OC207

TENTATIVE DATA

Silicon p-n-p alloy junction medium power transistor intended for general purpose industrial applications. SO-2/SB3-2 construction.

QUICK REFERENCE DATA

V_{CB} max. (I_E = 0mA) V_{CE} max. (cut-off)	-50	V
V_{CE} max. (I_C = 500mA)	-50	V
I_{CM} max.	500	mA
P_{tot} max. (T_{amb} = 25°C)	310	mW
h_{FE} (I_C = 150mA)	12-70	
f_T (typ)	2.0	Mc/s

RATINGS

Limiting values of operation according to the absolute maximum system as defined in publication 134 of the International Electrotechnical Commission.

Electrical

V_{CB} max. (I_E = 0mA) V_{CE} max. (cut-off)	-50	V
V_{CE} max. (I_C = 500mA)	-50	V
V_{EB} max. (I_C = 0mA)	-12	V
I_{CM} max.	500	mA
*$I_{C(AV)}$ max.	250	mA
I_{EM} max.	500	mA
*$I_{E(AV)}$ max.	250	mA
I_{BM} max.	125	mA
*$I_{B(AV)}$ max.	125	mA

*Averaged over any 20ms period.

P_{tot} max. See curve on page C2

$$P_{tot}\ \text{max.} = \frac{T_j\ \text{max.} - T_{amb}}{\Theta}$$

Thermal

T_{stg} max.	+150	^oC
T_{stg} min.	- 55	^oC
T_j max.	150	^oC

THERMAL CHARACTERISTICS

$\Theta_{j\text{-amb}}$

Without cooling clip in free air	0.4	$^oC/mW$
With cooling clip (type 56210) on a heatsink 7 x 7cm 16 s.w.g. aluminium	0.3	$^oC/mW$

$\Theta_{j\text{-case}}$	0.25	$^oC/mW$

BASIC PARAMETERS $V_{CE} = -6V$, $I_C = 1mA$

	Min.	Typ.	Max.	
$*r_e$	-	25	-	Ω
r_{bb}' (f = 0.5Mc/s)	50	130	250	Ω
c_{tc} (V_{CB} = -6V, I_E = 0)	45	60	100	pF
h_{fe} (I_C = 10mA)	20	50	120	
f_T	0.45	2.0	-	Mc/s

*The value of r_e given here is $\frac{kT}{q} \cdot \frac{1}{I_E} \approx \frac{25}{I_E}$ where I_E is in mA and T is in ^oK.

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

		Min.	Typ.	Max.	
Collector cut-off current	I_{CBO}				
$I_E = 0$, V_{CB} = -6V		-	1	100	nA
-32V		-	10	500	nA
V_{CB} = -6V, $T_j = 100^oC$		-	0.1	2.5	μA
-32V, $T_j = 100^oC$		-	0.5	10	μA

SILICON JUNCTION TRANSISTOR

OC207

Forward current transfer ratio	h_{FE}				
V_{CE} = -2V, I_C = 30mA		20	50	100	
-1V, 150mA		12	25	70	
-6V, 300mA		-	15	-	
Base voltage	V_{BE}				
V_{CB} = 0V, I_C = 150mA		-0.8	-1.2	-1.6	V
Collector saturation voltage	$V_{CE(sat)}$				
I_C = 150mA, I_B = 17mA		-	-280	-560	mV
Noise figure					
V_{CE} = -2V, I_E = 500μA f = 1kc/s, R_s = 500Ω		-	7	20	dB

ACCESSORY

Accessory	Code No.	Notes
Cooling clip	56210	Must be specifically ordered

SOLDERING AND WIRING RECOMMENDATIONS

1. When using a soldering iron, the transistors may be soldered directly into a circuit, but heat conducted to the junction should be kept to a minimum by the use of a heat shunt.

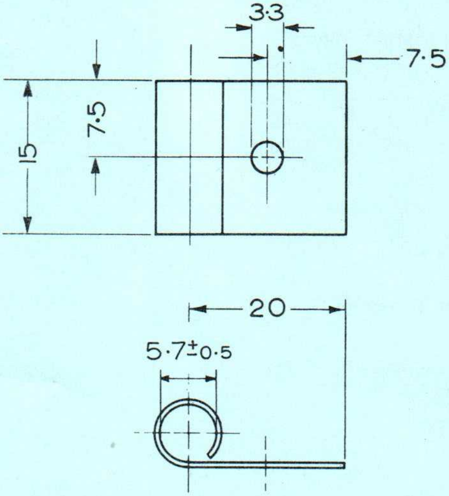
2. These transistors may be dip-soldered at a solder temperature of 245°C for a maximum soldering time of 5 seconds. The case temperature during soldering must not at any time exceed the maximum storage temperature. This recommendation applies to a transistor mounted flush on a board having punched-through holes, or spaced at least 1.5mm above a board having plated-through holes.

3. Care should be taken not to bend the leads nearer than 1.5mm from the seals.

OUTLINE AND DIMENSIONS

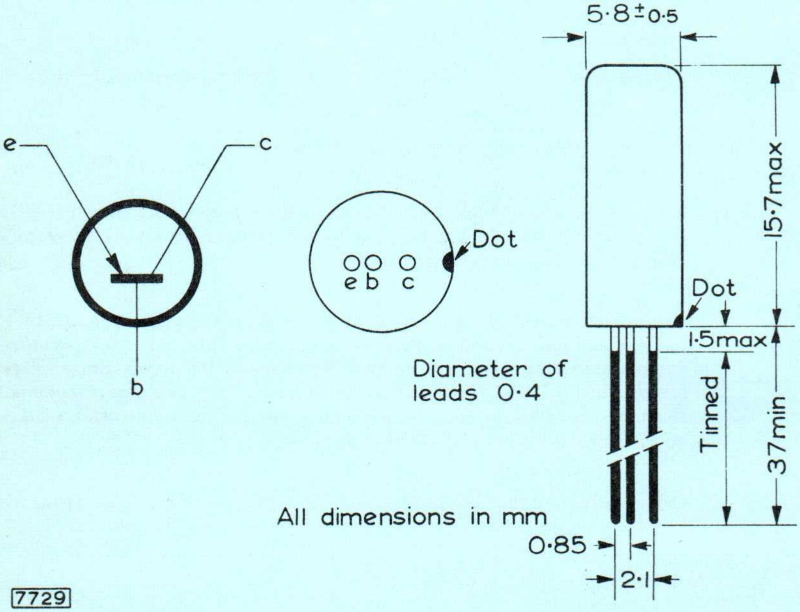
Conforming to V.A.S.C.A. SO-2/SB3-2

N.A.T.O. D5A/D5B



Cooling clip

Material: 0·5mm copper strip commercial half-hard BS899

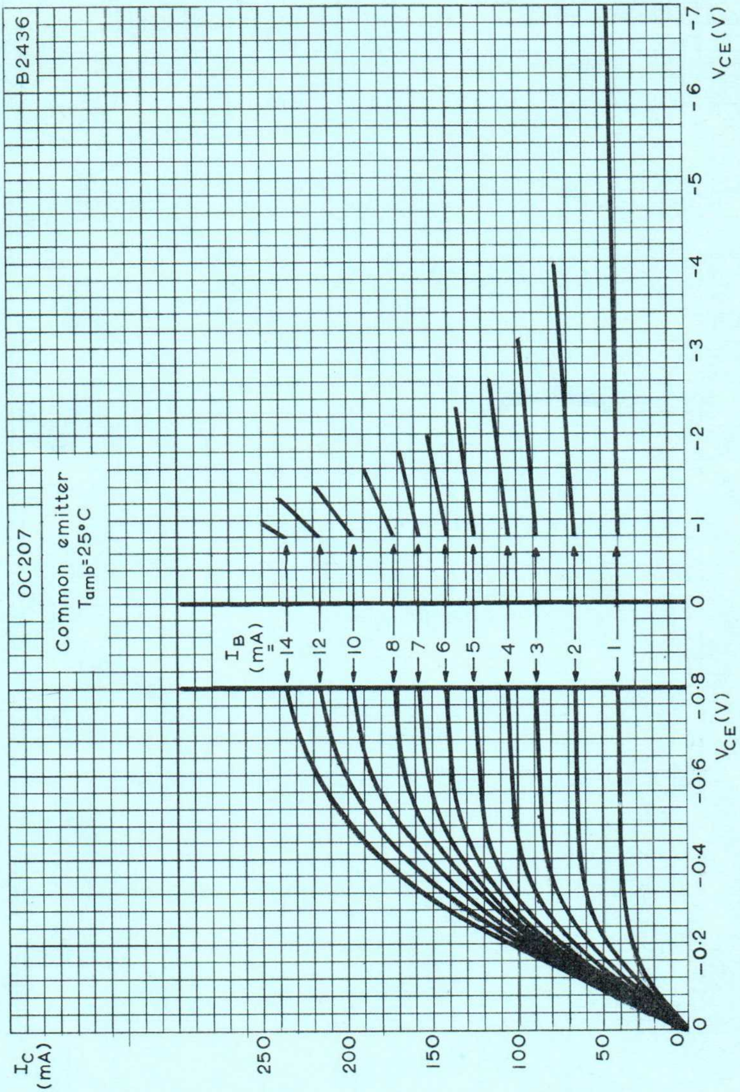


All dimensions in mm

7729

SILICON JUNCTION TRANSISTOR

OC207

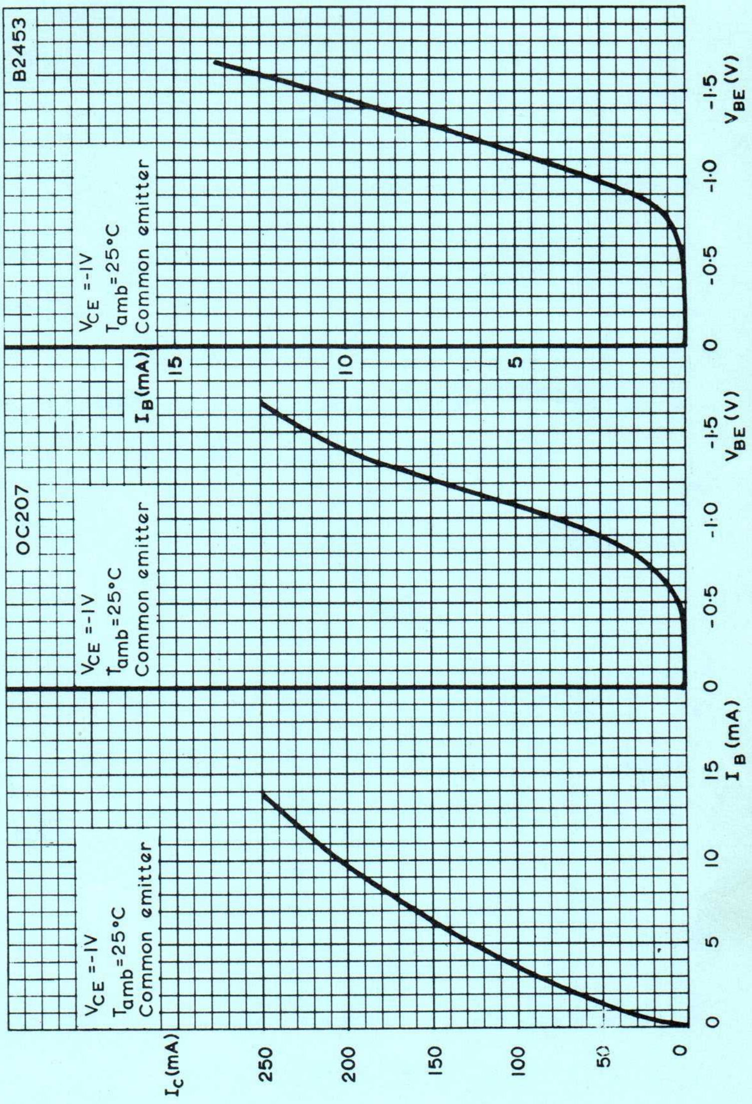


TYPICAL OUTPUT CHARACTERISTIC

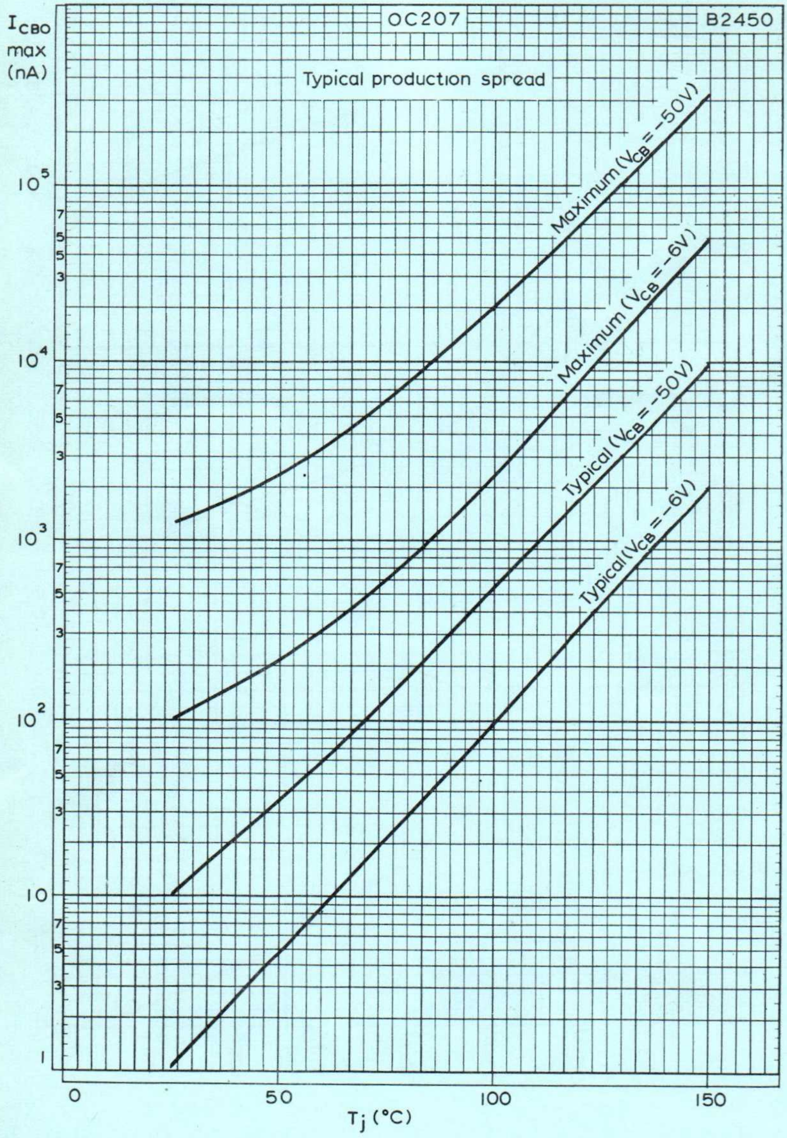
TOTAL DISSIPATION PLOTTED AGAINST AMBIENT TEMPERATURE

SILICON JUNCTION TRANSISTOR

OC207



TYPICAL MUTUAL, TRANSFER AND INPUT CHARACTERISTICS



COLLECTOR CUT-OFF CURRENT PLOTTED AGAINST JUNCTION TEMPERATURE

GERMANIUM P-N-P L.F. POWER TRANSISTORS

2N173 2N174 2N174A

Germanium p-n-p alloy transistors intended for general purpose l.f. power applications.

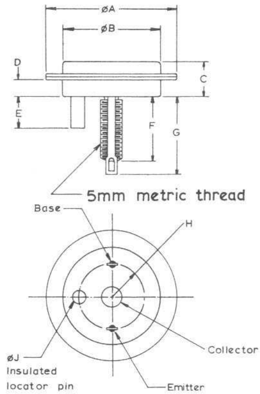
QUICK REFERENCE DATA

	2N173	2N174	2N174A		
$-V_{CBX}$ max. ($+V_{BE} = 1.5V$)	60	80	80		V
$-V_{EBO}$ max.	40	60	60		V
I_E max.				15	A
P_{tot} max. ($T_{mb} = 25^{o}C$)				150	W
T_j max.				100	^{o}C
h_{FE} at $-I_C = 1.2A$, $-V_{CE} = 2V$	-	-	40-80		
$-I_C = 5A$, $-V_{CE} = 2V$	35-70	25-50	>25		

Unless otherwise stated data is applicable to all types

OUTLINE AND DIMENSIONS

Conforming to B.S. 3934 SO-37/SB3-12) with metric thread
J.E.D.E.C. TO-36)



	Millimetres		
	Min.	Typ.	Max.
ØA	-	-	31
ØB	-	-	26.5
C	-	-	10.5
D	-	-	5.33
E	-	-	7.9
F	10	-	12
G	16	-	18
H	-	17.5	-
ØJ	-	-	3.5

Collector connected to mounting base

RATINGS

Limiting values of operation according to the absolute maximum system.

Electrical

$-V_{CBX}$ max. ($+V_{BE} = 1.5V$)	2N173	60	V
	2N174, 2N174A	80	V
$-V_{EBO}$ max.	2N173	40	V
	2N174, 2N174A	60	V
I_E max.		15	A
$-I_B$ max.		4.0	A
P_{tot} max. ($T_{mb} = 25^oC$)		150	W

Temperature

T_{stg} min.	-65	^oC
T_{stg} max.	100	^oC
T_j max.	100	^oC

THERMAL CHARACTERISTICS

Θ_{j-mb}	0.5	degC/W
Thermal capacity for pulses in the 1 to 10ms range	0.075	Ws/degC

ELECTRICAL CHARACTERISTICS ($T_j = 25^oC$ unless otherwise stated)

			Min.	Typ.	Max.	
$-I_{CBO}$	Collector cut-off current					
	$-V_{CB} = 2.0V$, $I_E = 0$	2N173, 2N174	-	100	-	μA
		2N174A	-	100	200	μA
	$-V_{CB} = 60V$, $I_E = 0$	2N173	-	2.0	8.0	mA
	$-V_{CB} = 80V$, $I_E = 0$	2N174, 2N174A	-	2.0	8.0	mA
	$-V_{CB} = 60V$, $I_E = 0$, $T_j = 70^oC$	2N173	-	-	15	mA
	$-V_{CB} = 80V$, $I_E = 0$, $T_j = 70^oC$	2N174	-	-	15	mA
	$-V_{CB} = 30V$, $I_E = 0$, $T_j = 70^oC$	2N174A	-	4.0	6.0	mA

ELECTRICAL CHARACTERISTICS (cont'd)

Symbol	Parameter / Conditions	Type	Min.	Typ.	Max.	Unit
$-I_{EBO}$	Emitter cut-off current					
	$-V_{EB}=40V, I_C=0$	2N173	-	1.0	8.0	mA
	$-V_{EB}=60V, I_C=0$	2N174, 2N174A	-	1.0	8.0	mA
	$-V_{EB}=30V, I_C=0, T_j=70^{o}C$	2N174A	-	4.0	6.0	mA
	Collector-emitter breakdown voltage					
$-V_{(BR)CEO}$	$-I_C=1.0A, I_B=0$	2N173	45	-	-	V
		2N174	55	-	-	V
$-V_{(BR)CEO}$	$-I_C=0.3A, I_B=0$	2N174A	-	60	-	V
$-V_{(BR)CES}$	$-I_C=0.3A, V_{BE}=0$	2N173	50	-	-	V
		2N174, 2N174A	70	-	-	V
$-V_{CE(sat)}$	Collector-emitter saturation voltage					
	$-I_C=12A, -I_B=2.0A$	2N173	-	0.3	1.0	V
		2N174	-	0.3	0.9	V
		2N174A	-	0.3	0.7	V
$-V_{BE}$	Base-emitter voltage					
	$-I_C=1.2A, -V_{CE}=2.0V$	2N174A	-	0.35	0.5	V
	$-I_C=5.0A, -V_{CE}=2.0V$	2N173	-	0.65	-	V
		2N174, 2N174A	-	0.65	0.9	V
$-V_{EB(fl)}$	Emitter-base floating potential					
	$-V_{CB}=60V, I_E=0$	2N173	-	0.15	1.0	V
	$-V_{CB}=80V, I_E=0$	2N174, 2N174A	-	0.15	1.0	V

			Min.	Typ.	Max.	
h_{FE}	Forward current transfer ratio					
	$-I_C = 1.2, -V_{CE} = 2.0V$	2N174A	40	55	80	
	$-I_C = 5.0A, -V_{CE} = 2.0V$	2N173	35	-	70	
		2N174	25	-	50	
		2N174A	25	35	-	
	$-I_C = 12A, -V_{CE} = 2.0V$	2N173	-	25	-	
		2N174	-	20	-	
	Cut-off frequency					
f_{hfe}	$-I_C = 5.0A, -V_{CE} = 6.0V$	2N173, 2N174	-	10	-	kHz
f_{hfb}	$-I_C = 1.0A, -V_{CB} = 12V$	2N174A	100	-	-	kHz
t_r	Rise time					
	$-I_C = 12A, -I_B = 2.0A, -V_{CE} = 12V$		-	15	-	μs
t_f	Fall time					
	$+V_{BE} = 6.0V, R_{BE} = 10\Omega, I_C = 0$		-	15	-	μs

ACCESSORIES (Code No.56213)

Supplied with devices

1 mica washer

1 insulating ring

1 cable lug

1 lock washer

1 hexagon nut M5

N-P-N SILICON A.F. OUTPUT TRANSISTOR

BD115

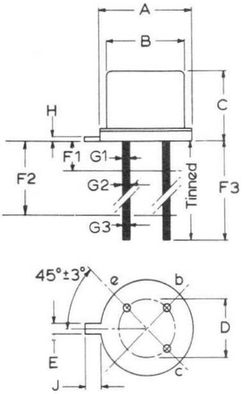
TENTATIVE DATA

N-P-N silicon output transistor intended for use in class 'A' output stages of audio amplifiers operating from a supply voltage of 100V.

QUICK REFERENCE DATA			
V_{CBO} max.		220	V
V_{CEO} max.		180	V
I_{CM} max.		150	mA
P_{tot} max. ($T_{amb} \leq 50^{o}C$, mounted on heatsink)		6.0	W
h_{FE} ($I_C = 50mA$, $V_{CE} = 100V$, $T_j = 25^{o}C$)	min.	22	
	typ.	60	

OUTLINE AND DIMENSIONS

Conforms to B.S. 3934 SO-3/SB3-3B
J.E.D.E.C. TO-39



Collector connected to case

Millimetres	Min.	Nom.	Max.
A	9.10	-	9.40
B	8.2	-	8.5
C	6.15	-	6.60
D	-	5.08	-
E	0.71	-	0.86
F1	-	-	0.51
F2	12.7	-	-
F3	12.7	-	15
G1	-	-	1.01
G2	0.41	-	0.48
G3	-	-	0.53
H	-	0.4	-
J	0.74	-	1.01

RATINGS

Limiting values of operation according to the absolute maximum system.

Electrical

Voltage

V_{CBO} max.	220	V
V_{CEO} max. (see page 0)	180	V
V_{CER} max. ($R_{BE} \leq 1.0k\Omega$)	220	V
V_{EBO} max.	5.0	V

Current

I_C max. (d.c.)	150	mA
I_{CM} max. (peak)	150	mA

Power

P_{tot} max.	$T_{amb} \leq 50^{o}C$, mounted on a 1.5mm blackened aluminium heatsink of at least $30cm^2$ (see page 6)	6.0	W

Temperature

T_{stg} range	-55 to +200	^{o}C
T_j max.	200	^{o}C

THERMAL CHARACTERISTICS

$R_{th(j-amb)}$	From junction to ambient in free air	200	degC/W
$R_{th(j-amb)}$	From junction to ambient mounted on a 1.5mm blackened aluminium heatsink of at least $30cm^2$	25	degC/W
$R_{th(j-mb)}$	From junction to mounting base	12.5	degC/W

ELECTRICAL CHARACTERISTICS ($T_j = 25^{o}C$ unless otherwise stated)

		Min.	Typ.	Max.	
I_{CBO}	Collector cut-off current $I_E = 0$, $V_{CB} = 200V$, $T_j = 200^{o}C$	-	550	-	μA
I_{EBO}	Emitter cut-off current $I_C = 0$, $V_{EB} = 5.0V$	-	-	100	μA
V_{BE}	*Base-emitter voltage $I_C = 50mA$, $V_{CE} = 100V$	-	-	1.0	V

*V_{BE} decreases by about 2.0mV/degC with increasing temperature.

GERMANIUM P-N-P L.F. POWER TRANSISTORS

2N441 2N442 2N443

Germanium p-n-p alloy transistors intended for general purpose l.f. power applications.

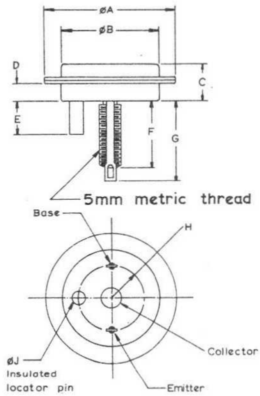
QUICK REFERENCE DATA

	2N441	2N442	2N443		
$-V_{CBX}$ max. ($+V_{BE} = 1.5V$)	40	50	60		V
$-V_{EBO}$ max.	20	30	40		V
I_E max.				15	A
P_{tot} max. ($T_{mb} = 25^oC$)				150	W
T_j max.				100	^oC
h_{FE} ($-I_C = 5A$, $-V_{CE} = 2V$)				20-40	

Unless otherwise stated data is applicable to all types

OUTLINE AND DIMENSIONS

Conforming to B.S.3934 SO-37/SB3-12) with metric thread
J.E.D.E.C. TO-36)



	Millimetres		
	Min.	Typ.	Max.
ØA	-	-	31
ØB	-	-	26.5
C	-	-	10.5
D	-	-	5.33
E	-	-	7.9
F	10	-	12
G	16	-	18
H	-	17.5	-
ØJ	-	-	3.5

Collector connected to mounting base

RATINGS

Limiting values of operation according to the absolute maximum system.

Electrical

	2N441	2N442	2N443		
$-V_{CBX}$ max. ($+V_{BE}$ = 1.5V)	40	50	60		V
$-V_{EBO}$ max.	20	30	40		V
I_E max.				15	A
$-I_B$ max.				4.0	A
P_{tot} max. (T_{mb} = 25°C)				150	W

Temperature

T_{stg} min.	-65	°C
T_{stg} max.	100	°C
T_j max.	100	°C

THERMAL CHARACTERISTICS

Θ_{j-mb}	0.5	degC/W
Thermal capacity for pulses in the 1 to 10ms range	0.075	Ws/degC

ELECTRICAL CHARACTERISTICS (T_j = 25°C)

			Min.	Typ.	Max.	
$-I_{CBO}$	Collector cut-off current					
	$-V_{CB}$ = 2.0V, I_E = 0		-	100	-	μA
	$-V_{CB}$ = 40V, I_E = 0	2N441	-	2.0	8.0	mA
	$-V_{CB}$ = 50V, I_E = 0	2N442	-	2.0	8.0	mA
	$-V_{CB}$ = 60V, I_E = 0	2N443	-	2.0	8.0	mA
$-I_{EBO}$	Emitter cut-off current					
	$-V_{EB}$ = 20V, I_C = 0	2N441	-	1.0	8.0	mA
	$-V_{EB}$ = 30V, I_C = 0	2N442	-	1.0	8.0	mA
	$-V_{EB}$ = 40V, I_C = 0	2N443	-	1.0	8.0	mA

ELECTRICAL CHARACTERISTICS (cont'd)

Symbol	Parameter / Conditions	Type	Min.	Typ.	Max.	Unit
	Collector-emitter breakdown voltage					
$-V_{(BR)CEO}$	$-I_C = 300mA,\ I_B = 0$	2N441	-	40	-	V
		2N442	-	45	-	V
		2N443	-	55	-	V
$-V_{(BR)CES}$	$-I_C = 300mA,\ V_{BE} = 0$	2N441	40	-	-	V
		2N442	45	-	-	V
		2N443	50	-	-	V
$-V_{CE(sat)}$	Collector-emitter saturation voltage					
	$-I_C = 12A,\ -I_B = 2.0A$	2N441, 2N442	-	0.3	-	V
		2N443	-	0.3	1.0	V
$-V_{BE}$	Base-emitter voltage					
	$-I_C = 5.0A,\ -V_{CE} = 2.0V$	2N441, 2N442	-	0.65	-	V
		2N443	-	0.65	0.9	V
$-V_{EB(fl)}$	Emitter-base floating potential					
	$-V_{CB} = 40V,\ I_E = 0$	2N441	-	-	1.0	V
	$-V_{CB} = 50V,\ I_E = 0$	2N442	-	-	1.0	V
	$-V_{CB} = 60V,\ I_E = 0$	2N443	-	-	1.0	V
h_{FE}	Forward current transfer ratio					
	$-I_C = 5.0A,\ -V_{CE} = 2.0V$		20	-	40	
	$-I_C = 12A,\ -V_{CE} = 2.0V$		-	20	-	
f_{hfe}	Cut-off frequency					
	$-I_C = 5.0A,\ -V_{CE} = 6.0V$		-	10	-	kHz
t_r	Rise time					
	$-I_C = 12A,\ -I_B = 2.0A,\ -V_{CE} = 12V$		-	15	-	μs
t_f	Fall time					
	$+V_{BE} = 6.0V,\ R_{BE} = 10\Omega,\ I_C = 0$		-	15	-	μs

ACCESSORIES (Code No.56213)

Supplied with devices:

1 mica washer

1 insulating ring

1 cable lug

1 lock washer

1 hexagon nut M5

SILICON N-P-N PLANAR TRANSISTORS

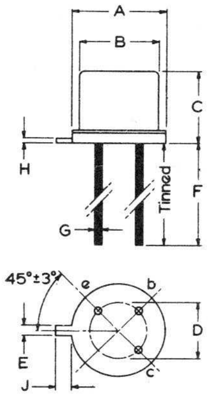
2N696 2N697

Silicon n-p-n planar transistors for general industrial applications.

QUICK REFERENCE DATA		
V_{CBO} max. (I_E = 0)	60	V
V_{CER} max. ($R_{BE} \leq 10\Omega$)	40	V
V_{EBO} max. (I_C = 0)	5.0	V
I_{CM} max.	500	mA
P_{tot} ($T_{case} = 25^{\circ}C$)	2.0	W
h_{FE}	2N696 20 - 60	
	2N697 40 - 120	
$\theta_{j\text{-}case}$	75	deg C/W

OUTLINE AND DIMENSIONS

Conforms to J.E.D.E.C. TO-5



	Millimetres		
	Min.	Nom.	Max.
A	8.64	8.9	9.4
B	7.75	8.15	8.5
C	6.1	6.35	6.6
D	-	5.08	-
E	0.71	0.79	0.86
F	38	-	-
G	-	0.45	-
H	-	0.4	-
J	0.74	0.85	1.01

Collector connected to envelope

RATINGS

Limiting values of operation according to the absolute maximum system.

Electrical

†V_{CBO} max. ($I_E = 0$)	60	V
†V_{CER} max. ($R_{BE} \leq 10\Omega$)	40	V
†V_{EBO} max. ($I_C = 0$)	5.0	V
I_{CM} max.	500	mA
†P_{tot} max. $T_{case} = 25^{o}C$	2.0	W
$T_{case} = 100^{o}C$	1.0	W
$T_{amb} = 25^{o}C$	0.6	W

Temperature

†T_{stg} min.	-65	^{o}C
†T_{stg} max.	200	^{o}C
†T_j max. (operating)	175	^{o}C

THERMAL CHARACTERISTICS

†$\Theta_{j\text{-}case}$	75	deg C/W
Derating factor	13.3	mW/deg C

ELECTRICAL CHARACTERISTICS ($T_{amb} = 25^{o}C$ unless otherwise stated)

		Min.	Typ.	Max.	
†$V_{CE(sat)}$	Collector-emitter saturation voltage				
	$I_C = 150mA$, $I_B = 15mA$	-	0.7	1.5	V
†$V_{BE(sat)}$	Base-emitter saturation voltage				
	$I_C = 150mA$, $I_B = 15mA$	-	1.0	1.3	V
†I_{CBO}	Collector current-off current				
	$I_E = 0$, $V_{CB} = 30V$	-	0.01	1.0	μA
	$I_E = 0$, $V_{CB} = 30V$, $T_{amb} = 150^{o}C$	-	0.7	100	μA
†c_{ob}	Output capacitance				
	$I_E = 0$, $V_{CB} = 10V$	-	17	35	pF
†h_{ib}	Input impedance				
	$I_C = 1.0mA$, $V_{CB} = 5.0V$	24	27	34	Ω
	$I_C = 5.0mA$, $V_{CB} = 10V$	4.0	6.3	8.0	Ω

			Min.	Typ.	Max.	
†h_{rb}	Voltage feedback ratio					
	$I_C=1.0mA$, $V_{CB}=5.0V$		-	0.7	3.0	$\times10^{-4}$
	$I_C=5.0mA$, $V_{CB}=10V$		-	0.8	3.0	$\times10^{-4}$
†h_{fe}	Small signal forward current transfer ratio					
	$I_C=1.0mA$, $V_{CE}=5.0V$		30	55	100	
	$I_C=5.0mA$, $V_{CE}=10V$		35	70	150	
†h_{ob}	Output admittance					
	$I_C=1.0mA$, $V_{CB}=5.0V$		0.1	0.16	0.5	µmho
	$I_C=5.0mA$, $V_{CB}=10V$		0.1	0.19	1.0	µmho
†h_{ie}	Input impedance					
	$I_C=1.0mA$, $V_{CE}=5.0V$		-	2.2	-	kΩ
†h_{re}	Voltage feedback ratio					
	$I_C=1.0mA$, $V_{CE}=5.0V$		-	3.6	-	$\times10^{-4}$
†h_{oe}	Output admittance					
	$I_C=1.0mA$, $V_{CE}=5.0V$		-	12.5	-	µmho
*†h_{FE}	Large signal forward current transfer ratio					
	$I_C=150mA$, $V_{CE}=10V$	2N696	20	40	60	
		2N697	40	75	120	
†h_{fe}	High frequency current gain					
	$I_C=50mA$, $V_{CE}=10V$					
	f=20Mc/s	2N696	2.0	3.0	-	
		2N697	2.5	4.0	-	

*Measured under pulse conditions to prevent excessive dissipation, pulse width=300µs, duty cycle=0.01.

†J.E.D.E.C. registered characteristics.

SOLDERING AND WIRING RECOMMENDATIONS

1. When using a soldering iron, transistors may be soldered directly into the circuit, but heat conducted to the junction should if possible be kept to a minimum by the use of a thermal shunt.

2. Transistors may be dip-soldered at a solder temperature of 245°C for a maximum soldering time of 5 seconds. The case temperature during dip-soldering must not at any time exceed the maximum storage temperature. These recommendations apply to a transistor mounted flush on a board having punched-through holes, or spaced at least 1.5mm above a board having plated-through holes.

3. Care should be taken not to bend the leads nearer than 1.5mm from the seal.

4. If the devices are stored at temperatures above 100°C before incorporation into equipment some deterioration of the external surface is likely to occur which may make soldering into the circuit difficult. Under these circumstances the leads should be retinned using a suitable activated flux.

SILICON PLANAR EPITAXIAL N-P-N TRANSISTOR

2N918

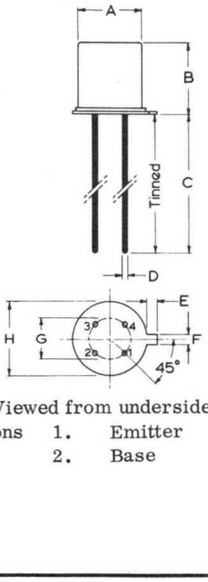
Silicon planar epitaxial n-p-n transistor primarily intended for low power r.f. amplifier and oscillator applications in the v.h.f. and u.h.f. ranges for industrial service. TO-72 construction, shield lead connected to the envelope.

QUICK REFERENCE DATA

V_{CBO} max. ($I_E = 0$)	30	V
V_{CEO} max. ($I_B = 0$)	15	V
I_C max.	50	mA
P_{tot} max. ($T_{amb} = 25^{\circ}C$)	200	mW
T_j max.	200	$^{\circ}C$
f_T min.	900	Mc/s ←
Max. unilateralised gain typ. $= 10 \log \frac{\lvert y_{fe} \rvert^2}{4g_{ie}.g_{oe}}$		
$I_C = 6.0mA$, $V_{CE} = 12V$, $f = 200Mc/s$	36	dB
NF max. ($I_C = 1.0mA$, $V_{CE} = 6.0V$, $f = 60Mc/s$, $R_s = 400\Omega$)	6.0	dB

OUTLINE AND DIMENSIONS

Conforming to J.E.D.E.C. TO-72



Viewed from underside

Millimetres

	Min.	Nom.	Max.
A	-	-	4.80
B	-	-	5.33
C	12.7	-	-
D	-	-	0.48
E	-	-	1.21
F	-	-	1.16
G	-	2.54	-
H	-	-	5.83

Connections 1. Emitter 3. Collector
2. Base 4. Shield connected to envelope

RATINGS

Limiting values of operation according to the absolute maximum system.

Electrical

† V_{CBO} max. ($I_E = 0$)	30	V
† V_{CEO} max. ($I_B = 0$)	15	V
† V_{EBO} max. ($I_C = 0$)	3.0	V
† I_C max.	50	mA
† P_{tot} max. ($T_{amb} = 25^oC$)	200	mW

Temperature

† T_{stg}	-65 to +200	^oC
† T_j max.	200	^oC

THERMAL CHARACTERISTICS

† Θ_{j-amb}	0.88	degC/mW
† Θ_{j-case}	0.58	degC/mW

ELECTRICAL CHARACTERISTICS ($T_j = 25^oC$ unless otherwise stated)

		Min.	Max.	
† I_{CBO}	Collector cut-off current			
	$V_{CB} = 15V$, $I_E = 0$	-	10	nA
	$V_{CB} = 15V$, $I_E = 0$, $T_j = 150^oC$	-	1.0	μA
† h_{FE}	Static forward current transfer ratio			
	$I_C = 3.0mA$, $V_{CE} = 1.0V$	20	-	
† $V_{CE(sat)}$	Collector-emitter saturation voltage			
	$I_C = 10mA$, $I_B = 1.0mA$	-	0.4	V
† $V_{BE(sat)}$	Base-emitter saturation voltage			
	$I_C = 10mA$, $I_B = 1.0mA$	-	1.0	V
f_T	Transition frequency (see note)			
	$I_C = 6.0mA$, $V_{CE} = 10V$	900	-	Mc/s ←
† c_{tc}	Collector capacitance			
	$V_{CB} = 10V$, $I_E = I_e = 0$, f = 140kc/s	-	1.7	pF
	$V_{CB} = 0$, $I_E = I_e = 0$, f = 140kc/s	-	3.0	pF
† c_{te}	Emitter capacitance			
	$V_{EB} = 0.5V$, $I_C = I_c = 0$, f = 140kc/s	-	2.0	pF
† P_O	Oscillator power output			
	$I_E = 8.0mA$, $V_{CB} = 15V$, f = 500Mc/s	30	-	mW

NOTE

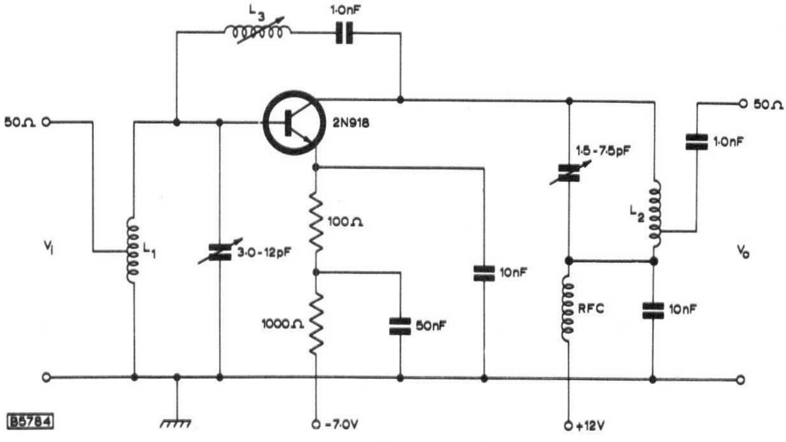
J.E.D.E.C. registration of this parameter at $I_C = 4.0mA$ and $V_{CE} = 10V$ is 600Mc/s min.

ELECTRICAL CHARACTERISTICS (cont"d)

		Min.	Typ.	Max.	
†NF	Noise figure $I_C = 1.0mA, V_{CE} = 6.0V, f = 60Mc/s$ $R_s = 400\Omega$	-		6.0	dB
	†Maximum unilateralised gain (typ.) $= 10 \log \frac{\lvert y_{fe} \rvert^2}{4g_{ie} \cdot g_{oe}}$ $I_C = 6.0mA, V_{CE} = 12V, f = 200Mc/s$	-	36	-	dB

For all measurements the shield lead is not grounded

Basic circuit for measuring available power gain (neutralised)



L_1 = 3.5 turns 1.3mm, tinned copper wire
coil diameter 8mm, length 11mm, turns ratio≈4 to 2.

L_2 = 8 turns 1.3mm, tinned copper wire
coil diameter 3mm, length 22mm, turns ratio≈8 to 1.

L_3 = 0.4 to 0.65μH
Shield lead is grounded.

†Available power gain at

I_C = 6mA, f = 200Mc/s (min.) 15 dB

†J.E.D.E.C. registered data.

SOLDERING AND WIRING RECOMMENDATIONS

1. When using a soldering iron, transistors may be soldered directly into the circuit, but heat conducted to the junction should if possible be kept to a minimum by the use of a thermal shunt.

2. Transistors may be dip-soldered at a solder temperature of 245^{o}C for a maximum soldering time of 5 seconds. The case temperature during dip-soldering must not at any time exceed the maximum storage temperature. These recommendations apply to a transistor mounted flush on a board having punched-through holes, or spaced at least 1.5mm above a board having plated through holes.

3. Care should be taken not to bend the leads nearer than 1.5mm from the seal.

4. If devices are stored above 100^{o}C before incorporation into equipment, some deterioration of the external surface is likely to occur which may make soldering into the circuit difficult. Under these circumstances the leads should be retinned using a suitable activated flux.

SILICON PLANAR TRANSISTORS

2N929
2N930

Silicon n-p-n planar transistor for use in high performance, low level, low noise amplifier applications both for direct current and for frequencies up to 100Mc/s.

QUICK REFERENCE DATA

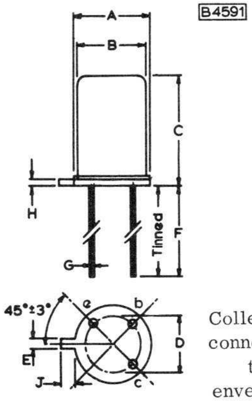
	2N929	2N930	
†V_{CBO} (I_E = 0)	45	45	V
†V_{CEO} (I_B = 0)	45	45	V
I_{CM} max.	60	60	mA
†P_{tot} (T_{amb} = 25°)	300	300	mW
T_j max.	175	175	°C
†h_{FE} (V_{CE} = 5.0V, I_C = 10μA, T_j = 25°C)	40 - 120	100 - 300	
†h_{FE} (V_{CE} = 5.0V, I_C = 10mA, T_j = 25°C)	100 - 350	200 - 600	
f_T typ. (V_{CE} = 5.0V, I_C = 0.5mA, T_j = 25°C)	80	80	Mc/s

Unless otherwise shown data is applicable to both types

OUTLINE AND DIMENSIONS

Conforms to J.E.D.E.C. TO-18

V.A.S.C.A. SO12A/SB3-6A



Collector connected to envelope

	Millimetres		
	Min.	Typ.	Max.
A	5.3	5.55	5.8
B	4.52	-	4.8
C	4.66	-	5.3
D	-	2.54	-
E	0.95	1.05	1.15
F	12.7	-	-
G	-	0.43	-
H	0.06	-	1.01
J	0.9	1.05	1.20

RATINGS

Limiting values of operation according to the absolute maximum system.

Electrical

†I_C (see note 1)	30	mA
I_{CM}	60	mA
I_E (see note 1)	35	mA
I_{EM}	70	mA
I_B (see note 1)	5.0	mA
I_{BM}	10	mA
†V_{CBO} ($I_E = 0$)	45	V
†V_{CEO} ($I_B = 0$)	45	V
†V_{EBO} ($I_C = 0$)	5.0	V
†P_{tot} max. ($T_{amb} = 25^{\circ}C$, see note 2)	300	mW
P_{tot} max. ($T_{case} = 25^{\circ}C$, see note 3)	600	mW

Thermal

†T_{stg} min.	-65	$^{\circ}C$
T_{stg} max. (see note 4)	200	$^{\circ}C$
T_j (operating range)	-65 to +175	$^{\circ}C$

THERMAL CHARACTERISTICS

θ_{j-amb}	0.5	deg C/mW
θ_{j-case}	0.25	deg C/mW

SILICON PLANAR TRANSISTORS

2N929
2N930

ELECTRICAL CHARACTERISTICS ($T_j = 25^{o}C$ unless otherwise stated)

			Min.	Typ.	Max.	
†I_{CBO}	Collector-base cut-off current					
	$I_E = 0$, $V_{CB} = 45V$		-	-	10*	nA
†I_{CES}	Collector-emitter cut-off current (base-emitter short circuited)					
	$V_{CB} = 45V$, $V_{BE} = 0$		-	-	10	nA
	$V_{CB} = 45V$, $V_{BE} = 0$, $T_j = 170^{o}C$		-	-	10	µA
†I_{CEO}	Collector-emitter cut-off current					
	$I_B = 0$, $V_{CE} = 5.0V$ (see note 5)		-	-	2.0	nA
†I_{EBO}	Emitter cut-off current					
	$I_C = 0$, $V_{EB} = 5.0V$		-	-	10*	nA
I_B	Base current					
	$V_{CB} = 5.0V$, $-I_E = 10mA$	2N929	-	-	100*	µA
		2N930	-	-	50*	µA
†$V_{CE(sat)}$	Collector-emitter saturation voltage					
	$I_B = 0.5mA$, $I_C = 10mA$		-	-	1.0	V
$V_{BE(sat)}$	Base-emitter saturation voltage					
	$I_C = 10mA$, $I_B = 0.5mA$		0.6	-	1.0	V
†$-V_{EB}$	Emitter-base voltage					
	$V_{CB} = 5.0V$, $-I_E = 0.5mA$		0.6*	-	0.8*	V

Symbol	Parameter / Conditions	Type	Min.	Typ.	Max.	Unit
†h_{FE}	Large signal forward current transfer ratio					
	$V_{CE}=5.0V$, $I_C=10\mu A$	2N929	40	-	120	
		2N930	100	-	300	
	$V_{CE}=5.0V$, $I_C=10\mu A$, $T_j=-55^oC$	2N929	10	-	-	
		2N930	20	-	-	
	$V_{CE}=5.0V$, $I_C=500\mu A$	2N929	60	-	-	
		2N930	150	-	-	
	$V_{CE}=5.0V$, $I_C=10mA$	2N929	100	-	350	
		2N930	200	-	600	
f_T	Transition frequency					
	$V_{CE}=5.0V$, $I_C=500\mu A$		50	80	-	Mc/s
†c_{ob}	Output capacitance					
	$V_{CB}=5.0V$, $I_E=0$, $f=1.0Mc/s$		-	-	8.0	pF
†NF	Average noise figure (see note 6)					
	$V_{CE}=5.0V$, $I_C=10\mu A$, $R_s=10k\Omega$, Noise bandwidth $=10c/s$ to $15.7kc/s$	2N929	-	-	4.0	dB
		2N930	-	-	3.0	dB

h-parameters

Common emitter

Measured at $V_{CE}=5.0V$, $I_C=1.0mA$, $f=1.0kc/s$

Symbol	Parameter	Type	Min.	Typ.	Max.	Unit
h_{ie}	Input impedance	2N929	-	5.0	-	kΩ
		2N930	-	10	-	kΩ
h_{re}	Reverse voltage transfer ratio	2N929	-	2.5	-	$\times 10^{-4}$
		2N930	-	5.5	-	$\times 10^{-4}$
†h_{fe}	Small signal forward current transfer ratio	2N929	60	200	350	
		2N930	150	350	600	
h_{oe}	Output admittance	2N929	-	14	-	μmho
		2N930	-	25	-	μmho

Common base

Measured at $V_C = +5.0V$, $I_E = 1.0mA$, $f = 1.0kc/s$

†h_{ib}	Input impedance	25	-	32	Ω
†h_{rb}	Reverse voltage transfer ratio	-	-	600	$x10^{-6}$
†h_{ob}	Output admittance	-	-	1.0	μmho

*These are the parameters which are recommended for acceptance testing purposes.

†J.E.D.E.C. registered characteristics.

NOTES

1. Averaged over any 20ms period.
2. Derate linearly to 175°C at the rate of 2.0mW/deg C.
3. Derate linearly to 175°C at the rate of 4.0mW/degC.
4. If stored at +200°C precautions should be taken to ensure adequate solderability of the leads.
5. Prevent illumination of the device during the measurement.
6. Measured with an amplifier having an effective bandwidth of 10c/s to 10kc/s.

SOLDERING AND WIRING RECOMMENDATIONS

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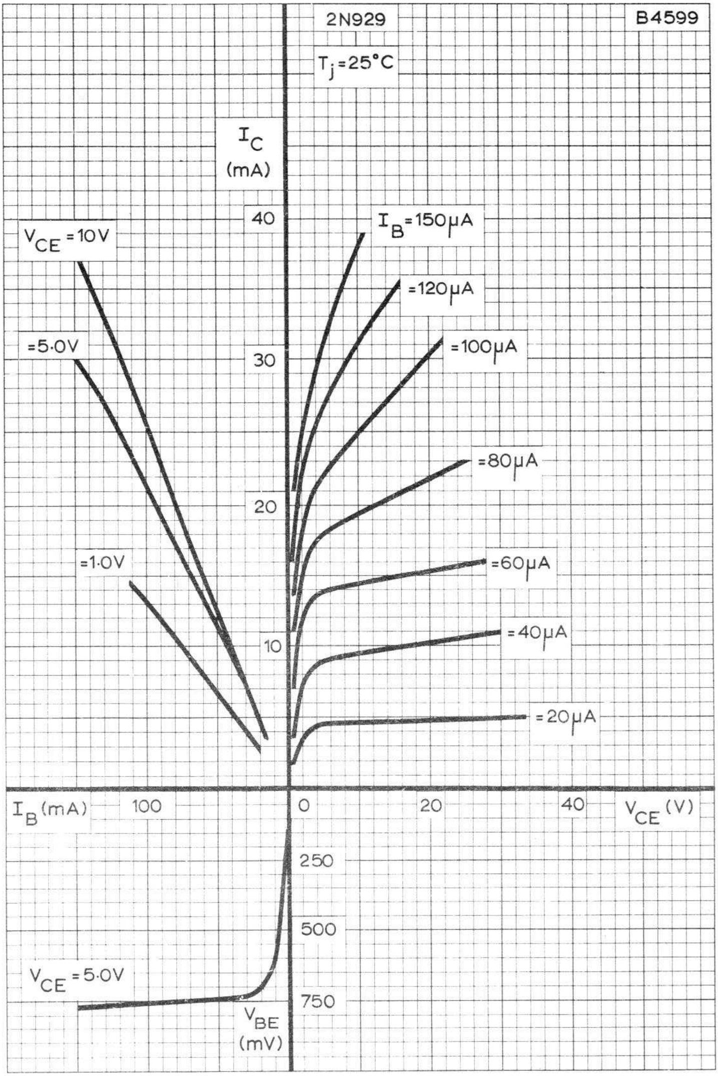
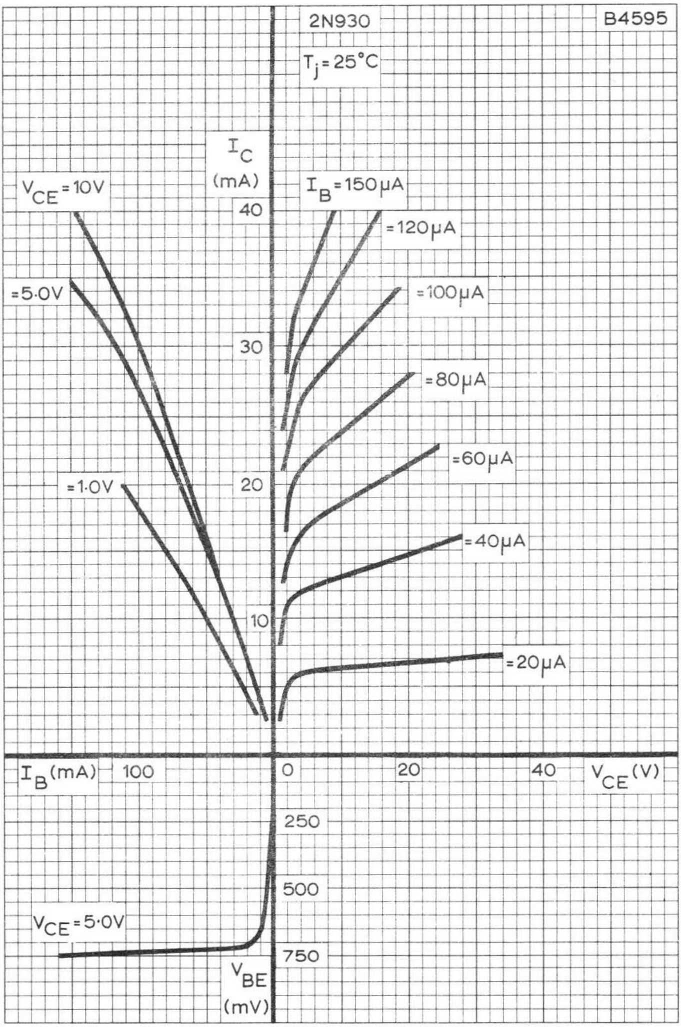
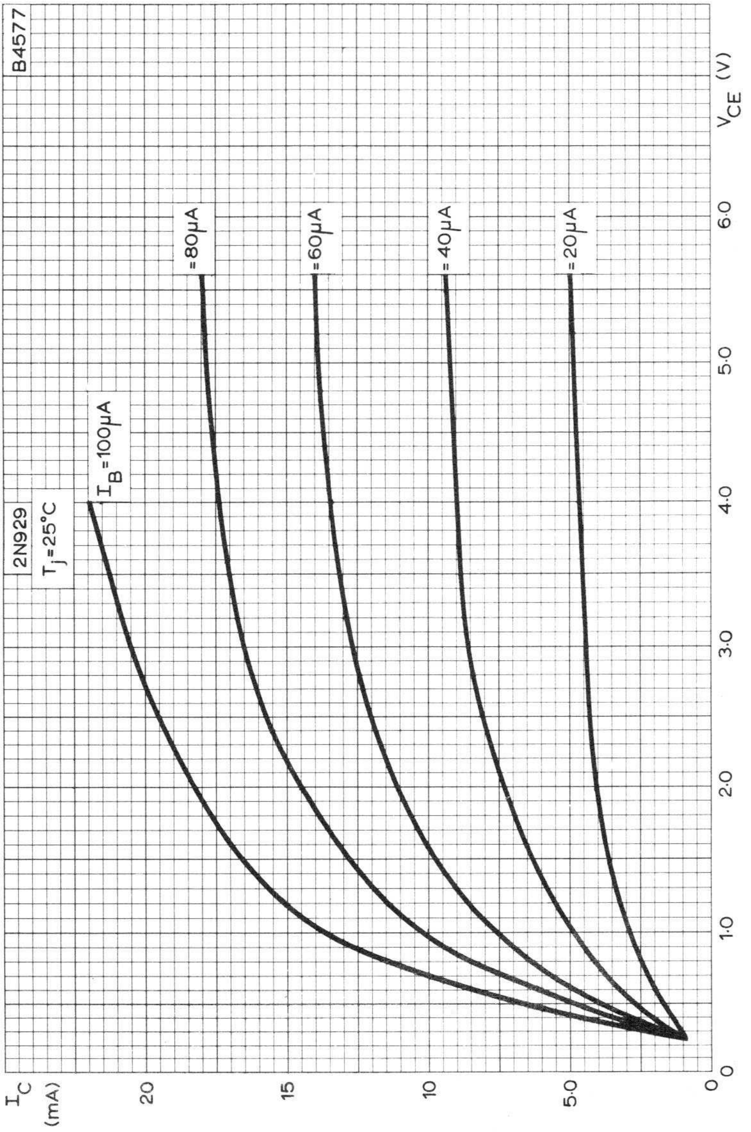
3. Care should be taken not to bend the leads nearer than 1.5mm from the seal.



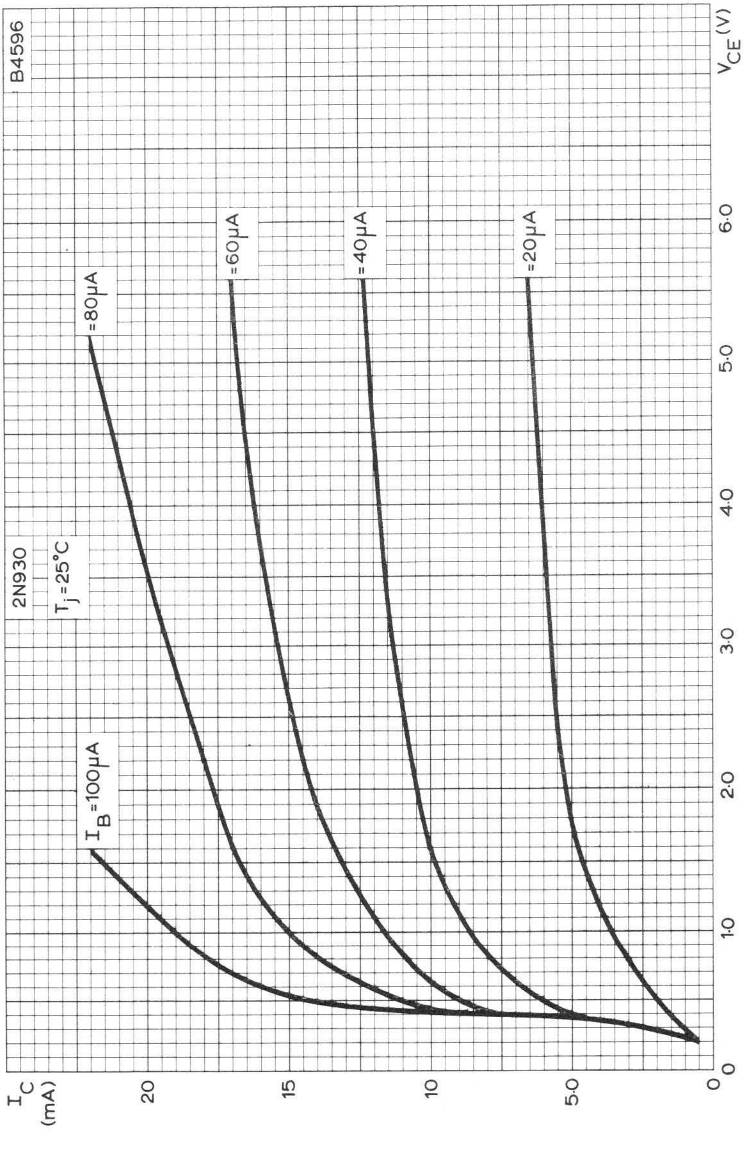
TYPICAL CHARACTERISTICS. COMMON EMITTER.



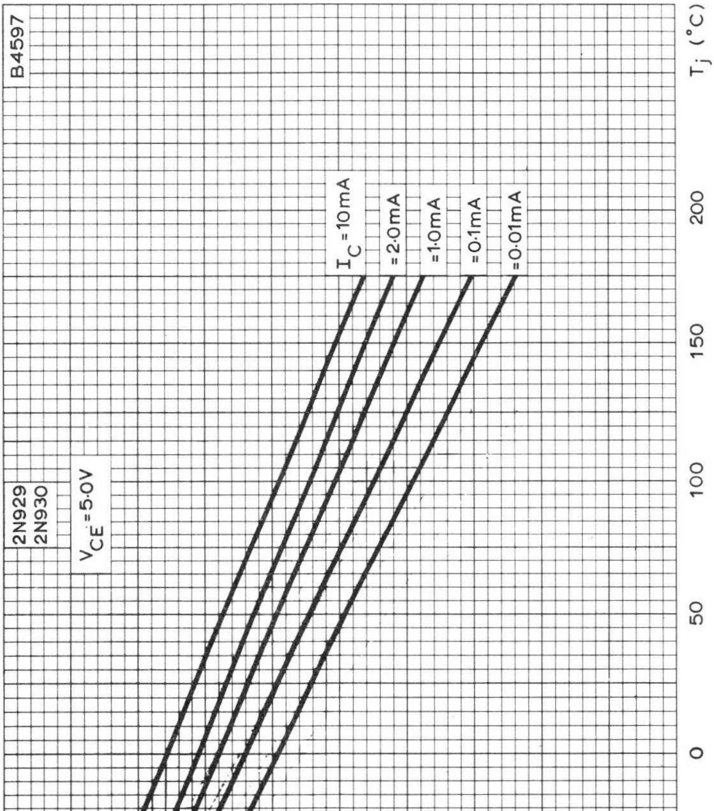
TYPICAL CHARACTERISTICS. COMMON EMITTER.



