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.

Collector voltage

	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

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

	OC28	OC29	OC35	OC36	
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

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

†Averaged over any 20ms period.

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

		Typical production spread Min.	Typ.	Max.	
Common base					
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

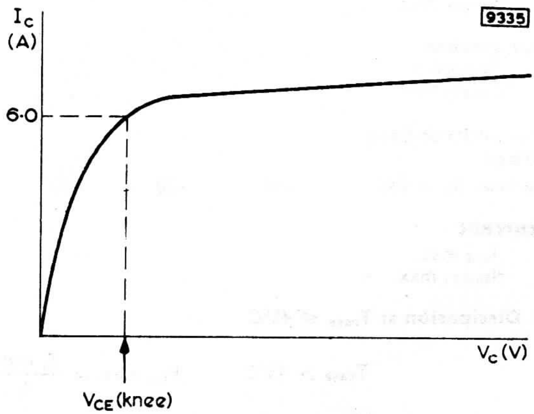


Fig. 1

		OC28		OC29		OC35		OC36		
Base current	I_B	*min.*	*max.*	*min.*	*max.*	*min.*	*max.*	*min.*	*max.*	
(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

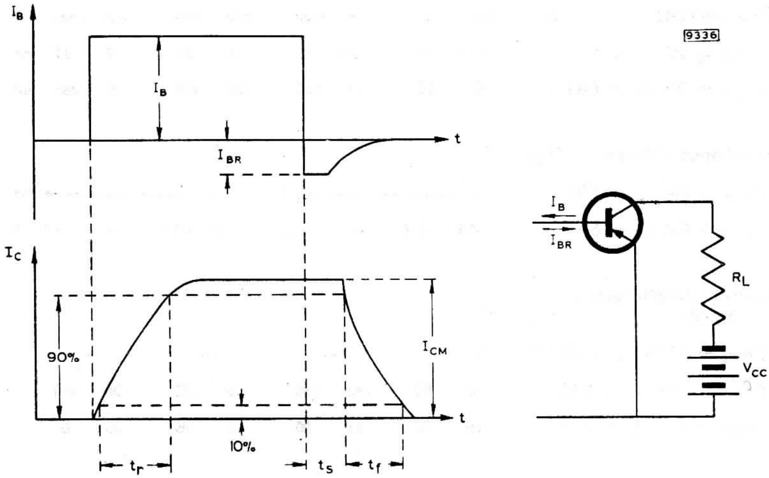


Fig. 2

		OC29	OC35	OC29	OC35	OC28	OC36	OC28	OC36	
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
'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 $$t_r = \frac{\beta}{\omega 1} \log_e \frac{h_{FE}\,|I_B|}{h_{FE}\,|I_B| - |I_{CM}|}$$

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

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

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

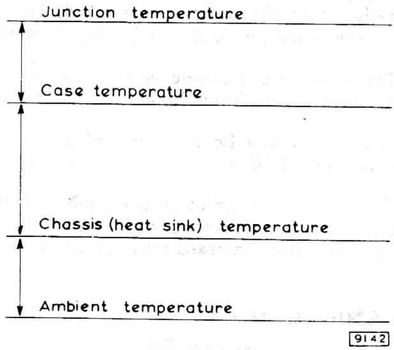


Fig. 3

*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, θ_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.

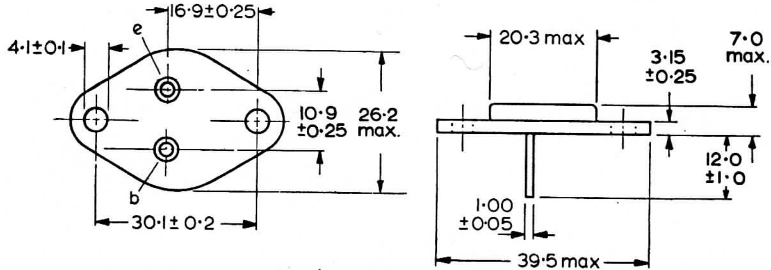
Average weight { 0.66 oz / 18.6 g

ACCESSORIES

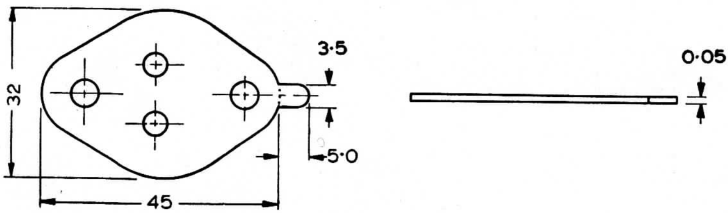
Accessories must be specifically ordered.

Accessory	Code No.	Notes
2 insulating bushes	56201a	Obtainable in packs for
1 mica washer	56201b	10 or 100 transistors.
1 metal washer	56214	

