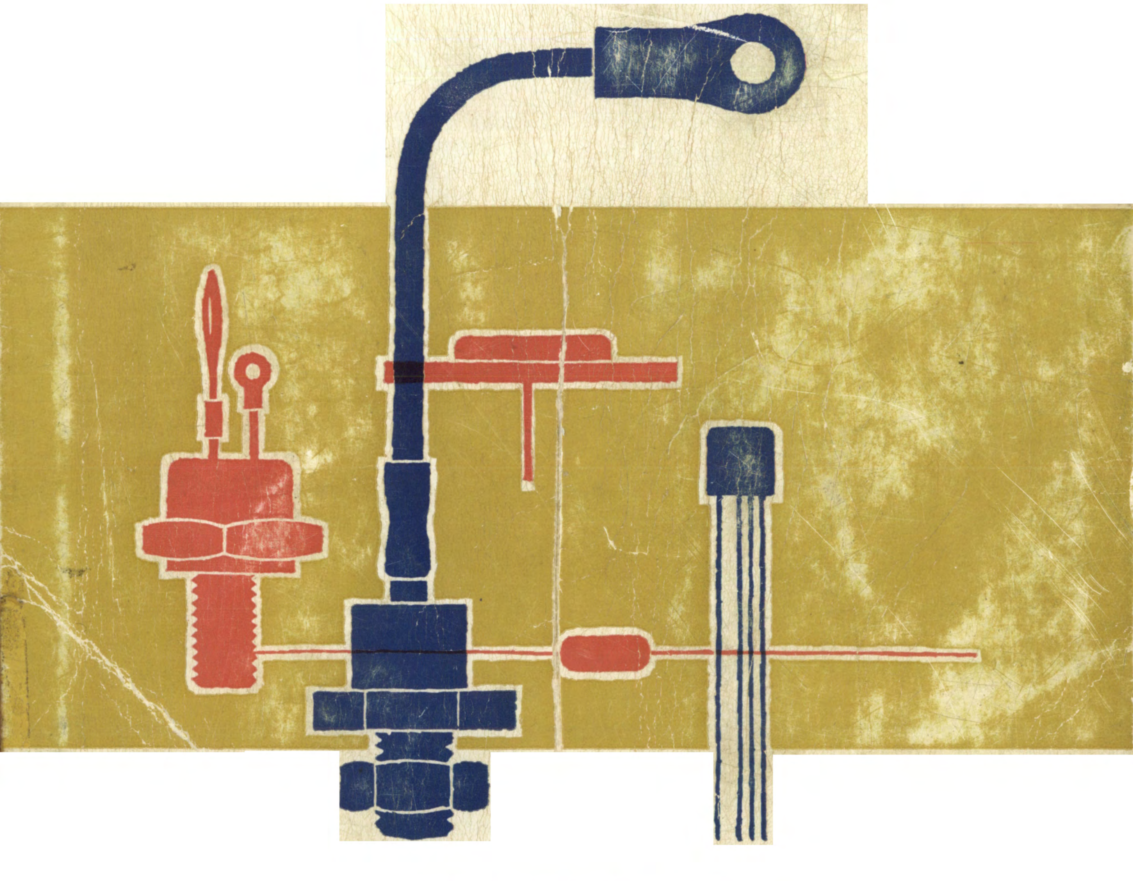
OCTOBER 1965

PHILIPS SEMICONDUCTOR HANDBOOK



PHILIPS ELECTRON TUBE DIVISION

II. VOLTAGES (continued)

Supply voltages are indicated by repeating the first index. The electrode with respect to which the voltage is measured is then indicated by the third subscript. Where difficulties might arise, the supply voltage may be indicated by subscript S.

Base voltage in common emitter circuits . .	V_{BE}	or V_{be}
Collector voltage in common base circuits	V_{CB}	or V_{cb}
Collector supply voltage in common base circuits	V_{CCB}	
Collector supply voltage in common emitter circuits	V_{CCE}	
Collector voltage in common emitter circuits	V_{CE}	or V_{ce}
Collector knee voltage in common emitter circuits	V_{CEK}	
Diode voltage	V_D	or V_d
HF voltage		V_{hf}
A.C. input voltage		V_i
A.C. output voltage		V_o
Oscillator voltage		V_{osc}
Supply voltage	V_S	

III. CURRENTS

A current flowing in the conventional direction from the external circuit into the electrode is called positive.

Base current	I_B	or I_b
Collector current	I_C	or I_c
Collector current in common base circuit when $I_E=0$	I_{CBO}	
Collector current in common emitter circuit when $I_B=0$	I_{CEO}	
Diode current	I_D	or I_d
Emitter current.	I_E	or I_e
Emitter current in common base circuit when $I_C=0$	I_{EBO}	
A.C. input current		I_i
A.C. output current.		I_o
Current of supply voltage source	I_S	
Surge current.	I_{surge}	

IV. POWERS

Collector dissipation	P_C	
A.C. power supplied by collector		P_c
A.C. input power of a circuit.		P_i
A.C. output power of a circuit		P_o
Power supplied by voltage source.	P_S	

V. CAPACITANCES

Shunt capacitance of a diode		C_{dk}
Load capacitance		[illegible]

VI. RESISTANCES

External resistance in the base lead	R_B	or r_b
Equivalent internal base resistance.		r_b
External resistance between base and emitter	R_{BE}	or R_{be}
External resistance in the collector lead . .	R_C	or R_c
Equivalent internal collector resistance. . .		r_c
Matching resistance of a push-pull amplifier (collector to collector)		R_{cc}
R.F. damping resistance of a diode circuit .		r_d
External resistance in the emitter lead . . .	R_E	or R_e
Equivalent internal emitter resistance . . .		r_e
Load resistance		R[illegible]
Equivalent internal transfer resistance of a transistor		[illegible]

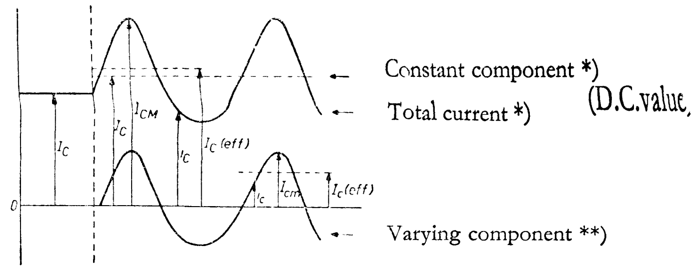
I. BASIC SYMBOLS

	Current		I or i
	Voltage		V or v
	Power		P or p
	Peak value		M or m
	R.M.S. value		eff
	Average or D.C. value		—[1]
	Input	subscript	i
	Output	subscript	o
Crystal Diodes	Cathode		K or k
	Anode		D or d
Transistors	Base		B or b
	Emitter		E or e
	Collector		C or c

The way in which these symbols are used is shown in fig. 1. In this figure a varying collector current is shown with its constant (D.C.) component[2]) and its varying (A.C.) component. The same can be done with other currents and with voltages and powers.

The following table may be used for indicating the various quantities:

Instantaneous values	lower case letters	i, v or p
Average (D.C.) values	capitals	I, V or P
R.M.S. values	capitals with the addition	I, V or P eff
Peak values	capitals with the subscript	I, V or P M or m[3])
Total currents, voltages or powers or their coo-stant components	are used with capital subscripts	K,D,B,E,C
Varying components	are used with lower case subscripts	k,d,b,e,c



*) Capital suffixes **) Lower case suffixes

Fig. 1

I_C	D.C. value	of total current
I_{CM}	peak value	
I_C (eff)	R.M.S. value	
i_C	instantaneous value	
I_{cm}	peak value	of varying component
I_c (eff)	R.M.S. value	
i_c	instantaneous value	

II. VOLTAGES

Voltages are indicated by the symbols V or v with two subscripts, the first of which indicates the electrode at which the voltage is measured and the second one the electrode with respect to which the voltage is measured (usually the common electrode in the case of transistors). When no confusion has to be feared, the second subscript may be omitted.

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[1]) The average value is understood when no symbol is used for R.M.S. or peak value.

[2]) The constant component is the same as the average value of the concerning quantity.

[3]) The capital subscript M is used after the capital subscripts K,D,B,E,C. The lower case subscript m is used after the lower case subscripts k,d,b,e,c.

VII. ADMITTANCES

Input admittance of a circuit	g_i
Output admittance of a circuit	g_o

VIII. FREQUENCIES

Cutt-off frequency of α_{fb} (= frequency at which the value of α_{fb} is 3dB below its D.C. value α_{FB})	$f_{\alpha b}$
Cut-off frequency of α_{fe} (= frequency at which the value of α_{fe} is 3dB below its D.C. value α_{FE})	$f_{\alpha e}$
Resonant frequency	f_o

IX. TEMPERATURES

Ambient temperature	T_{amb}
Junction temperature of a transistor	T_j
Variation of the junction temperature	$\triangle T_j$

X. h-PARAMETERS

Common base circuit

Input impedance, output short-circuited	h_{11b} or h_{ib}
Reverse voltage ratio, input open	h_{12b} or h_{rb}
Current transfer ratio, output short-circuited	$-h_{21b}$ or $-h_{fb}$
Output admittance, input open	h_{22b} or h_{ob}

Common emitter circuit

Input impedance, output short-circuited	h_{11e} or h_{ie}
Reverse voltage ratio, input open	h_{12e} or h_{re}
Current transfer ratio, output short-circuited	h_{21e} or h_{fe}
Output admittance, input open	h_{22e} or h_{oe}

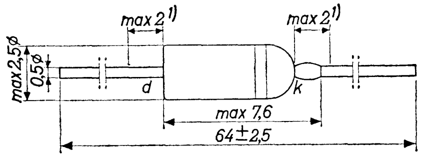
XI. VARIOUS SYMBOLS

Bandwidth	B
Distortion factor	d
Noise factor	F
Heat resistance	K
Averaging time of voltage and currents	t_{av}
Current gain factor of a transistor in common base circuits	α_{FB} or α_{fb}
Current gain factor of a transistor in common emitter circuits	α_{FE} or α_{fe}
Duty factor	δ
Efficiency	η
Wavelength	λ

Semiconductor diodes

POINT-CONTACT GERMANIUM DIODE in miniature all-glass construction for use in A.M. detector and ratio detector circuits

Dimensions in mm   The white band indicates the cathode side



LIMITING VALUES (Absolute max. values)

			T_{amb} =	25 °C	60 °C
Inverse voltage					
Average value (averaging time max. 50 msec)	$-V_D$	= max.		30 V	30 V
	(t_{av}	= max.		50 msec	50 msec)
Peak value	$-V_{DM}$	= max.		45 V	45 V
Forward current					
Average value (averaging time max. 50 msec) (See page D)	I_D	= max.		35 mA	15 mA
	(t_{av}	= max.		50 msec	50 msec)
Peak value	I_{DM}	= max.		100 mA	100 mA
Surge current (max. duration 1 sec)	I_{Dsurge}	= max.		200 mA	200 mA
	(t	= max.		1 sec	1 sec)

Temperatures

Storage temperature	T_S =	-55 °C to +75 °C
Operating ambient temperature	T_{amb} =	-55 °C to +60 °C

THERMAL DATA

Thermal resistance from junction to ambience in free air   K = max. 0.45 °C/mW

1) Not tinned

CHARACTERISTICS at T_{amb} = 25 °C

Forward current (I_D)	Forward voltage (V_D) =	Forward voltage (V_D) max.
0.1 mA	= 0.23 V	< 0.30 V
1 mA	= 0.56 V	< 0.88 V
30 mA	= 2.8 V	< 4.0 V 1)

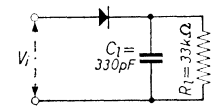
Inverse voltage ($-V_D$)	Reverse current ($-I_D$) =	Reverse current ($-I_D$) max.
1.5 V	= 0.8 µA	< 2.8 µA
10 V	= 4.5 µA	< 18 µA
30 V	= 35 µA	< 150 µA
45 V	= 90 µA	< 350 µA

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN

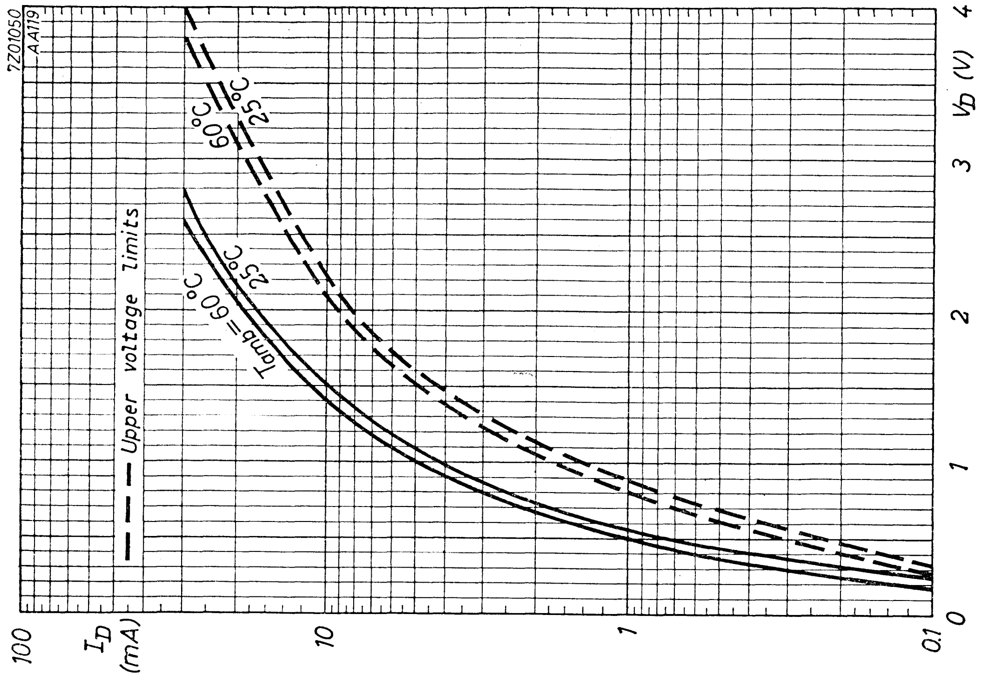
Forward current (I_D)	Forward voltage (V_D)			
	T_{amb} = 25 °C		T_{amb} = 60 °C	
	=	max.	=	max.
0.1 mA			= 0.16 V	< 0.25 V
1 mA			= 0.50 V	< 0.80 V
10 mA	= 1.5 V	< 2.2 V	= 1.4 V	< 2.1 V
30 mA 1)			= 2.6 V	< 3.8 V

Inverse voltage ($-V_D$)	Reverse current ($-I_D$)			
	T_{amb} = 25 °C		T_{amb} = 60 °C	
	=	max.	=	max.
0.1 V	= 0.35 µA	< 1.0 µA	= 4.5 µA	< 12 µA
1.5 V			= 6 µA	< 25 µA
10 V			= 16 µA	< 60 µA
30 V			= 60 µA	< 300 µA
45 V			= 170 µA	< 500 µA

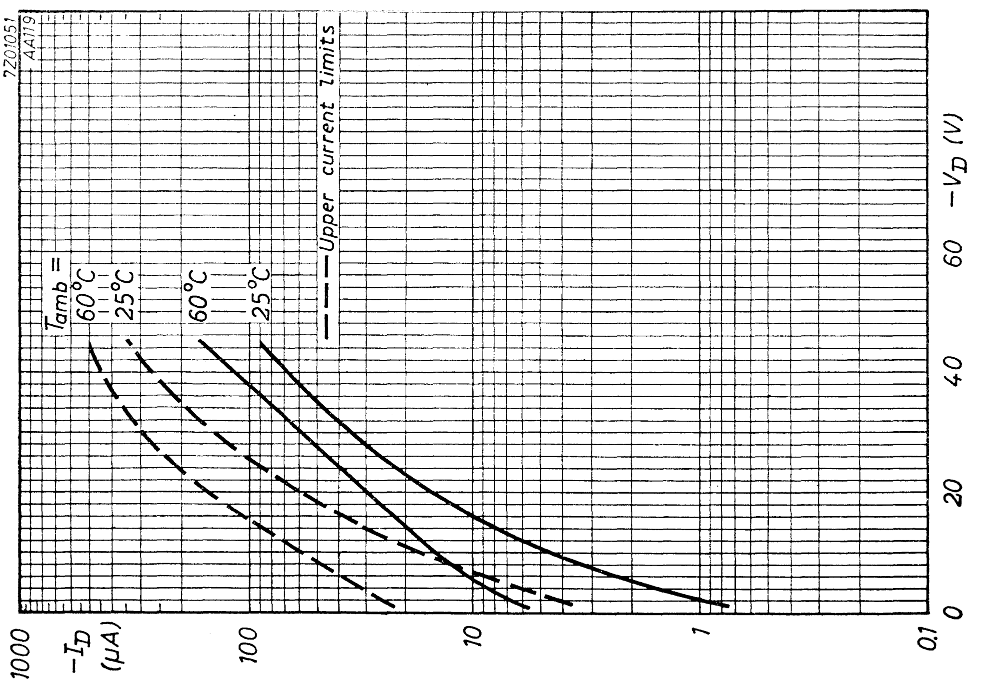
Input voltage	V_i =	3 Vrms
Frequency	f =	10.7 Mc/s
Efficiency	η =	85 %
Damping resistance	r_d =	15 kΩ > 13.5 kΩ < 19 kΩ



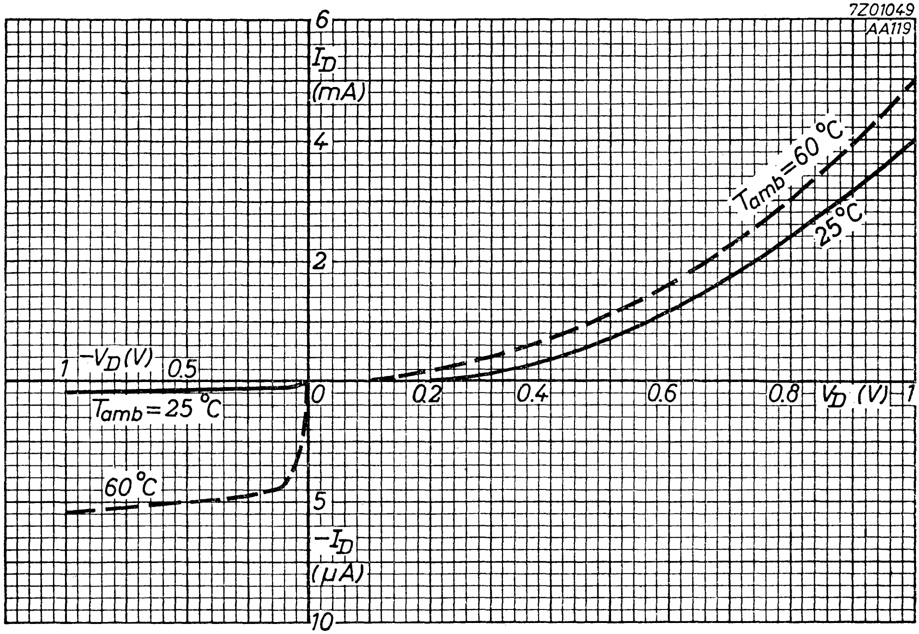
1) Measured with current pulses to prevent excessive dissipation


7Z01050
AA119
Upper voltage limits
T_{amb} = 60 °C
25 °C
60 °C
25 °C
I_D (mA)
100
10
1
0.1
0
1
2
3
4
V_D (V)

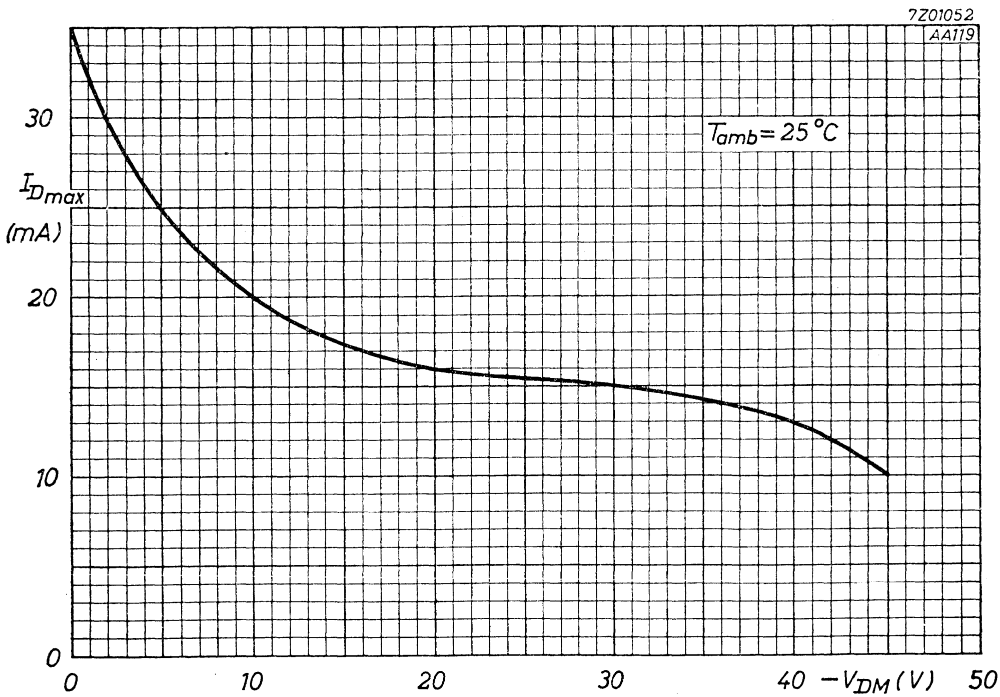
B


7Z01051
AA119
T_{amb} =
60 °C
25 °C
60 °C
25 °C
Upper current limits
$-I_D$ (μA)
1000
100
10
1
0.1
0
20
40
60
$-V_D$ (V)

A


7Z01049
AA119
6
I_D
(mA)
4
2
1
$-V_D$(V)
0.5
0
0.2
0.4
0.6
0.8
V_D (V)
1
T_{amb}=60 °C
25°C
T_{amb}=25 °C
60 °C
5
$-I_D$
(μA)
10

C


7Z01052
AA119
30
I_{Dmax}
(mA)
20
10
0
T_{amb}= 25 °C
0
10
20
30
40
$-V_{DM}$ (V)
50

D

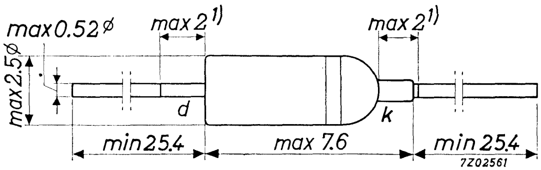
6.6.1962

POINT CONTACT DIODE

Germanium point contact diode in a subminiature all-glass DO-7 envelope primarily intended for computer applications.

QUICK REFERENCE DATA				
Repetitive peak reverse voltage	$-V_{DM}$	max.	90	V
Repetitive peak forward current	I_{DM}	max.	150	mA
Continuous forward current	I_D	max.	35	mA
Forward voltage drop at I_D = 5 mA; T_j = 25 °C	V_D	<	1.0	V
Reverse recovery current when switched from I_D = 30 mA to $-V_D$ = 35 V (R_L = 2.5 kΩ) at t_{rr} = 3.5 μs	$-I_D$	<	90	μA
Thermal resistance from junction to ambient	K	<	0.4	°C/mW

MECHANICAL DATA Dimensions in mm



The red band indicates the cathode side

1) Not tinned

7Z2 3120
1.1.1965

LIMITING VALUES (Absolute max. values)

Voltages

Continuous reverse voltage	$-V_D$	max.	60	V
Peak reverse voltage	$-V_{DM}$	max.	90	V

Currents

Continuous forward current	I_D	max.	35	mA
Average forward current (t_{av} = 20 ms)	I_{DAV}	max.	35	mA [1]
Repetitive peak forward current	I_{DM}	max.	150	mA [1]
Non repetitive peak forward current	$I_{DMsurge}$	max.	200	mA

Temperatures

Storage temperature	T_s		-55 to +75	^oC
Junction temperature	T_j	max.	75	^oC

THERMAL DATA

Thermal resistance from junction to ambient in free air	K	<	0.4	$^oC/mW$

CHARACTERISTICS

T_j = 25 ^oC unless otherwise specified

Forward voltage drop at I_D = 5 mA	V_D	typ.	0.72	V
		<	1.0	V
Reverse current at $-V_D$ = 50 V; T_j = 60 ^oC	$-I_D$	<	150	μA

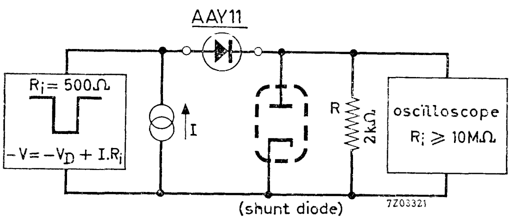
[1]) For pulse operation see page A

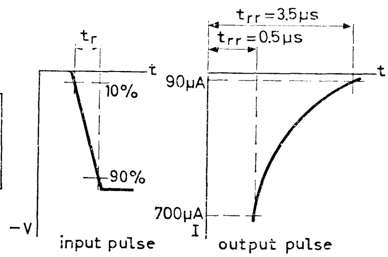
7Z2 3121

CHARACTERISTIC RANGE VALUES FOR EQUIPMENT DESIGN at T_j = 25 °C

Forward voltage drop				
		>	1.5	V
at I_D = 30 mA	V_D	typ.	2.1	V
		<	3.0	V
Reverse current				
at $-V_D$ = 50 V	$-I_D$	typ.	25	μA
		<	65	μA
at $-V_D$ = 90 V	$-I_D$	typ.	130	μA
		<	250	μA
Reverse recovery current when switched from I_D = 30 mA to $-V_D$ = 35 V (R_L = 2.5 kΩ)				
Measured at t_{rr} = 0.5 μs	$-I_D$	typ.	200	μA
		<	700	μA
Measured at t_{rr} = 3.5 μs	$-I_D$	typ.	25	μA
		<	90	μA

Test circuit





Reverse pulse:

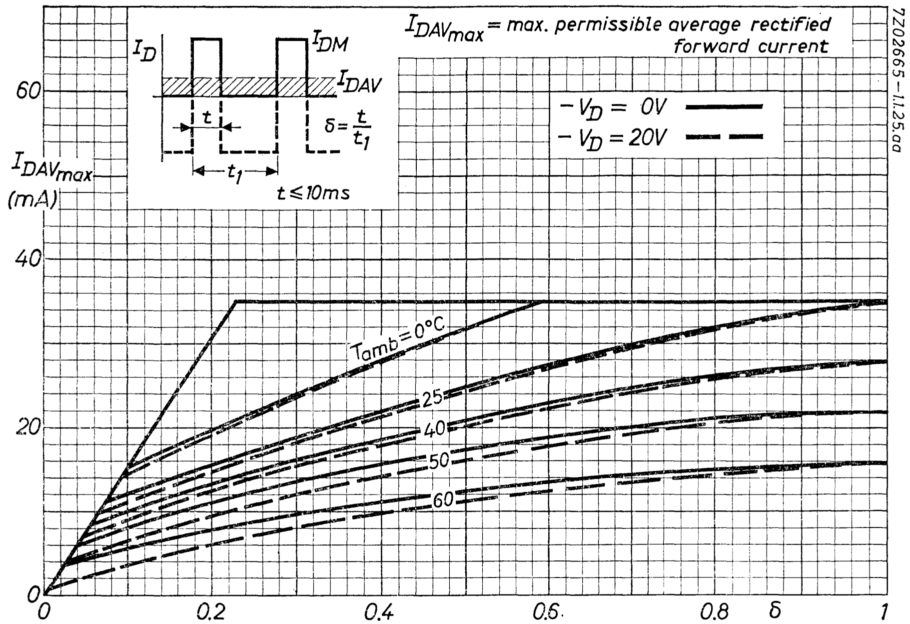
Rise time	t_r	≦	0.1 μs
Duty cycle	δ	=	0.5
Frequency	f	=	50 kc/s

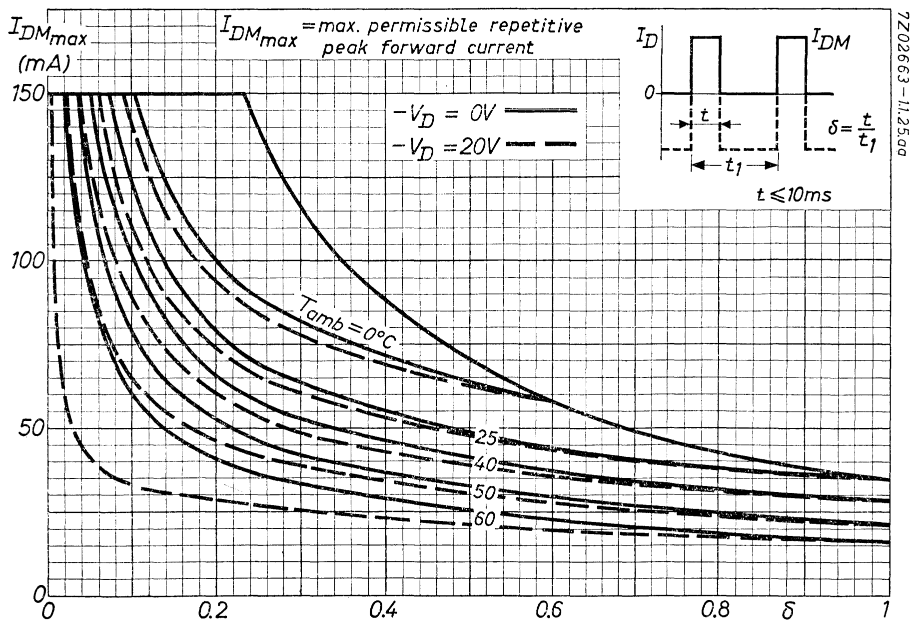
Circuit:

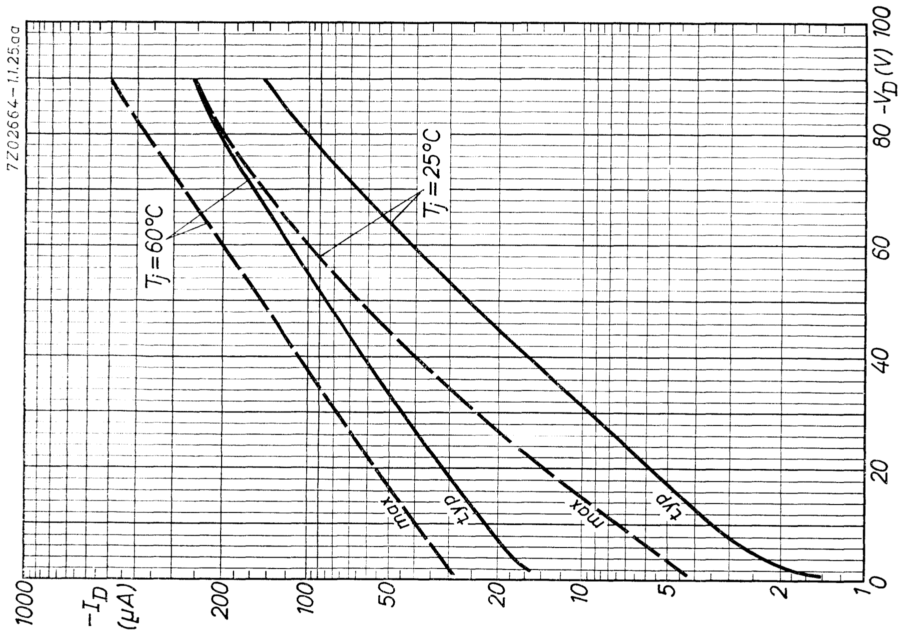
Capacitance	C	≦	30 pF (C = Oscilloscope + parasitical capacitance)

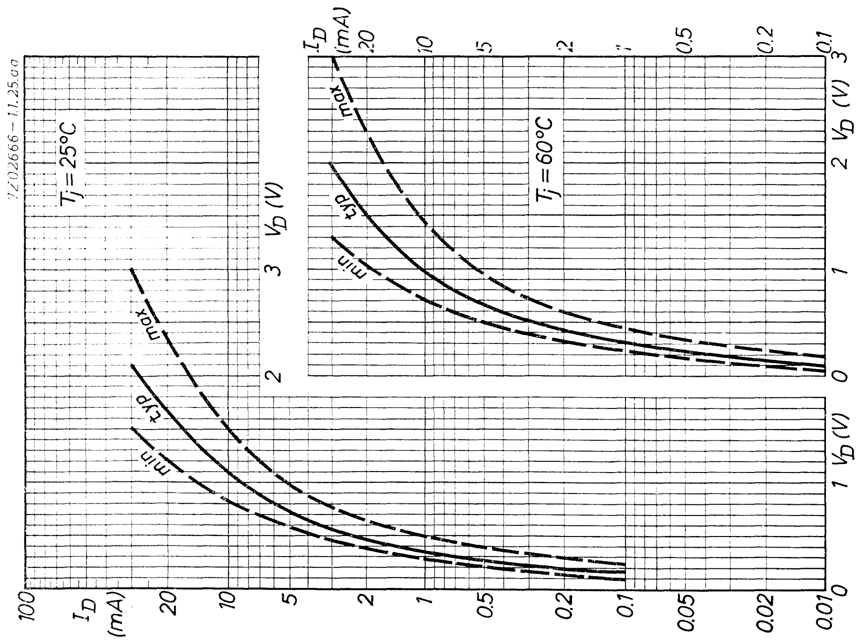
7Z2 3122

1.1.1965


I_{DAVmax} = max. permissible average rectified forward current
I_D
I_{DM}
I_{DAV}
t
$\delta = \frac{t}{t_1}$
t_1
t ≤ 10ms
$-V_D$ = 0V
$-V_D$ = 20V
I_{DAVmax} (mA)
T_{amb} = 0°C
25
40
50
60
0
20
40
60
0.2
0.4
0.6
0.8
δ
1
7Z02665 – 1.1.25.aa

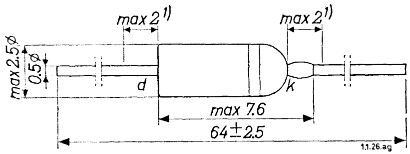

I_{DMmax} (mA)
I_{DMmax} = max. permissible repetitive peak forward current
I_D
I_{DM}
0
t
$\delta = \frac{t}{t_1}$
t_1
t ≤ 10ms
$-V_D$ = 0V
$-V_D$ = 20V
T_{amb} = 0°C
25
40
50
60
150
100
50
0
0.2
0.4
0.6
0.8
δ
1
7Z02663 – 1.1.25.aa


7Z02664-1.1.25.aa
$T_j = 60°C$
$T_j = 25°C$
max
typ
max
typ
$-I_D$ (μA)
1000
200
100
50
20
10
5
2
1
$-V_D$ (V)
0
20
40
60
80
100


7Z02666-1.1.25.aa
$T_j = 25°C$
$T_j = 60°C$
max
typ
min
max
typ
min
I_D (mA)
100
20
10
5
2
1
0.5
0.2
0.1
0.05
0.02
0.01
V_D (V)
0
1
2
3

POINT CONTACT GERMANIUM DIODE in miniature all-glass construction for high speed computer logic applications

Dimensions in mm   The white band indicates the cathode side



LIMITING VALUES (Absolute max. values)

Inverse voltage	$-V_D$	= max.	15 V
Forward current			
Continuous	I_D	= max.	20 mA
Peak value	I_{DM}	= max.	50 mA
Temperatures			
Junction temperature	T_j	= max.	75 °C
Operating ambient temperature	T_{amb}	=	-65°C to +60 °C
Storage temperature	T_s	=	-65°C to +75 °C

THERMAL DATA

Thermal resistance from junction to ambience in free air   K = max. 0.75 °C/mW

CHARACTERISTICS

T_j = 25 °C		
Forward current (I_D)	Forward voltage (V_D)	
	min.	max.
2 mA	0.25 V	0.45 V
10 mA	0.40 V	0.80 V
50 mA	0.60 V	1.5 V

T_{amb} = 60 °C	
Inverse voltage ($-V_D$)	Reverse current ($-I_D$)
	max.
5 V	30 µA
15 V	100 µA

1) Not tinned

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN

T_j = 60 °C		
Forward current (I_D)	Forward voltage (V_D)	
	min.	max.
2 mA	0.19 V	0.39 V
10 mA	0.34 V	0.74 V
50 mA	0.54 V	1.44 V

T_{amb} = 25 °C	
Inverse voltage ($-V_D$)	Reverse current ($-I_D$)
	max.
5 V	10 µA
15 V	60 µA

Diode capacitance

Inverse voltage	$-V_D$	=	1 V
Frequency	f	=	0.5 Mc/s
Ambient temperature	T_{amb}	=	25 °C
Diode capacitance	C_{dk}	<	1.2 pF

Reverse recovery time (see figs. 1, 3 and 4)

Initial forward current	I_D	=	3 mA
Inverse voltage	$-V_D$	=	1 V
Loop resistance	R_{loop}	=	100 Ω
Ambient temperature	T_{amb}	=	25 °C
Reverse recovery time for $-I_D$ = 1 mA	t_{rec}	= <	5 nsec 12 nsec

Reverse recovery current (see figs. 2, 3 and 5)

Initial forward current	I_D	=	3 mA
Inverse voltage	$-V_D$	=	5 V
Loop resistance	R_{loop}	=	500 Ω
Ambient temperature	T_{amb}	=	25 °C
Reverse recovery current after t = 50 nsec	$-I_D$	<	0.5 mA

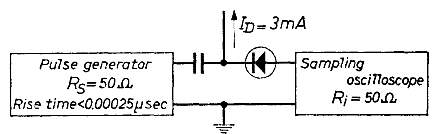
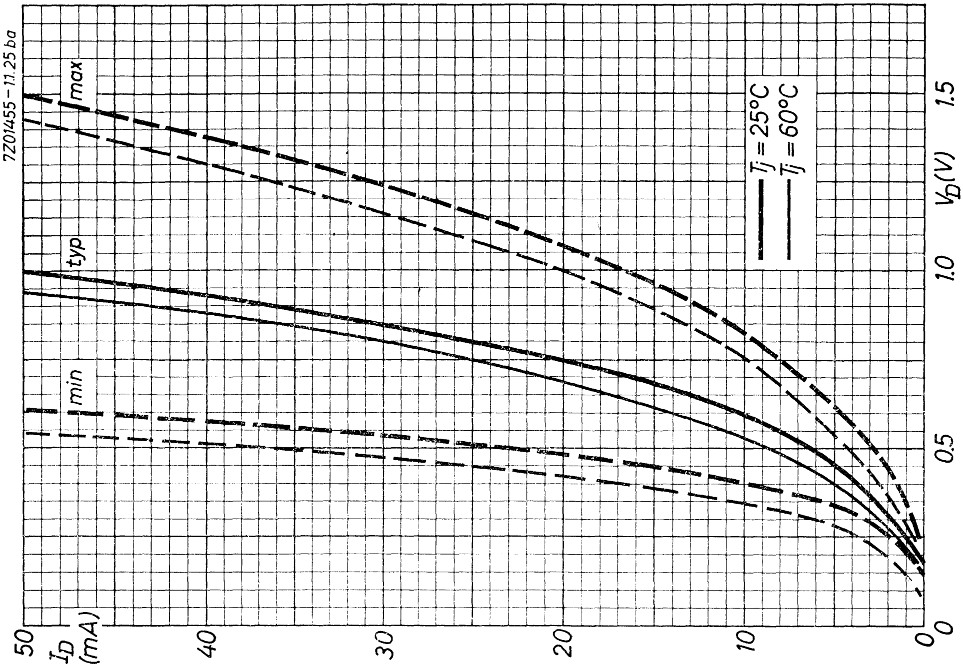


Fig. 1



A

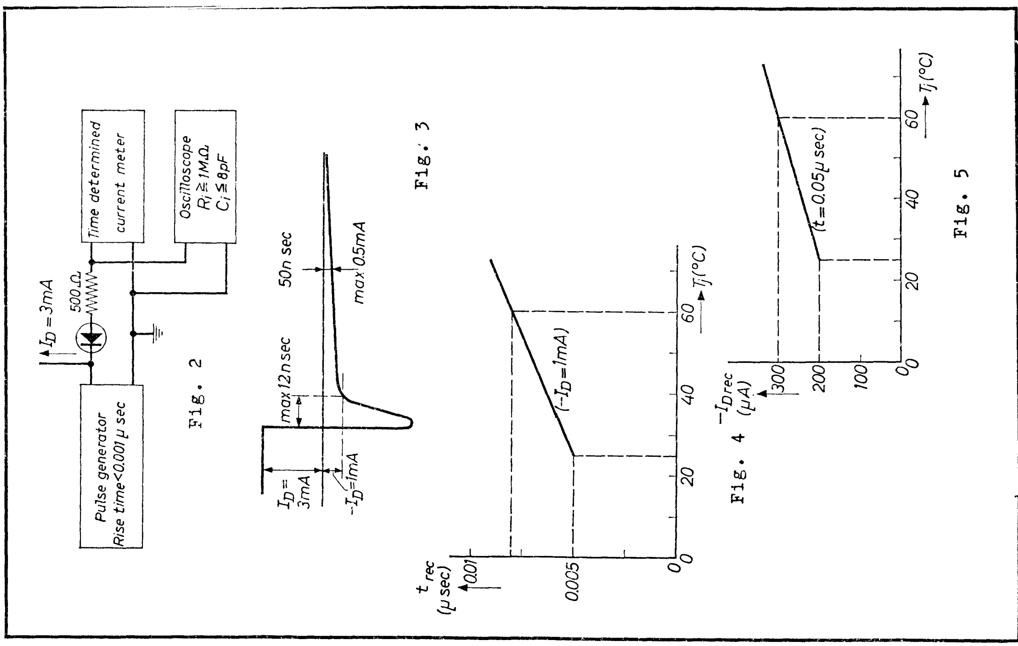


Fig. 2

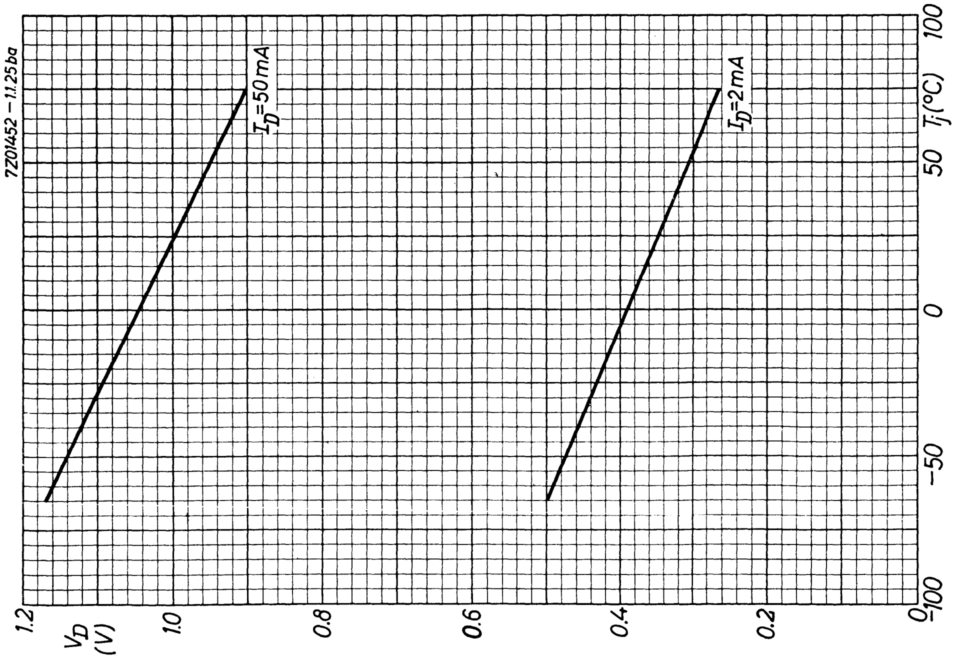
Fig. 3

Fig. 4

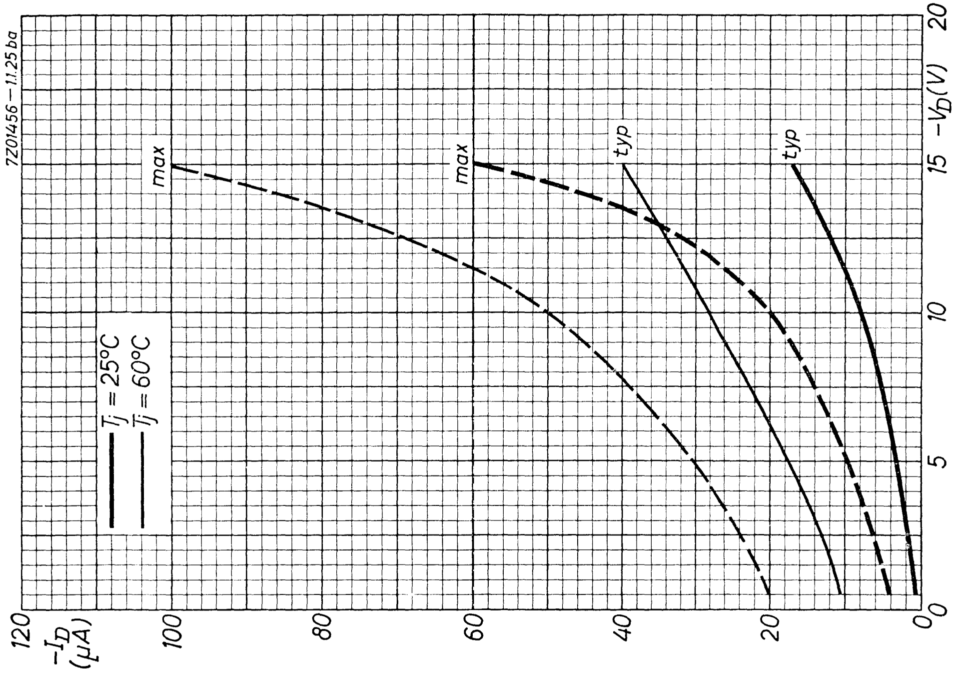
Fig. 5

4.4.1963

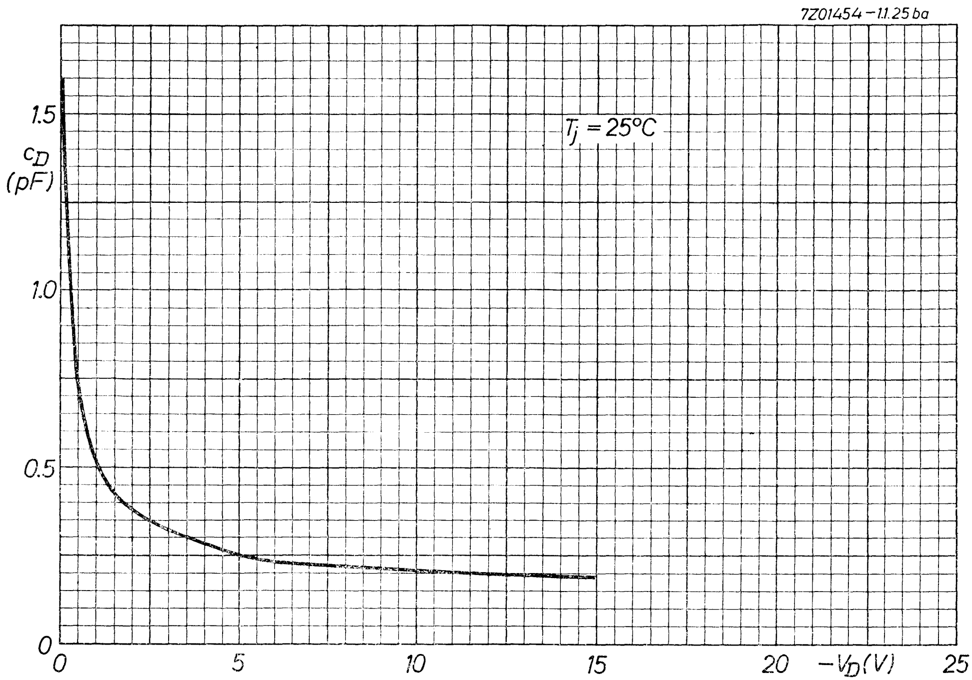
7Z2 1721


7Z01452 – 1.1.25 ba
I_D=50 mA
I_D=2 mA
V_D (V)
1.2
1.0
0.8
0.6
0.4
0.2
0
−100
−50
0
50
100
T_j(°C)

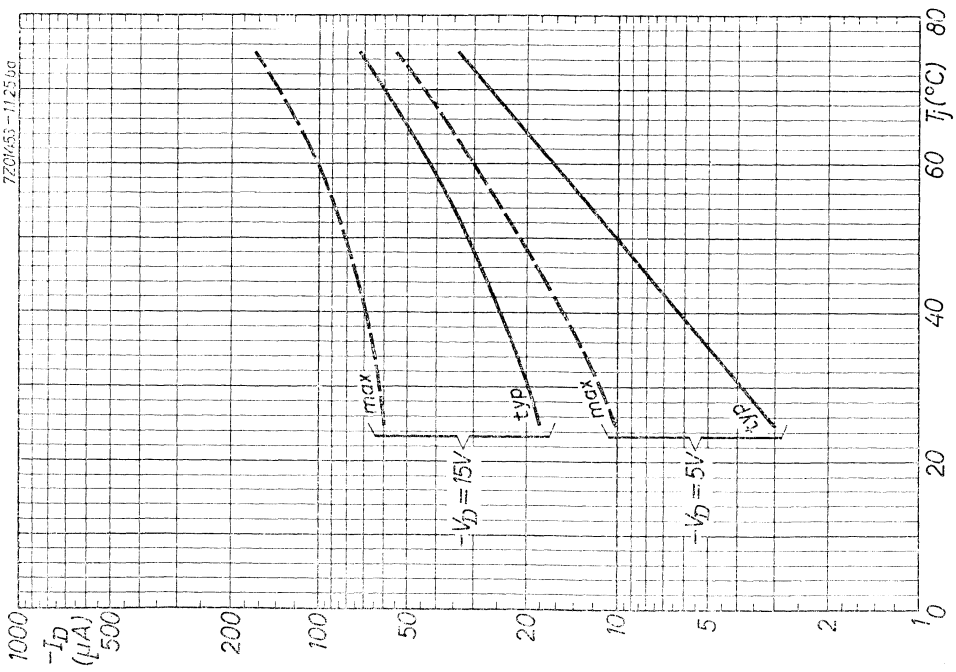
B


7Z01456 – 1.1.25 ba
max
max
typ
typ
T_j = 25°C
T_j = 60°C
$-I_D$ (μA)
120
100
80
60
40
20
0
5
10
15
20
$-V_D$ (V)

C


7Z01454 – 1.1.25 ba
$T_j = 25°C$
c_D (pF)
1.5
1.0
0.5
0
0
5
10
15
20
$-V_D$ (V)
25

E


7Z01453 – 1.1.25 ba
T_j (°C)
80
60
40
20
0
max
typ
max
typ
$-V_D = 15V$
$-V_D = 5V$
$-I_D$ (μA)
1000
500
200
100
50
20
10
5
2
1

D

4.4.1963

GERMANIUM JUNCTION DIODE FOR FAST SWITCHING APPLICATIONS

Germanium junction diode in all glass envelope for high current low hole storage applications

QUICK REFERENCE DATA

Max. reverse voltage	$-V_D$	= max.	30 V
Max. forward current	I_D	= max.	220 mA
Forward voltage at I_D = 200 mA (T_{amb} = 25 °C)	V_D	<	0.5 V
Recovered charge	Q_{rec}	<	200 pC
Thermal resistance	K	<	0.4 °C/mW

LIMITING VALUES (Absolute max. values)

Reverse voltage — $-V_D$ = max. 30 V

Forward current

Continuous or averaged over any 50 msec period	I_D	= max.	220 mA
See also pag. D	(t_{av}	=	50 msec)
Repetitive peak (pulse duration 25 msec)	I_{DM}	= max.	1 A
	(t	=	25 msec)
At T_{amb} = 60 °C	I_{DM}	= max.	0.5 A
	(t	=	25 msec)
Surge (see also page E)	I_{Dsurge}	= max.	4 A

Temperatures

Junction temperature	T_j	= max.	75 °C
Storage temperature	T_s	=	−55 to +75 °C

7Z2 2246

1.2.1964

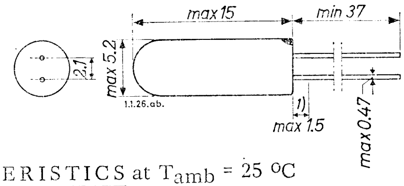
THERMAL DATA

Thermal resistance from junction to ambience — K = max. 0.4 °C/mW

MECHANICAL DATA

Dimensions in mm

The red dot indicates the position of the cathode



CHARACTERISTICS at T_{amb} = 25 °C

Forward current (I_D)	Forward voltage (V_D)
0.3 mA	< 0.19 V
30 mA	< 0.33 V
100 mA	< 0.42 V

Inverse voltage ($-V_D$)	Reverse current ($-I_D$)
1.5 V	< 5 μA
10 V	< 10 μA
30 V	< 60 μA

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN at T_{amb} = 25 °C unless otherwise specified

Reverse currents — See page C

Forward voltage

I_D = 1 A; T_j = 25 °C — V_D = 0.7 V

Capacitance (measured with small signal)

$-V_D$ = 3 V	c_D	=	7.3 pF	< 12 pF
V_D = 0 V	c_D	=	27 pF	

1) Not tinned

7Z2 2245

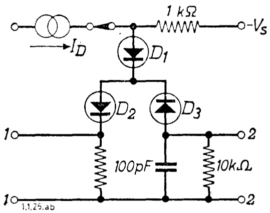
CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN
(continued) T_{amb} = 25 °C

Recovered charge

I_D = 10 mA; $-V_S$ = 10 V

Fall time of I_D < 0.01 μsec

Q_{rec} = 150 pC < 200 pC



D_1 = diode under test
D_2 = low hole storage diode
D_3 = diode with low forward voltage drop

Terminals 1: forward current wave form
Terminals 2: measuring of recovered charge

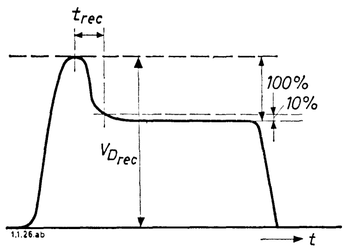
Recombination time

The recombination time is the time taken for the recovered charge in excess of that due to capacitance to fall to 10% of its peak value. Test circuit as for recovered charge but with delayed application of $-V_S$.

t_{recomb} = 0.05 μsec < 0.12 μsec

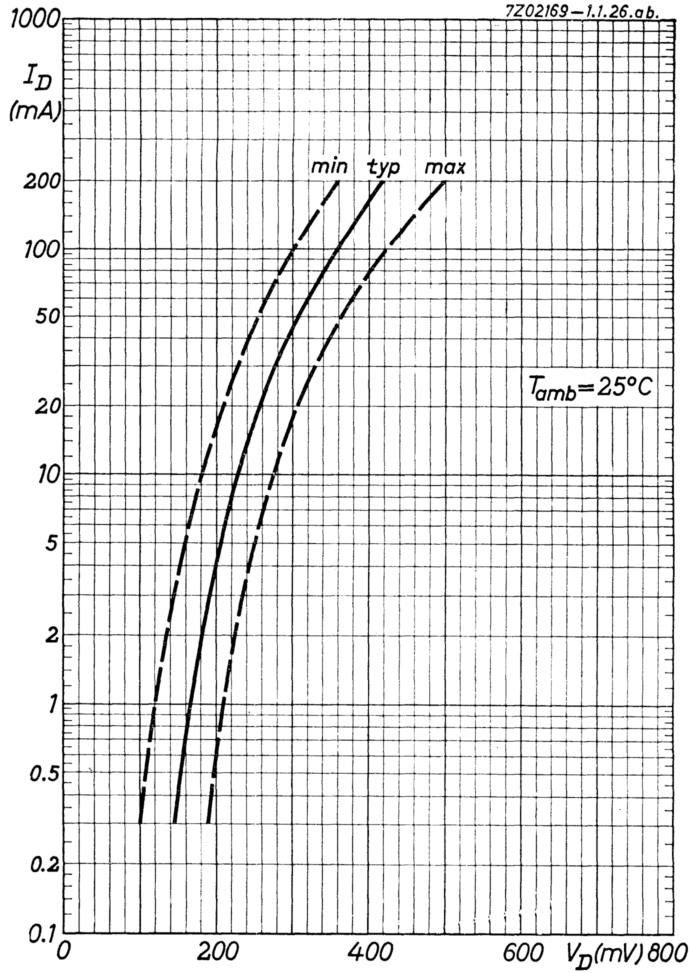
Forward recovery

I_D = 400 mA; rise time of I_D = 0.04 μsec

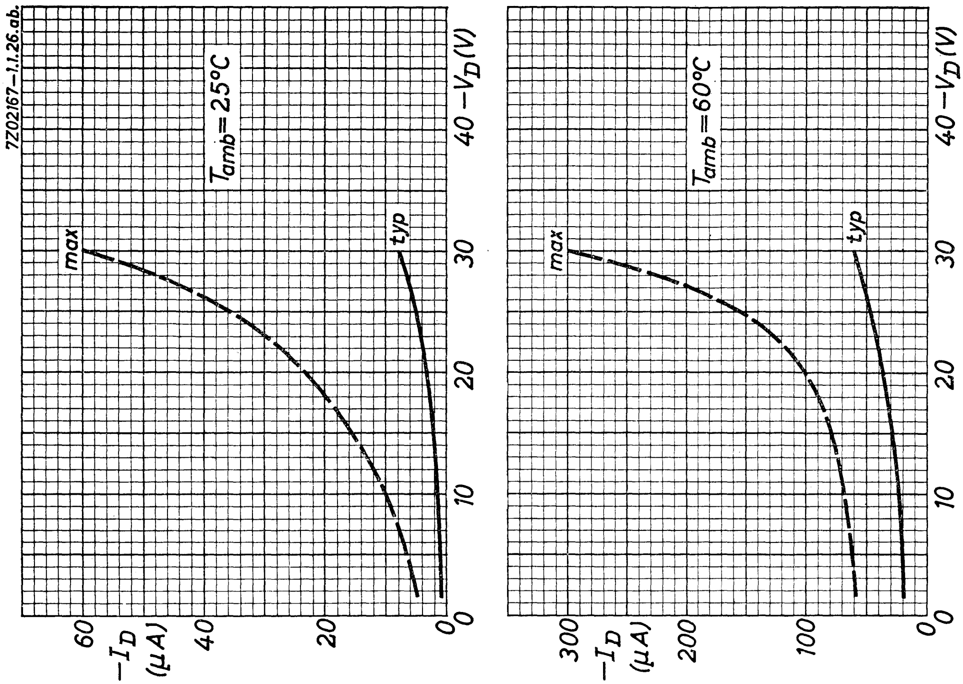


Forward recovery voltage	V_{Drec}	= 0.8 V	< 2.0 V
Forward recovery time	t_{rec}	= 0.06 μsec	

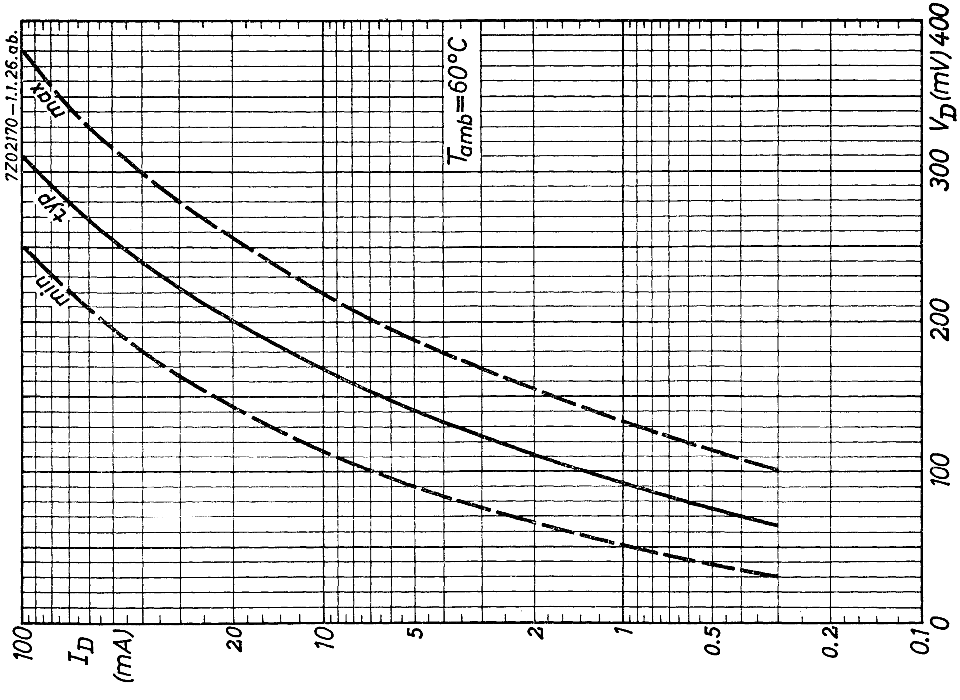
7Z2 2247



A

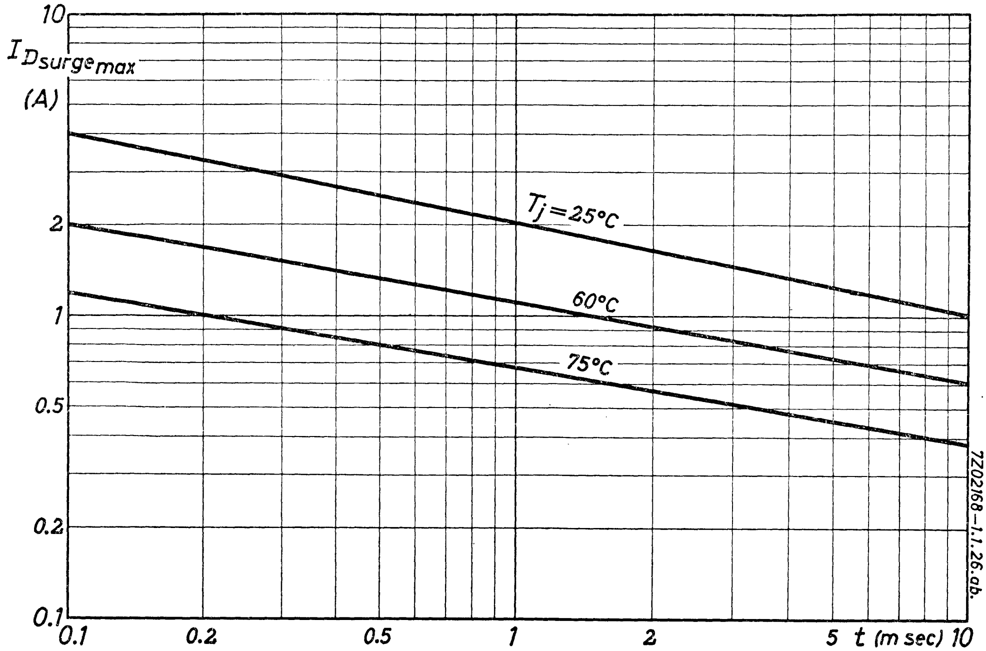

7Z02167—1.1.26.ab.
T_{amb}=25°C
max
typ
$-I_D$ (μA)
$-V_D$ (V)
0
20
40
60
10
30
T_{amb}=60°C
100
200
300

C

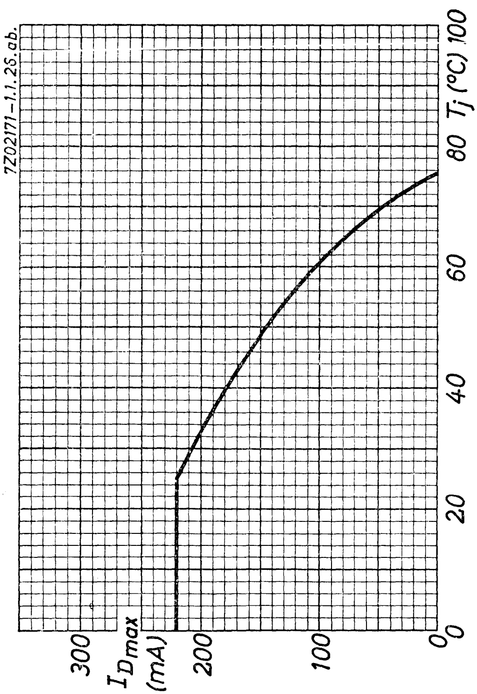

7Z02170—1.1.26.ab.
T_{amb}=60°C
max
typ
min
I_D (mA)
V_D (mV)
100
20
10
5
2
1
0.5
0.2
0.1
0
200
300
400

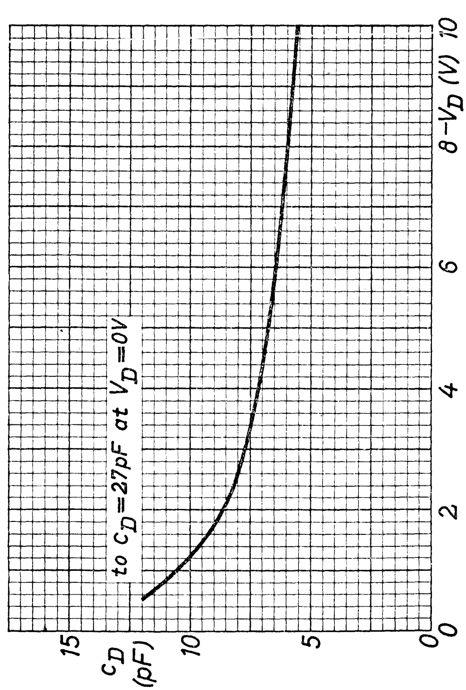
B

2.2.1964


10
$I_{D_{surge\,max}}$
(A)
2
1
0.5
0.2
0.1
0.1
0.2
0.5
1
2
5
t (m sec)
10
$T_j = 25°C$
60°C
75°C
7Z02168-1.1.26.ab.

E


7Z02171-1.1.25.ab.
T_j (°C)
100
80
60
40
20
0
300
$I_{D_{max}}$
(mA)
200
100
0

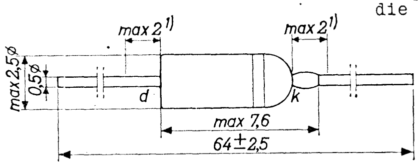

$-V_D$ (V)
10
8
6
4
2
0
15
C_D
(pF)
10
5
0
to $C_D = 27pF$ at $V_D = 0V$

D

GOLD-BONDED GERMANIUM DIODE in miniature double-ended all-glass construction for use in high-speed switching applications
DIODE AU GERMANIUM À POINTE D'OR en construction miniature tout-verre à sorties bilatérales destinée aux applications de commutation à grande vitesse
GERMANIUM-GOLDDRAHTDIODE in Miniatur-Allglastechnik mit zweiseitig ausgeführten Anschlüssen zur Verwendung als Schalter grosser Geschwindigkeit

Dimensions in mm
Dimensions en mm
Abmessungen in mm

The white band indicates the position of the cathode
L'anneau blanc indique la position de la cathode
Der weisse Ring bezeichnet die Katodenseite



Limiting values (Absolute max. values)
Caractéristiques limites (Valeurs max. absolues)
Grenzdaten (Absolute Maximalwerte)

T_{amb} =		25	60	°C
$-V_D$	= max.	8	8	V
I_D (t_{av} = max. 50 msec)	= max.	30	20	mA
I_{DM} (t = max. 5 msec)	= max.	100	50	mA
T_j	=	max.	75	°C

Storage temperature
Température d'emmagasinage = −55 °C/+75 °C
Lagerungstemperatur

1) Not tinned; non étamé; nicht verzinnt

Thermal data. Thermal resistance from junction to ambience in free air K ≦ 0.5 °C/mW
Données thermiques. Résistance thermique entre la jonction et l'ambiance à l'air libre K ≦ 0,5 °C/mW
Thermische Daten. Wärmewiderstand zwischen Kristall und Umgebung in freier Luft K ≦ 0,5 °C/mW

Characteristics range values for equipment design
Gammes de valeurs des caractéristiques pour l'étude d'équipements.
Kenndatenbereiche für Gerätentwurf

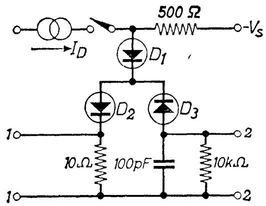
T_{amb} = 25 °C { unless otherwise specified / sauf indication différente / wenn nicht anders angegeben }

I_D =	1		mA	
V_D =	270	<	320	mV
I_D =	10		mA	
V_D =	500	<	600	mV
I_D =	30		mA	
V_D =	600	<	1000	mV
$-V_D$ =	1		V	
c_{dk} =	3,3		pF 1)	
$-V_D$ =	3		V	
c_{dk} =	1,3	<	2,0	pF 1)

$-V_D$ =	3			V
$-I_D$ =	5	<	25	µA
T_{amb} =	60			°C
$-V_D$ =	3			V
$-I_D$ =	30	<	85	µA
$-V_D$ =	8			V
$-I_D$ =	30	<	150	µA
T_{amb} =	60			°C
$-V_D$ =	8			V
$-I_D$ =	190			µA

1) Capacitance with small signals
Capacité à faible signal
Kapazität bei kleiner Signalstärke

Recovered charge
Récupération de charge
Freikommende Ladung



D_1 = diode under test
D_1 = diode à l'essai
D_1 = geprüfte Diode

D_2 = low hole storage diode
D_2 = diode à faible accumulation de lacunes
D_2 = Diode mit geringer Löcheraufspeicherung

D_3 = diode with low forward voltage drop
D_3 = diode à faible chute de tension en sens conducteur
D_3 = Diode mit niedrigem Spannungsabfall im Durchlasszustand

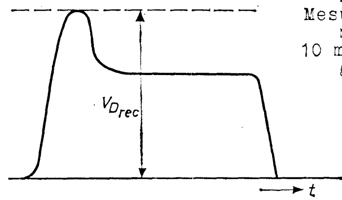
Terminals 1: forward current wave form
Bornes 1 : forme d'onde du courant en sens conducteur
Anschlussklemmen 1: Wellenform des Stromes in Durchlassrichtung

Terminals 2: measuring of recovered charge
Bornes 2 : mesure de la charge de récupération
Anschlussklemmen 2: Messung der freigekommenen Ladung

I_D	=	10		mA
Fall time of I_D Temps de descente de I_D Abfallzeit von I_D	<	0,005		µsec
$-V_S$	=	5		V
Q	=	20	< 30	pC

7Z2 0953 3.

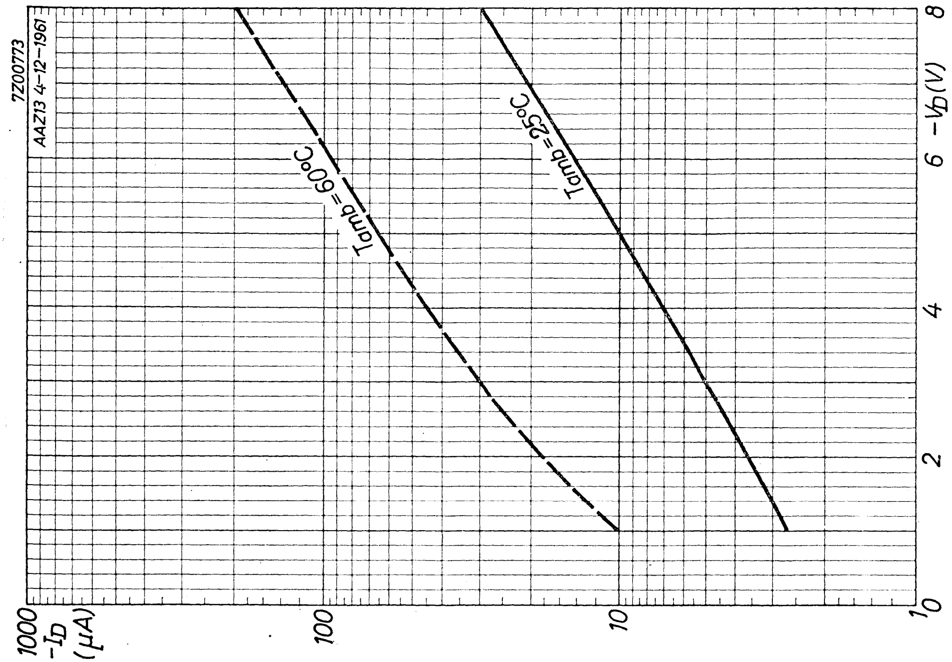
Forward recovery voltage
Tension de recouvrement en sens conducteur
Übergangsspannung in Durchlassrichtung



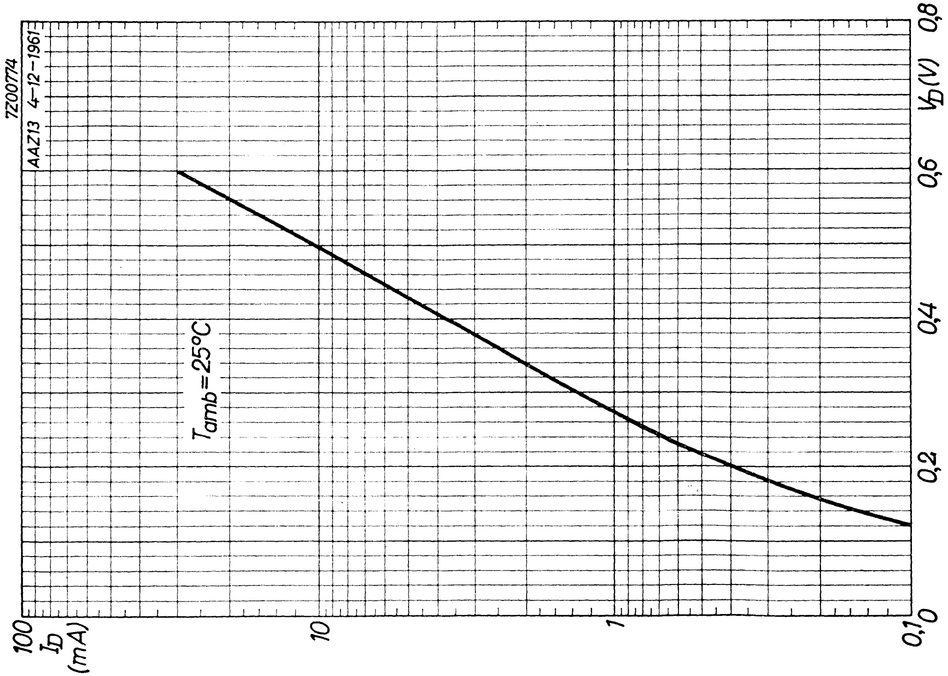
Measured at 10 mm from the seal
Mesuré à 10 mm du scellement
10 mm von der Einschmelzung gemessen

$\hat{I_D}$	=	20		mA
Rise time of I_D Temps de montée de I_D Anstiegszeit von I_D	=	0,005		µsec
$V_{D\ rec}$	=	0,7	<1,5	V

7Z2 0955 4.


7Z00773
AAZ13 4-12-1961
1000
$-I_D$
(μA)
100
10
1
0
2
4
6
8
$-V_D$(V)
T_{amb}=60°C
T_{amb}=25°C

B


7Z00774
AAZ13 4-12-1961
100
I_D
(mA)
10
1
0,1
0
0,2
0,4
0,6
0,8
V_D(V)
T_{amb}=25°C

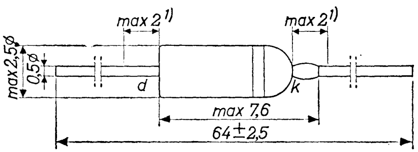
A

12.12.1961

GOLD-BONDED GERMANIUM DIODE in all-glass construction for general purpose applications
DIODE À CRISTAL DE GERMANIUM À POINTE D'OR en construction tout-verre miniature pour usages généraux
GERMANIUM-GOLDDRAHTDIODE in Miniatur-Allglastechnik für allgemeine Verwendungszwecke

Dimensions in mm
Dimensions en mm
Abmessungen in mm

The white band indicates the position of the cathode
L'anneau blanc indique la position de la cathode
Der weisse Ring bezeichnet die Katodenseite



Limiting values (Absolute max. values)
Caractéristiques limites (Valeurs max. absolues)
Grenzdaten (Absolute Maximalwerte)

	T_{amb} =	25 °C	60 °C
$-V_D$	= max.	75	75 V
$-V_{DM}$	= max.	75	75 V
$-V_{Dsurge}$ (t = max. 1 sec)	= max.	115	115 V
I_D direct current / courant continu / Gleichstrom	= max.	140	55 mA[2)]
I_D (t_{av} = max. 50 msec)	See pages E,F / Voir pages E,F / Siehe Seiten E,F		
I_{DM}	= max.	250	250 mA
I_{Dsurge} (t = max. 1 sec)	= max.	300	300 mA
T_{amb}	=	-55 °C/+60 °C	

Storage temperature
Température d'emmagasinage = -55 °C/+75 °C
Lagerungstemperatur

[1)] Not tinned
Non étamé
Nicht verzinnt

[2)] See also page D
Voir aussi page D
Siehe auch Seite D

Thermal data. Thermal resistance from junction to ambience in free air — K ≦ 0.45 °C/mW
Données thermiques. Résistance thermique entre la jonction et l'ambiance à l'air libre — K ≦ 0,45 °C/mW
Thermische Daten. Wärmewiderstand zwischen Kristall und Umgebung in freier Luft — K ≦ 0,45 °C/mW

Characteristics
Caractéristiques
Kenndaten

I_D (mA)	V_D(V) T_{amb} = 25 °C =	T_{amb} = 25 °C max.	T_{amb} = 60 °C =	T_{amb} = 60 °C max.
0,1	= 0,15	< 0,23	= 0,08	< 0,18
10	= 0,35	< 0,45	= 0,30	< 0,40
250[1)]	= 0,70	< 1,10	= 0,65	< 1,05

$-V_D$ (V)	$-I_D$(µA) T_{amb} = 25 °C =	T_{amb} = 25 °C max.	T_{amb} = 60 °C =	T_{amb} = 60 °C max.
1,5	= 0,6	< 2,5	= 12	< 30
10	= 1,0	< 4	= 16	< 60
75	= 10	< 25	= 35	<120

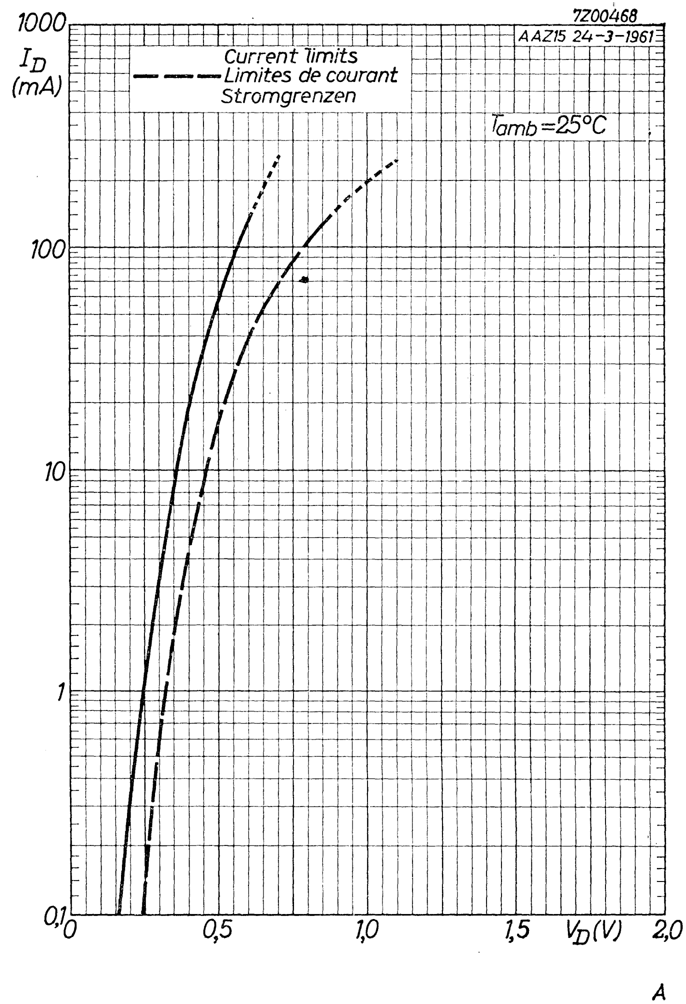
[1)] Measured under pulsed conditions to prevent excessive dissipation
Mesuré avec des impulsions pour prévenir une dissipation excessive
Zur Vermeidung einer übermässigen Verlustleistung mit Impulsen gemessen

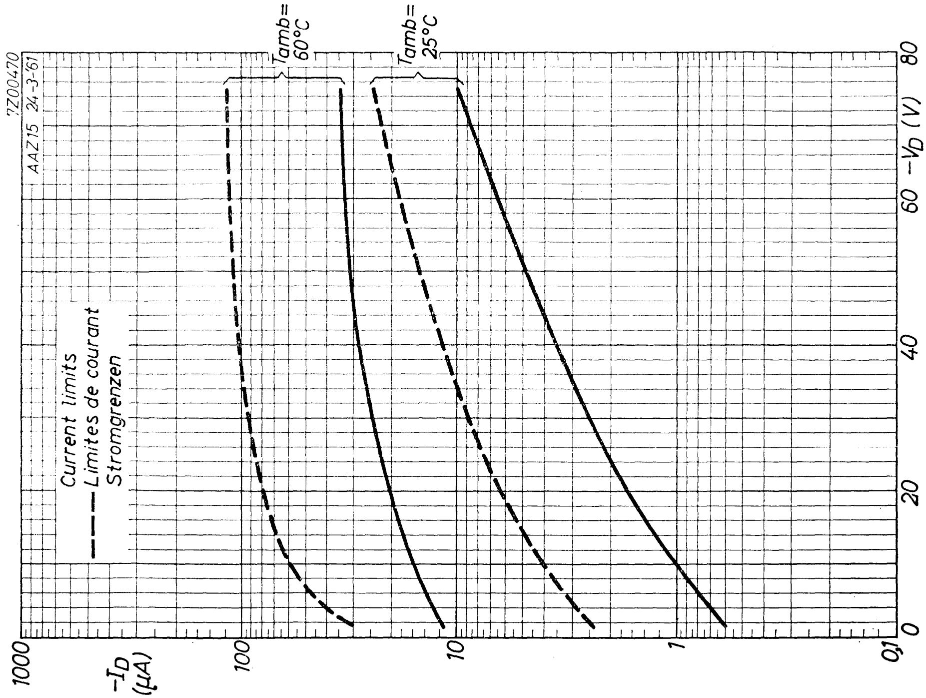
Characteristics (continued)
Caractéristiques (suite)
Kenndaten (Fortsetzung)

Capacitance
Capacité
Kapazität

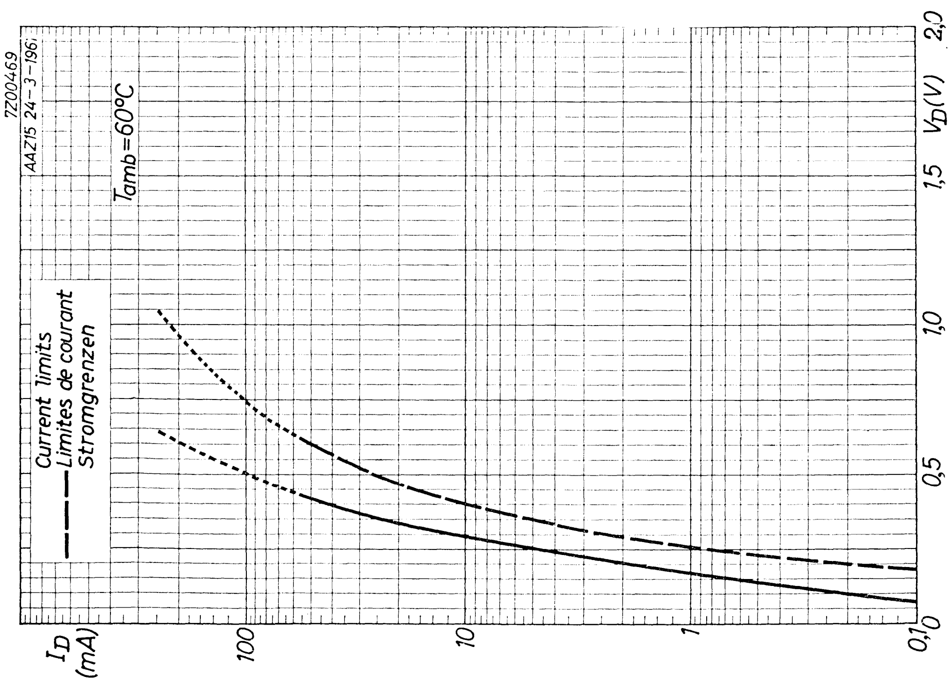
$-V_D$	=	0,75 V
f	=	0,5 Mc/s
c_{dk}	=	1,2 pF
	<	4,0 pF [1]

[1]) Characteristic range value for equipment design. For other characteristics range values for equipment design see curves pages A,B and C except for the points mentionned at page 2
Gamme de valeur caractéristique pour l'étude d'équipements. Pour les autres gammes de valeurs caractéristiques pour l'étude d'équipements voir les courbes pages A,B et C sauf les points mentionnés page 2
Charakteristischer Kenndatenbereich für Gerätentwurf. Für die übrigen charakteristischen Kenndatenbereiche für Gerätentwurf siehe die Kurven auf Seite A,B und C, mit Ausnahme der auf Seite 2 erwähnten Punkte

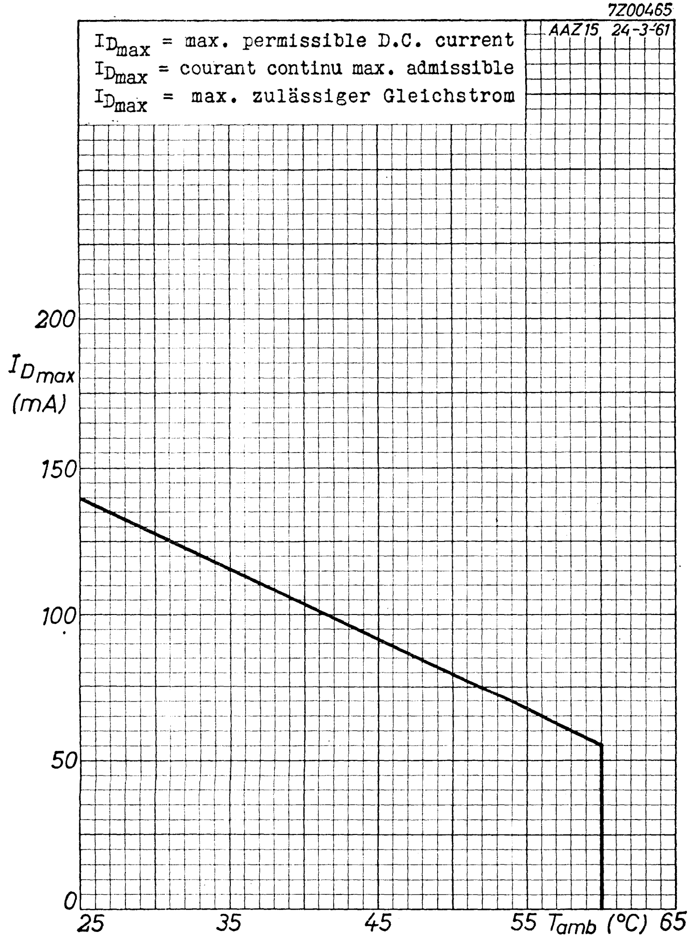



7Z00470
AAZ15 24-3-'61
Tamb= 60°C
Tamb= 25°C
Current limits
Limites de courant
Stromgrenzen
$-I_D$ (μA)
1000
100
10
1
0,1
0
20
40
60
80
$-V_D$ (V)

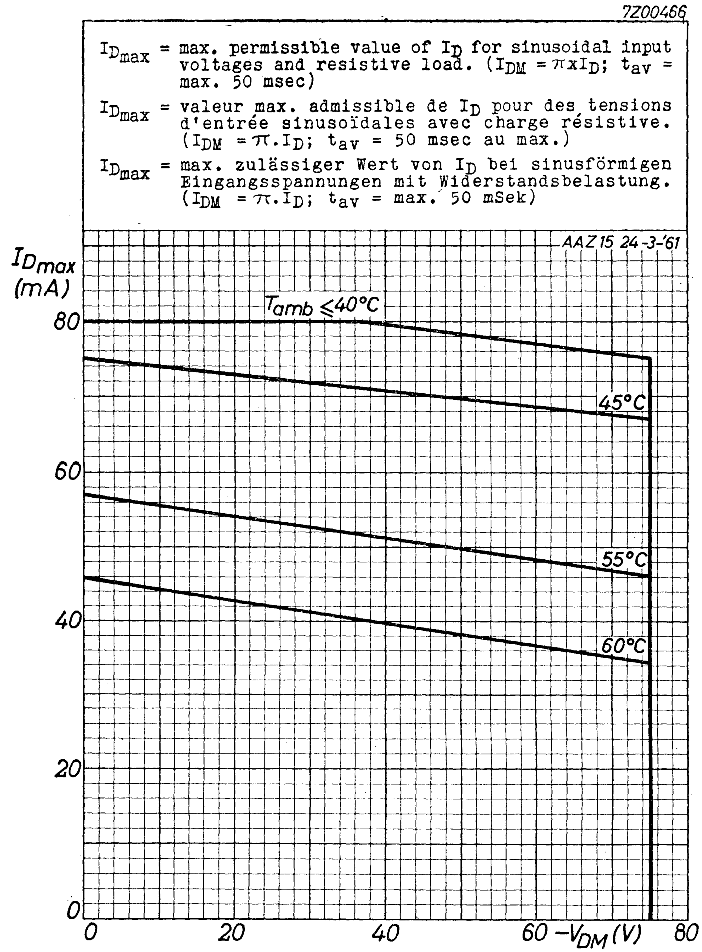
C


7Z00469
AAZ15 24-3-1961
Tamb=60°C
Current limits
Limites de courant
Stromgrenzen
I_D (mA)
100
10
1
0,1
0
0,5
1,0
1,5
2,0
V_D(V)

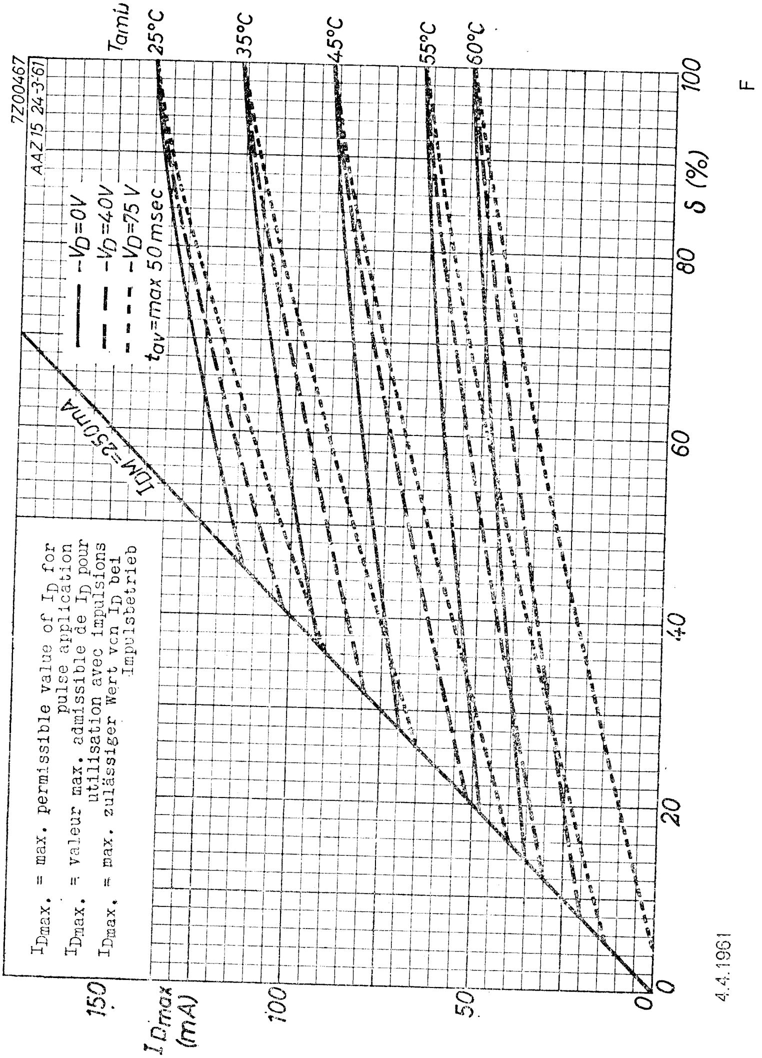
B


7Z00465
I_{Dmax} = max. permissible D.C. current
I_{Dmax} = courant continu max. admissible
I_{Dmax} = max. zulässiger Gleichstrom
AAZ15 24-3-'61
I_{Dmax} (mA)
200
150
100
50
0
25
35
45
55
T_{amb} (°C)
65

D


7Z00466
I_{Dmax} = max. permissible value of I_D for sinusoidal input voltages and resistive load. ($I_{DM} = \pi x I_D$; t_{av} = max. 50 msec)
I_{Dmax} = valeur max. admissible de I_D pour des tensions d'entrée sinusoïdales avec charge résistive. ($I_{DM} = \pi . I_D$; t_{av} = 50 msec au max.)
I_{Dmax} = max. zulässiger Wert von I_D bei sinusförmigen Eingangsspannungen mit Widerstandsbelastung. ($I_{DM} = \pi . I_D$; t_{av} = max. 50 mSek)
AAZ15 24-3-'61
I_{Dmax} (mA)
$T_{amb} \leq 40°C$
45°C
55°C
60°C
80
60
40
20
0
0
20
40
60
$-V_{DM}$ (V)
80

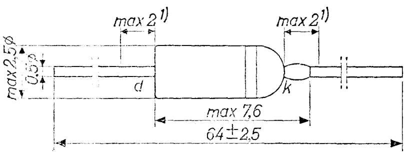
E


7Z00467
AAZ15 24-3-'61
Tamb
25°C
35°C
45°C
55°C
60°C
—VD=0V
—VD=40V
—VD=75V
tav=max 50msec
IDM=250mA
IDmax. = max. permissible value of ID for pulse application
IDmax. = valeur max. admissible de ID pour utilisation avec impulsions
IDmax. = max. zulässiger Wert von ID bei Impulsbetrieb
IDmax (mA)
150
100
50
0
δ (%)
0
20
40
60
80
100
F
4.4.1961

GOLD-BONDED GERMANIUM DIODE in miniature all-glass construction for high back resistance switching applications
DIODE À CRISTAL DE GERMANIUM À POINTE D'OR en construction tout-verre miniature pour applications de commutation à résistance inverse élevée
GERMANIUM-GOLDDRAHTDIODE in Miniatur-Allglastechnik zur Verwendung als Schalterdiode mit hohem Widerstand im Sperrzustand

Dimensions in mm
Dimensions en mm
Abmessungen in mm

The white band indicates the position of the cathode
L'anneau blanc marque la position de la cathode
Der weisse Ring bezeichnet die Katodenseite



Limiting values (Absolute max. values)
Caractéristiques limites (Valeurs max. absolues)
Grenzdaten (Absolute Maximalwerte)

		T_{amb} = 25 °C	60 °C
$-V_D$	= max.	50	50 V
$-V_{DM}$	= max.	50	50 V
$-V_{Dsurge}$ (t = max. 1 sec)	= max.	75	75 V
I_D { direct current / courant continu / Gleichstrom	= max.	110	40 mA [2])
I_D (t_{av} = max. 50 msec)	{ See pages D,E / Voir pages D,E / Siehe Seiten D,E		
I_{DM}	= max.	150	150 mA
I_{Dsurge} (t = max. 1 sec)	= max.	200	200 mA
T_{amb}	= − 55 °C/+ 60 °C		
Storage temperature / Température d'emmagasinage / Lagerungstemperatur	= − 55 °C/+ 75 °C		

[1]) Not tinned; non étamé; nicht verzinnt

[2]) See also page C; voir aussi page C; siehe auch Seite C

7Z2 0259 2.2.1964

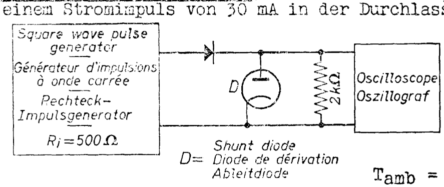
Thermal data. Junction temperature rise to ambient temperature in free air — $K \leq 0.45$ °C/mW
Données thermiques. Augmentation de la température de la jonction au regard de la température de l'ambiance à l'air libre — $K \leq 0{,}45$ °C/mW
Thermische Daten. Temperaturerhöhung des Kristalls in bezug auf die Umgebungstemperatur in freier Luft — $K \leq 0{,}45$ °C/mW

Characteristics
Caractéristiques
Kenndaten

I_D (mA)	V_D (V) T_{amb} = 25 °C =	T_{amb} = 25 °C max.	T_{amb} = 60 °C =	T_{amb} = 60 °C max.
0,1	=0,15	<0,25	=0,09	
10	=0,35	<0,65	=0,30	
150[1])	=0,74	<1,10	=0,68	

$-V_D$ (V)	$-I_D$ (µA) T_{amb} = 25 °C =	T_{amb} = 25 °C max.	T_{amb} = 60 °C =	T_{amb} = 60 °C max.
1,5	= 1,5	< 3,5	= 14	
10	= 4,0	< 20	= 22	
50	= 30	< 150	= 100	

Reverse recovery, measured at $-V_D$ = 35 V after forward current pulse of 30 mA
Recouvrement inverse, mesuré à $-V_D$ = 35 V après une impulsion de courant en sens conducteur de 30 mA
Übergangszeit für Sperrichtung, gemessen bei $-V_D$ = 35 V nach einem Stromimpuls von 30 mA in der Durchlassrichtung



T_{amb} = 25 °C

Measuring circuit; circuit de mesure; Messchaltung

[1]) See page 3; voir page 3; siehe Seite 3

7Z2 2248

Reverse recovery (continued)
Recouvrement inverse (suite)
Übergangszeit für Sperrichtung (Fortsetzung)

Pulse data
Données de l'impulsion
Impulsdaten

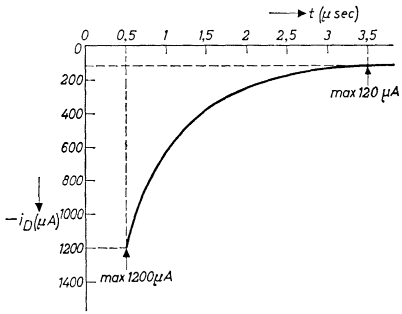
	f	=	50 kc/s
	δ	=	0,5
Rise time / Temps de montée / Anstiegszeit		<	0,1 µsec
	I_{DM}	=	30 mA
	$-V_{DM}$	=	35 V

Oscilloscope data
Données de l'oscilloscope
Daten des Oszillographen

	C C_{inp}	=	40 pF
Rise time / Temps de montée / Anstiegszeit		=	0,025 µsec

$-i_D$ { 0.5 µsec after the current impuls / 0,5 µsec après l'impulsion de courant / 0,5 µSek nach dem Stromimpuls } = 850 µA, <1200 µA

$-i_D$ { 3.5 µsec after the current impuls / 3,5 µsec après l'impulsion de courant / 3,5 µSek nach dem Stromimpuls } = 60 µA, < 120 µA



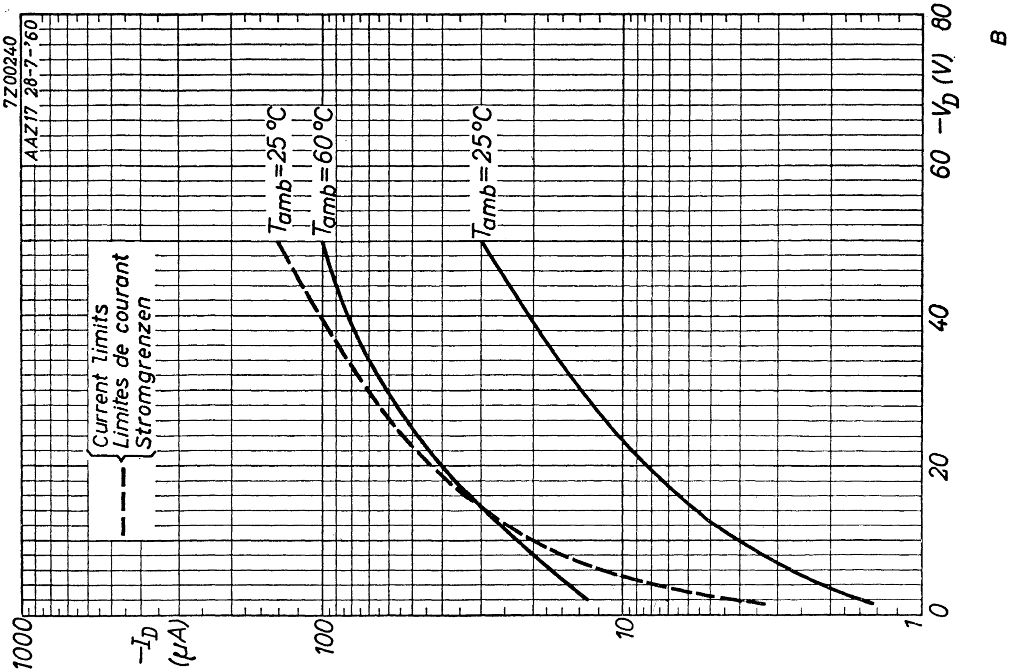
[1]) Measured under pulsed conditions to prevent excessive dissipation
Mesuré avec des impulsions pour prévenir une dissipation excessive
Zur Vermeidung einer übermässigen Verlustleistung mit Impulsen gemessen

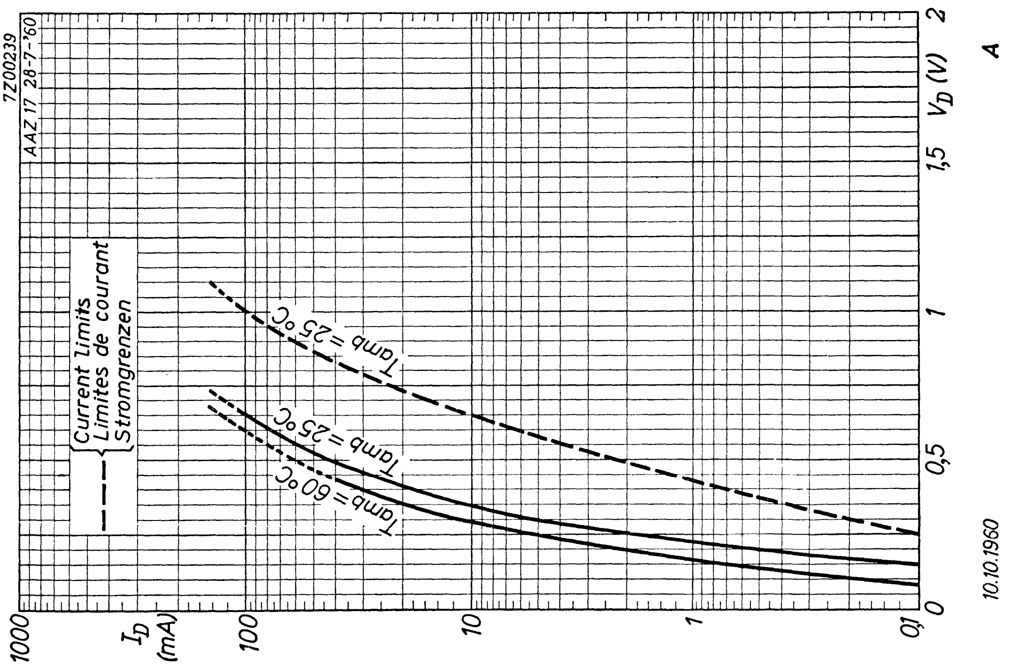
Characteristics (continued)
Caractéristiques (suite)
Kenndaten (Fortsetzung)

Capacitance
Capacité
Kapazität

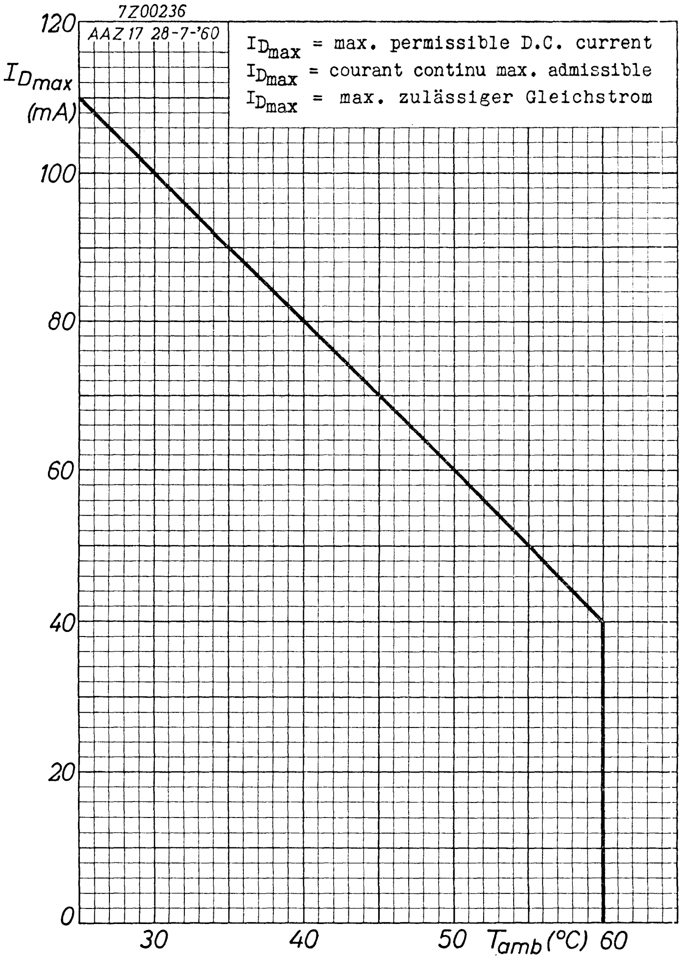
$-V_D$	=	0,75 V
f	=	0,5 Mc/s
c_{dk}	=	1,5 pF
	<	4,0 pF [1])

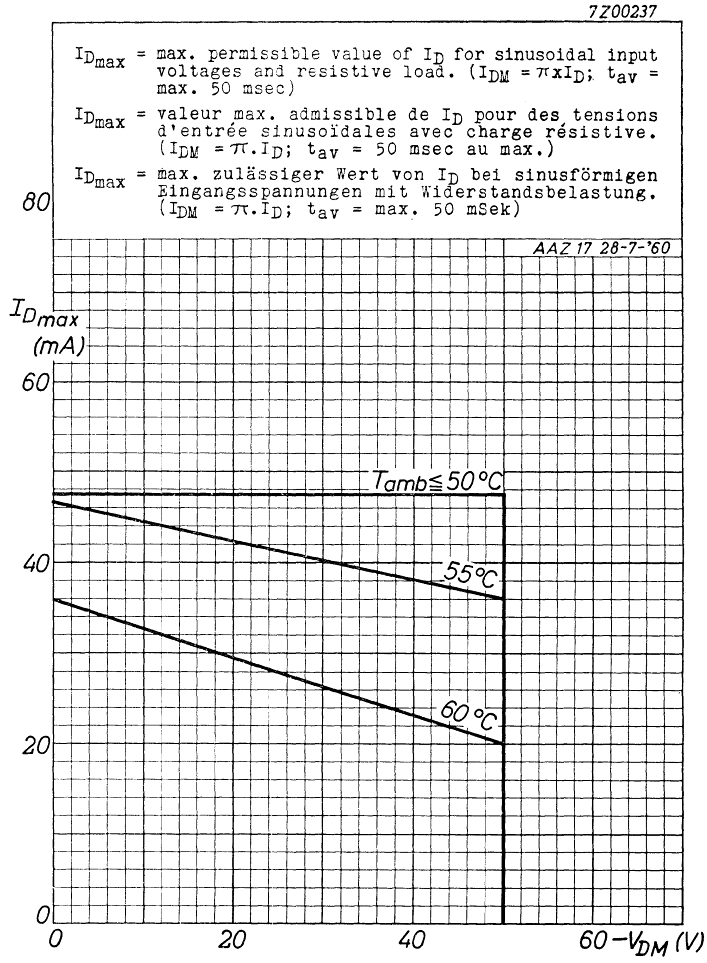
[1]) Characteristic range values for equipment design. For other characteristic range values for equipment design see curves pages A and B except the points mentionned at page 2
Gamme de valeurs caractéristiques pour l'étude d'équipements. Pour les autres gammes de valeurs caractéristiques pour l'étude d'équipements voir les courbes pages A et B sauf les points mentionnés page 2
Charakteristischer Wertbereich für Gerätentwurf. Für die übrigen charakteristischen Wertbereiche für Gerätentwurf siehe die Kurven Seiten A und B, mit Ausnahme der auf Seite 2 erwähnten Punkte.

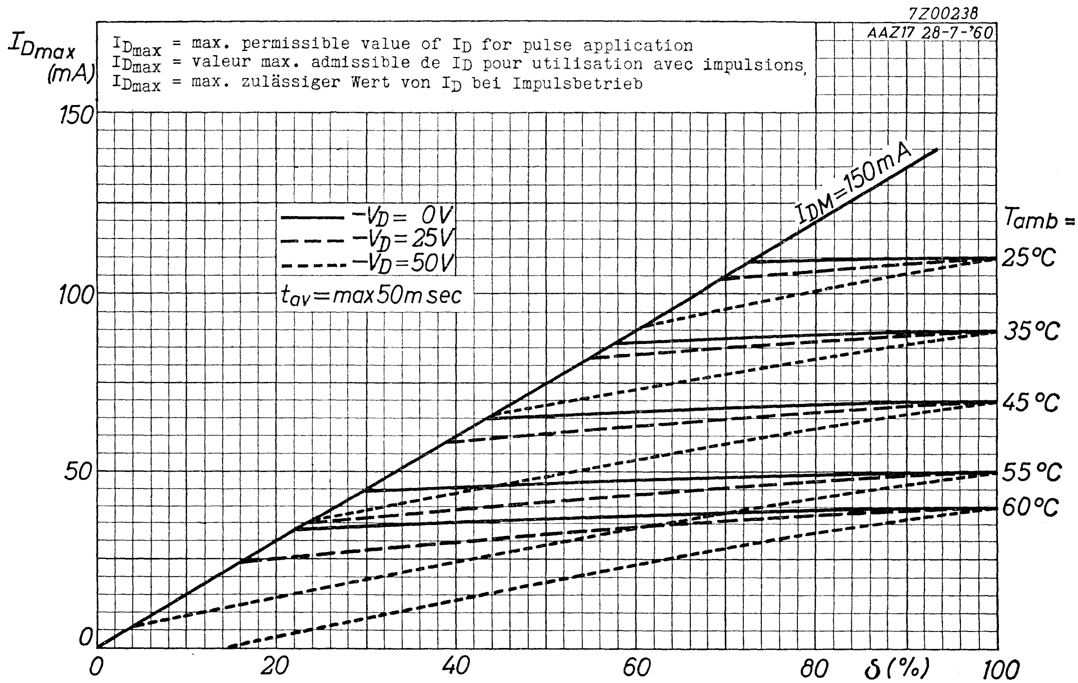

7Z00240
AAZ17 28-7-'60
Current limits
Limites de courant
Stromgrenzen
Tamb=25 °C
Tamb=60 °C
Tamb=25 °C
−ID (μA)
−VD (V)
1000
100
10
1
0
20
40
60
80
B


7Z00239
AAZ 17 28-7-'60
Current limits
Limites de courant
Stromgrenzen
Tamb = 25 °C
Tamb = 25 °C
Tamb = 60 °C
ID (mA)
VD (V)
1000
100
10
1
0,1
0
0,5
1
1,5
2
A

10.10.1960


7Z00236
AAZ 17 28-7-'60
$I_{D_{max}}$ = max. permissible D.C. current
$I_{D_{max}}$ = courant continu max. admissible
$I_{D_{max}}$ = max. zulässiger Gleichstrom
$I_{D_{max}}$ (mA)
120
100
80
60
40
20
0
30
40
50
T_{amb} (°C)
60


7Z00237
$I_{D_{max}}$ = max. permissible value of I_D for sinusoidal input voltages and resistive load. ($I_{DM} = \pi x I_D$; t_{av} = max. 50 msec)
$I_{D_{max}}$ = valeur max. admissible de I_D pour des tensions d'entrée sinusoïdales avec charge résistive. ($I_{DM} = \pi . I_D$; t_{av} = 50 msec au max.)
$I_{D_{max}}$ = max. zulässiger Wert von I_D bei sinusförmigen Eingangsspannungen mit Widerstandsbelastung. ($I_{DM} = \pi . I_D$; t_{av} = max. 50 mSek)
AAZ 17 28-7-'60
$I_{D_{max}}$ (mA)
80
60
40
20
0
$T_{amb} \leqq 50$ °C
55°C
60 °C
0
20
40
60
$-V_{DM}$ (V)


7Z00238
AAZ17 28-7-'60
I_{Dmax} = max. permissible value of I_D for pulse application
I_{Dmax} = valeur max. admissible de I_D pour utilisation avec impulsions,
I_{Dmax} = max. zulässiger Wert von I_D bei Impulsbetrieb
I_{Dmax} (mA)
150
100
50
0
0
20
40
60
80
100
δ (%)
I_{DM}=150mA
$-V_D$= 0V
$-V_D$=25V
$-V_D$=50V
t_{av}=max50msec
T_{amb} =
25°C
35°C
45°C
55°C
60°C

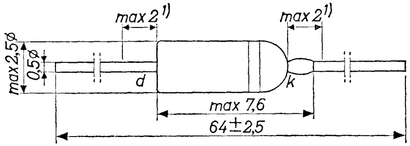
10.10.1960

E

GOLD-BONDED GERMANIUM DIODE in miniature all-glass construction for high current switching applications
DIODE À CRISTAL DE GERMANIUM À POINTE D'OR en construction tout-verre miniature pour applications de commutation à courant élevé
GERMANIUM-GOLDDRAHTDIODE in Miniatur-Allglastechnik zur Verwendung als Schalterdiode für hohe Ströme

Dimensions in mm
Dimensions en mm
Abmessungen in mm

The white band indicates the position of the cathode
L'anneau blanc marque la position de la cathode
Der weisse Ring bezeichnet die Katodenseite



Limiting values (Absolute max. values)
Caractéristiques limites (Valeurs max. absolues)
Grenzdaten (Absolute Maximalwerte)

		T_{amb} = 25 °C	60 °C
$-V_D$	= max.	20	20 V
$-V_{DM}$	= max.	20	20 V
$-V_{Dsurge}$ (t = max. 1 sec)	= max.	30	30 V
$-I_D$ {direct current / courant continu / Gleichstrom}	= max.	180	65 mA [2]
I_D (t_{av} = max. 50 msec)	See pages D,E / Voir pages D,E / Siehe Seite D,E		
I_{DM}	= max.	300	300 mA
I_{Dsurge} (t = max. 1 sec)	= max.	400	400 mA
T_{amb}	= - 55 °C/+ 60 °C		

Storage temperature
Température d'emmagasinage = - 55 °C/+ 75 °C
Lagerungstemperatur

[1]) Not tinned; non étamé; nicht verzinnt

[2]) See also page C; voir aussi page C; siehe auch Seite C

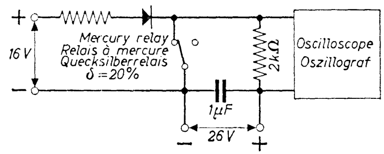
Thermal data. Junction temperature rise to ambient temperature in free air $K \leq 0.45$ °C/mW
Données thermiques. Augmentation de la température de la jonction au regard de la température de l'ambiance à l'air libre $K \leq 0,45$ °C/mW
Thermische Daten. Temperaturerhöhung des Kristalls in bezug auf die Umgebungstemperatur in freier Luft $K \leq 0,45$ °C/mW

Characteristics
Caractéristiques
Kenndaten

I_D (mA)	V_D (V)			
	T_{amb} = 25 °C		T_{amb} = 60 °C	
	=	max.	=	max.
0,1	= 0,15	< 0,21	= 0,09	
10	= 0,34	< 0,41	= 0,29	
300[1])		< 0,78		

$-V_D$ (V)	$-I_D$ (μA)			
	T_{amb} = 25 °C		T_{amb} = 60 °C	
	=	max.	=	max.
1,5	= 0,6	< 3,5	= 5	
10	= 3	< 15	= 8	
20	= 6	< 50	= 15	

Reverse recovery time, measured at $-V_D$ = 10 V after forward current pulse of 300 mA
Temps de recouvrement inverse, mesuré à $-V_D$ = 10 V après une impulsion de courant de 300 mA dans le sens conducteur
Übergangszeit für Sperrichtung, gemessen bei $-V_D$ = 10 V nach einem Stromimpuls von 300 mA in Durchlassrichtung



Measuring circuit; circuit de mesure; Messschaltung

[1]) See page 3; voir page 3; siehe Seite 3

Reverse recovery time (continued)
Temps de recouvrement inverse (suite)
Übergangszeit für Sperrichtung (Fortsetzung)

Pulse data
Données de l'impulsion
Impulsdaten

I_{DM}	=	300 mA
$-V_{DM}$	=	20 V
δ	=	20 %
f	=	50 c/s

Oscilloscope data
Données de l'oscilloscope
Daten des Oszillographen

C_{inp}	=	15 pF
R_{inp}	=	4 MΩ
Rise time / Temps de montée / Anstiegszeit	=	0,016 µsec

$-i_D$ { 3.5 µsec after the current impuls / 3,5 µsec après l'impulsion de courant / 3,5 µSek nach dem Stromimpuls: = 40 µA; < 150 µA

Column I: Setting of the diode and typical (average) measuring results of new diodes
II: Characteristic range values for equipment design 2)
Colonne I: Valeurs pour le réglage de la diode et les résultats moyens de mesures de diodes neuves.
II: Gamme de valeurs caractéristiques pour l'étude d'équipements 2)
Spalte I: Einstelldaten der Diode und mittlere Messergebnisse neuer Dioden
II: Charakteristischer Wertbereich für Gerätentwurf 2)

Page 2, Seite 2

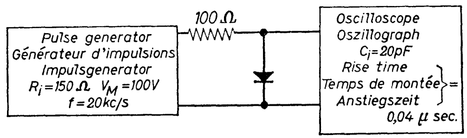
1) Measured under pulsed conditions to prevent excessive dissipation
Mesuré en service d'impulsions pour prévenir une dissipation excessive
Gemessen mit Impulsen zur Verhütung einer übermässigen Verlustleistung

2) For other characteristic range values for equipment design see curves at T_{amb} = 25 °C pages A and B
Pour les autres gammes de valeurs caractéristiques pour l'étude d'équipements voir les courbes à Tamb = 25 °C pages A et B
Für die übrigen charakteristischen Wertbereiche für Gerätentwurf siehe die Kurven bei T_{amb} = 25 °C Seiten A und B

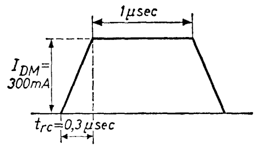
Capacitance
Capacité
Kapazität

		I	II	
$-V_D$	=	0,75		V
f	=	0,5		Mc/s
c_{dk}	=	1,8	< 4	pF

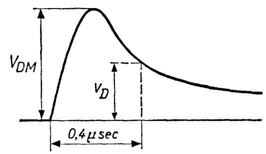
Forward recovery
Temps de recouvrement direct
Übergangszeit für Durchlassrichtung



Measuring circuit; circuit de mesure; Messanordnung

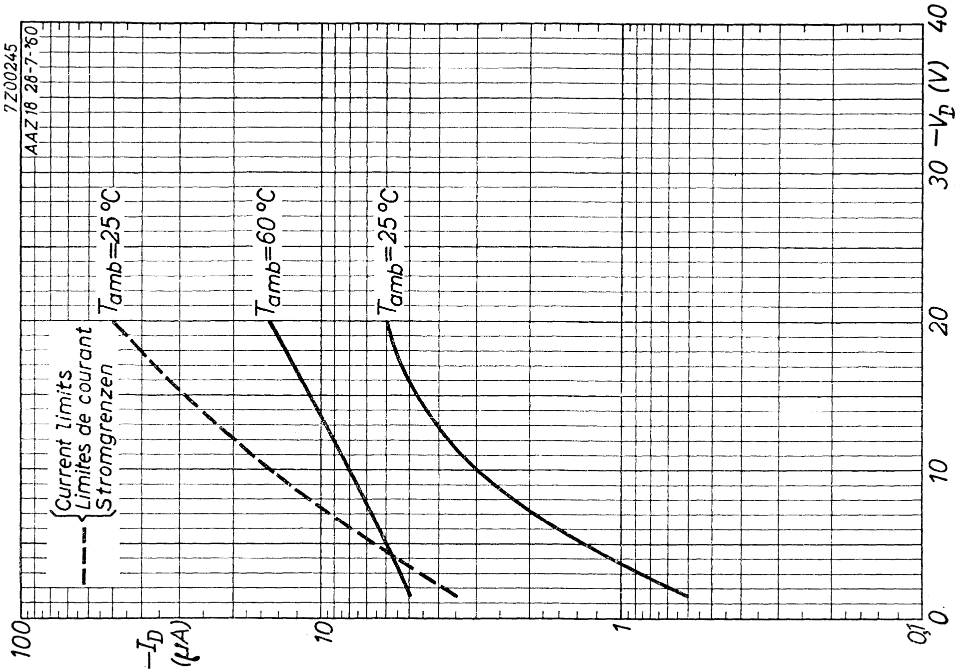


Current pulse
Impulsion de courant
Stromimpuls

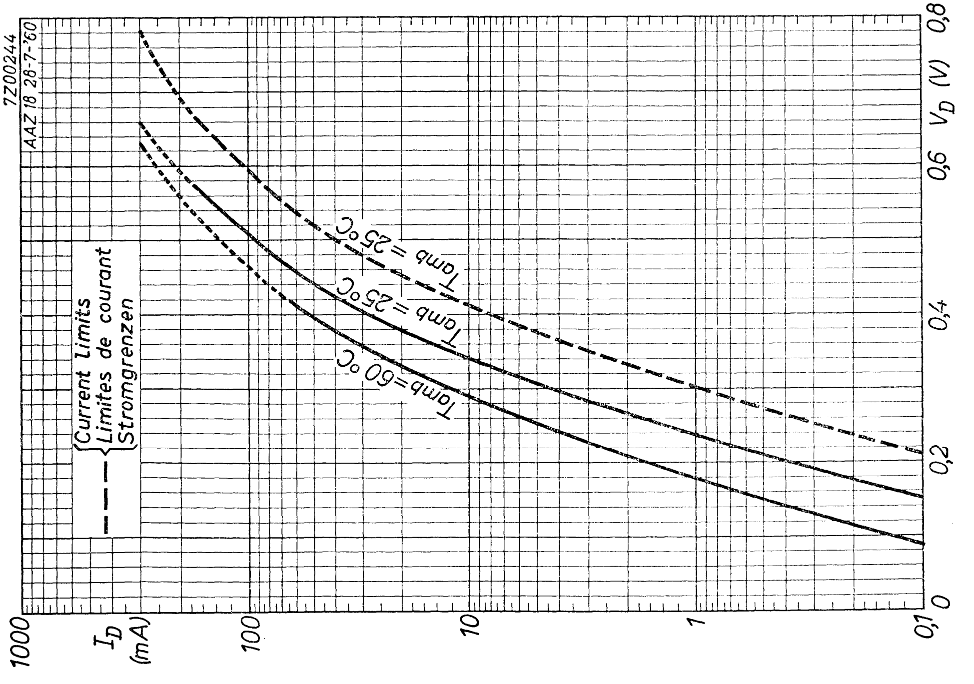


Voltage pulse
Impulsion de tension
Spannungsimpuls

		I	II	
I_{DM}	=	300		mA
t_{imp}	=	1		µsec
V_{DM}	=	0,65		V
v_D { after 0.4 µsec / après 0,4 µsec / nach 0,4 µSek	=	0,62		V

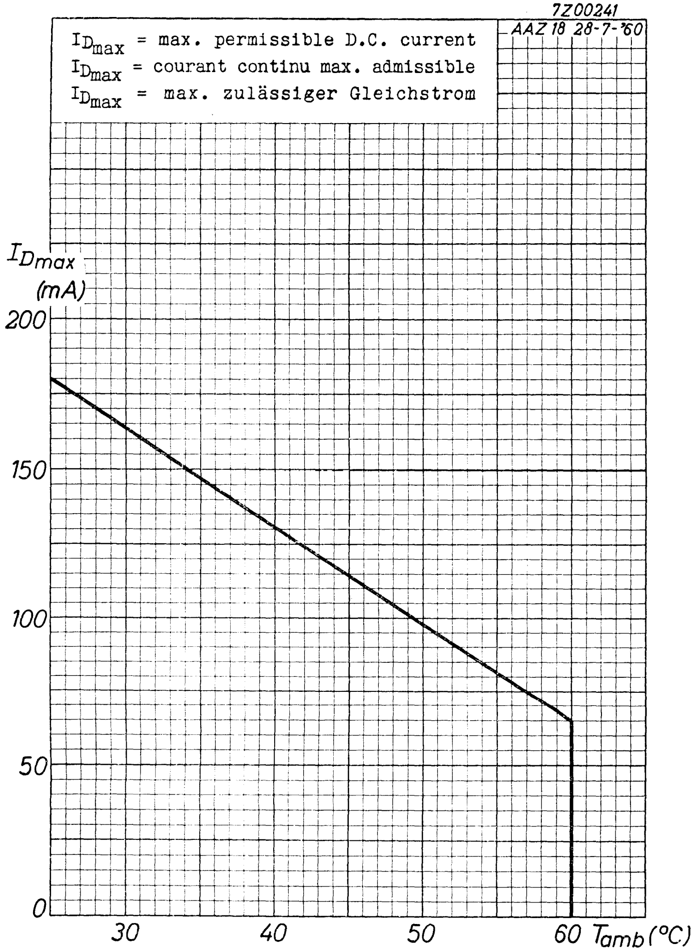

7Z00245
AAZ 18 28-7-'60
Current limits
Limites de courant
Stromgrenzen
T_{amb}=25 °C
T_{amb}=60 °C
T_{amb}=25 °C
$-I_D$ (μA)
100
10
1
0,1
0
10
20
30
40
$-V_D$ (V)

B

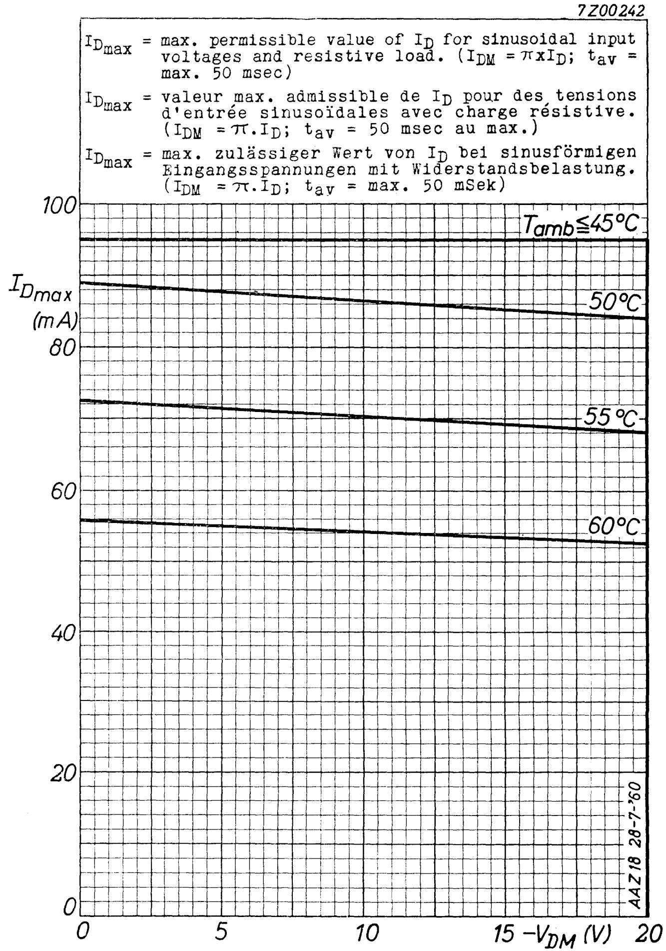

7Z00244
AAZ 18 28-7-'60
Current limits
Limites de courant
Stromgrenzen
T_{amb} = 25 °C
T_{amb} = 25 °C
T_{amb} = 60 °C
I_D (mA)
1000
100
10
1
0,1
0
0,2
0,4
0,6
0,8
V_D (V)

A

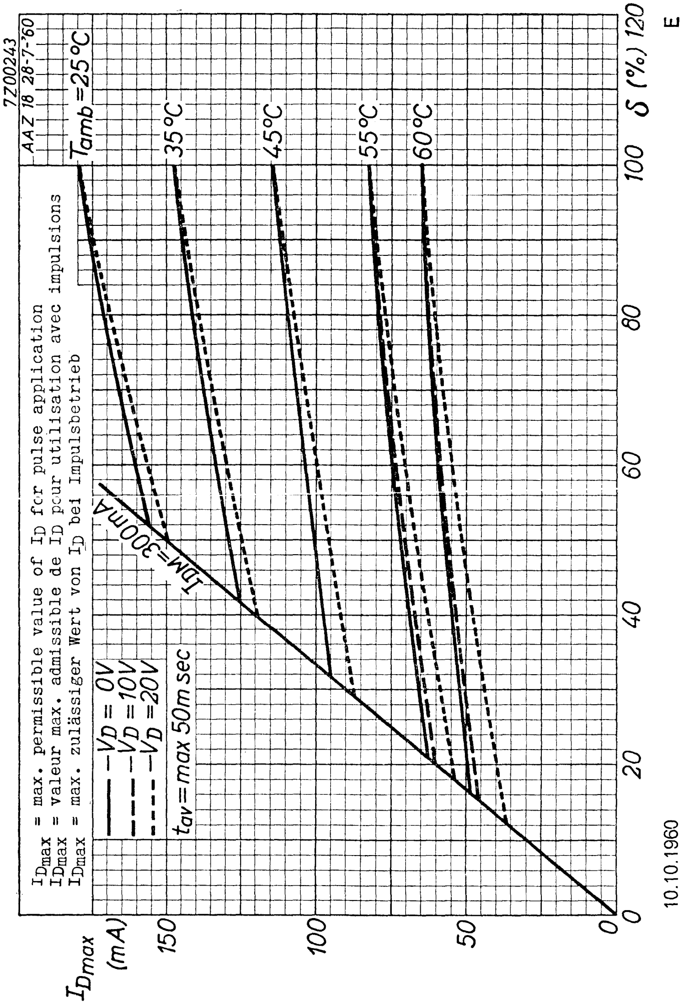
10.10.1960


7Z00241
AAZ 18 28-7-'60
I_{Dmax} = max. permissible D.C. current
I_{Dmax} = courant continu max. admissible
I_{Dmax} = max. zulässiger Gleichstrom
I_{Dmax} (mA)
200
150
100
50
0
30
40
50
60
T_{amb} (°C)

C


7Z00242
I_{Dmax} = max. permissible value of I_D for sinusoidal input voltages and resistive load. ($I_{DM} = \pi x I_D$; t_{av} = max. 50 msec)
I_{Dmax} = valeur max. admissible de I_D pour des tensions d'entrée sinusoïdales avec charge résistive. ($I_{DM} = \pi . I_D$; t_{av} = 50 msec au max.)
I_{Dmax} = max. zulässiger Wert von I_D bei sinusförmigen Eingangsspannungen mit Widerstandsbelastung. ($I_{DM} = \pi . I_D$; t_{av} = max. 50 mSek)
$T_{amb} \leqq 45°C$
50°C
55°C
60°C
I_{Dmax} (mA)
100
80
60
40
20
0
5
10
15
$-V_{DM}$ (V)
20
AAZ 18 28-7-'60

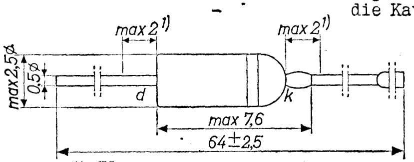
D


7Z00243
AAZ 18 28-7-'60
I_{Dmax} = max. permissible value of I_D for pulse application
I_{Dmax} = valeur max. admissible de I_D pour utilisation avec impulsions
I_{Dmax} = max. zulässiger Wert von I_D bei Impulsbetrieb
T_{amb}=25°C
35°C
45°C
55°C
60°C
I_{DM}=300mA
—— V_D = 0V
— — — V_D = 10V
- - - - V_D = 20V
t_{av}=max 50m sec
I_{Dmax}
(mA)
150
100
50
0
0
20
40
60
80
100
120
δ (%)
10.10.1960
E

GENERAL PURPOSE SILICON DIODE in miniature all-glass construction
DIODE A SILICIUM de construction miniature tout verre pour les usages généraux
ALLZWECKSILIZIUMDIODE in Miniatur- Allglasausführung

Dimensions in mm
Dimensions en mm
Abmessungen in mm

The white band indicates the position of the cathode
L'anneau blanc indique la position de la cathode
Der weisse Ring bezeichnet die Katodenseite



Limiting values (Absolute max. values)
Caractéristiques limites (Valeurs max. absolues)
Grenzdaten (Absolute Maximalwerte)

		$T_{amb} = 25^{o}C$	$T_{amb} = 90^{o}C$
$-V_D$	=	max. 60 V	max. 60 V
I_D	=	max. 90 mA	max. 18 mA 2)
I_{DM}	=	max. 100 mA	max. 100 mA
$I_{D\ surge}$ (T = max. 1 sec)	=	max. 200 mA	max. 200 mA
T_{amb}	=	-55 °C/ + 90 °C	

Storage temperature
Température d'emmagasinage = -55 °C/ + 90 °C
Lagerungstemperatur

Thermal data. Junction temperature rise to ambient temperature in free air K ≦ 0.4 °C/mW

Données thermiques. Augmentation de la température de la jonction au regard de la température de l'ambiance à l'air libre K ≦ 0,4 °C/mW

Thermische Daten. Temperaturerhöhung des Kristalls in Bezug auf die Umgebungstemperatur in freier Luft K ≦ 0,4 °C/mW

1) Not tinned; non étamé; nicht verzinnt
2) See pages B,C and D; voir pages B,C et D; siehe Seiten B,C und D

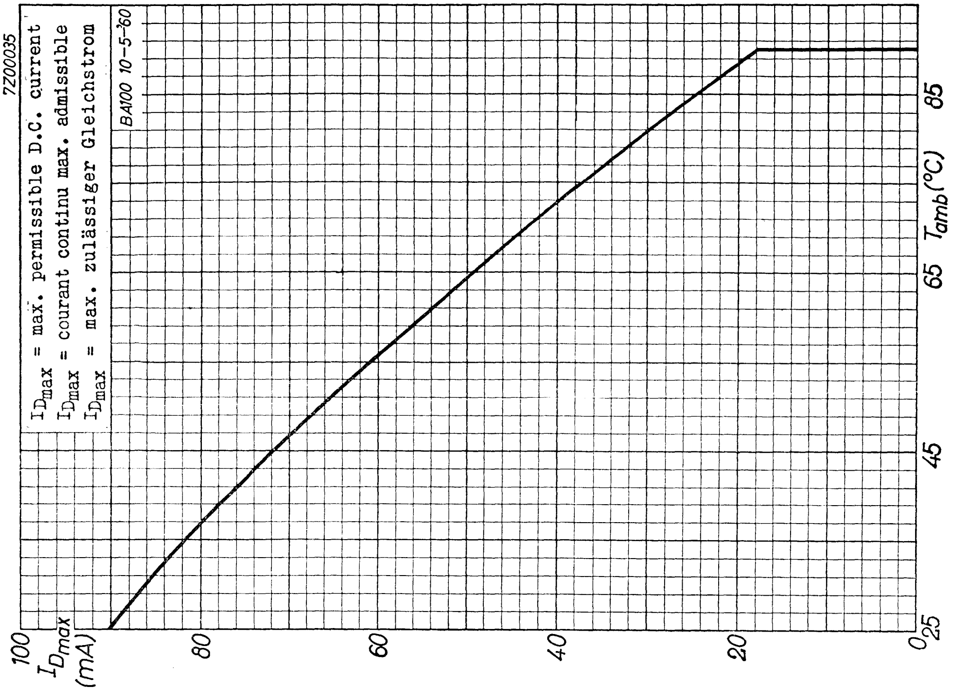
Characteristics
Caractéristiques
Kenndaten

I_D (mA)	V_D (V) T_{amb} = 25 °C =	min.	max.	T_{amb} = 60 °C =	min.	max.
0,1	= 0,55		< 0,75	= 0,5		
1,0	= 0,65	> 0,5	< 1,0	= 0,6	> 0,4	< 0,9
30	= 0,9		< 1,5	= 0,85		< 1,5

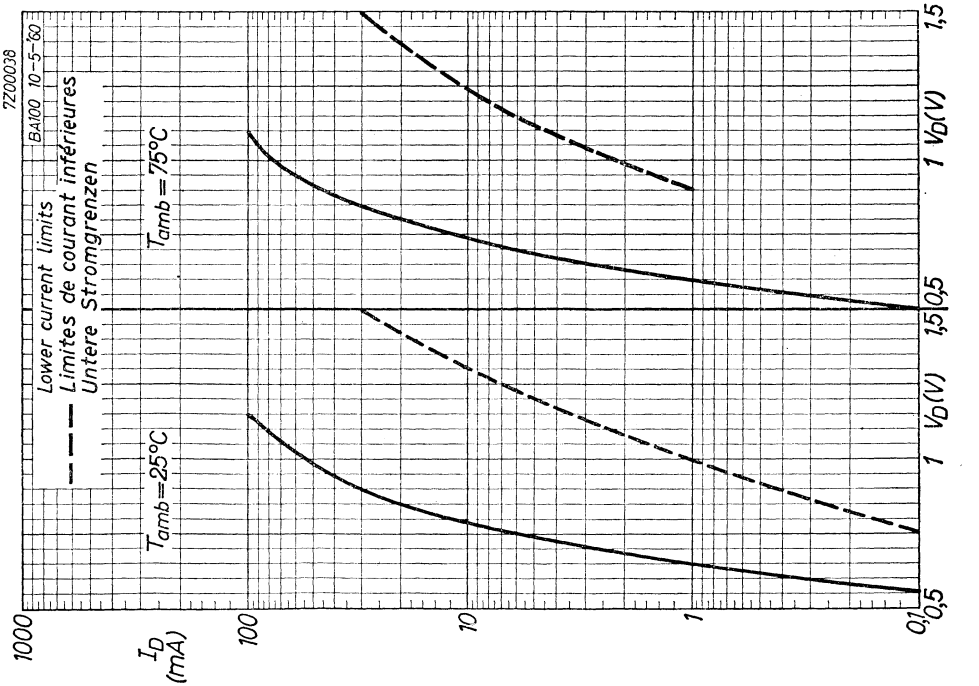
T_{amb} = 60 °C	
$-V_D$	$-I_D$
10 V	5,0 μA
60 V	10 μA

Characteristic range values for equipment design (see also page A)
Gamme de valeurs caractéristiques pour l'étude d'équipements (voir aussi page A)
Charakteristischer Wertbereich für Gerätentwurf (siehe auch Seite A)

T_{amb} = 75 °C	
$-V_D$	$-I_D$
10 V	< 10 μA
60 V	< 20 μA


7Z00035
BA100 10-5-'60
I_Dmax = max. permissible D.C. current
I_Dmax = courant continu max. admissible
I_Dmax = max. zulässiger Gleichstrom
100
I_Dmax (mA)
80
60
40
20
0
25
45
65
85
T_amb (°C)

B


7Z00038
BA100 10-5-'60
Lower current limits
Limites de courant inférieures
Untere Stromgrenzen
T_amb = 25°C
T_amb = 75°C
1000
I_D (mA)
100
10
1
0,1
0,5
1
V_D (V)
1,5
0,5
1
V_D (V)
1,5

A

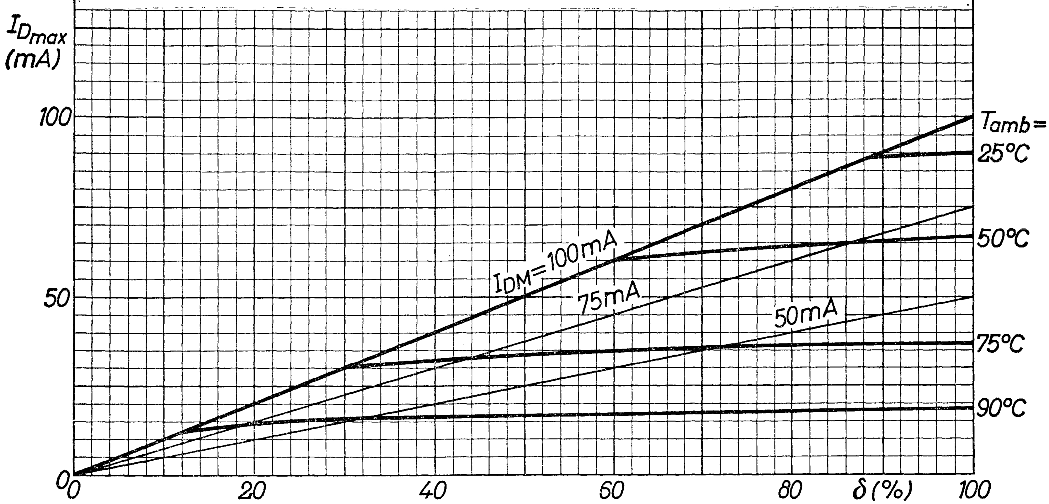
5.5.1960

7Z00037
BA100 10-5-'60

I_{Dmax} = max. permissible value of I_D for sinusoidal input voltages with capacitive load and for pulse applications. (t_{av} = max. 20 msec)

I_{Dmax} = valeur max. admissible de I_D pour des tensions d'entrée sinusoidales avec charge capacitive et pour utilisation avec impulsions. (t_{av} = 20 msec au max.)

I_{Dmax} = max. zulässiger Wert von I_D bei sinusförmigen Eingangsspannungen mit kapazitiver Belastung und bei Impulsbetrieb. (t_{av} = max. 20 mSek)



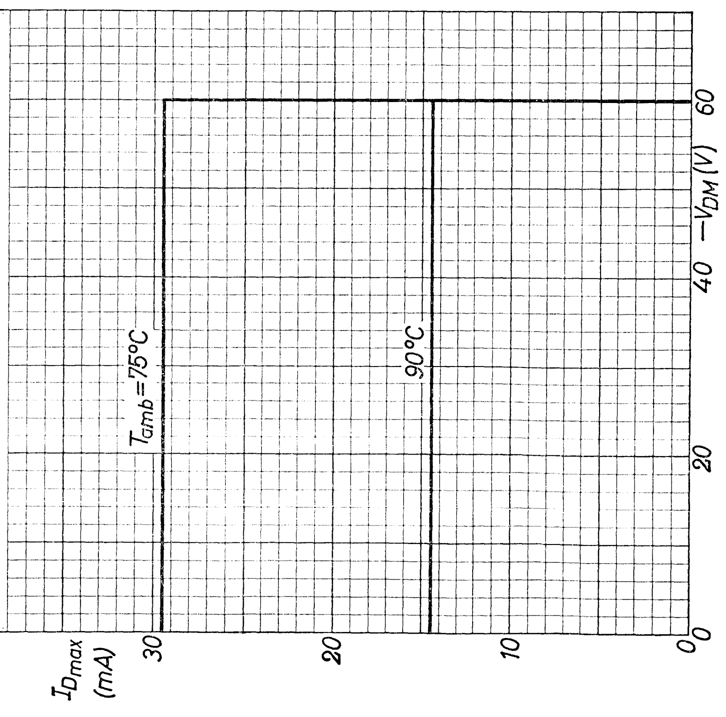
D

7Z00036
BA100 10-5-'60

I_{Dmax} = max. permissible value of I_D for sinusoidal input voltages and resistive load. ($I_{DM} = \pi x I_D$; t_{av} = max. 20 msec)

I_{Dmax} = valeur max. admissible de I_D pour des tensions d'entrée sinusoïdales avec charge résistive. ($I_{DM} = \pi . I_D$; t_{av} = 20 msec au max.)

I_{Dmax} = max. zulässiger Wert von I_D bei sinusförmigen Eingangsspannungen mit Widerstandsbelastung. ($I_{DM} = \pi . I_D$; t_{av} = max. 20 mSek)



C

VOLTAGE DEPENDENT CAPACITOR

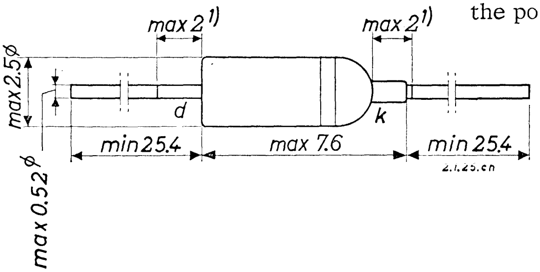
Voltage dependent silicon capacitor in subminiature all-glass DO-7 construction intended for automatic frequency control in television receivers.

QUICK REFERENCE DATA					
Inverse voltage (d.c.)	$-V_D$	=	max.	20	V
Reverse current (d.c.)	$-I_D$	=	max.	100	μA
Junction temperature	T_j	=	max.	90	^{o}C
Capacitance ratio	$\frac{c_D\ (-V_D = 10\ V)}{c_D\ (-V_D = 4\ V)}$	<		0.7	

MECHANICAL DATA

Dimensions in mm

The white band indicates the position of the cathode



LIMITING VALUES (Absolute max. values)

Inverse voltage (d.c.)	$-V_D$	=	max.	20	V
Reverse current (d.c.)	$-I_D$	=	max.	100	μA
Temperatures					
Junction temperature	T_j	=	max.	90	^{o}C
Storage temperature	T_s	=	−55 ^{o}C to +90		^{o}C

1) Not tinned

7Z2 2646

THERMAL DATA

Thermal resistance between junction and ambience in free air	K	<	0.4 $^{o}C/mW$

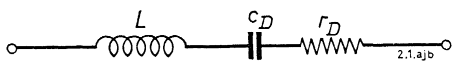
CHARACTERISTICS

Reverse current at T_j = 80 ^{o}C, $-V_D$ = 20 V	$-I_D$	<		5 μA
Capacitance at T_j = 25 ^{o}C, $-V_D$ = 4 V; f = 0.5 Mc/s	c_D	> 20	< 45	pF [1]

CHARACTERISTIC RANGE VALUES FOR EQUIPMENT DESIGN T_j = 25 ^{o}C

Series resistance at $-V_D$ = 4 V	r_D	= 1.7	< 3 Ω
Capacitance ratio at f ≦ 300 Mc/s	$\frac{c_D (-V_D = 10 V)}{c_D (-V_D = 4 V)}$		< 0.7

Simplified equivalent circuit



L = lead inductance ≈ 6 nH
r_D = series resistance
c_D = diode capacitance (see page 4)
} frequency independent up to f = 300 Mc/s

These data apply for a distance between the two measuring points of 10 mm

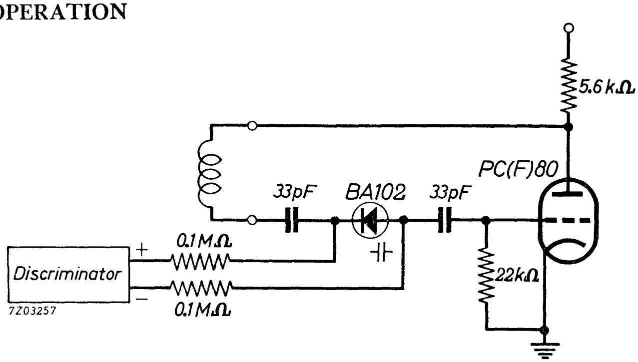
[1] For convenience reasons only the spread in the magnitude of c_D is indicated in more detail by means of coloured dots.

At $-V_D$ = 4 V; f = 0.5 Mc/s; T_{amb} = 25 ^{o}C

white dot :	c_D	> 20	< 24	pF
yellow dot:	c_D	> 24	< 30	pF
blue dot :	c_D	> 30	< 37	pF
green dot :	c_D	> 37	< 45	pF

7Z2 2647

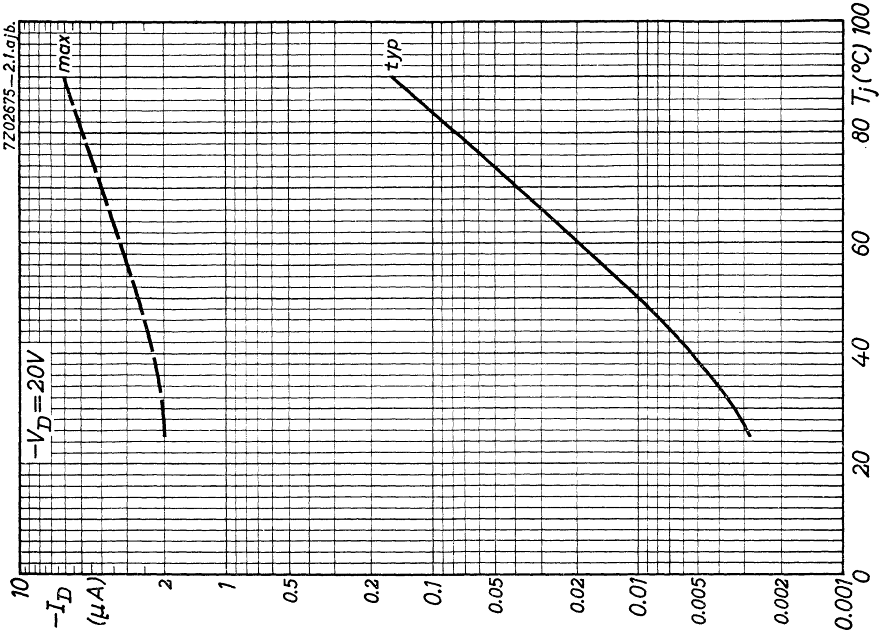
TYPICAL OPERATION

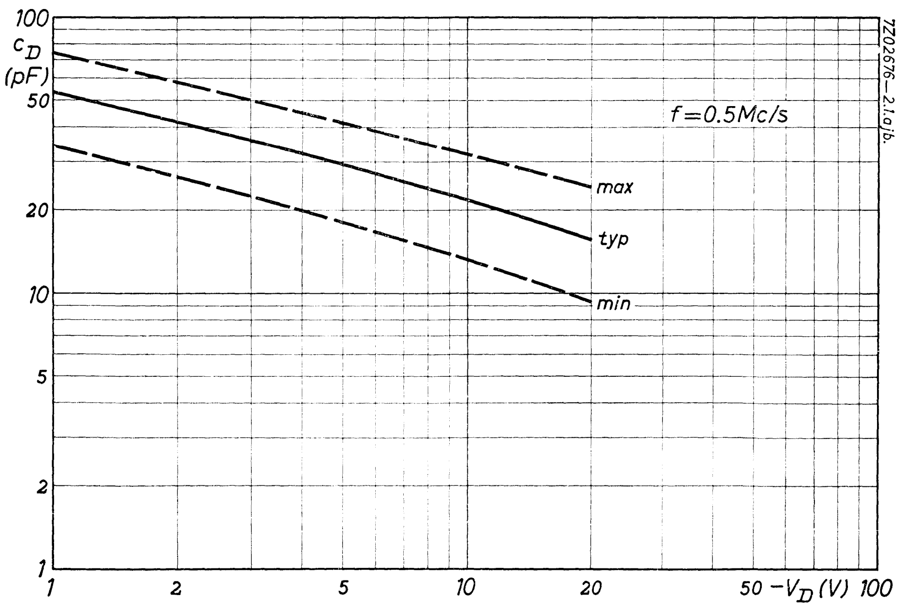


Basic circuit for automatic frequency control in TV receivers using the BA102 in series with the oscillator coil

Sensitivity of the discriminator	:	25	V/Mc/s
Reduction of the frequency deviation at band I	:	1:10	
Reduction of the frequency deviation at band III	:	1:25	

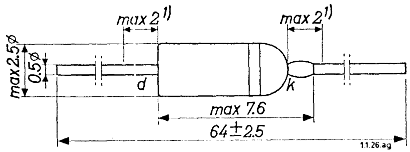
7Z2 3050


7Z02675—2.1.ajb.
max
typ
$-V_D = 20V$
10
$-I_D$
(μA)
2
1
0.5
0.2
0.1
0.05
0.02
0.01
0.005
0.002
0.001
0
20
40
60
80
T_j (°C)
100


100
c_D
(pF)
50
20
10
5
2
1
7Z02676—2.1.ajb.
f = 0.5Mc/s
max
typ
min
1
2
5
10
20
50
$-V_D$ (V)
100

SILICON ALLOYED JUNCTION DIODE in miniature all-glass construction for use as low voltage stabilizer

Dimensions in mm   The white band indicates the cathode side



LIMITING VALUES (Absolute max. values)

Continuous forward current	I_D	= max. 20 mA
Storage temperature	T_s	= -55 °C to +90 °C
Operating ambient temperature	T_{amb}	= -55 °C to +90 °C

THERMAL DATA

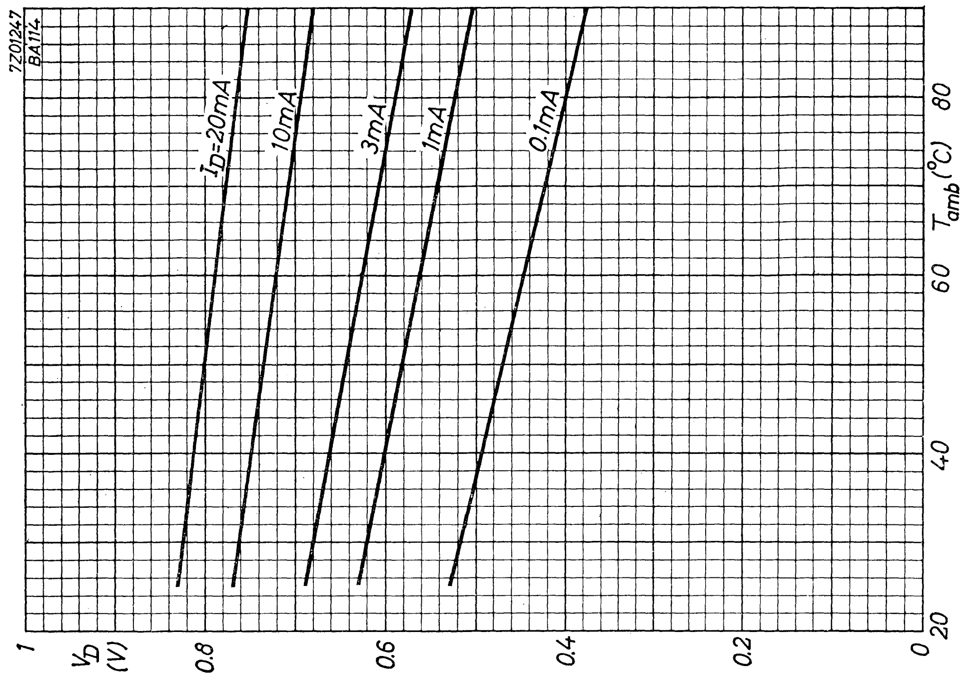
Thermal resistance from junction to ambience in free air	$K_{j\text{-}amb}$	= max. 0.4 °C/mW

CHARACTERISTICS at T_{amb} = 25 °C

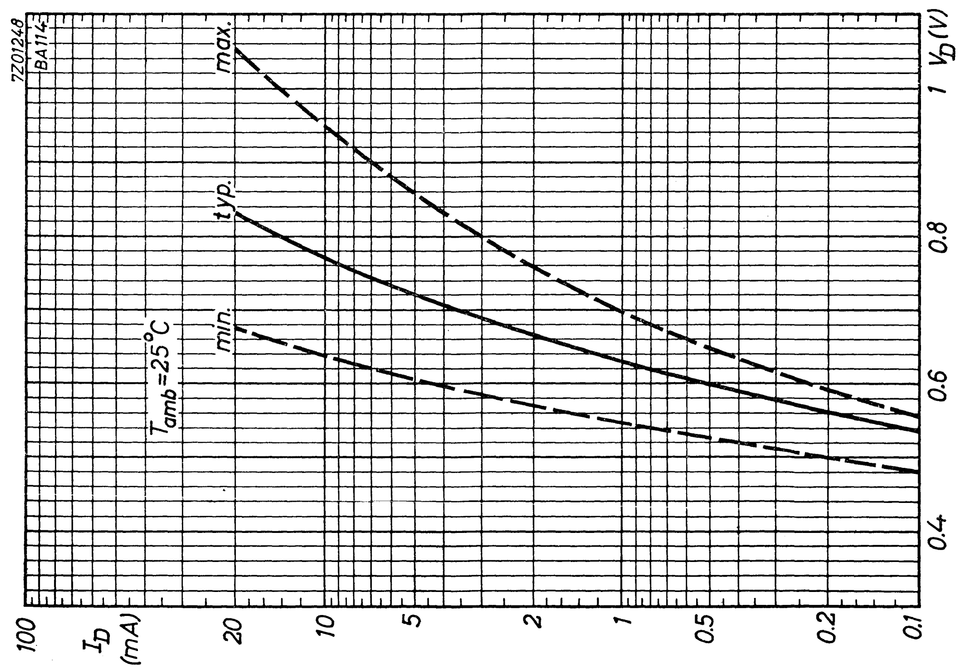
Forward voltage

V_D (I_D = 0.2 mA)	> 0.5 V
V_D (I_D = 3 mA)	< 0.8 V

1) Not tinned


7Z01247
BA114
I_D=20mA
10mA
3mA
1mA
0.1mA
V_D (V)
1
0.8
0.6
0.4
0.2
0
20
40
60
80
T_amb (°C)

B


7Z01248
BA114
max.
typ.
min.
T_amb=25°C
I_D (mA)
100
20
10
5
2
1
0.5
0.2
0.1
0.4
0.6
0.8
1
V_D (V)

A

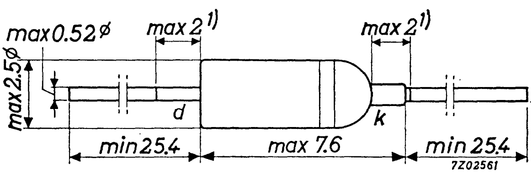
4.4.1963

SILICON PLANAR DIODE

Silicon planar diode in subminiature all glass DO-7 envelope for general purpose industrial applications

QUICK REFERENCE DATA				
Continuous inverse voltage	$-V_D$	=	max. 150	V
Repetitive peak forward current	I_{DM}	=	max. 250	mA
Continuous forward current	I_D	=	max. 170	mA
Forward voltage drop at I_D = 100 mA	V_D	<	1.5	V
Reverse recovery time when switched from I_D = 30 mA to $-V_D$ = 35 V; measured at $-I_D$ = 1 mA and with R_L = 2.5 kΩ	t_{rr}	<	2.5	μs
Thermal resistance between junction and ambience	K	<	0.4	°C/mW

MECHANICAL DATA Dimensions in mm



The white band indicates the cathode side

1) Not tinned

7Z2 3093

LIMITING VALUES (Absolute max. values)

Voltages

Continuous inverse voltage	$-V_D$	=	max.	150	V
Repetitive peak inverse voltage	$-V_{DM}$	=	max.	150	V

Currents

Average rectified forward current (t_{av} = 20 ms)	I_{DAV}	=	max.	170	mA [1])
Continuous forward current	I_D	=	max.	170	mA
Repetitive peak forward current	I_{DM}	=	max.	250	mA
Non-repetitive peak forward current					
for t_{max} = 1 μs	$I_{DMsurge}$	=	max.	2000	mA
for t_{max} = 1 s	$I_{DMsurge}$	=	max.	500	mA

Temperatures

Storage temperature	T_s	=	-65 °C to 200		°C
Junction temperature	T_j	=	max.	190	°C

THERMAL DATA

Thermal resistance between junction and ambience in free air	K	<	0.4	°C/mW

CHARACTERISTICS at T_j = 25 °C

Reverse current at $-V_D$ = 150 V	$-I_D$	<	100	nA
Forward voltage drop at I_D = 100 mA	V_D	<	1.5	V

[1]) For sinusoidal operation see page D

For pulse operation see page E

7Z2 3094

CHARACTERISTIC RANGE VALUES FOR EQUIPMENT DESIGN

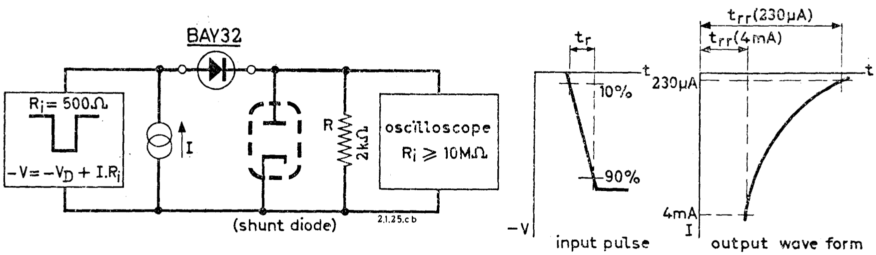
T_j = 25 °C unless otherwise specified

Diode capacitance at V_D = 0 V; f = 1 Mc/s [1]	c_d	<	15	pF
Reverse current at $-V_D$ = 150 V; T_j = 150 °C	$-I_D$	<	30	μA
Forward voltage at I_D = 250 mA; T_j = 150 °C	V_D	<	1.9	V ←

Reverse recovery time, when switched from
I_D = 30 mA to $-V_D$ = 35 V; R_L = 2.5 kΩ

Measured at $-I_D$ = 4 mA	t_{rr}	<	2.5	μs
Measured at $-I_D$ = 230 μA	t_{rr}	<	5.0	μs

Test circuit



Reverse pulse:

Rise time	t_r	≦	0.1 μs
Duty cycle	δ	=	0.5
Frequency	f	=	50 kc/s

Circuit:

Capacitance	C	≦	30 pF (C = Oscilloscope + parasitical capacitance)

---

[1]) See also page C

7Z2 3095

3.3.1965

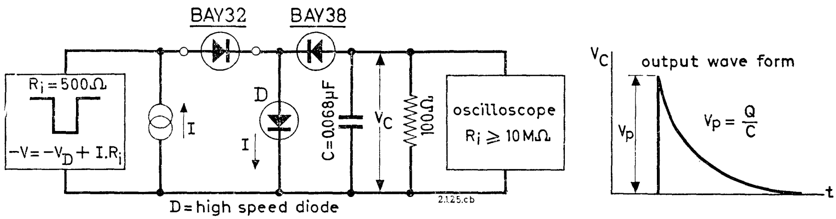
CHARACTERISTIC RANGE VALUES FOR EQUIPMENT DESIGN (continued)

$T_j = 25\ ^oC$

Stored charge, when switched from

$I_D = 10$ mA to $-V_D = 5$ V; $R_L = 500\ \Omega$ $\qquad Q_s \quad = 4$ nC $\quad < 10$ nC

Test circuit



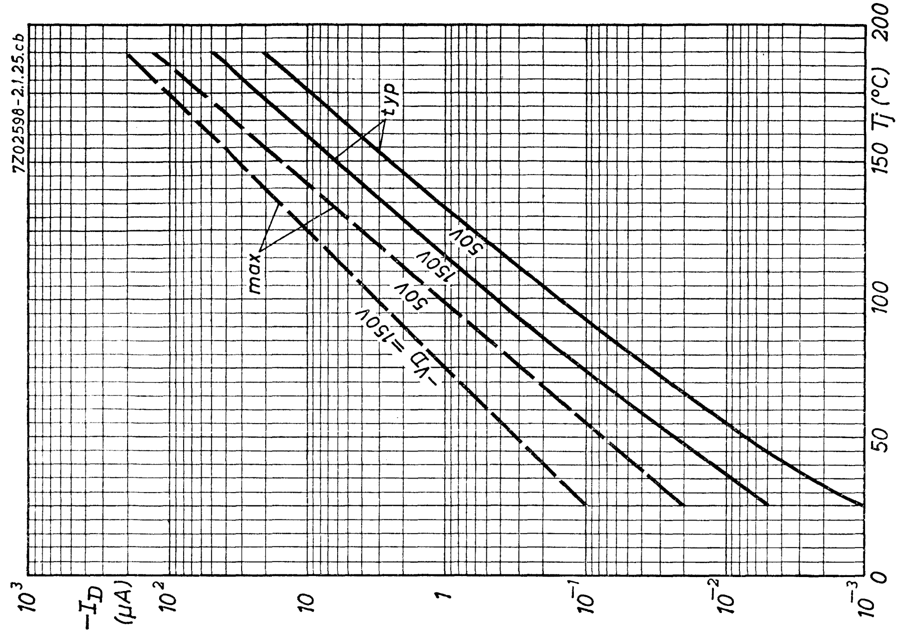
Reverse pulse:

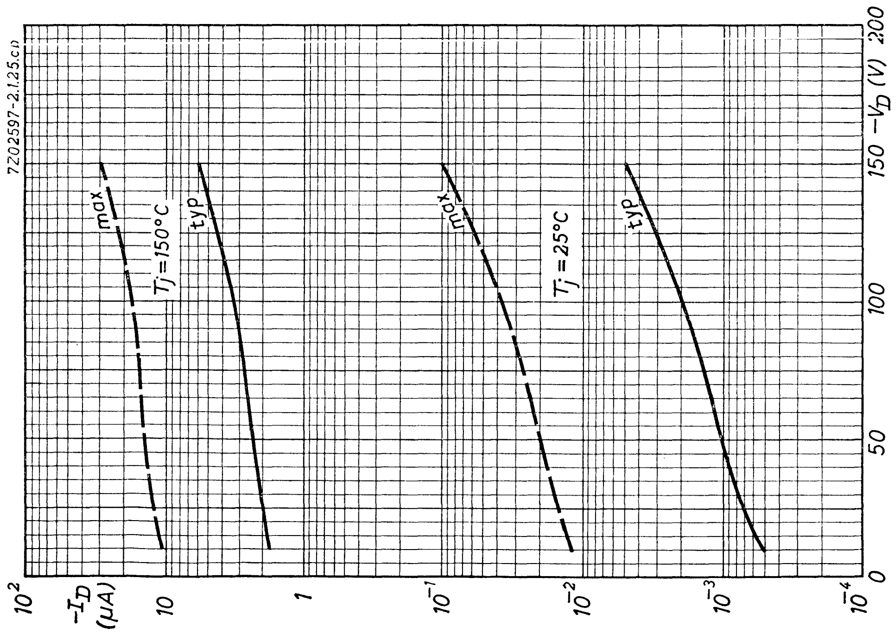
Rise time	t_r	=	15 ns
Pulse duration	t_p	=	35 μs
Frequency	f	=	25 kc/s

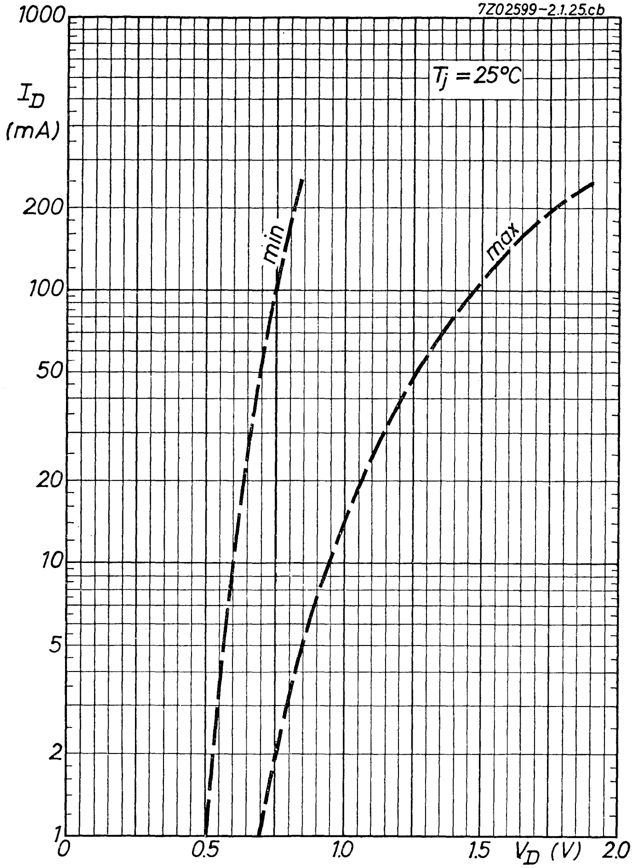
Circuit:

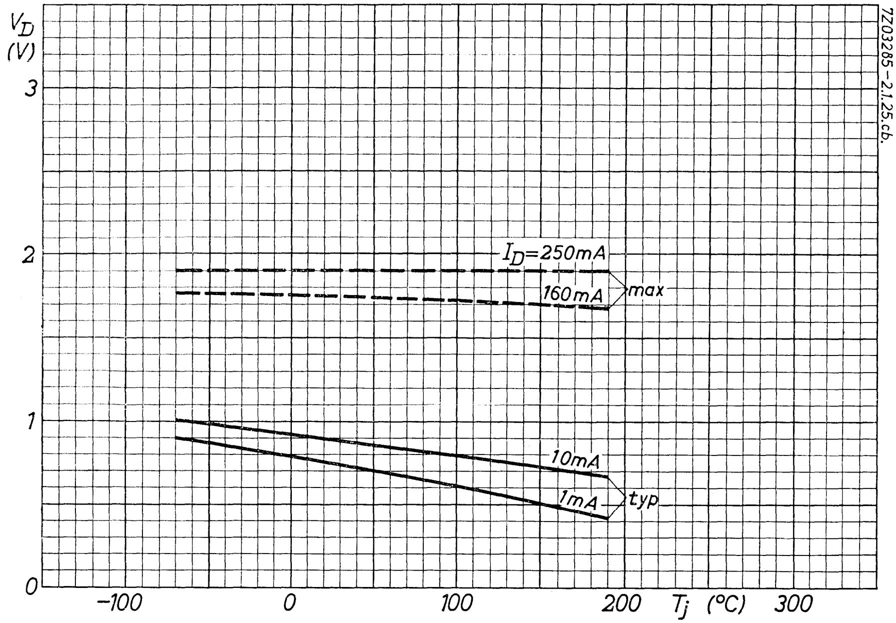
Capacitance	C	$\leq$	30 pF (C = Oscilloscope + parasitical capacitance)

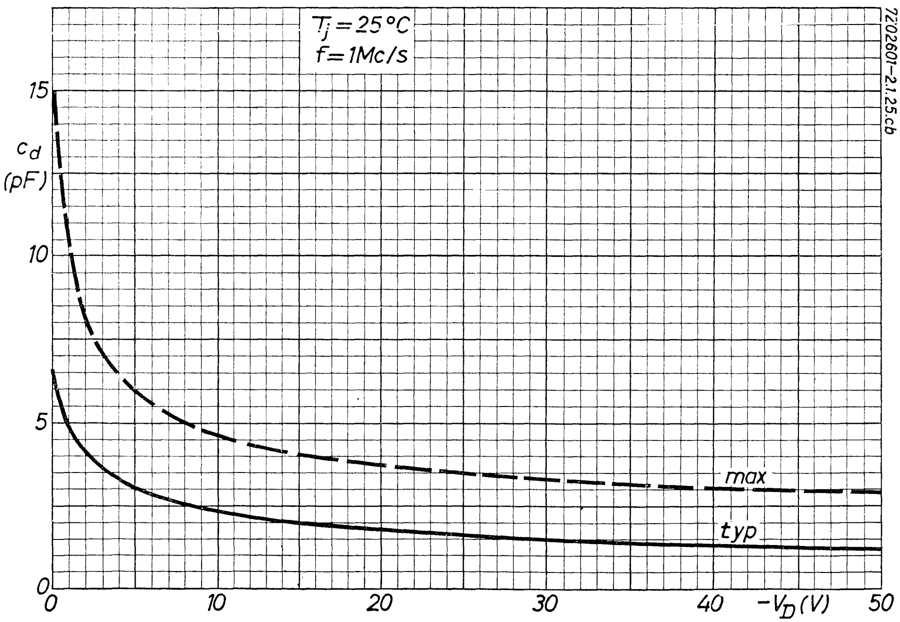
7Z2 2816

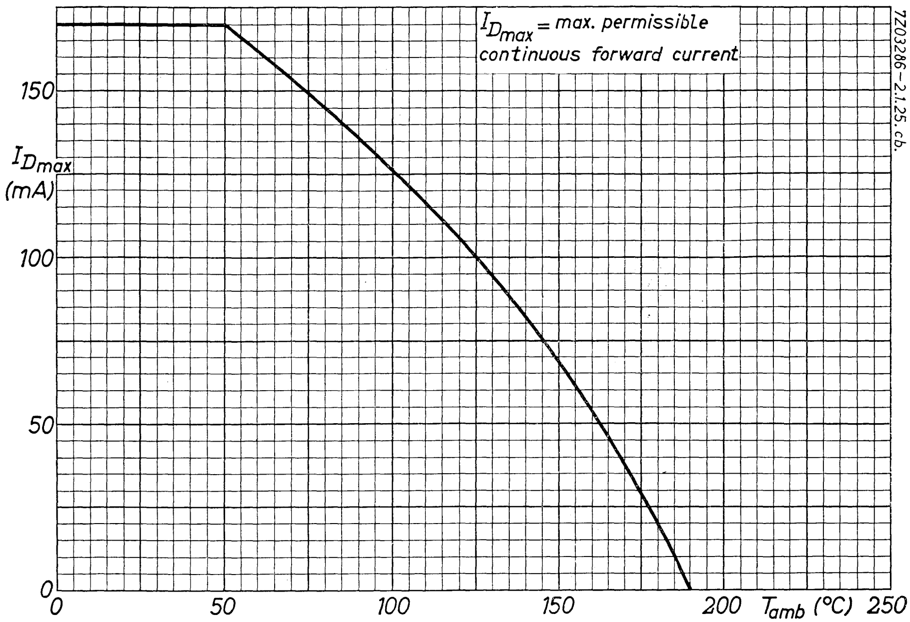

7Z02598-2.1.25.cb
typ
max
50V
150V
50V
−VD =150V
−ID (μA)
Tj (°C)
10^3
10^2
10
1
10^-1
10^-2
10^-3
0
50
100
150
200

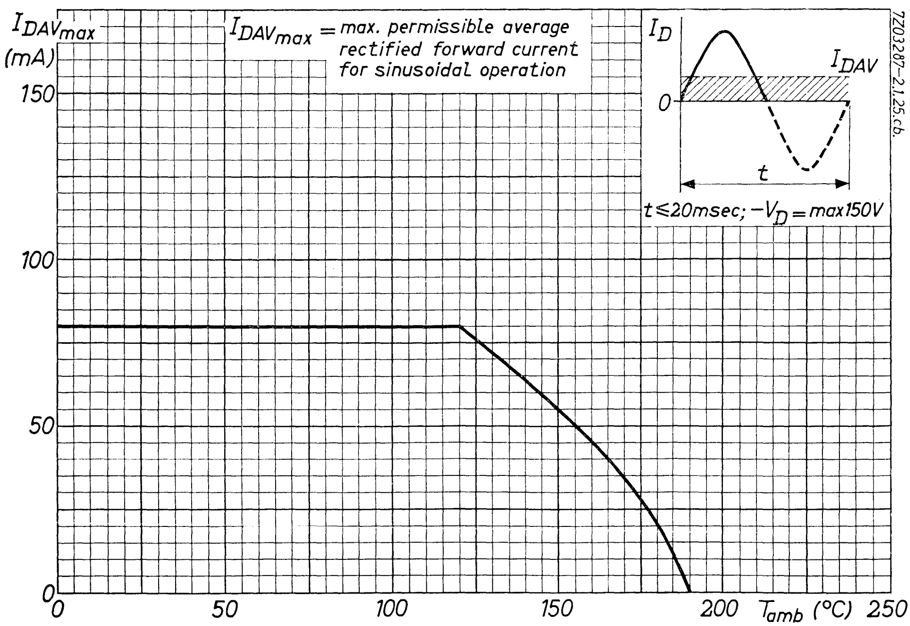

7Z02597-2.1.25.cb
max
typ
Tj =150°C
max
Tj =25°C
typ
−ID (μA)
−VD (V)
10^2
10
1
10^-1
10^-2
10^-3
10^-4
0
50
100
150
200

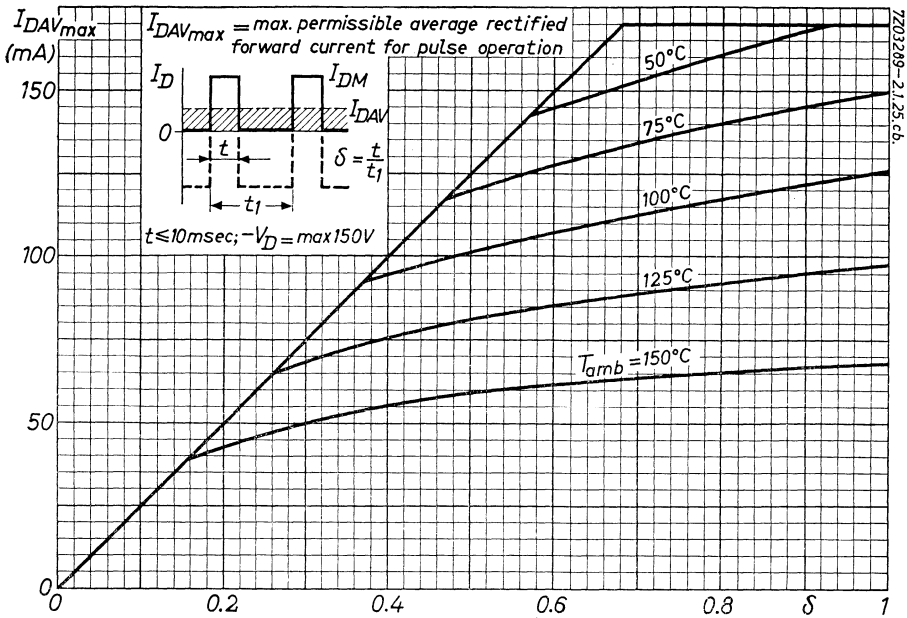

7Z02599-2.1.25.cb
I_D (mA)
1000
200
100
50
20
10
5
2
1
$T_j = 25°C$
min
max
0
0.5
1.0
1.5
V_D (V)
2.0

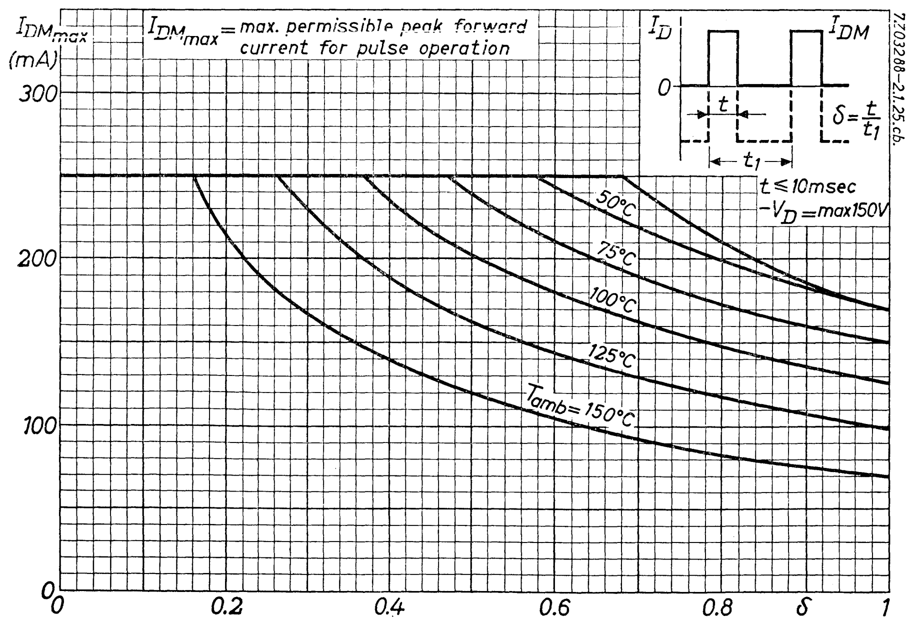

V_D
(V)
3
2
1
0
I_D=250mA
160mA
max
10mA
1mA
typ
-100
0
100
200
T_j (°C)
300
7Z03285-2.1.25.cb.


T_j = 25 °C
f = 1Mc/s
15
c_d
(pF)
10
5
0
max
typ
0
10
20
30
40
-V_D (V)
50
7Z02601-2.1.25.cb


I_{Dmax} = max. permissible continuous forward current
I_{Dmax} (mA)
150
100
50
0
0
50
100
150
200
T_{amb} (°C)
250
7Z03286-2.1.25.cb.


I_{DAVmax} (mA)
I_{DAVmax} = max. permissible average rectified forward current for sinusoidal operation
I_D
I_{DAV}
0
t
$t \leq 20$ msec; $-V_D$ = max 150V
150
100
50
0
0
50
100
150
200
T_{amb} (°C)
250
7Z03287-2.1.25.cb.


I_{DAVmax} (mA)
I_{DAVmax} = max. permissible average rectified forward current for pulse operation
I_D
I_{DM}
I_{DAV}
t
$\delta = \frac{t}{t_1}$
t_1
$t \leq 10$msec; $-V_D$ = max 150V
50°C
75°C
100°C
125°C
T_{amb} = 150°C
150
100
50
0
0.2
0.4
0.6
0.8
δ
1
7Z03289-2.1.25.cb.

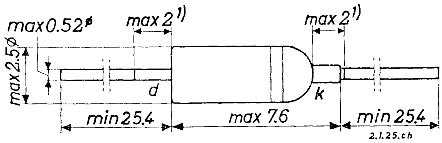

I_{DMmax} (mA)
I_{DMmax} = max. permissible peak forward current for pulse operation
I_D
I_{DM}
t
$\delta = \frac{t}{t_1}$
t_1
$t \leq 10$msec
$-V_D$ = max150V
50°C
75°C
100°C
125°C
T_{amb} = 150°C
300
200
100
0
0.2
0.4
0.6
0.8
δ
1
7Z03288-2.1.25.cb.

SILICON PLANAR DIODE

Silicon planar diode in subminiature all glass DO-7 envelope for general purpose industrial applications

QUICK REFERENCE DATA					
Continuous inverse voltage	$-V_D$	=	max.	150	V
Repetitive peak forward current	I_{DM}	=	max.	200	mA
Continuous forward current	I_D	=	max.	130	mA
Forward voltage drop at I_D = 100 mA	V_D	<		2.5	V
Reverse recovery time when switched from I_D = 30 mA to $-V_D$ = 35 V, measured at $-I_D$ = 4 mA and with R_L = 2.5 kΩ	t_{rr}	<		0.25	µs
Thermal resistance between junction and ambience	K	<		0.40	°C/mW

MECHANICAL DATA Dimensions in mm



The white band indicates the cathode side

[1]) Not tinned

7Z2 2817

LIMITING VALUES (Absolute max. values).

Voltages

Continuous inverse voltage	$-V_D$	=	max.	150	V	
Repetitive peak inverse voltage	$-V_{DM}$	=	max.	150	V	

Currents

Average rectified forward current (t_{av} = 20 ms)	I_{DAV}	=	max.	130	mA	1)
Continuous forward current	I_D	=	max.	130	mA	
Repetitive peak forward current	I_{DM}	=	max.	200	mA	
Non-repetive peak forward current						
for t_{max} = 1 μs	$I_{DMsurge}$	=	max.	1500	mA	
for t_{max} = 1 s	$I_{DMsurge}$	=	max.	350	mA	

Temperatures

Storage temperature	T_s	=	−65 °C to	200	°C	
Junction temperature	T_j	=	max.	190	°C	

THERMAL DATA

Thermal resistance between junction and ambience in free air	K	<	0.4	°C/mW	

CHARACTERISTICS at T_j = 25 °C

Reverse current at $-V_D$ = 150 V	$-I_D$	<	100	nA
Forward voltage drop at I_D = 100 mA	V_D	<	2.5	V

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[1]) For sinusoidal operation see page C

For pulse operation see page D

7Z2 2818

CHARACTERISTIC RANGE VALUES FOR EQUIPMENT DESIGN

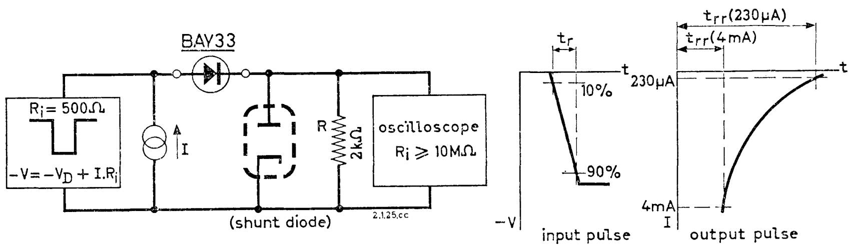
T_j = 25 °C unless otherwise specified

Diode capacitance at V_D = 0; f = 1 Mc/s [1]	c_d	<	15	pF
Reverse current at $-V_D$ = 150 V; T_j = 150 °C	$-I_D$	<	100	μA
Forward voltage at I_D = 200 mA; T_j = 190 °C	V_D	<	3.8	V

Reverse recovery time, when switched from
I_D = 30 mA to $-V_D$ = 35 V; R_L = 2.5 kΩ

Measured at $-I_D$ = 4 mA	t_{rr}	<	0.25	μs
Measured at $-I_D$ = 230 μA	t_{rr}	<	0.50	μs

Test circuit



Reverse pulse:

Rise time	t_r	≦	0.1 μs
Duty cycle	δ	=	0.5
Frequency	f	=	50 kc/s

Circuit:

Capacitance	C	≦	30 pF(C = Oscilloscope + parasitical capacitance)

[1]) See page E

7Z2 2819

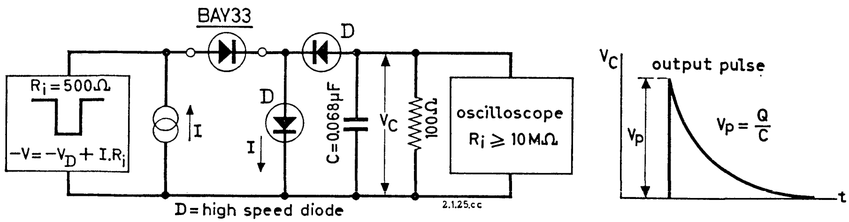
CHARACTERISTIC RANGE VALUES FOR EQUIPMENT DESIGN (continued)

$T_j = 25\ ^oC$

Stored charge, when switched from [1]

$I_D = 10$ mA to $-V_D = 5$ V; $R_L = 500\ \Omega$ — Q_s = 550 pC, < 700 pC

Test circuit



Reverse pulse:

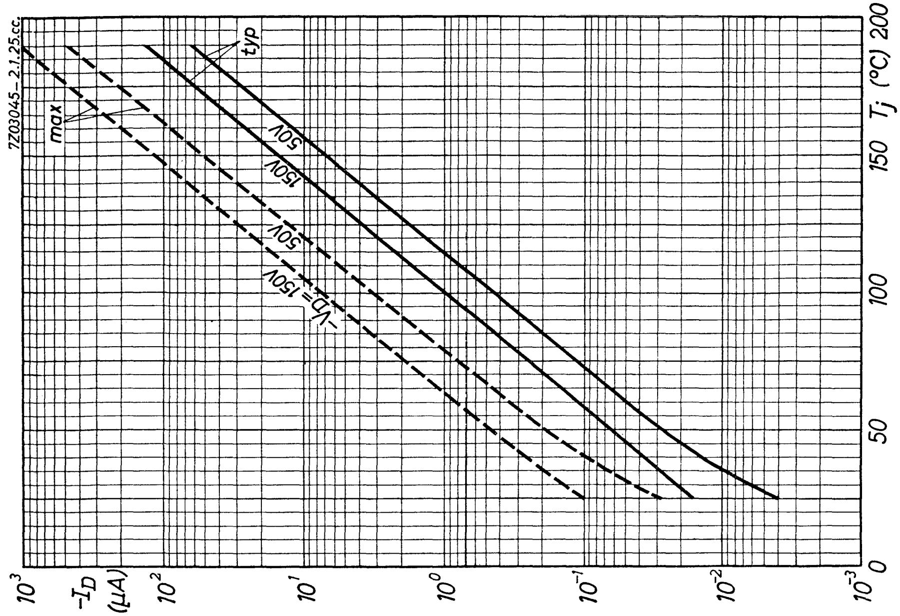
Rise time	t_r	=	15 ns
Pulse duration	t_p	=	35 μs
Frequency	f	=	25 kc/s

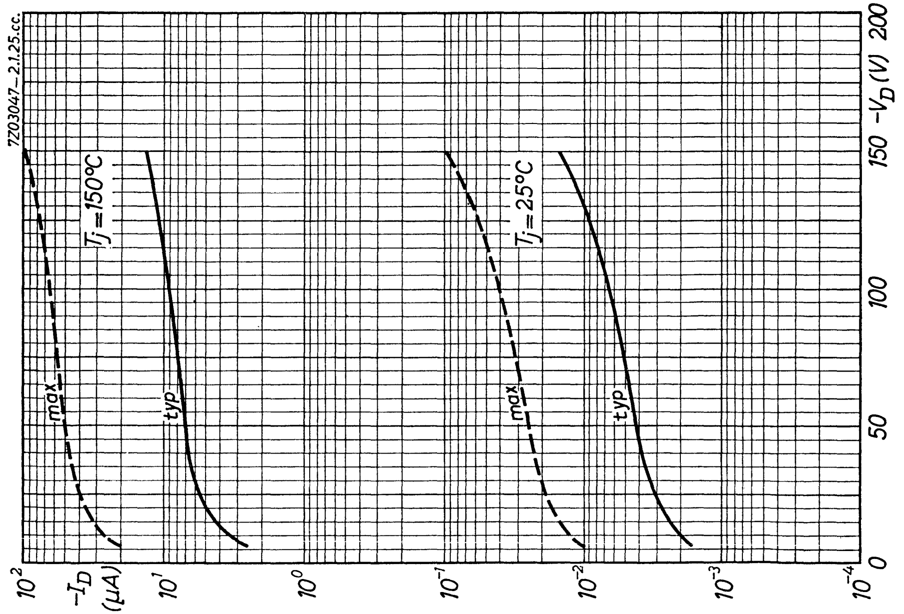
Circuit:

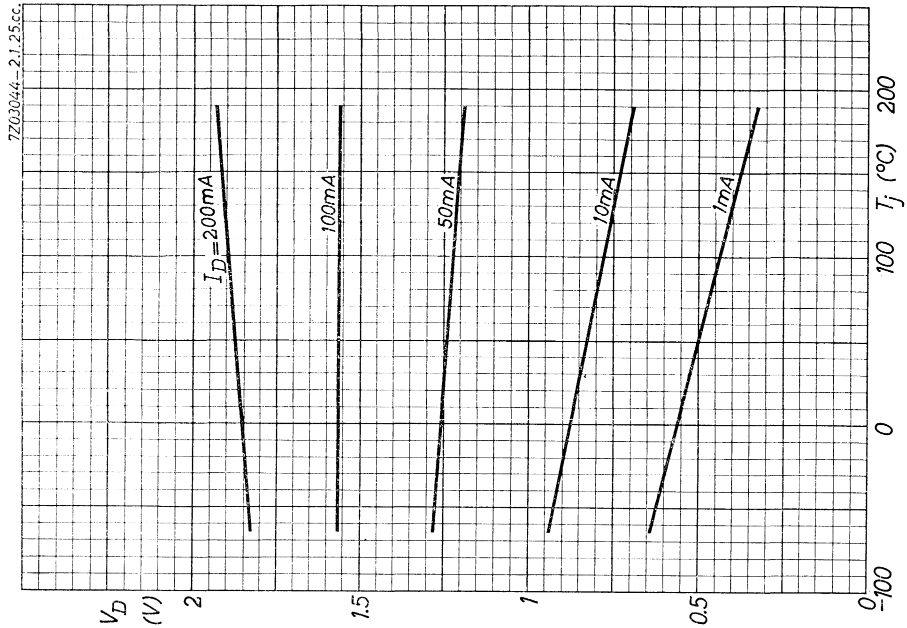
Capacitance	C	$\leq$	30 pF (C = Oscilloscope + parasitical capacitance)

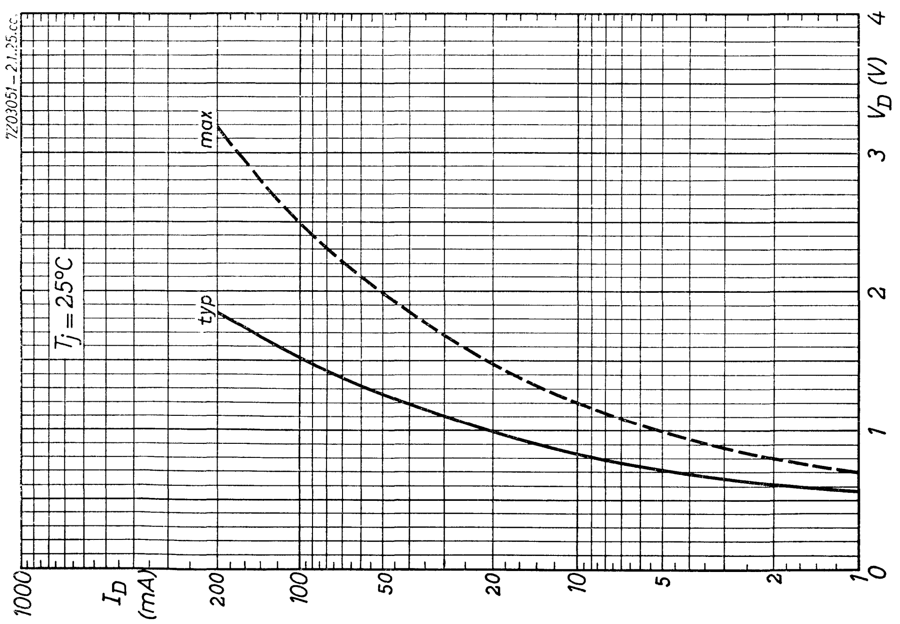
[1]) See also page F

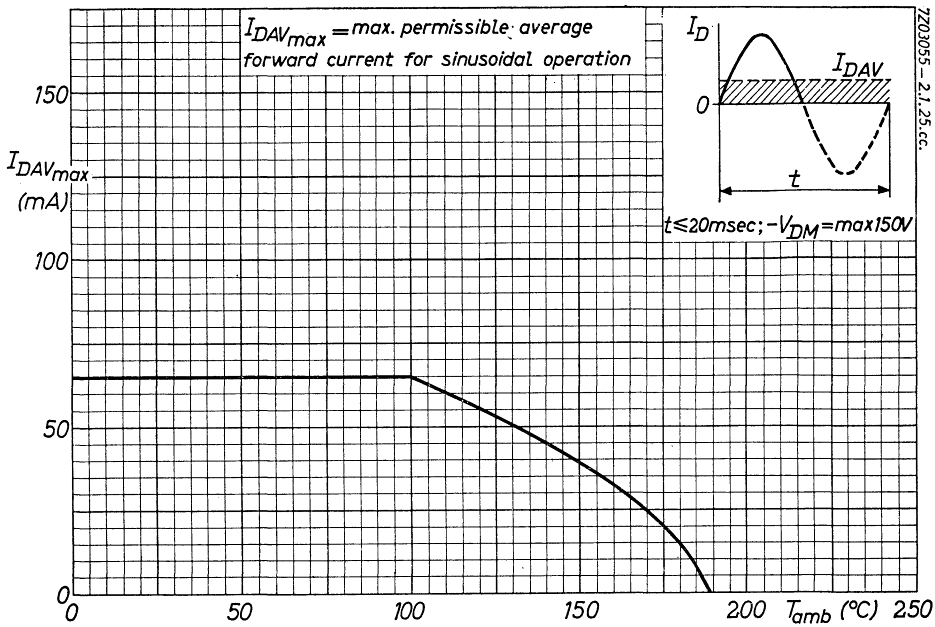
7Z2 2820


7Z03045-2.1.25.cc.
typ
max
50V
150V
50V
$-V_D = 150V$
$-I_D$ (μA)
10^3
10^2
10^1
10^0
10^{-1}
10^{-2}
10^{-3}
0
50
100
150
200
T_j (°C)

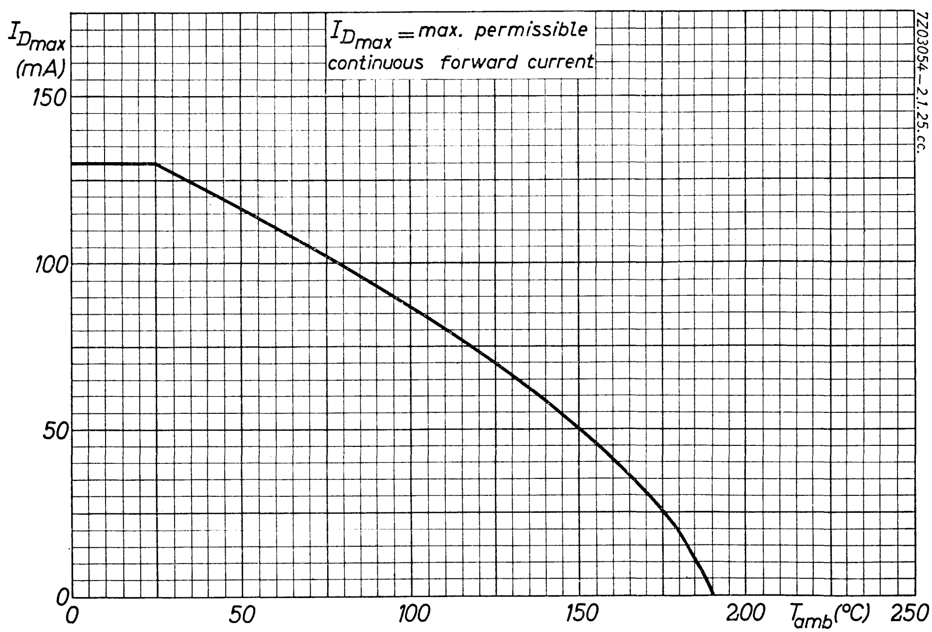

7Z03047-2.1.25.cc.
$T_j = 150°C$
$T_j = 25°C$
max
typ
max
typ
$-I_D$ (μA)
10^2
10^1
10^0
10^{-1}
10^{-2}
10^{-3}
10^{-4}
0
50
100
150
200
$-V_D$ (V)


7Z03044 – 2.1.25.cc.
I_D = 200mA
100mA
50mA
10mA
1mA
V_D (V)
2
1.5
1
0.5
0
T_j (°C)
200
100
0
–100

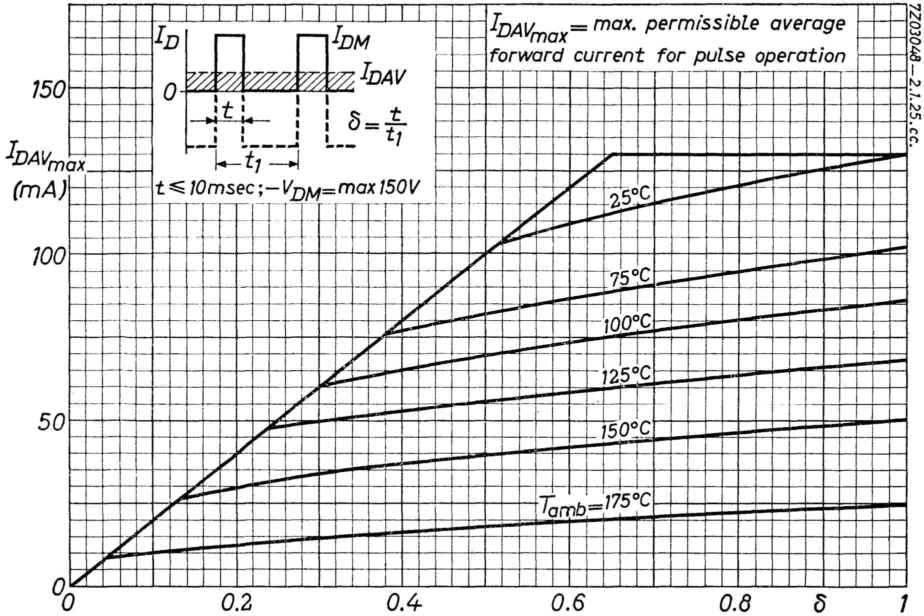

7Z03051 – 2.1.25.cc.
T_j = 25°C
max
typ
I_D (mA)
1000
200
100
50
20
10
5
2
1
V_D (V)
4
3
2
1
0

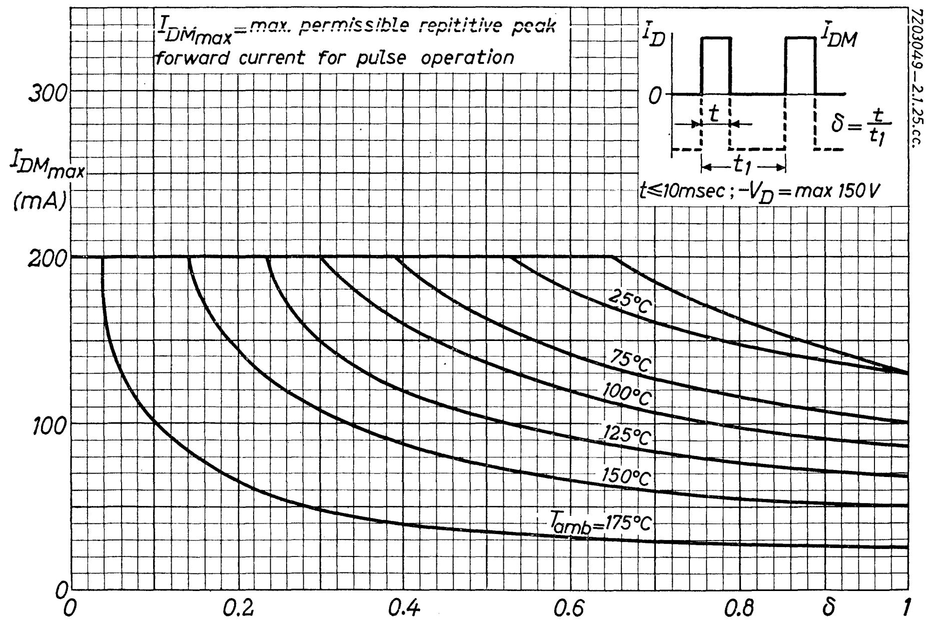


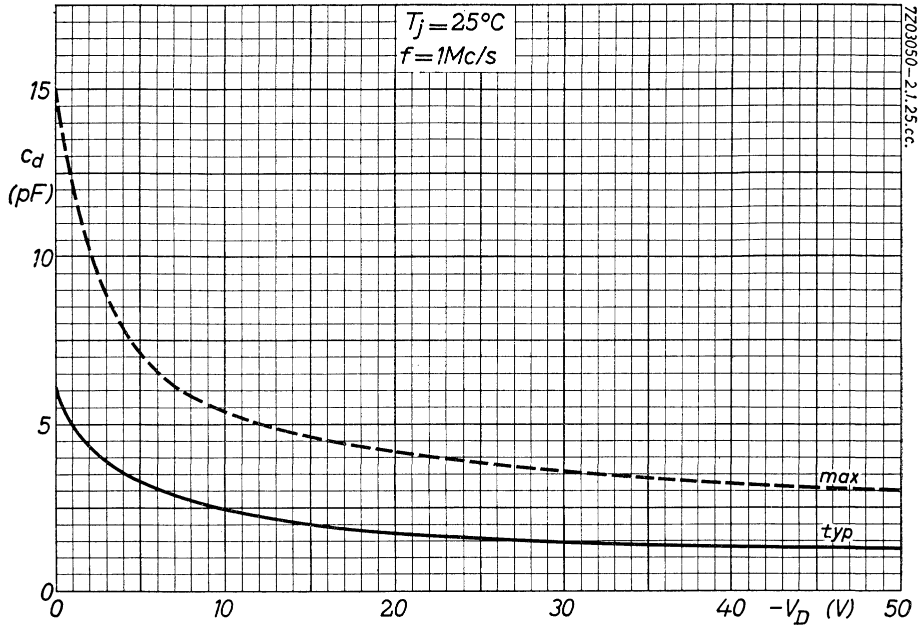
I_{DAVmax} = max. permissible average forward current for sinusoidal operation
I_{DAVmax} (mA)
150
100
50
0
0
50
100
150
200
T_{amb} (°C)
250
I_D
I_{DAV}
0
t
t≤20msec; $-V_{DM}$=max150V
7Z03055 – 2.1.25.cc.



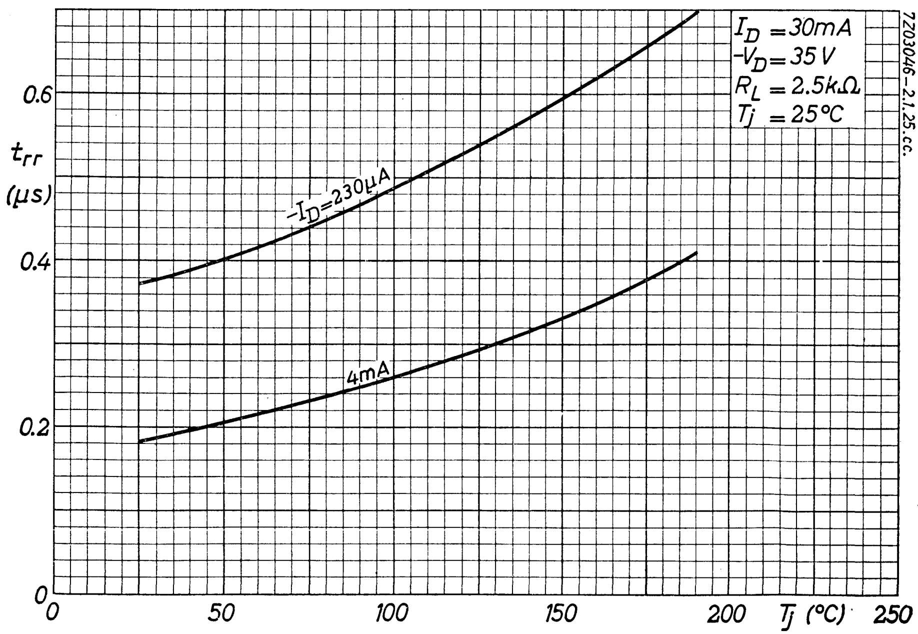
I_{Dmax} (mA)
I_{Dmax} = max. permissible continuous forward current
150
100
50
0
0
50
100
150
200
T_{amb}(°C)
250
7Z03054 – 2.1.25.cc.


I_{DAVmax} = max. permissible average forward current for pulse operation
I_D
I_{DM}
I_{DAV}
$\delta = \frac{t}{t_1}$
$t \leq 10$ msec; $-V_{DM}$ = max 150 V
I_{DAVmax} (mA)
25°C
75°C
100°C
125°C
150°C
T_{amb} = 175°C
δ
7Z03048—2.1.25.cc.

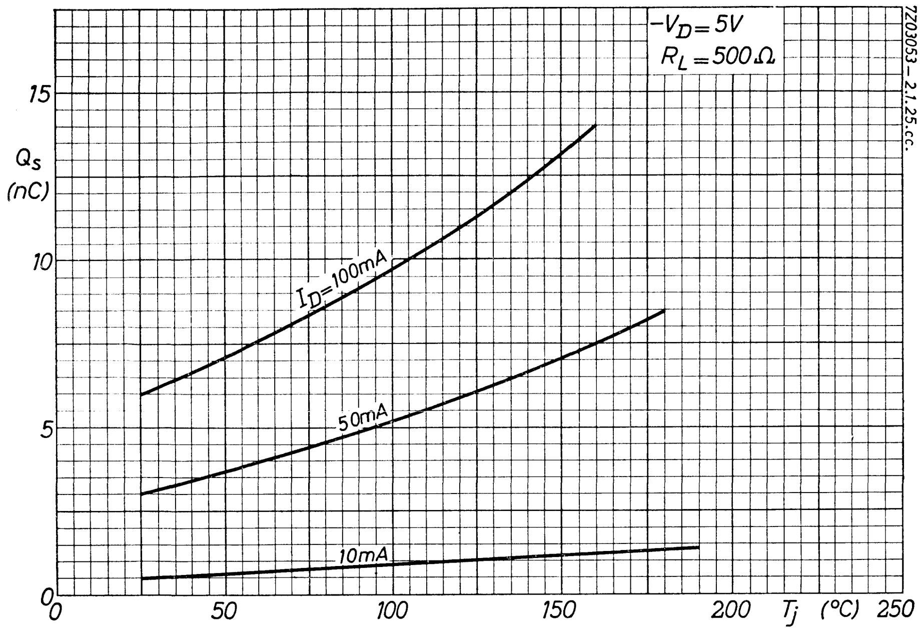

I_{DMmax} = max. permissible repititive peak forward current for pulse operation
I_D
I_{DM}
$\delta = \frac{t}{t_1}$
$t \leq 10$ msec; $-V_D$ = max 150 V
I_{DMmax} (mA)
25°C
75°C
100°C
125°C
150°C
T_{amb} = 175°C
δ
7Z03049—2.1.25.cc.



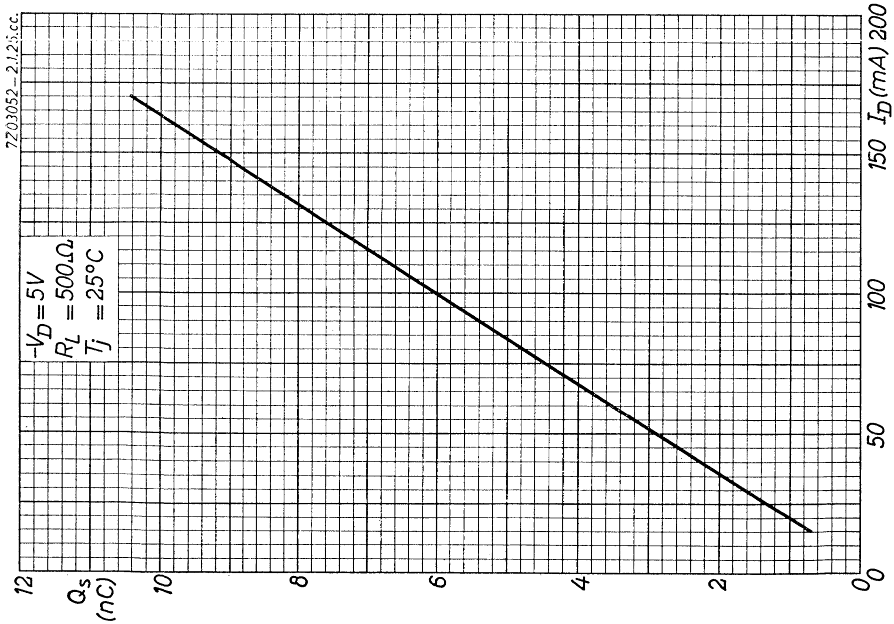
$T_j = 25°C$
$f = 1Mc/s$
7Z03050-2.1.25.cc.
15
c_d
(pF)
10
5
0
max
typ
0
10
20
30
40
$-V_D$ (V)
50



$I_D = 30mA$
$-V_D = 35V$
$R_L = 2.5k\Omega$
$T_j = 25°C$
7Z03046-2.1.25.cc.
0.6
t_{rr}
(µs)
0.4
0.2
0
$-I_D = 230µA$
4mA
0
50
100
150
200
T_j (°C)
250



7Z03053 – 2.1.25.cc.
$-V_D = 5V$
$R_L = 500\Omega$
Q_s (nC)
I_D=100mA
50mA
10mA
T_j (°C)
0
5
10
15
50
100
150
200
250



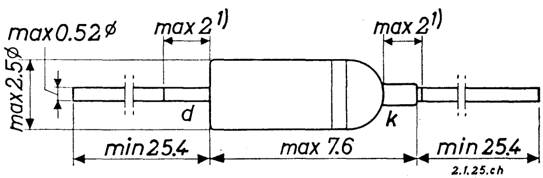
7Z03052 – 2.1.25.cc.
$-V_D = 5V$
$R_L = 500\Omega$
$T_j = 25°C$
I_D (mA)
Q_s (nC)
0
2
4
6
8
10
12
50
100
150
200

SILICON PLANAR EPITAXIAL DIODE

Silicon planar epitaxial diode in subminiature all glass DO-7 envelope with very high speed for general purposes and especially for logic applications

QUICK REFERENCE DATA					
Continuous inverse voltage	$-V_D$	=	max	50	V
Repetitive peak forward current	I_{DM}	=	max.	225	mA
Forward voltage drop at I_D = 50 mA	V_D	<		1	V
Reverse recovery time when switched from I_D = 10 mA to $-V_D$ = 1 V, measured at $-I_D$ = 1 mA and with R_L = 100 Ω	t_{rr}	<		4	ns
Thermal resistance between junction and ambience	K	<		0.4	°C/mW

MECHANICAL DATA Dimensions in mm



The white band indicates the cathode side

1) Not tinned

7Z2 2824

LIMITING VALUES (Absolute max. values)

Voltages

Continuous inverse voltage	$-V_D$	=	max.	50	V

Currents

Average rectified forward current (t_{av} = 20 ms)	I_{DAV}	=	max.	115	mA [1]) ←
Continuous forward current	I_D	=	max.	115	mA
Repetitive peak forward current	I_{DM}	=	max.	225	mA
Non-repetitive peak forward current					
for t = 1 μs	$I_{DMsurge}$	=	max.	2000	mA
for t = 1 s	$I_{DMsurge}$	=	max.	500	mA

Temperatures

Storage temperature	T_s	=	-65 °C to	200	°C
Junction temperature	T_j	=	max.	190	°C

THERMAL DATA

Thermal resistance between junction and ambience in free air	K	<	0.4	°C/mW

CHARACTERISTICS T_j = 25 °C

Reverse current at $-V_D$ = 50 V	$-I_D$	<	50	nA
Forward voltage drop at I_D = 50 mA	V_D	<	1	V

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1) For sinusoidal operation see page C

For pulse operation see page D

7Z2 2825

CHARACTERISTIC RANGE VALUES FOR EQUIPMENT DESIGN

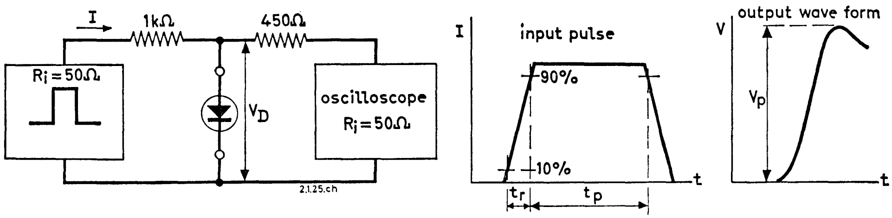
T_j = 25 °C unless otherwise specified

Diode capacitance at V_D = 0; f = 1 Mc/s [1]	c_d	<	2	pF
Reverse current at $-V_D$ = 50 V; T_j = 150 °C	$-I_D$	<	50	μA

Forward recovery voltage

I_D = 10 mA; t_r = 20 ns	V_{DM}	<	1.75	V
I_D = 100 mA; t_r = 50 ns	V_{DM}	<	3.00	V

Test circuit



Current pulse:

Rise time (10 mA)	t_r	=	20	ns
Rise time (100 mA)	t_r	=	50	ns
Pulse duration	t_p	=	120	ns
Duty cycle	δ	=	0.01	

Circuit:

Capacitance C $\leqq$ 1 pF (C = Oscilloscope + parasitical capacitance)

[1]) See page B

7Z2 2826

CHARACTERISTIC RANGE VALUES FOR EQUIPMENT DESIGN (continued)

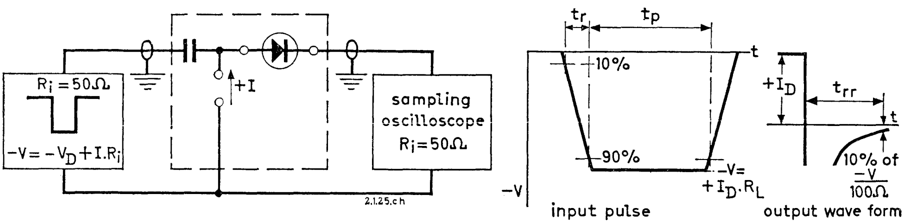
$T_j = 25\ ^{o}C$, unless otherwise specified

Reverse recovery time, when switched from

$I_D = 10$ mA to $-V_D = 1$ V; $R_L = 100\ \Omega$

Measured at $-I_D = 1$ mA $\quad t_{rr} < 4$ ns [1])

Test circuit



Reverse pulse:

Rise time	t_r =	0.6 ns
Pulse duration	t_p =	100 ns
Duty cycle	δ =	0.05

Circuit:

Capacitance $\quad C \leqq 1$ pF (C = Oscilloscope + parasitical capacitance)

[1]) See page E

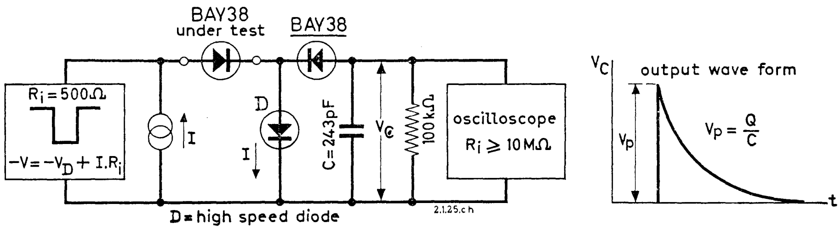
CHARACTERISTIC RANGE VALUES FOR EQUIPMENT DESIGN (continued)

T_j = 25 °C unless otherwise specified

Stored charge, when switched from

I_D = 10 mA to $-V_D$ = 5 V; R_L = 500 Ω Q_s < 35 pC

Test circuit



Reverse pulse:

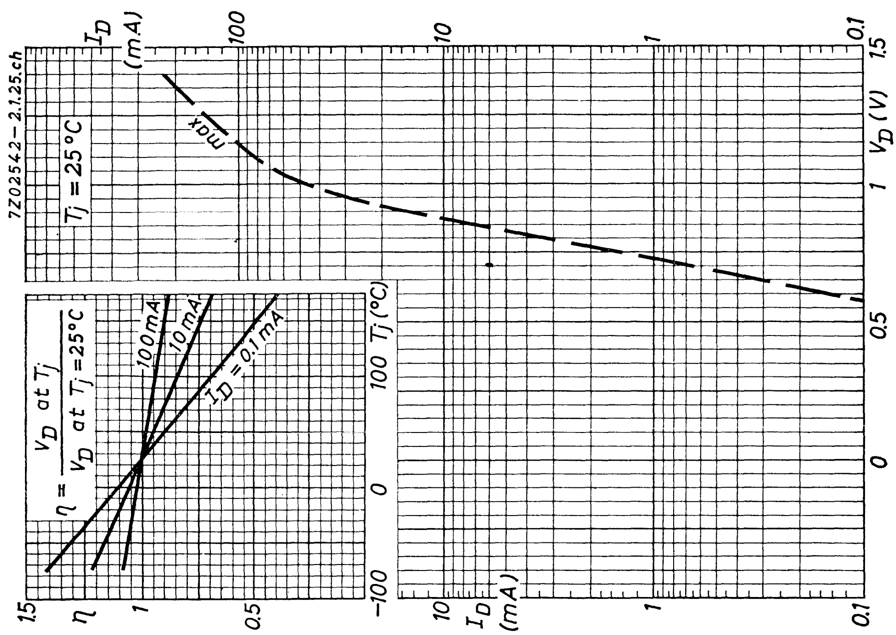
Rise time	t_r	=	2	ns
Pulse duration	t_p	=	400	ns
Duty cycle	δ	=	0.02	

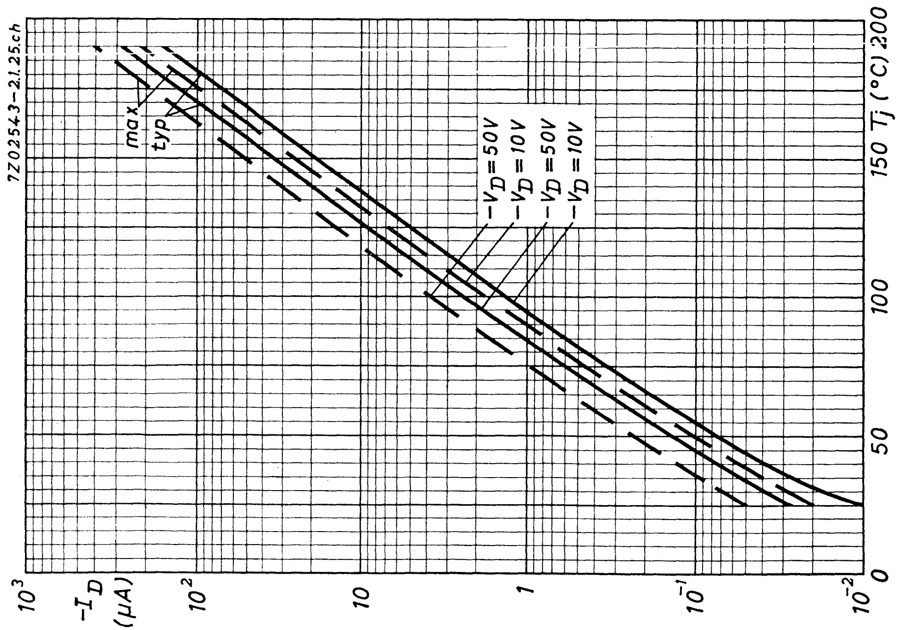
Circuit:

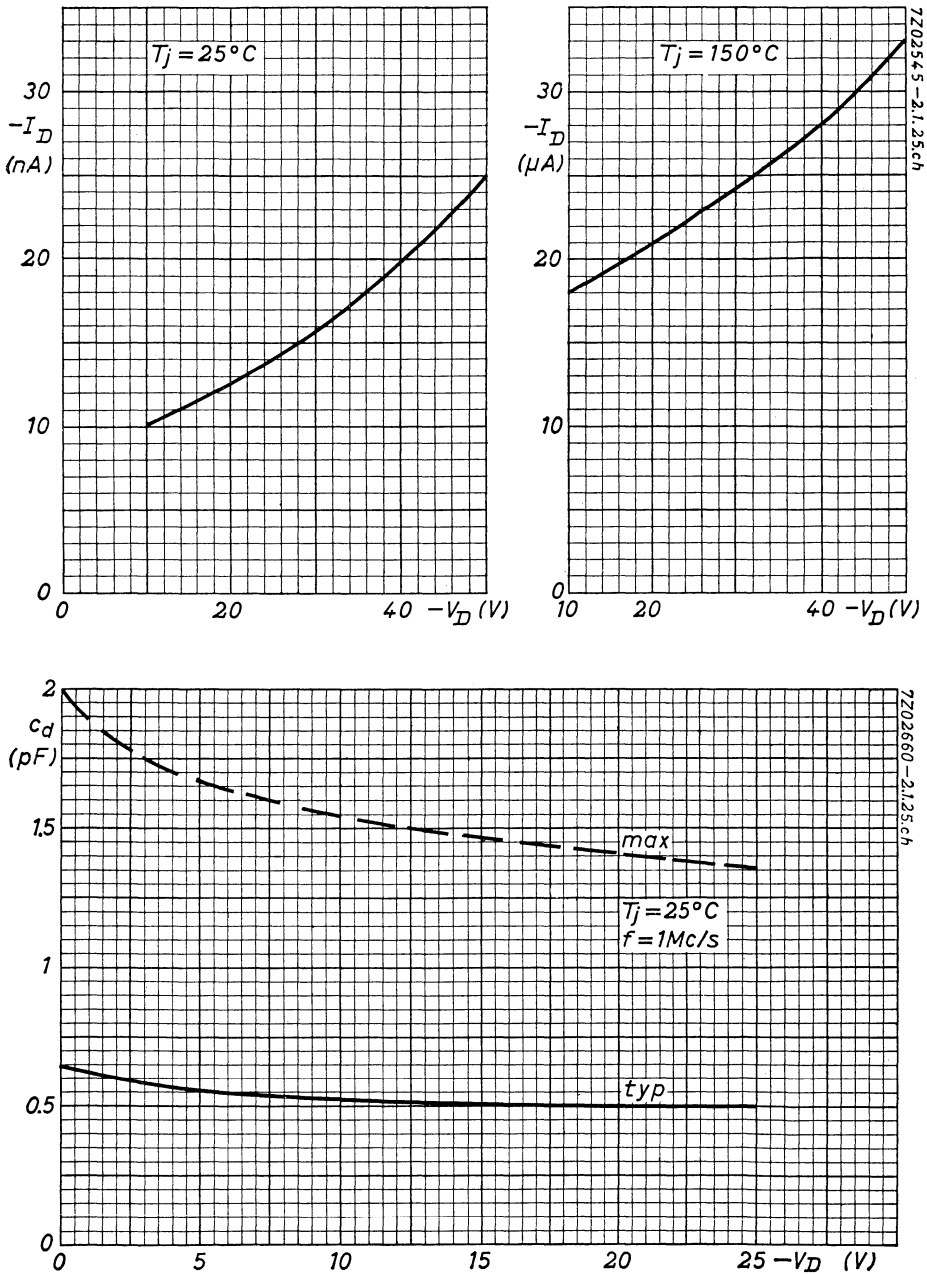
Capacitance	C	≦	7	pF (C = Oscilloscope + parasitical capacitance)

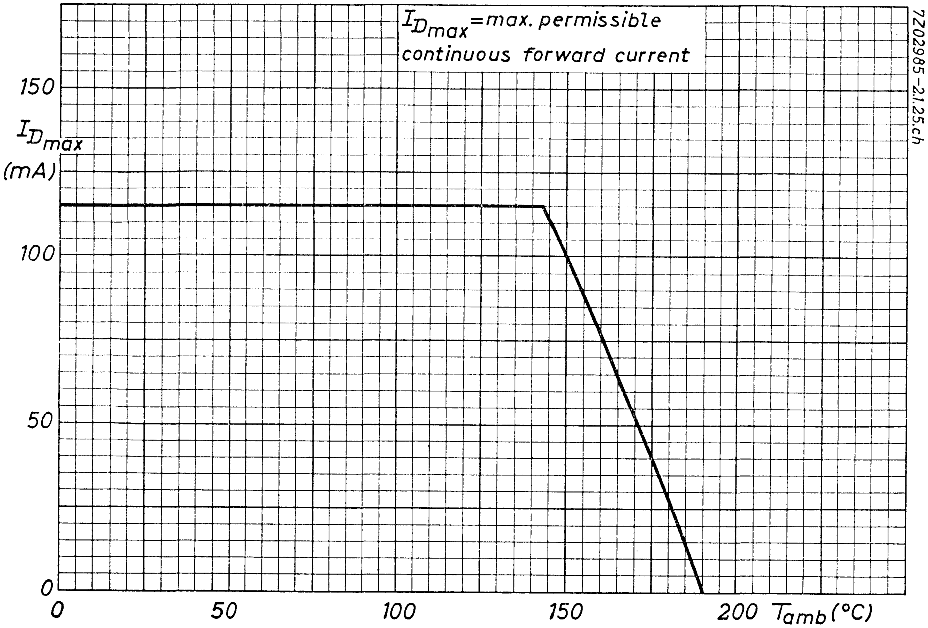
<u>MORE INFORMATION CONCERNING PRACTICAL CIRCUITS IS AVAILABLE IN ADVANCE INFORMATION NO.815 AND NO.818</u>

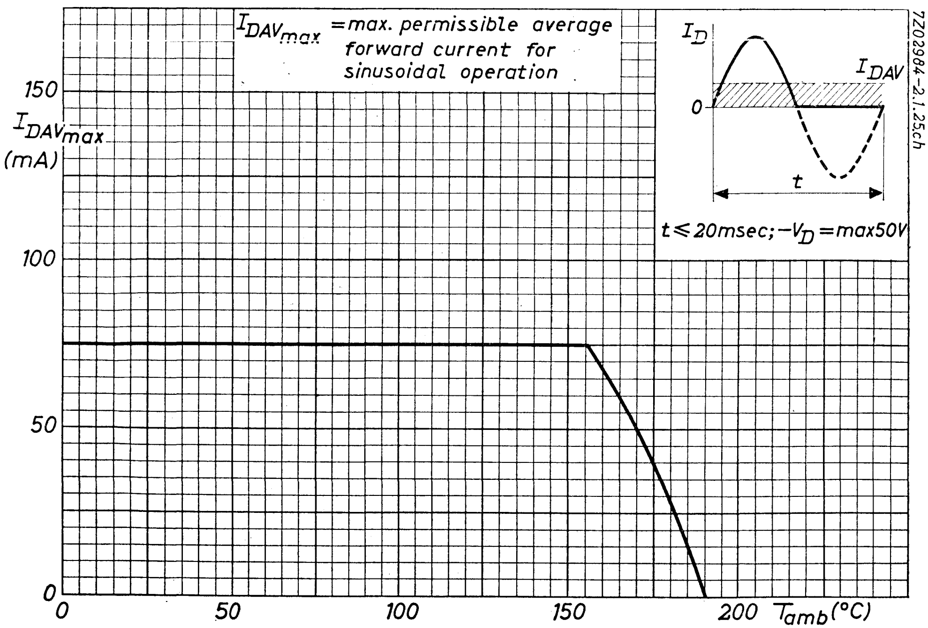
7Z2 2828

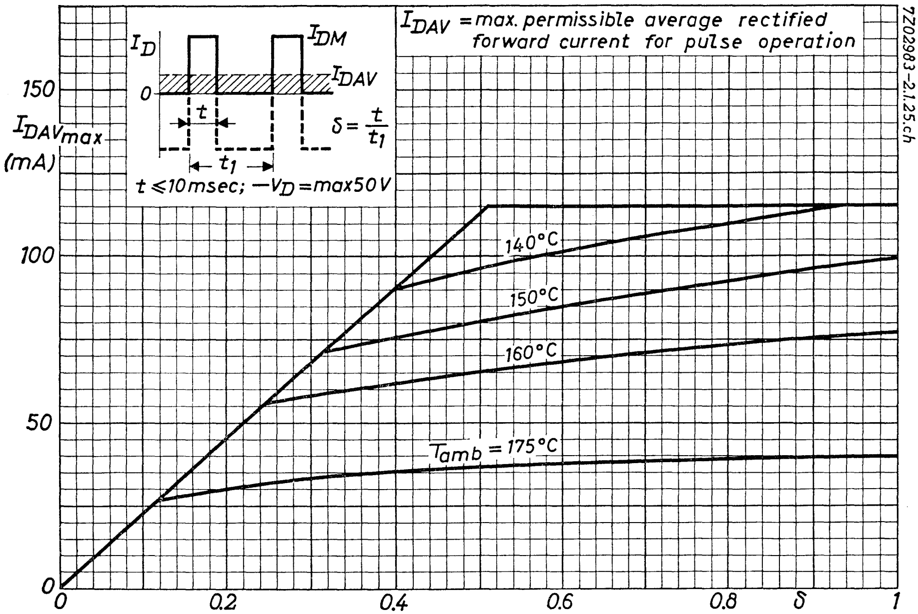

7Z02542 − 2.1.25.ch
Tj = 25 °C
ID (mA)
100
10
1
0.1
VD (V)
1.5
1
0.5
0
max
η = VD at Tj / VD at Tj = 25°C
100mA
10mA
ID = 0.1 mA
Tj (°C)
100
0
−100
1.5
η
1
0.5
10
ID (mA)
1
0.1

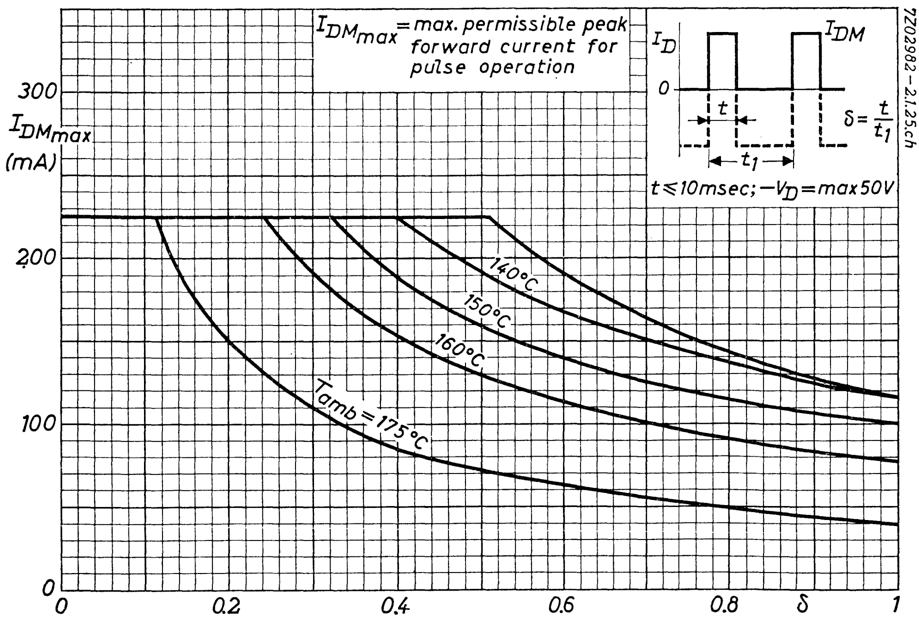

7Z02543 − 2.1.25.ch
−ID (μA)
10^3
10^2
10
1
10^-1
10^-2
Tj (°C)
200
150
100
50
0
max
typ
−VD = 50V
−VD = 10V
−VD = 50V
−VD = 10V

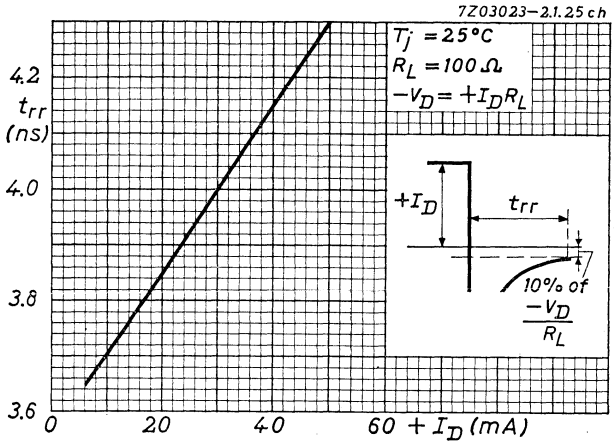

Tj = 25 °C
30
−I_D
(nA)
20
10
0
0
20
40 −V_D (V)
Tj = 150 °C
30
−I_D
(μA)
20
10
0
10
20
40 −V_D (V)
7Z02545−2.1.25.ch
2
c_d
(pF)
1.5
1
0.5
0
max
Tj = 25 °C
f = 1Mc/s
typ
0
5
10
15
20
25 −V_D (V)
7Z02660−2.1.25.ch

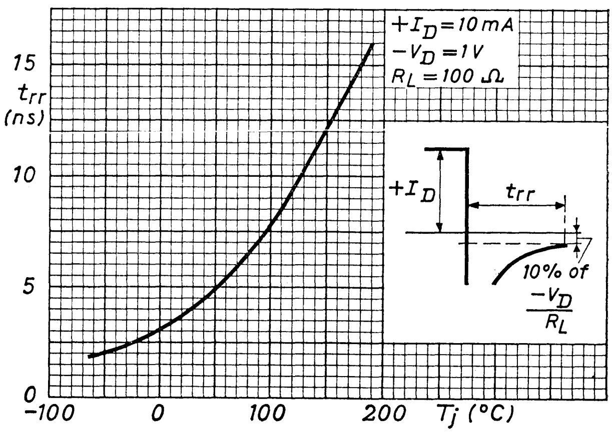

I_{Dmax} = max. permissible continuous forward current
150
I_{Dmax} (mA)
100
50
0
0
50
100
150
200
T_{amb} (°C)
7Z02985-2.1.25.ch


I_{DAVmax} = max. permissible average forward current for sinusoidal operation
150
I_{DAVmax} (mA)
100
50
0
0
50
100
150
200
T_{amb} (°C)
I_D
I_{DAV}
0
t
$t \leq 20 msec; -V_D = max 50 V$
7Z02984-2.1.25.ch


I_{DAV} = max. permissible average rectified forward current for pulse operation
7Z02983-2.1.25.ch
I_D
I_{DM}
I_{DAV}
0
t
t_1
$\delta = \frac{t}{t_1}$
$t \leq 10$ msec; $-V_D$ = max 50 V
I_{DAVmax} (mA)
150
100
50
0
140°C
150°C
160°C
T_{amb} = 175°C
0.2
0.4
0.6
0.8
δ
1


I_{DMmax} = max. permissible peak forward current for pulse operation
7Z02982-2.1.25.ch
I_D
I_{DM}
0
t
t_1
$\delta = \frac{t}{t_1}$
$t \leq 10$ msec; $-V_D$ = max 50 V
I_{DMmax} (mA)
300
200
100
0
140°C
150°C
160°C
T_{amb} = 175°C
0.2
0.4
0.6
0.8
δ
1


7Z03023–2.1.25 ch
T_j = 25 °C
R_L = 100 Ω
$-V_D = +I_D R_L$
4.2
t_{rr}
(ns)
4.0
3.8
3.6
0
20
40
60
$+I_D$ (mA)
$+I_D$
t_{rr}
10% of
$\frac{-V_D}{R_L}$

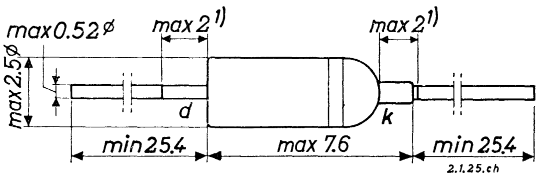

$+I_D$ = 10 mA
$-V_D$ = 1 V
R_L = 100 Ω
15
t_{rr}
(ns)
10
5
0
−100
0
100
200
T_j (°C)
$+I_D$
t_{rr}
10% of
$\frac{-V_D}{R_L}$

SILICON PLANAR EPITAXIAL DIODE

Silicon planar epitaxial diode in subminiature all glass DO-7 envelope for general purposes and especially for core gating in fast memories.

QUICK REFERENCE DATA					
Continuous inverse voltage	$-V_D$	=	max.	75	V
Repetitive peak forward current	I_{DM}	=	max.	750	mA
Forward voltage drop at I_D = 500 mA	V_D	=		0.8 to 1.0	V
Reverse recovery time when switched from I_D = 500 mA to $-V_D$ = 50 V, measured at $-I_D$ = 5 mA and with R_L = 1 kΩ	t_{rr}	<		160	ns
Thermal resistance between junction and ambience	K	<		0.4	°C/mW

MECHANICAL DATA Dimensions in mm



The white band indicates the cathode side

[1)] Not tinned

7Z2 2829

LIMITING VALUES (Absolute max. values)

Voltages

Continuous inverse voltage	$-V_D$	=	max.	75	V

Currents

Average rectified forward current (t_{av} = 20 ms)	I_{DAV}	=	max.	450	mA [1]
Continuous forward current	I_D	=	max.	450	mA
Repetitive peak forward current	I_{DM}	=	max.	750	mA
Non-repetitive peak forward current for t_{max} = 1 μs	$I_{DMsurge}$	=	max.	4000	mA

Temperatures

Storage temperature	T_s	=	-65 °C to	200	°C
Junction temperature	T_j	=	max.	190	°C

THERMAL DATA

Thermal resistance between junction and ambience in free air	K	<	0.4	°C/mW

CHARACTERISTICS T_j = 25 °C

Reverse current at $-V_D$ = 75 V	$-I_D$	<		100	nA
Forward voltage drop at I_D = 10 mA	V_D	<		0.7	V
at I_D = 500 mA	V_D	>	0.8 V	< 1.0	V

[1]) For sinusoidal operation see page B

For pulse operation see page C

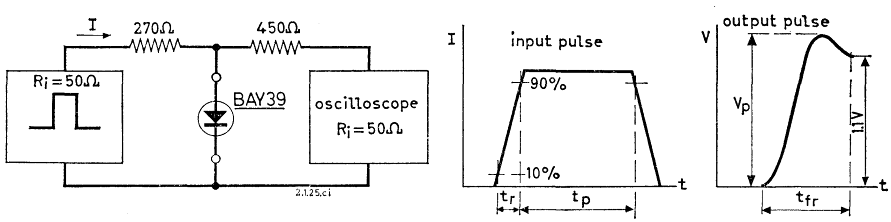
7Z2 2830

CHARACTERISTIC RANGE VALUES FOR EQUIPMENT DESIGN

T_j = 25 °C, unless otherwise specified

Diode capacitance at $-V_D$ = 10 V; f = 1 Mc/s [1]	c_d	<	7.5	pF
Reverse current at $-V_D$ = 75 V; T_j = 150 °C	$-I_D$	<	100	μA
Forward recovery at I_D = 500 mA; t_r = 50 ns				
Forward recovery voltage [1]	V_{DM}	<	3.0	V
Forward recovery time measured at V_D = 1.1 V	t_{fr}	<	60	ns

Test circuit



Current pulse:

Rise time	t_r	=	50	ns
Pulse duration	t_p	=	200	ns
Duty cycle	δ	=	0.01	

Circuit:

Capacitance $C \leq$ 1 pF (C = Oscilloscope + parasitical capacitance)

[1]) See also page E

7Z2 2831

CHARACTERISTIC RANGE VALUES FOR EQUIPMENT DESIGN (continued)

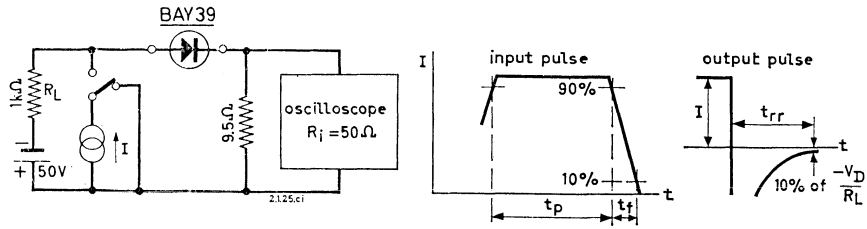
T_j = 25 °C, unless otherwise specified

Reverse recovery time, when switched from

I_D = 500 mA to $-V_D$ = 50 V; R_L = 1 kΩ

Measured at $-I_D$ = 5 mA $\quad t_{rr}$ < 160 ns [1]

Test circuit



Current pulse:

Fall time	t_f =	5	ns
Pulse duration	t_p =	5	ns
Duty cycle	δ =	0.01	

Circuit:

Capacitance $C \leqq$ 10 pF (C = Oscilloscope + parasitical capacitance)

[1]) See also page F

7Z2 2832

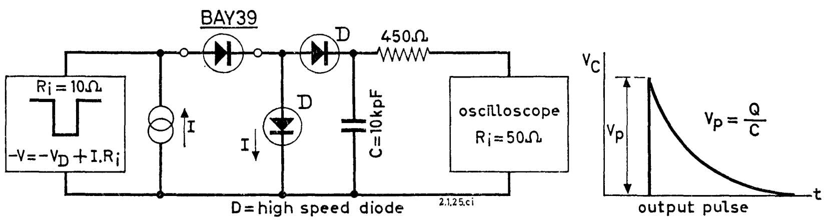
CHARACTERISTIC RANGE VALUES FOR EQUIPMENT DESIGN (continued)

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

Stored charge, when switched from

$I_D = 500$ mA to $-V_D = 5$ V; $R_L = 10\ \Omega$ $Q_s < 15$ nC [1])

Test circuit



Reverse pulse:

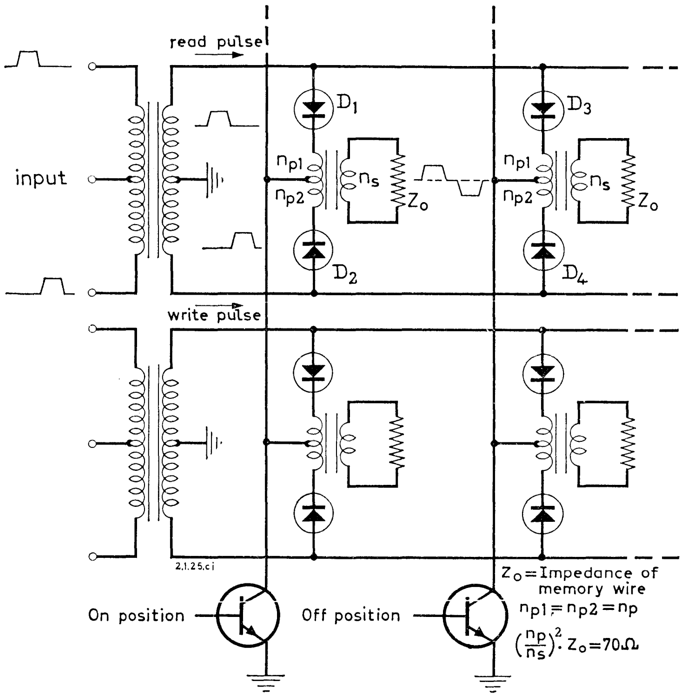
Rise time	t_r	=	4	ns
Pulse duration	t_p	=	150	μs
Duty cycle	δ	=	0.99	

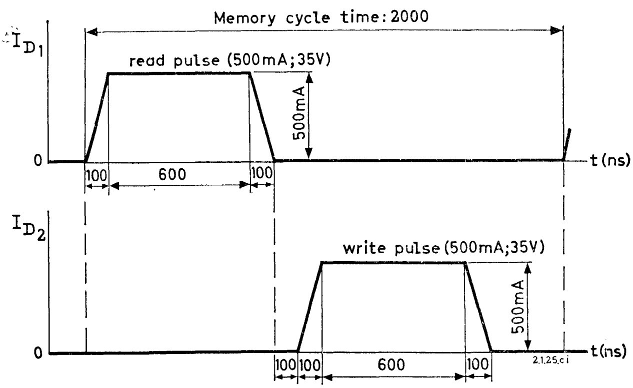
1) See also page F

7Z2 2833

APPLICATION INFORMATION

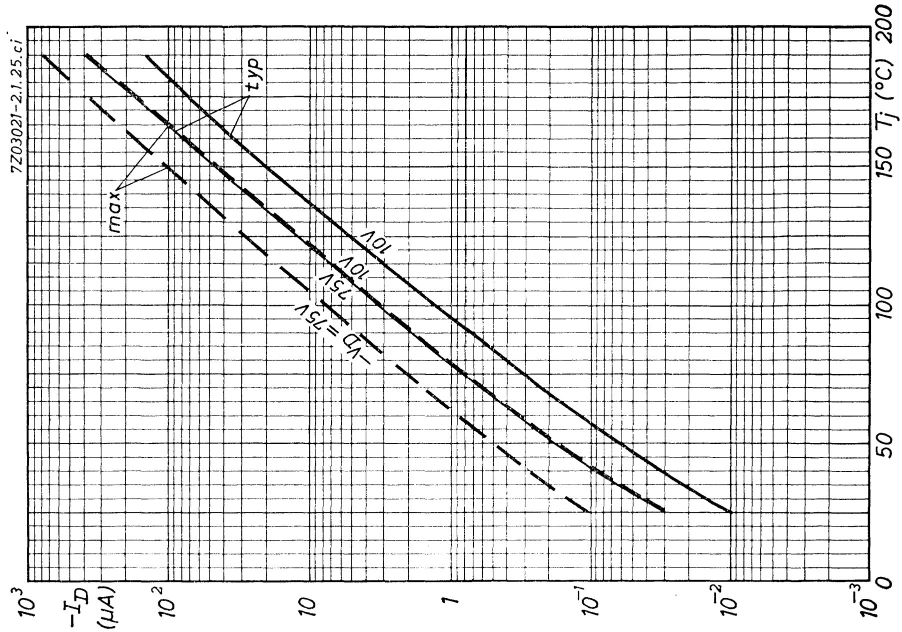
Transformer type selection matrix of a core memory

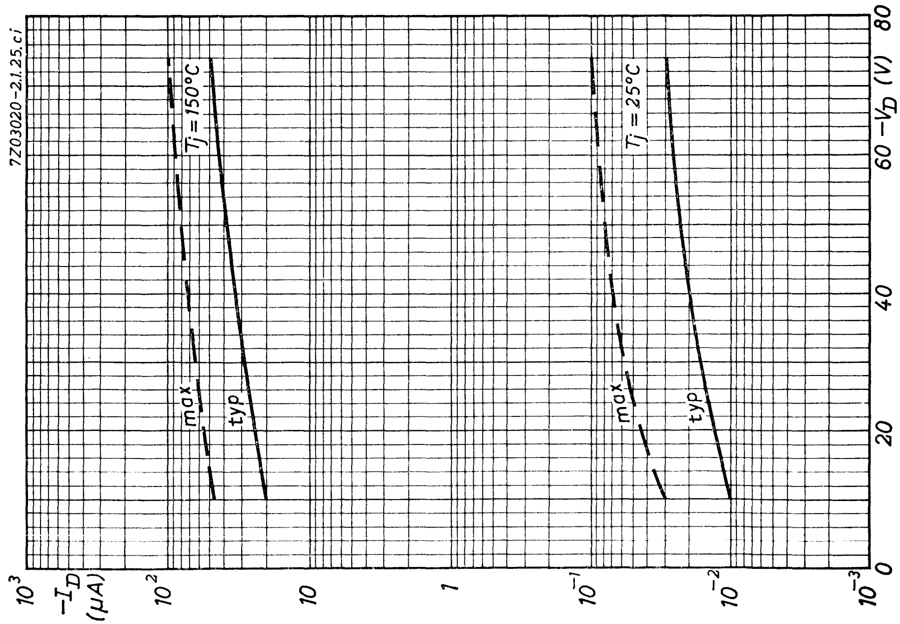


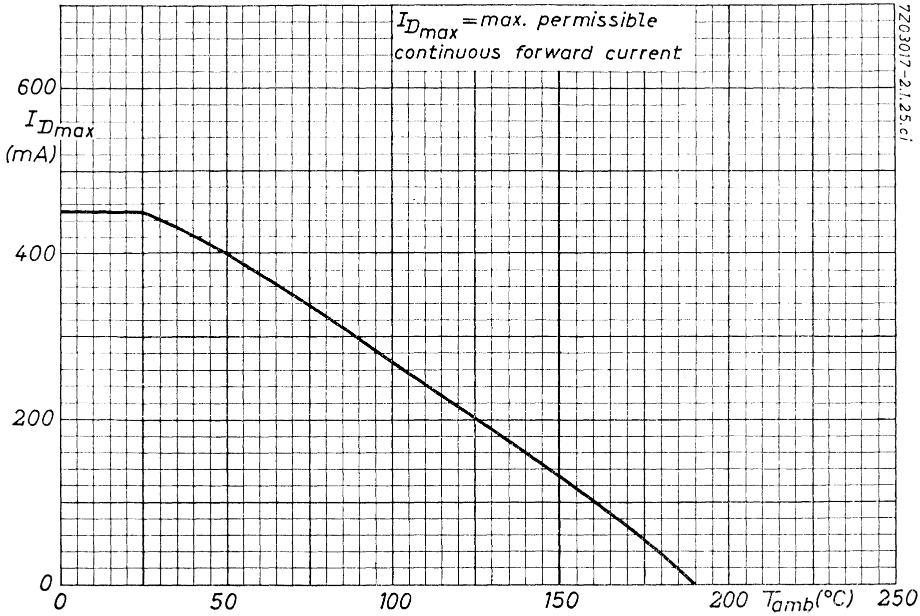


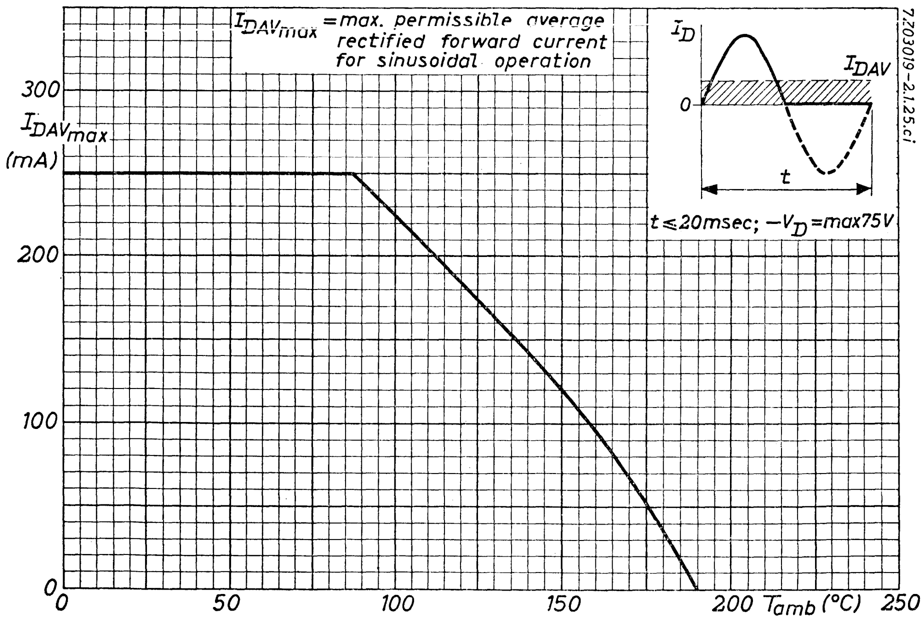
All diodes are of type BAY39

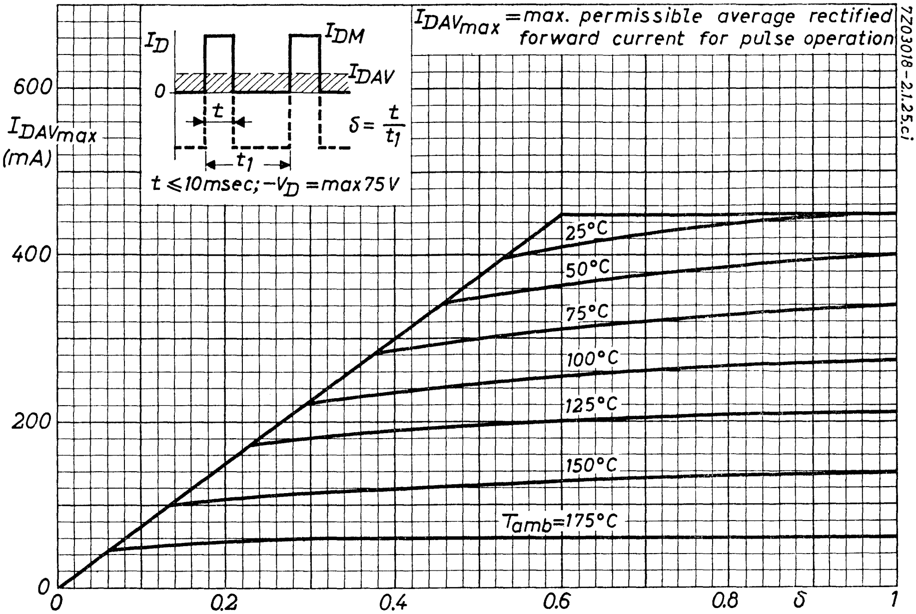
7Z2 2834


7Z03021-2.1.25.ci
typ
max
10V
10V
75V
$-V_D = 75V$
T_j (°C)
0
50
100
150
200
$-I_D$ (μA)
10^3
10^2
10
1
10^{-1}
10^{-2}
10^{-3}

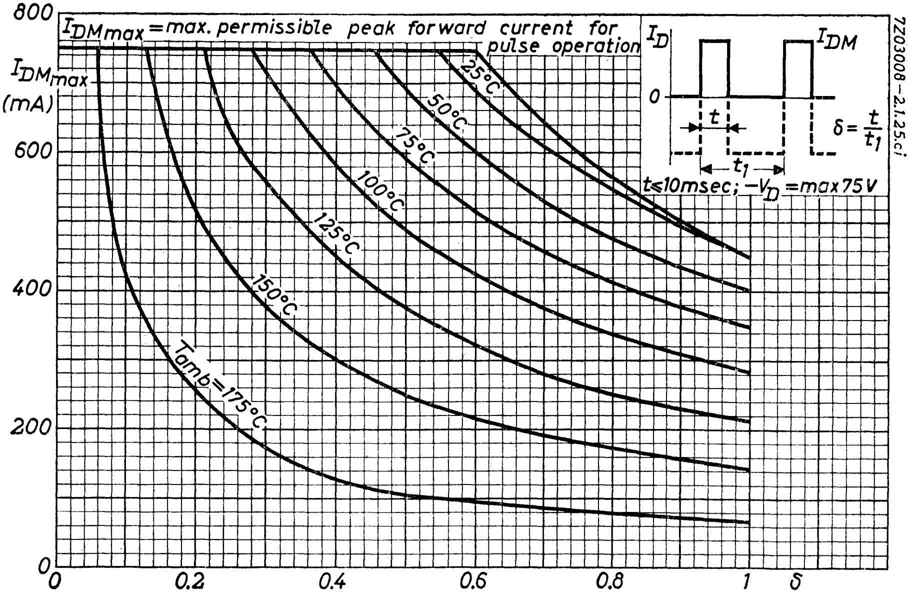

7Z03020-2.1.25.ci
$T_j = 150°C$
$T_j = 25°C$
max
typ
max
typ
$-V_D$ (V)
0
20
40
60
80
$-I_D$ (μA)
10^3
10^2
10
1
10^{-1}
10^{-2}
10^{-3}


I_{Dmax} = max. permissible continuous forward current
7Z03017-2.1.25.ci
600
I_{Dmax} (mA)
400
200
0
0
50
100
150
200 T_{amb}(°C)
250

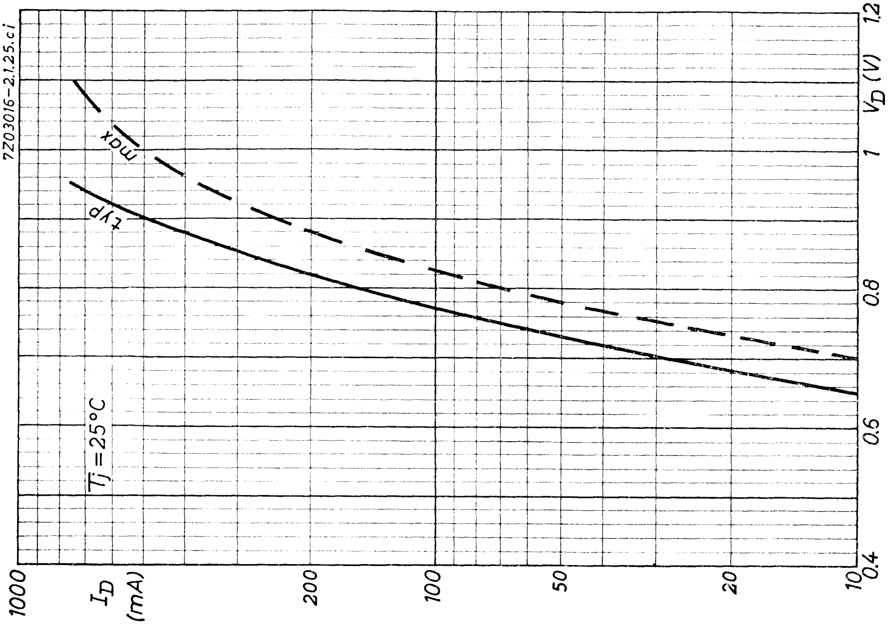

I_{DAVmax} = max. permissible average rectified forward current for sinusoidal operation
I_D
I_{DAV}
0
t
t ≤ 20msec; $-V_D$ = max75V
7Z03019-2.1.25.ci
300
I_{DAVmax} (mA)
200
100
0
0
50
100
150
200 T_{amb} (°C)
250



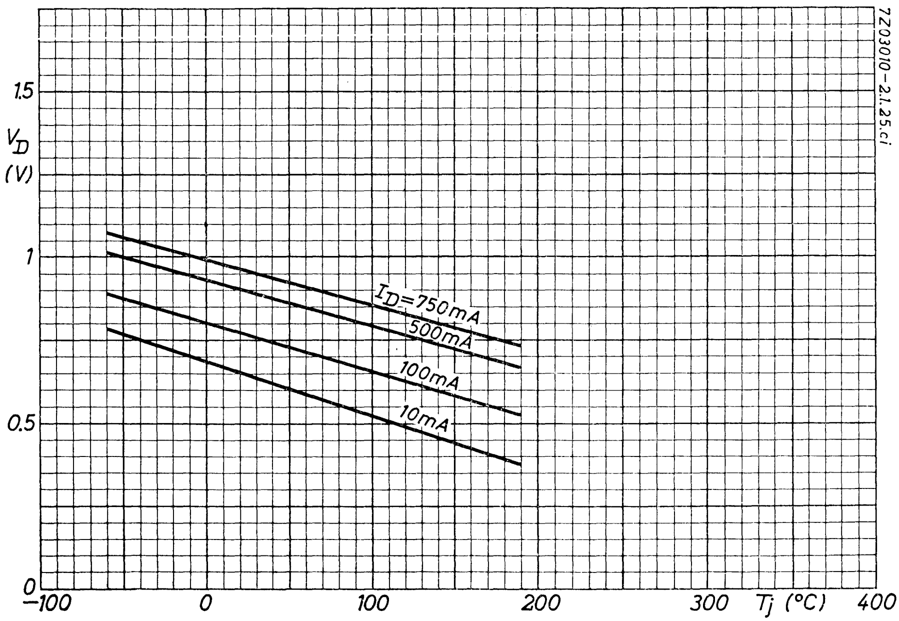
I_{DAVmax} = max. permissible average rectified forward current for pulse operation
7Z03018–2.1.25.ci
I_D
I_{DM}
I_{DAV}
0
t
t_1
$\delta = \frac{t}{t_1}$
$t \leq 10$ msec; $-V_D$ = max 75 V
I_{DAVmax} (mA)
600
400
200
0
0.2
0.4
0.6
0.8
δ
1
25°C
50°C
75°C
100°C
125°C
150°C
T_{amb}=175°C



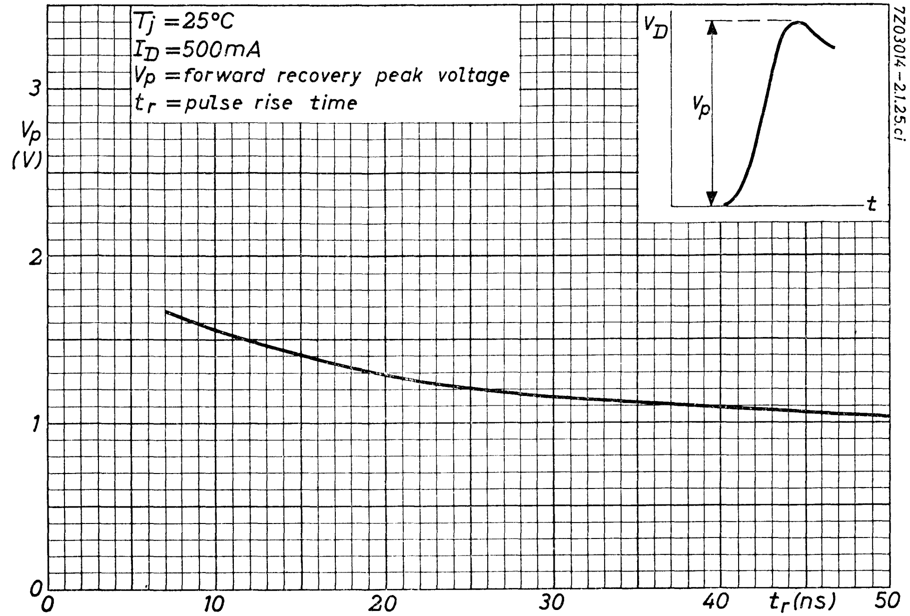
I_{DMmax} = max. permissible peak forward current for pulse operation
7Z03008–2.1.25.ci
I_D
I_{DM}
0
t
t_1
$\delta = \frac{t}{t_1}$
$t \leq 10$ msec; $-V_D$ = max 75 V
I_{DMmax} (mA)
800
600
400
200
0
0.2
0.4
0.6
0.8
1
δ
25°C
50°C
75°C
100°C
125°C
150°C
T_{amb}=175°C

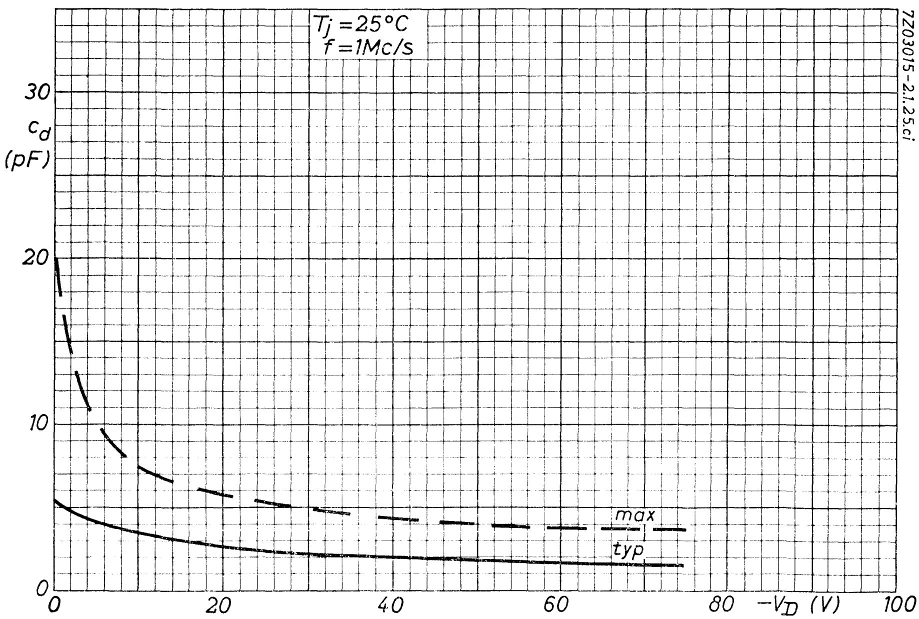


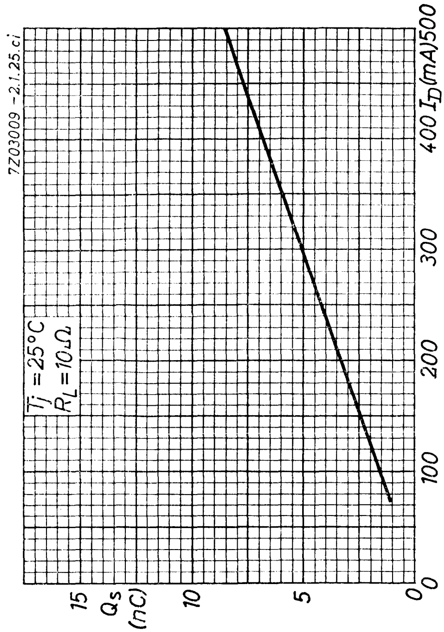
7Z03016−2.1.25.ci
max
typ
$T_j = 25°C$
V_D (V)
1.2
1
0.8
0.5
0.4
1000
I_D (mA)
200
100
50
20
10

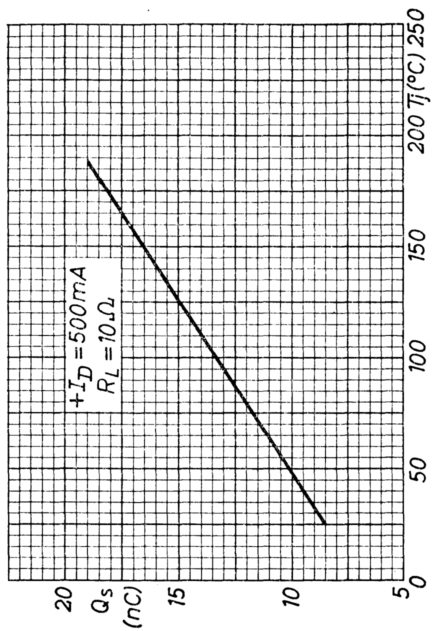


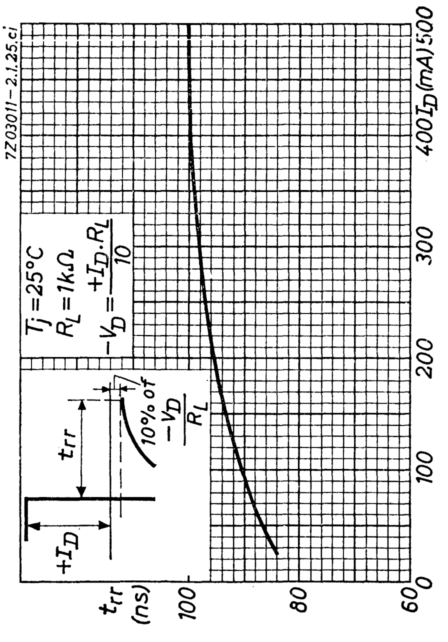
7Z03010−2.1.25.ci
1.5
V_D (V)
1
0.5
0
−100
0
100
200
300
T_j (°C)
400
I_D=750mA
500mA
100mA
10mA

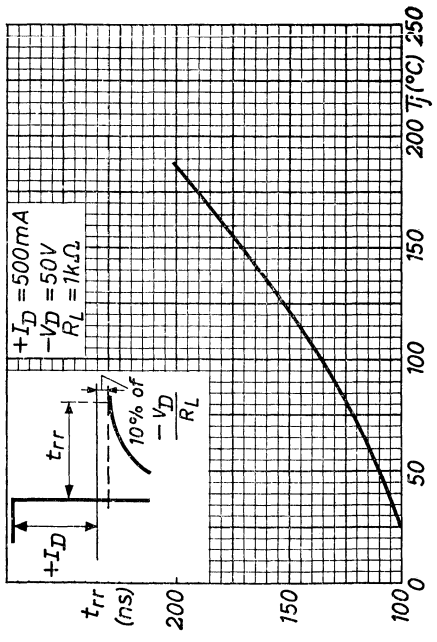

T_j = 25°C
I_D = 500 mA
V_p = forward recovery peak voltage
t_r = pulse rise time
V_p (V)
t_r (ns)
V_D
V_p
t
7Z03014-2.1.25.ci
0
1
2
3
10
20
30
40
50


T_j = 25°C
f = 1 Mc/s
c_d (pF)
max
typ
$-V_D$ (V)
7Z03015-2.1.25.ci
0
10
20
30
40
60
80
100


7Z03009 – 2.1.25.ci
$T_j = 25°C$
$R_L = 10 Ω$
Q_s (nC)
I_D (mA)
0
5
10
15
0
100
200
300
400
500

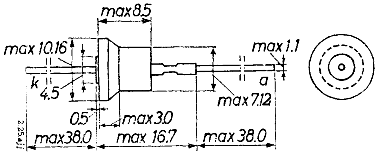

$+I_D = 500 mA$
$R_L = 10 Ω$
Q_s (nC)
T_j (°C)
5
10
15
20
0
50
100
150
200
250


7Z03011 – 2.1.25.ci
$T_j = 25°C$
$R_L = 1 kΩ$
$-V_D = \frac{+I_D \cdot R_L}{10}$
$+I_D$
t_{rr}
10% of $\frac{-V_D}{R_L}$
t_{rr} (ns)
I_D (mA)
60
80
100
0
100
200
300
400
500


$+I_D = 500 mA$
$-V_D = 50 V$
$R_L = 1 kΩ$
$+I_D$
t_{rr}
10% of $\frac{-V_D}{R_L}$
t_{rr} (ns)
T_j (°C)
100
150
200
0
50
100
150
200
250

SILICON DOUBLE DIFFUSED JUNCTION POWER DIODE for mains rectifier application in television receivers

Dimensions in mm



LIMITING VALUES (Absolute max. values) at T_{amb} = 70°C

Inverse voltage

Recurrent peak	$-V_{DM}$	= max.	800 V
Transient peak (max. duration 10 msec)	$-V_{DM}$ (t	= max. = max.	1250 V 10 msec)

Forward current

Average (averaging time = max. 50 msec)	I_D (t_{av}	= max. = max.	0.45 A [1]) 50 msec)
Recurrent peak	I_{DM}	= max.	5 A
Surge peak	I_{Dsurge}	=	[2])

Temperatures

Storage temperature	T_s	=	-55°C to +150°C
Operating ambient temperature	T_{amb}	= max.	70 °C

CHARACTERISTICS at diode base temperature T_m = 25 °C

Forward voltage

V_D (I_D = 5 A) = max. 1.5 V [3])

Reverse current

$-I_D$ ($-V_D$ = 1250 V) = max. 10 µA

[1]) At T_{amb} = 50 °C a maximum average forward current I_D = 0.55 A is permitted. See Fig.3 page 2 and for voltage doubler circuits also page E.

[2]) The diode can withstand the surge current during switching on ("inrush current") with an uncharged capacitor of 200 µF and a surge limiting resistor of 5 Ω at the specified maximum operating conditions.

[3]) Measured with current pulses to prevent excessive dissipation.

OPERATING CHARACTERISTICS (See also pages C and D)

If large mains voltage fluctuations may be expected a capacitor of 2200 pF (800 V) is recommended to be used in parallel with the diode

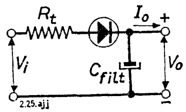


Fig.1

Input voltage	V_1	=	220	240	V(RMS)
Load capacitor	C_{filt}	=	200	200	µF
Surge limiting resistor	R_t	=	5	5	Ω
Output current	I_o	=	0.4	0.4	A
Output voltage	V_o	=	280	300	V

R_t = minimum required circuit resistance

When a transformer is present between the mains and the diode $R_t = R_s + N^2R_p + R_1$ (See circuit diagram below)

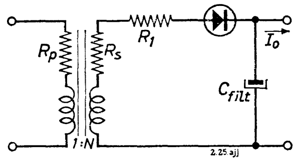


Fig.2

For operating characteristics for use as voltage doubler please refer to page E.

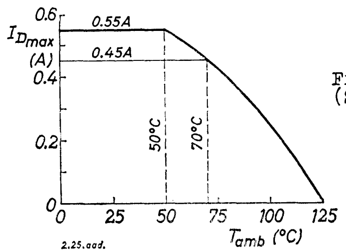
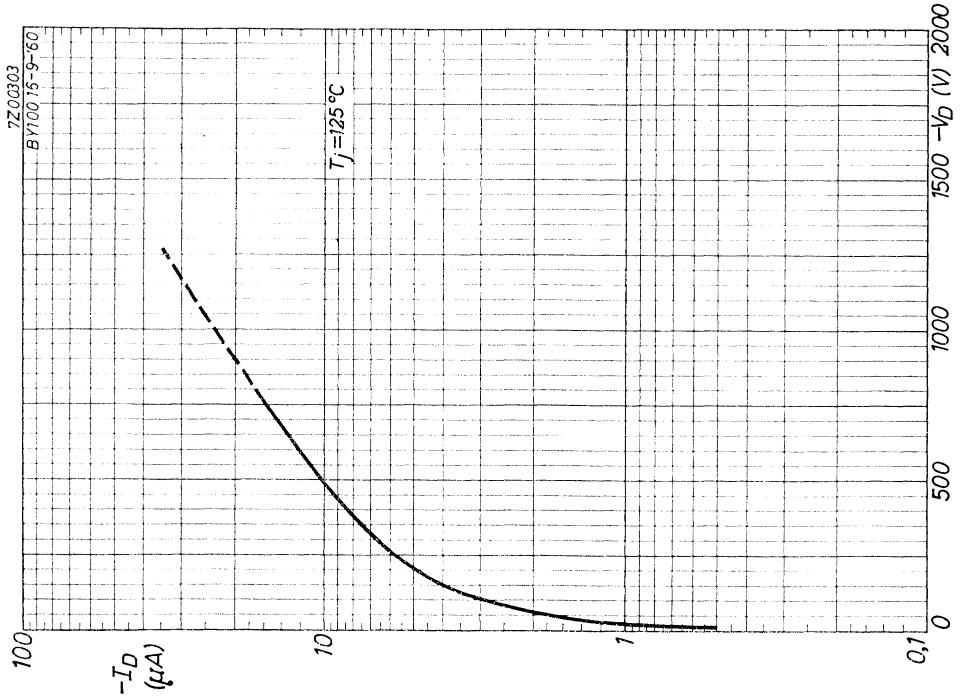
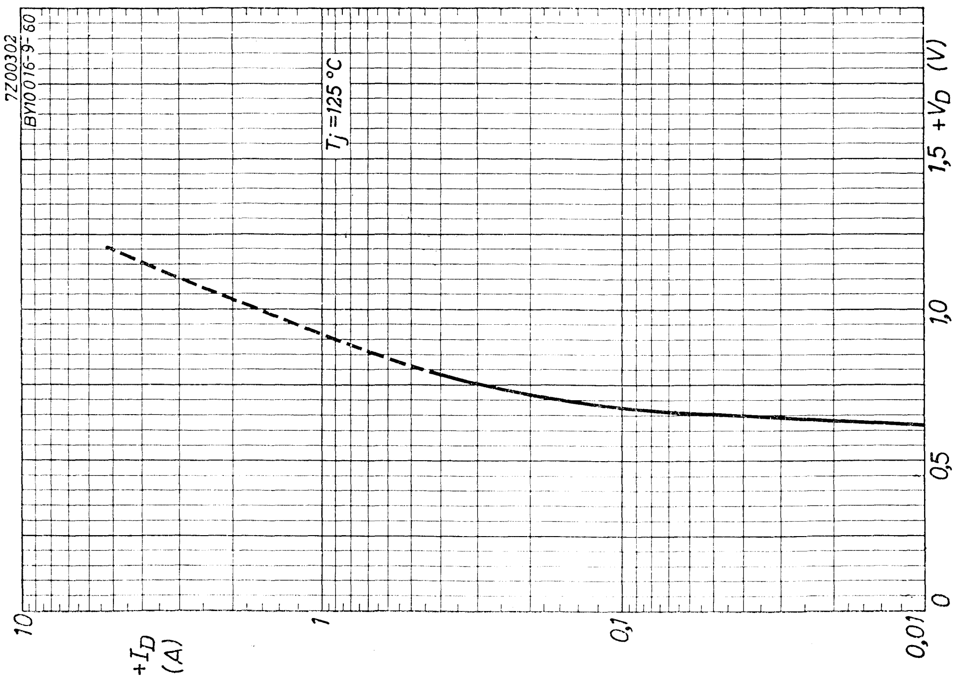


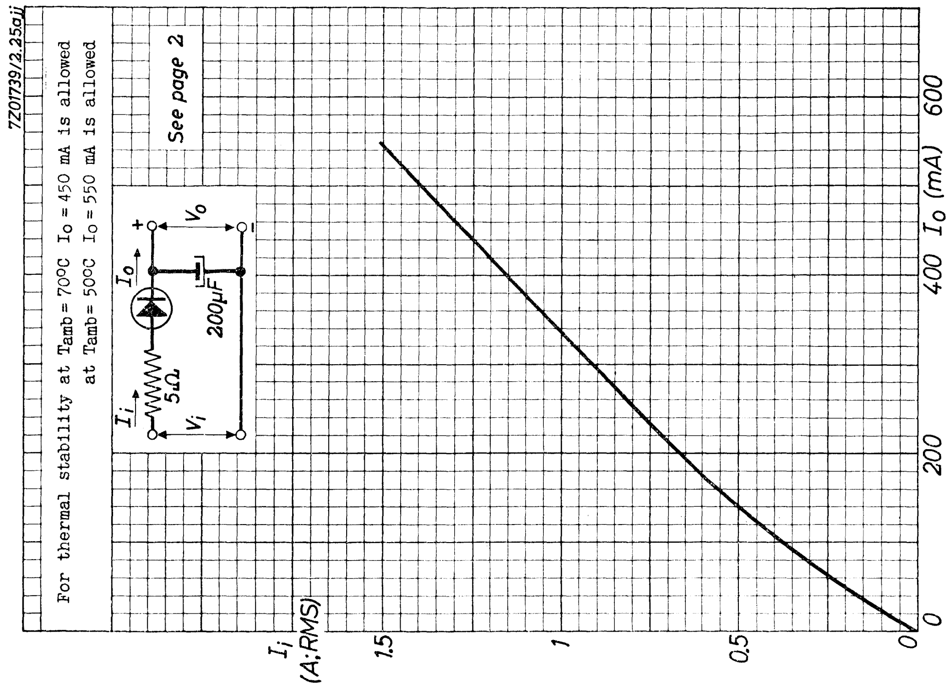
Fig.3 (See note [1]) page 1)


7Z00303
BY100 15-9-'60
T_j =125 °C
$-I_D$ (μA)
100
10
1
0,1
0
500
1000
1500
2000
$-V_D$ (V)

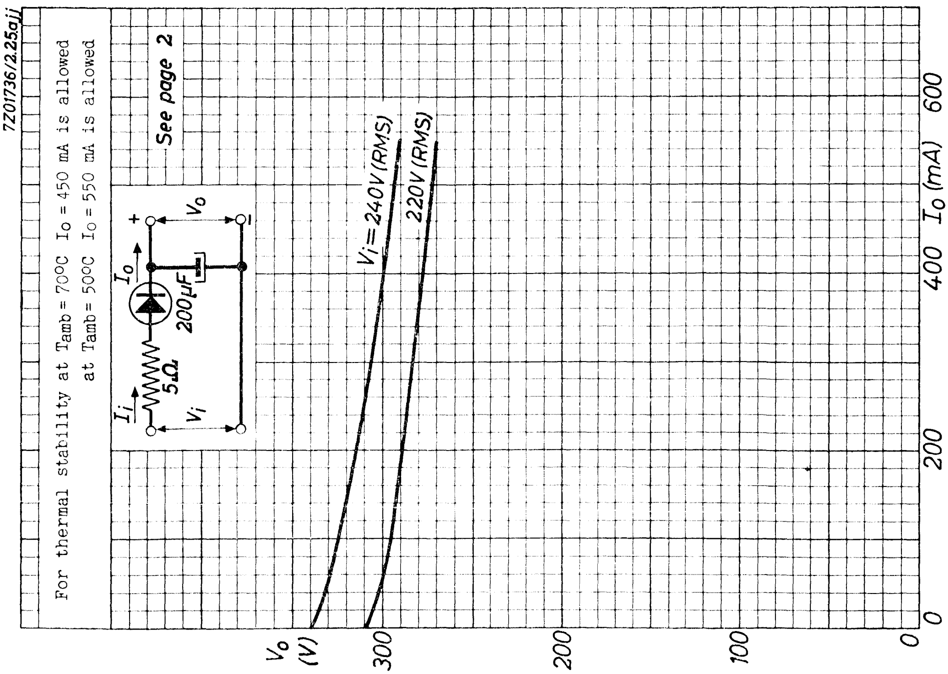
B


7Z00302
BY100 16-9-'60
T_j =125 °C
$+I_D$ (A)
10
1
0,1
0,01
0
0,5
1,0
1,5
$+V_D$ (V)

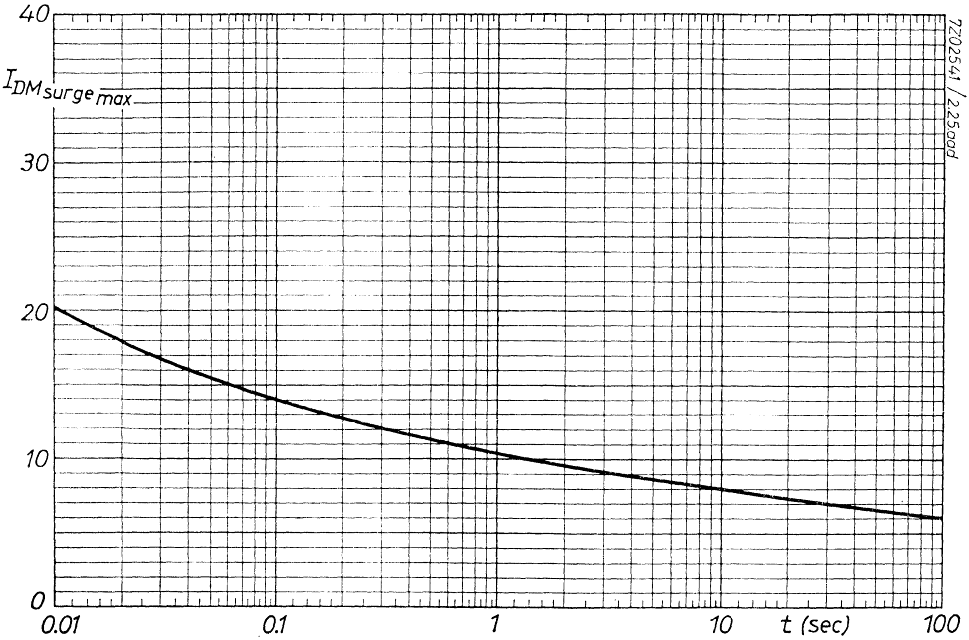
A


7Z01739/2.25ajj
For thermal stability at Tamb = 70°C Io = 450 mA is allowed
at Tamb = 50°C Io = 550 mA is allowed
See page 2
Ii
5Ω
Io
200µF
Vi
Vo
+
−
Ii (A,RMS)
1.5
1
0.5
0
Io (mA)
0
200
400
600

D

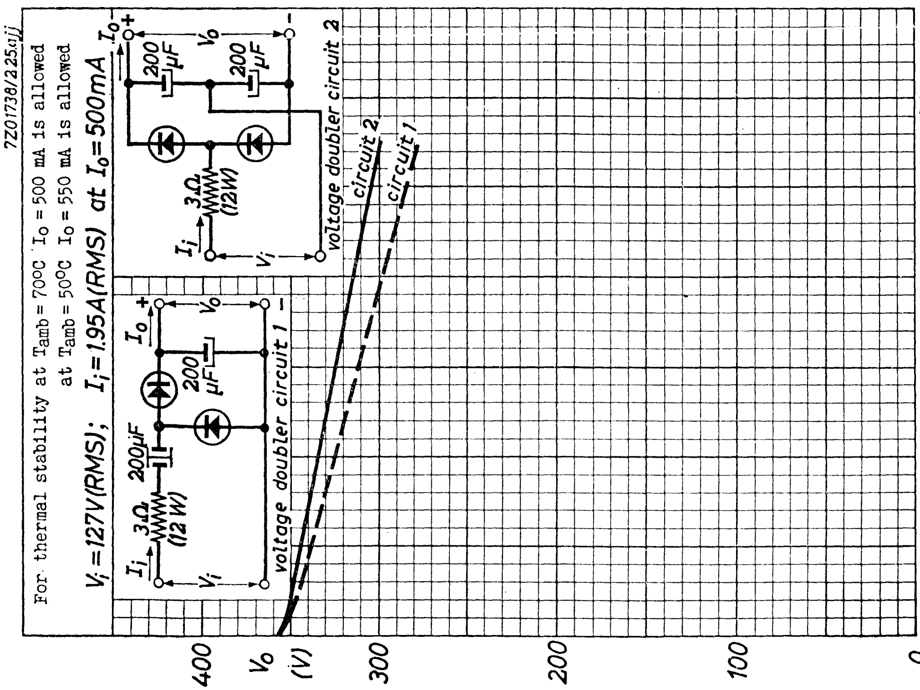

7Z01736/2.25ajj
For thermal stability at Tamb = 70°C Io = 450 mA is allowed
at Tamb = 50°C Io = 550 mA is allowed
See page 2
Ii
5Ω
Io
200µF
Vi
Vo
+
−
Vi = 240V (RMS)
220V (RMS)
Vo (V)
300
200
100
0
Io (mA)
0
200
400
600

C



40
$I_{DM surge max}$
30
20
10
0
0.01
0.1
1
10
t (sec)
100
7Z02541/2.25aad

F



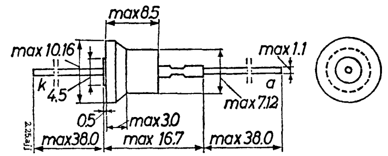
7Z01738/2.25ajj
For thermal stability at Tamb = 70°C Io = 500 mA is allowed
at Tamb = 50°C Io = 550 mA is allowed
V_i=127V(RMS); I_i=1.95A(RMS) at I_o=500mA
voltage doubler circuit 1
voltage doubler circuit 2
circuit 1
circuit 2
3.Ω (12W)
200μF
200 μF
V_o (V)
400
300
200
100
0
I_o (mA)
200
400
600

E

6.6.1964

SILICON DOUBLE DIFFUSED JUNCTION POWER DIODE for 110 to 127 volts mains rectifier application in television receivers

Dimensions in mm



LIMITING VALUES (Absolute max. values) at T_{amb} = 70 °C

Inverse voltage

Recurrent peak	$-V_{DM}$	= max.	450 V
Transient peak (max. duration 10 msec)	$-V_{DM}$	= max.	650 V
	(t	= max.	10 msec)

Forward current

Average (averaging time = max. 50 msec)	I_D	= max.	0.45 A [1])
	(t_{av}	= max.	50 msec)
Recurrent peak	I_{DM}	= max.	5 A
Surge peak	I_{Dsurge}	=	[2])

Temperatures

Storage temperature	T_s	=	-55°C to +150°C
Operating ambient temperature	T_{amb}	= max.	70 °C

CHARACTERISTICS at diode base temperature T_m = 25 °C

Forward voltage V_D (I_D = 5 A)	= max.	1.5 V [3])
Reverse current $-I_D$ ($-V_D$ = 650 V)	= max.	10 µA

[1]) At T_{amb} = 50 °C a maximum average forward current I_D = 0.55 A is permitted. See Fig.3 page 2 and for voltage doubler circuits also pages D and E.

[2]) The diode can withstand the surge current during switching on ("inrush current") with an uncharged capacitor of 200 µF and a surge limiting resistor of 3 Ω at the specified maximum operating conditions.

[3]) Measured with current pulses to prevent excessive dissipation.

OPERATING CHARACTERISTICS (See also pages C,D and E)

If large mains voltage fluctuations may be expected a capacitor of 2200 pF (500 V) is recommended to be used in parallel with the diode

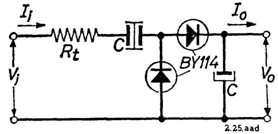


Fig.1

Input voltage	V_i	=	110	127	V(RMS)
Load capacitor	C_{filt}	=	200	200	µF
Surge limiting resistor	R_t	=	3	3	Ω

R_t = minimum required circuit resistance

When a transformer is present between the mains and the doubler circuit $R_t = R_s + N^2R_p + R_1$ (See circuit diagram below)

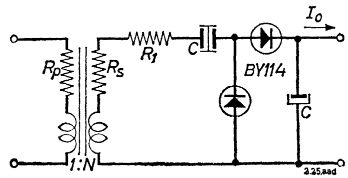


Fig.2

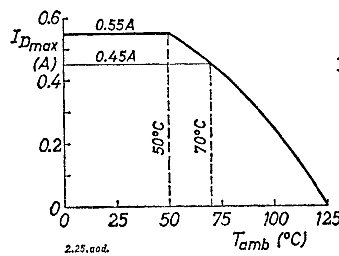
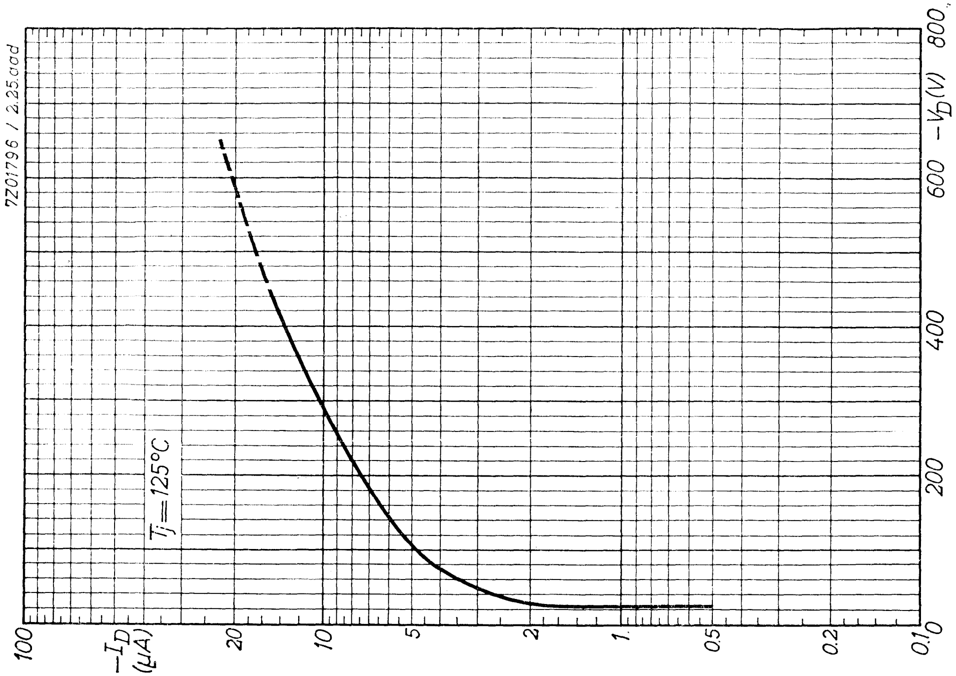
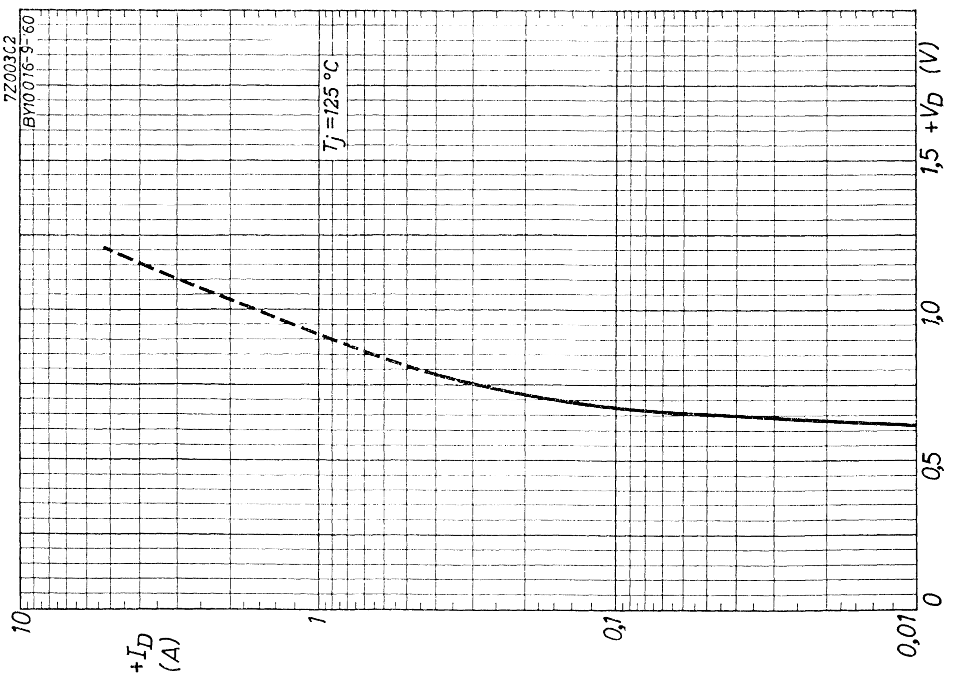


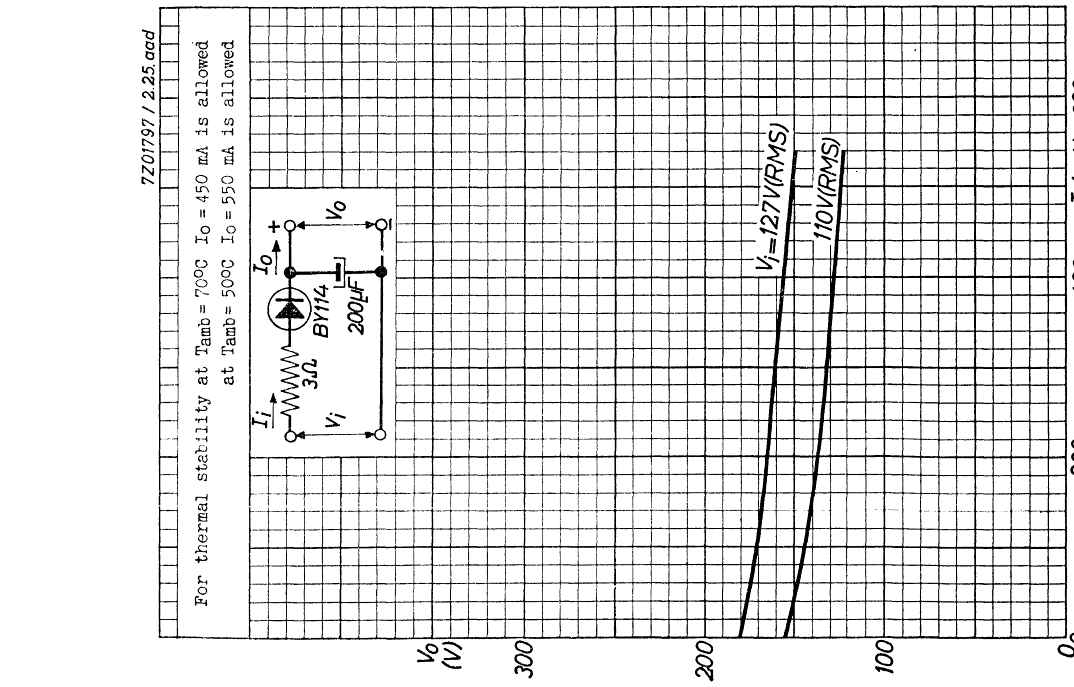
Fig.3 (See note [1]) page 1)


7Z01796 / 2.25.aad
Tj = 125°C
−I_D (µA)
100
20
10
5
2
1
0.5
0.2
0.1
0
200
400
600
800
−V_D (V)

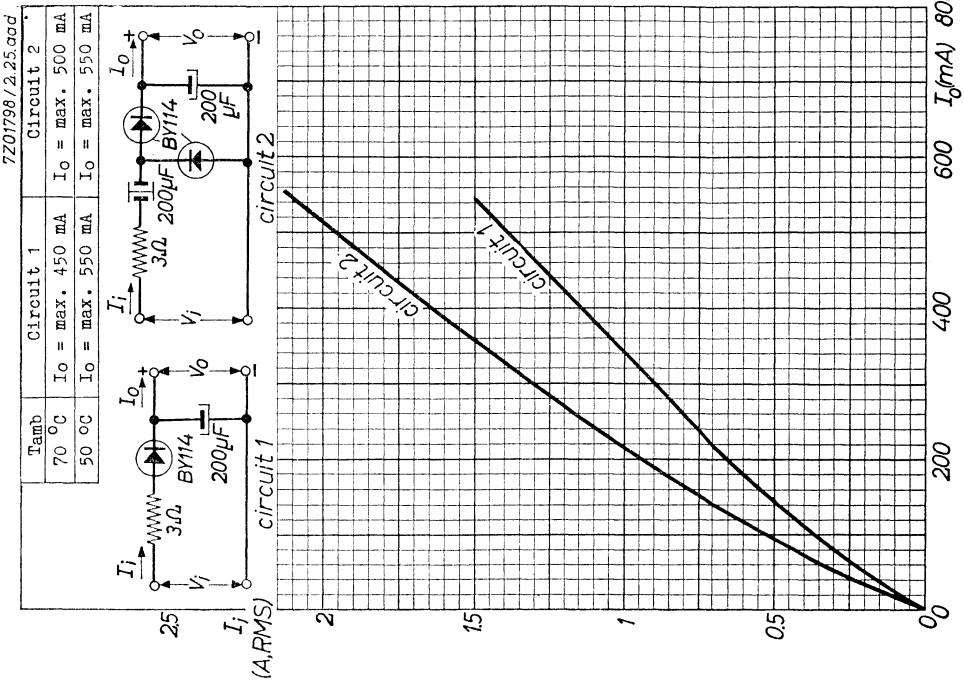
B


7Z003C2
BY10 016-9-'60
Tj = 125 °C
+I_D (A)
10
1
0,1
0,01
0
0,5
1,0
1,5
+V_D (V)

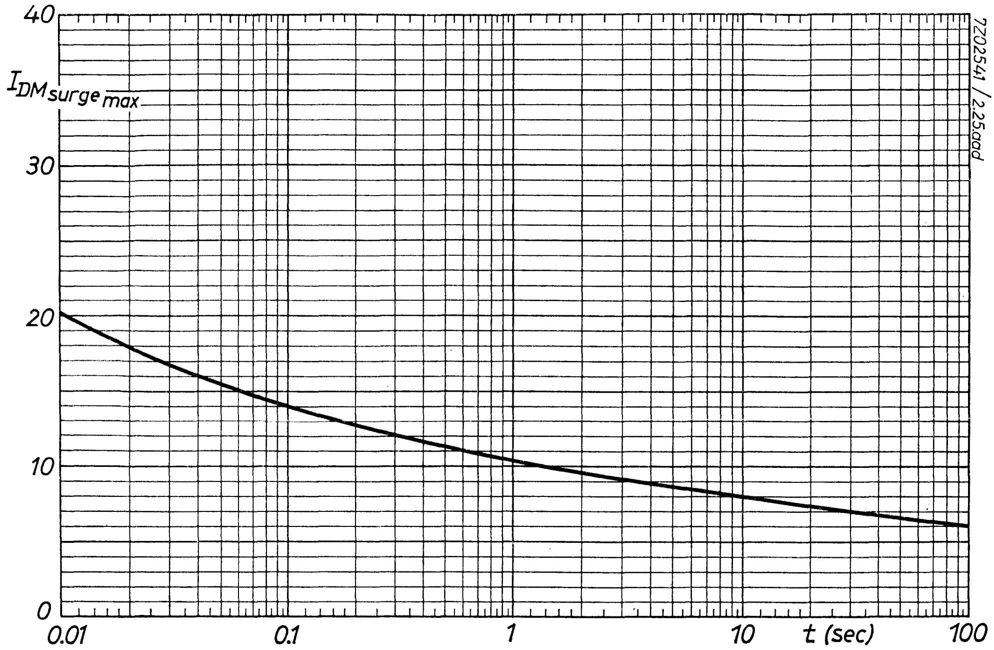
A


7Z01797 / 2.25.aad
For thermal stability at Tamb = 70°C Io = 450 mA is allowed
at Tamb = 50°C Io = 550 mA is allowed
Ii
3Ω
Vi
BY114
200μF
Io
+
Vo
−
Vi=127V(RMS)
110V(RMS)
Vo (V)
300
200
100
0
200
400
600
Io(mA)

C

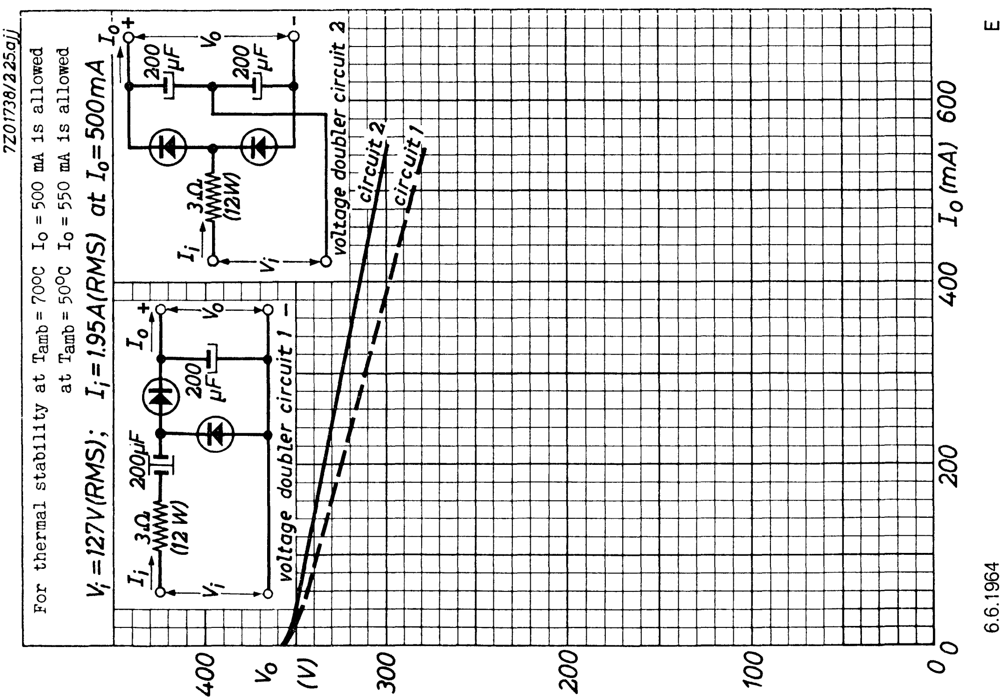

7Z01798 / 2.25.aad
Tamb | Circuit 1 | Circuit 2
70 °C | Io = max. 450 mA | Io = max. 500 mA
50 °C | Io = max. 550 mA | Io = max. 550 mA
Ii
3Ω
BY114
200μF
Io
+
Vo
−
Vi
circuit 1
200μF
200 μF
circuit 2
circuit 1
circuit 2
2.5
Ii (A,RMS)
2
1.5
1
0.5
0
200
400
600
800
Io(mA)

D


40
30
20
10
0
$I_{DM\,surge\,max}$
0.01
0.1
1
10
100
t (sec)
7Z02541 / 2.25.aad

F

E


7Z01738/2.25.ajj
For thermal stability at T_{amb} = 70°C I_O = 500 mA is allowed
at T_{amb} = 50°C I_O = 550 mA is allowed
V_i=127V(RMS); I_i=1.95A(RMS) at I_o=500mA
3Ω (12W)
200µF
200 µF
voltage doubler circuit 1
voltage doubler circuit 2
circuit 1
circuit 2
I_o (mA)
V_o (V)
400
300
200
100
0
600
6.6.1964

SILICON DIFFUSED JUNCTION POWER DIODE

Silicon diffused junction power diode in metal envelope for use as efficiency diode in line deflection circuits of television receivers

QUICK REFERENCE DATA			
Repetitive peak inverse voltage	$-V_{DM}$	= max.	300 V
Forward current, averaged over any 20 msec period	I_D	= max.	5 A
Repetitive peak forward current	I_{DM}	= max.	14 A
Thermal resistance between junction and diode base	K	<	5 °C/W

LIMITING VALUES (Absolute max. values)

Inverse voltage

Repetitive peak	$-V_{DM}$	= max.	300 V

Forward current

Averaged over any 20 msec period	I_D	= max.	5 A
Continuous	I_D	= max.	6 A
Repetitive peak	I_{DM}	= max.	14 A
Repetitive peak, duration 3 μsec	I_{DM}	= max.	20 A

Temperatures

Junction temperature	T_j	= max.	150 °C
Storage temperature	T_s	=	−55 °C to +150 °C

7Z2 2417

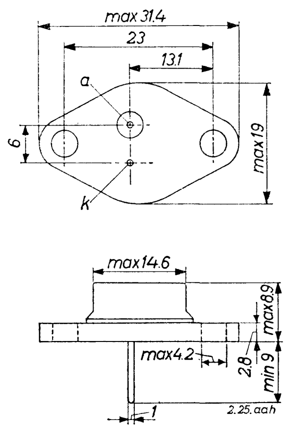
THERMAL DATA

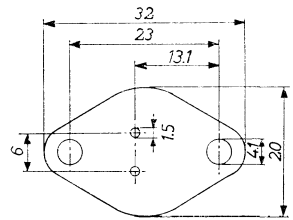
Thermal resistance

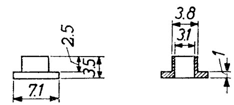
from junction to diode base	K_{j-m}	<	5 °C/W
from diode base to heat sink without mica washer	K_{m-h}	=	0.5 °C/W
with mica washer	K_{m-h}	=	1.5 °C/W

MECHANICAL DATA

Dimensions in mm

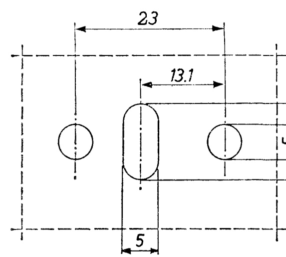






Mica insulation (50 to 100 μm) and insulation tubes

The cathode is connected to the case



Bore hole dimensions of heat sink

7Z2 2418

CHARACTERISTICS at $T_j = 25\ ^oC$

Reverse current at $-V_D = 300$ V — $-I_D < 100\ \mu A$

Forward voltage at $I_D = 14$ A — $V_D < 1.2$ V

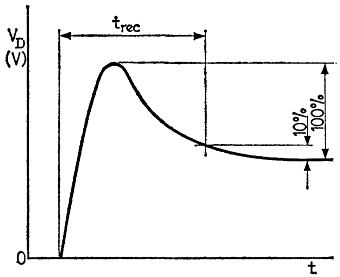
CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN up to $T_j = 150\ ^oC$

Forward recovery time

$I_D = 14$ A

Rise time of $I_D = 0.25\ \mu sec$

Forward recovery time $t_{rec} < 1.0\ \mu sec$



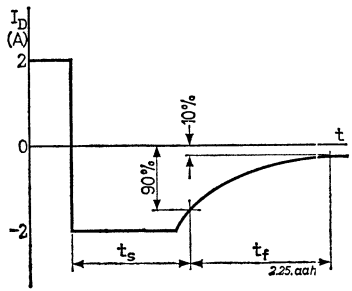
Forward output wave form

Reverse recovery time

When switching from $I_D = 2$ A to $-V_D = 30$ V; $-I_D$ limited to 2 A; rise time of $-V_D < 0.25\ \mu sec$

Delay time $t_s < 3\ \mu sec$

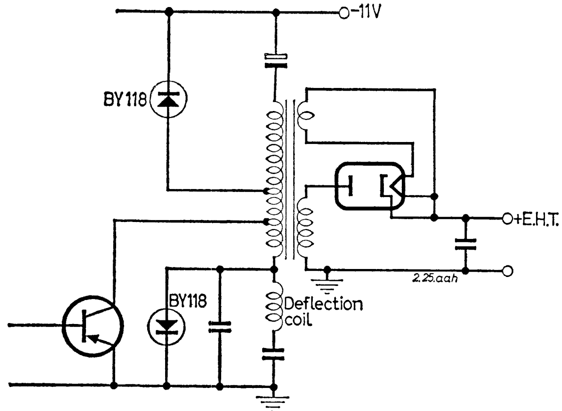
Fall time $t_f < 1\ \mu sec$



Reverse output wave form

7Z2 2419

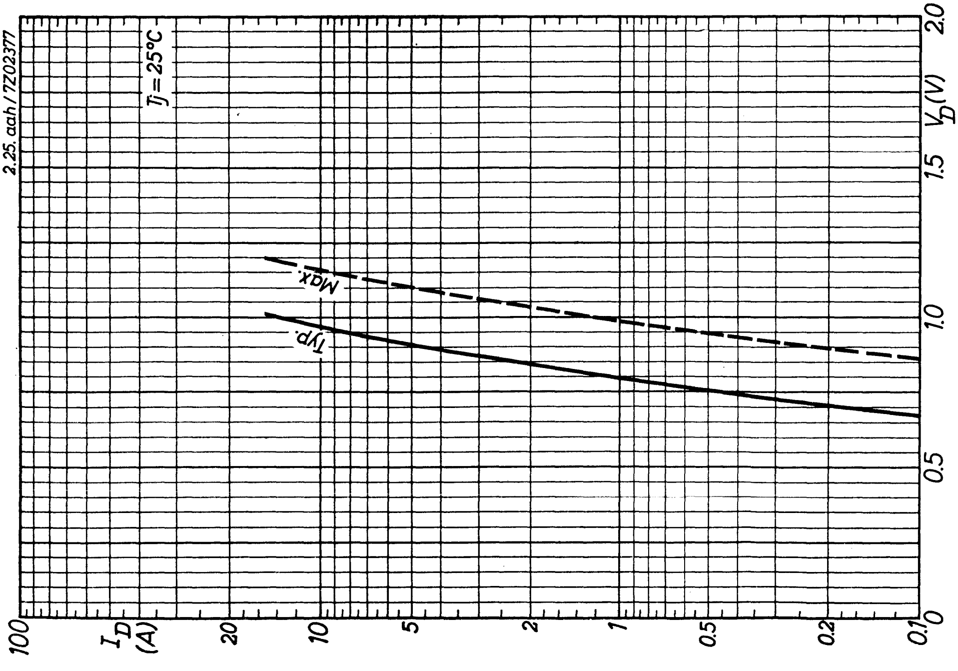
APPLICATION INFORMATION



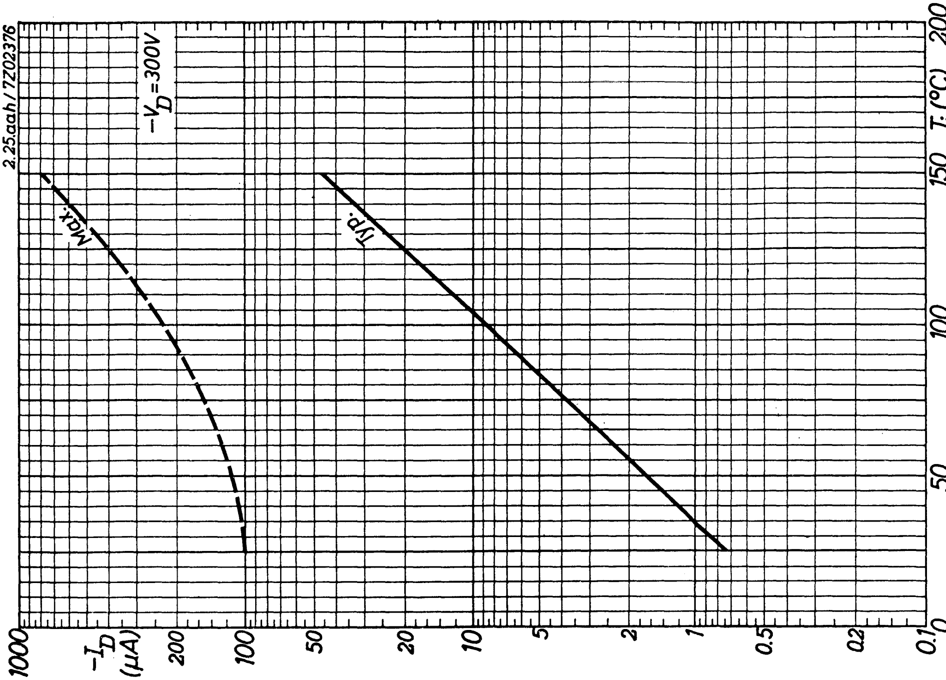
Typical fundamental line deflection circuit with a series efficiency diode and a parallel efficiency diode

7Z2 2425

5.5.1964

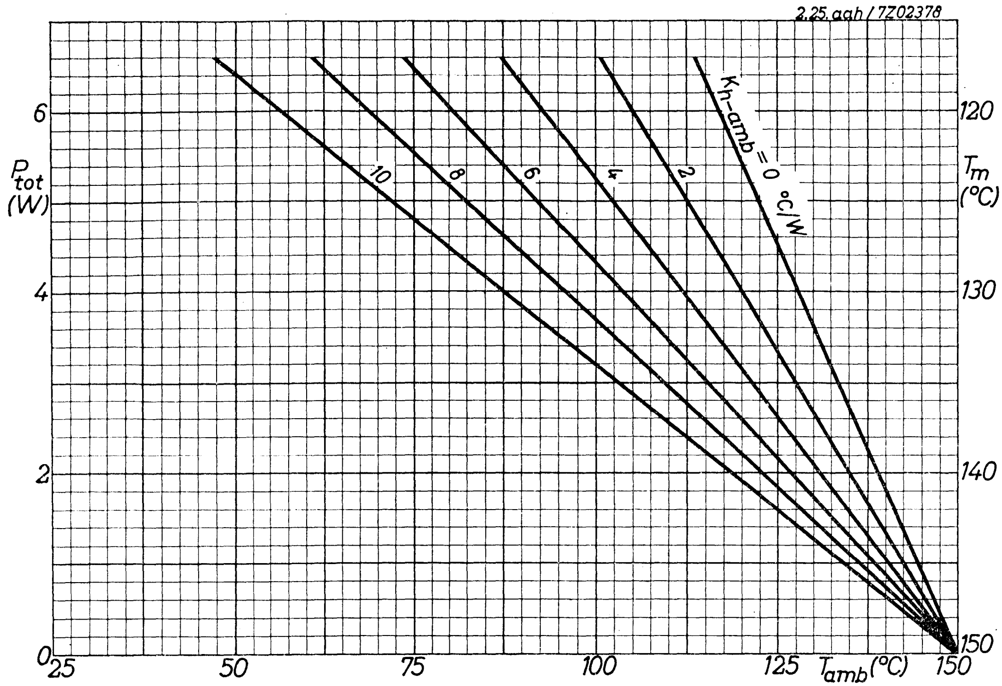

2.25. aah / 7Z02377
Tj = 25°C
Max.
Typ.
I_D (A)
100
20
10
5
2
1
0.5
0.2
0.1
0
0.5
1.0
1.5
2.0
V_D (V)

A

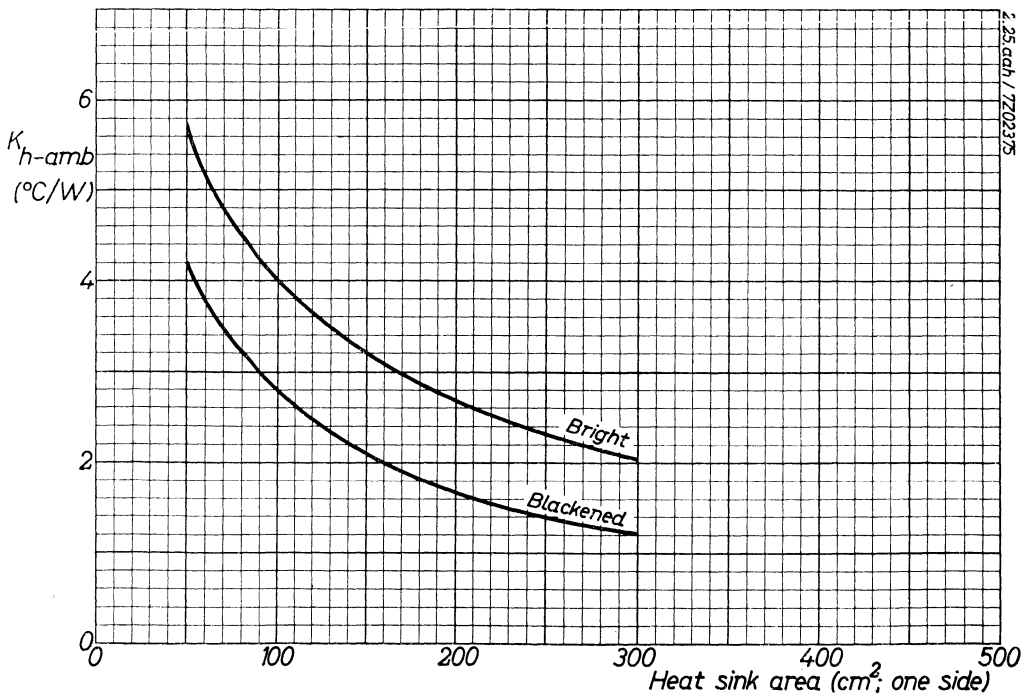

2.25.aah / 7Z02376
$-V_D$ = 300V
Max.
Typ.
$-I_D$ (μA)
1000
200
100
50
20
10
5
2
1
0.5
0.2
0.1
0
50
100
150
200
T_j (°C)

B

5.5.1964


2.25.aah / 7Z02378
6
4
2
0
P_{tot} (W)
25
50
75
100
125
T_{amb} (°C)
150
120
130
140
150
T_m (°C)
K_{h-amb} = 0 °C/W
2
4
6
8
10

C


2.25.aah / 7Z02375
K_{h-amb} (°C/W)
6
4
2
0
0
100
200
300
400
500
Heat sink area (cm²; one side)
Bright
Blackened

SILICON RECTIFIER DIODE

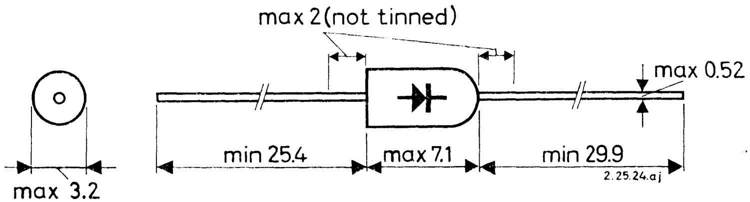
Double diffused silicon junction diode in an epoxy resin DO-14 envelope for low current rectifier applications

QUICK REFERENCE DATA

Crest working reverse voltage	$-V_{DMW}$	=	max.	800 V
Repetitive peak reverse voltage	$-V_{DM}$	=	max.	1600 V
Average forward current	I_D	=	max.	0.2 A
Repetitive peak forward current	I_{DM}	=	max.	1.5 A
Junction temperature	T_j	=	max.	125 °C
Operating ambient temperature	T_{amb}	=	max.	70 °C
Thermal resistance from junction to ambience	K	<		0.2 °C/mW

MECHANICAL DATA

Dimensions in mm

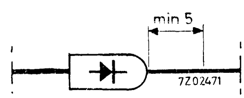


Envelope: epoxy resin; DO-14

The envelope fulfils the accelerated damp heat test described in I.E.C. publication 68-2, test D (severity IV, 6 cycles).

Iron soldering

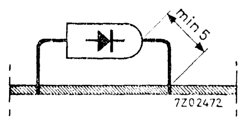
At a max. iron temperature of 300 °C the max. permissible soldering time is 3 sec, provided the soldering spot is at least 5 mm from the seal.



7Z2 2689

Dip soldering

At a max. solder temperature of 300 °C the max. permissible soldering time is 3 sec, provided the soldering spot is at least 5 mm from the seal.



If the diode is in contact with the print, the max. permissible temperature of the contact point is 125 °C.

LIMITING VALUES (absolute max. values)

Inverse voltage

Crest working	$-V_{DMW}$	= max.	800 V
Repetitive peak (duration < 1 msec)	$-V_{DM}$	= max.	1600 V
Non-repetitive peak (duration < 10 msec)	$-V_{DMsurge}$	= max.	1600 V

Forward current

Average (averaging time = 20 msec)			
for resistive or inductive load	I_D	= max.	0.2 A
for capacitive load	I_D	= max.	0.15 A
Repetitive peak	I_{DM}	= max.	1.5 A
Surge peak (of sinusoidal current, surge duration < 10 msec)	$I_{DMsurge}$	= max.	15 A [1]

Temperature

Storage	T_S	=	-65 to +125 °C
Junction	T_j	= max.	125 °C
Operating ambient	T_{amb}	= max.	70 °C

THERMAL DATA

Thermal resistance between junction and ambience	K	<	0.2 °C/mW

---

[1]) The BYX10 withstands also surge currents of 25 A max. during switching on ("inrush current") with an uncharged capacitor of 100 μF max.

7Z2 2690

CHARACTERISTICS

Reverse current

$-V_D = 1600$ V; $T_j = 25$ °C — $-I_D$ < 1 µA

Forward voltage drop

$I_D = 1.5$ A; $T_j = 25$ °C — V_D < 1.6 V

CHARACTERISTIC RANGE VALUES FOR EQUIPMENT DESIGN

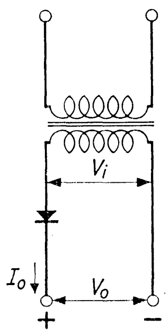
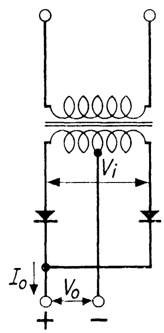
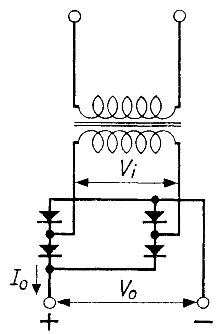
Reverse current

$-V_D = 800$ V; $T_j = 125$ °C — $-I_D$ < 50 µA

Forward voltage drop

$I_D = 0.2$ A; $T_j = 25$ °C — V_D < 1.1 V

OPERATING CHARACTERISTICS (See also page B)

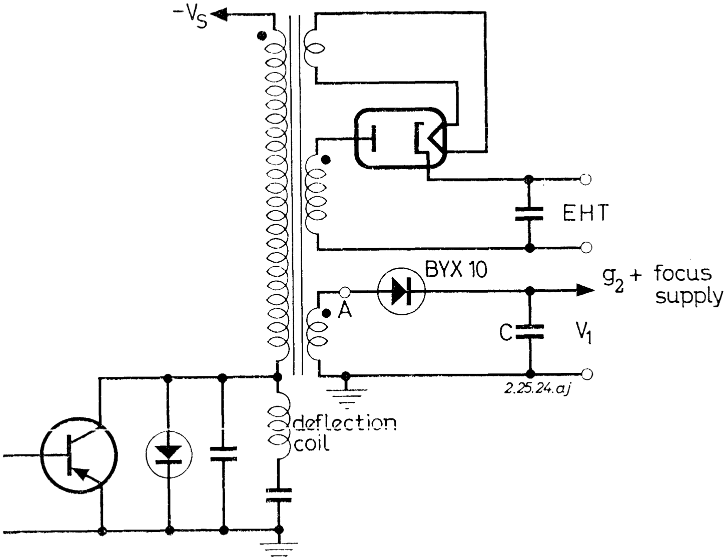
	Single-phase half-wave		Two-phase half-wave		Single-phase full wave (bridge)	
The I_O figures are absolute maximum values for resistive or inductive load.						
V_i (V_{RMS})	I_O (A)	V_O (V)	I_O (A)	V_O (V)	I_O (A)	V_O (V)
120	0.2	53	0.4	53	0.4	105
240	0.2	106	0.4	106	0.4	212
560	0.2	250	0.4	250	0.4	500

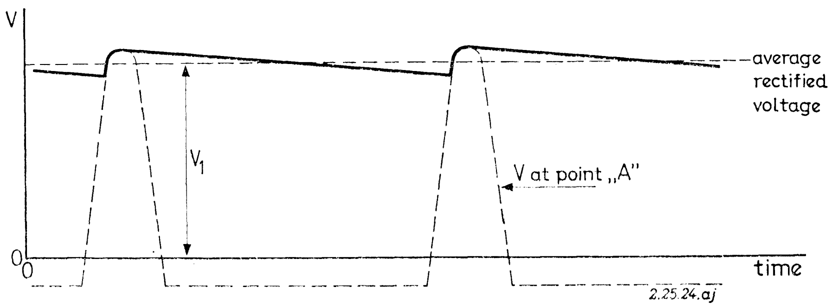
7Z2 2691

APPLICATION INFORMATION

BYX10 in the supply part for first anode and focus electrode of a TV picture tube

The first figure shows a typical line deflection circuit with EHT transformer, the second figure shows the voltage wave form of the g_2 and focus supply.

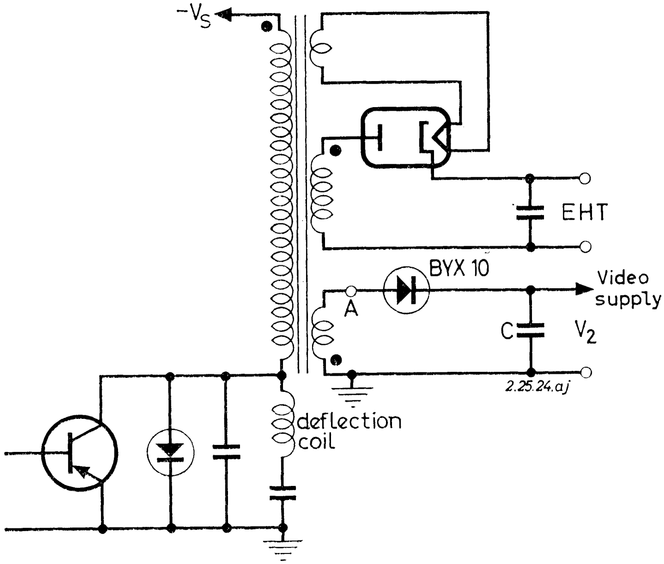


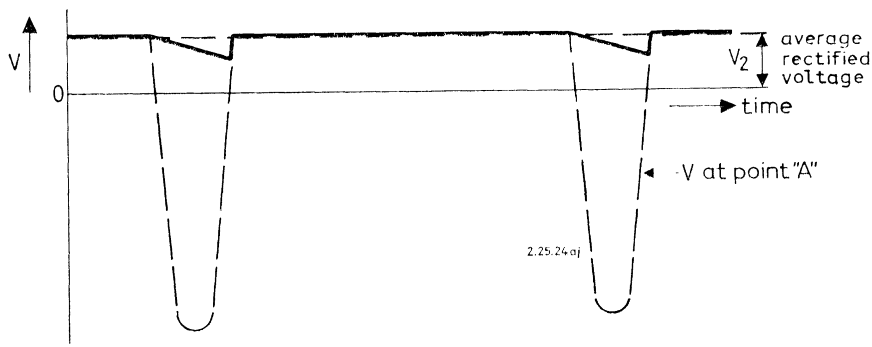


If capacitor C has such a value, that the "inrush current" through the diode could be higher than allowed, a surge resistor in series with the diode is recommended. 7Z2 2692

BYX10 in the supply part for the video amplifier transistor of a TV set

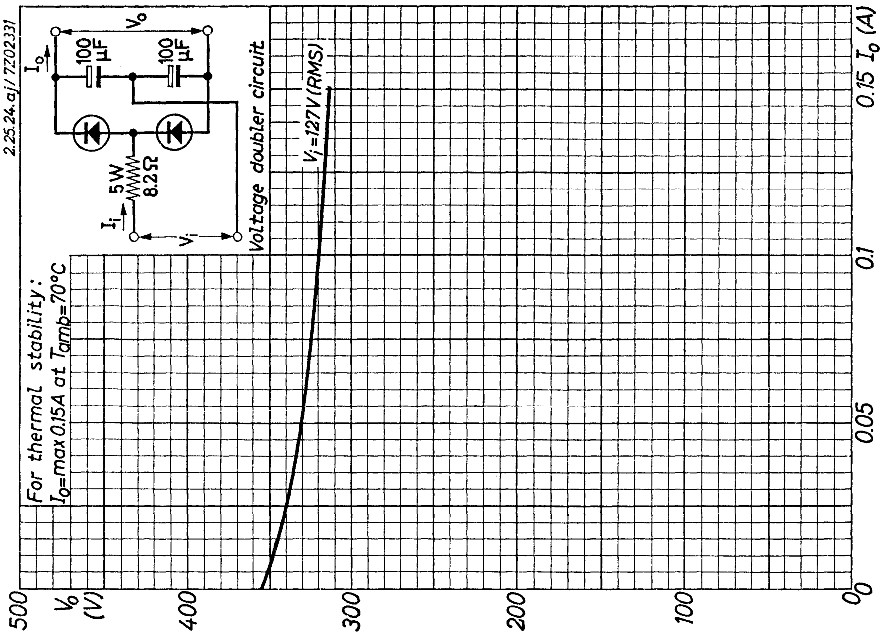
The first figure shows a typical line deflection circuit with EHT transformer, the second figure shows the voltage wave form of the video supply.

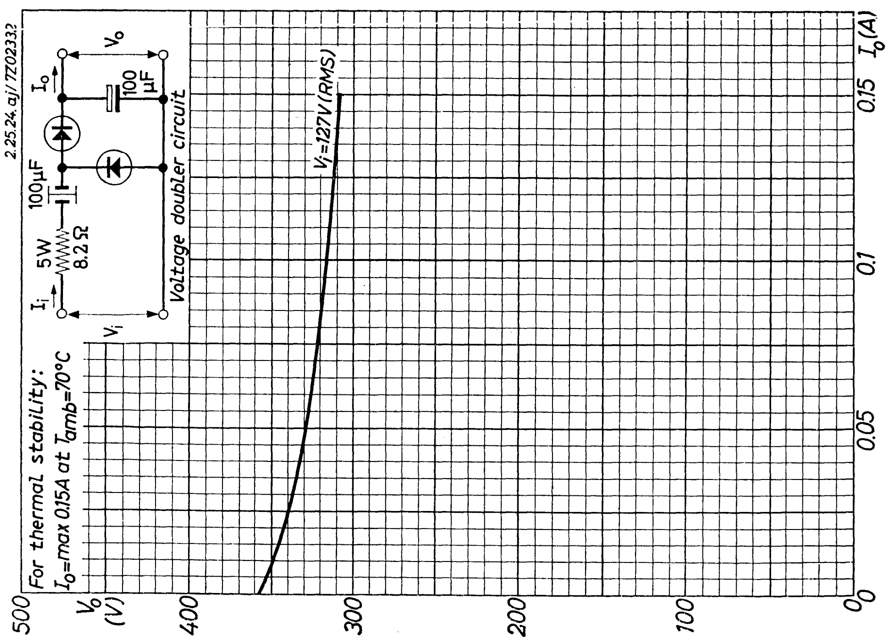


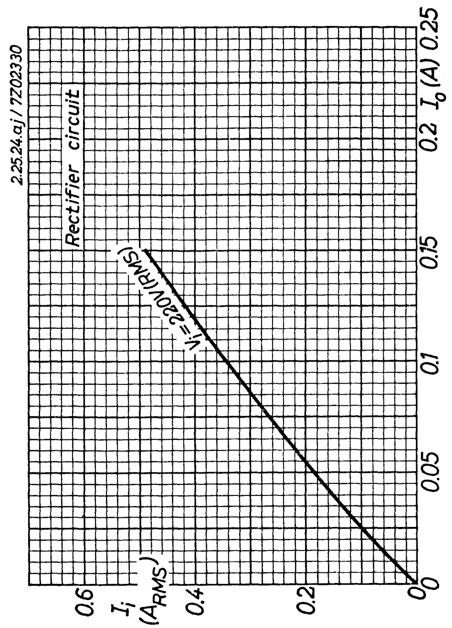


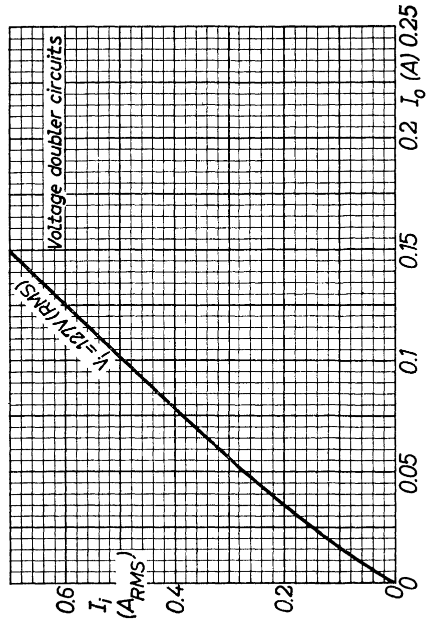
For thermal stability the ambient temperature should not exceed 55 °C.

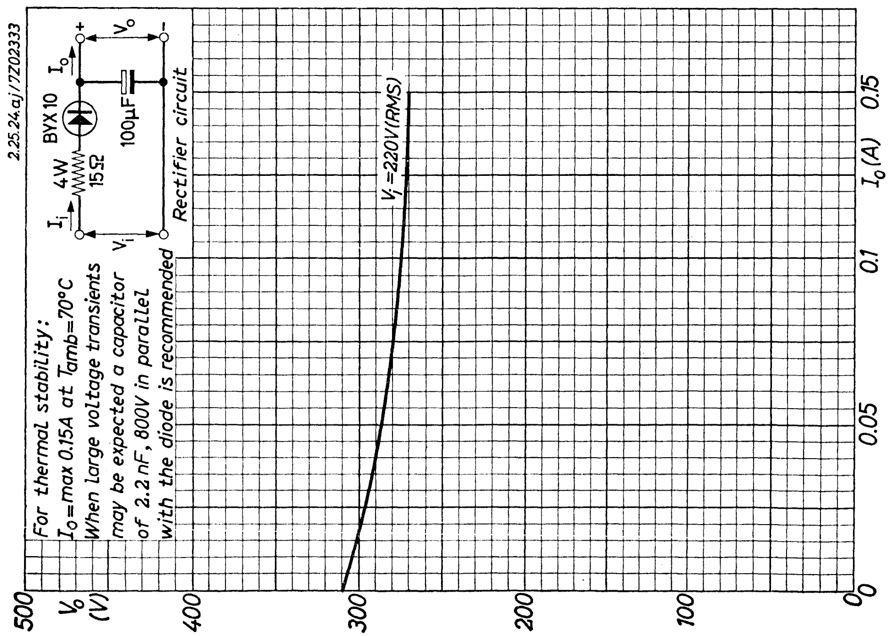
If capacitor C has such a value, that the "inrush current" through the diode could be higher than allowed, a surge resistor in series with the diode is recommended. 7Z2 2693

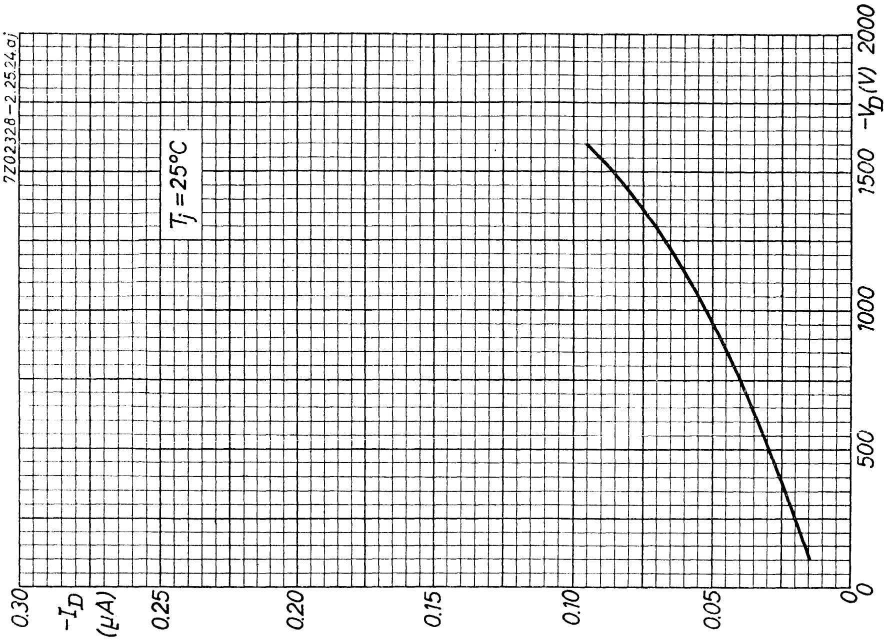

2.25.24.aj/7Z02331
For thermal stability:
I_o=max 0.15A at T_{amb}=70°C
Voltage doubler circuit
V_i=127V (RMS)
100 µF
100 µF
5W
8.2 Ω
I_o
I_i
V_o
V_i
V_o (V)
I_o (A)
500
400
300
200
100
0
0
0.05
0.1
0.15

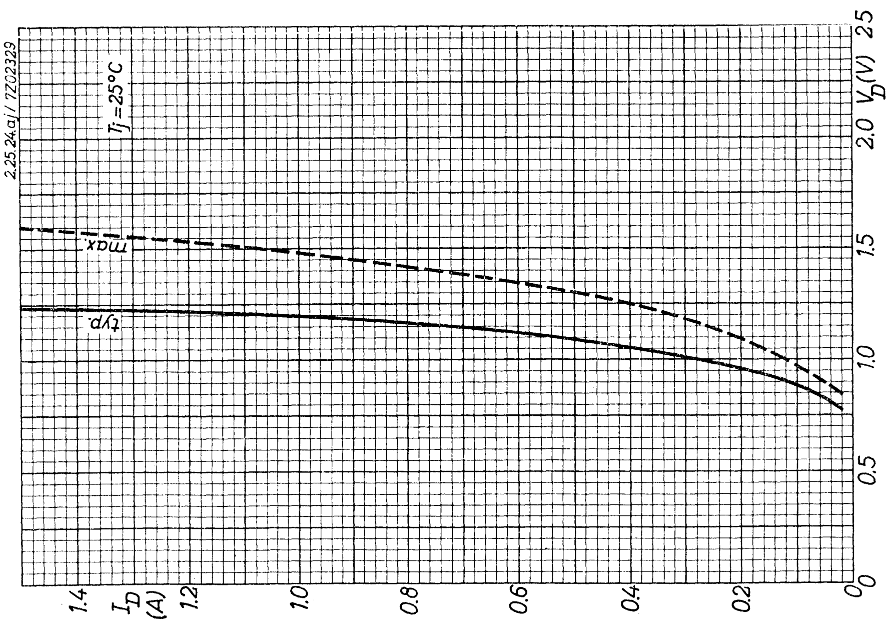

2.25.24.aj/7Z02332
For thermal stability:
I_o=max 0.15A at T_{amb}=70°C
Voltage doubler circuit
V_i=127V (RMS)
100µF
100 µF
5W
8.2 Ω
I_o
I_i
V_o
V_i
V_o (V)
I_o (A)
500
400
300
200
100
0
0
0.05
0.1
0.15


2.25.24.aj / 7Z02330
Rectifier circuit
V_i = 220V(RMS)
I_i (A_{RMS})
0.6
0.4
0.2
0
0
0.05
0.1
0.15
0.2
I_o (A) 0.25


Voltage doubler circuits
V_i = 127V(RMS)
I_i (A_{RMS})
0.6
0.4
0.2
0
0
0.05
0.1
0.15
0.2
I_o (A) 0.25


2.25.24.aj / 7Z02333
For thermal stability:
I_o = max 0.15A at T_{amb} = 70°C
When large voltage transients
may be expected a capacitor
of 2.2 nF, 800V in parallel
with the diode is recommended
I_i
4W
15Ω
BYX 10
100µF
I_o
V_i
V_o
+
−
Rectifier circuit
V_i = 220V(RMS)
500
V_o (V)
400
300
200
100
0
0
0.05
0.1
I_o (A) 0.15


7Z02328 - 2.25.24.aj
Tj = 25°C
-V_D (V)
2000
1500
1000
500
0
-I_D (μA)
0.30
0.25
0.20
0.15
0.10
0.05
0


2.25.24.aj / 7Z02329
Tj = 25°C
max.
typ.
V_D (V)
2.5
2.0
1.5
1.0
0.5
0
I_D (A)
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0

SILICON POWER DIODES

Double diffused silicon junction diodes for power rectifier applications. The series consists of the ten types BYX13-400, BYX13-400R, (in the same way) -600, -600R, -800, -800R, -1000, -1000R, -1200 and -1200R. The letter R means reverse polarity (anode connected to case) without change of any other data.