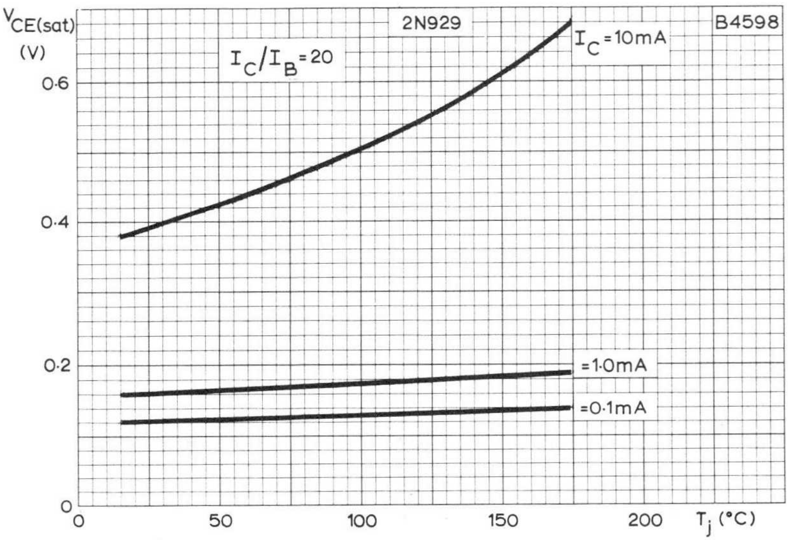
TYPICAL OUTPUT CHARACTERISTICS. COMMON EMITTER

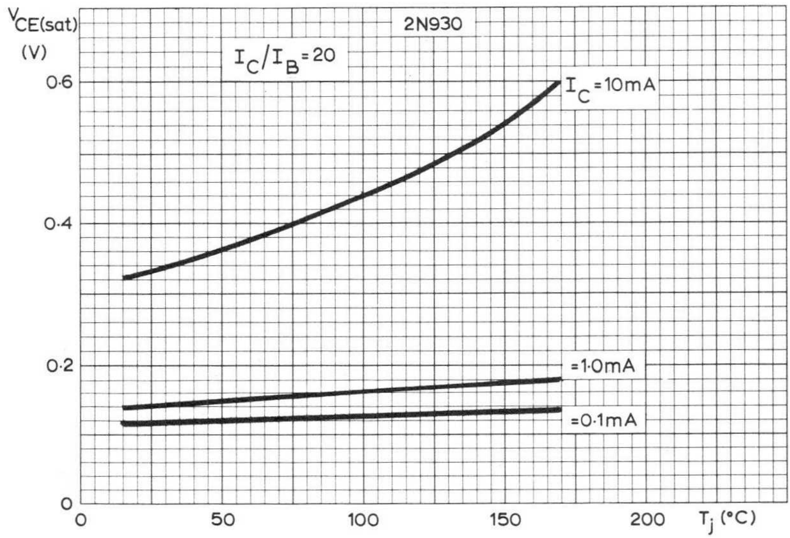


TYPICAL OUTPUT CHARACTERISTICS. COMMON EMITTER

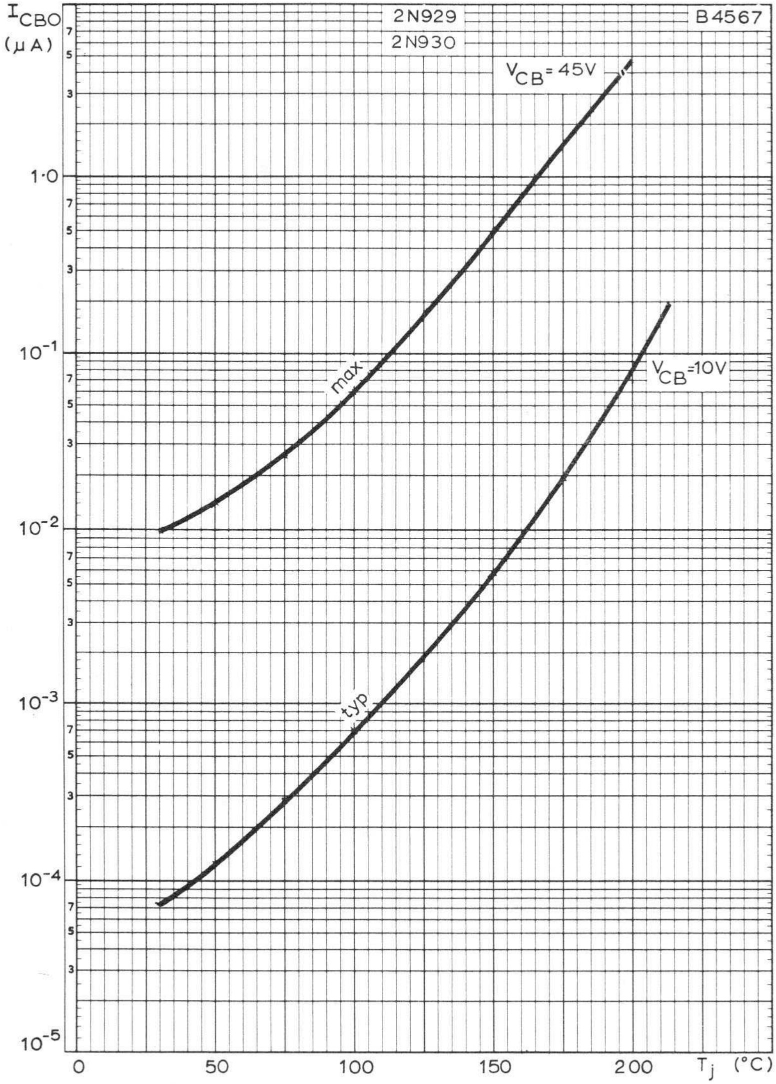


TYPICAL BASE-EMITTER VOLTAGE PLOTTED AGAINST JUNCTION TEMPERATURE WITH COLLECTOR CURRENT AS A PARAMETER

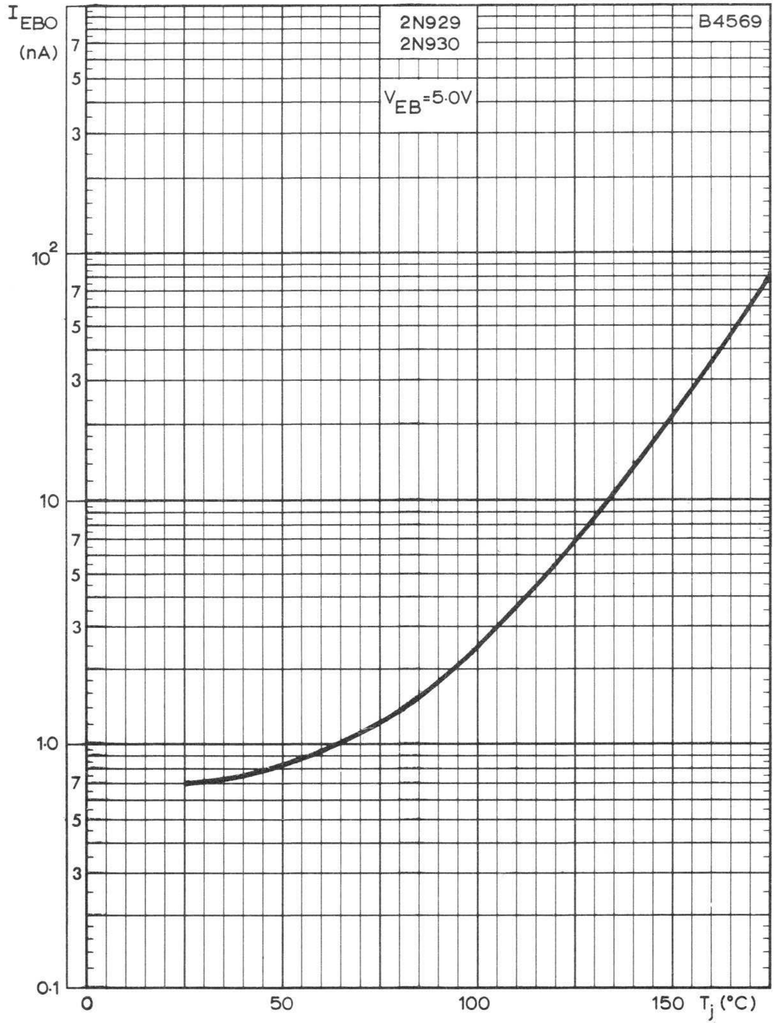




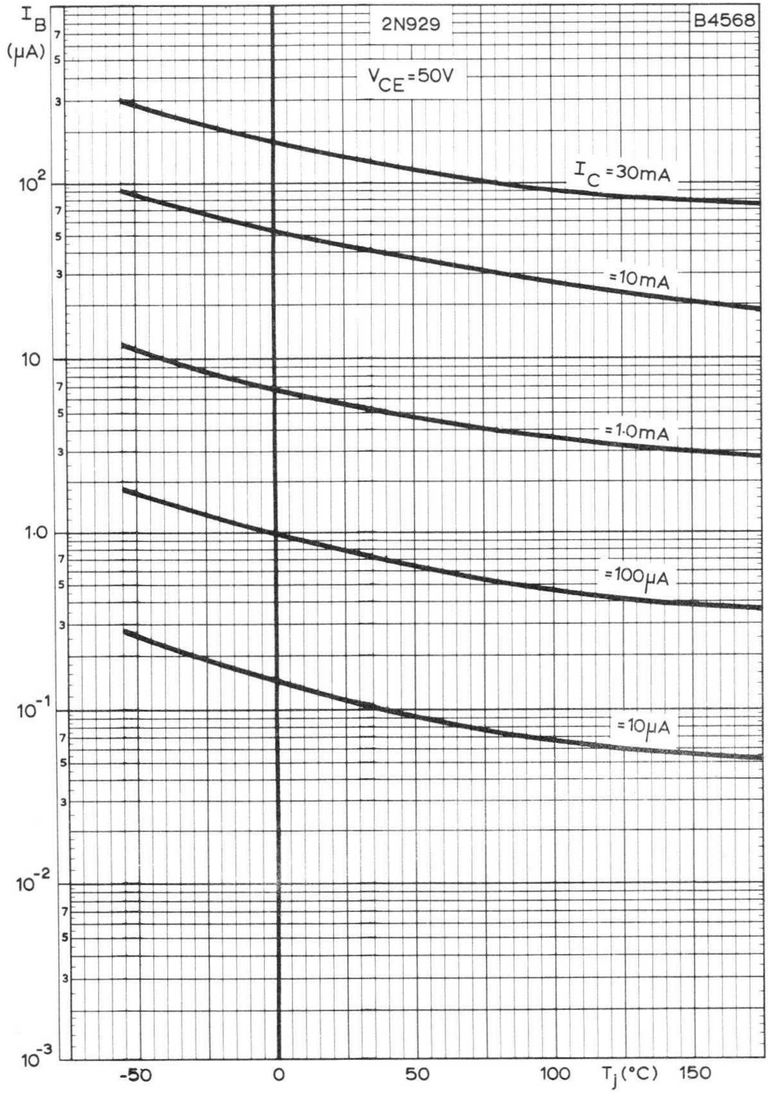
TYPICAL COLLECTOR-EMITTER SATURATION VOLTAGE PLOTTED AGAINST JUNCTION TEMPERATURE WITH COLLECTOR CURRENT AS A PARAMETER



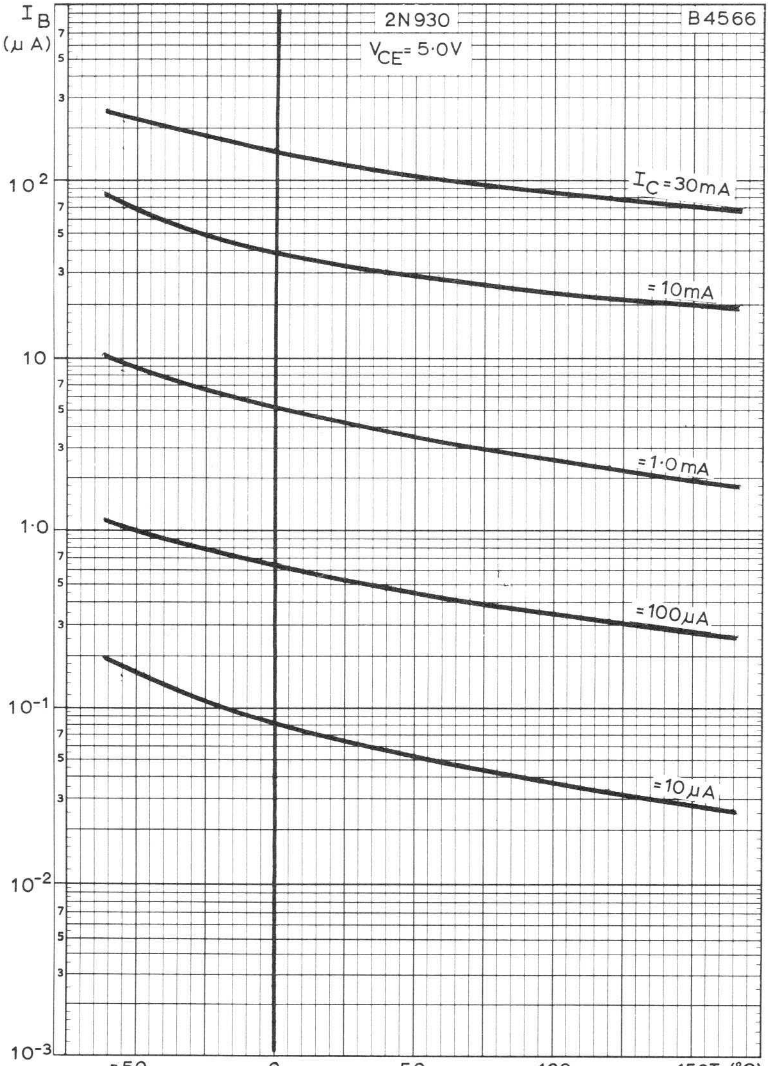
COLLECTOR CUT-OFF CURRENT PLOTTED AGAINST JUNCTION TEMPERATURE



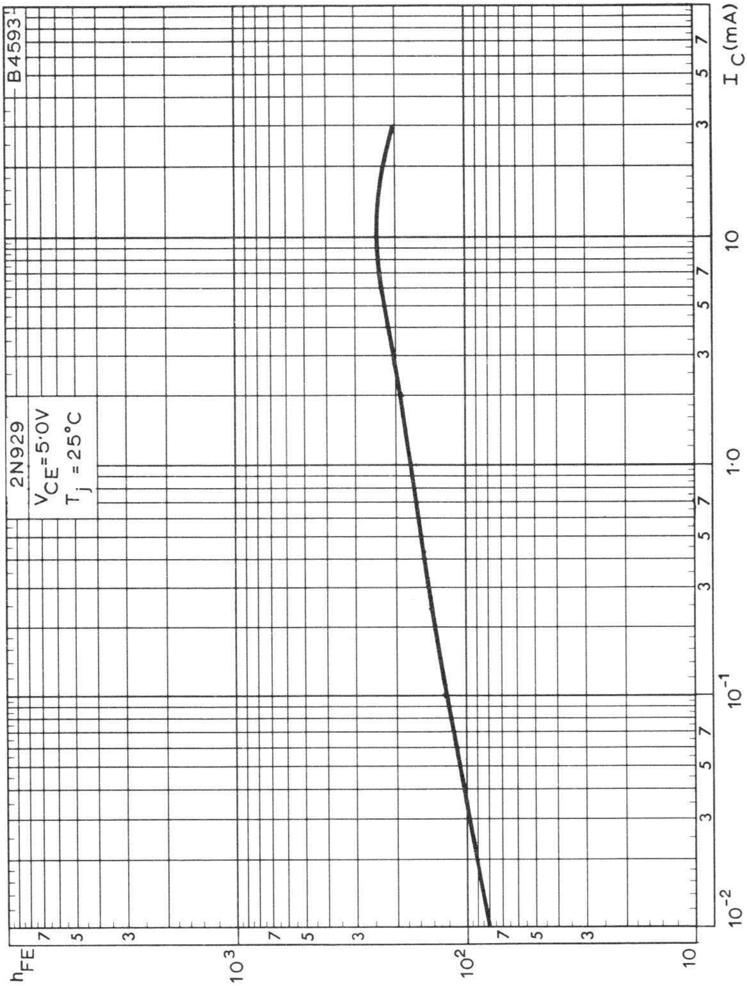
EMITTER CUT-OFF CURRENT PLOTTED AGAINST
JUNCTION TEMPERATURE



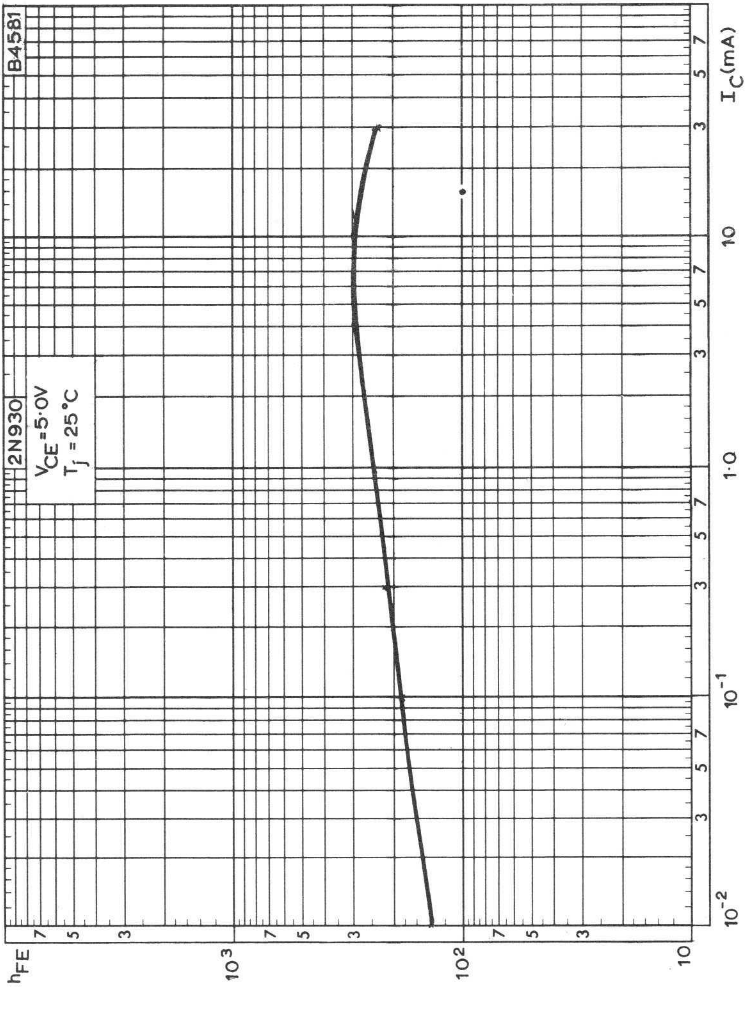
TYPICAL BASE CURRENT PLOTTED AGAINST JUNCTION TEMPERATURE WITH COLLECTOR CURRENT AS A PARAMETER



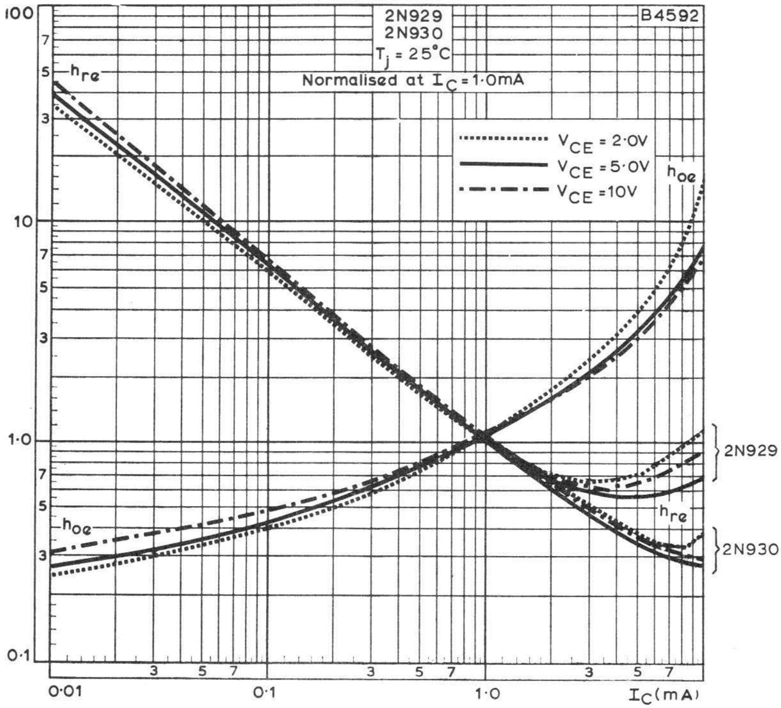
TYPICAL BASE CURRENT PLOTTED AGAINST JUNCTION TEMPERATURE WITH COLLECTOR CURRENT AS A PARAMETER



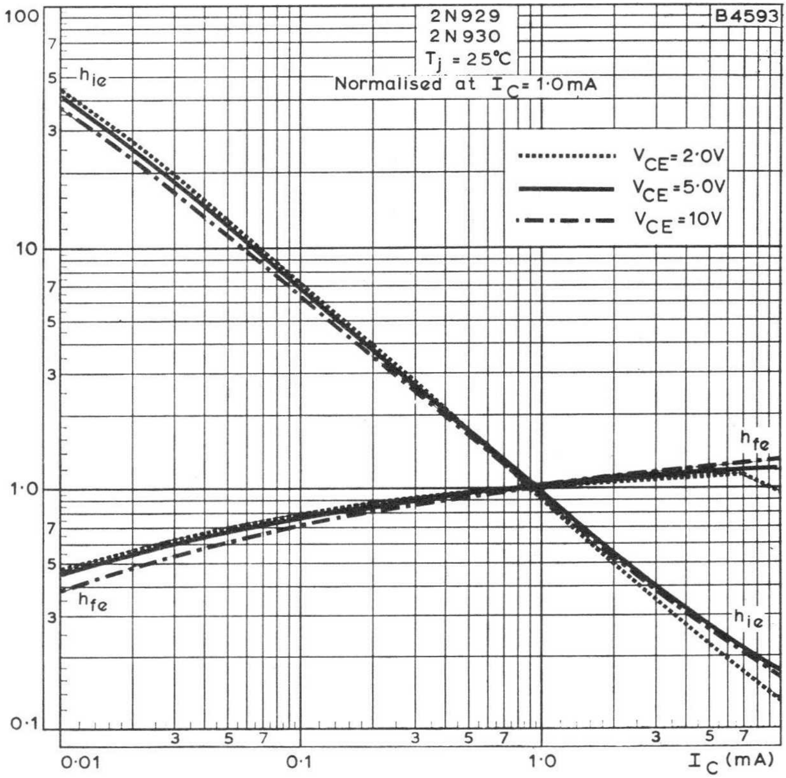
TYPICAL LARGE SIGNAL FORWARD CURRENT TRANSFER RATIO PLOTTED AGAINST COLLECTOR CURRENT



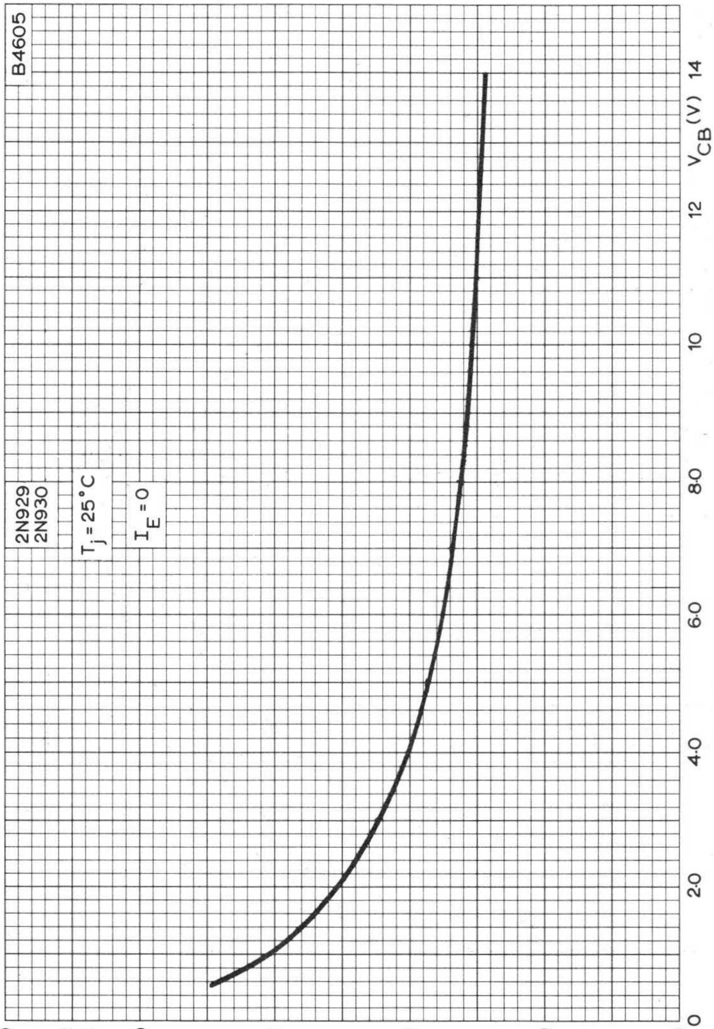
TYPICAL LARGE SIGNAL FORWARD CURRENT TRANSFER RATIO PLOTTED AGAINST COLLECTOR CURRENT



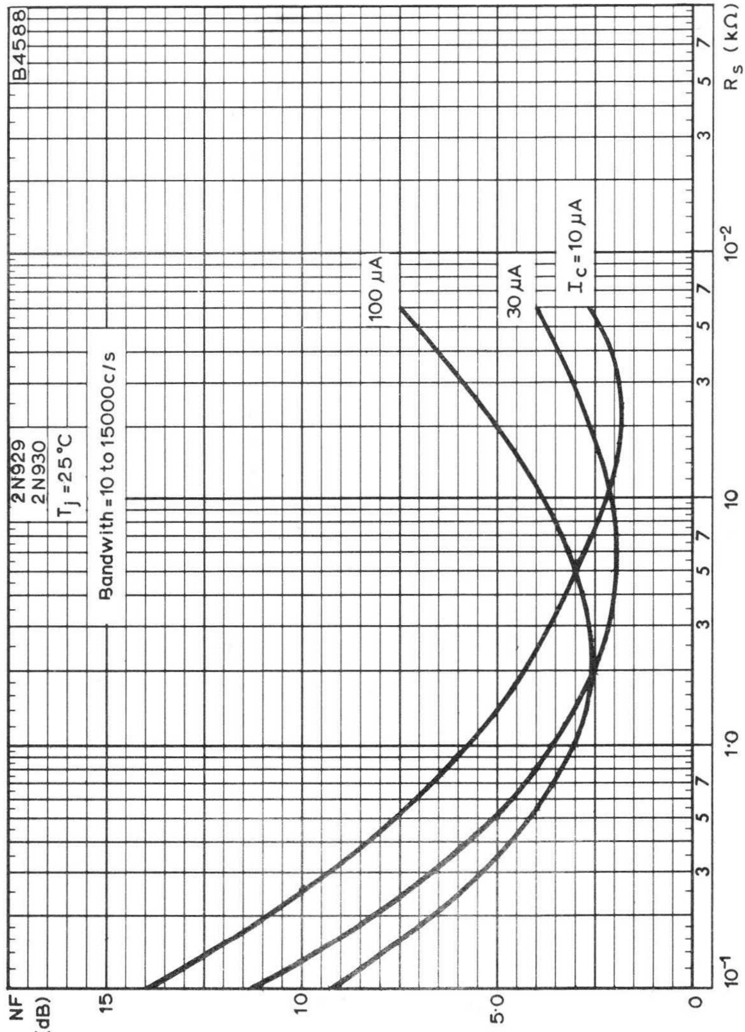
TYPICAL h-PARAMETERS PLOTTED AGAINST COLLECTOR CURRENT



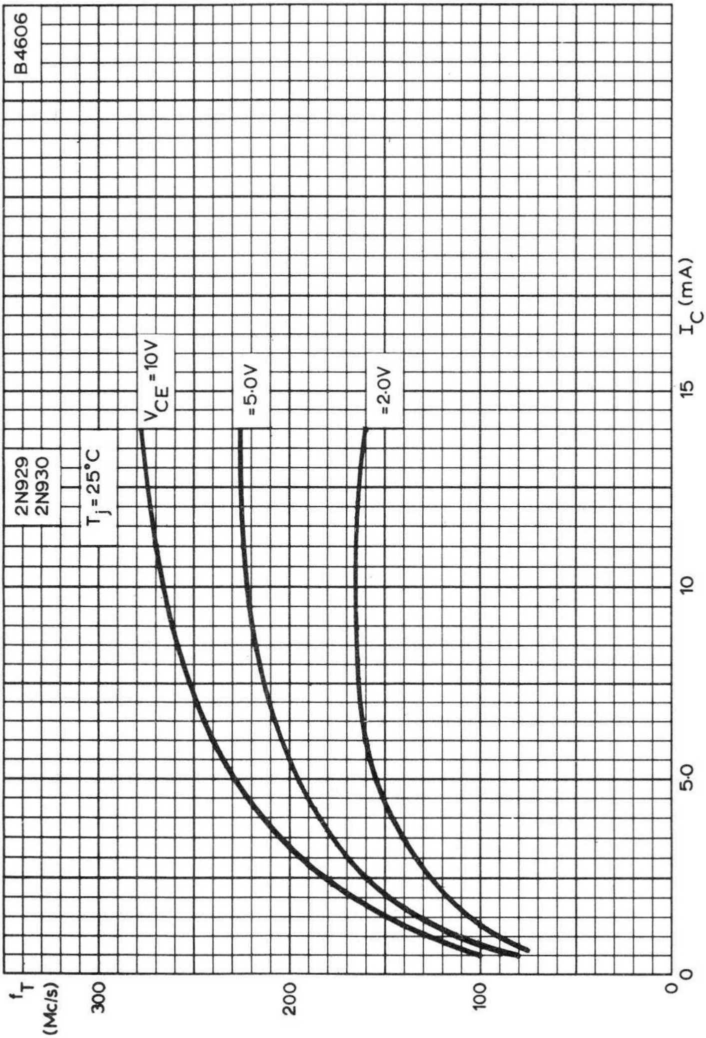
TYPICAL h-PARAMETERS PLOTTED AGAINST COLLECTOR CURRENT



TYPICAL COLLECTOR CAPACITANCE PLOTTED AGAINST COLLECTOR-BASE VOLTAGE



TYPICAL NOISE FIGURE PLOTTED AGAINST SOURCE IMPEDANCE
WITH COLLECTOR CURRENT AS A PARAMETER



TYPICAL TRANSITION FREQUENCY PLOTTED AGAINST COLLECTOR CURRENT WITH COLLECTOR-EMITTER VOLTAGE AS A PARAMETER

GERMANIUM P-N-P L.F. POWER TRANSISTOR

2N1100

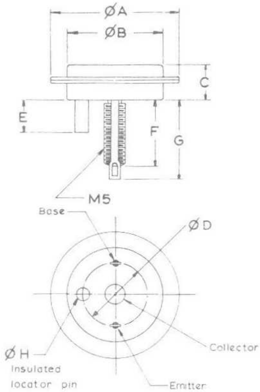
Germanium p-n-p junction transistor intended for l.f., high power industrial applications where high voltages and high currents are encountered.

QUICK REFERENCE DATA

V_{CB} max. ($I_E = 0$)	-100	V
V_{CE} max.	-80	V
I_{CM}	11	A
P_{tot} ($T_{case} = 25^{\circ}C$)	90	W
h_{FE} ($I_C = 5.0A$)	25 - 50	
f_{hfe}	10	kc/s

OUTLINE AND DIMENSIONS

Conforming to B.S. 3934 SO-37/SB3-12 J.E.D.E.C. TO-36 with metric thread



	Millimetres		
	Min.	Typ.	Max.
ØA	29	-	31
ØB	24.5	-	26.5
C	-	-	10.5
ØD	-	17.5	-
E	6.5	-	7.9
F	10	-	12
G	16	-	18
ØH	3.0	-	3.5

Collector connected to mounting base

RATINGS

Limiting values according to the absolute maximum system.

Electrical

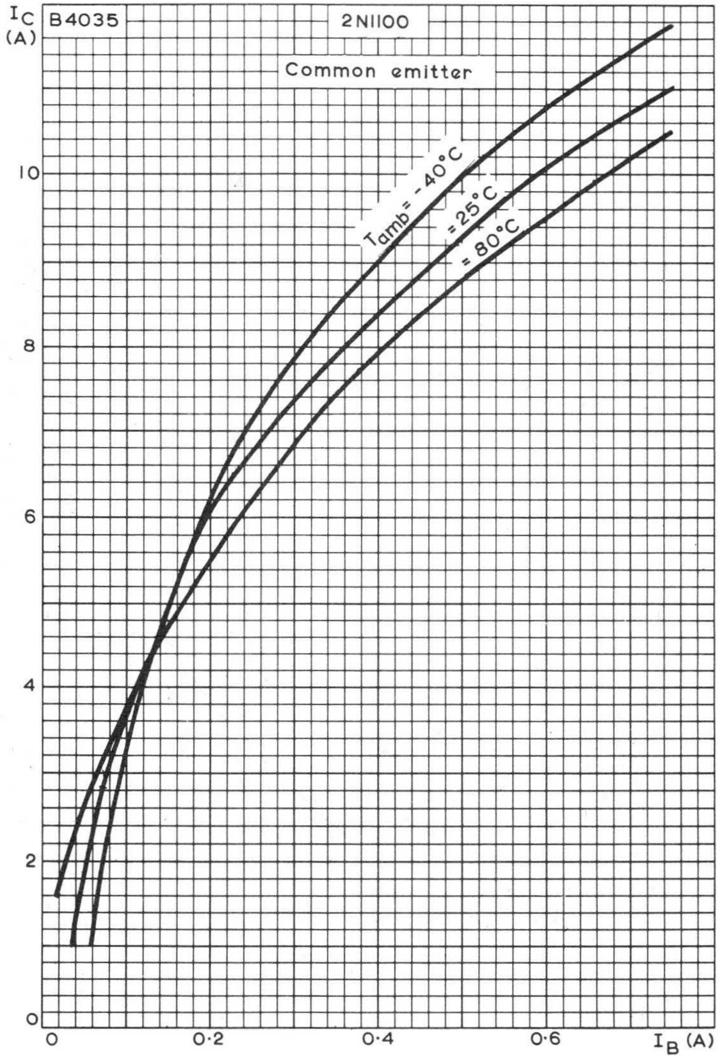
†V_{CB} max. (V_{EB}=1.5V)	-100	V
V_{CE} max.	-80	V
†I_E max.	15	A
I_{EM} max.	20	A
†I_B max.	4.0	A
†P_{tot} max. T_{case} = 25°C	90	W
T_{case} = 71°C	30	W

Thermal

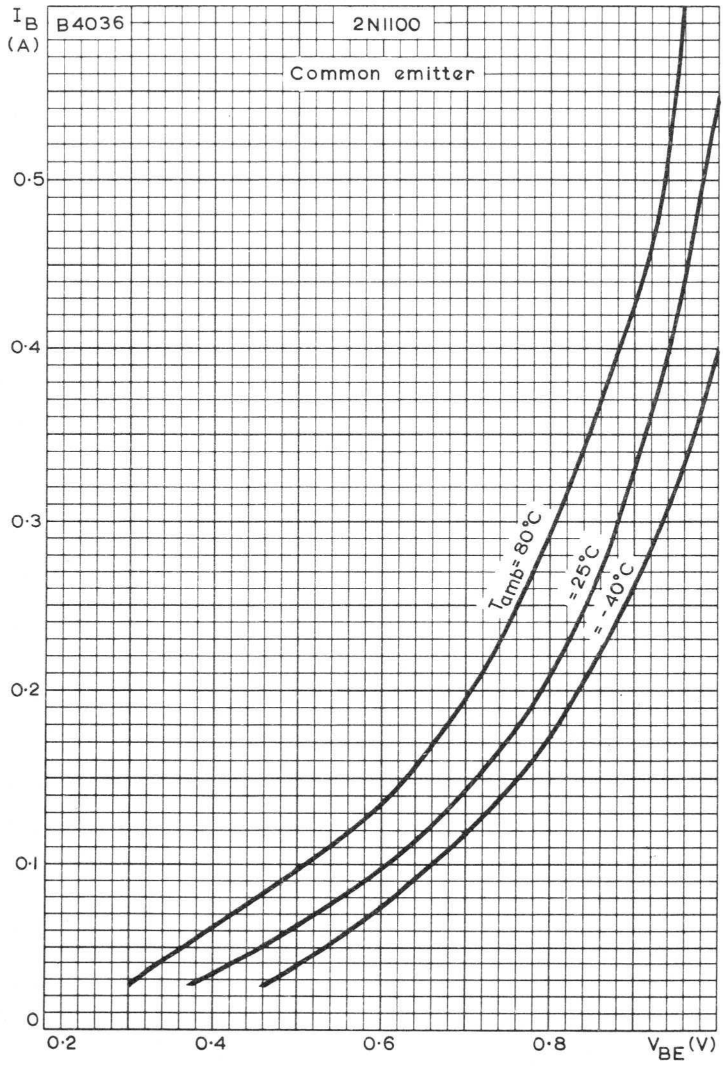
†T_{stg} min.	-65	°C
†T_{stg} max.	95	°C
†T_j max.	100	°C

THERMAL CHARACTERISTICS

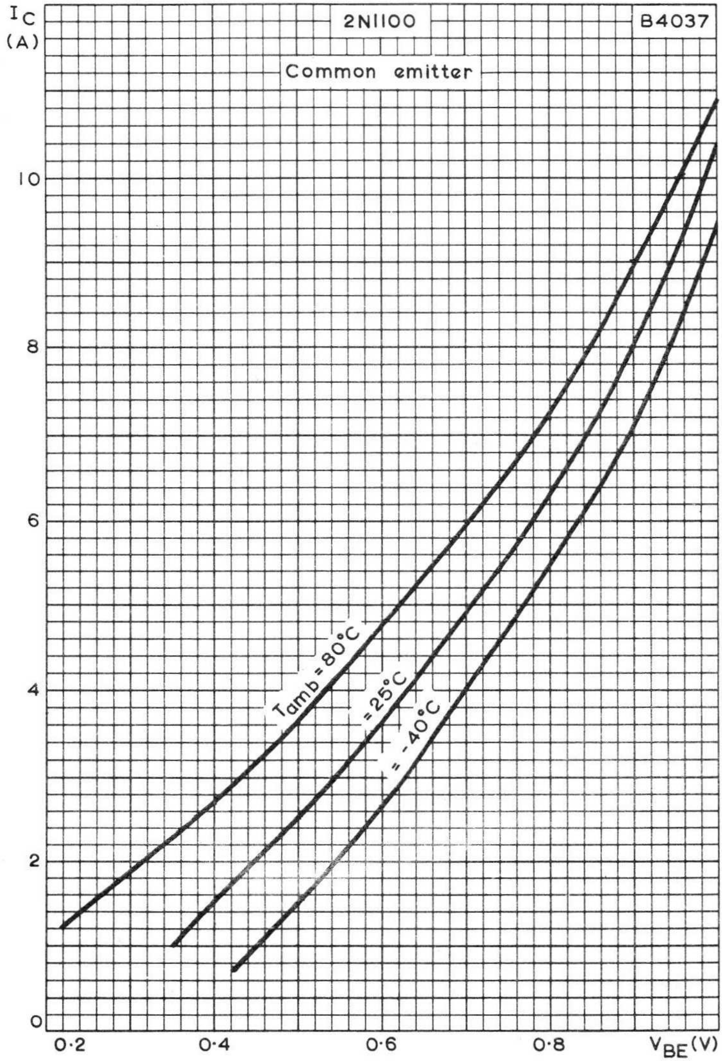
†$\Theta_{j\text{-}case}$	0.5	deg C/W
†Thermal capacity for pulses in 1 to 10ms range	0.075	W/deg C



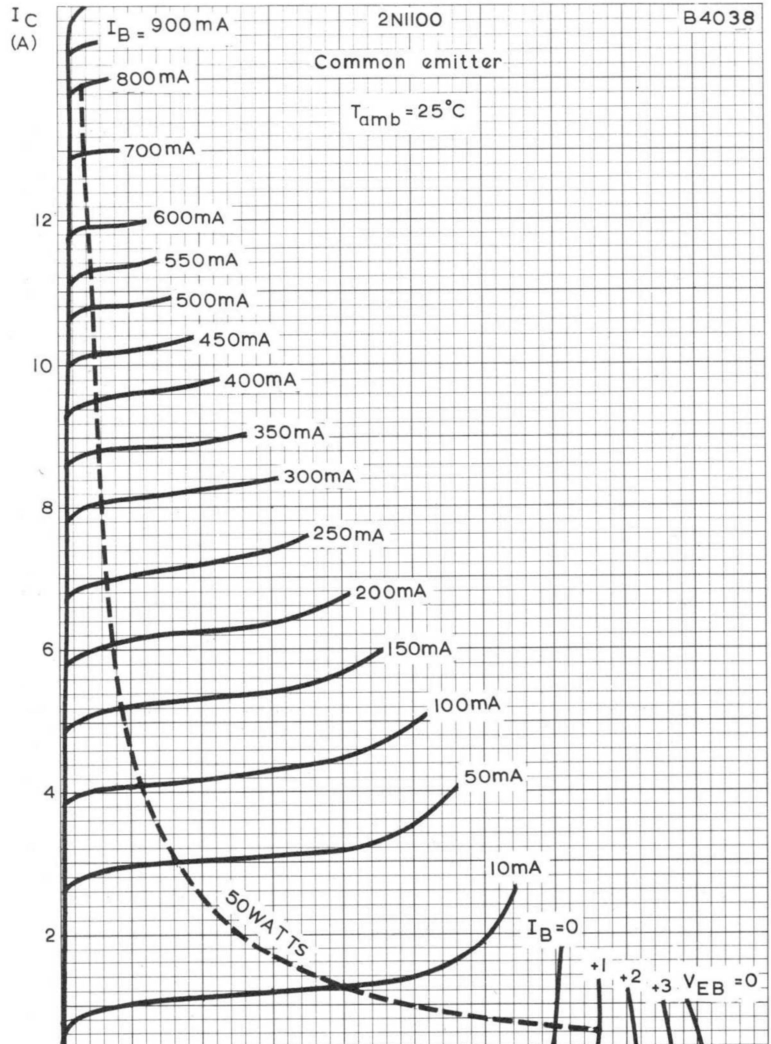
TRANSFER CHARACTERISTICS. T_{amb} = -40, 25 AND 80°C



INPUT CHARACTERISTICS. T_{amb} = -40, 25 AND 80°C



MUTUAL CHARACTERISTICS. $T_{amb} = -40$, 25 AND 80°C



OUTPUT CHARACTERISTICS. $T_{amb} = 25^{o}C$

P-N-P SILICON PLANAR EPITAXIAL TRANSISTORS

2N1131 2N1132

P-N-P silicon planar epitaxial transistors designed primarily for use in medium frequency amplifiers and medium speed switching applications.

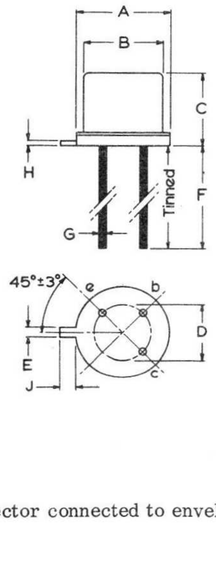
QUICK REFERENCE DATA

	2N1131	2N1132	
$-V_{CBO}$ max.	50		V
$-V_{CEO}$ max.	35		V
$-I_C$ max.	600		mA
P_{tot} max. ($T_{amb} = 25^oC$)	600		mW
T_j max.	175		^oC
h_{FE} ($-I_C = 150mA$, $-V_{CE} = 10V$)	20-45	30-90	
f_T min. ($-I_C = 50mA$, $f = 20MHz$)	50	60	MHz

Unless otherwise stated data is applicable to both types

OUTLINE AND DIMENSIONS

Conforming to B.S. 3934 SO-3/SB3-3A
J.E.D.E.C. TO-5



Millimetres

	Min.	Nom.	Max.
A	8.64	8.90	9.40
B	7.75	8.15	8.50
C	6.10	6.35	6.60
D	-	5.08	-
E	0.71	0.79	0.86
F	38	-	-
G	-	0.45	-
H	-	0.4	-
J	0.74	0.85	1.0

Collector connected to envelope

†RATINGS

Limiting values of operation according to the absolute maximum system.

Electrical

$-V_{CBO}$ max.	50	V
$-V_{CEO}$ max.	35	V
$-V_{CER}$ max. ($R_{BE} \leq 10\Omega$)	50	V
$-V_{EBO}$ max.	5.0	V
$-I_C$ max.	600	mA
P_{tot} max. ($T_{amb} = 25^{\circ}C$)	600	mW

Temperature

T_{stg} min.	-65	$^{\circ}C$
T_{stg} max.	200	$^{\circ}C$
T_j max.	175	$^{\circ}C$

†ELECTRICAL CHARACTERISTICS ($T_{amb} = 25^{\circ}C$ unless otherwise stated)

		Min.	Max.	
$-I_{CBO}$	Collector cut-off current			
	$-V_{CB} = 30V$, $I_E = 0$	-	1.0	μA
	$-V_{CB} = 30V$, $I_E = 0$, $T_{amb} = 150^{\circ}C$	-	100	μA
	$-V_{CB} = 50V$, $I_E = 0$	-	100	μA
$-I_{EBO}$	Emitter cut-off current			
	$-V_{EB} = 2.0V$, $I_C = 0$	-	100	μA
$-V_{CER(sust)}$	Collector-emitter sustaining voltage (pulsed)			
	$-I_C = 100mA$, $R_B \leq 10\Omega$	50	-	V
$-V_{CEO(sust)}$	Collector-emitter sustaining voltage (pulsed)			
	$-I_C = 100mA$, $I_B = 0$	35	-	V
$-V_{CE(sat)}$	Collector-emitter saturation voltage			
	$-I_C = 150mA$, $-I_B = 15mA$	-	1.5	V
$-V_{BE(sat)}$	Base-emitter saturation voltage			
	$-I_C = 150mA$, $-I_B = 15mA$	-	1.3	V
c_{ob}	Output capacitance			
	$-V_{CB} = 10V$, $I_E = 0$	-	45	pF

†J.E.D.E.C. registered data.

			Min.	Max.	
c_{ib}	Input capacitance $-V_{EB}=0.5V$, $I_C=0$		-	80	pF
f_T	Transition frequency $-I_C=50mA$, $-V_{CE}=10V$, f=20MHz	2N1131	50	-	MHz
		2N1132	60	-	MHz
h_{FE}	Static forward current transfer ratio (pulsed) $-I_C=5.0mA$, $-V_{CE}=10V$	2N1131	15	-	
		2N1132	25	-	
	$-I_C=150mA$, $-V_{CE}=10V$	2N1131	20	45	
		2N1132	30	90	

h-parameters

$-I_C=1.0mA$, $-V_C=5.0V$

			Min.	Max.	
h_{fe}	Small signal forward current transfer ratio	2N1131	15	50	
		2N1132	25	75	
h_{ib}	Input resistance		25	35	Ω
h_{rb}	Voltage feedback ratio		0	8.0	$\times10^{-4}$
h_{ob}	Output conductance		0	1.0	µmho

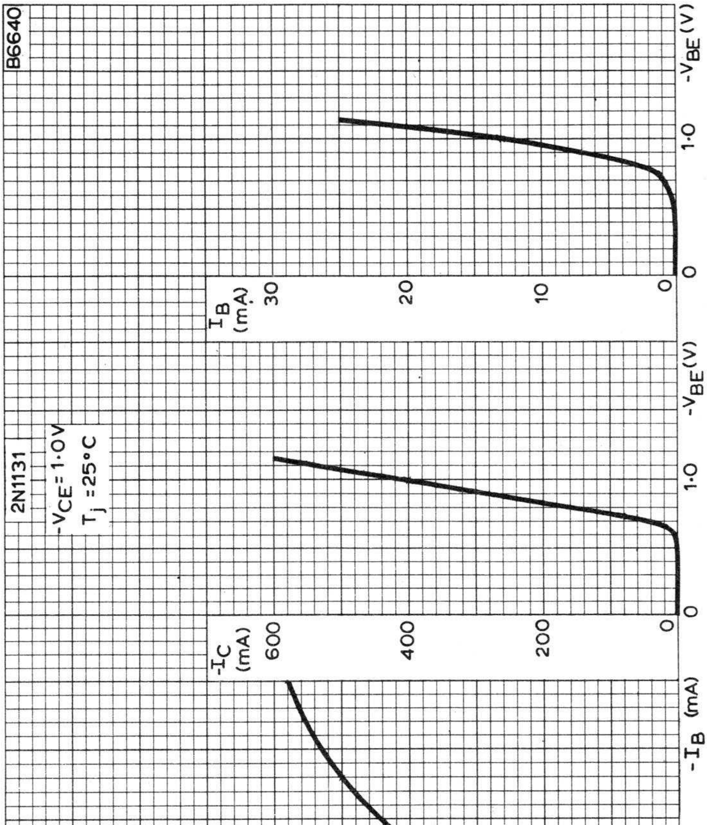
$-I_C=5.0mA$, $-V_C=10V$, f=1.0kHz

			Min.	Max.	
h_{fe}	Small signal forward current transfer ratio	2N1131	20	-	
		2N1132	30	-	
h_{ib}	Input resistance		-	10	Ω
h_{rb}	Voltage feedback ratio		0	8.0	$\times10^{-4}$
h_{ob}	Output conductance		0	5.0	µmho

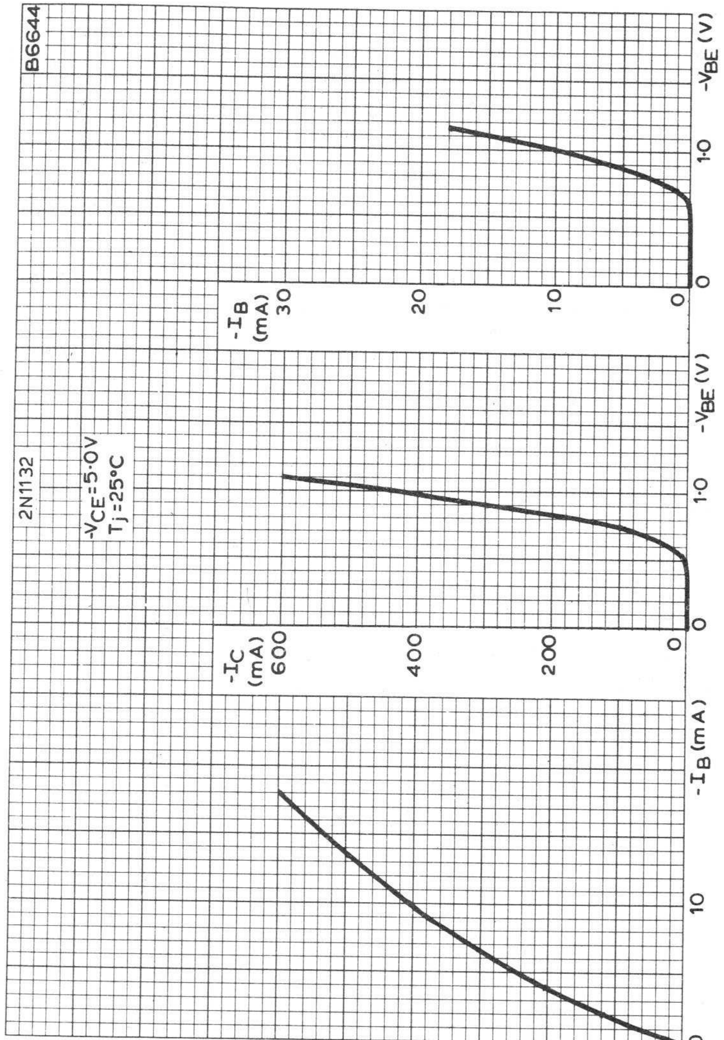
†SOLDERING RECOMMENDATION

Max. T_{lead} 1/16" from case for 10 seconds is 300°C.

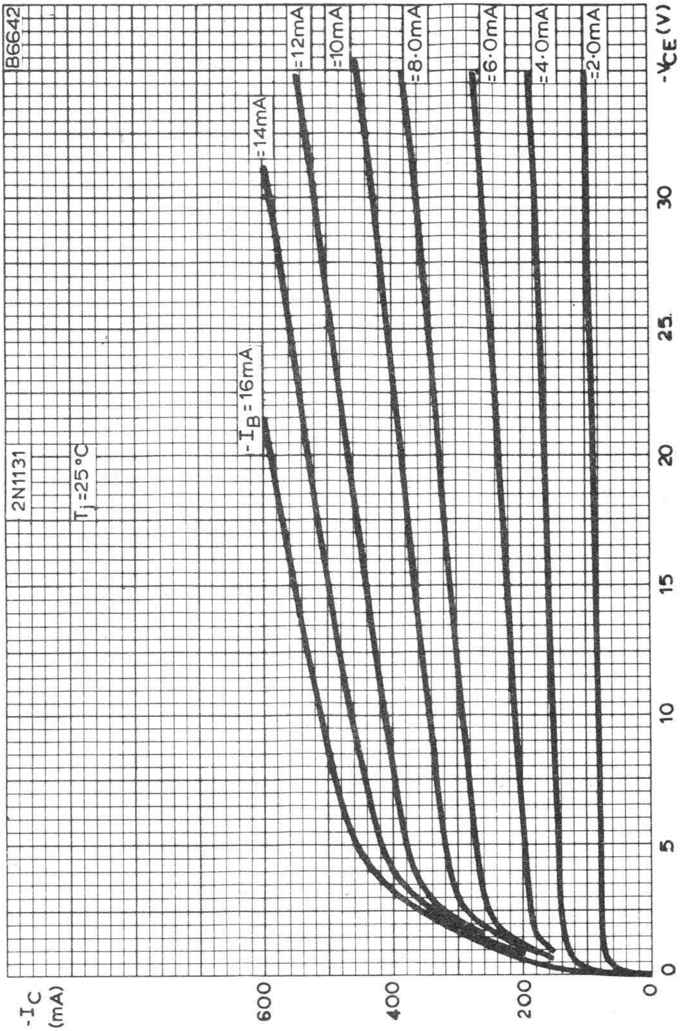
†J.E.D.E.C. registered data.



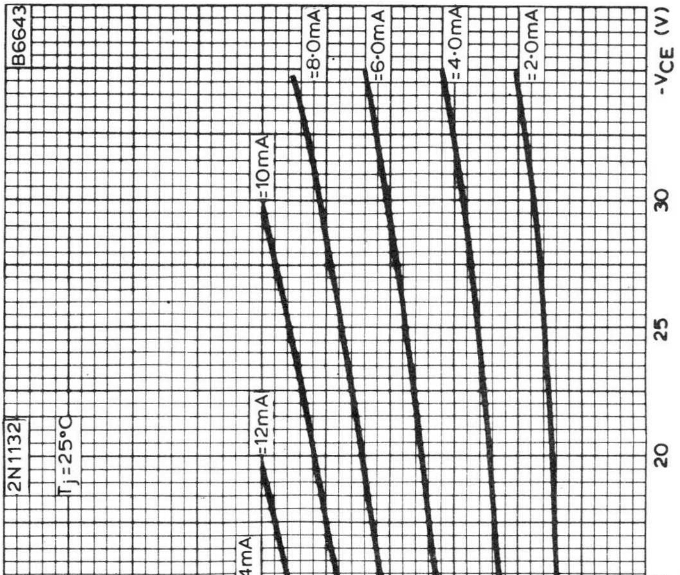
TYPICAL TRANSFER, MUTUAL AND INPUT CHARACTERISTICS



TYPICAL TRANSFER, MUTUAL AND INPUT CHARACTERISTICS



TYPICAL OUTPUT CHARACTERISTICS



TYPICAL OUTPUT CHARACTERISTICS

GERMANIUM N-P-N ALLOYED TRANSISTORS

2N1302 2N1306 2N1304 2N1308

Germanium n-p-n alloyed junction transistors primarily intended for use in medium current, medium speed logic circuits in computers and other general industrial applications.