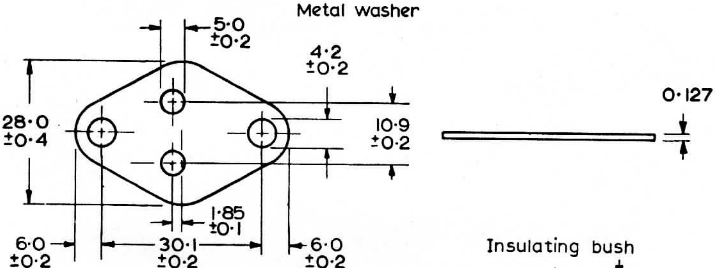
Transistor

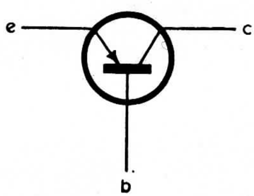


Mica washer

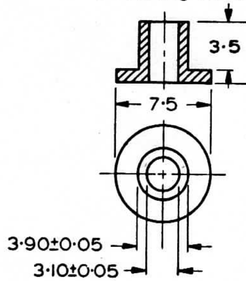


Metal washer





Insulating bush



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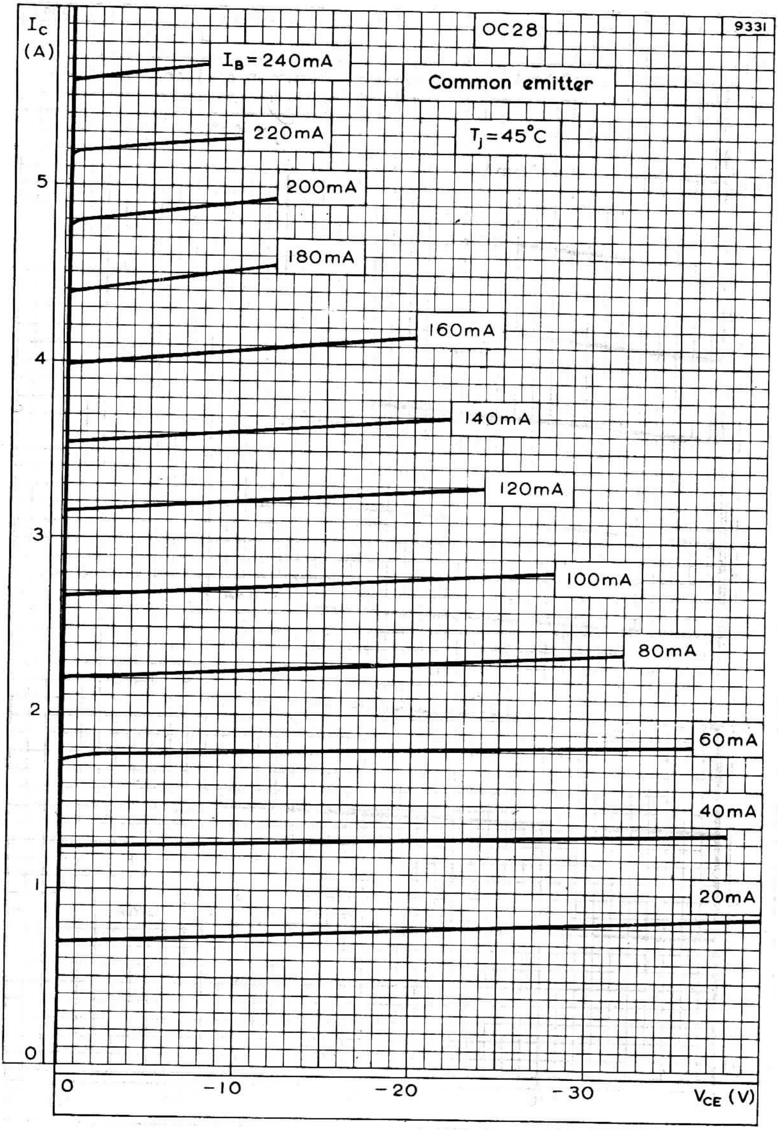
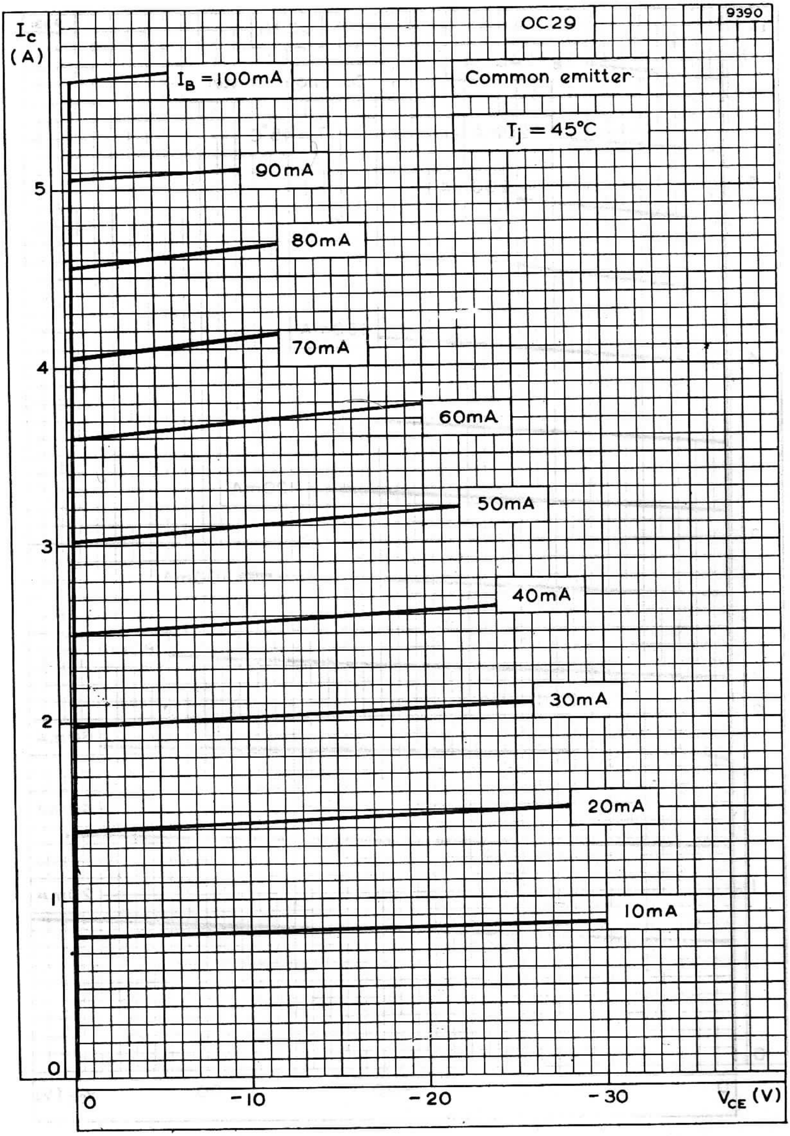
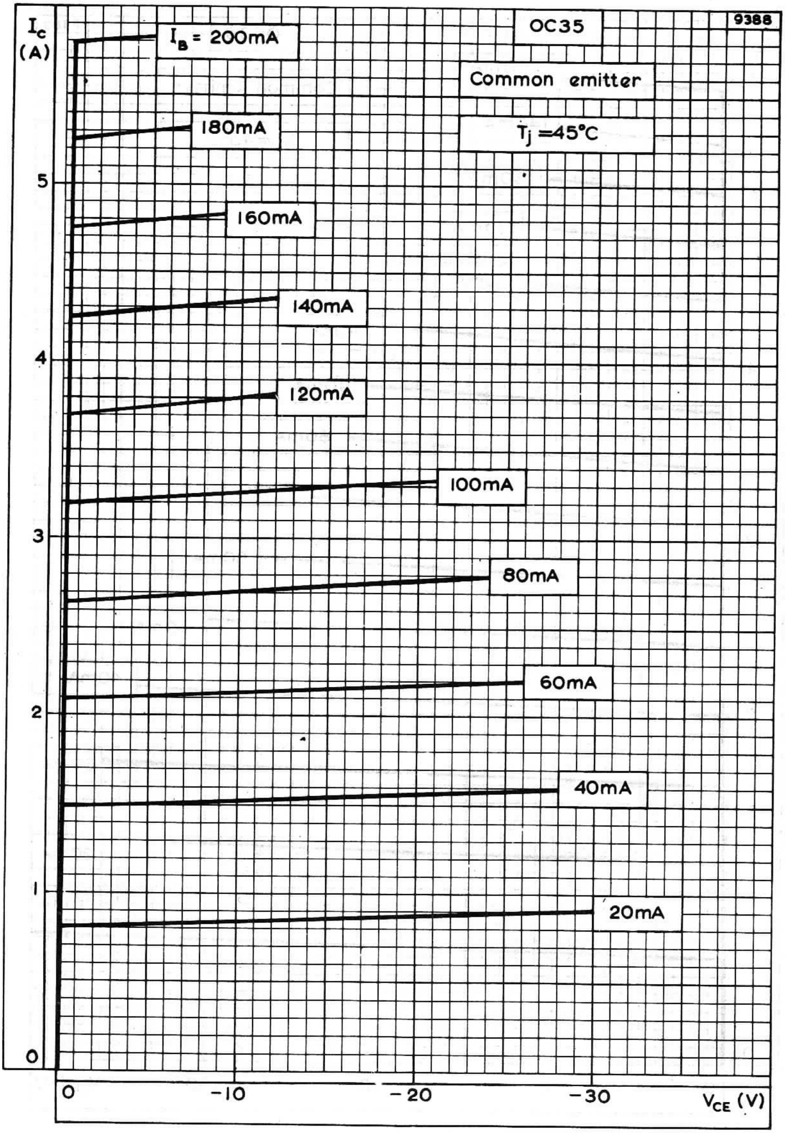
All dimensions in mm