LIMITING VALUES (Absolute max. values)

Inverse voltage [1]			BYX13-400	600	800	1000	1200
Continuous	$-V_D$	= max.	200	300	400	500	600 V
Crest working	$-V_{DMW}$	= max.	200	300	400	500	600 V
Repetitive peak [2]	$-V_{DM}$	= max	400	600	800	1000	1200 V
Non-repetitive peak (t = 10 msec)	$-V_{D\,surge}$	= max.	400	600	800	1000	1200 V

Forward current

Average	I_D	= max. 20 A [3]
Repetitive peak	I_{DM}	= max. 100 A
Surge peak	$I_{D\,surge}$	See Fig.E
Overcurrent capability for fusing (t < 10 msec)	I_D^2t	= max. 570 A^2sec [4]

1) All diodes are tested individually for $-I_D$ being less than 10 mA at a diode base temperature of 125 °C and at the maximum permissible repetitive peak inverse voltage.
2) Commutation effects.
3) Averaging time = 20 msec. For six-phase circuits or capacitive load this average current is max. 16 A. See also Fig.D.
4) R.M.S. value of I_D

7Z2 2432

LIMITING VALUES (Absolute max. values) (continued)

Temperature

Storage	T_s	-65 to +150 °C
Junction	T_j	= max. 150 °C
Operating ambient	T_{amb}	See Fig. D
Diode base	T_m	See Fig. D

THERMAL DATA

Thermal resistance

from junction to diode base	K_{j-m}	<	1.1 °C/W
from diode base to heatsink	K_{m-h}	=	0.3 °C/W

CHARACTERISTICS

Forward voltage at a diode base temperature of 25 °C

I_D = 1 A	V_D	<	0.9 V
I_D = 100 A	V_D	<	2 V [1]

Reverse current at a diode base temperature of 125 °C

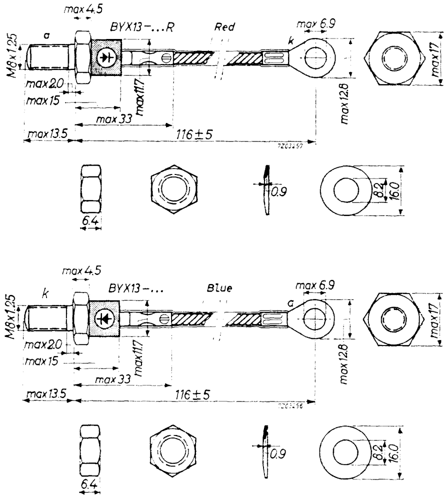
BYX13-400 :	$-V_D$ = 200 V	$-I_D$	<	2 mA
BYX13-600 :	$-V_D$ = 300 V	$-I_D$	<	2 mA
BYX13-800 :	$-V_D$ = 400 V	$-I_D$	<	2 mA
BYX13-1000:	$-V_D$ = 500 V	$-I_D$	<	1.7 mA
BYX13-1200:	$-V_D$ = 600 V	$-I_D$	<	1.4 mA

1) Measured with current pulses to prevent excessive dissipation.

7Z2 2433

MECHANICAL DATA

Dimensions in mm



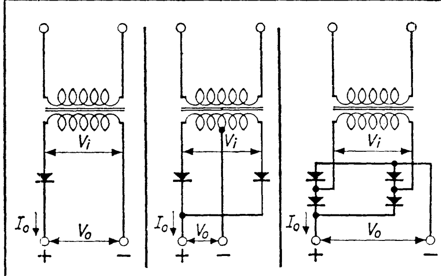
Nut: M8 x 1.25

Metal spring washer

Cross-section of flexible conducting lead	=	4 mm^2
Hole in heatsink	=	max. 8.5 mm diameter
Mounting torque		min. 30 cm kg for good heat conductance max. 60 cm kg
Net weight	=	25 g
	=	35 g with mounting accessories

7Z2 3117

OPERATING CHARACTERISTICS as rectifier

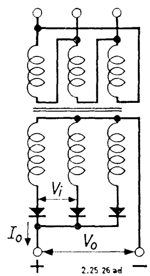
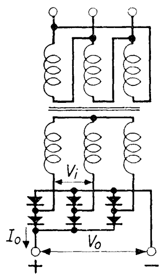


	V_i (V_{RMS})	Single-phase half-wave I_o (A)	Single-phase half-wave V_o (V)	Two-phase half-wave I_o (A)	Two-phase half-wave V_o (V)	Single-phase full-wave (bridge) I_o (A)	Single-phase full-wave (bridge) V_o (V)
BYX13-400	140	20	60	40	60	40	125
-600	210	20	90	40	90	40	185
-800	280	20	125	40	125	40	250
-1000	350	20	155	40	155	40	310
-1200	420	20	185	40	185	40	375

The V_i and I_o figures are absolute max. values for resistive or inductive load. No source impedance is assumed. The equipment designer has to determine an average design such that these values will not be exceeded.

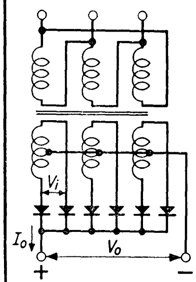
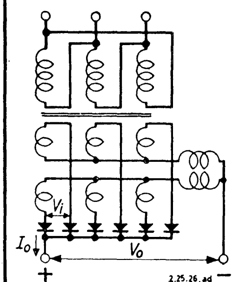
7Z2 2435

OPERATING CHARACTERISTICS as rectifier (continued)

		Three-phase star		Three-phase full-wave (bridge)	
					
	V_i (V_{RMS})	I_o (A)	V_o (V)	I_o (A)	V_o (V)
BYX13-400	140	60	95	60	185
-600	210	60	135	60	280
-800	280	60	190	60	375
-1000	350	60	235	60	470
-1200	420	60	280	60	565

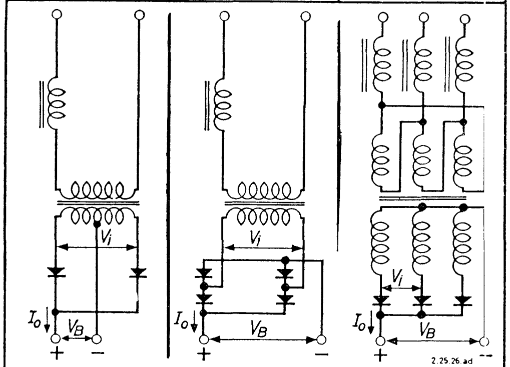
7Z2 2436

OPERATING CHARACTERISTICS as rectifier (continued)

		Six-phase star		Three-phase double-Y with interphase transformer	
					
	V_i (V_{RMS})	I_o (A)	V_o (V)	I_o (A)	V_o (V)
BYX13-400	140	96	95	120	80
-600	210	96	135	120	120
-800	280	96	190	120	160
-1000	350	96	235	120	200
-1200	420	96	280	120	240

7Z2 2437

OPERATING CHARACTERISTICS for battery charging



BYX13:	V_i (V_{RMS})	Two-phase half-wave I_o (A)	V_B (V)	n	Single-phase full-wave (bridge) I_o (A)	V_B (V)	n	Three-phase star I_o (A)	V_B (V)	n
−400	125	20	60	27	20	120	54	30	70	32
−600	190	20	90	41	20	180	82	30	105	47
−800	255	20	120	54	20	240	108	30	135	60
−1000	315	20	150	68	20	300	136	30	170	77
−1200	380	20	180	81	20	360	162	30	205	93

n = maximum number of Pb cells in series (nominal voltage per cell = 2.2 V).

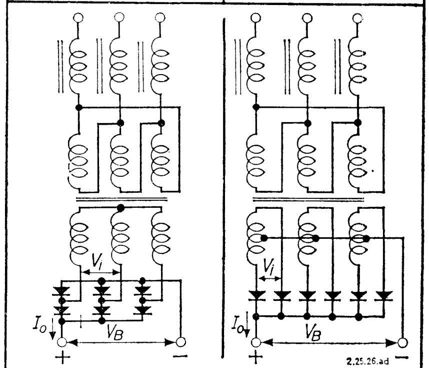
All values are nominal for battery load.

The possibility of mains voltage fluctuations of max. 10% has been taken into account.

For current limiting use is made of inductors in series with the primary of the mains transformer.

7Z2 2438

OPERATING CHARACTERISTICS for battery charging (continued)



	V_i (V_{RMS})	Three-phase full-wave (bridge) I_o (A)	V_B (V)	n	Six-phase star I_o (A)	V_B (V)	n
BYX13−400	125	30	120	54	60	60	27
−600	190	30	180	82	60	90	41
−800	255	30	240	108	60	120	54
−1000	315	30	300	136	60	150	68
−1200	380	30	360	162	60	180	81

7Z2 2439

OPERATING NOTES

1. If there is a possibility that transient inverse voltages will exceed the max. permissible value of $-V_{Dsurge}$, a damping circuit should be placed across the transformer or across the diode. A series R.C. circuit or a voltage dependent resistor may be used. The values of the R.C. components may be calculated as follows:

a. If connected to the primary of the transformer:	b. If connected to the secondary of the transformer:
$C \approx 200 \frac{I_{Po}}{V} \mu F$; $R \approx \frac{150}{C} \Omega$	$C \approx 450 \frac{I_{Po}.V}{(-V_{DM})^2} \mu F$; $R \approx \frac{200}{C} \Omega$

In which: V = transformer primary R.M.S. voltage (V)
$-V_{DM}$ = crest working inverse voltage (V)
I_{Po} = magnetizing primary R.M.S. current (A)

2. In order to prevent the diode from being damaged by surge currents higher than given in Fig.D, the use of a fast fuse is recommended.

EXAMPLE OF HEATSINK CALCULATION

In a three-phase full-wave circuit the total output current is 42 A (current per diode is 14 A), the ambient temperature is 88 °C and the contact thermal resistance (K_{m-h}) is 0.3 °C/W.

Fig.E shows that the power dissipation is 22 W, that the max. permissible temperature of the diode base is 125.5 °C, and that the heatsink should have a thermal resistance (K_{h-amb}) of maximum 1.4 °C/W. This can be obtained with:

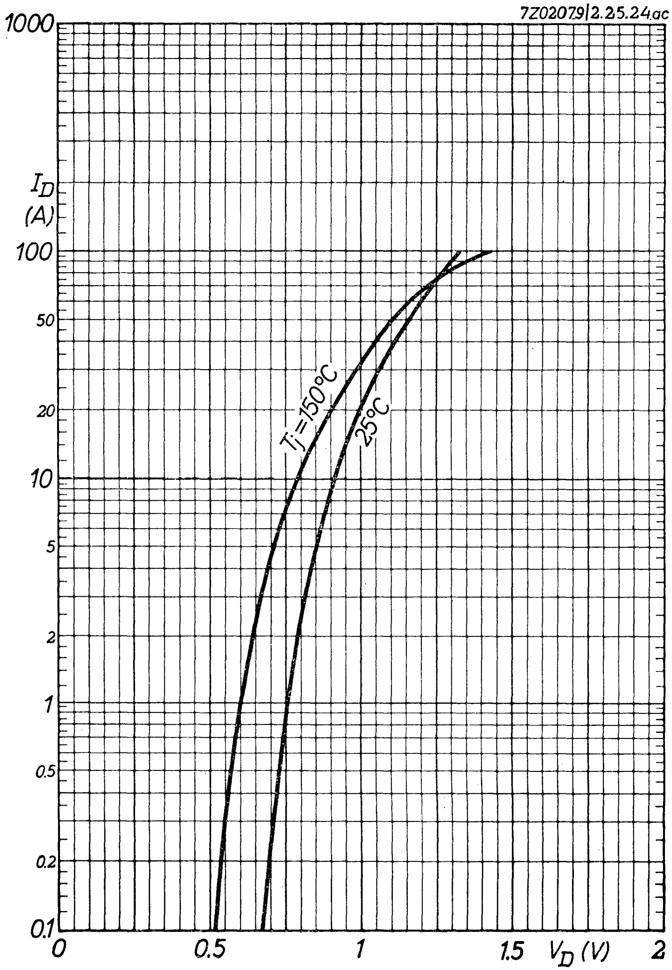
A. a die-cast heatsink

For this application the types of die-cast heatsink 56221 or 56236 are available (type 56236 = type 56221 + insulated mounting support). Fig.G shows that for either type the required air speed is approx. 1 m/sec; for type 56228 and type 56238 approx. 3 m/sec.

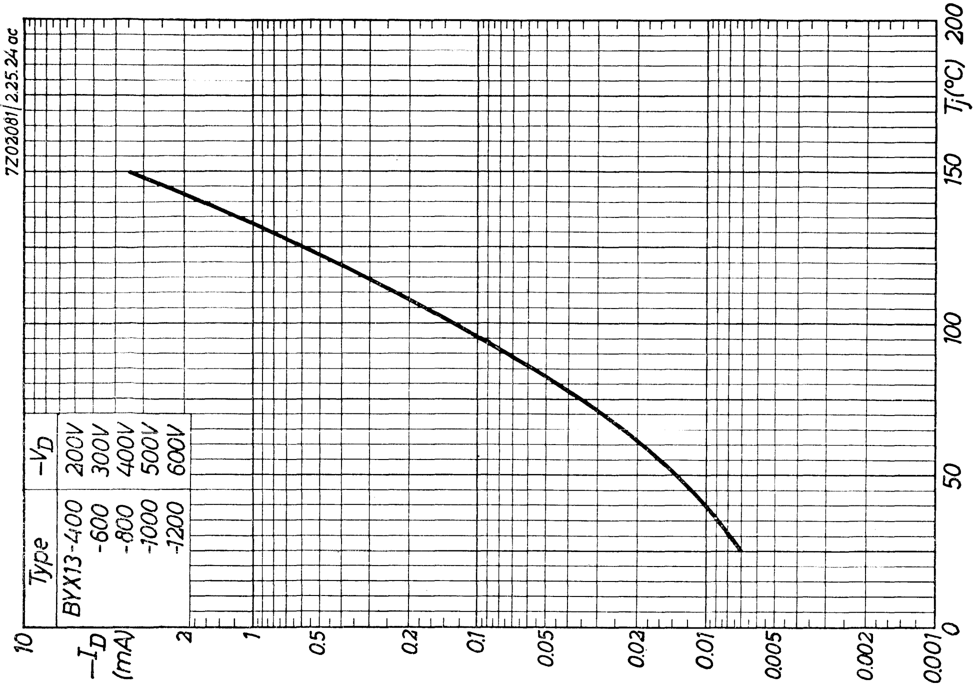
B. a flat cooling fin

Fig.F shows that the minimum required heatsink area is 83 cm^2 (e.g. 9.1 cm x 9.1 cm) at an air speed of 5 m/sec.

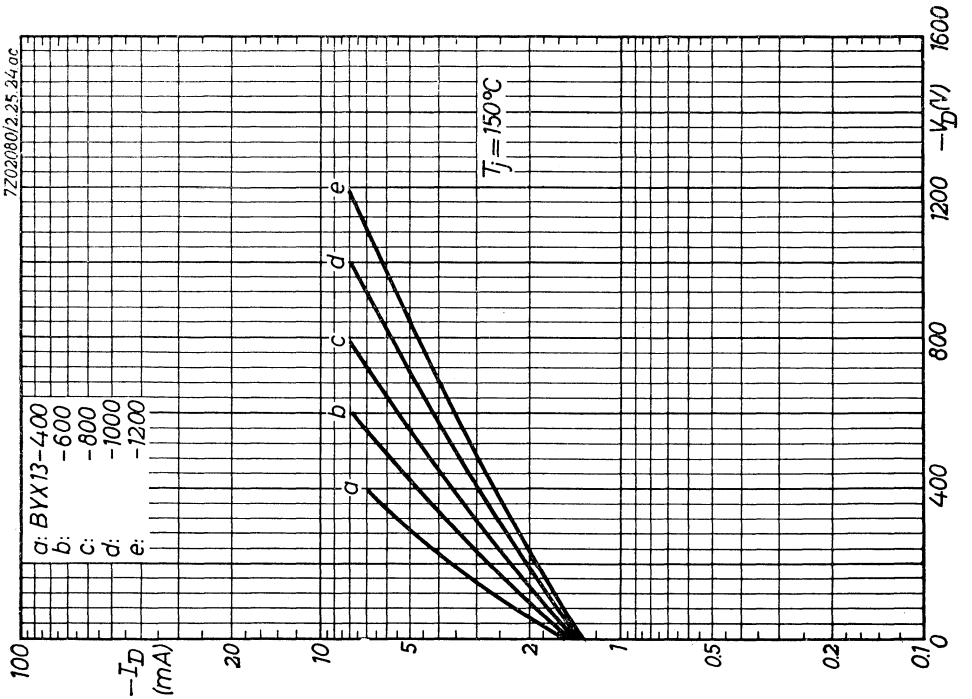
7Z2 3297



A

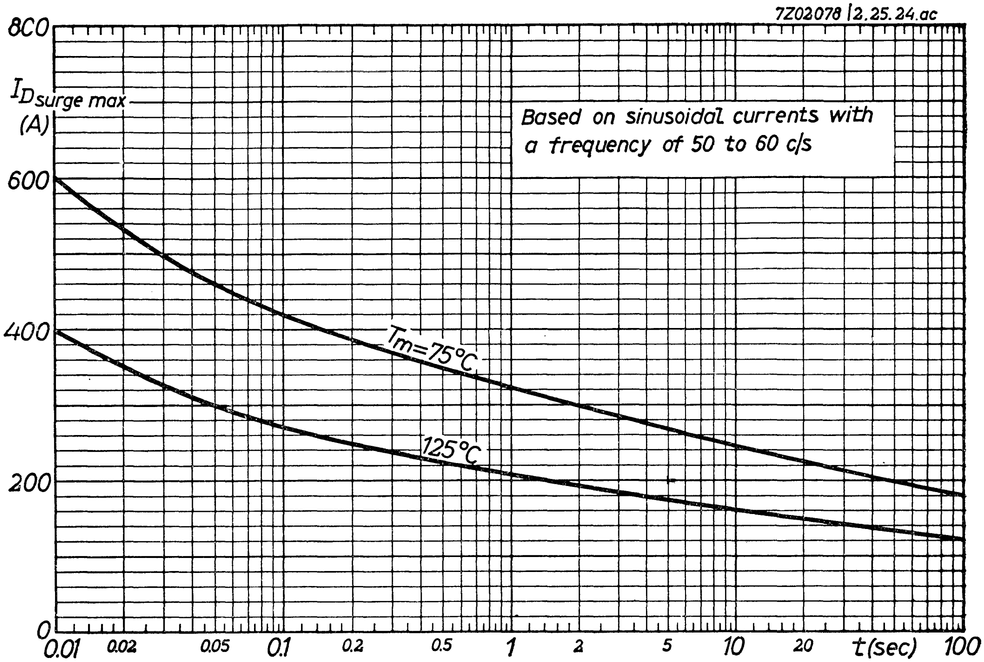

7Z02081/2.25.24ac
Type
$-V_D$
BYX13-400 200V
-600 300V
-800 400V
-1000 500V
-1200 600V
$-I_D$ (mA)
10
2
1
0.5
0.2
0.1
0.05
0.02
0.01
0.005
0.002
0.001
0
50
100
150
200
T_j(°C)

C

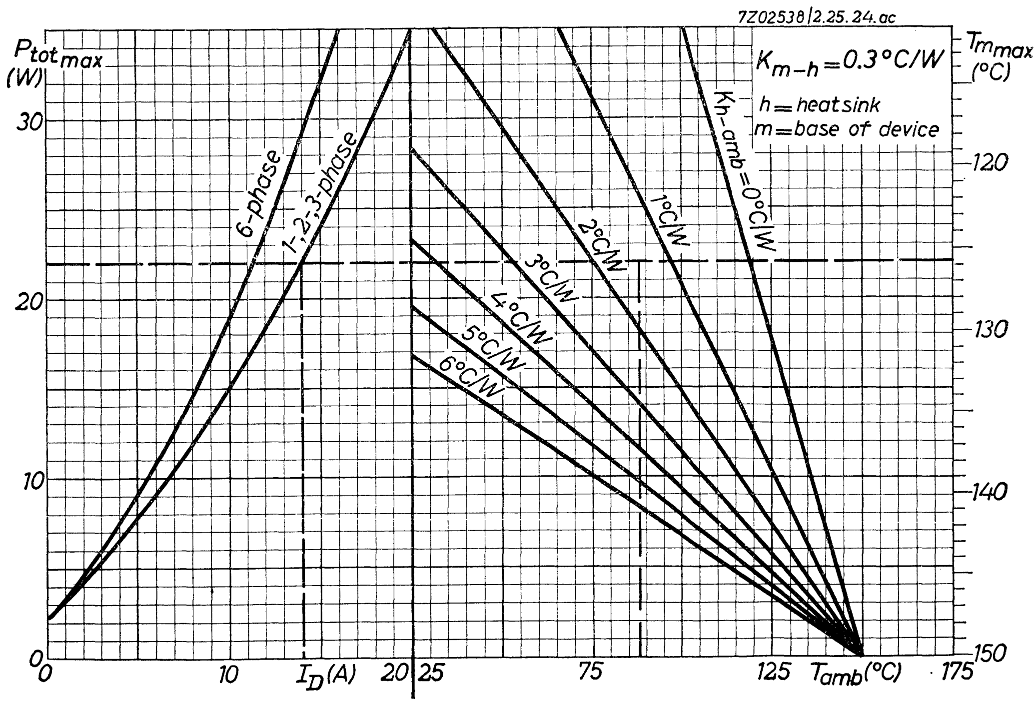

7Z02080/2.25.24ac
a: BYX13-400
b: -600
c: -800
d: -1000
e: -1200
a
b
c
d
e
$T_j = 150°C$
$-I_D$ (mA)
100
20
10
5
2
1
0.5
0.2
0.1
0
400
800
1200
1600
$-V_D$(V)

B

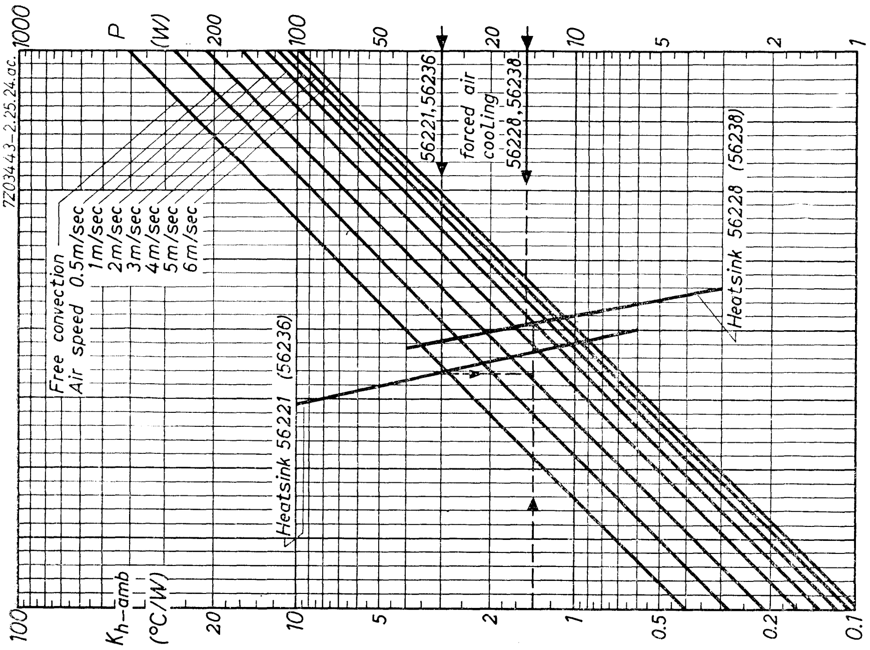
5.5.1964


7Z02078 | 2.25.24.ac
$I_{D surge\ max}$ (A)
800
600
400
200
0
Based on sinusoidal currents with a frequency of 50 to 60 c/s
Tm=75°C
125°C
0.01
0.02
0.05
0.1
0.2
0.5
1
2
5
10
20
t(sec)
100

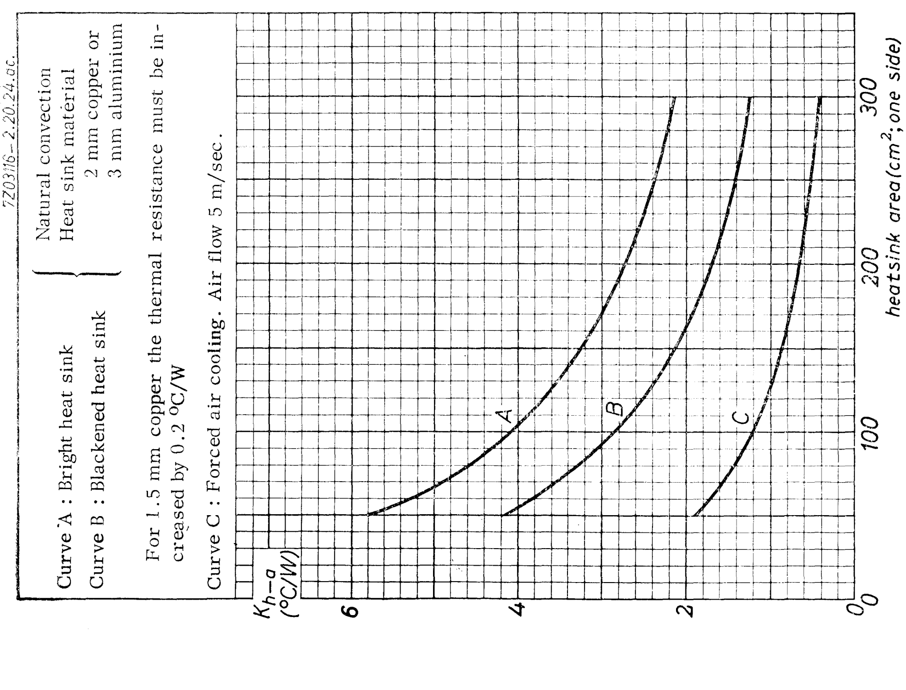
D


7Z02538 | 2.25.24.ac
$P_{tot\ max}$ (W)
30
20
10
0
K_{m-h}=0.3°C/W
h=heatsink
m=base of device
$T_{m\ max}$ (°C)
120
130
140
150
6-phase
1-,2-,3-phase
K_{h-amb}=0°C/W
1°C/W
2°C/W
3°C/W
4°C/W
5°C/W
6°C/W
0
10
I_D(A)
20
25
75
125
T_{amb}(°C)
175

E


7Z03443-2.25.24.ac.
P (W)
1000
200
100
50
20
10
5
2
1
Free convection
Air speed 0.5m/sec
1m/sec
2m/sec
3m/sec
4m/sec
5m/sec
6m/sec
56221,56236
forced air cooling
56228,56238
Heatsink 56228 (56238)
Heatsink 56221 (56236)
K h-amb (°C/W)
100
20
10
5
2
1
0.5
0.2
0.1

G


7Z03116-2.20.24.ac.
Curve A : Bright heat sink
Curve B : Blackened heat sink
Natural convection
Heat sink material
2 mm copper or
3 nm aluminium
For 1.5 mm copper the thermal resistance must be increased by 0.2 °C/W
Curve C : Forced air cooling. Air flow 5 m/sec.
K h-a (°C/W)
6
4
2
0
A
B
C
0
100
200
300
heatsink area (cm²; one side)

F

SILICON POWER DIODES

Double diffused silicon junction diodes for power rectifier applications. The series consists of the ten types BYX14-400, BYX14-400R, (in the same way) -600, -600R, -800, -800R, -1000, -1000R, -1200 and -1200R. The letter R means reverse polarity (anode connected to base) without change of any other data.

QUICK REFERENCE DATA

Inverse voltage		BYX14-400	600	800	1000	1200	
Crest working	$-V_{DMW}$	max. 200	300	400	500	600	V
Repetitive peak	$-V_{DM}$	max. 400	600	800	1000	1200	V

Forward current

Average	I_D	max.	150 A [3]
Repetitive peak	I_{DM}	max.	750 A
Junction temperature	T_j	max.	190 °C
Thermal resistance			
From junction to base	K_{j-m}	max.	0.28 °C/W

LIMITING VALUES (Absolute max. values)

Inverse voltage [1]		BYX14-400	600	800	1000	1200	
Continuous	$-V_D$	max. 200	300	400	500	600	V
Crest working	$-V_{DMW}$	max. 200	300	400	500	600	V
Repetitive peak [2]	$-V_{DM}$	max. 400	600	800	1000	1200	V
Non-repetitive peak (t = 10 msec)	$-V_{Dsurge}$	max. 400	600	800	1000	1200	V

1)2)3) See page 2.

7Z2 2487

LIMITING VALUES (Absolute values) (continued)

Forward current

Average	I_D	max.	150 A [3]
Repetitive peak	I_{DM}	max.	750 A
Surge peak	I_{Dsurge}	See Fig. E.	
Overcurrent capability for fusing (t<10 msec)	I_D^2t	max.	32000 A^2s [4]

Temperature

Storage	T_s	min.	-65 °C
		max.	190 °C
Junction	T_j	max.	190 °C
Diode base	T_m	See Fig. D.	

THERMAL DATA

Thermal resistance

between junction and diode base	K_{j-m}	<	0.28 °C/W
between diode base and heatsink	K_{m-h}	=	0.07 °C/W

1) All diodes are tested individually for $-I_D < 25$ mA at a diode base temperature of 175 °C and at the maximum permissible repetitive peak inverse voltage.

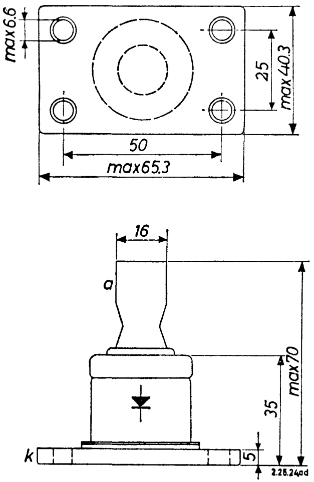
2) Commutation effects.

3) Averaged over any 20 msec period.
If the applied crest working voltage does not exceed 200 V, the average forward current I_D = max. 200 A.
For six-phase circuits or capacitive load the average forward current I_D = max. 120 A when $-V_{DMW} > 200$ V and I_D = max. 160 A when $-V_{DMW} \leq 200$ V

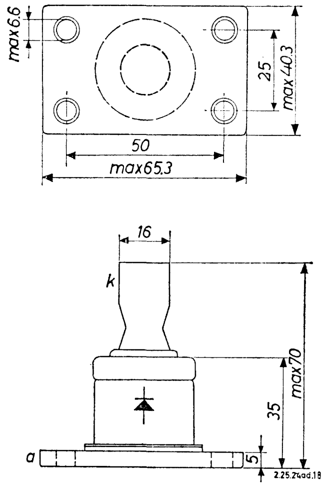
4) R.M.S. value of I_D.

7Z2 3045

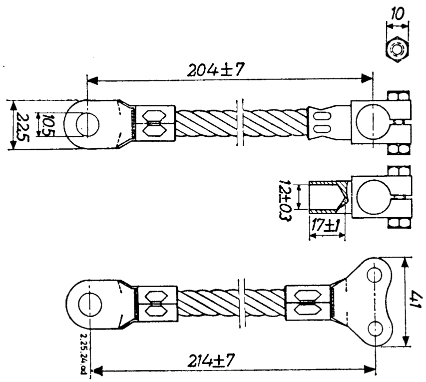
MECHANICAL DATA (Dimensions in mm)



BYX14-400 to -1200



BYX14-400R to -1200R



Top lead 56243

Clamp 56244

Base lead 56247

Cross-section of flexible conducting leads: 50 mm²

5.5.1964

7Z2 2379

MECHANICAL DATA (continued)

Mounting the top lead

For connecting the clamp to the top of the diode the use of two spanners is recommended to avoid the risk of destructing the glass insulating part of the diode.
Torque on nut: min. 30 cm kg for good electrical contact
max. 60 cm kg

Mounting the base of the diode to a heatsink

Torque on nuts (M6 bolts):

min. 30 cm kg for good thermal and electrical contact.
max. 60 cm kg

For heatsink types see operating note No.3 on page 10.

Weight

Diode	BYX14:	230 g
Top lead	56243:	170 g
Clamp	56244:	69 g
Base lead	56247:	128 g

CHARACTERISTICS at a diode base temperature of 175 °C

Forward voltage

$I_D = 750$ A $V_D < 1.8$ V [1])

Reverse current

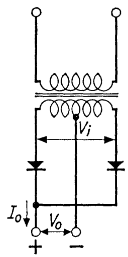
BYX14-400 ; $-V_D = 200$ V	}	$-I_D < 15$ mA
BYX14-600 ; $-V_D = 300$ V		
BYX14-800 ; $-V_D = 400$ V		
BYX14-1000; $-V_D = 500$ V		
BYX14-1200; $-V_D = 600$ V		

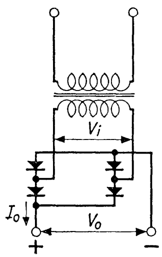
[1]) Measured with current pulses to prevent excessive dissipation

7Z2 2380

OPERATING CHARACTERISTICS as rectifier

		Two-phase half-wave		Single-phase full-wave (bridge)	
	V_i (VRMS)	I_o (A)	V_o (V)	I_o (A)	V_o (V)
BYX14-400	140	300	60	300	125
-600	210	300	90	300	185
-800	280	300	125	300	250
-1000	350	300	155	300	310
-1200	420	300	185	300	375



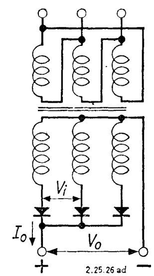


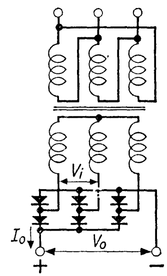
The V_i and I_o figures are absolute max. values for resistive or inductive load. No source impedance is assumed. The equipment designer has to determine an average design such that these values will not be exceeded. See, however, note 3) page 2.

7Z2 2489

OPERATING CHARACTERISTICS as rectifier (continued)

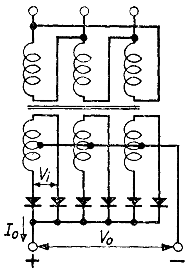
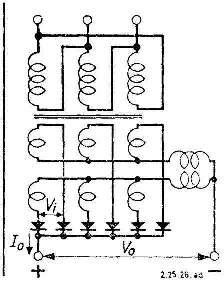
		Three-phase star		Three-phase full-wave (bridge)	
	V_i (VRMS)	I_o (A)	V_o (V)	I_o (A)	V_o (V)
BYX14-400	140	450	95	450	185
-600	210	450	135	450	280
-800	280	450	190	450	375
-1000	350	450	235	450	470
-1200	420	450	280	450	565





7Z2 2382

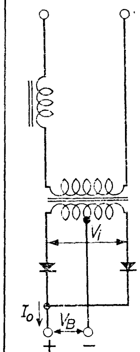
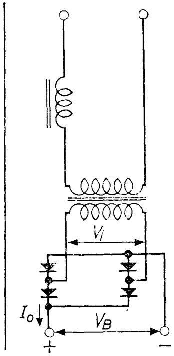
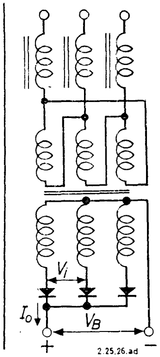
OPERATING CHARACTERISTICS as rectifier (continued)

	Six-phase star		Three-phase double-Y with interphase transformer	
				

	V_i (V_{RMS})	I_o (A)	V_o (V)	I_o (A)	V_o (V)
BYX14-400	140	720	95	900	80
-600	210	720	135	900	120
-800	280	720	190	900	160
-1000	350	720	235	900	200
-1200	420	720	280	900	240

7Z2 2383

OPERATING CHARACTERISTICS for battery charging

		Two-phase half-wave			Single-phase full-wave (bridge)			Three-phase star		
										
BYX14:	V_i (V_{RMS})	I_o (A)	V_B (V)	n	I_o (A)	V_B (V)	n	I_o (A)	V_B (V)	n
-400	125	150	60	27	150	120	54	225	70	32
-600	190	150	90	41	150	180	82	225	105	47
-800	255	150	120	54	150	240	108	225	135	60
-1000	315	150	150	68	150	300	136	225	170	77
-1200	380	150	180	81	150	360	162	225	205	93

n = maximum number of Pb cells in series (nominal voltage per cell = 2.2 V)

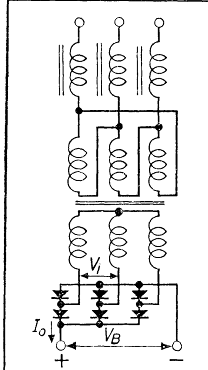
All values are nominal for battery load

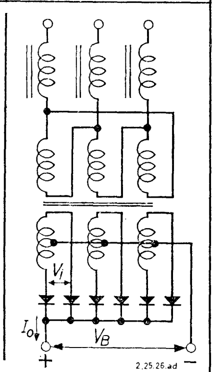
The possibility of mains voltage fluctuations of max. 10% has been taken into account.

For current limiting use is made of inductors in series with the primary of the mains transformer.

7Z2 2384

OPERATING CHARACTERISTICS for battery charging
(continued)





	V_i (V_{RMS})	Three-phase full-wave (bridge)			Six-phase star		
		I_o (A)	V_B (V)	n	I_o (A)	V_B (V)	n
BYX14-400	125	225	120	54	450	60	27
-600	190	225	180	82	450	90	41
-800	255	225	240	108	450	120	54
-1000	315	225	300	136	450	150	68
-1200	380	225	360	162	450	180	81

7Z2 2385

OPERATING NOTES

1. If there is a possibility that transient inverse voltages will exceed the max. permissible value of $-V_{D\,surge}$, a damping circuit should be placed across the transformer or across the diode. A series R.C. circuit or a voltage dependent resistor may be used. The values of the R.C. components may be calculated as follows:

   a. If connected to the primary of the transformer:

   $$C \approx 200 \frac{I_{p_o}}{V} \mu F; \quad R \approx \frac{150}{C} \Omega$$

   b. If connected to the secondary of the transformer:

   $$C \approx 450 \frac{I_{p_o} \cdot V}{(-V_{DM})^2} \mu F; \quad R \approx \frac{200}{C} \Omega$$

   In which: V = transformer primary R.M.S. voltage (V)
   $-V_{DM}$ = crest working inverse voltage (V)
   I_{p_o} = magnetizing primary R.M.S. current (A)

2. In order to prevent the diode from being damaged by surge currents higher than given in Fig. E, the use of a fast fuse is recommended.

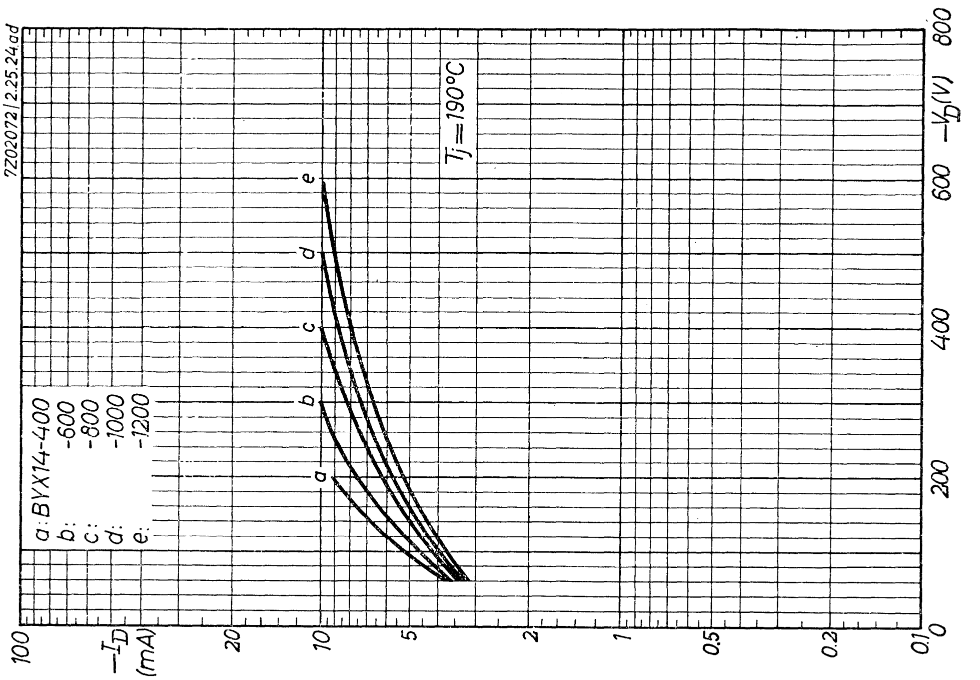
3. For the heatsinks profiled extruded aluminium rods, types 56259 and 56260, are available.

EXAMPLE OF HEATSINK CALCULATION

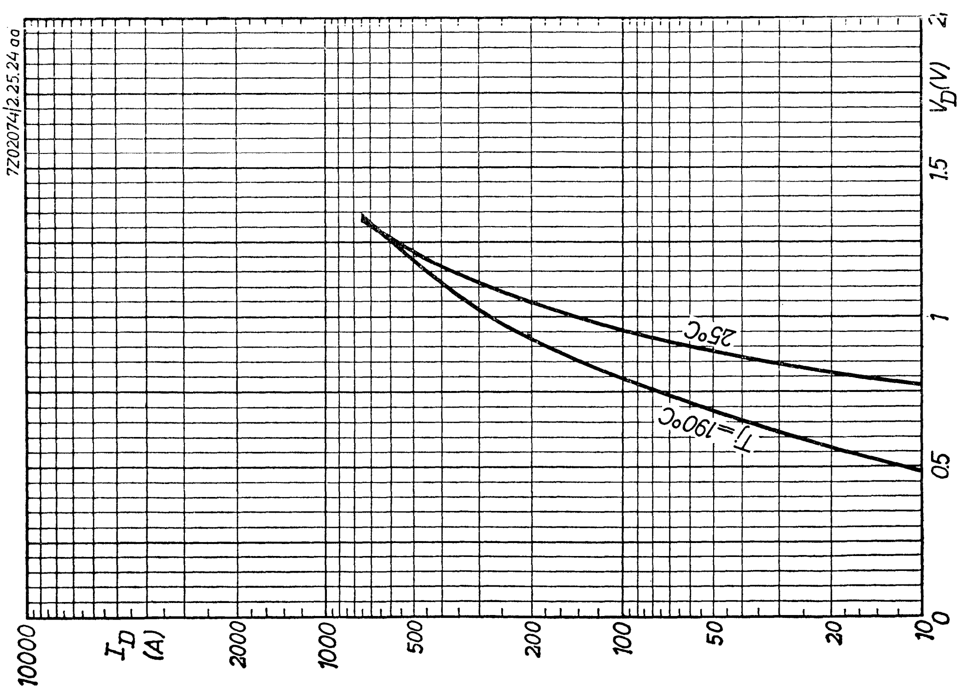
In a three-phase full-wave circuit the total output current is 300 A (current per diode is 100 A), the ambient temperature is 75 °C and the contact thermal resistance ($K_{m\text{-}h}$) is 0.07 °C/W.

Fig.D shows that the power dissipation is 145 W, that the max. permissible temperature of the diode base is 149.5 °C, and that the heatsink should have a thermal resistance ($K_{h\text{-}amb}$) of maximum 0.44 °C/W

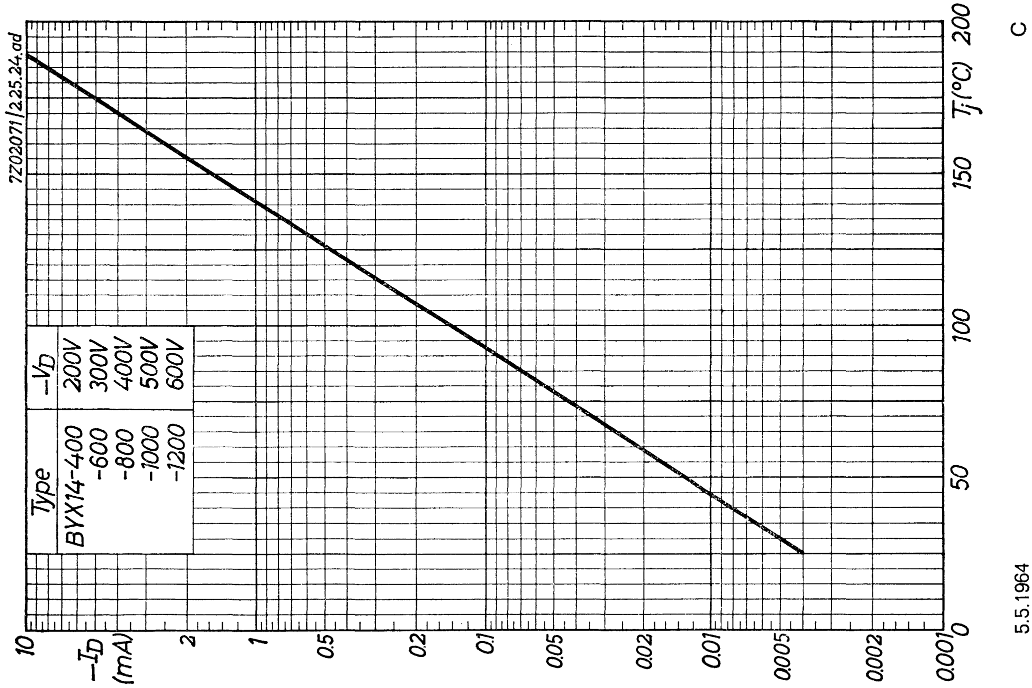
7Z2 3046

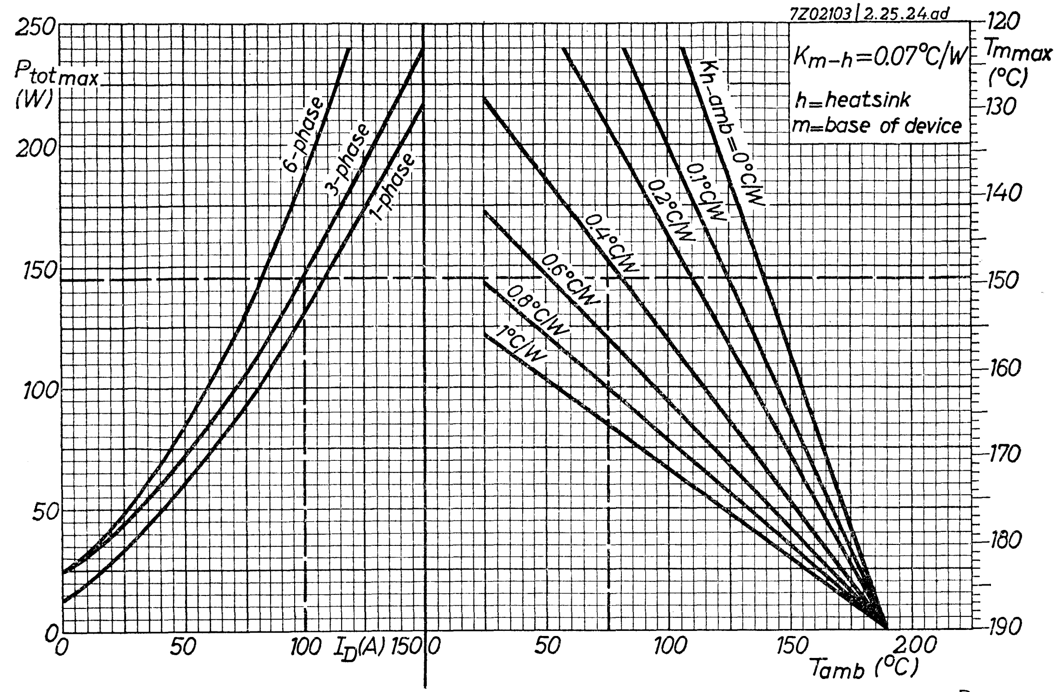

7202072/2.25.24ad
Tj=190°C
a: BYX14-400
b: -600
c: -800
d: -1000
e: -1200
a
b
c
d
e
−I_D (mA)
100
20
10
5
2
1
0.5
0.2
0.1
0
200
400
600
800
−V_D (V)

B

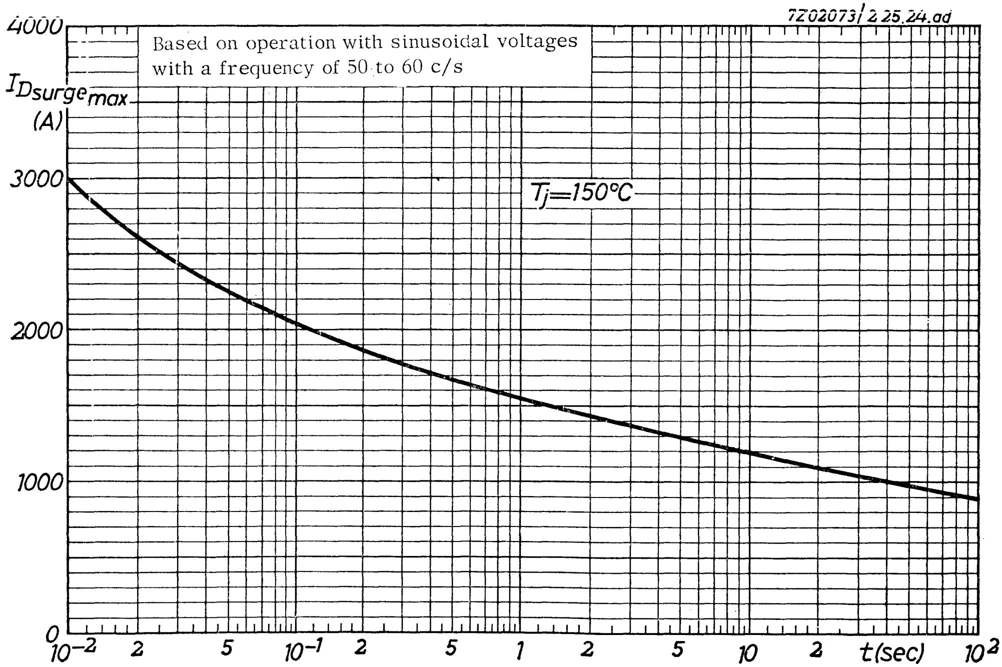

7202074/2.25.24aa
I_D (A)
10000
2000
1000
500
200
100
50
20
10
0
0.5
1
1.5
2
V_D (V)
Tj=190°C
25°C

A


7Z02071/2.25.24.ad
Type
BYX14-400
-600
-800
-1000
-1200
$-V_D$
200V
300V
400V
500V
600V
$-I_D$ (mA)
10
2
1
0.5
0.2
0.1
0.05
0.02
0.01
0.005
0.002
0.001
0
50
100
150
200
T_j (°C)


7Z02103 | 2.25.24.ad
K_{m-h}=0.07°C/W
h=heatsink
m=base of device
$P_{tot max}$ (W)
6-phase
3-phase
1-phase
Kh-amb=0°C/W
0.1°C/W
0.2°C/W
0.4°C/W
0.6°C/W
0.8°C/W
1°C/W
I_D(A)
Tamb (°C)
T_{mmax} (°C)
0
50
100
150
200
250
120
130
140
150
160
170
180
190

D


7Z02073 / 2.25.24.ad
Based on operation with sinusoidal voltages
with a frequency of 50 to 60 c/s
$I_{Dsurge max}$ (A)
T_j=150°C
t(sec)
0
1000
2000
3000
4000

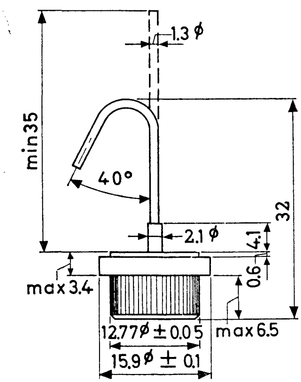
SILICON POWER DIODES

Silicon diffused junction diodes in metal case for use in power rectifiers, especially in a.c. generating systems of motor cars with battery voltages of up to 24 V. The diodes can be press-mounted or soldered at the bottom or mounted with an adaptor.
The BYX20-200R (anode to case) is the reverse polarity type of the BYX20-200 (cathode to case).

QUICK REFERENCE DATA					
Crest working inverse voltage	$-V_{DM}$	=	max.	85	V
Repetitive peak inverse voltage	$-V_{DM}$	=	max.	200	V
Average forward current	I_D	=	max.	25	A
Repetitive peak forward current	I_{DM}	=	max.	80	A
Junction temperature	T_j	=	max.	175	°C
Thermal resistance from junction to case	K_{j-c}	<		1	°C/W

MECHANICAL DATA

Dimensions in mm



Marked in red : Cathode connected to case BYX20-200

Marked in blue: Anode connected to case BYX20-200R

For mounting instructions see page 3

Not delivered with the device:
Mounting adapter 56232

7Z2 2792

LIMITING VALUES (Absolute max. values)

Voltages

Continuous inverse voltage	$-V_D$	=	max.	75	V
Crest working inverse voltage	$-V_{DM}$	=	max.	85	V
Repetitive peak inverse voltage (e.g. commutation effects)	$-V_{DM}$	=	max.	200	V
Non-repetitive peak inverse voltage (t = max. 10 ms)	$-V_{DMsurge}$	=	max.	200	V

Currents

Average forward current (averaged over any 20 ms period)	I_D	=	max.	25	A
Repetitive peak forward current	I_{DM}	=	max.	80	A
Peak forward surge current (t < 10 ms)	$I_{DMsurge}$	=	max.	300	A

Temperatures

Storage temperature	T_s	=	-65 °C to $+150$	°C
Junction temperature	T_j	=	175	°C

THERMAL DATA

Thermal resistance from junction to case	K_{j-c}	<	1	°C/W
Thermal resistance from case to heatsink				
press-mounted	K_{c-h}	<	0.5	°C/W
mounted with adaptor 56232	K_{c-h}	<	1	°C/W

CHARACTERISTICS $T_j = 25$ °C unless otherwise specified

Forward voltage drop				
at $I_D = 25$ A	V_D	<	1.2	V
at $I_D = 80$ A	V_D	<	1.4	V
Reverse current at $T_j = 125$ °C				
$-V_D = 75$ V	$-I_D$	<	1.1	mA

7Z2 2793

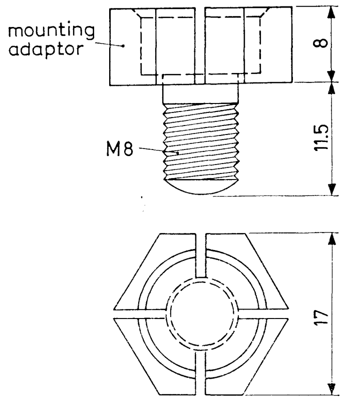
ACCESSORIES AND MOUNTING INSTRUCTIONS

Dimensions in mm

Mounting adaptor 56232

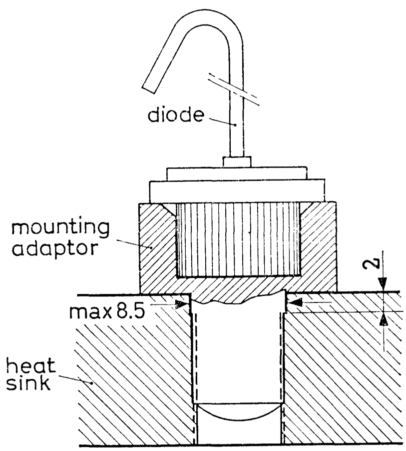
Type 56232 consists of a body, a spring washer and a nut.

Thermal resistance from case to heatsink: $K_{c-h} = 1\ ^{o}C/W$



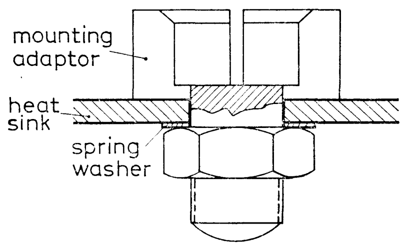
Mounting method 1

Torque on nut	= min.	50	cm kg
	= max.	100	cm kg



Mounting method 2

Diameter of hole in heatsink	= max.	8.5	mm
Torque on nut	= max.	50	cm kg



ACCESSORIES AND MOUNTING INSTRUCTIONS (continued)

Bottom-mounting

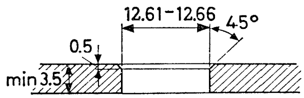
Soldering temperature	T	= max. 235	°C
Soldering time	t	= max. 30	s

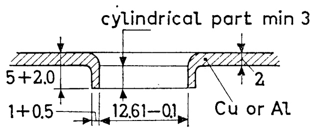
Press-mounting

Diameter of hole in heatsink: from 12.61 to 12.66 mm [1])

Force to seat the diode : max. 400 kg

Examples:

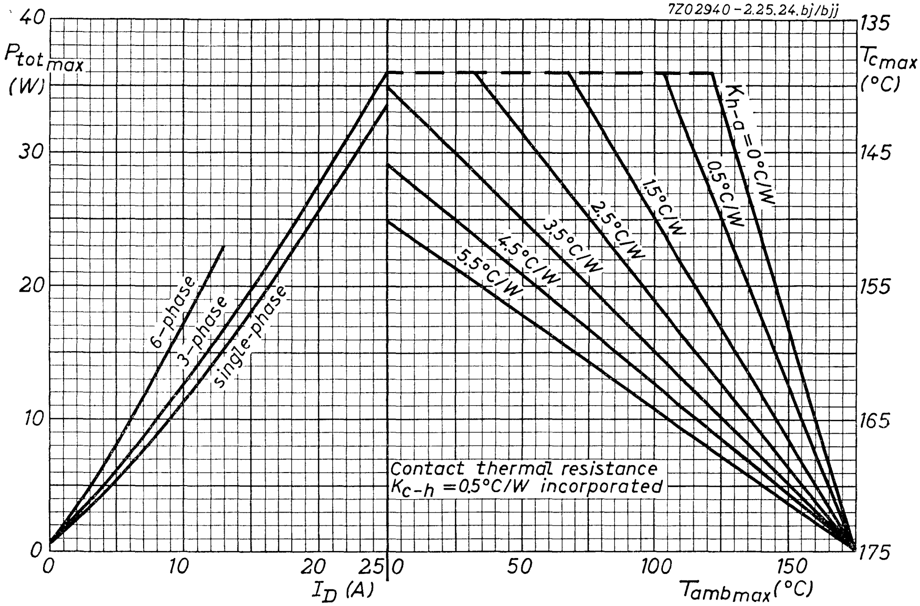




[1]) Diameter required depends on hardness of heatsink material.

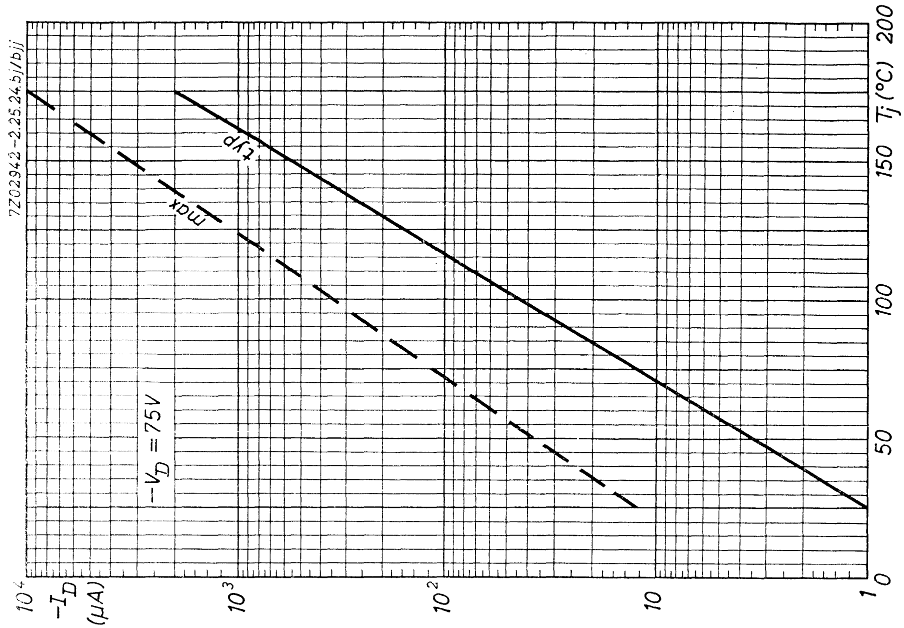
7Z2 2795

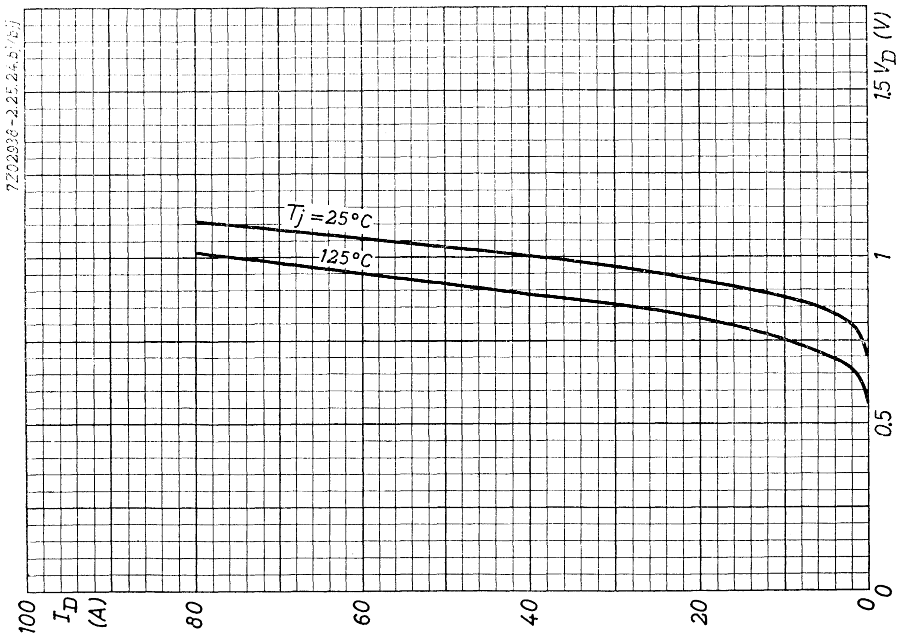
1.1.1965

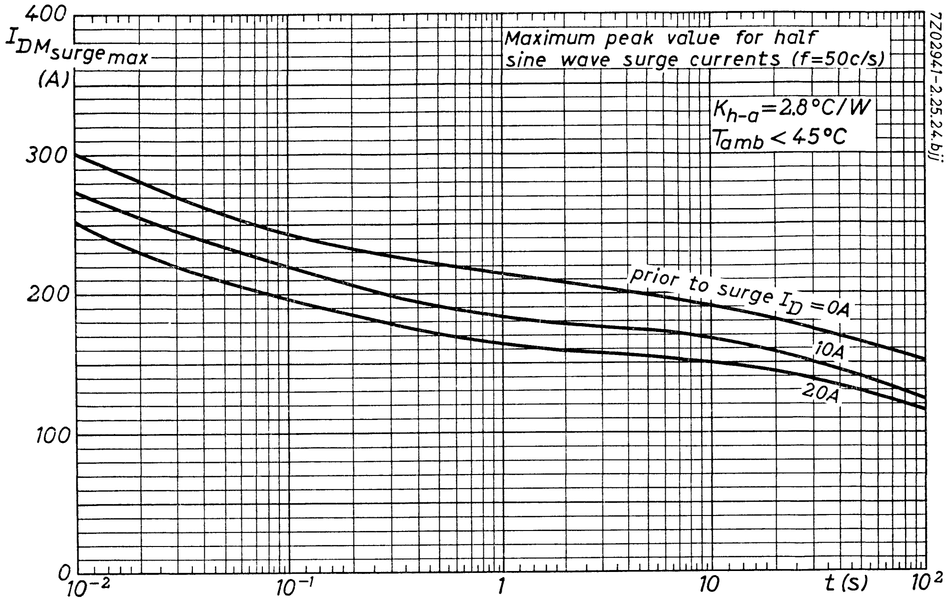


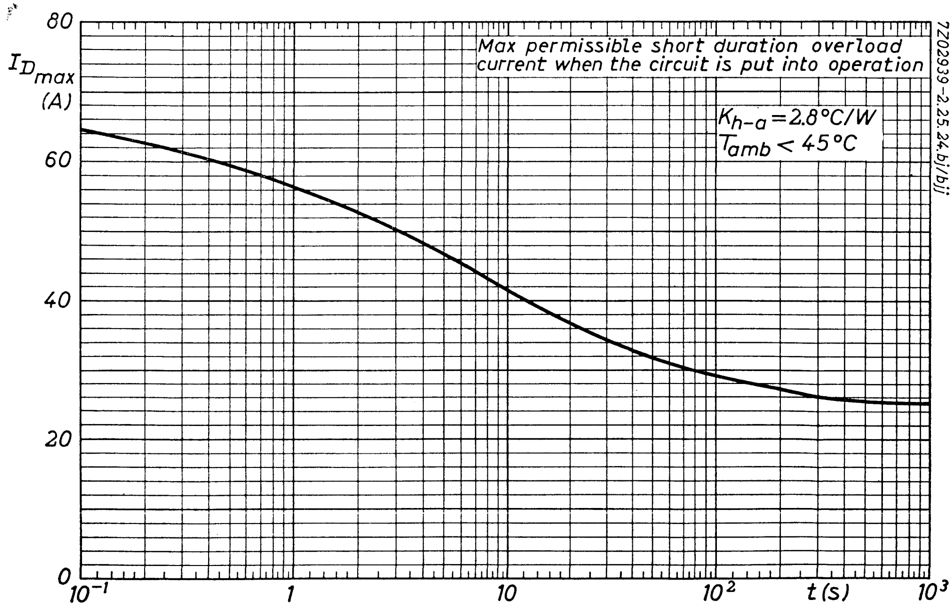
The method of using the curves is as follows:
Starting with the curve of maximum dissipation as a function of average forward current, for a particular current value trace upwards to meet the appropriate curve. Then trace horizontally until the appropriate K-curve is reached (in the case of a given heatsink). Then trace downwards to determine the maximum permissible ambient temperature.
Alternatively, when the maximum ambient temperature is known and the heatsing required is to be determined, trace horizontally until the vertical through the given ambient temperature is reached. The K-value corresponding to the intersection is the maximum thermal resistance from heatsink to ambience.

7Z2 2796


typ
max
−V_D = 75V
T_j (°C)
200
150
100
50
0
10^4
−I_D
(μA)
10^3
10^2
10
1


T_j = 25°C
125°C
1.5 V_D (V)
1
0.5
0
100
I_D
(A)
80
60
40
20
0


400
$I_{DM_{surge\,max}}$
(A)
300
200
100
0
Maximum peak value for half sine wave surge currents (f=50c/s)
K_{h-a}=2.8°C/W
T_{amb} < 45°C
prior to surge I_D =0A
10A
20A
10^{-2}
10^{-1}
1
10
t (s)
10^2
7Z02941-2.25.24.bij


80
$I_{D_{max}}$
(A)
60
40
20
0
Max permissible short duration overload current when the circuit is put into operation
K_{h-a}=2.8°C/W
T_{amb} < 45°C
10^{-1}
1
10
10^2
t (s)
10^3
7Z02939-2.25.24.bij/bij

For data and curves of these rectifiers
please refer to BYZ14 series

7Z2 1824

SILICON DIFFUSED JUNCTION DIODES for use as power rectifier, especially for A.C. generating systems in motor cars with battery voltages up to 24 V.
The diodes have a metal case for press-fitted mounting or bottom-soldering.

The BYY21 is the reverse polarity type of the BYY20 (see outline drawing)

LIMITING VALUES (Absolute max. values)

Inverse voltage			
Continuous	$-V_D$	= max.	75 V
Recurrent peak	$-V_{DM}$	= max.	75 V
Transient peak	$-V_{DM}$	= max.	200 V
Surge peak (max. duration 10 msec)	$-V_{Dsurge}$ (t	= max. = max.	200 V 10 msec)
Forward current			
Average (averaging time max. 20 msec)	I_D	= max.	18 A
Recurrent peak	I_{DM}	= max.	60 A
Surge (max. duration 100 msec)	I_{Dsurge} (t	= max. = max.	140 A [1] 100 msec)
Temperatures			
Junction temperature	T_j	= max.	175 °C
Storage temperature	T_s	=	-65°C to +150°C

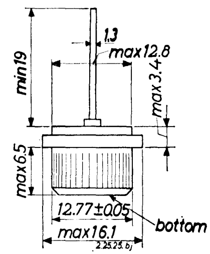
THERMAL DATA

Thermal resistance from junction to case	K_{j-c}	= max.	2 °C/W
Thermal resistance from case to heat sink (if press mounted)	K_{c-h}	= max.	0.5 °C/W
Thermal resistance from case to heat sink (if mounted with adaptor 56232)	K_{c-h}	=	1.0 °C/W

[1]) Square wave pulse

MECHANICAL DATA

Dimensions in mm



Diameter of hole in heat sink 12.61-12.66 mm

Max. force to seat the diode 300 kg

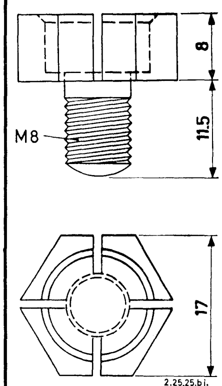
Solder temperature for bottom mounting max.230 ± 5 °C during max. 30 sec

POLARITY

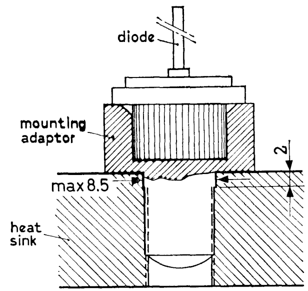
BYY20: anode connected to the envelope; blue mark

BYY21: cathode connected to the envelope; red mark

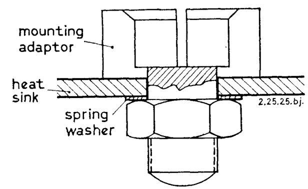
Mounting adaptor 56232



Mounting methods



Minimum torque: 50 cm kg
Maximum torque: 100 cm kg



Hole in heat sink: max. 8.5 mm
Maximum torque: 50 cm kg

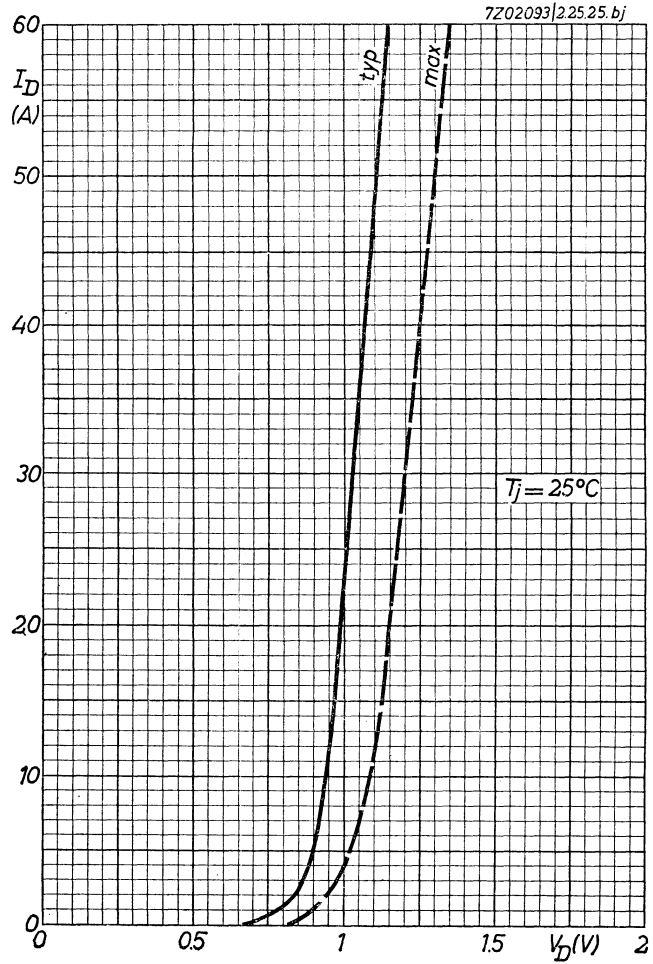
CHARACTERISTICS

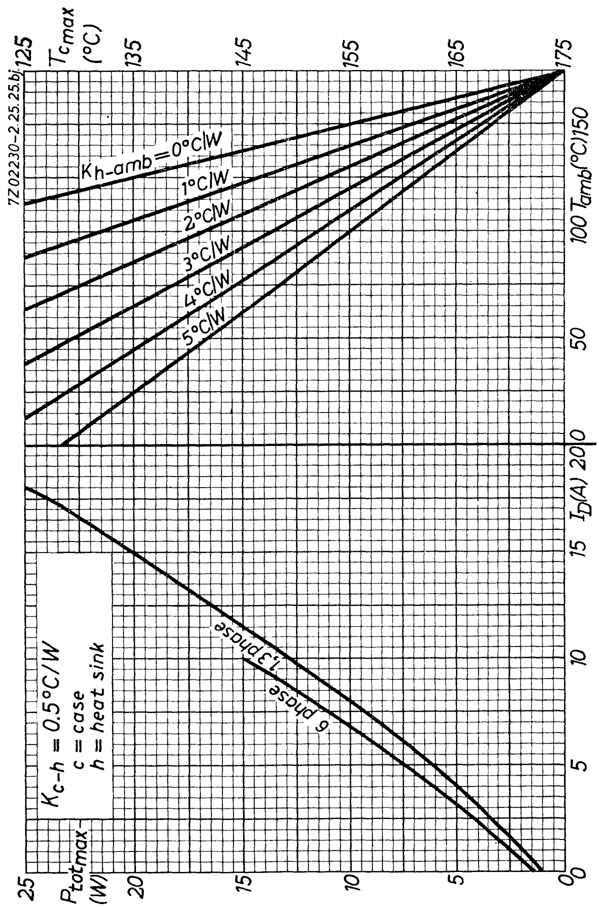
Forward voltage

V_D (I_D = 18 A; T_j = 25 °C)	< 1.15 V
V_D (I_D = 60 A; T_j = 25 °C)	< 1.35 V

Reverse current

$-I_D$ ($-V_D$ = 75 V; T_j = 140 °C)	< 4 mA




7Z02230-2.25.25.bj
T_{cmax} (°C)
125
135
145
155
165
175
K_{h-amb} = 0°C/W
1°C/W
2°C/W
3°C/W
4°C/W
5°C/W
T_{amb} (°C)
0
50
100
150
I_D (A)
0
5
10
15
20
P_{totmax} (W)
0
5
10
15
20
25
K_{c-h} = 0.5°C/W
c = case
h = heat sink
3 phase
6 phase

B

3.3.1965

DOUBLE-DIFFUSED SILICON JUNCTION DIODES for power rectifier applications

BYY23		BYY22
The BYY68	are the reverse polarity types of the	BYY67
BYY25		BYY24

(See outline drawing)

RECOMMENDED RATINGS

If the diodes are used within the recommended ratings, stable operation is ensured.

		BYY22/23	BYY67/68	BYY24/25
Inverse voltage [1]				
Continuous	$-V_D$	200 V	300 V	400 V
Recurrent peak	$-V_{DM}$	200 V	300 V	400 V
Transient peak	$-V_{DM}$	400 V	600 V	800 V
Surge peak (max. duration 10 msec)	$-V_{Dsurge}$	400 V	600 V	800 V
Forward current				
Average (averaging time max. 20 msec)	I_D [2]	10 A	10 A	10 A
Recurrent peak	I_{DM}	50 A	50 A	50 A
Surge peak	I_{Dsurge}	See page E		
Temperatures				
Junction	T_j	150 °C	150 °C	150 °C
Storage	T_s	-65 °C to +150 °C		
Operating ambient	T_{amb}	See page D		
Diode base	T_m	See page D		

THERMAL DATA

Thermal resistance from junction to diode base K = max. 1.1 °C/W [3]

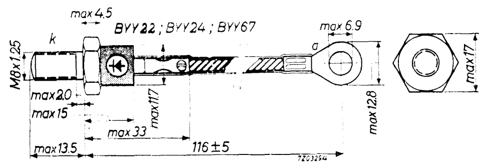
Thermal resistance from diode base to heat sink K = 0.3 °C/W

[1] Each diode is tested individually at $-I_D \leq 10$ mA at a diode base temperature of 125 °C and a peak inverse voltage of 400 V for the BYY22/23; 600 V for the BYY67/68; 800 V for the BYY24/25

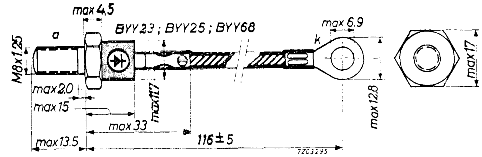
[2] For six-phase circuits or capacitive load the average current is max. 8 A. See also page D.

For battery chargers the average current may be exceeded by 25% when a fully discharged battery is taken under charge.

[3] This value is intended as a calculating figure.



Dimensions in mm



Metal spring washer

Nut: M8x1.25

Cross-section of flexible conducting lead 4 mm²

Diameter of hole in heat sink max. 8.5 mm

Mounting torque: min. 30 cm kg for good heat conductance
max. 60 cm kg

Net weight 25 g

Net weight with mounting accessories 35 g

CHARACTERISTICS

Forward voltage at diode base temperature of 25 °C

V_D (I_D = 1 A) < 0.9 V

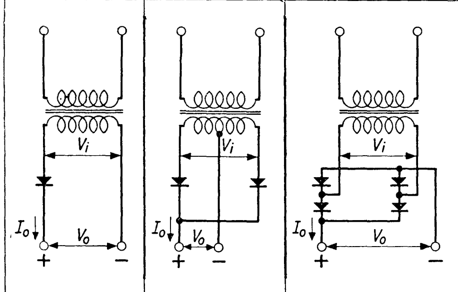
V_D (I_D = 50 A) < 1.5 V [1]

Reverse current at diode base temperature of 125 °C

	$-V_D$ (V)	$-I_D$ (mA)
BYY22/23	200	max. 2
BYY67/68	300	max. 2
BYY24/25	400	max. 2

[1] Measured with current pulses to prevent excessive dissipation

OPERATING CHARACTERISTICS as rectifier



	V_i V_{RMS}	Single phase Half wave I_o (A)	V_o (V)	Two phase Half wave I_o (A)	V_o (V)	Single phase Full wave bridge I_o (A)	V_o (V)
BYY22/23	140	10	60	20	60	20	125
BYY67/68	210	10	90	20	90	20	185
BYY24/25	230	10	125	20	125	20	250

The V_i and I_o values are max. values for resistive or inductive load. No source impedance is assumed.

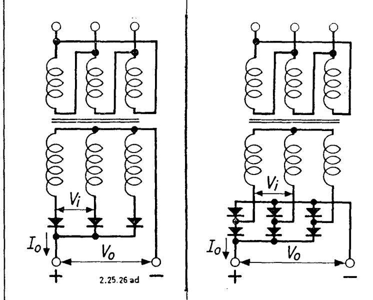
The equipment designer has to determine an average design such that these values will not be exceeded.

Example for heat sink calculation

For a given application the minimum required heat sink area can be determined as follows:
If in a three-phase full-wave circuit I_o = 25 A (8.3 A per diode) and T_{amb} = 75 °C, it follows from page D that the maximum value of the thermal resistance between the diode base and ambience is 4.7 °C/W.
When natural convection and a black heat sink are provided the minimum required heat sink area is 50 cm² according to page F.
From page D it may be seen that the temperature of the diode base is about 137 °C and that the dissipation is max. 12 W.

See also pages 4 and 5

OPERATING CHARACTERISTICS as rectifier (continued)



	V_i (V_{RMS})	Three phase star I_o (A)	V_o (V)	Three phase Full wave bridge I_o (A)	V_o (V)
BYY22/23	140	30	95	30	190
BYY67/68	210	30	140	30	285
BYY24/25	280	30	190	30	380

OPERATING NOTES

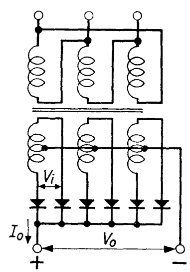
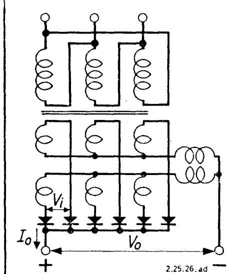
1) In order to prevent the diode from being damaged by surge currents higher than those mentioned at page E a fast fuse is recommended

2) The values of K include a thermal resistance between diode base and heat sink of about 0.3 °C/W

3) When there is a possibility that transient voltage surges will cause an inverse voltage higher than the rated surge value, a damping circuit across the transformer or across the diode should be applied, e.g. a series R.C. circuit or a voltage dependent resistor. Dimensioning of the R.C. circuit may be done according to the following formulae:

See page 5

OPERATING CHARACTERISTICS as rectifier (continued)

		Six phase Star		Three phase double Y with interphase transformer	
					
	V_i (V_{RMS})	I_o (A)	V_o (V)	I_o (A)	V_o (V)
BYY22/23	140	48	95	60	80
BYY67/68	210	48	135	60	120
BYY24/25	280	48	190	60	165

OPERATING NOTES (continued from page 4)

a. When applied to the primary side of the transformer:

$$C_1 \approx 200 \frac{I_{po}}{V} \ \mu F \qquad R_1 \approx \frac{150}{C_1} \ \Omega$$

b. When applied to the secondary of the transformer:

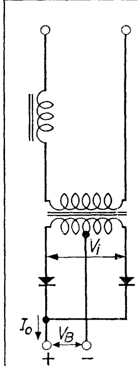
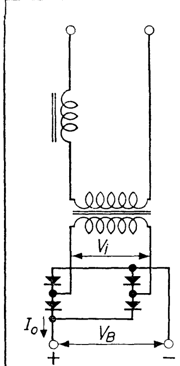
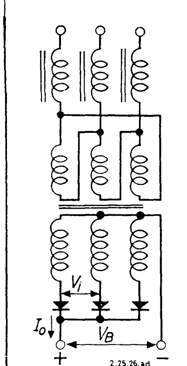
$$C_2 \approx 450 \frac{I_{po} \cdot V}{(-V_{DM})^2} \ \mu F \qquad R_2 \approx \frac{200}{C_2} \ \Omega$$

In which:

V = transformer primary R.M.S. voltage (V)
$-V_{DM}$ = recurrent peak inverse voltage (V)
I_{po} = magnetizing primary R.M.S. current (A)

7Z2 1779

OPERATING CHARACTERISTICS for battery charging

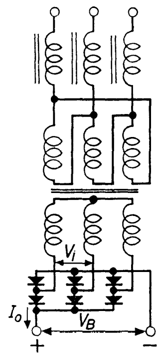
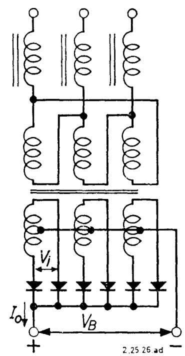
		Two phase Half wave			Single phase Full wave bridge			Three phase star		
										
	V_i V_{RMS}	I_o (A)	V_B (V)	n	I_o (A)	V_B (V)	n	I_o (A)	V_B (V)	n
BYY22/23	125	12	60	27	12	120	54	18	70	32
BYY67/68	190	12	90	41	12	180	82	18	105	47
BYY24/25	255	12	120	54	12	240	108	18	135	60

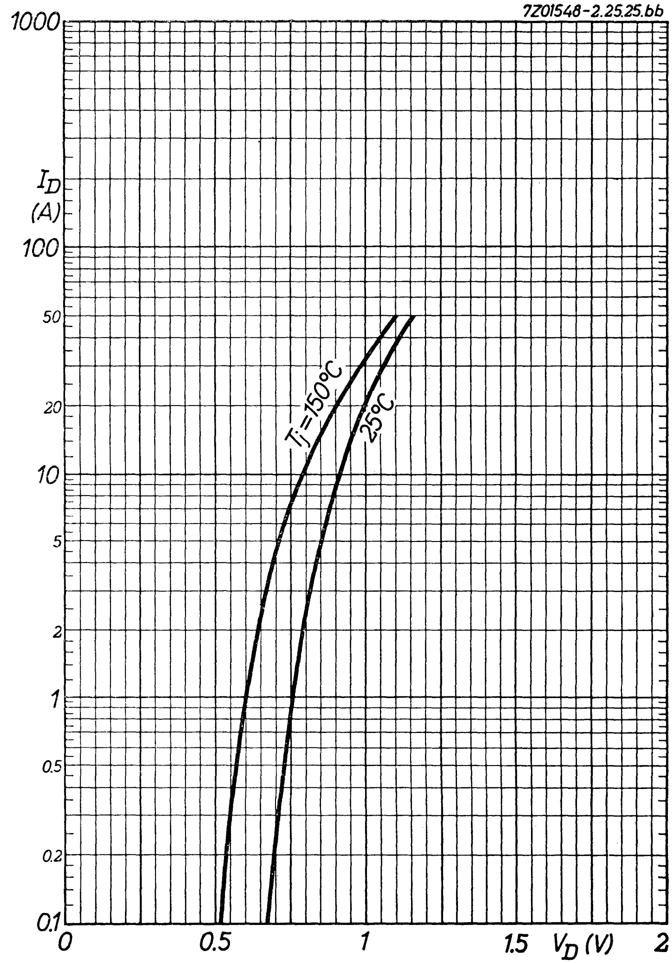
n = maximum number of Pb cells in series (nominal voltage per cell = 2.2 V)

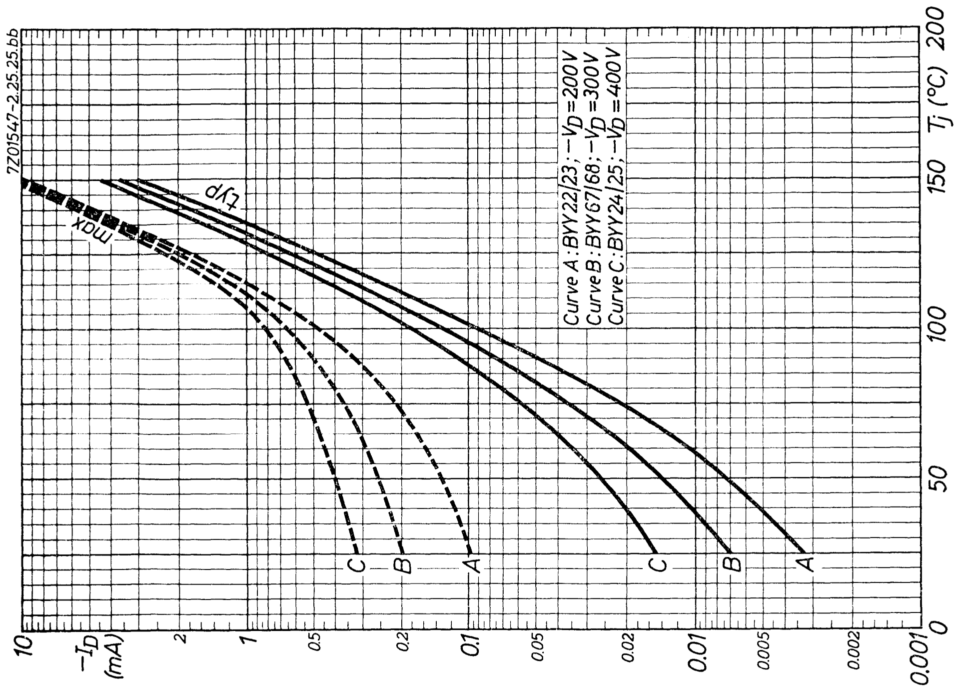
The above data are nominal values with battery load. The possibility of mains voltage fluctuations of max. 10 % has been taken into account. For current limiting use is made of inductors in series with the primary of the mains transformer

7Z2 1780

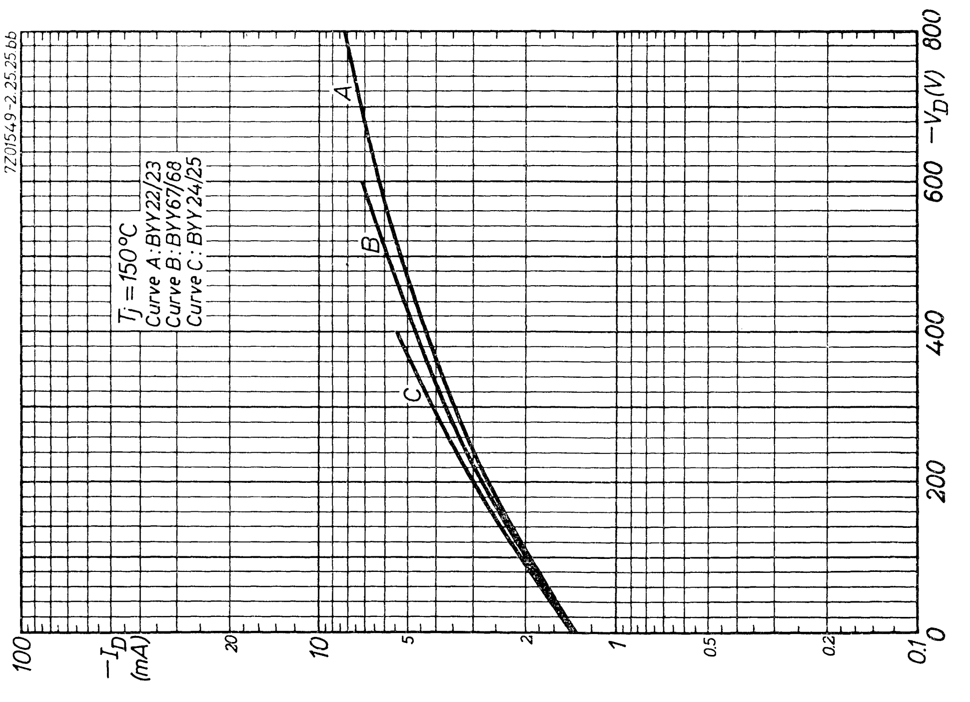
OPERATING CHARACTERISTICS for battery charging (continued)

		Three phase Full wave bridge			Six phase star		
							
	V_1 (V_{RMS})	I_o (A)	V_B (V)	n	I_o (A)	V_B (V)	n
BYY22/23	125	18	120	54	36	60	27
BYY67/68	190	18	180	82	36	90	41
BYY24/25	255	18	240	108	36	120	54

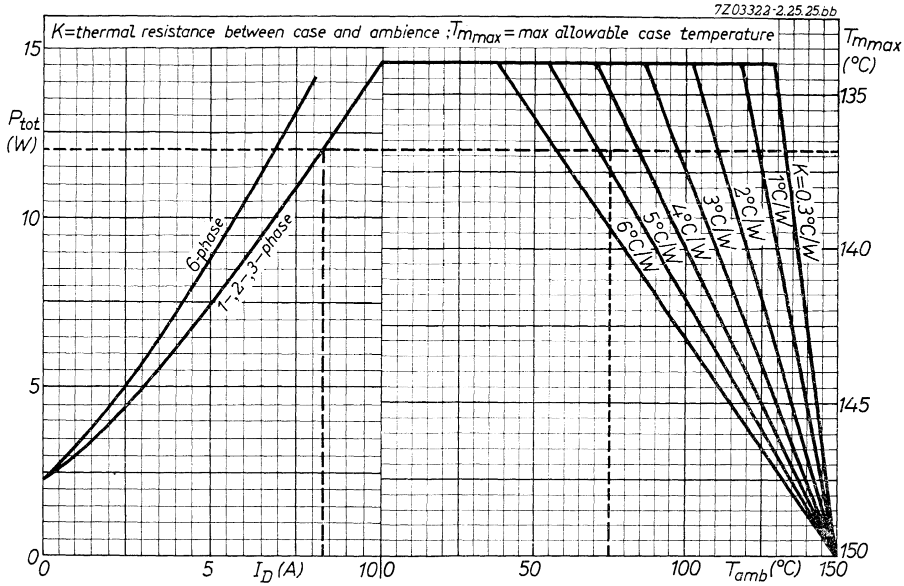



7Z01547-2.25.25.bb
Curve A: BYY22/23; $-V_D$=200V
Curve B: BYY67/68; $-V_D$=300V
Curve C: BYY24/25; $-V_D$=400V
typ
max
A
B
C
$-I_D$ (mA)
T_j (°C)
10
2
1
0.5
0.2
0.1
0.05
0.02
0.01
0.005
0.002
0.001
0
50
100
150
200

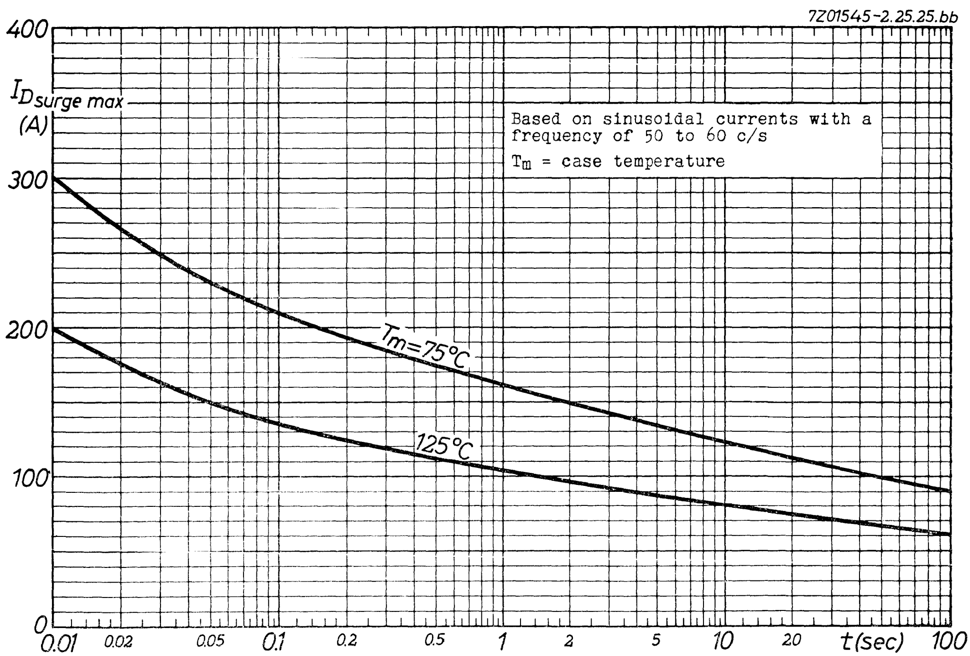
C


7Z01549-2.25.25.bb
T_j=150°C
Curve A: BYY22/23
Curve B: BYY67/68
Curve C: BYY24/25
A
B
C
$-I_D$ (mA)
$-V_D$(V)
100
20
10
5
2
1
0.5
0.2
0.1
0
200
400
600
800

B

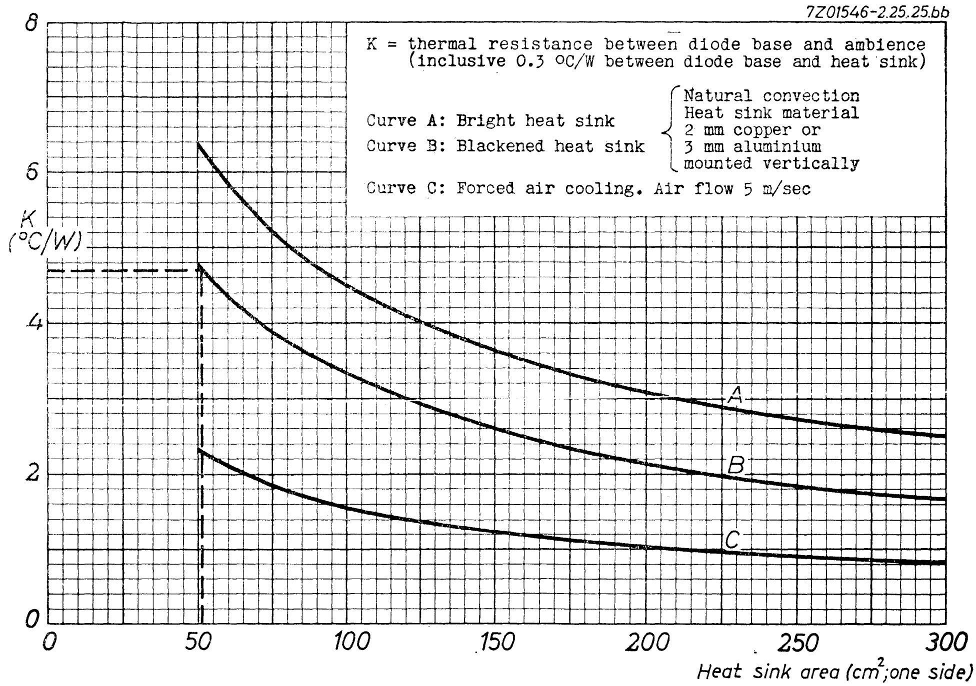

7Z03322-2.25.25.bb
K=thermal resistance between case and ambience ; $T_{m max}$ = max allowable case temperature
P_{tot} (W)
$T_{m max}$ (°C)
6-phase
1-,2-,3-phase
6°C/W
5°C/W
4°C/W
3°C/W
2°C/W
1°C/W
K=0.3°C/W
I_D (A)
T_{amb} (°C)
0
5
10
15
135
140
145
150
50
100

D


7Z01545-2.25.25.bb
$I_{D surge max}$ (A)
Based on sinusoidal currents with a frequency of 50 to 60 c/s
T_m = case temperature
T_m=75°C
125°C
t(sec)
0
100
200
300
400
0.01
0.02
0.05
0.1
0.2
0.5
1
2
5
10
20
100

5.5.1963

E


7Z01546-2.25.25.bb
K = thermal resistance between diode base and ambience (inclusive 0.3 °C/W between diode base and heat sink)
Curve A: Bright heat sink
Curve B: Blackened heat sink
Natural convection
Heat sink material
2 mm copper or
3 mm aluminium
mounted vertically
Curve C: Forced air cooling. Air flow 5 m/sec
K (°C/W)
8
6
4
2
0
0
50
100
150
200
250
300
Heat sink area (cm²; one side)
A
B
C

For data and curves of these rectifiers
please refer to BYZ14 series

REVISED DATA
IS UNDER PREPARATION

7Z2 3300

SILICON POWER DIODES

Double diffused silicon junction diodes for application in power rectifiers with an average current of max. 40 A.

The BYZ14 and the BYZ15 have identical electrical properties, but reverse electrode connections. The same applies to the BYY73/74, the BYY15/16, the BYY75/76 and the BYY77/78 (see outline drawing).

RECOMMENDED RATINGS

When the diodes are used within the recommended ratings, stable operation is ensured.

Inverse voltage [1]		BYZ14 BYZ15	BYY73 BYY74	BYY15 BYY16	BYY75 BYY76	BYY77 BYY78
Continuous	$-V_D$ = max.	200	300	400	500	600 V
Repetitive peak	$-V_{DM}$ = max.	200	300	400	500	600 V
Transient peak	$-V_{DM}$ = max.	400	600	800	1000	1200 V
Surge peak [2]	$-V_{Dsurge}$ = max.	400	600	800	1000	1200 V

Forward current (all types)

Average (averaging time 20 msec)	I_D	= max. 40 A [3]
Repetitive peak	I_{DM}	= max. 200 A
Surge peak	I_{Dsurge}	See page E
Overcurrent capability [4] for fusing (t = 10 msec)	$I_D^2 t$	= max. 2250 A^2sec

1)2)3)4) See page 2

7Z2 2387

RECOMMENDED RATINGS (continued)

Temperatures

Junction temperature	T_j	= max. 150 °C
Storage temperature	T_s	= −65 to +150 °C
Operating ambient	T_{amb}	See page D
Diode base	T_m	See page D

CHARACTERISTICS

Forward voltage at a diode base temperature of 25 °C

at I_D = 1 A	V_D < 0.8 V
at I_D = 200 A	V_D < 1.8 V [5]

Reverse current at a diode base temperature of 125 °C

	$-V_D$	$-I_D$
BYZ14/15	200 V	< 2.0 mA
BYY73/74	300 V	< 2.0 mA
BYY15/16	400 V	< 2.0 mA
BYY75/76	500 V	< 1.7 mA
BYY77/78	600 V	< 1.4 mA

Page 1

1) Each diode is tested individually for $-I_D$ < 10 mA at a diode base temperature of 125 °C and at a peak inverse voltage equal to the rated transient peak inverse voltage

2) Duration 10 msec

3) For six-phase circuits or capacitive load, the average forward current is max. 32 A. See also page D.

4) R.M.S. value of I_D

5) Measured with current pulses to prevent excessive dissipation

7Z2 2388

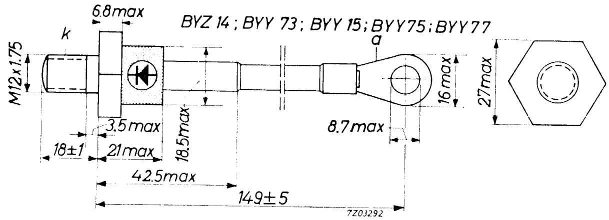
THERMAL DATA

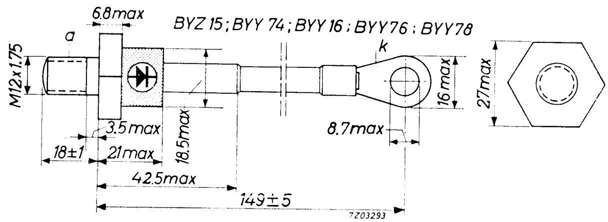
Thermal resistance

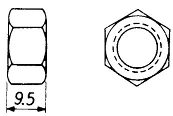
from junction to diode base	K = max. 1.0 °C/W
from diode base to heat sink	K = 0.15 °C/W

MECHANICAL DATA

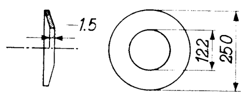
Dimensions in mm







Nut : M12 x 1.75



Metal spring washer

Cross section of flexible conducting lead 10 mm²

Diameter hole in heat sink max. 13 mm

Mounting torque : min. 100 cm kg for good heat conductance
max. 250 cm kg

Net weight 80 g

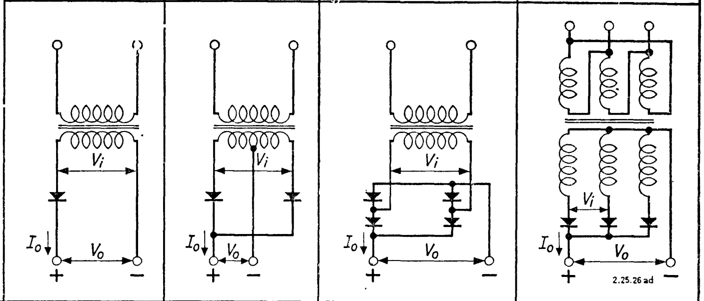
Net weight with mounting accessories 100 g

7Z2 3105

OPERATING CHARACTERISTICS AS RECTIFIER

The V_i and I_O values are max. values for resistive or inductive load. No source impedance is assumed. The equipment designer has to determine an average design such that these values will not be exceeded.

		Single phase Half wave		Two phase Half wave		Single phase Full wave bridge		Three phase star	



	V_i (V_{RMS})	I_O (A)	V_O (V)	I_O (A)	V_O (V)	I_O (A)	V_O (V)	I_O (A)	V_O (V)
BYZ14/15	140	40	60	80	60	80	125	120	95
BYY73/74	210	40	90	80	90	80	185	120	140
BYY15/16	280	40	125	80	125	80	250	120	190
BYY75/76	350	40	155	80	155	80	310	120	235
BYY77/78	420	40	185	80	185	80	375	120	280

7Z2 2390

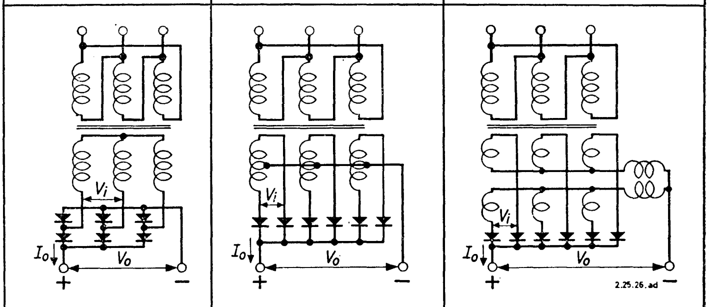
V_i = transformer secondary R.M.S. voltage

I_O = average D.C. output current

V_O = average D.C. output voltage

OPERATING CHARACTERISTICS AS RECTIFIER (continued)

		Three phase Full wave bridge		Six phase star		Three phase double Y with interphase transformer	

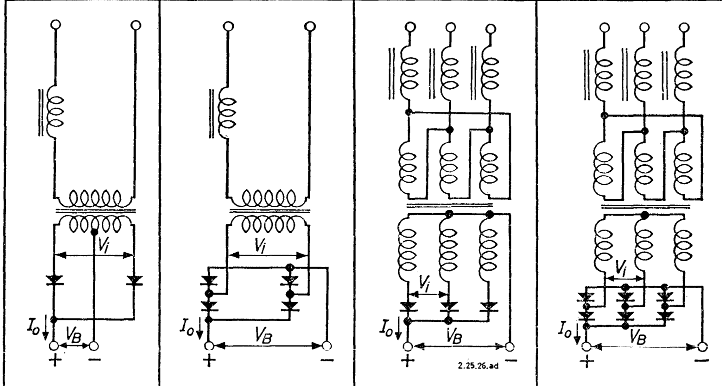


	V_i (V_{RMS})	I_O (A)	V_O (V)	I_O (A)	V_O (V)	I_O (A)	V_O (V)
BYZ14/15	140	120	190	192	95	240	80
BYY73/74	210	120	280	192	140	240	120
BYY15/16	280	120	375	192	190	240	160
BYY75/76	350	120	470	192	235	240	200
BYY77/78	420	120	565	192	280	240	240

7Z2 2391

OPERATING CHARACTERISTICS FOR BATTERY CHARGING

Two phase Half wave | Single phase Full wave bridge | Three phase star | Three phase Full wave bridge



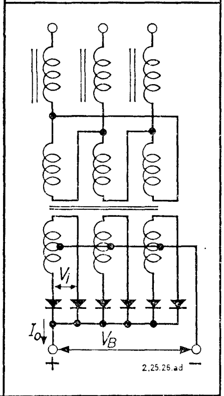
	V_i (V_{RMS})	Two phase Half wave			Single phase Full wave bridge			Three phase star			Three phase Full wave bridge		
		I_o (A)	V_B (V)	n	I_o (A)	V_B (V)	n	I_o (A)	V_B (V)	n	I_o (A)	V_B (V)	n
BYZ14/15	125	40	60	27	40	120	54	60	70	32	60	120	54
BYY73/74	190	40	90	41	40	180	82	60	105	47	60	180	82
BYY15/16	255	40	120	54	40	240	108	60	135	60	60	240	108
BYY75/76	315	40	150	68	40	300	136	60	170	77	60	300	136
BYY77/78	380	40	180	81	40	360	162	60	205	93	60	360	162

7Z2 2392

6

OPERATING CHARACTERISTICS AS BATTERY CHARGER (continued)

Six phase star



	V_i (V_{RMS})	I_o (A)	V_B (V)	n
BYZ14/15	125	120	60	27
BYY73/74	190	120	90	41
BYY15/16	255	120	120	54
BYY75/76	315	120	150	68
BYY77/78	380	120	180	81

7Z2 2431

V_i = transformer secondary R.M.S. voltage

I_o = average D.C. output current

V_B = battery voltage

n = maximum number of Pb cells in series (nominal voltage per cell = 2.2 V)

The above data are nominal values for battery load. The possibility of mains voltage fluctuations of max. 10% has been taken into account.
For current limiting use has been made of inductors in series with the primary of the mains transformer.

OPERATING NOTES

1) When there is a possibility that transient voltage surges will cause an inverse voltage higher than the rated surge value, a damping circuit across the transformer or across the diode should be applied, e.g. a series R.C. circuit or a voltage dependent resistor. Dimensioning of the R.C. circuit may be done according to the following formulae:

a. When applied to the primary side of the transformer:

$$C_1 \approx 200 \frac{I_{p_o}}{V} \mu F \qquad R_1 \approx \frac{150}{C_1} \Omega$$

b. When applied to the secondary of the transformer:

$$C_2 \approx 450 \frac{I_{p_o} \cdot V}{(-V_{DM})^2} \mu F \qquad R_2 \approx \frac{200}{C_2} \Omega$$

In which:

V = transformer primary R.M.S. voltage (V)

$-V_{DM}$ = repetitive peak inverse voltage (V)

I_{p_o} = magnetizing primary R.M.S. current (A)

2) In order to prevent the diode from being damaged by surge currents higher than those mentioned at page E a fast fuse is recommended.

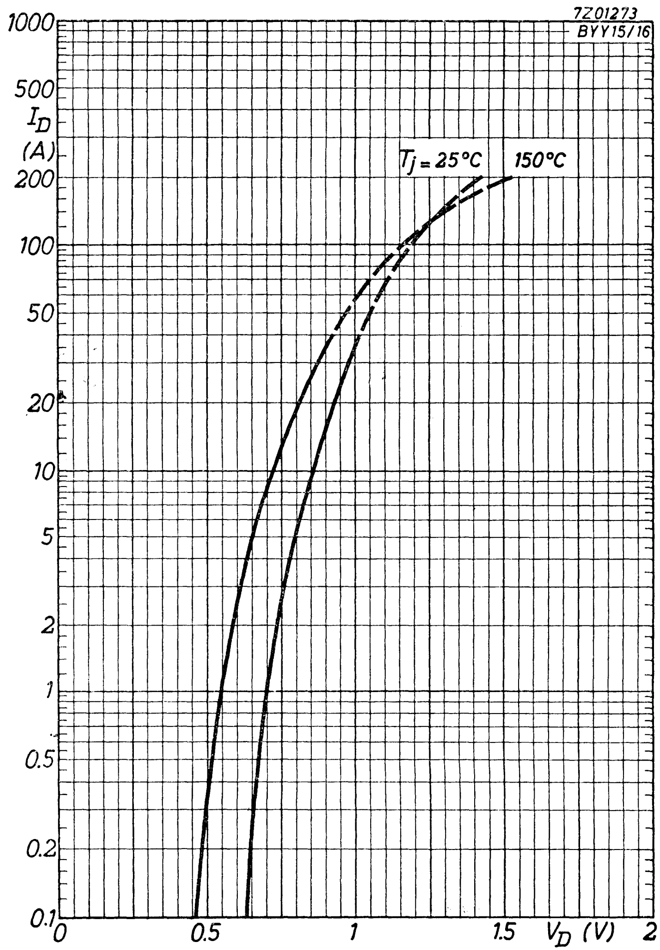
3) The values of K include a thermal resistance between diode base and heat sink of about 0.15 °C/W.

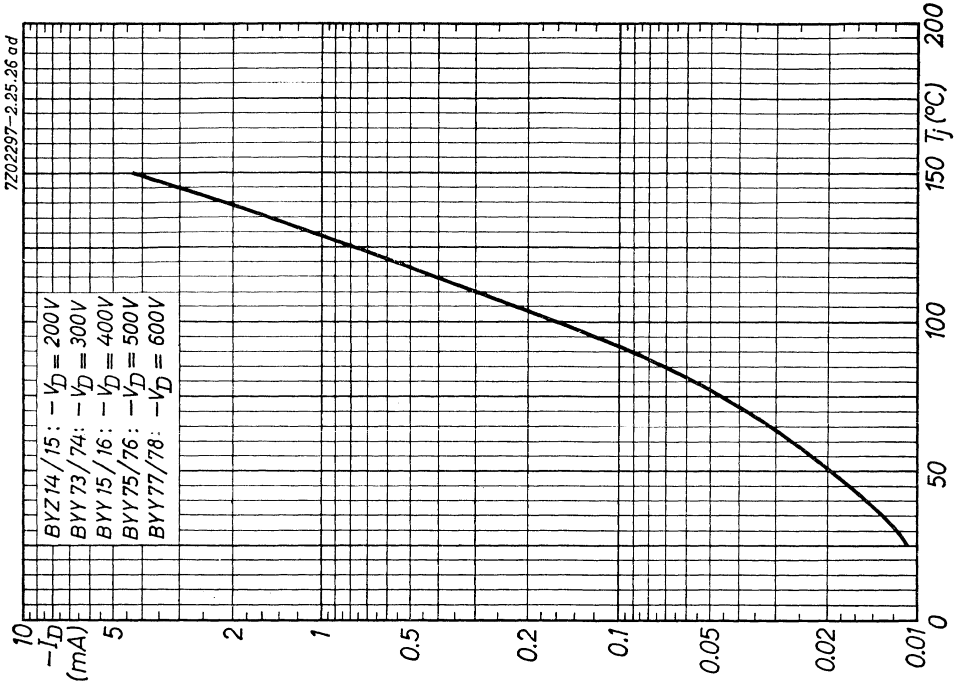
EXAMPLE for heat sink calculation

For a given application the minimum required heat sink area can be determined as follows:

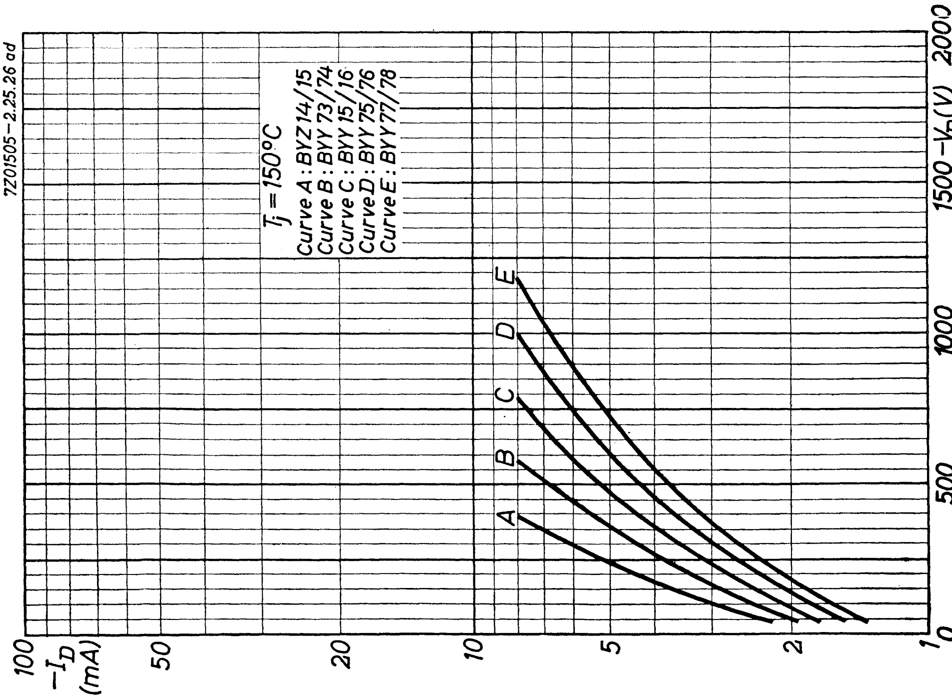
If in a three-phase full-wave circuit I_o = 90 A (30A per diode) and T_{amb} = 50 °C, it follows from page D that the maximum value of the thermal resistance between the diode base and ambience is 1.4 °C/W. When forced convection of 5 m/sec is provided the minimum required heat sink area is 100 cm^2 according to page F.

From page D it may be seen that the temperature of the diode base is about 108 °C and that the dissipation is max. 42 W. 7Z2 2394



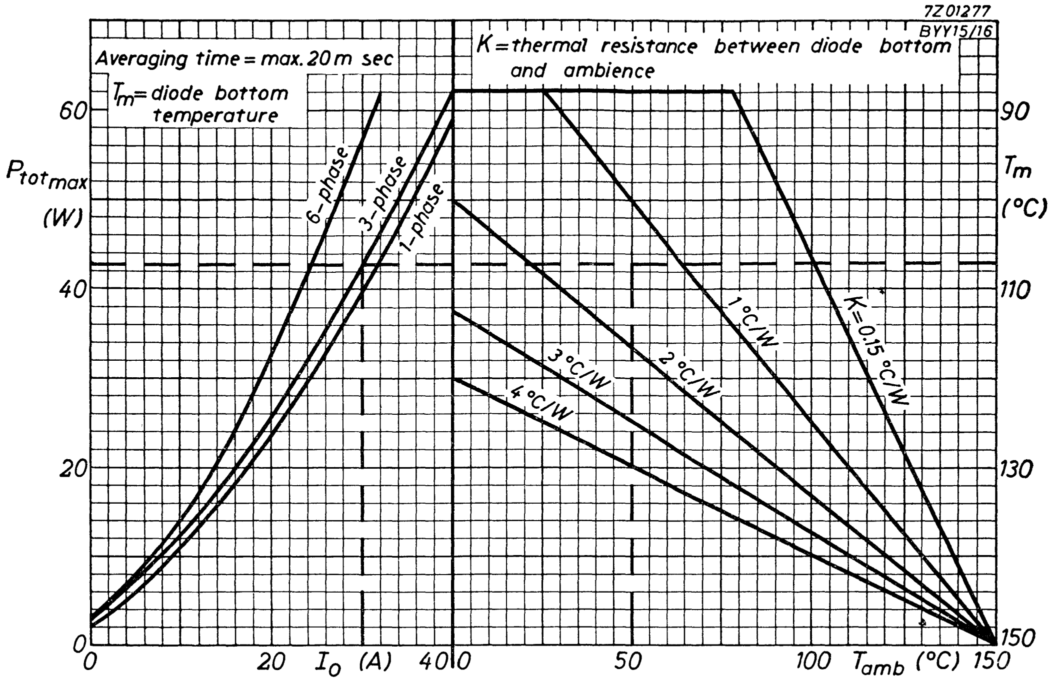

7Z02297-2.25.26 ad
BYZ14/15 : $-V_D$ = 200V
BYY73/74: $-V_D$ = 300V
BYY15/16 : $-V_D$ = 400V
BYY75/76 : $-V_D$ = 500V
BYY77/78 : $-V_D$ = 600V
$-I_D$ (mA)
10
5
2
1
0.5
0.2
0.1
0.05
0.02
0.01
0
50
100
150
200
T_j (°C)

C

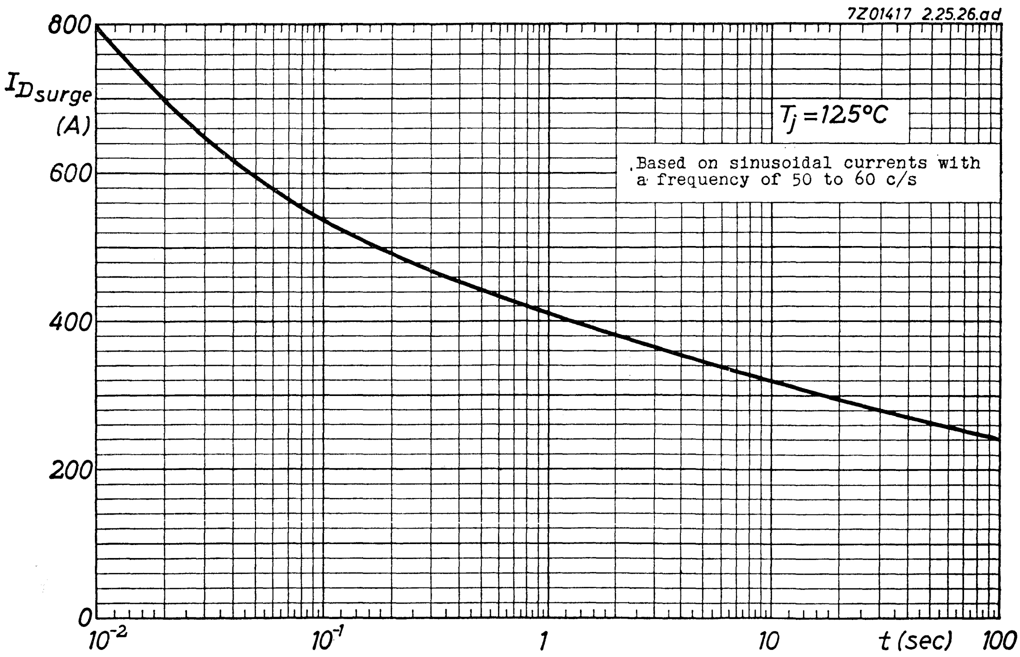

7Z01505-2.25.26 ad
T_j = 150°C
Curve A : BYZ14/15
Curve B : BYY73/74
Curve C : BYY15/16
Curve D : BYY75/76
Curve E : BYY77/78
A
B
C
D
E
$-I_D$ (mA)
100
50
20
10
5
2
1
0
500
1000
1500
2000
$-V_D$ (V)

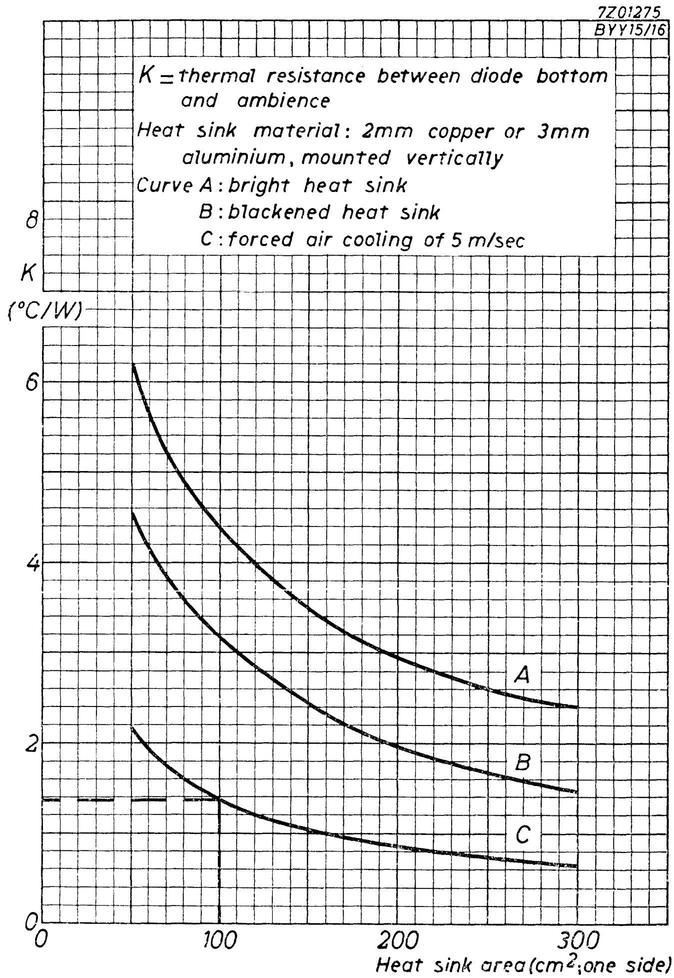
B

5.5.1964


7Z01277
BYY15/16
Averaging time = max. 20 m sec
T_m= diode bottom temperature
K = thermal resistance between diode bottom and ambience
60
40
20
0
$P_{tot\,max}$ (W)
6-phase
3-phase
1-phase
0
20
I_O (A)
40
0
50
100
T_{amb} (°C)
150
1 °C/W
2 °C/W
3 °C/W
4 °C/W
K=0.15 °C/W
90
110
130
150
T_m (°C)

D


7Z01417 2.25.26.ad
800
600
400
200
0
$I_{D\,surge}$ (A)
T_j =125°C
Based on sinusoidal currents with a frequency of 50 to 60 c/s
10^{-2}
10^{-1}
1
10
t (sec)
100


7Z01275
BYY15/16
K = thermal resistance between diode bottom and ambience
Heat sink material: 2mm copper or 3mm aluminium, mounted vertically
Curve A: bright heat sink
B: blackened heat sink
C: forced air cooling of 5 m/sec
K (°C/W)
8
6
4
2
0
A
B
C
0
100
200
300
Heat sink area (cm²; one side)

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN (continued) T_{amb} = 25 °C

Type No.	Zener current	Zener voltage		Temperature coefficient	Dynamic impedance
	$-I_D$	$-V_D$		$\Delta(-V_D)/\Delta T$	r_D
		average	range values		
BZY64	1 mA	4.3 V	3.3 to 5.0 V	-2.2 mV/°C	375 Ω
	5 mA	4.9 V		-1.7 mV/°C	77 Ω
	20 mA	5.3 V		-1.2 mV/°C	12 Ω
BZY65	1 mA	5.1 V	4.4 to 6.0 V	-1.8 mV/°C	360 Ω
	5 mA	5.6 V		-0.5 mV/°C	50 Ω
	20 mA	5.9 V		+1.0 mV/°C	6.0 Ω
BZY66	1 mA	6.2 V	5.3 to 7.2 V	+0.5 mV/°C	200 Ω
	5 mA	6.3 V		+1.8 mV/°C	12 Ω
	20 mA	6.4 V		+2.5 mV/°C	2.0 Ω
BZY67	1 mA	7.5 V	6.4 to 8.7 V	+4.0 mV/°C	8.0 Ω
	5 mA	7.6 V		+4.3 mV/°C	2.8 Ω
	20 mA	7.7 V		+4.6 mV/°C	1.7 Ω

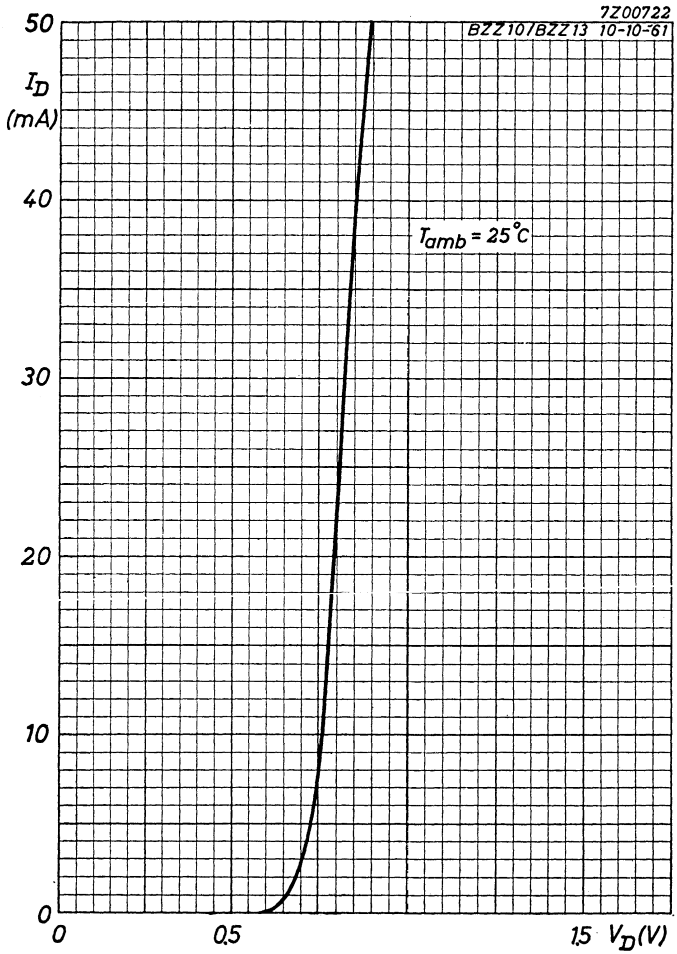
2

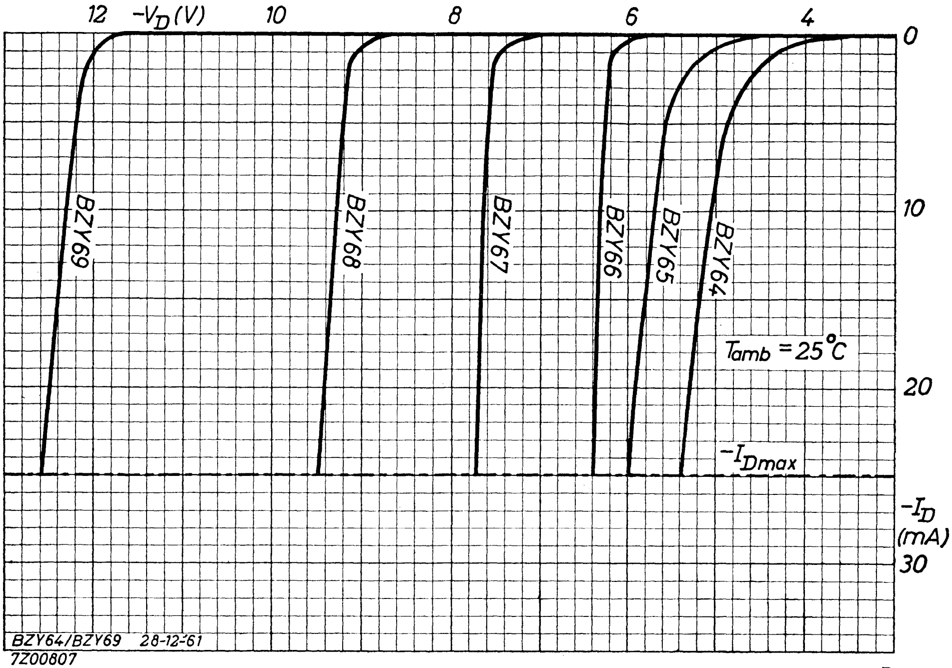
7Z2 1127

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN (continued) T_{amb} = 25 °C

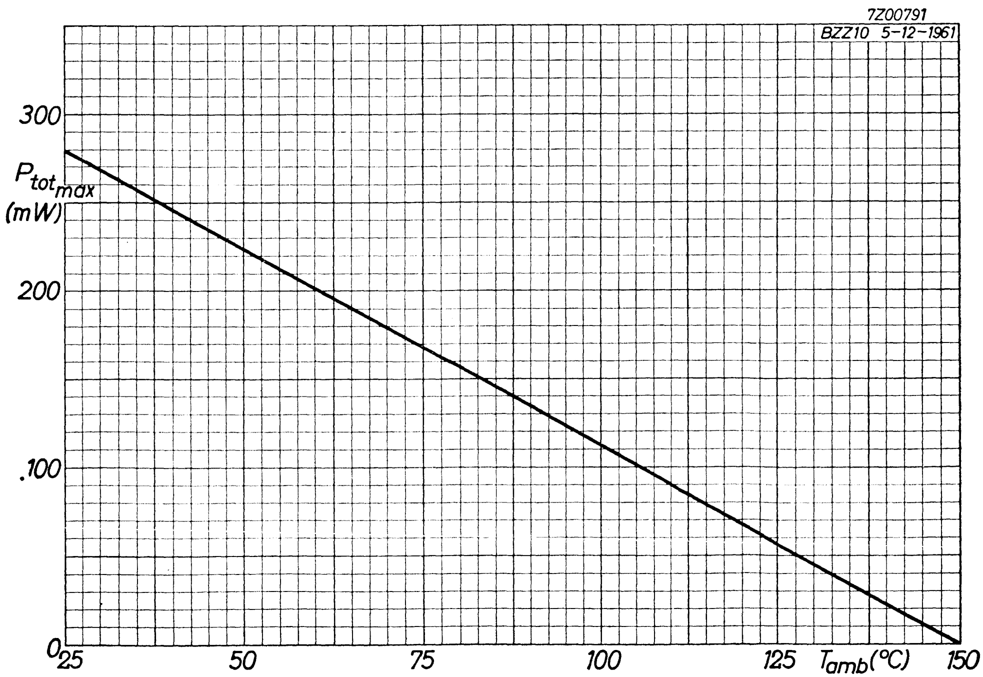
type No.	Zener current	Zener voltage		Temperature coefficient	Dynamic impedance
	$-I_D$	$-V_D$		$\Delta(-V_D)/\Delta T$	r_D
		average	range values		
BZY68	1 mA	9.1 V	7.7 to 10.6 V	+6.2 mV/°C	8.0 Ω
	5 mA	9.2 V		+6.4 mV/°C	3.5 Ω
	20 mA	9.4 V		+6.6 mV/°C	3.0 Ω
BZY69	1 mA	12.0 V	9.4 to 15.0 V	+9.2 mV/°C	21 Ω
	5 mA	12.2 V		+9.3 mV/°C	11 Ω
	20 mA	12.5 V		+9.4 mV/°C	7.0 Ω

3


7Z00722
BZZ10/BZZ13 10-10-61
50
I_D
(mA)
40
30
20
10
0
0
0.5
1.5
V_D(V)
T_{amb} = 25 °C


12
$-V_D$ (V)
10
8
6
4
0
10
20
30
$-I_D$ (mA)
$-I_{Dmax}$
BZY69
BZY68
BZY67
BZY66
BZY65
BZY64
T_{amb} = 25 °C
BZY64/BZY69 28-12-61
7Z00807

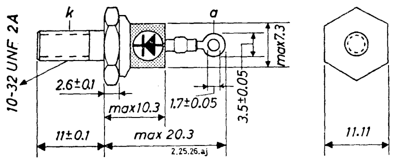
B


7Z00791
BZZ10 5-12-1961
300
200
100
0
$P_{tot_{max}}$ (mW)
25
50
75
100
125
150
T_{amb} (°C)

C

SILICON ALLOY JUNCTION DIODE with 15 % tolerance for use as medium current VOLTAGE STABILIZER or as a VOLTAGE REFERENCE

Dimensions in mm



The diode is supplied with nut, metal washer and metal locking washer

LIMITING VALUES (Absolute max. values)

Forward current	I_D	= max.	0.5 A
Reverse current	$-I_D$	= max.	0.5 A
Surge reverse current (max. duration 100 µsec)	$-I_{D\,surge}$ (t	= max. = max.	10 A [1] 100 µsec)
Dissipation (See also pages J and K)	P	= max.	$\frac{T_{jmax}-T_{amb}}{K}$
Storage temperature	T_s	=	-55 °C to +150 °C

THERMAL DATA

Thermal resistance from junction to ambience in free air	K_{j-amb}	= max.	70 °C/W
Thermal resistance from junction to case	K_{j-c}	= max.	10 °C/W

[1]) For surge currents of longer duration see page I

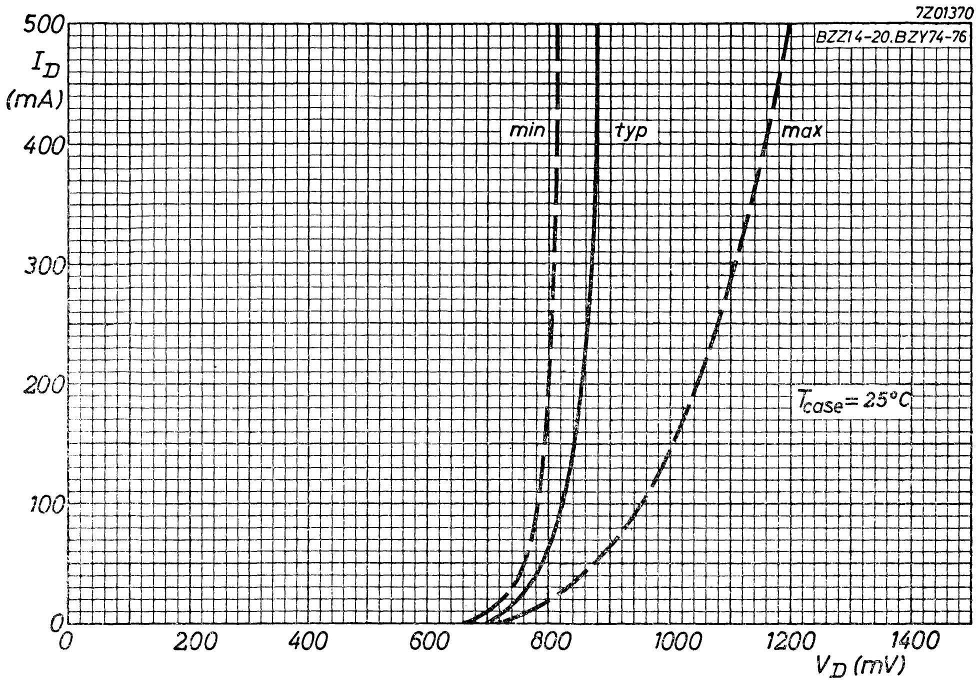
CHARACTERISTICS at a case temperature of 25 °C

		BZY74	BZY75	BZY76
Forward voltage (V_D) at I_D = 200 mA	min.	0.8 V	0.8 V	0.8 V
	max.	1.05 V	1.05 V	1.05 V
Zener voltage ($-V_D$) at $-I_D$ = 20 mA	min.	5.3 V	6.4 V	7.7 V
	typ.	6.2 V	7.5 V	9.1 V
	max.	7.2 V	8.7 V	10.6 V
Dynamic resistance (r_D) at $-I_D$ = 20 mA	max.	13 Ω	10 Ω	11 Ω
Leakage current ($-I_D$) at $-V_D$ = 3 V	typ.	0.15 µA	0.04 µA	
	max.	0.5 µA	0.5 µA	
Leakage current ($-I_D$) at $-V_D$ = 5 V	typ.			0.04 µA
	max.			0.4 µA

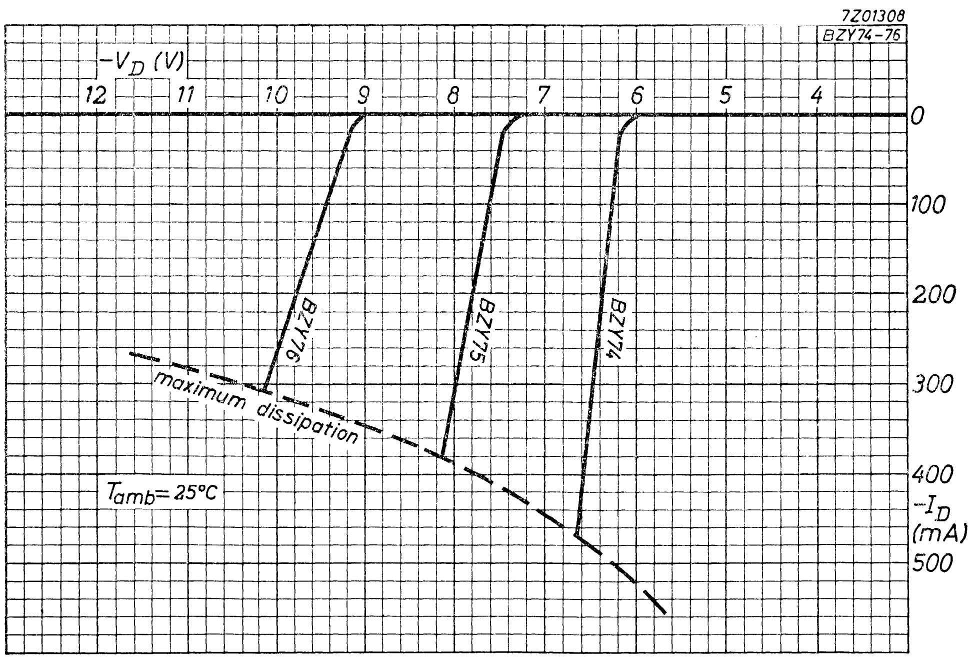
CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN

Case temperature = 25 °C

			BZY74	BZY75	BZY76	
Forward voltage (V_D)	I_D = 0-0.5 A	min. typ. max.	See page A			
Zener voltage ($-V_D$)	$-I_D$ = 50 mA	min.	5.4	6.4	7.8	V
		typ.	6.25	7.5	9.2	V
		max.	7.2	8.8	10.7	V
	$-I_D$ = 100 mA	min.	5.5	6.4	7.8	V
		typ.	6.3	7.6	9.3	V
		max.	7.4	9.0	11.0	V
	$-I_D$ = 200 mA	min.	5.5	6.6	8.0	V
		typ.	6.35	7.7	9.45	V
		max.	7.4	9.4	11.3	V
	$-I_D$ = 500 mA	min.	5.5	6.6	8.0	V
		typ.	6.6	7.82	9.55	V
		max.	7.9	9.5	11.6	V
Dynamic resistance (r_D)	$-I_D$ = 100 mA	typ.	See page G			
		max.	4.0	5.0	5.0	Ω
	$-I_D$ = 500 mA	typ.	See page G			
		max.	2.5	3.0	3.0	Ω
Temperature coefficient $\frac{\Delta(-V_D)}{\Delta T}$	$-I_D$ = 20 mA	typ.	See page F			
		min.	-0.4	2.0	4.0	mV/°C
		max.	4.0	6.0	8.0	mV/°C
	$-I_D$ = 100 mA	typ.	See page F			
		min.	0.5	2.5	3.0	mV/°C
		max.	4.0	6.1	11.0	mV/°C
	$-I_D$ = 500 mA	typ.	See page F			
		min.	0.0	2.5	3.0	mV/°C
		max.	4.0	7.0	11.0	mV/°C
Capacitance (c_{dk})	$-V_D$ = 2 V	typ.	475	350	250	pF

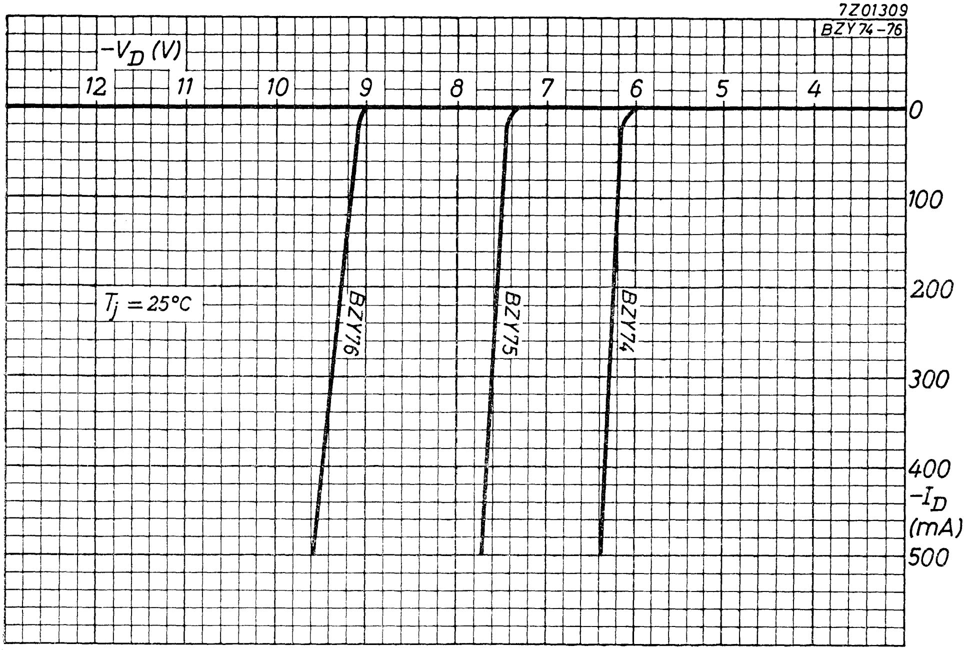

7Z01370
BZZ14-20.BZY74-76
500
I_D
(mA)
400
300
200
100
0
min
typ
max
T_{case}= 25°C
0
200
400
600
800
1000
1200
1400
V_D (mV)

A

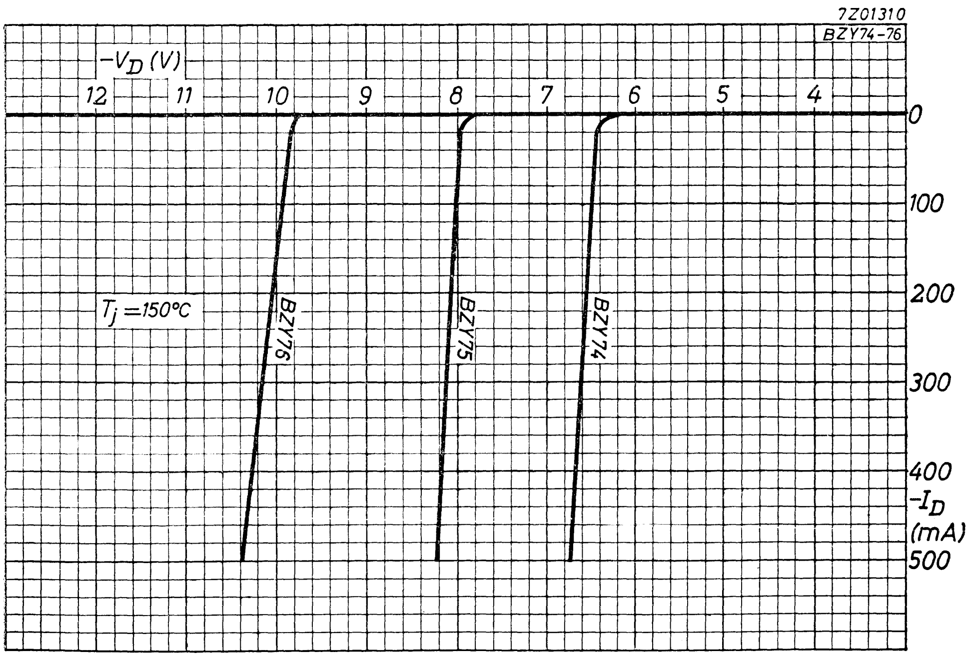

7Z01308
BZY74-76
$-V_D$ (V)
12
11
10
9
8
7
6
5
4
0
100
200
300
400
$-I_D$
(mA)
500
BZY76
BZY75
BZY74
maximum dissipation
T_{amb}= 25°C

4.4.1963

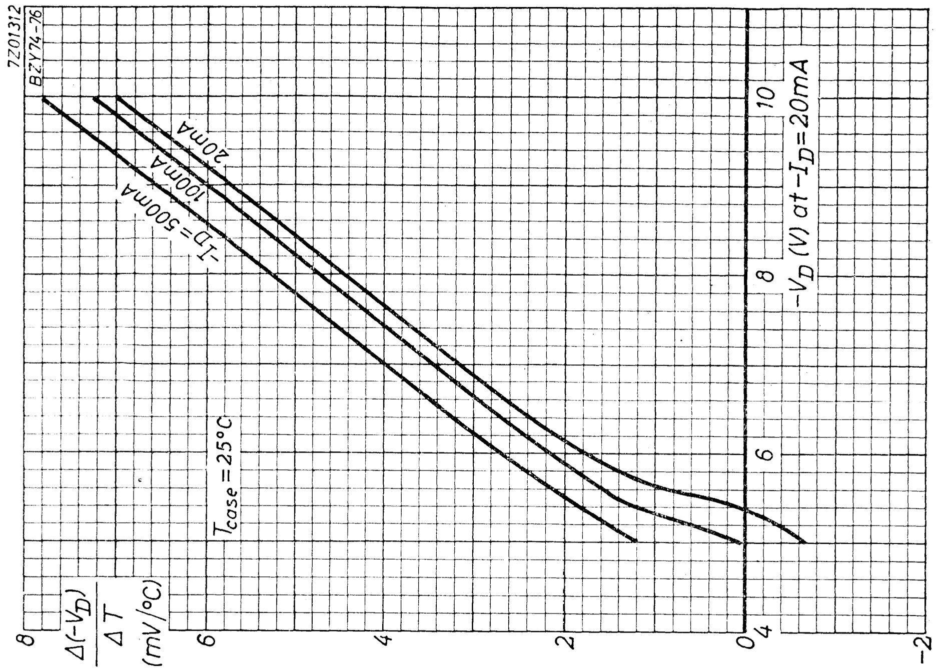
B


7Z01309
BZY74–76
$-V_D$ (V)
12
11
10
9
8
7
6
5
4
0
100
200
300
400
$-I_D$ (mA)
500
T_j = 25°C
BZY76
BZY75
BZY74

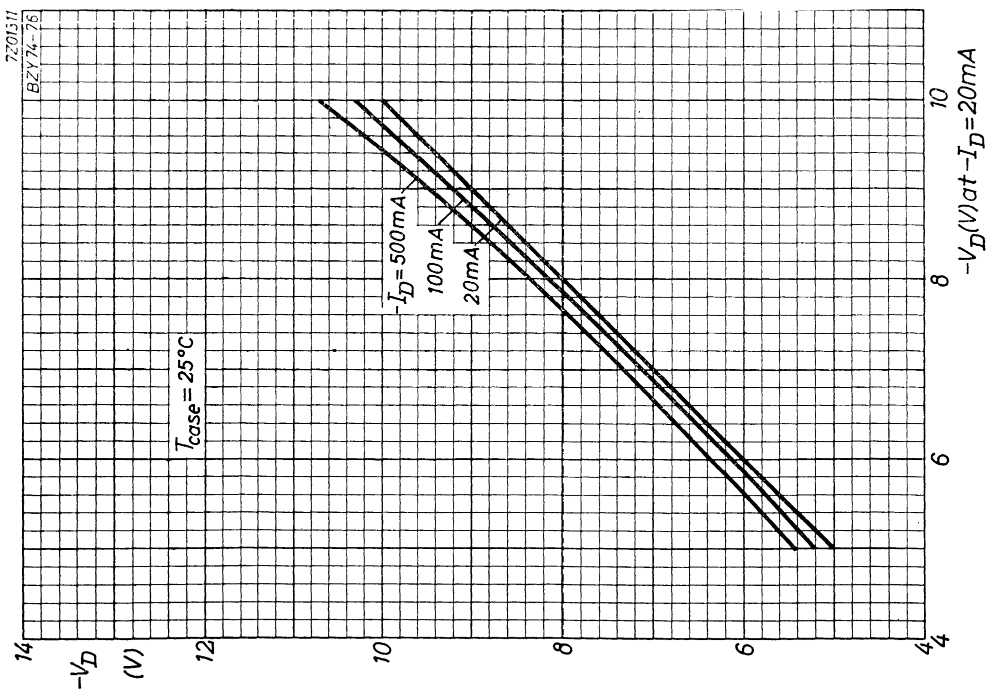
C


7Z01310
BZY74–76
$-V_D$ (V)
12
11
10
9
8
7
6
5
4
0
100
200
300
400
$-I_D$ (mA)
500
T_j = 150°C
BZY76
BZY75
BZY74

D

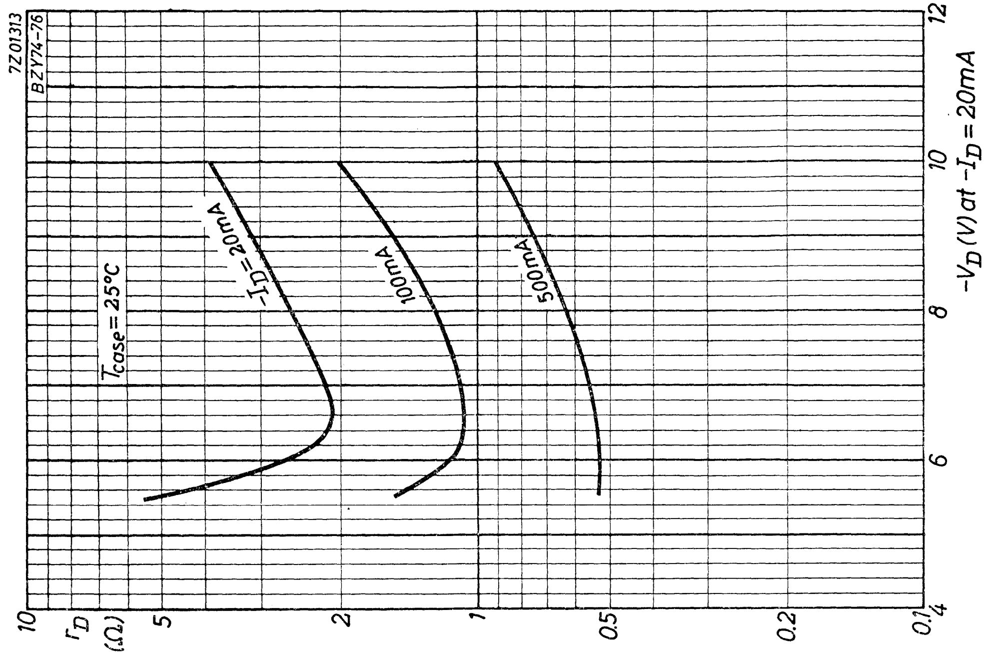

7Z01312
BZY74-76
$\frac{\Delta(-V_D)}{\Delta T}$ (mV/°C)
8
6
4
2
0
−2
T_{case} = 25°C
$-I_D$ = 500mA
100mA
20mA
4
6
8
10
$-V_D$ (V) at $-I_D$=20mA

F

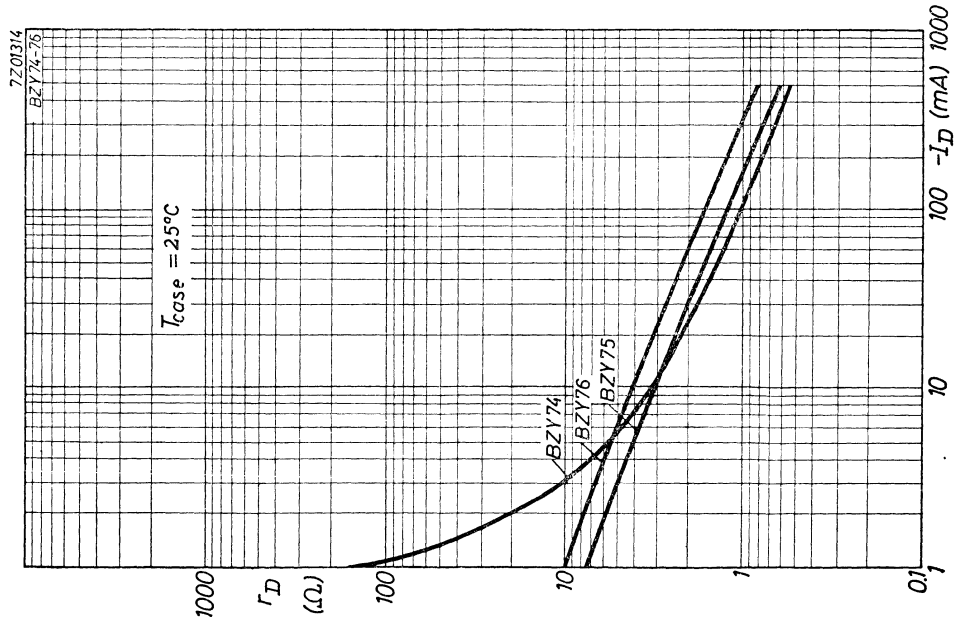

7Z01311
BZY74-76
$-V_D$ (V)
14
12
10
8
6
4
T_{case} = 25°C
$-I_D$ = 500mA
100mA
20mA
4
6
8
10
$-V_D$(V)at $-I_D$=20mA

E

4.4.1963

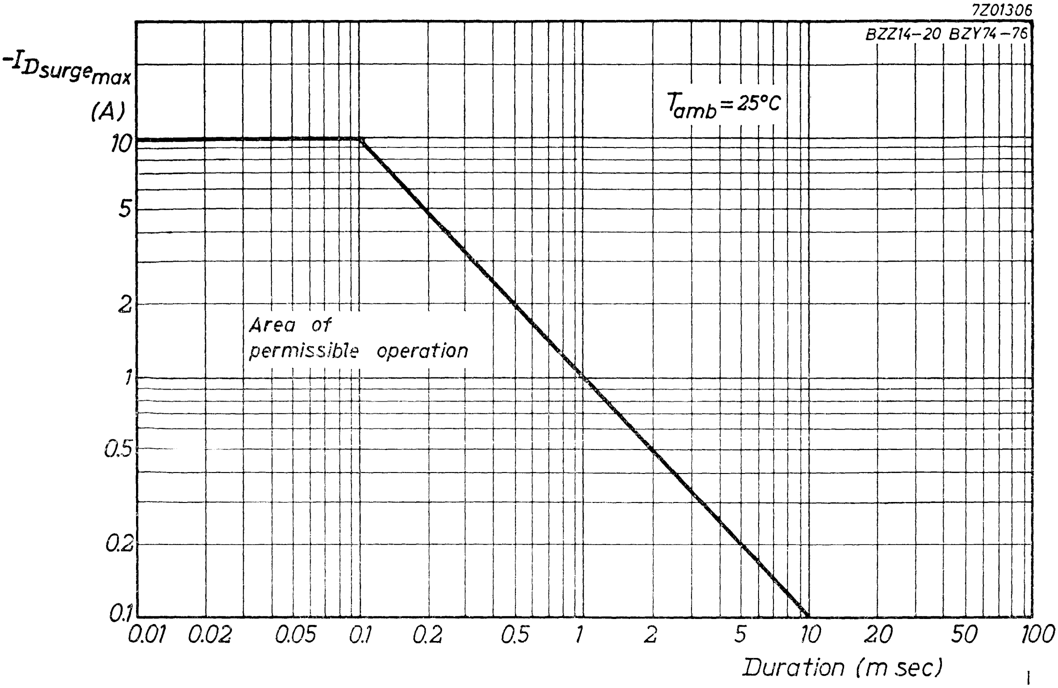

7Z01313
BZY74-76
$T_{case} = 25°C$
$-I_D = 20mA$
100mA
500mA
r_D (Ω)
10
5
2
1
0.5
0.2
0.1
4
6
8
10
12
$-V_D$ (V) at $-I_D = 20mA$

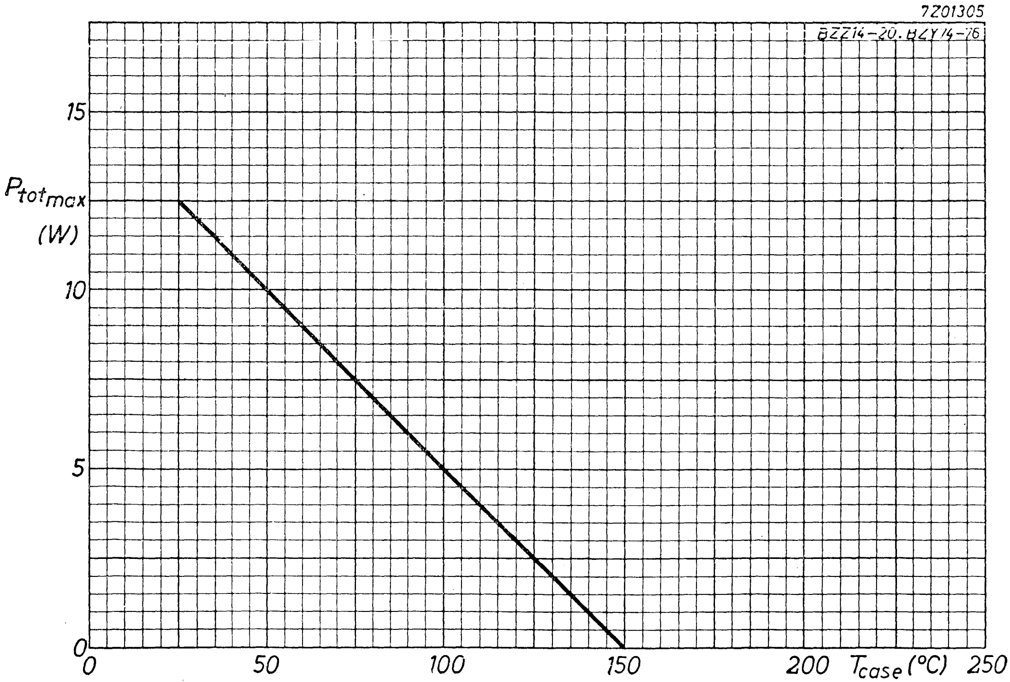
H

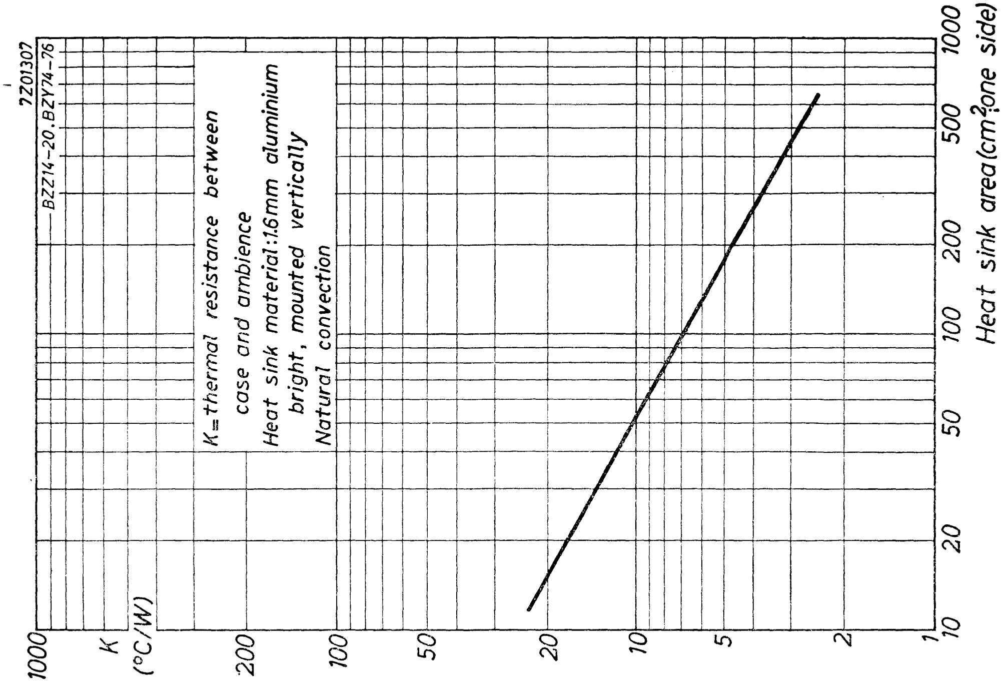

7Z01314
BZY74-76
$T_{case} = 25°C$
BZY74
BZY76
BZY75
r_D (Ω)
1000
100
10
1
0.1
1
10
100
1000
$-I_D$ (mA)

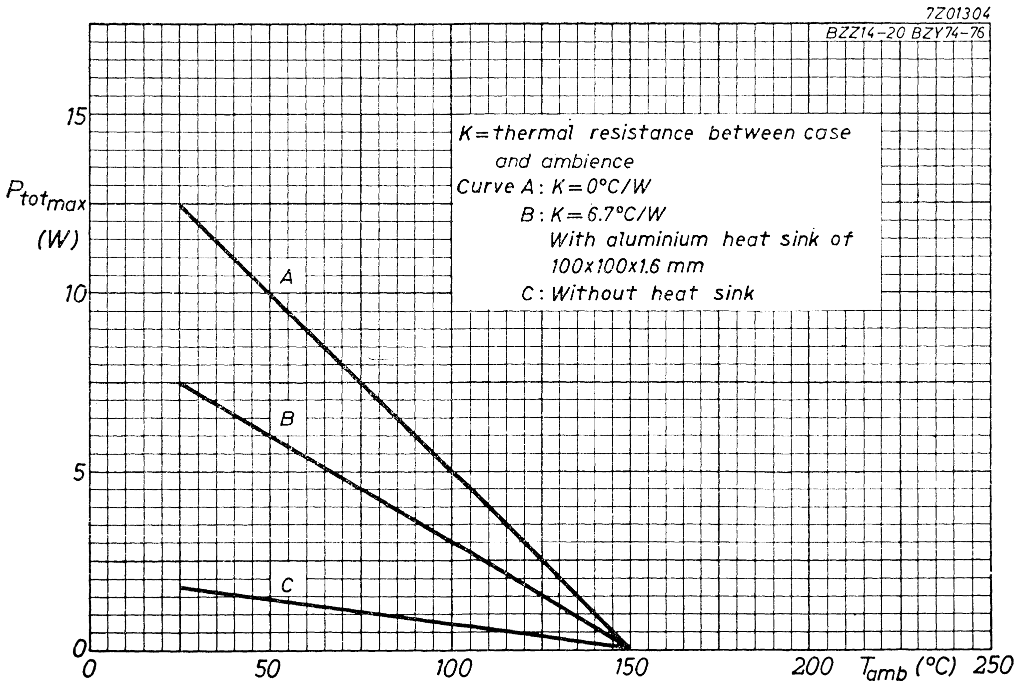
G

4.4.1963


7Z01306
BZZ14-20 BZY74-76
$-I_{D surge max}$
(A)
T_{amb} = 25°C
Area of permissible operation
10
5
2
1
0.5
0.2
0.1
0.01
0.02
0.05
0.1
0.2
0.5
1
2
5
10
20
50
100
Duration (m sec)


7Z01305
BZZ14-20. BZY74-76
$P_{tot max}$
(W)
15
10
5
0
0
50
100
150
200
T_{case} (°C)
250


7Z01307
BZZ14-20.BZY74-76
K=thermal resistance between case and ambience
Heat sink material: 1.6mm aluminium bright, mounted vertically
Natural convection
K (°C/W)
1000
200
100
50
20
10
5
2
1
Heat sink area (cm²; one side)
10
20
50
100
200
500
1000

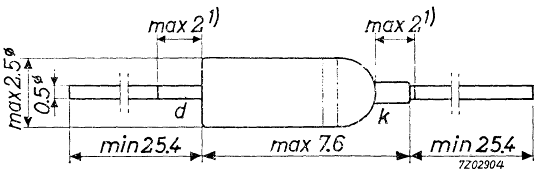

7Z01304
BZZ14-20 BZY74-76
K=thermal resistance between case and ambience
Curve A: K=0°C/W
B: K=6.7°C/W
With aluminium heat sink of 100x100x1.6 mm
C: Without heat sink
A
B
C
P_{totmax} (W)
15
10
5
0
0
50
100
150
200
T_{amb} (°C)
250

VOLTAGE REGULATOR DIODES

Silicon alloy junction diodes in subminiature all glass DO-7 case for use as low current voltage stabilisers or as voltage references.
The series consists of eight types with typical Zener voltages ranging from 4.7 V to 9.1 V with a 5% tolerance. [2])

QUICK REFERENCE DATA					
Zener current (peak value)	$-I_{DM}$	= max.	250	mA
Power dissipation	P	= max.	400	mW
Junction temperature	T_j	= max.	150	^oC
Thermal resistance between junction and ambience in free air	K	<	0.31	$^oC/mW$

MECHANICAL DATA Dimensions in mm



1) Not tinned

2) The part of the typenumber after the hyphen consists of a letter, indicating the nominal tolerance in % (C = 5%) and a voltage, indicating the typical Zener voltage in volts (the letter V is used in place of the decimal point when this occurs).

7Z2 2864

LIMITING VALUES (Absolute max. values)

Forward current (peak value)	I_{DM}	= max.	250	mA
Zener current (peak value)	$-I_{DM}$	= max.	250	mA
Average zener current	$-I_{D(AV)}$	see pages D and F		
Surge power	P_{surge}	see page C		
Power dissipation	P	= max.	400	mW
Storage temperature	T_s	=	−55 to +150	^oC
Junction temperature	T_j	= max.	150	^oC

THERMAL DATA

Thermal resistance from junction to ambience in free air — K < 0.31 $^oC/mW$

CHARACTERISTICS at T_{amb} = 25 ^oC

Forward voltage at $+I_D$ = 10 mA — V_D < 900 mV

BZY88-	Zener voltage (V) at $-I_D$ = 5 mA			Dynamic resistance (Ω) at $-I_D$ = 5 mA	Reverse current (μA)	at $-V_D$ (V)
	typ.	min.	max.	max.	max.	
C4V7	4.7	4.4	5.0	150	0.9	2
C5V1	5.1	4.8	5.4	150	0.9	2
C5V6	5.6	5.3	6.0	75	0.45	2
C6V2	6.2	5.8	6.6	50	0.45	3
C6V8	6.8	6.4	7.2	15	0.45	3
C7V5	7.5	7.1	7.9	15	0.45	3
C8V2	8.2	7.7	8.7	20	0.35	5
C9V1	9.1	8.6	9.6	25	0.35	5

7Z2 2865

CHARACTERISTIC RANGE VALUES FOR EQUIPMENT DESIGN at T_{amb} = 25 °C

BZY88–	Zener current $-I_D$	Zener voltage $-V_D$ typ.	Zener voltage $-V_D$ range	Temperature coefficient $d(-V_D)/dT$	Dynamic resistance r_d	Diode capacitance at $-V_D$ = 3 V c_d
C4V7	1 mA	4.1 V	4.4 to 5.1 V	−2.0 mV/°C	390 Ω	290 pF
	5 mA	4.7 V		−1.55 mV/°C	82 Ω	
	20 mA	5.1 V		−0.75 mV/°C	16 Ω	
C5V1	1 mA	4.65 V	4.8 to 5.4 V	−1.9 mV/°C	340 Ω	275 pF
	5 mA	5.10 V		−1.2 mV/°C	46 Ω	
	20 mA	5.35 V		−0.1 mV/°C	7 Ω	
C5V6	1 mA	5.3 V	5.3 to 6.0 V	−1.4 mV/°C	290 Ω	260 pF
	5 mA	5.6 V		−0.2 mV/°C	22 Ω	
	20 mA	5.75 V		+1.0 mV/°C	2.7 Ω	
C6V2	1 mA	5.9 V	5.8 to 6.6 V	+1.6 mV/°C	205 Ω	240 pF
	5 mA	6.2 V		+2.0 mV/°C	7.0 Ω	
	20 mA	6.4 V		+2.2 mV/°C	1.4 Ω	

CHARACTERISTIC RANGE VALUES FOR EQUIPMENT DESIGN at T_{amb} = 25 °C

BZY88-	Zener current $-I_D$	Zener voltage $-V_D$ typ.	Zener voltage $-V_D$ range	Temperature coefficient $d(-V_D)/dT$	Dynamic resistance r_d	Diode capacitance at $-V_D$ = 3 V c_d
C6V8	1 mA	6.7 V	6.4 to 7.2 V	+3.2 mV/°C	60 Ω	220 pF
	5 mA	6.8 V		+3.2 mV/°C	3.0 Ω	
	20 mA	6.9 V		+3.2 mV/°C	1.1 Ω	
C7V5	1 mA	7.45 V	7.1 to 7.9 V	+4.2 mV/°C	8.6 Ω	190 pF
	5 mA	7.5 V		+4.2 mV/°C	3.0 Ω	
	20 mA	7.65 V		+4.2 mV/°C	1.16 Ω	
C8V2	1 mA	8.1 V	7.7 to 8.7 V	+5.0 mV/°C	10 Ω	150 pF
	5 mA	8.2 V		+5.0 mV/°C	3.5 Ω	
	20 mA	8.4 V		+5.0 mV/°C	1.35 Ω	
C9V1	1 mA	9.0 V	8.6 to 9.6 V	+6.0 mV/°C	14 Ω	140 pF
	5 mA	9.1 V		+6.0 mV/°C	4.75 Ω	
	20 mA	9.4 V		+6.0 mV/°C	1.8 Ω	

7Z2 2867

OPERATING NOTES

1. Dissipation and heatsink considerations.

(a) Steady-state conditions

The maximum allowable steady-state dissipation P_S is given by the relationship

$$P_{S\ max.} = \frac{T_{j\ max.} - T_{amb}}{K_{j\text{-}amb}}$$

where $T_{j\ max.}$ is the maximum permissible operating junction temperature,

T_{amb} is the ambient temperature,

$K_{j\text{-}amb}$ is the total thermal resistance between junction and ambience.

(b) Pulse conditions (see fig. next page)

The maximum allowable pulse power P_p is given by the formula

$$P_p = \frac{(T_{j\ max.} - T_{amb}) - (P_s . K_{j\text{-}amb})}{K_t}$$

where P_s is the steady-state dissipation, excluding that in the pulses,

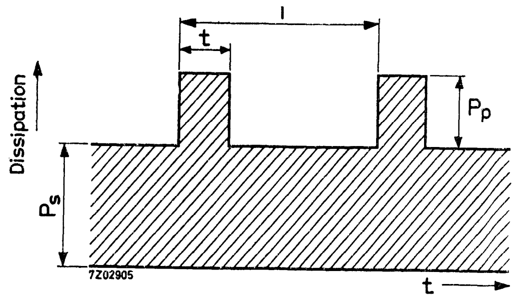
K_t is the effective transient thermal resistance of the device between junction and ambience and is a function of the pulse duration t and duty cycle δ (see page F, lower figure),

δ is the duty cycle and is equal to the pulse duration t divided by the periode duration T.

The steady-state power P_S when biased in the zener direction at a given zener current can be found from page F, upper figure. With the additional pulsed power dissipation P_p calculated from the above expression, the total peak zener power dissipation P_{tot} is $P_s + P_p$. From page F, upper figure the maximum allowable peak zener current at P_{tot} can now be read. This peak zener current is subject to the absolute maximum rating. For pulse durations longer than the temperature stabilisation time of the diode t_{stab}, the maximum dissipation P_{tot} is equal to the steady-state power $P_{S\ max.}$ The temperature stabilisation time for the BZY88-C4V7 to BZY88-C9V1 is 100 s (see page F, lower figure).

7Z2 2868

OPERATING NOTES (continued)



Example

The following example illustrates how to calculate the maximum permissible peak zener current of a BZY88-C7V5 zener diode mounted in free air at a maximum ambient temperature of 60 °C. The steady-state zener current is 10 mA, the duty cycle 0.1 and the pulse duration 1 ms.

The steady-state dissipation P_s at a zener current of 10 mA (from page F, upper figure) = 0.076 W.

The transient thermal resistance K_t with a duty cycle of 0.1 and a pulse duration of 1 ms (from page F, lower figure)

$$K_t = 41.5\ ^oC/W$$

The maximum pulse power dissipation

$$P_p = \frac{(T_{j\ max.} - T_{amb}) - P_s \cdot K_{j\text{-}amb}}{K_t}$$

if P_s = 76 mW, K_t = 41.5 °C/W

then $$P_p = \frac{(150 - 60) - (76 \times 0.31)}{41.5} = 1.6\ W$$

therefore, the total peak power,

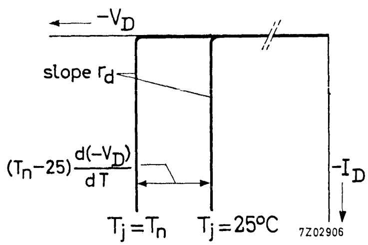
$$P_{tot} = (1.6\ W + 0.076\ W) = 1.68\ W$$

From page F, upper figure, the corresponding peak zener current is 200 mA. This is within the maximum peak rating of the BZY88-C7V5 and is therefore permissible.

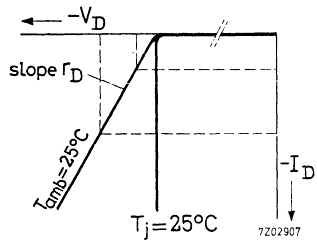
7Z2 2869

2. Zener characteristics

The basic characteristic of a zener diode is the dynamic zener characteristic, that is, the variation of zener voltage when a current pulse is applied in the reverse direction. The slope of this characteristic is r_d. Typical dynamic characteristics at T_j = 25 and 150 °C are given at page B for each type of diode. Because of the temperature sensitivity of the zener characteristics, the dynamic characteristics at any other operating temperature will be displaced from those at T_j = 25 °C by a voltage corresponding to $d(-V_D)/dT \times (T_n - 25)$ °C, where $d(-V_D)/dT$ is the temperature coefficient of the diode and T_n is a nominal operating temperature. This is illustrated below.



Dynamic characteristics



Static characteristic

The static characteristic of the diode is obtained by connecting the steady-state zener voltages at various direct zener currents and may, therefore, be used to determine the operating point at any zener current. This is shown above. The slope of the static characteristic will depend on

(1) the dynamic resistance, r_d,

(2) the rise in junction temperature due to internal dissipation and the thermal resistance from junction to ambience, $(-V_D)(-I_D)K_{j\text{-amb}}$.

(3) the temperature coefficient of the diode, $d(-V_D)/dT$.

From the above, the static slope resistance r_D is found to be

$$r_D \approx r_d + (-V_D)\,K_{j\text{-amb}}\,d(-V_D)/dT$$

where r_d is the dynamic resistance, $-V_D$ is the steady-state zener voltage and is equal to

$$\frac{-V_D'}{1-(-I_D)\,.\,K_{j\text{-amb}}\,d(-V_D)/dT}$$

$-V_D'$ being the zener voltage at $T_j = T_n$ at the working current $-I_D$.

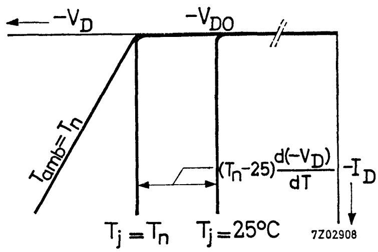
7Z2 2870

OPERATING NOTES (continued)

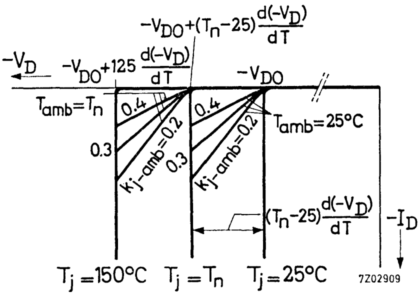
The position of this static characteristic in relation to the dynamic characteristic at $T_j = 25\ ^oC$ is dependent on the ambient temperature and the temperature coefficient, the low-current voltage being displaced by

$$d(-V_D)/dT \times (T_n-25)^oC$$

from the low current voltage, $-V_{DO}$ on the dynamic characteristic at T_j=25 ^oC (See figure below)



Next figure shows typical dynamic characteristics at T_j = 25, 150 and a nominal temperature, T_n ^oC. It also shows static characteristics at ambient temperatures of 25 and T_n ^oC with various values of $K_{j\text{-amb}}$



Typical static characteristics for each type of diode are given at page A. These curves were obtained with the device mounted in free air at an ambient temperature of 25 ^oC.

The slope resistance for pulse operation can be calculated by incorporating the transient thermal resistance K_t into the formula for r_D. Curves of K_t plotted against pulse duration and duty cycle are given in the lower figure on page F.

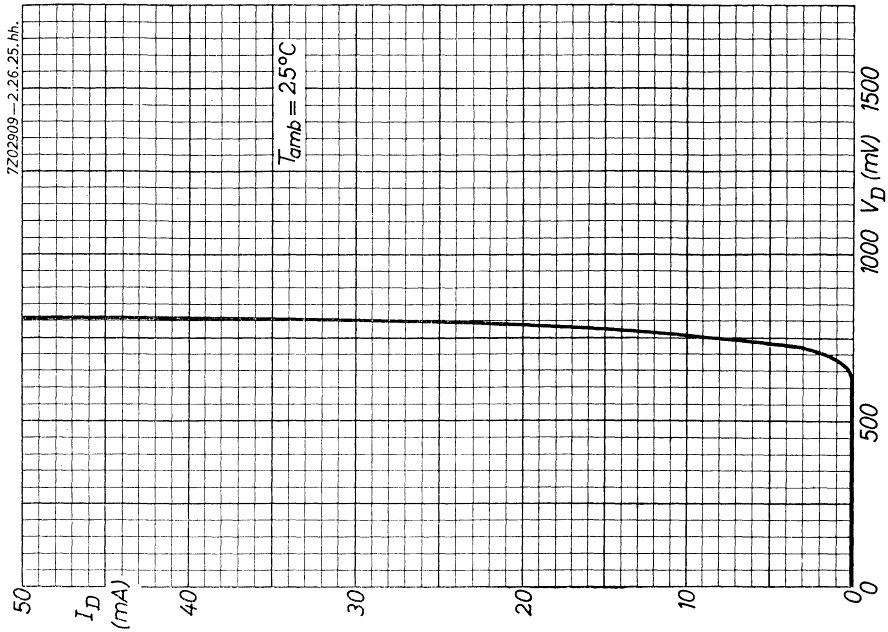
3. When using a soldering iron, the diode may be soldered directly into a circuit, but heat conducted to the junction should be kept to a minimum by use of a thermal shunt.

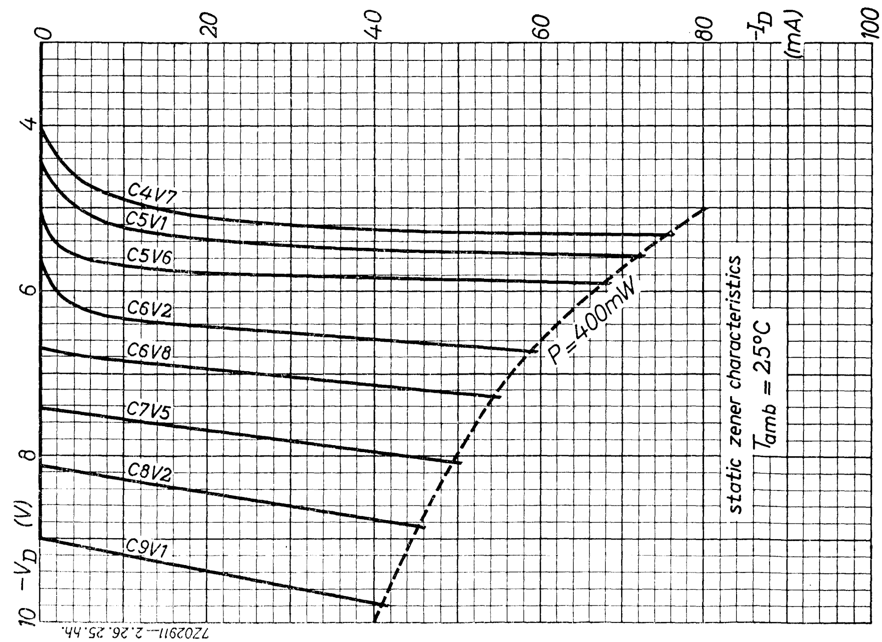
7Z2 2871

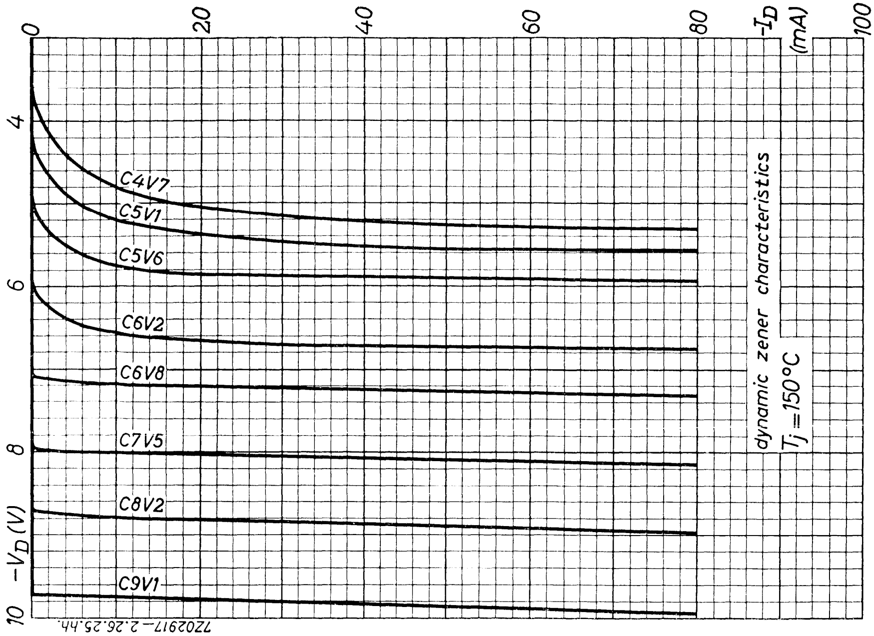
OPERATING NOTES (continued)

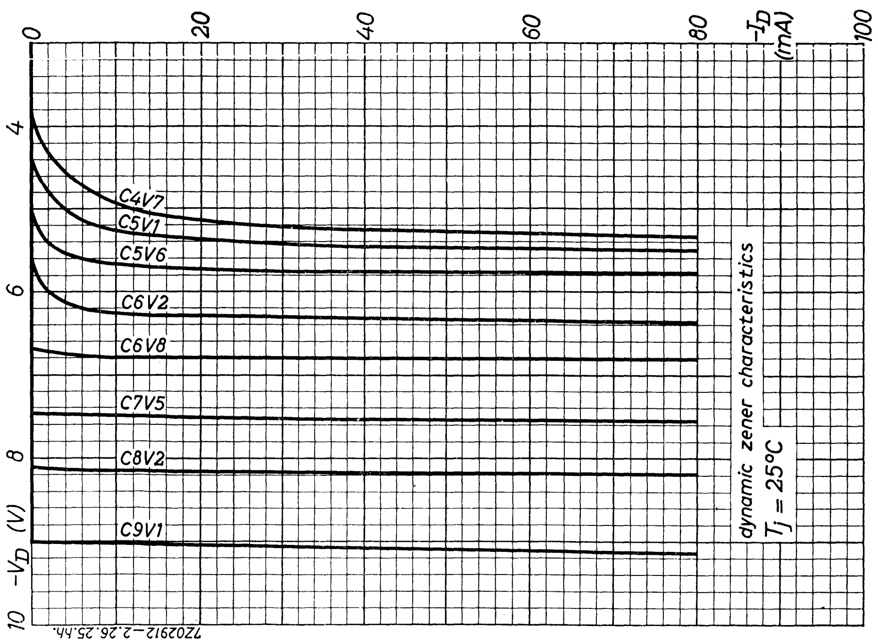
4. Diodes may be dip soldered at a solder temperature of 245 °C for a maximum soldering time of 5 seconds. The case temperature during dip soldering must not at any time exceed the maximum storage temperature. These recommendations apply to a diode with the anode end mounted flush on the board with punched-through holes. For mounting the cathode end onto the board the diode must be spaced 5 mm from the underside of the printed circuit board in the case of punched-through holes or 5 mm from the top of the board for plated-through holes.

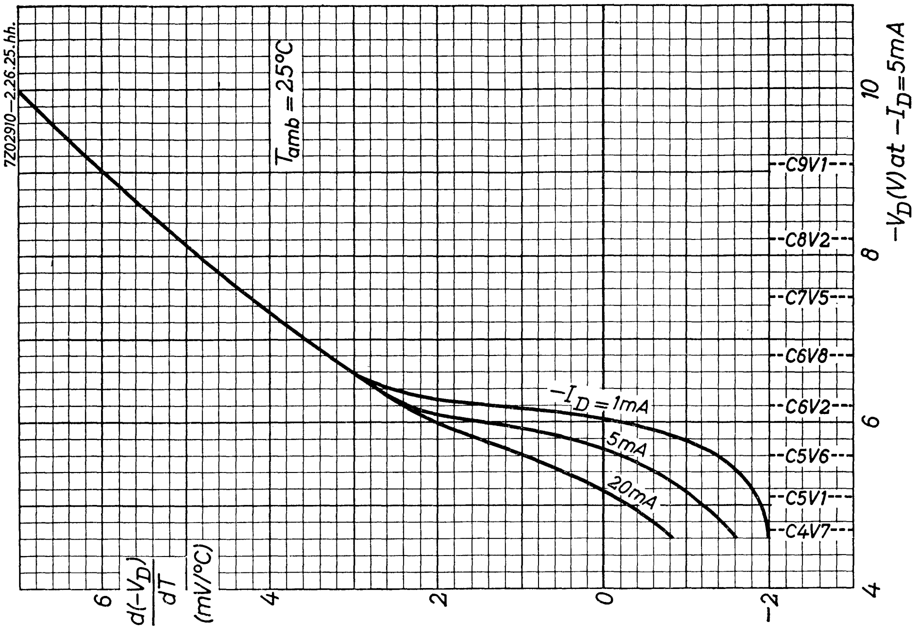
5. Care should be taken not to bend the leads nearer than 1.5 mm from the seals.

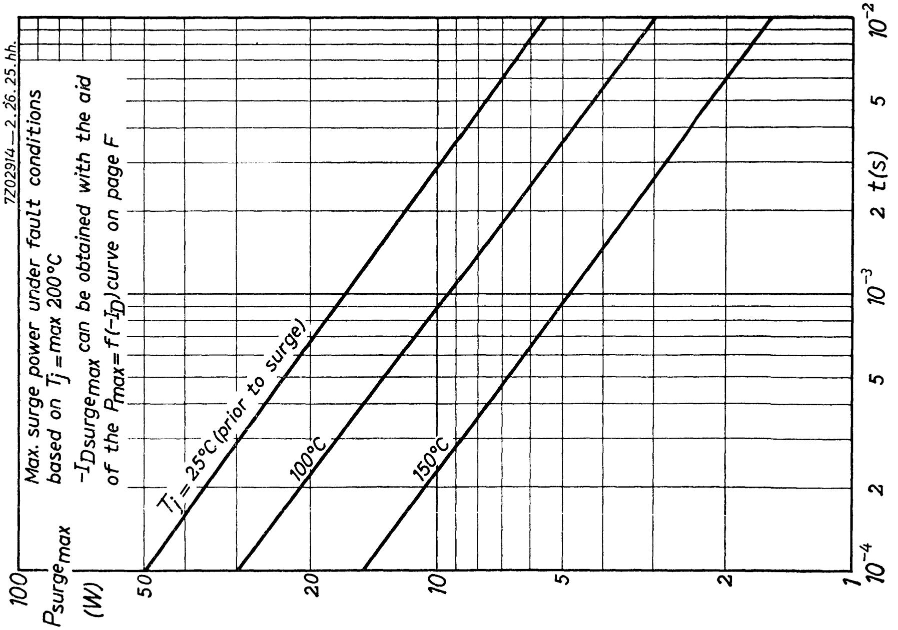

7Z02909—2.26.25.hh.
$T_{amb} = 25°C$
V_D (mV)
1500
1000
500
0
I_D (mA)
50
40
30
20
10
0

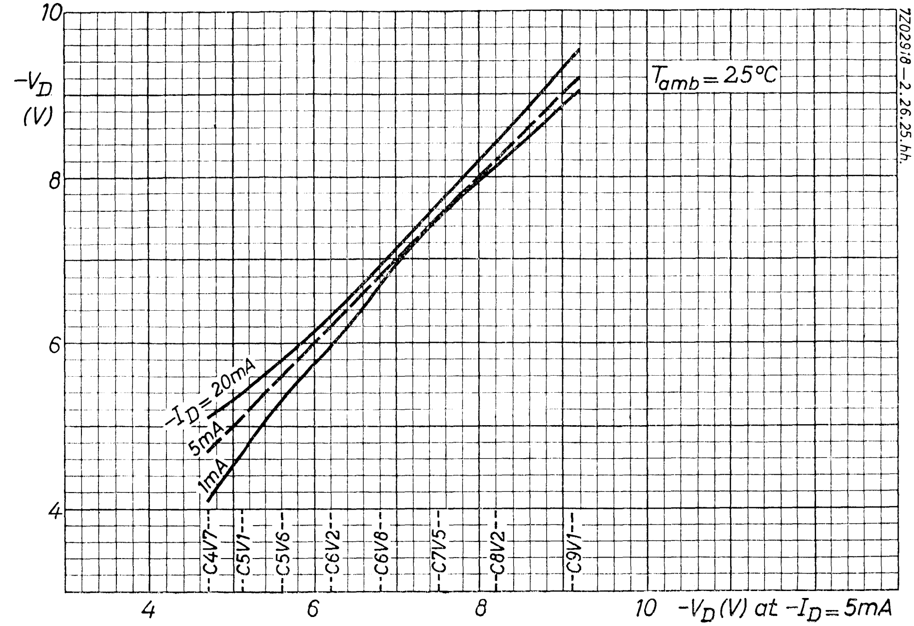

$-I_D$ (mA)
0
20
40
60
80
100
$-V_D$ (V)
4
6
8
10
C4V7
C5V1
C5V6
C6V2
C6V8
C7V5
C8V2
C9V1
P = 400mW
static zener characteristics
$T_{amb} = 25°C$
7Z02911—2.26.25.hh.


dynamic zener characteristics
$T_j = 150°C$
$-I_D$ (mA)
$-V_D$ (V)
C4V7
C5V1
C5V6
C6V2
C6V8
C7V5
C8V2
C9V1
0
20
40
60
80
100
4
6
8
10
7Z02917-2.26.25.44.

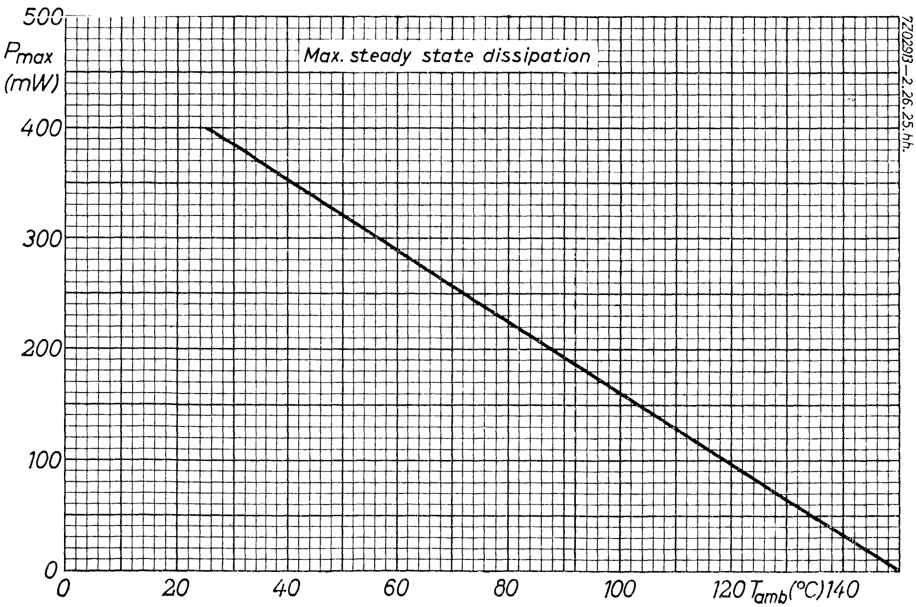

dynamic zener characteristics
$T_j = 25°C$
$-I_D$ (mA)
$-V_D$ (V)
C4V7
C5V1
C5V6
C6V2
C6V8
C7V5
C8V2
C9V1
0
20
40
60
80
100
4
6
8
10
7Z02912-2.26.25.44.


7Z02910—2.26.25.hh.
$T_{amb} = 25°C$
$-I_D = 1mA$
5mA
20mA
C9V1
C8V2
C7V5
C6V8
C6V2
C5V6
C5V1
C4V7
$\frac{d(-V_D)}{dT}$ (mV/°C)
6
4
2
0
−2
$-V_D(V)$ at $-I_D = 5mA$
4
6
8
10

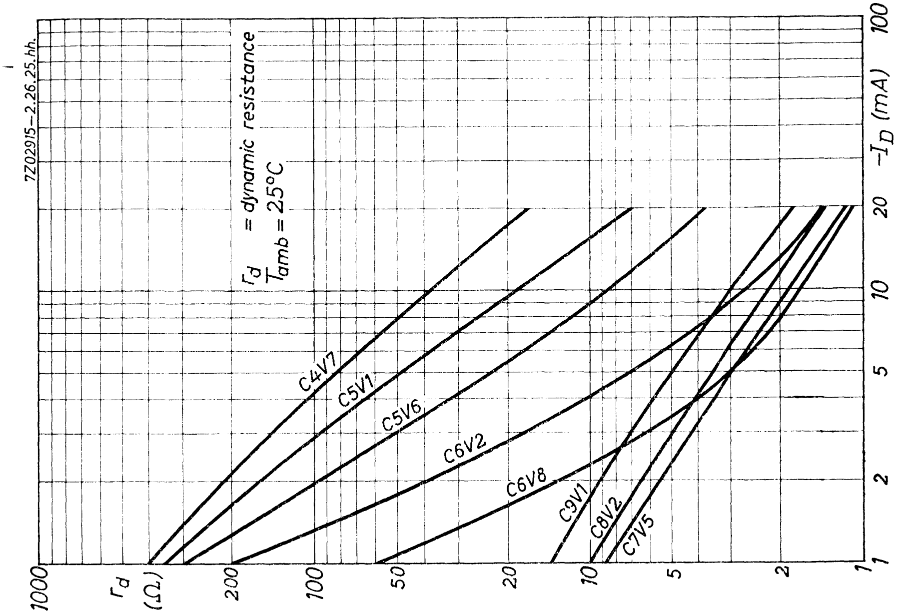

7Z02914—2.26.25.hh.
Max. surge power under fault conditions based on T_j = max 200°C
$-I_{Dsurge max}$ can be obtained with the aid of the $P_{max} = f(-I_D)$ curve on page F
$T_j = 25°C$ (prior to surge)
100°C
150°C
$P_{surge max}$ (W)
100
50
20
10
5
2
1
t(s)
10^{-4}
2
5
10^{-3}
2
5
10^{-2}

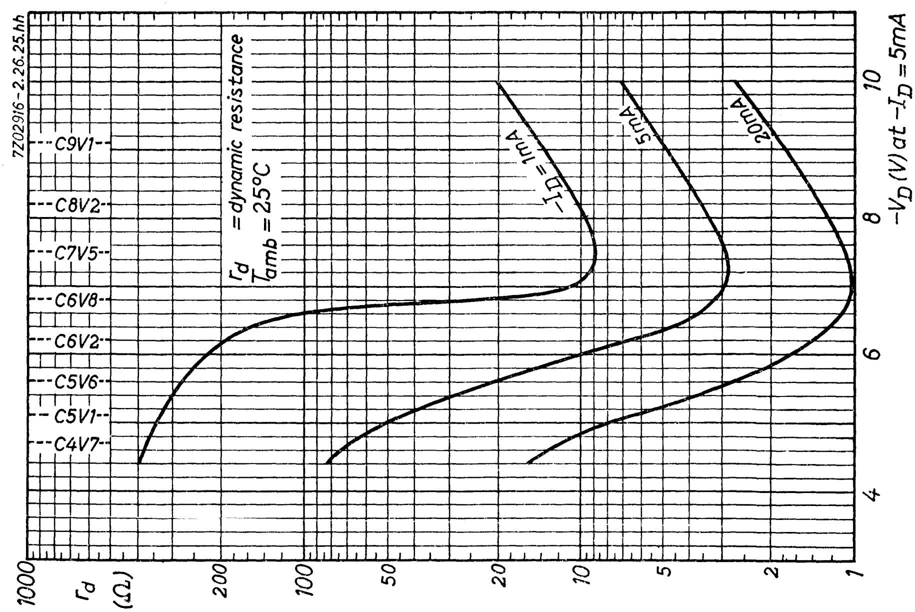


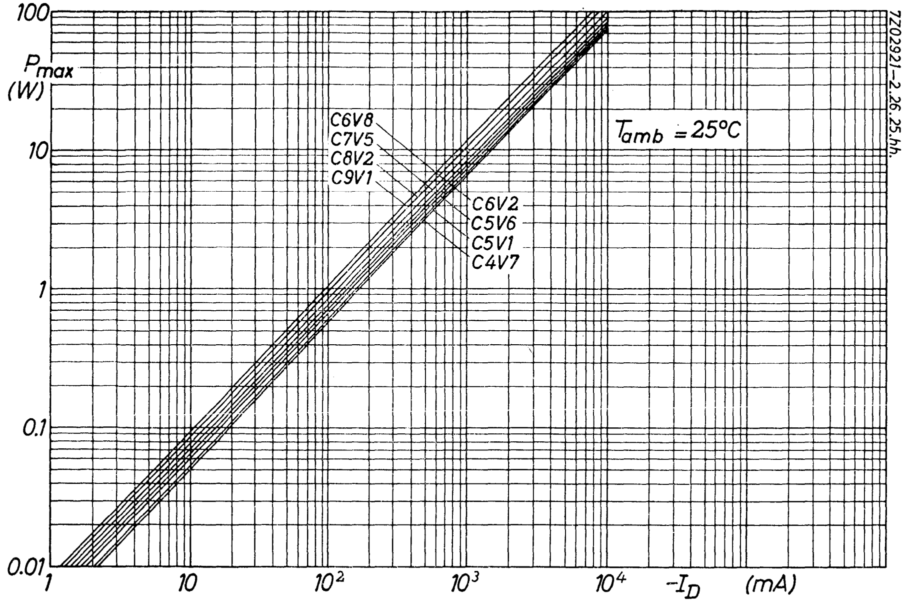
10
$-V_D$
(V)
8
6
4
$T_{amb} = 25°C$
$-I_D = 20mA$
5mA
1mA
C4V7
C5V1
C5V6
C6V2
C6V8
C7V5
C8V2
C9V1
4
6
8
10
$-V_D$ (V) at $-I_D = 5mA$
7Z02918—2.26.25.hh.

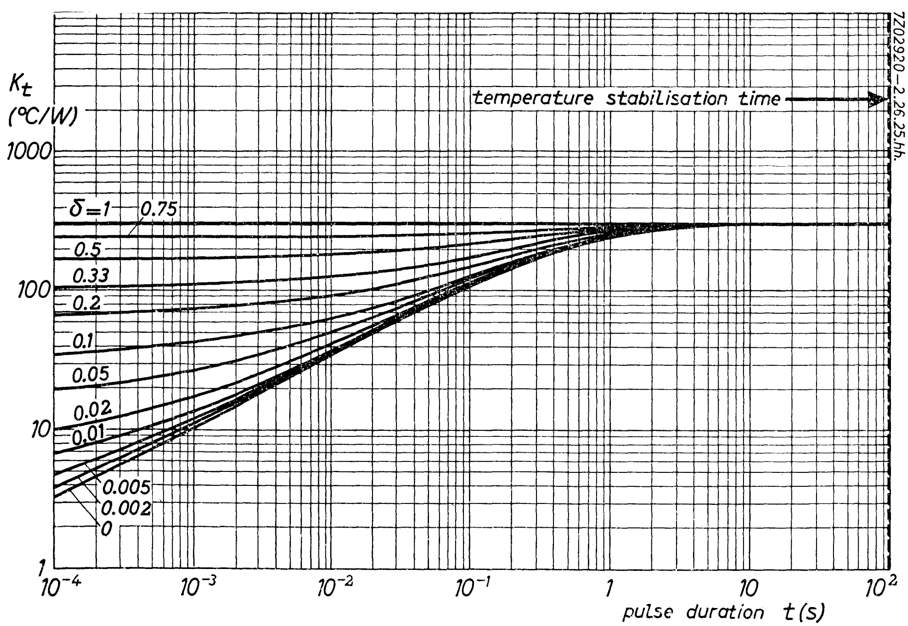


500
P_{max}
(mW)
400
300
200
100
0
Max. steady state dissipation
0
20
40
60
80
100
120
T_{amb} (°C)
140
7Z02913—2.26.25.hh.


7Z02915-2.26.25.hh.
r_d = dynamic resistance
T_{amb} = 25°C
C4V7
C5V1
C5V6
C6V2
C6V8
C9V1
C8V2
C7V5
r_d (Ω)
1000
200
100
50
20
10
5
2
1
$-I_D$ (mA)
1
2
5
10
20
100


7Z02916-2.26.25.hh
r_d = dynamic resistance
T_{amb} = 25°C
C9V1
C8V2
C7V5
C6V8
C6V2
C5V6
C5V1
C4V7
$-I_D$ = 1mA
5mA
20mA
r_d (Ω)
1000
200
100
50
20
10
5
2
1
$-V_D$ (V) at $-I_D$ = 5mA
4
6
8
10


100
10
1
0.1
0.01
P_{max} (W)
C6V8
C7V5
C8V2
C9V1
C6V2
C5V6
C5V1
C4V7
T_{amb} = 25°C
1
10
10^2
10^3
10^4
$-I_D$ (mA)
7Z02921-2.26.25.hh.


K_t (°C/W)
1000
100
10
1
temperature stabilisation time
δ=1
0.75
0.5
0.33
0.2
0.1
0.05
0.02
0.01
0.005
0.002
0
10^{-4}
10^{-3}
10^{-2}
10^{-1}
1
10
10^2
pulse duration t (s)
7Z02920-2.26.25.hh.

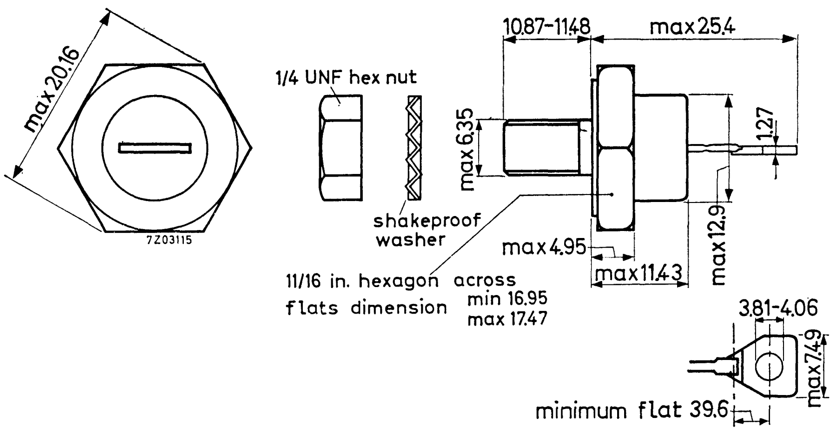
VOLTAGE REGULATOR DIODES

Diffused silicon diodes in DO-5 envelope for use in power stabilisation and transient suppression circuits.
The series consists of 22 types with typical zener voltages ranging from 10 V to 75 V with a 5% tolerance. Reverse polarity types stud anode are available.[1])

QUICK REFERENCE DATA					
Zener current (peak value)	$-I_{DM}$	=	max.	100	A
Total power dissipation at T_m = 65 °C	P_{tot}	=	max.	75	W
Surge power at T_m = 65 °C	P_{surge}	=	max.	4.4	kW
Junction temperature	T_j	=	max.	175	°C
Thermal resistance between junction and mounting base in free air	K_{j-m}	<		1.47	°C/W

MECHANICAL DATA

Dimensions in mm



Polarity of connections: BZY91 - C10 to C75 stud cathode
BZY91 - C10R to C75R stud anode

Torque on nut : max. 35 cm kg
min. 17.5 cm kg (for good thermal contact)

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1) The part after the hyphen consists of one letter indicating the nominal tolerance in % (C = 5%) and a number, indicating the typical zener voltage in volts. Reverse polarity types are denoted by "R" at the end of the type number.

7Z2 2929

LIMITING VALUES (Absolute max. values)

Forward current (peak value)	I_{DM}	=	max.	30	A
Average forward current	$I_{D(AV)}$	=	max.	10	A [1]
Zener current (peak value)	$-I_{DM}$	=	max.	100	A
Total power dissipation at $T_m = 65\ ^oC$	P_{tot}	=	max.	75	W
Surge power at $T_m = 65\ ^oC$; $\delta = 0$					
for t = 100 μs	P_{surge}	=	max.	4.4	kW
for t = 1 ms	P_{surge}	=	max.	1.48	kW
for t = 10 ms	P_{surge}	=	max.	500	W
for t = 100 ms	P_{surge}	=	max.	170	W
Storage temperature	T_S	=		−55 to 175	^oC
Junction temperature	T_j	=	max.	175	^oC

THERMAL DATA

Thermal resistance from junction to mounting base	K_{j-m}	<	1.47	$^oC/W$
Thermal resistance from mounting base to heatsink	K_{m-h}	=	0.2	$^oC/W$

[1]) Averaged over any 20 ms period.

7Z2 2930

CHARACTERISTICS at T_m = 25 °C

Forward voltage at $+I_D$ = 10 A V_D = 1.5 V

BZY91-.. BZY91-..R	Zener voltage (V)[1] at $-I_D$ = 2 A typ.	min.	max.	Dynamic resistance (Ω) at $-I_D$ = 2 A max.	Reverse voltage (V) at which $-I_D \leq$ 1 mA
C10	10	9.4	10.6	0.4	6.8
C11	11	10.4	11.6	0.4	7.5
C12	12	11.4	12.6	0.5	8.2
C13	13	12.4	14.1	0.5	9.1
C15	15	13.9	15.6	0.6	10
C16	16	15.4	17.1	0.6	11
C18	18	16.9	19.1	0.7	12

BZY91-.. BZY91-..R	Zener voltage (V)[1] at $-I_D$ = 1 A typ.	min.	max.	Dynamic resistance (Ω) at $-I_D$ = 1 A max.	Reverse voltage (V) at which $-I_D \leq$ 1 mA
C20	20	18.9	21.2	0.8	13
C22	22	20.8	23.3	0.8	15
C24	24	22.7	25.9	0.9	16
C27	27	25.1	28.9	1.0	18
C30	30	28	32	1.1	20
C33	33	31	35	1.2	22
C36	36	34	38	1.3	24

BZY91-.. BZY91-..R	Zener voltage (V)[1] at $-I_D$ = 0.5 A typ.	min.	max.	Dynamic resistance (Ω) at $-I_D$ = 0.5 A max.	Reverse voltage (V) at which $-I_D \leq$ 1 mA
C39	39	37	41	1.4	27
C43	43	40	45	1.5	30
C47	47	44	50	1.7	33
C51	51	48	54	1.8	36
C56	56	53	60	2.0	39
C62	62	58	66	2.2	43
C68	68	64	72	2.4	47
C75	75	71	79	2.6	51

[1]) The zener voltage is measured by a pulse method with $t_p \leq 100\ \mu s$, duty cycle $\leq$ 0.001 and T_j = 25 °C.

7Z2 2931

OPERATING NOTES

1. Dissipation and heatsink considerations.

a. Steady-state conditions.

The maximum allowable steady-state dissipation P_S is given by the relationship

$$P_S \text{ max.} = \frac{T_j \text{ max.} - T_{amb}}{K_{j-a}}$$

where T_j max. is the maximum permissible operating junction temperature,

T_{amb} is the ambient temperature,

K_{j-a} is the total thermal resistance between junction and ambience ($K_{j-m} + K_{m-h} + K_{h-a}$),

K_{m-h} is the thermal resistance between the mounting base and heatsink,that is 0.2 $^{\circ}$C/W

K_{h-a} is the thermal resistance of the heatsink (see page J).

b. Pulse conditions (see fig. next page).

The maximum allowable pulse power P_p is given by the formula

$$P_p = \frac{(T_j \text{ max.} - T_{amb}) - (P_S \cdot K_{j-a})}{K_t + \delta \cdot K_{m-a}}$$

where P_S is the steady-state dissipation, excluding that in the pulses,

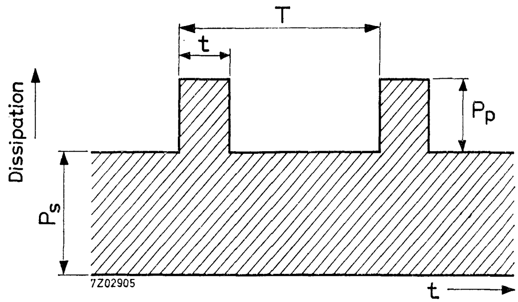
K_t is the effective transient thermal resistance of the device between junction and mounting base and is a function of the pulse duration t and duty cycle δ (see page H),

δ is the duty cycle and is equal to the pulse duration t divided by the period duration T,

K_{m-a} is the total thermal resistance between the mounting base and ambience (i.e. $K_{m-h} + K_{h-a}$).

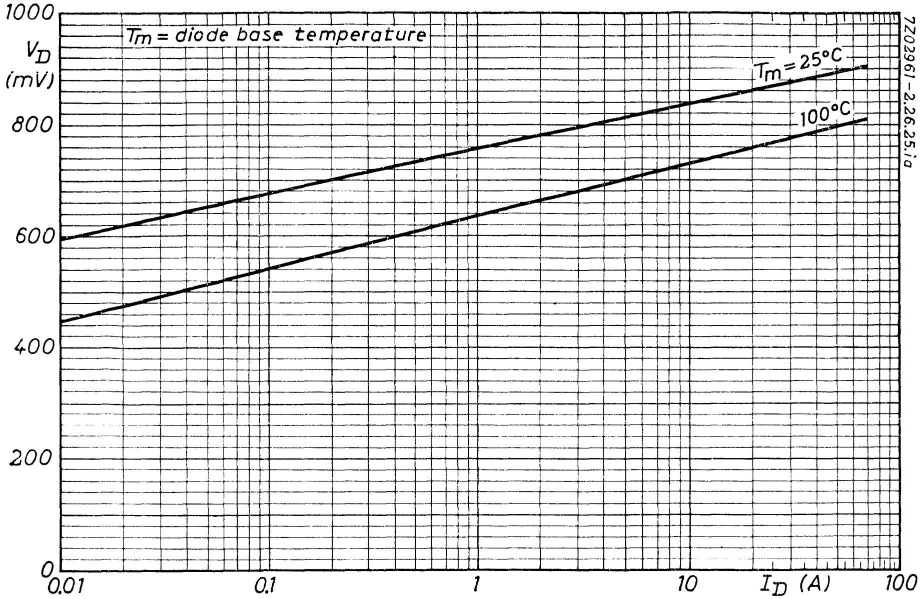
7Z2 2932

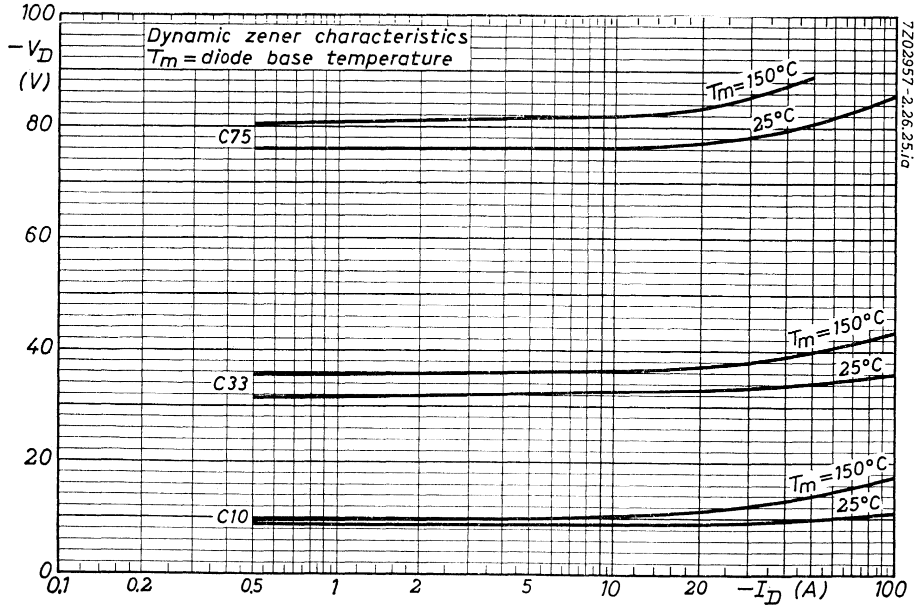
OPERATING NOTES (continued)

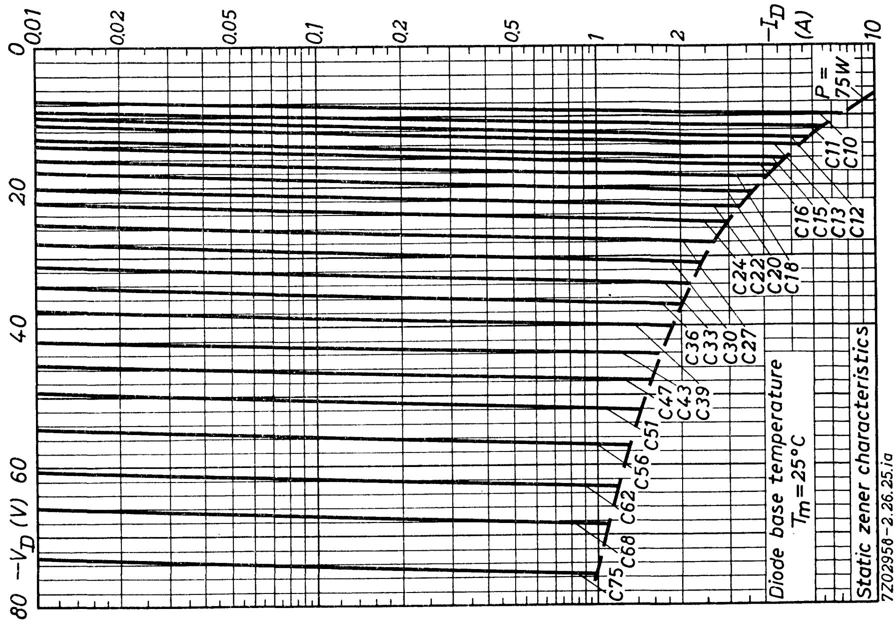


The steady-state power P_S when biased in the zener direction at a given zener current can be found from page K, lower figure. With the additional pulsed power dissipation P_p calculated from the expression on page 4, the total peak zener power dissipation $P_{tot} = P_S + P_p$. From page K, upper figure the maximum allowable peak zener current at P_{tot} can now be read. This peak zener current is subject to the absolute maximum rating. For pulse durations longer than the temperature stabilisation time of the diode t_{stab}, the maximum allowable power P_{tot} is equal to the maximum steady-state power $P_{S\,max}$. The temperature stabilisation time for the BZY91 series is 2 s (see page H).

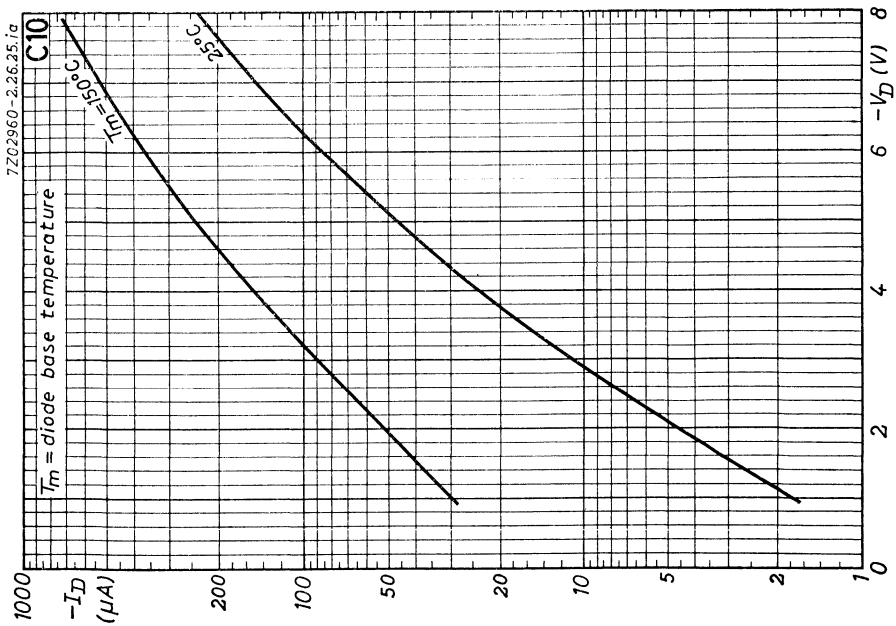
2. Care must be taken to ensure that the connecting lug is not bent or twisted.


1000
V_D
(mV)
800
600
400
200
0
0.01
0.1
1
10
I_D (A)
100
T_m = diode base temperature
T_m = 25°C
100°C
7Z02961-2.26.25.ia

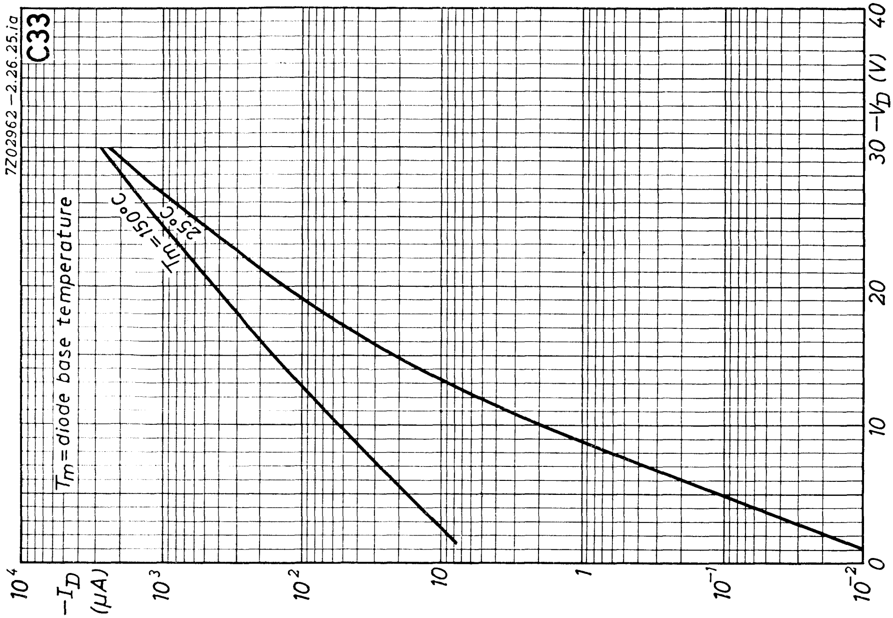

100
$-V_D$
(V)
80
60
40
20
0
0.1
0.2
0.5
1
2
5
10
20
$-I_D$ (A)
100
Dynamic zener characteristics
T_m = diode base temperature
C75
C33
C10
T_m = 150°C
25°C
T_m = 150°C
25°C
T_m = 150°C
25°C
7Z02957-2.26.25.ia

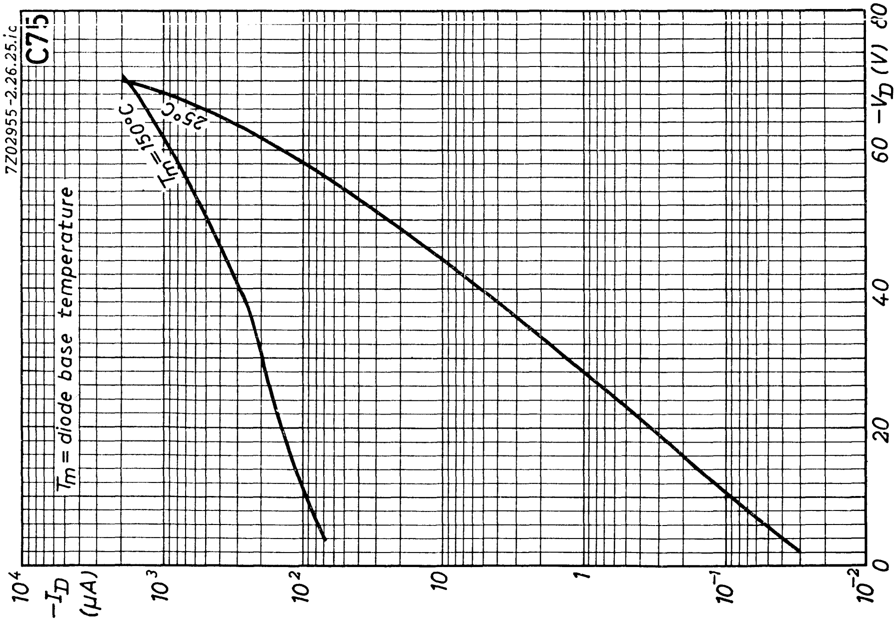


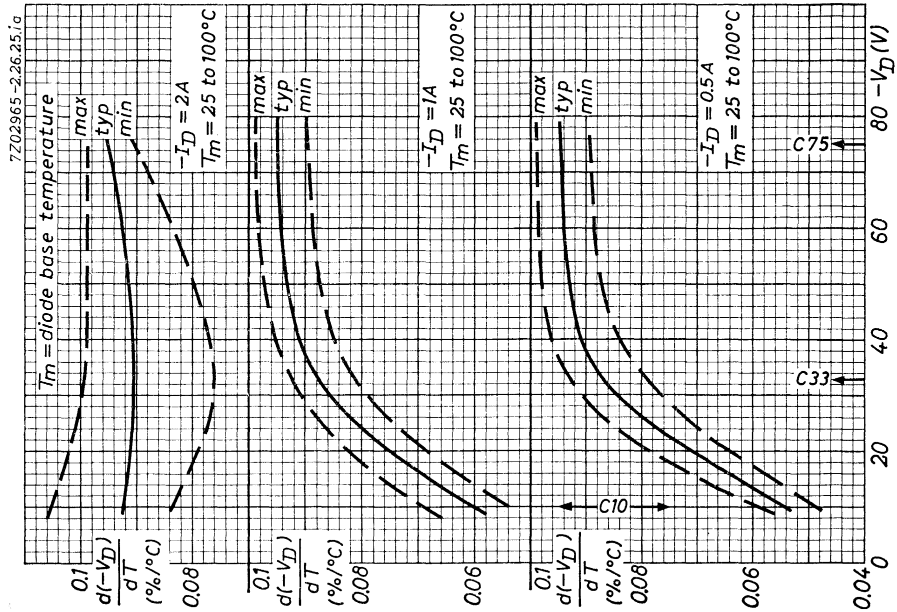
$-I_D$ (A)
$-V_D$ (V)
P = 75W
C10
C11
C12
C13
C15
C16
C18
C20
C22
C24
C27
C30
C33
C36
C39
C43
C47
C51
C56
C62
C68
C75
Diode base temperature
T_m=25°C
Static zener characteristics
7Z02958-2.26.25.ia

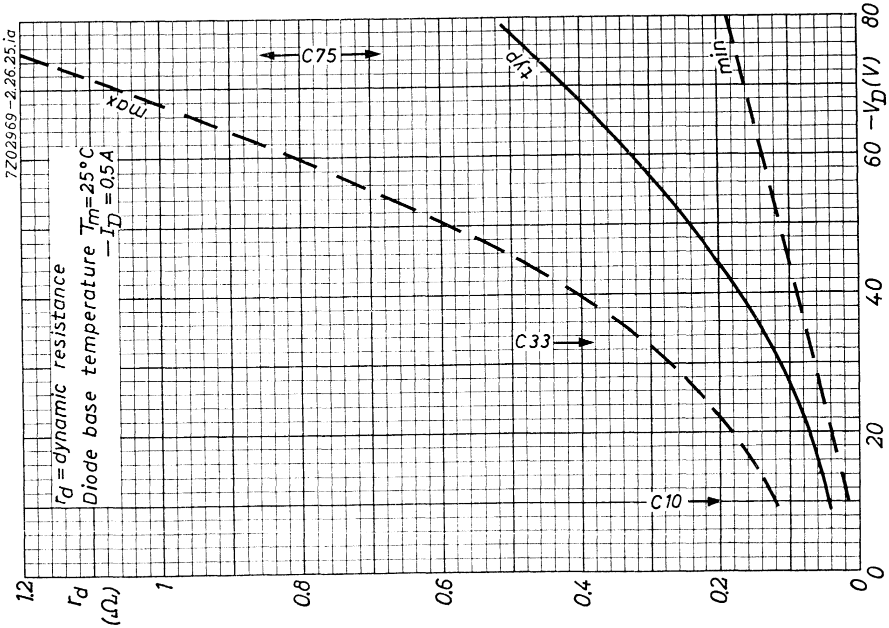


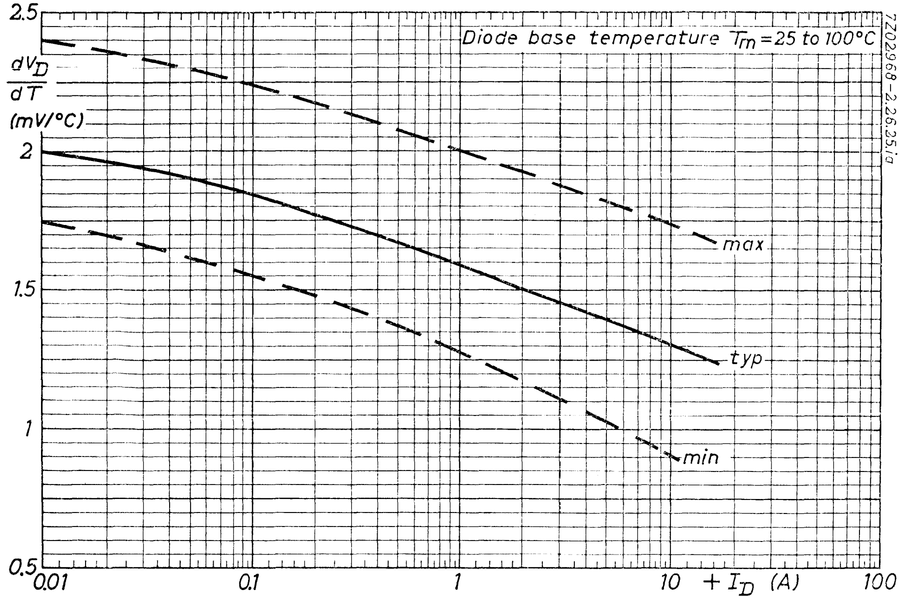
C10
T_m = diode base temperature
7Z02960-2.26.25.ia
T_m=150°C
25°C
$-I_D$ (μA)
$-V_D$ (V)


C33
7Z02962-2.26.25.ia
Tm = diode base temperature
Tm = 150°C
25°C
−VD (V)
−ID (μA)
0
10
20
30
40
10^4
10^3
10^2
10
1
10^-1
10^-2

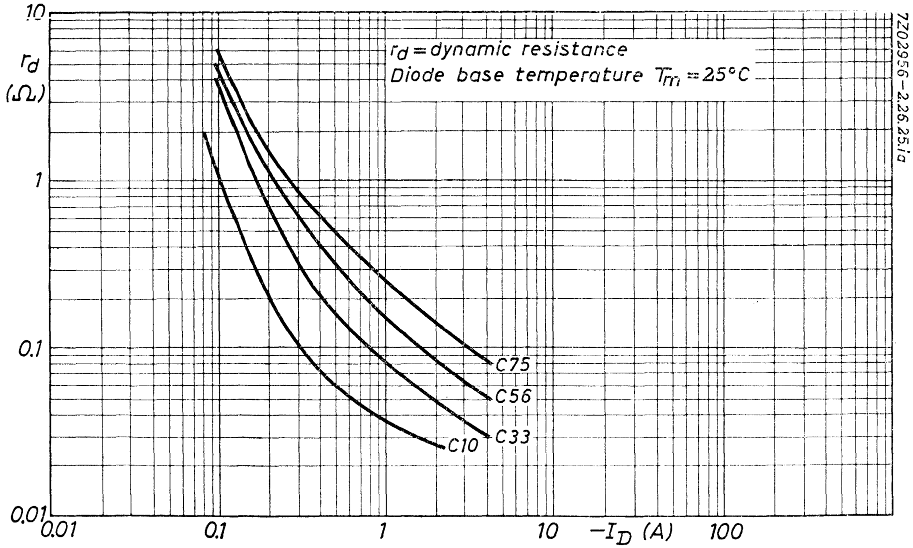

C75
7Z02955-2.26.25.ic
Tm = diode base temperature
Tm = 150°C
25°C
−VD (V)
−ID (μA)
0
20
40
60
80
10^4
10^3
10^2
10
1
10^-1
10^-2


7Z02965-2.26.25.ia
Tm = diode base temperature
max
typ
min
−ID = 2A
Tm = 25 to 100°C
−ID = 1A
Tm = 25 to 100°C
−ID = 0.5A
Tm = 25 to 100°C
C75
C33
C10
d(−VD)/dT (%/°C)
0.1
0.08
0.06
0.04
0
20
40
60
80 −VD (V)

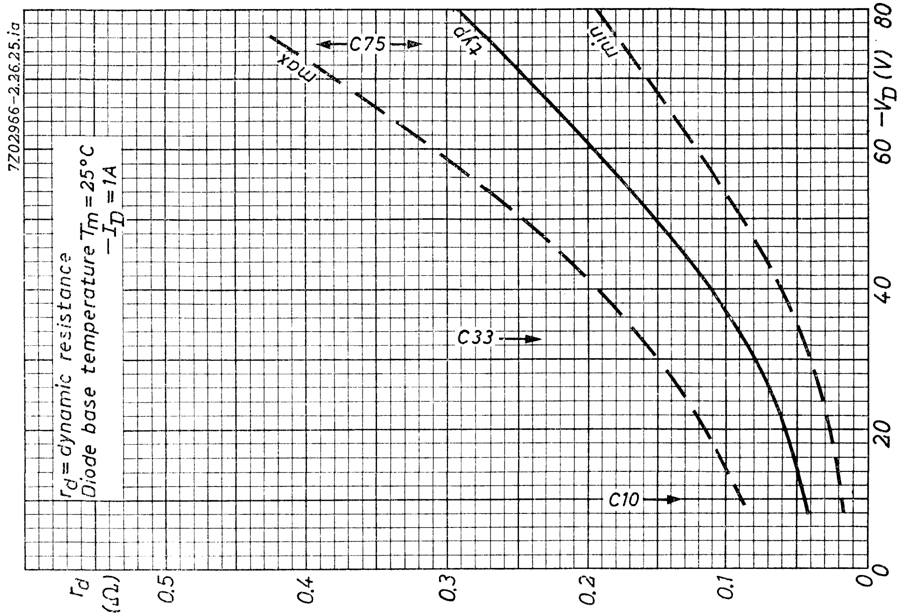

7Z02969-2.26.25.ia
rd = dynamic resistance
Diode base temperature Tm = 25°C
−ID = 0.5A
max
typ
min
C75
C33
C10
rd (Ω)
1.2
1
0.8
0.6
0.4
0.2
0
20
40
60
80 −VD (V)

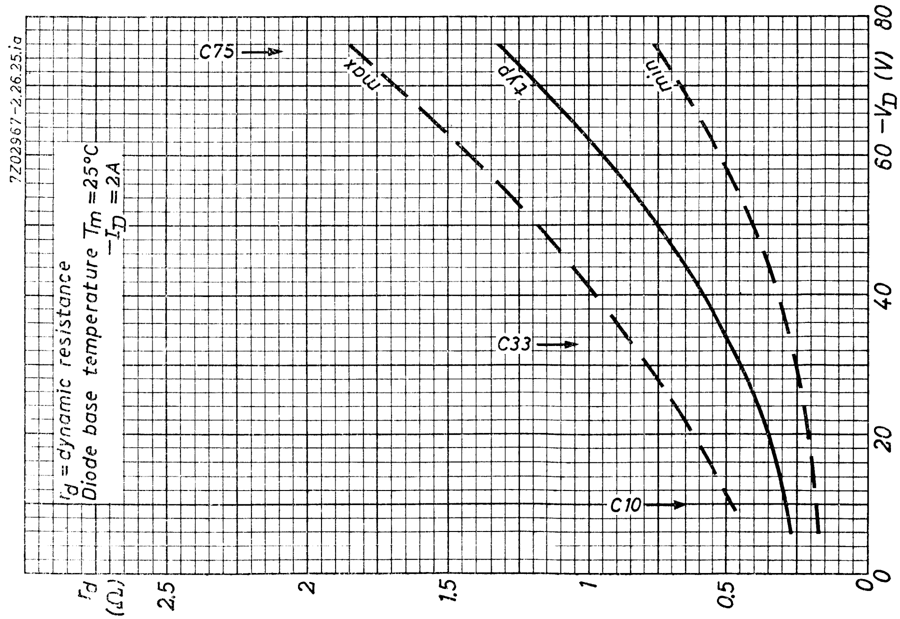


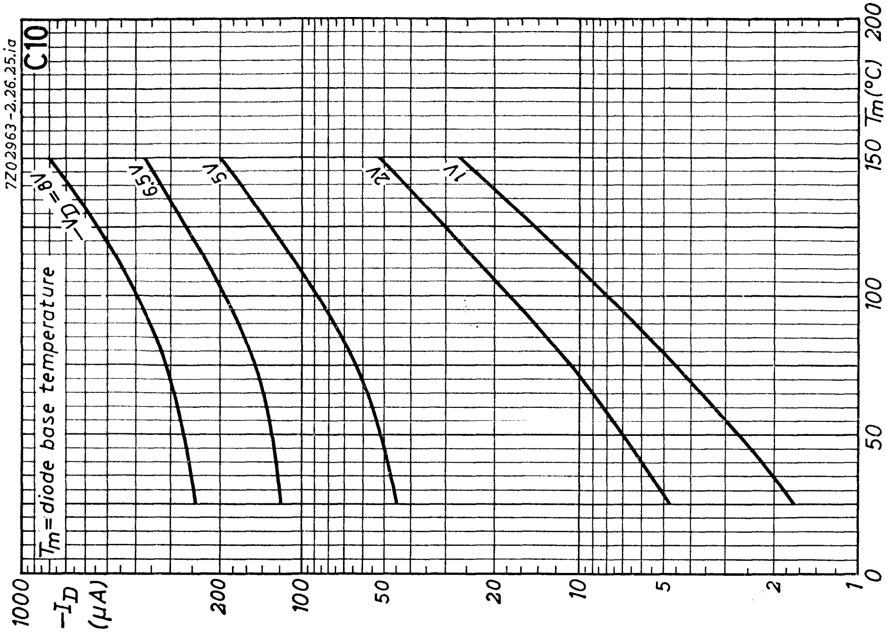
Diode base temperature T_m = 25 to 100°C
dV_D/dT (mV/°C)
max
typ
min
+ I_D (A)
7Z02968-2.26.25.ia

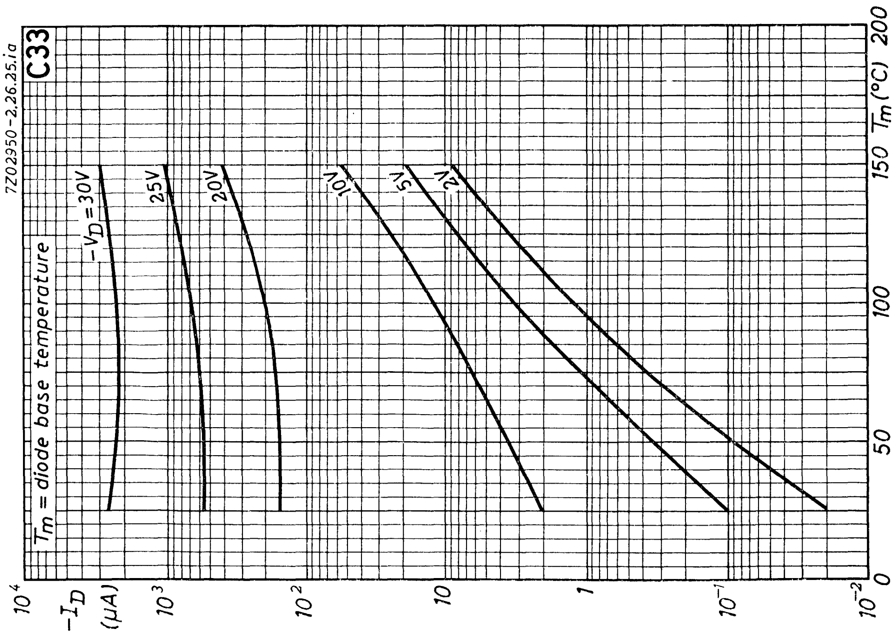


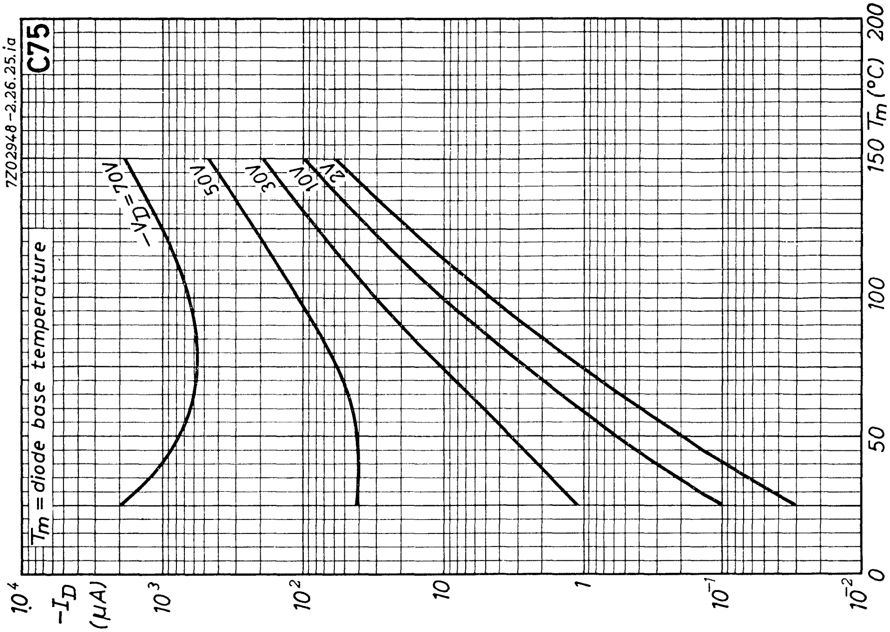
r_d = dynamic resistance
Diode base temperature T_m = 25°C
r_d (Ω)
C75
C56
C33
C10
−I_D (A)
7Z02956-2.26.25.ia

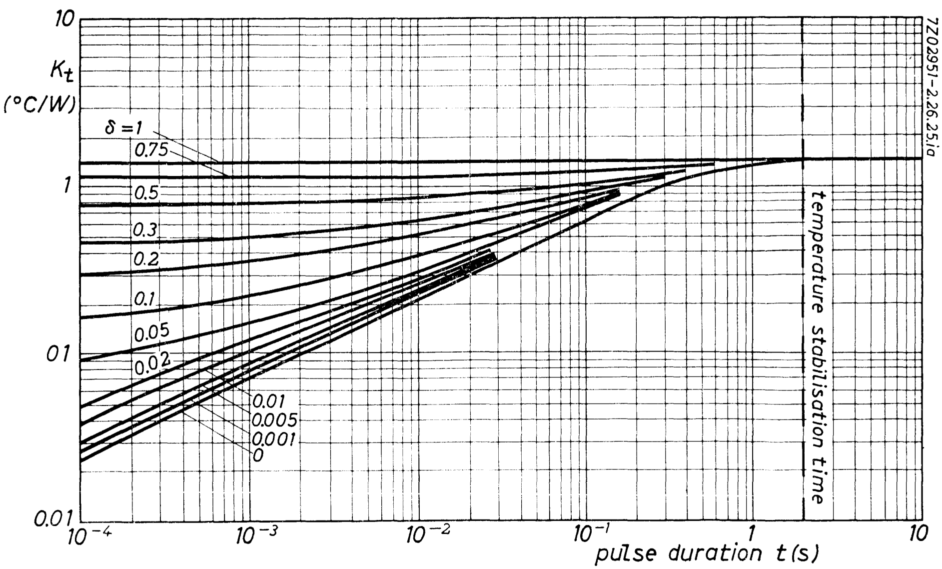

7Z02966-2.26.25.ia
r_d = dynamic resistance
Diode base temperature T_m = 25°C
$-I_D$ = 1A
C75
C33
C10
max
typ
min
r_d
(Ω)
0.5
0.4
0.3
0.2
0.1
0
0
20
40
60
80
$-V_D$ (V)

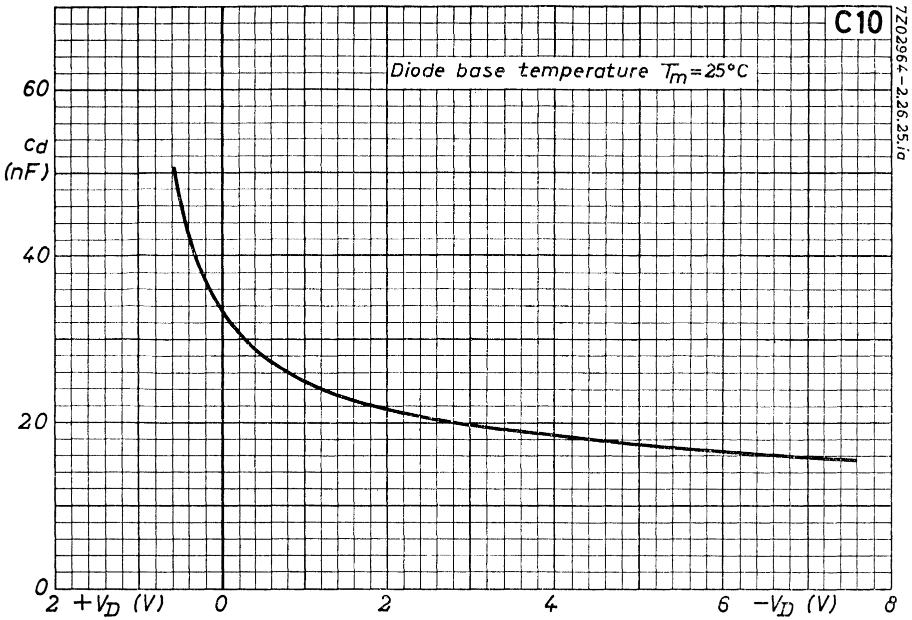

7Z02967-2.26.25.ia
r_d = dynamic resistance
Diode base temperature T_m = 25°C
$-I_D$ = 2A
C75
C33
C10
max
typ
min
r_d
(Ω)
2.5
2
1.5
1
0.5
0
0
20
40
60
80
$-V_D$ (V)

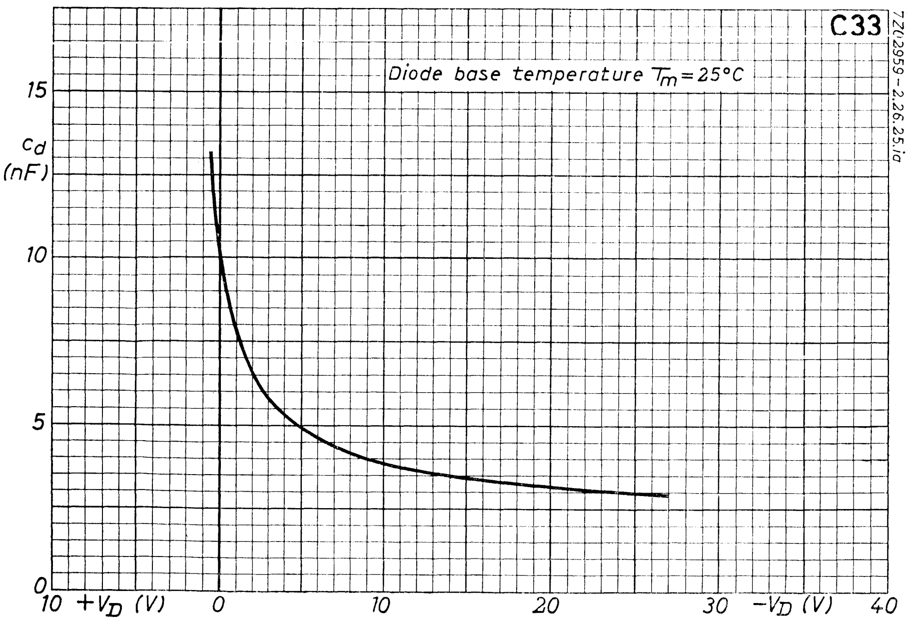

C10
7Z02963-2.26.25.ia
T_m = diode base temperature
$-V_D$ = 8V
6.5V
5V
2V
1V
$-I_D$ (μA)
T_m (°C)

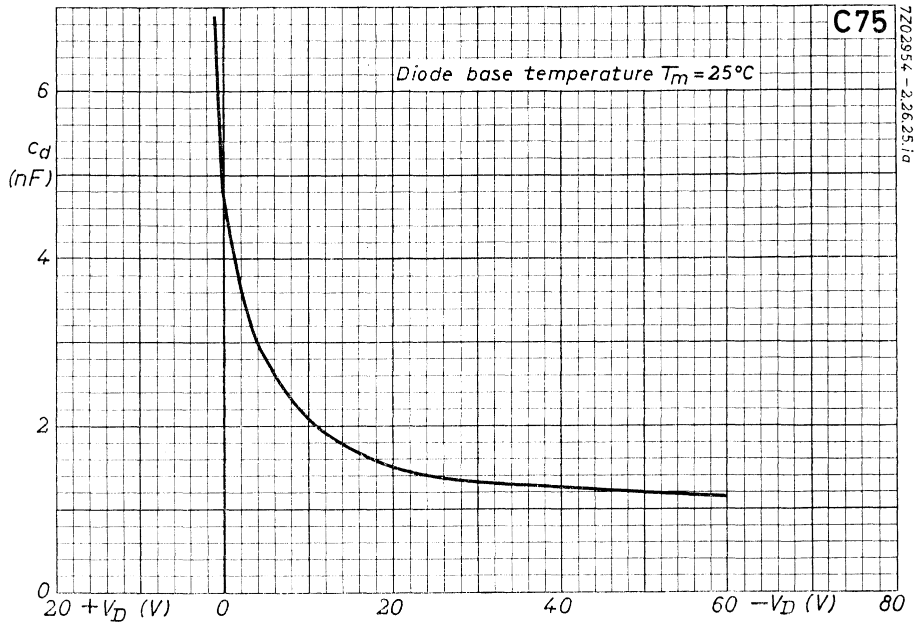

C33
7Z02950-2.26.25.ia
T_m = diode base temperature
$-V_D$ = 30V
25V
20V
10V
5V
2V
$-I_D$ (μA)
T_m (°C)

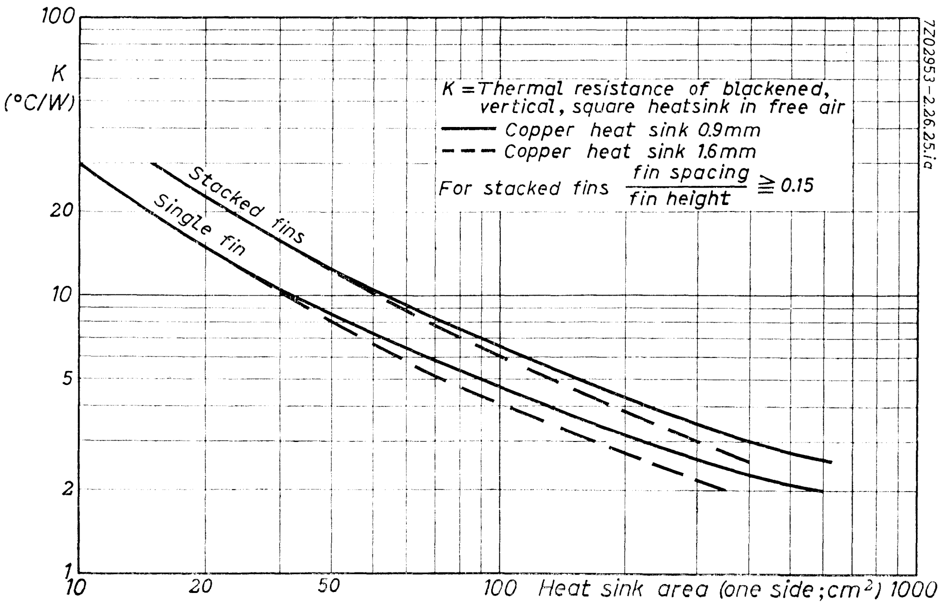

C75
7Z02948-2.26.25.ia
T_m = diode base temperature
$-V_D$ = 70V
50V
30V
10V
2V
$-I_D$ (μA)
10^4
10^3
10^2
10
1
10^{-1}
10^{-2}
T_m (°C)
0
50
100
150
200

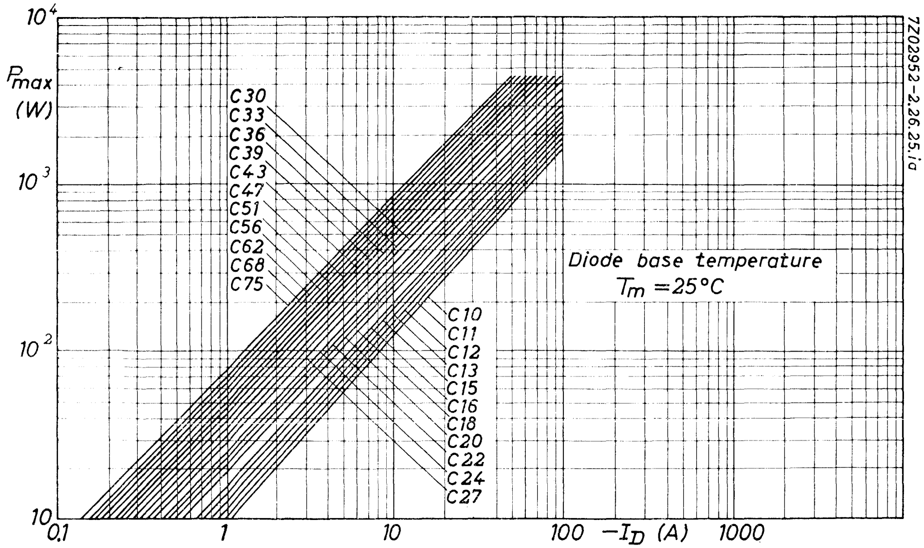

K_t (°C/W)
10
1
01
0.01
δ = 1
0.75
0.5
0.3
0.2
0.1
0.05
0.02
0.01
0.005
0.001
0
temperature stabilisation time
7Z02951-2.26.25.ia
10^{-4}
10^{-3}
10^{-2}
10^{-1}
1
10
pulse duration t (s)

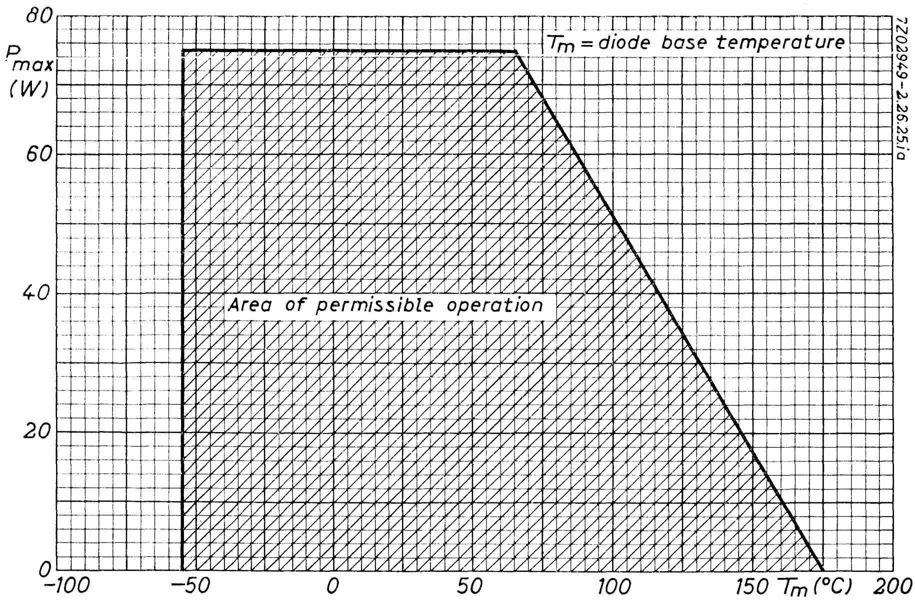

C10
Diode base temperature T_m = 25°C
7Z02964-2.26.25.ia
60
c_d
(nF)
40
20
0
2 $+V_D$ (V)
0
2
4
6 $-V_D$ (V)
8


C33
Diode base temperature T_m = 25°C
7Z02959-2.26.25.ia
15
c_d
(nF)
10
5
0
10 $+V_D$ (V)
0
10
20
30 $-V_D$ (V)
40


C75
7Z02954-2.26.25.ia
Diode base temperature T_m = 25°C
c_d
(nF)
6
4
2
0
20 +V_D (V)
0
20
40
60 −V_D (V)
80


7Z02953-2.26.25.ia
K
(°C/W)
100
20
10
5
2
1
K = Thermal resistance of blackened, vertical, square heatsink in free air
Copper heat sink 0.9mm
Copper heat sink 1.6mm
For stacked fins fin spacing / fin height ≧ 0.15
Stacked fins
Single fin
10
20
50
100
Heat sink area (one side; cm²)
1000


7Z02952-2.26.25.ia
P_{max} (W)
10^4
10^3
10^2
10
C30
C33
C36
C39
C43
C47
C51
C56
C62
C68
C75
C10
C11
C12
C13
C15
C16
C18
C20
C22
C24
C27
Diode base temperature
T_m = 25°C
0.1
1
10
100
1000
$-I_D$ (A)


7Z02949-2.26.25.ia
P_{max} (W)
80
60
40
20
0
T_m = diode base temperature
Area of permissible operation
−100
−50
0
50
100
150
200
T_m (°C)

7Z2 1082

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN at T_{amb} = 25°C, unless otherwise specified

Type No.	Zener current	Zener voltage		Temperature coefficient	Dynamic impedance
	$-I_D$	$-V_D$		$\Delta(-V_D)/\Delta T$	r_D
		average	range values		
BZZ10	1 mA	6.0 V	5.3 to 6.6 V	-1.0 mV/°C	280 Ω
	5 mA	6.15 V		+1.0 mV/°C	27 Ω
	20 mA	6.3 V		+2.0 mV/°C	3.0 Ω
	1 to 15 mA		5.0 to 7.0 V[1])		
BZZ11	1 mA	6.5 V	5.8 to 7.2 V	+1.5 mV/°C	140 Ω
	5 mA	6.55 V		+2.2 mV/°C	6.0 Ω
	20 mA	6.75 V		+3.0 mV/°C	2.0 Ω
	1 to 15 mA		5.5 to 7.5 V[1])		
BZZ12	1 mA	7.2 V	6.4 to 7.9 V	+3.3 mV/°C	17 Ω
	5 mA	7.25 V		+3.7 mV/°C	3.0 Ω
	20 mA	7.35 V		+4.1 mV/°C	1.5 Ω
	1 to 15 mA		6.2 to 8.2 V[1])		
BZZ13	1 mA	8.0 V	7.1 to 8.7 V	+4.6 mV/°C	6.0 Ω
	5 mA	8.05 V		+4.9 mV/°C	3.0 Ω
	20 mA	8.2 V		+5.2 mV/°C	2.0 Ω
	1 to 15 mA		7.0 to 9.0 V[1])		

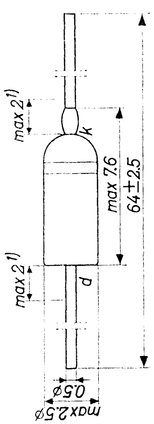
[1]) In the temperature range T_{amb} = 10 to 60 °C

2

SILICON ALLOY JUNCTION DIODE in double-ended all-glass construction for use as low current VOLTAGE STABILIZER or as a VOLTAGE REFERENCE

Dimensions in mm

The white band indicates the position of the cathode



LIMITING VALUES (Absolute maximum values)

Forward current	I_D = max.	50 mA
Reverse current	$-I_D$ = max.	25 mA
Total dissipation (see also page C)	P_{tot} = max.	$\frac{150-T_{amb}}{0.45}$ mW
Junction temperature	T_j = max.	150 °C
Storage temperature	T_s =	-55 °C to +150 °C

THERMAL DATA

Thermal resistance from junction to ambience in free air K = max. 0.45 °C/mW

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN

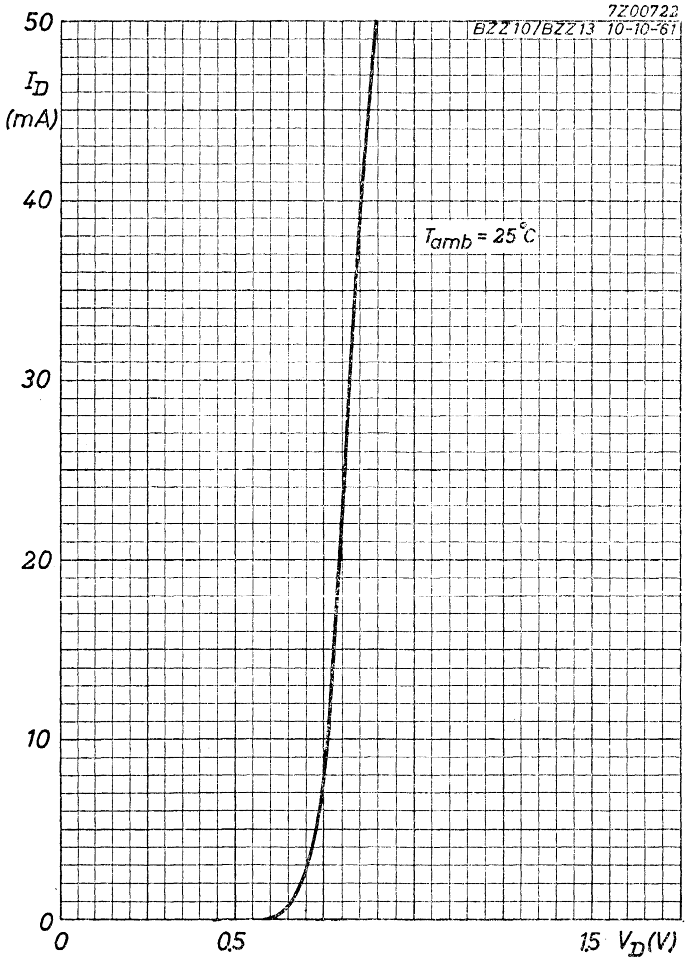
T_{amb} = 25 °C	
Forward current	Forward voltage
I_D	V_D
0.1 mA	610 mV
10 mA	760 mV

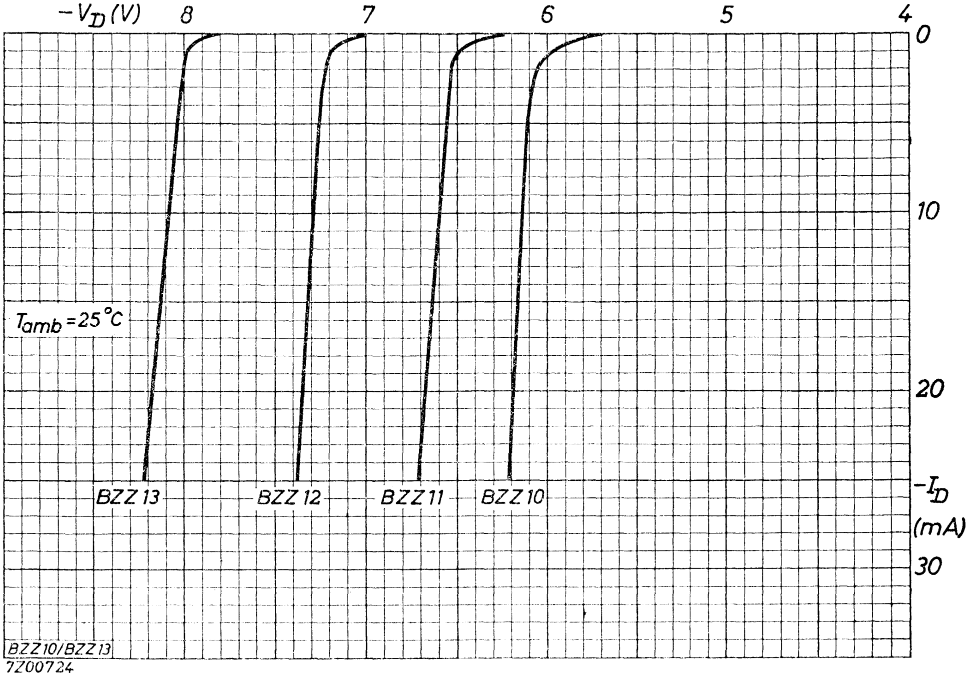
T_{amb} = 60 °C	
Reverse voltage	Reverse current
$-V_D$	$-I_D$
1.0 V	0.004 μA

[1]) Not tinned

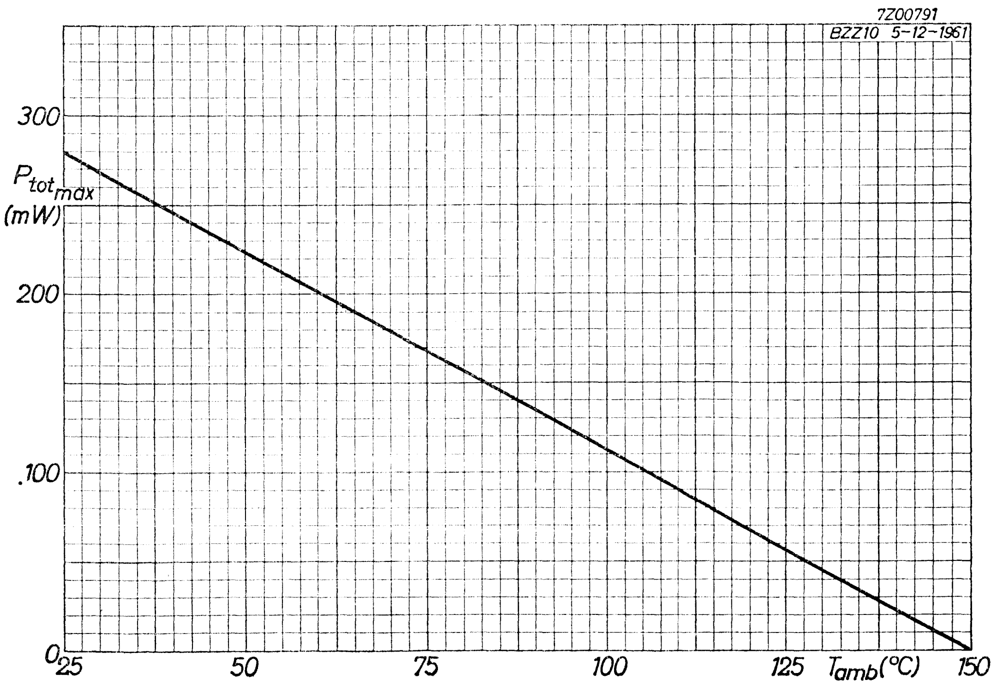
7Z2 1081
4.4.1962

1.


7Z00722
BZZ10/BZZ13 10-10-61
50
I_D
(mA)
40
30
20
10
0
0
0.5
1.5 V_D(V)
T_{amb} = 25 °C


$-V_D$ (V)
8
7
6
5
4
0
10
20
30
$-I_D$ (mA)
T_{amb} = 25 °C
BZZ 13
BZZ 12
BZZ 11
BZZ 10
BZZ10/BZZ13
7Z00724

B


7Z00791
BZZ10 5-12-1961
300
200
100
0
$P_{tot_{max}}$ (mW)
25
50
75
100
125
150
T_{amb} (°C)

C

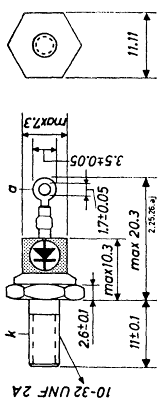
7Z2 1747

CHARACTERISTICS at a case temperature of 25 °C

		BZZ14	BZZ15	BZZ16	BZZ17	BZZ18	BZZ19	BZZ20
Forward voltage (V_D) at I_D = 200 mA	min.	0.8 V	0.8 V	0.8 V	0.8 V	0.8 V	0.8 V	0.8 V
	max.	1.05 V	1.05 V	1.05 V	1.05 V	1.05 V	1.05 V	1.05 V
Zener voltage ($-V_D$) at $-I_D$ = 20 mA	min.	5.3 V	5.8 V	6.4 V	7.1 V	7.7 V	8.6 V	9.5 V
	typ.	5.6 V	6.2 V	6.8 V	7.5 V	8.2 V	9.1 V	10.0 V
	max.	6.0 V	6.6 V	7.2 V	7.9 V	8.7 V	9.6 V	10.6 V
Dynamic resistance (r_D) at $-I_D$ = 20 mA	max.	13 Ω	6 Ω	5 Ω	7.5 Ω	10 Ω	10 Ω	11 Ω
Leakage current ($-I_D$) at $-V_D$ = 2 V	typ.	0.15 μA	0.125 μA					
	max.	0.5 μA	0.5 μA					
Leakage current ($-I_D$) at $-V_D$ = 3 V	typ.			0.04 μA	0.04 μA			
	max.			0.5 μA	0.5 μA			
Leakage current ($-I_D$) at $-V_D$ = 5 V	typ.					0.04 μA	0.04 μA	
	max.					0.4 μA	0.4 μA	0.4 μA

SILICON ALLOY JUNCTION DIODE with 5 % tolerance for use as medium current VOLTAGE STABILIZER or as a VOLTAGE REFERENCE

Dimensions in mm



The diode is supplied with nut, metal washer and metal locking washer

LIMITING VALUES (Absolute max. values)

Forward current	I_D	= max.	0.5 A
Reverse current	$-I_D$	= max.	0.5 A
Surge reverse current (max. duration 100 μsec)	$-I_{Dsurge}$	= max.	10 A [1]
	(t	= max.	100 μsec)
Dissipation (See also pages I and J)	P	= max.	$\frac{T_{jmax}-T_{amb}}{K}$
Storage temperature	T_s	=	−55 °C to +150 °C

THERMAL DATA

Thermal resistance from junction to ambience in free air	$K_{j\text{-}amb}$	= max.	70 °C/W
Thermal resistance from junction to case	$K_{j\text{-}c}$	= max.	10 °C/W

[1]) For surge currents of longer duration see page H

7Z2 1746
4.4.1963

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN

Case temperature = 25 °C

			BZZ14	BZZ15	BZZ16	BZZ17	
Forward voltage (V_D)	I_D = 0-0.5 A	min. typ. max.	See page A				
Zener voltage ($-V_D$)	$-I_D$ = 50 mA	min.	5.4	5.8	6.4	7.0	V
		typ.	5.7	6.25	6.8	7.5	V
		max.	6.2	6.8	7.2	8.0	V
	$-I_D$ = 100 mA	min.	5.5	5.8	6.4	7.2	V
		typ.	5.72	6.3	6.9	7.6	V
		max.	6.3	6.8	7.4	8.2	V
	$-I_D$ = 200 mA	min.	5.5	5.9	6.6	7.2	V
		typ.	5.85	6.35	6.95	7.7	V
		max.	6.4	7.0	7.4	8.4	V
	$-I_D$ = 500 mA	min.	5.5	6.0	6.6	7.1	V
		typ.	5.97	6.6	7.12	7.82	V
		max.	6.5	7.4	7.9	8.5	V
Dynamic resistance (r_D)	$-I_D$ = 100 mA	typ.	See page G				
		max.	4	2.5	2.5	3.5	Ω
	$-I_D$ = 500 mA	typ.	See page G				
		max.	1.0	2.0	2.5	3.0	Ω
Temperature coefficient $\frac{\Delta(-V_D)}{\Delta T}$	$-I_D$ = 20 mA	typ.	See page F				
		min.	-0.4	1.0	2.0	3.0	mV/°C
		max.	2.5	3.5	4.0	4.5	mV/°C
	$-I_D$ = 100 mA	typ.	See page F				
		min.	0.5	2.0	2.5	3.0	mV/°C
		max.	3.0	4.0	4.0	4.0	mV/°C
	$-I_D$ = 500 mA	typ.	See page F				
		min.	0.0	1.5	2.5	3.0	mV/°C
		max.	3.0	4.0	4.0	7.0	mV/°C
Capacitance (c_{dk})	$-V_D$ = 2 V	typ.	575	475	375	350	pF

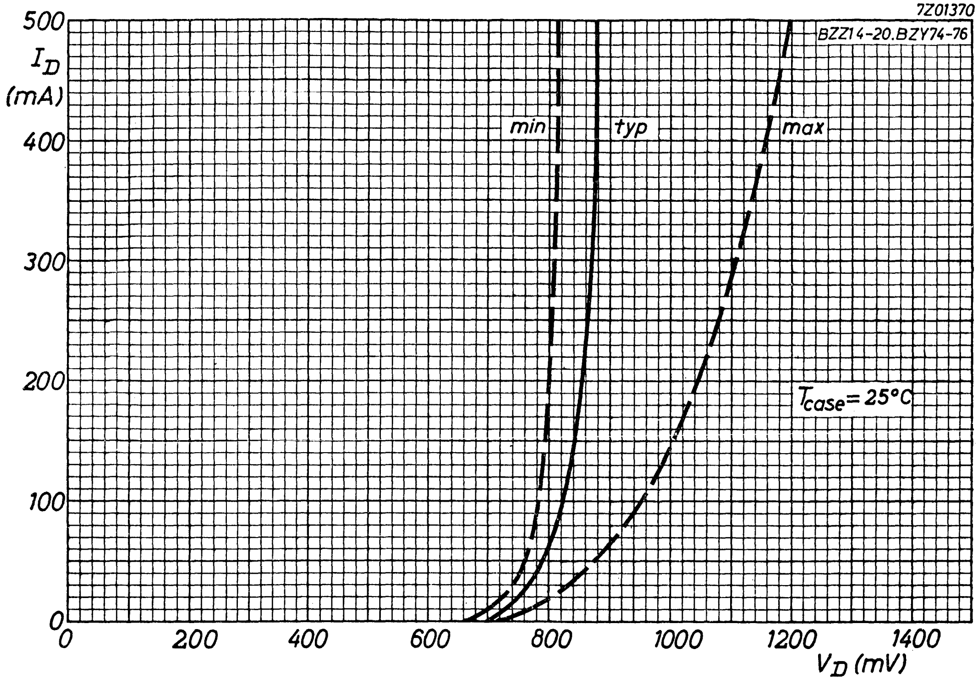
7Z2 1748
4.4.1963

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN (continued)

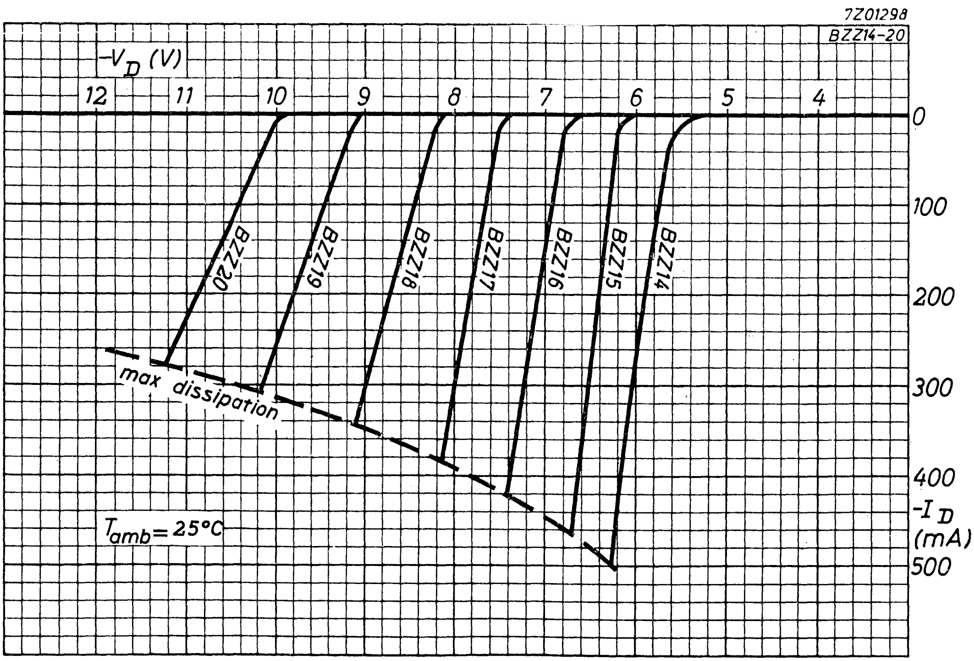
Case temperature = 25 °C

			BZZ18	BZZ19	BZZ20	
Forward voltage (V_D)	I_D = 0-0.5 A	min. typ. max.	See page A			
Zener voltage ($-V_D$)	$-I_D$ = 50 mA	min.	7.8	8.6	9.6	V
		typ.	8.25	9.2	10.2	V
		max.	8.8	9.8	10.7	V
	$-I_D$ = 100 mA	min.	7.8	8.8	9.6	V
		typ.	8.35	9.3	10.3	V
		max.	9.0	10.0	11.0	V
	$-I_D$ = 200 mA	min.	8.0	9.0	9.9	V
		typ.	8.45	9.45	10.5	V
		max.	9.4	10.5	11.3	V
	$-I_D$ = 500 mA	min.	8.0	8.8	10.0	V
		typ.	8.57	9.55	10.72	V
		max.	9.5	10.2	11.6	V
Dynamic resistance (r_D)	$-I_D$ = 100 mA	typ.	See page G			
		max.	5	5	5	Ω
	$-I_D$ = 500 mA	typ.	See page G			
		max.	3.0	3.0	3.0	Ω
Temperature coefficient $\frac{\Delta(-V_D)}{\Delta T}$	$-I_D$ = 20 mA	typ.	See page F			
		min.	4.0	3.5	6.0	mV/°C
		max.	6.0	6.5	8.0	mV/°C
	$-I_D$ = 100 mA	typ.	See page F			
		min.	3.0	4.0	3.0	mV/°C
		max.	6.1	7.0	11.0	mV/°C
	$-I_D$ = 500 mA	typ.	See page F			
		min.	3.5	4.5	3.0	mV/°C
		max.	6.8	7.5	11.0	mV/°C
Capacitance (c_{dk})	$-V_D$ = 2 V	typ.	300	250		pF

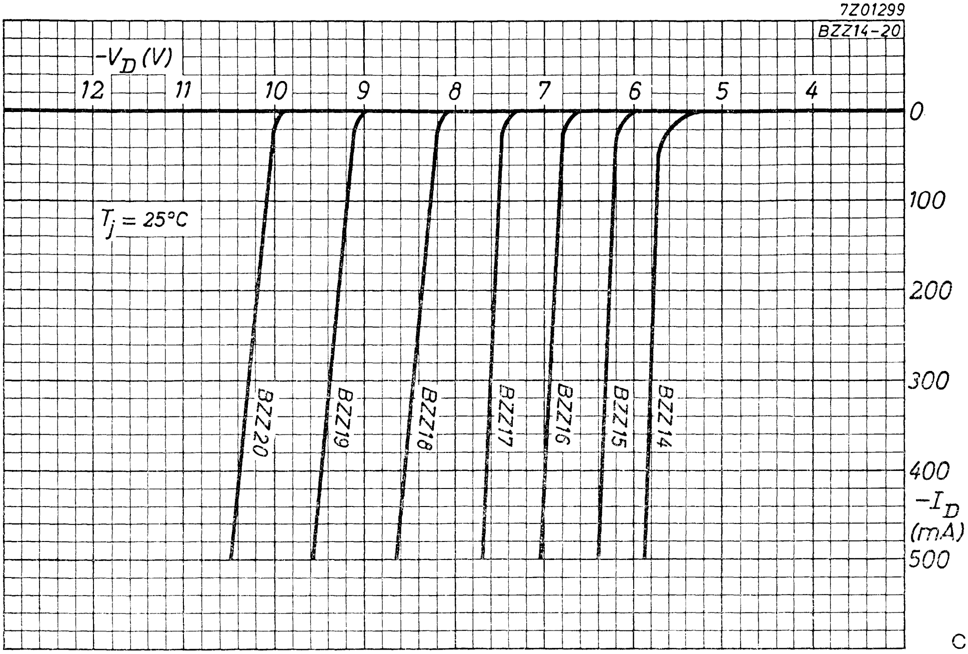
7Z2 1749


7Z01370
BZZ14-20.BZY74-76
I_D (mA)
500
400
300
200
100
0
min
typ
max
T_{case} = 25°C
0
200
400
600
800
1000
1200
1400
V_D (mV)

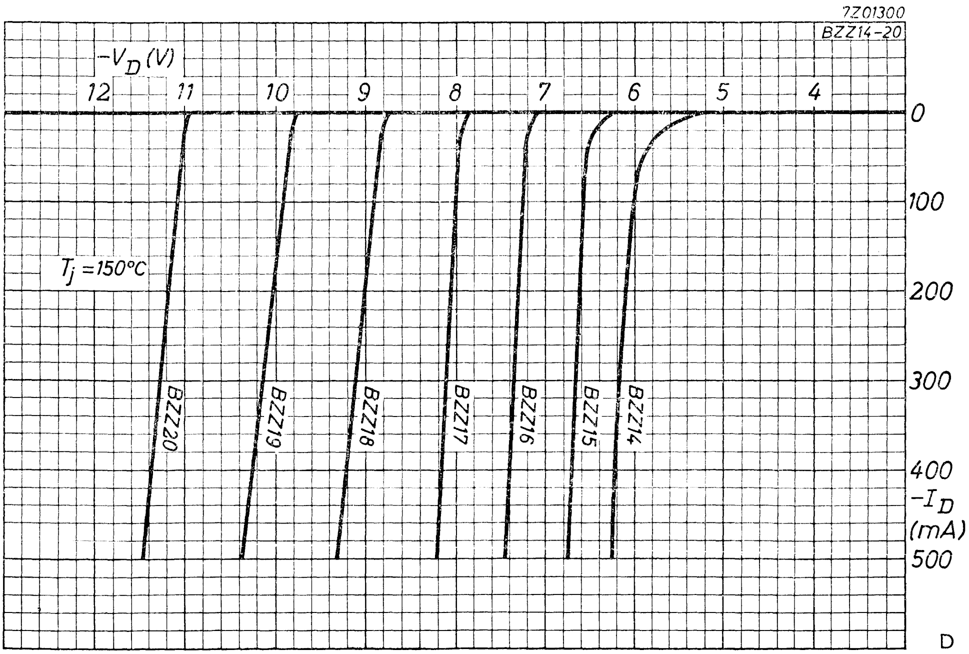
A


7Z01298
BZZ14-20
$-V_D$ (V)
12
11
10
9
8
7
6
5
4
0
100
200
300
400
$-I_D$ (mA)
500
BZZ20
BZZ19
BZZ18
BZZ17
BZZ16
BZZ15
BZZ14
max dissipation
T_{amb} = 25°C

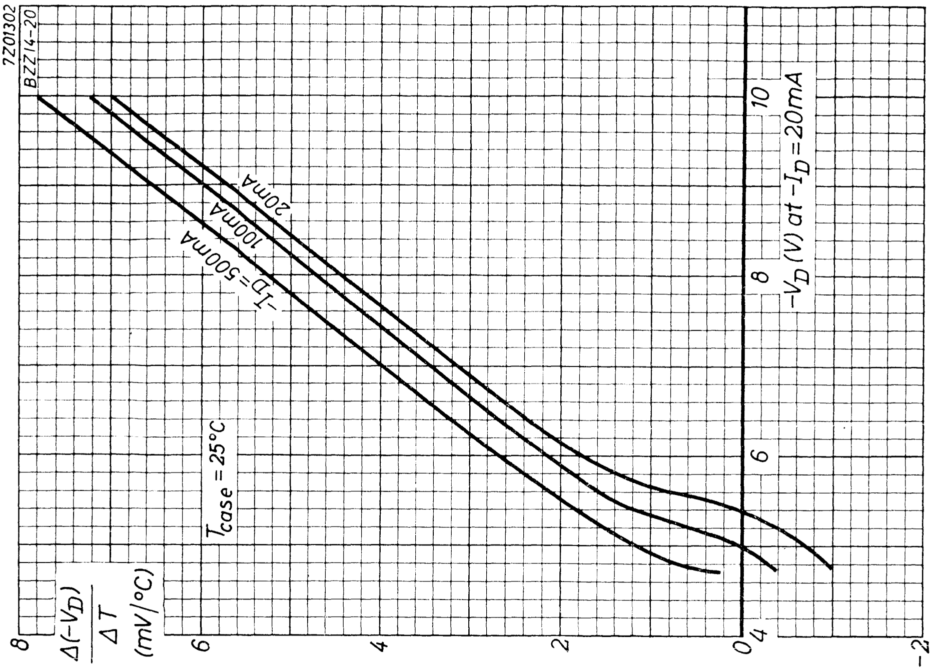
B


7Z01299
BZZ14-20
$-V_D$ (V)
12
11
10
9
8
7
6
5
4
0
100
200
300
400
500
$-I_D$
(mA)
T_j = 25°C
BZZ20
BZZ19
BZZ18
BZZ17
BZZ16
BZZ15
BZZ14

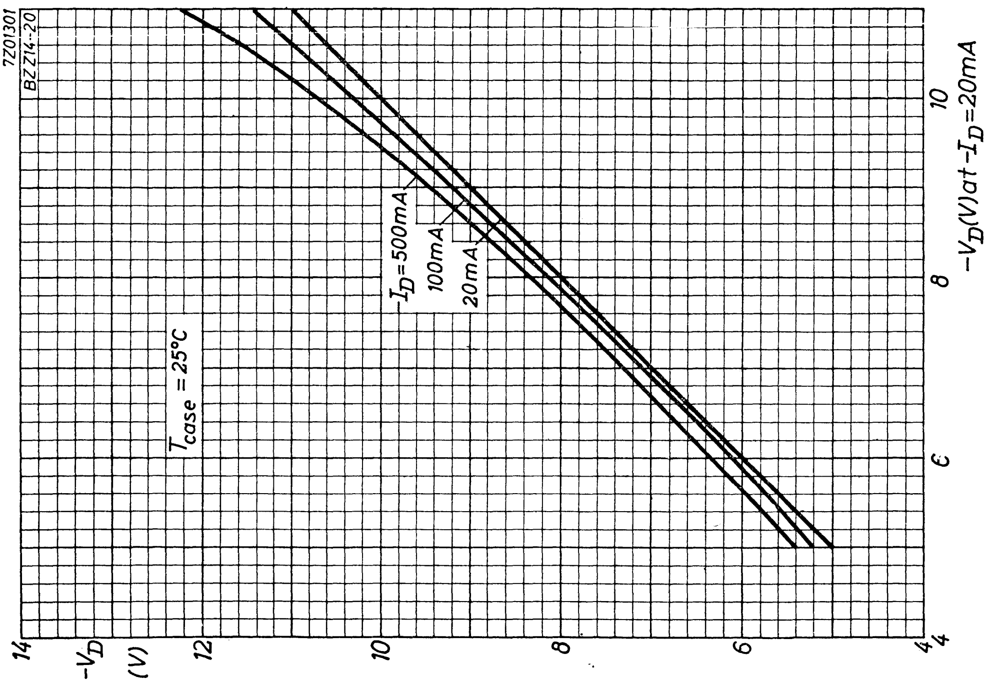
C


7Z01300
BZZ14-20
$-V_D$ (V)
12
11
10
9
8
7
6
5
4
0
100
200
300
400
500
$-I_D$
(mA)
T_j =150°C
BZZ20
BZZ19
BZZ18
BZZ17
BZZ16
BZZ15
BZZ14

D


7Z01302
BZZ14-20
Δ(−V_D)/ΔT (mV/°C)
T_case = 25°C
−I_D=500mA
100mA
20mA
−V_D (V) at −I_D=20mA
8
6
4
2
0
−2
4
6
8
10

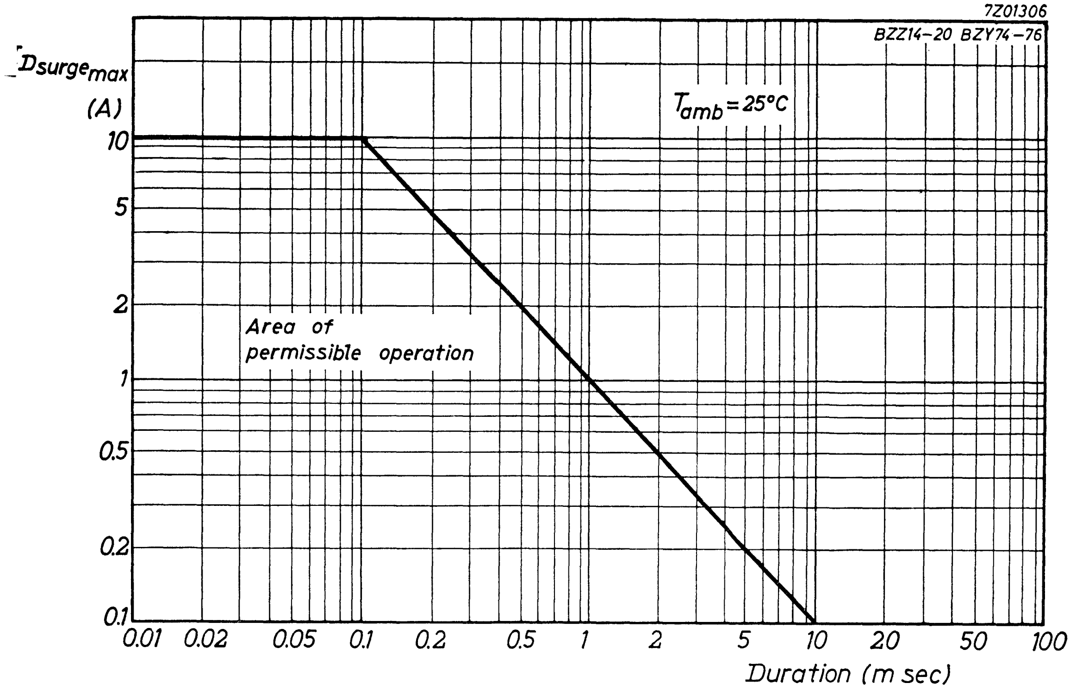
F


7Z01301
BZZ14-20
−V_D (V)
T_case = 25°C
−I_D=500mA
100mA
20mA
−V_D(V)at −I_D=20mA
14
12
10
8
6
4
4
6
8
10

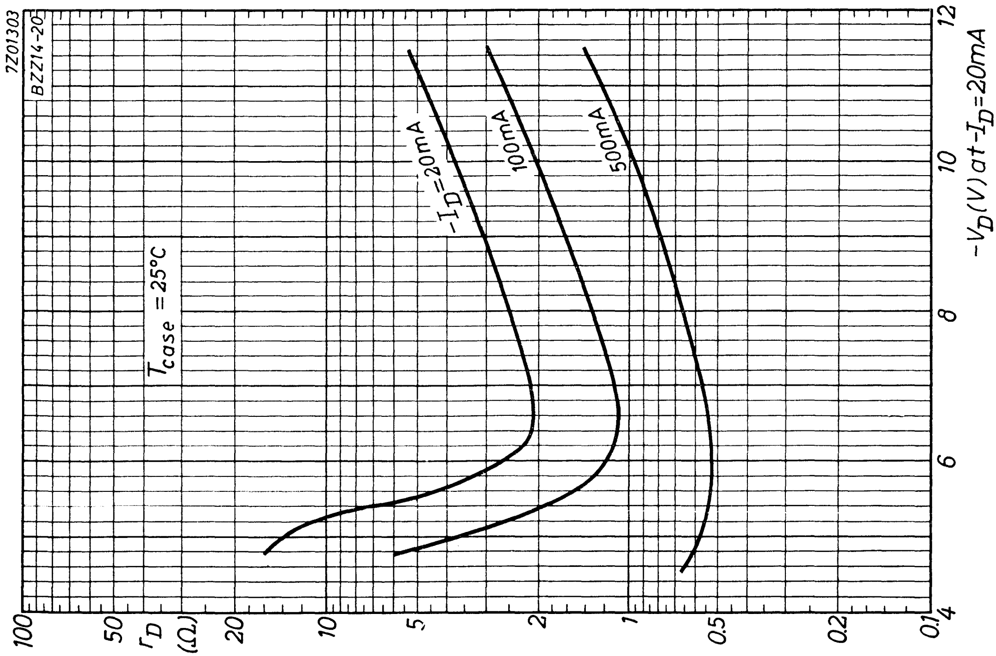
E

4.4.1963

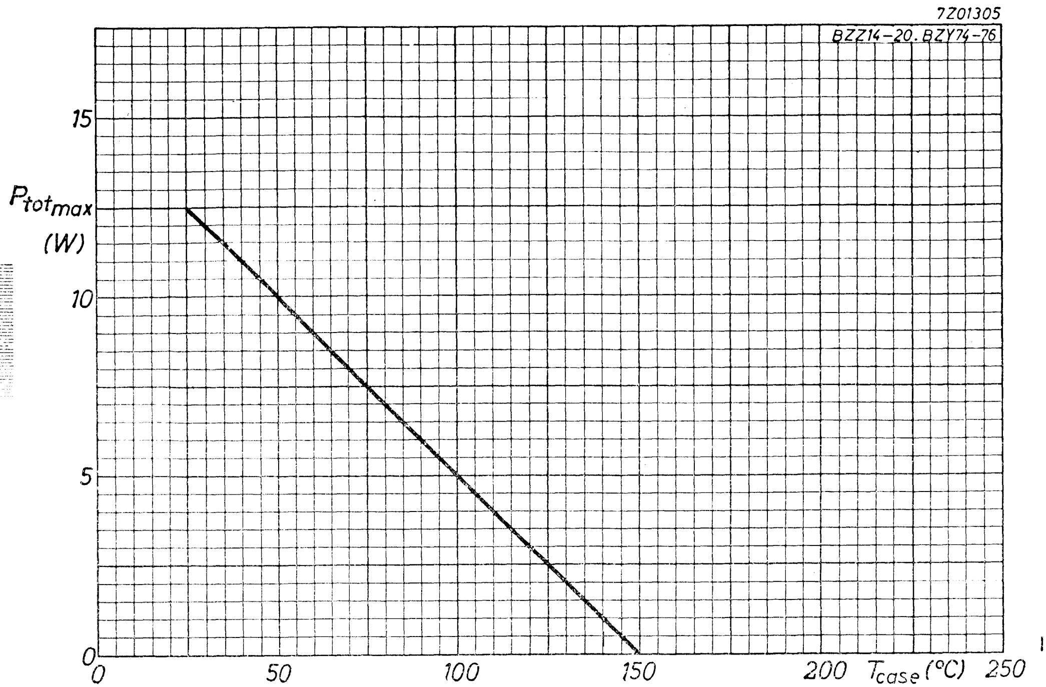
H

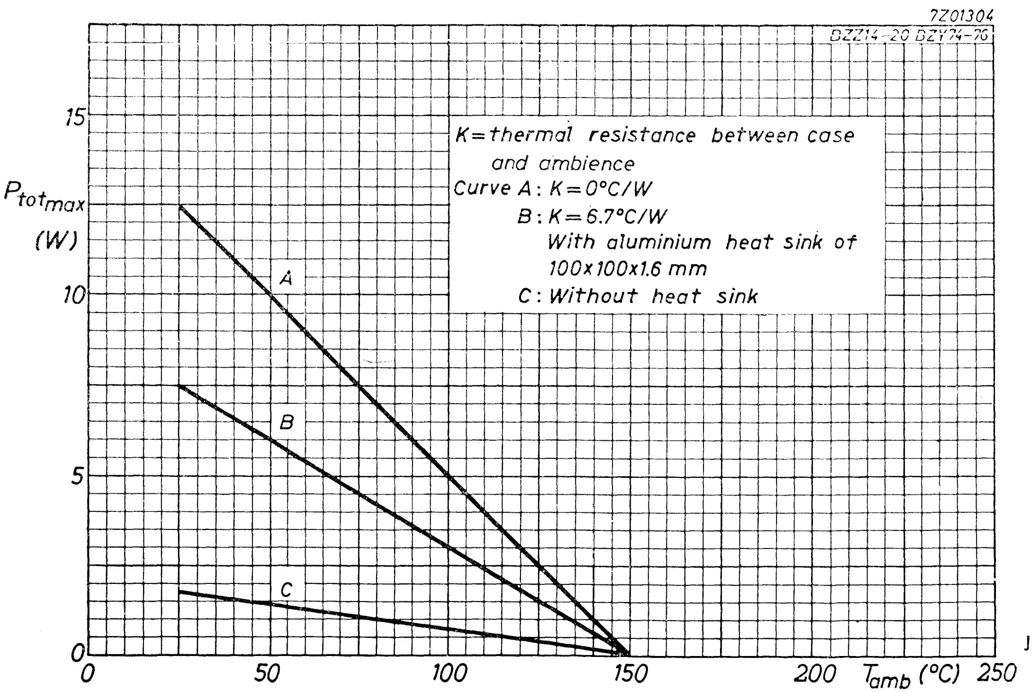

7Z01306
BZZ14–20 BZY74–76
$I_{Dsurge\,max}$ (A)
T_{amb} = 25°C
Area of permissible operation
10
5
2
1
0.5
0.2
0.1
0.01 0.02 0.05 0.1 0.2 0.5 1 2 5 10 20 50 100
Duration (m sec)

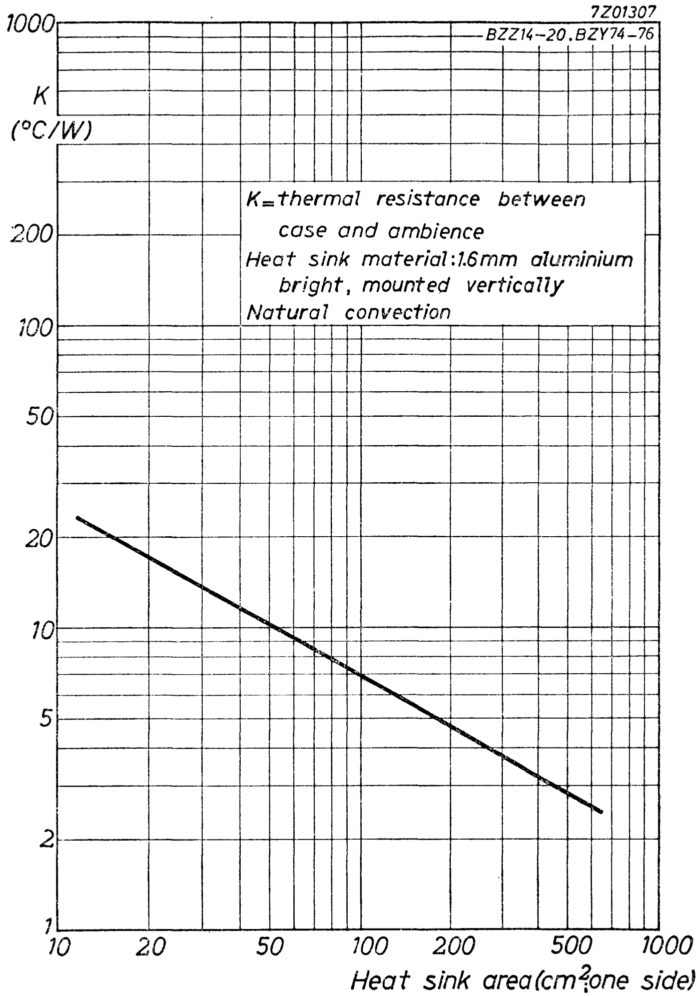
G


7Z01303
BZZ14–20
T_{case} = 25°C
$-I_D$=20mA
100mA
500mA
r_D (Ω)
100 50 20 10 5 2 1 0.5 0.2 0.1
$-V_D$(V) at $-I_D$=20mA
4 6 8 10 12

4.4.1963


7Z01305
BZZ14-20. BZY74-76
$P_{tot_{max}}$
(W)
15
10
5
0
0
50
100
150
200
T_{case} (°C)
250

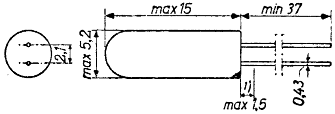

7Z01304
BZZ14-20 BZY74-76
$P_{tot_{max}}$
(W)
15
10
5
0
0
50
100
150
200
T_{amb} (°C)
250
K = thermal resistance between case and ambience
Curve A: K = 0°C/W
B: K = 6.7°C/W
With aluminium heat sink of 100x100x1.6 mm
C: Without heat sink
A
B
C


7Z01307
BZZ14-20, BZY74-76
1000
K
(°C/W)
200
100
50
20
10
5
2
1
10
20
50
100
200
500
1000
Heat sink area (cm²; one side)
K = thermal resistance between case and ambience
Heat sink material: 1.6mm aluminium bright, mounted vertically
Natural convection

GOLD-BONDED GERMANIUM DIODE in all glass construction, designed as a general purpose diode
DIODE A CRISTAL DE GERMANIUM A POINTE D'OR de construction tout verre, conçue pour usages généraux
GERMANIUM-GOLDDRAHTDIODE in Allglastechnik für allgemeine Verwendungszwecke

Dimensions in mm
Dimensions in mm
Abmessungen in mm

The red dot indicates the position of the cathode
Le point rouge marque la position de la cathode
Der rote Punkt indiziert die Katodenseite



Limiting values (Absolute max. values)
Caractéristiques limites (Valeurs max. absolues)
Grenzdaten (Absolute Maximalwerte)

Valid at / Valable à / Gültig bei T_{amb}	=	25	75 °C
$-V_D$	=	max. 100	50 V[2][3]
$-V_{DM}$	=	max. 100	50 V[3]
I_D (t_{av} = max. 50 msec)	=	max. 115	35 mA[3]
I_{DM}	=	max. 350	350 mA
I_D surge	=	max. 500	mA[4]
I_D surge	=	max. 600	mA[5]
I_D pulse (δ = 1%)	=	max.1000	mA[6]
T_{amb}	=	-55 °C/+75°C	[7]
Storage temperature / Température d'emmagasinage / Lagerungstemperatur	=	-55 °C/+90°C	

[1])Not tinned; non étamé; nicht verzinnt

[2])Constant D.C. voltage
Tension continue constante
Konstante Gleichspannung

[3])For derating curves see page D
Pour les courbes de réduction voir page D
Für die Reduktionskurven siehe Seite D

[4])[5])[6])[7])See page 2; voir page 2; siehe Seite 2

7.7.1957 939 2488

Characteristics
Caractéristiques
Kenndaten

	T_{amb} = 25 °C			T_{amb} = 60 °C		
	=	min.	max.	=	min.	max.
V_D (I_D=0,1mA)	= 0,15	>0,10	<0,25	= 0,08	>0,03	<0,20 V
V_D (I_D= 10mA)	= 0,4	>0,25	<0,55	= 0,35	>0,20	<0,50 V
V_D (I_D=200mA)	= 0,8	>0,50	< 1,0	= 0,77	>0,48	< 1,0 V
V_D (I_D=300mA)	= 0,9	>0,55	<1,25	= 0,88	>0,55	<1,25 V
$-I_D$($-V_D$=1,5 V)	= 0,8	> 0,2	< 5	= 15	> 5	< 26 µA
$-I_D$($-V_D$= 10 V)	= 1,1	> 0,3	< 6	= 20	>5,5	< 30 µA
$-I_D$($-V_D$= 50 V)	= 2,5	>0,45	< 9	= 32	>7,5	< 60 µA
$-I_D$($-V_D$=100 V)	= 8	> 0,7	< 30	= 50	> 10	< 120 µA

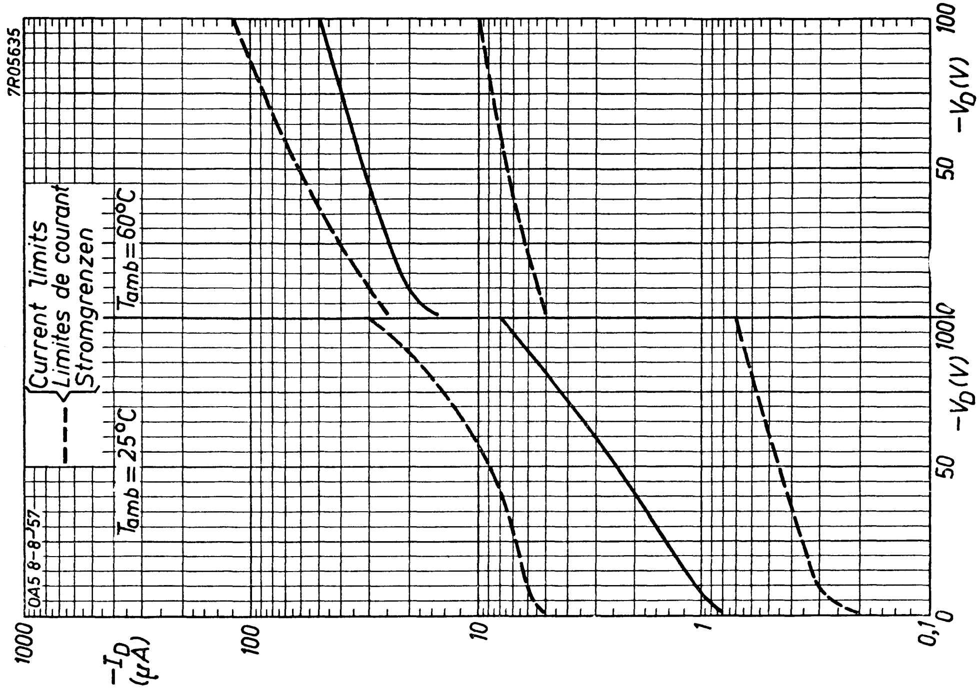
[4])Max. duration 1 sec
Durée 1 sec. au max.
Max. Dauer 1 Sek.

[5])Max. duration 0.3 sec
Durée 0,3 sec au max.
Max. Dauer 0,3 Sek.

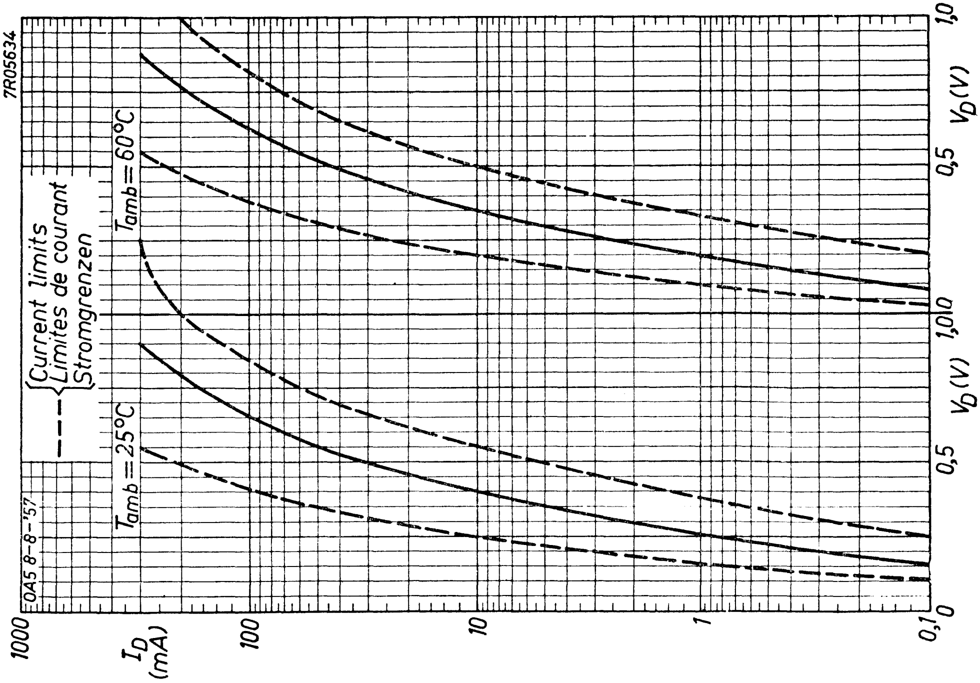
[6])Pulse duration max. 1 µsec
Durée de l'impuls 1 µsec au max.
Impulsdauer max. 1 µSek.

[7])During operation
Pendant l'opération
Während des Betriebs

939 2489

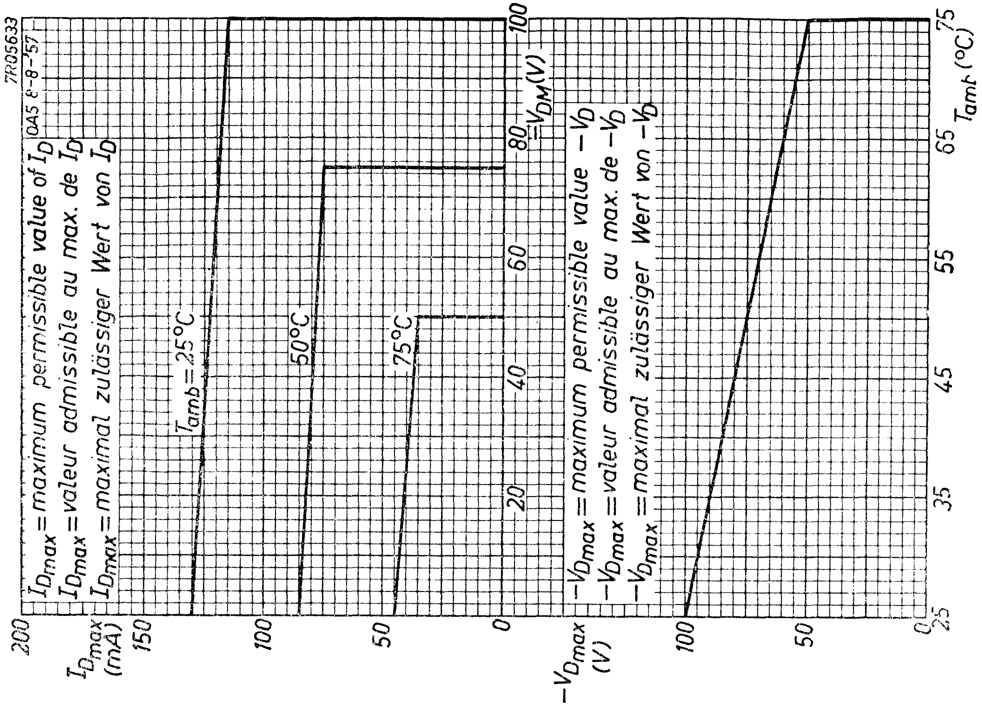

7R05635
OA5 8-8-'57
$T_{amb}=25°C$
$T_{amb}=60°C$
Current limits
Limites de courant
Stromgrenzen
$-I_D$ (μA)
1000
100
10
1
0,1
0
50
100
$-V_D(V)$

B

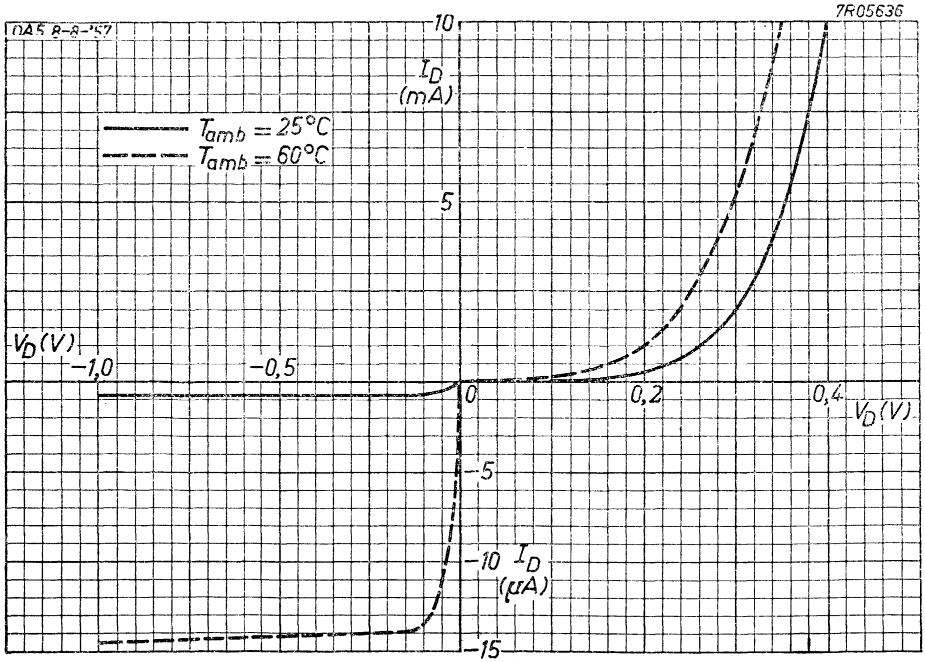

7R05634
OA5 8-8-'57
$T_{amb}=25°C$
$T_{amb}=60°C$
Current limits
Limites de courant
Stromgrenzen
I_D (mA)
1000
100
10
1
0,1
0
0,5
1,0
$V_D(V)$

A

7.7.1957


7R05633
OA5 8-8-'57
I_{Dmax} = maximum permissible value of I_D
I_{Dmax} = valeur admissible au max. de I_D
I_{Dmax} = maximal zulässiger Wert von I_D
T_{amb} = 25°C
50°C
75°C
100
80
60
40
20
0
$-V_{DM}$(V)
$-V_{Dmax}$ = maximum permissible value $-V_D$
$-V_{Dmax}$ = valeur admissible au max. de $-V_D$
$-V_{Dmax}$ = maximal zulässiger Wert von $-V_D$
75
65
55
45
35
25
T_{amb} (°C)
200
150
100
50
0
I_{Dmax} (mA)
100
50
0
$-V_{Dmax}$ (V)

D


OA5 8-8-'57
7R05636
10
5
I_D (mA)
T_{amb} = 25°C
T_{amb} = 60°C
V_D(V)
−1,0
−0,5
0
0,2
0,4
V_D(V)
−5
−10
I_D (μA)
−15

C

7.7.1957

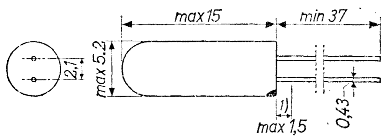
GOLD-BONDED GERMANIUM DIODE in single-ended all-glass construction designed for high forward current switching applications

DIODE A CRISTAL DE GERMANIUM A POINTE D'OR en construction tout-verre avec connexions unilatérales, conçue pour applications de commutateur à courant élevé en sens conducteur

GERMANIUM-GOLDDRAHTDIODE in Allglastechnik mit Elektroden - anschlüssen an einer Seite zur Verwendung als Schalterdiode mit hohem Strom in der Durchlassrichtung

Dimensions in mm
Dimensions en mm
Abmessungen in mm

The red dot indicates the position of the cathode
Le point rouge indique la position de la cathode
Der rote Punkt bezeichnet die Katodenseite



Limiting values (Absolute max. values)
Caractéristiques limites (Valeurs max. absolues)
Grenzdaten (Absolute Maximalwerte)

	T_{amb} = 25 °C	= 75 °C
$-V_D$	= max. 25 V	max. 25 V
$-V_{DM}$	= max. 25 V	max. 25 V
$-V_{D\,surge}$ (t = max. 1 sec)	= max. 30 V	max. 30 V
I_D {direct current / courant continu / Gleichstrom}	= max. 140 mA	max. 50 mA[2])
I_D (t_{av} = max. 50 msec)	See pages E,F / Voir pages E,F / Siehe Seiten E,F	
I_{DM}	= max. 250 mA	max. 250 mA
$I_{D\,surge}$ (t = max. 1 sec)	= max. 400 mA	max. 400 mA
T_{amb}	= -55 °C/ +75 °C	

Storage temperature
Température d'emmagasinage = -55 °C/ +75 °C
Lagerungstemperatur

[1]) Not tinned; non étamé; nicht verzinnt
[2]) See also page D; voir aussi page D; siehe auch Seite D

Thermal data. Junction temperature rise to ambient temperature in free air K $\leq$ 0.4 °C/mW
Données thermiques. Augmentation de la température de la jonction au regard de la température de l'ambiance à l'air libre K $\leq$ 0,4 °C/mW
Thermische Daten. Temperaturerhöhung in bezug auf die Umgebungstemperatur in freier Luft K $\leq$ 0,4 °C/mW

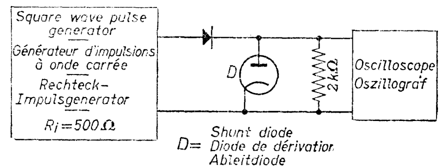
Characteristics
Caractéristiques
Kenndaten

I_D (mA)	V_D(V) T_{amb} = 25°C =	min.	max.	T_{amb} = 60°C =	min.	max.
0,1	= 0,18	> 0,12	< 0,26	= 0,11	> 0,06	< 0,19
1	= 0,25	> 0,20	< 0,33	= 0,20	> 0,14	< 0,28
10	= 0,38	> 0,30	< 0,48	= 0,35	> 0,25	< 0,43
30	= 0,50	> 0,36	< 0,65	= 0,47	> 0,32	< 0,61
50	= 0,56	> 0,40	< 0,78	= 0,54	> 0,37	< 0,75
250[1])	= 1,00		< 1,65			

$-V_D$ (V)	$-I_D$(µA) T_{amb} = 25°C =	T_{amb} = 60°C =	max.
1,5	= 0,4	= 5	< 20
10	= 1,5	= 9	< 30
25	= 6,0	= 22	< 150

Reverse recovery, measured at $-V_D$ = 5 V after forward current pulse of 5 mA
Recouvrement inverse, mesuré à $-V_D$ = 5 V après une impulsion de courant en sens conducteur de 5 mA
Übergangszeit für Sperrichtung, gemessen bei $-V_D$ = 5 V nach einem Stromimpuls von 5 mA in der Durchlassrichtung

T_{amb} = 25°C



Measuring circuit; circuit de mesure; Messschaltung

[1])See page 3; voir page 3; siehe Seite 3.

Reverse recovery (continued)
Recouvrement inverse (suite)
Übergangszeit für Sperrichtung (Fortsetzung)

Pulse data
Données de l'impulsion
Impulsdaten

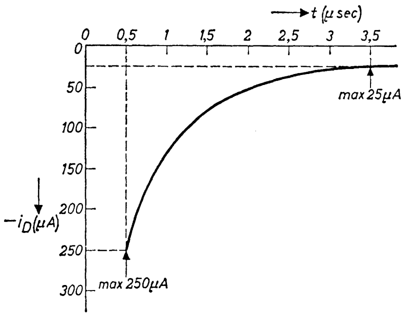
	f	=	50 kc/s
	δ	=	0,5
Rise time / Temps de montée / Anstiegszeit		<	0,1 µsec
	I_{DM}	=	5 mA
	$-V_{DM}$	=	5 V

Oscilloscope data
Données de l'oscilloscope
Daten des Oszillografen

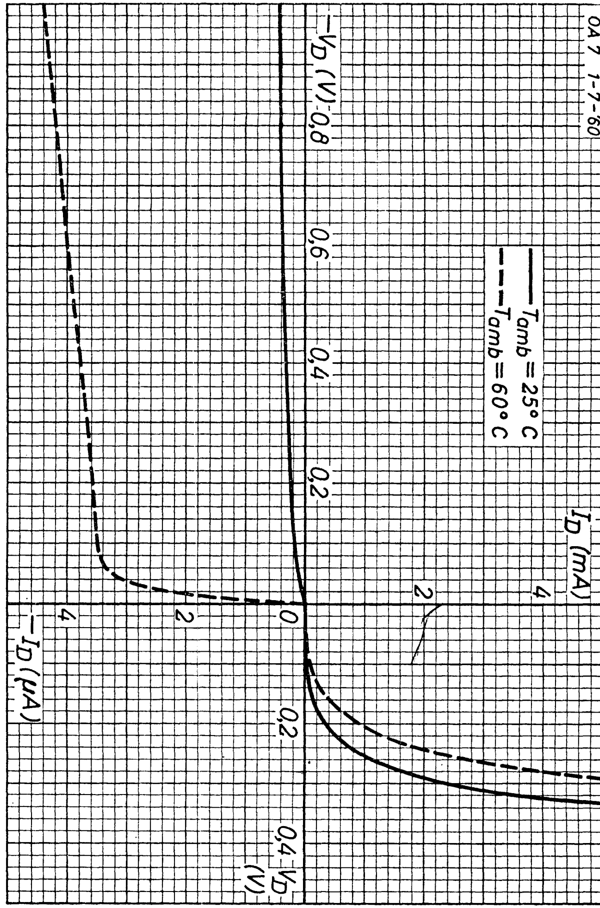
	C_{inp}	=	40 pF
Rise time / Temps de montée / Anstiegszeit		=	0,025 µsec

$-i_D$ { 0.5 µsec after the current impuls / 0,5 µsec après l'impulsion de courant / 0,5 µSek nach dem Stromimpuls } = 140 µA, < 250 µA

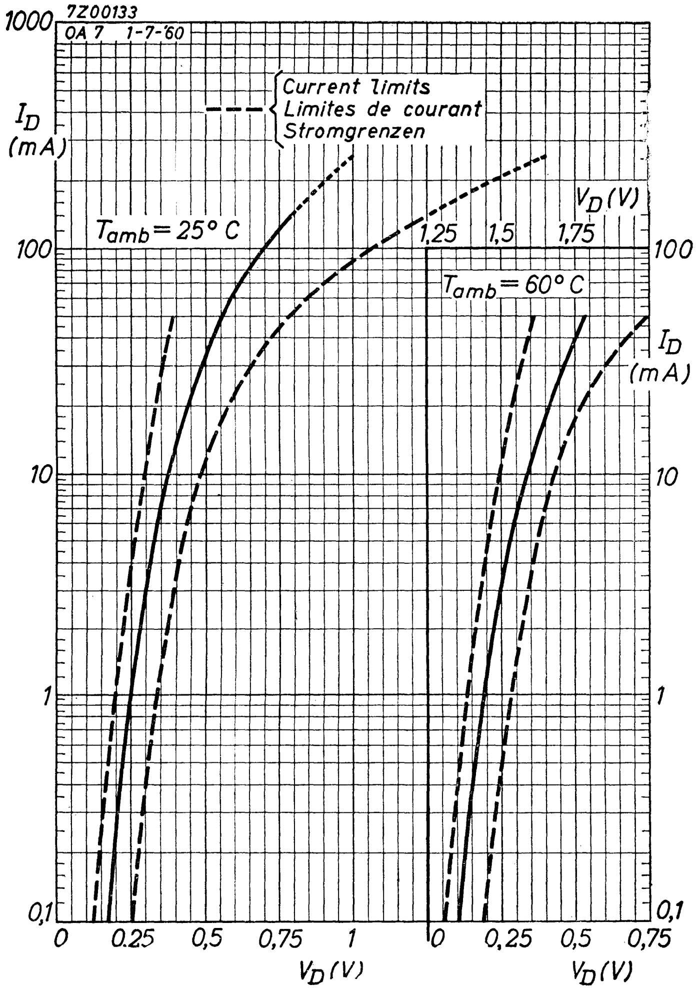
$-i_D$ { 3.5 µsec after the current impuls / 3,5 µsec après l'impulsion de courant / 3,5 µSek nach dem Stromimpuls } < 25 µA



[1]) Measured under pulsed conditions to prevent excessive dissipation
Mesuré avec des impulsions pour prévenir une dissipation excessive
Zur Vermeidung einer übermässigen Verlustleistung mit Impulsen gemessen

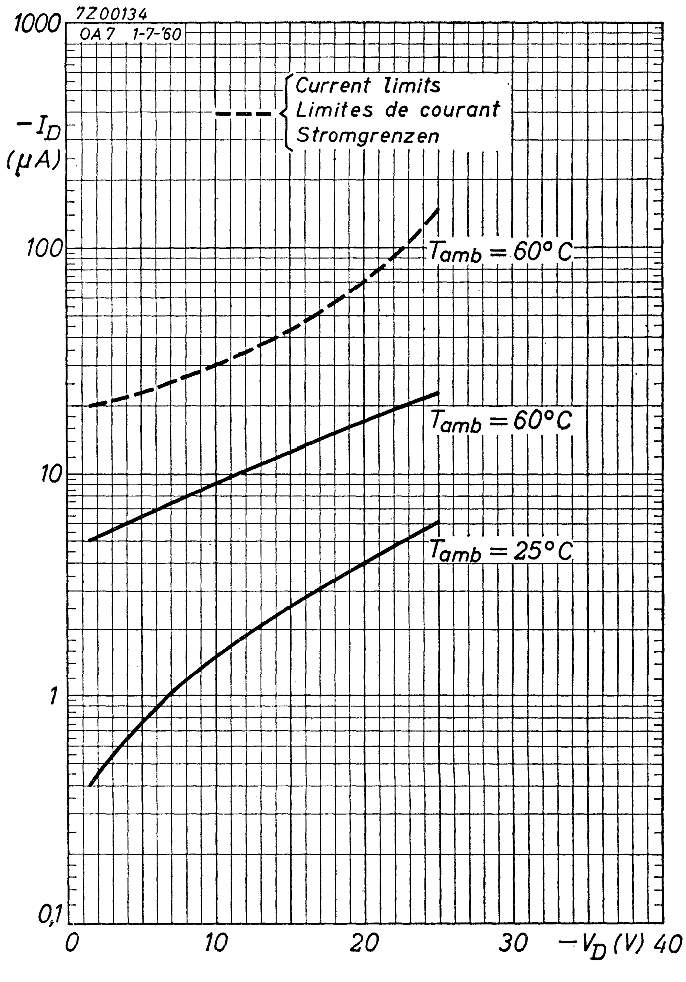


A

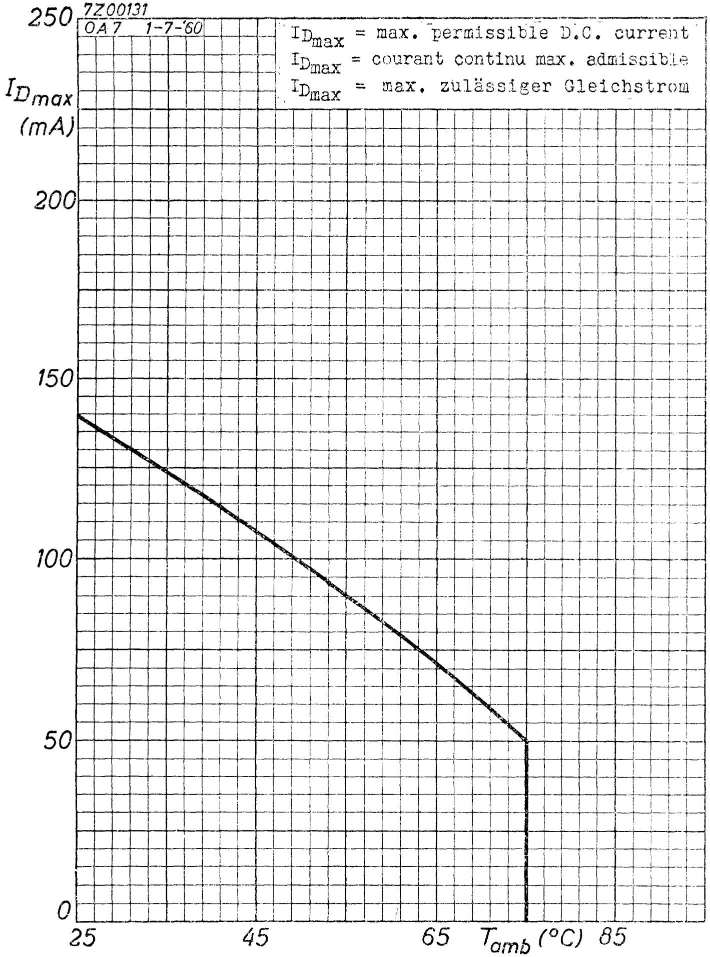

7Z00133
OA 7 1-7-'60
1000
I_D (mA)
Current limits
Limites de courant
Stromgrenzen
T_{amb}= 25° C
100
10
1
0,1
0
0,25
0,5
0,75
1
V_D (V)
V_D (V)
1,25
1,5
1,75
T_{amb}= 60° C
I_D (mA)
100
10
1
0,1
0
0,25
0,5
0,75
V_D (V)

6.6.1960

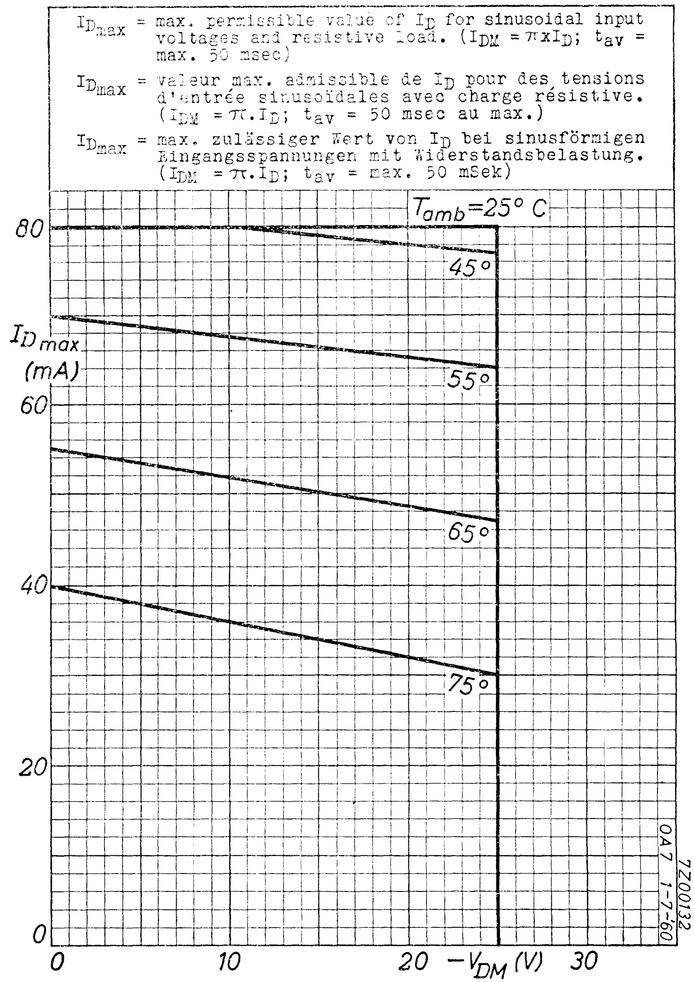
B


7Z00134
OA 7 1-7-'60
1000
$-I_D$ (μA)
Current limits
Limites de courant
Stromgrenzen
T_{amb} = 60° C
T_{amb} = 60°C
T_{amb} = 25° C
100
10
1
0,1
0
10
20
30
$-V_D$ (V) 40

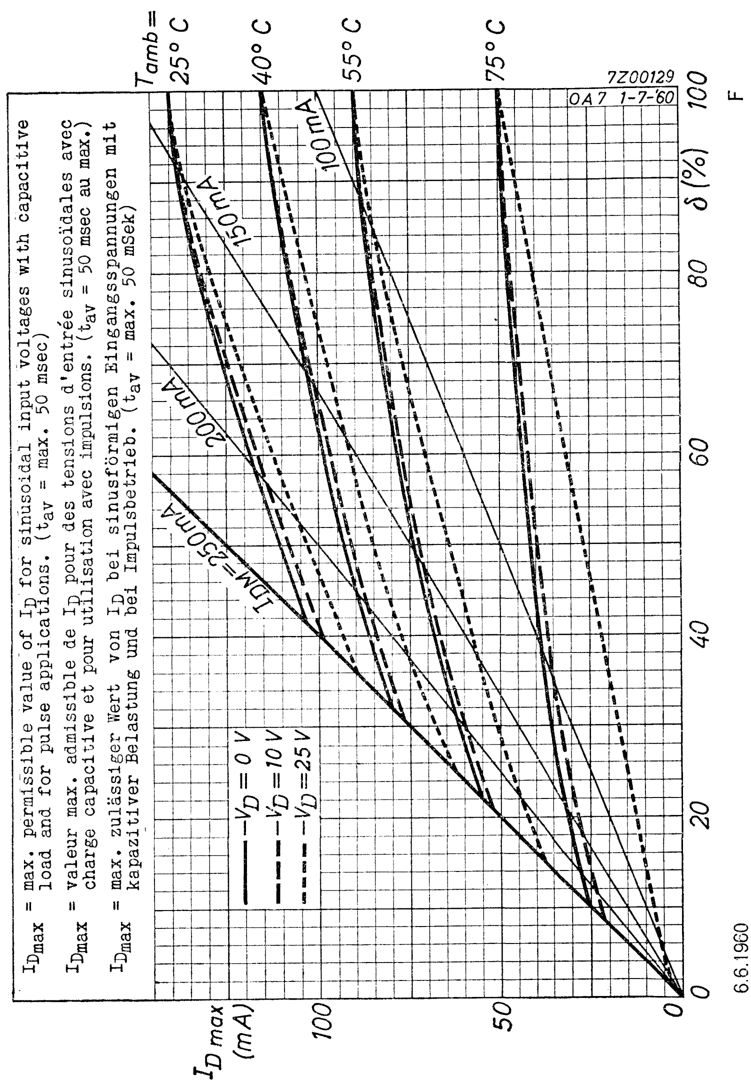
C


7Z00131
OA7 1-7-'60
I_{Dmax} = max. permissible D.C. current
I_{Dmax} = courant continu max. admissible
I_{Dmax} = max. zulässiger Gleichstrom
I_{Dmax} (mA)
250
200
150
100
50
0
25
45
65
85
T_{amb} (°C)

D


I_{Dmax} = max. permissible value of I_D for sinusoidal input voltages and resistive load. ($I_{DM} = \pi x I_D$; t_{av} = max. 50 msec)
I_{Dmax} = valeur max. admissible de I_D pour des tensions d'entrée sinusoïdales avec charge résistive. ($I_{DM} = \pi . I_D$; t_{av} = 50 msec au max.)
I_{Dmax} = max. zulässiger Wert von I_D bei sinusförmigen Eingangsspannungen mit Widerstandsbelastung. ($I_{DM} = \pi . I_D$; t_{av} = max. 50 mSek)
T_{amb}=25° C
45°
55°
65°
75°
I_{Dmax} (mA)
80
60
40
20
0
0
10
20
30
$-V_{DM}$ (V)
7Z00132
OA7 1-7-'60

E


I_{Dmax} = max. permissible value of I_D for sinusoidal input voltages with capacitive load and for pulse applications. (t_{av} = max. 50 msec)
I_{Dmax} = valeur max. admissible de I_D pour des tensions d'entrée sinusoïdales avec charge capacitive et pour utilisation avec impulsions. (t_{av} = 50 msec au max.)
I_{Dmax} = max. zulässiger Wert von I_D bei sinusförmigen Eingangsspannungen mit kapazitiver Belastung und bei Impulsbetrieb. (t_{av} = max. 50 mSek)
T_{amb} =
25° C
40° C
55° C
75° C
7Z00129
OA 7 1-7-'60
I_{DM}=250mA
200mA
150mA
100mA
$-V_D = 0$ V
$-V_D = 10$ V
$-V_D = 25$ V
$I_{D\,max}$ (mA)
100
50
0
δ (%)
0
20
40
60
80
100
6.6.1960
F

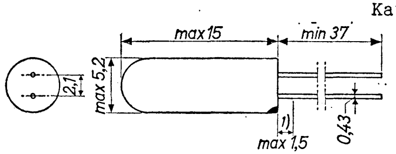
GOLD-BONDED GERMANIUM DIODE in single-ended all-glass construction, designed for high-current switching applications

DIODE A CRISTAL DE GERMANIUM A POINT D'OR en construction tout verre à sorties unilatérales; la diode est conçue pour applications de commutation à courants élevés

GERMANIUM-GOLDDRAHTDIODE in Allglastechnik mit einseitiger Drahtausführung; die Diode ist bestimmt für Schalteranwendungen mit hohen Strömen

Dimensions in mm
Dimensions en mm
Abmessungen in mm

The red dot indicates the position of the cathode
Le point rouge marque la position de la cathode
Der rote Punkt indiziert die Katodenseite



Limiting values (Absolute max. values)
Caractéristiques limites (Valeurs max. absolues)
Grenzdaten (Absolute Maximalwerte)

T_{amb} =		25	75	°C
$-V_D$	= max.	25	25	V
$-V_{DM}$	= max.	25	25	V
$-V_{Dsurge}$ (t = max. 1 sec)	= max.	40	40	V
I_D direct current / courant continu / Gleichstrom	= max.	270	90	mA [2]
I_D (t_{av} = max. 50 msec)	See pages E to G / Voir pages E - G / Siehe Seiten E bis G			
I_{DM}	= max.	500	500	mA
I_{Dsurge} (t = max. 1 sec)	= max.	800	800	mA
T_{amb}	=	-55 °C/+ 75		°C
Storage temperature / Température d'emmagasinage / Lagerungstemperatur	=	-55 °C/+ 90		°C

[1]) Not tinned; non étamé; nicht verzinnt
[2]) See also page E; voir aussi page E; siehe auch Seite E.