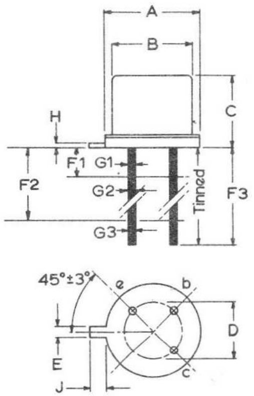
QUICK REFERENCE DATA

2N	1302	1304	1306	1308	
V_{CBO} max.	25	25	25	25	V
V_{CEO} max.	25	20	15	15	V
I_{CM} max.	300	300	300	300	mA
P_{tot} max. (T_{amb} = 25°C)	150	150	150	150	mW
T_j max.	85	85	85	85	°C
h_{FE} min. (I_C = 10mA, V_{CE} = 1.0V)	20	40	60	80	
$V_{CE(sat)}$ max. (I_C = 10mA, I_B = I_C/h_{FE} min.)	200	200	200	200	mV
f_T typ. (I_C = 1.0mA, V_{CE} = 5.0V)	10	15	20	30	MHz
t_{on} typ. ($t_d + t_r$)	285	270	225	220	ns
t_{off} typ. ($t_s + t_f$)	865	850	815	790	ns

Unless otherwise stated data is applicable to all types

OUTLINE AND DIMENSIONS

Conforming to B.S. 3934 SO-3/SB3-3A
J.E.D.E.C. TO-5



	Millimetres Min.	Typ	Max.
A	9.10	-	9.4
B	8.20	-	8.50
C	-	-	6.60
D	-	5.08	-
E	-	-	0.86
F1	-	-	0.51
F2	12.7	-	-
F3	38.1	-	41.3
G1	-	-	1.01
G2	-	-	0.48
G3	-	-	0.53
H	-	0.4	-
J	-	-	1.0

The base is electrically connected to the envelope

RATINGS

Limiting values of operation according to the absolute maximum system

Electrical

V_{CBO} max.		25	V
V_{CEO} max.	2N1302	25	V
	2N1304	20	V
	2N1306, 1308	15	V
V_{EBO} max.		25	V
I_C max. (d.c. or averaged over any 20ms period)		200	mA
I_{CM} max.		300	mA
P_{tot} max. ($T_{amb}=25^oC$)		150	mW

Temperature

T_{stg} min.	-65	^oC
T_{stg} max.	100	^oC
T_j max.	85	^oC

THERMAL CHARACTERISTICS

Θ_{j-amb} (in free air)	0.4 deg C/mW
Θ_{j-case}	0.2 deg C/mW

ELECTRICAL CHARACTERISTICS ($T_j = 25^oC$ unless otherwise stated)

			Min.	Typ.	Max.	
I_{CBO}	Collector cut-off current $V_{CB}=25V, I_E=0$		-	3.0	6.0	μA
I_{EBO}	Emitter cut-off current $V_{EB}=25V, I_C=0$		-	2.2	6.0	μA
I_{CEX}	Collector-emitter cut-off current $-V_{BE}=0.2V$, $V_{CE}=20V$, $T_j=55^oC$	2N1302, 4	-	-	50	μA
	$-V_{BE}=0.2V, V_{CE}=15V$, $T_j=55^oC$	2N1306, 8	-	-	50	μA
$V_{BE(sat)}$	Base-emitter saturation voltage $I_C=10mA$, $I_B=0.5mA$	2N1302	0.15	0.30	0.40	V
		2N1304	0.15	0.25	0.35	V
		2N1306	0.15	0.24	0.35	V
		2N1308	0.15	0.23	0.35	V

GERMANIUM N-P-N ALLOYED TRANSISTORS

2N1302 2N1306 2N1304 2N1308

			Min.	Typ	Max.	
$V_{CE(sat)}$	Collector-emitter saturation voltage					
	I_C=10mA, I_B=0.5mA	2N1302	-	0.1	0.2	V
	I_C=10mA, I_B=0.25mA	2N1304	-	0.1	0.2	V
	I_C=10mA, I_B=0.17mA	2N1306	-	0.1	0.2	V
	I_C=10mA, I_B=0.13mA	2N1308	-	0.1	0.2	V
V_{pt}	Punch-through voltage	2N1302	25	-	-	V
		2N1304	20	-	-	V
		2N1306,8	15	-	-	V
h_{FE}	Static forward current transfer ratio					
	I_C=10mA, V_{CE}=1.0V	2N1302	20	50	-	
		2N1304	40	70	100	
		2N1306	60	100	200	
		2N1308	80	150	300	
	I_C=200mA, V_{CE}=0.35V	2N1302	10	48	-	
		2N1304	15	65	-	
		2N1306	20	95	-	
		2N1308	20	145	-	
C_c	Collector capacitance					
	V_{CB}=5.0V, I_E=I_e=0, f=1.0MHz		-	12	20	pF
C_e	Emitter capacitance					
	V_{EB}=5.0V, I_C=I_c=0, f=1.0MHz		-	8.0	-	pF
f_T	Transition frequency					
	I_C=1.0mA, V_{CE}=5.0V	2N1302	3.0	10	-	MHz
		2N1304	5.0	15	-	MHz
		2N1306	10	20	-	MHz
		2N1308	15	30	-	MHz

Typical switching times (see fig.1)

		2N 1302	1304	1306	1308	
t_d	Delay time	65	60	55	55	ns
t_r	Rise time	220	210	170	165	ns
t_s	Storage time	500	500	500	500	ns
t_f	Fall time	365	350	315	290	ns

Typical recovered charge (see fig.2)

Q_s		800	700	650	600	pC

TEST CIRCUITS AND WAVEFORMS

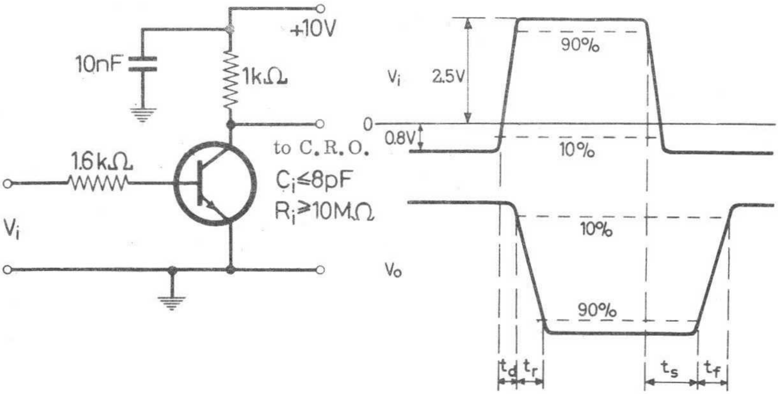
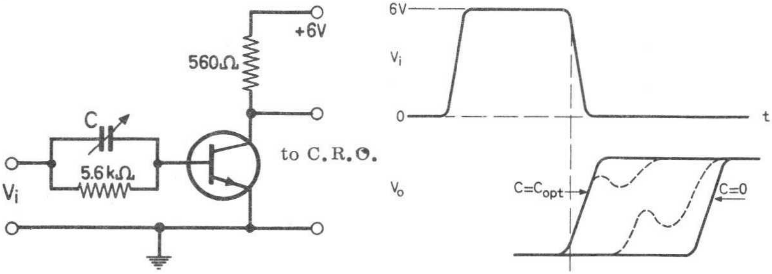


Fig.1



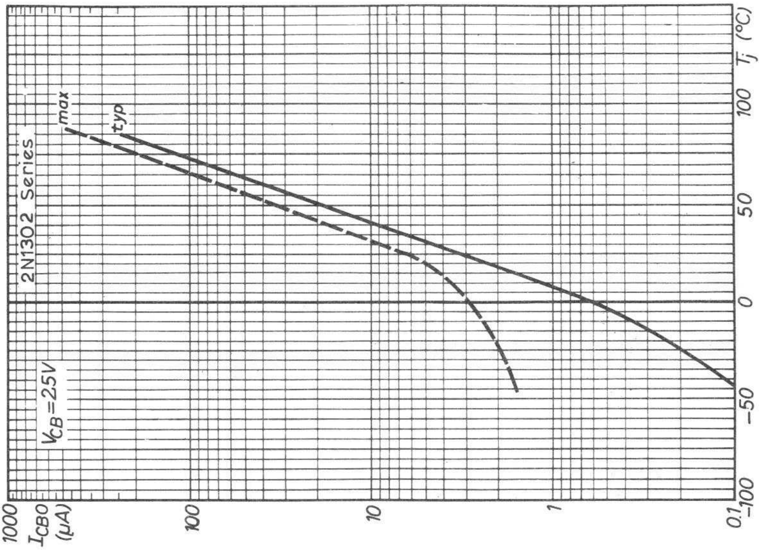
Adjust C from zero to C_{opt}

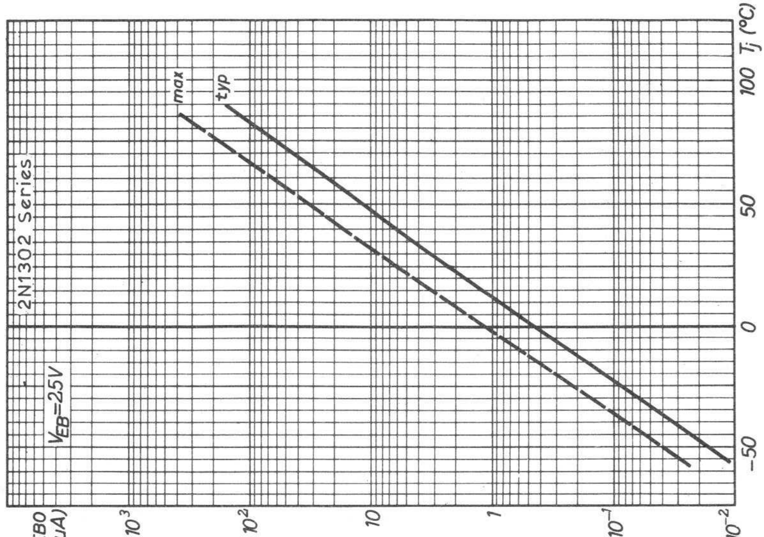
$Q_s = C_{opt} \times V_i$

Fig. 2

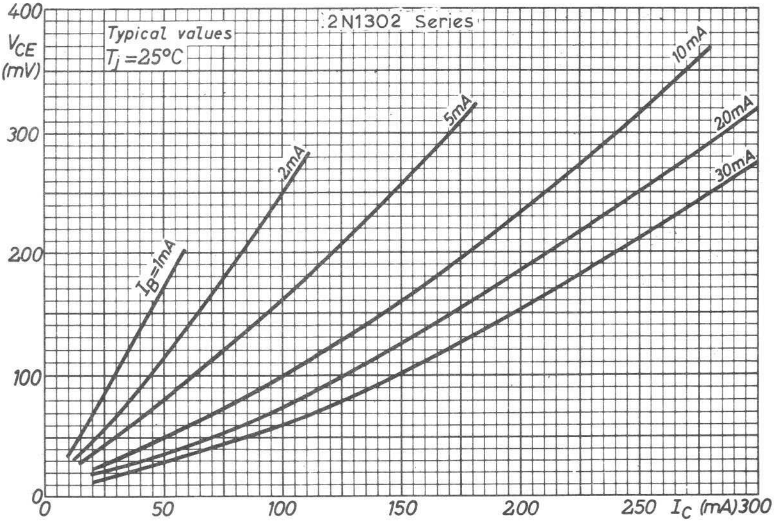
GERMANIUM N-P-N ALLOYED TRANSISTORS

2N1302 2N1306 2N1304 2N1308

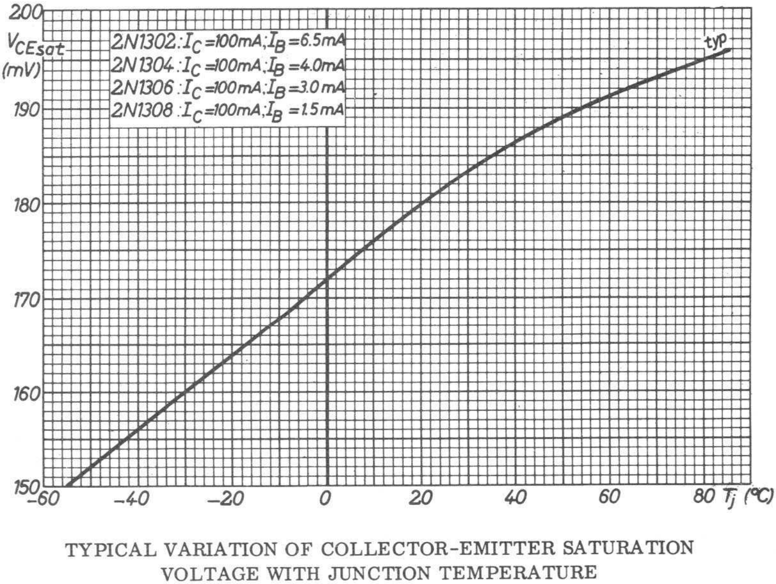




VARIATION OF COLLECTOR AND EMITTER CUT-OFF CURRENT WITH JUNCTION TEMPERATURE



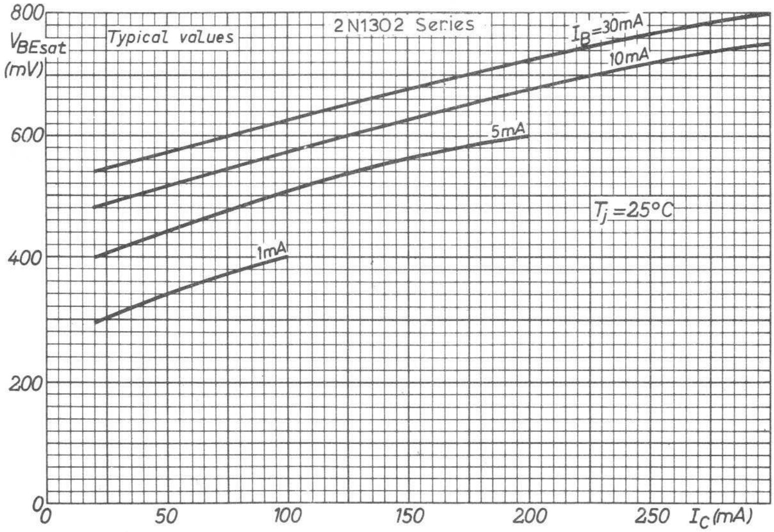
COLLECTOR-EMITTER VOLTAGE PLOTTED AGAINST COLLECTOR CURRENT



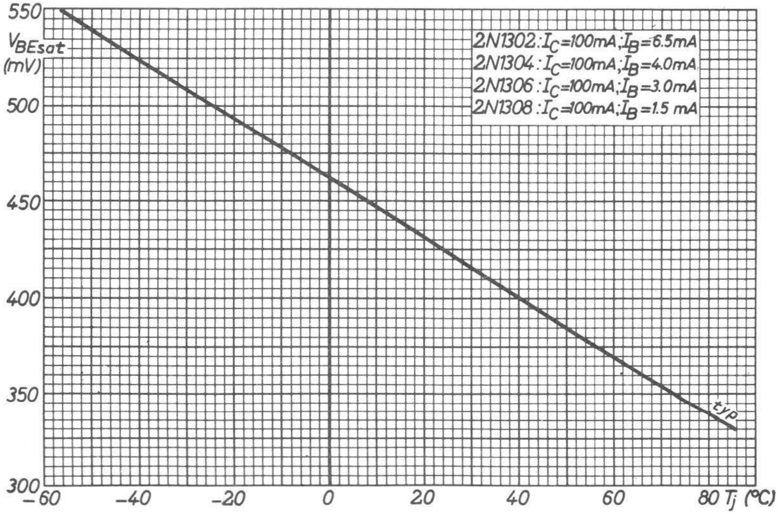
TYPICAL VARIATION OF COLLECTOR-EMITTER SATURATION VOLTAGE WITH JUNCTION TEMPERATURE

GERMANIUM N-P-N ALLOYED TRANSISTORS

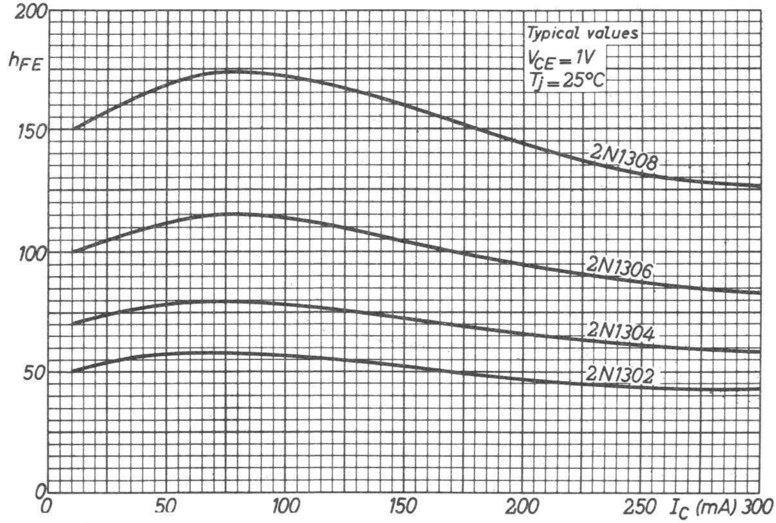
2N1302 2N1306 2N1304 2N1308



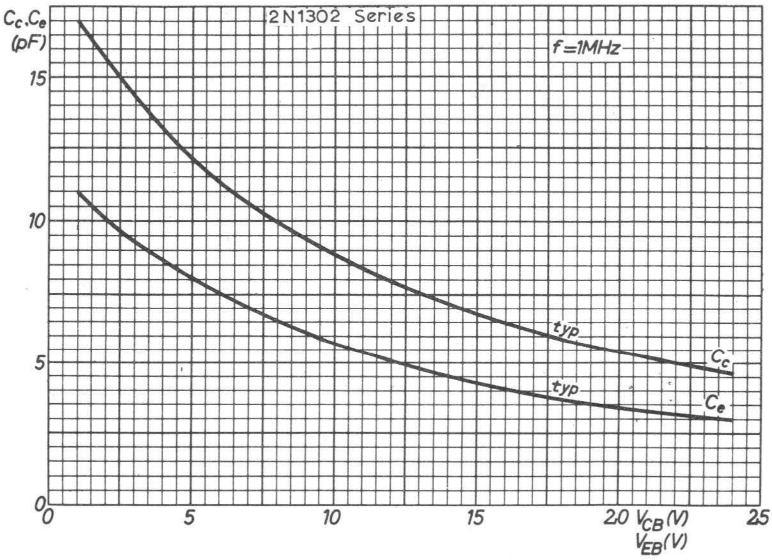
BASE-EMITTER SATURATION VOLTAGE PLOTTED AGAINST COLLECTOR CURRENT



TYPICAL VARIATION OF BASE-EMITTER SATURATION VOLTAGE WITH JUNCTION TEMPERATURE



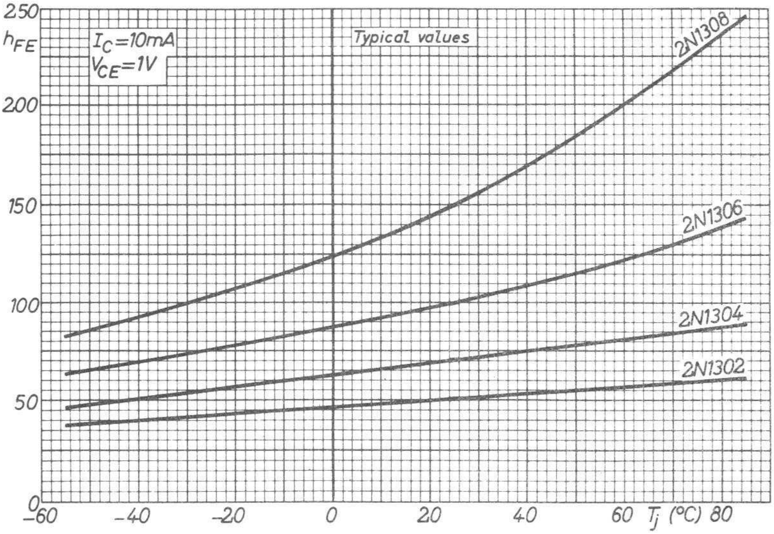
STATIC FORWARD CURRENT TRANSFER RATIO PLOTTED AGAINST COLLECTOR CURRENT



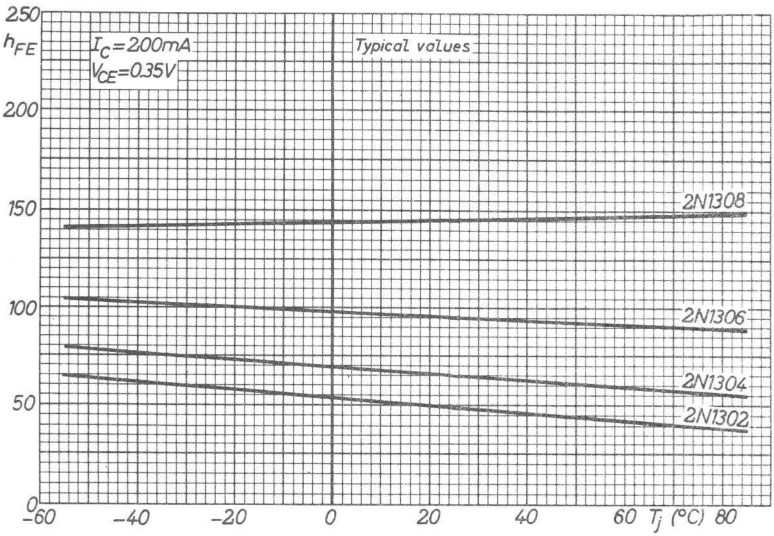
COLLECTOR AND EMITTER CAPACITANCE PLOTTED AGAINST COLLECTOR-BASE AND EMITTER-BASE VOLTAGE RESPECTIVELY

GERMANIUM N-P-N ALLOYED TRANSISTORS

2N1302 2N1306 2N1304 2N1308



TYPICAL VARIATION OF STATIC FORWARD CURRENT TRANSFER RATIO WITH JUNCTION TEMPERATURE, I_C = 10mA



TYPICAL VARIATION OF STATIC FORWARD CURRENT TRANSFER RATIO WITH JUNCTION TEMPERATURE, I_C = 200mA

GERMANIUM P-N-P ALLOYED TRANSISTORS

2N1303 2N1307 2N1305 2N1309

Germanium p-n-p alloyed junction transistors primarily intended for use in medium current, medium speed logic circuits in computers and other general industrial applications.

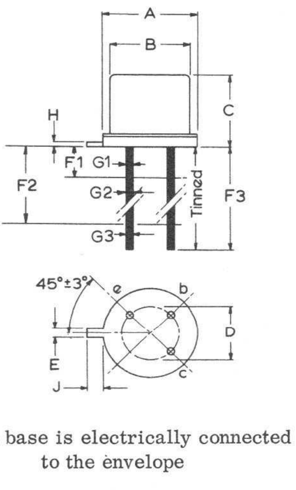
QUICK REFERENCE DATA

2N	1303	1305	1307	1309	
$-V_{CBO}$ max.	30	30	30	30	V
$-V_{CEO}$ max.	25	20	15	15	V
$-I_{CM}$ max.	300	300	300	300	mA
P_{tot} max. (T_{amb} = 25 °C)	150	150	150	150	mW
T_j max.	85	85	85	85	°C
h_{FE} min. ($-I_C$ = 10mA, $-V_{CE}$ = 1.0V)	20	40	60	80	
$-V_{CE(sat)}$ max. ($-I_C$ = 10mA, $-I_B = I_C/h_{FE}$ min.)	200	200	200	200	mV
f_T typ. ($-I_C$ = 1.0mA, $-V_{CE}$ = 5.0V)	5	10	15	20	MHz
t_{on} typ. ($t_d + t_r$)	360	255	230	200	ns
t_{off} typ. ($t_s + t_f$)	1300	1150	1050	1050	ns

Unless otherwise stated data is applicable to all types

OUTLINE AND DIMENSIONS

Conforming to B.S. 3934 SO-3/SB3-3A
J.E.D.E.C. TO-5



The base is electrically connected to the envelope

	Millimetres Min.	Typ.	Max.
A	9.10	-	9.4
B	8.20	-	8.50
C	-	-	6.60
D	-	5.08	-
E	-	-	0.86
F1	-	-	0.51
F2	12.7	-	-
F3	38.1		41.3
G1	-	-	1.01
G2	-	-	0.48
G3	-	-	0.53
H	-	0.4	-
J	-	-	1.0

RATINGS

Limiting values of operation according to the absolute maximum system.

Electrical

$-V_{CBO}$ max.		30	V
$-V_{CEO}$ max.	2N1303	25	V
	2N1305	20	V
	2N1307, 1309	15	V
$-V_{EBO}$ max.		25	V
$-I_C$ max. (d.c. or averaged over any 20ms period)		200	mA
$-I_{CM}$ max.		300	mA
P_{tot} max. (T_{amb} = 25°C)		150	mW

Temperature

T_{stg} min.	-65	°C
T_{stg} max.	100	°C
T_j max.	85	°C

THERMAL CHARACTERISTICS

$\Theta_{j\text{-}amb}$ (in free air)	0.4 deg C/mW
$\Theta_{j\text{-}case}$	0.2 deg C/mW

ELECTRICAL CHARACTERISTICS (T_j = 25°C unless otherwise stated)

			Min.	Typ.	Max.	
$-I_{CBO}$	Collector cut-off current					
	$-V_{CB}$ = 25V, I_E = 0		-	3.0	6.0	μA
$-I_{EBO}$	Emitter cut-off current					
	$-V_{EB}$ = 25V, I_C = 0		-	1.7	6.0	μA
$-I_{CEX}$	Collector-emitter cut-off current					
	$+V_{BE}$ = 0.2V, $-V_{CE}$ = 15V, T_j = 55°C		-	-	50	μA
$-V_{BE(sat)}$	Base-emitter saturation voltage					
	$-I_C$ = 10mA, $-I_B$ = 0.5mA	2N1303	0.15	0.30	0.40	V
		2N1305	0.15	0.25	0.35	V
		2N1307	0.15	0.24	0.35	V
		2N1309	0.15	0.23	0.35	V

GERMANIUM P-N-P ALLOYED TRANSISTORS

2N1303 2N1307 2N1305 2N1309

Symbol	Parameter	Type	Min.	Typ.	Max.	Unit
$-V_{CE(sat)}$	Collector-emitter saturation voltage					
	$-I_C=10mA, -I_B=0.5mA$	2N1303	-	0.1	0.2	V
	$-I_C=10mA, -I_B=0.25mA$	2N1305	-	0.1	0.2	V
	$-I_C=10mA, -I_B=0.17mA$	2N1307	-	0.1	0.2	V
	$-I_C=10mA, -I_B=0.13mA$	2N1309	-	0.1	0.2	V
V_{pt}	Punch-through voltage	2N1303	25	-	-	V
		2N1305	20	-	-	V
		2N1307	15	-	-	V
		2N1309	15	-	-	V
h_{FE}	Static forward current transfer ratio					
	$-I_C=10mA, -V_{CE}=1.0V$	2N1303	20	50	-	
		2N1305	40	70	100	
		2N1307	60	100	200	
		2N1309	80	150	300	
	$-I_C=200mA, -V_{CE}=0.35V$	2N1303	10	35	-	
		2N1305	15	55	-	
		2N1307	20	90	-	
		2N1309	20	130	-	
C_c	Collector capacitance					
	$-V_{CB}=5.0V, I_E=I_e=0$, f = 1.0MHz		-	10	20	pF
C_e	Emitter capacitance					
	$-V_{EB}=5.0V, I_C=I_c=0$, f = 1.0MHz		-	7.0	-	pF
f_T	Transition frequency					
	$-I_C=1.0mA, -V_{CE}=5.0V$	2N1303	3.0	5.0	-	MHz
		2N1305	5.0	10	-	MHz
		2N1307	10	15	-	MHz
		2N1309	15	20	-	MHz

Typical switching times (see fig.1)

		2N	1303	1305	1307	1309	
t_d	Delay time		60	55	50	45	ns
t_r	Rise time		300	200	180	155	ns
t_s	Storage time		700	700	700	700	ns
t_f	Fall time		600	450	350	350	ns

Typical recovered charge (see fig.2)

Q_s	1000	1000	1000	1000	pC

TEST CIRCUITS AND WAVEFORMS

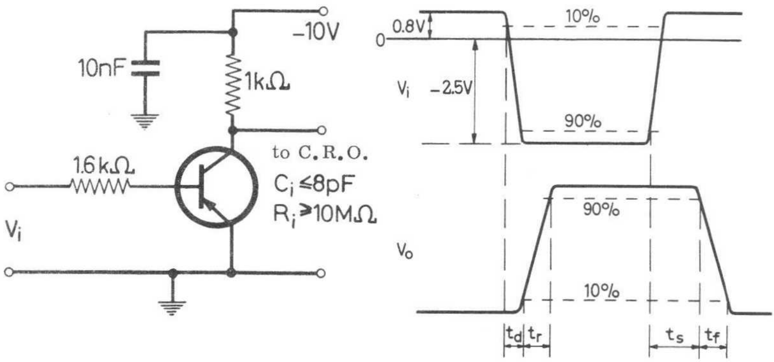
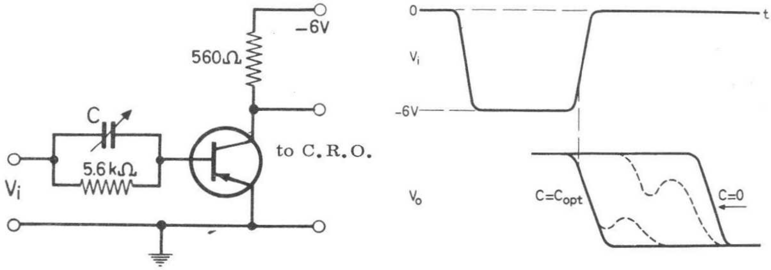


Fig.1



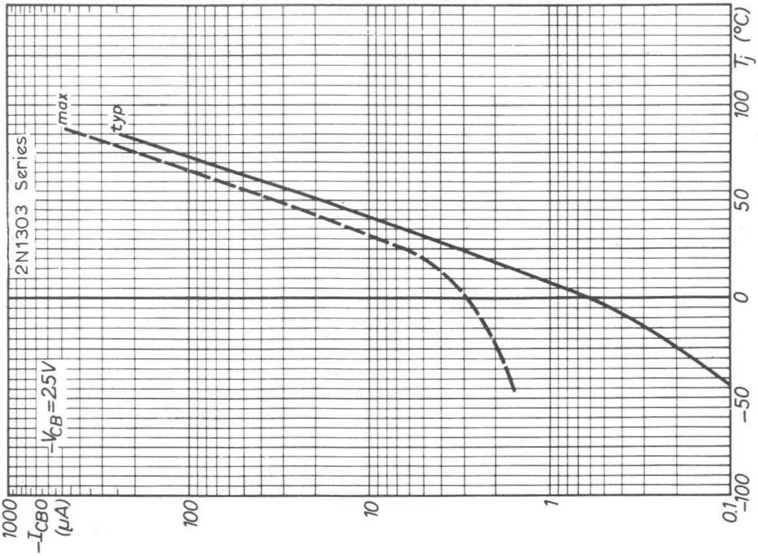
Adjust C from zero to C_{opt}

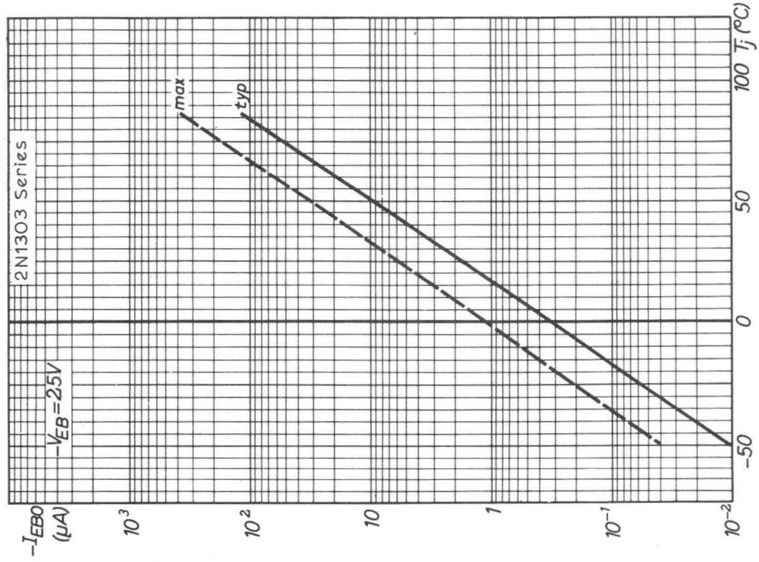
$Q_s = C_{opt} \times V_i$

Fig. 2

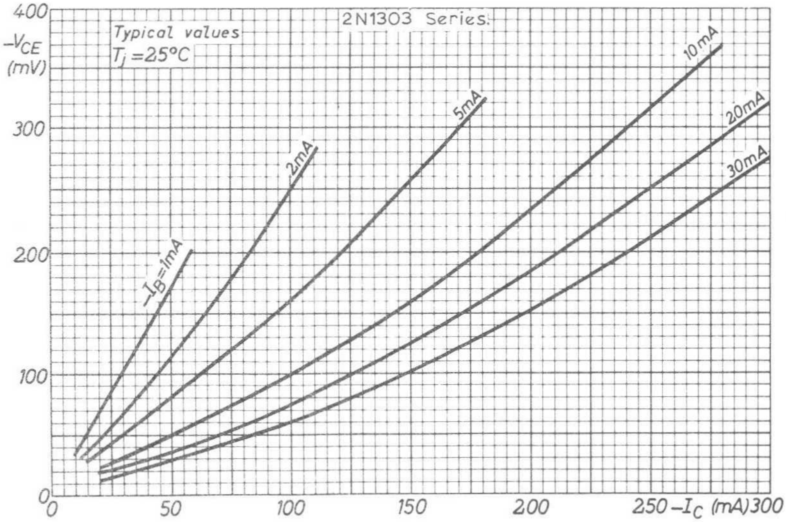
GERMANIUM P-N-P ALLOYED TRANSISTORS

2N1303 2N1307 2N1305 2N1309

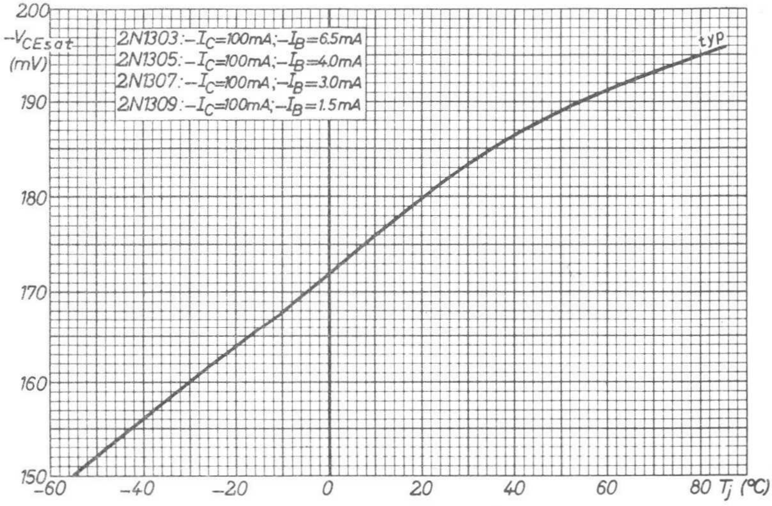




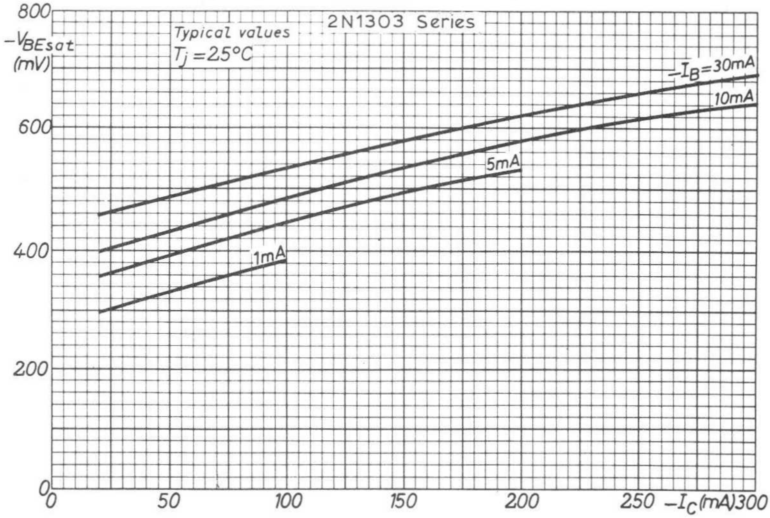
VARIATION OF COLLECTOR AND EMITTER CUT-OFF CURRENT WITH JUNCTION TEMPERATURE



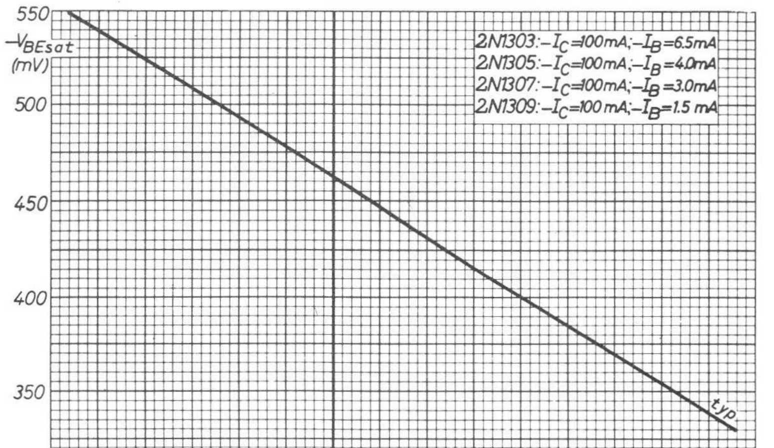
COLLECTOR-EMITTER VOLTAGE PLOTTED AGAINST COLLECTOR CURRENT



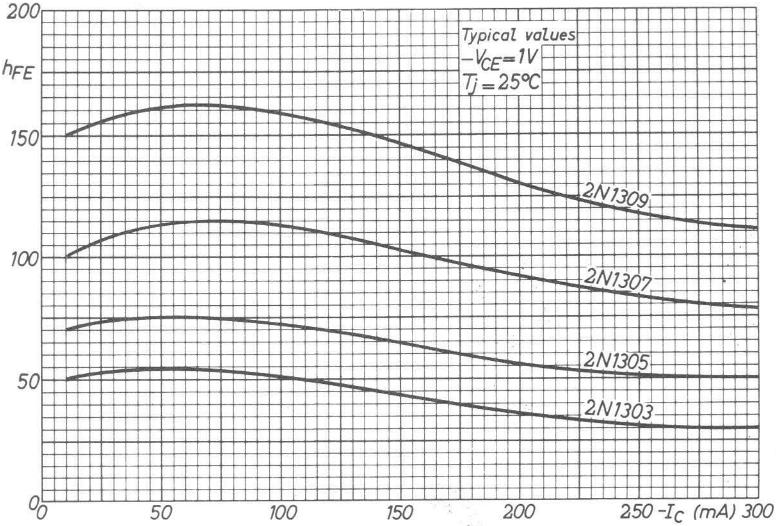
TYPICAL VARIATION OF COLLECTOR-EMITTER SATURATION VOLTAGE WITH JUNCTION TEMPERATURE



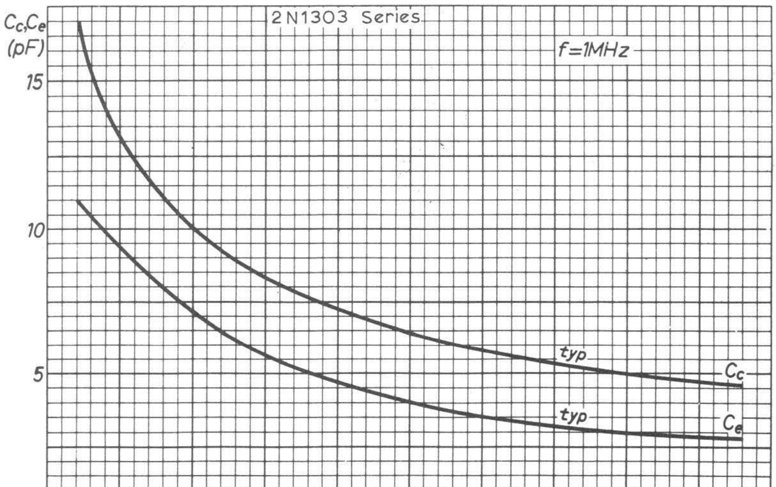
BASE-EMITTER SATURATION VOLTAGE PLOTTED AGAINST COLLECTOR CURRENT



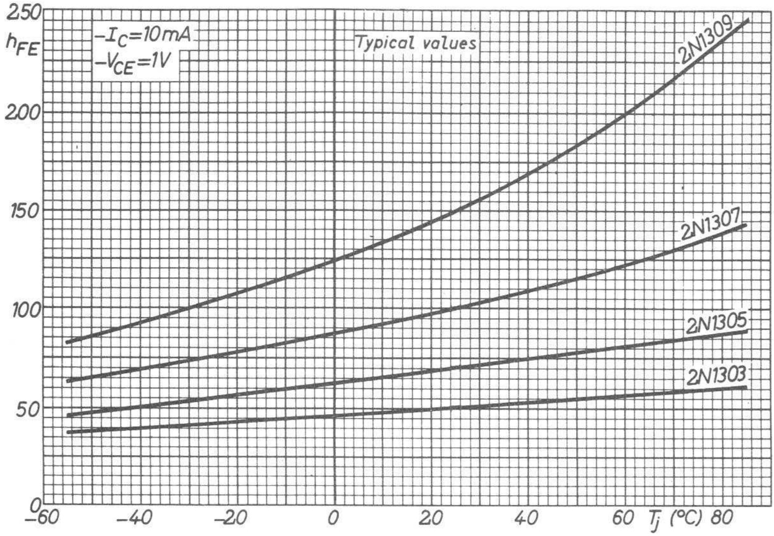
TYPICAL VARIATION OF BASE-EMITTER SATURATION VOLTAGE WITH JUNCTION TEMPERATURE



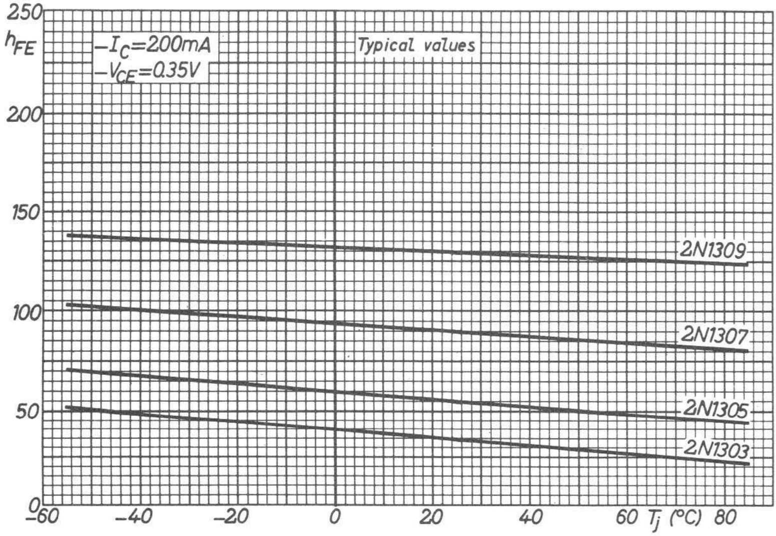
STATIC FORWARD CURRENT TRANSFER RATIO PLOTTED AGAINST COLLECTOR CURRENT



COLLECTOR AND EMITTER CAPACITANCE PLOTTED AGAINST COLLECTOR-BASE AND EMITTER-BASE VOLTAGE RESPECTIVELY



TYPICAL VARIATION OF STATIC FORWARD CURRENT TRANSFER RATIO WITH JUNCTION TEMPERATURE, $-I_C$ = 10mA



TYPICAL VARIATION OF STATIC FORWARD CURRENT TRANSFER RATIO WITH JUNCTION TEMPERATURE, $-I_C$ = 200mA

GERMANIUM P-N-P L.F. POWER TRANSISTOR

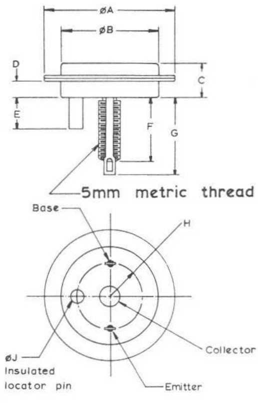
2N1358

Germanium p-n-p alloy transistor intended for general purpose l.f. power applications.

QUICK REFERENCE DATA		
$-V_{CBX}$ max. ($+V_{BE} = 1.5V$)	80	V
$-V_{EBO}$ max.	60	V
I_E max.	15	A
P_{tot} max. ($T_{mb} = 25^oC$)	150	W
T_j max.	100	^oC
h_{FE} ($-I_C = 1.2A$, $-V_{CE} = 2.0V$)	40-80	

OUTLINE AND DIMENSIONS

Conforming to B.S. 3934 SO-37/SB3-12 } with metric thread
J.E.D.E.C. TO-36



Collector connected to mounting base

	Millimetres		
	Min.	Typ.	Max.
ØA	-	-	31
ØB	-	-	26.5
C	-	-	10.5
D	-	-	5.33
E	-	-	7.9
F	10	-	12
G	16	-	18
H	-	17.5	-
ØJ	-	-	3.5

RATINGS

Limiting values of operation according to the absolute maximum system.

Electrical

$-V_{CBX}$ max. ($+V_{BE}=1.5V$)	80	V
$-V_{EBO}$ max.	60	V
I_E max.	15	A
$-I_B$ max.	4.0	A
P_{tot} max. ($T_{mb}=25^{o}C$)	150	W

Temperature

T_{stg} min.	-65	^{o}C
T_{stg} max.	100	^{o}C
T_j max.	100	^{o}C

THERMAL CHARACTERISTICS

Θ_{j-mb}	0.5	degC/W
Thermal capacity for pulses in the 1 to 10ms range	0.075	Ws/degC

ELECTRICAL CHARACTERISTICS ($T_j=25^{o}C$ unless otherwise stated)

		Min.	Typ.	Max.	
	Collector cut-off current				
$-I_{CBO}$	$-V_{CBO}=2.0V$, $I_E=0$	-	100	200	μA
	$-V_{CBO}=30V$, $I_E=0$, $T_j=70^{o}C$	-	4.0	6.0	mA
$-I_{CBX}$	$-V_{CB}=80V$, $+V_{BE}=1.5V$	-	2.0	8.0	mA
$-I_{EBO}$	Emitter cut-off current				
	$-V_{EB}=60V$, $I_C=0$	-	1.0	8.0	mA
	$-V_{EB}=30V$, $I_C=0$, $T_j=70^{o}C$	-	4.0	6.0	mA
	Collector-emitter breakdown voltage				
$-V_{(BR)CEO}$	$-I_C=300mA$, $I_B=0$	40	-	-	V
$-V_{(BR)CES}$	$-I_C=300mA$, $V_{BE}=0$	70	-	-	V
$-V_{CE(sat)}$	Collector-emitter saturation voltage				
	$-I_C=12A$, $-I_B=2.0A$	-	0.3	0.7	V
$-V_{BE}$	Base-emitter voltage				
	$-I_C=1.2A$, $-V_{CE}=2.0V$	-	0.35	0.5	V
	$-I_C=5.0A$, $-V_{CE}=2.0V$	-	0.65	0.9	V

ELECTRICAL CHARACTERISTICS (cont'd)

Symbol	Parameter	Min.	Typ.	Max.	
$-V_{EB(fl)}$	Emitter-base floating potential $-V_{CB} = 80V$, $I_E = 0$	-	0.15	1.0	V
h_{FE}	Forward current transfer ratio				
	$-I_C = 1.2A$, $-V_{CE} = 2.0V$	40	55	80	
	$-I_C = 5.0A$, $-V_{CE} = 2.0V$	25	35	-	
f_{hfb}	Cut-off frequency $-I_C = 1.0A$, $-V_{CB} = 12V$	100	-	-	kHz
t_r	Rise time $-I_C = 12A$, $-I_B = 2.0A$, $-V_{CE} = 12V$	-	15	-	μs
t_f	Fall time $+V_{BE} = 6.0V$, $R_{BE} = 10\Omega$, $I_C = 0$	-	15	-	μs

ACCESSORIES (Code No. 56213)

Supplied with devices:

1 Mica washer

1 Insulating ring

1 Cable lug

1 Lock washer

1 Hexagon nut M5

SILICON PLANAR EPITAXIAL N-P-N TRANSISTOR

2N1420

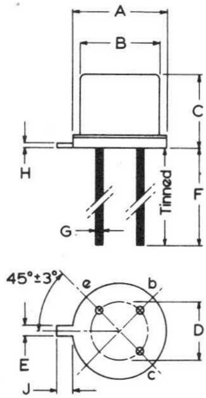
High gain n-p-n silicon transistor intended for use in high performance switching, oscillator and amplifier applications. TO-5 envelope.

QUICK REFERENCE DATA

V_{CBO} ($I_E = 0$)	60	V
V_{CER} ($R_{BE} \leq 10\Omega$)	30	V
I_{CM} max.	1.0	A
P_{tot} max. ($T_{amb} = 25^{o}C$)	600	mW
h_{FE} (I_C 150mA, $V_{CE} = +10V$)	100 - 300	

OUTLINE AND DIMENSIONS

Conforming to J.E.D.E.C. TO-5



	Millimetres		
	Min.	Nom.	Max.
A	8.64	8.9	9.4
B	7.75	8.15	8.5
C	6.1	6.35	6.6
D	-	5.08	-
E	0.71	0.79	0.86
F	38	-	-
G	-	0.45	-
H	-	0.4	-
J	0.74	0.85	1.01

Collector connected to envelope

RATINGS

Limiting values of operation according to the absolute maximum system.

Electrical

†V_{CBO} ($I_E = 0$)	60	V
†V_{CER} ($R_{BE} \leq 10\Omega$)	30	V
†V_{EBO} ($I_C = 0$)	5.0	V
†I_{CM}	1.0	A
†P_{tot} max. ($T_{amb} = 25^{\circ}C$)	600	mW
($T_{case} = 100^{\circ}C$)	1.0	W
($T_{case} = 25^{\circ}C$)	2.0	W

Temperature

†T_{stg} min.	-65	$^{\circ}C$
†T_{stg} max.	+200	$^{\circ}C$
†T_j max. (operating)	+175	$^{\circ}C$

THERMAL CHARACTERISTICS

†$\theta_{j\text{-}case}$	75	deg C/W
†$\theta_{j\text{-}amb}$	250	deg C/W

ELECTRICAL CHARACTERISTICS ($T_{amb} = 25^{\circ}C$ unless otherwise stated)

		Min.	Max.	
†I_{CBO}	Collector cut-off current			
	$V_{CB} = 30V$, $I_E = 0$	-	1.0	μA
	$V_{CB} = 30V$, $I_E = 0$, $T_{amb} = 150^{\circ}C$	-	100	μA
†$V_{BR(CBO)}$	Collector-base breakdown voltage			
	$I_C = 100\mu A$, $I_E = 0$	60	-	V
†$V_{CER(sust)}$	Collector emitter sustaining voltage			
	$R_{BE} \leq 10\Omega$, $I_C = 100mA$ (pulsed)	30	-	V
†$V_{CE(sat)}$	Collector-emitter saturation voltage			
	$I_C = 150mA$, $I_B = 15mA$	-	1.5	V
†$V_{BE(sat)}$	Base-emitter saturation voltage			
	$I_C = 150mA$, $I_B = 15mA$	-	1.3	V
†h_{FE}	Large signal forward current transfer ratio			
	$I_C = 150mA$, $V_{CE} = 10V$	100	300	

		Min.	Max.	
†h_{fe}	Small signal high frequency current gain			
	$I_C = 50mA$, $V_C = 10V$, $f = 20Mc/s$	2.5	-	
†c_{ob}	Output capacitance			
	$V_{CB} = 10V$, $I_E = 0$	-	35	pF

†J.E.D.E.C. registered data.

SOLDERING AND WIRING RECOMMENDATIONS

1. When using a soldering iron, transistors may be soldered directly into the circuit, but heat conducted to the junction should if possible be kept to a minimum by the use of a thermal shunt.

2. Transistors may be dip-soldered at a solder temperature of 245°C for a maximum soldering time of 5 seconds. The case temperature during dip-soldering must not at any time exceed the maximum storage temperature. These recommendations apply to a transistor mounted flush on a board having punched-through holes, or spaced at least 1.5mm above a board having plated-through holes.

3. Care should be taken not to bend the leads nearer than 1.5mm from the seal.

4. If devices are stored above 100°C before incorporation into equipment, some deterioration of the external surface is likely to occur which may make soldering into the circuit difficult. Under these circumstances the leads should be retinned using a suitable activated flux.

SILICON PLANAR N-P-N TRANSISTOR

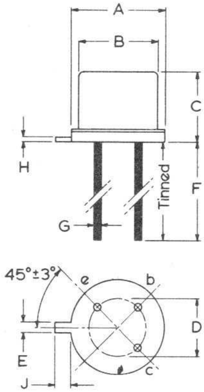
2N1711

Silicon n-p-n double diffused planar transistor designed for a wide variety of applications including d.c. and wideband amplifiers.

QUICK REFERENCE DATA		
V_{CBO} max. ($I_E = 0$)	+75	V
V_{CER} max. ($R_{BE} \leq 10\Omega$)	+50	V
I_{CM} max.	1.0	A
P_{tot} max. ($T_{amb} = 25^{\circ}C$)	800	mW
h_{FE} ($I_{CM} = 150mA$, $V_{CE} = +10V$)	100 - 300	

OUTLINE AND DIMENSIONS

Conforming to J.E.D.E.C. TO-5



	Millimetres		
	Min.	Nom.	Max.
A	8.64	8.9	9.4
B	7.75	8.15	8.5
C	6.1	6.35	6.6
D	-	5.08	-
E	0.71	0.79	0.86
F	38	-	-
G	-	0.45	-
H	-	0.4	-
J	0.74	0.85	1.01

Collector connected to envelope

RATINGS

Limiting values of operation according to the absolute maximum system.

Electrical

†V_{CBO} max. (I_E = 0)	+75	V
†V_{CER} max. (R_{BE} ≤10Ω)	+50	V
†V_{EBO} max. (I_C = 0)	+7.0	V
V_{CEO} max. (I_B = 0)	+30	V
†I_{CM} max.	1.0	A
†P_{tot} max. T_{case} = 25°C	3.0	W
T_{case} = 100°C	1.7	W
T_{amb} = 25°C	800	mW

Temperature

†T_{stg} min.	-65	°C
T_{stg} max.	200*	°C
†T_j (operating range)	-65 to +200	°C

*See Soldering and Wiring Recommendation No.4.

THERMAL CHARACTERISTICS

†Θ_{j-case}	58.3 degC/W
†Θ_{j-amb}	219 degC/W

ELECTRICAL CHARACTERISTICS (T_{amb} = 25°C unless otherwise stated)

		Min.	Max.	
†I_{CBO}	Collector cut-off current			
	V_{CB} = 60V, I_E = 0	-	10	nA
	V_{CB} = 60V, I_E = 0, T_{amb} = 150°C	-	10	μA
†I_{EBO}	Emitter cut-off current			
	V_{EB} = 5.0V, I_C = 0	-	5.0	nA
†$V_{BR(CBO)}$	Collector-base breakdown voltage			
	I_C = 100μA, I_E = 0	+75	-	V
†$V_{BR(EBO)}$	Emitter-base breakdown voltage			
	I_E = 100μA, I_C = 0	+7.0	-	V
†$V_{CER(sust)}$	Collector-emitter sustaining voltage (See note 1)			
	R_{BE} ≤10Ω, I_C = 100mA	+50	-	V

SILICON PLANAR N-P-N TRANSISTOR

2N1711

		Min.	Max.	
†$V_{CE(sat)}$	Collector-emitter saturation voltage (See note 1) $I_B = 15mA$, $I_C = 150mA$	-	+1.5	V
†$V_{BE(sat)}$	Base-emitter saturation voltage (See note 1) $I_B = 15mA$, $I_C = 150mA$	-	+1.3	V
†h_{FE}	Large signal forward current transfer ratio			
	$I_C = 500mA$, $V_{CE} = 10V$ (See note 1)	40	-	
	$I_C = 150mA$, $V_{CE} = 10V$ (See note 1)	100	300	
	$I_C = 10mA$, $V_{CE} = 10V$ (See note 1)	75	-	
	$I_C = 10mA$, $V_{CE} = 10V$, $T_{amb} = -55^oC$	35	-	
	$I_C = 0.1mA$, $V_{CE} = 10V$	35	-	
	$I_C = 0.01mA$, $V_{CE} = 10V$	20		

Small Signal characteristics

		Min.	Max.	
†h_{fe}	Small signal forward current transfer ratio			
	$I_C = 1.0mA$, $V_{CE} = 5.0V$, f=1.0kc/s	50	200	
	$I_C = 5.0mA$, $V_{CE} = 10V$, f=1.0kc/s	70	300	
†h_{ib}	Input impedance			
	$I_C = 1.0mA$, $V_{CB} = 5.0V$, f=1.0kc/s	24	34	Ω
	$I_C = 5.0mA$, $V_{CB} = 10V$, f=1.0kc/s	4.0	8.0	Ω
†h_{rb}	Voltage feedback ratio			
	$I_C = 1.0mA$, $V_{CB} = 5.0V$, f=1.0kc/s	-	5.0	$\times 10^{-4}$
	$I_C = 5.0mA$, $V_{CB} = 10V$, f=1.0kc/s	-	5.0	$\times 10^{-4}$

		Min.	Max.	
†h_{ob}	Output admittance $I_C = 1.0mA$, $V_{CB} = 5.0V$, f=1.0kc/s	0.1	0.5	µmho
	$I_C = 5.0mA$, $V_{CB} = 10V$, f=1.0kc/s	0.1	1.0	µmho
†h_{fe}	Small signal forward current transfer ratio $I_C = 50mA$, $V_{CE} = 10V$, f=20Mc/s	3.5	-	
†c_{ob}	Output capacitance $I_C = 0$, $V_{CB} = 10V$	-	25	pF
†c_{ib}	Input capacitance $I_C = 0$, $V_{EB} = 0.5V$	-	80	pF
†NF	Noise figure $I_C = 0.3mA$, $V_{CE} = 10V$, f=1.0kc/s, $R_S = 510\Omega$, 1 cycle bandwidth	-	8.0	dB

†J.E.D.E.C. registered data

NOTE

1. Measured under pulsed conditions to prevent excessive dissipation pulse duration = 300µs, duty cycle≤1%.

SOLDERING AND WIRING RECOMMENDATIONS

1. When using a soldering iron, transistors may be soldered directly into the circuit, but heat conducted to the junction should if possible be kept to a minimum by the use of a thermal shunt.
2. Transistors may be dip-soldered at a solder temperature of 245°C for a maximum soldering time of 5 seconds. The case temperature during dip-soldering must not at any time exceed tha maximum storage temperature. These recommendations apply to a transistor mounted flush on a board having punched-through holes, or spaced at least 1.5mm above a board having plated-through holes.
3. Care should be taken not to bend the leads nearer than 1.5mm from the seal.
4. If devices are stored above 100°C before incorporation into equipment, some deterioration of the external surface is likely to occur which may make soldering into the circuit difficult. Under these circumstances the leads should be retinned using a suitable activated flux.

N-P-N SILICON TRANSISTOR

2N1893

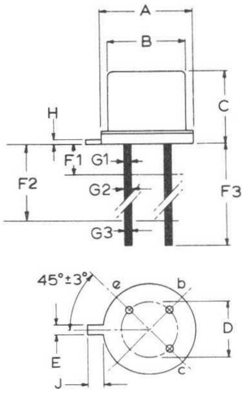
High voltage silicon n-p-n transistor intended for use in high performance amplifier, oscillator and switching applications.

QUICK REFERENCE DATA		
V_{CBO} max.	120	V
V_{CER} max. ($R_{BE} \leq 10\Omega$)	100	V
I_C max.	500	mA
P_{tot} max. ($T_{case} = 25^{o}C$)	3.0	W
T_j max.	200	^{o}C
h_{FE} at $I_C = 0.1mA$, $V_{CE} = 10V$	>20	
$I_C = 10mA$, $V_{CE} = 10V$, $T = -55^{o}C$	>20	
$I_C = 10mA$, $V_{CE} = 10V$	>35	
$I_C = 150mA$, $V_{CE} = 10V$	40 to 120	

OUTLINE AND DIMENSIONS

Conforming to B.S. 3934 SO - 3/SB3 - 3A

J.E.D.E.C. TO - 5



The collector is connected to the envelope

Millimetres	Min.	Typ.	Max.
A	9.10	-	9.4
B	8.2	-	8.5
C	6.15	-	6.60
D	-	5.1	-
E	0.71	-	0.86
F1	-	-	0.51
F2	12.7	-	-
F3	38.0	-	41.3
G1	-	-	1.01
G2	0.41	-	0.48
G3	-	-	0.53
H	-	0.4	-
J	0.74	-	1.0

RATINGS

Limiting values of operation according to the absolute maximum system.

Electrical

V_{CBO} max.	120	V
V_{CEO} max.	80	V
V_{CER} max. ($R_{BE} \leq 10\Omega$)	100	V
V_{EBO} max.	7.0	V
I_C max.	500	mA
P_{tot} max., $T_{amb} = 25^oC$	0.8	W
$T_{case} = 100^oC$	1.7	W
$T_{case} = 25^oC$	3.0	W

Temperature

T_{stg} min.	-65	^oC
T_{stg} max.	200	^oC
T_j max.	200	^oC

THERMAL CHARACTERISTICS

θ_{j-amb}	219	degC/W
θ_{j-case}	58.3	degC/W

ELECTRICAL CHARACTERISTICS ($T_{amb} = 25^oC$ unless otherwise stated)

		Min.	Max.	
I_{CBO}	Collector cut-off current			
	$V_{CB} = 90V$, $I_E = 0$	-	10	nA
	$V_{CB} = 90V$, $I_E = 0$, $T_{amb} = 150^oC$	-	15	μA
I_{EBO}	Emitter cut-off current			
	$V_{EB} = 5.0V$, $I_C = 0$	-	10	nA
$V_{(BR)CBO}$	Collector-base breakdown voltage			
	$I_C = 100\mu A$, $I_E = 0$	120	-	V
$V_{(BR)EBO}$	Emitter-base breakdown voltage			
	$I_E = 100\mu A$, $I_C = 0$	7.0	-	V

N-P-N SILICON TRANSISTOR

2N1893

Symbol	Parameter / Conditions	Min.	Max.	Unit
	*Collector-emitter sustaining voltage			
$V_{CER(sust)}$	$I_C = 100mA$, $R_{BE} \leq 10\Omega$	100	-	V
$V_{CEO(sust)}$	$I_C = 30mA$, $I_B = 0$	80	-	V
$V_{CE(sat)}$	*Collector-emitter saturation voltage			
	$I_C = 50mA$, $I_B = 5.0mA$	-	1.2	V
	$I_C = 150mA$, $I_B = 15mA$	-	5.0	V
$V_{BE(sat)}$	*Base-emitter saturation voltage			
	$I_C = 50mA$, $I_B = 5.0mA$	-	0.9	V
	$I_C = 150mA$, $I_B = 15mA$	-	1.3	V
h_{FE}	Static forward current transfer ratio			
	$I_C = 0.1mA$, $V_{CE} = 10V$	20	-	
	$I_C = 10mA$, $V_{CE} = 10V$, $T = -55^oC$	20	-	
	*$I_C = 10mA$, $V_{CE} = 10V$	35	-	
	*$I_C = 150mA$, $V_{CE} = 10V$	40	120	
h_{fe}	Small signal forward current transfer ratio (common emitter)			
	$I_C = 1.0mA$, $V_{CE} = 5.0V$, $f = 1.0kHz$	30	100	
	$I_C = 5.0mA$, $V_{CE} = 10V$, $f = 1.0kHz$	45	-	
	$I_C = 50mA$, $V_{CE} = 10V$, $f = 20MHz$	2.5	-	
C_{tc}	Collector capacitance			
	$V_{CB} = 10V$, $I_E = I_e = 0$	-	15	pF
C_{te}	Emitter capacitance			
	$V_{EB} = 0.5V$, $I_C = I_c = 0$	-	85	pF

*Measured under pulsed conditions to avoid excessive dissipation, pulse duration $\leq 300\mu s$, duty cycle < 0.02.

h - parameters at f = 1.0kHz (common base)

		Min.	Typ.	Max.	
	I_C = 1.0mA, V_{CE} = 5.0V				
h_{ib}	Input impedance	20	-	30	Ω
h_{rb}	Voltage feedback ratio	-	1.25	-	$\times 10^{-4}$
h_{ob}	Output conductance	-	0.5	-	μmho
	I_C = 5.0mA, V_{CE} = 10V				
h_{ib}	Input impedance	4.0	-	8.0	Ω
h_{rb}	Voltage feedback ratio	-	1.50	-	$\times 10^{-4}$
h_{ob}	Output conductance	-	0.5	-	μmho

N-P-N SILICON PLANAR EPITAXIAL TRANSISTORS

2N2217 2N2218 2N2219

N-P-N silicon planar expitaxial transistors designed primarily for high speed switching, d.c. amplifier and v.h.f. - u.h.f. communications applications.

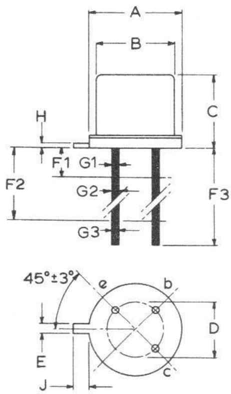
QUICK REFERENCE DATA

V_{CBO} max.			60	V
V_{CEO} max.			30	V
I_C max.			800	mA
P_{tot} max. (T_{amb} = 25°C)			800	mW
T_j max.			175	°C
f_T min. (I_C = 20mA, V_{CE} = 20V, f = 100MHz)			250	MHz
	2N2217	2N2218	2N2219	
h_{FE} min. I_C = 0.1mA, V_{CE} = 10V	-	20	35	
I_C = 10mA, V_{CE} = 10V	17	35	75	
I_C = 500mA, V_{CE} = 10V	-	20	30	

Unless otherwise stated data is applicable to all types

OUTLINE AND DIMENSIONS

Conforming to B.S. 3934 SO-3/SB3-3A
J.E.D.E.C. TO-5



Collector connected to envelope

Millimetres

	Min.	Typ.	Max.
A	9.10	-	9.39
B	8.2	-	8.50
C	6.15	-	6.60
D	-	5.08	-
E	0.71	-	0.86
F1	-	-	0.51
F2	12.7	-	-
F3	38.1	-	41.3
G1	-	-	1.01
G2	0.41	-	0.48
G3	-	-	0.53
H	-	0.4	-
J	0.74	-	1.01

†RATINGS

Limiting values of operation according to the absolute maximum system.