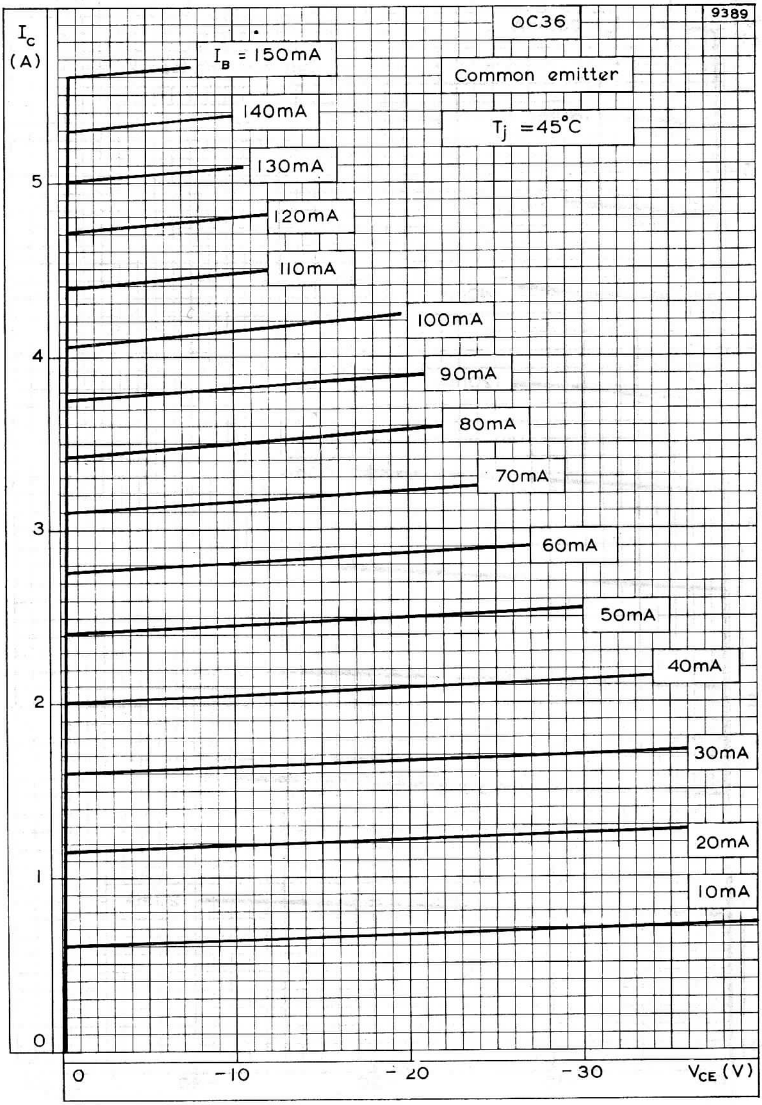
OUTPUT CHARACTERISTIC FOR OC28. COMMON EMITTER