Thermal data. Junction temperature rise to ambient temperature in free air	K ≤ 0.35 °C/mW
Données thermiques. Augmentation de la température de la jonction au regard de la température de l'ambiance à l'air libre	K ≤ 0,35 °C/mW
Thermische Daten. Temperaturerhöhung des Kristalls in bezug auf die Umgebungstemperatur in freier Luft	K ≤ 0,35 °C/mW

Characteristics
Caractéristiques
Kenndaten

I_D (mA)	V_D (V)			
	T_{amb} = 25 °C		T_{amb} = 60 °C	
0,1	= 0,15	< 0,21	= 0,09	< 0,15
10	= 0,33	< 0,41	= 0,28	< 0,35
500 [1])	= 0,70	< 0,90	= 0,66	

$-V_D$ (V)	$-I_D$ (μA)			
	T_{amb} = 25 °C		T_{amb} = 60 °C	
1,5	= 0,7	< 3,5	= 8	< 20
10	= 1,5	< 10	= 12	< 45
25	= 7,0	< 50	= 20	< 100

Dynamical characteristics
Caractéristiques dynamiques T_{amb} = 25 °C
Dynamische Kenndaten

Column I: Setting of the diode and typical (average) measuring results of new diodes
II: Characteristic range values for equipment design
Colonne I: Valeurs pour le réglage de la diode et les résultats moyens de mesures de diodes neuves.
II: Gamme de valeurs caractéristiques pour l'étude d'équipements
Spalte I: Einstelldaten der Diode und mittlere Messergebnisse neuer Dioden
II: Charakteristischer Wertbereich für Gerätentwurf

[1]) Measured under pulsed conditions to prevent excessive dissipation.
Mesuré en service d'impulsions pour prévenir une dissipation excessive
Gemessen mit Impulsen zur Verhütung einer übermässigen Verlustleistung

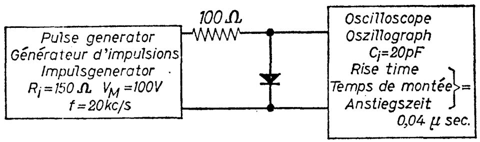
Dynamical characteristics (continued)
Caractéristiques dynamiques (suite)
Dynamische Kenndaten (Fortsetzung)

T_{amb} = 25 °C

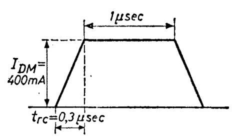
Capacitance
Capacité
Kapazität

		I	II	
$-V_D$	=	0,75		V
f	=	0,5		Mc/s
c_{dk}	=	3	< 7	pF

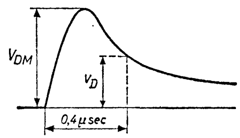
Forward recovery
Temps de recouvrement direct
Übergangszeit für Durchlassrichtung



Measuring circuit; circuit de mesure; Messanordnung



Current pulse
Impulsion de courant
Stromimpuls



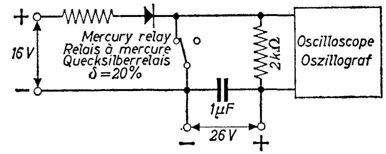
Voltage pulse
Impulsion de tension
Spannungsimpuls

		I	II	
I_{DM}	=	400		mA
t_{imp}	=	1		µsec
V_{DM}	=	0,8	< 1,4	V
V_D { after 0.4 µsec / après 0,4 µsec / nach 0,4 µSek		0,7	< 1,0	V

Dynamical characteristics (continued)
Caractéristiques dynamiques (suite)
Dynamische Kenndaten (Fortsetzung)

T_{amb} = 25 °C

Reverse recovery time, measured at $-V_D$ = 10 V after forward current pulse of 400 mA
Temps de recouvrement inverse, mesuré à $-V_D$ = 10 V après une impulsion de courant de 400 mA dans le sens conducteur
Übergangszeit für Sperrichtung, gemessen bei $-V_D$ = 10 V nach einem Stromimpuls von 400 mA in Durchlassrichtung



Measuring circuit; circuit de mesure; Messanordnung

Pulse data
Données de l'impulsion
Impulsdaten

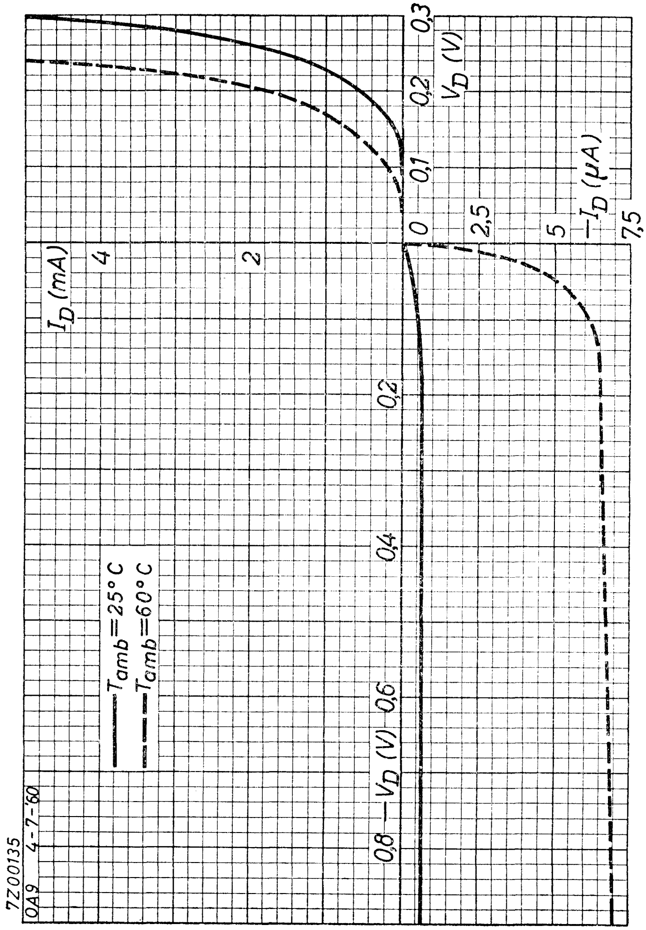
I_{DM}	=	400	mA
$-V_{DM}$	=	10	V
δ	=	20	%
f	=	50	c/s

Oscilloscope data
Données de l'oscilloscope
Daten des Oszillografen

C_{inp}	=	15	pF
R_{inp}	=	4	MΩ

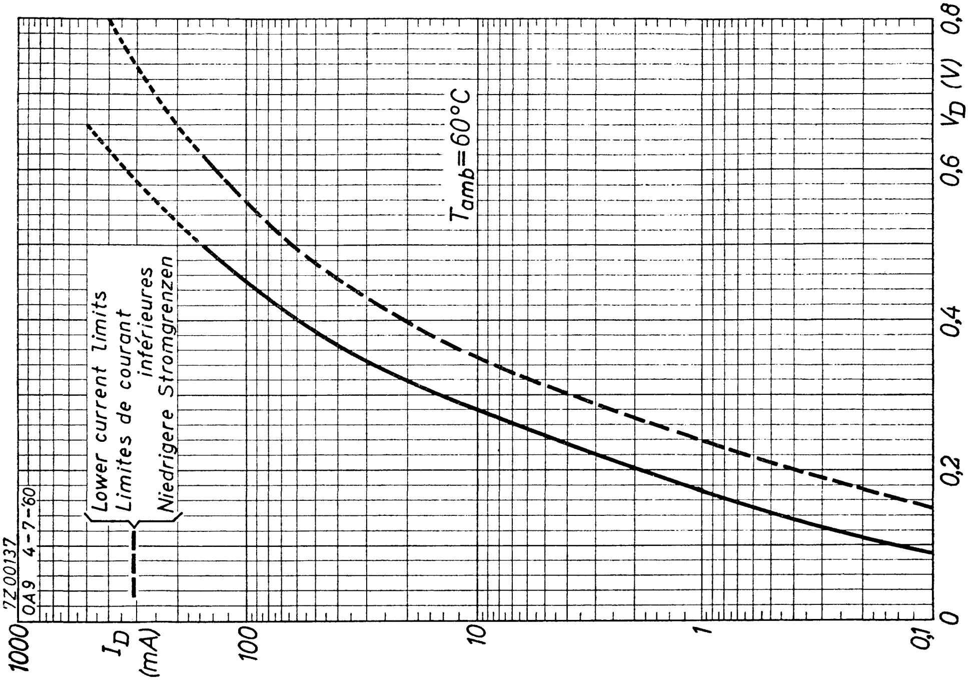
Rise time
Temps de montée = 0,016 µsec
Anstiegszeit

		I	II
$-i_D$ { 3.5 µsec after the current impuls / 3,5 µsec après l'impulsion de courant / 3,5 µSek nach dem Stromimpuls	=		< 150 µA

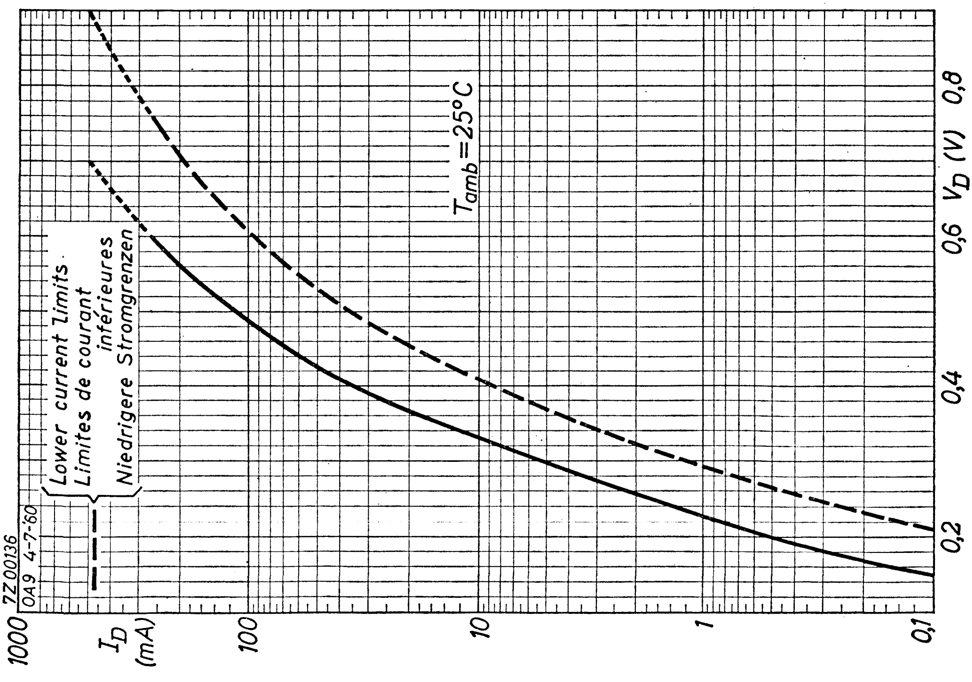

I_D (mA)
4
2
V_D (V)
0,3
0,2
0,1
0
$-I_D$ (μA)
2,5
5
7,5
$-V_D$ (V)
0,2
0,4
0,6
0,8
T_{amb}=25° C
T_{amb}=60° C
7Z00135
OA9
4-7-'60

A

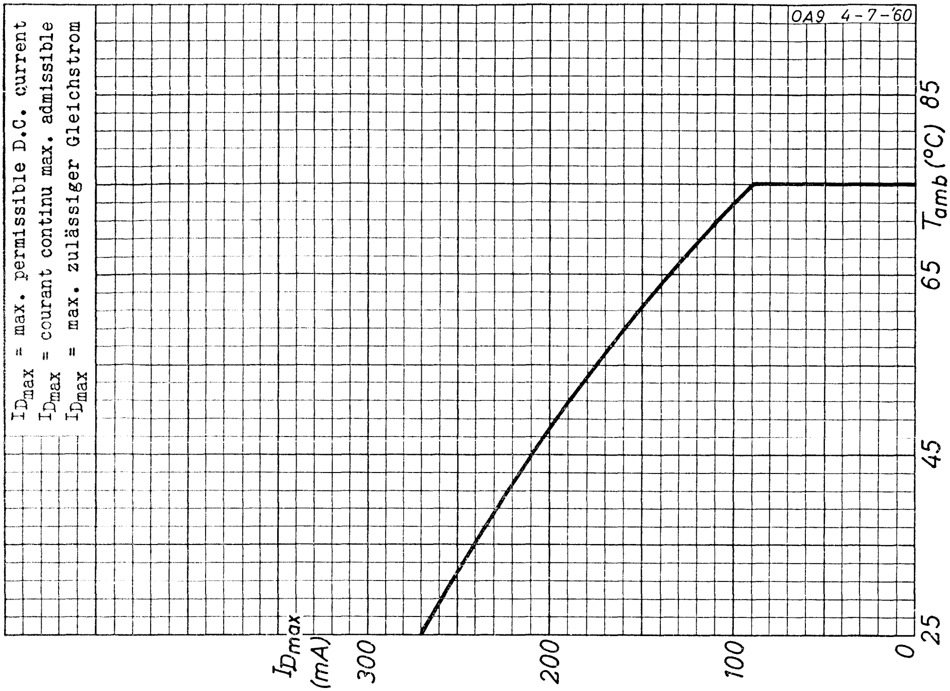
5.5.1960


OA9
7Z00137
4-7-'60
Lower current limits
Limites de courant inférieures
Niedrigere Stromgrenzen
T_{amb}=60°C
I_D (mA)
1000
100
10
1
0,1
0
0,2
0,4
0,6
V_D (V)
0,8

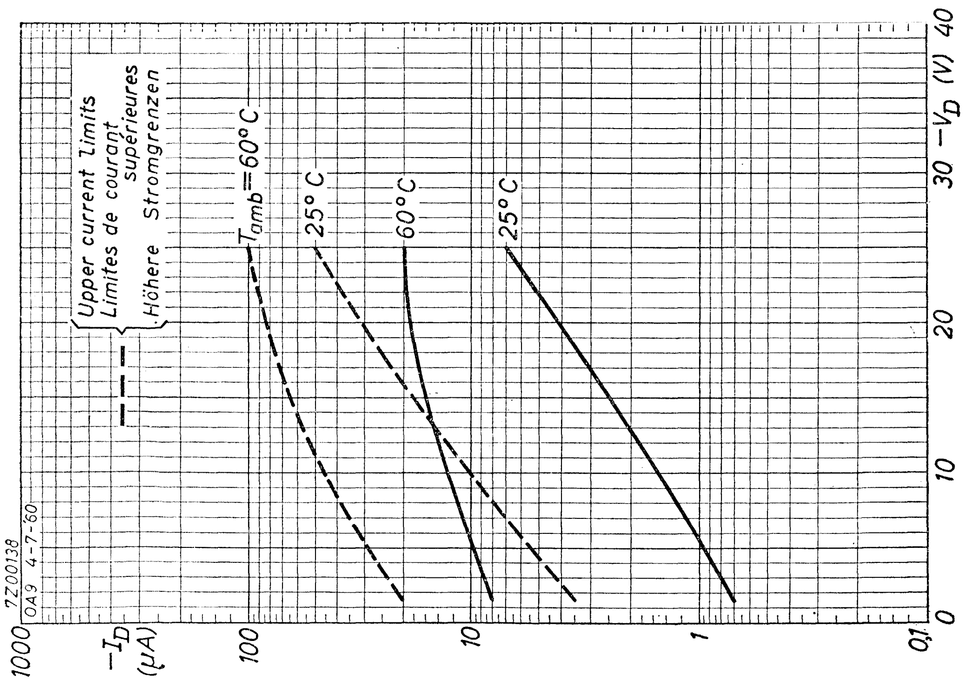
C


OA9
7Z00136
4-7-'60
Lower current limits
Limites de courant inférieures
Niedrigere Stromgrenzen
T_{amb}=25°C
I_D (mA)
1000
100
10
1
0,1
0,2
0,4
0,6
V_D (V)
0,8

B


7Z00139
OA9 4-7-'60
$I_{D max}$ = max. permissible D.C. current
$I_{D max}$ = courant continu max. admissible
$I_{D max}$ = max. zulässiger Gleichstrom
$I_{D max}$ (mA)
300
200
100
0
25
45
65
85
T_{amb} (°C)

E


7Z00138
OA9 4-7-'60
Upper current limits
Limites de courant supérieures
Höhere Stromgrenzen
T_{amb}=60°C
25°C
60°C
25°C
$-I_D$ (μA)
1000
100
10
1
0,1
0
10
20
30
40
$-V_D$ (V)

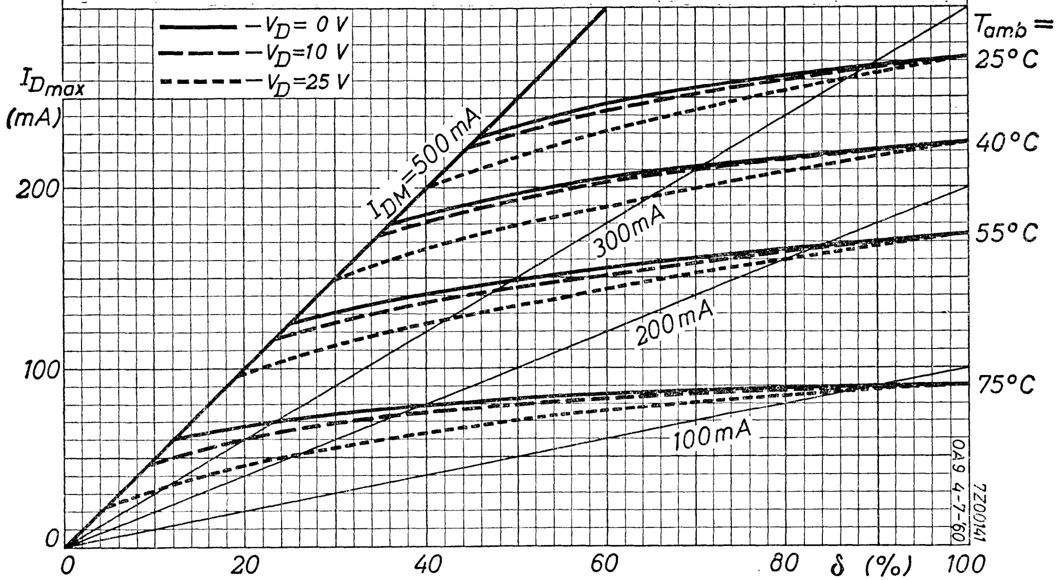
D

G

I_{Dmax} = max. permissible value of I_D for sinusoidal input voltages with capacitive load and for pulse applications. (t_{av} = max. 50 msec)

I_{Dmax} = valeur max. admissible de I_D pour des tensions d'entrée sinusoïdales avec charge capacitive et pour utilisation avec impulsions. (t_{av} = 50 msec au max.)

I_{Dmax} = max. zulässiger Wert von I_D bei sinusförmigen Eingangsspannungen mit kapazitiver Belastung und bei Impulsbetrieb. (t_{av} = max. 50 mSek)

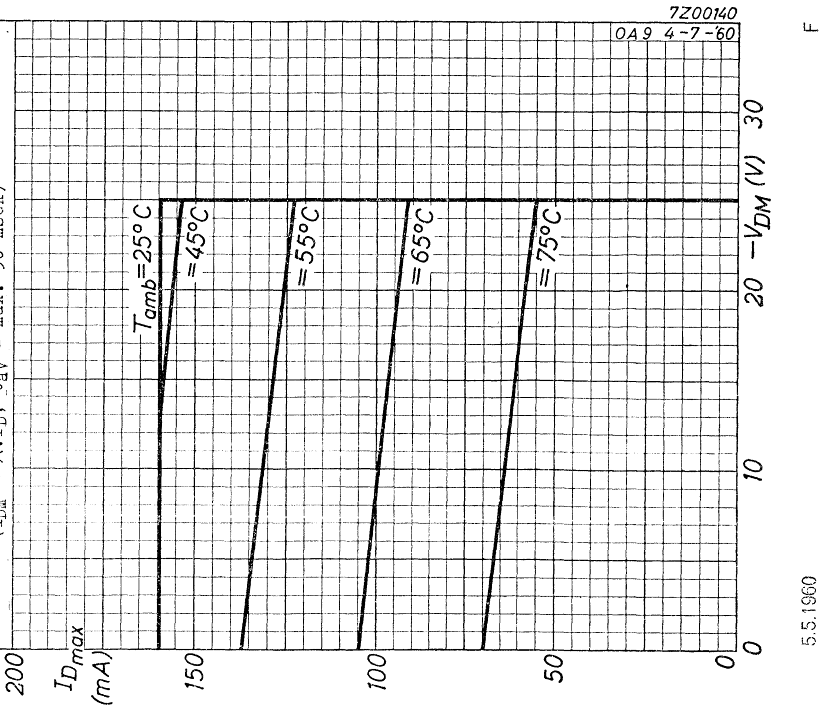


F

I_{Dmax} = max. permissible value of I_D for sinusoidal input voltages and resistive load. ($I_{DM} = \pi \times I_D$; t_{av} = max. 50 msec)

I_{Dmax} = valeur max. admissible de I_D pour des tensions d'entrée sinusoïdales avec charge résistive. ($I_{DM} = \pi . I_D$; t_{av} = 50 msec au max.)

I_{Dmax} = max. zulässiger Wert von I_D bei sinusförmigen Eingangsspannungen mit Widerstandsbelastung. ($I_{DM} = \pi . I_D$; t_{av} = max. 50 mSek)



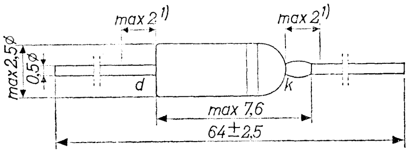
REVISED DATA
IS UNDER PREPARATION

7Z2 3300
3.3.1965

GOLD-BONDED GERMANIUM DIODE in miniature all-glass construction designed for high forward current switching applications
DIODE A CRISTAL DE GERMANIUM A POINTE D'OR en construction tout-verre miniature conçue pour applications de commutation à courant élevé dans le sens conducteur
GERMANIUM-GOLDDRAHTDIODE in Miniatur-Allglastechnik zur Verwendung als Schalterdiode mit hohem Strom in der Durchlassrichtung

Dimensions in mm
Dimensions en mm
Abmessungen in mm

The white band indicates the position of the cathode
L'anneau blanc marque la position de la cathode
Der weise Ring bezeichnet die Katodenseite



Limiting values (Absolute max. values)
Caractéristiques limites (Valeurs max. absolues)
Grenzdaten (Absolute Maximalwerte)

	T_{amb} =	25 °C	60 °C
$-V_D$	= max.	25	25 V
$-V_{DM}$	= max.	25	25 V
$-V_{Dsurge}$ (t = max. 1 sec)	= max.	30	30 V
I_D {direct current / courant continu / Gleichstrom}	= max.	110	50 mA [2]
I_D (t_{av} = max. 50 msec)	{See pages F,G / Voir pages F,G / Siehe Seiten F,G}		
I_{DM}	= max.	150	150 mA
I_{Dsurge} (t = max. 1 sec)	= max.	200	200 mA
T_{amb}	= -55 °C/+ 60 °C		

Storage temperature
Température d'emmagasinage = -55 °C/+ 75 °C
Lagerungstemperatur

[1]) Not tinned; non étamé; nicht verzinnt

[2]) See also page E; voir aussi page E; siehe auch Seite E

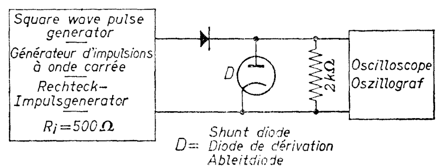
Thermal data. Junction temperature rise to ambient temperature in free air K ≦ 0.45 °C/mW
Données thermiques. Augmentation de la température de la jonction au regard de la température de l'imbiance à l'air libre K ≦ 0,45 °C/mW
Thermische Daten. Temperaturerhöhung des Kristalls in bezug auf die Umgebungstemperatur in freier Luft K ≦ 0,45 °C/mW

Characteristics
Caractéristiques
Kenndaten

I_D (mA)	V_D (V)					
	T_{amb} = 25 °C			T_{amb} = 60 °C		
	=	min.	max.	=	min.	max.
1	=0,26	>0,20	<0,33	=0,20	>0,14	<0,28
10	=0,40	>0,30	<0,48	=0,36	>0,25	<0,43
30	=0,54	>0,36	<0,65	=0,50		

$-V_D$ (V)	$-I_D$ (µA)		
	T_{amb} = 25 °C	T_{amb} = 60 °C	
	=	=	max.
1,5	= 0,6	= 6	< 20
10	= 3,5	= 13	< 40
25	= 10	= 28	<160

Reverse recovery, measured at $-V_D$ = 5 V after forward current pulse of 5 mA
Recouvrement inverse, mesuré à $-V_D$ = 5 V après une impulsion de courant en sens conducteur de 5 mA
Übergangszeit für Sperrichtung, gemessen bei $-V_D$ = 5 V nach einem Stromimpuls von 5 mA in der Durchlassrichtung
T_{amb} = 25 °C



Measuring circuit; circuit de mesure; Messchaltung

Reverse recovery (continued)
Recouvrement inverse (suite)
Übergangszeit für Sperrichtung (Fortsetzung)

Pulse data
Données de l'impulsion
Impulsdaten

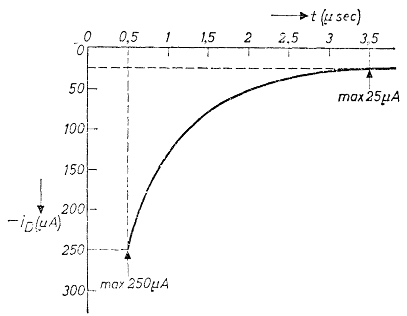
	f	=	50 kc/s
	δ	=	0,5
Rise time / Temps de montée / Anstiegszeit		<	0,1 µsec
	I_{DM}	=	5 mA
	$-V_{DM}$	=	5 V

Oscilloscope data
Données de l'oscilloscope
Daten des Oszillographen

	C_{inp}	=	40 pF
Rise time / Temps de montée / Anstiegszeit		=	0,025 µsec

$-i_D$ { 0.5 µsec after the current impuls / 0,5 µsec après l'impulsion de courant / 0,5 µSek nach dem Stromimpuls } < 250 µA

$-i_D$ { 3.5 µsec after the current impuls / 3,5 µsec après l'impulsion de courant / 3,5 µSek nach dem Stromimpuls } < 25 µA

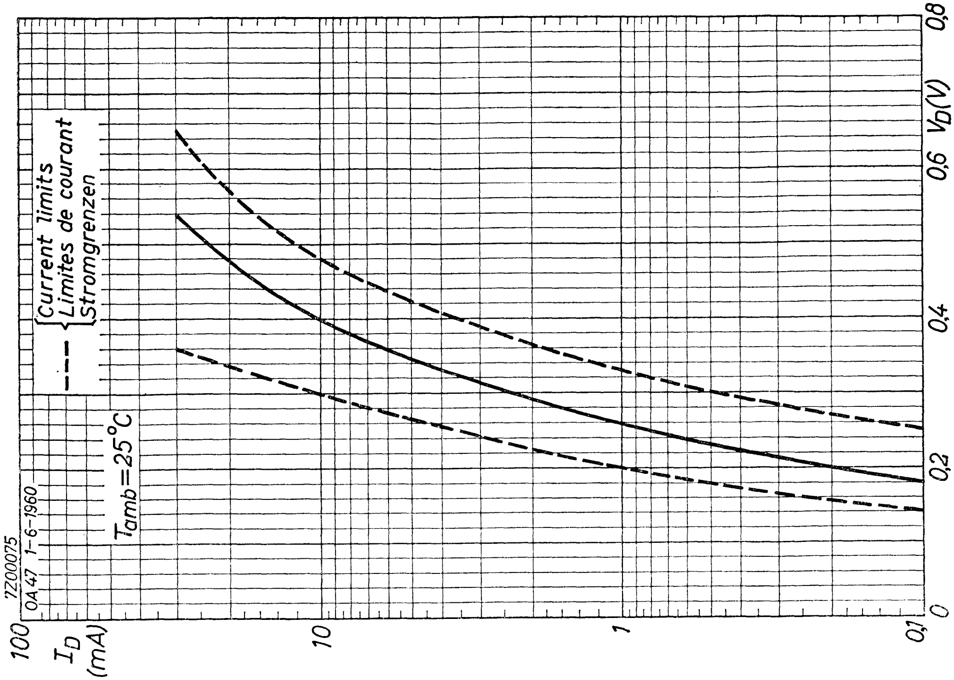


Characteristics (continued)
Caractéristiques (suite)
Kenndaten (Fortsetzung)

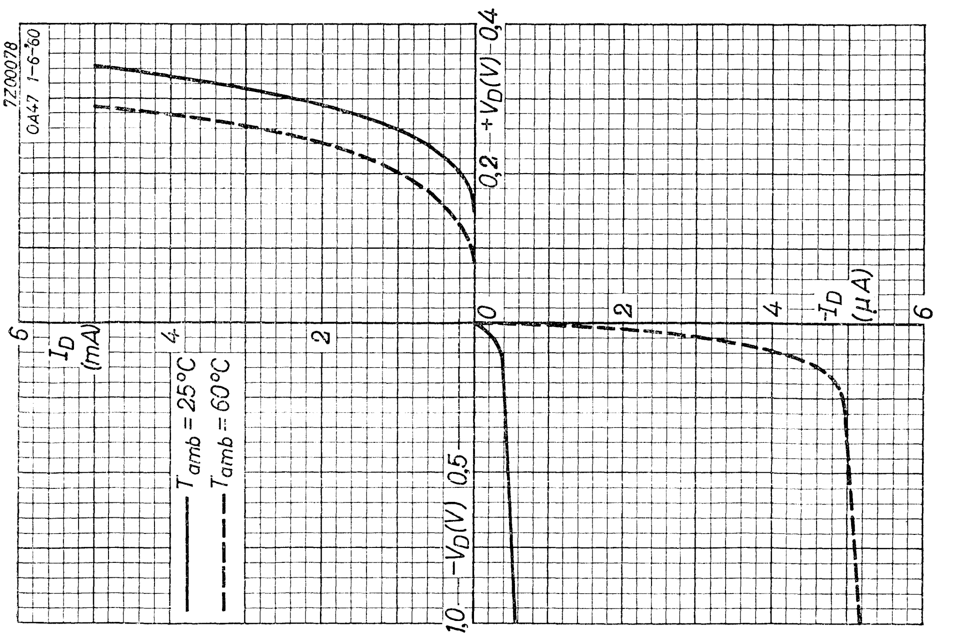
Capacitance
Capacité
Kapazität

$-V_D$	=	0,75 V
f	=	0,5 Mc/s
c_{dk}	=	1,0 pF
	<	3,5 pF [1]

[1] Characteristic range values for equipment design. For other characteristic range values for equipment design see curves pages B, C and D except the points mentionned at page 2.
Gamme de valeurs caractéristiques pour l'étude d'équipements. Pour les autres gammes de valeurs caractéristiques pour l'étude d'équipements voir les courbes pages B, C et D sauf les points mentionnés page 2
Charakteristischer Wertbereich für Gerätentwurf. Für die übrigen charakteristischen Wertbereiche für Gerätentwurf siehe die Kurven Seiten B, C und D, mit Ausnahme der auf Seite 2 erwähnten Punkte.

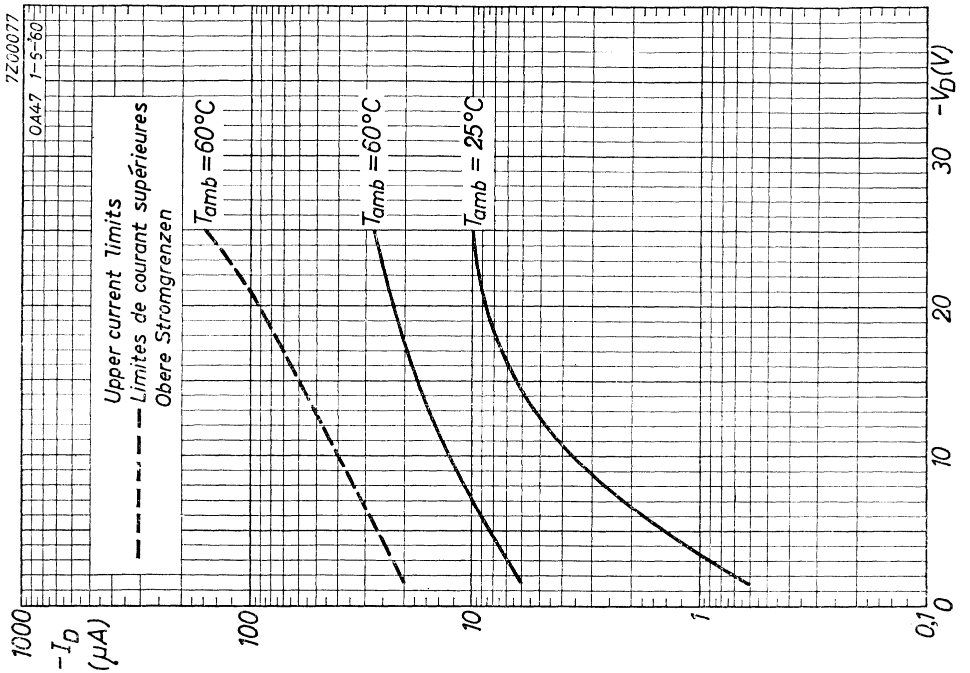

7Z00075
OA 47 1-6-1960
T_{amb}=25°C
Current limits
Limites de courant
Stromgrenzen
100
I_D (mA)
10
1
0,1
0
0,2
0,4
0,6
V_D(V)
0,8

B

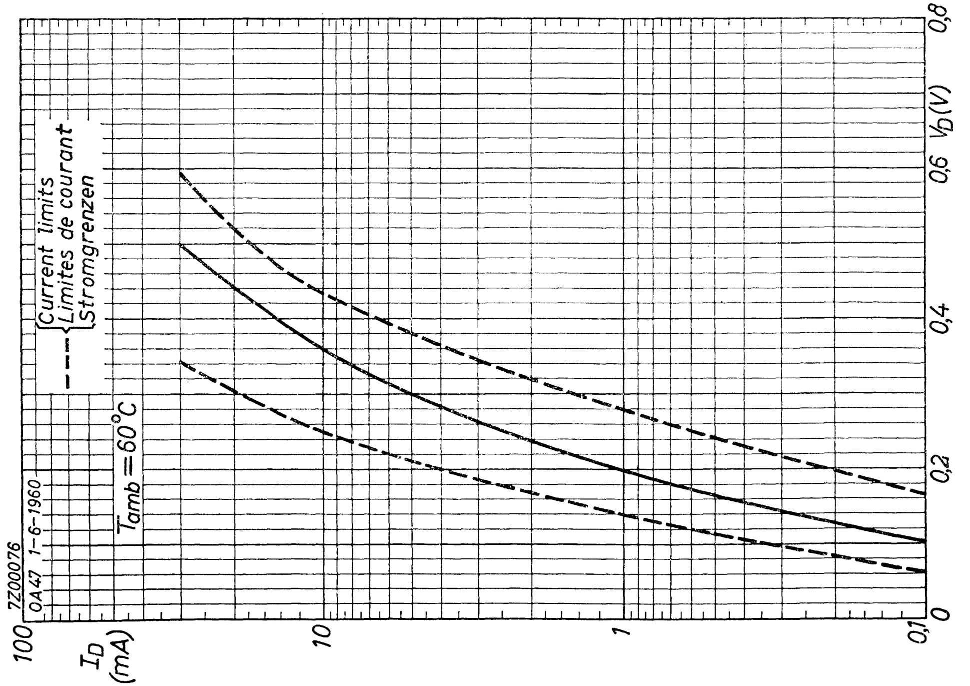

7Z00078
OA47 1-6-60
6
I_D (mA)
4
2
0
0,2
+V_D(V)
0,4
T_{amb} = 25°C
T_{amb} = 60°C
1,0
$-V_D$(V)
0,5
2
4
$-I_D$ (μA)
6

A

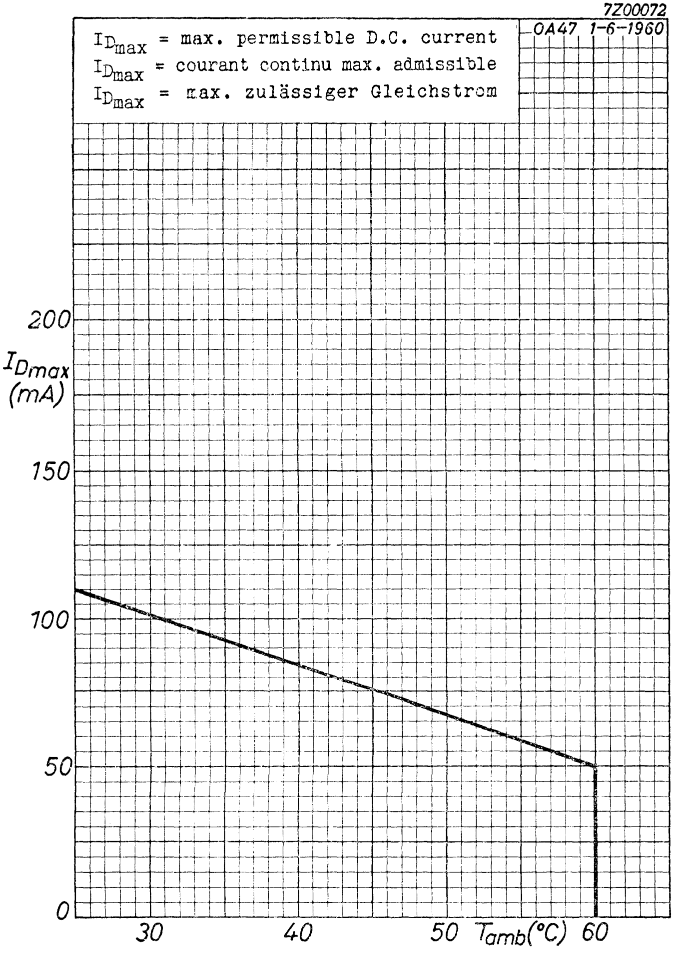
10.10.1960

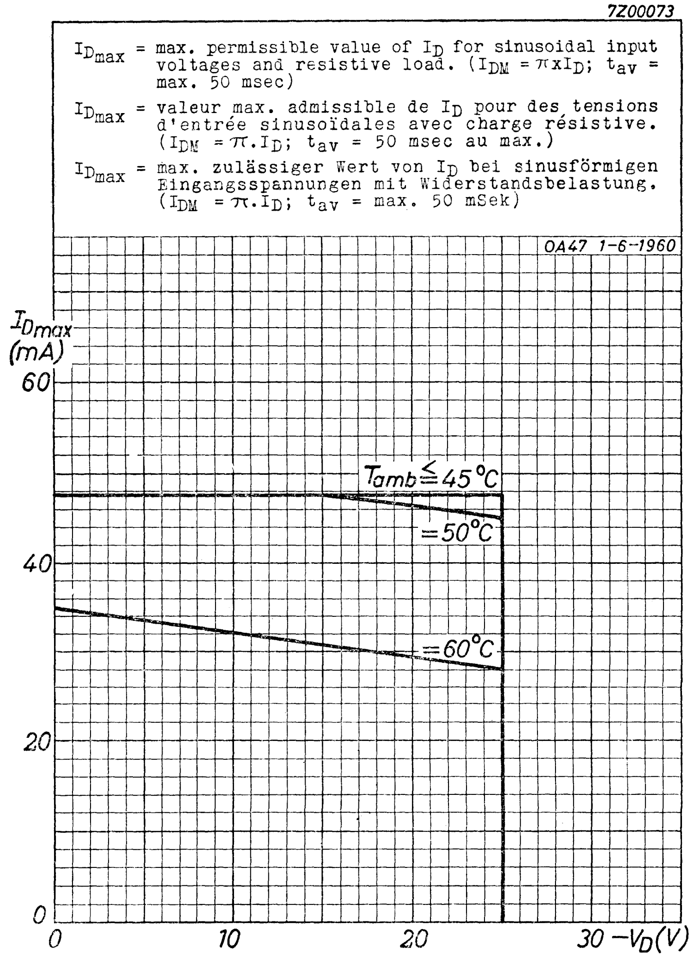

7Z00077
OA47 1-5-'60
Upper current limits
Limites de courant supérieures
Obere Stromgrenzen
T_{amb} = 60°C
T_{amb} = 60°C
T_{amb} = 25°C
$-I_D$ (μA)
1000
100
10
1
0,1
0
10
20
30
$-V_D$(V)

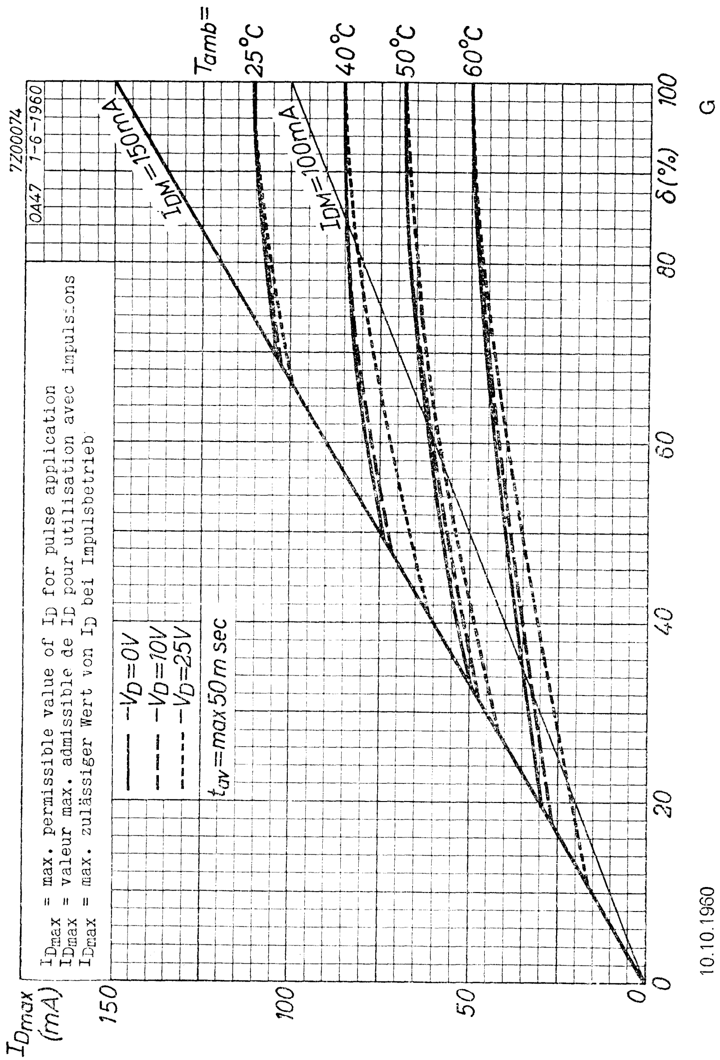
D


7Z00076
OA47 1-6-1960
Current limits
Limites de courant
Stromgrenzen
T_{amb} = 60°C
I_D (mA)
100
10
1
0,1
0
0,2
0,4
0,6
0,8
V_D(V)

C


7Z00072
OA47 1-6-1960
I_{Dmax} = max. permissible D.C. current
I_{Dmax} = courant continu max. admissible
I_{Dmax} = max. zulässiger Gleichstrom
I_{Dmax} (mA)
200
150
100
50
0
30
40
50
60
T_{amb}(°C)

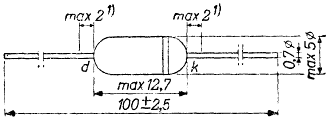

7Z00073
I_{Dmax} = max. permissible value of I_D for sinusoidal input voltages and resistive load. ($I_{DM} = \pi x I_D$; t_{av} = max. 50 msec)
I_{Dmax} = valeur max. admissible de I_D pour des tensions d'entrée sinusoïdales avec charge résistive. ($I_{DM} = \pi . I_D$; t_{av} = 50 msec au max.)
I_{Dmax} = max. zulässiger Wert von I_D bei sinusförmigen Eingangsspannungen mit Widerstandsbelastung. ($I_{DM} = \pi . I_D$; t_{av} = max. 50 mSek)
OA47 1-6-1960
I_{Dmax} (mA)
60
40
20
0
10
20
30
$-V_D$(V)
$T_{amb} \leq 45°C$
= 50°C
= 60°C


I_{Dmax} = max. permissible value of I_D for pulse application
I_{Dmax} = valeur max. admissible de I_D pour utilisation avec impulsions
I_{Dmax} = max. zulässiger Wert von I_D bei Impulsbetrieb
$-V_D$=0V
$-V_D$=10V
$-V_D$=25V
t_{av}=max 50 m sec
I_{DM}=150mA
I_{DM}=100mA
T_{amb}=
25°C
40°C
50°C
60°C
OA47 1-6-1960
7200074
I_{Dmax} (mA)
150
100
50
0
0
20
40
60
80
100
δ(%)
G
10.10.1960

GERMANIUM DIODE for use as video detector
DIODE A CRISTAL DE GERMANIUM pour la détection vidéo
GERMANIUMDIODE zur Video-Demodulation

Dimensions in mm
Dimensions en mm
Abmessungen in mm

The white band indicates the position of the cathode
L'anneau blanc marque la position de la cathode
Der weisse Ring indiziert die Katodenseite



Limiting values (Absolute max. values)
Caractéristiques limites (Valeurs max. absolues)
Grenzdaten (Absolute Maximalwerte)

$-V_{DM}$	= max. 22,5 V
$-V_D$ (t_{av} = max. 50 msec)	= max. 15 V
I_D	= max. 50 mA [2])
I_{DM}	= max. 150 mA
I_{surge}	= max. 400 mA [3])
T_{amb}	= -50°C/+75 °C

[1]) Not tinned; non étamé; nicht verzinnt

[2]) For the relation between simultaneously allowable maximum values of $-V_{DM}$ and I_D see the derating curve (page D). Operation in accordance with this derating curve is prescribed. The derating curve is valid at $T_{amb} \leq 25$ °C. At higher temperatures an extra derating of I_D by a factor $\frac{25}{T_{amb}}$ is prescribed.

Pour le rapport entre les valeurs maximum de $-V_{DM}$ et I_D admissibles simultanément voir la courbe de réduction (page D). Une opération en accord avec cette courbe est prescrite. La courbe de réduction est valable à $T_{amb} \leq 25$°C. A des températures plus élevées une réduction supplémentaire de I_D par un facteur $\frac{25}{T_{amb}}$ est prescrite.

Für die Beziehung zwischen den gleichzeitig zulässigen Höchstwerten von $-V_{DM}$ und I_D siehe die Reduktionskurve (Seite D). Betrieb entsprechend dieser Kurve ist vorgeschrieben. Die Reduktionskurve ist gültig bei $T_{amb} \leq 25$ °C. Bei höheren Temperaturen ist eine zusätzliche Reduktion von I_D mit einem Faktor $\frac{25}{T_{amb}}$ vorgeschrieben.

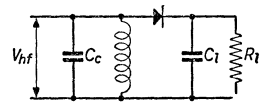
[3]) Max. duration 1 sec.
Durée 1 sec. au max.
Max. Dauer 1 Sek.

Capacitance
Capacité
Kapazität
C_{dk} = 1 pF

Characteristics
Caractéristiques
Kenndaten
T_{amb} = 25 °C

V_D (I_D = 0,1 mA)	> 0,1	< 0,25 V
$-I_D$ ($-V_D$ = 1,5 V)	> 1	< 30 µA

Operating characteristics as video detector
Caractéristiques d'utilisation en détectrice vidéo
Betriebsdaten als Video-Demodulator

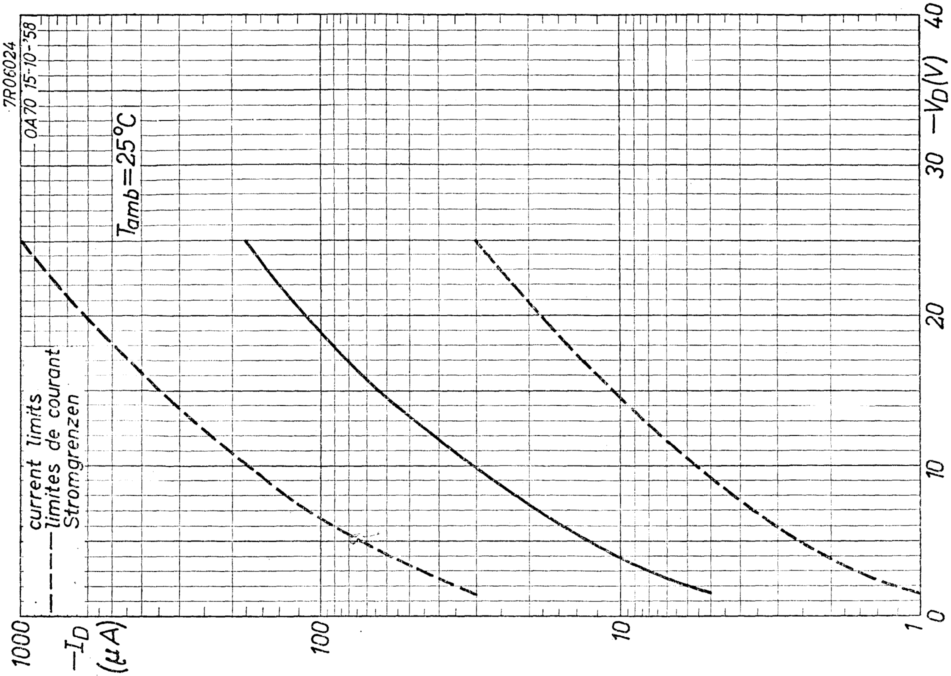


V_{hfm}	= 5 V
R_ℓ	= 3,9 kΩ
C_ℓ	= 10 pF
C_c	= 20 pF
f	= 30 Mc/s
η	= 62 %
rd	= 3 kΩ

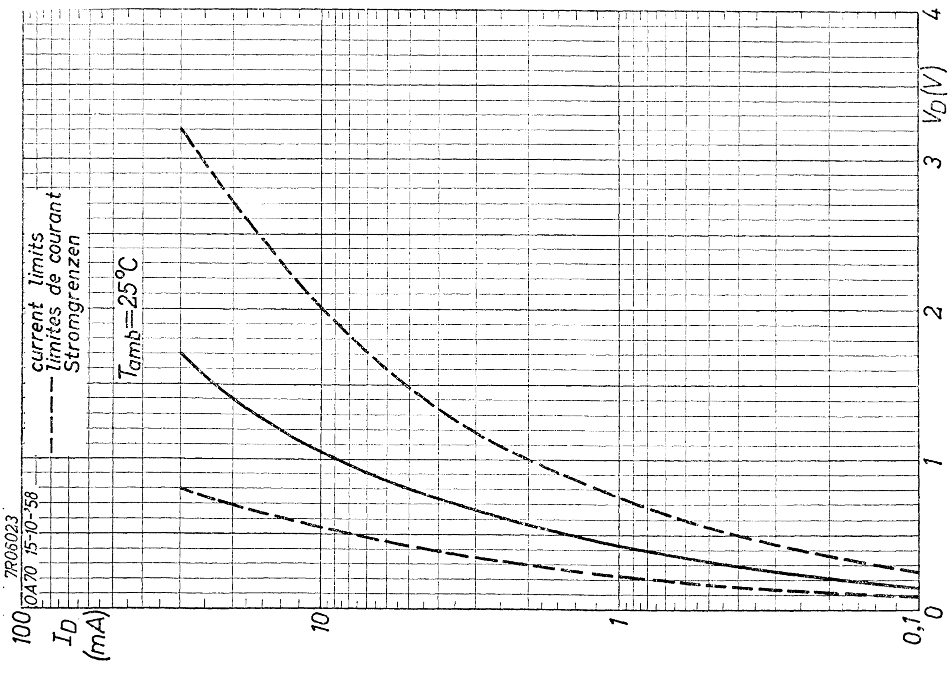
See also pages E to J
Voir aussi pages E jusqu'à J
Siehe also Seiten E bis J

Net weight
Poids net
Nettogewicht
0,6 g

OA70

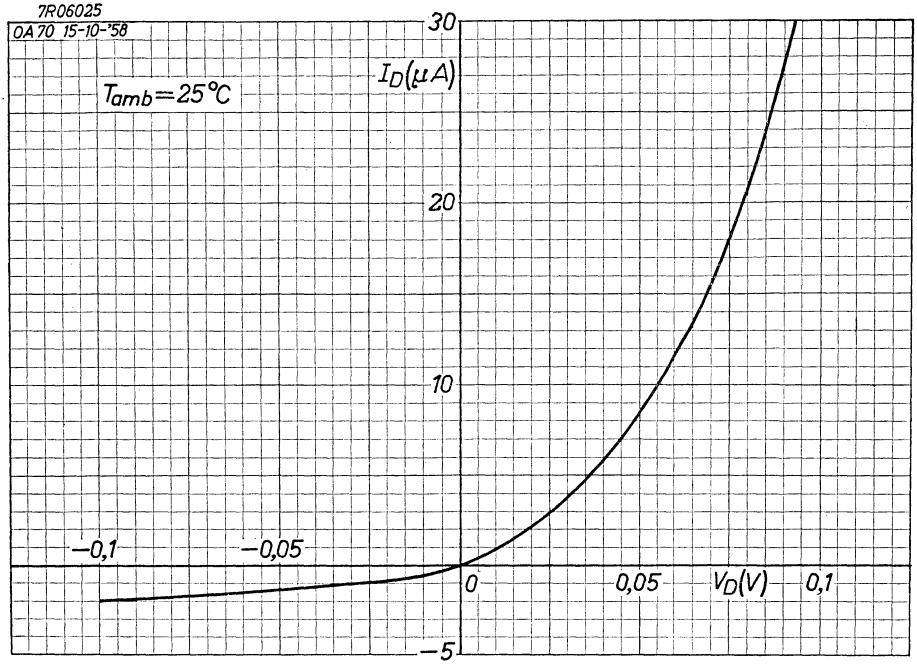


B



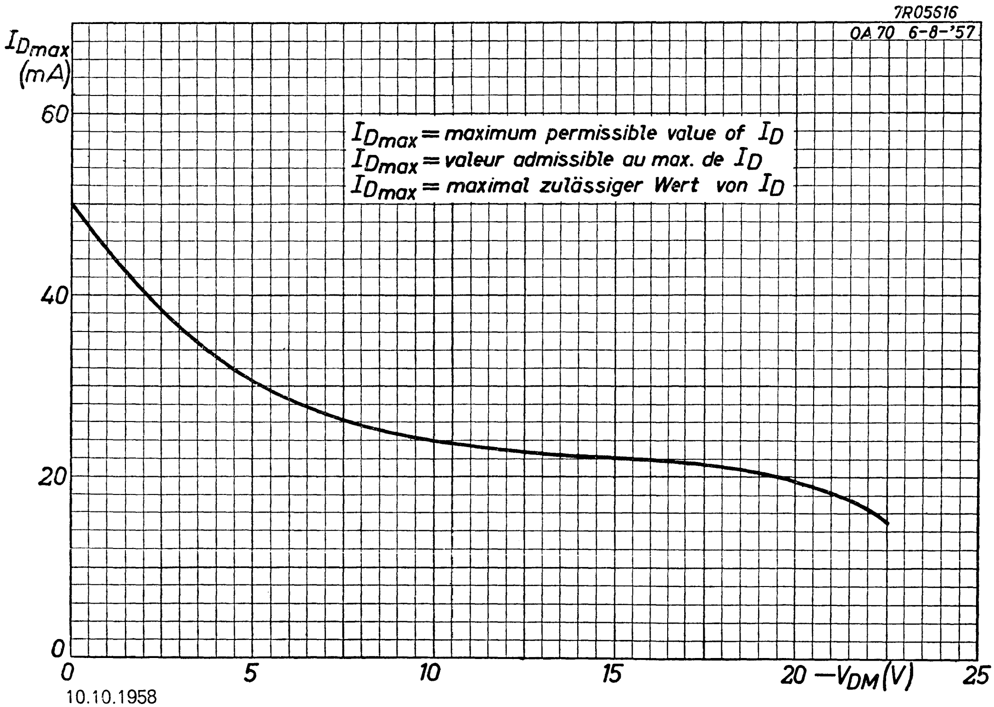
A

10.10.1958



7R06025
OA 70 15-10-'58
T_{amb}=25°C
I_D(μA)
30
20
10
−5
−0,1
−0,05
0
0,05
V_D(V)
0,1

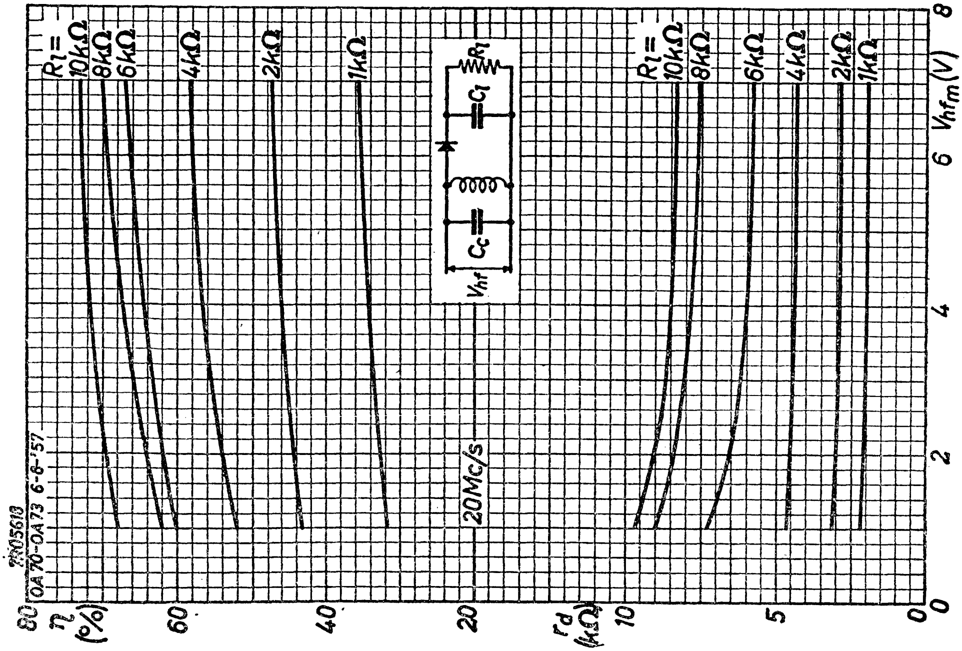
C



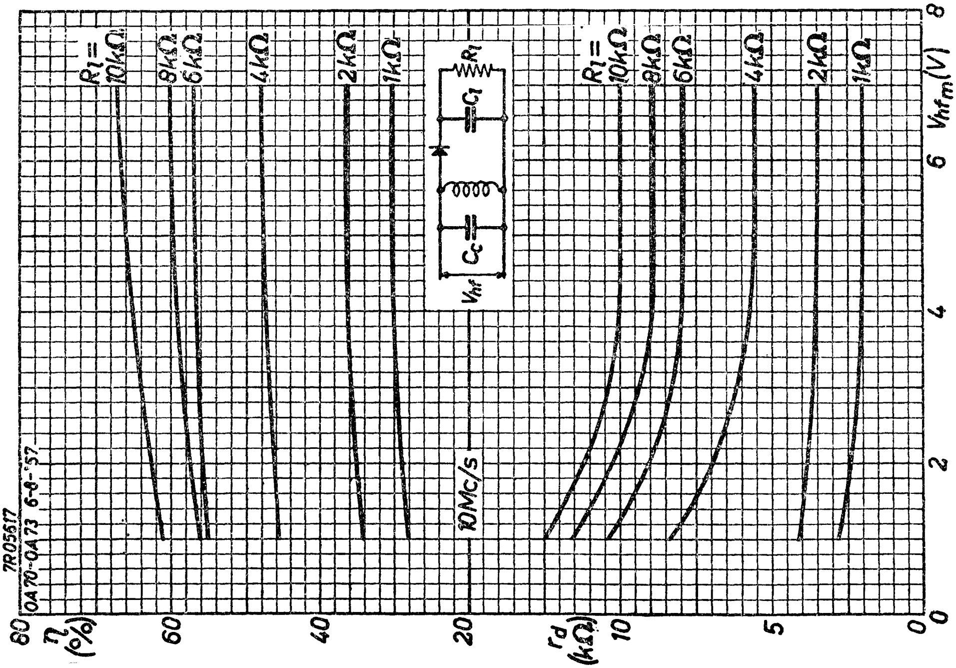
7R05616
OA 70 6-8-'57
I_{Dmax}
(mA)
60
40
20
0
I_{Dmax} = maximum permissible value of I_D
I_{Dmax} = valeur admissible au max. de I_D
I_{Dmax} = maximal zulässiger Wert von I_D
0
5
10
15
20
−V_{DM}(V)
25

D

10.10.1958

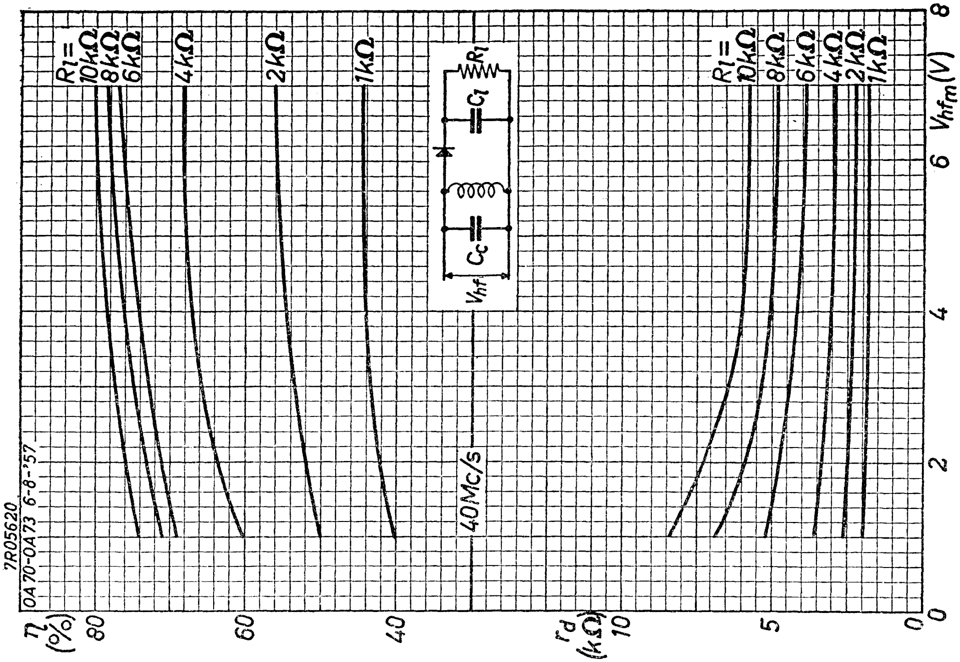

7R05618
OA70-OA73 6-6-'57
η (%)
rd (kΩ)
20Mc/s
Vhfm (V)
Rl =
10kΩ
8kΩ
6kΩ
4kΩ
2kΩ
1kΩ
Vhf
Cc
C1
Rl

F

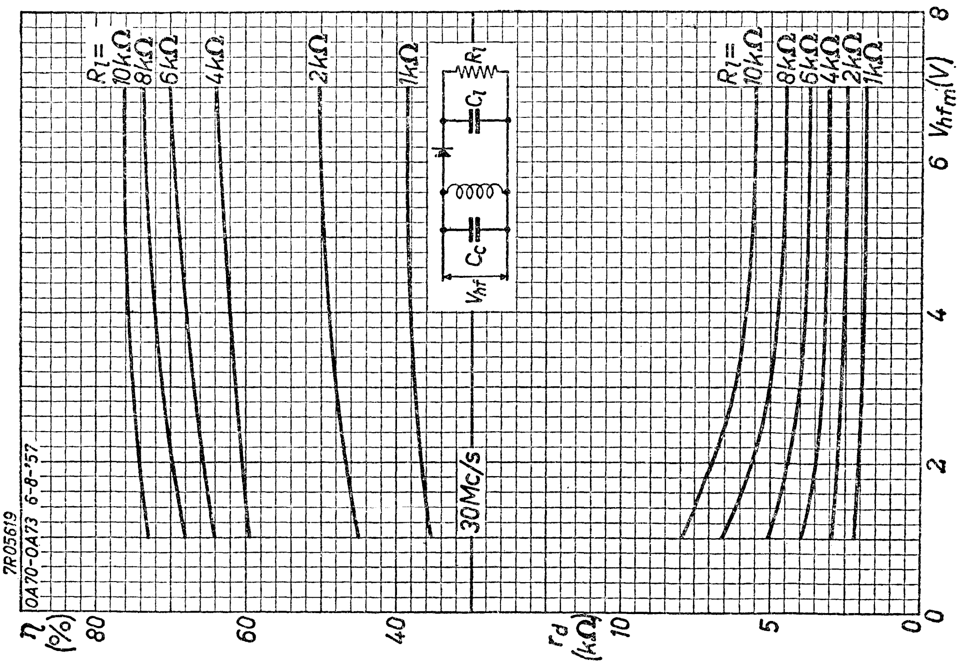

7R05617
OA70-OA73 6-6-'57
η (%)
rd (kΩ)
10Mc/s
Vhfm (V)
Rl =
10kΩ
8kΩ
6kΩ
4kΩ
2kΩ
1kΩ
Vhf
Cc
C1
Rl

E

7.7.1957

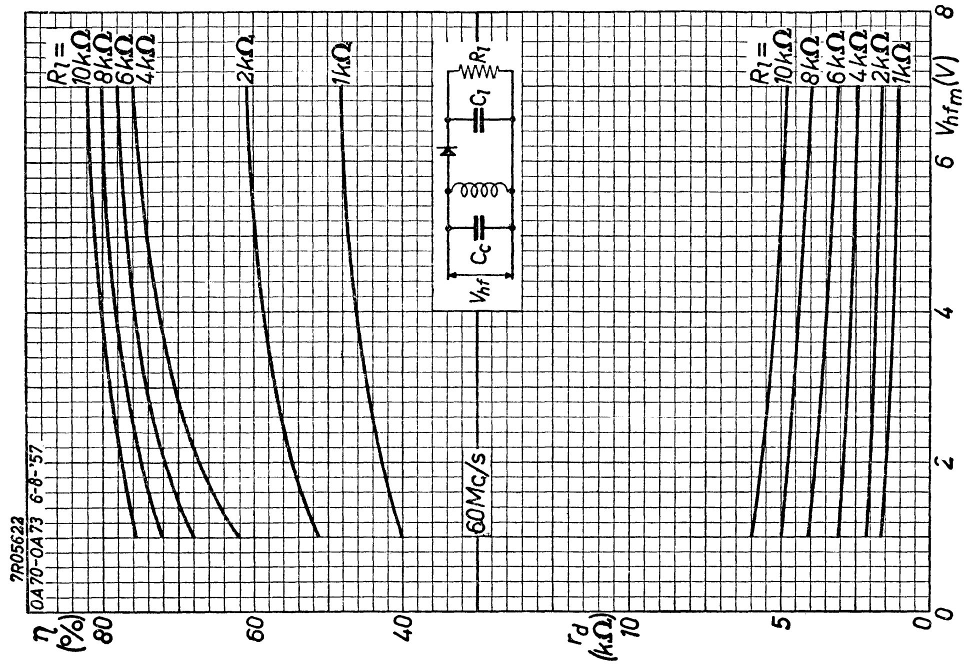

7R05620
OA70-OA73 6-8-'57
η (%)
r_d (kΩ)
V_{hfm}(V)
40Mc/s
R_l =
10kΩ
8kΩ
6kΩ
4kΩ
2kΩ
1kΩ
V_{hf}
C_c
C_l
R_l

H

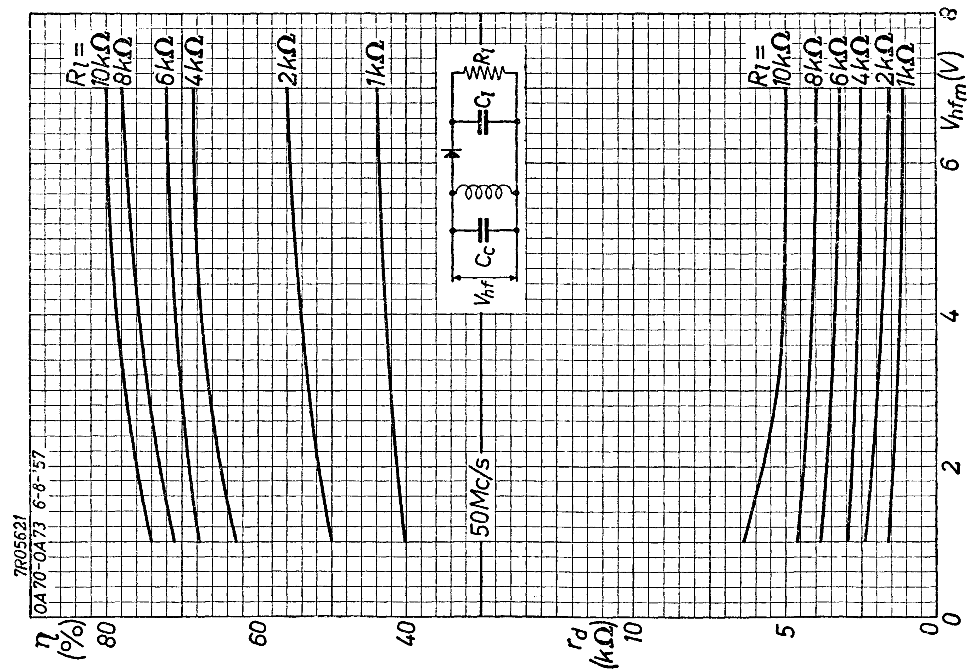

7R05619
OA70-OA73 6-8-'57
η (%)
r_d (kΩ)
V_{hfm}(V)
30Mc/s
R_l =
10kΩ
8kΩ
6kΩ
4kΩ
2kΩ
1kΩ
V_{hf}
C_c
C_l
R_l

G

7.7.1957


7R05622
OA70-OA73 6-8-'57
η (%)
80
60
40
r_d (kΩ)
10
5
0
0
2
4
6
8
V_{hfm}(V)
60Mc/s
R_l = 10kΩ
8kΩ
6kΩ
4kΩ
2kΩ
1kΩ
V_{hf}
C_c
C_l
R_l

J


7R05621
OA70-OA73 6-8-'57
η (%)
80
60
40
r_d (kΩ)
10
5
0
0
2
4
6
8
V_{hfm}(V)
50Mc/s
R_l = 10kΩ
8kΩ
6kΩ
4kΩ
2kΩ
1kΩ
V_{hf}
C_c
C_l
R_l

I

GERMANIUM DIODES

Germanium r.f. rectifier diode in all glass construction with high reverse resistance.
Type 2-OA72 consists of 2 diodes OA72 selected for operation in a ratio detector or similar circuits.

LIMITING VALUES (Absolute max. values)

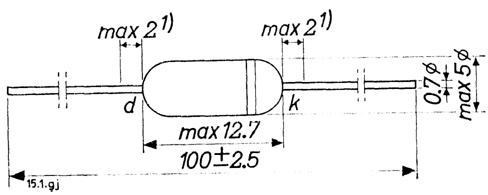
			T_{amb} = 25 °C	T_{amb} = 60 °C
Reverse voltage	$-V_D$	max.	30 V	30 V
Reverse peak voltage	$-V_{DM}$	max.	45 V	45 V
Forward current (d.c.)	I_D	max.	10 mA	4 mA
Forward current (peak value)	I_{DM}	max.	100 mA	100 mA
Forward surge current ($t < 1$ s)	I_{Dsurge}	max.	200 mA	200 mA

CHARACTERISTICS T_{amb} = 25 °C

Forward voltage drop			
at I_D = 0.1 mA	V_D	typ.	0.2 V
at I_D = 10 mA	V_D	typ.	1.4 V
at I_D = 30 mA	V_D	typ.	2.4 V
Reverse current			
at $-V_D$ = 1.5 V	$-I_D$	typ.	0.8 μA
$-V_D$ = 10 V	$-I_D$	typ.	4.5 μA
$-V_D$ = 30 V	$-I_D$	typ.	50 μA
$-V_D$ = 45 V	$-I_D$	typ.	130 μA

MECHANICAL DATA

Dimensions in mm



The white band indicates the cathode side.

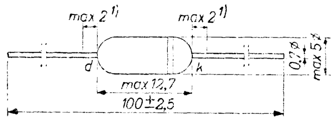
1) Not tinned

7Z2 3190

GERMANIUM DIODE in all glass construction for use as video detector
DIODE A CRISTAL DE GERMANIUM de construction tout verre pour la détection vidéo
GERMANIUMDIODE in Allglastechnik zur Video-Demodulation

Dimensions in mm
Dimensions en mm
Abmessungen in mm

The white band indicates the position of the cathode
L'anneau blanc marque la position de la cathode
Der weisse Ring indiziert die Katodenseite



Limiting values (Absolute max. values)
Caractéristiques limites (Valeurs max. absolues)
Grenzdaten (Absolute Maximalwerte)

$-V_{DM}$	= max.	30 V
$-V_D$ (t_{av} = max. 50 msec)	= max.	20 V
I_D ($-V_{DM}$ = 0 V)	= max.	50 mA [2]
I_{DM}	= max.	150 mA
I_{surge}	= max.	400 mA [3]
T_{amb}	=	-50°C/+75 °C

[1]) Not tinned; non étamé; nicht verzinnt

[2]) For the relation between simultaneously allowable maximum values of $-V_{DM}$ and I_D see the derating curve (page D) Operation in accordance with this derating curve is prescribed. The derating curve is valid at $T_{amb} \leq 25$ °C. At higher temperatures an extra derating of I_D by a factor $\frac{25}{T_{amb}}$ is prescribed
Pour le rapport entre les valeurs maximum de $-V_{DM}$ et I_D admissibles simultanément voir la courbe de réduction (page D). Une opération en accord avec cette courbe est prescrite. La courbe de réduction est valable à $T_{amb} \leq 25$°C A des températures plus élevées une réduction supplémentaire de I_D par un facteur $\frac{25}{T_{amb}}$ est prescrite.
Für die Beziehung zwischen den gleichzeitig zulässigen Höchstwerten von $-V_{DM}$ und I_D siehe die Reduktionskurve (Seite D). Betrieb entsprechend dieser Kurve ist vorgeschrieben. Die Reduktionskurve ist gültig bei $T_{amb} \leq 25$°C. Bei höheren Temperaturen ist eine zusätzliche Reduktion von I_D mit einem Faktor $\frac{25}{T_{amb}}$ vorgeschrieben.

[3]) Max. duration 1 sec.; durée 1 sec. au max.; max. Dauer 1 Sek.

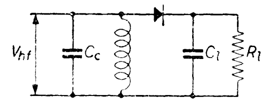
Capacitance
Capacité
Kapazität

C_{dk} = 1 pF

Characteristics
Caractéristiques T_{amb} = 25 °C
Kenndaten

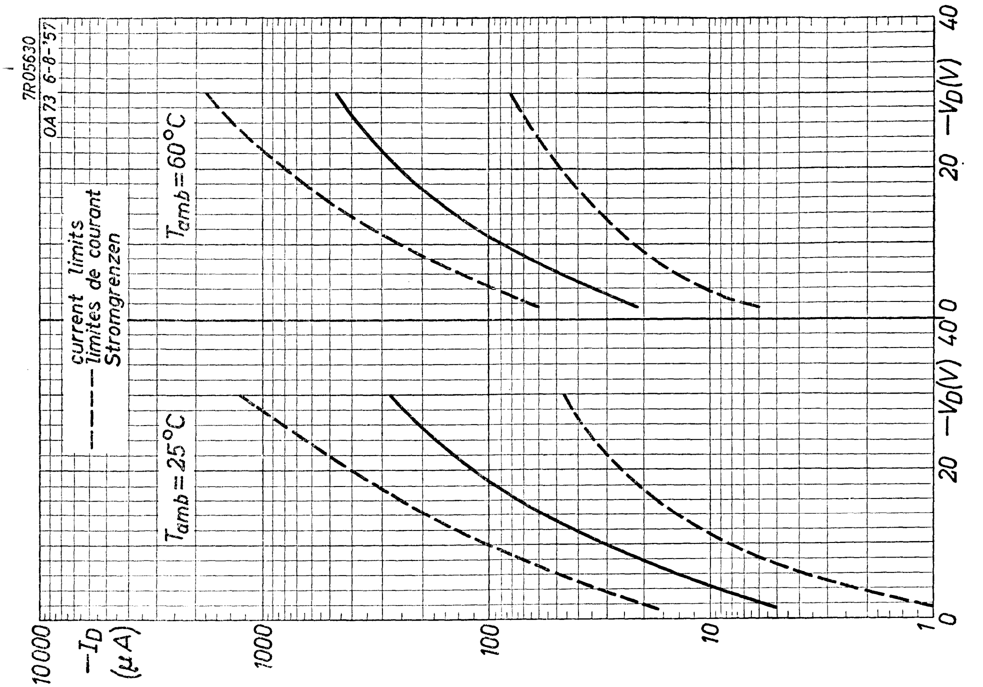
	Min.	Max.
V_D (I_D = 8 mA)	> 0,5	< 1,0 V
V_D (I_D = 0,1 mA)	> 0,1	< 0,2 V
$-I_D$ ($-V_D$ = 1,5 V)	> 1	< 18 µA
$-I_D$ ($-V_D$ = 10 V)	> 8	< 100 µA
$-I_D$ ($-V_D$ = 20 V)	> 25	< 400 µA
$-I_D$ ($-V_D$ = 30 V)	> 45	< 1200 µA

Operating characteristics as video detector
Caractéristiques d'utilisation en détectrice vidéo
Betriebsdaten als Video-Demodulator

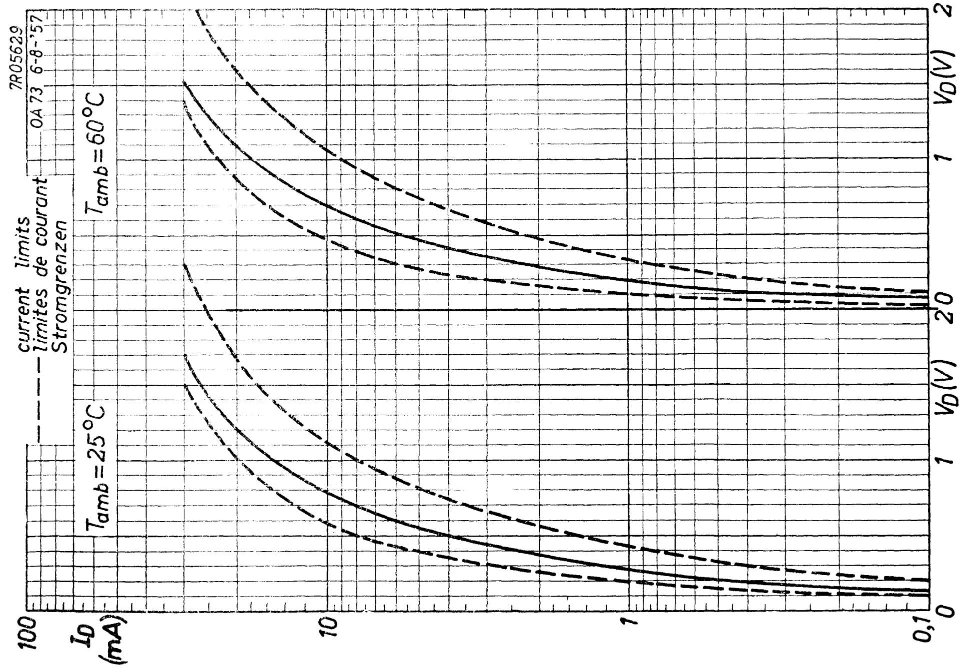


V_{hfm}	=	5 V
R_l	=	3,9 kΩ
C_l	=	10 pF
C_c	=	20 pF
f	=	30 Mc/s
η	=	62 %
r_d	=	3 kΩ

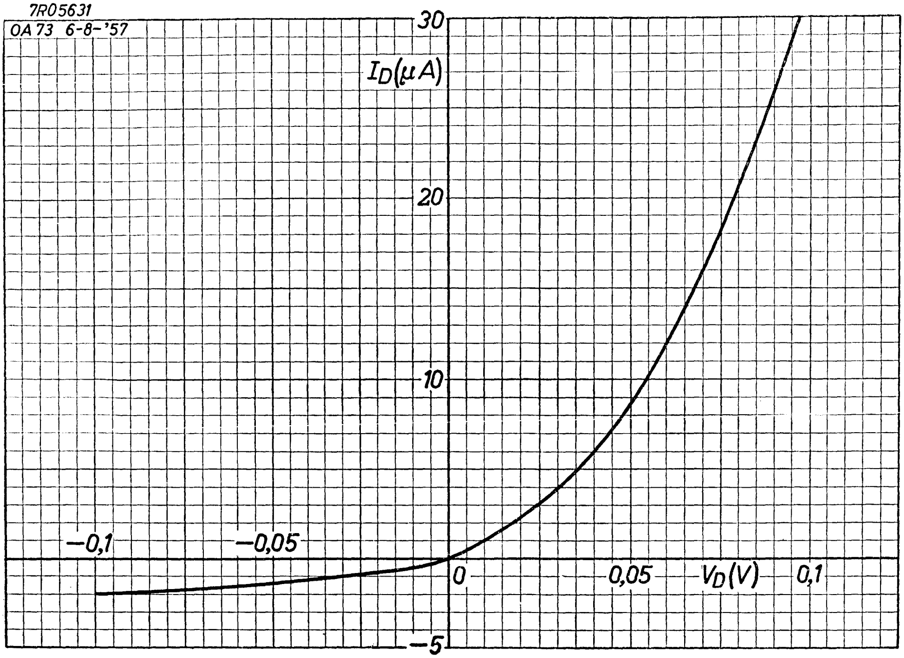
Net weight
Poids net 0, 6 g
Nettogewicht


7R05630
OA73 6-8-'57
current limits
limites de courant
Stromgrenzen
Tamb=60°C
Tamb=25°C
−VD(V)
−VD(V)
0
20
40
0
20
40
−ID
(μA)
10000
1000
100
10
1

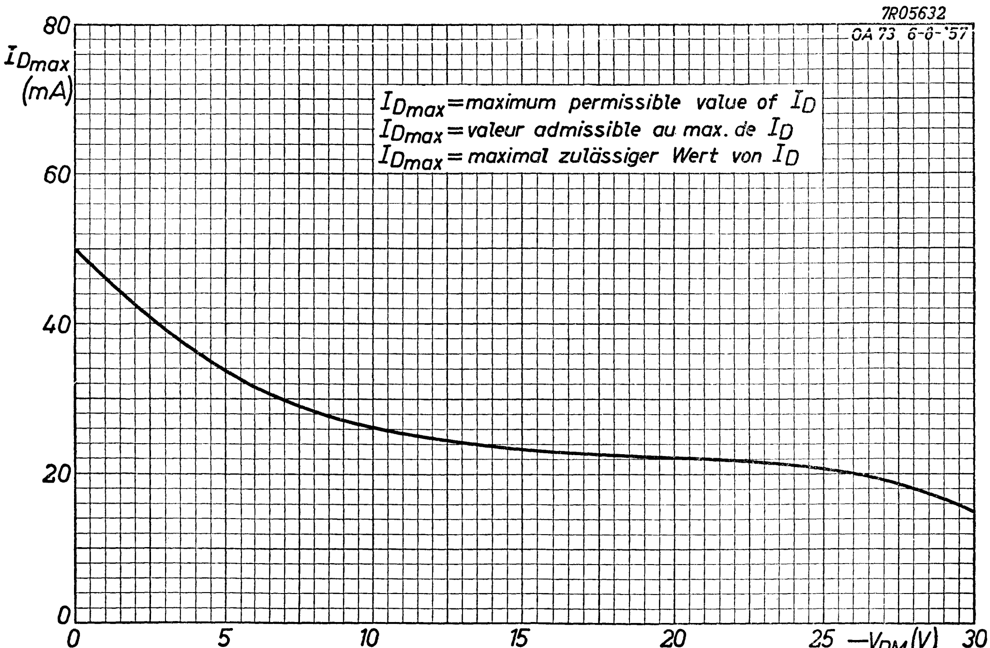
B


7R05629
OA73 6-8-'57
current limits
limites de courant
Stromgrenzen
Tamb=60°C
Tamb=25°C
VD(V)
VD(V)
0
1
2
0
1
2
ID
(mA)
100
10
1
0,1

A


7R05631
OA 73 6-8-'57
$I_D(\mu A)$
30
20
10
−5
−0,1
−0,05
0
0,05
$V_D(V)$
0,1

C


7R05632
OA 73 6-8-'57
I_{Dmax} (mA)
80
60
40
20
0
I_{Dmax} = maximum permissible value of I_D
I_{Dmax} = valeur admissible au max. de I_D
I_{Dmax} = maximal zulässiger Wert von I_D
0
5
10
15
20
25
$-V_{DM}(V)$
30

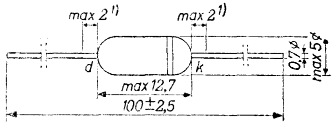
D

7.7.1957

GERMANIUM DIODE in all glass construction for use in AM detection circuits
TYPE 2-OA79 consists of 2 diodes OA 79 selected for operation in a ratio detector circuit
DIODE A CRISTAL DE GERMANIUM de construction tout verre pour opération en circuits détecteur AM
LE TYPE 2-OA79 est composé de deux diodes OA 79 selectionnées pour opération en circuits détecteur ratio
GERMANIUMDIODE in Allglastechnik zur Verwendung in AM-Gleichrichterschaltungen
TYPENNUMMER 2-OA79 besteht aus 2 Dioden OA 79 die ausgesucht sind zur Verwendung in Ratiodetektorschaltungen

Dimensions in mm
Dimensions en mm
Abmessungen in mm

The white band indicates the position of the cathode
L'anneau blanc marque la position de la cathode
Der weisse Ring indiziert die Katodenseite



Limiting values (Absolute max. values)
Caractéristiques limites (Valeurs max. absolues)
Grenzdaten (Absolute Maximalwerte)

Valid at / Valable à / Gültig bei T_{amb}	=	25	60 °C
$-V_D$ (tav = 50 msec)	= max.	30	30 V
$-V_{DM}$	= max.	45	45 V[2)]
I_D (tav = 50 msec)	= max.	35	15 mA[2)]
I_{DM}	= max.	100	100 mA
I_{surge}	= max.	200	200 mA[3)]
T_{amb}	=	-50 °C/+ 60 °C	

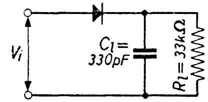
[1)] Not tinned
Non étamé
Nicht verzinnt

[2)] See page 4
Voir page 4
Siehe Seite 4

[3)] Max. duration 1 sec
Durée 1 sec. au max.
Max. Dauer 1 Sek.

Characteristics
Caractéristiques
Kenndaten

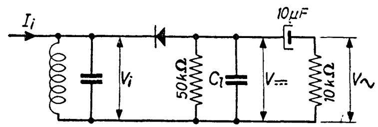
	Tamb = 25°C			Tamb = 60°C		
	=	Min.	Max.	=	Min.	Max.
V_D(I_D = 0,1 mA)	= 0,23	>0,15	<0,30	= 0,16	>0,1	<0,25 V
V_D(I_D = 10 mA)	= 1,5	>0,8	<2,2	= 1,4	>0,7	<2,1 V
V_D(I_D = 30 mA)	= 2,8	>1,4	<4,0	= 2,6	>1,2	<3,8 V
$-I_D$($-V_D$ = 0,1 V)	= 0,35		<1,0	= 4,5		<12 µA
$-I_D$($-V_D$ = 1,5 V)	= 0,8	>0,1	<2,8	= 6	>0,8	<25 µA
$-I_D$($-V_D$ = 10 V)	= 4,5	>0,4	<18	= 16	>2,5	<60 µA
$-I_D$($-V_D$ = 30 V)	= 35	>1,5	<150	= 60	>8	<300 µA
$-I_D$($-V_D$ = 45 V)	= 90	>4	<350	= 170	>15	<500 µA



Tamb	=	25 °C		
V_i	=	3 Veff		
f	=	10,7 Mc/s		
η	=	85 %		
r_d	=	15 kΩ	>13,5 kΩ	<19 kΩ

Operating characteristics as A.M. detector
Caractéristiques d'utilisation en détectrice A.M.
Betriebsdaten als AM-Signalgleichrichter

Tamb	=	25 °C
V_i	=	0,1 Veff
f	=	0,5 Mc/s
V=	=	55 mV
V~	=	4,5 mVeff [1)]
r_d	=	40 kΩ [2)]

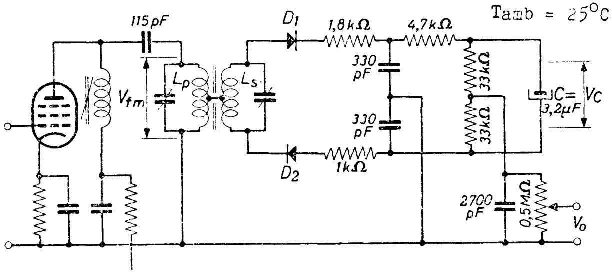


[1)] Ii 30 % modulated
Ii modulé de 30 %
Ii 30 % moduliert

[2)] Unmodulated input signal
Signal d'entrée non modulé
Nicht-moduliertes Eingangssignal

Operating characteristics of a matched pair 2-OA 79 as ratio detector
Caractéristiques d'utilisation d'une paire jumelle 2-OA 79 en détectrice ratio
Betriebsdaten eines Diodenpaars 2-OA 79 als Ratio-Detektor

$T_{amb} = 25\,^{o}C$



For optimum A.M. suppression D1 must be that diode of the matched pair which has the better dynamic forward characteristic

Afin d'obtenir la suppression A.M. optimum, D1 sera cette diode de la paire jumelle qui a la meilleure caractéristique dynamique en sens conducteur

Zur Erhaltung der optimalen AM-Unterdrückung muss D1 diejenige Diode des Diodenpaars sein die die beste dynamische Kennlinie in Durchlassrichtung hat

Primary circuit / Circuit primaire / Primärkreis	L_p	=	7,4 μH
	Q	=	80 [1])
	R	=	40 kΩ[1])
Tap / Prise / Anzapfung		=	0,5
Secundary circuit / Circuit secondaire / Sekundärkreis	L_s	=	4,4 μH
	Q	>	150 [1])
	R	>	45 kΩ[1])
KQ		=	0,8 [2])
f_o		=	10,7 Mc/s
Δf		=	15 kc/s
m		=	30 %
α $\{f = f_o;\ 2\ V < V_C < 20\ V\}$		≧	30
α $\{f = f_o \pm 25\ kc/s;\ 2\ V < V_C < 20\ V\}$		≧	15

f_o = resonance frequency; fréquence de résonance; Resonanzfrequenz
Δf = Frequency sweep; balayage de fréquence; Frequenzhub
m = AM modulation factor; facteur de modulation AM; AM-Modulationstiefe
α = AM suppression factor; coefficient de suppression AM; AM Unterdrückungsfaktor

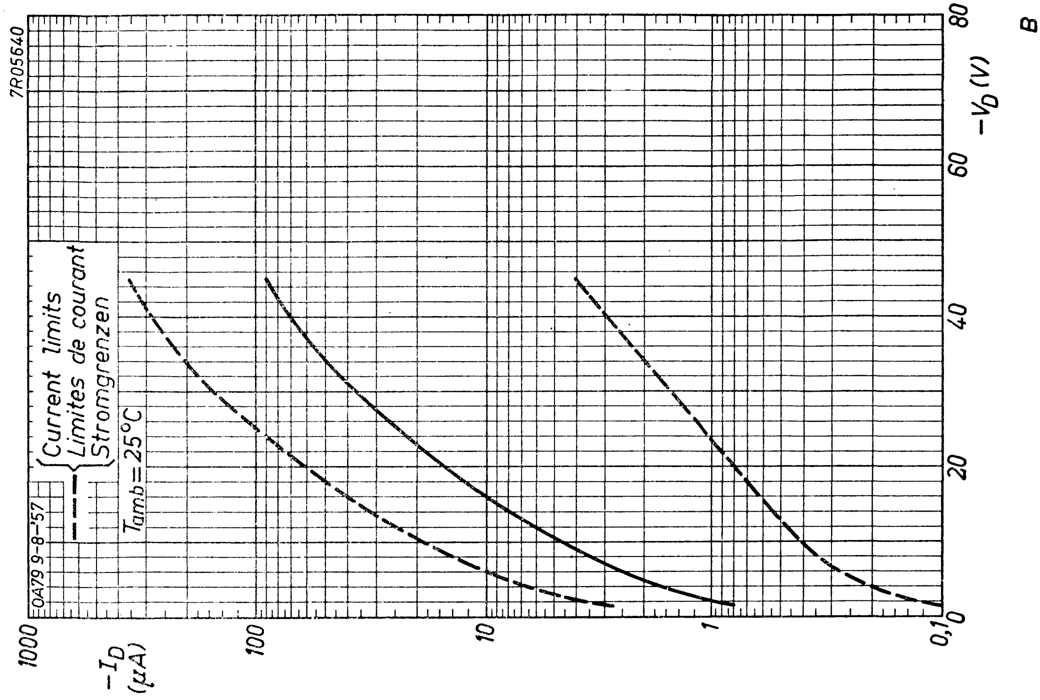
1) Undamped / Non amorti / Ungedämpft

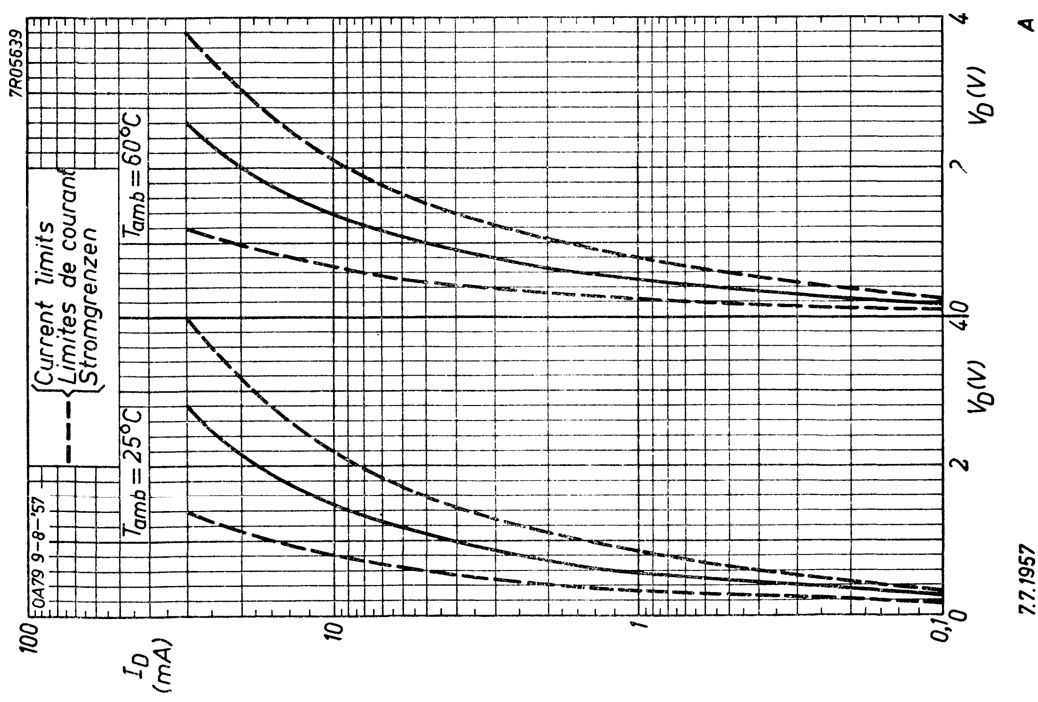
2) Measured in the circuit with V_{fm} = 350 mV / Mesuré dans le circuit avec V_{fm} = 350 mV / In der Schaltung mit V_{fm} = 350 mV gemessen

2) For the relation between simultaneously allowable maximum values of $-V_{DM}$ and I_D see the derating curve (page E.) Operation in accordance with this derating curve is prescribed. The derating curve is valid at $T_{amb} \leq 25\,^{o}C$. At higher temperatures an extra derating of I_D by a factor $\frac{25}{T_{amb}}$ is prescribed.

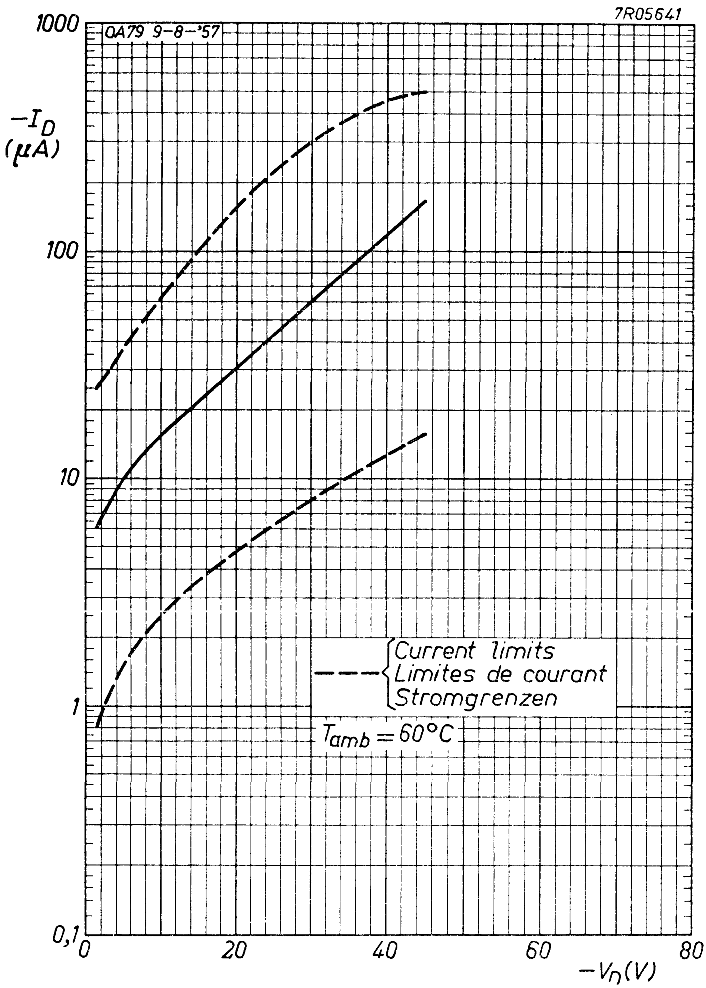
Pour le rapport entre les valeurs maximum de $-V_{DM}$ et I_D admissibles simultanément voir la courbe de réduction (page E). Une opération en accord avec cette courbe est prescrite. La courbe de réduction est valable à $T_{amb} \leq 25\,^{o}C$. A des températures plus élevées une réduction supplémentaire de I_D par un facteur $\frac{25}{T_{amb}}$ est prescrite.

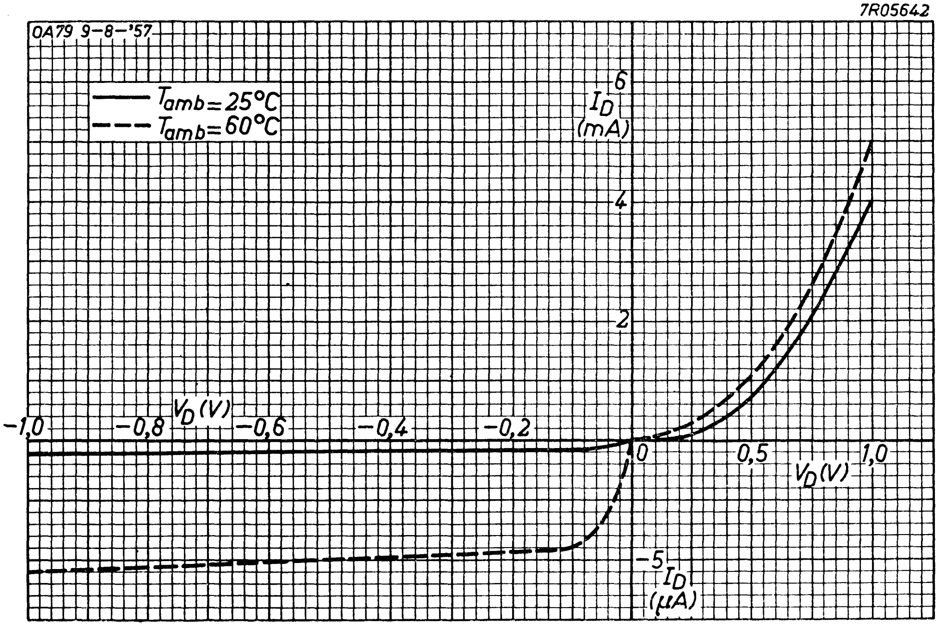
Für die Beziehung zwischen den gleichzeitig zulässigen Höchstwerten von $-V_{DM}$ und I_D siehe die Reduktionskurve (Seite E). Betrieb entsprechend dieser Kurve ist vorgeschrieben. Die Reduktionskurve ist gültig bei $T_{amb} \leq 25\,^{o}C$. Bei höheren Temperaturen ist eine zusätzliche Reduktion von I_D mit einem Faktor $\frac{25}{T_{amb}}$ vorgeschrieben.


7R05640
OA79 9-8-'57
Current limits
Limites de courant
Stromgrenzen
$T_{amb} = 25°C$
$-I_D$ (μA)
1000
100
10
1
0,1
0
20
40
60
80
$-V_D$ (V)
B

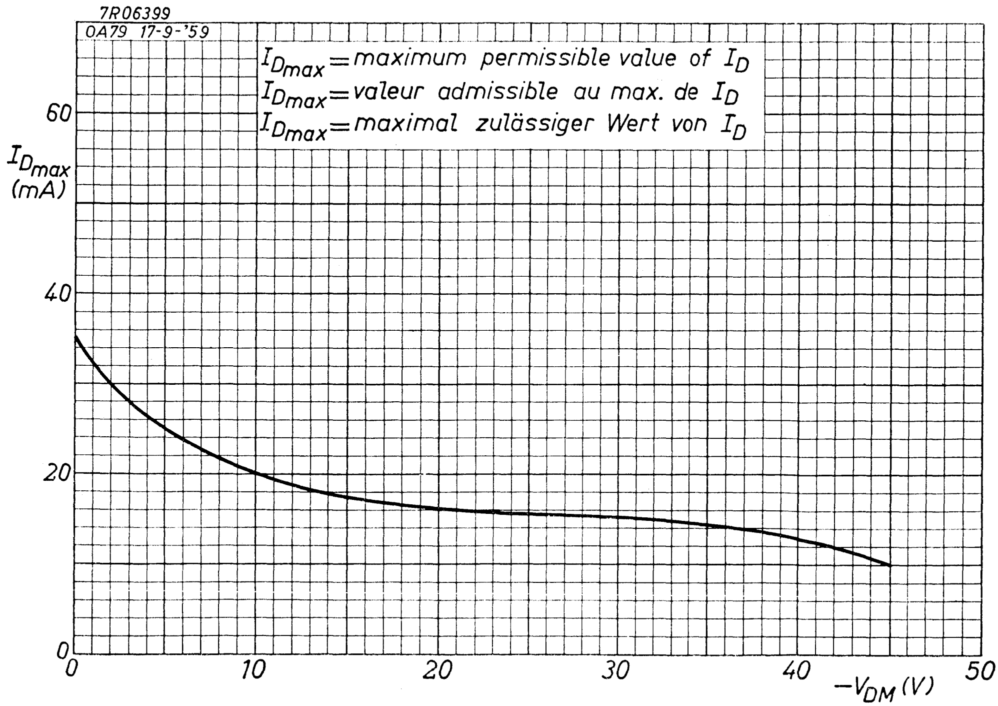

7R05639
OA79 9-8-'57
Current limits
Limites de courant
Stromgrenzen
$T_{amb} = 25°C$
$T_{amb} = 60°C$
I_D (mA)
100
10
1
0,1
0
2
4
V_D (V)
A

7.7.1957


7R05641
OA79 9-8-'57
1000
100
10
1
0,1
$-I_D$ (μA)
0
20
40
60
80
$-V_D$ (V)
Current limits
Limites de courant
Stromgrenzen
$T_{amb} = 60°C$


7R05642
OA79 9-8-'57
$T_{amb}=25°C$
$T_{amb}=60°C$
6
4
2
I_D (mA)
V_D (V)
-1,0
-0,8
-0,6
-0,4
-0,2
0
0,5
1,0
V_D (V)
-5
I_D (μA)

D


7R06399
OA79 17-9-'59
I_{Dmax} = maximum permissible value of I_D
I_{Dmax} = valeur admissible au max. de I_D
I_{Dmax} = maximal zulässiger Wert von I_D
60
40
20
0
I_{Dmax} (mA)
0
10
20
30
40
50
$-V_{DM}$ (V)

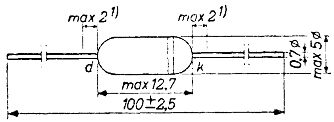
E

9.9.1959

GERMANIUM DIODE in all glass construction for high inverse voltages
DIODE A CRISTAL DE GERMANIUM de construction tout verre pour des tensions inverses élevées
GERMANIUMDIODE in Allglastechnik für hohe Sperrspannungen

Dimensions in mm
Dimensions en mm
Abmessungen in mm

The white band indicates the position of the cathode
L'anneau blanc marque la position de la cathode
Der weisse Ring indiziert die Katodenseite



Limiting values (Absolute max. values)
Caractéristiques limites (Valeurs max. absolues)
Grenzdaten (Absolute Maximalwerte)

Valid at / Valable à / Gültig bei					
T_{amb}	=		25	75	°C
$-V_D$(t_{av} = max.50 msec)	=	max.	90	75	V
$-V_{DM}$	=	max.	115	100	V [2]
I_D(t_{av} = max.50 msec)	=	max.	50	17	mA [2]
I_{DM}	=	max.	150	150	mA
I_{surge}	=	max.	500	500	mA [3]
T_{amb}	=		-50°C/+75 °C		

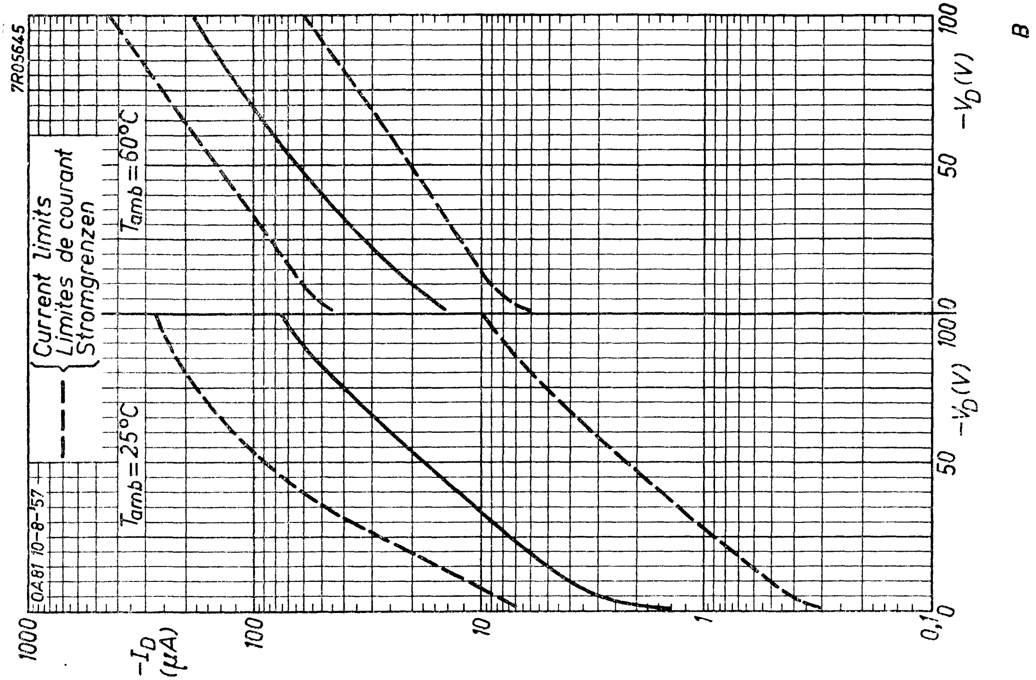
[1])Not tinned; non étamé; nicht verzinnt

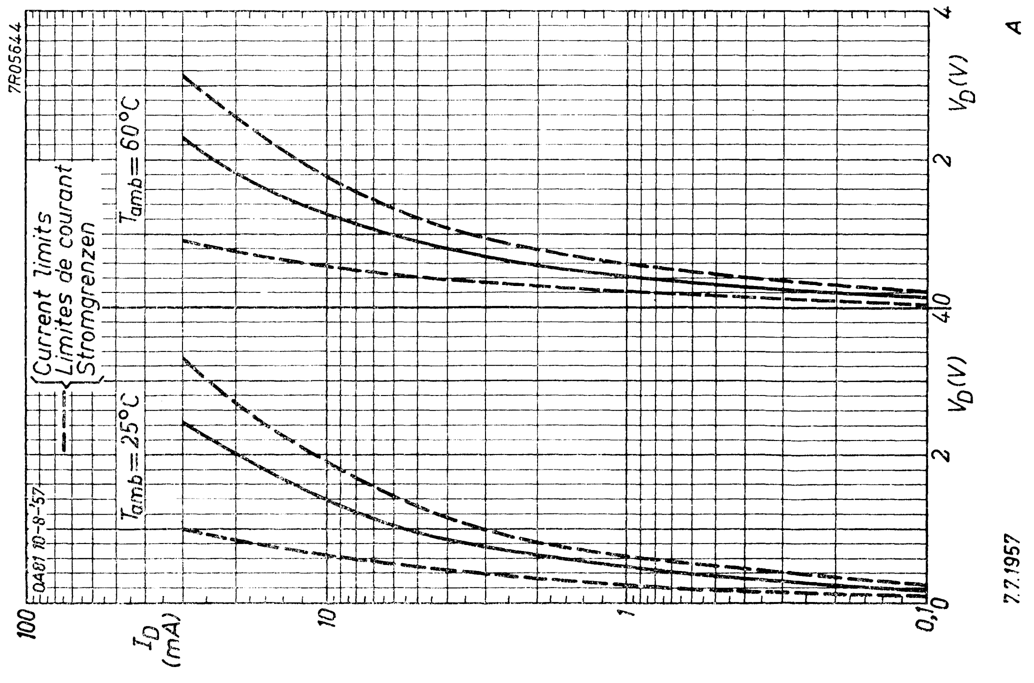
[2])At page D derating curves are given representing the max. permissible value of I_D as a function of $-V_{DM}$ at T_{amb} = 25, 50 and 75 °C. At intermediate temperatures the max. permissible values of I_D can be found by linear interpolation
Sur la page D des courbes de réduction sont données représentant la valeur max. admissible de I_D en fonction de $-V_{DM}$ à T_{amb} = 25, 50 et 75 °C. A des températures intermédiaires les valeurs admissibles aux max. de I_D peuvent être trouvées par interpolation linéaire
Auf Seite D sind Reduktionskurven gegeben, die den max. zulässigen Wert von I_D als Funktion von $-V_{DM}$ bei T_{amb} = 25, 50 and 75 °C darstellen. Bei zwischenliegenden Temperaturen können die max. zulässigen Werte von I_D mittels linearer Interpolation gefunden werden

[3])Max. duration 1 sec.; Durée 1 sec. au max.;Max.Dauer 1 Sek.

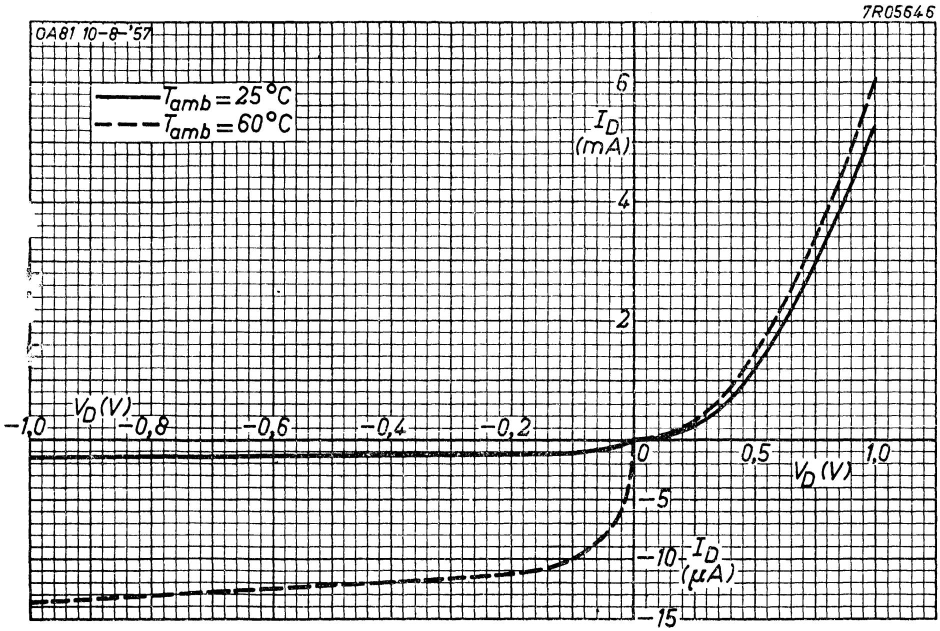
Characteristics
Caractéristiques
Kenndaten

	T_{amb} = 25 °C			T_{amb} = 60 °C		
	=	Min.	Max.	=	Min.	Max.
V_D(I_D =0,1 mA)	= 0,2	>0,1	<0,25	= 0,13	>0,05	<0,2 V
V_D(I_D = 10 mA)	= 1,4	>0,65	<1,9	= 1,3	>0,55	<1,8 V
V_D(I_D = 30 mA)	=2,45	>1,0	<3,3	= 2,3	>0,9	<3,15 V
$-I_D$($-V_D$= 1,5 V)	= 1,5	>0,3	<7	= 15	>6	<45 µA
$-I_D$($-V_D$= 10 V)	= 4	>0,5	<11	= 20	>9	<60 µA
$-I_D$($-V_D$= 75 V)	= 40	>5,5	<180	= 115	>35	<260 µA
$-I_D$($-V_D$= 100 V)	= 75	>10	<275	= 190	>60	<450 µA

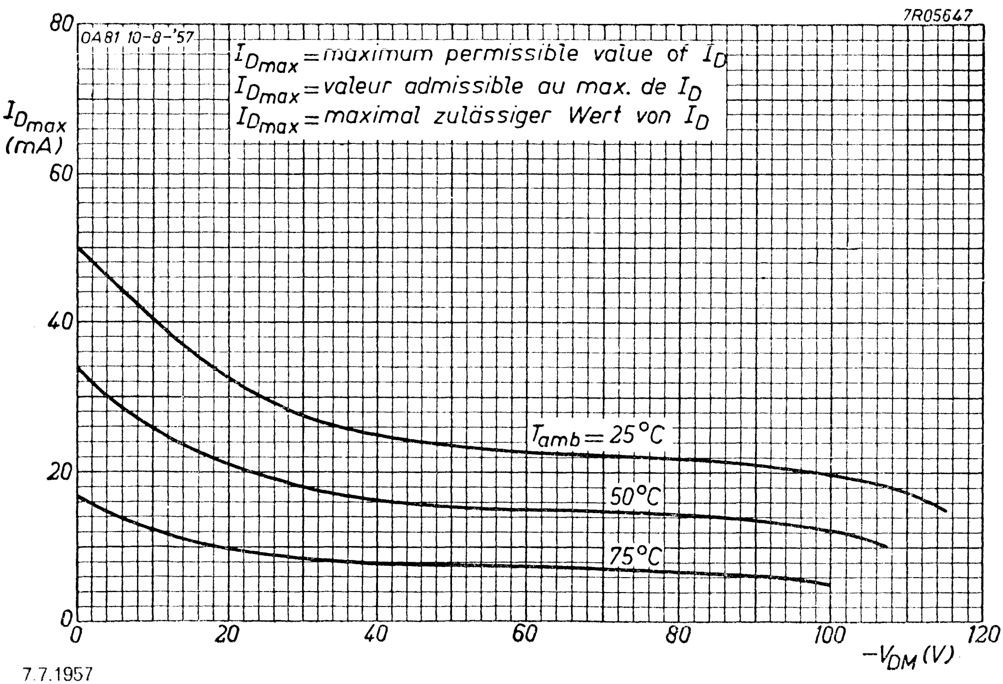

7R05645
OA81 10-8-'57
Current limits
Limites de courant
Stromgrenzen
$T_{amb} = 25°C$
$T_{amb} = 60°C$
$-I_D$ (µA)
1000
100
10
1
0,1
0
50
100
$-V_D$ (V)
B


7R05644
OA81 10-8-'57
Current limits
Limites de courant
Stromgrenzen
$T_{amb} = 25°C$
$T_{amb} = 60°C$
I_D (mA)
100
10
1
0,1
0
2
4
V_D (V)
A

7.7.1957


7R05646
OA81 10-8-'57
T_{amb} = 25 °C
T_{amb} = 60 °C
I_D (mA)
6
4
2
V_D (V)
−1,0
−0,8
−0,6
−0,4
−0,2
0
0,5
1,0
V_D (V)
−5
−10
I_D (μA)
−15

C

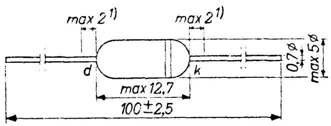

7R05647
OA81 10-8-'57
I_{Dmax} = maximum permissible value of I_D
I_{Dmax} = valeur admissible au max. de I_D
I_{Dmax} = maximal zulässiger Wert von I_D
I_{Dmax} (mA)
80
60
40
20
0
T_{amb} = 25 °C
50 °C
75 °C
0
20
40
60
80
100
120
$-V_{DM}$ (V)

D

GERMANIUM DIODE in all glass construction for high inverse voltages
DIODE A CRISTAL DE GERMANIUM de construction tout verre pour des tensions inverses élevées
GERMANIUMDIODE in Allglastechnik für hohe Sperrspannungen

Dimensions in mm
Dimensions en mm
Abmessungen in mm

The white band indicates the position of the cathode
L'anneau blanc marque la position de la cathode
Der weisse Ring indiziert die Katodenseite



Limiting values (Absolute max. values)
Caractéristiques limites (Valeurs max. absolues)
Grenzdaten (Absolute Maximalwerte)

Valid at / Valable à / Gültig bei				
T_{amb}	=	25	75	°C
$-V_D$(tav = max.50 msec)	= max.	90	75	V
$-V_{DM}$	= max.	115	100	V [2]
I_D(tav = max.50 msec)	= max.	50	17	mA [2]
I_{DM}	= max.	150	150	mA
I_{surge}	= max.	500	500	mA [3]
T_{amb}	=	-50°C/+75 °C		

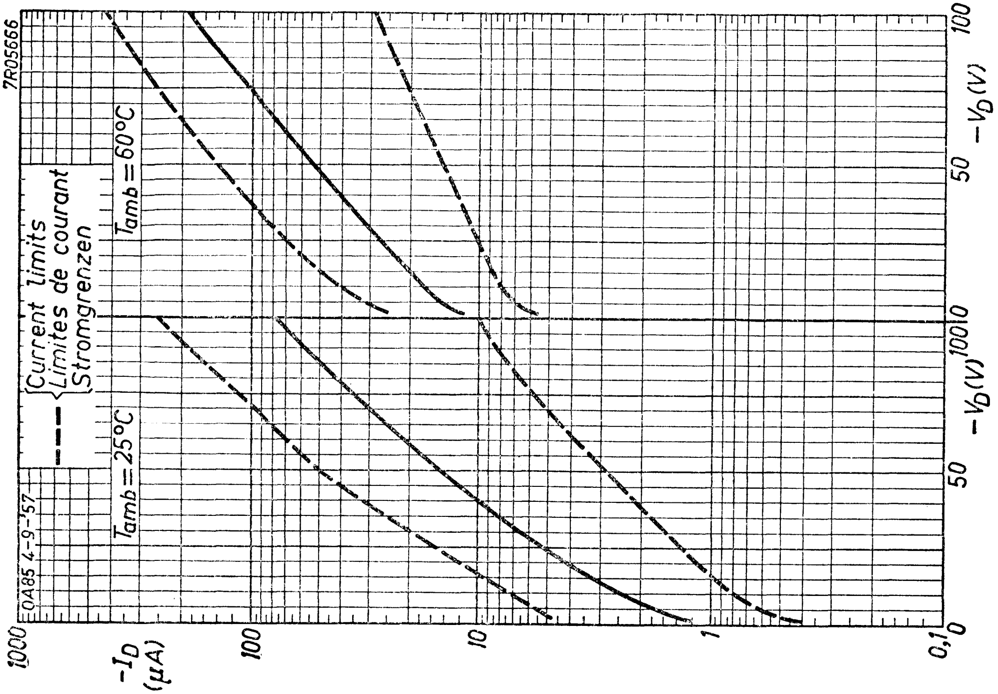
[1])Not tinned; non étamé; nicht verzinnt

[2])At page D derating curves are given representing the max. permissible value of I_D as a function of $-V_{DM}$ at T_{amb} = 25, 50 and 75 °C. At intermediate temperatures the max. permissible values of I_D can be found by linear interpolation
Sur la page D des courbes de réduction sont données représentant la valeur max. admissible de I_D en fonction de $-V_{DM}$ à T_{amb} = 25, 50 et 75 °C. A des températures intermédiaires les valeurs admissibles aux max. de I_D peuvent être trouvées par interpolation linéaire
Auf Seite D sind Reduktionskurven gegeben, die den max. zulässigen Wert von I_D als Funktion von $-V_{DM}$ bei T_{amb} = 25, 50 and 75 °C darstellen. Bei zwischenliegenden Temperaturen können die max. zulässigen Werte von I_D mittels linearer Interpolation gefunden werden

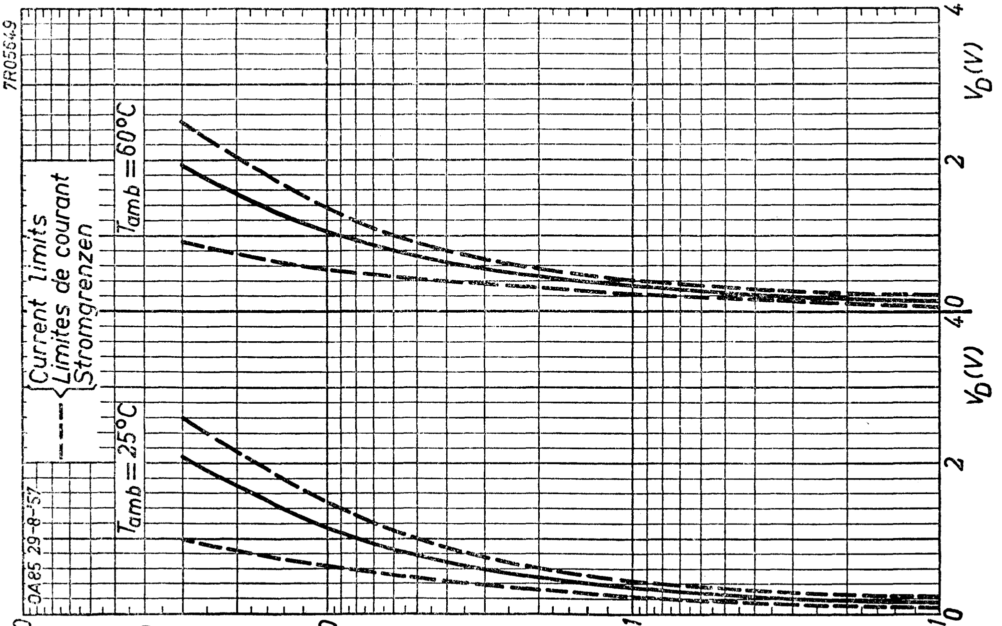
[3])Max. duration 1 sec.; Durée 1 sec. au max.;Max.Dauer 1 Sek.

Characteristics
Caractéristiques
Kenndaten

	T_{amb} = 25 °C			T_{amb} = 60 °C			
	=	Min.	Max.	=	Min.	Max.	
V_D (I_D = 0,1 mA)	= 0,2	>0,1	<0,25	= 0,13	>0,05	<0,2	V
V_D (I_D = 10 mA)	=1,15	>0,65	<1,5	= 1,05	>0,55	<1,4	V
V_D (I_D = 30 mA)	=2,05	>1,0	<2,6	= 1,95	>0,9	<2,5	V
$-I_D$ ($-V_D$ = 1,5 V)	= 1,2	>0,4	<4,5	= 12	>5,5	<26	µA
$-I_D$ ($-V_D$ = 10 V)	= 2,5	>0,8	<7	= 17	>8	<40	µA
$-I_D$ ($-V_D$ = 75 V)	= 35	>5,7	<110	= 100	>20	<250	µA
$-I_D$ ($-V_D$ = 100 V)	= 75	>10	<250	= 190	>30	<430	µA

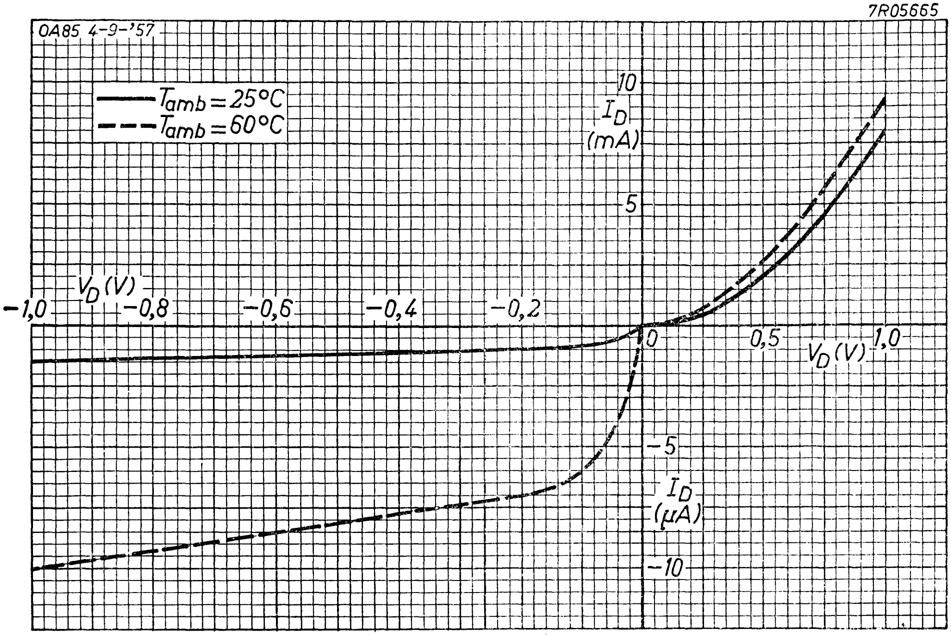

7R05666
OA85 4-9-'57
Current limits
Limites de courant
Stromgrenzen
T_{amb} = 25°C
T_{amb} = 60°C
$-I_D$ (μA)
1000
100
10
1
0,1
0
50
100
$-V_D$ (V)

B

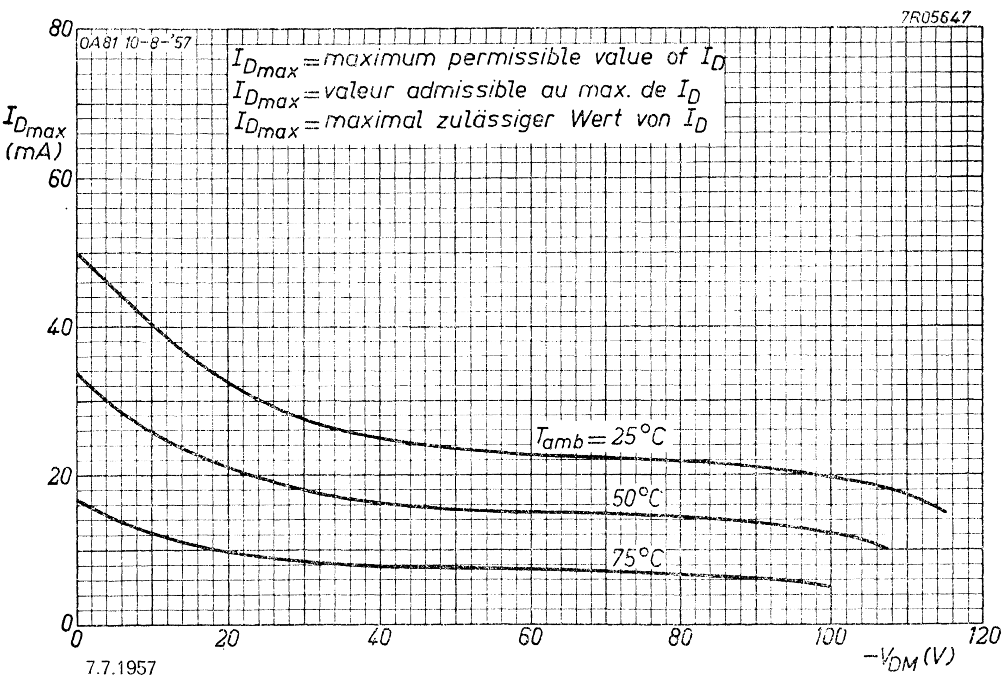

7R05649
OA85 29-8-'57
Current limits
Limites de courant
Stromgrenzen
T_{amb} = 25°C
T_{amb} = 60°C
I_D (mA)
100
10
1
0,1
0
2
4
V_D (V)

A

7.7.1957


7R05665
OA85 4-9-'57
T_{amb}=25°C
T_{amb}=60°C
10
I_D
(mA)
5
V_D (V)
−1,0
−0,8
−0,6
−0,4
−0,2
0
0,5
V_D (V)
1,0
−5
I_D
(μA)
−10

C


7R05647
OA81 10-8-'57
I_{Dmax}=maximum permissible value of I_D
I_{Dmax}=valeur admissible au max. de I_D
I_{Dmax}=maximal zulässiger Wert von I_D
I_{Dmax}
(mA)
80
60
40
20
0
T_{amb}=25°C
50°C
75°C
0
20
40
60
80
100
120
$-V_{DM}$ (V)

D

7.7.1957

GERMANIUM DIODES

Germanium diodes in all glass construction for use in computers.

LIMITING VALUES (Absolute max. values)		T_{amb} = 25 °C	T_{amb} = 60 °C
Reverse voltage	$-V_D$	max. 60 V	60 V
Reverse peak voltage	$-V_{DM}$	max. 90 V	90 V
Forward current	I_D	max. 35 mA	15 mA
Forward peak current	I_{DM}	max. 150 mA	150 mA

CHARACTERISTICS

		T_{amb} = 25 °C	T_{amb} = 60 °C
Forward voltage drop			
I_D = 5 mA	V_D	typ 0.78 V	typ 0.72 V
		0.6 to 1 V	0.5 to 0.95 V
I_D = 30 mA	V_D	typ 2.15 V	typ 1.9 V
		1.5 to 3 V	1.3 to 2.8 V
Reverse current			
$-V_D$ = 10 V	$-I_D$	typ 2.5 μA	typ 20 μA
		0.8 to 7 μA	6 to 40 μA
$-V_D$ = 60 V	$-I_D$	typ 35 μA	typ 75 μA
		5.7 to 92 μA	25 to 200 μA

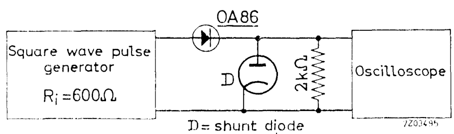
Reverse recovery time, when switched from I_D = 30 mA to $-V_D$ = 35 V

Measured at $-I_D$ = 700 μA t_{rr} < 0.5 μs

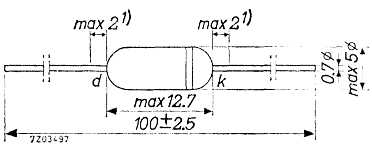
Measured at $-I_D$ = 87.5 μA t_{rr} < 3.5 μs

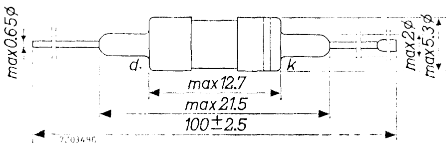
Test circuit

Pulse:	f	=	50 kc/s
	δ	=	0.5
	t_r	<	0.1 μs
Oscilloscope:	C_{inp}	=	40 pF
	t_r	<	25 ns



MECHANICAL DATA





The white band indicates the cathode side

1) Not tinned

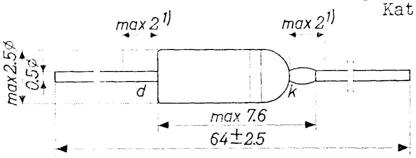
Clip-in execution (OA86C)

7Z2 3191

GERMANIUM DIODE in miniature all glass construction for use as video detector
DIODE A CRISTAL DE GERMANIUM de construction tout verre miniature pour utilisation en détectrice vidéo
GERMANIUMDIODE in Miniatur-Allglasausführung zur Video-Demodulation

Dimensions in mm
Dimensions en mm
Abmessungen in mm

The white band indicates the position of the cathode
L'anneau blanc marque la position de la cathode
Der weisse Ring indiziert die Katodenseite



Limiting values (Absolute max. values)
Caractéristiques limites (Valeurs max. absolues)
Grenzdaten (Absolute Maximalwerte)

T_{amb} = 75 °C

$-V_D$ (t_{av} = max. 50 msec)	= max. 20 V
$-V_{DM}$	= max. 30 V
$-V_{Dsurge}$	= max. 40 V[2]
I_D (t_{av} = max. 50 msec)	= max. 8 mA[3]
I_{DM}	= max. 45 mA
I_{Dsurge} (t = max.1 sec)	= max. 200 mA
T_{amb}	= -55°C/+75 °C

Storage temperature
Température d'emmagasinage = -55°C/+90 °C
Lagerungstemperatur

[1])Not tinned; non étamé; nicht verzinnt

[2])Allowable in a video detector circuit. See also page F.
Admis dans un circuit détecteur vidéo. Voir aussi page F.
Erlaubt in einer Video-Demodulationsschaltung. Siehe auch Seite F.

[3])At the max. allowed value of $-V_{DM}$
A la valeur max. admissible de $-V_{DM}$
Bei dem max. zulässigen Wert von $-V_{DM}$

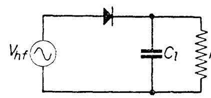
Characteristics
Caractéristiques
Kenndaten

Statical
Statique
Statisch

	T_{amb} = 25 °C			T_{amb} = 60 °C		
	=	min.	max.	=	min.	max.
V_D(I_D=0,1 mA)	=0,18	>0,1	<0,25	=0,12	-	<0,20 V
V_D(I_D= 10 mA)	= 1,0	>0,5	<1,5	=0,95	>0,4	<1,4 V
V_D(I_D= 30 mA)	= 2,0	>1,1	<3,2	=1,95	>1,0	<3,1 V
$-I_D$($-V_D$=1,5 V)	= 2,4	-	<10	= 11	-	<40 µA
$-I_D$($-V_D$= 10 V)	= 20	-	<135	= 45	-	<270 µA
$-I_D$($-V_D$= 20 V)	= 90	-	<450	= 140	-	<650 µA
$-I_D$($-V_D$= 30 V)	= 300	-	<1100	= 400	-	<1500 µA

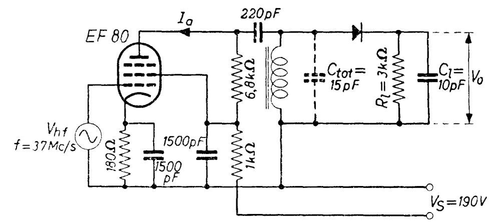
Dynamical
Dynamique
Dynamisch

T_{amb} = 25 °C



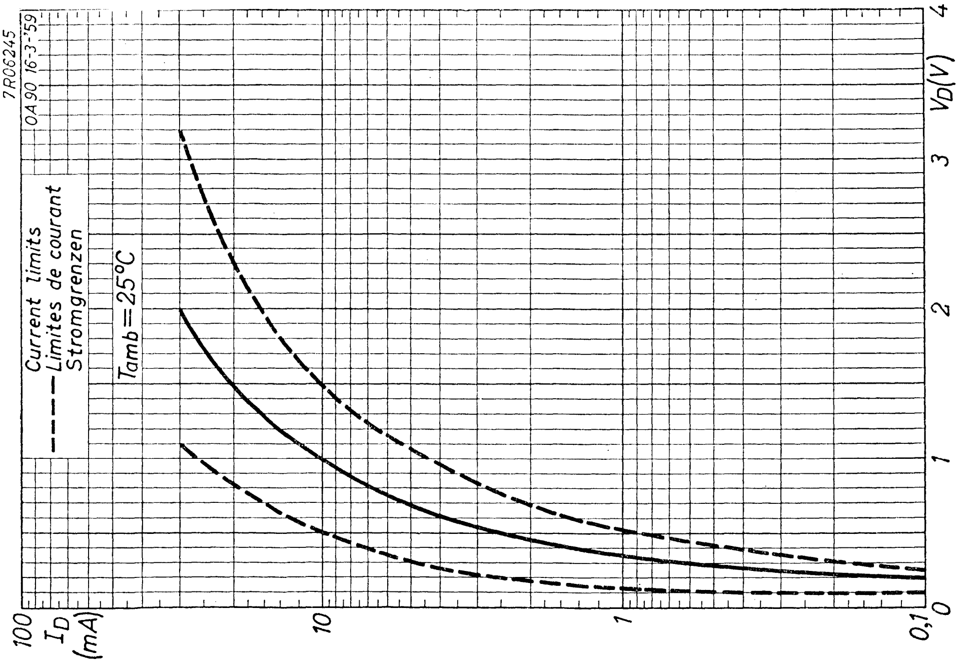
V_{hfm}	= 5	1,4	0,5	5 V
R	= 3	3	3	3,9 kΩ
C	= 10	10	10	10 pF
f	= 40	40	40	30 Mc/s
η	= 63	54	34	>60 %
r_d	= 2,4	2,8	3,7	>2,9 kΩ

Operating characteristics for use as video detector
Caractéristiques d'utilisation en détectrice vidéo
Betriebsdaten als Video-Demodulator

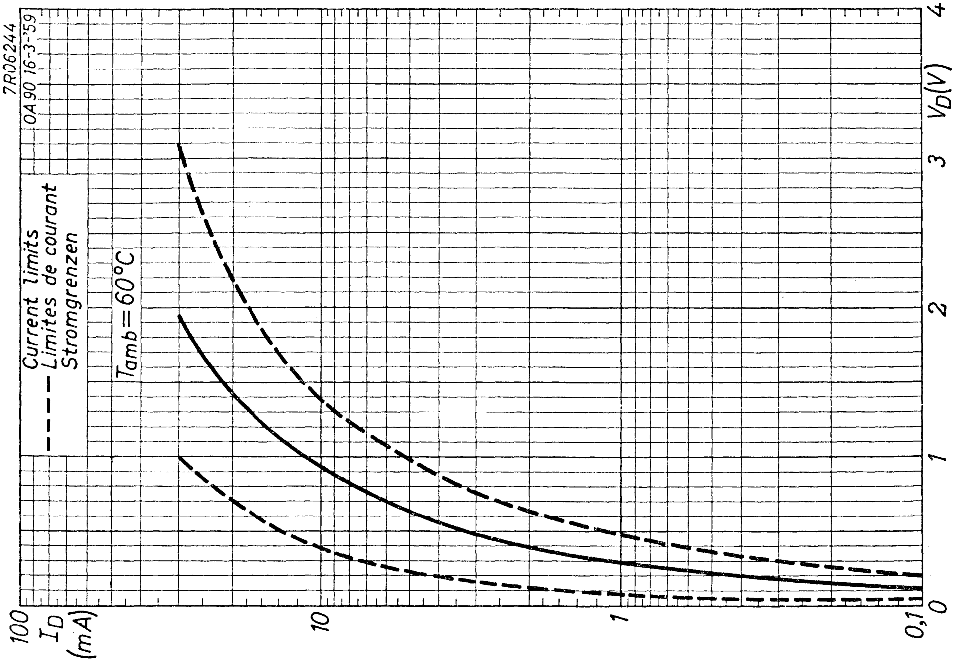


Q of the tuned circuit = 19 (diode removed)
Q du circuit accordé = 19 (diode éloignée)
Q des abgestimmten Kreises = 19 (Diode entfernt)

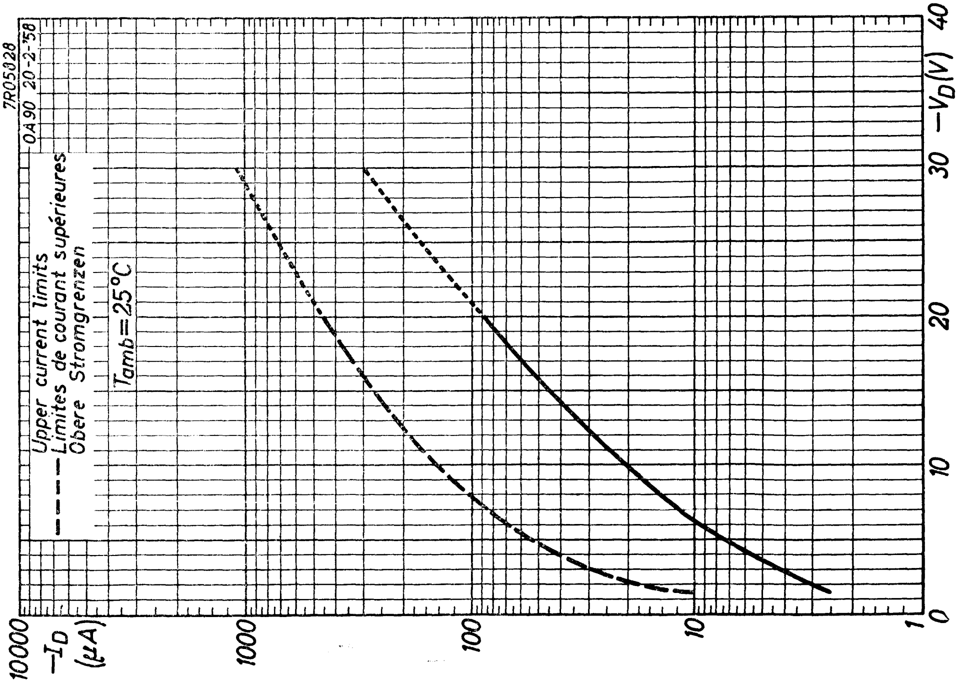
I_{am}	= 2,5	0,25	mA
V_o	= 2,7	0,20	V
B	= 4,7	4,1	Mc/s


7R06245
OA90 16-3-'59
Current limits
Limites de courant
Stromgrenzen
T_{amb} = 25°C
I_D (mA)
100
10
1
0,1
0
1
2
3
4
V_D(V)

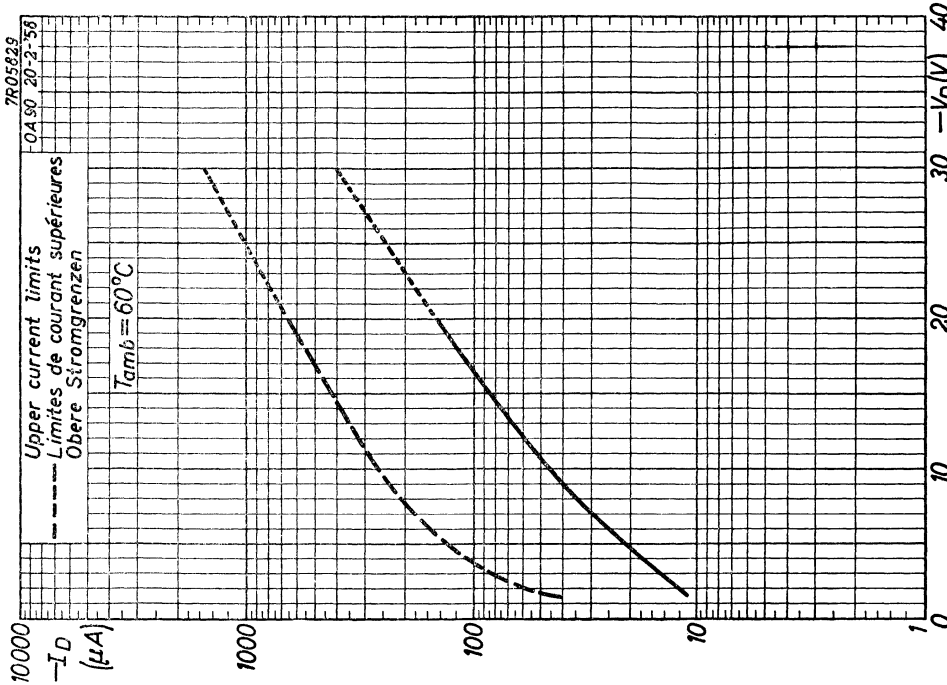
A


7R06244
OA90 16-3-'59
Current limits
Limites de courant
Stromgrenzen
T_{amb} = 60°C
I_D (mA)
100
10
1
0,1
0
1
2
3
4
V_D(V)

B


7R05828
OA90 20-2-'58
Upper current limits
Limites de courant supérieures
Obere Stromgrenzen
Tamb = 25°C
10000
$-I_D$ (μA)
1000
100
10
1
0
10
20
30
40
$-V_D$(V)

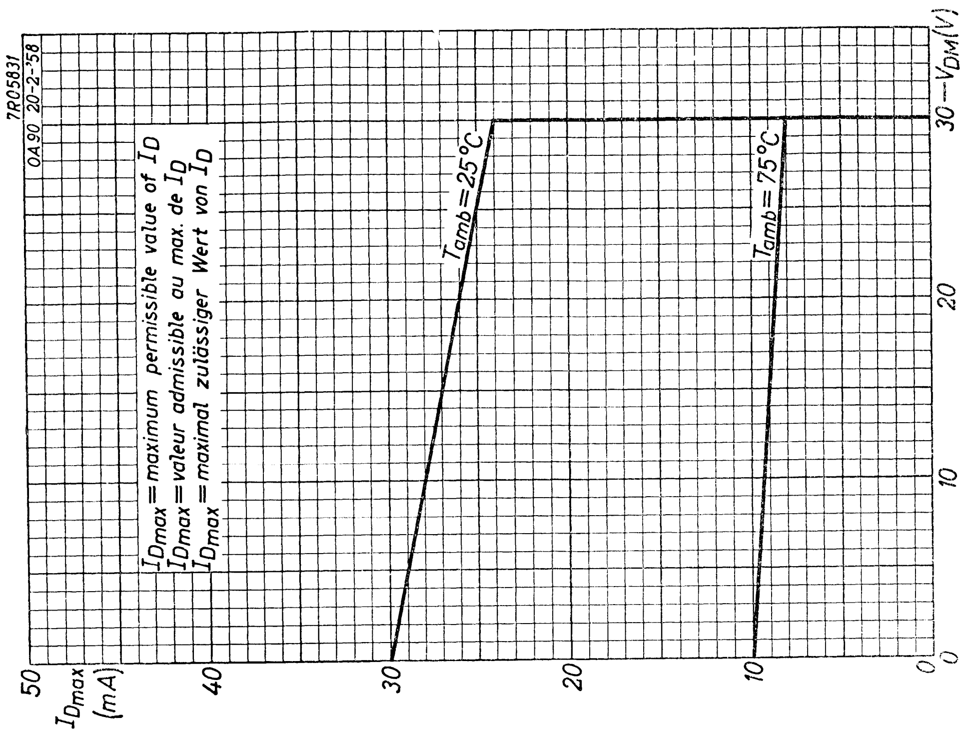
C


7R05829
OA90 20-2-'58
Upper current limits
Limites de courant supérieures
Obere Stromgrenzen
Tamb = 60°C
10000
$-I_D$ (μA)
1000
100
10
1
0
10
20
30
40
$-V_D$(V)

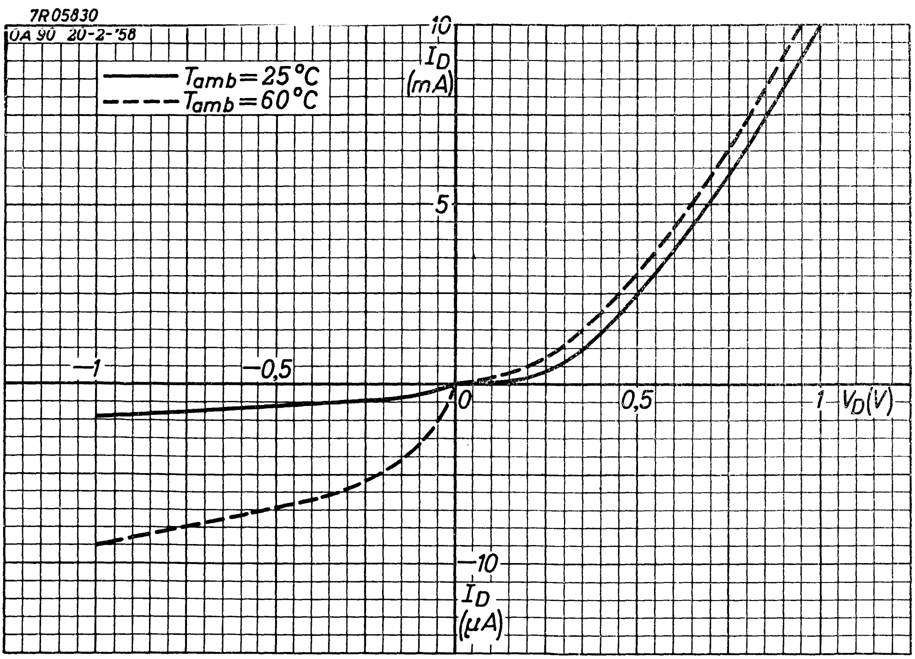
D

3.3.1958

F


7R05831
OA90 20-2-'58
I_{Dmax} = maximum permissible value of I_D
I_{Dmax} = valeur admissible au max. de I_D
I_{Dmax} = maximal zulässiger Wert von I_D
T_{amb} = 25°C
T_{amb} = 75°C
30 — V_{DM}(V)
20
10
0
50
I_{Dmax} (mA)
40
30
20
10
0

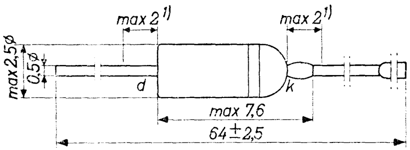
E


7R05830
OA 90 20-2-'58
T_{amb} = 25°C
T_{amb} = 60°C
10
I_D (mA)
5
−1
−0,5
0
0,5
1
V_D(V)
−10
I_D (μA)

GENERAL PURPOSE GERMANIUM DIODE in miniature all glass construction for high inverse voltages
DIODE A CRISTAL DE GERMANIUM de construction tout verre miniature pour les usages généraux à tension inverse élevée
ALLZWECKGERMANIUMDIODE in Miniatur-Allglasausführung für hohe Sperrspannungen

Dimensions in mm
Dimensions en mm
Abmessungen in mm

The white band indicates the position of the cathode
L'anneau blanc marque la position de la cathode
Der weisse Ring indiziert die Katodenseite



Limiting values (Absolute max. values)
Caractéristiques limites (Valeurs max. absolues)
Grenzdaten (Absolute Maximalwerte)

Valid at / Valable à / Gültig bei			T_{amb} = 25	75 °C
$-V_D$ (tav = max. 50 msec)	=	max.	90	75 V
$-V_{DM}$	=	max.	115	100 V
I_D (tav = max. 50 msec)	=	max.	50	17 mA 2)
I_{DM}	=	max.	150	150 mA
I_{Dsurge} (t = max. 1 sec)	=	max.	500	500 mA
T_{amb}	=		-55 °C/+75 °C	
Storage temperature / Température d'emmagasinage / Lagerungstemperatur			-55 °C/+75 °C	

1) Not tinned; non étamé; nicht verzinnt

2) At page D derating curves are given representing the max. permissible value of I_D as a function of $-V_{DM}$ at T_{amb} = 25, 50 and 75 °C. At intermediate temperatures the max. permissible values of I_D can be found by linear interpolation

Sur la page D des courbes de réduction sont données représentant la valeur max. admissible de I_D en fonction de $-V_{DM}$ à T_{amb} = 25, 50 et 75 °C. A des températures intermédiaires les valeurs admissibles aux max. de I_D peuvent être trouvées par interpolation linéaire

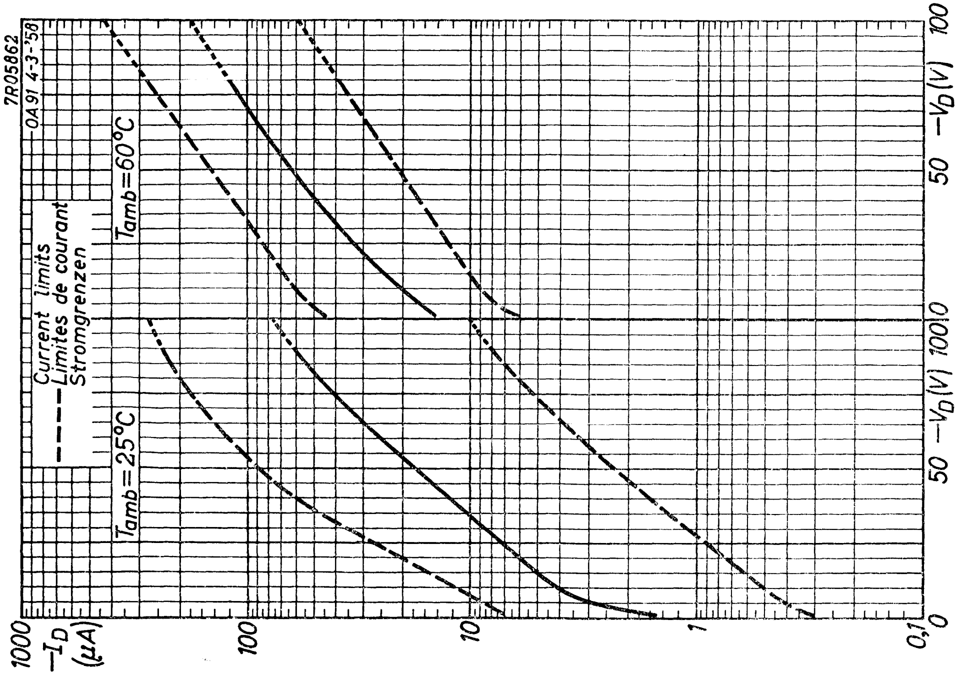
Auf Seite D sind Reduktionskurven gegeben, die den max. zulässigen Wert von I_D als Funktion von $-V_{DM}$ bei T_{amb} = 25, 50 und 75 °C darstellen. Bei zwischenliegenden Temperaturen können die max. zulässigen Werte von I_D mittels linearer Interpolation gefunden werden

Characteristics
Caractéristiques
Kenndaten

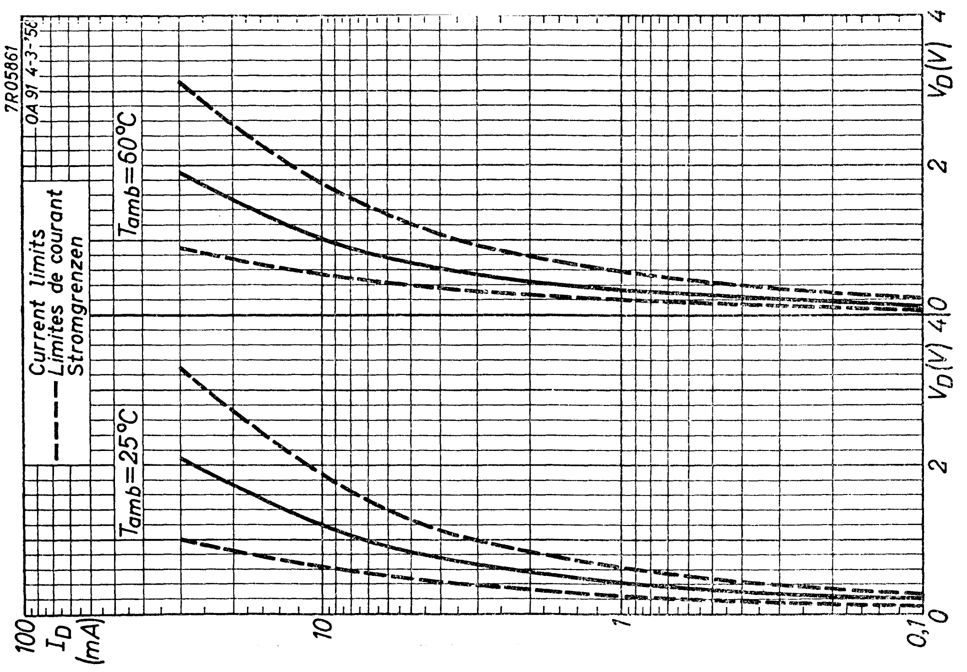
Thermal resistance (junction to free air)
Résistance thermique (de la jonction jusqu'à l'air libre)
Thermischer Widerstand (vom Kristall bis freier Luft)

K = max. 0,4 °C/mW

	T_{amb} = 25 °C			T_{amb} = 60 °C		
	=	min.	max.	=	min.	max.
V_D (I_D = 0,1 mA)	=0,18	> 0,1	<0,25	= 0,1	>0,05	<0,2 V
V_D (I_D = 10 mA)	= 1,2	>0,65	< 1,9	=1,05	>0,55	<1,8 V
V_D (I_D = 30 mA)	= 2,1	> 1,0	< 3,3	= 1,9	> 0,9	<3,15 V
$-I_D$ ($-V_D$ = 1,5 V)	= 1,5	> 0,3	< 7	= 15	> 6	< 45 µA
$-I_D$ ($-V_D$ = 10 V)	= 4	> 0,5	< 11	= 20	> 9	< 60 µA
$-I_D$ ($-V_D$ = 75 V)	= 40	> 5,5	< 180	= 115	> 35	<260 µA
$-I_D$ ($-V_D$ = 100 V)	= 75	> 10	< 275	= 190	> 60	<450 µA

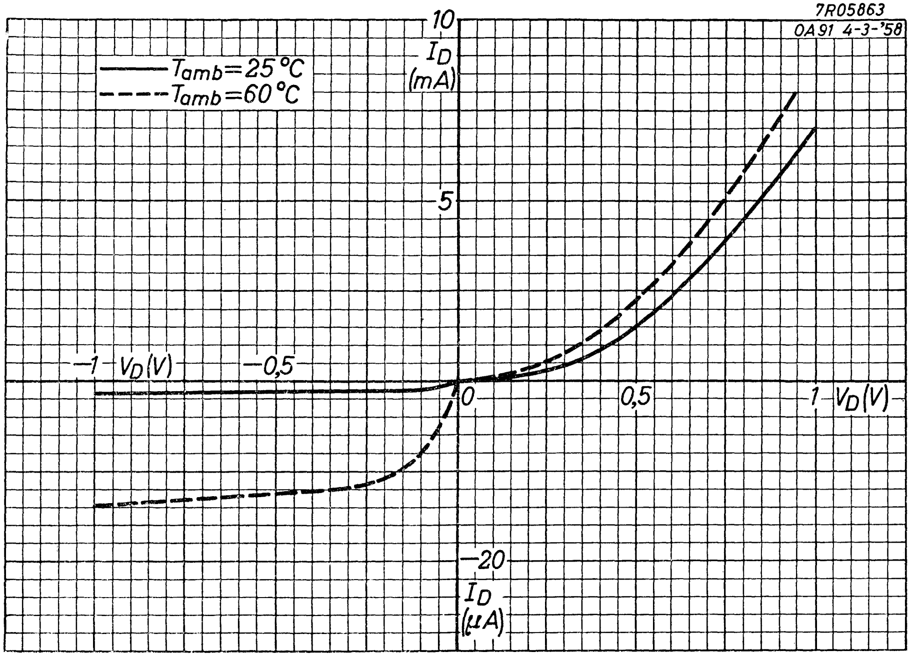

7R05862
OA91 4-3-'58
Current limits
Limites de courant
Stromgrenzen
Tamb=25°C
Tamb=60°C
1000
$-I_D$
(μA)
100
10
1
0,1
0
50
100
$-V_D(V)$

B

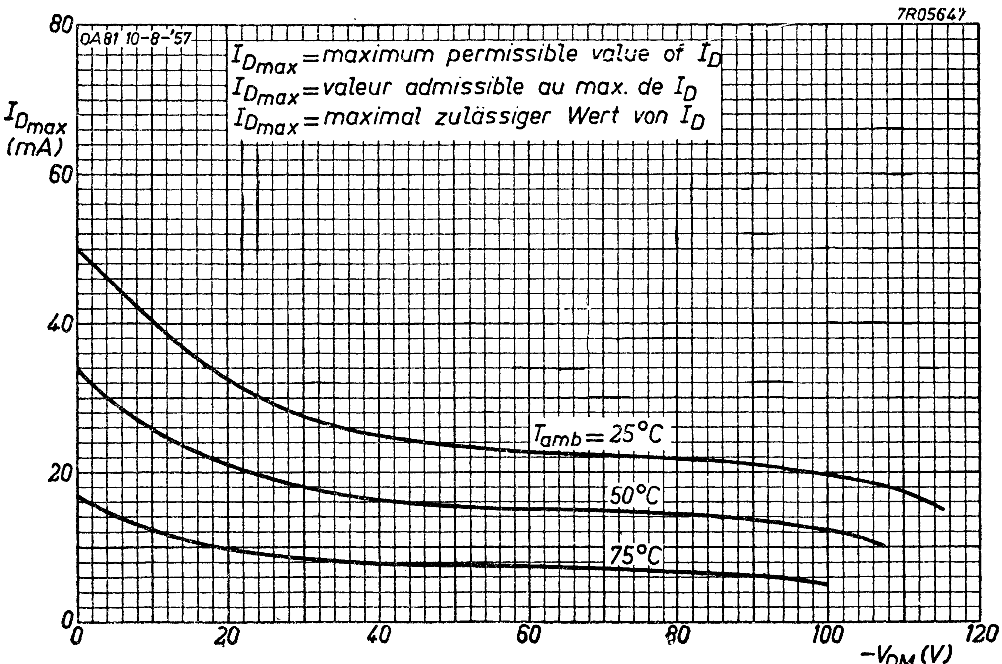

7R05861
OA91 4-3-'58
Current limits
Limites de courant
Stromgrenzen
Tamb=25°C
Tamb=60°C
100
I_D
(mA)
10
1
0,1
0
2
4
$V_D(V)$

A

3.3.1958


7R05863
OA91 4-3-'58
Tamb=25 °C
Tamb=60 °C
10
ID
(mA)
5
−1 VD(V)
−0,5
0
0,5
1 VD(V)
−20
ID
(μA)

C


7R05647
OA81 10-8-'57
IDmax=maximum permissible value of ID
IDmax=valeur admissible au max. de ID
IDmax=maximal zulässiger Wert von ID
IDmax
(mA)
80
60
40
20
0
Tamb=25°C
50°C
75°C
0
20
40
60
80
100
120
−VDM (V)

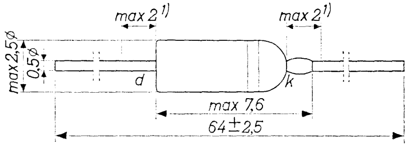
D

3.3.1958

GERMANIUM DIODE in miniature all glass construction for computer applications
DIODE À CRISTAL DE GERMANIUM de construction tout verre miniature pour utilisation dans des machines à calculer
GERMANIUMDIODE in Miniatur-Allglasausführung zur Verwendung in Rechenmaschinen

Dimensions in mm
Dimensions en mm
Abmessungen in mm

The white band indicates the position of the cathode
L'anneau blanc indique la position de la cathode
Der weisse Ring bezeichnet die Katodenseite



Limiting values (Absolute max. values)
Caractéristiques limites (Valeurs max. absolues)
Grenzdaten (Absolute Maximalwerte)

T_{amb}	=	75 °C
$-V_D$	= max.	15 V
$-V_{DM}$	= max.	15 V
$-V_{Dsurge}$	= max.	20 V
I_D direct current / courant continu / Gleichstrom	= max.	10 mA[2)]
I_D (t_{av} = max. 50 msec)	See pages F and G / Voir pages F et G / Siehe Seiten F und G	
I_{DM}	= max.	50 mA
I_{Dsurge}(t = max. 1 sec)	= max.	100 mA
T_{amb}	=	-55 °C/+75 °C
Storage temperature / Température d'emmagasinage / Lagerungstemperatur	=	-55 °C/+90 °C

[1)] Not tinned; non étamé; nicht verzinnt
[2)] See also page E; voir aussi page E; siehe auch Seite E

THERMAL DATA. Thermal resistance from junction to ambience in free air K ≦ 0.55 °C/mW
DONNÉES THERMIQUES. Résistance thermique entre la jonction et l'ambiance à l'air libre K ≦ 0,55 °C/mW
THERMISCHE DATEN. Wärmewiderstand zwischen Kristall und Umgebung in freier Luft K ≦ 0,55 °C/mW

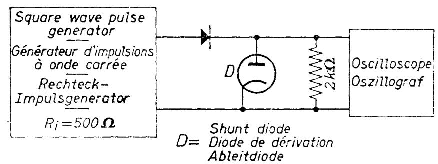
Characteristics
Caractéristiques
Kenndaten

V_D(I_D = 3 mA; T_{amb} = 25 °C)=0,55 V.	> 0,30 V	< 1,00 V
$-I_D$($-V_D$ = 15 V; T_{amb}= 60 °C)= 40 µA		< 155 µA

Characteristic range values for equipment design (see also pages A,B,C,D)
Gammes de valeurs des caractéristiques pour l'étude d'équipements (voir aussi pages A,B,C,D)
Kenndatenbereiche für Gerätentwurf (siehe auch Seiten A, B,C,D)

Capacitance / Capacité / Kapazität cdk { $-V_D$ = 0,75 V; f = 0,5 Mc/s } < 0,5 pF

Reverse recovery, measured at $-V_D$ = 5 V after forward current pulse of 5 mA
Recouvrement inverse, mesuré à $-V_D$ = 5 V après une impulsion de courant en sens conducteur de 5 mA
Übergangszeit für Sperrichtung, gemessen bei $-V_D$ = 5 V nach einem Stromimpuls von 5 mA in der Durchlassrichtung
T_{amb} = 25 °C



Measuring circuit; circuit de mesure; Messschaltung

Reverse recovery (continued)
Recouvrement inverse (suite)
Übergangszeit für Sperrichtung (Fortsetzung)

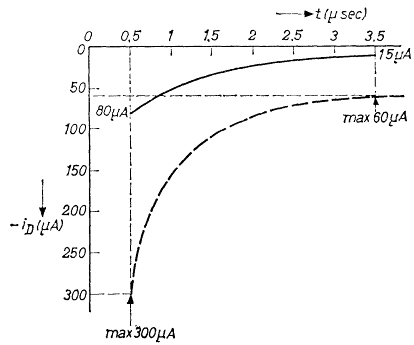
Pulse data
Données de l'impulsion
Impulsdaten

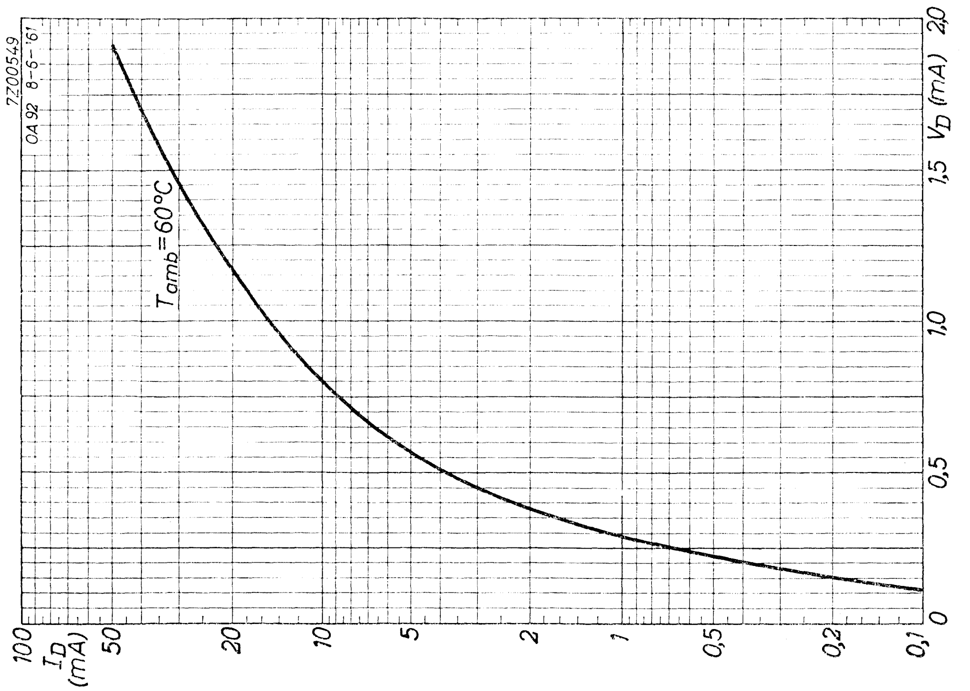
	f	=	50 kc/s
	δ	=	0,5
Rise time Temps de montée Anstiegszeit		<	0,1 µsec
	I_{DM}	=	5 mA
	$-V_{DM}$	=	5 V

Oscilloscope data
Données de l'oscilloscope
Daten des Oszillografen

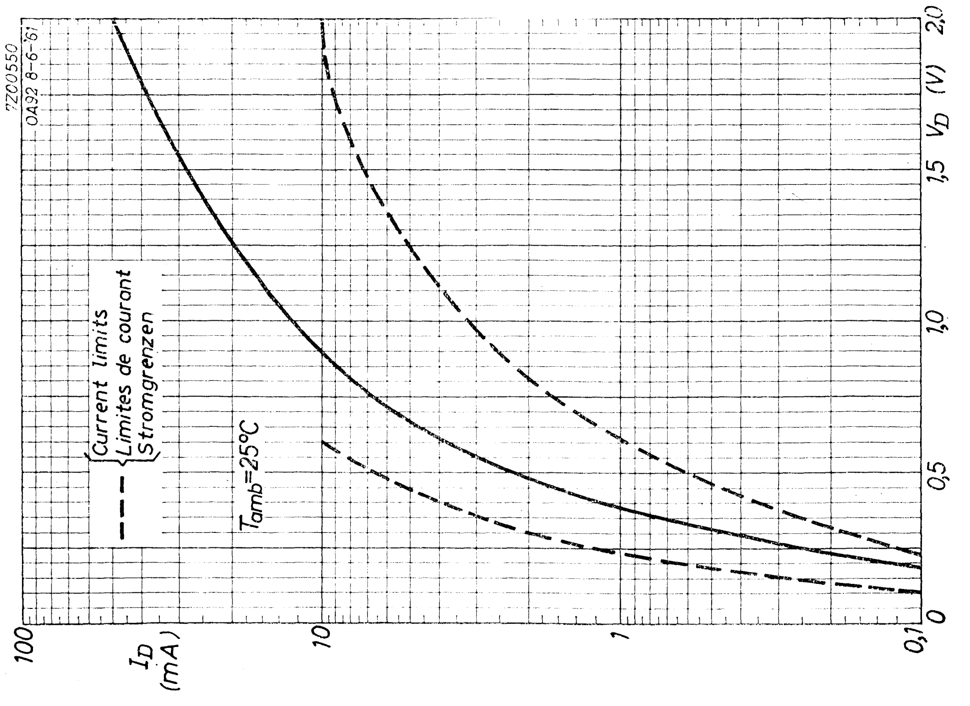
	C_{inp}	=	40 pF
Rise time Temps de montée Anstiegszeit		=	0,025 µsec

$-i_D$	0.5 µsec after the current impuls 0,5 µsec apres l'impulsion de courant 0,5 µSek nach dem Stromimpuls	= <	80 µA 300 µA
$-i_D$	3.5 µsec after the current impuls 3,5 µsec apres l'impulsion de courant 3,5 µSek nach dem Stromimpuls	= <	15 µA 60 µA



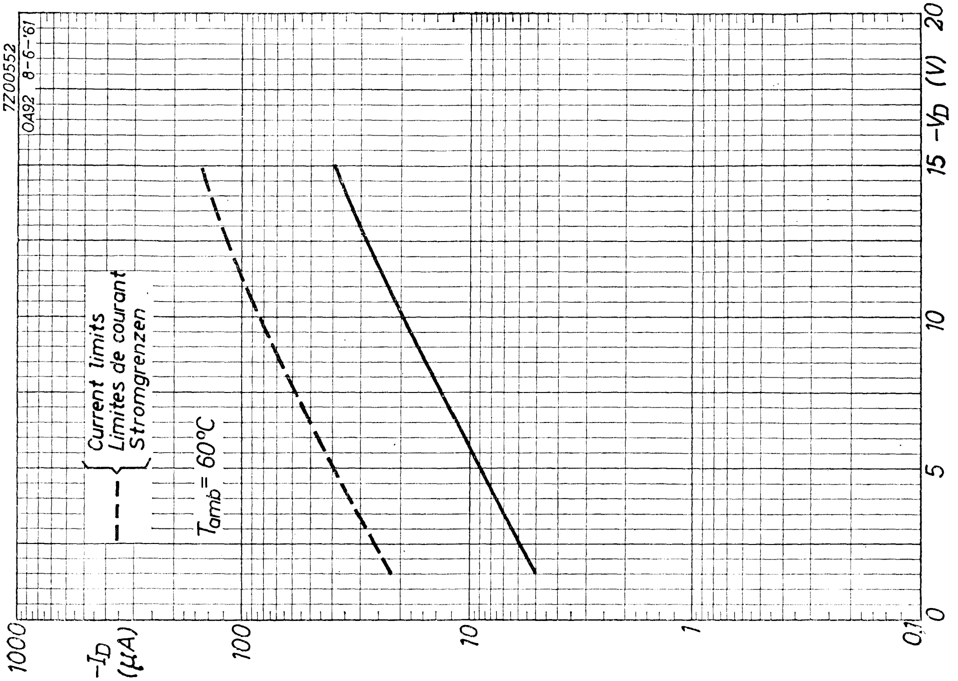

7Z00549
OA 92 8-6-'61
T_{amb}=60°C
I_D (mA)
100
50
20
10
5
2
1
0,5
0,2
0,1
0
0,5
1,0
1,5
2,0
V_D (mA)

B

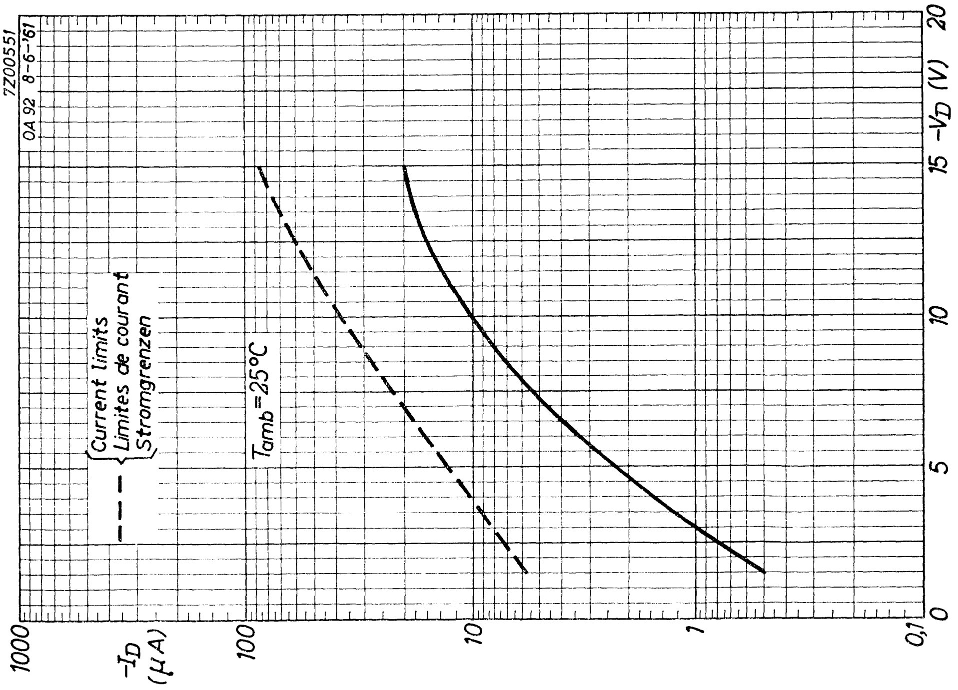

7Z00550
OA92 8-6-'61
Current limits
Limites de courant
Stromgrenzen
T_{amb}=25°C
I_D (mA)
100
10
1
0,1
0
0,5
1,0
1,5
2,0
V_D (V)

A

6.6.1961

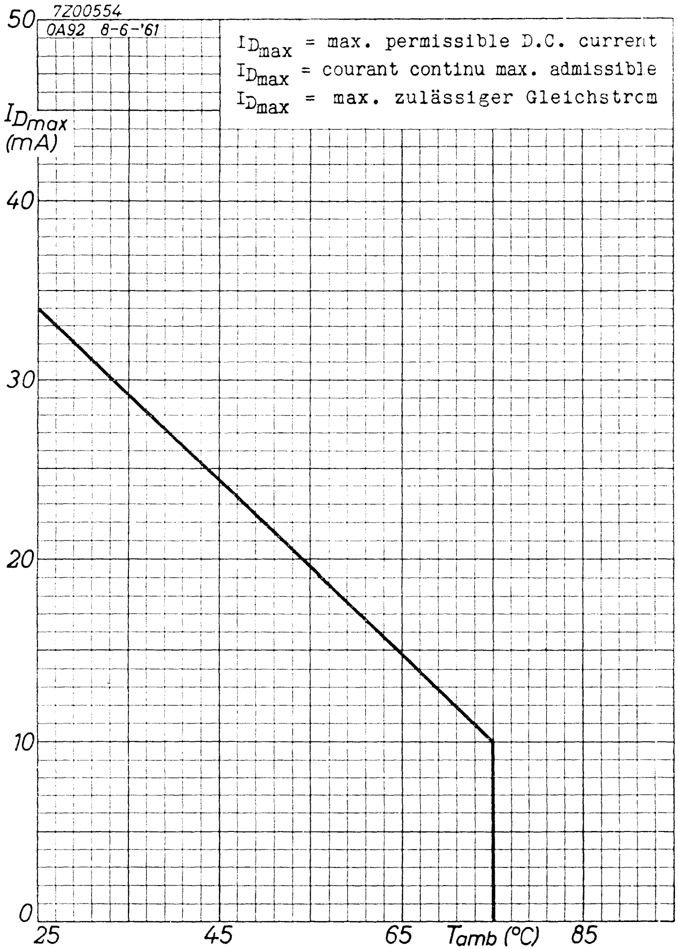

7Z00552
OA92 8-6-'61
Current limits
Limites de courant
Stromgrenzen
T_{amb} = 60°C
$-I_D$ (μA)
1000
100
10
1
0,1
0
5
10
15
20
$-V_D$ (V)

D

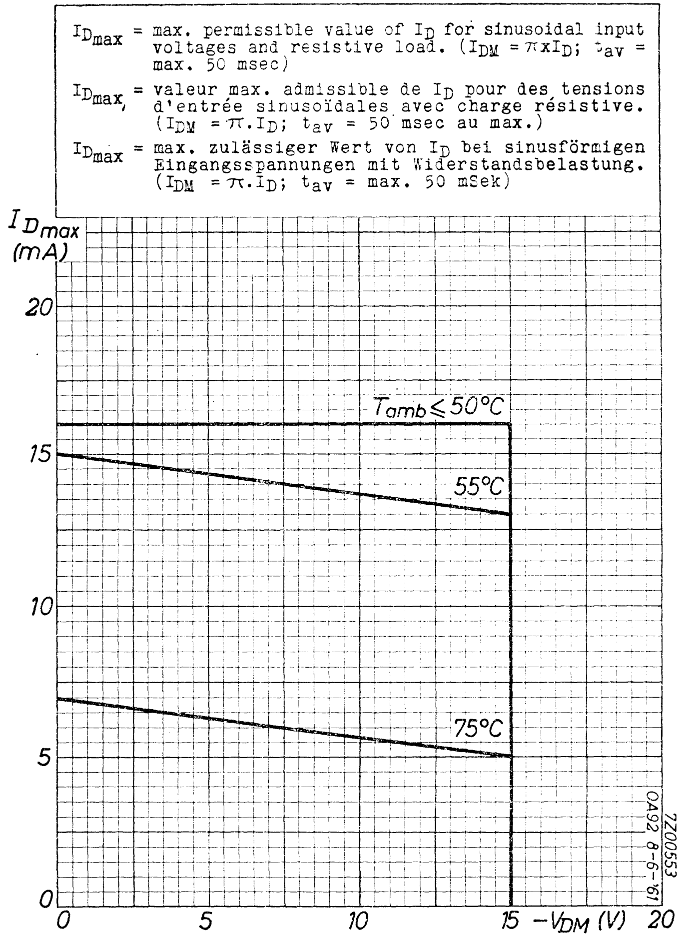

7Z00551
OA 92 8-6-'61
Current limits
Limites de courant
Stromgrenzen
T_{amb} = 25°C
$-I_D$ (μA)
1000
100
10
1
0,1
0
5
10
15
20
$-V_D$ (V)

C

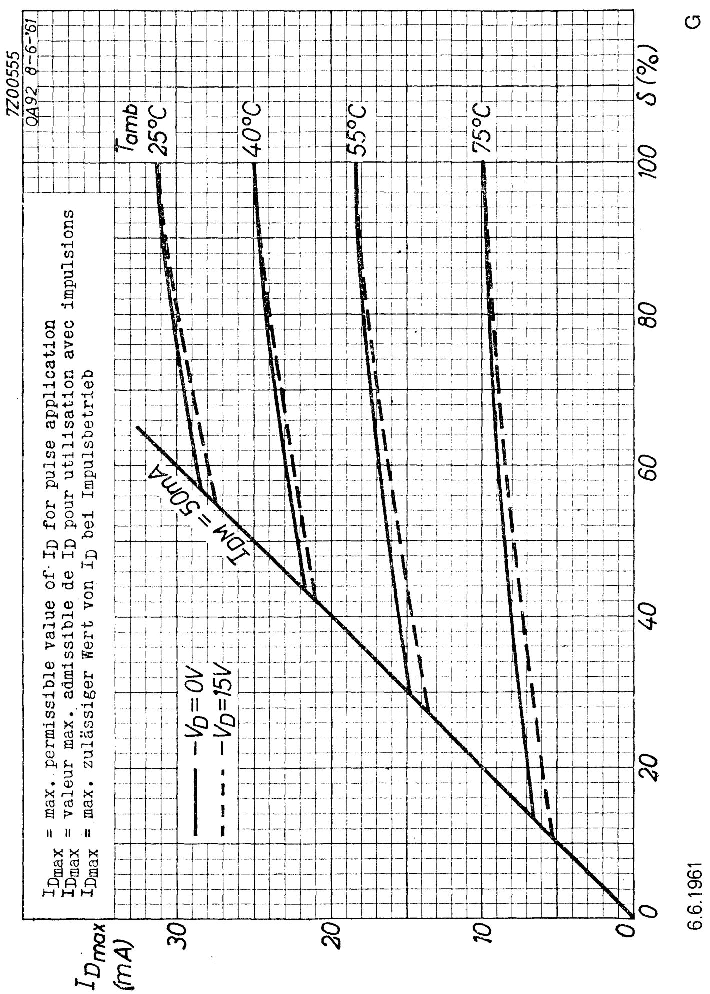
6.6.1961


7Z00554
OA92 8-6-'61
$I_{D_{max}}$ = max. permissible D.C. current
$I_{D_{max}}$ = courant continu max. admissible
$I_{D_{max}}$ = max. zulässiger Gleichstrom
$I_{D_{max}}$ (mA)
50
40
30
20
10
0
25
45
65
85
T_{amb} (°C)

E


$I_{D_{max}}$ = max. permissible value of I_D for sinusoidal input voltages and resistive load. ($I_{DM} = \pi x I_D$; t_{av} = max. 50 msec)
$I_{D_{max}}$ = valeur max. admissible de I_D pour des tensions d'entrée sinusoïdales avec charge résistive. ($I_{DM} = \pi . I_D$; t_{av} = 50 msec au max.)
$I_{D_{max}}$ = max. zulässiger Wert von I_D bei sinusförmigen Eingangsspannungen mit Widerstandsbelastung. ($I_{DM} = \pi . I_D$; t_{av} = max. 50 mSek)
$I_{D_{max}}$ (mA)
20
15
10
5
0
$T_{amb} \leq 50°C$
55°C
75°C
7Z00553
OA92 8-6-'61
0
5
10
15
20
$-V_{DM}$ (V)

F

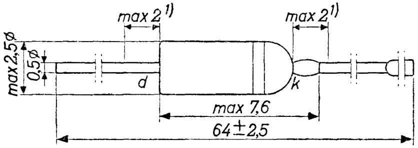

7Z00555
OA92 8-6-'61
I_{Dmax} = max. permissible value of I_D for pulse application
I_{Dmax} = valeur max. admissible de I_D pour utilisation avec impulsions
I_{Dmax} = max. zulässiger Wert von I_D bei Impulsbetrieb
$-V_D = 0V$
$-V_D = 15V$
$I_{DM} = 50mA$
T_{amb}
25°C
40°C
55°C
75°C
I_{Dmax} (mA)
30
20
10
0
0
20
40
60
80
100
S (%)
6.6.1961

G

GENERAL PURPOSE GERMANIUM DIODE in miniature all glass construction for high inverse voltages
DIODE A CRISTAL DE GERMANIUM de construction tout verre miniature pour les usages généraux à tension inverse élevée
ALLZWECKGERMANIUMDIODE in Miniatur-Allglasausführung für hohe Sperrspannungen

Dimensions in mm
Dimensions en mm
Abmessungen in mm

The white band indicates the position of the cathode
L'anneau blanc marque la position de la cathode
Der weisse Ring indiziert die Katodenseite



Limiting values (Absolute max. values)
Caractéristiques limites (Valeurs max. absolues)
Grenzdaten (Absolute Maximalwerte)

Valid at / Valable à / Gültig bei T_{amb}	=	25	75	°C
$-V_D$ (t_{av} = max. 50 msec)	= max.	90	75	V
$-V_{DM}$	= max.	115	100	V
I_D (t_{av} = max. 50 msec)	= max.	50	17	mA [2]
I_{DM}	= max.	150	150	mA
I_{Dsurge} (t = max. 1 sec)	= max.	500	500	mA
T_{amb}	=	-55°C/+75°C		
Storage temperature / Température d'emmagasinage / Lagerungstemperatur	=	-55°C/+75°C		

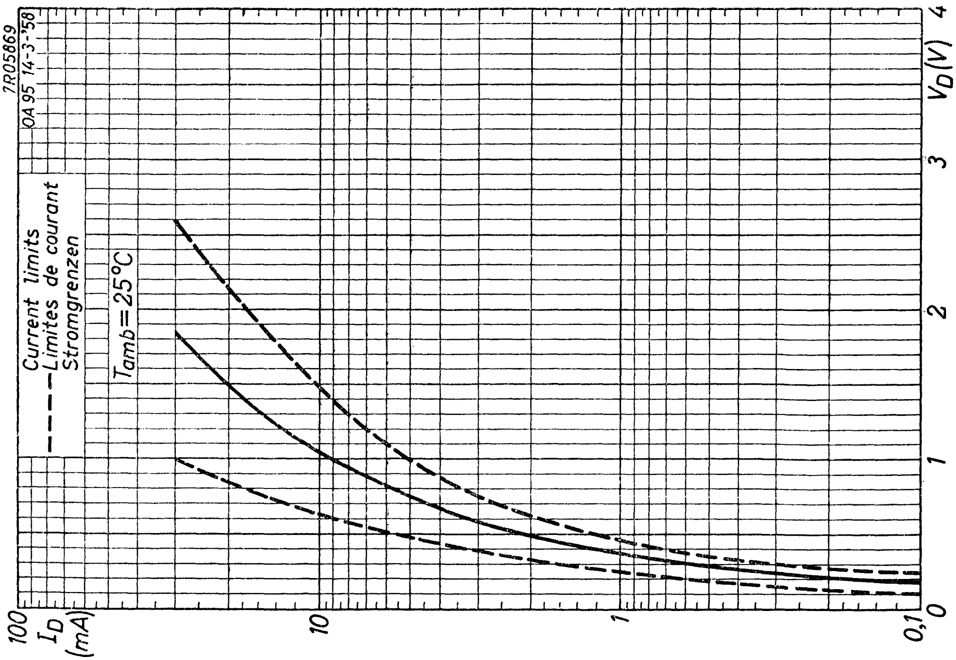
[1]) Not tinned; non étamé; nicht verzinnt

[2]) At page E derating curves are given representing the max. permissible value of I_D as a function of $-V_{DM}$ at T_{amb} = 25, 50 and 75 °C. At intermediate temperatures the max. permissible values of I_D can be found by linear interpolation
Sur la page E des courbes de réduction sont données représentant la valeur max.admissible de I_D en fonction de $-V_{DM}$ à T_{amb} = 25, 50 et 75 °C. A des températures intermédiaires les valeurs admissibles aux max. de I_D peuvent être trouvées par interpolation linéaire
Auf Seite E sind Reduktionskurven gegeben, die den max. zulässigen Wert von I_D als Funktion von $-V_{DM}$ bei T_{amb} = 25, 50 und 75 °C darstellen. Bei zwischenliegenden Temperaturen können die max. zulässigen Werte von I_D mittels linearer Interpolation gefunden werden

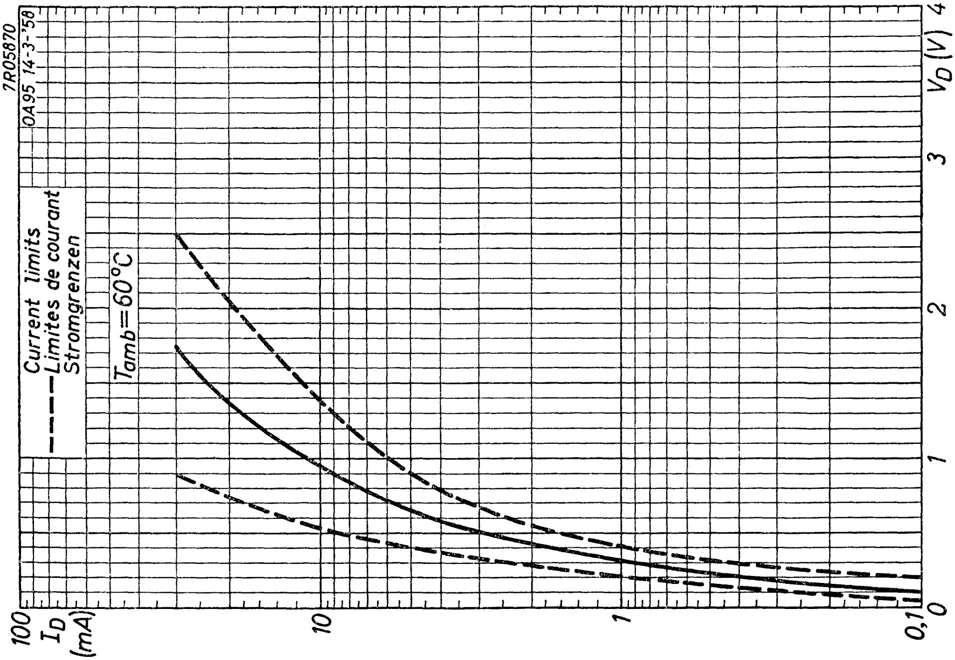
Characteristics
Caractéristiques
Kenndaten

Thermal resistance (junction to free air)
Résistance thermique (de la jonction jusqu'à l'air libre)
Thermischer Widerstand (vom Kristall bis freier Luft)
K = max. 0,4 °C/mW

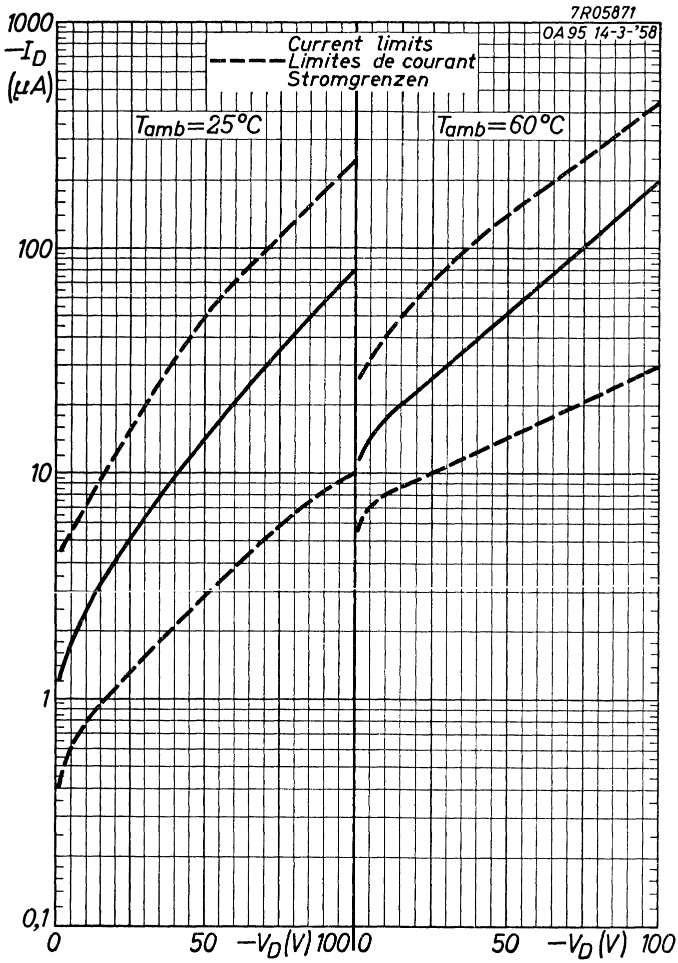
	T_{amb} = 25 °C			T_{amb} = 60 °C		
	=	min.	max.	=	min.	max.
V_D(I_D = 0,1 mA)	=0,18	>0,1	<0,25	= 0,1	>0,05	< 0,2 V
V_D(I_D = 10 mA)	=1,05	>0,65	<1,5	=0,95	>0,55	< 1,4 V
V_D(I_D = 30 mA)	=1,85	>1,0	<2,6	=1,75	>0,9	< 2,5 V
$-I_D$($-V_D$ = 1,5 V)	= 1,2	>0,4	<4,5	= 12	>5,5	< 26 µA
$-I_D$($-V_D$ = 10 V)	= 2,5	>0,8	< 7	= 17	> 8	< 40 µA
$-I_D$($-V_D$ = 75 V)	= 35	>5,7	<110	= 100	> 20	< 250 µA
$-I_D$($-V_D$ = 100 V)	= 80	> 10	<250	= 200	> 30	< 430 µA


7R05869
OA 95 14-3-'58
Current limits
Limites de courant
Stromgrenzen
T_{amb}=25°C
I_D (mA)
100
10
1
0,1
V_D(V)
0
1
2
3
4

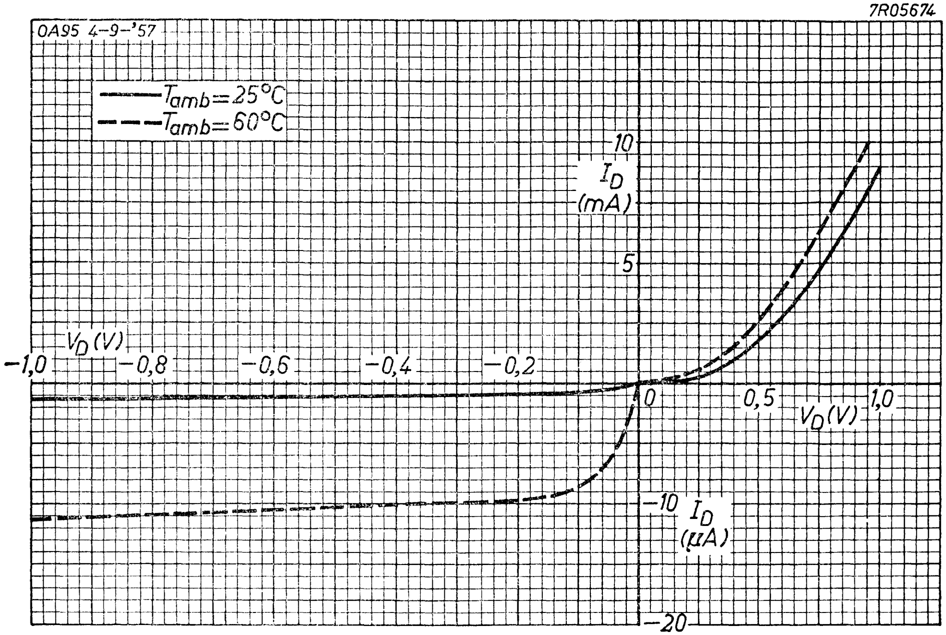
A


7R05870
OA95 14-3-'58
Current limits
Limites de courant
Stromgrenzen
T_{amb}=60°C
I_D (mA)
100
10
1
0,1
V_D(V)
0
1
2
3
4

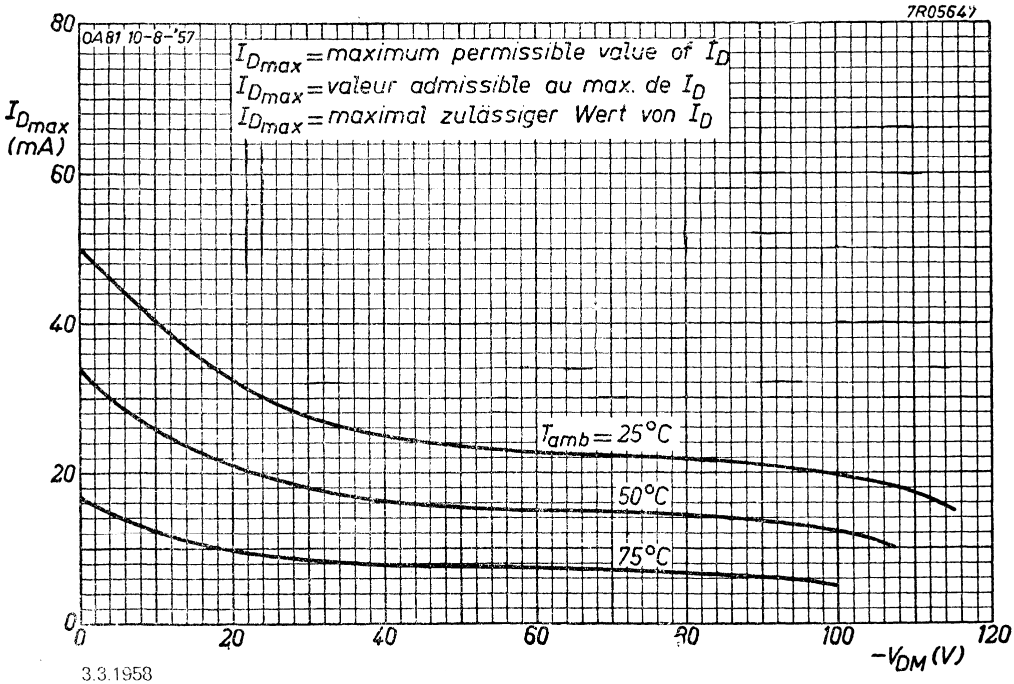
B



7R05871
OA 95 14-3-'58
Current limits
Limites de courant
Stromgrenzen
T_{amb}=25°C
T_{amb}=60°C
1000
$-I_D$
(μA)
100
10
1
0,1
0
50
$-V_D$(V)
100
0
50
$-V_D$(V)
100


7R05674
OA95 4-9-'57
T_{amb}=25°C
T_{amb}=60°C
10
I_D
(mA)
5
V_D (V)
−1,0
−0,8
−0,6
−0,4
−0,2
0
0,5
V_D (V)
1,0
−10
I_D
(μA)
−20

D


7R05647
80
OA81 10-8-'57
I_{Dmax} = maximum permissible value of I_D
I_{Dmax} = valeur admissible au max. de I_D
I_{Dmax} = maximal zulässiger Wert von I_D
I_{Dmax}
(mA)
60
40
20
0
T_{amb} = 25°C
50°C
75°C
0
20
40
60
80
100
120
$-V_{DM}$ (V)

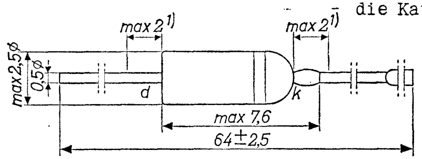
E

3.3.1958

GENERAL PURPOSE SILICON DIODE of the alloyed junction type with low inverse current in miniature all-glass construction for operation at high ambient temperatures
DIODE AU SILICIUM POUR USAGES GENERAUX de type jonction par alliage et de construction miniature tout verre pour utilisation aux températures ambiantes élevées
Legierte ALLZWECKSILIZIUMDIODE in Miniatur-Allglasausführung mit niedrigem Strom in der Sperrichtung zur Verwendung bei hohen Umgebungstemperaturen

Dimensions in mm
Dimensions en mm
Abmessungen in mm

The white band indicates the position of the cathode
L'anneau blanc indique la position de la cathode
Der weisse Ring bezeichnet die Katodenseite



Limiting values (Absolute max. values)
Caractéristiques limites (Valeurs max. absolues)
Grenzdaten (Absolute Maximalwerte)

		T_{amb} = 25°C	= 125°C
$-V_D$	=	max. 50 V	max. 50 V
I_D {direct current / courant continu / Gleichstrom}	=	max. 160 mA	max. 48 mA 2)
I_D (t_{av} = max. 50 msec)		{See pages C and D / Voir pages C et D / Siehe Seite C und D}	
I_{DM}	=	max. 250 mA	max. 125 mA
T_{amb}	=	-55 °C/ +125 °C	
Storage temperatur / Température d'emmagasinage / Lagerungstemperatur	=	-55 °C/ +125 °C	

1) Not tinned
Non étamé
Nicht verzinnt

2) See also page B
Voir aussi page B
Siehe auch Seite B

Thermal data. Junction temperature rise to ambient temperature in free air K ≦ 0.4 °C/mW
Données thermiques. Augmentation de la température de la jonction au regard de la température de l'ambiance à l'air libre K ≦ 0,4 °C/mW
Thermische Daten. Temperaturerhöhung in bezug auf die Umgebungstemperatur in freier Luft K ≦ 0,4 °C/mW

Characteristics
Caractéristiques
Kenndaten

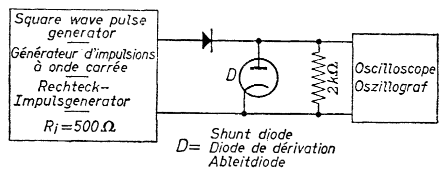
I_D (mA)	V_D (V) T_{amb} = 25°C		T_{amb} = 125°C
0,1	0,52	< 0,62	0,30
10	0,80	< 0,96	0,65
30	0,90	< 1,15	0,80

$-V_D$ (V)	$-I_D$ (μA) T_{amb} = 25°C		T_{amb} = 125°C	
50	0,02	< 0,1	1	< 10

Capacitance
Capacité
Kapazität

T_{amb} = 25 °C
$-V_D$ = 0,75 V
f = 0,5 Mc/s
C_D = 10 pF
C_D < 25 pF 1)

Reverse recovery
Recouvrement inverse
Übergangszeit für Sperrichtung
T_{amb} = 25 °C



Measuring circuit; circuit de mesure; Messchaltung

1) Characteristic value for equipment design
Valeur caractéristique pour l'étude d'équipements
Charakteristischer Wert für Gerätentwurf

Reverse recovery (continued)
Recouvrement inverse (suite)
Übergangszeit für Sperrichtung (Fortsetzung)

Pulse data
Données de l'impulsion
Impulsdaten

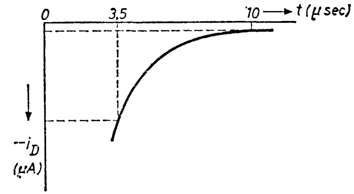
f = 50 kc/s
δ = 0,5

Rise time
Temps de montée
Anstiegszeit
< 0,1 μsec

Oscilloscope data
Données de l'oscilloscope
Daten des Oszillographen

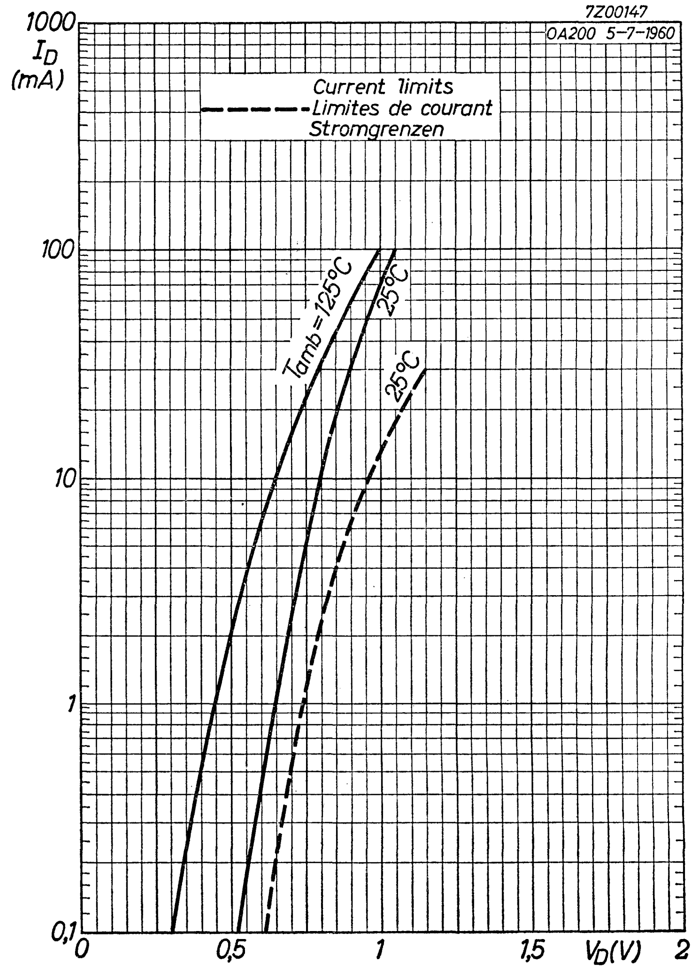
C_{inp} = 40 pF

Rise time
Temps de montée
Anstiegszeit
= 0,025 μsec

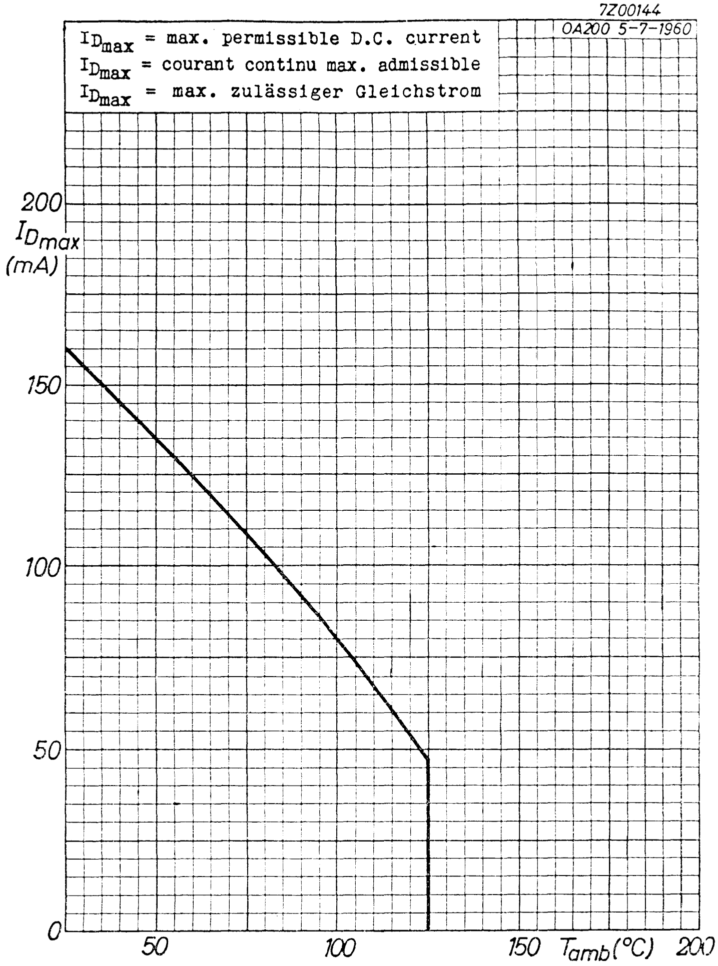


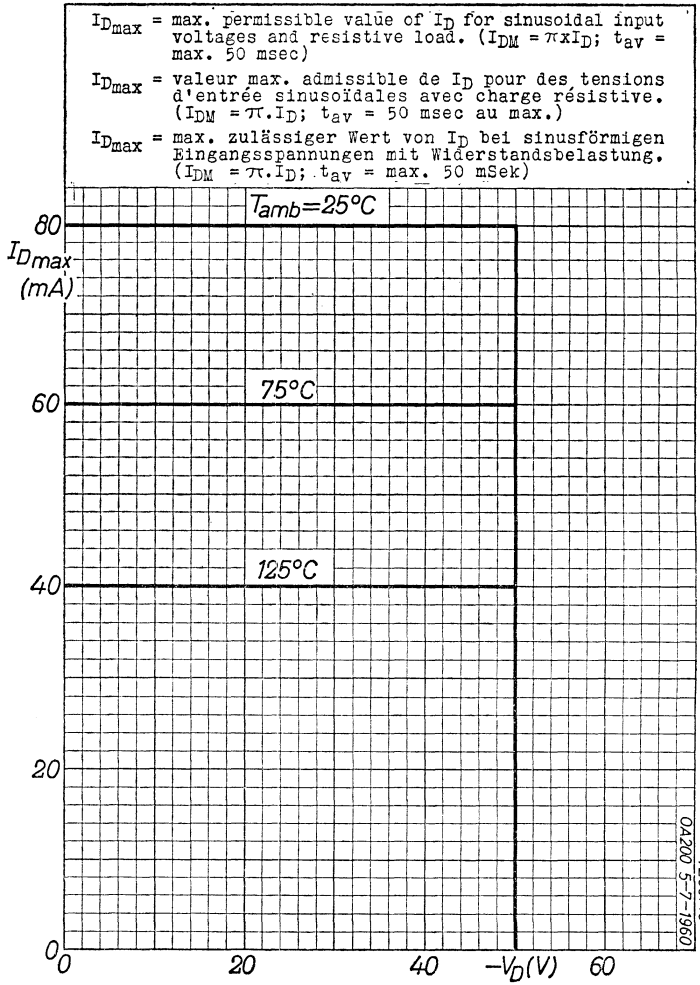
I_{DM} [1] (mA)	$-V_{DM}$ [1] (V)	$-i_D$ t = 3,5 μsec	$-i_D$ t = 10 μsec
5	5	1,2 mA	35 μA
30	35	4 mA	230 μA

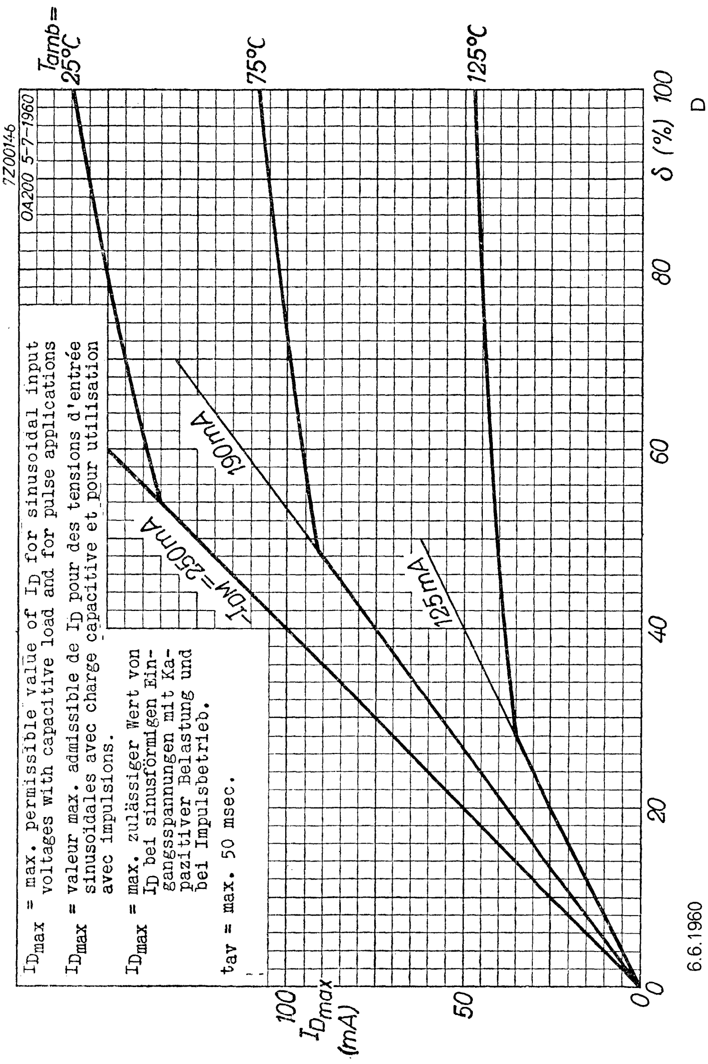
[1]) Reverse voltage pulse ($-V_{DM}$) after forward current pulse (I_{DM})
Impulsion de tension inverse ($-V_{DM}$) après impulsion de courant en sens conducteur (I_{DM})
Spannungsimpuls in Sperrichtung ($-V_{DM}$) nach Stromimpuls in Durchlassrichtung (I_{DM})



A


7Z00144
OA200 5-7-1960
I_{Dmax} = max. permissible D.C. current
I_{Dmax} = courant continu max. admissible
I_{Dmax} = max. zulässiger Gleichstrom
200
I_{Dmax} (mA)
150
100
50
0
50
100
150
T_{amb} (°C)
200


I_{Dmax} = max. permissible value of I_D for sinusoidal input voltages and resistive load. ($I_{DM} = \pi x I_D$; t_{av} = max. 50 msec)
I_{Dmax} = valeur max. admissible de I_D pour des tensions d'entrée sinusoïdales avec charge résistive. ($I_{DM} = \pi . I_D$; t_{av} = 50 msec au max.)
I_{Dmax} = max. zulässiger Wert von I_D bei sinusförmigen Eingangsspannungen mit Widerstandsbelastung. ($I_{DM} = \pi . I_D$; t_{av} = max. 50 mSek)
T_{amb}=25°C
75°C
125°C
80
I_{Dmax} (mA)
60
40
20
0
0
20
40
$-V_D$ (V)
60
7Z00145
OA200 5-7-1960

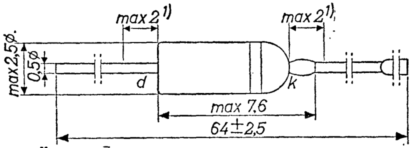

ID max = max. permissible value of ID for sinusoidal input voltages with capacitive load and for pulse applications
ID max = valeur max. admissible de ID pour des tensions d'entrée sinusoïdales avec charge capacitive et pour utilisation avec impulsions.
ID max = max. zulässiger Wert von ID bei sinusförmigen Eingangsspannungen mit Kapazitiver Belastung und bei Impulsbetrieb.
tav = max. 50 msec.
7Z00146
OA200 5-7-1960
Tamb=
25°C
75°C
125°C
190mA
IDM=250mA
125mA
ID max (mA)
100
50
0
20
40
60
80
100
δ (%)
D
6.6.1960

OA202

GENERAL PURPOSE SILICON DIODE of the alloyed junction type with low inverse current in miniature all-glass construction for operation at high ambient temperatures
DIODE AU SILICIUM POUR USAGES GENERAUX de type jonction par alliage et de construction miniature tout verre pour utilisation aux températures ambiantes élevées
Legierte ALLZWECKSILIZIUMDIODE in Miniatur- Allglasausführung mit niedrigem Strom in der Sperrichtung zur Verwendung bei hohen Umgebungstemperaturen

Dimensions in mm
Dimensions en mm
Abmessungen in mm

The white band indicates the position of the cathode
L'anneau blanc indique la position de la cathode
Der weisse Ring bezeichnet die Katodenseite



Limiting values (Absolute max. values)
Caractéristiques limites (Valeurs max. absolues)
Grenzdaten (Absolute Maximalwerte)

		T_{amb} = 25°C	= 125°C
$-V_D$		= max. 150 V	max. 150 V
I_D	direct current / courant continu / Gleichstrom	= max. 160 mA	max. 48 mA 2)
I_D (t_{av} = max. 50 msec)		See pages C and D / Voir pages C et D / Siehe Seite C und D	
I_{DM}		= max. 250 mA	max. 125 mA
T_{amb}		= -55 °C/ +125 °C	
Storage temperatur / Température d'emmagasinage / Lagerungstemperatur		= -55 °C/ +125 °C	

1) Not tinned
Non étamé
Nicht verzinnt

2) See also page B
Voir aussi page B
Siehe auch Seite B

Thermal data. Junction temperature rise to ambient temperature in free air K = 0.4 °C/mW
Données thermiques. Augmentation de la température de la jonction au regard de la température de l'ambiance à l'air libre K = 0,4 °C/mW
Thermische Daten. Temperaturerhöhung in bezug auf die Umgebungstemperatur in freier Luft K = 0,4 °C/mW

Characteristics
Caractéristiques
Kenndaten

I_D (mA)	V_D (V) T_{amb} = 25°C		T_{amb} = 125°C
0,1	0,52	< 0,62	0,30
10	0,80	< 0,96	0,65
30	0,90	< 1,15	0,80

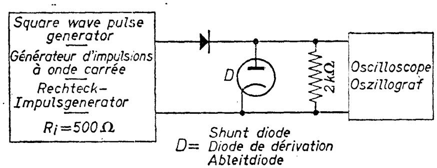
$-V_D$ (V)	$-I_D$ (μA) T_{amb} = 25°C		T_{amb} = 125°C	
150	0,01	< 0,1	0,5	< 10

Capacitance
Capacité
Kapazität

T_{amb} = 25 °C
$-V_D$ = 0,75 V
f = 0,5 Mc/s
C_D = 10 pF
C_D < 25 pF 1)

Reverse recovery
Recouvrement inverse
Übergangszeit für Sperrichtung

T_{amb} = 25°C



Measuring circuit; circuit de mesure; Messchaltung

1) Characteristic value for equipment design
Valeur caractéristique pour l'étude d'équipements
Charakteristischer Wert für Gerätentwurf

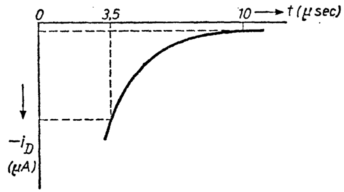
Reverse recovery (continued)
Recouvrement inverse (suite)
Übergangszeit für Sperrichtung (Fortsetzung)

Pulse data
Données de l'impulsion
Impulsdaten

f	=	50 kc/s
δ	=	0,5
Rise time / Temps de montée / Anstiegszeit	<	0,1 μsec

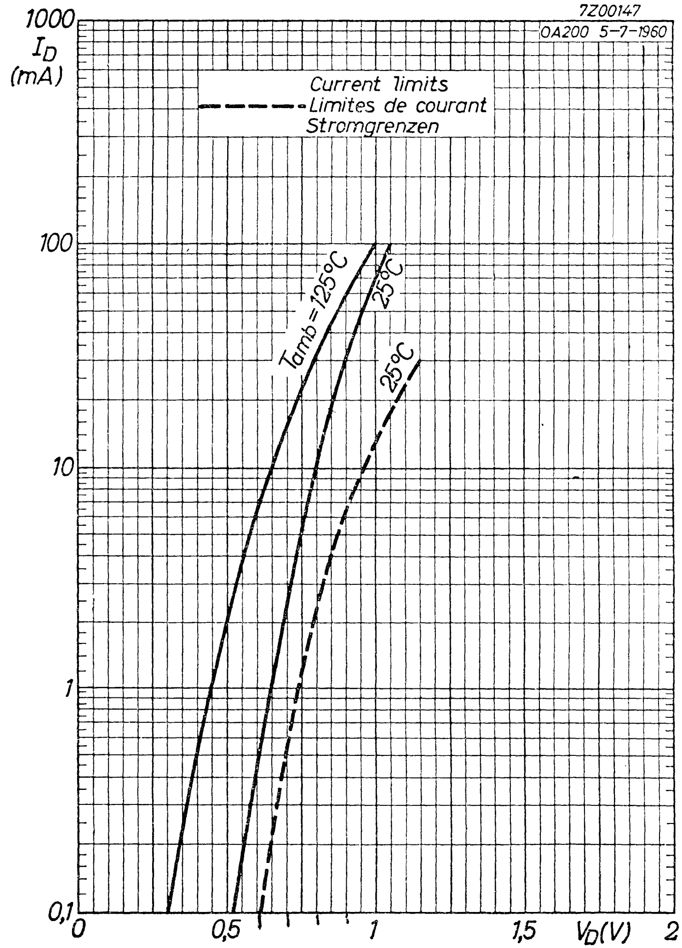
Oscilloscope data
Données de l'oscilloscope
Daten des Oszillographen

C_{inp}	=	40 pF
Rise time / Temps de montée / Anstiegszeit	=	0,025 μsec

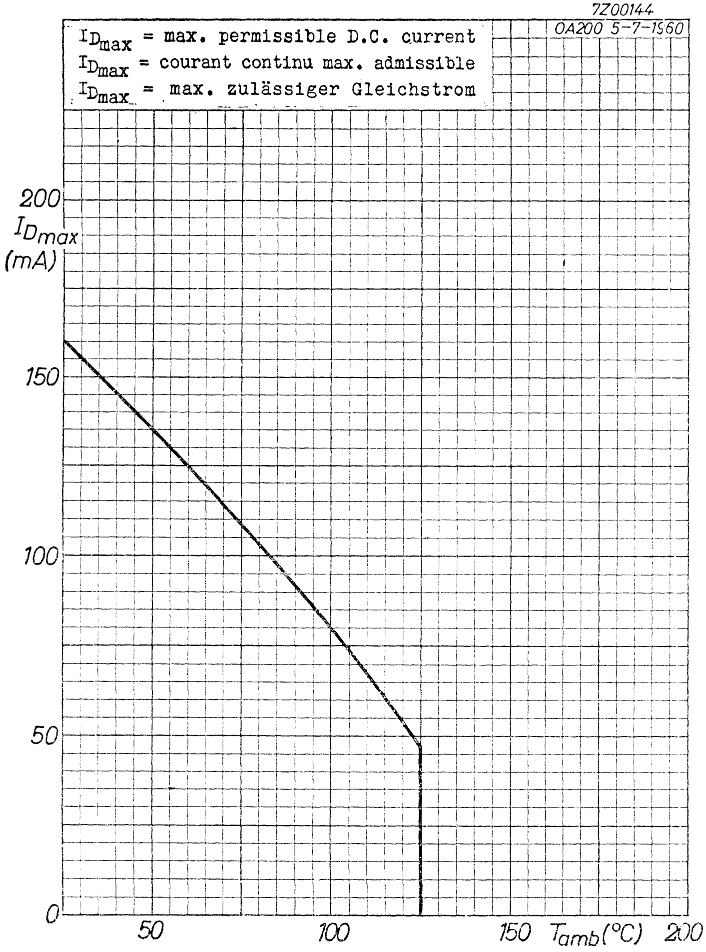


1) I_{DM} (mA)	1) $-V_{DM}$ (V)	$-i_D$	
		t = 3,5 μsec	t = 10 μsec
5	5	1,2 mA	35 μA
30	35	4 mA	230 μA

1) Reverse voltage pulse ($-V_{DM}$) after forward current pulse (I_{DM})
Impulsion de tension inverse ($-V_{DM}$) après impulsion de courant en sens conducteur (I_{DM})
Spannungsimpuls in Sperrichtung ($-V_{DM}$) nach Stromimpuls in Durchlassrichtung (I_{DM})



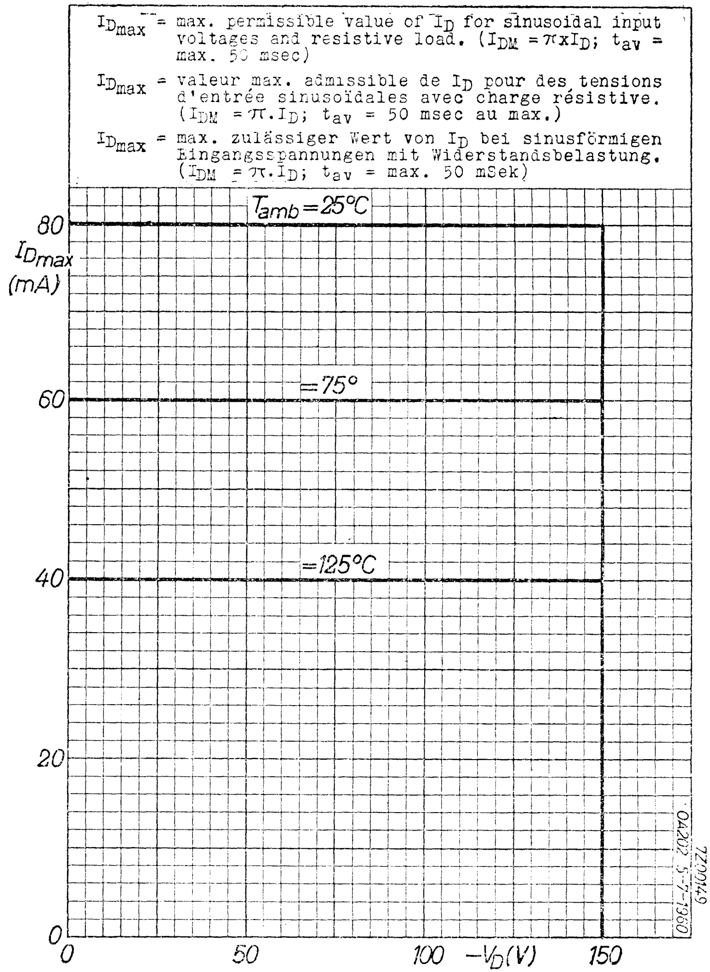
A



7Z00144
OA200 5-7-1960
$I_{D max}$ = max. permissible D.C. current
$I_{D max}$ = courant continu max. admissible
$I_{D max}$ = max. zulässiger Gleichstrom
200
$I_{D max}$ (mA)
150
100
50
0
50
100
150
T_{amb}(°C)
200

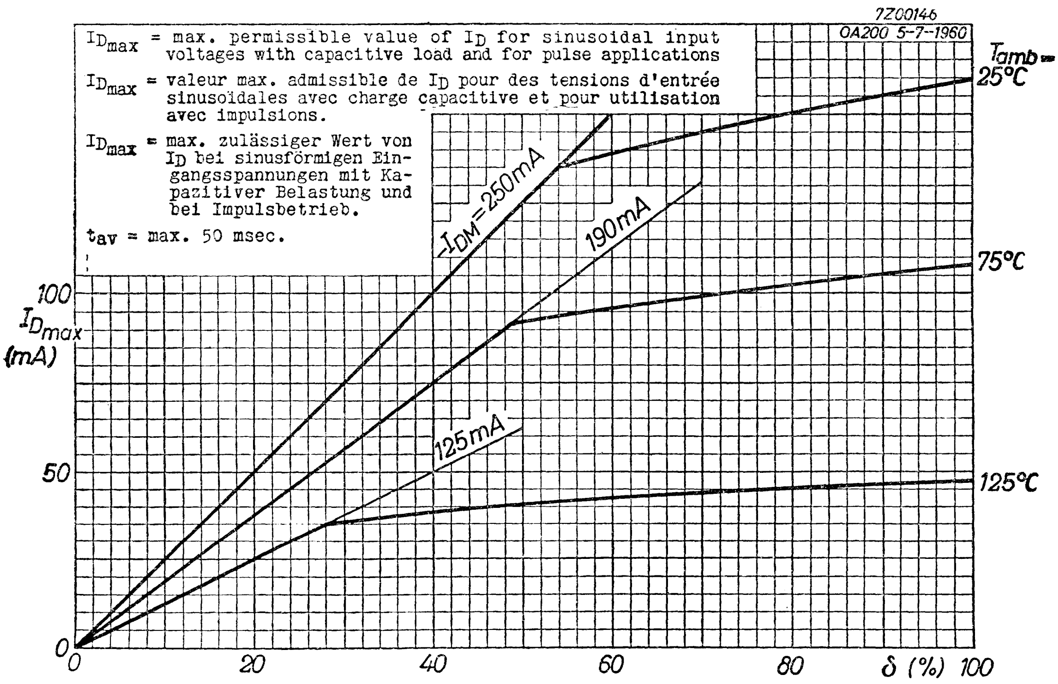
6.6.1960

B



7Z00149
OA202 5-7-1960
$I_{D max}$ = max. permissible value of I_D for sinusoidal input voltages and resistive load. ($I_{DM} = \pi x I_D$; t_{av} = max. 50 msec)
$I_{D max}$ = valeur max. admissible de I_D pour des tensions d'entrée sinusoïdales avec charge résistive. ($I_{DM} = \pi . I_D$; t_{av} = 50 msec au max.)
$I_{D max}$ = max. zulässiger Wert von I_D bei sinusförmigen Eingangsspannungen mit Widerstandsbelastung. ($I_{DM} = \pi . I_D$; t_{av} = max. 50 mSek)
T_{amb}=25°C
=75°
=125°C
80
$I_{D max}$ (mA)
60
40
20
0
0
50
100
$-V_D$(V)
150

C


7Z00146
OA200 5-7-1960
I_{Dmax} = max. permissible value of I_D for sinusoidal input voltages with capacitive load and for pulse applications
I_{Dmax} = valeur max. admissible de I_D pour des tensions d'entrée sinusoïdales avec charge capacitive et pour utilisation avec impulsions.
I_{Dmax} = max. zulässiger Wert von I_D bei sinusförmigen Eingangsspannungen mit Kapazitiver Belastung und bei Impulsbetrieb.
t_{av} = max. 50 msec.
T_{amb} = 25°C
75°C
125°C
$-I_{DM}$=250mA
190mA
125mA
I_{Dmax} (mA)
100
50
0
0
20
40
60
80
δ (%) 100

6.6.1960

D

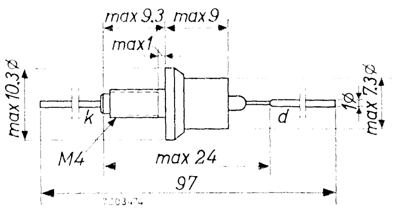
SILICON DIODE

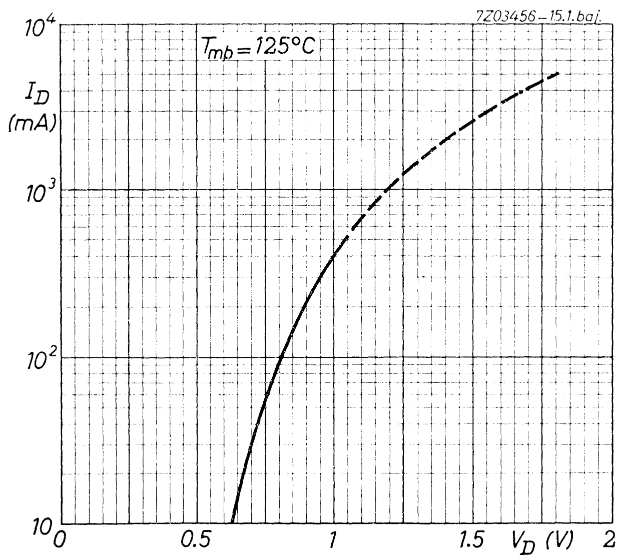
Silicon junction diode for use as a 127 V mains rectifier in television receivers.

LIMITING VALUES (Absolute max. values)

Peak reverse voltage	$-V_{DM}$	max. 400	V
Average forward current (t_{av} = 50 ms)	I_D	max. 0.5	A
Peak forward current	I_{DM}	max. 5	A

MECHANICAL DATA Dimensions in mm





7Z2 3302

3.3.1965

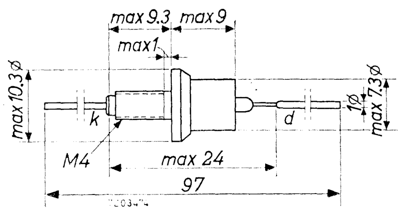
SILICON DIODE

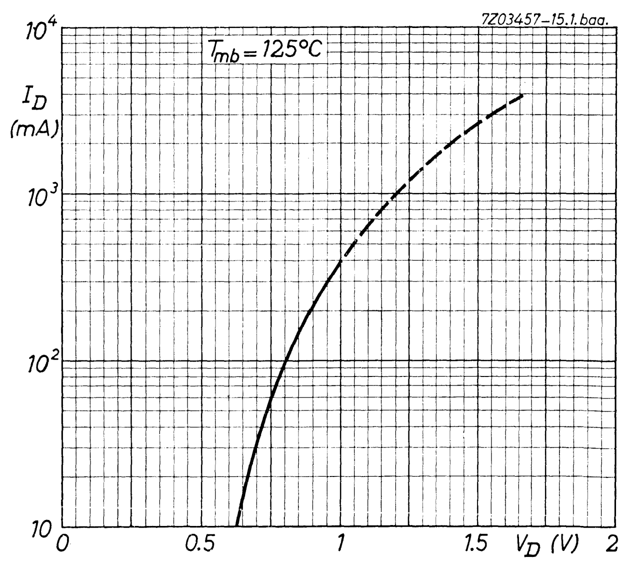
Silicon junction diode for use as a 250 V mains rectifier in television receivers.

LIMITING VALUES (Absolute max. values)

Peak reverse voltage	$-V_{DM}$	max.	800	V
Average forward current (t_{av} = 50 ms)	I_D	max.	0.4	A
Peak forward current	I_{DM}	max.	4	A

MECHANICAL DATA Dimensions in mm





7Z2 3303

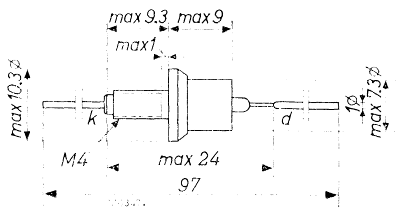
SILICON DIODE

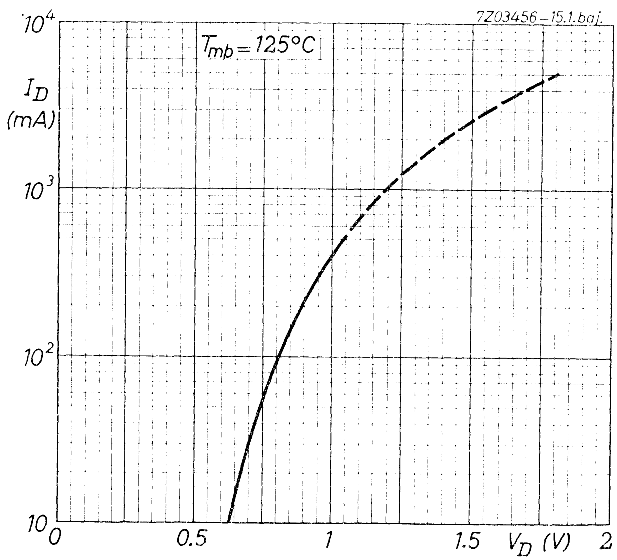
Silicon junction diode for use as a 220 V mains rectifier in television receivers.

LIMITING VALUES (Absolute max. values)

Peak reverse voltage	$-V_{DM}$	max.	700	V
Average forward current (t_{av} = 50 ms)	I_D	max.	0.5	A
Peak forward current	I_{DM}	max.	5	A

MECHANICAL DATA Dimensions in mm





7Z2 3304

3.3.1965

SILICON ZENER DIODES

Silicon alloy junction diodes in all-glass construction with external metal can for use as low current voltage stabilizer or as a voltage reference.

QUICK REFERENCE DATA

		OAZ200/207	OAZ208/213
Reverse zener voltage	$-V_D$ =	4.7 to 9.1 V	4.3 to 12 V
Zener voltage tolerance		5 %	15 %
Max. reverse zener current (repetitive peak)	$-I_{DM}$ =	max. 250 mA	
Max. junction temperature	T_j =	max. 150 °C	
Thermal resistance between junction and case	K =	0.15 °C/mW	

LIMITING VALUES (Absolute max. values)

Forward current

Continuous and averaged over any 20 msec period	I_D	= max.	100 mA
	(t_{av}	=	20 msec)
Repetitive peak	I_{DM}	= max.	250 mA

Reverse zener current

Continuous and averaged over any 20 msec period	See pages I and J		
Repetitive peak	$-I_{DM}$	= max.	250 mA
Surge current, duration 100 µsec See also page L	$-I_{Dsurge}$	= max.	10 A
	(t	=	100 µsec)

Dissipation

See pages 8, 9, I and J

Temperatures

Junction temperature	T_j	= max.	150 °C
Storage temperature	T_s	=	−55 to +150 °C

7Z2 2250

THERMAL DATA

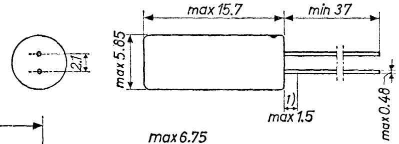
Thermal resistance

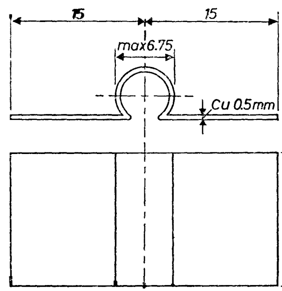
between junction and case	K	=	0.15 °C/mW
between junction and ambience a. without cooling fin in free air	K	=	0.4 °C/mW
b. with type A or extended type B cooling fin in free air	K	=	0.3 °C/mW
c. with standard type B cooling fin on heat sink of 3.5 x 3.5 cm^2 of 1.6 mm aluminium	K	=	0.25 °C/mW

MECHANICAL DATA

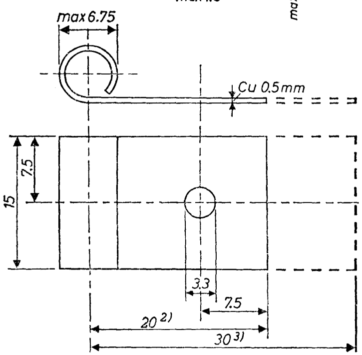
Dimensions in mm

The coloured dot indicates the position of the cathode





Type A
Type No. 56209



Type B
Type No. 56210

1) Not tinned
2) Standard type B cooling fin
3) Extended type B cooling fin

7Z2 2251

CHARACTERISTICS at T_{case} = 25 °C

I_D (mA)	V_D (mV) typ.	min.	max.
10	= 730	> 620	< 820
100	= 800	> 700	< 920

Type No.	$-I_D$ (mA)	$-V_D$ (V) typ.	min.	max.	$-V_D$ (V)	$-I_D$ (μA) typ.	max.
OAZ200	1	= 4.7	> 4.4	< 5.0	2	= 0.12	< 0.50
	5	= 5.2	> 4.9	< 5.6			
	20	= 5.6	> 5.3	< 5.9			
OAZ201	1	= 5.1	> 4.8	< 5.4	2	= 0.04	< 0.50
	5	= 5.6	> 5.2	< 6.0			
	20	= 5.9	> 5.6	< 6.2			
OAZ202	1	= 5.6	> 5.3	< 6.0	2	= 0.02	< 0.30
	5	= 6.0	> 5.6	< 6.3			
	20	= 6.2	> 5.9	< 6.6			
OAZ203	1	= 6.2	> 5.8	< 6.6	2	= 0.04	< 0.30
	5	= 6.3	> 6.1	< 6.8			
	20	= 6.4	> 6.1	< 6.9			
OAZ204	1	= 6.8	> 6.4	< 7.2	3	= 0.02	< 0.25
	5	= 6.9	> 6.4	< 7.3			
	20	= 7.0	> 6.5	< 7.4			
OAZ205	1	= 7.5	> 7.1	< 7.9	3	= 0.005	< 0.20
	5	= 7.6	> 7.1	< 8.0			
	20	= 7.7	> 7.1	< 8.2			
OAZ206	1	= 8.2	> 7.7	< 8.7	5	= 0.02	< 0.20
	5	= 8.2	> 7.7	< 8.8			
	20	= 8.4	> 7.8	< 9.0			
OAZ207	1	= 9.1	> 8.6	< 9.6	5	= 0.015	< 0.15
	5	= 9.2	> 8.6	< 9.8			
	20	= 9.4	> 8.8	< 10.0			

7Z2 2252

CHARACTERISTICS at T_{case} = 25 °C (continued)

Type No.	$-I_D$ (mA)	$-V_D$ (V) typ.	min.	max.	$-V_D$ (V)	$-I_D$ (μA) typ.	max.
OAZ208	1	= 4.3	> 3.3	< 5.0	1.5	= 0.10	< 0.50
	5	= 4.9	> 3.8	< 5.6			
	20	= 5.3	> 4.3	< 5.9			
OAZ209	1	= 5.1	> 4.4	< 6.0	1.5	= 0.04	< 0.50
	5	= 5.6	> 4.9	< 6.3			
	20	= 5.9	> 5.3	< 6.4			
OAZ210	1	= 6.2	> 5.3	< 7.2	2	= 0.02	< 0.50
	5	= 6.3	> 5.6	< 7.3			
	20	= 6.4	> 5.9	< 7.4			
OAZ211	1	= 7.5	> 6.4	< 8.7	2	= 0.02	< 0.30
	5	= 7.6	> 6.4	< 8.8			
	20	= 7.7	> 6.5	< 9.0			
OAZ212	1	= 9.1	> 7.7	< 10.6	5	= 0.015	< 0.20
	5	= 9.2	> 7.7	< 10.8			
	20	= 9.4	> 7.8	< 11.1			
OAZ213	1	= 12	> 9.4	< 15.0	5	= 0.010	< 0.15
	5	= 12.2	> 9.4	< 15.3			
	20	= 12.5	> 9.6	< 15.7			

7Z2 2253

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN at T_{case} = 25 °C

Type No.	$-I_D$ (mA)	$\Delta(-V_D)/\Delta T$ (mV/°C)[1] typ.	min.	max.	r_D (Ω)[2] typ.	min.	max.
OAZ200	1	= -2.0	>-2.75	<-1.25	= 350	>320	<400
	5	= -1.2	>-1.75	< 0.0	= 56	> 30	< 70
	20	= 0.2	>-1.5	< 1.5	= 9.0	>3.0	< 15
OAZ201	1	= -1.8	>-2.5	<-1.0	= 330	>270	<400
	5	= -0.6	>-1.5	< 1.0	= 45	> 12	< 75
	20	= 1.0	>-0.5	< 2.5	= 5.7	>1.0	< 13
OAZ202	1	= -1.0	>-2.5	< 1.5	= 275	> 50	<380
	5	= 0.8	>-1.0	< 2.5	= 24	>5.0	< 55
	20	= 1.9	> 0.5	< 3.5	= 3.2	>1.0	< 6
OAZ203	1	= 0.5	>-1.0	< 3.0	= 215	> 10	<280
	5	= 1.7	> 0.5	< 3.5	= 9.5	>2.5	< 25
	20	= 2.6	> 1.0	< 4.0	= 2.3	>1.0	< 11
OAZ204	1	= 2.5	> 0.0	< 4.0	= 40	>5.0	<170
	5	= 3.0	> 2.0	< 4.0	= 4.7	>2.0	< 24
	20	= 3.6	> 2.0	< 5.0	= 2.0	>0.5	< 8
OAZ205	1	= 4.0	> 2.0	< 5.0	= 8.6	>3.0	< 35
	5	= 4.3	> 2.0	< 5.0	= 3.7	>1.0	< 17
	20	= 4.6	> 2.0	< 5.5	= 2.2	>0.75	< 12
OAZ206	1	= 5.0	> 2.0	< 7.0	= 7.6	>2.5	< 28
	5	= 5.2	> 2.0	< 7.5	= 3.8	>1.0	< 15
	20	= 5.4	> 2.0	< 7.5	= 2.4	>1.0	< 10
OAZ207	1	= 6.2	> 4.0	< 7.0	= 9.6	>2.5	< 45
	5	= 6.4	> 4.0	< 7.0	= 4.9	>1.5	< 25
	20	= 6.6	> 4.0	< 8.0	= 2.9	>0.75	< 20

1) Temperature coefficient of zener voltage
2) Dynamic impedance

7Z2 2254

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN at T_{case} = 25 °C (continued)

Type No.	$-I_D$ (mA)	$\Delta(-V_D)/\Delta T$ (mV/°C[1]) typ.	min.	max.	r_D (Ω)[2] typ.	min.	max.
OAZ208	1	= -2.0	>-3.5	<-0.5	= 350	>320	<400
	5	= -1.4	>-2.2	< 0.0	= 62	> 30	< 80
	20	= -0.5	>-2.0	< 1.5	= 12	>3.0	< 20
OAZ209	1	= -1.8	>-2.75	< 1.5	= 330	> 50	<400
	5	= -0.6	>-1.75	< 2.5	= 45	>5.0	< 75
	20	= 1.0	>-1.5	< 3.5	= 5.7	>1.0	< 15
OAZ210	1	= 0.5	>-2.5	< 4.0	= 215	>5.0	<380
	5	= 1.7	>-1.0	< 4.0	= 9.5	>2.0	< 55
	20	= 2.6	> 0.5	< 5.0	= 2.3	>0.5	< 11
OAZ211	1	= 4.0	> 0.0	< 7.0	= 8.6	>2.5	<170
	5	= 4.3	> 2.0	< 7.5	= 3.7	>1.0	< 24
	20	= 4.6	> 2.0	< 7.5	= 2.2	>0.5	< 12
OAZ212	1	= 6.2	> 2.5	< 8.5	= 9.6	>2.5	< 45
	5	= 6.4	> 2.5	< 8.5	= 4.9	>1.0	< 25
	20	= 6.6	> 2.5	< 8.5	= 2.9	>0.7	< 20
OAZ213	1	= 9.2	> 4.0	< 12	= 35	–	< 70
	5	= 9.3	> 4.0	< 12	= 12	–	< 40
	20	= 9.4	> 4.0	< 12	= 5.6	–	< 16

1) Temperature coefficient of zener voltage
2) Dynamic impedance

7Z2 2255

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN at T_{case} = 25 °C (continued)

Type No.	c_D (pF) at $-V_D$ = 3 V		
	typ.	min.	max.
OAZ200	= 420	> 200	< 650
OAZ201	= 400	> 100	< 650
OAZ202	= 360	> 100	< 600
OAZ203	= 300	> 100	< 500
OAZ204	= 300	> 100	< 450
OAZ205	= 250	> 100	< 400
OAZ206	= 220	> 50	< 350
OAZ207	= 170	> 50	< 300
OAZ208	= 420	> 200	< 700
OAZ209	= 400	> 100	< 650
OAZ210	= 300	> 100	< 600
OAZ211	= 300	> 50	< 450
OAZ212	= 170	> 50	< 350
OAZ213	= 150	> 50	< 250

7Z2 2256

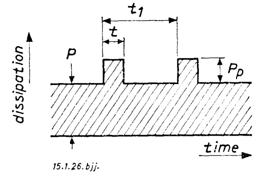
DETERMINATION OF THE PEAK POWER RATING

For, a pulse duration, shorter than the "temperature stabilisation time"

$$P_p = \frac{T_{j\,max} - T_{amb} - K_{j\text{-}amb} \times P}{K_t + \delta \times K_{c\text{-}amb}}$$

For a pulse duration, longer than the "temperature stabilisation time"

$$P_p = \frac{T_{j\,max} - T_{amb}}{K_{j\text{-}amb}} - P$$



t	= pulse duration
t_1	= pulse period
δ	= t/t_1 = duty factor
P	= constant power dissipation
P_p	= permissible pulse power dissipation over P
K_t	= transient thermal resistance, which is a function of t and δ (see page K)
$K_{j\text{-}amb}$	= thermal resistance between junction and ambience
$K_{c\text{-}amb}$	= thermal resistance between case and ambience
$T_{j\,max}$	= maximum permissible junction temperature
T_{amb}	= ambient temperature

Temperature stabilisation time = 30 sec (see page K)

7Z2 2313

DETERMINATION OF THE PEAK POWER RATING
(continued)

Example

Calculation of the permissible peak zener current of an OAZ205 when:

1. The diode is mounted in free air with $T_{amb} = 60\ ^{o}C$
2. The steady-state zener current $-I_D = 10$ mA
3. The pulses have a duration $t = 1$ msec and a duty factor $\delta = 0.1$

The pulses have duration, shorter than the temperature stabilisation time of 30 sec, so the peak power can be calculated from

$$P_p = \frac{T_{j\,max} - T_{amb} - K_{j\text{-}amb} \times P}{K_t + \delta \times K_{c\text{-}amb}}$$

where

$T_{j\,max}$ = 150 ^{o}C

T_{amb} = 60 ^{o}C

$K_{j\text{-}amb}$ = 0.4 $^{o}C/mW$

P = 86 mW, according to page J

K_t (at t = 1 msec and $\delta = 0.1$) = 0.018 $^{o}C/mW$, according to page K

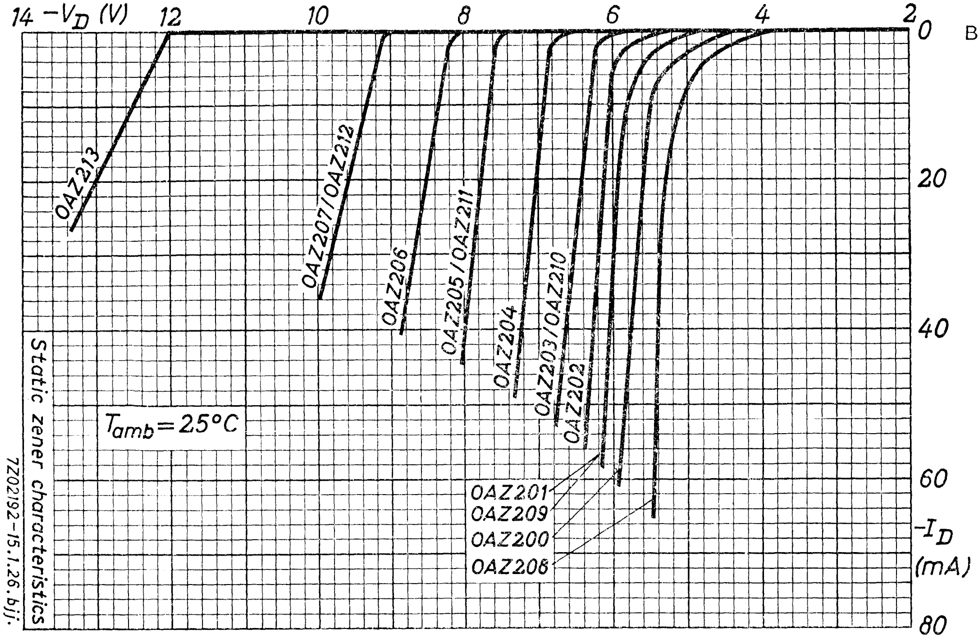
δ = 0.1

$K_{c\text{-}amb} = K_{j\text{-}amb} - K_{j\text{-}c} = 0.4 - 0.15 = 0.25\ ^{o}C/mW$

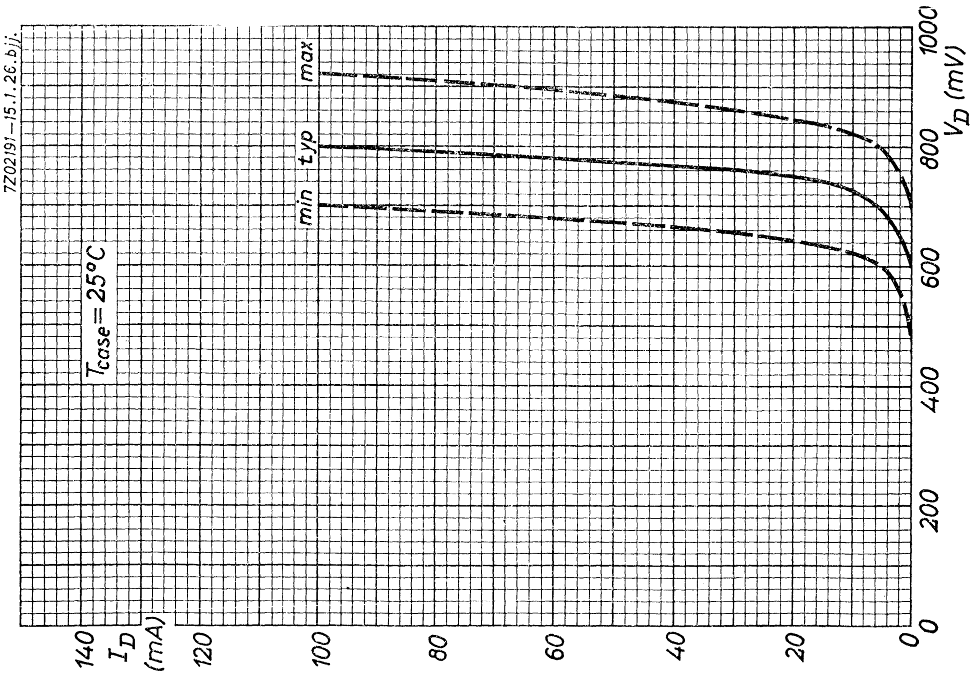
$$\text{So } P_p = \frac{150 - 60 - 0.4 \times 86}{0.018 + 0.1 \times 0.25} = 1294 \text{ mW}$$

The total peak power $P_{tot} = 1294 + 86 = 1380$ mW = 1.38 W.

From page J it may be seen that the corresponding zener current $-I_D = 180$ mA

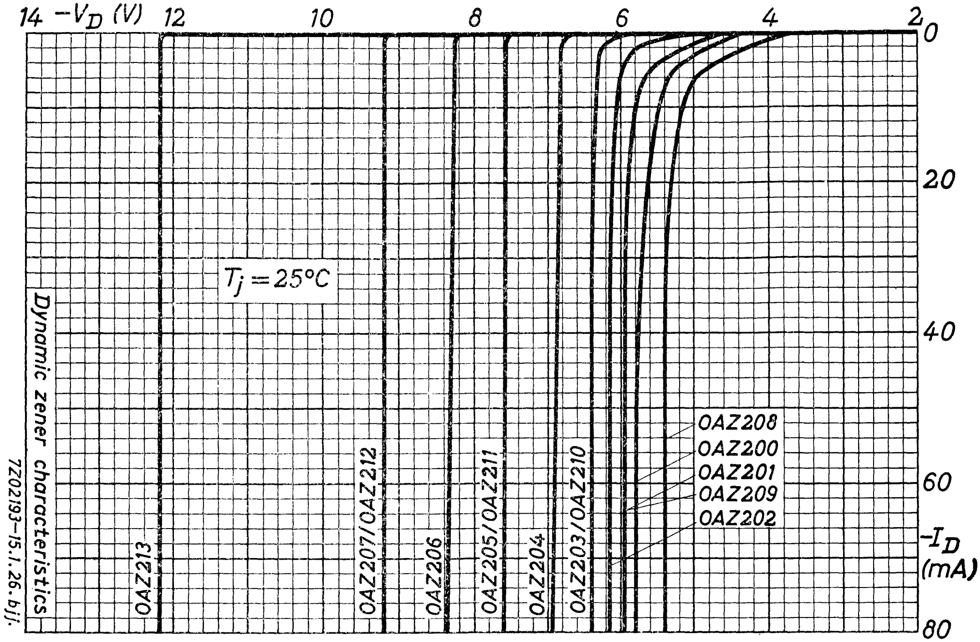

14 −V_D (V)
12
10
8
6
4
2
0
20
40
60
80
−I_D (mA)
OAZ213
OAZ207/OAZ212
OAZ206
OAZ205/OAZ211
OAZ204
OAZ203/OAZ210
OAZ202
OAZ201
OAZ209
OAZ200
OAZ208
T_amb = 25°C
Static zener characteristics
7Z02192-15.1.26.bjj.

B

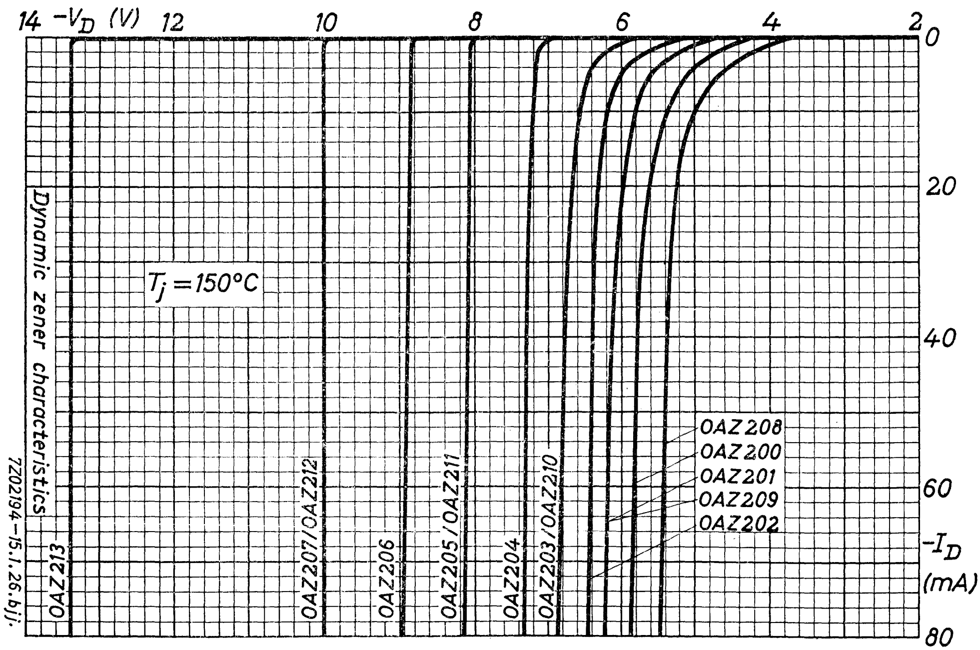

7Z02191-15.1.26.bjj.
max
typ
min
T_case = 25°C
V_D (mV)
1000
800
600
400
200
0
I_D (mA)
140
120
100
80
60
40
20
0

A

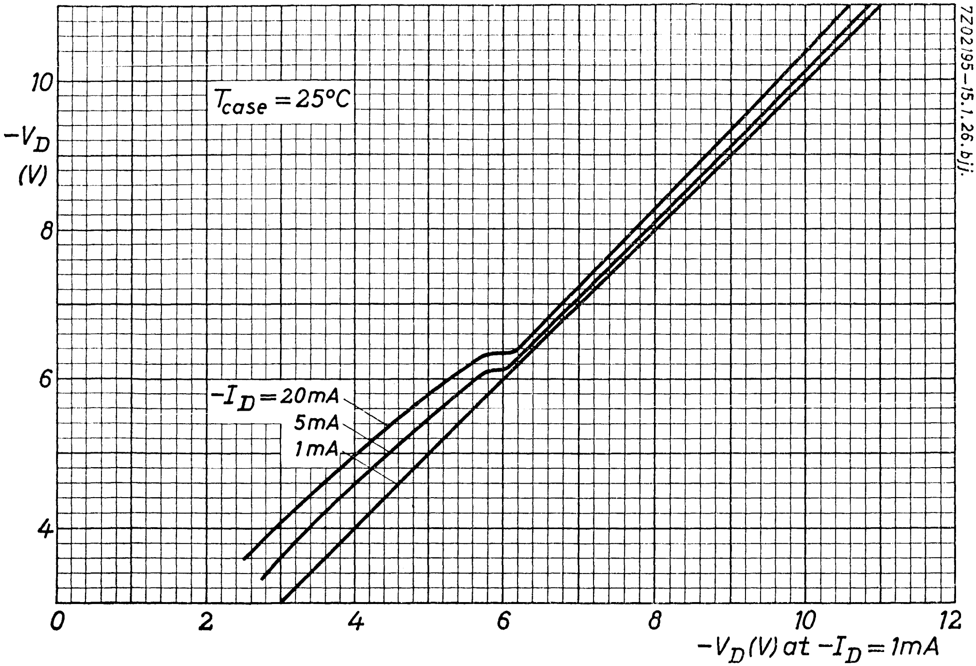
2.2.1964


14 $-V_D$ (V) 12 10 8 6 4 2
0
20
40
60
$-I_D$ (mA)
80
$T_j = 25°C$
Dynamic zener characteristics
7Z02193–15.1.26.bij.
OAZ213
OAZ207/OAZ212
OAZ206
OAZ205/OAZ211
OAZ204
OAZ203/OAZ210
OAZ208
OAZ200
OAZ201
OAZ209
OAZ202

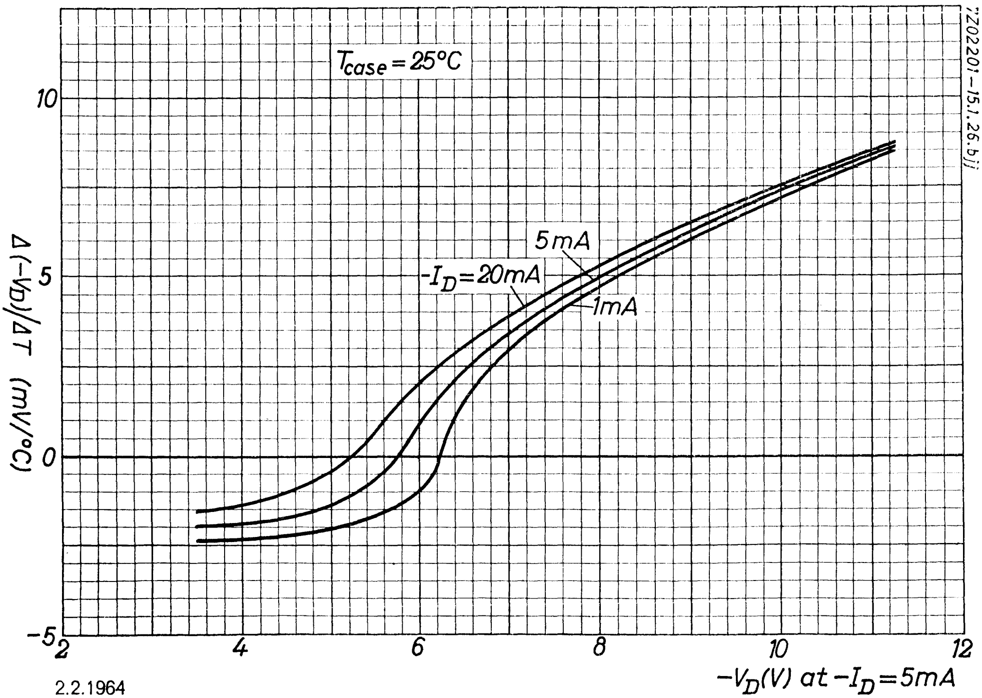
C


14 $-V_D$ (V) 12 10 8 6 4 2
0
20
40
60
$-I_D$ (mA)
80
$T_j = 150°C$
Dynamic zener characteristics
7Z02194–15.1.26.bij.
OAZ213
OAZ207/OAZ212
OAZ206
OAZ205/OAZ211
OAZ204
OAZ203/OAZ210
OAZ208
OAZ200
OAZ201
OAZ209
OAZ202

D

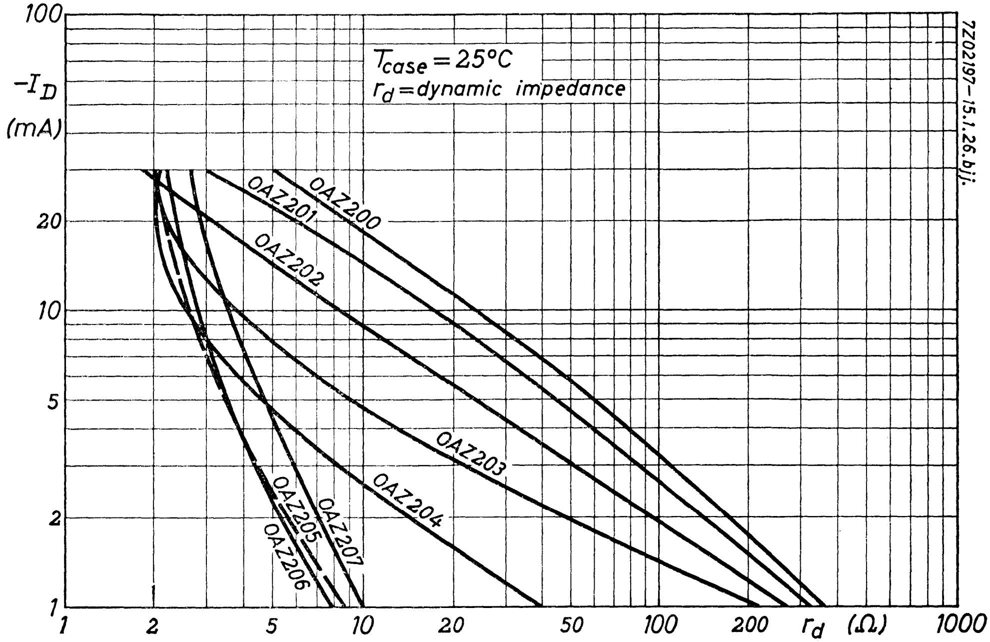

7Z02195–15.1.26.bjj.
$T_{case} = 25°C$
$-V_D$ (V)
10
8
6
4
$-I_D = 20mA$
5mA
1mA
0
2
4
6
8
10
12
$-V_D(V)$ at $-I_D = 1mA$

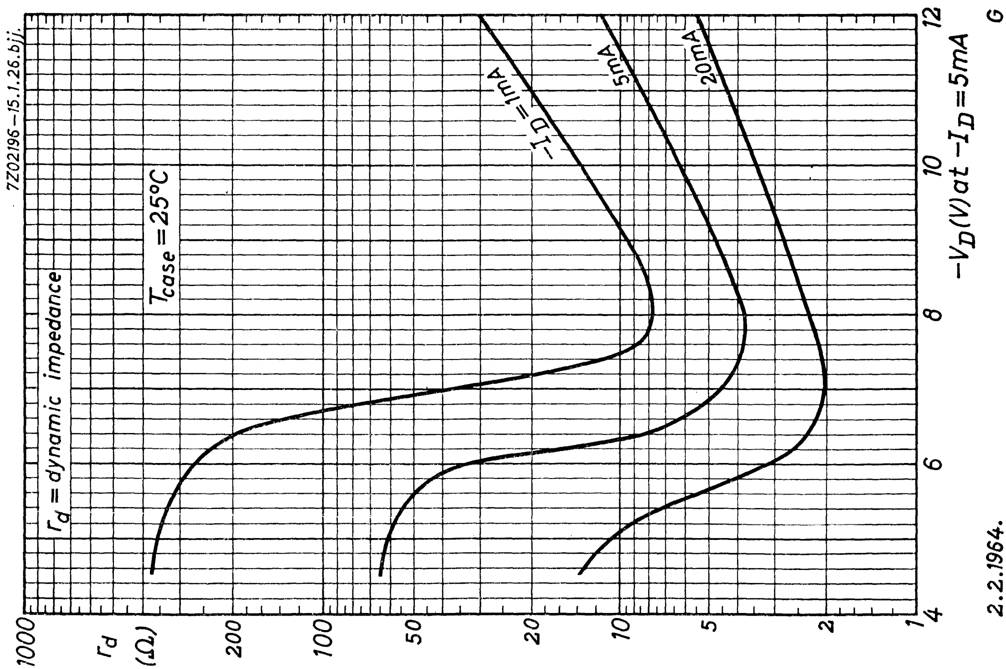
E


7Z02201–15.1.26.bjj
$T_{case} = 25°C$
$\Delta(-V_D)/\Delta T$ (mV/°C)
10
5
0
−5
5mA
$-I_D = 20mA$
1mA
2
4
6
8
10
12
$-V_D(V)$ at $-I_D = 5mA$

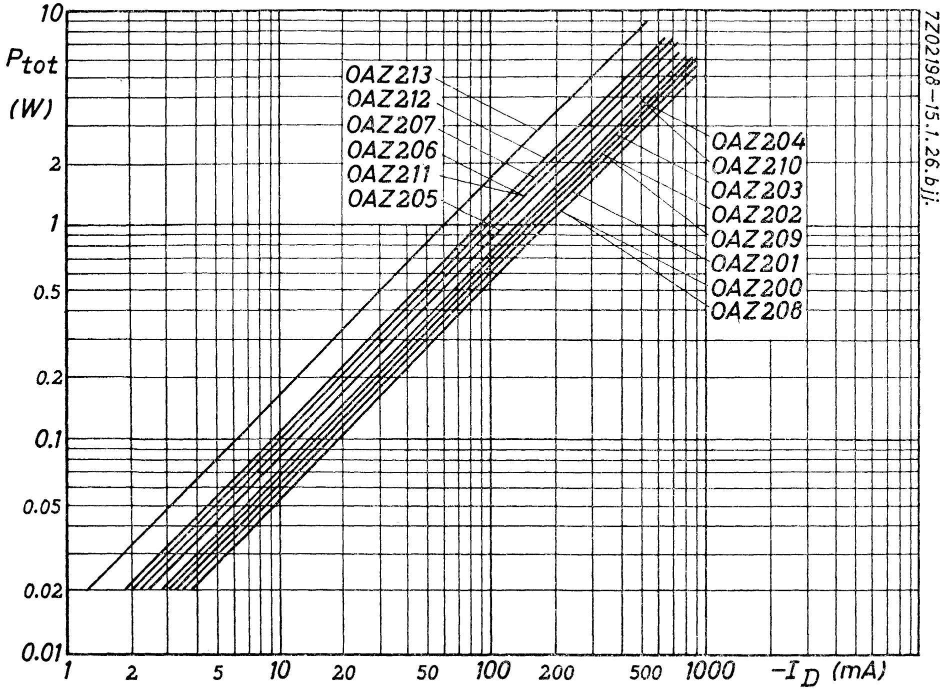
F

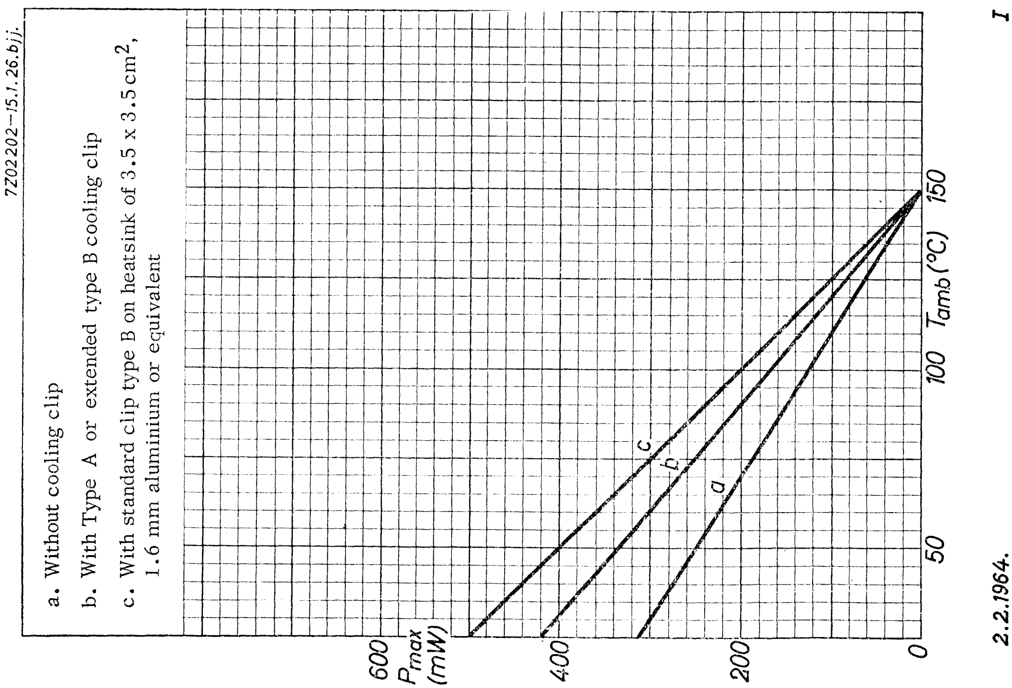
2.2.1964


7Z02197-15.1.26.bij.
H
$T_{case} = 25°C$
r_d = dynamic impedance
$-I_D$ (mA)
100
20
10
5
2
1
OAZ200
OAZ201
OAZ202
OAZ203
OAZ204
OAZ205
OAZ206
OAZ207
1
2
5
10
20
50
100
200
r_d (Ω)
1000

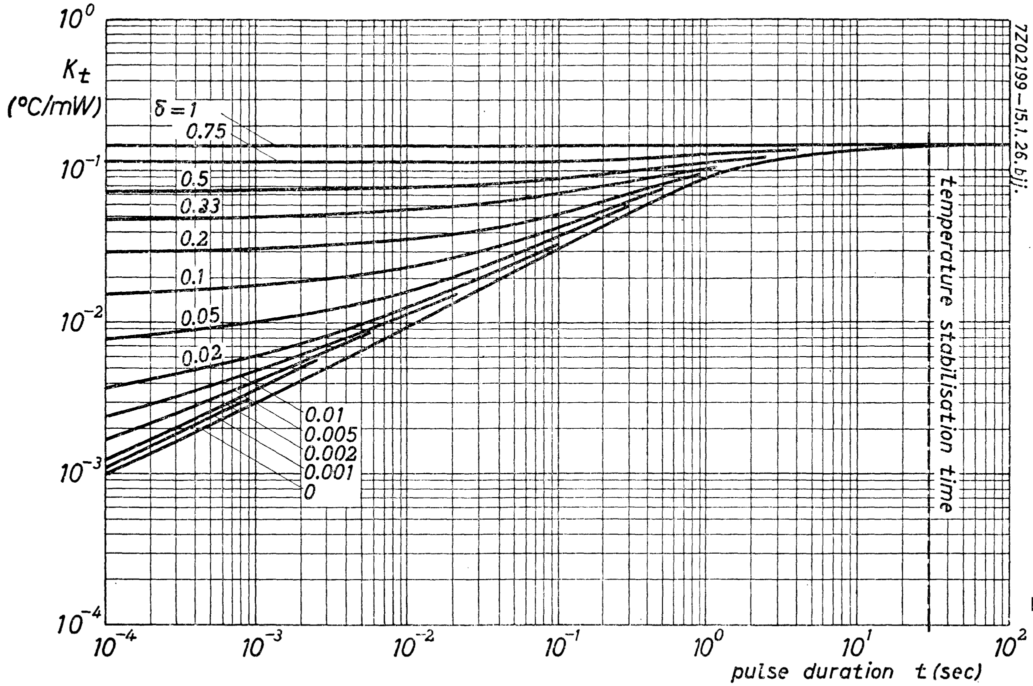

7Z02196-15.1.26.bij.
G
r_d = dynamic impedance
$T_{case} = 25°C$
$-I_D = 1mA$
5mA
20mA
r_d (Ω)
1000
200
100
50
20
10
5
2
1
$-V_D$(V) at $-I_D = 5mA$
4
6
8
10
12

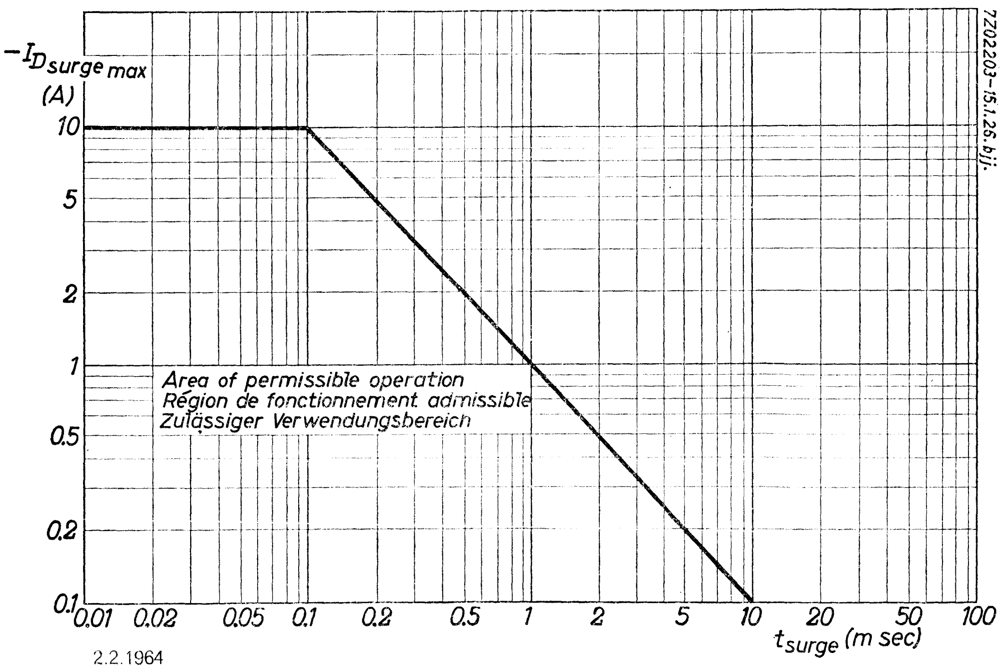
2.2.1964.


7Z02198-15.1.26.bjj.
P_{tot} (W)
10
2
1
0.5
0.2
0.1
0.05
0.02
0.01
1
2
5
10
20
50
100
200
500
1000
$-I_D$ (mA)
OAZ213
OAZ212
OAZ207
OAZ206
OAZ211
OAZ205
OAZ204
OAZ210
OAZ203
OAZ202
OAZ209
OAZ201
OAZ200
OAZ208


7Z02202-15.1.26.bjj.
a. Without cooling clip
b. With Type A or extended type B cooling clip
c. With standard clip type B on heatsink of 3.5 x 3.5 cm², 1.6 mm aluminium or equivalent
P_{max} (mW)
600
400
200
0
50
100
T_{amb} (°C)
150
a
b
c

2.2.1964.


K_t
(°C/mW)
δ = 1
0.75
0.5
0.33
0.2
0.1
0.05
0.02
0.01
0.005
0.002
0.001
0
temperature stabilisation time
pulse duration t (sec)
7Z02199–15.1.26.bij.
K


$-I_{D\,surge\,max}$
(A)
Area of permissible operation
Région de fonctionnement admissible
Zulässiger Verwendungsbereich
t_{surge} (m sec)
7Z02203–15.1.26.bij.
L

2.2.1964

Silicon controlled rectifiers (Thyristors)

P-GATE SILICON CONTROLLED RECTIFIERS 20 AMP. SERIES

P-gate all diffused silicon controlled rectifiers in a metal case for power control and power switching applications up to 400 c/s.
The series consists of types BTX12-100R, -200R, -300R, -400R, -500R and -600R [1]).

QUICK REFERENCE DATA							
		BTX12-					
Voltages		100R	200R	300R	400R	500R	600R
Repetitive peak inverse voltage	$-V_{DM}$ max.	400	400	500	500	600	600 V
Repetitive peak forward blocking voltage	V_{DM} max.	100	200	300	400	500	600 V

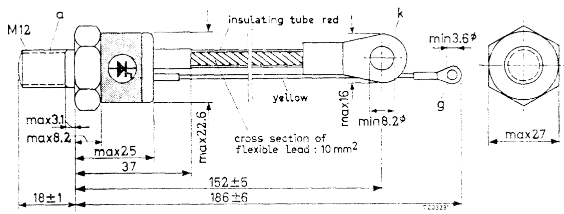
Currents			
Average forward current	I_D	= max.	20 A
Repetitive peak forward current	I_{DM}	= max.	175 A
Sinusoidal peak forward surge current (10 msec)	$I_{DMsurge}$	= max.	250 A
Junction temperature	T_j	=	-55 °C to +125 °C
Thermal resistance			
from junction to base of device	K	<	1.45 °C/W

[1]) The group of figures after the hyphen indicates the rated maximum repetitive peak voltage in the case of equal ratings.
When there is a difference between forward and inverse ratings, the lower value is indicated.
The letter R denotes stud-anode connection.

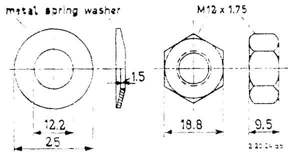
7Z2 2502

MECHANICAL DATA

Dimensions in mm



Except for the metrical thread the outline conforms to TO-49



Mounting accessories

Diameter of hole in heatsink	:	max. 13 mm
Mounting torque	:	max. 200 cm kg min. 100 cm kg (for good heat conductance)
Net weight	:	95 g
Weight with accessories	:	115 g

7Z2 3119

LIMITING VALUES (Absolute max. values) $f \leq 400$ c/s

Anode to cathode

		BTX12-100R	200R	300R	400R	500R	600R
Crest working inverse voltage	$-V_{DMW}$ max.	100	200	300	400	500	600 V 2)
Repetitive peak inverse voltage 1)	$-V_{DM}$ max.	400	400	500	500	600	600 V 2)
Non-repetitive inverse voltage ($t < 10$ msec)	$-V_{DM\,surge}$ max.	400	400	500	500	700	700 V 2)
Crest working blocking voltage	V_{DMW} max.	100	200	300	400	500	600 V 3)
Repetitive peak forward blocking voltage 1)	V_{DM} max.	100	200	300	400	500	600 V 3)
Non-repetitive peak forward blocking voltage	$V_{DM\,surge}$ max.	500	500	500	500	700	700 V 4)

Average forward current (averaged over any 20 msec period)	I_D	= max.	20 A
R.M.S. forward current	I_D	= max.	31 A R.M.S.
Repetitive peak forward current	I_{DM}	= max.	175 A
Surge current	See curve fig. K		

1) e.g. commutation effects.

2) These ratings apply for a gate voltage range of -5 V to $+0.25$ V and for a total thermal resistance between junction and ambient < 13 °C/W.

3) With $R_{max.} = 100\ \Omega$ between gate and cathode for BTX12-500R and -600R.

4) This voltage may be applied without damage but the controlled rectifier may switch into the on-state. When this happens the current that can flow should not exceed the rated forward current.

LIMITING VALUES (Absolute max. values) (continued)

Anode to cathode (continued)

Repetitive peak reverse current during turn-off	$-I_{DM}$	= max.	20 A
Rate of rise during turn-on	dI/dt	= max.	5 A/µsec
I squared t (for fusing)	I^2t 1)	= max.	250 A^2sec

Gate to cathode

Peak power dissipation	P_{GM}	= max.	5 W
Average power dissipation	P_G	= max.	0.5 W
Peak forward voltage	V_{GM}	= max.	10 V
Peak inverse voltage	$-V_{GM}$	= max.	5 V
Peak current	I_{GM}	= max.	2 A

Temperatures

Storage temperature	T_s	= -55 °C to 125 °C
Junction temperature	T_j	= -55 °C to 125 °C

THERMAL DATA

Thermal resistance between

junction and base of device	K	<	1.45 °C/W
base of device and heatsink	K	=	0.15 °C/W

1) R.M.S. value of I

CHARACTERISTICS at T_j = 125 °C unless otherwise specified f ≦ 400 c/s

Anode to cathode		BTX12-100R	200R	300R	400R	500R	600R	
Forward break-over voltage	$V_{Db.o.}$	>100	>200	>300	>400	>500	>600	V
Forward leakage current at $V_{DMmax.}$	I_D	< 8	< 8	< 5	< 5	<5[1]	<5[1]	mA
Reverse leakage current at $-V_{DMmax.}$	$-I_D$	< 8	< 8	< 5	< 5	< 5	< 5	mA

Forward voltage at I_D = 175 A	V_D	<	3.5 V [2]
Holding current	I_{DH}	=	40 mA
Rate of rise of forward blocking voltage	dV/dt	<	20 V/μsec

Gate to cathode (see also fig. D and E)

Voltage to fire all units (T_j = 25 °C)	V_G	>	3 V
Voltage not to fire any unit	V_G	<	0.25 V
Current to fire all units (T_j = 25 °C)	I_G	>	50 mA

Switching characteristics (See also fig. F)

Turn-on time ($t_d + t_r$)	t_{on}	=	4 μsec
Delay time	t_d	=	1.3 μsec
Rise time	t_r	=	2.7 μsec
Turn-off time	t_{off}	=	10 μsec

[1]) With R = 100 Ω between gate and cathode.

[2]) Measured with current pulses to prevent excessive dissipation.

7Z2 2505

OPERATING NOTES

1. When there is a possibility that transient voltage surges will cause an inverse voltage, higher than the maximum permissible non-repetitive peak inverse voltage, or a forward voltage higher than the maximum permissible repetitive peak forward blocking voltage, a damping circuit across the transformer should be applied e.g. a series RC damping circuit. Dimensioning of the RC damping circuit may be done according to the following formulae:

$C_1 = A_1 \frac{I_o}{V_1}$ (μF) and $R_1 = \frac{B_1}{C_1}$ (Ω), when applied to the primary side of the transformer.

$C_2 = A_2 \frac{I_o}{V_1} T^2$ (μF) and $R_2 = \frac{B_2}{C_2}$ (Ω), when applied to the secondary side of the transformer.

Where: $T = V_1/V_2$

V_1 = transformer primary RMS voltage (V)

V_2 = transformer secondary RMS voltage (V)

I_o = magnetizing primary RMS current (A)

$\frac{-V_{DMsurge}}{-V_{DMW}}$ $\frac{V_{DM}}{V_{DMW}}$ [1])	1	1.25	1.5	2
A_1	800	550	400	200
A_2	900	620	450	225
B_1	300	260	225	150
B_2	350	310	275	200

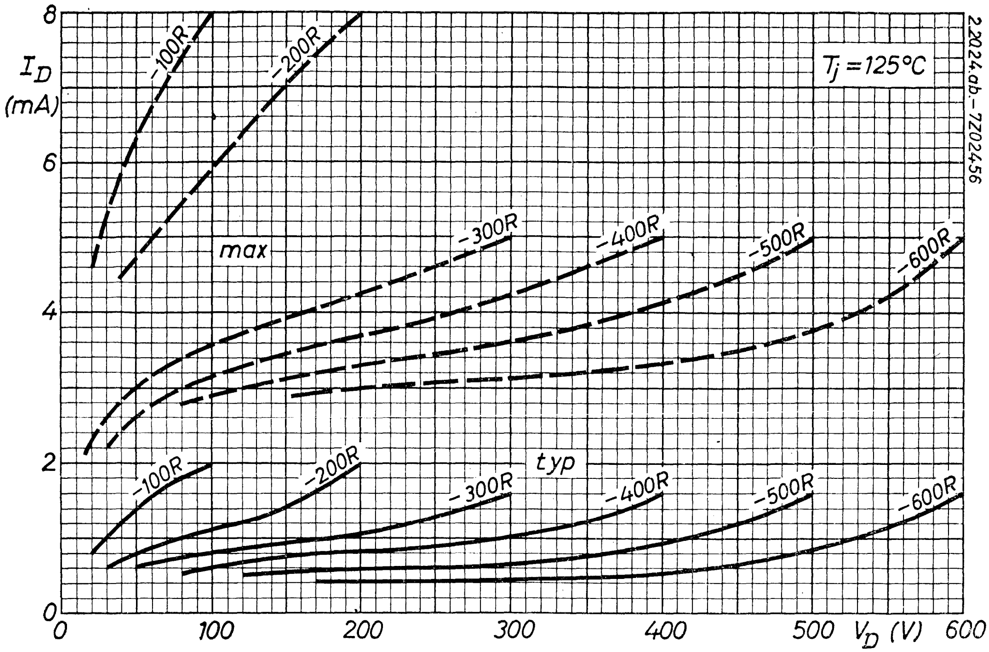
[1]) V_{DMW} and $-V_{DMW}$ stand for the applied crest working voltages.

2. In order to prevent the SCR from being damaged by surge currents, higher than those indicated by the curves of fig.K a fast fuse is recommended.

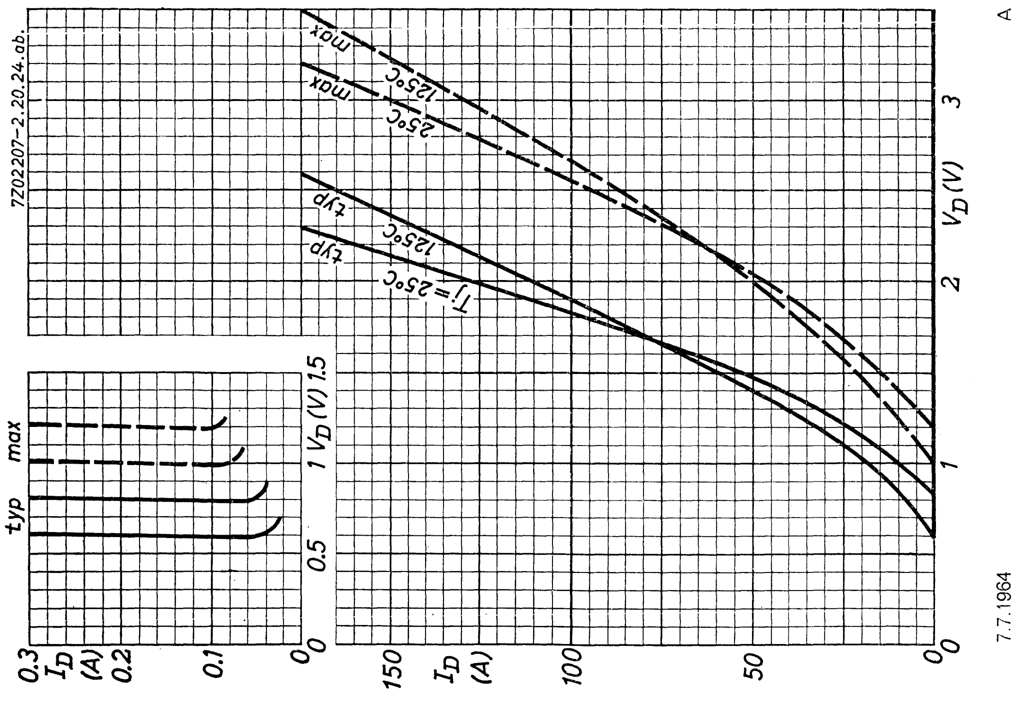
3. At any application of the BTX12-500R and the BTX12-600R the resistance between gate and cathode shall be max. 100 Ω.

7Z2 2506

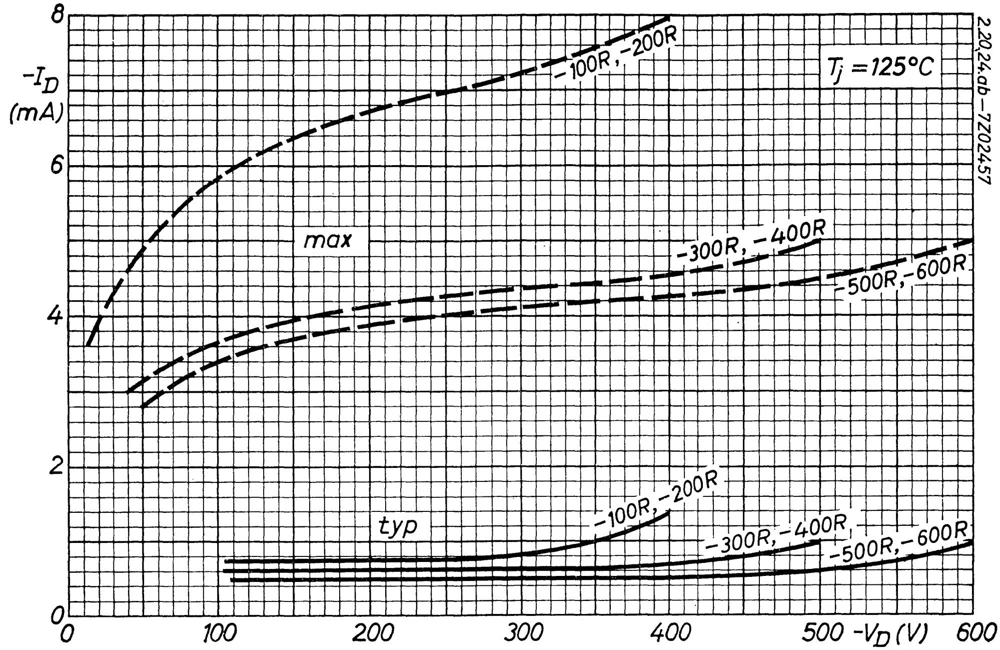
B


2.2024.ab.-7Z02456
I_D (mA)
T_j = 125°C
max
−100R
−200R
−300R
−400R
−500R
−600R
typ
V_D (V)
0
2
4
6
8
100
200
300
400
500
600

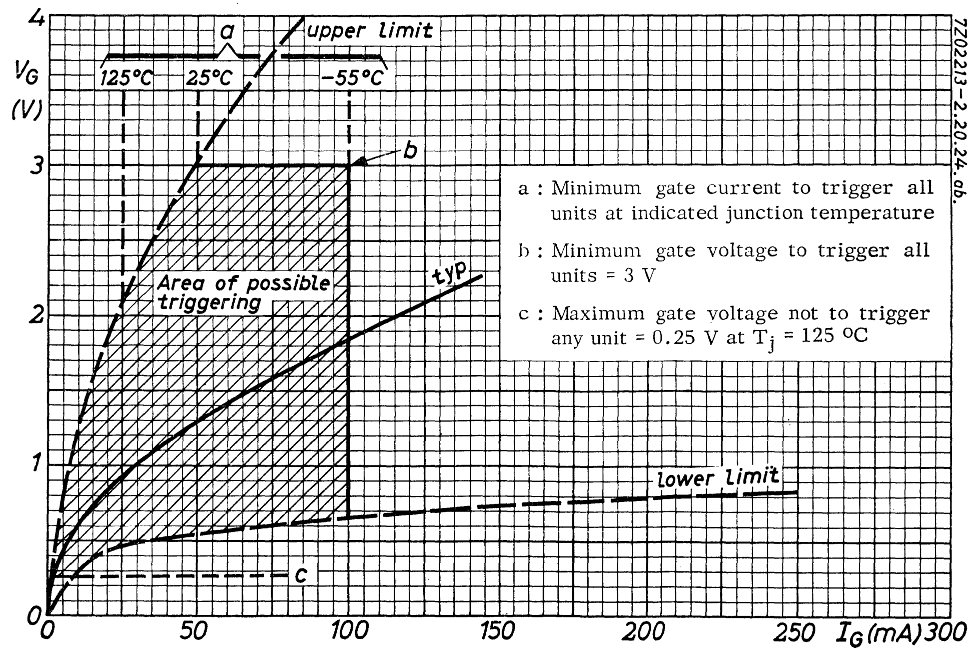
A


7Z02207-2.20.24.ab.
max
125°C
25°C
typ
T_j = 25°C
V_D (V)
I_D (A)
0.3
0.2
0.1
150
100
50
0.5
1
1.5
2
3

7.7.1964



C



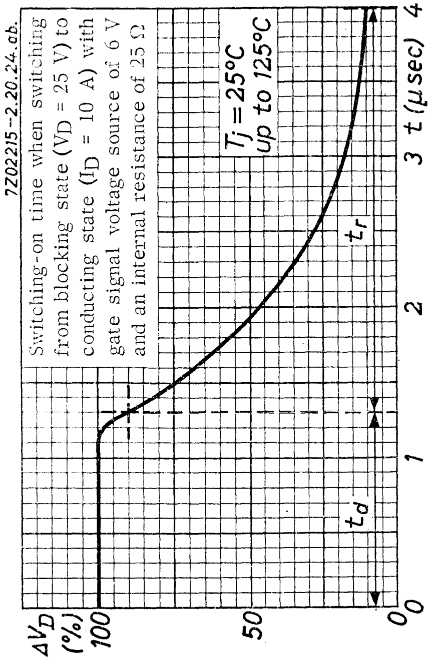
a : Minimum gate current to trigger all units at indicated junction temperature

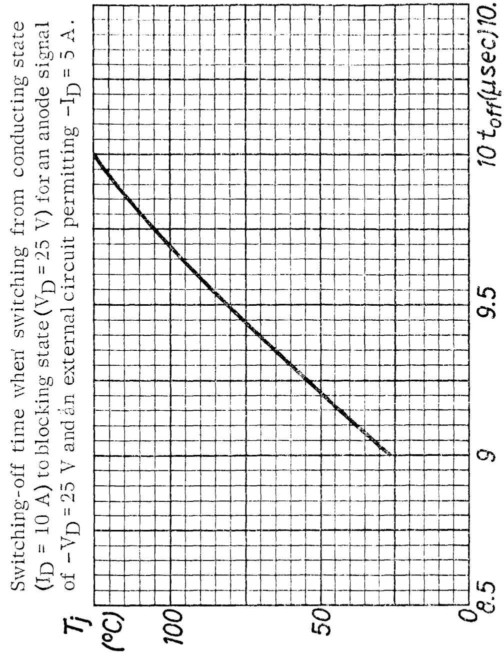
b : Minimum gate voltage to trigger all units = 3 V

c : Maximum gate voltage not to trigger any unit = 0.25 V at T_j = 125 °C

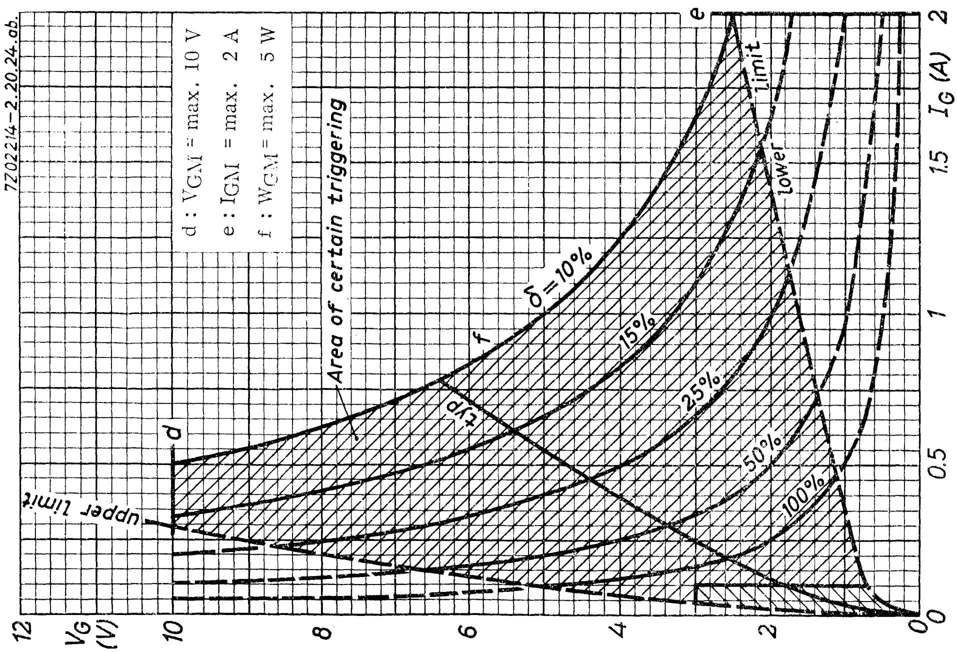
D

7.7.1964


7Z02215-2.20.24.ab.
Switching-on time when switching from blocking state (V_D = 25 V) to conducting state (I_D = 10 A) with gate signal voltage source of 6 V and an internal resistance of 25 Ω
T_j = 25°C up to 125°C
ΔV_D (%)
100
50
0
0
1
2
3
4
t (μsec)
t_d
t_r

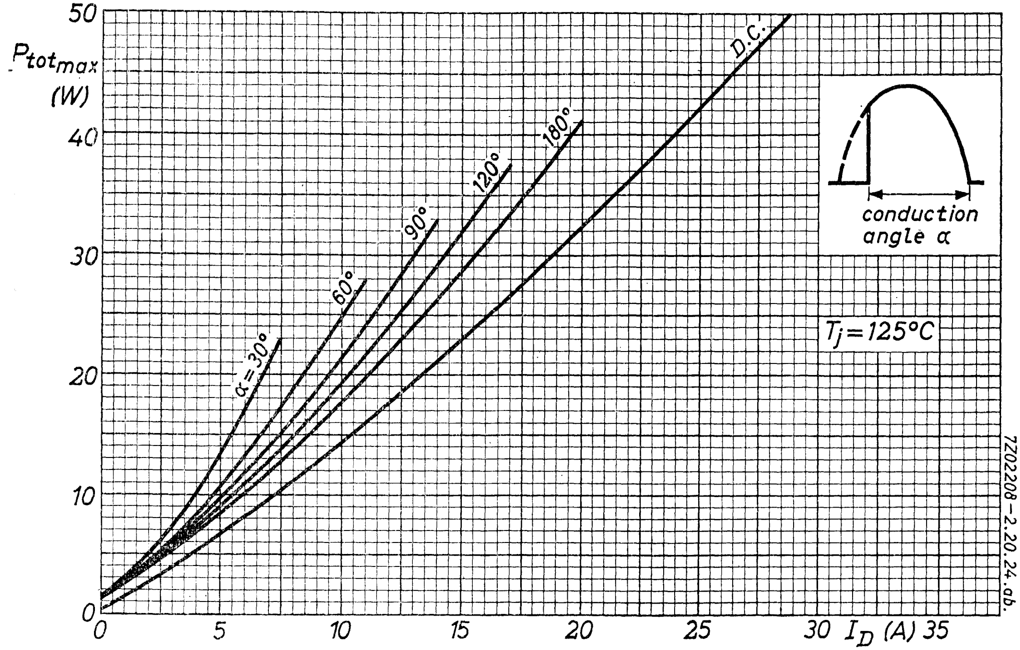

Switching-off time when switching from conducting state (I_D = 10 A) to blocking state (V_D = 25 V) for an anode signal of $-V_D$ = 25 V and an external circuit permitting $-I_D$ = 5 A.
T_j (°C)
100
50
0
8.5
9
9.5
10
10.5
t_{off} (μsec)

F

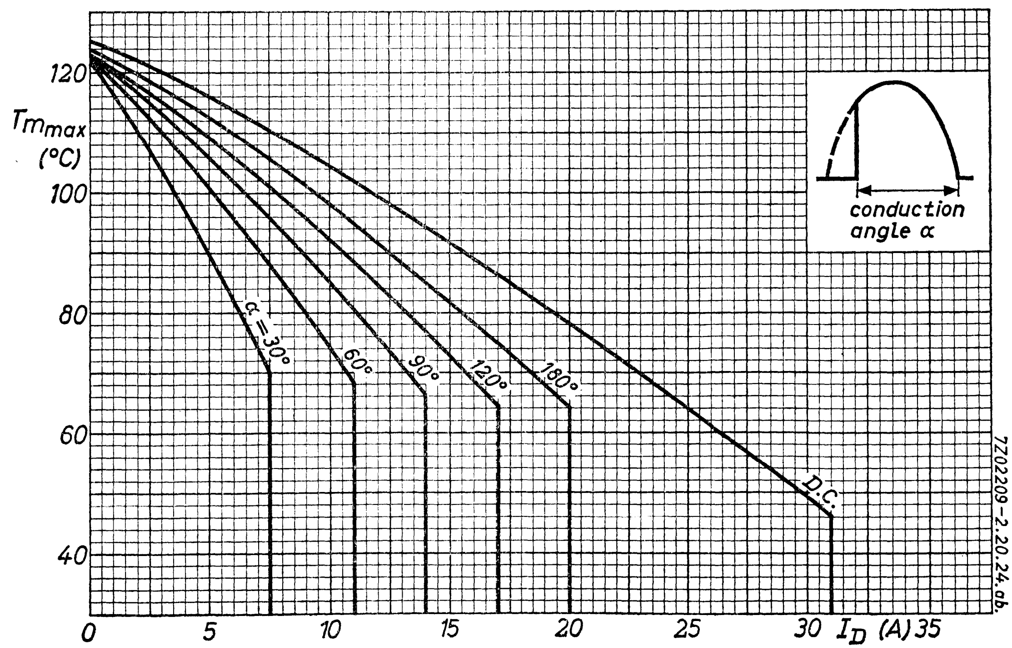

7Z02214-2.20.24.ab.
d : V_{GM} = max. 10 V
e : I_{GM} = max. 2 A
f : W_{GM} = max. 5 W
Area of certain triggering
V_G (V)
12
10
8
6
4
2
0
0
0.5
1
1.5
2
I_G (A)
d
e
f
δ = 10%
15%
25%
50%
100%
typ
upper limit
lower limit

E

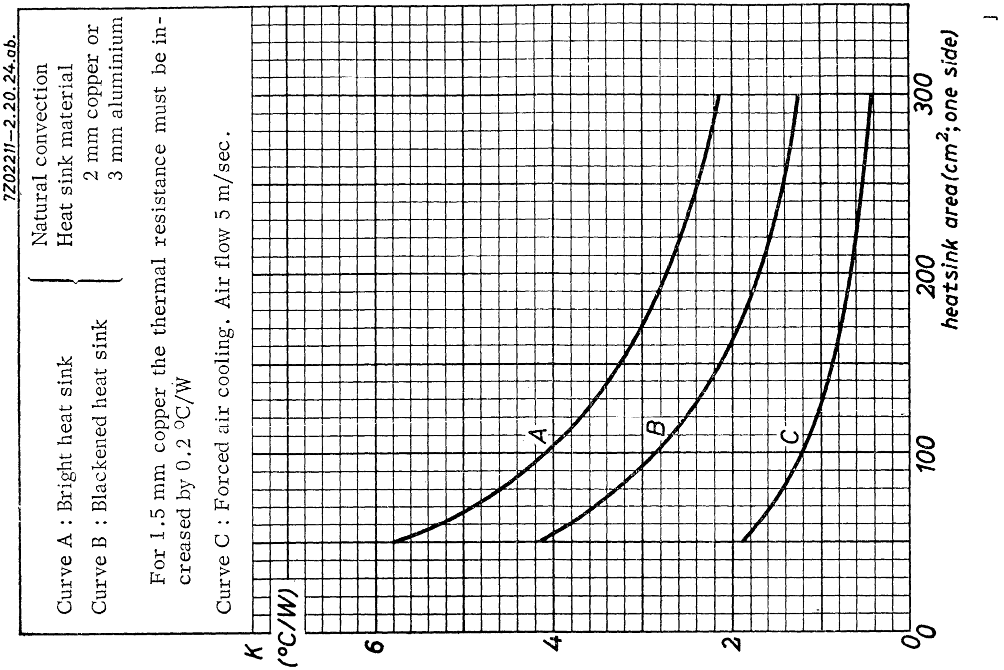
7.7.1964

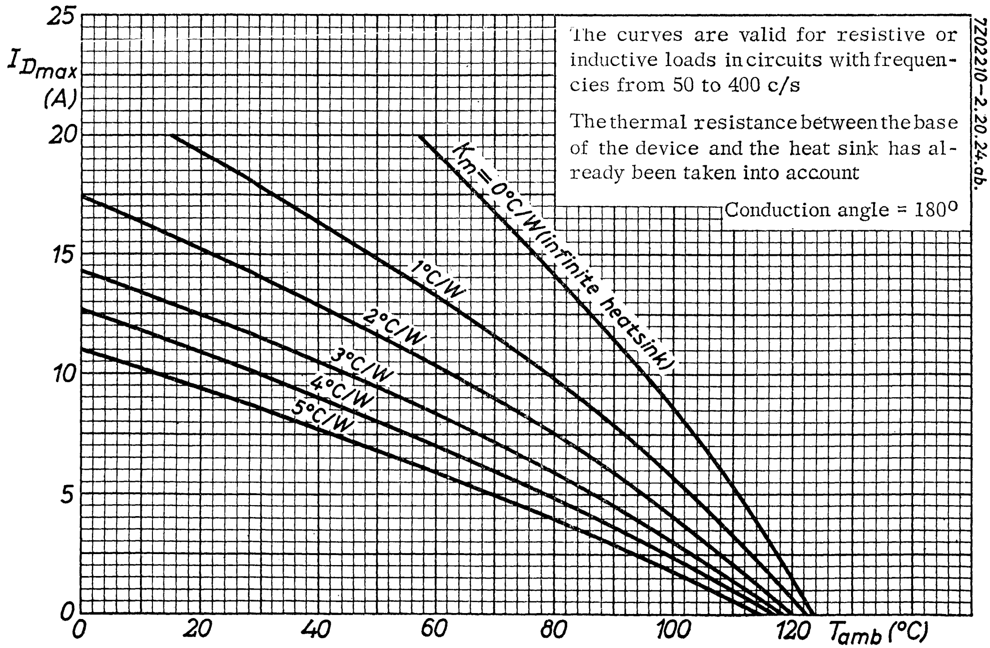

50
40
30
20
10
0
Ptot max
(W)
0
5
10
15
20
25
30
ID (A)
35
α = 30°
60°
90°
120°
180°
D.C.
conduction
angle α
Tj = 125°C
7Z02208-2.20.24.ab.

G

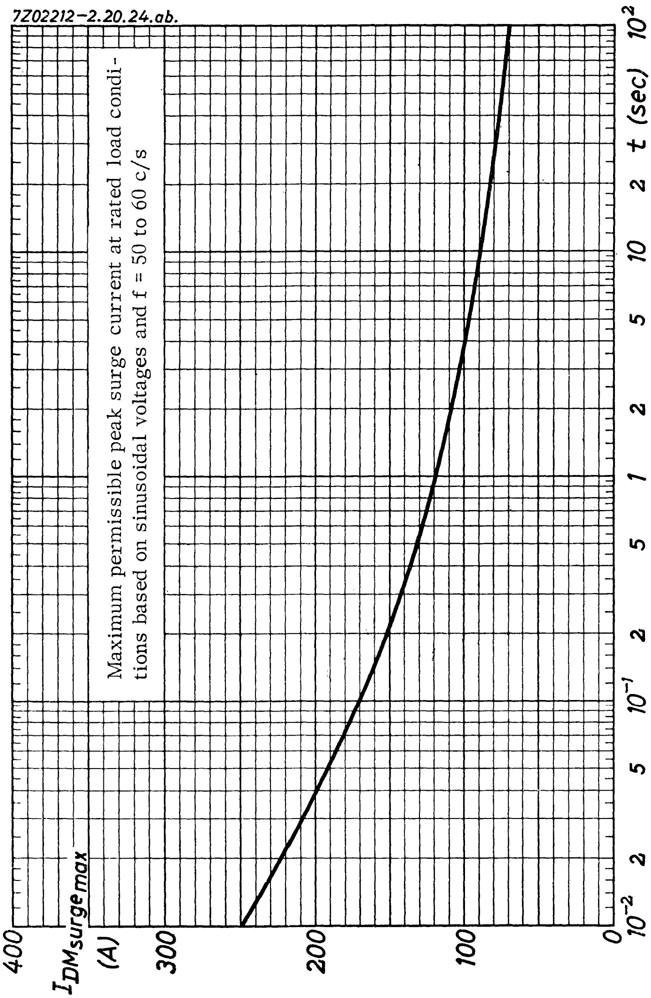

120
100
80
60
40
Tm max
(°C)
0
5
10
15
20
25
30
ID (A)
35
α = 30°
60°
90°
120°
180°
D.C.
conduction
angle α
7Z02209-2.20.24.ab.

H


7Z02211–2.20.24.ab.
Curve A : Bright heat sink
Curve B : Blackened heat sink
Natural convection
Heat sink material
2 mm copper or
3 mm aluminium
For 1.5 mm copper the thermal resistance must be increased by 0.2 °C/W
Curve C : Forced air cooling. Air flow 5 m/sec.
A
B
C
K
(°C/W)
6
4
2
0
0
100
200
300
heatsink area(cm²; one side)


I_{Dmax}
(A)
25
20
15
10
5
0
0
20
40
60
80
100
120
T_{amb} (°C)
The curves are valid for resistive or inductive loads in circuits with frequencies from 50 to 400 c/s
The thermal resistance between the base of the device and the heat sink has already been taken into account
Conduction angle = 180°
Km=0°C/W(infinite heatsink)
1°C/W
2°C/W
3°C/W
4°C/W
5°C/W
7Z02210–2.20.24.ab.

7.7.1964


7Z02212-2.20.24.ab.
Maximum permissible peak surge current at rated load conditions based on sinusoidal voltages and f = 50 to 60 c/s
$I_{DMsurge\,max}$
(A)
400
300
200
100
0
t (sec)
10^{-2}
2
5
10^{-1}
2
5
1
2
5
10
2
10^{2}

7.7.1964

K

P-GATE SILICON CONTROLLED RECTIFIERS
30 AMP. SERIES

P-gate all diffused silicon controlled rectifiers in a metal case for power control and power switching applications.
The series consists of types BTX13-100R, -200R, -300R, -400R, -500R and -600R

QUICK REFERENCE DATA

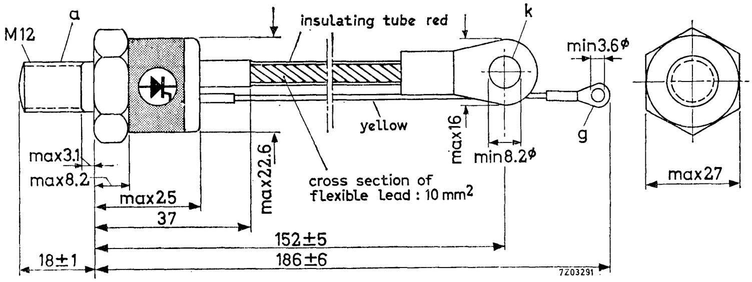
		BTX13-					
Voltages		100R	200R	300R	400R	500R	600R
Repetitive peak inverse voltage	$-V_{DM}$ max.	400	400	500	500	600	600 V
Repetitive peak forward blocking voltage	V_{DM} max.	100	200	300	400	500	600 V

Currents			
Average forward current	I_D	= max.	30 A
Repetitive peak forward current	I_{DM}	= max.	250 A
Sinusoidal peak forward surge current (10 msec)	$I_{DMsurge}$	= max.	300 A
Junction temperature	T_j	=	−55 °C to +125 °C
Thermal resistance			
from junction to base of device	K	<	0.90 °C/W

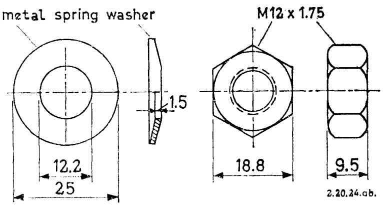
7Z2 2694

MECHANICAL DATA

Dimensions in mm



Except for the metrical thread the outline conforms to TO-49



Mounting accessories

Diameter of hole in heatsink : max. 13 mm

Mounting torque : max. 200 cm kg
min. 100 cm kg (for good heat conductance)

Net weight : 95 g

Weight with accessories : 115 g

7Z2 3291

LIMITING VALUES (Absolute max. values) $f < 400$ c/s

Anode to cathode		BTX13-100R	200R	300R	400R	500R	600R
Crest working inverse voltage	$-V_{DMW}$ max.	100	200	300	400	500	600 V [2]
Repetitive peak inverse voltage [1]	$-V_{DM}$ max.	400	400	500	500	600	600 V [2]
Non-repetitive peak inverse voltage ($t < 10$ msec)	$-V_{DM}$ surge max.	400	400	500	500	700	700 V [2]
Crest working blocking voltage	V_{DMW} max.	100	200	300	400	500	600 V [3]
Repetitive peak forward blocking voltage [1]	V_{DM} max.	100	200	300	400	500	600 V [3]
Non-repetitive peak forward blocking voltage	V_{DM} surge max.	500	500	500	500	700	700 V [4]

Average forward current (averaged over any 20 msec period)	I_D	= max. 30 A
R.M.S. forward current	I_D	= max. 48 A R.M.S.
Repetitive peak forward current	I_{DM}	= max. 250 A
Surge current		See curve at page 11

[1]) e.g. commutation effects

[2]) These ratings apply for a gate voltage range of −5 V to +0.25 V and for a total thermal resistance between junction and ambient < 13 °C/W.

[3]) With $R_{max.}$ = 100 Ω between gate and cathode for BTX13-500R and -600R.

[4]) This voltage may be applied without damage but the controlled rectifier may switch into the on-state. When this happens the current that can flow should not exceed the rated forward current.

7Z2 2695

LIMITING VALUES (Absolute max. values) (continued)

Anode to cathode (continued)

Repetitive peak reverse current during turn-off	$-I_{DM}$	= max.	20 A
Rate of rise during turn-on	dI/dt	= max.	5 A/µsec
I squared t (for fusing)	I^2t [1]	= max.	300 A^2sec

Gate to cathode

Peak power dissipation	P_{GM}	= max.	5 W
Average power dissipation	P_G	= max.	0.5 W
Peak forward voltage	V_{GM}	= max.	10 V
Peak inverse voltage	$-V_{GM}$	= max.	5 V
Peak current	I_{GM}	= max.	2 A

Temperatures

Storage temperature	T_s	= -55 °C to 125 °C
Junction temperature	T_j	= -55 °C to 125 °C

THERMAL DATA

Thermal resistance between

junction and base of device	K	<	0.90 °C/W
base of device and heatsink	K	=	0.15 °C/W

[1]) R.M.S. value of I

7Z2 2696

CHARACTERISTICS at T_j = 125 °C unless otherwise specified
f ≦ 400 c/s

Anode to cathode,		BTX13-100R	200R	300R	400R	500R	600R
Forward break-over voltage	$V_{D\,b.o.}$	>100	>200	>300	>400	>500	>600V
Forward leakage current at $V_{DMmax.}$	I_D	< 8	< 8	< 5	< 5	<5[1]	<5[1] mA
Reverse leakage current at $-V_{DMmax.}$	$-I_D$	< 8	< 8	< 5	< 5	< 5	< 5 mA

Forward voltage at I_D = 250 A	V_D	<	3.5 V [2]
Holding current	I_{DH}	=	40 mA
Rate of rise of forward blocking voltage	dV/dt	<	20 V/μsec

Gate to cathode (See also page B and C)

Voltage to fire all units (T_j = 25 °C)	V_G	>	3 V
Voltage not to fire any unit	V_G	<	0.25 V
Current to fire all units (T_j = 25 °C)	I_G	>	50 mA

Switching characteristics (See also page E)

Turn-on time ($t_d + t_r$)	t_{on}	=	4 μsec
Delay time	t_d	=	1.3 μsec
Rise time	t_r	=	2.7 μsec
Turn-off time (T_j = 25 °C)	t_{off}	=	6 μsec

---

1) With R = 100 Ω between gate and cathode.

2) Measured with current pulses to prevent excessive dissipation.

7Z2 2697

OPERATING NOTES

1. When there is a possibility that transient voltage surges will cause an inverse voltage, higher than the maximum permissible non-repetitive peak inverse voltage, or a forward voltage higher than the maximum permissible repetitive peak forward blocking voltage, a damping circuit across the transformer should be applied e.g. a series RC damping circuit. Dimensioning of the RC damping circuit may be done according to the following formulae:

$C_1 = A_1 \frac{I_o}{V_1}$ (μF) and $R_1 = \frac{B_1}{C_1}$ (Ω), when applied to the primary side of the transformer.

$C_2 = A_2 \frac{I_o}{V_1} T^2$ (μF) and $R_2 = \frac{B_2}{C_2}$ (Ω), when applied to the secondary side of the transformer.

Where: $T = V_1/V_2$

V_1 = transformer primary RMS voltage (V)

V_2 = transformer secondary RMS voltage (V)

I_o = magnetizing primary RMS current (A)

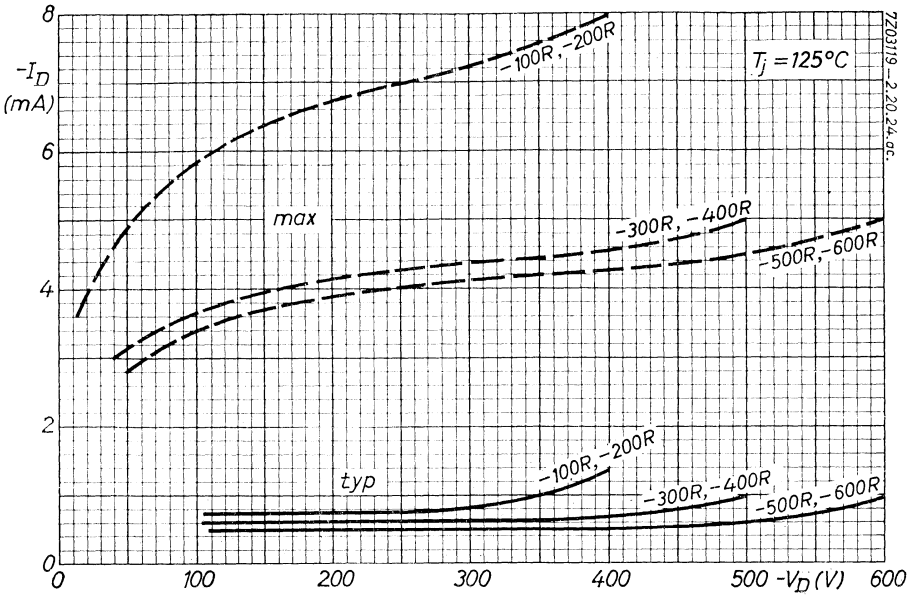
$\frac{-V_{DMsurge}}{-V_{DMW}}$ or $\frac{V_{DM}}{V_{DMW}}$ 1)	1	1.25	1.5	2
A_1	800	550	400	200
A_2	900	620	450	225
B_1	300	260	225	150
B_2	350	310	275	200

1) V_{DMW} and $-V_{DMW}$ stand for the applied crest working voltage.

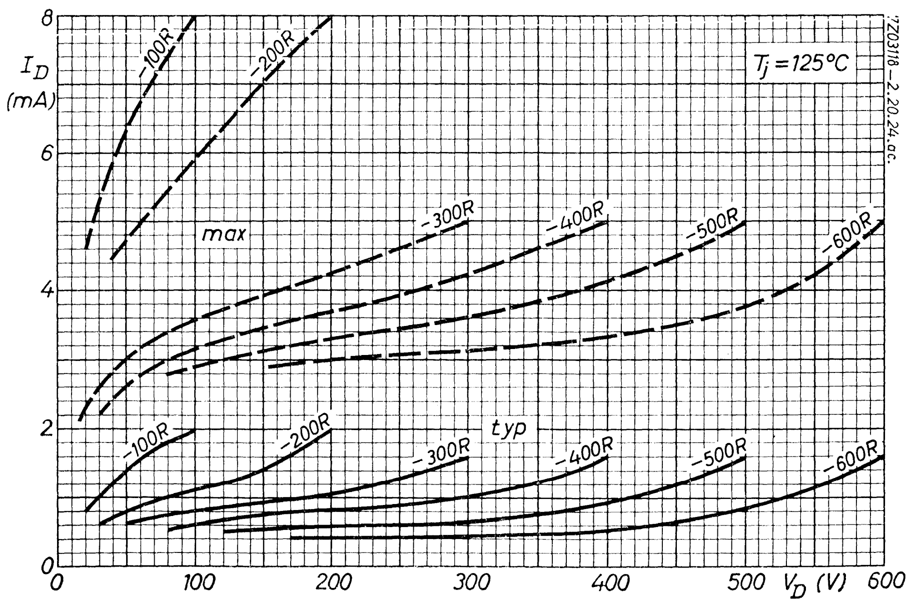
2. In order to prevent the SCR from being damaged by surge currents, higher than those indicated by the curve of page C, a fast fuse is recommended.

3. At any application of the BTX13-500R and the BTX13-600R the resistance between gate and cathode shall be max. 100 Ω.

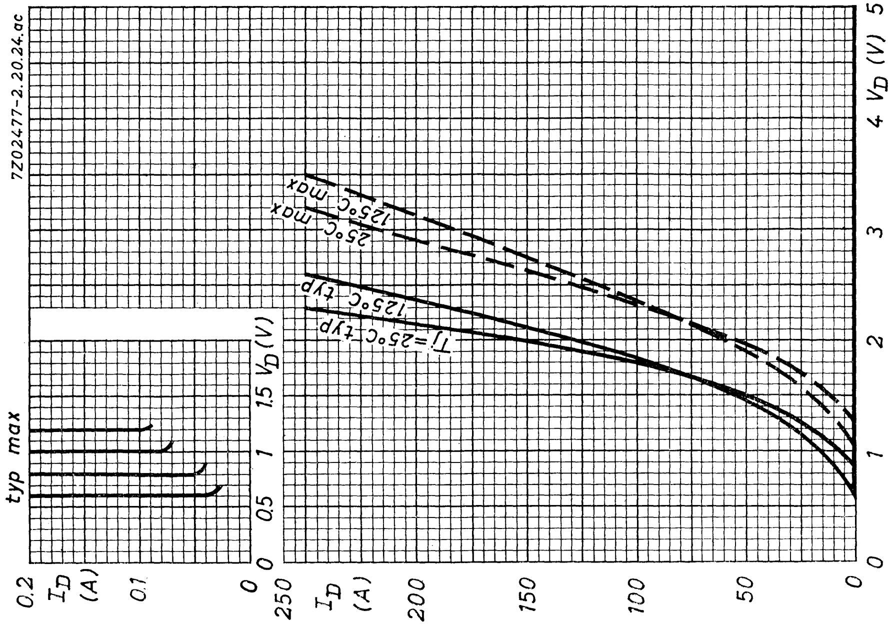
7Z2 2698

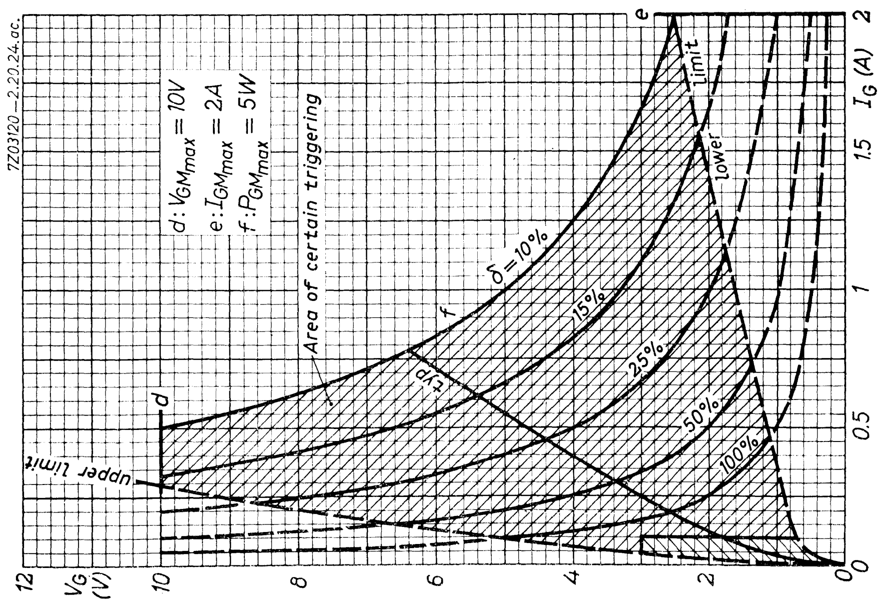


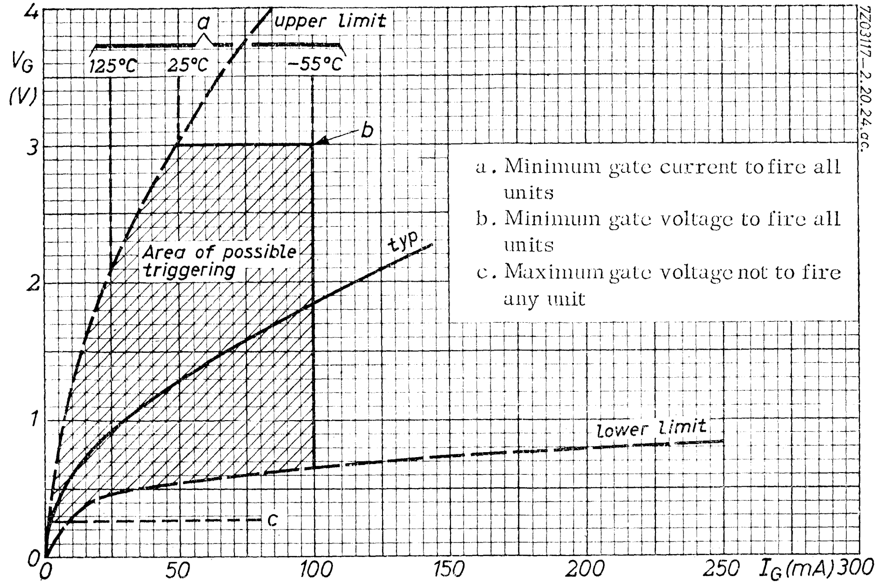
8
6
4
2
0
$-I_D$
(mA)
$T_j = 125°C$
7Z03119—2.20.24.ac.
max
−100R, −200R
−300R, −400R
−500R, −600R
typ
−100R, −200R
−300R, −400R
−500R, −600R
0
100
200
300
400
500
600
$-V_D$ (V)

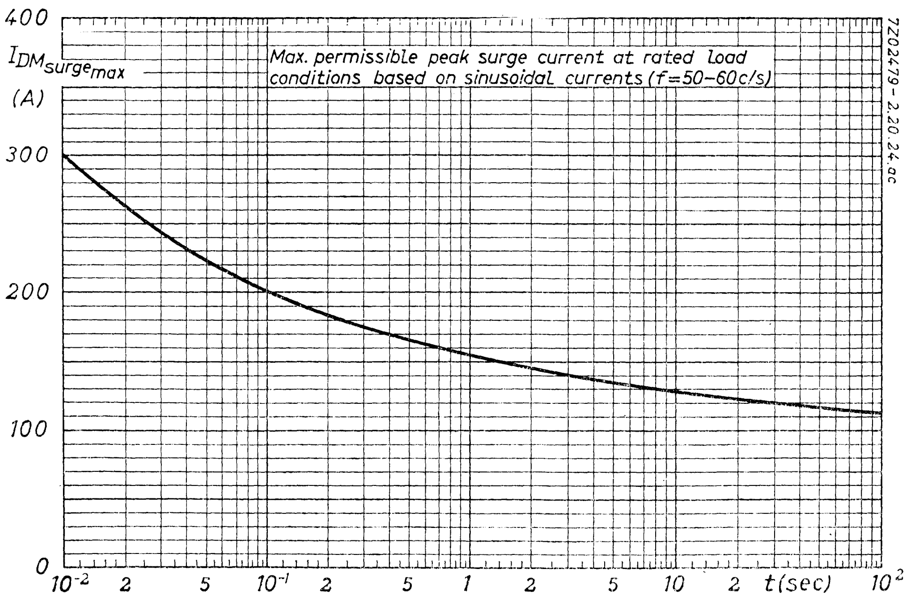


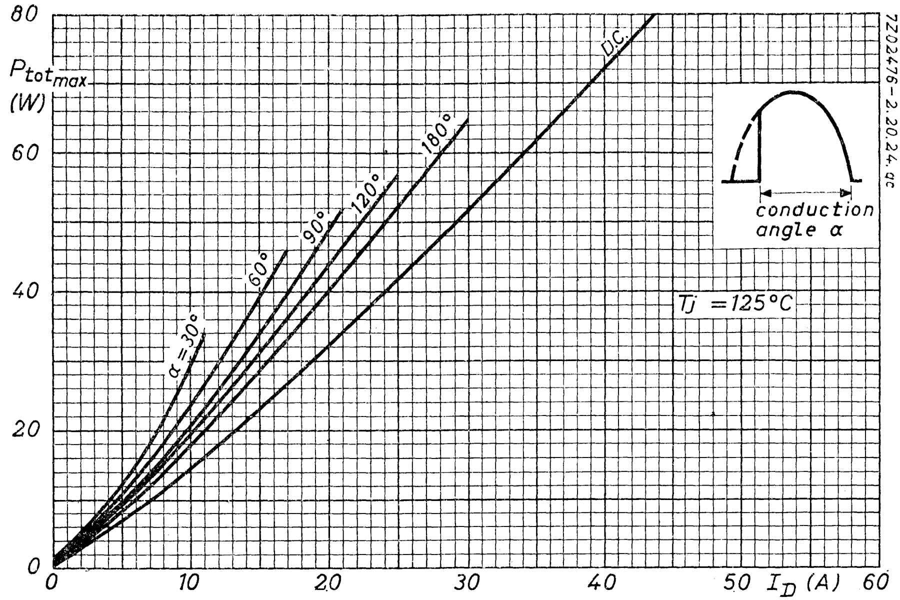
8
6
4
2
0
I_D
(mA)
$T_j = 125°C$
7Z03118—2.20.24.ac.
max
−100R
−200R
−300R
−400R
−500R
−600R
typ
−100R
−200R
−300R
−400R
−500R
−600R
0
100
200
300
400
500
600
V_D (V)

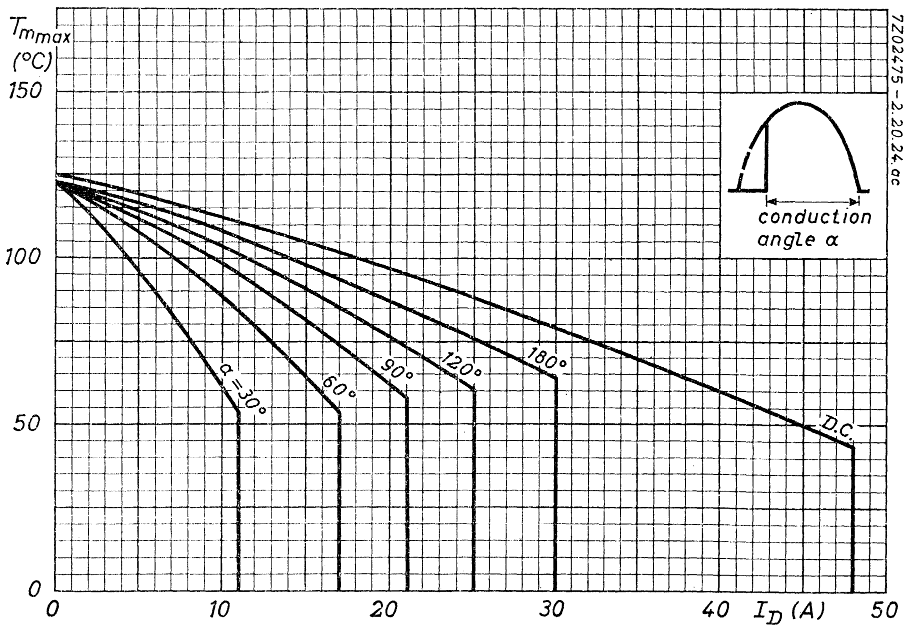

7Z02477-2.20.24.ac
typ max
T_j = 25°C typ
125°C typ
25°C max
125°C max
I_D (A)
V_D (V)

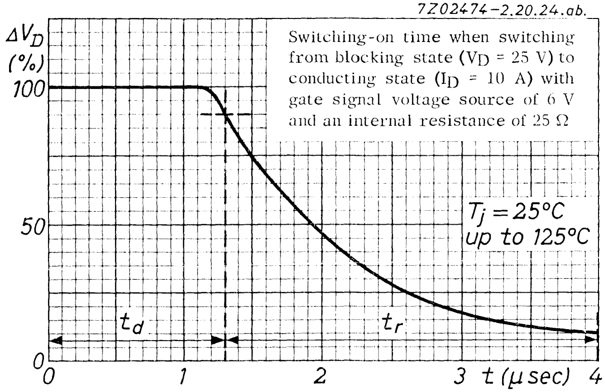

7Z03120-2.20.24.ac.
d: V_{GMmax} = 10V
e: I_{GMmax} = 2A
f: P_{GMmax} = 5W
Area of certain triggering
δ = 10%
15%
25%
50%
100%
upper limit
lower limit
typ
V_G (V)
I_G (A)


7Z03117-2.20.24.ac
V_G (V)
I_G (mA)
a
upper limit
125°C
25°C
−55°C
b
Area of possible triggering
typ
lower limit
c
a. Minimum gate current to fire all units
b. Minimum gate voltage to fire all units
c. Maximum gate voltage not to fire any unit

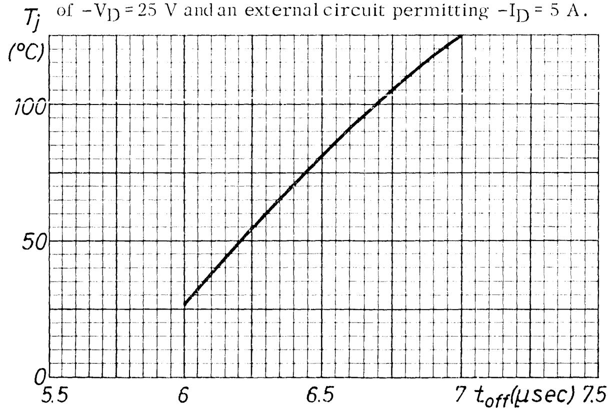

7Z02479-2.20.24.ac
$I_{DMsurge max}$ (A)
Max. permissible peak surge current at rated load conditions based on sinusoidal currents (f=50-60c/s)
t (sec)

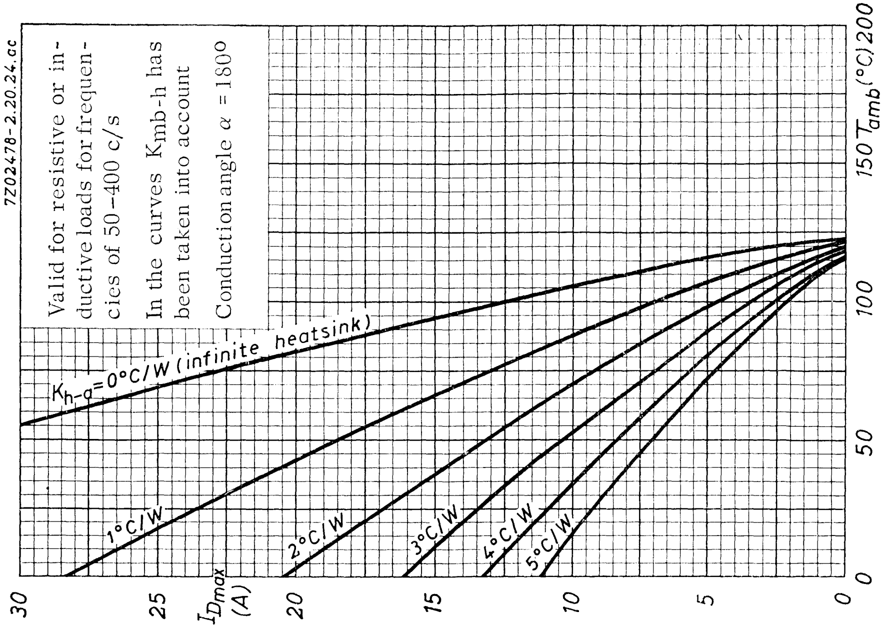

80
60
40
20
0
$P_{tot_{max}}$
(W)
0
10
20
30
40
50
60
I_D (A)
α = 30°
60°
90°
120°
180°
D.C.
conduction
angle α
Tj = 125°C
7Z02476-2.20.24.ac

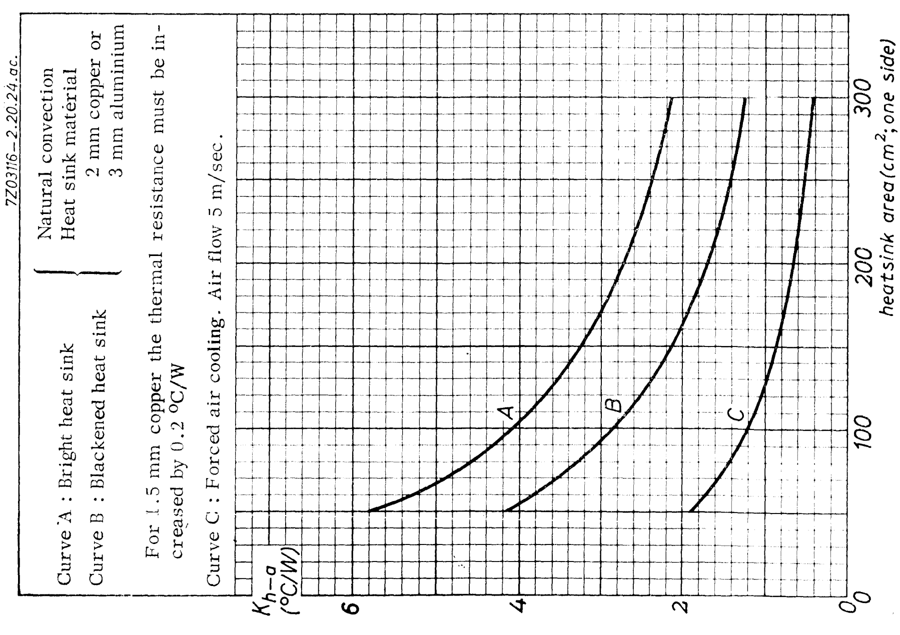

$T_{m_{max}}$
(°C)
150
100
50
0
0
10
20
30
40
50
I_D (A)
α = 30°
60°
90°
120°
180°
D.C.
conduction
angle α
7Z02475-2.20.24.ac



Switching-off time when switching from conducting state (I_D = 10 A) to blocking state (V_D = 25 V) for an anode signal of $-V_D$ = 25 V and an external circuit permitting $-I_D$ = 5 A.




7Z02478-2.20.24.ac
Valid for resistive or inductive loads for frequencies of 50-400 c/s
In the curves Kmb-h has been taken into account
Conduction angle α = 180°
K_{h-a}=0°C/W (infinite heatsink)
1°C/W
2°C/W
3°C/W
4°C/W
5°C/W
I_{Dmax} (A)
T_{amb} (°C)
0
5
10
15
20
25
30
50
100
150
200


7Z03116-2.20.24.ac.
Curve A : Bright heat sink
Curve B : Blackened heat sink
Natural convection
Heat sink material
2 mm copper or
3 mm aluminium
For 1.5 mm copper the thermal resistance must be increased by 0.2 °C/W
Curve C : Forced air cooling. Air flow 5 m/sec.
A
B
C
K_{h-a} (°C/W)
heatsink area (cm², one side)
0
2
4
6
100
200
300

P-GATE SILICON CONTROLLED RECTIFIER
4.7 AMP.

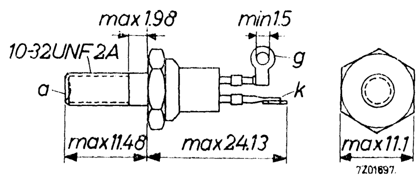
P-gate silicon controlled rectifier in a metal case for power control and power switching applications.