Electrical

V_{CBO} max.	60	V
V_{CEO} max.	30	V
V_{EBO} max.	5.0	V
I_C max.	800	mA
P_{tot} max. (T_{amb} = 25°C)	800	mW

Temperature

T_{stg} min.	-65	°C
T_{stg} max.	200	°C
T_j max.	175	°C

†THERMAL CHARACTERISTICS

$\Theta_{j\text{-}amb}$ (above 25°C)	0.19 degC/mW
$\Theta_{j\text{-}case}$ (above 25°C)	0.05 degC/mW

†ELECTRICAL CHARACTERISTICS (T_{amb} = 25°C unless otherwise stated)

		Min.	Max.	
I_{CBO}	Collector cut-off current			
	V_{CB} = 50V, I_E = 0	-	10	nA
	V_{CB} = 50V, I_E = 0, T_{amb} = 150°C	-	10	μA
I_{EBO}	Emitter cut-off current			
	V_{EB} = 3.0V, I_C = 0	-	10	nA
$V_{(BR)CBO}$	Collector-base breakdown voltage			
	I_C = 10μA, I_E = 0	60	-	V
$V_{(BR)CEO}$	Collector-emitter breakdown voltage			
	I_C = 10mA, I_B = 0	30	-	V
$V_{(BR)EBO}$	Emitter-base breakdown voltage			
	I_E = 10μA, I_C = 0	5.0	-	V
$V_{CE(sat)}$	*Collector-emitter saturation voltage			
	I_C = 150mA, I_B = 15mA	-	0.4	V
	I_C = 500mA, I_B = 50mA, 2N2218,9	-	1.6	V

*Pulsed conditions, pulse width≤300μs, duty cycle≤2%.

†J.E.D.E.C. registered data.

			Min.	Max.	
$V_{BE(sat)}$	*Base-emitter saturation voltage				
	$I_C = 150mA, I_B = 15mA$		-	1.3	V
	$I_C = 500mA, I_B = 50mA$,	2N2218, 9	-	2.6	V
h_{FE}	Forward current transfer ratio				
	$I_C = 0.1mA, V_{CE} = 10V$	2N2218	20	-	
		2N2219	35	-	
	$I_C = 1.0mA, V_{CE} = 10V$	2N2217	12	-	
		2N2218	25	-	
		2N2219	50	-	
	$I_C = 10mA, V_{CE} = 10V$	2N2217	17	-	
		2N2218	35	-	
		2N2219	75		
	*$I_C = 150mA, V_{CE} = 1.0V$	2N2217	10	-	
		2N2218	20	-	
		2N2219	50		
	*$I_C = 150mA, V_{CE} = 10V$	2N2217	20	60	
		2N2218	40	120	
		2N2219	100	300	
	*$I_C = 500mA, V_{CE} = 10V$	2N2218	20	-	
		2N2219	30	-	
f_T	Transition frequency				
	$I_C = 20mA, V_{CE} = 20V, f = 100MHz$		250	-	MHz
C_{ob}	Collector capacitance				
	$V_{CB} = 10V, I_E = 0$		-	8.0	pF
$Re(h_{ie})$	Real part of input impedance				
	$I_C = 20mA, V_{CE} = 20V, f = 300MHz$		-	60	Ω

*Pulsed conditions, pulse width $\leq 300\mu s$, duty cycle $\leq 2\%$

N-P-N SILICON PLANAR EPITAXIAL TRANSISTORS

2N2218A 2N2219A

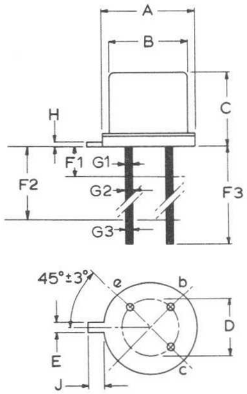
N-P-N silicon planar epitaxial transistors designed primarily for high speed saturated switching applications for industrial service

QUICK REFERENCE DATA			
V_{CBO} max.		75	V
V_{CEO} max. (I_C = 0 to 500mA)		40	V
I_C max.		800	mA
P_{tot} max. (T_{amb} = 25°C)		800	mW
T_j max.		175	°C
h_{FE} (I_C = 150mA, V_{CE} = 10V)	2N2218A	40-120	
	2N2219A	100-300	
f_T min. (I_C = 20mA, V_{CE} = 20V, f = 100MHz)	2N2218A	250	MHz
	2N2219A	300	MHz
t_s max. (I_{CS} = 150mA, I_B = $-I_{BM}$ = 15mA)		225	ns

Unless otherwise stated data is applicable to both types

OUTLINE AND DIMENSIONS

Conforming to B.S 3934 SO-3/SB3-3A
J.E.D.E.C. TO-5



Collector connected to envelope

Millimetres	Min.	Typ.	Max.
A	9.10	-	9.39
B	8.2	-	8.50
C	6.15	-	6.60
D	-	5.08	-
E	0.71	-	0.86
F1	-	-	0.51
F2	12.7	-	-
F3	38.1	-	41.3
G1	-	-	1.01
G2	0.41	-	0.48
G3	-	-	0.53
H	-	0.4	-
J	0.74	-	1.01

†RATINGS

Limiting values of operation according to the absolute maximum system.

Electrical

V_{CBO} max.	75	V
V_{CEO} max. ($I_C = 0$ to 500mA)	40	V
V_{EBO} max.	6.0	V
I_C max.	800	mA
P_{tot} max. ($T_{amb} = 25^oC$)	800	mW

Temperature

T_{stg} min.	-65	^oC
T_{stg} max.	200	^oC
T_j max.	175	^oC
T_{lead} max. (1/16" from case for 60 seconds)	200	^oC

†THERMAL CHARACTERISTICS

Θ_{j-amb} (above 25^oC)	0.19	degC/mW
Θ_{j-case} (above 25^oC)	0.05	degC/mW

†ELECTRICAL CHARACTERISTICS ($T_{amb} = 25^oC$ unless otherwise stated)

		Min.	Max.	
I_{CBO}	Collector cut-off current			
	$V_{CB} = 60V$, $I_E = 0$	-	10	nA
	$V_{CB} = 60V$, $I_E = 0$, $T_{amb} = 150^oC$	-	10	μA
I_{CEX}	Collector-emitter cut-off current			
	$V_{CE} = 60V$, $-V_{BE} = 3.0V$	-	10	nA
$-I_{BEX}$	Base current			
	$V_{CE} = 60V$, $-V_{BE} = 3.0V$	-	20	nA
I_{EBO}	Emitter cut-off current			
	$V_{EB} = 3.0V$, $I_C = 0$	-	10	nA
$V_{(BR)CBO}$	Collector-base breakdown voltage			
	$I_C = 10\mu A$, $I_E = 0$	75	-	V
$V_{(BR)CEO}$	Collector-emitter breakdown voltage			
	$I_C = 10mA$, $I_B = 0$	40	-	V
$V_{(BR)EBO}$	Emitter-base breakdown voltage			
	$I_E = 10\mu A$, $I_C = 0$	6.0	-	V

†J.E.D.E.C. registered data

N-P-N SILICON PLANAR EPITAXIAL TRANSISTORS

2N2218A 2N2219A

			Min.	Max.	
$V_{CE(sat)}$	*Collector-emitter saturation voltage				
	$I_C = 150mA$, $I_B = 15mA$		-	0.3	V
	$I_C = 500mA$, $I_B = 50mA$		-	1.0	V
$V_{BE(sat)}$	*Base-emitter saturation voltage				
	$I_C = 150mA$, $I_B = 15mA$		0.6	1.2	V
	$I_C = 500mA$, $I_B = 50mA$		-	2.0	V
h_{FE}	Forward current transfer ratio				
	$I_C = 0.1mA$, $V_{CE} = 10V$	2N2218A	20	-	
		2N2219A	35	-	
	$I_C = 1.0mA$, $V_{CE} = 10V$	2N2218A	25	-	
		2N2219A	50	-	
	$I_C = 10mA$, $V_{CE} = 10V$	2N2218A	35		
		2N2219A	75		
	$I_C = 10mA$, $V_{CE} = 10V$,				
	$T_{amb} = -55^oC$	2N2218A	15	-	
		2N2219A	35	-	
	$I_C = 150mA$, $V_{CE} = 1.0V$	2N2218A	20	-	
		2N2219A	50	-	
	*$I_C = 150mA$, $V_{CE} = 10V$	2N2218A	40	120	
		2N2219A	100	300	
	*$I_C = 500mA$, $V_{CE} = 10V$	2N2218A	25	-	
		2N2219A	40	-	
C_{ob}	Output capacitance				
	$V_{CB} = 10V$, $I_E = 0$, $f = 100kHz$		-	8.0	pF
C_{ib}	Input capacitance				
	$V_{EB} = 0.5V$, $I_C = 0$, $f = 100kHz$		-	25	pF
f_T	Transition frequency				
	$I_C = 20mA$, $V_{CE} = 20V$,				
	$f = 100MHz$	2N2218A	250	-	MHz
		2N2219A	300	-	MHz
r'_bC_c	Collector-base time constant				
	$I_C = 20mA$, $V_{CE} = 20V$, $f = 31.8MHz$		-	150	ps

*Pulsed conditions, pulse width $\leq 300\mu s$, duty cycle $\leq 2\%$.

			Min.	Max.	
N	Noise figure $I_C = 100\mu A$, $V_{CE} = 10V$, $R_g = 1.0k\Omega$, f = 1.0kHz, bandwidth = 1.0Hz	2N2219A	-	4.0	dB
Re (h_{ie})	Real part of input impedance $I_C = 20mA$, $V_{CE} = 20V$, f = 300MHz		-	60	Ω

h-parameters

Measured at $I_C = 1.0mA$, $V_{CE} = 10V$, f = 1.0kHz

h_{fe}	Small signal forward current transfer ratio	2N2218A	30	150	
		2N2219A	50	300	
h_{re}	Voltage feedback ratio	2N2218A	-	5.0×10^{-4}	
		2N2219A	-	8.0×10^{-4}	
h_{ie}	Input resistance	2N2218A	1.0	3.5	kΩ
		2N2219A	2.0	8.0	kΩ
h_{oe}	Output conductance	2N2218A	3.0	15	μmho
		2N2219A	5.0	35	μmho

Measured at $I_C = 10mA$, $V_{CE} = 10V$, f = 1.0kHz

h_{fe}	Small signal forward current transfer ratio	2N2218A	50	300	
		2N2219A	75	375	
h_{re}	Voltage feedback ratio	2N2218A	-	2.5×10^{-4}	
		2N2219A	-	4.0×10^{-4}	
h_{ie}	Input resistance	2N2218A	0.2	1.0	kΩ
		2N2219A	0.25	1.25	kΩ
h_{oe}	Output conductance	2N2218A	10	100	μmho
		2N2219A	25	200	μmho

Switching characteristics

		Max.	
Turn-on (see Fig. 1 and 3)			
$V_{CC}=30V$, $I_{CS}=150mA$, $I_B=15mA$, $V_{BEoff}=0.5V$			
t_d	Turn-on delay time	10	ns
t_r	Rise time	25	ns
Turn-off (see Fig. 2 and 3)			
$V_{CC}=30V$, $I_{CS}=150mA$, $I_B=-I_{BM}=15mA$			
t_s	Storage time	225	ns
t_f	Fall time	60	ns

TEST CIRCUITS

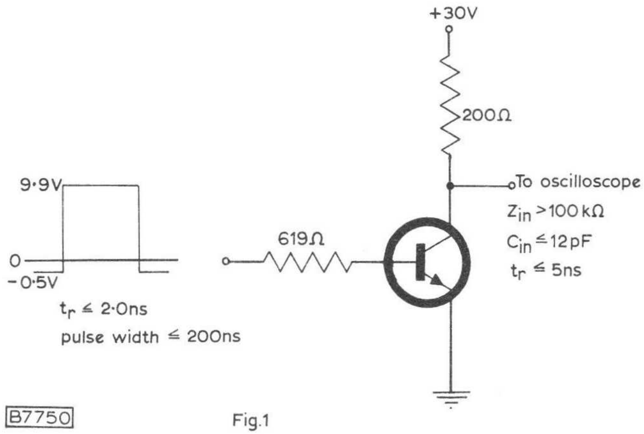
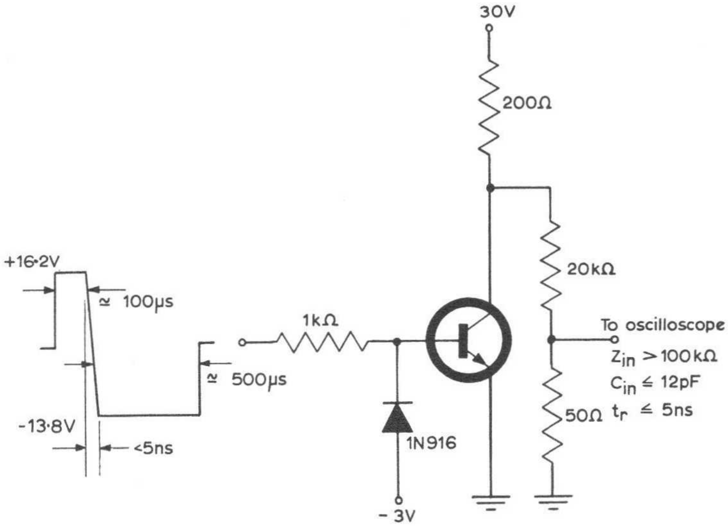


Fig.1

Equivalent test circuit for measuring delay and rise times

TEST CIRCUITS (cont'd)

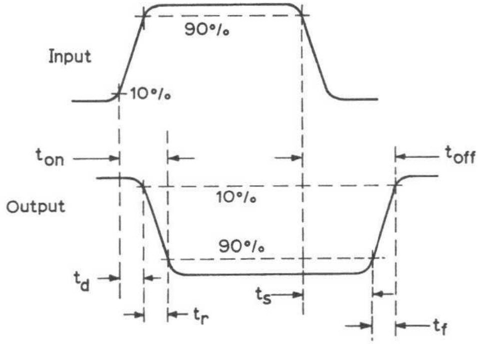


B7751

Fig. 2

Equivalent test circuit for measuring storage and fall times

WAVEFORMS



B7752

Fig. 3

N-P-N SILICON PLANAR EPITAXIAL TRANSISTORS

2N2220
2N2221
2N2222

N-P-N silicon planar epitaxial transistors designed primarily for high speed switching, d.c. amplifier and v.h.f. -u.h.f. communications applications.

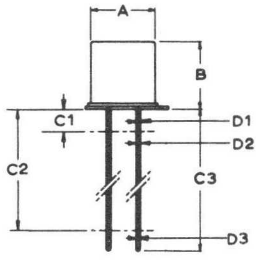
QUICK REFERENCE DATA

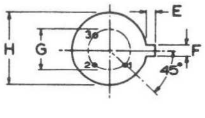
V_{CBO} max.			60	V
V_{CEO} max.			30	V
I_C max.			800	mA
P_{tot} max. (T_{amb} = 25°C)			500	mW
T_j max.			175	°C
f_T min. (I_C = 20mA, V_{CE} = 20V, f = 100MHz)			250	MHz
	2N2220	2N2221	2N2222	
h_{FE} min. I_C = 0.1mA, V_{CE} = 10V	-	20	35	
I_C = 10mA, V_{CE} = 10V	17	35	75	
I_C = 500mA, V_{CE} = 10V	-	20	30	

Unless otherwise stated data is applicable to all types

OUTLINE AND DIMENSIONS

Conforming to B.S. 3934 SO - 12A/SB3 - 6A
J.E.D.E.C. TO - 18





Viewed from underside

Millimetres

	Min.	Typ.	Max.
A	4.53	-	4.8
B	4.66	-	5.33
C1	-	-	0.51
C2	12.7	-	-
C3	12.7	-	15
D1	-	-	1.01
D2	0.41	-	0.48
D3	-	-	0.53
E	0.84	-	1.17
F	0.92	-	1.16
G	-	2.54	-
H	5.31	-	5.84

Connections:

1. Emitter
2. Base
3. Collector connected to envelope

† RATINGS

Limiting values of operation according to the absolute maximum system.

Electrical

V_{CBO} max.	60	V
V_{CEO} max.	30	V
V_{EBO} max.	5.0	V
I_C max.	800	mA
P_{tot} max. ($T_{amb} = 25^oC$)	500	mW

Temperature

T_{stg} min.	-65	^oC
T_{stg} max.	200	^oC
T_j max.	175	^oC

† THERMAL CHARACTERISTICS

Θ_{j-amb} (above 25^oC)	0.30	degC/mW
Θ_{j-case} (above 25^oC)	0.083	degC/mW

† ELECTRICAL CHARACTERISTICS ($T_{amb} = 25^oC$ unless otherwise stated)

		Min.	Max.	
I_{CBO}	Collector cut-off current			
	$V_{CB} = 50V$, $I_E = 0$	-	10	nA
	$V_{CB} = 50V$, $I_E = 0$, $T_{amb} = 150^oC$	-	10	μA
I_{EBO}	Emitter cut-off current			
	$V_{EB} = 3.0V$, $I_C = 0$	-	10	nA
$V_{(BR)CBO}$	Collector-base breakdown voltage			
	$I_C = 10\mu A$, $I_E = 0$	60	-	V
$V_{(BR)CEO}$	Collector-emitter breakdown voltage			
	$I_C = 10mA$, $I_B = 0$	30	-	V
$V_{(BR)EBO}$	Emitter-base breakdown voltage			
	$I_E = 10\mu A$, $I_C = 0$	5.0	-	V
$V_{CE(sat)}$	*Collector-emitter saturation voltage			
	$I_C = 150mA$, $I_B = 15mA$	-	0.4	V
	$I_C = 500mA$, $I_B = 50mA$, 2N2221, 2	-	1.6	V

*Pulsed conditions, pulse width $\leq 300\mu s$, duty cycle $\leq 2\%$

† J.E.D.E.C. registered data.

N-P-N SILICON PLANAR EPITAXIAL TRANSISTORS

2N2220 2N2221 2N2222

				Min.	Max.	
$V_{BE(sat)}$	*Base-emitter saturation voltage					
	I_C=150mA, I_B = 15mA			-	1.3	V
	I_C = 500mA, I_B=50mA,		2N2221, 2	-	2.6	V
h_{FE}	Forward current transfer ratio					
	I_C = 0.1mA, V_{CE} = 10V		2N2221	20	-	
			2N2222	35	-	
	I_C = 1.0mA, V_{CE} = 10V		2N2220	12	-	
			2N2221	25	-	
			2N2222	50	-	
	I_C = 10mA, V_{CE} = 10V		2N2220	17	-	
			2N2221	35	-	
			2N2222	75	-	
	*I_C = 150mA, V_{CE} = 1.0V		2N2220	10	-	
			2N2221	20	-	
			2N2222	50	-	
	*I_C = 150mA, V_{CE} = 10V		2N2220	20	60	
			2N2221	40	120	
			2N2222	100	300	
	*I_C = 500mA, V_{CE} = 10V		2N2221	20	-	
			2N2222	30	-	
f_T	Transition frequency					
	I_C = 20mA, V_{CE} = 20V, f=100MHz			250	-	MHz
C_{ob}	Collector capacitance					
	V_{CB} = 10V, I_E = 0			-	8.0	pF
$Re(h_{ie})$	Real part of input impedance					
	I_C =20mA, V_{CE} =20V, f=300MHz			-	60	Ω

*Pulsed conditions, pulse width $\leq 300\mu s$, duty cycle $\leq 2\%$

N-P-N SILICON PLANAR EPITAXIAL TRANSISTORS

2N2221A 2N2222A

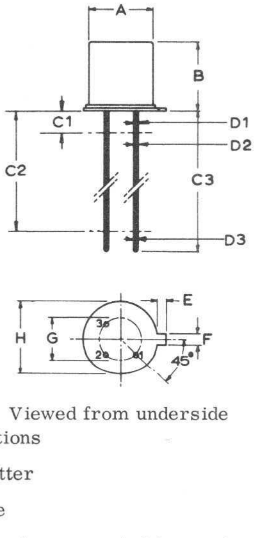
N-P-N silicon planar epitaxial transistors designed primarily for high speed saturated switching applications for industrial service

QUICK REFERENCE DATA			
V_{CBO} max.		75	V
V_{CEO} max. (I_C = 0 to 500mA)		40	V
I_C max.		800	mA
P_{tot} max. (T_{amb} = 25^oC)		500	mW
T_j max.		175	^oC
h_{FE} (I_C = 150mA, V_{CE} = 10V)	2N2221A	40-120	
	2N2222A	100-300	
f_T min. (I_C = 20mA, V_{CE} = 20V, f = 100MHz)	2N2221A	250	MHz
	2N2222A	300	MHz
t_s max. (I_{CS} = 150mA, I_B = $-I_{BM}$ = 15mA)		225	ns

Unless otherwise stated data is applicable to both types

OUTLINE AND DIMENSIONS

Conforming to B.S. 3934 SO-12A/SB3-6A
J.E.D.E.C. TO-18



Viewed from underside

	Millimetres		
	Min.	Typ.	Max.
A	4.53	-	4.8
B	4.66	-	5.33
C1	-	-	0.51
C2	12.7	-	-
C3	12.7	-	15
D1	-	-	1.01
D2	0.41	-	0.48
D3	-	-	0.53
E	0.84	-	1.17
F	0.92	-	1.16
G	-	2.54	-
H	5.31	-	5.84

Connections

1. Emitter
2. Base
3. Collector connected to envelope

†RATINGS

Limiting values of operation according to the absolute maximum system.

Electrical

V_{CBO} max.	75	V
V_{CEO} max. ($I_C = 0$ o 500mA)	40	V
V_{EBO} max.	6.0	V
I_C max.	800	mA
P_{tot} max. ($T_{amb} = 25^oC$)	500	mW

Temperature

T_{stg} min.	-65	^oC
T_{stg} max.	200	^oC
T_j max.	175	^oC
T_{lead} max. (1/16" from case for 60 seconds)	200	^oC

†THERMAL CHARACTERISTICS

Θ_{j-amb} (above 25^oC)	0.30	degC/mW
Θ_{j-case} (above 25^oC)	0.083	degC/mW

†ELECTRICAL CHARACTERISTICS ($T_{amb} = 25^oC$ unless otherwise stated)

		Min.	Max.	
I_{CBO}	Collector cut-off current			
	$V_{CB} = 60V$, $I_E = 0$	-	10	nA
	$V_{CB} = 60V$, $I_E = 0$, $T_{amb} = 150^oC$	-	10	μA
I_{CEX}	Collector-emitter cut-off current $V_{CE} = 60V$, $-V_{BE} = 3.0V$	-	10	nA
$-I_{BEX}$	Base current $V_{CE} = 60V$, $-V_{BE} = 3.0V$	-	20	nA
I_{EBO}	Emitter cut-off current $V_{EB} = 3.0V$, $I_C = 0$	-	10	nA
$V_{(BR)CBO}$	Collector-base breakdown voltage $I_C = 10\mu A$, $I_E = 0$	75	-	V
$V_{(BR)CEO}$	Collector-emitter breakdown voltage $I_C = 10mA$, $I_B = 0$	40	-	V
$V_{(BR)EBO}$	Emitter-base breakdown voltage $I_E = 10\mu A$, $I_C = 0$	6.0	-	V

†J.E.D.E.C. registered data.

N-P-N SILICON PLANAR EPITAXIAL TRANSISTORS

2N2221A 2N2222A

			Min.	Max.	
$V_{CE(sat)}$	*Collector-emitter saturation voltage				
	I_C=150mA, I_B=15mA		-	0.3	V
	I_C=500mA, I_B=50mA		-	1.0	V
$V_{BE(sat)}$	*Base-emitter saturation voltage				
	I_C=150mA, I_B=15mA		0.6	1.2	V
	I_C=500mA, I_B=50mA		-	2.0	V
h_{FE}	Forward current transfer ratio				
	I_C=0.1mA, V_{CE}=10V	2N2221A	20	-	
		2N2222A	35	-	
	I_C=1.0mA, V_{CE}=10V	2N2221A	25	-	
		2N2222A	50	-	
	I_C=10mA, V_{CE}=10V	2N2221A	35	-	
		2N2222A	75	-	
	I_C=10mA, V_{CE}=10V,				
	T_{amb}=-55°C	2N2221A	15	-	
		2N2222A	35	-	
	I_C=150mA, V_{CE}=1.0V	2N2221A	20	-	
		2N2222A	50	-	
	*I_C=150mA, V_{CE}=10V	2N2221A	40	120	
		2N2222A	100	300	
	*I_C=500mA, V_{CE}=10V	2N2221A	25	-	
		2N2222A	40		
C_{ob}	Output capacitance				
	V_{CB}=10V, I_E=0, f=100kHz		-	8.0	pF
C_{ib}	Input capacitance				
	V_{EB}=0.5V, I_C=0, f=100kHz		-	25	pF
f_T	Transition frequency				
	I_C=20mA, V_{CE}=20V,				
	f=100MHz	2N2221A	250	-	MHz
		2N2222A	300	-	MHz

*Pulsed conditions, pulse width≤300μs, duty cycle≤2%

			Min.	Max.	
r'_bC_c	Collector-base time constant $I_C = 20mA$, $V_{CE} = 20V$, $f = 31.8MHz$		-	150	ps
N	Noise figure $I_C = 100\mu A$, $V_{CE} = 10V$, $R_g = 1.0k\Omega$, $f = 1.0kHz$, bandwidth = 1.0Hz	2N2222A	-	4.0	dB
$Re(h_{ie})$	Real part of input impedance $I_C = 20mA$, $V_{CE} = 20V$, $f = 300MHz$		-	60	Ω

h-parameters

Measured at $I_C = 1.0mA$, $V_{CE} = 10V$, $f = 1.0kHz$

			Min.	Max.	
h_{fe}	Small signal forward current transfer ratio	2N2221A	30	150	
		2N2222A	50	300	
h_{re}	Voltage feedback ratio	2N2221A	-	5.0×10^{-4}	
		2N2222A	-	8.0×10^{-4}	
h_{ie}	Input resistance	2N2221A	1.0	3.5	kΩ
		2N2222A	2.0	8.0	kΩ
h_{oe}	Output conductance	2N2221A	3.0	15	μmho
		2N2222A	5.0	35	μmho

Measured at $I_C = 10mA$, $V_{CE} = 10V$, $f = 1.0kHz$

			Min.	Max.	
h_{fe}	Small signal forward current transfer ratio	2N2221A	50	300	
		2N2222A	75	375	
h_{re}	Voltage feedback ratio	2N2221A	-	2.5×10^{-4}	
		2N2222A	-	4.0×10^{-4}	
h_{ie}	Input resistance	2N2221A	0.2	1.0	kΩ
		2N2222A	0.25	1.25	kΩ
h_{oe}	Output conductance	2N2221A	10	100	μmho
		2N2222A	25	200	μmho

Switching characteristics

		Max.	
Turn-on time (see Fig. 1 and 3)			
V_{CC} = 30V, I_{CS} = 150mA, I_B = 15mA, V_{BEoff} = 0.5V			
t_d	Turn-on delay time	10	ns
t_r	Rise time	25	ns
Turn-off time (see Fig. 2 and 3)			
V_{CC} = 30V, I_{CS} = 150mA, I_B = $-I_{BM}$ = 15mA			
t_s	Storage time	225	ns
t_f	Fall time	60	ns

TEST CIRCUITS

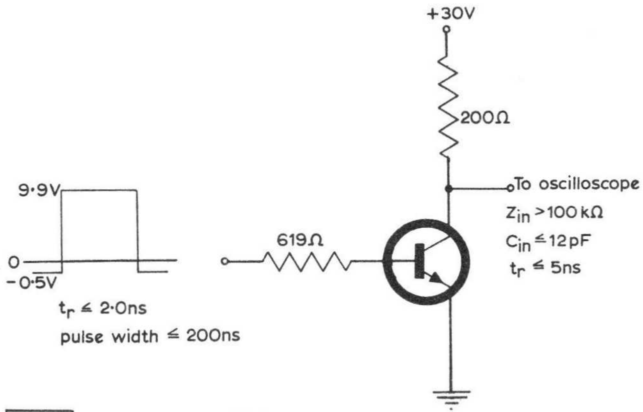
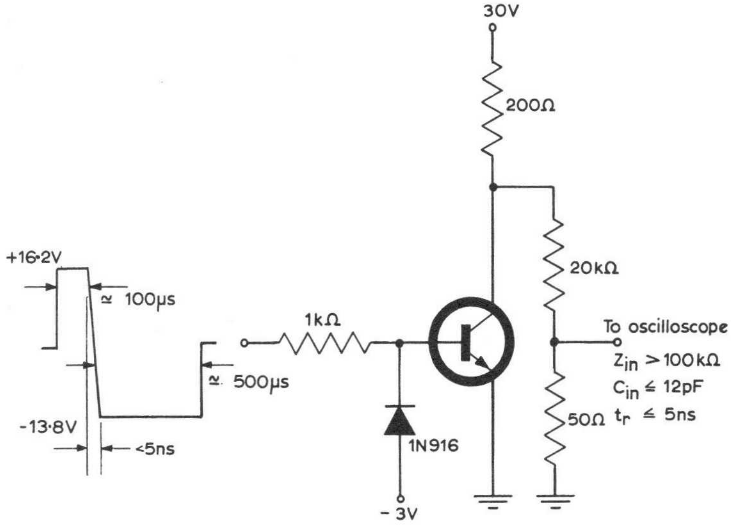


Fig.1

Equivalent test circuit for measuring delay and rise times

TEST CIRCUITS (cont'd)

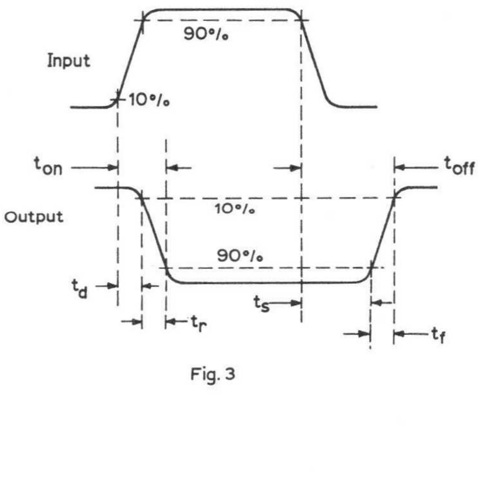


B7751

Fig. 2

Equivalent test circuit for measuring storage and fall times

WAVEFORMS



B7752

Fig. 3

SILICON N-P-N EPITAXIAL PLANAR TRANSISTOR

2N2297

Silicon n-p-n epitaxial planar transistor intended for large signal h.f. and v.h.f. amplifier applications.

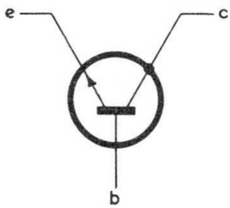
QUICK REFERENCE DATA

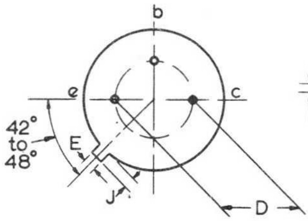
V_{CB} max. ($I_E = 0$)	+80	V
V_{CE} max.	+35	V
I_C max.	1.0	A
P_{tot} max. ($T_{amb} = 25^{o}C$)	800	mW
h_{FE} ($I_{CM} = 150mA$, $V_{CE} = +10V$)	40 - 120	
f_T min. ($I_C = 50mA$, $V_{CE} = +10V$, $f = 20Mc/s$)	60	Mc/s

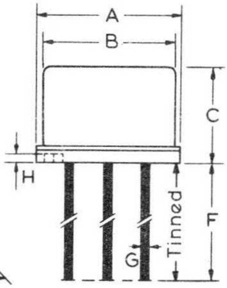
OUTLINE AND DIMENSIONS

Conforming to J.E.D.E.C. TO-5

B2390







Collector connected to envelope

	Millimetres				Millimetres		
	Min.	Nom.	Max.		Min.	Nom.	Max.
A	8.64	8.9	9.4	F	38	-	-
B	7.75	8.15	8.50	G	-	0.45	-
C	6.10	6.35	6.60	*H	-	0.4	-
D	-	5.08	-	J	0.74	0.85	1.01
E	0.71	0.79	0.86	*Thickness of locating tab.			

RATINGS

Limiting values of operation according to the absolute maximum system.

Electrical

†V_{CB} max. ($I_E = 0$)	+80	V
†V_{CE} max. ($I_B = 0$)	+35	V
†V_{EB} max. ($I_C = 0$)	+7.0	V
†I_C max.	1.0	A
†P_{tot} max. $T_{case} = 25^{o}C$	5.0	W
$T_{case} = 100^{o}C$	2.8	W
$T_{amb} = 25^{o}C$	0.8	W

Thermal

†T_{stg} min.	-65	^{o}C
T_{stg} max.	200*	^{o}C
†T_j max. (operating)	200	^{o}C

*See Soldering and Wiring Recommendation No. 4.

THERMAL CHARACTERISTICS

†Derating factor at $T_{case} = 25^{o}C$	28.6	mW/deg C
$T_{amb} = 25^{o}C$	4.6	mW/deg C

SILICON N-P-N EPITAXIAL PLANAR TRANSISTOR

2N2297

ELECTRICAL CHARACTERISTICS (T_{amb} = 25°C unless otherwise stated)

		Min.	Max.	
†I_{CBO}	Collector cut-off current			
	V_{CB} = +60V, I_E = 0	-	10	nA
	V_{CB} = +60V, I_E = 0, T_{amb} = 150	-	10	μA
†I_{EBO}	Emitter cut-off current			
	V_{EB} = 5.0V, I_C = 0	-	10	nA
†$V_{CEO(sust.)}$	Collector-emitter sustaining voltage			
	I_C = 30mA (See note 1)	35	-	V
†$V_{(BR)CBO}$	Collector-base breakdown voltage			
	I_C = 100μA, I_E = 0	80	-	V
†$V_{(BR)EBO}$	Emitter-base breakdown voltage			
	I_E = 100μA, I_C = 0	7.0	-	V
†$V_{CE(sat)}$	Collector-emitter saturation voltage			
	I_C = 150mA, I_B = 15mA	-	0.2	V
	I_C = 1.0A, I_B = 100mA (See notes 1 and 2)	-	1.0	V
†$V_{BE(sat)}$	Base-emitter saturation voltage			
	I_C = 1.0A, I_B = 100mA (See notes 1 and 2)	-	1.6	V
†h_{FE}	Large signal forward current transfer ratio			
	I_C = 150mA, V_{CE} = 10V (See note 1)	40	120	
	I_C = 10mA, V_{CE} = 10V (See note 1)	30	-	
	I_C = 1.0A, V_{CE} = 10V (See note 1)	15	-	

		Min.	Max.	
†f_T	Transition frequency			
	I_C=50mA, V_{CE}=+10V, f=20Mc/s	60	-	Mc/s
†c_{ob}	Output capacitance			
	V_{CB}=10V, I_E=0	-	12	pF
†c_{ib}	Open-circuit input capacitance			
	I_C=0, V_{EB}=0.5V	-	80	pF
†$r_{b'}, c_c$	Collector-base time constant			
	I_C=10mA, V_{CB}=10V, f=4.0Mc/s	-	800	ps

†J.E.D.E.C. Registered Data.

NOTES

1. Measured under pulsed conditions to prevent excessive dissipation. P.W. ≏300µs, duty cycle ≤1%.

2. Measured at a point on the lead ≤12.7mm (0.5in) from the seating plane of the transistor

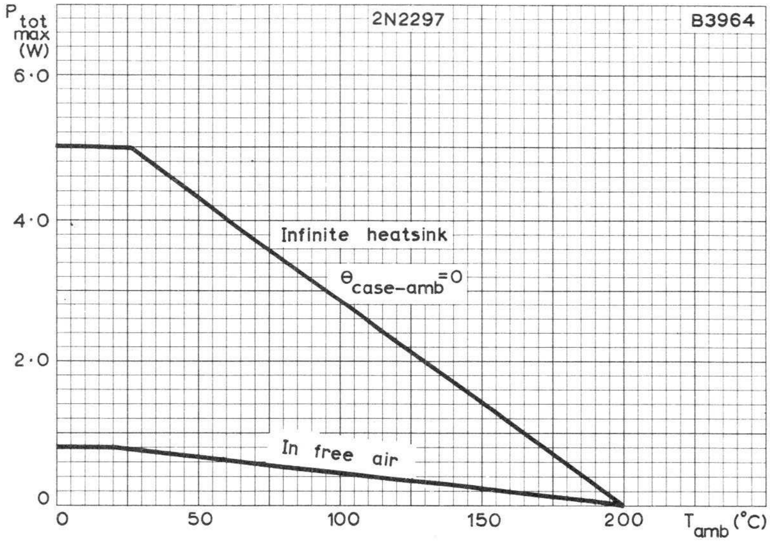
SOLDERING AND WIRING RECOMMENDATIONS

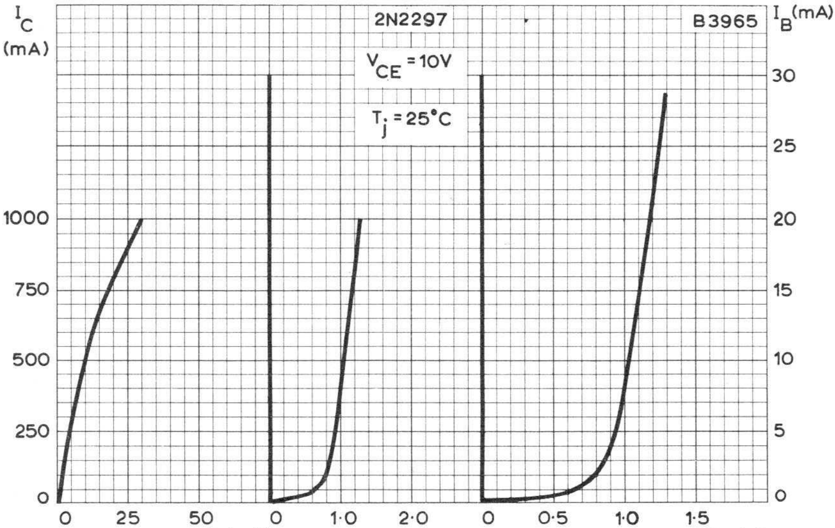
1. When using a soldering iron, transistors may be soldered directly into the circuit, but heat conducted to the junction should if possible be kept to a minimum by the use of a thermal shunt.

2. Transistors may be dip-soldered at a solder temperature of 245°C for a maximum soldering time of 5 seconds. The case temperature during soldering must not at any time exceed the maximum storage temperature. These recommendations apply to a transistor mounted flush on a board having punched-through holes, or spaced at least 1.5mm above a board having plated-through holes.

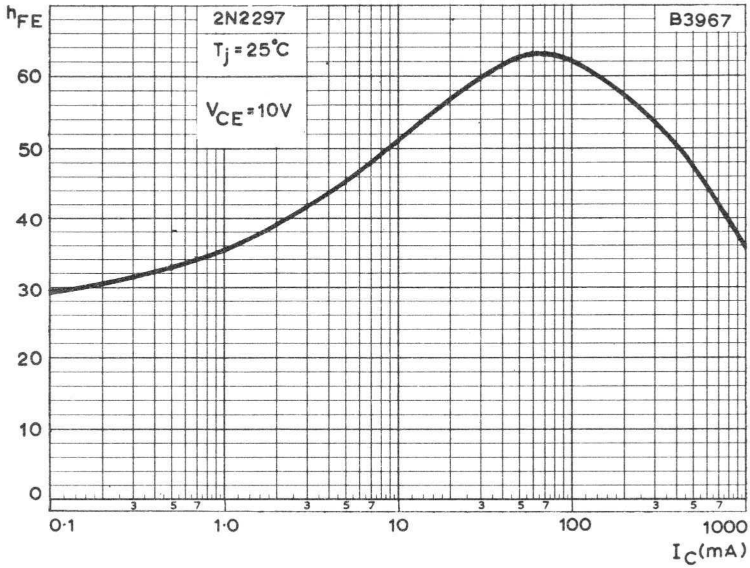
3. Care should be taken not to bend the leads nearer than 1.5mm from the seal.

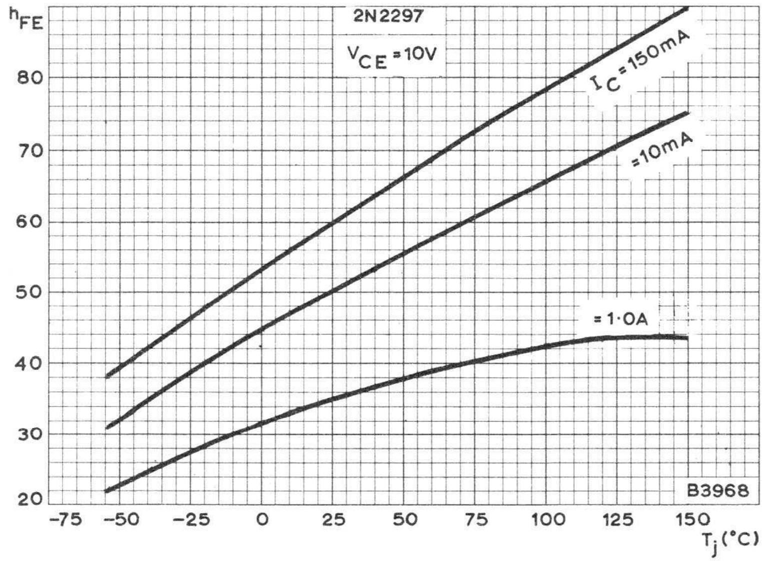
4. After storage at temperatures greater than 125°C it may be necessary to take precautions in order to ensure adequate solderability of the leads.



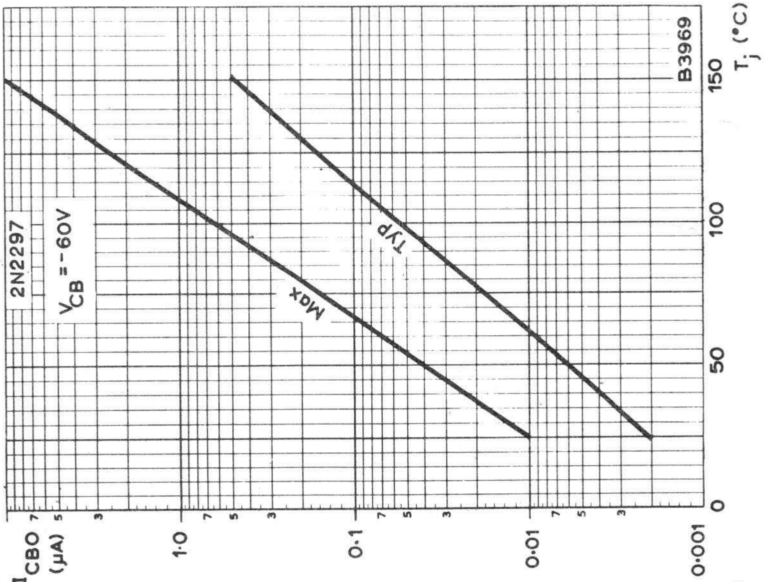


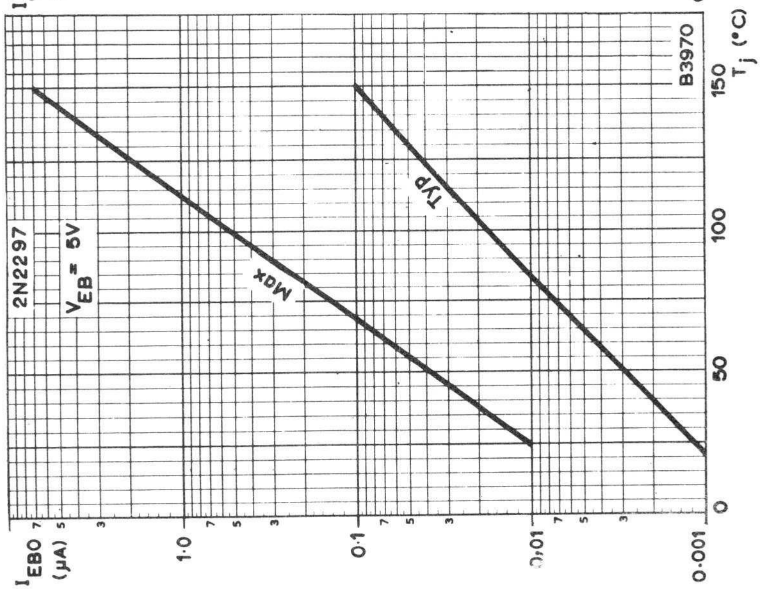
MAXIMUM TOTAL DISSIPATION PLOTTED AGAINST AMBIENT TEMPERATURE.
TYPICAL TRANSFER, MUTUAL AND INPUT CHARACTERISTICS





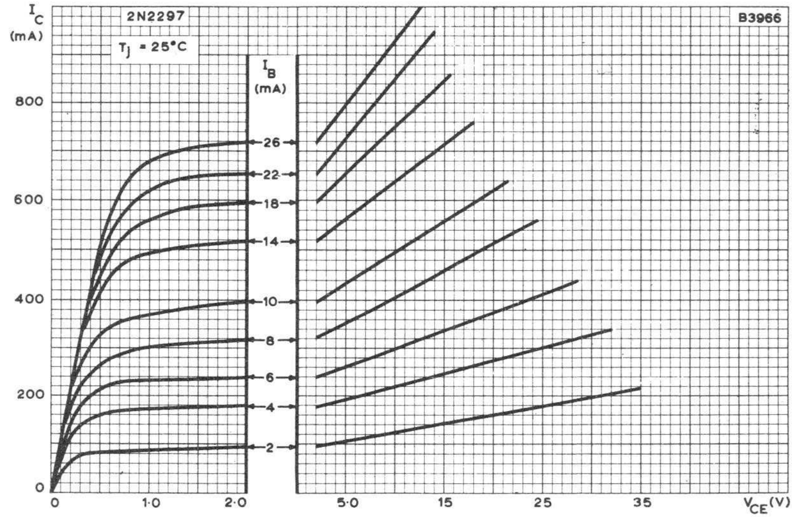
TYPICAL LARGE SIGNAL FORWARD CURRENT TRANSFER RATIO
PLOTTED AGAINST COLLECTOR CURRENT
TYPICAL LARGE SIGNAL FORWARD CURRENT TRANSFER RATIO
PLOTTED AGAINST JUNCTION TEMPERATURE

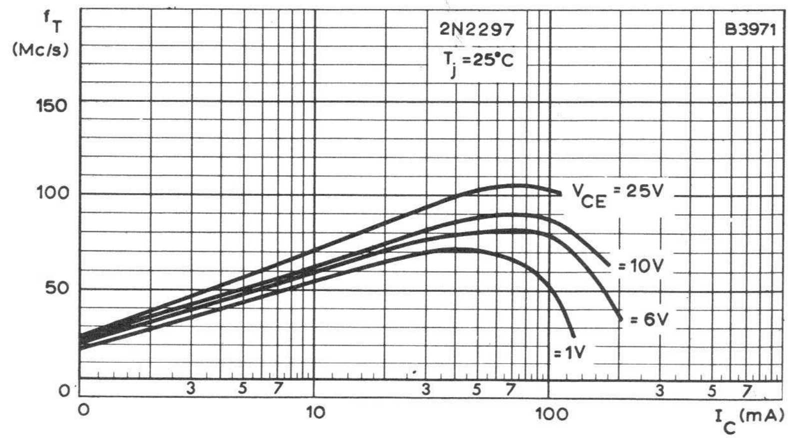




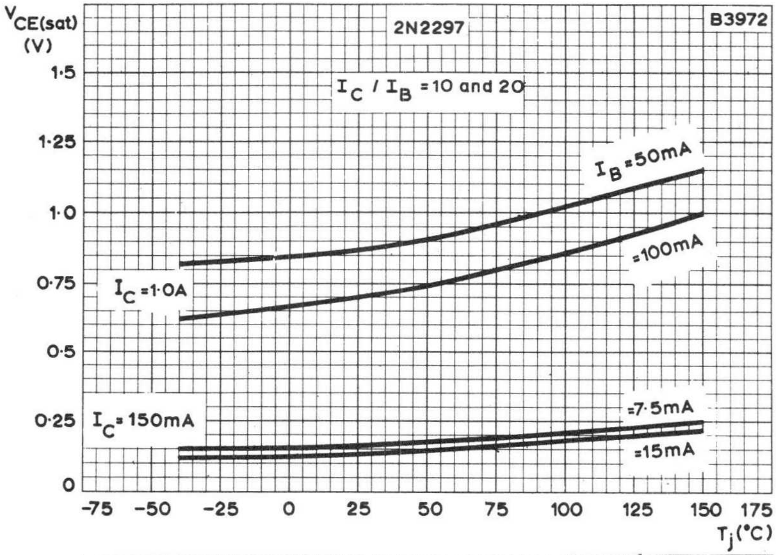
COLLECTOR CUT-OFF CURRENT PLOTTED AGAINST JUNCTION TEMPERATURE

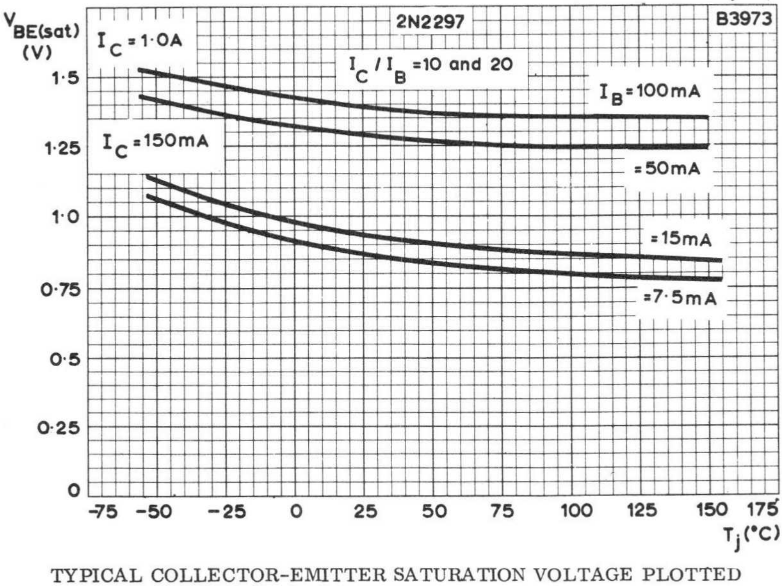
EMITTER CUT-OFF CURRENT PLOTTED AGAINST JUNCTION TEMPERATURE





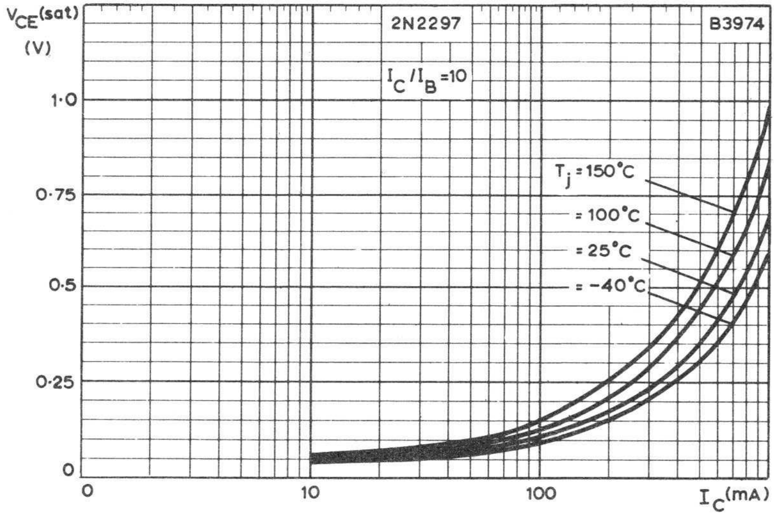
TYPICAL OUTPUT CHARACTERISTICS. $T_j = 25^{o}C$
TYPICAL TRANSITION FREQUENCY PLOTTED AGAINST COLLECTOR CURRENT.
COLLECTOR-EMITTER VOLTAGE AS PARAMETER

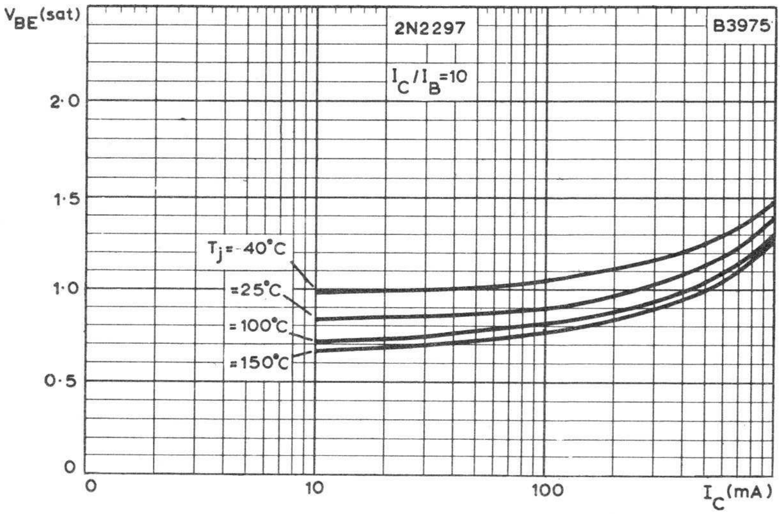




TYPICAL COLLECTOR-EMITTER SATURATION VOLTAGE PLOTTED AGAINST JUNCTION TEMPERATURE. COLLECTOR AND BASE CURRENTS AS PARAMETERS

TYPICAL BASE-EMITTER SATURATION VOLTAGE PLOTTED AGAINST JUNCTION TEMPERATURE. COLLECTOR AND BASE CURRENTS AS PARAMETERS



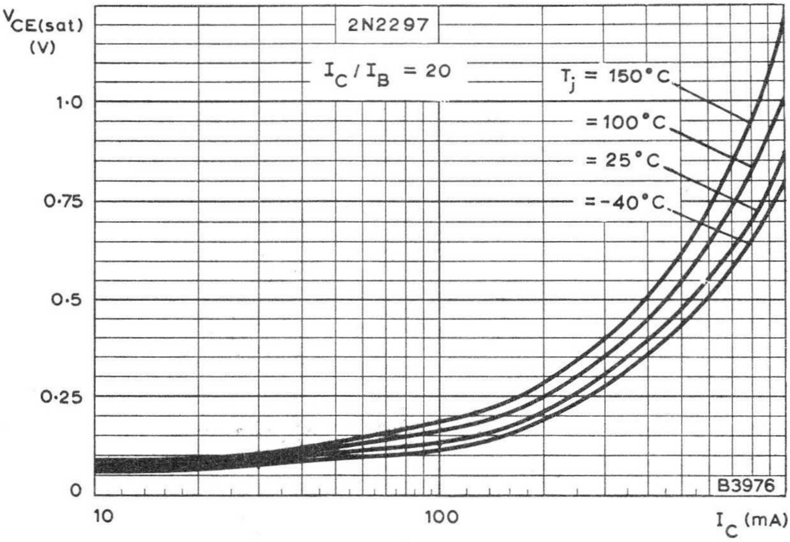


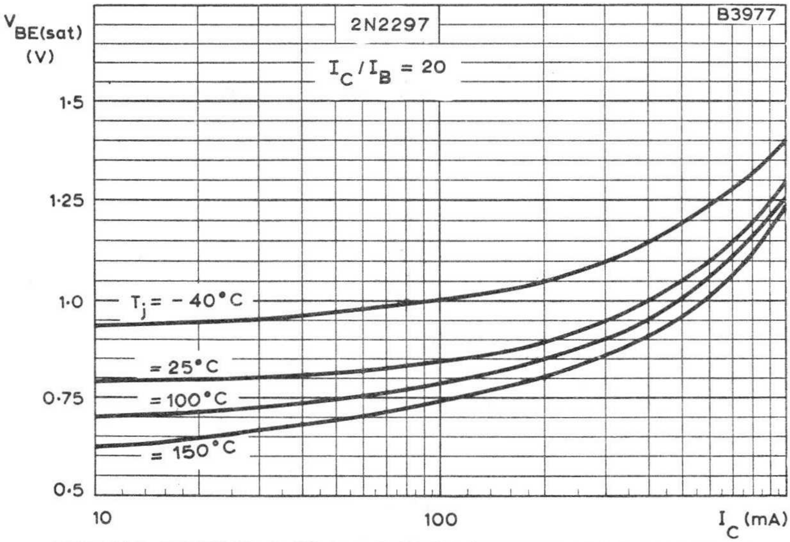
TYPICAL COLLECTOR-EMITTER SATURATION VOLTAGE PLOTTED AGAINST COLLECTOR CURRENT, WITH JUNCTION TEMPERATURE AS PARAMETER. $I_C/I_B = 10$.

TYPICAL BASE-EMITTER SATURATION VOLTAGE PLOTTED AGAINST COLLECTOR CURRENT, WITH JUNCTION TEMPERATURE AS PARAMETER. $I_C/I_B = 10$.

SILICON N-P-N EPITAXIAL PLANAR TRANSISTOR

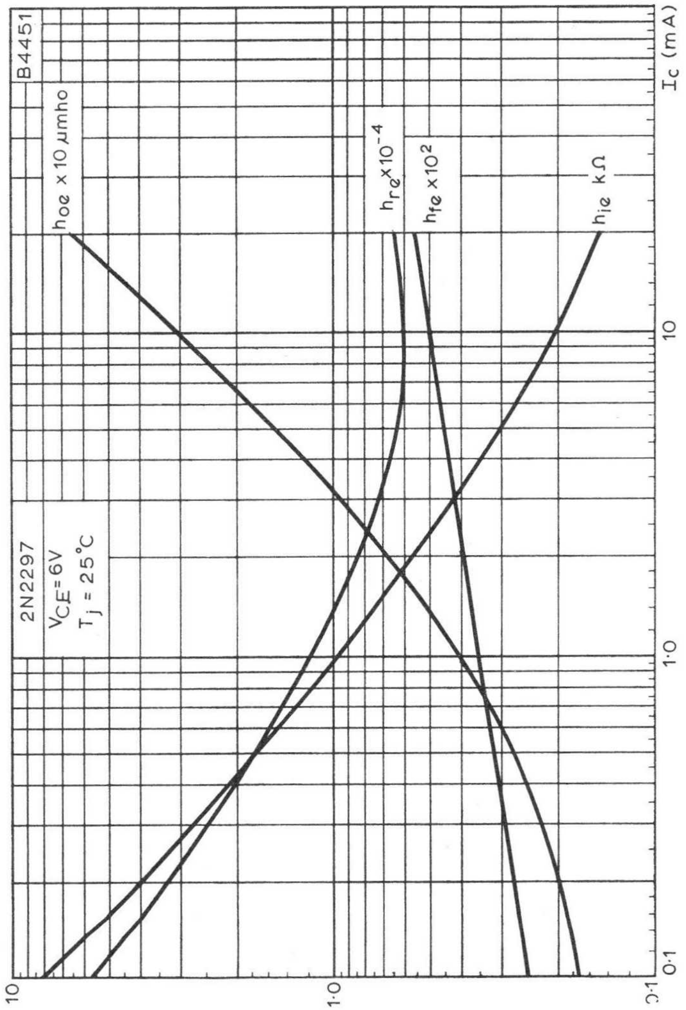
2N2297





TYPICAL COLLECTOR-EMITTER SATURATION VOLTAGE PLOTTED AGAINST COLLECTOR CURRENT, WITH JUNCTION TEMPERATURE AS PARAMETER. $I_C/I_B = 20$.