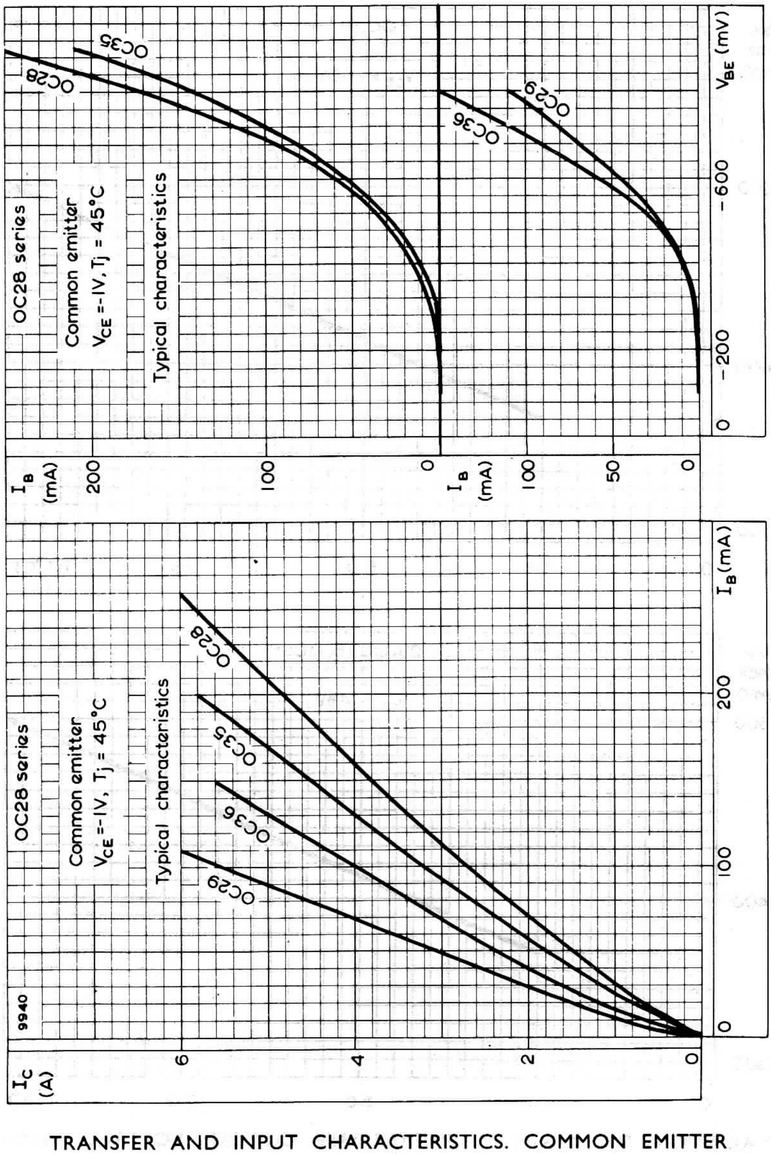
OUTPUT CHARACTERISTIC FOR OC29. COMMON EMITTER



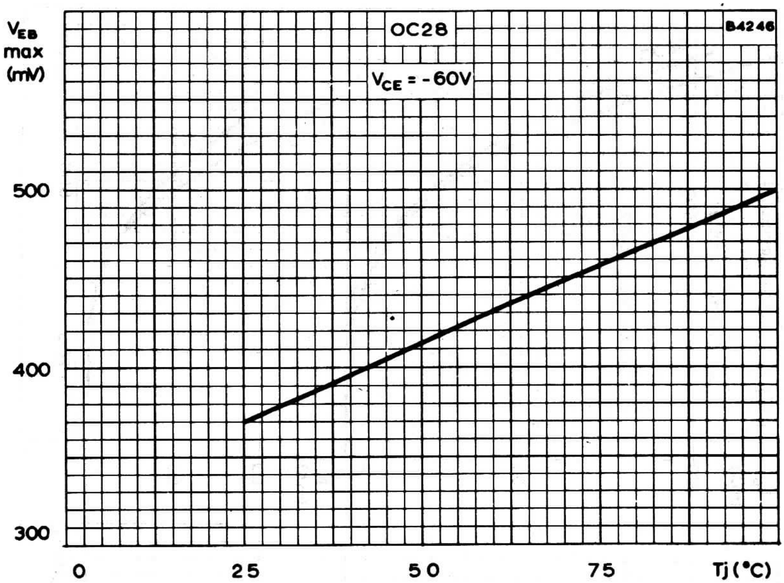
OUTPUT CHARACTERISTIC FOR OC35. COMMON EMITTER