QUICK REFERENCE DATA				
Repetitive peak reverse voltage	$-V_{DM}$	max.	150	V
Repetitive peak forward blocking voltage	V_{DM}	max.	150	V
Average forward current	I_{DAV}	max.	4.7	A
Repetitive peak forward current	I_{DM}	max.	20	A
Junction temperature	T_j	max.	125	^oC
Thermal resistance, junction-mounting base	K	<	3.1	$^oC/W$

MECHANICAL DATA Dimensions in mm

Supplied with the device
(Code No 56212)

10 UNF nut, tag and shakeproof washer



Recommended diameter of hole in heatsink: 5.2 mm

Mounting torque for good heat conductance: min. 9 cm kg
max. 17 cm kg

Net weight 7.6 g

7Z2 3130

LIMITING VALUES (Absolute max. values) f = 50-400 c/s

Anode to cathode

Continuous reverse voltage	$-V_D$	max.	150	V
Crest working reverse voltage	$-V_{DMW}$	max.	150	V
Repetitive peak reverse voltage	$-V_{DM}$	max.	150	V
Non-repetitive peak reverse voltage ($t < 5$ ms)	$-V_{DMsurge}$	max.	225	V
Continuous forward blocking voltage at $T_{mb} < 100$ °C	V_D	max.	150	V
Repetitive peak forward blocking voltage	V_{DM}	max.	150	V
Non-repetitive peak forward voltage	$V_{DMsurge}$	max.	480	V
Average forward current at T_{mb} = 60 °C	I_{DAV}	max.	4.7	A
at T_{mb} = 85 °C	I_{DAV}	max.	3.75	A
Repetitive peak forward current	I_{DM}	max.	20	A
Surge forward current peak for one cycle at 50 c/s	$I_{DMsurge}$	max.	40	A
Repetitive peak reverse current during turn-off	$-I_{DM}$	max.	5	A

Gate to cathode

Peak forward voltage	V_{GM}	max.	10	V
Peak reverse voltage	$-V_{GM}$	max.	5	V
Peak current	I_{GM}	max.	2	A
Peak power dissipation	P_{GM}	max.	5	W
Average power dissipation (t_{av} = 20 ms)	P_G	max.	0.5	W

Temperatures

Storage temperature	T_s		-55 to +125	°C
Junction temperature	T_j	max.	125	°C

NOTES

1. A positive gate voltage > 250 mV must not be applied to the gate when V_D is positive.
2. To ensure that no device will thermally run away at max. voltage ratings, the total thermal resistance between mounting base and ambient must be less than 18 °C/W.

7Z2 3131

THERMAL DATA

Thermal resistance from junction to mounting base	K	<	3.1	°C/W
Thermal resistance from mounting base to heatsink (torque of 9 cm kg on nut)	K	=	0.6	°C/W

CHARACTERISTICS

T_j = 125 °C unless otherwise specified

Anode to cathode

Forward breakover voltage [1]	$V_{Db.o.}$	>	150	V
Forward leakage current V_{DM} = 150 V [2]	I_D	<	8	mA
Reverse leakage current at $-V_{DM}$ = 150 V [2][3]	$-I_D$	<	8	mA
Forward voltage drop at I_D = 20 A; T_j = 25 °C [2]	V_D	<	2.3	V

Gate to cathode

Voltage to fire all units at T_j = 25 °C	V_G	>	2.0	V
Voltage not to fire any unit	V_G	<	0.25	V
Current to fire all units at T_j = 25 °C	I_G	>	25	mA
Current not to fire any unit	I_G	<	0.19	mA

CHARACTERISTIC RANGE VALUES FOR EQUIPMENT DESIGN

T_j = 125 °C unless otherwise specified

Holding current	I_{DM}	typ.	15	mA
Turn-on time ($t_{on} = t_d + t_r$) I_{DM} = 10 A; I_G = 30 mA	t_{on}	typ.	5	µs
Turn-off time for I_D = 10 A (See page C)				
Rate of rise dV/dt = 25 V/µs; $-I_D$ = 4 A	t_{off}	typ.	15	µs
		<	25	µs
Rate of rise of forward voltage, not to trigger the device	dV/dt	typ.	25	V/µs

1) This voltage may be exceeded up to 480 V, but the thyristor may conduct at any voltage over the min. breakover voltage.

2) Measured under pulsed conditions to prevent excessive dissipation.

3) A positive gate voltage > 250 mV must not be applied to the gate when V_D is positive.

7Z2 3132

OPERATING NOTES

1. When there is a possibility that transient voltage surges will cause an inverse voltage, higher than the maximum permissible non-repetitive peak inverse voltage, a damping circuit across the transformer should be applied, e.g. a series RC damping circuit. Dimensioning of the RC damping circuit may be done according to the following formulae:

$\frac{-V_{DMsurge}}{-V_{DMW}}$ 1)	R-C in primary of transformer		R-C in secondary of transformer	
	C_1 (μF)	R_1C_1 (μs)	C_2 (μF)	R_2C_2 (μs)
2.0	$200 \frac{I_o}{V_1}$	150	$225 \frac{I_o}{V_1} T^2$	200
1.5	$400 \frac{I_o}{V_1}$	225	$450 \frac{I_o}{V_1} T^2$	275
1.25	$550 \frac{I_o}{V_1}$	260	$620 \frac{I_o}{V_1} T^2$	310
1.0	$800 \frac{I_o}{V_1}$	300	$900 \frac{I_o}{V_1} T^2$	350

1) $-V_{DMW}$ stands for the applied crest working voltage

Where I_o = magnetising primary r.m.s. current (A)

V_1 = transformer primary r.m.s. voltage (V)

V_2 = transformer secondary r.m.s. voltage (V)

$T = \frac{V_1}{V_2}$

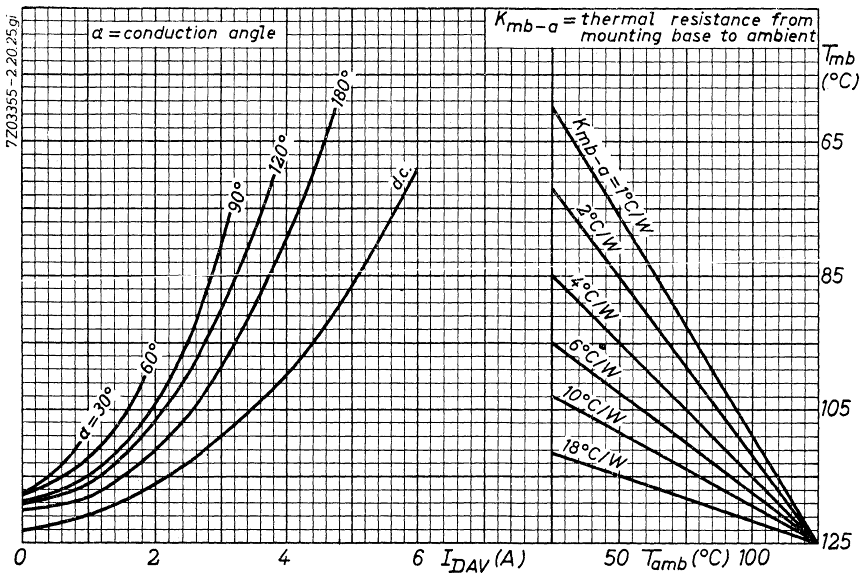
2. To ensure that all thyristors trigger, the firing circuit must provide both the minimum gate voltage and the minimum gate current to fire all units at the operating temperature. To do this, the source resistance load line on the gate characteristic must pass through, or above and to the right of, the intersection of the minimum trigger voltage and current, providing the limiting values of gate voltage, current and power are not exceeded. (See page A).

3. Thyristors 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.

OPERATING NOTES (continued)

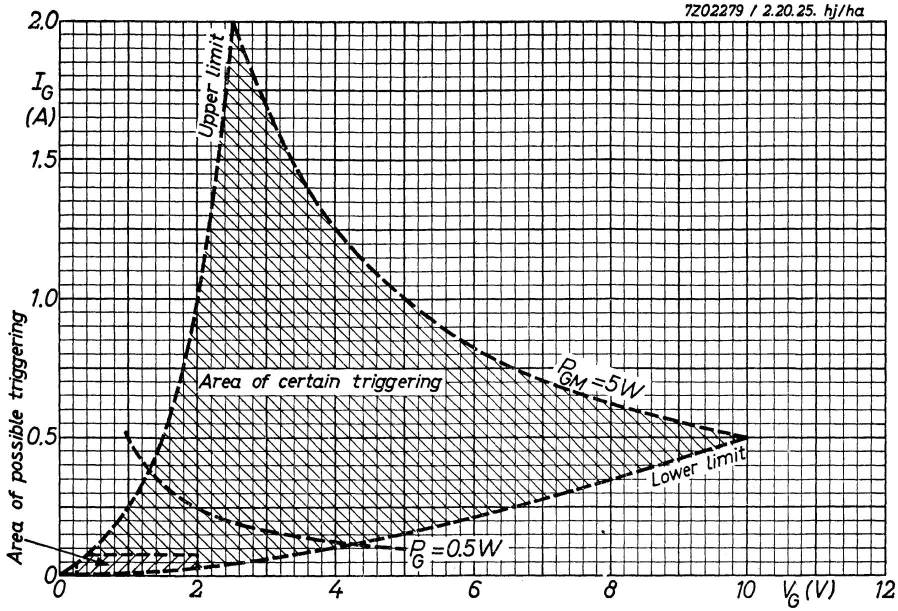
4. Dissipation and heatsink considerations

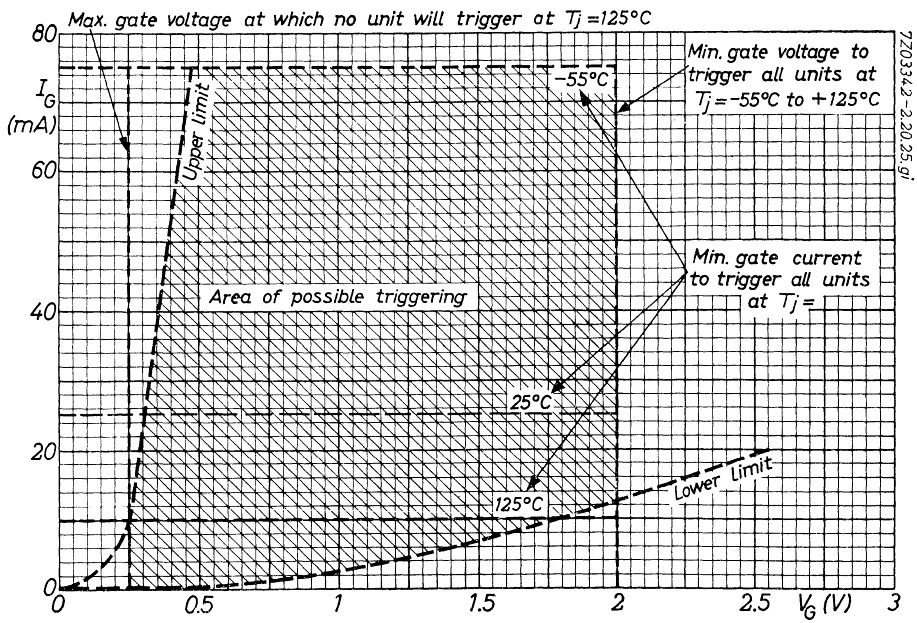
The method of using the curves of the figure below is as follows:
Starting with the left hand curve, for a particular current value trace upwards to meet the appropriate conduction angle curve. Then trace horizontally until the appropriate K-curve is reached (in the case of a given heatsink). Then trace downwards to determine the maximum permissible ambient temperature.
Alternatively, when the maximum ambient temperature is known and the heatsink required is to be determined, trace horizontally until the vertical through the given ambient temperature is reached. The K-value corresponding to the intersection is the maximum thermal resistance from mounting base to ambience. Subtracting the contact thermal resistance gives the maximum thermal resistance of the heatsink.

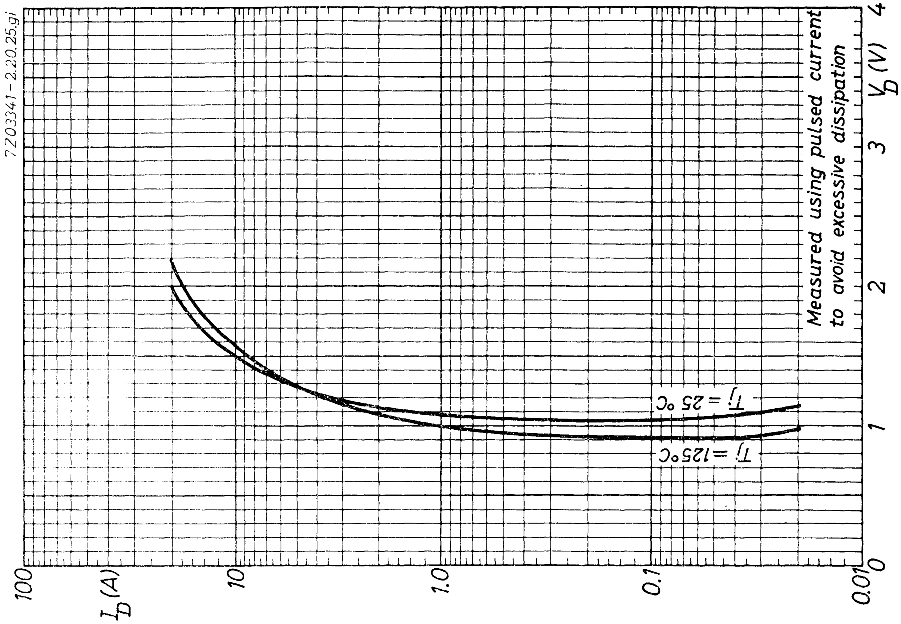


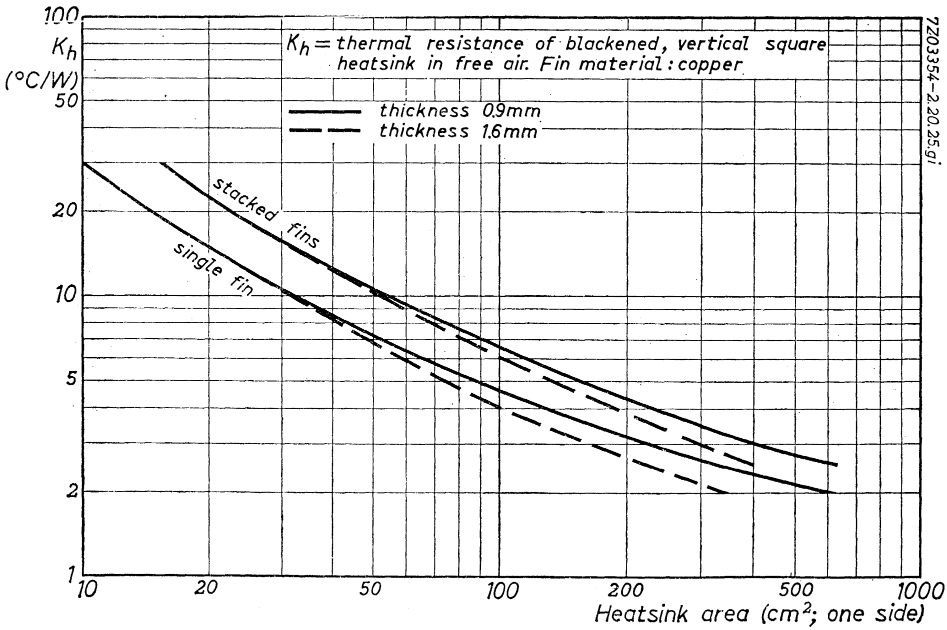
Max. permissible mounting base and ambient temperature for various values of I_{DAV} and K

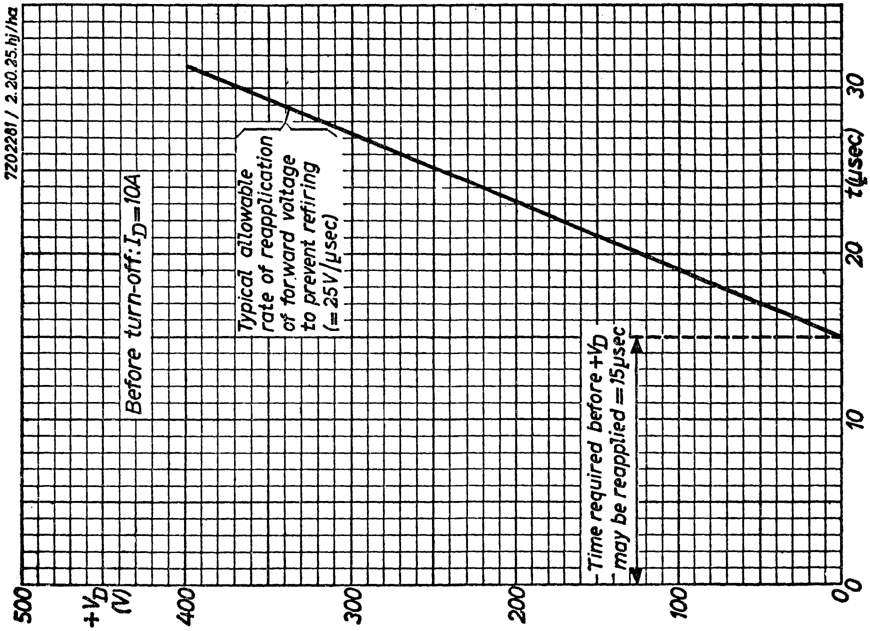
7Z2 3247

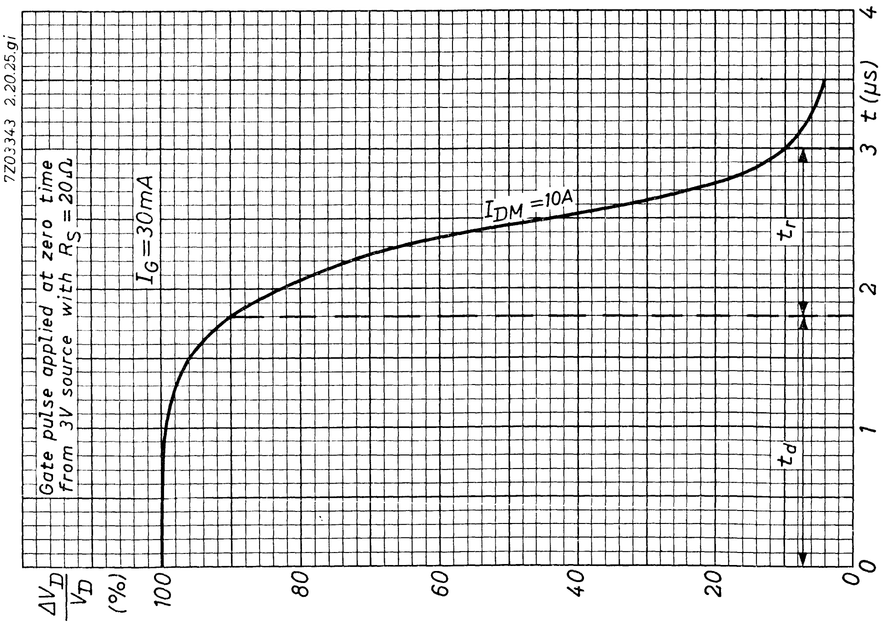

7Z02279 / 2.20.25. hj/ha
I_G (A)
Upper limit
Area of certain triggering
P_{GM} = 5W
Lower limit
P_G = 0.5W
Area of possible triggering
V_G (V)
2.0
1.5
1.0
0.5
0
0
2
4
6
8
10
12


Max. gate voltage at which no unit will trigger at Tj = 125°C
7Z03342-2.20.25.gi
I_G (mA)
Upper limit
−55°C
Min. gate voltage to trigger all units at Tj = −55°C to +125°C
Area of possible triggering
Min. gate current to trigger all units at Tj =
25°C
125°C
Lower Limit
V_G (V)
80
60
40
20
0
0
0.5
1
1.5
2
2.5
3


7Z03341-2.20.25.gi
Measured using pulsed current to avoid excessive dissipation
V_D (V)
4
3
2
1
0
T_j = 25 °C
T_j = 125 °C
100
I_D (A)
10
1.0
0.1
0.01


100
K_h
(°C/W)
50
20
10
5
2
1
K_h = thermal resistance of blackened, vertical square heatsink in free air. Fin material: copper
thickness 0.9mm
thickness 1.6mm
stacked fins
single fin
7Z03354-2.20.25.gi
10
20
50
100
200
500
1000
Heatsink area (cm²; one side)


7Z02281 / 2.20.25.hj/ha
Before turn-off: I_D=10A
Typical allowable rate of reapplication of forward voltage to prevent refiring (≈25V/μsec)
Time required before $+V_D$ may be reapplied ≈15μsec
+V_D (V)
t(μsec)
500
400
300
200
100
0
0
10
20
30


7Z03343 2.20.25.gi
Gate pulse applied at zero time from 3V source with R_S = 20Ω
I_G=30mA
I_{DM}=10A
t_r
t_d
$\frac{\Delta V_D}{V_D}$ (%)
t (μs)
100
80
60
40
20
0
0
1
2
3
4

P-GATE SILICON CONTROLLED RECTIFIERS

P-gate all diffused silicon controlled rectifiers for power control and power switching applications

QUICK REFERENCE DATA

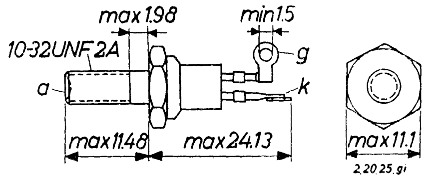
Voltages				BTY 80	BTY 81
Repetitive peak inverse voltage	$-V_{DM}$	=	max.	250 V	400 V
Repetitive peak forward blocking voltage	V_{DM}	=	max.	250 V	400 V
Currents					
Average forward current	I_D	=	max.	4.7	A
Repetitive peak forward current	I_{DM}	=	max.	20	A
Sinusoidal peak forward surge current (10 msec)	I_{Dsurge}	=	max.	40	A
Junction temperature	T_j	=		−55 °C to +104	°C
Thermal resistance from junction to base of device	K	=	max.	3.1	°C/W

7Z2 2705

MECHANICAL DATA

Minimum torque on nut for good thermal contact	8 cm kg
Maximum torque on nut	17 cm kg
Net weight	7.6 g

Dimensions in mm



LIMITING VALUES (Absolute max. values)

Anode to cathode			BTY 80	BTY 81
Crest working inverse voltage	$-V_{DMW}$	= max.	250 V	400 V [2]
Repetitive peak inverse voltage [1]	$-V_{DM}$	= max.	250 V	400 V [2]
Non-repetitive peak inverse voltage (t < 5 msec)	$-V_{Dsurge}$	= max.	350 V	500 V [2]
Crest working blocking voltage	V_{DMW}	= max.	250 V	400 V
Repetitive peak forward blocking voltage [1]	V_{DM}	= max.	250 V	400 V
Non-repetitive peak forward blocking voltage	V_{Dsurge}	= max.	480 V	480 V [3]

[1] e.g. commutation effects.

[2] A positive voltage greater than 0.25 V must not be applied to the gate when the anode is negative with respect to the cathode.

[3] This voltage may be applied without damage but the controlled rectifier may switch into the on-state. When this happens the current that can flow should not exceed the rated forward current.

7Z2 2706

LIMITING VALUES (Absolute max. values) (continued)

Anode to cathode (continued)

Average forward current (averaged over any 20 msec period)	I_D	= max.	4.7 A
R.M.S. forward current	I_{Drms}	= max.	7.4 A
Repetitive peak forward current	I_{DM}	= max.	20 A
Surge current (10 ms)	$I_{DM\,surge}$	= max.	40 A
Repetitive peak reverse current during turn-off	$-I_{DM}$	= max.	5 A

Gate to cathode

Peak power dissipation	P_{GM}	= max.	5 W
Average power dissipation	P_G	= max.	0.5 W
Peak forward voltage	V_{GM}	= max.	10 V
Peak inverse voltage	$-V_{GM}$	= max.	5 V
Peak current	I_{GM}	= max.	2 A

Temperatures

Storage temperature	T_s	= −55 °C to +104 °C
Junction temperature	T_j	= −55 °C to +104 °C

THERMAL DATA

Thermal resistance from

junction to base of device	K	= max.	3.1 °C/W
junction to free air (without heatsink)	K	= max.	70 °C/W
base of device to heatsink	K	=	0.6 °C/W

7Z2 2707

CHARACTERISTICS at T_j = 104 °C unless otherwise specified

Anode to cathode		BTY 80	BTY 81
Forward breakover voltage	$V_{Db.o.}$	> 250	> 400 V
Forward leakage current			
V_{DM} = 250 V	I_D	< 5.0 mA	-
V_{DM} = 400 V	I_D	-	< 2.0 mA
Reverse leakage current			
$-V_{DM}$ = 250 V	$-I_D$	< 5.0 mA	-
$-V_{DM}$ = 400 V	$-I_D$	-	< 2.0 mA
Forward voltage at I_D = 20 A, T_{mb} = 25 °C	V_D	< 2.3 V [1]	
Holding current	I_{DH}	= 15 mA	
Gate to cathode			
Voltage to fire all units (T_{mb} = 25 °C)	V_G	> 2.0 V [2]	
Voltage not to fire any unit (T_{mb} = 100 °C)	V_G	< 0.25 V	
Current to fire all units (T_{mb} = 25 °C)	I_G	> 25 mA [2]	
Current not to fire any unit (T_{mb} = 100 °C)	I_G	< 0.19 mA	

SWITCHING CHARACTERISTICS (See also page C)

Turn-on time ($t_d + t_r$)	t_{on}	=	3.0 μsec
Delay time	t_d	=	1.8 μsec
Rise time	t_r	=	1.2 μsec
Turn-off time	t_{off}	=	15 μsec

[1]) Measured with current pulses to prevent excessive dissipation
[2]) See also page A

7Z2 2708

OPERATING NOTES

1. Controlled rectifiers 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.

2. The connecting lugs should not be bent or twisted.

3. To ensure thermal stability the thermal resistance between nut and ambience should be smaller than 18 $^oC/W$.

4. When there is a possibility that transient voltage surges will cause an inverse voltage, higher than the maximum permissible non-repetitive peak inverse voltage, a damping circuit across the transformer or across the SCR should be applied e.g. a series RC damping circuit or a voltage dependent resistor. Dimensioning of the RC damping circuit may be done according to the following formulae:

$$C_1 = 200 \frac{I_o}{V} \ (\mu F) \text{ and } R_1 = \frac{150}{C_1} \ (\Omega)$$

when applied to the primary side of the transformer

$$C_2 = 450 \frac{I_o V}{(-V_{DM})^2} \ (\mu F) \text{ and } R_2 = \frac{200}{C_2} \ (\Omega)$$

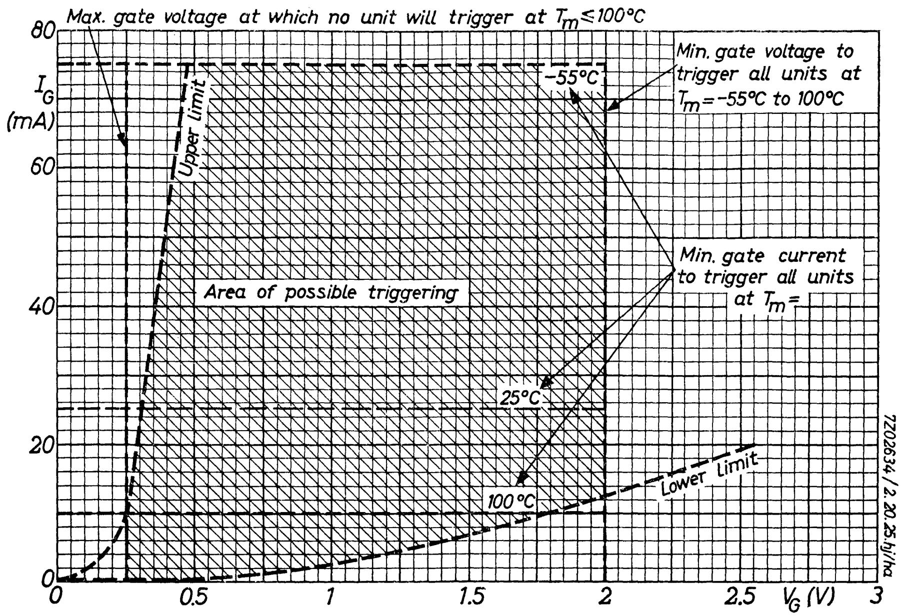
when applied to the secondary side of the transformer

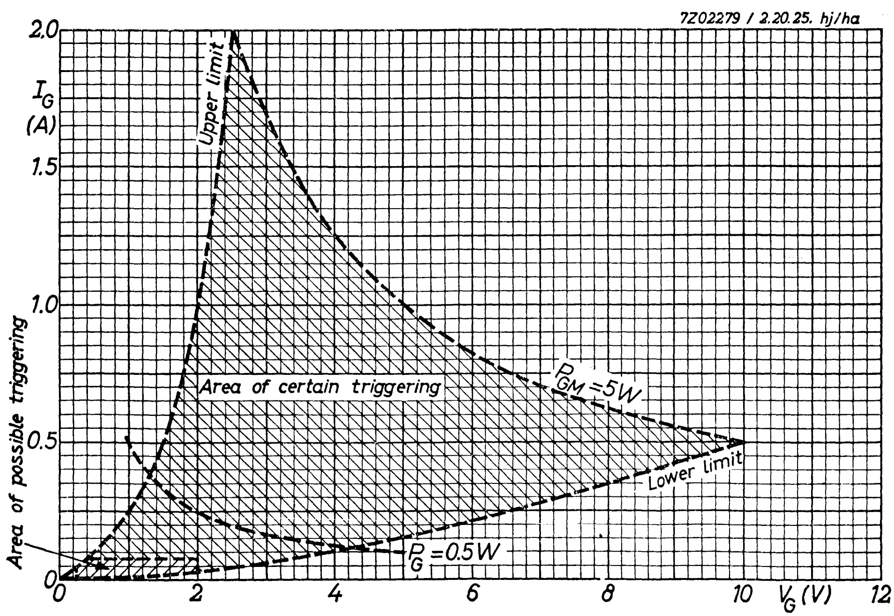
where V = transformer primary RMS voltage (V)

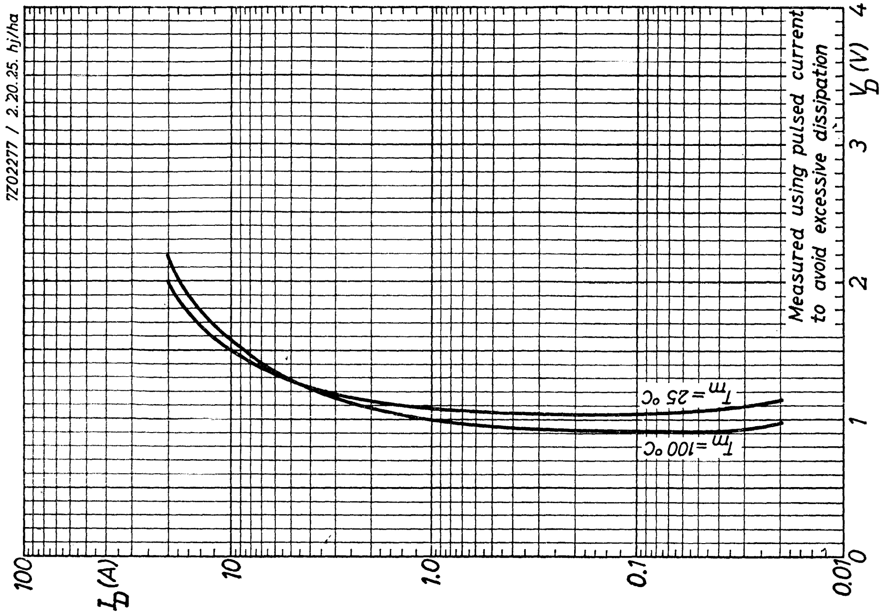
I_o = magnetizing primary RMS current (A)

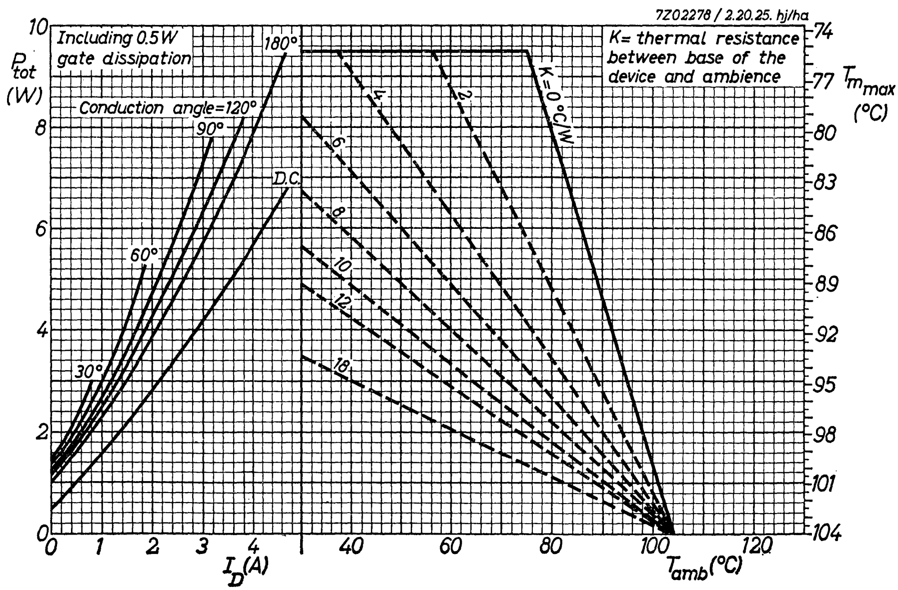
$-V_{DM}$ = repetitive peak inverse voltage (V)

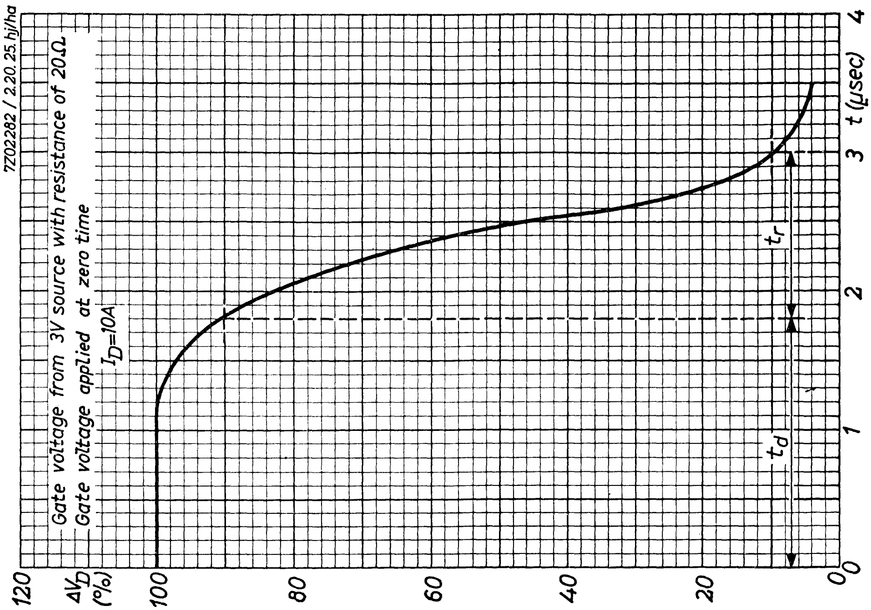
7Z2 2709

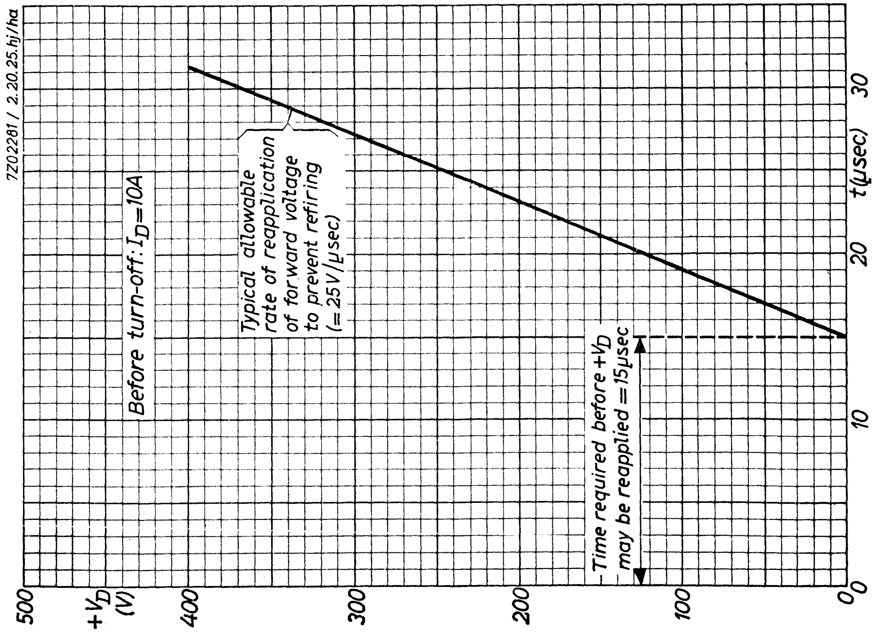

Max. gate voltage at which no unit will trigger at $T_m \leq 100°C$
80
I_G
(mA)
60
40
20
0
Upper limit
Area of possible triggering
−55°C
Min. gate voltage to trigger all units at T_m=−55°C to 100°C
Min. gate current to trigger all units at T_m=
25°C
100°C
Lower limit
0
0.5
1
1.5
2
2.5
V_G (V)
3
7Z02634 / 2.20.25.hj/ha


7Z02279 / 2.20.25. hj/ha
2.0
I_G
(A)
1.5
1.0
0.5
0
Upper limit
Area of certain triggering
P_{GM}=5W
Lower limit
P_G=0.5W
Area of possible triggering
0
2
4
6
8
10
V_G (V)
12


7Z02277 / 2.20.25. hj/ha
Measured using pulsed current to avoid excessive dissipation
V_D (V)
T_m = 25 °C
T_m = 100 °C
I_D (A)
100
10
1.0
0.1
0.01
0
1
2
3
4


7Z02278 / 2.20.25. hj/ha
Including 0.5 W gate dissipation
P_{tot} (W)
Conduction angle=120°
180°
90°
60°
30°
D.C.
K= thermal resistance between base of the device and ambience
K=0 °C/W
2
4
6
8
10
12
18
$T_{m_{max}}$ (°C)
74
77
80
83
86
89
92
95
98
101
104
I_D (A)
T_{amb} (°C)
0
1
2
3
4
40
60
80
100
120


7Z02282 / 2.20.25.hj/ha
Gate voltage from 3V source with resistance of 20Ω
Gate voltage applied at zero time
I_D=10A
120
ΔV_D (%)
100
80
60
40
20
0
0
1
2
3
4
t (μsec)
t_d
t_r


7Z02281 / 2.20.25.hj/ha
Before turn-off: I_D=10A
Typical allowable rate of reapplication of forward voltage to prevent refiring (≈ 25V/μsec)
Time required before $+V_D$ may be reapplied ≈ 15μsec
500
$+V_D$ (V)
400
300
200
100
0
0
10
20
30
t(μsec)

P-GATE SILICON CONTROLLED RECTIFIERS
12 AMP. SERIES

P-gate silicon controlled rectifiers in a metal case for power control and power switching applications.
The series consists of types BTY87-100R, -200R, -300R, -400R, -500R, -600R and -700R

QUICK REFERENCE DATA

		BTY87-						
Voltages		100R	200R	300R	400R	500R	600R	700R
Repetitive peak inverse voltage	$-V_{DM}$ max.	100	200	300	400	500	600	700 V
Repetitive peak forward blocking voltage	V_{DM} max.	100	200	300	400	500	600	700 V

Currents

Average forward current	I_D	= max.	12 A
Repetitive peak forward current	I_{DM}	= max.	115 A
Junction temperature	T_j	=	−55 °C to +125 °C
Thermal resistance			
from junction to base of device	K	<	2 °C/W

7Z2 2710

LIMITING VALUES (Absolute max. values)

Anode to cathode		BTY87-100R	BTY87-200R	BTY87-300R	BTY87-400R	BTY87-500R	BTY87-600R	BTY87-700R
Crest working inverse voltage	$-V_{DMW}$ max.[1])	100	200	300	400	500	600	700 V
Repetitive peak inverse voltage	$-V_{DM}$ max.[1])	100	200	300	400	500	600	700 V
Non-repetitive peak inverse voltage ($t < 5$ msec)	$-V_{DM}$ surge max.[1])	150	300	400	500	600	720	850 V
Crest working forward blocking voltage	V_{DMW} max.[1])	100	200	300	400	500	600	700 V
Non-repetitive peak forward voltage	V_{DM} surge max.	500	500	500	500	850	850	850 V

D.C. forward current	I_D	= max.	15 A
Average forward current (See page 7)	I_D	= max.	12 A
Repetitive peak forward current	I_{DM}	= max.	115 A
Surge forward current peak for one cycle at 50 c/s (See page A)	$I_{DMsurge}$	= max.	106 A

1) These ratings do not apply when the gate is positive with respect to cathode. To ensure that no device will thermally run away at maximum voltage ratings, the total thermal resistance between junction and ambient must be less than 11 °C/W.

7Z2 2711

LIMITING VALUES (Absolute max. values) (continued)

Anode to cathode (continued)

Repetitive peak reverse current during turn-off	$-I_{DM}$	=	max.	20 A
I squared t (1.5 -10 msec for fusing)	I^2t [1]	=	max.	55 A^2sec

Gate to cathode

Peak forward voltage	V_{GM}	=	max.	10 V
Peak inverse voltage	$-V_{GM}$	=	max.	5 V
Peak current	I_{GM}	=	max.	2 A
Peak power dissipation	P_{GM}	=	max.	5 W
Average power dissipation	P_G	=	max.	0.5 W

Temperatures

Storage temperature	T_S	=	-55 °C to 125 °C
Junction temperature	T_j	=	-55 °C to 125 °C

THERMAL DATA

Thermal resistance between

junction and base of device	K	<	2.0 °C/W
base of device and heatsink (torque of 17 cm.kg on nut)	K	=	0.2 °C/W
base of device and heatsink with mica washer	K	=	4.0 °C/W

[1]) R.M.S. value of I (See also page B)

7Z2 2712

CHARACTERISTICS at T_j = 125 °C unless otherwise specified

Anode to cathode

		BTY87-100R	200R	300R	400R	500R	600R	700R
Forward break-over voltage	$V_{D b.o.}$ min.[1]	100	200	300	400	500	600	700 V
Forward leakage current at $V_{DMmax.}$	I_D max.	13	12	10	8	6	5	4.5 mA
Reverse leakage current at $-V_{DMmax.}$	$-I_D$ max.[2]	13	12	10	8	6	5	4.5 mA

Forward voltage drop at I_D = 50 A (T_j = 25 °C) V_D < 3.0 V

Gate to catnode

Voltage to fire all units (T_j = 25 °C) V_G > 3.5 V

Voltage not to fire any unit V_G < 0.3 V

Current to fire all units (T_j = 25 °C) I_G > 65 mA

CHARACTERISTIC RANGE VALUES FOR EQUIPMENT DESIGN

T_j = 125 °C unless otherwise specified

Holding current I_{DH} = 10 mA

Turn-on time ($t_{on} = t_d + t_r$. See page C)

Before triggering $+V_D$ = 50 V, I_D = 1 A t_{on} = 2.5 μs
I_D = 10 A t_{on} = 3.0 μs
I_D = 50 A t_{on} = 4.4 μs

Before triggering $+V_D$ = 400 V, I_D = 1 A t_{on} = 1.0 μs
I_D = 10 A t_{on} = 1.5 μs
I_D = 50 A t_{on} = 2.0 μs

---

[1]) This voltage may be exceeded up to $V_{DM surge max.}$, but the device may conduct at any voltage over $V_{D b.o.}$ min.

[2]) These limits do not apply when the gate is positive with respect to cathode.

7Z2 2713

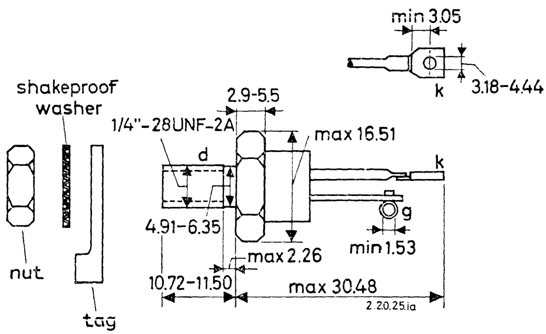
CHARACTERISTIC RANGE VALUES FOR EQUIPMENT DESIGN

(continued) T_j = 125 °C unless otherwise specified

Turn-off time for I_D = 10 A (See page D) Rate of rise dV/dt = 20 V/μs $-I_D$ = 5 A to 20 A	t_{off}	=	15 μs
Rate of rise of forward voltage not to trigger the device	dV/dt		100 V/μs

MECHANICAL DATA

Dimensions in mm



Recommended diameter of hole in heatsink	:		6.5	mm
Mounting torque for good heat conductance	:	min.	17	cmkg
	:	max.	35	cmkg
Net weight	:		10	g
Weight with accessories	:		15	g

Supplied with the device : 1/4 in UNF nut
Shakeproof washer
Tag

Supplied on request (Code No.56264) : Insulating bush
Mica washer

7Z2 2714

OPERATING NOTES

1. When there is a possibility that transient voltage surges will cause an inverse voltage, higher than the maximum permissible non-repetitive peak inverse voltage, a damping circuit across the transformer should be applied, e.g. a series RC damping circuit. Dimensioning of the RC damping circuit may be done according to the following formulae:

$\frac{-V_{DMsurge}}{-V_{DMW}}$ 1)	R-C in primary of transformer		R-C in secondary of transformer	
	C_1 (μF)	R_1C_1 (μs)	C_2 (μF)	R_2C_2 (μs)
2.0	$200 \frac{I_o}{V_1}$	150	$225 \frac{I_o}{V_1} T^2$	200
1.5	$400 \frac{I_o}{V_1}$	225	$450 \frac{I_o}{V_1} T^2$	275
1.25	$550 \frac{I_o}{V_1}$	260	$620 \frac{I_o}{V_1} T^2$	310
1.0	$800 \frac{I_o}{V_1}$	300	$900 \frac{I_o}{V_1} T^2$	350

1) $-V_{DMW}$ stands for the applied crest working voltage

Where I_o = magnetising primary r.m.s. current (A)

V_1 = transformer primary r.m.s. voltage (V)

V_2 = transformer secondary r.m.s. voltage (V)

$$T = \frac{V_1}{V_2}$$

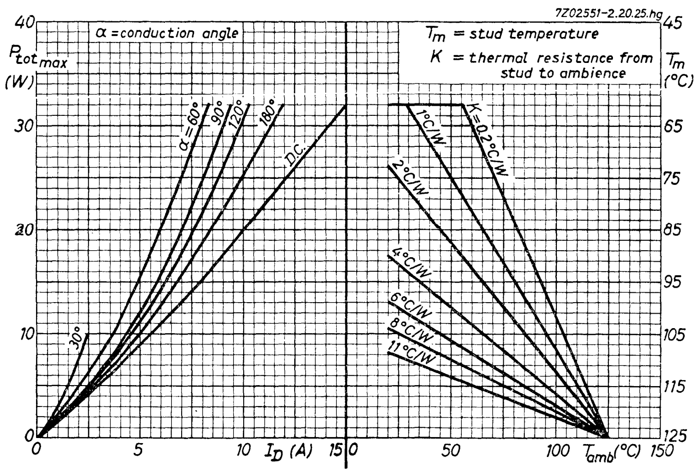
2. To ensure that all thyristors trigger, the firing circuit must provide both the minimum gate-voltage and the minimum gate-current to fire all units at the operating temperature. To do this, the source resistance load line on the gate characteristic must pass through, or above and to the right of, the intersection of the minimum trigger voltage and current, providing the limiting values of gate voltage, current and power are not exceeded. (See page A)

7Z2 2715

OPERATING NOTES (continued)

3. Dissipation and heatsink considerations

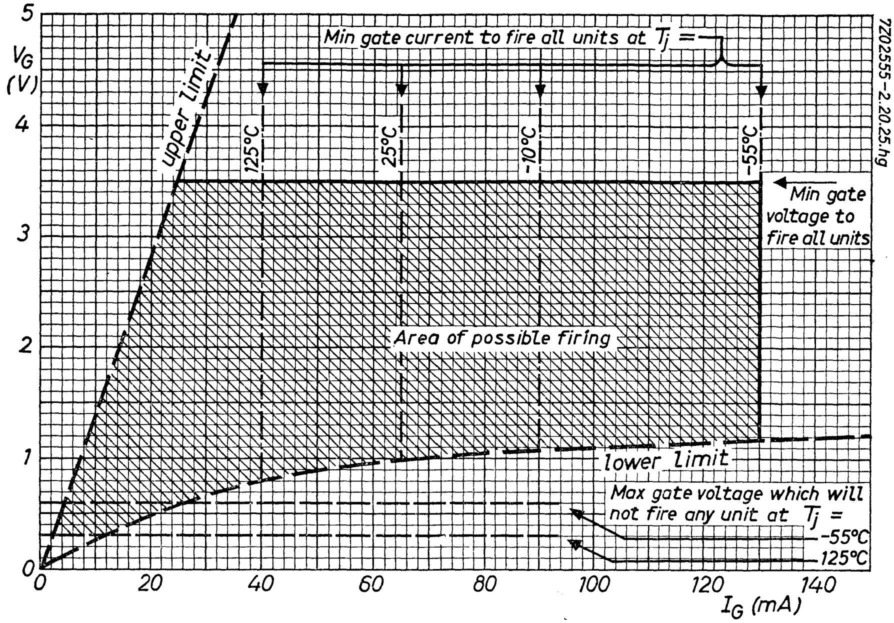
The method of using the curves of the figure below is as follows: Starting with the curve of maximum dissipation as a function of average forward current, for a particular current value trace upwards to meet the appropriate conduction angle curve. Then trace horizontally until the appropriate K-curve is reached (in the case of a given heatsink). Then trace downwards to determine the maximum permissible ambient temperature.
Alternatively, when the maximum ambient temperature is known and the heatsink required is to be determined, trace horizontally until the vertical through the given ambient temperature is reached. The K-value corresponding to the intersection is the maximum thermal resistance from mounting base to ambience. Subtracting the contact thermal resistance gives the maximum thermal resistance of the heatsink, the size of which can then be found from page C.



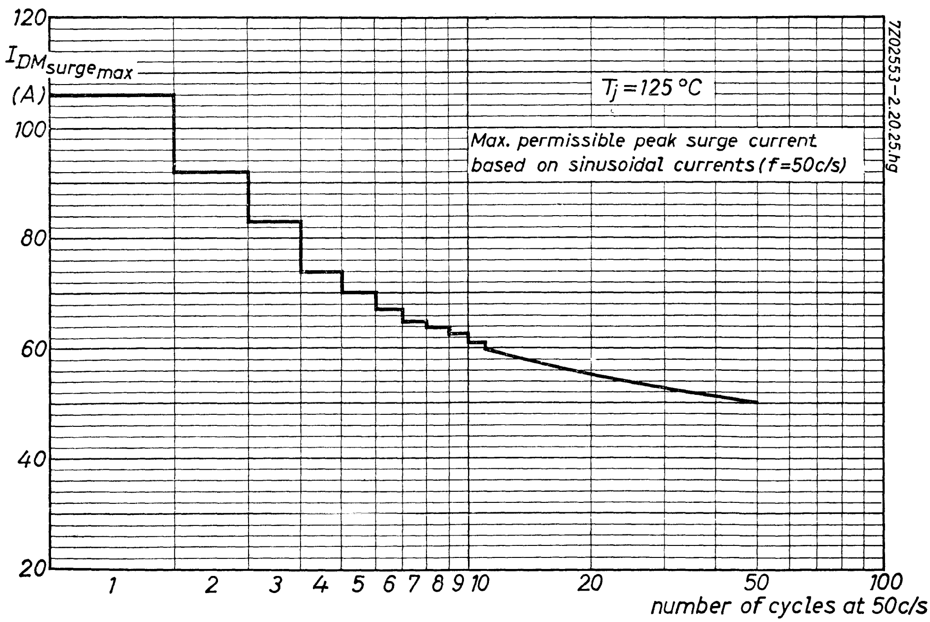
Dissipation as a function of average current and corresponding max. permissible ambient temperature for various values of K

4. Thyristors 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.

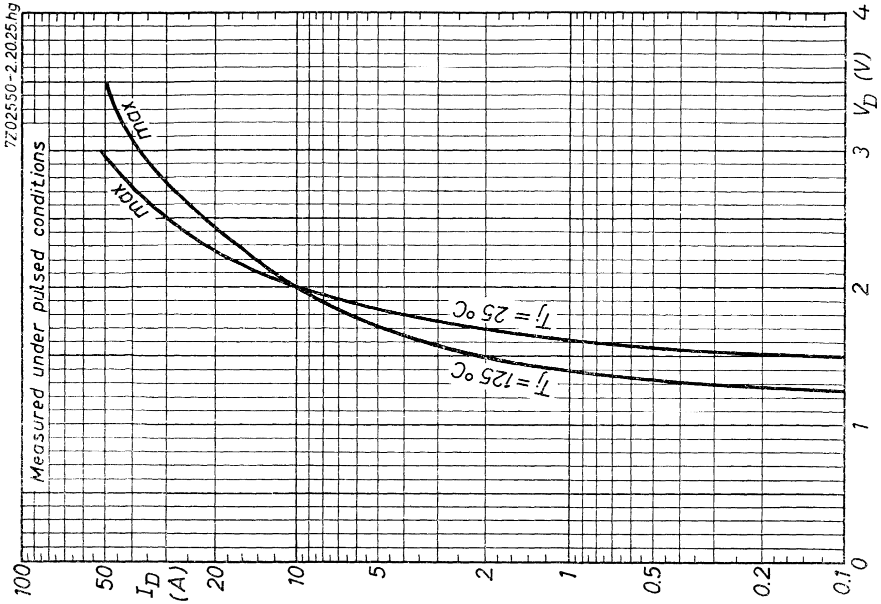
7Z2 2716

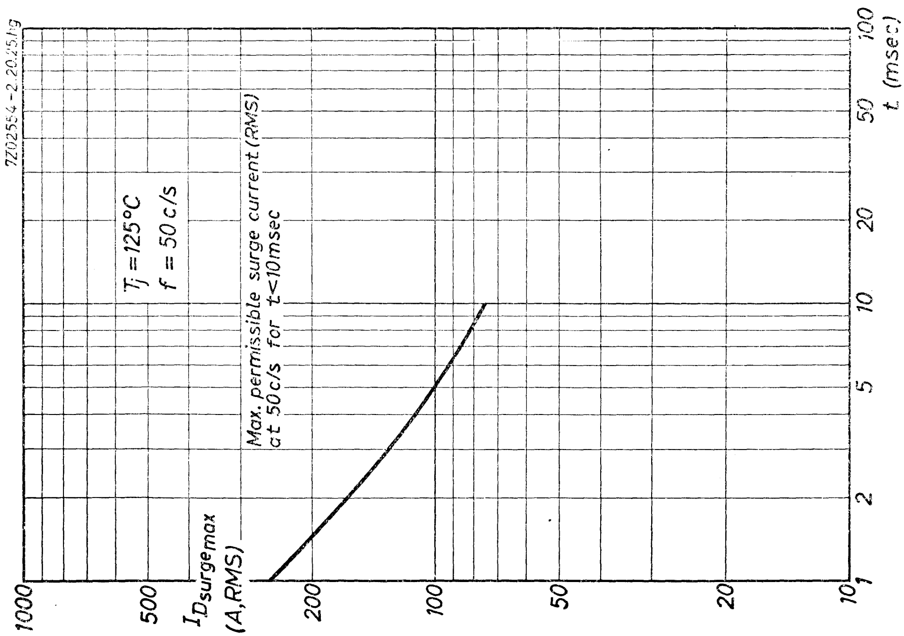


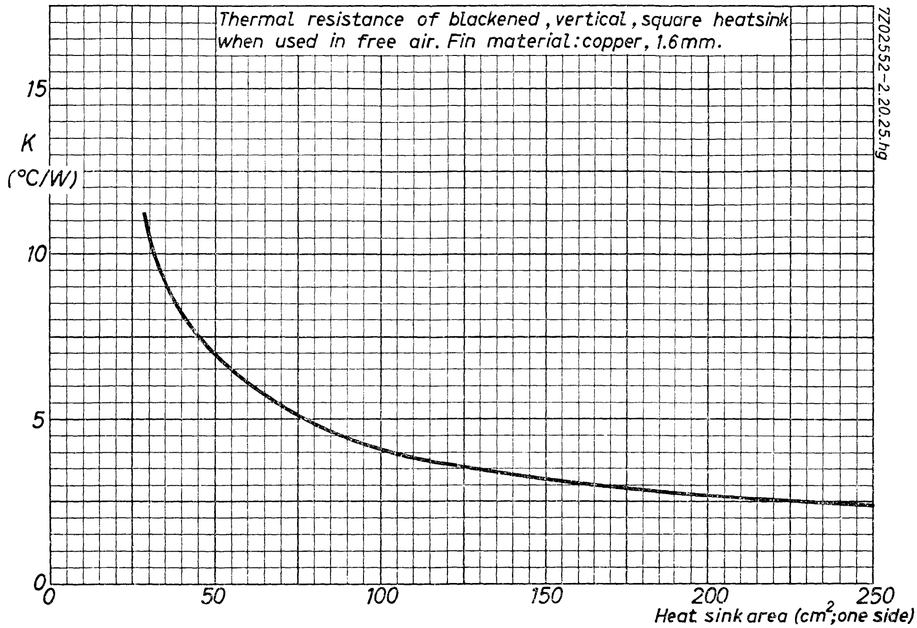
7Z02555-2.20.25.hg
5
4
3
2
1
0
V_G (V)
Min gate current to fire all units at T_j =
125°C
25°C
-10°C
-55°C
upper limit
Min gate voltage to fire all units
Area of possible firing
lower limit
Max gate voltage which will not fire any unit at T_j =
-55°C
125°C
0
20
40
60
80
100
120
140
I_G (mA)

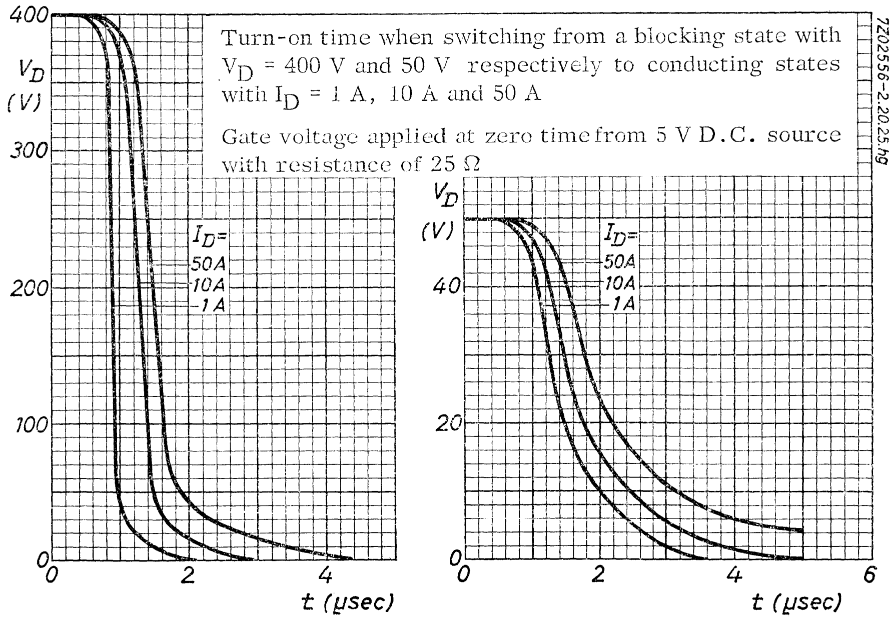


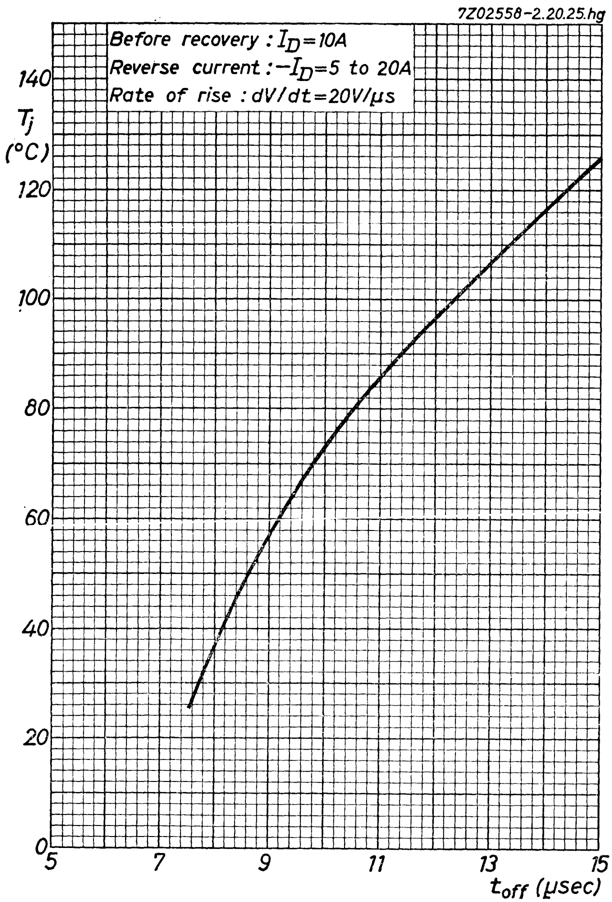
7Z02553-2.20.25.hg
120
100
80
60
40
20
$I_{DMsurge max}$ (A)
T_j = 125 °C
Max. permissible peak surge current based on sinusoidal currents (f=50c/s)
1
2
3
4
5
6
7
8
9
10
20
50
100
number of cycles at 50c/s

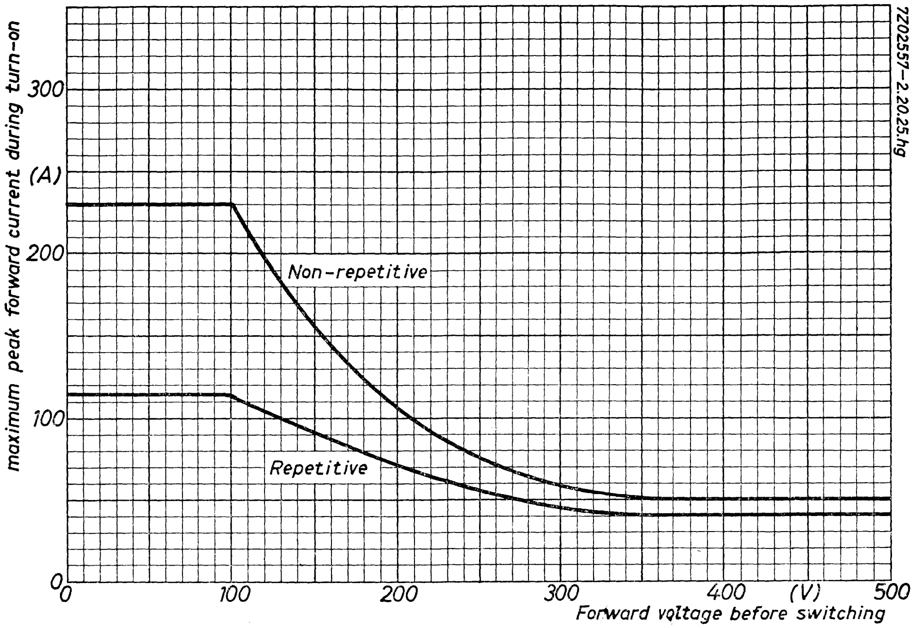

7Z02550-2.20.25.hg
Measured under pulsed conditions
max
max
Tj = 25 °C
Tj = 125 °C
I_D (A)
100
50
20
10
5
2
1
0.5
0.2
0.1
V_D (V)
0
1
2
3
4

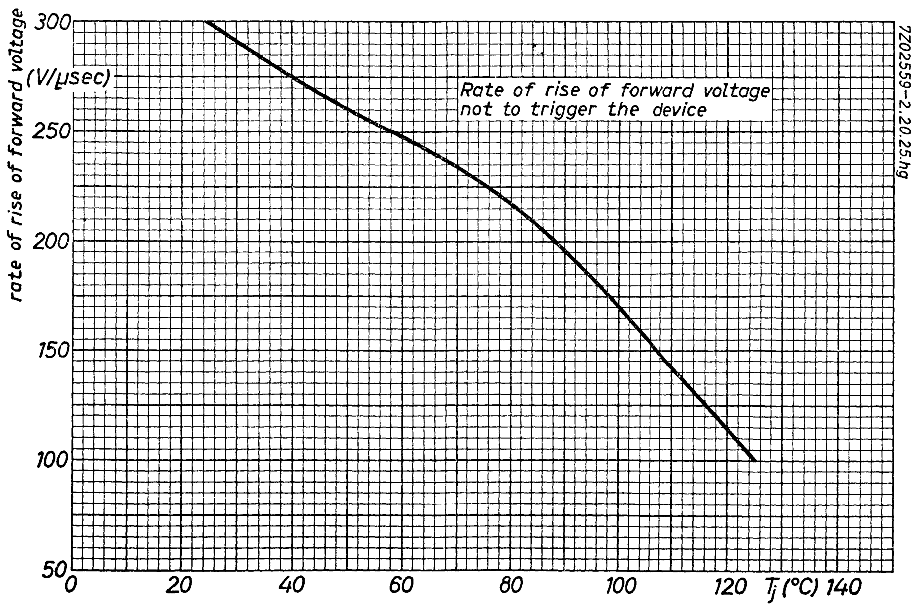

7Z02554-2.20.25.hg
Tj = 125°C
f = 50 c/s
Max. permissible surge current (RMS)
at 50 c/s for t<10msec
I_Dsurgemax
(A,RMS)
1000
500
200
100
50
20
10
t (msec)
1
2
5
10
20
50
100


Thermal resistance of blackened, vertical, square heatsink when used in free air. Fin material: copper, 1.6 mm.
7Z02552-2.20.25.hg
K
(°C/W)
15
10
5
0
0
50
100
150
200
250
Heat sink area (cm²; one side)


Turn-on time when switching from a blocking state with V_D = 400 V and 50 V respectively to conducting states with I_D = 1 A, 10 A and 50 A
Gate voltage applied at zero time from 5 V D.C. source with resistance of 25 Ω
7Z02556-2.20.25.hg
V_D
(V)
400
300
200
100
0
I_D=
50A
10A
1A
0
2
4
t (μsec)
V_D
(V)
40
20
0
I_D=
50A
10A
1A
0
2
4
6
t (μsec)


7Z02558-2.20.25.hg
Before recovery : I_D=10A
Reverse current : $-I_D$=5 to 20A
Rate of rise : dV/dt=20V/µs
140
T_j
(°C)
120
100
80
60
40
20
0
5
7
9
11
13
15
t_{off} (µsec)


maximum peak forward current during turn-on
(A)
300
200
100
0
Non-repetitive
Repetitive
7Z02557-2.20.25.hg
0
100
200
300
400
(V)
500
Forward voltage before switching


rate of rise of forward voltage
(V/µsec)
300
250
200
150
100
50
Rate of rise of forward voltage
not to trigger the device
7Z02559-2.20.25.hg
0
20
40
60
80
100
120
T_j (°C) 140

P-GATE SILICON CONTROLLED RECTIFIERS
16 AMP. SERIES

P-gate silicon controlled rectifiers in a metal case for power control and power switching applications.
The series consists of types BTY91-100R, -200R, -300R, -400R, -500R, -600R and -700R

QUICK REFERENCE DATA

		BTY91-						
Voltages		100R	200R	300R	400R	500R	600R	700R
Repetitive peak inverse voltage	$-V_{DM}$ max.	100	200	300	400	500	600	700 V
Repetitive peak forward blocking voltage	V_{DM} max.	100	200	300	400	500	600	700 V

Currents		
Average forward current	I_D = max.	16 A
Repetitive peak forward current	I_{DM} = max.	140 A
Junction temperature	T_j =	−55 °C to +125 °C
Thermal resistance		
from junction to base of device	K <	2 °C/W

7Z2 2720

LIMITING VALUES (Absolute max. values)

Anode to cathode		BTY91-100R	200R	300R	400R	500R	600R	700R
Crest working inverse voltage	$-V_{DMW}$ max.[1]	100	200	300	400	500	600	700 V
Repetitive peak inverse voltage	$-V_{DM}$ max.[1]	100	200	300	400	500	600	700 V
Non-repetitive peak inverse voltage ($t < 5$ msec)	$-V_{DM}$ surge max.[1]	150	300	400	500	600	720	850 V
Crest working forward blocking voltage	V_{DMW} max.[1]	100	200	300	400	500	600	700 V
Non-repetitive peak forward voltage	V_{DM} surge max.	500	500	500	500	850	850	850 V

D.C. forward current	I_D	= max.	19 A
Average forward current (See page 7)	I_D	= max.	16 A
Repetitive peak forward current	I_{DM}	= max.	140 A
Surge forward current peak for one cycle at 50 c/s (See page A)	$I_{DMsurge}$	= max.	136 A

1) These ratings do not apply when the gate is positive with respect to cathode. To ensure that no device will thermally run away at maximum voltage ratings, the total thermal resistance between junction and ambient must be less than 11 °C/W.

7Z2 2721

LIMITING VALUES (Absolute max. values) (continued)

Anode to cathode (continued)

Repetitive peak reverse current during turn-off	$-I_{DM}$	= max.	20 A
I squared t (1.5 – 10 msec for fusing)	I^2t [1]	= max.	75 A^2sec

Gate to cathode

Peak forward voltage	V_{GM}	= max.	10 V
Peak inverse voltage	$-V_{GM}$	= max.	5 V
Peak current	I_{GM}	= max.	2 A
Peak power dissipation	P_{GM}	= max.	5 W
Average power dissipation	P_G	= max.	0.5 W

Temperatures

Storage temperature	T_s	= –55 °C to 125 °C
Junction temperature	T_j	= –55 °C to 125 °C

THERMAL DATA

Thermal resistance between

junction and base of device	K	<	2.0 °C/W
base of device and heatsink (torque of 17 cm.kg on nut)	K	=	0.2 °C/W
base of device and heatsink with mica washer	K	=	4.0 °C/W

[1]) R.M.S. value of I (See also page B)

7Z2 2722

CHARACTERISTICS at T_j = 125 °C unless otherwise specified

Anode to cathode

		BTY91-100R	200R	300R	400R	500R	600R	700R
Forward break-over voltage	$V_{D\,b.o.}$ min.[1]	100	200	300	400	500	600	700 V
Forward leakage current at $V_{DMmax.}$	I_D max.	13	12	10	8	6	5	4.5 mA
Reverse leakage current at $-V_{DMmax.}$	$-I_D$ max.[2]	13	12	10	8	6	5	4.5 mA

Forward voltage drop at I_D = 50 A (T_j = 25 °C) V_D < 2.0 V

Gate to cathode

Voltage to fire all units (T_j = 25 °C) V_G > 3.0 V

Voltage not to fire any unit V_G < 0.25 V

Current to fire all units (T_j = 25 °C) I_G > 40 mA

CHARACTERISTIC RANGE VALUES FOR EQUIPMENT DESIGN

T_j = 125 °C unless otherwise specified

Holding current I_{DH} = 10 mA

Turn-on time ($t_{on} = t_d + t_r$. See page C)

Before triggering $+V_D$ = 50 V, I_D = 1 A t_{on} = 2.5 μs
I_D = 10 A t_{on} = 3.0 μs
I_D = 50 A t_{on} = 4.4 μs

Before triggering $+V_D$ = 400 V, I_D = 1 A t_{on} = 1.0 μs
I_D = 10 A t_{on} = 1.5 μs
I_D = 50 A t_{on} = 2.0 μs

1) This voltage may be exceeded up to $V_{DM\,surge\,max.}$, but the device may conduct at any voltage over $V_{D\,b.o.}$ min.

2) These limits do not apply when the gate is positive with respect to cathode.

7Z2 2727

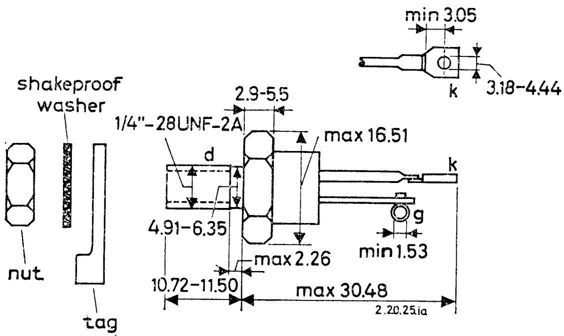
CHARACTERISTIC RANGE VALUES FOR EQUIPMENT DESIGN

(continued) T_j = 125 °C unless otherwise specified

Turn-off time for I_D = 10 A (See page D) Rate of rise dV/dt = 20 V/μs $-I_D$ = 5 A to 20 A	t_{off}	=	20 μs
Rate of rise of forward voltage not to trigger the device	dV/dt		100 V/μs

MECHANICAL DATA

Dimensions in mm



Recommended diameter of hole in heatsink	:	6.5 mm
Mounting torque for good heat conductance	:	min. 17 cmkg
	:	max. 35 cmkg
Net weight	:	10 g
Weight with accessories	:	15 g
<u>Supplied with the device</u>	:	1/4 in UNF nut Shakeproof washer Tag
<u>Supplied on request</u> (Code No.56264)	:	Insulating bush Mica washer

7Z2 2729

1.1.1965

OPERATING NOTES

1. When there is a possibility that transient voltage surges will cause an inverse voltage, higher than the maximum permissible non-repetitive peak inverse voltage, a damping circuit across the transformer should be applied, e.g. a series RC damping circuit. Dimensioning of the RC damping circuit may be done according to the following formulae:

$\frac{-V_{DMsurge}}{-V_{DMW}}$ [1]	R-C in primary of transformer		R-C in secondary of transformer	
	C_1 (μF)	R_1C_1 (μs)	C_2 (μF)	R_2C_2 (μs)
2.0	$200\,\frac{I_o}{V_1}$	150	$225\,\frac{I_o}{V_1}T^2$	200
1.5	$400\,\frac{I_o}{V_1}$	225	$450\,\frac{I_o}{V_1}T^2$	275
1.25	$550\,\frac{I_o}{V_1}$	260	$620\,\frac{I_o}{V_1}T^2$	310
1.0	$800\,\frac{I_o}{V_1}$	300	$900\,\frac{I_o}{V_1}T^2$	350

[1]) $-V_{DMW}$ stands for the applied crest working voltage

Where I_o = magnetising primary r.m.s. current (A)

V_1 = transformer primary r.m.s. voltage (V)

V_2 = transformer secondary r.m.s. voltage (V)

$T = \frac{V_1}{V_2}$

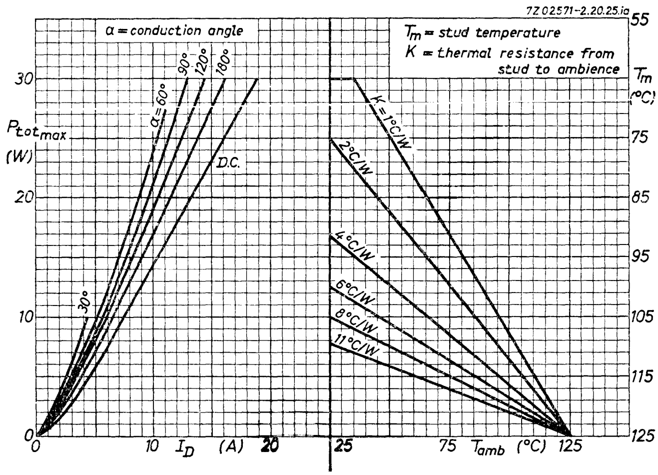
2. To ensure that all thyristors trigger, the firing circuit must provide both the minimum gate-voltage and the minimum gate-current to fire all units at the operating temperature. To do this, the source resistance load line on the gate characteristic must pass through, or above and to the right of, the intersection of the minimum trigger voltage and current, providing the limiting values of gate voltage, current and power are not exceeded. (See page A)

7Z2 2715

OPERATING NOTES (continued)

3. Dissipation and heatsink considerations

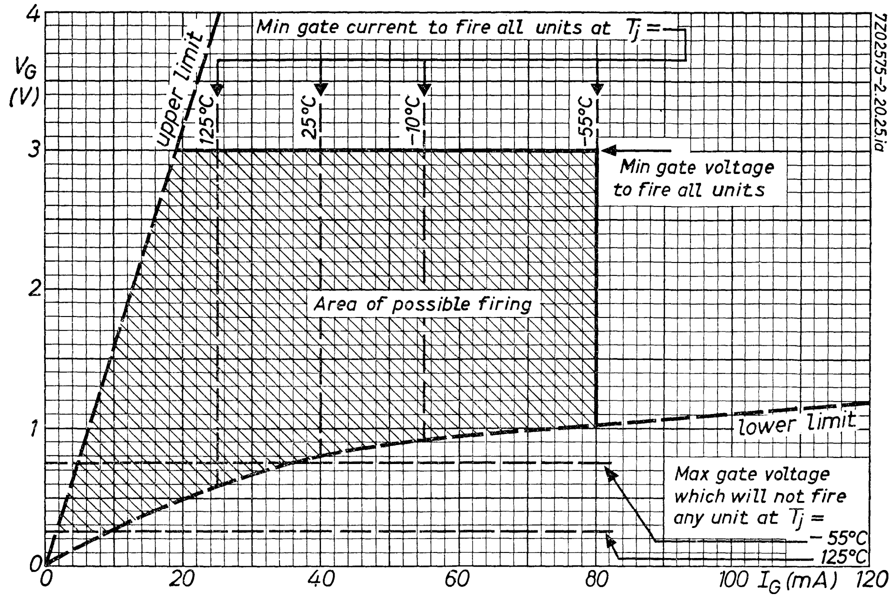
The method of using the curves of the figure below is as follows: Starting with the curve of maximum dissipation as a function of average forward current, for a particular current value trace upwards to meet the appropriate conduction angle curve. Then trace horizontally until the appropriate K-curve is reached (in the case of a given heatsink). Then trace downwards to determine the maximum permissible ambient temperature.
Alternatively, when the maximum ambient temperature is known and the heatsink required is to be determined, trace horizontally until the vertical through the given ambient temperature is reached. The K-value corresponding to the intersection is the maximum thermal resistance from mounting base to ambience. Subtracting the contact thermal resistance gives the maximum thermal resistance of the heatsink, the size of which can then be found from page C.



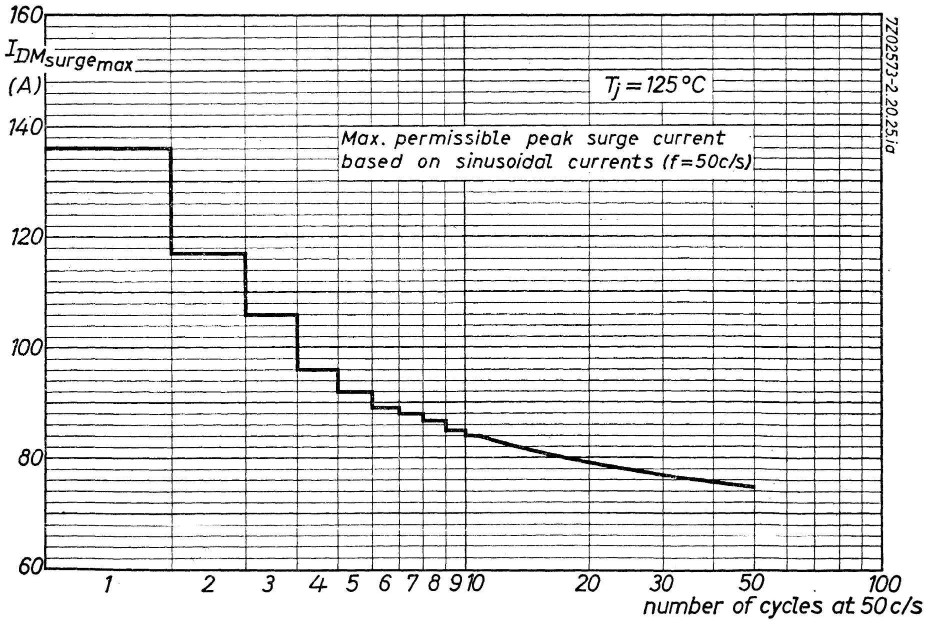
Dissipation as a function of average current and corresponding max. permissible ambient temperature for various values of K

4. Thyristors 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.

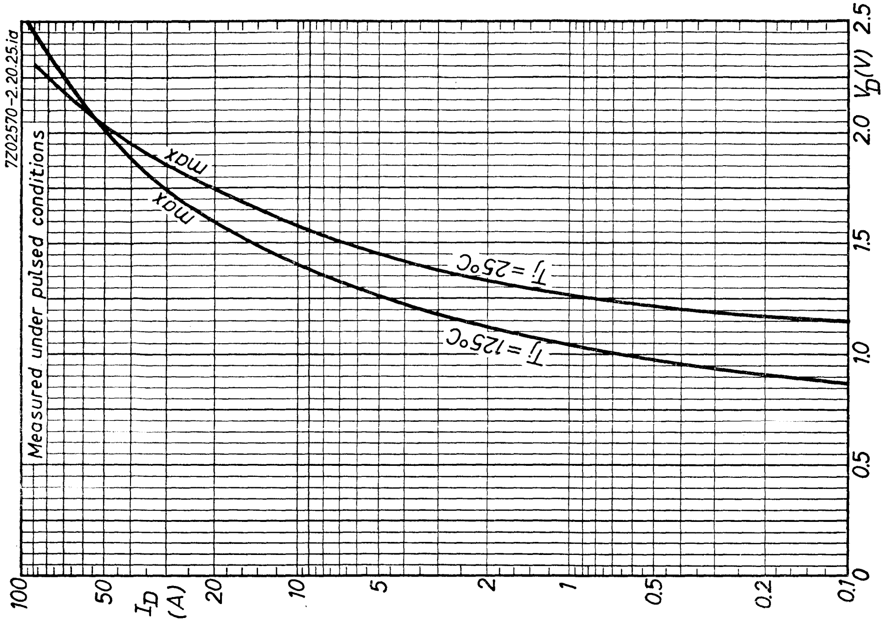
7Z2 2730

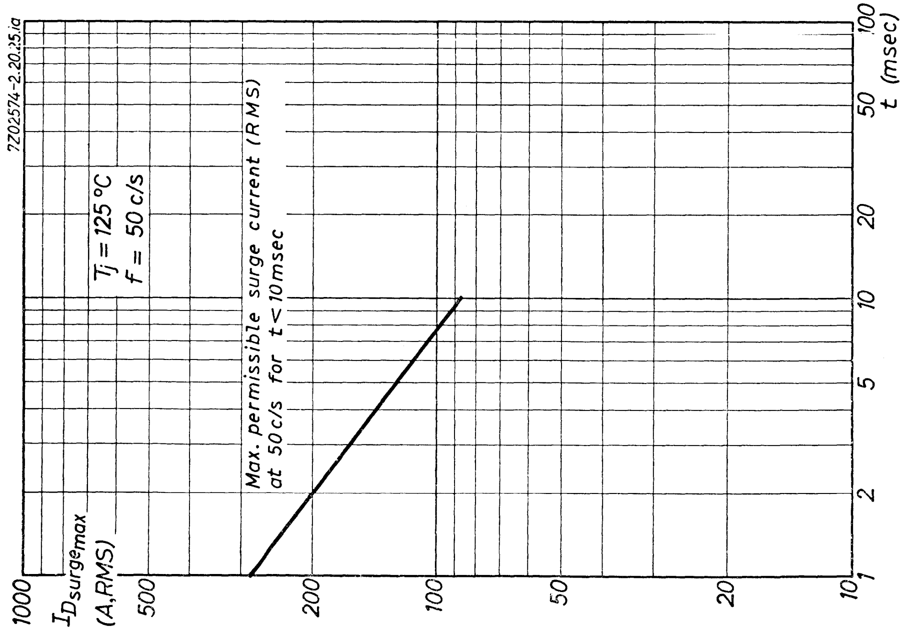


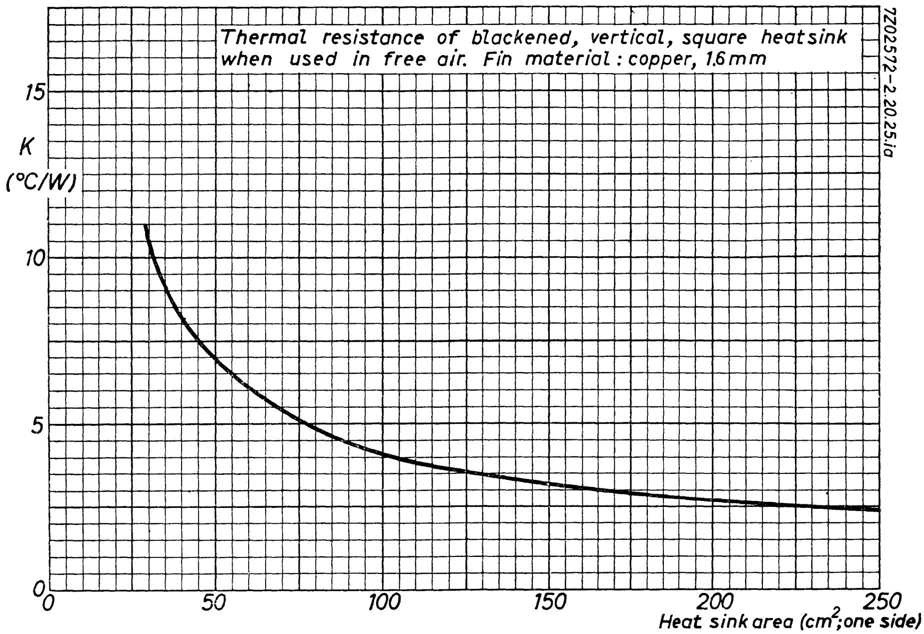
7Z02575-2.20.25.ia
V_G (V)
Min gate current to fire all units at T_j =
125°C
25°C
−10°C
−55°C
upper limit
Min gate voltage to fire all units
Area of possible firing
lower limit
Max gate voltage which will not fire any unit at T_j =
− 55°C
125°C
I_G (mA)

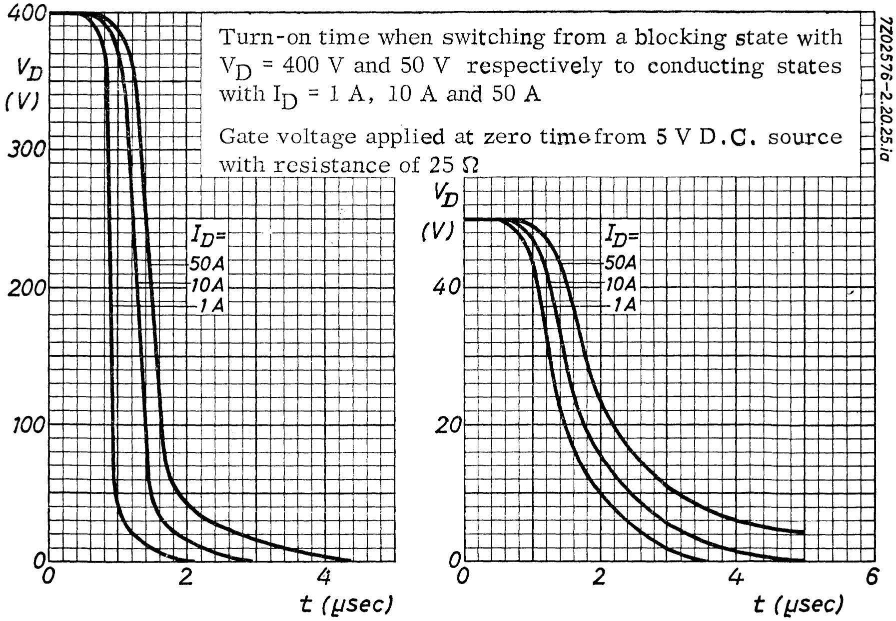


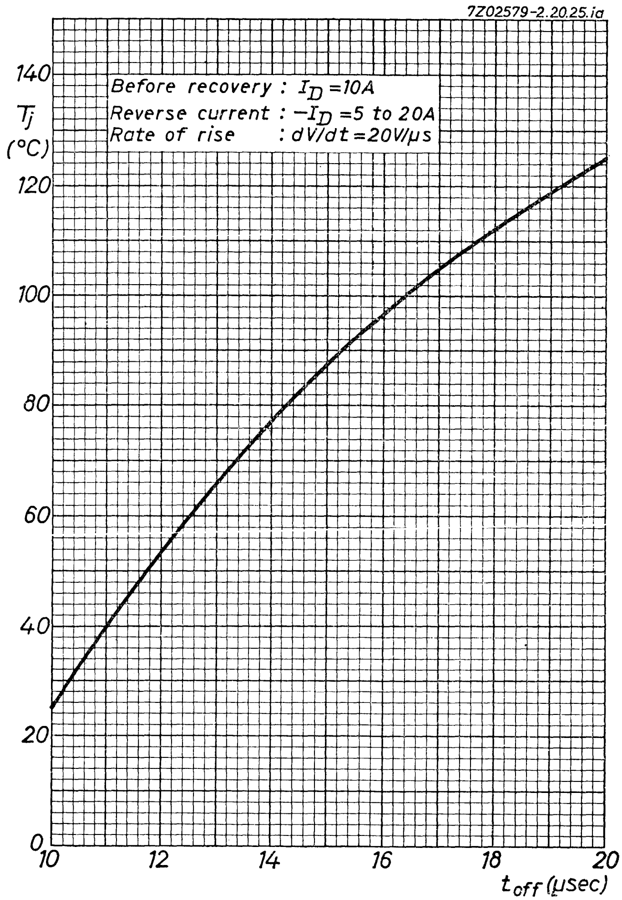
7Z02573-2.20.25.ia
$I_{DMsurge_{max}}$ (A)
$T_j = 125\,°C$
Max. permissible peak surge current based on sinusoidal currents (f=50c/s)
number of cycles at 50c/s

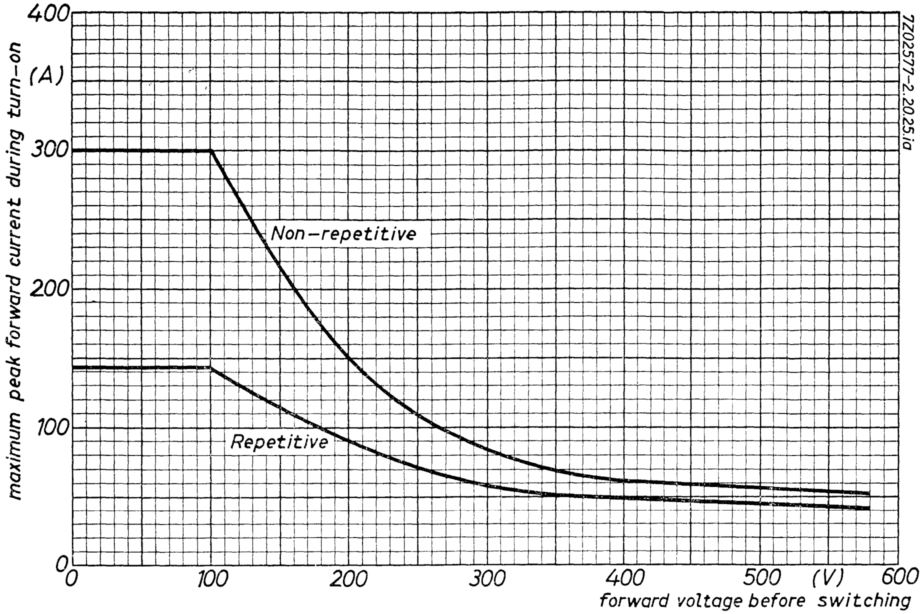

7Z02570-2.20.25.ia
Measured under pulsed conditions
max
max
$T_j = 25°C$
$T_j = 125°C$
V_D (V)
2.5
2.0
1.5
1.0
0.5
0
I_D (A)
100
50
20
10
5
2
1
0.5
0.2
0.1

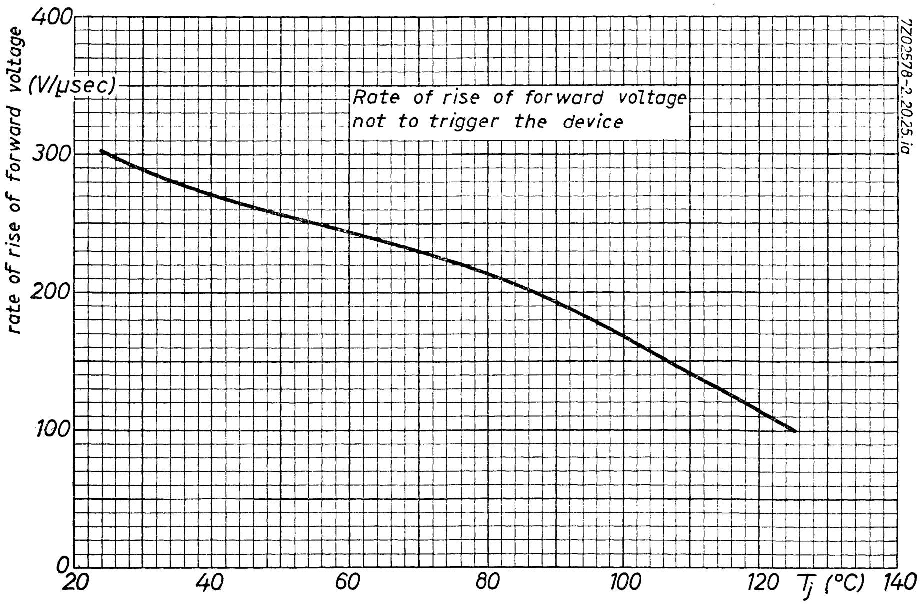

7Z02574-2.20.25.ia
$T_j = 125$ °C
f = 50 c/s
Max. permissible surge current (RMS)
at 50 c/s for t < 10 msec
$I_{D surge max}$
(A,RMS)
1000
500
200
100
50
20
10
t (msec)
100
50
20
10
5
2
1


Thermal resistance of blackened, vertical, square heatsink when used in free air. Fin material: copper, 1.6 mm
7Z02572-2.20.25.ia
K
(°C/W)
15
10
5
0
0
50
100
150
200
250
Heat sink area (cm²; one side)


Turn-on time when switching from a blocking state with V_D = 400 V and 50 V respectively to conducting states with I_D = 1 A, 10 A and 50 A
Gate voltage applied at zero time from 5 V D.C. source with resistance of 25 Ω
7Z02576-2.20.25.ia
V_D
(V)
400
300
200
100
0
I_D=
50A
10A
1 A
0
2
4
t (μsec)
V_D
(V)
40
20
0
I_D=
50A
10A
1 A
0
2
4
6
t (μsec)


7Z02579-2.20.25.ia
Before recovery : I_D =10A
Reverse current : $-I_D$ =5 to 20A
Rate of rise : dV/dt =20V/μs
T_j (°C)
0
20
40
60
80
100
120
140
10
12
14
16
18
20
t_{off} (μsec)


maximum peak forward current during turn-on
(A)
400
300
200
100
0
Non-repetitive
Repetitive
0
100
200
300
400
500
(V)
600
forward voltage before switching
7Z02577-2.20.25.ia


rate of rise of forward voltage
(V/µsec)
400
300
200
100
0
Rate of rise of forward voltage
not to trigger the device
20
40
60
80
100
120
T_j (°C)
140
7Z02578-2.20.25.ia

P-GATE SILICON CONTROLLED RECTIFIERS
50 AMP. SERIES

P-gate silicon controlled rectifiers in a metal case for power control and power switching applications.
The series consists of types BTY95-100R, -200R, -300R, -400R, -500R, -600R and -700R

QUICK REFERENCE DATA

		BTY95-						
Voltages		100R	200R	300R	400R	500R	600R	700R
Repetitive peak inverse voltage	$-V_{DM}$ max.	100	200	300	400	500	600	700 V
Repetitive peak forward blocking voltage	V_{DM} max.	100	200	300	400	500	600	700 V

Currents			
Average forward current	I_D	= max.	50 A
Repetitive peak forward current	I_{DM}	= max.	700 A
Junction temperature	T_j	=	−55 °C to +125 °C
Thermal resistance			
from junction to base of device	K	<	0.6 °C/W

7Z2 2734

LIMITING VALUES (Absolute max. values)

Anode to cathode		BTY95-100R	BTY95-200R	BTY95-300R	BTY95-400R	BTY95-500R	BTY95-600R	BTY95-700R
Crest working inverse voltage	$-V_{DMW}$ max.[1]	100	200	300	400	500	600	700 V
Repetitive peak inverse voltage	$-V_{DM}$ max.[1]	100	200	300	400	500	600	700 V
Non-repetitive peak inverse voltage ($t < 5$ msec)	$-V_{DM}$ surge max.[1]	150	300	400	500	600	720	850 V
Crest working forward blocking voltage	V_{DMW} max.[1]	100	200	300	400	500	600	700 V

Non-repetitive peak forward voltage	V_{DM}	= max.	850 V
D.C. forward current	I_D	= max.	75 A
Average forward current (See page 7)	I_D	= max.	50 A
Repetitive peak forward current	I_{DM}	= max.	700 A
Surge forward current peak for one cycle at 50 c/s (See page A)	$I_{DMsurge}$	= max.	680 A

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[1]) These ratings do not apply when the gate is positive with respect to cathode. To ensure that no device will thermally run away at maximum voltage ratings, the total thermal resistance between junction and ambient must be less than 4 °C/W.

7Z2 2735

LIMITING VALUES (Absolute max. values) (continued)

Anode to cathode (continued)

Repetitive peak reverse current during turn-off	$-I_{DM}$	= max.	30 A
I squared t (1.5 – 10 msec for fusing)	I^2t [1]	= max.	2000 A^2sec

Gate to cathode

Peak forward voltage	V_{GM}	= max.	10 V
Peak inverse voltage	$-V_{GM}$	= max.	5 V
Peak current	I_{GM}	= max.	2 A
Peak power dissipation	P_{GM}	= max.	5 W
Average power dissipation	P_G	= max.	0.5 W

Temperatures

Storage temperature	T_s	=	−55 °C to 125 °C
Junction temperature	T_j	=	−55 °C to 125 °C

THERMAL DATA

Thermal resistance between

junction and base of device	K	<	0.6 °C/W
base of device and heatsink	K	=	0.1 °C/W

[1]) R.M.S. value of I (See also page B)

7Z2 2736

CHARACTERISTICS at T_j = 125 °C unless otherwise specified

Anode to cathode		BTY95-100R	200R	300R	400R	500R	600R	700R	
Forward break-over voltage	$V_{D\,b.o.}$ min.[1]	100	200	300	400	500	600	700	V
Forward leakage current at $V_{DMmax.}$	I_D max.	13	12	10	8	12	12	12	mA
Reverse leakage current at $-V_{DMmax.}$	$-I_D$ max.[2]	13	12	10	8	12	12	12	mA

Forward voltage drop at I_D = 500 A (T_j = 25 °C) V_D < 3.3 V

Gate to cathode

Voltage to fire all units (T_j = 25 °C)	V_G	>	3 V
Voltage not to fire any unit	V_G	<	0.25 V
Current to fire all units (T_j = 25 °C)	I_G	>	80 mA

CHARACTERISTIC RANGE VALUES FOR EQUIPMENT DESIGN

T_j = 125 °C unless otherwise specified

Holding current	I_{DH}	=	10 mA
Turn-on time for I_D = 50 A (See page D)			
before triggering V_D = 50 V	$t_{on} = t_d + t_r$	=	6 µs
before triggering V_D = 400 V	$t_{on} = t_d + t_r$	=	3 µs
Turn-off time for I_D = 50 A (See page C) rate of rise dV/dt = 5 V/µs $-I_D$ = 10 A to 30 A	t_{off}	=	20 µs
Rate of rise of forward voltage not to trigger the device	dV/dt		10 V/µs

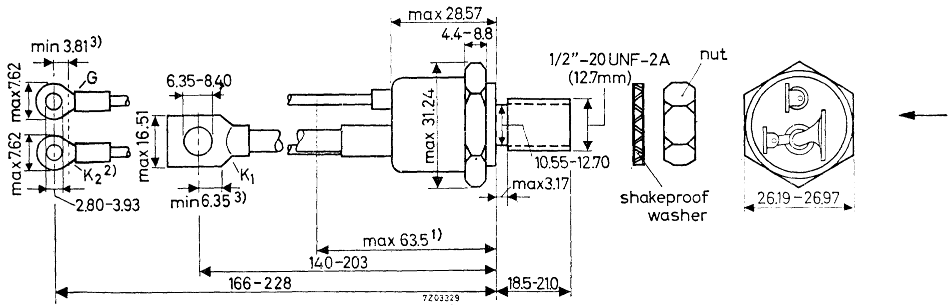
1) This voltage may be exceeded up to 850 V, but the device may conduct at any voltage over $V_{D\,b.o.}$ min.

2) These limits do not apply when the gate is positive with respect to cathode.

7Z2 2737

MECHANICAL DATA

Dimensions in mm



Diameter of hole in heatsink	:	max.	13	mm
Mounting torque for good heat conductance	:	min.	90	cm kg
	:	max.	175	cm kg
Net weight	:		88	g
Weight with accessories	:		108	g

Supplied with the device : $\frac{1}{2}$ in UNF nut
Shakeproof washer

NOTES

1) This distance allows for the leads to be bent at right angles.

2) Second cathode lead.

3) Minimum flat.

7Z2 3168

OPERATING NOTES

1. When there is a possibility that transient voltage surges will cause an inverse voltage, higher than the maximum permissible non-repetitive peak inverse voltage, a damping circuit across the transformer should be applied, e.g. a series RC damping circuit. Dimensioning of the RC damping circuit may be done according to the following formulae:

$\frac{-V_{DMsurge}}{-V_{DMW}}$ [1]	R-C in primary of transformer		R-C in secondary of transformer	
	C_1 (μF)	R_1C_1 (μs)	C_2 (μF)	R_2C_2 (μs)
2.0	$200 \frac{I_o}{V_1}$	150	$225 \frac{I_o}{V_1} T^2$	200
1.5	$400 \frac{I_o}{V_1}$	225	$450 \frac{I_o}{V_1} T^2$	275
1.25	$550 \frac{I_o}{V_1}$	260	$620 \frac{I_o}{V_1} T^2$	310
1.0	$800 \frac{I_o}{V_1}$	300	$900 \frac{I_o}{V_1} T^2$	350

[1]) $-V_{DMW}$ stands for the applied crest working inverse voltage

Where I_o = magnetising primary r.m.s. current (A)

V_1 = transformer primary r.m.s. voltage (V)

V_2 = transformer secondary r.m.s. voltage (V)

$$T = \frac{V_1}{V_2}$$

2. To ensure that all thyristors trigger, the firing circuit must provide both the minimum gate-voltage and the minimum gate-current to fire all units at the operating temperature. To do this, the source resistance load line on the gate characteristic must pass through, or above and to the right of, the intersection of the minimum trigger voltage and current, providing the limiting values of gate voltage, current and power are not exceeded. (See page A)

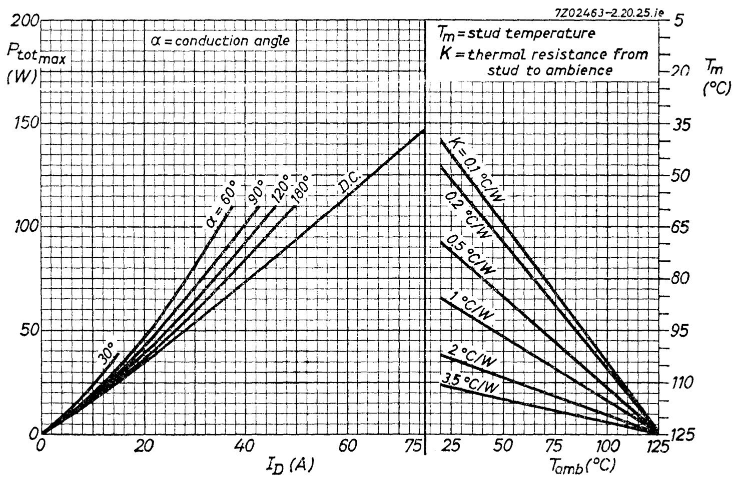
7Z2 2739

OPERATING NOTES (continued)

3. Dissipation and heatsink considerations

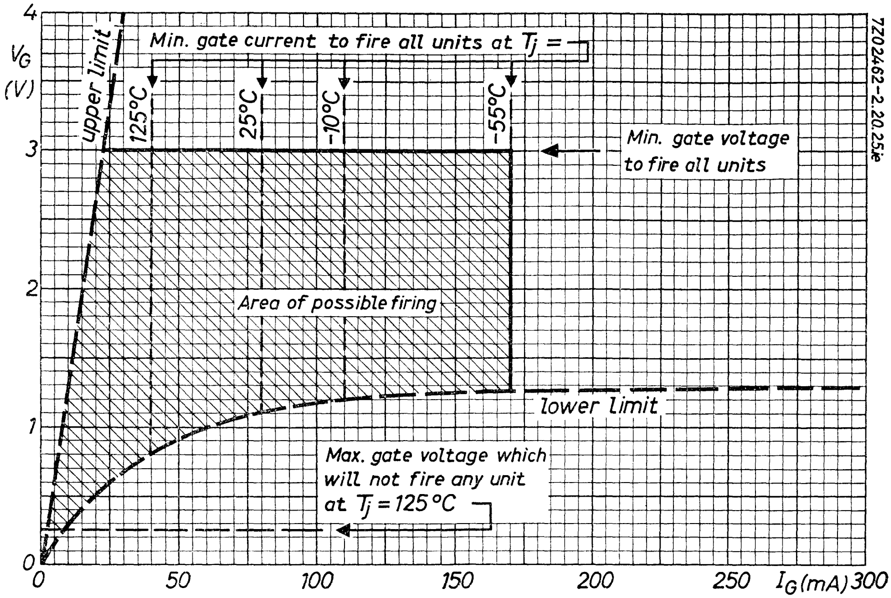
The method of using the curves of the figure below is as follows: Starting with the curve of maximum dissipation as a function of average forward current, for a particular current value trace upwards to meet the appropriate conduction angle curve. Then trace horizontally until the appropriate K-curve is reached (in the case of a given heatsink). Then trace downwards to determine the maximum permissible ambient temperature.

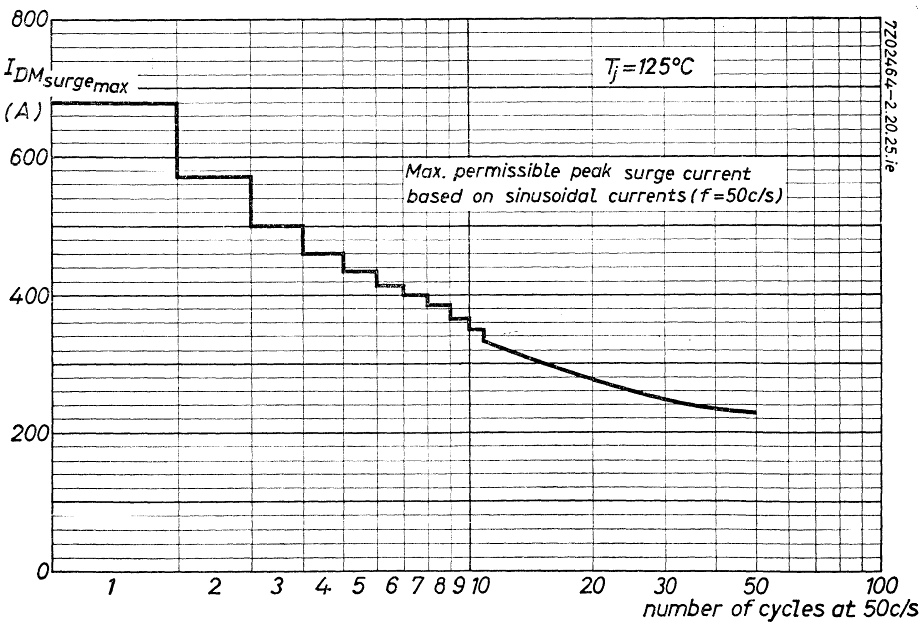
Alternatively, when the maximum ambient temperature is known and the heatsink required is to be determined, trace horizontally until the vertical through the given ambient temperature is reached. The K-value corresponding to the intersection is the maximum thermal resistance from mounting base to ambience. Subtracting the contact thermal resistance gives the maximum thermal resistance of the heatsink, the size of which can then be found from page C.

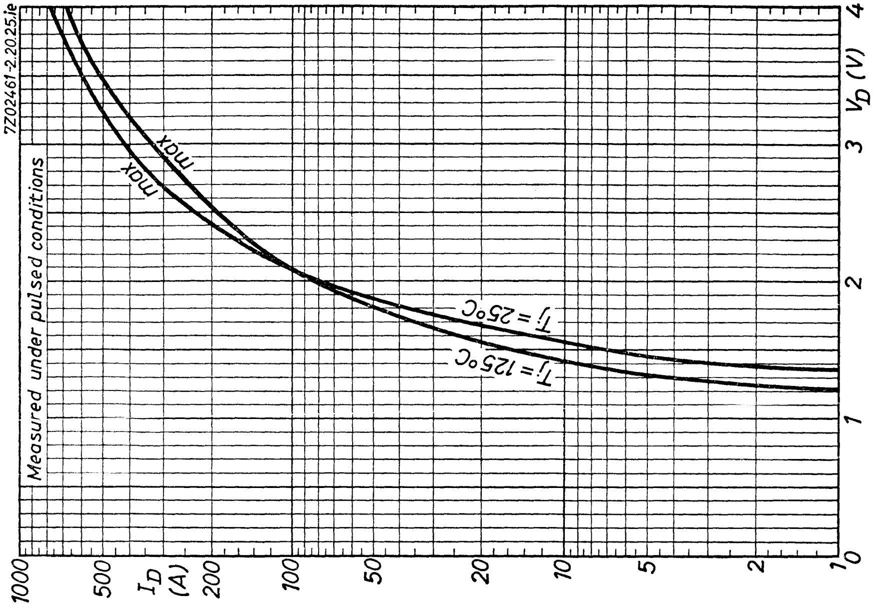


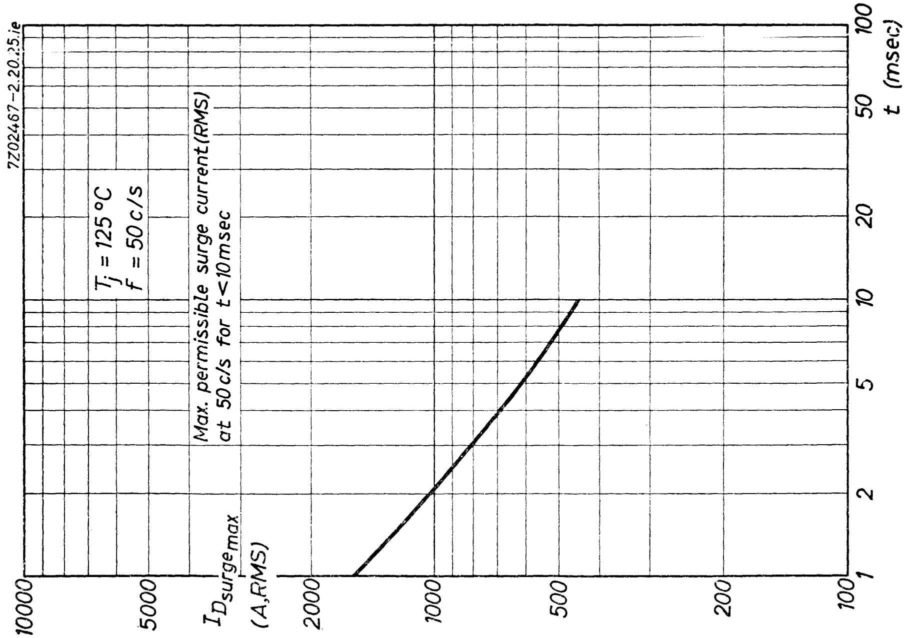
Dissipation as a function of average current and corresponding maximum permissible ambient temperature for various values of K.

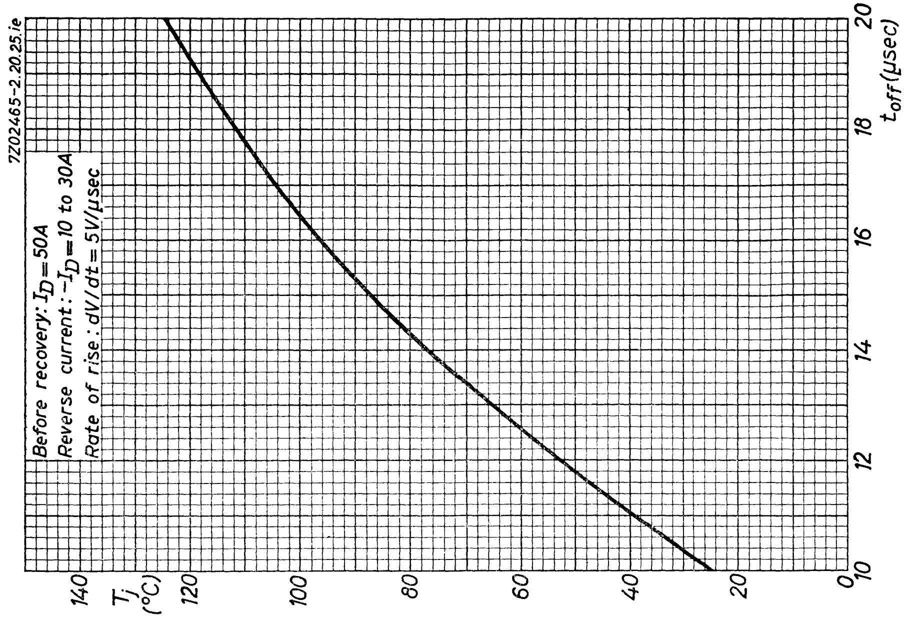
7Z2 2740

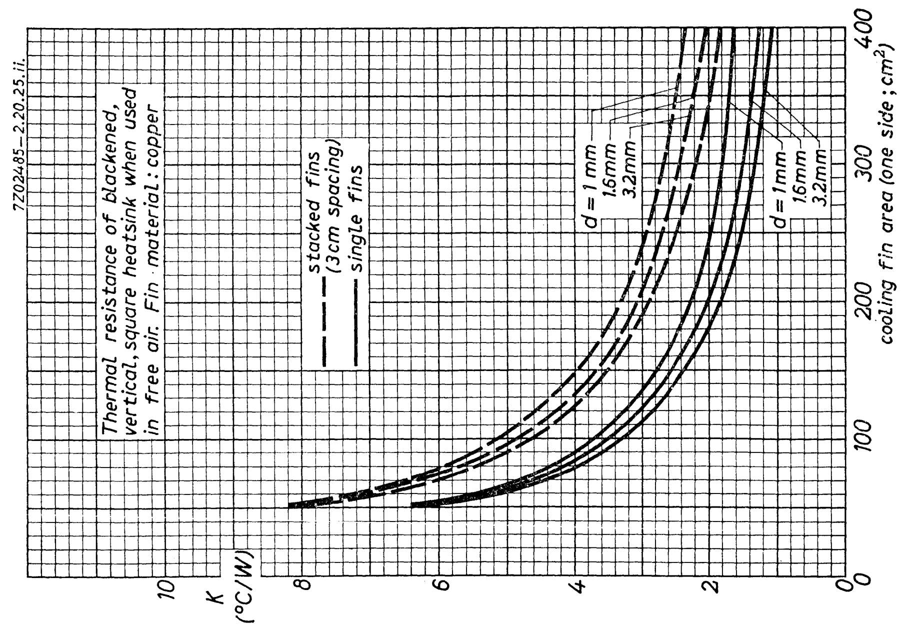

4
V_G
(V)
3
2
1
0
0
50
100
150
200
250
I_G(mA) 300
upper limit
Min. gate current to fire all units at T_j =
125°C
25°C
-10°C
-55°C
Min. gate voltage to fire all units
Area of possible firing
lower limit
Max. gate voltage which will not fire any unit at T_j = 125 °C
7Z02462-2.20.25.ie

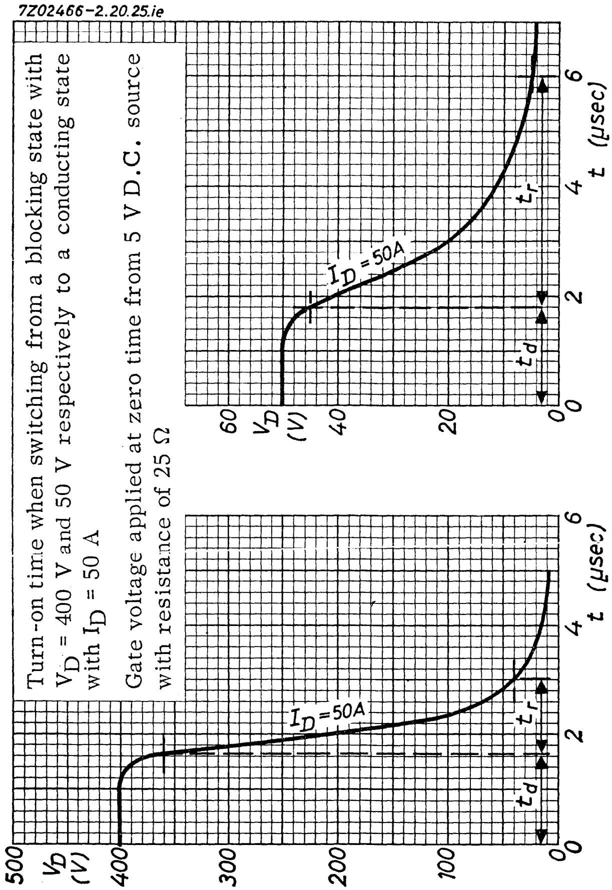

800
$I_{DMsurgemax}$
(A)
600
400
200
0
T_j=125°C
Max. permissible peak surge current based on sinusoidal currents (f=50c/s)
1
2
3
4
5
6
7
8
9
10
20
30
50
100
number of cycles at 50c/s
7Z02464-2.20.25.ie


7Z02461-2.20.25.ie
Measured under pulsed conditions
max
max
Tj = 25 °C
Tj = 125 °C
V_D (V)
I_D (A)
1000
500
200
100
50
20
10
5
2
1
0
1
2
3
4


7Z02467-2.20.25.ie
Tj = 125 °C
f = 50 c/s
Max. permissible surge current (RMS)
at 50 c/s for t<10 msec
I_Dsurge max
(A,RMS)
t (msec)
10000
5000
2000
1000
500
200
100
1
2
5
10
20
50
100


7Z02465-2.20.25.ie
Before recovery: I_D = 50A
Reverse current: -I_D = 10 to 30A
Rate of rise: dV/dt = 5V/μsec
T_j (°C)
140
120
100
80
60
40
20
0
10
12
14
16
18
20
t_off (μsec)


7Z02485-2.20.25.ii.
Thermal resistance of blackened, vertical, square heatsink when used in free air. Fin material: copper
stacked fins (3cm spacing)
single fins
d = 1 mm
1.6mm
3.2mm
d = 1mm
1.6mm
3.2mm
K (°C/W)
10
8
6
4
2
0
0
100
200
300
400
cooling fin area (one side; cm²)


7Z02466-2.20.25.ie
Turn-on time when switching from a blocking state with V_D = 400 V and 50 V respectively to a conducting state with I_D = 50 A
Gate voltage applied at zero time from 5 V D.C. source with resistance of 25 Ω
I_D = 50A
V_D (V)
t (μsec)
t_d
t_r
500
400
300
200
100
0
60
40
20
0
2
4
6

P-GATE SILICON CONTROLLED RECTIFIERS
70 AMP. SERIES

P-gate silicon controlled rectifiers in a metal case for power control and power switching applications.
The series consists of types BTY99-100R, -200R, -300R, -400R, -500R, -600R and -700R.

QUICK REFERENCE DATA

		BTY99-						
Voltages		100R	200R	300R	400R	500R	600R	700R
Repetitive peak inverse voltage	$-V_{DM}$ max.	100	200	300	400	500	600	700 V
Repetitive peak forward blocking voltage	V_{DM} max.	100	200	300	400	500	600	700 V

Currents			
Average forward current	I_D	= max.	70 A
Repetitive peak forward current	I_{DM}	= max.	1000 A
Junction temperature	T_j	=	−55 °C to +125 °C
Thermal resistance			
from junction to base of device	K	<	0.4 °C/W

7Z2 2741

LIMITING VALUES (Absolute max. values)

Anode to cathode		BTY99-100R	BTY99-200R	BTY99-300R	BTY99-400R	BTY99-500R	BTY99-600R	BTY99-700R
Crest working inverse voltage	$-V_{DMW}$ max.[1]	100	200	300	400	500	600	700 V
Repetitive peak inverse voltage	$-V_{DM}$ max.[1]	100	200	300	400	500	600	700 V
Non-repetitive peak inverse voltage ($t < 5$ msec)	$-V_{DM}$ surge max.[1]	150	300	400	500	600	720	850 V
Crest working forward blocking voltage	V_{DMW} max.[1]	100	200	300	400	500	600	700 V

Non-repetitive peak forward voltage	V_{DM}	= max. 850 V
D.C. forward current	I_D	= max. 100 A
Average forward current (See page 7)	I_D	= max. 70 A
Repetitive peak forward current	I_{DM}	= max. 1000 A
Surge forward current peak for one cycle at 50 c/s (See page A)	$I_{DMsurge}$	= max. 900 A

[1]) These ratings do not apply when the gate is positive with respect to cathode. To ensure that no device will thermally run away at maximum voltage ratings, the total thermal resistance between junction and ambient must be less than 4 °C/W.

7Z2 2742

LIMITING VALUES (Absolute max. values) (continued)

Anode to cathode (continued)

Repetitive peak reverse current during turn-off	$-I_{DM}$	= max.	30 A
I squared t (1.5 – 10 msec for fusing)	I^2t [1]	= max.	4000 A^2sec

Gate to cathode

Peak forward voltage	V_{GM}	= max.	10 V
Peak inverse voltage	$-V_{GM}$	= max.	5 V
Peak current	I_{GM}	= max.	2 A
Peak power dissipation	P_{GM}	= max.	5 W
Average power dissipation	P_G	= max.	0.5 W

Temperatures

Storage temperature	T_s	= −55 °C to 125 °C
Junction temperature	T_j	= −55 °C to 125 °C

THERMAL DATA

Thermal resistance between

junction and base of device	K	<	0.4 °C/W
base of device and heatsink	K	=	0.1 °C/W

[1]) R.M.S. value of I (See also page B)

7Z2 2743

CHARACTERISTICS at T_j = 125 °C unless otherwise specified

Anode to cathode

		BTY99-100R	200R	300R	400R	500R	600R	700R	
Forward breakover voltage	$V_{D\,b.o.}$ min.[1]	100	200	300	400	500	600	700	V
Forward leakage current at $V_{DMmax.}$	I_D max.	13	12	10	8	12	12	12	mA
Reverse leakage current at $-V_{DMmax.}$	$-I_D$ max.[2]	13	12	10	8	12	12	12	mA

Forward voltage drop at I_D = 500 A (T_j = 25 °C) V_D < 2.5 V

Gate to cathode

Voltage to fire all units (T_j = 25 °C)	V_G	>	3 V
Voltage not to fire any unit	V_G	<	0.25 V
Current to fire all units (T_j = 25 °C)	I_G	>	70 mA

CHARACTERISTIC RANGE VALUES FOR EQUIPMENT DESIGN

T_j = 125 °C unless otherwise specified

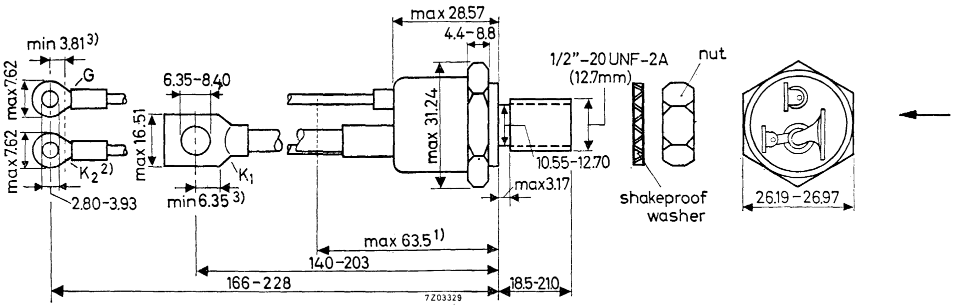
Holding current	I_{DH}	=	10 mA
Turn-on time for I_D = 50 A (See page D)			
before triggering V_D = 50 V	$t_{on} = t_d + t_r$	=	6 µs
before triggering V_D = 400 V	$t_{on} = t_d + t_r$	=	3 µs
Turn-off time for I_D = 50 A (See page C) rate of rise dV/dt = 5 V/µs $-I_D$ = 10 A to 30 A	t_{off}	=	20 µs
Rate of rise of forward voltage not to trigger the device	dV/dt		10 V/µs

[1] This voltage may be exceeded up to 850 V, but the device may conduct at any voltage over $V_{D\,b.o.\,min.}$

[2] These limits do not apply when the gate is positive with respect to cathode.

7Z2 2744

MECHANICAL DATA Dimensions in mm



Diameter of hole in heatsink	:	max.	13	mm
Mounting torque for good heat conductance	:	min.	90	cm kg
	:	max.	175	cm kg
Net weight	:		88	g
Weight with accessories	:		108	g

Supplied with the device : $\frac{1}{2}$ in UNF nut
Shakeproof washer

NOTES

1) This distance allows for the leads to be bent at right angles.

2) Second cathode lead.

3) Minimum flat.

7Z2 3168

OPERATING NOTES

1. When there is a possibility that transient voltage surges will cause an inverse voltage, higher than the maximum permissible non-repetitive peak inverse voltage, a damping circuit across the transformer should be applied, e.g. a series RC damping circuit. Dimensioning of the RC damping circuit may be done according to the following formulae:

$\frac{-V_{DMsurge}}{-V_{DMW}}$ 1)	R-C in primary of transformer		R-C in secondary of transformer	
	C_1 (μF)	R_1C_1 (μs)	C_2 (μF)	R_2C_2 (μs)
2.0	$200 \frac{I_o}{V_1}$	150	$225 \frac{I_o}{V_1} T^2$	200
1.5	$400 \frac{I_o}{V_1}$	225	$450 \frac{I_o}{V_1} T^2$	275
1.25	$550 \frac{I_o}{V_1}$	260	$620 \frac{I_o}{V_1} T^2$	310
1.0	$800 \frac{I_o}{V_1}$	300	$900 \frac{I_o}{V_1} T^2$	350

1) $-V_{DMW}$ stands for the applied crest working inverse voltage

Where I_o = magnetising primary r.m.s. current (A)

V_1 = transformer primary r.m.s. voltage (V)

V_2 = transformer secondary r.m.s. voltage (V)

$T = \frac{V_1}{V_2}$

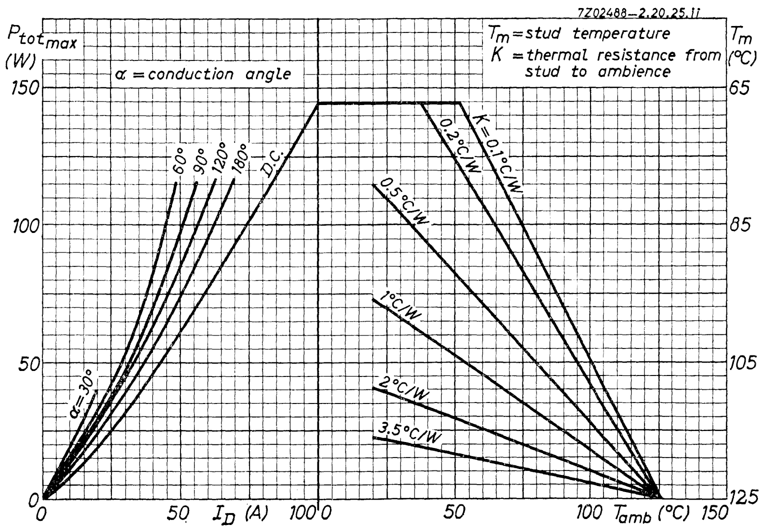
2. To ensure that all thyristors trigger, the firing circuit must provide both the minimum gate-voltage and the minimum gate-current to fire all units at the operating temperature. To do this, the source resistance load line on the gate characteristic must pass through, or above and to the right of, the intersection of the minimum trigger voltage and current, providing the limiting values of gate voltage, current and power are not exceeded. (See page A)

7Z2 2739

OPERATING NOTES (continued)

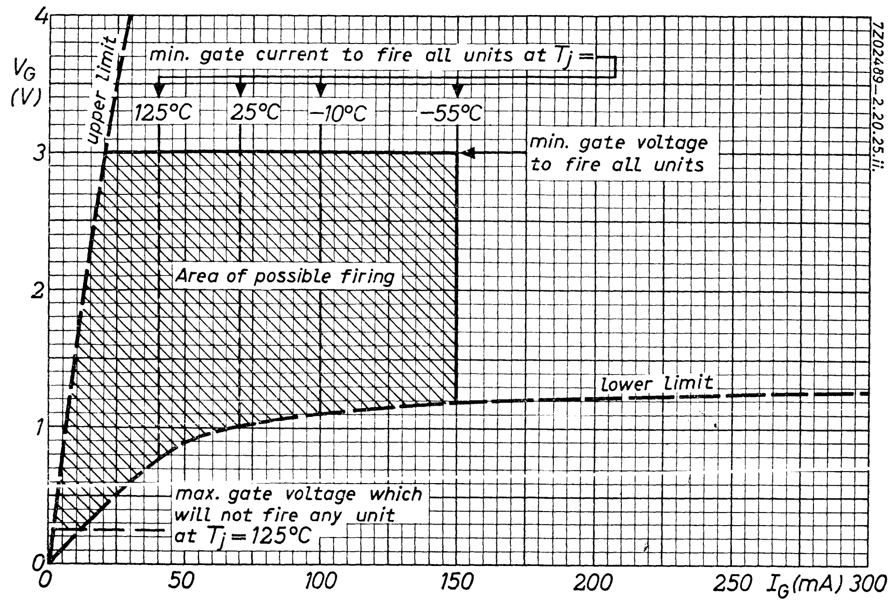
3. Dissipation and heatsink considerations

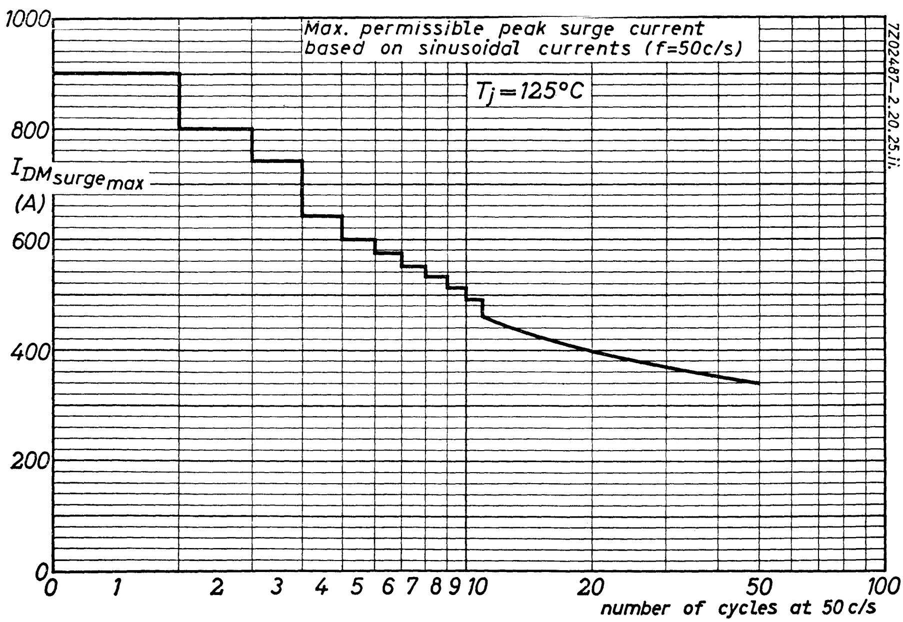
The method of using the curves of the figure below is as follows: Starting with the curve of maximum dissipation as a function of average forward current, for a particular current value trace upwards to meet the appropriate conduction angle curve. Then trace horizontally until the appropriate K-curve is reached (in the case of a given heatsink). Then trace downwards to determine the maximum permissible ambient temperature.
Alternatively, when the maximum ambient temperature is known and the heatsink required is to be determined, trace horizontally until the vertical through the given ambient temperature is reached. The K-value corresponding to the intersection is the maximum thermal resistance from mounting base to ambience. Subtracting the contact thermal resistance gives the maximum thermal resistance of the heatsink, the size of which can then be found from page C.

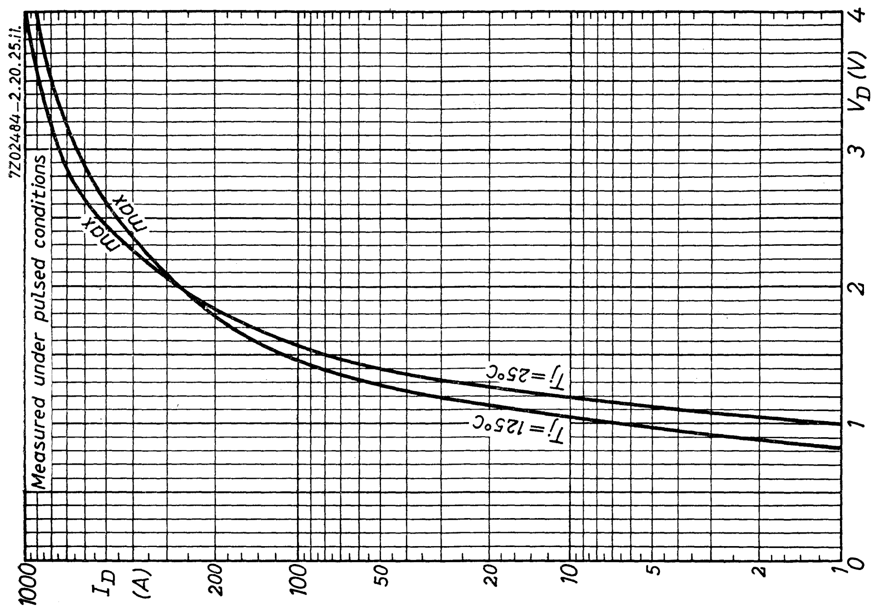


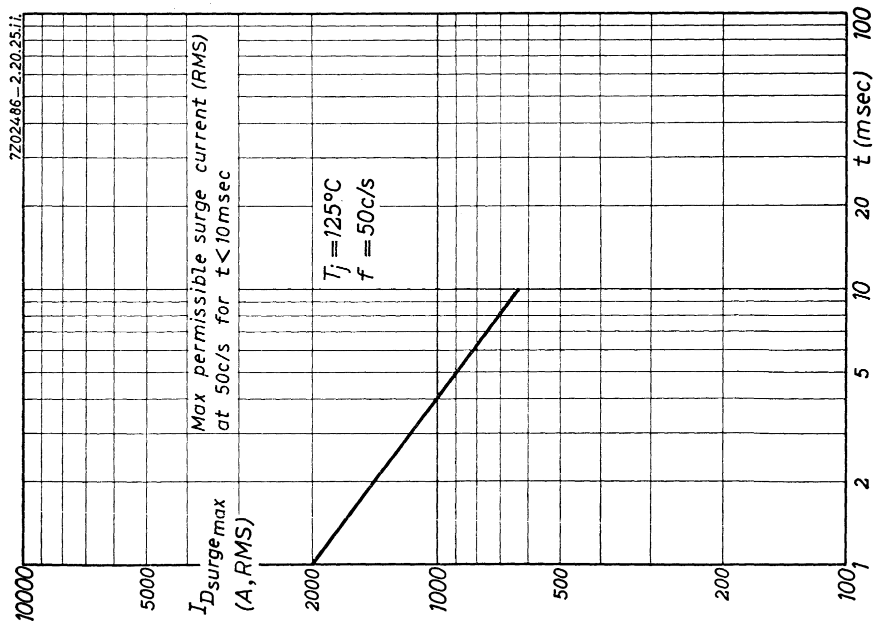
Dissipation as a function of average current and corresponding maximum permissible ambient temperature for various values of K.

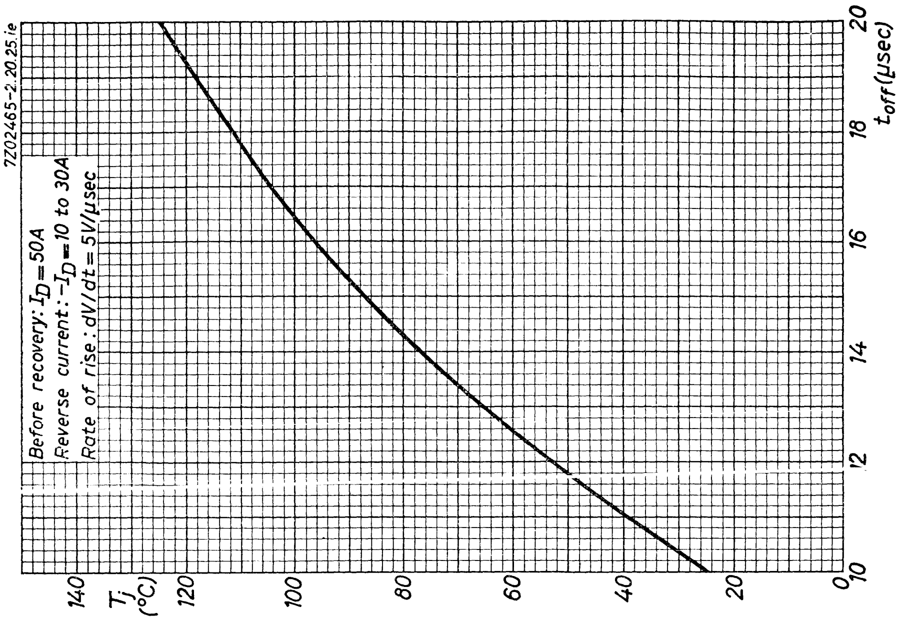
7Z2 2745

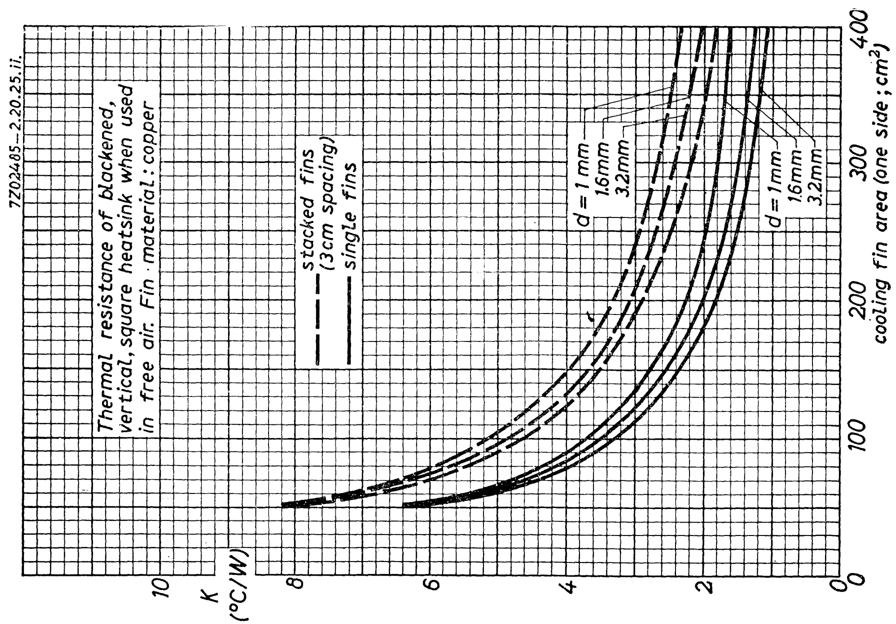

7Z02489—2.20.25.ii.
min. gate current to fire all units at T_j =
125°C
25°C
−10°C
−55°C
upper limit
min. gate voltage to fire all units
Area of possible firing
lower limit
max. gate voltage which will not fire any unit at T_j = 125°C
V_G (V)
I_G (mA)
0
1
2
3
4
50
100
150
200
250
300

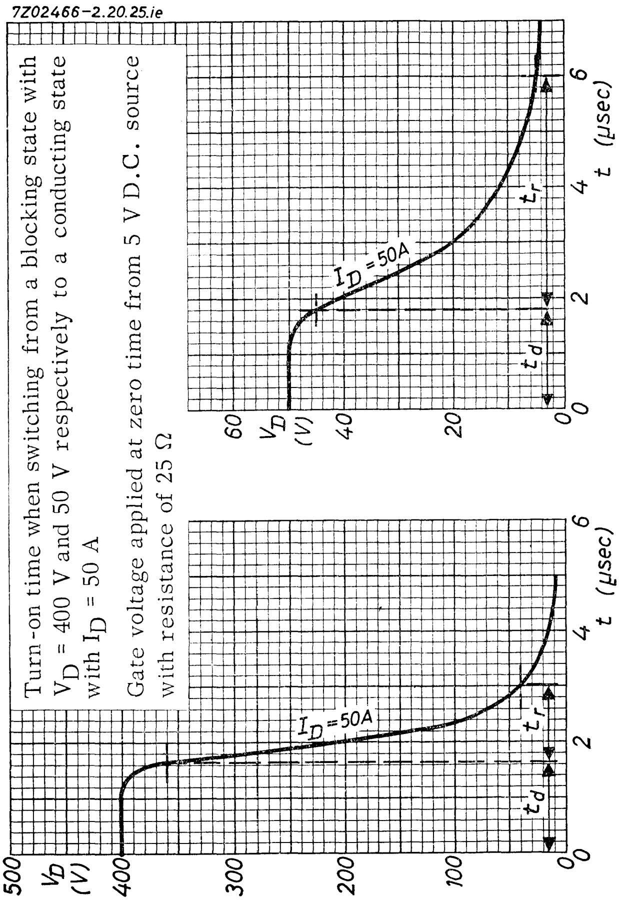

7Z02487—2.20.25.ii.
Max. permissible peak surge current based on sinusoidal currents (f=50c/s)
T_j = 125°C
$I_{DM surge max}$ (A)
0
200
400
600
800
1000
1
2
3
4
5
6
7
8
9
10
20
50
100
number of cycles at 50 c/s


7Z02484-2.20.25.i.i.
Measured under pulsed conditions
max
max
Tj=25°C
Tj=125°C
V_D (V)
4
3
2
1
0
I_D (A)
1000
200
100
50
20
10
5
2
1


7Z02486-2.20.25.i.i.
Max permissible surge current (RMS) at 50c/s for t<10msec
Tj=125°C
f =50c/s
t (msec)
100
20
10
5
2
1
I_Dsurge max (A,RMS)
10000
5000
2000
1000
500
200
100


7Z02465-2.20.25.ie
Before recovery: $I_D = 50A$
Reverse current: $-I_D = 10$ to $30A$
Rate of rise: $dV/dt = 5V/\mu sec$
T_j (°C)
0
20
40
60
80
100
120
140
10
12
14
16
18
20
t_{off} (µsec)


7Z02485-2.20.25.ii.
Thermal resistance of blackened, vertical, square heatsink when used in free air. Fin material: copper
stacked fins (3cm spacing)
single fins
d = 1 mm
1.6mm
3.2mm
d = 1mm
1.6mm
3.2mm
K (°C/W)
0
2
4
6
8
10
0
100
200
300
400
cooling fin area (one side; cm²)


7Z02466−2.20.25.ie
Turn-on time when switching from a blocking state with
V_D = 400 V and 50 V respectively to a conducting state
with I_D = 50 A
Gate voltage applied at zero time from 5 V D.C. source
with resistance of 25 Ω
V_D (V)
500
400
300
200
100
0
60
40
20
0
I_D = 50A
I_D = 50A
t_d
t_r
t_d
t_r
0
2
4
6
t (μsec)
0
2
4
6
t (μsec)

Transistors

GERMANIUM P-N-P TRANSISTOR

Low noise germanium transistor in all glass envelope for use as input stage of tape recorders with a speed of up to 19 cm/s.

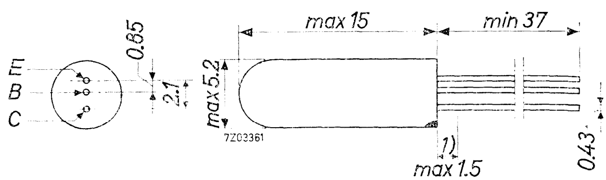
LIMITING VALUES (Absolute max. values)

Collector-base voltage	$-V_{CB}$	max.	15	V
Collector-emitter voltage	$-V_{CE}$	max.	15	V
Collector current (peak value)	$-I_{CM}$	max.	10	mA
Total dissipation up to T_{amb} = 25 °C	P_{tot}	max.	80	mW
Junction temperature	T_j	max.	75	°C

CHARACTERISTICS T_j = 25 °C

Small signal current gain		>	35	
$-I_C$ = 0.3 mA; $-V_{CE}$ = 5 V	h_{fe}	typ.	60	
		<	160	
Cut-off frequency				
I_E = 0.3 mA; $-V_{CB}$ = 5 V	f_{hfb}	>	2	Mc/s
Noise figure at f = 30 c/s to 15 kc/s				
I_E = 0.3 mA; $-V_{CB}$ = 5 V; R_S = 1.5 kΩ	F	<	5	dB

MECHANICAL DATA Dimensions in mm



The red dot indicates the collector. 7Z2 3180

1) Not tinned

GERMANIUM ALLOY JUNCTION TRANSISTOR of the p-n-p type in metal envelope for use in pre-amplifier and driver stages with battery voltages up to 14 V.

LIMITING VALUES (Absolute max. values)

Collector

Voltage (base reference)	$-V_{CB}$	= max.	32 V
Voltage (emitter reference)	$-V_{CE}$	= max.	32 V 1)
Current	$-I_C$	= max.	100 mA

Emitter

Voltage (base reference)	$-V_{EB}$	= max.	10 V

Base

Current	$-I_B$	= max.	5 mA

Dissipation

Total dissipation	P_{tot}	= max.	500 mW

Temperatures

Storage temperature	T_s	=	−55 °C to +90 °C
Junction temperature	T_j	= max.	90 °C

THERMAL DATA

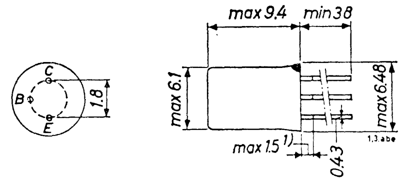
Thermal resistance from junction to ambience in free air	K = max. 0.3 °C/mW
Thermal resistance from junction to ambience with cooling fin mounted on heat sink of at least 12.5 cm²	K = max. 0.09 °C/mW

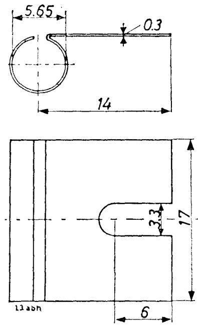
1) For recommended practical limits of $-V_{CE}$ see page F

7Z2 3102
3.3.1965

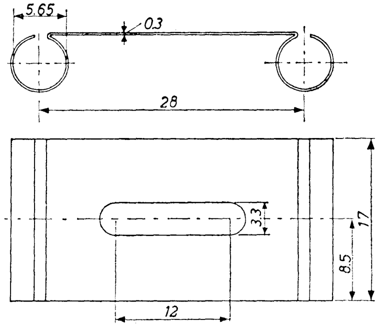
Dimensions in mm

The red dot indicates the collector side





Cooling fin 56227



Cooling fin 56226

CHARACTERISTICS at Tamb = 25 °C

Collector current at I_E = 0 mA

$-I_{CBO}$ ($-V_{CB}$ = 10 V; I_E = 0 mA)	<	10 µA

Collector voltage at V_{BE} = 0 V

$-V_{CB}$ ($-I_C$ = 500 µA; V_{BE} = 0 V)	>	32 V

Emitter voltage at I_C = 0 mA

$-V_{EB}$ ($-I_E$ = 200 µA; I_C = 0 mA)	>	10 V

1) Not tinned

7Z2 1751

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN

Tamb = 25 °C unless otherwise specified

Collector current at I_E = 0 mA			
$-I_{CBO}$		See page D	
Emitter current at I_C = 0 mA			
$-I_{EBO}$	$\{-V_{EB}$ = 5 V; I_C = 0 mA; T_j = 75 °C$\}$		< 550 μA
Current amplification factor $\frac{I_C - I_{CBO}}{I_B + I_{CBO}}$			
h_{FE}	(I_E = 2 mA; $-V_{CB}$ = 5 V)	= 100	> 50
h_{FE}	(I_E = 50 mA; V_{CB} = 0 V)	= 95	
h_{FE}	(I_E = 100 mA; V_{CB} = 0 V)	= 80	
Base voltage			
$-V_{BE}$	(I_E = 2 mA; $-V_{CB}$ = 5 V)	= 105 mV	
$-V_{BE}$	(I_E = 100 mA; V_{CB} = 0 V)		< 400 mV
Frequency at which $\lvert h_{fe}\rvert$ = 1			
f_1	($-V_{CB}$ = 2 V; I_E = 10 mA)	= 1.7 Mc/s	> 1.3 Mc/s
Cut-off frequency			
$f_{\alpha e}$	($-V_{CB}$ = 2 V; I_E = 10 mA)	= 17 kc/s	> 10 kc/s
Base resistance			
$\lvert z_{rb}\rvert$	$\{-V_{CB}$ = 5 V; I_E = 1 mA; f = 0.45 Mc/s$\}$	= 90 Ω	
Collector capacitance			
c_c	$\{-V_{CB}$ = 5 V; I_E = 0 mA; f = 0.45 Mc/s$\}$	= 40 pF	< 50 pF
Noise figure			
F	$\{-V_{CB}$ = 5 V; I_E = 0.5 mA; f = 1 kc/s; B = 200 c/s; Input source resistance = 500 Ω$\}$	= 4 dB	< 10 dB

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN (continued)

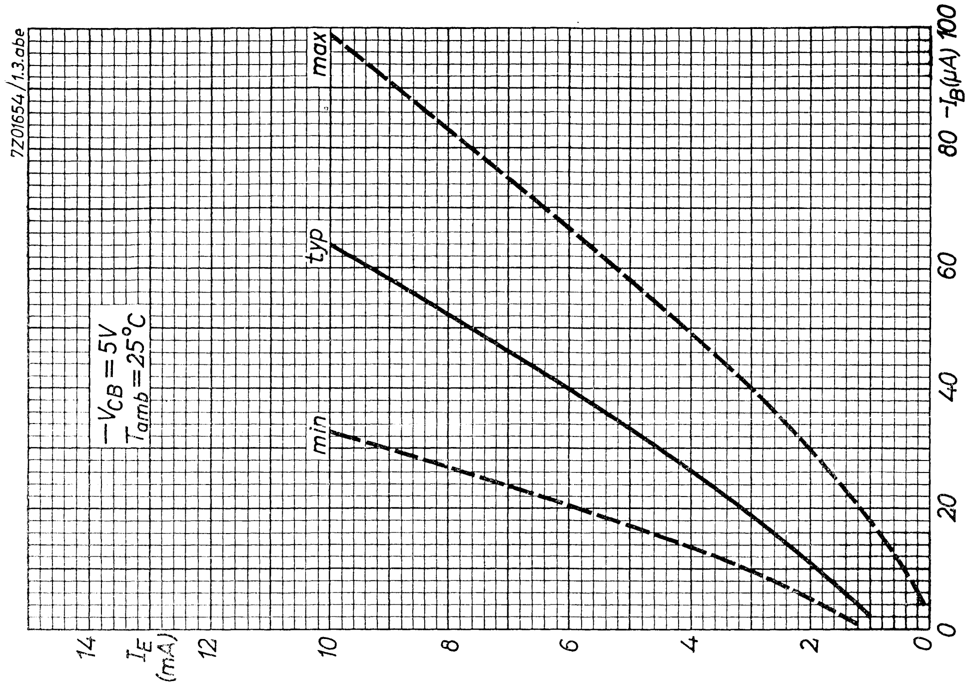
Tamb = 25 °C

Small signal parameters

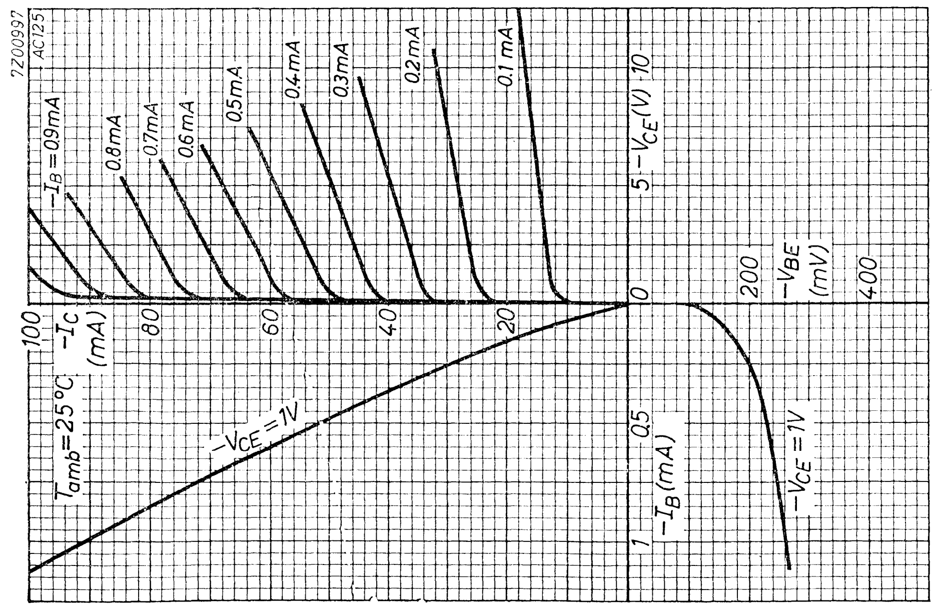
Measured at

Collector voltage	$-V_{CB}$ = 5 V	
Emitter current	I_E = 2 mA	
Frequency	f = 1 kc/s	

Input impedance	h_{ie} = 1.7 kΩ	> 1.1 kΩ < 2.5 kΩ
Voltage feedback ratio	h_{re} = 6.5×10^{-4}	< 8.5×10^{-4}
Current amplification factor	h_{fe} = 125	> 80 < 170
Output admittance	h_{oe} = 80 μA/V	< 110 μA/V

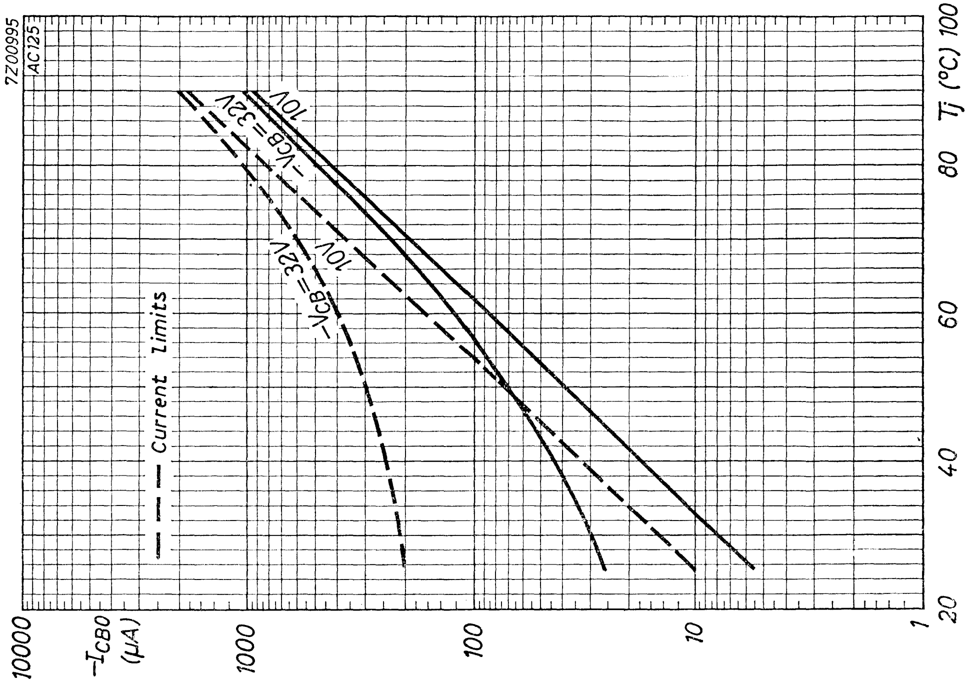

7Z01654/1.3.abe
$-V_{CB}=5V$
$T_{amb}=25°C$
max
typ
min
I_E (mA)
14
12
10
8
6
4
2
0
0
20
40
60
80
100
$-I_B(\mu A)$

B

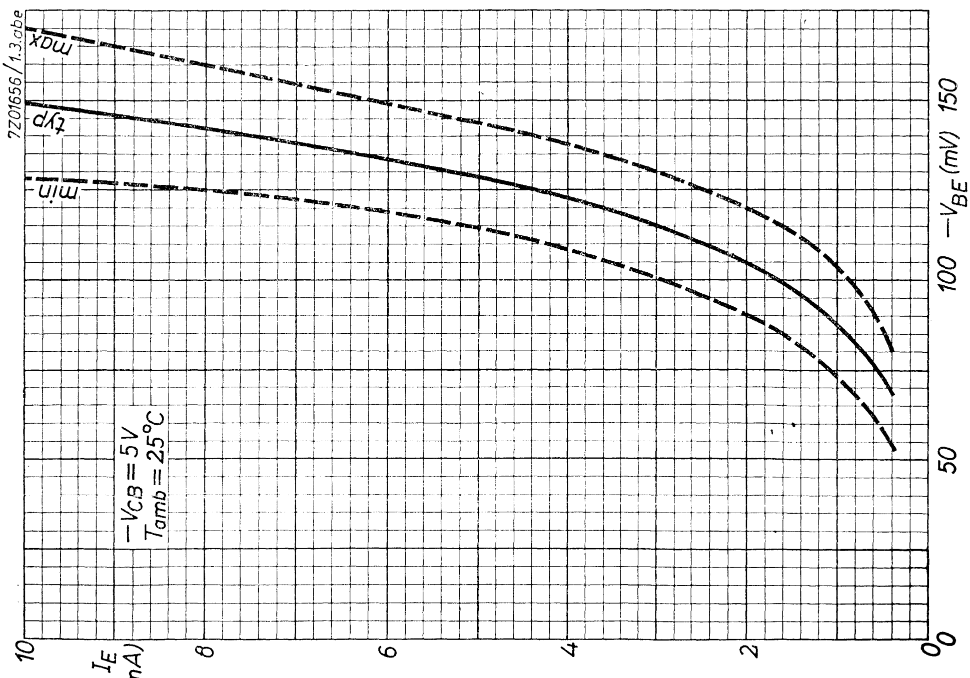

7Z00997
AC125
$T_{amb}=25°C$
$-I_C$ (mA)
100
80
60
40
20
$-I_B=0.9mA$
0.8mA
0.7mA
0.6mA
0.5mA
0.4mA
0.3mA
0.2mA
0.1 mA
0
5
10
$-V_{CE}(V)$
$-V_{CE}=1V$
0.5
1
$-I_B$ (mA)
200
400
$-V_{BE}$ (mV)
$-V_{CE}=1V$

A

4.4.1963

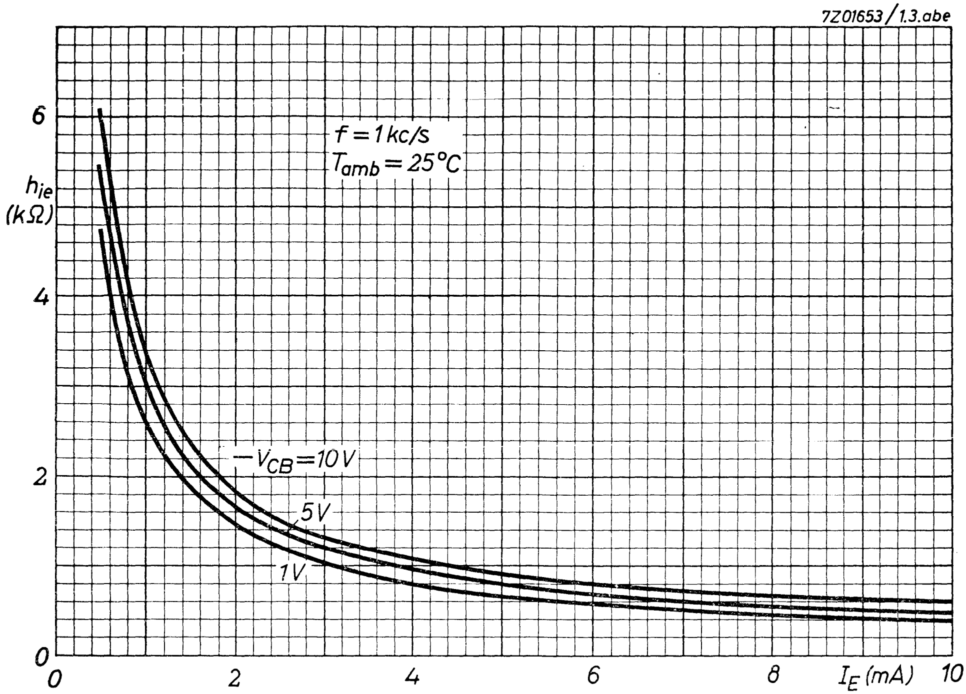

7Z00995
AC125
Current Limits
−V_CB = 32V
10V
−V_CB = 32V
10V
−I_CBO (µA)
10000
1000
100
10
1
Tj (°C)
20
40
60
80
100

D

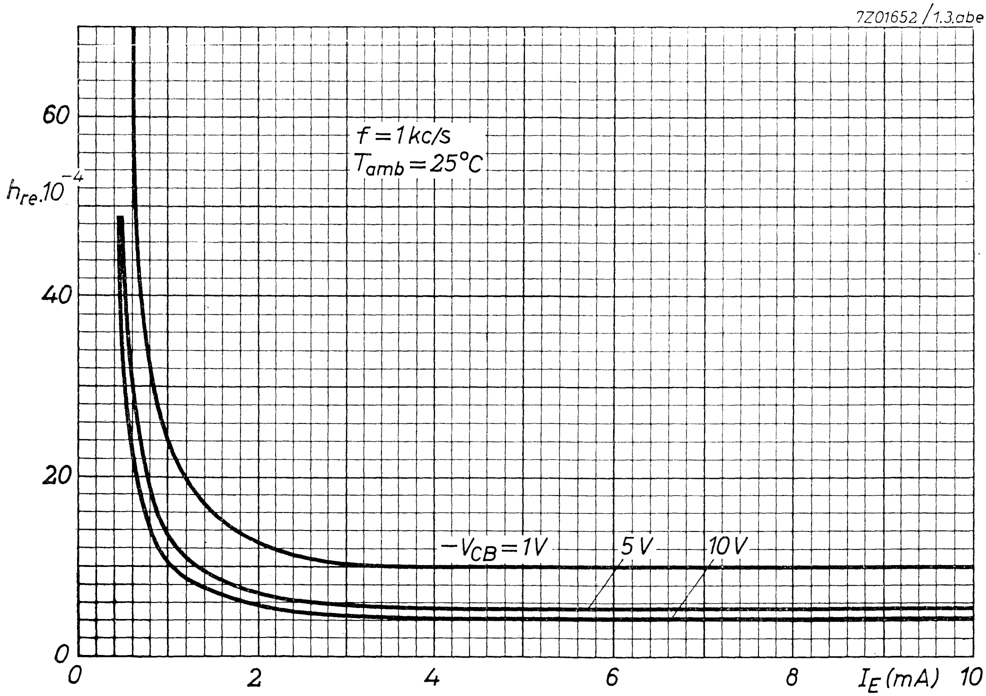

7Z01656/1.3.abe
max
typ
min
−V_CB = 5 V
T_amb = 25°C
I_E (mA)
10
8
6
4
2
0
−V_BE (mV)
0
50
100
150

C

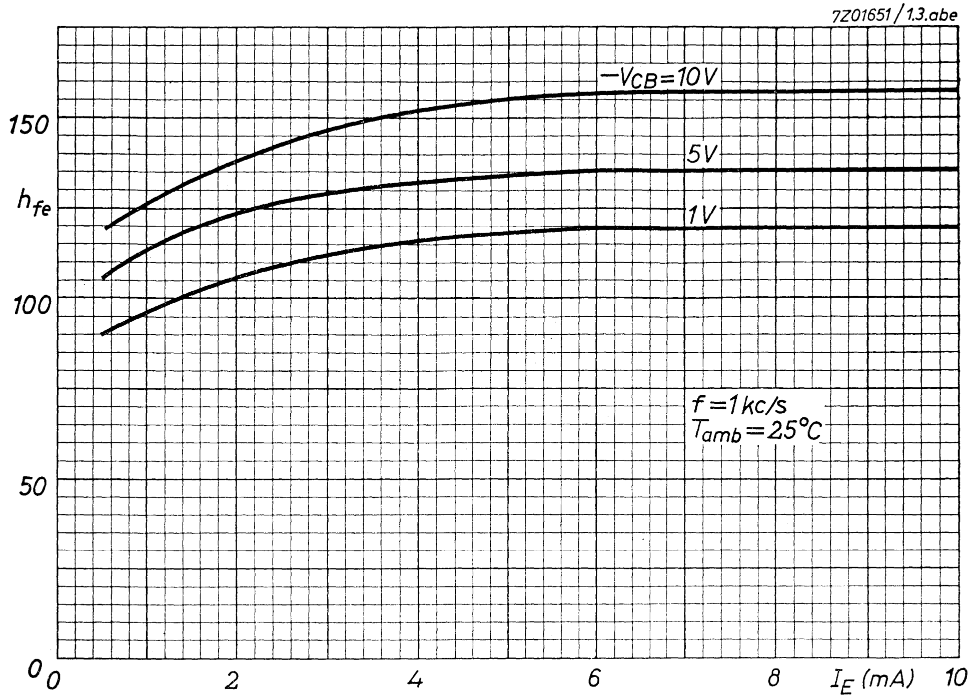
4.4.1963


7Z01653/1.3.abe
f = 1 kc/s
Tamb = 25°C
hie
(kΩ)
6
4
2
0
−VCB = 10 V
5 V
1 V
0
2
4
6
8
IE (mA)
10

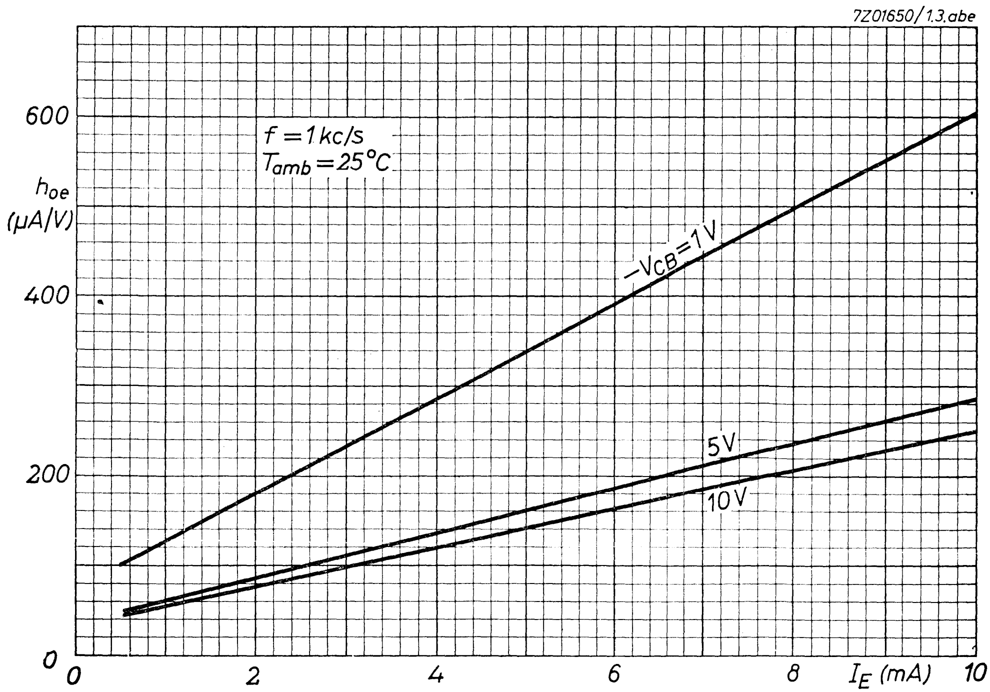
E


7Z01652/1.3.abe
f = 1 kc/s
Tamb = 25°C
hre.10−4
60
40
20
0
−VCB = 1 V
5 V
10 V
0
2
4
6
8
IE (mA)
10

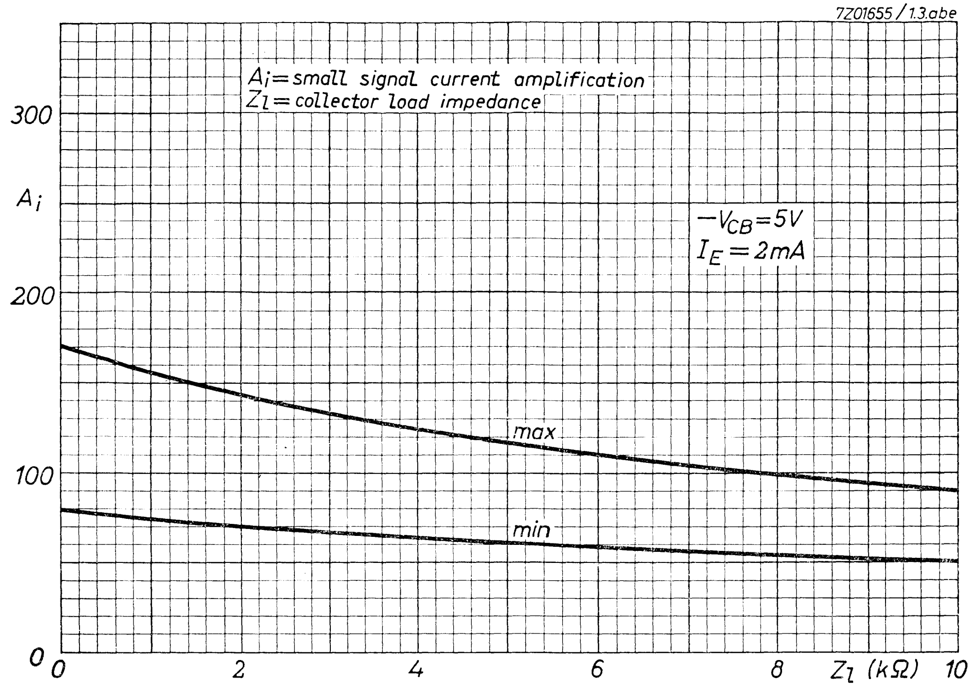
F

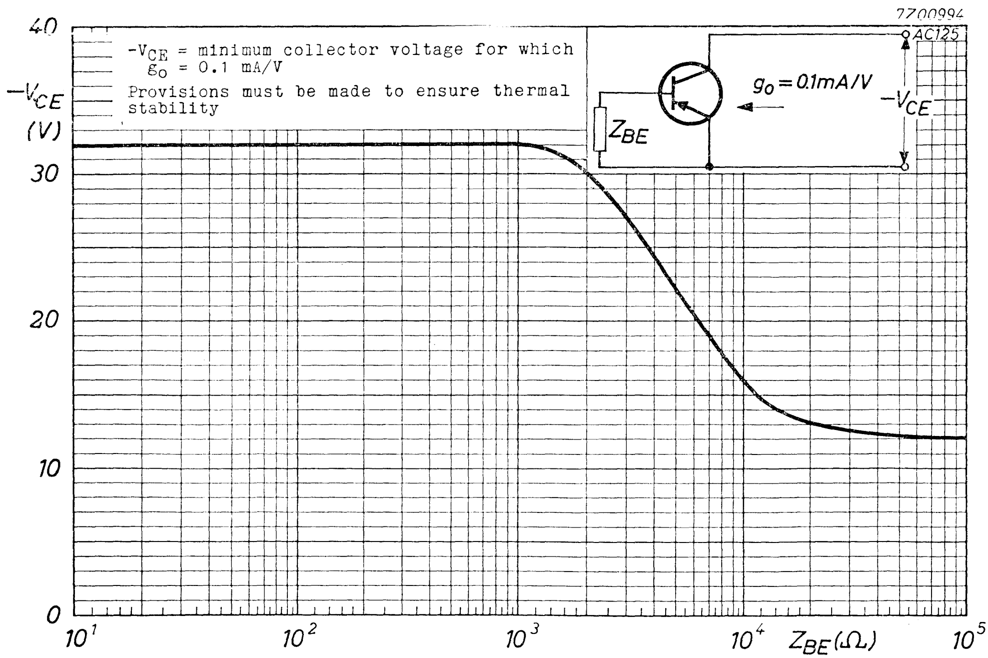

7Z01651/1.3.abe
$-V_{CB}$=10V
5V
1V
h_{fe}
150
100
50
0
f=1kc/s
T_{amb}=25°C
0
2
4
6
8
I_E (mA)
10

G


7Z01650/1.3.abe
600
400
200
0
h_{oe}
(μA/V)
f=1kc/s
T_{amb}=25°C
$-V_{CB}$=1V
5V
10V
0
2
4
6
8
I_E (mA)
10

H


7Z01655 / 1.3.abe
A_i = small signal current amplification
Z_l = collector load impedance
$-V_{CB}$ = 5V
I_E = 2mA
max
min
A_i
300
200
100
0
0
2
4
6
8
Z_l (kΩ)
10


7Z00994
AC125
$-V_{CE}$ = minimum collector voltage for which g_o = 0.1 mA/V
Provisions must be made to ensure thermal stability
g_o = 0.1mA/V
$-V_{CE}$
Z_{BE}
$-V_{CE}$ (V)
40
30
20
10
0
10^1
10^2
10^3
10^4
Z_{BE} (Ω)
10^5

4.4.1963

GERMANIUM ALLOY JUNCTION TRANSISTOR of the p-n-p type in metal envelope for use in pre-amplifier and driver stages with battery voltages up to 14 V.

LIMITING VALUES (Absolute max. values)

Collector

Voltage (base reference)	$-V_{CB}$ = max.	32 V
Voltage (emitter reference)	$-V_{CE}$ = max.	32 V [1])
Current	$-I_C$ = max.	100 mA

Emitter

Voltage (base reference)	$-V_{EB}$ = max.	10 V

Base

Current	$-I_B$ = max.	5 mA

Dissipation

Total dissipation	P_{tot} = max.	500 mW

Temperatures

Storage temperature	T_s =	-55 °C to +90 °C
Junction temperature	T_j = max.	90 °C

THERMAL DATA

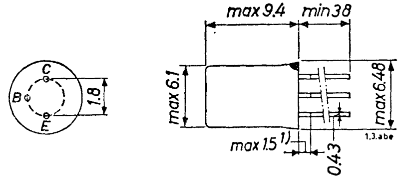
Thermal resistance from junction to ambience in free air	K = max. 0.3 °C/mW
Thermal resistance from junction to ambience with cooling fin mounted on heat sink of at least 12.5 cm²	K = max. 0.09 °C/mW

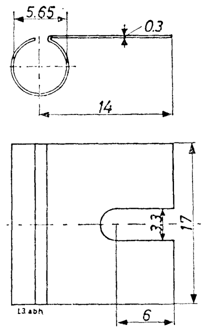
1) For recommended practical limits of $-V_{CE}$ see page F

7Z2 3102
3.3.1965

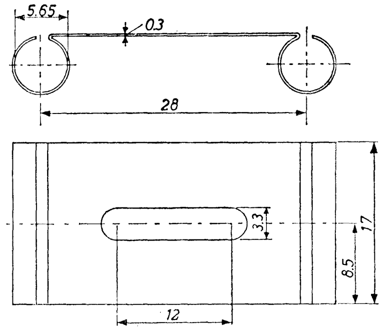
Dimensions in mm

The red dot indicates the collector side





Cooling fin 56227



Cooling fin 56226

CHARACTERISTICS at T_{amb} = 25 °C

Collector current at I_E = 0 mA

$-I_{CBO}$ ($-V_{CB}$ = 10 V; I_E = 0 mA)	<	10 µA

Collector voltage at V_{BE} = 0 V

$-V_{CB}$ ($-I_C$ = 500 µA; V_{BE} = 0 V)	>	32 V

Emitter voltage at I_C = 0 mA

$-V_{EB}$ ($-I_E$ = 200 µA; I_C = 0 mA)	>	10 V

1) Not tinned

7Z2 1751

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN

T_{amb} = 25 °C unless otherwise specified

Collector current at I_E = 0 mA

$-I_{CBO}$		See page D	

Emitter current at I_C = 0 mA

$-I_{EBO}$	$-V_{EB}$ = 5 V; I_C = 0 mA; T_j = 75 °C		< 550 µA

Current amplification factor $\frac{I_C - I_{CBO}}{I_B + I_{CBO}}$

h_{FE}	(I_E = 2 mA; $-V_{CB}$ = 5 V)	= 140	> 65
h_{FE}	(I_E = 50 mA; V_{CB} = 0 V)	= 135	
h_{FE}	(I_E = 100 mA; V_{CB} = 0 V)	= 105	

Base voltage

$-V_{BE}$	(I_E = 2 mA; $-V_{CB}$ = 5 V)	= 105 mV	
$-V_{BE}$	(I_E = 100 mA; V_{CB} = 0 V)		< 400 mV

Frequency at which $|h_{fe}|$ = 1

f_1	($-V_{CB}$ = 2 V; I_E = 10 mA)	= 2.3 Mc/s	> 1.7 Mc/s

Cut-off frequency

$f_{\alpha e}$	($-V_{CB}$ = 2 V; I_E = 10 mA)	= 17 kc/s	> 10 kc/s

Base resistance

$\lvert z_{rb} \rvert$	$-V_{CB}$ = 5 V; I_E = 1 mA; f = 0.45 Mc/s	= 90 Ω	

Collector capacitance

c_c	$-V_{CB}$ = 5 V; I_E = 0 mA; f = 0.45 Mc/s	= 40 pF	< 50 pF

Noise figure

F	$-V_{CB}$ = 5 V; I_E = 0.5 mA; f = 1 kc/s; B = 200 c/s; Input source resistance = 500 Ω	= 4 dB	< 10 dB

7Z2 1804
4.4.1963

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN (continued)

T_{amb} = 25 °C

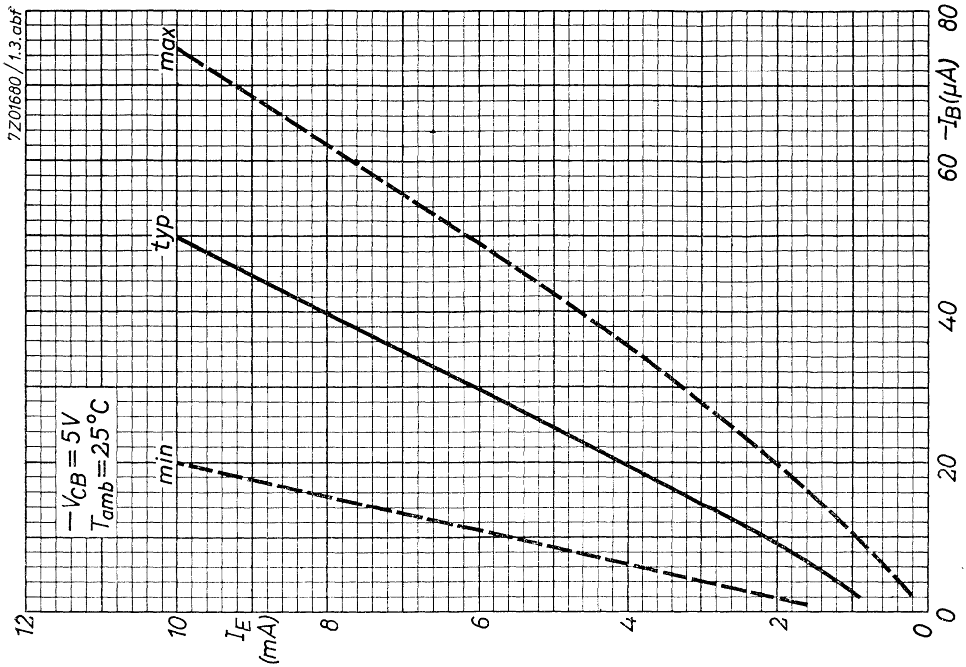
Small signal parameters

Measured at

Collector voltage	$-V_{CB}$	= 5 V
Emitter current	I_E	= 2 mA
Frequency	f	= 1 kc/s

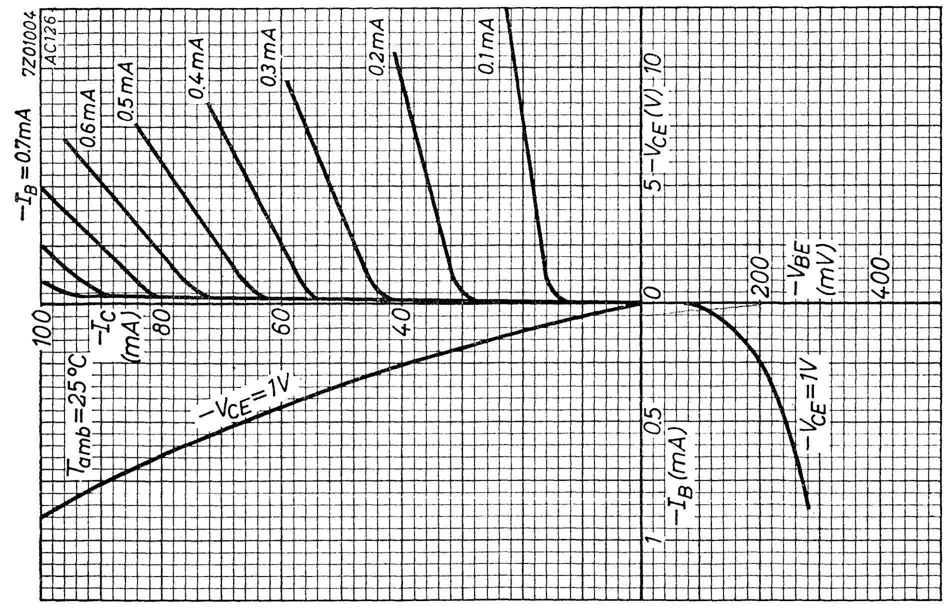
Input impedance	h_{ie} = 2.4 kΩ	> 1.7 kΩ < 3.8 kΩ
Voltage feedback ratio	h_{re} = 8×10^{-4}	< 13×10^{-4}
Current amplification factor	h_{fe} = 180	> 130 < 300
Output admittance	h_{oe} = 100 µA/V	< 170 µA/V

7Z2 1174



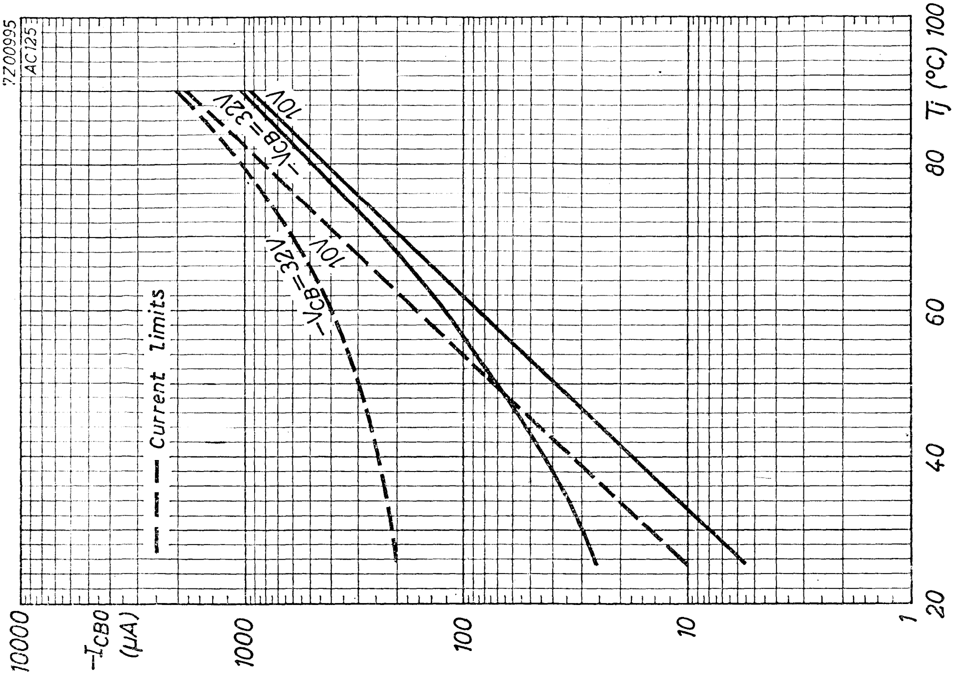
7Z01680/1.3.abf
max
typ
min
$-V_{CB}=5V$
$T_{amb}=25°C$
I_E (mA)
0
2
4
6
8
10
12
$-I_B$ (μA)
0
20
40
60
80

B

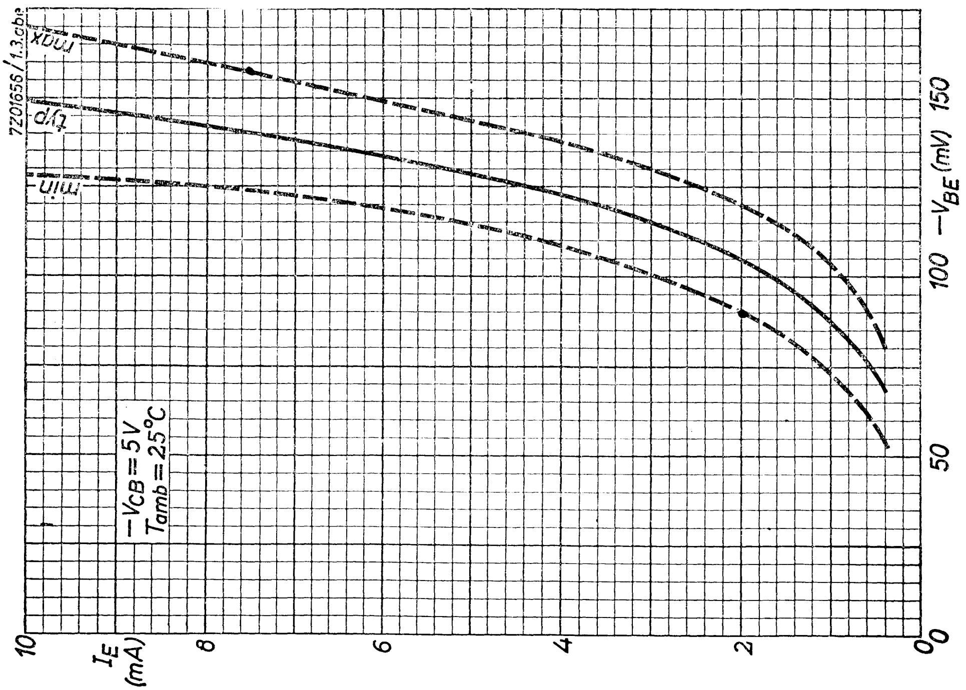


7Z01004
AC126
$-I_B=0.7mA$
0.6mA
0.5mA
0.4mA
0.3mA
0.2mA
0.1mA
$-I_C$ (mA)
100
80
60
40
$T_{amb}=25°C$
$-V_{CE}=1V$
0
5
10
$-V_{CE}$ (V)
$-I_B$ (mA)
0.5
1
200
400
$-V_{BE}$ (mV)
$-V_{CE}=1V$

A

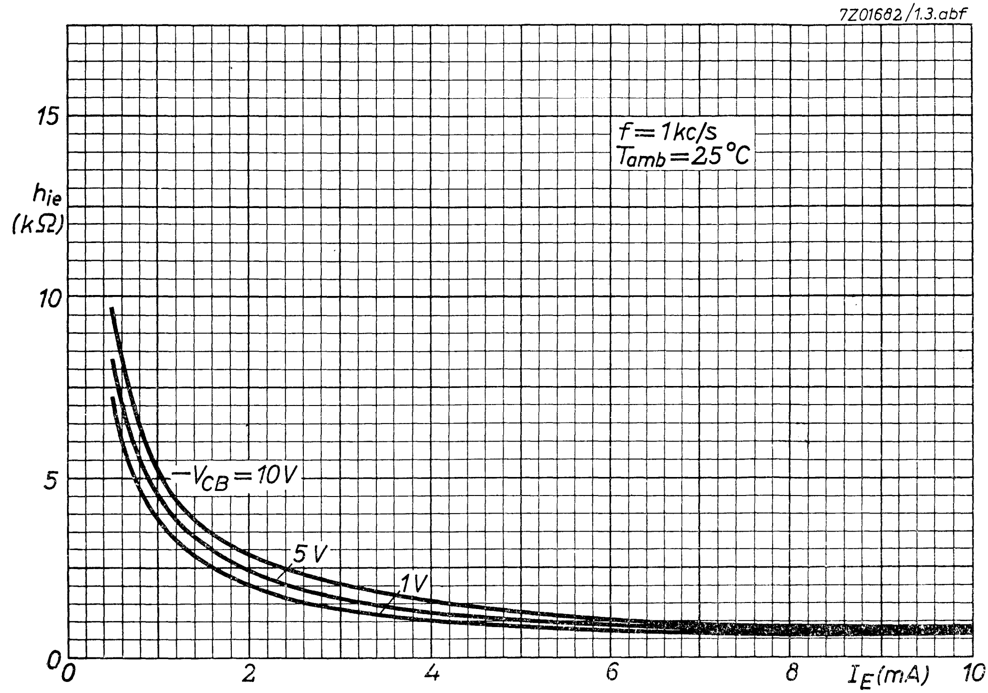

7Z00995
AC125
$-I_{CBO}$ (μA)
10000
1000
100
10
1
20
40
60
80
100
Tj (°C)
Current Limits
$-V_{CB}=32V$
10V
$-V_{CB}=32V$
10V

D

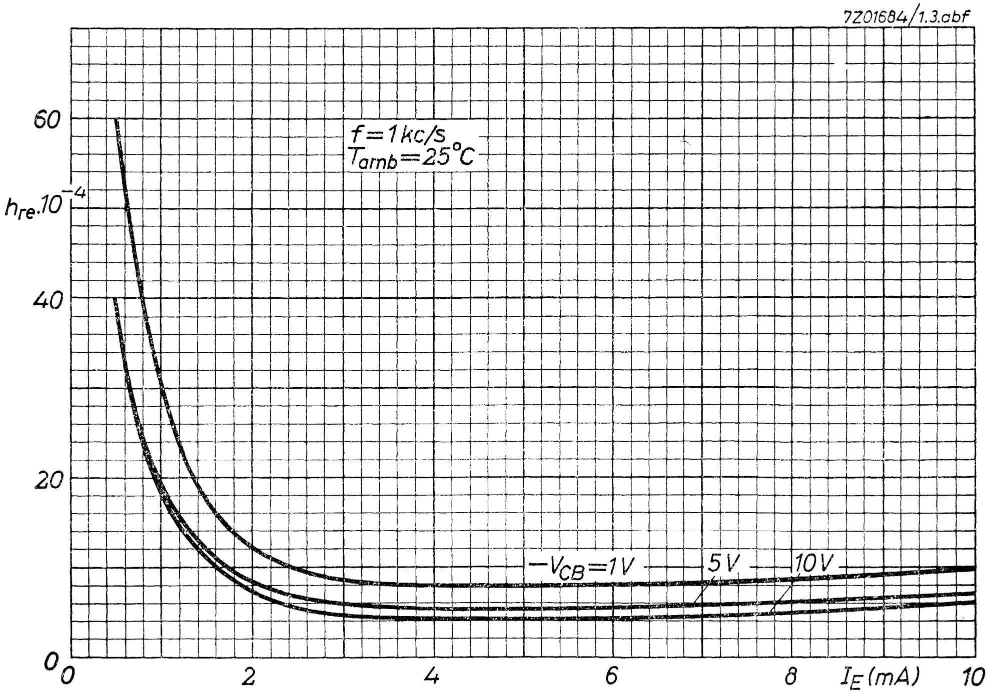

7Z01656/1.3.cbe
I_E (mA)
10
8
6
4
2
0
0
50
100
150
$-V_{BE}$ (mV)
max
typ
min
$-V_{CB}=5V$
$T_{amb}=25°C$

C

4.4.1963

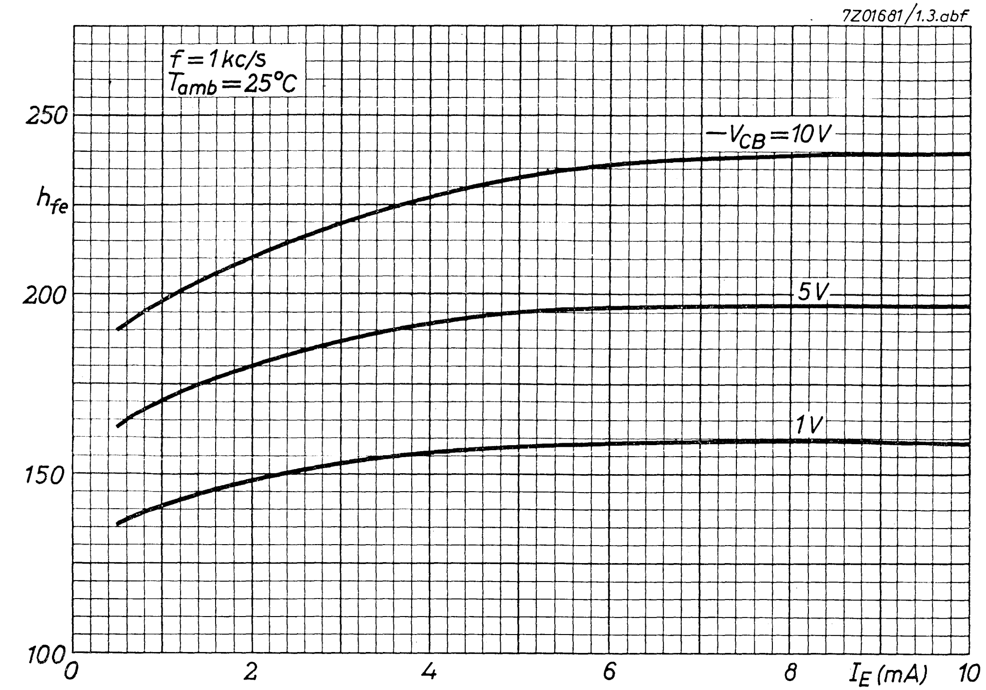

7Z01682/1.3.abf
f = 1 kc/s
T_amb = 25 °C
h_ie (kΩ)
15
10
5
0
−V_CB = 10 V
5 V
1 V
0
2
4
6
8
I_E (mA)
10

E

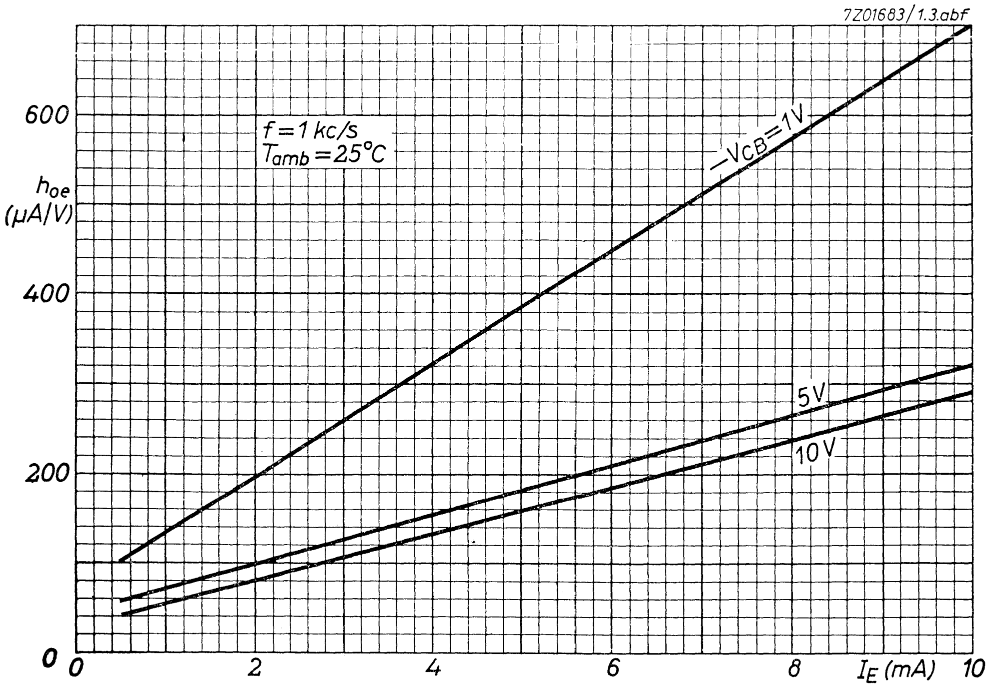

7Z01684/1.3.abf
f = 1 kc/s
T_amb = 25 °C
h_re.10^-4
60
40
20
0
−V_CB = 1 V
5 V
10 V
0
2
4
6
8
I_E (mA)
10

F

4.4.1963

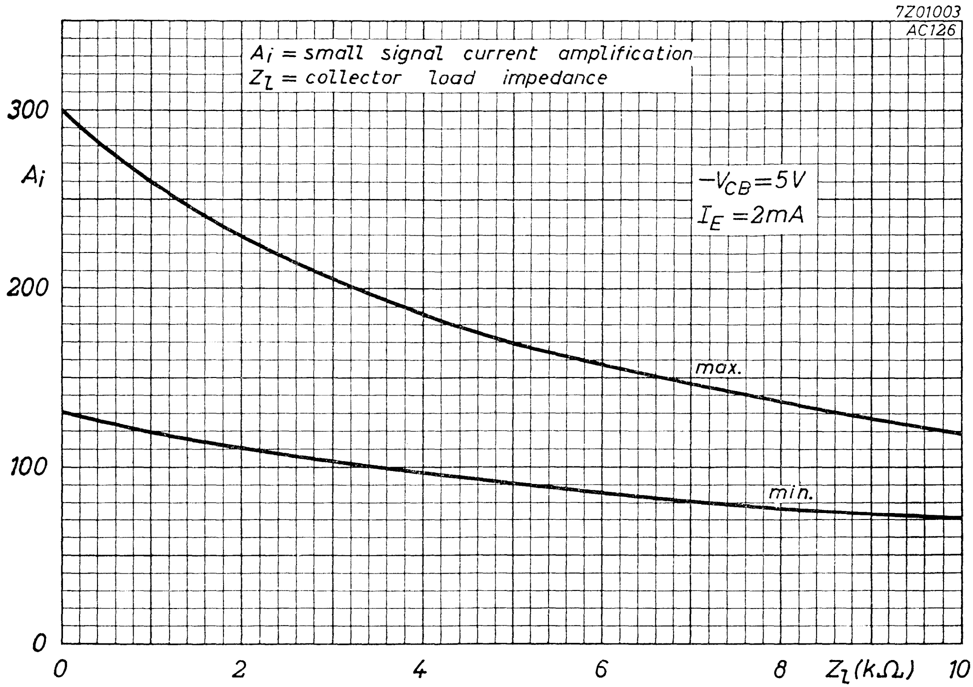

7Z01681/1.3.abf
f = 1 kc/s
T_{amb} = 25°C
250
h_{fe}
200
150
100
0
2
4
6
8
10
I_E (mA)
$-V_{CB}$ = 10 V
5 V
1 V

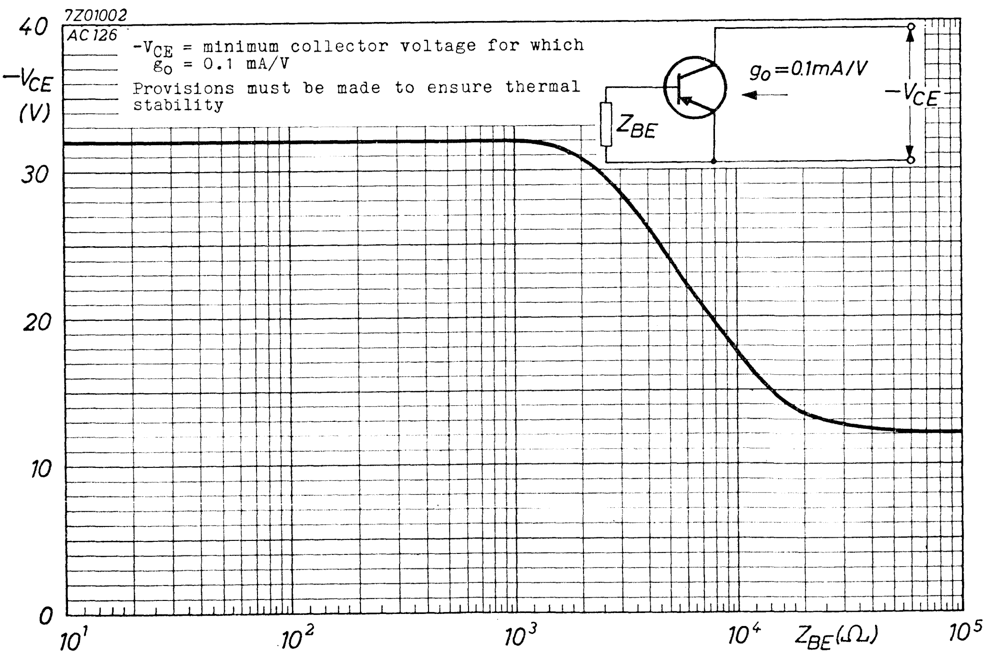
G


7Z01683/1.3.abf
600
f = 1 kc/s
T_{amb} = 25°C
h_{oe}
(μA/V)
400
200
0
0
2
4
6
8
10
I_E (mA)
$-V_{CB}$ = 1 V
5 V
10 V

H

4.4.1963


7Z01003
AC126
A_i = small signal current amplification
Z_l = collector load impedance
300
A_i
200
100
0
$-V_{CB}$=5V
I_E =2mA
max.
min.
0
2
4
6
8
Z_l(kΩ)
10


7Z01002
AC 126
$-V_{CE}$ = minimum collector voltage for which g_o = 0.1 mA/V
Provisions must be made to ensure thermal stability
40
$-V_{CE}$
(V)
30
20
10
0
g_o=0.1mA/V
$-V_{CE}$
Z_{BE}
10^1
10^2
10^3
10^4
Z_{BE}(Ω)
10^5

4.4.1963

HIGH GAIN GERMANIUM N-P-N TRANSISTOR

Germanium alloy junction transistor of the n-p-n type in metal case with high gain primarily intended for operation in complementary symmetrical class B output stages in combination with type AC128 or AC132.

LIMITING VALUES (Absolute max. values)

Collector				
Voltage (base reference)	V_{CB}	=	max.	32 V
Voltage (emitter reference)	V_{CE}	=	max.	32 V [1]
Current	I_C	=	max.	500 mA
Emitter				
Voltage (base reference)	V_{EB}	=	max.	10 V
Base				
Current	I_B	=	max.	25 mA
Dissipation				
Total dissipation	P_{tot}	=	max.	340 mW
Temperatures				
Storage temperature	T_s	=		−55 °C to +90 °C
Junction temperature				
continuous	T_j	=	max.	90 °C
incidentally (max. 200 hrs)	T_j	=	max.	100 °C

[1]) See page G

7Z2 3049

3.3.1965

THERMAL DATA

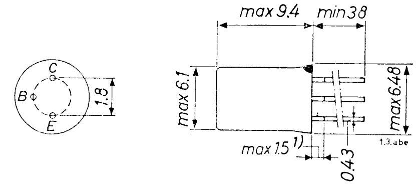
Thermal resistance from

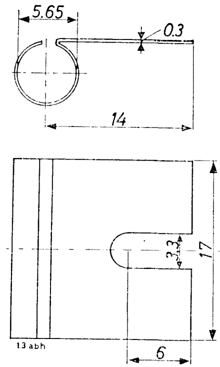
junction to case	K	=	max. 0.11 °C/mW
junction to ambience in free air	K	=	max. 0.37 °C/mW
junction to ambience with cooling fin mounted on a heatsink of at least 12.5 cm^2	K	=	max. 0.16 °C/mW

MECHANICAL DATA

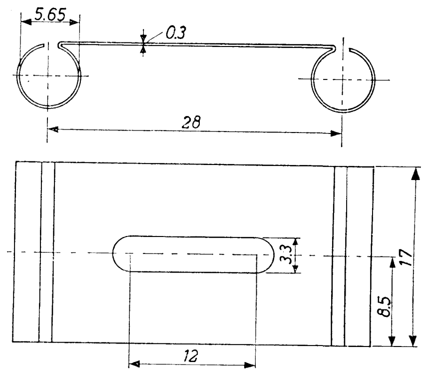
The blue dot indicates the collector

Dimensions in mm





Cooling fin 56227



Cooling fin 56226

[1]) Not tinned

7Z2 2310

CHARACTERISTICS at T_{amb} = 25 °C

Collector current at $I_E = 0$			
$V_{CB} = 0.5$ V	I_{CBO}	<	10 µA
Collector voltage at $V_{BE} = 0$			
$I_C = 500$ µA	V_{CB}	>	32 V
Emitter voltage at $I_C = 0$			
$I_E = 200$ µA	V_{EB}	>	10 V

Characteristics of matched pairs AC127/AC128

Ratio of D.C. current amplification factors			
$\|I_E\| = 300$ mA; $V_{CB} = 0$	h_{FE1}/h_{FE2}	=	1.1

Characteristics of matched pairs AC127/AC132

Ratio of D.C. current amplification factors			
$\|I_E\| = 50$ mA; $V_{CB} = 0$	h_{FE1}/h_{FE2}	= <	1.1 1.25

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN T_{amb} = 25 °C, unless otherwise specified

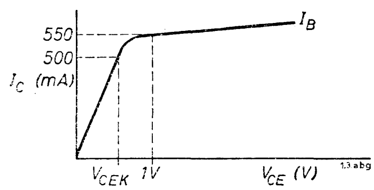
Collector current at $I_E = 0$	I_{CBO}	See page F	
Emitter current at $I_C = 0$			
$V_{EB} = 5$ V; $T_j = 75$ °C	I_{EBO}	<	550 µA
Large signal current amplification factor 1)			
$-I_E = 20$ mA; $V_{CB} = 0$	h_{fel}	=	100
$-I_E = 50$ mA; $V_{CB} = 0$	h_{fel}	=	105
$-I_E = 200$ mA; $V_{CB} = 0$	h_{fel}	=	90
$-I_E = 500$ mA; $V_{CB} = 0$	h_{fel}	=	50

1) $h_{fel} = \dfrac{I_C - I_{CBO}}{I_B + I_{CBO}}$ for V_{CE} = constant.

7Z2 2311

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN (continued) T_{amb} = 25 °C

Base voltage. See also pages C and E				
$V_{CB} = 5$ V; $-I_E = 2$ mA	V_{BE}	= 120 mV		
$V_{CB} = 0$ V; $-I_E = 500$ mA	V_{BE}			< 1.2 V
Collector knee voltage at $I_C = 500$ mA				
	I_B	=	value at which I_C = 550 mA and V_{CE} = 1 V	

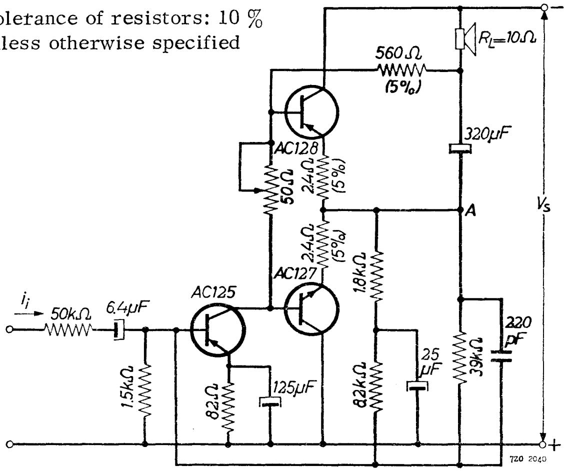


	V_{CEK}			< 1 V
Frequency at which $\|h_{fe}\| = 1$				
$V_{CB} = 2$ V; $-I_E = 10$ mA	f_1	= 2.5 Mc/s		> 1.5 Mc/s
Cut-off frequency				
$V_{CB} = 2$ V; $-I_E = 10$ mA	$f_{\alpha e}$	=	20 kc/s	> 10 kc/s
Base impedance at f = 0.45 Mc/s				
$V_{CB} = 5$ V; $-I_E = 1$ mA	$\|z_{rb}\|$	=	70 Ω	
Collector capacitance				
$V_{CB} = 5$ V; $I_E = 0$; f = 0.45 Mc/s	c_c	=	70 pF	
Noise figure at f = 1 kc/s				
$V_{CB} = 5$ V; $-I_E = 0.5$ mA; B = 200 c/s; Input source resistance = 500 Ω	F	=	4 dB	< 10 dB

7Z2 2312

OPERATING CHARACTERISTICS OF A MATCHED PAIR AC127/AC128 as class B complementary symmetrical amplifier with an output power of 550 mW.

Tolerance of resistors: 10 %
unless otherwise specified



Stable continuous operation is ensured up to an ambient temperature of 45 °C provided each transistor is mounted with a cooling fin (code No. 56226)

Figures apply for T_{amb} = 25 °C

Supply voltage	V_S	= 9 V	
Output power (d_{tot} = 10%)	P_o	= 550 mW	> 500 mW
Distortion	d_{tot}	= see curve page 6	

Output stage

Zero signal emitter current	$\|I_E\|$	= 3 mA	
Peak collector current	$\|I_{CM}\|$	= 300 mA	
Midtap voltage on point A	V_A	= 4.9 V	

Driver stage

Collector current	$-I_C$	= 7 mA	

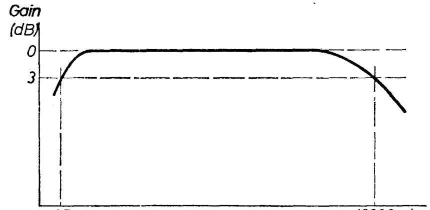
7Z2 2321

OPERATING CHARACTERISTICS OF A MATCHED PAIR AC127/AC128 as class B complementary symmetrical amplifier with an output power of 550 mW (continued)

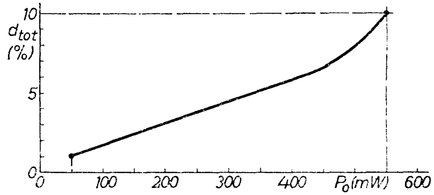
Sensitivity

Input current (R.M.S. value)

P_o = 550 mW	I_i = 120 μA
P_o = 50 mW	I_i = 35 μA



Typical frequency response

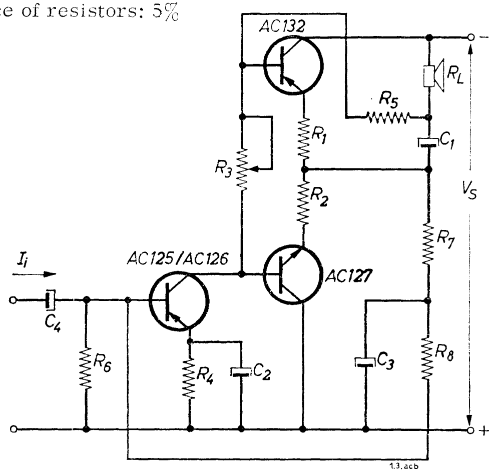


Typical distortion as a function of output power

7Z2 2322

OPERATING CHARACTERISTICS OF A MATCHED PAIR AC127/AC132 as class B complementary symmetrical amplifier with an output power of 370 mW

Tolerance of resistors: 5%



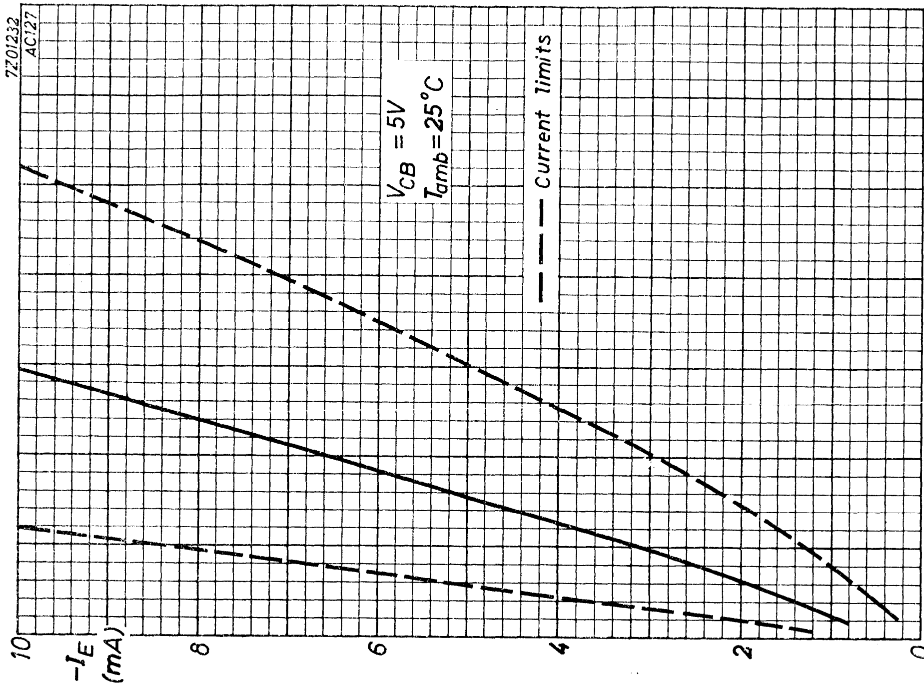
Stable continuous operation is ensured up to T_{amb} = 45 °C

For the 370 mW circuit each transistor should be mounted with a cooling fin.

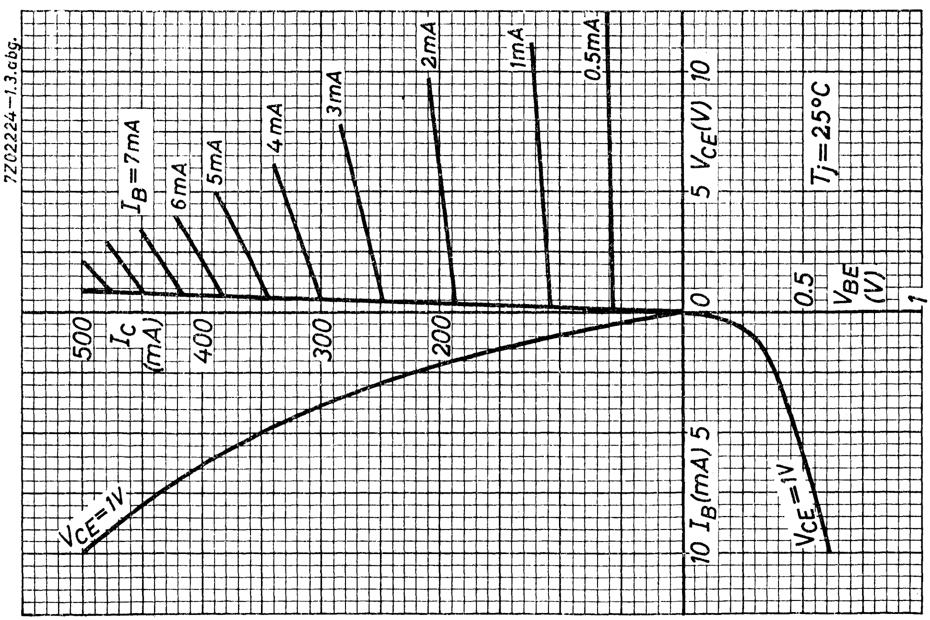
For tables see next page

OPERATING CHARACTERISTICS OF A MATCHED PAIR AC127/AC132 (continued)

			I	II	III
Supply voltage	V_S	=	6	9	9 V
Power output (at d = 10%)	P_o	=	115	110	370 mW
	P_o	= min.	105	100	300 mW
Distortion	d	=	See page H		
Output stage					
Zero signal emitter current	I_{E1}	=	2	2	2 mA
	$-I_{E2}$	=	2	2	2 mA
Emitter resistors	R_1	=	3.3	4.7	3.9 Ω
	R_2	=	3.3	4.7	3.9 Ω
Bias resistor	R_3	= max.	100	250	50 Ω
Coupling capacitor	C_1	=	200	64	320 μF
Load resistance	R_L	=	25	70	15 Ω
Peak collector current at P_o = max.	$\|I_{CM}\|$	=	90	50	200 mA
Driver stage					
Collector current	$-I_C$	=	2.7	1.2	7.6 mA
Emitter resistor	R_4	=	180	680	82 Ω
Collector resistor	R_5	=	910	3300	510 Ω
Bias resistors	R_6	=	4.7	6.8	1.8 kΩ
	R_7	=	3.9	4.7	2.2 kΩ
	R_8	=	15	24	6.8 kΩ
Decoupling capacitors	C_2	=	40	25	120 μF
	C_3	=	25	25	25 μF
Coupling capacitor	C_4	=	6.4	6.4	6.4 μF
Input current at P_o = max. (RMS value)					
with AC125	I_i	=	20	10	55 μA
with AC126	I_i	=	15	8	40 μA
Input current at P_o = 50 mW (RMS value)					
with AC125	I_i	=	11.5	6	17 μA
with AC126	I_i	=	9	4.5	12.5 μA
Total harmonic distortion at P_o = 50 mW	d_{tot}	=	2.5	3.8	2.0 %


7Z01232
AC127
V_{CB} = 5V
T_{amb} = 25°C
Current limits
$-I_E$ (mA)
10
8
6
4
2
0
0
50
100
150
I_B (μA)

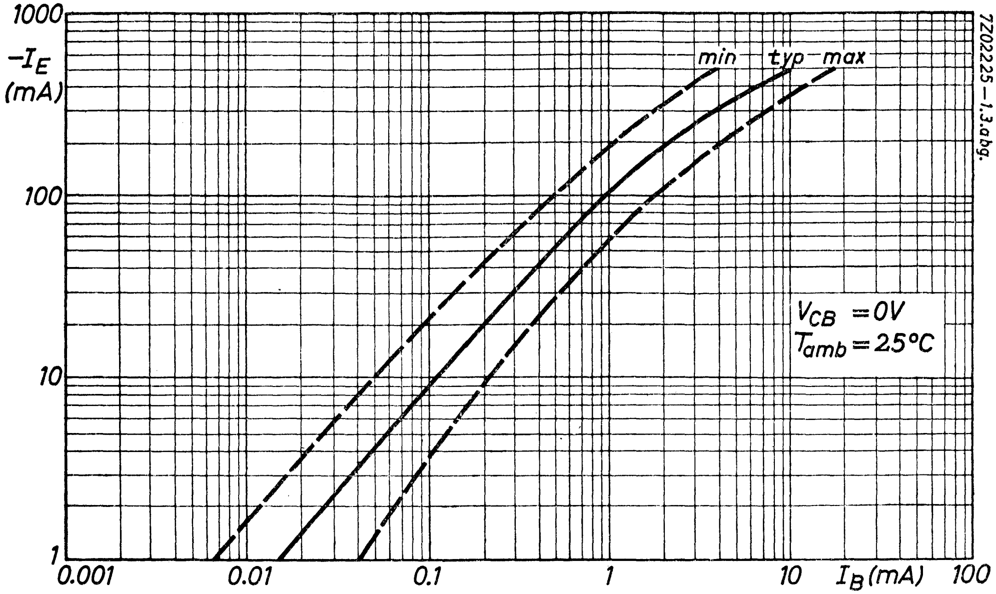
B


7Z02224-1.3.cbg.
I_B = 7mA
6mA
5mA
4mA
3mA
2mA
1mA
0.5mA
V_{CE} (V)
5
10
0
0.5
1
V_{BE} (V)
I_C (mA)
500
400
300
200
T_j = 25°C
V_{CE} = 1V
V_{CE} = 1V
10 I_B (mA) 5

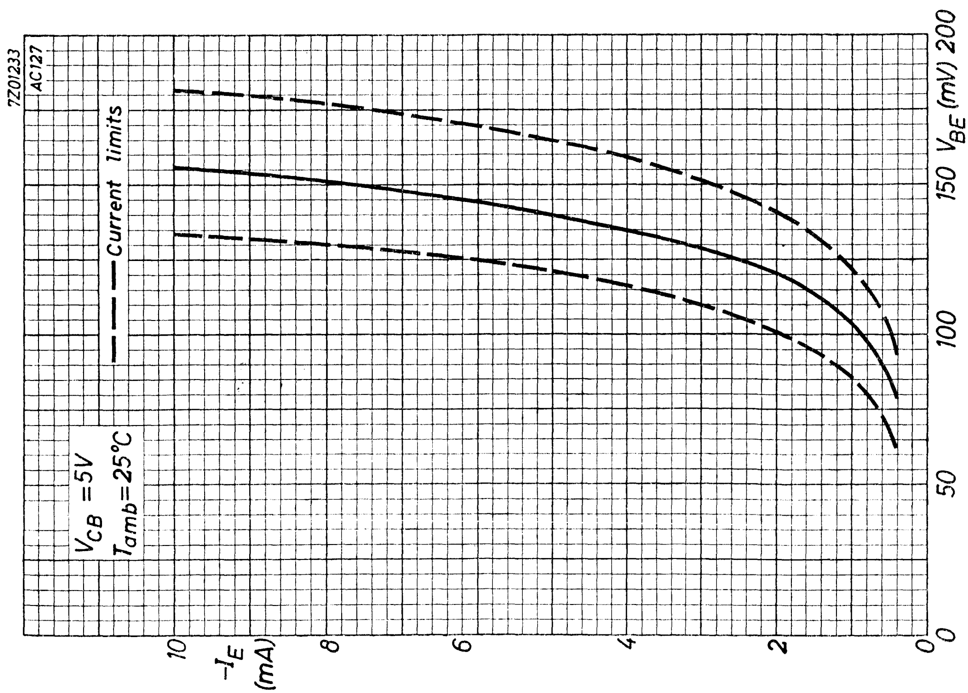
A

4.4.1964

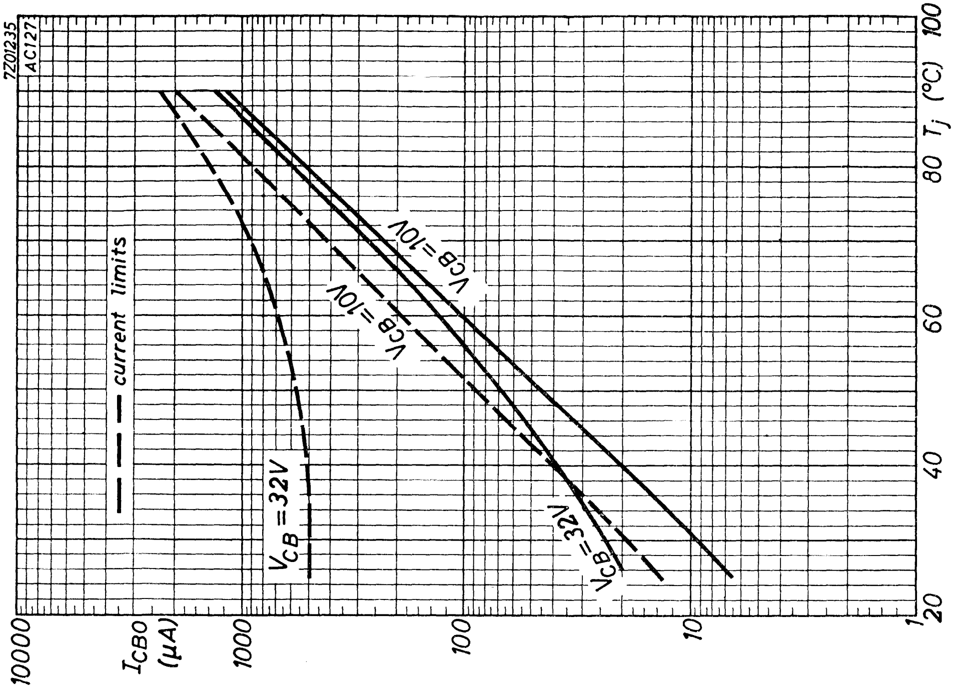
D


1000
100
10
1
$-I_E$ (mA)
min
typ
max
V_{CB} = 0V
T_{amb} = 25°C
0.001
0.01
0.1
1
10
100
I_B (mA)
7Z02225–1.3.abg.

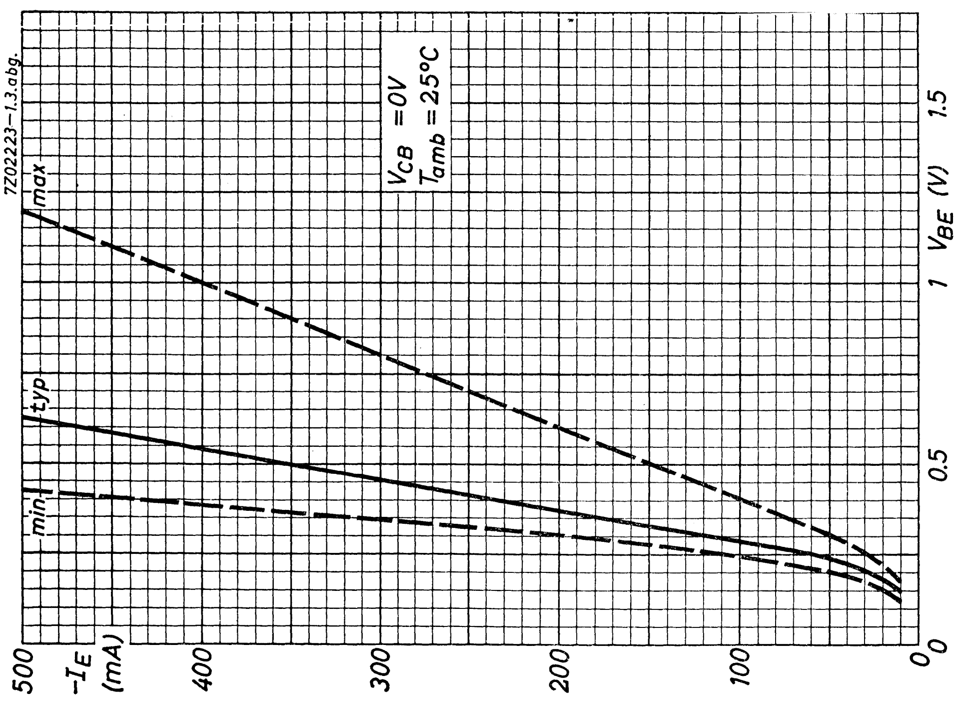
C


7Z01233
AC127
Current limits
V_{CB} = 5V
T_{amb} = 25°C
V_{BE} (mV)
200
150
100
50
0
$-I_E$ (mA)
10
8
6
4
2
0

4.4.1964

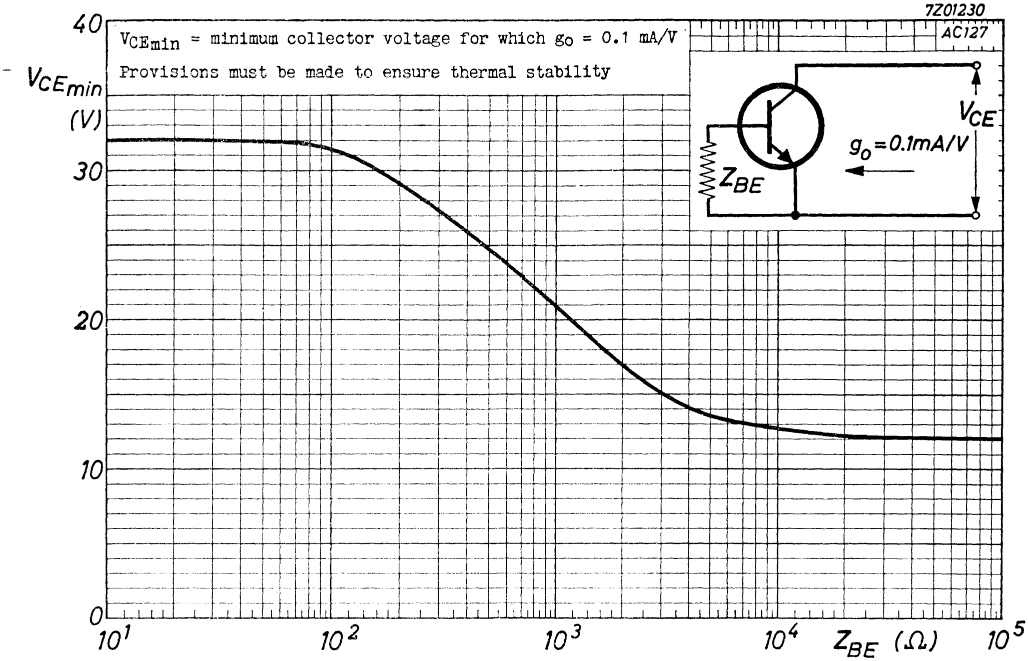

7Z01235
AC127
current limits
VCB = 10V
VCB = 10V
VCB = 32V
VCB = 32V
ICBO (µA)
Tj (°C)
10000
1000
100
10
1
20
40
60
80
100

F

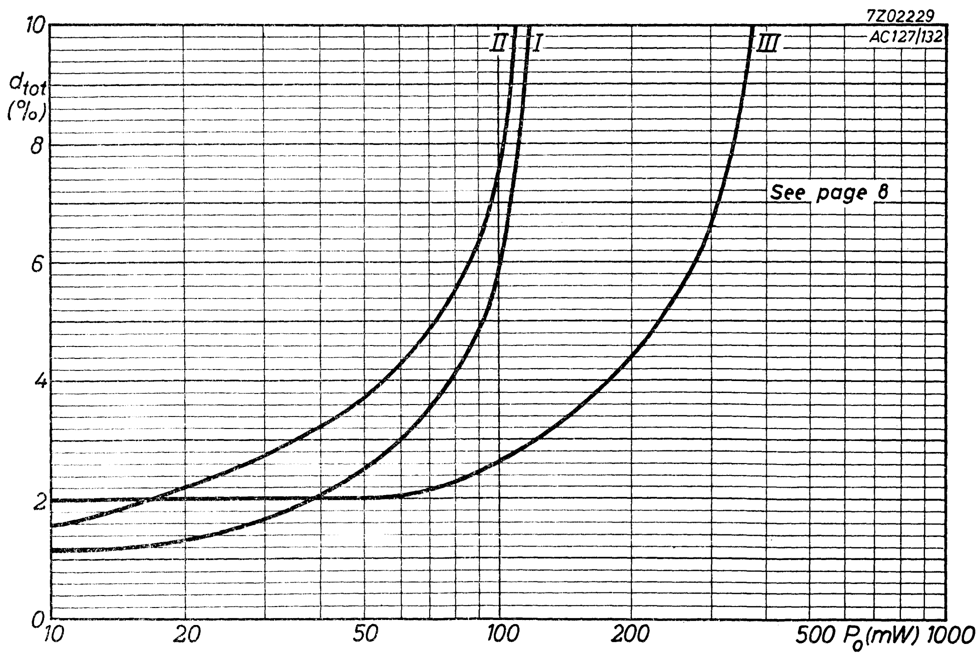

7Z02223-1.3.abg.
max
typ
min
VCB = 0V
Tamb = 25°C
−IE (mA)
VBE (V)
500
400
300
200
100
0
0.5
1
1.5

E

4.4.1964


7Z01230
AC127
V_{CEmin} = minimum collector voltage for which g_o = 0.1 mA/V
Provisions must be made to ensure thermal stability
V_{CEmin} (V)
Z_{BE}
V_{CE}
g_o=0.1mA/V
Z_{BE} (Ω)
40
30
20
10
0
10^1
10^2
10^3
10^4
10^5

G


7Z02229
AC127/132
d_{tot} (%)
II
I
III
See page 8
10
8
6
4
2
0
10
20
50
100
200
500 P_o(mW) 1000

H

4.4.1964

HIGH GAIN GERMANIUM P-N-P TRANSISTOR

Germanium alloy junction transistor of the p-n-p type in metal case with high gain for use in class A and class B output stages with battery voltages up to 14 volts and a power output up to 2.4 watts.

Type 2-AC128 consists of 2 transistors AC128 that are matched for operation in a low distortion class B amplifier.

LIMITING VALUES (Absolute max. values)

Collector			
Voltage (base reference)	$-V_{CB}$	= max.	32 V
Voltage (emitter reference)	$-V_{CE}$	= max.	32 V [1])
Current	$-I_C$	= max.	1 A
Emitter			
Voltage (base reference)	$-V_{EB}$	= max.	10 V
Base			
Current	$-I_B$	= max.	40 mA
Dissipation			
Total dissipation	P_{tot}	= max.	700 mW
Temperatures			
Storage temperature	T_s	=	−55 °C to +75 °C
Junction temperature continuous	T_j	= max.	90 °C
incidentally (max. 200 hrs)	T_j	= max.	100 °C

[1]) See page H

7Z2 2326

4.4.1964

1

THERMAL DATA

Thermal resistance from

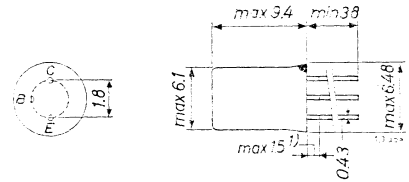
junction to case	K	= max. 0.04 °C/mW
junction to ambience in free air	K	= max. 0.29 °C/mW
junction to ambience with cooling fin in free air	K	= max. 0.14 °C/mW
junction to ambience with cooling fin mounted on a heatsink of at least 12.5 cm²	K	= max. 0.08 °C/mW

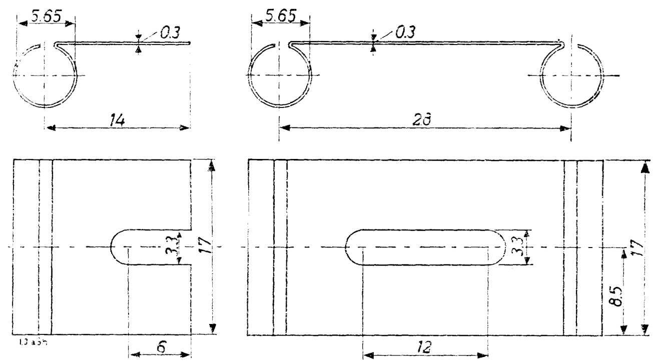
MECHANICAL DATA

The red dot indicates the collector

Dimensions in mm

1) Not tinned





Cooling fin 56227

Cooling fin 56226

7Z2 2327

CHARACTERISTICS at T_{amb} = 25 °C

Collector current at $I_E = 0$

$-V_{CB}$ = 10 V	$-I_{CBO}$	<	10 μA

Collector voltage at $I_E = 0$

$-I_C$ = 200 μA	$-V_{CB}$	>	32 V

Emitter voltage at $I_C = 0$

$-I_E$ = 200 μA	$-V_{EB}$	>	10 V

Base voltage at $V_{CB} = 0$

I_E = 50 mA	$-V_{BE}$	<	300 mV
I_E = 300 mA	$-V_{BE}$	<	450 mV

Characteristics of matched pairs 2-AC128

Ratio of D.C. current amplification factors

I_E = 50 mA; V_{CB} = 0	h_{FE1}/h_{FE2} = 1.1		< 1.25
I_E = 300 mA; V_{CB} = 0	h_{FE1}/h_{FE2} = 1.1		< 1.25

Characteristics of matched pairs AC127/AC128

Ratio of D.C. current amplification factors

$\|I_E\|$ = 300 mA; V_{CB} = 0	h_{FE1}/h_{FE2} = 1.1

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN

T_{amb} = 25 °C, unless otherwise specified

Emitter current at $I_C = 0$

$-V_{EB}$ = 5 V; T_j = 75 °C	$-I_{EBO}$	< 500 μA

D.C. current amplification factor

I_E = 50 mA; V_{CB} = 0	h_{FE} = 90	> 55 < 175
I_E = 300 mA; V_{CB} = 0	h_{FE} = 90	> 60 < 175
I_E = 1 A; V_{CB} = 0	h_{FE} = 80	> 45 < 165

7Z2 2328

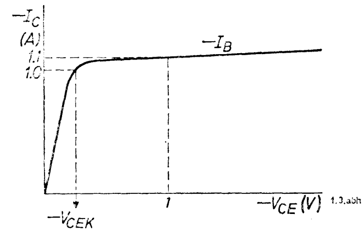
CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN (continued)

T_{amb} = 25 °C

Collector knee voltage at $-I_C$ = 1 A

$-I_B$ = value at which $-I_C$ = 1.1 A

and $-V_{CE}$ = 1 V	$-V_{CEK}$	< 0.6 V



Frequency at which $|h_{fe}| = 1$

$-V_{CB}$ = 2 V; I_E = 10 mA	f_1 = 1.5 Mc/s	> 1.0 Mc/s

Cut-off frequency

$-V_{CB}$ = 2 V; I_E = 10 mA	$f_{\alpha e}$ = 15 kc/s	> 10 kc/s

Base resistance

$-V_{CB}$ = 5 V; I_E = 1 mA	$r_{bb'}$ = 25 Ω

Collector capacitance

$-V_{CB}$ = 5 V; I_E = 0	c_c = 100 pF

Current gain linearity (see curve B, page G)	λ_{500} = 0.60	> 0.50 [1])

1) $\lambda_{500} = \frac{A_i \text{ at } 500 \text{ mA}}{A_i \text{ max.}}$, where A_i = loaded small-signal current amplification.

7Z2 2329

OPERATING CHARACTERISTICS OF A MATCHED PAIR 2-AC128 as class B output amplifier

For circuit diagram see page 6

V_S	=	6	9	9 V
T_{amb}	=	max. 55	max. 55	max. 45 °C
I_E (V_i = 0)	=	2 x 3	2 x 3	2 x 3 mA
R_1 [1]	=	2.0	2.2	3.5 [2] kΩ
R_2 [1]	=	47	39	[3] Ω
R_E	=	2.2	3.9	1.5 Ω
R_p	=	1.5	1.5	1.0 kΩ
R_{cc}	=	65	98	62 Ω
P_c max. [4]	=	2 x 0.425	2 x 0.65	2 x 1.05 W
P_o max. [5]	=	0.75	1.1	1.9 W
$-I_{CM}$ (P_o = max.)	=	300	300	500 mA
$-I_C$ (P_o = max.)	=	2 x 95	2 x 95	2 x 150 mA
V_{im} (P_o = max.)	=	5.5	6.0	6.6 V [6]
d_{tot} (P_o = max.)	=	3.5	4.0	5.5 %
V_{im} (P_o = 50 mW)	=	1.6	1.4	1.1 V [6]
d_{tot} (P_o = 50 mW)	=	2.0	2.0	2.5 %

[1]) Tolerance of bias resistors: 5 %

[2]) Variable resistor

[3]) This resistance is composed of a 68 Ω resistor in parallel with a 130 Ω NTC resistor (code No. E201 BC/A 130E)

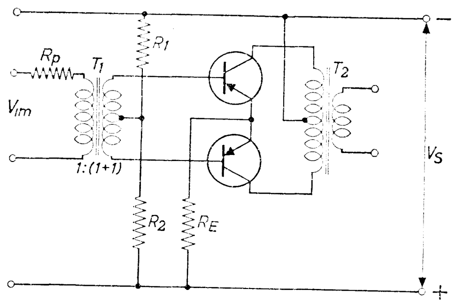
[4]) Output power of two transistors

[5]) Power delivered to the primary of the output transformer

[6]) Losses in the driver transformer are not taken into account

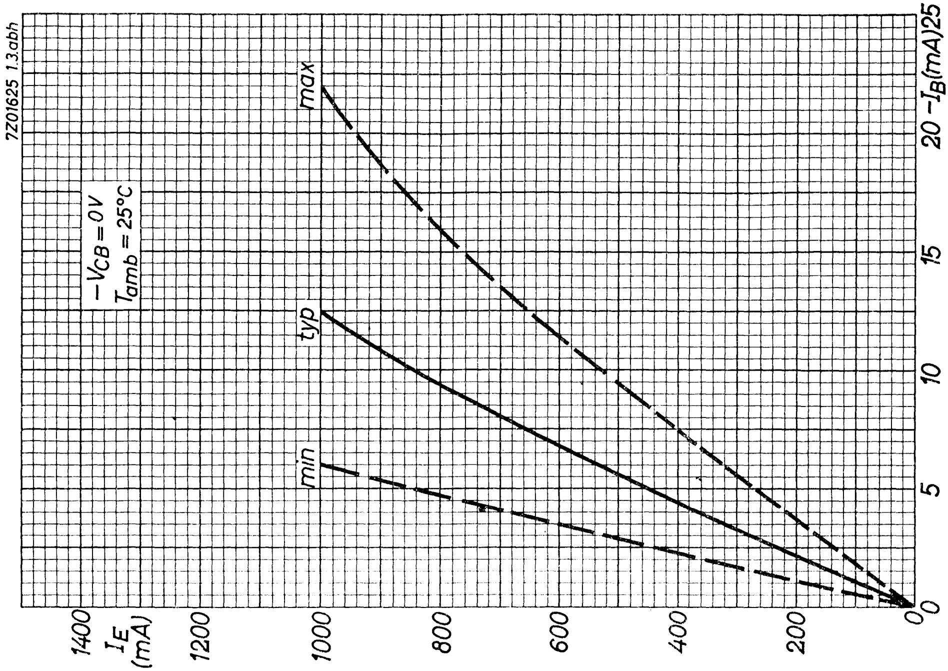
7Z2 2330

OPERATING CHARACTERISTICS OF A MATCHED PAIR 2-AC128 as class B output amplifier (continued)

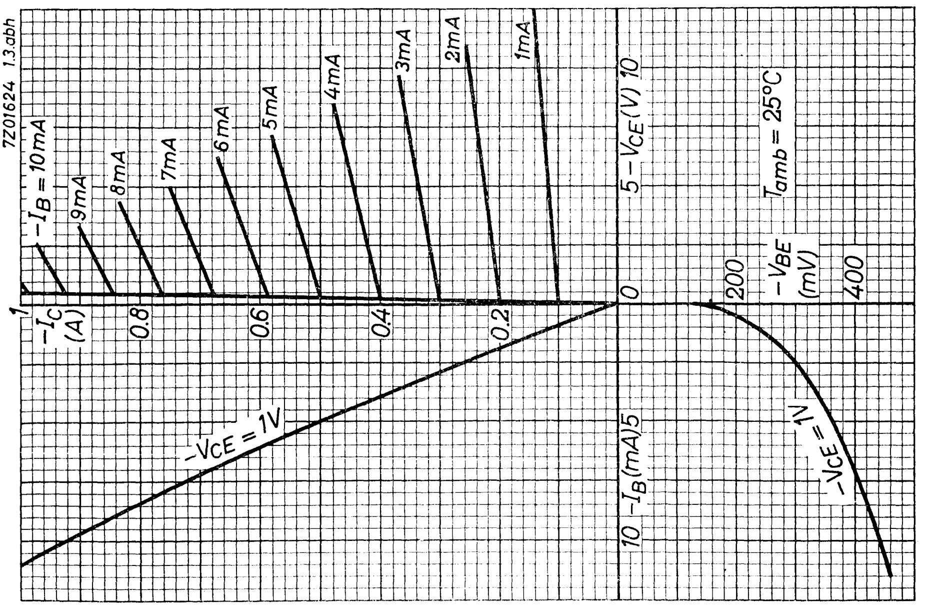


To provide stability the total resistance in the base circuit of each transistor is less than 100 Ω.
The data on page 5 are valid for continuous operation up to the ambient temperatures specified in the tables. Then the junction temperature will not exceed 90 °C (K = 0.09 °C/mW)
R_p = input source resistance.

7Z2 2331

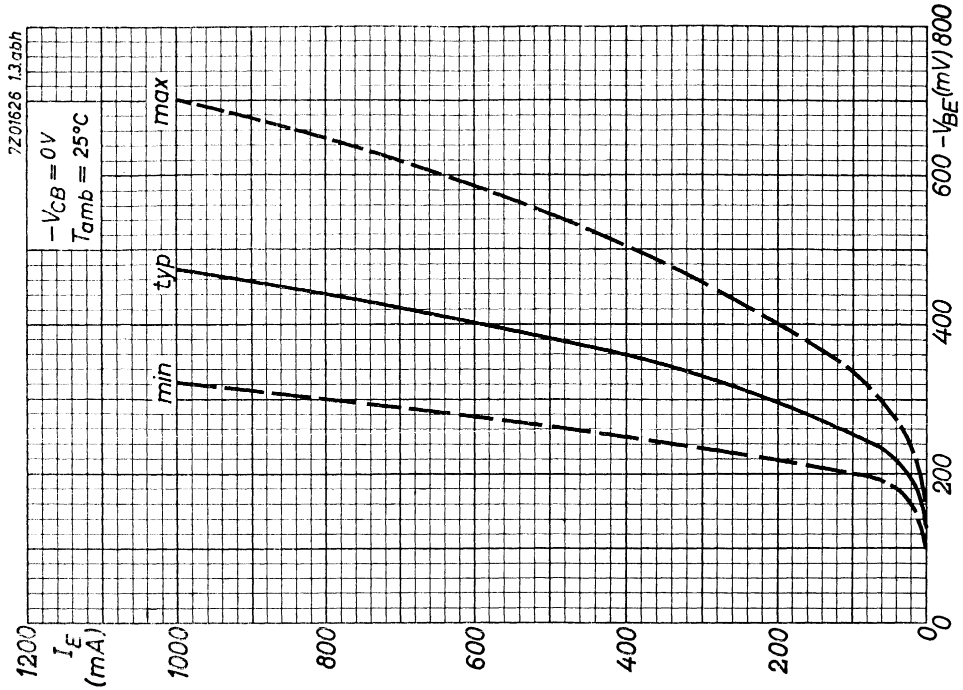

7Z01625 1.3.abh
$-V_{CB} = 0V$
$T_{amb} = 25°C$
max
typ
min
I_E (mA)
1400
1200
1000
800
600
400
200
0
0
5
10
15
20
25
$-I_B$ (mA)

B

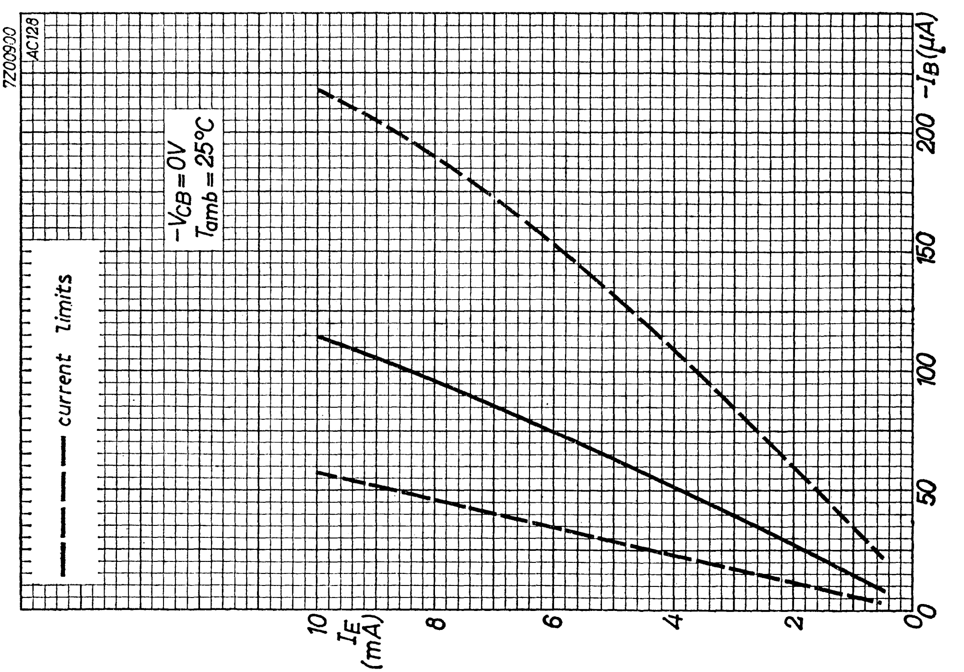

7Z01624 1.3.abh
$-I_B = 10mA$
9mA
8mA
7mA
6mA
5mA
4mA
3mA
2mA
1mA
$-I_C$ (A)
1
0.8
0.6
0.4
0.2
0
5
10
$-V_{CE}$ (V)
$T_{amb} = 25°C$
$-V_{CE} = 1V$
10
5
$-I_B$ (mA)
200
400
$-V_{BE}$ (mV)
$-V_{CE} = 1V$

A

4.4.1963

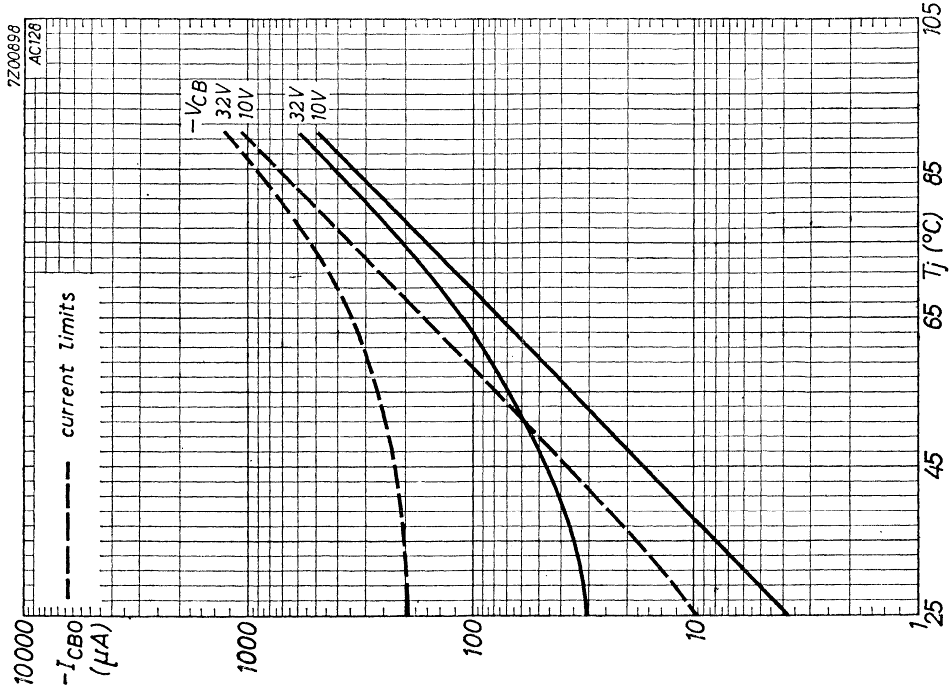

7Z01626 1.3.abh
−V_CB = 0 V
T_amb = 25°C
max
typ
min
I_E
(mA)
1200
1000
800
600
400
200
0
0
200
400
600
−V_BE (mV) 800

D

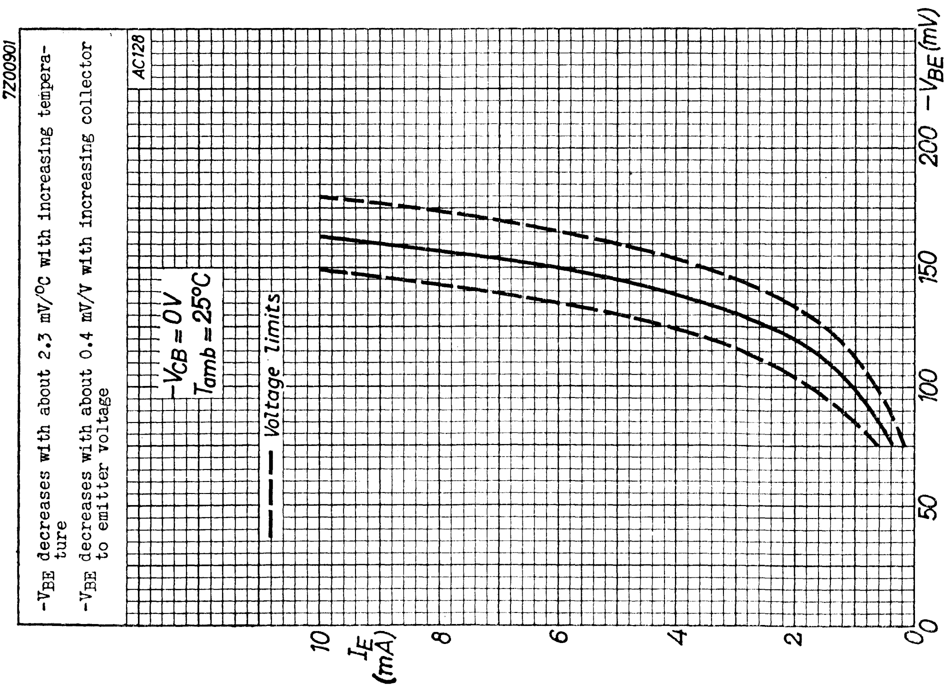

7Z00900
AC128
current limits
−V_CB = 0V
T_amb = 25°C
I_E
(mA)
10
8
6
4
2
0
0
50
100
150
200
−I_B (μA)

C

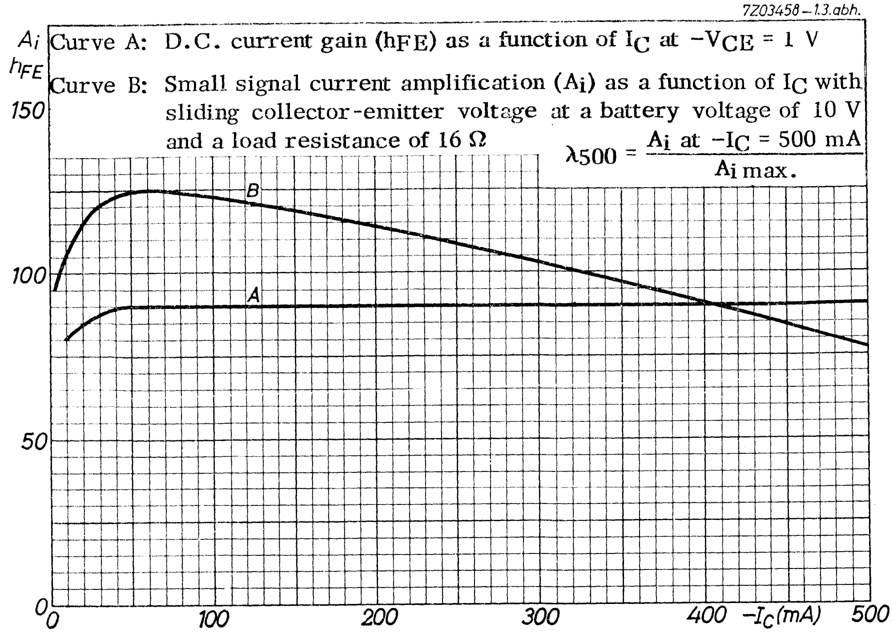
4.4.1963


7Z00898
AC128
$-V_{CB}$
32V
10V
32V
10V
current limits
10000
$-I_{CBO}$ (μA)
1000
100
10
1
25
45
65
85
105
T_j (°C)

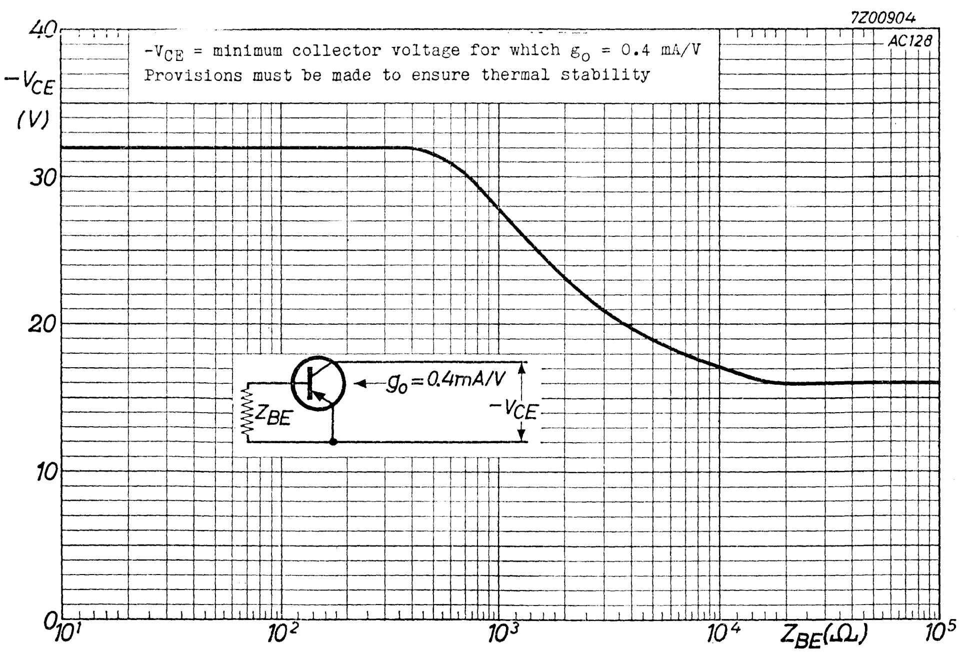
F


7Z00901
$-V_{BE}$ decreases with about 2.3 mV/°C with increasing temperature
$-V_{BE}$ decreases with about 0.4 mV/V with increasing collector to emitter voltage
AC128
$-V_{CB} = 0V$
$T_{amb} = 25°C$
Voltage limits
10
I_E (mA)
8
6
4
2
0
0
50
100
150
200
$-V_{BE}$ (mV)

E


7Z03458–1.3.abh.
A_i
h_{FE}
Curve A: D.C. current gain (h_{FE}) as a function of I_C at $-V_{CE}$ = 1 V
Curve B: Small signal current amplification (A_i) as a function of I_C with sliding collector-emitter voltage at a battery voltage of 10 V and a load resistance of 16 Ω
$\lambda_{500} = \frac{A_i \text{ at } -I_C = 500 \text{ mA}}{A_i \text{ max.}}$
150
100
50
0
B
A
0
100
200
300
400
$-I_C$(mA)
500

G


7Z00904
AC128
$-V_{CE}$ = minimum collector voltage for which g_o = 0.4 mA/V
Provisions must be made to ensure thermal stability
40
$-V_{CE}$
(V)
30
20
10
0
g_o = 0.4mA/V
$-V_{CE}$
Z_{BE}
10^1
10^2
10^3
10^4
Z_{BE}(Ω)
10^5

H

3.3.1965

HIGH GAIN GERMANIUM P-N-P TRANSISTOR

Germanium alloy junction transistor of the p-n-p type in metal case with high gain primarily intended for operation in complementary symmetrical class B output stages in combination with type AC127.

Type 2-AC132 consists of 2 transistors AC132 that are matched for operation in a class B output amplifier

LIMITING VALUES (Absolute max. values)

Collector			
Voltage (base reference)	$-V_{CB}$	= max.	32 V
Voltage (emitter reference)	$-V_{CE}$	= max.	32 V [1])
Current	$-I_C$	= max.	200 mA
Emitter			
Voltage (base reference)	$-V_{EB}$	= max.	10 V
Base			
Current	$-I_B$	= max.	10 mA
Dissipation			
Total dissipation	P_{tot}	= max.	500 mW
Temperatures			
Storage temperature	T_s	=	−55 °C to +90 °C
Junction temperature	T_j	= max.	90 °C

[1]) See page G

7Z2 3101

THERMAL DATA

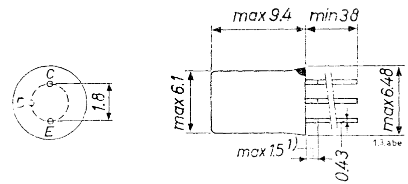
Thermal resistance from

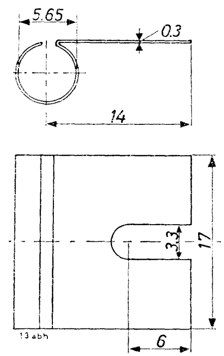
junction to case	K = max. 0.05 °C/mW
junction to ambience in free air	K = max. 0.30 °C/mW
junction to ambience with cooling fin mounted on a heatsink of at least 12.5 cm^2	K = max. 0.09 °C/mW

MECHANICAL DATA

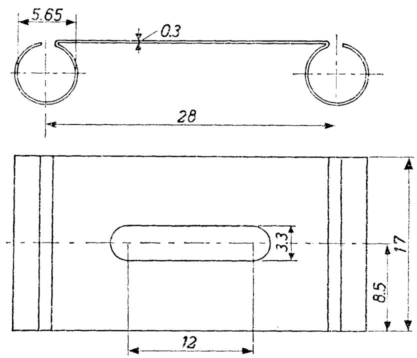
The red dot indicates the collector

Dimensions in mm





Cooling fin 56227



Cooling fin 56226

[1]) Not tinned

7Z2 2333

CHARACTERISTICS at T_{amb} = 25 °C

Collector current at $I_E = 0$			
$-V_{CB}$ = 0.5 V	$-I_{CBO}$	<	10 μA
Collector voltage at $V_{BE} = 0$			
$-I_C$ = 500 μA	$-V_{CB}$	>	32 V
Emitter voltage at $I_C = 0$			
$-I_E$ = 200 μA	$-V_{EB}$	>	10 V

Characteristics of matched pairs 2-AC132

Ratio of D.C. current amplification factors

I_E = 20 mA; V_{CB} = 0	h_{FE1}/h_{FE2} = 1.1	< 1.25	
I_E = 200 mA; V_{CB} = 0	h_{FE1}/h_{FE2} = 1.1	< 1.25	

Characteristics of matched pairs AC127/AC132
(See also data sheets of AC127)

Ratio of D.C. current amplification factors

$\|I_E\|$ = 50 mA; V_{CB} = 0	h_{FE1}/h_{FE2} = 1.1	< 1.25

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN

T_{amb} = 25 °C unless otherwise specified

Collector current at $I_E = 0$	$-I_{CEO}$	See page F	
Emitter current at $I_C = 0$			
$-V_{EB}$ = 5 V; T_j = 75 °C	$-I_{EBO}$	<	550 μA
Large signal current amplification factor 1)			
I_E = 20 mA; V_{CB} = 0	h_{fel}	=	135
I_E = 50 mA; V_{CB} = 0	h_{fel}	=	115
I_E = 200 mA; V_{CB} = 0	h_{fel}	=	70

1) $h_{fel} = \dfrac{I_C - I_{CBO}}{I_B + I_{CBO}}$ for V_{CE} = constant

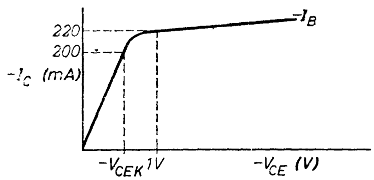
7Z2 2334

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN (continued)

T_{amb} = 25 °C

Base voltage (emitter reference)			
$-V_{CB}$ = 5 V; I_E = 2 mA	$-V_{BE}$	= 105 mV	
V_{CB} = 0 ; I_E = 200 mA	$-V_{BE}$	< 550 mV	

Collector knee voltage at $-I_C$ = 200 mA



$-I_B$ = value at which $-I_C$ = 220 mA and $-V_{CE}$ = 1 V

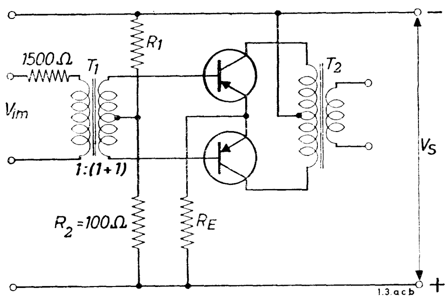
$-V_{CEK}$ < 350 mV

Frequency at which $\|h_{fe}\|$ = 1			
$-V_{CB}$ = 2 V; I_E = 10 mA	f_1 = 2 Mc/s	> 1.3 Mc/s	
Cut-off frequency			
$-V_{CB}$ = 2 V; I_E = 10 mA	$f_{\alpha e}$ = 17 kc/s	> 10 kc/s	
Base impedance at f = 0.45 Mc/s			
$-V_{CB}$ = 5 V; I_E = 1 mA	$\|z_{rb}\|$ = 90 Ω		
Collector capacitance			
$-V_{CB}$ = 5 V; I_E = 0; f = 0.45 Mc/s	c_c = 40 pF		
Noise figure at f = 1 kc/s			
$-V_{CB}$ = 5 V; I_E = 0.5 mA; B = 200 c/s; Input source resistance = 500 Ω	F = 4 dB	< 10 dB	

OPERATING CHARACTERISTICS OF A MATCHED PAIR AC127/AC132 please refer to data sheets of AC127

7Z2 2335

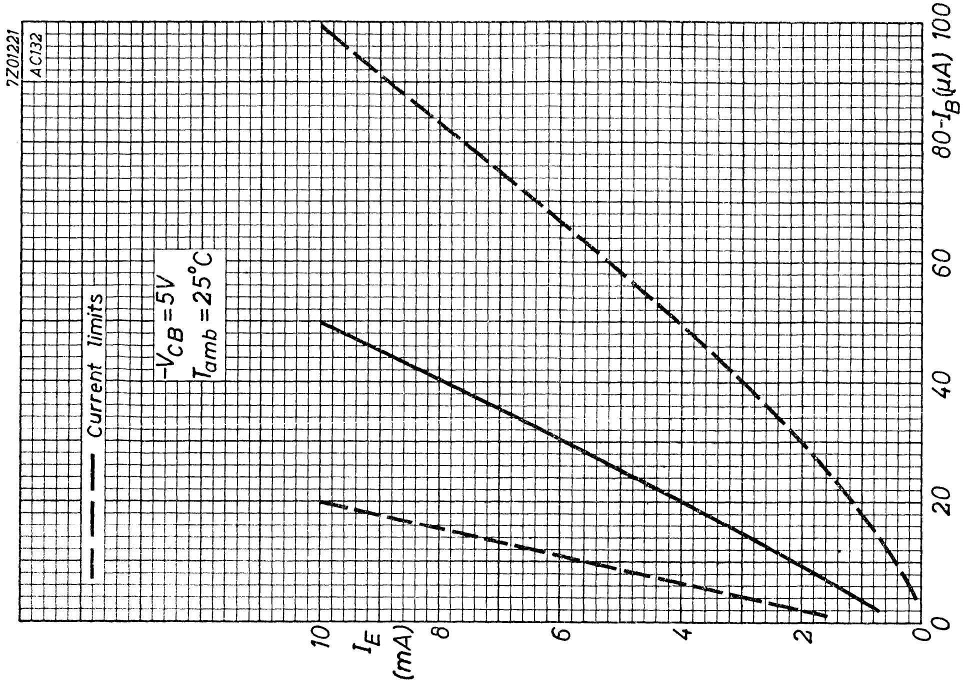
OPERATING CHARACTERISTICS OF A MATCHED PAIR 2-AC132 as class B output amplifier



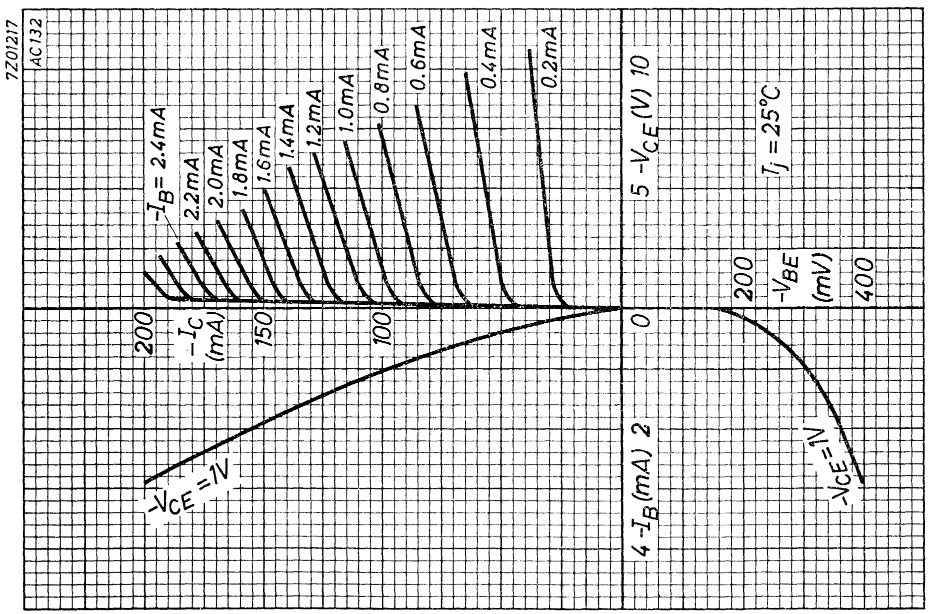
The transistors can be used without cooling fins or heatsinks. Stable continuous operation is ensured up to T_{amb} = 45 °C
Figures apply for T_{amb} = 25 °C

V_S	=	6	9	V
I_E (V_i = 0)	=	2 x 1.5	2 x 1.5	mA
R_1	=	5.6	6.8	kΩ
R_E	=	5	14	Ω
R_{cc}	=	160	292	Ω
P_{cmax} 1)	=	2 x 180	2 x 220	mW
P_{omax} 2)	=	310	365	mW
$-I_{CM}$ (P_o = max.)	=	125	100	mA
$-I_C$ (P_o = max.)	=	40	32	mA
V_i (P_o = max.)	=	4	3.8	V
d_{tot} (P_o = max.)	=	7	6	%
V_i (P_o = 50 mW)	=	1.40	1.35	V
d_{tot} (P_o = 50 mW)	=	2.5	3.0	%

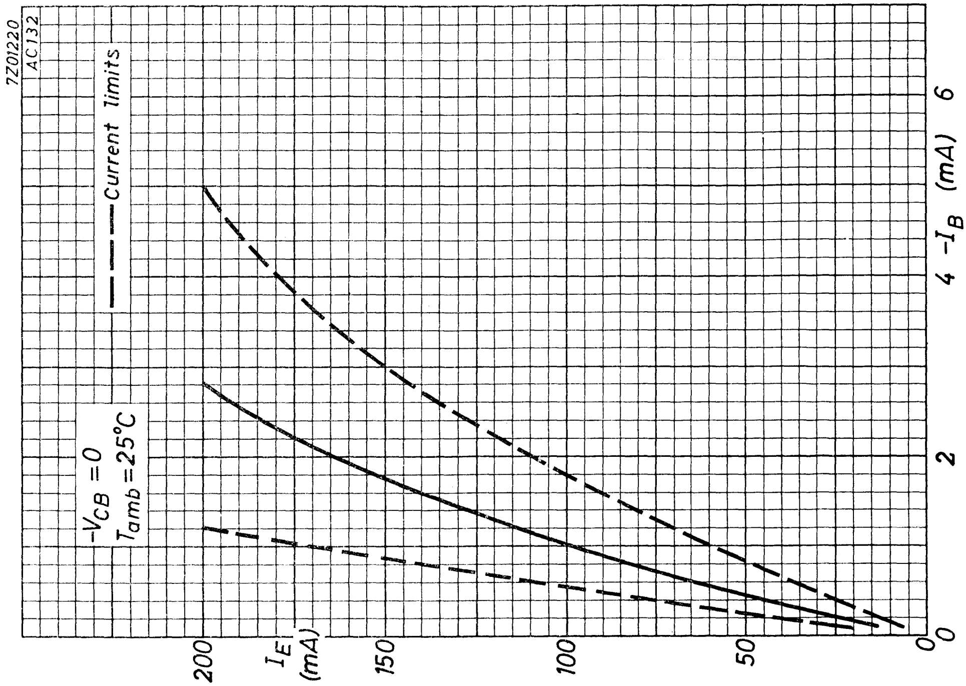
1) Output power of two transistors
2) Power delivered to the primary of the output transformer


7Z01221
AC132
Current limits
−V_CB = 5V
T_amb = 25°C
I_E (mA)
10
8
6
4
2
0
0
20
40
60
80 −I_B (μA) 100

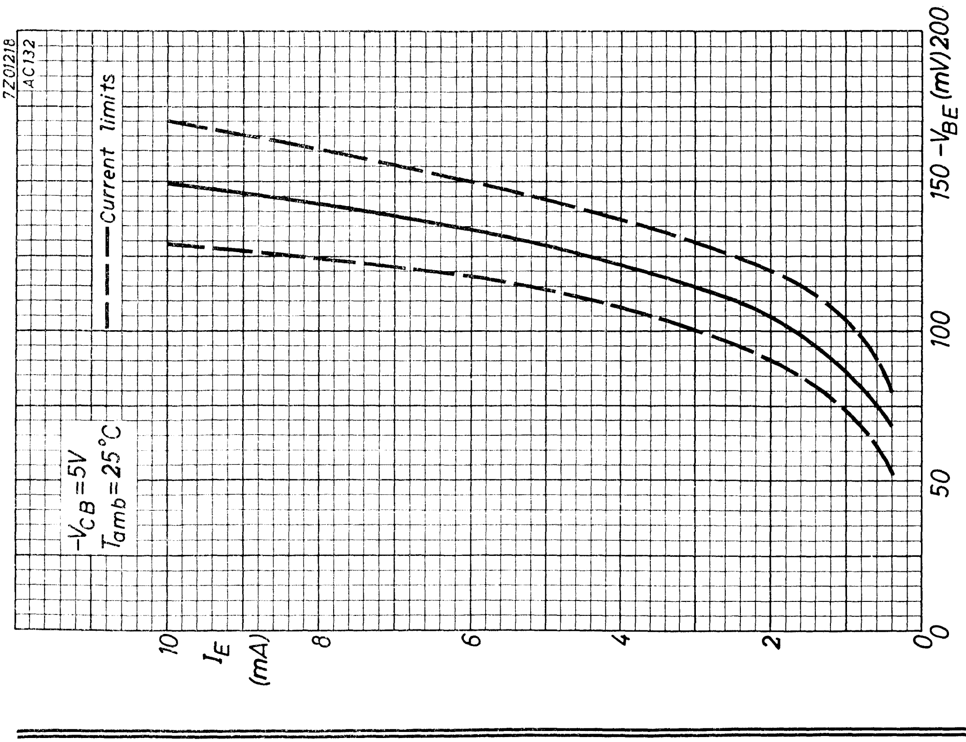
B


7Z01217
AC132
−I_B = 2.4mA
2.2mA
2.0mA
1.8mA
1.6mA
1.4mA
1.2mA
1.0mA
0.8mA
0.6mA
0.4mA
0.2mA
5 −V_CE (V) 10
T_j = 25°C
200
−I_C (mA)
150
100
0
4 −I_B (mA) 2
−V_CE = 1V
200
−V_BE (mV)
400
−V_CE = 1V

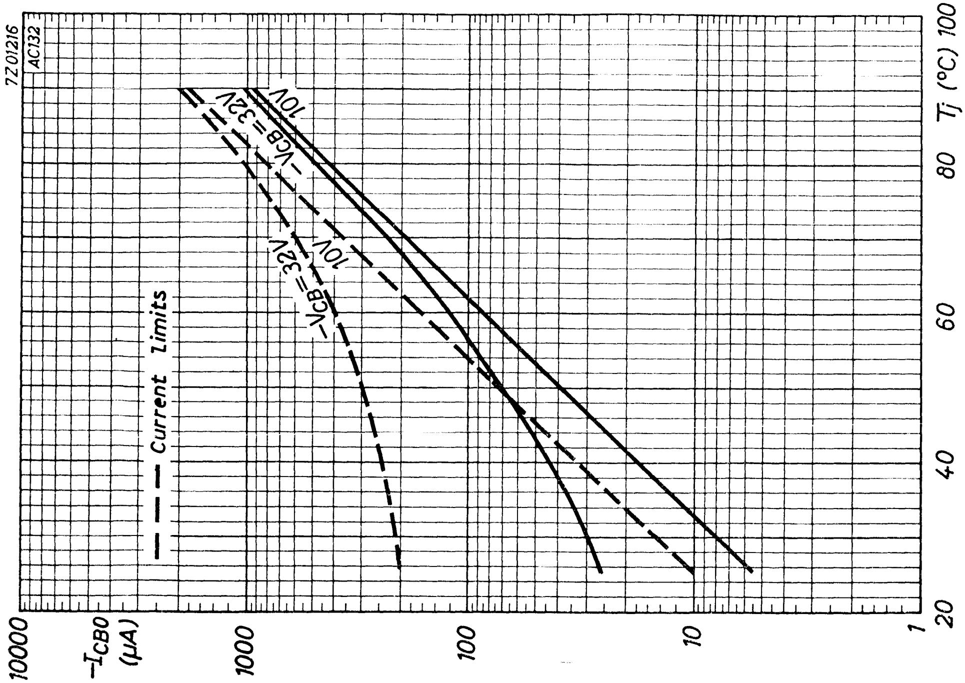
A


7Z01220
AC132
Current limits
$-V_{CB} = 0$
$T_{amb} = 25°C$
I_E (mA)
200
150
100
50
0
0
2
4 $-I_B$ (mA)
6

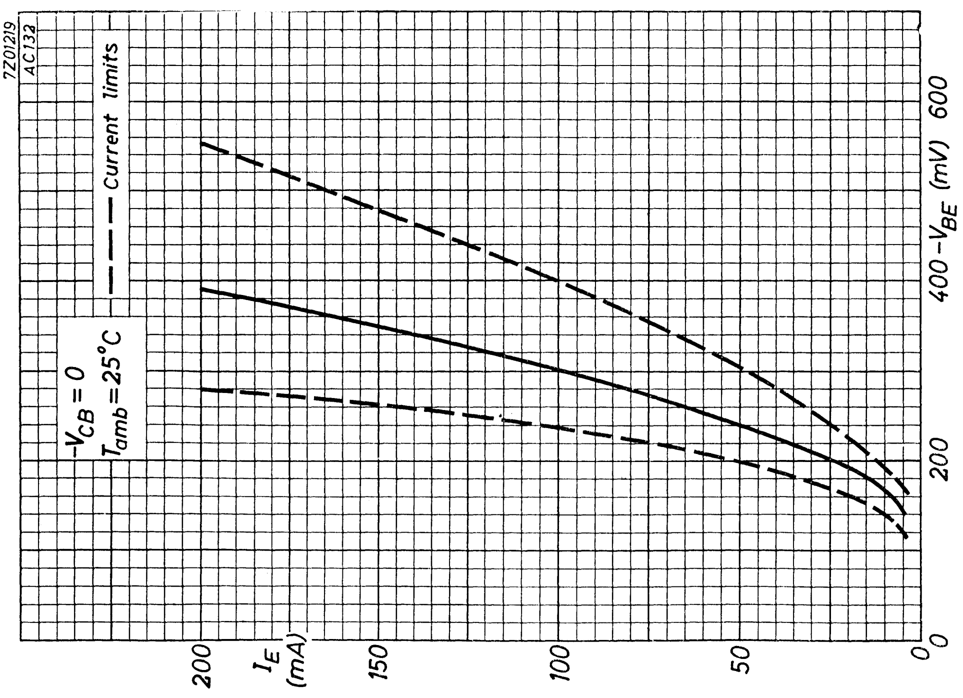
D


7Z01218
AC132
Current limits
$-V_{CB} = 5V$
$T_{amb} = 25°C$
I_E (mA)
10
8
6
4
2
0
0
50
100
150 $-V_{BE}$ (mV) 200

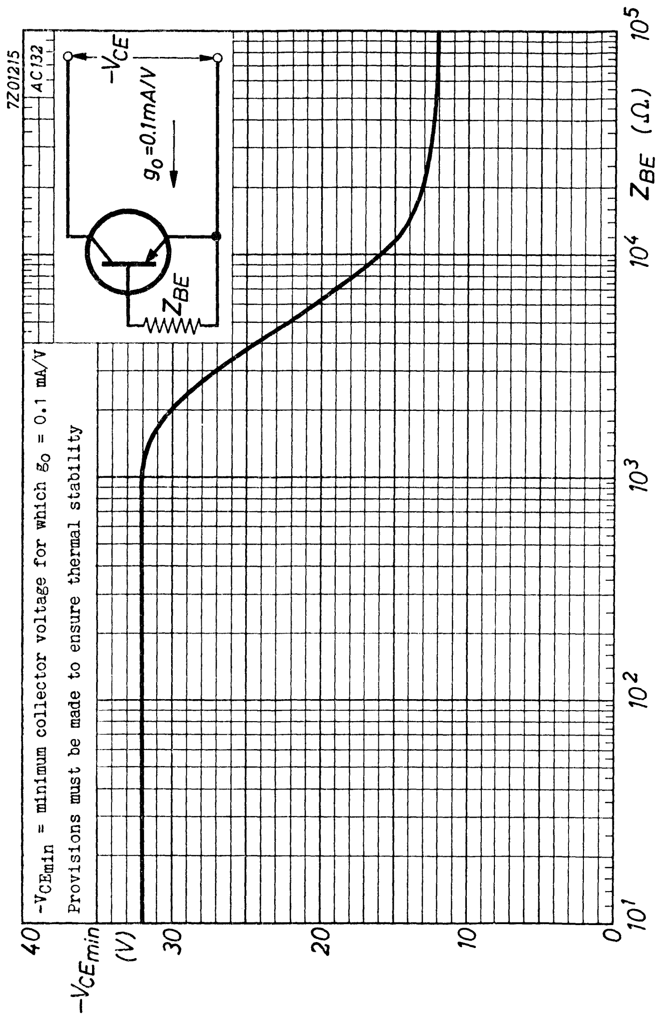
C


7Z01216
AC132
— — Current limits
$-V_{CB}=32V$
10V
$-V_{CB}=32V$
10V
$-I_{CBO}$ (μA)
10000
1000
100
10
1
20
40
60
80
100
T_j (°C)

F


7Z01219
AC132
$-V_{CB}=0$
$T_{amb}=25°C$
— — Current limits
I_E (mA)
200
150
100
50
0
0
200
400
600
$-V_{BE}$ (mV)

E


7Z01215
AC132
$-V_{CEmin}$ = minimum collector voltage for which g_o = 0.1 mA/V
Provisions must be made to ensure thermal stability
$-V_{CE}$
g_o=0.1mA/V
Z_{BE}
$-V_{CEmin}$ (V)
40
30
20
10
0
10^1
10^2
10^3
10^4
10^5
Z_{BE} (Ω)

2.2.1963

G

GERMANIUM N-P-N TRANSISTOR

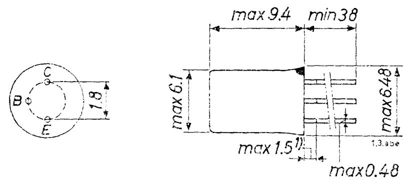
Germanium alloy junction transistor of the n-p-n type in TO-1 metal case for operation in low noise pre-amplifiers.

QUICK REFERENCE DATA

Collector voltage (base reference)	V_{CB}	=	max.	32 V
Collector current	I_C	=	max.	10 mA
Total dissipation	P_{tot}	=	max.	200 mW
Current amplification factor $-I_E = 500\ \mu A$; $V_{CB} = 5$ V	h_{fe}	> 45		< 110
Transition frequency $I_C = 10$ mA; $V_{CE} = 2$ V	f_T	=		2.5 Mc/s
Thermal resistance from junction to ambience	K	<		0.37 °C/mW
Noise figure	F	=		3 dB

MECHANICAL DATA

The blue dot indicates the collector — Dimensions in mm



[1]) Not tinned

7Z2 2494

LIMITING VALUES (Absolute max. values)

Collector				
Voltage (base reference)	V_{CB}	=	max.	32 V
Voltage (emitter reference)	V_{CE}	=	max.	32 V [1])
Current	I_C	=	max.	10 mA
Emitter				
Voltage (base reference)	V_{EB}	=	max.	10 V
Dissipation				
Total dissipation	P_{tot}	=	max.	200 mW
Temperatures				
Storage temperature	T_s	=		−55 °C to +90 °C
Junction temperature Continuous	T_j	=	max.	90 °C
Incidentally (up to a total of 200 hours)	T_j	=	max.	100 °C

THERMAL DATA

Thermal resistance between junction and ambience in free air	K	=	max.	0.37 °C/mW

CHARACTERISTICS at T_j = 25 °C

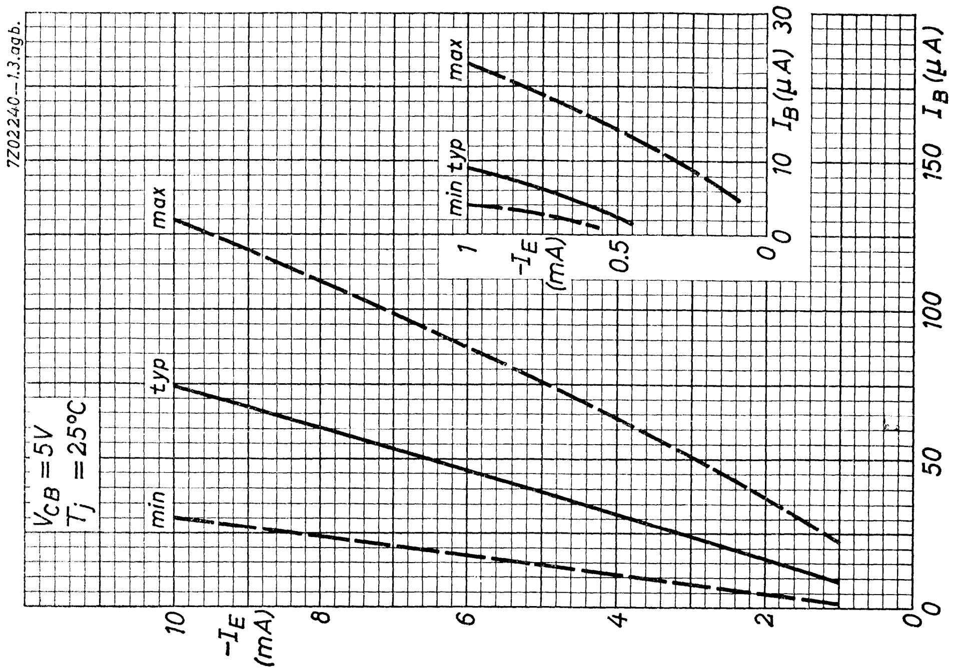
Collector current at $I_E = 0$; $V_{CB} = 10$ V	I_{CBO}	<	10 μA
Emitter current at $I_C = 0$; $V_{EB} = 10$ V	I_{EBO}	<	200 μA
Current amplification factor $-I_E = 500\ \mu A$; $V_{CB} = 5$ V; f = 1 kc/s	h_{fe}	>	45
		<	110

[1]) See also page 1

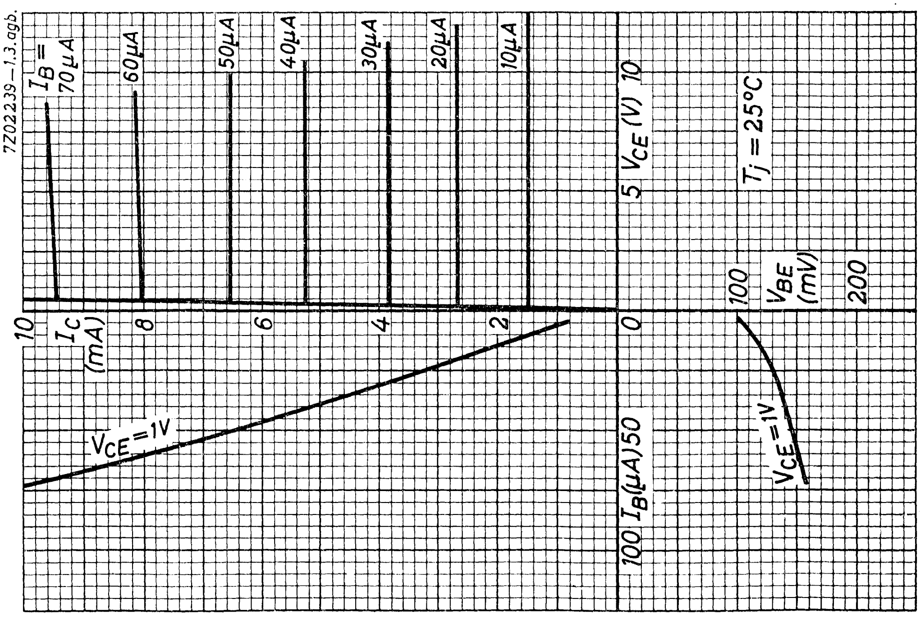
7Z2 2495

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN at T_j = 25 °C, unless otherwise specified

Collector current at $I_E = 0$			
$V_{CB} = 32$ V (See also page D)	I_{CBO}	<	200 μA
Emitter current at $I_C = 0$			
$V_{EB} = 5$ V; $T_j = 75$ °C	I_{EBO}	<	550 μA
Transition frequency			
$V_{CE} = 2$ V; $I_C = 10$ mA	f_T	=	2.5 Mc/s
		>	1.5 Mc/s
Noise figure at f = 1 kc/s			
$V_{CE} = 5$ V; $I_C = 0.5$ mA			
Bandwidth B = 200 c/s			
Input source resistance = 500 Ω	F	=	3 dB
		<	4 dB
Cut-off frequency			
$V_{CE} = 2$ V; $I_C = 10$ mA	$f_{\alpha e}$	=	20 kc/s
		>	10 kc/s
Base impedance at f = 0.45 Mc/s			
$V_{CB} = 5$ V; $-I_E = 1$ mA	$\lvert z_{rb} \rvert$	=	70 Ω
Collector capacitance at f = 0.45 Mc/s			
$V_{CB} = 5$ V; $I_E = 0$	c_c	=	70 pF

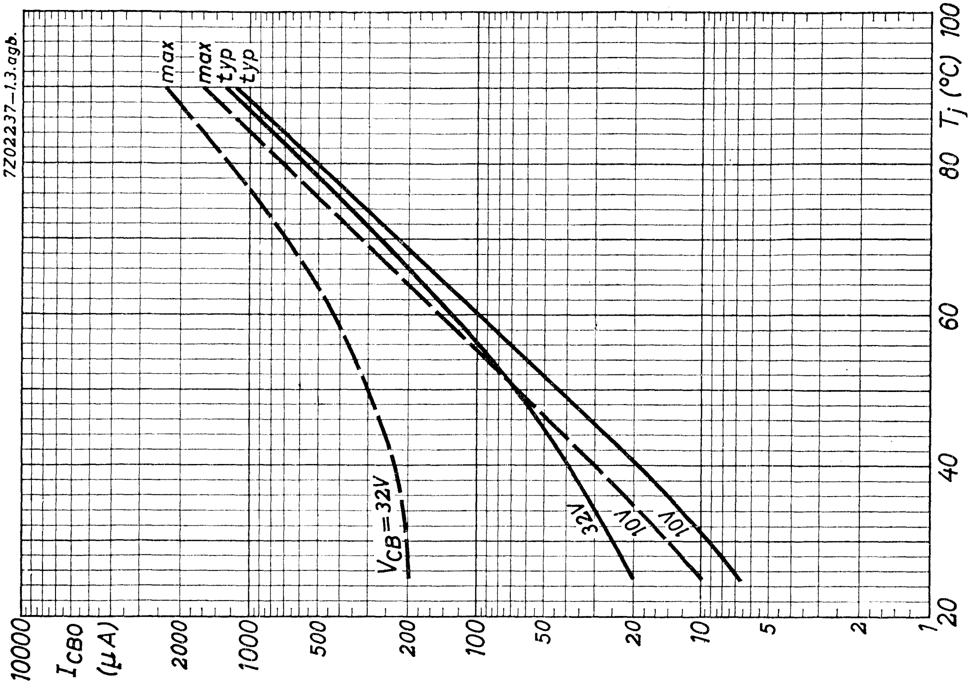

7Z02240—1.3.agb.
V_CB = 5V
T_j = 25°C
max
typ
min
−I_E (mA)
I_B (µA)
−I_E (mA)
I_B (µA)
0
2
4
6
8
10
0
50
100
150
0
0.5
1
0
10
30

B

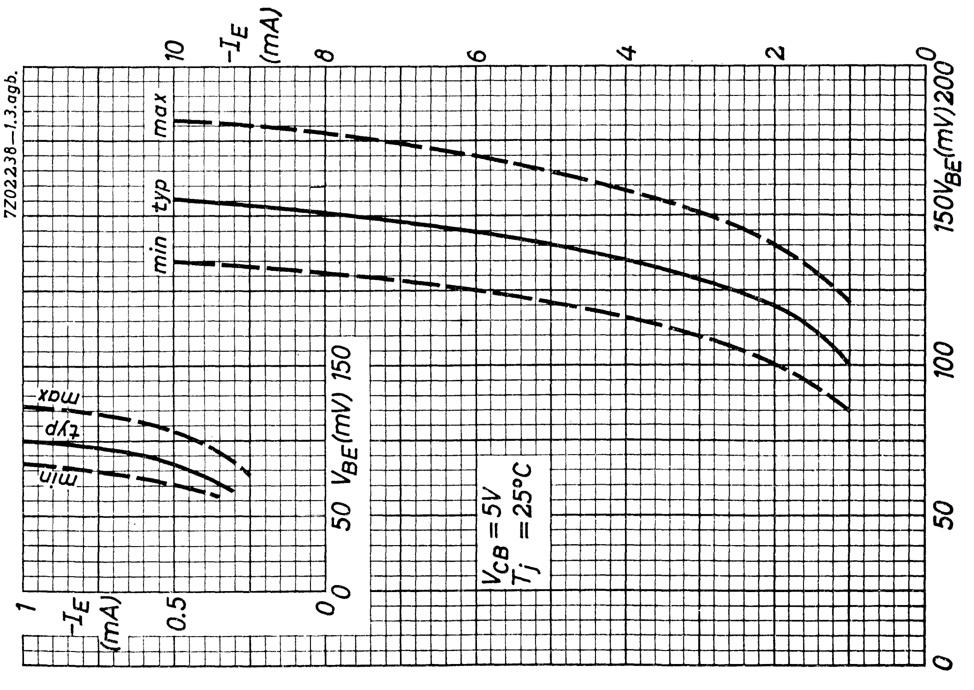

7Z02239—1.3.agb.
I_B = 70µA
60µA
50µA
40µA
30µA
20µA
10µA
I_C (mA)
10
8
6
4
2
0
5
V_CE (V)
10
V_CE = 1V
50
100
I_B (µA)
100
V_BE (mV)
200
T_j = 25°C
V_CE = 1V

A

6.6.1964

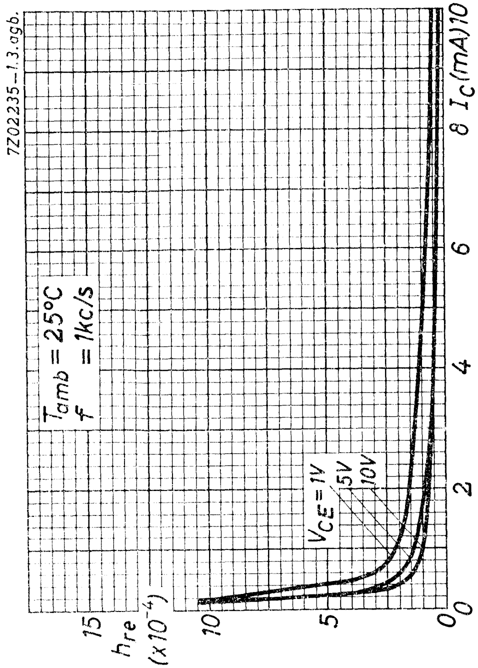

7Z02237—1.3.agb.
max
max
typ
typ
V_{CB} = 32V
32V
10V
10V
I_{CBO} (μA)
10000
2000
1000
500
200
100
50
20
10
5
2
1
20
40
60
80
100
T_j (°C)

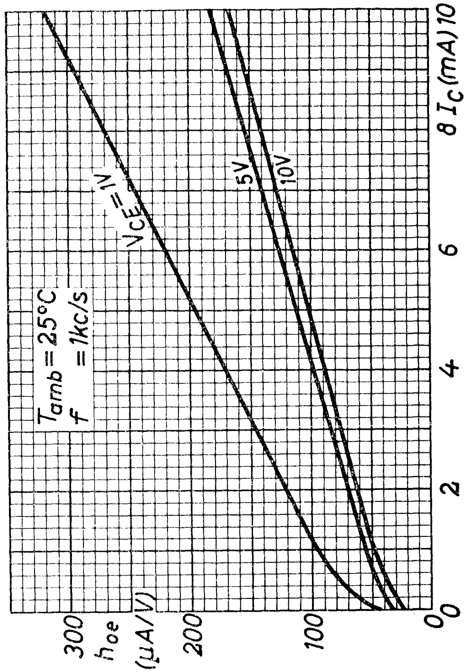
D


7Z02238—1.3.agb.
min
typ
max
min
typ
max
V_{CB} = 5V
T_j = 25°C
$-I_E$ (mA)
1
0.5
0
0
50
V_{BE} (mV)
150
$-I_E$ (mA)
10
8
6
4
2
0
0
50
100
150
V_{BE} (mV)
200

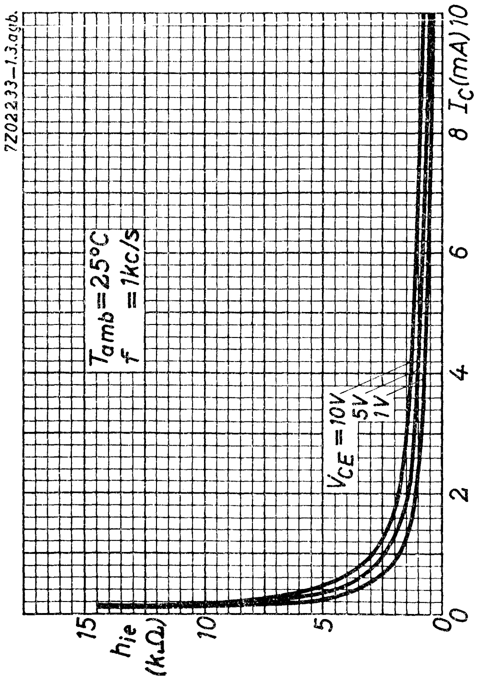
C

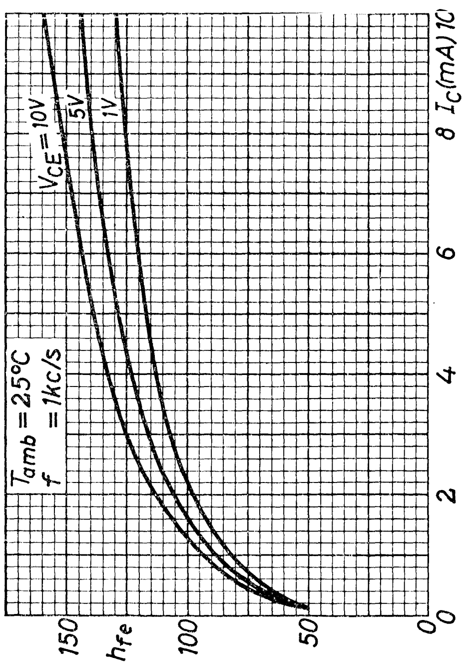
6.6.1964


7Z02235-1.3.agb.
T_{amb} = 25°C
f = 1kc/s
V_{CE} = 1V
5V
10V
h_{re}
(x10^{-4})
15
10
5
0
0
2
4
6
8
I_C(mA) 10


T_{amb} = 25°C
f = 1kc/s
V_{CE} = 1V
5V
10V
h_{oe}
(µA/V)
300
200
100
0
0
2
4
6
8
I_C(mA) 10

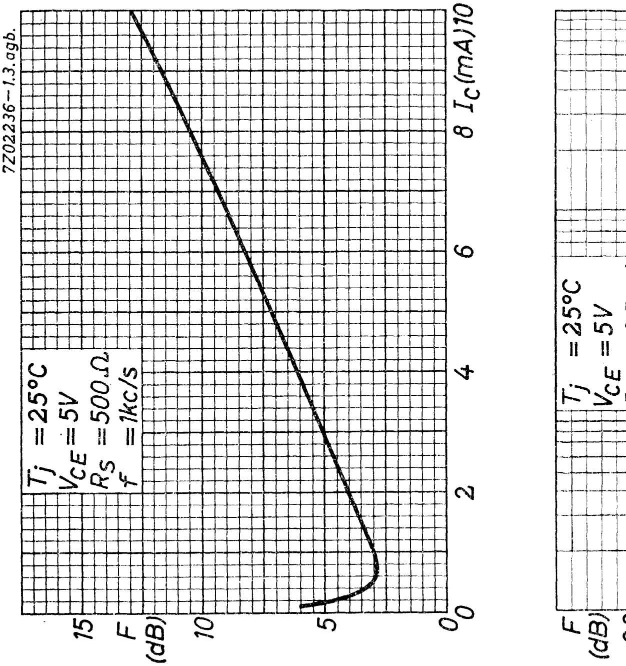
F

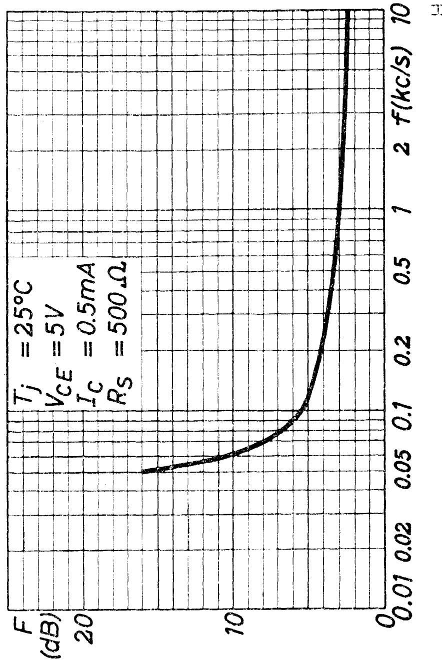

7Z02233-1.3.agb.
T_{amb} = 25°C
f = 1kc/s
V_{CE} = 10V
5V
1V
h_{ie}
(kΩ)
15
10
5
0
0
2
4
6
8
I_C(mA) 10


T_{amb} = 25°C
f = 1kc/s
V_{CE} = 10V
5V
1V
h_{fe}
150
100
50
0
0
2
4
6
8
I_C(mA) 10

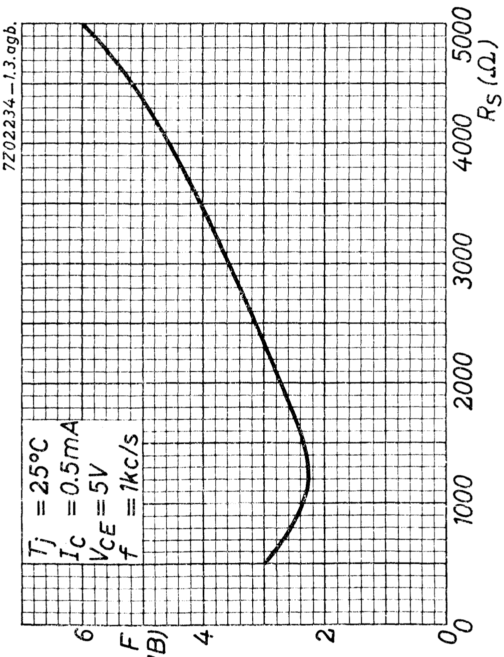
E

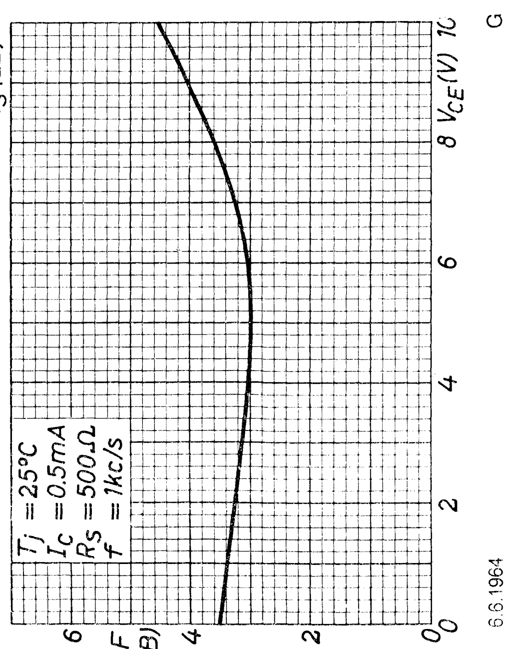
6.6.1964


7Z02236−1.3.agb.
T_j = 25°C
V_{CE} = 5V
R_S = 500Ω
f = 1kc/s
F (dB)
15
10
5
0
0
2
4
6
8
10
I_C(mA)

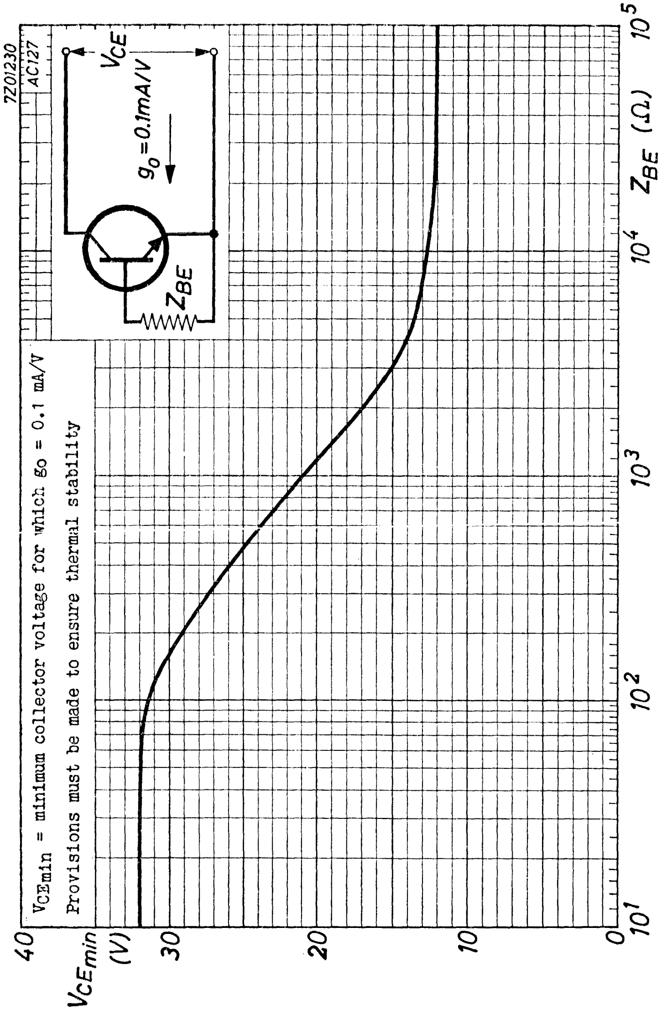

T_j = 25°C
V_{CE} = 5V
I_C = 0.5mA
R_S = 500Ω
F (dB)
20
10
0
0.01
0.02
0.05
0.1
0.2
0.5
1
2
10
f(kc/s)

H


7Z02234−1.3.agb.
T_j = 25°C
I_C = 0.5mA
V_{CE} = 5V
f = 1kc/s
F (dB)
6
4
2
0
0
1000
2000
3000
4000
5000
R_S(Ω)


T_j = 25°C
I_C = 0.5mA
R_S = 500Ω
f = 1kc/s
F (dB)
6
4
2
0
0
2
4
6
8
10
V_{CE}(V)

G


7Z01230
AC127
VCEmin = minimum collector voltage for which go = 0.1 mA/V
Provisions must be made to ensure thermal stability
VCE
go=0.1mA/V
ZBE
VCEmin
(V)
40
30
20
10
0
10¹
10²
10³
10⁴
10⁵
ZBE (Ω)

6.6.1964

P-N-P GERMANIUM POWER TRANSISTOR

Germanium alloy junction transistor of the p-n-p type in a metal case for low frequency high quality output stages.

Type 2-AD139 consists of two transistors AD139 that are matched to operate in a low-distortion class B amplifier.

LIMITING VALUES (Absolute max. values)

Collector

Voltage (base reference)	$-V_{CB}$	= max.	32 V
Voltage (emitter reference)	$-V_{CE}$	= max.	32 V [1]
Current, peak value	$-I_{CM}$	= max.	3 A
Current, averaged over any 50 msec period	$-I_C$ (t_{av}	= max. =	1 A 50 msec)

Emitter

Voltage (base reference)	$-V_{EB}$	= max.	10 V

Base

Current, averaged over any 50 msec period	$-I_B$ (t_{av}	= max. =	0.2 A 50 msec)

Dissipation

Total dissipation	P_{tot}	= max.	13 W

[1] a. See also page F.
b. At high voltages a maximum transient energy of 3 mWsec should not be exceeded.

7Z2 2402

LIMITING VALUES (Absolute max. values) (continued)

Temperatures

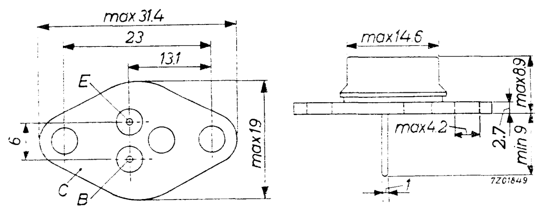
Storage temperature	T_s	=	-55 °C to +75 °C
Junction temperature			
Continuous	T_j	= max.	90 °C
Incidentally (total duration max. 200 hrs)	T_j (t	= max. = max.	100 °C 200 hrs)

THERMAL DATA

Thermal resistance from junction to base of device	K	= max.	4 °C/W
Thermal resistance from base of device to heatsink			
without mica washer	K	=	0.5 °C/W
with mica washer	K	=	1.5 °C/W

MECHANICAL DATA

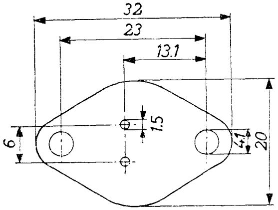
Dimensions in mm

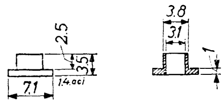


7Z2 3092

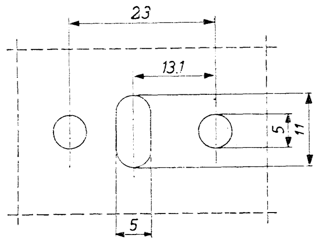
MECHANICAL DATA (continued)

Dimensions in mm





Mica insulation washer
(thickness 50 to 100 μ)
and insulation tubes



Bore-hole dimensions
for heatsink

Code number of mica insulation washer and insulation tubes.: 56239

CHARACTERISTICS at $T_j = 25\ ^oC$

Collector current			
$-V_{CE} = 32$ V; $V_{BE} = 1$ V	$-I_C$	<	1 mA
Emitter current at $I_C = 0$			
$-V_{EB} = 10$ V	$-I_{EBO}$	<	1 mA
Base current			
$I_E = 0.1$ A; $V_{CB} = 0$	$-I_B$	> <	1 mA 4 mA
$I_E = 1$ A; $V_{CB} = 0$	$-I_B$	> <	9 mA 33 mA

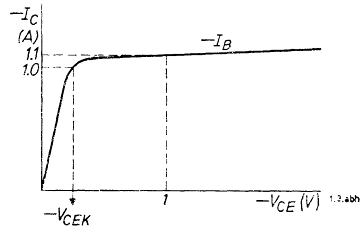
Characteristics of matched pairs 2-AD139

Ratio of D.C. amplification factors			
$-V_{CB} = 0$ $I_E = 100$ mA	h_{FE1}/h_{FE2}	<	1.25
$-V_{CB} = 0$ $I_E = 1$ A	h_{FE1}/h_{FE2}	<	1.25

7Z2 2404

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN $T_j = 25\ ^oC$ unless otherwise specified

Collector current at $I_E = 0$ [1]			
$-V_{CB} = 0.5$ V	$-I_{CBO}$	<	25 μA
Collector voltage (emitter reference)			
$-I_C = 0.5$ A; $V_{BE} = 2$ V	$-V_{CE}$	>	32 V
$-I_C = 0.5$ A; $I_B = 0$	$-V_{CE}$	>	16 V
Collector knee voltage at $-I_C = 1$ A			
$-I_B$ = value at which $-I_C = 1.1$ A and $-V_{CE} = 1$ V	$-V_{CEK}$	<	0.4 V



Base current			
$I_E = 10$ mA; $-V_{CB} = 10$ V (See also page B)	$-I_B$	<	0.5 mA
Base voltage (emitter reference)			
$I_E = 10$ mA; $-V_{CB} = 10$ V (See also page C)	$-V_{BE}$	> <	115 mV 155 mV
Cut-off frequency at			
$-V_{CE} = 2$ V; $I_E = 0.1$ A	f_{ce}	>	10 kc/s

[1]) See also page D.

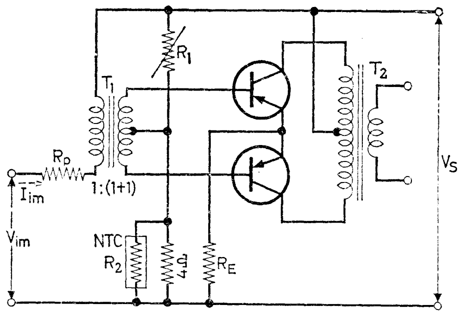
7Z2 2405

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN (continued) $T_j = 25\ ^oC$

Current gain linearity at

$R_L = 12\ \Omega$; $V_S = 14$ V $\lambda_{1A} = 0.55 \quad > 0.45$ [1])

OPERATING CHARACTERISTICS OF A MATCHED PAIR 2-AD139 as class B output amplifier



Stable continuous operation is ensured up to an ambient temperature of 60 °C provided each transistor has been mounted on a 1.5 mm copper heatsink of at least 10 cm x 10 cm.

1) R_L = load resistance, V_S = battery voltage

$\lambda_{1A} = \frac{A_i \text{ at } 1\text{ A}}{A_i \text{ max.}}$, where A_i = loaded small-signal current amplification.

7Z2 2406

OPERATING CHARACTERISTICS OF A MATCHED PAIR 2-AD139 as class B output amplifier (continued)

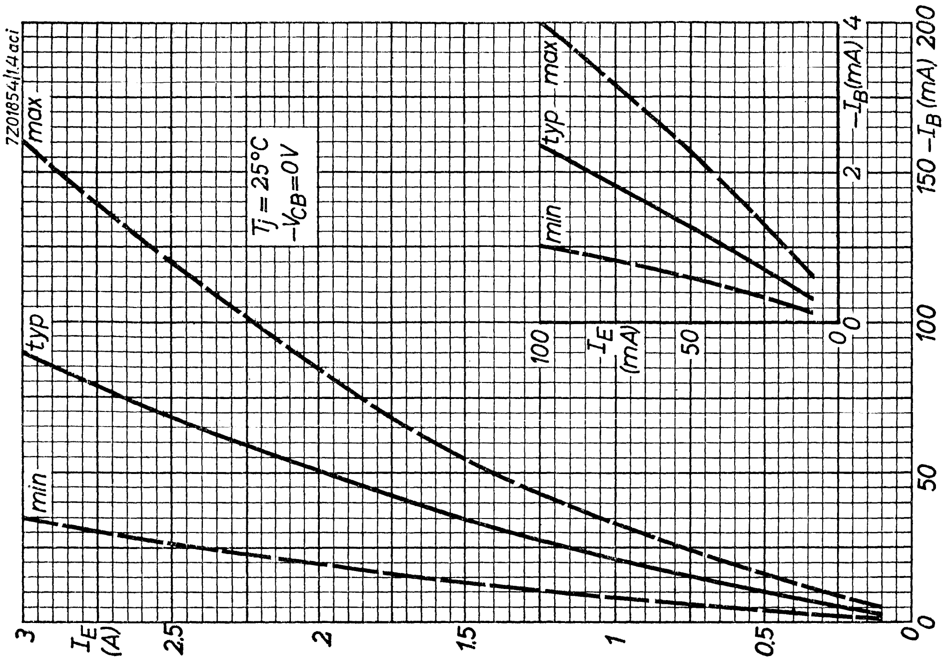
V_S	=	7 (<8)	14 (<16)	V
$-I_C$ (V_i = 0)	=	60	60	mA
R_1	=	100	200	Ω
R_2 [1])	=	4	4	Ω
R_E	=	0.1	0.39	Ω
R_p	=	200	130	Ω
R_{cc}	=	17.5	72	Ω
P_c max. [2])	=	2 x 2.55	2 x 2.55	W
P_o max. [3])	=	2 x 2.5	2 x 2.5	W
$-I_{CM}$ (P_o = 5 W)	=	1500	750	mA
$-I_C$ (P_o = 5 W)	=	480	240	mA
V_{im} (P_o = 5 W)	=	7.5	2.65	V
I_{im} (P_o = 5 W)	=	36	16.7	mA
d_{tot} (P_o = 5 W)	=	6	4.5	%
I_{im} (P_o = 50 mW)	=	3.4	1.67	mA
d_{tot} (P_o = 50 mW)	=	1.5	1	%

1) Code No. B8 320 01P/4E. This NTC resistor must be mounted on the heatsink, close to the transistor.

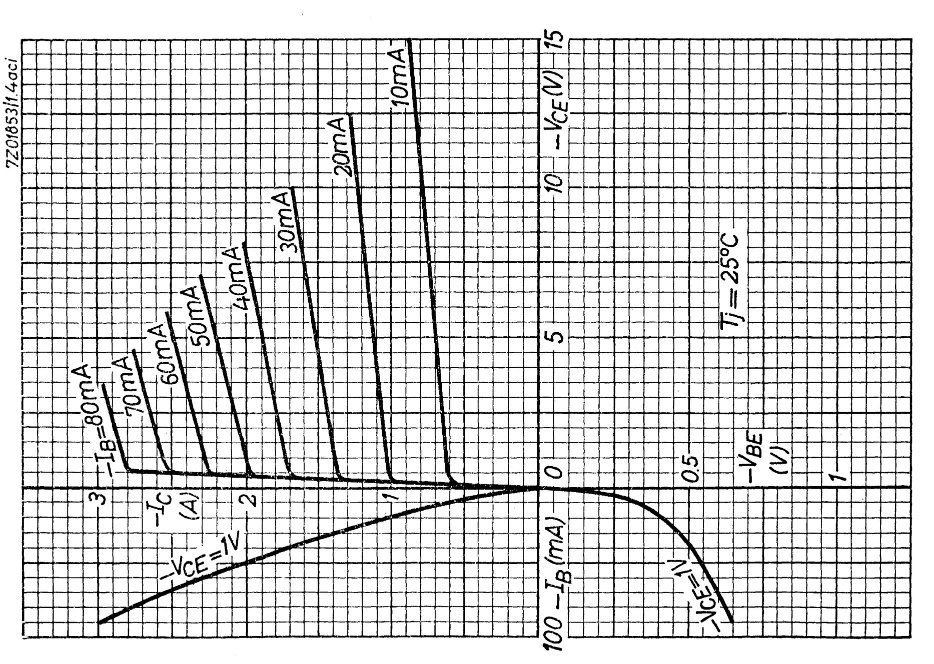
2) Max. output power of the two transistors.

3) Max. power delivered to the primary of the output transformer.

7Z2 2407


7Z01854/1.4aci
Tj = 25°C
−VCB = 0V
max
typ
min
IE (A)
−IB (mA)
IE (mA)
−IB (mA)

B


7Z01853/1.4aci
Tj = 25°C
−IB = 80mA
70mA
60mA
50mA
40mA
30mA
20mA
10mA
−VCE (V)
−IC (A)
−VBE (V)
−VCE = 1V
−IB (mA)
−VCE = 1V

A

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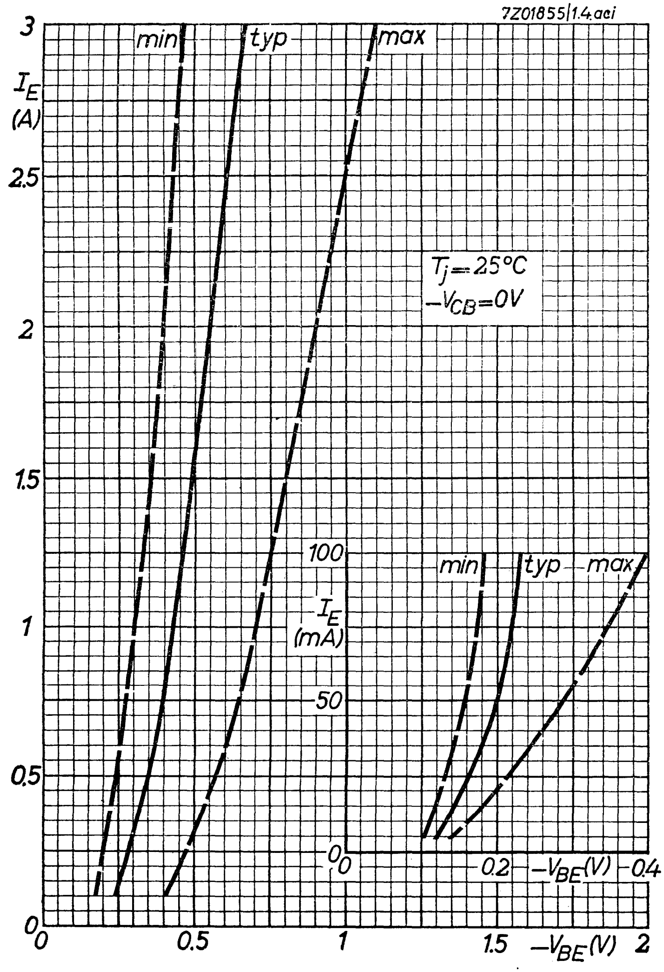
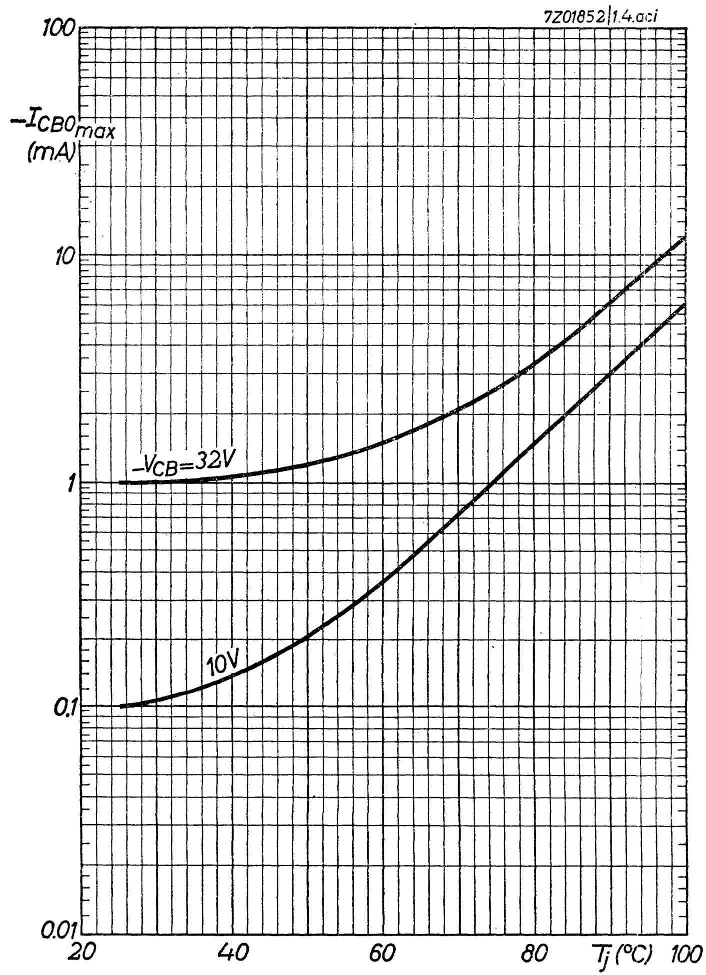
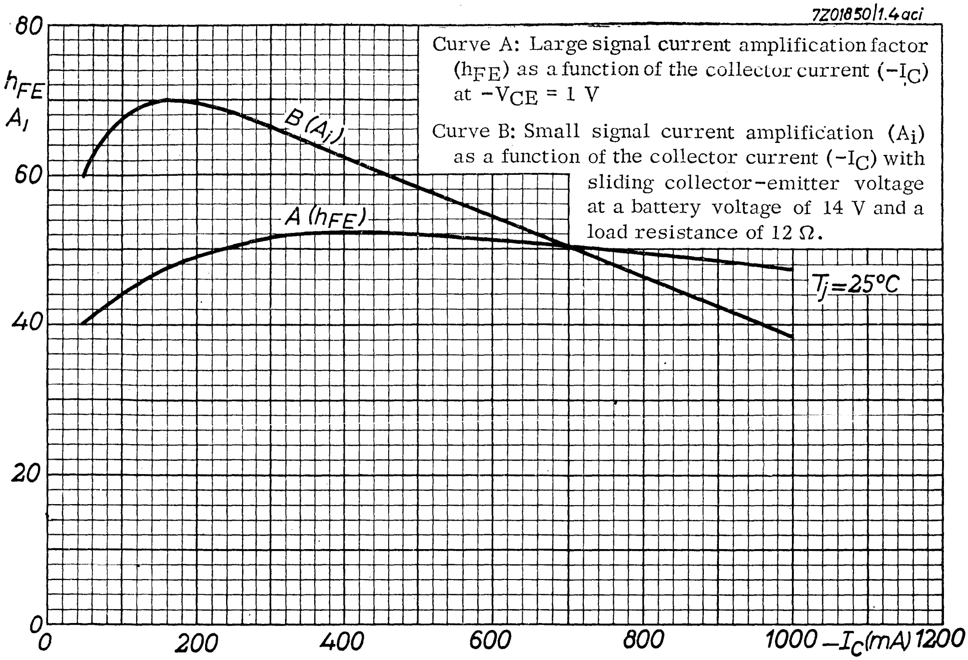

7Z01855|1.4.aci
I_E (A)
3
2.5
2
1.5
1
0.5
0
0
0.5
1
1.5
$-V_{BE}$(V)
2
min
typ
max
T_j = 25°C
$-V_{CB}$=0V
I_E (mA)
100
50
0
0
0.2
$-V_{BE}$(V)
0.4
min
typ
max

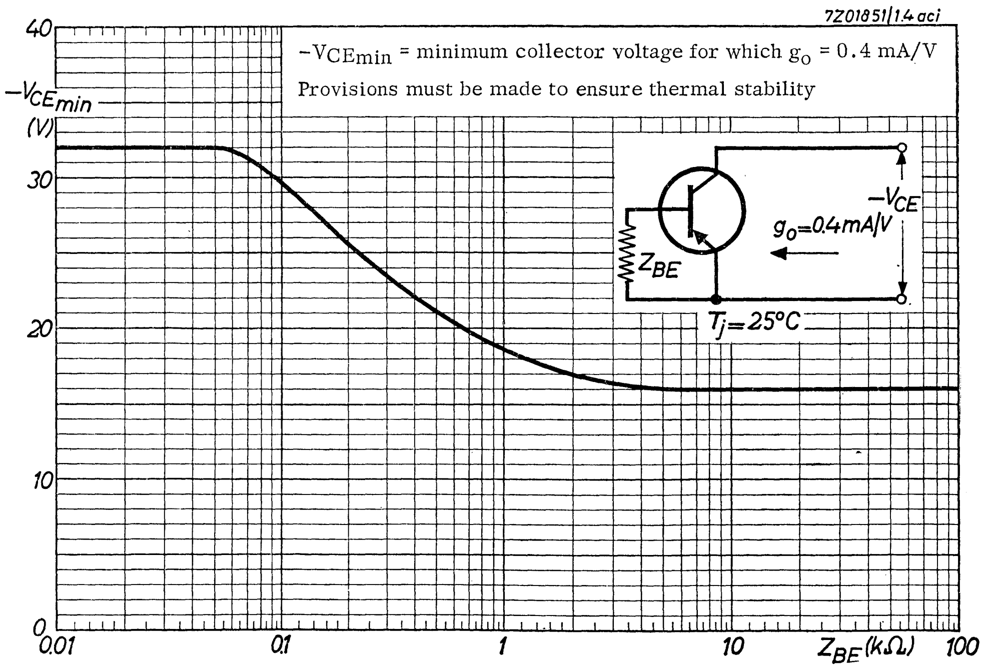
C


7Z01852|1.4.aci
$-I_{CBO}$ max (mA)
100
10
1
0.1
0.01
20
40
60
80
T_j (°C)
100
$-V_{CB}$=32V
10V

D


7Z01850/1.4aci
Curve A: Large signal current amplification factor (h_{FE}) as a function of the collector current ($-I_C$) at $-V_{CE}$ = 1 V
Curve B: Small signal current amplification (A_i) as a function of the collector current ($-I_C$) with sliding collector-emitter voltage at a battery voltage of 14 V and a load resistance of 12 Ω.
h_{FE}
A_i
B (A_i)
A (h_{FE})
T_j=25°C
80
60
40
20
0
0
200
400
600
800
1000
$-I_C$(mA)
1200

E


7Z01851/1.4aci
$-V_{CEmin}$ = minimum collector voltage for which g_o = 0.4 mA/V
Provisions must be made to ensure thermal stability
$-V_{CEmin}$
(V)
$-V_{CE}$
g_o=0.4mA/V
Z_{BE}
T_j=25°C
40
30
20
10
0
0.01
0.1
1
10
Z_{BE}(kΩ)
100

F

6.6.1964

P-N-P GERMANIUM POWER TRANSISTORS

Germanium alloy junction power transistors of the p-n-p type in TO-3 metal case, primarily intended for use in class B push-pull output stages with a power output up to 20 Watts and frame deflection output stages.

Type 2-AD149 consists of 2 transistors AD149 that are matched for operation in a class B output amplifier.

QUICK REFERENCE DATA

Collector voltage (base reference)	$-V_{CB}$	=	max.	50 V
Collector voltage (emitter reference)	$-V_{CE}$	=	max.	50 V
Collector current	$-I_C$	=	max.	3.5 A
Total dissipation	P_{tot}	=	max.	22.5 W
Junction temperature (continuous)	T_j	=	max.	100 °C
Cut-off frequency	$f_{\alpha e}$	=		10 kc/s
Thermal resistance between junction and transistor bottom	K	<		2.0 °C/W
D.C. current amplification factor				
$-I_C$ = 1 A	h_{FE}	> 30		< 100
$-I_C$ = 3 A	h_{FE}	> 20		< 85

7Z2 2497

LIMITING VALUES (Absolute max. values)

Collector				
Voltage (base reference)	$-V_{CB}$	=	max.	50 V
Voltage (emitter reference)	$-V_{CE}$	=	max.	50 V [1]
Current	$-I_C$	=	max.	3.5 A
Emitter				
Voltage (base reference)	$-V_{EB}$	=	max.	20 V
Base				
Current	$-I_B$	=	max.	0.5 A
Dissipation				
Total dissipation	P_{tot}	=	max.	22.5 W
Temperatures				
Storage temperature	T_s	=		-65 °C to 100 °C
Junction temperature				
continuous	T_j	=	max.	100 °C
incidentally (max. 200 hrs)	T_j	=	max.	110 °C

THERMAL DATA

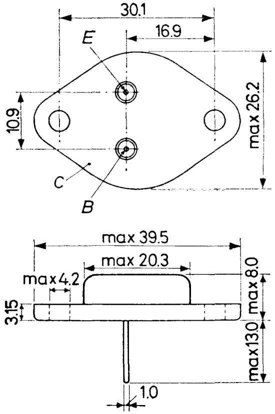
Thermal resistance between			
junction and transistor bottom	K	<	2 °C/W
transistor bottom and heatsink without insulating materials and with lead washer	K	=	0.2 °C/W
transistor bottom and heatsink with mica and insulating tubes	K	=	0.5 °C/W

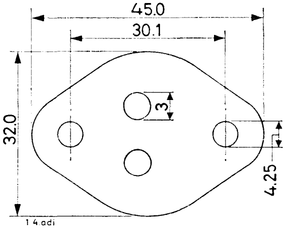
[1]) See also fig.J

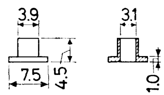
7Z2 2498

MECHANICAL DATA

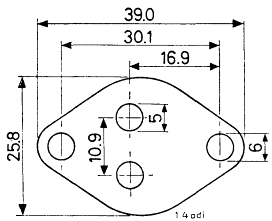
Dimensions in mm







Codenumber 56201A
Mica insulation (50 μm)
and insulation tubes



Codenumber 56201B
Lead washer (1 mm)

7Z2 2499

CHARACTERISTICS at $T_j = 25\ ^oC$

Emitter current at $I_C = 0$					
$-V_{EB} = 20$ V	$-I_{EBO}$			<	3 mA
Base current					
$I_E = 1$ A; $V_{CB} = 0$	$-I_B$	>	10 mA	<	32 mA
$I_E = 3$ A; $V_{CB} = 0$	$-I_B$	>	35 mA	<	140 mA

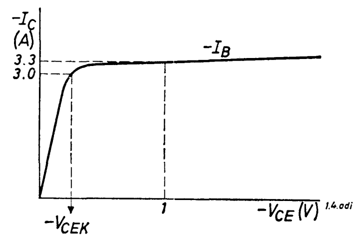
CHARACTERISTICS OF MATCHED PAIRS

Ratio of the D.C. current amplification factors

at $-I_C = 0.3$ A	h_{FE1}/h_{FE2}	= 1.1	< 1.25
at $-I_C = 3$ A	h_{FE1}/h_{FE2}	= 1.1	< 1.25

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN at $T_j = 25\ ^oC$

Collector current at $I_E = 0$	$-I_{CBO}$, see fig. G	
Base current	$-I_B$, see fig. F and H	
Base voltage	$-V_{BE}$, see fig. D and E	
Collector knee voltage at $-I_C = 3$ A; $-I_B$ = value at which $-I_C = 3.3$ A and $-V_{CE} = 1$ V	$-V_{CEK}$	< 0.7 V



see also fig.B

7Z2 2500

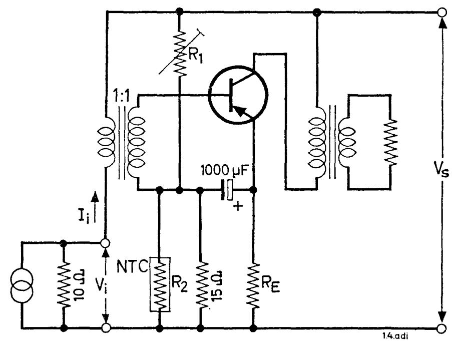
CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN (continued) T_j = 25 °C

Avalanche breakdown voltage	See fig.C		
Base impedance at f = 450 kc/s			
I_E = 1 mA; $-V_{CB}$ = 5 V	$\lvert z_{rb} \rvert$	= 30 Ω	
Collector capacitance at f = 450 kc/s			
$-V_{CB}$ = 5 V; I_E = 0	c_c	= 220 pF	
Emitter capacitance at f = 450 kc/s			
$-V_{EB}$ = 5 V; I_C = 0	c_e	= 140 pF	
Transition frequency			
$-V_{CE}$ = 2 V; $-I_C$ = 0.5 A	f_T	= 500 kc/s	> 300 kc/s
Cut-off frequency			
$-V_{CE}$ = 2 V; $-I_C$ = 0.5 A	$f_{\alpha e}$	= 10 kc/s	> 7 kc/s
Current gain linearity [1])	λ_{3A}	= 0.35	> 0.2

[1]) $\lambda_{3A} = \frac{A_i \text{ at } 3\text{ A}}{A_i \text{ at } 0.1\text{ A}}$ (See figure I)

7Z2 2501

OPERATING CHARACTERISTICS in a class A amplifier



NOTES

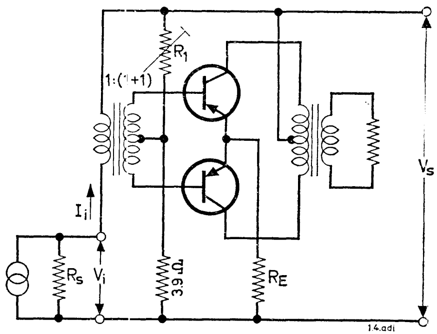
1. R_2, an NTC-resistor B8 320 01P/50E, shall be mounted on the heatsink near the transistor.
2. Stable continuous operation is ensured up to T_{amb} = 55 °C, provided each transistor has been mounted on a 1.5 mm copper heatsink of at least 18 x 18 cm^2 (circuit I) or 15 x 15 cm^2 (circuit II).

		Circuit I	Circuit II	
V_S	=	7 (max. 8)	14 (max. 16)	V
$-I_C$ (V_i = 0)	=	1.8	0.72	A
R_1	=	50	200	Ω
R_E	=	0.3	0.5	Ω
R_C	=	4	23	Ω
$P_{c\,max}$ [1])	=	4.3	4.1	W
$P_{o\,max}$ [2])	=	4	4	W
V_{im} (P_o = 4 W)	=	0.48	0.40	V
I_{im} (P_o = 4 W)	=	35	12	mA
d_{tot} (P_o = 4 W)	=	9.5	7.5	%
I_{im} (P_o = 50 mW)	=	2.5	1	mA
d_{tot} (P_o = 50 mW)	=	2.5	1.5	%

[1]) Output power of the transistor.
[2]) Power, delivered to the primary of the output transformer.

7Z2 2512

OPERATING CHARACTERISTICS OF A MATCHED PAIR 2-AD149 as class B output amplifier



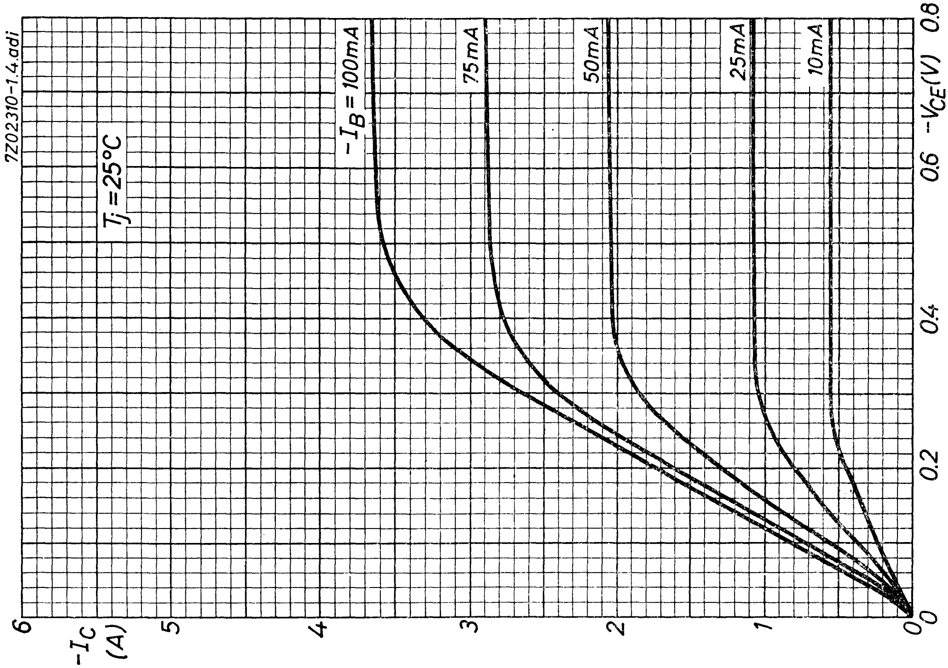
NOTE

Stable continuous operation is ensured up to T_{amb} = 55 °C, provided each transistor has been mounted on a 1.5 mm copper heat-sink of at least 5 x 5 cm^2 (circuit I) or 6 x 6 cm^2 (circuit II).