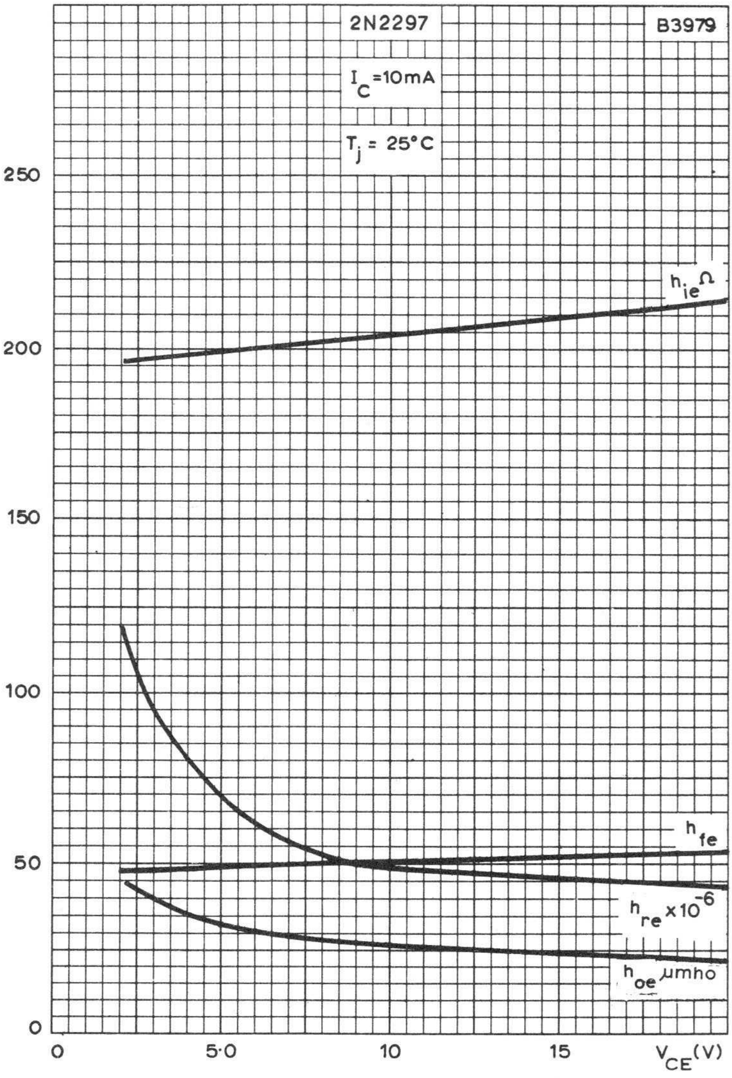
TYPICAL BASE-EMITTER SATURATION VOLTAGE PLOTTED AGAINST COLLECTOR CURRENT, WITH JUNCTION TEMPERATURE AS PARAMETER. $I_C/I_B = 20$.



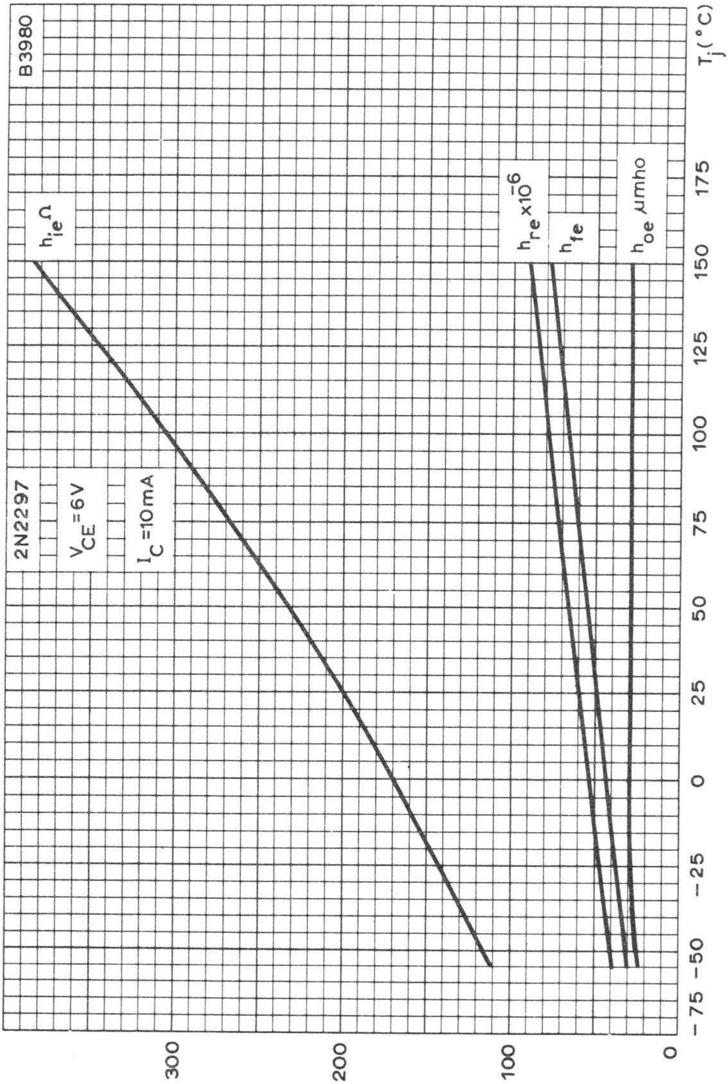
TYPICAL VARIATION OF h PARAMETERS WITH COLLECTOR CURRENT

SILICON N-P-N EPITAXIAL PLANAR TRANSISTOR

2N2297



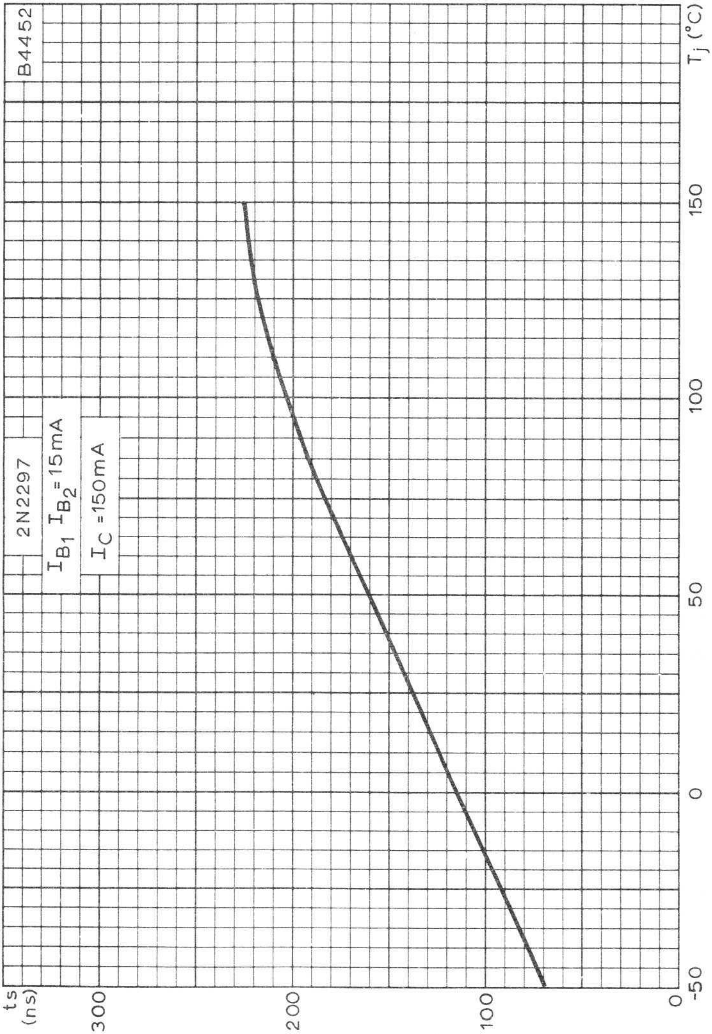
TYPICAL VARIATION OF h PARAMETERS WITH COLLECTOR-EMITTER VOLTAGE



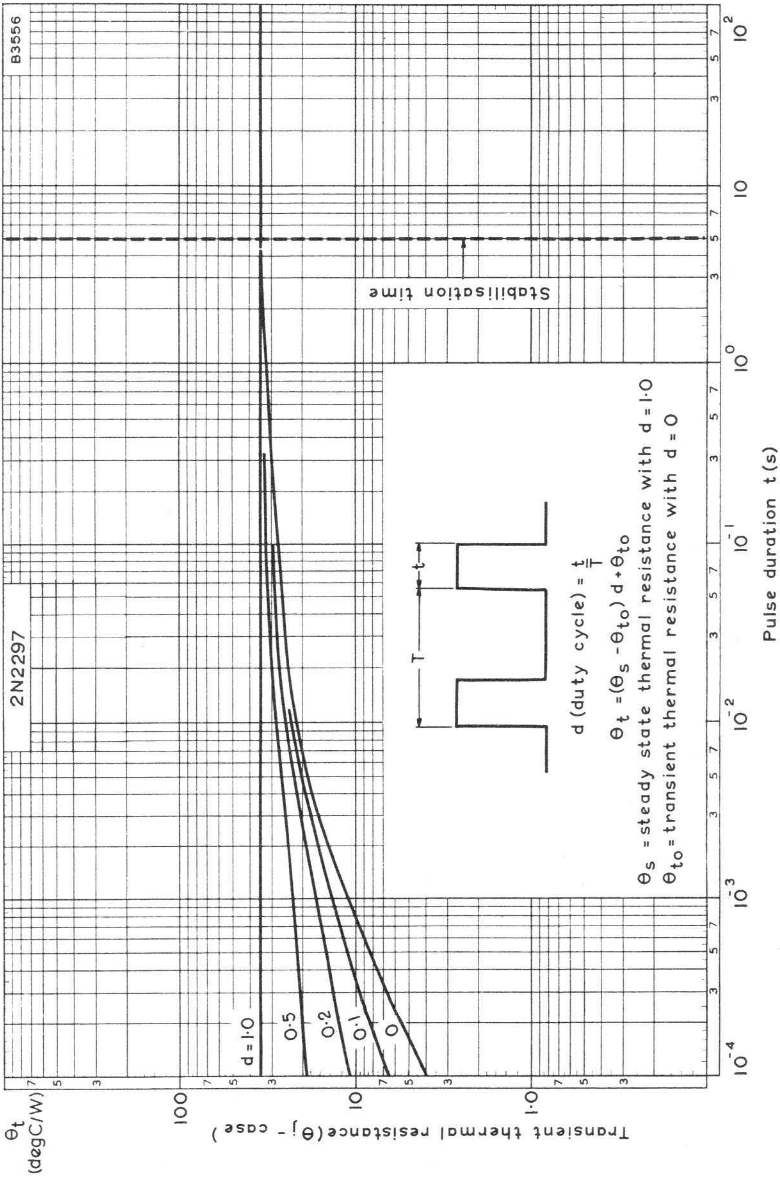
TYPICAL VARIATION OF h PARAMETERS WITH JUNCTION TEMPERATURE

SILICON N-P-N EPITAXIAL PLANAR TRANSISTOR

2N2297



TYPICAL VARIATION OF STORAGE TIME WITH JUNCTION TEMPERATURE



TRANSIENT THERMAL RESISTANCE FOR VARIOUS DUTY FACTORS
PLOTTED AGAINST PULSE DURATION

P-N-P SILICON PLANAR EPITAXIAL TRANSISTOR

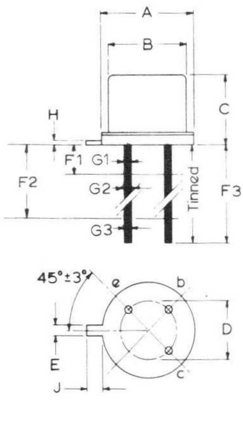
2N2303

P-N-P silicon planar epitaxial transistor primarily for use in medium frequency amplifier applications.

QUICK REFERENCE DATA		
$-V_{CBO}$ max.	50	V
$-V_{CEO}$ max.	35	V
$-I_C$ max.	500	mA
P_{tot} max. ($T_{amb} \leq 25^oC$)	600	mW
h_{FE} ($-I_C$ = 150mA, $-V_{CE}$ = 10V)	75 - 200	
f_T min. ($-I_C$ = 50mA, $-V_{CE}$ = 10V, f = 20MHz)	60	MHz

OUTLINE AND DIMENSIONS

Conforms to B.S. 3934 SO-3/SB3-3A
J.E.D.E.C. TO-5



Collector connected to can

	Millimetres		
	Min.	Nom.	Max.
A	9.10	-	9.40
B	8.20	-	8.50
C	6.10	-	6.60
D	-	5.08	-
E	0.71	-	0.86
F1	-	-	0.51
F2	12.7	-	-
F3	38.1	-	41.3
G1	-	-	1.01
G2	0.41	-	0.48
G3	-	-	0.53
H	-	0.4	-
J	0.74	-	1.0

RATINGS

Limiting values of operation according to the absolute maximum system.

Electrical

$-V_{CBO}$ max.	50	V
$-V_{CER}$ max. ($R_{BE} \leq 10\Omega$)	50	V
$-V_{CEO}$ max.	35	V
$-V_{EBO}$ max.	5.0	V
$-I_C$ max.	500	mA
P_{tot} max. ($T_{amb} \leq 25^{o}C$)	600	mW

Temperature

T_{stg}	-65 to +200	^{o}C
T_j max.	200	^{o}C

THERMAL CHARACTERISTIC

$R_{th(j-amb)}$	292	degC/W

ELECTRICAL CHARACTERISTICS ($T_{amb} = 25^{o}C$ unless otherwise stated)

		Min.	Max.	
$-I_{CBO}$	Collector cut-off current			
	$-V_{CB} = 30V$, $I_E = 0$	-	1.0	μA
	$-V_{CB} = 30V$. $I_E = 0$, $T_{amb} = 150^{o}C$	-	100	μA
$-I_{EBO}$	Emitter cut-off current			
	$-V_{EB} = 2.0V$, $I_C = 0$	-	100	μA
$-V_{(BR)CBO}$	Collector-base breakdown voltage			
	$I_C = 100\mu A$, $I_E = 0$	50	-	V
	Collector-emitter sustaining voltage			
$-V_{CER(sust)}$	$^{*}-I_C = 100mA$, $R_{BE} \leq 10\Omega$	50	-	V
$-V_{CEO(sust)}$	$^{*}-I_C = 100mA$, $I_B = 0$	35	-	V
$-V_{(BR)EBO}$	Emitter-base breakdown voltage			
	$I_E = 100\mu A$, $I_C = 0$	5.0	-	V

*Pulse measurement, pulse width = 300μs, duty cycle = 1%.

ELECTRICAL CHARACTERISTICS (cont'd)

		Min.	Max.	
$-V_{CE(sat)}$	Collector-emitter saturation voltage $-I_C = 150mA$, $-I_B = 15mA$	-	1.5	V
$-V_{BE(sat)}$	Base-emitter saturation voltage $-I_C = 150mA$, $-I_B = 15mA$	-	1.3	V
h_{FE}	Static forward current transfer ratio			
	$*-I_C = 5.0mA$, $-V_{CE} = 10V$	75	-	
	$*-I_C = 150mA$, $-V_{CE} = 10V$	75	200	
C_{ob}	Output capacitance $-V_{CB} = 10V$, $I_E = 0$, $f = 140kHz$	-	45	pF
C_{ib}	Input capacitance $-V_{EB} = 0.5V$, $I_C = 0$, $f = 140kHz$	-	80	pF
f_T	Transition frequency $-I_C = 50mA$, $-V_{CE} = 10V$, $f = 20MHz$	60	-	MHz
h-parameters				
h_{fe}	Forward current transfer ratio			
	$-I_C = 1.0mA$, $-V_{CE} = 5.0V$, $f = 1.0kHz$	75	300	
	$-I_C = 5.0mA$, $-V_{CE} = 10V$, $f = 1.0kHz$	75	-	
$-I_C = 1.0mA$, $-V_{CB} = 5.0V$, $f = 1.0kHz$				
h_{ib}	Input resistance	25	35	Ω
h_{rb}	Voltage feedback ratio	-	8.0	$\times 10^{-4}$
h_{ob}	Output conductance	-	1.0	μmho

*Pulse measurement, pulse width = 300μs, duty cycle = 1%.

ELECTRICAL CHARACTERISTICS (cont'd)

h-parameters (cont'd)

$-I_C = 5.0mA$, $-V_{CB} = 10V$, $f = 1.0kHz$

		Min.	Max.	
h_{ib}	Input resistance	-	10	Ω
h_{rb}	Voltage feedback ratio	-	8.0	$\times10^{-4}$
h_{ob}	Output conductance	-	5.0	μmho

N-P-N SILICON PLANAR EPITAXIAL TRANSISTOR

2N2410

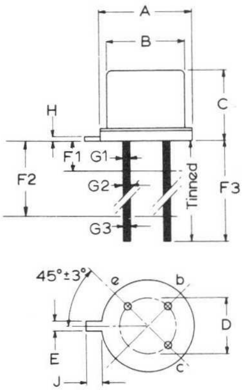
N-P-N silicon planar epitaxial transistor designed primarily for high speed, medium power, saturated switching applications for industrial service.

QUICK REFERENCE DATA

V_{CBO} max.	60	V
V_{CEO} max.	30	V
I_C max.	800	mA
P_{tot} max. ($T_{amb} \leq 25^oC$)	800	mW
h_{FE} ($I_C = 150mA$, $V_{CE} = 10V$)	30 to 120	
f_T min. ($I_C = 50mA$, $V_{CE} = 10V$, $f = 100MHz$)	200	MHz
t_{on} max.	65	ns
t_{off} max.	65	ns

OUTLINE AND DIMENSIONS

Conforms to B.S. 3934 SO-3/SB3-3A
J.E.D.E.C. TO-5



Collector connected to can

	Millimetres		
	Min.	Nom.	Max.
A	9.10	-	9.40
B	8.20	-	8.50
C	6.10	-	6.60
D	-	5.08	-
E	0.71	-	0.86
F1	-	-	0.51
F2	12.7	-	-
F3	38.1	-	41.3
G1	-	-	1.01
G2	0.41	-	0.48
G3	-	-	0.53
H	-	0.4	-
J	0.74	-	1.0

RATINGS

Limiting values of operation according to the absolute maximum system.

Electrical

V_{CBO} max.	60	V
V_{CER} max. ($R_{BE} \leq 10\Omega$)	40	V
V_{CEO} max.	30	V
V_{EBO} max.	5.0	V
I_C max.	800	mA
P_{tot} max. ($T_{amb} \leq 25^{o}C$)	800	mW

Temperature

T_{stg} min.	-65	^{o}C
T_{stg} max.	200	^{o}C
T_j	200	^{o}C

THERMAL CHARACTERISTIC

$R_{th(j-amb)}$	220	degC/W

ELECTRICAL CHARACTERISTICS ($T_{amb} = 25^{o}C$ unless otherwise stated)

		Min.	Max.	
I_{CBO}	Collector-base cut-off current $V_{CB}=30V$, $I_E=0$	-	0.3	μA
I_{CES}	Collector-emitter cut-off current $V_{CE}=30V$, $V_{BE}=0$	-	0.3	μA
	$V_{CE}=30V$, $V_{BE}=0$, $T_{amb}=150^{o}C$	-	350	μA
I_{EBO}	Emitter-base cut-off current $V_{EB}=4.0V$, $I_C=0$	-	0.3	μA
$V_{(BR)CBO}$	Collector-base breakdown voltage $I_C=100\mu A$, $I_E=0$	60	-	V
	Collector-emitter breakdown voltage			
$V_{(BR)CER}$	*$I_C=30mA$, $R_{BE}=10\Omega$	40	-	V
$V_{(BR)CEO}$	*$I_C=30mA$, $I_B=0$	30	-	V
$V_{(BR)EBO}$	Emitter-base breakdown voltage $I_E=100\mu A$, $I_C=0$	5.0	-	V

*Pulse measurement, pulse width = 300μs, duty cycle = 2%.

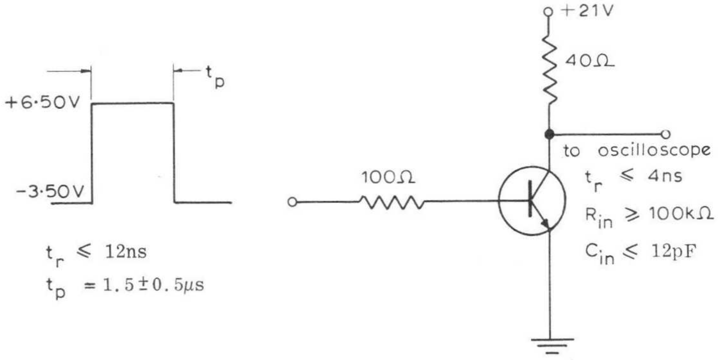
ELECTRICAL CHARACTERISTICS (Continued)

		Min.	Max.	
$V_{CE(sat)}$	Collector-emitter saturation voltage			
	$*I_C = 150mA, I_B = 15mA$	-	0.45	V
	$*I_C = 500mA, I_B = 50mA$	-	1.3	V
V_{BE}	Base-emitter voltage			
	$*I_C = 150mA, I_B = 15mA$	-	1.2	V
	$*I_C = 500mA, I_B = 50mA$	-	1.6	V
h_{FE}	Static forward current transfer ratio			
	$*I_C = 10mA, V_{CE} = 10V$	30	120	
	$*I_C = 150mA, V_{CE} = 10V$	30	120	
	$*I_C = 500mA, V_{CE} = 10V$	25	100	
	$*I_C = 150mA, V_{CE} = 1.0V$	15	-	
C_{ob}	Output capacitance			
	$I_E = 0, V_{CB} = 10V, f = 1.0MHz$	-	11	pF
C_{ib}	Input capacitance			
	$I_C = 0, V_{EB} = 0.5V, f = 1.0MHz$	-	50	pF
f_T	Transition frequency			
	$I_C = 50mA, V_{CE} = 10V, f = 100MHz$	200	-	MHz
Switching characteristics (See test circuit and waveforms on page 4)				
	$I_{CM} = 500mA, I_{Bon} = -I_{Boff} = 50mA$			
t_{on}	Turn-on time	-	65	ns
t_{off}	Turn-off time	-	65	ns

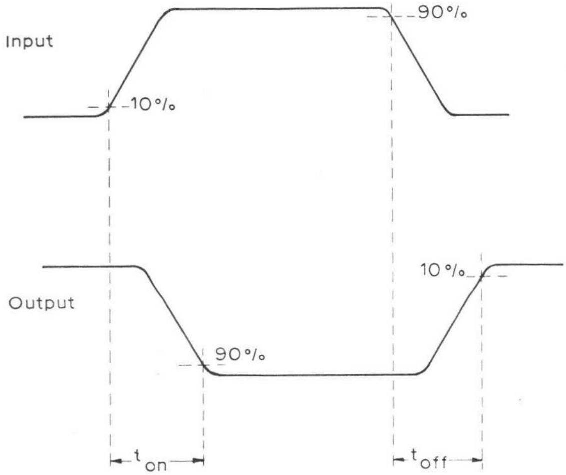
*Pulse measurement, pulse width = 300μs, duty cycle = 2%

Switching characteristics

Test circuit



Waveforms



P-N-P SILICON PLANAR EPITAXIAL TRANSISTORS

2N2411 2N2412

P-N-P silicon planar epitaxial transistors designed primarily for very high speed, medium power saturated switching applications for industrial service.

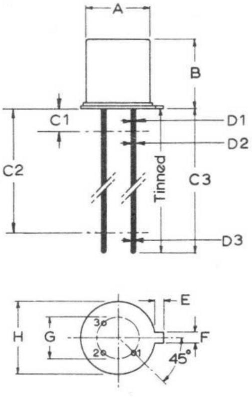
QUICK REFERENCE DATA

	2N2411		2N2412	
$-V_{CBO}$ max.		25		V
$-V_{CEO}$ max.		20		V
$-I_C$ max.		100		mA
P_{tot} max. ($T_{amb} = 25^{o}C$)		300		mW
h_{FE} ($-I_C = 10mA$, $-V_{CE} = 0.5V$)	20-60		40-120	
f_T min. ($-I_C = 10mA$, $f = 100MHz$)		140		MHz
t_s max.		90		ns

Unless otherwise stated, data is applicable to both types

OUTLINE AND DIMENSIONS

Conforming to B.S. 3934 SO-12A/SB3-6A
J.E.D.E.C. TO-18



Millimetres

	Min.	Typ.	Max.
A	4.53	-	4.8
B	4.66	-	5.33
C1	-	-	0.51
C2	12.7	-	-
C3	12.7	-	15
D1	-	-	1.01
D2	0.41	-	0.48
D3	-	-	0.53
E	0.84	-	1.17
F	0.92	-	1.16
G	-	2.54	-
H	5.31	-	5.84

Viewed from underside

Connections 1. Emitter 3. Collector connected to envelope

2. Base

†RATINGS

Limiting values of operation according to the absolute maximum system.

Electrical

$-V_{CBO}$ max.	25	V
$-V_{CEO}$ max.	20	V
$-V_{EBO}$ max.	5.0	V
$-I_C$ max. (d.c.)	100	mA
P_{tot} max. ($T_{amb}=25^{o}C$)	300	mW

Temperature

T_{stg} min.	-65	^{o}C
T_{stg} max.	200	^{o}C
T_j max.	200	^{o}C
T_{lead} max. (1/16" from case, for 10 seconds)	300	^{o}C

†THERMAL DERATING FACTOR

Junction to ambient ($T_{amb}=25^{o}C$) 1.72 mW/degC

†ELECTRICAL CHARACTERISTICS ($T_{amb}=25^{o}C$ unless otherwise stated)

		Min.	Max.	
$-I_{CBO}$	Collector cut-off current $-V_{CB}=25V$, $I_E=0$	-	10	nA
$-I_{CES}$	Collector cut-off current $-V_{CE}=25V$, $V_{BE}=0$	-	10	nA
	$-V_{CE}=25V$, $V_{BE}=0$, $T_{amb}=150^{o}C$	-	10	μA
$-I_{EBO}$	Emitter cut-off current $-V_{EB}=5.0V$, $I_C=0$	-	10	nA
$-V_{(BR)CEO}$	Collector-emitter breakdown voltage $-I_C=10mA$*, $I_B=0$	20	-	V

†J.E.D.E.C. registered data

*Pulse condition, pulse width = 300μs, duty cycle ≤2%.

P-N-P SILICON PLANAR EPITAXIAL TRANSISTORS

2N2411 2N2412

Symbol	Parameter		Min.	Max.	
$-V_{CE(sat)}$	Collector-emitter saturation voltage				
	$-I_C=10mA$, $-I_B=1.0mA$		-	0.20	V
$-V_{BE}$	Base-emitter voltage				
	$-I_C=10mA$, $-I_B=1.0mA$		0.70	0.90	V
h_{FE}	Static forward current transfer ratio				
	$-I_C=50\mu A$, $-V_{CE}=0.5V$	2N2411	10	-	
		2N2412	20	-	
	$-I_C=10mA$, $-V_{CE}=0.5V$	2N2411	20	60	
		2N2412	40	120	
	$-I_C=10mA$, $-V_{CE}=0.5V$, $T_{amb}=-55^oC$	2N2411	10	-	
		2N2412	20	-	
	$-I_C=50mA$*, $-V_{CE}=1.0V$	2N2411	10	-	
		2N2412	20	-	
f_T	Transition frequency				
	$-I_C=10mA$, $-V_{CE}=10V$, $f=100MHz$		140	-	MHz
C_{ob}	Common base, open circuit output capacitance				
	$-V_{CB}=5.0V$, $I_E=0$, $f=1.0MHz$		-	5.0	pF
C_{ib}	Common base, open circuit input capacitance				
	$-V_{EB}=0.5V$, $I_C=0$, $f=1.0MHz$		-	8.0	pF

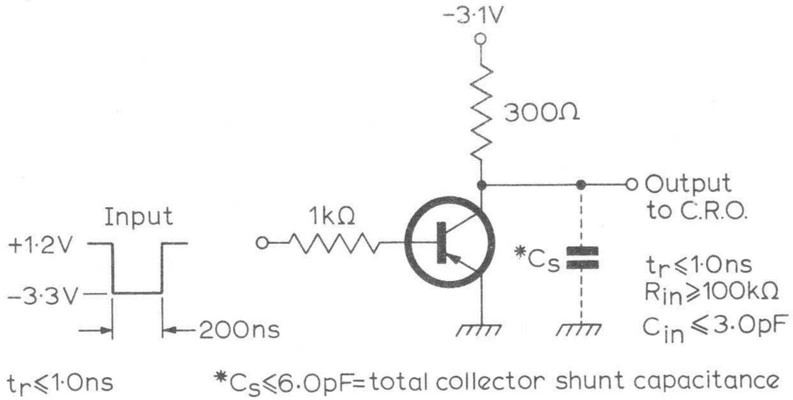
Switching characteristics (see test circuit on page D4)

Symbol	Parameter	Min.	Max.	
t_d	Turn-on delay time	-	10	ns
t_r	Rise time	-	20	ns
t_{on}	Turn-on time ($t_d + t_r$)	-	25	ns
t_s	Storage time	-	90	ns
t_f	Fall time	-	20	ns
t_{off}	Turn-off time ($t_s + t_f$)	-	100	ns

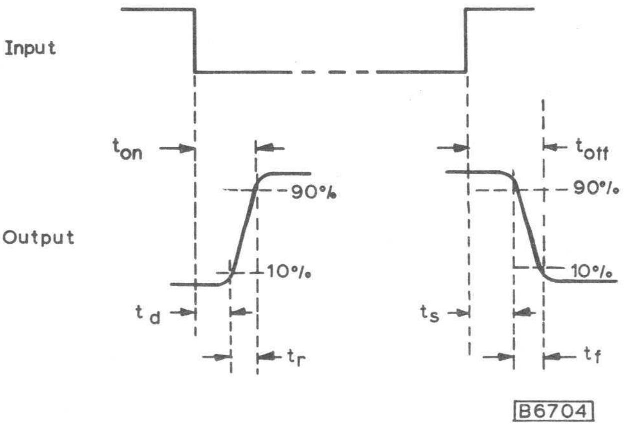
*Pulse condition, pulse width = 300μs, duty cycle ≤2%.

SWITCHING TIMES

TEST CIRCUIT



WAVEFORMS



SILICON N-P-N PLANAR TRANSISTORS

2N2483 2N2484

Silicon n-p-n planar transistors primarily intended for use in high performance, low level, low noise amplifier applications both for direct current and frequencies up to 100Mc/s. TO-18 construction with collector connected to envelope.

QUICK REFERENCE DATA

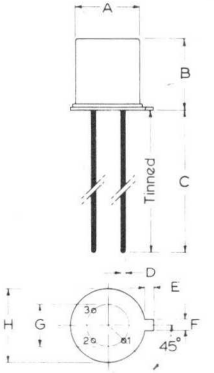
		2N2483		2N2484	
V_{CBO} max. ($I_E = 0$)			60		V
V_{CEO} max. ($I_B = 0$)			60		V
I_{CM} max.			50		mA
P_{tot} max. ($T_{amb} \leq 25^{o}C$)			360		mW
T_j max.			200		^{o}C
h_{FE} ($I_C = 10\mu A$, $V_{CE} = 5.0V$)	min.	40		100	
	max.	120		500	
h_{FE} ($I_C = 1.0mA$, $V_{CE} = 5.0V$)	min.	175		250	
f_T typ. ($I_C = 0.5mA$, $V_{CE} = 5.0V$)			80		Mc/s
NF max. ($I_C = 10\mu A$, $V_{CE} = 5.0V$, $B = 15.7kc/s$, $R_s = 10k\Omega$)		4.0		3.0	dB

Unless otherwise stated data is applicable to both types

OUTLINE AND DIMENSIONS

Conforming to J.E.D.E.C. TO-18

V.A.S.C.A. SO-12A/SB3-6A



Millimetres

	Min.	Nom.	Max.
A	-	-	4.8
B	-	-	5.3
C	-	12.7	-
D	-	0.43	-
E	-	1.0	-
F	-	1.05	-
G	-	2.54	-
H	5.3	5.55	5.8

Connections 1. Emitter 3. Collector
2. Base

Collector connected to metal envelope

RATINGS

Limiting values of operation according to the absolute maximum system.

Electrical

†V_{CBO} max. ($I_E = 0$)	60	V
†V_{CEO} max. ($I_B = 0$)	60	V
†V_{EBO} max. ($I_C = 0$)	6.0	V
†I_{CM} max.	50	mA
†P_{tot} max. ($T_{amb} \leq 25^{\circ}C$)	360	mW

Temperature

†T_{stg} min.	-65	$^{\circ}C$
†T_{stg} max.	200	$^{\circ}C$
†T_j max. (operating)	200	$^{\circ}C$

THERMAL CHARACTERISTICS

†θ_{j-amb}	0.48 deg C/mW
†θ_{j-case}	0.15 deg C/mW

ELECTRICAL CHARACTERISTICS ($T_j = 25^{\circ}C$ unless otherwise stated)

		Min.	Typ.	Max.	
†I_{CBO}	Collector cut-off current				
	$V_{CB} = 45V$, $I_E = 0$	-	-	10	nA
	$V_{CB} = 45V$, $I_E = 0$, $T_j = 150^{\circ}C$	-	-	10	μA
†I_{EBO}	Emitter cut-off current				
	$V_{EB} = 5.0V$, $I_C = 0$	-	-	10	nA
†$V_{CE(sat)}$	Collector-emitter saturation voltage				
	$I_C = 1.0mA$, $I_B = 0.1mA$	-	-	350	mV
†V_{BE}	Base-emitter voltage				
	$I_C = 0.1mA$, $V_{CE} = 5.0V$	0.5	-	0.7	V

			Min.	Typ.	Max.	
†h_{FE}	Static forward current transfer ratio					
	$I_C = 1.0\mu A$, $V_{CE} = 5.0V$	2N2484	30	-	-	
	$I_C = 10\mu A$, $V_{CE} = 5.0V$	2N2483	40	-	120	
		2N2484	100	-	500	
	$I_C = 10\mu A$, $V_{CE} = 5.0V$, $T_j = -55^{o}C$	2N2483	10	-	-	
		2N2484	20	-	-	
	$I_C = 100\mu A$, $V_{CE} = 5.0V$	2N2483	75	-	-	
		2N2484	175	-	-	
	$I_C = 500\mu A$, $V_{CE} = 5.0V$	2N2483	100	-	-	
		2N2484	200	-	-	
	$I_C = 1.0mA$, $V_{CE} = 5.0V$	2N2483	175	-	-	
		2N2484	250	-	-	
	*$I_C = 10mA$, $V_{CE} = 5.0V$	2N2483	-	-	500	
		2N2484	-	-	800	
f_T	Transition frequency					
	$I_C = 50\mu A$, $V_{CE} = 5.0V$	2N2483	12	-	-	Mc/s
		2N2484	15	-	-	Mc/s
	$I_C = 0.5mA$, $V_{CE} = 5.0V$	2N2483	60	80	-	Mc/s
		2N2484	60	80	-	Mc/s

*Measured under pulsed conditions to avoid excessive dissipation, pulse width = 300μs, duty cycle < 0.01.

			Min.	Typ.	Max.	
†c_{tc}	Collector capacitance					
	$V_{CB} = 5.0V$, $I_E = I_e = 0$, $f = 1.0Mc/s$		-	-	6.0	pF
†c_{te}	Emitter capacitance					
	$V_{EB} = 0.5V$, $I_C = I_c = 0$, $f = 1.0Mc/s$		-	-	6.0	pF

			Min.	Typ.	Max.	
Small signal h-parameters						
Measured at I_C = 1.0mA, V_{CE} = 5.0V, f = 1.0kc/s						
†h_{ie}	Input impedance	2N2483	1.5	-	13	kΩ
		2N2484	3.5	-	24	kΩ
†h_{re}	Reverse voltage transfer ratio		-	-	8.0	$\times 10^{-4}$
†h_{fe}	Forward current transfer ratio	2N2483	80	-	450	
		2N2484	150	-	900	
†h_{oe}	Output admittance	2N2483	-	-	30	μmho
		2N2484	-	-	40	μmho
†NF	Noise figure					
	I_C = 10μA, V_{CE} = 5.0V, R_s = 10kΩ, f = 100c/s, B = 20c/s	2N2483	-	-	15	dB
		2N2484	-	-	10	dB
	f = 1.0kc/s, B = 200c/s	2N2483	-	-	4.0	dB
		2N2484	-	-	3.0	dB
	f = 10kc/s, B = 2.0kc/s	2N2483	-	-	3.0	dB
		2N2484	-	-	2.0	dB
†NF	Wideband noise figure					
	I_C = 10μA, V_{CE} = 5.0V, B = 15.7kc/s, R_s = 10kΩ	2N2483	-	-	4.0	dB
		2N2484	-	-	3.0	dB

†J.E.D.E.C. registered data

SOLDERING AND WIRING RECOMMENDATIONS

1. When using a soldering iron, transistors may be soldered directly into the circuit, but heat conducted to the junction should if possible be kept to a minimum by the use of a thermal shunt.

2. Transistors may be dip-soldered at a solder temperature of 245°C for a maximum soldering time of 5 seconds. The case temperature during dip-soldering must not at any time exceed the maximum storage temperature. These recommendations apply to a transistor mounted flush on a board having punched-through holes, or spaced at least 1.5mm above a board having plated-through holes.

3. Care should be taken not to bend the leads nearer than 1.5mm from the seal.

4. If devices are stored above 100°C before incorporation into equipment some deterioration of the external surface is likely to occur which may make soldering into the circuit difficult. Under these circumstances the leads should be retinned using a suitable activated flux.

P-N-P SILICON PLANAR EPITAXIAL TRANSISTORS

2N2904
2N2904A

P-N-P silicon planar epitaxial medium power transistors designed primarily for high-speed saturated switching and driver applications for industrial service.

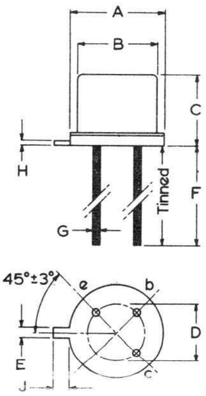
QUICK REFERENCE DATA

	2N2904		2N2904A	
$-V_{CBO}$ max.		60		V
$-V_{CEO}$ max. ($-I_C$ < 100mA)	40		60	V
$-I_C$ max.		600		mA
P_{tot} max. (T_{amb} = 25°C)		600		mW
T_j max.		200		°C
h_{FE} ($-I_C$ = 150mA, $-V_{CE}$ = 10V)		40-120		
f_T min. ($-I_C$ = 50mA, f = 100MHz)		200		MHz
t_s max. ($-I_{CS}$ = 150mA, $-I_B$ = $+I_{BM}$ = 15mA)		80		ns

Unless otherwise stated data is applicable to both types

OUTLINE AND DIMENSIONS

Conforming to B.S. 3934 SO-3/SB3-3A
J.E.D.E.C. TO-5



Millimetres

	Min.	Nom.	Max.
A	8.64	8.90	9.40
B	7.75	8.15	8.50
C	6.10	6.35	6.60
D	-	5.08	-
E	0.71	0.79	0.86
F	38	-	-
G	-	0.45	-
H	-	0.4	-
J	0.74	0.85	1.0

Collector connected to envelope

RATINGS

Limiting values of operation according to the absolute maximum system.

Electrical

†$-V_{CBO}$ max.		60	V
†$-V_{CEO}$ max. ($-I_C$ = 0 to 100mA)	2N2904	40	V
	2N2904A	60	V
†$-V_{EBO}$ max.		5.0	V
†$-I_C$ max.		600	mA
P_{tot} max. (T_{amb} = 25°C)		600	mW

†Temperature

T_{stg} min.	-65	°C
T_{stg} max.	200	°C
T_j max.	200	°C

THERMAL CHARACTERISTIC

$\Theta_{j\text{-}amb}$	292	degC/W

†ELECTRICAL CHARACTERISTICS (T_{amb} = 25°C unless otherwise stated)

			Min.	Max.	
$-I_{CBO}$	Collector cut-off current $-V_{CB}$ = 50V, I_E = 0	2N2904	-	20	nA
		2N2904A	-	10	nA
	$-V_{CB}$ = 50V, I_E = 0, T_{amb} = 150°C	2N2904	-	20	μA
		2N2904A	-	10	μA
$-I_{CEX}$	Collector-emitter cut-off current $-V_{CE}$ = 30V, $+V_{BE}$ = 0.5V		-	50	nA
I_{BEX}	Base current $-V_{CE}$ = 30V, $+V_{BE}$ = 0.5V		-	50	nA
$-V_{(BR)CBO}$	Collector-base breakdown voltage $-I_C$ = 10μA, I_E = 0		60	-	V
$-V_{(BR)CEO}$	*Collector-emitter breakdown voltage $-I_C$ = 10mA, I_B = 0	2N2904	40	-	V
		2N2904A	60	-	V

*Pulse condition, pulse width ≤300μs, duty cycle ≤2%.

†J.E.D.E.C. registered data.

P-N-P SILICON PLANAR EPITAXIAL TRANSISTORS

2N2904 2N2904A

			Min.	Max.	
$-V_{(BR)EBO}$	Emitter-base breakdown voltage				
	$-I_E = 10\mu A$, $I_C = 0$		5.0	-	V
$-V_{CE(sat)}$	*Collector-emitter saturation voltage				
	$-I_C = 150mA$, $-I_B = 15mA$		-	0.4	V
	$-I_C = 500mA$, $-I_B = 50mA$		-	1.6	V
$-V_{BE(sat)}$	*Base-emitter saturation voltage				
	$-I_C = 150mA$, $-I_B = 15mA$		-	1.3	V
	$-I_C = 500mA$, $-I_B = 50mA$		-	2.6	V
h_{FE}	Static forward current transfer ratio				
	$-I_C = 0.1mA$, $-V_{CE} = 10V$	2N2904	20	-	
		2N2904A	40	-	
	$-I_C = 1.0mA$, $-V_{CE} = 10V$	2N2904	25	-	
		2N2904A	40	-	
	$-I_C = 10mA$, $-V_{CE} = 10V$	2N2904	35	-	
		2N2904A	40	-	
	*$-I_C = 150mA$, $-V_{CE} = 10V$		40	120	
	*$-I_C = 500mA$, $-V_{CE} = 10V$	2N2904	20	-	
		2N2904A	40	-	
c_{ob}	Common base, open circuit output capacitance				
	$-V_{CB} = 10V$, $I_E = 0$, $f = 100kHz$		-	8.0	pF
c_{ib}	Common base, open circuit input capacitance				
	$V_{BE} = 2.0V$, $I_C = 0$, $f = 100kHz$		-	30	pF
f_T	Transition frequency				
	$-V_{CE} = 20V$, $-I_C = 50mA$, $f = 100MHz$		200	-	MHz

*Pulse condition, pulse width $\leq 300\mu s$, duty cycle $\leq 2\%$.

Switching characteristics

		Max.	
Turn-on (see Fig.1)			
$-V_{CC} = 30V$, $-I_{CS} = 150mA$, $-I_B = 15mA$			
t_d	Turn-on delay time	10	ns
t_r	Rise time	40	ns
t_{on}	Turn-on time ($t_d + t_r$)	45	ns
Turn-off (see Fig.2)			
$-V_{CC} = 6V$, $-I_{CS} = 150mA$, $-I_B = +I_{BM} = 15mA$			
t_s	Storage time	80	ns
t_f	Fall time	30	ns
t_{off}	Turn-off time ($t_s + t_f$)	100	ns

TEST CIRCUITS

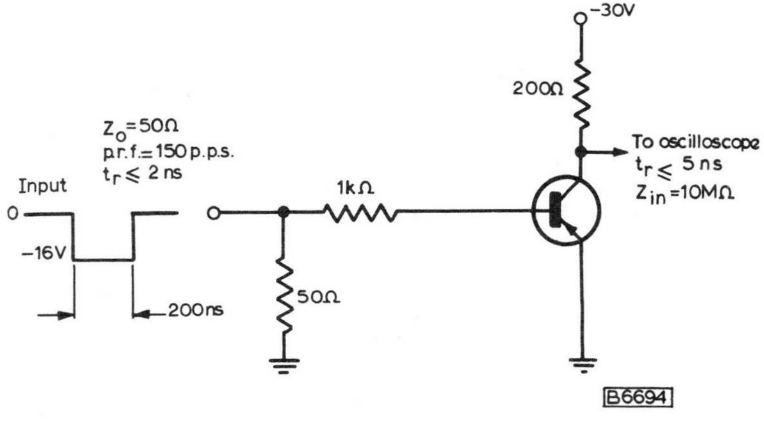


Fig.1

Test circuit for determining delay, rise and turn-on time

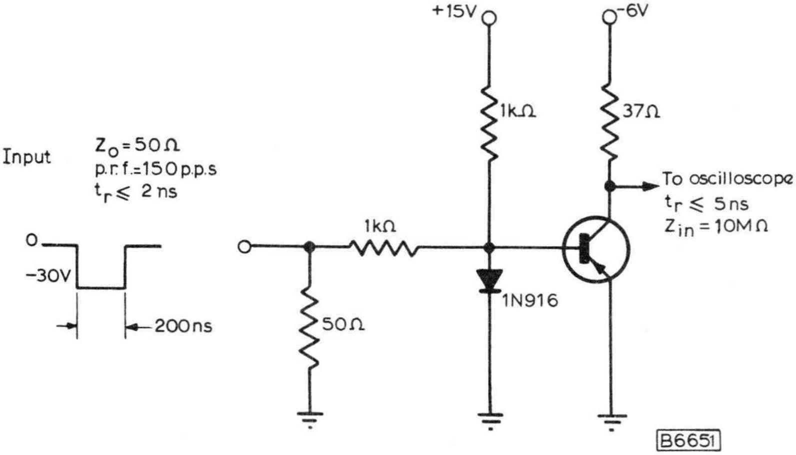


Fig. 2

Test circuit for determining storage, fall and turn-off time

WAVEFORMS

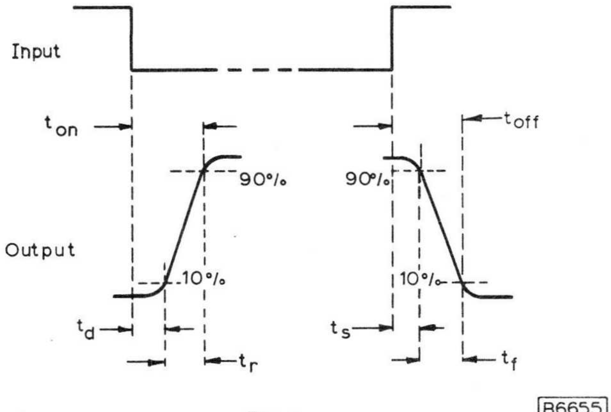
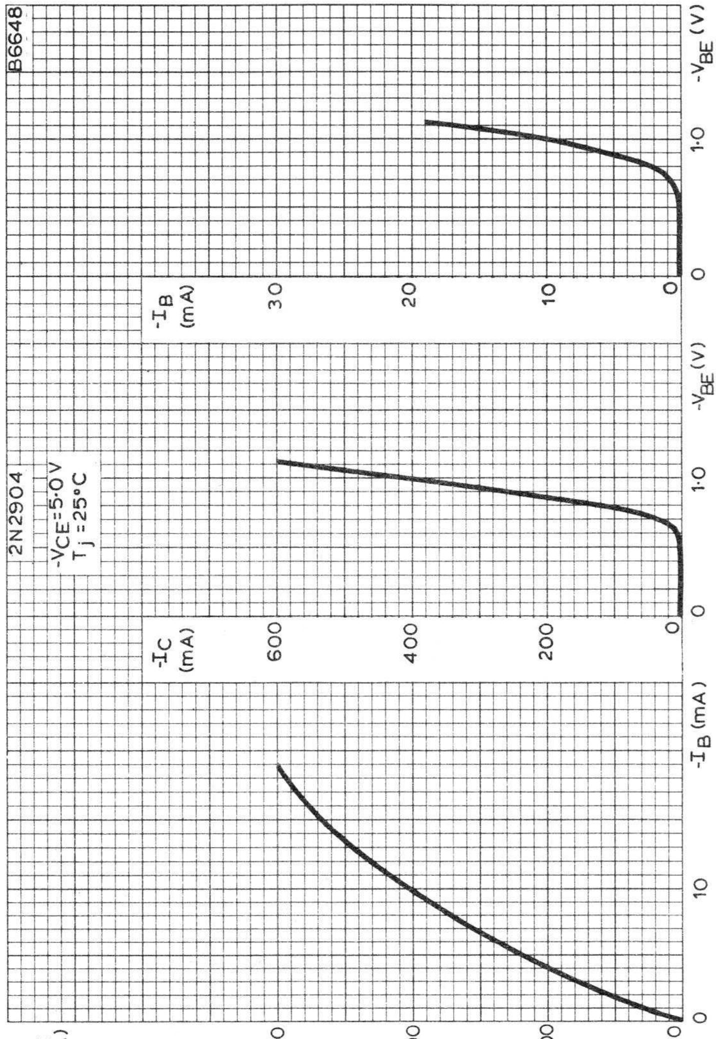


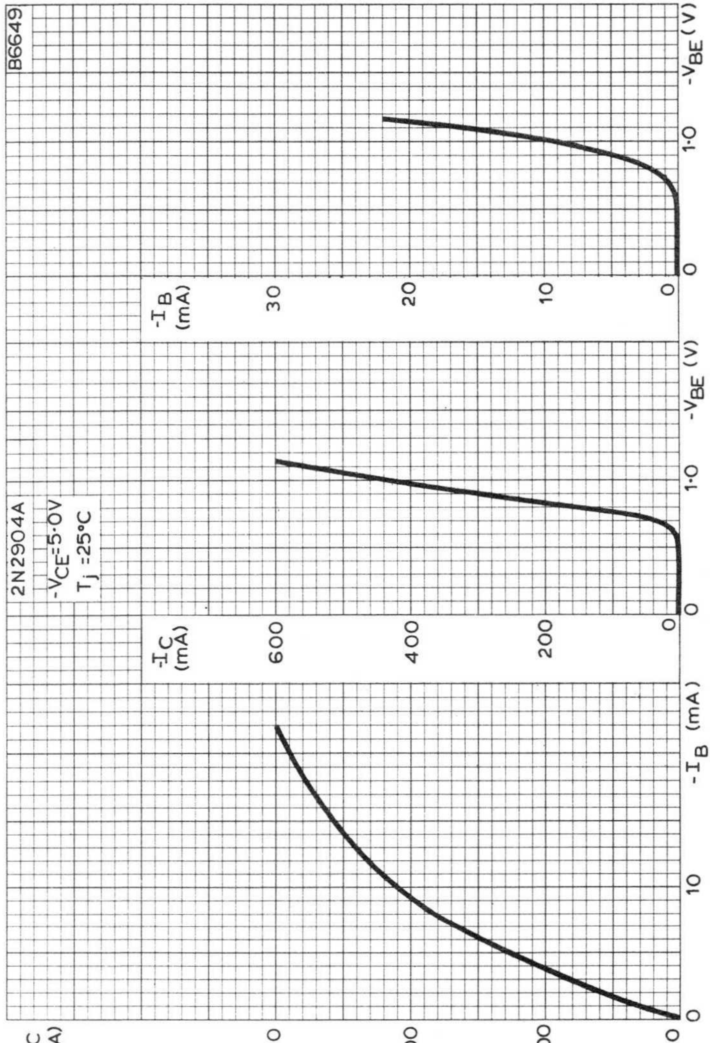
Fig. 3

P-N-P SILICON PLANAR EPITAXIAL TRANSISTORS

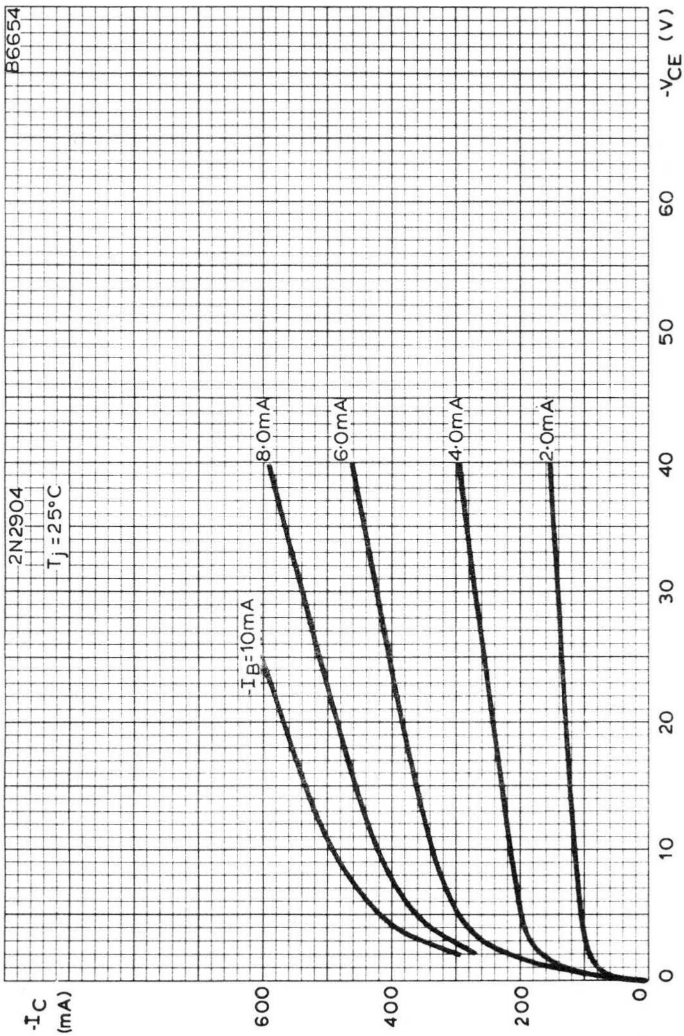
2N2904
2N2904A



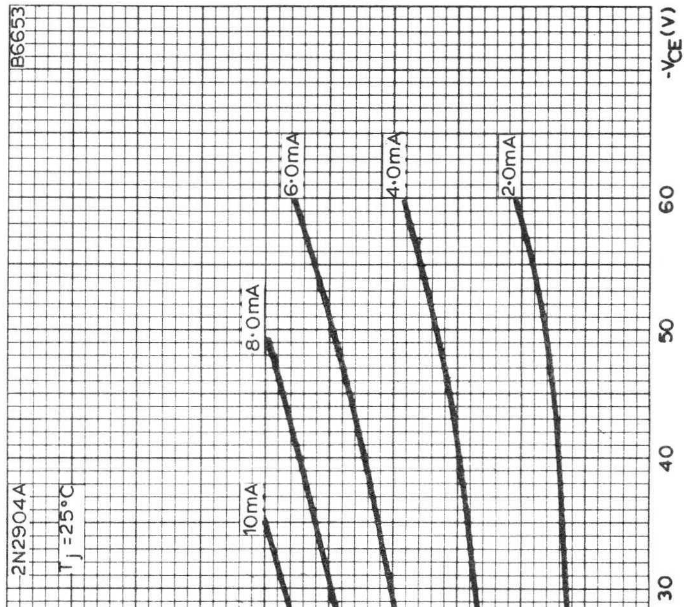
TYPICAL TRANSFER, MUTUAL AND INPUT CHARACTERISTICS



TYPICAL TRANSFER, MUTUAL AND INPUT CHARACTERISTICS



TYPICAL OUTPUT CHARACTERISTICS



TYPICAL OUTPUT CHARACTERISTICS

P-N-P SILICON PLANAR EPITAXIAL TRANSISTORS

2N2905
2N2905A

P-N-P silicon planar epitaxial medium power transistors designed primarily for high-speed saturated switching and driver applications for industrial service.

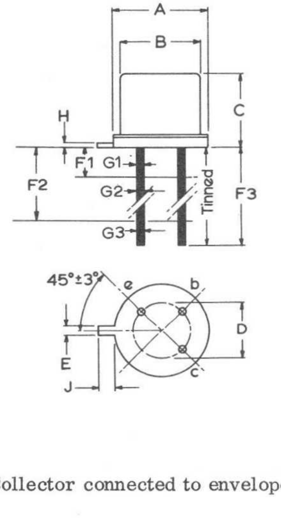
QUICK REFERENCE DATA

	2N2905	2N2905A	
$-V_{CBO}$ max.	60		V
$-V_{CEO}$ max.	40	60	V
$-I_C$ max.	600		mA
P_{tot} max. ($T_{amb}=25^oC$)	600		mW
T_j max.	200		^oC
h_{FE} ($-I_C=150mA$, $-V_{CE}=10V$)	100-300		
f_T min. ($-I_C=50mA$, $f=100MHz$)	200		MHz
t_s max. ($-I_{CS}=150mA$, $-I_B=+I_{BM}=15mA$)	80		ns

Unless otherwise stated data is applicable to both types

OUTLINE AND DIMENSIONS

Conforming to B.S. 3934 SO-3/SB3-3A
J.E.D.E.C. TO-5



Collector connected to envelope

Millimetres

	Min.	Typ.	Max.
A	9.10	-	9.39
B	8.2	-	8.50
C	6.15	-	6.60
D	-	5.08	-
E	0.71	-	0.86
F1	-	-	0.51
F2	12.7	-	-
F3	38.1	-	41.3
G1	-	-	1.01
G2	0.41	-	0.48
G3	-	-	0.53
H	-	0.4	-
J	0.74	-	1.01

†RATINGS

Limiting values of operation according to the absolute maximum system.

Electrical

$-V_{CBO}$ max.		60	V
$-V_{CEO}$ max. ($-I_C$=0 to 100mA)	2N2905	40	V
	2N2905A	60	V
$-V_{EBO}$ max.		5.0	V
$-I_C$ max.		600	mA
P_{tot} max. (T_{amb}=25°C)		600	mW

Temperature

T_{stg} min.	-65	°C
T_{stg} max.	200	°C
T_j max.	200	°C

†THERMAL CHARACTERISTIC

$\Theta_{j\text{-}amb}$	290	degC/W

†ELECTRICAL CHARACTERISTICS (T_{amb}=25°C unless otherwise stated)

			Min.	Max.	
$-I_{CBO}$	Collector cut-off current $-V_{CB}$=50V, I_E=0	2N2905	-	20	nA
		2N2905A	-	10	nA
	$-V_{CB}$=50V, I_E=0, T_{amb}=150°C	2N2905	-	20	µA
		2N2905A	-	10	µA
$-I_{CEX}$	Collector-emitter cut-off current $-V_{CE}$=30V, $+V_{BE}$=0.5V		-	50	nA
I_{BEX}	Base current $-V_{CE}$=30V, $+V_{BE}$=0.5V		-	50	nA
$-V_{(BR)CBO}$	Collector-base breakdown voltage $-I_C$=10µA, I_E=0		60	-	V
$-V_{(BR)CEO}$	*Collector-emitter breakdown voltage $-I_C$=10mA, I_B=0	2N2905	40	-	V
		2N2905A	60	-	V

†J.E.D.E.C. registered data

*Pulse condition, pulse width ≤300µs, duty cycle ≤2%.

P-N-P SILICON PLANAR EPITAXIAL TRANSISTORS

2N2905 2N2905A

			Min.	Max.	
$-V_{(BR)EBO}$	Emitter-base breakdown voltage				
	$-I_E = 10\mu A$, $I_C = 0$		5.0	-	V
$-V_{CE(sat)}$	*Collector-emitter saturation voltage				
	$-I_C = 150mA$, $-I_B = 15mA$		-	0.4	V
	$-I_C = 500mA$, $-I_B = 50mA$		-	1.6	V
$-V_{BE(sat)}$	*Base-emitter saturation voltage				
	$-I_C = 150mA$, $-I_B = 15mA$		-	1.3	V
	$-I_C = 500mA$, $-I_B = 50mA$		-	2.6	V
h_{FE}	Static forward current transfer ratio				
	$-I_C = 0.1mA$, $-V_{CE} = 10V$	2N2905	35	-	
		2N2905A	75	-	
	$-I_C = 1.0mA$, $-V_{CE} = 10V$	2N2905	50	-	
		2N2905A	100	-	
	$-I_C = 10mA$, $-V_{CE} = 10V$	2N2905	75	-	
		2N2905A	100	-	
	*$-I_C = 150mA$, $-V_{CE} = 10V$		100	300	
	*$-I_C = 500mA$, $-V_{CE} = 10V$	2N2905	30	-	
		2N2905A	50	-	
C_{ob}	Common base, open circuit output capacitance				
	$-V_{CB} = 10V$, $I_E = 0$, $f = 100kHz$		-	8.0	pF
C_{ib}	Common base, open circuit input capacitance				
	$+V_{BE} = 2.0V$, $I_C = 0$, $f = 100kHz$		-	30	pF
f_T	Transition frequency				
	$-V_{CE} = 20V$, $-I_C = 50mA$, $f = 100MHz$		200	-	MHz

*Pulse conditions, pulse width = 300μA, duty cycle ≤2%.