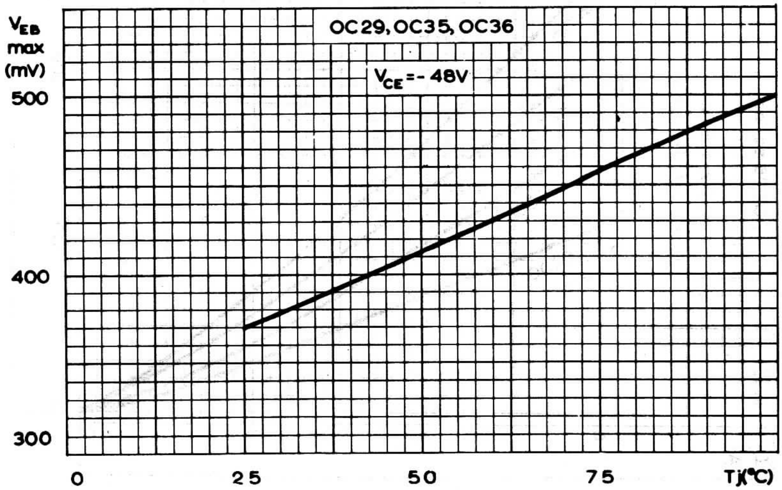


OUTPUT CHARACTERISTIC FOR OC36. COMMON EMITTER

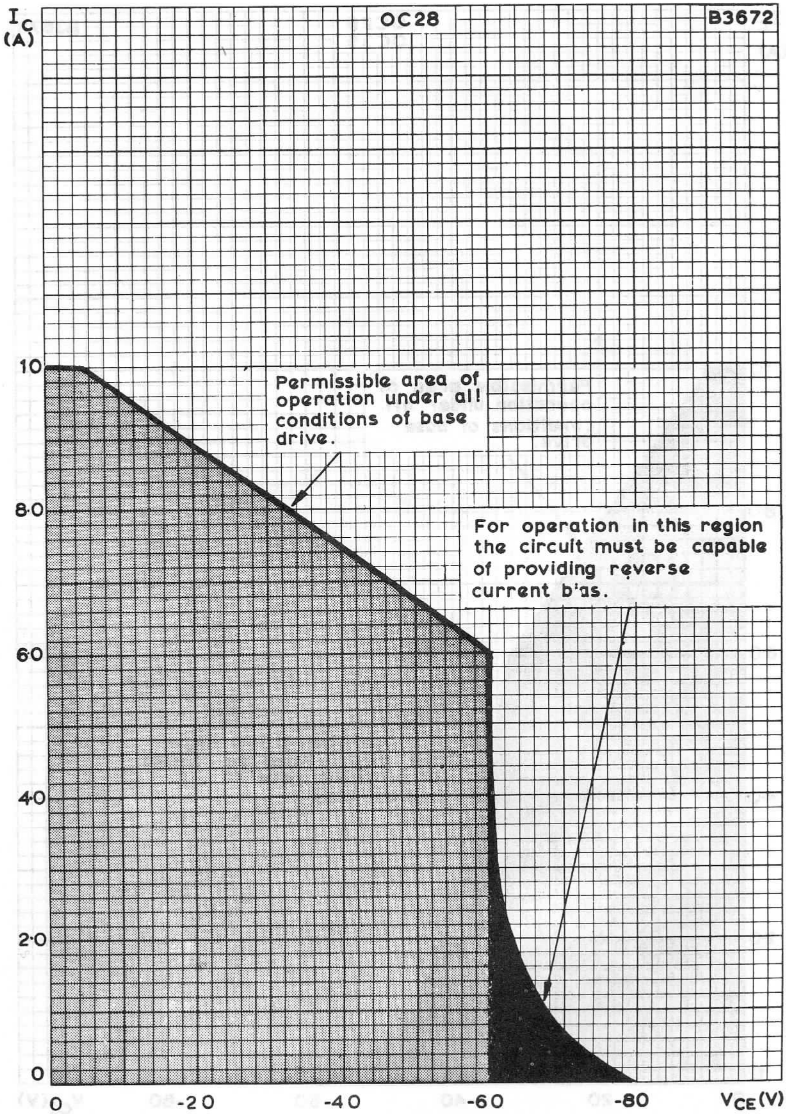


TRANSFER AND INPUT CHARACTERISTICS. COMMON EMITTER

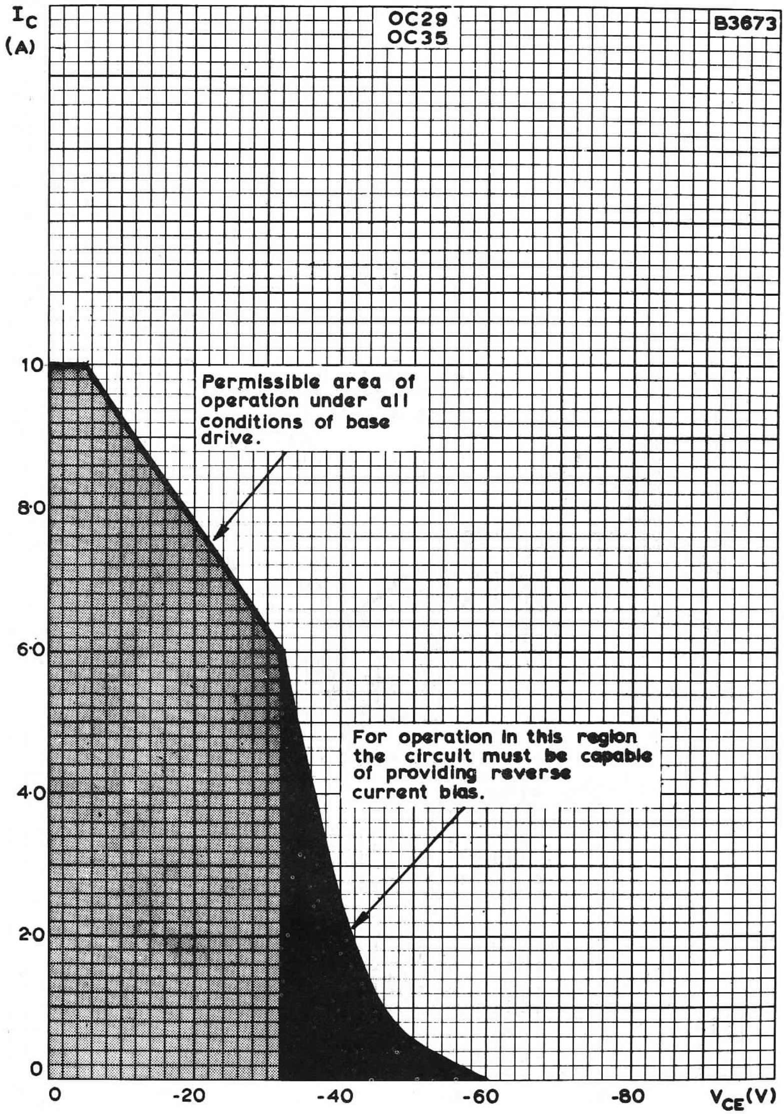