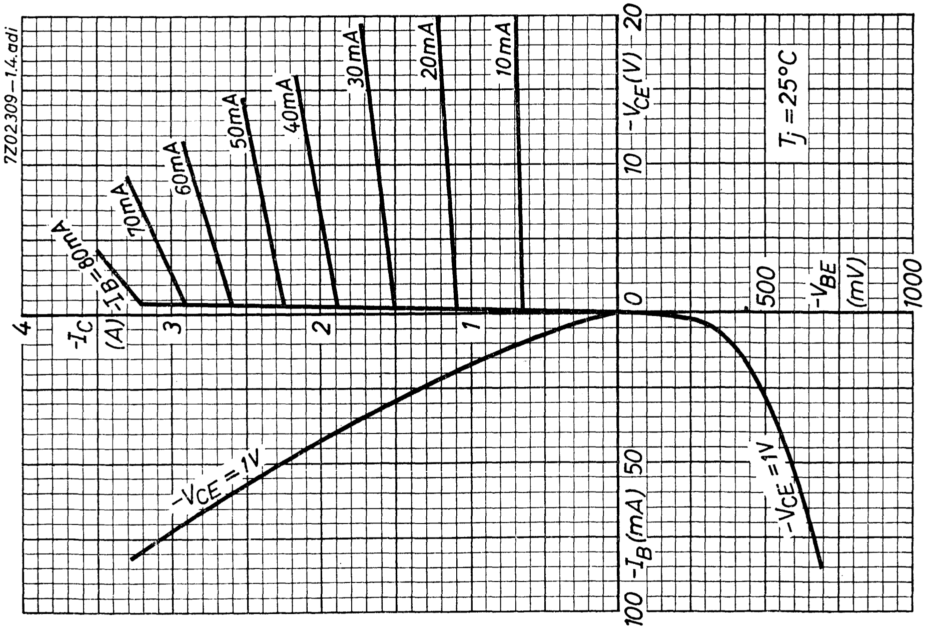
		Circuit I	Circuit II	
V_S	=	7 (max. 8)	14 (max. 16)	V
$-I_C$ (V_i = 0)	=	2 x 30	2 x 30	mA
R_1	=	200	350	Ω
R_E	=	0	0.47	Ω
R_S	=	450	370	Ω
R_{cc}	=	9	16	Ω
$P_{c\,max}$ 1)	=	9.75	20	W
$P_{o\,max}$ 2)	=	9.75	17.9	W
$-I_{CM}$ (P_o = max)	=	3	3	A
$-I_C$ (P_o = max)	=	2 x 0.48	2 x 0.48	A
V_{im} (P_o = max)	=	0.81	2.2	V
I_{im} (P_o = max)	=	75	75	mA
d_{tot} (P_o = max)	=	10	10	%
I_{im} (P_o = 50 mW)		4	2.5	mA
d_{tot} (P_o = 50 mW)		2.5	2	%

1) Output power of two transistors.
2) Power, delivered to the primary of the output transformer.

7Z2 2513

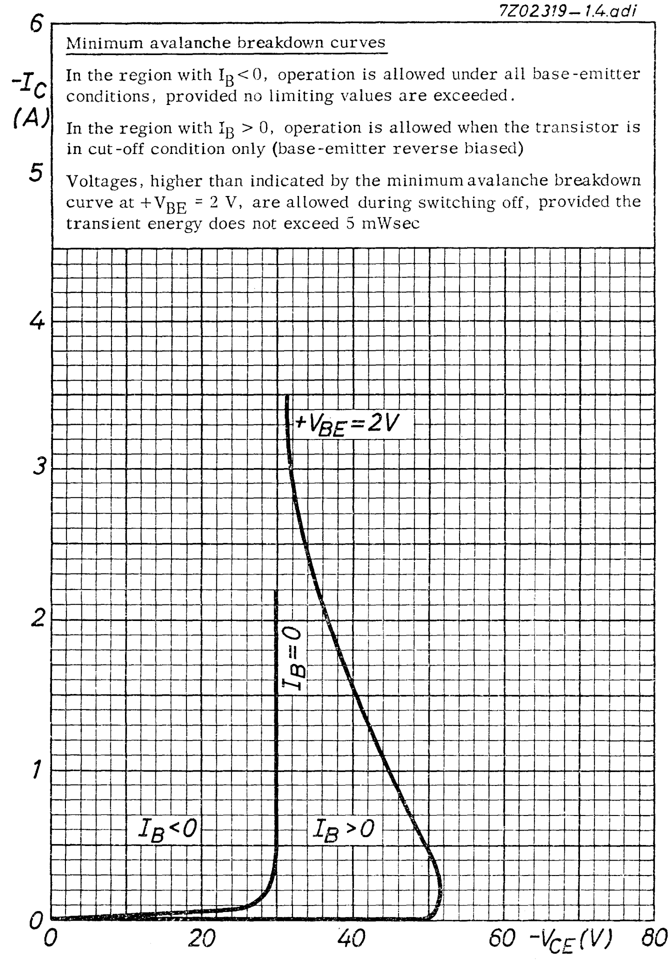

7Z02310-1.4.adi
$T_j = 25°C$
$-I_B = 100mA$
75mA
50mA
25mA
10mA
$-I_C$ (A)
6
5
4
3
2
1
0
0
0.2
0.4
0.6
0.8
$-V_{CE}(V)$

B

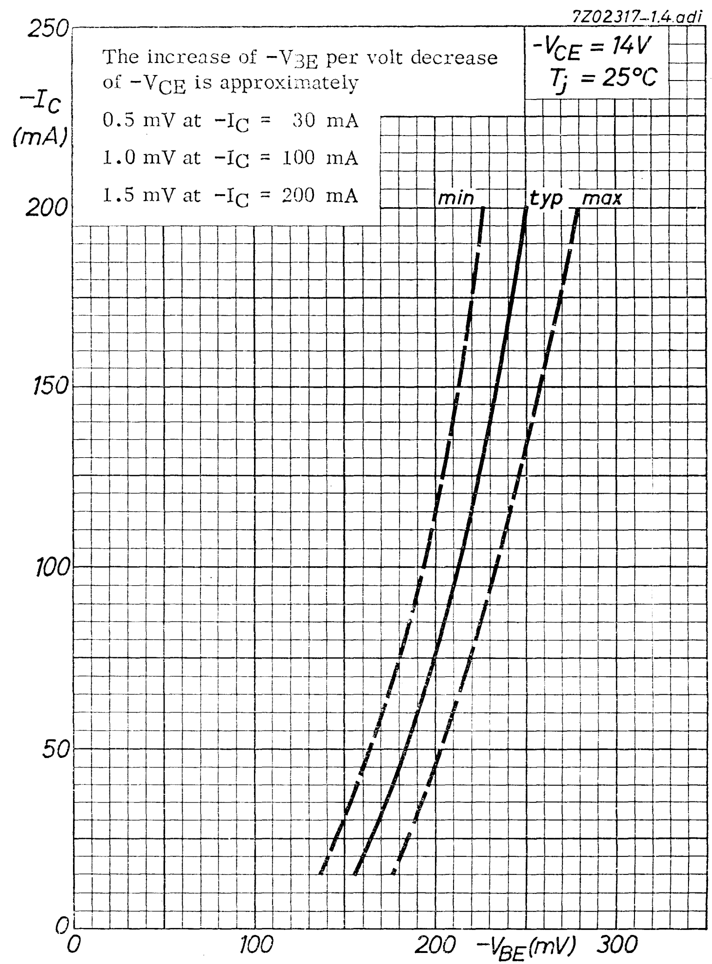

7Z02309-1.4.adi
$-I_B = 80mA$
70mA
60mA
50mA
40mA
30mA
20mA
10mA
$-I_C$ (A)
4
3
2
1
0
10
20
$-V_{CE}(V)$
$T_j = 25°C$
$-V_{CE} = 1V$
$-V_{CE} = 1V$
100
50
$-I_B(mA)$
500
1000
$-V_{BE}$ (mV)

A

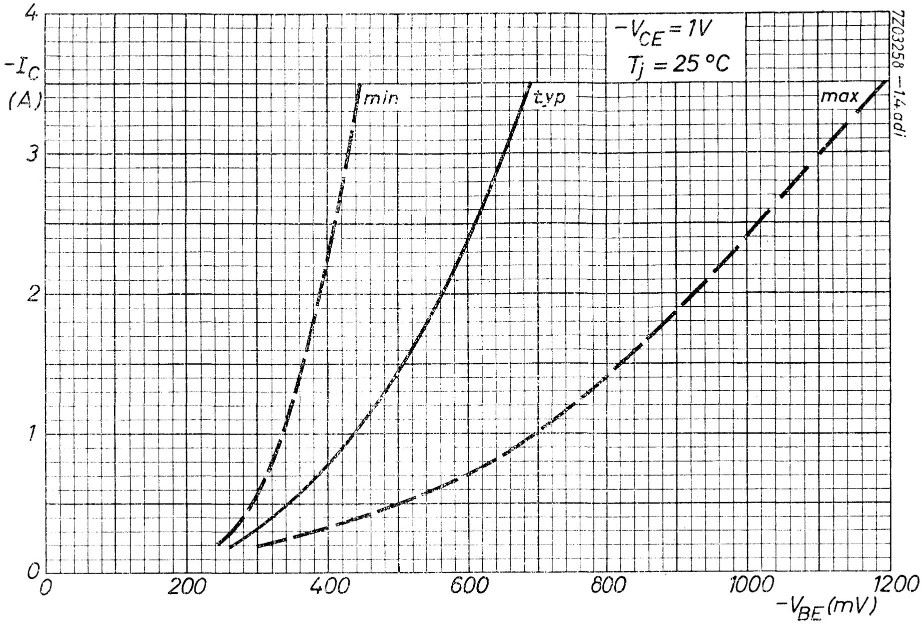
7.7.1964


7Z02319–1.4.adi
Minimum avalanche breakdown curves
In the region with $I_B < 0$, operation is allowed under all base-emitter conditions, provided no limiting values are exceeded.
In the region with $I_B > 0$, operation is allowed when the transistor is in cut-off condition only (base-emitter reverse biased)
Voltages, higher than indicated by the minimum avalanche breakdown curve at $+V_{BE}$ = 2 V, are allowed during switching off, provided the transient energy does not exceed 5 mWsec
$-I_C$ (A)
6
5
4
3
2
1
0
$+V_{BE}=2V$
$I_B=0$
$I_B<0$
$I_B>0$
0
20
40
60
80
$-V_{CE}$ (V)

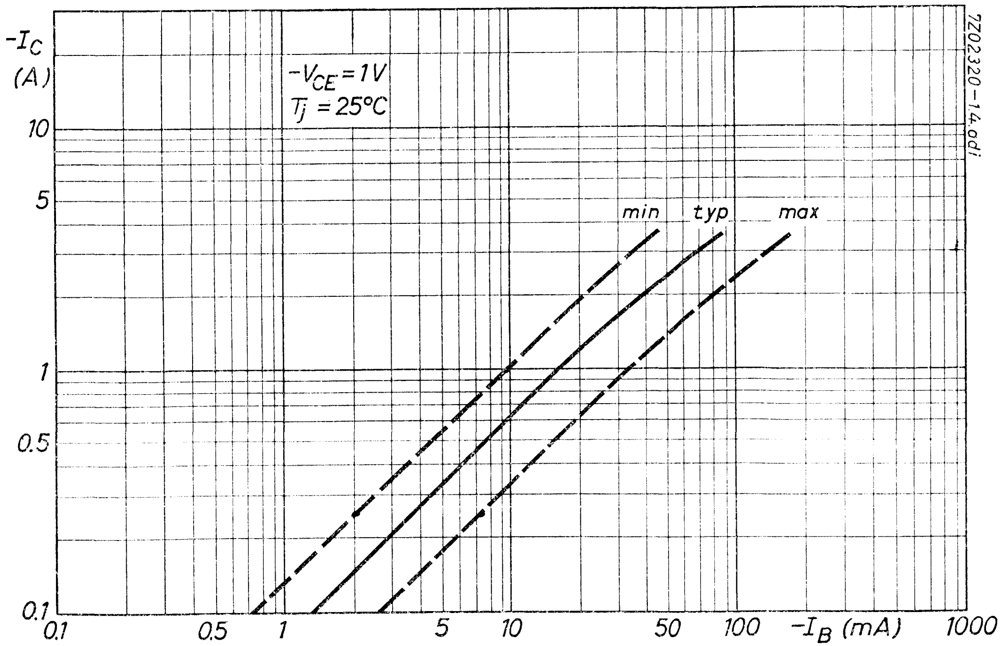
C


7Z02317–1.4.adi
The increase of $-V_{BE}$ per volt decrease of $-V_{CE}$ is approximately
0.5 mV at $-I_C$ = 30 mA
1.0 mV at $-I_C$ = 100 mA
1.5 mV at $-I_C$ = 200 mA
$-V_{CE}$ = 14V
T_j = 25°C
$-I_C$ (mA)
250
200
150
100
50
0
min
typ
max
0
100
200
300
$-V_{BE}$ (mV)

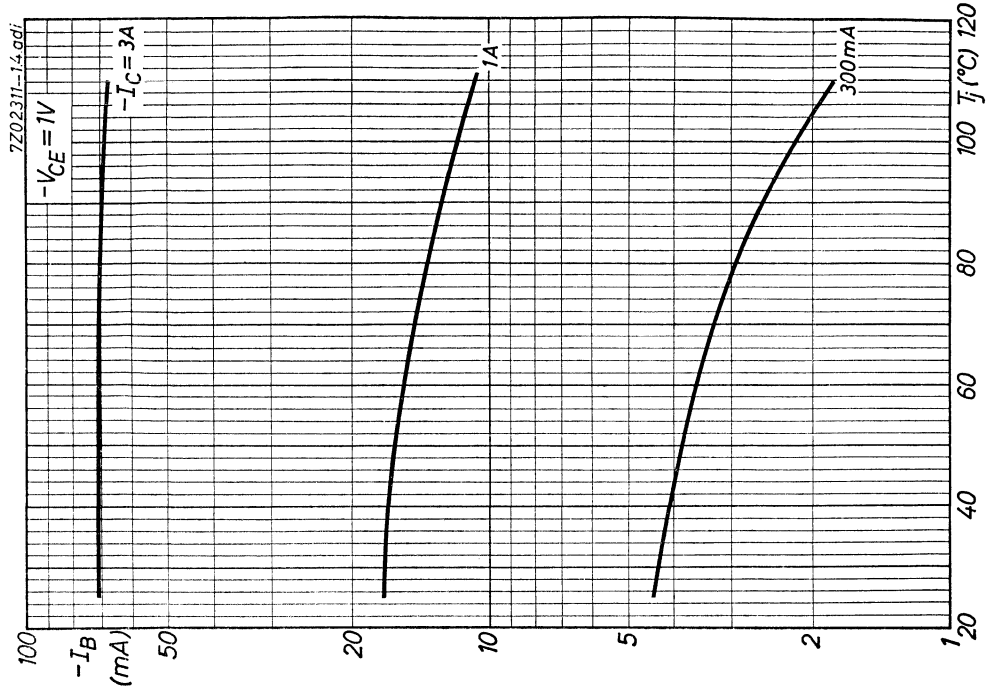
D


4
$-I_C$
(A)
3
2
1
0
0
200
400
600
800
1000
1200
$-V_{BE}$(mV)
$-V_{CE}$ = 1V
T_j = 25 °C
min
typ
max
7Z03258 — 14.adi

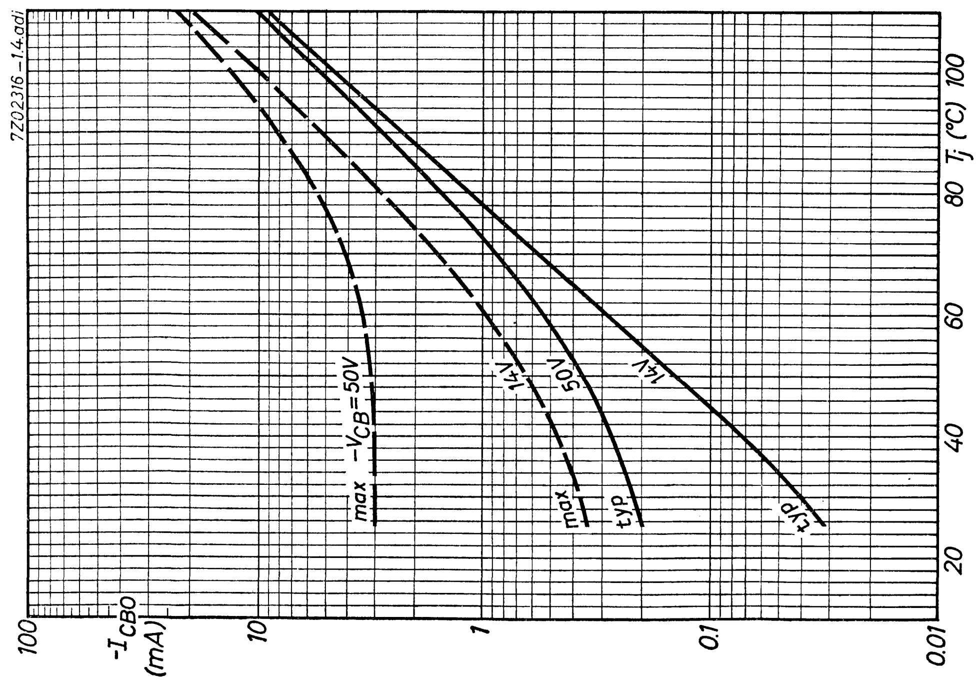
E


$-I_C$
(A)
10
5
1
0.5
0.1
0.1
0.5
1
5
10
50
100
$-I_B$ (mA)
1000
$-V_{CE}$ = 1V
T_j = 25°C
min
typ
max
7Z02320 — 14.adi

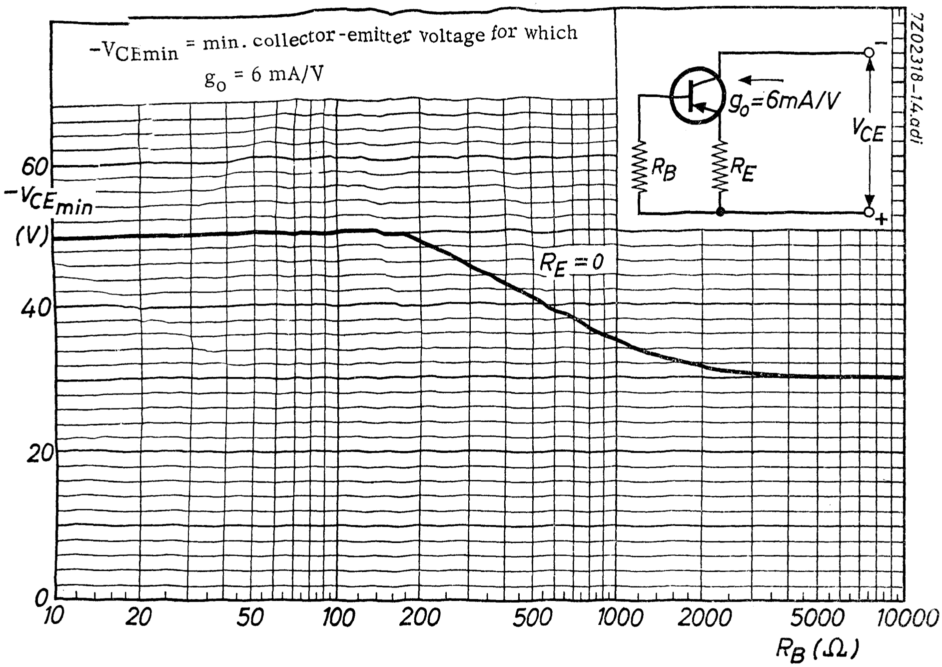
F

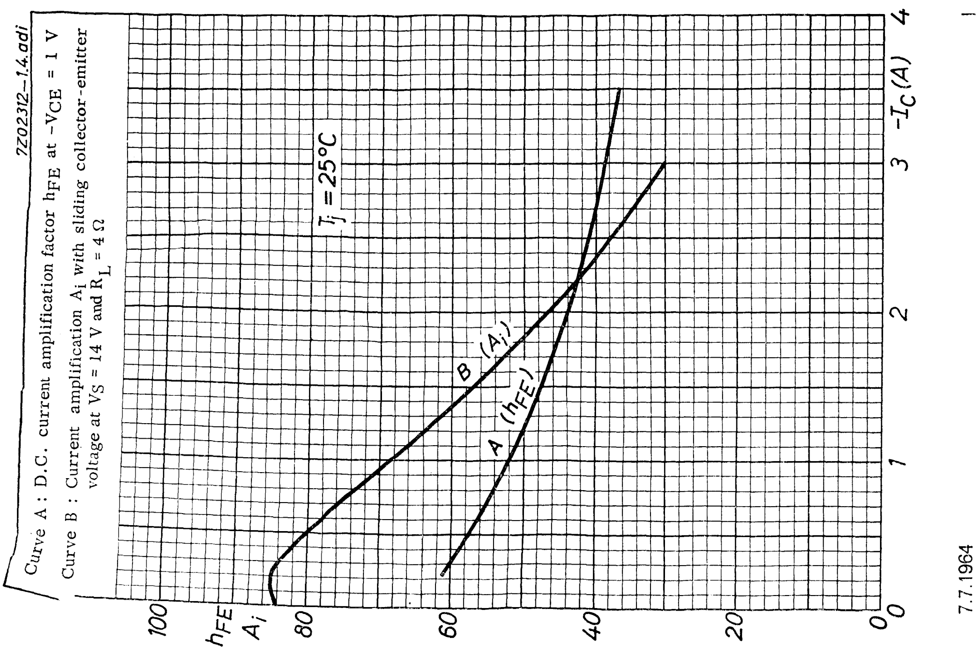

7Z02311-1.4.adi
$-V_{CE}=1V$
$-I_C=3A$
1A
300mA
$-I_B$ (mA)
100
50
20
10
5
2
1
T_j (°C)
20
40
60
80
100
120

H

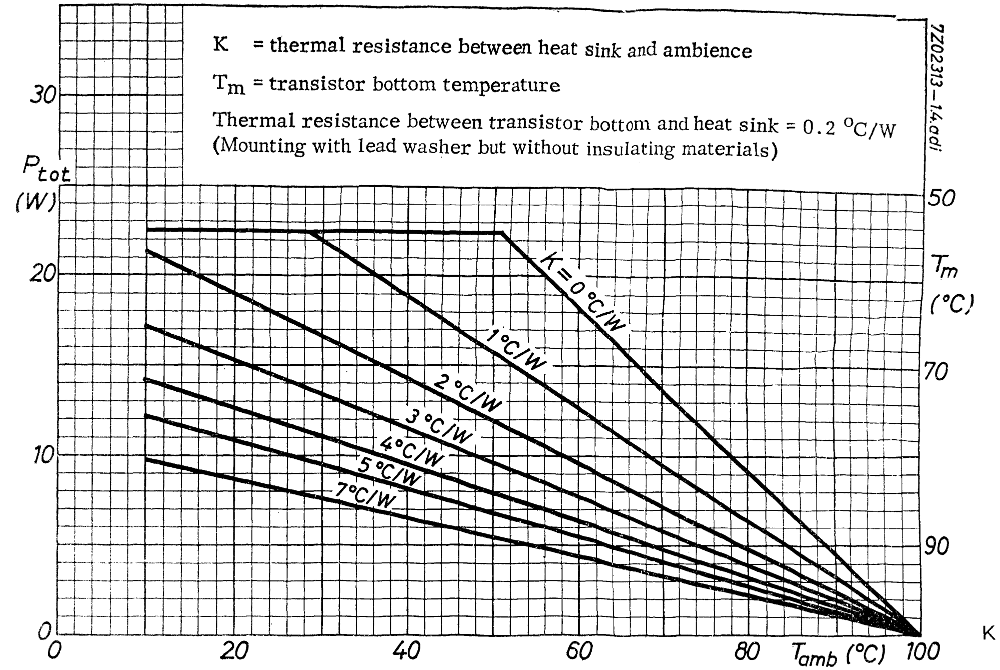

7Z02316-1.4.adi
$-I_{CBO}$ (mA)
100
10
1
0.1
0.01
T_j (°C)
20
40
60
80
100
max
$-V_{CB}=50V$
14V
max
50V
typ
14V
typ

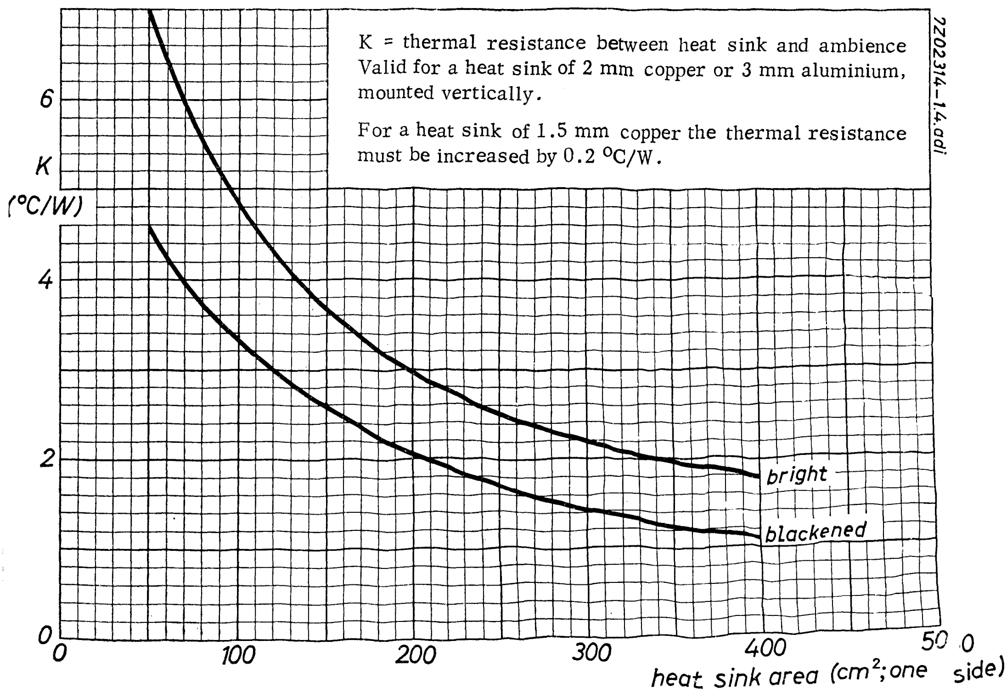
G


-VCEmin = min. collector-emitter voltage for which
go = 6 mA/V
go=6mA/V
VCE
RB
RE
7Z02318-1.4.adi
60
-VCEmin
(V)
40
20
0
RE = 0
10
20
50
100
200
500
1000
2000
5000
10000
RB (Ω)


7Z02312-1.4.adi
Curve A : D.C. current amplification factor hFE at -VCE = 1 V
Curve B : Current amplification Ai with sliding collector-emitter voltage at VS = 14 V and RL = 4 Ω
Tj = 25°C
B (Ai)
A (hFE)
-IC (A)
4
3
2
1
0
100
hFE
Ai
80
60
40
20
0

7.7.1964


K = thermal resistance between heat sink and ambience
Tm = transistor bottom temperature
Thermal resistance between transistor bottom and heat sink = 0.2 °C/W
(Mounting with lead washer but without insulating materials)
7Z02313-1.4.adi
Ptot (W)
30
20
10
0
50
Tm (°C)
70
90
K = 0 °C/W
1 °C/W
2 °C/W
3 °C/W
4 °C/W
5 °C/W
7 °C/W
0
20
40
60
80
Tamb (°C)
100
K


K = thermal resistance between heat sink and ambience
Valid for a heat sink of 2 mm copper or 3 mm aluminium, mounted vertically.
For a heat sink of 1.5 mm copper the thermal resistance must be increased by 0.2 °C/W.
7Z02314-1.4.adi
K (°C/W)
6
4
2
0
bright
blackened
0
100
200
300
400
500
heat sink area (cm²; one side)
L

GERMANIUM P-N-P POWER TRANSISTOR

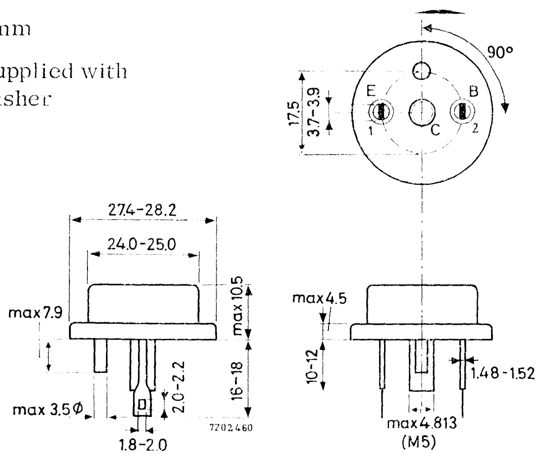
Germanium alloy power transistor of the p-n-p type, in metal case, for high power and high current application

QUICK REFERENCE DATA					
Collector voltage (base reference)	$-V_{CB}$	=	max.	80	V
Collector voltage (emitter reference)	$-V_{CE}$	=	max.	60	V
Emitter voltage (base reference)	$-V_{EB}$	=	max.	40	V
Collector current peak	$-I_{CM}$	=	max.	30	A
Total dissipation at T_{case} = 30 °C	P_{tot}	=	max.	100	W
Junction temperature	T_j	=	max.	90	°C
D.C. current amplification factor at I_E = 25 A	h_{FE}	>		15	

MECHANICAL DATA

Dimensions in mm

The device is supplied with nut and mica washer



7Z2 3363

LIMITING VALUES (Absolute max. values)

Collector						
Voltage (base reference)	$-V_{CB}$	=	max.	80	V	
Voltage (emitter reference)	$-V_{CE}$	=	max.	60	V	[1]
Current (average)	$-I_C$	=	max.	25	A	
Current (peak value)	$-I_{CM}$	=	max.	30	A	
Emitter						
Voltage (base reference)	$-V_{EB}$	=	max.	40	V	
Current (average)	I_E	=	max.	28	A	
Current (peak value)	I_{EM}	=	max.	35	A	
Base						
Current (average)	$-I_B$	=	max.	3	A	
Current (peak value)	$-I_{BM}$	=	max.	5	A	
Dissipation at $T_{case} = 30\ ^{o}C$	P_{tot}	=	max.	100	W	[1]
Temperatures						
Storage temperature	T_s	=	$-55\ ^{o}C$ to	90	^{o}C	
Junction temperature	T_j	=	max.	90	^{o}C	

THERMAL DATA

Thermal resistance between junction and transistor bottom	K	<	0.6	$^{o}C/W$	[1]

[1]) See page G.

7Z2 2686

CHARACTERISTICS $T_j = 25\ ^{o}C$

Collector current at $I_E = 0$							
$-V_{CB} = 80$ V	$-I_{CBO}$	=	0.5	mA	<	4	mA
Emitter current at $I_C = 0$							
$-V_{EB} = 40$ V	$-I_{EBO}$	=	0.5	mA	<	4	mA
Collector voltage (emitter reference)							
$-I_C = 1$ A; $V_{BE} = 0$	$-V_{CES}$	=	90	V	>	60	V
Collector-emitter sustaining voltage							
$-I_C = 25$ A; $+V_{BE} = 2$ V	$-V_{CE_{sust}}$				>	40	V
Collector saturation voltage [1]							
$-I_C = 25$ A; $-I_B = 2.5$ A	$-V_{CE_{sat}}$	=	0.15	V	<	0.5	V
Emitter floating potential							
$I_E = 0$ $-V_{CBO} = 80$ V	$-V_{EBF}$	=	0.2	V	<	1.0	V
Base voltage (emitter reference) [1]							
$I_E = 25$ A; $V_{CB} = 0$	$-V_{BE}$	=	1.2	V	<	2	V
D.C. current amplification factor [1]							
$I_E = 25$ A; $V_{CB} = 0$	h_{FE}	=	25		>	15	

[1]) Measured with pulses

7Z2 2687

CHARACTERISTIC RANGE VALUES FOR EQUIPMENT DESIGN

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

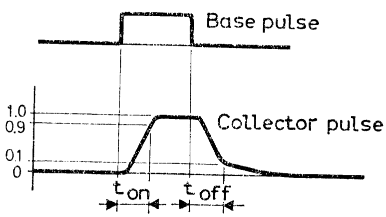
Collector current at $I_E = 0$			
$-V_{CB} = 2\ V$	$-I_{CBO}$	$= 50\ \mu A$	$< 200\ \mu A$
Emitter current at $I_C = 0$			
$-V_{EB} = 2\ V$	$-I_{EBO}$	$= 50\ \mu A$	$< 200\ \mu A$
Collector current at $+V_{BE} = 1\ V$			
$-V_{CE} = 80\ V;\ T_j = 90\ ^{\circ}C$	$-I_{CEX}$ [1]	$= 3\ mA$	
D.C. current amplification factor			
$I_E = 5\ A;\ V_{CB} = 0$	h_{FE}	$= 60$	> 40 < 120
Base voltage (emitter reference)			
$I_E = 5\ A;\ V_{CB} = 0$	$-V_{BE}$	$= 0.6\ V$	$< 1\ V$
Current amplification factor			
$-I_C = 1\ A;\ -V_{CE} = 12\ V$ $f = 100\ kc/s$	h_{fe}	$= 1.7$	> 1
Collector capacitance			
$I_E = 0\ \ -V_{CB} = 12\ V$	c_c	$= 350\ pF$	

Turn on time

$-I_C = 25\ A;\ -I_B = 2\ A;$
$-V_{CC} = 18\ V$ $\quad t_{on} = 25\ \mu s$

Turn off time

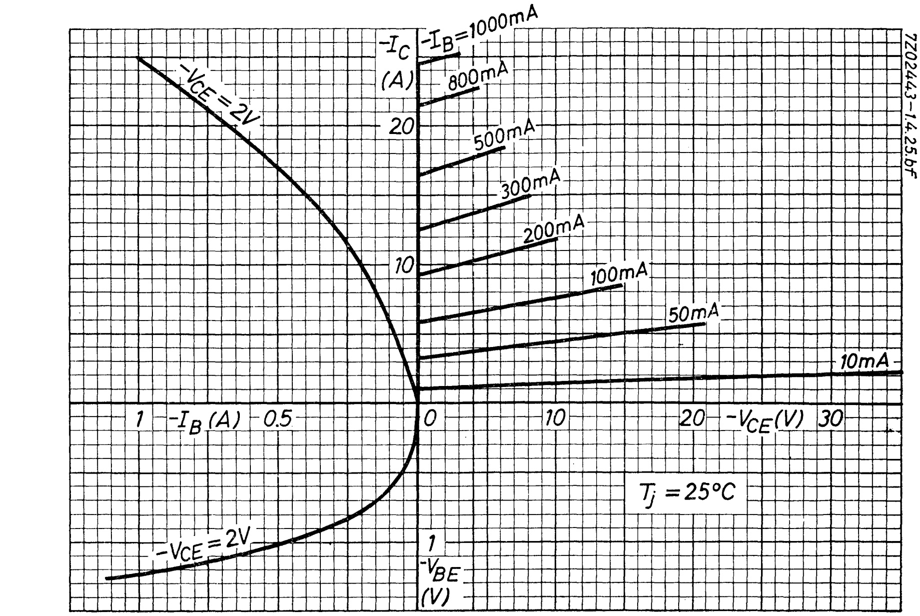
$-I_C = 25\ A;\ V_{BE_{off}} = 6\ V;$
$R_{BE} = 10\ \Omega$ $\quad t_{off} = 75\ \mu s$

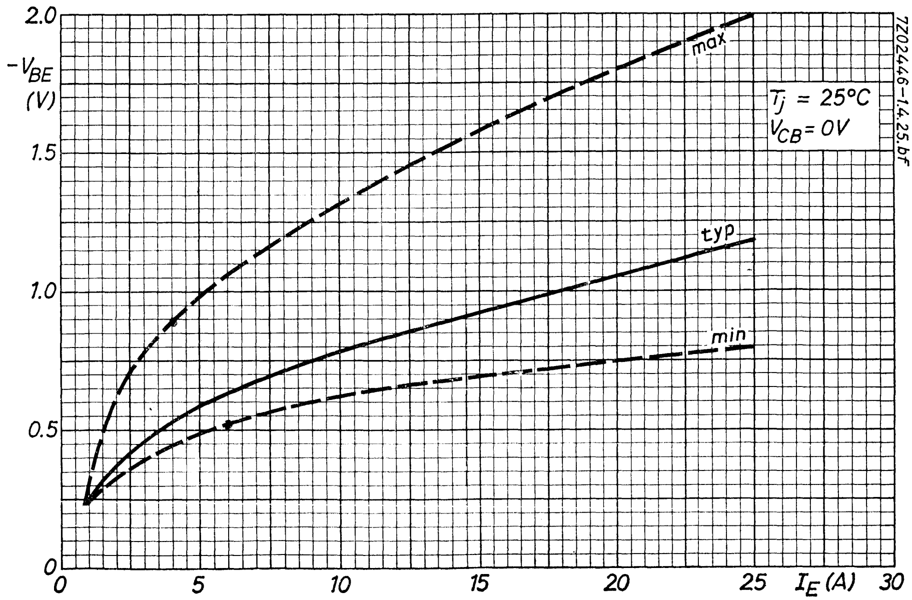


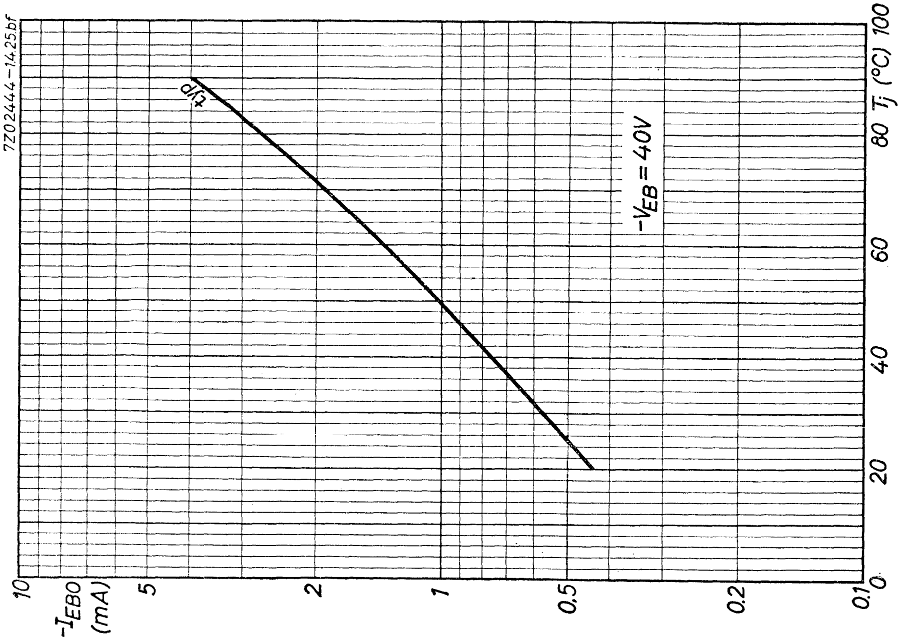
1) X stands for reverse biased emitter-base junction

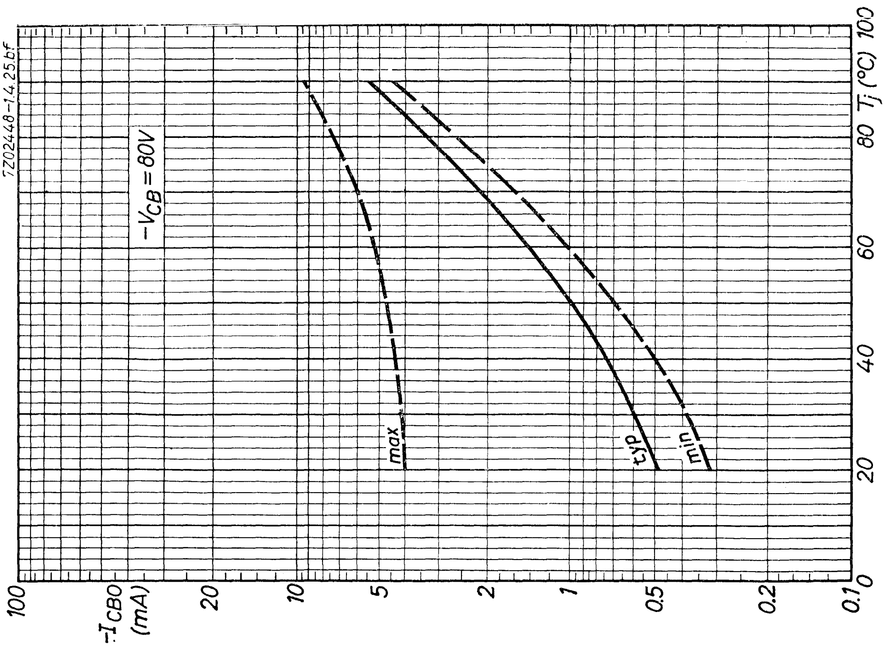
7Z2 2688

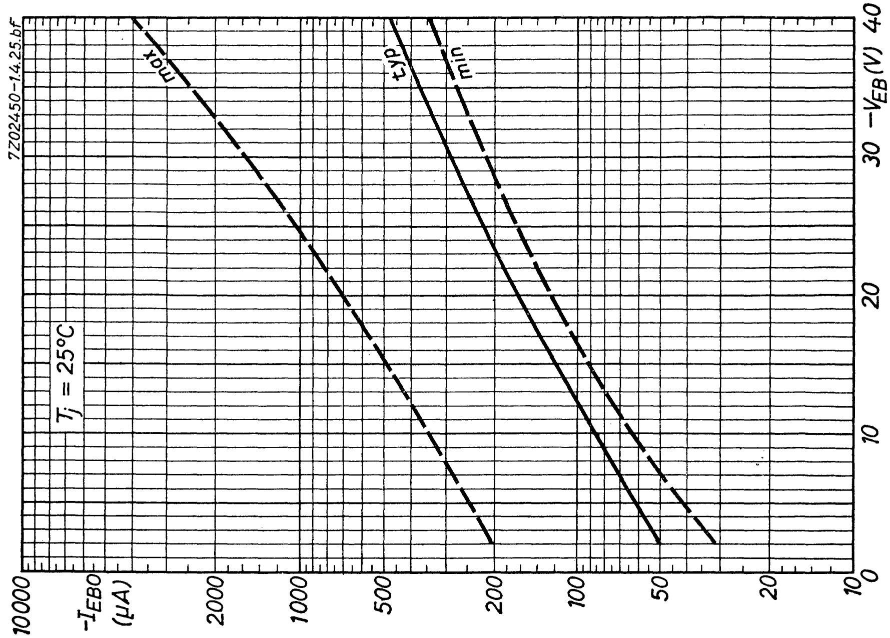
1.1.1965

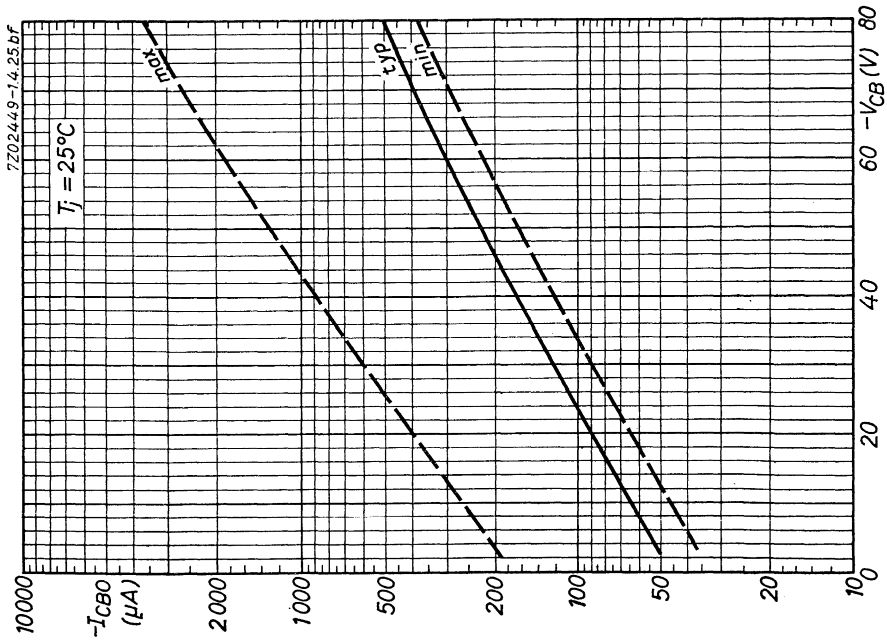

$-I_C$ (A)
$-I_B$=1000mA
800mA
500mA
300mA
200mA
100mA
50mA
10mA
20
10
$-V_{CE}$=2V
1
$-I_B$ (A)
0.5
0
10
20
$-V_{CE}$(V)
30
T_j =25°C
$-V_{CE}$=2V
1
$-V_{BE}$
(V)
7Z02443-1.4.25.bF

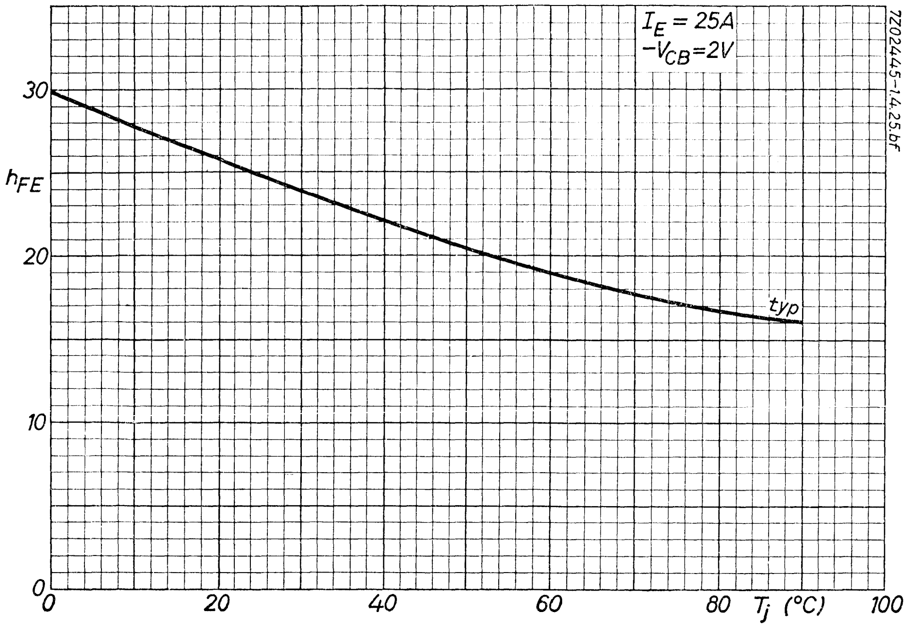

2.0
$-V_{BE}$
(V)
1.5
1.0
0.5
0
max
typ
min
T_j = 25°C
V_{CB}= 0V
0
5
10
15
20
25
I_E (A)
30
7Z02446-1.4.25.bF


7Z02444-1.4.25.bf
typ
$-V_{EB} = 40V$
$-I_{EBO}$ (mA)
T_j (°C)

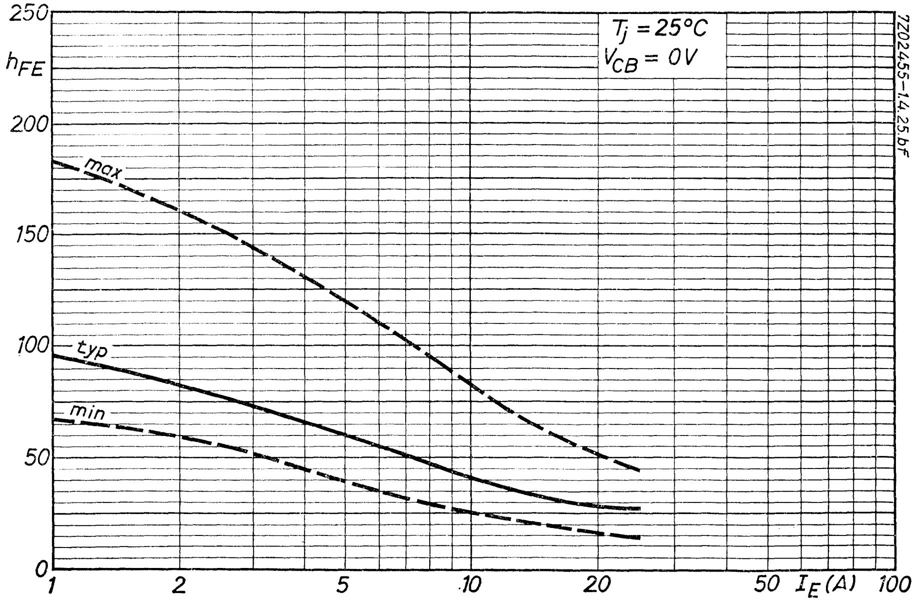

7Z02448-1.4.25.bf
$-V_{CB} = 80V$
max
typ
min
$-I_{CBO}$ (mA)
T_j (°C)


7Z02450-1.4.25.bf
T_j = 25°C
max
typ
min
$-I_{EBO}$ (μA)
10000
2000
1000
500
200
100
50
20
10
$-V_{EB}$ (V)
0
10
20
30
40

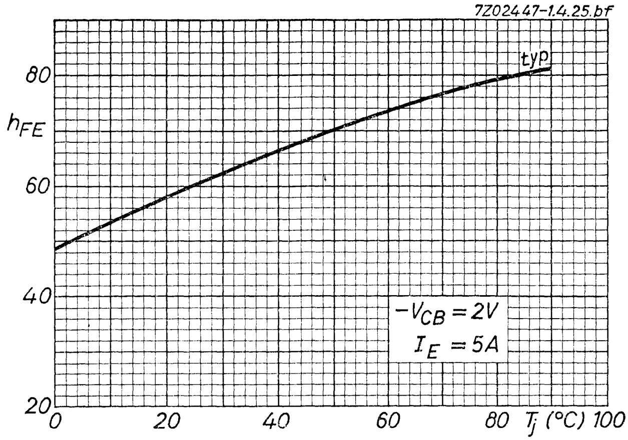

7Z02449-1.4.25.bf
T_j = 25°C
max
typ
min
$-I_{CBO}$ (μA)
10000
2000
1000
500
200
100
50
20
10
$-V_{CB}$ (V)
0
20
40
60
80

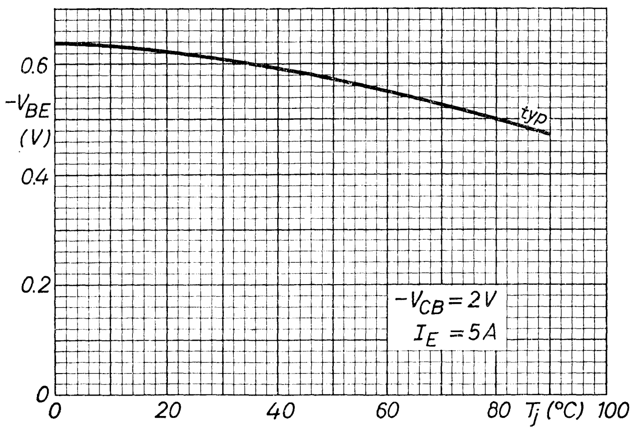


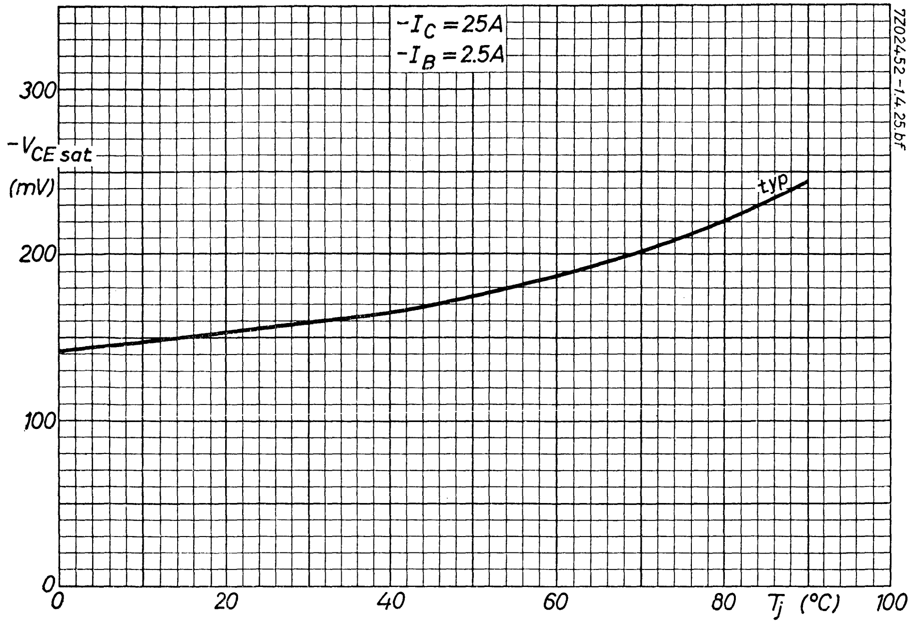
$I_E = 25A$
$-V_{CB}=2V$
7Z02445-1.4.25.bF
h_{FE}
30
20
10
0
typ
0
20
40
60
80
T_j (°C)
100

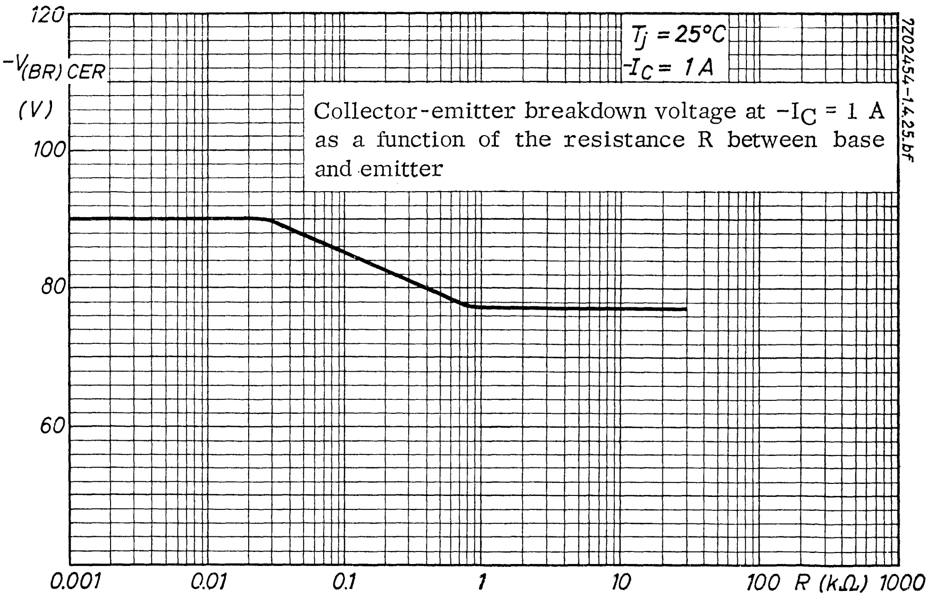


$T_j = 25°C$
$V_{CB} = 0V$
7Z02455-1.4.25.bF
h_{FE}
250
200
150
100
50
0
max
typ
min
1
2
5
10
20
50
I_E (A)
100

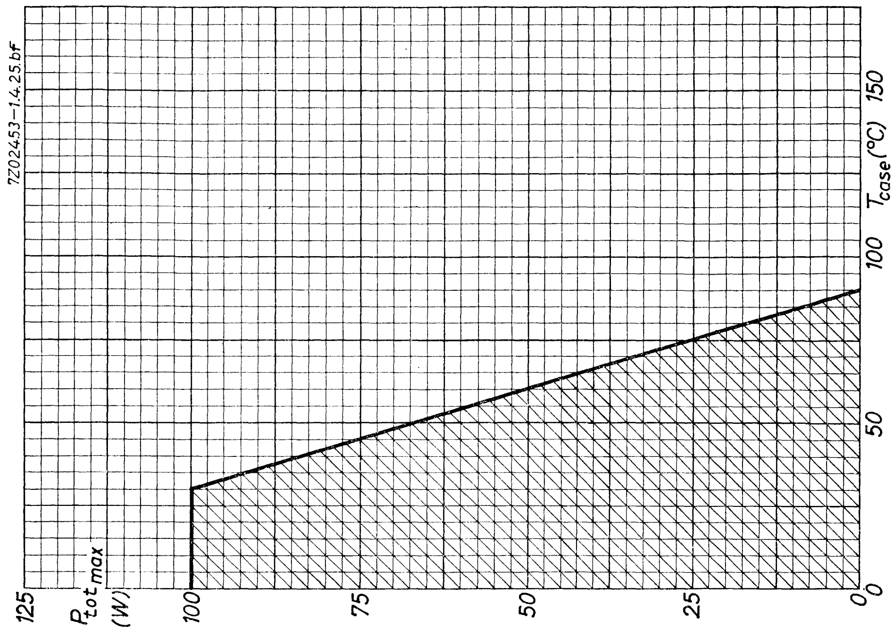

7Z02447-1.4.25.bf
typ
80
h_{FE}
60
40
20
$-V_{CB} = 2V$
$I_E = 5A$
0
20
40
60
80
T_j (°C)
100

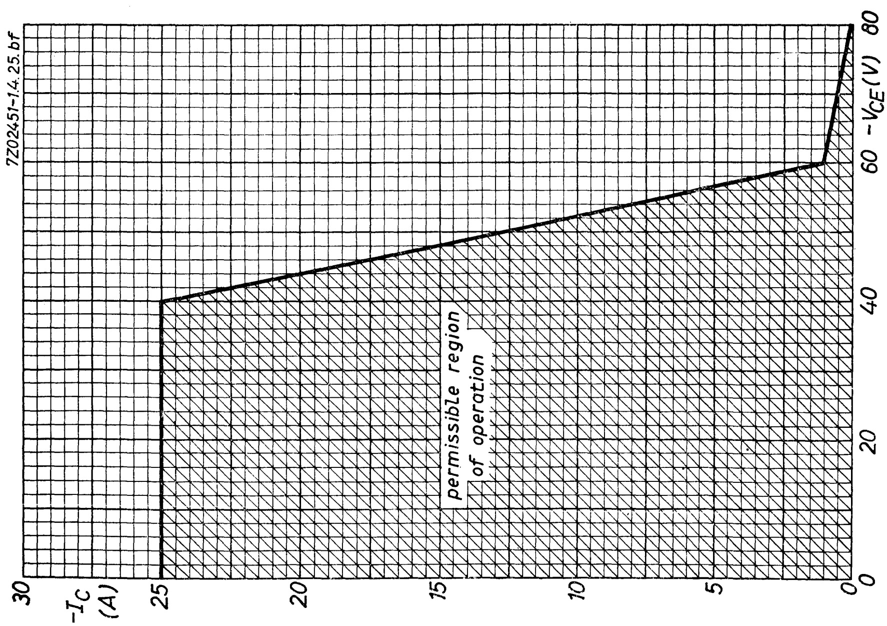

0.6
$-V_{BE}$
(V)
0.4
0.2
0
typ
$-V_{CB} = 2V$
$I_E = 5A$
20
40
60
80
T_j (°C)
100





Collector-emitter breakdown voltage at $-I_C = 1$ A as a function of the resistance R between base and emitter


7Z02453-1.4.25.bf
$P_{tot\,max}$ (W)
125
100
75
50
25
0
0
50
100
150
T_{case} (°C)


7Z02451-1.4.25.bf
$-I_C$ (A)
30
25
20
15
10
5
0
0
20
40
60
80
$-V_{CE}$ (V)
permissible region of operation

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

GERMANIUM ALLOY JUNCTION POWER TRANSISTORS of the p-n-p type in metal envelope for A.F. applications.

LIMITING VALUES (Absolute max. values)

			ADZ11	ADZ12
Collector				
Voltage (base reference)	$-V_{CB}$	= max.	50 V	80 V
Voltage (emitter reference)	$-V_{CE}$	= max.	40 V	60 V
Current				
Peak value	$-I_{CM}$	= max.	20 A	20 A
D.C. value	$-I_C$	= max.	15 A	15 A
Dissipation	P_C	= max.	45 W	45 W
Emitter				
Voltage (base reference)	$-V_{EB}$	= max.	30 V	50 V
Current				
Peak value	I_{EM}	= max.	22 A	22 A
D.C. value	I_E	= max.	17 A	17 A
Base				
Current				
Peak value	$-I_{BM}$	= max.	4 A	4 A
D.C. value	$-I_B$	= max.	2 A	2 A

Temperatures

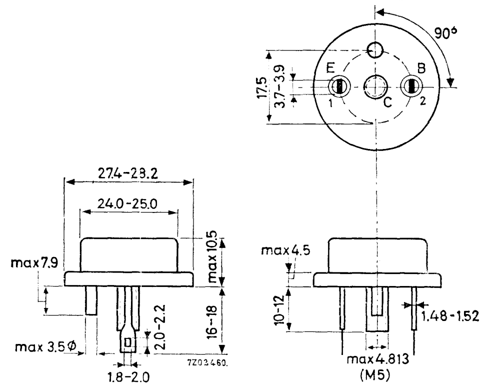
Storage temperature	T_s	=	−55 °C to +75 °C
Junction temperature	T_j	= max.	90 °C

THERMAL DATA

Thermal resistance between junction and transistor bottom	K	= max.	0.8 °C/W

7Z2 2148

Dimensions in mm



CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN

Transistor bottom temperature = 25 °C

Collector current at $I_E = 0$

$-V_{CB}$ = 2 V		$-I_{CBO}$	<	0.2 mA
$-V_{CB}$ = 50 V	(ADZ11)	$-I_{CBO}$	<	8 mA
$-V_{CB}$ = 80 V	(ADZ12)			

Emitter current at $I_C = 0$

$-V_{EB}$ = 2 V		$-I_{EBO}$	<	0.2 mA
$-V_{EB}$ = 30 V	(ADZ11)	$-I_{EBO}$	<	8 mA
$-V_{EB}$ = 50 V	(ADZ12)			

Emitter voltage at $I_E = 0$

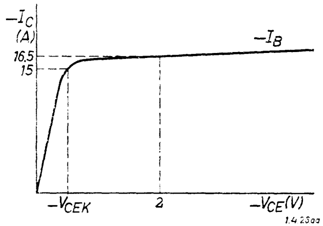
$-V_{CB}$ = 50 V	(ADZ11)	$-V_{EB}$	<	1 V
$-V_{CB}$ = 80 V	(ADZ12)			

7Z2 3364

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN
Transistor bottom temperature = 25 °C (continued)

Collector knee-voltage

$-I_C$ = 15 A; $-I_B$ is that value at which
$-I_C$ = 16.5 A and $-V_{CE}$ = 2 V $-V_{CEK}$ < 1 V



Base voltage

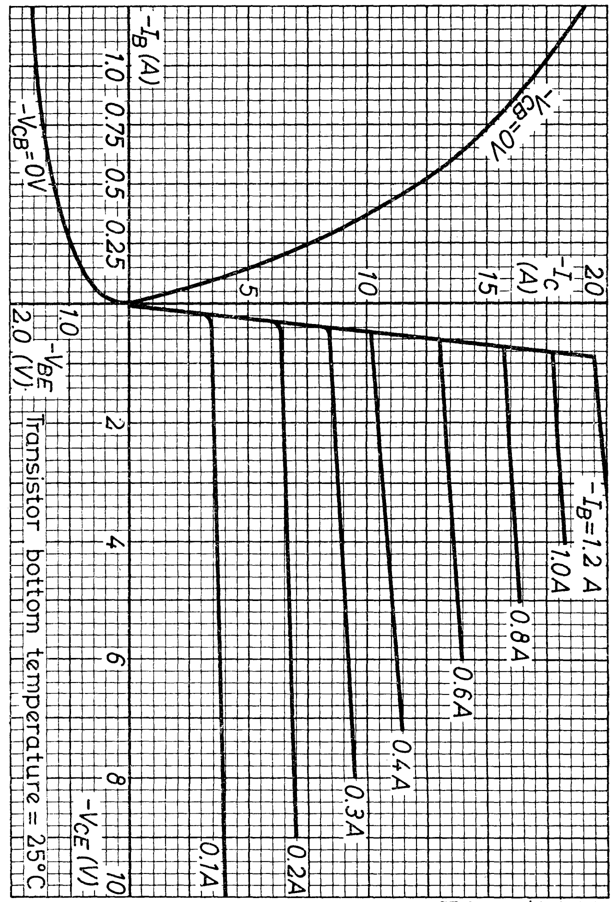
$-V_{CB}$ = 0; $-I_C$ = 1.2 A	$-V_{BE}$	< 0.7 V
$-V_{CB}$ = 0; $-I_C$ = 5 A	$-V_{BE}$	< 1.2 V
$-V_{CB}$ = 0; $-I_C$ = 15 A	$-V_{BE}$	< 2 V

Cut-off frequency

$-V_{CB}$ = 12; I_E = 1 A	ADZ11:	$f_{\alpha b}$	> 80 kc/s
	ADZ12:	$f_{\alpha b}$	> 100 kc/s

D.C. current amplification factor

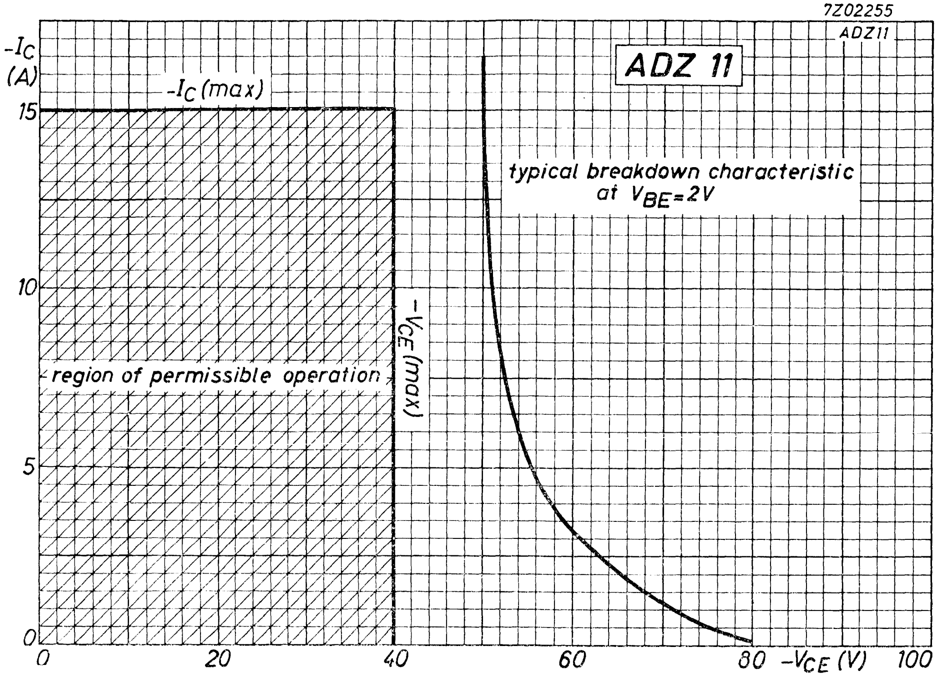
$-V_{CB}$ = 0; $-I_C$ = 1.2 A	h_{FE}	> 40
	h_{FE}	< 120
$-V_{CB}$ = 0; $-I_C$ = 5 A	h_{FE}	> 25
$-V_{CB}$ = 0; $-I_C$ = 15 A	h_{FE}	> 15



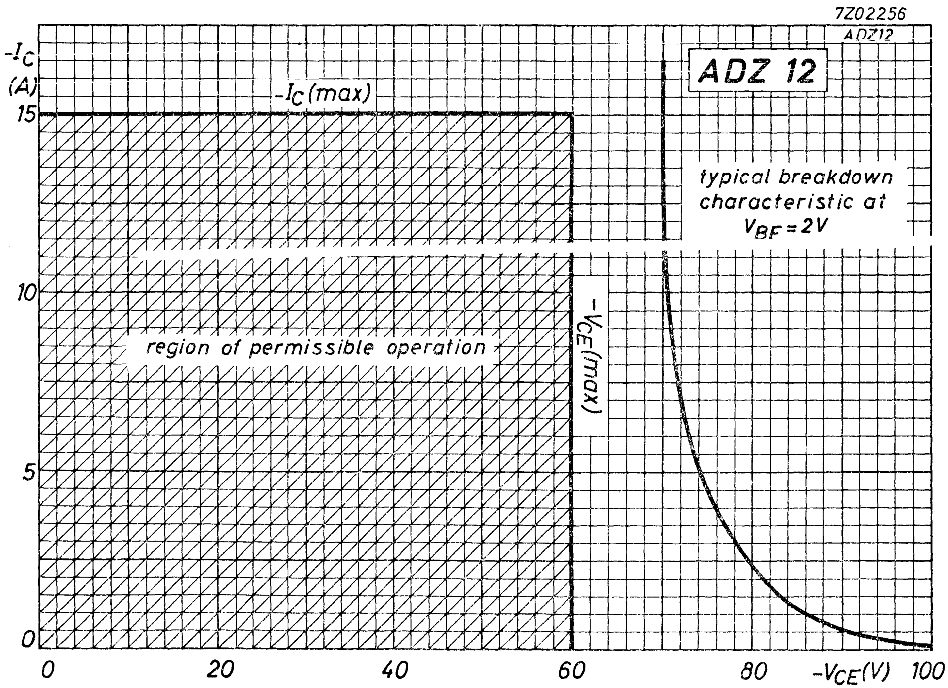
7Z02095 / 1.4.26 ab

A

7Z2 2150


7Z02255
ADZ11
ADZ 11
$-I_C$ (A)
$-I_C$ (max)
typical breakdown characteristic at V_{BE} = 2V
region of permissible operation
$-V_{CE}$ (max)
15
10
5
0
0
20
40
60
80
$-V_{CE}$ (V)
100

B


7Z02256
ADZ12
ADZ 12
$-I_C$ (A)
$-I_C$ (max)
typical breakdown characteristic at V_{BE} = 2V
region of permissible operation
$-V_{CE}$ (max)
15
10
5
0
0
20
40
60
80
$-V_{CE}$ (V)
100

C

R.F. ALLOY-DIFFUSED GERMANIUM TRANSISTOR of the p-n-p type with low noise and high gain at V.H.F. for amplifier, oscillator and convertor circuits up to 260 Mc/s. The transistor is hermetically sealed in a metal can and absolutely moisture proof.

TRANSISTOR H.F. À CRISTAL DE GERMANIUM du type p-n-p en technique alliage-diffusion à faible bruit et amplification élevée aux fréquences V.H.F. pour les circuits amplificateurs, oscillateurs et convertisseurs jusqu'à 260 MHz. Le transistor est scellé hermétiquement dans un boîtier métallique et protégé contre l'humidité.

HF p-n-p GERMANIUMTRANSISTOR nach dem Legierungs-Diffusionsverfahren mit schwachem Rauschen und hoher Verstärkung bei VHF-Frequenzen zur Verwendung in Verstärker-, Oszillator und Mischschaltungen bis zu 260 MHz. Der Transistor ist hermetisch abgeschlossen in einem Metallgehäuse und absolut sicher für Feuchtigkeit.

Limiting values (Absolute max. values)
Caractéristiques limites (Valeurs max. absolues)
Grenzdaten (Absolute Maximalwerte)

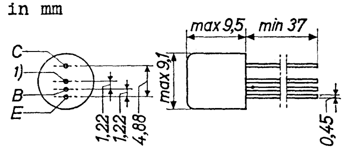
$-V_{CB}$	= max.	25 V
$-I_C$	= max.	10 mA
I_E	= max.	10 mA
$-I_E$	= max.	1 mA
P_C ($T_{amb} \leq 45\ ^oC$)	= max.	50 mW
T_j continuous operation / service continu / Dauerbetrieb	= max.	75 °C
T_j intermittent operation / service intermittent / aussetzender Betrieb	= max.	90 °C 1)
Storage temperature / Température d'emmagasinage / Lagerungstemperatur	=	−55 °C/+75 °C

Thermal data; Données thermiques; Thermische Daten

Thermal resistance from junction to ambience in free air	K ≦	0.6 °C/mW
Résistance thermique entre la jonction et l'ambiance à l'air libre	K ≦	0,6 °C/mW
Thermischer Widerstand zwischen dem Kristall und der Umgebung in freier Luft	K ≦	0,6 °C/mW

1) Total duration max. 200 hours
Durée totale 200 heures au max.
Gesamtdauer max. 200 Stunden

Dimensions in mm
Dimensions en mm
Abmessungen in mm



Characteristics
Caractéristiques $T_{amb} = 25\ ^oC$
Kenndaten

$-I_{CBO}$	($-V_{CB}$ = 12 V)		< 10 µA
$-V_{CB}$	($-I_C$ = 50 µA; I_E = 0 mA)		> 25 V
$-V_{EB}$	($-I_E$ = 50 µA; I_C = 0 mA)		> 0,5 V
$-I_B$	($-V_{CB}$ = 12 V; $-I_C$ = 1 mA)		< 50 µA
$-V_{BE}$	($-V_{CB}$ = 12 V; $-I_C$ = 1 mA)	> 220 mV	< 360 mV

Characteristics range values for equipment design
Gammes de valeurs des caractéristiques pour l'étude d'équipements
Kenndatenbereiche für Gerätentwurf $T_{amb} = 25\ ^oC$

$-V_{CB}$ = 12 V; I_E = 1 mA	f_1 = 180 Mc/s 2)	
$-V_{CE}$ = 12 V; $-I_C$ = 1 mA; f = 1 kc/s	h_{fe} > 20	
$-V_{CB}$ = 12 V; I_E = 1 mA; f = 2 Mc/s	$\|z_{rb}\|$ = 10 Ω 3)	
$-V_{CE}$ = 12 V; $-I_C$ = 1 mA; f = 200 Mc/s; R_S = 30 Ω 4)	F = 6 dB	< 7,5 dB
Circuit page 4 / Schaltung Seite 4	G = 13 dB	> 10 dB 5)

1) Interlead shield and metal case
Blindage entre les connexions et boîtier métallique
Abschirmung zwischen den Anschlüssen und Metallgehäuse

2)3)4)5) See page 3; voir page 3; siehe Seite 3

Characteristics range values for equipme t design (continued)
Gammes de valeurs des caractéristiques pour l'étude d'équipements (suite)
Kenndatenbereiche für Gerätentwurf (Fc rtsetzung)

T_{amb} = 25 °C

Small signal characteristics
Caractéristiques pour les signau faibles
Kenndaten für kleine Signale

$-V_{CE}$ = 12 V; $-I_C$ = 1 mA; f = 0,45 Mc/s	- re	=	0,8 pF
$-V_{CE}$ = 12 V; $-I_C$ = 1 mA; f = 35 Mc/s	oe	=	10 µA/V
	oe	=	2 pF
$-V_{CB}$ = 12 V; I_E = 1 mA; f = 200 Mc/s	ib	=	30 mA/V
	- ib	=	12 pF
	| rb|	=	0,4 mA/V
	- rb	=	90 °
	| rb|	=	25 mA/V
	rb	=	90 °
	ob	=	0,3 mA/V
	ob	=	1,8 pF

2) f_1 = Frequency at which $|h_{fe}|$ = 1
f_1 = la fréquence à laquelle $|h_{fe}|$ 1
f_1 = Frequenz bei der $|h_{fe}|$ = 1

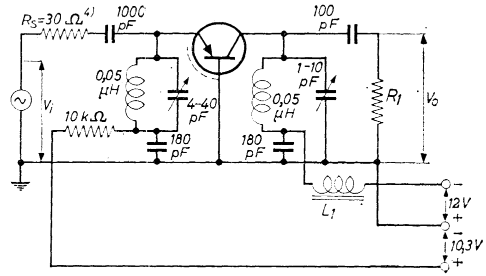
3) Intrinsic base impedance
Impédance intrinsèque de la base
Innere Impedanz der Basis

4) Input source impedance
Impédance de la source d'entrée
Impedanz der Eingangsspannungsquelle

5) Available power gain
Amplification de puissance disponible
Verfügbare Leistungsverstärkung

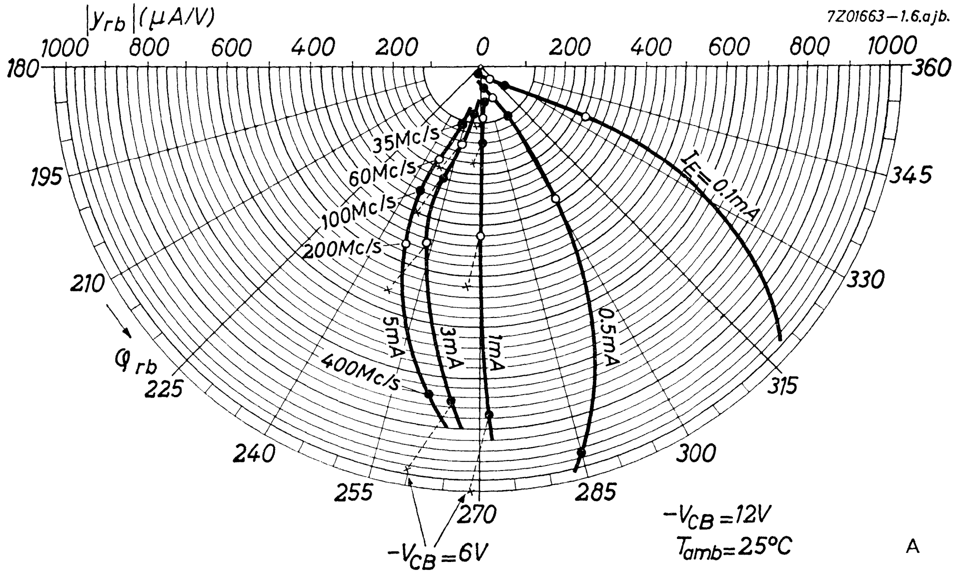
R_1 is chosen so that the total impedance R_L of the tuned circuit is 2.0 kΩ
R_1 est choisie tellement que l'impédance totale R_L du circuit accordé est de 2,0 kΩ
R_1 wird derartig gewählt, dass die Gesamtimpedanz R_L des abgestimmten Kreises 2,0 kΩ ist.

L_1 = ferrite bead
L_1 = perle magnétique
L_1 = Ferritperle

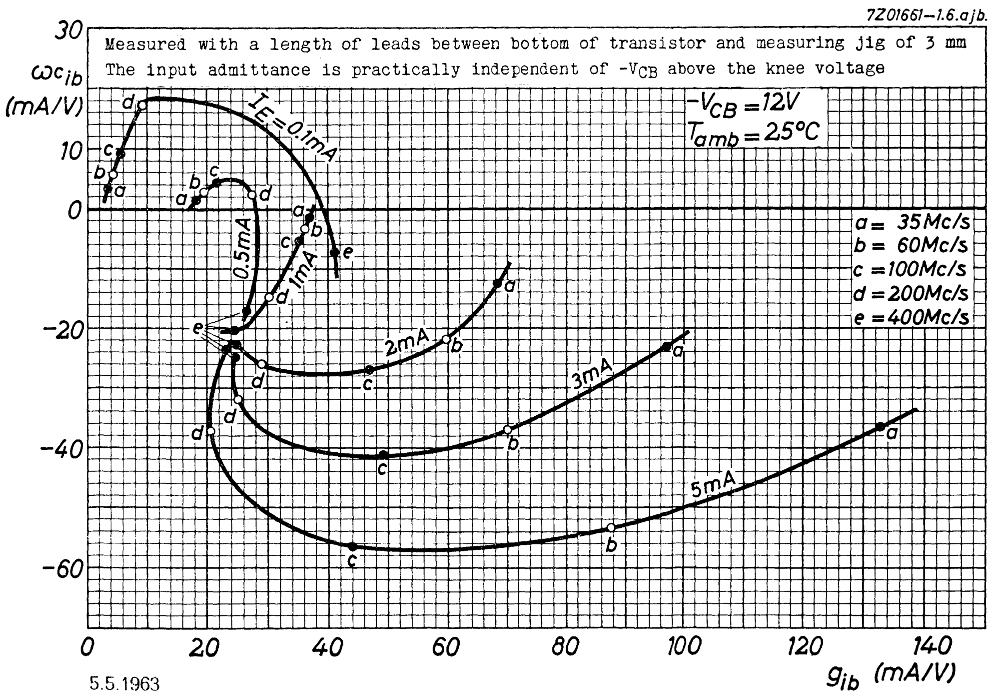


4) Input source impedance
Impédance de la source d'entrée
Impedanz der Eingangsspannungsquelle

Measured with a length of leads between bottom of transistor and measuring jig of 3 mm

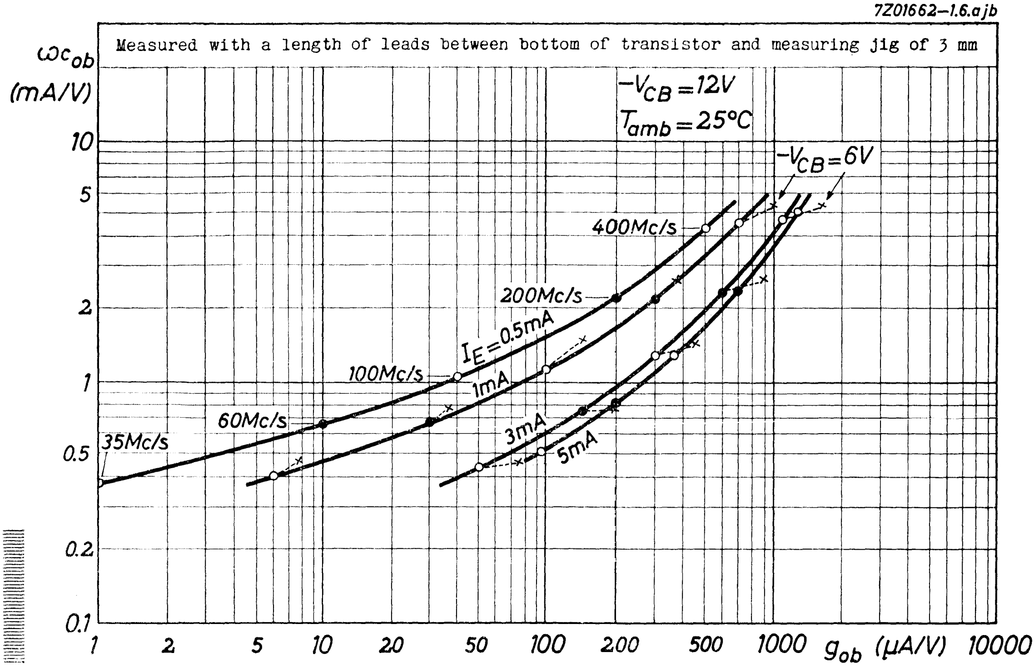


A



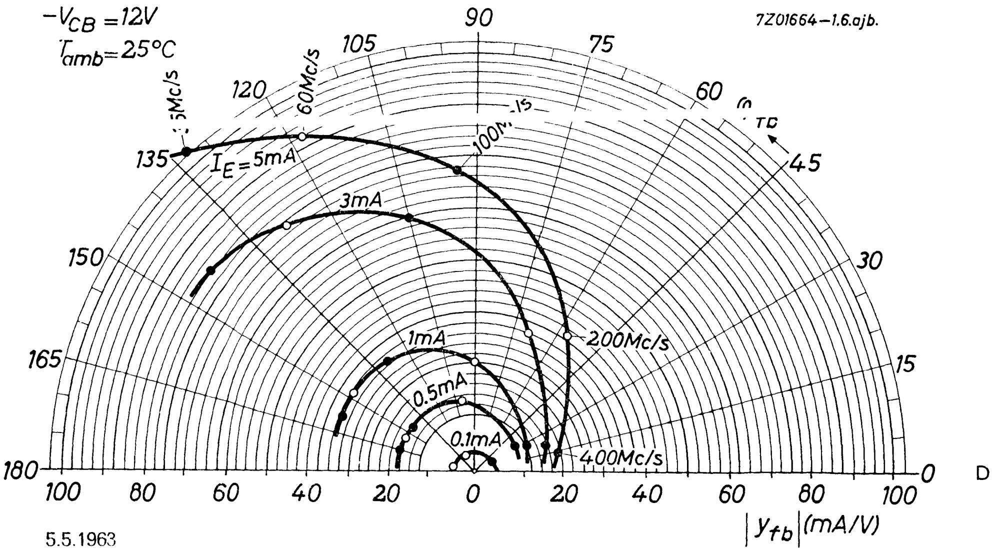
B

5.5.1963



C

Measured with a length of leads between bottom of transistor and measuring jig of 3 mm
The forward transfer admittance is practically independent of $-V_{CB}$ above the knee voltage



D

For data and curves of these types please refer
to types AF124 to AF127.

7Z2 2337

R.F. GERMANIUM ALLOY-DIFFUSED TRANSISTOR of the p-n-p type for medium power, high voltage, high frequency applications, e.g. in the video output stage of television receivers

LIMITING VALUES (Absolute max. values)

Collector

Voltage (emitter reference) (See also page G)	$-V_{CE}$	= max.	70 V
Current	$-I_C$	= max.	30 mA
Dissipation	P_C	= max.	375 mW

Emitter

Current	I_E	= max.	33 mA
Reverse current	$-I_E$	= max.	1 mA

Base

Current	$-I_B$	= max.	3 mA
Reverse current	I_B	= max.	1 mA

Temperatures

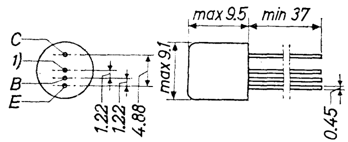
Storage temperature	T_s	=	-55 to +75 °C
Junction temperature continuous operation	T_j	= max.	75 °C
intermittent operation (total duration max. 200 hours)	T_j (t	= max. = max.	90 °C 200 hrs)

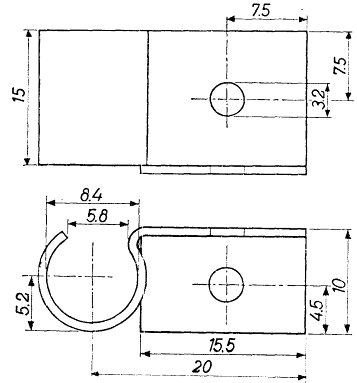
THERMAL DATA

Thermal resistance from junction

to ambience in free air	K	= max.	0.25 °C/mW
with cooling fin	K	= max.	0.12 °C/mW

Dimensions in mm





Cooling fin
No. 56207
Painted black

CHARACTERISTICS at T_{amb} = 25 °C

Collector voltage			
$-V_{CB}$ ($-I_C$ = 1 mA; I_E = 0 mA)	= 95 V	> 70 V	
Emitter voltage			
$-V_{EB}$ ($-I_E$ = 50 µA; I_C = 0 mA)	= 1.5 V	> 0.5 V	
Base current			
$-I_B$ (I_E = 10 mA; $-V_{CB}$ = 2 V)	= 55 µA	< 275 µA	

REMARK

Driving the transistor into the bottoming knee region results in an excessively high turn-off delay

1) Interlead shield and metal case

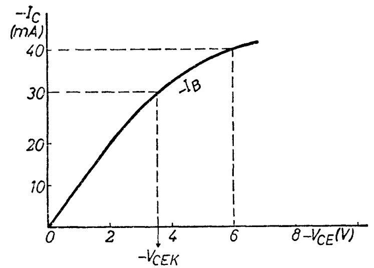
CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN at $T_{amb} = 25\ ^{o}C$

Collector current		See page B	
Base voltage			
$-V_{BE}$ (I_E = 10 mA; $-V_{CB}$ = 2 V)	=		< 375 mV

Knee voltage

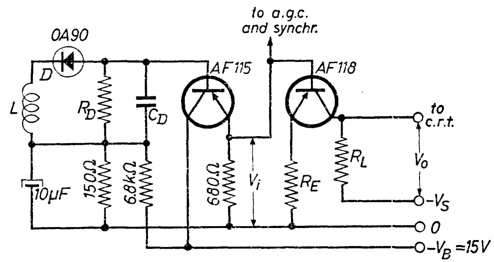
Measured at $-I_C$ = 30 mA

$-I_B$ = value at which $-I_C$ = 40 mA when $-V_{CE}$ = 6 V



$-V_{CEK}$	= 3.5 V		< 5 V
Intrinsic base impedance			
$\lvert z_{rb}\rvert$ (I_E = 10 mA; $-V_{CB}$ = 6 V; f = 2 Mc/s)	= 30 Ω		
Frequency at which $\lvert h_{fe}\rvert$ = 1			
f_1 (I_E = 10 mA; $-V_{CB}$ = 6 V)	= 175 Mc/s		> 125 Mc/s
Forward transfer admittance			
$\lvert y_{fe}\rvert$ (I_E = 10 mA; $-V_{CB}$ = 6 V; f = 10.7 Mc/s)	= 130 mA/V		> 100 mA/V
Feedback capacitance			
$-c_{re}$ (I_E = 10 mA; $-V_{CB}$ = 6 V; f = 10.7 Mc/s)	= 1.8 pF		< 2.3 pF

OPERATING CHARACTERISTICS in a video output stage for a supply voltage up to 70 V



L = secondary winding of the coupling transformer between last I.F. stage and video detector

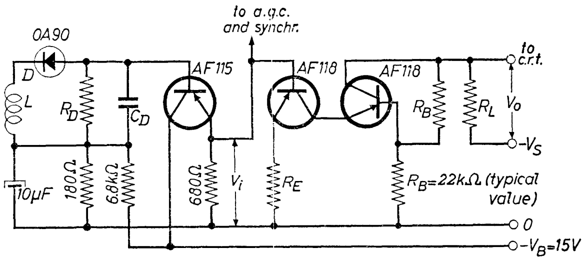
D, R_D, C_D = detection circuit

R_E should be chosen according to $A_V = \frac{V_o}{V_i} \approx \frac{R_L}{R_E}$, in which A_V is the voltage amplication of the output stage

Supply voltage	$-V_S$ =	50	60	70 V
Load resistance	R_L =	2.7	3.9	4.7 kΩ
Output voltage (black to white)	V_o =	32	39	45 V
Bandwidth at -3 dB	B =	6.0	4.1	3.4 Mc/s

If necessary enhancing of the bandwidth by a peaking coil in series with R_L (shunt compensation) or by a peaking coil in series with the lead to the cathode ray tube (series compensation) is possible

<u>OPERATING CHARACTERISTICS</u> in a video output stage for a supply voltage up to 110 V



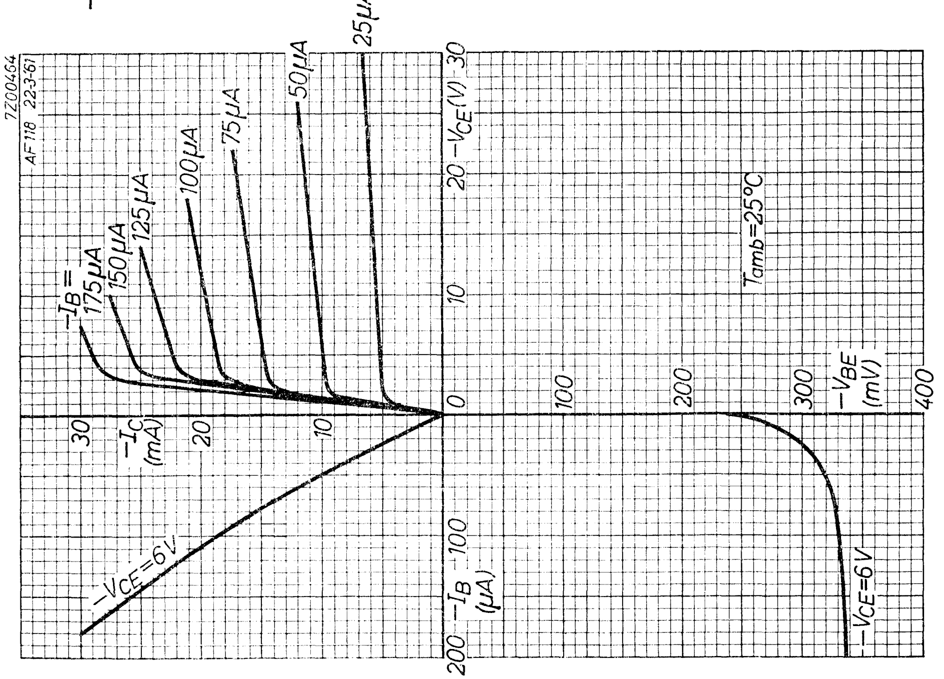
L = secondary winding of the coupling transformer between last I.F. stage and video detector

D, R_D, C_D = detection circuit

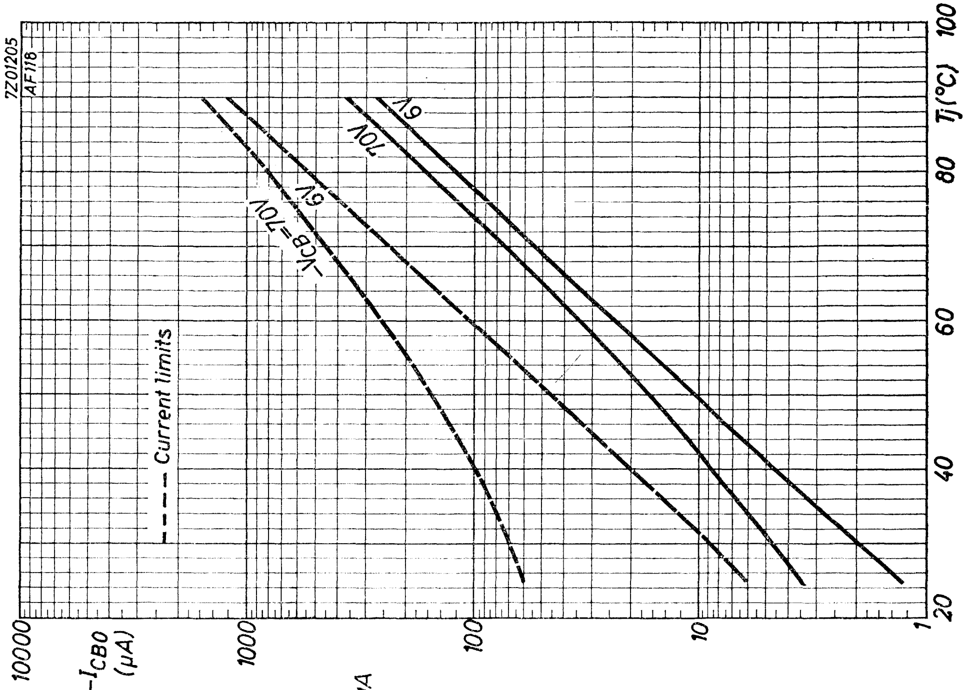
R_E should be chosen according to $A_v = \frac{V_o}{V_i} \approx \frac{1}{R_E} \cdot \frac{2R_B \cdot R_L}{2R_B + R_L}$, in which A_v is the voltage amplification of the output stage

Supply voltage	$-V_S$ =	90	110 V
Load resistance	R_L =	4.7	6.8 kΩ
Output voltage (black to white)	V_o =	57	65 V
Bandwidth at -3 dB	B =	3.5	2.4 Mc/s

If necessary enhancing of the bandwidth by a peaking coil in series with R_L (shunt compensation) or by a peaking coil in series with the lead to the cathode ray tube (series compensation) is possible

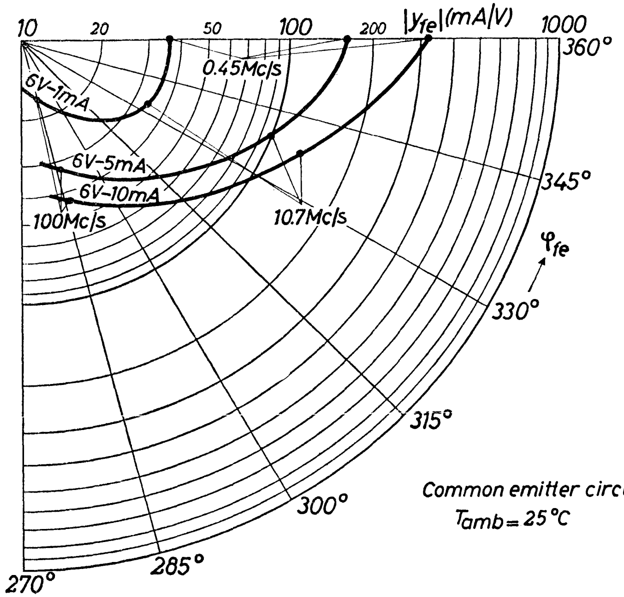

7Z00464
AF118 22-3-61
$-I_B$=
175μA
150μA
125μA
100μA
75μA
50μA
25μA
$-V_{CE}$(V)
0
10
20
30
$-I_C$
(mA)
30
20
10
$-V_{CE}$=6V
$-I_B$
(μA)
100
200
T_{amb}=25°C
$-V_{BE}$
(mV)
100
200
300
400
$-V_{CE}$=6V

A

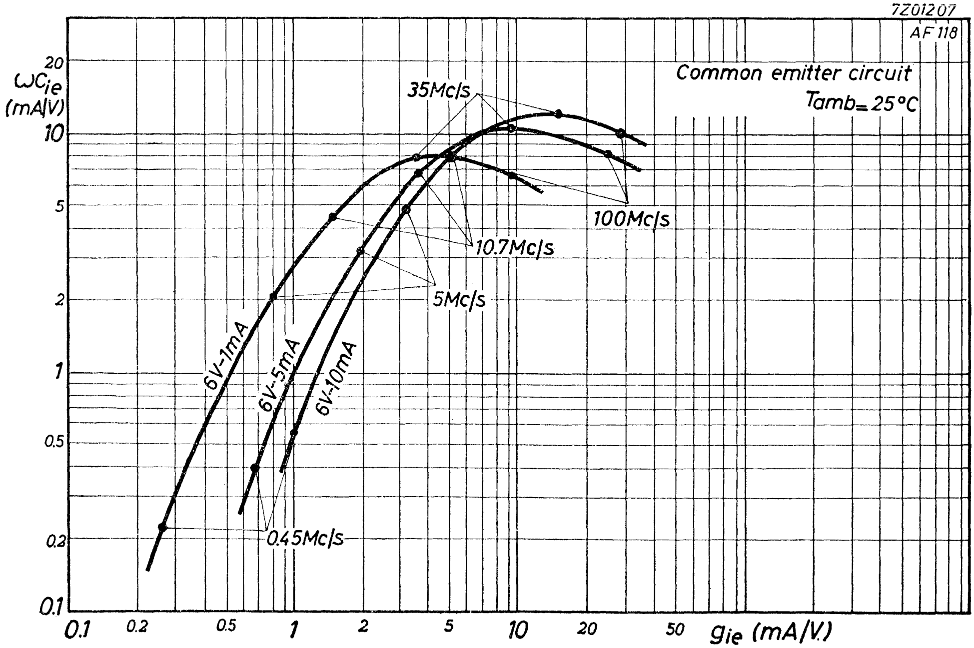

7Z01205
AF118
$-I_{CBO}$
(μA)
10000
1000
100
10
1
Current limits
$-V_{CB}$=10V
6V
10V
6V
Tj(°C)
20
40
60
80
100

B

9.9.1962

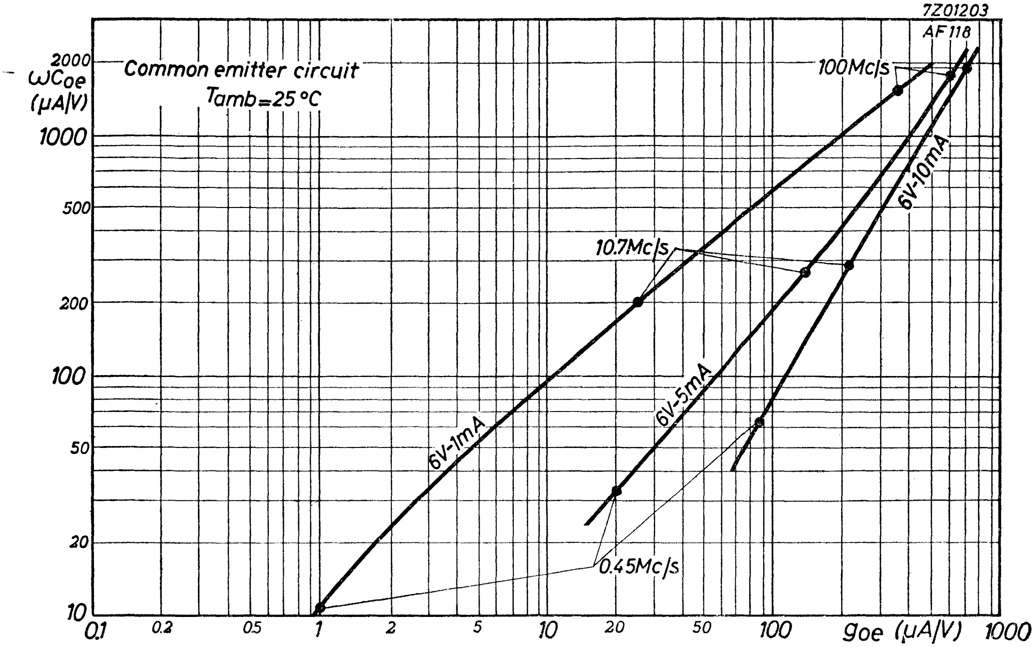

10
20
50
100
200
|y_{fe}|(mA/V)
1000
360°
345°
330°
315°
300°
285°
270°
φ_{fe}
0.45Mc/s
6V-1mA
6V-5mA
6V-10mA
100Mc/s
10.7Mc/s
Common emitter circuit
T_{amb}= 25°C
7Z01210
AF118

C

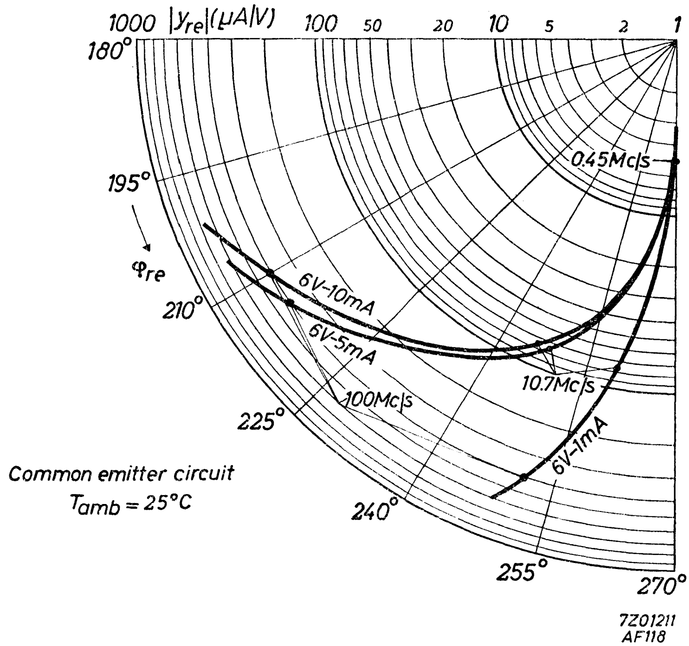

7Z01207
AF 118
Common emitter circuit
T_{amb}= 25°C
ωC_{ie}
(mA/V)
20
10
5
2
1
0.5
0.2
0.1
0.1
0.2
0.5
1
2
5
10
20
50
g_{ie} (mA/V)
35Mc/s
100Mc/s
10.7Mc/s
5Mc/s
0.45Mc/s
6V-1mA
6V-5mA
6V-10mA

D

9.9.1962

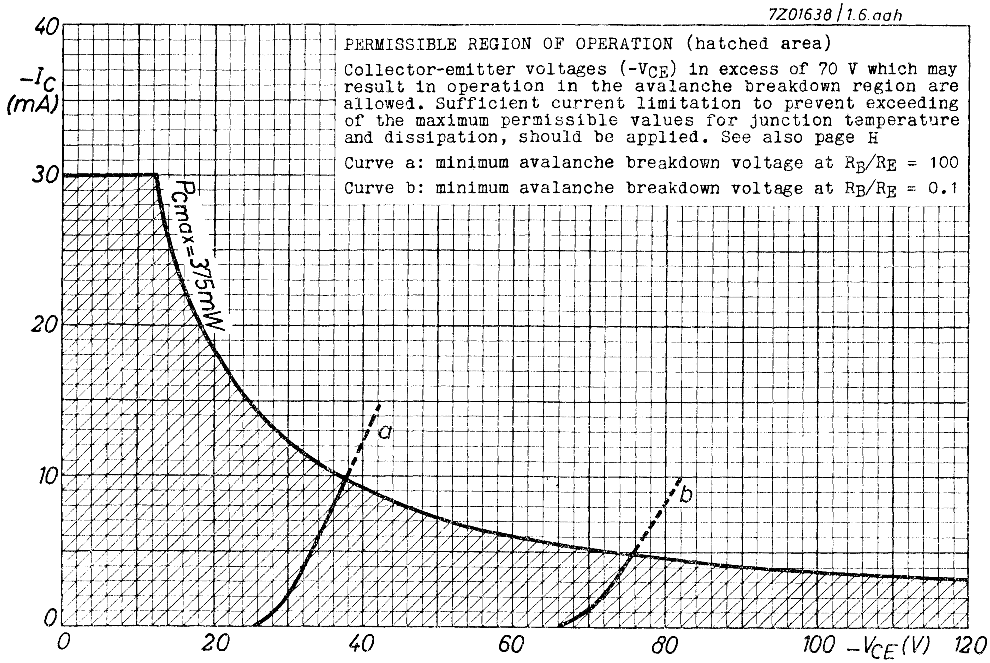

7Z01203
AF118
ωCoe (μA/V)
Common emitter circuit
Tamb = 25 °C
100Mc/s
10.7Mc/s
0.45Mc/s
6V-1mA
6V-5mA
6V-10mA
goe (μA/V)
2000
1000
500
200
100
50
20
10
0.1
0.2
0.5
1
2
5
10
20
50
100
1000

E

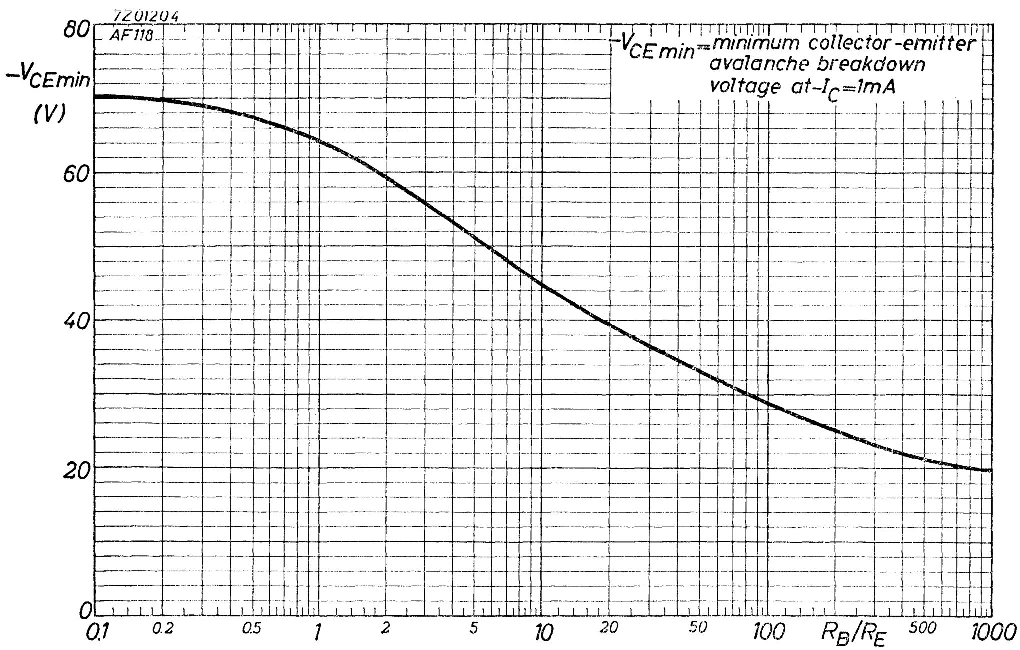

1000 |yre| (μA/V) 100 50 20 10 5 2 1
180°
195°
φre
210°
225°
240°
255°
270°
0.45Mc/s
6V-10mA
6V-5mA
100Mc/s
10.7Mc/s
6V-1mA
Common emitter circuit
Tamb = 25°C
7Z01211
AF118

F

9.9.1962


7Z01638 / 1.6.aah
PERMISSIBLE REGION OF OPERATION (hatched area)
Collector-emitter voltages (-VCE) in excess of 70 V which may result in operation in the avalanche breakdown region are allowed. Sufficient current limitation to prevent exceeding of the maximum permissible values for junction temperature and dissipation, should be applied. See also page H
Curve a: minimum avalanche breakdown voltage at RB/RE = 100
Curve b: minimum avalanche breakdown voltage at RB/RE = 0.1
-IC (mA)
PCmax=375mW
a
b
-VCE (V)
0
20
40
60
80
100
120
10
30

G


7Z01204
AF118
-VCEmin (V)
-VCEmin = minimum collector-emitter avalanche breakdown voltage at -IC=1mA
RB/RE
0.1
0.2
0.5
1
2
5
10
20
50
100
500
1000
0
20
40
60
80

H

4.4.1963

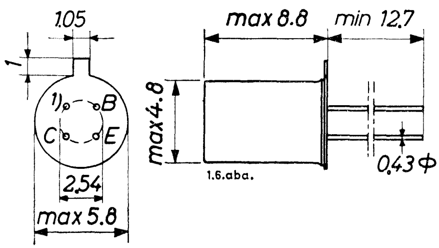
R.F. GERMANIUM ALLOY-DIFFUSED TRANSISTOR

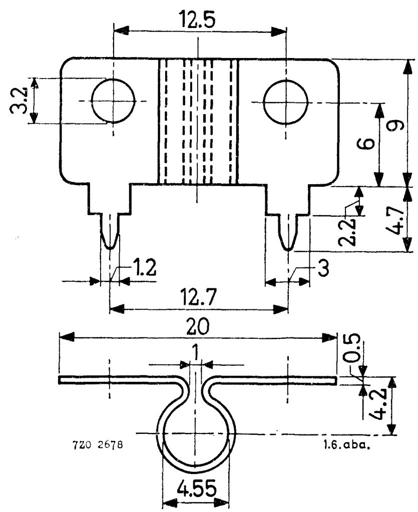
Germanium alloy-diffused junction transistor of the p-n-p type in metal case for use in IF amplifiers of TV receivers and in low noise USW preamplifiers.

QUICK REFERENCE DATA				
Collector to base voltage	$-V_{CB}$	=	max.	25 V
Collector to emitter voltage	$-V_{CE}$	=	max.	25 V
Collector current peak	$-I_{CM}$	=	max.	15 mA
Total dissipation	P_{tot}	=	max.	135 mW
Junction temperature (continuous)	T_j	=	max.	75 °C
Transition frequency	f_T	=		270 Mc/s

MECHANICAL DATA

Dimensions in mm





Cooling fin 56263

7Z2 2681

LIMITING VALUES (Absolute max. values)

Voltages

Collector to base voltage	$-V_{CB}$	= max.	25 V
Collector to emitter voltage	$-V_{CE}$	= max.	25 V[1])

Currents

Collector current (peak value)	$-I_{CM}$	= max.	15 mA
Collector current (continuous)	$-I_C$	= max.	10 mA
Emitter current (peak value)	I_{EM}	= max.	15 mA
Emitter current (continuous)	I_E	= max.	10 mA
Reverse emitter current (continuous)	$-I_E$	= max.	1 mA

Dissipation

Total dissipation	P_{tot}	= max.	135 mW

Temperatures

Storage temperature	T_s	=	-55^oC to $+75\ ^oC$
Junction temperature			
continuous operation	T_j	= max.	75 ^oC
incidentally	T_j	= max.	90 ^oC

THERMAL DATA

Thermal resistance from

junction to transistor bottom	K	<	0.22 $^oC/mW$
junction to ambience in free air	K	<	0.45 $^oC/mW$
junction to ambience with cooling fin	K	<	0.32 $^oC/mW$

CHARACTERISTICS $T_{amb} = 25\ ^oC$

Collector current at $I_E = 0$; $-V_{CB} = 10$ V	$-I_{CBO}$	= 1.2 μA	<	8 μA
Base current at $-V_{CE} = 10$ V; $I_E = 3$ mA	$-I_B$	= 40 μA	<	100 μA
Base to emitter voltage at $-V_{CE} = 10$ V; $I_E = 3$ mA	$-V_{BE}$	= 320 mV	>	280 mV
			<	380 mV

1) Provided $R_B/R_E < 100$ and $R_E > 200\ \Omega$

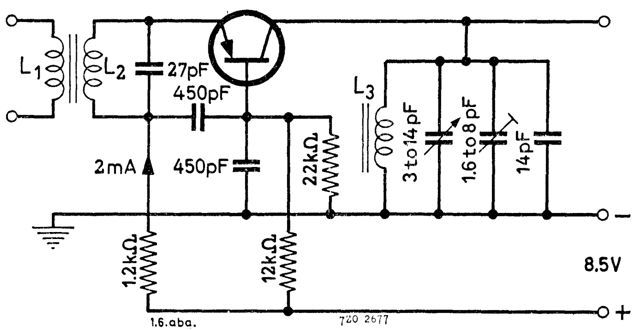
7Z2 2682

CHARACTERISTIC RANGE VALUES FOR EQUIPMENT DESIGN

T_{amb} = 25 °C unless otherwise specified

Collector current at I_E = 0 $-V_{CB}$ = 10 V; T_j = 75 °C	$-I_{CBO}$		< 150 μA
Base-emitter voltage at $-V_{CE}$ = 5 V; I_E = 2 mA	$-V_{BE}$	= 310 mV	> 260 mV < 360 mV
Transition frequency $-V_{CE}$ = 10 V; I_E = 3 mA	f_T	= 270 Mc/s	
Feedback capacitance at $-V_{CE}$ = 10 V; I_E = 1 mA f = 450 kc/s	$-c_{re}$	= 0.45 pF	> 0.25 pF < 0.65 pF

Measuring circuit for USW preamplifier   f = 100 Mc/s



L_1 : 7 turns, 0.3 mm copper enamelled, silk

L_2 : 4 turns, 0.3 mm copper enamelled

(L_1 and L_2 wound simultaneously on M_4 ferrite core)

L_3 : 4 turns, 1.0 mm silverplated copper. Quality factor Q_o = 200

Power gain	=	19 dB	> 17 dB
Noise figure	=	4.5 dB	< 6 dB [1]

[1] To obtain minimum noise figure the terminating admittance at the input of the transistor shall be (11−6j) mA/V

7Z2 3381

Small-signal parameters at T_{amb} = 25 °C

f = 450 kc/s; $-V_{CB}$ = 5 V; I_E = 2 mA

	g_{ie} mA/V	c_{ie} pF	$\lvert y_{re}\rvert$ μA/V	$-\varphi_{re}$	$\lvert y_{fe}\rvert$ mA/V	$-\varphi_{fe}$	g_{oe} μA/V	c_{oe} pF
typ.	0.8	45	1.7	90°	73		0.8	2.7
min.	0.4	30	1.1		70		0.5	2.0
max.	1.5	80	2.4		76	1°	2.0	3.5

f = 5.5 Mc/s; $-V_{CB}$ = 5 V; I_E = 2 mA

	g_{ie} mA/V	c_{ie} pF	$\lvert y_{re}\rvert$ μA/V	$-\varphi_{re}$	$\lvert y_{fe}\rvert$ mA/V	$-\varphi_{fe}$	g_{oe} μA/V	c_{oe} pF
typ.	1.0	45	21	90°	71	10°	5.0	2.6
min.	0.45	30	14		69	5°	1.5	2.0
max.	1.6	80	29		76	16°	10	3.3

f = 10.7 Mc/s; $-V_{CB}$ = 5 V; I_E = 2 mA

	g_{ie} mA/V	c_{ie} pF	$\lvert y_{re}\rvert$ μA/V	$-\varphi_{re}$	$\lvert y_{fe}\rvert$ mA/V	$-\varphi_{fe}$	g_{oe} μA/V	c_{oe} pF
typ.	1.3	45	40	90°	70	13°	13	2.5
min.	0.5	30	28		65	7°	4	1.9
max.	1.7	80	57		76	20°	26	3.2

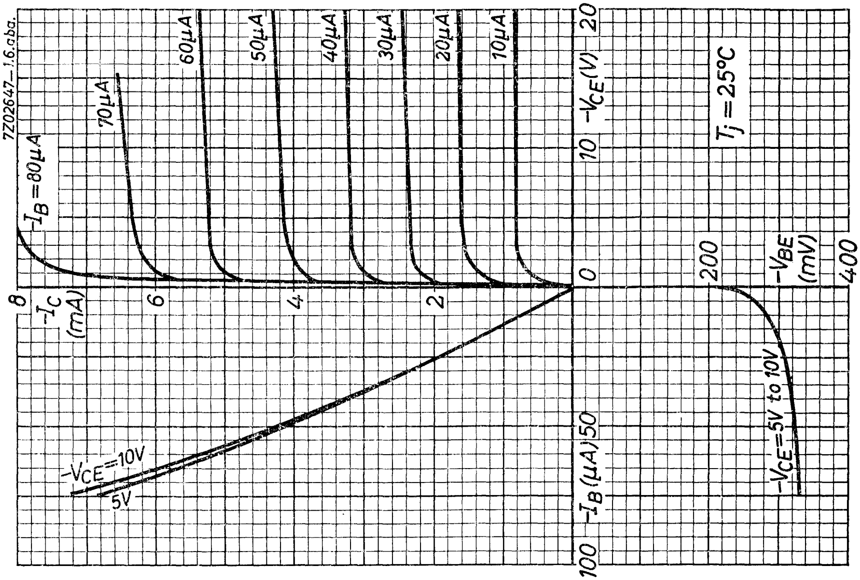
f = 35 Mc/s; $-V_{CE}$ = 10 V; I_E = 3 mA

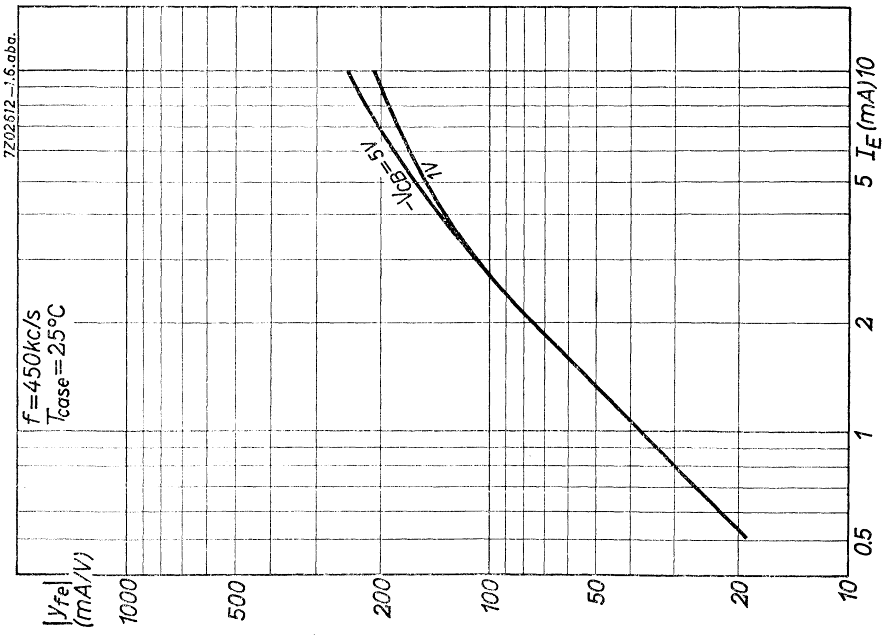
	g_{ie} mA/V	c_{ie} pF	$\lvert y_{re}\rvert$ μA/V	$-\varphi_{re}$	$\lvert y_{fe}\rvert$ mA/V	$-\varphi_{fe}$	g_{oe} μA/V	c_{oe} pF
typ.	6.5	35	100	100°	80	38°	100	1.8
min.	4	20	60	90°	63	20°	50	1.0
max.	9	55	140	110°	100	55°	160	2.5

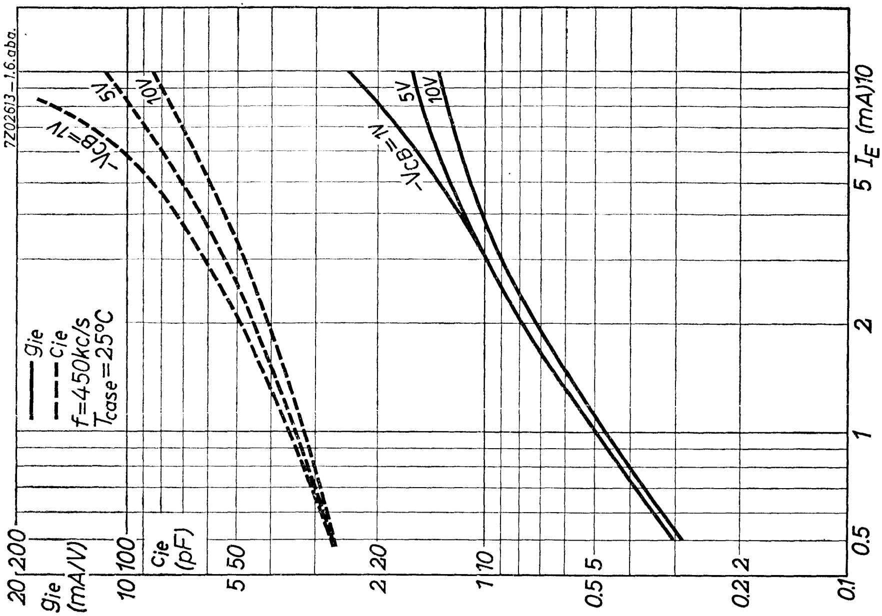
f = 100 Mc/s; $-V_{CE}$ = 5 V; I_E = 2 mA

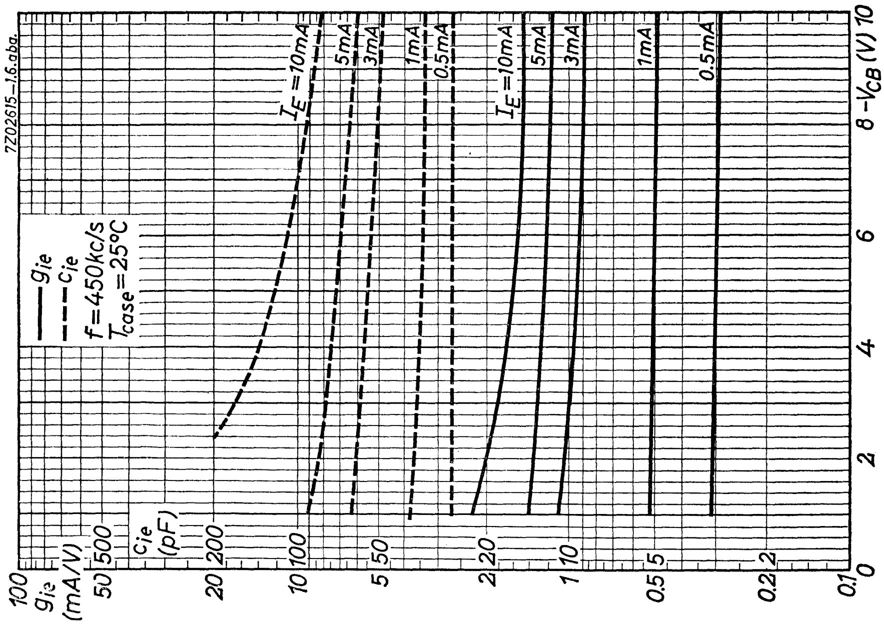
	g_{ie} mA/V	c_{ie} pF	$\lvert y_{re}\rvert$ μA/V	$-\varphi_{re}$	$\lvert y_{fe}\rvert$ mA/V	$-\varphi_{fe}$	g_{oe} μA/V	c_{oe} pF
typ.	32	35	320	120°	34	110°	250	1.6
min.	16	25	200	100°	20	105°	120	1.0
max.	60	45	450	140°	50	120°	400	2.0

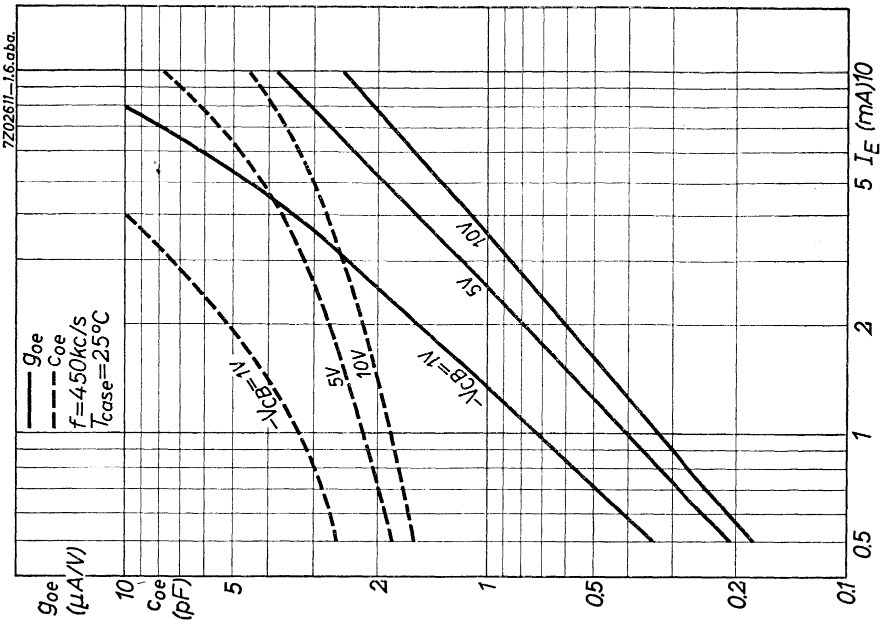
7Z2 2684

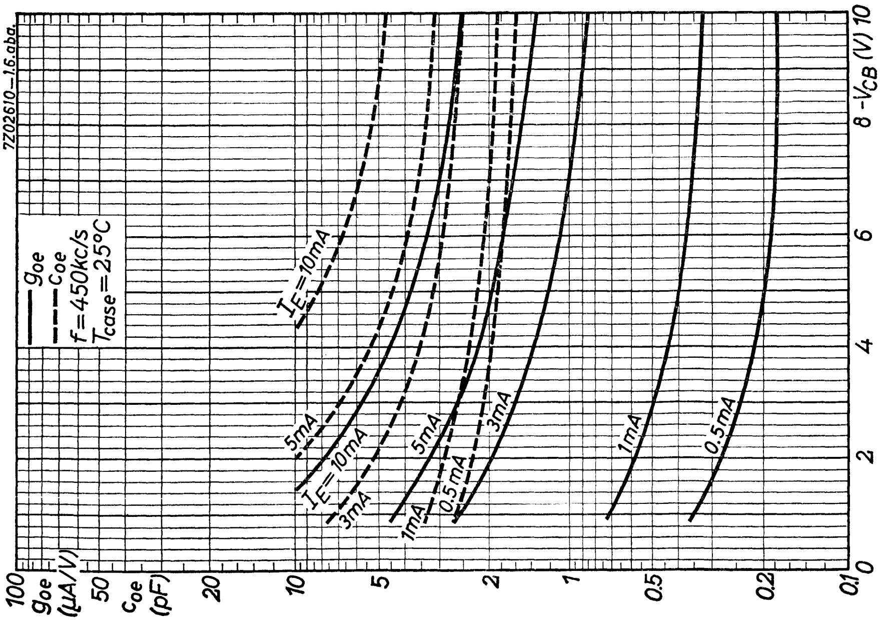

7Z02647—1.6.aba.
$-I_B$=80µA
70µA
60µA
50µA
40µA
30µA
20µA
10µA
$-V_{CE}$(V)
T_j=25°C
$-I_C$ (mA)
$-I_B$ (µA)
$-V_{BE}$ (mV)
$-V_{CE}$=10V
5V
$-V_{CE}$=5V to 10V

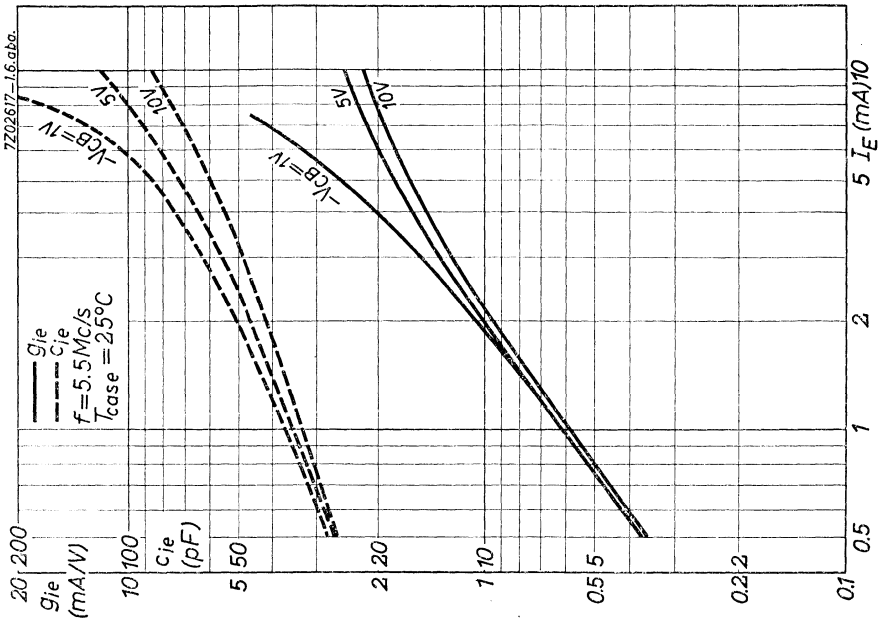

7Z02612—1.6.aba.
f=450kc/s
T_{case}=25°C
$|y_{fe}|$ (mA/V)
I_E (mA)
$-V_{CB}$=5V
1V

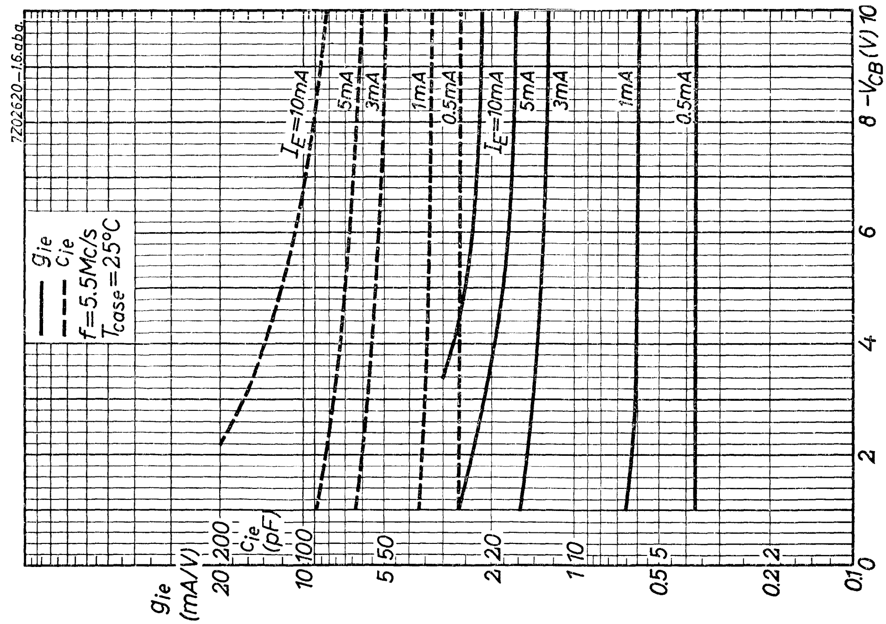

7Z02613–1.6.aba.
g_{ie}
c_{ie}
f=450kc/s
T_{case}=25°C
$-V_{CB}$=1V
5V
10V
g_{ie} (mA/V)
c_{ie} (pF)
I_E (mA)

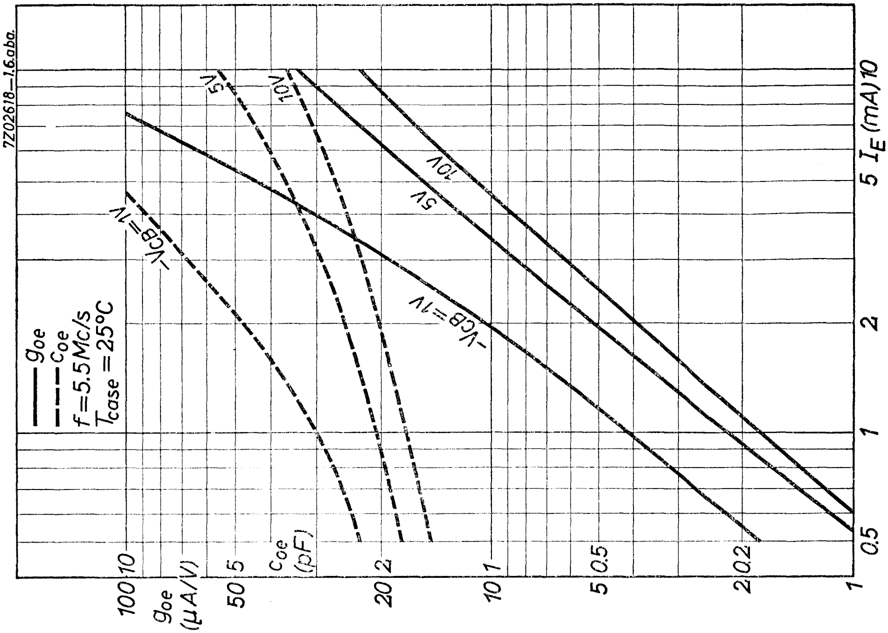

7Z02615–1.6.aba.
g_{ie}
c_{ie}
f=450kc/s
T_{case}=25°C
I_E=10mA
5mA
3mA
1mA
0.5mA
g_{ie} (mA/V)
c_{ie} (pF)
$-V_{CB}$ (V)

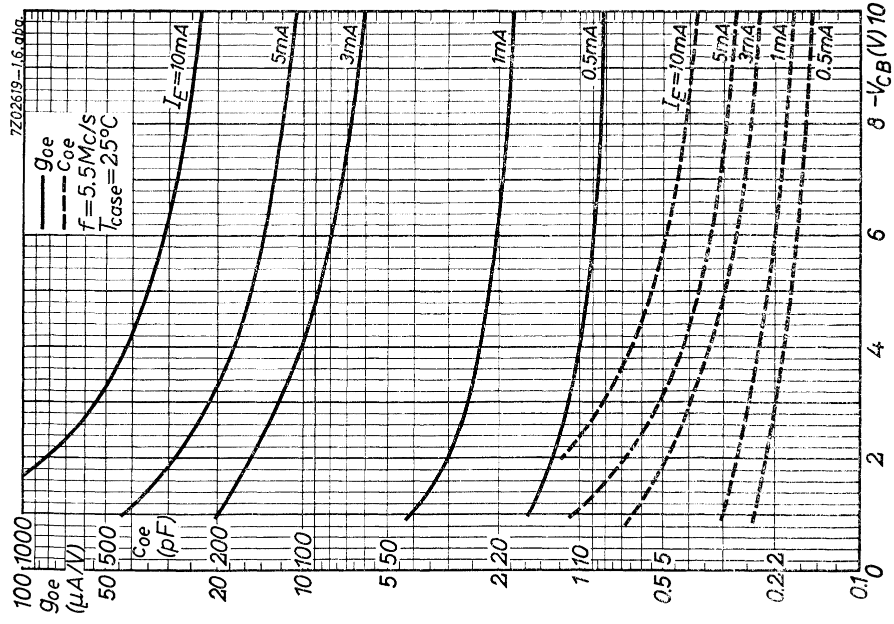

7Z02611—1.6.aba.
g_{oe}
c_{oe}
f=450kc/s
T_{case}=25°C
g_{oe} (μA/V)
c_{oe} (pF)
I_E (mA)
$-V_{CB}$=1V
5V
10V

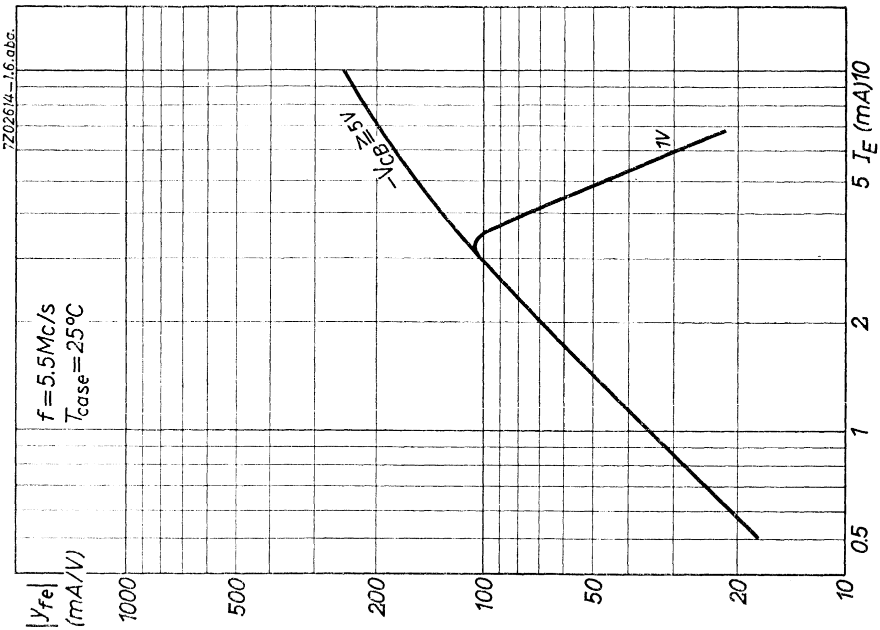

7Z02610—1.6.aba.
g_{oe}
c_{oe}
f=450kc/s
T_{case}=25°C
g_{oe} (μA/V)
c_{oe} (pF)
$-V_{CB}$ (V)
I_E=10mA
5mA
3mA
1mA
0.5mA

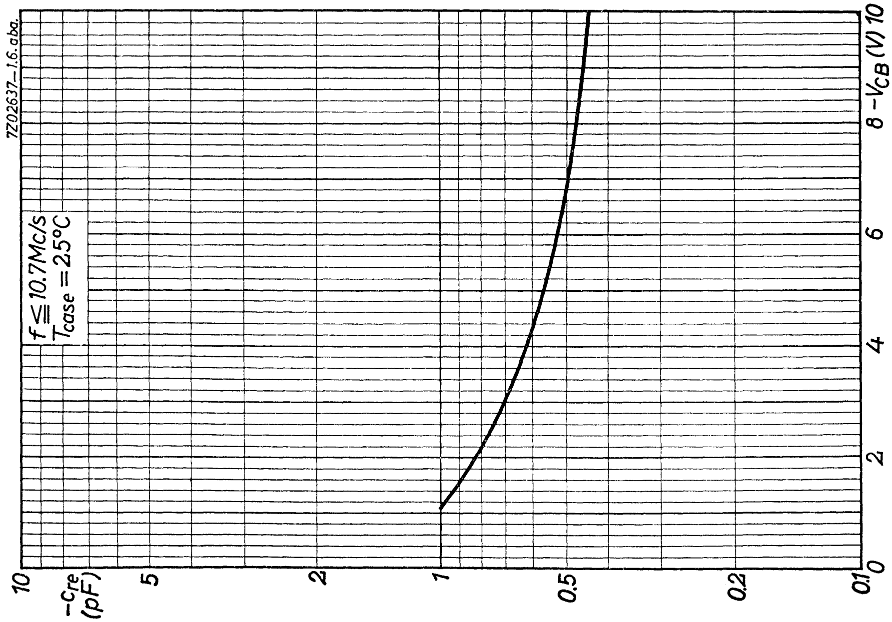

7Z02617–1.6.aba.
g_{ie}
c_{ie}
f=5.5Mc/s
T_{case}=25°C
$-V_{CB}$=1V
5V
10V
g_{ie} (mA/V)
c_{ie} (pF)
I_E (mA)
20 200
10 100
5 50
2 20
1 10
0.5 5
0.2 2
0.1
0.5
1
2
5
10

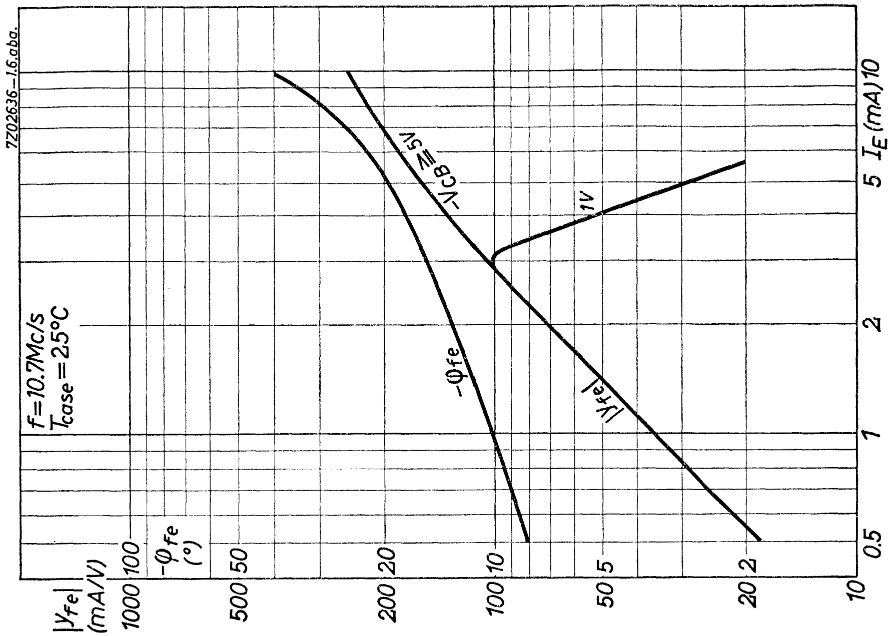

7Z02620–1.6.aba.
g_{ie}
c_{ie}
f=5.5Mc/s
T_{case}=25°C
I_E=10mA
5mA
3mA
1mA
0.5mA
g_{ie} (mA/V)
c_{ie} (pF)
$-V_{CB}$ (V)
20 200
10 100
5 50
2 20
1 10
0.5 5
0.2 2
0.1
0
2
4
6
8
10

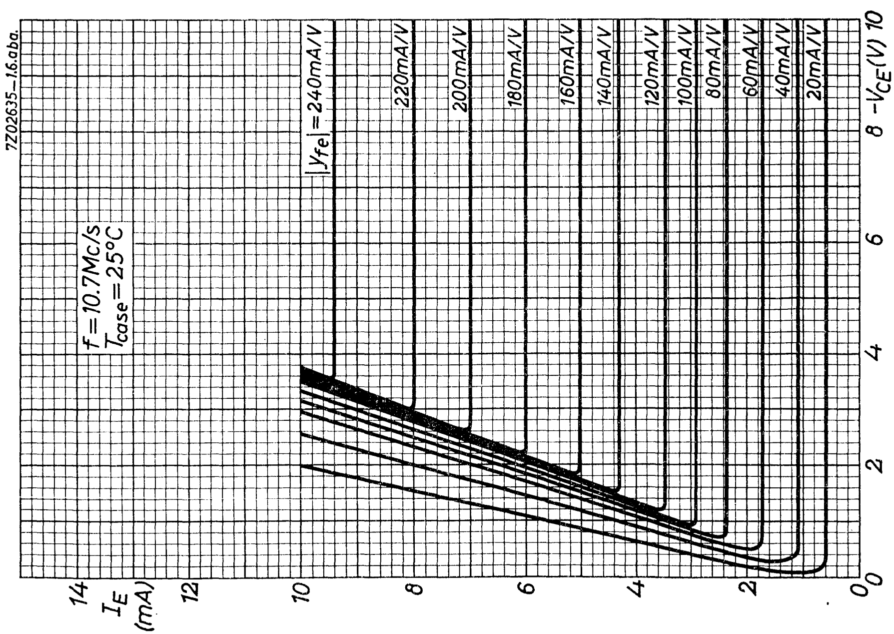

7Z02618—1.6.aba.
goe
Coe
f=5.5Mc/s
Tcase=25°C
-VCB=1V
5V
10V
IE (mA)
goe (μA/V)
Coe (pF)

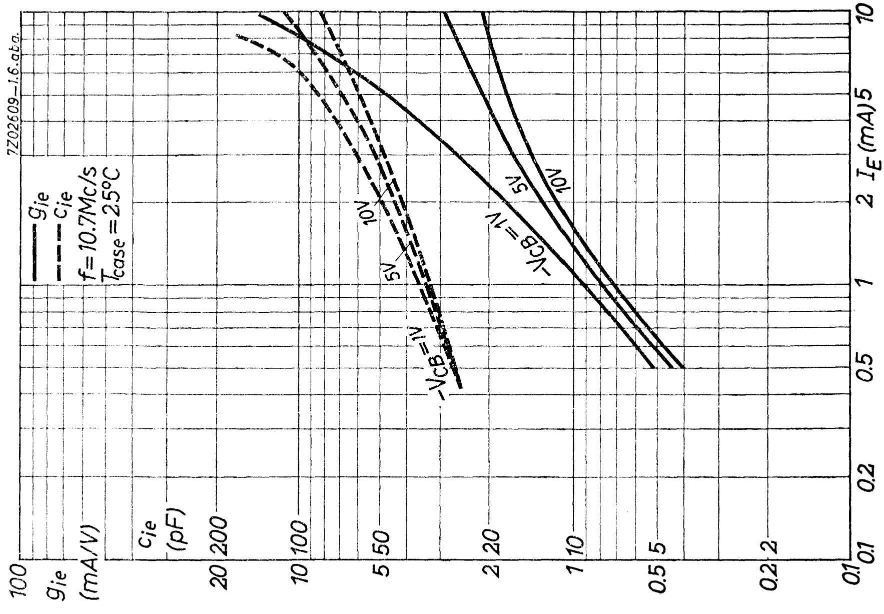

7Z02619—1.6.aba.
goe
Coe
f=5.5Mc/s
Tcase=25°C
IE=10mA
5mA
3mA
1mA
0.5mA
-VCB (V)
goe (μA/V)
Coe (pF)

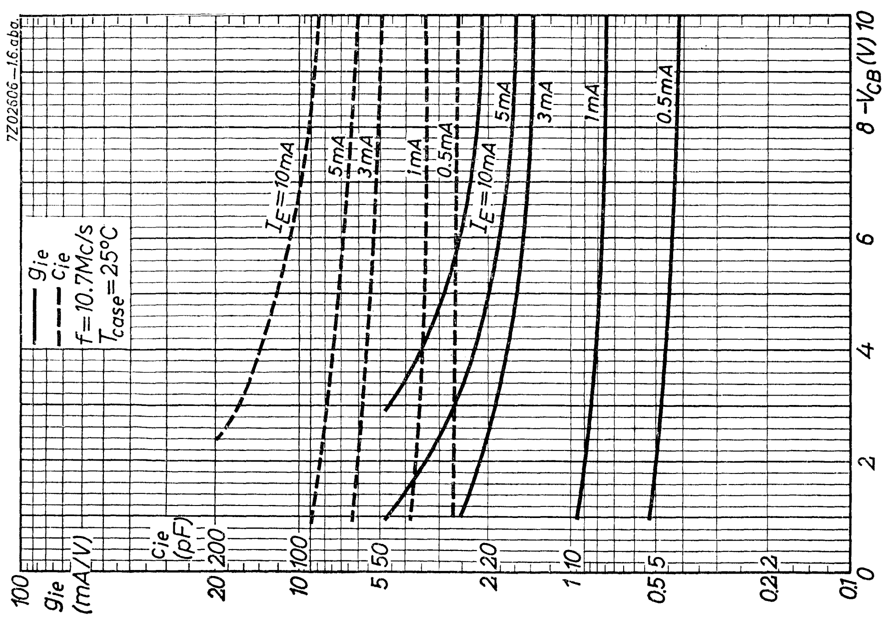

7Z02614—1.6.abc.
f = 5.5Mc/s
T_{case} = 25°C
$|y_{fe}|$ (mA/V)
1000
500
200
100
50
20
10
0.5
1
2
5
I_E (mA) 10
$-V_{CB} \geqq 5V$
1V

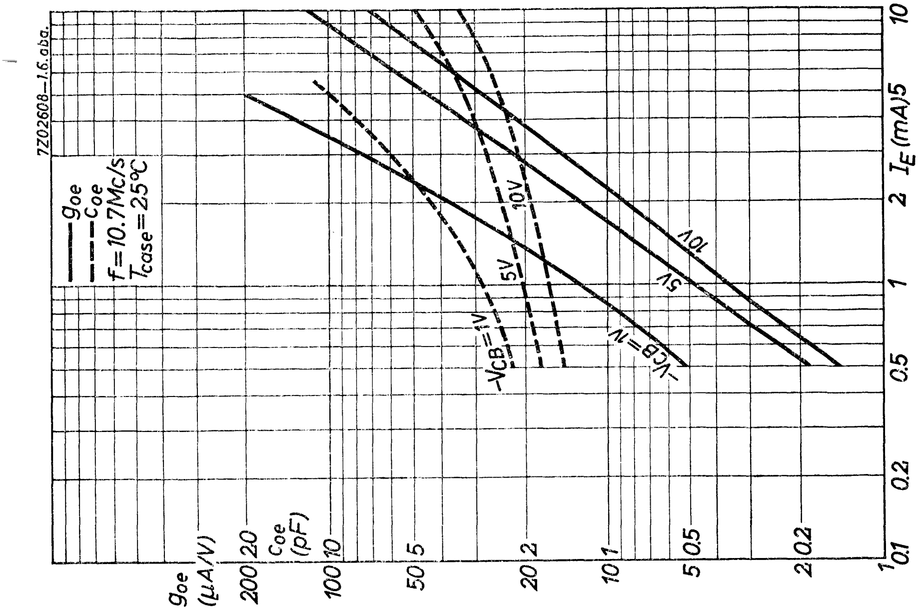

7Z02637—1.6.aba.
f ≦ 10.7Mc/s
T_{case} = 25°C
10
$-c_{re}$ (pF)
5
2
1
0.5
0.2
0.1
0
2
4
6
8 $-V_{CB}$ (V) 10

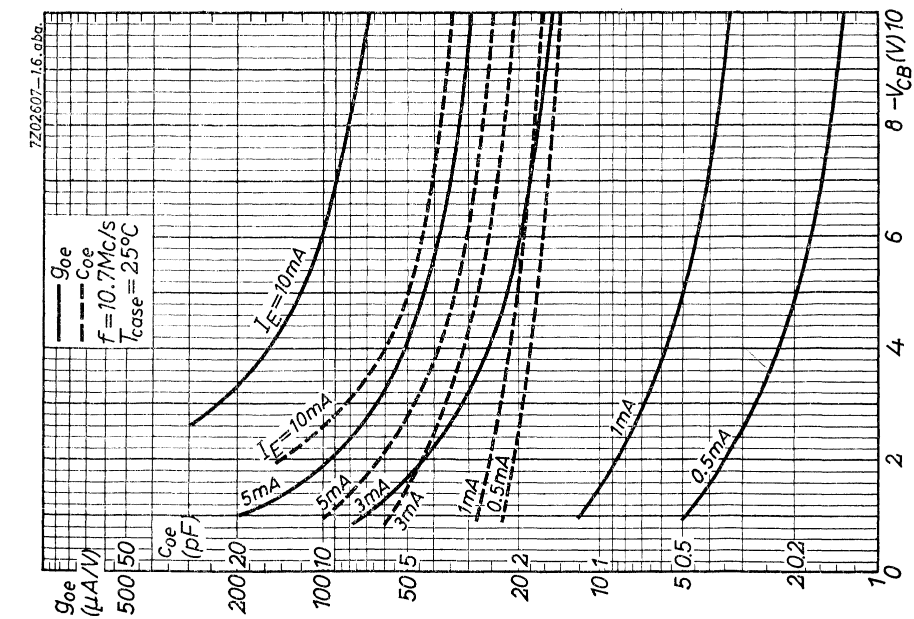

7Z02636—1.6.aba.
f=10.7Mc/s
Tcase=25°C
-φfe
|yfe|
-VCB≧5V
1V
|yfe| (mA/V)
1000
500
200
100
50
20
10
-φfe (°)
100
50
20
10
5
2
0.5
1
2
5
IE (mA) 10

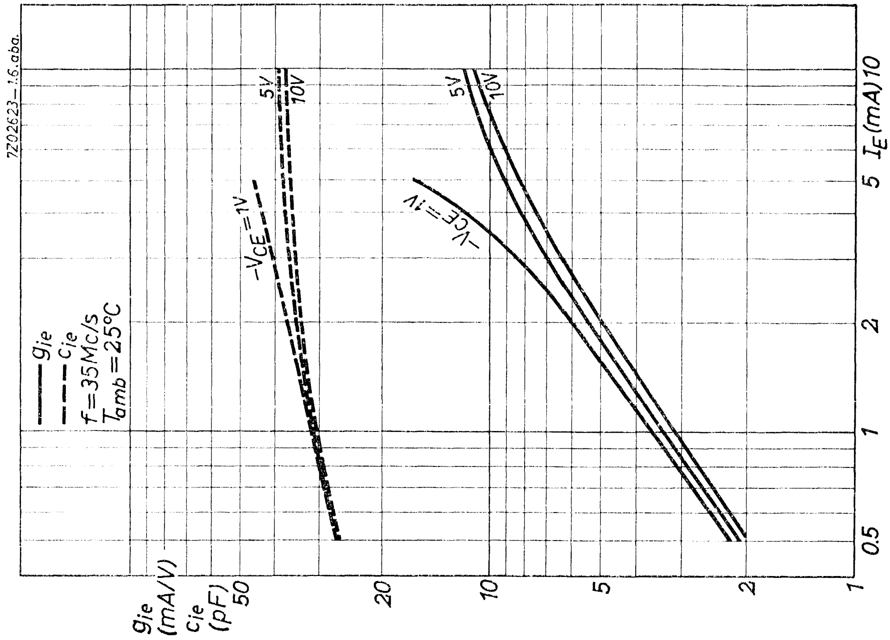

7Z02635—1.6.aba.
f=10.7Mc/s
Tcase=25°C
|yfe|=240mA/V
220mA/V
200mA/V
180mA/V
160mA/V
140mA/V
120mA/V
100mA/V
80mA/V
60mA/V
40mA/V
20mA/V
14
IE (mA)
12
10
8
6
4
2
0
2
4
6
8 -VCE(V) 10

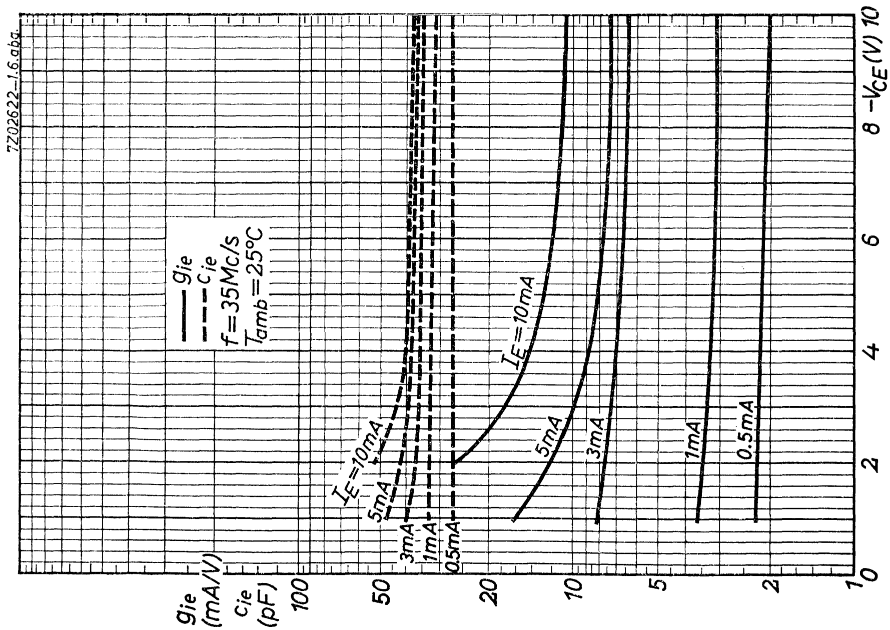

7Z02609–1.6.abc.
g_{ie}
c_{ie}
f=10.7Mc/s
T_{case}=25°C
$-V_{CB}$=1V
5V
10V
$-V_{CB}$=1V
5V
10V
g_{ie} (mA/V)
c_{ie} (pF)
I_E (mA)

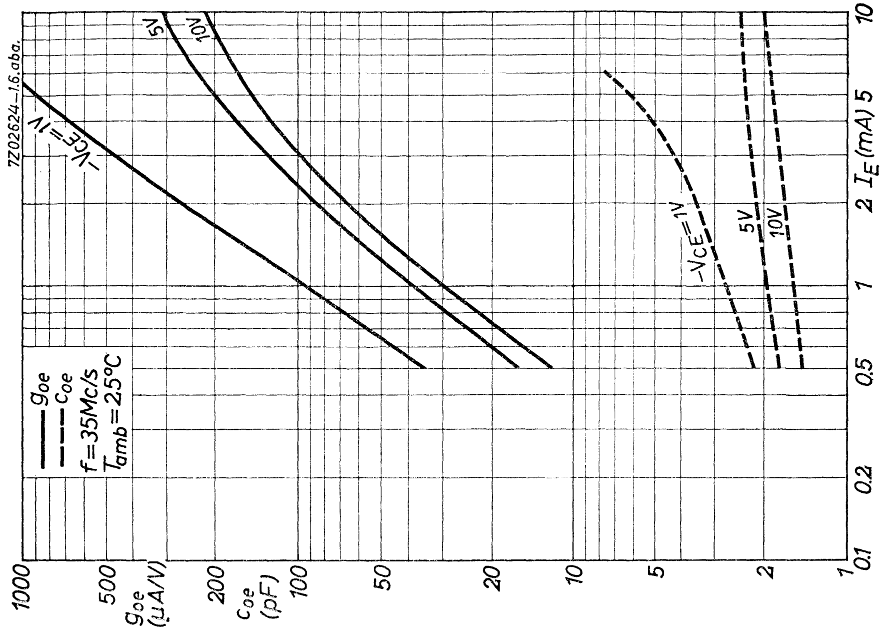

7Z02606–1.6.abc.
g_{ie}
c_{ie}
f=10.7Mc/s
T_{case}=25°C
I_E=10mA
5mA
3mA
1mA
0.5mA
I_E=10mA
5mA
3mA
1mA
0.5mA
g_{ie} (mA/V)
c_{ie} (pF)
$-V_{CB}$ (V)

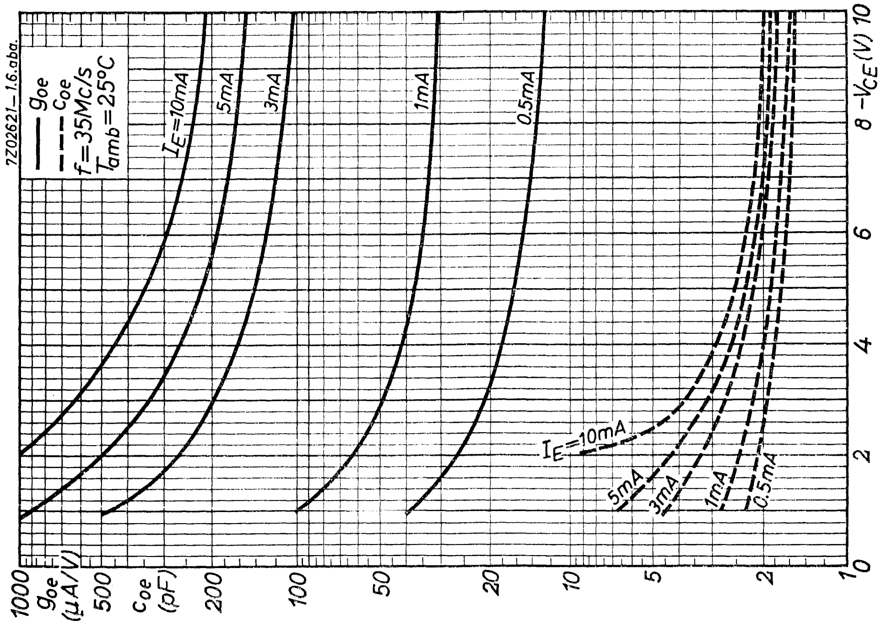

7Z02608–1.6.aba.
goe
coe
f=10.7Mc/s
Tcase=25°C
goe (µA/V)
coe (pF)
IE (mA)
−VCB=1V
5V
10V

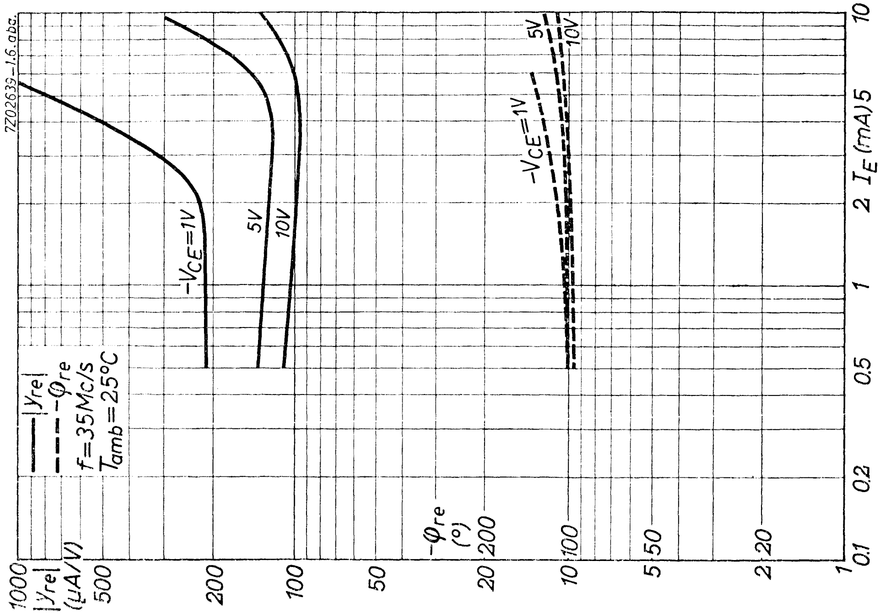

7Z02607–1.6.aba.
goe
coe
f=10.7Mc/s
Tcase=25°C
goe (µA/V)
coe (pF)
−VCB (V)
IE=10mA
5mA
3mA
1mA
0.5mA

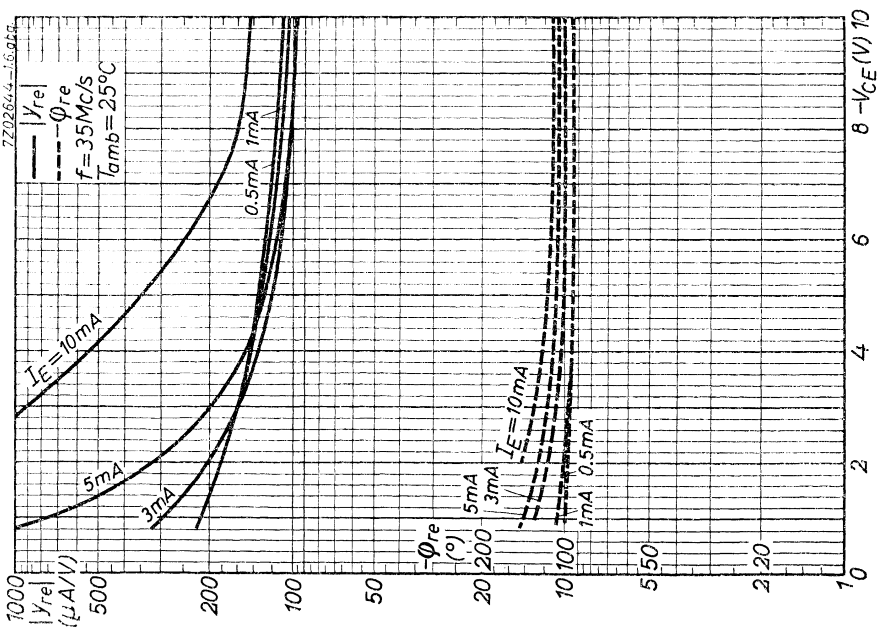

7Z02623—1.6.aba.
gie
cie
f=35Mc/s
Tamb=25°C
5V
10V
−VCE=1V
gie (mA/V)
cie (pF)
IE (mA)

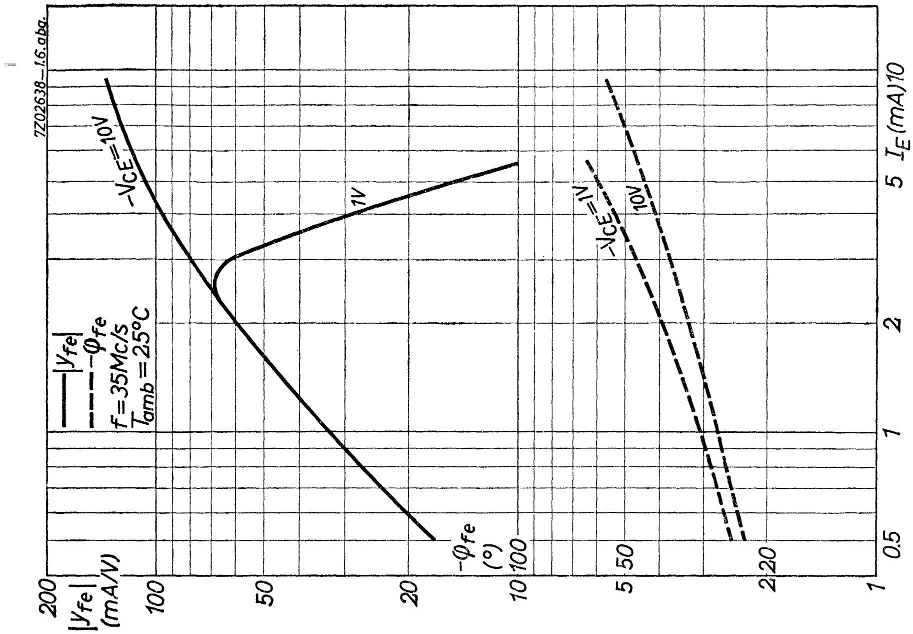

7Z02622—1.6.aba.
gie
cie
f=35Mc/s
Tamb=25°C
IE=10mA
5mA
3mA
1mA
0.5mA
gie (mA/V)
cie (pF)
−VCE (V)

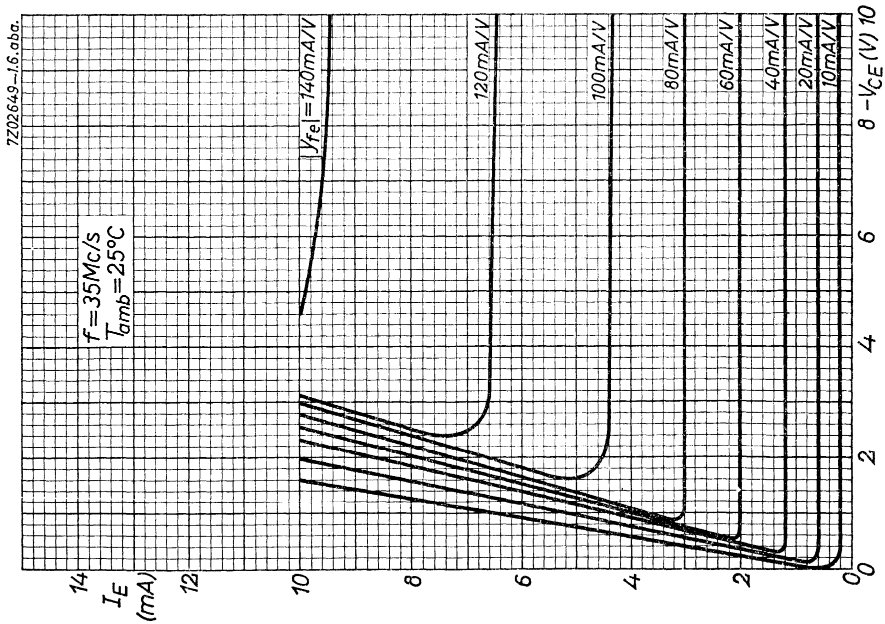

7Z02624-1.6.aba.
g_{oe}
c_{oe}
f=35Mc/s
T_{amb}=25°C
$-V_{CE}$=1V
5V
10V
g_{oe} (μA/V)
c_{oe} (pF)
I_E(mA)
1000
500
200
100
50
20
10
5
2
1
0.1
0.2
0.5
1
2
5
10

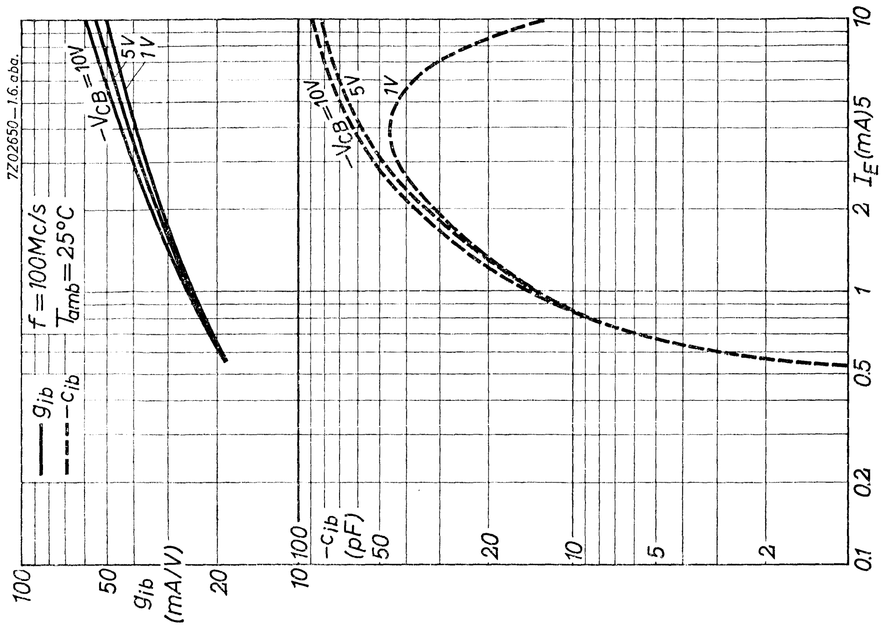

7Z02621-1.6.aba.
g_{oe}
c_{oe}
f=35Mc/s
T_{amb}=25°C
I_E=10mA
5mA
3mA
1mA
0.5mA
g_{oe} (μA/V)
c_{oe} (pF)
$-V_{CE}$(V)
1000
500
200
100
50
20
10
5
2
1
0
2
4
6
8
10

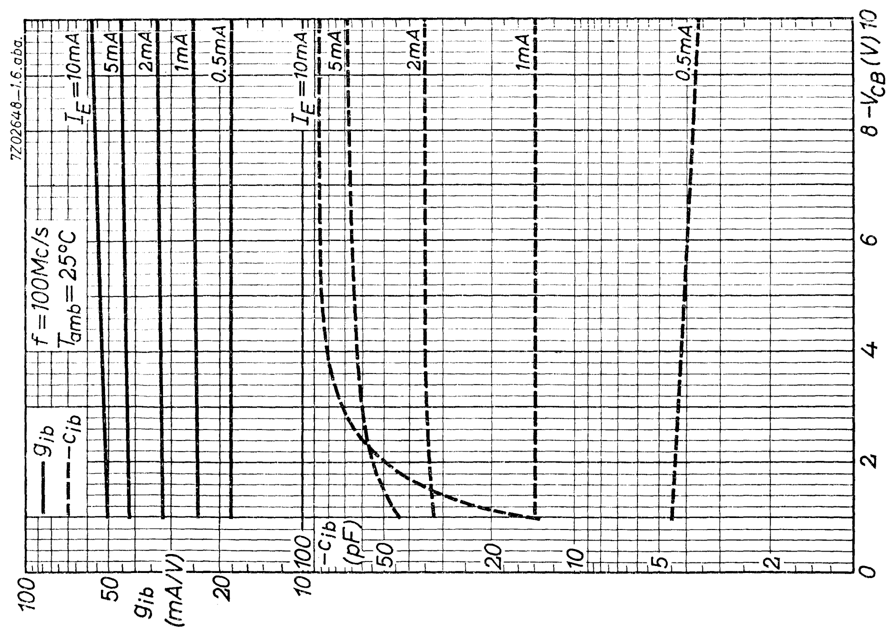

7Z02639-1.6.aba.
|yre|
-φre
f=35Mc/s
Tamb=25°C
-VCE=1V
5V
10V
|yre| (μA/V)
-φre (°)
IE (mA)

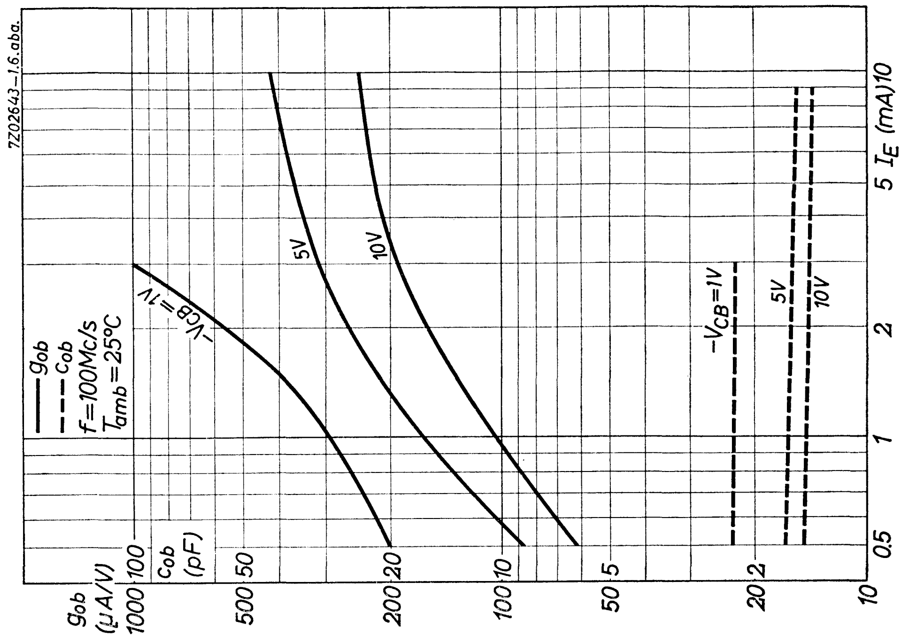

7Z02644-1.6.aba.
|yre|
-φre
f=35Mc/s
Tamb=25°C
IE=10mA
5mA
3mA
1mA
0.5mA
|yre| (μA/V)
-φre (°)
-VCE (V)

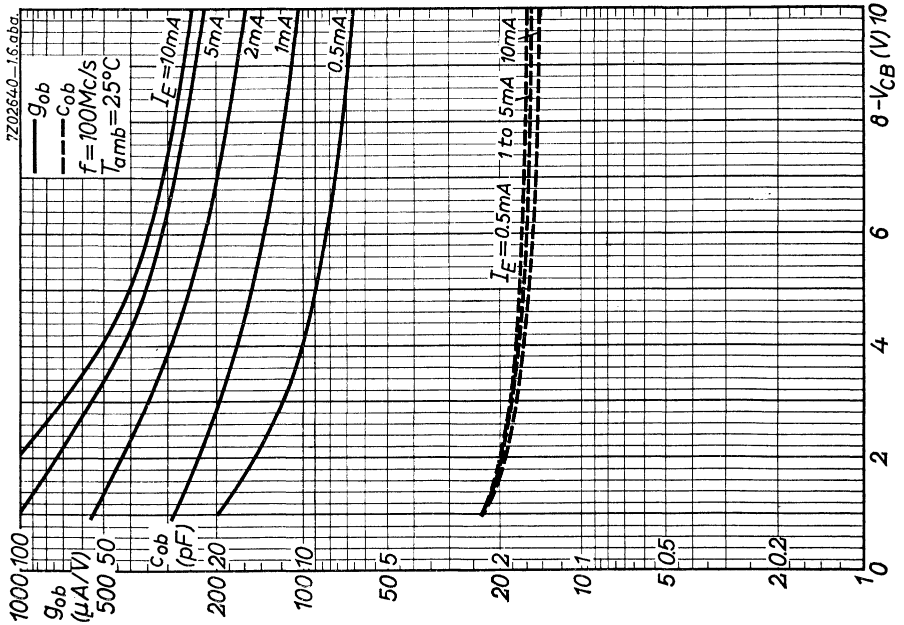

7Z02638-1.6.abg.
|yfe|
-φfe
f=35Mc/s
Tamb=25°C
-VCE=10V
1V
-VCE=1V
10V
|yfe| (mA/V)
200
100
50
20
10
5
2
1
-φfe (°)
100
50
20
0.5
1
2
5
IE (mA) 10

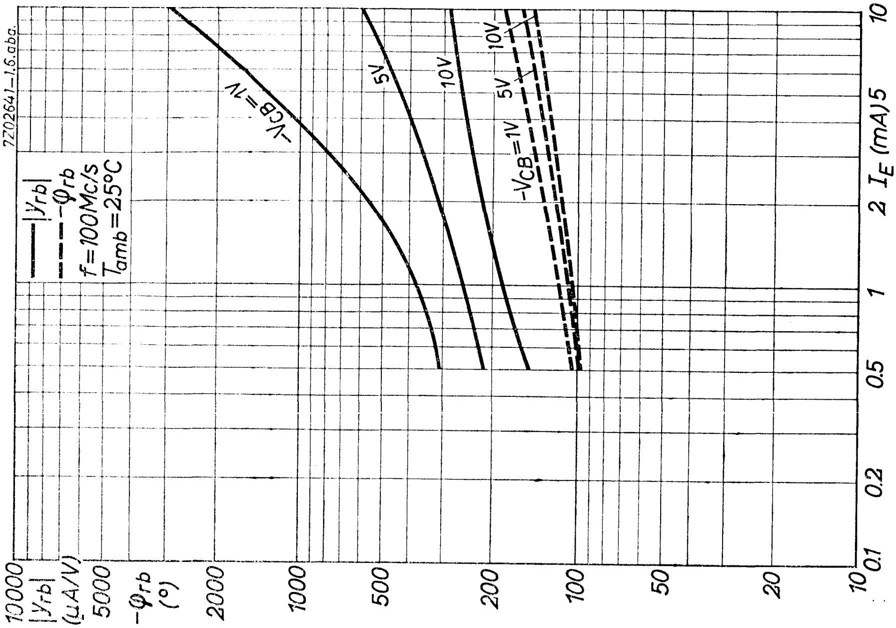

7Z02649-1.6.aba.
f=35Mc/s
Tamb=25°C
|yfe|=140mA/V
120mA/V
100mA/V
80mA/V
60mA/V
40mA/V
20mA/V
10mA/V
IE (mA)
14
12
10
8
6
4
2
0
0
2
4
6
8 -VCE (V) 10

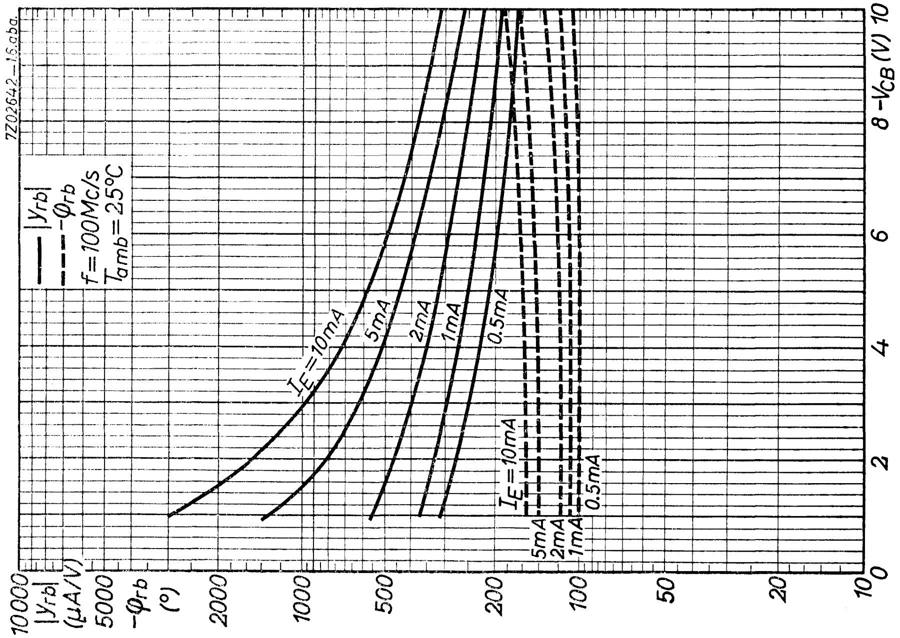

7Z02650—1.6.aba.
g_{ib}
$-c_{ib}$
f = 100Mc/s
T_{amb} = 25°C
$-V_{CB}$ = 10V
5V
1V
g_{ib} (mA/V)
$-c_{ib}$ (pF)
I_E (mA)
100
50
20
10
5
2
0.1
0.2
0.5
1
2
5
10

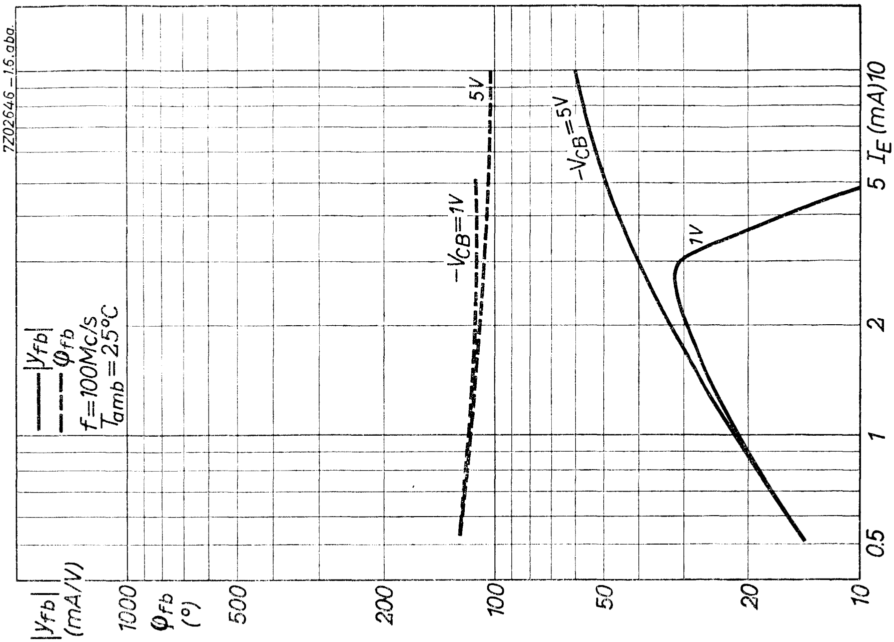

7Z02648—1.6.aba.
g_{ib}
$-c_{ib}$
f = 100Mc/s
T_{amb} = 25°C
I_E = 10mA
5mA
2mA
1mA
0.5mA
g_{ib} (mA/V)
$-c_{ib}$ (pF)
$-V_{CB}$ (V)
100
50
20
10
5
2
0
2
4
6
8
10

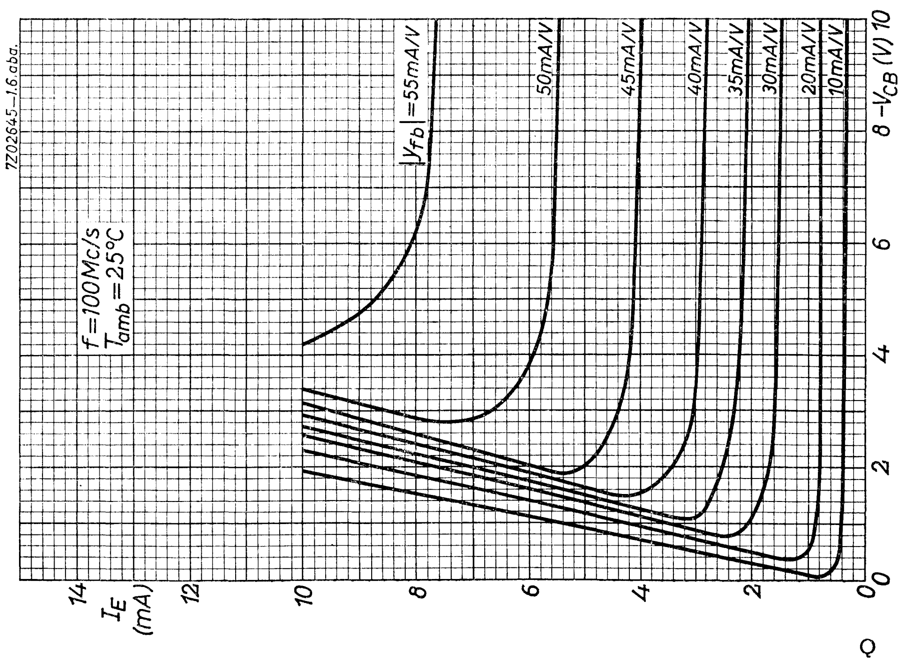

7Z02643–1.6.aba.
g_{ob}
c_{ob}
f=100Mc/s
T_{amb}=25°C
$-V_{CB}$=1V
5V
10V
$-V_{CB}$=1V
5V
10V
g_{ob} (μA/V)
c_{ob} (pF)
0.5
1
2
5 I_E (mA) 10


7Z02640–1.6.aba.
g_{ob}
c_{ob}
f=100Mc/s
T_{amb}=25°C
I_E=10mA
5mA
2mA
1mA
0.5mA
I_E=0.5mA
1 to 5mA
10mA
g_{ob} (μA/V)
c_{ob} (pF)
0
2
4
6
8 $-V_{CB}$ (V) 10

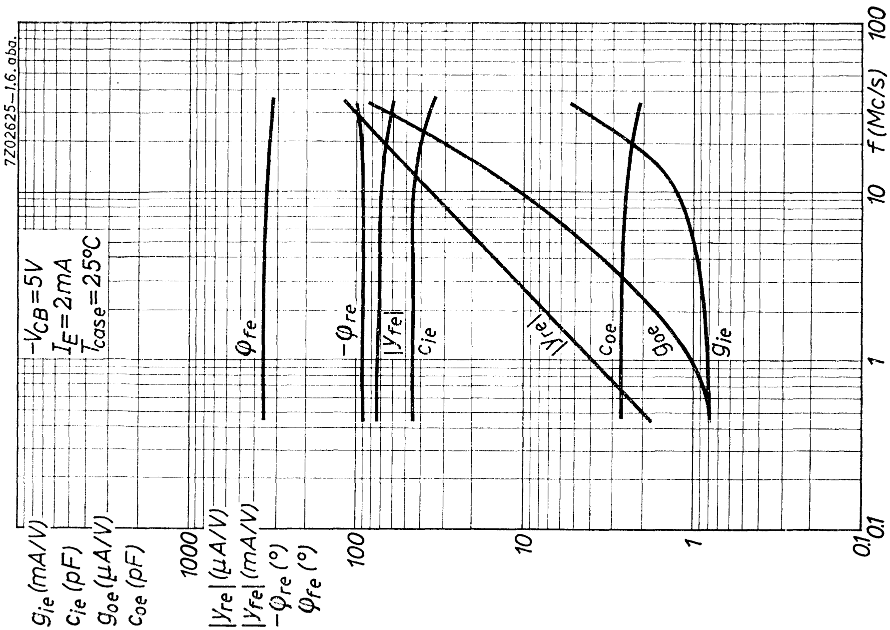

7Z02641–1.6.aba.
|y_rb|
–φ_rb
f=100Mc/s
T_amb=25°C
–V_CB=1V
5V
10V
–V_CB=1V
5V
10V
|y_rb| (μA/V)
–φ_rb (°)
10000
5000
2000
1000
500
200
100
50
20
10
I_E (mA)
0.1
0.2
0.5
1
2
5
10

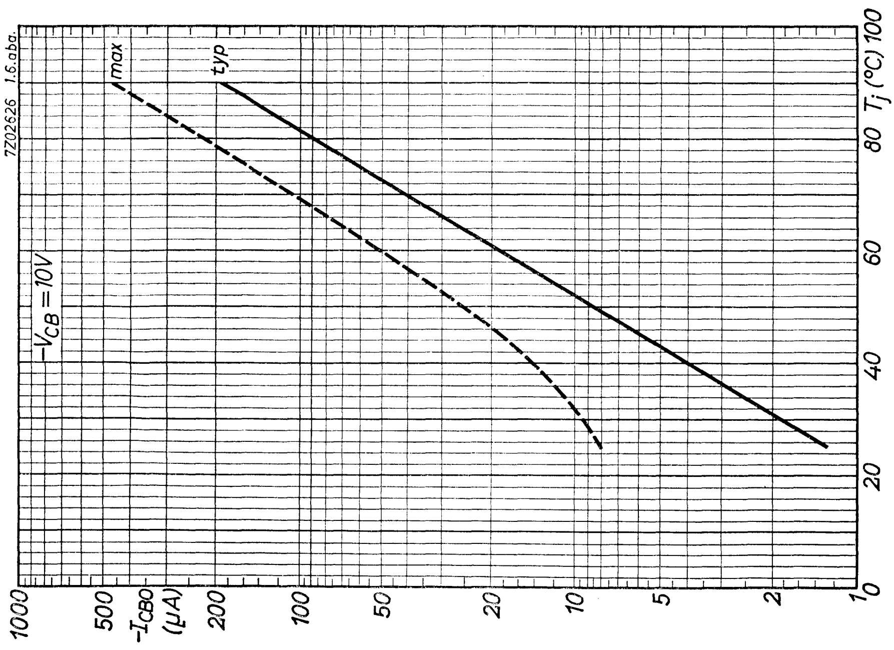

7Z02642–1.6.aba.
|y_rb|
–φ_rb
f=100Mc/s
T_amb=25°C
I_E=10mA
5mA
2mA
1mA
0.5mA
I_E=10mA
5mA
2mA
1mA
0.5mA
|y_rb| (μA/V)
–φ_rb (°)
10000
5000
2000
1000
500
200
100
50
20
10
–V_CB (V)
0
2
4
6
8
10


7Z02646—1.6.aba.
|yfb|
φfb
f=100Mc/s
Tamb=25°C
−VCB=1V
5V
−VCB=5V
1V
|yfb| (mA/V)
φfb (°)
1000
500
200
100
50
20
10
0.5
1
2
5
IE (mA)10


7Z02645—1.6.aba.
f=100Mc/s
Tamb=25°C
|yfb|=55mA/V
50mA/V
45mA/V
40mA/V
35mA/V
30mA/V
20mA/V
10mA/V
IE (mA)
14
12
10
8
6
4
2
0
0
2
4
6
8 −VCB (V) 10

Q

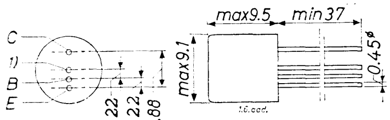

7Z02625–1.6.aba.
$-V_{CB}=5V$
$I_E=2mA$
$T_{case}=25°C$
φ_{fe}
$-\varphi_{re}$
$|y_{fe}|$
c_{ie}
$|y_{re}|$
c_{oe}
g_{oe}
g_{ie}
g_{ie} (mA/V)
c_{ie} (pF)
g_{oe} (μA/V)
c_{oe} (pF)
$|y_{re}|$ (μA/V)
$|y_{fe}|$ (mA/V)
$-\varphi_{re}$ (°)
φ_{fe} (°)
1000
100
10
1
0.1
0.1
1
10
100
f (Mc/s)


7Z02626 1.6.aba.
max
typ
$-V_{CB}=10V$
1000
500
$-I_{CBO}$ (μA)
200
100
50
20
10
5
2
1
0
20
40
60
80
100
T_j (°C)

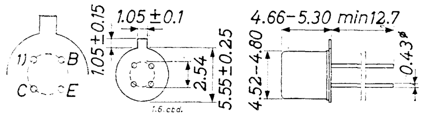
GERMANIUM ALLOY-DIFFUSED TRANSISTOR of the p-n-p type in metal envelope with low noise and high power gain at 100 Mc/s, for use as R.F. amplifier in F.M. receivers

Dimensions in mm

AF114



AF124



LIMITING VALUES (Absolute max. values)

Collector

Voltage (base reference)		$-V_{CB}$	= max.	32 V
Voltage (emitter reference)		$-V_{CE}$	= max.	32 V 2)
Current		$-I_C$	= max.	10 mA
Dissipation ($T_{amb} \leq 45$ °C)	AF114	P_C	= max.	75 mW
Dissipation	AF124	P_C	= max.	60 mW

Emitter

Reverse current	$-I_E$	= max.	1 mA

Base

Current	$\lvert I_B \rvert$	= max.	1 mA

Temperatures

Storage temperature	T_s	=	-55 °C to +75 °C
Junction temperature			
continuous operation	T_j	= max.	75 °C
intermittent operation (total duration max. 200 hrs)	T_j (t	= max. = max.	90 °C 200 hrs)

THERMAL DATA

Thermal resistance from junction to ambience in free air	AF114	K	= max.	0.6 °C/mW
	AF124	K	= max.	0.75 °C/mW
Thermal resistance from junction to case	AF124	K	= max.	0.4 °C/mW

1) Interlead shield and metal case

2) See also page F.

CHARACTERISTICS at T_{amb} = 25 °C

Collector current at I_E = 0 mA

$-I_{CBO}$ ($-V_{CB}$ = 6 V; I_E = 0 mA)	= 1.2 µA	< 8 µA

Collector voltage at I_E = 0 mA

$-V_{CB}$ ($-I_C$ = 50 µA; I_E = 0 mA)		> 32 V

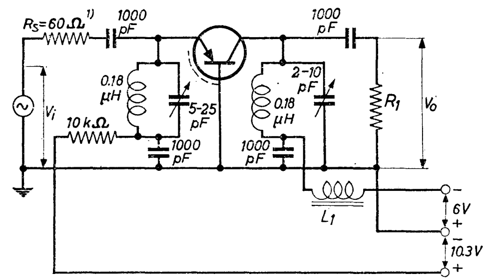
Base current

$-I_B$ ($-V_{CB}$ = 6 V; I_E = 1 mA)	= 7 µA	< 25 µA

Base voltage

$-V_{BE}$ ($-V_{CB}$ = 6 V; I_E = 1 mA)	= 270 mV	> 210 mV < 330 mV

Test circuit for power gain at 100 Mc/s



R_1 is chosen so that the total impedance R_L of the tuned circuit is 3.3 kΩ

L_1 = ferrite bead

Available power gain at 100 Mc/s in the circuit above

G (f = 100 Mc/s)	= 14 dB	> 12.5 dB

The available power gain is defined as

$$G = \frac{V_o^2}{V_i^2} \cdot \frac{4R_S}{R_L} = 0.073 \frac{V_o^2}{V_i^2} .$$

1) Input source impedance

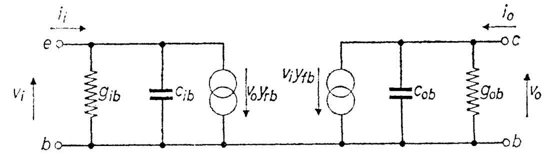
CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN

T_{amb} = 25 °C

Emitter voltage			
$-V_{EB}$ ($-I_E$ = 50 µA; I_C = 0 mA)	=	1.5 V	> 1.0 V
Frequency at which $\|h_{fe}\|$ = 1			
f_1 ($-V_{CB}$ = 6 V; I_E = 1 mA)	=	75 Mc/s	
Intrinsic base impedance			
$\|z_{rb}\|$ ($-V_{CB}$ = 6 V; I_E = 1 mA; f = 2 Mc/s)	=	20 Ω	
Feedback capacitance			
$-c_{re}$ ($-V_{CE}$ = 6 V; I_E = 1 mA; f = 0.45 Mc/s)	=	1.5 pF	
Current amplification factor			
h_{fe} ($-V_{CE}$ = 6 V; I_E = 1 mA; f = 1 kc/s)	=	150	
Noise figure			
F ($-V_{CB}$ = 6 V; I_E = 1 mA; f = 100 Mc/s; Input source resistance = 60 Ω)	=	8 dB	< 9.5 dB

7Z2 1131
5.5.1962

SMALL SIGNAL PARAMETERS measured with a length of lead between transistor bottom and measuring jig of 5 mm

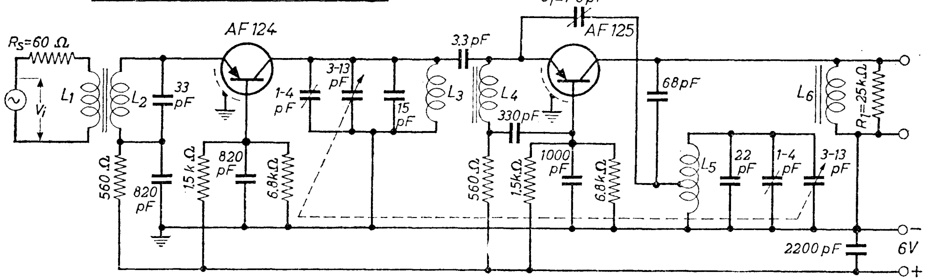


Measured at

Collector voltage	$-V_{CB}$	=	6 V
Emitter current	I_E	=	1 mA
Frequency	f	=	100 Mc/s
Input conductance	g_{ib}	=	15 mA/V
Input capacitance	$-c_{ib}$	=	5 pF
Feedback admittance	$\|y_{rb}\|$	=	0.45 mA/V
Phase angle of feedback admittance	φ_{rb}	=	250 °
Transfer admittance	$\|y_{fb}\|$	=	16 mA/V
Phase angle of transfer admittance	φ_{fb}	=	35 °
Output conductance	g_{ob}	=	0.3 mA/V
Output capacitance	c_{ob}	=	2.5 pF

7Z2 1132

FRONT-END UNIT OF F.M. TUNER



For data of the oscillator-mixer stage please refer to the data sheets of type AF125

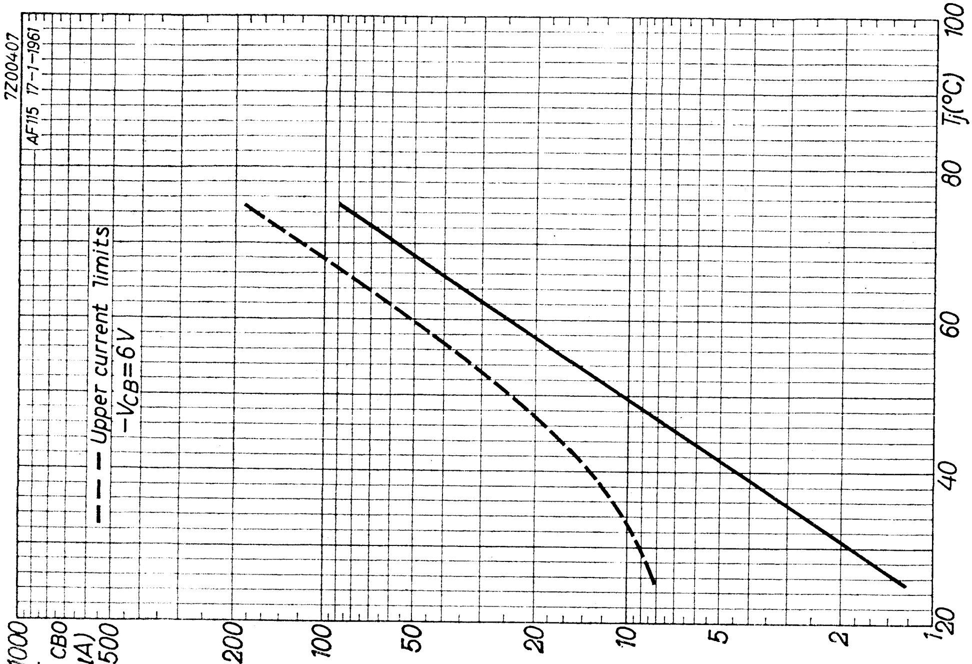
Coil data. L_1: $4\frac{1}{2}$ turns of 0.3 mm enamelled copper wire, wound between L_2

L_2: 4 turns of 1 mm enamelled copper wire, winding pitch 2 mm; inductance L = 0.18 µH; unloaded Q-factor Q_o = 60 to 80

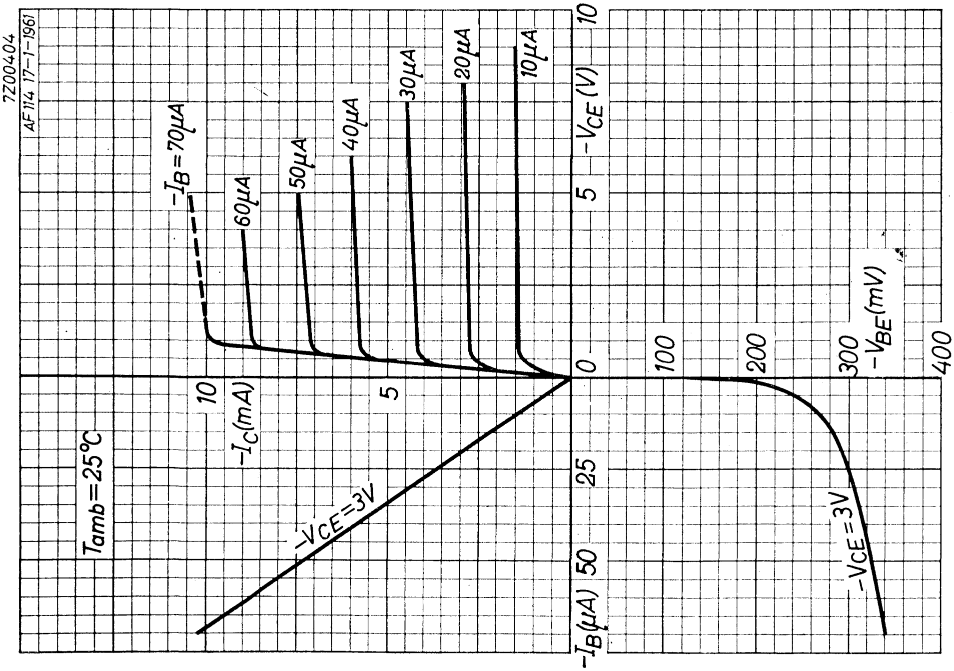
L_3: $3\frac{1}{4}$ turns of 1 mm silvered copper wire, winding pitch 2 mm; inductance L = 0.086 µH; unloaded Q-factor Q_o = 200

Operating characteristics

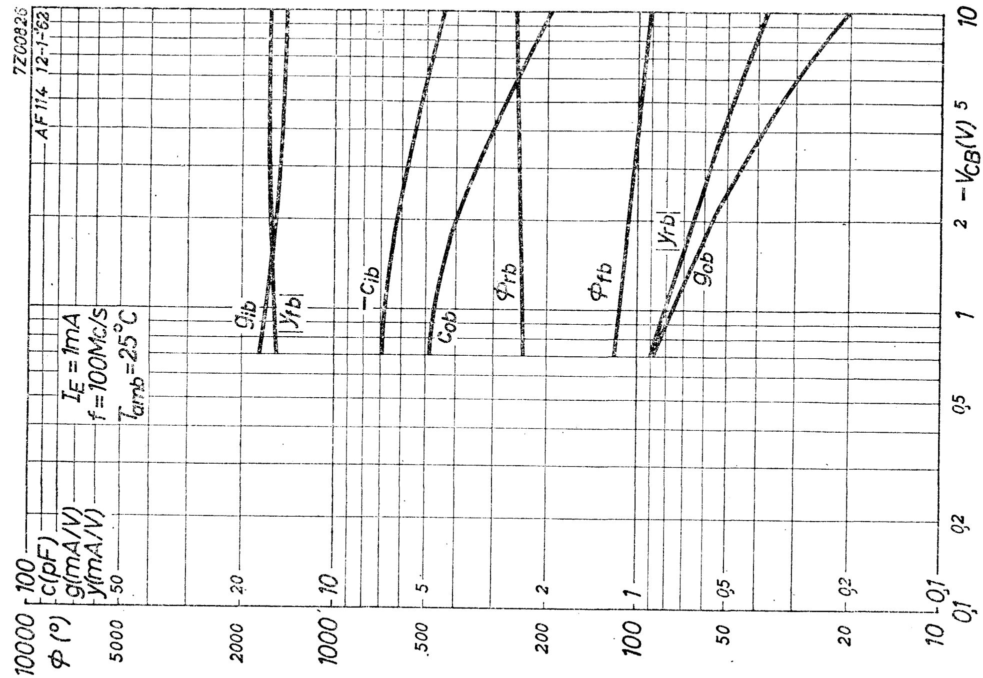
Frequency range	f	= 87 to 101 Mc/s	
Collector current AF124	$-I_C$	= 1.4 mA	
Total available power gain	G	= 28 dB	> 24 dB
Total noise factor	F	= 8 dB	< 9.5 dB
Oscillator voltage at aerial terminals		= 1.5 mV	
Image rejection		= 27 dB	


7Z00407
AF115 17-1-1961
– – – Upper current limits
$-V_{CB}$=6V
$-I_{CBO}$ (μA)
1000
500
200
100
50
20
10
5
2
1
20
40
60
80
100
T_j(°C)

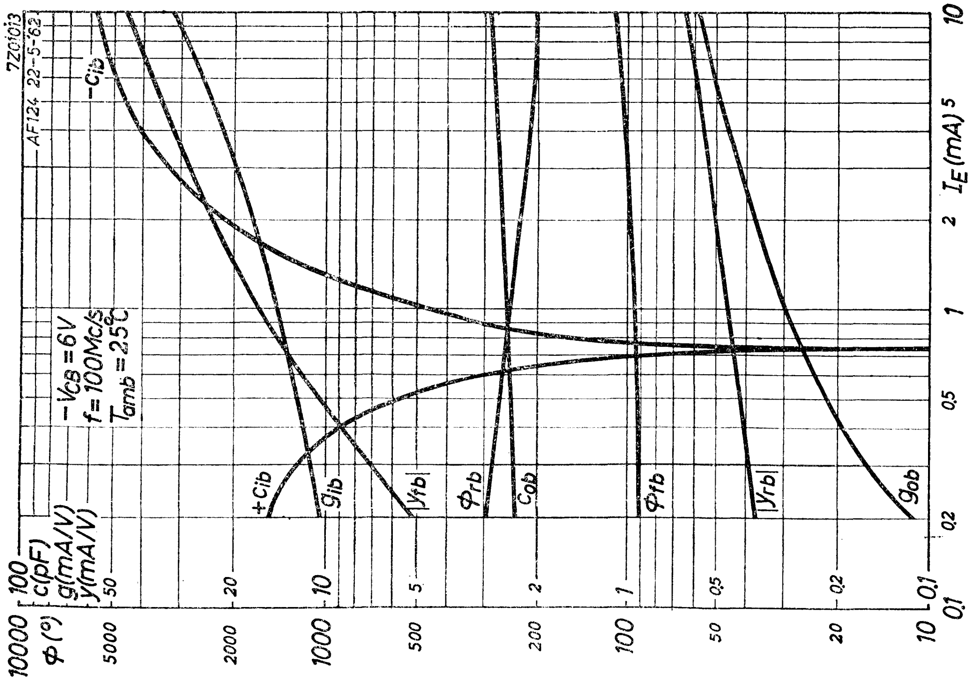
B


7Z00404
AF114 17-1-1961
T_{amb}=25°C
$-I_B$=70μA
60μA
50μA
40μA
30μA
20μA
10μA
$-V_{CE}$(V)
10
5
0
$-I_C$(mA)
10
5
$-V_{CE}$=3V
25
50
$-I_B$(μA)
100
200
300
400
$-V_{BE}$(mV)
$-V_{CE}$=3V

A

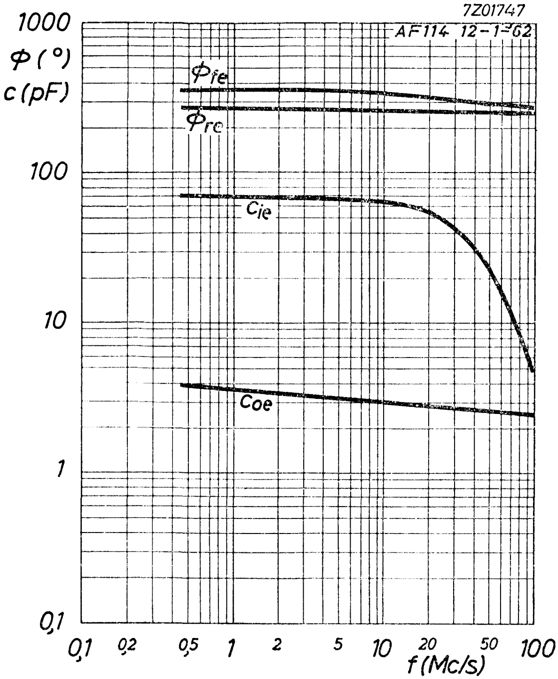

7Z00826
AF114 12-1-'62
I_E = 1mA
f = 100Mc/s
T_{amb} = 25°C
10000
Φ (°)
100
c(pF)
g(mA/V)
y(mA/V)
g_{ib}
$|y_{fb}|$
$-c_{ib}$
c_{ob}
φ_{rb}
φ_{fb}
$|y_{rb}|$
g_{ob}
$-V_{CB}$(V)

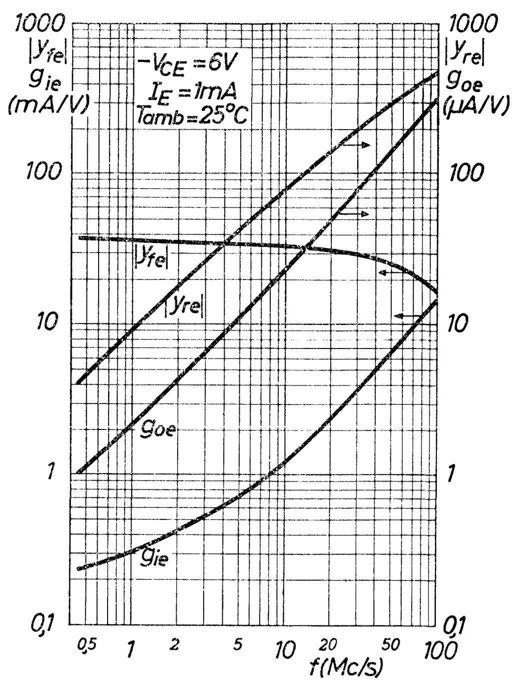
D


7Z01013
AF124 22-5-'62
$-V_{CB}$ = 6V
f = 100Mc/s
T_{amb} = 25°C
10000
Φ (°)
100
c(pF)
g(mA/V)
y(mA/V)
$-c_{ib}$
$+c_{ib}$
g_{ib}
$|y_{fb}|$
φ_{rb}
c_{ob}
φ_{fb}
$|y_{rb}|$
g_{ob}
I_E(mA)

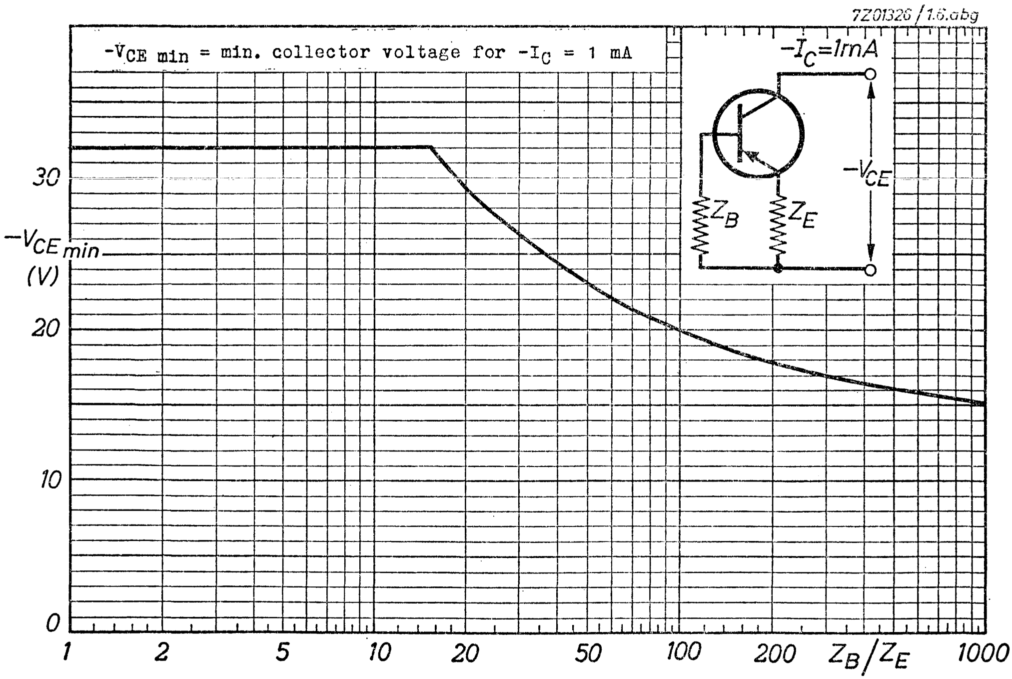
C

5.5.1962


7Z01747
AF114 12-1-62
1000
100
10
1
0,1
Φ (°)
c (pF)
ϕ_{fe}
ϕ_{re}
c_{ie}
c_{oe}
0,1
0,2
0,5
1
2
5
10
20
50
100
f (Mc/s)


1000
100
10
1
0,1
$|y_{fe}|$
g_{ie}
(mA/V)
$|y_{re}|$
g_{oe}
(μA/V)
$-V_{CE}=6V$
$I_E=1mA$
Tamb=25°C
$|y_{fe}|$
$|y_{re}|$
g_{oe}
g_{ie}
0,5
1
2
5
10
20
50
100
f(Mc/s)

E


7Z01326 / 1.6.abg
$-V_{CE\ min}$ = min. collector voltage for $-I_C$ = 1 mA
$-I_C=1mA$
$-V_{CE}$
Z_B
Z_E
$-V_{CE\ min}$
(V)
30
20
10
0
1
2
5
10
20
50
100
200
Z_B/Z_E
1000

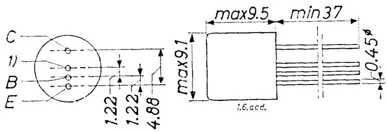
F

5.5.1963

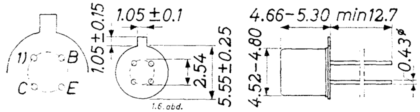
GERMANIUM ALLOY-DIFFUSED TRANSISTOR of the p-n-p type in metal envelope with high conversion gain up to 100 Mc/s, for use as mixer-oscillator in F.M. receivers and as R.F. amplifier and mixer-oscillator in short-wave receivers up to 27 Mc/s

Dimensions in mm

AF115



AF125



LIMITING VALUES (Absolute max. values)

Collector			
Voltage (base reference)		$-V_{CB}$ = max.	32 V
Voltage (emitter reference)		$-V_{CE}$ = max.	32 V [2]
Current		$-I_C$ = max.	10 mA
Dissipation ($T_{amb} \leq 45\ ^oC$)	AF115	P_C = max.	75 mW
Dissipation	AF125	P_C = max.	60 mW
Emitter Reverse current		$-I_E$ = max.	1 mA
Base Current		$\lvert I_B \rvert$ = max.	1 mA
Temperatures			
Storage temperature		T_s =	-55 °C to +75 °C
Junction temperature			
continuous operation		T_j = max.	75 °C
intermittent operation (total duration max. 200 hrs)		T_j = max.	90 °C
		(t = max.	200 hrs)

THERMAL DATA

Thermal resistance from junction to ambience in free air	AF115	K = max.	0.6 °C/mW
	AF125	K = max.	0.75 °C/mW
Thermal resistance from junction to case	AF125	K = max.	0.4 °C/mW

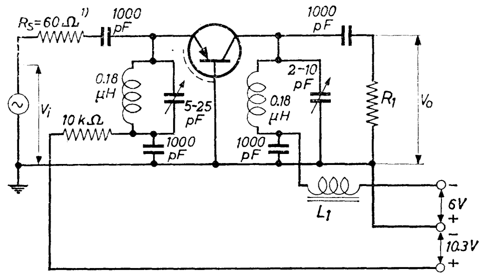
[1]) Interlead shield and metal case

[2]) See also page J

CHARACTERISTICS at T_{amb} = 25 °C

Collector current at I_E = 0 mA			
$-I_{CBO}$ ($-V_{CB}$ = 6 V; I_E = 0 mA)	= 1.2 µA	<	8 µA
Collector voltage at I_E = 0 mA			
$-V_{CB}$ ($-I_C$ = 50 µA; I_E = 0 mA)		>	32 V
Base current			
$-I_B$ ($-V_{CB}$ = 6 V; I_E = 1 mA)	= 7 µA	<	25 µA
Base voltage			
$-V_{BE}$ ($-V_{CB}$ = 6 V; I_E = 1 mA)	= 270 mV	> <	210 mV 330 mV

Test circuit for power gain at 100 Mc/s



R_1 is chosen so that the total impedance R_L of the tuned circuit is 3.3 kΩ

L_1 = ferrite bead

Available power gain at 100 Mc/s in the circuit above

G (f = 100 Mc/s) = 13 dB > 10 dB

The available power gain is defined as

$$G = \frac{V_o^2}{V_i^2} \cdot \frac{4R_S}{R_L} = 0.073\ \frac{V_o^2}{V_i^2}\ .$$

[1]) Input source impedance

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN

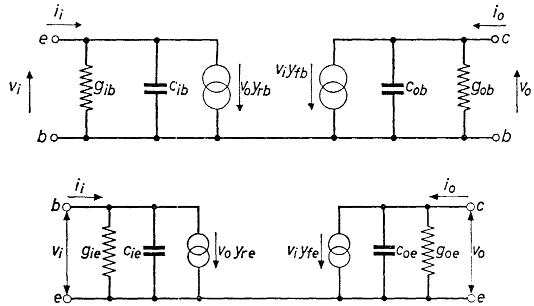
T_{amb} = 25 °C

Emitter voltage				
$-V_{EB}$	$(-I_E = 50\ \mu A;\ I_C = 0$ mA)	=	1.5 V	> 1.0 V
Frequency at which $\vert h_{fe}\vert$ = 1				
f_1	$(-V_{CB} = 6$ V; $I_E = 1$ mA)	=	75 Mc/s	
Intrinsic base impedance				
$\vert z_{rb}\vert$	$-V_{CB} = 6$ V; $I_E = 1$ mA; f = 2 Mc/s	=	25 Ω	
Feedback capacitance				
$-c_{re}$	$-V_{CE} = 6$ V; $I_E = 1$ mA; f = 0.45 Mc/s	=	1.5 pF	
Current amplification factor				
h_{fe}	$-V_{CE} = 6$ V; $I_E = 1$ mA; f = 1 kc/s	=	150	
Noise figure				
F	$-V_{CB} = 6$ V; $I_E = 1$ mA; f = 100 Mc/s; Input source resistance = 60 Ω	=	9.5 dB	
F	$-V_{CE} = 6$ V; $I_E = 1$ mA; f = 10.7 Mc/s; Input source resistance = 200 Ω	=	3.0 dB	
F	$-V_{CE} = 6$ V; $I_E = 1$ mA; f = 1 Mc/s; Input source resistance = 500 Ω	=	1.5 dB	< 3 dB
Conversion noise figure				
F	$-V_{CE} = 6$ V; $I_E = 1$ mA; f = 1 Mc/s; Input source resistance = 500 Ω	=	3 dB	< 5 dB
F	$-V_{CE} = 6$ V; $I_E = 1$ mA; f = 200 kc/s; Input source resistance = 2 kΩ	=	4 dB	< 7 dB

7Z2 1135

5.5.1963

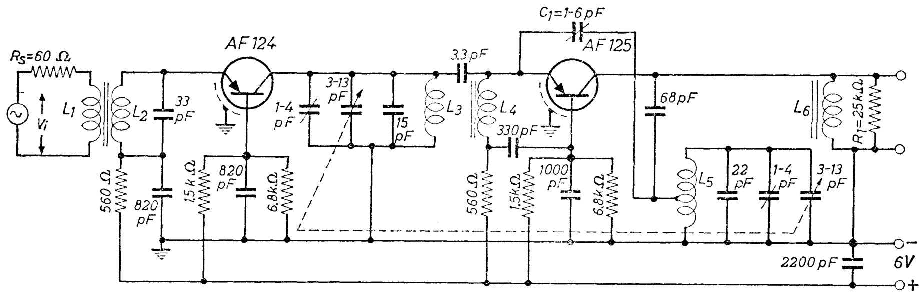
Small signal parameters measured with a length of lead between transistor bottom and measuring jig of 5 mm



Common base			Common emitter			Common emitter		
$-V_{CB}$	=	6 V	$-V_{CE}$	=	6 V	$-V_{CE}$	=	6 V
I_E	=	1 mA	I_E	=	1 mA	I_E	=	1 mA
f	=	100 Mc/s	f	=	10.7 Mc/s	f	=	0.45 Mc/s
g_{ib}	=	15 mA/V	g_{ie}	=	1.3 mA/V	g_{ie}	=	0.25 mA/V
$-c_{ib}$	=	5 pF	c_{ie}	=	65 pF	c_{ie}	=	70 pF
$\vert y_{rb}\vert$	=	0.45 mA/V	$\vert y_{re}\vert$	=	80 µA/V	$\vert y_{re}\vert$	=	4 µA/V
φ_{rb}	=	250 °	φ_{re}	=	260 °	φ_{re}	=	270 °
$\vert y_{fb}\vert$	=	15 mA/V	$\vert y_{fe}\vert$	=	34 mA/V	$\vert y_{fe}\vert$	=	37 mA/V
φ_{rb}	=	95 °	φ_{fe}	=	335 °	φ_{fe}	=	0 °
g_{ob}	=	0.35 mA/V	g_{oe}	=	25 µA/V	g_{oe}	=	1.0 µA/V
c_{ob}	=	2.5 pF	c_{oe}	=	3.0 pF	c_{oe}	=	4 pF

7Z2 1801

FRONT-END UNIT OF F.M. TUNER



7Z2 1137

For data of the R.F. stage please refer to the data sheets of type AF124

The oscillator voltage at the emitter of the AF125 should be adjusted to 80 mV by means of C_1 at a battery voltage V_S = 4 V

Coil data. L_4: 6 turns of 0.5 mm enamelled copper wire, closely wound; inductance L = 0.65 µH

L_5: $2\frac{1}{2}$ turns of 1 mm silvered copper wire, winding pitch 2 mm; inductance L = 0.062 µH unloaded Q-factor Q_o > 200. Tap at $1\frac{1}{8}$ turn from the earth side

L_6: 18 turns of 36 x 0.03 copper wire, enamelled, soldering graded, stranded, open covered, closely wound; inductance L = 2.9 µH; unloaded Q-factor Q_o = 120; Q-factor loaded with 25 kΩ = 60. Screening can A3 304 20

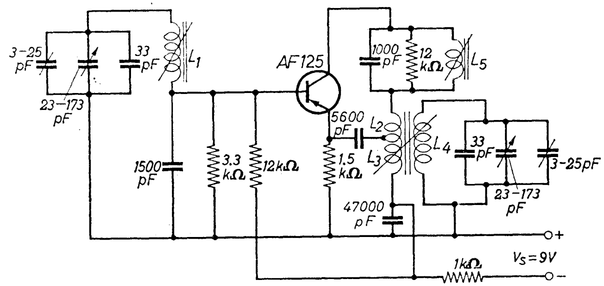
Operating characteristics

Collector current AF125 $-I_C$ = 1.5 mA

Oscillator voltage at the aerial terminals = 1.5 mV

Shift of the oscillator frequency as a function of the battery voltage is about 50 kc/s from 6 to 5 V and about 100 kc/s from 5 to 4 V

SELF-OSCILLATING MIXER STAGE for the frequency range from 15.1 to 26.1 Mc/s



OPERATING CHARACTERISTICS measured at

Battery voltage	V_S	= 9 V
Collector voltage	$-V_{CE}$	= 6 V
Emitter current	I_E	= 1 mA

f	V_{osc} 1)	Δf_{osc} 2)	P_o/P_i 3)
(Mc/s)	(V)	(kc/s)	(dB)
15	0.11	3	26
20	0.14	2	23
26	0.15	10	20

For coil data see page 7

1) Oscillator voltage, measured between emitter and earth

2) Frequency shift by a battery voltage variation from 9 to 6 V

3) Conversion gain, defined as the ratio between the I.F. power in a 10 kΩ load (the total I.F. impedance in the collector lead) and the available R.F. power in the aerial circuit

7Z2 1138

SELF-OSCILLATING MIXER STAGE (continued)

Coil data.

L_1: $5\frac{1}{2}$ turns of 0.25 mm enamelled copper wire, closely wound on coil former with diameter of 7 mm; inductance L = 0.59 µH; unloaded Q-factor Q_o = 100 at f = 15 Mc/s, Q_o = 115 at f = 26 Mc/s

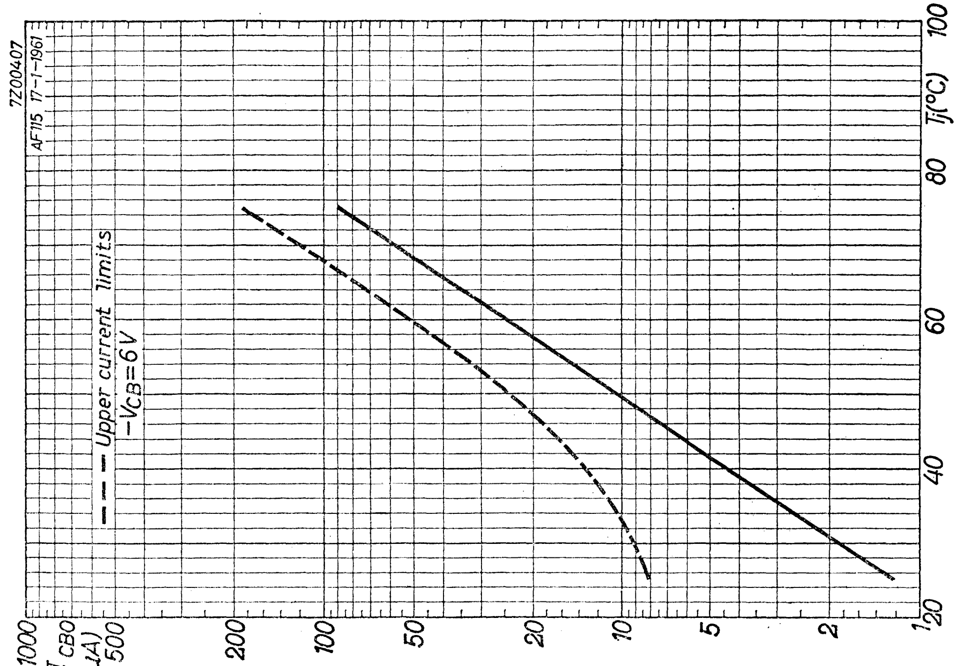
L_2: $1\frac{1}{4}$ turns of 0.25 mm enamelled copper wire, wound in L_4 at earth side

L_3: 1 turn of 0.25 mm enamelled copper wire, wound in L_4 at earth side

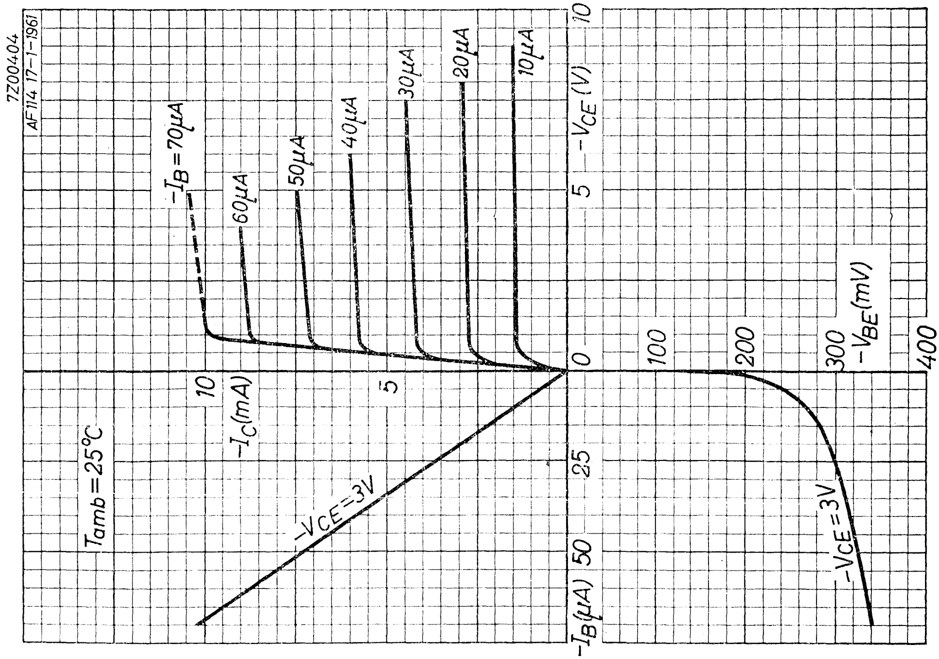
L_4: $6\frac{1}{2}$ turns of 0.9 mm enamelled copper wire, closely wound on coil former with diameter of 7 mm; inductance L = 0.46 µH; unloaded Q-factor Q_o = 110 at f = 15 Mc/s and at f = 26 Mc/s

L_5: Inductance L = 125 µH; unloaded Q-factor Q_o = 140

7Z2 1139
5.5.1962

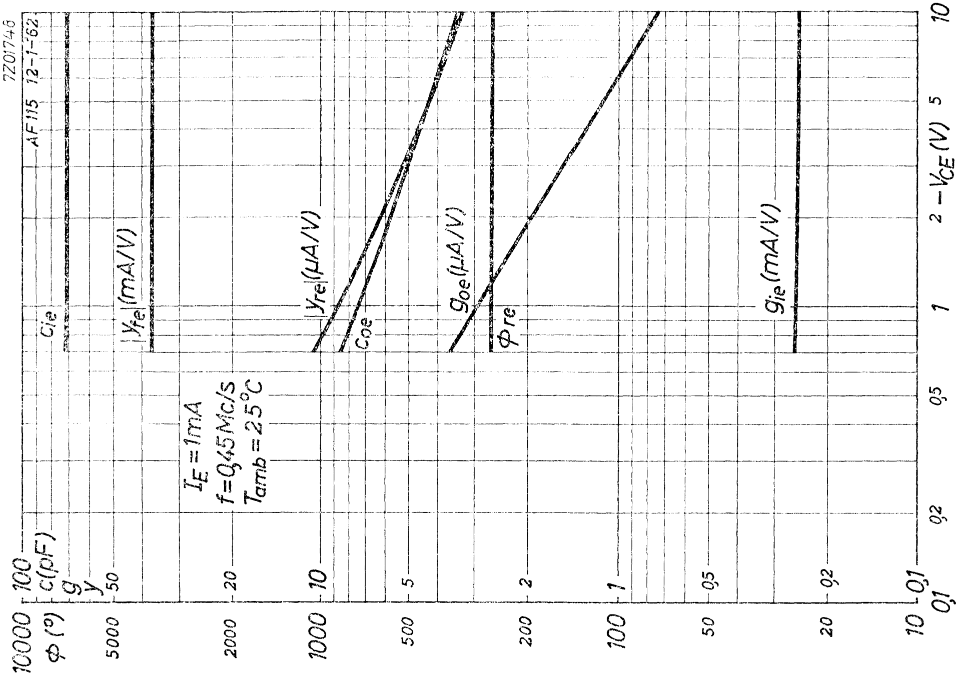

7Z00407
AF115 17-1-1961
Upper current limits
−V_CB=6V
1000
500
200
100
50
20
10
5
2
1
−I_CBO (μA)
20
40
60
80
100
Tj(°C)

B


7Z00404
AF114 17-1-1961
−I_B=70μA
60μA
50μA
40μA
30μA
20μA
10μA
0
5
10
−V_CE (V)
10
5
−I_C(mA)
T_amb=25°C
−V_CE=3V
25
50
−I_B(μA)
100
200
300
400
−V_BE(mV)
−V_CE=3V

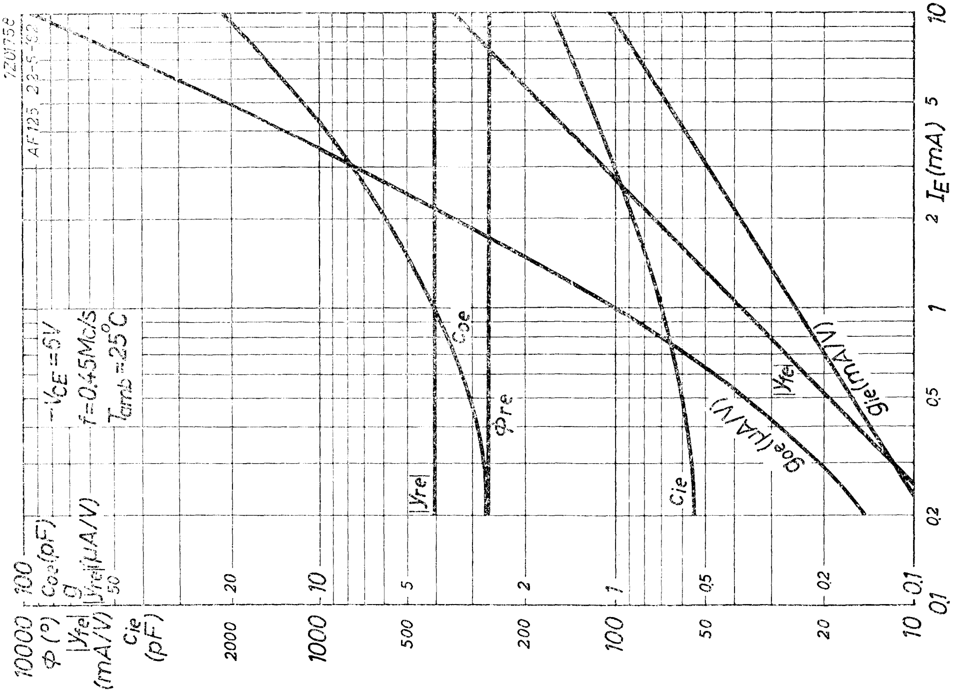
A

AF125



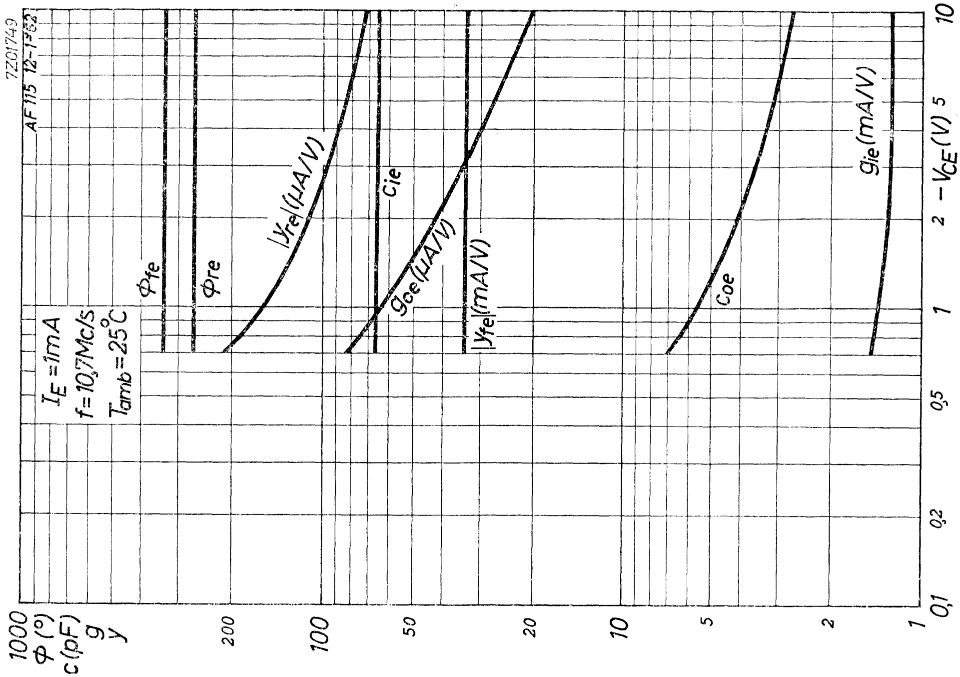
7Z01748 AF115 12-1-62
I_E = 1mA
f = 0,45 Mc/s
T_{amb} = 25°C
$|y_{fe}|$ (mA/V)
$|y_{re}|$ (μA/V)
g_{oe} (μA/V)
g_{ie} (mA/V)
c_{ie}
c_{oe}
φ_{re}
$-V_{CE}$ (V)
10000 φ (°)
100 c (pF) g y

D

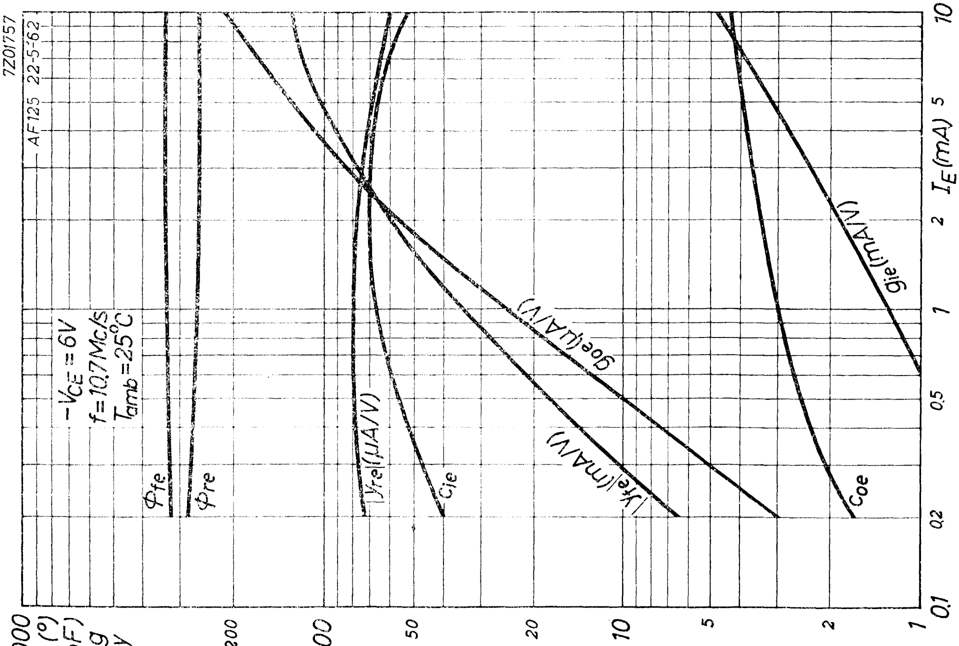


7Z01758 AF125 23-5-62
$-V_{CE}$ = 5V
f = 0,45 Mc/s
T_{amb} = 25°C
I_E (mA)
$|y_{fe}|$
g_{ie} (mA/V)
g_{oe} (μA/V)
$|y_{re}|$
c_{ie}
c_{oe}
φ_{re}
10000 φ (°) $|y_{fe}|$ (mA/V) c_{ie} (pF)
100 c_{oe} (pF) g $|y_{re}|$ (μA/V)

C


7Z01749
AF115 12-1-62
I_E = 1mA
f = 10,7Mc/s
T_{amb} = 25°C
φ_{fe}
φ_{re}
$|y_{re}|(\mu A/V)$
c_{ie}
$g_{oe}(\mu A/V)$
$|y_{fe}|(mA/V)$
c_{oe}
$g_{ie}(mA/V)$
1000
φ (°)
c(pF)
g
y
200
100
50
20
10
5
2
1
0,1
0,2
0,5
1
2
5
10
$-V_{CE}$ (V)

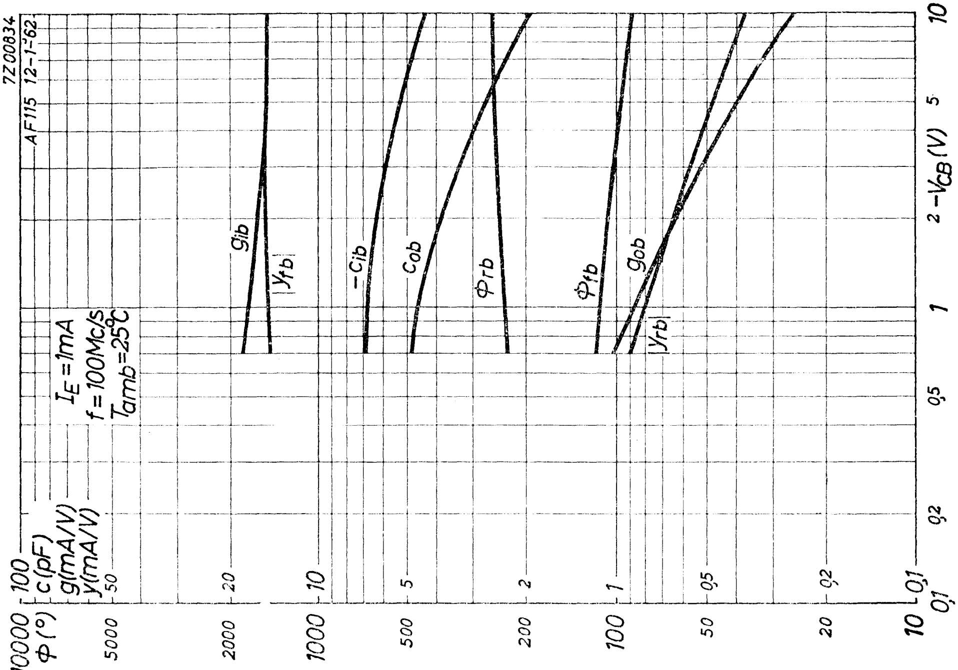
F


7Z01757
AF125 22-5-62
$-V_{CE}$ = 6V
f = 10,7Mc/s
T_{amb} = 25°C
φ_{fe}
φ_{re}
$|y_{re}|(\mu A/V)$
c_{ie}
$|y_{fe}|(mA/V)$
$g_{oe}(\mu A/V)$
$g_{ie}(mA/V)$
c_{oe}
1000
φ (°)
c(pF)
g
y
200
100
50
20
10
5
2
1
0,1
0,2
0,5
1
2
5
10
I_E (mA)

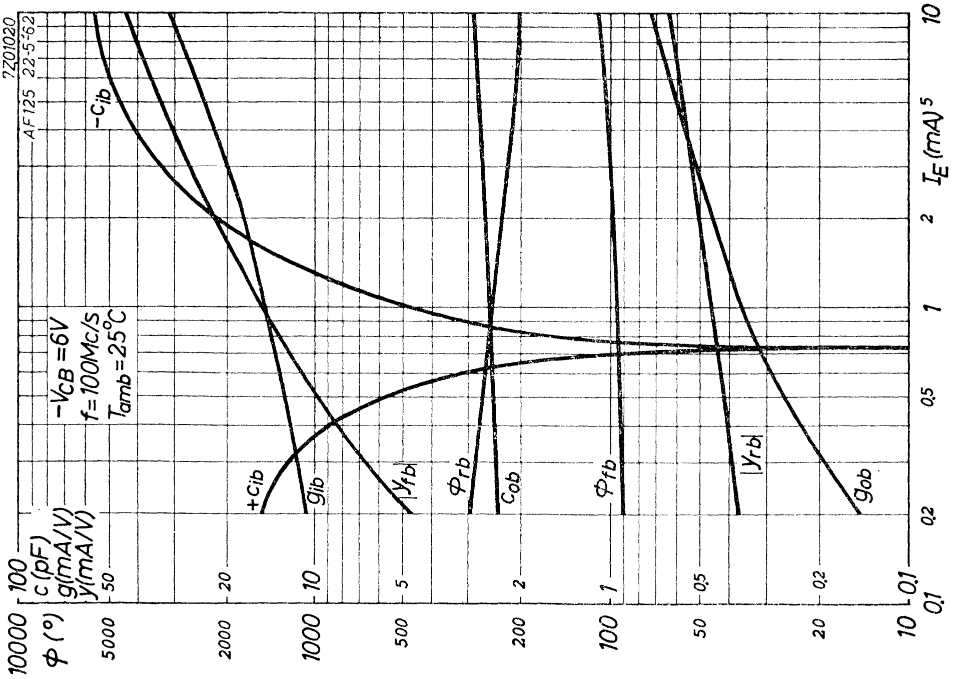
E

5.5.1963

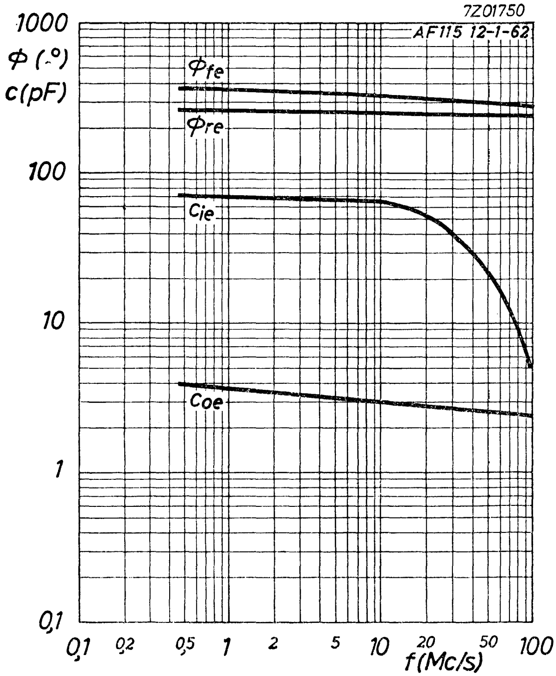
AF125

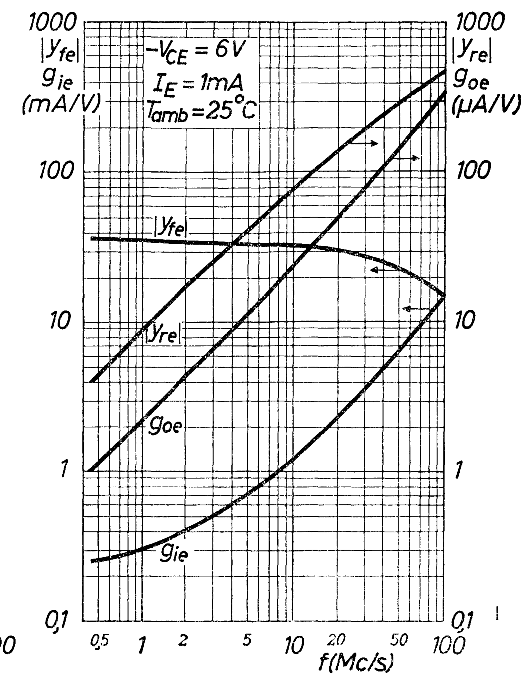

7Z00834
AF115 12-1-62
I_E = 1mA
f = 100Mc/s
T_{amb} = 25°C
Φ (°)
c (pF)
g (mA/V)
y (mA/V)
g_{ib}
$|y_{fb}|$
$-c_{ib}$
c_{ob}
φ_{rb}
φ_{fb}
g_{ob}
$|y_{rb}|$
$-V_{CB}$ (V)

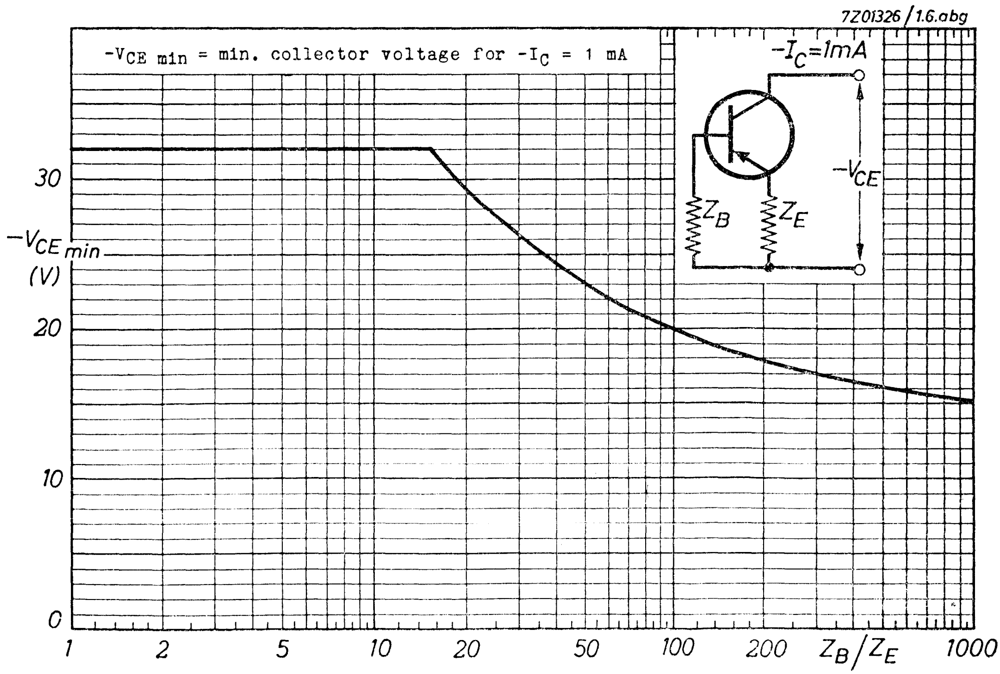
H


7Z01020
AF125 22-5-62
$-V_{CB}$ = 6V
f = 100Mc/s
T_{amb} = 25°C
Φ (°)
c (pF)
g (mA/V)
y (mA/V)
$-c_{ib}$
$+c_{ib}$
g_{ib}
$|y_{fb}|$
φ_{rb}
c_{ob}
φ_{fb}
$|y_{rb}|$
g_{ob}
I_E (mA)

G


7Z01750
AF115 12-1-62
1000
Φ (°)
c (pF)
φfe
φre
Cie
Coe
100
10
1
0,1
0,1 0,2 0,5 1 2 5 10 20 50 100
f (Mc/s)

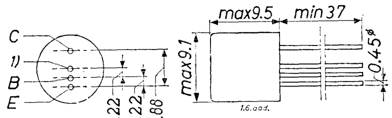

1000
|yfe|
gie
(mA/V)
−VCE = 6V
IE = 1mA
Tamb = 25°C
|yre|
goe
(μA/V)
|yfe|
|yre|
goe
gie
100
10
1
0,1
0,5 1 2 5 10 20 50 100
f (Mc/s)


7Z01326/1.6.abg
−VCE min = min. collector voltage for −IC = 1 mA
−IC=1mA
−VCE
ZB
ZE
30
−VCE min
(V)
20
10
0
1 2 5 10 20 50 100 200 ZB/ZE 1000

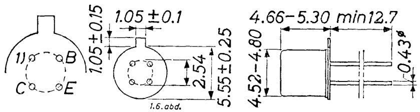
GERMANIUM ALLOY-DIFFUSED TRANSISTOR of the p-n-p type in metal envelope with low output conductance and low collector capacitance at 10.7 Mc/s and with low noise and good A.G.C. performance at high ambient temperatures, for use as I.F. amplifier in A.M. and F.M. receivers and as R.F. amplifier and mixer-oscillator in short-wave receivers up to 16 Mc/s

Dimensions in mm

AF116



AF126



LIMITING VALUES (Absolute max. values)

Collector				
Voltage (base reference)		$-V_{CB}$	= max.	32 V
Voltage (emitter reference)		$-V_{CE}$	= max.	32 V [2]
Current		$-I_C$	= max.	10 mA
Dissipation ($T_{amb} \leq 45\ ^oC$)	AF116	P_C	= max.	75 mW
Dissipation	AF126	P_C	= max.	60 mW
Emitter Reverse current		$-I_E$	= max.	1 mA
Base Current		$\|I_B\|$	= max.	1 mA
Temperatures				
Storage temperature		T_s	=	-55 °C to +75 °C
Junction temperature				
continuous operation		T_j	= max.	75 °C
intermittent operation (total duration max. 200 hrs)		T_j (t	= max. = max.	90 °C 200 hrs)

THERMAL DATA

Thermal resistance from junction to ambience in free air	AF116	K	= max.	0.6 °C/mW
	AF126	K	= max.	0.75 °C/mW
Thermal resistance from junction to case	AF126	K	= max.	0.4 °C/mW

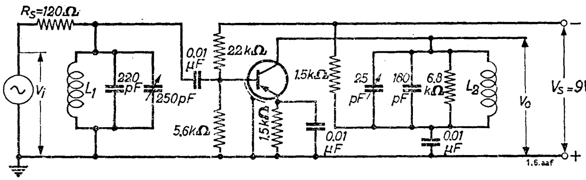
[1]) Interlead shield and metal case

[2]) See also page H

CHARACTERISTICS at T_{amb} = 25 °C

Collector current at I_E = 0 mA		
$-I_{CBO}$ ($-V_{CB}$ = 6 V; I_E = 0 mA)	= 1.2 µA	< 8 µA
Collector voltage at I_E = 0 mA		
$-V_{CB}$ ($-I_C$ = 50 µA; I_E = 0 mA)		> 32 V
Base current		
$-I_B$ ($-V_{CB}$ = 6 V; I_E = 1 mA)	= 7 µA	< 25 µA
Base voltage		
$-V_{BE}$ ($-V_{CB}$ = 6 V; I_E = 1 mA)	= 270 mV	> 210 mV < 330 mV

Test circuit for power gain at 10.7 Mc/s



L_1: inductance L = 0.5 µH; unloaded Q-factor Q_o = 100

L_2: inductance L = 2.47 µH; unloaded Q-factor Q_o = 100

R_S: input source resistance

R_L: total collector resistance = 4.8 kΩ

Available power gain at 10.7 Mc/s in the circuit above

G (f = 10.7 Mc/s) = 25 dB > 19 dB

The available power gain is defined as

$$G = \frac{4R_S}{R_L}\ \frac{V_o^2}{V_i^2} = 0.1\ \frac{V_o^2}{V_i^2}$$

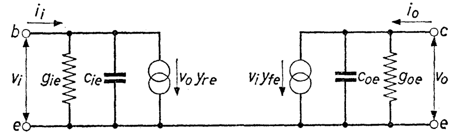
CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN

T_{amb} = 25 °C

Emitter voltage			
$-V_{EB}$ ($-I_E$ = 50 µA; I_C = 0 mA)	= 1.5 V		> 1.0 V
Frequency at which $\|h_{fe}\|$ = 1			
f_1 ($-V_{CB}$ = 6 V; I_E = 1 mA)	= 75 Mc/s		
Intrinsic base impedance			
$\|z_{rb}\|$ ($-V_{CB}$ = 6 V; I_E = 1 mA; f = 2 Mc/s)	= 27 Ω		
Feedback capacitance			
$-c_{re}$ ($-V_{CE}$ = 6 V; I_E = 1 mA; f = 0.45 Mc/s)	= 1.5 pF		
Current amplification factor			
h_{fe} ($-V_{CE}$ = 6 V; I_E = 1 mA; f = 1 kc/s)	= 150		
Noise figure			
F ($-V_{CE}$ = 6 V; I_E = 1 mA; f = 10.7 Mc/s; Input source resistance = 200 Ω)	= 3.0 dB		< 4.5 dB
F ($-V_{CE}$ = 6 V; I_E = 1 mA; f = 1 Mc/s; Input source resistance = 500 Ω)	= 1.5 dB		< 3 dB
Conversion noise figure			
F ($-V_{CE}$ = 6 V; I_E = 1 mA; f = 1 Mc/s; Input source resistance = 500 Ω)	= 3 dB		< 5 dB
F ($-V_{CE}$ = 6 V; I_E = 1 mA; f = 200 kc/s; Input source resistance = 2 kΩ)	= 4 dB		< 7 dB

7Z2 1142 5.5.1962

<u>Small signal parameters</u> measured with a length of lead between transistor bottom and measuring jig of 5 mm



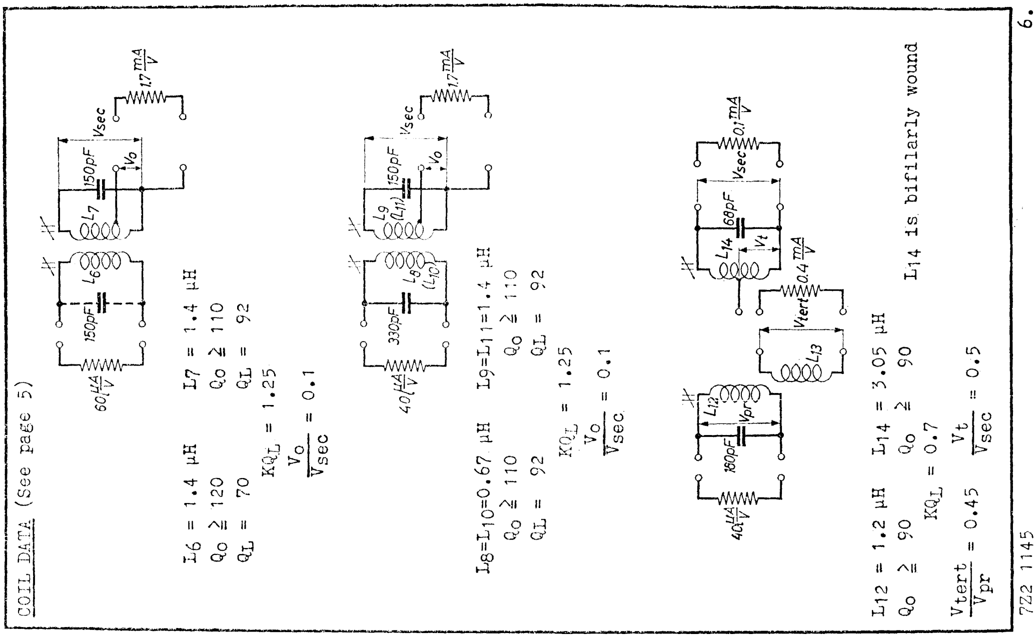
Measured in common emitter circuit at

Collector voltage $-V_{CE}$ = 6 V

Emitter current I_E = 1 mA

Frequency	f = 10.7 Mc/s	f = 0.45 Mc/s
Input conductance	g_{ie} = 1.7 mA/V	g_{ie} = 0.25 mA/V
Input capacitance	c_{ie} = 60 pF	c_{ie} = 70 pF
Feedback admittance	$\|y_{re}\|$ = 0.1 mA/V	$\|y_{re}\|$ = 4.0 µA/V
Phase angle of feedback admittance	φ_{re} = 260 °	φ_{re} = 270°
Transfer admittance	$\|y_{fe}\|$ = 32 mA/V	$\|y_{fe}\|$ = 37 mA/V
Phase angle of transfer admittance	φ_{fe} = 335 °	φ_{fe} = 0 °
Output conductance	g_{oe} = 40 µA/V	g_{oe} = 1.0 µA/V
Output capacitance	c_{oe} = 3.5 pF	c_{oe} = 4.0 pF

7Z2 1143

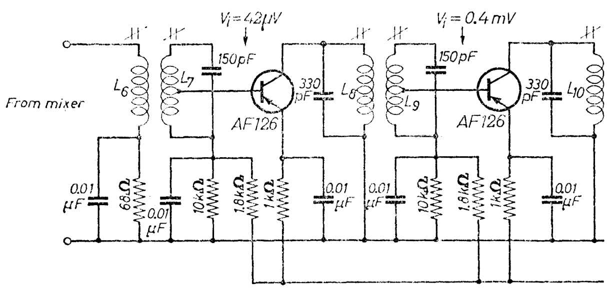


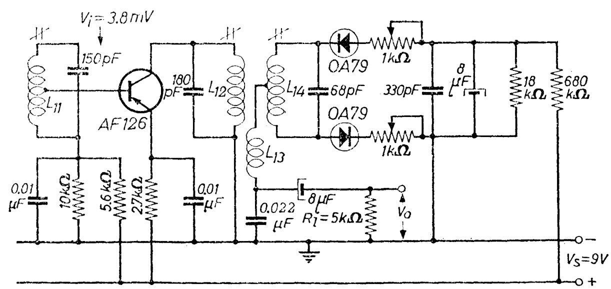
5

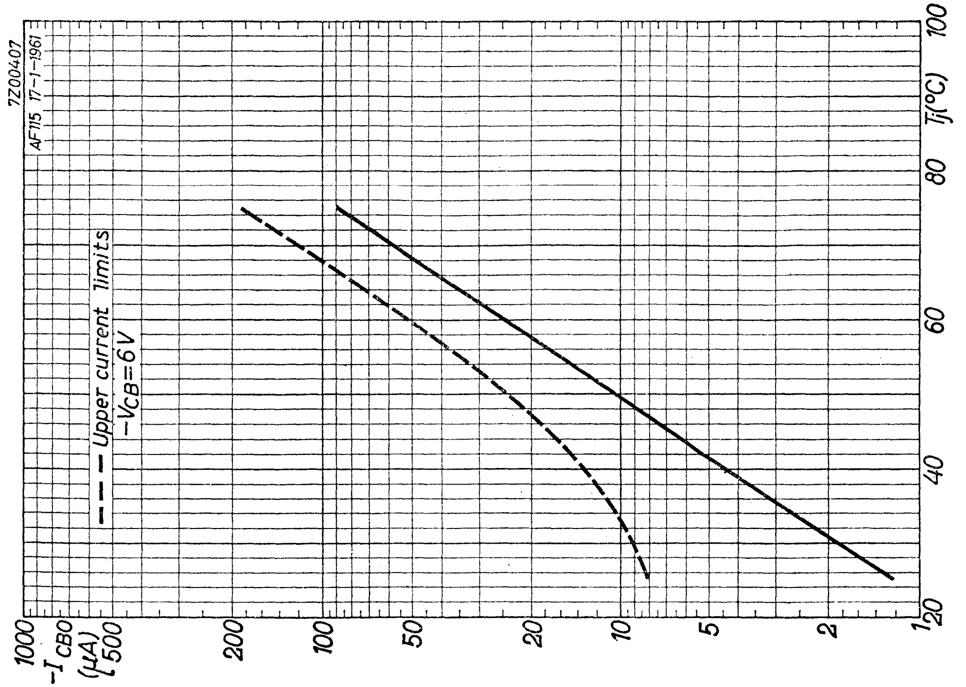
I.F. AMPLIFIER FOR 10.7 Mc/s

I_E of each transistor = 1.0 mA

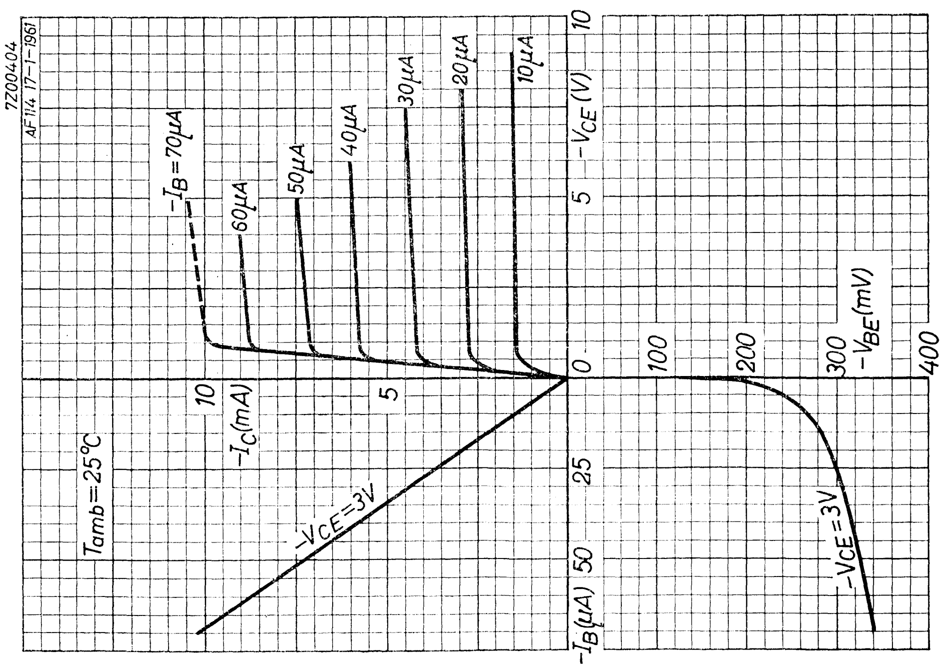
For coil data please refer to page 6



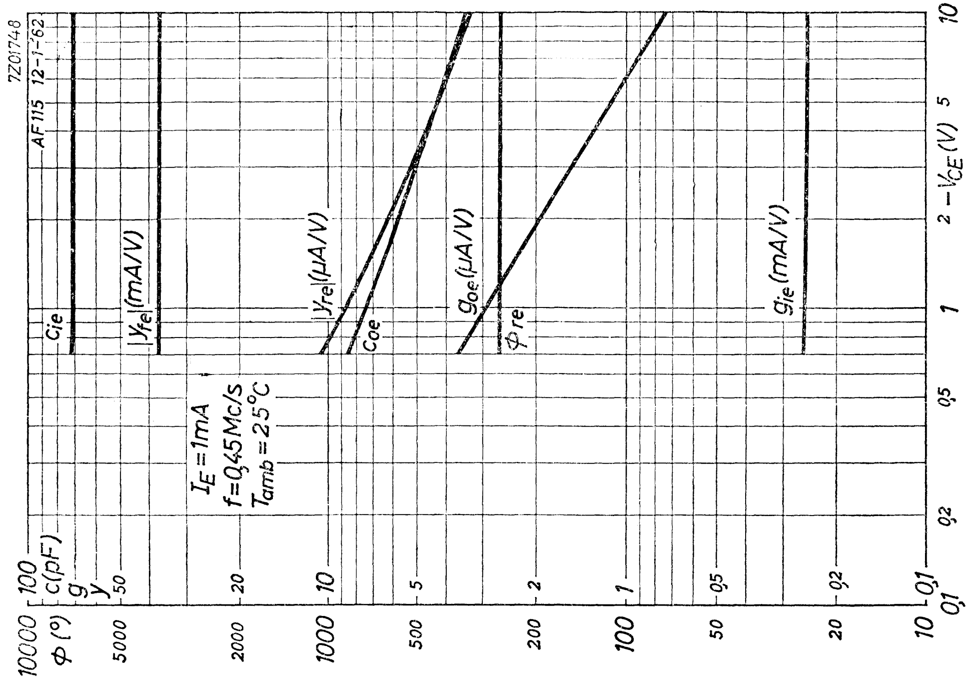



7Z00407
AF115 17-1-1961
Upper current limits
$-V_{CB}=6V$
$-I_{CBO}$ (μA)
1000
500
200
100
50
20
10
5
2
1
20
40
60
80
100
T_j(°C)

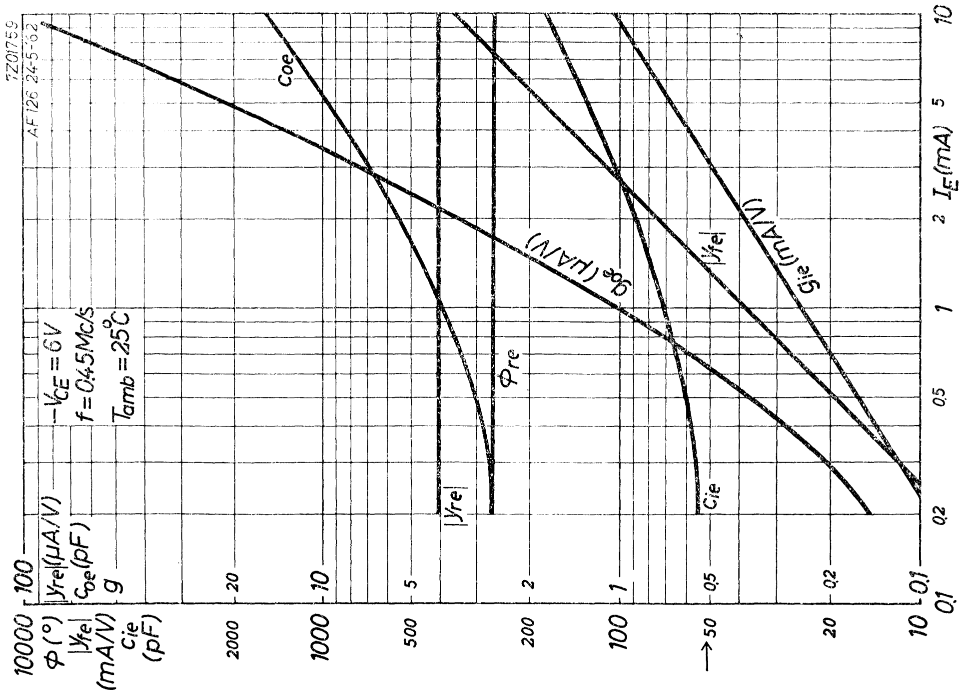
B


7Z00404
AF114 17-1-1961
$T_{amb}=25°C$
$-I_B=70μA$
60μA
50μA
40μA
30μA
20μA
10μA
$-V_{CE}$(V)
0
5
10
$-I_C$(mA)
10
5
25
50
$-I_B$(μA)
$-V_{CE}=3V$
100
200
300
400
$-V_{BE}$(mV)
$-V_{CE}=3V$

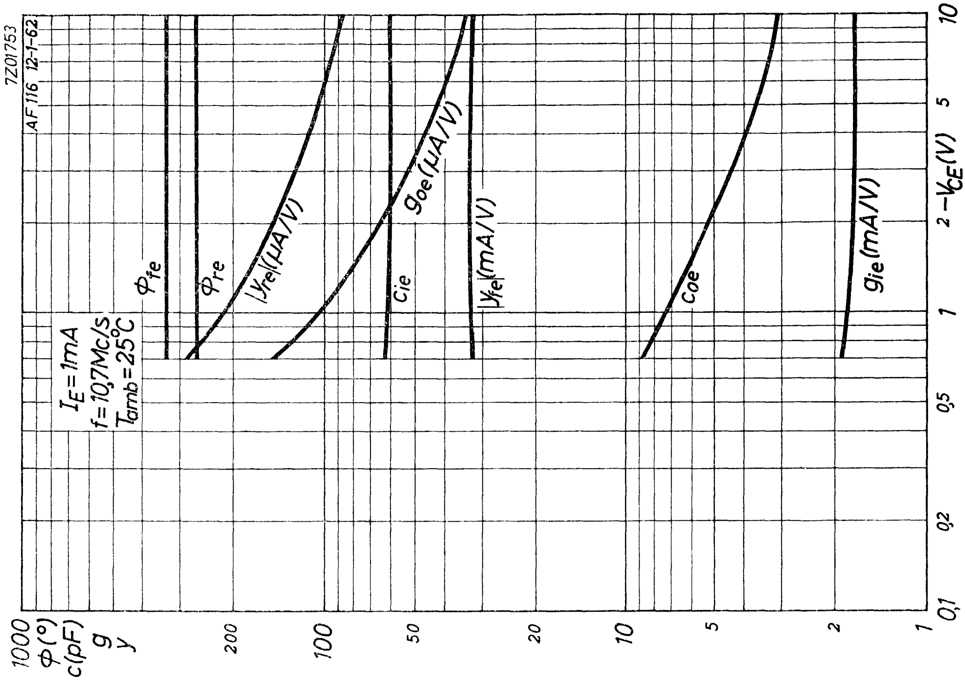
A


7Z01748
AF115 12-1-62
I_E = 1mA
f = 0,45Mc/s
T_{amb} = 25°C
C(pF)
g
y
Φ (°)
C_{ie}
$|y_{fe}|$ (mA/V)
$|y_{re}|$ (μA/V)
C_{oe}
g_{oe} (μA/V)
φ_{re}
g_{ie} (mA/V)
$-V_{CE}$ (V)
10000
5000
2000
1000
500
200
100
50
20
10
100
50
20
10
5
2
1
0,5
0,2
0,1
0,01
0,1
0,2
0,5
1
2
5
10

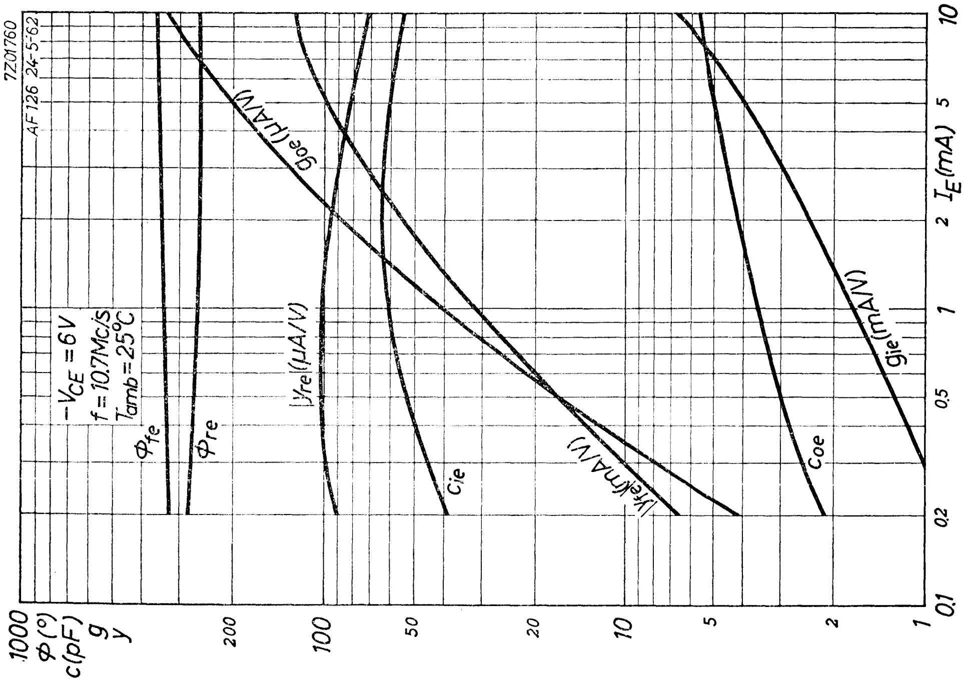
D


7Z01759
AF126 24-5-62
$-V_{CE}$ = 6V
f = 0.45Mc/s
T_{amb} = 25°C
Φ (°)
$|y_{fe}|$ (mA/V)
C_{ie} (pF)
$|y_{re}|$ (μA/V)
C_{oe} (pF)
g
C_{oe}
$|y_{re}|$
φ_{re}
g_{oe} (μA/V)
C_{ie}
$|y_{fe}|$
g_{ie} (mA/V)
I_E (mA)
10000
2000
1000
500
200
100
→50
20
10
100
20
10
5
2
1
0,5
0,2
0,1
0,1
0,2
0,5
1
2
5
10

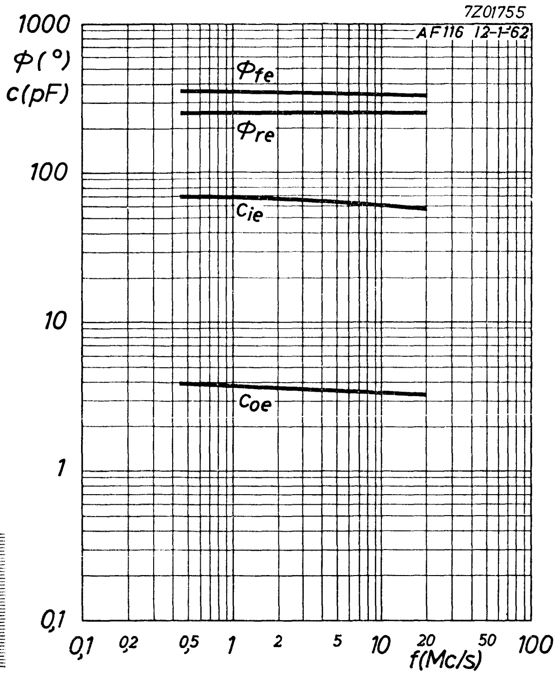
C

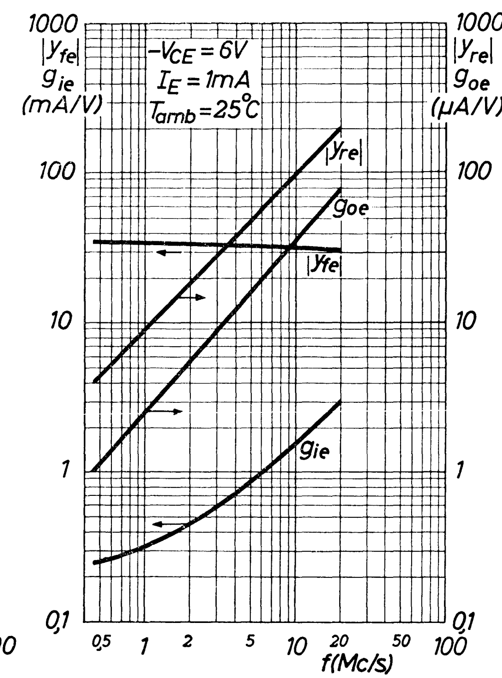

7Z01753
AF 116 12-1-62
I_E = 1mA
f = 10,7Mc/s
T_{amb} = 25°C
φ(°)
c(pF)
g
y
φ_{fe}
φ_{re}
$|y_{re}|(\mu A/V)$
$g_{oe}(\mu A/V)$
c_{ie}
$|y_{fe}|(mA/V)$
c_{oe}
$g_{ie}(mA/V)$
$-V_{CE}(V)$

F

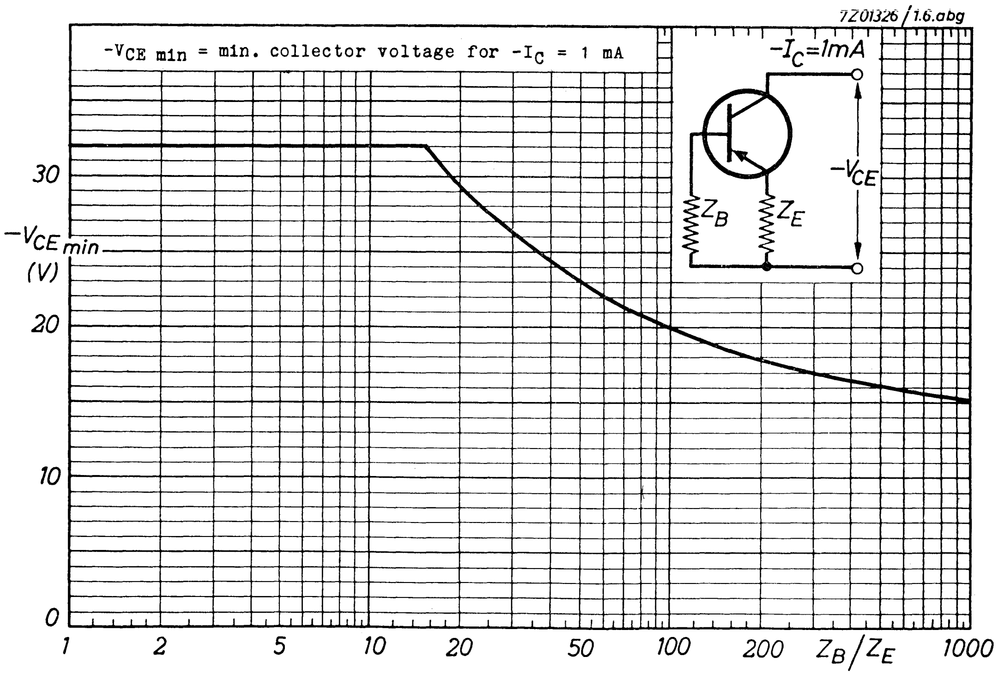

7Z01760
AF 126 24-5-62
$-V_{CE}$ = 6V
f = 10,7Mc/s
T_{amb} = 25°C
φ(°)
c(pF)
g
y
φ_{fe}
φ_{re}
$|y_{re}|(\mu A/V)$
$g_{oe}(\mu A/V)$
c_{ie}
$|y_{fe}|(mA/V)$
c_{oe}
$g_{ie}(mA/V)$
$I_E(mA)$

E


7Z01755
AF116 12-1-'62
1000
φ(°)
c(pF)
φfe
φre
100
Cie
10
Coe
1
0,1
0,1
0,2
0,5
1
2
5
10
20
50
100
f(Mc/s)


1000
|yfe|
gie
(mA/V)
−VCE = 6V
IE = 1mA
Tamb = 25°C
1000
|yre|
goe
(μA/V)
|yre|
goe
|yfe|
gie
100
10
1
0,1
0,5
1
2
5
10
20
50
100
f(Mc/s)

G


7Z01326 / 1.6.abg
-VCE min = min. collector voltage for -IC = 1 mA
−IC=1mA
−VCE
ZB
ZE
−VCE min
(V)
30
20
10
0
1
2
5
10
20
50
100
200
ZB/ZE
1000

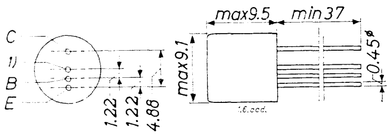
H

5.5.1963

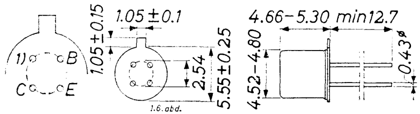
GERMANIUM ALLOY-DIFFUSED TRANSISTOR of the p-n-p type in metal envelope with low collector capacitance, low noise and good A.G.C. performance at high ambient temperatures, for use as I.F. amplifier, R.F. amplifier and oscillator-mixer in A.M. receivers up to 6 Mc/s

Dimensions in mm

AF117



AF127



LIMITING VALUES (Absolute max. values)

Collector				
Voltage (base reference)		$-V_{CB}$	= max.	32 V
Voltage (emitter reference)		$-V_{CE}$	= max.	32 V [2])
Current		$-I_C$	= max.	10 mA
Dissipation ($T_{amb} \leq 45$ °C)	AF117	P_C	= max.	75 mW
Dissipation	AF127	P_C	= max.	60 mW
Emitter Reverse current		$-I_E$	= max.	1 mA
Base Current		$\|I_B\|$	= max.	1 mA
Temperatures				
Storage temperature		T_s	=	-55 °C to +75 °C
Junction temperature				
continuous operation		T_j	= max.	75 °C
intermittent operation (total duration max. 200 hrs)		T_j	= max.	90 °C
		(t	= max.	200 hrs)

THERMAL DATA

Thermal resistance from junction to ambience in free air	AF117	K	= max.	0.6 °C/mW
	AF127	K	= max.	0.75 °C/mW
Thermal resistance from junction to case	AF127	K	= max.	0.4 °C/mW

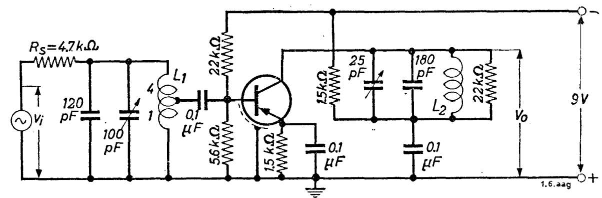
1) Interlead shield and metal case

2) See also page E

CHARACTERISTICS at Tamb = 25 °C

Collector current at I_E = 0 mA		
$-I_{CBO}$ ($-V_{CB}$ = 6 V; I_E = 0 mA)	= 1.2 μA	< 8 μA
Collector voltage at I_E = 0 mA		
$-V_{CB}$ ($-I_C$ = 50 μA; I_E = 0 mA)		> 32 V
Base current		
$-I_B$ ($-V_{CB}$ = 6 V; I_E = 1 mA)	= 7 μA	< 25 μA
Base voltage		
$-V_{BE}$ ($-V_{CB}$ = 6 V; I_E = 1 mA)	= 270 mV	> 210 mV < 330 mV

Test circuit for power gain at f = 0.45 Mc/s



L_1: inductance L = 625 μH; unloaded Q-factor Q_o = 140; tap at t = 0.2

L_2: inductance L = 625 μH; unloaded Q-factor Q_o = 140

R_S: input source resistance

R_L: total collector resistance = 20 kΩ

Available power gain at 0.45 Mc/s in the circuit above

G (f = 0.45 Mc/s) = 42 dB > 40 dB

The available power gain is defined by

$$G = \frac{4R_S}{R_L} \cdot \frac{V_o^2}{V_i^2} = 0.94 \frac{V_o^2}{V_i^2}$$

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN

T_{amb} = 25 °C

Emitter voltage

$-V_{EB}$ ($-I_E$ = 50 µA; I_C = 0 mA) = 1.5 V > 1.0 V

Frequency at which $|h_{fe}|$ = 1

f_1 ($-V_{CB}$ = 6 V; I_E = 1 mA) = 75 Mc/s

Intrinsic base impedance

$|z_{rb}|$ { $-V_{CB}$ = 6 V; I_E = 1 mA; f = 2 Mc/s } = 35 Ω

Feedback capacitance

$-c_{re}$ { $-V_{CE}$ = 6 V; I_E = 1 mA; f = 0.45 Mc/s } = 1.5 pF

Current amplification factor

h_{fe} { $-V_{CE}$ = 6 V; I_E = 1 mA; f = 1 kc/s } = 150

Noise figure

F { $-V_{CE}$ = 6 V; I_E = 1 mA; f = 1 Mc/s; Input source resistance = 500 Ω } = 1.5 dB < 3 dB

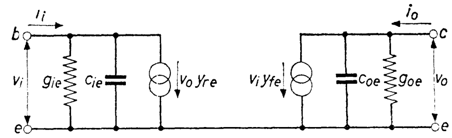
Conversion noise figure

F { $-V_{CE}$ = 6 V; I_E = 1 mA; f = 1 Mc/s; Input source resistance = 500 Ω } = 3 dB < 5 dB

F { $-V_{CE}$ = 6 V; I_E = 1 mA; f = 200 kc/s; Input source resistance = 2 kΩ } = 4 dB < 7 dB

7Z2 1148

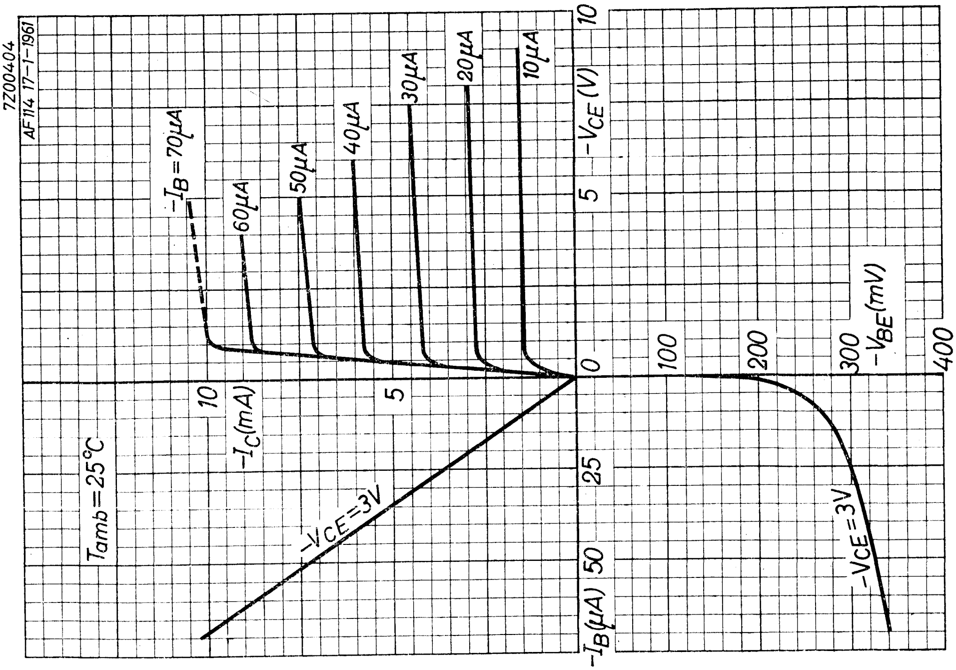
Small signal parameters



Measured in common emitter circuit at

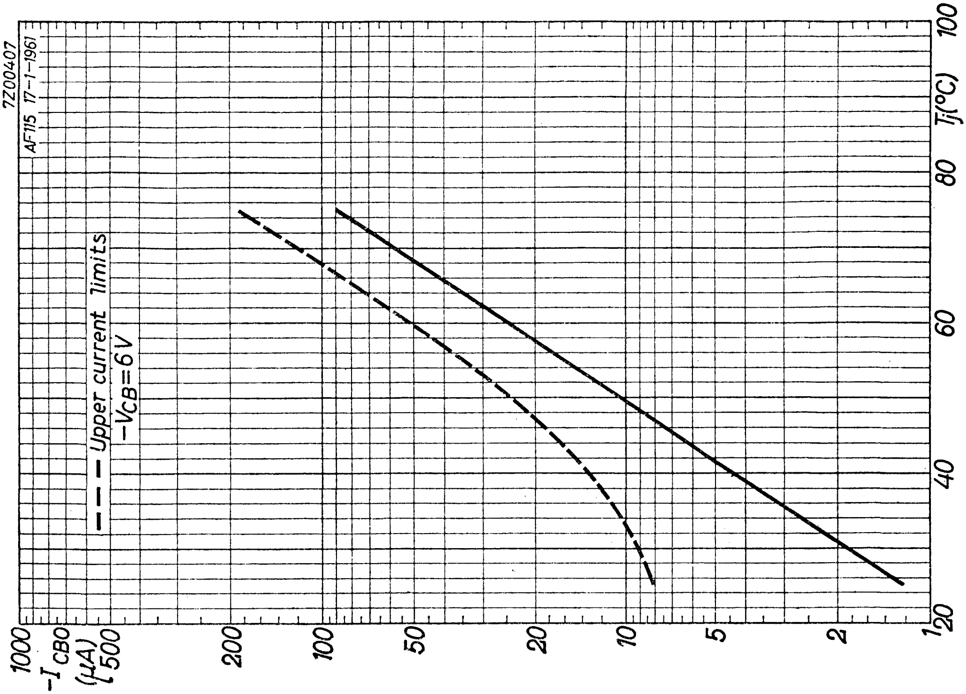
Collector voltage	$-V_{CE}$	= 6 V
Emitter current	I_E	= 1 mA
Frequency	f	= 0.45 Mc/s
Input conductance	g_{ie}	= 0.25 mA/V
Input capacitance	c_{ie}	= 70 pF
Feedback admittance	$\|y_{re}\|$	= 4.0 µA/V
Phase angle of feedback admittance	φ_{re}	= 270 °
Transfer admittance	$\|y_{fe}\|$	= 37 mA/V
Phase angle of transfer admittance	φ_{fe}	= 0 °
Output conductance	g_{oe}	= 1.0 µA/V
Output capacitance	c_{oe}	= 4.0 pF

7Z2 1149



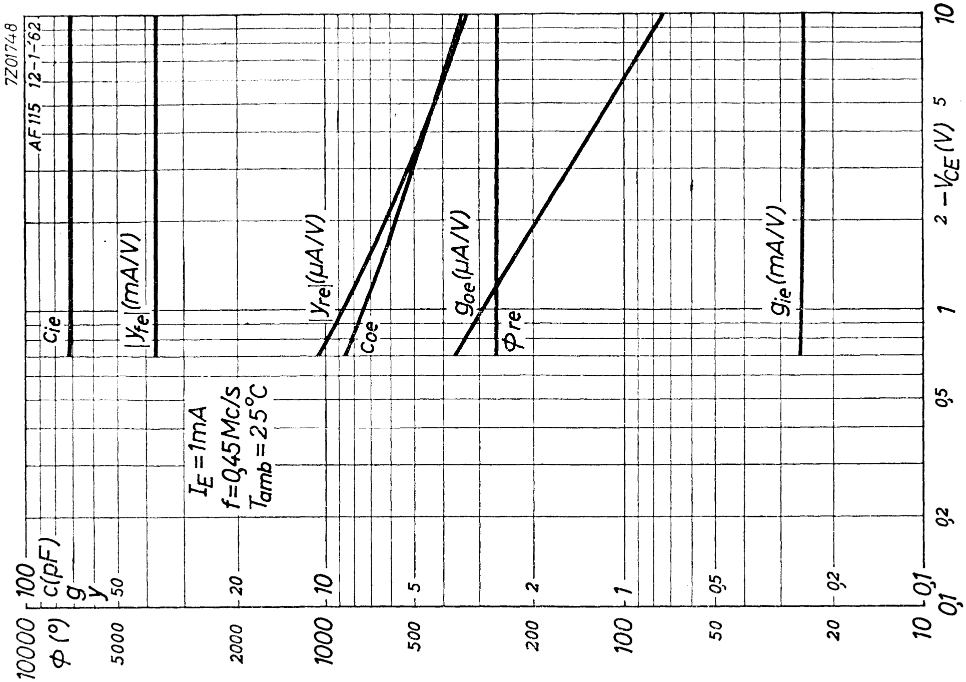
7Z00404
AF114 17-1-1961
$T_{amb}=25°C$
$-I_B=70\mu A$
60μA
50μA
40μA
30μA
20μA
10μA
$-V_{CE}$ (V)
$-I_C$(mA)
$-V_{CE}=3V$
$-I_B(\mu A)$
$-V_{BE}$(mV)
$-V_{CE}=3V$

A

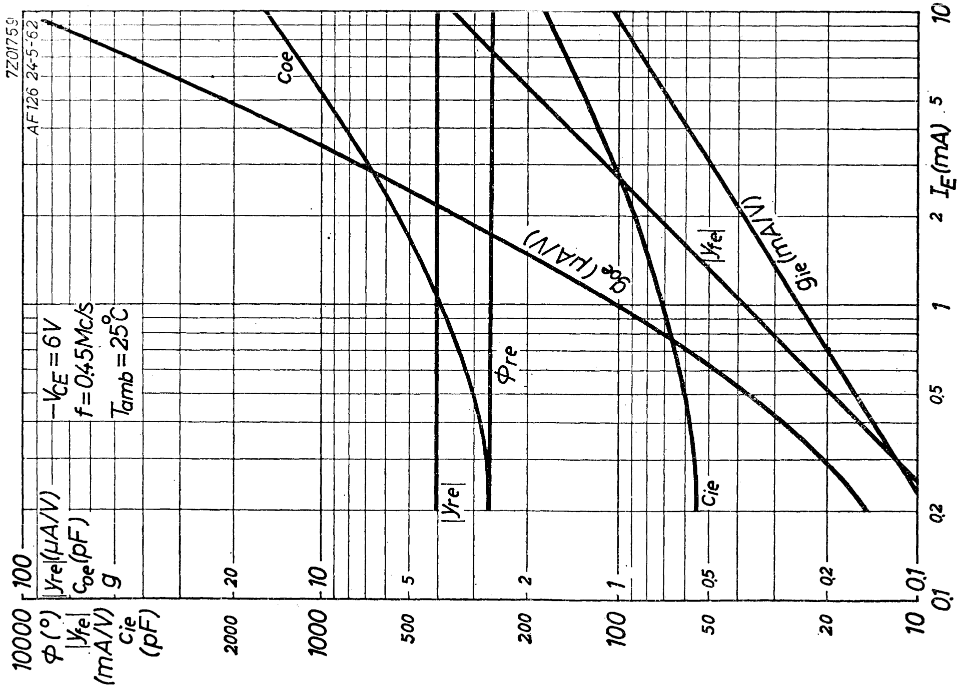


7Z00407
AF115 17-1-1961
Upper current limits
$-V_{CB}=6V$
$-I_{CBO}$ (μA)
T_j(°C)

B

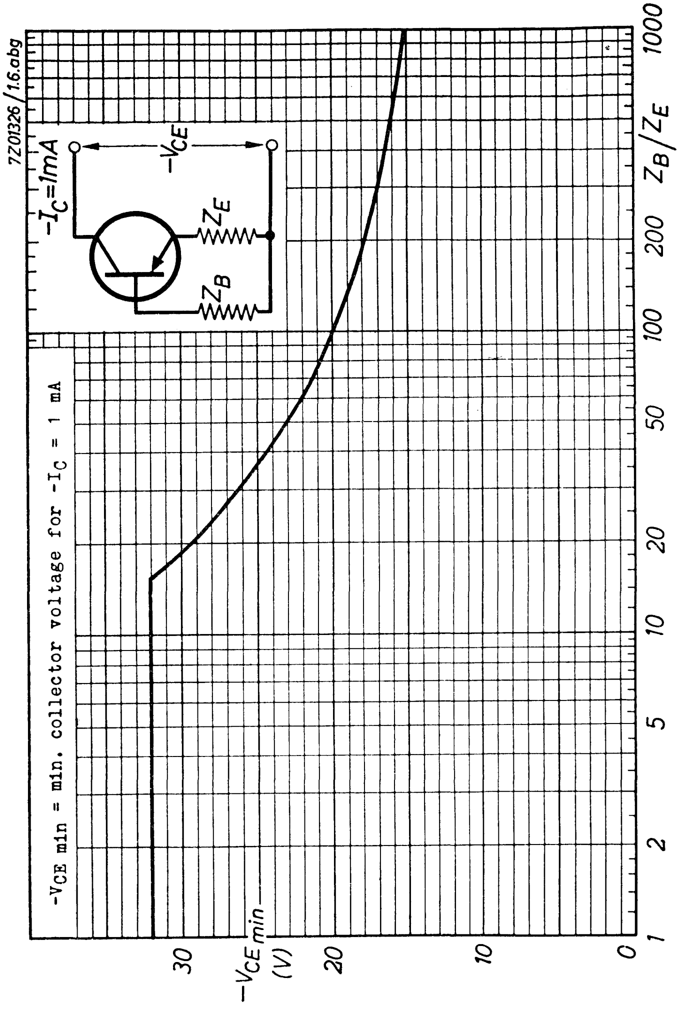

7Z01748
AF115 12-1-'62
Cie
|yfe|(mA/V)
|yre|(μA/V)
Coe
goe(μA/V)
φre
gie(mA/V)
IE=1mA
f=0,45Mc/s
Tamb=25°C
φ (°)
c(pF)
g
y
−VCE(V)

D


7Z01759
AF126 24-5-'62
−VCE=6V
f=0.45Mc/s
Tamb=25°C
Coe
φre
goe(μA/V)
|yfe|
gie(mA/V)
Cie
|yre|
φ (°)
|yfe| (mA/V)
cie (pF)
|yre|(μA/V)
coe(pF)
g
IE(mA)

C

5.5.1963


7Z01326/1.6.abg
$-V_{CE\,min}$ = min. collector voltage for $-I_C$ = 1 mA
$-I_C$=1mA
$-V_{CE}$
Z_E
Z_B
$-V_{CE\,min}$
(V)
30
20
10
0
1
2
5
10
20
50
100
200
1000
Z_B/Z_E

E

12.12.1962

R.F. GERMANIUM ALLOY-DIFFUSED TRANSISTOR

Germanium alloy-diffused transistor of the p-n-p type in a metal case with low noise and high gain up to 260 Mc/s, for use in V.H.F. applications as amplifier-, oscillator- and converter circuits.

LIMITING VALUES (Absolute max. values)

Collector		
Voltage (base reference)	$-V_{CB}$ = max.	25 V
Current	$-I_C$ = max.	10 mA
Emitter		
Reverse current	$-I_E$ = max.	1 mA
Base		
Current	$-I_B$ = max.	1 mA
Dissipation		
Total dissipation at $T_{amb} = 45\ ^oC$	P_{tot} = max.	75 mW
Temperatures		
Storage temperature	T_s =	$-55\ ^oC$ to $+75\ ^oC$
Junction temperature continuous	T_j = max.	75 ^oC
incidentally (total duration max. 200 hrs)	T_j = max. (t = max.	90 ^oC 200 hrs)

THERMAL DATA

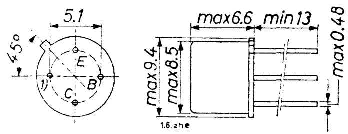
Thermal resistance from junction to ambience in free air	K = max.	0.6 ^oC/mW

7Z2 3044

3.3.1965

1

Dimensions in mm
TO-12 case



CHARACTERISTICS at T_{amb} = 25 ^oC

Collector current at $I_E = 0$			
$-V_{CB}$ = 12 V	$-I_{CBO}$	<	10 μA
$-V_{CB}$ = 25 V	$-I_{CBO}$	<	50 μA
Emitter voltage at $I_C = 0$			
$-I_E$ = 50 μA	$-V_{EB}$	>	0.5 V
Base current			
$-V_{CB}$ = 12 V; $-I_C$ = 1 mA	$-I_B$	<	50 μA
Base voltage			
$-V_{CB}$ = 12 V; $-I_C$ = 1 mA	$-V_{BE}$	>	220 mV
	$-V_{BE}$	<	360 mV

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN

T_{amb} = 25 ^oC

Frequency at which $\lvert h_{fe}\rvert = 1$	
$-V_{CB}$ = 12 V; I_E = 1 mA	f_1 = 180 Mc/s
Base impedance	
$-V_{CB}$ = 12 V; I_E = 1 mA f = 2 Mc/s	$\lvert z_{rb}\rvert$ = 10 Ω
Feedback capacitance	
$-V_{CE}$ = 12 V; $-I_C$ = 1 mA f = 0.45 Mc/s	$-c_{re}$ = **0.8 pF**

1) Shield lead

7Z2 2409

2

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN (continued)

$T_{amb} = 25^oC$

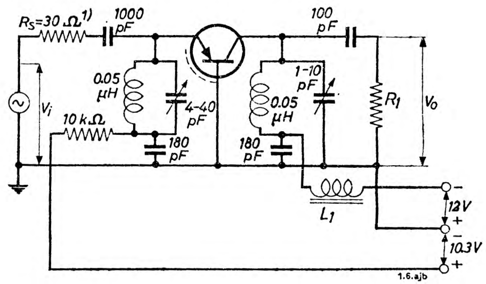
Current amplification factor

$-V_{CE} = 12$ V; $-I_C = 1$ mA f = 1 kc/s	h_{fe}	> 20

Noise figure

$-V_{CE} = 12$ V; $-I_C = 1$ mA f = 200 Mc/s Input source resistance = 30 Ω	F =	6 dB	< 7.5 dB

Test circuit for power gain at 200 Mc/s



R_1 is chosen such that the total impedance R_L of the tuned circuit is 2.0 kΩ.

L_1 = ferrite bead

Available power gain at 200 Mc/s in the circuit above

	G =	13 dB	> 10 dB

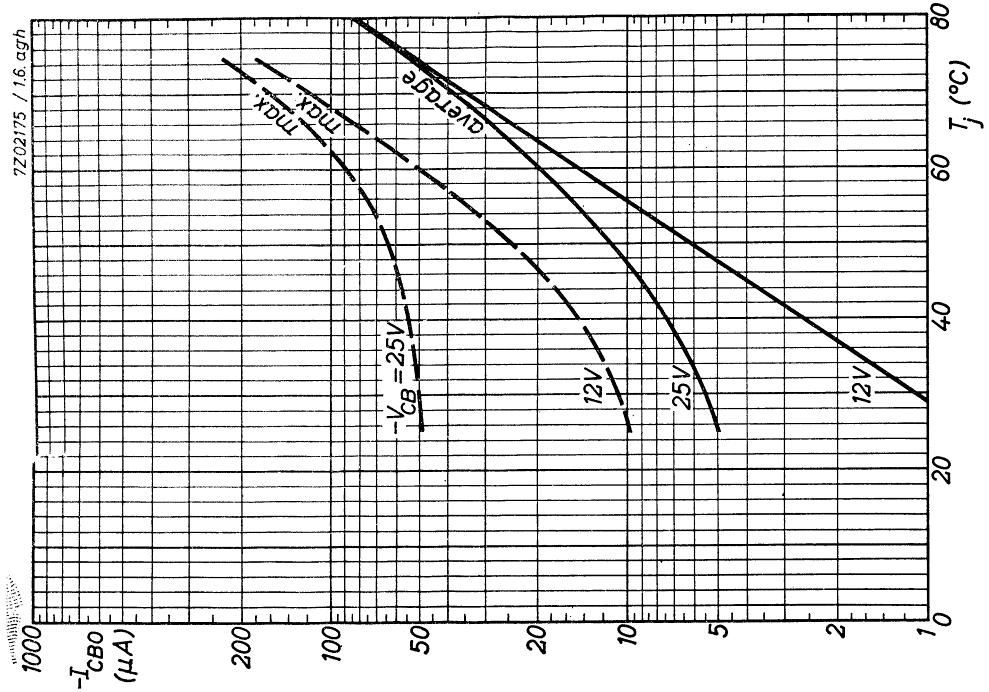
The available power gain is defined as

$$G = \frac{V_o^2}{V_i^2} \cdot \frac{4R_S}{R_L} = 0.06 \frac{V_o^2}{V_i^2}$$

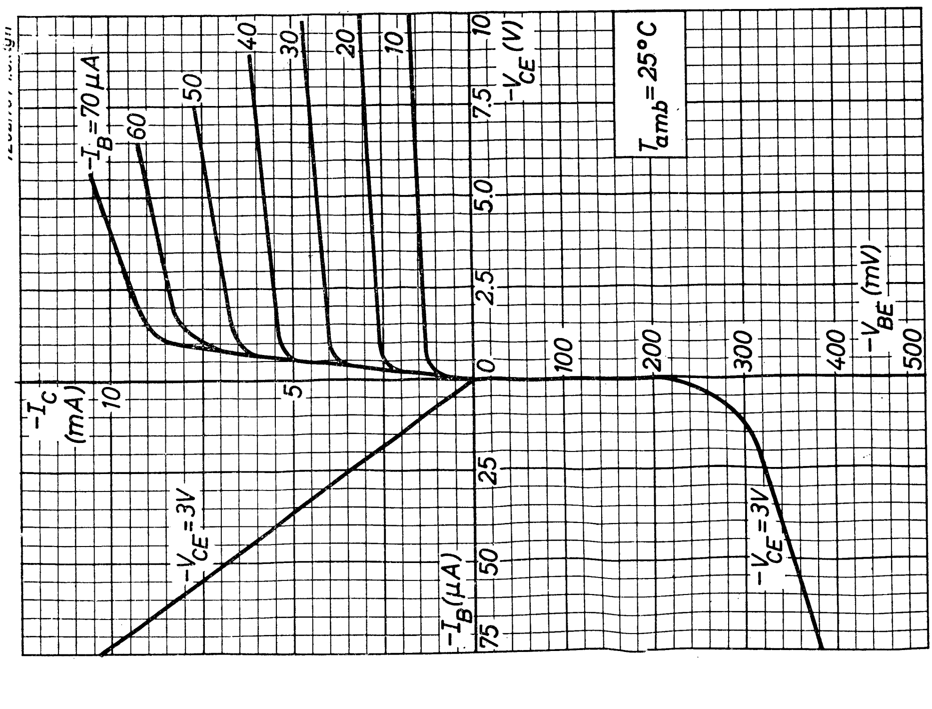
---

1) Input source resistance

7Z2 2410


7Z02175 / 1.6.agh
average
max.
max.
$-V_{CB}$=25V
12V
25V
12V
T_j (°C)
$-I_{CBO}$ (μA)
1000
200
100
50
20
10
5
2
1
0
20
40
60
80

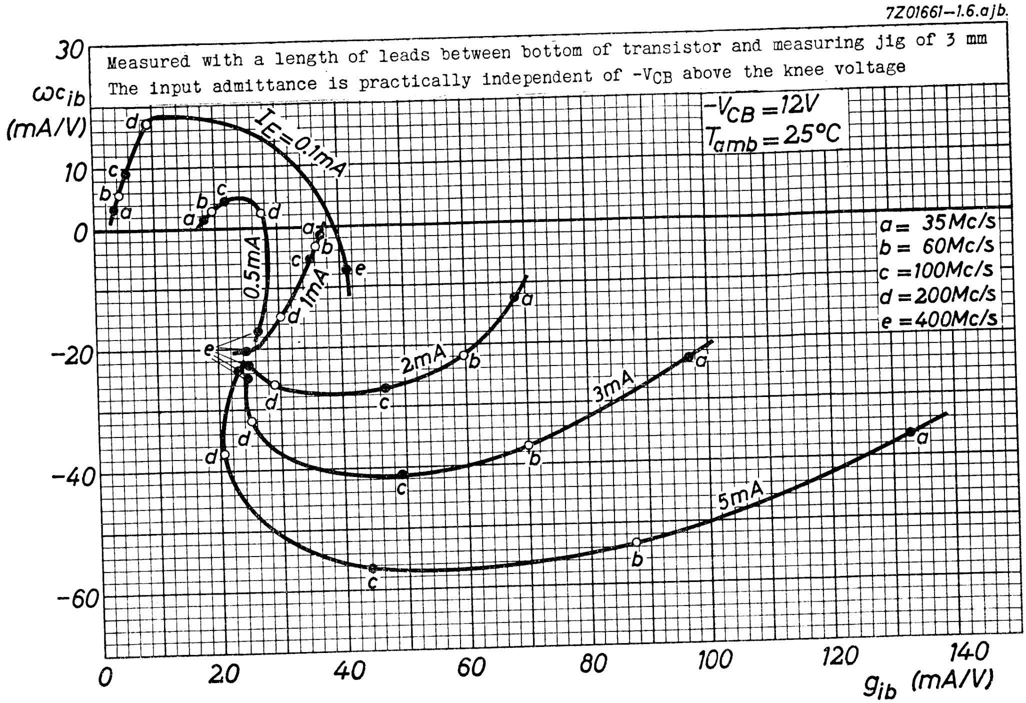
B


$-I_B$=70 μA
60
50
40
30
20
10
$-V_{CE}$ (V)
T_{amb}=25°C
$-I_C$ (mA)
$-V_{BE}$ (mV)
$-I_B$ (μA)
$-V_{CE}$=3V
$-V_{CE}$=3V
10
7.5
5.0
2.5
0
100
200
300
400
500
25
50
75

A

G.6.1964

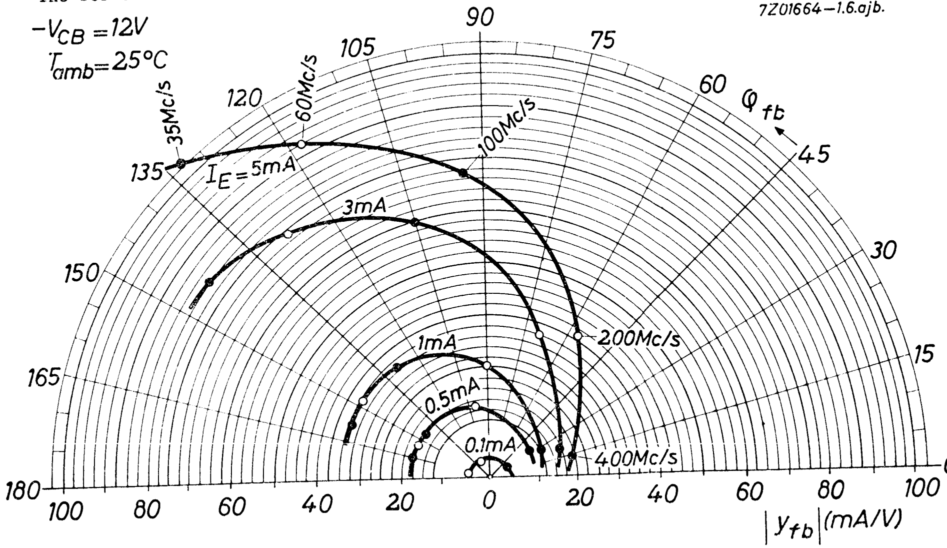
7Z01661-1.6.ajb.



C

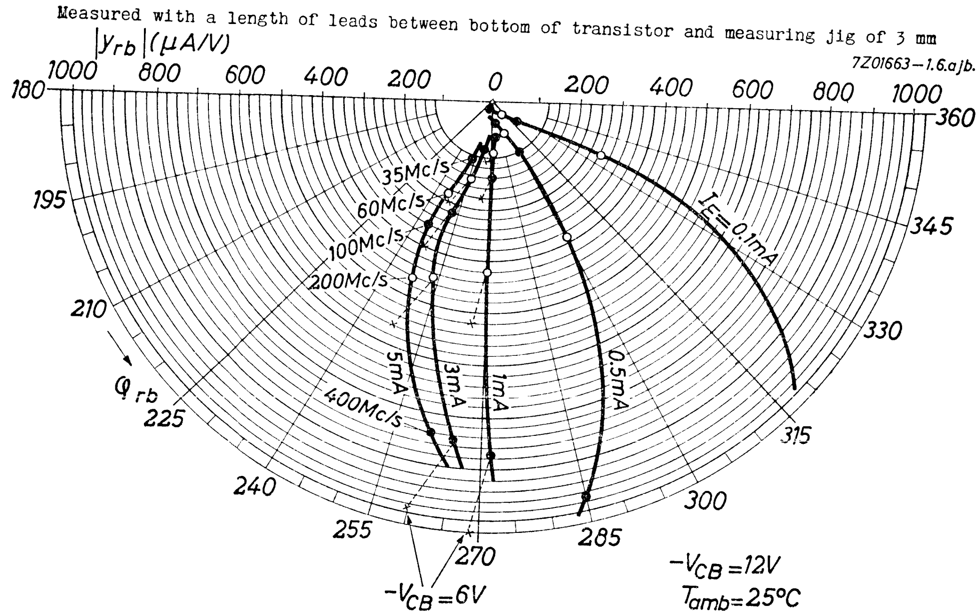
Measured with a length of leads between bottom of transistor and measuring jig of 3 mm
The forward transfer admittance is practically independent of $-V_{CB}$ above the knee voltage

7Z01664-1.6.ajb.



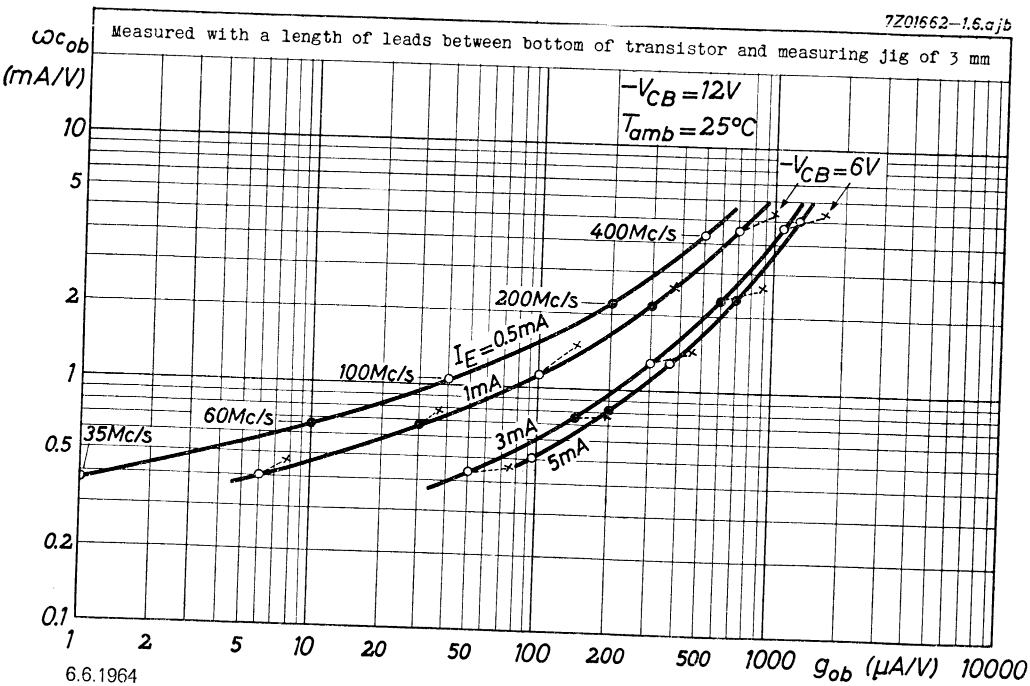
D

6.6.1964



Measured with a length of leads between bottom of transistor and measuring jig of 3 mm
|y_rb| (μA/V)
7Z01663–1.6.ajb.
1000 800 600 400 200 0 200 400 600 800 1000
180 195 210 225 240 255 270 285 300 315 330 345 360
φ_rb
35Mc/s
60Mc/s
100Mc/s
200Mc/s
400Mc/s
5mA
3mA
1mA
0.5mA
I_E = 0.1mA
−V_CB = 6V
−V_CB = 12V
T_amb = 25°C

E



7Z01662–1.6.ajb
Measured with a length of leads between bottom of transistor and measuring jig of 3 mm
ωc_ob (mA/V)
10 5 2 1 0.5 0.2 0.1
−V_CB = 12V
T_amb = 25°C
−V_CB = 6V
400Mc/s
200Mc/s
I_E = 0.5mA
100Mc/s
1mA
60Mc/s
35Mc/s
3mA
5mA
1 2 5 10 20 50 100 200 500 1000 g_ob (μA/V) 10000

F

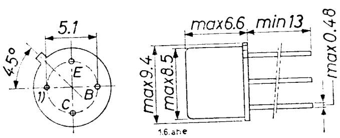
6.6.1964

R.F. GERMANIUM
ALLOY-DIFFUSED TRANSISTOR

R.F. germanium alloy-diffused transistor of the p-n-p type in TO-12 metal case with low leakage current at high temperature and low noise.

Application: R.F. amplifier, mixer-oscillator and I.F. amplifier stages with frequencies up to 27 Mc/s in car radios.

Dimensions in mm



LIMITING VALUES (Absolute limits)

Voltages

Collector to base voltage	$-V_{CB}$	= max.	32 V
Collector to emitter voltage	$-V_{CE}$	= max.	32 V [2])

Currents

Collector current	$-I_C$	= max.	30 mA
Base current	$-I_B$	= max.	1 mA
Emitter reverse current			
continuous	$-I_E$	= max.	1 mA
peak	$-I_{EM}$	= max.	10 mA

Dissipation

Total dissipation	P_{tot}	= max.	120 mW

[1]) Shield lead
2) See also minimum $-V_{CE}$ for $-I_C = 1$ mA at page G

7Z2 2420

LIMITING VALUES (continued)

Temperatures

Storage temperature	T_s	=	−55 °C to +100 °C
Junction temperature			
continuous operation	T_j	= max.	90 °C
incidentally, up to a total of 200 hours	T_j	= max.	100 °C

THERMAL DATA

Thermal resistance from junction to ambience in free air	$K_{j\text{-}amb}$	= max.	0.45 °C/mW

CHARACTERISTICS at $T_{amb} = 25$ °C

Collector leakage current at			
$-V_{CB} = 10$ V; $I_E = 0$ mA	$-I_{CBO}$	= 0.5 μA	< 3 μA
Base current at			
$-V_{CB} = 10$ V; $I_E = 1$ mA	$-I_B$	> 5 μA	< 25 μA

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN at $T_{amb} = 25$ °C

Collector leakage current	$-I_{CBO}$	See page B	
Emitter reverse voltage at			
$-I_E = 50$ μA; $I_C = 0$ mA	$-V_{EB}$	= 1.8 V	> 1.2 V
$-I_E = 1$ mA; $I_C = 0$ mA	$-V_{EB}$	= 2.4 V	> 1.5 V
Base-emitter voltage at			
$-V_{CB} = 10$ V; $I_E = 1$ mA	$-V_{BE}$	= 280 mV	> 220 mV < 340 mV
Feedback capacitance at			
$-V_{CE} = 10$ V; $-I_C = 1$ mA; f = 0.45 Mc/s	$-c_{re}$	=	1.5 pF

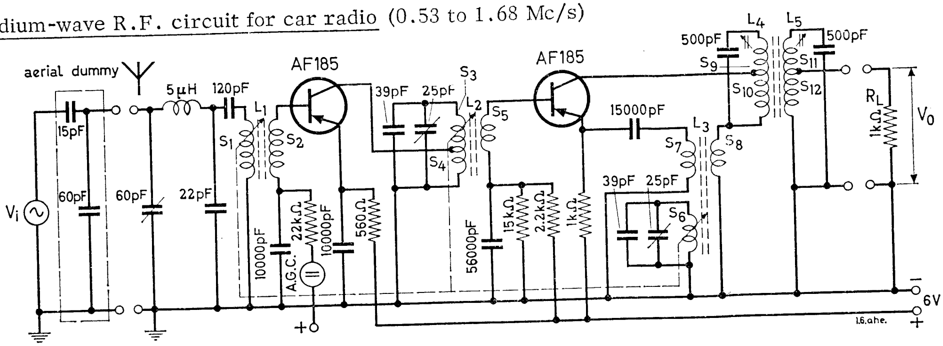
7Z2 2421

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN
at T_{amb} = 25 °C (continued)

Base-emitter input resistance, at				
$-V_{CE}$ = 10 V; $-I_C$ = 1 mA; f = 35 Mc/s	$Re(h_{ic})$	=		30 Ω
Frequency at which $\|h_{fe}\|$ = 1 at				
$-V_{CE}$ = 10 V; $-I_C$ = 1 mA	f_1	=		80 Mc/s
Noise figure at				
$-V_{CE}$ = 10 V; $-I_C$ = 1 mA and:				
f = 0.2 Mc/s; R_S = 200 Ω	F	=	1.5 dB	
f = 1 Mc/s; R_S = 200 Ω	F	=	1.5 dB	
f = 1 Mc/s; R_S = 50 Ω	F	=	3 dB	< 4 dB
f = 10.7 Mc/s; R_S = 300 Ω	F	=	1.5 dB	
Conversion noise figure at				
$-V_{CE}$ = 10 V; $-I_C$ = 1 mA and:				
f = 0.2 Mc/s; R_S = 500 Ω	F_c	=	4.5 dB	< 8 dB
f = 1 Mc/s; R_S = 300 Ω	F_c	=	3 dB	< 5 dB
Small-signal parameters	See pages C, D, E and F			

Remark. The small-signal parameters have been measured with a length of leads of 5 mm between bottom of transistor and measuring jig.

Medium-wave R.F. circuit for car radio (0.53 to 1.68 Mc/s)



Stable continuous operation is insured up to an ambient temperature of 60 °C

D.C. adjustments

Emitter current of R.F. transistor	I_E =	1.0 mA
Emitter current of mixer transistor	I_E =	0.7 mA

Sensitivity at a frequency of 1 Mc/s, a modulation depth of 30% and a noise bandwidth of 4.5 kc/s

at a Signal to noise ratio	S/N =	26 dB	20 dB
Aerial E.M.F.	V_i =	26 µV	13 µV

7Z2 2423

Voltage gain V_o/V_i = 350

4

COIL DATA

Coil No.	L_1	L_2	L_3	L_4	L_5
Measuring frequency	1 Mc/s	1 Mc/s	1.45 Mc/s	0.45 Mc/s	0.45 Mc/s
Inductance	$S_1 = 150\text{-}1500\,\mu H$	$S_3+S_4 = 150\text{-}1500\,\mu H$	$S_6 = 94\text{-}444\,\mu H$	$S_9+S_{10} = 250\,\mu H$	$S_{11}+S_{12} = 250\,\mu H$
Total tuning capacitance	60 pF	60 pF	60 pF	500 pF	500 pF
Q_o	80	80	50	150	150
Tapping ratio	$\frac{V_{S_2}}{V_i} = 0.33$[1]	$\frac{V_{S_4}}{V_{S_3}+V_{S_4}} = 0.14$ $\frac{V_{S_5}}{V_{S_4}} = 0.5$	$\frac{V_{S_8}}{V_{S_6}} = 0.14$ $\frac{V_{S_7}}{V_{S_8}} = 0.14$	$\frac{V_{S_{10}}}{V_{S_9}+V_{S_{10}}} = 0.3$	$\frac{V_{S_{12}}}{V_{S_{11}}+V_{S_{12}}} = 0.07$

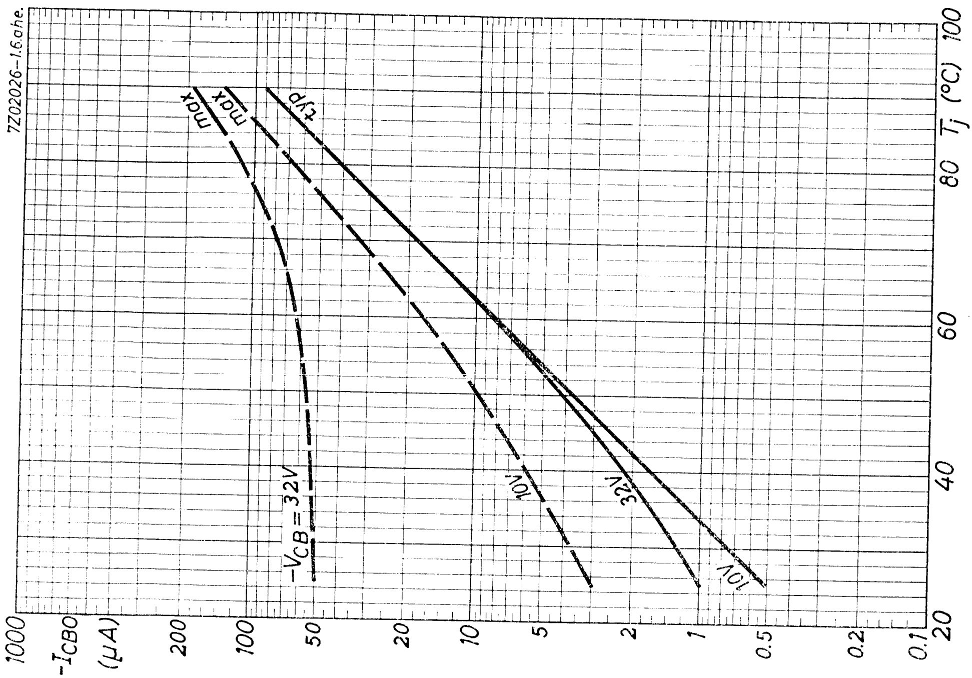
Source impedance across S_2 at 1 Mc/s = 200 Ω

Coupling between L_4 and L_5 : KQ_o = 1.2

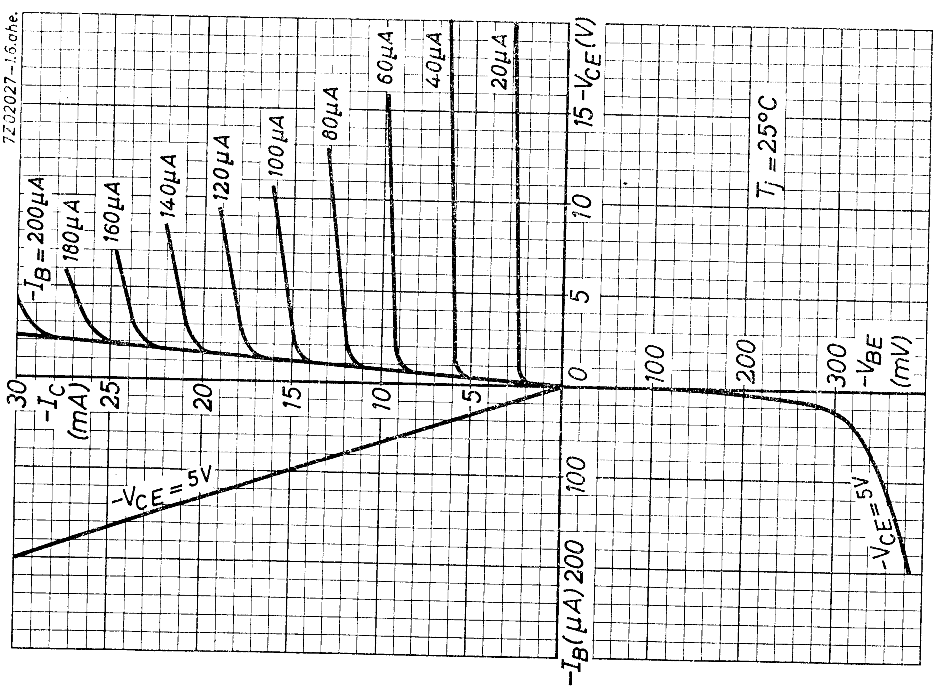
7Z2 2424

5

[1]) Measured without AF185

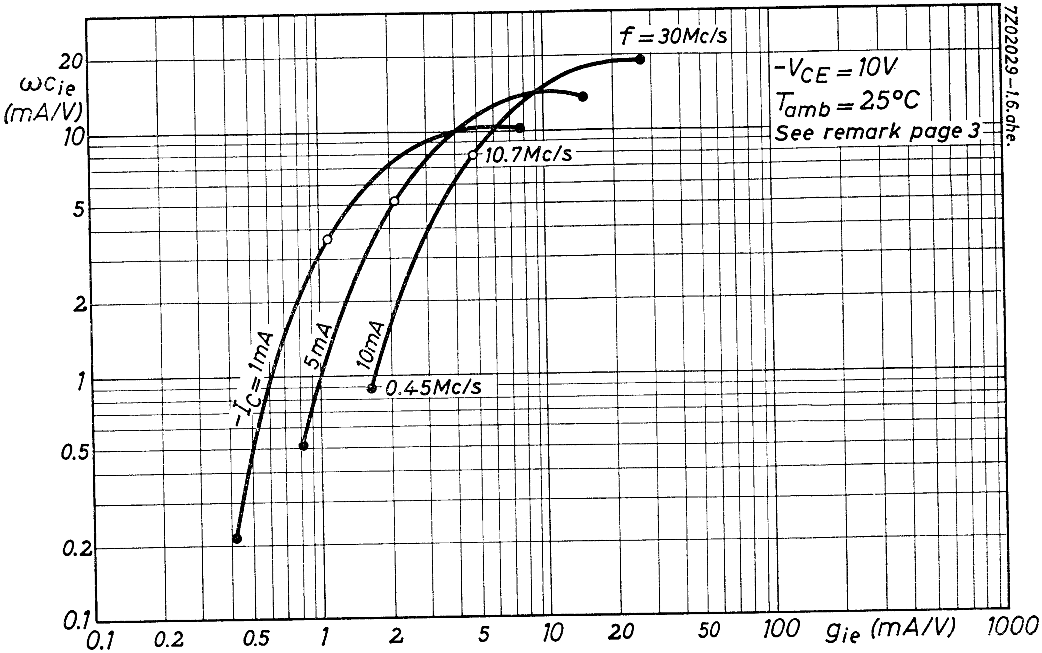

7Z02026-1.6.ahe.
$-I_{CBO}$ (μA)
T_j (°C)
max
max
typ
$-V_{CB}$ = 32V
10V
32V
10V

B

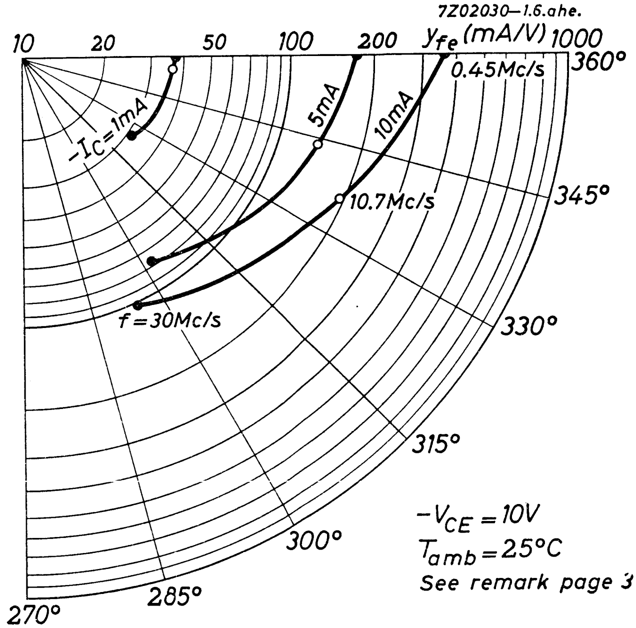

7Z02027-1.5.ahe.
$-I_B$ = 200 μA
180 μA
160 μA
140 μA
120 μA
100 μA
80 μA
60 μA
40 μA
20 μA
$-V_{CE}$ (V)
T_j = 25°C
$-I_C$ (mA)
$-V_{BE}$ (mV)
$-V_{CE}$ = 5V
$-V_{CE}$ = 5V
$-I_B$ (μA)

A

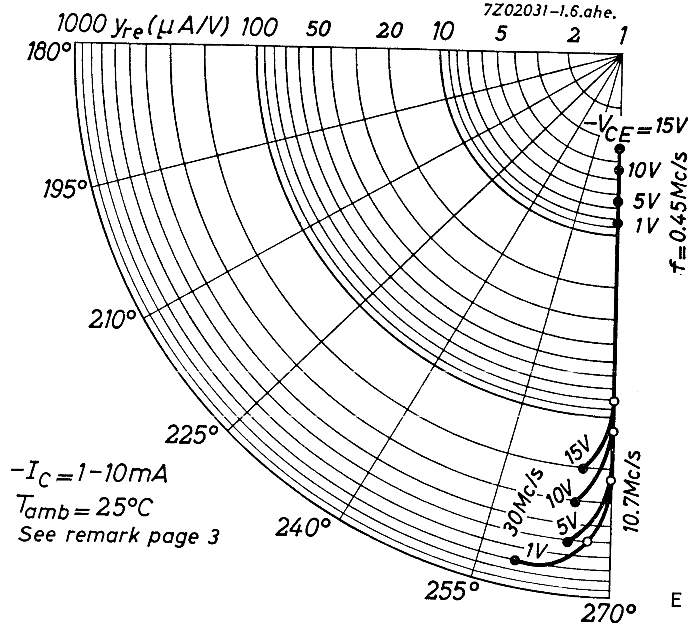
6.6.1964


7Z02029—1.6.ahe.
f = 30Mc/s
$-V_{CE} = 10V$
$T_{amb} = 25°C$
See remark page 3
10.7Mc/s
0.45Mc/s
$-I_C = 1mA$
5mA
10mA
ωc_{ie} (mA/V)
g_{ie} (mA/V)

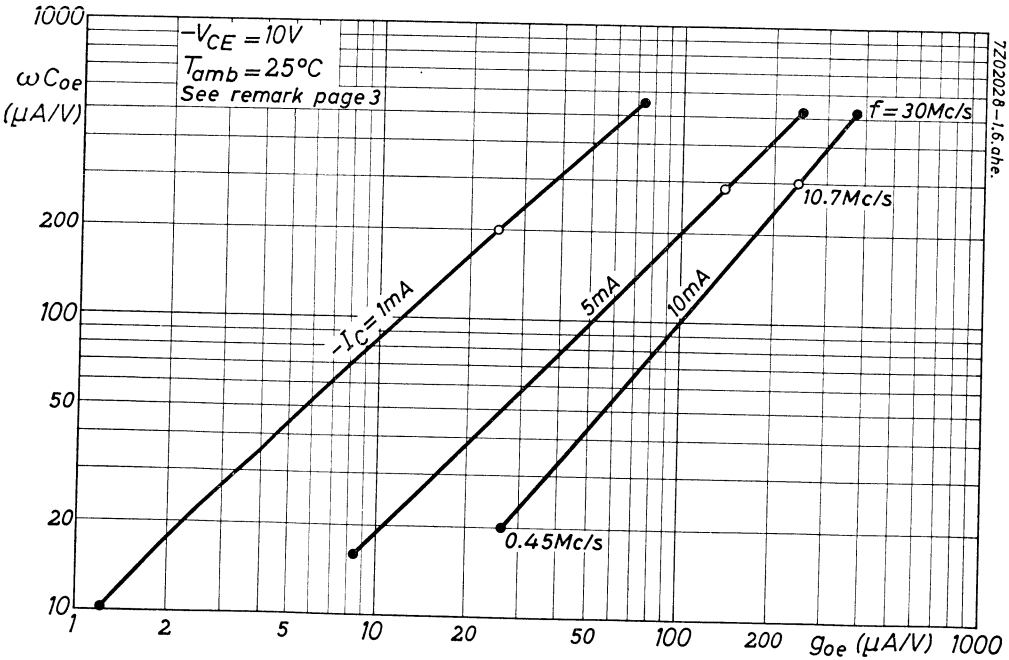
C


7Z02030—1.6.ahe.
y_{fe} (mA/V)
0.45Mc/s
10.7Mc/s
f = 30Mc/s
$-I_C = 1mA$
5mA
10mA
$-V_{CE} = 10V$
$T_{amb} = 25°C$
See remark page 3

D

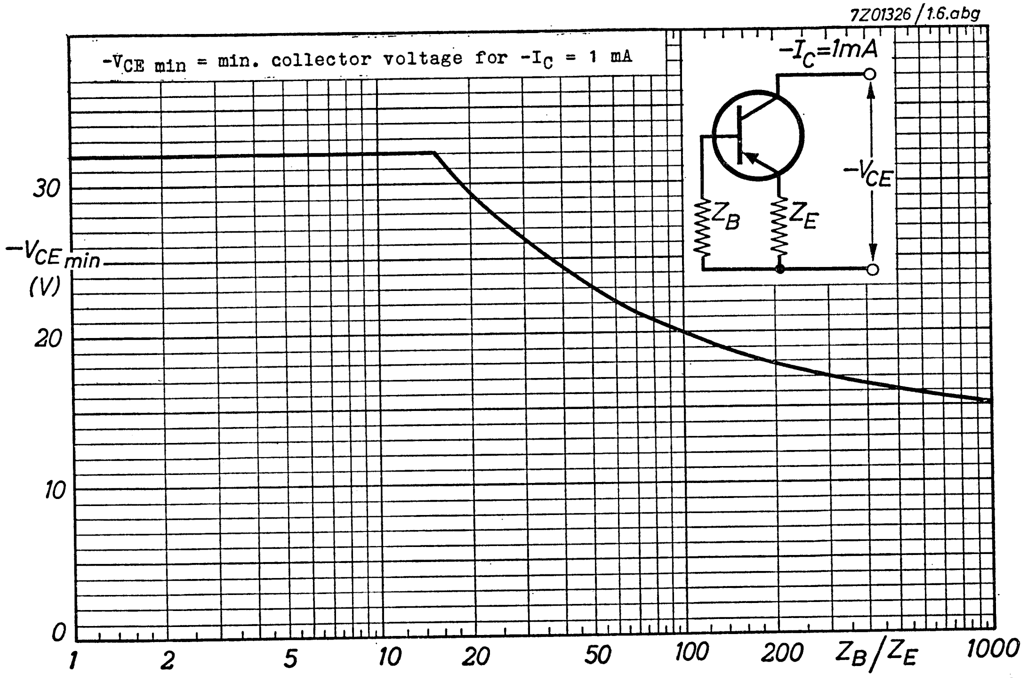

7Z02031-1.6.ahe.
1000 y_{re} (µA/V) 100 50 20 10 5 2 1
180°
195°
210°
225°
240°
255°
270°
$-V_{CE}$ = 15V
10V
5V
1V
f = 0.45Mc/s
15V
10V
5V
1V
30Mc/s
10.7Mc/s
$-I_C$ = 1–10mA
T_{amb} = 25°C
See remark page 3

E


7Z02028-1.6.ahe.
1000
ωCoe
(µA/V)
200
100
50
20
10
1
2
5
10
20
50
100
200
goe (µA/V)
1000
$-V_{CE}$ = 10V
T_{amb} = 25°C
See remark page 3
$-I_C$ = 1mA
5mA
10mA
f = 30Mc/s
10.7Mc/s
0.45Mc/s

F

6.6.1964


7Z01326/1.6.abg
-V_CE min = min. collector voltage for -I_C = 1 mA
-I_C=1mA
-V_CE
Z_B
Z_E
30
-V_CE min
(V)
20
10
0
1
2
5
10
20
50
100
200
Z_B/Z_E
1000

V.H.F. alloy-diffused germanium transistor of the p-n-p type in TO-39 metal case for use as a power amplifier in transmitters with frequencies up to 180 Mc/s

LIMITING VALUES (Absolute max. limits)

Collector

Voltage (base reference)	$-V_{CB}$ = max.	32 V
Voltage (emitter reference)	$-V_{CE}$ = max.	32 V 1)
Peak current	$-I_{CM}$ = max.	300 mA
Continuous current	$-I_C$ = max.	150 mA

Emitter

Peak current	I_{EM} = max.	350 mA
Continuous current	I_E = max.	200 mA
Peak reverse current	$-I_{EM}$ = max.	30 mA
Continuous reverse current	$-I_E$ = max.	10 mA

Dissipation

Total dissipation	P_{tot} = max.	800 mW 2)

Temperatures

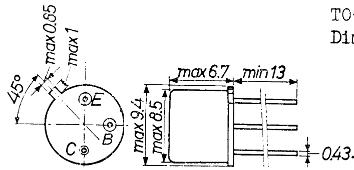
Storage temperature	T_S =	-55 °C to +75 °C
Junction temperature		
continuous operation	T_j = max.	90 °C
incidentally, up to a total of 200 hrs	T_j = max.	100 °C

THERMAL DATA

Thermal resistance from junction to ambience		
in free air	K <	0.25 °C/mW
mounted on heat sink of at least 12.5 cm^2	K <	0.08 °C/mW
Thermal resistance from junction to case	K <	0.035 °C/mW

1) At $-I_C$ = 1 mA and V_{BE} = 0 V

2) The max. incidental junction temperature of 100 °C may also be reached by a peak dissipation of 1000 mW.