Switching characteristics

			Max.	
Turn-on (see fig.1)				
$-V_{CC}=30V$, $-I_{CS}=150mA$, $-I_B=15mA$				
	t_d	Turn-on delay time	10	ns
	t_r	Rise time	40	ns
	t_{on}	Turn-on time (t_d+t_r)	45	ns
Turn-off (see fig.2)				
$-V_{CC}=6.0V$, $-I_{CS}=150mA$, $-I_B=+I_{BM}=15mA$				
	t_s	Storage time	80	ns
	t_f	Fall time	30	ns
	t_{off}	Turn-off time (t_s+t_f)	100	ns

TEST CIRCUITS

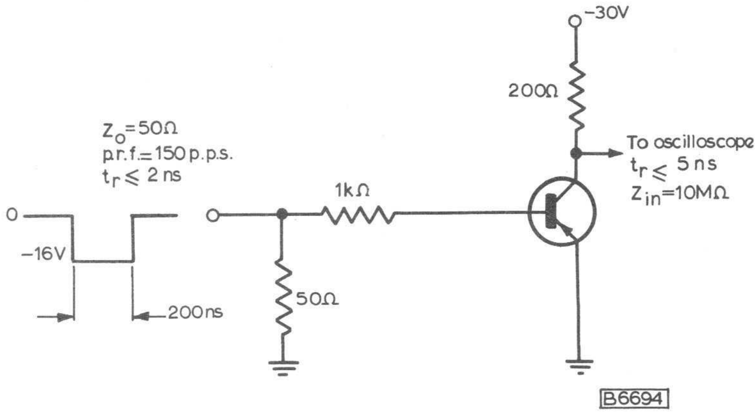


Fig.1

Test circuit for determining delay, rise and turn-on time

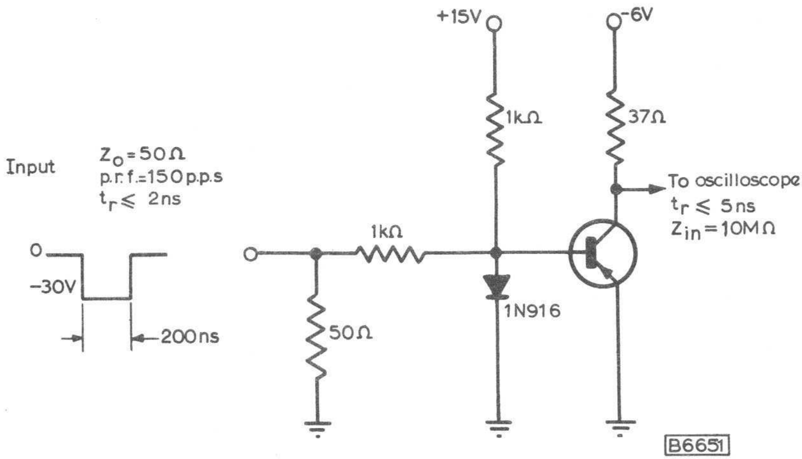


Fig. 2

Test circuit for determining storage, fall and turn-off time

WAVEFORMS

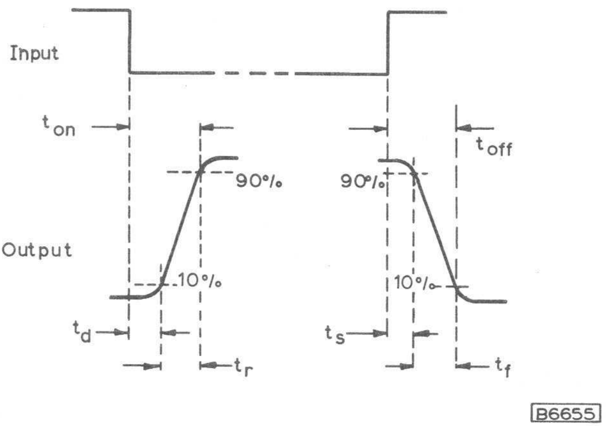


Fig. 3

P-N-P SILICON PLANAR EPITAXIAL TRANSISTORS

2N2906
2N2906A

P-N-P silicon planar epitaxial medium power transistors designed primarily for high-speed saturated switching and driver applications for industrial service.

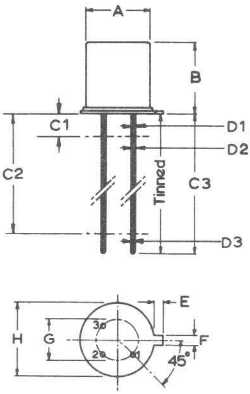
QUICK REFERENCE DATA

	2N2906		2N2906A	
$-V_{CBO}$ max.		60		V
$-V_{CEO}$ max. ($-I_C < 100mA$)	40		60	V
$-I_C$ max.		600		mA
P_{tot} max. ($T_{amb} = 25^oC$)		400		mW
T_j max.		200		^oC
h_{FE} ($-I_C = 150mA, -V_{CE} = 10V$)		40-120		
f_T min. ($-I_C = 50mA, f = 100MHz$)		200		MHz
t_s max. ($-I_{CS} = 150mA$, $-I_B = +I_{BM} = 15mA$)		80		ns

Unless otherwise stated data is applicable to both types

OUTLINE AND DIMENSIONS

Conforms to J.E.D.E.C. TO-18
B.S. 3934 SO-12A/SB3-6A



Viewed from underside

Millimetres	Min.	Typ.	Max.
A	4.53	-	4.8
B	4.66	-	5.33
C1	-	-	0.51
C2	12.7	-	-
C3	12.7	-	15
D1	-	-	1.01
D2	0.41	-	0.48
D3	-	-	0.53
E	0.84	-	1.17
F	0.92	-	1.16
G	-	2.54	-
H	5.31	-	5.84

Connections 1. Emitter 3. Collector connected to envelope
2. Base

†RATINGS

Limiting values of operation according to the absolute maximum system.

Electrical

$-V_{CBO}$ max.		60	V
$-V_{CEO}$ max. ($-I_C$ = 0 to 100mA)	2N2906	40	V
	2N2906A	60	V
$-V_{EBO}$ max.		5.0	V
$-I_C$ max.		600	mA
P_{tot} max. (T_{amb} = 25 ^oC)		400	mW

Temperature

T_{stg} min.	-65	^oC
T_{stg} max.	200	^oC
T_j max.	200	^oC

†THERMAL CHARACTERISTIC

$\Theta_{j\text{-}amb}$	0.44	degC/mW

†ELECTRICAL CHARACTERISTICS (T_{amb} = 25 ^oC unless otherwise stated)

			Min.	Max.	
$-I_{CBO}$	Collector cut-off current				
	$-V_{CB}$ = 50V, I_E = 0	2N2906	-	20	nA
		2N2906A	-	10	nA
	$-V_{CB}$ = 50V, I_E = 0, T_{amb} = 150 ^oC	2N2906	-	20	μA
		2N2906A	-	10	μA
$-I_{CEX}$	Collector-emitter cut-off current				
	$-V_{CE}$ = 30V, $+V_{BE}$ = 0.5V		-	50	nA
I_{BEX}	Base current				
	$-V_{CE}$ = 30V, $+V_{BE}$ = 0.5V		-	50	nA
$-V_{(BR)CBO}$	Collector-base breakdown voltage				
	$-I_C$ = 10μA, I_E = 0		60	-	V
$-V_{(BR)CEO}$	*Collector-emitter breakdown voltage				
	$-I_C$ = 10mA, I_B = 0	2N2906	40	-	V
		2N2906A	60	-	V

*Pulse condition, pulse width≤300μs, duty cycle≤2%.

†J.E.D.E.C. registered data.

			Min.	Max.	
$-V_{(BR)EBO}$	Emitter-base breakdown voltage				
	$-I_E = 10\mu A$, $I_C = 0$		5.0	-	V
$-V_{CE(sat)}$	*Collector-emitter saturation voltage				
	$-I_C = 150mA$, $-I_B = 15mA$		-	0.4	V
	$-I_C = 500mA$, $-I_B = 50mA$		-	1.6	V
$-V_{BE(sat)}$	*Base-emitter saturation voltage				
	$-I_C = 150mA$, $-I_B = 15mA$		-	1.3	V
	$-I_C = 500mA$, $-I_B = 50mA$		-	2.6	V
h_{FE}	Static forward current transfer ratio				
	$-I_C = 0.1mA$, $-V_{CE} = 10V$	2N2906	20	-	
		2N2906A	40	-	
	$-I_C = 1.0mA$, $-V_{CE} = 10V$	2N2906	25	-	
		2N2906A	40	-	
	$-I_C = 10mA$, $-V_{CE} = 10V$	2N2906	35	-	
		2N2906A	40	-	
	*$-I_C = 150mA$, $-V_{CE} = 10V$		40	120	
	*$-I_C = 500mA$, $-V_{CE} = 10V$	2N2906	20	-	
		2N2906A	40	-	
C_{ob}	Common base, open circuit output capacitance				
	$-V_{CB} = 10V$, $I_E = 0$, $f = 100kHz$		-	8.0	pF
C_{ib}	Common base, open circuit input capacitance				
	$V_{BE} = 2.0V$, $I_C = 0$, $f = 100kHz$		-	30	pF
f_T	Transition frequency				
	$-V_{CE} = 20V$, $-I_C = 50mA$, $f = 100MHz$		200	-	MHz

*Pulse condition, pulse width $\leq 300\mu s$, duty cycle $\leq 2\%$.

Switching characteristics

			Max.	
Turn-on (see Fig.1)				
$-V_{CC}=30V$, $-I_{CS}=150mA$, $-I_B=15mA$				
	t_d	Turn-on delay time	10	ns
	t_r	Rise time	40	ns
	t_{on}	Turn-on time (t_d+t_r)	45	ns
Turn-off (see Fig.2)				
$-V_{CC}=6V$, $-I_{CS}=150mA$, $-I_B=+I_{BM}=15mA$				
	t_s	Storage time	80	ns
	t_f	Fall time	30	ns
	t_{off}	Turn-off time (t_s+t_f)	100	ns

TEST CIRCUITS

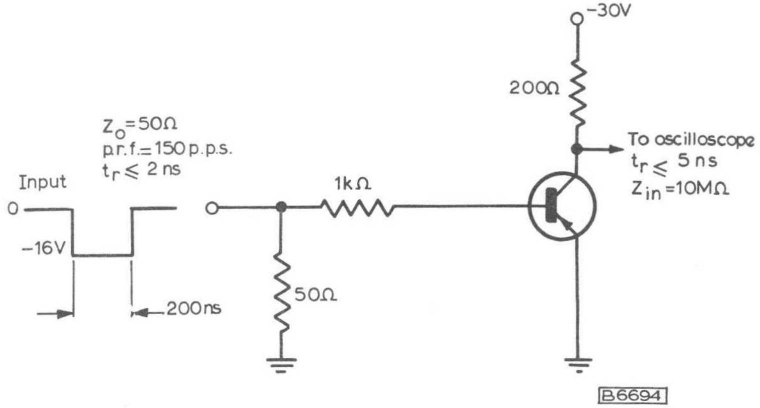


Fig.1

Test circuit for determining delay, rise and turn-on time

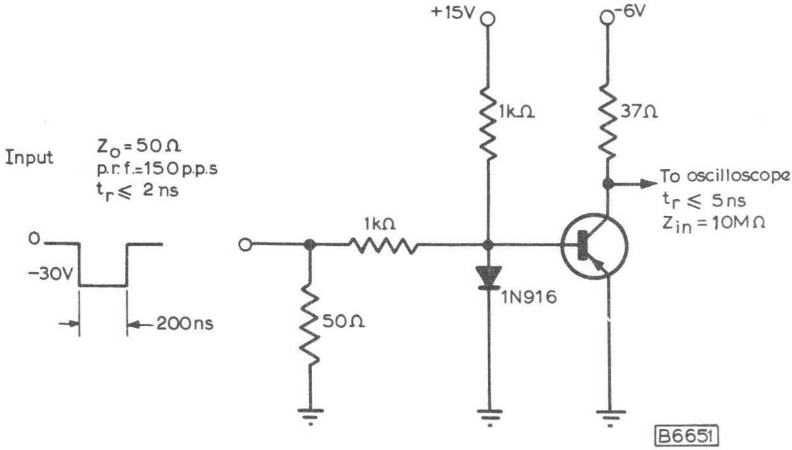


Fig.2

Test circuit for determining storage, fall and turn-off time

WAVEFORMS

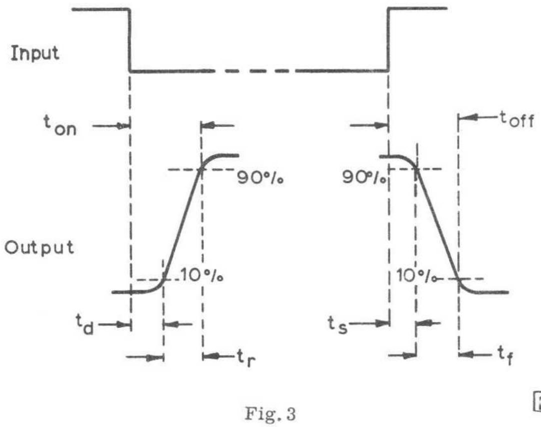


Fig. 3

P-N-P SILICON PLANAR EPITAXIAL TRANSISTORS

2N2907
2N2907A

P-N-P silicon planar epitaxial medium power transistors designed primarily for high-speed saturated switching and driver applications for industrial service.

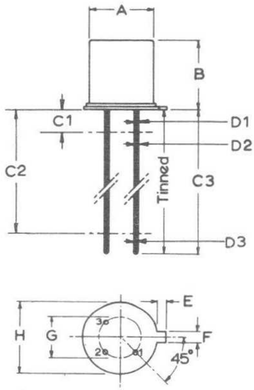
QUICK REFERENCE DATA

	2N2907		2N2907A	
$-V_{CBO}$ max.		60		V
$-V_{CEO}$ max. ($-I_C < 100$mA)	40		60	V
$-I_C$ max.		600		mA
P_{tot} max. ($T_{amb} = 25^oC$)		400		mW
T_j max.		200		^oC
h_{FE} ($-I_C = 150$mA, $-V_{CE} = 10$V)		100-300		
f_T min. ($-I_C = 50$mA, f = 100MHz)		200		MHz
t_s max. ($-I_{CS} = 150$mA, $-I_B = +I_{BM} = 15$mA)		80		ns

Unless otherwise stated data is applicable to both types

OUTLINE AND DIMENSIONS

Conforms to J.E.D.E.C. TO-18
B.S. 3934 SO-12A/SB3-6A



Viewed from underside

Millimetres

	Min.	Typ.	Max.
A	4.53	-	4.8
B	4.66	-	5.33
C1	-	-	0.51
C2	12.7	-	-
C3	12.7	-	15
D1	-	-	1.01
D2	0.41	-	0.48
D3	-	-	0.53
E	0.84	-	1.17
F	0.92	-	1.16
G	-	2.54	-
H	5.31	-	5.84

Connections 1. Emitter 3. Collector connected to envelope
2. Base

†RATINGS

Limiting values of operation according to the absolute maximum system.

Electrical

$-V_{CBO}$ max.		60	V
$-V_{CEO}$ max. ($-I_C = 0$ to 100mA)	2N2907	40	V
	2N2907A	60	V
$-V_{EBO}$ max.		5.0	V
$-I_C$ max.		600	mA
P_{tot} max. ($T_{amb} = 25^oC$		400	mW

Temperature

T_{stg} min.	-65	^oC
T_{stg} max.	200	^oC
T_j max.	200	^oC

†THERMAL CHARACTERISTIC

Θ_{j-amb}	0.44	degC/mW

†ELECTRICAL CHARACTERISTICS ($T_{amb} = 25^oC$ unless otherwise stated)

			Min.	Max.	
$-I_{CBO}$	Collector cut-off current				
	$-V_{CB} = 50V$, $I_E = 0$	2N2907	-	20	nA
		2N2907A	-	10	nA
	$-V_{CB} = 50V$, $I_E = 0$, $T_{amb} = 150^oC$	2N2907	-	20	µA
		2N2907A	-	10	µA
$-I_{CEX}$	Collector-emitter cut-off current				
	$-V_{CE} = 30V$, $+V_{BE} = 0.5V$		-	50	nA
I_{BEX}	Base current				
	$-V_{CE} = 30V$, $+V_{BE} = 0.5V$		-	50	nA
$-V_{(BR)CBO}$	Collector-base breakdown voltage				
	$-I_C = 10\mu A$, $I_E = 0$		60	-	V
$-V_{(BR)CEO}$	*Collector-emitter breakdown voltage				
	$-I_C = 10mA$, $I_B = 0$	2N2907	40	-	V
		2N2907A	60	-	V

*Pulse condition, pulse width≤300µs, duty cycle≤2%.

†J.E.D.E.C. registered data

P-N-P SILICON PLANAR EPITAXIAL TRANSISTORS

2N2907 2N2907A

Symbol	Parameter		Min.	Max.	
$-V_{(BR)EBO}$	Emitter-base breakdown voltage				
	$-I_E = 10\mu A$, $I_C = 0$		5.0	-	V
$-V_{CE(sat)}$	*Collector-emitter saturation voltage				
	$-I_C = 150mA$, $-I_B = 15mA$		-	0.4	V
	$-I_C = 500mA$, $-I_B = 50mA$		-	1.6	V
$-V_{BE(sat)}$	*Base-emitter saturation voltage				
	$-I_C = 150mA$, $-I_B = 15mA$		-	1.3	V
	$-I_C = 500mA$, $-I_B = 50mA$		-	2.6	V
h_{FE}	Static forward current transfer ratio				
	$-I_C = 0.1mA$, $-V_{CE} = 10V$	2N2907	35	-	
		2N2907A	75	-	
	$-I_C = 1.0mA$, $-V_{CE} = 10V$	2N2907	50	-	
		2N2907A	100	-	
	$-I_C = 10mA$, $-V_{CE} = 10V$	2N2907	75	-	
		2N2907A	100	-	
	*$-I_C = 150mA$, $-V_{CE} = 10V$		100	300	
	*$-I_C = 500mA$, $-V_{CE} = 10V$	2N2907	30	-	
		2N2907A	50	-	
C_{ob}	Common base, open circuit output capacitance				
	$-V_{CB} = 10V$, $I_E = 0$, $f = 100kHz$		-	8.0	pF
C_{ib}	Common base, open circuit input capacitance				
	$+V_{BE} = 2.0V$, $I_C = 0$, $f = 100kHz$		-	30	pF
f_T	Transition frequency				
	$-V_{CE} = 20V$, $-I_C = 50mA$, $f = 100MHz$		200	-	MHz

*Pulse conditions, pulse width = 300μA, duty cycle ≤2%.

Switching characteristics

		Max.	
Turn-on (see fig.1)			
$-V_{CC}=30V$, $-I_{CS}=150mA$, $-I_B=15mA$			
t_d	Turn-on delay time	10	ns
t_r	Rise time	40	ns
t_{on}	Turn-on time (t_d+t_r)	45	ns
Turn-off (see fig.2)			
$-V_{CC}=6.0V$, $-I_{CS}=150mA$, $-I_B=+I_{BM}=15mA$			
t_s	Storage time	80	ns
t_f	Fall time	30	ns
t_{off}	Turn-off time (t_s+t_f)	100	ns

TEST CIRCUITS

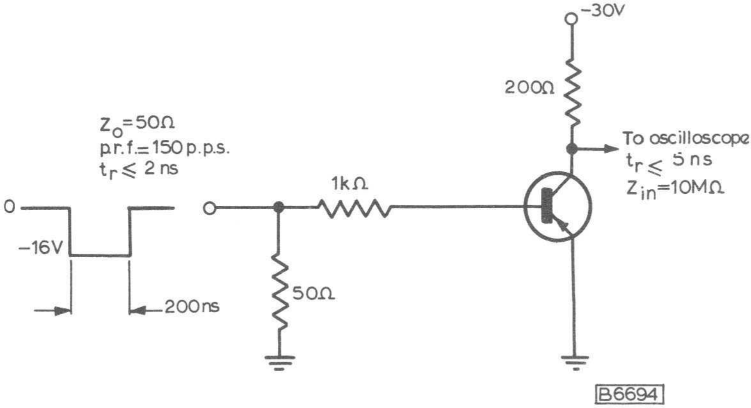


Fig.1

Test circuit for determining delay, rise and turn-on time

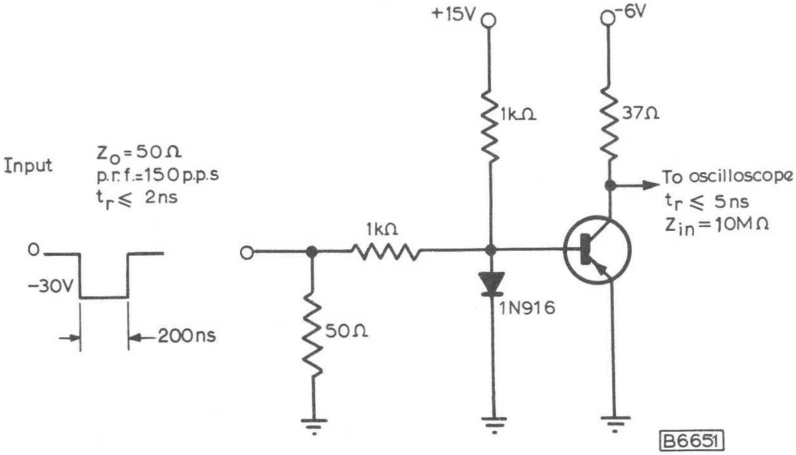


Fig. 2

Test circuit for determining storage, fall and turn-off time

WAVEFORMS

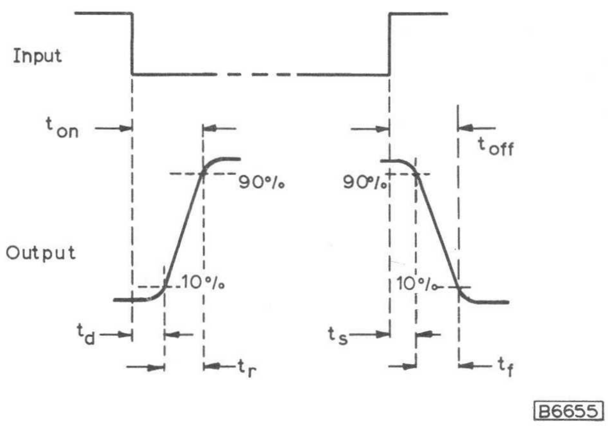


Fig. 3

N-P-N SILICON PLANAR TRANSISTOR

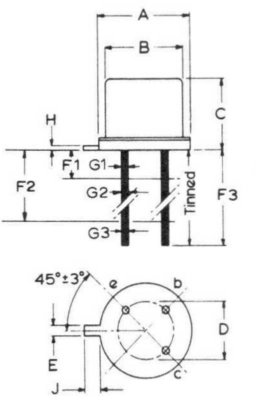
2N3053

N-P-N silicon planar transistor designed for medium speed, saturated and nonsaturated switching applications for industrial service.

QUICK REFERENCE DATA		
V_{CBO} max.	60	V
V_{CEO} max.	40	V
I_C max.	700	mA
P_{tot} max. (T_{case} = 25 ^oC)	5.0	W
T_j max.	200	^oC
h_{FE} (I_C = 150mA, V_{CE} = 10V)	50-250	
f_T min. (I_C = 50mA, V_{CE} = 10V, f = 20MHz)	100	MHz

OUTLINE AND DIMENSIONS

Conforming to B.S. 3934 SO-3/SB3-3A
J.E.D.E.C. TO-5



Millimetres	Min.	Nom.	Max.
A	9. 10	-	9.39
B	8.20	-	8.50
C	6.15	-	6.60
D	-	5.08	-
E	0.71	-	0.86
F1	-	-	0.51
F2	12.7	-	-
F3	38.1	-	41.3
G1	-	-	1.01
G2	0.41	-	0.48
G3	-	-	0.53
H	-	0.4	-
J	0.74	-	1.01

Collector connected to case

†RATINGS

Limiting values of operation according to the absolute maximum system.

Electrical

V_{CBO} max.	60	V
*V_{CEO} max.	40	V
V_{EBO} max.	5.0	V
I_C max.	700	mA
P_{tot} max. ($T_{case} = 25^oC$)	5.0	W

Temperature

T_{stg} min.	-65	^oC
T_{stg} max.	200	^oC
T_j max.	200	^oC

*For $I_C = 0$ to 100mA (pulsed), pulse duration = 300μs, duty factor = 1.8%; 0 to 700mA for shorter pulses.

†THERMAL CHARACTERISTIC

$\Theta_{j\text{-}case}$ (above 25^oC)	35	degC/W

†ELECTRICAL CHARACTERISTICS ($T_{amb} = 25^oC$)

		Min.	Max.	
I_{CEX}	Collector-emitter cut-off current $V_{CE} = 60V$, $-V_{BE} = 1.5V$	-	0.25	μA
$-I_{BEX}$	Base current $V_{CE} = 60V$, $-V_{BE} = 1.5V$	-	0.25	μA
$V_{(BR)CBO}$	Collector-base breakdown voltage $I_C = 100\mu A$, $I_E = 0$	60	-	V
$V_{(BR)EBO}$	Emitter-base breakdown voltage $I_E = 100\mu A$, $I_C = 0$	5.0	-	V
	**Collector-emitter breakdown voltage			
$V_{(BR)CEO}$	$I_C = 100\mu A$, $I_B = 0$	40	-	V
$V_{(BR)CER}$	$I_C = 100mA$, $R_{BE} = 10\Omega$	50	-	V

**Pulse test, pulse width = 300μs, duty factor = 1.8%.

†J.E.D.E.C. registered data.

N-P-N SILICON PLANAR TRANSISTOR

2N3053

ELECTRICAL CHARACTERISTICS (cont'd)

		Min.	Max.	
$V_{CE(sat)}$	Collector-emitter saturation voltage $I_C = 150mA$, $I_B = 15mA$	-	1.4	V
$V_{BE(sat)}$	Base-emitter saturation voltage $I_C = 150mA$, $I_B = 15mA$	-	1.7	V
V_{BE}	Base-emitter voltage $I_C = 150mA$, $V_{CE} = 2.5V$	-	1.7	V
h_{FE}	Static forward current transfer ratio			
	$I_C = 150mA$, $V_{CE} = 2.5V$	25	-	
	**$I_C = 150mA$, $V_{CE} = 10V$	50	250	
f_T	Transition frequency $I_C = 50mA$, $V_{CE} = 10V$, $f = 20MHz$	100	-	MHz
C_{ob}	Output capacitance $V_{CB} = 10V$, $I_C = 0$, $f = 140kHz$	-	15	pF
C_{ib}	Input capacitance $V_{EB} = 0.5V$, $I_E = 0$, $f = 140kHz$	-	80	pF

**Pulse test, pulse width = 300μs, duty factor = 1.8%.

N-P-N SILICON DIFFUSED POWER TRANSISTOR

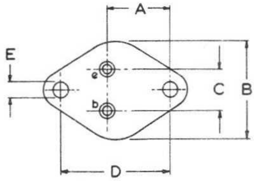
2N3055

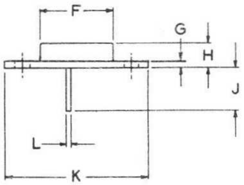
N-P-N silicon diffused power transistor, intended for high quality amplifiers, power supplies, inverters and similar industrial applications.

QUICK REFERENCE DATA		
V_{CBO} max.	100	V
V_{CER} max. ($R_{BE}=100\Omega$)	70	V
I_C max.	15	A
P_{tot} max. ($T_{mb} \leq 25^{\circ}C$)	115	W
T_j max.	200	$^{\circ}C$
h_{FE} ($I_C=4.0A$, $V_{CE}=4.0V$)	20-70	
f_T min. ($I_C=1.0A$, $V_{CE}=4.0V$, $f=1.0MHz$)	0.8	MHz

OUTLINE AND DIMENSIONS

Conforming to B.S. 3934 SO-5A/SB2-2
J.E.D.E.C. TO-3





Millimetres	Min.	Typ.	Max.
A	-	16.9	-
B	-	-	26.6
C	-	10.9	-
D	-	30.1	-
E	4.0	-	4.2
F	-	-	20.3
G	-	0.9	-
H	-	-	9.5
J	11	-	13
K	-	-	39.5
L	-	1.0	-

Collector electrically connected to the envelope

RATINGS

Limiting values of operation according to the absolute maximum system.

Electrical

V_{CBO} max.	100	V
V_{CER} max. ($R_{BE}=100\Omega$)	70	V
V_{EBO} max.	7.0	V
I_C max.	15	A
I_B max.	7.0	A
P_{tot} max. ($T_{mb} \leq 25^{o}C$)	115	W

Temperature

T_{stg} range	-65 to +200	^{o}C
T_j max.	200	^{o}C

THERMAL CHARACTERISTIC

$R_{th(j-mb)}$	1.5	degC/W

ELECTRICAL CHARACTERISTICS ($T_j = 25^{o}C$ unless otherwise stated)

		Min.	Max.	
	Collector cut-off current			
I_{CEO}	$V_{CE}=30V$, $I_B=0$	-	0.7	mA
I_{CEX}	$V_{CE}=100V$, $-V_{BE}=1.5V$	-	5.0	mA
I_{CEX}	$V_{CE}=100V$, $-V_{BE}=1.5V$, $T_j=150^{o}C$	-	10	mA
I_{EBO}	Emitter cut-off current $V_{EB}=7.0V$, $I_C=0$	-	5.0	mA
	Collector-emitter sustaining voltage			
$V_{CEO(sust)}$	$I_C=0.2A$, $I_B=0$	60	-	V
$V_{CER(sust)}$	$I_C=0.2A$, $R_{BE}=100\Omega$	70	-	V
V_{BE}	Base-emitter voltage $I_C=4.0A$, $V_{CE}=4.0V$	-	1.8	V
$V_{CE(sat)}$	Collector-emitter saturation voltage			
	$I_C=4.0A$, $I_B=0.4A$	-	1.1	V
	$I_C=10A$, $I_B=3.3A$	-	4.0	V

ELECTRICAL CHARACTERISTICS (cont'd)

		Min.	Max.	
h_{FE}	Static forward current transfer ratio I_C=4.0A, V_{CE}=4.0V	20	70	
f_T	Transition frequency I_C=1.0A, V_{CE}=4.0V, f=1.0MHz	0.8	-	MHz
h_{fe}	Small signal forward current transfer ratio I_C=1.0A, V_{CE}=4.0V, f=1.0kHz	15	-	

N-P-N SILICON PLANAR EPITAXIAL TRANSISTOR

2N3108

N-P-N silicon planar epitaxial transistor designed primarily for medium speed saturated switching applications for industrial service.

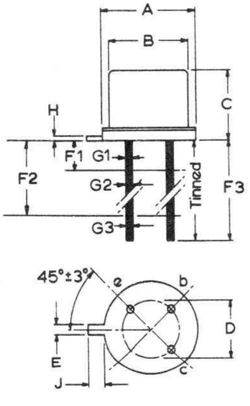
QUICK REFERENCE DATA

V_{CBO} max.	100	V
V_{CEO} max. (I_C = 1.0 to 50mA)	60	V
I_C max.	1.0	A
P_{tot} max. (T_{amb} = 25°C)	800	mW
T_j max.	200	°C
h_{FE} (I_C = 150mA)	40-120	
f_T min. (I_C = 50mA, f = 20MHz)	60	MHz
t_{on} max.	200	ns
t_{off} max.	600	ns

OUTLINE AND DIMENSIONS

Conforms to B.S. 3934 SO-3/SB3-3A

J.E.D.E.C. TO-5



The collector is connected to the envelope

	Millimetres		
	Min.	Nom.	Max.
A	9.10	-	9.39
B	8.2	-	8.50
C	6.15	-	6.60
D	-	5.08	-
E	0.71	-	0.86
F1	-	-	0.51
F2	12.7	-	-
F3	38.1	-	41.3
G1	-	-	1.01
G2	0.41	-	0.48
G3	-	-	0.53
H	-	0.4	-
J	0.74	-	1.01

†RATINGS

Limiting values of operation according to the absolute maximum system.

Electrical

V_{CBO} max.	100	V
V_{CEO} max. (I_C = 1.0 to 50mA)	60	V
V_{EBO} max.	7.0	V
I_C max.	1.0	A
P_{tot} max. (T_{amb} = 25°C)	800	mW

Temperature

T_{stg} min.	-65	°C
T_{stg} max.	200	°C
T_j max.	200	°C
T_{lead} max. (1/16" from case for 60 seconds)	300	°C

†THERMAL CHARACTERISTIC

$\Theta_{j\text{-}amb}$	220	degC/W

†ELECTRICAL CHARACTERISTICS (T_{amb} = 25°C unless otherwise stated)

		Min.	Max.	
I_{CES}	Collector-emitter cut-off current V_{CE} = 60V, V_{EB} = 0	-	10	nA
I_{CBO}	Collector cut-off current V_{CB} = 60V, I_E = 0, T_{amb} = 150°C	-	10	μA
I_{EBO}	Emitter cut-off current V_{EB} = 5.0V, I_C = 0	-	10	nA
$V_{(BR)CBO}$	Collector-base breakdown voltage I_C = 100μA, I_E = 0	100	-	V
$V_{(BR)CEO}$	*Collector-emitter breakdown voltage I_C = 30mA, I_B = 0	60	-	V
$V_{(BR)EBO}$	Emitter-base breakdown voltage I_E = 100μA, I_C = 0	7.0	-	V

†J.E.D.E.C. registered data

*Pulse condition, pulse width = 300μs, duty cycle = 1%.

N-P-N SILICON PLANAR EPITAXIAL TRANSISTOR

2N3108

		Min.	Max.	
$V_{CE(sat)}$	*Collector-emitter saturation voltage			
	I_C=150mA, I_B=15mA	-	0.25	V
	I_C=1000mA, I_B=100mA	-	1.0	V
$V_{BE(sat)}$	*Base-emitter saturation voltage			
	I_C=150mA, I_B=15mA	-	1.1	V
	I_C=1000mA, I_B=100mA	-	2.0	V
h_{FE}	Static forward current transfer ratio			
	I_C=100μA, V_{CE}=10V	20	-	
	*I_C=150mA, V_{CE}=1.0V	40	120	
	*I_C=150mA, V_{CE}=10V, T_{amb}=-55°C	15	-	
	*I_C=500mA, V_{CE}=10V	25	-	
h_{fe}	Small signal forward current transfer ratio I_C=50mA, V_{CE}=10V, f=20MHz	3.0	-	
C_{ob}	Output capacitance V_{CB}=10V, I_E=0, f=140kHz	-	20	pF
C_{ib}	Input capacitance V_{EB}=0.5V, I_C=0, f=140kHz	-	80	pF
N	Noise figure I_C=30μA, V_{CE}=10V, f=1.0kHz, R_s=1.0kΩ, power bandwidth=200Hz	-	7.0	dB

Switching characteristics (see Fig. 1)
Measured at I_C=150mA, I_{Bon}=-I_{Boff}=7.5mA, V_{CE}=20V

		Min.	Max.	
t_{on}	Turn-on time	-	200	ns
t_{off}	Turn-off time	-	600	ns

*Pulse conditions, pulse width=300μs, duty cycle=1%.

TEST CIRCUIT

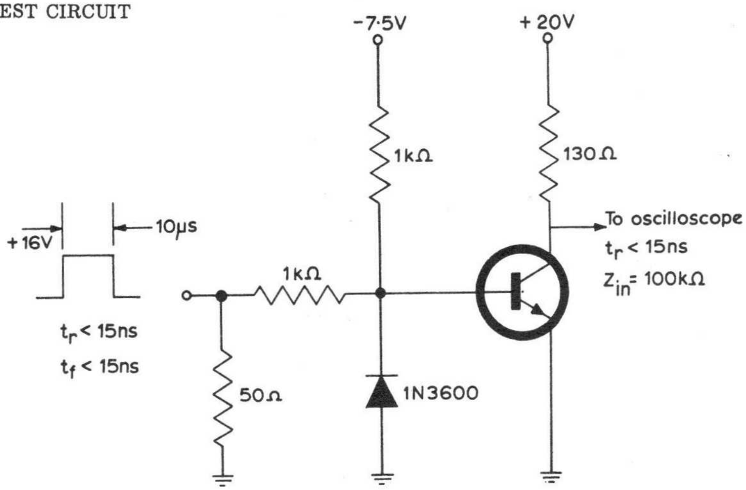
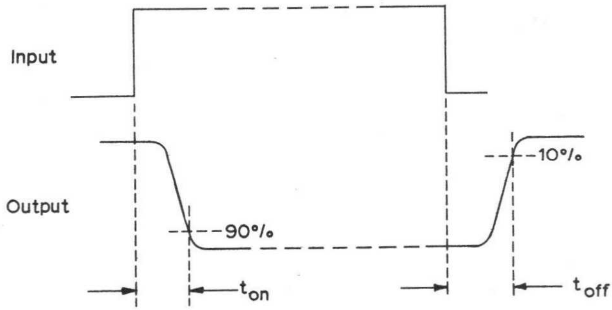


Fig 1.

Waveforms



P-N-P SILICON PLANAR EPITAXIAL TRANSISTOR

2N3133

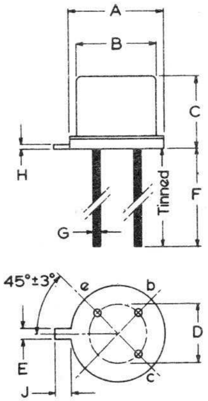
P-N-P silicon planar epitaxial medium power transistor designed primarily for high speed saturated switching applications for industrial service.

QUICK REFERENCE DATA

$-V_{CBO}$ max.	50	V
$-V_{CEO}$ max.	35	V
$-I_C$ max.	600	mA
P_{tot} max. ($T_{amb} = 25^{\circ}C$)	600	mW
T_j max.	200	$^{\circ}C$
h_{FE} ($-I_C = 150mA$)	40-120	
f_T min. ($-I_C = 50mA$, f = 100MHz)	200	MHz
t_{on} max.	75	ns
t_{off} max.	150	ns

OUTLINE AND DIMENSIONS

Conforming to B.S. 3934 SO-3/SB3-3A
J.E.D.E.C. TO-5



	Millimetres		
	Min.	Nom.	Max.
A	8.64	8.90	9.40
B	7.75	8.15	8.50
C	6.10	6.35	6.60
D	-	5.08	-
E	0.71	0.79	0.86
F	38	-	-
G	-	0.45	-
H	-	0.4	-
J	0.74	0.85	1.0

Collector connected to envelope

†RATINGS

Limiting values of operation according to the absolute maximum system.

Electrical

$-V_{CBO}$ max.	50	V
$-V_{CEO}$ max. ($-I_C$ = 0 to 600mA)	35	V
$-V_{EBO}$ max.	4.0	V
$-I_C$ max.	600	mA
P_{tot} max. (T_{amb} = 25°C)	600	mW

Temperature

T_{stg} min.	-65	°C
T_{stg} max.	200	°C
T_j max.	200	°C

†THERMAL CHARACTERISTIC

$\Theta_{j\text{-}amb}$	292	degC/W

†ELECTRICAL CHARACTERISTICS (T_{amb} = 25°C unless otherwise stated)

		Min.	Max.	
$-I_{CBO}$	Collector cut-off current			
	$-V_{CB}$ = 30V, I_E = 0	-	50	nA
	$-V_{CB}$ = 30V, I_E = 0, T_{amb} = 150°C	-	30	μA
$-I_{CEX}$	Collector-emitter cut-off current			
	$-V_{CE}$ = 30V, $+V_{BE}$ = 0.5V	-	0.1	μA
I_{BEX}	Base current			
	$-V_{CE}$ = 30V, $+V_{BE}$ = 0.5V	-	0.1	μA
$-V_{(BR)CBO}$	Collector-base breakdown voltage			
	$-I_C$ = 10μA, I_E = 0	50	-	V
$-V_{(BR)CEO}$	*Collector-emitter breakdown voltage			
	$-I_C$ = 10mA, I_B = 0	35	-	V
$-V_{(BR)EBO}$	Emitter-base breakdown voltage			
	$-I_E$ = 10μA, I_C = 0	4.0	-	V

†J.E.D.E.C. registered data

*Pulse condition, pulse width ≤300μs, duty cycle ≤2%.

P-N-P SILICON PLANAR EPITAXIAL TRANSISTOR

2N3133

		Min.	Max.	
$-V_{CE(sat)}$	*Collector-emitter saturation voltage $-I_C = 150mA$, $-I_B = 15mA$	-	0.6	V
$-V_{BE(sat)}$	*Base-emitter saturation voltage $-I_C = 150mA$, $-I_B = 15mA$	-	1.5	V
h_{FE}	*Static forward current transfer ratio			
	$-I_C = 1.0mA$, $-V_{CE} = 10V$	25	-	
	$-I_C = 150mA$, $-V_{CE} = 1.0V$	10	-	
	$-I_C = 150mA$, $-V_{CE} = 10V$	40	120	
c_{ob}	Common base, open circuit output capacitance $-V_{CB} = 10V$, $I_E = 0$, $f = 100kHz$	-	10	pF
c_{ib}	Common base, open circuit input capacitance $+V_{BE} = 2.0V$, $I_C = 0$, $f = 100KHz$	-	40	pF
f_T	Transition frequency $-I_C = 50mA$, $-V_{CE} = 20V$, $f = 100MHz$	200	-	MHz

*Pulse conditions, pulse width $\leq 300\mu s$, duty cycle $\leq 2\%$.

Switching characteristics

		Min.	Max.	
t_{on}	Turn-on time (see fig.1) $-V_{CC} = 30V$, $V_{BE(off)} = 0$, $-I_{CS} = 150mA$, $-I_B = 15mA$	-	75	ns
t_{off}	Turn-off time (see fig.2) $-V_{CC} = 6.0V$, $-I_{CS} = 150mA$, $-I_B = +I_{BM} = 15mA$	-	150	ns

Test circuits

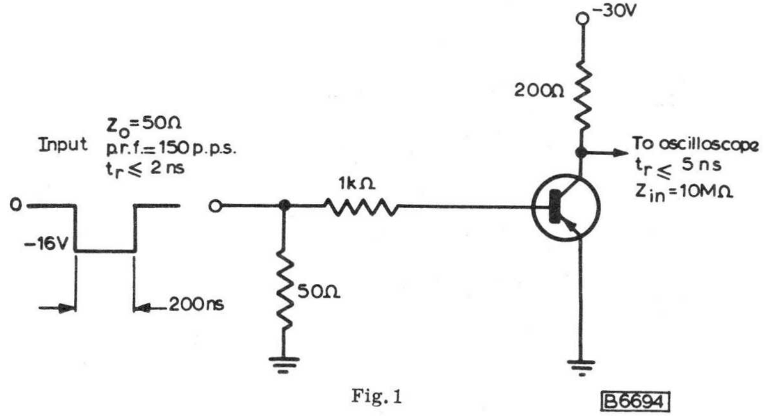


Fig. 1

Test circuit for determining turn-on time

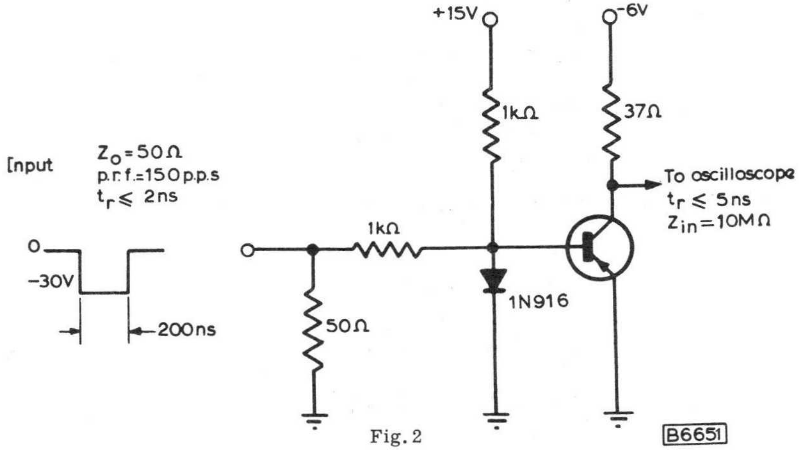


Fig. 2

Test circuit for determining turn-off time

Waveforms

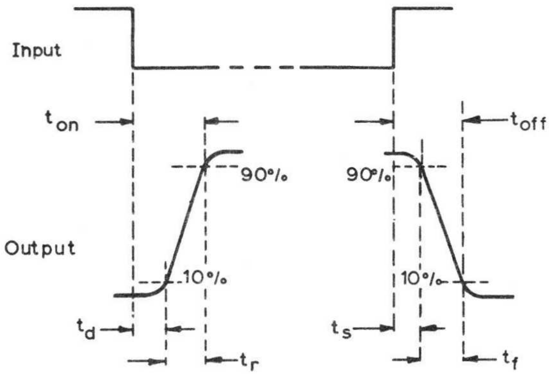
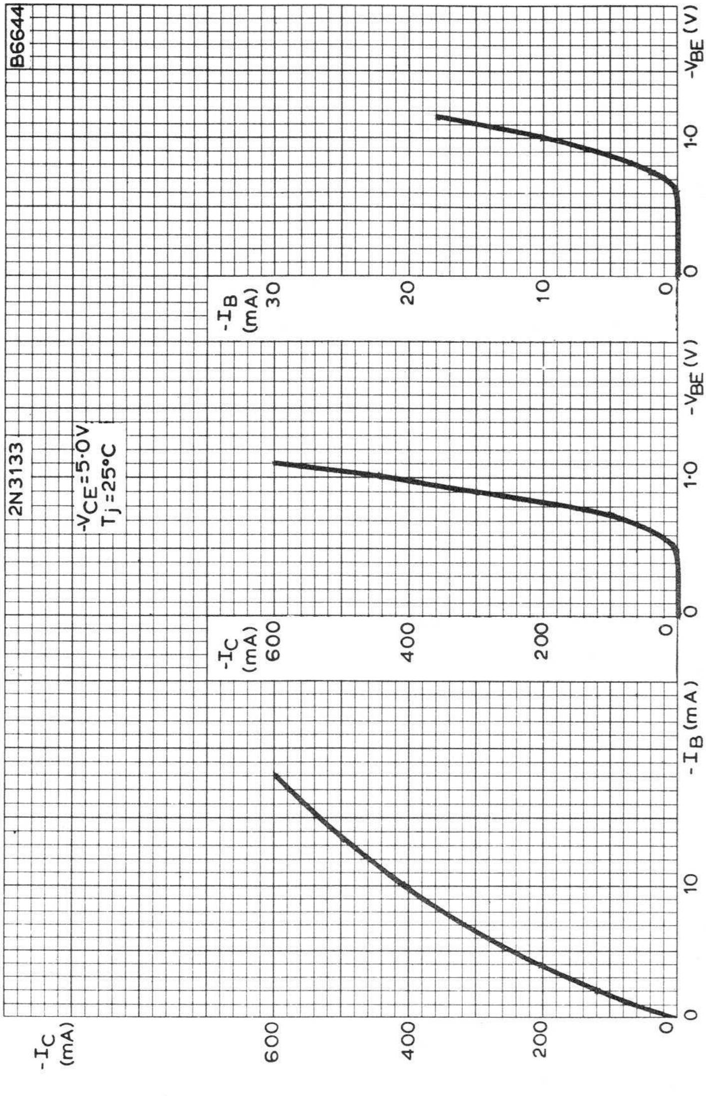


Fig. 3

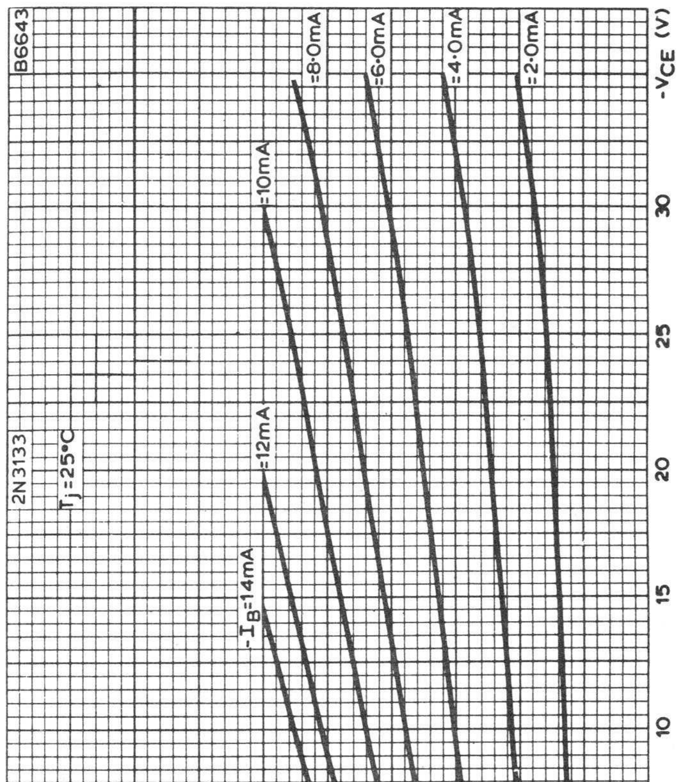
B6655

P-N-P SILICON PLANAR EPITAXIAL TRANSISTOR

2N3133



TYPICAL TRANSFER, MUTUAL AND INPUT CHARACTERISTICS



TYPICAL OUTPUT CHARACTERISTICS

P-N-P SILICON PLANAR EPITAXIAL TRANSISTOR

2N3134

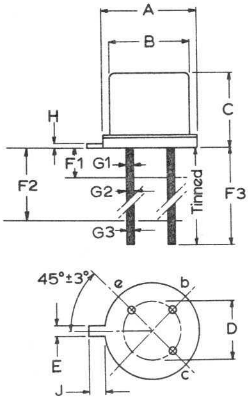
P-N-P silicon planar epitaxial medium power transistor designed primarily for high speed saturated switching applications for industrial service.

QUICK REFERENCE DATA

$-V_{CBO}$ max.	50	V
$-V_{CEO}$ max.	35	V
$-I_C$ max.	600	mA
P_{tot} max. ($T_{amb} = 25^oC$)	600	mW
T_j max.	200	^oC
h_{FE} ($-I_C = 150mA$, $-V_{CE} = 10V$)	100-300	
f_T min. ($-I_C = 50mA$, $f = 100MHz$)	200	MHz
t_{on} max.	75	ns
t_{off} max.	150	ns

OUTLINE AND DIMENSIONS

Conforming to B.S. 3934 SO-3/SB3-3A
J.E.D.E.C. TO-5



Millimetres	Min.	Typ.	Max.
A	9.10	-	9.39
B	8.2	-	8.50
C	6.15	-	6.60
D	-	5.08	-
E	0.71	-	0.86
F1	-	-	0.51
F2	12.7	-	-
F3	38.1	-	41.3
G1	-	-	1.01
G2	0.41	-	0.48
G3	-	-	0.53
H	-	0.4	-
J	0.74	-	1.01

Collector connected to envelope

†RATINGS

Limiting values of operation according to the absolute maximum system.

Electrical

$-V_{CBO}$ max.	50	V
$-V_{CEO}$ max. ($-I_C$ = 0 to 600mA)	35	V
$-V_{EBO}$ max.	4.0	V
$-I_C$ max.	600	mA
P_{tot} max. (T_{amb} = 25°C)	600	mW

Temperature

T_{stg} min.	-65	°C
T_{stg} max.	200	°C
T_j max.	200	°C

†THERMAL CHARACTERISTIC

θ_{j-amb}	290	degC/W

†ELECTRICAL CHARACTERISTICS (T_{amb} = 25°C unless otherwise stated)

		Min.	Max.	
$-I_{CBO}$	Collector cut-off current $-V_{CB}$ = 30V, I_E = 0	-	0.05	µA
	$-V_{CB}$ = 30V, I_E = 0, T_{amb} = 150°C	-	30	µA
$-I_{CEX}$	Collector cut-off current $-V_{CE}$ = 30V, $+V_{BE}$ = 0.5V	-	0.1	µA
I_{BEX}	Base current $-V_{CE}$ = 30V, $+V_{BE}$ = 0.5V	-	0.1	µA
$-V_{(BR)CBO}$	Collector-base breakdown voltage $-I_C$ = 10µA, I_E = 0	50	-	V
$-V_{(BR)CEO}$	*Collector-emitter breakdown voltage $-I_C$ = 10mA, I_B = 0	35	-	V
$-V_{(BR)EBO}$	Emitter-base breakdown voltage $-I_E$ = 10µA, I_C = 0	4.0	-	V

†J.E.D.E.C. registered data

*Pulse condition, pulse width ≤300µs, duty cycle ≤2%.

P-N-P SILICON PLANAR EPITAXIAL TRANSISTOR

2N3134

		Min.	Max.	
$-V_{CE(sat)}$	*Collector-emitter saturation voltage $-I_C = 150mA$, $-I_B = 15mA$	-	0.6	V
$-V_{BE(sat)}$	*Base-emitter saturation voltage $-I_C = 150mA$, $-I_B = 15mA$	-	1.5	V
h_{FE}	*Static forward current transfer ratio			
	$-I_C = 1.0mA$, $-V_{CE} = 10V$	50	-	
	$-I_C = 150mA$, $-V_{CE} = 1.0V$	25	-	
	$-I_C = 150mA$, $-V_{CE} = 10V$	100	300	
C_{ob}	Common base, open circuit output capacitance $-V_{CB} = 10V$, $I_E = 0$, $f = 100kHz$	-	10	pF
C_{ib}	Common base, open circuit input capacitance $+V_{BE} = 2.0V$, $I_C = 0$, $f = 100kHz$	-	40	pF
f_T	Transition frequency $-I_C = 50mA$, $-V_{CE} = 20V$, $f = 100MHz$	200	-	MHz
Switching characteristics				
t_{on}	Turn-on time (see fig.1) $-V_{CC} = 30V$, $-I_{CS} = 150mA$, $-I_B = 15mA$, $V_{BE(off)} = 0$	-	75	ns
t_{off}	Turn-off time (see fig.2) $-V_{CC} = 6.0V$, $-I_{CS} = 150mA$, $-I_B = +I_{BM} = 15mA$	-	150	ns

*Pulse conditions, pulse width $\leq 300\mu s$, duty cycle $\leq 2\%$.

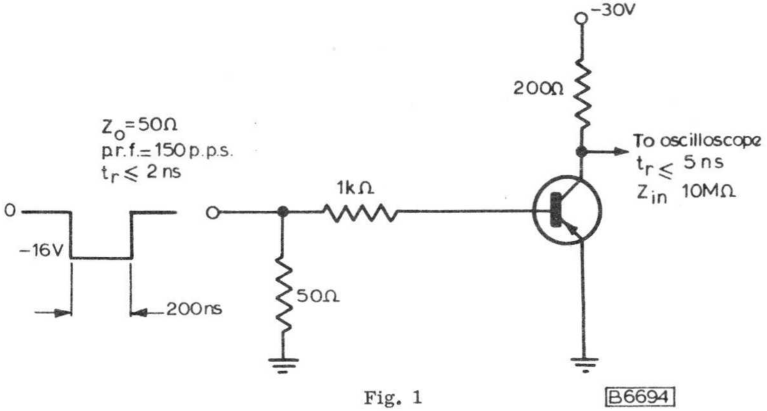


Fig. 1

Test circuit for determining turn-on time

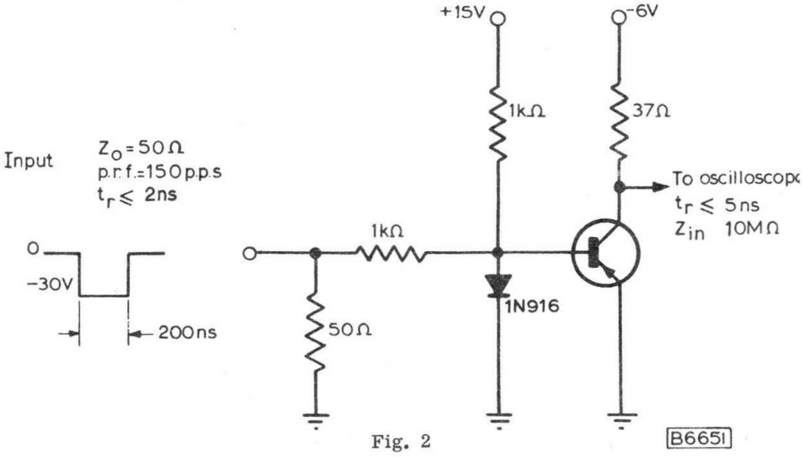


Fig. 2

Test circuit for determining turn-off time

WAVEFORMS

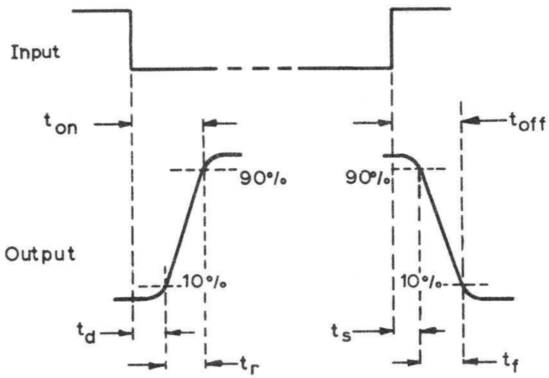


Fig. 3

B6655

P-N-P SILICON PLANAR EPITAXIAL TRANSISTORS

2N3135 2N3136

P-N-P silicon planar epitaxial transistors designed primarily for high speed saturated switching applications for industrial service.

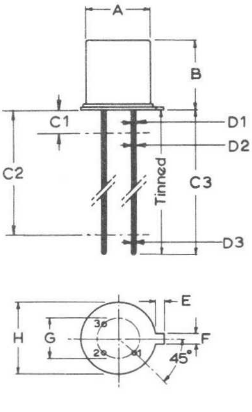
QUICK REFERENCE DATA

	2N3135	2N3136	
$-V_{CBO}$ max.	50		V
$-V_{CEO}$ max.	35		V
$-I_C$ max.	600		mA
P_{tot} max.	400		mW
T_j max.	200		^oC
h_{FE} ($-I_C$ = 150mA, $-V_{CE}$ = 10V)	40-120	100-300	
f_T min. ($-I_C$ = 50mA, f = 100MHz)	200		MHz
t_{on} max.	75		ns
t_{off} max.	150		ns

Unless otherwise stated data is applicable to both types.

OUTLINE AND DIMENSIONS

Conforms to B.S. 3934 SO-12A/SB3-6A
J.E.D.E.C. TO-18



Viewed from underside

Millimetres

	Min.	Nom.	Max.
A	4.53	-	4.8
B	4.66	-	5.33
C1	-	-	0.51
C2	12.7	-	-
C3	12.7	-	15
D1	-	-	1.01
D2	0.41	-	0.48
D3	-	-	0.53
E	0.84	-	1.17
F	0.92	-	1.16
G	-	2.54	-
H	5.31	-	5.84

Connections
1. Emitter
2. Base
3. Collector connected to envelope

†RATINGS

Limiting values of operation according to the absolute maximum system.

Electrical

$-V_{CBO}$ max.	50	V
$-V_{CEO}$ max. ($-I_C$ = 0 to 600mA)	35	V
$-V_{EBO}$ max.	4.0	V
$-I_C$ max.	600	mA
P_{tot} max. (T_{amb} = 25°C)	400	mW

Temperature

T_{stg} min.	-65	°C
T_{stg} max.	200	°C
T_j max.	200	°C

†THERMAL CHARACTERISTIC

Θ_{j-amb}	0.44	degC/mW

†ELECTRICAL CHARACTERISTICS (T_{amb} = 25°C unless otherwise stated)

		Min.	Max.	
$-I_{CBO}$	Collector cut-off current $-V_{CB}$ = 30V, I_E = 0	-	0.05	µA
	$-V_{CB}$ = 30V, I_E = 0, T_{amb} = 150°C	-	30	µA
$-I_{CEX}$	Collector cut-off current $-V_{CE}$ = 30V, $+V_{BE}$ = 0.5V	-	0.1	µA
I_{BEX}	Base current $-V_{CE}$ = 30V, $+V_{BE}$ = 0.5V	-	0.1	µA
$-V_{(BR)CBO}$	Collector-base breakdown voltage $-I_C$ = 10µA, I_E = 0	50	-	V
$-V_{(BR)CEO}$	*Collector-emitter breakdown voltage $-I_C$ = 10mA, I_B = 0	35	-	V
$-V_{(BR)EBO}$	Emitter-base breakdown voltage $-I_E$ = 10µA, I_C = 0	4.0	-	V

†J.E.D.E.C. registered data

*Pulse condition, pulse width≤300µs, duty cycle≤2%.

ELECTRICAL CHARACTERISTICS (cont'd)

Symbol	Parameter	Conditions	Type	Min.	Max.	Unit
$-V_{CE(sat)}$	*Collector-emitter saturation voltage	$-I_C = 150mA$, $-I_B = 15mA$		-	0.6	V
$-V_{BE(sat)}$	*Base-emitter saturation voltage	$-I_C = 150mA$, $-I_B = 15mA$		-	1.5	V
h_{FE}	*Static forward current transfer ratio	$-I_C = 1.0mA$, $-V_{CE} = 10V$	2N3135	25	-	
			2N3136	50	-	
		$-I_C = 150mA$, $-V_{CE} = 1.0V$	2N3135	10	-	
			2N3136	25	-	
		$-I_C = 150mA$, $-V_{CE} = 10V$	2N3135	40	120	
			2N3136	100	300	
C_{ob}	Common base, open circuit output capacitance	$-V_{CB} = 10V$, $I_E = 0$, f = 100kHz		-	10	pF
C_{ib}	Common base, open circuit input capacitance	$+V_{BE} = 2.0V$, $I_C = 0$, f = 100kHz		-	40	pF
f_T	Transition frequency	$-I_C = 50mA$, $-V_{CE} = 20V$, f = 100MHz		200	-	MHz

Switching characteristics

Symbol	Parameter	Conditions	Min.	Max.	Unit
t_{on}	Turn-on time (see fig. 1)	$-V_{CC} = 30V$, $-I_{CS} = 150mA$, $-I_B = 15mA$, $V_{BEoff} = 0$	-	75	ns
t_{off}	Turn-off time (see fig. 2)	$-V_{CC} = 6.0V$, $-I_{CS} = 150mA$, $-I_B = +I_{BM} = 15mA$	-	150	ns

*pulse condition, pulse width ≤ 300 μs, duty cycle ≤ 2%.