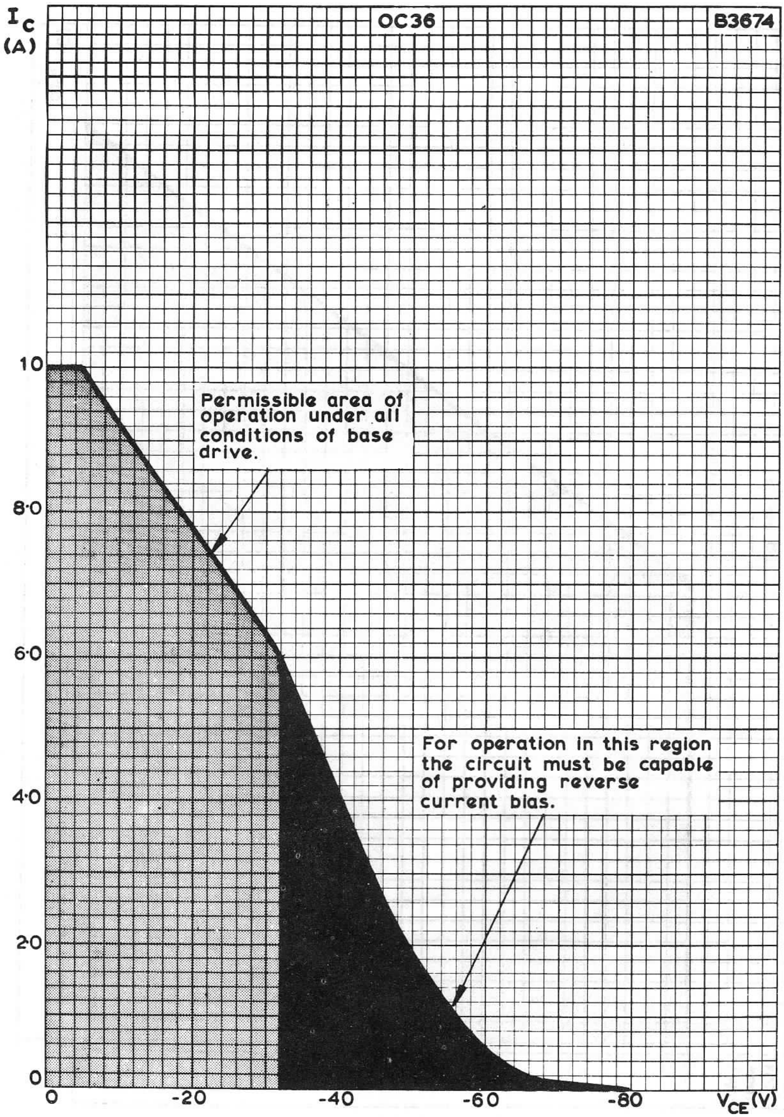
VARIATION OF MAXIMUM EMITTER-BASE CUT-OFF VOLTAGE WITH JUNCTION TEMPERATURE



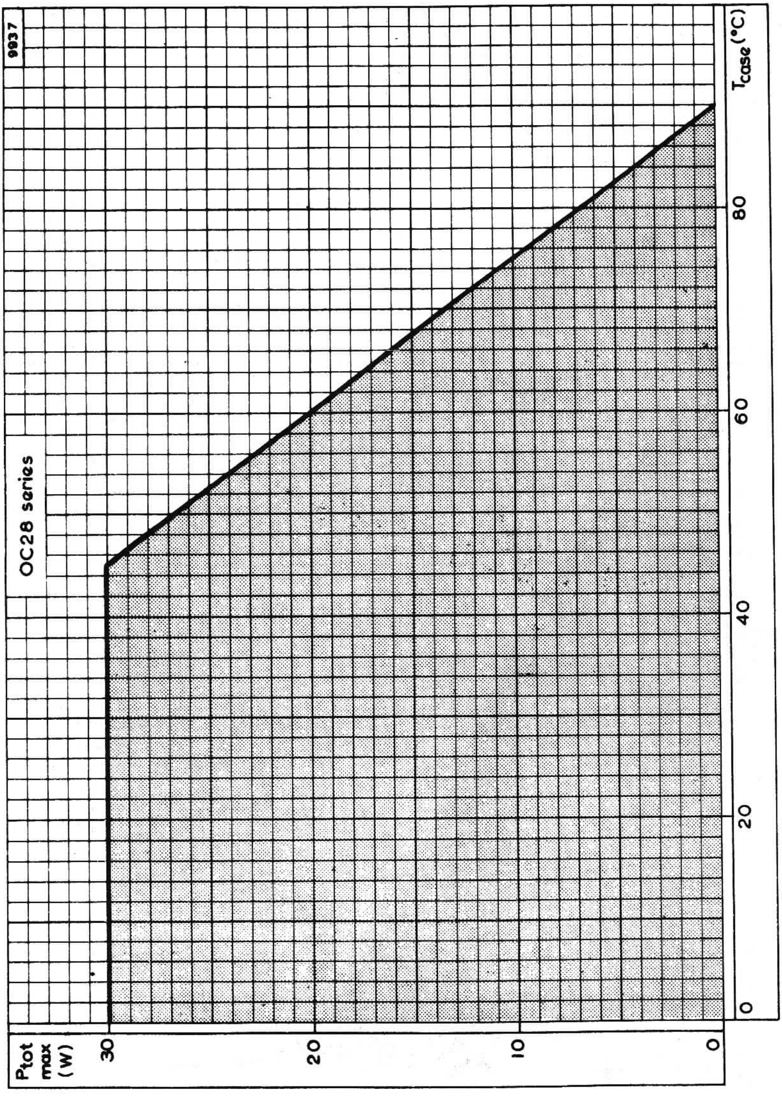
COLLECTOR CURRENT PLOTTED AGAINST ABSOLUTE MAXIMUM COLLECTOR-EMITTER VOLTAGE. OC28