TO-39 case
Dimensions in mm

The collector is electrically connected to the case.

Accessories for insulated mounting can be delivered separately (type number 56218).

CHARACTERISTICS at T_{amb} = 25 °C

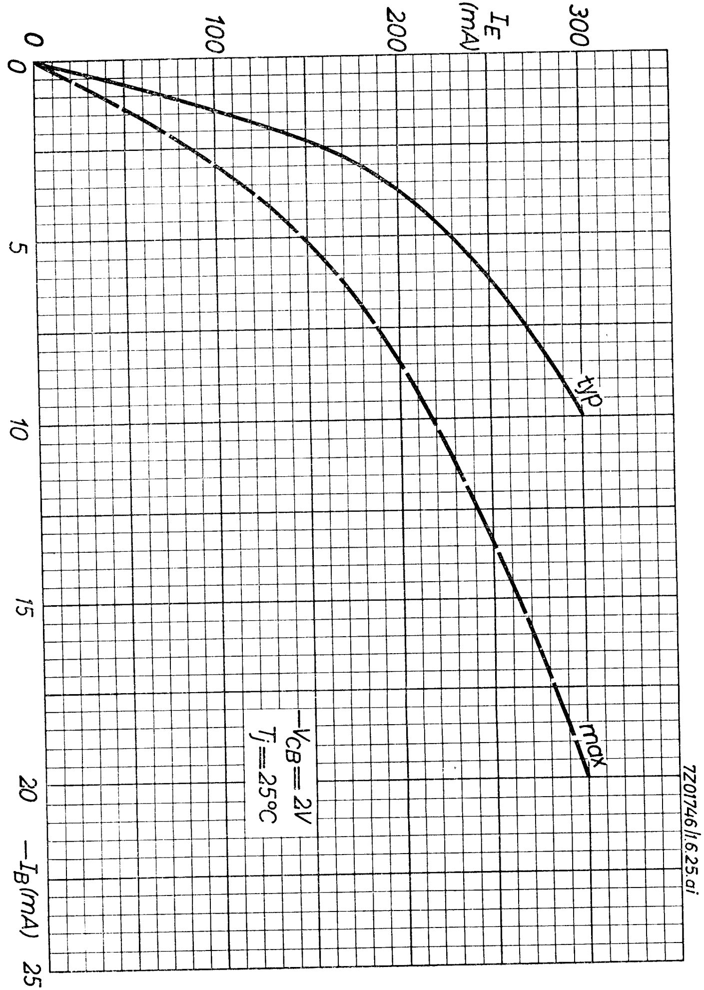
Collector leakage current at			
$-V_{CB}$ = 10 V; I_E = 0 mA	$-I_{CBO}$	<	10 μA
$-V_{CB}$ = 32 V; I_E = 0 mA	$-I_{CBO}$	<	1 mA
Emitter leakage current at			
$-V_{EB}$ = 0.5 V; I_C = 0 mA	$-I_{EBO}$	<	1 mA
Base current at			
I_E = 100 mA; V_{CB} = 2 V	$-I_B$	<	3 mA

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN

T_{amb} = 25 °C

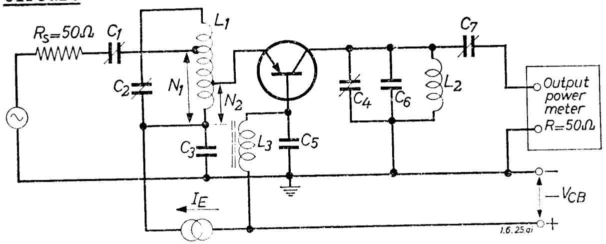
Collector leakage current	$-I_{CBO}$	See page E	
Base current at			
I_E = 80 mA; $-V_{CB}$ = 12 V	$-I_B$	= 1	< 2 mA
Collector saturation voltage at			
$-I_C$ = 300 mA; $-I_B$ = 20 mA	$-V_{CE}$		< 1 V
Frequency at which $\|h_{fe}\|$ = 1 at			
I_E = 100 mA; $-V_{CB}$ = 5 V	f_1	= 350	> 225 Mc/s
Base-emitter input resistance, output short-circuited for H.F. at			
I_E = 100 mA; $-V_{CB}$ = 5 V; f = 100 Mc/s	r_{ie}	= 18	Ω
Collector capacitance at			
$-V_{CB}$ = 10 V; I_E = 0 mA; f = 0.5 Mc/s	c_c	= 12	pF

A



OPERATING CHARACTERISTICS as V.H.F. power amplifier at Tamb = 25°C

Circuit



f	= 80	180 Mc/s
C_1	= 50	15 pF
C_2	= 50	15 pF
C_3	= 10	1 nF
C_4	= 50	15 pF
C_5 1)	= 10	0.12 nF
C_6	= 82	0 pF
C_7	= 100	15 pF

f	= 80	180 Mc/s
L_1	= 0.1	0.08 μH
L_2	= 0.03	0.02 μH
L_3	= H.F.choke	
N_1/N_{tot}	= 1	0.5
N_2/N_{tot}	= 0.5	0.22
Q_1	> 150	>200
Q_2	> 150	>200

Characteristics

Output power and available power gain at

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

f = 80 Mc/s { P_o > 500 mW; G > 10 dB 2) }

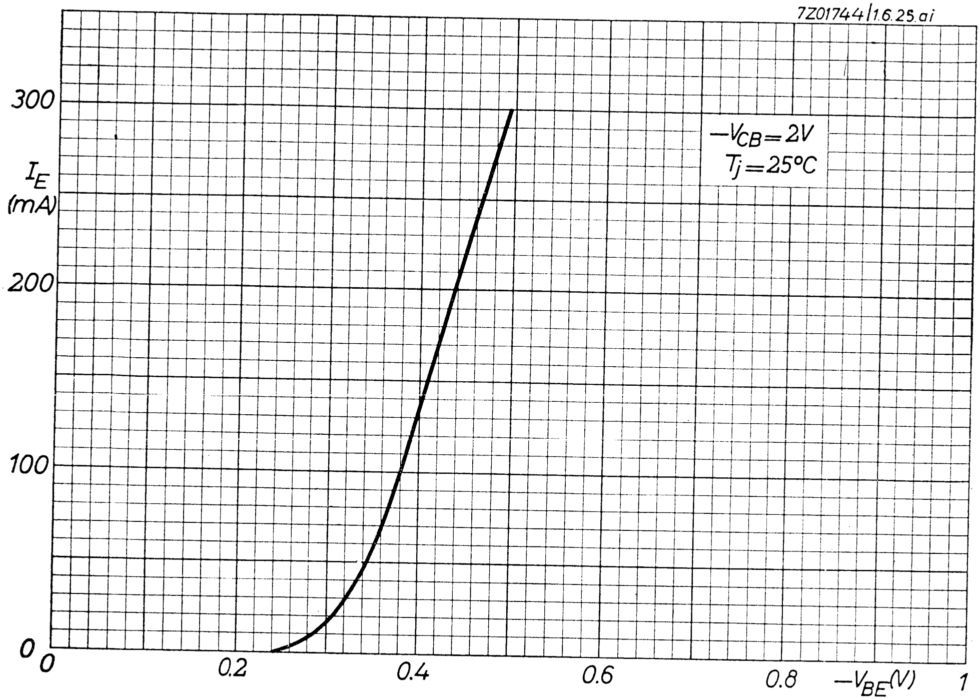
f = 180 Mc/s { P_o > 400 mW; G > 9 dB 2) }

Design considerations

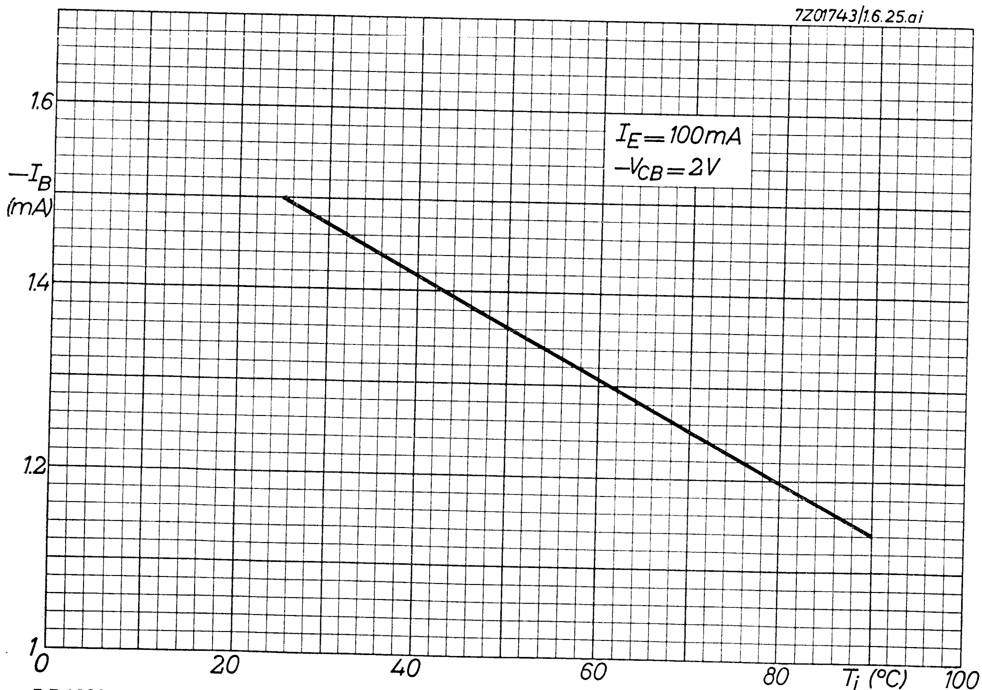
If the transistor is mounted on a heat sink with the aid of accessories for insulated mounting (e.g. accessories 56218), case and heat sink constitute a capacitor with the insulation as dielectricum. As the collector is connected to the case the total collector capacitance will be higher. Measures should be taken to prevent too high a capacitance, especially at 180 Mc/s.

1) The capacitor C_5 should be chosen so that its series inductance can be neglected (e.g. a tubular ceramic capacitor mounted in a copper block).

2) Without insertion losses and at stated min. P_o


7Z01744/1.6.25.ai
300
200
100
0
I_E (mA)
$-V_{CB} = 2V$
$T_j = 25°C$
0
0.2
0.4
0.6
0.8
$-V_{BE}$(V)
1

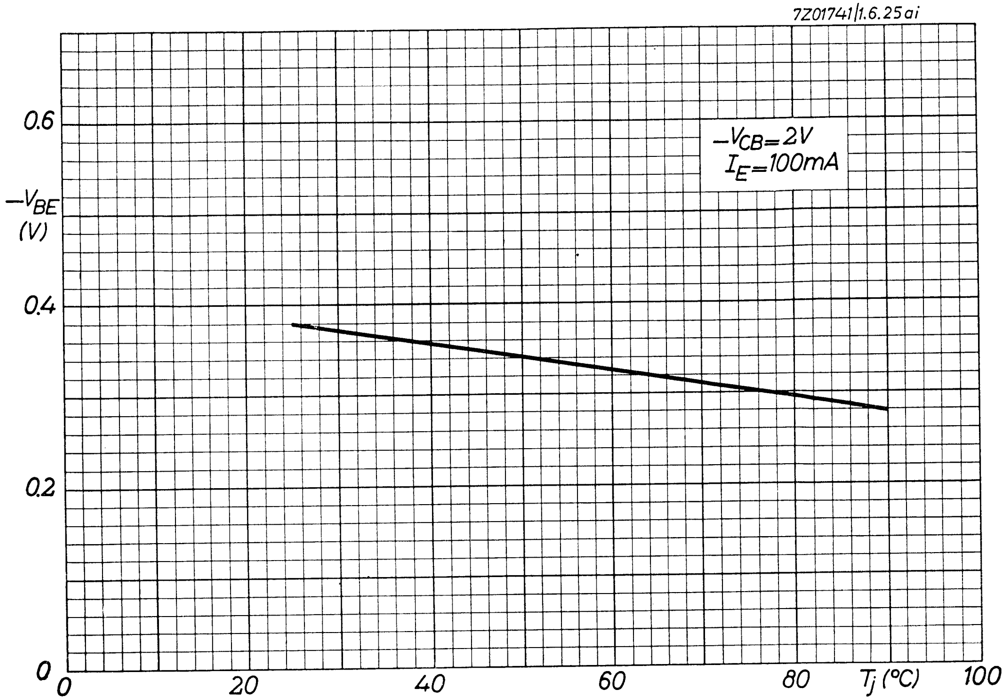
B


7Z01743/1.6.25.ai
1.6
1.4
1.2
1
$-I_B$ (mA)
$I_E = 100mA$
$-V_{CB} = 2V$
0
20
40
60
80
T_j (°C)
100

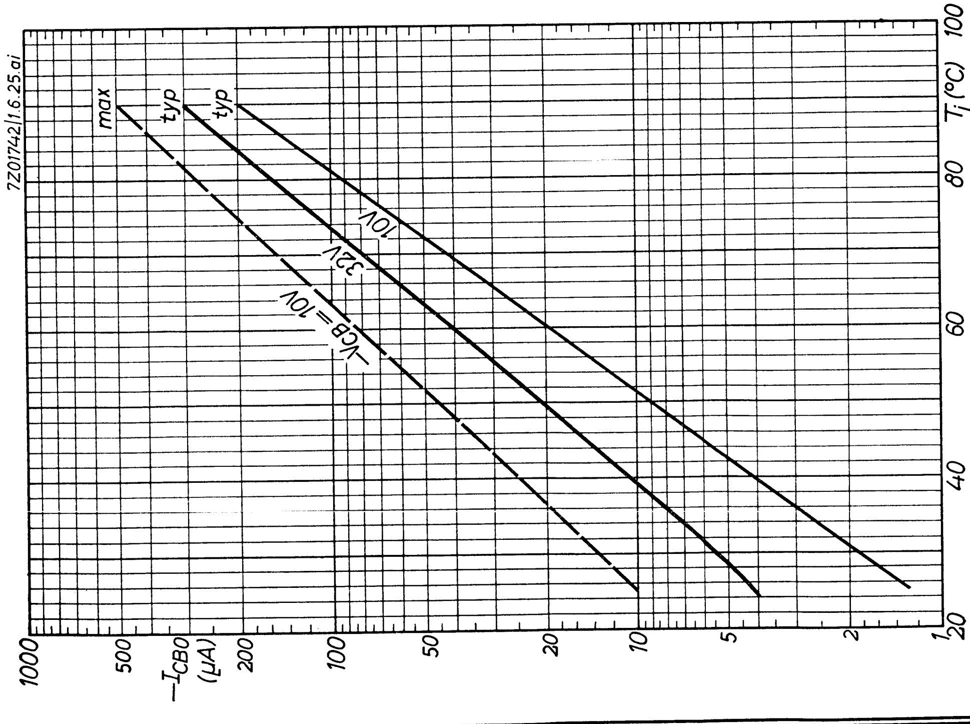
C

5.5.1963

D


7Z01741|1.6.25ai
−V_BE (V)
0.6
0.4
0.2
0
−V_CB=2V
I_E=100mA
0
20
40
60
80
T_j (°C)
100

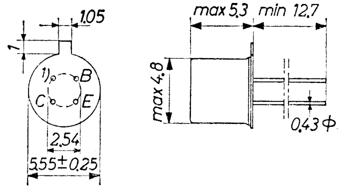
E


7Z01742|1.6.25.ai
max
typ
typ
10V
32V
−V_CB=10V
−I_CBO (μA)
1000
500
200
100
50
20
10
5
2
1
T_j (°C)
100
80
60
40
20

5.5.1963

GERMANIUM JUNCTION TRANSISTOR of the p-n-p alloy diffused type in metal envelope for V.H.F. operation up to 200 Mc/s

Dimensions in mm



LIMITING VALUES (Absolute max. values)

Collector			
Voltage (emitter reference)	$-V_{CE}$	= max.	20 V [2]
Voltage (base reference)	$-V_{CB}$	= max.	20 V
Current	$-I_C$	= max.	10 mA
Emitter			
Reverse voltage (base reference)	$-V_{EB}$	= max.	500 mV
Current	I_E	= max.	10 mA
Reverse current	$-I_E$	= max.	1.0 mA
Base			
Current	$-I_B$	= max.	1.0 mA
Dissipation			
Total dissipation	P_{tot}	= max.	$\frac{T_j\,max - T_{amb}}{K}$ [3]
Temperatures			
Storage	T_S	=	-55 °C/+75 °C
Junction, continuous operation	T_j	= max.	75 °C
Junction, intermittent operation (total duration max. 200 hours)	T_j (t	= max. = max.	90 °C 200 hrs)

THERMAL DATA

Thermal resistance from junction to ambience in free air	K	= max.	0.6 °C/mW

[1]) Interlead shield
[2]) At $V_{BE} \geq 500$ mV. At $-I_C$ = 10 mA, $-V_{CE}$ = max. 10 V
[3]) See also page H

7Z2 1108
5.5.1962

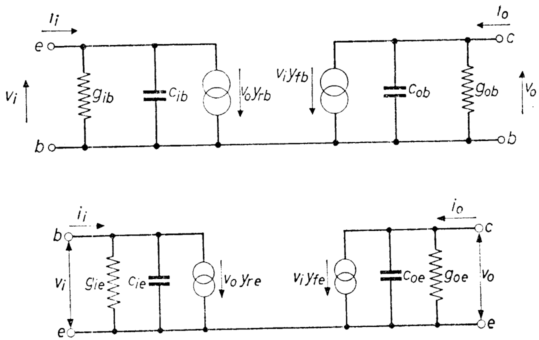
CHARACTERISTICS RANGE VALUES for equipment design

T_{amb} = 25 °C

Collector current at I_E = 0 mA			
$-I_{CBO}$	($-V_{CB}$ = 6 V)	= 1.0 µA	< 6.0 µA
$-I_{CBO}$	($-V_{CB}$ = 20 V)	= 2.6 µA	< 50 µA
Emitter current at I_C = 0 mA			
$-I_{EBO}$	($-V_{EB}$ = 0.5 V)	= 2.0 µA	< 27 µA
Base voltage			
$-V_{BE}$	($-V_{CE}$ = 6 V; $-I_C$ = 1 mA)	= 310 mV	> 220 mV < 380 mV
$-V_{BE}$	($-V_{CE}$ = 2 V; $-I_C$ = 10 mA)	= 380 mV	
D.C. current amplification factor			
h_{FE}	($-V_{CE}$ = 6 V; $-I_C$ = 1 mA)	= 60	> 20
h_{FE}	($-V_{CE}$ = 2 V; $-I_C$ = 10 mA)	= 60	> 25
Frequency at which $\lvert h_{fe}\rvert$ = 1			
f_1	($-V_{CE}$ = 6 V; $-I_C$ = 1 mA)	= 180 Mc/s	> 135 Mc/s
Current amplification factor			
h_{fe}	$-V_{CE}$ = 6 V; $-I_C$ = 1 mA; f = 1 kc/s	= 70	> 20
Intrinsic base impedance			
z_{rb}	$-V_{CE}$ = 6 V; $-I_C$ = 1 mA; f = 2 Mc/s	= 10 Ω	
Feedback capacitance			
c_{re}	$-V_{CE}$ = 6 V; $-I_C$ = 1 mA; f = 450 kc/s	= 1.0 pF	< 1.5 pF
Noise			
F	$-V_{CE}$ = 12 V; $-I_C$ = 1 mA; f = 200 Mc/s; Input source resistance = 30Ω	= 6.0 dB	< 7.5 dB
Available power gain in the circuit of page 4			
	G_a	= 13 dB	> 10 dB

7Z2 1109

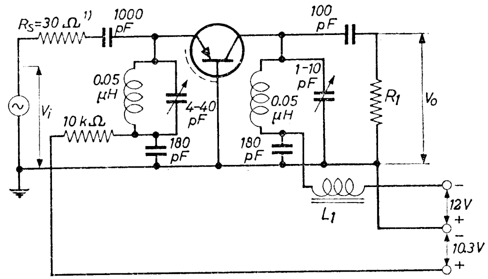
Small signal parameters. Measured with a length of lead between transistor bottom and measuring jig of 5 mm



Measured at:	Common base	Common emitter
Collector voltage	V_{CB} = 12 V	$-V_{CE}$ = 12 V
Collector current		$-I_C$ = 1 mA
Emitter current	I_E = 1 mA	
Frequency	f = 200 Mc/s	f = 200 Mc/s
Input conductance	g_{ib} = 32.5 mA/V	g_{ie} = 28 mA/V
Input capacitance	$-c_{ib}$ = 10 pF	c_{ie} = 13 pF
Feedback admittance	$\|y_{rb}\|$ = 0.41 mA/V	$\|y_{re}\|$ = 0.50 mA/V
Phase angle of feed-back admittance	$-\varphi_{rb}$ = 80 °	$-\varphi_{re}$ = 110 °
Transfer admittance	$\|y_{fb}\|$ = 30 mA/V	$\|y_{fe}\|$ = 34 mA/V
Phase angle of trans-fer admittance	φ_{fb} = 115 °	$-\varphi_{fe}$ = 68 °
Output conductance	g_{ob} = 0.22 mA/V	g_{oe} = 0.22 mA/V
Output capacitance	c_{ob} = 2.0 pF	c_{oe} = 2.0 pF

7Z2 1110
5.5.1962

Test circuit for power gain at 200 Mc/s

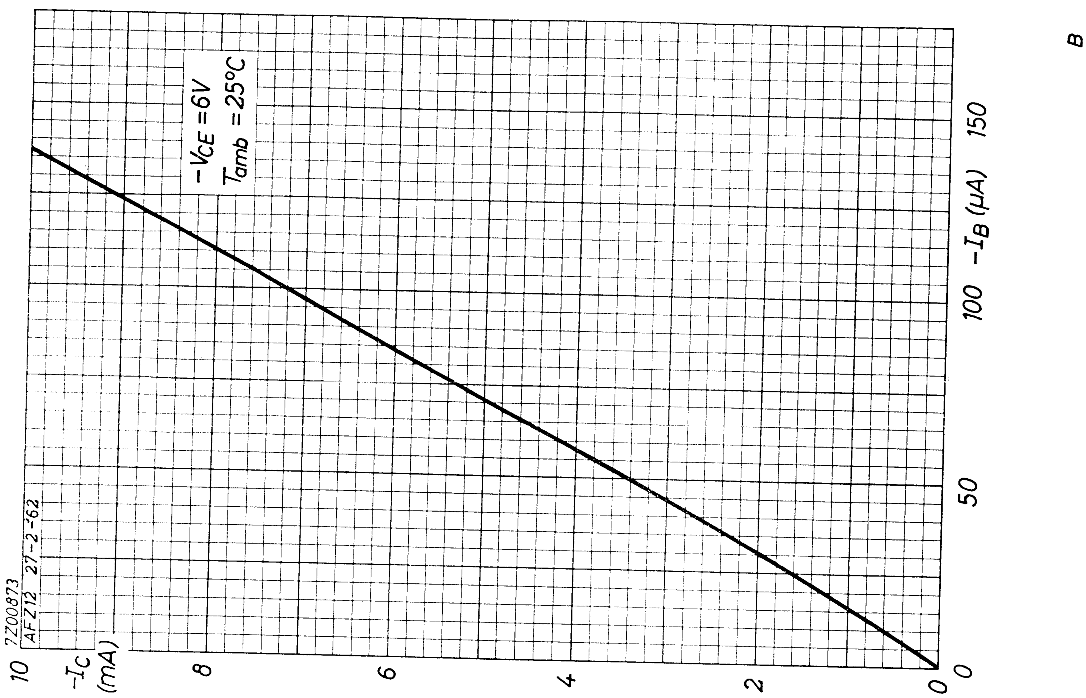


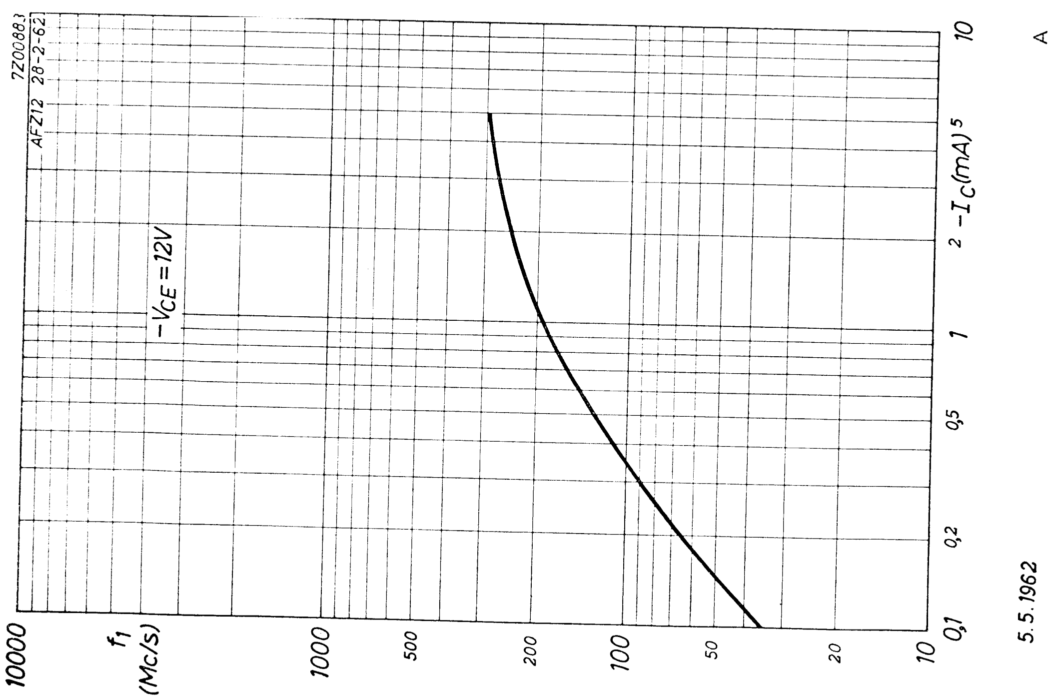
R_1 is chosen so that the total impedance R_L of the tuned circuit is 2 kΩ

L_1 = ferrite bead

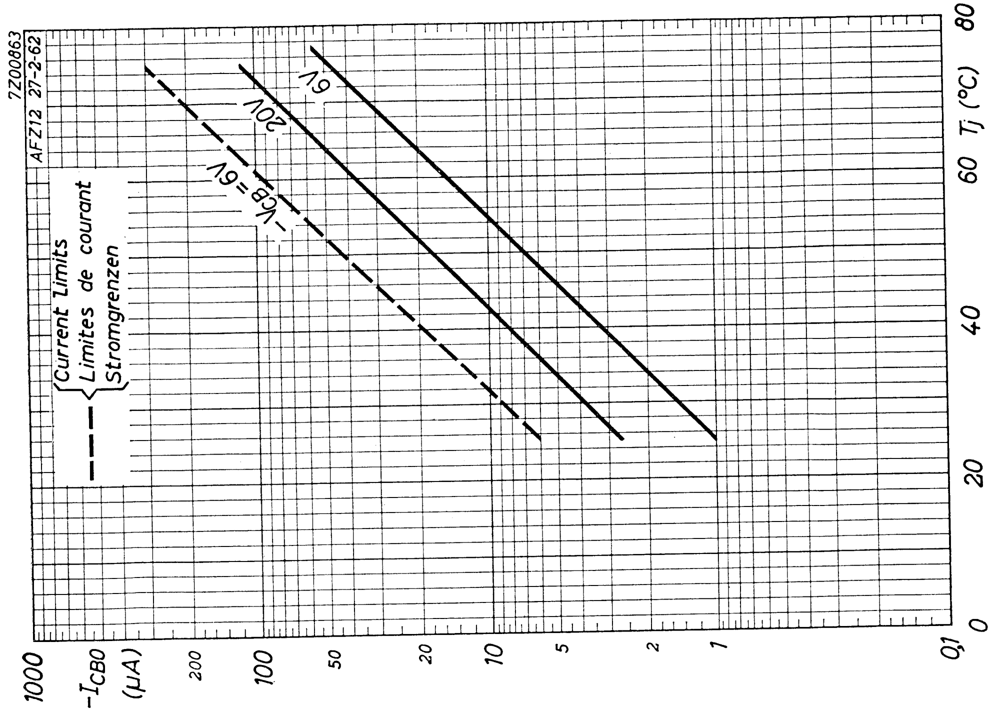
1) Input source impedance

7Z2 1111

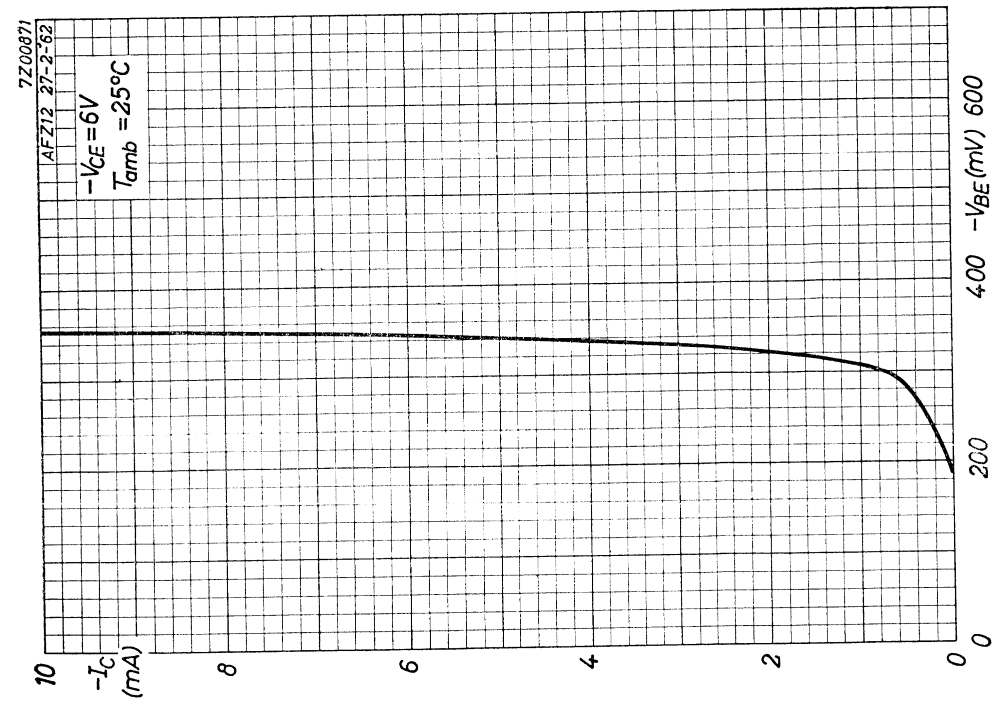

7Z00873
AFZ12 27-2-62
$-V_{CE}$ = 6V
T_{amb} = 25°C
$-I_C$ (mA)
10
8
6
4
2
0
0
50
100
150
$-I_B$ (μA)
B


7Z00883
AFZ12 28-2-62
$-V_{CE}$ = 12V
f_1 (Mc/s)
10000
1000
500
200
100
50
20
10
0,1
0,2
0,5
1
2
5
10
$-I_C$ (mA)
A

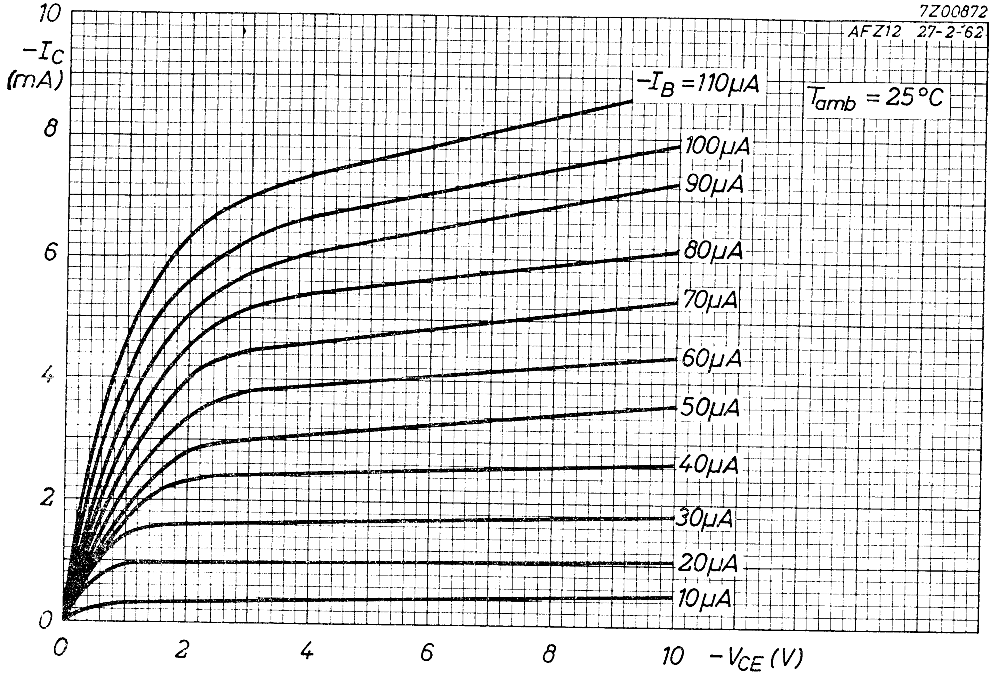
5.5.1962


7Z00863
AFZ12 27-2-62
Current Limits
Limites de courant
Stromgrenzen
$-V_{CB}$=6V
20V
6V
1000
$-I_{CBO}$
(μA)
200
100
50
20
10
5
2
1
0,1
0
20
40
60
80
T_j (°C)

D

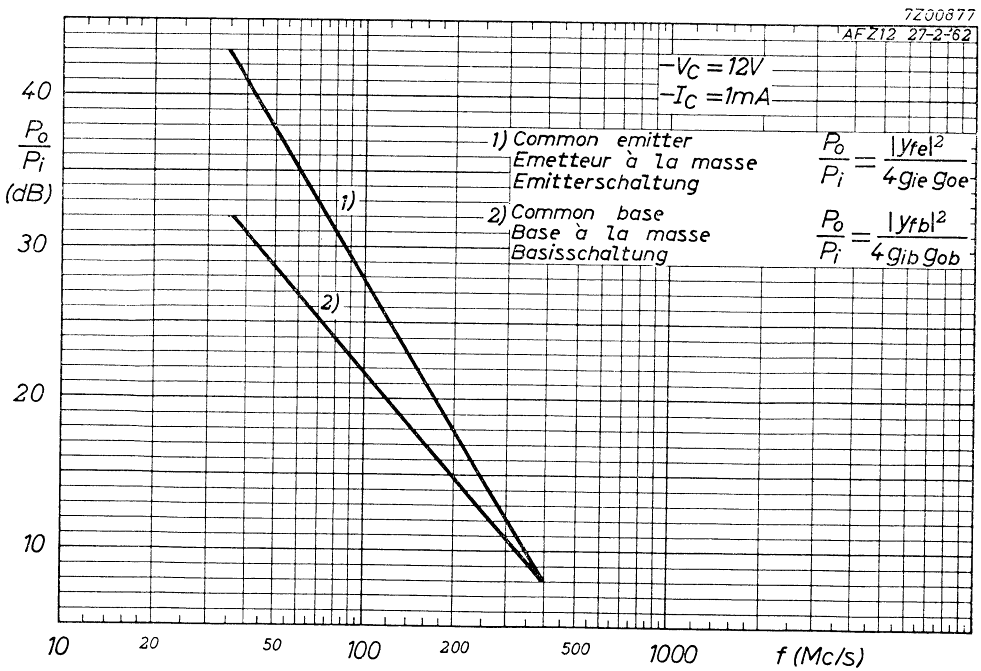

7Z00871
AFZ12 27-2-62
$-V_{CE}$=6V
T_{amb} =25°C
10
$-I_C$
(mA)
8
6
4
2
0
0
200
400
600
$-V_{BE}$ (mV)

C



7Z00872
AFZ12 27-2-62
10
$-I_C$
(mA)
8
6
4
2
0
$-I_B = 110\mu A$
$T_{amb} = 25°C$
100µA
90µA
80µA
70µA
60µA
50µA
40µA
30µA
20µA
10µA
0
2
4
6
8
10
$-V_{CE}$ (V)

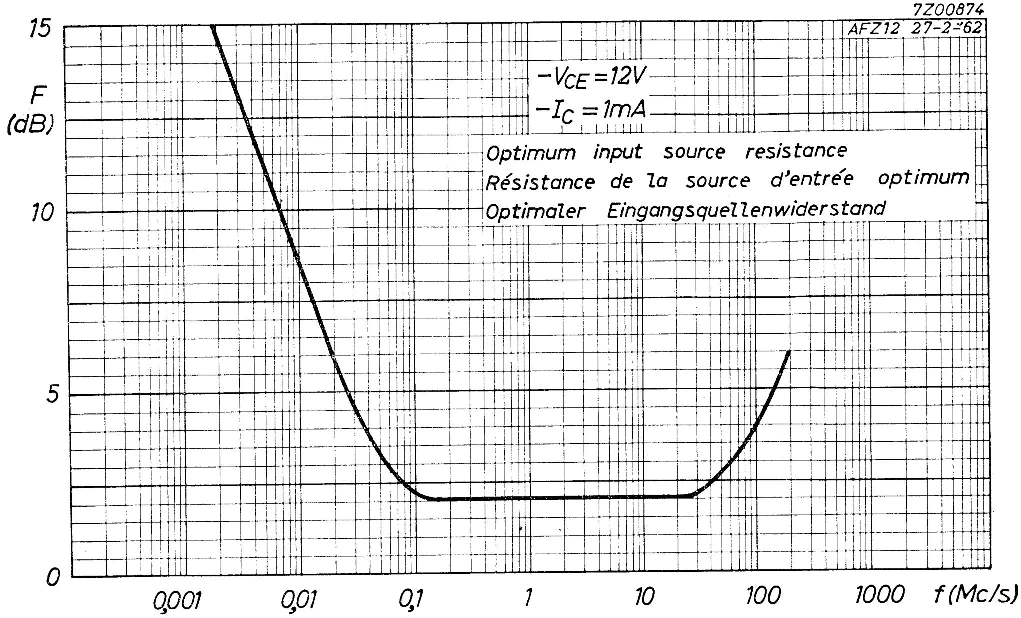
E



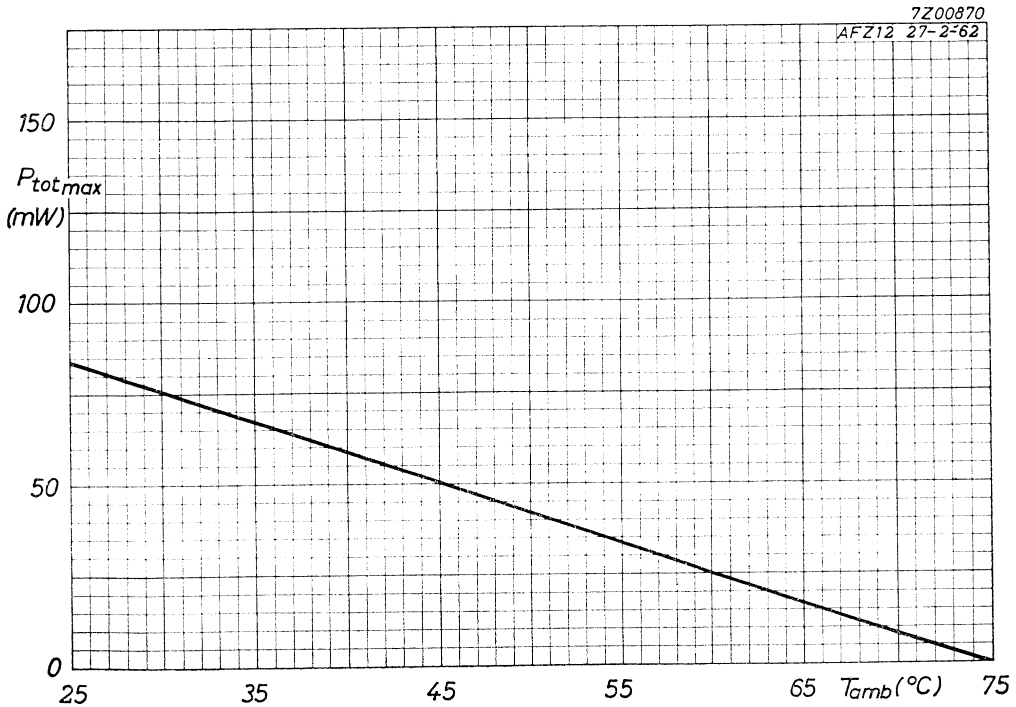
7Z00877
AFZ12 27-2-62
$-V_C = 12V$
$-I_C = 1mA$
40
$\frac{P_o}{P_i}$
(dB)
30
20
10
1) Common emitter
Emetteur à la masse
Emitterschaltung
$\frac{P_o}{P_i} = \frac{|y_{fe}|^2}{4 g_{ie} g_{oe}}$
2) Common base
Base à la masse
Basisschaltung
$\frac{P_o}{P_i} = \frac{|y_{fb}|^2}{4 g_{ib} g_{ob}}$
1)
2)
10
20
50
100
200
500
1000
f (Mc/s)

F

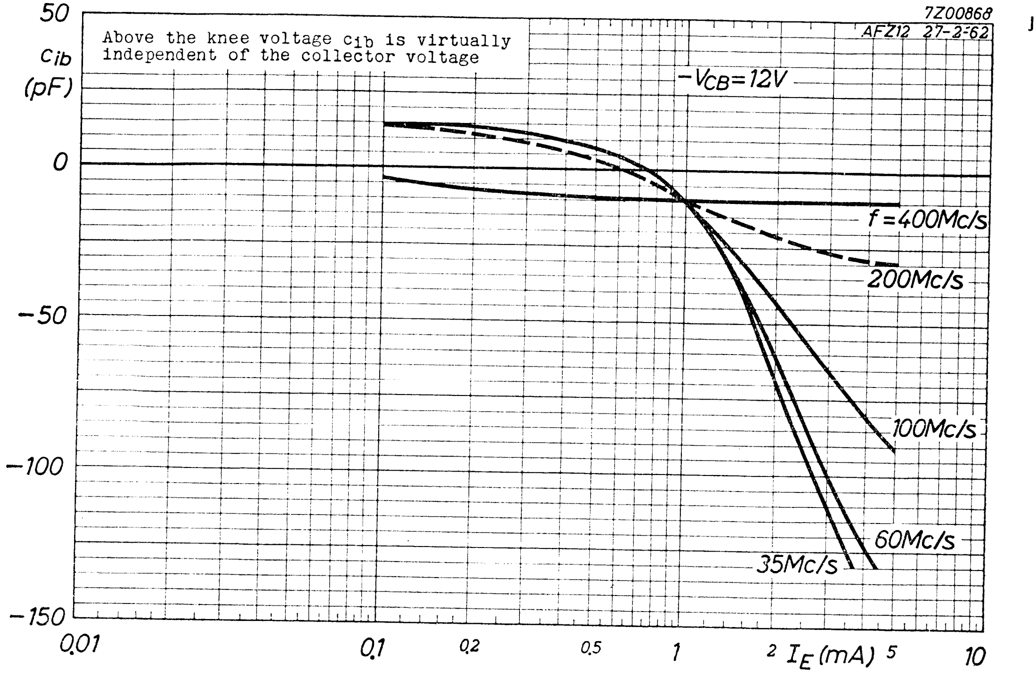
5.5.1962

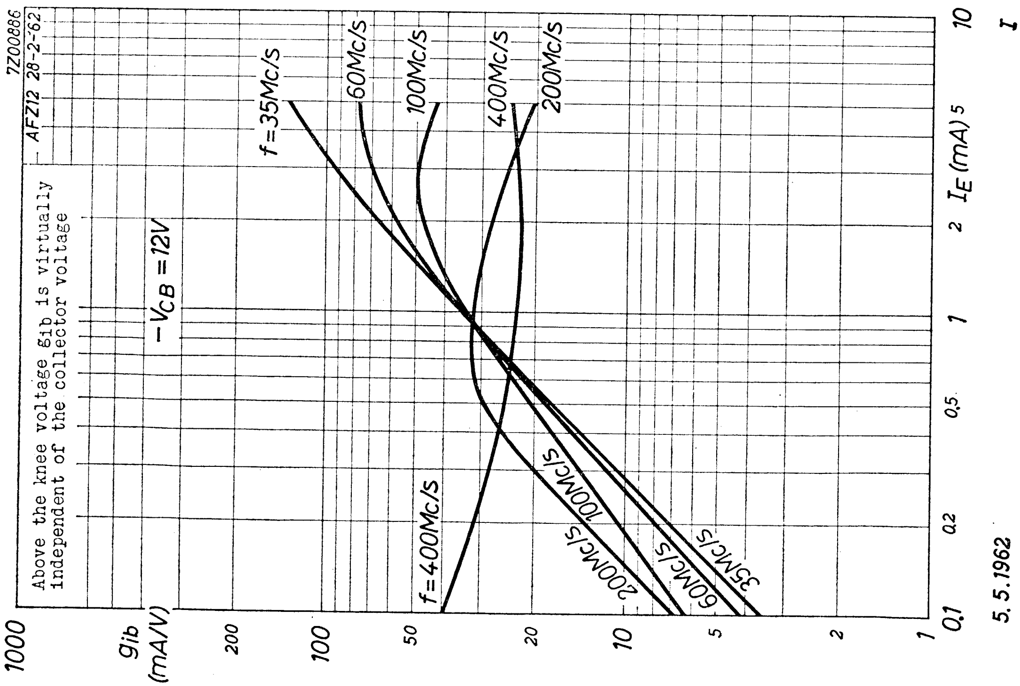

7Z00874
AFZ12 27-2-62
15
F
(dB)
10
5
0
$-V_{CE} = 12V$
$-I_C = 1mA$
Optimum input source resistance
Résistance de la source d'entrée optimum
Optimaler Eingangsquellenwiderstand
0,001
0,01
0,1
1
10
100
1000
f (Mc/s)

G

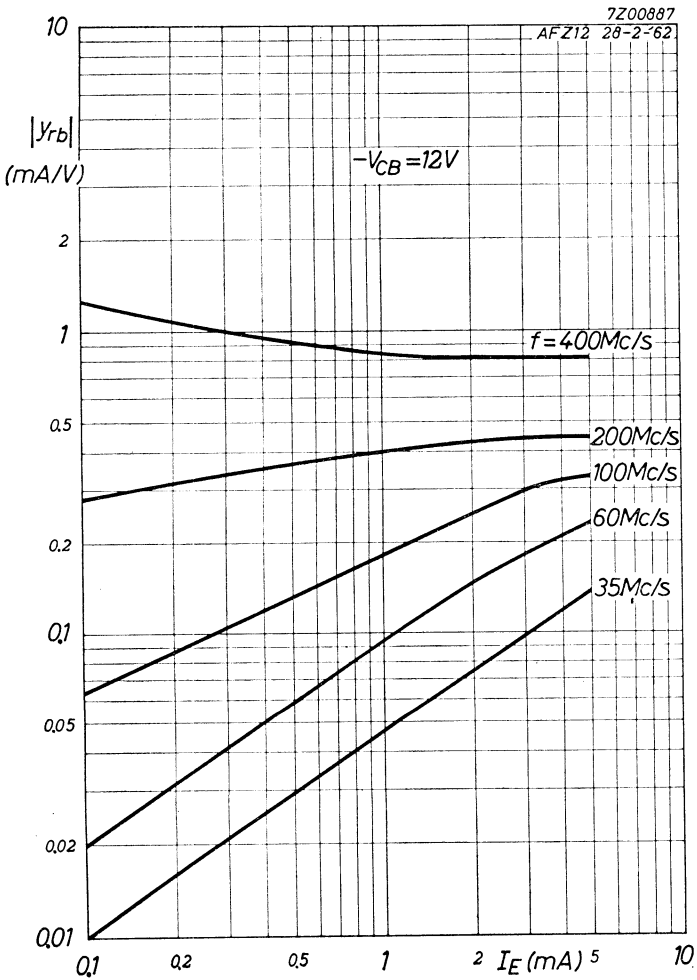

7Z00870
AFZ12 27-2-62
150
$P_{tot\,max}$
(mW)
100
50
0
25
35
45
55
65
T_{amb} (°C)
75

H


7Z00868
AFZ12 27-2-62
Above the knee voltage c_{ib} is virtually independent of the collector voltage
c_{ib} (pF)
$-V_{CB}$ = 12V
f = 400Mc/s
200Mc/s
100Mc/s
60Mc/s
35Mc/s
50
0
−50
−100
−150
0.01
0.1
0.2
0.5
1
2
5
10
I_E (mA)

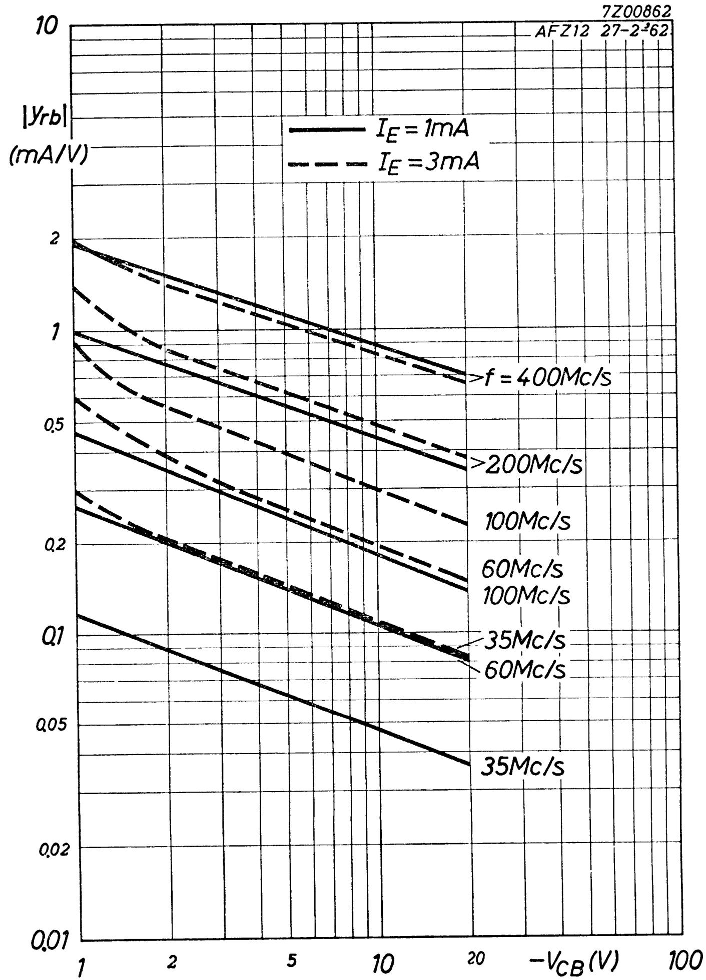

7Z00886
AFZ12 28-2-62
Above the knee voltage g_{ib} is virtually independent of the collector voltage
$-V_{CB}$ = 12V
f = 35Mc/s
60Mc/s
100Mc/s
400Mc/s
200Mc/s
f = 400Mc/s
200Mc/s
100Mc/s
60Mc/s
35Mc/s
g_{ib} (mA/V)
1000
200
100
50
20
10
5
2
1
I_E (mA)
0.1
0.2
0.5
1
2
5
10

5.5.1962

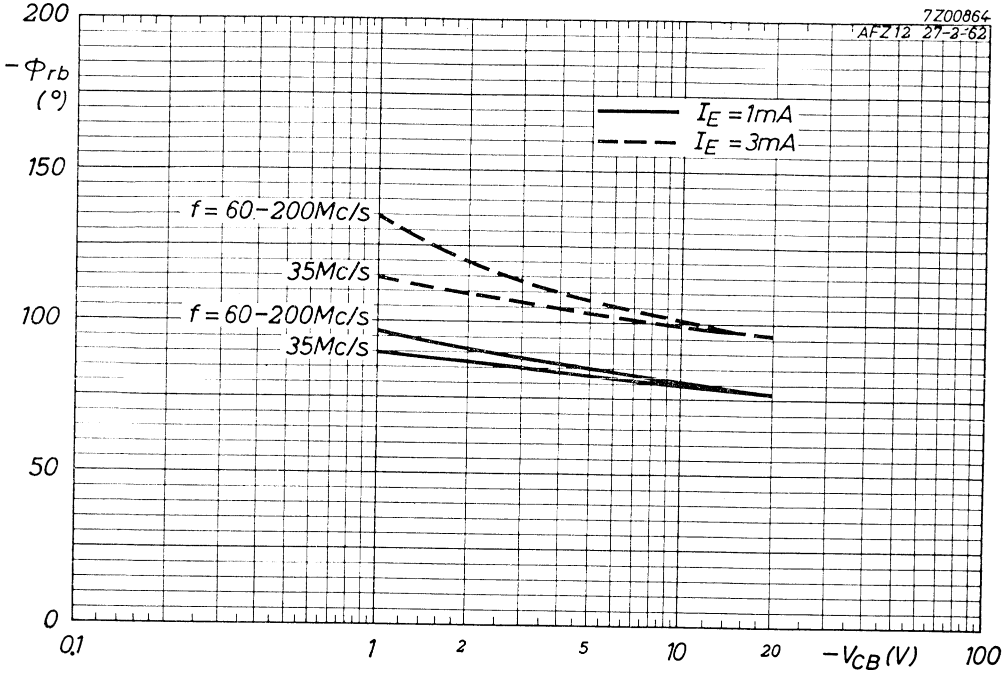

7Z00887
AFZ12 28-2-'62
$|y_{rb}|$ (mA/V)
$-V_{CB}$=12V
f=400Mc/s
200Mc/s
100Mc/s
60Mc/s
35Mc/s
10
2
1
0.5
0.2
0.1
0.05
0.02
0.01
0.1
0.2
0.5
1
2
I_E (mA)
5
10

5.5.1962

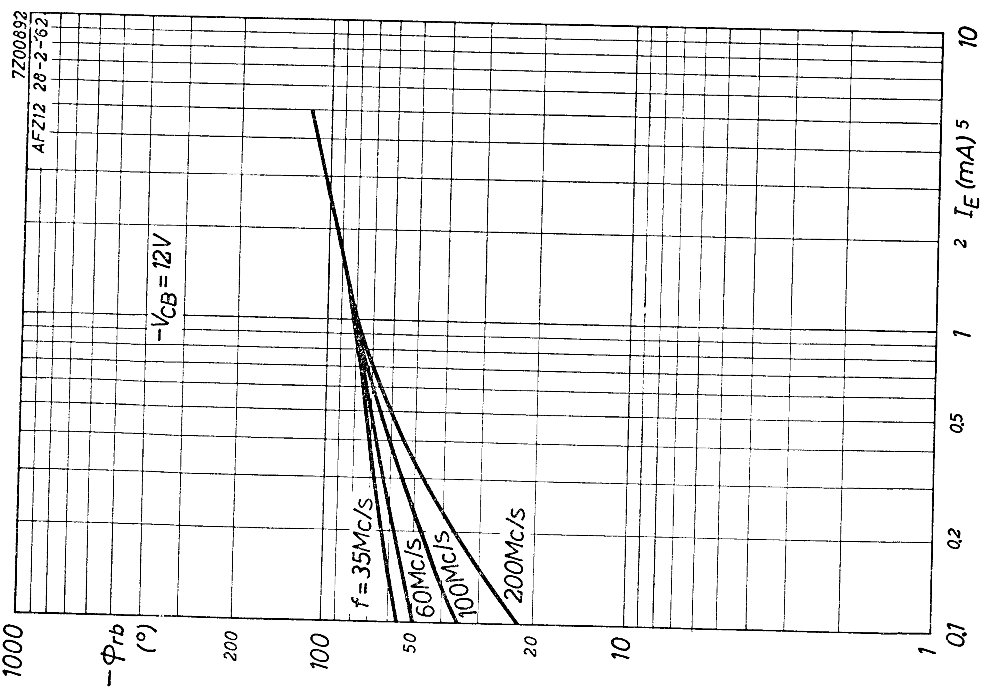
K


7Z00862
AFZ12 27-2-'62
$|y_{rb}|$ (mA/V)
I_E=1mA
I_E=3mA
f=400Mc/s
200Mc/s
100Mc/s
60Mc/s
100Mc/s
35Mc/s
60Mc/s
35Mc/s
10
2
1
0.5
0.2
0.1
0.05
0.02
0.01
1
2
5
10
20
$-V_{CB}$(V)
100

L

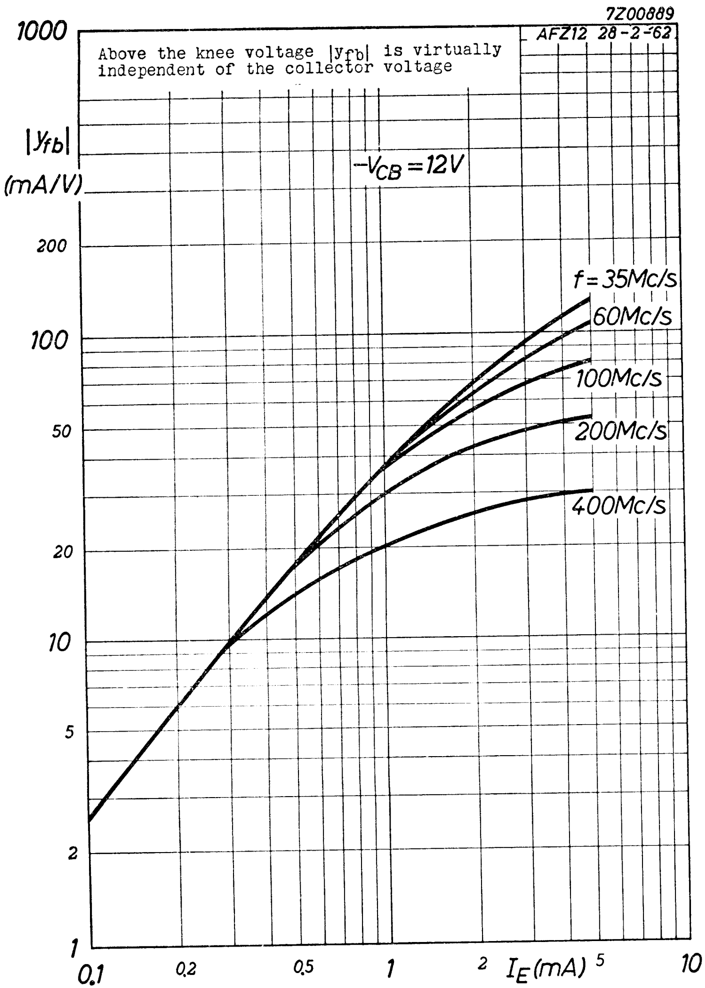

7Z00864
AFZ12 27-2-62
$-\varphi_{rb}$ (°)
200
150
100
50
0
I_E = 1mA
I_E = 3mA
f = 60-200Mc/s
35Mc/s
f = 60-200Mc/s
35Mc/s
0.1
1
2
5
10
20
$-V_{CB}$ (V)
100

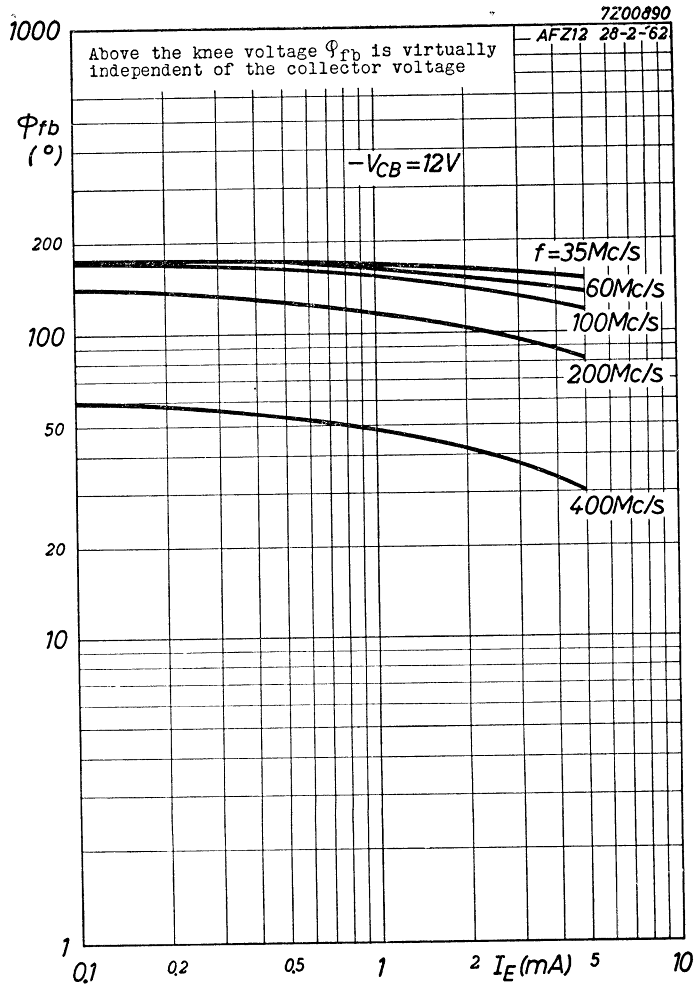
N

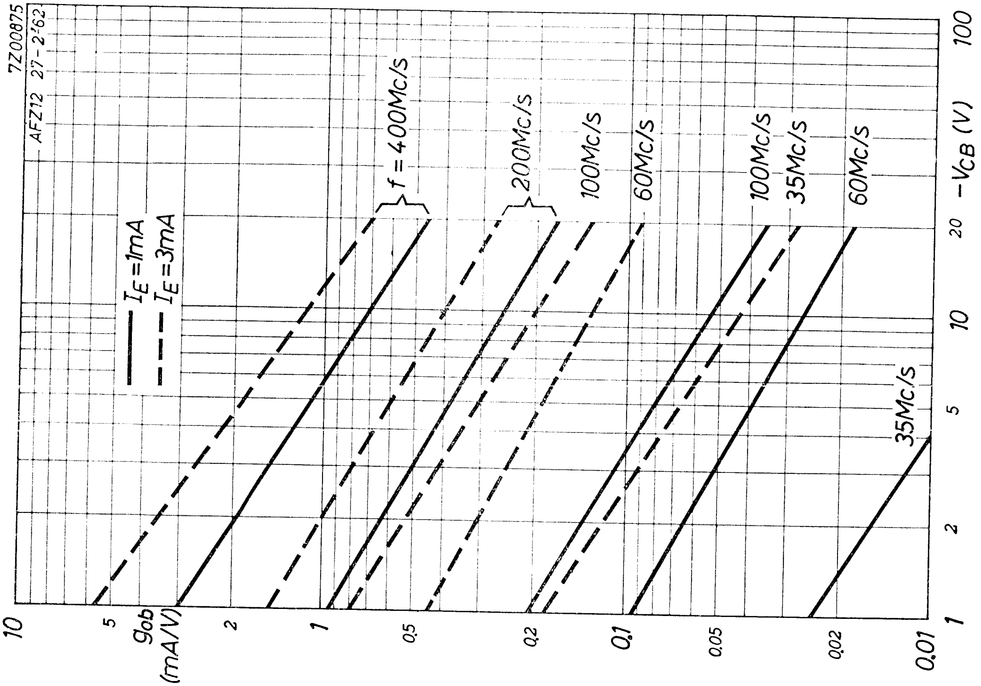

7Z00892
AFZ12 28-2-62
$-V_{CB}$ = 12V
f = 35Mc/s
60Mc/s
100Mc/s
200Mc/s
1000
$-\varphi_{rb}$ (°)
200
100
50
20
10
1
I_E (mA)
10
5
2
1
0.5
0.2
0.1

M

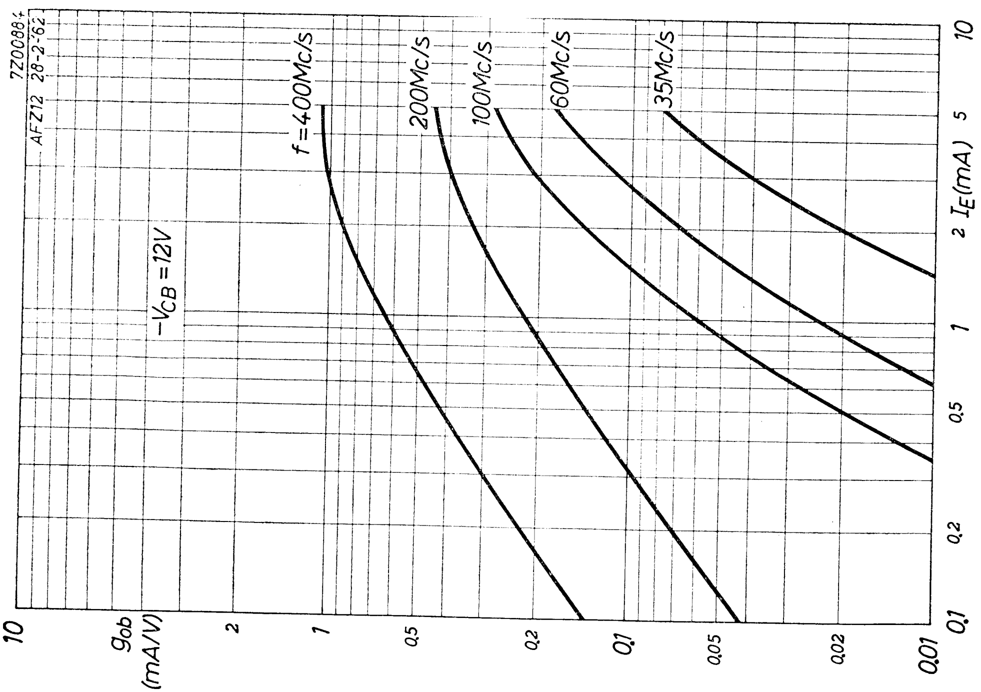
5.5.1962


7Z00889
AFZ12 28-2-'62
Above the knee voltage $|y_{fb}|$ is virtually independent of the collector voltage
$|y_{fb}|$ (mA/V)
$-V_{CB}=12V$
f = 35Mc/s
60Mc/s
100Mc/s
200Mc/s
400Mc/s
1000
200
100
50
20
10
5
2
1
0.1
0.2
0.5
1
2
5
10
I_E (mA)


7Z00890
AFZ12 28-2-'62
Above the knee voltage φ_{fb} is virtually independent of the collector voltage
φ_{fb} (°)
$-V_{CB}=12V$
f = 35Mc/s
60Mc/s
100Mc/s
200Mc/s
400Mc/s
1000
200
100
50
20
10
1
0.1
0.2
0.5
1
2
5
10
I_E (mA)

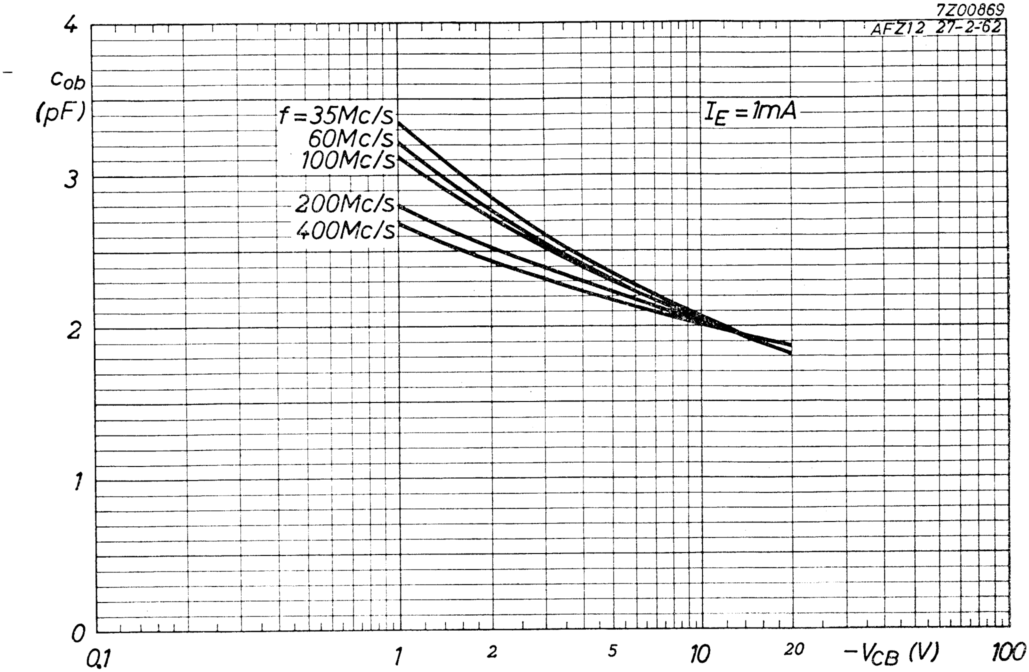

7Z00875
AFZ12 27-2-'62
I_E=1mA
I_E=3mA
f = 400Mc/s
200Mc/s
100Mc/s
60Mc/s
100Mc/s
35Mc/s
60Mc/s
35Mc/s
g_{ob} (mA/V)
$-V_{CB}$ (V)
10
5
2
1
0.5
0.2
0.1
0.05
0.02
0.01
1
2
5
10
20
100

R

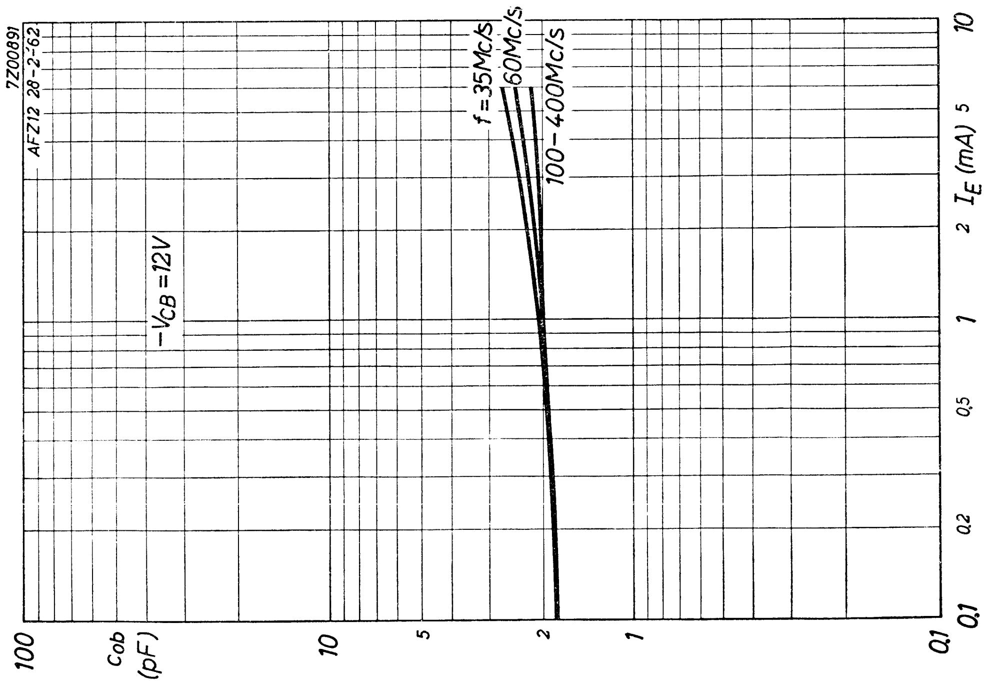

7Z00884
AFZ12 28-2-'62
$-V_{CB}$=12V
f=400Mc/s
200Mc/s
100Mc/s
60Mc/s
35Mc/s
g_{ob} (mA/V)
I_E(mA)
10
2
1
0.5
0.2
0.1
0.05
0.02
0.01
0.1
0.2
0.5
1
2
5
10

Q

5.5.1962

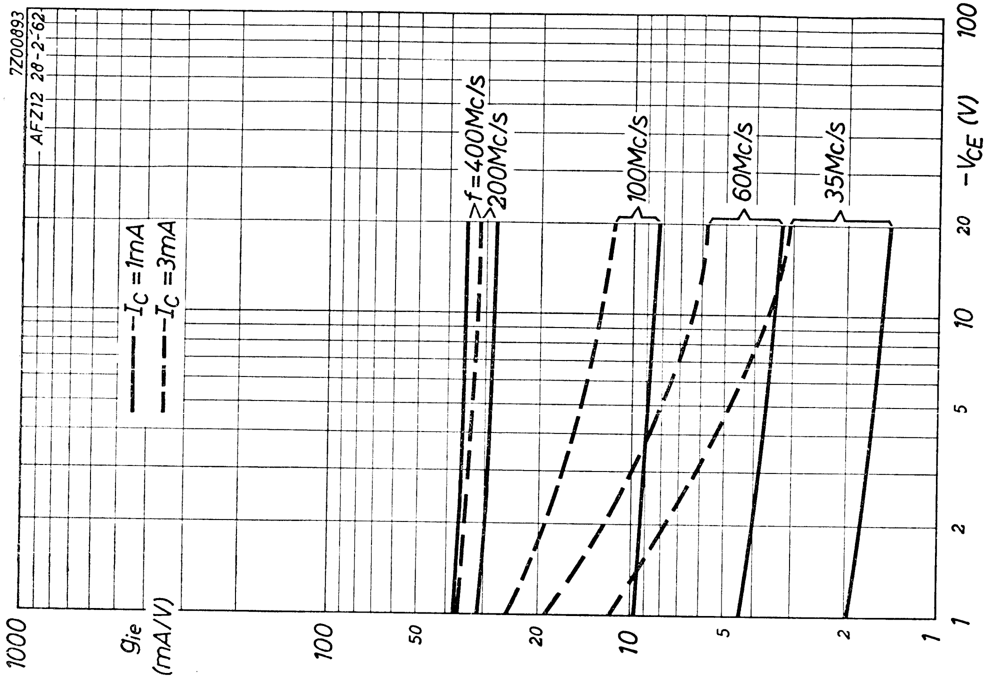

7Z00869
AFZ12 27-2-62
c_{ob} (pF)
$I_E = 1mA$
f = 35Mc/s
60Mc/s
100Mc/s
200Mc/s
400Mc/s
4
3
2
1
0
0.1
1
2
5
10
20
$-V_{CB}$ (V)
100

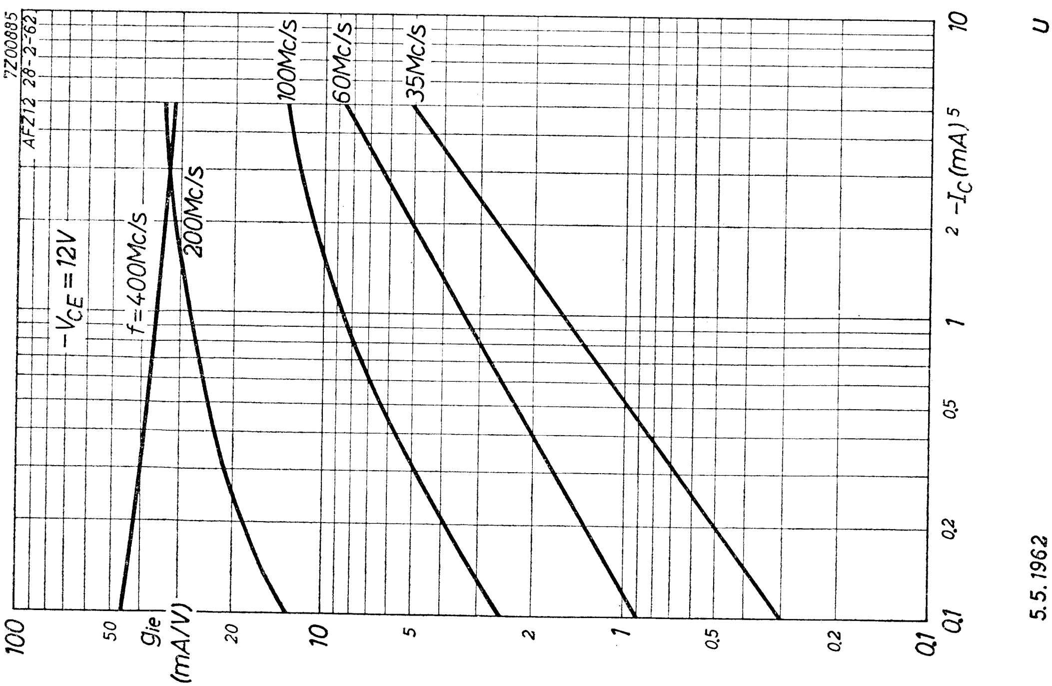
T


7Z00891
AFZ12 28-2-62
$-V_{CB} = 12V$
f = 35Mc/s
60Mc/s
100-400Mc/s
I_E (mA)
10
5
2
1
0.5
0.2
0.1
100
c_{ob} (pF)
10
5
2
1
0.1

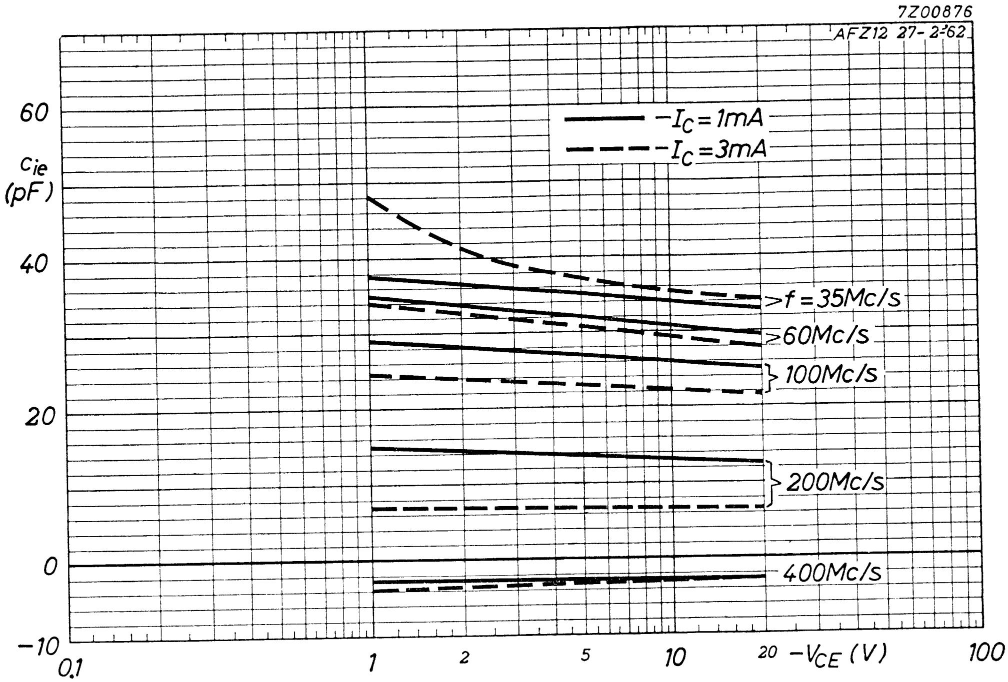
S

5.5.1962

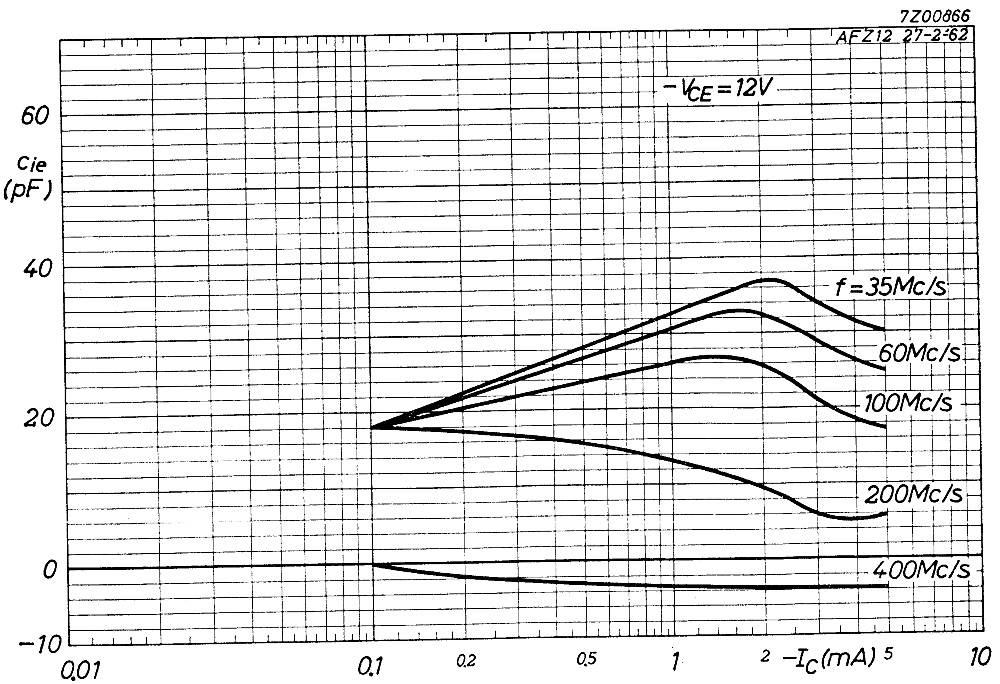

7Z00893
AFZ12 28-2-62
$-I_C = 1mA$
$-I_C = 3mA$
f=400Mc/s
200Mc/s
100Mc/s
60Mc/s
35Mc/s
g_{ie} (mA/V)
$-V_{CE}$ (V)
V


7Z00885
AFZ12 28-2-62
$-V_{CE} = 12V$
f=400Mc/s
200Mc/s
100Mc/s
60Mc/s
35Mc/s
g_{ie} (mA/V)
$-I_C$ (mA)
U

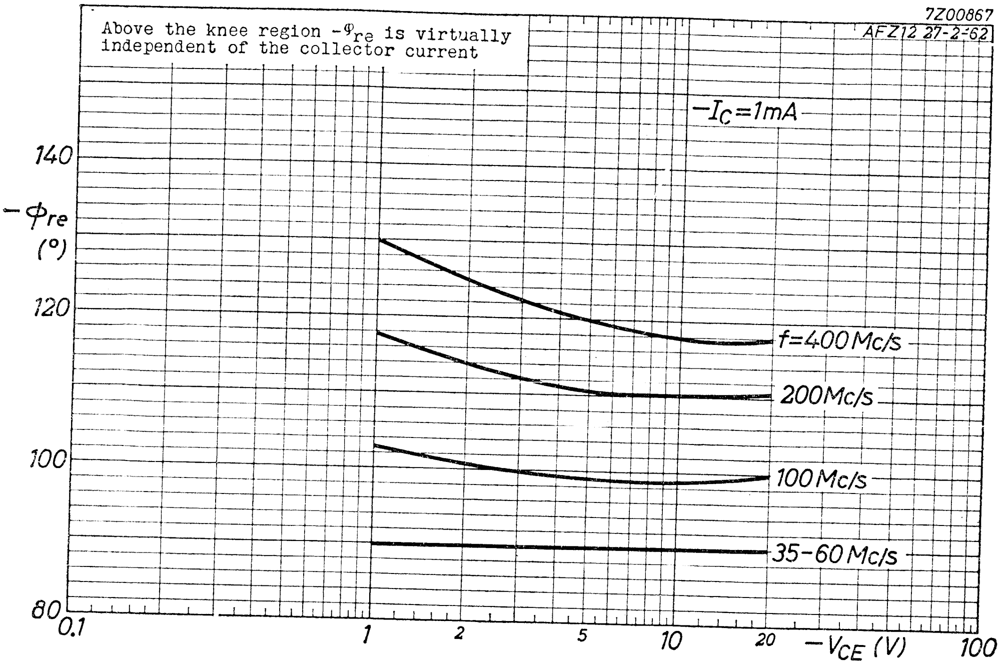
5.5.1962


7Z00876
AFZ12 27-2-62
60
c_{ie}
(pF)
40
20
0
−10
$-I_C = 1mA$
$-I_C = 3mA$
> f = 35Mc/s
≥ 60Mc/s
100Mc/s
200Mc/s
400Mc/s
0,1
1
2
5
10
20
$-V_{CE}$ (V)
100

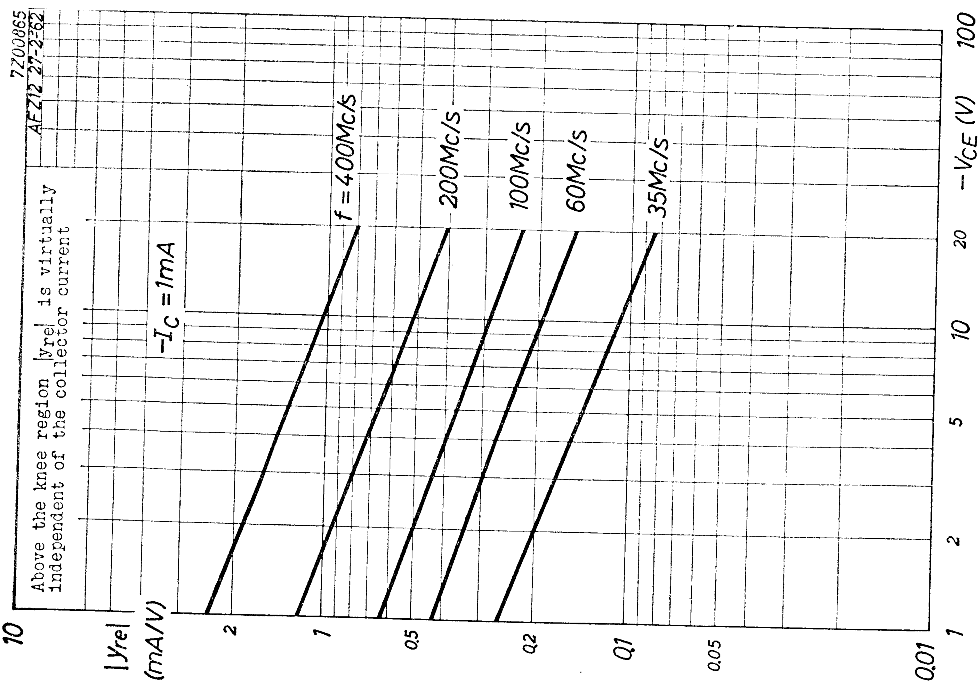
W


7Z00866
AFZ12 27-2-62
$-V_{CE} = 12V$
60
c_{ie}
(pF)
40
20
0
−10
f = 35Mc/s
60Mc/s
100Mc/s
200Mc/s
400Mc/s
0,01
0,1
0,2
0,5
1
2
$-I_C$(mA)
5
10

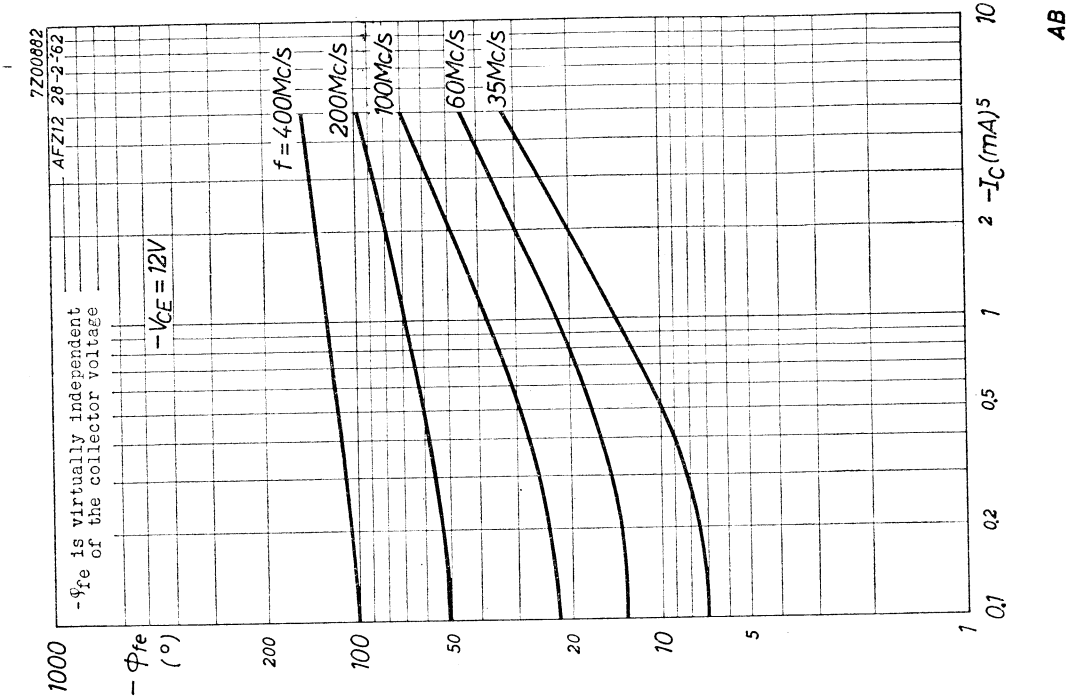
X


Above the knee region $-\varphi_{re}$ is virtually independent of the collector current
7Z00867
AFZ12 27-2-62
$-I_C$=1mA
$-\varphi_{re}$ (°)
140
120
100
80
f=400Mc/s
200Mc/s
100Mc/s
35-60Mc/s
0.1
1
2
5
10
20
$-V_{CE}$ (V)
100

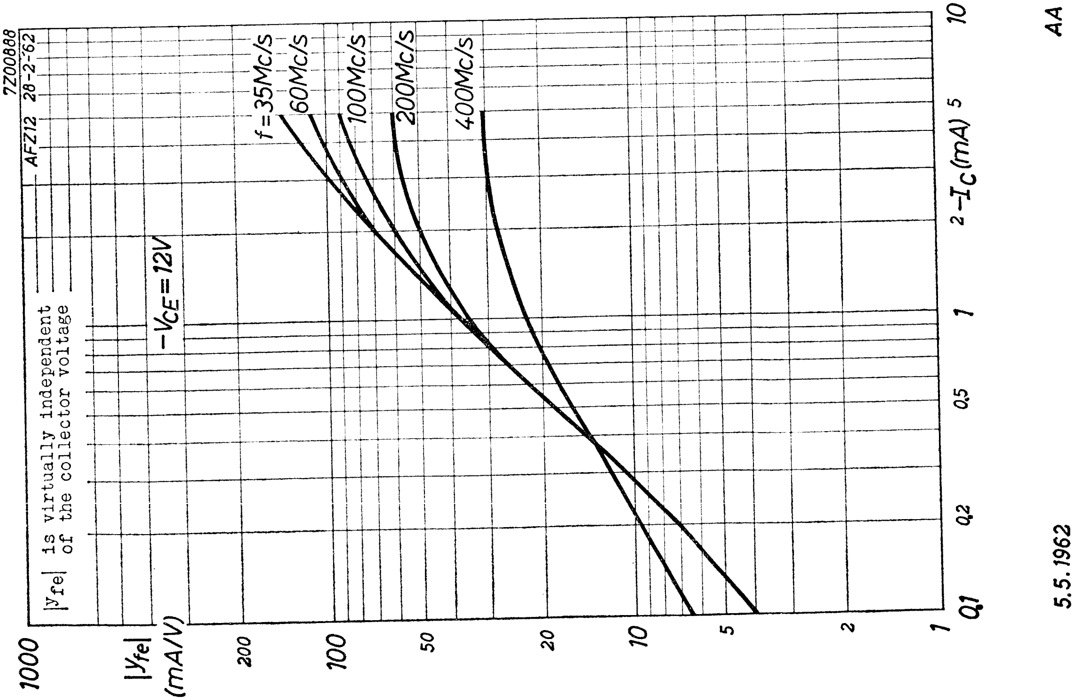
Z


7Z00865
AFZ12 27-2-62
Above the knee region $|y_{rel}|$ is virtually independent of the collector current
$-I_C$=1mA
f=400Mc/s
200Mc/s
100Mc/s
60Mc/s
35Mc/s
10
$|y_{rel}|$ (mA/V)
2
1
0.5
0.2
0.1
0.05
0.01
1
2
5
10
20
$-V_{CE}$ (V)
100

Y


7Z00882
AFZ12 28-2-'62
$-\varphi_{fe}$ is virtually independent of the collector voltage
$-V_{CE} = 12V$
f = 400Mc/s
200Mc/s
100Mc/s
60Mc/s
35Mc/s
1000
$-\varphi_{fe}$ (°)
200
100
50
20
10
5
1
0.1
0.2
0.5
1
2
5
10
$-I_C$ (mA)

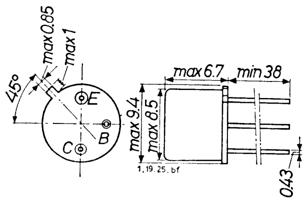
AB


7Z00888
AFZ12 28-2-'62
$|y_{fe}|$ is virtually independent of the collector voltage
$-V_{CE} = 12V$
f = 35Mc/s
60Mc/s
100Mc/s
200Mc/s
400Mc/s
1000
$|y_{fe}|$ (mA/V)
200
100
50
20
10
5
2
1
0.1
0.2
0.5
1
2
5
10
$-I_C$ (mA)

AA

GERMANIUM p-n-p ALLOY TRANSISTOR for medium current medium speed computer logic applications and for general purposes

Dimensions in mm



The base is electrically connected to the case

LIMITING VALUES (Absolute max. values)

Collector

Voltage (base reference)	$-V_{CB}$	= max.	30 V
Voltage (emitter reference) (See also page M)	$-V_{CE}$	= max.	25 V
Current (averaging time = max. 20 msec)	$-I_C$ (t_{av}	= max. = max.	200 mA 20 msec)
Peak current	$-I_{CM}$	= max.	300 mA

Emitter

Voltage (base reference)	$-V_{EB}$	= max.	20 V
Current (averaging time = max. 20 msec)	I_E (t_{av}	= max. = max.	230 mA 20 msec)
Peak current	I_{EM}	= max.	300 mA

Base

Current (averaging time = max. 20 msec)	$-I_B$ (t_{av}	= max. = max.	30 mA 20 msec)
Peak current	$-I_{BM}$	= max.	300 mA

Dissipation

Total dissipation	P_{tot}	= max.	150 mW [1])

Temperatures

Junction temperature	T_j	= max.	85 °C
Storage temperature	T_s	=	-65 °C to +100 °C

[1]) The maximum permissible dissipation for a certain application can be calculated from the formula:

$$P_{tot} = \text{max.} \frac{T_{j\,max.} - T_{amb}}{K_{j-amb}}$$

7Z2 1725 3.3.1965

THERMAL DATA

Thermal resistance from junction to ambience in free air	K_{j-amb} = max. 0.4 °C/mW
Thermal resistance from junction to case	K_{j-c} = max. 0.2 °C/mW

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

Collector-base leakage current

$-I_{CBO}$ ($-V_{CB}$ = 5 V; I_E = 0 mA)	< 3 µA

Emitter-base leakage current

$-I_{EBO}$ ($-V_{EB}$ = 5 V; I_C = 0 mA)	< 3 µA

Base current

$-I_B$ (I_E = 10 mA; V_{CB} = 0 V)	< 325 µA
$-I_B$ (I_E = 100 mA; V_{CB} = 0 V)	< 4.75 mA

Emitter-base voltage

$-V_{EB}$ ($-I_E$ = 100 µA; I_C = 0 mA; T_{amb} = 60 °C)	> 20 V
V_{EB} (I_E = 100 mA; V_{CB} = 0 V)	< 0.65 V
$-V_{BE}$ ($-I_C$ = 50 mA; $-I_B$ = 2.4 mA)	< 0.55 V

Punch through voltage

V_{PT}	> 25 V

7Z2 3036

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN

T_{amb} = 25 °C unless otherwise specified

Collector current		
$-I_C$ {$-V_{CE}$ = 25 V; V_{BE} = 0.2 V; T_{amb} = 60 °C}	<	35 µA
Base current		
I_B {$-V_{CE}$ = 20 V; V_{BE} = 5 V; T_{amb} = 60 °C}	<	35 µA
Collector voltage (See also page L)		
$-V_{CE}$ ($-I_C$ = 5 mA; I_B = 0 mA)	>	15 V
Floating potential		
$-V_{BE}$ ($-V_{CE}$ = 25 V; T_{amb} = 60 °C)	<	200 mV
Direct current amplification factor		
h_{FE} (I_E = 20 mA; V_{CB} = 0 V)	> <	30 80
h_{FE} (I_E = 200 mA; V_{CB} = 0 V)	>	15
Base emitter voltage		
$-V_{BE}$ (I_E = 300 mA; V_{CB} = 0 V)	<	1.5 V
Collector voltage during bottoming		
$-V_{CE}$ ($-I_C$ = 10 mA; $-I_B$ = 0.33 mA)	<	0.20 V
$-V_{CE}$ ($-I_C$ = 50 mA; $-I_B$ = 2 mA)	<	0.25 V
Base voltage		
$-V_{BE}$ ($-I_C$ = 10 mA; $-I_B$ = 0.4 mA)	> <	0.20 V 0.37 V
Frequency at which $\|h_{fe}\|$ = 1		
f_1 ($-V_{CE}$ = 5 V; $-I_C$ = 3 mA)	>	4 Mc/s
Collector capacitance		
c_c ($-V_{CB}$ = 5 V; I_E = 0 mA)	<	16 pF
Emitter capacitance		
c_e ($-V_{EB}$ = 5 V; I_C = 0 mA)	<	13 pF

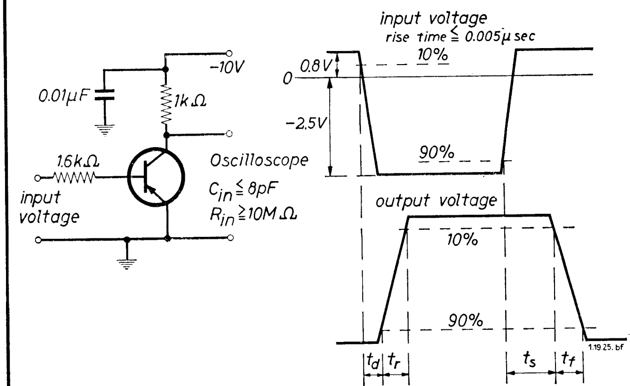
CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN (continued)

Tamb = 25 °C

Transient behaviour		
Time constant with current feed		
τ_c ($-V_{CE}$ = 0.75 V; $-I_{CM}$ = 50 mA)	<	2.2 µsec
Time constant with voltage feed		
τ_v ($-V_{CE}$ = 0.75 V; $-I_{CM}$ = 1 mA)	<	0.2 µsec
Desaturation time constant		
τ_s ($-I_C$ = 0 mA; $-I_B$ = 1 mA)	<	1.25 µsec
On demand current gain		
β_T {ΔI_C = 50 mA; t = 0.1 µsec; $-V_{CE} \leqq$ 0.3 V}	> =	10 15

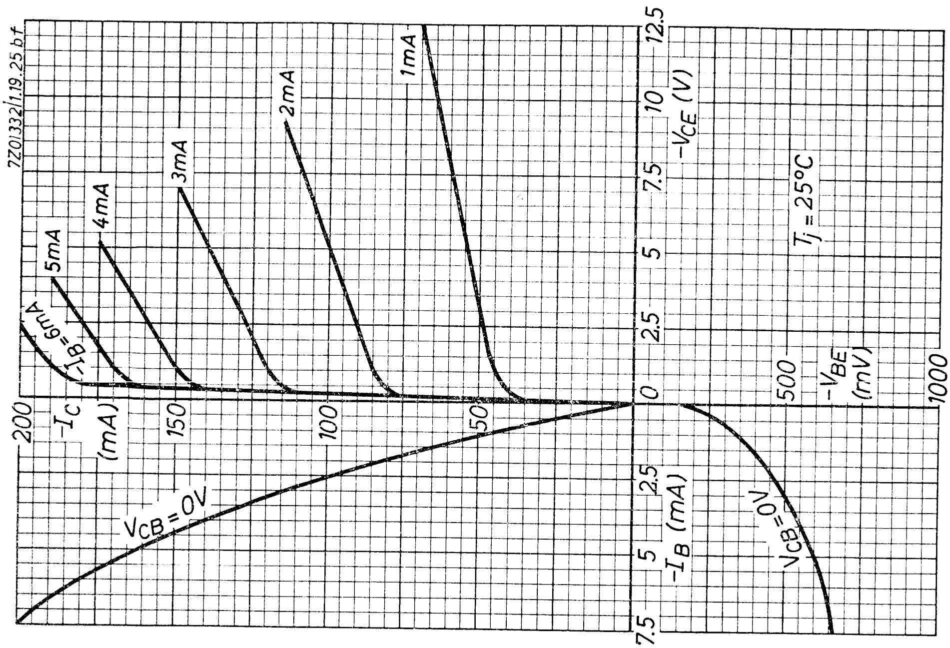
SWITCHING CHARACTERISTICS at T_{amb} = 25 °C

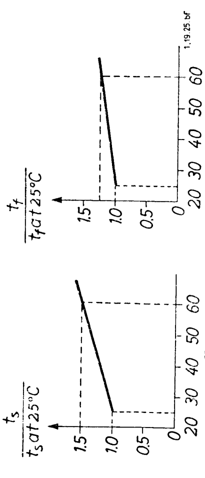
Delay time	t_d	<	0.09 µsec
Rise time	t_r	<	0.49 µsec
Storage time	t_s	<	1.35 µsec
Fall time	t_f	<	0.73 µsec



See also page 5

A





7Z2 1750
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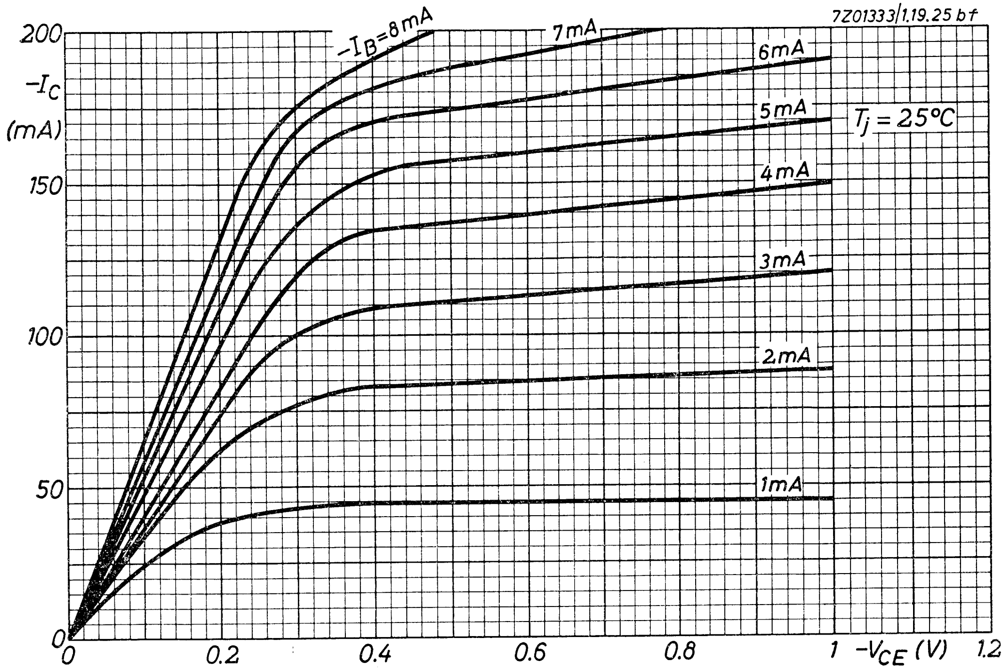
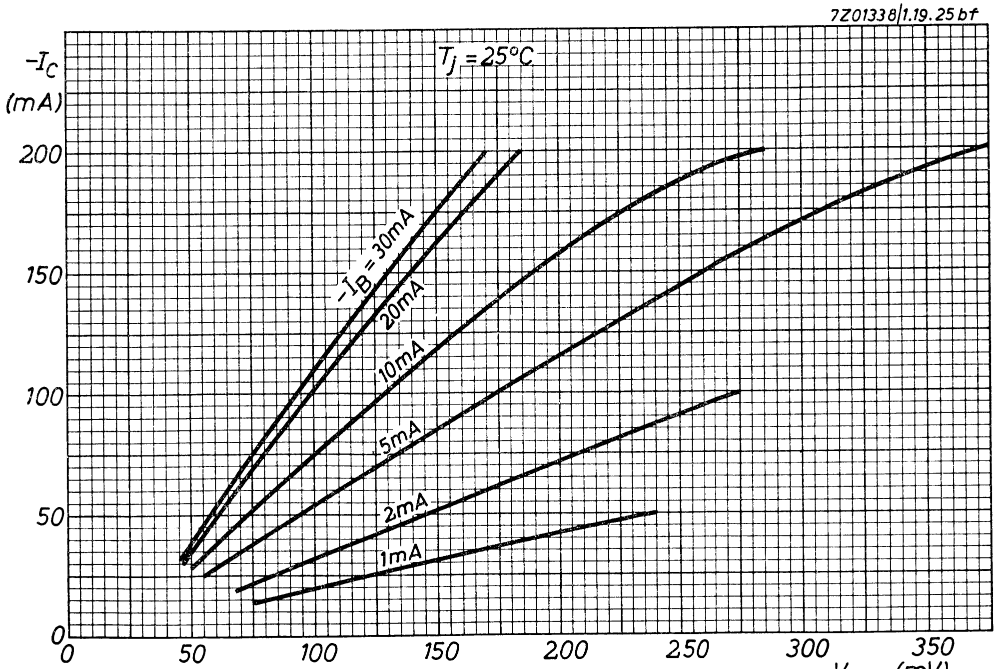
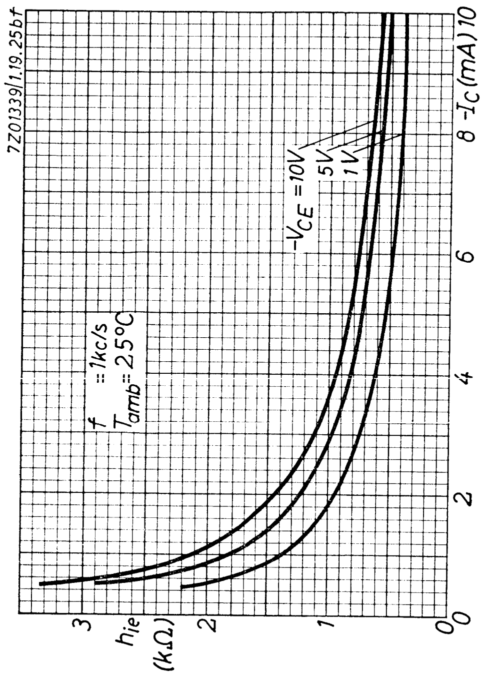

7Z01333/1.19.25 bf
$-I_B$=8mA
7mA
6mA
5mA
4mA
3mA
2mA
1mA
T_j = 25°C
$-I_C$ (mA)
200
150
100
50
0
0
0.2
0.4
0.6
0.8
1
1.2
$-V_{CE}$ (V)

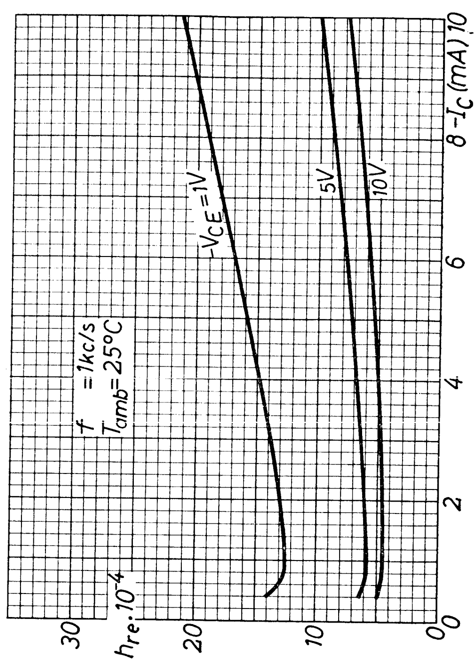
B


7Z01338/1.19.25 bf
T_j = 25°C
$-I_C$ (mA)
200
150
100
50
0
$-I_B$ = 30mA
20mA
10mA
5mA
2mA
1mA
0
50
100
150
200
250
300
350
$-V_{CE}$ (mV)

C

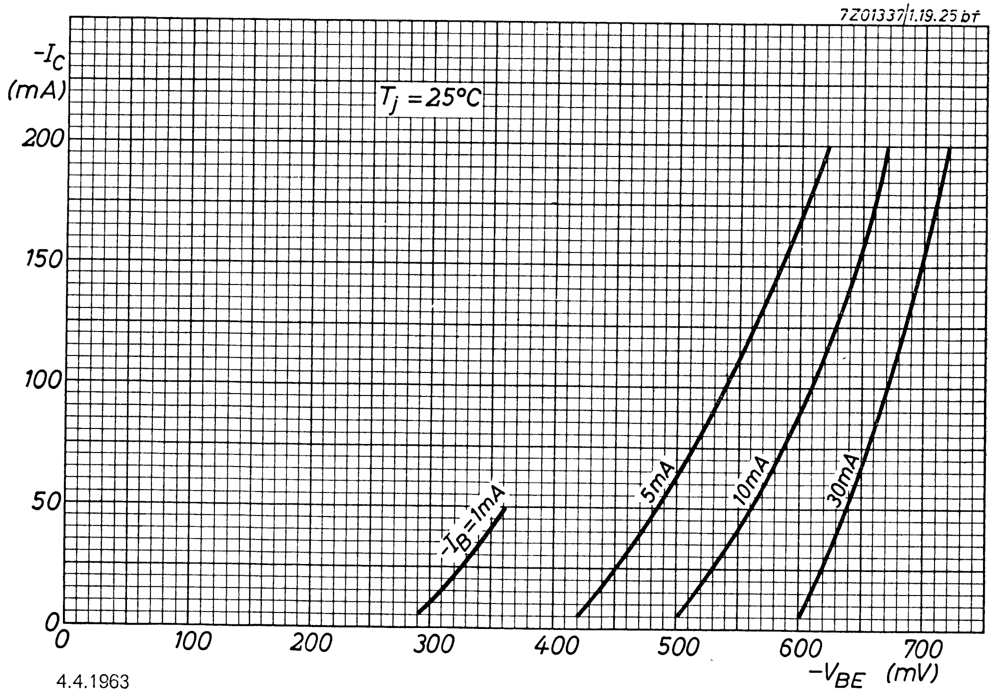
4.4.1963


7Z01339/1.19.25bf
f = 1kc/s
T_{amb} = 25°C
$-V_{CE}$ = 10V
5V
1V
h_{ie}
(kΩ)
$-I_C$ (mA)


f = 1kc/s
T_{amb} = 25°C
$-V_{CE}$ = 1V
5V
10V
$h_{re}.10^{-4}$
$-I_C$ (mA)

E

D


7Z01337/1.19.25bf
$-I_C$
(mA)
T_j = 25°C
$-I_B$ = 1mA
5mA
10mA
30mA
$-V_{BE}$ (mV)

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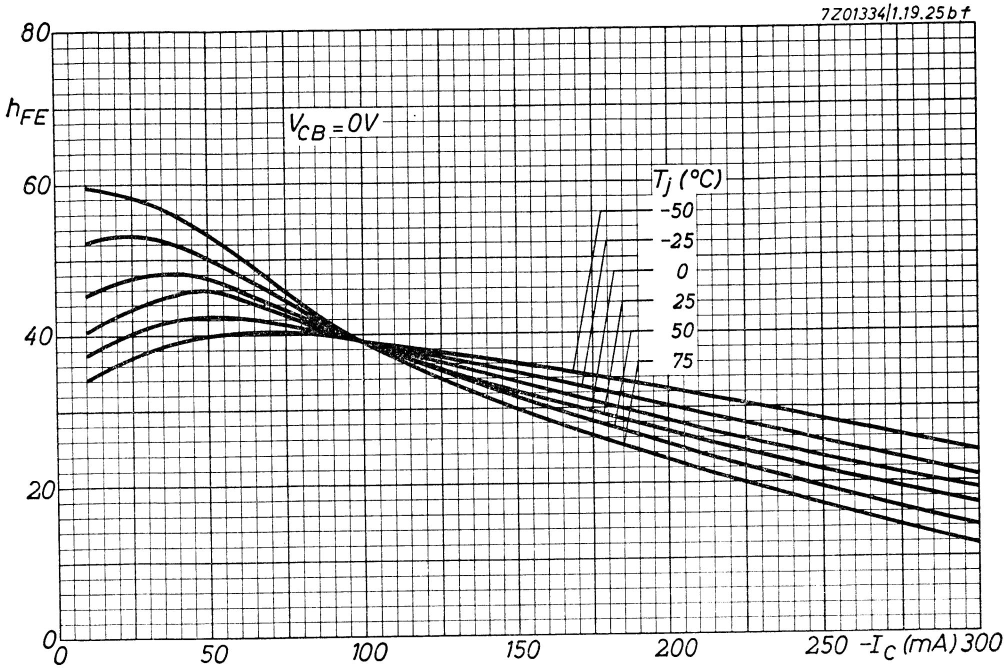
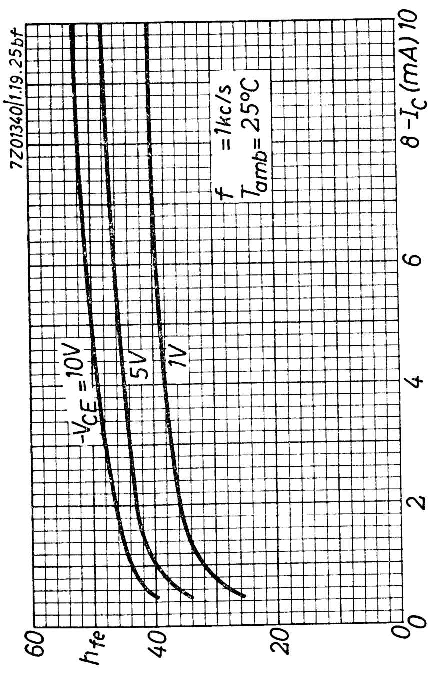
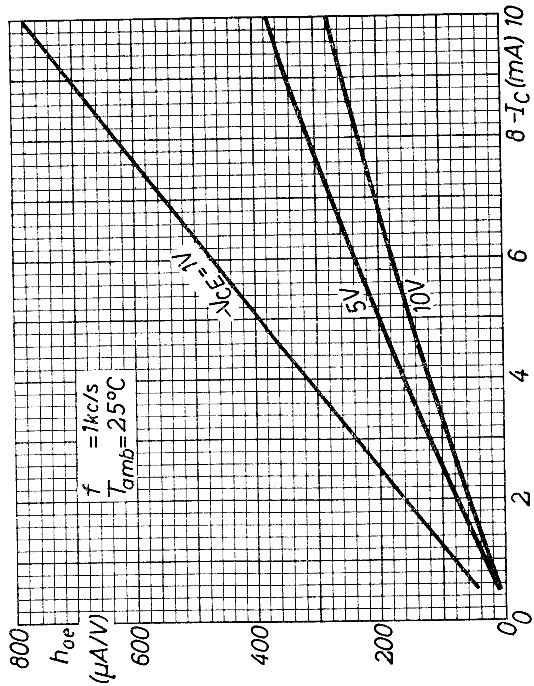
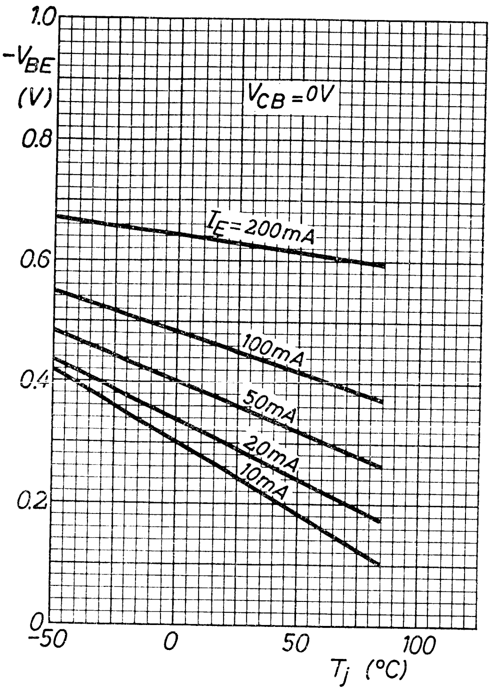
G

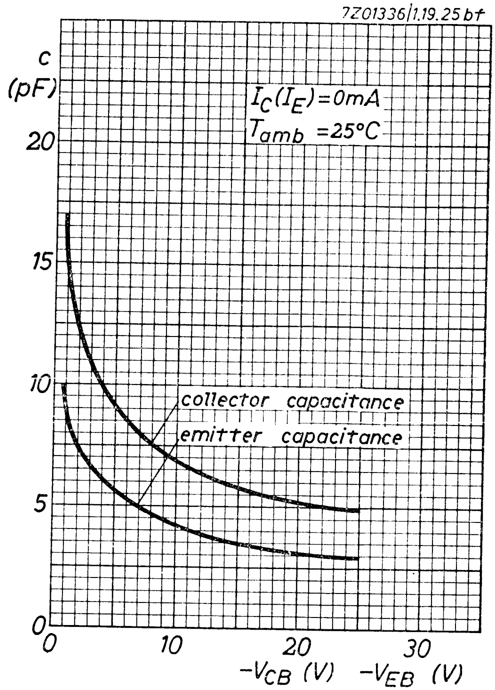

7Z01334/1.19.25bf
h_{FE}
$V_{CB}=0V$
T_j (°C)
-50
-25
0
25
50
75
80
60
40
20
0
0
50
100
150
200
250
$-I_C$ (mA)
300

F

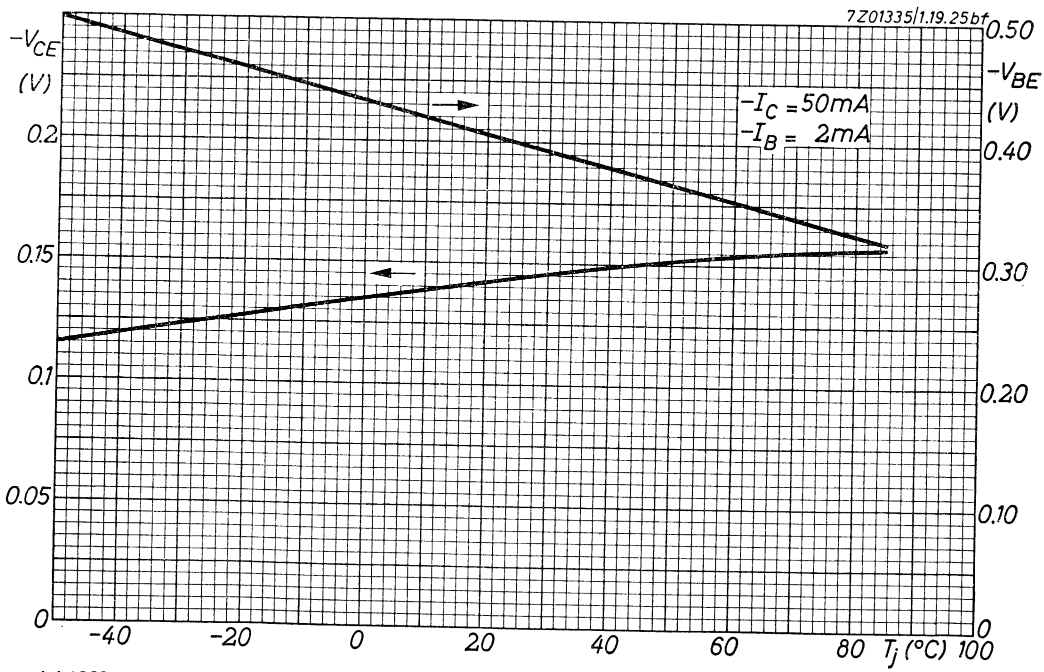

7Z01340/1.19.25bf
f =1kc/s
T_{amb}= 25°C
$-V_{CE}$ =10V
5V
1V
h_{fe}
60
40
20
0
0
2
4
6
8
$-I_C$ (mA)
10


f =1kc/s
T_{amb}=25°C
$-V_{CE}$ = 1V
5V
10V
h_{oe}
(µA/V)
800
600
400
200
0
0
2
4
6
8
$-I_C$ (mA)
10


1.0
$-V_{BE}$
(V)
0.8
0.6
0.4
0.2
0
$V_{CB}=0V$
$I_E=200mA$
100mA
50mA
20mA
10mA
-50
0
50
100
T_j (°C)


7Z01336/1.19.25 bf
c
(pF)
20
15
10
5
0
$I_C(I_E)=0mA$
$T_{amb}=25°C$
collector capacitance
emitter capacitance
0
10
20
30
$-V_{CB}$ (V) $-V_{EB}$ (V)

H


7Z01335/1.19.25bf
$-V_{CE}$
(V)
0.2
0.15
0.1
0.05
0
0.50
$-V_{BE}$
(V)
0.40
0.30
0.20
0.10
0
$-I_C=50mA$
$-I_B=\ 2mA$
-40
-20
0
20
40
60
80
T_j (°C)
100

I

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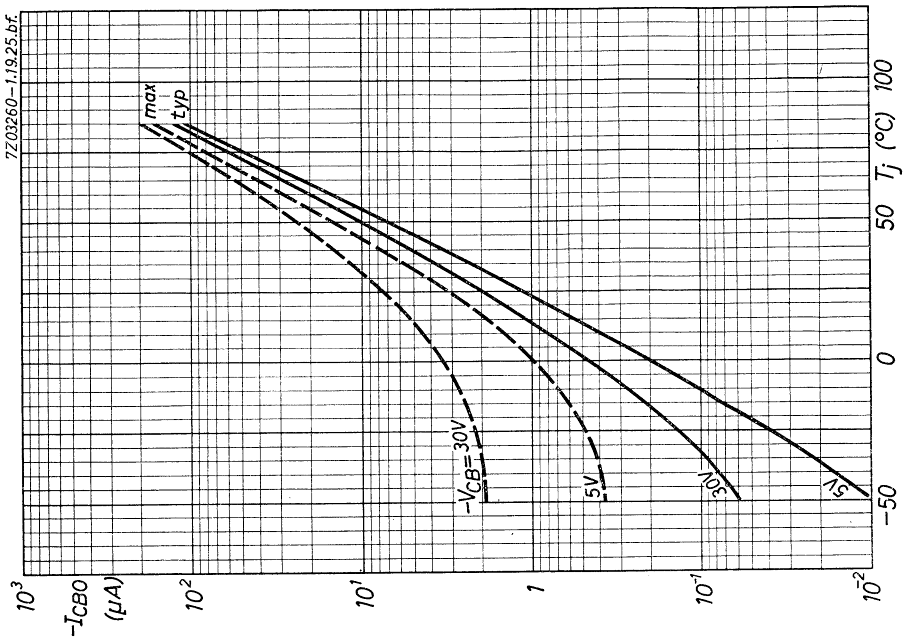
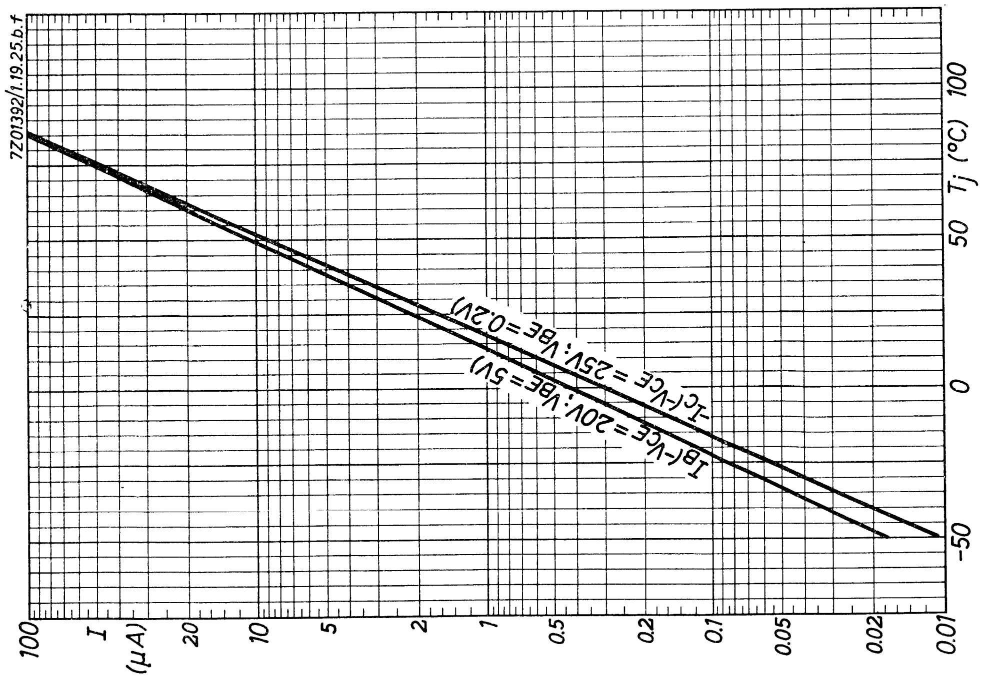
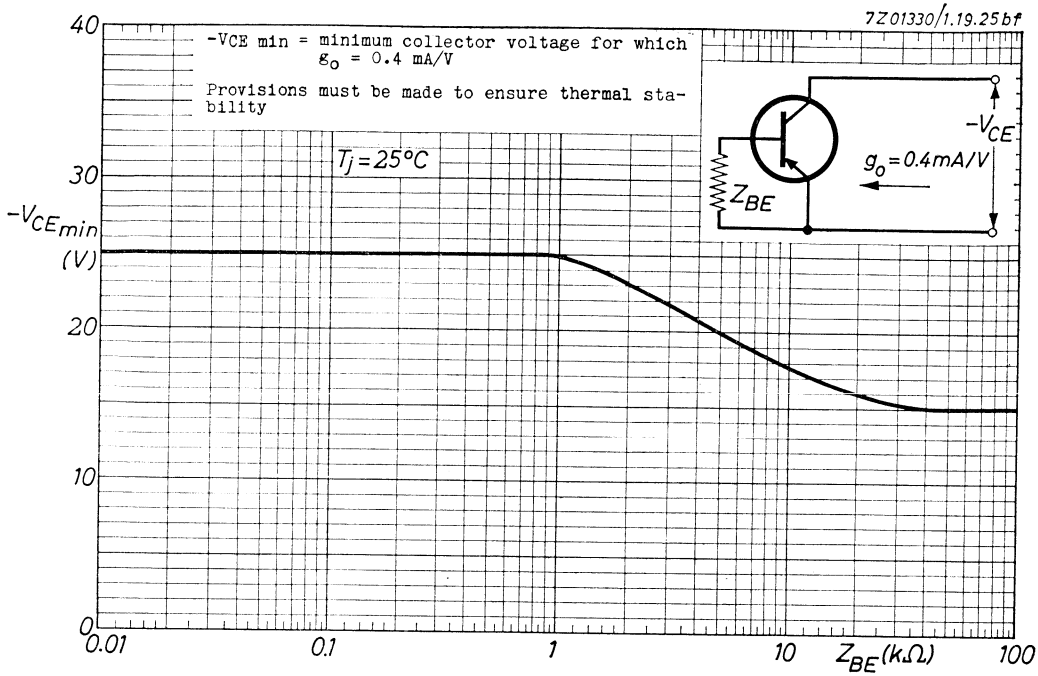
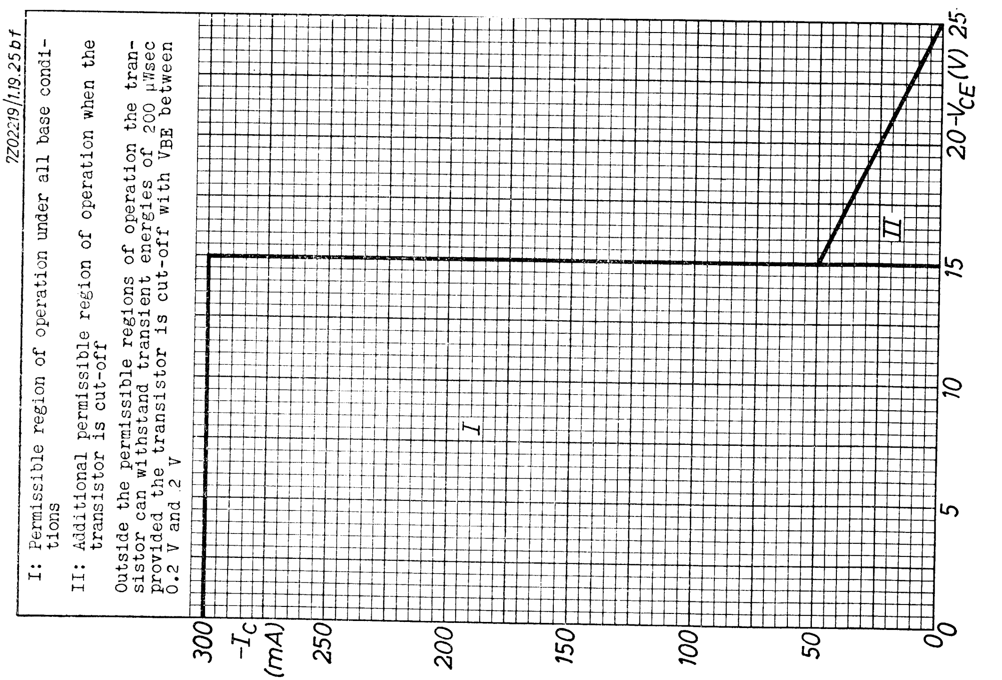

7Z03260-1.19.25.bf.
$-I_{CBO}$ (μA)
10^3
10^2
10^1
1
10^{-1}
10^{-2}
max
typ
$-V_{CB}=30V$
5V
30V
5V
T_j (°C)
−50
0
50
100

K


7Z01392/1.19.25.b.f
I (μA)
100
20
10
5
2
1
0.5
0.2
0.1
0.05
0.02
0.01
$-I_C(-V_{CE}=25V; V_{BE}=0.2V)$
$I_B(-V_{CE}=20V; V_{BE}=5V)$
T_j (°C)
−50
0
50
100

J


7Z01330/1.19.25bf
-VCE min = minimum collector voltage for which g_o = 0.4 mA/V
Provisions must be made to ensure thermal stability
$T_j = 25°C$
$-V_{CE}$
$g_o = 0.4 mA/V$
Z_{BE}
$-V_{CE min}$ (V)
40
30
20
10
0
0.01
0.1
1
10
Z_{BE} (kΩ)
100


7Z02219/1.19.25bf
I: Permissible region of operation under all base conditions
II: Additional permissible region of operation when the transistor is cut-off
Outside the permissible regions of operation the transistor can withstand transient energies of 200 μWsec provided the transistor is cut-off with V_{BE} between 0.2 V and 2 V
I
II
$-V_{CE}$ (V)
25
20
15
10
5
0
$-I_C$ (mA)
300
250
200
150
100
50
0

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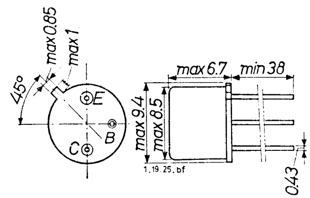
GERMANIUM p-n-p ALLOY TRANSISTOR for medium current medium speed computer logic applications and for general purposes

Dimensions in mm



The base is electrically connected to the case

LIMITING VALUES (Absolute max. values)

Collector

Voltage (base reference)	$-V_{CB}$	= max.	25 V
Voltage (emitter reference) (See also page M)	$-V_{CE}$	= max.	20 V
Current (averaging time = max. 20 msec)	$-I_C$ (t_{av}	= max. = max.	200 mA 20 msec)
Peak current	$-I_{CM}$	= max.	300 mA

Emitter

Voltage (base reference)	$-V_{EB}$	= max.	20 V
Current (averaging time = max. 20 msec)	I_E (t_{av}	= max. = max.	230 mA 20 msec)
Peak current	I_{EM}	= max.	300 mA

Base

Current (averaging time = max. 20 msec)	$-I_B$ (t_{av}	= max. = max.	30 mA 20 msec)
Peak current	$-I_{BM}$	= max.	300 mA

Dissipation

Total dissipation	P_{tot}	= max.	150 mW [1])

Temperatures

Junction temperature	T_j	= max.	85 °C
Storage temperature	T_s	=	-65 °C to +100 °C

[1]) The maximum permissible dissipation for a certain application can be calculated from the formula:

$$P_{tot} = \text{max.} \frac{T_{j\,max} - T_{amb}}{K_{j-amb}}$$

7Z2 1729 3.3.1965 1.

THERMAL DATA

Thermal resistance from junction to ambience in free air	K_{j-amb}	= max. 0.4 °C/mW
Thermal resistance from junction to case	K_{j-c}	= max. 0.2 °C/mW

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

Collector-base leakage current

$-I_{CBO}$ ($-V_{CB}$ = 5 V; I_E = 0 mA)	< 3 µA

Emitter-base leakage current

$-I_{EBO}$ ($-V_{EB}$ = 5 V; I_C = 0 mA)	< 3 µA

Base current

$-I_B$ (I_E = 10 mA; V_{CB} = 0 V)	< 195 µA
$-I_B$ (I_E = 100 mA; V_{CB} = 0 V)	< 3.25 mA

Emitter-base voltage

$-V_{EB}$ {$-I_E$ = 100 µA; I_C = 0 mA; T_{amb} = 60 °C}	> 20 V
V_{EB} (I_E = 100 mA; V_{CB} = 0 V)	< 0.55 V
$-V_{BE}$ ($-I_C$ = 50 mA; $-I_B$ = 1.55 mA)	< 0.45 V

Punch through voltage

V_{PT}	> 20 V

7Z2 3038 2.

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN

T_{amb} = 25 °C unless otherwise specified

Collector current		
$-I_C$ { $-V_{CE}$ = 20 V; V_{BE} = 0.2 V; T_{amb} = 60 °C }	<	35 μA
Base current		
I_B { $-V_{CE}$ = 20 V; V_{BE} = 5 V; T_{amb} = 60 °C }	<	35 μA
Collector voltage (See also page L)		
$-V_{CE}$ ($-I_C$ = 5 mA; I_B = 0 mA)	>	15 V
Floating potential		
$-V_{BE}$ ($-V_{CE}$ = 20 V; T_{amb} = 60 °C)	<	200 mV
Direct current amplification factor		
h_{FE} (I_E = 20 mA; V_{CB} = 0 V)	>	50
	<	150
h_{FE} (I_E = 200 mA; V_{CB} = 0 V)	>	20
Base-emitter voltage		
$-V_{BE}$ (I_E = 300 mA; V_{CB} = 0 V)	<	1.4 V
Collector voltage during bottoming		
$-V_{CE}$ ($-I_C$ = 10 mA; $-I_B$ = 0.2 mA)	<	0.20 V
$-V_{CE}$ ($-I_C$ = 50 mA; $-I_B$ = 1.25 mA)	<	0.25 V
Base voltage		
$-V_{BE}$ ($-I_C$ = 10 mA; $-I_B$ = 0.25 mA)	>	0.15 V
	<	0.32 V
Frequency at which $\|h_{fe}\|$ = 1		
f_1 ($-V_{CE}$ = 5 V; $-I_C$ = 3 mA)	>	6 Mc/s
Collector capacitance		
c_c ($-V_{CB}$ = 5V; I_E = 0 mA)	<	16 pF
Emitter capacitance		
c_e ($-V_{EB}$ = 5 V; I_C = 0 mA)	<	13 pF

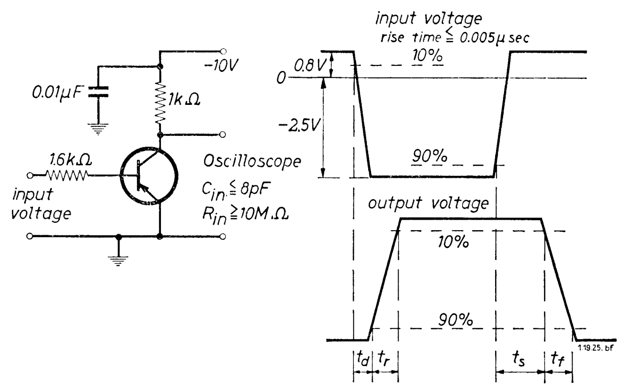
CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN (continued)

T_{amb} = 25 °C

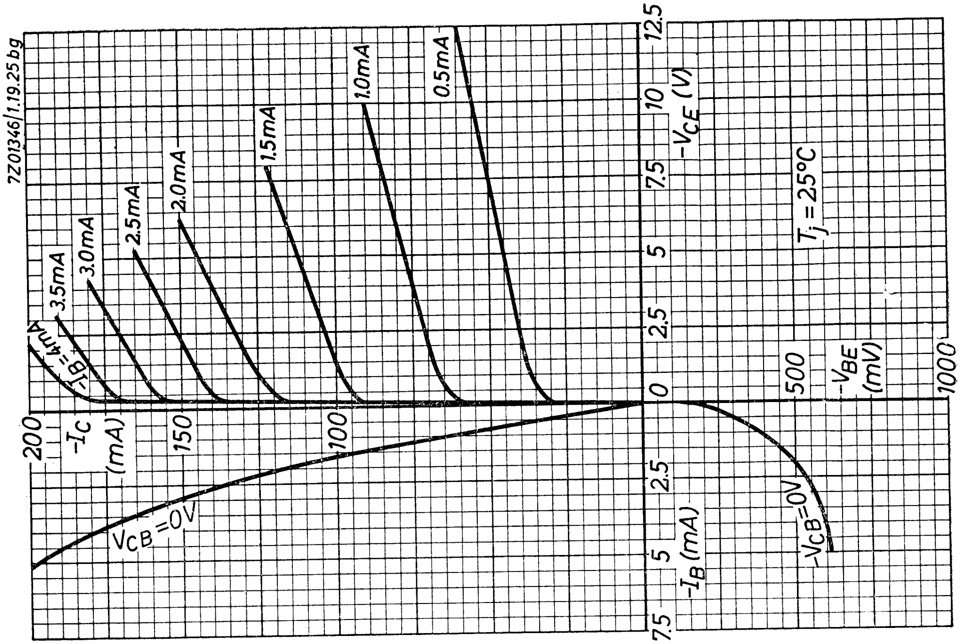
Transient behaviour		
Time constant with current feed		
τ_c ($-V_{CE}$ = 0.75 V; $-I_{CM}$ = 50 mA)	<	2.2 μsec
Time constant with voltage feed		
τ_v ($-V_{CE}$ = 0.75 V; $-I_{CM}$ = 1 mA)	<	0.2 μsec
Desaturation time constant		
τ_s ($-I_C$ = 0 mA; $-I_B$ = 1 mA)	<	1.25 μsec
On demand current gain		
β_T { ΔI_C = 50 mA; t = 0.1 μsec; $-V_{CE} \leqq$ 0.3 V }	>	10
	=	25

SWITCHING CHARACTERISTICS at T_{amb} = 25 °C

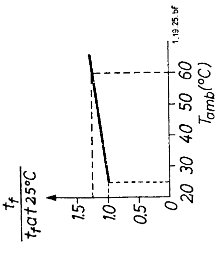
Delay time	t_d	<	0.075 μsec
Rise time	t_r	<	0.35 μsec
Storage time	t_s	<	1.50 μsec
Fall time	t_f	<	0.62 μsec

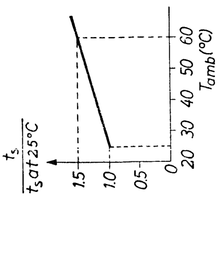


See also page 5



A





7Z2 1750
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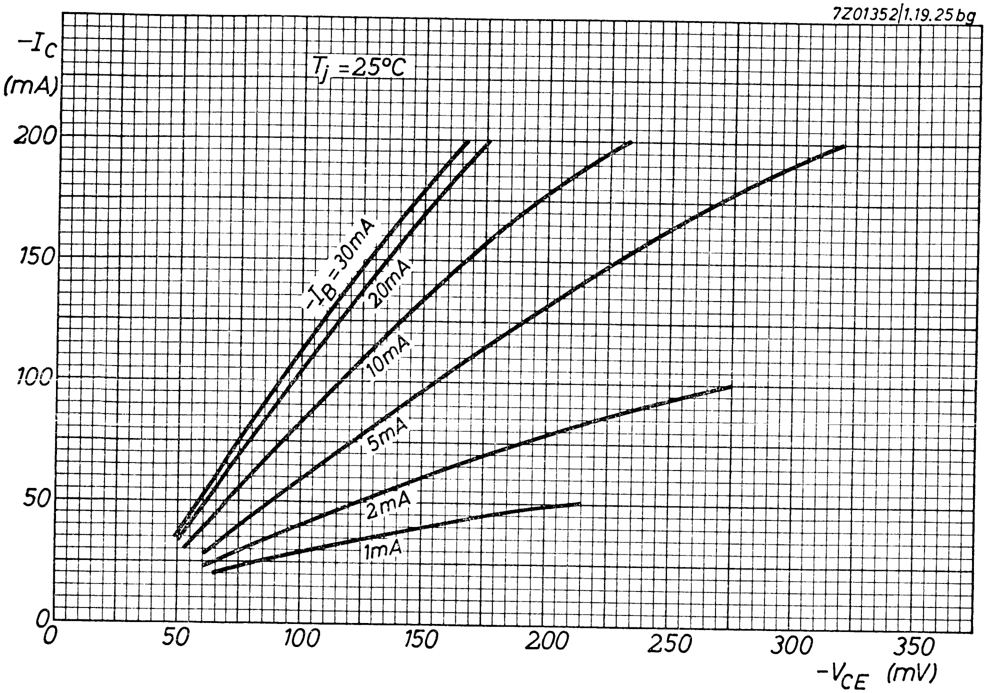
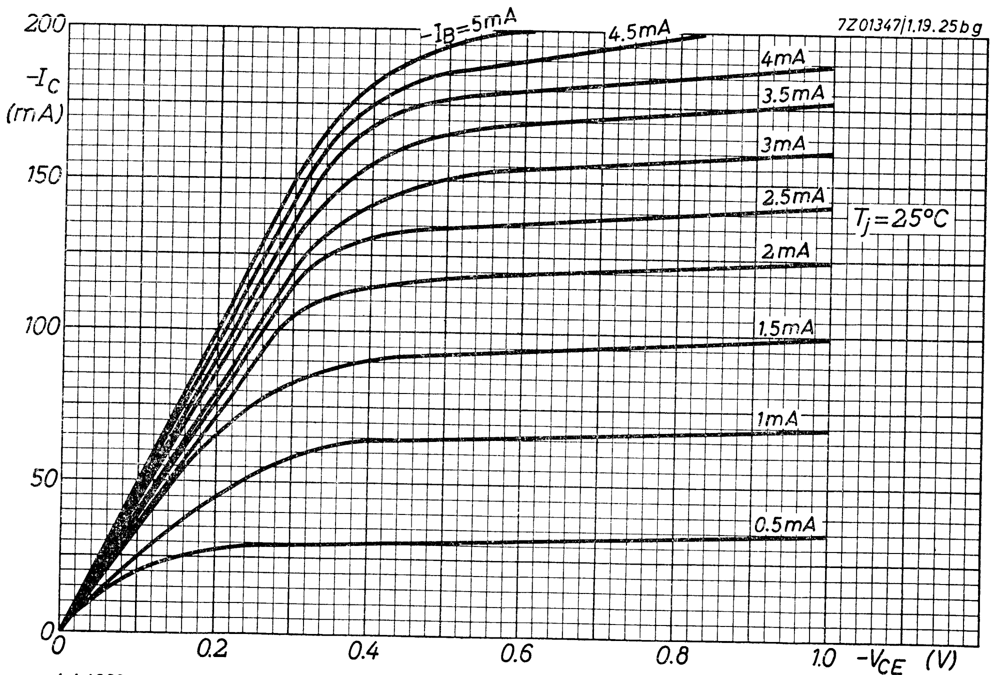
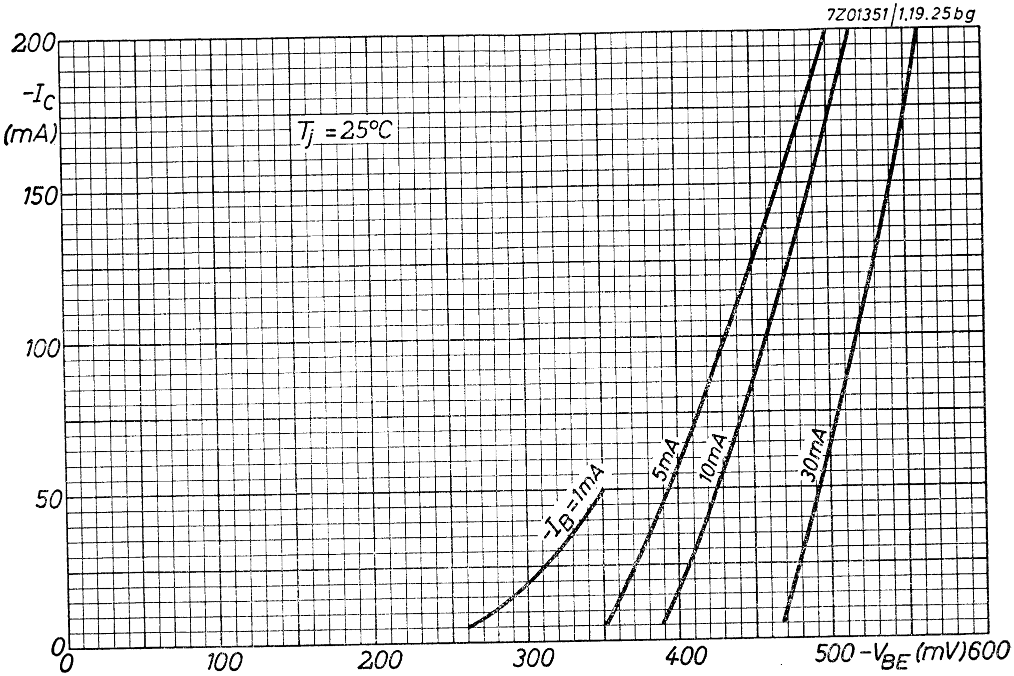

7Z01352/1.19.25bg
$-I_C$ (mA)
$T_j = 25°C$
200
150
100
50
0
$-I_B = 30mA$
20mA
10mA
5mA
2mA
1mA
0
50
100
150
200
250
300
350
$-V_{CE}$ (mV)

B

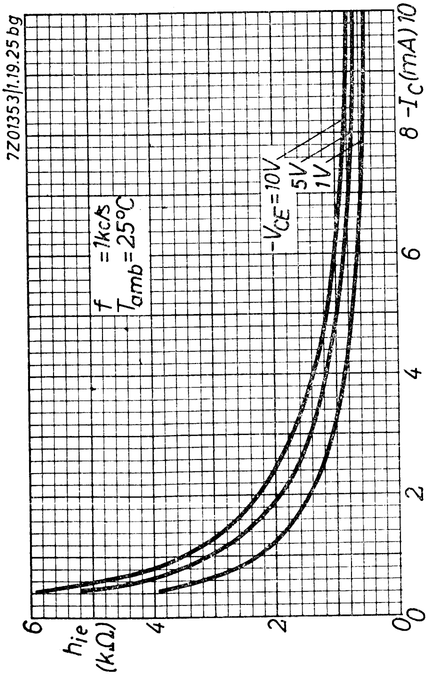

7Z01347/1.19.25bg
200
$-I_C$ (mA)
150
100
50
0
$-I_B = 5mA$
4.5mA
4mA
3.5mA
3mA
2.5mA
2mA
1.5mA
1mA
0.5mA
$T_j = 25°C$
0
0.2
0.4
0.6
0.8
1.0
$-V_{CE}$ (V)

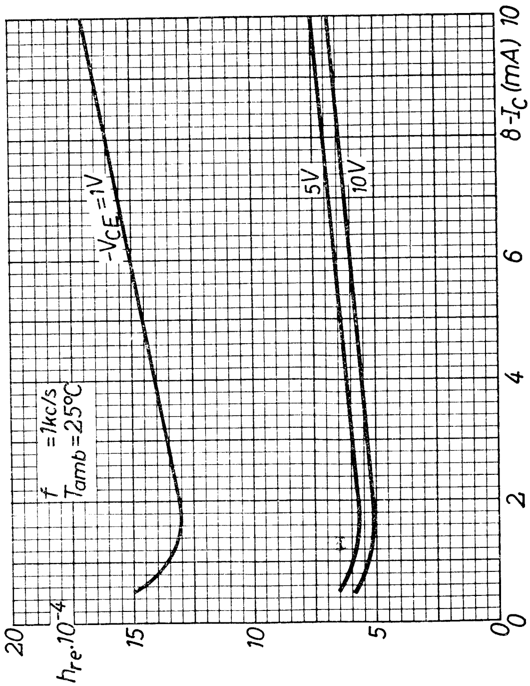
C

D

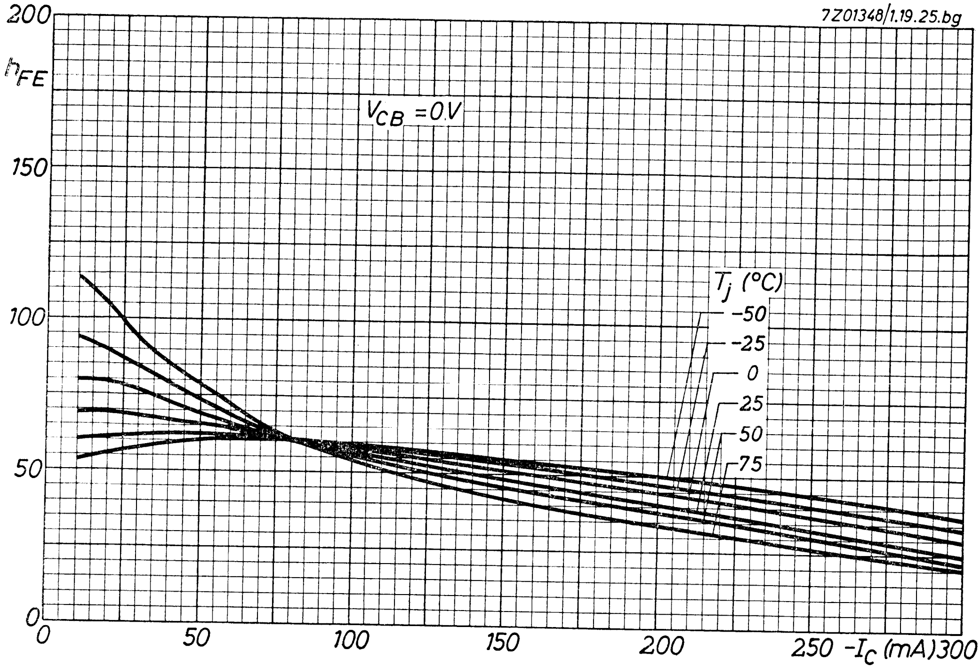

7Z01351/1.19.25bg
200
$-I_C$
(mA)
150
100
50
0
T_j = 25°C
$-I_B$=1mA
5mA
10mA
30mA
0
100
200
300
400
500 $-V_{BE}$ (mV) 600

E

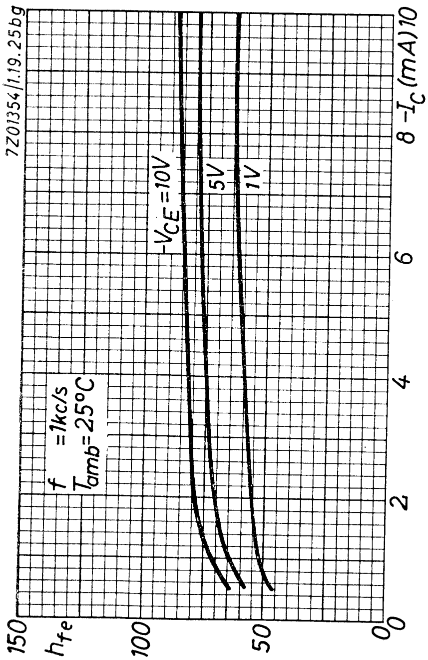

7Z01353/1.19.25bg
f = 1kc/s
T_{amb} = 25°C
$-V_{CE}$=10V
5V
1V
h_{ie}
(kΩ)
$-I_C$ (mA)

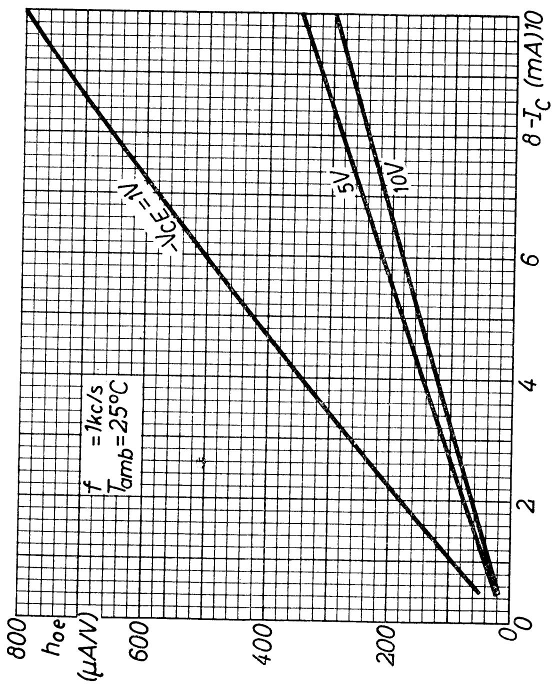

f = 1kc/s
T_{amb} = 25°C
$-V_{CE}$ = 1V
5V
10V
$h_{re} \cdot 10^{-4}$
$-I_C$ (mA)

F

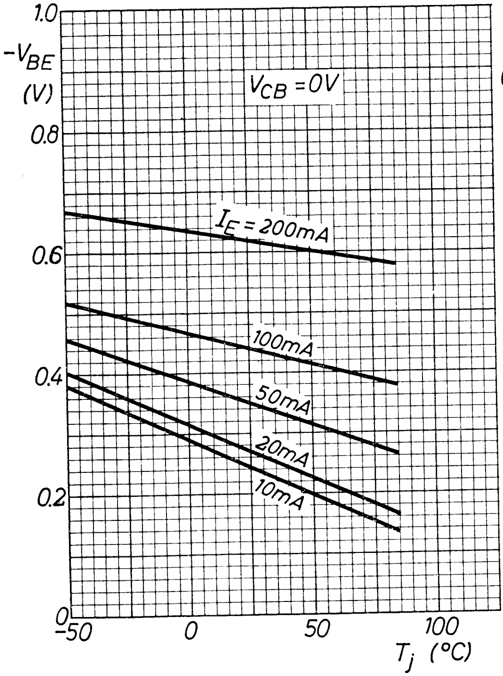

7Z01348/1.19.25.bg
h_{FE}
$V_{CB} = 0V$
T_j (°C)
−50
−25
0
25
50
75
200
150
100
50
0
0
50
100
150
200
250
$-I_C$ (mA)
300

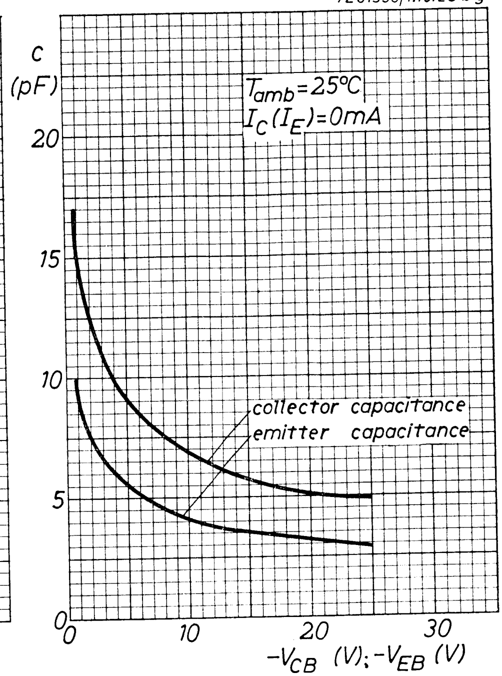
G


7Z01354/1.19.25bg
$-V_{CE}$=10V
5V
1V
f =1kc/s
T_{amb}=25°C
h_{fe}
150
100
50
0
0
2
4
6
8
$-I_C$ (mA)
10

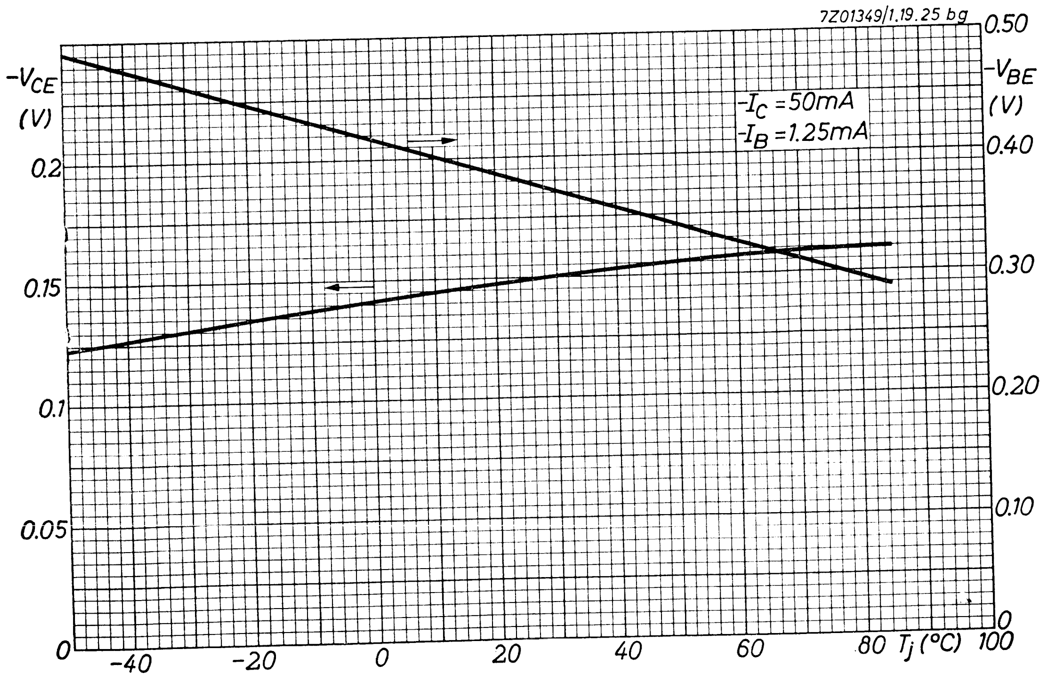

$-V_{CE}$=1V
5V
10V
f =1kc/s
T_{amb}=25°C
h_{oe}
(μA/V)
800
600
400
200
0
0
2
4
6
8
$-I_C$ (mA)
10

4.4.1963

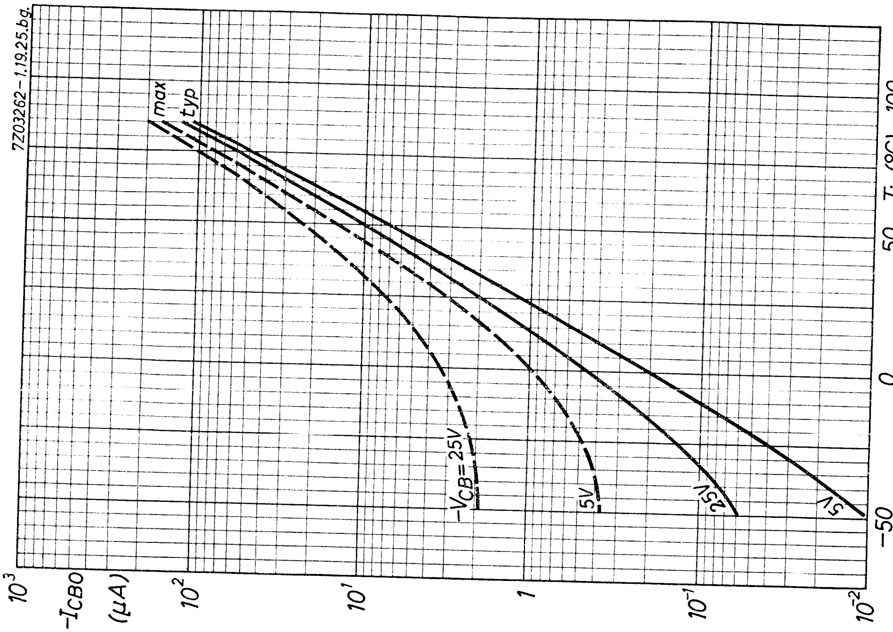

7Z01350/1.19.25 bg
1.0
$-V_{BE}$
(V)
0.8
0.6
0.4
0.2
0
$V_{CB} = 0V$
$I_E = 200mA$
100mA
50mA
20mA
10mA
-50
0
50
100
T_j (°C)


C
(pF)
20
15
10
5
0
$T_{amb} = 25°C$
$I_C(I_E) = 0mA$
collector capacitance
emitter capacitance
0
10
20
30
$-V_{CB}$ (V); $-V_{EB}$ (V)

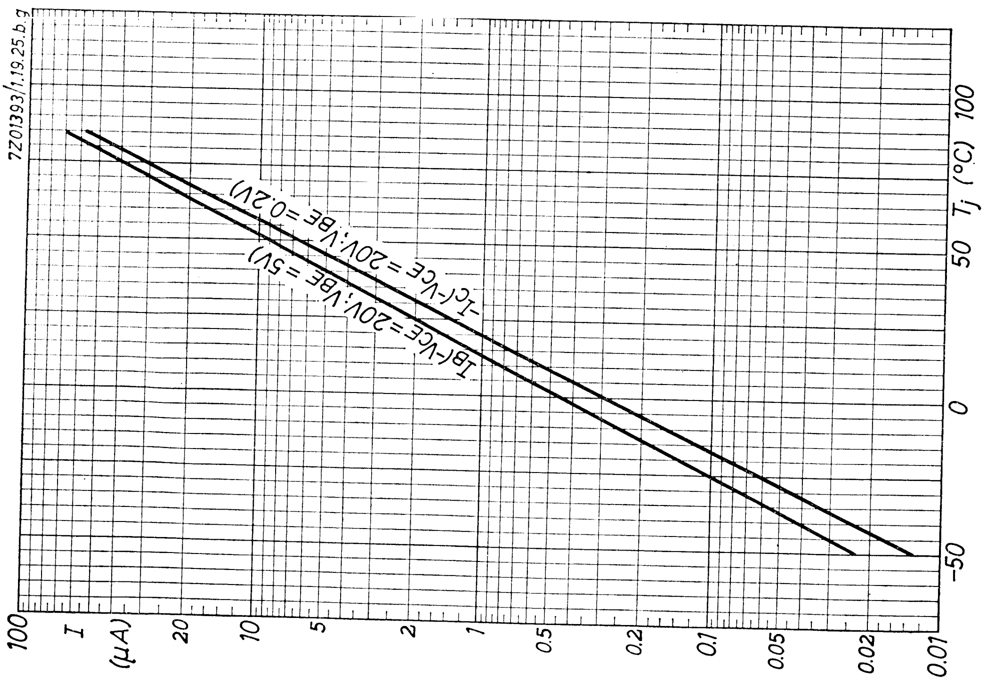
H


7Z01349/1.19.25 bg
$-V_{CE}$
(V)
0.2
0.15
0.1
0.05
0
$-V_{BE}$
(V)
0.50
0.40
0.30
0.20
0.10
0
$-I_C = 50mA$
$-I_B = 1.25mA$
-40
-20
0
20
40
60
80
T_j (°C)
100

I

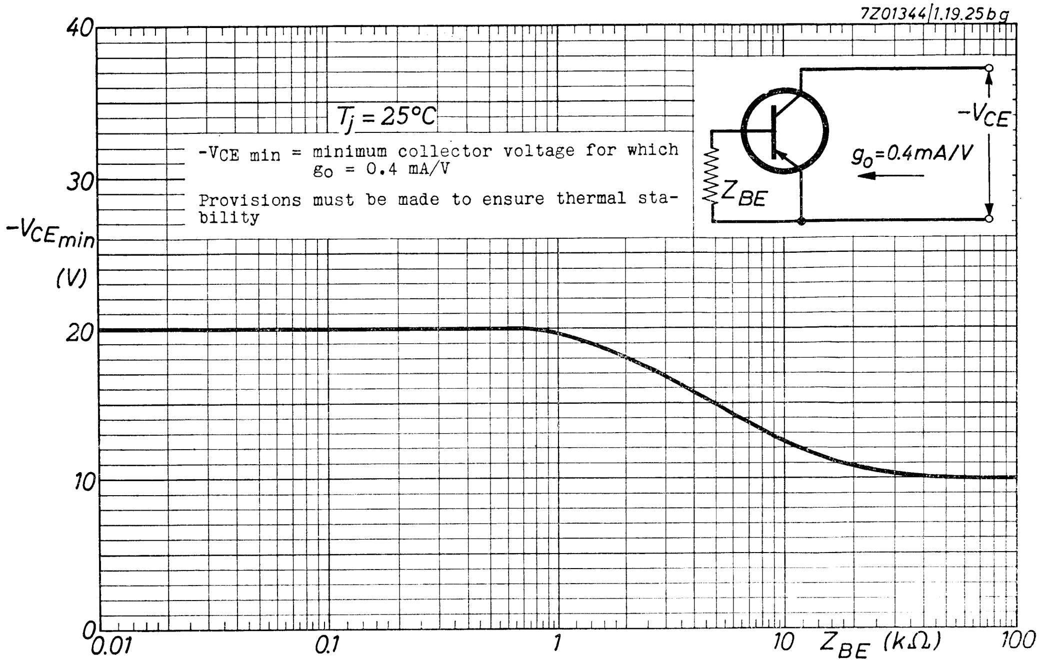

7Z03262-1.19.25.bg.
$-I_{CBO}$
(μA)
10^3
10^2
10^1
1
10^{-1}
10^{-2}
max
typ
$-V_{CB}=25V$
5V
25V
5V
−50
0
50
100
T_j (°C)

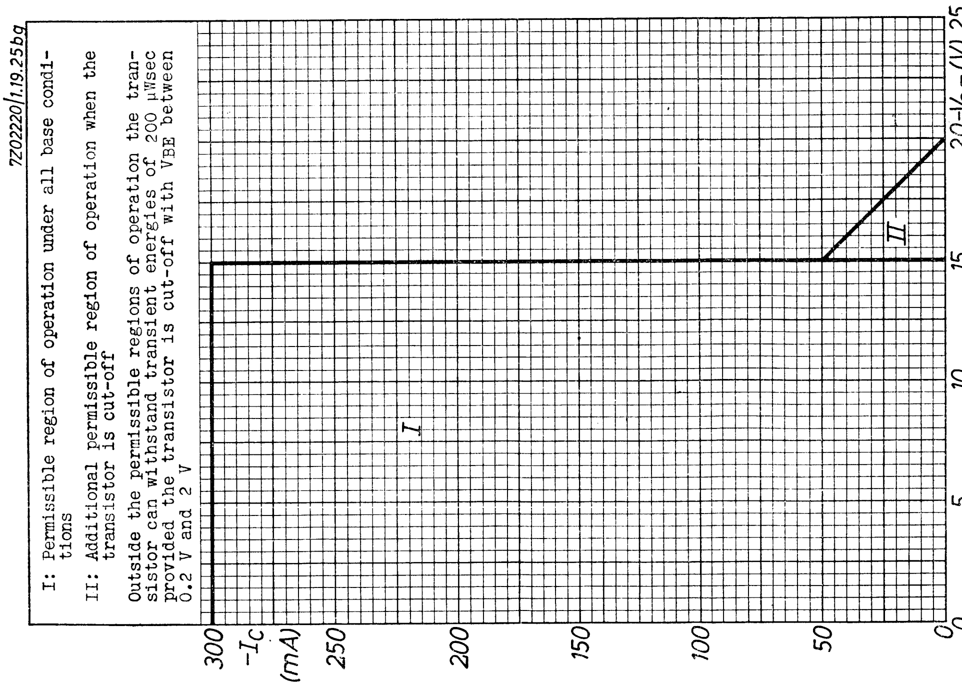
K


7Z01393/1.19.25.b.g
I
(μA)
100
20
10
5
2
1
0.5
0.2
0.1
0.05
0.02
0.01
$-I_C(-V_{CE}=20V; V_{BE}=0.2V)$
$I_B(-V_{CE}=20V; V_{BE}=5V)$
−50
0
50
100
T_j (°C)

J

M


7Z01344/1.19.25bg
40
30
20
10
0
$-V_{CE\,min}$
(V)
$T_j = 25°C$
$-V_{CE\,min}$ = minimum collector voltage for which g_o = 0.4 mA/V
Provisions must be made to ensure thermal stability
Z_{BE}
$-V_{CE}$
g_o=0.4mA/V
0.01
0.1
1
10
Z_{BE} (kΩ)
100

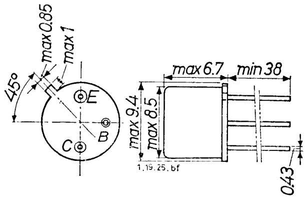

7Z02220/1.19.25bg
I: Permissible region of operation under all base conditions
II: Additional permissible region of operation when the transistor is cut-off
Outside the permissible regions of operation the transistor can withstand transient energies of 200 µWsec provided the transistor is cut-off with V_{BE} between 0.2 V and 2 V
I
II
$-I_C$
(mA)
300
250
200
150
100
50
0
0
5
10
15
20
$-V_{CE}$ (V)
25

L

4.4.1963

GERMANIUM n-p-n ALLOY TRANSISTORS for medium current medium speed computer logic applications

SOT 5 metal envelope — Dimensions in mm



The base is electrically connected to the case

LIMITING VALUES (Absolute max. values)

		ASY28	ASY29	
Collector				
Voltage (base reference)	V_{CB} = max.	30 V	25 V	
Voltage (emitter reference)	V_{CE} = max.	25 V	20 V	
Current (averaging time = max. 20 msec)	I_C = max.	100		mA
	(t_{av} = max.	20		msec)
Peak current	I_{CM} = max.	200		mA
Emitter				
Voltage (base reference)	V_{EB} = max.	20		V
Current (averaging time = max. 20 msec)	$-I_E$ = max.	125		mA
	(t_{av} = max.	20		msec)
Peak current	$-I_{EM}$ = max.	200		mA
Base				
Current (averaging time = max. 20 msec)	I_B = max.	25		mA
	(t_{av} = max.	20		msec)
Peak current	I_{BM} = max.	200		mA
Dissipation				
Total dissipation	P_{tot} = max.	125		mW
Temperatures				
Junction temperature	T_j = max.	75		°C
Storage temperature	T_s =	−65°C to +75		°C

THERMAL DATA

Thermal resistance from junction to ambience in free air — $K_{j\text{-}amb}$ = max. 0.4 °C/mW

Thermal resistance from junction to case — $K_{j\text{-}c}$ = max. 0.2 °C/mW

CHARACTERISTICS at T_{amb} = 25 °C

	ASY28	ASY29
Collector-base leakage current		
I_{CBO} (V_{CB} = 5 V; I_E = 0 mA)	< 3 μA	< 3 μA
Emitter-base leakage current		
I_{EBO} (V_{EB} = 5 V; I_C = 0 mA)	< 3 μA	< 3 μA
Base current		
I_B ($-I_E$ = 10 mA; V_{CB} = 0 V)	< 325 μA	< 195 μA
I_B ($-I_E$ = 100 mA; V_{CB} = 0 V)	< 4.75 mA	< 3.25 mA
Collector-emitter saturation voltage		
V_{CE} (I_C = 50 mA; I_B = 2 mA)	< 0.25 V	
V_{CE} (I_C = 50 mA; I_B = 1.25 mA)		< 0.25 V
Punch through voltage		
V_{PT}	> 25 V	> 20 V

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN

T_{amb} = 25 °C unless otherwise specified

	ASY28	ASY29
Collector reverse current		
I_C (V_{CE} = 25 V; $-V_{BE}$ = 0.2 V; T_{amb} = 60 °C)	< 35 μA	
I_C (V_{CE} = 20 V; $-V_{BE}$ = 0.2 V; T_{amb} = 60 °C)		< 35 μA
Base current		
I_B (V_{CE} = 20 V; $-V_{BE}$ = 5 V; T_{amb} = 60 °C)	< 35 μA	< 35 μA
Direct current amplification factor		
h_{FE} ($-I_E$ = 20 mA; V_{CB} = 0 V)	> 30 < 80	> 50 < 150
Base-emitter voltage		
V_{BE} ($-I_E$ = 100 mA; V_{CB} = 0 V)	< 0.65 V	< 0.55 V
Collector-emitter saturation voltage		
V_{CE} (I_C = 10 mA; I_B = 0.33 mA)	< 0.20 V	
V_{CE} (I_C = 10 mA; I_B = 0.2 mA)		< 0.20 V

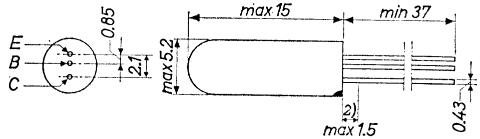
CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN (continued)

$T_{amb} = 25\ ^oC$

	ASY28	ASY29
Base voltage		
V_{BE} (I_C = 10 mA; I_B = 0.4 mA)	> 0.20 V < 0.37 V	
V_{BE} (I_C = 10 mA; I_B = 0.25 mA)		> 0.15 V < 0.32 V
V_{BE} (I_C = 50 mA; I_B = 2.4 mA)	< 0.55 V	
V_{BE} (I_C = 50 mA; I_B = 1.55 mA)		< 0.45 V
Frequency at which $\lvert h_{fe} \rvert$ = 1		
f_1 (V_{CE} = 5 V; I_C = 3 mA)	> 4 Mc/s	> 10 Mc/s
Collector capacitance		
c_c (V_{CB} = 5 V; I_E = 0 mA)	< 16 pF	< 16 pF
Emitter capacitance		
c_e (V_{EB} = 5 V; I_C = 0 mA)	< 13 pF	< 13 pF
Transient behaviour		
Time constant with current feed		
τ_c (V_{CE} = 0.75 V; I_{CM} = 50 mA)	< 2.2 µsec	< 2.2 µsec
Time constant with voltage feed		
τ_v (V_{CE} = 0.75 V; I_{CM} = 1 mA)	< 0.2 µsec	< 0.2 µsec
Desaturation time constant		
τ_s (I_C = 0 mA; I_B = 1 mA)	< 1.4 µsec	< 1.4 µsec

GERMANIUM ALLOY TRANSISTOR of the p-n-p type in all-glass construction for medium-current medium-speed computer logic applications

Dimensions in mm — The red dot indicates the collector



LIMITING VALUES (Absolute maximum values)

Collector

Voltage (base reference)	$-V_{CB}$ = max.	25 V
Voltage (emitter reference)	$-V_{CE}$ = max.	20 V
Current		
Peak	$-I_{CM}$ = max.	200 mA
D.C. and average (averaging time = max. 20 msec)	$-I_C$ = max.	100 mA
	(t_{av} = max.	20 msec)

Emitter

Voltage (base reference)	$-V_{EB}$ = max.	20 V
Current		
Peak	I_{EM} = max.	200 mA
D.C. and average (averaging time = max. 20 msec)	I_E = max.	125 mA
	(t_{av} = max.	20 msec)

Base

Current		
Peak	$-I_{BM}$ = max.	200 mA
D.C. and average (averaging time = max. 20 msec)	$-I_B$ = max.	25 mA
	(t_{av} = max.	20 msec)

Dissipation

Total dissipation	P_{tot} = max.	125 mW 1)

Temperatures

Storage	T_S =	-55 °C to +75 °C
Junction	T_j = max.	75 °C

1) The maximum admissible dissipation for a certain application can be calculated from the formula: $P_{tot} = \text{max.}\ \frac{T_{j\,max} - T_{amb}}{K}$

2) Not tinned

7Z2 1118
5.5.1962

THERMAL DATA

Thermal resistance from junction to ambience in free air	K = max. 0.4 °C/mW
Thermal resistance from junction to case	K = max. 0.2 °C/mW

CHARACTERISTICS

T_{amb} = 25 °C unless otherwise specified

Collector current at I_E = 0 mA		
$-I_{CBO}$ ($-V_{CB}$ = 5 V)	<	3 µA
Emitter current at I_C = 0 mA		
$-I_{EBO}$ ($-V_{EB}$ = 5 V)	<	3 µA
Base current at V_{CB} = 0 V		
$-I_B$ (I_E = 10 mA; V_{CB} = 0 V)	<	325 µA
$-I_B$ (I_E = 20 mA; V_{CB} = 0 V)	> <	250 µA 645 µA
$-I_B$ (I_E = 100 mA; V_{CB} = 0 V)	<	4.75 mA
Collector voltage		
$-V_{CB}$ ($-I_C$ = 40 µA; I_E = 0 mA; T_{amb} = 60 °C)	>	25 V
Emitter voltage		
$-V_{EB}$ ($-I_E$ = 100 µA; I_C = 0 mA; T_{amb} = 60 °C)	>	20 V
V_{EB} (I_E = 100 mA; V_{CB} = 0 V)	<	0.65 V
$-V_{BE}$ ($-I_C$ = 50 mA; $-I_B$ = 2.4 mA)	<	0.55 V
Punch through voltage		
V_{PT}	>	20 V

7Z2 2263

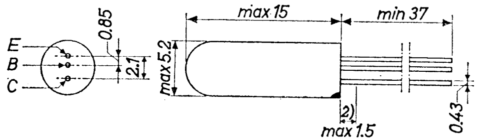
CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN

T_{amb} = 25 °C unless otherwise specified

Collector current		
$-I_C$ {$-V_{CE}$ = 20 V; V_{BE} = 0.2 V; T_{amb} = 60 °C}	<	35 μA
Base current		
I_B {$-V_{CE}$ = 20 V; V_{BE} = 5 V; T_{amb} = 60 °C}	<	35 μA
Collector voltage		
$-V_{CE}$ ($-I_C$ = 5 mA; I_B = 0 mA)	>	15 V
Floating potential		
$-V_{BE}$ ($-V_{CE}$ = 25 V; T_{amb} = 60 °C)	<	200 mV
Collector voltage in bottoming		
$-V_{CE}$ ($-I_C$ = 10 mA; $-I_B$ = 0.33 mA)	<	0.20 V
$-V_{CE}$ ($-I_C$ = 50 mA; $-I_B$ = 2.0 mA)	<	0.25 V
Base voltage		
$-V_{BE}$ ($-I_C$ = 10 mA; $-I_B$ = 0.4 mA)	>	0.20 V
	<	0.37 V
Frequency at which $\|h_{fe}\|$ = 1		
f_1 ($-V_{CE}$ = 5 V; $-I_C$ = 3 mA)	>	4 Mc/s
Collector capacitance		
c_c ($-V_{CB}$ = 5 V; I_E = 0 mA)	<	16 pF
Emitter capacitance		
c_e ($-V_{EB}$ = 5 V; I_C = 0 mA)	<	13 pF
Transient behaviour		
Time constant with current feed		
τ_c ($-V_{CE}$ = 0.75 V; $-I_{CM}$ = 50 mA)	<	2.2 μsec
Time constant with voltage feed		
τ_v ($-V_{CE}$ = 0.75 V; $-I_{CM}$ = 1 mA)	<	0.2 μsec
Desaturation time constant		
τ_s ($-I_C$ = 0 mA; $-I_B$ = 1 mA)	<	1.4 μsec

GERMANIUM ALLOY TRANSISTOR of the p-n-p type in all-glass construction for medium-current medium-speed computer logic applications

Dimensions in mm   The red dot indicates the collector



LIMITING VALUES (Absolute maximum values)

Collector

Voltage (base reference)	$-V_{CB}$ = max.	25 V
Voltage (emitter reference)	$-V_{CE}$ = max.	20 V
Current		
Peak	$-I_{CM}$ = max.	200 mA
D.C. and average (averaging time = max. 20 msec)	$-I_C$ = max.	100 mA
	(t_{av} = max.	20 msec)

Emitter

Voltage (base reference)	$-V_{EB}$ = max.	20 V
Current		
Peak	I_{EM} = max.	200 mA
D.C. and average (averaging time = max. 20 msec)	I_E = max.	125 mA
	(t_{av} = max.	20 msec)

Base

Current		
Peak	$-I_{BM}$ = max.	200 mA
D.C. and average (averaging time = max. 20 msec)	$-I_B$ = max.	25 mA
	(t_{av} = max.	20 msec)

Dissipation

Total dissipation	P_{tot} = max.	125 mW [1])

Temperatures

Storage	T_s =	-55 °C to +75 °C
Junction	T_j = max.	75 °C

1) The maximum admissible dissipation for a certain application can be calculated from the formula: $P_{tot} = \text{max.} \frac{T_{j\,max} - T_{amb}}{K}$

2) Not tinned

7Z2 1118
5.5.1962

THERMAL DATA

Thermal resistance from junction to ambience in free air	K = max. 0.4 °C/mW
Thermal resistance from junction to case	K = max. 0.2 °C/mW

CHARACTERISTICS

T_{amb} = 25 °C unless otherwise specified

Collector current at I_E = 0 mA		
$-I_{CBO}$ ($-V_{CB}$ = 5 V)	<	3 μA
Emitter current at I_C = 0 mA		
$-I_{EBO}$ ($-V_{EB}$ = 5 V)	<	3 μA
Base current at V_{CB} = 0 V		
$-I_B$ (I_E = 10 mA; V_{CB} = 0 V)	<	195 μA
$-I_B$ (I_E = 20 mA; V_{CB} = 0 V)	> <	130 μA 390 μA
$-I_B$ (I_E = 100 mA; V_{CB} = 0 V)	<	3.25 mA
Collector voltage		
$-V_{CB}$ ($-I_C$ = 40 μA; I_E = 0 mA; T_{amb} = 60 °C)	>	25 V
Emitter voltage		
$-V_{EB}$ ($-I_E$ = 100 μA; I_C = 0 mA; T_{amb} = 60 °C)	>	20 V
V_{EB} (I_E = 100 mA; V_{CB} = 0 V)	<	0.55 V
$-V_{BE}$ ($-I_C$ = 50 mA; $-I_B$ = 1.55 mA)	<	0.45 V
Punch through voltage		
V_{PT}	>	20 V

7Z2 2265

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN

T_{amb} = 25 °C unless otherwise specified

Collector current		
$-I_C$ { $-V_{CE}$ = 20 V; V_{BE} = 0.2 V; T_{amb} = 60 °C }	<	35 µA
Base current		
I_B { $-V_{CE}$ = 20 V; V_{BE} = 5 V; T_{amb} = 60 °C }	<	35 µA
Collector voltage		
$-V_{CE}$ ($-I_C$ = 5 mA; I_B = 0 mA)	>	15 V
Floating potential		
$-V_{BE}$ ($-V_{CE}$ = 20 V; T_{amb} = 60 °C)	<	200 mV
Collector voltage in bottoming		
$-V_{CE}$ ($-I_C$ = 10 mA; $-I_B$ = 0.2 mA)	<	0.20 V
$-V_{CE}$ ($-I_C$ = 50 mA; $-I_B$ = 1.25 mA)	<	0.25 V
Base voltage		
$-V_{BE}$ ($-I_C$ = 10 mA; $-I_B$ = 0.25 mA)	> <	0.15 V 0.32 V
Frequency at which $\lvert h_{fe}\rvert = 1$		
f_1 ($-V_{CE}$ = 5 V; $-I_C$ = 3 mA)	>	6 Mc/s
Collector capacitance		
c_c ($-V_{CB}$ = 5 V; I_E = 0 mA)	<	16 pF
Emitter capacitance		
c_e ($-V_{EB}$ = 5 V; I_C = 0 mA)	<	13 pF
Transient behaviour		
Time constant with current feed		
τ_c ($-V_{CE}$ = 0.75 V; $-I_{CM}$ = 50 mA)	<	2.2 µsec
Time constant with voltage feed		
τ_v ($-V_{CE}$ = 0.75 V; $-I_{CM}$ = 1 mA)	<	0.2 µsec
Desaturation time constant		
τ_s ($-I_C$ = 0 mA; $-I_B$ = 1 mA)	<	1.4 µsec

ASY76 ASY77 ASY80

GERMANIUM P-N-P SWITCHING TRANSISTORS

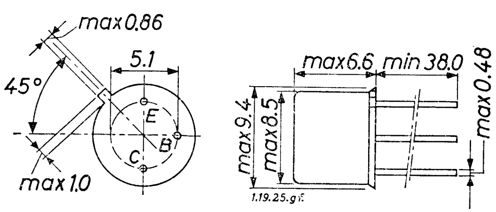
Germanium alloy junction transistors of the p-n-p type in TO-5 metal case for amplifying, switching and pulse oscillating applications.

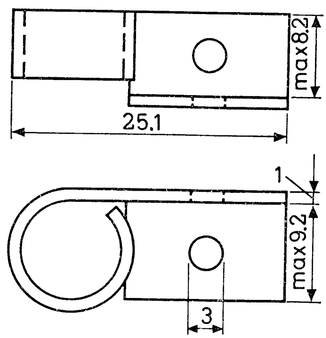
QUICK REFERENCE DATA

			ASY76	ASY77	ASY80	
Collector-base voltage	$-V_{CB}$	=	max. 40	60	40	V
Collector-emitter voltage	$-V_{CE}$	=	max. 32	60	40	V
D.C. current amplification factor at $-I_C$ = 600 mA; $-V_{CE}$ = 1 V	h_{FE}		> 20	> 20	> 40	
Peak collector current	$-I_{CM}$	=		max. 1000		mA
Total dissipation up to T_{amb} = 25 °C	P_{tot}	=		max. 500		mW
Junction temperature	T_j	=		max. 85		°C
Thermal resistance from junction to case	K	<		75		°C/W
Transition frequency	f_T	=		900		kc/s

MECHANICAL DATA

Dimensions in mm





Base connected to case

7Z2 2788

Code number of cooling fin and mounting clip 56265

LIMITING VALUES (Absolute max. values)

Voltages

			ASY76	ASY77	ASY80	
Collector to base voltage	$-V_{CB}$	=	max. 40	60	40	V
Collector to emitter voltage	$-V_{CE}$	=	max. 32	60	40	V
Reverse emitter to base voltage	$-V_{EB}$	=	max. 10	10	20	V

Currents

Collector current				
continuous and average [1]	$-I_C$	=	max. 500	mA
peak	$-I_{CM}$	=	max. 1000	mA
Emitter current				
continuous and average [1]	I_E	=	max. 540	mA
peak	I_{EM}	=	max. 1200	mA
Base current				
continuous and average [1]	$-I_B$	=	max. 40	mA
peak	$-I_{BM}$	=	max. 200	mA

Dissipation

Total dissipation up to $T_{amb} = 25\ ^{o}C$	P_{tot}	=	max. 500	mW

Temperatures

Storage temperature	T_s	=	−65 to +85	^{o}C
Junction temperature	T_j	=	max. 85	^{o}C

THERMAL DATA

Thermal resistance from junction to ambience in free air	K	<	250	$^{o}C/W$
to ambience in free air, mounted with cooling fin on a heatsink of 12.5 cm^2	K	<	120	$^{o}C/W$
to case	K	<	75	$^{o}C/W$

---

[1]) Averaged over any 20 ms period

7Z2 2789

CHARACTERISTICS at $T_j = 25\ ^oC$

		ASY76	ASY77	ASY80	
Collector current at $I_E = 0$					
$-V_{CB} = 10\ V$	$-I_{CBO}$	= 4.5 < 10	4.5 < 10	4.5 < 10	μA μA
Emitter current at $I_C = 0$ $+V_{BE} = 10\ V$	$-I_{EBO}$	< 20	< 20	< 20	μA
Base current at					
$-V_{CB} = 6\ V;\ I_E = 10\ mA$	$-I_B$	< 220	< 220		μA
$V_{CB} = 0\ ;\ I_E - 50\ mA$	$-I_B$			> 300 < 820	μA μA
$V_{CB} = 0\ ;\ I_E = 300\ mA$	$-I_B$	> 2.3 < 11.5	> 2.3 < 11.5	 < 5.9	mA mA

CHARACTERISTIC RANGE VALUES FOR EQUIPMENT DESIGN

$T_j = 25\ ^oC$, unless otherwise specified

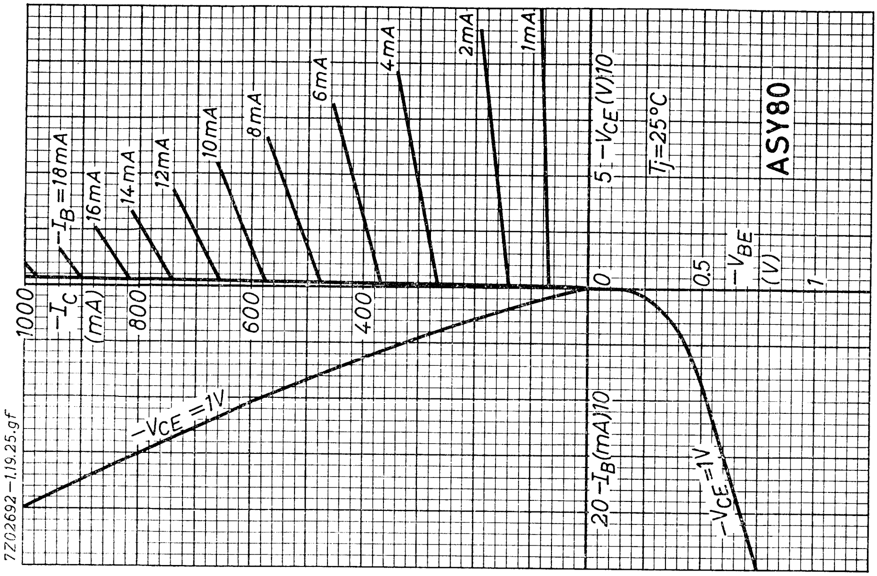
		ASY76	ASY77	ASY80	
Collector current at $I_E = 0$					
$-V_{CB} = 40\ V$	$-I_{CBO}$	< 40		< 40	μA
$-V_{CB} = 60\ V$	$-I_{CBO}$		< 40		μA
Collector current at $+V_{BE} = 0.5\ V$					
$-V_{CE} = 30\ V$	$-I_{CEX}$	< 30		< 30	μA
$-V_{CE} = 60\ V$	$-I_{CEX}$		< 30		μA
$-V_{CE} = 30\ V;\ T_j = 60\ ^oC$	$-I_{CEX}$	< 200		< 200	μA
$-V_{CE} = 60\ V;\ T_j = 60\ ^oC$	$-I_{CEX}$		< 200		μA
Collector-emitter voltage at					
$+V_{BE} = 0.6\ V;\ -I_C = 600\ mA$	$-V_{CEX}$			> 32	V
Collector-emitter saturation voltage at:					
$-I_C = 300\ mA;\ -I_B = 12\ mA$	$-V_{CEsat}$	< 300	< 300		mV
$-I_C = 300\ mA;\ -I_B = 6\ mA$	$-V_{CEsat}$			< 400	mV

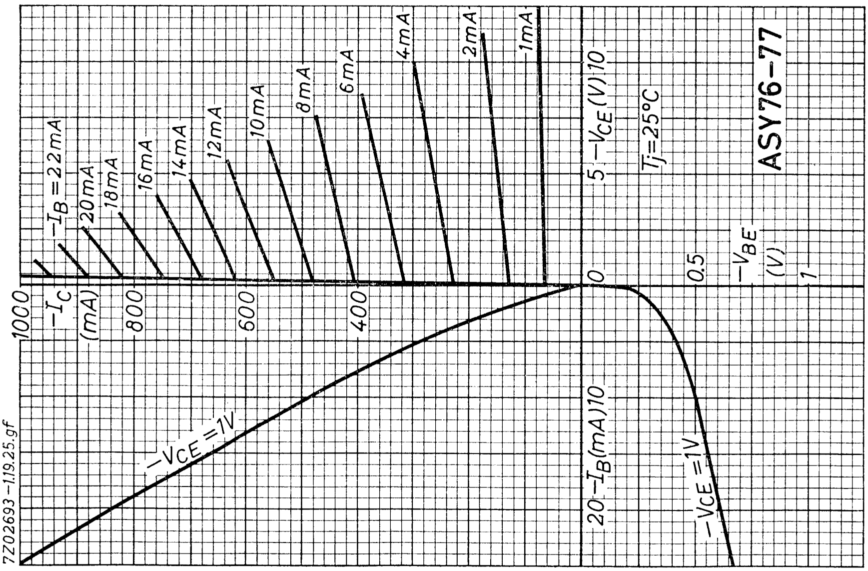
CHARACTERISTIC RANGE VALUES FOR EQUIPMENT DESIGN (continued)

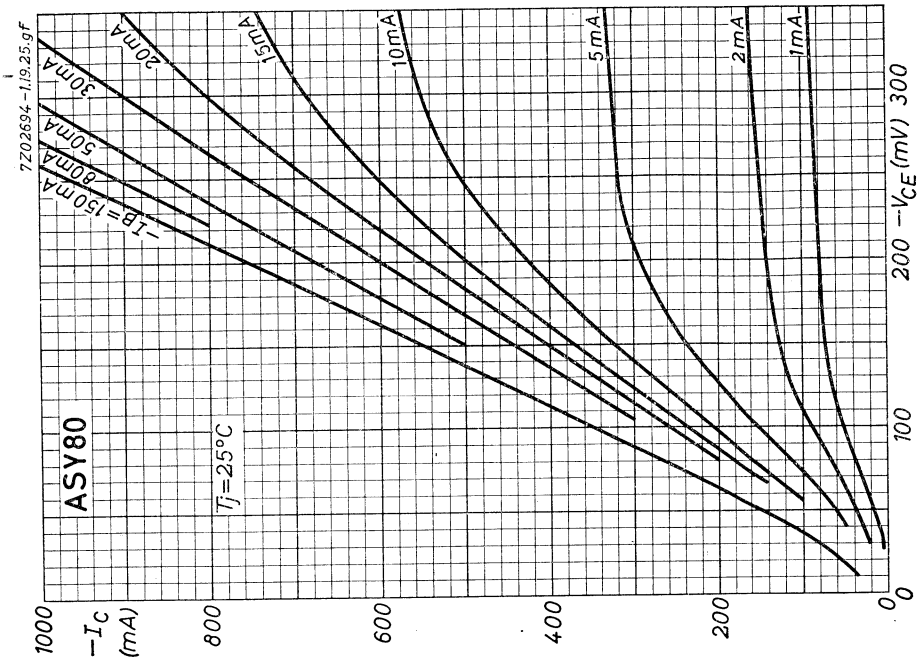
$T_j = 25\ ^oC$

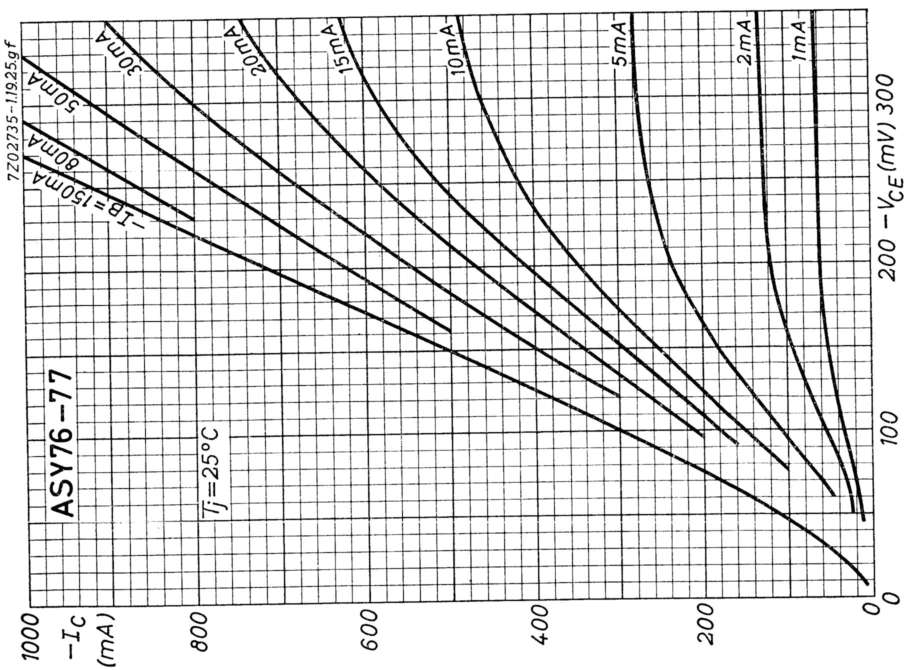
Base-emitter voltage at				
$V_{CB} = 0;\ I_E = 300$ mA	$-V_{BE}$	=	420	mV
		<	750	mV
Emitter-base floating potential at $I_E = 0$				
ASY76, ASY80: $-V_{CB} = 40$ V; ASY77 : $-V_{CB} = 60$ V	V_{EBF}	<	300	mV
Base impedance at f = 0.5 Mc/s				
$-V_{CB} = 5$ V; $I_E = 1$ mA	$\lvert z_{rb} \rvert$	=	75	Ω
Transition frequency at				
$-V_{CE} = 5$ V; $-I_C = 10$ mA, ASY76, ASY77	f_T	>	500	kc/s
$-V_{CE} = 5$ V; $-I_C = 10$ mA, ASY80	f_T	>	700	kc/s
Noise factor at f = 1 kc/s				
$-V_{CB} = 2$ V; $I_E = 0.5$ mA; B = 200 c/s; $R_S = 500\ \Omega$	F	<	15	dB
Collector capacitance with open emitter at f = 1 Mc/s				
$-V_{CB} = 5$ V	c_c	=	40	pF
		<	60	pF
Emitter capacitance with open collector at f = 1 Mc/s				
$-V_{EB} = 5$ V	c_e	=	30	pF
		<	50	pF

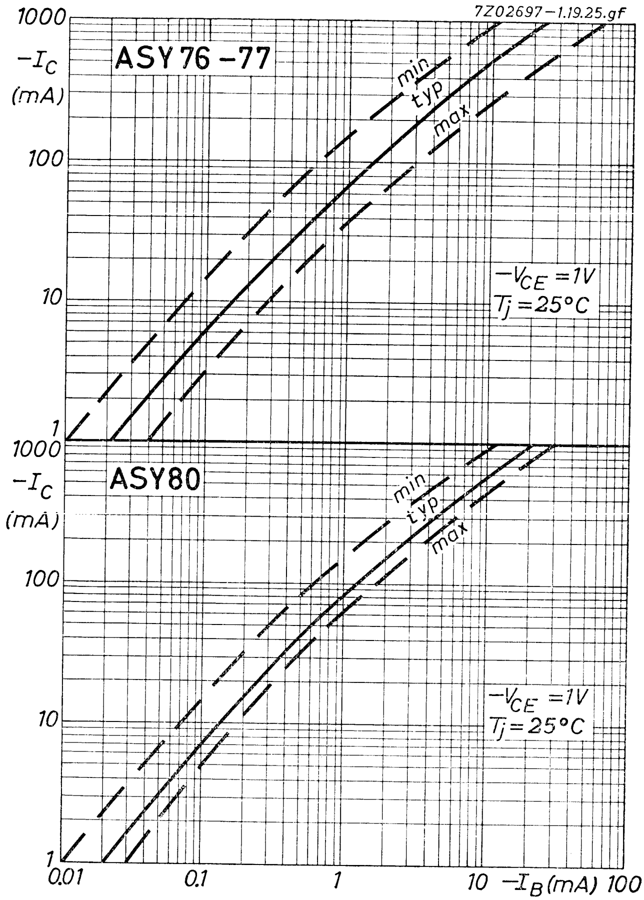
7Z2 2791

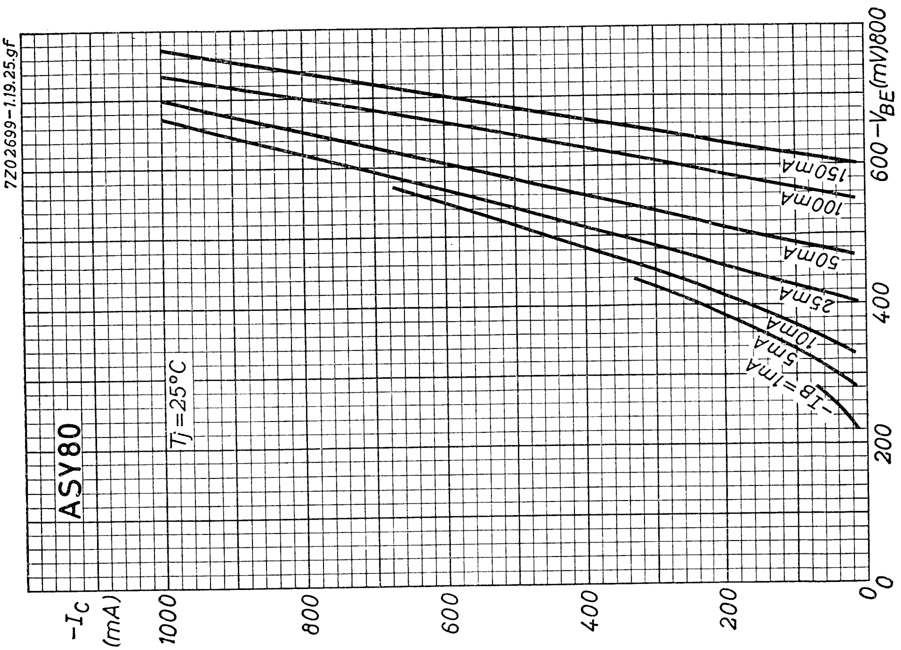

ASY80
T_j=25°C
$-I_B$=18mA
16mA
14mA
12mA
10mA
8mA
6mA
4mA
2mA
1mA
0
5
$-V_{CE}$(V)10
0.5
1
$-V_{BE}$
(V)
1000
$-I_C$
(mA)
800
600
400
$-V_{CE}$=1V
10
20 $-I_B$(mA)
$-V_{CE}$=1V
7Z02692-1.19.25.gf

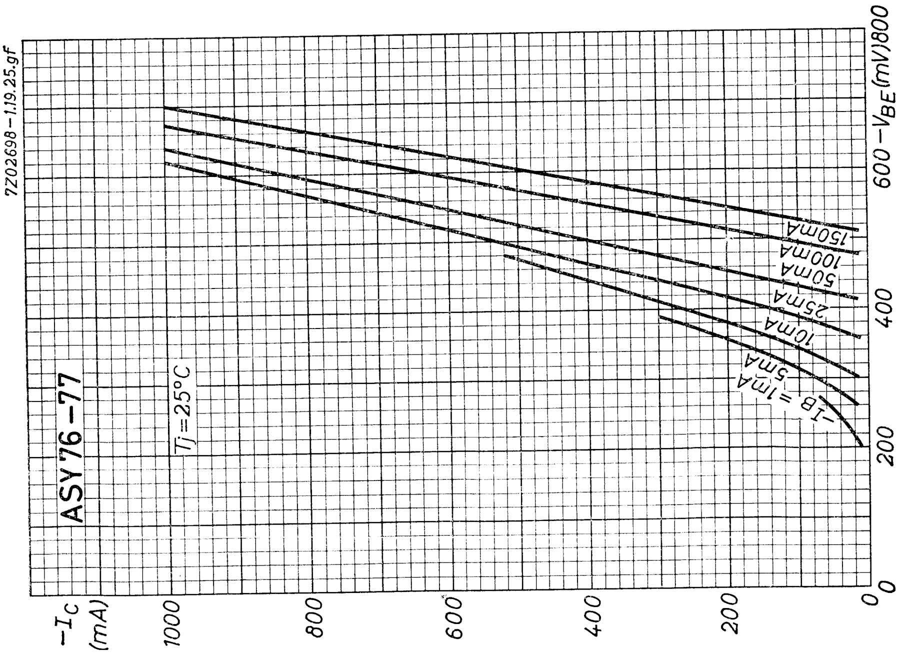

ASY76-77
T_j=25°C
$-I_B$=22mA
20mA
18mA
16mA
14mA
12mA
10mA
8mA
6mA
4mA
2mA
1mA
0
5
$-V_{CE}$(V)10
0.5
1
$-V_{BE}$
(V)
1000
$-I_C$
(mA)
800
600
400
$-V_{CE}$=1V
10
20 $-I_B$(mA)
$-V_{CE}$=1V
7Z02693-1.19.25.gf

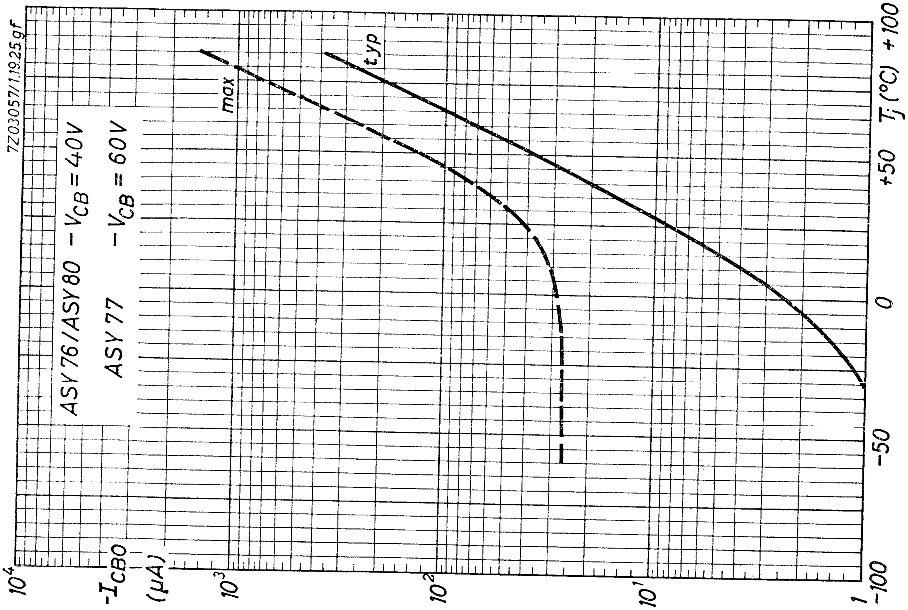

ASY80
Tj=25°C
7Z02694-1.19.25.gf
−IB=150mA
80mA
50mA
30mA
20mA
15mA
10mA
5mA
2mA
1mA
−IC
(mA)
1000
800
600
400
200
0
0
100
200
300
−VCE (mV)

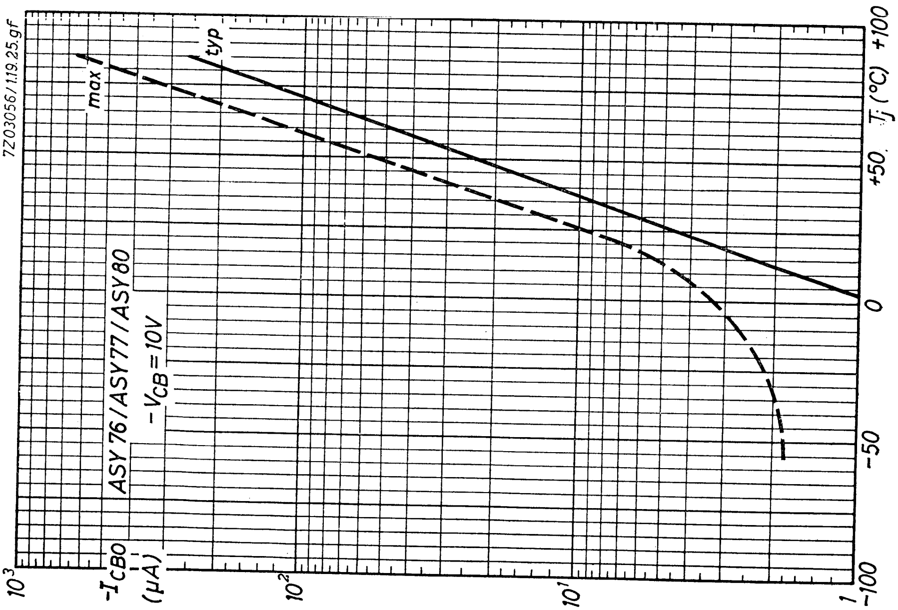

ASY76−77
Tj=25°C
7Z02735-1.19.25.gf
−IB=150mA
80mA
50mA
30mA
20mA
15mA
10mA
5mA
2mA
1mA
−IC
(mA)
1000
800
600
400
200
0
0
100
200
300
−VCE (mV)

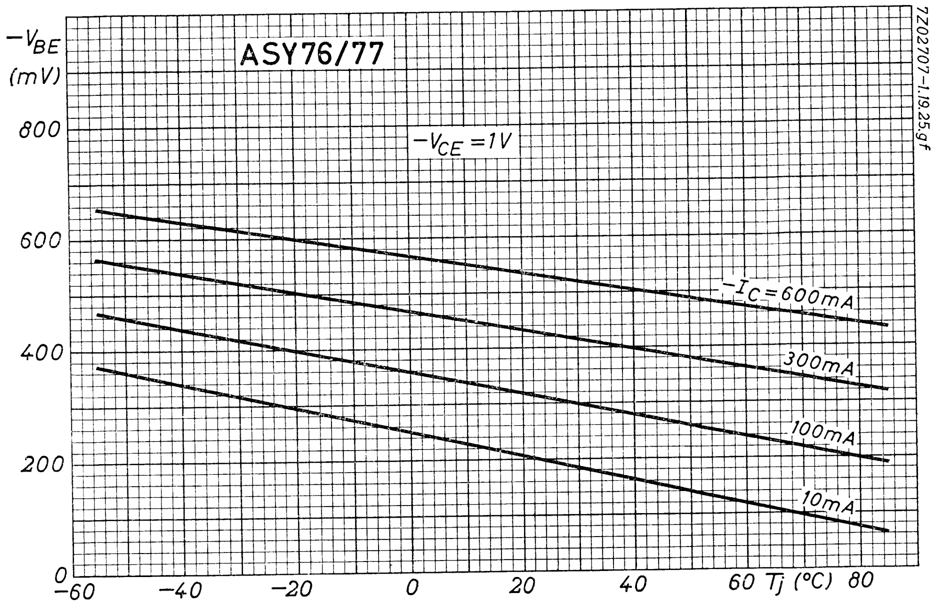

7Z02697-1.19.25.gf
ASY 76 -77
$-I_C$ (mA)
1000
100
10
1
min
typ
max
$-V_{CE}$ = 1V
T_j = 25°C
ASY80
$-I_C$ (mA)
1000
100
10
1
min
typ
max
$-V_{CE}$ = 1V
T_j = 25°C
0.01
0.1
1
10
$-I_B$ (mA)
100

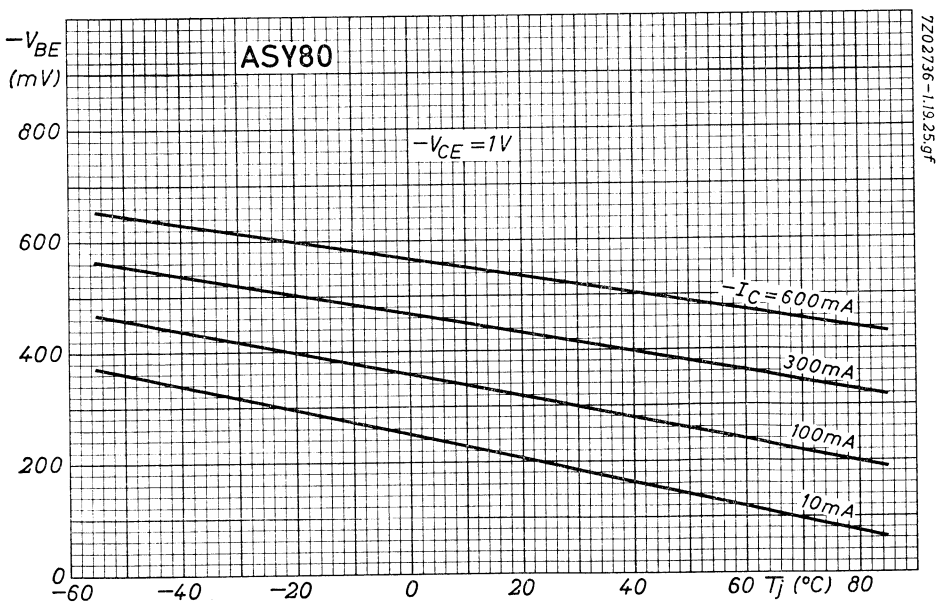

7Z02699-1.19.25.gf
ASY80
Tj = 25°C
150mA
100mA
50mA
25mA
10mA
5mA
-IB = 1mA
$-I_C$ (mA)
1000
800
600
400
200
0
0
200
400
600
$-V_{BE}$ (mV) 800

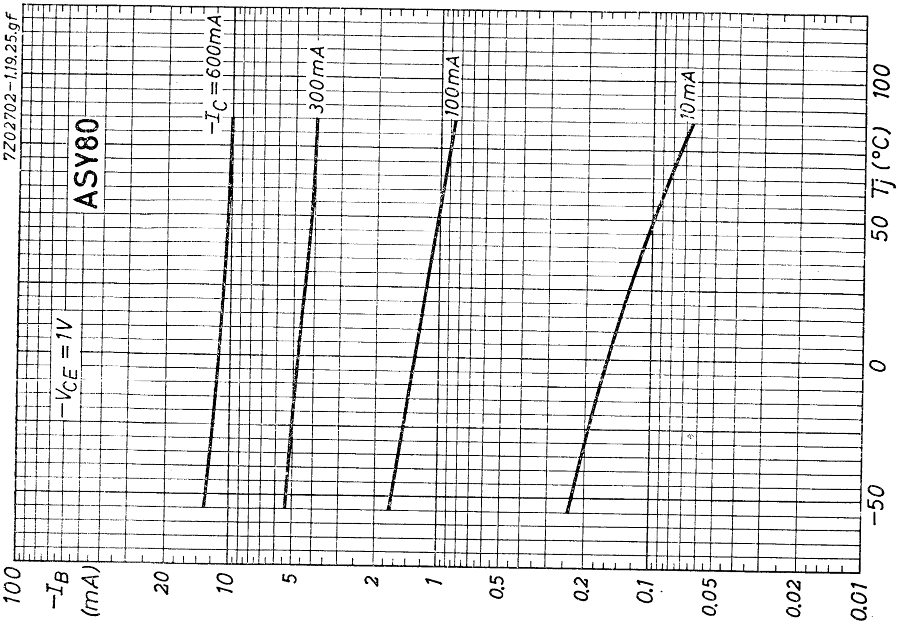

7Z02698-1.19.25.gf
ASY76-77
Tj = 25°C
150mA
100mA
50mA
25mA
10mA
5mA
-IB = 1mA
$-I_C$ (mA)
1000
800
600
400
200
0
0
200
400
600
$-V_{BE}$ (mV) 800

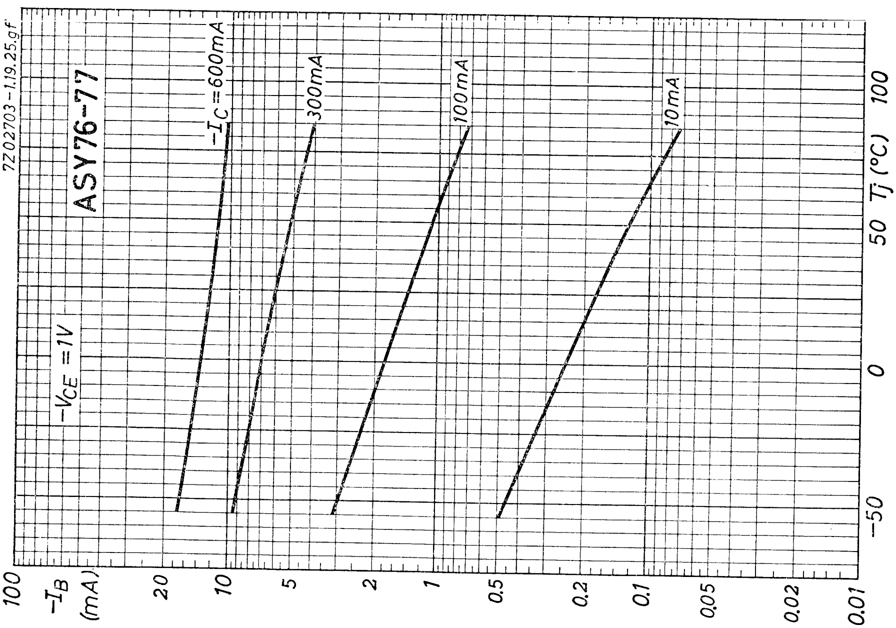

7Z03057/1.19.25.gf
ASY76/ASY80 − V_CB = 40V
ASY77 − V_CB = 60V
max
typ
−I_CBO (μA)
10^4
10^3
10^2
10^1
1
T_j (°C)
−100
−50
0
+50
+100

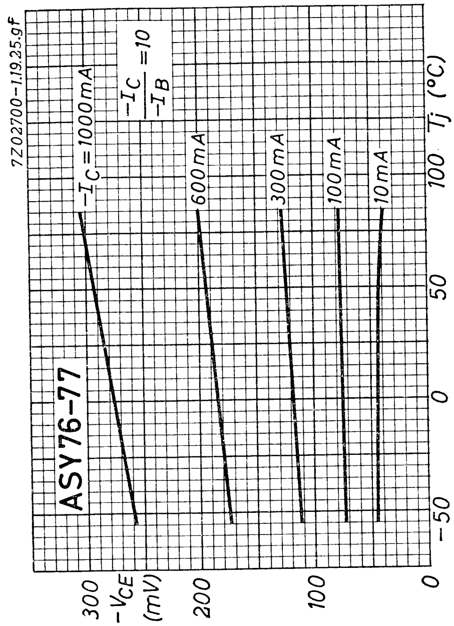

7Z03056/1.19.25.gf
ASY76/ASY77/ASY80
−V_CB=10V
max
typ
−I_CBO (μA)
10^3
10^2
10^1
1
T_j (°C)
−100
−50
0
+50
+100

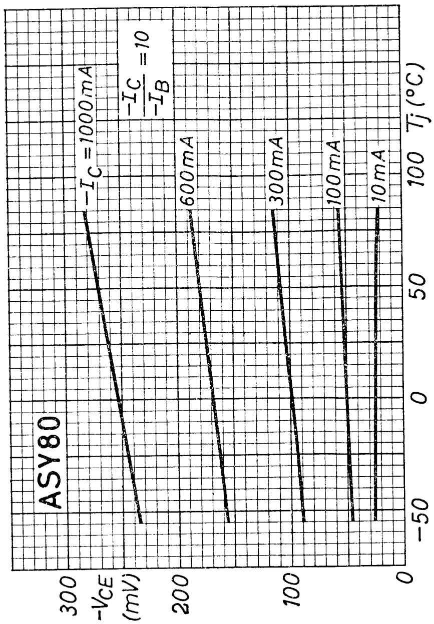

ASY76/77
$-V_{BE}$
(mV)
800
600
400
200
0
$-V_{CE} = 1V$
$-I_C = 600mA$
300mA
100mA
10mA
−60
−40
−20
0
20
40
60
T_j (°C)
80
7Z02707-1.19.25.gf

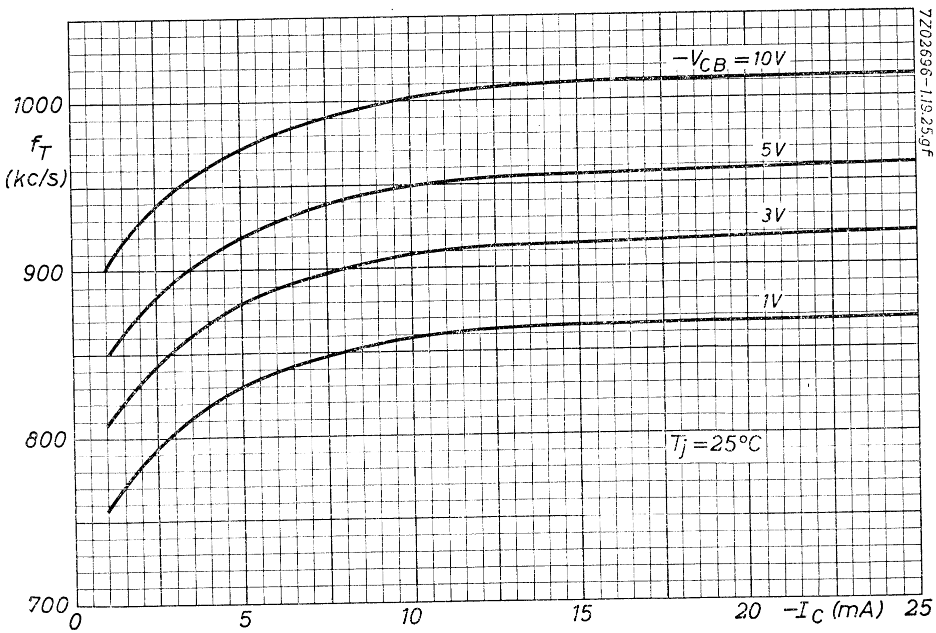

ASY80
$-V_{BE}$
(mV)
800
600
400
200
0
$-V_{CE} = 1V$
$-I_C = 600mA$
300mA
100mA
10mA
−60
−40
−20
0
20
40
60
T_j (°C)
80
7Z02736-1.19.25.gf


7Z02702-1.19.25.gf
ASY80
$-V_{CE} = 1V$
$-I_C = 600mA$
300mA
100mA
10mA
Tj (°C)
100
50
0
−50
$-I_B$ (mA)
100
20
10
5
2
1
0.5
0.2
0.1
0.05
0.02
0.01

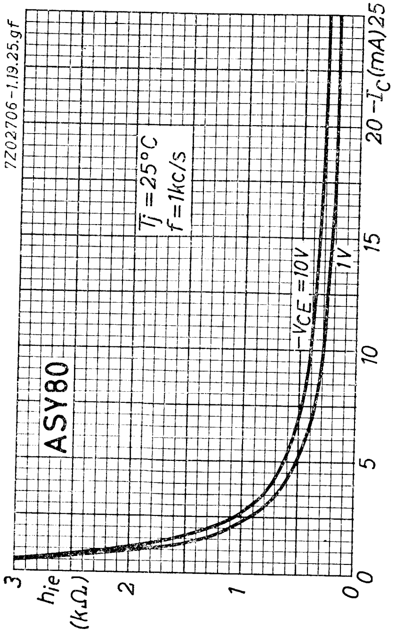

7Z02703-1.19.25.gf
ASY76-77
$-V_{CE} = 1V$
$-I_C = 600mA$
300mA
100mA
10mA
Tj (°C)
100
50
0
−50
$-I_B$ (mA)
100
20
10
5
2
1
0.5
0.2
0.1
0.05
0.02
0.01

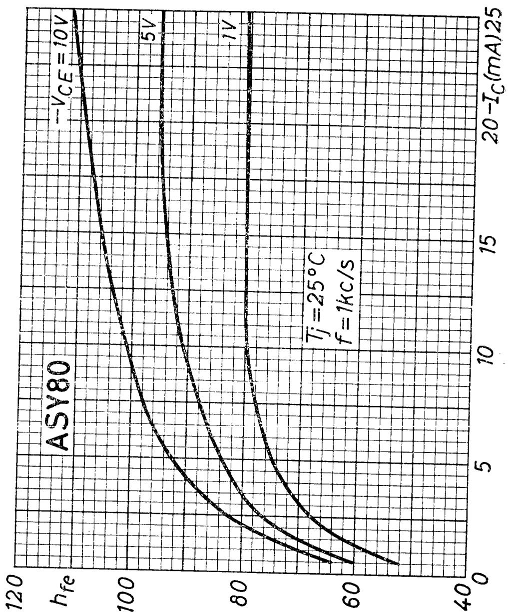

7Z02700-1.19.25.gF
ASY76-77
$\frac{-I_C}{-I_B}=10$
$-I_C=1000mA$
600mA
300mA
100mA
10mA
Tj (°C)
100
50
0
−50
300
200
100
0
$-V_{CE}$ (mV)

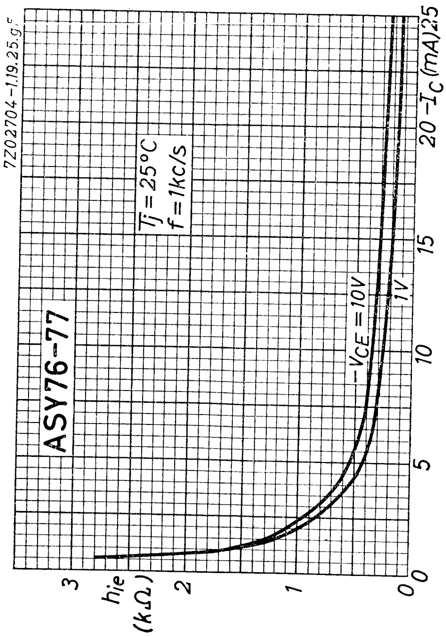

ASY80
$\frac{-I_C}{-I_B}=10$
$-I_C=1000mA$
600mA
300mA
100mA
10mA
Tj (°C)
100
50
0
−50
300
200
100
0
$-V_{CE}$ (mV)

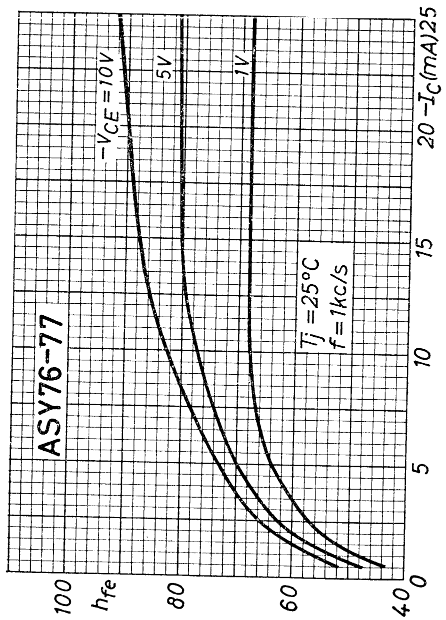

7Z02696-1.19.25.gF
$-V_{CB}=10V$
5V
3V
1V
$T_j=25°C$
1000
900
800
700
f_T (kc/s)
0
5
10
15
20
25
$-I_C$ (mA)

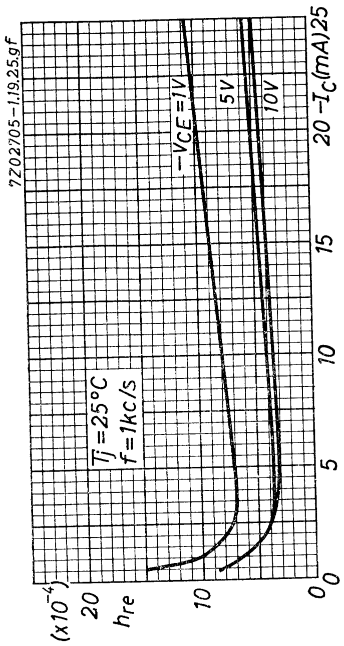
1.1.1965

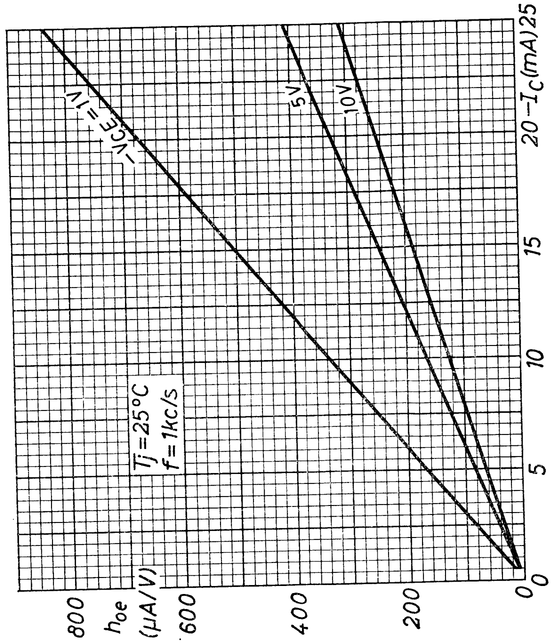

7Z02706-1.19.25.gf
ASY80
$T_j = 25°C$
$f = 1kc/s$
$-V_{CE} = 10V$
1V
h_{ie} (kΩ)
$-I_C$ (mA)

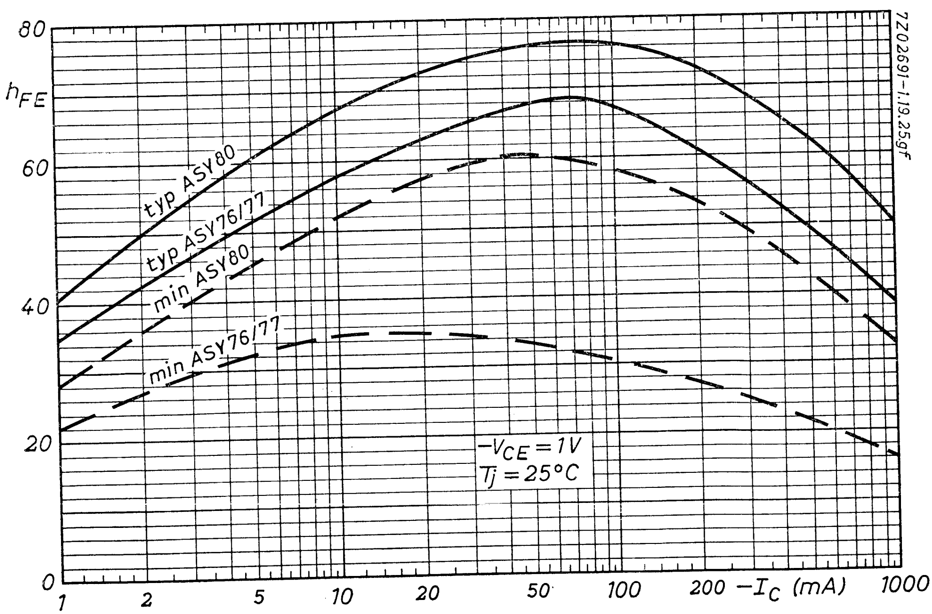

ASY80
$-V_{CE} = 10V$
5V
1V
$T_j = 25°C$
$f = 1kc/s$
h_{fe}
$-I_C$ (mA)

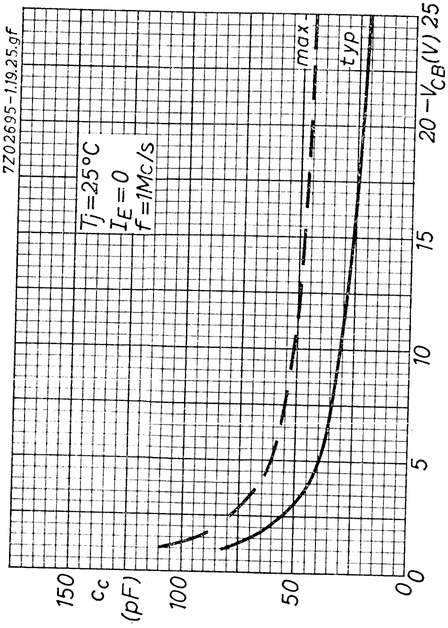

7Z02704-1.19.25.gf
ASY76-77
$T_j = 25°C$
$f = 1kc/s$
$-V_{CE} = 10V$
1V
h_{ie} (kΩ)
$-I_C$ (mA)


ASY76-77
$-V_{CE} = 10V$
5V
1V
$T_j = 25°C$
$f = 1kc/s$
h_{fe}
$-I_C$ (mA)

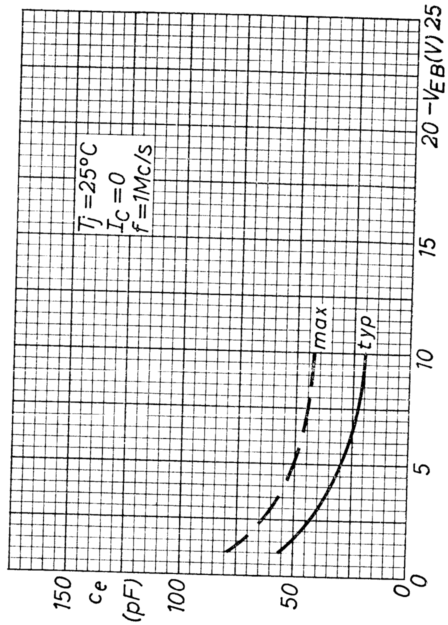

7Z02705-1.19.25.gf
$-V_{CE}=1V$
5V
10V
$T_j=25°C$
$f=1kc/s$
$(x10^{-4})$
h_{re}
20
10
0
0
5
10
15
20
$-I_C$(mA)25


$-V_{CE}=1V$
5V
10V
$T_j=25°C$
$f=1kc/s$
h_{oe}
(μA/V)
800
600
400
200
0
0
5
10
15
20
$-I_C$(mA)25

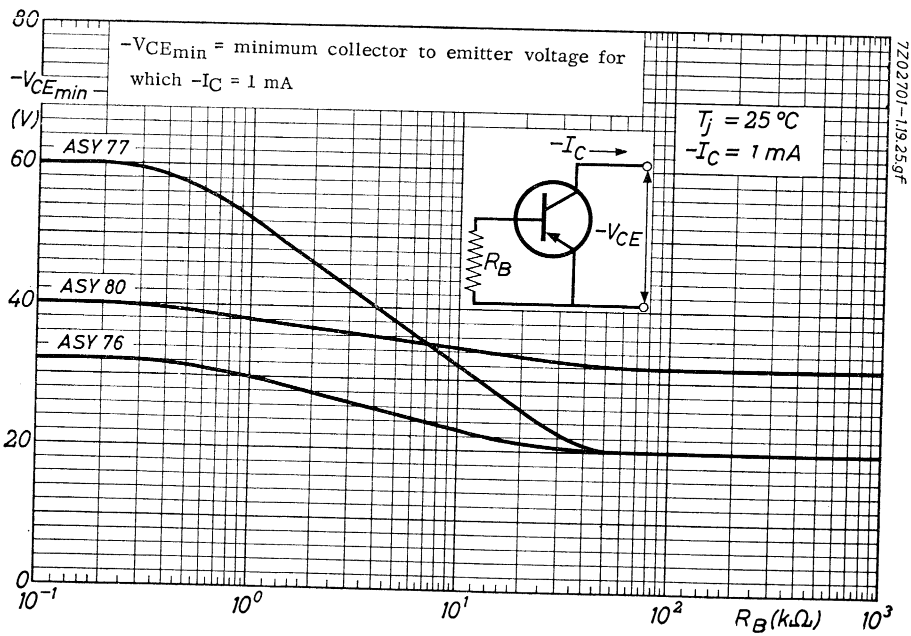

h_{FE}
80
60
40
20
0
typ ASY80
typ ASY76/77
min ASY80
min ASY76/77
$-V_{CE}=1V$
$T_j=25°C$
7Z02691-1.19.25.gf
1
2
5
10
20
50
100
200
$-I_C$ (mA)
1000



7Z02695-1.19.25.gF
$T_j = 25°C$
$I_E = 0$
f = 1Mc/s
max
typ
$-V_{CB}$ (V)
C_c (pF)



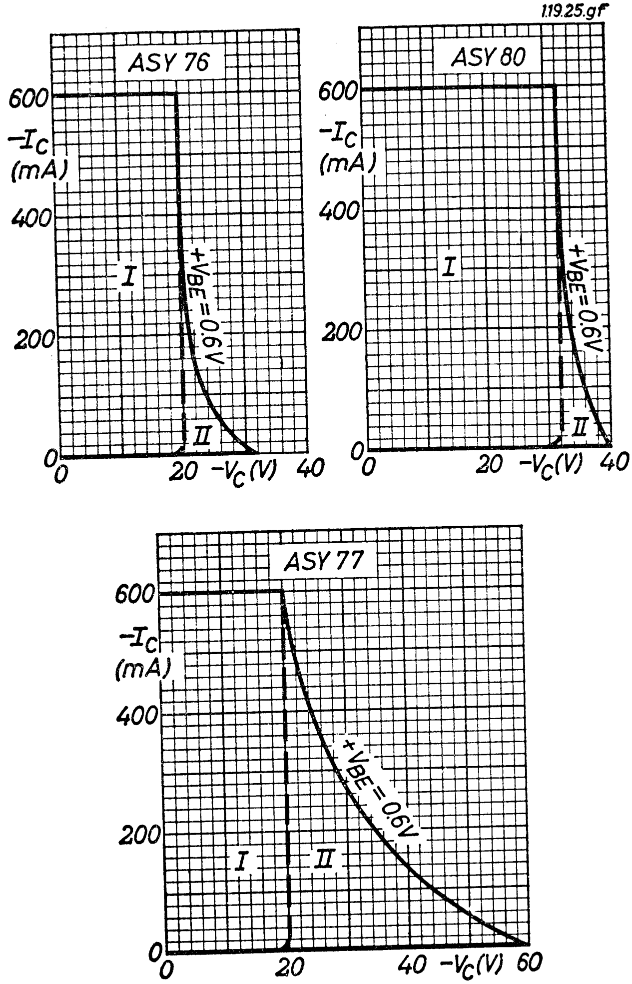
$T_j = 25°C$
$I_C = 0$
f = 1Mc/s
max
typ
$-V_{EB}$ (V)
C_e (pF)



$-V_{CEmin}$ = minimum collector to emitter voltage for which $-I_C$ = 1 mA
$-V_{CEmin}$ (V)
ASY 77
ASY 80
ASY 76
T_j = 25 °C
$-I_C$ = 1 mA
$-I_C$
$-V_{CE}$
R_B
R_B (kΩ)
7Z02701-1.19.25.gF

K

1.1.1965



I = permissible region of operation under all base-emitter conditions

II = additional region of operation when the transistor is in cut-off condition with $+V_{BE} = 0.6$ V.

During switching off voltages higher than those indicated by the minimum avalanche curves at $+V_{BE} = 0.6$ V are allowed if the transient energy is less than 12 mWsec:

7Z2 2536
7Z2 2537

GERMANIUM P-N-P POWER SWITCHING TRANSISTORS

Low spread medium gain germanium power transistors of the p-n-p type in TO-3 metal case for power switching at high currents.

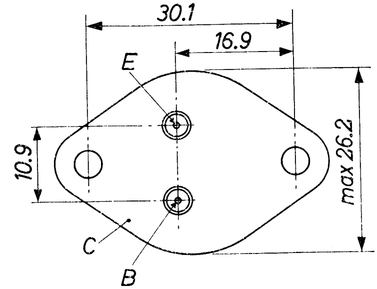
QUICK REFERENCE DATA

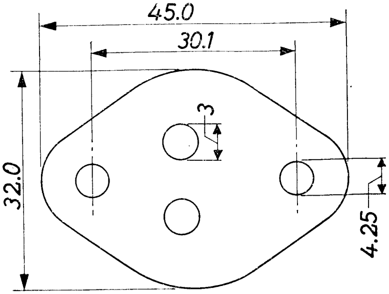
			ASZ 15	ASZ 16	ASZ 17	ASZ 18	
Collector-base voltage	$-V_{CBO}$	= max.	100	60	60	100	V
Collector-emitter voltage	$-V_{CEO}$	= max.	60	32	32	32	V
Power dissipation up to T_{mb} = 45 °C	P_{tot}	= max.	30	30	30	30	W
Junction temperature	T_j	= max.	90	90	90	90	°C
D.C. current amplification factor							
$-V_{CE}$ = 1 V; $-I_C$ = 1 A	h_{FE}		>20 <55	> 45 <130	>25 <75	> 30 <110	
$-V_{CE}$ = 1 V; $-I_C$ = 6 A	h_{FE}		>15 <30	> 35 < 80	>20 <45	> 20 < 65	
Transition frequency							
$-V_{CE}$ = 5 V; $-I_C$ = 1 A	f_T	=	200	250	220	220	kc/s

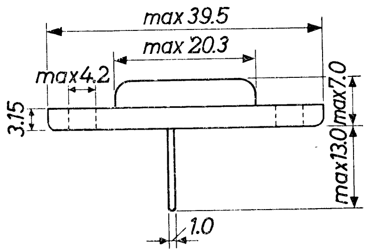
7Z2 2934

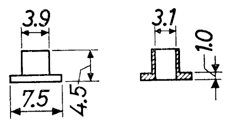
MECHANICAL DATA

Dimensions in mm

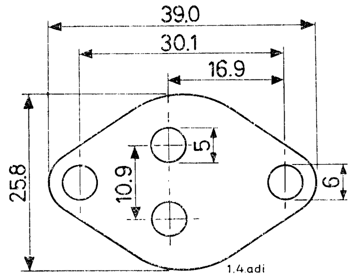








Codenumber 56 201 A
Mica insulation (50 μm)
and insulation tubes



Codenumber 56 201 B
Lead washer (1 mm)

7Z2 2935

LIMITING VALUES (Absolute max. values)

			ASZ 15	ASZ 16	ASZ 17	ASZ 18		
Voltages								
Collector-base (open emitter)	$-V_{CBO}$	= max.	100	60	60	100	V [1]	←
Collector-emitter (open base)	$-V_{CEO}$	= max.	60	32	32	32	V [2]	
Emitter-base (open collector)	$-V_{EBO}$	= max.	40	20	20	40	V	
Currents								
Collector current (d.c.)	$-I_C$	= max.	8				A	←
Collector current (peak value)	$-I_{CM}$	= max.	10				A	
Emitter current (d.c.)	I_E	= max.	9				A	←
Emitter current (peak value)	I_{EM}	= max.	12				A	
Base current (d.c.)	$-I_B$	= max.	1				A	
Base current (peak value)	$-I_{BM}$	= max.	2				A	
Power dissipation [3]								
Total power dissipation up to T_{mb} = 45 °C	P_{tot}	= max.	30				W	
Temperatures								
Storage temperature	T_s	=	-65 to +90				°C	
Junction temperature continuous	T_j	= max.	90				°C	
Junction temperature incidentally	T_j	= max.	100				°C	

(Currents, power dissipation and temperatures apply to all types ASZ15 to ASZ18.)

[1]) When switched from a thermally stable on-state with max. junction temperature to a not stabilized cut-off condition, V_{CBOmax} is allowed, provided T_{amb} < 55 °C and K_{tot} < 9 °C/W for ASZ16 and ASZ17
K_{tot} < 5 °C/W for ASZ15 and ASZ18

[2]) See page F and G

[3]) See operating notes and page A and H

7Z2 2936

THERMAL DATA

Thermal resistance from

junction to mounting base	K	<	1.5	°C/W
mounting base to heatsink without insulating material	K	=	0.2	°C/W
mounting base to heatsink with lead washer and mica washer	K	=	0.5	°C/W

CHARACTERISTICS

Collector current at $I_E = 0$

$-V_{CB} = 0.5$ V	$-I_{CBO}$	<	0.1	mA
$-V_{CB} = -V_{CBO}$ max.	$-I_{CBO}$	<	3.0	mA

Emitter current at $I_C = 0$

$-V_{EB} = -V_{EBO}$ max.	$-I_{EBO}$	<	3.0	mA

		ASZ 15	ASZ 16	ASZ 17	ASZ 18	
Base current at $V_{CB} = 0$						
$I_E = 1$ A	$-I_B$	>17.5	> 7.2	> 13	> 9	mA
		< 50	<21.5	< 38	< 33	mA
$I_E = 6$ A	$-I_B$	> 190	> 73	>130	> 90	mA
		< 375	< 165	<285	<285	mA
Emitter-base voltage at $V_{CB} = 0$						
$I_E = 6$ A	V_{EB}	> 0.6		>0.4		mV
		< 1.6	< 1.4	<1.4	<1.6	mV

7Z2 2937

CHARACTERISTIC RANGE VALUES FOR EQUIPMENT DESIGN

T_j = 25 °C unless otherwise specified

Collector current at $I_E = 0$

$-V_{CB} = -V_{CBO\,max.}$; T_j = 100 °C	$-I_{CBO}$	<	30	mA

Saturation voltages at

$-I_C$ = 10 A; $-I_B$ = 1 A	$-V_{CE\,sat}$	<	0.4	V
	$-V_{BE\,sat}$	<	1.4	V

Emitter floating potential

$I_E = 0$; T_{mb} = 100 °C

ASZ15, ASZ18: $-V_{CB}$ = 60 V ASZ16, ASZ17: $-V_{CB}$ = 48 V	$-V_{EBF}$	<	0.5	V

Collector capacitance at f = 500 kc/s

$-V_{CB}$ = 5 V; $I_E = 0$	c_c	=	190	pF

Emitter capacitance at f = 500 kc/s

$-V_{EB}$ = 5 V; $I_C = 0$	c_e	=	150	pF

			ASZ 15	ASZ 16	ASZ 17	ASZ 18	
Transition frequency $-V_{CE}$ = 5 V; $-I_C$ = 1 A	f_T	=	200	250	220	220	kc/s
D.C. current amplification factor $-V_{CE}$ = 1 V; $-I_C$ = 1 A	h_{FE}		>20 <55	> 45 <130	>25 <75	> 30 <110	
$-V_{CE}$ = 1 V; $-I_C$ = 6 A	h_{FE}		>15 <30	> 35 < 80	>20 <45	> 20 < 65	

<u>Characteristics of matched pairs</u>

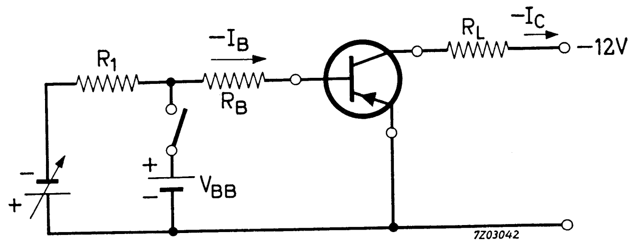
Ratio of the d.c. current amplification factors

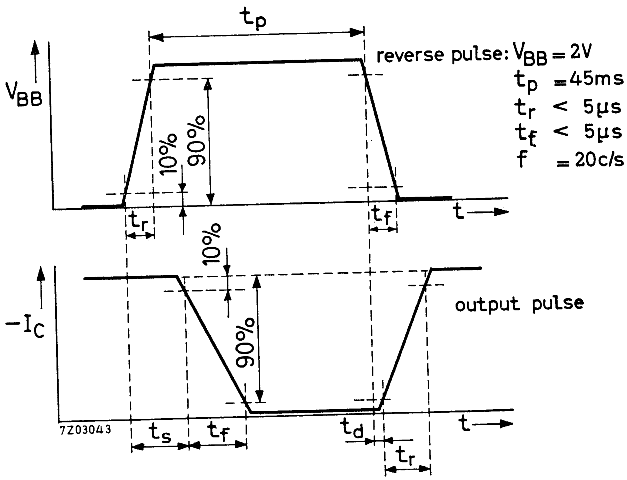
at $-I_C$ = 0.3 A	h_{FE1}/h_{FE2}	<	1.25
at $-I_C$ = 6.0 A	h_{FE1}/h_{FE2}	<	1.25

7Z2 2938

CHARACTERISTIC RANGE VALUES FOR EQUIPMENT DESIGN(continued)

Switching times in "ON-OFF" switching circuits at T_j = 25 °C





Circuit I

R_B = 10 Ω; R_1 = 220 Ω; R_L = 12 Ω

ASZ15: $-I_B$ = 75 mA	$-I_C$ = 1 A	delay time	t_d	<	2	μs
ASZ16: $-I_B$ = 35 mA		rise time	t_r	<	25	μs
ASZ17: $-I_B$ = 60 mA		storage time	t_s	<	10	μs
ASZ18: $-I_B$ = 50 mA		fall time	t_f	<	20	μs

Circuit II

R_B = 1 Ω; R_1 = 13 Ω; R_L = 1.2 Ω

ASZ15: $-I_B$ = 1.35 A	$-I_C$ = 10 A	delay time	t_d	<	1	μs
ASZ16: $-I_B$ = 0.6 A		rise time	t_r	<	20	μs
ASZ17: $-I_B$ = 1.0 A		storage time	t_s	<	15	μs
ASZ18: $-I_B$ = 1.0 A		fall time	t_f	<	35	μs

7Z2 2939

OPERATING NOTES

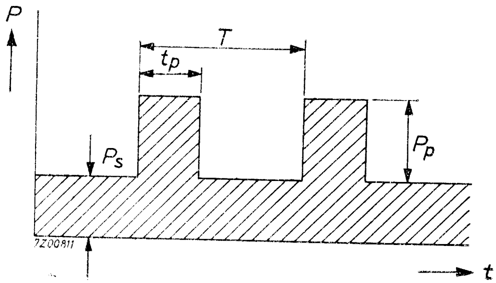
Determination of peak power ratings

For a pulse duration, shorter than the temperature stabilisation time

$$P_p = \frac{T_{j\,max} - T_{amb} - (K_{j-mb} + K_{mb-h} + K_{h-a}).P_s}{K_t + \delta . K_{h-a}}$$

For a pulse duration, longer than the temperature stabilisation time

$$P_p = \frac{T_{j\,max} - T_{amb}}{K_{j-mb} + K_{mb-h} + K_{h-a}} - P_s$$



Where:

t_p = pulse duration
T = pulse period
δ = t_p/T = duty cycle
P_s = steady state power dissipation
P_p = permissible pulse power dissipation over P_s
K_{j-mb} = thermal resistance from junction to mounting base
K_{mb-h} = thermal resistance from mounting base to heatsink
K_{h-a} = thermal resistance from heatsink to ambience
K_t = transient thermal resistance = $f(t, \delta)$; see page H
(for durations longer than the temperature stabilisation time
$K_t = K_{j-h} = K_{j-mb} + K_{mb-h}$)
$T_{j\,max}$ = max. permissible junction temperature
T_{amb} = ambient temperature
Temperature stabilisation time = 1 s (see page H)

Example: P_s = 5 W, t = 1 ms, δ = 0.1, K_{mb-h} = 0.5 °C/W, K_{h-a} = 4.25 °C/W and T_{amb} = 25 °C

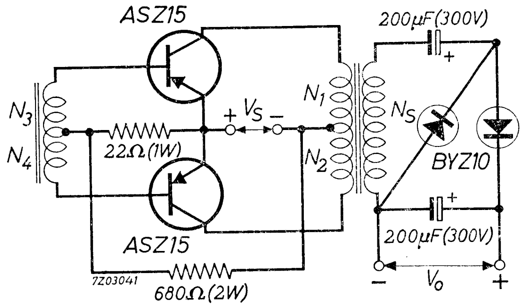
From t = 1 ms and δ = 0.1 it follows that K_t = 0.28 °C/W (page H)

Then $P_p = \dfrac{90 - 25 - (1.5 + 0.5 + 4.25) \times 5}{0.28 + 0.1 \times 4.25} \approx 47.5$ W

7Z2 2940

APPLICATION INFORMATION

Typical operation in a d.c. to d.c. converter



The data below have been designed for continuous operation up to T_{amb} = 55 °C. Incidentally, operation up to T_{amb} = 60 °C is permitted.
(Based on K_{j-a} = 15 °C/W per transistor)

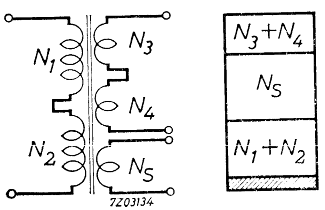
V_S	=	28 V
I_S	=	2.5 A
P_S	=	70 W
V_o	=	220 V
I_o	=	270 mA
P_o	=	60 W
η	=	86 %
f	=	450 c/s

Losses

In transistors	:	2x2 W
In diodes	:	2x0.3 W
In biasing resistors	:	1.7 W
In transformer	:	3.7 W

Transformer data

The transformer core consists of square loop material
(Telcon HCR alloy type 227)
Stacking height = 15 mm



$N_1 + N_2$
$N_3 + N_4$ are bifilarly wound

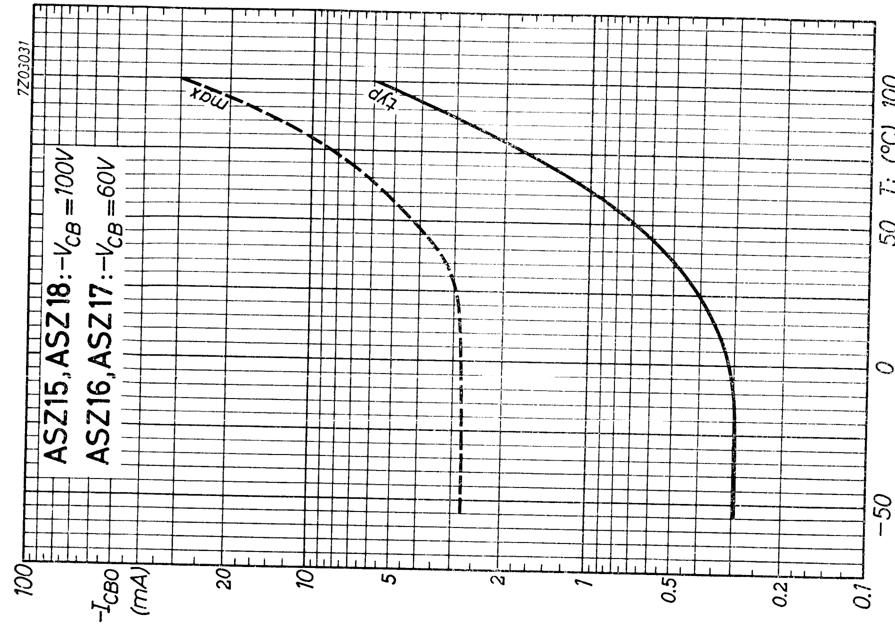
$N_1 = N_2$ = 46 turns of enamelled copper wire, 1 mm

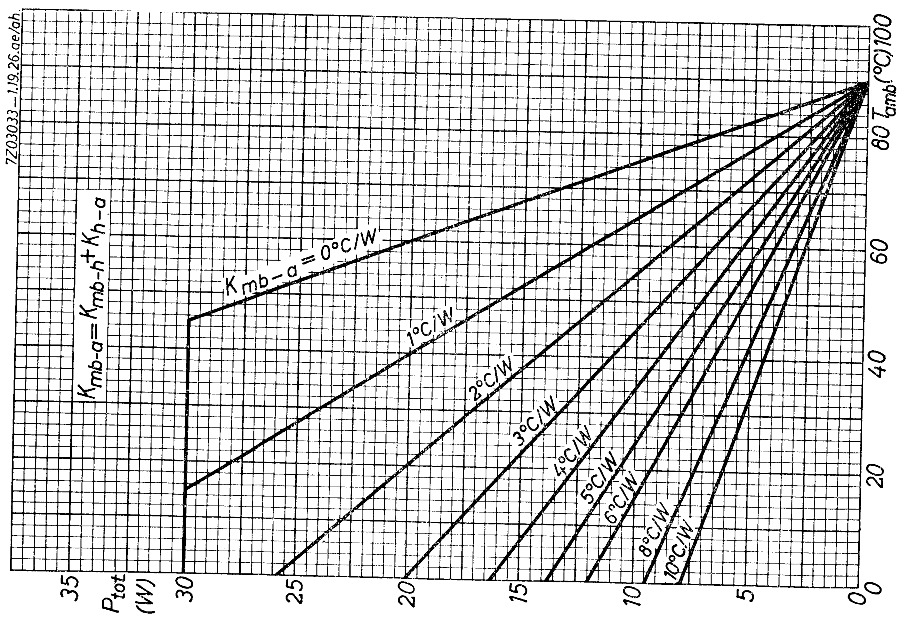
$N_3 = N_4$ = 5 turns of enamelled copper wire, 0.5 mm

N_S = 190 turns of enamelled copper wire, 0.5 mm

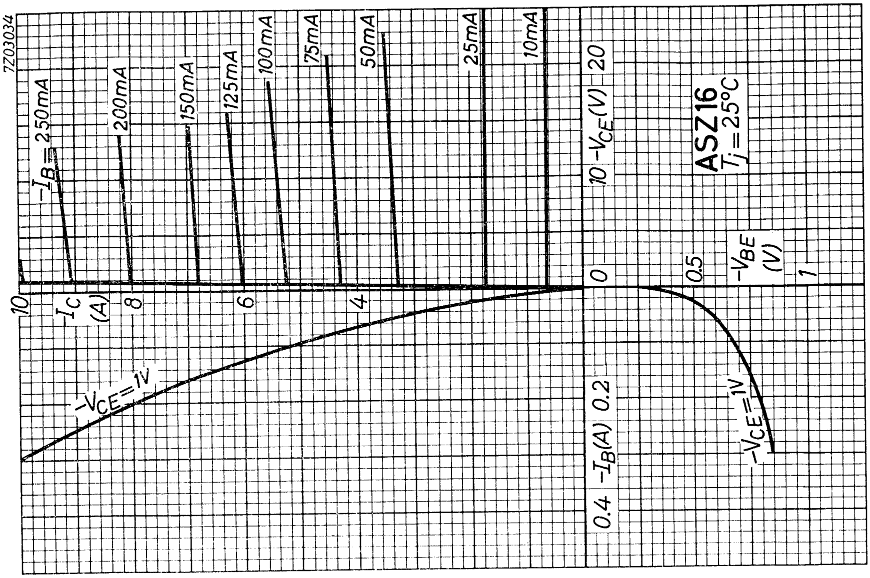
7Z2 2941

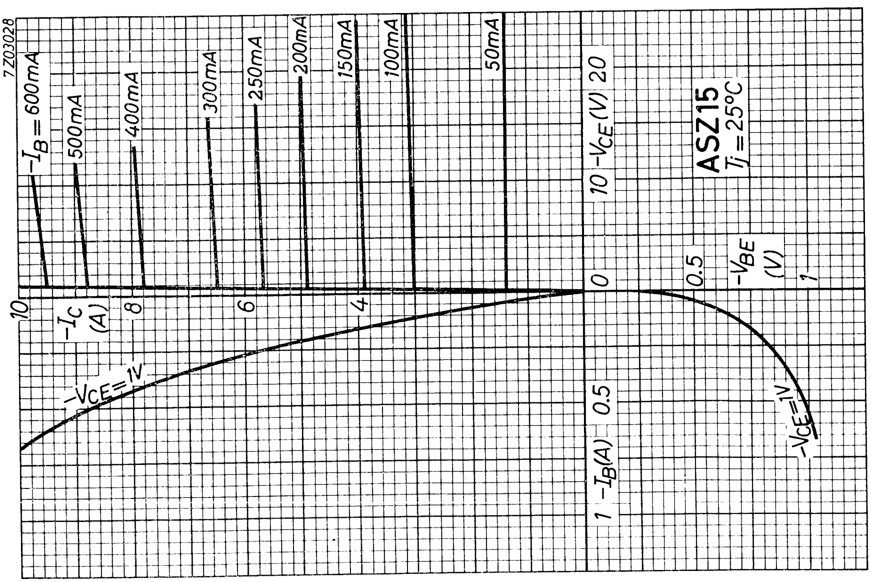
3.3.1965

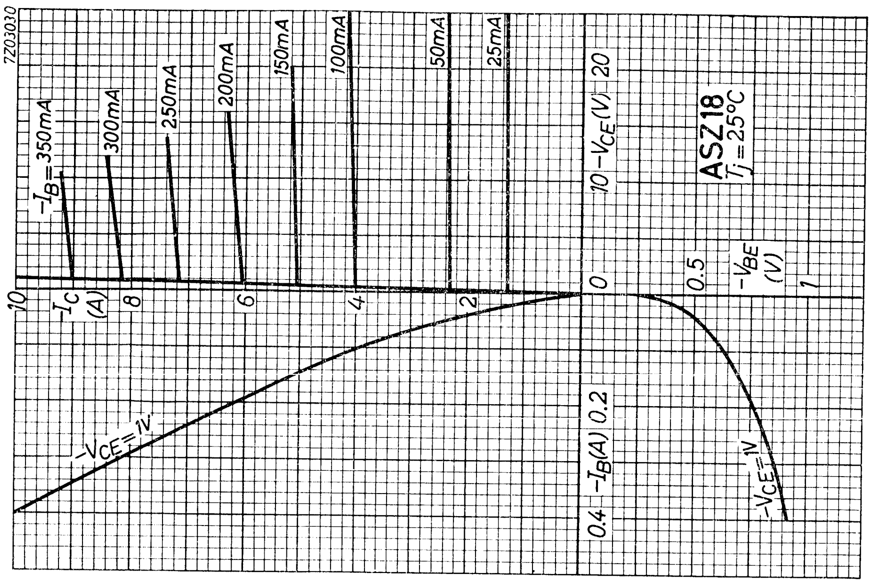

7Z03031
ASZ15,,ASZ18: −VCB = 100V
ASZ16,,ASZ17: −VCB = 60V
max
typ
−ICBO (mA)
100
20
10
5
2
1
0.5
0.2
0.1
Tj (°C)
−50
0
50
100


7Z03033 – 1.19.26.ae/ah
Kmb-a = Kmb-h + Kh-a
Kmb-a = 0°C/W
1°C/W
2°C/W
3°C/W
4°C/W
5°C/W
6°C/W
8°C/W
10°C/W
Ptot (W)
35
30
25
20
15
10
5
0
Tamb (°C)
0
20
40
60
80
100

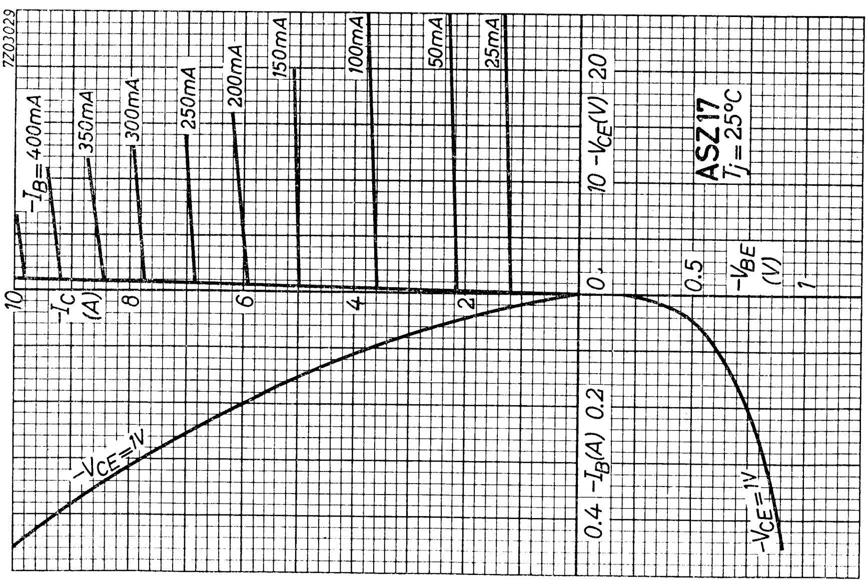
A


7Z03034
$-I_B$ = 250mA
200mA
150mA
125mA
100mA
75mA
50mA
25mA
10mA
$-I_C$ (A)
10
8
6
4
0
10 $-V_{CE}$(V) 20
ASZ16
T_j = 25°C
$-V_{CE}$ = 1V
0.2 $-I_B$(A) 0.4
0.5
$-V_{BE}$ (V)
1
$-V_{CE}$ = 1V

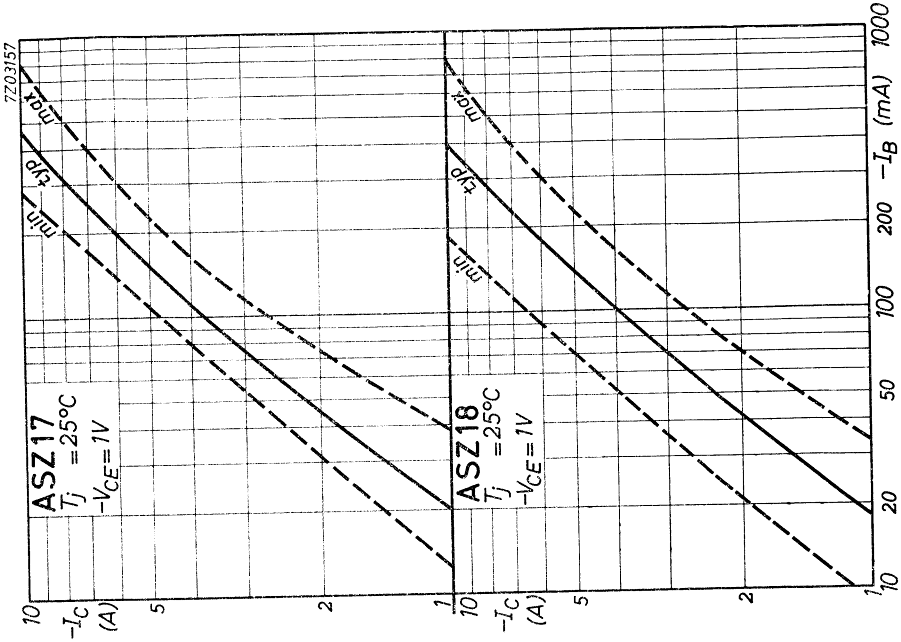

7Z03028
$-I_B$ = 600mA
500mA
400mA
300mA
250mA
200mA
150mA
100mA
50mA
$-I_C$ (A)
10
8
6
4
0
10 $-V_{CE}$(V) 20
ASZ15
T_j = 25°C
$-V_{CE}$ = 1V
0.5 $-I_B$(A) 1
0.5
$-V_{BE}$ (V)
1
$-V_{CE}$ = 1V

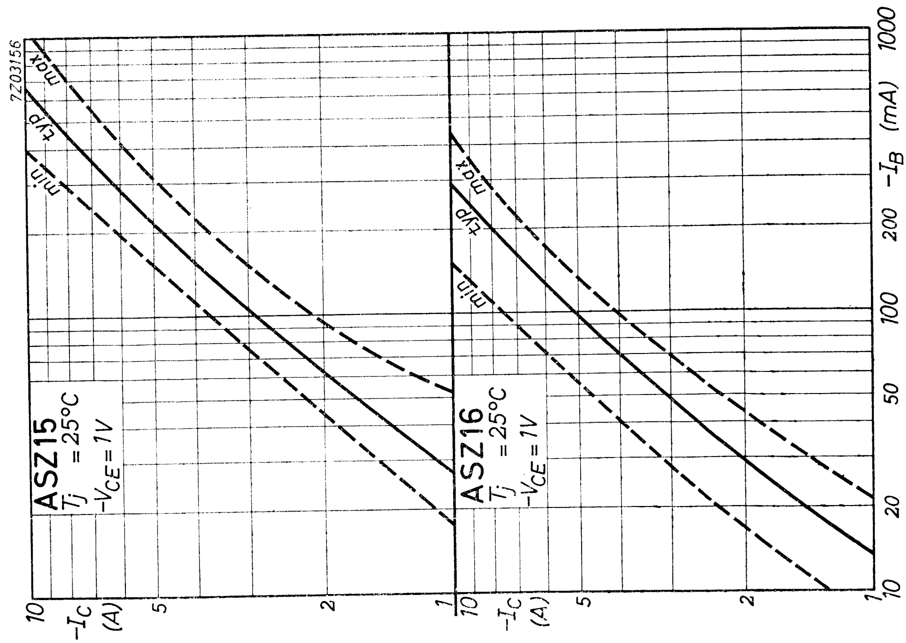


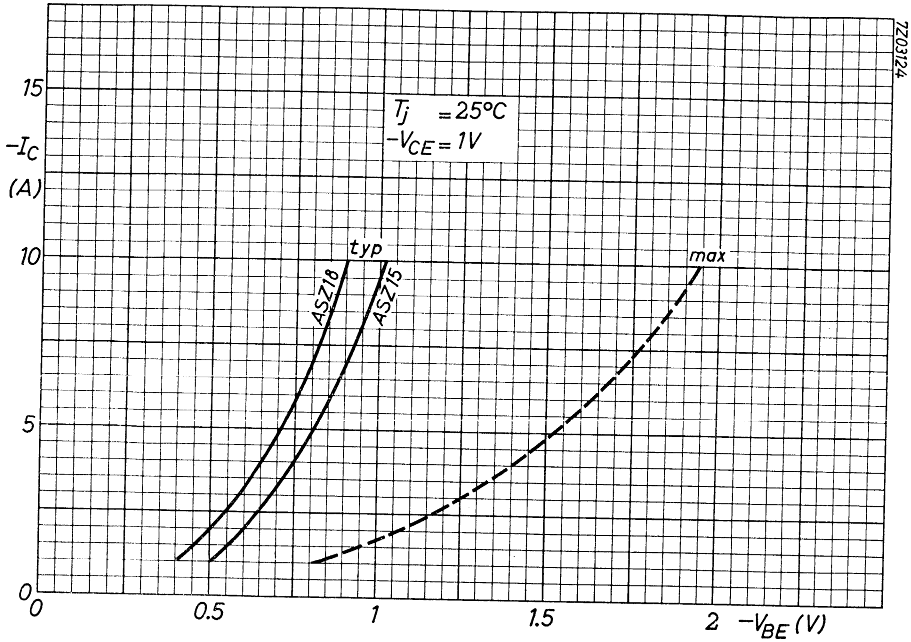
7Z03030
ASZ18
$T_j = 25°C$
$-I_B = 350mA$
300mA
250mA
200mA
150mA
100mA
50mA
25mA
$-I_C$ (A)
10
8
6
4
2
0
10 $-V_{CE}(V)$ 20
0.5
$-V_{BE}$ (V)
1
$-V_{CE} = 1V$
0.4 $-I_B(A)$ 0.2
$-V_{CE} = 1V$

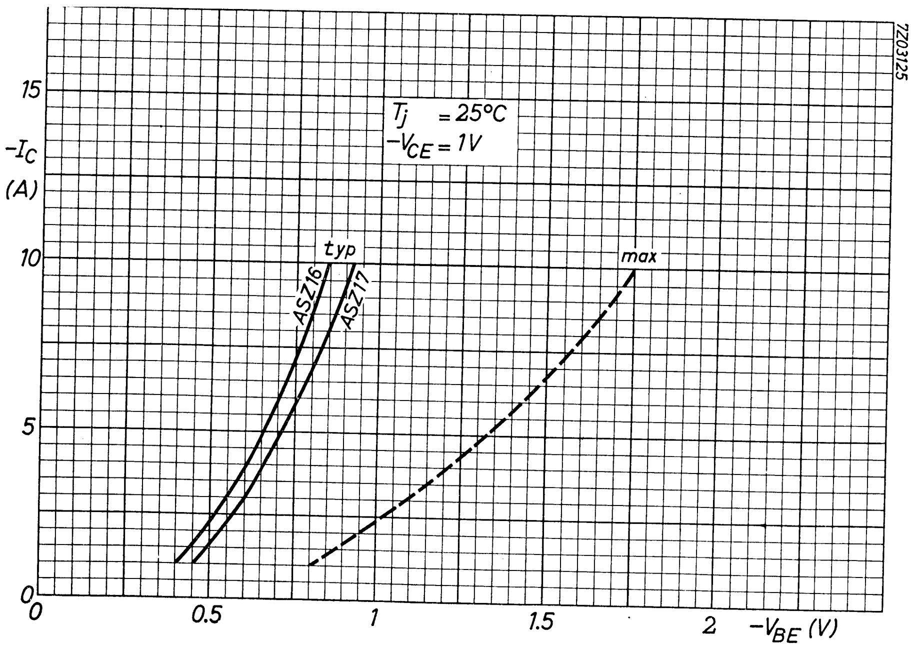


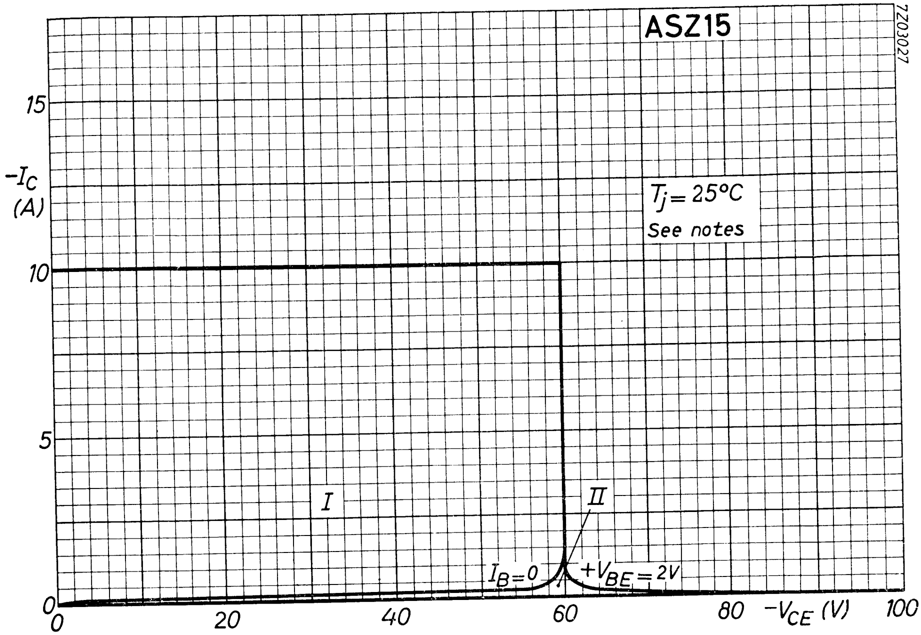
7Z03029
ASZ17
$T_j = 25°C$
$-I_B = 400mA$
350mA
300mA
250mA
200mA
150mA
100mA
50mA
25mA
$-I_C$ (A)
10
8
6
4
2
0
10 $-V_{CE}(V)$ 20
0.5
$-V_{BE}$ (V)
1
$-V_{CE} = 1V$
0.4 $-I_B(A)$ 0.2
$-V_{CE} = 1V$

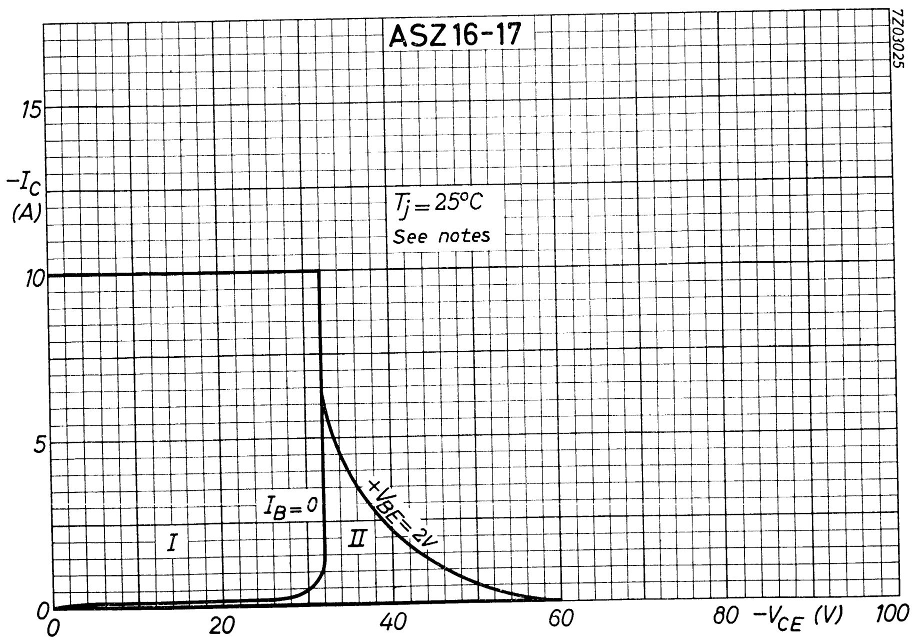

7Z03157
ASZ17
T_j = 25°C
$-V_{CE}$ = 1V
ASZ18
T_j = 25°C
$-V_{CE}$ = 1V
max
typ
min
$-I_C$ (A)
10
5
2
1
$-I_B$ (mA)
10
20
50
100
200
1000

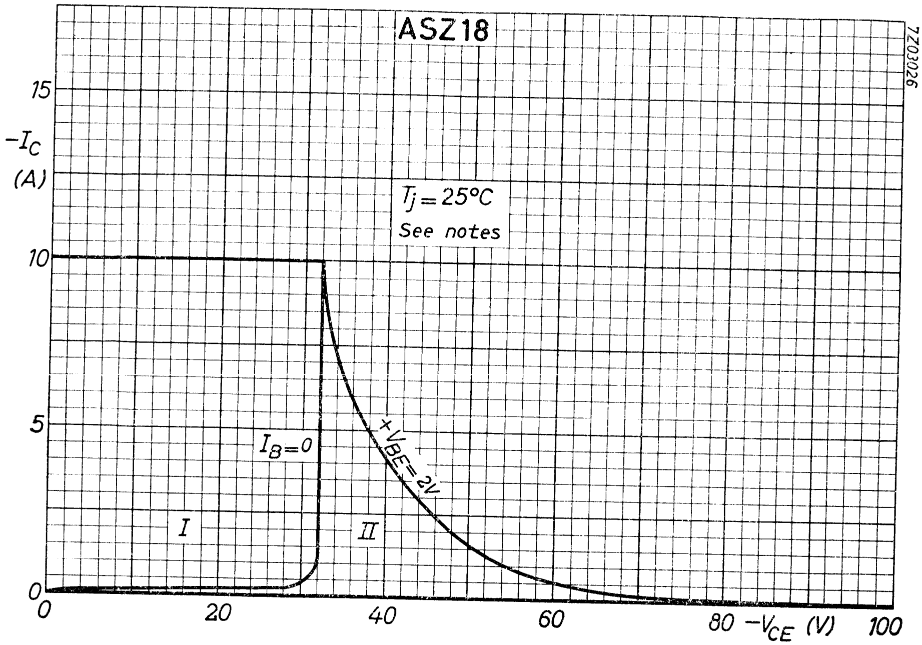

7Z03156
ASZ15
T_j = 25°C
$-V_{CE}$ = 1V
ASZ16
T_j = 25°C
$-V_{CE}$ = 1V
max
typ
min
$-I_C$ (A)
10
5
2
1
$-I_B$ (mA)
10
20
50
100
200
1000


7Z03124
T_j = 25°C
$-V_{CE}$ = 1V
15
$-I_C$
(A)
10
5
0
0
0.5
1
1.5
2
$-V_{BE}$ (V)
typ
max
ASZ18
ASZ15


7Z03125
T_j = 25°C
$-V_{CE}$ = 1V
15
$-I_C$
(A)
10
5
0
0
0.5
1
1.5
2
$-V_{BE}$ (V)
typ
max
ASZ16
ASZ17


ASZ15
7Z03027
15
$-I_C$
(A)
10
5
0
$T_j = 25°C$
See notes
I
II
$I_B = 0$
$+V_{BE} = 2V$
0
20
40
60
80
$-V_{CE}$ (V)
100


ASZ16-17
7Z03025
15
$-I_C$
(A)
10
5
0
$T_j = 25°C$
See notes
$I_B = 0$
$+V_{BE} = 2V$
I
II
0
20
40
60
80
$-V_{CE}$ (V)
100



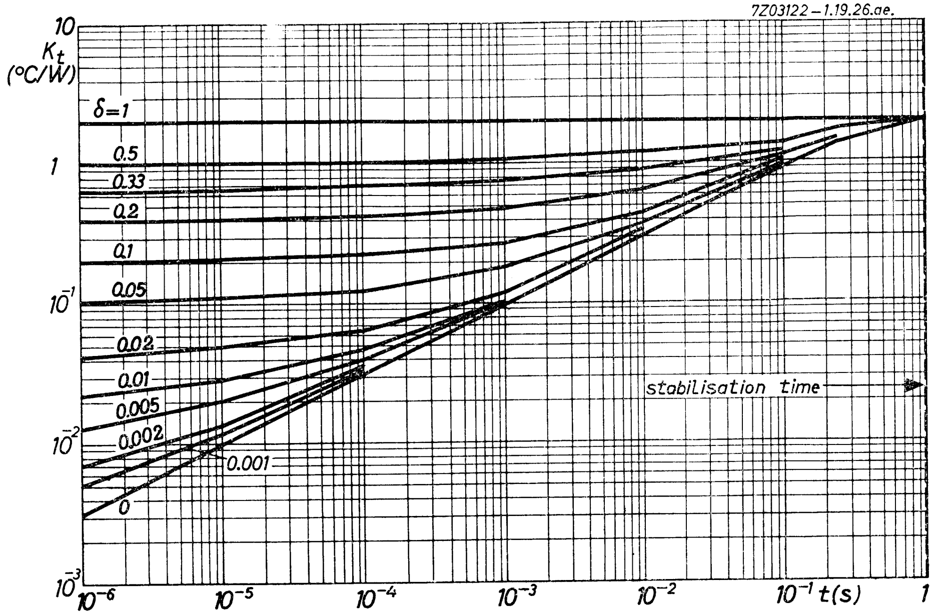
NOTES

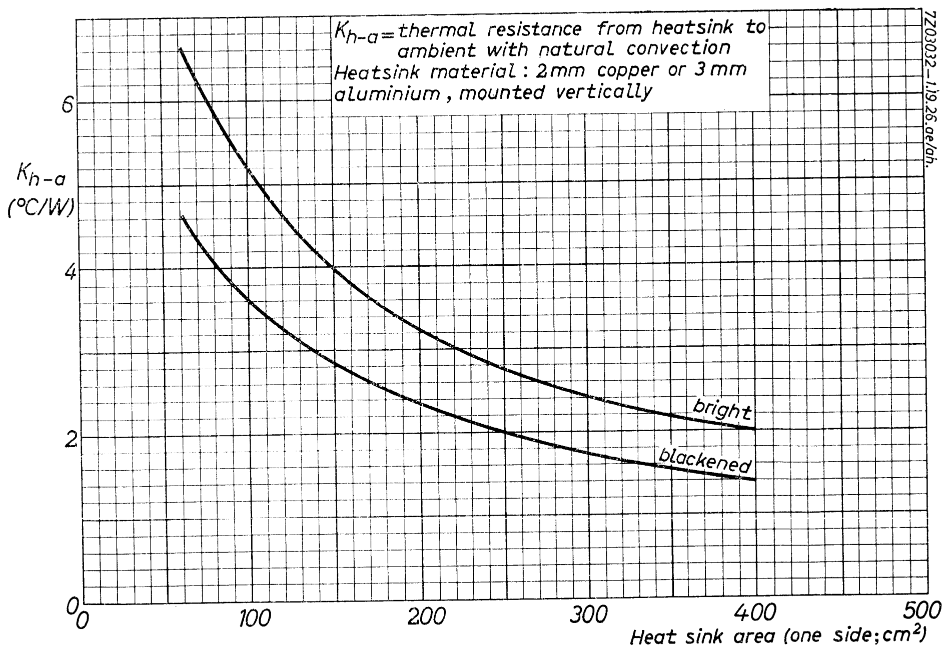
I permissible region of operation under all base-emitter conditions

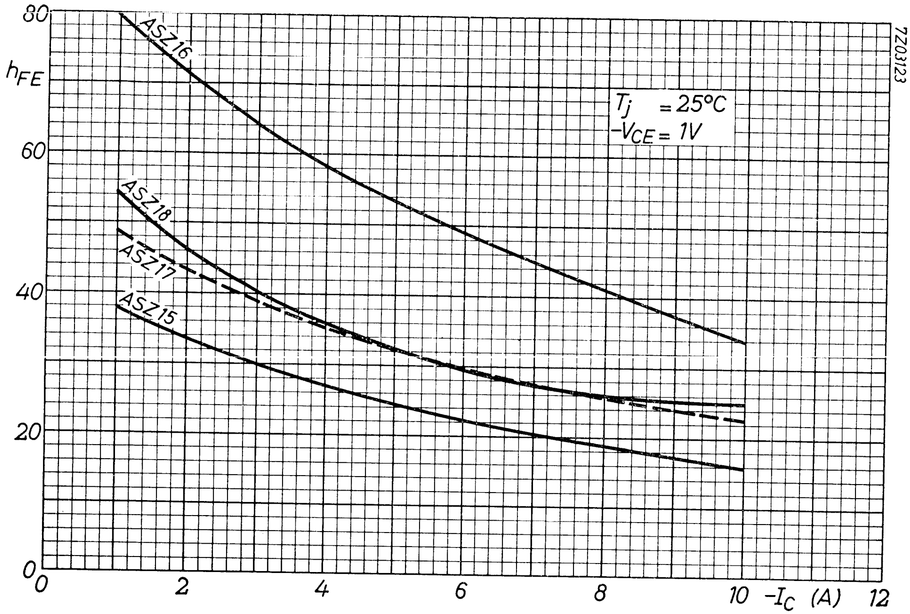
II additional region of operation when the transistor is cut-off with $+V_{BE} = 2$ V

During switching-off, voltages higher than those indicated by the minimum avalanche breakdown curves at $+V_{BE} = 2$ V are allowed, provided the transient energy is less than 8 mWs.

7Z2 3097


7Z03122-1.19.26.ae.
10
K_t
(°C/W)
δ=1
0.5
0.33
0.2
0.1
0.05
0.02
0.01
0.005
0.002
0.001
0
1
10^{-1}
10^{-2}
10^{-3}
stabilisation time
10^{-6}
10^{-5}
10^{-4}
10^{-3}
10^{-2}
10^{-1} t(s)
1


K_{h-a} = thermal resistance from heatsink to ambient with natural convection
Heatsink material: 2mm copper or 3mm aluminium, mounted vertically
7Z03032-1.19.26.ae/ah.
K_{h-a}
(°C/W)
6
4
2
0
bright
blackened
0
100
200
300
400
500
Heat sink area (one side; cm²)


80
h_{FE}
60
40
20
0
0
2
4
6
8
10
$-I_C$ (A)
12
ASZ16
ASZ18
ASZ17
ASZ15
T_j = 25°C
$-V_{CE}$ = 1V
7Z03123

P-N-P ALLOY DIFFUSED TRANSISTOR

Germanium alloy diffused transistor of the p-n-p type in metal case for use in wide band amplifier applications and current mode switching.

LIMITING VALUES (Absolute maximum values)

Collector			
Voltage (base reference)	$-V_{CB}$	= max.	40 V
Voltage (emitter reference) See also page G	$-V_{CE}$	= max.	40 V
Current	$-I_C$	= max.	25 mA
Base			
Current	$-I_B$	= max.	25 mA
Reverse current			
Continuous	I_B	= max.	1 mA
Peak	I_{BM}	= max.	10 mA
Dissipation			
Total dissipation	P_{tot}	= max.	110 mW
Temperatures			
Storage temperature	T_s	= max.	75 °C
Junction temperature			
Continuous operation	T_j	=	−55 °C to +75 °C
Incidentally (up to a total of 200 hours)	T_j	= max.	90 °C

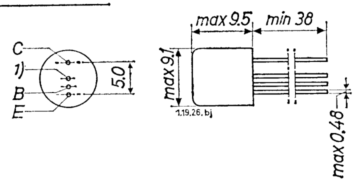
7Z2 2428

THERMAL DATA

Thermal resistance from junction to ambience in free air $K_{j\text{-}amb} < 0.6$ °C/mW

MECHANICAL DATA

Dimensions in mm



CHARACTERISTICS at $T_{amb} = 25$ °C

Collector current at $I_E = 0$

$-V_{CB} = 6$ V	$-I_{CBO}$	<	4.5 μA
$-V_{CB} = 40$ V	$-I_{CBO}$	<	50 μA

Emitter current at $I_C = 0$

$-V_{EB} = 1$ V	$-I_{EBO}$	<	50 μA

Base current

$-V_{CB} = 6$ V; $I_E = 1$ mA	$-I_B$	<	25 μA
$-V_{CB} = 2$ V; $I_E = 10$ mA	$-I_B$	>	20 μA

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN at $T_{amb} = 25$ °C, unless otherwise specified

Base-emitter voltage

$-V_{CB} = 6$ V; $I_E = 1$ mA	$-V_{BE}$	<	330 mV
		>	210 mV
$-V_{CB} = 2$ V; $I_E = 10$ mA	$-V_{BE}$	<	400 mV
		>	260 mV

1) Shield lead

7Z2 2429

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN at T_{amb} = 25 °C (continued)

A.C. amplification factor

$-V_{CB} \leqq 6$ V; $I_E \leqq 10$ mA; $T_{amb} = 60$ °C	h_{fb}	<	1.01
$-V_{CE} = 6$ V; $-I_C = 1$ mA; f = 1 kc/s	h_{fe}	>	45

Frequency at which $|h_{fe}| = 1$

$-V_{CB} = 6$ V; $I_E = 1$ mA	f_1	=	75 Mc/s
		>	40 Mc/s
$-V_{CB} = 2$ V; $I_E = 10$ mA	f_1	>	100 Mc/s

Intrinsic base impedance

$-V_{CB} = 6$ V; $I_E = 1$ mA; f = 2 Mc/s	$\|z r_b\|$	<	120 Ω

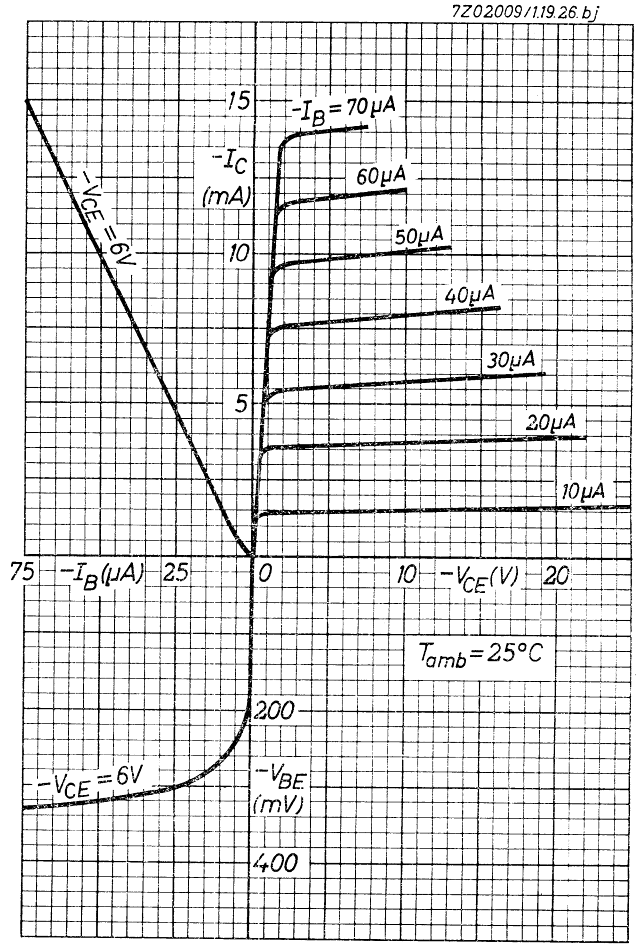
Collector capacitance

$-V_{CB} = 6$ V; $I_E = 0$ mA; f = 0.45 Mc/s	c_c	<	2.5 pF

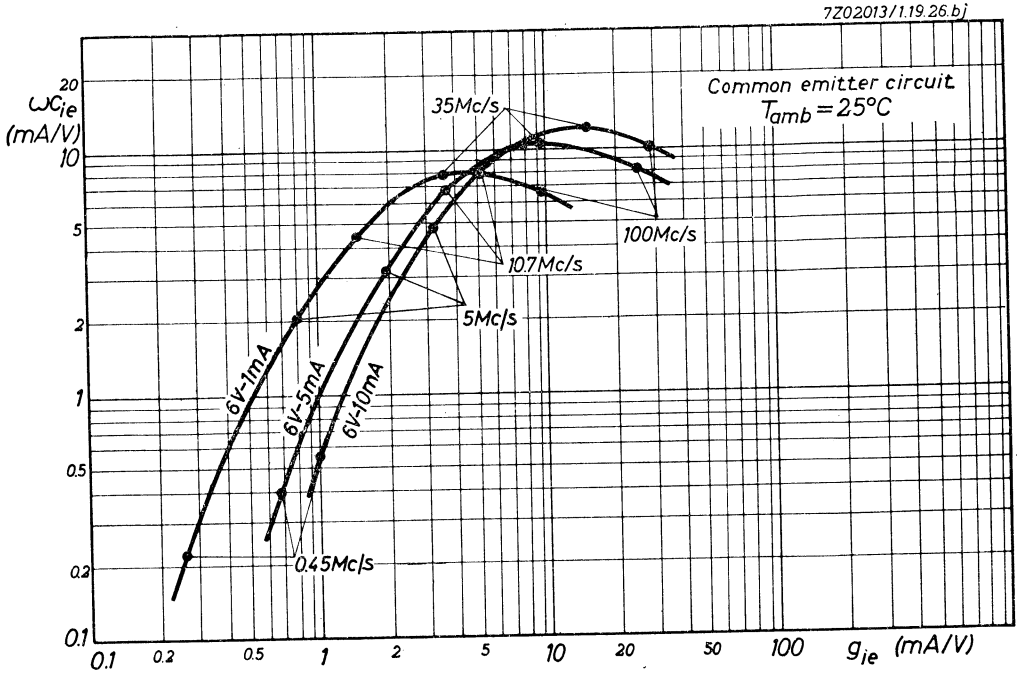
Noise figure

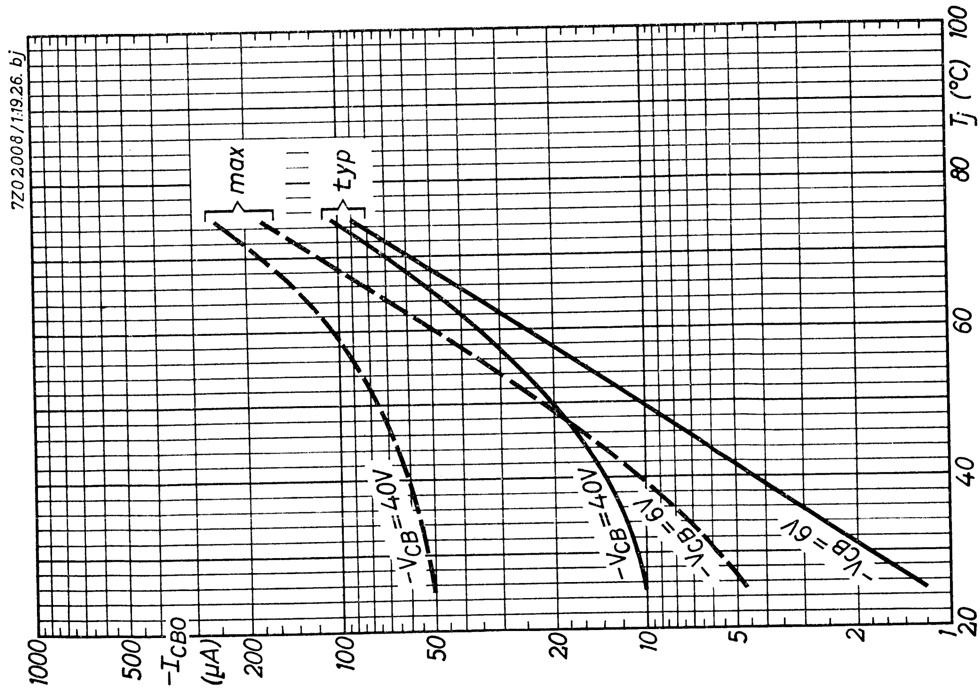
$-V_{CE} = 6$ V; $-I_C = 1$ mA; f = 1 kc/s; $R_S = 500\ \Omega$ [1]	F	=	15 dB
		<	20 dB
$-V_{CE} = 6$ V; $-I_C = 1$ mA; f = 0.45 Mc/s; $R_S = 500\ \Omega$ [1]	F	<	6 dB

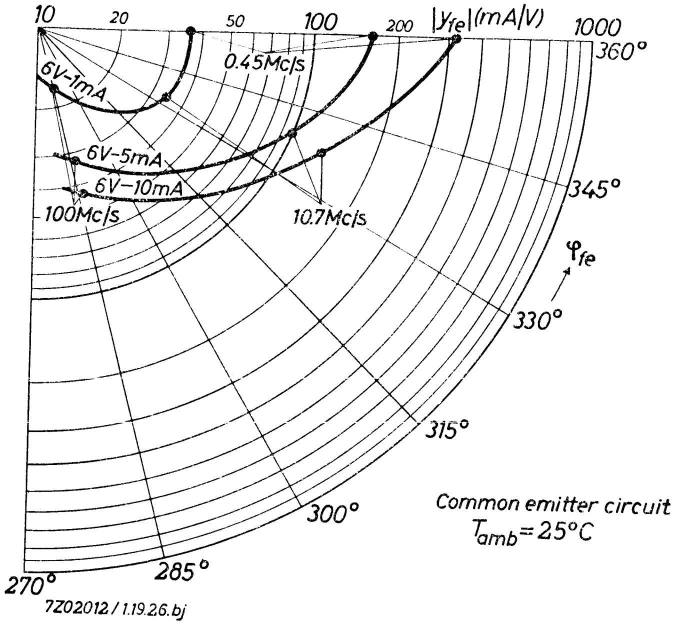
[1]) R_S = input source resistance



7Z2 2430

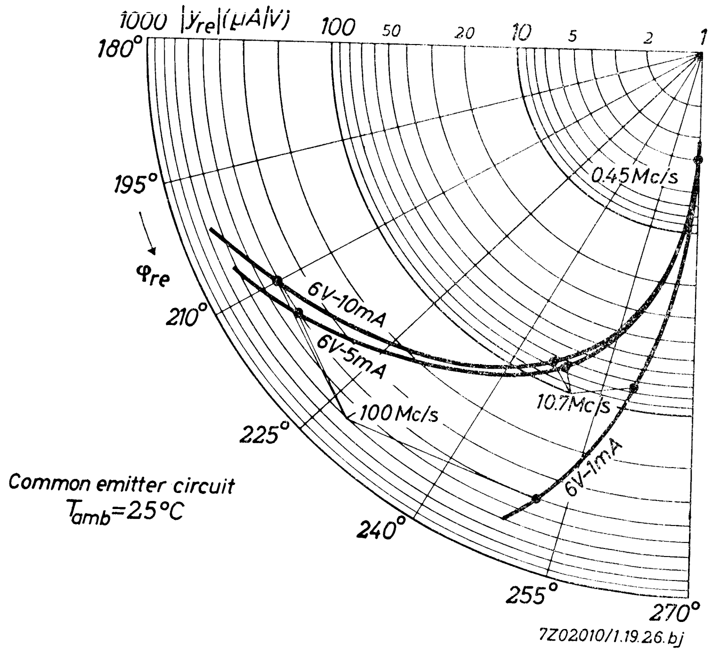

7Z02013/1.19.26.bj
C
Common emitter circuit
$T_{amb} = 25°C$
ωC_{ie} (mA/V)
35Mc/s
100Mc/s
10.7Mc/s
5Mc/s
0.45Mc/s
6V-1mA
6V-5mA
6V-10mA
g_{ie} (mA/V)


B
7Z02008/1.19.26.bj
max
typ
$-V_{CB}=40V$
$-V_{CB}=6V$
T_j (°C)
$-I_{CBO}$ (μA)
6.6.1964



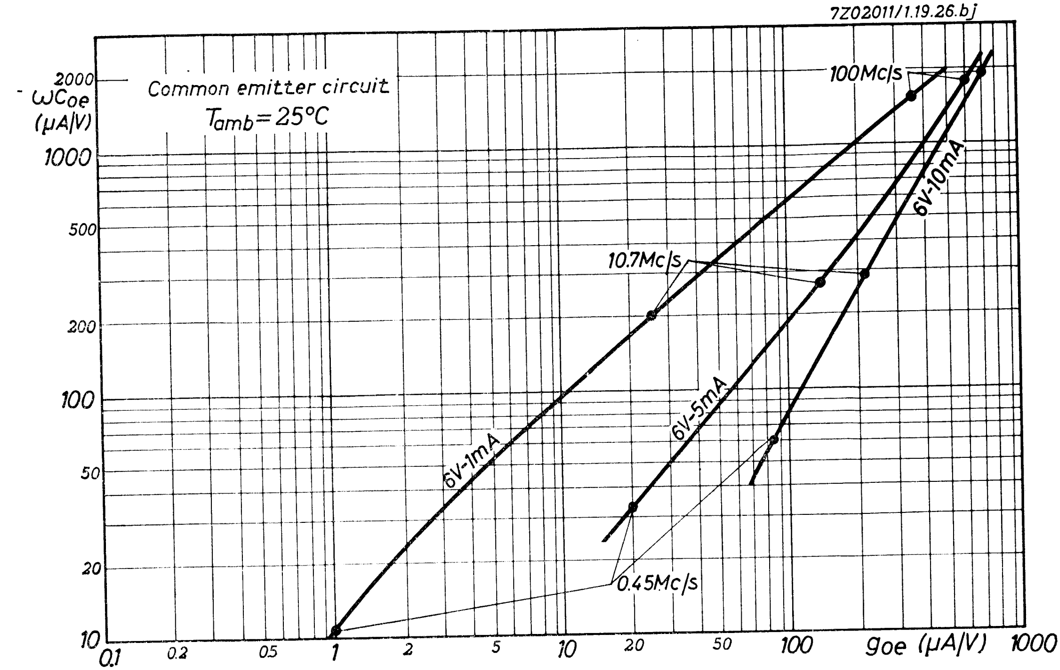
10
20
50
100
200
|y_fe|(mA/V)
1000
360°
0.45Mc/s
6V-1mA
6V-5mA
6V-10mA
100Mc/s
10.7Mc/s
345°
φfe
330°
315°
300°
285°
270°
Common emitter circuit
Tamb=25°C
7Z02012/1.19.26.bj

D

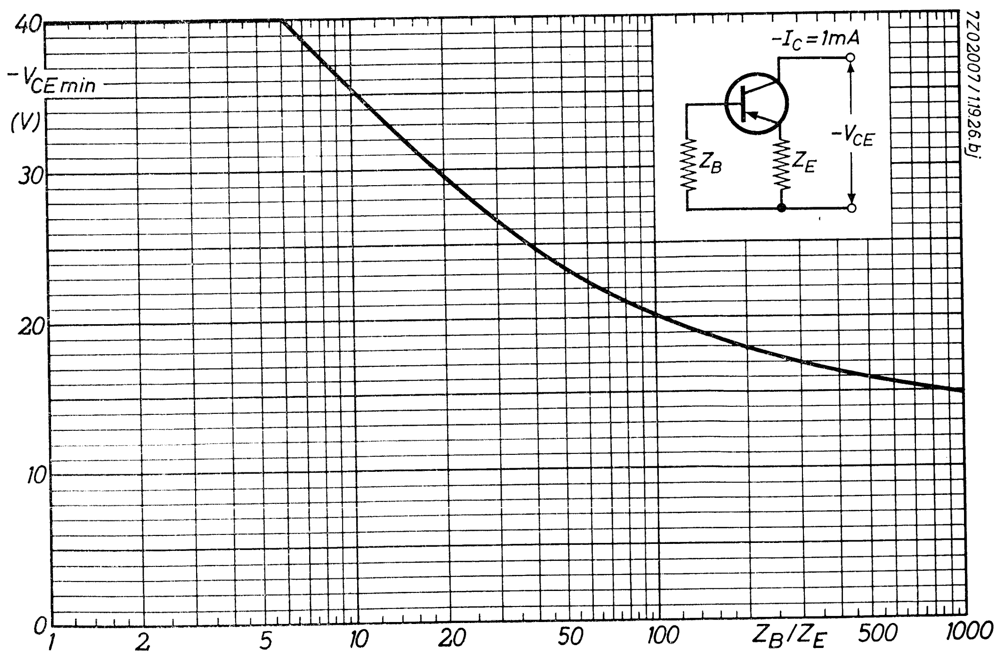


1000
|y_re|(μA/V)
100
50
20
10
5
2
1
180°
195°
φre
210°
225°
240°
255°
270°
0.45Mc/s
6V-10mA
6V-5mA
100Mc/s
10.7Mc/s
6V-1mA
Common emitter circuit
Tamb=25°C
7Z02010/1.19.26.bj

E


7Z02011/1.19.26.bj
Common emitter circuit
$T_{amb} = 25°C$
$-\omega C_{oe}$ (μA/V)
2000
1000
500
200
100
50
20
10
100Mc/s
10.7Mc/s
0.45Mc/s
6V-1mA
6V-5mA
6V-10mA
0.1
0.2
0.5
1
2
5
10
20
50
100
goe (μA/V)
1000

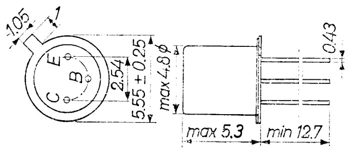
F


7Z02007/1.19.26.bj
$-V_{CE\,min}$ (V)
40
30
20
10
0
$-I_C = 1mA$
Z_B
Z_E
$-V_{CE}$
1
2
5
10
20
50
100
Z_B/Z_E
500
1000

G

ALLOY-DIFFUSED TRANSISTOR of the p-n-p type in metal envelope for high-speed saturated logic applications

Dimensions in mm — Collector connected to case



LIMITING VALUES (Absolute max. values)

Collector

Voltage (base reference)	$-V_{CB}$	= max.	20 V
Voltage (emitter reference)	$-V_{CE}$	= max.	15 V
Current			
Peak	$-I_{CM}$	= max.	50 mA
D.C. and average (averaging time max. 20 msec)	$-I_C$	= max.	30 mA
	(t_{av}	=	20 msec)

Emitter

Reverse current [1]			
Peak	$-I_{EM}$	= max.	10 mA
D.C. and average (averaging time max. 20 msec)	$-I_E$	= max.	5 mA
	(t_{av}	=	20 msec)

Base

Current			
Peak	$-I_{BM}$	= max.	10 mA
D.C. and average (averaging time max. 20 msec)	$-I_B$	= max.	5 mA
	(t_{av}	=	20 msec)

Dissipation

Total dissipation	P_{tot}	= max.	120 mW

Temperatures

Storage temperature	T_s	=	-55 °C to +75 °C
Junction temperature	T_j	= max.	85 °C

[1]) When the current is not limited the voltage must be less than 2.5 V

2.2.1964 7Z2 2267

THERMAL DATA

Thermal resistance from junction to ambience in free air	K = max. 0.50 °C/mW
Thermal resistance from junction to case	K = max. 0.18 °C/mW

CHARACTERISTICS

T_{amb} = 25 °C unless otherwise specified

Collector current		
$-I_C$ { $-V_{CE}$ = 15 V; $-V_{EB}$ = 0.2 V; T_{amb} = 60 °C }	<	60 μA
Emitter current at I_C = 0 mA		
$-I_{EBO}$ ($-V_{EB}$ = 0.5 V; I_C = 0 mA)	<	2 μA
Base current		
$-I_B$ { $-V_{CE}$ = 15 V; $-V_{EB}$ = 0.2 V; T_{amb} = 60 °C }	<	60 μA
Collector voltage		
$-V_{CB}$ { $-I_C$ = 100 μA; I_E = 0 mA; T_{amb} = 60 °C }	>	20 V
$-V_{CE}$ ($-I_C$ = 100 μA; V_{BE} = 0 V)	>	15 V
$-V_{CE}$ ($-I_C$ = 5 mA; $-I_B$ = 0 mA)	>	9 V
$-V_{CE}$ ($-I_C$ = 10 mA; $-I_B$ = 1 mA)	<	0.35 V
$-V_{CE}$ ($-I_C$ = 50 mA; $-I_B$ = 3 mA)	<	1.10 V
Emitter voltage		
$-V_{EB}$ { $-I_E$ = 100 μA; I_C = 0 mA; T_{amb} = 60 °C }	>	2.5 V
Base voltage		
$-V_{BE}$ ($-I_C$ = 10 mA; $-I_B$ = 0.44 mA)	> <	0.25 V 0.5 V
D.C. current amplification factor		
h_{FE} ($-V_{CE}$ = 0.5 V; $-I_C$ = 10 mA)	>	30
h_{FE} ($-V_{CE}$ = 1.0 V; $-I_C$ = 30 mA)	>	50

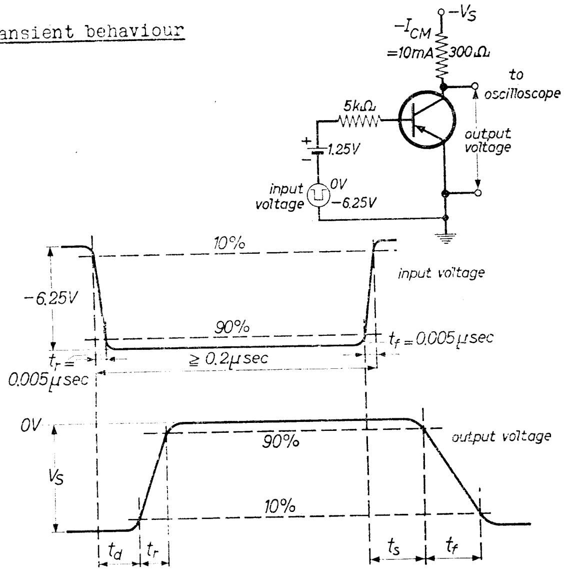
7Z2 1162

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN

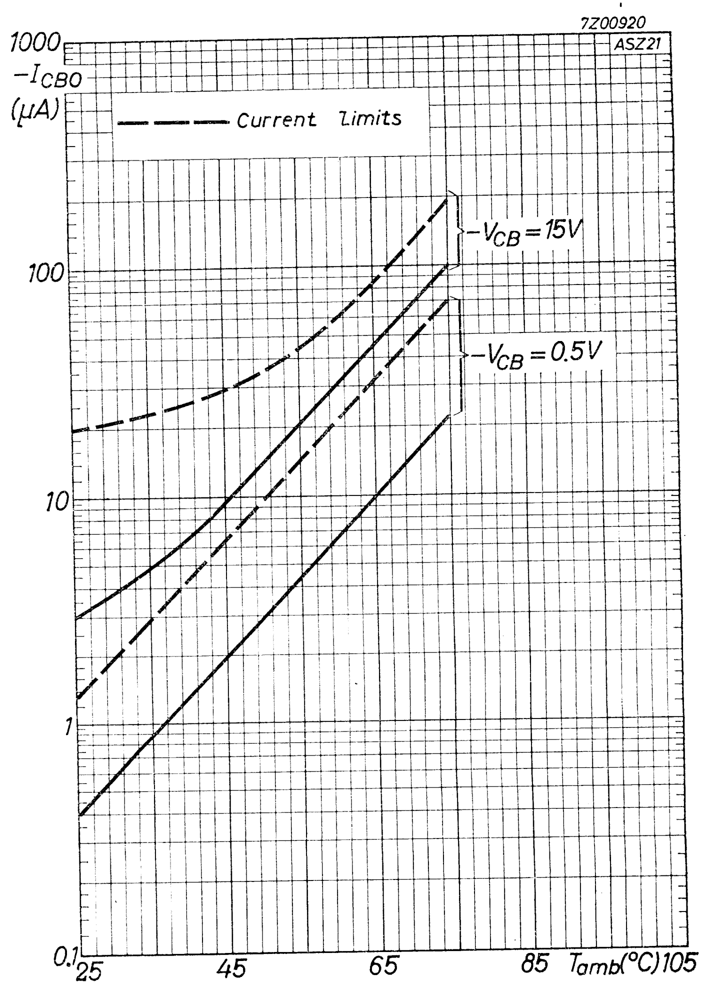
Tamb = 25 °C

Base voltage		
$-V_{BE}$ ($-I_C$ = 30 mA; $-I_B$ = 0.9 mA)	> 0.35 V < 0.75 V	
Frequency at which $\lvert h_{fe} \rvert$ = 1		
f_1 (I_E = 10 mA; $-V_{CB}$ = 2 V)	>	300 Mc/s
Collector capacitance		
c_c ($-V_{CB}$ = 6 V; I_E = 0 mA)	<	5 pF
Emitter capacitance		
c_e ($-V_{EB}$ = 1 V; I_C = 0 mA)	<	12 pF

Transient behaviour



Delay time	t_d = 0.03 μsec	> 0.015 μsec	< 0.040 μsec
Rise time	t_r = 0.02 μsec	> 0.010 μsec	< 0.035 μsec
Storage time	t_s = 0.04 μsec	> 0.025 μsec	< 0.060 μsec
Fall time	t_f = 0.04 μsec	> 0.025 μsec	< 0.055 μsec

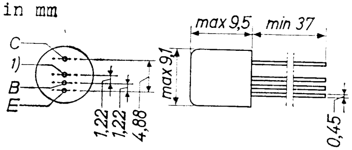


A

7Z2 1163
5.5.1962

ALLOY-DIFFUSED JUNCTION TRANSISTOR of the p-n-p type in metal can for generating short duration pulses
TRANSISTOR À JONCTIONS du type p-n-p EN TECHNIQUE ALLIAGE-DIFFUSION dans un boîtier métallique pour la production d'impulsions à courte durée
p-n-p-FLÄCHENTRANSISTOR NACH DEM DIFFUSIONSLEGIERUNGS-VERFAHREN in Metallgehäuse zur Erzeugung von Impulsen kurzer Dauer

Dimensions in mm
Dimensions en mm
Abmessungen in mm



Limiting values (Absolute max. values)
Caractéristiques limites (Valeurs max. absolues)
Grenzdaten (Absolute Maximalwerte)

$-I_{CM}$	= max.	100 mA
$-I_{CQ}$	= max.	2 mA [2]
$-V_{EB}$	= max.	2 V
P_{tot}	= max.	$\frac{T_{j max} - T_{amb}}{K}$ [3]
T_j	= max.	75 °C

Storage temperature
Température d'emmagasinage = -55 °C/+75 °C
Lagerungstemperatur

[1]) Interlead shield and metal case
Blindage entre les connexions et boîtier métallique
Abschirmung zwischen den Anschlüssen und Metallgehäuse

[2]) Quiescent avalanche
Courant de collecteur de repos
Kollektorruhestrom

[3]) See also pages A and B
Voir aussi pages A et B
Siehe auch Seiten A und B

Thermal data. Thermal resistance

from junction to ambience in free air	K ≦	0.6 °C/mW
from junction to case	K ≦	0.5 °C/mW

Données thermiques. Résistance thermique

entre les jonctions et l'ambiance à l'air libre	K ≦	0,6 °C/mW
entre les jonctions et le boîtier	K ≦	0,5 °C/mW

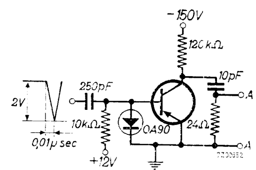
Thermische Daten. Wärmewiderstand

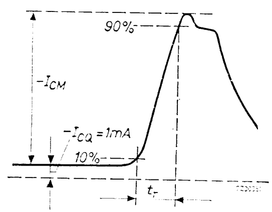
zwischen Kristall und Umgebung in freier Luft	K ≦	0,6 °C/mW
zwischen Kristall und Gehäuse	K ≦	0,5 °C/mW

Characteristics range values for equipment design
Gammes de valeurs des caractéristiques pour l'étude d'équipements
Kenndatenbereiche für Gerätentwurf

		T_{amb} = 25 °C	
$-V_{CB}$ = 6 V	$-I_{CBO}$ = 2,0 μA	< 8,0 μA	
$-V_{EB}$ = 0,5 V	$-I_{EBO}$ = 0,1 μA	< 0,5 μA	
$-I_C$ = 1 mA; I_E = 0 mA	$-V_{CB}$ = 24 V	> 15 V	< 30 V
$-V_{CB}$ = 6 V; I_E = 0 mA	$C_{b'c}$	< 4,0 pF	

Collector current pulse
Impulsion du courant de collecteur
Kollektorstromimpuls





$-I_{CM}$ = 40	<	60 mA [1]
t_r		< 0,001 μsec

[1]) See page 3
Voir page 3
Siehe Seite 3

Collector current pulse (continued)
Impulsion du courant de collecteur (suite)
Kollektorstromimpuls (Fortsetzung)

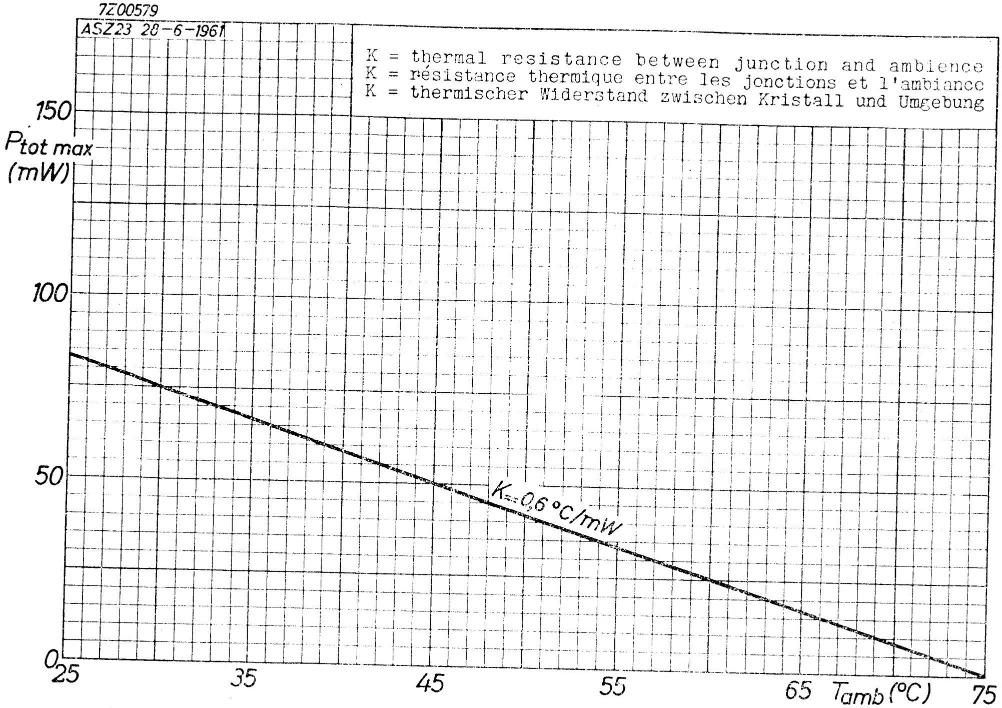
Terminals A : to sampling oscilloscope
Bornes A : pour oscilloscope stroboscopique
Anschlussklemmen A: nach stroboskopischem Oszillographen

The resistance of 24 Ω should be a non inductive type and may be conveniently obtained by four lengths of coaxial cable in parallel with short circuit terminations (Each length = 1.5 m, Z_o = 95 Ω)

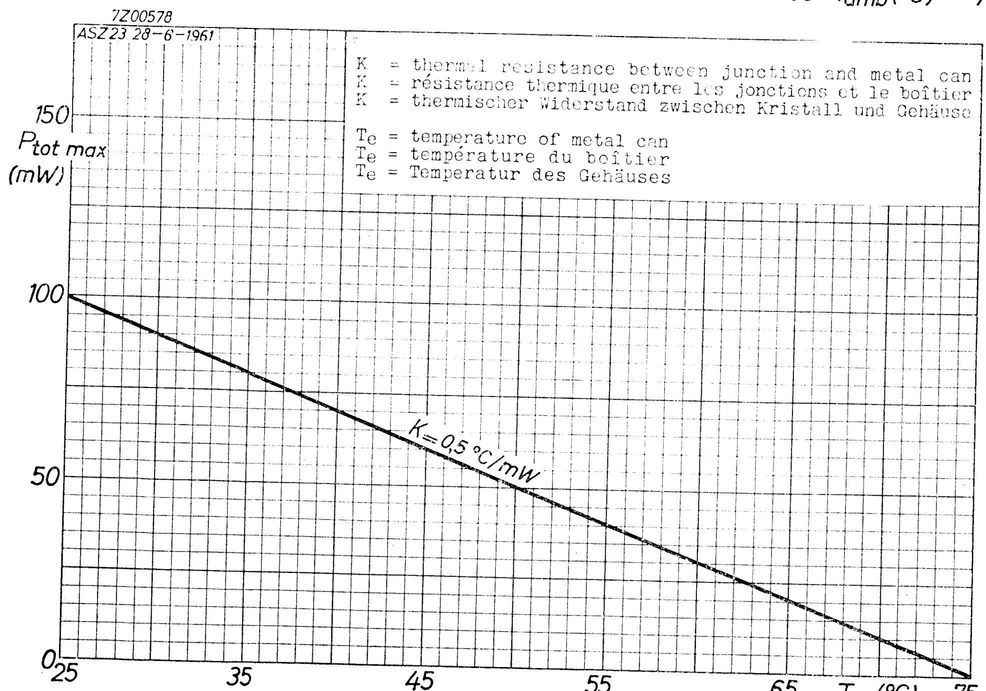
La résistance de 24 Ω doit être non-inductive et peut être obtenue par quatre pièces de câble coaxial en parallèle avec les extrémités en court-circuit (chaque pièce de 1,5 m, Z_o = 95 Ω)

Der Widerstand von 24 Ω soll induktionsfrei sein und kann mittels vier parallelgeschalteten Koaxialkabelstücke mit kurzgeschlossenen Enden erhalten werden (jedes Stück 1,5 m, Z_o = 95 Ω)

[1]) Higher values may be achieved in the circuit shown provided the collector circuit capacitance < 15 pF
Des valeurs plus élevées peuvent être obtenues dans le circuit page 2, si la capacité du circuit de collecteur est < 15 pF
Wenn die Kapazität der Kollektorschaltung < 15 pF ist, können in der angegebenen Schaltung höhere Werte erhalten werden


7Z00579
ASZ23 28-6-1961
K = thermal resistance between junction and ambience
K = résistance thermique entre les jonctions et l'ambiance
K = thermischer Widerstand zwischen Kristall und Umgebung
150
Ptot max
(mW)
100
50
0
25
35
45
55
65
75
K=0,6 °C/mW
Tamb (°C)

A


7Z00578
ASZ23 28-6-1961
K = thermal resistance between junction and metal can
K = résistance thermique entre les jonctions et le boîtier
K = thermischer Widerstand zwischen Kristall und Gehäuse
Te = temperature of metal can
Te = température du boîtier
Te = Temperatur des Gehäuses
150
Ptot max
(mW)
100
50
0
25
35
45
55
65
75
K=0,5 °C/mW
Te (°C)

B

GERMANIUM P-N-P POWER TRANSISTORS

Germanium alloy diffused power transistors of the p-n-p type in TO-3 metal case with the collector connected to the case.
The AU101 is meant for use in a line deflection output stage; the AU102 for the corresponding driver stage.

LIMITING VALUES (Absolute max. values)

			AU101	AU102
Collector-base voltage	$-V_{CB}$	max.	120 V	40 V
Collector-emitter voltage	$-V_{CE}$	max.	120 V	40 V
Collector current (d.c. and average)	$-I_C$	max.	10 A	
Total dissipation	P_{tot}	max.	10 W	
Junction temperature (continuous)	T_j	max.	90 °C	

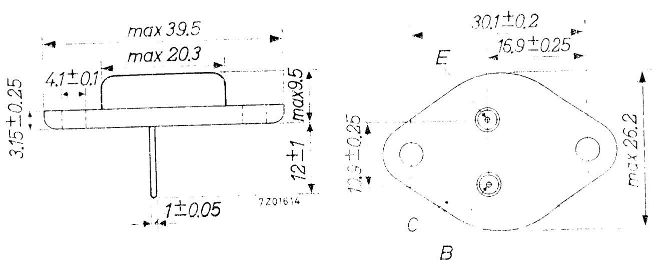
THERMAL RESISTANCE

From junction to mounting base	K	<	2.0 °C/W

CHARACTERISTICS T_j = 25 °C unless otherwise specified

D.C. current gain				
I_E = 10 A; V_{CB} = 0	AU101	h_{FE}		12 to 50
	AU102	h_{FE}	>	7
Transition frequency				
$-I_C$ = 0.5 A; $-V_{CE}$ = 2 V		f_T	>	400 kc/s
Fall time from $-I_C$ = 8 A				
T_j = 90 °C	AU101	t_f	<	2.6 μs
	AU102	t_f	<	3.9 μs

MECHANICAL DATA Dimensions in mm



TO-3
Collector connected to case

7Z2 3305

3.3.1965

ALLOY-DIFFUSED GERMANIUM POWER TRANSISTOR of the p-n-p type for non-saturated switching applications
TRANSISTOR DE PUISSANCE AU GERMANIUM DU TYPE p-n-p EN TECHNIQUE ALLIAGE-DIFFUSÉ pour applications de commutation sans saturation
DIFFUSIONSLEGIERTER p-n-p-GERMANIUM-LEISTUNGSTRANSISTOR für Schalteranwendungen ohne Sättigung

Limiting values (Absolute max. values)
Caractéristiques limites (Valeurs max. absolues)
Grenzdaten (Absolute Maximalwerte)

$-V_{CB}$	= max.	70 V [1])
$-V_{CE}$ (V_{BE} > 0,2 V)	= max.	60 V [2])
$-I_C$	= max.	700 mA [1])
I_E	= max.	750 mA
$-I_E$	= max.	50 mA
$-I_B$ (t_{av} = max. 20 msec)	= max.	50 mA
$-I_{BM}$	= max.	700 mA
P_{tot} (t_{av} = max. 20 msec)	= max.	6 W [3])
P_{tot} (t_{av} = max. 20 msec)	= max.	$\frac{T_{j\,max} - T_{amb}}{K}$ [4])
T_j	= max.	75 °C
Storage temperature Température d'emmagasinage Lagerungstemperatur	=	-55 °C/+75 °C

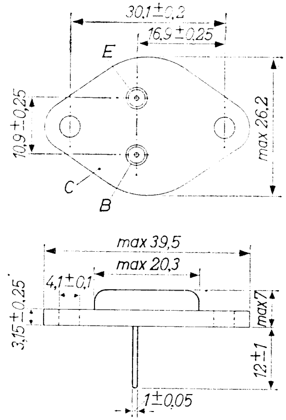
[1]) See also page C. During switching-off operation outside region II of page C is permissible provided the inductance of the circuit ≦ 250 µH and the switch-off time ≦ 15 µsec.
Voir aussi page C. Pendant la mise hors circuit le fonctionnement en dehors de la région II de page C est permis pourvu que l'inductance du circuit ≦ 250 µH et la durée de la mise hors circuit ≦ 15 µsec.
Siehe auch Seite C. Während des Ausschaltens ist Betrieb ausserhalb des Bereiches II auf Seite C erlaubt wenn die Selbstinduktion der Schaltung ≦ 250 µH und die Ausschaltdauer ≦ 15 µSek.

[2]) For common emitter operation due measures have to be taken to ensure electrical and thermal stability
Pour le fonctionnement à émetteur commun il faut prendre des mesures convenables pour assurer la stabilité électrique et thermique
Bei Betrieb in Emitterschaltung müssen geeignete Massnahmen getroffen werden zur Sicherung der elektrischen und thermischen Stabilität.

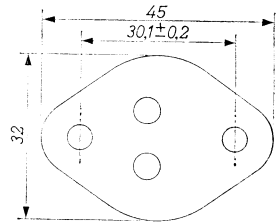
[3])[4]) See page 2; voir page 2; siehe Seite 2

7Z2 0975
1.1.1962

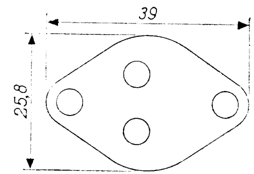
Dimensions in mm
Dimensions en mm
Abmessungen in mm



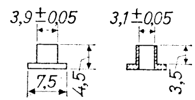
Mica insulation, 0.05 mm
Isolement de mica, 0,05 mm
Glimmerisolierung, 0,05 mm



Lead washer, 1 mm
Plaque de plomb, 1 mm
Bleischeibe, 1 mm



Insulation tubes
Isolateurs de traversée
Durchführungsisolatoren



[3]) Up to a transistor bottom temperature of 50 °C
Jusqu'à une température du fond du transistor de 50 °C
Bei einer Transistorbodentemperatur niedriger als 50 °C

[4]) At transistor bottom temperatures higher than 50 °C. K is the thermal resistance between junction and ambience
Aux températures du fond du transistor au-dessus de 50 °C. K est la résistance thermique entre les jonctions du transistor et l'ambiance
Bei Transistorbodentemperaturen höher als 50 °C. K ist der thermische Widerstand zwischen Transistorkristall und Umgebung.