TEST CIRCUITS

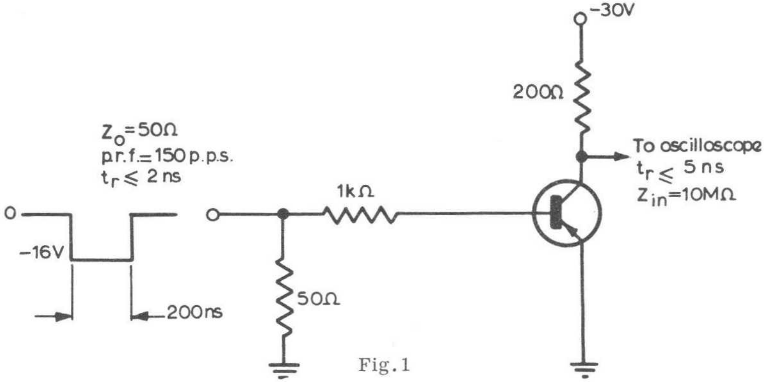


Fig.1

Test circuit for determining turn-on time

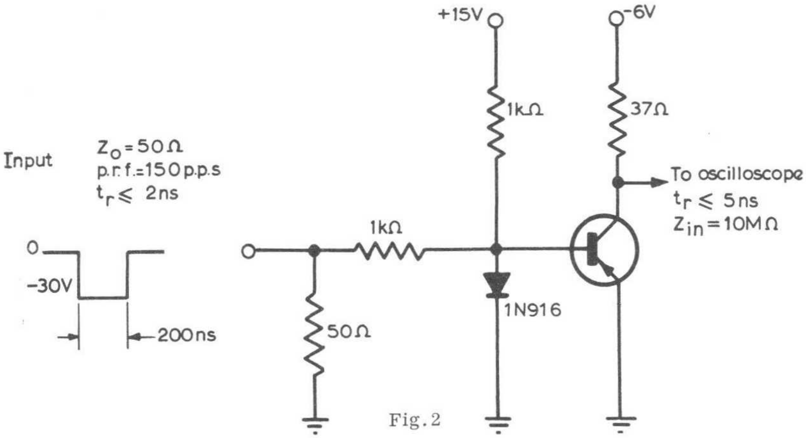


Fig.2

Test circuit for determining turn-off time

WAVEFORMS

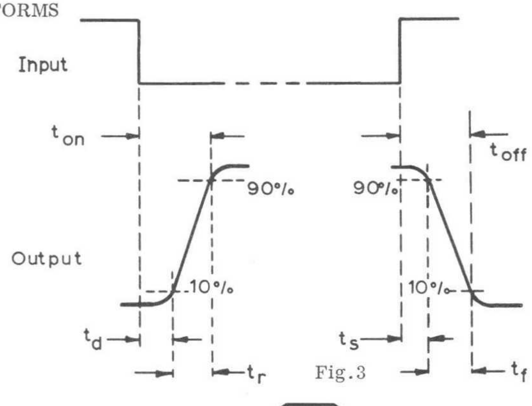


Fig.3

P-N-P SILICON PLANAR EPITAXIAL TRANSISTORS

2N3250 2N3250A

P-N-P silicon planar epitaxial, medium power transistors designed primarily for high speed saturated switching applications for industrial service.

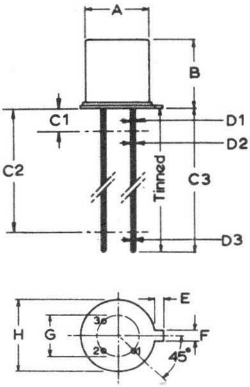
QUICK REFERENCE DATA

	2N3250		2N3250A	
$-V_{CBO}$ max.	50		60	V
$-V_{CEO}$ max.	40		60	V
$-I_C$ max.		200		mA
P_{tot} max. (T_{amb} = 25°C)		360		mW
h_{FE} ($-V_{CE}$ = 1.0V, $-I_C$ = 10mA)		50-150		
f_T min. ($-I_C$ = 10mA, f = 100MHz)		250		MHz
t_s max. ($-I_{CS}$ = 10mA, $-I_B$ = $+I_{BM}$ = 1.0mA)		175		ns

Unless otherwise stated data is applicable to both types

OUTLINE AND DIMENSIONS

Conforming to B.S. 3934 SO-12A/SB3-6A
J.E.D.E.C. TO-18



Viewed from underside

	Millimetres Min.	Typ.	Max.
A	4.53	-	4.8
B	4.66	-	5.33
C1	-	-	0.51
C2	12.7	-	-
C3	12.7	-	15
D1	-	-	1.01
D2	0.41	-	0.48
D3	-	-	0.53
E	0.84	-	1.17
F	0.92	-	1.16
G	-	2.54	-
H	5.31	-	5.84

Connections 1. Emitter 3. Collector connected to envelope
2. Base

†RATINGS

Limiting values of operation according to the absolute maximum system.

Electrical

	2N3250		2N3250A	
$-V_{CBO}$ max.	50		60	V
$-V_{CEO}$ max. ($-I_C$ =0 to 200mA)	40		60	V
$-V_{EBO}$ max.		5.0		V
$-I_C$ max. (d.c.)		200		mA
P_{tot} max. (T_{amb} = 25°C)		360		mW

Temperature

T_{stg} min.	-65	°C
T_{stg} max.	200	°C
T_j max.	200	°C
T_{lead} max. (1/16" from case for 60 seconds)	300	°C

†THERMAL DERATING FACTOR

Junction to ambient (T_{amb} = 25°C)	2.06	mW/deg C

†ELECTRICAL CHARACTERISTICS (T_{amb} = 25°C unless otherwise stated)

			Min.	Max.	
$-I_{CEX}$	Collector-emitter cut-off current $-V_{CE}$ = 40V, $+V_{BE}$ = 3.0V		-	20	nA
I_{BEX}	Base current $-V_{CE}$ = 40V, $+V_{BE}$ = 3.0V		-	50	nA
$-V_{(BR)CBO}$	Collector-base breakdown voltage $-I_C$ = 10μA, I_E = 0	2N3250	50	-	V
		2N3250A	60	-	V
$-V_{(BR)CEO}$	*Collector-emitter breakdown voltage $-I_C$ = 10mA, I_B = 0	2N3250	40	-	V
		2N3250A	60	-	V
$-V_{(BR)EBO}$	Emitter-base breakdown voltage $-I_E$ = 10μA, I_C = 0		5.0	-	V

*Pulse condition, pulse width = 300μs, duty cycle = 2%

†J.E.D.E.C. registered data

		Min.	Max.	
$-V_{CE(sat)}$	*Collector-emitter saturation voltage			
	$-I_C = 10mA$, $-I_B = 1.0mA$	-	0.25	V
	$-I_C = 50mA$, $-I_B = 5.0mA$	-	0.5	V
$-V_{BE(sat)}$	*Base-emitter saturation voltage			
	$-I_C = 10mA$, $-I_B = 1.0mA$	0.6	0.9	V
	$-I_C = 50mA$, $-I_B = 5.0mA$	-	1.2	V
h_{FE}	*Static forward current transfer ratio			
	$-I_C = 0.1mA$, $-V_{CE} = 1.0V$	40	-	
	$-I_C = 1.0mA$, $-V_{CE} = 1.0V$	45	-	
	$-I_C = 10mA$, $-V_{CE} = 1.0V$	50	150	
	$-I_C = 50mA$, $-V_{CE} = 1.0V$	15	-	
C_{ob}	Common base, open circuit output capacitance			
	$-V_{CB} = 10V$, $I_E = 0$, $f = 100kHz$	-	6.0	pF
C_{ib}	Common base, open circuit input capacitance			
	$+V_{BE} = 1.0V$, $I_C = 0$, $f = 100kHz$	-	8.0	pF
f_T	Transition frequency			
	$-I_C = 10mA$, $-V_{CE} = 20V$			
	$f = 100MHz$	250	-	MHz
r'_bC_c	Collector-base time constant			
	$-I_C = 10mA$, $-V_{CE} = 20V$,			
	$f = 31.8MHz$	-	250	ps
N	Noise figure			
	$-I_C = 100\mu A$, $-V_{CE} = 5.0V$,			
	$R_g = 1.0k\Omega$, $f = 100Hz$	-	6.0	dB

*Pulse condition, pulse width = 300μs, duty cycle = 2%

h-parameters

Measured at $-I_C = 1.0mA$, $-V_{CE} = 10V$, $f = 1.0kHz$

		Min.	Max.	
h_{fe}	Small signal forward current transfer ratio	50	200	
h_{re}	Voltage feedback ratio	-	10	$\times 10^{-4}$
h_{ie}	Input impedance	1.0	6.0	kΩ
h_{oe}	Output admittance	4.0	40	µmho

Switching characteristics

Turn-on (see Fig.1 and 3)

$-V_{CC} = 3.0V$, $+V_{BE} = 0.5V$, $-I_{CS} = 10mA$, $-I_B = 1.0mA$

t_d	Turn-on delay time	-	35	ns
t_r	Rise time	-	35	ns

Turn-off (see Fig.2 and 3)

$-V_{CC} = 3.0V$, $-I_{CS} = 10mA$, $-I_B = +I_{BM} = 1.0mA$

t_s	Storage time	-	175	ns
t_f	Fall time		50	ns

TEST CIRCUITS

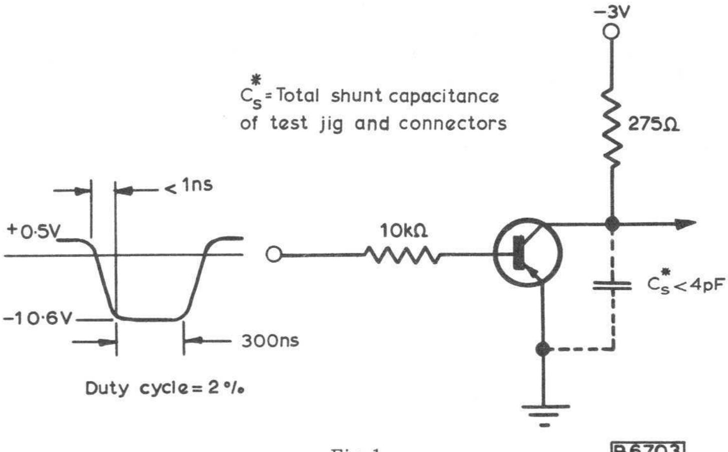


Fig. 1

Test circuit for determining delay and rise time

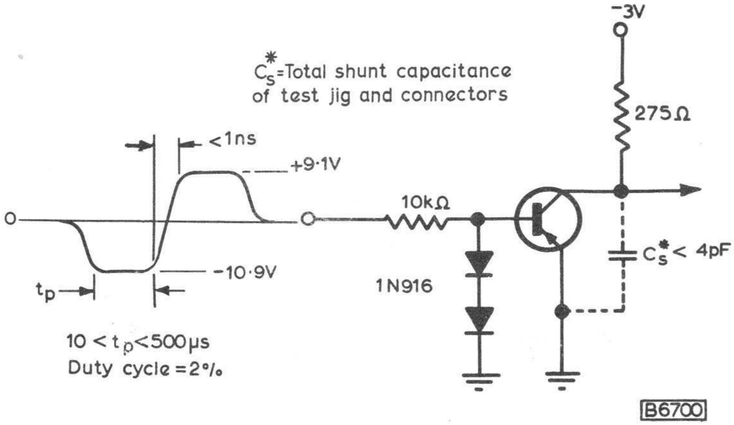


Fig. 2

Test circuit for determining storage and fall time

WAVEFORMS

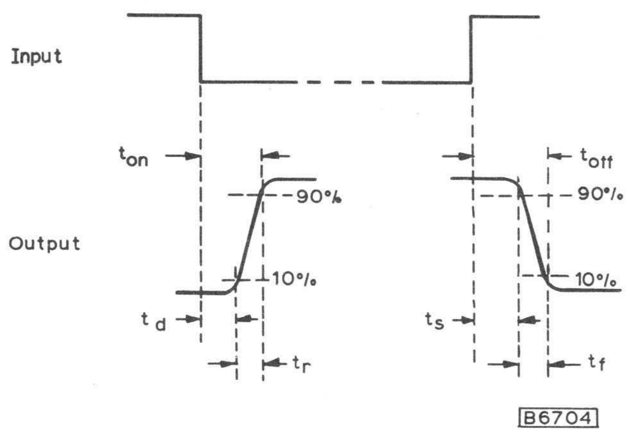


Fig. 3

P-N-P SILICON PLANAR EPITAXIAL TRANSISTORS

2N3251 2N3251A

P-N-P silicon planar epitaxial, medium power transistors designed primarily for high speed saturated switching applications for industrial service.

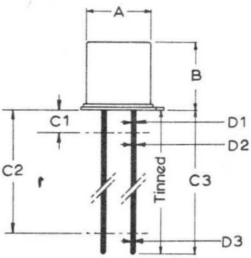
QUICK REFERENCE DATA

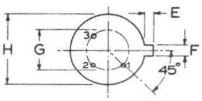
	2N3251		2N3251A	
$-V_{CBO}$ max.	50		60	V
$-V_{CEO}$ max.	40		60	V
$-I_C$ max.		200		mA
P_{tot} max. ($T_{amb} = 25^oC$)		360		mW
h_{FE} ($-V_{CE} = 1.0V$, $-I_C = 10mA$)		100-300		
f_T min. ($-I_C = 10mA$, $f = 100MHz$)		300		MHz
t_s max. ($-I_{CS} = 10mA$, $-I_B = +I_{BM} = 1.0mA$)		200		ns

Unless otherwise stated data is applicable to both types

OUTLINE AND DIMENSIONS

Conforming to B.S. 3934 SO-12A/SB3-6A
J.E.D.E.C. TO-18





Viewed from underside

	Millimetres Min.	Typ.	Max.
A	4.53	-	4.8
B	4.66	-	5.33
C1	-	-	0.51
C2	12.7	-	-
C3	12.7	-	15
D1	-	-	1.01
D2	0.41	-	0.48
D3	-	-	0.53
E	0.84	-	1.17
F	0.92	-	1.16
G	-	2.54	-
H	5.31	-	5.84

Connections 1. Emitter 3. Collector connected to envelope
2. Base

† RATINGS

Limiting values of operation according to the absolute maximum system.

Electrical

	2N3251		2N3251A	
$-V_{CBO}$ max.	50		60	V
$-V_{CEO}$ max. ($-I_C$ = 0 to 200mA)	40		60	V
$-V_{EBO}$ max.		5.0		V
$-I_C$ max. (d.c.)		200		mA
P_{tot} max. (T_{amb} = 25°C)		360		mW

Temperature

T_{stg} min.	-65	°C
T_{stg} max.	200	°C
T_j max.	200	°C
T_{lead} max. (1/16" from case for 60 seconds)	300	°C

† THERMAL DERATING FACTOR

Junction to ambient (T_{amb} = 25°C)	2.06	mW/deg C

† ELECTRICAL CHARACTERISTICS (T_{amb} = 25°C unless otherwise stated)

			Min.	Max.	
$-I_{CEX}$	Collector-emitter cut-off current $-V_{CE}$ = 40V, $+V_{BE}$ = 3.0V		-	20	nA
I_{BEX}	Base current $-V_{CE}$ = 40V, $+V_{BE}$ = 3.0V		-	50	nA
$-V_{(BR)CBO}$	Collector-base breakdown voltage $-I_C$ = 10μA, I_E = 0	2N3251	50	-	V
		2N3251A	60	-	V
$-V_{(BR)CEO}$	*Collector-emitter breakdown voltage $-I_C$ = 10mA, I_B = 0	2N3251	40	-	V
		2N3251A	60	-	V
$-V_{(BR)EBO}$	Emitter-base breakdown voltage $-I_E$ = 10μA, I_C = 0		5.0	-	V

*Pulse condition, pulse width = 300μs, duty cycle = 2%

†J.E.D.E.C. registered data

P-N-P SILICON PLANAR EPITAXIAL TRANSISTORS

2N3251 2N3251A

Symbol	Parameter	Min.	Max.	Unit
$-V_{CE(sat)}$	*Collector-emitter saturation voltage			
	$-I_C = 10mA$, $-I_B$ 1.0mA	-	0.25	V
	$-I_C = 50mA$, $-I_B = 5.0mA$	-	0.5	V
$-V_{BE(sat)}$	*Base-emitter saturation voltage			
	$-I_C = 10mA$, $-I_B = 1.0mA$	0.6	0.9	V
	$-I_C = 50mA$, $-I_B = 5.0mA$	-	1.2	V
h_{FE}	*Static forward current transfer ratio			
	$-I_C = 0.1mA$, $-V_{CE} = 1.0V$	80	-	
	$-I_C = 1.0mA$, $-V_{CE} = 1.0V$	90	-	
	$-I_C = 10mA$, $-V_{CE} = 1.0V$	100	300	
	$-I_C = 50mA$, $-V_{CE} = 1.0V$	30		
C_{ob}	Common base, open circuit output capacitance			
	$-V_{CB} = 10V$, $I_E = 0$, $f = 100kHz$	-	6.0	pF
C_{ib}	Common base, open circuit input capacitance			
	$+V_{BE} = 1.0V$, $I_C = 0$, $f = 100kHz$	-	8.0	pF
f_T	Transition frequency			
	$-I_C = 10mA$, $-V_{CE} = 20V$			
	$f = 100MHz$	300	-	MHz
$r'_b C_c$	Collector-base time constant			
	$-I_C = 10mA$, $-V_{CE} = 20V$,			
	$f = 31.8MHz$	-	250	ps
N	Noise figure			
	$-I_C = 100\mu A$, $-V_{CE} = 5.0V$,			
	$R_g = 1.0k\Omega$, $f = 100Hz$	-	6.0	dB

*Pulse condition, pulse width = 300μs, duty cycle = 2%

h-parameters

Measured at $-I_C = 1.0mA$, $-V_{CE} = 10V$, $f = 1.0kHz$

		Min.	Max.	
h_{fe}	Small signal forward current transfer ratio	100	400	
h_{re}	Voltage feedback ratio	-	20	$\times 10^{-4}$
h_{ie}	Input impedance	2.0	12	kΩ
h_{oe}	Output admittance	10	60	μmho

Switching characteristics

Turn-on (see Fig.1 and 3)

$-V_{CC} = 3.0V$, $+V_{BE} = 0.5V$, $-I_{CS} = 10mA$, $-I_B = 1.0mA$

t_d	Turn-on delay time	-	35	ns
t_r	Rise time	-	35	ns

Turn-off (see Fig.2 and 3)

$-V_{CC} = 3.0V$, $-I_{CS} = 10mA$, $-I_B = +I_{BM} = 1.0mA$

t_s	Storage time	-	200	ns
t_f	Fall time	-	50	ns

TEST CIRCUITS

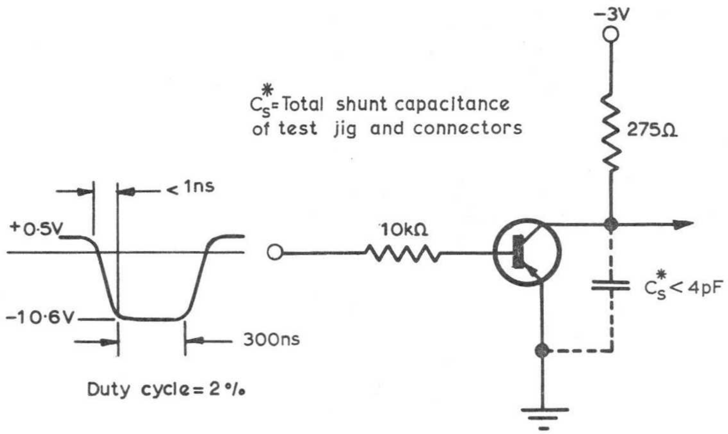


Fig.1

B6703

Test circuit for determining delay and rise time

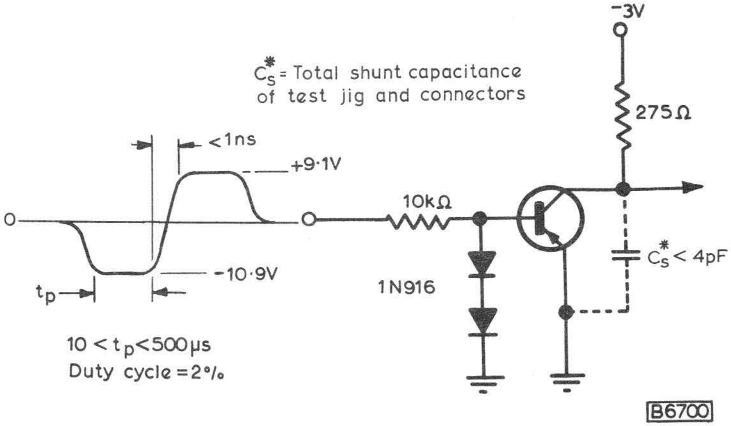


Fig. 2

Test circuit for determining storage and fall time

WAVEFORMS

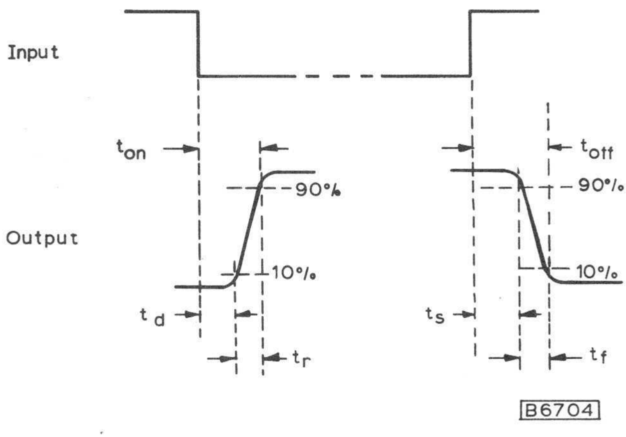


Fig. 3

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

2N3375 2N3553 2N3632

The 2N3553, 2N3375, and 2N3632 are silicon power transistors. The 2N3553 and 2N3375 are designed for v.h.f./u.h.f. application and the 2N3632 for v.h.f. application in industrial and military transmitting equipment.

QUICK REFERENCE DATA

	2N3553	2N3375	2N3632	
V_{CBO} max.	65	65	65	V
V_{CEO} max.	40	40	40	V
I_{CM} max.	1.0	1.5	3.0	A
P_{tot} max. ($T_{mb} \leqslant 25°C$)	7.0	11.6	23	W
T_j max. (operating)	200	200	200	°C
f_T typ.	500	500	400	MHz
Output power at $V_{CE} = 28V$, common emitter				
P_{out} min. ($P_{in} = 0.25W$, f = 175MHz)	2.5	—	—	W
P_{out} min. ($P_{in} = 1.0W$, f = 100MHz)	—	7.5	—	W
P_{out} min. ($P_{in} = 1.0W$, f = 400MHz)	—	3.0	—	W
P_{out} min. ($P_{in} = 3.5W$, f = 175MHz)	—	—	13.5	W

OUTLINE AND DIMENSIONS

For details see page D4.

2N3553 Conforms to J.E.D.E.C. TO-39, B.S. 3934 SO-3/SB3-3B
2N3375 and 2N3632 Conform to J.E.D.E.C. TO-60

RATINGS

Limiting values of operation according to the absolute maximum system.

Electrical

	2N3553	2N3375	2N3632	
V_{CBO} max.	65	65	65	V
V_{CEO} max.	40	40	40	V
V_{EBO} max.	4.0	4.0	4.0	V
I_C max.	0.35	0.5	1.0	A
I_{CM} max.	1.0	1.5	3.0	A
*P_{tot} max.($T_{mb} \leqslant 25°C$)	7.0	11.6	23	W

Temperature

T_{stg} min.	−65	°C
T_{stg} max.	+200	°C
T_j max. (operating)	+200	°C

*See safe operation area curves on pages C1 and C2

THERMAL CHARACTERISTICS

	2N3553	2N3375	2N3632	
θ_{j-mb}	25	15	7.5	degC/W
θ_{mb-h}	—	0.6	0.6	degC/W
θ_{mb-h} (mounted with top clamping washer of accessory 56218)	1.0	—	—	degC/W
θ_{mb-h} (mounted with top clamping washer of accessory 56218 and a Boron nitride washer for electrical insulation)	1.2	—	—	degC/W

ELECTRICAL CHARACTERISTICS ($T_j = 25°C$)

		2N3553	2N3375	2N3632	
$V_{(BR)CBO}$ min.	Collector-base breakdown voltage $I_C = 250\mu A$, $I_E = 0$	65	65	65	V
$V_{(BR)CEX}$ min.**	Collector-emitter breakdown voltage $I_C = 0$ to 200mA, $V_{EB} = 1.5V$, $R_B = 33\Omega$	65	65	65	V
$V_{(BR)CEO}$ min.**	$I_C = 0$ to 200mA, $I_B = 0$	40	40	40	V
$V_{(BR)EBO}$ min.	Emitter-base breakdown voltage $I_E = 250\mu A$, $I_C = 0$	4.0	4.0	4.0	V
I_{CEO} max.	Collector cut-off current $V_{CE} = 30V$, $I_B = 0$	100	100	250	μA
h_{FE}	Large signal forward current transfer ratio				
	$I_C = 125mA$, $V_{CE} = 5.0V$ min.	15	15	—	
	max.	200	200	—	
	$I_C = 250mA$, $V_{CE} = 5.0V$ min.	10	10	10	
	max.	100	100	150	
	$I_C = 1000mA$, $V_{CE} = 5.0V$ min.	—	—	5	
	max.	—	—	110	

**Pulsed through an inductor (25mH); $\delta = 0.5$; f = 50Hz.

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

2N3375 2N3553 2N3632

ELECTRICAL CHARACTERISTICS ($T_j = 25°C$)

		2N3553	2N3375	2N3632	
V_{BE}	Base-Emitter Voltage (max.)				
	$I_C = 250mA, V_{CE} = 5V$	1.5	—	—	V
	$I_C = 500mA, V_{CE} = 5V$	—	1.5	—	V
	$I_C = 1000mA, V_{CE} = 5V$	—	—	1.5	V
$V_{CE(Sat)}$	Collector-emitter saturation voltage (max.)				
	$I_C = 250mA, I_B = 50mA$	1.0	—	—	V
	$I_C = 500mA, I_B = 100mA$	—	1.0	—	V
	$I_C = 1000mA, I_B = 200mA$	—	—	1.0	V
f_T typ.	Transition frequency				
	$V_{CE} = 28V, I_C = 125mA$	500	500	—	MHz
	$= 500mA$	—	—	400	MHz
C_{tc}	Collector capacitance				
	$V_{CB} = 28V, I_E = I_e = 0, f = 1MHz$ (max.)	10	10	20	pF
C_C	Collector-case capacitance (max.)	—	6.0	6.0	pF
$R_{e(hie)}$	Real part of input impedance				
	$f = 200MHz, I_C = 125mA, V_{CE} = 28V$ (max.)	20	20	—	Ω
	$f = 200MHz, I_C = 250mA, V_{CE} = 28V$ (max.)	—	—	20	Ω

R.F. Performance

in un-neutralised common emitter amplifier

$V_{CE} = 28V$

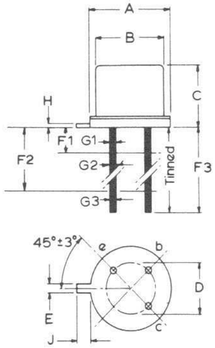
Type	Freq.	Power out	Power in	I_C	η	Circuit No,
2N3553	175MHz	2.5W	<0.25W	<180mA	>50%	fig 2
2N3375	100MHz	7.5W	<1.0W	<410mA	>65%	fig 1
2N3375	400MHz	>3.0W	1.0W	270mA	>40%	fig 3
2N3632	175MHz	>13.5W	3.5W	690mA	>70%	fig 2

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

OUTLINE AND DIMENSIONS FOR 2N3553

Conforms to J.E.D.E.C. TO-39

B.S.3934 SO-3/SB3-3B

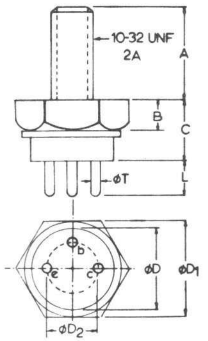


	Millimetres Min.	Nom.	Max.
A	8.64	8.9	9.4
B	7.75	8.15	8.5
C	6.1	6.36	6.6
D	–	5.08	–
E	0.71	0.79	0.86
F	13	–	–
H	–	0.4	–
J	0.74	0.85	1.0

Collector connected to case

OUTLINE AND DIMENSIONS FOR 2N3375, 2N3632

Conforms to TO-60



	Millimetres Nom.
A	11.10
B	3.18
C	6.86
ϕD	8.38
ϕD_1	10.92
ϕD_2	5.08
L	3.81
ϕT	0.97

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

2N3375 2N3553 2N3632

SOLDERING AND WIRING RECOMMENDATIONS (2N3553)

1. When using a soldering iron, transistors may be soldered directly into the circuit, but heat conducted to the junction should if possible be kept to a minimum by the use of a thermal shunt.
2. Transistors may be dip-soldered at a solder temperature of 245°C for a maximum soldering time of 5 seconds. The case temperature during soldering must not at any time exceed the maximum storage temperature. These recommendations apply to a transistor mounted flush on a board having punched-through holes, or spaced at least 1.5mm above a board having plated-through holes.
3. Care should be taken not to bend the leads nearer than 1.5mm from the seal.
4. If devices are stored at temperatures above 100°C before incorporation into equipment, some deterioration of the external surface is likely to occur which may make soldering into the circuit difficult. Under these circumstances the leads should be retinned using a suitable activated, flux.

NOTES (2N3375, 2N3632)

1. A heatsink thermal resistance of 3degC/W is recommended for operation in ambient temperature up to 65°C.

CAUTION

This device incorporates Beryllium Oxide, the dust of which is toxic. The device is entirely safe provided that it is not dismantled.
Care should be taken to ensure that all those who may handle, use or dispose of this device are aware of its nature and of the necessary safety precautions. In particular, it should never be thrown out with general industrial or domestic waste.

DISPOSAL SERVICE

Devices requiring disposal may be returned to Mullard Service Department. They must be separately and securely packed and clearly identified. If any are damaged or broken they MUST NOT be sent through the post. In this case advice is available from the Service Department.

Service Department,
Mullard Limited,
New Road,
Mitcham,
Surrey.

COMMON EMITTER TEST CIRCUIT 100MHz 2N3375

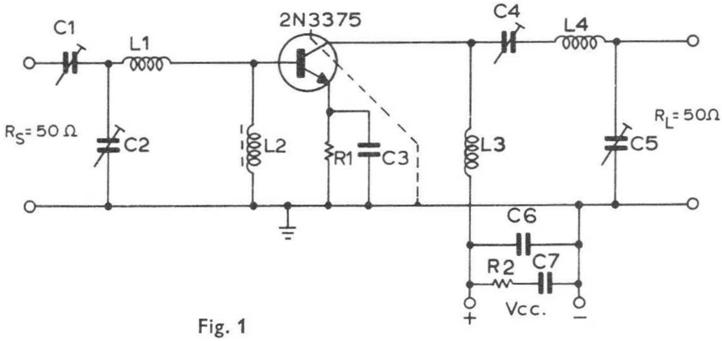


Fig. 1

C_1 = 3,5–61,5pF	air trimmer.
C_2 = 3,5–61,5pF	air trimmer.
C_3 = 10nF	polyester.
C_4 = 4–29pF	air trimmer.
C_5 = 4–29pF	air trimmer.
C_6 = 330pF	ceramic.
C_7 = 10ηF	polyester.

L_1 = 2 turns of 1.5mm closely wound enamelled Cu wire, int. diam. 10mm, leads: 2 × 10mm.

L_2 = Ferroxcube choke coil, Z (at 100MHz) = 700Ω ± 20%.

L_3 = 23 turns of 0.7mm closely wound enamelled Cu wire, int. diam. 6mm.

L_4 = 5 turns of 1.5mm closely wound enamelled Cu wire, int. diam. 12mm, leads: 2 × 10mm.

R_1 = 1.35Ω carbon.

R_2 = 10Ω carbon.

COMMON EMITTER TEST CIRCUIT 175MHz 2N3553, 2N3632

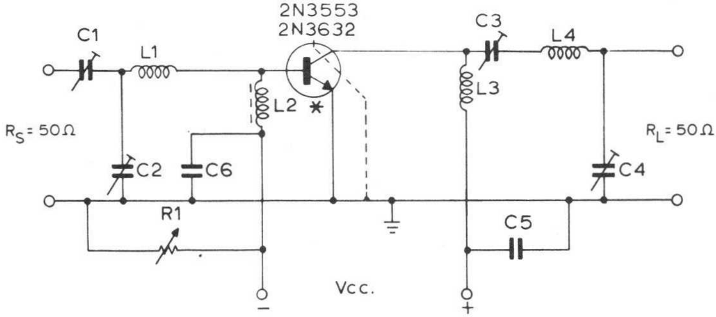


Fig. 2

C_1, C_2, C_3, C_4	= 4–29pF	air trimmer.
C_5	= 10nF	polyester.
C_6	= 100pF	ceramic.

L_1 = 1 turn of 1mm Cu wire, int. diam. 10mm; Leads: 2 × 10mm.

L_2 = Ferroxcube choke coil. Z (at 175MHz) = $550\Omega \pm 20\%$.

L_3 = 15 turns of 0.7mm closely wound enamelled Cu wire, int. diam 4mm.

L_4 = 3 turns of 1.5mm closely wound enamelled Cu wire, int. diam 12mm, Leads: 2 × 20mm.

R = 0–2Ω for 2N3632 and R = 0Ω for 2N3553.

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

COMMON EMITTER TEST CIRCUIT 400MHz 2N3375

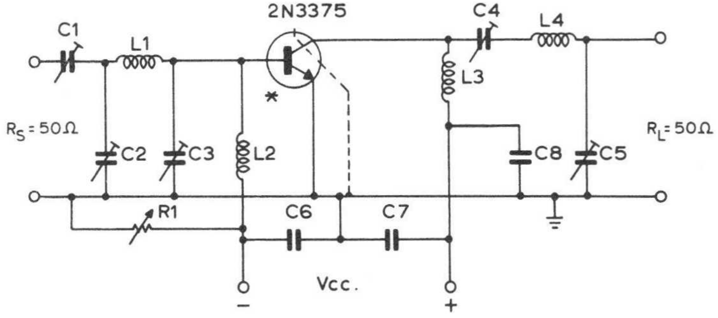


Fig. 3

C_1 =	0.7–6.7pF	ceramic trimmer.
C_2 =	0.7–6.7pF	ceramic trimmer.
C_3 =	0.5–3.5pF	ceramic trimmer.
C_4 =	3–19pF	air trimmer.
C_5 =	3–19pF	air trimmer.
C_6 =	15pF	ceramic.
C_7 =	15pF	ceramic.
C_8 =	4700pF	ceramic.

L_1 = 20mm straight Cu wire diam. 1.5mm, spaced 8mm from chassis.

L_2 = 17 turns of 0.5mm closely wound enamelled Cu wire, int. diam. 3mm.

L_3 = 7 turns of 0.5mm closely wound enamelled Cu wire, int. diam. 3mm.

L_4 = 1 turn of 1.5mm Cu wire, int. diam. 10mm, leads: 2 × 5mm.

R = 0–5Ω.

*Emitter connected to case as short as possible.

FREQUENCY DOUBLER TEST CIRCUIT 87.5MHz–175MHz 2N3553

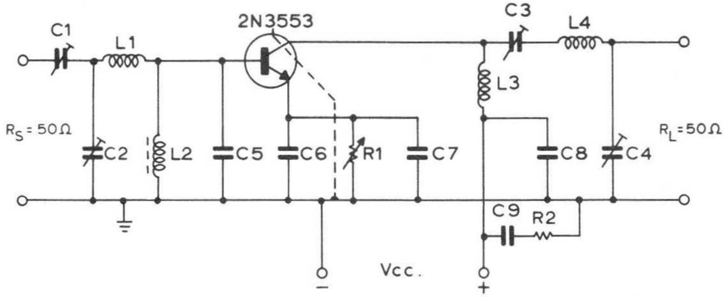


Fig. 4

C_1, C_2, C_3	= 4–29pF	air trimmer.
C_4	= 3.5–61.5pF	air trimmer.
C_5	= 56pF	ceramic.
C_6	= 680pF	ceramic.
C_7	= 150pF	ceramic.
C_8	= 100pF	ceramic.
C_9	= 10nF	polyester.

L_1 = 5 turns of 1mm Cu wire, winding pitch 1.5mm, int. diam. 6mm, Leads: 2 × 12mm.

L_2 = Ferroxcube choke coil, Z (at 87.5MHz) = $750\Omega \pm 20\%$.

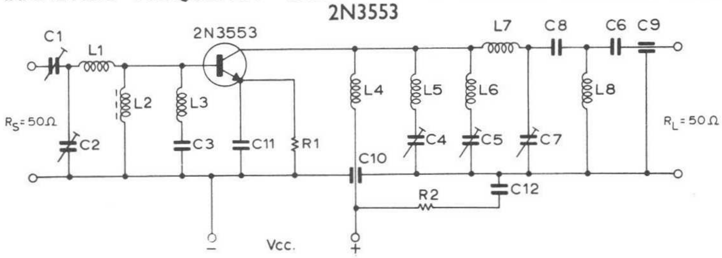
L_3 = 15 turns of 0.7mm closely wound enamelled Cu wire, int. diam. 4mm.

L_4 = 6 turns of 1mm Cu wire, winding pitch 1.5mm, int. diam. 6mm, leads: 2 × 12mm.

R_1 = 0–50Ω.

R_2 = 10Ω carbon.

PARAMETRIC FREQUENCY TREBLER TEST CIRCUIT 156.7MHz–470MH
2N3553



*Tuned to second harmonic frequency.

Fig. 5

C_1, C_2, C_3, C_4	4–29pF	air trimmer.	C_8 = 1pF	ceramic.	
			C_9 = 12pF	ceramic	feed through.
			C_{10} = 100pF	ceramic.	feed through.
			C_{11} = 1000pF	ceramic.	
C_5, C_6, C_7	4–10.4pF	air trimmer.	C_{12} = 15nF	polyester.	
			R_1 = 2.2Ω	carbon.	
			R_2 = 10Ω	carbon.	

L_1 = 35mm straight Cu wire, diam. 1mm, spaced 5.5mm from chassis.

L_2 = Ferroxcube choke coil, Z (at 156,7MHz) = 600Ω ± 20%.

L_3 = 18mm straight Cu wire, diam. 1mm, spaced 5.5mm from chassis.

L_4 = 7 turns of 0.5mm closely wound enamelled Cu wire, int. diam. 3.5mm.

L_5 = 3 turns of 1mm Cu wire, winding pitch 1.7mm, int. diam. 8.5mm, leads: 2 × 10mm.

L_6 = 2 turns of 1mm Cu wire, winding pitch 1.7mm, int. diam. 7mm, leads: 2 × 10mm.

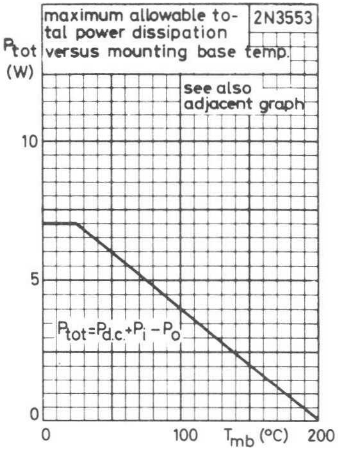
L_7 = 40mm straight Cu wire, diam. 1.5mm spaced 5.5mm from chassis.

L_8 = 1 turn of 1mm Cu wire, int. diam. 7mm, leads: 2 × 5mm.

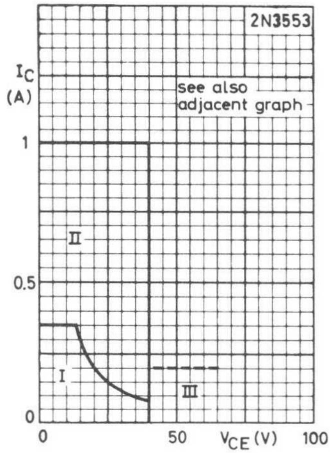
Performance

Typical performance at a supply voltage of 28V.

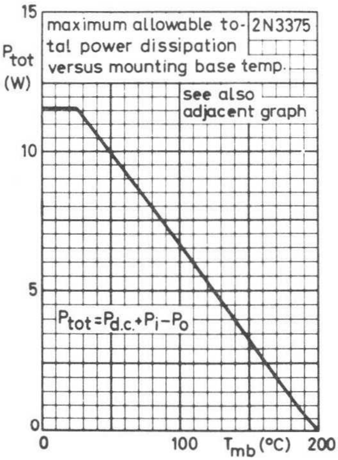
P_o	P_i	G	I_C	η
(W)	(W)	(dB)	(mA)	(%)
1.5	0.27	7.5	125	43
2.0	0.39	7.1	156	46



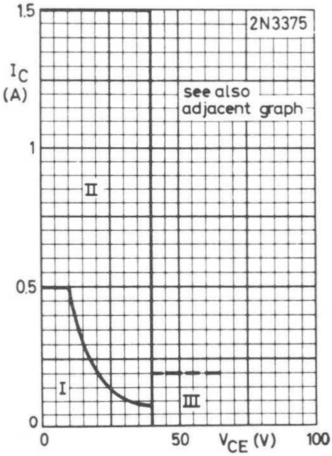
maximum allowable total power dissipation versus mounting base temp.
2N3553
P_{tot} (W)
see also adjacent graph
$P_{tot} = P_{d.c.} + P_i - P_o$
10
5
0
0
100
T_{mb} (°C)
200



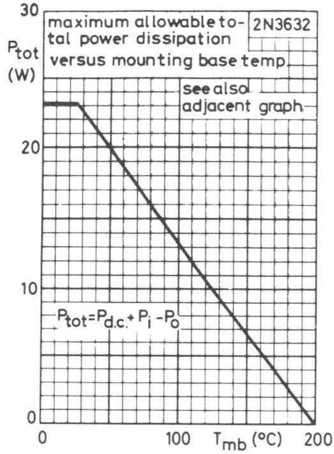
2N3553
I_C (A)
see also adjacent graph
1
0.5
0
II
I
III
0
50
V_{CE} (V)
100

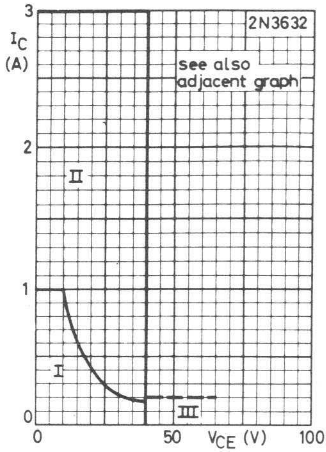


maximum allowable total power dissipation versus mounting base temp.
2N3375
P_{tot} (W)
see also adjacent graph
$P_{tot} = P_{d.c.} + P_i - P_o$
15
10
5
0
0
100
T_{mb} (°C)
200



2N3375
I_C (A)
see also adjacent graph
1.5
1
0.5
0
II
I
III
0
50
V_{CE} (V)
100





EXPLANATION OF AREAS OF SAFE OPERATION

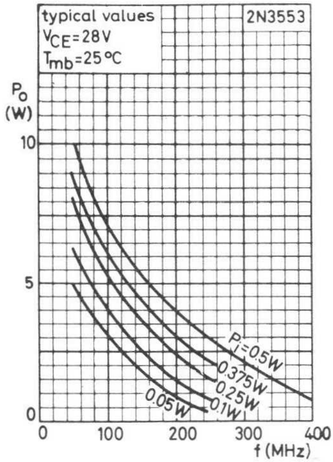
Region I — Operation is allowed under all base-emitter conditions, provided no limiting values are exceeded (d.c. and a.c. operation).

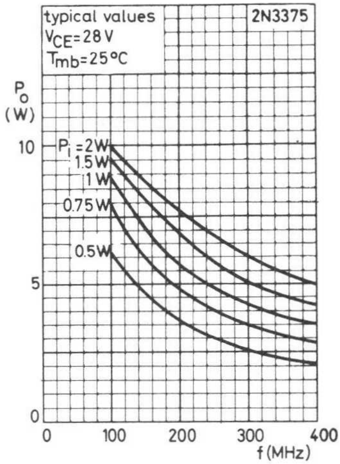
Region II — Operating is allowed under all base-emitter conditions with frequencies $\geqslant$ 1MHz, provided no limiting values are exceeded.
Care must be taken to reduce the d.c. adjustment to region I before removing the a.c. signal.
This may be achieved by an appropriate bias in class A, B or C.

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

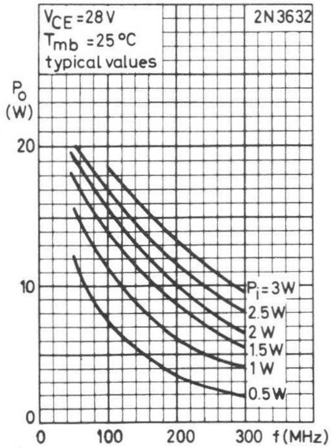
SILICON V.H.F. N-P-N POWER TRANSISTORS

2N3375
2N3553
2N3632

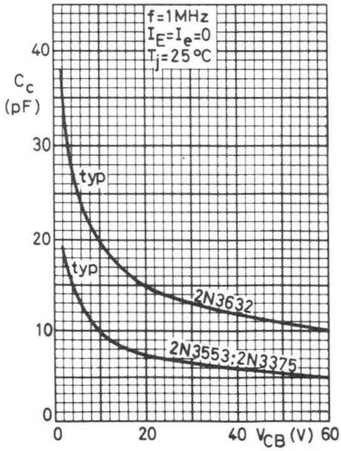




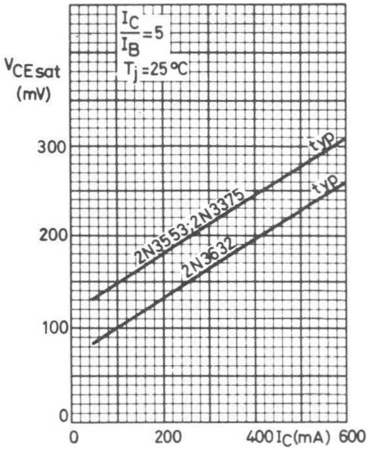
TYPICAL OUTPUT POWER PLOTTED AGAINST FREQUENCY

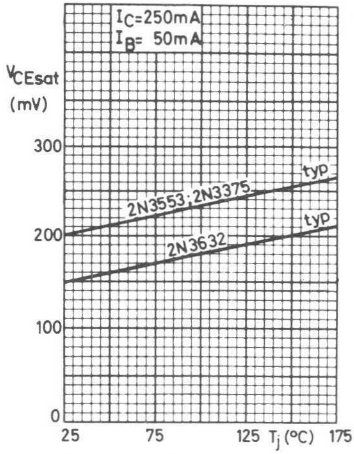


TYPICAL OUTPUT POWER PLOTTED AGAINST FREQUENCY

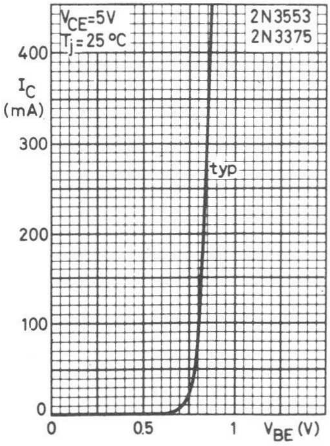


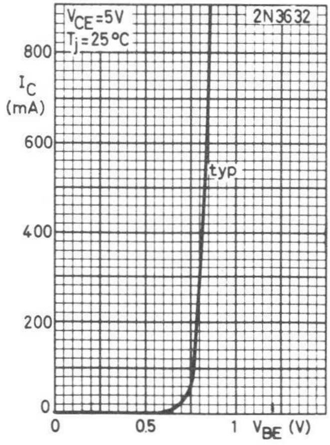
TYPICAL COLLECTOR CAPACITANCE PLOTTED AGAINST COLLECTOR-BASE VOLTAGE





TYPICAL COLLECTOR-EMITTER SATURATION VOLTAGE PLOTTED AGAINST JUNCTION TEMPERATURE

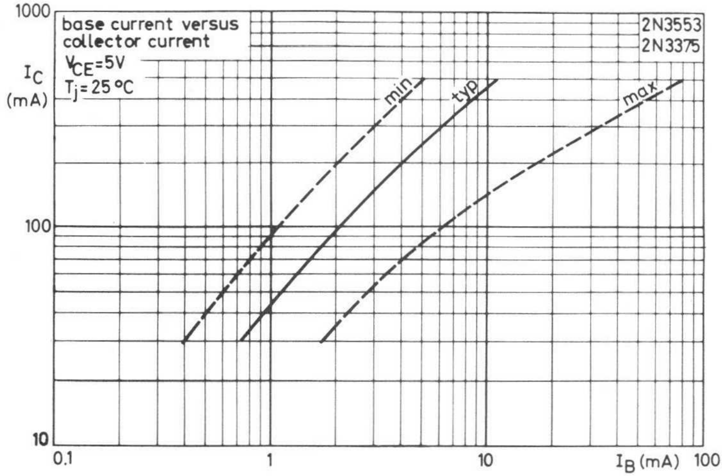


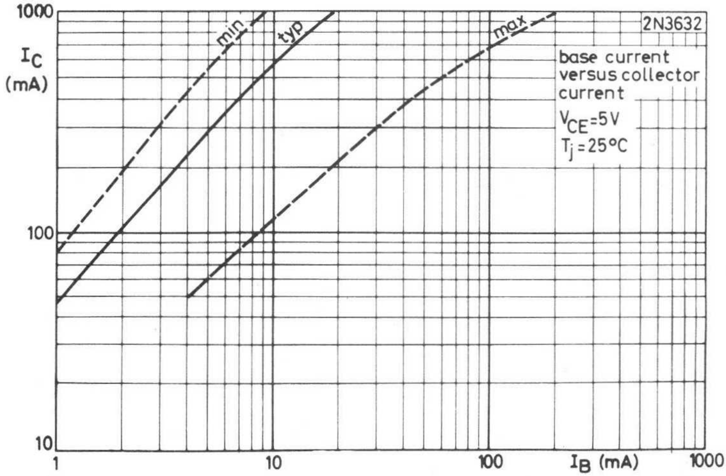


TYPICAL COLLECTOR CURRENT PLOTTED AGAINST BASE-EMITTER VOLTAGE

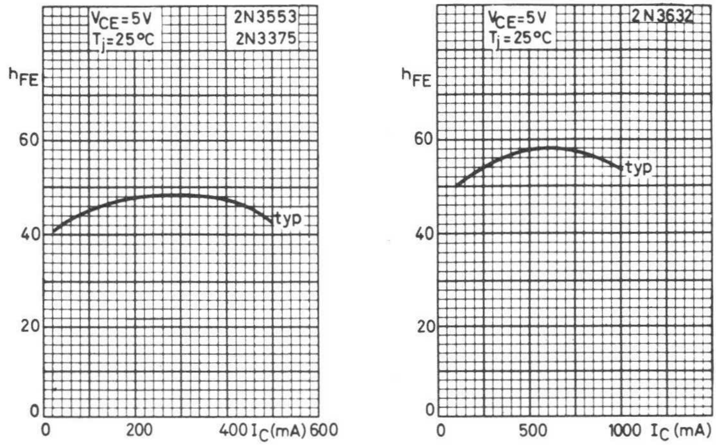
SILICON V.H.F. N-P-N POWER TRANSISTORS

2N3375
2N3553
2N3632

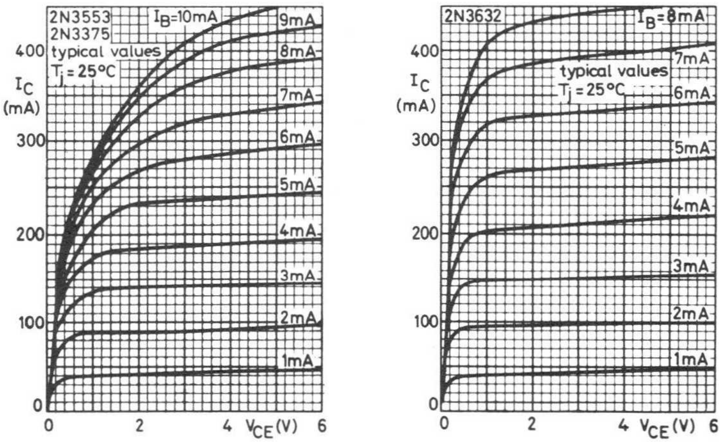




COLLECTOR CURRENT PLOTTED AGAINST BASE CURRENT



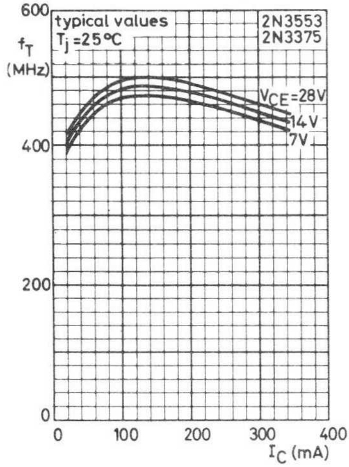
TYPICAL LARGE SIGNAL FORWARD CURRENT TRANSFER RATIO PLOTTED AGAINST COLLECTOR CURRENT

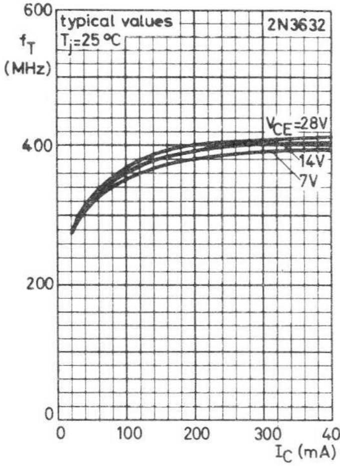


COLLECTOR CURRENT PLOTTED AGAINST COLLECTOR-EMITTER VOLTAGE WITH BASE CURRENT AS A PARAMETER

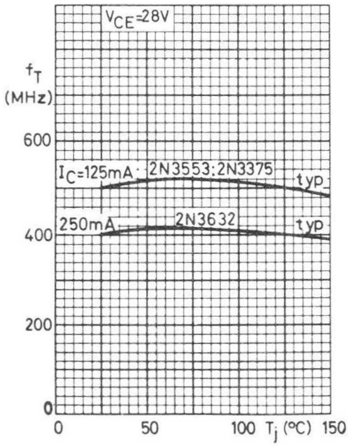
SILICON V.H.F. N-P-N POWER TRANSISTORS

2N3375 2N3553 2N3632

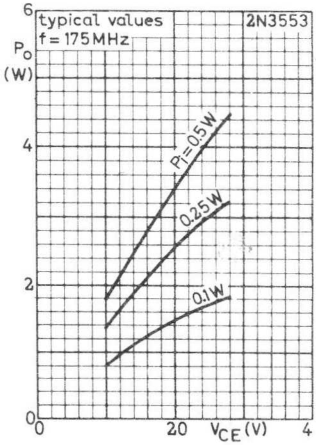




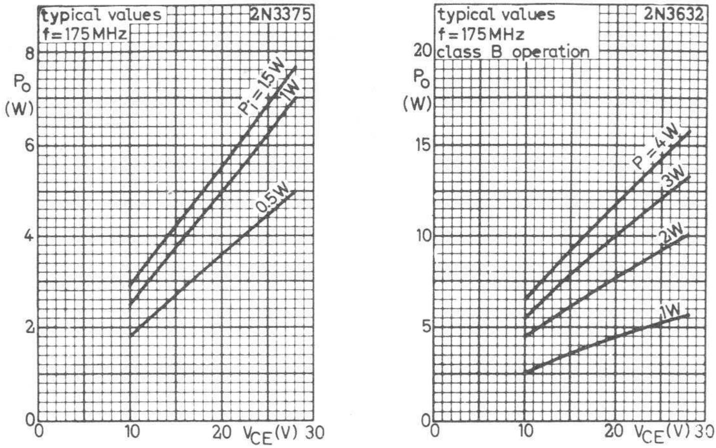
TYPICAL TRANSITION FREQUENCY PLOTTED AGAINST COLLECTOR CURRENT WITH COLLECTOR-EMITTER VOLTAGE AS A PARAMETER



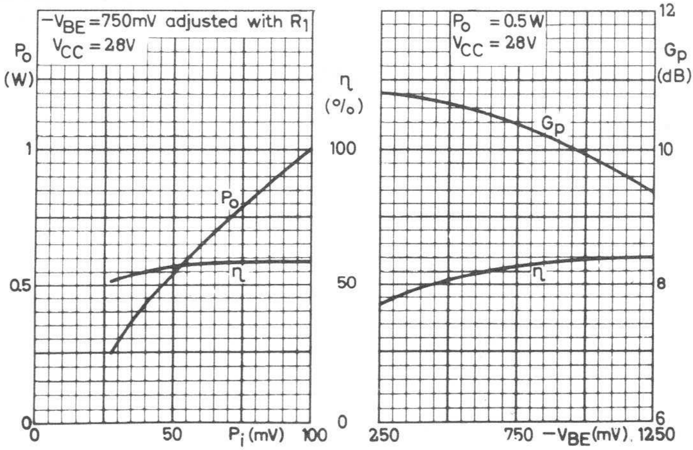
TYPICAL TRANSITION FREQUENCY PLOTTED AGAINST JUNCTION TEMPERATURE



OUTPUT POWER PLOTTED AGAINST COLLECTOR-EMITTER VOLTAGE WITH INPUT POWER AS A PARAMETER



OUTPUT POWER PLOTTED AGAINST COLLECTOR-EMITTER VOLTAGE WITH INPUT POWER AS A PARAMETER



POWER GAIN, POWER OUTPUT, AND EFFICIENCY CURVES PLOTTED AGAINST INPUT POWER AND BASE-EMITTER VOLTAGE FOR DOUBLER CIRCUIT ON PAGE D9

N-CHANNEL SILICON FIELD-EFFECT TRANSISTOR

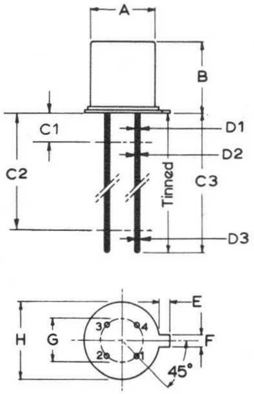
2N3823

N-channel, depletion-type, silicon planar epitaxial field-effect transistor intended for v.h.f. amplifier and mixer applications in industrial service.

QUICK REFERENCE DATA		
V_{DS} max.	30	V
$-V_{GSS}$ max.	30	V
I_{DSS} (V_{DS}=15V, V_{GS}=0)	4.0 - 20	mA
P_{tot} max. (T_{amb}≤25°C)	300	mW
C_{rss} max. (V_{DS}=15V, V_{GS}=0, f=1.0MHz)	2.0	pF
$\|y_{fs}\|$ min. (V_{DS}= 15V, V_{GS}=0, f=200MHz)	3.2	mmho
N max. (V_{DS}=15V, V_{GS}=0, f=100MHz, R_G=1.0kΩ)	2.5	dB

OUTLINE AND DIMENSIONS

Conforms to B.S. 3934 SO-12A/SB4-3
J.E.D.E.C. TO-72



Millimetres

	Min.	Nom.	Max.
A	4.53	-	4.8
B	4.66	-	5.33
C1	-	-	0.51
C2	12.7	-	-
C3	12.7	-	15
D1	-	-	1.01
D2	0.41	-	0.48
D3	-	-	0.53
E	0.84	-	1.17
F	0.92	-	1.16
G	-	2.54	-
H	5.31	-	5.84

Viewed from underside

All electrodes are electrically insulated from the case

Connections

1. Source
2. Drain
3. Gate
4. Case

RATINGS

Limiting values of operation according to the absolute maximum system.

Electrical

V_{DS} max.	30	V
V_{DG} max.	30	V
$-V_{GSS}$ max. ($-I_G = 1.0\mu A$, $V_{DS} = 0$)	30	V
I_G max.	10	mA
P_{tot} max. ($T_{amb} \leq 25^{o}C$)	300	mW

Temperature

T_{stg} range	-65 to +200	^{o}C
T_j max.	200	^{o}C

THERMAL CHARACTERISTICS

$R_{th(j-amb)}$	0.59	degC/mW

ELECTRICAL CHARACTERISTICS ($T_{amb} = 25^{o}C$ unless otherwise stated)

The fourth lead (case) is connected to the source for all measurements.

		Min.	Max.	
Static				
$-I_{GSS}$	Gate cut-off current			
	$-V_{GS} = 20V$, $V_{DS} = 0$	-	0.5	nA
	$-V_{GS} = 20V$, $V_{DS} = 0$, $T_{amb} = 150^{o}C$	-	0.5	μA
I_{DSS}	Zero-gate-voltage drain current			
	*$V_{DS} = 15V$, $V_{GS} = 0$	4.0	20	mA
$-V_{(BR)GSS}$	Gate-source breakdown voltage			
	$-I_G = 1.0\mu A$, $V_{DS} = 0$	30	-	V
$-V_{GS}$	Gate-source voltage			
	$V_{DS} = 15V$, $I_D = 400\mu A$	1.0	7.5	V
$-V_{GS(off)}$	Gate-source cut-off voltage			
	$V_{DS} = 15V$, $I_D = 0.5nA$	-	8.0	V

*Pulse measurements, pulse width = 100ms, duty cycle $\leq$ 10%.

ELECTRICAL CHARACTERISTICS (cont'd)

Small signal y-parameters

Common source, $V_{DS}=15V$, $V_{GS}=0$

*f = 1.0kHz		Min.	Max.	
$\lvert y_{fs} \rvert$	Transfer admittance	3.5	6.5	mmho
$\lvert y_{os} \rvert$	Output admittance	-	35	μmho
f = 1.0MHz				
C_{rss}	Feedback capacitance	-	2.0	pF
C_{iss}	Input capacitance	-	6.0	pF
f = 200MHz				
$\lvert y_{fs} \rvert$	Transfer admittance	3.2	-	mmho
g_{is}	Input conductance	-	800	μmho
g_{os}	Output conductance	-	200	μmho

Noise

N	Spot noise figure f = 100MHz, $R_G = 1.0k\Omega$, $V_{DS}=15V$, $V_{GS}=0$	-	2.5	dB

*Pulse measurements, pulse width = 100ms, duty cycle ≤ 10%.