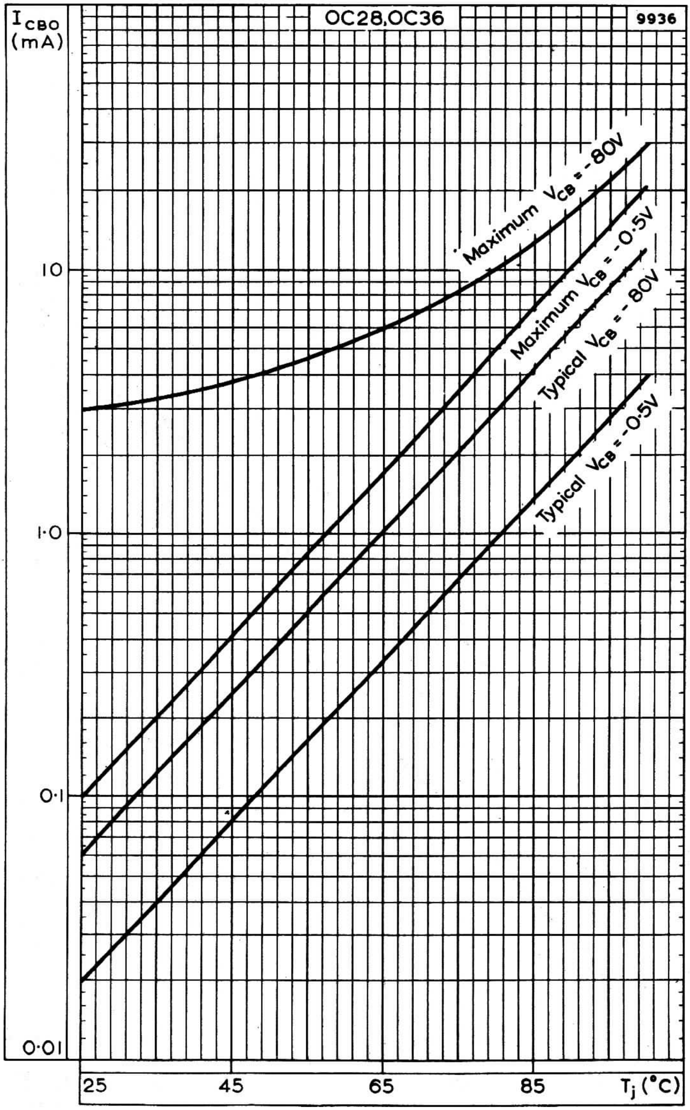
COLLECTOR CURRENT PLOTTED AGAINST ABSOLUTE MAXIMUM COLLECTOR-EMITTER VOLTAGE. OC29, OC35



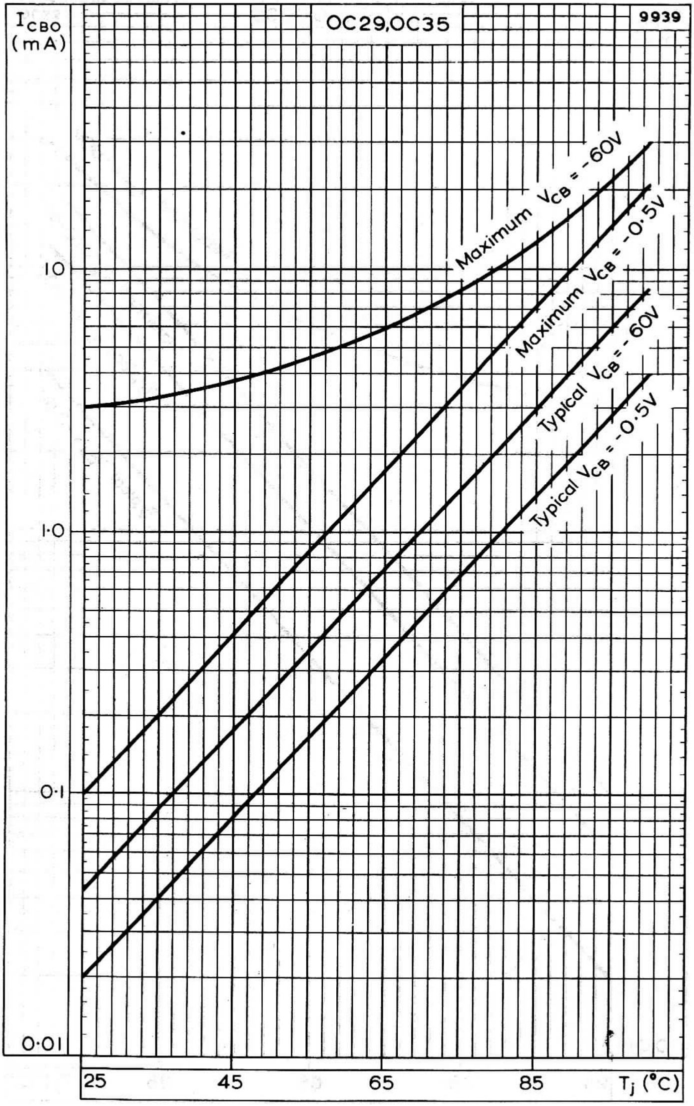
COLLECTOR CURRENT PLOTTED AGAINST ABSOLUTE MAXIMUM COLLECTOR-EMITTER VOLTAGE. OC36