7Z2 0976

THERMAL DATA. Thermal resistance between junction and transistor bottom	K = max. 4.0 °C/W
Thermal resistance between transistor bottom and heat sink, when mounted with mica and lead washers (see page 2)	K = max. 0.5 °C/W
DONNÉES THERMIQUES. Résistance thermique entre les jonctions et le fond du transistor	K = max. 4,0 °C/W
Résistance thermique entre le fond du transistor et la plaque de refroidissement si le transistor est monté avec des plaques de mica et de plomb (voir page 2)	K = max. 0,5 °C/W
THERMISCHE DATEN. Wärmewiderstand zwischen Kristall und Transistorboden	K = max. 4,0 °C/W
Wärmewiderstand zwischen Transistorboden und Kühlplatte wenn der Transistor mit Glimmer- und Bleiplatten montiert ist (siehe Seite 2)	K = max. 0,5 °C/W

Characteristics
Caractéristiques
Kenndaten

T_m = temperature of transistor bottom
T_m = température du fond du transistor
T_m = Temperatur des Transistorbodens

$-V_{CE}$ = 60 V
V_{BE} = 1 V
T_m = 60 °C
$-I_C$ < 1 mA

$-I_E$ = 1 mA
I_C = 0 mA
T_m = 60 °C
$-V_{EB}$ > 1,5 V

$-V_{CE}$ = 60 V
R_{BE} = 56 Ω
T_m = 60 °C
$-I_C$ < 2 mA

I_E = 600 mA
$-V_{CB}$ = 10 V
T_m = 60 °C
V_{EB} > 0,1 V

I_E = 600 mA
$-V_{CB}$ = 10 V
T_m = 25 °C
V_{EB} < 0,45 V

7Z2 0977
1.1.1962

Characteristics (continued)
Caractéristiques (suite)
Kenndaten (Fortsetzung)

$-I_C$ = 3 mA
I_E = 0 mA
T_m = 60 °C
$-V_{CB}$ > 70 V

I_E = 600 mA
$-V_{CB}$ = 30 V
T_j = 75 °C
$+I_B$ < 6 mA

$-V_{CE}$ = 60 V
V_{BE} = 1 V
T_m = 60 °C
$-I_B$ < 1 mA

I_E = 600 mA
$-V_{CB}$ = 10 V
T_m = 25 °C
$-I_B$ < 15 mA

Characteristics range values for equipment design
Gammes de valeurs des caractéristiques pour l'étude d'équipements
Kenndatenbereiche für Gerätentwurf

T_{amb} = 25 °C

$-I_{CBO}$ { see page B / voir page B / siehe Seite B }

$-V_{CB}$ = 10 V
I_E = 0 mA
c_c < 85 pF 2)

I_E = 300 mA
$-V_{CB}$ = 10 V
f_1 1) = 120 Mc/s > 60 Mc/s

$-V_{CB}$ = 60 V
I_E = 0 mA
c_c < 45 pF 2)

1) Frequency at which $|h_{fe}| = 1$
Fréquence à laquelle $|h_{fe}| = 1$
Frequenz bei der $|h_{fe}| = 1$

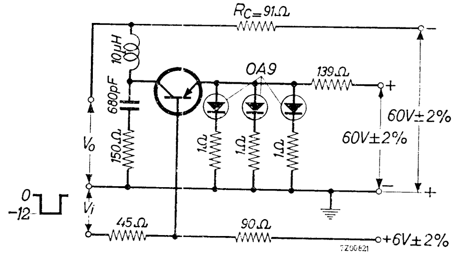
2) Collector capacitance
Capacité du collecteur
Kollektorkapazität

7Z2 0978

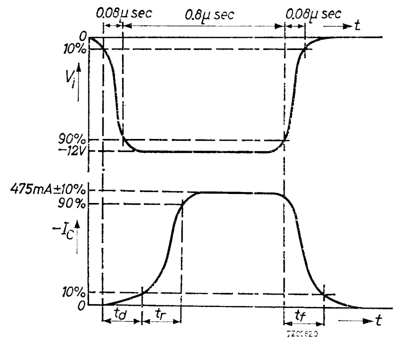
Characteristics range values for equipment design (continued)
Gammes de valeurs des caractéristiques pour l'étude d'équipements (suite)
Kenndatenbereiche für Gerätentwurf (Fortsetzung)

Transient response
Phénomènes transitoires
Ausgleichsvorgänge

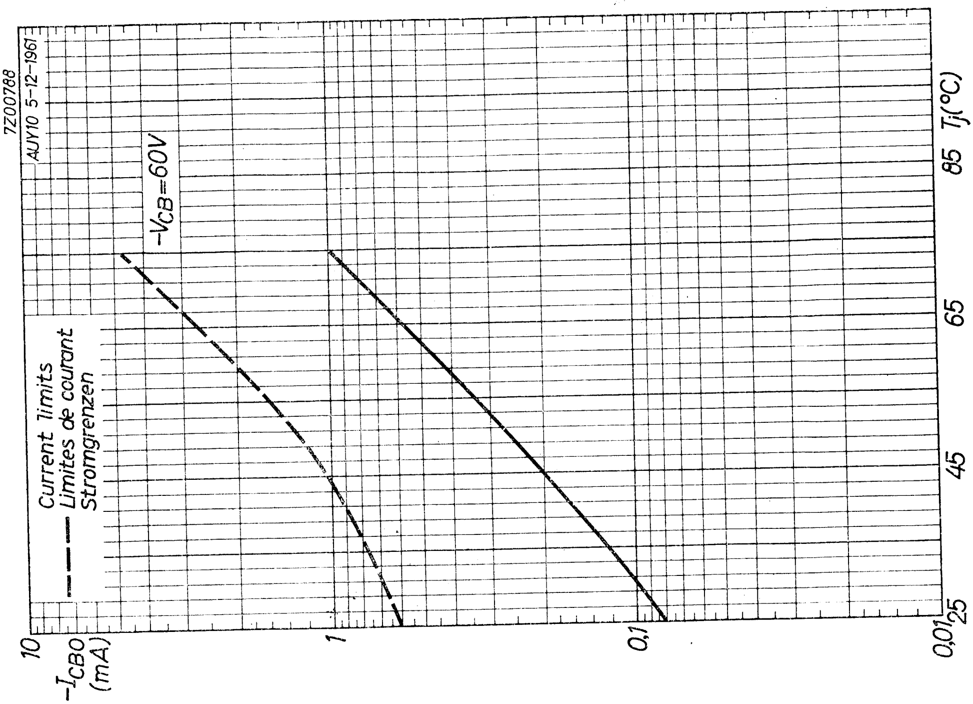
T_{amb} = 25 °C



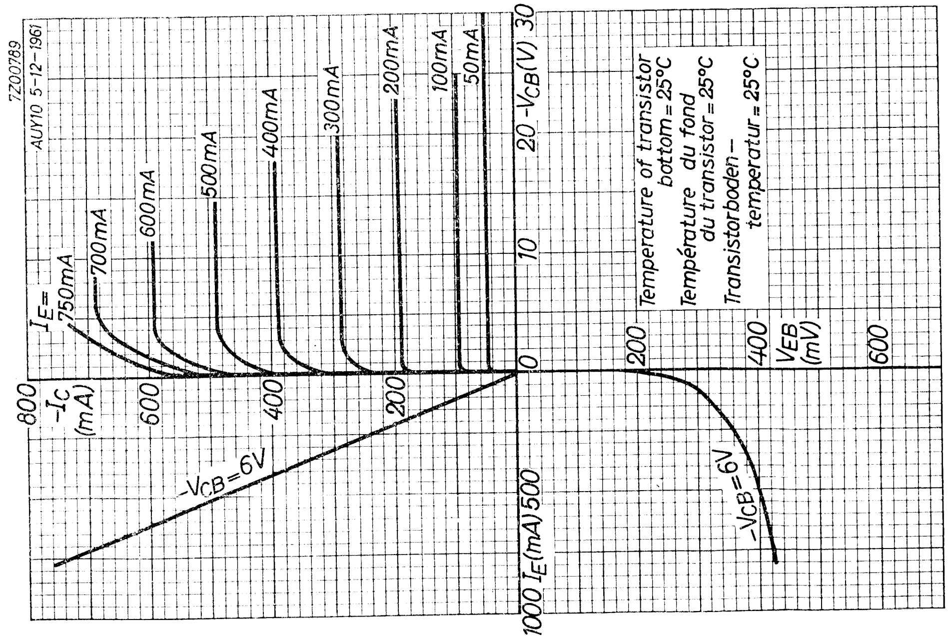
Tolerance of resistors ± 2 %
Tolérance des résistances ± 2 %
Streuung der Widerstände ± 2 %



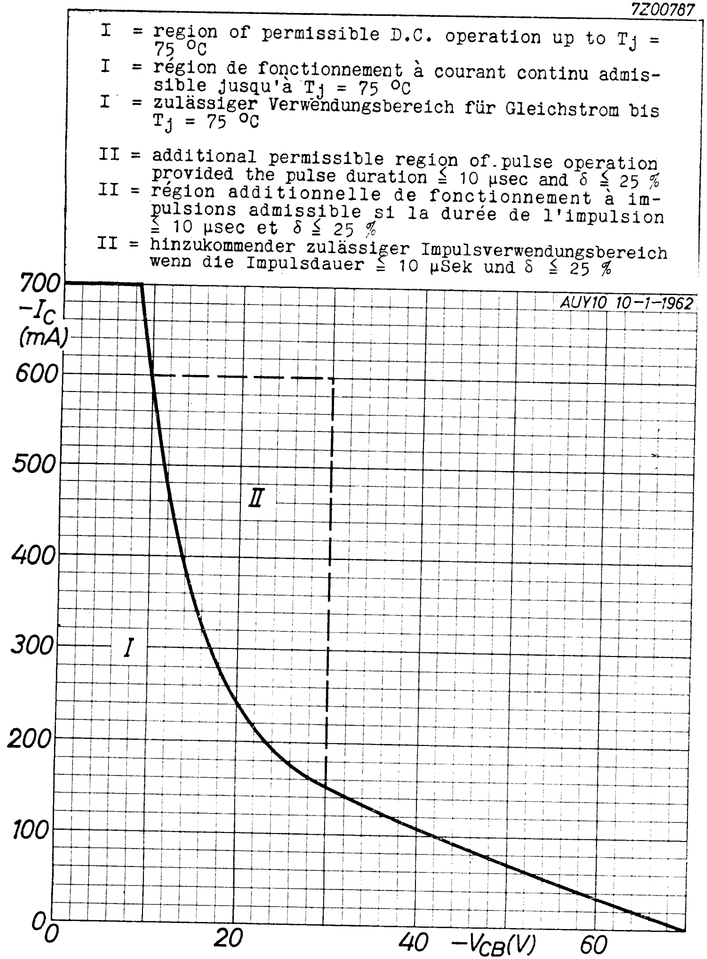
t_d < 0,2 μsec
t_r < 0,2 μsec
t_f < 0,2 μsec


7Z00788
AUY10 5-12-1961
Current limits
Limites de courant
Stromgrenzen
$-V_{CB}=60V$
$-I_{CBO}$ (mA)
10
1
0,1
0,01
25
45
65
85
T_j(°C)

B

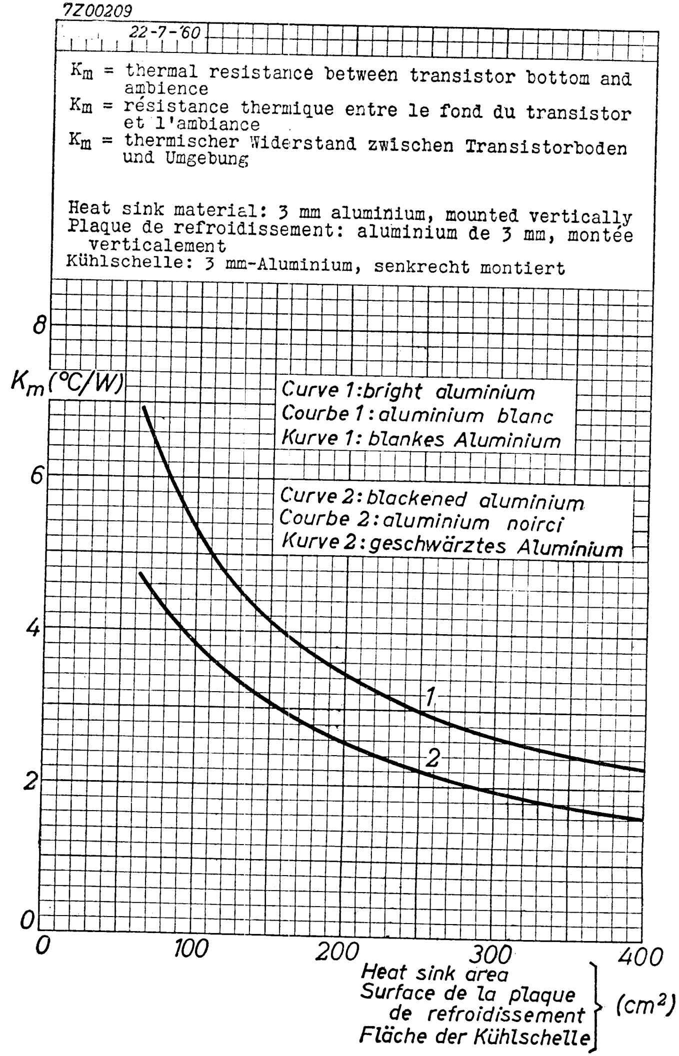

7Z00789
AUY10 5-12-1961
$I_E=$
750mA
700mA
600mA
500mA
400mA
300mA
200mA
100mA
50mA
$-I_C$ (mA)
800
600
400
200
0
10
20
30
$-V_{CB}$(V)
$-V_{CB}=6V$
1000
500
I_E(mA)
200
400
600
V_{EB} (mV)
$-V_{CB}=6V$
Temperature of transistor bottom = 25°C
Température du fond du transistor = 25°C
Transistorboden-temperatur = 25°C

A


7Z00787
I = region of permissible D.C. operation up to T_j = 75 °C
I = région de fonctionnement à courant continu admissible jusqu'à T_j = 75 °C
I = zulässiger Verwendungsbereich für Gleichstrom bis T_j = 75 °C
II = additional permissible region of pulse operation provided the pulse duration ≦ 10 μsec and δ ≦ 25 %
II = région additionnelle de fonctionnement à impulsions admissible si la durée de l'impulsion ≦ 10 μsec et δ ≦ 25 %
II = hinzukommender zulässiger Impulsverwendungsbereich wenn die Impulsdauer ≦ 10 μSek und δ ≦ 25 %
AUY10 10-1-1962
$-I_C$ (mA)
700
600
500
400
300
200
100
0
I
II
0
20
40
60
$-V_{CB}$(V)

1.1.1962

C


7Z00209
22-7-60
K_m = thermal resistance between transistor bottom and ambience
K_m = résistance thermique entre le fond du transistor et l'ambiance
K_m = thermischer Widerstand zwischen Transistorboden und Umgebung
Heat sink material: 3 mm aluminium, mounted vertically
Plaque de refroidissement: aluminium de 3 mm, montée verticalement
Kühlschelle: 3 mm-Aluminium, senkrecht montiert
K_m (°C/W)
8
6
4
2
0
Curve 1: bright aluminium
Courbe 1: aluminium blanc
Kurve 1: blankes Aluminium
Curve 2: blackened aluminium
Courbe 2: aluminium noirci
Kurve 2: geschwärztes Aluminium
1
2
0
100
200
300
400
Heat sink area
Surface de la plaque de refroidissement
Fläche der Kühlschelle
(cm²)

D

SILICON TRANSISTOR of the p-n-p alloy type with metal envelope for medium voltage and current industrial applications

LIMITING VALUES (Absolute max. values)

Collector

Voltage (base reference)	$-V_{CB}$ = max.	32 V
Voltage (emitter reference)	$-V_{CE}$ = max.	32 V [1]
Average current (averaging time = max. 20 msec)	$-I_C$ = max. (t_{av} = max.	250 mA 20 msec)
Peak current	$-I_{CM}$ = max.	500 mA

Emitter

Voltage (base reference)	$-V_{EB}$ = max.	12 V
Average current (averaging time = max. 20 msec)	I_E = max. (t_{av} = max.	250 mA 20 msec)
Peak current	I_{EM} = max.	500 mA

Base

Current	$-I_B$ = max.	125 mA

Dissipation

Total dissipation — See page F

Temperatures

Storage temperature	T_s =	$-55\ ^{o}C$ to $+150\ ^{o}C$
Junction temperature	T_j = max.	150 ^{o}C

THERMAL DATA

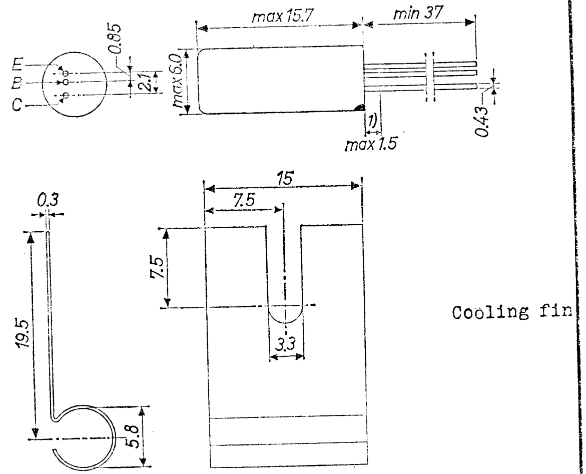
Thermal resistance between junction and ambience

without cooling fin in free air	K = max.	0.4 $^{o}C/mW$
with cooling fin on heat sink of 70x70x1.6 mm aluminium	K = max.	0.3 $^{o}C/mW$
Thermal resistance between junction and case	K = max.	0.25 $^{o}C/mW$

[1]) At $+V_{BE}$ > 500 mV. At $-I_C$ = 200 mA $-V_{CE}$ = max. 24 V

7Z2 1048
6.6.1962

Dimensions in mm The red dot indicates the collector



CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN

T_j = 25 ^{o}C

Collector current at I_E = 0 mA				
$-I_{CBO}$($-V_{CB}$ = 6 V; I_E = 0 mA)	=	0.02 µA	<	0.1 µA
Emitter current at I_C = 0 mA				
$-I_{EBO}$($-V_{EB}$ = 6 V; I_C = 0 mA)	=	0.02 µA	<	0.1 µA
Collector voltage				
$-V_{CE}$ ($-I_C$ = 125 mA; $-I_B$ = 17 mA)	=	250 mV		
Base voltage				
$-V_{BE}$ ($-V_{CE}$ = 2 V; $-I_C$ = 150 mA)	=	1.0 V	<	1.6 V
D.C. current amplification factor				
h_{FE} ($-V_{CE}$ = 2 V; $-I_C$ = 30 mA)	=	24	>	12
h_{FE} ($-V_{CE}$ = 1 V; $-I_C$ = 150 mA)	=	15	>	10
Noise figure				
F {$-V_{CE}$ = 2 V; $-I_C$ = 500 µA; Input source resistance = 500 Ω}	=	7 dB	<	20 dB

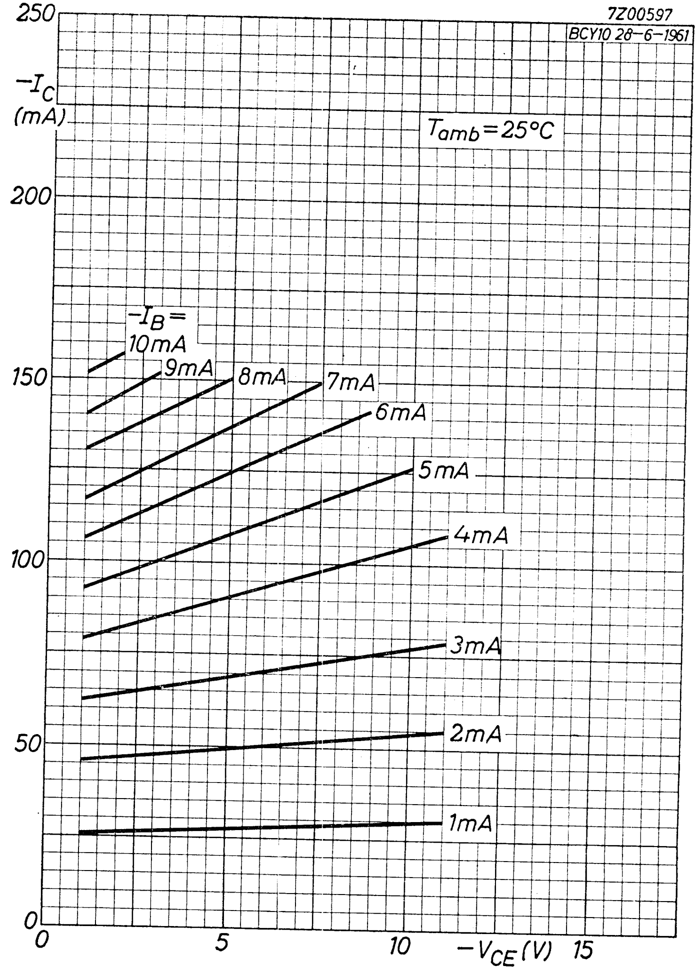
[1]) Not tinned

7Z2 1049

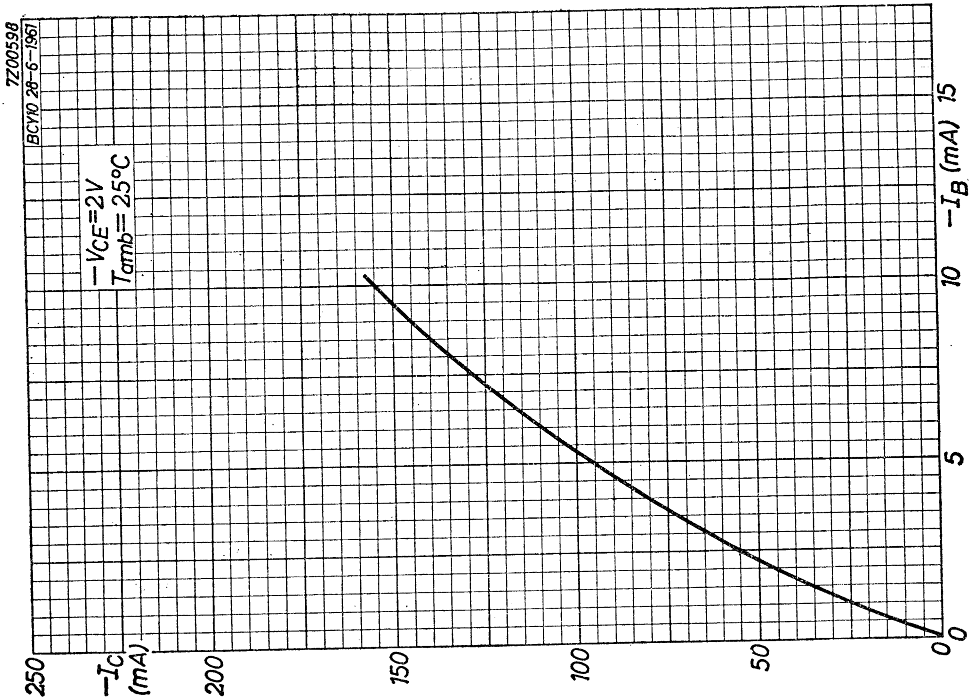
Parameters

Collector voltage	$-V_{CE}$	= 6 V
Collector current	$-I_C$	= 1 mA
Intrinsic base resistance	$r_{bb'}$	= 100 Ω
Frequency at which $\lvert h_{fe} \rvert = 1$	f_1	= 1.5 Mc/s
Collector voltage	$-V_{CE}$	= 6 V
Collector current	$-I_C$	= 10 mA
Current amplification factor at low frequencies	h_{fe}	= 40
Collector voltage	$-V_{CE}$	= 6 V
Emitter current	I_E	= 0 mA
Feedback capacitance	$c_{b'c}$	= 90 pF

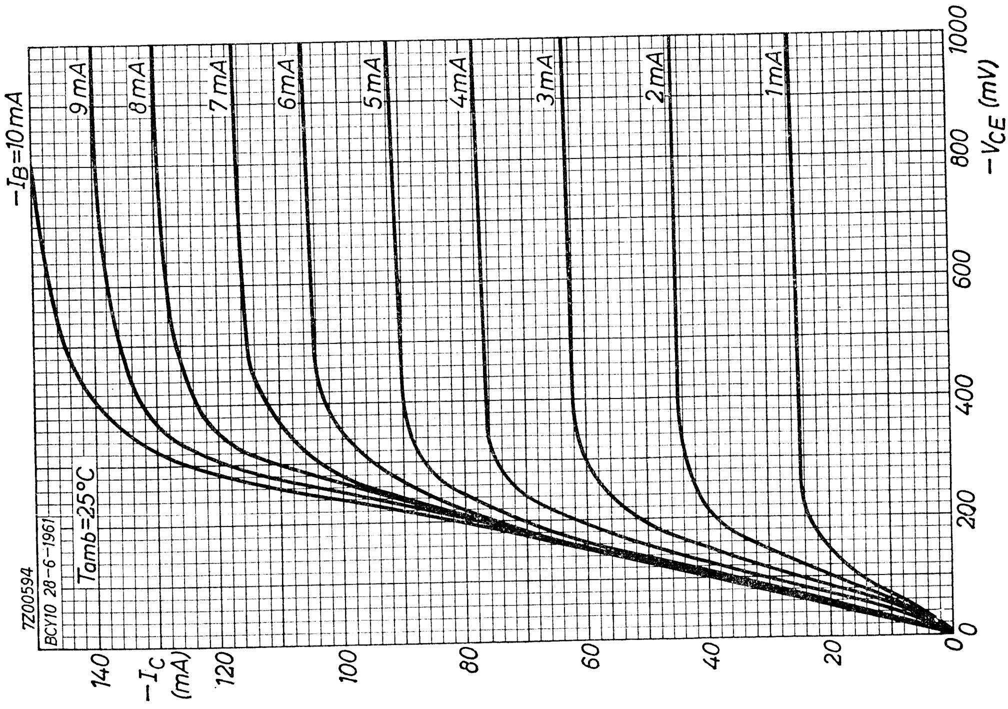
7Z2 1050
6.6.1962



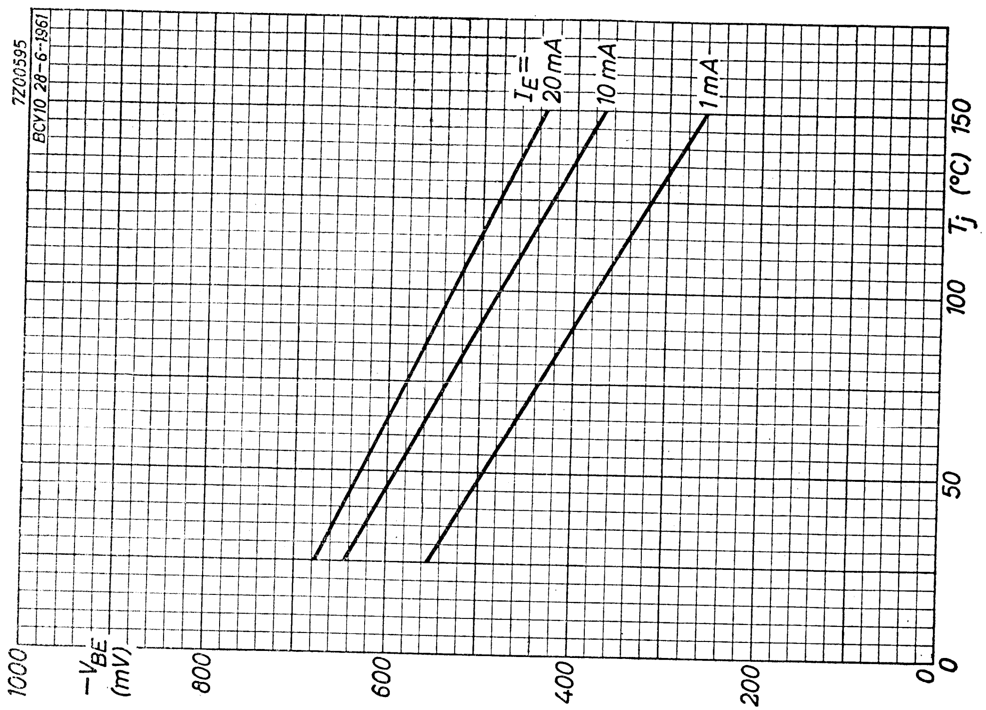
A


7Z00598
BCY10 28-6-1961
$-V_{CE}$=2V
T_{amb}=25°C
$-I_C$ (mA)
250
200
150
100
50
0
0
5
10
15
$-I_B$ (mA)

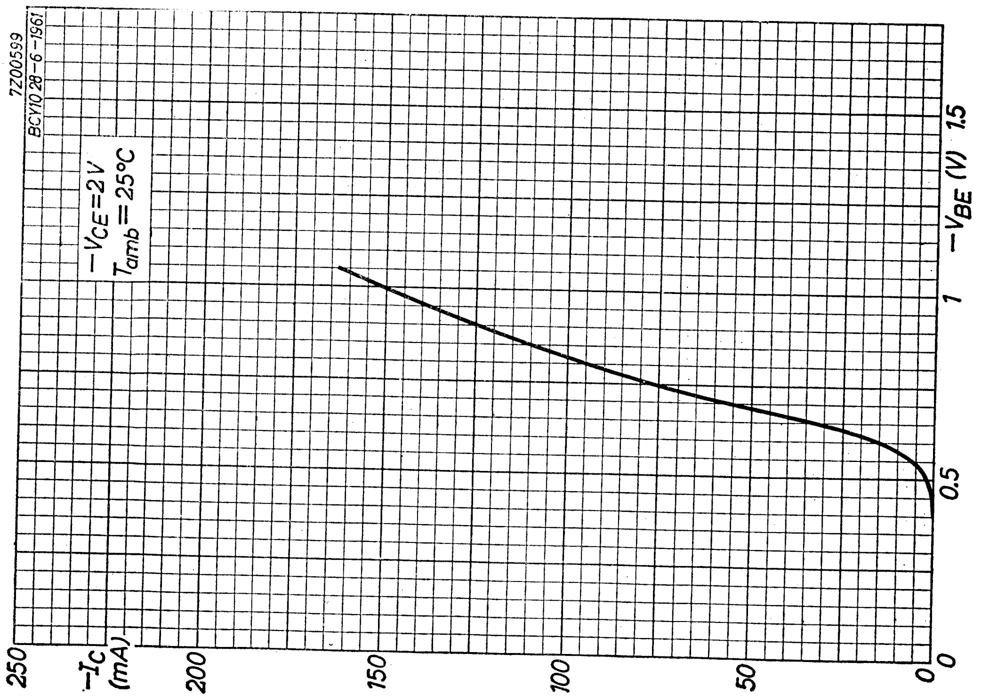
C


7Z00594
BCY10 28-6-1961
T_{amb}=25°C
$-I_B$=10mA
9mA
8mA
7mA
6mA
5mA
4mA
3mA
2mA
1mA
$-I_C$ (mA)
140
120
100
80
60
40
20
0
0
200
400
600
800
1000
$-V_{CE}$ (mV)

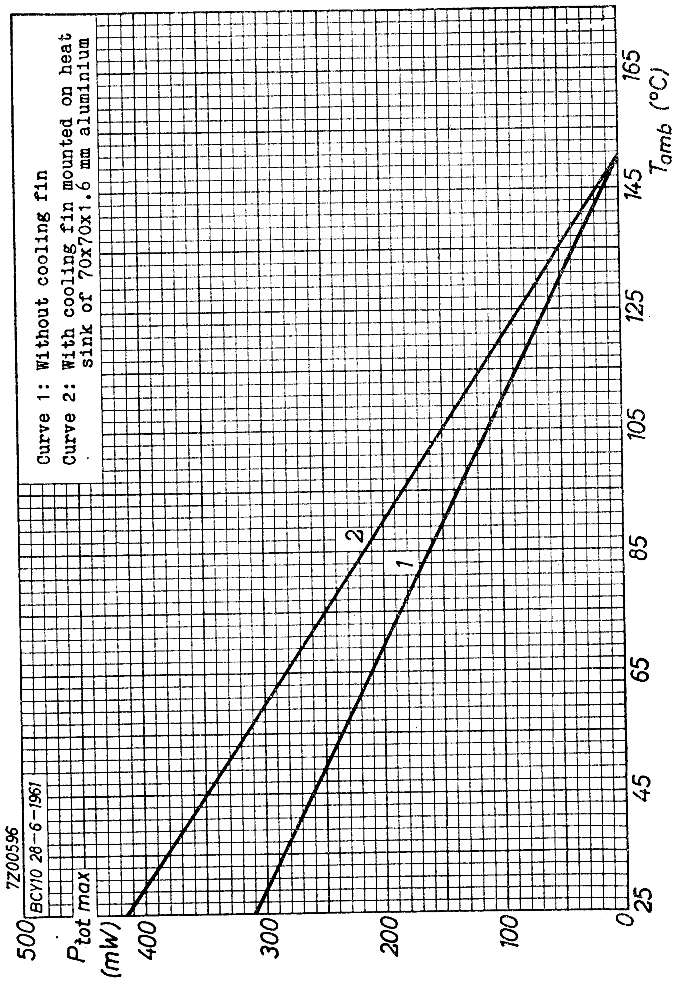
B


7Z00595
BCY10 28-6-1961
I_E =
20 mA
10 mA
1 mA
$-V_{BE}$ (mV)
1000
800
600
400
200
0
0
50
100
150
T_j (°C)

E


7Z00599
BCY10 28-6-1961
$-V_{CE}$ = 2 V
T_{amb} = 25°C
$-I_C$ (mA)
250
200
150
100
50
0
0
0.5
1
1.5
$-V_{BE}$ (V)

D


7Z00596
BCY10 28-6-1961
Curve 1: Without cooling fin
Curve 2: With cooling fin mounted on heat sink of 70x70x1.6 mm aluminium
$P_{tot\ max}$ (mW)
500
400
300
200
100
0
25
45
65
85
105
125
145
165
T_{amb} (°C)
1
2

6.6.1962

F

SILICON TRANSISTOR of the p-n-p alloy type with metal envelope for high voltage medium current industrial applications

LIMITING VALUES (Absolute max. values)

Collector

Voltage (base reference)	$-V_{CB}$ = max.	60 V
Voltage (emitter reference)	$-V_{CE}$ = max.	60 V 1)
Average current (averaging time = max. 20 msec)	$-I_C$ = max. (t_{av} = max.	250 mA 20 msec)
Peak current	$-I_{CM}$ = max.	500 mA

Emitter

Voltage (base reference)	$-V_{EB}$ = max.	12 V
Average current (averaging time = max. 20 msec)	I_E = max. (t_{av} = max.	250 mA 20 msec)
Peak current	I_{EM} = max.	500 mA

Base

Current	$-I_B$ = max.	125 mA

Dissipation

Total dissipation	See page F

Temperatures

Storage temperature	T_s =	-55 °C to +150 °C
Junction temperature	T_j = max.	150 °C

THERMAL DATA

Thermal resistance between junction and ambience

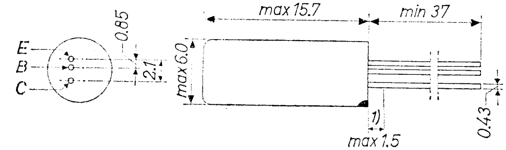
without cooling fin in free air	K = max.	0.4 °C/mW
with cooling fin on heat sink of 70x70x1.6 mm aluminium	K = max.	0.3 °C/mW
Thermal resistance between junction and case	K = max.	0.25 °C/mW

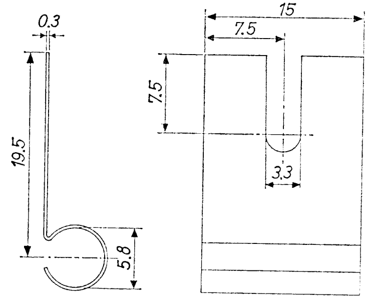
1) At $+V_{BE}$ > 500 mV.

7Z2 1051

6 6 1962

Dimensions in mm The red dot indicates the collector





Cooling fin

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN

T_j = 25 °C

Collector current at I_E = 0 mA			
$-I_{CBO}$ ($-V_{CB}$ = 6 V; I_E = 0 mA)	=	0.02 µA	< 0.1 µA
Emitter current at I_C = 0 mA			
$-I_{EBO}$ ($-V_{EB}$ = 6 V; I_C = 0 mA)	=	0.02 µA	< 0.1 µA
Collector voltage			
$-V_{CE}$ ($-I_C$ = 125 mA; $-I_B$ = 17 mA)	=	250 mV	
Base voltage			
$-V_{BE}$ ($-V_{CE}$ = 2 V; $-I_C$ = 150 mA)	=	1.0 V	< 1.6 V
D.C. current amplification factor			
h_{FE} ($-V_{CE}$ = 2 V; $-I_C$ = 30 mA)	=	24	> 12
h_{FE} ($-V_{CE}$ = 1 V; $-I_C$ = 150 mA)	=	15	> 10
Noise figure			
F { $-V_{CE}$ = 2 V; $-I_C$ = 500 µA; Input source resistance = 500 Ω }	=	7 dB	< 20 dB

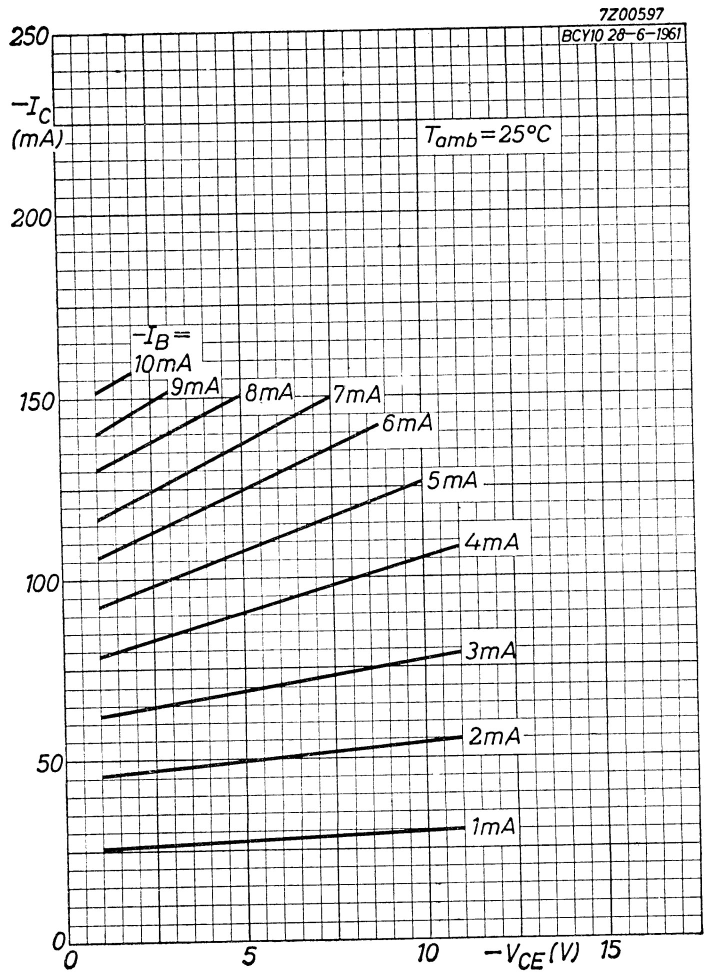
1) Not tinned

7Z2 1049

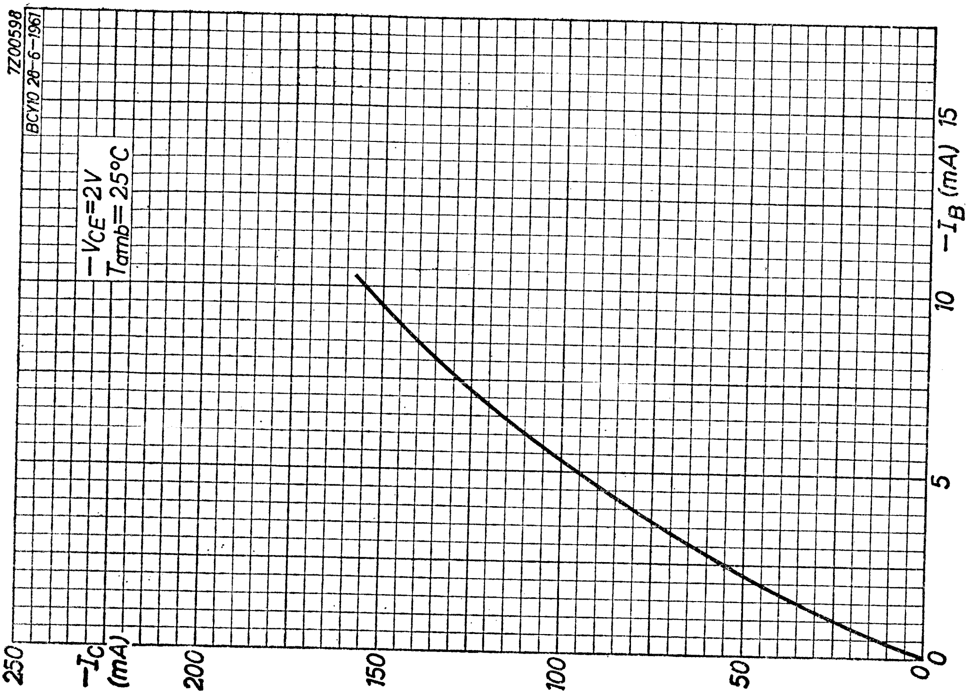
Parameters

Collector voltage	$-V_{CE}$	=	6 V
Collector current	$-I_C$	=	1 mA
Intrinsic base resistance	$r_{bb'}$	=	100 Ω
Frequency at which $\lvert h_{fe} \rvert = 1$	f_1	=	1.5 Mc/s
Collector voltage	$-V_{CE}$	=	6 V
Collector current	$-I_C$	=	10 mA
Current amplification factor at low frequencies	h_{fe}	=	40
Collector voltage	$-V_{CE}$	=	6 V
Emitter current	I_E	=	0 mA
Feedback capacitance	$c_{b'c}$	=	90 pF

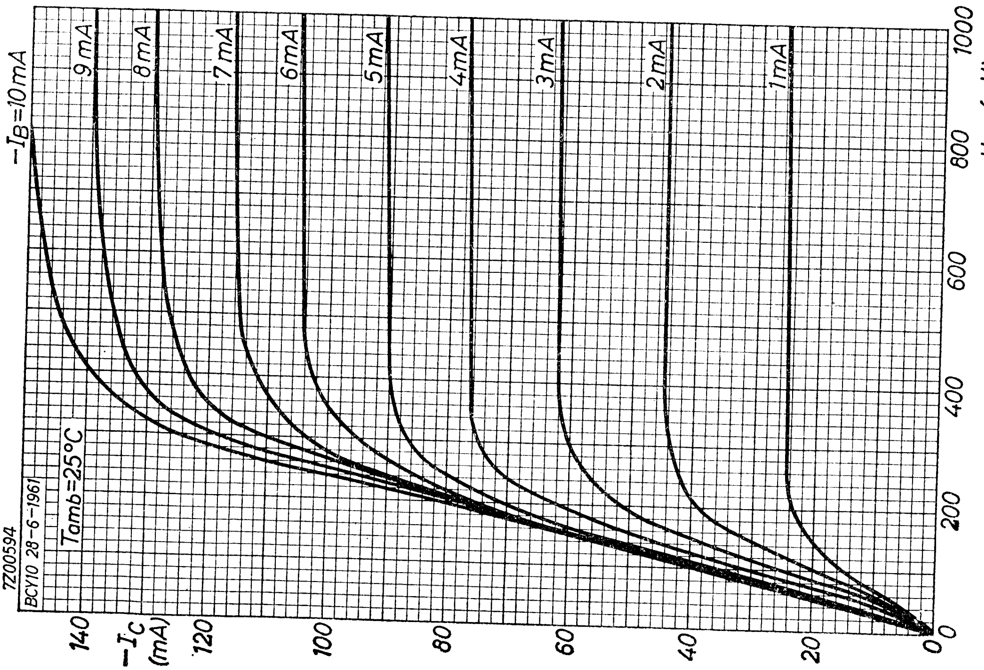
7Z2 1050
6.6.1962



A

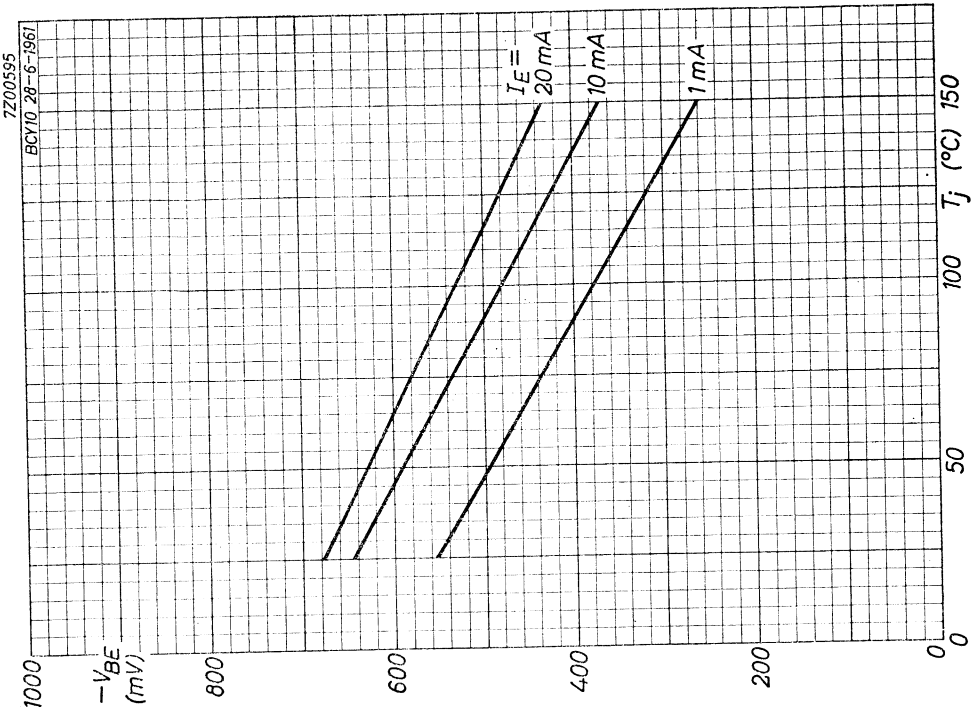

7Z00598
BCY10 28-6-1961
$-V_{CE}$=2V
T_{amb}=25°C
$-I_C$ (mA)
250
200
150
100
50
0
0
5
10
15
$-I_B$ (mA)

C

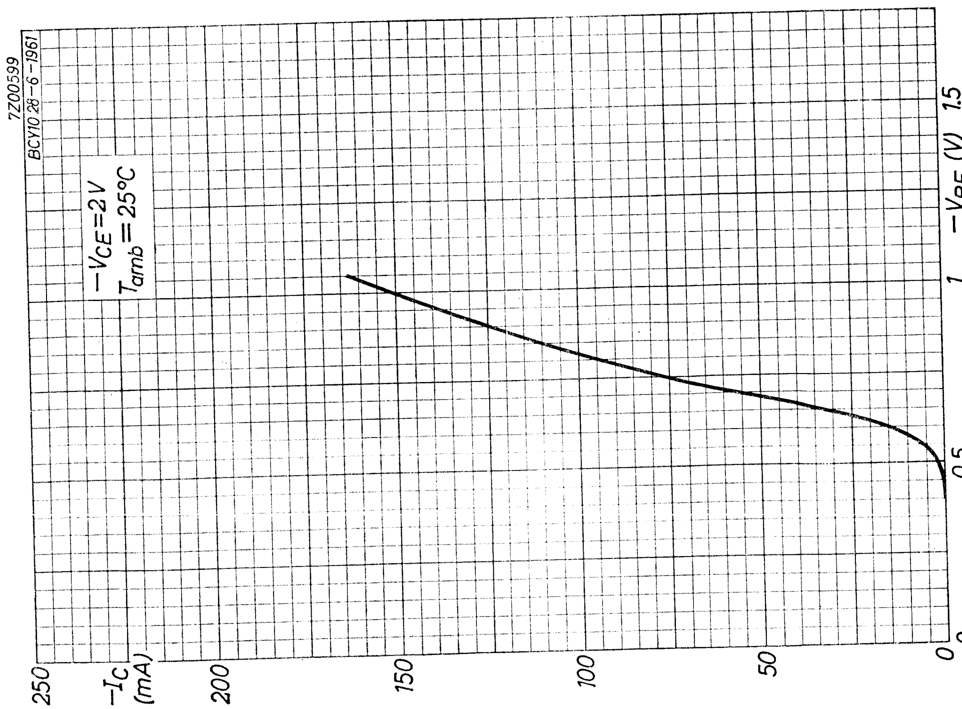

7Z00594
BCY10 28-6-1961
T_{amb}=25°C
$-I_B$=10mA
9mA
8mA
7mA
6mA
5mA
4mA
3mA
2mA
1mA
$-I_C$ (mA)
140
120
100
80
60
40
20
0
0
200
400
600
800
1000
$-V_{CE}$ (mV)

B

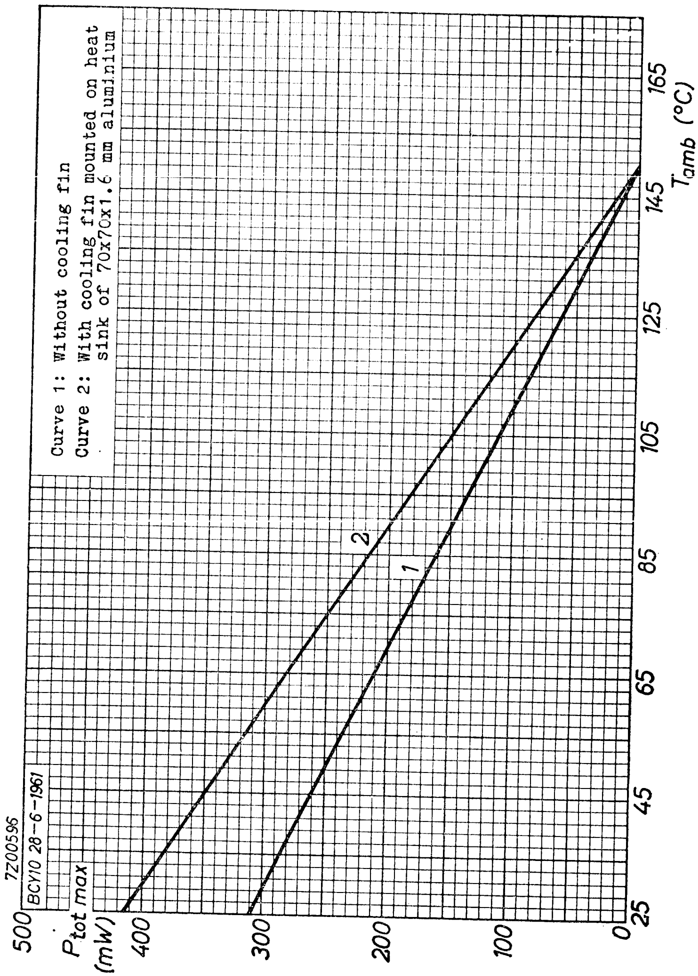
6.6.1962


7Z00595
BCY10 28-6-1961
I_E =
20 mA
10 mA
1 mA
$-V_{BE}$ (mV)
1000
800
600
400
200
0
0
50
100
150
T_j (°C)

E


7Z00599
BCY10 28-6-1961
$-V_{CE}$ = 2 V
T_{amb} = 25°C
$-I_C$ (mA)
250
200
150
100
50
0
0
0.5
1
1.5
$-V_{BE}$ (V)

D


7Z00596
BCY10 28-6-1961
Curve 1: Without cooling fin
Curve 2: With cooling fin mounted on heat sink of 70x70x1.6 mm aluminium
500
Ptot max (mW)
400
300
200
100
0
25
45
65
85
105
125
145
165
Tamb (°C)
1
2

6.6.1962

F

SILICON TRANSISTOR of the p-n-p alloy type with metal envelope for medium voltage and current industrial applications

LIMITING VALUES (Absolute max. values)

Collector

Voltage (base reference)	$-V_{CB}$ = max.	32 V
Voltage (emitter reference)	$-V_{CE}$ = max.	32 V [1]
Average current (averaging time = max. 20 msec)	$-I_C$ = max. (t_{av} = max.	250 mA 20 msec)
Peak current	$-I_{CM}$ = max.	500 mA

Emitter

Voltage (base reference)	$-V_{EB}$ = max.	12 V
Average current (averaging time = max. 20 msec)	I_E = max. (t_{av} = max.	250 mA 20 msec)
Peak current	I_{EM} = max.	500 mA

Base

Current	$-I_B$ = max.	125 mA

Dissipation

Total dissipation	See page A

Temperatures

Storage temperature	T_s = -55 °C to +150 °C
Junction temperature	T_j = max. 150 °C

THERMAL DATA

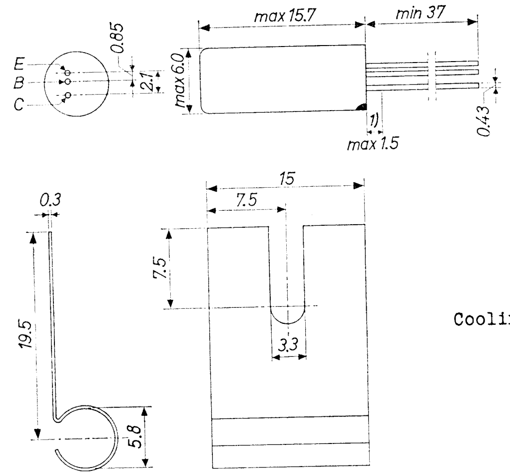
Thermal reistance between junction and ambience

without cooling fin in free air	K = max.	0.4 °C/mW
with cooling fin on heat sink of 70x70x1.6 mm aluminium	K = max.	0.3 °C/mW
Thermal resistance between junction and case	K = max.	0.25 °C/mW

[1]) At $+V_{BE}$ > 500 mV. AT $-I_C$ = 200 mA $-V_{CE}$ = max. 24 V

7Z2 1063
6.6.1962

Dimensions in mm   The red dot indicates the collector



Cooling fin

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN

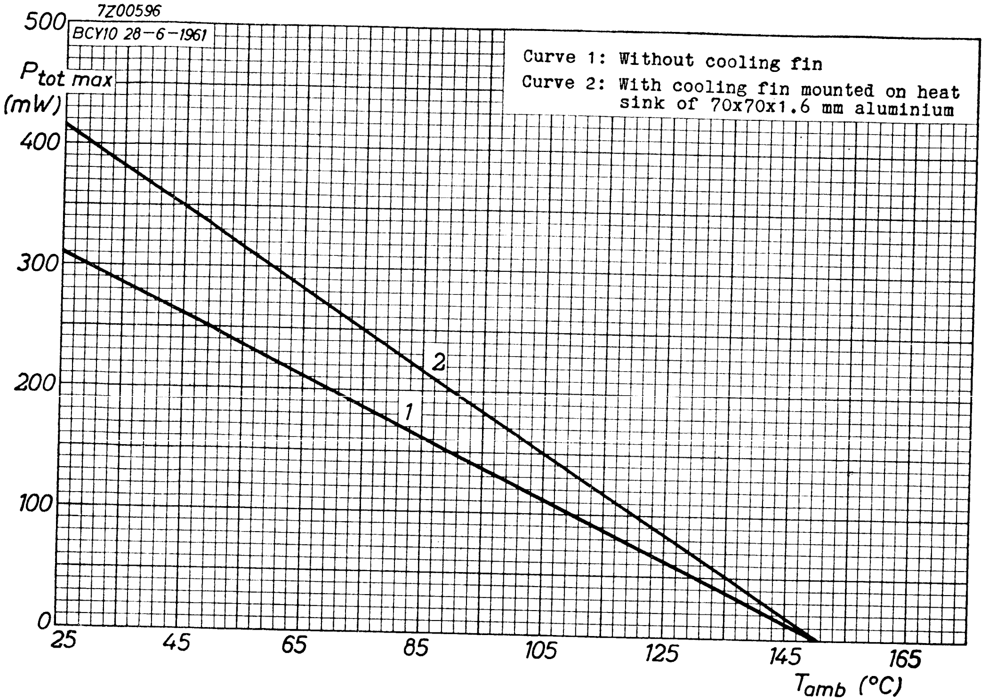
T_j = 25 °C

Collector current at I_E = 0 mA		
$-I_{CBO}$ ($-V_{CB}$ = 6 V; I_E = 0 mA)	= 0.02 µA	< 0.1 µA
Emitter current at I_C = 0 mA		
$-I_{EBO}$ ($-V_{EB}$ = 6 V; I_C = 0 mA)	= 0.02 µA	< 0.1 µA
Collector voltage		
$-V_{CE}$ ($-I_C$ = 125 mA; $-I_B$ = 17 mA)	250 mV	< 550 mV
Base voltage		
$-V_{BE}$ ($-V_{CE}$ = 1 V; $-I_C$ = 150 mA)	= 1.0 V	< 1.6 V
D.C. current amplification factor		
h_{FE} ($-V_{CE}$ = 2 V; $-I_C$ = 30 mA)	= 40	
h_{FE} ($-V_{CE}$ = 1 V; $-I_C$ = 150 mA)	= 25	
h_{FE} ($-V_{CE}$ = 6 V; $-I_C$ = 300 mA)	= 15	> 10
Noise figure		
F {$-V_{CE}$ = 2 V; $-I_C$ = 500 µA; Input source resistance = 500 Ω}	= 7 dB	< 20 dB

[1]) Not tinned

7Z2 1232

A



Parameters

Collector voltage	$-V_{CE}$	= 6 V
Collector current	$-I_C$	= 1 mA
Intrinsic base resistance	$r_{bb'}$	= 100 Ω
Frequency at which $\lvert h_{fe}\rvert = 1$	f_1	= 2.0 Mc/s
Collector voltage	$-V_{CE}$	= 6 V
Collector current	$-I_C$	= 10 mA
Current amplification factor at low frequencies	h_{fe}	= 40
Collector voltage	$-V_{CE}$	= 6 V
Emitter current	I_E	= 0 mA
Feedback capacitance	$c_{b'c}$	= 90 pF

P-N-P SILICON TRANSISTORS

Silicon alloy junction transistors of the p-n-p type in TO-5 metal case with insulated leads for relay switching, resistor logic circuits and general industrial applications.

QUICK REFERENCE DATA

		BCY 30	BCY 31	BCY 32	BCY 33	BCY 34
Collector voltage (base reference)	$-V_{CB_{max.}}$ (V)	64	64	64	32	32
Collector voltage (emitter reference)	$-V_{CE_{max.}}$ (V)	64	64	64	32	32
Collector current peak	$-I_{CM_{max.}}$ (mA)	100	100	100	100	100
Total dissipation	$P_{tot_{max.}}$ (mW)	250	250	250	250	250
Junction temperature	$T_{j_{max.}}$ (^oC)	150	150	150	150	150
Current amplification factor $-V_{CE} = 6$ V; $-I_C = 1$ mA	h_{fe}	25	35	55	25	35
Thermal resistance from junction to ambience	K ($^oC/mW$)	0.5	0.5	0.5	0.5	0.5

7Z2 2519

LIMITING VALUES (Absolute max. values)

		BCY 30-31	BCY 32	BCY 33-34	
Collector					
Voltage (base reference)	$-V_{CB}$ = max.	64	64	32	V
Voltage (emitter reference)	$-V_{CE}$ = max.	64	64	32	V [1]
Current (peak value)	$-I_{CM}$ = max.	100	100	100	mA
Current (averaged over any 20 msec period)	$-I_C$ = max.	50	50	50	mA
Emitter					
Voltage (base reference)	$-V_{EB}$ = max.	45	32	16	V
Base					
Current (peak value)	$-I_{BM}$ = max.		50		mA
Current (averaged over any 20 msec period)	$-I_B$ = max.		15		mA
Dissipation					
Total dissipation	P_{tot} = max.		250		mW
Temperatures					
Storage temperature	T_s =		−55 ^oC to 150		^oC
Junction temperature	T_j = max.		150		^oC

THERMAL DATA

Thermal resistance between junction and ambience in free air (without cooling clip) — K < 0.5 $^oC/mW$

junction and case — K < 0.35 $^oC/mW$

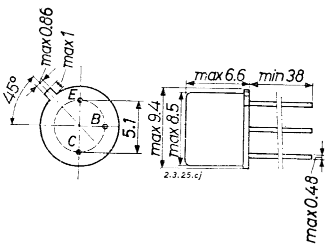
[1]) See also curves at page H

7Z2 2520

MECHANICAL DATA

TO-5 metal case; leads insulated from the case

Dimensions in mm



CHARACTERISTICS at T_{amb} = 25 °C

Collector current at $I_E = 0$; $-V_{CB} = 6$ V	$-I_{CBO}$	= 1 nA		< 100 nA
Emitter current at $I_C = 0$; $-V_{EB} = 6$ V	$-I_{EBO}$	= 1 nA		< 100 nA
Base voltage (emitter reference); $-I_C = 20$ mA; $-V_{CB} = 0$	$-V_{BE}$	= 0.8 V		< 1.25 V
Collector saturation voltage at $-I_C = 20$ mA; $-I_B = 3$ mA	$-V_{CE}$	= 160 mV		< 550 mV

D.C. current amplification factor
$-I_C = 20$ mA; $-V_{CB} = 0$

BCY30	h_{FE}	= 18	> 10	< 30
BCY31	h_{FE}	= 28	> 13	< 55
BCY32	h_{FE}	= 35	> 17	< 70
BCY33	h_{FE}	= 18	> 10	< 30
BCY34	h_{FE}	= 28	> 13	< 55

7Z2 2521

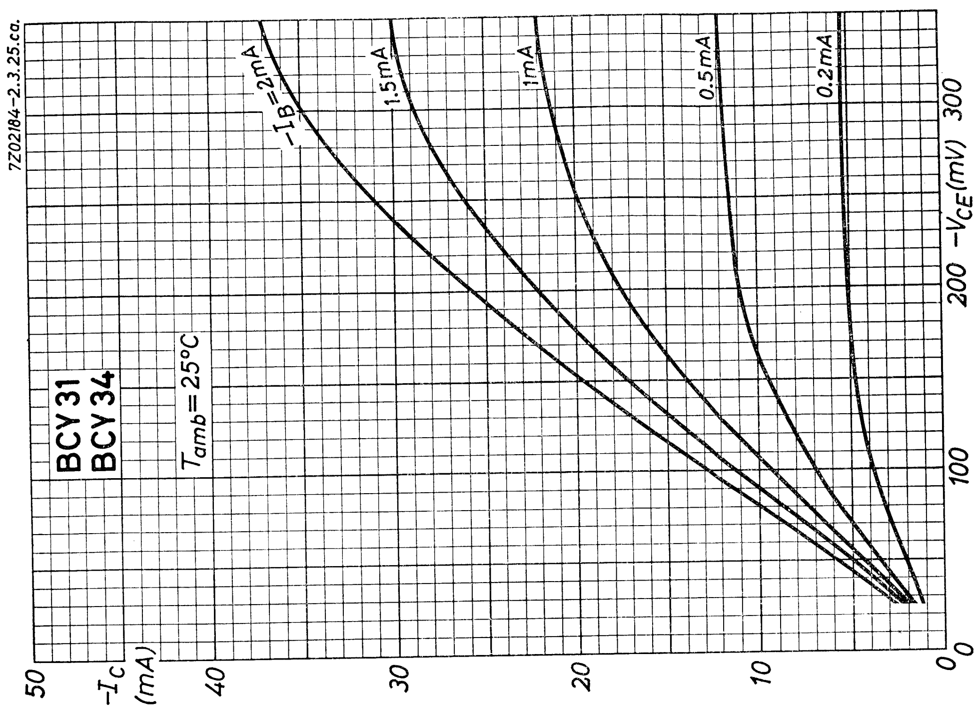
6.6.1964

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN T_{amb} = 25 °C, unless otherwise specified

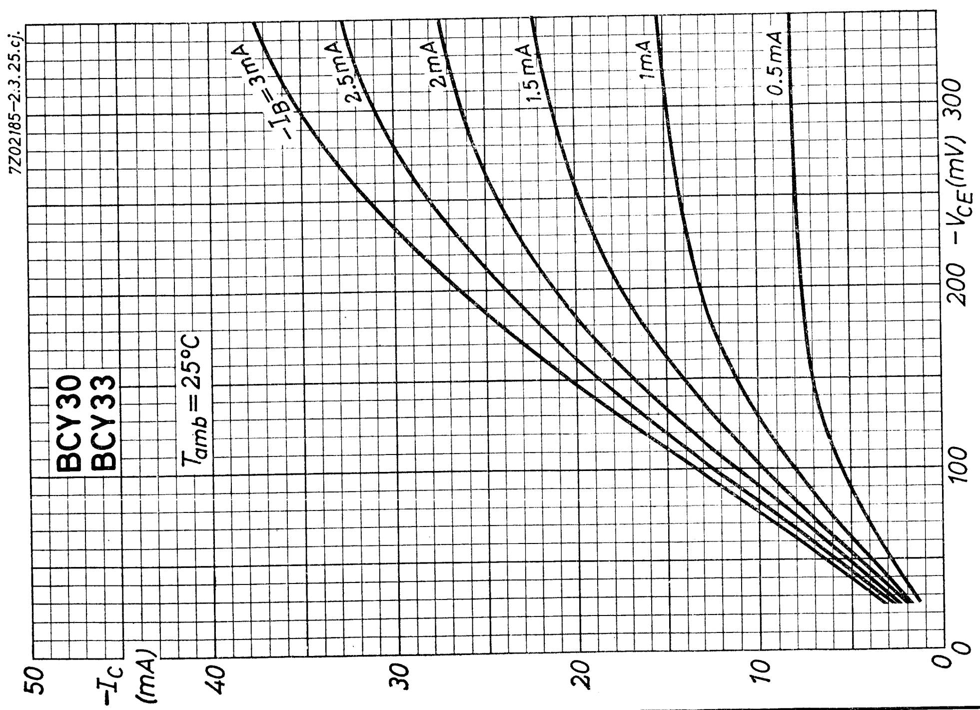
Collector current at $I_E = 0$	$-I_{CBO}$	See pages D and E		
Emitter current at $I_C = 0$; $-V_{EB} = 6$ V; $T_j = 100$ °C	$-I_{EBO}$	= 0.1 μA		< 2.5 μA
Collector capacitance; $-V_{CB} = 6$ V; $I_E = 0$	c_c	= 28 pF	> 15 pF	< 80 pF
Noise figure at f = 1 kc/s; $-V_{CE} = 2$ V; $I_E = 500$ μA; Input source resistance = 500 Ω	F	= 8 dB		< 20 dB

		BCY 30	BCY 31	BCY 32	BCY 33	BCY 34
Current amplification factor at f = 1 kc/s; $-V_{CE} = 6$ V; $-I_C = 1$ mA	h_{fe}	= 25 > 15 < 35	= 35 > 25 < 60	= 55 > 35 < 80	= 25 > 15 < 35	= 35 > 25 < 60
Transition frequency; $-V_{CE} = 6$ V; $-I_C = 1$ mA	f_T (Mc/s)	= 1.2 >0.25	= 1.7 >0.25	= 2.5 >0.4	= 1.5 >0.4	= 2.4 >0.6
Base impedance at f = 1 kc/s; $-V_{CE} = 6$ V; $-I_C = 1$ mA	$\lvert z_{rb} \rvert$ (Ω)	= 160 < 500	= 220 < 500	= 230 <500	= 190 <500	= 235 <500

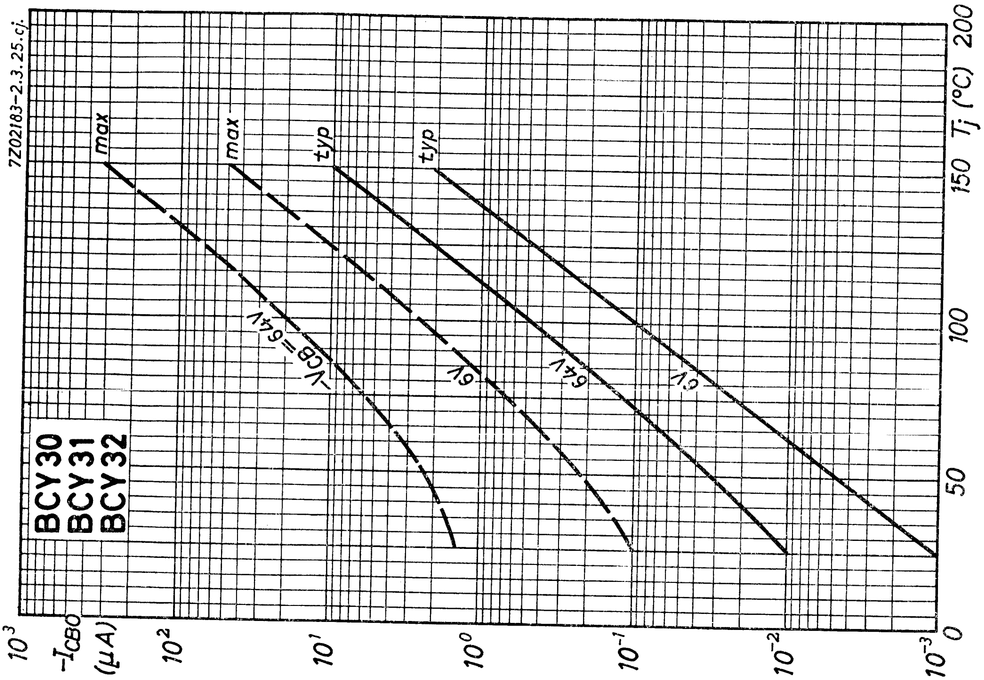
7Z2 2522


7Z02184–2.3.25.ca.
BCY31
BCY34
T_{amb}=25°C
$-I_B$=2mA
1.5mA
1mA
0.5mA
0.2mA
$-I_C$ (mA)
50
40
30
20
10
0
0
100
200
300
$-V_{CE}$(mV)

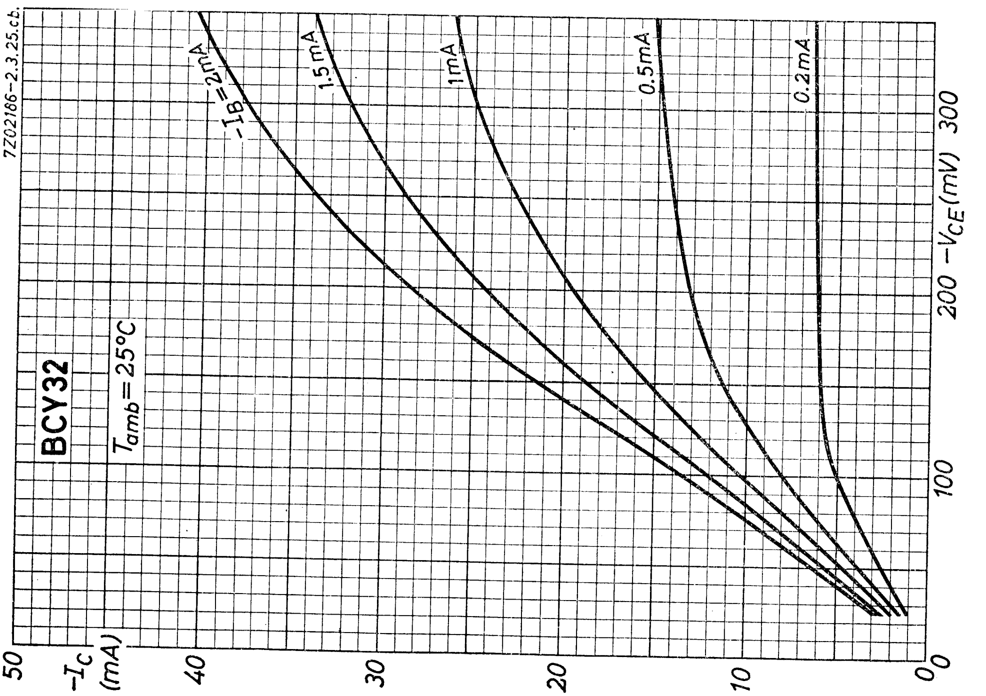
B


7Z02185–2.3.25.cj.
BCY30
BCY33
T_{amb}=25°C
$-I_B$=3mA
2.5mA
2mA
1.5mA
1mA
0.5mA
$-I_C$ (mA)
50
40
30
20
10
0
0
100
200
300
$-V_{CE}$(mV)

A

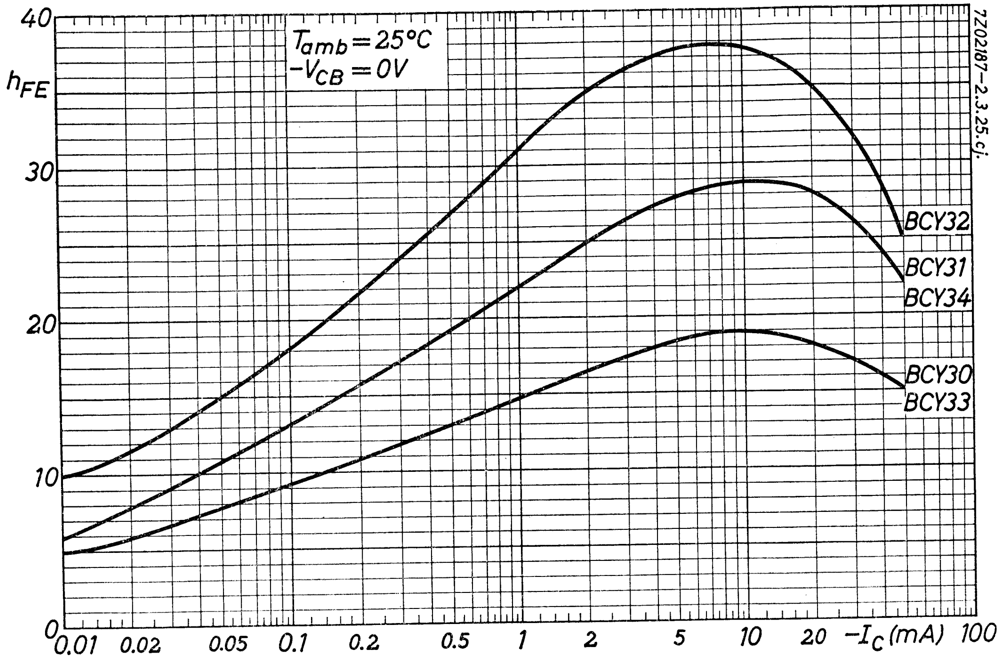

7Z02183-2.3.25.cj.
BCY30
BCY31
BCY32
max
max
typ
typ
$-V_{CB}=64V$
6V
64V
6V
$-I_{CBO}$ (μA)
10^3
10^2
10^1
10^0
10^{-1}
10^{-2}
10^{-3}
0
50
100
150
200
T_j (°C)

D


7Z02186-2.3.25.cb.
BCY32
$T_{amb}=25°C$
$-I_B=2mA$
1.5mA
1mA
0.5mA
0.2mA
$-I_C$ (mA)
50
40
30
20
10
0
0
100
200
300
$-V_{CE}$ (mV)

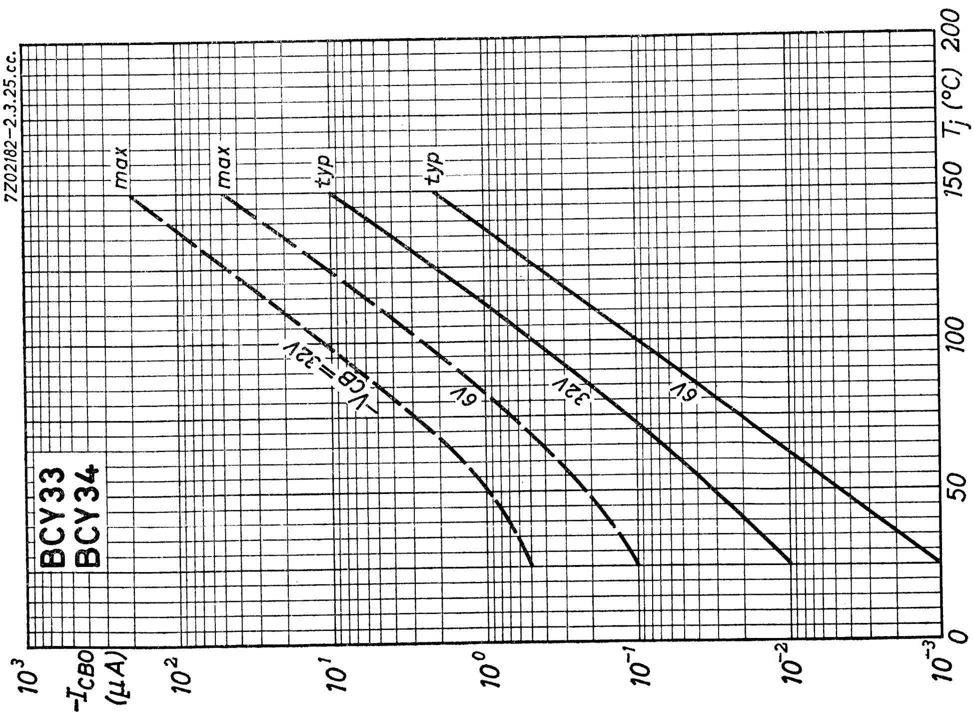
C

6.6.1964



$T_{amb} = 25°C$
$-V_{CB} = 0V$
h_{FE}
40
30
20
10
0
0.01
0.02
0.05
0.1
0.2
0.5
1
2
5
10
20
$-I_C$ (mA)
100
BCY32
BCY31
BCY34
BCY30
BCY33
7Z02187-2.3.25.c.

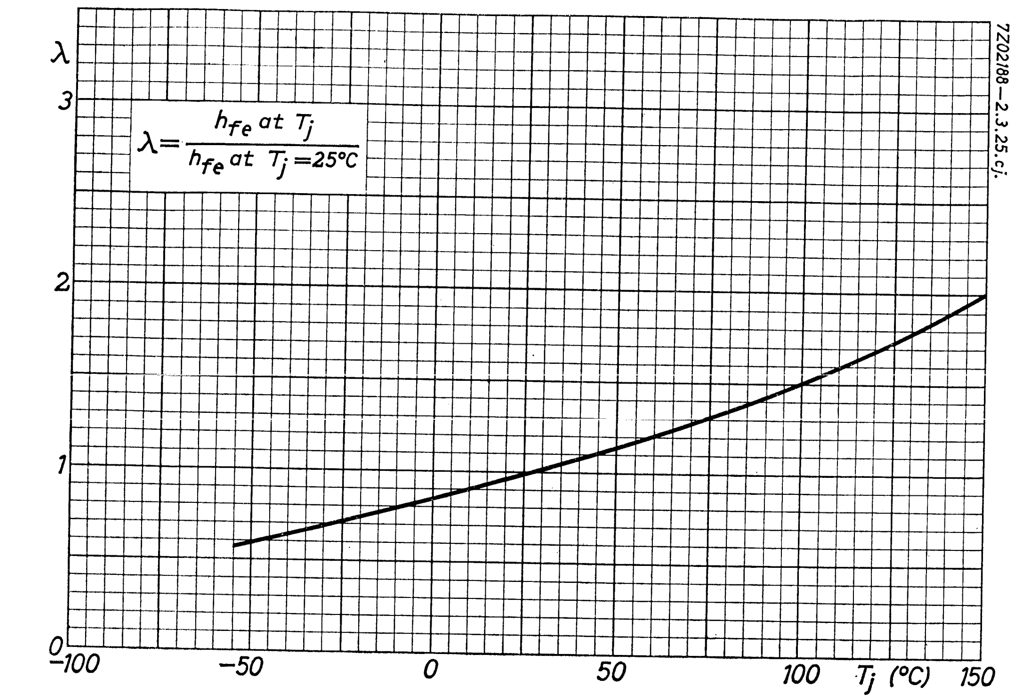
F



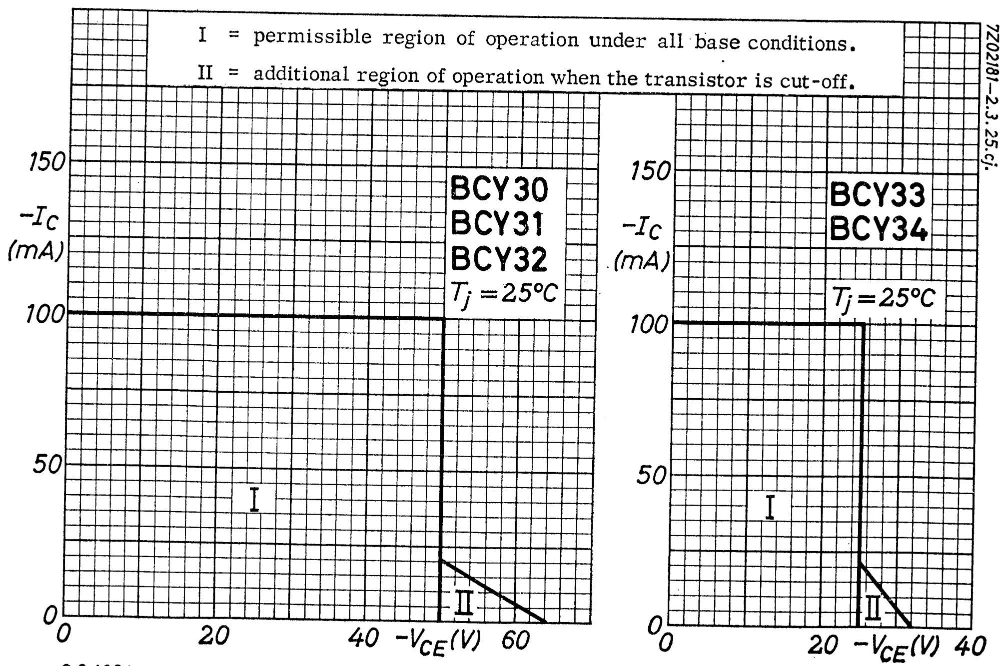
BCY33
BCY34
7Z02182-2.3.25.cc.
max
max
typ
typ
$-V_{CB} = 32V$
6V
32V
6V
$-I_{CBO}$ (μA)
10^3
10^2
10^1
10^0
10^{-1}
10^{-2}
10^{-3}
T_j (°C)
0
50
100
150
200

E

6.6.1964

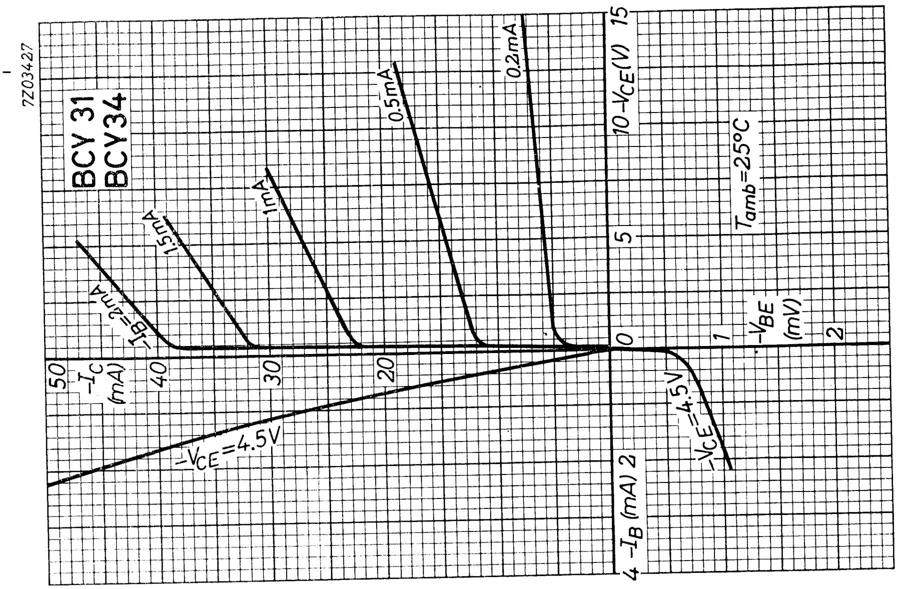

λ
3
2
1
0
$\lambda = \frac{h_{fe} \text{ at } T_j}{h_{fe} \text{ at } T_j = 25°C}$
−100
−50
0
50
100
T_j (°C)
150
7Z02188−2.3.25.cj.

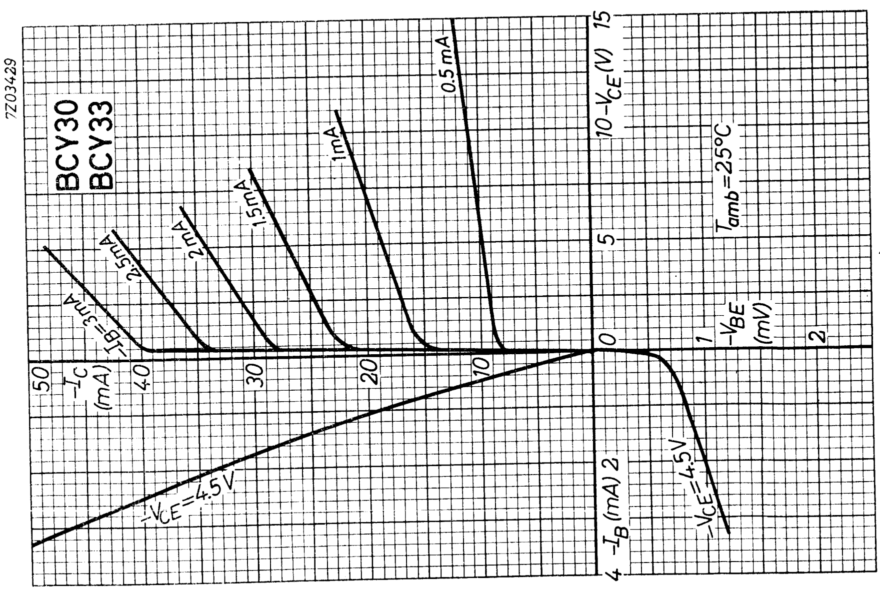
G


I = permissible region of operation under all base conditions.
II = additional region of operation when the transistor is cut-off.
150
$-I_C$
(mA)
100
50
0
0
20
40
$-V_{CE}$(V)
60
BCY30
BCY31
BCY32
T_j = 25°C
I
II
150
$-I_C$
(mA)
100
50
0
0
20
$-V_{CE}$(V)
40
BCY33
BCY34
T_j = 25°C
I
II
7Z02181−2.3.25.cj.

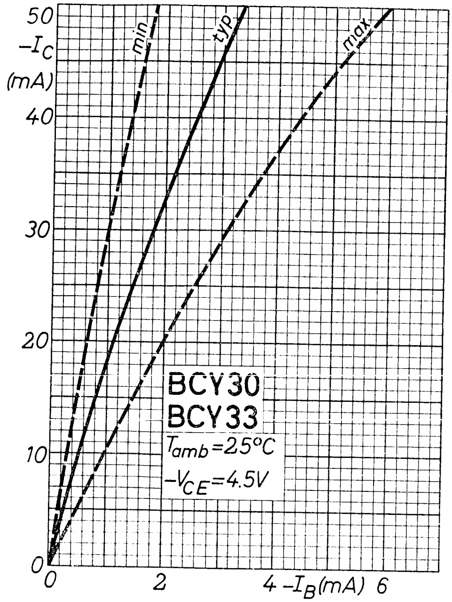
H

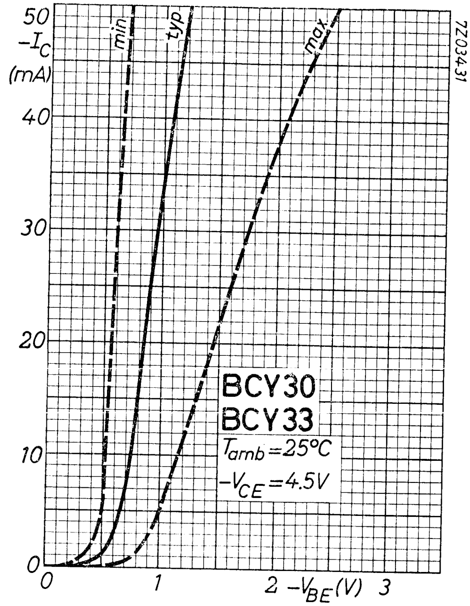
6.6.1964


7Z03427
BCY 31
BCY34
$-I_B$=2mA
1.5mA
1mA
0.5mA
0.2mA
50
$-I_C$ (mA)
40
30
20
0
5
10 $-V_{CE}$(V) 15
T_{amb}=25°C
1
$-V_{BE}$ (mV)
2
$-V_{CE}$=4.5V
$-V_{CE}$=4.5V
4 $-I_B$ (mA) 2

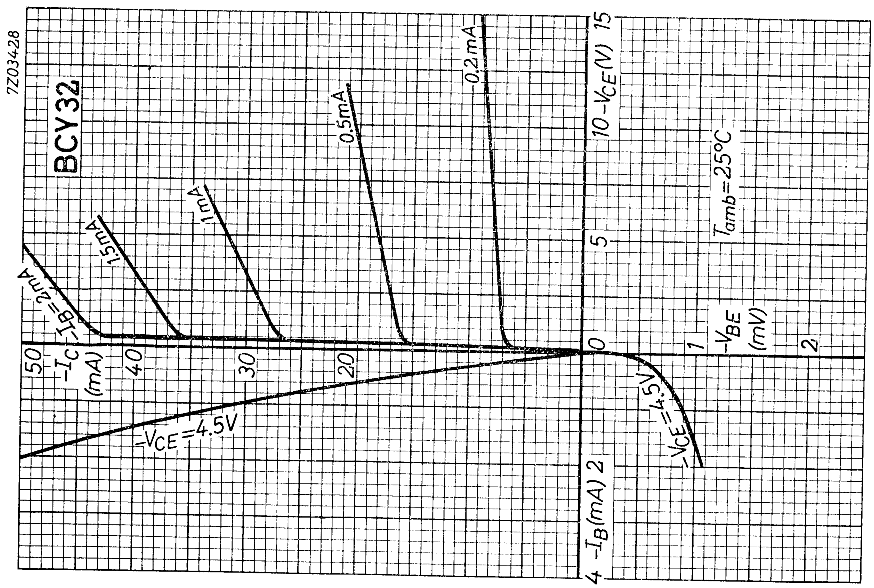

7Z03429
BCY30
BCY33
$-I_B$=3mA
2.5mA
2mA
1.5mA
1mA
0.5mA
50
$-I_C$ (mA)
40
30
20
10
0
5
10 $-V_{CE}$(V) 15
T_{amb}=25°C
1
$-V_{BE}$ (mV)
2
$-V_{CE}$=4.5V
$-V_{CE}$=4.5V
4 $-I_B$ (mA) 2

3.3.1965


50
$-I_C$
(mA)
40
30
20
10
0
0
2
4 $-I_B$(mA) 6
min
typ
max
BCY30
BCY33
T_{amb}=25°C
$-V_{CE}$=4.5V

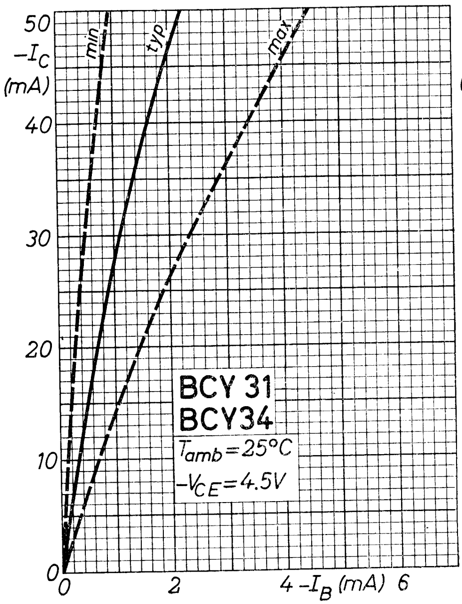

50
$-I_C$
(mA)
40
30
20
10
0
0
1
2 $-V_{BE}$(V) 3
min
typ
max
BCY30
BCY33
T_{amb}=25°C
$-V_{CE}$=4.5V
7Z03431

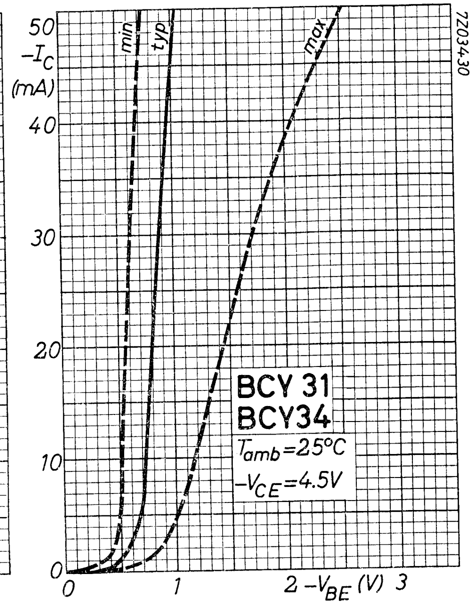
L


7Z03428
BCY32
$-I_B$=2mA
1.5mA
1mA
0.5mA
0.2mA
15
10 $-V_{CE}$(V)
5
0
$-I_C$ (mA)
50
40
30
20
$-V_{CE}$=4.5V
1
2
$-V_{BE}$ (mV)
$-V_{CE}$=4.5V
T_{amb}=25°C
$-I_B$(mA) 2
4

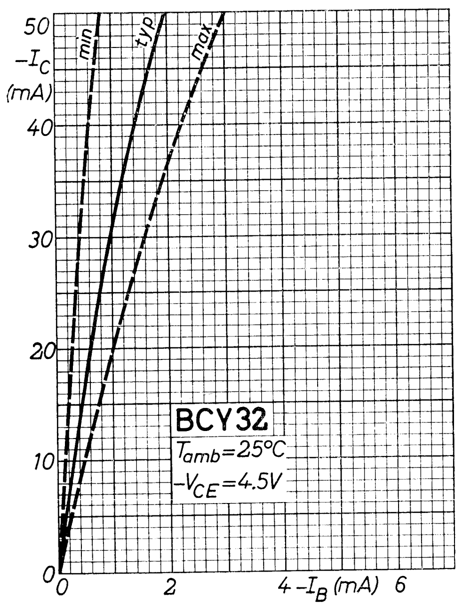
K

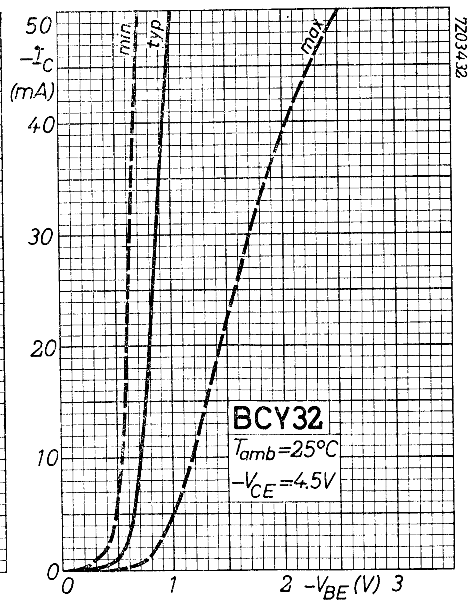
3.3.1965


50
$-I_C$
(mA)
40
30
20
10
0
min
typ
max
BCY 31
BCY34
$T_{amb}=25°C$
$-V_{CE}=4.5V$
0
2
4 $-I_B$ (mA) 6


7Z03430
50
$-I_C$
(mA)
40
30
20
10
0
min
typ
max
BCY 31
BCY34
$T_{amb}=25°C$
$-V_{CE}=4.5V$
0
1
2 $-V_{BE}$ (V) 3

M


50
$-I_C$
(mA)
40
30
20
10
0
min
typ
max
BCY32
$T_{amb}=25°C$
$-V_{CE}=4.5V$
0
2
4 $-I_B$ (mA) 6


7Z03432
50
$-I_C$
(mA)
40
30
20
10
0
min
typ
max
BCY32
$T_{amb}=25°C$
$-V_{CE}=4.5V$
0
1
2 $-V_{BE}$ (V) 3

N

P-N-P SILICON TRANSISTORS

Silicon alloy junction transistors of the p-n-p type in TO-5 metal case with the base connected to the case for relay switching, resistor logic circuits and general industrial applications.

QUICK REFERENCE DATA

		BCY 38	BCY 39	BCY 40	BCY 54
Collector voltage (base reference)	$-V_{CB_{max.}}$ (V)	32	64	32	50
Collector voltage (emitter reference) cut-off	$-V_{CE_{max.}}$ (V)	32	64	32	50
$-I_C$ = 500 mA	$-V_{CE_{max.}}$ (V)	24	60	24	50
Collector current peak	$-I_{CM_{max.}}$ (mA)	500	500	500	500
Total dissipation	$P_{tot_{max.}}$ (mW)	410	410	410	410
Junction temperature	$T_{j_{max.}}$ (^oC)	150	150	150	150
D.C. current amplification factor $-V_{CE}$ = 1 V, $-I_C$ = 150 mA	h_{FE}	> 10 < 30	> 10 < 50	> 15 <120	> 12 < 70
Transition frequency (typical)	f_T (Mc/s)	1.5	1.5	2.5	2.0

7Z2 2523

LIMITING VALUES (Absolute max. values)

		BCY 38	BCY 39	BCY 40	BCY 54	
Collector						
Voltage (base reference)	$-V_{CB}$ = max.	32	64	32	50	V
Voltage (emitter reference) cut-off	$-V_{CE}$ = max.	32	64	32	50	V
$-I_C$ = 500 mA	$-V_{CE}$ = max.	24	60	24	50	V
Current (peak value)	$-I_{CM}$ = max.	500				mA
Current (average) 1)	$-I_C$ = max.	250				mA
Emitter						
Voltage (base reference)	$-V_{EB}$ = max.	12				V
Current (peak value)	I_{EM} = max.	500				mA
Current (average) 1)	I_E = max.	250				mA
Base						
Current (peak value)	$-I_{BM}$ = max.	125				mA
Current (average) 1)	$-I_B$ = max.	125				mA
Dissipation						
Total dissipation	P_{tot} = max.	410				mW
Temperatures						
Storage temperature	T_s =	−55 °C to 150				°C
Junction temperature	T_j = max.	150				°C

THERMAL DATA

Thermal resistance between

junction and ambience in free air $K < 0.3\ ^oC/mW$

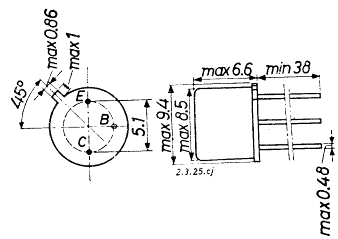
junction and case $K < 0.12\ ^oC/mW$

1) Averaged over any 20 msec period

7Z2 2524

MECHANICAL DATA

TO-5 metal case
Base connected to the case
Dimensions in mm



CHARACTERISTICS at T_{amb} = 25 °C

Collector current at $I_E = 0$			
$-V_{CB}$ = 6 V		$-I_{CBO}$	< 100 nA
Emitter current at $I_C = 0$			
$-V_{EB}$ = 6 V		$-I_{EBO}$	< 100 nA
Base voltage (emitter reference)			
I_E = 150 mA; V_{CB} = 0		$-V_{BE}$	< 1.9 V
Collector saturation voltage at			
$-I_C$ = 125 mA; $-I_B$ = 17 mA		$-V_{CE}$	< 880 mV

Base current

V_{CB} = 0; I_E = 150 mA	BCY38	$-I_B$	> 5 mA	< 14 mA
	BCY39	$-I_B$	> 3 mA	< 14 mA
	BCY40	$-I_B$	> 1.25 mA	< 9 mA
	BCY54	$-I_B$	> 2 mA	< 12 mA

7Z2 2525

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN T_{amb} = 25 °C, unless otherwise specified

Collector current at $I_E = 0$				
$-V_{CB}$ = 6 V; T_j = 25 °C		$-I_{CBO}$	= 1 nA	< 100 nA
$-V_{CB}$ = 6 V; T_j = 100 °C		$-I_{CBO}$	= 0.1 μA	< 2.5 μA
Emitter current at $I_C = 0$				
$-V_{EB}$ = 6 V; T_j = 25 °C		$-I_{EBO}$	= 1 nA	< 100 nA
$-V_{EB}$ = 6 V; T_j = 100 °C		$-I_{EBO}$	= 0.1 μA	< 2.5 μA

Base voltage

$-V_{CE}$ = 1 V; $-I_C$ = 150 mA	BCY38	$-V_{BE}$	= 1.5 V	< 1.9 V
	BCY39	$-V_{BE}$	= 1.5 V	< 1.9 V
	BCY40	$-V_{BE}$	= 1.4 V	< 1.9 V
	BCY54	$-V_{BE}$	= 1.2 V	< 1.9 V

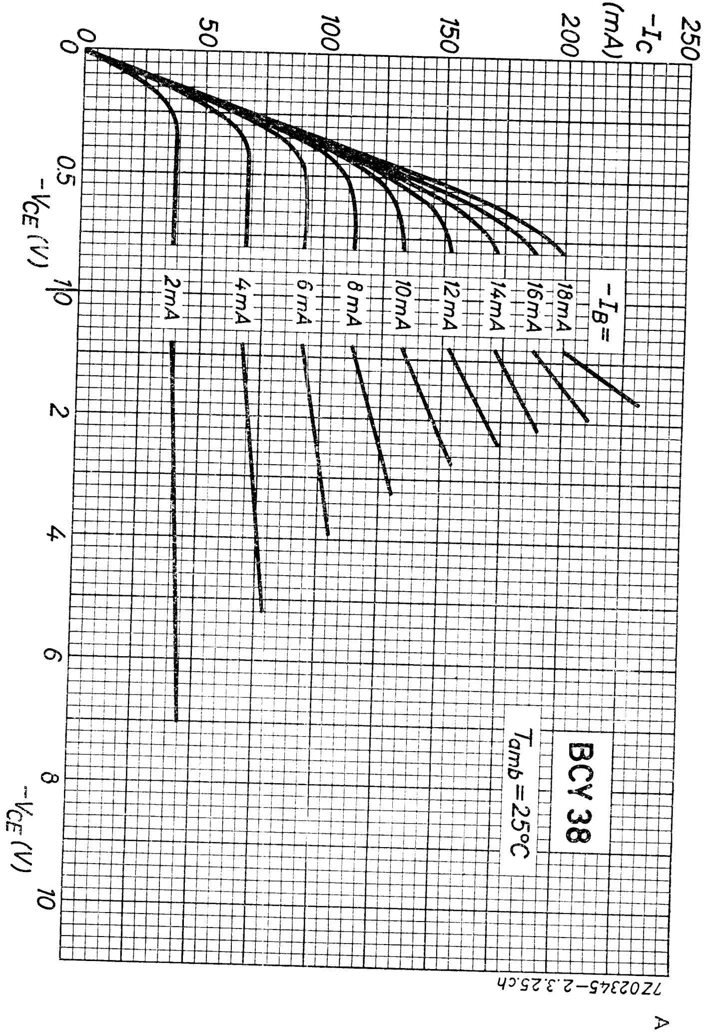
Collector saturation voltage

$-I_C$ = 125 mA; $-I_B$ = 17 mA	BCY38	$-V_{CE}$	= 460 mV	< 880 mV
	BCY39	$-V_{CE}$	= 360 mV	< 880 mV
	BCY40	$-V_{CE}$	= 330 mV	< 880 mV
	BCY54	$-V_{CE}$	= 360 mV	< 880 mV

Noise figure at f = 1 kc/s

$-V_{CE}$ = 2 V; I_E = 500 μA; Input source resistance = 500 Ω	F	= 8 dB	< 20 dB

7Z2 2526

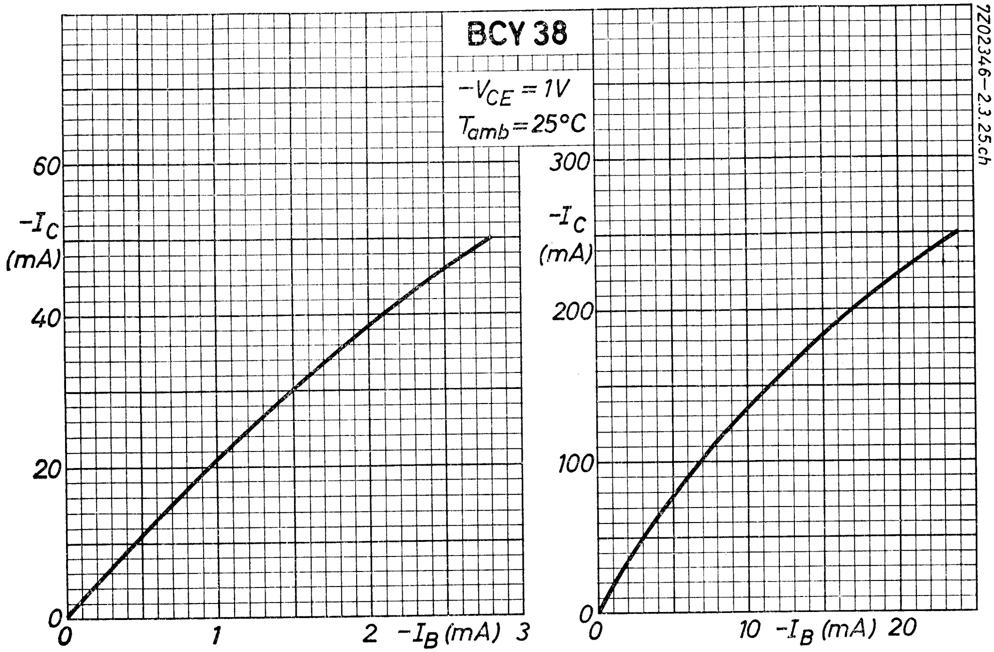


CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN (continued)

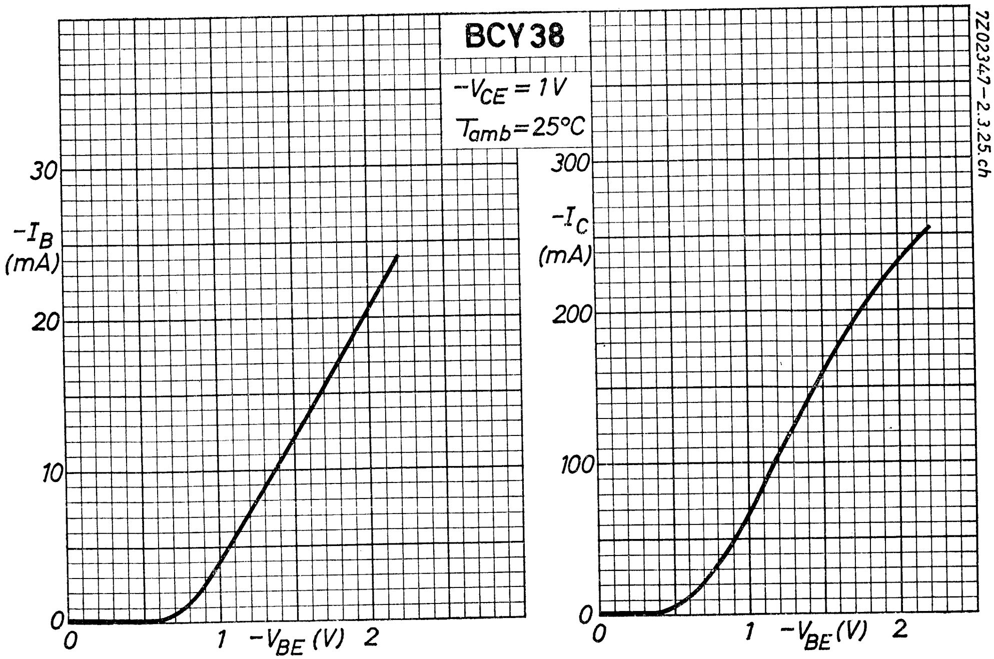
		BCY 38	BCY 39	BCY 40	BCY 54
Current amplification factor at f = 1 kc/s $-V_{CE}$ = 6 V; $-I_C$ = 10 mA	h_{fe}	= 27 > 15 < 100	= 35 > 15 < 100	= 45 > 30 < 160	= 50 > 20 < 120
Transition frequency $-V_{CE}$ = 6 V; $-I_C$ = 1 mA	f_T (Mc/s)	= 1.5 >0.45	= 1.5 >0.45	= 2.5 >0.85	= 2.0 >0.45
Base impedance at f = 1 kc/s $-V_{CE}$ = 6 V; $-I_C$ = 1 mA	$\|z_{rb}\|$ (Ω)	= 80 < 250	= 90 < 250	= 110 < 250	= 130 < 250
Collector capacitance $-V_{CB}$ = 6 V; I_E = 0	c_c (pF)	= 75 < 150	= 75 < 150	= 75 < 150	= 60 < 100
D.C. current amplification factor $-V_{CE}$ = 1 V; $-I_C$ = 30 mA	h_{FE}	= 20 > 12	= 30 > 12	= 35 > 22	= 50 > 20 < 100
$-V_{CE}$ = 1 V; $-I_C$ = 150 mA	h_{FE}	= 13 > 10 < 30	= 19 > 10 < 50	= 23 > 15 < 120	= 25 > 12 < 70
$-V_{CB}$ = 6V; I_{EM} = 330 mA[1])	h_{FE}	= 10	= 10	= 15 > 10	= 15

[1]) Measured under pulsed conditions

7Z2 2527

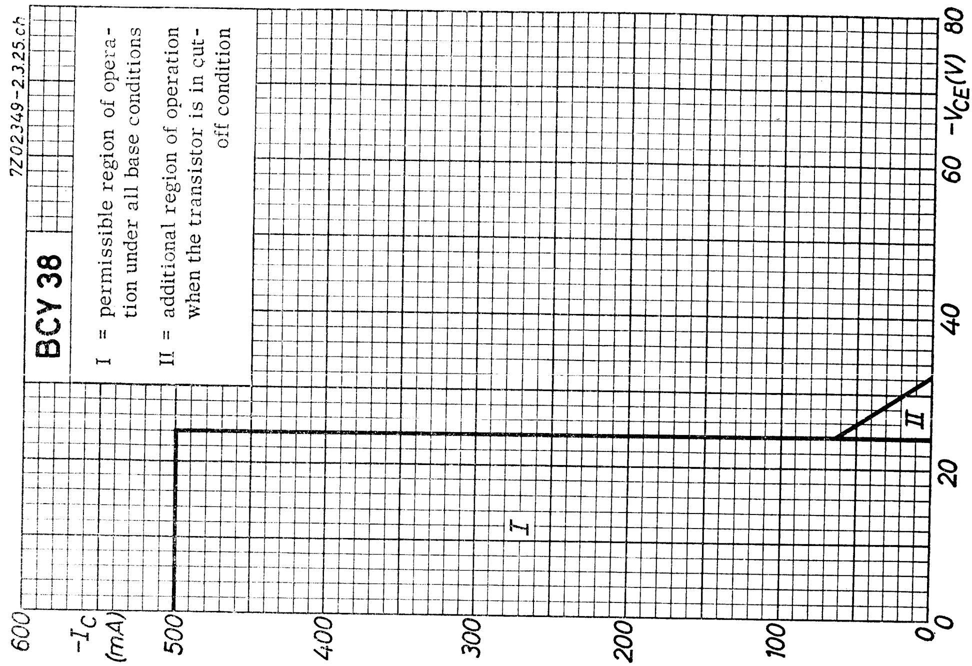

BCY 38
$-V_{CE}$ = 1V
T_{amb}=25°C
60
$-I_C$
(mA)
40
20
0
0
1
2
$-I_B$ (mA)
3
300
$-I_C$
(mA)
200
100
0
0
10
$-I_B$ (mA)
20
7Z02346-2.3.25.ch

B

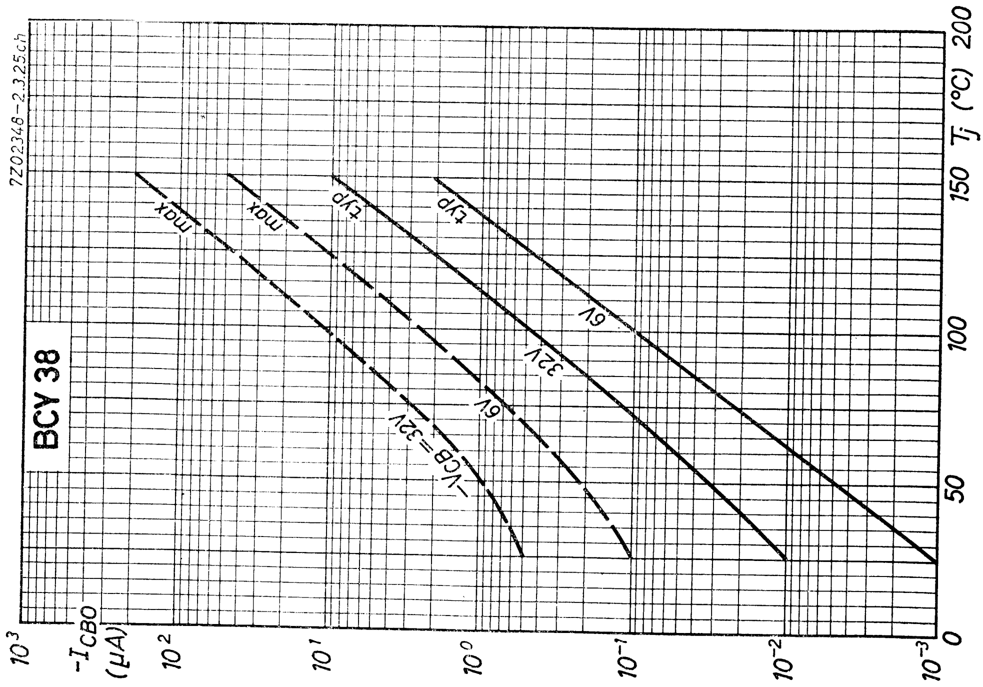

BCY 38
$-V_{CE}$ = 1V
T_{amb}=25°C
30
$-I_B$
(mA)
20
10
0
0
1
$-V_{BE}$ (V)
2
300
$-I_C$
(mA)
200
100
0
0
1
$-V_{BE}$(V)
2
7Z02347-2.3.25.ch

C

7.7.1964

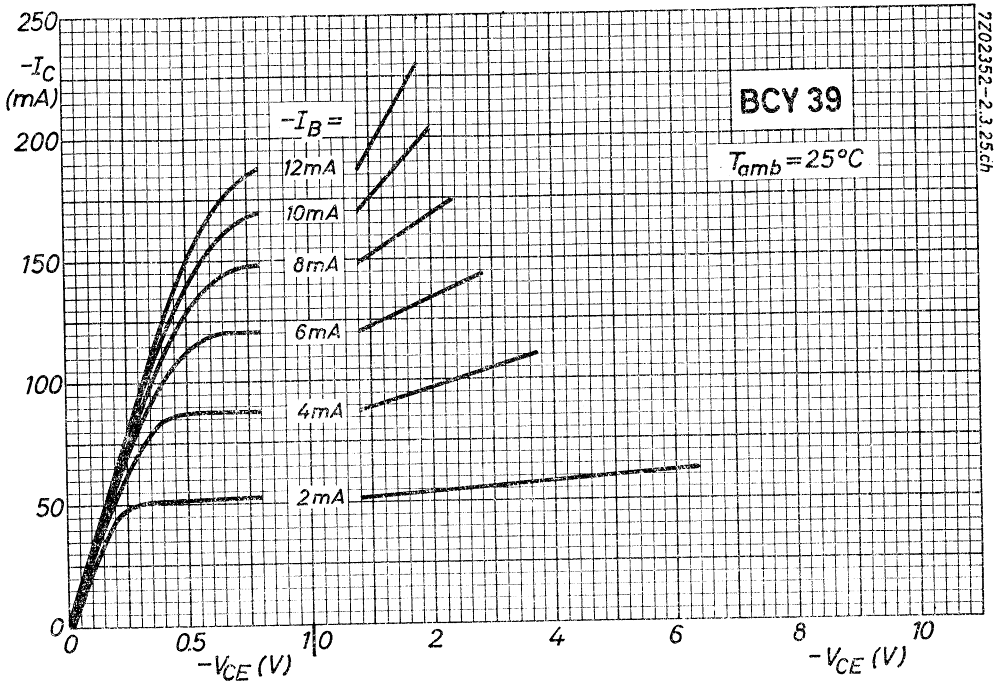

7Z02349-2.3.25.ch
BCY 38
I = permissible region of operation under all base conditions
II = additional region of operation when the transistor is in cut-off condition
I
II
$-I_C$ (mA)
$-V_{CE}$(V)

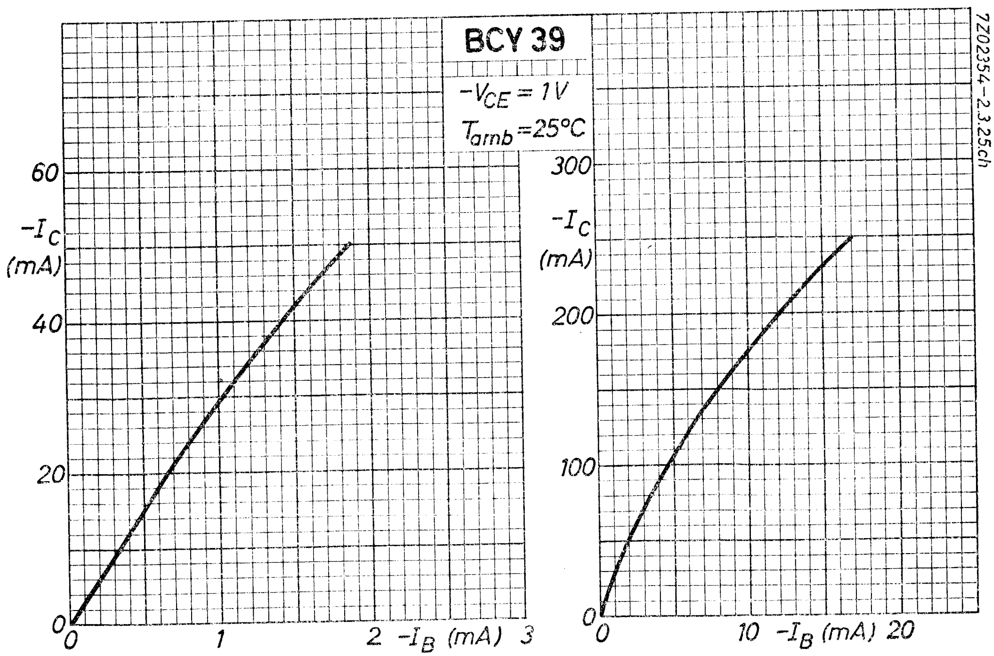
E

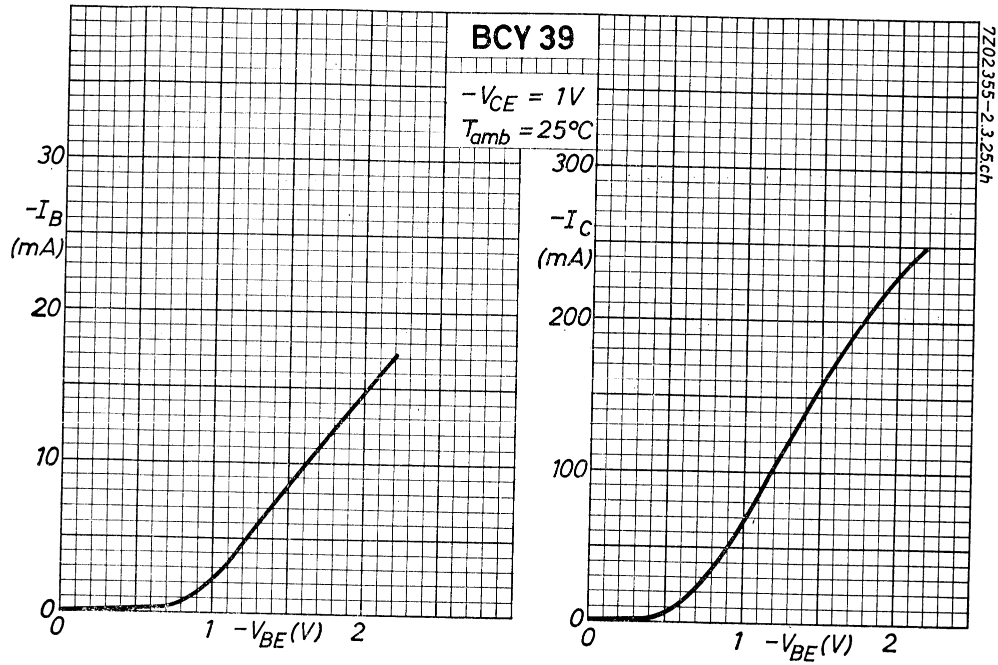

7Z02348-2.3.25ch
BCY 38
max
max
typ
typ
6V
32V
6V
$-V_{CB}$ = 32V
$-I_{CBO}$ (μA)
T_j (°C)

D

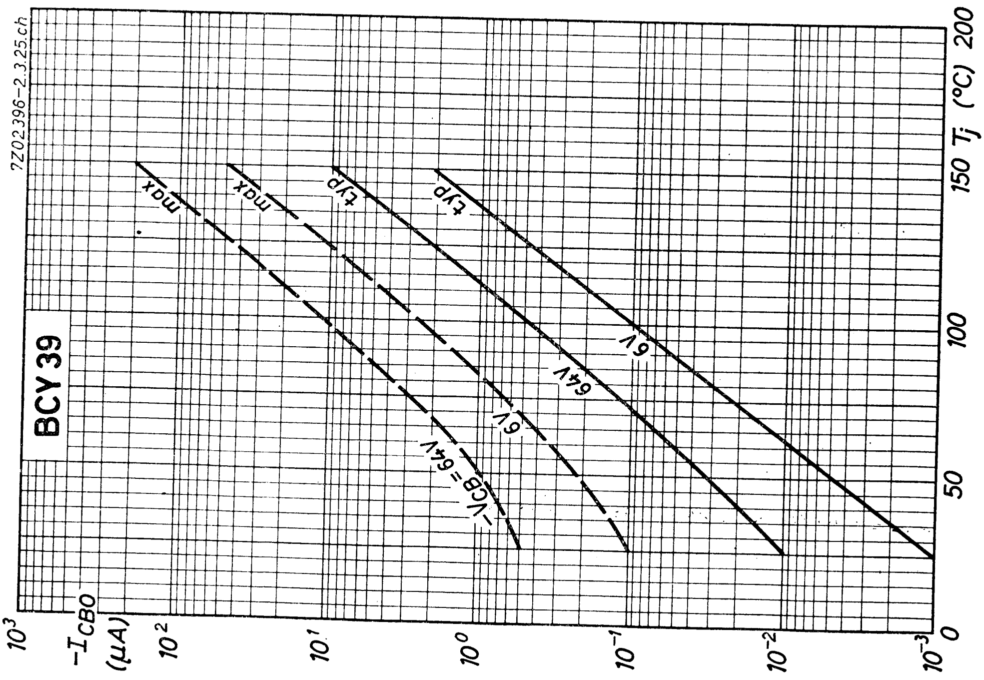
7.7.1964


BCY 39
$T_{amb} = 25°C$
$-I_B =$
12mA
10mA
8mA
6mA
4mA
2mA
$-I_C$ (mA)
250
200
150
100
50
0
0
0.5
1.0
2
4
6
8
10
$-V_{CE}$ (V)
$-V_{CE}$ (V)
7Z02352-2.3.25.ch


BCY 39
$-V_{CE} = 1V$
$T_{amb} = 25°C$
$-I_C$ (mA)
60
40
20
0
0
1
2
3
$-I_B$ (mA)
$-I_C$ (mA)
300
200
100
0
0
10
20
$-I_B$ (mA)
7Z02354-2.3.25.ch

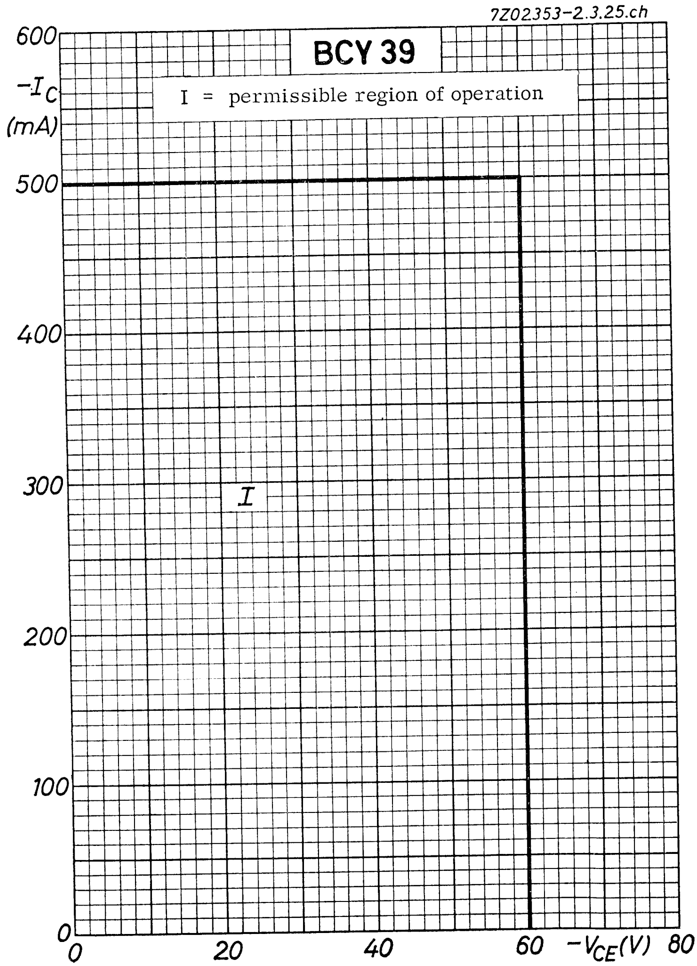

BCY 39
$-V_{CE}$ = 1V
T_{amb} = 25°C
$-I_B$ (mA)
$-V_{BE}$ (V)
$-I_C$ (mA)
7Z02355-2.3.25.ch

H

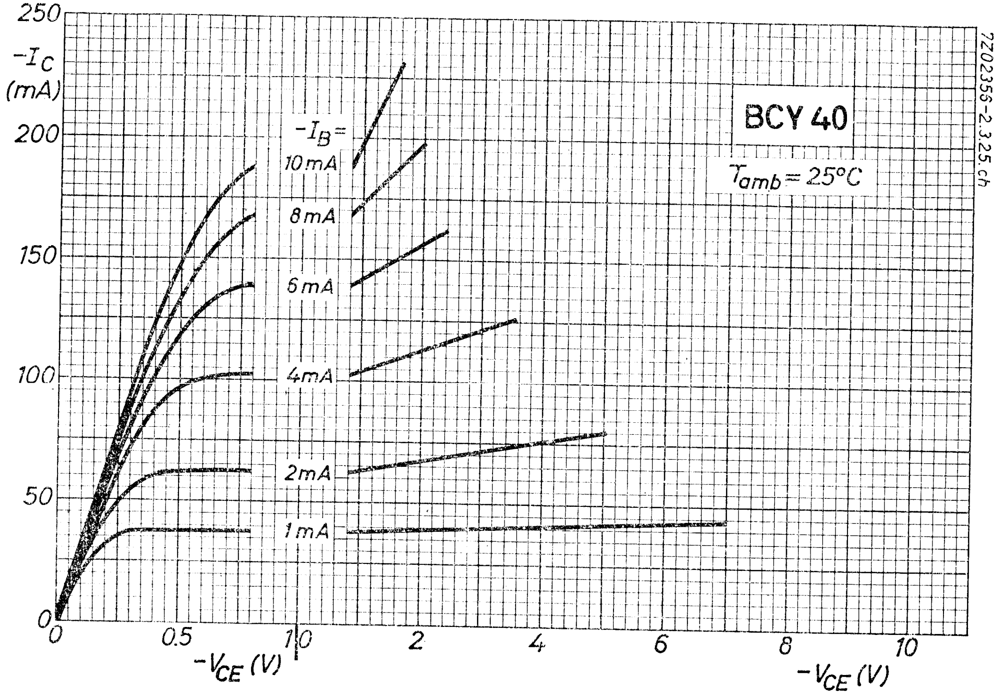

BCY 39
7Z02396-2.3.25.ch
$-I_{CBO}$ (μA)
T_j (°C)
max
typ
6V
64V
$-V_{CB}$ = 64V

I

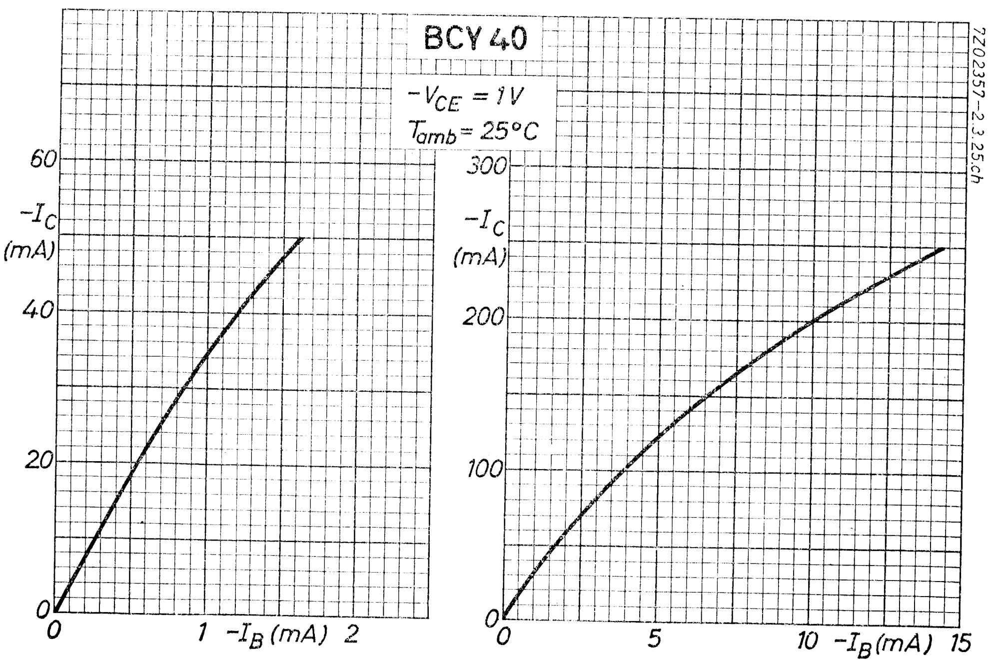
7.7.1964


7Z02353-2.3.25.ch
BCY 39
I = permissible region of operation
600
$-I_C$
(mA)
500
400
300
I
200
100
0
0
20
40
60
$-V_{CE}(V)$
80

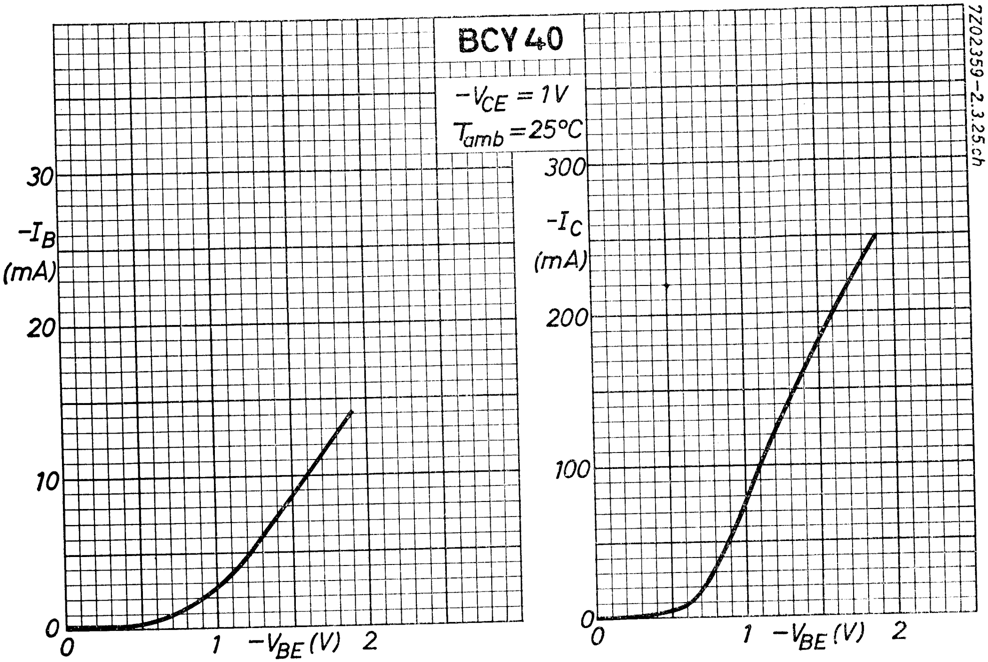
J

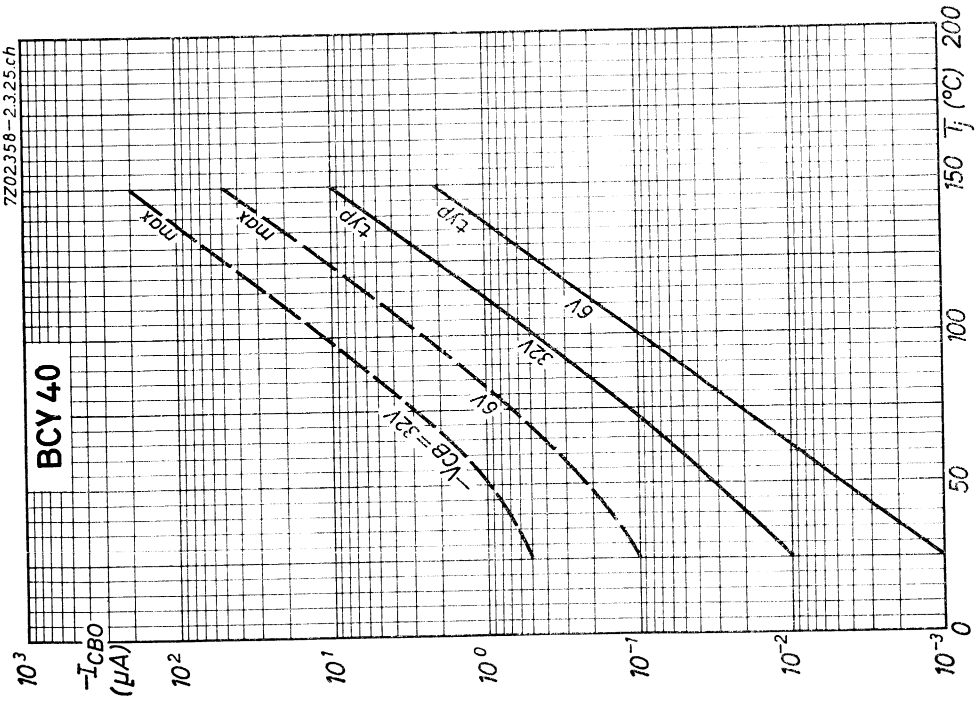

250
$-I_C$
(mA)
200
150
100
50
0
$-I_B=$
10 mA
8 mA
6 mA
4mA
2mA
1 mA
BCY 40
$T_{amb} = 25°C$
7Z02356-2.3.25.ch
0
0.5
1.0
2
4
6
8
10
$-V_{CE}$ (V)
$-V_{CE}$ (V)

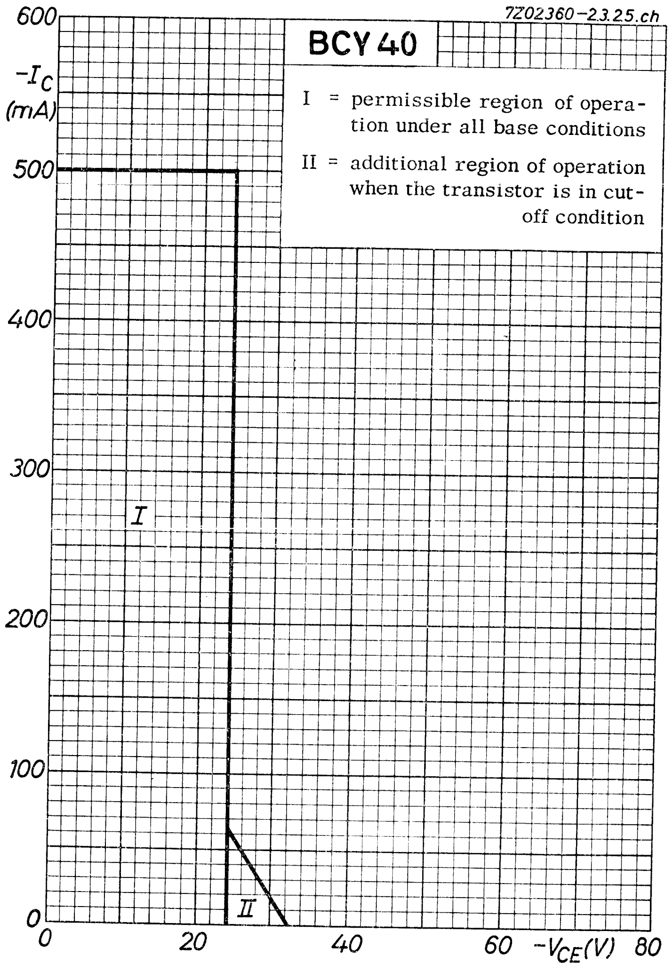
K


BCY 40
$-V_{CE} = 1V$
$T_{amb} = 25°C$
7Z02357-2.3.25.ch
60
$-I_C$
(mA)
40
20
0
0
1
$-I_B$ (mA)
2
300
$-I_C$
(mA)
200
100
0
0
5
10
$-I_B$(mA)
15

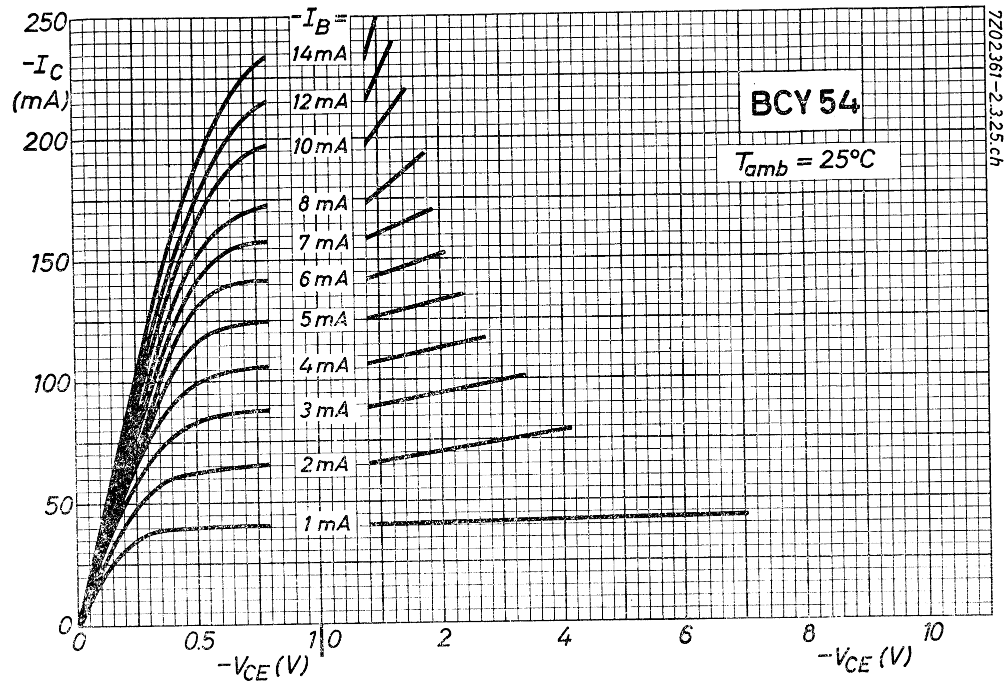
L

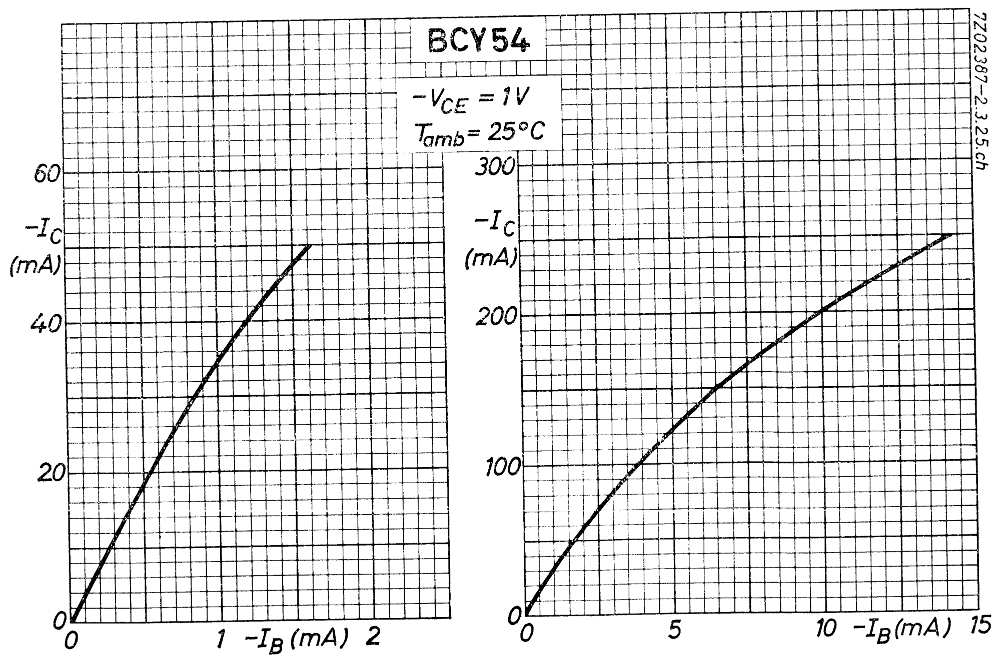

BCY 40
$-V_{CE} = 1V$
$T_{amb} = 25°C$
30
20
10
0
$-I_B$ (mA)
0
1
$-V_{BE}$ (V)
2
300
200
100
0
$-I_C$ (mA)
7Z02359-2.3.25.ch

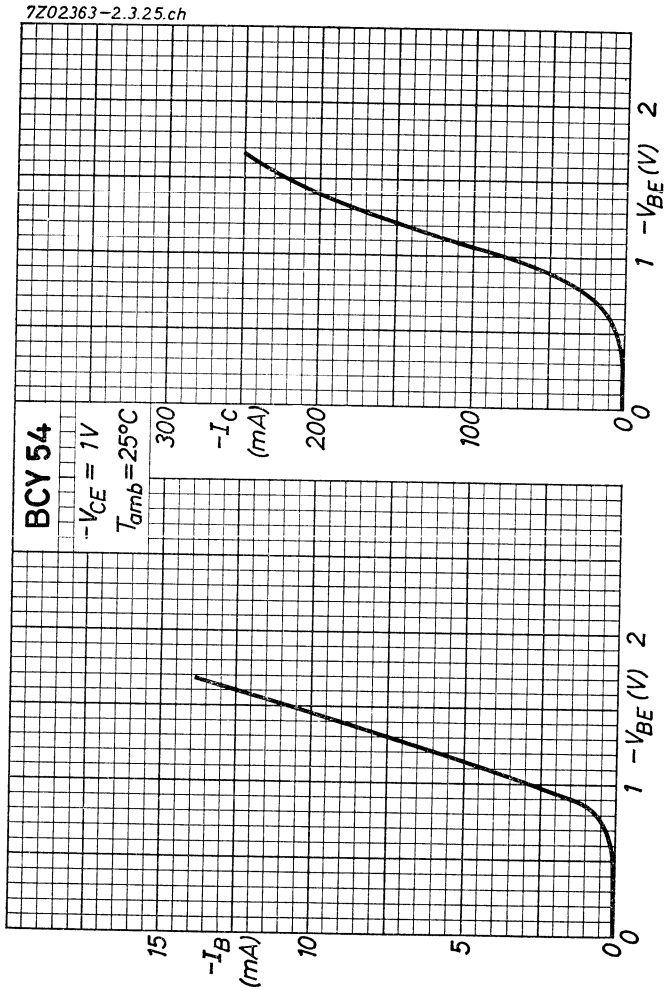

BCY 40
7Z02358-2.3.25.ch
max
max
typ
typ
6V
32V
6V
$-V_{CB} = 32V$
10^3
$-I_{CBO}$ (μA)
10^2
10^1
10^0
10^{-1}
10^{-2}
10^{-3}
0
50
100
150
200
T_j (°C)


7Z02360-2.3.25.ch
BCY 40
I = permissible region of operation under all base conditions
II = additional region of operation when the transistor is in cut-off condition
600
$-I_C$
(mA)
500
400
300
200
100
0
I
II
0
20
40
60
$-V_{CE}$(V)
80

7.7.1964

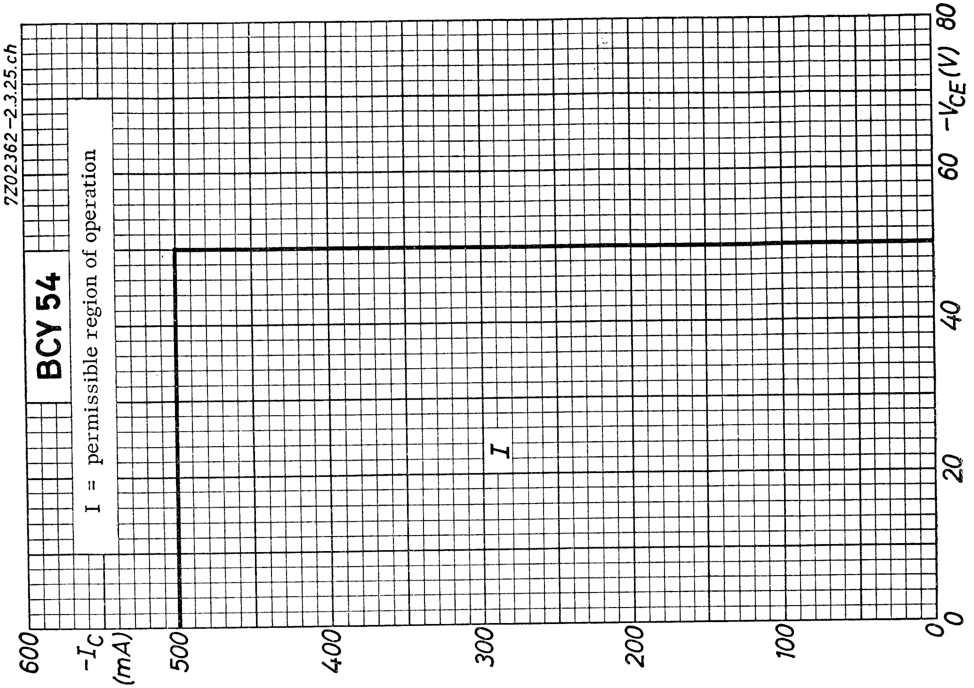

BCY 54
T_{amb} = 25°C
$-I_B$ =
14 mA
12 mA
10 mA
8 mA
7 mA
6 mA
5 mA
4 mA
3 mA
2 mA
1 mA
$-I_C$ (mA)
250
200
150
100
50
0
0
0.5
1.0
2
4
6
8
10
$-V_{CE}$ (V)
$-V_{CE}$ (V)
7Z02361-2.3.25.ch

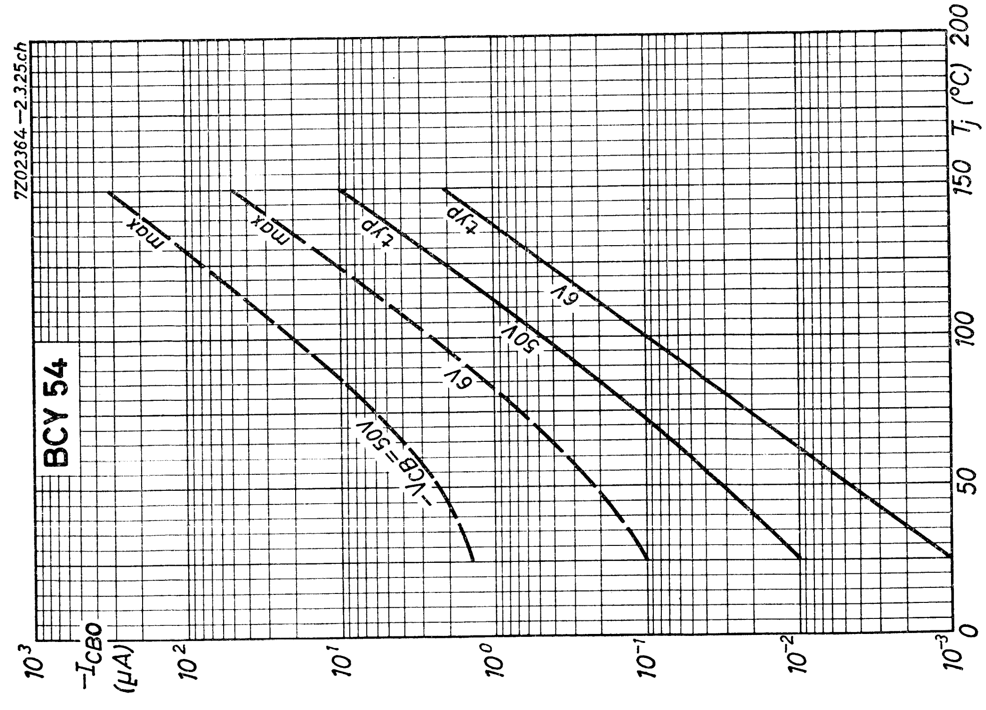

BCY54
$-V_{CE}$ = 1V
T_{amb} = 25°C
$-I_C$ (mA)
60
40
20
0
0
1
2
$-I_B$ (mA)
$-I_C$ (mA)
300
200
100
0
0
5
10
15
$-I_B$ (mA)
7Z02387-2.3.25.ch


7Z02363-2.3.25.ch
BCY 54
$-V_{CE} = 1V$
$T_{amb}=25°C$
$-I_C$ (mA)
300
200
100
0
0
1
2
$-V_{BE}$ (V)
$-I_B$ (mA)
15
10
5
0
0
1
2
$-V_{BE}$ (V)

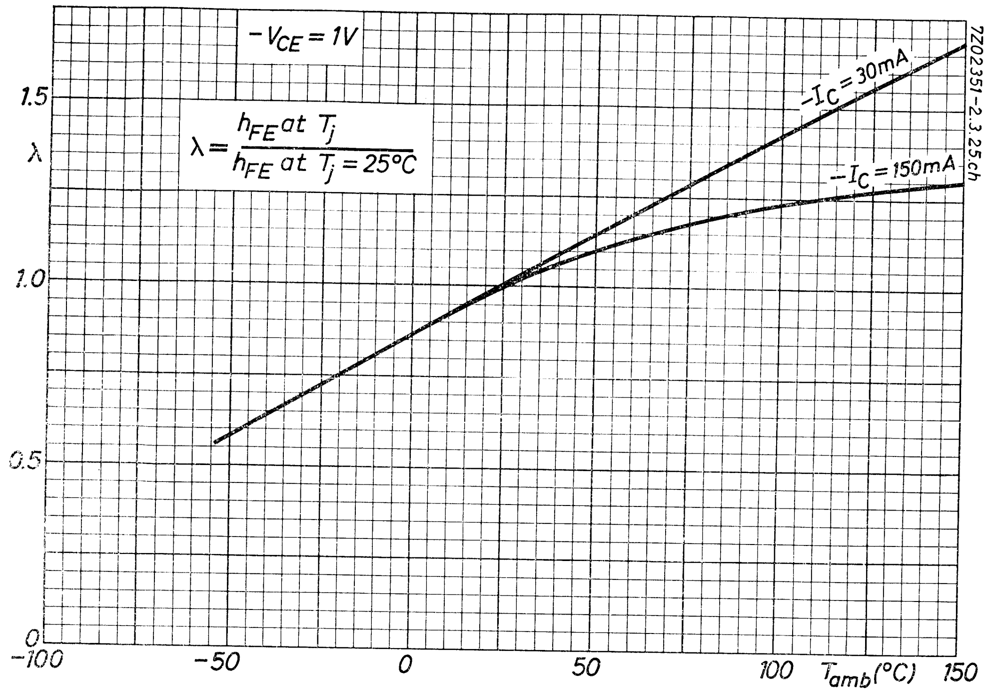
7.7.1964

R

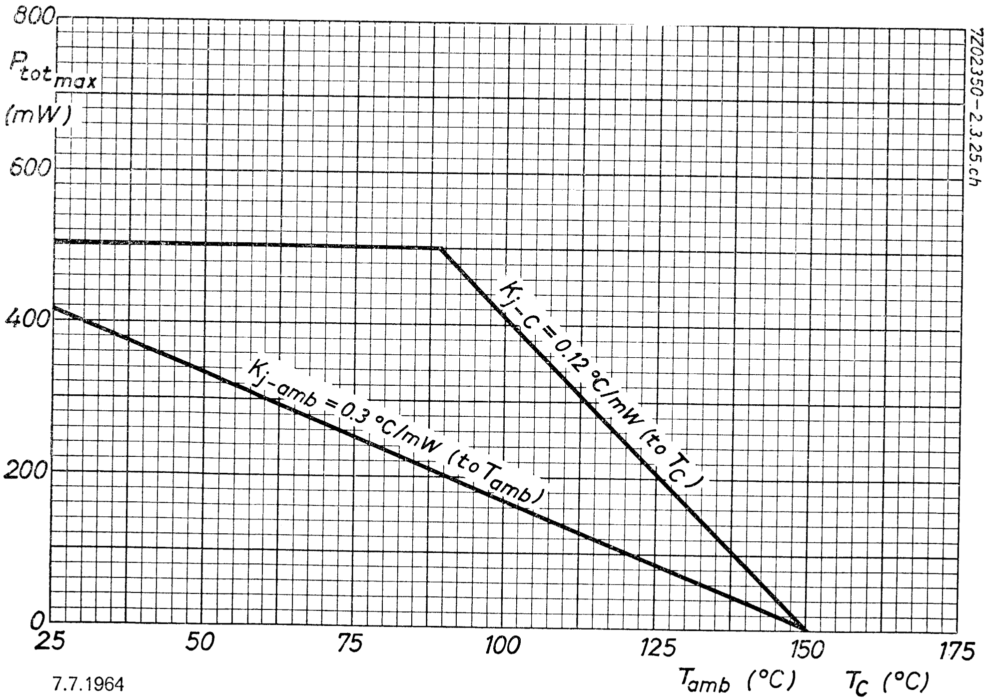

7Z02362-2.3.25.ch
BCY 54
I = permissible region of operation
I
$-I_C$ (mA)
600
500
400
300
200
100
0
0
20
40
60
80
$-V_{CE}$ (V)


7Z02364-2.3.25.ch
BCY 54
$-I_{CBO}$ (μA)
10^3
10^2
10^1
10^0
10^{-1}
10^{-2}
10^{-3}
max
max
typ
typ
$-V_{CB}$ = 50V
6V
50V
6V
0
50
100
150
200
T_j (°C)

7.7.1964

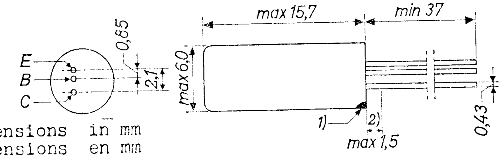

$-V_{CE} = 1V$
$\lambda = \frac{h_{FE} \text{ at } T_j}{h_{FE} \text{ at } T_j = 25°C}$
$-I_C = 30mA$
$-I_C = 150mA$
7Z02351-2.3.25.ch
λ
1.5
1.0
0.5
0
−100
−50
0
50
100
150
T_{amb}(°C)

U


$P_{tot_{max}}$
(mW)
800
600
400
200
0
$K_{j-C} = 0.12$ °C/mW (to T_C)
$K_{j-amb} = 0.3$ °C/mW (to T_{amb})
7Z02350-2.3.25.ch
25
50
75
100
125
150
175
T_{amb} (°C) T_C (°C)

V

SILICON A.F. TRANSISTOR of the p-n-p alloy type in all-glass construction with external metal can for use in audio amplifiers and for general industrial applications
TRANSISTOR B.F. AU SILICIUM du type p-n-p par alliage en construction tout verre avec enveloppe métallique pour l'utilisation dans des amplificateurs B.F. et pour applications générales industrielles
Legierter NF p-n-p-SILIZIUMTRANSISTOR in Allglastechnik mit Metallumhüllung zur Verwendung in NF-Verstärkern und für allgemeine industrielle Anwendungen



Dimensions in mm
Dimensions en mm
Abmessungen in mm

Limiting values (Absolute max. values)
Caractéristiques limites (Valeurs max. absolues)
Grenzdaten (Absolute Maximalwerte)

$-V_{CB}$ = max. 25 V		$-I_C$ =	max. 50 mA
$-V_{CBM}$ = max. 25 V		$-I_{CM}$ =	max. 50 mA
$-V_{CE}$ = max. 25 V		$-I_B$ =	max. 15 mA
$-V_{CEM}$ = max. 25 V		$-I_{BM}$ =	max. 15 mA
$-V_{EB}$ = max. 20 V		P_C	see page G / voir page G / siehe Seite G
$-V_{EBM}$ = max. 20 V			

T_j {continuous operation / service continu / Dauerbetrieb} = max. 150 °C

Storage temperature
Température d'emmagasinage = $-55^{\circ}C/+150^{\circ}C$
Lagerungstemperatur

[1]) The red dot indicates the collector
Le point rouge indique le collecteur
Der rote Punkt bezeichnet den Kollektoranschluss

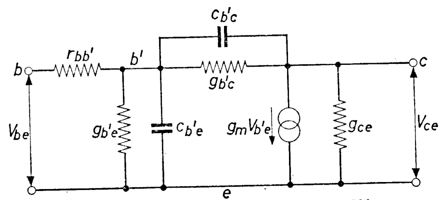
[2]) Not tinned; non étamé; nicht verzinnt

Thermal data. Junction temperature rise to ambient temperature in free air $K \leq 0.5\ ^{\circ}C/mW$
Données thermiques. Augmentation de la température de la jonction au regard de la température de l'ambiance à l'air libre $K \leq 0,5\ ^{\circ}C/mW$
Thermische Daten. Temperaturerhöhung in Bezug auf die Umgebungstemperatur in freier Luft $K \leq 0,5\ ^{\circ}C/mW$

Characteristics
Caractéristiques
Kenndaten

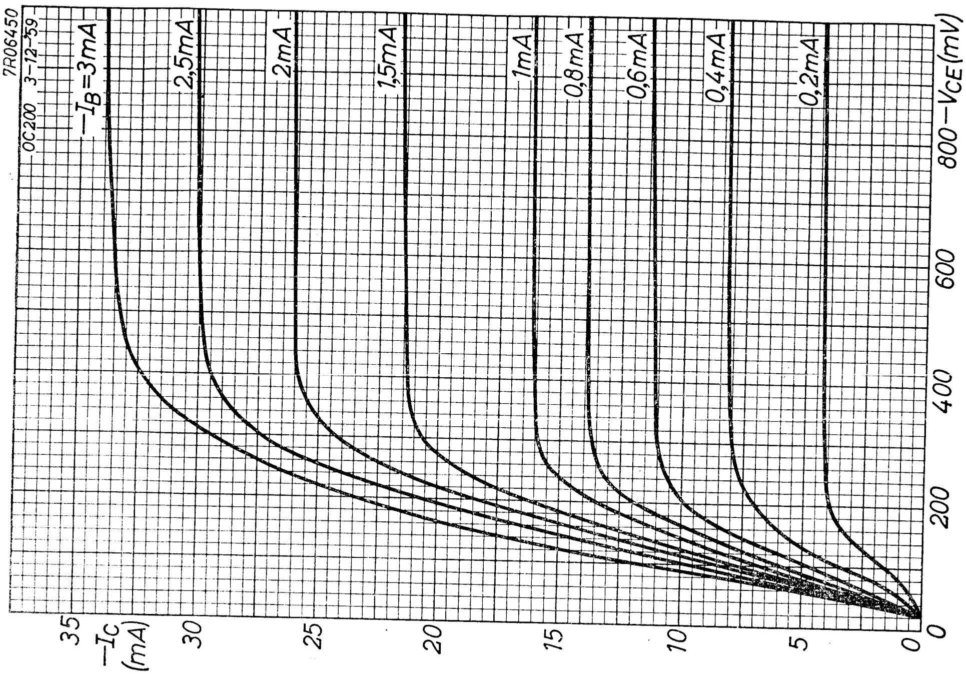
$T_j = 25\ ^{\circ}C$ {unless otherwise specified / sauf indication différente / wenn nicht anders angegeben

$-I_{CBO}(-V_{CB} = 10\ V)$	= 0,001 µA	< 0,1 µA
$-I_{CBO}(-V_{CB} = 10\ V;\ T_j = 100\ ^{\circ}C)$	= 0,1 µA	< 10 µA
$-I_{EBO}(-V_{EB} = 10\ V)$	= 0,001 µA	< 0,1 µA
$-I_{EBO}(-V_{EB} = 10\ V;\ T_j = 100\ ^{\circ}C)$	= 0,1 µA	< 10 µA
$-V_{CE}\ (-I_C = 7\ mA;\ -I_B = 1\ mA)$	= 130 mV	< 320 mV
$F\ (-V_{CE} = 2\ V;\ -I_C = 0,5\ mA)$	= 8,0 dB[1])	

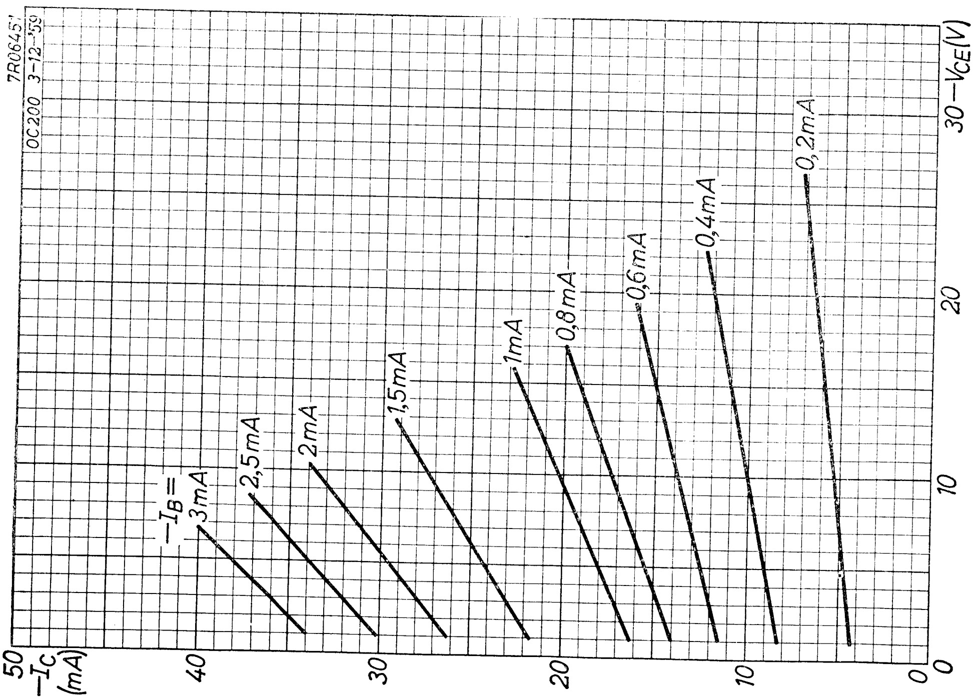


			Min.	Max.
Measured at / Mesuré à / Gemessen bei	$-V_{CE}$	= 6		V
	$-I_C$	= 1		mA
	$r_{bb'}$	= 125		< 350 Ω
	$C_{b'c}$	= 45		< 80 pF
	$f_{\alpha b}$	= 1,0	> 0,3	< 3,5 Mc/s
	h_{fe} (f = 1 kc/s)	= 20	> 15	< 60
	h_{fe} {f = 1 kc/s; $T_{amb} = -50^{\circ}C$}	=	> 10	

[1]) Noise factor measured at f = 1 kc/s with an input source impedance of 500 Ω
Facteur de bruit mesuré à f = 1 kHz avec une impédance de source d'entrée de 500 Ω
Rauschzahl gemessen bei f = 1 kHz mit einer Impedanz der Eingangsspannungsquelle von 500 Ω

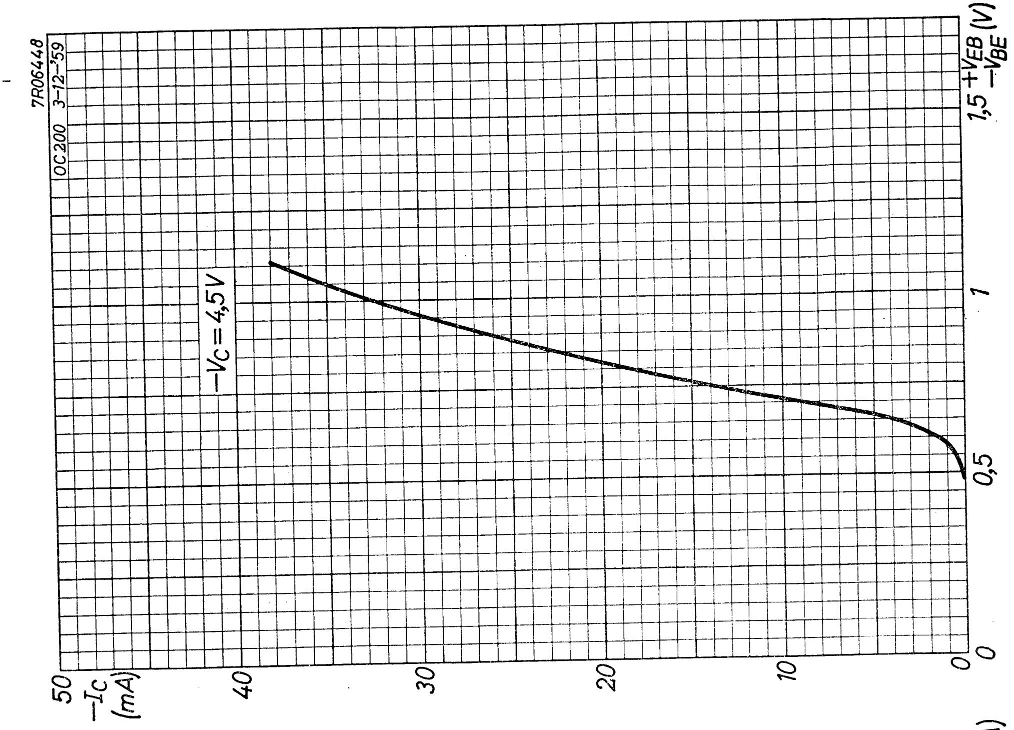

OC200 3-12-59
7R06450
$-I_B$=3mA
2,5mA
2mA
1,5mA
1mA
0,8mA
0,6mA
0,4mA
0,2mA
$-I_C$ (mA)
35
30
25
20
15
10
5
0
0
200
400
600
800
$-V_{CE}$(mV)

B

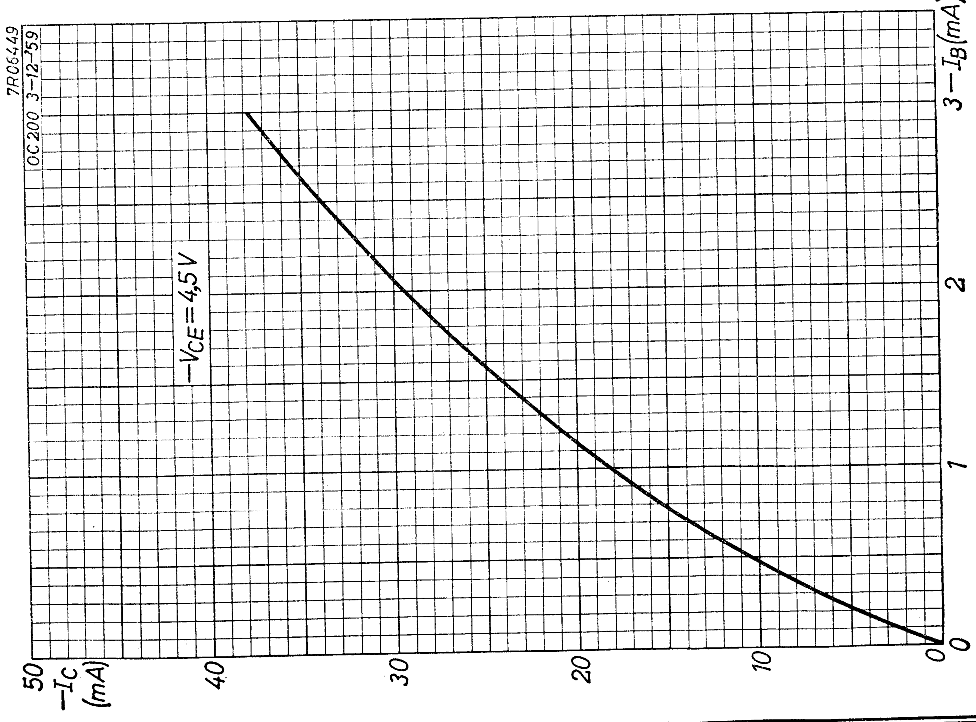

OC200 3-12-59
$-I_B$= 3mA
2,5mA
2mA
1,5mA
1mA
0,8mA
0,6mA
0,4mA
0,2mA
50
$-I_C$ (mA)
40
30
20
10
0
0
10
20
30
$-V_{CE}$(V)

A

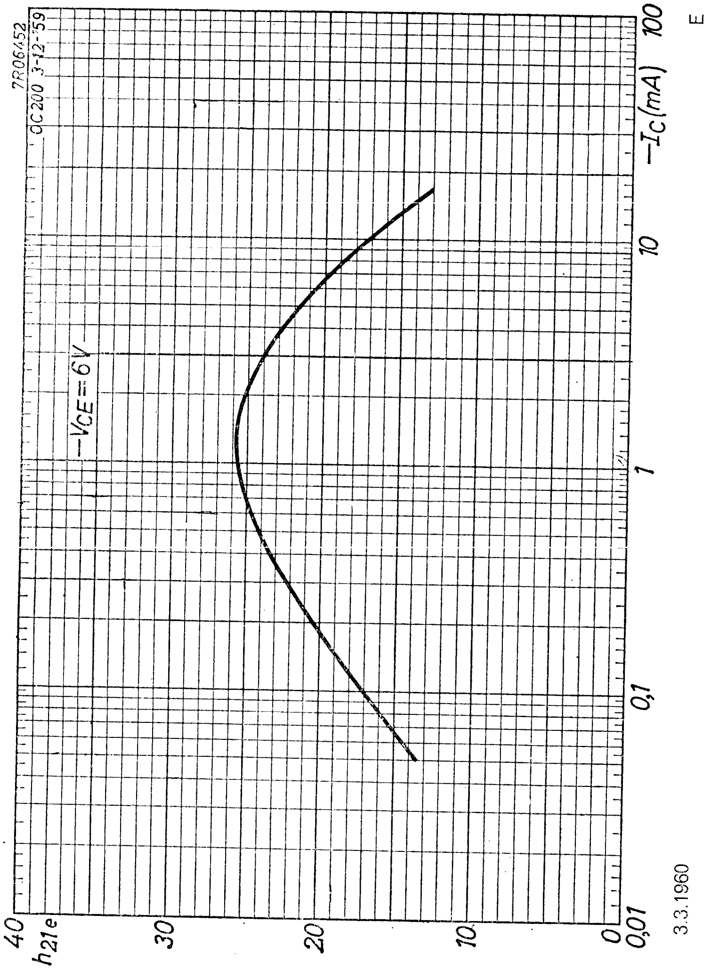
3.3.1960

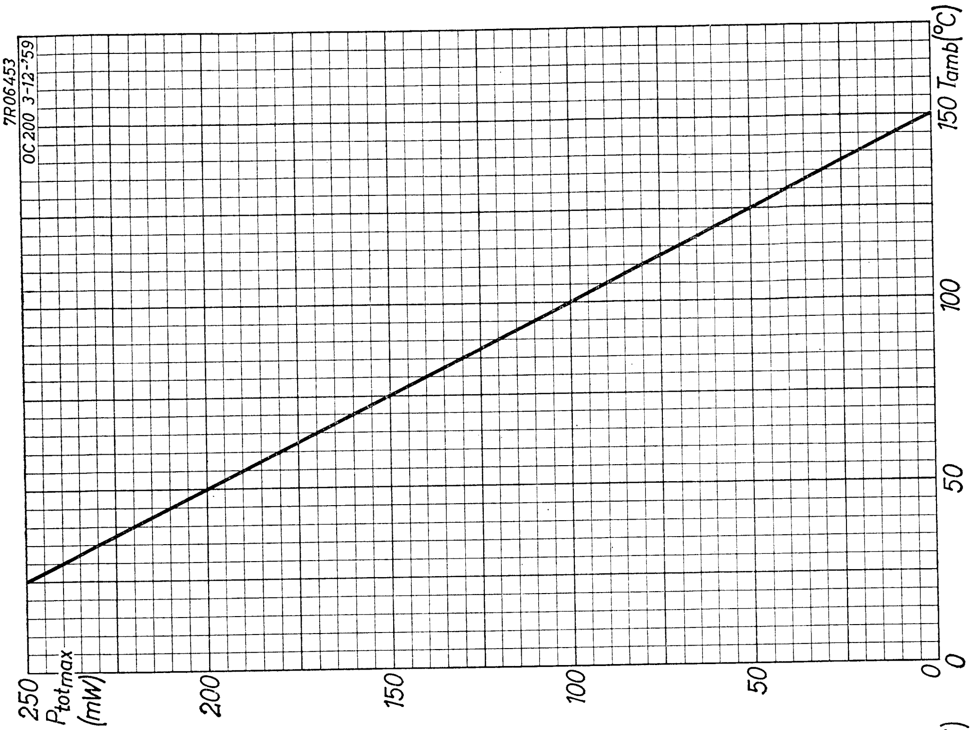

7R06448
OC200 3-12-'59
−V_C = 4,5 V
50
−I_C (mA)
40
30
20
10
0
0
0,5
1
1,5 +V_EB (V)
−V_BE

D

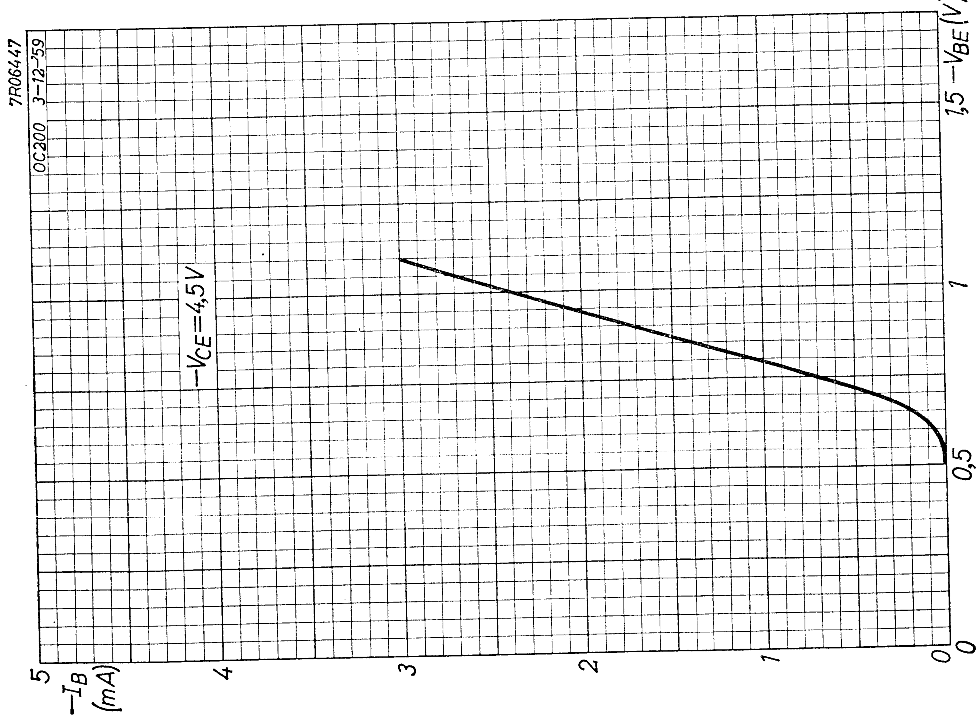

7R06449
OC200 3-12-'59
−V_CE = 4,5 V
50
−I_C (mA)
40
30
20
10
0
0
1
2
3 −I_B (mA)

C


7R06452
OC200 3-12-'59
$-V_{CE} = 6\,V$
$-I_C\,(mA)$
100
10
1
0,1
0,01
40
30
20
10
0
h_{21e}
E
3.3.1960


7R06453
OC 200 3-12-'59
$P_{tot\,max}$ (mW)
250
200
150
100
50
0
0
50
100
150 T_{amb} (°C)

G


7R06447
OC200 3-12-'59
$-I_B$ (mA)
5
4
3
2
1
0
0
0,5
1
1,5 $-V_{BE}$ (V)
$-V_{CE}$=4,5V

F

SILICON MEDIUM FREQUENCY TRANSISTOR of the p-n-p alloy type in all-glass construction with external metal can for use in audio amplifiers and for general industrial applications where improved frequency performance and current gain are required

TRANSISTOR ALLIÉ AU SILICIUM POUR FRÉQUENCES MOYENNES du type p-n-p en construction tout verre avec enveloppe métallique pour l'utilisation dans les amplificateurs B.F. et pour les applications générales industrielles qui requièrent des propriétés améliorées par rapport à la fréquence et l'amplification de courant

Legierter p-n-p-SILIZIUMTRANSISTOR für mittlere Frequenzen in Allglastechnik mit Metallumhüllung zur Verwendung in NF-Verstärkern und für allgemeine industrielle Anwendungen, wo bessere Eigenschaften in Bezug auf Frequenz und Stromverstärkung erwünscht sind

Limting values (Absolute max. values)
Caractéristiques limites (Valeurs max. absolues)
Grenzdaten (Absolute Maximalwerte)

$-V_{CB}$	= max.	25 V
$-V_{CBM}$	= max.	25 V
$-V_{CE}$	= max.	25 V
$-V_{CEM}$	= max.	25 V
$-V_{EB}$	= max.	20 V
$-V_{EBM}$	= max.	20 V
$-I_C$	= max.	50 mA
$-I_{CM}$	= max.	50 mA
$-I_B$	= max.	15 mA
$-I_{BM}$	= max.	15 mA
P_C	see page G / voir page G / siehe Seite G	

T_J continuous operation / service continu / Dauerbetrieb = max. 150 °C

Storage temperature / Température d'emmagasinage / Lagerungstemperatur = −55°C/+150°C

7Z2 0999
2.2.1962

Thermal data.

Thermal resistance between junction and ambience in free air

without cooling clip	K = max. 0.5 °C/mW
with cooling clip	K = max. 0.42 °C/mW

Thermal resistance between junction and case K = max. 0.35 °C/mW

Données thermiques.

Résistance thermique entre les jonctions et l'ambiance à l'air libre

sans ailette de refroidissement	K = max. 0,5 °C/mW
avec ailette de refroidissement	K = max. 0,42 °C/mW

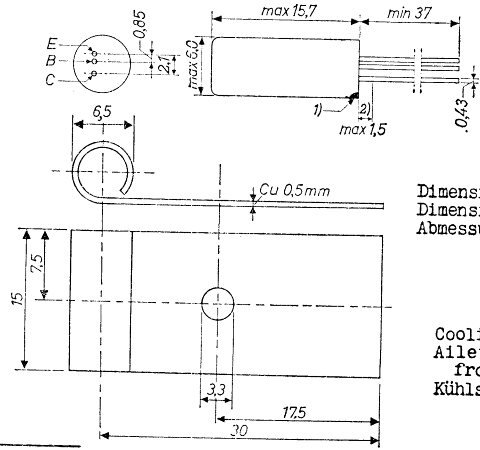
Résistance thermique entre les jonctions et le boîtier K = max. 0,35 °C/mW

Thermische Daten.

Wärmewiderstand zwischen Kristall und Umgebung in freier Luft

ohne Kühlschelle	K = max. 0,5 °C/mW
mit Kühlschelle	K = max. 0,42 °C/mW

Wärmewiderstand zwischen Kristall und Gehäuse K = max. 0,35 °C/mW



Dimensions in mm
Dimensions en mm
Abmessungen in mm

Cooling fin
Ailette de refroidissement
Kühlschelle

[1]) The red dot indicates the collector
Le point rouge indique le collecteur
Der rote Punkt bezeichnet den Kollektoranschluss

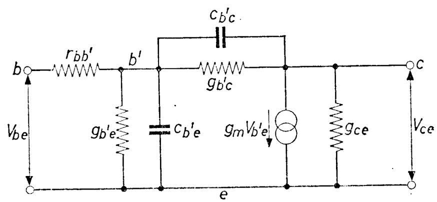
[2]) Not tinned; non étamé; nicht verzinnt

7Z2 1000

Characteristics
Caractéristiques
Kenndaten

$T_j = 25\ ^{\circ}C$ { unless otherwise specified / sauf indication différente / wenn nicht anders angegeben

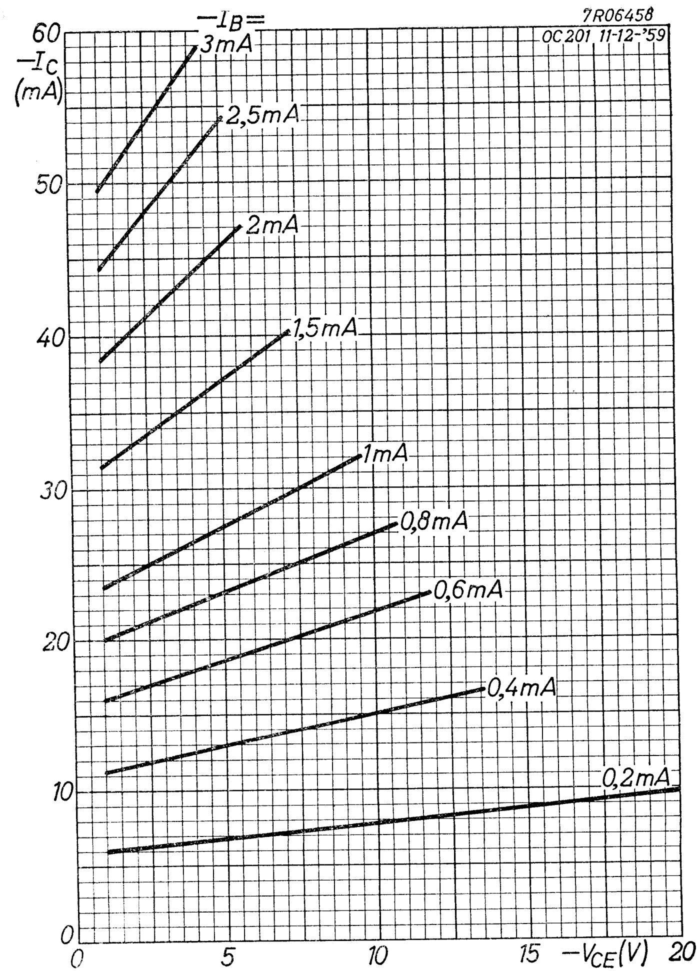
$-I_{CBO}(-V_{CB} = 10\ V)$	= 0,001 µA	< 0,1 µA
$-I_{CBO}(-V_{CB} = 10\ V;\ T_j = 100\ ^{\circ}C)$	= 0,1 µA	< 10 µA
$-I_{EBO}(-V_{EB} = 10\ V)$	= 0,001 µA	< 0,1 µA
$-I_{EBO}(-V_{EB} = 10\ V;\ T_j = 100\ ^{\circ}C)$	= 0,1 µA	< 10 µA
$-V_{CE}\ (-I_C = 7\ mA;\ -I_B = 1\ mA)$	= 100 mV	< 320 mV
$F\ (-V_{CE} = 2\ V;\ -I_C = 0{,}5\ mA)$	= 6,0 dB [1]	



Measured at / Mesuré à / Gemessen bei			Min.	Max.	
	$-V_{CE}$	= 6			V
	$-I_C$	= 1			mA
	$r_{bb'}$	= 125		<350	Ω
	$c_{b'c}$	= 50		< 80	pF
	$f_{\alpha b}$	= 1,5	>1,0		Mc/s
	h_{fe} (f = 1 kc/s)	= 35	> 25	< 60	

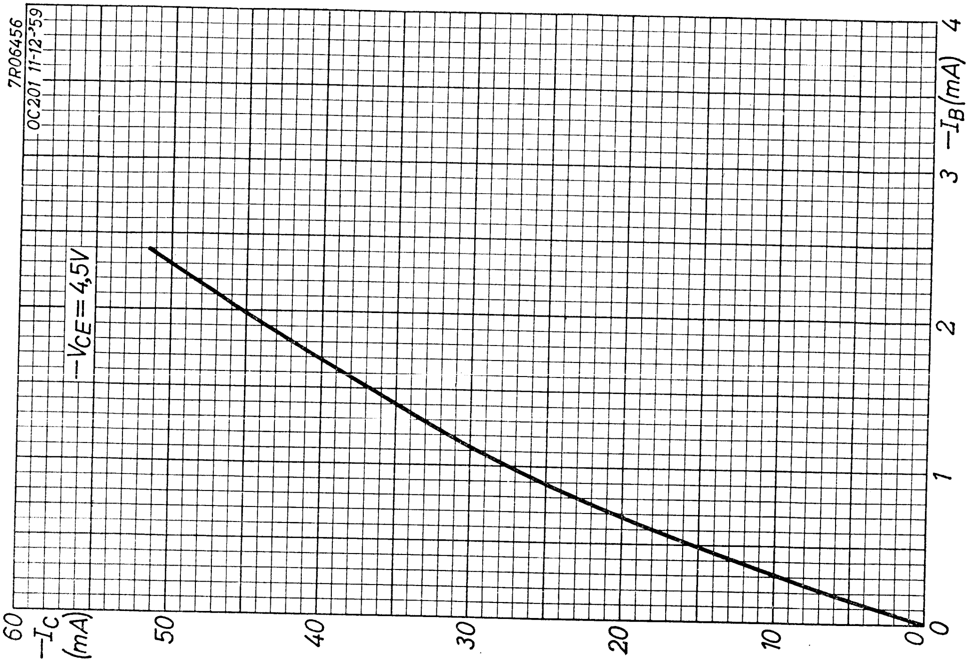
[1]) Noise factor measured at f = 1 kc/s with an input source impedance of 500 Ω
Facteur de bruit mesuré à f = 1 kHz avec une impédance de source d'entrée de 500 Ω
Rauschzahl gemessen bei f = 1 kHz mit einer Impedanz der Eingangsspannungsquelle von 500 Ω

7Z2 1001
2.2.1962

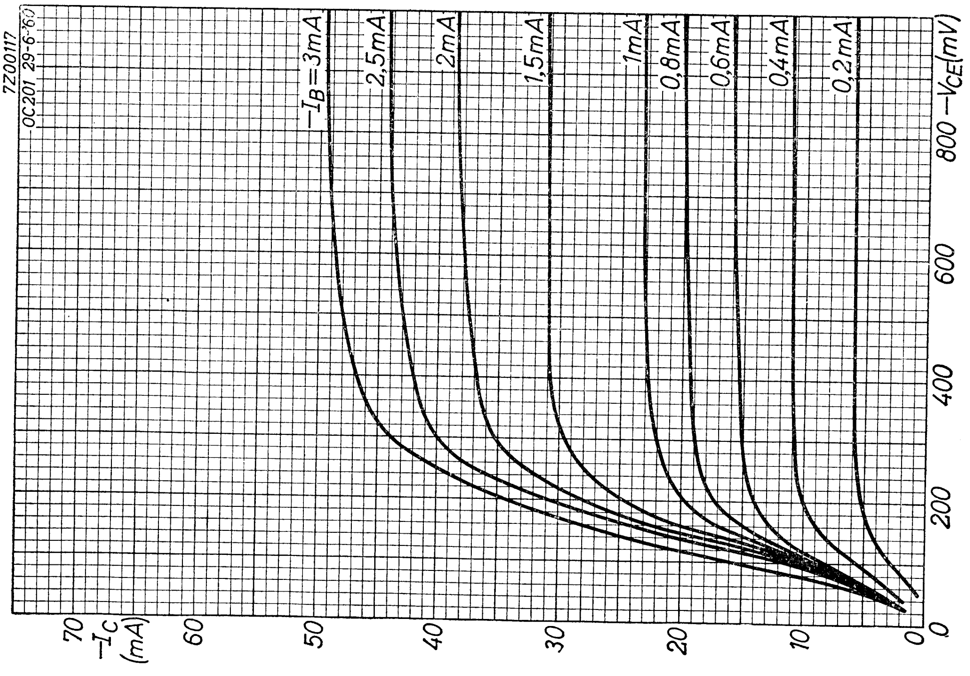


7.7.1960

A

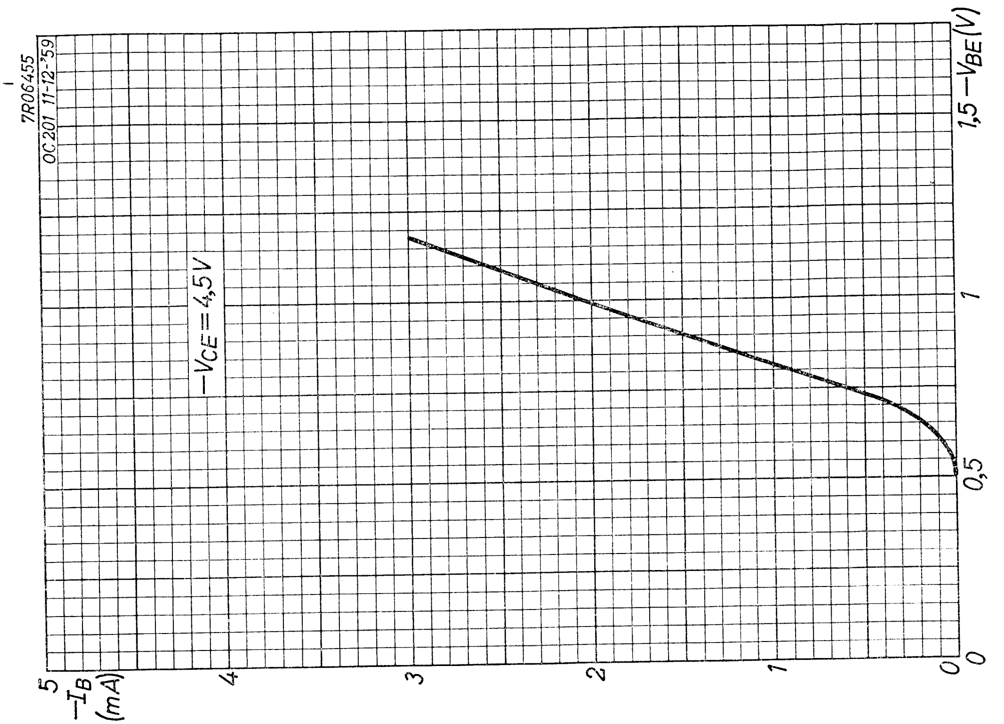

7R06456
OC201 11-12-'59
$-V_{CE} = 4,5V$
$-I_C$ (mA)
$-I_B$ (mA)
0
10
20
30
40
50
60
0
1
2
3
4

C

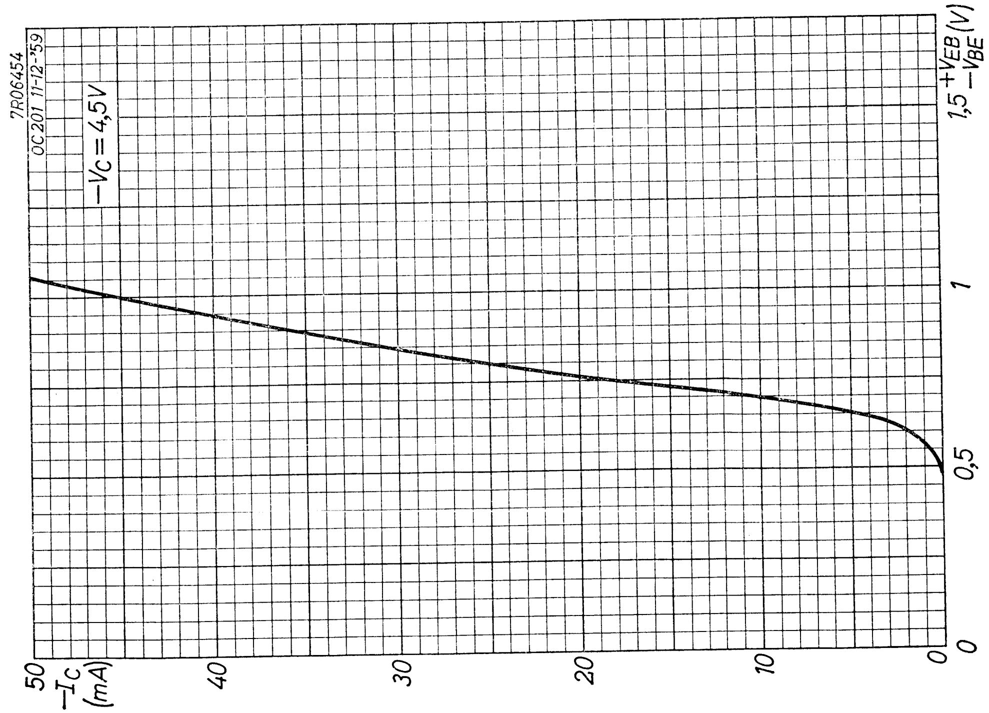

7Z00117
OC201 29-6-'60
$-I_B = 3mA$
2,5mA
2mA
1,5mA
1mA
0,8mA
0,6mA
0,4mA
0,2mA
$-I_C$ (mA)
$-V_{CE}$ (mV)
0
10
20
30
40
50
60
70
0
200
400
600
800

B

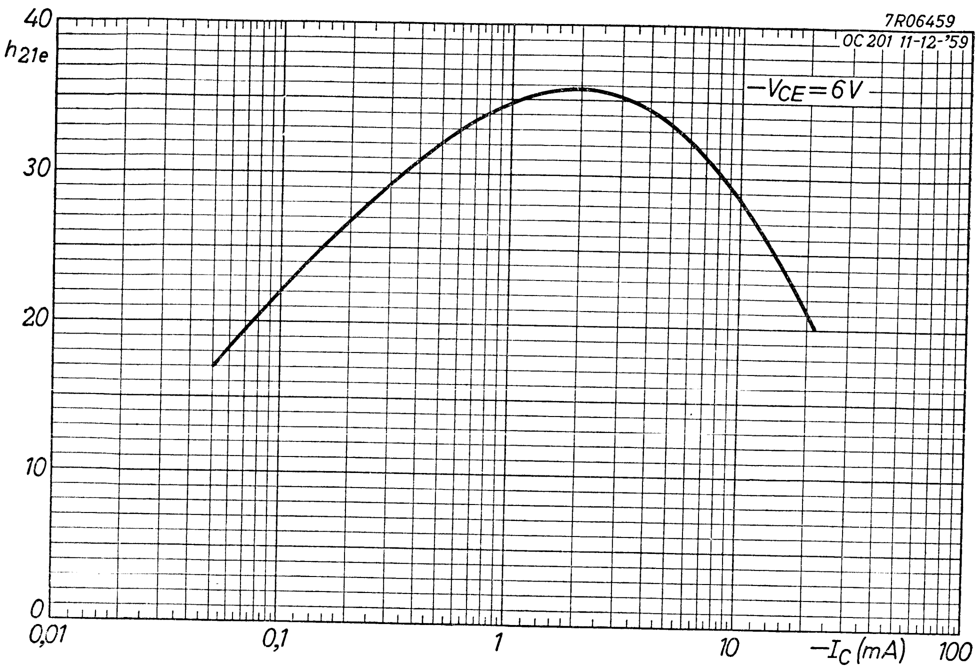
3.3.1960


7R06455
OC201 11-12-'59
−V_CE = 4,5V
−I_B (mA)
0
1
2
3
4
5
0
0,5
1
1,5 −V_BE (V)

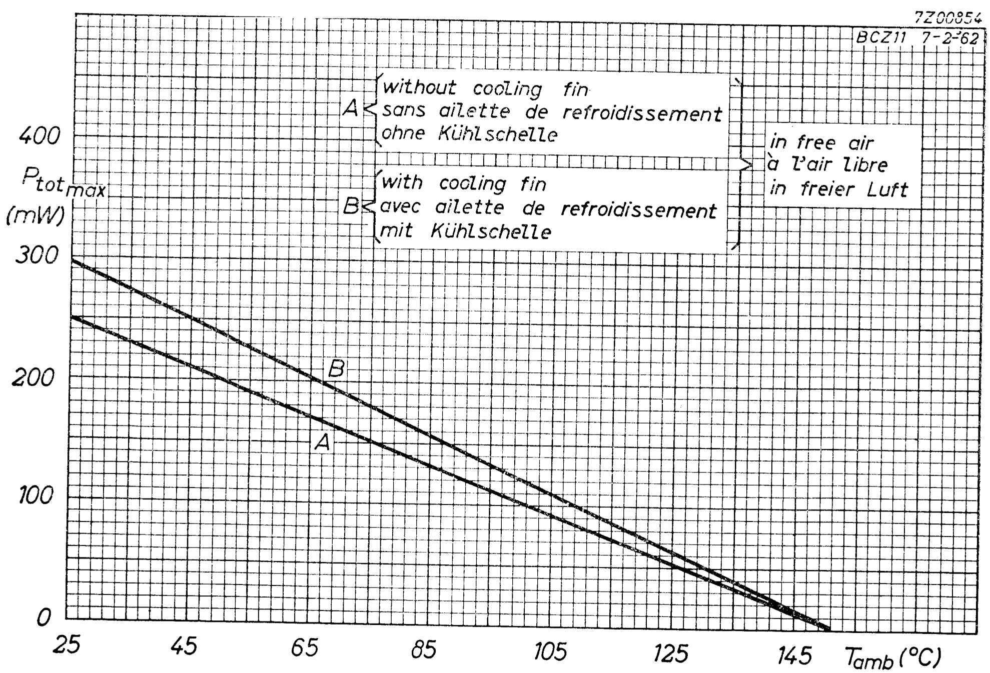
E


7R06454
OC201 11-12-'59
−V_C = 4,5V
−I_C (mA)
0
10
20
30
40
50
0
0,5
1
1,5 +V_EB −V_BE (V)

D


7R06459
OC 201 11-12-'59
40
h_{21e}
30
20
10
0
$-V_{CE}=6V$
0,01
0,1
1
10
100
$-I_C$ (mA)

F


7Z00854
BCZ11 7-2-'62
A
without cooling fin
sans ailette de refroidissement
ohne Kühlschelle
B
with cooling fin
avec ailette de refroidissement
mit Kühlschelle
in free air
à l'air libre
in freier Luft
400
$P_{tot_{max}}$
(mW)
300
200
100
0
B
A
25
45
65
85
105
125
145
T_{amb} (°C)

G

2.2.1962

SILICON A.F. TRANSISTOR of the p-n-p alloy type in all-glass construction with external metal can, suitable for high voltage applications

LIMITING VALUES (Absolute max. values)

Collector

Voltage (base reference)			
average or D.C. value	$-V_{CB}$	= max.	60 V
peak value	$-V_{CBM}$	= max.	60 V
Voltage (emitter reference)			
average or D.C. value	$-V_{CE}$	= max.	60 V[1]
peak value	$-V_{CEM}$	= max.	60 V[1]
Current			
average value	$-I_C$	= max.	50 mA
peak value	$-I_{CM}$	= max.	50 mA

Emitter

Reverse voltage (base reference)			
average or D.C. value	$-V_{EB}$	= max.	30 V
peak value	$-V_{EBM}$	= max.	30 V

Base

Current			
average value	$-I_B$	= max.	15 mA
peak value	$-I_{BM}$	= max.	15 mA

Dissipation

Total dissipation (see also page A) P_{tot} = max. $\frac{T_{j\,max} - T_{amb}}{K}$

Temperatures

Continuous junction temperature	T_j	= max.	150 °C
Storage temperature	T_s	= −55 °C to +150 °C	

THERMAL DATA

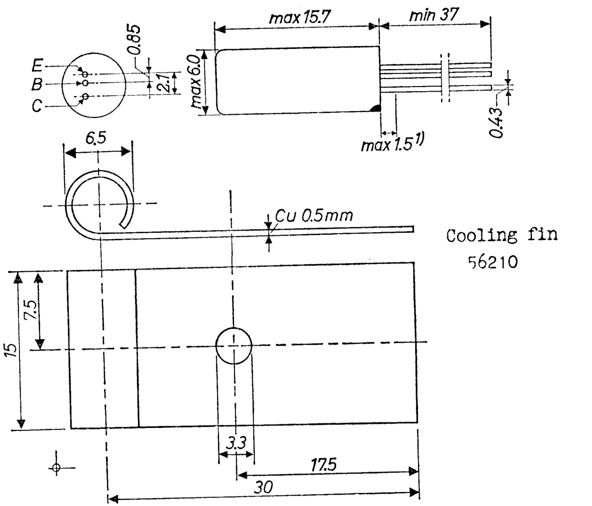
Thermal resistance from junction to ambience without cooling fin in free air	K	= max.	0.5 °C/mW
Thermal resistance from junction to ambience with cooling fin 56210 in free air	K	= max.	0.42 °C/mW
Thermal resistance from junction to case	K	= max.	0.35 °C/mW

[1]) These figures apply with an external base to ground resistance of less than 10 kΩ

7Z2 1740
4.4.1963

Dimensions in mm

The red dot indicates the collector



Cooling fin
56210

[1]) Not tinned

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

Common base circuit

Collector current				
$-I_{CBO}$	($-V_{CB}$ = 10 V; I_E = 0 mA)	= 0.01 µA	<	0.1 µA
$-I_{CBO}$	($-V_{CB}$ = 10 V; I_E = 0 mA; T_{amb} = 100 °C)	= 0.1 µA	<	10 µA
Emitter current				
$-I_{EBO}$	($-V_{EB}$ = 10 V; I_C = 0 mA)	= 0.01 µA	<	0.1 µA
$-I_{EBO}$	($-V_{EB}$ = 10 V; I_C = 0 mA; T_{amb} = 100 °C)	= 0.1 µA	<	10 µA

7Z2 1741

CHARACTERISTICS at T_{amb} = 25 °C (continued)

Common emitter circuit

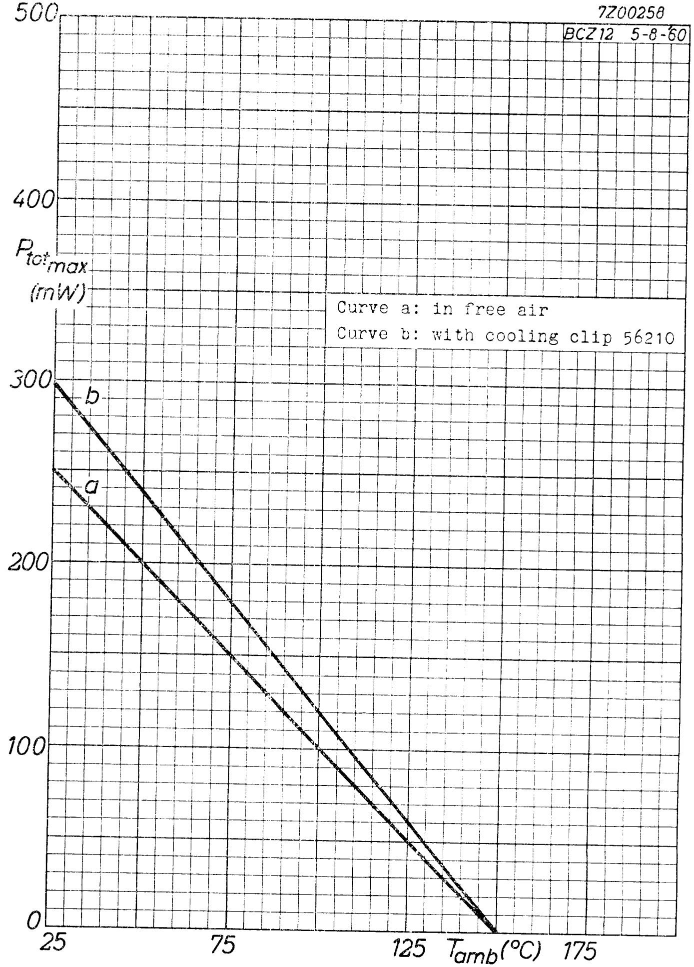
Collector knee voltage			
$-V_{CEK}$ ($-I_C$ = 7 mA; $-I_B$ = 1 mA)	=	0.13 V	< 0.32 V
Noise figure			
F { $-V_{CE}$ = 2 V; I_C = 0.5 mA; f = 1 kc/s; input source resistance = 500 Ω }	=	8 dB	

SMALL SIGNAL CHARACTERISTICS

Measured at $-V_{CE}$ = 6 V; $-I_C$ = 1 mA

Emitter resistance	r_e =	25 Ω [1]	
Intrinsic base resistance	$r_{bb'}$ =	125 Ω	< 350 Ω
Feedback capacitance	$c_{b'c}$ =	40 pF	< 80 pF
Cut-off frequency	$f_{\alpha b}$ =	1 Mc/s	
Current amplification factor at f = 1 kc/s	h_{fe} =	15	> 10

[1]) The value of r_e is given here as $r_e = \frac{kT}{q} \cdot \frac{1}{I_E} \approx \frac{25}{I_E}$ (I_E in mA)



SILICON SUBMINIATURE P-N-P AF TRANSISTOR

Silicon alloy junction transistors of the p-n-p type in subminiature metal envelope for AF applications

LIMITING VALUES (Absolute maximum values)

Collector			
Voltage (emitter reference)	$-V_{CE}$	= max.	20 V [1]
Voltage (base reference)	$-V_{CB}$	= max.	20 V
Current	$-I_C$	= max.	10 mA
Dissipation at $T_{amb} < 50\ ^oC$	P_C	= max.	85 mW
Emitter			
Voltage (base reference)	$-V_{EB}$	= max.	20 V
Current	I_E	= max.	10 mA
Base			
Current	$-I_B$	= max.	2 mA
Temperatures			
Junction temperature	T_j	= max.	150 °C
Storage temperature	T_s	= max.	125 °C

THERMAL DATA

Thermal resistance from junction to ambience in free air	K	= max.	1.2 °C/mW

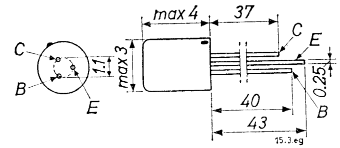
[1]) Permissible when $R_{BE} \leq 100\ k\Omega$

7Z2 2338

MECHANICAL DATA

Dimensions in mm

The red dot indicates the collector



CHARACTERISTICS at $T_{amb} = 25\ ^oC$

Collector to base leakage current			
$-V_{CB} = 12$ V; $I_E = 0$ mA	$-I_{CBO}$		< 0.01 μA
Emitter to base leakage current			
$-V_{EB} = 12$ V; $I_C = 0$ mA	$-I_{EBO}$		< 0.01 μA
Base current			
$-V_{CB} = 2$ V; $I_E = 10$ mA	$-I_B$	= 340 μA	< 770 μA

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN at $T_{amb} = 25\ ^oC$, unless otherwise specified

Collector to base leakage current			
$-V_{CB} = 12$ V; $I_E = 0$ mA; $T_j = 100\ ^oC$	$-I_{CBO}$		< 0.5 μA
Emitter to base leakage current			
$-V_{EB} = 12$ V; $I_C = 0$ mA; $T_j = 100\ ^oC$	$-I_{EBO}$		< 0.5 μA
Collector saturation voltage			
$-I_C = 10$ mA; $-I_B = 1.1$ mA	$-V_{CE}$		< 0.25 V
Base voltage			
$-V_{CB} = 2$ V; $I_E = 0.1$ mA	$-V_{BE}$	= 520 mV	< 610 mV
$-V_{CB} = 2$ V; $I_E = 10$ mA	$-V_{BE}$	= 710 mV	< 850 mV

7Z2 2339

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN at T_{amb} = 25 °C (continued)

Current amplification factor

$-V_{CB}$ = 2 V, I_E = 1 mA	BCZ13	h_{fe} = 25	> 15	< 40
	BCZ14	h_{fe} = 55	> 30	< 90

Collector capacitance

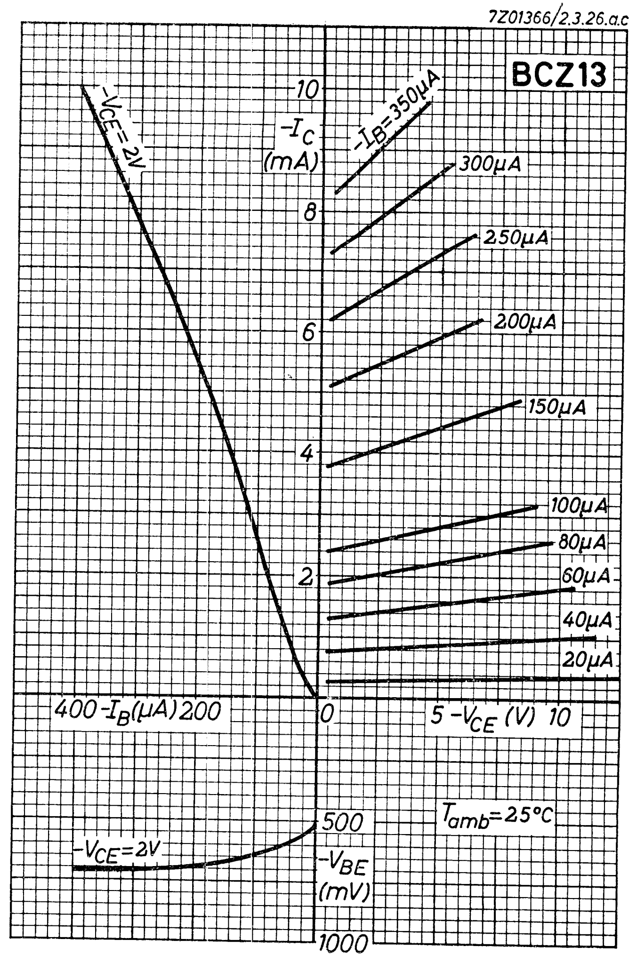
$-V_{CB}$ = 6 V; I_E = 0 mA	c_c = 25 pF	< 40 pF

Frequency at which $|h_{fe}|$ = 1

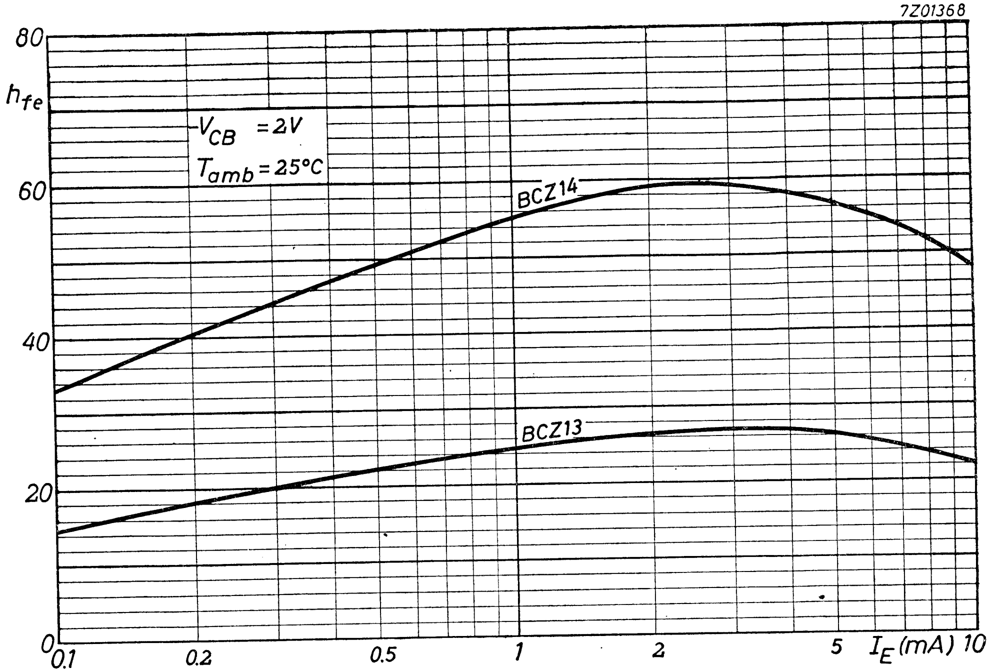
$-V_{CB}$ = 6 V; I_E = 1 mA	f_1 = 1.5 Mc/s	> 0.5 Mc/s

Noise figure

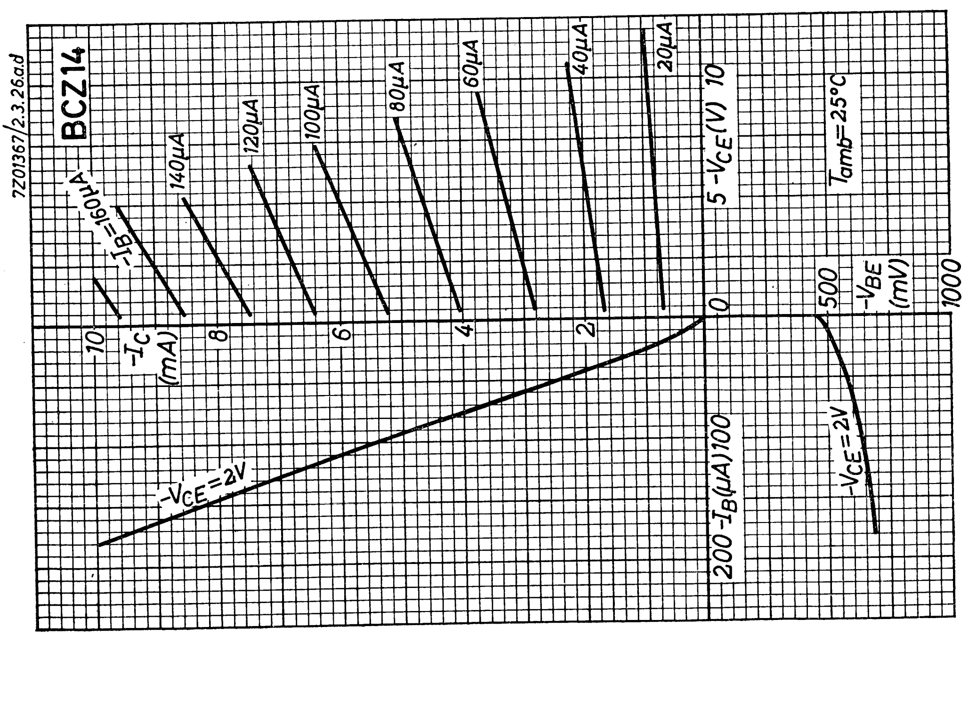
$-V_{CB}$ = 2 V; I_E = 0.5 mA; f = 1 kc/s; input source resistance = 500 Ω	F = 5 dB	< 10 dB



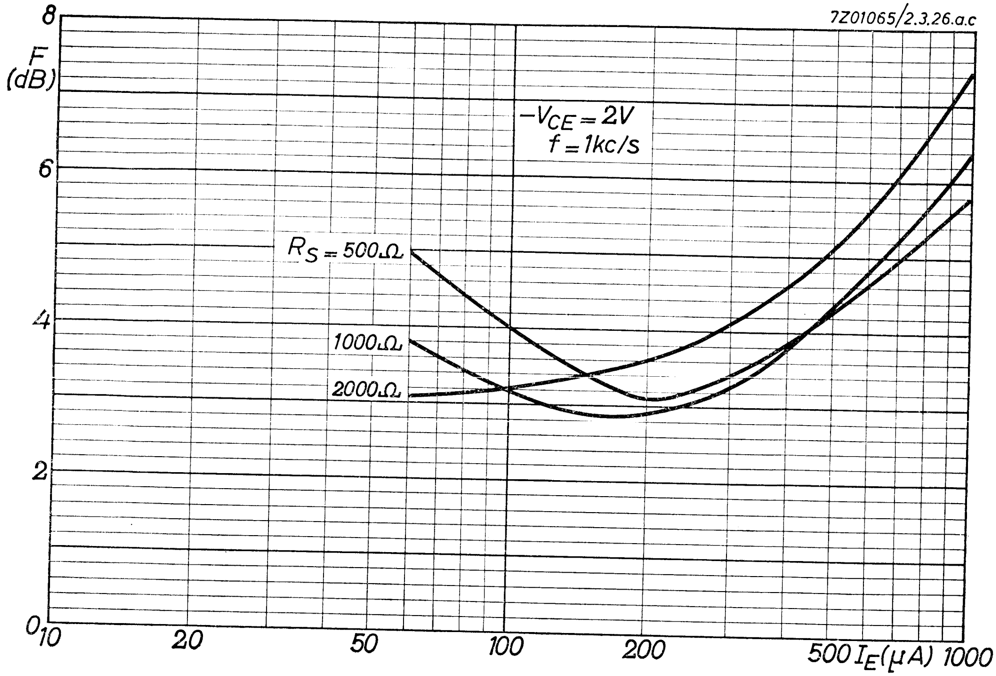
7Z2 2340


7Z01368
80
h_{fe}
$-V_{CB}$ = 2V
T_{amb} = 25°C
60
BCZ14
40
BCZ13
20
0
0.1
0.2
0.5
1
2
5
I_E(mA) 10

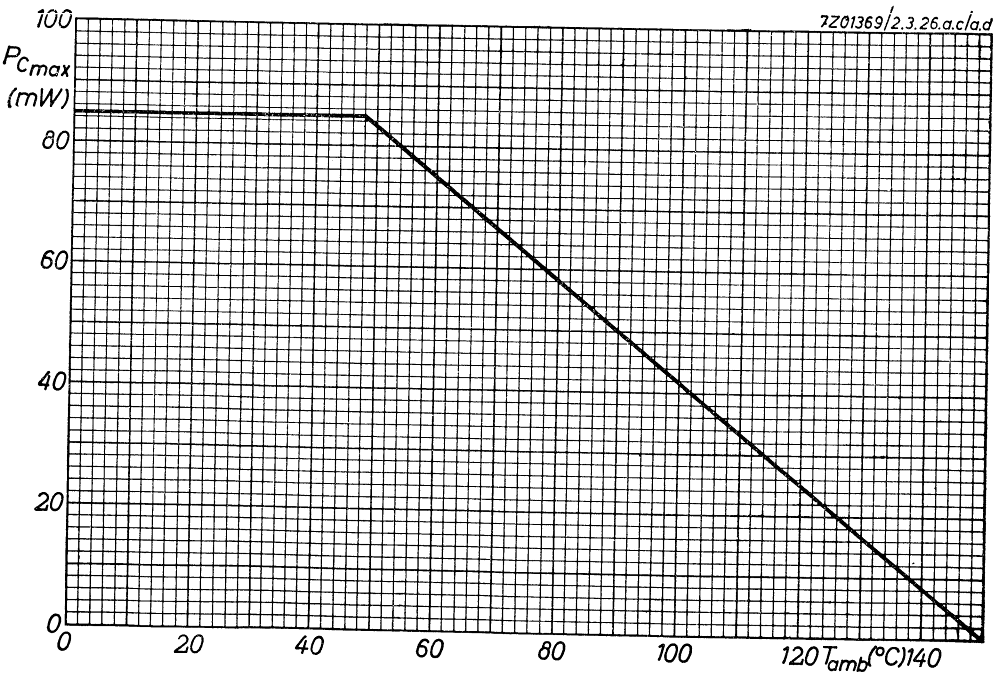
C


7Z01367/2.3.26.a.d
BCZ14
$-I_B$=160μA
140μA
120μA
100μA
80μA
60μA
40μA
20μA
5 $-V_{CE}$(V) 10
T_{amb}=25°C
10
$-I_C$ (mA)
8
6
4
2
0
500
$-V_{BE}$ (mV)
1000
$-V_{CE}$=2V
200 $-I_B$(μA) 100
$-V_{CE}$=2V

B


7Z01065/2.3.26.a.c
F
(dB)
$-V_{CE} = 2V$
$f = 1kc/s$
$R_S = 500\Omega$
1000Ω
2000Ω
8
6
4
2
0
10
20
50
100
200
500 $I_E (\mu A)$ 1000

D

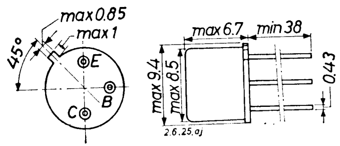

7Z01369/2.3.26.a.c/a.d
$P_{C_{max}}$
(mW)
100
80
60
40
20
0
0
20
40
60
80
100
120 T_{amb} (°C) 140

E

N-P-N SILICON MESA H.F. TRANSISTORS

Silicon mesa H.F. transistors of the n-p-n type in TO-5 metal case for amplifying applications.

Dimensions in mm
Leads insulated from case



LIMITING VALUES (absolute max. limits)

Collector

Voltage (base reference)	V_{CB}	= max. 45 V
Voltage (emitter ref.; $-V_{BE}$ = 1 V)	V_{CE}	= max. 45 V
Average [1]) and continuous current	I_C	= max. 50 mA
Peak current	I_{CM}	= max. 75 mA

Emitter

Voltage (base reference)	V_{EB}	= max. 5 V

Base

Average [1]) and continuous current	I_B	= max. 5 mA
Peak current	I_{BM}	= max. 7.5 mA

Dissipation

Total dissipation	P_{tot}	= max. 300 mW

Temperatures

Junction temperature	T_j	= max. 175 °C
Storage temperature	T_s	= max. 175 °C
	T_s	= min. -55 °C

[1]) Averaging time max. 20 msec

7Z2 2341

THERMAL DATA

Thermal resistance from junction to ambience in free air	$K_{j\text{-}amb}$	< 0.5 °C/mW
to case	$K_{j\text{-}m}$	< 0.35 °C/mW

CHARACTERISTICS at T_{amb} = 25 °C

		BFY10	BFY11	
Collector leakage current at V_{CB} = 20 V; I_E = 0 mA	I_{CBO}	< 2		μA
Emitter leakage current at V_{EB} = 5 V; I_C = 0 mA	I_{EBO}	< 50		μA
Base current at V_{CB} = 5 V; $-I_E$ = 10 mA	I_B	> 200 < 400	> 80 μA < 250 μA	

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN
T_{amb} = 25 °C, unless otherwise specified

		BFY10	BFY11	
Collector leakage current at V_{CB} = 20 V; I_E = 0 mA; T_{amb} = 125 °C	I_{CBO}	< 15		μA
Collector voltage at I_C = 100 μA; I_B = 0 mA	V_{CEO}	> 25		V
I_C = 50 μA; V_{BE} = -1 V	V_{CE}	> 45		V
I_C = 50 μA; I_E = 0 mA	V_{CBO}	> 45		V
Collector saturation voltage at I_C = 10 mA; I_B = 1 mA	V_{CE}	< 1.5		V
Base emitter voltage at V_{CB} = 5 V; $-I_E$ = 10 mA	V_{BE}	< 1.5		V
Small signal current amplification factor at V_{CB} = 5 V; $-I_E$ = 5 mA; f = 1 kc/s	h_{fe}	> 20	> 35	

7Z2 2342

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN

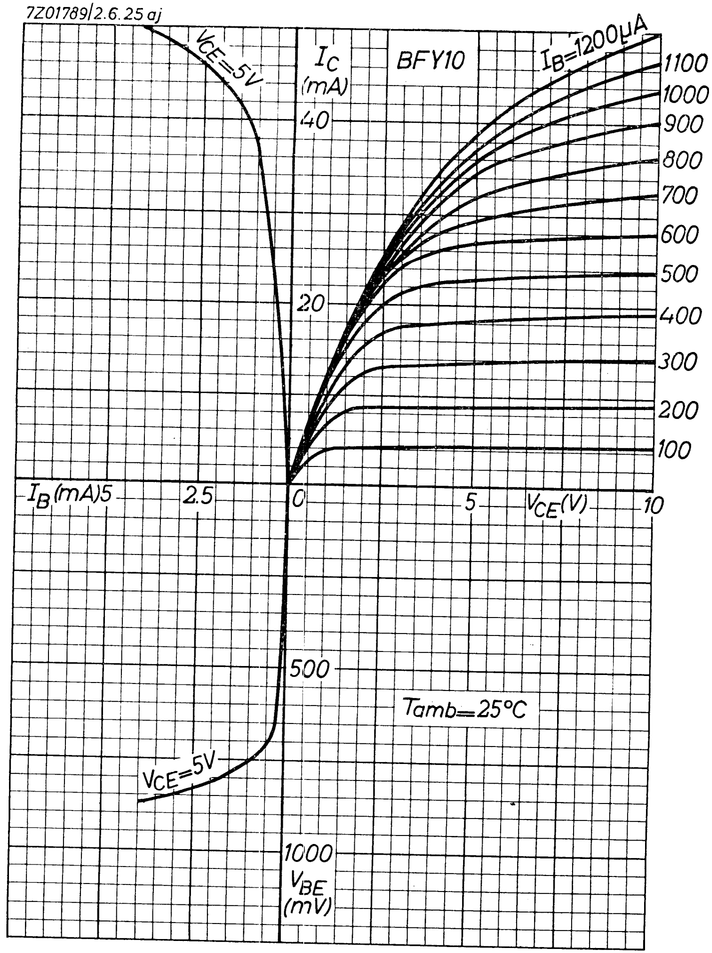
(continued) T_{amb} = 25 °C

Frequency at which $\lvert h_{fe}\rvert = 1$ at V_{CB} = 10 V; $-I_E$ = 5 mA	f_1	> 60 = 120	Mc/s Mc/s
Noise figure at V_{CB} = 10 V; $-I_E$ = 5 mA; f = 0.45 Mc/s	F	= 20 < 40	dB dB
Output capacitance at V_{CB} = 10 V; I_E = 0 mA	c_c	< 3	pF

Small-signal parameters of BFY10 and BFY11 at

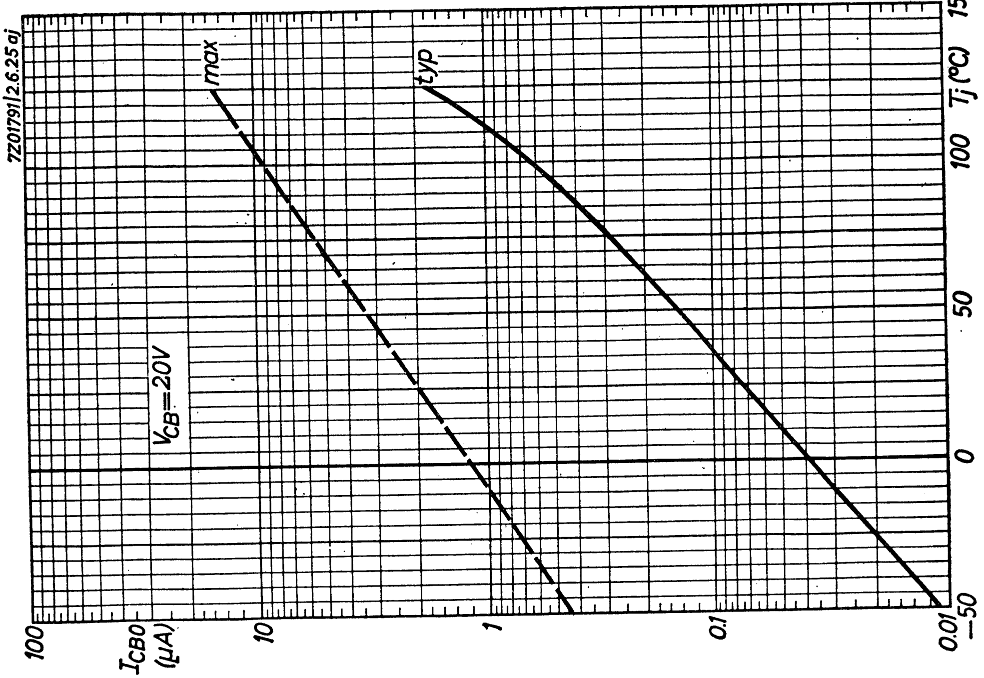
V_{CB} = 10 V; $-I_E$ = 5 mA; f = 35 Mc/s

	Common emitter	Common base
Input conductance	g_{ie} = 5 mA/V	g_{ib} = 17 mA/V
Input capacitance	c_{ie} = 16 pF	c_{ib} = 85 pF
Feedback admittance	$\lvert y_{re}\rvert$ = 0.3 mA/V	$\lvert y_{rb}\rvert$ = 0.8 mA/V
Phase angle of feedback admittance	φ_{re} = 265 °	φ_{rb} = 210 °
Transfer admittance	$\lvert y_{fe}\rvert$ = 22 mA/V	$\lvert y_{fb}\rvert$ = 22 mA/V
Phase angle of transfer admittance	φ_{fe} = 282 °	φ_{fb} = 122 °
Output conductance	g_{oe} = 1 mA/V	g_{ob} = 1 mA/V
Output capacitance	c_{oe} = 3.6 pF	c_{ob} = 3.6 pF

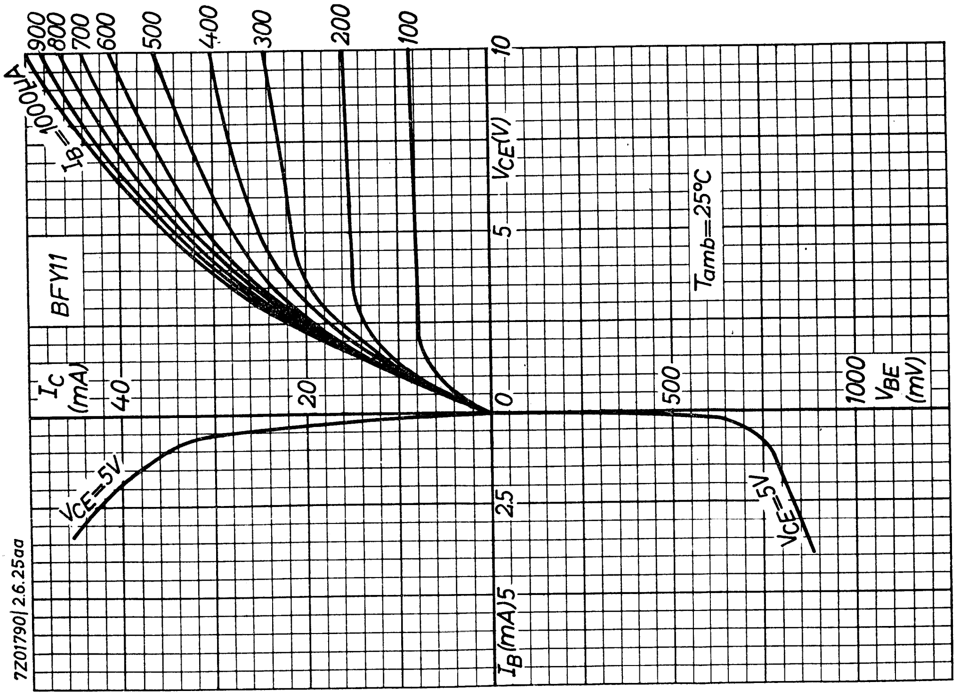


7Z2 2343

A


7Z01791|2.6.25 aj
max
typ
V_{CB}=20V
I_{CBO} (μA)
100
10
1
0.1
0.01
−50
0
50
100
150
T_j (°C)

C


7Z01790|2.6.25aa
BFY11
I_C (mA)
40
20
0
I_B=1000μA
900
800
700
600
500
400
300
200
100
V_{CE}=5V
V_{CE}(V)
5
10
T_{amb}=25°C
2.5
I_B(mA)5
500
1000
V_{BE} (mV)
V_{CE}=5V

B

SILICON N-P-N PLANAR EPITAXIAL TRANSISTORS

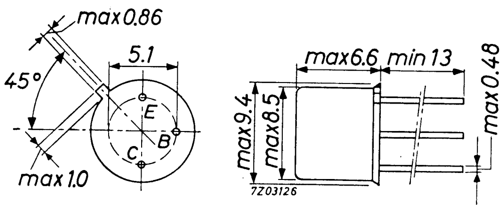
Silicon planar epitaxial transistors of the n-p-n type in TO-39 metal case with the collector connected to the case, especially intended for use in v.h.f. medium power amplifiers or as output stage in small transmitters or as driver for transmitting tubes.

QUICK REFERENCE DATA

			BFY44	BFY70	
Collector to base voltage	V_{CBO}	=	max. 80	60	V
Collector to emitter voltage	V_{CEO}	=	max. 60	40	V
Emitter to base voltage	V_{EBO}	=	max. 4	4	V
Collector current	I_C	=	max. 1	1	A
Power dissipation up to T_c = 25 °C	P_{tot}	=	max. 5	5	W
Collector to emitter saturation voltage at I_B = 100 mA; I_C = 500 mA	V_{CEsat}	=	0.4	0.4	V
Transition frequency V_{CB} = 10 V; $-I_E$ = 100 mA	f_T	=	210	210	Mc/s
Amplifier output at f = 180 Mc/s					
Output power at V_{CE} = 40 V	P_o	=	2.1		W
Output power at V_{CE} = 28 V	P_o	=		1.5	W
Power gain	G_p	=	7	7	dB
Efficiency	η	=	50	50	%

MECHANICAL DATA

Dimensions in mm



TO-39 metal case
Collector connected to case

7Z2 2874

 TENTATIVE DATA 3.3.1965

LIMITING VALUES (Absolute max. values)

			BFY44	BFY70	
Voltages					
Collector to base voltage (open emitter)	V_{CBO}	=	max. 80	60	V
Collector to emitter voltage (open base)	V_{CEO}	=	max. 60	40	V
Emitter to base voltage (open collector)	V_{EBO}	=	max. 4	4	V

Currents				
Collector current (d.c.)	I_C	=	max. 1.0	A
Collector current (peak value)	I_{CM}	=	max. 1.0	A
Emitter current (d.c.)	$-I_E$	=	max. 1.2	A
Emitter current (peak value)	$-I_{EM}$	=	max. 1.2	A
Base current (d.c.)	I_B	=	max. 0.2	A
Base current (peak value)	I_{BM}	=	max. 0.2	A
Power dissipation				
Total power dissipation up to T_C = 25 °C	P_{tot}	=	max. 5	W [1]
Temperatures				
Storage temperature	T_s	=	−65°C to +200	°C
Junction temperature	T_j	=	max. 200	°C

THERMAL DATA

Thermal resistance from junction to case	K	<	35	°C/W

[1]) See also page D lower figure.

7Z2 2875

CHARACTERISTICS $T_j = 25\ ^oC$ unless otherwise specified

		BFY44	BFY70
Collector current at $I_E = 0$			
$V_{CB} = 40$ V	I_{CBO}	= 3 nA < 500 nA	
$V_{CB} = 28$ V	I_{CBO}		= 3 nA < 500 nA
Collector to emitter breakdown voltage			
$V_{BE} = 0$; $I_C = 0.5$ mA	$V_{(BR)CES}$	> 80 V	> 60 V
$R_{BE} = 10\ \Omega$; $I_C = 1$ mA	$V_{(BR)CER}$	> 80 V	> 60 V
$I_B = 0$; $I_C = 10$ mA	$V_{(BR)CEO}$	> 60 V	> 40 V
Emitter to base breakdown voltage			
$I_C = 0$; $I_E = 0.1$ mA	$V_{(BR)EBO}$	= 6 V	> 4 V
D.C. current amplification factor			
$V_{CB} = 5$ V; $-I_E = 500$ mA	h_{FE}	= 20	> 5
Collector to emitter saturation voltage			
$I_B = 100$ mA; $I_C = 500$ mA	V_{CEsat}	= 0.4 V	< 0.7 V
Emitter to base saturation voltage			
$I_B = 100$ mA; $I_C = 500$ mA	V_{BEsat}	= 1 V	< 1.5 V
Output power in common base configuration at f = 180 Mc/s			
BFY44: $V_{CE} = 40$ V; $I_C = 107$ mA;			
$P_i = 0.425$ W	P_o	= 2.1 W	> 1.7 W
Power gain	G_p	= 7 dB	> 6 dB
Efficiency	η	= 50 %	> 40 %
BFY70: $V_{CE} = 28$ V; $I_C = 107$ mA;			
$P_i = 0.3$ W	P_o	= 1.5 W	> 1.2 W
Power gain	G_p	= 7 dB	> 6 dB
Efficiency	η	= 50 %	> 40 %

7Z2 2876

CHARACTERISTIC RANGE VALUES FOR EQUIPMENT DESIGN

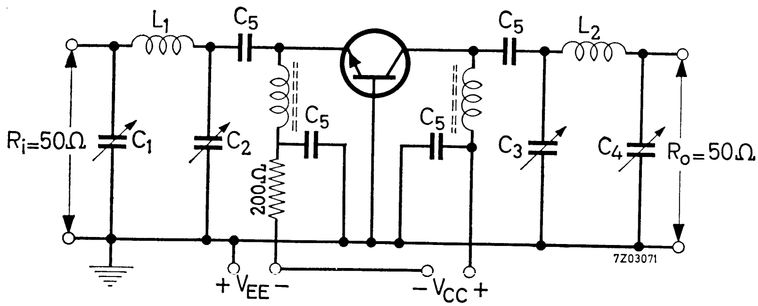
T_j = 25 °C unless otherwise specified

Collector current at $I_E = 0$						
BFY44: $V_{CB} = 40$ V; BFY70: $V_{CB} = 28$ V; $T_{amb} = 150$ °C	I_{CBO}	=	1.5	<	50	µA
Emitter current at $I_C = 0$						
$V_{EB} = 1$ V	I_{EBO}	=	1	<	500	nA
D.C. current amplification factor						
$V_{CB} = 10$ V; $-I_E = 150$ mA	h_{FE}	=	20			
Common base output capacitance at f = 1 Mc/s						
BFY44: $V_{CB} = 40$ V; $I_E = 0$	c_c	=	7	<	12	pF
BFY70: $V_{CB} = 28$ V; $I_E = 0$	c_c	=	7	<	14	pF
Feedback time constant at f = 10.7 Mc/s						
$V_{CB} = 20$ V; $-I_E = 30$ mA	$\left\|\frac{h_{rb}}{\omega}\right\|$	=	18	<	35	ps
Transition frequency						
$V_{CB} = 10$ V; $-I_E = 100$ mA	f_T	=			210	Mc/s
y-parameters in common base configuration						
$V_{CB} = 24$ V; $-I_E = 150$ mA; f = 180 Mc/s						
$y_{ib} = g_{ib} + j\omega c_{ib}$	g_{ib}	=	48			mA/V
	$-c_{ib}$	=	120			pF
$y_{ob} = g_{ob} + j\omega c_{ob}$	g_{ob}	=	4.3			mA/V
	$-c_{ob}$	=	13.5			pF
$y_{fb} = y_{fb} \cdot e^{j\varphi_{fb}}$	$\|y_{fb}\|$	=	98			mA/V
	φ_{fb}	=	62			o
y-parameters in common emitter configuration						
$V_{CB} = 24$ V; $-I_E = 150$ mA; f = 180 Mc/s						
$y_{ie} = g_{ie} + j\omega c_{ie}$	g_{ie}	=	96			mA/V
	$-c_{ie}$	=	32			pF

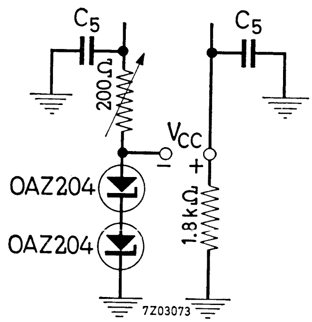
7Z2 2877

APPLICATION INFORMATION

A. Typical amplifier circuit



Alternative method of biasing



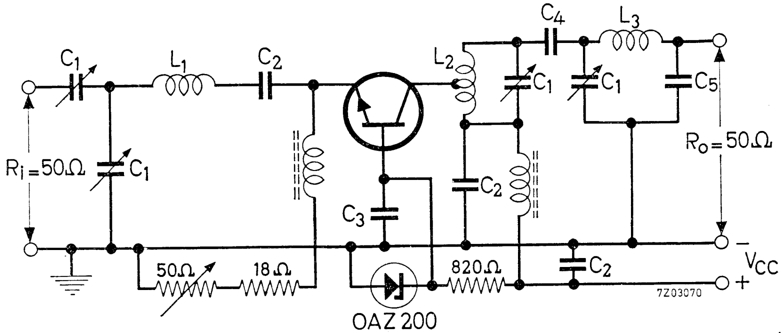
Components	f = 100 Mc/s	f = 180 Mc/s
C_1, C_2, C_4	25 pF variable air capacitor + 22 pF mica	25 pF variable air capacitor
C_3	25 pF variable air capacitor	25 pF variable air capacitor
C_5	3.3 nF	1 nF
L_1	2 turns Cu wire 1 mm d = 12 mm	1 turn Cu wire 1.2 mm d = 12 mm
L_2	3.5 turns Cu wire 1 mm d = 12 mm	2 turns Cu wire 1.2 mm d = 12 mm

7Z2 2878

3.3.1965

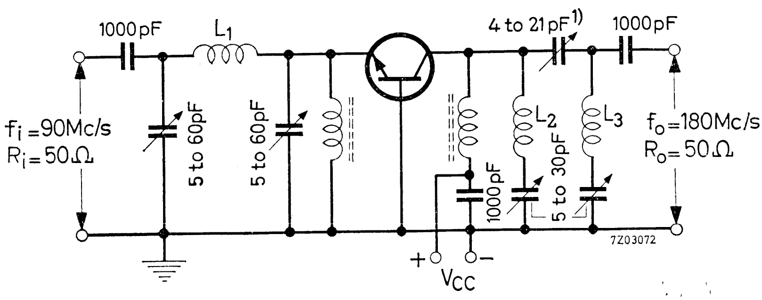
APPLICATION INFORMATION (continued)

B. Typical amplifier circuit



Components	f = 80 Mc/s	f = 165 Mc/s
C_1	60 pF	25 pF
C_2	680 pF	100 pF
C_3	680 pF	82 pF
C_4	4.7 pF	2.2 pF
C_5	82 pF	33 pF
L_1	2 turns Cu wire 1 mm d = 10 mm	straight Cu wire 1 mm length 40 mm
L_2	3 turns enamelled Cu wire 1.5 mm; d = 12 mm	2 turns Cu wire 1 mm d = 10 mm
Tap	1.2 turn from cold side	0.8 turn from cold side
L_3	3 turns enamelled Cu wire 1.5 mm; d = 12 mm	2 turns Cu wire 1 mm d = 10 mm

C. Frequency doubler 90-180 Mc/s



1) Variable ceramic capacitor

7Z2 2879

APPLICATION INFORMATION (continued)

C. Frequency doubler 90-180 Mc/s (continued)

L_1 ≈ 70 nH; 1.5 turns
L_2 ≈ 90 nH; 2 turns
L_3 ≈ 140 nH; 3 turns

} Cu wire 1.2 mm; d = 12 mm

Typical performance

V_{CE} (V)	I_C (mA)	P_i = (mW) f_i = 90 Mc/s	P_o (mW) f_o = 180 Mc/s	G_p (dB)	η (%)
40[1])	110	130	920	8.5	21
30	94	110	700	8.0	25
20	82	110	460	6.2	28

[1]) V_{CE} = 40 V is for BFY44 only.

FOR MORE INFORMATION SEE APPLICATION INFORMATION BULLETIN AI518

OPERATING NOTE

Although second breakdown is always possible in transistors, it generally occurs beyond the limiting values due to appropriate design. Resistivity, basewidth and geometry are chosen such that this destructive phenomenon is not met with under normal conditions.

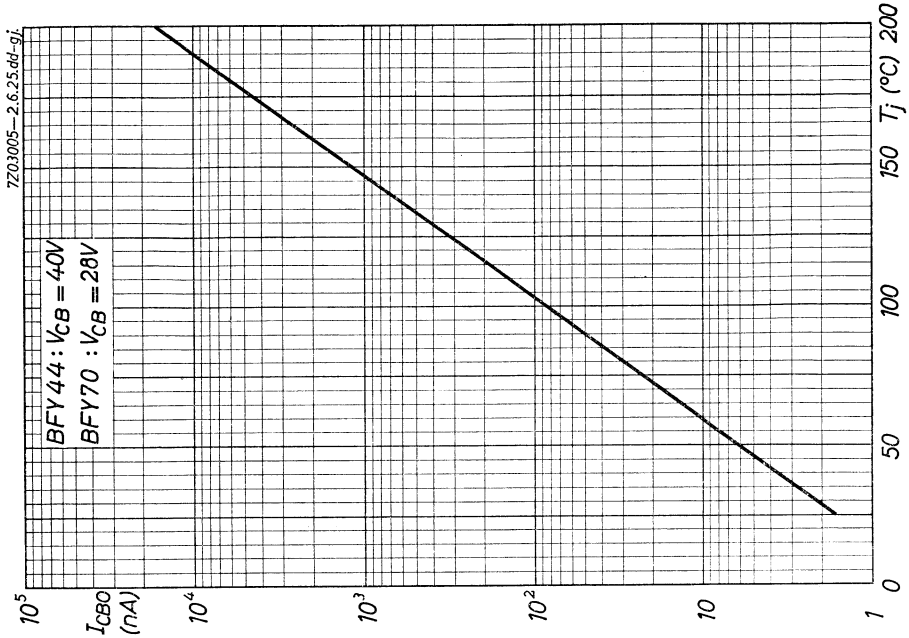
Unfortunately, for good high frequency performance contradictory conditions may be required and then a compromise has to be accepted, leading to a device in which second breakdown does occur within "normal" conditions, especially for d.c. and low frequency operation.

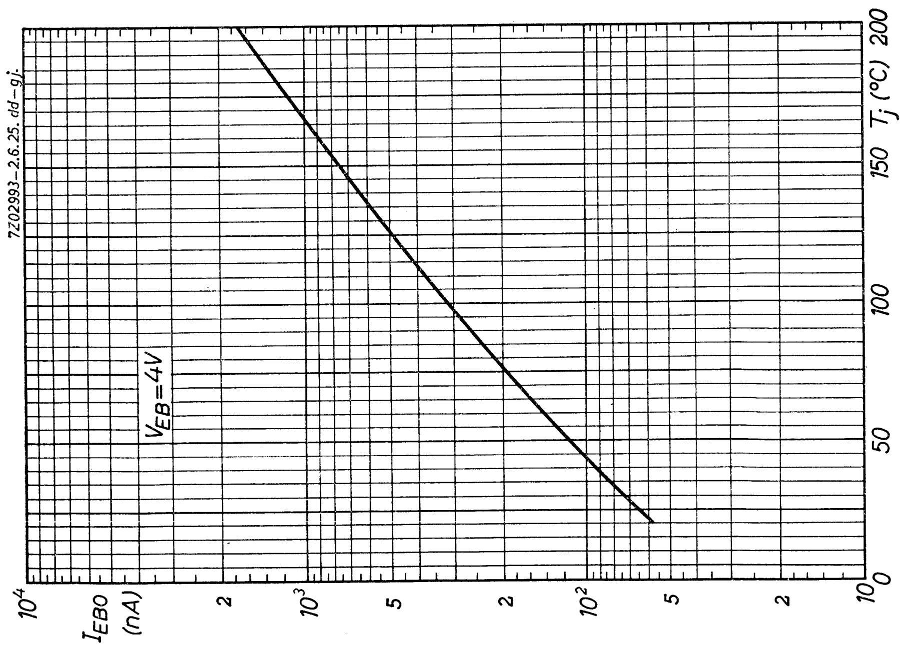
At frequencies higher than 1 Mc/s, second breakdown will not occur, but at lower frequencies certain restrictions have to be taken into account in order not to damage the device. These special limits for lower frequencies are shown in the "area of permissible operation" (second breakdown loci).

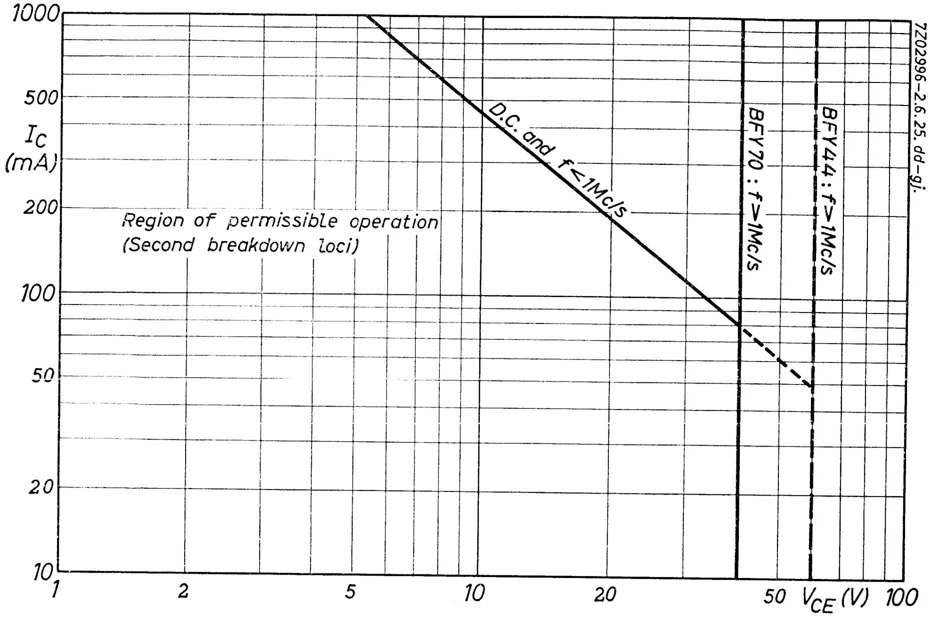
Example

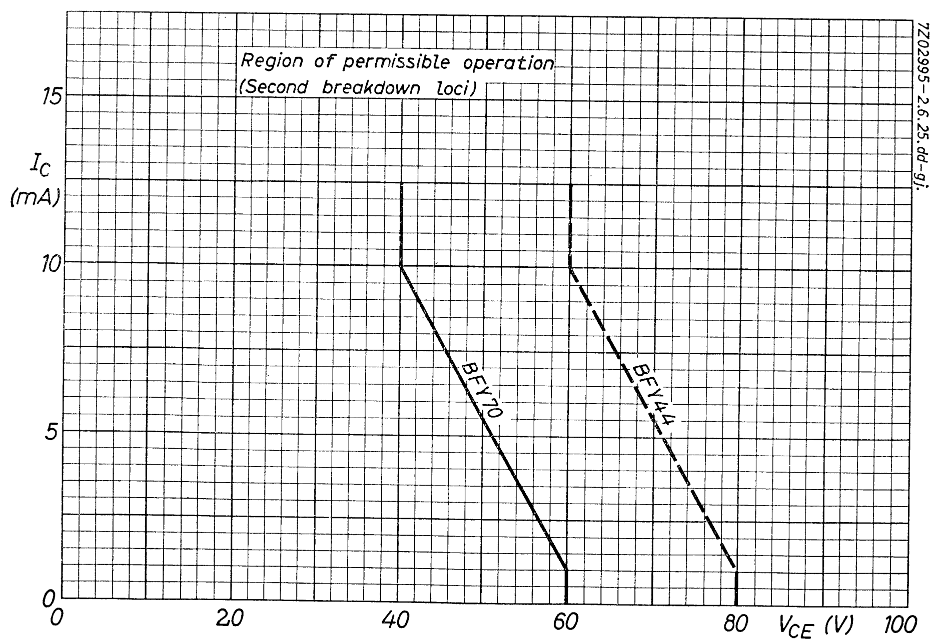
At 100 Mc/s, in class A operation with strong signals one may apply V_{CE} = 28 V and I_C = 300 mA.
However, the signal should not be withdrawn without first decreasing the current to a value lower than 120 mA.
(That may be achieved by appropriate biasing in class A, B or C).

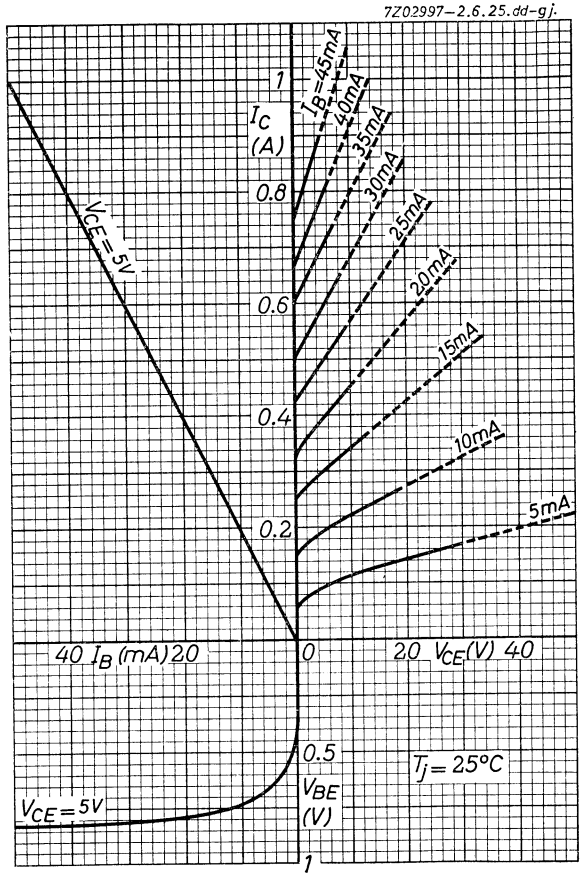
7Z2 2880

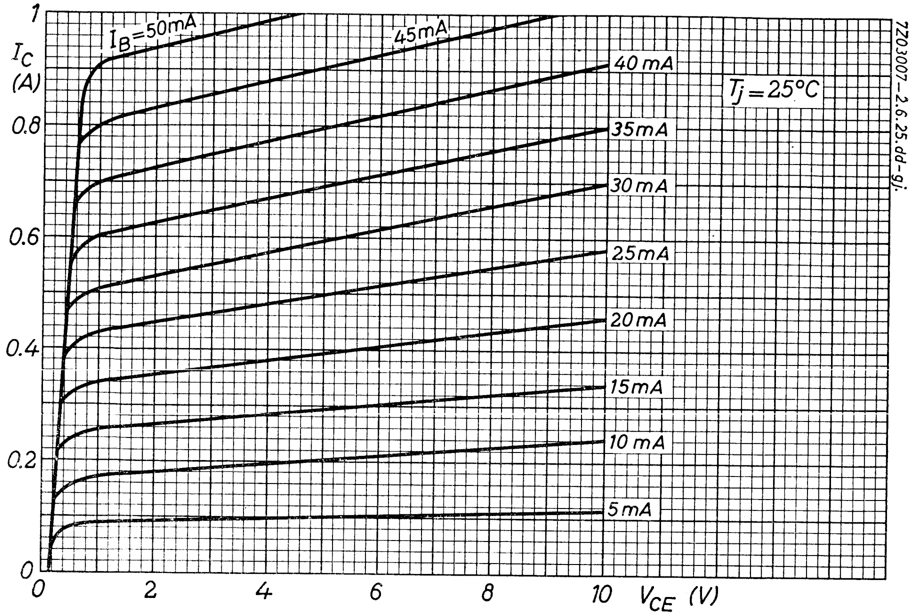

7Z03005—2.6.25.dd-gj.
BFY44 : V_{CB} = 40V
BFY70 : V_{CB} = 28V
I_{CBO} (nA)
10^5
10^4
10^3
10^2
10
1
0
50
100
150
200
T_j (°C)

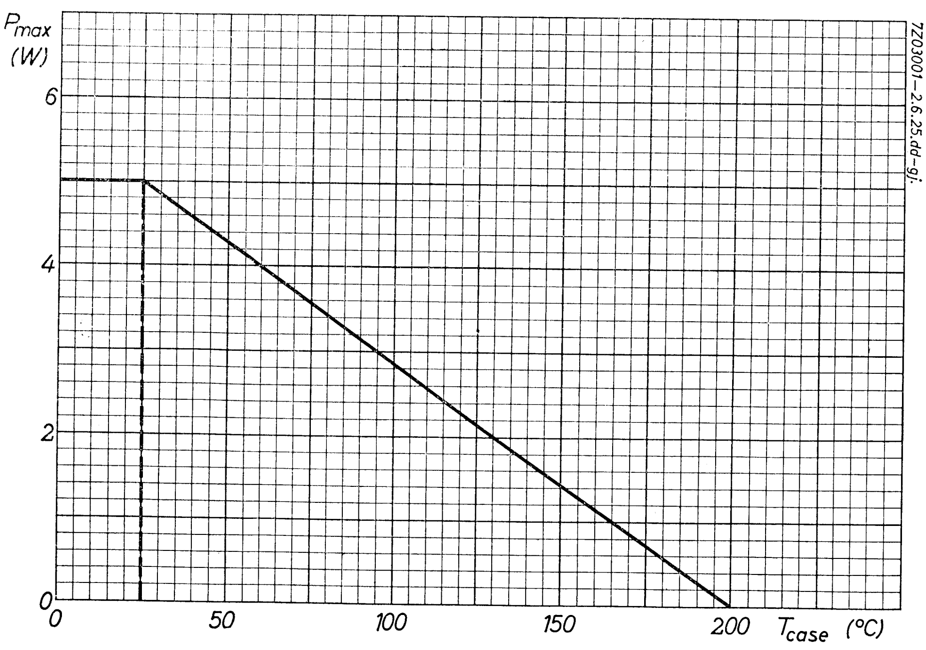

7Z02993-2.6.25. dd-gj.
V_{EB}=4V
I_{EBO} (nA)
10^4
2
10^3
5
2
10^2
5
2
10
0
50
100
150
200
T_j (°C)

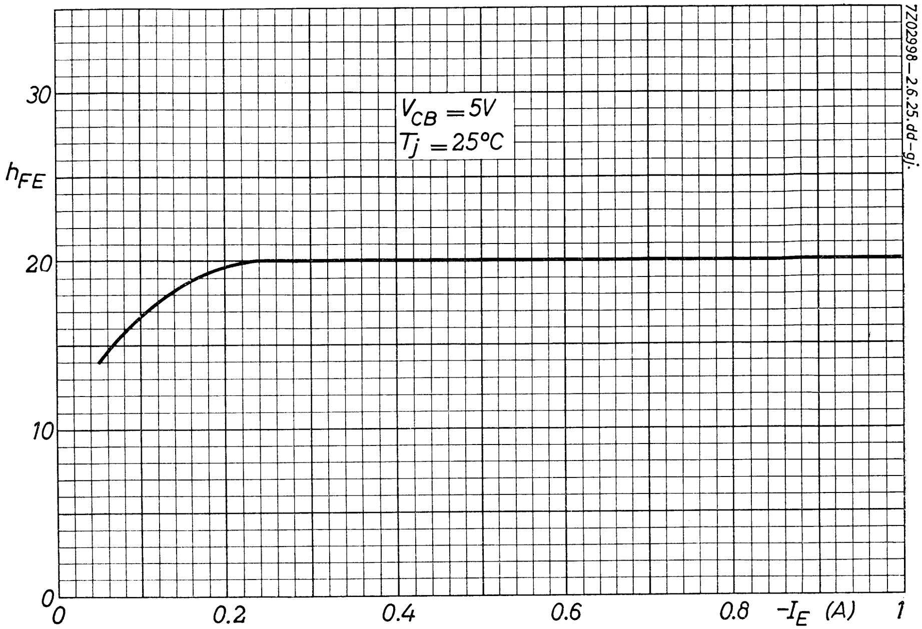

1000
500
I_C
(mA)
200
100
50
20
10
1
2
5
10
20
50
V_{CE} (V)
100
D.C. and f<1Mc/s
BFY70 : f>1Mc/s
BFY44 : f>1Mc/s
Region of permissible operation
(Second breakdown loci)
7Z02996-2.6.25.dd-gj.

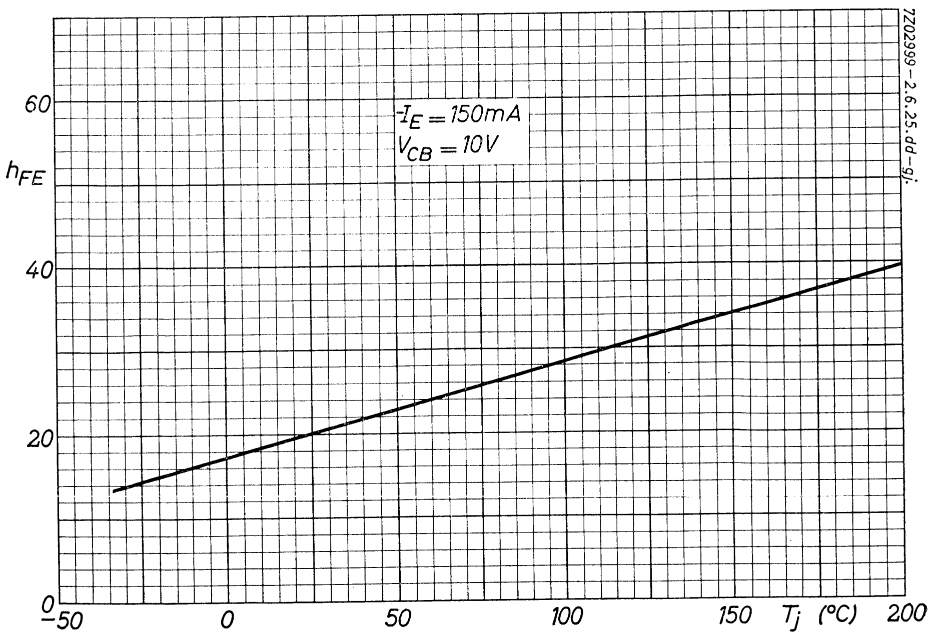

15
I_C
(mA)
10
5
0
0
20
40
60
80
V_{CE} (V)
100
Region of permissible operation
(Second breakdown loci)
BFY70
BFY44
7Z02995-2.6.25.dd-gj.

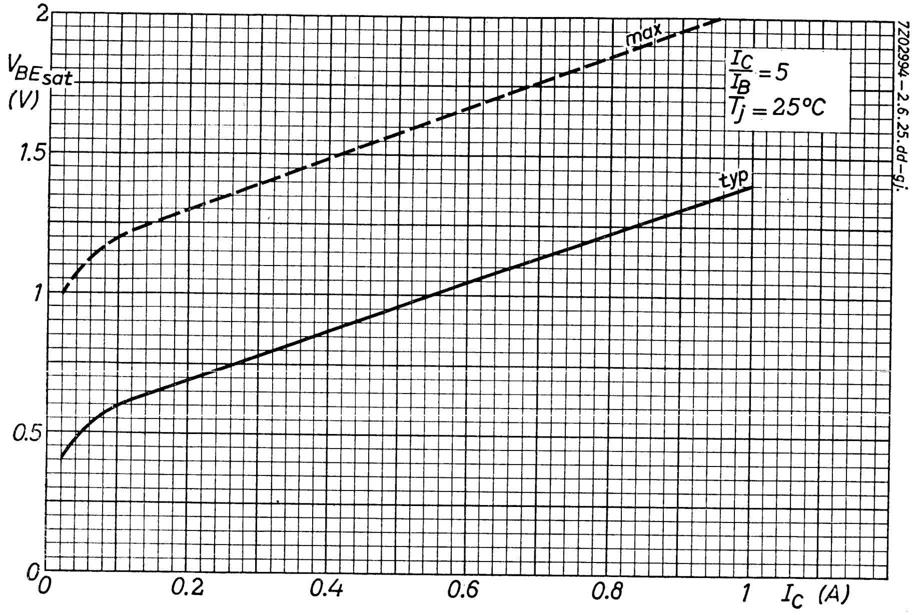

7Z02997–2.6.25.dd-gj.
1
I_C
(A)
0.8
0.6
0.4
0.2
I_B=45mA
40mA
35mA
30mA
25mA
20mA
15mA
10mA
5mA
V_{CE} = 5V
40 I_B (mA) 20
0
20 V_{CE}(V) 40
0.5
V_{BE}
(V)
1
T_j = 25°C
V_{CE} = 5V

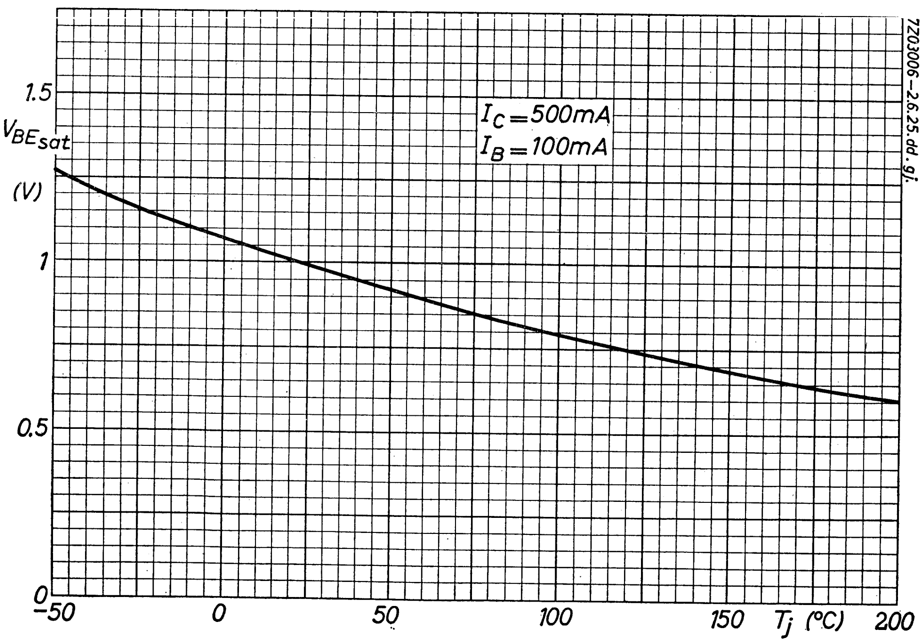

I_C
(A)
1
0.8
0.6
0.4
0.2
0
I_B=50mA
45mA
40 mA
35mA
30 mA
25mA
20mA
15mA
10 mA
5mA
T_j = 25°C
7Z03007–2.6.25.dd–gj.
0
2
4
6
8
10
V_{CE} (V)

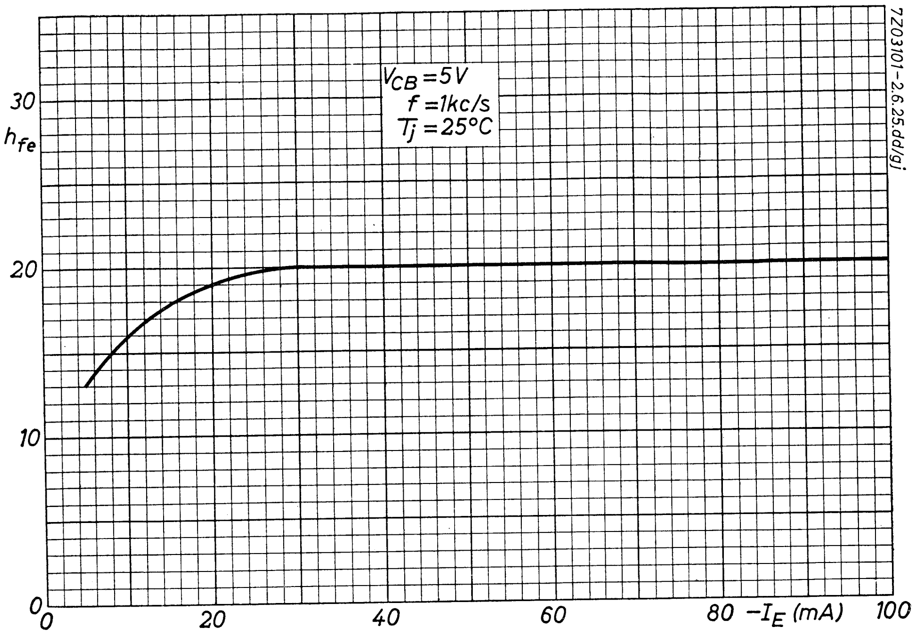

P_{max}
(W)
6
4
2
0
7Z03001–2.6.25.dd–gj.
0
50
100
150
200
T_{case} (°C)

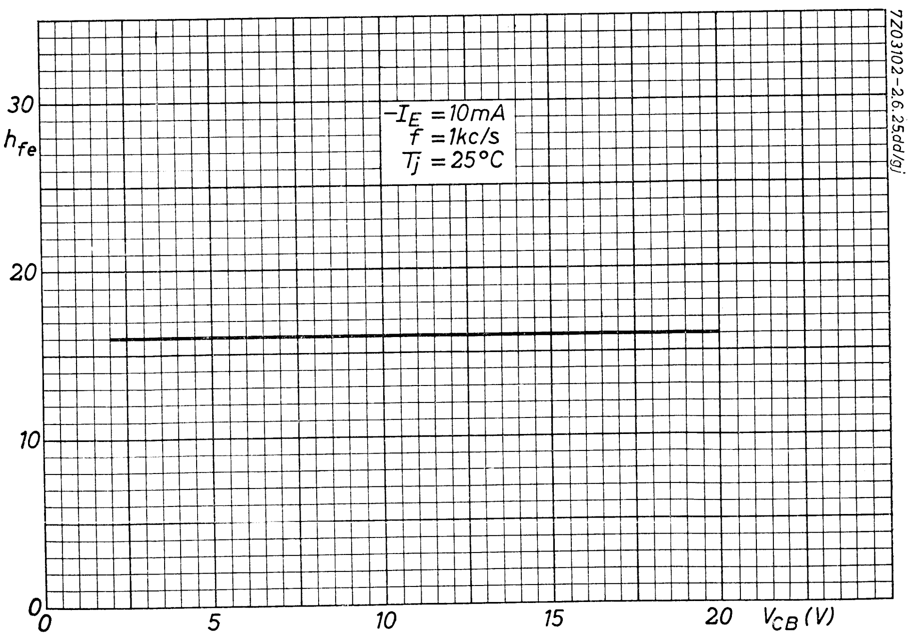

7Z02998—2.6.25.dd-gj.
$V_{CB} = 5V$
$T_j = 25°C$
h_{FE}
30
20
10
0
0
0.2
0.4
0.6
0.8
$-I_E$ (A)
1

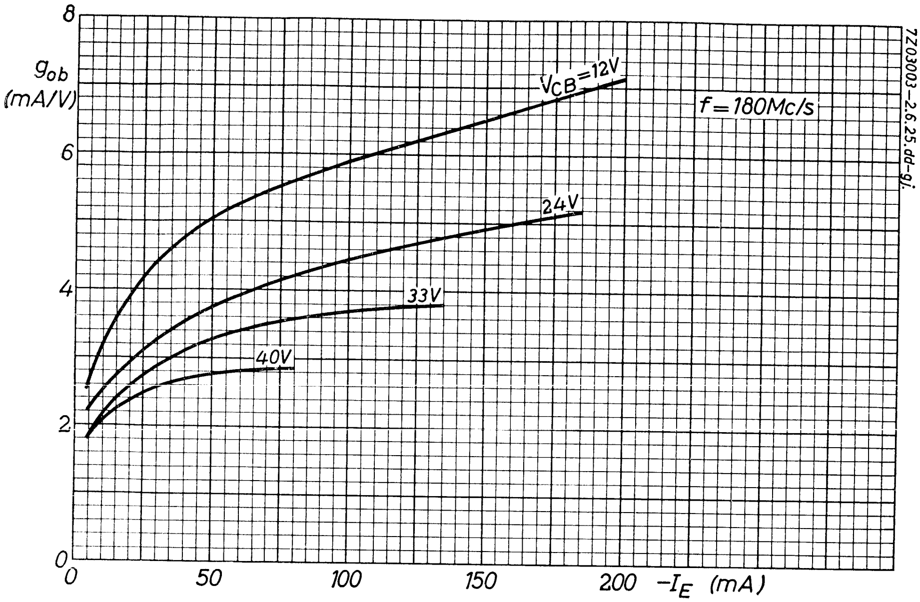

7Z02999—2.6.25.dd-gj.
$-I_E = 150mA$
$V_{CB} = 10V$
h_{FE}
60
40
20
0
−50
0
50
100
150
T_j (°C)
200

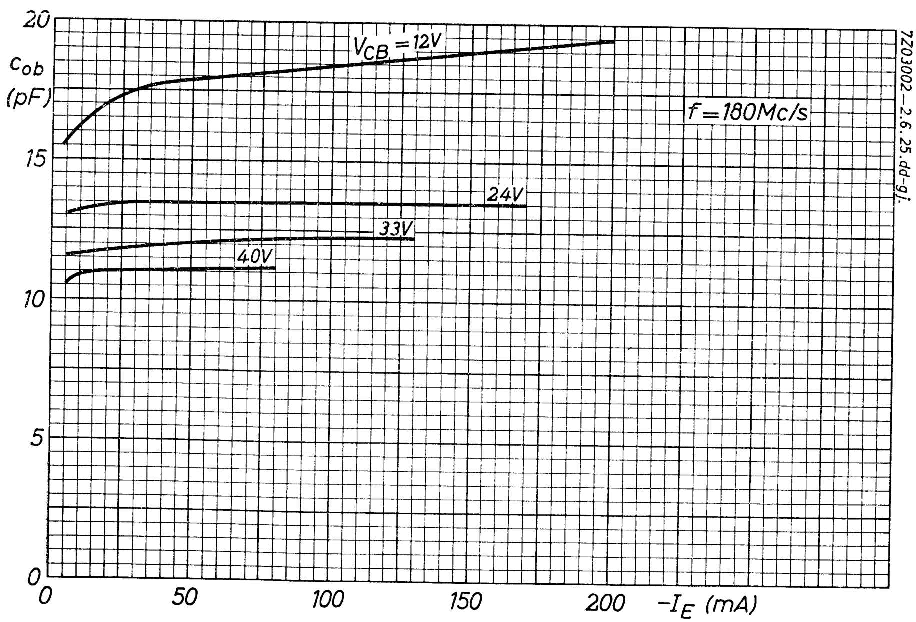

2
$V_{BE_{sat}}$
(V)
1.5
1
0.5
0
0
0.2
0.4
0.6
0.8
1
I_C (A)
max
typ
$\frac{I_C}{I_B}=5$
$T_j=25°C$
7Z02994–2.6.25.dd–gj.


1.5
$V_{BE_{sat}}$
(V)
1
0.5
0
−50
0
50
100
150
T_j (°C)
200
$I_C=500mA$
$I_B=100mA$
7Z03006–2.6.25.dd.gj.

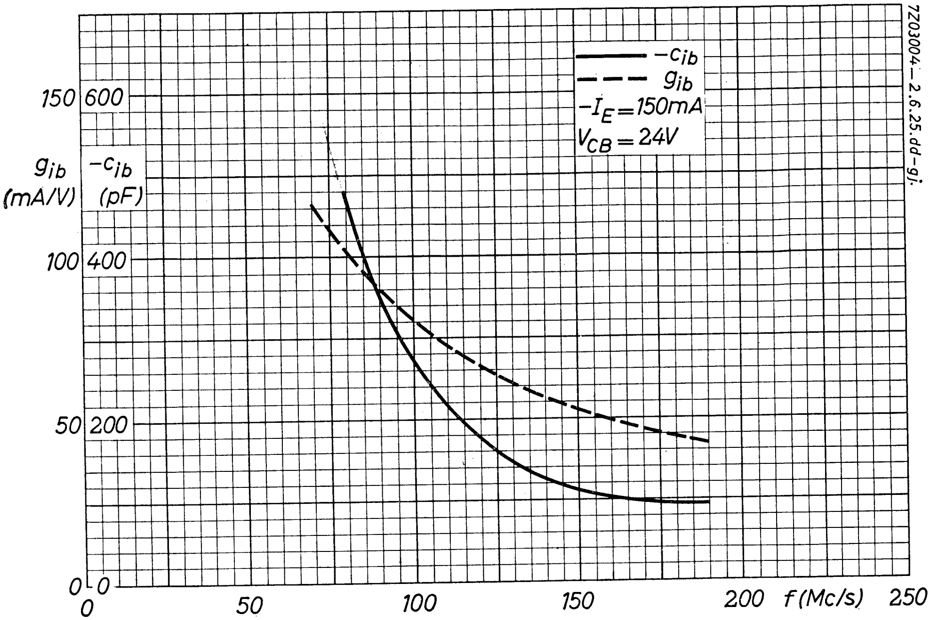

7Z03101-2.6.25dd/gj
V_{CB} = 5 V
f = 1kc/s
T_j = 25°C
h_{fe}
30
20
10
0
0
20
40
60
80
100
$-I_E$ (mA)

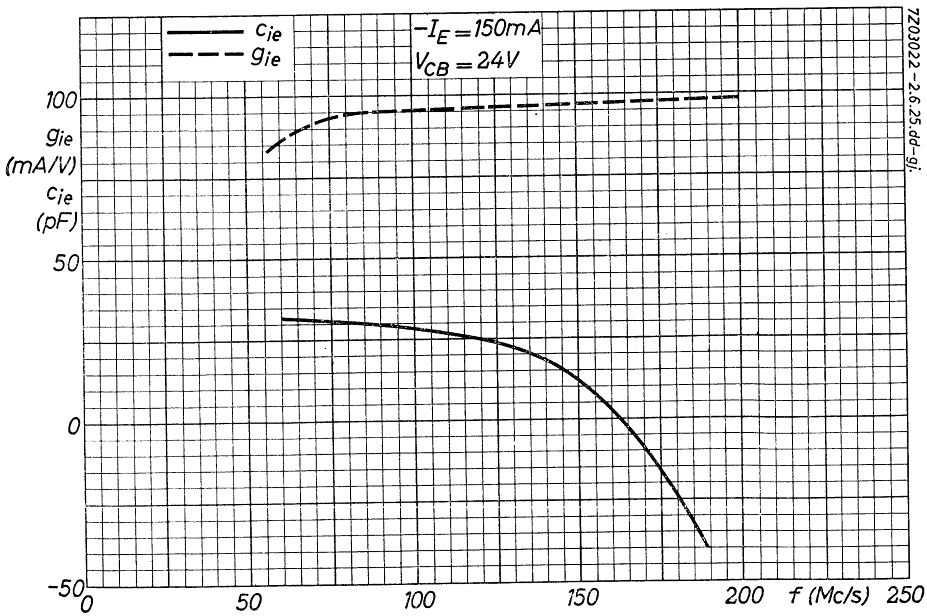

7Z03102-2.6.25dd/gj
$-I_E$ = 10mA
f = 1kc/s
T_j = 25°C
h_{fe}
30
20
10
0
0
5
10
15
20
V_{CB} (V)

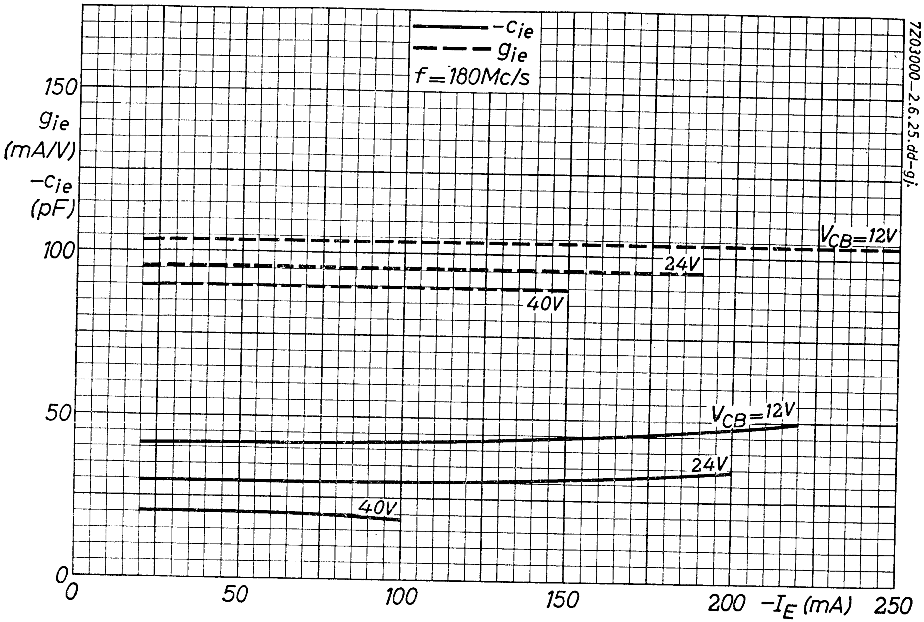

8
g_{ob}
(mA/V)
6
4
2
0
0
50
100
150
200
$-I_E$ (mA)
V_{CB}=12V
24V
33V
40V
f=180Mc/s
7Z03003-2.6.25.dd-gj.

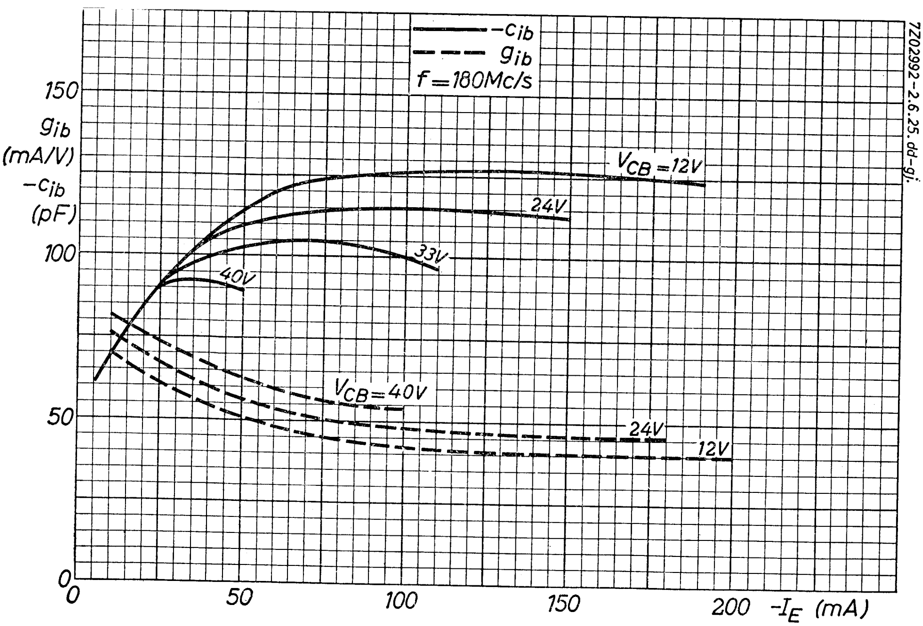

20
c_{ob}
(pF)
15
10
5
0
0
50
100
150
200
$-I_E$ (mA)
V_{CB}=12V
24V
33V
40V
f=180Mc/s
7Z03002-2.6.25.dd-gj.

3.3.1965


$-c_{ib}$
g_{ib}
$-I_E = 150mA$
$V_{CB} = 24V$
g_{ib} (mA/V)
$-c_{ib}$ (pF)
150 600
100 400
50 200
0 0
0
50
100
150
200
f (Mc/s)
250
7Z03004-2.6.25.dd-gj.

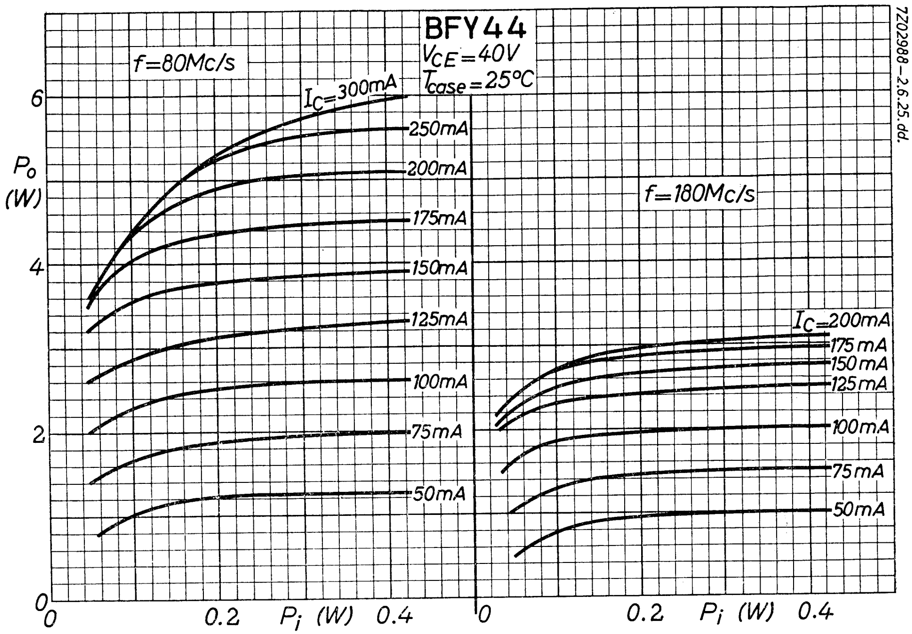

c_{ie}
g_{ie}
$-I_E = 150mA$
$V_{CB} = 24V$
100
g_{ie} (mA/V)
c_{ie} (pF)
50
0
-50
0
50
100
150
200
f (Mc/s)
250
7Z03022-2.6.25.dd-gj.

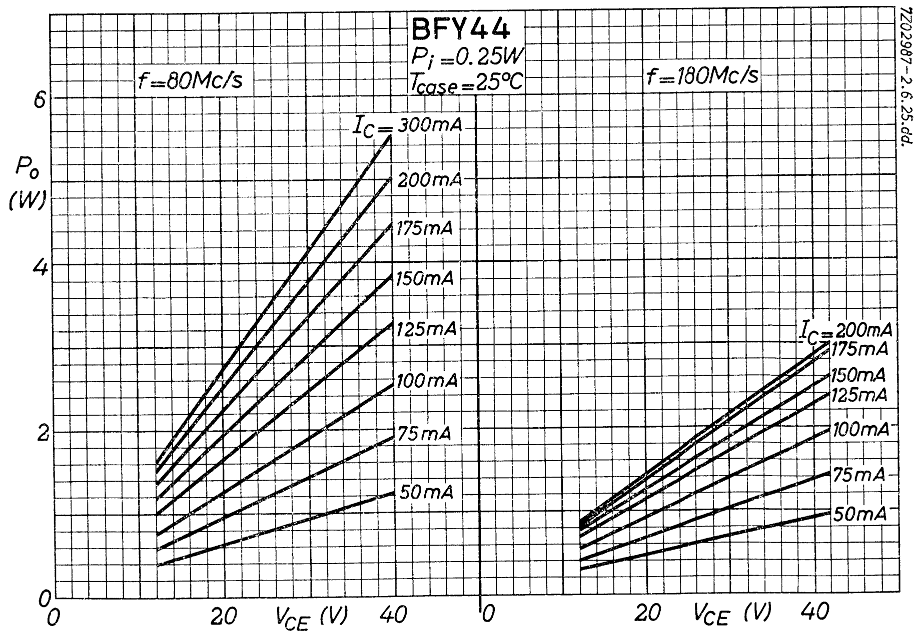

−cie
gie
f = 180Mc/s
150
gie
(mA/V)
−cie
(pF)
100
50
0
0
50
100
150
200
−IE (mA)
250
VCB=12V
24V
40V
VCB=12V
24V
40V
7Z03000−2.6.25.dd−gj.

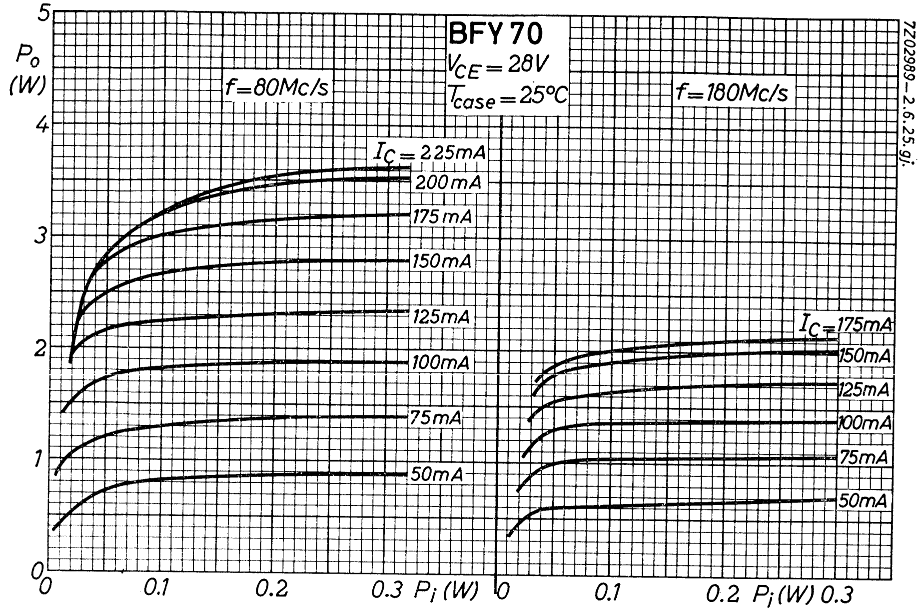

−cib
gib
f = 180Mc/s
150
gib
(mA/V)
−cib
(pF)
100
50
0
0
50
100
150
200
−IE (mA)
VCB = 12V
24V
33V
40V
VCB = 40V
24V
12V
7Z02992−2.6.25.dd−gj.

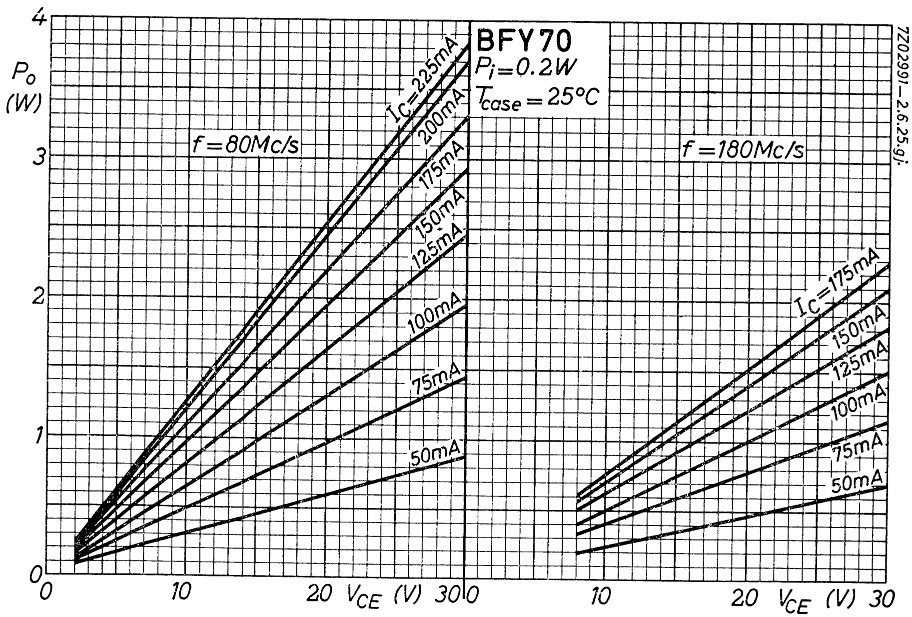
J

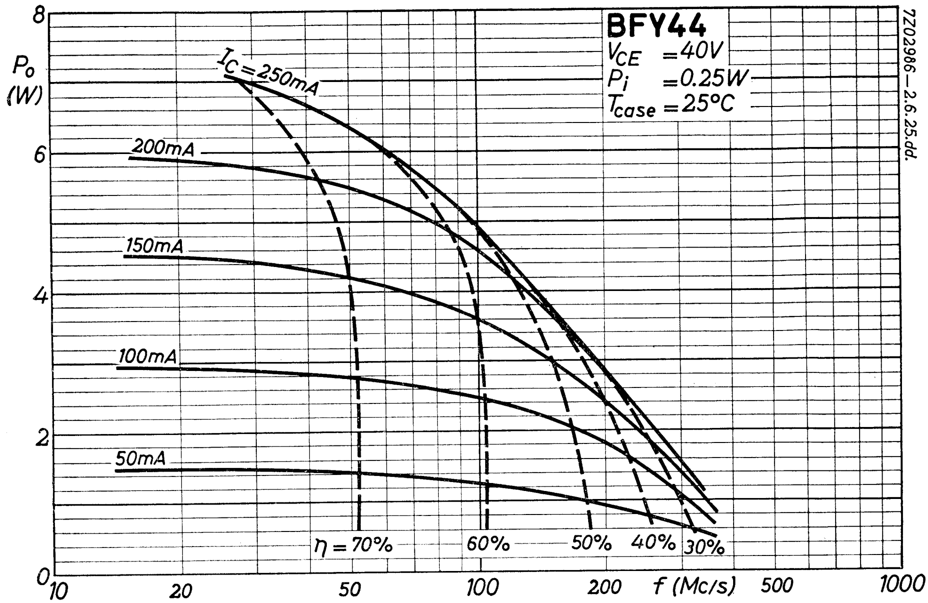
3.3.1965

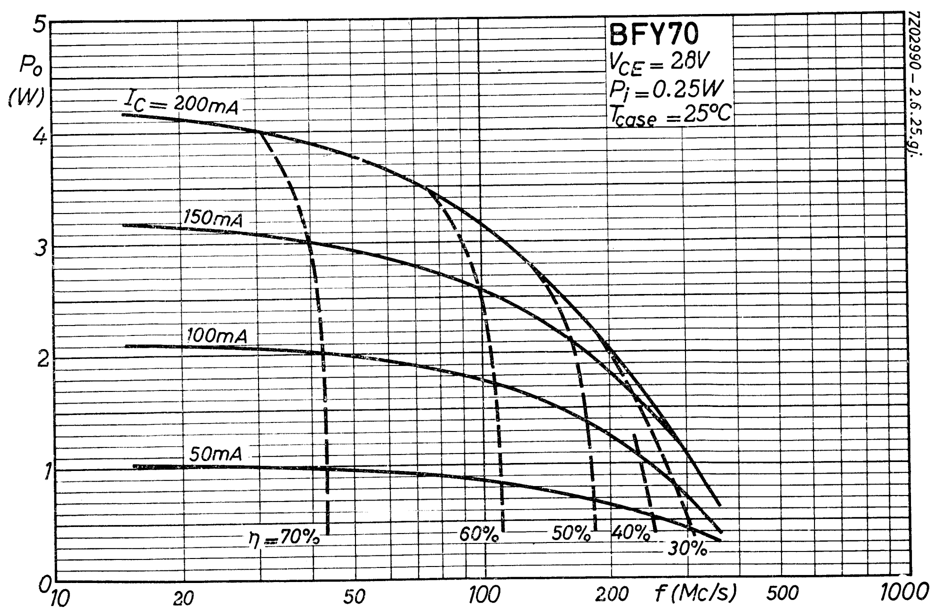

BFY44
V_{CE} = 40V
T_{case} = 25°C
f = 80Mc/s
f = 180Mc/s
I_C = 300mA
250mA
200mA
175mA
150mA
125mA
100mA
75mA
50mA
I_C = 200mA
175 mA
150 mA
125 mA
100mA
75 mA
50mA
P_o (W)
P_i (W)
0
0.2
0.4
2
4
6
7Z02988-2.6.25.dd.


BFY44
P_i = 0.25W
T_{case} = 25°C
f = 80Mc/s
f = 180Mc/s
I_C = 300mA
200mA
175mA
150mA
125mA
100mA
75mA
50mA
I_C = 200mA
175mA
150mA
125mA
100mA
75mA
50mA
P_o (W)
V_{CE} (V)
0
20
40
2
4
6
7Z02987-2.6.25.dd.


BFY 70
VCE = 28V
Tcase = 25°C
f=80Mc/s
f=180Mc/s
Po (W)
Pi (W)
IC = 225mA
200 mA
175 mA
150mA
125mA
100mA
75mA
50mA
IC=175mA
7Z02989–2.6.25.gj.


BFY70
Pi=0.2W
Tcase = 25°C
f=80Mc/s
f=180Mc/s
Po (W)
VCE (V)
IC=225mA
200mA
175mA
150mA
125mA
100mA
75mA
50mA
IC=175mA
7Z02991–2.6.25.gj.

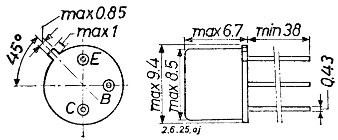

BFY44
V_{CE} = 40V
P_i = 0.25W
T_{case} = 25°C
P_o (W)
I_C = 250mA
200mA
150mA
100mA
50mA
η = 70%
60%
50%
40%
30%
f (Mc/s)
7Z02986 — 2.6.25.dd.


BFY70
V_{CE} = 28V
P_i = 0.25W
T_{case} = 25°C
P_o (W)
I_C = 200mA
150mA
100mA
50mA
η = 70%
60%
50%
40%
30%
f (Mc/s)
7Z02990 — 2.6.25.gj.

N-P-N SILICON MESA SWITCHING TRANSISTORS

Silicon mesa transistors of the n-p-n type in TO-5 metal case for low-current, high-speed switching applications

Dimensions in mm
Leads insulated from case



LIMITING VALUES (absolute max. limits)

			BSY10	BSY11	
Collector					
Voltage (base reference)	V_{CB}	= max.	60	45	V
Voltage (emitter ref.; $-V_{BE}$ = 1 V)	V_{CE}	= max.	60	45	V
Average [1]) and continuous current	I_C	= max.	50		mA
Peak current	I_{CM}	= max.	75		mA
Emitter					
Voltage (base reference)	V_{EB}	= max.	5		V
Base					
Average [1]) and continuous current	I_B	= max.	5		mA
Peak current	I_{BM}	= max.	7.5		mA
Dissipation					
Total dissipation	P_{tot}	= max.	300		mW
Temperatures					
Junction temperature	T_j	= max.	175		°C
Storage temperature	T_s	= max.	175		°C
	T_s	= min.	-55		°C

[1]) Averaging time 20 msec

7Z2 2344

THERMAL DATA

Thermal resistance from junction to ambience in free air	$K_{j\text{-}amb}$	<	0.5	°C/mW
to case	$K_{j\text{-}m}$	<	0.35	°C/mW

CHARACTERISTICS at T_{amb} = 25 °C

		BSY10	BSY11	
Collector leakage current at V_{CB} = 20 V; I_E = 0 mA	I_{CBO}	< 2		μA
Emitter leakage current at V_{EB} = 5 V; I_C = 0 mA	I_{EBO}	< 50		μA
Base current at V_{CB} = 5 V; $-I_E$ = 10 mA	I_B	> 125 < 225	> 80 < 165	μA
Collector saturation voltage at I_C = 10 mA; I_B = 1 mA	V_{CE}	< 1		V

7Z2 2345

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN

at T_{amb} = 25 °C, unless otherwise specified

		BSY10	BSY11	
Collector leakage current at V_{CB} = 20 V; I_E = 0 mA; T_{amb} = 125 °C	I_{CBO}	< 15		μA
Collector voltage at				
I_C = 100 μA; I_B = 0 mA	V_{CEO}	> 30	> 25	V
I_C = 50 μA; V_{BE} = -1 V	V_{CE}	> 60	> 45	V
I_C = 50 μA; I_E = 0 mA	V_{CBO}	> 60	> 45	V
Base emitter voltage at V_{CB} = 5 V; $-I_E$ = 10 mA	V_{BE}	< 1.5		V
Small-signal current amplification factor at V_{CB} = 5 V; $-I_E$ = 5 mA; f = 1 kc/s	h_{fe}	> 40	> 55	
Frequency at which $\|h_{fe}\|$ = 1 at V_{CB} = 10 V; $-I_E$ = 5 mA	f_1	> 60 = 180		Mc/s Mc/s
Noise figure at V_{CB} = 10 V; $-I_E$ = 5 mA	F	= 20 < 40		dB dB
Collector capacitance at				
V_{CB} = 20 V; I_E = 0 mA	c_c	< 5		pF
V_{CB} = 5 V; I_E = 0 mA	c_c	= 5		pF
Emitter capacitance V_{EB} = 2 V; I_C = 0 mA	c_e	= 9		pF

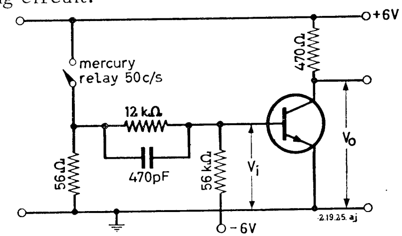
7Z2 2346

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN

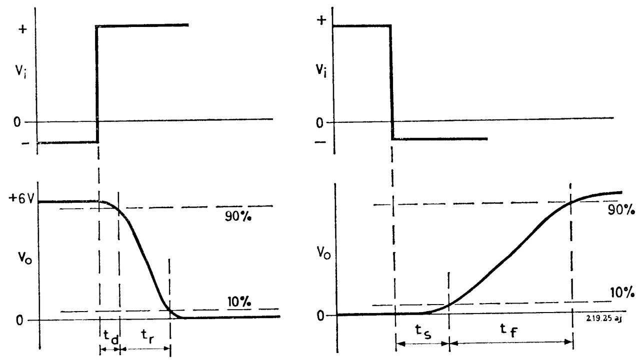
(continued)

Switching characteristics at T_{amb} = 25 °C

Measuring circuit:



Oscilloscope: C_i < 20 pF; R_i > 1 MΩ

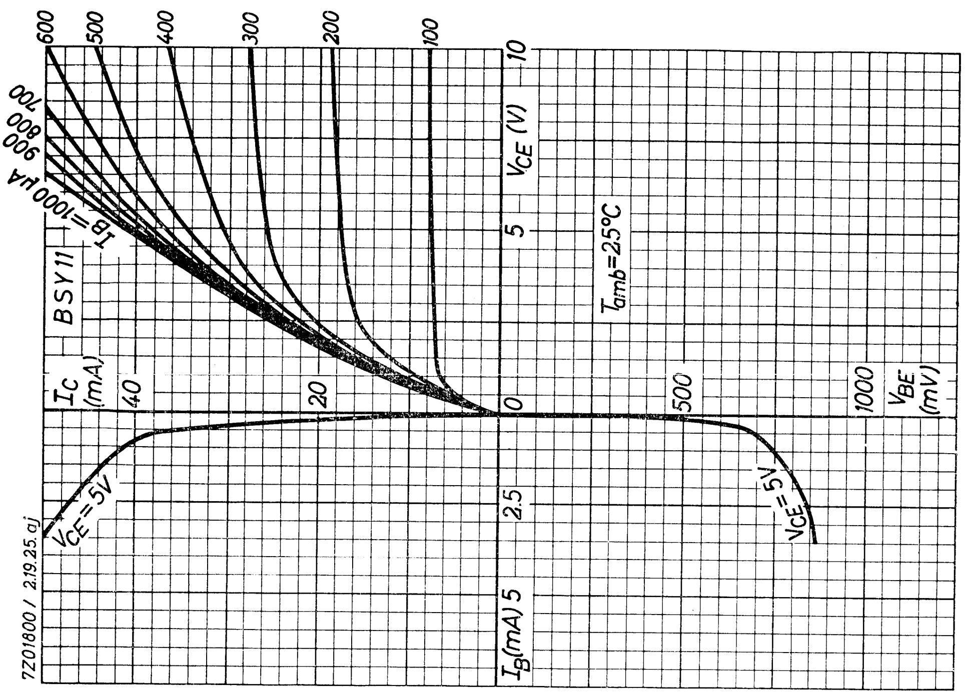


Delay time	t_d =	4.7 nsec
Rise time	t_r =	13 nsec
Storage time	t_s =	35 nsec
Fall time	t_f =	75 nsec

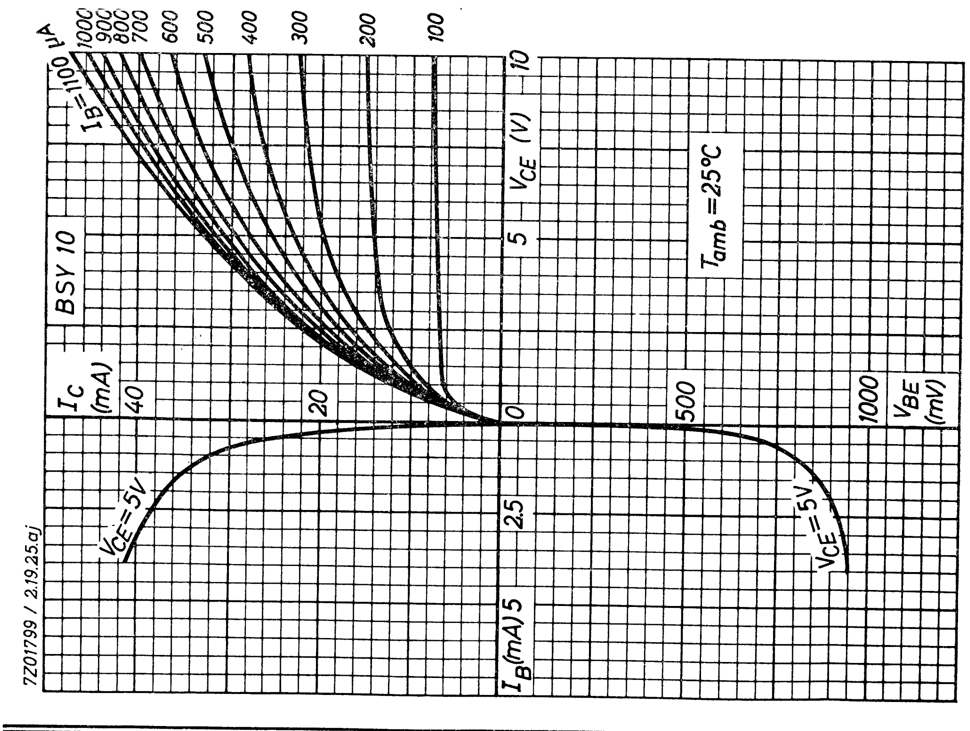
Turn-on time = $t_d + t_r$

Turn-off time = $t_s + t_f$

7Z2 2347

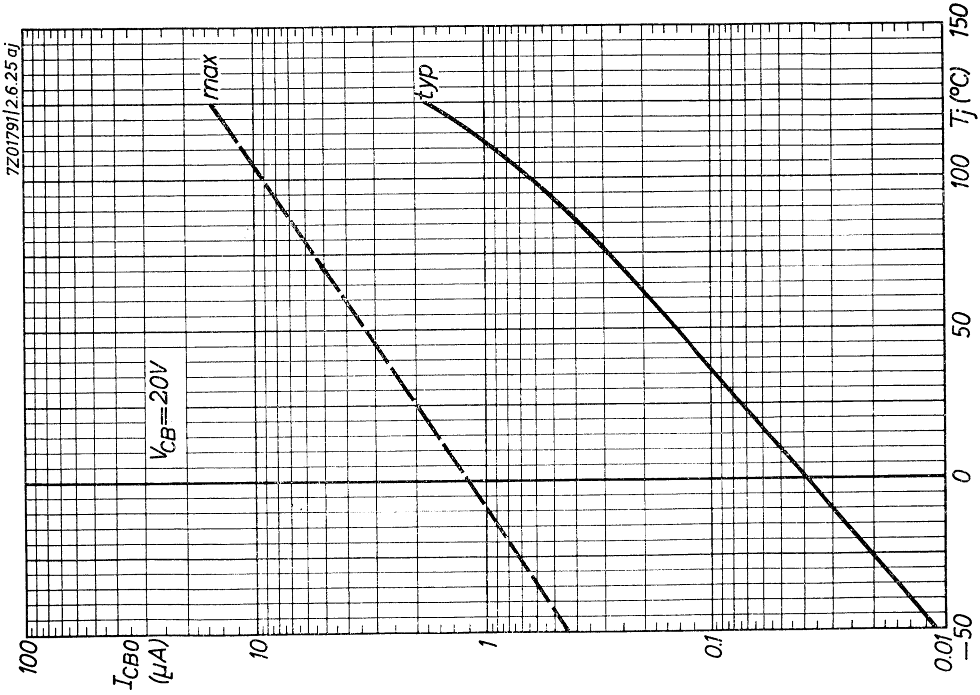

BSY11
T_{amb}=25°C
I_C (mA)
V_{CE} (V)
V_{BE} (mV)
I_B(mA)
I_B=1000 µA
900
800
700
600
500
400
300
200
100
V_{CE}=5V
7Z01800 / 2.19.25.aj

B


BSY 10
T_{amb}=25°C
I_C (mA)
V_{CE} (V)
V_{BE} (mV)
I_B(mA)
I_B=1100 µA
1000
900
800
700
600
500
400
300
200
100
V_{CE}=5V
7Z01799 / 2.19.25.aj

A

2.2.1964


7Z01791/2.6.25 aj
I_{CBO} (μA)
100
10
1
0.1
0.01
V_{CB}=20V
max
typ
−50
0
50
100
150
T_j (°C)

SILICON N-P-N PLANAR EPITAXIAL HIGH-SPEED SWITCHING TRANSISTORS

Silicon planar epitaxial transistors of the n-p-n type in TO-18 metal case for general purposes and especially for high-speed saturated logic applications.

QUICK REFERENCE DATA

Collector voltage (base reference)		V_{CB}	=	max. 20 V
Collector voltage (emitter reference) $V_{BE} \leqq 0$		V_{CE}	=	max. 15 V
Collector current (peak value)		I_{CM}	=	max. 200 mA
Total dissipation		P_{tot}	=	max. 300 mW
D.C. current amplification factor I_C = 10 mA; V_{CE} = 0.35 V	BSY38	h_{FE}	> 30	< 60
	BSY39	h_{FE}	> 40	< 120
I_C = 100 mA; V_{CE} = 1 V	BSY38	h_{FE}	> 15	< 45
	BSY39	h_{FE}	> 20	< 70
Transition frequency I_C = 10 mA; V_{CE} = 2 V		f_T	=	typ. 350 Mc/s
Storage time $I_C = I_B = -I_{BM}$[1]) = 10 mA		t_s	=	8 nsec
Thermal resistance between junction and ambience		K	=	max. 0.5 °C/mW

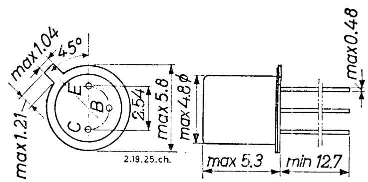
[1]) $-I_{BM}$ is the reverse current peak that occurs during switching off.

7Z2 2543

MECHANICAL DATA

Dimensions in mm

Collector connected to case



LIMITING VALUES (Absolute max. values)

Collector

Voltage (base reference)	V_{CB}	=	max.	20 V
Voltage (emitter reference)	V_{CE}	=	max.	15 V
Current (peak value)	I_{CM}	=	max.	200 mA
Current (averaged over any 20 msec period)	I_C	=	max.	100 mA

Emitter

Voltage (base reference)	V_{EB}	=	max.	5 V

Dissipation

Total dissipation	P_{tot}	=	max.	300 mW

Temperatures

Storage temperature	T_s	=	−65 °C to 175 °C	
Junction temperature	T_j	=	max.	175 °C

THERMAL DATA

Thermal resistance between

junction and ambience	K	=	max.	0.5 °C/mW
junction and case	K	=	max.	0.15 °C/mW

7Z2 2544

CHARACTERISTICS at $T_j = 25\ ^oC$

Collector current at $I_E = 0$, $V_{CB} = 20$ V	I_{CBO}		<	100 nA
Emitter current at $I_C = 0$, $V_{EB} = 5$ V	I_{EBO}		<	500 nA
Collector voltage (emitter reference) $I_C = 10$ mA; $I_B = 0$	V_{CE}	> 12		V
Saturation voltages $I_C = 10$ mA; $I_B = 1$ mA	V_{CE}		<	0.25 V
	V_{BE}	> 0.7	<	0.85 V
$I_C = 100$ mA; $I_B = 10$ mA	V_{CE}		<	0.6 V
	V_{BE}		<	1.5 V
Base current $I_C = 10$ mA; $V_{CE} = 0.35$ V, BSY38	I_B	> 167	<	333 μA
BSY39	I_B	> 83	<	250 μA

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN $T_j = 25\ ^oC$ unless otherwise specified

Collector current at $I_E = 0$, $V_{CB} = 20$ V; $T_j = 150\ ^oC$ (See also page E)	I_{CBO}	<	10 μA
Collector current at $V_{BE} = 0$, $V_{CE} = 15$ V; $T_j = 55\ ^oC$	I_C	<	0.4 μA
Collector current at $V_{CE} = 10$ V; $V_{BE} = 0.35$ V, $T_j = 100\ ^oC$ (See also pages G, H)	I_C	<	30 μA
Emitter current at $I_C = 0$, $V_{EB} = 5$ V; $T_j = 150\ ^oC$	I_{EBO}	<	10 μA
Base current at $V_{CE} = 15$ V; $-V_{BE} = 3$ V, $T_j = 55\ ^oC$ (See also page F)	$-I_B$	<	0.6 μA

7Z2 2545

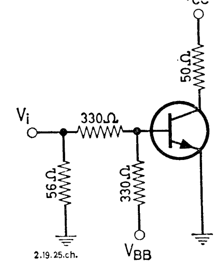
6.6.1964

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN (continued) $T_j = 25\ ^oC$ unless otherwise specified

Collector capacitance at $I_E = 0$, $V_{CB} = 5$ V; f = 1 Mc/s	c_c			< 5 pF
Emitter capacitance at $I_C = 0$, $V_{EB} = 1$ V; f = 1 Mc/s	c_e			< 6 pF
Current amplification factor at f = 100 Mc/s, $I_C = 10$ mA; $V_{CE} = 2$ V	h_{fe}	=	3.5	> 2
D.C. current amplification factor $I_C = 100$ mA; $V_{CE} = 1$ V, BSY38	h_{FE}	>	15	< 45
BSY39	h_{FE}	>	20	< 70

SWITCHING CHARACTERISTICS

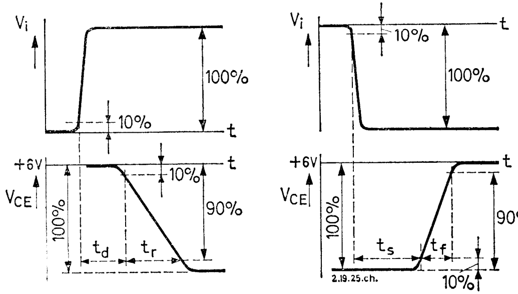
t_{on} and t_{off} circuit



V_i: rise time < 1 nsec

pulse width > 60 nsec

duty cycle = 2%



7Z2 2546

SWITCHING CHARACTERISTICS (continued)

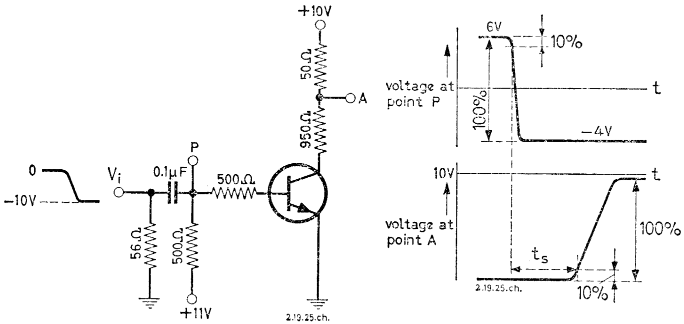
Turn on time (see figure page 4 and page X)

I_C = 100 mA; I_B = 40 mA
V_{CC} = 6 V; $-V_{BB}$ = 4.5 V $t_{on} = t_d + t_r$ = 9 nsec < 14 nsec
V_i = 20 V

Turn off time (see figure page 4 and page Y)

I_C = 100 mA; I_B = 40 mA
V_{CC} = 6 V; V_{BB} = 15.3 V $t_{off} = t_f + t_s$ = 25 nsec < 45 nsec
$-V_i$ = 20 V

Storage time (see also page Z)



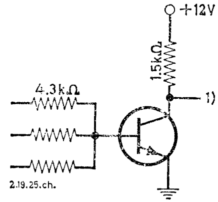
$I_C = I_B = -I_{BM}$ = 10 mA t_s = 8 nsec < 16 nsec

$-I_{BM}$ is the reverse current peak that occurs during switching off. The value of $-I_{BM}$ is determined and limited by the applied cut-off voltage and series resistance.

7Z2 2547

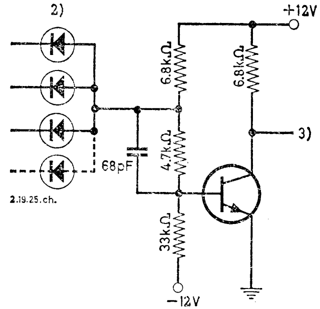
TYPICAL PULSE CIRCUITS

NOR gate
(resistor transistor logic)



Typical delay time per stage :
60 nsec

NAND gate
(diode transistor logic)



Typical delay time per stage :
30 nsec

Fan in = 3 : Circuit may be driven by max. 3 identical circuits

Fan out = 3 : Circuit may be loaded by max. 3 identical circuits

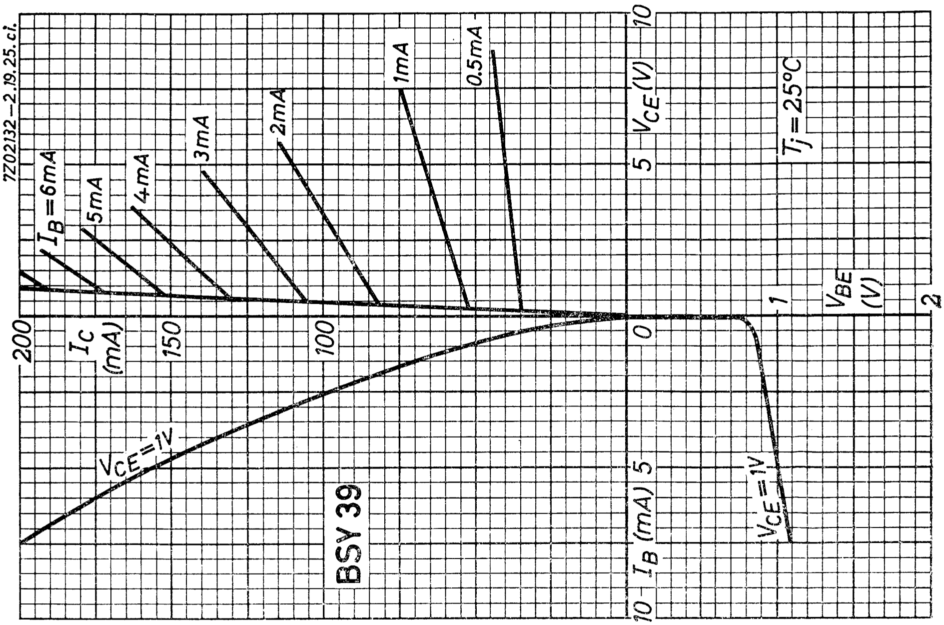
Note: Fan in and fan out figures for both circuits have been calculated for worst case conditions.

1) fan in = fan out = 3

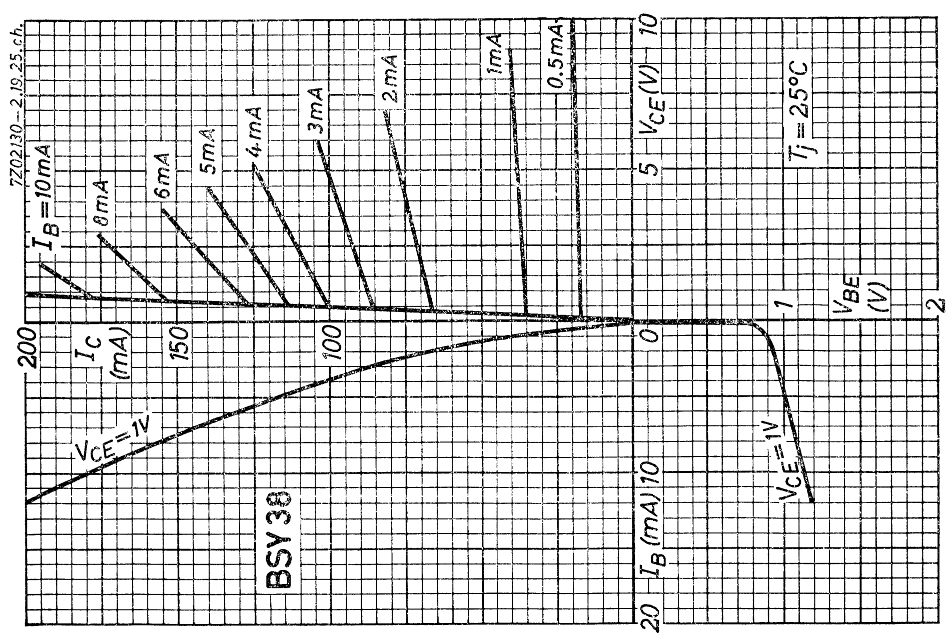
2) fast silicon epitaxial logic diodes; fan in = 10

3) fan out for BSY38 = 5; fan out for BSY39 = 7

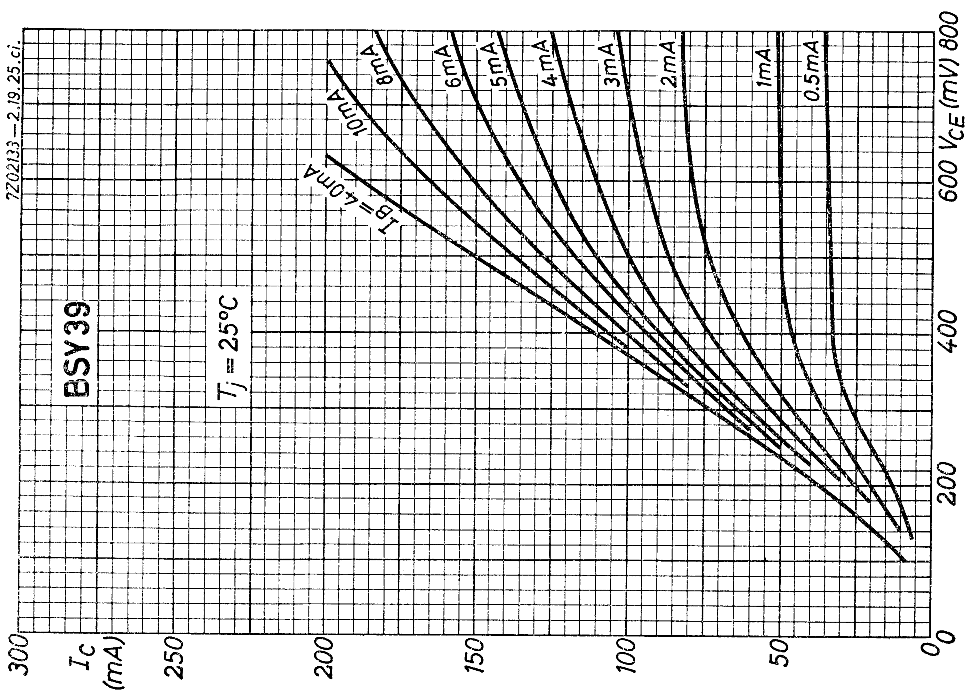
7Z2 2548


7Z02132—2.19.25.cl.
I_B=6mA
5mA
4mA
3mA
2mA
1mA
0.5mA
V_CE (V)
10
5
0
T_j=25°C
V_BE (V)
1
2
200
I_C (mA)
150
100
V_CE=1V
BSY 39
I_B (mA)
10

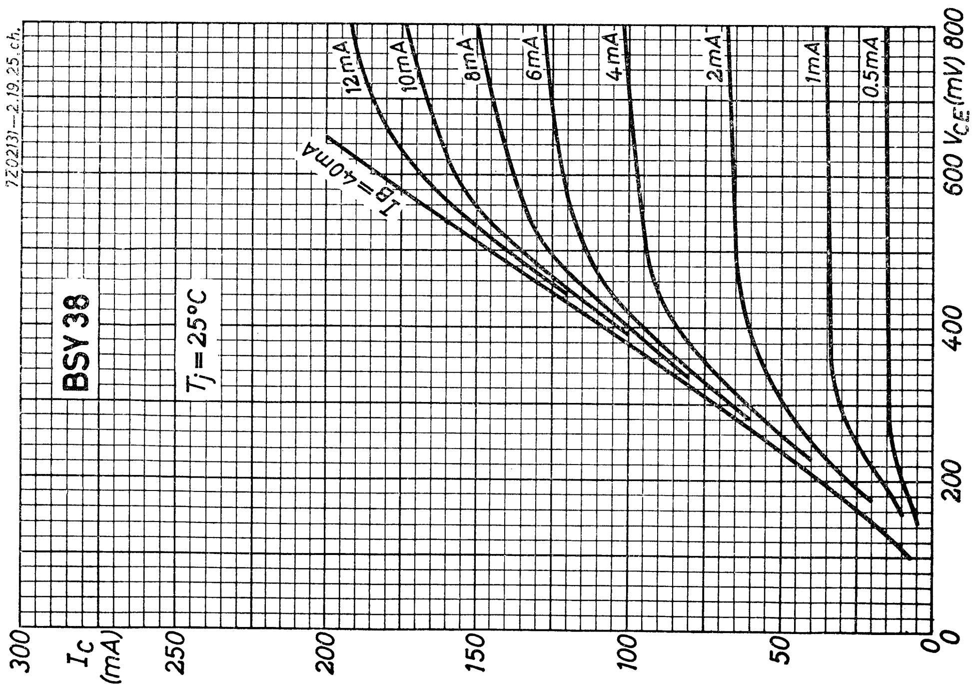
B


7Z02130—2.19.25.ch.
I_B=10mA
8mA
6mA
5mA
4mA
3mA
2mA
1mA
0.5mA
V_CE (V)
10
5
0
T_j=25°C
V_BE (V)
1
2
200
I_C (mA)
150
100
V_CE=1V
BSY 38
I_B (mA)
20

A


7Z02133—2.19.25.ci.
BSY39
$T_j = 25°C$
$I_B = 40mA$
10mA
8mA
6mA
5mA
4mA
3mA
2mA
1mA
0.5mA
I_C (mA)
300
250
200
150
100
50
0
0
200
400
600 V_{CE} (mV) 800

D


7Z02131—2.19.25.ch.
BSY38
$T_j = 25°C$
$I_B = 40mA$
12mA
10mA
8mA
6mA
4mA
2mA
1mA
0.5mA
I_C (mA)
300
250
200
150
100
50
0
0
200
400
600 V_{CE} (mV) 800

C

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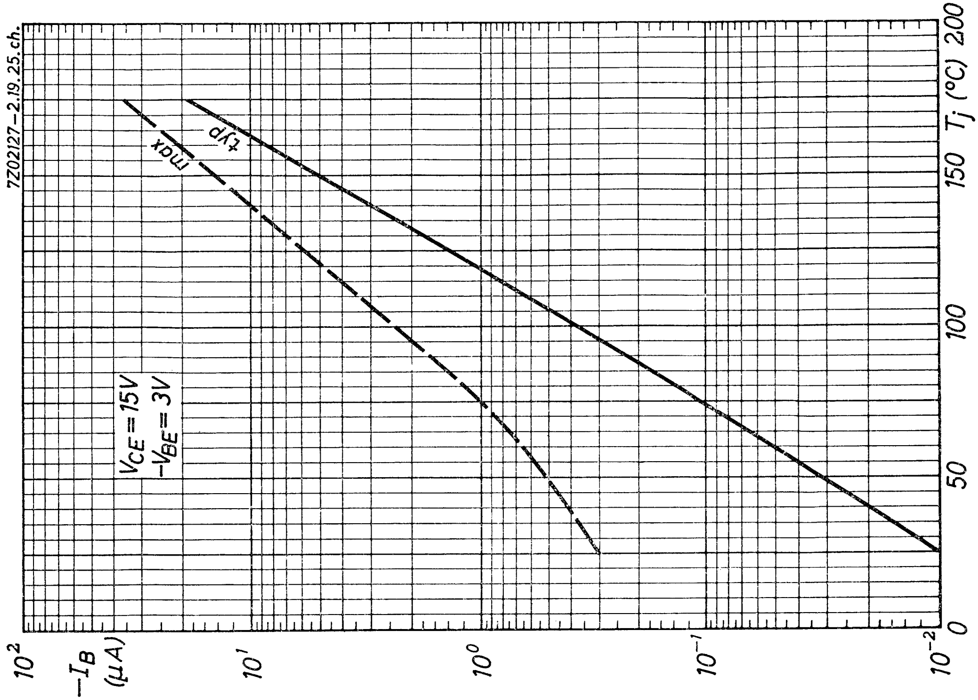
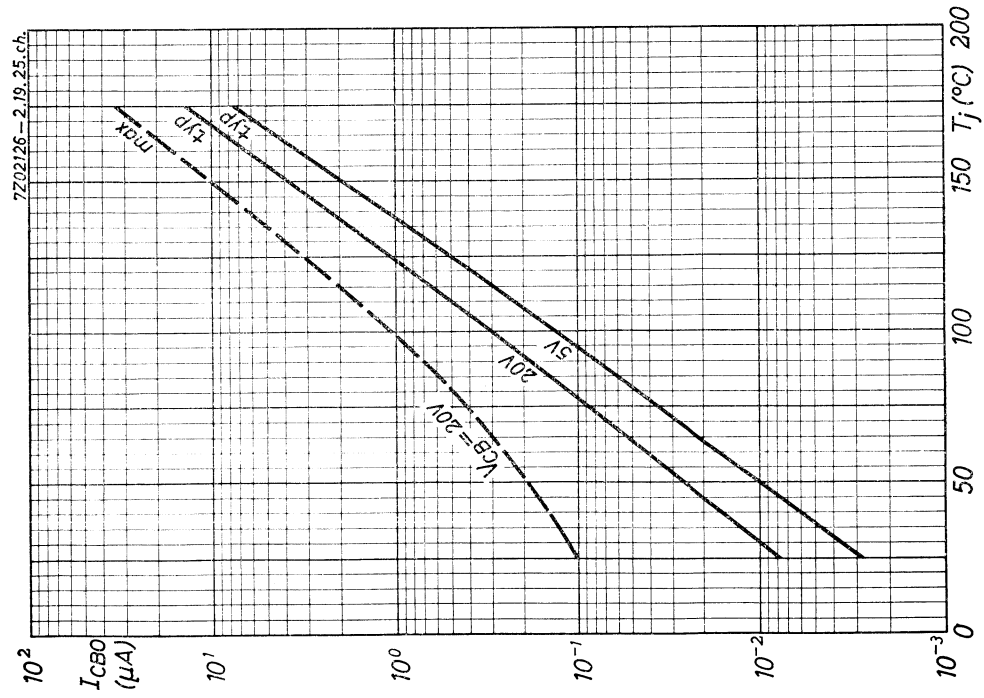
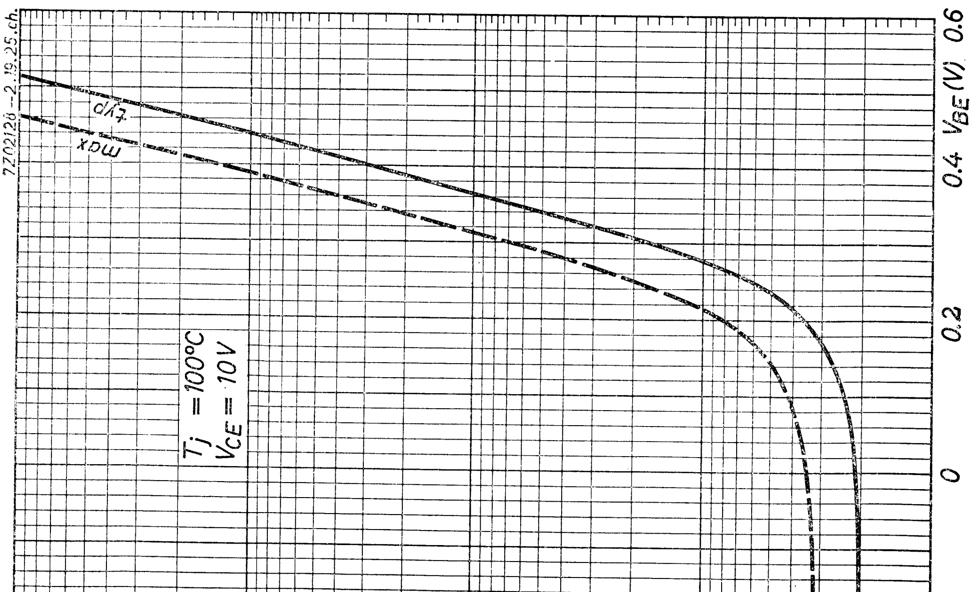

7Z02127–2.19.25.ch.
$-I_B$ (μA)
10^2
10^1
10^0
10^{-1}
10^{-2}
$V_{CE} = 15V$
$-V_{BE} = 3V$
max
typ
0
50
100
150
200
T_j (°C)

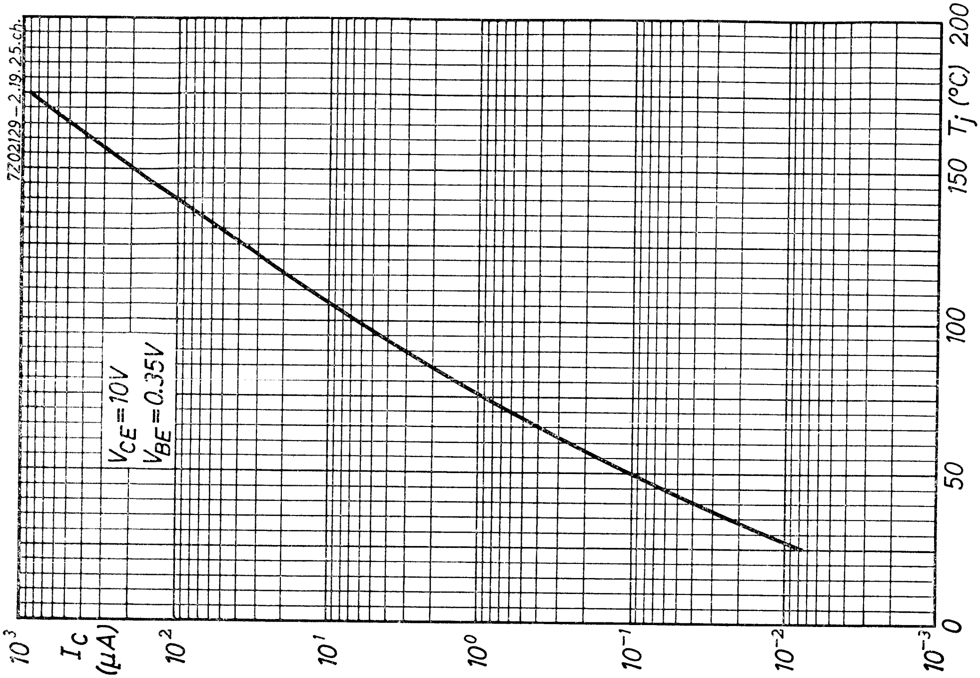
F


7Z02126–2.19.25.ch.
I_{CBO} (μA)
10^2
10^1
10^0
10^{-1}
10^{-2}
10^{-3}
max
typ
typ
$V_{CB} = 20V$
20V
5V
0
50
100
150
200
T_j (°C)

E

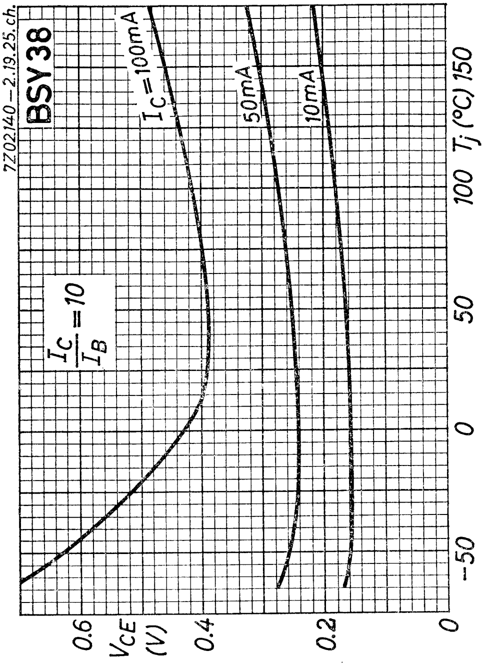

7Z02128 - 2.19.25.ch.
T_j = 100°C
V_{CE} = 10 V
typ
max
I_C (μA)
1000
200
100
50
20
10
5
2
1
0.5
0.2
0.1
−0.2
0
0.2
0.4
0.6
V_{BE} (V)

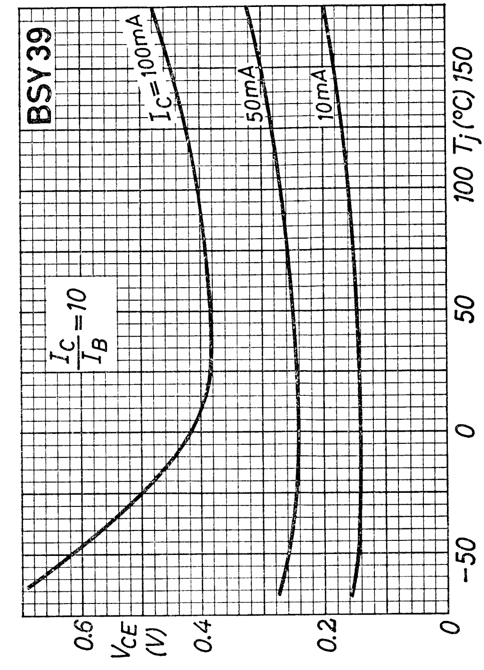
G

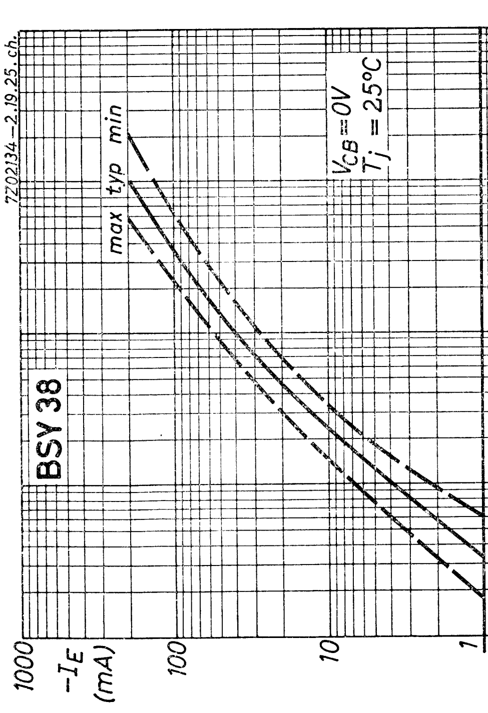

7Z02129 - 2.19.25.ch.
V_{CE} = 10V
V_{BE} = 0.35V
I_C (μA)
10^3
10^2
10^1
10^0
10^{-1}
10^{-2}
10^{-3}
0
50
100
150
200
T_j (°C)

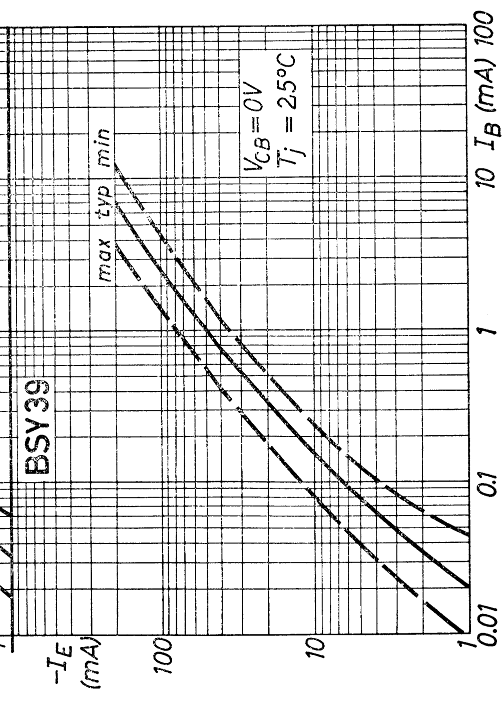
H

6.6.1964


7Z02140 — 2.19.25.ch.
BSY 38
$\frac{I_C}{I_B} = 10$
$I_C = 100mA$
50mA
10mA
V_{CE} (V)
0.6
0.4
0.2
0
−50
0
50
100
150
T_j (°C)


BSY 39
$\frac{I_C}{I_B} = 10$
$I_C = 100mA$
50mA
10mA
V_{CE} (V)
0.6
0.4
0.2
0
−50
0
50
100
150
T_j (°C)


7Z02134 — 2.19.25.ch.
BSY 38
max
typ
min
$V_{CB} = 0V$
$T_j = 25°C$
$-I_E$ (mA)
1000
100
10
1


BSY 39
max
typ
min
$V_{CB} = 0V$
$T_j = 25°C$
$-I_E$ (mA)
100
10
1
0.01
0.1
1
10
100
I_B (mA)

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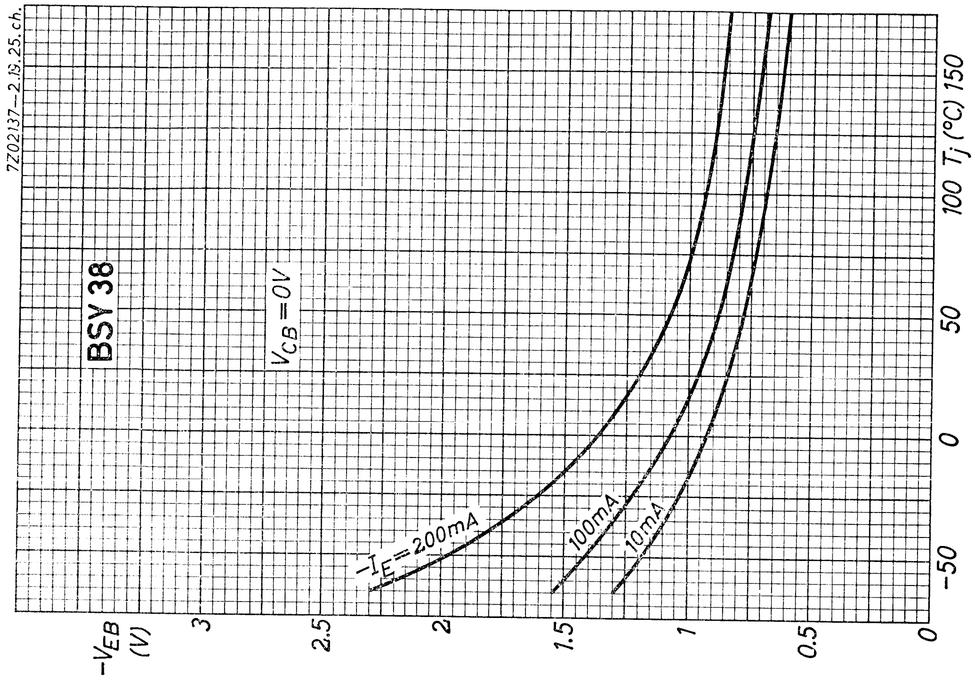
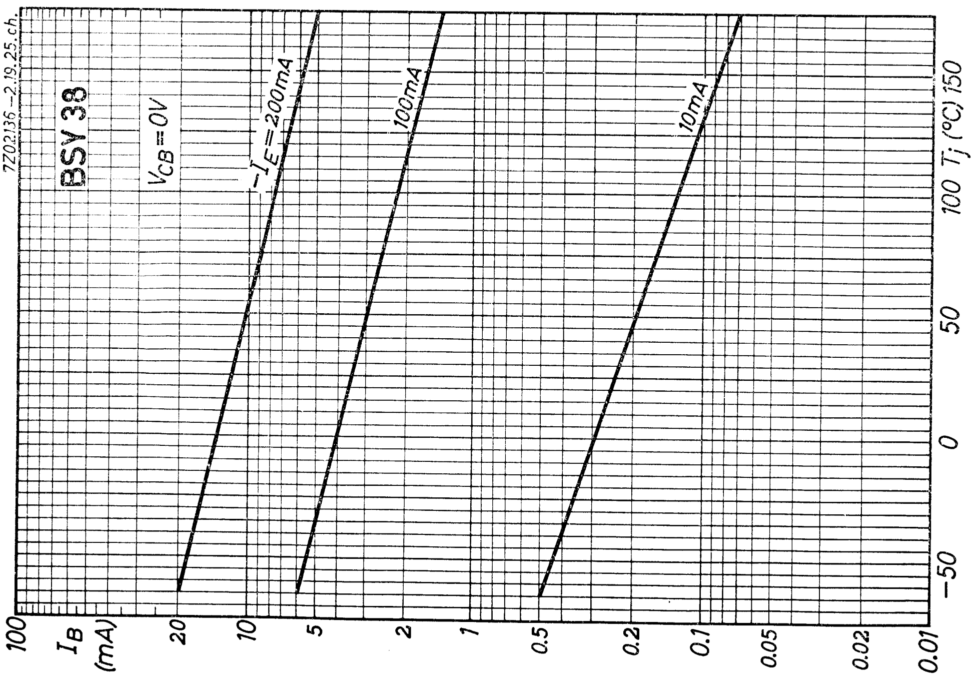
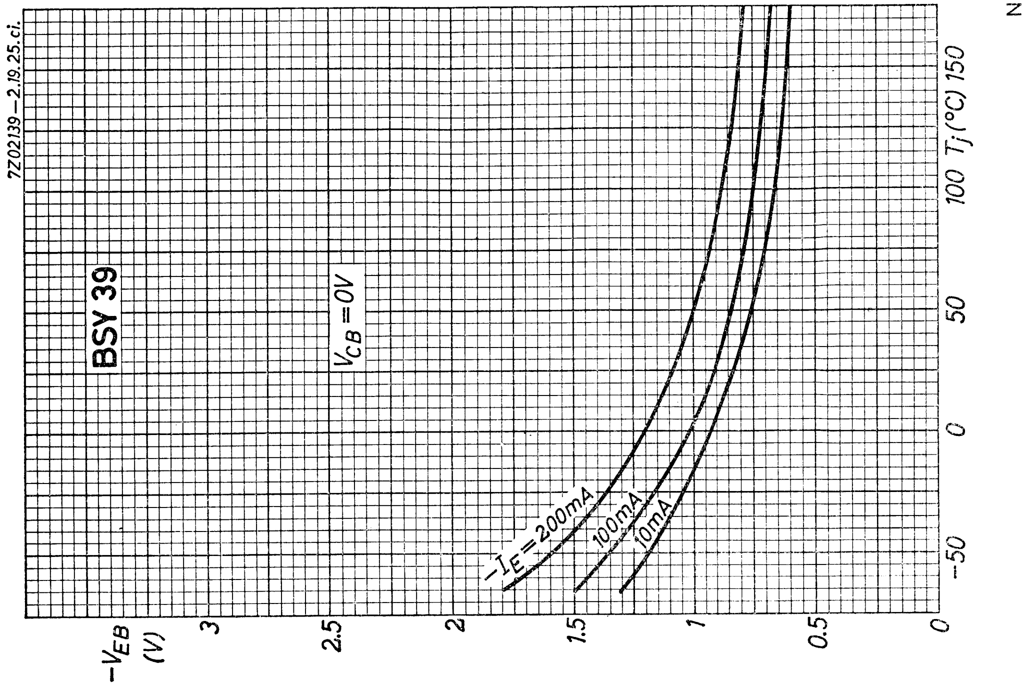
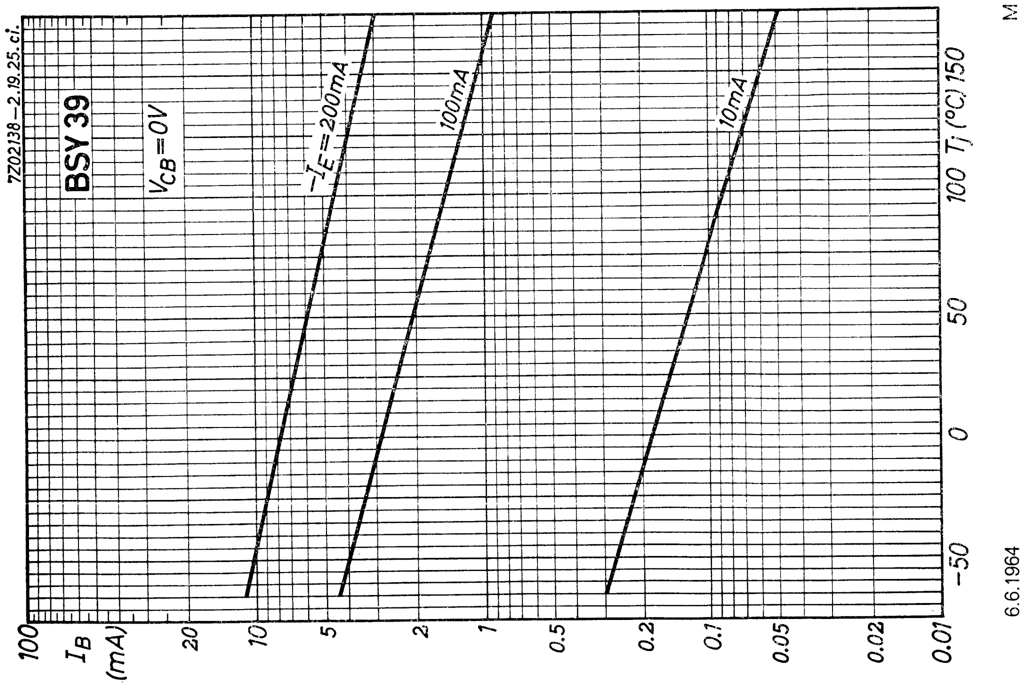

7Z02137-2.19.25.ch.
BSY 38
$V_{CB}=0V$
$-I_E=200mA$
100mA
10mA
$-V_{EB}$ (V)
3
2.5
2
1.5
1
0.5
0
-50
0
50
100
T_j (°C)
150

L


7Z02136-2.19.25.ch.
BSY 38
$V_{CB}=0V$
$-I_E=200mA$
100mA
10mA
100
I_B (mA)
20
10
5
2
1
0.5
0.2
0.1
0.05
0.02
0.01
-50
0
50
100
T_j (°C)
150

K


7Z02139—2.19.25.ci.
BSY 39
$V_{CB}=0V$
$-I_E=200mA$
100mA
10mA
$-V_{EB}$ (V)
3
2.5
2
1.5
1
0.5
0
−50
0
50
100 T_j (°C) 150
N


7Z02138—2.19.25.ci.
BSY 39
$V_{CB}=0V$
$-I_E=200mA$
100mA
10mA
100
I_B (mA)
20
10
5
2
1
0.5
0.2
0.1
0.05
0.02
0.01
−50
0
50
100 T_j (°C) 150
M

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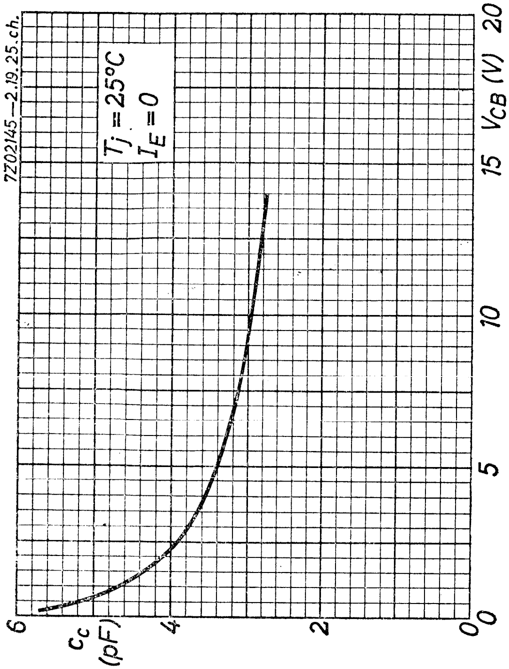
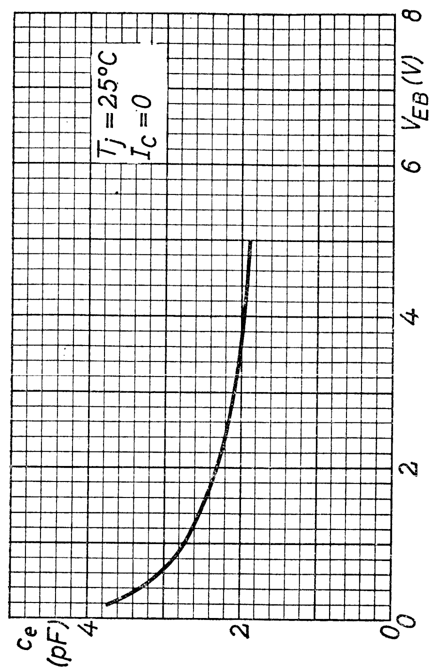
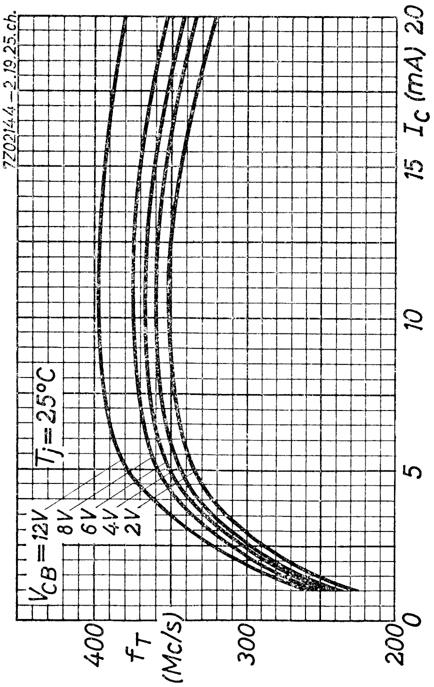
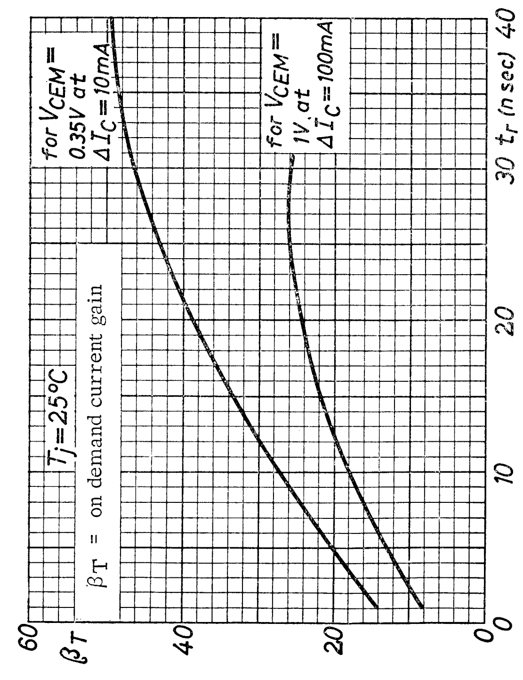

7Z02145—2.19.25.ch.
Tj = 25°C
IE = 0
Cc (pF)
VCB (V)
0 5 10 15 20
0 2 4 6

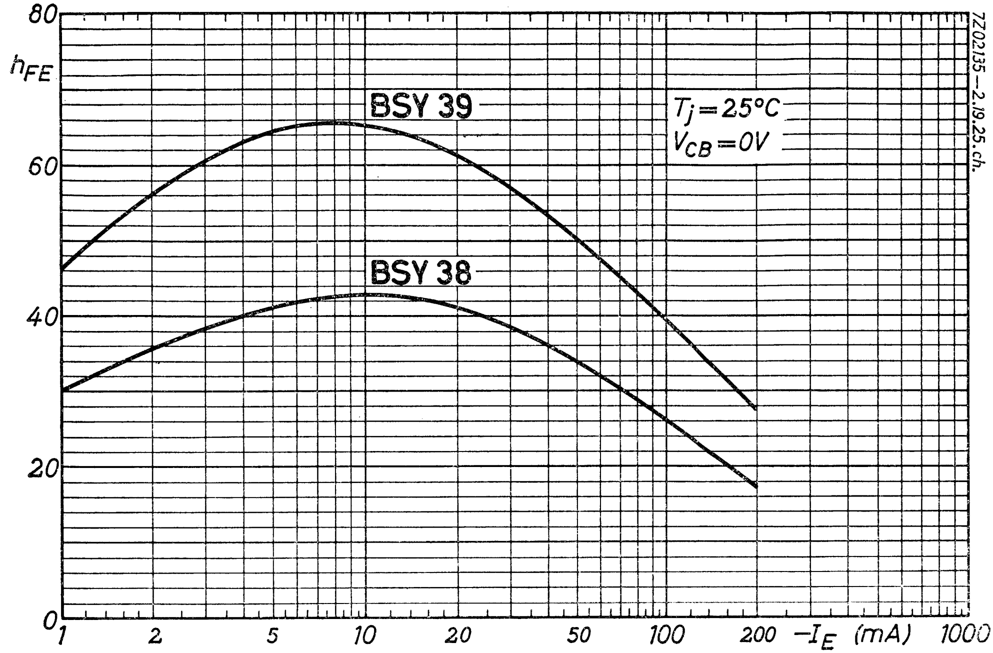

Tj = 25°C
IC = 0
Ce (pF)
VEB (V)
0 2 4 6 8
0 2 4

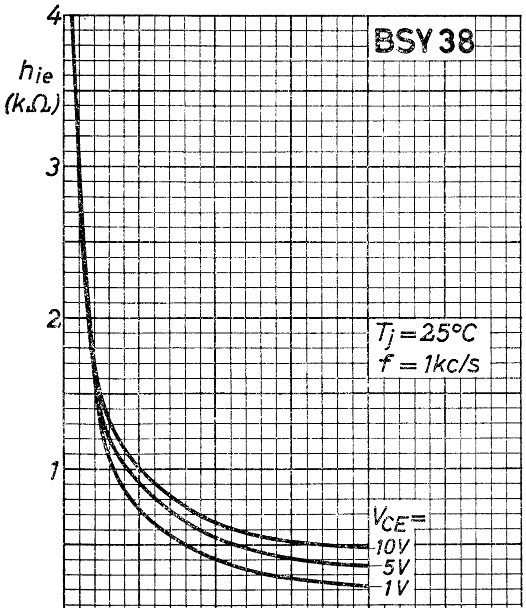
P

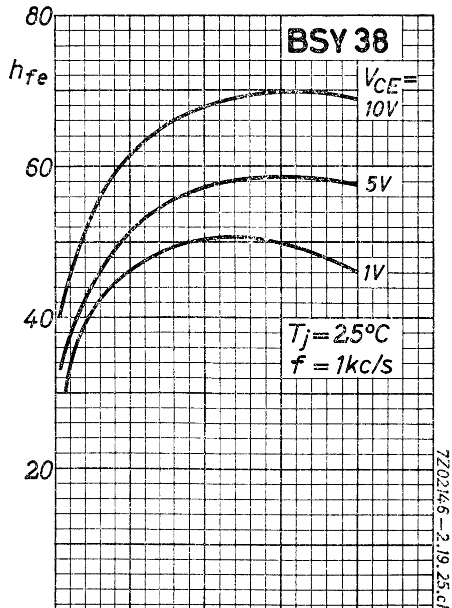

7Z02144—2.19.25.ch.
Tj = 25°C
VCB = 12V
8V
6V
4V
2V
fT (Mc/s)
IC (mA)
0 5 10 15 20
200 300 400


Tj = 25°C
βT = on demand current gain
for VCEM = 0.35V at ΔIC = 10mA
for VCEM = 1V at ΔIC = 100mA
βT
tr (n sec)
0 10 20 30 40
0 20 40 60

6.6.1964

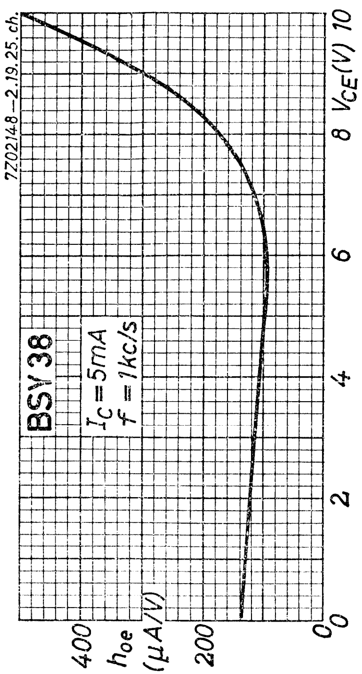

80
h_{FE}
60
40
20
0
BSY 39
BSY 38
$T_j = 25°C$
$V_{CB} = 0V$
7Z02135—2.19.25.ch.
1
2
5
10
20
50
100
200
$-I_E$ (mA)
1000

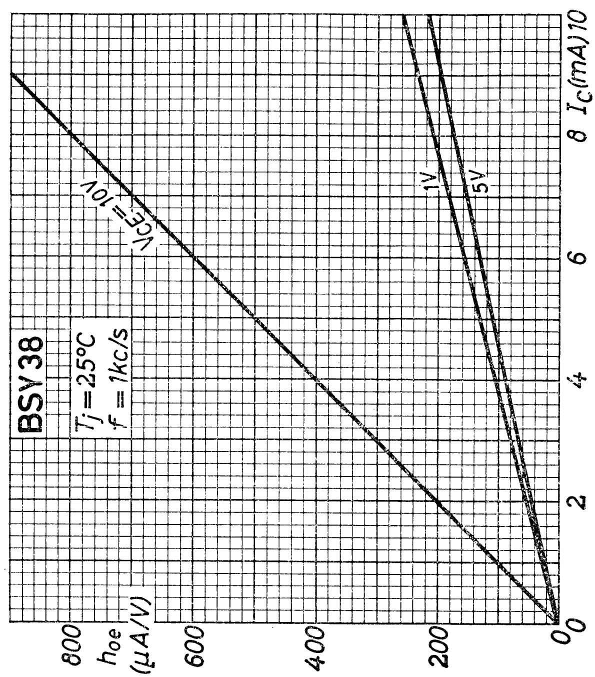

4
h_{ie}
(kΩ)
3
2
1
0
BSY 38
$T_j = 25°C$
f = 1kc/s
V_{CE}=
10V
5V
1V
0
5
10
I_C (mA)
15


80
h_{fe}
60
40
20
0
BSY 38
V_{CE}=
10V
5V
1V
$T_j = 25°C$
f = 1kc/s
7Z02146—2.19.25.ch.
0
5
I_C (mA)
10

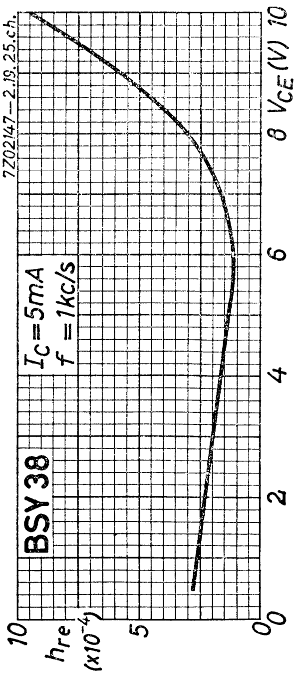
R

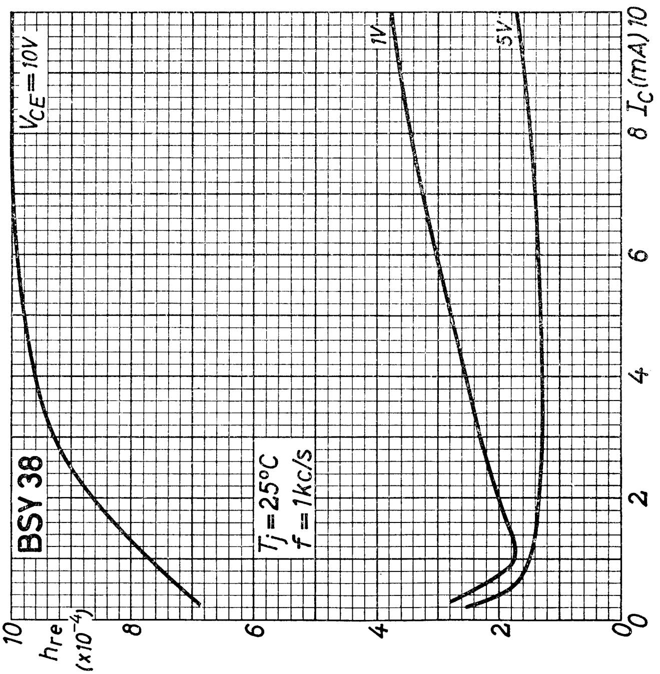
6.6.1964


7Z02148—2.19.25.ch.
BSY38
$I_C = 5mA$
$f = 1kc/s$
h_{oe} $(\mu A/V)$
400
200
0
0
2
4
6
8
$V_{CE}(V)$ 10


BSY38
$T_j = 25°C$
$f = 1kc/s$
h_{oe} $(\mu A/V)$
800
600
400
200
0
0
2
4
6
8
$I_C(mA)$ 10
$V_{CE} = 10V$
1V
5V

T


7Z02147—2.19.25.ch.
BSY38
$I_C = 5mA$
$f = 1kc/s$
h_{re} $(x10^{-4})$
10
5
0
0
2
4
6
8
$V_{CE}(V)$ 10


BSY38
$T_j = 25°C$
$f = 1kc/s$
h_{re} $(x10^{-4})$
10
8
6
4
2
0
0
2
4
6
8
$I_C(mA)$ 10
$V_{CE} = 10V$
1V
5V

S

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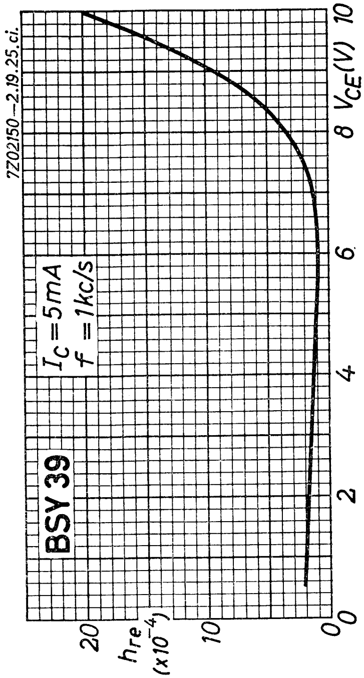
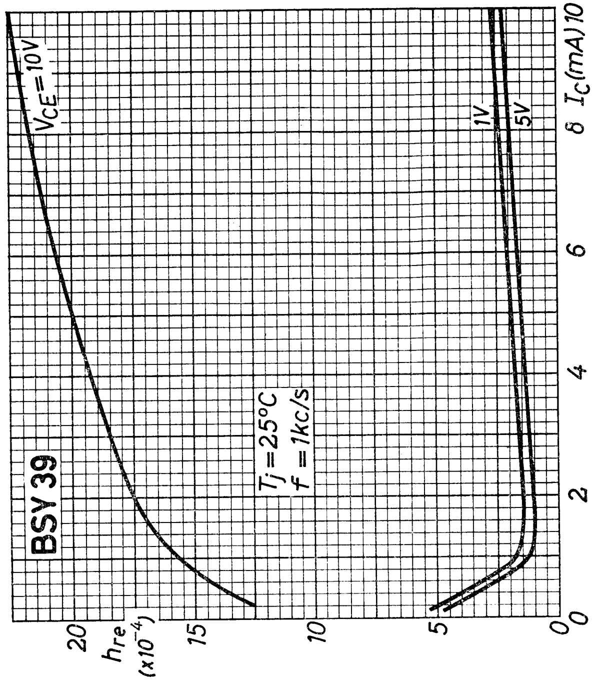
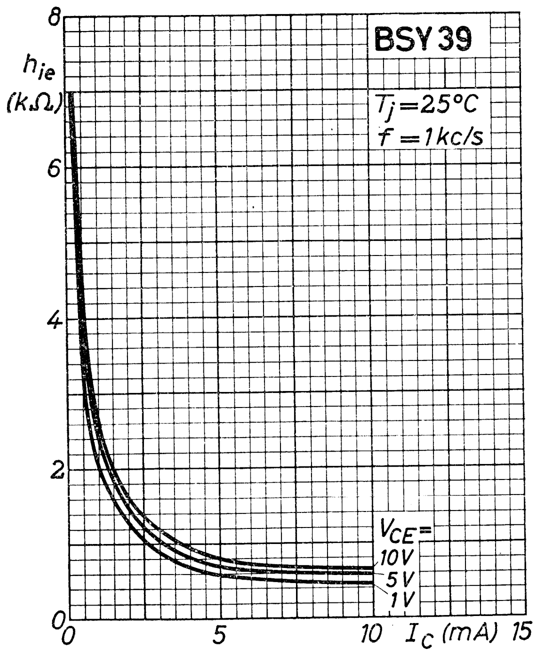
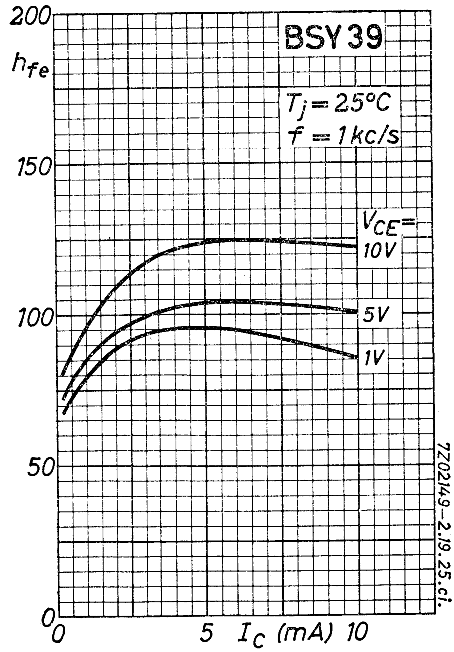
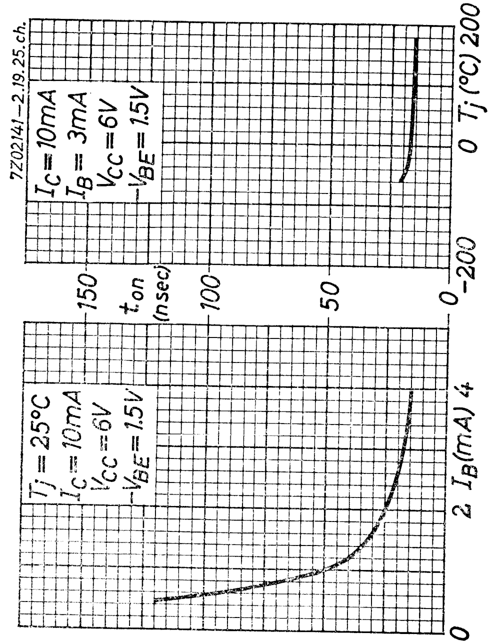

7Z02150—2.19.25.ci.
BSY 39
$I_C = 5mA$
$f = 1kc/s$
$V_{CE}(V)$
h_{re} $(x10^{-4})$
0
2
4
6
8
10
20

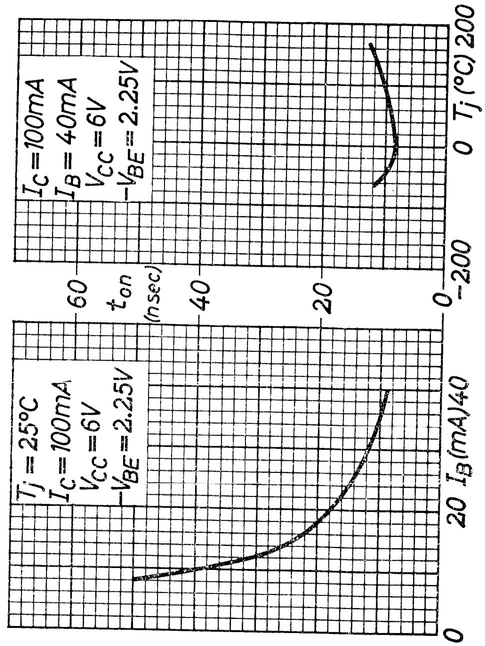

BSY 39
$T_j = 25°C$
$f = 1kc/s$
$V_{CE} = 10V$
1V
5V
$I_C(mA)$
h_{re} $(x10^{-4})$
0
2
4
6
8
10
5
15
20


BSY 39
$T_j = 25°C$
$f = 1kc/s$
h_{ie} $(k\Omega)$
$V_{CE} =$
10V
5V
1V
I_C (mA)
0
2
4
5
6
8
10
15

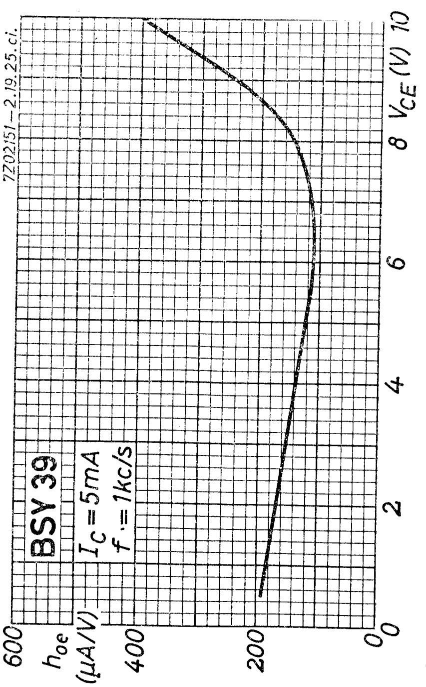

BSY 39
$T_j = 25°C$
$f = 1kc/s$
h_{fe}
$V_{CE} =$
10V
5V
1V
I_C (mA)
7Z02149—2.19.25.ci.
0
5
10
50
100
150
200

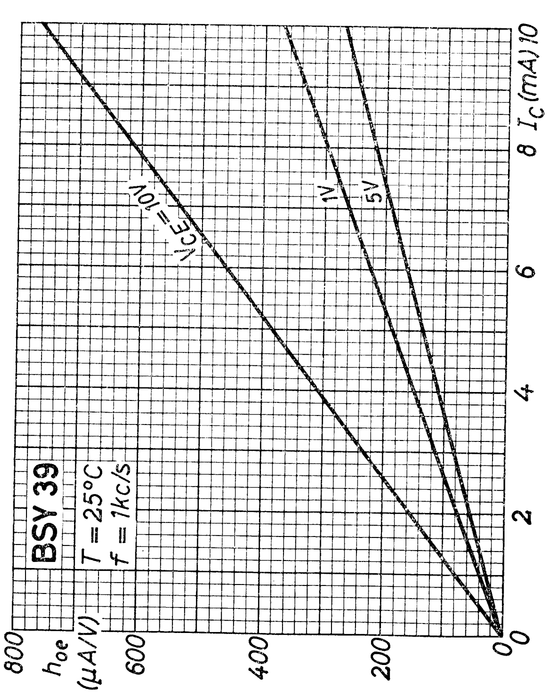
6.6.1964


7Z02141-2.19.25.ch.
$I_C = 10mA$
$I_B = 3mA$
$V_{CC} = 6V$
$-V_{BE} = 1.5V$
$T_j = 25°C$
$I_C = 10mA$
$V_{CC} = 6V$
$-V_{BE} = 1.5V$
t_{on} (nsec)
150
100
50
0
-200
0
T_j (°C) 200
0
2
I_B (mA) 4


$I_C = 100mA$
$I_B = 40mA$
$V_{CC} = 6V$
$-V_{BE} = 2.25V$
$T_j = 25°C$
$I_C = 100mA$
$V_{CC} = 6V$
$-V_{BE} = 2.25V$
t_{on} (nsec)
60
40
20
0
-200
0
T_j (°C) 200
0
20
I_B (mA) 40

X


7Z02151-2.19.25.ci.
BSY 39
$I_C = 5mA$
$f = 1kc/s$
h_{oe} (μA/V)
600
400
200
0
0
2
4
6
8
V_{CE} (V) 10

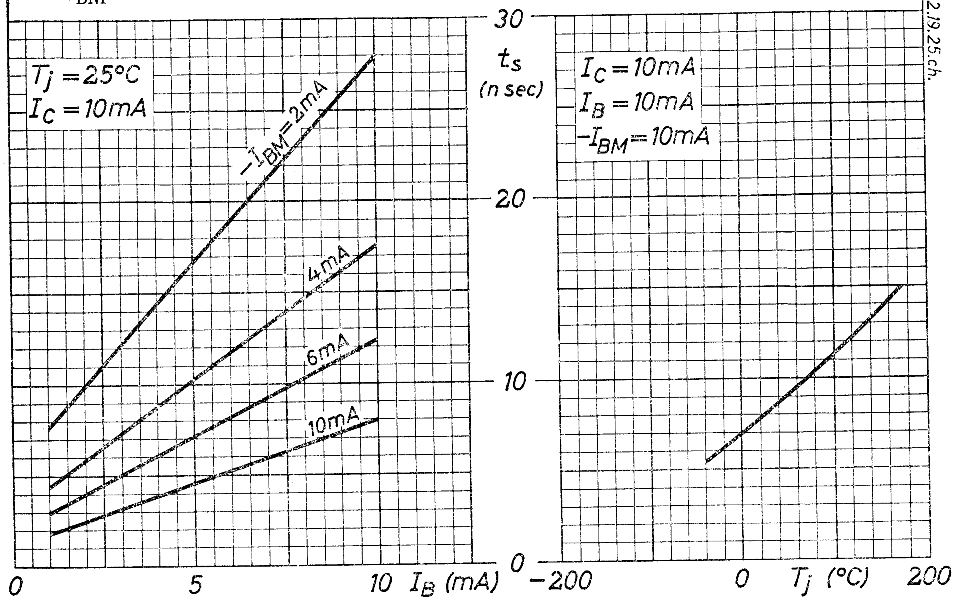

BSY 39
$T = 25°C$
$f = 1kc/s$
h_{oe} (μA/V)
800
600
400
200
0
0
2
4
6
8
I_C (mA) 10
$V_{CE} = 10V$
1V
5V

W

6.6.1964

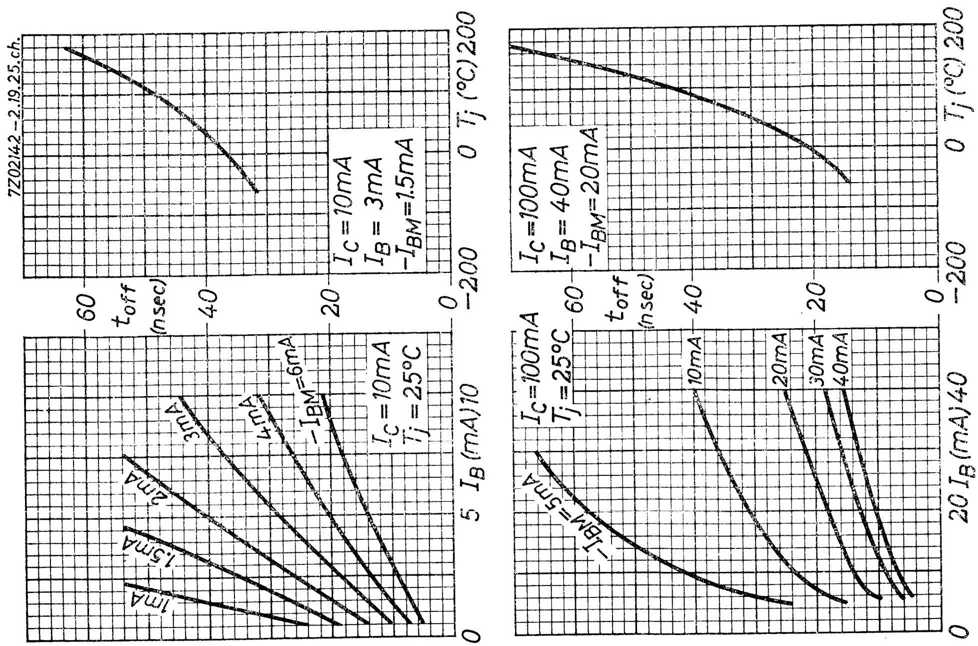
Z

−I_{BM} is the reverse current peak that occurs during switching off. The indicated value of −I_{BM} is determined and limited by the applied cut-off voltage and series resistance.