N-P-N SILICON PLANAR EPITAXIAL U.H.F. TRANSISTOR

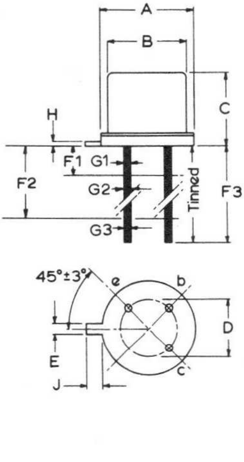
2N3866

N-P-N silicon planar epitaxial transistor primarily intended for use in the output, driver and pre-driver stages of class A, B or C amplifiers, frequency multipliers and oscillators of v.h.f. and u.h.f. equipment.
Encapsulated in a metal TO-39 envelope with the collector connected to the case.

QUICK REFERENCE DATA		
V_{CER} max.	55	V
V_{CEO} max.	30	V
I_C max.	400	mA
P_{tot} max. ($T_{case} \leq 25^{o}C$)	5.0	W
T_j max.	200	^{o}C
f_T typ. ($I_C = 25mA$, $V_{CE} = 15V$, $f = 100MHz$)	700	MHz
P_o typ. ($P_i < 100mW$, $V_{CE} = 28V$, $f = 400MHz$)	1.0	W
η min. ($P_o = 1.0W$, $V_{CE} = 28V$, $f = 400MHz$)	45	%

OUTLINE AND DIMENSIONS

Conforms to B.S. 3934 SO-3/SB3-3B
J.E.D.E.C. TO-39



	Millimetres		
	Min.	Typ.	Max.
A	9.10	-	9.40
B	8.2	-	8.5
C	6.15	-	6.60
D	-	5.08	-
E	0.71	-	0.86
F1	-	-	0.51
F2	12.7	-	-
F3	12.7	-	15
G1	-	-	1.01
G2	0.41	-	0.48
G3	-	-	0.53
H	-	0.4	-
J	0.74	-	1.01

Collector connected to case

RATINGS

Limiting values of operation according to the absolute maximum system.

Electrical

V_{CBO} max.	55	V
V_{CER} max. ($R_{BE}=10\Omega$)	55	V
V_{CEO} max.	30	V
V_{EBO} max.	3.5	V
I_C max.	400	mA
I_{CM} max.	400	mA
P_{tot} max. ($T_{case} \leq 25^oC$)	5.0	W

Temperature

T_{stg} min.	-65	^oC
T_{stg} max.	200	^oC
T_j max.	200	^oC

THERMAL CHARACTERISTICS

$R_{th(j-amb)}$	In free air	200	degC/W
$R_{th(j-case)}$		35	degC/W
$R_{th(case-h)}$	Mounted with a top clamping washer of accessory 56218	1.0	degC/W
$R_{th(case-h)}$	Mounted with a top clampling washer of accessory 56218 and a boron nitride washer for electrical insulation	1.2	degC/W

ELECTRICAL CHARACTERISTICS ($T_j=25^oC$ unless otherwise stated)

		Min.	Typ.	Max.	
I_{CEO}	Collector cut-off current $V_{CE}=28V$, $I_B=0$	-	-	20	μA
$V_{(BR)CBO}$	Collector-base breakdown voltage $I_C=100\mu A$, $I_E=0$	55	-	-	V
	Collector-emitter breakdown voltages				
$V_{(BR)CER}$	$I_C=5.0mA$, $R_{BE}=10\Omega$	55	-	-	V
$V_{(BR)CEO}$	$I_C=5.0mA$, $I_B=0$	30	-	-	V
$V_{(BR)EBO}$	Collector-base breakdown voltage $I_E=100\mu A$, $I_C=0$	3.5	-	-	V

N-P-N SILICON PLANAR EPITAXIAL U.H.F. TRANSISTOR

2N3866

ELECTRICAL CHARACTERISTICS (cont'd)

		Min.	Typ.	Max.	
$V_{CE(sat)}$	Collector-emitter saturation voltage $I_C = 100mA$, $I_B = 20mA$	-	-	1.0	V
h_{FE}	Static forward current transfer ratio				
	$I_C = 50mA$, $V_{CE} = 5.0V$	10	-	200	
	$I_C = 360mA$, $V_{CE} = 5.0V$	5	-	-	
f_T	Transition frequency $I_C = 25mA$, $V_{CE} = 15V$, $f = 100MHz$	-	700	-	MHz
C_{tc}	Collector capacitance $V_{CB} = 28V$, $I_E = I_e = 0$, $f = 1.0MHz$	-	-	3.0	pF

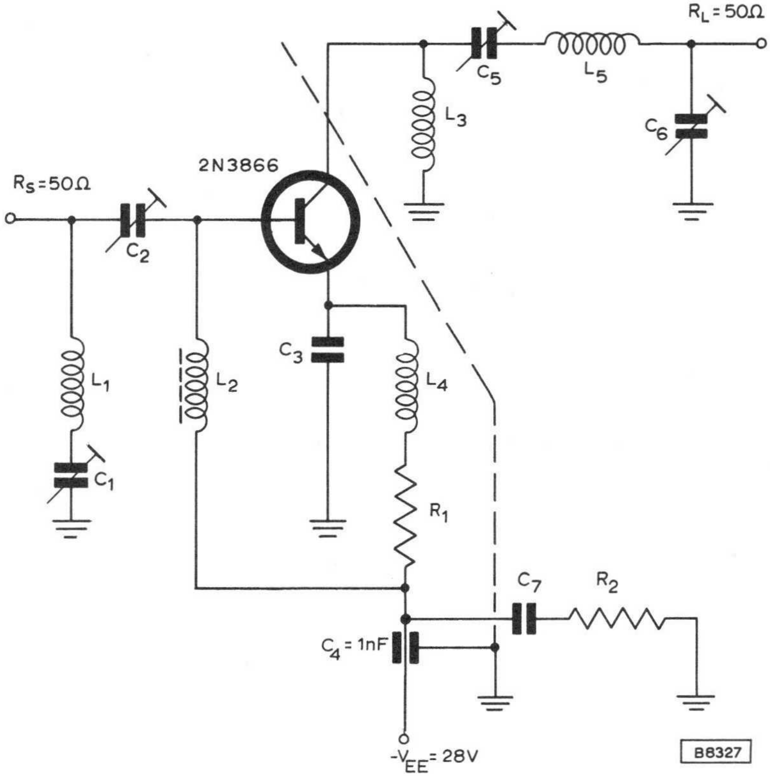
Typical r.f. performance

$V_{CE} = 28V$, $T_{case} = 25^{o}C$

f	Frequency	100	250	400*	MHz
P_i	Input power	50	100	< 100	mW
I_C	Collector current	< 107	< 107	< 79	mA
P_o	Output power	1.8	1.5	1.0	W
η	Efficiency	> 60	> 50	> 45	%

*The transistor can withstand a load mismatch having a v.s.w.r. of 3, varied through all phases for conditions as given above (see also test circuit)

Common emitter test circuit (f = 400 MHz)



Components

C_1, C_2, C_5 = 4 to 29pF air trimmers

C_3 = 12pF

C_6 = 4 to 14pF air trimmer

C_7 = 12nF

R_1 = 5.6Ω

R_2 = 10Ω

L_1 = 2 turns of 1mm Cu wire, int. dia. 6mm, winding pitch 3mm

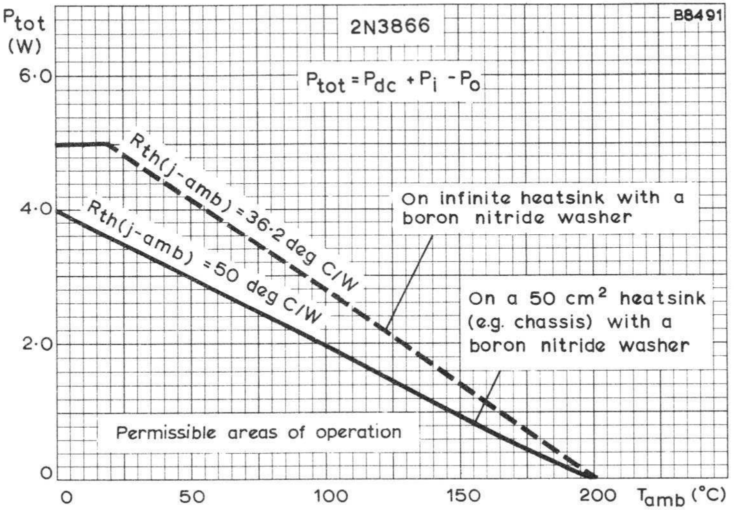
L_2 = ferroxcube choke coil (Z = 450Ω at 250MHz)

L_3, L_4 = 6 turns of 0.5mm en. Cu wire, int. dia. 3.5mm (100nH)

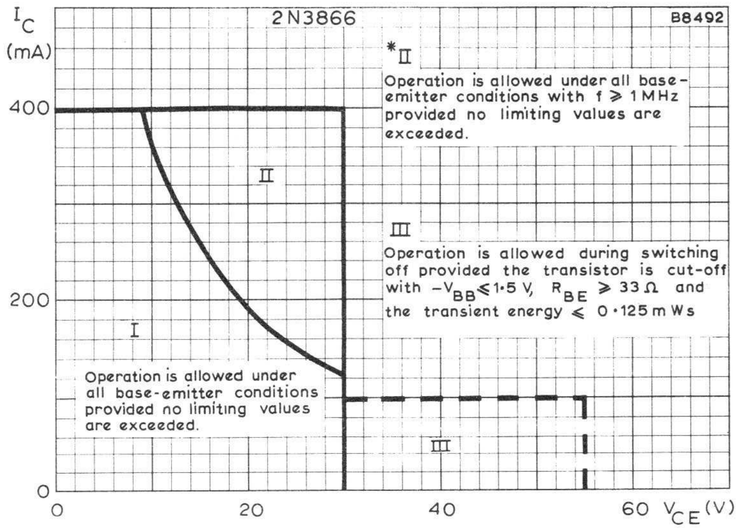
L_5 = 2 turns of 1mm Cu wire, int. dia. 7mm, winding pitch 2.5mm, leads 2 × 15mm

N-P-N SILICON PLANAR EPITAXIAL U.H.F. TRANSISTOR

2N3866

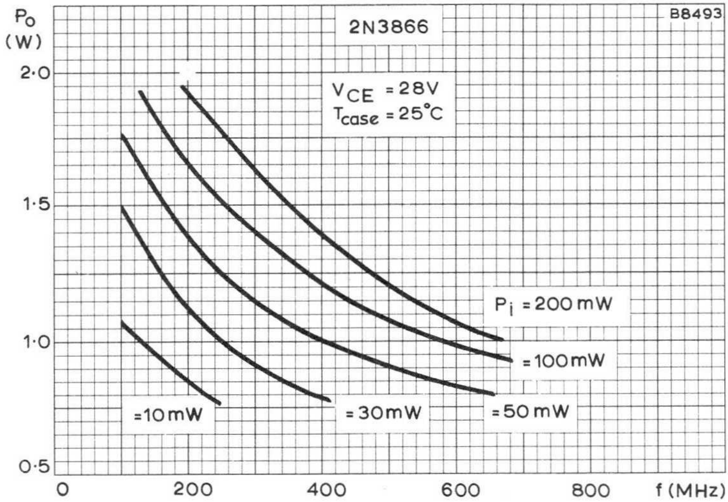


MAXIMUM TOTAL DISSIPATION PLOTTED AGAINST AMBIENT TEMPERATURE

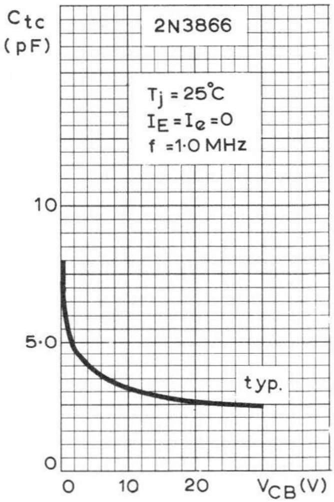


AREAS OF SAFE OPERATION

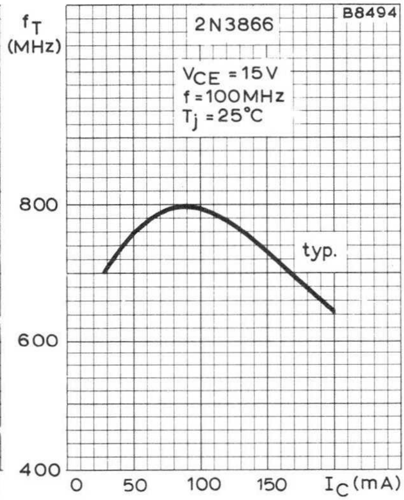
*II Care must be taken to reduce the steady state current to region I before removing the a.c. signal. This may be achieved by appropriate bias in class A, B or C.



TYPICAL VARIATION OF OUTPUT POWER WITH FREQUENCY AND INPUT POWER



Collector capacitance versus collector-base voltage



Transition frequency versus collector current

SILICON VHF N-P-N POWER TRANSISTOR

2N3553

For ratings, characteristics and mechanical details see 2N3375 Data Sheet

SILICON VHF N-P-N POWER TRANSISTOR

2N3632

For ratings, characteristics and mechanical details see 2N3375 Data Sheet

SILICON PLANAR EPITAXIAL N-P-N TRANSISTORS

2N2569 2N2570

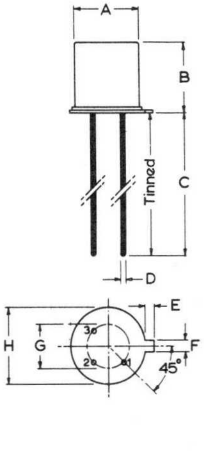
Silicon planar epitaxial n-p-n transistors with low leakage currents and low offset voltages, for use as choppers in d.c. amplifiers and sampling circuits.

QUICK REFERENCE DATA

V_{offset} max. ($I_B = 150\mu A$)	2N2569	250	μV
	2N2570	500	μV
I_C max.		100	mA
P_{tot} max. ($T_{amb} = 25^{\circ}C$)		300	mW
h_{FE} min. ($I_C = 100\ \mu A$, $V_{CE} = +10V$)		50	
f_T ($I_C = 10mA$, $V_{CE} = +10V$, $f = 100MHz$)		100	MHz

OUTLINE AND DIMENSIONS

Conforms to J.E.D.E.C. TO-18
B.S. 3934 SO-12A/SB3-6A



Millimetres

	Min.	Nom.	Max.
A	-	-	4.8
B	-	-	5.3
C	-	12.7	-
D	-	0.43	-
E	-	1.0	-
F	-	1.05	-
G	-	2.54	-
H	5.3	5.55	5.8

Collector connected to metal envelope

Connections
1. Emitter
2. Base
3. Collector

†RATINGS

Limiting values of operation according to the absolute maximum system.

Electrical

V_{CBO} max. (I_E=0)	20	V
V_{CEO} max. (I_B=0)	5.0	V
V_{EBO} max. (I_C=0)	5.0	V
I_C max.	100	mA
P_{tot} max. ($T_{amb} \leq 25^{o}C$)	300	mW

Temperature

T_{stg} min.	-65	^{o}C
T_{stg} max.	200	^{o}C
T_j max. (operating)	175	^{o}C

†THERMAL CHARACTERISTIC

$\Theta_{j\text{-}amb}$	0.50	degC/mW

†ELECTRICAL CHARACTERISTICS (T_{amb} = $25^{o}C$ unless otherwise stated)

			Min.	Max.	
I_{CBO}	Collector cut-off current V_{CB}=15V, I_E=0		-	10	nA
I_{EBO}	Emitter cut-off current V_{EB}=5.0V, I_C=0		-	2.0	nA
$V_{(BR)CBO}$	Collector-base breakdown voltage I_E=0, I_C=100μA		20	-	V
V_{offset}	Offset voltage I_B=150μA, I_E=0	2N2569	-	250	μV
		2N2570	-	500	μV
	I_B=1.0mA, I_E=0	2N2569	-	500	μV
		2N2570	-	1.0	mV
V_{EC}	Emitter-collector voltage I_B=1.0mA, I_E=100μA		-	3.0	mV
h_{FE}	Static forward current transfer ratio I_C=100μA, V_{CE}=10V		50	-	
f_T	Transition frequency I_C=10mA, V_{CE}=10V, f=100MHz		100	-	MHz

†J.E.D.E.C. Registered data

		Min.	Max.	
c_{ob}	Output capacitance $I_E=0$, $V_{CB}=0.5V$ f=1.0MHz	-	10	pF
c_{ib}	Input capacitance $I_C=0$, $V_{EB}=0.5V$, f=1.0MHz	-	10	pF

SOLDERING AND WIRING RECOMMENDATIONS

1. When using a soldering iron, transistors may be soldered directly into the circuit, but heat conducted to the junction should if possible be kept to a minimum by the use of a thermal shunt.
2. Transistors may be dip-soldered at a solder temperature of 245°C for a maximum soldering time of 5 seconds. The case temperature during dip-soldering must not at any time exceed the maximum storage temperature. These recommendations apply to a transistor mounted flush on a board having punched-through holes, or spaced at least 1.5mm above a board having plated-through holes.
3. Care should be taken not to bend the leads nearer than 1.5mm from the seal.
4. If devices are stored above 100°C before incorporation into equipment some deterioration of the external surface is likely to occur which may make soldering into the circuit difficult. Under these circumstances the leads should be retinned using a suitable activated flux.

SILICON PLANAR EPITAXIAL N-P-N TRANSISTORS

2N3570 2N3571 2N3572

Silicon planar epitaxial n-p-n transistor intended for use in low power r.f. oscillator and amplifier applications in the v.h.f. and u.h.f. ranges for industrial service. TO-72 construction.

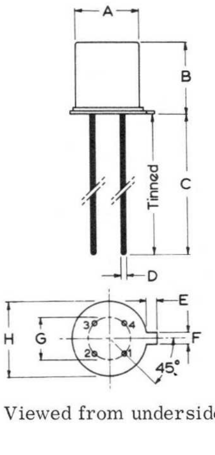
QUICK REFERENCE DATA

	2N3570	2N3571	2N3572	
V_{CBO} max. ($I_E = 0$)	30	25	25	V
V_{CEO} max. ($I_B = 0$)	15	15	13	V
I_C max.			50	mA
P_{tot} max. ($T_{amb} \leq 25^{o}C$)			200	mW
f_T min. ($I_C = 5.0mA$, $V_{CE} = 6.0V$)	1.5	1.2	1.0	Gc/s
f_T max. ($I_C = 5.0mA$, $V_{CE} = 6.0V$)			2.4	Gc/s
c_{re} max. ($I_E = 0$, $V_{CB} = 6.0V$, f = 1.0Mc/s)	0.75	0.85	0.85	pF
NF max. ($-I_E = 2.0mA$, $V_{CB} = 6.0V$, f = 1.0Gc/s, $R_s = 50\Omega$)	7.0	-	-	dB
NF max. ($-I_E = 2.0mA$, $V_{CB} = 6.0V$, f = 450Mc/s, $R_s = 100\Omega$)	-	4.0	6.0	dB

Unless otherwise stated data is applicable to all types in the series

OUTLINE AND DIMENSIONS

Conforms to J.E.D.E.C. TO-72



Viewed from underside

Connections

1. Emitter
2. Base
3. Collector
4. Shield connected to envelope

	Millimetres Min.	Nom.	Max.
A	-	-	4.8
B	-	-	5.3
C	12.7	-	-
D	-	-	0.48
E	-	-	1.21
F	-	-	1.16
G	-	2.54	-
H	-	-	5.83

RATINGS

Limiting values of operation according to the absolute maximum system.

Electrical

†V_{EBO} max. ($I_C = 0$)		3.0	V
†V_{CBO} max. ($I_E = 0$)	2N3570	30	V
	2N3571	25	V
	2N3572	25	V
†V_{CEO} max. ($I_B = 0$)	2N3570	15	V
	2N3571	15	V
	2N3572	13	V
†I_C max. (D.C. collector current)		50	mA
†P_{tot} max. ($T_{amb} \leq 25^oC$)		200	mW
($T_{case} \leq 25^oC$)		350	mW

Temperature

†T_{stg} min.	-65	^oC
†T_{stg} max.	200	^oC
†T_j max. operating	200	^oC

THERMAL CHARACTERISTICS

†θ_{j-amb}	0.88 degC/mW
†θ_{j-case}	0.50 degC/mW

ELECTRICAL CHARACTERISTICS ($T_{amb} = 25^oC$ unless otherwise stated)

			Min.	Max.	
†I_{CBO}	Collector cut-off current				
	$V_{CB} = 6.0V$, $I_E = 0$		-	10	nA
	$V_{CB} = 6.0V$, $I_E = 0$, $T_{amb} = 150^oC$		-	1.0	μA
†h_{FE}	Large signal forward current transfer ratio				
	$I_C = 5.0mA$, $V_{CE} = 6.0V$	2N3570	20	150	
		2N3571	20	200	
		2N3572	20	300	
†$V_{(BR)CBO}$	Collector-base breakdown voltage				
	$I_E = 0$, $I_C = 1.0\mu A$	2N3570	30	-	V
		2N3571	25	-	V
		2N3572	25	-	V

			Min.	Max.	
†$V_{(BR)EBO}$	Emitter-base breakdown voltage $I_C = 0$, $-I_E = 10\mu A$		3.0	-	V
†$V_{(BR)CEO}$	Collector-emitter breakdown voltage $I_B = 0$, $I_C = 2.0mA$	2N3570	15	-	V
		2N3571	15	-	V
		2N3572	13	-	V
†h_{fe}	Small signal forward current transfer ratio $I_C = 5.0mA$, $V_{CE} = 6.0V$, f = 1.0kc/s	2N3570	20	200	
		2N3571	20	250	
		2N3572	20	350	
†c_{re}	Reverse transfer capacitance (see note 1) $I_E = 0$, $V_{CB} = 6.0V$, f = 1.0Mc/s	2N3570	-	0.75	pF
		2N3571	-	0.85	pF
		2N3572	-	0.85	pF
†$r_{bb'}c_{b'c}$	Reverse transfer time constant $-I_E = 5.0mA$, $V_{CB} = 6.0V$, f = 10.7Mc/s	2N3570	1.0	8.0	ps
		2N3571	1.0	10	ps
		2N3572	1.0	13	ps
†$\|h_{fe}\|$	Small signal forward current transfer ratio $V_{CE} = 6.0V$, $I_C = 5.0mA$, f = 400Mc/s	2N3570	3.75	6.0	
		2N3571	3.0	6.0	
		2N3572	2.5	6.0	
†NF	Noise figure $-I_E = 2.0mA$, $V_{CB} = 6.0V$ f = 1.0Gc/s, $R_s = 50\Omega$	2N3570	-	7.0	dB
	$-I_E = 2.0mA$, $V_{CB} = 6.0V$ f = 450Mc/s, $R_s = 100\Omega$	2N3571	-	4.0	dB
		2N3572	-	6.0	dB

NOTE

1. The shield lead is grounded for all measurements except c_{re}.

†J.E.D.E.C. registered data.

SOLDERING AND WIRING RECOMMENDATIONS

1. When using a soldering iron, transistors may be soldered directly into the circuit, but heat conducted to the junction should if possible be kept to a minimum by the use of a thermal shunt.

2. Transistors may be dip-soldered at a solder temperature of 245°C for a maximum soldering time of 5 seconds. The case temperature during soldering must not at any time exceed the maximum storage temperature. These recommendations apply to a transistor mounted flush on a board having punched-through holes, or spaced at least 1.5mm above a board having plated-through holes.

3. Care should be taken not to bend the leads nearer than 1.5mm from the seal.

4. If devices are stored at temperatures above 100°C before incorporation into equipment, some deterioration of the external surface is likely to occur which may make soldering into the circuit difficult. Under these circumstances the leads should be retinned using a suitable activated flux.

SILICON V.H.F. POWER TRANSISTORS

2N3924 2N3926 2N3927

The 2N3924, 2N3926, 2N3927 are silicon v.h.f. power transistors specifically intended for large signal v.h.f. applications in industrial and military transmitting equipment.

QUICK REFERENCE DATA

	2N3924	2N3926	2N3927	
V_{CBO} max.	36	36	36	V
V_{CEO} max.	18	18	18	V
I_{CM} max.	1.5	3.0	4.5	A
P_{tot} max. ($T_{mb} \leqslant 25°C$)	7.0	11.6	23	W
T_j max. (operating)	200	200	200	°C
f_T min.	250	250	200	MHz
Output power at $V_{CE} = 13.5V$, $f = 175MHz$, common emitter				
P_{out} min. ($P_{in} = 1.0W$, $\eta = 70\%$)	4.0	–	–	W
P_{out} min. ($P_{in} = 2.0W$, $\eta = 70\%$)	–	7.0	–	W
P_{out} min. ($P_{in} = 4.0W$, $\eta = 80\%$)	–	–	12	W

OUTLINE AND DIMENSIONS

For details see page D4

2N3924 Conforms to J.E.D.E.C. TO-39, B.S. 3934 SO-3/SB3-3B

2N3926 and 2N3927 Conform to J.E.D.E.C. TO-60

RATINGS

Limiting values of operation according to the absolute maximum system.

Electrical

	2N3924	2N3926	2N3927	
V_{CBO} max.	36	36	36	V
V_{CEO} max.	18	18	18	V
V_{EBO} max.	4.0	4.0	4.0	V
I_C max.	0.5	1.0	1.5	A
I_{CM} max.	1.5	3.0	4.5	A
P_{tot} max. ($T_{mb} \leqslant 25°C$)	7.0	11.6	23	W

Temperature

T_{stg} min.	−65	°C
T_{stg} max.	+200	°C
T_j max. (operating)	+200	°C

THERMAL CHARACTERISTICS

	2N3924	2N3926	2N3927	
θ_{j-mb}	25	15	7.5	degC/W
θ_{mb-h} (contact thermal resistance)	–	0.6	0.6	degC/W
θ_{mb-h} (if mounted with top mtg washer of accessory 56218)	1.0	–	–	degC/W
θ_{mb-h} (if mounted with top mtg washer of 56218 and a Boron nitride washer)	1.2	–	–	degC/W

ELECTRICAL CHARACTERISTICS ($T_j = 25°C$)

		2N3924	2N3926	2N3927	
$V_{(BR)CBO}$ min.	Collector-base breakdown voltage $I_C = 250\mu A$, $I_E = 0$	36	36	36	V
	Collector-emitter breakdown voltage				
$V_{(BR)CEX}$ min.**	$I_C = 0$ to 400mA, $V_{EB} = 1.5V$, $R_B = 33\Omega$	36	36	36	V
$V_{(BR)CEO}$ min.**	$I_C = 0$ to 400mA, $I_B = 0$	18	18	18	V
$V_{(BR)EBO}$ min.	Emitter-base breakdown voltage $I_E = 250\mu A$, $I_C = 0$	4.0	4.0	4.0	V
I_{CEO} max.	Collector cut-off current $V_{CE} = 15V$, $I_B = 0$,				
	$T_j = 25°C$	100	100	250	µA
	$T_j = 150°C$	5	5	5	mA

**Pulsed through an inductor (25mH); $\delta = 0.5$, f = 50Hz.

SILICON V.H.F. POWER TRANSISTORS

2N3924 2N3926 2N3927

			2N3924	2N3926	2N3927	
h_{FE}	Static forward current transfer ratio.					
	$I_C = 250mA$; $V_{CE} = 5.0V$	min.	10	–	–	
		max.	150	–	–	
	$I_C = 500mA$; $V_{CE} = 5.0V$	min.	–	5.0	–	
		max.	–	150	–	
	$I_C = 1000mA$; $V_{CE} = 5.0V$	min.	–	–	5.0	
		max.	–	–	150	
V_{BE}	Base-emitter voltage					
	$I_C = 250mA$; $I_B = 50mA$	max.	1.5	–	–	V
	$I_C = 500mA$; $I_B = 100mA$	max.	–	1.5	–	V
	$I_C = 1000mA$; $I_B = 200mA$	max.	–	–	1·5	V
$V_{CE(Sat)}$	Collector-emitter saturation voltage					
	$I_C = 250mA$; $I_B = 50mA$	max.	0.75	–	–	V
	$I_C = 500mA$; $I_B = 100mA$	max.	–	0.75	–	V
	$I_C = 1000mA$; $I_B = 200mA$	max.	–	–	1.0	V
f_T min.	Transition frequency					
	$V_{CE} = 13.5V$, $I_C = 100mA$		250	250	–	MHz
	$V_{CE} = 13.5V$; $I_C = 200mA$		–	–	200	MHz
C_{tc} max.	Collector output capacitance					
	$V_{CB} = 13.5V$; $f = 1.0MHz$; $I_E = I_e = 0$		20	20	45	pF
	Collector-case capacitance max.		–	5.0	5.0	pF
$R_{e(hie)}$	Real part of input impedance	max.				
	$f = 200MHz$; $I_C = 100mA$; $V_{CE} = 13.5V$		20	20	–	Ω
	$f = 200MHz$; $I_C = 200mA$; $V_{CE} = 13.5V$		–	–	20	Ω

R.F. power output

in un-neutralised common emitter amplifier
$V_{CE} = 13.5V$; $f = 175MHz$

	2N3924	2N3926	2N3927	
P_{out} min. Output power				
$I_C < 420mA$; $P_{in} < 1.0W$; $\eta > 70\%$	4.0	–	–	W
$I_C < 740mA$; $P_{in} < 2.0W$; $\eta > 70\%$	–	7.0	–	W
$I_C < 1100mA$; $P_{in} < 4.0W$; $\eta > 80\%$	–	–	12	W

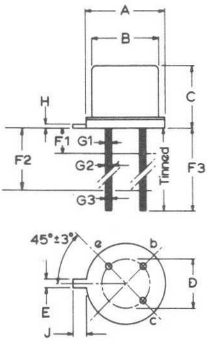
OPERATING NOTE

The transistors can withstand an output V.S.W.R. of 3 : 1 varied through all phases for the conditions in the above (power output) data.

OUTLINE AND DIMENSIONS FOR 2N3924

Conforms to J.E.D.E.C. TO-39

B.S.3934 SO-3/SB3-3B

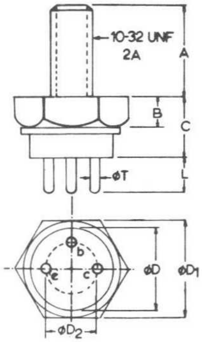


	Millimetres		
	Min.	Nom.	Max.
A	8.64	8.9	9.4
B	7.75	8.15	8.5
C	6.1	6.35	6.6
D	–	5.08	–
E	0.71	0.79	0.86
F	13	–	–
G	–	–	0.48
H	–	0.4	–
J	0.74	0.85	1.0

Collector connected to case

OUTLINE AND DIMENSIONS FOR 2N3926. 2N3927

Conform to TO-60



	Millimetres
	Nom.
A	11.10
B	3.18
C	6.86
ϕD	8.38
ϕD_1	10.92
ϕD_2	5.08
L	3.81
ϕT	0.97

Envelope insulated

SOLDERING AND WIRING RECOMMENDATIONS (2N3924)

1. When using a soldering iron, transistors may be soldered directly into the circuit, but heat conducted to the junction should if possible be kept to a minimum by the use of a thermal shunt.
2. Transistors may be dip-soldered at a solder temperature of 245°C for a maximum soldering time of 5 seconds. The case temperature during soldering must not at any time exceed the maximum storage temperature. These recommendations apply to a transistor mounted flush on a board having punched-through holes, or spaced at least 1.5mm above a board having plated-through holes.
3. Care should be taken not to bend the leads nearer than 1.5mm from the seal.
4. If devices are stored at temperatures above 100°C before incorporation into equipment, some deterioration of the external surface is likely to occur which may make soldering into the circuit difficult. Under these circumstances the leads should be retinned using a suitable activated flux.

NOTES (2N3926, 2N3927)

1. A heatsink thermal resistance of 3degC/W is recommended for operation in ambient temperature up to 65°C.

CAUTION

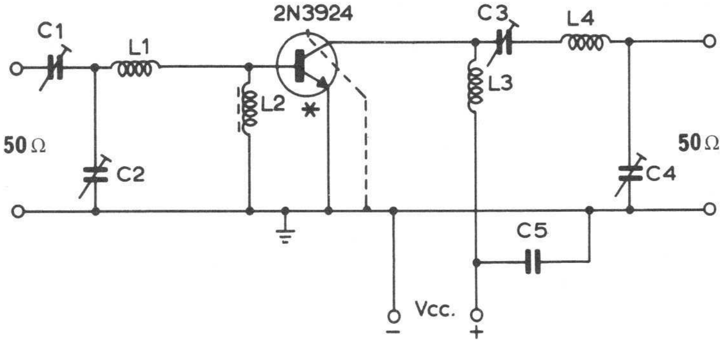
This device incorporates Beryllium Oxide, the dust of which is toxic. The device is entirely safe provided that it is not dismantled.
Care should be taken to ensure that all those who may handle, use or dispose of this device are aware of its nature and of the necessary safety precautions. In particular, it should never be thrown out with general industrial or domestic waste.

DISPOSAL SERVICE

Devices requiring disposal may be returned to Mullard Service Department. They must be separately and securely packed and clearly identified. If any are damaged or broken they MUST NOT be sent through the post. In this case advice is available from the Service Department.

Service Department,
Mullard Limited,
New Road,
Mitcham,
Surrey.

Common emitter test circuit 175MHz (2N3924)



$\left.\begin{array}{l}C_1\\C_2\\C_3\\C_4\end{array}\right\}$ = 4-29pF air trimmer.

C_5 = 10nF polyester.

L_1 = 1 turn of 1mm Cu wire, int. diam. 10mm; Leads: 2×10mm.

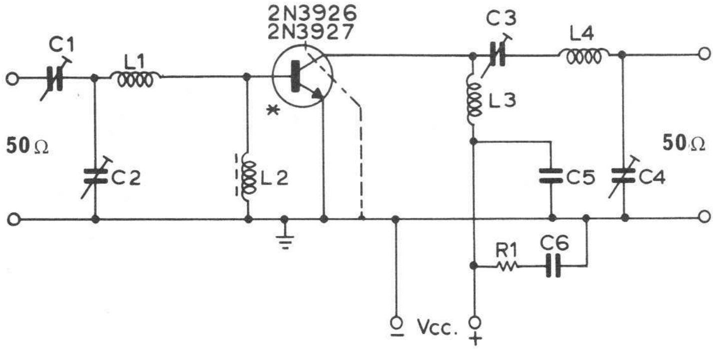
L_2 = Ferroxcube choke coil. Z (at 175MHz) = 550Ω±20%.
(number 4312 020 36641)

L_3 = 15 turns of 0.7mm closely wound enamelled Cu wire, int. diam. 4mm.

L_4 = 3 turns of 1.5mm closely wound enamelled Cu wire, int. diam. 12mm, Leads: 2×20mm.

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

Common emitter test circuit 175MHz (2N3926 - 2N3927)



C_1, C_2, C_3, C_4 = 4-29pF air trimmer.

C_5 = 100pF ceramic.

C_6 = 10nF polyester.

L_1 = 1 turn of 1mm Cu wire, int. diam. 10mm; Leads: 2×10mm.

L_2 = Ferroxcube choke coil. Z (at 175MHz) = 550Ω±20%. (number 4312 020 36641).

L_3 = 15 turns of 0.7mm closely wound enamelled Cu wire, int. diam. 4mm.

L_4 = 2 turns of 1.5mm closely wound enamelled Cu wire, int. diam. 8.5mm. Leads: 2×20mm.

R_1 = 10Ω.

*Emitters of the 2N3926 and 2N3927 are connected to case as short as possible.

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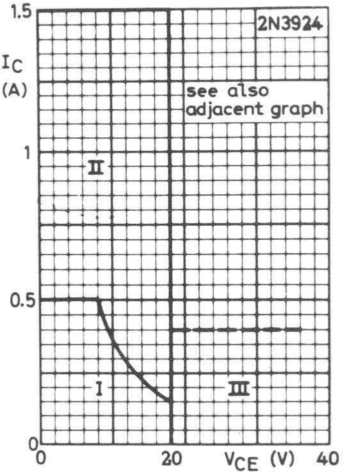
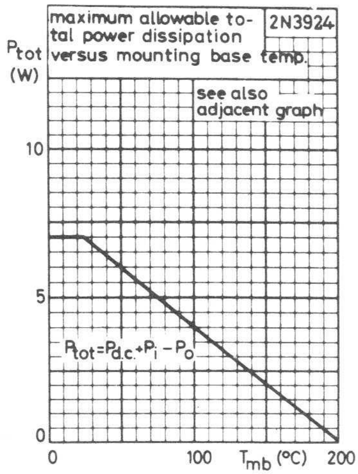
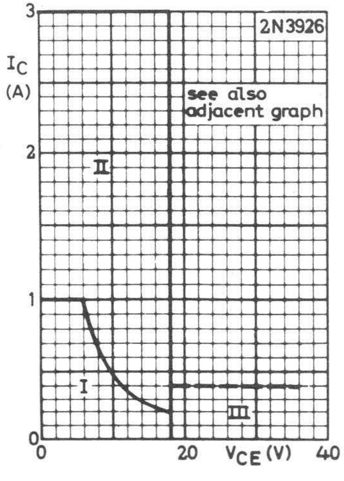
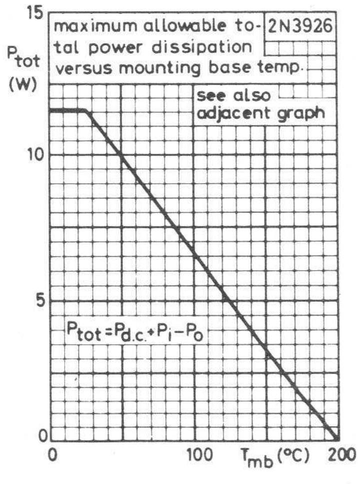
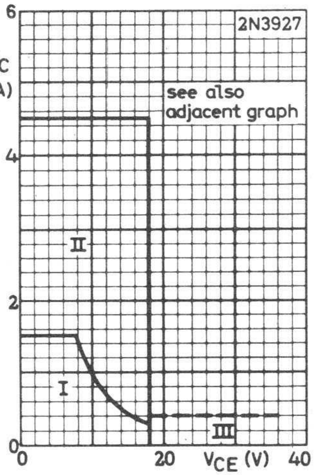
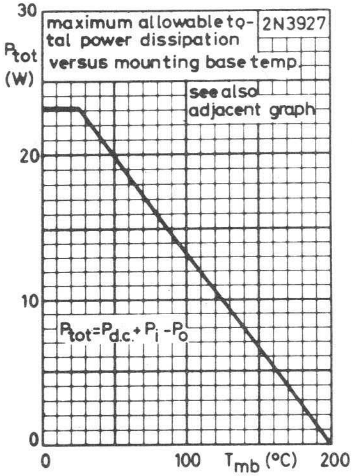

2N3924
see also
adjacent graph
I_C
(A)
1.5
1
0.5
0
II
I
III
0
20
V_{CE} (V)
40


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


2N3926
see also
adjacent graph
I_C
(A)
3
2
1
0
II
I
III
0
20
V_{CE} (V)
40


maximum allowable total power dissipation versus mounting base temp.
2N3926
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





EXPLANATION OF AREAS OF SAFE OPERATION

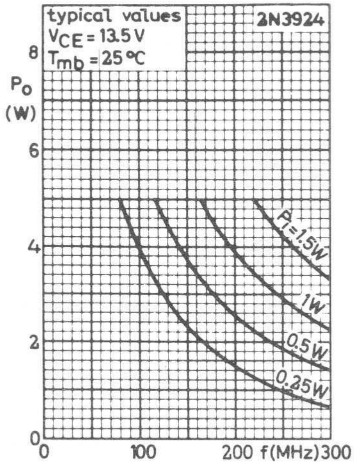
Region I — Operation is allowed under all base-emitter conditions, provided no limiting values are exceeded (d.c. and a.c. operation).

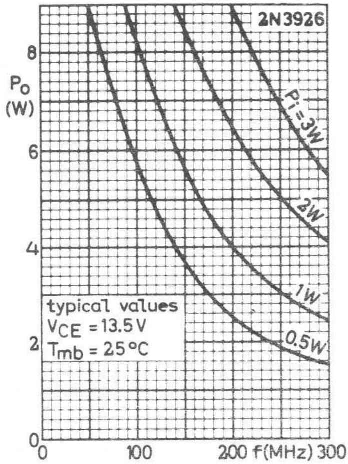
Region II — Operating is allowed under all base-emitter conditions with frequencies $\geqslant$ 1MHz, provided no limiting values are exceeded.
Care must be taken to reduce the d.c. adjustment to region I before removing the a.c. signal.
This may be achieved by an appropriate bias in class A, B or C.

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

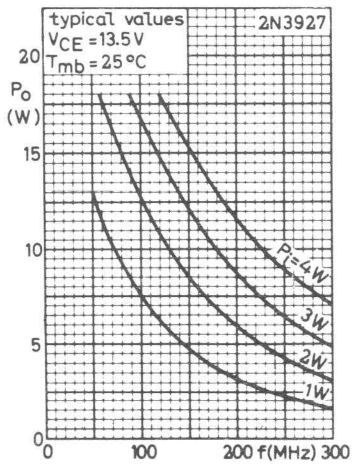
SILICON V.H.F. POWER TRANSISTORS

2N3924 2N3926 2N3927

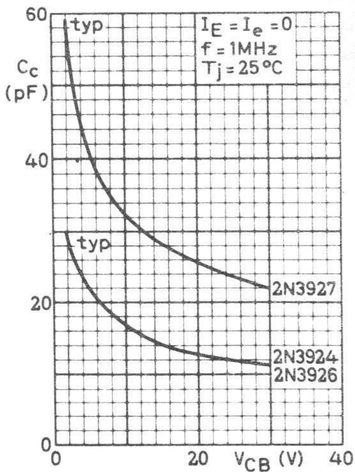




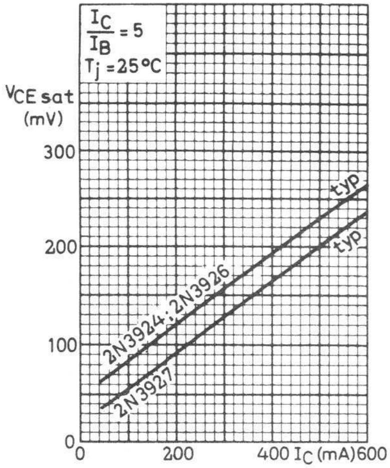
OUTPUT POWER PLOTTED AGAINST FREQUENCY WITH INPUT POWER AS A PARAMETER



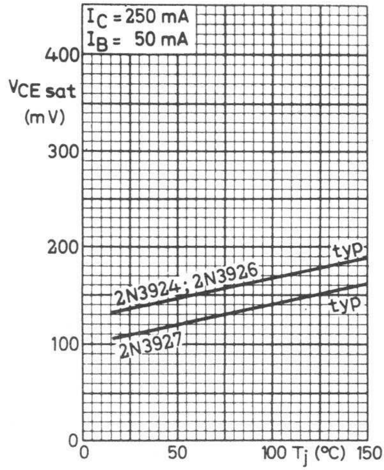
OUTPUT POWER PLOTTED AGAINST FREQUENCY WITH INPUT POWER AS A PARAMETER



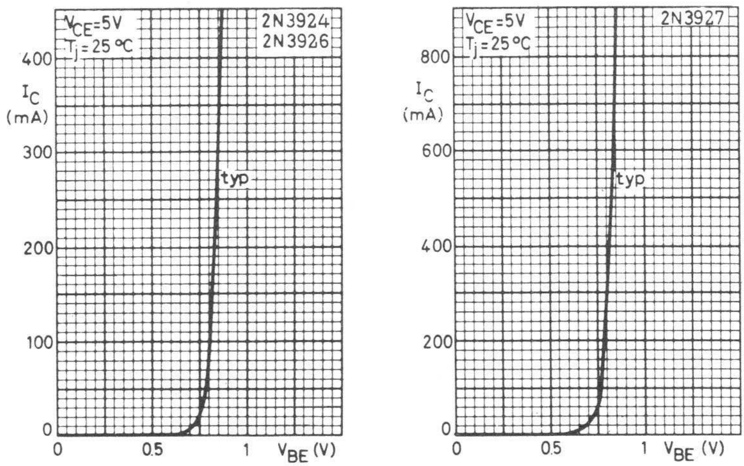
COLLECTOR CAPACITANCE PLOTTED AGAINST COLLECTOR-BASE VOLTAGE



COLLECTOR-EMITTER SATURATION VOLTAGE PLOTTED AGAINST COLLECTOR CURRENT

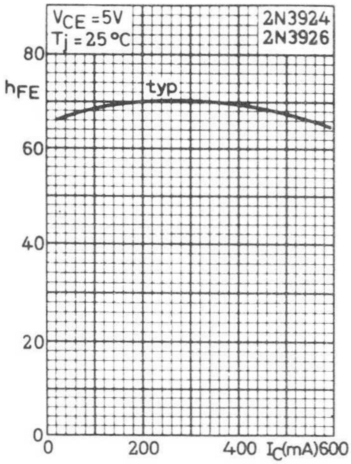


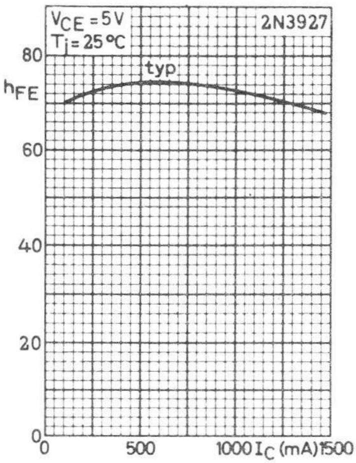
COLLECTOR-EMITTER SATURATION VOLTAGE PLOTTED AGAINST JUNCTION TEMPERATURE



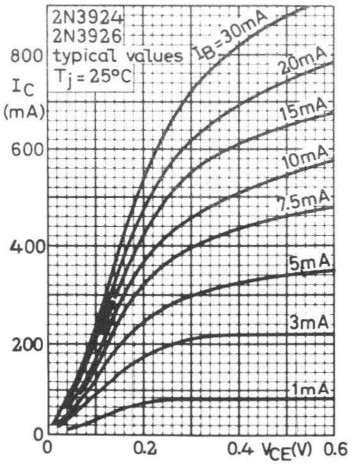
COLLECTOR CURRENT PLOTTED AGAINST BASE-EMITTER VOLTAGE

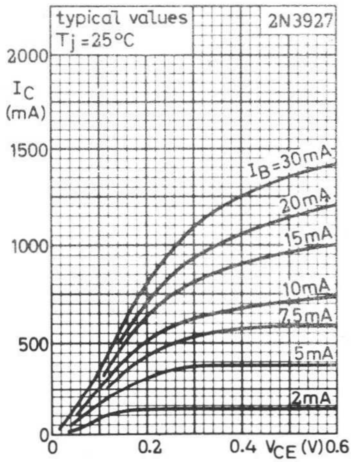
Mullard



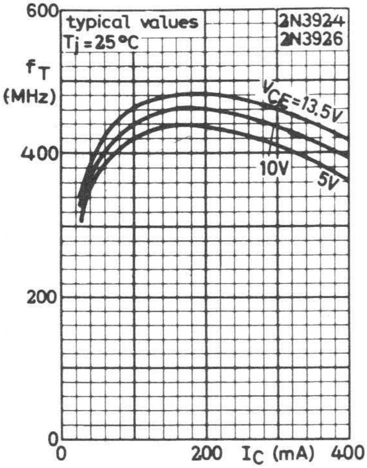


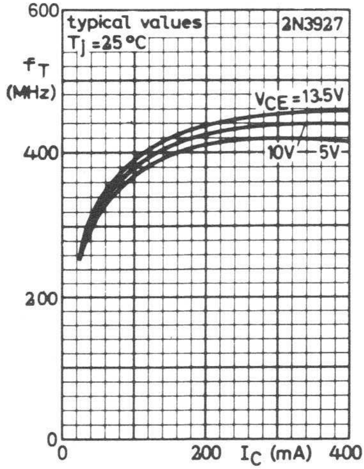
LARGE SIGNAL FORWARD CURRENT TRANSFER RATIO PLOTTED AGAINST COLLECTOR CURRENT



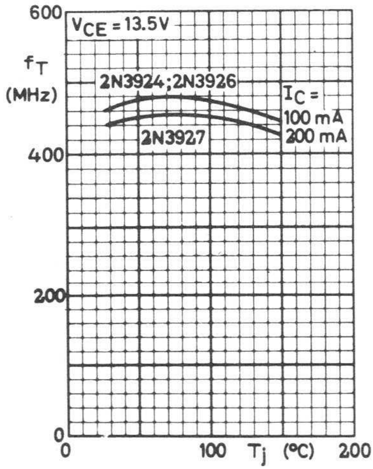


COLLECTOR CURRENT PLOTTED AGAINST COLLECTOR-EMITTER VOLTAGE WITH BASE CURRENT AS A PARAMETER





TRANSITION FREQUENCY PLOTTED AGAINST
COLLECTOR CURRENT WITH COLLECTOR-EMITTER
VOLTAGE AS A PARAMETER



TRANSITION FREQUENCY
PLOTTED AGAINST
JUNCTION TEMPERATURE

N-P-N SILICON PLANAR EPITAXIAL U.H.F. TRANSISTOR

2N4427

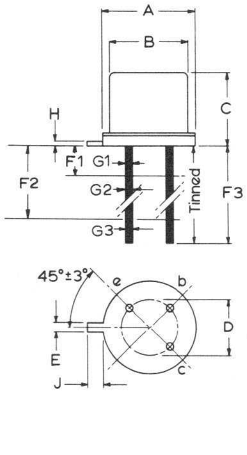
N-P-N silicon planar epitaxial transistor primarily intended for use in the output, driver and pre-driver stages of class A, B or C amplifiers, frequency multipliers and oscillators of v.h.f. and u.h.f. equipment.
Encapsulated in a metal TO-39 envelope with the collector connected to the case.

QUICK REFERENCE DATA

V_{CER} max.	40	V
V_{CEO} max.	20	V
I_C max.	400	mA
P_{tot} max. ($T_{case} \leq 25^{o}C$)	3.5	W
T_j max.	200	^{o}C
f_T typ. ($I_C = 25mA$, $V_{CE} = 10V$, $f = 100MHz$)	700	MHz
P_o typ. ($P_i < 100mW$, $V_{CE} = 12V$, $f = 175MHz$)	1.0	W
η min. ($P_o = 1.0W$, $V_{CE} = 12V$, $f = 175MHz$)	50	%

OUTLINE AND DIMENSIONS

Conforms to B.S. 3934 SO-3/SB3-3B
J.E.D.E.C. TO-39



Collector connected to case

	Millimetres		
	Min.	Typ.	Max.
A	9.10	-	9.40
B	8.2	-	8.5
C	6.15	-	6.60
D	-	5.08	-
E	0.71	-	0.86
F1	-	-	0.51
F2	12.7	-	-
F3	12.7	-	15
G1	-	-	1.01
G2	0.41	-	0.48
G3	-	-	0.53
H	-	0.4	-
J	0.74	-	1.01

RATINGS

Limiting values of operation according to the absolute maximum system.

Electrical

V_{CBO} max.	40	V
V_{CER} max. ($R_{BE}=10\Omega$)	40	V
V_{CEO} max.	20	V
V_{EBO} max.	2.0	V
I_C max.	400	mA
I_{CM} max.	400	mA
P_{tot} max. ($T_{case}\leq 25^{\circ}C$)	3.5	W

Temperature

T_{stg} min.	-65	$^{\circ}C$
T_{stg} max.	200	$^{\circ}C$
T_j max.	200	$^{\circ}C$

THERMAL CHARACTERISTICS

$R_{th(j-amb)}$	In free air	200	degC/W
$R_{th(j-case)}$		35	degC/W
$R_{th(case-h)}$	Mounted with a top clamping washer of accessory 56218	1.0	degC/W
$R_{th(case-h)}$	Mounted with a top clamping washer of accessory 56218 and a boron nitride washer for electrical insulation	1.2	degC/W

ELECTRICAL CHARACTERISTICS ($T_j = 25^{\circ}C$ unless otherwise stated)

		Min.	Typ.	Max.	
I_{CEO}	Collector cut-off current $V_{CE}=12V$, $I_B=0$	-	-	20	μA
$V_{(BR)CBO}$	Collector-base breakdown voltage $I_C=100\mu A$, $I_E=0$	40	-	-	V
	Collector-emitter breakdown voltages				
$V_{(BR)CER}$	$I_C=5.0mA$, $R_{BE}=10\Omega$	40	-	-	V
$V_{(BR)CEO}$	$I_C=5.0mA$, $I_B=0$	20	-	-	V
$V_{(BR)EBO}$	Collector-base breakdown voltage $I_E=100\mu A$, $I_C=0$	2.0	-	-	V

ELECTRICAL CHARACTERISTICS (cont'd)

		Min.	Typ.	Max.	
$V_{CE(sat)}$	Collector-emitter saturation voltage				
	$I_C = 100mA$, $I_B = 20mA$	-	-	0.5	V
h_{FE}	Static forward current transfer ratio				
	$I_C = 100mA$, $V_{CE} = 5.0V$	10	-	200	
	$I_C = 360mA$, $V_{CE} = 5.0V$	5	-	-	
f_T	Transition frequency				
	$I_C = 25mA$, $V_{CE} = 10V$, $f = 100MHz$	-	700	-	MHz
C_{tc}	Collector capacitance				
	$V_{CB} = 12V$, $I_E = I_e = 0$, $f = 1.0MHz$	-	-	4.0	pF

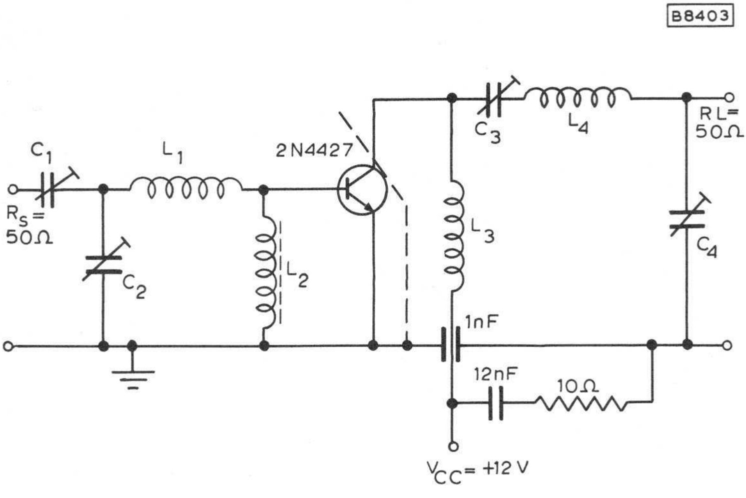
Typical r.f. performance

$V_{CE} = 12V$, $T_{case} = 25^{o}C$

f	Frequency	175*	470	MHz
P_i	Input power	< 100	100	mW
I_C	Collector current	< 167	67	mA
P_o	Output power	1.0	0.4	W
η	Efficiency	> 50	50	%

*The transistor can withstand a load mismatch having a v.s.w.r. of 3, varied through all phases for conditions as given above (see also test circuit)

Common emitter test circuit (f = 175MHz)



Components

C_1, C_2, C_3, C_4 = 4 to 29pF air trimmers

L_1 = 2 turns of 1mm Cu wire, int. dia. 6mm, winding pitch 2mm, leads 2 × 10mm

L_2 = ferroxcube choke coil (Z = 550Ω at 175MHz)

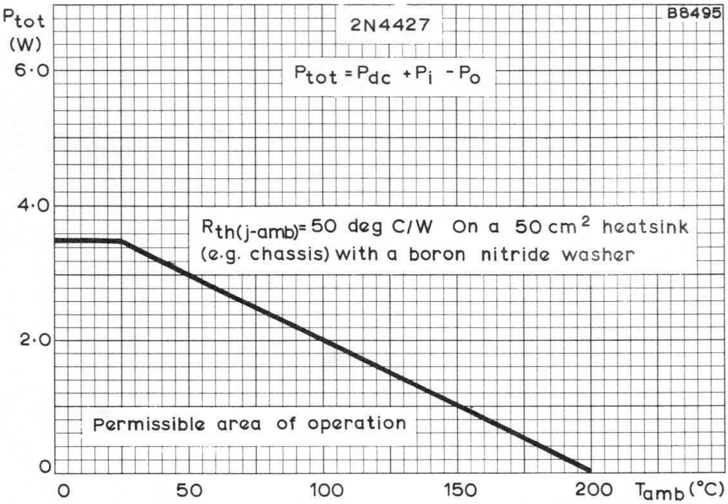
L_3 = 2 turns of 1mm Cu wire, int. dia. 5mm, winding pitch 2mm, leads 2 × 10mm

L_4 = 3 turns of 1.5mm Cu wire, int. dia. 10mm, winding pitch 2mm, leads 2 × 15mm

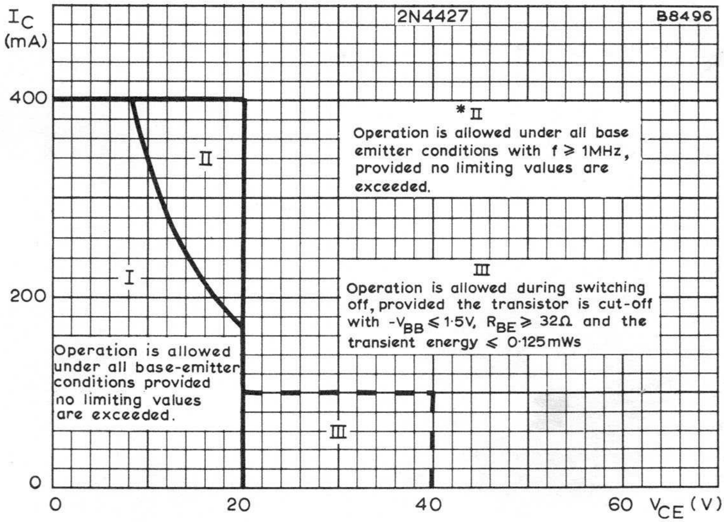
The length of the external emitter wire of the 2N4427 is 1.6mm

N-P-N SILICON PLANAR EPITAXIAL U.H.F. TRANSISTOR

2N4427

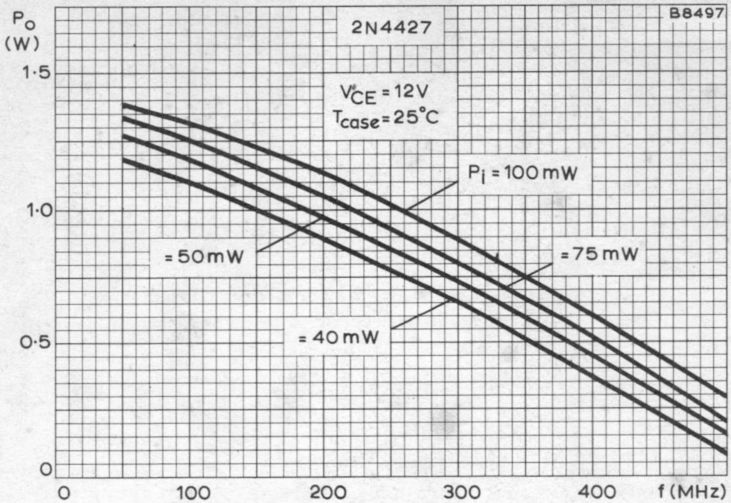


MAXIMUM TOTAL DISSIPATION PLOTTED AGAINST AMBIENT TEMPERATURE

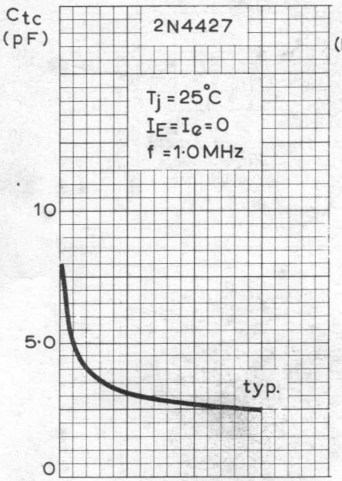


AREAS OF SAFE OPERATION

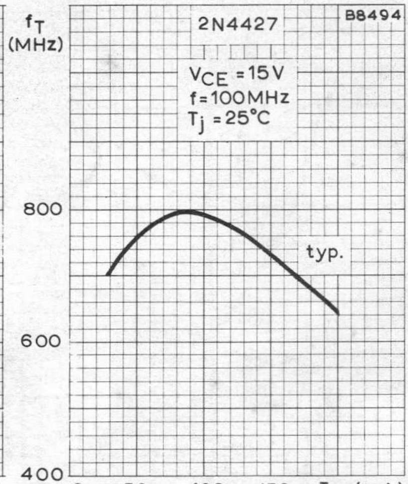
*II Care must be taken to reduce the steady state current to region I before removing the a.c. signal. This may be achieved by appropriate bias in class A, B or C.



TYPICAL VARIATION OF OUTPUT POWER WITH FREQUENCY AND INPUT POWER



Collector capacitance versus collector-base voltage



Transition frequency versus collector current