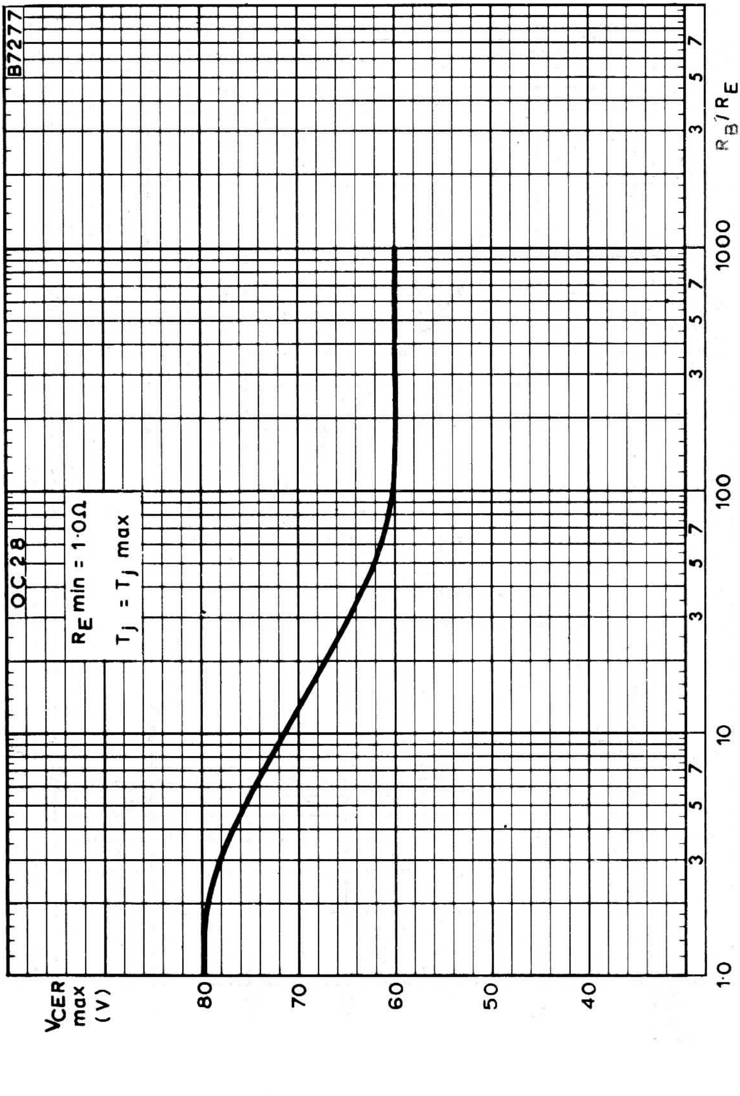
MAXIMUM TOTAL DISSIPATION PLOTTED AGAINST CASE TEMPERATURE



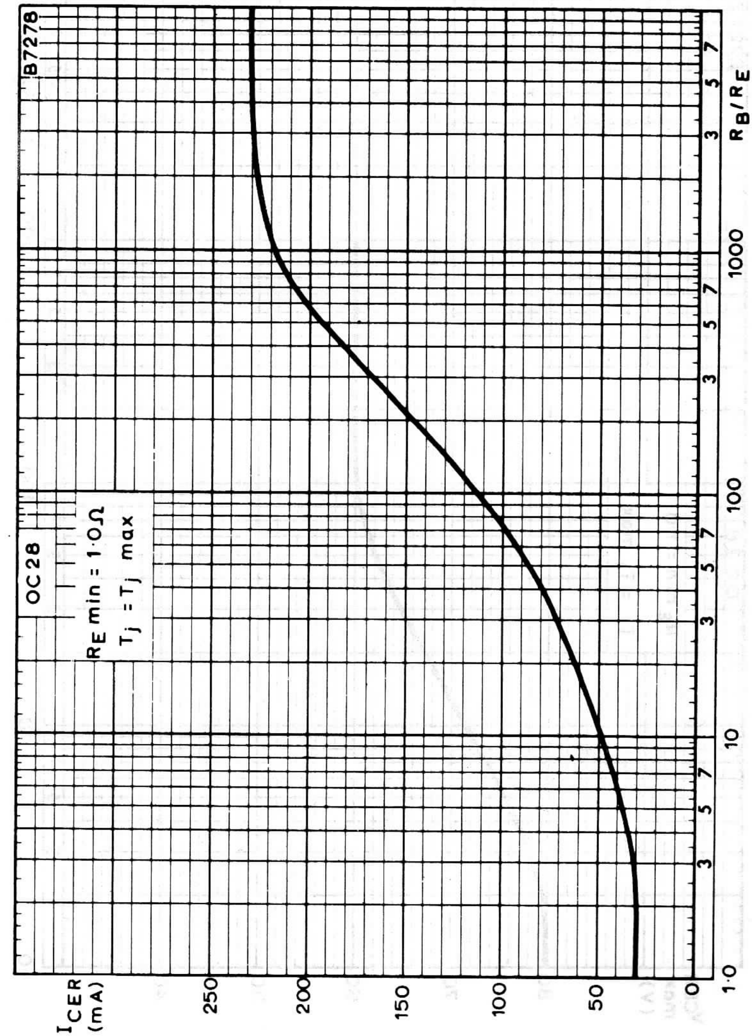
VARIATION OF I_{CBO} WITH JUNCTION TEMPERATURE. OC28, OC36



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