7Z02143–2.19.25.ch.

Y



7Z02142–2.19.25.ch.

6.6.1964

R.F. POWER TRANSISTOR of the p-n-p type for use in high-speed industrial switching applications, digital computers and high-quality audio amplifiers

LIMITING VALUES (Absolute max. values)

Collector

Voltage (emitter reference; averaging time = max. 20 msec)	$-V_{CE}$ = max. (t_{av} = max.	24 V [1]) 20 msec)
Peak voltage (emitter reference)	$-V_{CEM}$ = max.	32 V [1])
Voltage (base reference; averaging time = max. 20 msec)	$-V_{CB}$ = max. (t_{av} = max.	36 V 20 msec)
Peak voltage (base reference)	$-V_{CBM}$ = max.	47 V
Current (averaging time = max. 20 msec)	$-I_C$ = max. (t_{av} = max.	1 A 20 msec)
Peak current	$-I_{CM}$ = max.	2 A

Emitter

Reverse voltage (base reference; averaging time = max. 20 msec)	$-V_{EB}$ = max. (t_{av} = max.	12 V 20 msec)
Peak reverse voltage	$-V_{EBM}$ = max.	15 V
Current (averaging time = max. 20 msec)	I_E = max. (t_{av} = max.	1.2 A 20 msec)
Peak current	I_{EM} = max.	2.2 A

Base

Current	$-I_B$ = max.	200 mA
Peak current	$-I_{BM}$ = max.	200 mA

Dissipation

Total dissipation (See also pages F and G)	P_{tot} = max.	$\frac{90^{o} - T_{amb}}{K}$

Temperatures

Storage temperature	T_S =	−55 °C to +75 °C
Junction temperature	T_j = max.	90 °C

THERMAL DATA

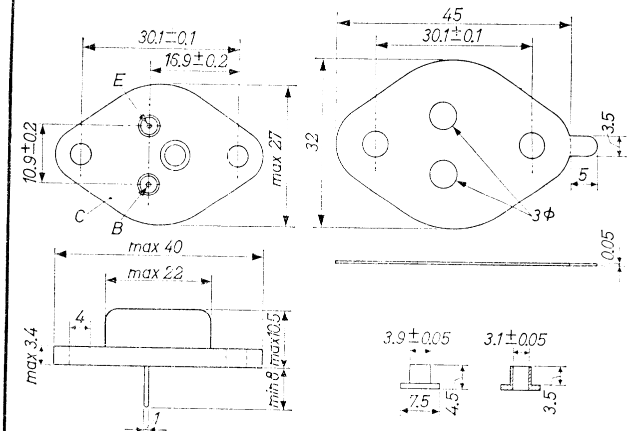
Thermal resistance from junction to transistor bottom	K =	3 °C/W
Thermal resistance from transistor bottom to heat sink with mica insulation	K =	0.5 °C/W
without insulation	K =	0.2 °C/W

[1]) See pages D and E

7Z2 1219
6.6.1962

Dimensions in mm

Mica insulation



Insulation bush

CHARACTERISTICS at T_j = 25 °C

Collector current at I_E = 0 mA

$-I_{CBO}(-V_{CB} = 10\ V;\ I_E = 0\ mA)$ = 30 µA < 100 µA

Emitter current at I_C = 0 mA

$-I_{EBO}(-V_{EB} = 10\ V;\ I_C = 0\ mA)$ = 20 µA < 100 µA

Collector bottoming voltage

$-V_{CE}\ (-I_C = 1\ A;\ -I_B = 30\ mA)$ = 0.6 V

Base voltage

$-V_{BE}\ (-V_{CE} = 2\ V;\ -I_C = 100\ mA)$ = 0.26 V < 0.35 V

$-V_{BE}\ (-V_{CE} = 2\ V;\ -I_C \doteq 1\ A)$ = 1.0 V < 2.0 V

D.C. current amplification factor

$h_{FE}\ (-V_{CE} = 2\ V;\ -I_C = 100\ mA)$ = 200

$h_{FE}\ (-V_{CE} = 2\ V;\ -I_C = 1\ A)$ = 150 > 50

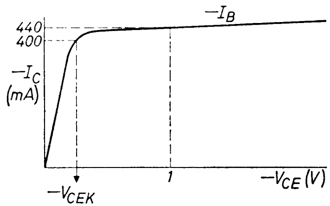
7Z2 1220

CHARACTERISTICS (continued)

Collector knee voltage

Measured at $-I_C$ = 400 mA

$-I_B$ = value at which $-I_C$ = 440 mA when $-V_{CE}$ = 1 V

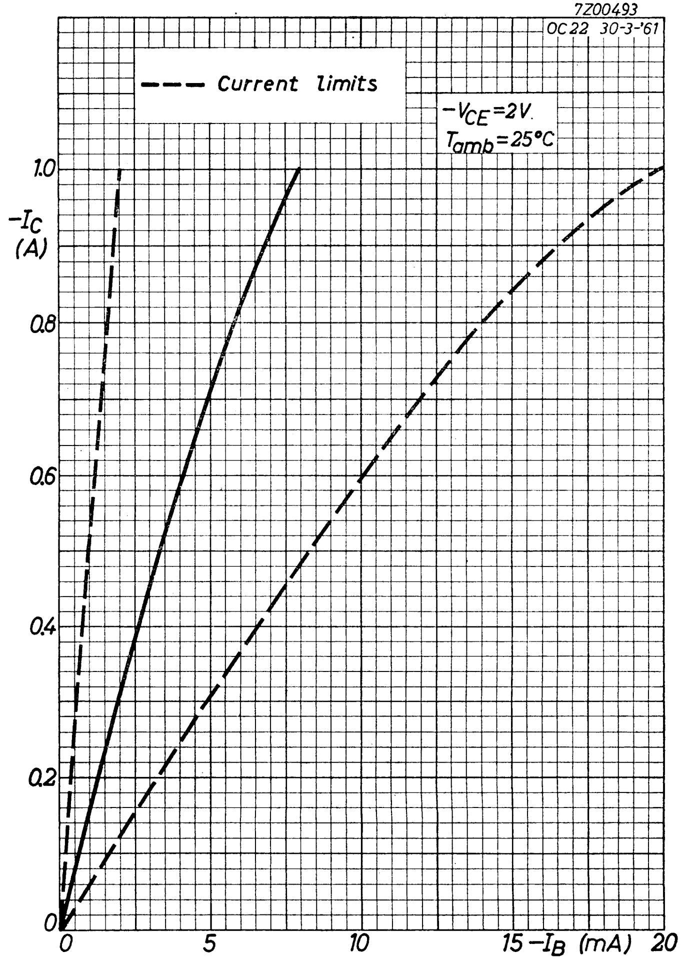


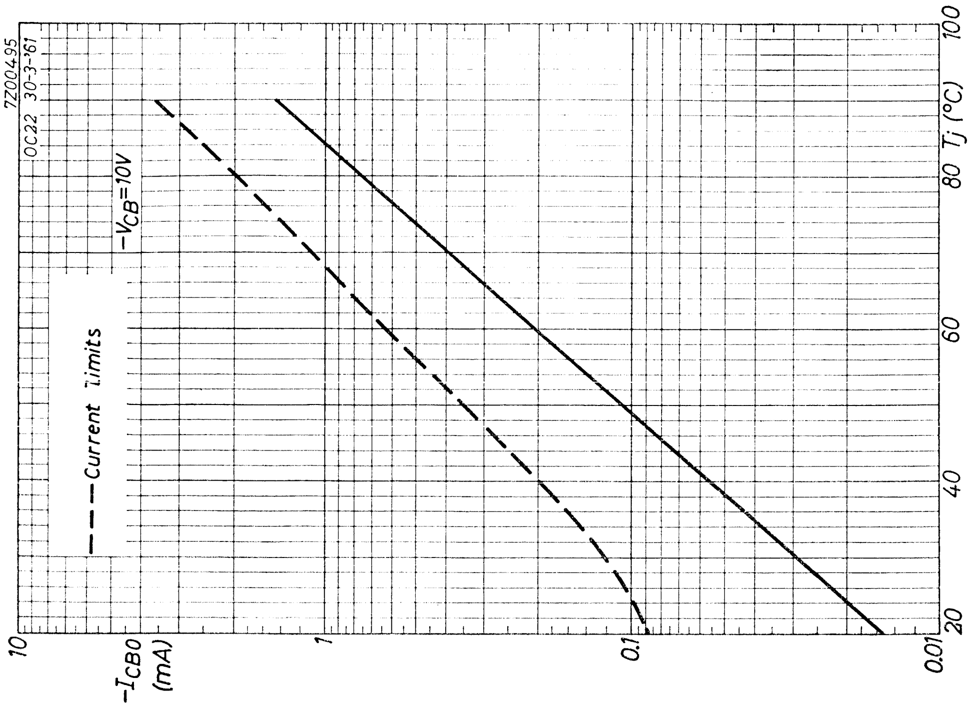
$-V_{CEK}$ = 0.4 V < 0.6 V

Parameters

Measured at

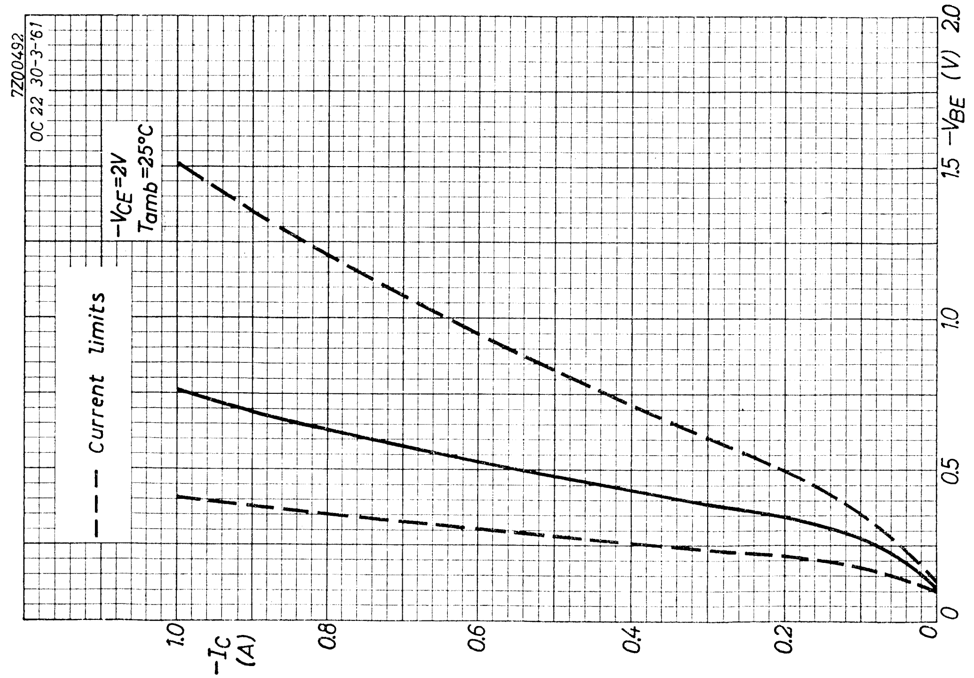
Collector voltage	$-V_{CE}$	= 2 V
Collector current	$-I_C$	= 400 mA
Transistor bottom temperature	T_m	= 25 °C
Intrinsic base resistance	$r_{bb'}$	= 100 Ω
Feedback capacitance	$c_{b'c}$	= 170 pF
Cut-off frequency	$f_{\alpha b}$	= 2.5 Mc/s
Intrinsic transconductance	g_m	= 16 A/V
Current amplification factor at low frequencies	h_{fe}	= 180





7Z00495
OC22 30-3-'61
−V_CB=10V
— — — Current limits
−I_CBO (mA)
10
1
0.1
0.01
Tj (°C)
20
40
60
80
100

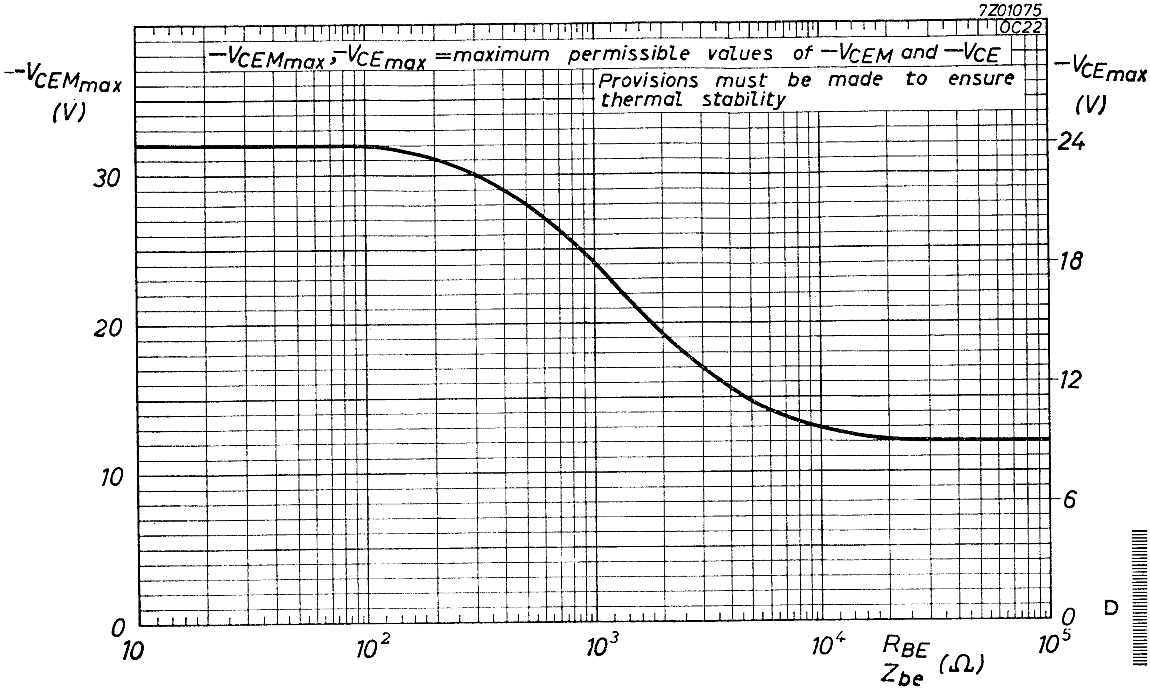
C



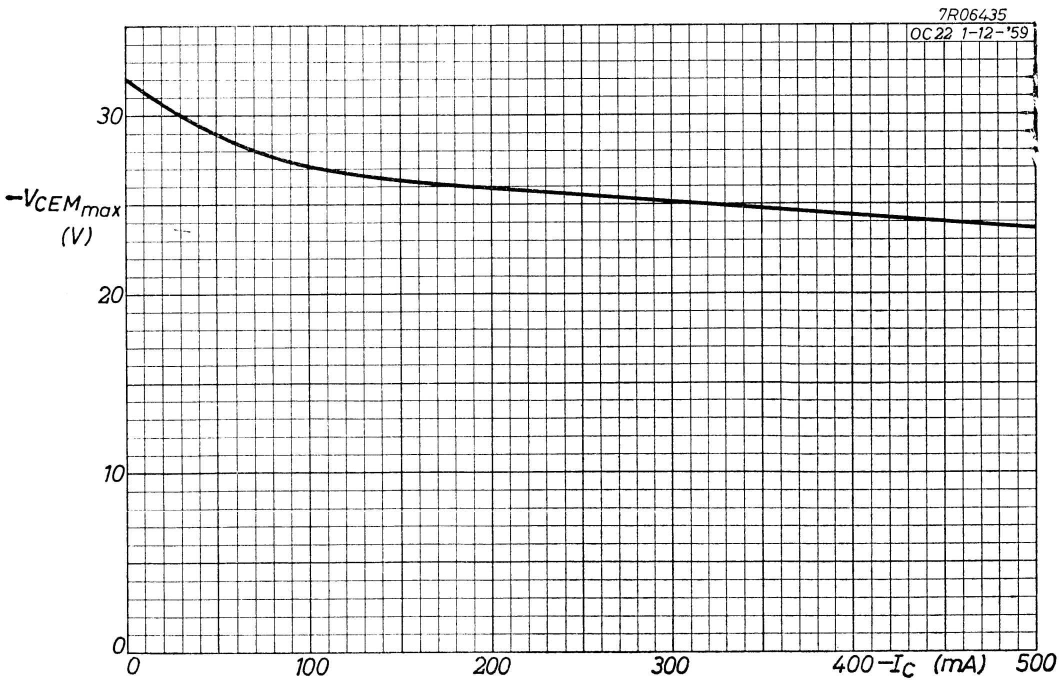
7Z00492
OC 22 30-3-'61
−V_CE=2V
T_amb=25°C
— — — Current limits
−I_C (A)
1.0
0.8
0.6
0.4
0.2
0
0.5
1.0
1.5
2.0
−V_BE (V)

B

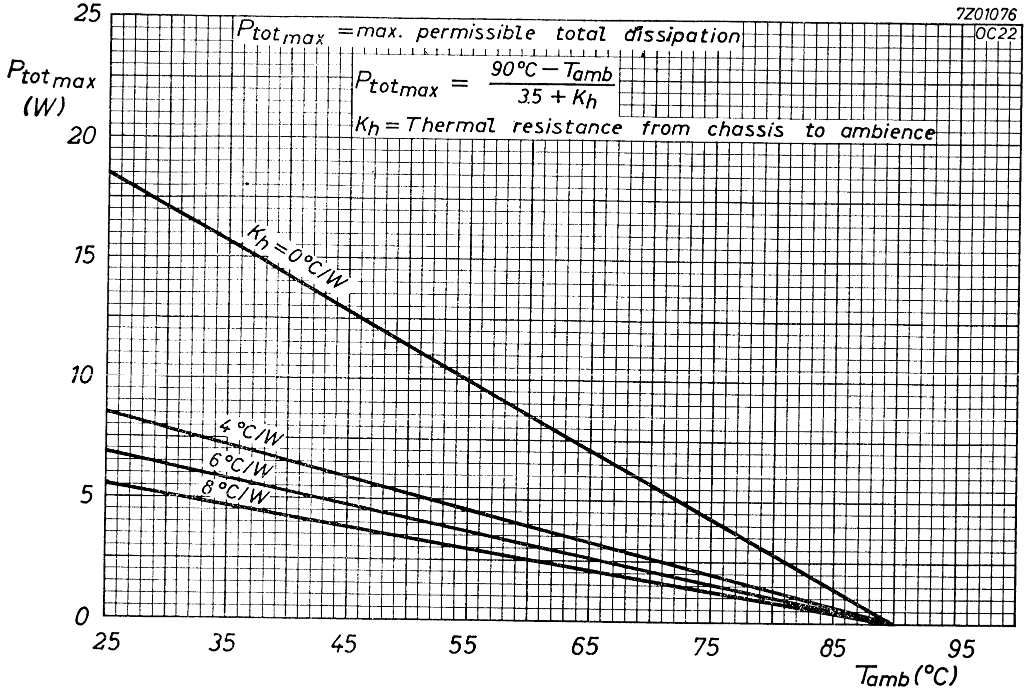
6.6.1962


7Z01075
OC22
$-V_{CEMmax}$, $-V_{CEmax}$ = maximum permissible values of $-V_{CEM}$ and $-V_{CE}$
Provisions must be made to ensure thermal stability
$-V_{CEMmax}$ (V)
$-V_{CEmax}$ (V)
0
10
20
30
0
6
12
18
24
10
10^2
10^3
10^4
10^5
R_{BE} Z_{be} (Ω)

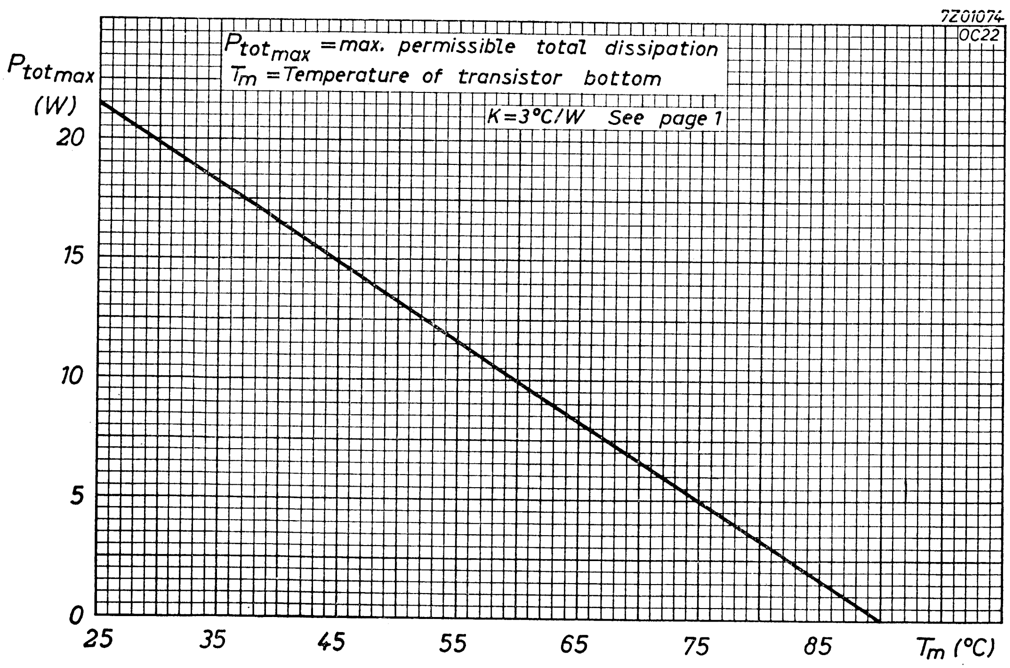
D


7R06435
OC22 1-12-'59
$-V_{CEMmax}$ (V)
0
10
20
30
0
100
200
300
400
500
$-I_C$ (mA)

E


7Z01076
OC22
$P_{tot\,max}$ = max. permissible total dissipation
$P_{tot\,max} = \frac{90°C - T_{amb}}{3.5 + K_h}$
K_h = Thermal resistance from chassis to ambience
$P_{tot\,max}$ (W)
K_h = 0°C/W
4 °C/W
6 °C/W
8 °C/W
T_{amb} (°C)

F


7Z01074
OC22
$P_{tot\,max}$ = max. permissible total dissipation
T_m = Temperature of transistor bottom
K = 3°C/W See page 1
$P_{tot\,max}$ (W)
T_m (°C)

G

6.6.1962

R.F. POWER TRANSISTOR of the p-n-p type for use in high-speed industrial switching applications, digital computers; particularly suitable as a pulse generator for a ferrite store

LIMITING VALUES (Absolute max. values)

Collector

Voltage (emitter reference; averaging time = max. 20 msec)	$-V_{CE}$ = max. (t_{av} = max.	24 V [1] 20 msec)
Peak voltage (emitter reference)	$-V_{CEM}$ = max.	40 V [1]
Voltage (base reference; averaging time = max. 20 msec)	$-V_{CB}$ = max. (t_{av} = max.	36 V 20 msec)
Peak voltage (base reference)	$-V_{CBM}$ = max.	55 V
Current (averaging time = max. 20 msec)	$-I_C$ = max. (t_{av} = max.	1 A 20 msec)
Peak current	$-I_{CM}$ = max.	2 A

Emitter

Reverse voltage (base reference; averaging time = max. 20 msec)	$-V_{EB}$ = max. (t_{av} = max.	12 V 20 msec)
Peak reverse voltage	$-V_{EBM}$ = max.	15 V
Current (averaging time = max. 20 msec)	I_E = max. (t_{av} = max.	1.2 A 20 msec)
Peak current	I_{EM} = max.	2.2 A

Base

Current	$-I_B$ = max.	200 mA
Peak current	$-I_{BM}$ = max.	200 mA

Dissipation

Total dissipation (See also pages F and G) P_{tot} = max. $\frac{90^{o}-T_{amb}}{K}$

Temperatures

Storage temperature	T_s	= −55 °C to +75 °C
Junction temperature	T_j	= max. 90 °C

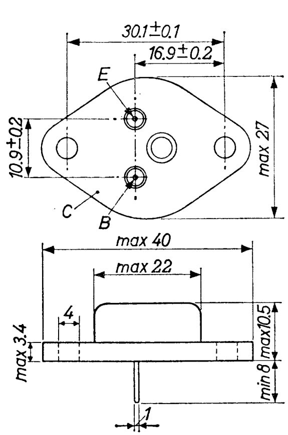
THERMAL DATA

Thermal resistance from junction to transistor bottom	K =	3 °C/W
Thermal resistance from transistor bottom to heat sink		
with mica insulation	K =	0.5 °C/W
without insulation	K =	0.2 °C/W

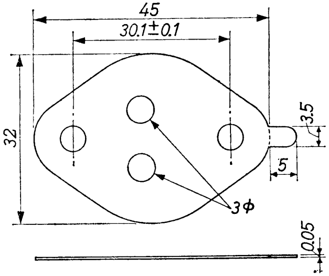
[1]) See pages D and E

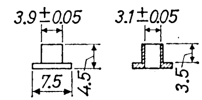
7Z2 1222
6.6.1962

Dimensions in mm



Mica insulation





Insulation bush

CHARACTERISTICS at T_j = 25 °C

Collector current at I_E = 0 mA			
$-I_{CBO}$ ($-V_{CB}$ = 10 V; I_E = 0 mA)	= 30 µA	<	100 µA
Emitter current at I_C = 0 mA			
$-I_{EBO}$ ($-V_{EB}$ = 10 V; I_C = 0 mA)	= 20 µA	<	100 µA
Collector bottoming voltage			
$-V_{CE}$ ($-I_C$ = 1 A; $-I_B$ = 30 mA)	= 0.4 V		
Collector current			
$-I_C$ ($-V_{CE}$ = 40 V; V_{BE} = 0.5 V)	=	<	2 mA
Base voltage			
$-V_{BE}$ ($-V_{CE}$ = 2 V; $-I_C$ = 100 mA)	= 0.25 V	<	0.35 V
$-V_{BE}$ ($-V_{CE}$ = 2 V; $-I_C$ = 1 A)	= 0.8 V	<	2.0 V
D.C. current amplification factor			
h_{FE} ($-V_{CE}$ = 2 V; $-I_C$ = 100 mA)	= 200		
h_{FE} ($-V_{CE}$ = 2 V; $-I_C$ = 1 A)	= 150	>	50

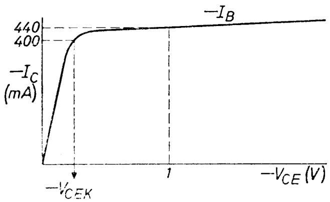
7Z2 1223

CHARACTERISTICS (continued)

Collector knee voltage

Measured at $-I_C$ = 400 mA

$-I_B$ = value at which $-I_C$ = 440 mA when $-V_{CE}$ = 1 V



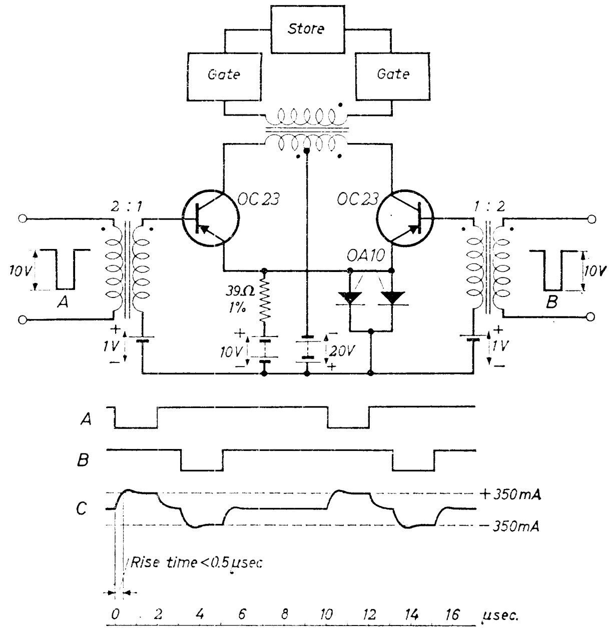
$-V_{CEK}$ = 0.35 V < 0.6 V

Parameters

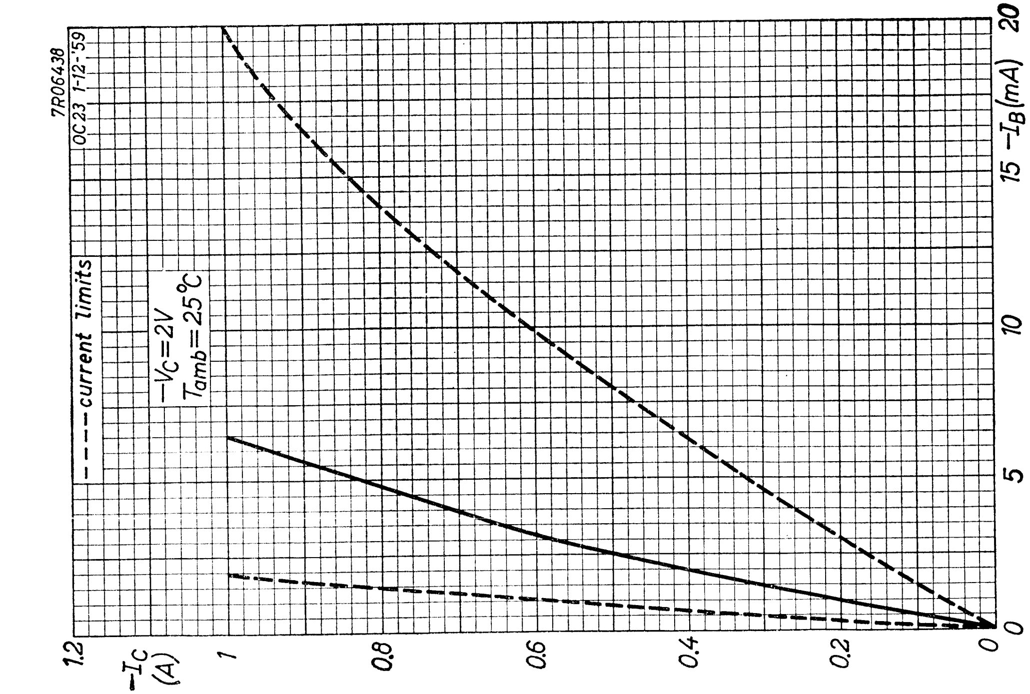
Measured at

Collector voltage	$-V_{CE}$	= 2 V
Collector current	$-I_C$	= 400 mA
Transistor bottom temperature	T_m	= 25 °C
Intrinsic base resistance	$r_{bb'}$	= 80 Ω
Feedback capacitance	$c_{b'c}$	= 170 pF
Cut-off frequency	$f_{\alpha b}$	= 2.5 Mc/s
Intrinsic transconductance	g_m	= 16 A/V
Current amplification factor at low frequencies	h_{fe}	= 180

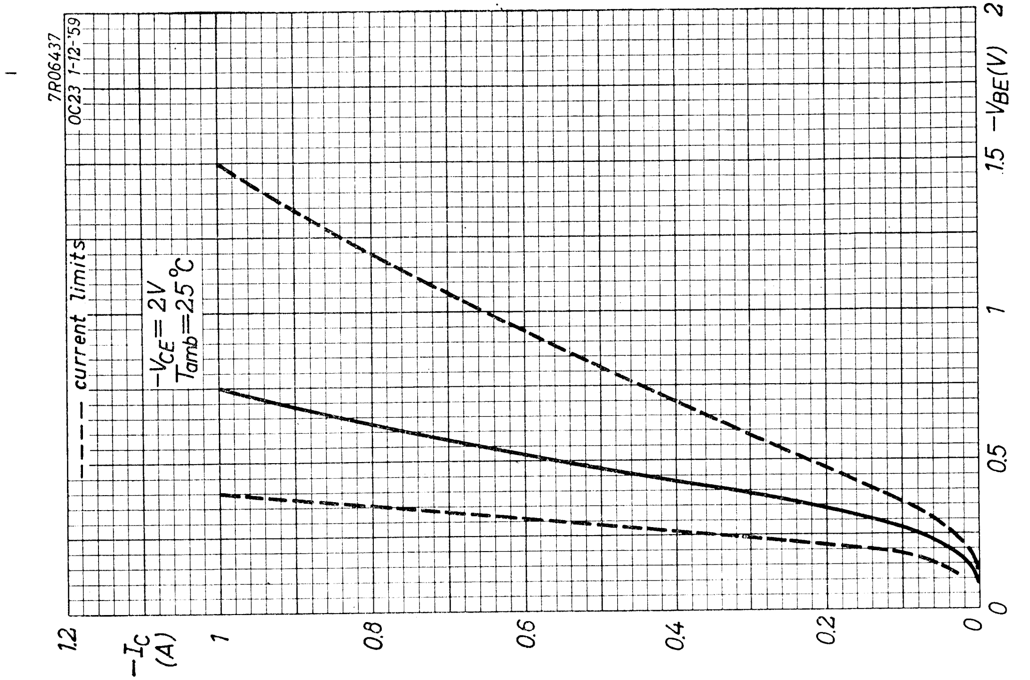
OPERATING CHARACTERISTICS for typical pulse amplifier driving a ferrite store



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

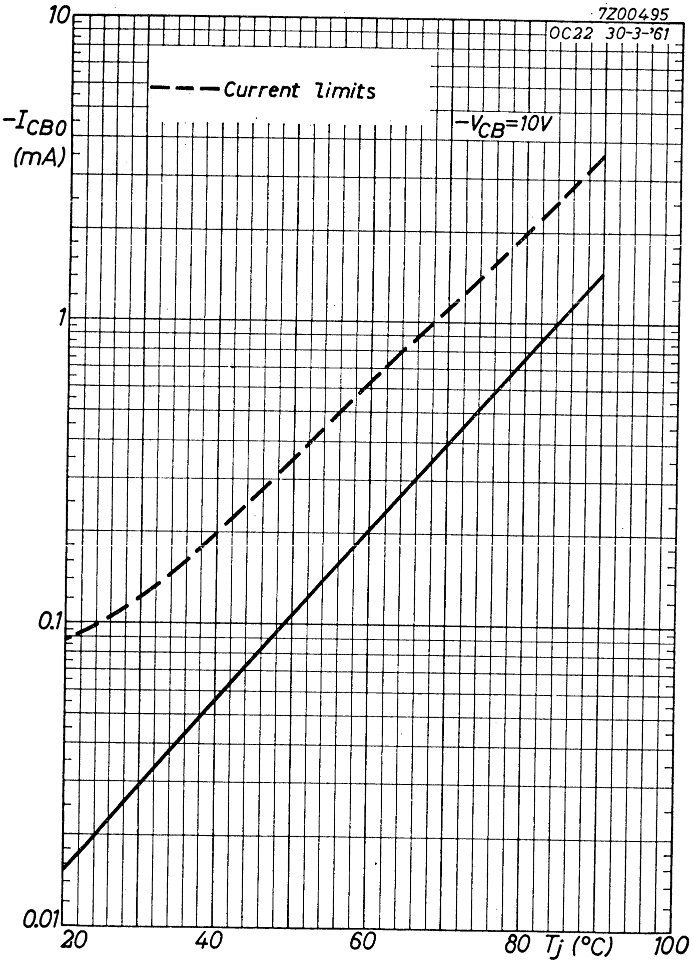

7R06438
OC23 1-12-'59
- - - - current limits
$-V_C = 2V$
$T_{amb} = 25°C$
$-I_C$ (A)
1.2
1
0.8
0.6
0.4
0.2
0
0
5
10
15
20
$-I_B$ (mA)

A

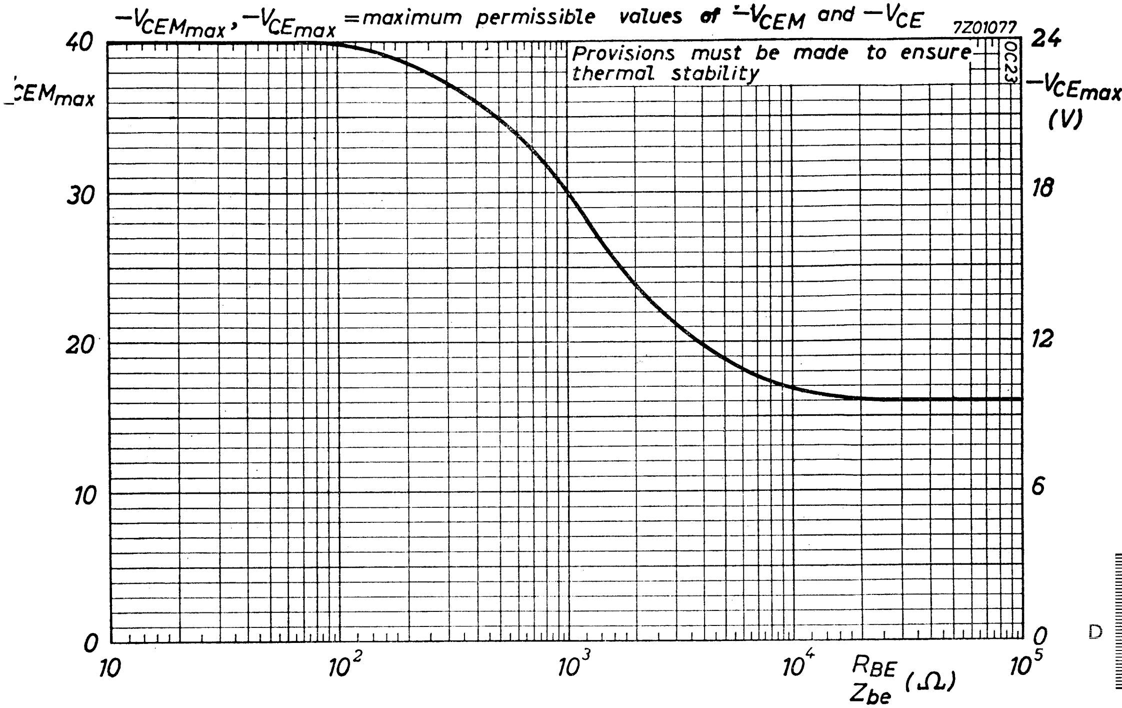

7R06437
OC23 1-12-'59
- - - - current limits
$-V_{CE} = 2V$
$T_{amb} = 25°C$
$-I_C$ (A)
1.2
1
0.8
0.6
0.4
0.2
0
0
0.5
1
1.5
2
$-V_{BE}$ (V)

B

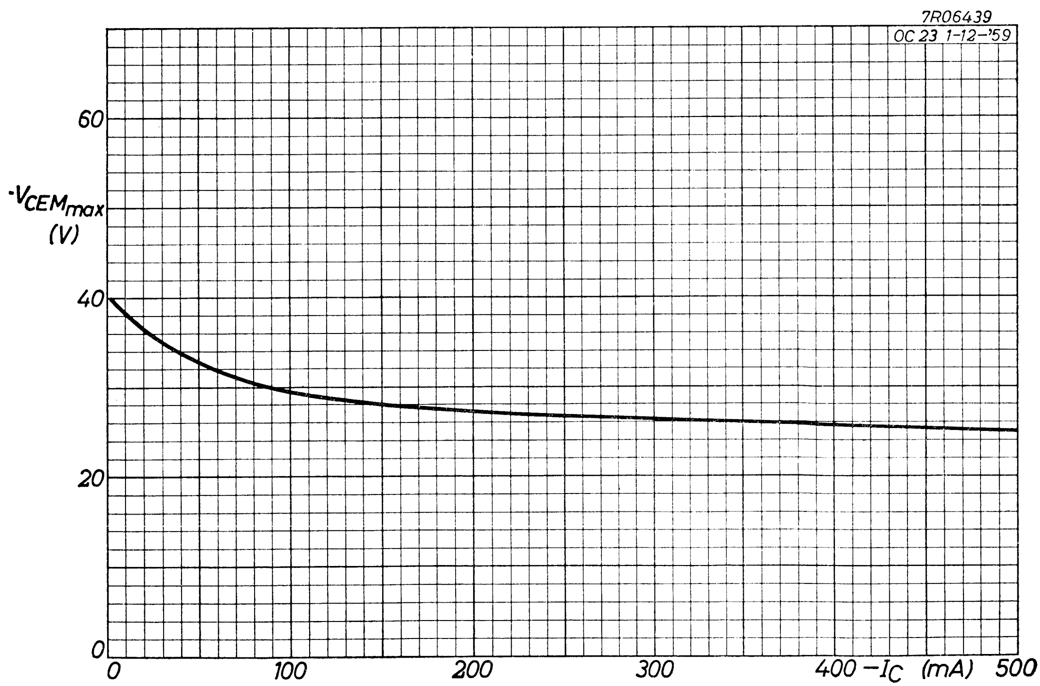
6.6.1962



7Z00495
OC22 30-3-'61
Current limits
$-I_{CBO}$ (mA)
$-V_{CB}$=10V
10
1
0.1
0.01
20
40
60
80
100
T_j (°C)

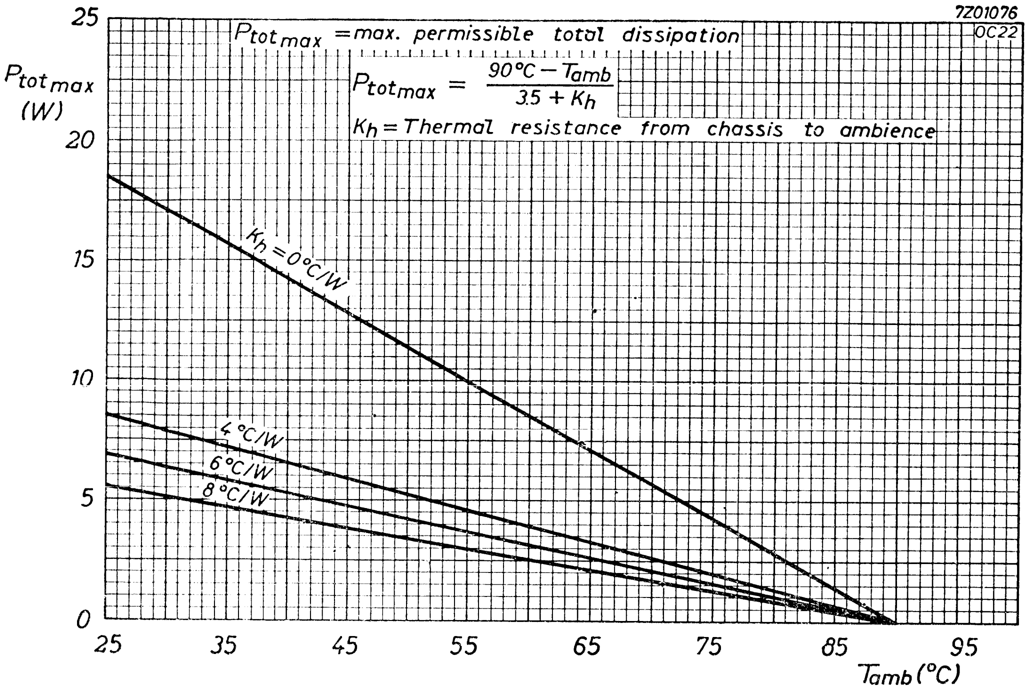

$-V_{CEMmax}$, $-V_{CEmax}$ = maximum permissible values of $-V_{CEM}$ and $-V_{CE}$
7Z01077
Provisions must be made to ensure thermal stability
OC23
$-V_{CEMmax}$
$-V_{CEmax}$
(V)
40
30
20
10
0
24
18
12
6
0
10
10^2
10^3
10^4
10^5
R_{BE}
Z_{be} (Ω)

D

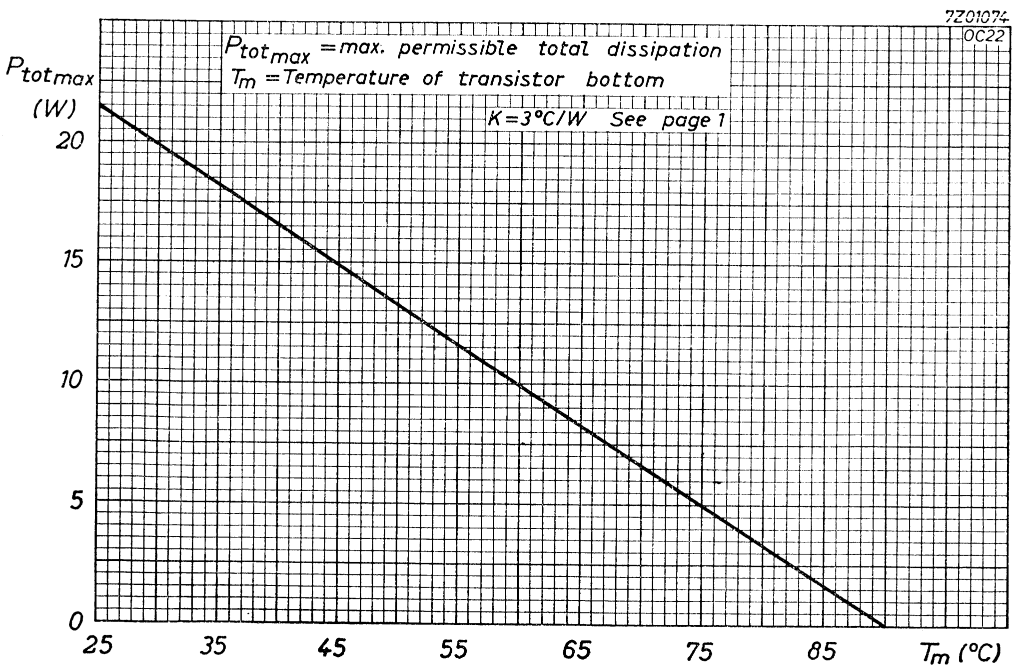

7R06439
OC 23 1-12-'59
$-V_{CEMmax}$
(V)
60
40
20
0
0
100
200
300
400
500
$-I_C$ (mA)

E

6.6.1962


7Z01076
OC22
$P_{tot\,max}$ = max. permissible total dissipation
$P_{tot\,max} = \frac{90°C - T_{amb}}{3.5 + K_h}$
K_h = Thermal resistance from chassis to ambience
$P_{tot\,max}$ (W)
K_h = 0°C/W
4 °C/W
6 °C/W
8 °C/W
0
5
10
15
20
25
35
45
55
65
75
85
95
T_{amb} (°C)

F


7Z01074
OC22
$P_{tot\,max}$ = max. permissible total dissipation
T_m = Temperature of transistor bottom
K = 3°C/W See page 1
$P_{tot\,max}$ (W)
0
5
10
15
20
25
35
45
55
65
75
85
T_m (°C)

G

6.6.1962

R.F. POWER TRANSISTOR of the p-n-p type for use in high-speed industrial switching applications, digital computers and for medium frequency transmitter and carrier telephony applications

LIMITING VALUES (Absolute max. values)

Collector

Voltage (emitter reference; averaging time = max. 20 msec)	$-V_{CE}$ (t_{av}	= max. = max.	24 V 1) 20 msec)
Peak voltage (emitter reference)	$-V_{CEM}$	= max.	40 V 1)
Voltage (base reference; averaging time = max. 20 msec)	$-V_{CB}$ (t_{av}	= max. = max.	36 V 20 msec)
Peak voltage (base reference)	$-V_{CBM}$	= max.	47 V
Current (averaging time = max. 20 msec)	$-I_C$ (t_{av}	= max. = max.	1 A 20 msec)
Peak current	$-I_{CM}$	= max.	2 A

Emitter

Reverse voltage (base reference; averaging time = max. 20 msec)	$-V_{EB}$ (t_{av}	= max. = max.	12 V 20 msec)
Peak reverse voltage	$-V_{EBM}$	= max.	15 V
Current (averaging time = max. 20 msec)	I_E (t_{av}	= max. = max.	1.2 A 20 msec)
Peak current	I_{EM}	= max.	2.2 A

Base

Current	$-I_B$	= max.	200 mA
Peak current	$-I_{BM}$	= max.	200 mA

Dissipation

Total dissipation (See also pages F and G)	P_{tot}	= max.	$\frac{90^o - T_{amb}}{K}$

Temperatures

Storage temperature	T_s	=	-55 °C to +75 °C
Junction temperature	T_j	= max.	90 °C

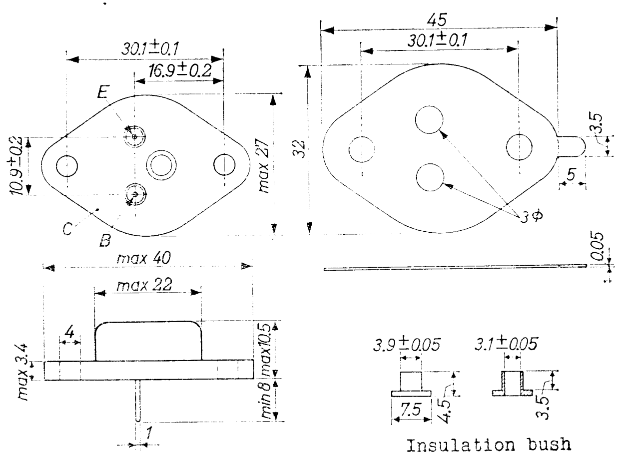
THERMAL DATA

Thermal resistance from junction to transistor bottom	K	=	3 °C/W
Thermal resistance from transistor bottom to heat sink			
with mica insulation	K	=	0.5 °C/W
without insulation	K	=	0.2 °C/W

1) See pages D and E

7Z2 1226
6.6.1962

Dimensions in mm



CHARACTERISTICS at T_j = 25 °C

Collector current at I_E = 0 mA				
$-I_{CBO}$ ($-V_{CB}$ = 10 V; I_E = 0 mA)	=	30 µA	<	100 µA
Emitter current at I_C = 0 mA				
$-I_{EBO}$ ($-V_{EB}$ = 10 V; I_C = 0 mA)	=	20 µA	<	100 µA
Collector bottoming voltage				
$-V_{CE}$ ($-I_C$ = 1 A; $-I_B$ = 30 mA)	=	0.4 V		
Collector current				
$-I_C$ ($-V_{CE}$ = 40 V; V_{BE} = 0.5 V)	=		<	2 mA
Base voltage				
$-V_{BE}$ ($-V_{CE}$ = 2 V; $-I_C$ = 100 mA)	=	0.25 V	<	0.35 V
$-V_{BE}$ ($-V_{CE}$ = 2 V; $-I_C$ = 1 A)	=	0.8 V	<	2.0 V
D.C. current amplification factor				
h_{FE} ($-V_{CE}$ = 2 V; $-I_C$ = 100 mA)	=	200		
h_{FE} ($-V_{CE}$ = 2 V; $-I_C$ = 1 A)	=	150	>	50

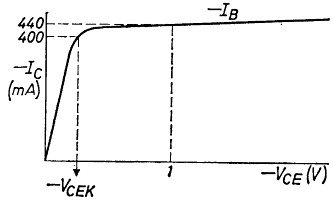
7Z2 1223

CHARACTERISTICS (continued)

Collector knee voltage

Measured at $-I_C$ = 400 mA

$-I_B$ = value at which $-I_C$ = 440 mA when $-V_{CE}$ = 1 V



$-V_{CEK}$ = 0.35 V < 0.6 V

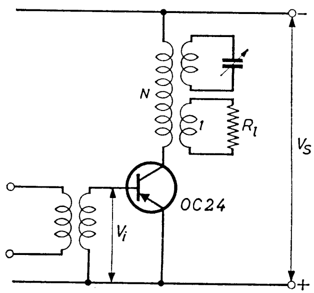
Parameters

Measured at

Collector voltage	$-V_{CE}$	=	2 V
Collector current	$-I_C$	=	400 mA
Transistor bottom temperature	T_m	=	25 °C
Intrinsic base resistance	$r_{bb'}$	=	70 Ω
Feedback capacitance	$c_{b'c}$	=	170 pF
Cut-off frequency	f_{db}	=	2.5 Mc/s
Intrinsic transconductance	g_m	=	16 A/V
Current amplification factor at low frequencies	h_{fe}	=	180

OPERATING CHARACTERISTICS as R.F. class B amplifier

T_{amb} = 25 °C



Transformer ratio N = 3.33:1

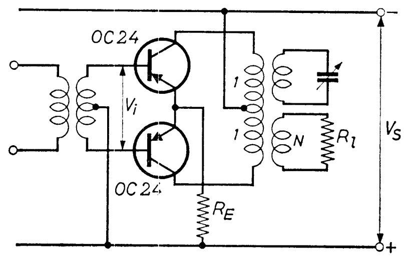
OPERATING CHARACTERISTICS as R.F. class B amplifier (continued)

T_{amb} = 25 °C

Supply voltage	V_S	=	-12 V
Frequency	f	=	500 kc/s
Load resistance	R_ℓ	=	12 Ω
D.C. collector current	$-I_C$	=	90 mA
Peak drive voltage	V_{im}	=	2.1 V
Drive power	P_i	=	25 mW
Power delivered to load	P_o	=	500 mW

OPERATING CHARACTERISTICS as R.F. class B push-pull amplifier

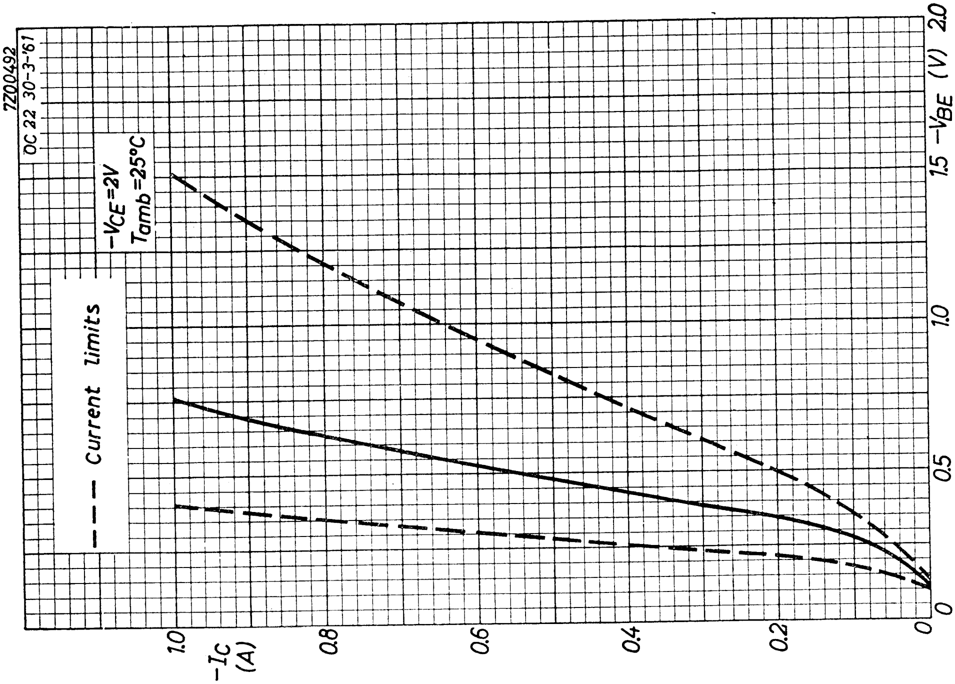
T_{amb} = 25 °C



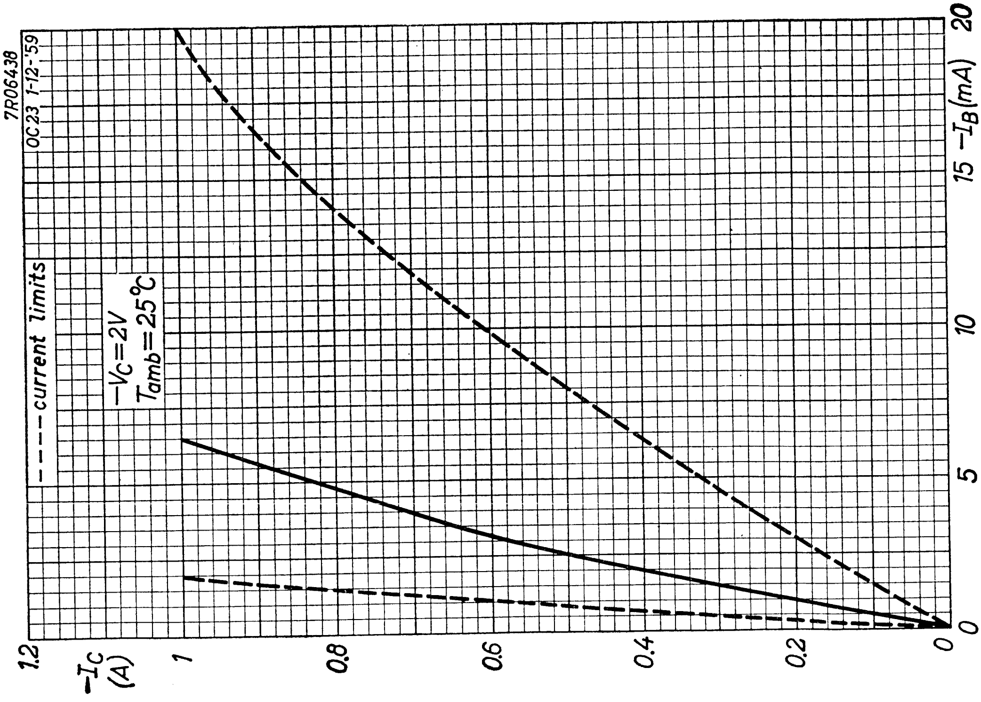
Transformer ratio (1:1):N = (1+1):2

Supply voltage	V_S	=	-12 V
Frequency	f	=	500 kc/s
Emitter resistor	R_E	=	1.0 Ω
Load resistance	R_ℓ	=	90 Ω
Transistor load	R_{cc}	=	90 Ω
Collector current	$-I_C$	=	2x275 mA
Peak collector current	$-I_{CM}$	=	865 mA
Peak drive voltage	V_{im}	=	5.4 V
Drive power	P_i	=	325 mW
Power delivered to load	P_o	=	3.0 W

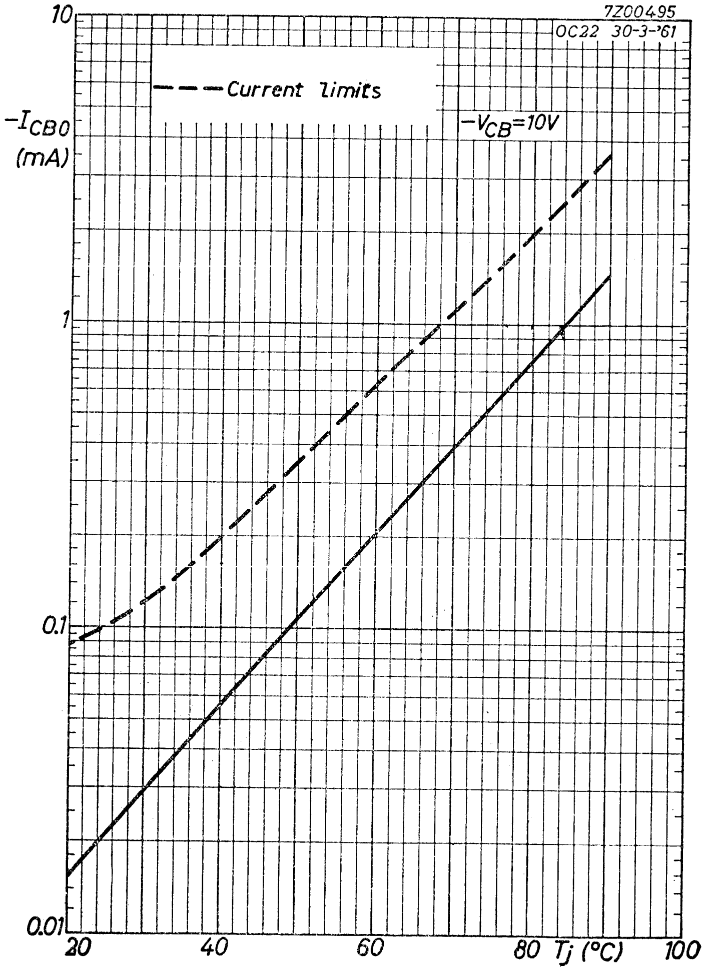
For operation up to an ambient temperature of 55 °C, the thermal resistance of each heat sink should be less than 4.5 °C/W

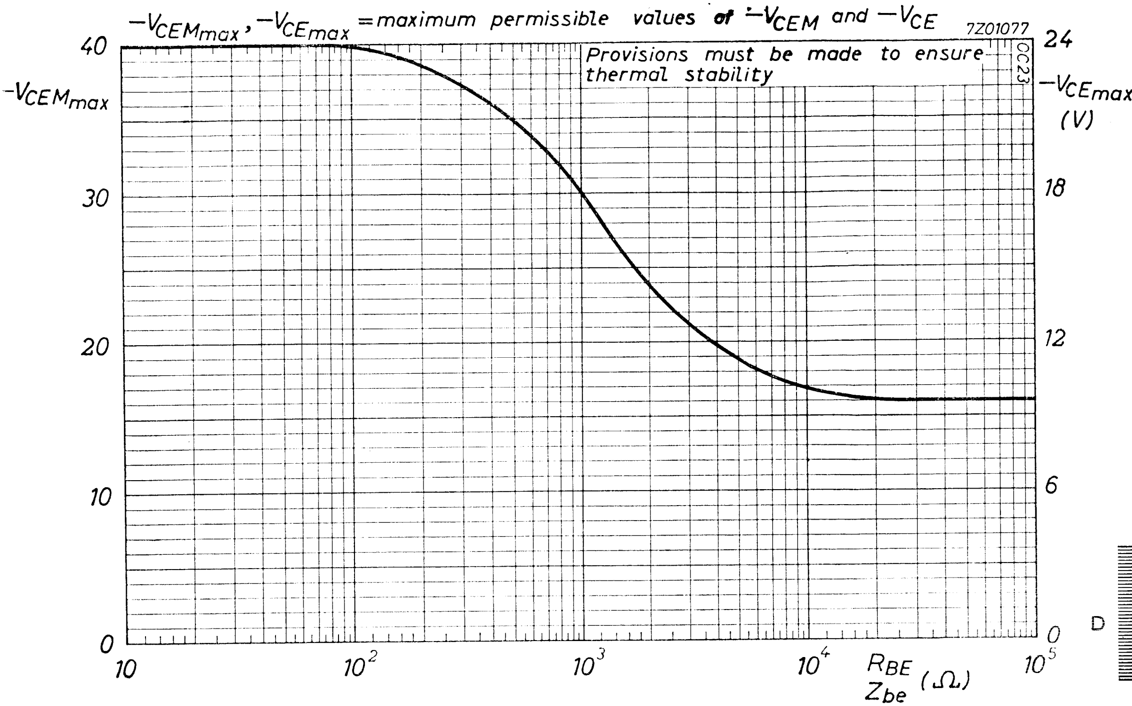

7Z00492
OC 22 30-3-'61
$-V_{CE}=2V$
$T_{amb}=25°C$
— — — Current limits
$-I_C$ (A)
1.0
0.8
0.6
0.4
0.2
0
0.5
1.0
1.5
2.0
$-V_{BE}$ (V)

B


7R06438
OC 23 1-12-'59
- - - - current limits
$-V_C=2V$
$T_{amb}=25°C$
$-I_C$ (A)
1.2
1
0.8
0.6
0.4
0.2
0
5
10
15
20
$-I_B$ (mA)

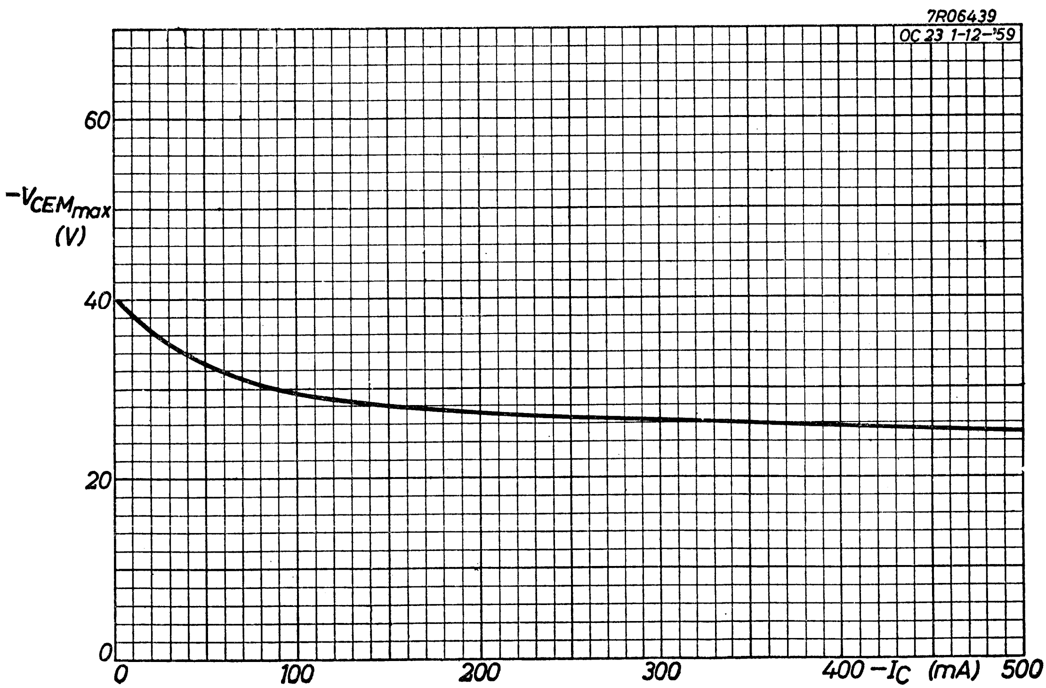
A


7Z00495
OC22 30-3-'61
Current limits
$-I_{CB0}$
(mA)
$-V_{CB}$=10V
10
1
0.1
0.01
20
40
60
80
100
T_j (°C)



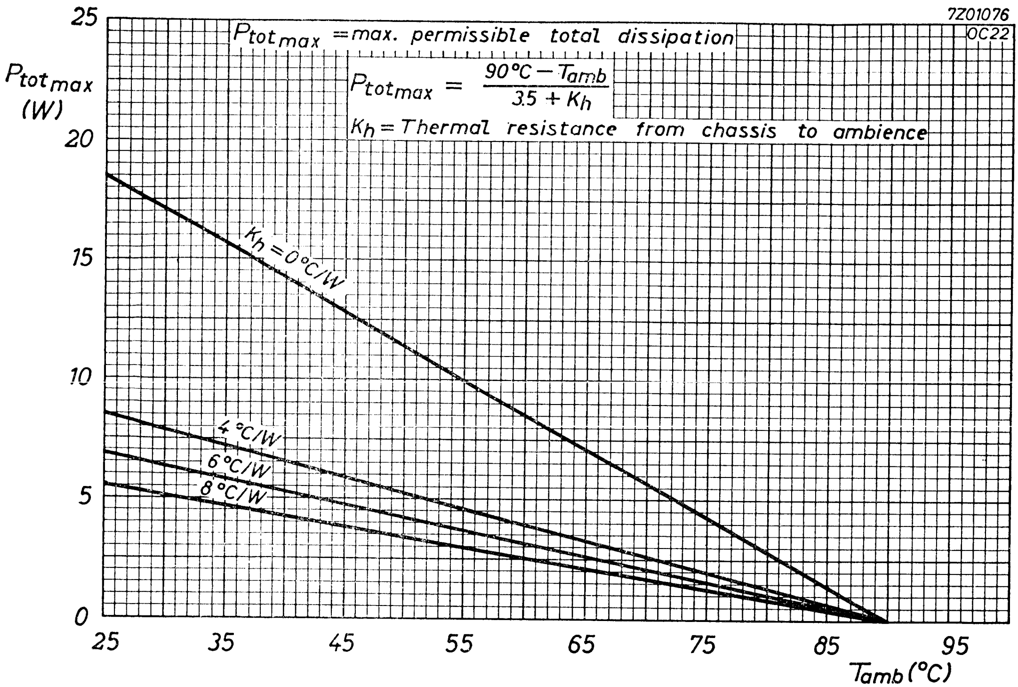
$-V_{CEMmax}$, $-V_{CEmax}$ = maximum permissible values of $-V_{CEM}$ and $-V_{CE}$
7Z01077
Provisions must be made to ensure thermal stability
OC23
$-V_{CEMmax}$
$-V_{CEmax}$ (V)
40
30
20
10
0
24
18
12
6
0
10
10^2
10^3
10^4
10^5
R_{BE} Z_{be} (Ω)

D

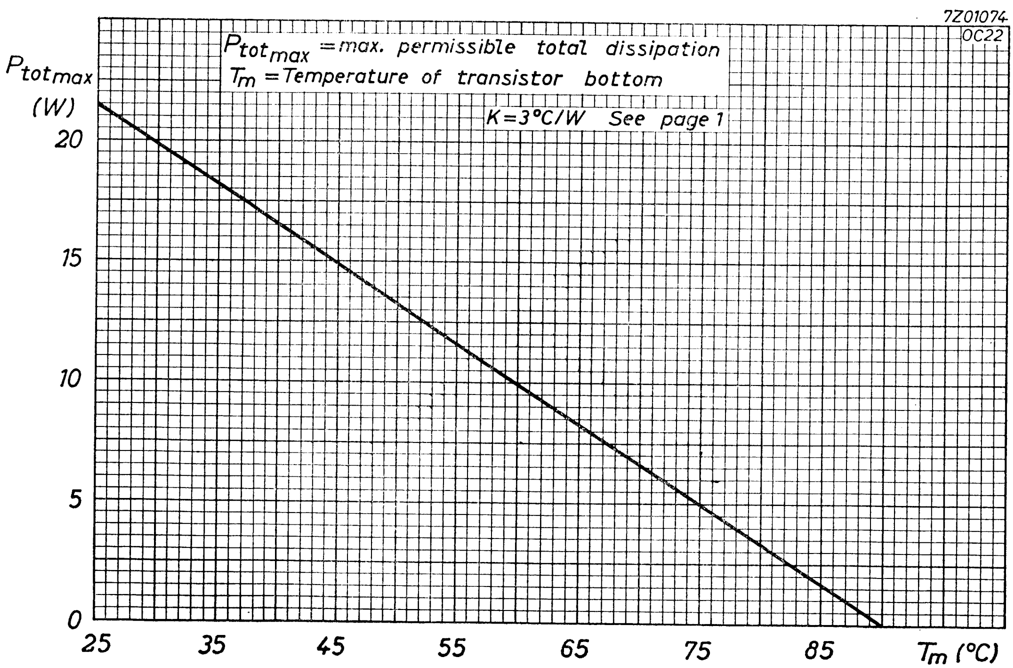


7R06439
OC 23 1-12-'59
$-V_{CEMmax}$ (V)
60
40
20
0
0
100
200
300
400
500
$-I_C$ (mA)

E


7Z01076
OC22
Ptot max = max. permissible total dissipation
Ptot max = 90°C − Tamb / 3.5 + Kh
Kh = Thermal resistance from chassis to ambience
Ptot max (W)
25
20
15
10
5
0
Kh = 0°C/W
4°C/W
6°C/W
8°C/W
25
35
45
55
65
75
85
95
Tamb (°C)

F


7Z01074
OC22
Ptot max = max. permissible total dissipation
Tm = Temperature of transistor bottom
K = 3°C/W See page 1
Ptot max (W)
20
15
10
5
0
25
35
45
55
65
75
85
Tm (°C)

G

6.6.1962

GERMANIUM POWER TRANSISTOR

Germanium transistor of the p-n-p type in TO-3 metal case for use in class A and B output stages at battery voltages of 7 and 14 V.
Type 2-OC26 consists of a matched pair, selected for operation in class B output stages.

LIMITING VALUES (Absolute max. values)

Collector-base voltage	$-V_{CB}$	max.	40	V
Collector-emitter voltage	$-V_{CE}$	max.	40	V
Collector current	$-I_C$	max.	3.5	A
Total dissipation up to $T_{mb} = 75\ ^oC$	P_{tot}	max.	12.5	W
Junction temperature	T_j	max.	90	^oC

CHARACTERISTICS $T_j = 25\ ^oC$

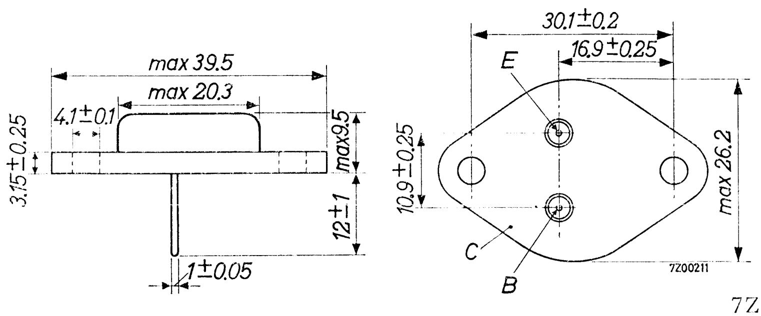
D.C. current gain

$-I_C = 30$ mA; $-V_{CE} = 14$ V	h_{FE}		20 to 75	
$-I_C = 1$ A; $-V_{CE} = 1$ V	h_{FE}		20 to 55	
$-I_C = 3$ A; $-V_{CE} = 1$ V	h_{FE}		15 to 45	

Cut-off frequency

$-I_C = 1$ A; $-V_{CE} = 6$ V	f_{hfe}	typ.	4.5	kc/s

MECHANICAL DATA Dimensions in mm



7Z2 3181

GERMANIUM POWER TRANSISTOR

Germanium transistor of the p-n-p type in metal case for use in class A and B output stages at battery voltages of 7 and 14 V.
Type 2-OC30 consists of a matched pair, selected for operation in a class B circuit with low distortion and low spread in quiescent currents.

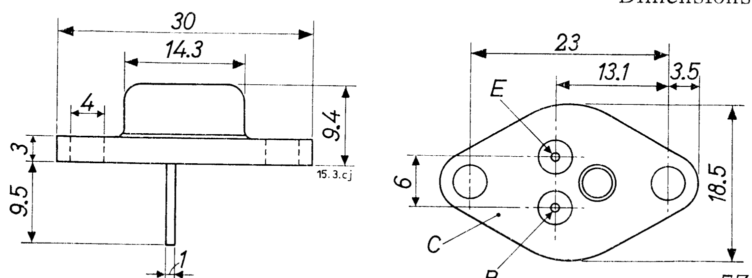
LIMITING VALUES (Absolute max. values)

Collector-base voltage	$-V_{CB}$	max.	16	V
Collector-emitter voltage	$-V_{CE}$	max.	16	V
Collector current (peak value)	$-I_{CM}$	max.	1.4	A
Total dissipation up to T_{mb} = 45 °C	P_{tot}	max.	4	W
Junction temperature	T_j	max.	75	°C

CHARACTERISTICS T_j = 25 °C

D.C. current gain				
$-I_C$ = 10 mA; $-V_{CE}$ = 14 V	h_{FE}	typ.	32	
$-I_C$ = 100 mA; $-V_{CE}$ = 7 V	h_{FE}	typ.	36	
$-I_C$ = 800 mA; $-V_{CE}$ = 1 V	h_{FE}	typ.	28	
$-I_C$ = 1.5 A; $-V_{CE}$ = 1 V	h_{FE}	typ.	22	
Cut-off frequency				
$-I_C$ = 0.1 A; $-V_{CE}$ = 7 V	f_{hfe}	typ.	9	kc/s

MECHANICAL DATA Dimensions in mm



7Z2 3189

3.3.1965

REVISED DATA
IS UNDER PREPARATION

REVISED DATA
IS UNDER PREPARATION

7Z2 3300
3.3.1965

GERMANIUM SWITCHING TRANSISTORS

Germanium transistors of the p-n-p type in all glass construction for medium current high speed computer switching applications.

LIMITING VALUES (Absolute max. values)

Collector-base voltage	$-V_{CB}$	max.	20	V
Collector-emitter voltage with $+V_{BE} > 0.2$ V	$-V_{CE}$	max.	20	V
Collector current (d.c. or average)	$-I_C$	max.	100	mA
Collector current (peak value)	$-I_{CM}$	max.	125	mA
Emitter current (d.c. or average)	I_E	max.	100	mA
Base current (d.c. or average)	$-I_B$	max.	15	mA
Total power dissipation up to $T_{amb} = 25\ ^{\circ}C$	P_{tot}	max.	80	mW
Junction temperature: continuous	T_j	max.	75	$^{\circ}C$
incidentally	T_j	max.	90	$^{\circ}C$

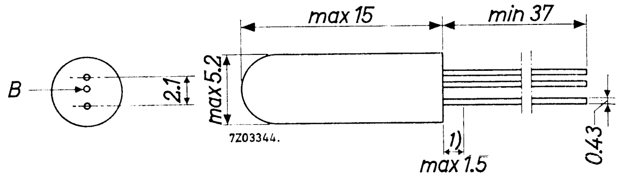
THERMAL RESISTANCE

From junction to ambient in free air	K	<	0.6	$^{\circ}C/mW$

CHARACTERISTICS at $T_j = 25\ ^{\circ}C$

		OC46	OC47
D.C. current gain			
$-I_C = 15$ mA; $-V_{CB} = 0$	h_{FE}	20 to 80	50 to 200
Cut-off frequency			
$I_E = 3$ mA; $-V_{CB} = 5$ V	f_{hfb}	> 3 Mc/s	> 4.5 Mc/s

MECHANICAL DATA Dimensions in mm



The red dot indicates the collector

1) Not tinned

7Z2 3192

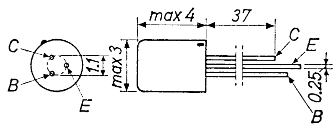
SUBMINIATURE GERMANIUM JUNCTION TRANSISTOR of the p-n-p type in hermetically sealed-in metal case construction for the pre-stages in hearing aids

TRANSISTRON SUBMINIATURE A JONCTION A CRISTAL DE GERMANIUM du type p-n-p en construction boîte métallique scellée hermétiquement pour les préamplificateurs de prothèses auditives

p-n-p-GERMANIUM-FLÄCHENTRANSISTOR in Subminiaturtechnik mit hermetisch abgeschlossenem Metallgehäuse für die Vorstufen von Hörgeräten

Dimensions in mm
Dimensions en mm
Abmessungen in mm

The red dot indicates the collector connection
Le point rouge marque la connexion du collecteur
Der rote Punkt indiziert den Kollektoranschluss



Limiting values (Absolute max. values)
Caractéristiques limites (Valeurs max. absolues)
Grenzdaten (Absolute Maximalwerte)

$-V_{CB}$	= max. 7 V	$-I_C$ (t_{av} = max.20 msec)	= max. 5 mA
$-V_{CBM}$	= max. 7 V	$-I_{CM}$	= max.10 mA
$-V_{CE}$	= max. 3 V[1]	I_E (t_{av} = max.20 msec)	= max. 5 mA
$-V_{CEM}$	= max. 7 V[1]	I_{EM}	= max.10 mA
$-V_{EB}$	= max. 7 V	P_C	= max.20 mW[2]
$-V_{EBM}$	= max. 7 V	T_j	= max.75 °C

Storage temperature
Température d'emmagasinage = $-65^{\circ}C/+75^{\circ}C$
Lagerungstemperatur

Characteristics
Caractéristiques T_{amb} = 25 °C
Kenndaten

Common base; Base à la masse; Basis schaltung

$-I_{CBO}$	($-V_{CB}$ = 2 V)	= 1,5 µA
$-I_{CBO}$	($-V_{CB}$ = 2 V; T_{amb} = 35 °C)	= 3,5 µA
$-I_{EBO}$	($-V_{EB}$ = 2 V)	= 1,5 µA
F	($-V_{CB}$ = 2 V; I_E = 0,5 mA)	< 10 dB

1) Z_{BE} = max. 10 kΩ
2) See also page A; voir aussi page A; siehe auch Seite A

Characteristics (continued)
Caractéristiques (suite) T_{amb} = 25 °C
Kenndaten (Fortsetzung)

Common emitter; Emetteur à la masse; Emitterschaltung

$-I_{CEO}$ ($-V_{CE}$ = 0,5 V) < 100 µA

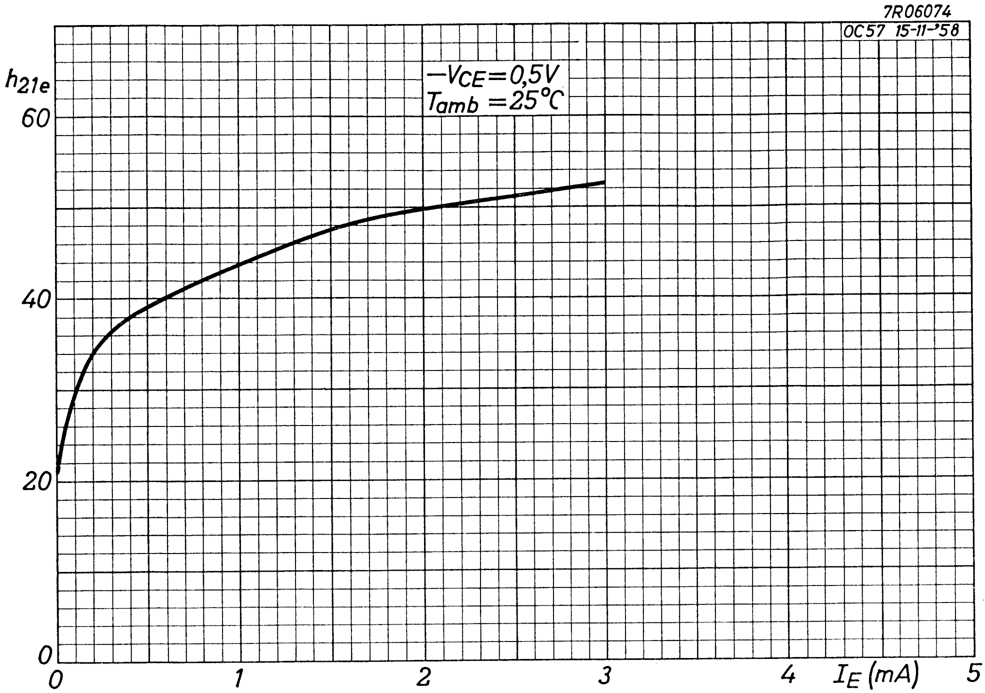
$-I_{CEO}$ ($-V_{CE}$ = 0,5 V; T_{amb} = 35 °C) < 300 µA

Small signal characteristics at
Caractéristiques pour faibles signaux à
Kenndaten für kleine Signale bei
{ T_{amb} = 25 °C; $-V_{CE}$ = 0,5 V; I_E = 0,25 mA }

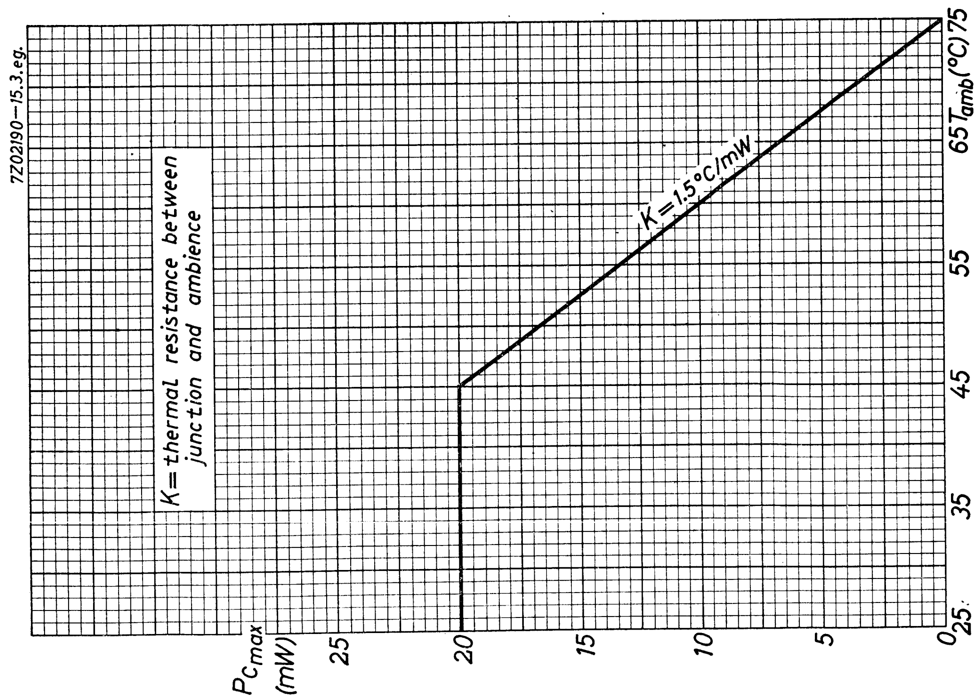
h-parameter measured at f = 1 kc/s	$-I_B$	= 8		µA
paramètre h mesuré à f = 1 kHz	$-V_{BE}$	= 120		mV
h-Parameter gemessen bei f = 1 kHz	h_{21e}	= 35	>20	
	$f_{\alpha e}$	=	>10	kc/s

Junction temperature
Température de la jonction
Kristalltemperatur

Junction temperature rise in free air
Augmentation de la température de la jonction en l'air libre
Temperaturerhöhung des Kristalls in freier Luft
K ≦ 1,5 °C/mW


7R06074
OC57 15-11-'58
h21e
60
40
20
0
0
1
2
3
4
IE (mA)
5
−VCE=0,5V
Tamb =25°C

B

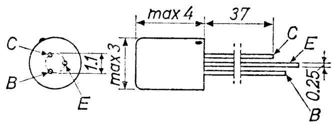

7Z02190—15.3.eg.
K= thermal resistance between junction and ambience
K=1.5°C/mW
Tamb(°C)
75
65
55
45
35
25
Pcmax (mW)
25
20
15
10
5
0

A

SUBMINIATURE GERMANIUM JUNCTION TRANSISTOR of the p-n-p type in hermetically sealed-in metal case construction for the pre-stages in hearing aids
TRANSISTRON SUBMINIATURE A JONCTION A CRISTAL DE GERMANIUM du type p-n-p en construction boîte métallique scellée hermétiquement pour les préamplificateurs de prothèses auditives
p-n-p-GERMANIUM-FLÄCHENTRANSISTOR in Subminiaturtechnik mit hermetisch abgeschlossenem Metallgehäuse für die Vorstufen von Hörgeräten

Dimensions in mm
Dimensions en mm
Abmessungen in mm

The red dot indicates the collector connection
Le point rouge marque la connexion du collecteur
Der rote Punkt indiziert den Kollektoranschluss



Limiting values (Absolute max. values)
Caractéristiques limites (Valeurs max. absolues)
Grenzdaten (Absolute Maximalwerte)

$-V_{CB}$	= max. 7 V	$-I_C$ (t_{av} = max.20 msec)	= max. 5 mA
$-V_{CBM}$	= max. 7 V	$-I_{CM}$	= max.10 mA
$-V_{CE}$	= max. 3 V^1)	I_E (t_{av} = max.20 msec)	= max. 5 mA
$-V_{CEM}$	= max. 7 V^1)	I_{EM}	= max.10 mA
$-V_{EB}$	= max. 7 V	P_C	= max.20 mW^2)
$-V_{EBM}$	= max. 7 V	T_j	= max.75 °C

Storage temperature
Température d'emmagasinage = -65°C/+75°C
Lagerungstemperatur

Characteristics
Caractéristiques T_{amb} = 25 °C
Kenndaten

Common base; Base à la masse; Basis schaltung

$-I_{CBO}$	($-V_{CB}$ = 2 V)	= 1,5 µA
$-I_{CBO}$	($-V_{CB}$ = 2 V; T_{amb} = 35 °C)	= 3,5 µA
$-I_{EBO}$	($-V_{EB}$ = 2 V)	= 1,5 µA
F	($-V_{CB}$ = 2 V; I_E =0,5 mA)	< 10 dB

1) Z_{BE} = max. 10 kΩ
2) See also page A; voir aussi page A; siehe auch Seite A

Characteristics (continued)
Caractéristiques (suite) T_{amb} = 25 °C
Kenndaten (Fortsetzung)

Common emitter; Emetteur à la masse; Emitterschaltung

$-I_{CEO}$ ($-V_{CE}$ = 0,5 V)	< 100 µA
$-I_{CEO}$ ($-V_{CE}$ = 0,5 V; T_{amb} = 35 °C)	< 300 µA

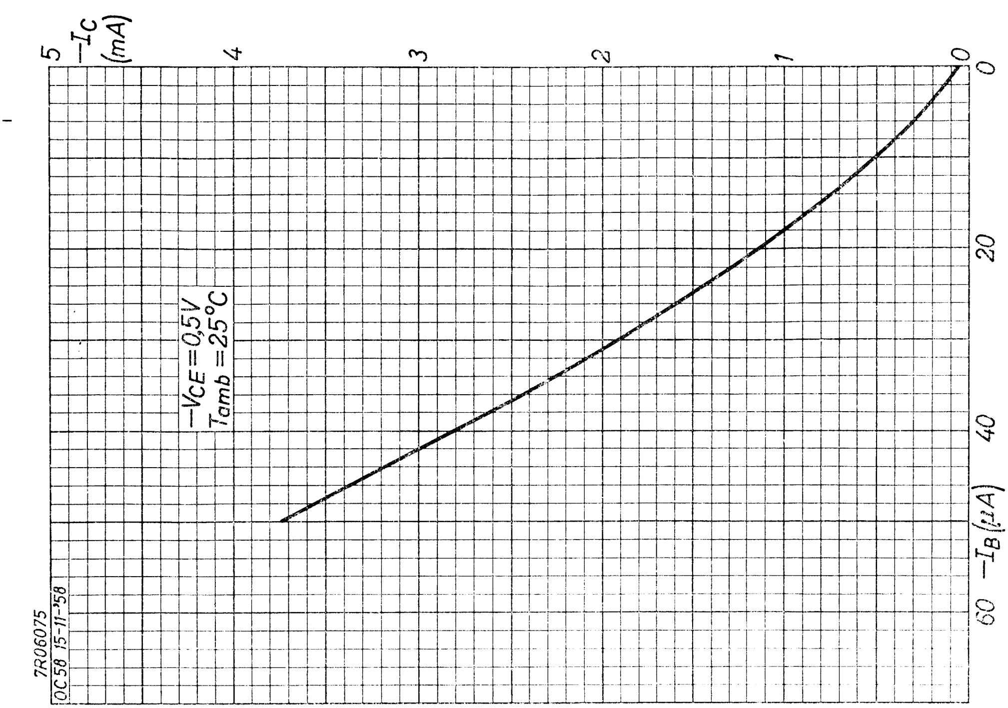
Small signal characteristics at
Caractéristiques pour faibles signaux à
Kenndaten für kleine Signale bei
T_{amb} = 25 °C; $-V_{CE}$ = 0,5 V; I_E = 0,25 mA

h-parameter measured at f = 1 kc/s
paramètre h mesuré à f = 1 kHz
h-Parameter gemessen bei f = 1 kHz

$-I_B$	=	4,5		µA
$-V_{BE}$	=	120		mV
h_{21e}	=	55	> 30	
$f_{\alpha e}$	=		> 10 kc/s	

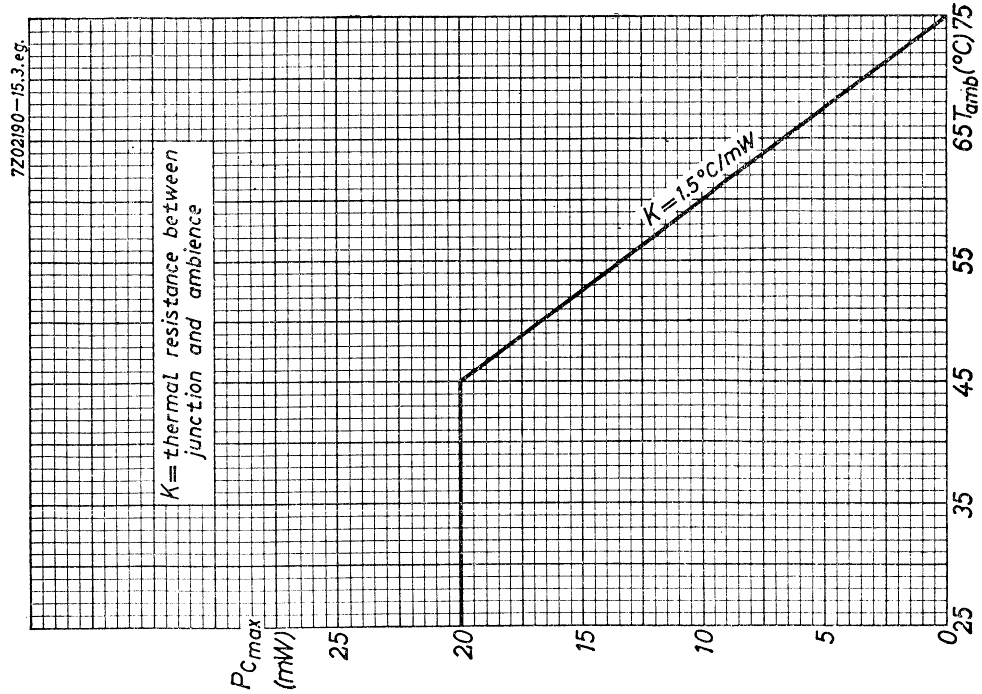
Junction temperature
Température de la jonction
Kristalltemperatur

Junction temperature rise in free air
Augmentation de la température de la jonction en l'air libre
Temperaturerhöhung des Kristalls in freier Luft
K ≦ 1,5 °C/mW



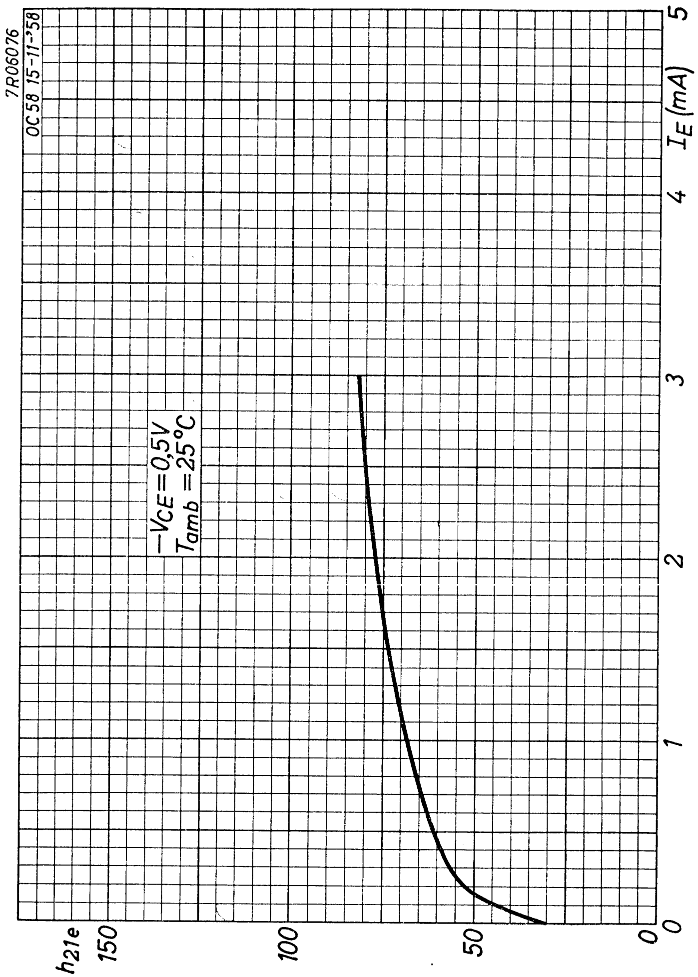
−IC (mA)
5
4
3
2
1
0
−VCE=0,5V
Tamb=25°C
7R06075
OC58 15-11-'58
0
20
40
60
−IB (μA)

B



7Z02190−15.3.eg.
K=thermal resistance between junction and ambience
K=1.5°C/mW
PCmax (mW)
25
20
15
10
5
0
25
35
45
55
65
75
Tamb (°C)

A


7R06076
OC58 15-11-'58
h_{21e}
150
100
50
0
$-V_{CE}=0,5V$
$T_{amb}=25°C$
0
1
2
3
4
5
I_E (mA)

C

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Dimensions en mm
Abmessungen in mm

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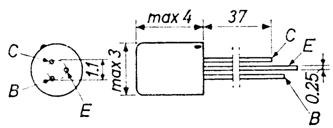
Le point rouge marque la connexion du collecteur
Der rote Punkt indiziert den Kollektoranschluss



Limiting values (Absolute max. values)
Caractéristiques limites (Valeurs max. absolues)
Grenzdaten (Absolute Maximalwerte)

$-V_{CB}$	= max. 7 V	$-I_C$ (t_{av} = max.20 msec)	= max. 5 mA
$-V_{CBM}$	= max. 7 V	$-I_{CM}$	= max.10 mA
$-V_{CE}$	= max. 3 V[1])	I_E (t_{av} = max.20 msec)	= max. 5 mA
$-V_{CEM}$	= max. 7 V[1])	I_{EM}	= max.10 mA
$-V_{EB}$	= max. 7 V	P_C	= max.20 mW[2])
$-V_{EBM}$	= max. 7 V	T_j	= max.75 °C

Storage temperature
Température d'emmagasinage = $-65^{\circ}C/+75^{\circ}C$
Lagerungstemperatur

Characteristics
Caractéristiques T_{amb} = 25 °C
Kenndaten

Common base; Base à la masse; Basis schaltung

$-I_{CBO}$	($-V_{CB}$ = 2 V)	= 1,5 µA
$-I_{CBO}$	($-V_{CB}$ = 2 V; T_{amb} = 35 °C)	= 3,5 µA
$-I_{EBO}$	($-V_{EB}$ = 2 V)	= 1,5 µA
F	($-V_{CB}$ = 2 V; I_E =0,5 mA)	< 10 dB

1) Z_{BE} = max. 10 kΩ
2) See also page A; voir aussi page A; siehe auch Seite A

Characteristics (continued)
Caractéristiques (suite) T_{amb} = 25 °C
Kenndaten (Fortsetzung)

Common emitter; Emetteur à la masse; Emitterschaltung

$-I_{CEO}$	($-V_{CE}$ = 0,5 V)	< 120 µA
$-I_{CEO}$	($-V_{CE}$ = 0,5 V; T_{amb} = 35 °C)	< 300 µA

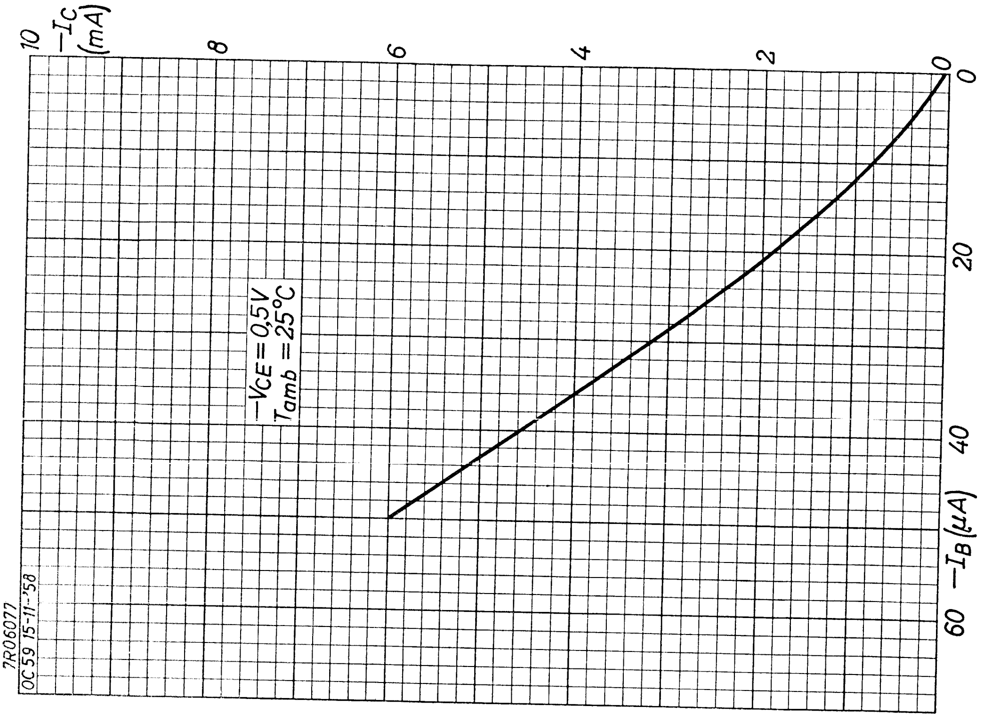
Small signal characteristics at
Caractéristiques pour faibles signaux à
Kenndaten für kleine Signale bei
{ T_{amb} = 25 °C; $-V_{CE}$ = 0,5 V; I_E = 0,25 mA }

h-parameter measured at f = 1 kc/s
paramètre h mesuré à f = 1 kHz
h-Parameter gemessen bei f = 1 kHz

$-I_B$	= 3,5		µA
$-V_{BE}$	= 120		mV
h_{21e}	= 80	> 50	
$f_{\alpha e}$	=	> 10 kc/s	

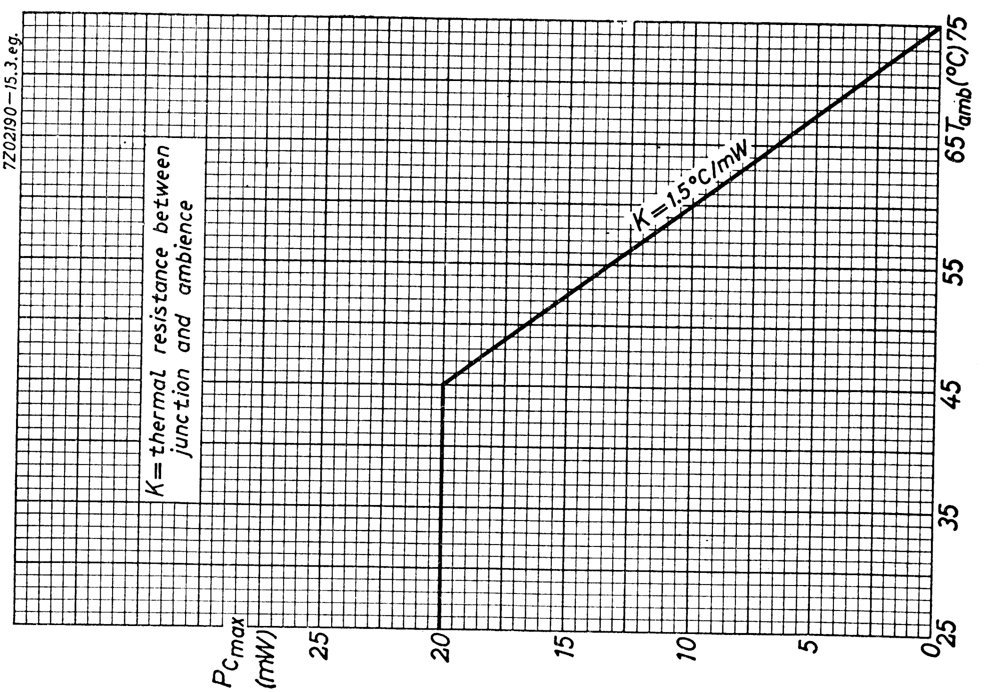
Junction temperature
Température de la jonction
Kristalltemperatur

Junction temperature rise in free air
Augmentation de la température de la jonction en l'air libre
Temperaturerhöhung des Kristalls in freier Luft
K ≦ 1,5 °C/mW



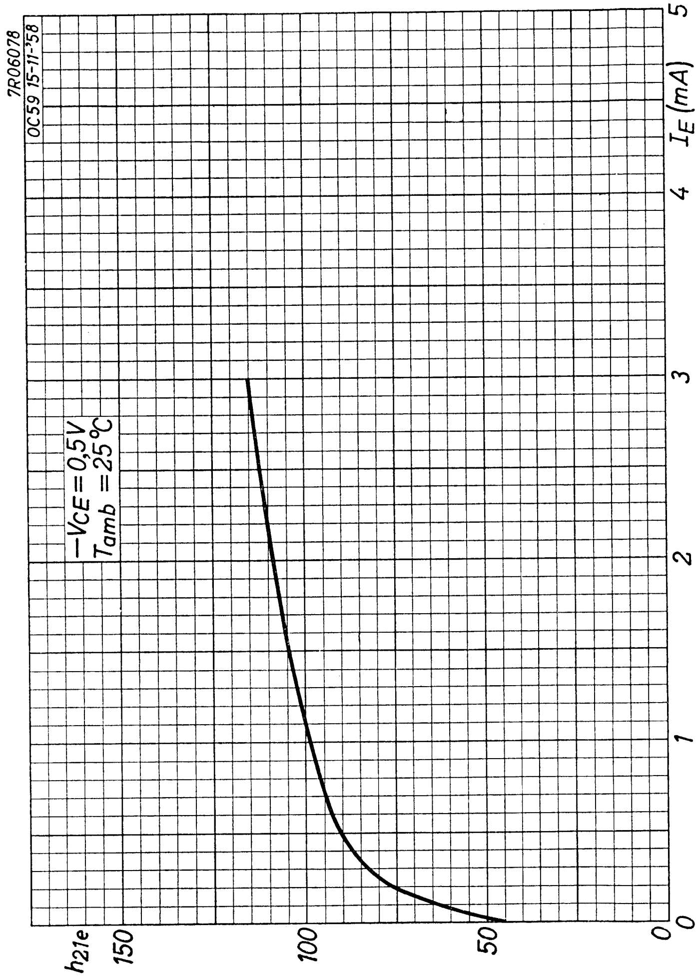
−I_C (mA)
10
8
6
4
2
0
−V_CE = 0,5V
T_amb = 25°C
−I_B (μA)
0
20
40
60
7R06077
OC59 15-11-'58

B



P_Cmax (mW)
25
20
15
10
5
0
25
35
45
55
65 T_amb (°C) 75
K = 1.5°C/mW
K = thermal resistance between junction and ambience
7Z02190-15.3.eg.

A


7R06078
OC59 15-11-'58
$-V_{CE} = 0{,}5V$
$T_{amb} = 25°C$
h_{21e}
150
100
50
0
0
1
2
3
4
5
I_E (mA)

C

12.12.1958

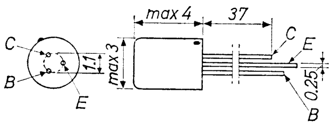
SUBMINIATURE GERMANIUM JUNCTION TRANSISTOR of the p-n-p type in hermetically sealed-in metal case construction for the output stage of hearing aids

TRANSISTRON SUBMINIATURE A JONCTION A CRISTAL DE GERMANIUM du type p-n-p en construction boîte métallique scellée hermétiquement pour l'étage de sortie de prothèses auditives

p-n-p-GERMANIUM-FLÄCHENTRANSISTOR in Subminiaturtechnik mit hermetisch abgeschlossenem Metallgehäuse für die Endstufen von Hörgeräten

Dimensions in mm
Dimensions en mm
Abmessungen in mm

The red dot indicates the collector connection
Le point rouge marque la connection du collecteur
Der rote Punkt indiziert den Kollektoranschluss



Limiting values (Absolute max. values)
Caractéristiques limites (Valeurs max. absolues)
Grenzdaten (Absolute Maximalwerte)

$-V_{CB}$	= max.7 V	$-I_C$ (t_{av} = max.20 msec)	= max. 5 mA
$-V_{CBM}$	= max.7 V	$-I_{CM}$	= max.10 mA
$-V_{CE}$	= max.3 V[1]	I_E (t_{av} = max.20 msec)	= max. 5 mA
$-V_{CEM}$	= max.7 V[1]	I_{EM}	= max.10 mA
$-V_{EB}$	= max.7 V	P_C	= max.20 mW[2]
$-V_{EBM}$	= max.7 V	T_j	= max.75 °C

Storage temperature
Température d'emmagasinage = -65°C/+75°C
Lagerungstemperatur

Characteristics
Caractéristiques T_{amb} = 25 °C
Kenndaten

Common base; Base à la masse; Basisschaltung

$-I_{CBO}$	($-V_{CB}$ = 2 V)	= 1,5 µA
$-I_{CBO}$	($-V_{CB}$ = 2 V; T_{amb} = 35 °C)	= 3,5 µA
$-I_{EBO}$	($-V_{EB}$ = 2 V)	= 1,5 µA
F	($-V_{CB}$ = 2 V; I_E = 0,5 mA)	< 15 dB

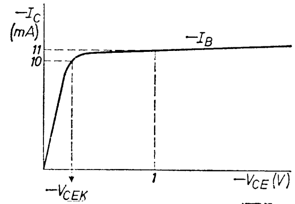
[1]) Z_{BE} = max. 10 kΩ
[2]) See also page D; voir aussi page D; siehe auch Seite D

Characteristics (continued)
Caractéristiques (suite)
Kenndaten (Fortsetzung) T_{amb} = 25 °C

Common emitter; Emetteur à la masse; Emitterschaltung

$-I_{CEO}$	($-V_{CE}$ = 2 V)		< 120		µA
$-I_{CEO}$	($-V_{CE}$ = 2 V; T_{amb} = 35 °C)		< 360		µA
$-I_C$	($-V_{CE}$ = 2 V; $-I_B$ = 50 µA)	= 3,75	> 3	< 5,4	mA

Collector knee voltage
Tension de coude du collecteur
Kniespannung des Kollektors



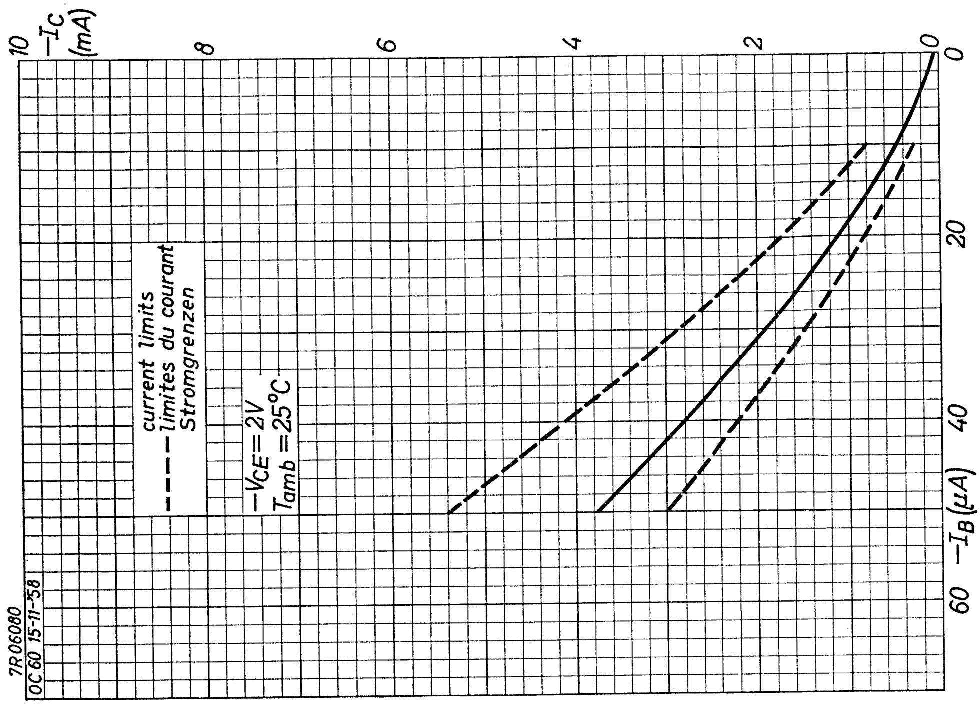
$-I_C$ = 10 mA

$-I_B$ = the value at which / la valeur à laquelle / der Wert bei dem $-I_C$ = 11 mA when / si / wenn $-V_{CE}$ = 1 V

$-V_{CEK}$ = 0,18 V < 0,25 V

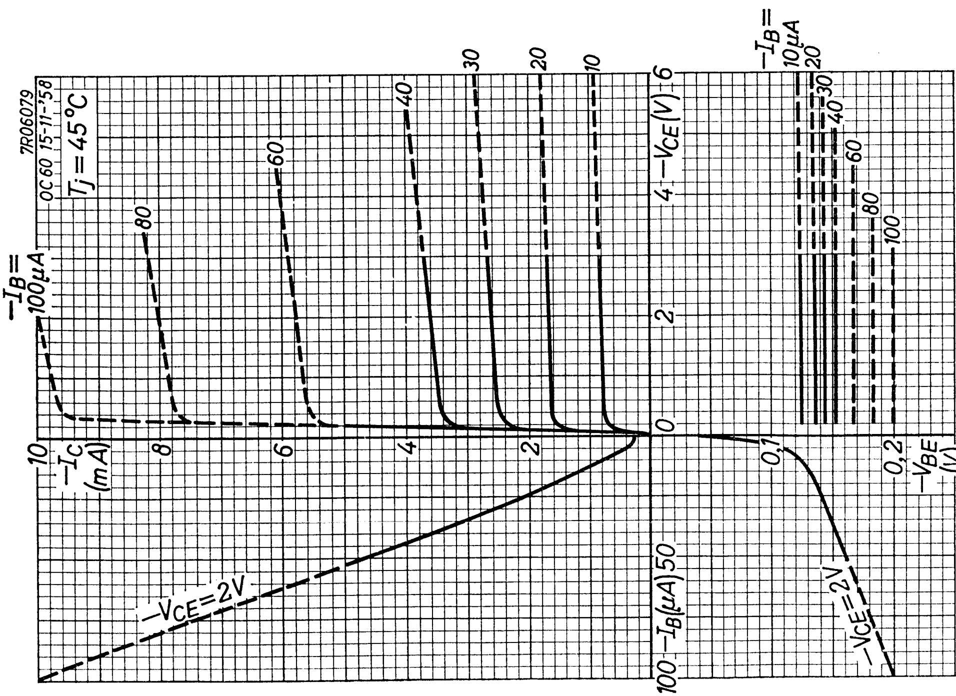
Junction temperature
Température de la jonction
Kristalltemperatur

Junction temperature rise in free air
Augmentation de la température de la jonction en l'air libre
Temperaturerhöhung des Kristalls in freier Luft
K ≦ 1,5 °C/mW



7R06080
OC 60 15-11-'58
−I_C (mA)
10
8
6
4
2
0
current limits
limites du courant
Stromgrenzen
−V_CE=2V
T_amb=25°C
0
20
40
60
−I_B(µA)

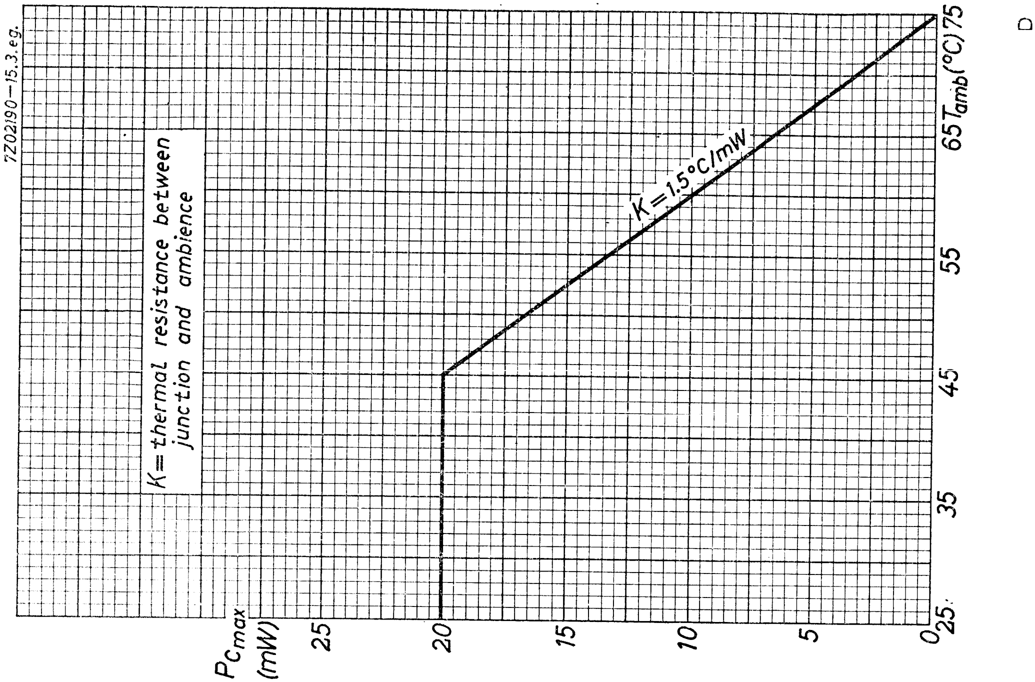
B

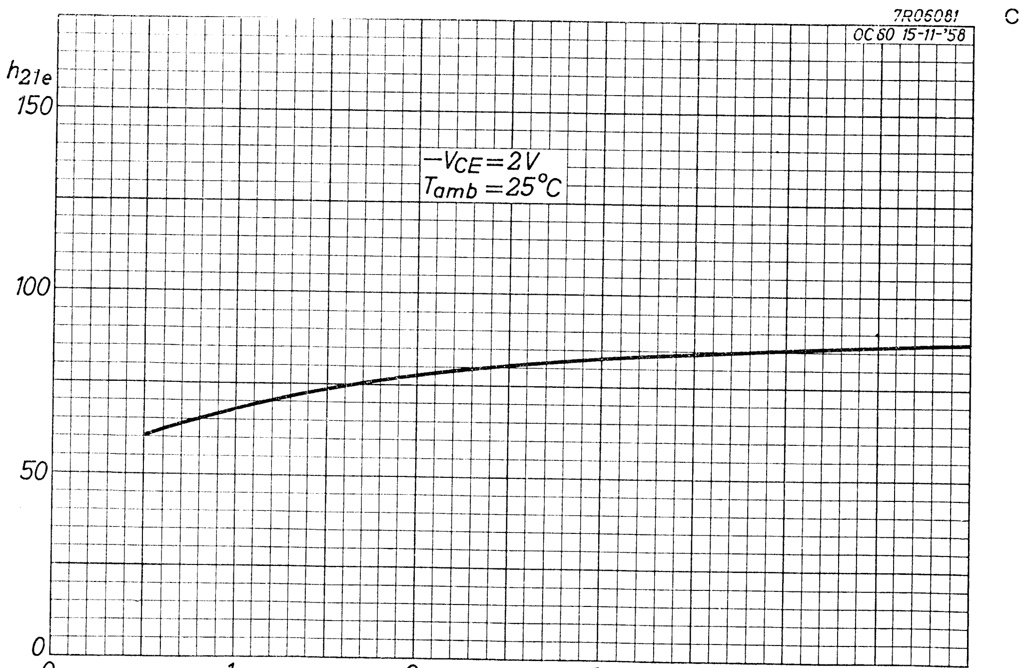


7R06079
OC 60 15-11-'58
T_j=45°C
−I_B=100µA
80
60
40
30
20
10
−I_C (mA)
10
8
6
4
2
0
2
4
6
−V_CE(V)
−I_B=
10µA
20
30
40
60
80
100
−V_CE=2V
100
50
−I_B(µA)
0,1
0,2
−V_BE (V)
−V_CE=2V

A

12.12.1958


7Z02190—15.3.eg.
K = thermal resistance between junction and ambience
K=1.5°C/mW
$P_{C max}$ (mW)
25
20
15
10
5
0
T_{amb} (°C)
75
65
55
45
35
25
D


7R06081
OC 60 15-11-'58
h_{21e}
150
100
50
0
$-V_{CE}$=2V
T_{amb}=25°C
0
1
2
3
4
5
I_E (mA)
C

GERMANIUM P-N-P TRANSISTOR

Germanium transistor of the p-n-p type in all-glass construction for general purpose applications.

LIMITING VALUES (Absolute max. values)

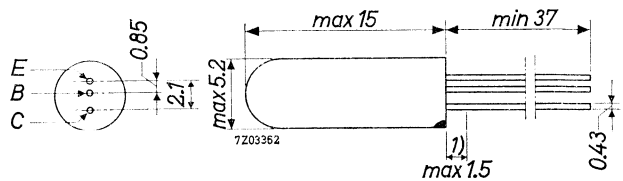
Collector-emitter voltage at $+V_{BE} > 0.1$ V	$-V_{CE}$	max.	30	V
Collector current (d.c. and average)	$-I_C$	max.	10	mA
Collector current (peak value)	$-I_{CM}$	max.	50	mA
Total dissipation up to T_{amb} = 25 °C	P_{tot}	max.	125	mW
Junction temperature: continuous	T_j	max.	75	°C
incidentally	T_j	max.	90	°C

CHARACTERISTICS

D.C. current gain at T_j = 25 °C				
$-I_C$ = 0.4 mA; $-V_{CE}$ = 4.5 V	h_{FE}	typ.	40 21 to 65	
$-I_C$ = 10 mA; $-V_{CE}$ = 4.5 V	h_{FE}	typ.	40 18 to 53	
Small signal current gain at T_j = 25 °C				
$-I_C$ = 0.5 mA; $-V_{CE}$ = 2 V	h_{fe}	typ.	30	
Cut-off frequency				
$-I_C$ = 0.5 mA; $-V_{CE}$ = 2 V	f_{hfe}	typ.	15	kc/s

MECHANICAL DATA

Dimensions in mm



The red dot indicates the collector

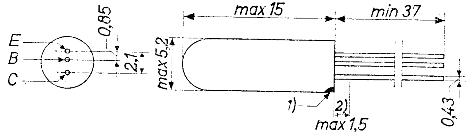
7Z2 3183

1) Not tinned

3.3.1965

GERMANIUM TRANSISTOR of the p-n-p type in all-glass construction, suitable for general purposes
TRANSISTRON A CRISTAL DE GERMANIUM du type p-n-p en construction tout-verre, prévu pour les usages généraux
p-n-p-GERMANIUM-ALLZWECKTRANSISTOR in Allglastechnik

Dimensions in mm
Dimensions en mm
Abmessungen in mm



Limiting values (Absolute max. values)
Caractéristiques limites (Valeurs max. absolues)
Grenzdaten (Absolute Maximalwerte)

$-V_{CE}$	= max. 30 V 3)	I_E	= max. 15 mA
$-V_{CEM}$	= max. 30 V 3)	I_{EM}	= max. 70 mA
$-I_C$	= max. 10 mA	$-I_B$	= max. 5 mA
$-I_{CM}$	= max. 50 mA	$-I_{BM}$	= max. 20 mA

P_C { see page N / voir page N / siehe Seite N }

T_j { continuous operation / service continu / Dauerbetrieb } = max. 75 °C

T_j { intermittent operation / service intermittent / aussetzender Betrieb } = max. 90 °C 4)

Storage temperature
Température d'emmagasinage
Lagerungstemperatur = -55/+75 °C

1) The red dot indicates the collector
Le point rouge marque le collecteur
Der rote Punkt indiziert den Kollektor

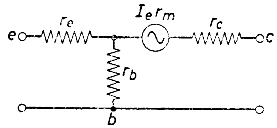
2) Not tinned; non-étamé; nicht verzinnt

3) 4) See page 2; voir page 2; siehe Seite 2

Characteristics
Caractéristiques
Kenndaten

T_{amb} = 25 °C

Common base; Base à la masse; Basisschaltung



Measured at / Mesuré à / Gemessen bei

			Min.	Max.	
$-V_{CB}$	=	2			V
$-I_E$	=	3			mA
f	=	1000			c/s
r_e	=	6,5			Ω
r_b	=	500			Ω
r_c	=	625			kΩ
r_m	=	611			kΩ
h_{11b}	=	17	>10	<25	Ω
$-h_{21b}$	=	0,979	>0,968	<0,987	
h_{22b}	=	1,6		<2,7	µA/V
h_{12b}	=	8.10^{-4}			
$-I_{CBO}$ ($-V_{CB}$=4,5 V)	=	4,5		<12	µA

3) These values are permissible at $V_{BE} \geq 0.1$ V. See also page M

Ces valeurs sont admissibles à $V_{BE} \geq 0,1$ V. Voir aussi page M

Diese Werte sind erlaubt bei $V_{BE} \geq 0,1$ V. Siehe auch Seite M

4) Total duration max. 200 hours. Likelihood of full performance at this temperature is also dependent upon the type of application

Durée totale 200 heures au max. La probabilité d'opération optimum à cette température est aussi dépendante du genre de l'application

Gesamtdauer max. 200 Stunden. Die Wahrscheinlichkeit optimaler Wirkung bei dieser Temperatur wird auch von der Verwendungsart bestimmt

Characteristics (continued)
Caractéristiques (continuation) Tamb = 25 °C
Kenndaten (Fortsetzung)

Common emitter; Emetteur à la masse; Emitterschaltung

Measured at / Mesuré à / Gemessen bei: $-V_{CE}$ = 2 V; $-I_C$ = 3 mA; f = 1000 c/s

h_{11e}	= 0,8	>0,4	<1,5	kΩ
h_{21e}	= 47	>30	<75	
h_{22e}	= 80		<200	µA/V
h_{12e}	= $5{,}4\cdot10^{-4}$		$<17\cdot10^{-4}$	
$f_{\alpha e}$	= 10			kc/s
F [1])	= 10		<15	dB

$-I_{CEO}$ ($-V_{CE}$ = 4,5 V)	= 150		<325	µA
$-I_C$ ($-V_{CE}$ = 4,5 V, $-I_B$ = 10 µA)	= 0,7	>0,33	<1,20	mA
$-V_{BE}$ ($-V_{CE}$ = 4,5 V, $-I_B$ = 10 µA)	= 110	>80	<155	mV
$-I_C$ ($-V_{CE}$ = 4,5 V, $-I_B$ = 250 µA)	= 14	>7,2	<21	mA
$-V_{BE}$ ($-V_{CE}$ = 4,5 V, $-I_B$ = 250 µA)	= 270	>210	<385	mV

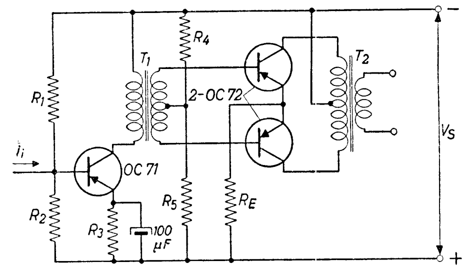
Junction temperature
Température de la jonction
Kristalltemperatur

Junction temperature rise in free air
Augmentation de la température de la jonction en l'air libre
Temperaturerhöhung des Kristalls in freier Luft
K ≦ 0,4 °C/mW

[1])Noise factor at $-I_C$ = 0.5 mA with input source impedance = 500 Ω
Facteur de bruit à $-I_C$ = 0,5 mA avec impédance de la source d'entrée = 500 Ω
Rauschfaktor bei $-I_C$ = 0,5 mA bei einer Impedanz der Eingangsspannungsquelle = 500 Ω

Operating characteristics as driver of push-pull output stage with 2-OC 72
Caractéristiques d'utilisation comme préamplificateur d'un étage de sortie push-pull avec 2-OC 72
Betriebsdaten als Treiber für eine Gegentaktendstufe mit 2-OC 72

Tamb = 25 °C



For the data of the push-pull output stage please refer to the operating characteristics of the OC 72
Pour les données de l'étage de sortie push-pull voir les caractéristiques d'utilisation du OC 72
Für die Daten der Gegentaktendstufe siehe die Betriebsdaten des OC 72

A. 2-OC 72 with cooling fins
2-OC 72 avec ailettes de refroidissement
2-OC 72 mit Kühlschellen

V_S	= 12	9	6	6	V
$-V_{CE}$	= 10,5	4,1	4,5	4,2	V
I_E	= 1,3	3,0	4,0	2,3	mA
R_1	= 68	12	15	39	kΩ
R_2	= 8,2	15	4,7	15	kΩ
R_3	= 820	1500	270	470	Ω
I_{bm} (P_o [1]) = 50 mW)	= 7	10,5	11	3,6	µA
I_{im} (P_o [1]) = 50 mW)	= 8,4	12	13,5	4,0	µA
N_{pr}/N_{sec} [2])	= $\frac{3,0}{1+1}$	$\frac{1,4}{1+1}$	$\frac{1,7}{1+1}$	$\frac{3,5}{1+1}$	

[1])Output power of the push-pull output stage
Puissance de sortie de l'étage de sortie push-pull
Ausgangsleistung der Gegentaktendstufe

[2])Transformer ratio of the driver transformer
Rapport de transformation du transformateur intermédiaire
Transformationsverhältnis des Treibertransformators

Operating characteristics as driver of push-pull output stage with 2-OC 72 (continued)
Caractéristiques d'utilisation comme préamplificateur d'un étage de sortie push-pull avec 2-OC 72 (continuation)
Betriebsdaten als Treiber für eine Gegentaktendstufe mit 2-OC 72 (Fortsetzung)

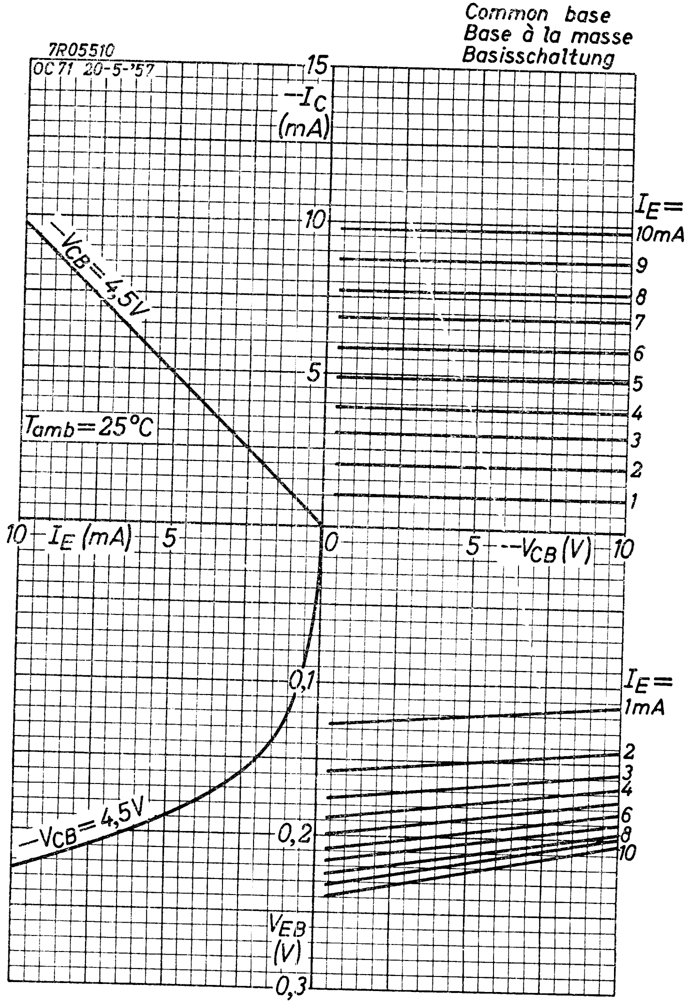
T_{amb} = 25 °C

B. 2-OC 72 without cooling fin
2-OC 72 sans ailettes de refroidissement
2-OC 72 ohne Kühlschellen

V_S	=	6	4,5 V
$-V_{CE}$	=	4,5	3 V
I_E	=	4,8	6,5 mA
R_1	=	8,2	6,8 kΩ
R_2	=	2,7	2,2 kΩ
R_3	=	220	120 Ω
I_{bm} (P_o[1]) = 50 mW)	=	14	23 µA
I_{im} (P_o[1]) = 50 mW)	=	17,5	31 µA
N_{pr}/N_{sec}[2])	=	$\frac{1,35}{1+1}$	$\frac{1,0}{1+1}$

[1]) Output power of the push-pull output stage
Puissance de sortie de l'étage de sortie push-pull
Ausgangsleistung der Gegentaktendstufe

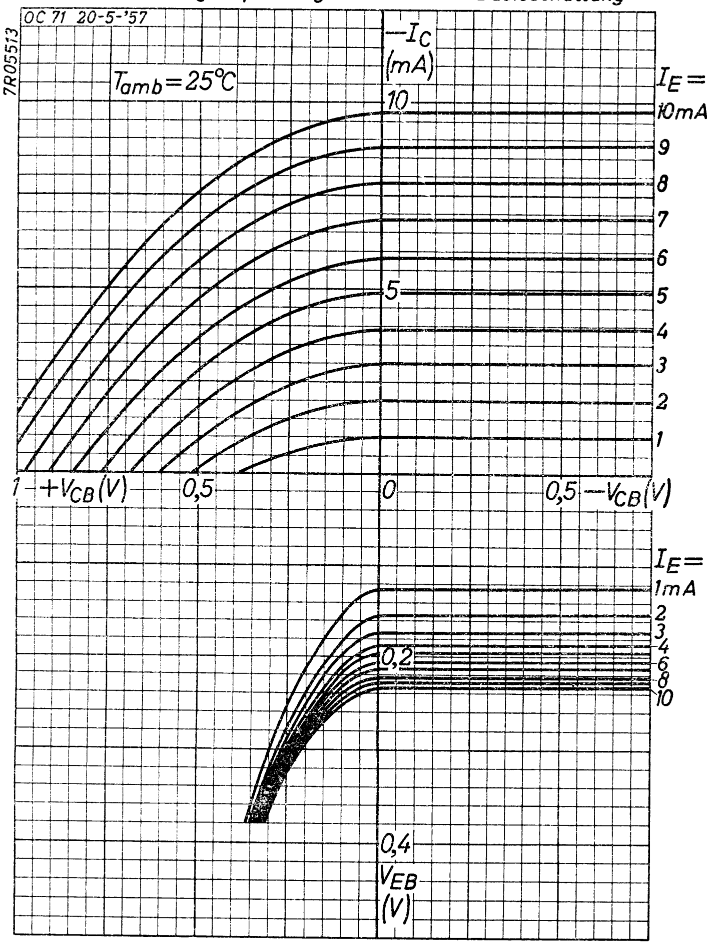
[2]) Transformer ratio of the driver transformer
Rapport de transformation du transformateur intermédiaire
Transformationsverhältnis des Treibertransformators



A

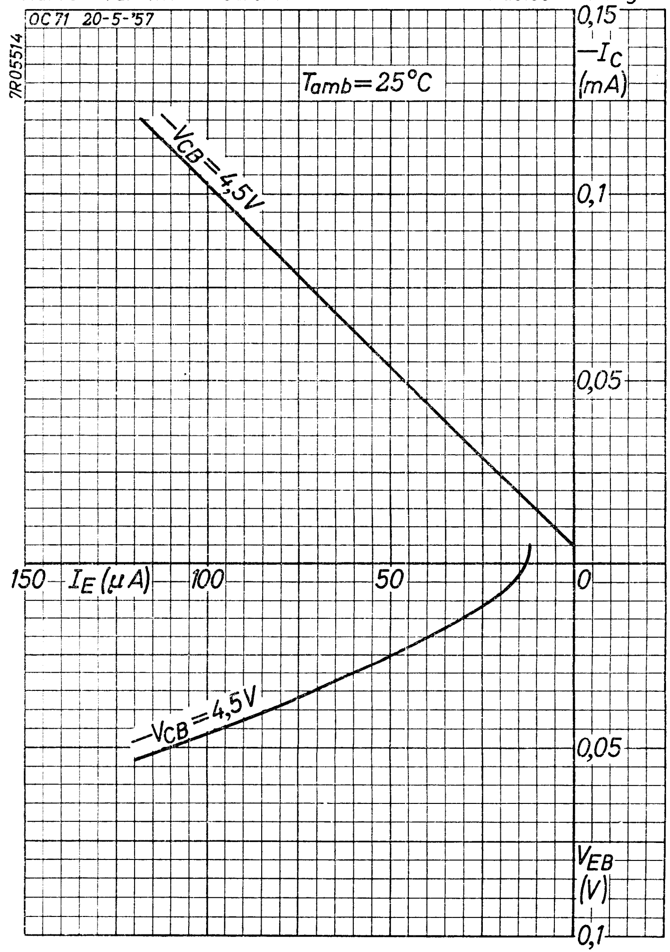
Small voltage curves
Courbes pour petites tensions
Kurven für niedrige Spannungen

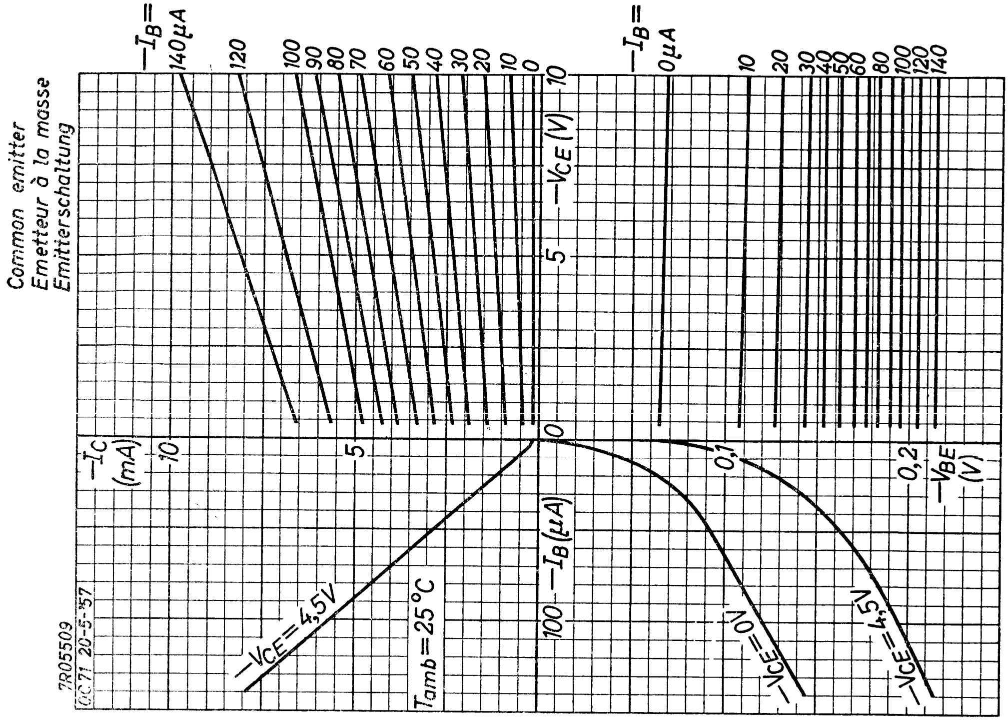
Common base
Base à la masse
Basisschaltung



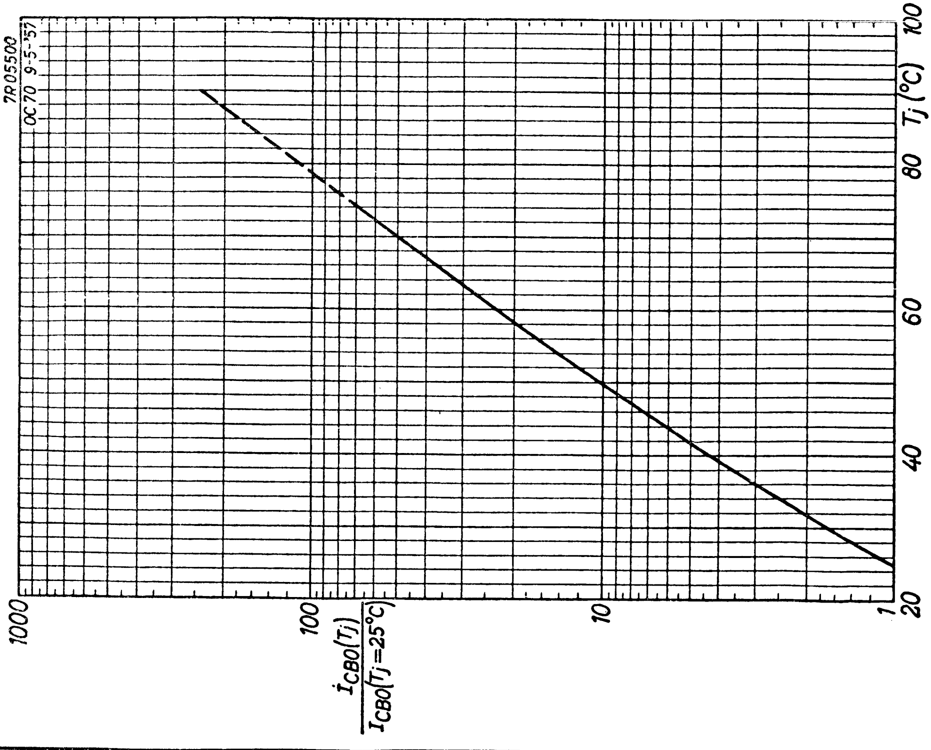
Small current curves
Courbes pour petits courants
Kurven für kleine Ströme

Common base
Base à la masse
Basisschaltung




Common emitter
Emetteur à la masse
Emitterschaltung
$-I_B =$ 140 µA
120
100
90
80
70
60
50
40
30
20
10
0
$-I_B =$ 0 µA
10
20
30
40
50
60
80
100
120
140
$-V_{CE}$ (V)
10
5
0
$-I_C$ (mA)
10
5
$-I_B$ (µA)
100
0,1
0,2
$-V_{BE}$ (V)
$-V_{CE} = 4{,}5$V
$T_{amb} = 25$°C
$-V_{CE} = 0$V
$-V_{CE} = 4{,}5$V
7R05509
OC71 20-5-'57

E

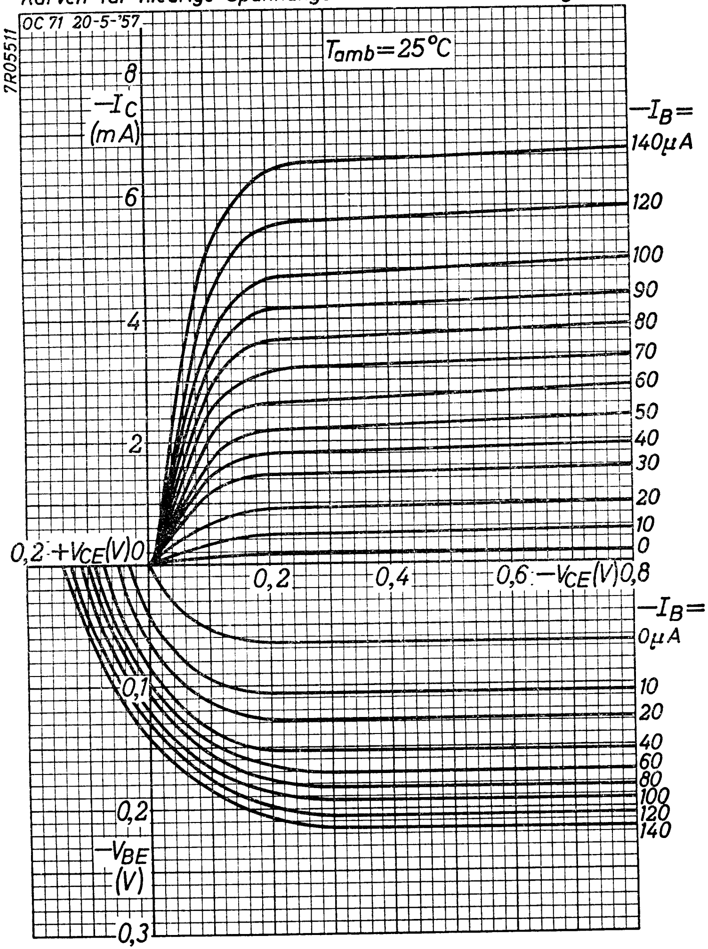

7R05500
OC70 9-5-'57
1000
100
10
1
$\frac{I_{CBO}(T_j)}{I_{CBO}(T_j=25°C)}$
20
40
60
80
100
T_j (°C)

D

5.5.1957

Small voltage curves
Courbes pour petites tensions
Kurven für niedrige Spannungen

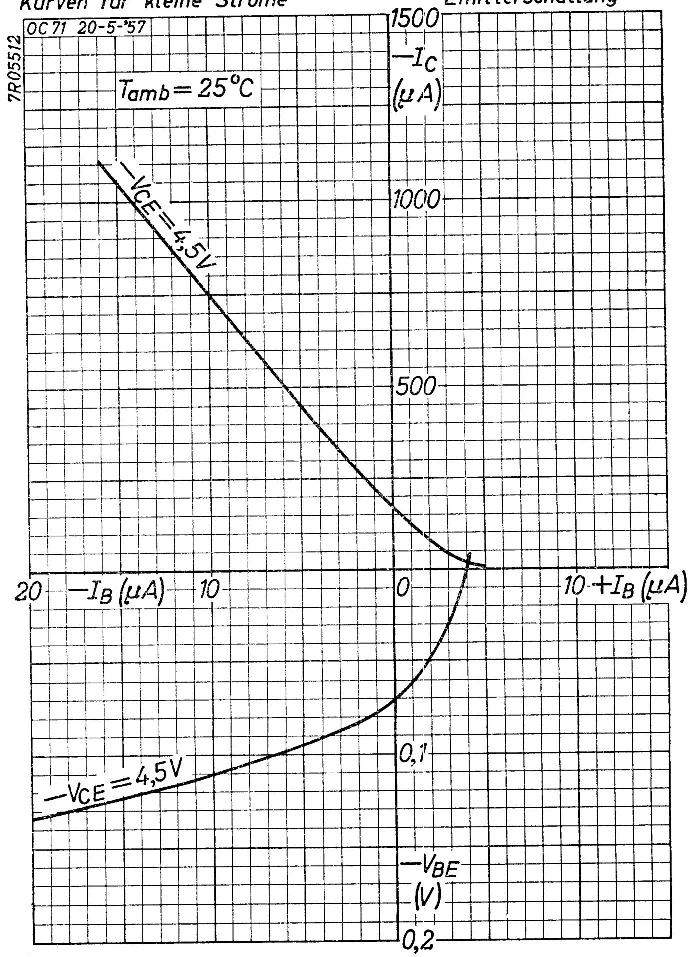
Common emitter
Emetteur à la masse
Emitterschaltung



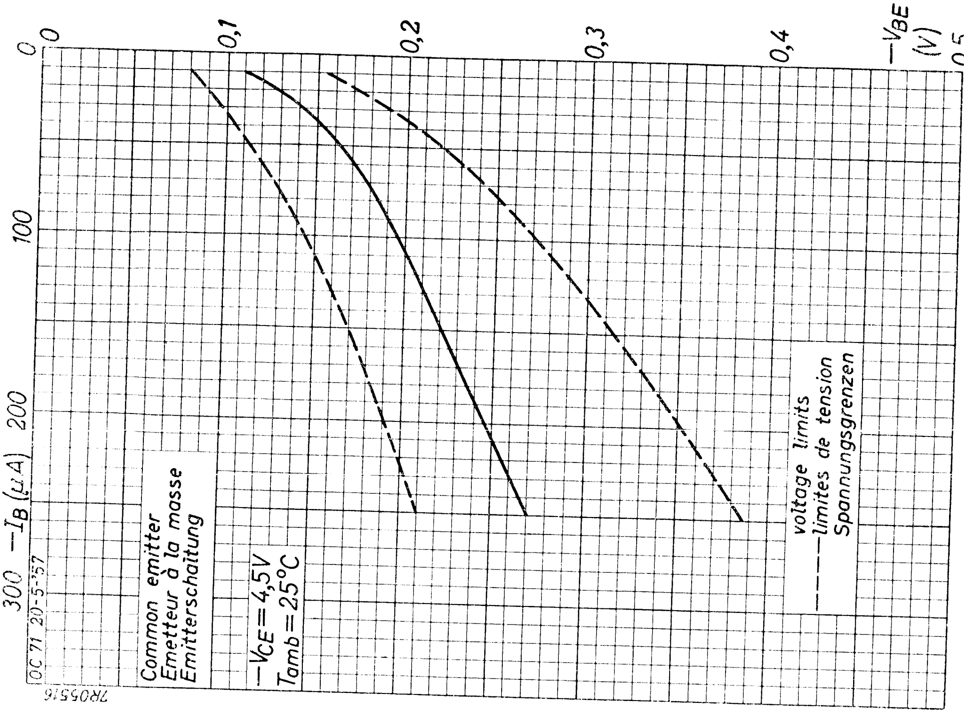
F

Small current curves
Courbes pour petits courants
Kurven für kleine Ströme

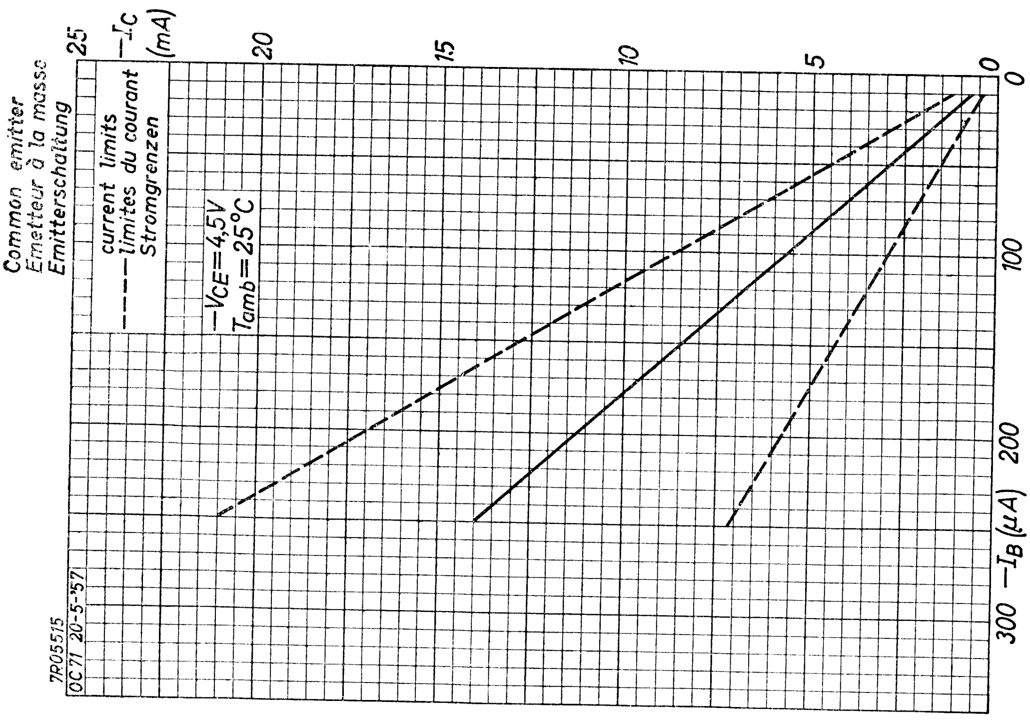
Common emitter
Emetteur à la masse
Emitterschaltung



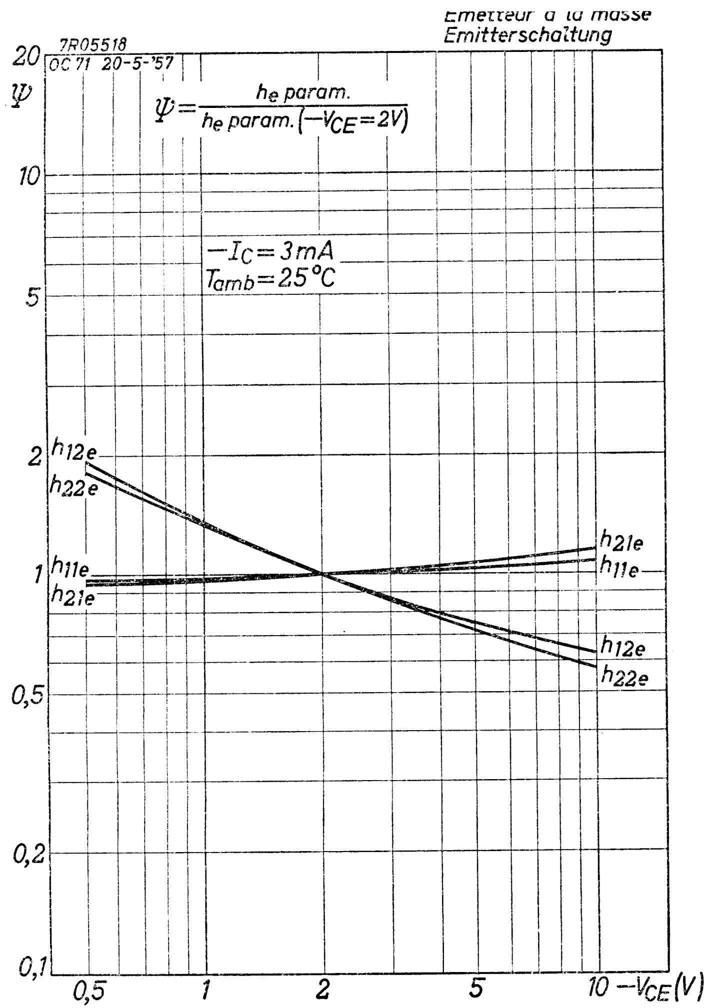
G


0
0,1
0,2
0,3
0,4
0,5
$-V_{BE}$ (V)
100
200
300
$-I_B$ (µA)
Common emitter
Emetteur à la masse
Emitterschaltung
$-V_{CE}$=4,5V
T_{amb}=25°C
voltage limits
limites de tension
Spannungsgrenzen
OC 71 20-5-'57
7R05516

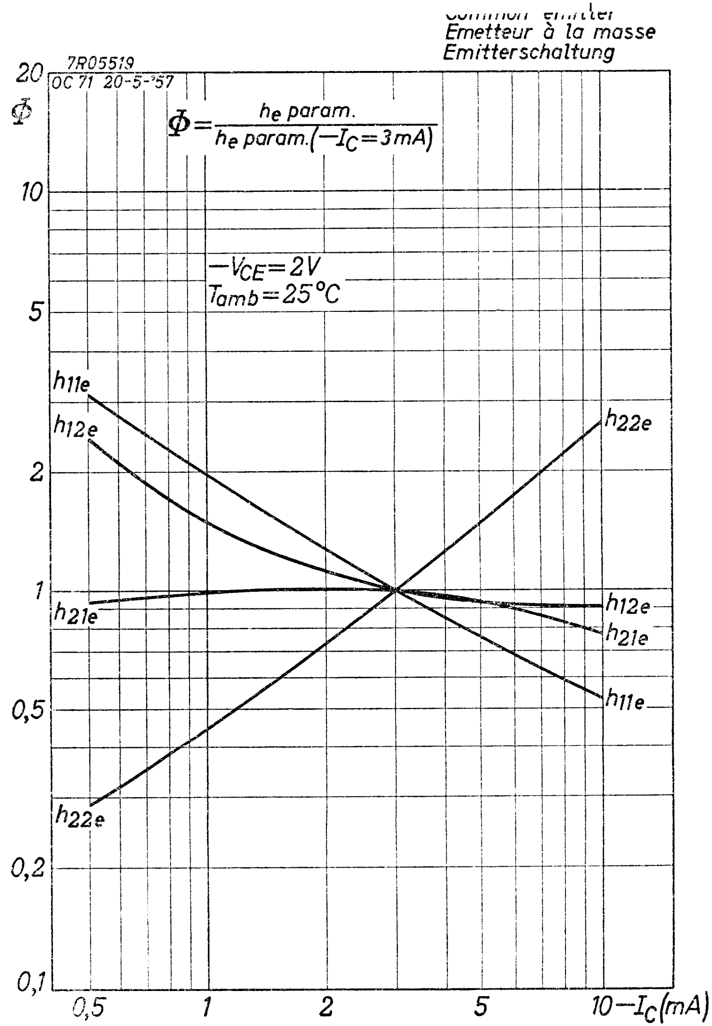
I


25
20
15
10
5
0
$-I_C$ (mA)
100
200
300
$-I_B$ (µA)
Common emitter
Emetteur à la masse
Emitterschaltung
current limits
limites du courant
Stromgrenzen
$-V_{CE}$=4,5V
T_{amb}=25°C
7R05515
OC71 20-5-'57

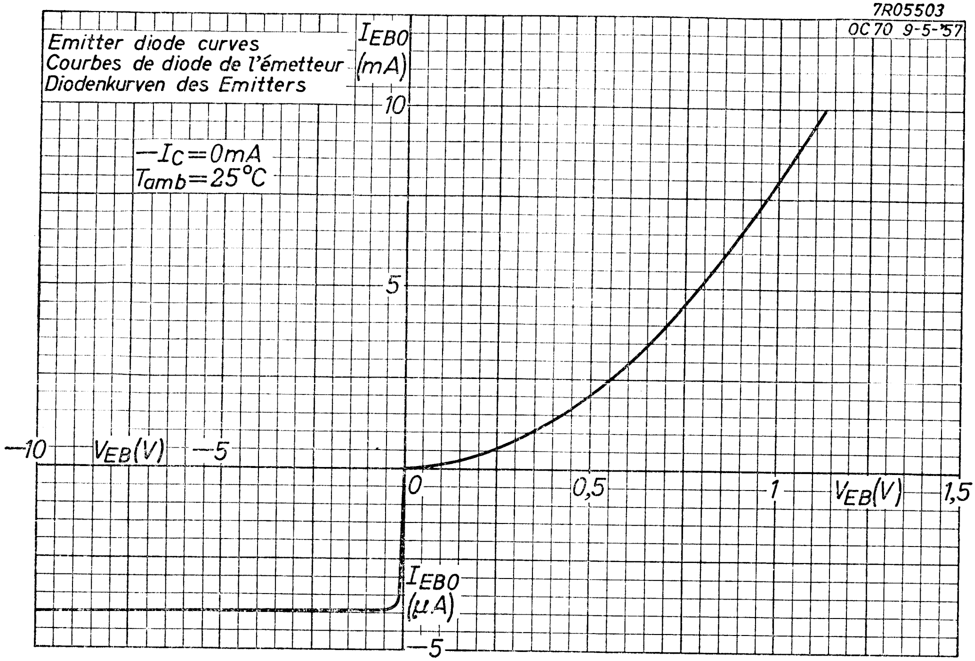
H


Emetteur à la masse
Emitterschaltung
7R05518
OC 71 20-5-'57
Ψ = he param. / he param. (−VCE = 2V)
−IC = 3 mA
Tamb = 25 °C
h12e
h22e
h11e
h21e
h21e
h11e
h12e
h22e
Ψ
20
10
5
2
1
0,5
0,2
0,1
0,5
1
2
5
10 −VCE (V)

J

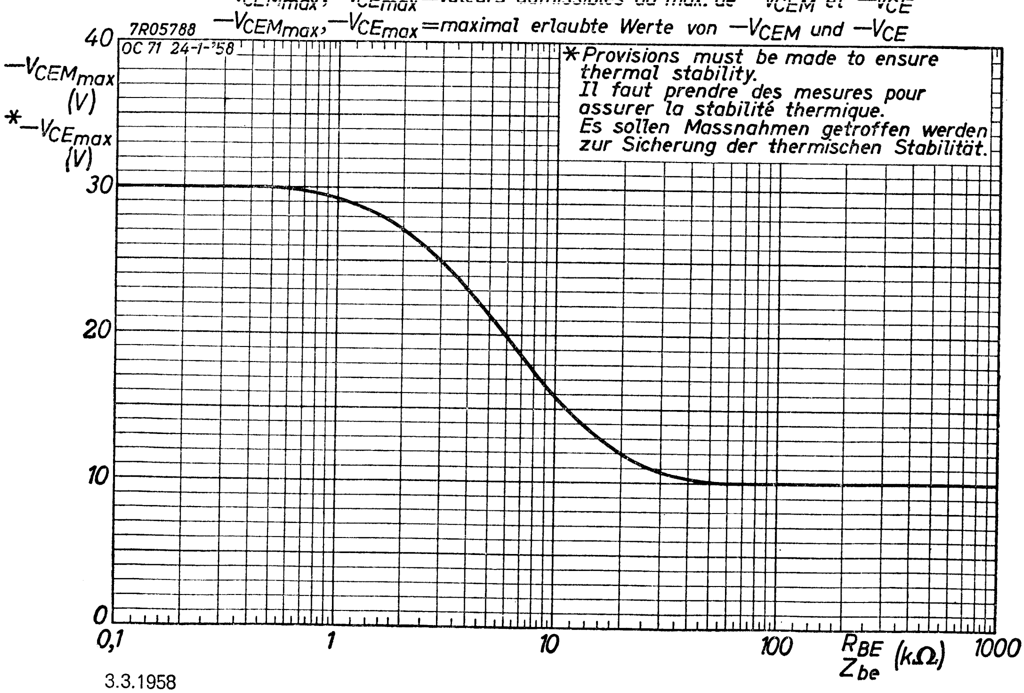

Emetteur à la masse
Emitterschaltung
7R05519
OC 71 20-5-'57
Φ = he param. / he param. (−IC = 3 mA)
−VCE = 2V
Tamb = 25 °C
h11e
h12e
h21e
h22e
h22e
h12e
h21e
h11e
Φ
20
10
5
2
1
0,5
0,2
0,1
0,5
1
2
5
10 −IC (mA)

K



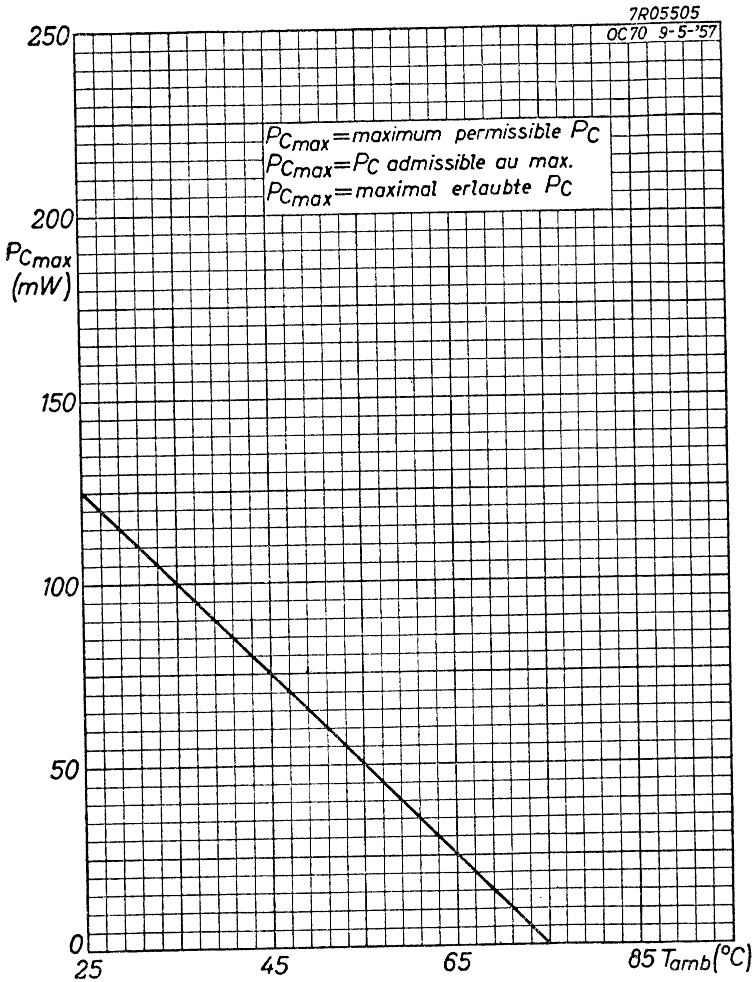
L

$-V_{CEMmax}$, $-V_{CEmax}$ = maximum permissible values of $-V_{CEM}$ and $-V_{CE}$
$-V_{CEMmax}$, $-V_{CEmax}$ = valeurs admissibles au max. de $-V_{CEM}$ et $-V_{CE}$
$-V_{CEMmax}$, $-V_{CEmax}$ = maximal erlaubte Werte von $-V_{CEM}$ und $-V_{CE}$



M

3.3.1958

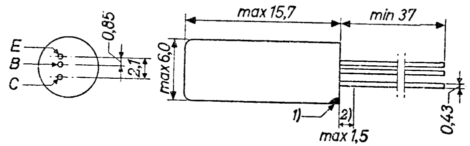


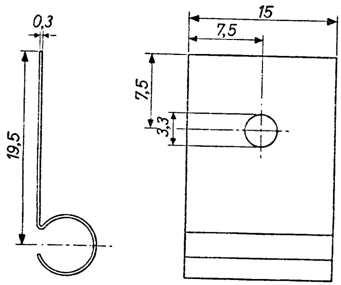
7R05505
OC70 9-5-'57
$P_{C_{max}}$ = maximum permissible P_C
$P_{C_{max}}$ = P_C admissible au max.
$P_{C_{max}}$ = maximal erlaubte P_C
250
200
$P_{C_{max}}$ (mW)
150
100
50
0
25
45
65
85 T_{amb} (°C)

GERMANIUM TRANSISTOR of the p-n-p type for A.F. medium power class A and B output stages and for switching and pulse oscillating circuits. The transistor can be used with a cooling fin which can be ordered separately.
TYPE 2-OC72 consists of 2 transistors OC72 selected for operation in a class B circuit with low distortion at small and large signals and with low spread in quiescent currents.

TRANSISTRON A CRISTAL DE GERMANIUM du type p-n-p pour étages de sortie B.F. classe A et B, de puissance moyenne et pour circuits de commutation et d'oscillation pulsée. Le transistron peut être utilisé avec une ailette de refroidissement qui peut être commandée séparément.
LE TYPE 2-OC72 est composé de 2 transistrons OC72 selectionnés pour opération en circuit classe B avec distorsion faible à des signaux faibles et élevés et avec dispersion faible des courants de repos.

p-n-p-GERMANIUMTRANSISTOR für NF Klasse A und B Endstufen mittlerer Leistung und für Schalt- und Impulsoszillationsstromkreise. Der Transistor kann mit einer Kühlschelle verwendet werden, die separat bestellt werden kann.
DIE TYPENNUMMER 2-OC72 besteht aus 2 Transistoren OC72 die ausgesucht sind zur Verwendung in Klasse B Schaltung mit geringer Verzerrung bei kleinen und grossen Signalen und mit kleiner Streuung der Ruheströme.





Dimensions in mm
Dimensions en mm
Abmessungen in mm

Cooling fin 56 200
Ailette de refroidissement 56 200
Kühlschelle 56 200

[1])The red dot indicates the collector
Le point rouge marque le collecteur
Der rote Punkt indiziert den Kollektor

[2])Not tinned; non-étamé; nicht verzinnt

Limiting values (Absolute max. values)
Caractéristiques limites (Valeurs max. absolues)
Grenzdaten (Absolute Maximalwerte)

$-V_{CB}$ = max. 32 V	$-I_C$	(t_{av} = max.20 msec)	=max. 50 mA	[1])
$-V_{CBM}$ = max. 32 V	$-I_{CM}$		=max.125 mA	[1])
$-V_{CE}$ See page C / Voir page C / Siehe S. C	$-I_C$	(t_{av}=max.20 msec)	=max.125 mA	[2])
$-V_{CEM}$	$\|I_{CM}\|$		=max.250 mA	[2])
$-V_{EB}$ = max. 10 V	I_E	(t_{av}=max.20 msec)	=max. 50 mA	[1])
$-V_{EBM}$ = max. 10 V	I_{EM}		=max.130 mA	[1])
P_C See page D / Voir page D / Siehe S. D	I_E	(t_{av}=max.20 msec)	=max.125 mA	[2])
	$\|I_{EM}\|$		=max.250 mA	[2])
	$-I_B$	(t_{av}=max.20 msec)	=max. 20 mA	[2])
	$\|I_{BM}\|$		=max.125 mA	[2])
T_j continuous operation / service continu / Dauerbetrieb			=max. 75 °C	
T_j intermittent operation / service intermittent / aussetzender Betrieb			=max. 90 °C	[3])
Storage temperature / Température d'emmagasinage / Lagerungstemperatur			=-55/+75 °C	

[1])Based on low distortion requirements in class A or B amplifiers
Fondé sur les exigences de faible distorsion dans le cas de amplificateurs classe A ou B
Basiert auf den Bedingungen für geringe Verzerrung in Klasse A oder B Verstärkern

[2])For switching or oscillating purposes
Pour l'usage comme commutateur ou oscillateur
Bei Verwendung in Schalt- oder Oszillatorstromkreisen

[3])Total duration max. 200 hours. Likelihood of full performance at this temperature is also dependent upon the type of application
Durée totale 200 heures au max. La probabilité d'opération optimum à cette température est aussi dépendante du genre de l'application
Gesamtdauer max. 200 Stunden. Die Wahrscheinlichkeit optimaler Wirkung bei dieser Temperatur wird auch von der Verwendungsart bestimmt

Characteristics
Caractéristiques
Kenndaten

T_{amb} = 25 °C

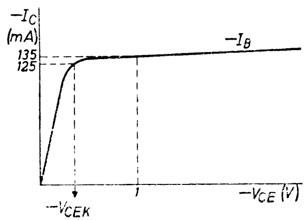
Common_base; Base_à_la masse; Basisschaltung

			Min.	Max.
$-I_{CBO}$	($-V_{CB}$ = 10 V)	= 4,5		<10 µA
$-I_{EBO}$	($-V_{EB}$ = 10 V)	= 4,5		<10 µA
$f_{\alpha b}$	($-V_{CB}$ = 6 V; I_E = 10 mA)	=	>350	kc/s

Common_emitter; Emetteur_à_la masse; Emitterschaltung

			Min.	Max.
$-I_{CEO}$	($-V_{CE}$ = 6 V)	= 125	>50	<300 µA
$-I_C$	($-V_{CE}$ = 30 V; $+V_{BE}$ ≥0,5 V)	= 7,5	>3	<15 µA
$f_{\alpha e}$	($-V_{CE}$ = 6 V; I_E = 10 mA)		>8	kc/s
F [1])	($-V_{CE}$ = 2 V; I_E =0,5 mA)			<15 dB

Collector knee voltage
Tension de coude du collecteur
Kniespannung des Kollektors



$-I_C$ = 125 mA

$-I_B$ { the value at which $-I_C$ = 135 mA when $-V_{CE}$ = 1 V
la valuer à laquelle $-I_C$ = 135 mA si $-V_{CE}$ = 1 V
der Wert bei dem $-I_C$ = 135 mA wenn $-V_{CE}$ = 1 V }

$-V_{CEK}$ < 0,4 V

[1]) Noise factor measured at 1000 c/s with an input source impedance of 500 Ω

Facteur de bruit mesuré à 1000 Hz avec une impédance de la source d'entrée de 500 Ω

Rauschfaktor gemessen bei 1000 Hz mit einer Impedanz der Eingangsspannungsquelle von 500 Ω

Characteristics (continued)
Caractéristiques (continuation)
Kenndaten (Fortsetzung)

Common_emitter; Emetteur_à_la masse; Emitterschaltung

Large signal characteristics
Caractéristiques pour grands signaux
Kenndaten für grosse Signale

$-V_{CE}$ (V)	I_E (mA)	$-V_{BE}$ (V)		α_{FE}		
		Min.	Max.	=	Min.	Max.
6	1,5	> 0,13	< 0,17			
5,4	10			70	> 45	< 120
0,7	80		< 0,45	50	> 30	< 90
0,7	125		< 0,70		> 25	
1	250				> 15	

Junction temperature
Température de la jonction
Kristalltemperatur

Junction temperature rise in free air

without cooling fin and heat sink K = 0.4 °C/mW

with cooling fin type 56200 and heat sink of at least 12.5 cm² K = 0.3 °C/mW

Augmentation de la température de la jonction en l'air libre

sans ailette de refroidissement et sans plaque additionnelle de refroidissement K = 0,4 °C/mW

avec ailette de refroidissement type 56200 et avec plaque additionnelle de refroidissement de 12,5 cm² au moins K = 0,3 °C/mW

Temperaturerhöhung des Kristalls in freier Luft

ohne Kühlschelle und ohne zusätzliche Kühlfläche K = 0,4 °C/mW

mit Kühlschelle Type 56200 und mit zusätzlicher Kühlfläche von mindestens 12,5 cm² K = 0,3 °C/mW

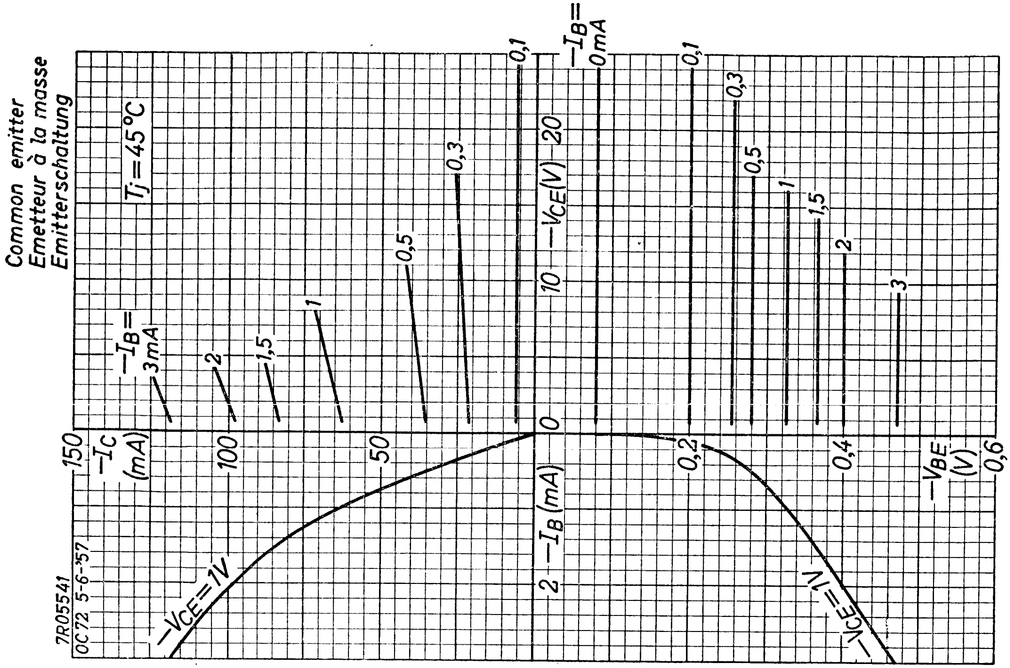
Characteristics of matched pair 2-OC72
Caractéristiques d'une paire jumelle 2-OC72
Kenndaten eines Transistorpaars 2-OC72

T_{amb} = 25 °C

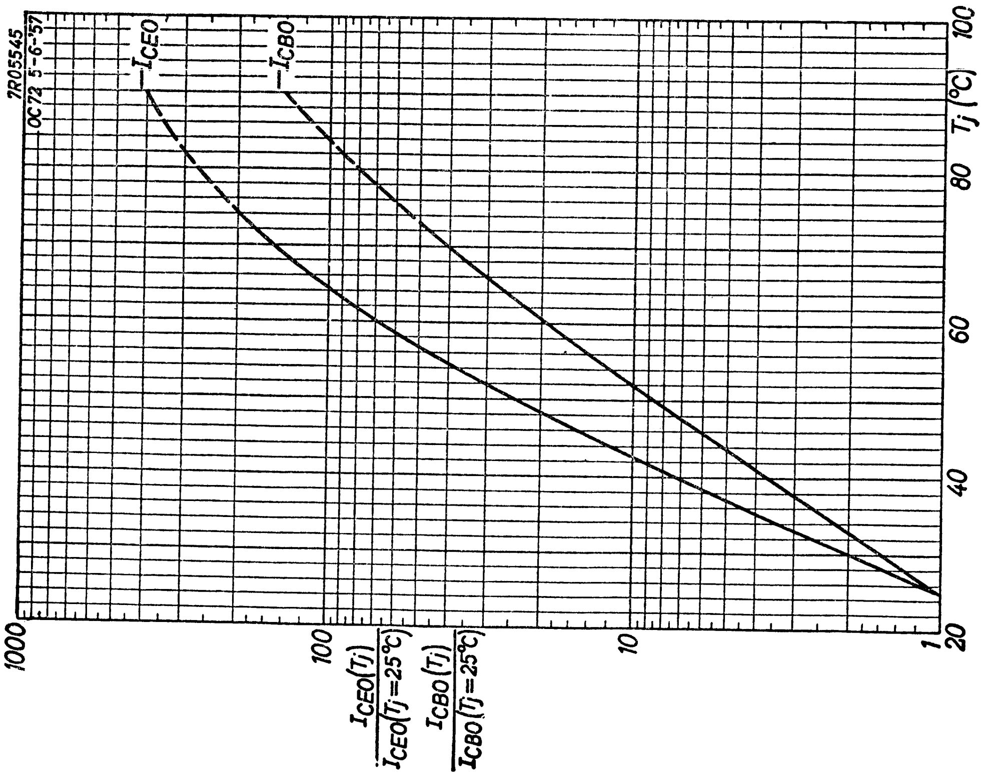
Ratio of α_{FE} of the two transistors both at I_E = 80 mA and at I_E = 10 mA 1.15 >1.0 <1.3

Rapport de α_{FE} des deux transistrons à I_E = 80 mA et à I_E = 10 mA 1,15 >1,0 <1,3

Verhältnis von α_{FE} beider Transistoren bei I_E = 80 mA und bei I_E = 10 mA 1,15 >1,0 <1,3


Common emitter
Emetteur à la masse
Emitterschaltung
$T_j = 45°C$
$-I_B =$ 3mA
2
1,5
1
0,5
0,3
0,1
$-I_B =$ 0mA
0,1
0,3
0,5
1
1,5
2
3
$-V_{CE}(V)$
10
20
$-I_C$ (mA)
150
100
50
0
$-I_B$ (mA)
2
$-V_{CE}=1V$
$-V_{CE}=1V$
0,2
0,4
0,6
$-V_{BE}$ (V)
7R05541
OC72 5-6-'57

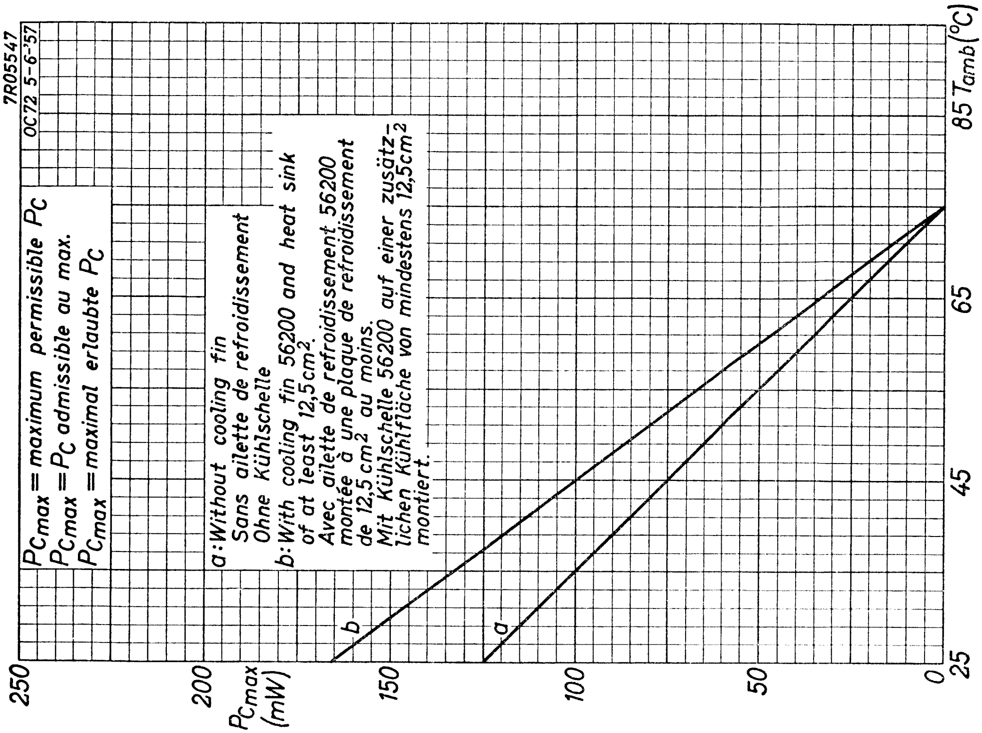
B


7R05545
OC72 5-6-'57
$-I_{CEO}$
$-I_{CBO}$
1000
100
10
1
20
40
60
80
100
T_j (°C)
$\frac{I_{CEO}(T_j)}{I_{CEO}(T_j=25°C)}$
$\frac{I_{CBO}(T_j)}{I_{CBO}(T_j=25°C)}$

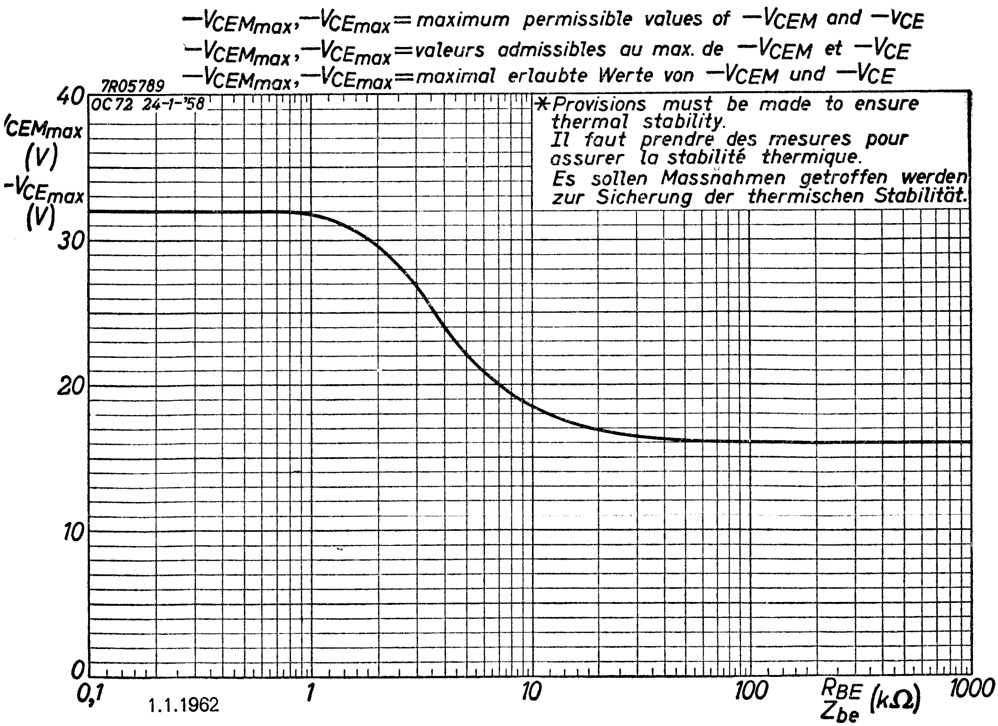
A

3.3.1958

D


7R05547
OC72 5-6-'57
P_{Cmax} = maximum permissible P_C
P_{Cmax} = P_C admissible au max.
P_{Cmax} = maximal erlaubte P_C
a: Without cooling fin
Sans ailette de refroidissement
Ohne Kühlschelle
b: With cooling fin 56200 and heat sink of at least 12,5 cm²
Avec ailette de refroidissement 56200 montée à une plaque de refroidissement de 12,5 cm² au moins.
Mit Kühlschelle 56200 auf einer zusätzlichen Kühlfläche von mindestens 12,5 cm² montiert.
a
b
250
200
150
100
50
0
P_{Cmax} (mW)
25
45
65
85
T_{amb} (°C)

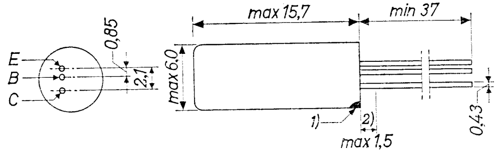
C

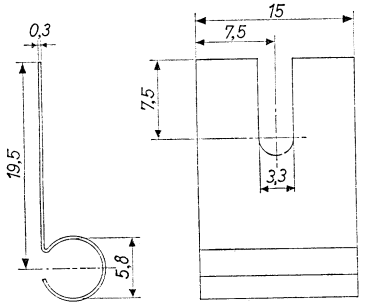

$-V_{CEMmax}$, $-V_{CEmax}$ = maximum permissible values of $-V_{CEM}$ and $-V_{CE}$
$-V_{CEMmax}$, $-V_{CEmax}$ = valeurs admissibles au max. de $-V_{CEM}$ et $-V_{CE}$
$-V_{CEMmax}$, $-V_{CEmax}$ = maximal erlaubte Werte von $-V_{CEM}$ und $-V_{CE}$
7R05789
OC72 24-1-'58
*Provisions must be made to ensure thermal stability.
Il faut prendre des mesures pour assurer la stabilité thermique.
Es sollen Massnahmen getroffen werden zur Sicherung der thermischen Stabilität.
$-V_{CEMmax}$ (V)
$-V_{CEmax}$ (V)
40
30
20
10
0
0,1
1
10
100
1000
R_{BE}
Z_{be} (kΩ)

GERMANIUM TRANSISTOR of the p-n-p type in all-glass construction with metal cover; designed for class A and B output stages for battery voltages up to 9 volts and power outputs of approximately 1 watt.
TYPE 2-OC74 consists of 2 transistors OC74 selected for operation in a class B circuit with low distortion and low spread in base-emitter voltages

TRANSISTOR A CRISTAL DE GERMANIUM du type p-n-p en construction tout-verre avec enveloppe métallique; conçu pour des étages de sortie classe A et B à des tensions de batterie jusqu'à 9 volt et avec une puissance de sortie d'environ 1 watt.
LE TYPE 2-OC74 est composé de 2 transistors OC74 sélectionnés pour fonctionnement en circuit classe B avec distorsion faible et avec dispersion faible sur les tensions base-émetteur

p-n-p-GERMANIUMTRANSISTOR in Allglastechnik mit Metallumhüllung für Klasse A und B Ausgangsstufen für Batteriespannungen bis 9 V und mit einer Ausgangsleistung von etwa 1 W.
DAS TRANSISTORPAAR 2-OC74 besteht aus 2 Transistoren OC74, die ausgesucht worden sind zur Verwendung in Klasse B-Schaltung mit geringer Verzerrung und mit kleiner Streuung der Basis-Emitterspannungen.





Dimensions in mm
Dimensions en mm
Abmessungen in mm

Cooling fin 56200
Ailette de refroidissement 56200
Kühlschelle 56200

1) The red dot indicates the collector
Le point rouge marque le collecteur
Der rote Punkt bezeichnet den Kollektor

2) Not tinned; non-étamé; nicht verzinnt

Limiting values (Absolute max. values)
Caractéristiques limites (Valeurs max. absolues)
Grenzdaten (Absolute Maximalwerte)

$-V_{CB}$ = max. 20 V		$-I_C$	= max. 300 mA
$-V_{CE}$ = max. 20 V 1)		I_E	= max. 310 mA
$-V_{EB}$ = max. 6 V		P_C	see page C / voir page C / siehe Seite C

T_j { continuous operation / service continu / Dauerbetrieb } = max. 75 °C

T_j { intermittent operation / service intermittent / aussetzender Betrieb } = max. 90 °C 2)

Storage temperature
Température d'emmagasinage = $-55^{\circ}C/+75\ ^{\circ}C$
Lagerungstemperatur

THERMAL DATA

Junction temperature rise to ambient temperature in free air

without cooling fin or heat sink	$K \leq 0.22\ ^{\circ}C/mW$
with cooling fin vertically in free air or mounted on board	$K \leq 0.15\ ^{\circ}C/mW$
with cooling fin type 56200 on heat sink of at least 12.5 cm^2	$K \leq 0.09\ ^{\circ}C/mW$

Données thermiques: voir page 3
Thermische Daten: siehe Seite 3

1) See also page B. Voltage excursion up to this value will not cause distortion due to curvature of the output characteristic
Voir aussi page B. Modulation de la tension jusqu'à cette valeur n'entraînera pas de distorsion par suite de la courbure de la caractéristique de sortie
Siehe auch Seite B. Spannungsaussteuerung bis zu diesem Wert wird keine Verzerrung infolge Krümmung der Ausgangskennlinie zur Folge haben

2) Total duration max. 200 hours. Likelihood of full performance at this temperature is also dependent upon the type of application
Durée totale 200 heures au max. La probabilité de fonctionnement optimum à cette température est aussi dépendante du genre d'application
Gesamtdauer max. 200 Stunden. Die Wahrscheinlichkeit optimaler Wirkung bei dieser Temperatur wird auch von der Verwendungsart bestimmt

Thermal data: see page 2

DONNÉES THERMIQUES

Augmentation de la température de la jonction au regard de la température de l'ambiance à l'air libre

Sans ailette de refroidissement et sans plaque additionnelle de refroidissement	K ≦	0,22 °C/mW
Avec ailette de refroidissement verticalement à l'air libre ou monté à une plaque isolante	K ≦	0,15 °C/mW
Avec ailette de refroidissement et avec plaque additionnelle de refroidissement de 12,5 cm² au moins	K ≦	0,09 °C/mW

THERMISCHE DATEN

Temperaturerhöhung des Kristalls in bezug auf die Umgebungstemperatur in freier Luft

ohne Kühlschelle und ohne zusätzliche Kühlfläche	K ≦	0,22 °C/mW
mit Kühlschelle senkrecht in freier Luft oder montiert an einer isolierenden Platte	K ≦	0,15 °C/mW
mit Kühlschelle montiert an einer zusätzlichen Kühlplatte von mindestens 12,5 cm²	K ≦	0,09 °C/mW

Characteristics
Caractéristiques
Kenndaten

T_{amb} = 25 °C { unless otherwise specified / sauf indication différente / wenn nicht anders angegeben

$-I_{CBO}$	($-V_{CB}$ = 9 V)	=	10	< 20 µA
$-I_{CBO}$	{$-V_{CB}$ = 9 V, T_{amb} = 60 °C}	=	100	< 330 µA
$-I_{EBO}$	($-V_{EB}$ = 6 V)	=	7	< 20 µA
$-I_C$	$-V_{CB}$ = 6 V, $-V_{BE}$ = 155 mV	>	2,5	< 10 mA

$-V_{CB}$ (V)	I_E (mA)	$-I_B$ (mA)			$-V_{BE}$ (mV) [1]	
		=	min.	max.	=	max.
6	50	0,5	>0,3	<0,92	230	<300
0,5	300	4,5	>2,8	< 8,5	450	<700

[1]) $-V_{BE}$ decreases with about 2.3 mV/°C at increasing temperatures
A des températures montantes $-V_{BE}$ se diminue d'environ 2,3 mV/°C
Bei steigender Temperatur nimmt $-V_{BE}$ um etwa 2,3 mV/°C ab

Characteristics (continued)
Caractéristiques (suite)
Kenndaten (Fortsetzung)

Column I: Setting of the transistor and typical (average) measuring results of new transistors
II: Characteristic range values for equipment design

Colonne I: Valeurs pour le réglage du transistor et les résultats moyens de mesures de transistors neufs
II: Gamme de valeurs caractéristiques pour l'étude d'équipements

Spalte I: Einstelldaten des Transistors und mittlere Messergebnisse neuer Transistoren
II: Charakteristischer Wertbereich für Gerätentwurf

T_{amb} = 25 °C { unless otherwise specified / sauf indication contraire / wenn nicht anders angegeben

		I	II	
$-V_{EB}$	=	6		V
T_{amb}	=	60		°C
$-I_{EBO}$	=	80	< 300	µA
$-V_{CB}$	=	6		V
I_E	=	5		mA
f	=	1		kc/s
F	=	15	< 27	dB
$-V_{CE}$	=	6		V
$-I_C$	=	50		mA
$f_{\alpha e}$	=	14	> 8	kc/s
$-V_{CE}$	=	6		V
$-I_C$	=	5		mA
$-V_{BE}$	=	155	135-175	mV [1])

		I	II	
$-V_{CE}$	=	6		V
$-I_C$	=	10		mA
$r_{bb'}$	=	50	< 100 Ω	
$-V_{CE}$	=	6		V
$-I_C$	=	5		mA
h_{FE}	=	75	40-200	
$-V_{CE}$	=	6		V
$-I_C$	=	50		mA
h_{FE}	=	100	60-150	
$-V_{CE}$	=	1		V
$-I_C$	=	300		mA
h_{FE}	=	65	40-100	
$-I_C$	=	300		mA
$-I_B$	=	[2])		
$-V_{CEK}$	=	0,35	< 0,6 V	

[1]) See page 3; voir page 3; siehe Seite 3

[2]) $-I_B$ = { the value at which $-I_C$ = 330 mA when $-V_{CE}$ = 1V / la valeur à laquelle $-I_C$ = 330 mA lorsque $-V_{CE}$ = 1V / der Wert bei dem $-I_C$ = 330 mA wenn $-V_{CE}$ = 1 V

Characteristics (continued)
Caractéristiques (suite)
Kenndaten (Fortsetzung)

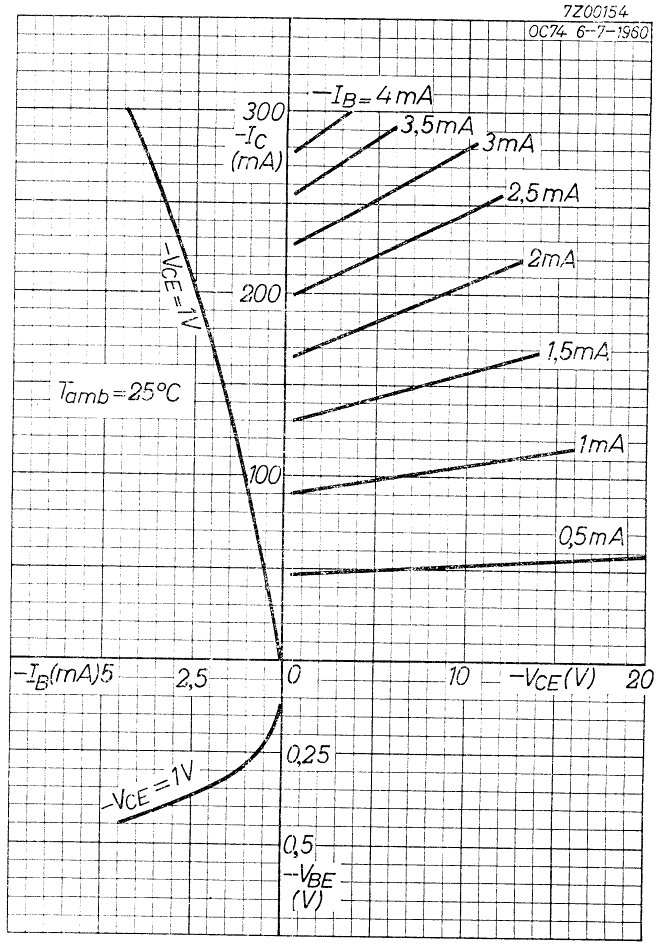
T_{amb} = 25 °C

		I	II	
V_S	=	9		V
R_C	=	27		Ω [1]
$\frac{h_{fe}(-I_C = 300\ mA)}{h_{fe_{max}}}$	=	0,45		

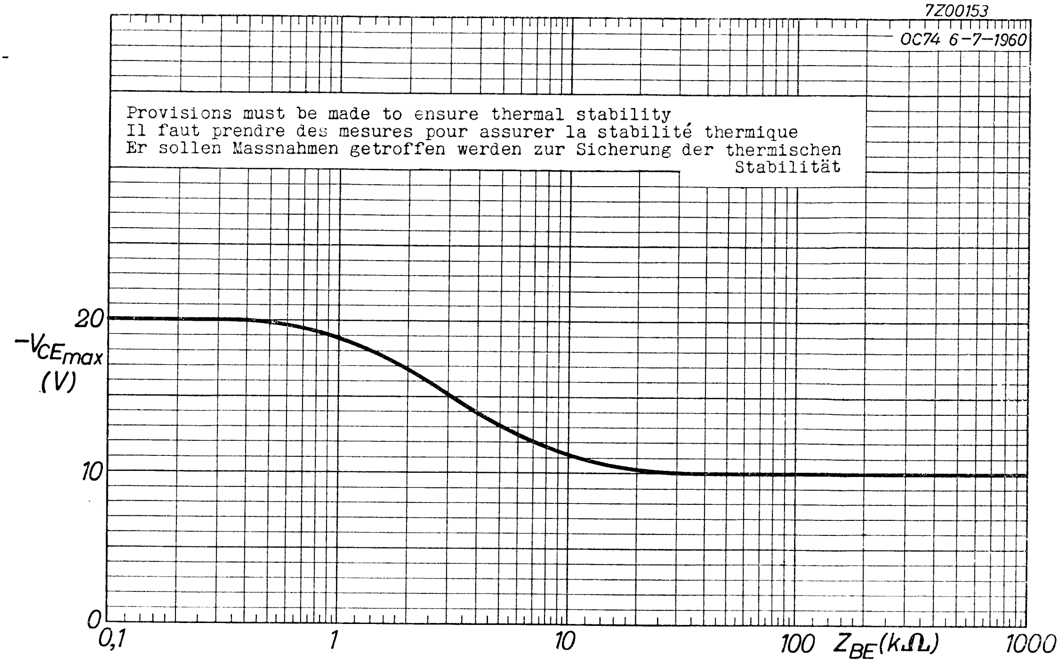
Ratio of h_{FE} of the two transistors of a matched pair 2-OC74
Rapport de h_{FE} des deux transistors d'une paire jumelle 2-OC74
Verhältnis von h_{FE} beider Transistoren eines Transistorpaars 2-OC74

		I	II	
$-V_{CE}$	=	6		V
$-I_C$	=	50		mA
$\frac{h_{FE(1)}}{h_{FE(2)}}$	=	1,15	< 1,3	
$-V_{CE}$	=	1		V
$-I_C$	=	300		mA
$\frac{h_{FE(1)}}{h_{FE(2)}}$	=	1,15	< 1,3	

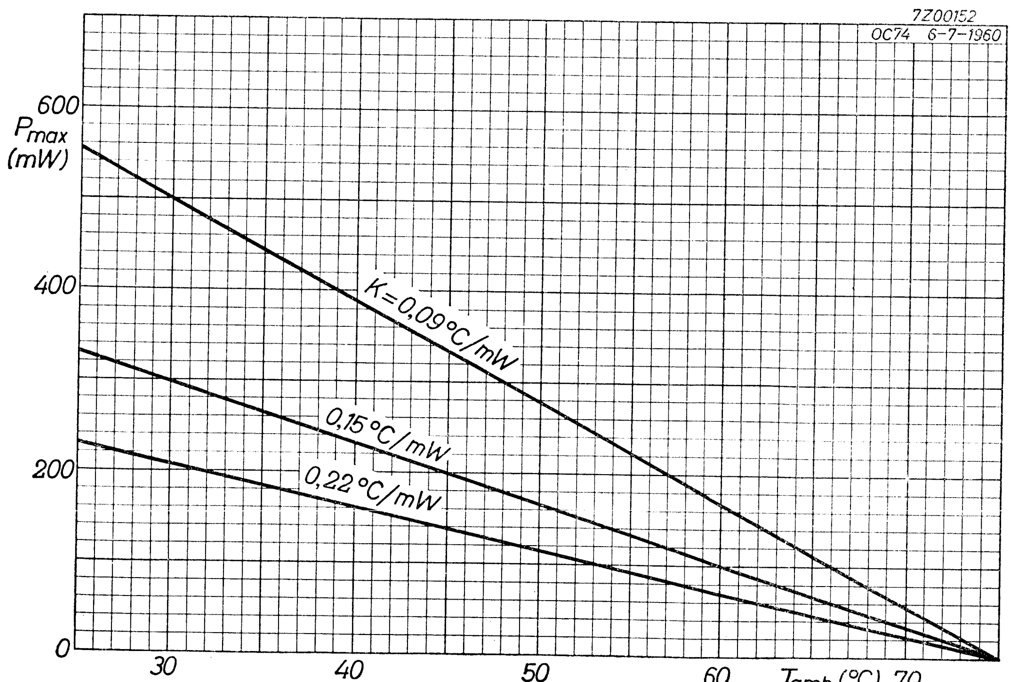
[1]) Collector resistor, for A.C. short-circuited
Résistance extérieure du collecteur, en court-circuit pour courant alternatif
Äusserer Kollektorwiderstand, für Wechselstrom kurzgeschlossen



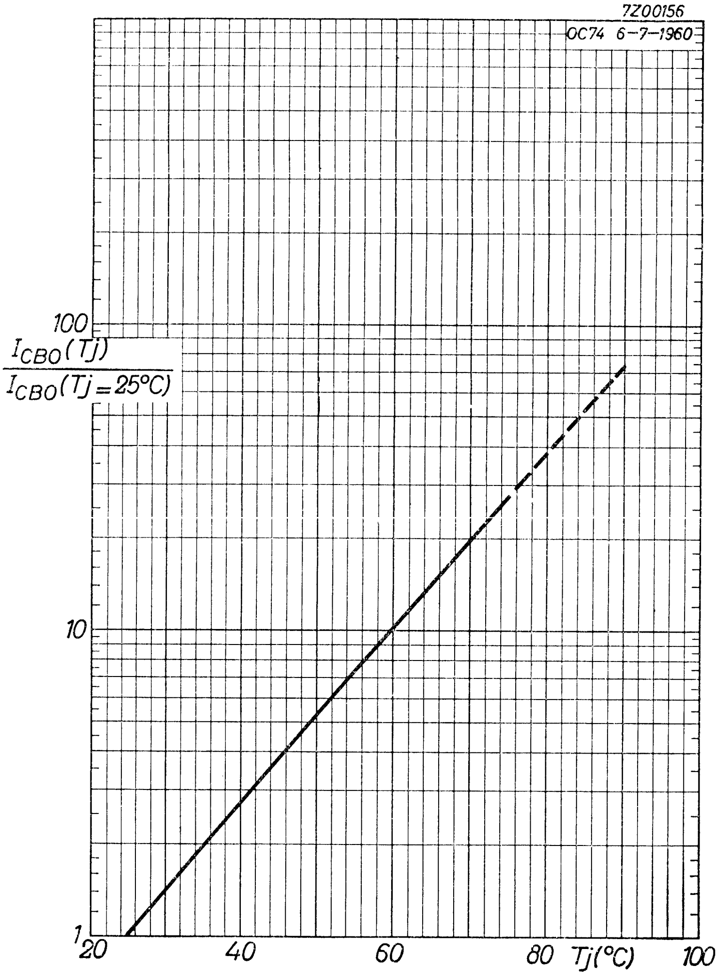
A


7Z00153
OC74 6-7-1960
Provisions must be made to ensure thermal stability
Il faut prendre des mesures pour assurer la stabilité thermique
Er sollen Massnahmen getroffen werden zur Sicherung der thermischen Stabilität
20
$-V_{CE max}$
(V)
10
0
0,1
1
10
100
Z_{BE} (kΩ)
1000

B

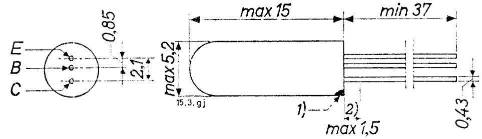

7Z00152
OC74 6-7-1960
600
P_{max}
(mW)
400
200
0
K=0,09°C/mW
0,15°C/mW
0,22°C/mW
30
40
50
60
T_{amb} (°C)
70

C


7Z00156
OC74 6-7-1960
100
10
1
$I_{CBO}(Tj)$ / $I_{CBO}(Tj=25°C)$
20
40
60
80
100
Tj(°C)

GERMANIUM TRANSISTOR of the p-n-p type in all-glass construction, suitable for general purposes
TRANSISTRON A CRISTAL DE GERMANIUM du type p-n-p en construction tout-verre, prévu pour les usages généraux
p-n-p-GERMANIUM-ALLZWECKTRANSISTOR in Allglastechnik

Dimensions in mm
Dimensions en mm
Abmessungen in mm



Limiting values (Absolute max. values)
Caractéristiques limites (Valeurs max. absolues)
Grenzdaten (Absolute Maximalwerte)

$-V_{CE}$	= max. 30 V [3]
$-V_{CEM}$	= max. 30 V [3]
$-I_C$ (t_{av} = max. 20 msec)	= max. 10 mA
$-I_{CM}$	= max. 50 mA
P_C	See page B / Voir page B / Siehe Seite B
I_E (t_{av} = max. 20 msec)	= max. 15 mA
I_{EM}	= max. 70 mA
$-I_B$ (t_{av} = max. 20 msec)	= max. 5 mA
$-I_{BM}$	= max. 20 mA
T_j continuous operation / service continu / Dauerbetrieb	= max. 75 °C
T_j intermittent operation / service intermittent / aussetzender Betrieb	= max. 90 °C [4]
Storage temperature / Température d'emmagasinage / Lagerungstemperatur	= -55/+75 °C

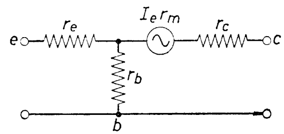
[1]) The red dot indicates the collector
Le point rouge marque le collecteur
Der rote Punkt indiziert den Kollektor

[2]) Not tinned; non-étamé; nicht verzinnt

[3])[4]) See page 2; voir page 2; siehe Seite 2

Characteristics
Caractéristiques T_{amb} = 25 °C
Kenndaten

Common base; Base à la masse; Basisschaltung



Measured at / Mesuré à / Gemessen bei	$-V_{CB}$	=	2	V
	$-I_C$	=	3	mA
	f	=	1000	c/s
	r_e	=	6,4	Ω
	r_b	=	720	Ω
	r_c	=	722	kΩ
	r_m	=	715	kΩ
	h_{11b}	=	14	Ω
	$-h_{21b}$	=	0,989	
	h_{22b}	=	1,4	µA/V
	h_{12b}	=	$10 \cdot 10^{-4}$	

$-I_{CBO}$ ($-V_{CB}$ = 4,5 V) = 4,5 <12 µA

[3]) These values are permissible at $V_{BE} \geqq 0.5$ V. See also page C
Ces valeurs sont admissibles à $V_{BE} \geqq 0,5$ V. Voir aussi page C
Diese Werte sind erlaubt bei $V_{BE} \geqq 0,5$ V. Siehe auch Seite C

[4]) Total duration max. 200 hours. Likelihood of full performance at this temperatureis also dependent upon the type of application
Durée totale 200 heures au max. La probabilité d'opération optimum à cette température est aussi dépendante du genre de l'application
Gesamtdauer max. 200 Stunden. Die Wahrscheinlichkeit optimaler Wirkung bei dieser Temperatur wird auch von der Verwendungsart bestimmt

Characteristics (continued)
Caractéristiques (continuation)
Kenndaten (Fortsetzung)

Common emitter; Emetteur à la masse; Emitterschaltung

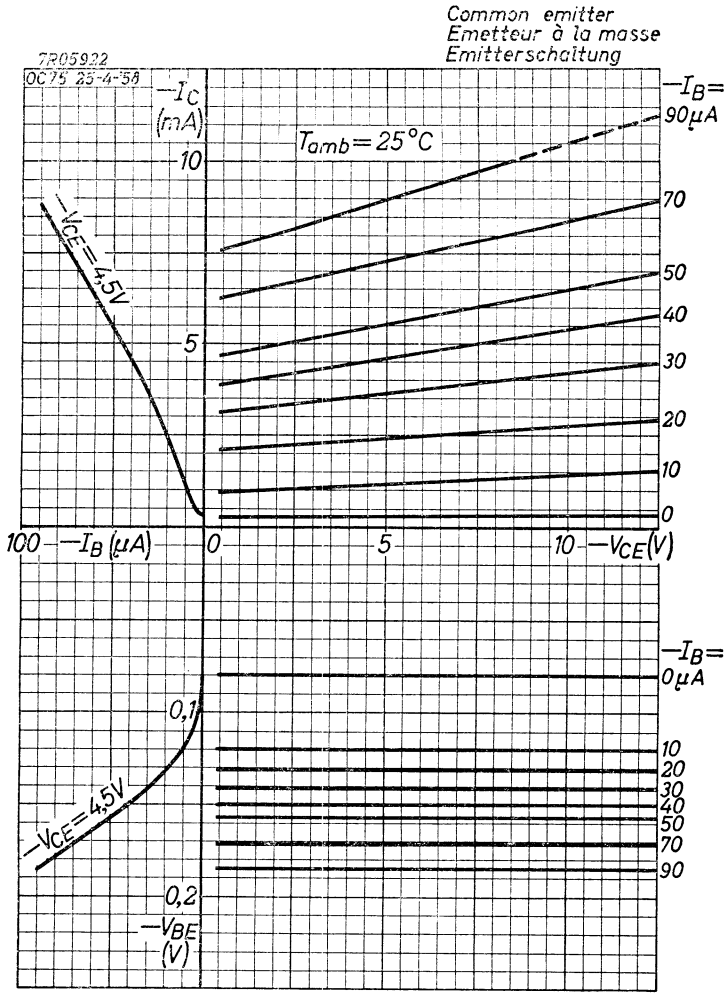
Measured at / Mesuré à / Gemessen bei	$-V_{CE}$	=	2			V
	$-I_C$	=	3			mA
	f	=	1000			c/s
	h_{11e}	=	1,3			kΩ
	h_{21e}	=	90	>65	<130	
	h_{22e}	=	125			µA/V
	h_{12e}	=	$8 \cdot 10^{-4}$			
	$f_{\alpha e}$	=	8			kc/s
	F[1])	=	10		<15	dB

$-I_{CEO}$	($-V_{CE}$ = 4,5 V)	=	350		<550	µA
$-I_C$	$-V_{CE}$ = 4,5 V	=	1,1	>0,75	<1,9	mA
$-V_{BE}$	$-I_B$ = 10 µA	=	120	> 90	<175	mV
$-I_C$	$-V_{CE}$ = 4,5 V	=	22	>13,5	<33	mA
$-V_{BE}$	$-I_B$ = 250 µA	=	270	>210	<385	mV

Junction temperature
Température de la jonction
Kristalltemperatur

Junction temperature rise in free air
Augmentation de la température de la jonction en l'air libre
Temperaturerhöhung des Kristalls in freier Luft

$K \leqq 0,4$ °C/mW



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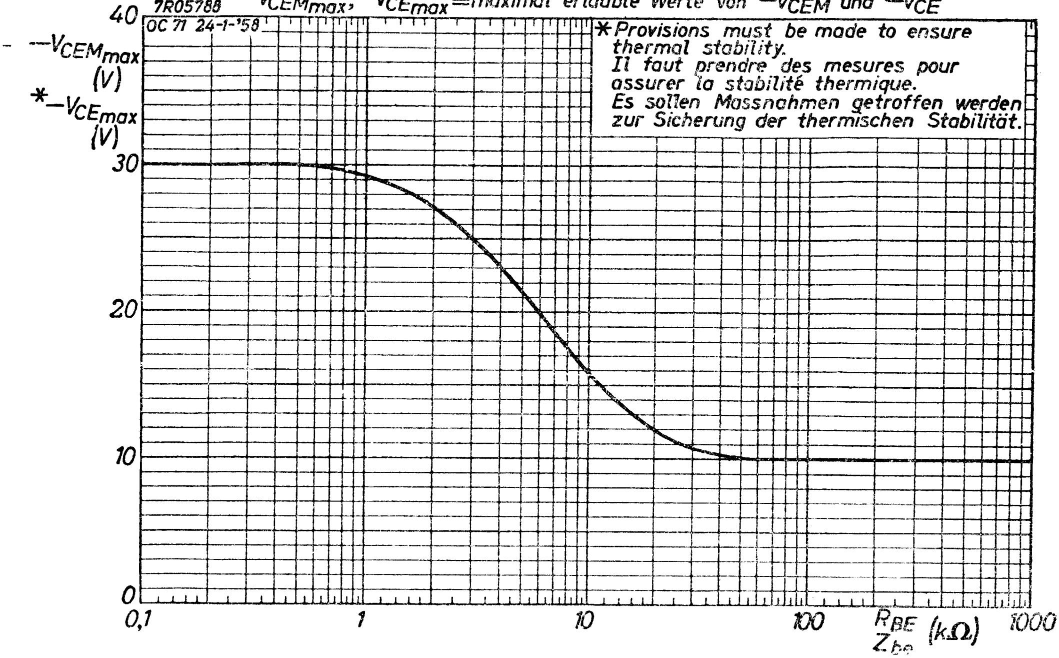
[1]) Noise factor at $-I_C$ = 0.5 mA with input source impedance = 500 Ω
Facteur de bruit à $-I_C$ = 0,5 mA avec impédance de la source d'entrée = 500 Ω
Rauschfaktor bei $-I_C$ = 0,5 mA bei einer Impedanz der Eingangsspannungsquelle = 500 Ω

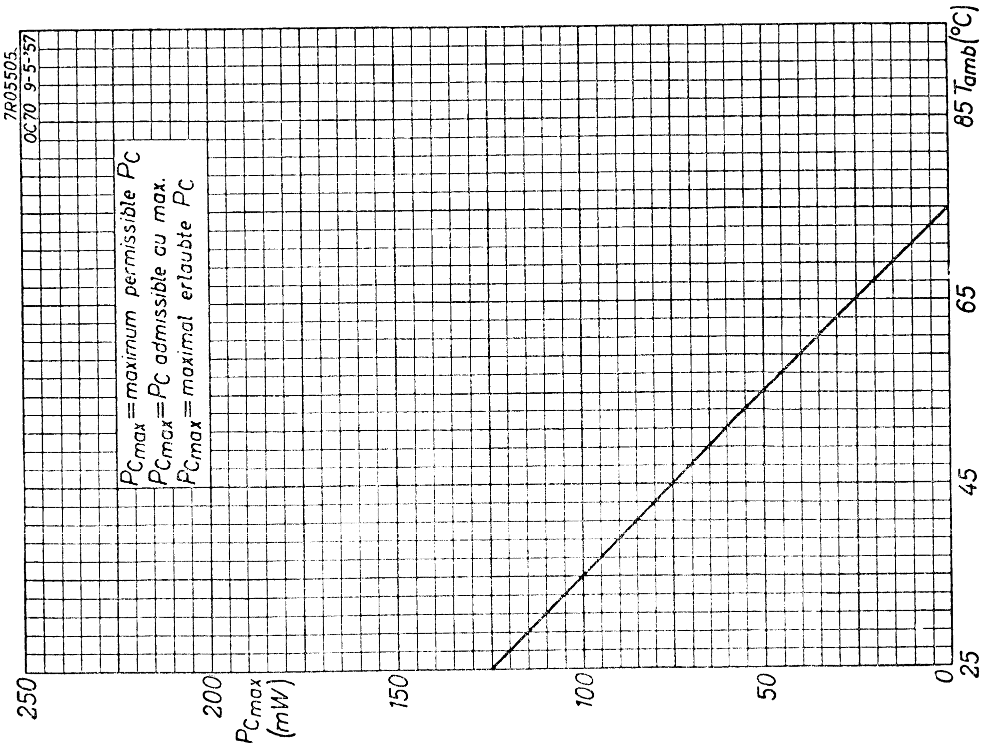
$-V_{CEMmax}$, $-V_{CEmax}$ = maximum permissible values of $-V_{CEM}$ and $-V_{CE}$

$-V_{CEMmax}$, $-V_{CEmax}$ = valeurs admissibles au max. de $-V_{CEM}$ et $-V_{CE}$

$-V_{CEMmax}$, $-V_{CEmax}$ = maximal erlaubte Werte von $-V_{CEM}$ und $-V_{CE}$

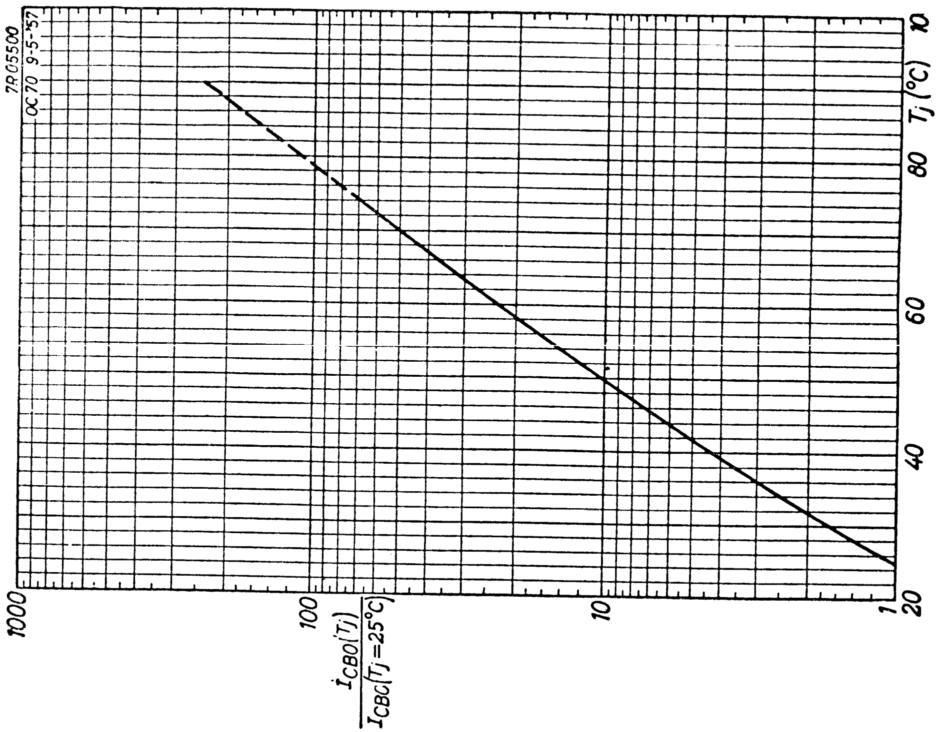


C



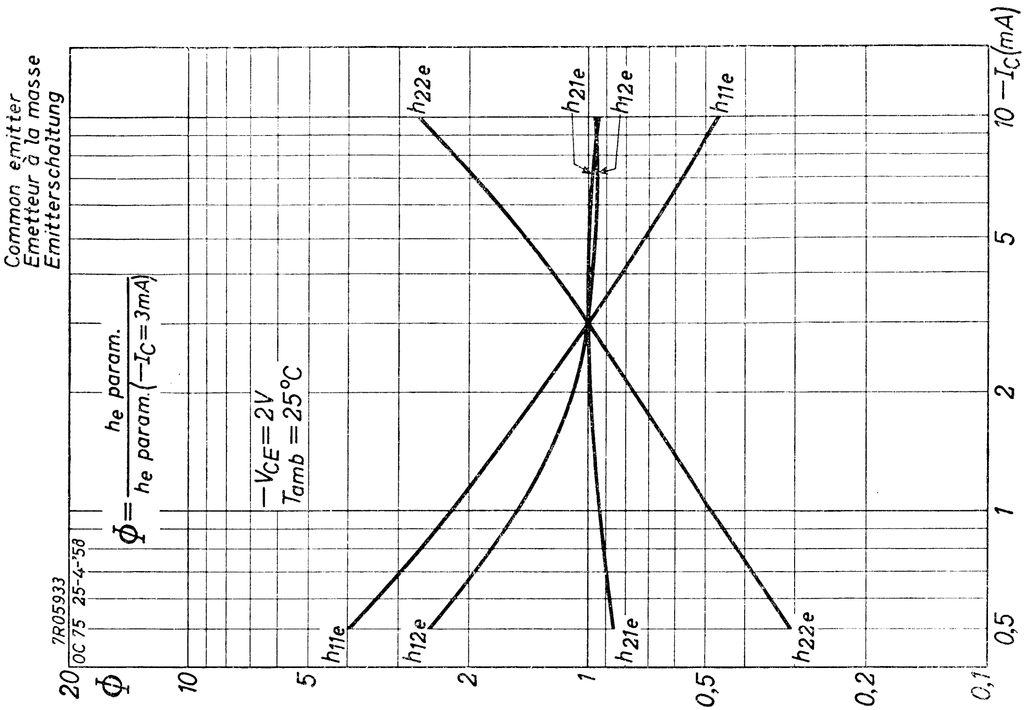
B

6.6.1958

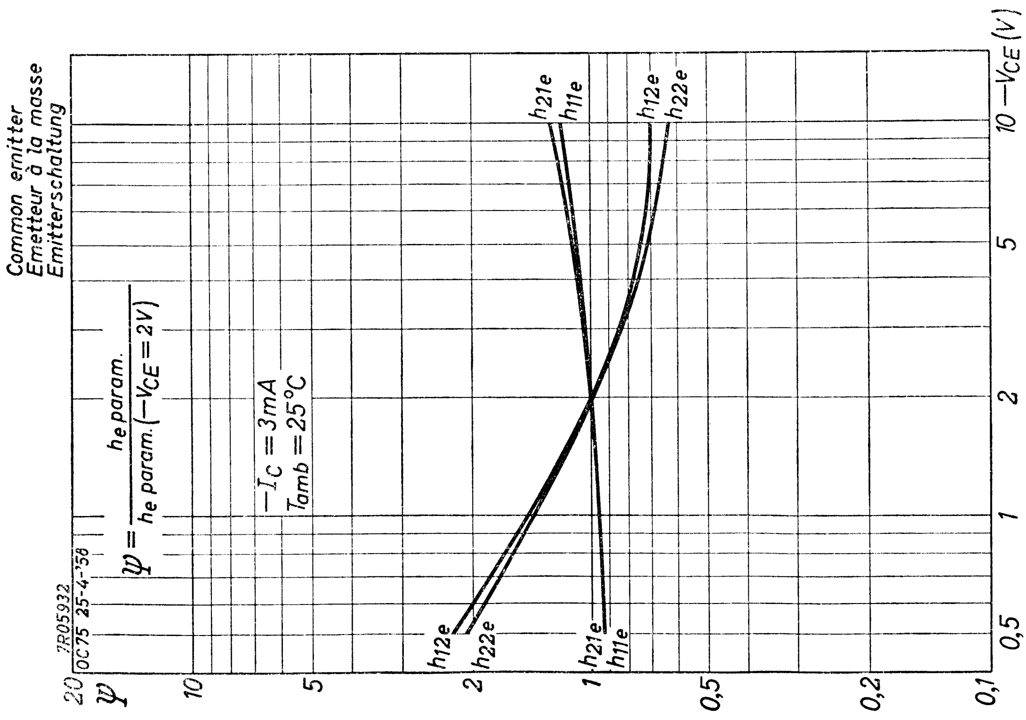

7R05500
OC70 9-5-'57
1000
100
10
1
$\frac{I_{CBO}(T_j)}{I_{CBO}(T_j=25^\circ C)}$
20
40
60
80
100
T_j (°C)

D

6.6.1958


Common emitter
Emetteur à la masse
Emitterschaltung
$\Phi = \frac{h_e \text{ param.}}{h_e \text{ param.} (-I_C = 3mA)}$
$-V_{CE} = 2V$
$T_{amb} = 25°C$
7R05933
OC 75 25-4-'58
h22e
h21e
h12e
h11e
20
10
5
2
1
0,5
0,2
0,1
0,5
1
2
5
10 $-I_C$ (mA)

F

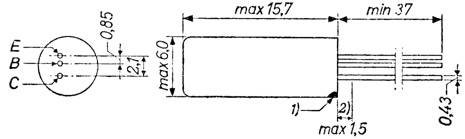

Common emitter
Emetteur à la masse
Emitterschaltung
$\Psi = \frac{h_e \text{ param.}}{h_e \text{ param.} (-V_{CE} = 2V)}$
$-I_C = 3mA$
$T_{amb} = 25°C$
7R05932
OC 75 25-4-'58
h21e
h11e
h12e
h22e
20
10
5
2
1
0,5
0,2
0,1
0,5
1
2
5
10 $-V_{CE}$ (V)

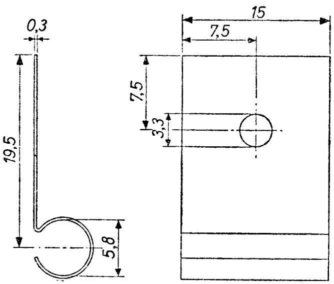
E

GERMANIUM TRANSISTOR of the p-n-p type in all glass construction with metal cover for switching and pulse-oscillating circuits, such as D.C. converters. The transistor can be used with a cooling fin for higher dissipations

TRANSISTRON A CRISTAL DE GERMANIUM du type p-n-p, en construction tout verre avec enveloppe métallique, pour circuits de commutation et d'oscillation pulsée comme les convertisseurs à tension continue. Le transistron peut être utilisé avec une ailette de refroidissement pour des dissipations plus élevées

p-n-p-GERMANIUMTRANSISTOR in Allglastechnik mit Metallumhüllung für Schalt- und Impulsoszillationsstromkreise wie Gleichspannungswandler. Der Transistor kann für höhere Dissipation mit einer Kühlschelle verwendet werden





Dimensions in mm
Dimensions en mm
Abmessungen in mm

Cooling fin 56 200
Ailette de refroidissement 56 200
Kühlschelle 56 200

Limiting values (Absolute max. values)
Caractéristiques limites (Valeurs max. absolues)
Grenzdaten (Absolute Maximalwerte)

$-V_{CB}$	= max. 32 V 3)	$-I_C$ (tav = max. 20 msec)	= max. 125 mA
$-V_{CBM}$	= max. 32 V	$\|I_{CM}\|$	= max. 250 mA
$-V_{CE}$	= max. 32 V 3) 4)	I_E (tav = max. 20 msec)	= max. 125 mA
$-V_{CEM}$	= max. 32 V 4)	$\|I_{EM}\|$	= max. 250 mA
$-V_{EBM}$	= max. 10 V	$-I_B$ (tav = max. 20 msec)	= max. 20 mA
P_{tot}	See page D / Voir page D / Siehe Seite D	$\|I_{BM}\|$	= max. 125 mA

Continued on page 2
Continué sur page 2
Fortsetzung auf Seite 2

Limiting values (Absolute max. values), continued
Caractéristiques limites (Valeurs max. absolues), suite
Grenzdaten (Absolute Maximalwerte), Fortsetzung

T_j	continuous operation / service continu / Dauerbetrieb	= max.	75 °C
T_j	intermittent operation / service intermittent / aussetzender Betrieb	= max.	90 °C 5)
	Storage temperature / Température d'emmagasinage / Lagerungstemperatur	=	-55°C/+75 °C

1) The red dot indicates the collector
Le point rouge marque le collecteur
Der rote Punkt indiziert den Kollektor

2) Not tinned; non-étamé; nicht verzinnt

3) For derating curves at higher junction temperatures see pages E, F and G
Pour les courbes d'abaissement aux températures plus hautes de la jonction voir pages E, F et G
Für Reduktionskurven bei höheren Kristalltemperaturen siehe Seiten E, F und G

4) For derating curve at higher base to ground impedances see page C
Pour courbe d'abaissement aux impédances plus hautes entre base et masse voir page C
Für Reduktionskurve bei höheren Impedanzen zwischen Basis und Erde siehe Seite C

5) Total duration max. 200 hours. Likelihood of full performance at this temperature is also dependent upon the type of application
Durée totale 200 heures au max. La probabilité d'opération optimum à cette température est aussi dépendante du genre d'application
Gesamtdauer max. 200 Stunden. Die Wahrscheinlichkeit optimaler Wirkung bei dieser Temperatur wird auch von der Verwendungsart bestimmt

Characteristics
Caractéristiques T_{amb} = 25 °C
Kenndaten

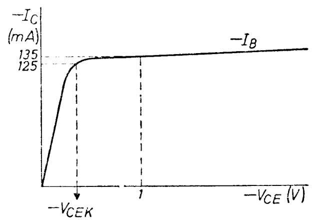
Common_base; Base_à_la masse; Basisschaltung

			Min.	Max.	
$-I_{CBO}$	($-V_{CB}$ = 10 V)	= 4,5		< 10	µA
$-I_{EBO}$	($-V_{EB}$ = 10 V)	= 4,5		< 8	µA
$f_{\alpha b}$	($-V_{CB}$ = 6 V; I_E = 10 mA)	= 900	>350		kc/s

Common_emitter; Emetteur_à_la masse; Emitterschaltung

$-I_{CEO}$	($-V_{CE}$ = 6 V)	= 200	<600 µA
$-I_C$	($-V_{CE}$ = 30 V; V_{BE} ≥ 0,5 V)	= 7,5	<15 µA
F [1]	($-V_{CE}$ = 2 V; I_E = 0,5 mA)	= 8	<15 dB

Collector knee voltage
Tension de coude du collecteur
Kniespannung des Kollektors



$-I_C$ = 125 mA

$-I_B$ = { the value at which $-I_C$ = 135 mA when $-V_{CE}$ = 1 V
la valeur à laquelle $-I_C$ = 135 mA si $-V_{CE}$ = 1 V
der Wert bei dem $-I_C$ = 135 mA wenn $-V_{CE}$ = 1 V }

$-V_{CEK}$ = 0,3 V < 0,4 V

[1]) Noise factor measured at f = 1000 c/s with an input source impedance of 500 Ω
Facteur de bruit mesuré à f = 1000 Hz avec une impédance de la source d'entrée de 500 Ω
Rauschfaktor gemessen bei f = 1000 Hz mit einer Impedanz der Eingangsspannungsquelle von 500 Ω

Large signal characteristics
Caractéristiques pour grands signaux
Kenndaten für grosse Signale

$-V_{CE}$ (V)	I_E (mA)	$-V_{BE}$ (V) max.	α_{FE} min.	α_{FE} max.
5,4	10	-	> 45	< 330
0,7	80	< 0,45	> 30	< 230
0,7	125	< 0,70	> 25	< 170
1	250	-	> 15	< 125

Junction temperature
Température de la jonction
Kristalltemperatur

Junction temperature rise in free air

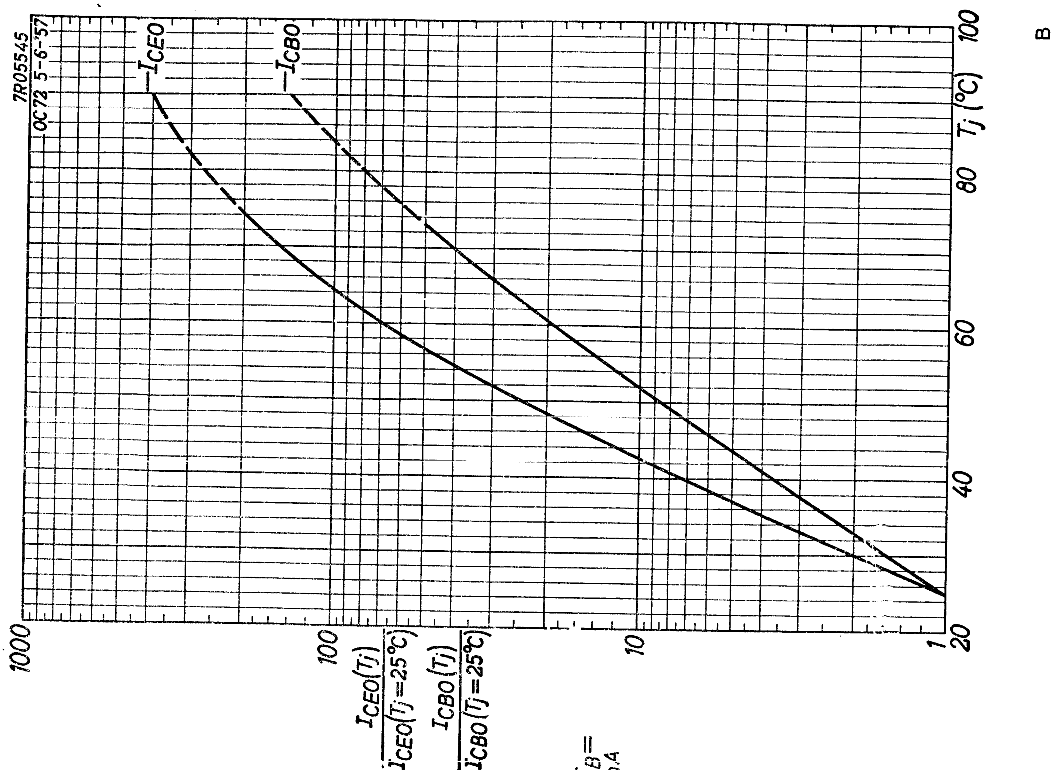
without cooling fin and heat sink K < 0.4 °C/mW
with cooling fin type 56200 and heat sink of at least 12.5 cm² K < 0.3 °C/mW

Augmentation de la température de la jonction en l'air libre

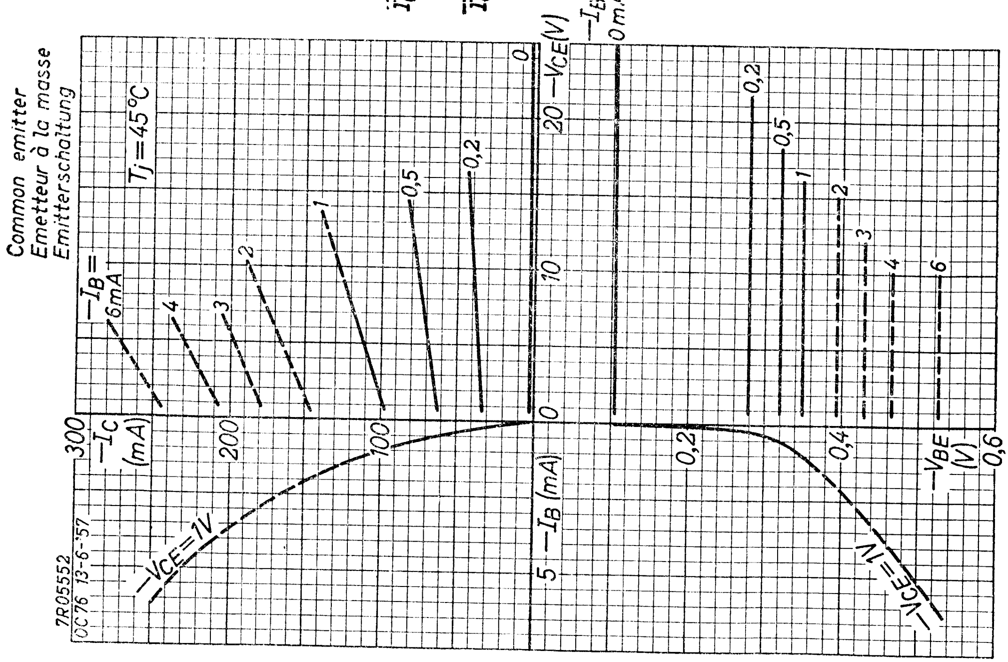
sans ailette de refroidissement et sans plaque additionnelle de refroidissement K < 0,4 °C/mW
avec ailette de refroidissement type 56200 et avec plaque additionnelle de refroidissement de 12,5 cm² au moins K < 0,3 °C/mW

Temperaturerhöhung des Kristalls in freier Luft

ohne Kühlschelle und ohne zusätzliche Kühlfläche K < 0,4 °C/mW
mit Kühlschelle Type 56200 und mit zusätzlicher Kühlfläche von mindestens 12,5 cm² K < 0,3 °C/mW


7R05545
OC72 5-6-'57
$-I_{CEO}$
$-I_{CBO}$
1000
100
10
1
20
40
60
80
100
T_j (°C)
$\frac{I_{CEO}(T_j)}{I_{CEO}(T_j=25°C)}$
$\frac{I_{CBO}(T_j)}{I_{CBO}(T_j=25°C)}$

B

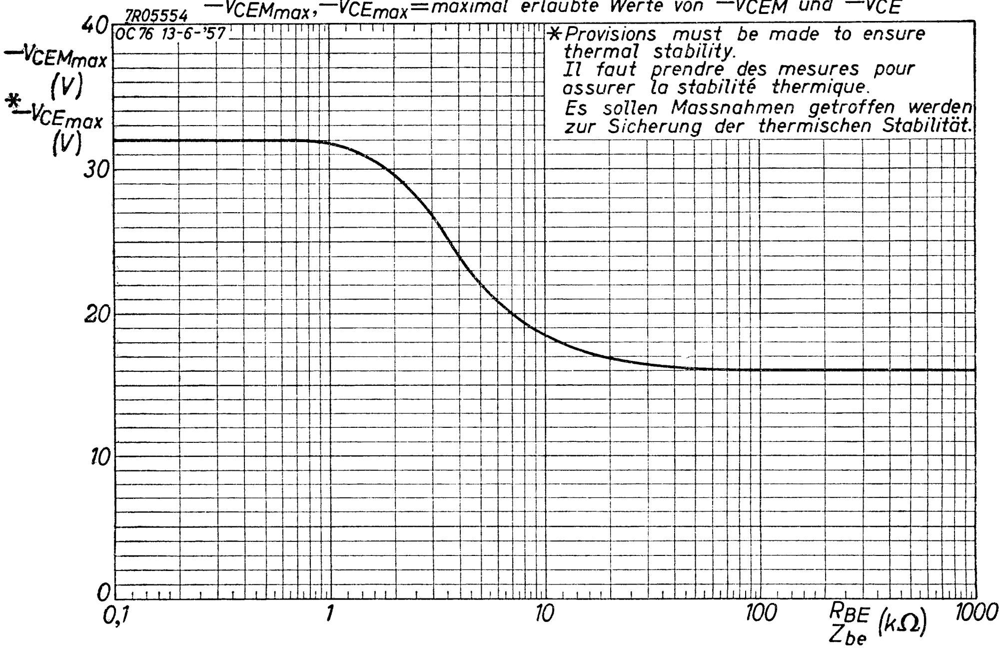

Common emitter
Emetteur à la masse
Emitterschaltung
$T_j = 45°C$
$-I_B =$ 6mA
4
3
2
1
0,5
0,2
0
$-V_{CE}$(V)
$-I_B =$ 0 mA
0,2
0,5
1
2
3
4
6
300
200
100
0
$-I_C$ (mA)
$-V_{CE}$=1V
5
$-I_B$ (mA)
0,2
0,4
0,6
$-V_{BE}$ (V)
7R05552
OC76 13-6-'57

A

$-V_{CEMmax}, -V_{CEmax}$ = maximum permissible values of $-V_{CEM}$ and $-V_{CE}$

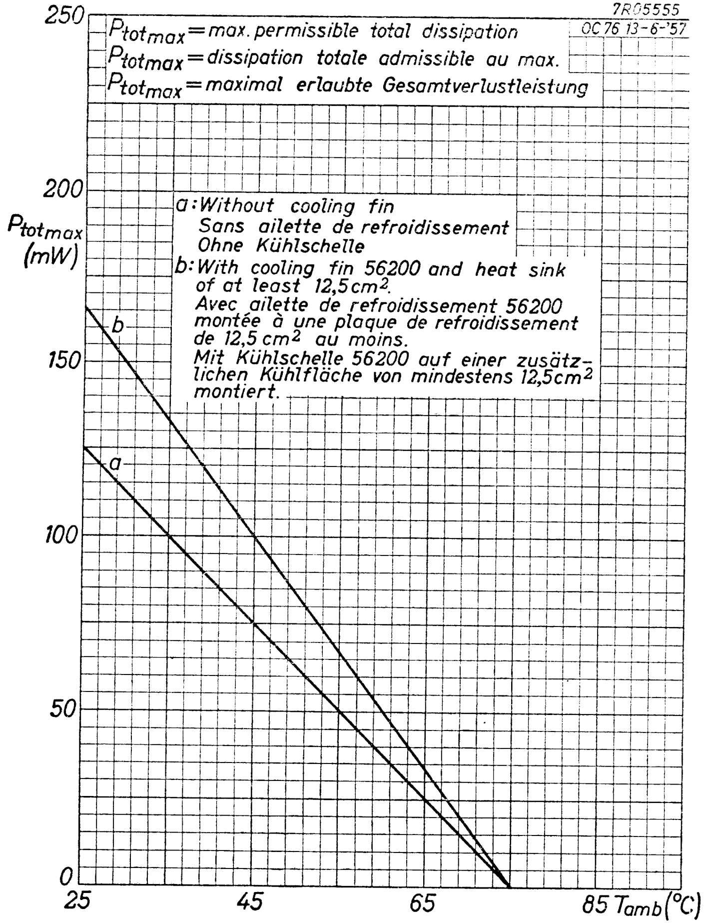
$-V_{CEMmax}, -V_{CEmax}$ = valeurs admissibles au max. de $-V_{CEM}$ et $-V_{CE}$

$-V_{CEMmax}, -V_{CEmax}$ = maximal erlaubte Werte von $-V_{CEM}$ und $-V_{CE}$

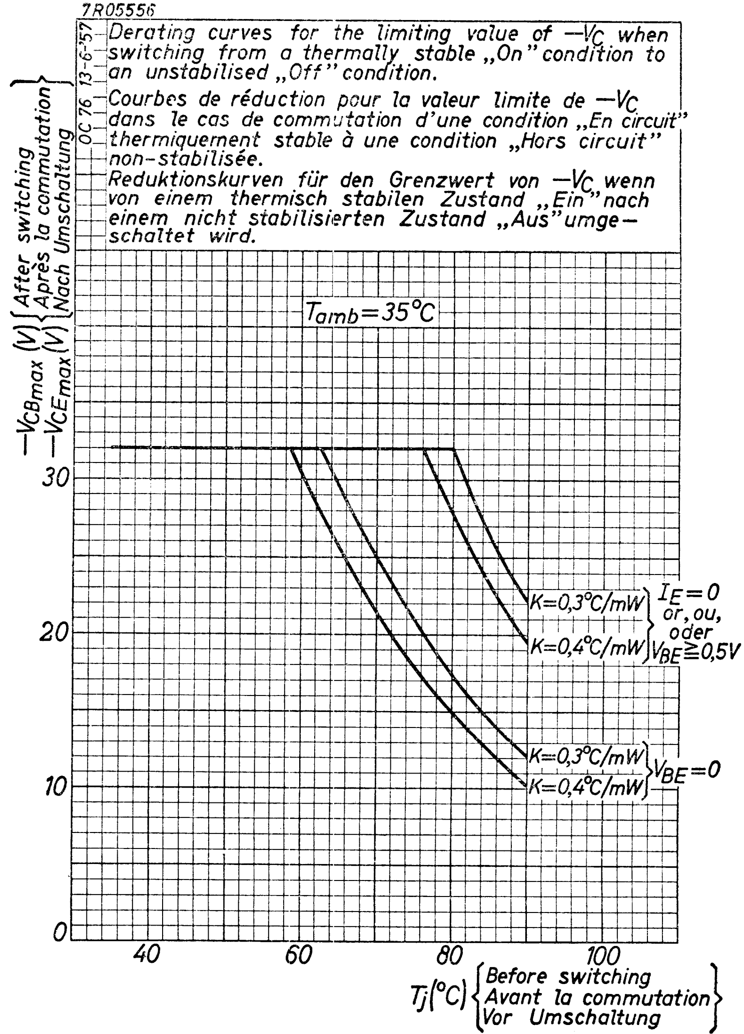


5.5.1957

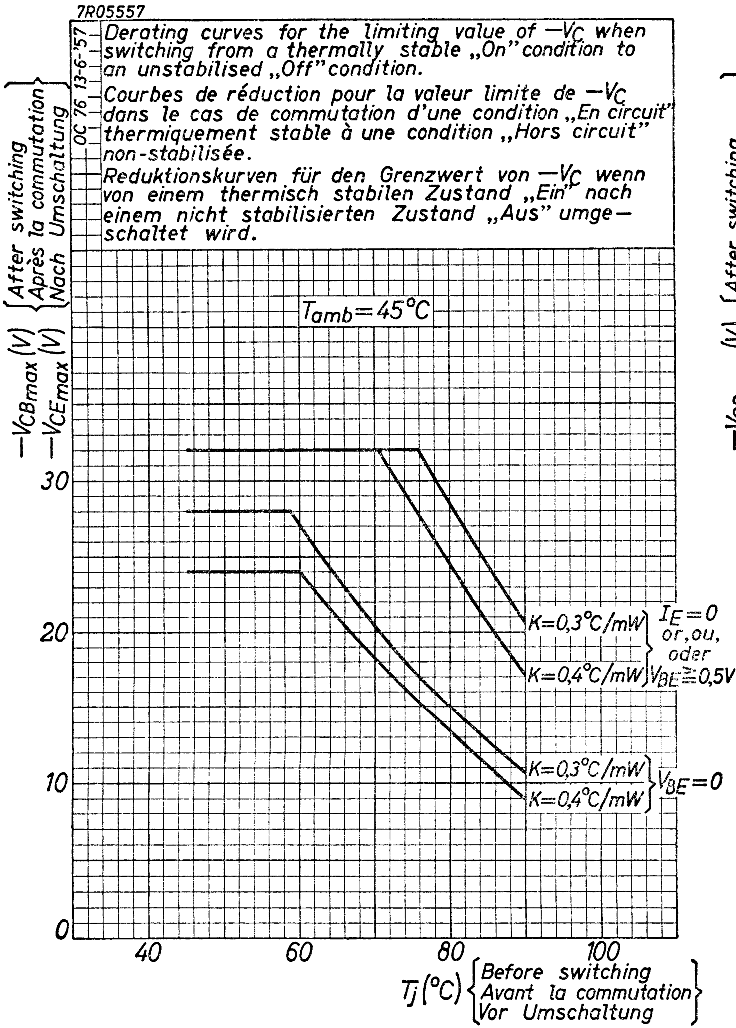
C


7R05555
OC 76 13-6-'57
P_{totmax} = max. permissible total dissipation
P_{totmax} = dissipation totale admissible au max.
P_{totmax} = maximal erlaubte Gesamtverlustleistung
a: Without cooling fin
Sans ailette de refroidissement
Ohne Kühlschelle
b: With cooling fin 56200 and heat sink of at least 12,5 cm².
Avec ailette de refroidissement 56200 montée à une plaque de refroidissement de 12,5 cm² au moins.
Mit Kühlschelle 56200 auf einer zusätzlichen Kühlfläche von mindestens 12,5 cm² montiert.
P_{totmax} (mW)
250
200
150
100
50
0
25
45
65
85
T_{amb} (°C)
a
b

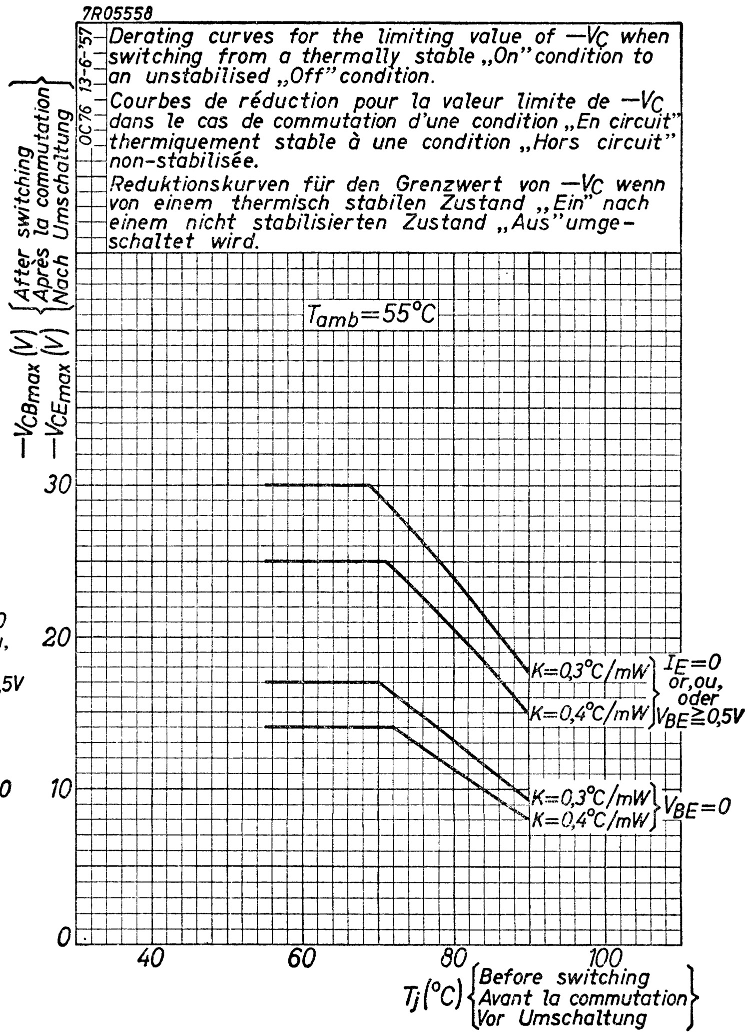
D


7R05556
OC 76 13-6-'57
Derating curves for the limiting value of $-V_C$ when switching from a thermally stable „On" condition to an unstabilised „Off" condition.
Courbes de réduction pour la valeur limite de $-V_C$ dans le cas de commutation d'une condition „En circuit" thermiquement stable à une condition „Hors circuit" non-stabilisée.
Reduktionskurven für den Grenzwert von $-V_C$ wenn von einem thermisch stabilen Zustand „Ein" nach einem nicht stabilisierten Zustand „Aus" umgeschaltet wird.
T_{amb} = 35°C
$-V_{CBmax}$ (V) / $-V_{CEmax}$ (V) {After switching / Après la commutation / Nach Umschaltung}
30
20
10
0
40
60
80
100
T_j (°C) {Before switching / Avant la commutation / Vor Umschaltung}
K=0,3°C/mW
K=0,4°C/mW
I_E = 0 or, ou, oder $V_{BE} \geq 0{,}5$ V
K=0,3°C/mW
K=0,4°C/mW
V_{BE} = 0

E


7R05557
OC 76 13-6-'57
Derating curves for the limiting value of $-V_C$ when switching from a thermally stable „On" condition to an unstabilised „Off" condition.
Courbes de réduction pour la valeur limite de $-V_C$ dans le cas de commutation d'une condition „En circuit" thermiquement stable à une condition „Hors circuit" non-stabilisée.
Reduktionskurven für den Grenzwert von $-V_C$ wenn von einem thermisch stabilen Zustand „Ein" nach einem nicht stabilisierten Zustand „Aus" umgeschaltet wird.
$T_{amb}=45°C$
$-V_{CBmax}$ (V)
$-V_{CEmax}$ (V)
After switching
Après la commutation
Nach Umschaltung
K=0,3°C/mW
K=0,4°C/mW
$I_E=0$ or, ou, oder $V_{BE}\geqq0{,}5V$
K=0,3°C/mW
K=0,4°C/mW
$V_{BE}=0$
0
10
20
30
40
60
80
100
T_j (°C)
Before switching
Avant la commutation
Vor Umschaltung

F

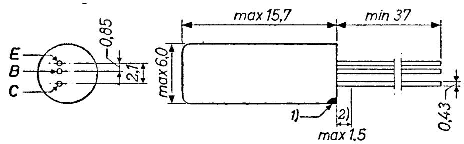

7R05558
OC76 13-6-'57
Derating curves for the limiting value of $-V_C$ when switching from a thermally stable „On" condition to an unstabilised „Off" condition.
Courbes de réduction pour la valeur limite de $-V_C$ dans le cas de commutation d'une condition „En circuit" thermiquement stable à une condition „Hors circuit" non-stabilisée.
Reduktionskurven für den Grenzwert von $-V_C$ wenn von einem thermisch stabilen Zustand „Ein" nach einem nicht stabilisierten Zustand „Aus" umgeschaltet wird.
$T_{amb}=55°C$
$-V_{CBmax}$ (V)
$-V_{CEmax}$ (V)
After switching
Après la commutation
Nach Umschaltung
K=0,3°C/mW
K=0,4°C/mW
$I_E=0$ or, ou, oder $V_{BE}\geqq0{,}5V$
K=0,3°C/mW
K=0,4°C/mW
$V_{BE}=0$
0
10
20
30
40
60
80
100
T_j (°C)
Before switching
Avant la commutation
Vor Umschaltung

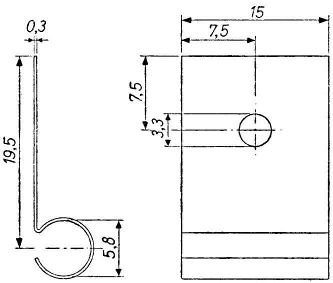
G

GERMANIUM TRANSISTOR of the p-n-p type in all glass construction with metal cover for switching and pulse-oscillating circuits, such as D.C. converters. The transistor can be used with a cooling fin for higher dissipations

TRANSISTRON A CRISTAL DE GERMANIUM du type p-n-p, en construction tout verre avec enveloppe métallique, pour circuits de commutation et d'oscillation pulsée comme les convertisseurs à tension continue. Le transistron peut être utilisé avec une ailette de refroidissement pour des dissipations plus élevées

p-n-p-GERMANIUMTRANSISTOR in Allglastechnik mit Metallumhüllung für Schalt- und Impulsoszillationsstromkreise wie Gleichspannungswandler. Der Transistor kann für höhere Dissipation mit einer Kühlschelle verwendet werden





Dimensions in mm
Dimensions en mm
Abmessungen in mm

Cooling fin 56 200
Ailette de refroidissement 56 200
Kühlschelle 56 200

Limiting values (Absolute max. values)
Caractéristiques limites (Valeurs max. absolues)
Grenzdaten (Absolute Maximalwerte)

$-V_{CB}$ = max. 60 V [3]	$-I_C$ (t_{av} = max. 20 msec)	= max.	125 mA
$-V_{CBM}$ = max. 60 V	$\lvert I_{CM}\rvert$	= max.	250 mA
$-V_{CE}$ = max. 60 V [3][4]	I_E (t_{av} = max. 20 msec)	= max.	125 mA
$-V_{CEM}$ = max. 60 V [4]	$\lvert I_{EM}\rvert$	= max.	250 mA
$-V_{EBM}$ = max. 10 V	$-I_B$ (t_{av} = max. 20 msec)	= max.	20 mA
P_{tot} { See page D / Voir page D / Siehe Seite D	$\lvert I_{BM}\rvert$	= max.	125 mA

Continued on page 2; Continué sur page 2; Fortsetzung auf S.2

Limiting values (Absolute max. values). continued
Caractéristiques limites (Valeurs max. absolues), suite
Grenzdaten (Absolute Maximalwerte), Fortsetzung

T_j	continuous operation / service continu / Dauerbetrieb	= max.	75 °C
T_j	intermittent operation / service intermittent / aussetzender Betrieb	= max.	90 °C [5]
	Storage temperature / Température d'emmagasinage / Lagerungstemperatur	=	-55°C/+75 °C

[1] The red dot indicates the collector
Le point rouge marque le collecteur
Der rote Punkt indiziert den Kollektor

[2] Not tinned; non-étamé; nicht verzinnt

[3] For derating curves at higher junction temperatures see pages E, F and G
Pour les courbes d'abaissement aux températures plus hautes de la jonction voir pages E, F et G
Für Reduktionskurven bei höheren Kristalltemperaturen siehe Seiten E, F und G

[4] For derating curve at higher base to ground impedances see page C
Pour courbe d'abaissement aux impédances plus hautes entre base et masse voir page C
Für Reduktionskurve bei höheren Impedanzen zwischen Basis und Erde siehe Seite C

[5] Total duration max. 200 hours. Likelihood of full performance at this temperature is also dependent upon the type of application
Durée totale 200 heures au max. La probabilité d'opération optimum à cette température est aussi dépendante du genre d'application
Gesamtdauer max. 200 Stunden. Die Wahrscheinlichkeit optimaler Wirkung bei dieser Temperatur wird auch von der Verwendungsart bestimmt

Characteristics
Caractéristiques
Kenndaten

T_{amb} = 25 °C

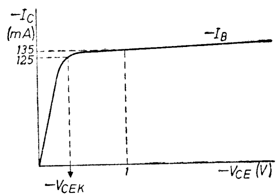
Common base; Base à la masse; Basisschaltung

		Min.	Max.
$-I_{CBO}$ ($-V_{CB}$ = 10 V)	=	4,5	<10 µA
$-I_{EBO}$ ($-V_{EB}$ = 10 V)	=	4,5	<10 µA
$f_{\alpha b}$ ($-V_{CB}$ = 6 V, I_E = 10 mA)	=	>350	kc/s

Common emitter; Emetteur à la masse; Emitterschaltung

$-I_{CEO}$ ($-V_{CE}$ = 6 V)	=	200	<600 µA
$-I_C$ ($-V_{CE}$ = 60 V, $V_{BE} \geq$ 0,5 V)	=	15	<30 µA
F[1] ($-V_{CE}$ = 2 V, I_E = 0,5 mA)			<15 dB

Collector knee voltage
Tension de coude du collecteur
Kniespannung des Kollektors



$-I_C$ = 125 mA

$-I_B$ = the value at which $-I_C$ = 135 mA when $-V_{CE}$ = 1 V
la valeur à laquelle $-I_C$ = 135 mA si $-V_{CE}$ = 1 V
der Wert bei dem $-I_C$ = 135 mA wenn $-V_{CE}$ = 1 V

$-V_{CEK}$ < 0,4 V

---

[1]) Noise factor measured at f = 1000 c/s with an input source impedance of 500 Ω
Facteur de bruit mesuré à f = 1000 Hz avec une impédance de la source d'entrée de 500 Ω
Rauschfaktor gemessen bei f = 1000 Hz mit einer Impedanz der Eingangsspannungsquelle von 500 Ω

Large signal characteristics
Caractéristiques pour grands signaux
Kenndaten für grosse Signale

$-V_{CE}$ (V)	I_E (mA)	$-V_{BE}$(V) Max.	α_{FE} Min.
5,4	10		> 45
0,7	80	< 0,45	> 30
0,7	125	< 0,70	> 25
1	250		> 15

Junction temperature
Température de la jonction
Kristalltemperatur

Junction temperature rise in free air

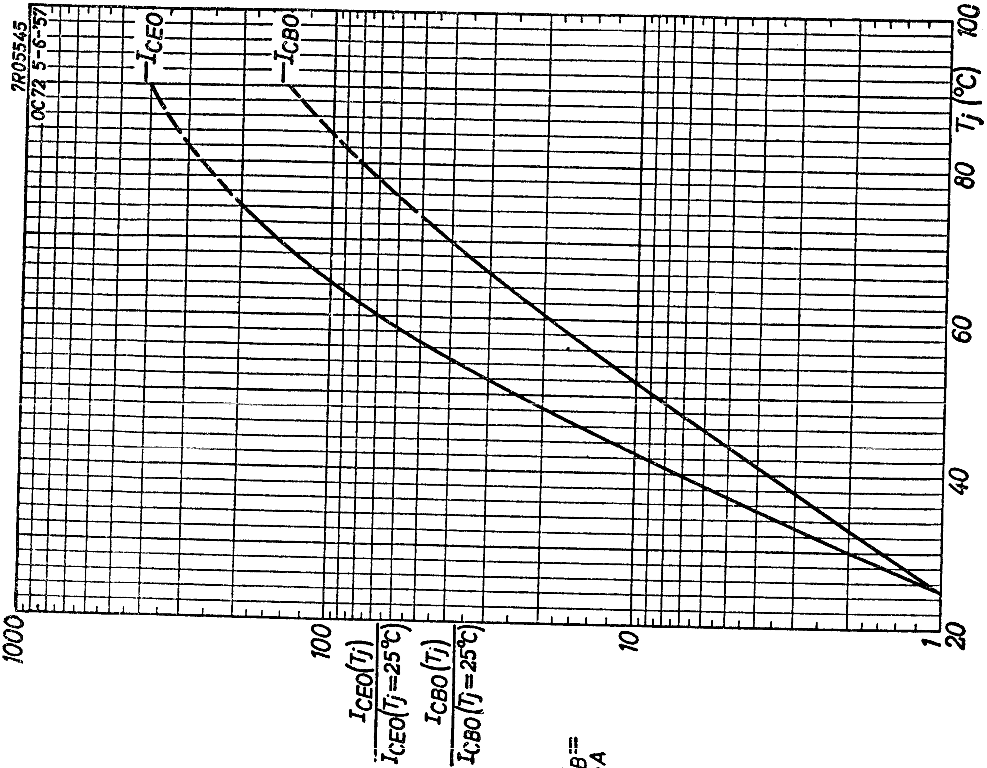
without cooling fin and heat sink — K < 0.4 °C/mW
with cooling fin type 56200 and heat sink of at least 12.5 cm² — K < 0.3 °C/mW

Augmentation de la température de la jonction en l'air libre

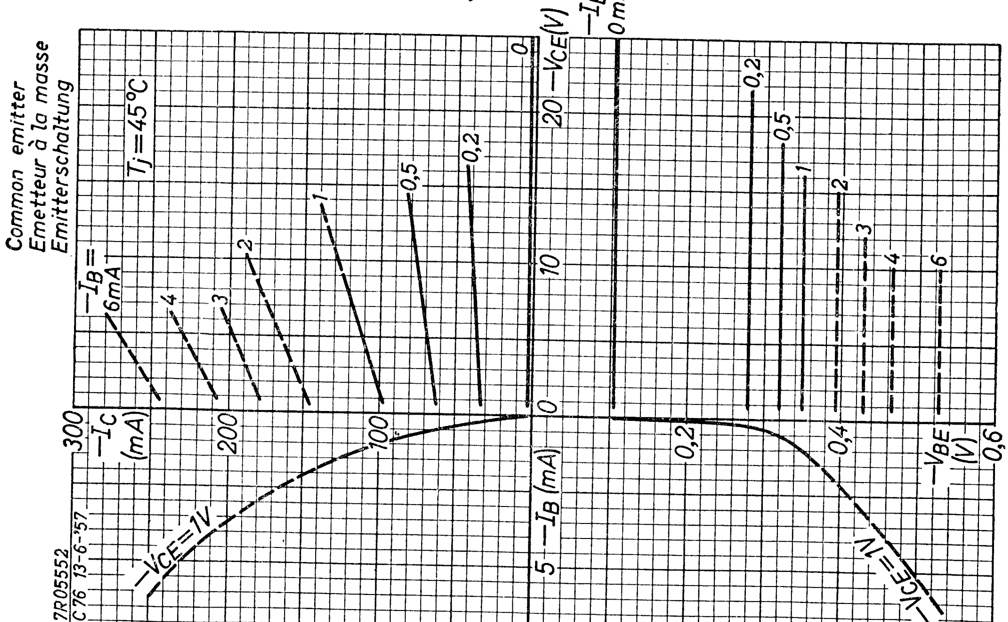
sans ailette de refroidissement et sans plaque additionnelle de refroidissement — K < 0,4 °C/mW
avec ailette de refroidissement type 56200 et avec plaque additionnelle de refroidissement de 12,5 cm² au moins — K < 0,3 °C/mW

Temperaturerhöhung des Kristalls in freier Luft

ohne Kühlschelle und ohne zusätzliche Kühlfläche — K < 0,4 °C/mW
mit Kühlschelle Type 56200 und mit zusätzlicher Kühlfläche von mindestens 12,5 cm² — K < 0,3 °C/mW


7R05545
OC72 5-6-'57
$-I_{CEO}$
$-I_{CBO}$
T_j (°C)
20
40
60
80
100
1000
100
10
1
$\frac{I_{CEO}(T_j)}{I_{CEO}(T_j=25°C)}$
$\frac{I_{CBO}(T_j)}{I_{CBO}(T_j=25°C)}$

B


Common emitter
Emetteur à la masse
Emitterschaltung
$T_j=45°C$
$-I_B=$ 6mA
4
3
2
1
0,5
0,2
0
$-V_{CE}(V)$
$-I_B=$ 0mA
0,2
0,5
1
2
3
4
6
$-I_C$ (mA)
300
200
100
$-I_B$ (mA)
5
$-V_{CE}=1V$
$-V_{BE}$ (V)
0,2
0,4
0,6
10
20
7R05552
OC76 13-6-'57

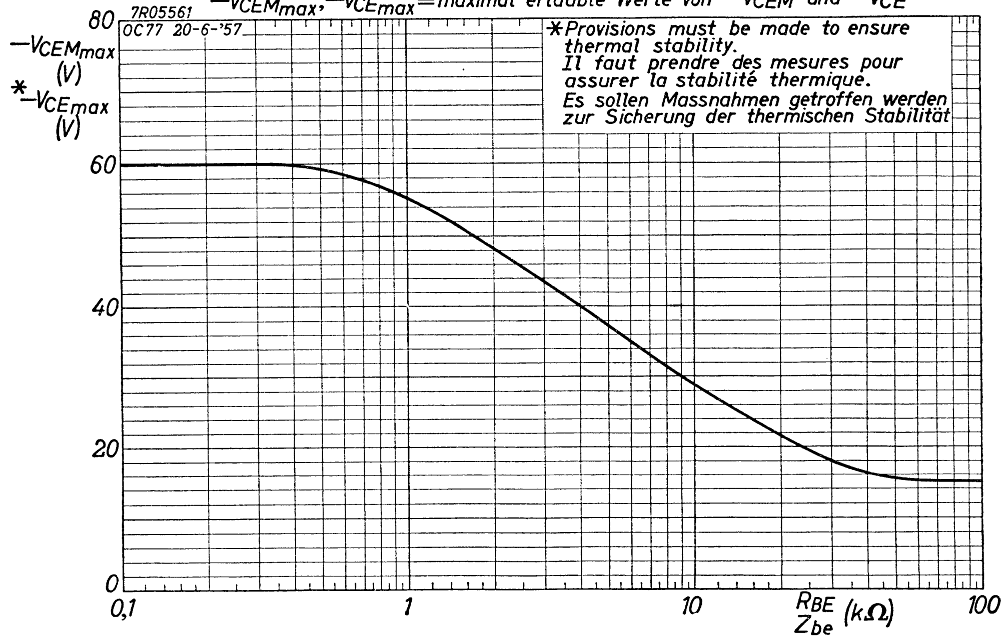
A

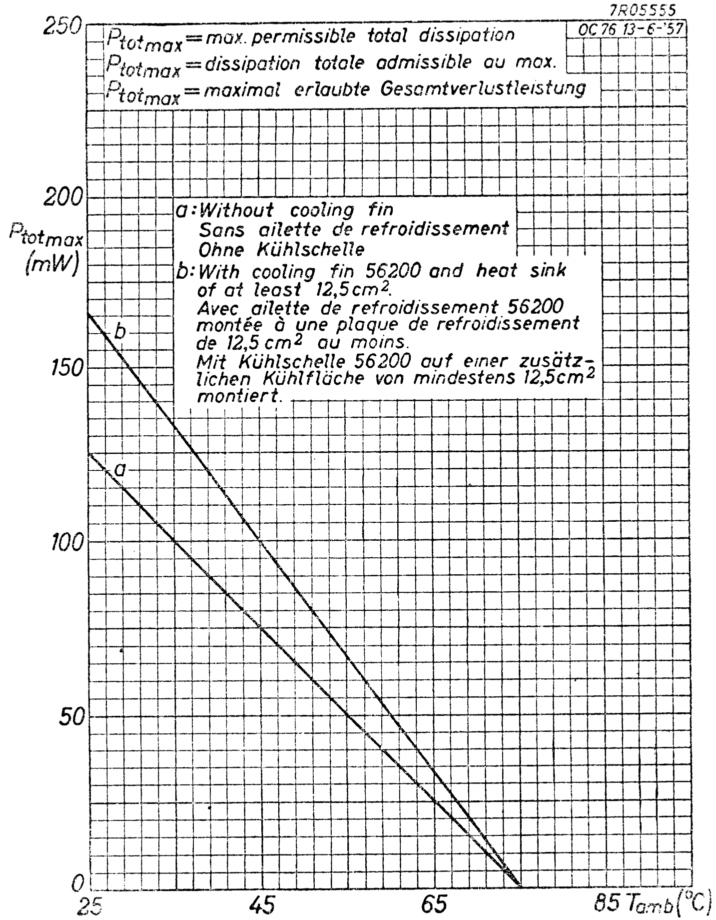
5.5.1957

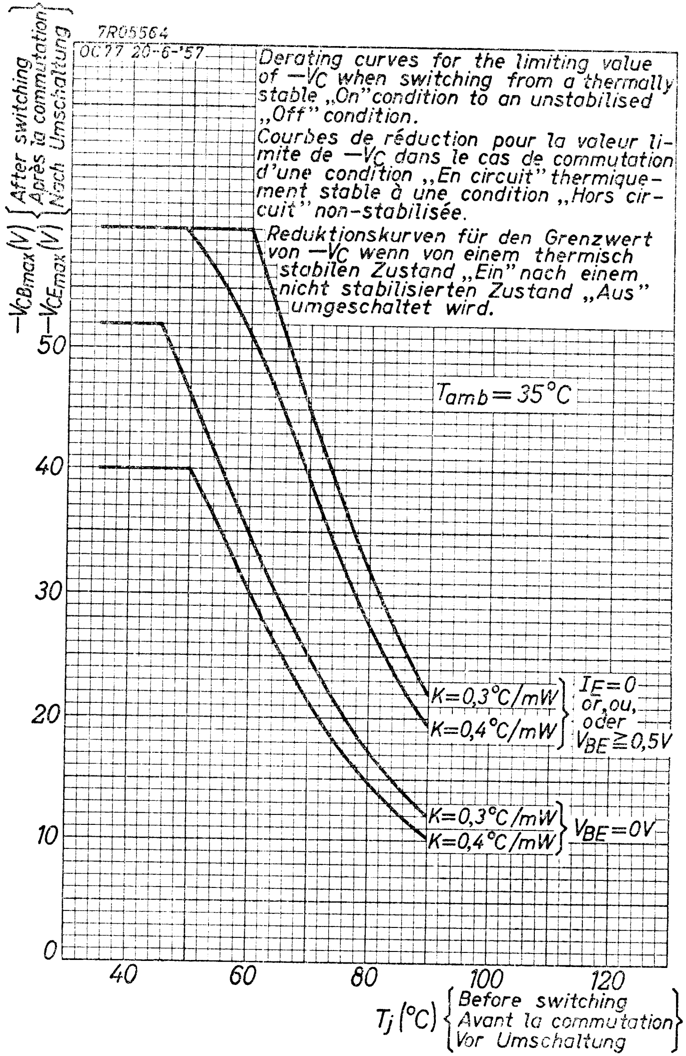
$-V_{CEMmax}$, $-V_{CEmax}$ = maximum permissible values of $-V_{CEM}$ and $-V_{CE}$

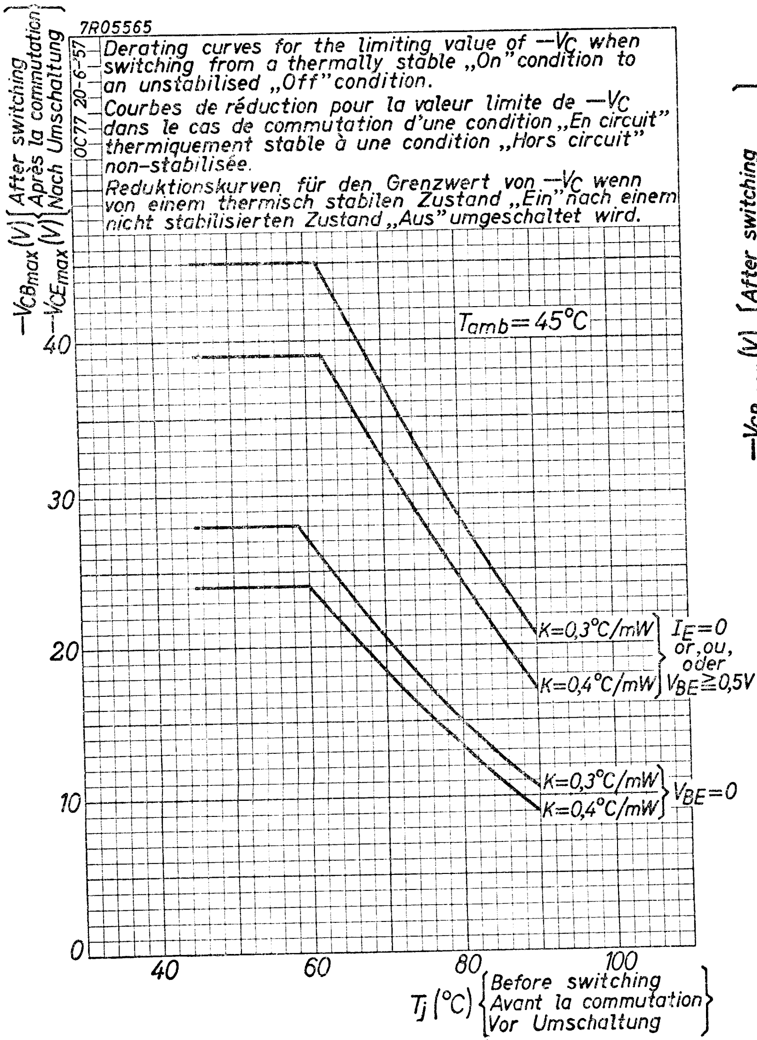
$-V_{CEMmax}$, $-V_{CEmax}$ = valeurs admissibles au max. de $-V_{CEM}$ et $-V_{CE}$

$-V_{CEMmax}$, $-V_{CEmax}$ = maximal erlaubte Werte von $-V_{CEM}$ und $-V_{CE}$

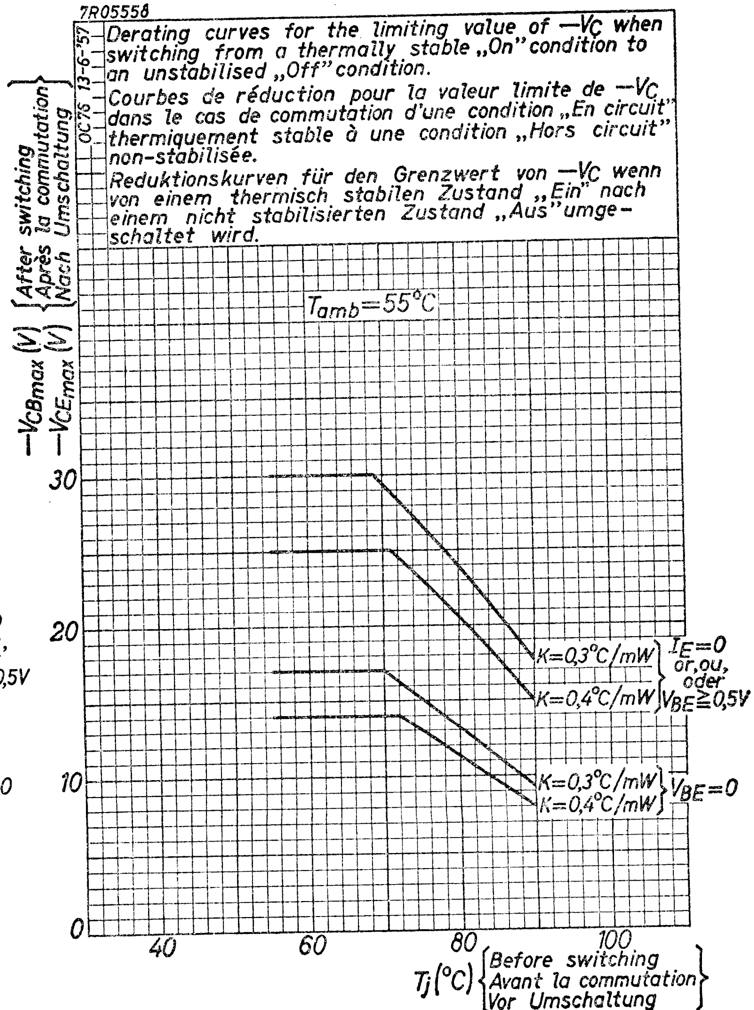



7R05555
OC76 13-6-'57
P_{totmax} = max. permissible total dissipation
P_{totmax} = dissipation totale admissible au max.
P_{totmax} = maximal erlaubte Gesamtverlustleistung
a: Without cooling fin
Sans ailette de refroidissement
Ohne Kühlschelle
b: With cooling fin 56200 and heat sink of at least 12,5 cm².
Avec ailette de refroidissement 56200 montée à une plaque de refroidissement de 12,5 cm² au moins.
Mit Kühlschelle 56200 auf einer zusätzlichen Kühlfläche von mindestens 12,5 cm² montiert.
P_{totmax} (mW)
250
200
150
100
50
0
25
45
65
85
T_{amb} (°C)
a
b


7R05564
OC77 20-6-'57
Derating curves for the limiting value of $-V_C$ when switching from a thermally stable „On" condition to an unstabilised „Off" condition.
Courbes de réduction pour la valeur limite de $-V_C$ dans le cas de commutation d'une condition „En circuit" thermiquement stable à une condition „Hors circuit" non-stabilisée.
Reduktionskurven für den Grenzwert von $-V_C$ wenn von einem thermisch stabilen Zustand „Ein" nach einem nicht stabilisierten Zustand „Aus" umgeschaltet wird.
$T_{amb} = 35°C$
$-V_{CBmax}$ (V)
$-V_{CEmax}$ (V)
After switching
Après la commutation
Nach Umschaltung
50
40
30
20
10
0
40
60
80
100
120
T_j (°C)
Before switching
Avant la commutation
Vor Umschaltung
K=0,3°C/mW
K=0,4°C/mW
$I_E = 0$
or, ou, oder
$V_{BE} \geq 0,5V$
K=0,3°C/mW
K=0,4°C/mW
$V_{BE} = 0V$


7R05565
OC77 20-6-'57
Derating curves for the limiting value of $-V_C$ when switching from a thermally stable „On" condition to an unstabilised „Off" condition.
Courbes de réduction pour la valeur limite de $-V_C$ dans le cas de commutation d'une condition „En circuit" thermiquement stable à une condition „Hors circuit" non-stabilisée.
Reduktionskurven für den Grenzwert von $-V_C$ wenn von einem thermisch stabilen Zustand „Ein" nach einem nicht stabilisierten Zustand „Aus" umgeschaltet wird.
$T_{amb} = 45°C$
$-V_{CBmax}$ (V) / $-V_{CEmax}$ (V) {After switching / Après la commutation / Nach Umschaltung}
$K=0,3°C/mW$
$K=0,4°C/mW$
$I_E=0$ or, ou, oder $V_{BE} \geqq 0,5V$
$K=0,3°C/mW$
$K=0,4°C/mW$
$V_{BE}=0$
T_j (°C) {Before switching / Avant la commutation / Vor Umschaltung}
0
10
20
30
40
40
60
80
100

F


7R05558
OC76 13-6-'57
Derating curves for the limiting value of $-V_C$ when switching from a thermally stable „On" condition to an unstabilised „Off" condition.
Courbes de réduction pour la valeur limite de $-V_C$ dans le cas de commutation d'une condition „En circuit" thermiquement stable à une condition „Hors circuit" non-stabilisée.
Reduktionskurven für den Grenzwert von $-V_C$ wenn von einem thermisch stabilen Zustand „Ein" nach einem nicht stabilisierten Zustand „Aus" umgeschaltet wird.
$T_{amb} = 55°C$
$-V_{CBmax}$ (V) / $-V_{CEmax}$ (V) {After switching / Après la commutation / Nach Umschaltung}
$K=0,3°C/mW$
$K=0,4°C/mW$
$I_E=0$ or, ou, oder $V_{BE} \geqq 0,5V$
$K=0,3°C/mW$
$K=0,4°C/mW$
$V_{BE}=0$
T_j (°C) {Before switching / Avant la commutation / Vor Umschaltung}
0
10
20
30
40
60
80
100

G

GERMANIUM P-N-P TRANSISTOR

Germanium transistor of the p-n-p type in all glass construction with metal envelope. It is meant for class A output and driver stages at battery voltages of up to 12 V.

LIMITING VALUES (Absolute max. values)

Collector-base voltage	$-V_{CB}$	max.	26	V
Collector-emitter voltage	$-V_{CE}$	max.	26	V
Collector current (d.c. and average)	$-I_C$	max.	300	mA
Total dissipation up to T_{amb} = 25 °C	P_{tot}	max.	550	mW
Junction temperature: continuous	T_j	max.	75	°C
incidentally	T_j	max.	90	°C

THERMAL RESISTANCE

From junction to ambient	K	<	0.22	°C/mW

CHARACTERISTICS

D.C. current gain at T_j = 25 °C

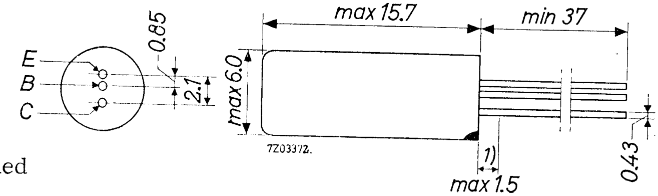
$-I_C$ = 5 mA; $-V_{CE}$ = 6 V	h_{FE}	typ.	50	
			25 to 125	
$-I_C$ = 50 mA; $-V_{CE}$ = 6 V	h_{FE}	typ.	60	
			40 to 100	
$-I_C$ = 300 mA; $-V_{CE}$ = 1 V	h_{FE}	typ.	40	
			25 to 75	

Cut-off frequency

$-I_C$ = 50 mA; $-V_{CE}$ = 6 V	f_{hfe}	typ.	16	kc/s
		>	8	kc/s

MECHANICAL DATA

Dimensions in mm



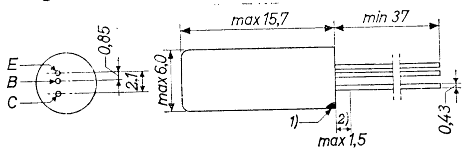
1) Not tinned

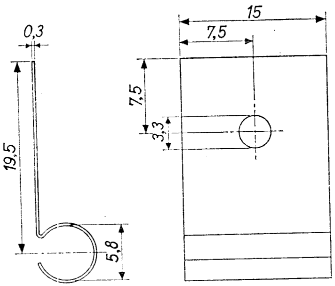
The red dot indicates the collector

7Z2 3184

3.3.1965

GERMANIUM TRANSISTOR of the p-n-p type in all-glass construction with metal cover for switching and pulse-oscillating circuits
TRANSISTRON À CRISTAL DE GERMANIUM du type p-n-p en construction tout verre avec enveloppe métallique, pour des circuits de commutation et d'oscillation pulsée
p-n-p-GERMANIUMTRANSISTOR in Allglastechnik mit Metallumhüllung für Schalt- und Impulsoszillationsstromkreise





Dimensions in mm
Dimensions en mm
Abmessungen in mm

Cooling fin 56 200
Ailette de refroidissement 56 200
Kühlschelle 56 200

Limiting values (Absolute max. values)
Caractéristiques limites (Valeurs max. absolues)
Grenzdaten (Absolute Maximalwerte)

$-V_{CB}$ = max.	32 V	$-I_C$ (t_{av} = max. 50 msec)	= max.300 mA
$-V_{CE}$ = max.	32 V	$-I_{CM}$	= max.600 mA
$-V_{EB}$ = max.	20 V	I_E (t_{av} = max. 50 msec)	= max.340 mA
P_C = max.	550 mW [3]	I_{EM}	= max.630 mA
		$-I_B$ (t_{av} = max. 50 msec)	= max. 40 mA
		$-I_{BM}$	= max.200 mA

Continued at page 2
Continué sur page 2
Fortsetzung auf Seite 2

[1]) The red dot indicates the collector
Le point rouge marque le collecteur
Der rote Punkt indiziert den Kollektor

[2]) Not tinned; non-étamé; nicht verzinnt

[3]) T_{amb} = 25 °C

938 3522
3.3.1959

Limiting values (Absolute max. values), continued
Caractéristiques limites (Valeurs max. absolues), suite
Grenzdaten (Absolute Maximalwerte), Fortsetzung

T_j { continuous operation / service continu / Dauerbetrieb = max. 75 °C

T_j { intermittent operation / service intermittent / aussetzender Betrieb = max. 90 °C [1])

Storage temperature
Température d'emmagasinage
Lagerungstemperatur = -55°C/+75°C

Junction temperature
Température de la jonction
Kristalltemperatur

Junction temperature rise in free air

without cooling fin and heat sink	K ≦	0.22 °C/mW
with cooling fin type 56200 and heat sink of at least 12.5 cm²	K ≦	0.09 °C/mW

Augmentation de la température de la jonction en l'air libre

sans ailette de refroidissement et sans plaque additionnelle de refroidissement	K ≦	0,22 °C/mW
avec ailette de refroidissement type 56200 et avec plaque additionnelle de refroidissement de 12,5 cm² au moins	K ≦	0,09 °C/mW

Temperaturerhöhung des Kristalls in freier Luft

ohne Kühlschelle und ohne zusätzliche Kühlfläche	K ≦	0,22 °C/mW
mit Kühlschelle Type 56200 und mit zusätzlicher Kühlfläche von mindestens 12,5 cm²	K ≦	0,09 °C/mW

[1]) Total duration max. 200 hours. Likelihood of full performance at this temperature is also dependent upon the type of application
Durée totale 200 heures au max. La probabilité d'opération optimum à cette température est aussi dépendante du genre d'application
Gesamtdauer max. 200 Stunden. Die Wahrscheinlichkeit optimaler Wirkung bei dieser Temperatur wird auch von der Verwendungsart bestimmt

938 3523

Characteristics
Caractéristiques
Kenndaten

$T_{amb} = 25\ ^{\circ}C$

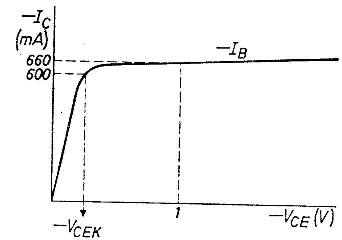
Common base; Base à la masse; Basisschaltung

$-I_{CBO}$	$(-V_{CB} = 12\ V)$	=	10 µA
		= max.	20 µA
$-I_{CBO}$	$(-V_{CB} = 12\ V;\ T_{amb} = 60\ ^{\circ}C)$	= max.	330 µA
$-I_{EBO}$	$(-V_{EB} = 6\ V)$	=	6 µA
		= max.	20 µA
$-V_{CB}$	$(-I_{CBO} = 50\ \mu A;\ I_E = 0)$	= min.	32 V
V_{EB}	$(-I_{EBO} = 50\ \mu A;\ I_E = 0)$	= min.	20 V
$-V_{EB}$	$(-V_{CB} = 32\ V;\ I_E = 0)$	= max.	0,55 V [1]
$f_{\alpha b}$	$(-V_{CB} = 6\ V;\ I_E = 50\ mA)$	=	2 Mc/s

Common emitter; Emetteur à la masse; Emitterschaltung

$-V_{CE}$	$(-I_C = 600\ mA;\ V_{BE} = 0\ V)$	= min.	32 V [2]
$r_{bb'}$	$(-V_{CE} = 6\ V;\ I_E = 1\ mA)$	=	60 Ω [3]

Collector knee voltage
Tension de coude du collecteur
Kniespannung des Kollektors



$-I_C$ = 0,6 A

$-I_B$ = the value at which $-I_C = 0{,}66$ A when $-V_{CE} = 1$ V
la valeur à laquelle $-I_C = 0{,}66$ A si $-V_{CE} = 1$ V
der Wert bei dem $-I_C = 0{,}66$ A wenn $-V_{CE} = 1$ V

$-V_{CEK}$ = 0,4 V $< 0{,}9$ V

[1]) Floating potential
Potentiel flottant
Schwimmendes Potential

[2]) Measured under pulse conditions
Mesuré à l'aide d'impulsions
Mit Impulsen gemessen

[3]) See page 4; voir page 4; siehe Seite 4

Characteristics (continued)
Caractéristiques (suite)
Kenndaten (Fortsetzung)

$T_{amb} = 25\ ^{\circ}C$

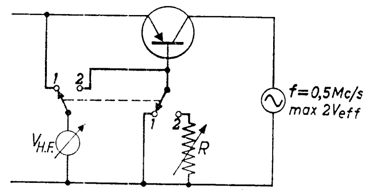
Common emitter; Emetteur à la masse; Emitterschaltung

Large signal characteristics
Caractéristiques pour grands signaux
Kenndaten für grosse Signale

α_{FE}	$(I_E = 50\ mA;\ -V_{CE} = 6\ V)$	= 180
α_{FE}	$(I_E = 600\ mA;\ V_{CB} = 0\ V)$	= 85
$-V_{BE}$	$(I_E = 600\ mA;\ V_{CB} = 0\ V)$	= 0,6 V

[3]) From page 3; de la page 3; von Seite 3

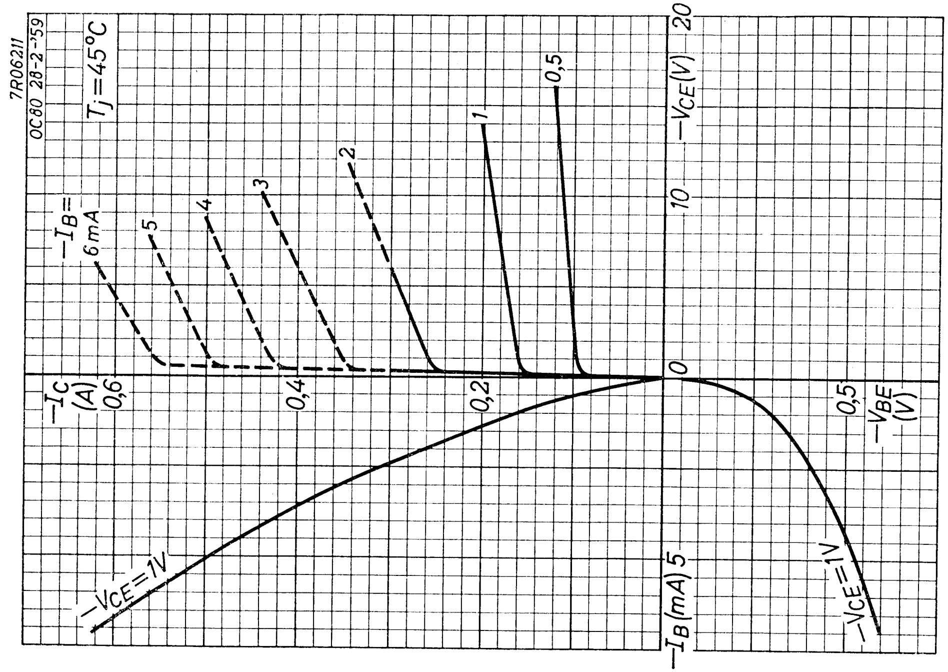
Test method for the intrinsic base resistance $r_{bb'}$
Méthode d'essai pour la résistance intrinsèque de la base $r_{bb'}$
Verfahren zur Prüfung des inneren Basiswiderstandes $r_{bb'}$



The collector must be screened statically from the rest of the circuit. D.C. working point of the transistor: $-V_{CE} = 6$ V, $I_E = 1$ mA
In position 1 the reading of the H.F. voltmeter is adjusted to a certain value. In position 2 the reading of the voltmeter is adjusted to the same value with the aid of the variable resistor R. Now the value of $r_{bb'}$ is the same as that of R

Le collecteur doit être blindé d'une façon électrostatique du reste du circuit. Point de fonctionnement du transistron: $-V_{CE} = 6$ V, $I_E = 1$ mA
Dans la position 1 la lecture du voltmètre H.F. est réglée à une certaine valeur. Dans la position 2 le voltmètre est réglé à la même valeur à l'aide de la résistance variable R. La valeur de $r_{bb'}$ est alors égale à la valeur de R

Der Kollektor muss elektrostatisch von der übrigen Schaltung abgeschirmt werden. Arbeitspunkt des Transistors: $-V_{CE} = 6$ V, $I_E = 1$ mA
In Stellung 1 wird der HF-Voltmeter auf einen gewissen Wert eingestellt. In Stellung 2 wird der Voltmeter mit Hilfe des veränderlichen Widerstandes R auf denselben Wert eingestellt. Der Wert von $r_{bb'}$ ist dann gleich dem Wert von R

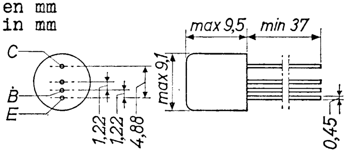

7R06211
OC80 28-2-'59
$T_j = 45°C$
$-I_B =$ 6 mA
5
4
3
2
1
0,5
$-I_C$ (A)
0,6
0,4
0,2
0
10
20
$-V_{CE}$(V)
0,5
$-V_{BE}$ (V)
$-I_B$(mA) 5
$-V_{CE}$=1V
$-V_{CE}$=1V

A

3.3.1959

GERMANIUM p-n-p ALLOY TRANSISTOR for use in high speed industrial switching applications, digital computers and high quality audio amplifiers
TRANSISTOR ALLIÉ AU GERMANIUM du type p-n-p pour utilisation dans les applications industrielles de commutation à grande vitesse, dans les machines à calculer numériques et dans les amplificateurs basses fréquences de haute qualité
p-n-p-GERMANIUM-LEGIERUNGSTRANSISTOR zur Verwendung für industrielle Schaltzwecke hoher Geschwindigkeit, in numerischen Rechenmaschinen und in Tonverstärkern hoher Qualität

Dimensions in mm
Dimensions en mm
Abmessungen in mm



Limiting values (Absolute max. values)
Caractéristiques limites (Valeurs max. absolues)
Grenzdaten (Absolute Maximalwerte)

$-V_{CB}$	= max. 32 V
$-V_{CE}$ ($+V_{BE}$ > 500 mV)	= max. 32 V [1]
$-V_{EB}$	= max. 12 V
$-I_C$ (t_{av} = max. 20 msec)	= max. 0,5 A
$-I_{CM}$	= max. 2,0 A
P_{tot}	see page G / voir page G / siehe Seite G
T_j	= max. 90 °C
Storage temperature / Température d'emmagasinage / Lagerungstemperatur	= -55°C/+75°C

[1]) See also page F
Voir aussi page F
siehe auch Seite F

Thermal data. Thermal resistance from

junction to ambience in free air	K = max. 0.22 °C/mW
junction to case	K = max. 0.06 °C/mW

Données thermiques. Résistance thermique

entre les jonctions et l'ambiance à l'air libre	K = max. 0,22 °C/mW
entre les jonctions et le boîtier	K = max. 0,06 °C/mW

Thermische Daten. Wärmewiderstand

zwischen Kristall und Umgebung in freier Luft	K = max. 0,22 °C/mW
zwischen Kristall und Gehäuse	K = max. 0,06 °C/mW

Characteristics range values for equipment design
Gammes de valeurs des caractéristiques pour l'étude d'équipements
Kenndatenbereiche für Gerätentwurf

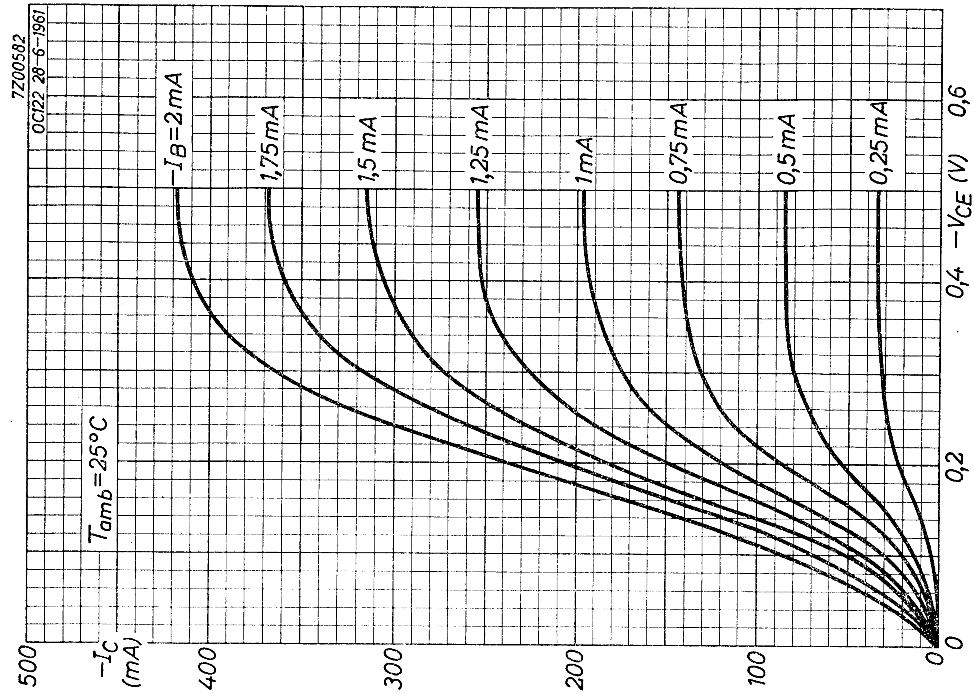
T_j = 25 °C

$-V_{CB}$ = 24 V		$-V_{CE}$ = 2 V	
$-I_{CBO}$ = 40 µA	< 150 µA	$-I_C$ = 100 mA	
		$-V_{BE}$ = 0,27 V	< 0,35 V
$-V_{CB}$ = 32 V			
$-I_{CBO}$ = 50 µA	< 350 µA	$-V_{CE}$ = 6 V	
		$-I_C$ = 100 mA	
$-V_{EB}$ = 10 V		h_{FE} = 180	> 50
$-I_{EBO}$ = 20 µA	< 100 µA		

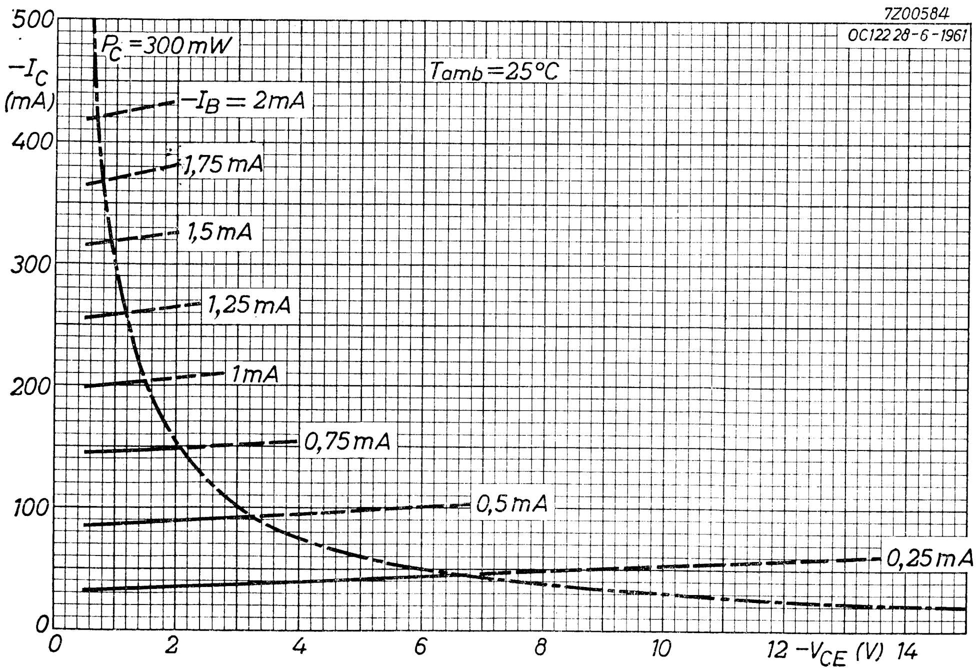
$-V_{CE}$		= 2 V
$-I_C$		= 100 mA
$r_{bb'}$	intrinsic base resistance / résistance de base intrinsèque / innere Basiswiderstand	= 80 Ω
f_1	frequency at which $\lvert h_{fe}\rvert = 1$ / fréquence à laquelle $\lvert h_{fe}\rvert = 1$ / Frequenz bei der $\lvert h_{fe}\rvert = 1$	= 1,3 Mc/s
g_m	intrinsic transconductance / transconductance intrinsèque / innere Steilheit	= 4,0 mA/V

$-V_{CE}$		= 6 V
I_E		= 0 mA
$c_{b'c}$	feedback capacitance / capacité de réaction / Rückwirkungskapazität	= 170 pF

7Z2 0994

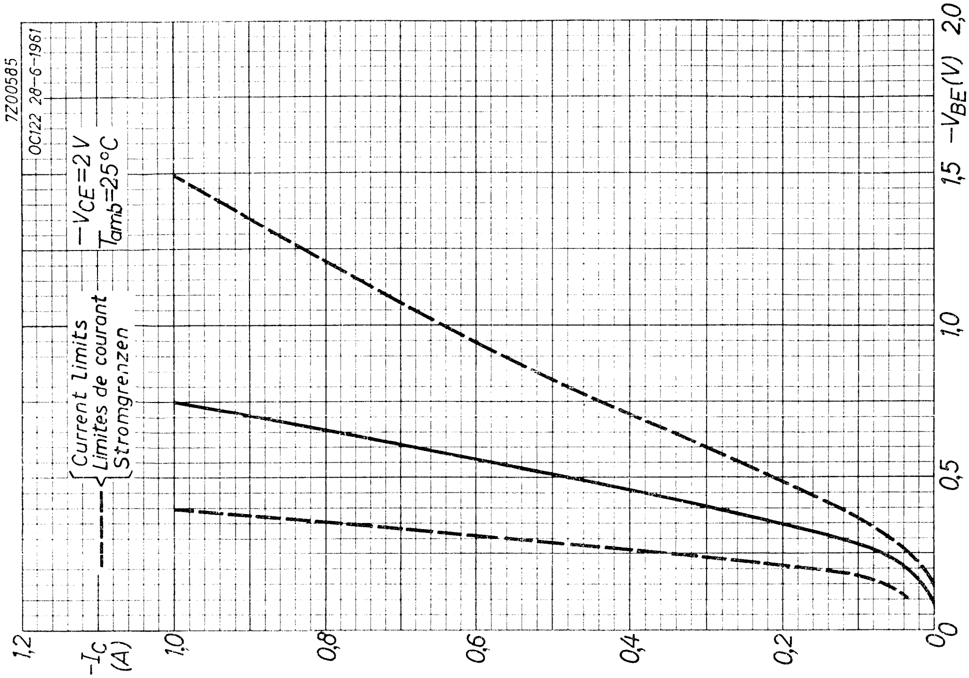

7Z00582
OC122 28-6-1961
$-I_B$=2mA
1,75mA
1,5mA
1,25mA
1mA
0,75mA
0,5mA
0,25mA
T_{amb}=25°C
$-I_C$ (mA)
500
400
300
200
100
0
0,6
0,4
0,2
0
$-V_{CE}$ (V)

B

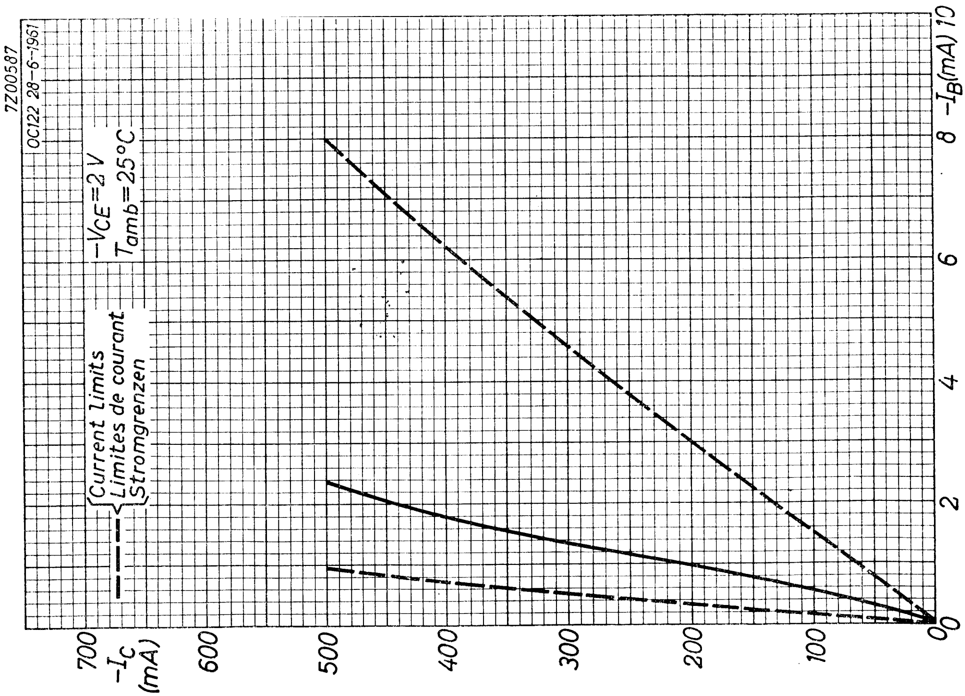

7Z00584
OC122 28-6-1961
P_C=300mW
T_{amb}=25°C
$-I_C$ (mA)
$-I_B$ = 2mA
1,75mA
1,5mA
1,25mA
1mA
0,75mA
0,5mA
0,25mA
500
400
300
200
100
0
0
2
4
6
8
10
12 $-V_{CE}$ (V) 14

A

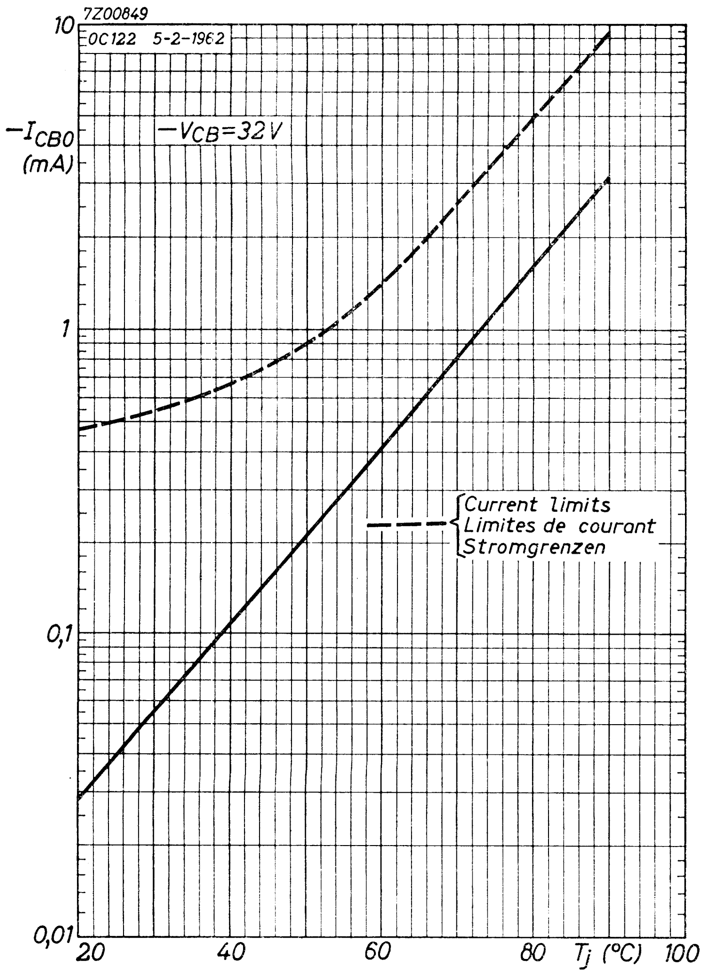
2.2.1962


7Z00585
OC122 28-6-1961
−V_{CE}=2 V
T_{amb}=25°C
Current Limits
Limites de courant
Stromgrenzen
−I_C (A)
1,2
1,0
0,8
0,6
0,4
0,2
0
0
0,5
1,0
1,5
2,0
−V_{BE}(V)

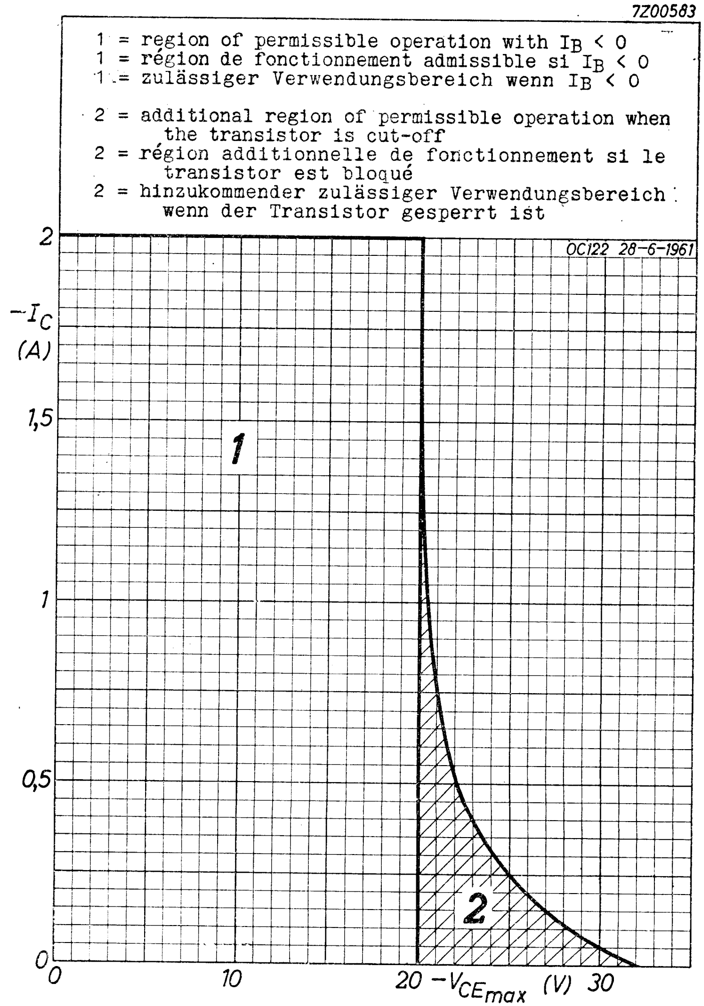
D


7Z00587
OC122 28-6-1961
−V_{CE}=2 V
T_{amb}=25°C
Current Limits
Limites de courant
Stromgrenzen
−I_C (mA)
700
600
500
400
300
200
100
0
0
2
4
6
8
10
−I_B(mA)

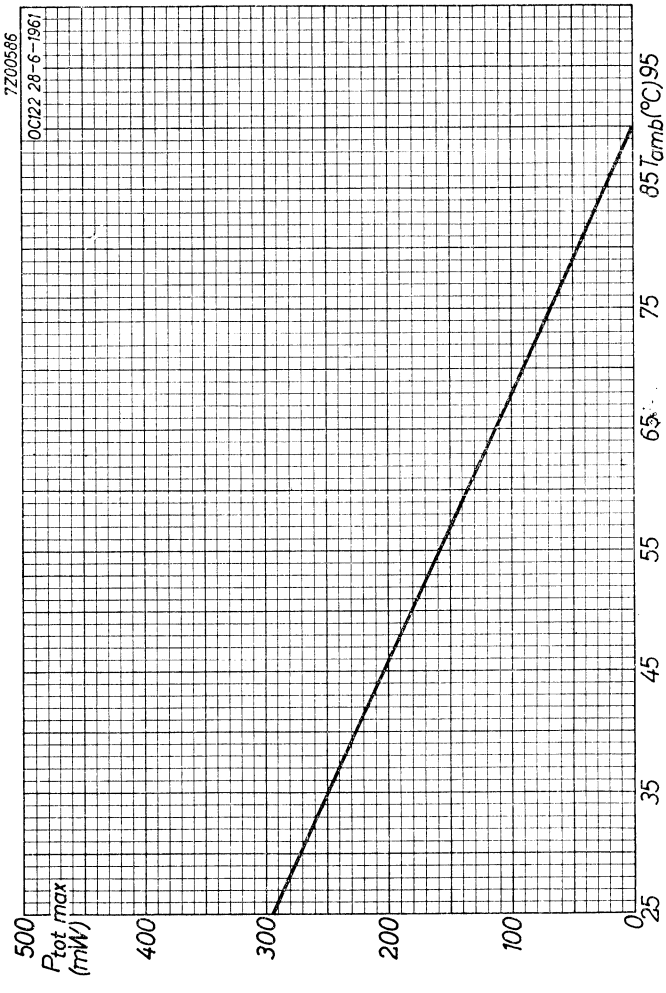
C


7Z00849
OC122 5-2-1962
$-I_{CBO}$ (mA)
$-V_{CB}=32V$
10
1
0,1
0,01
Current limits
Limites de courant
Stromgrenzen
20
40
60
80
T_j (°C)
100

E


7Z00583
1 = region of permissible operation with $I_B < 0$
1 = région de fonctionnement admissible si $I_B < 0$
1 = zulässiger Verwendungsbereich wenn $I_B < 0$
2 = additional region of permissible operation when the transistor is cut-off
2 = région additionnelle de fonctionnement si le transistor est bloqué
2 = hinzukommender zulässiger Verwendungsbereich wenn der Transistor gesperrt ist
OC122 28-6-1961
$-I_C$ (A)
2
1,5
1
0,5
0
0
10
20
30
$-V_{CEmax}$ (V)
1
2

F


7Z00586
OC122 28-6-1961
$P_{tot\ max}$ (mW)
500
400
300
200
100
0
25
35
45
55
65
75
85
T_{amb} (°C)
95

G

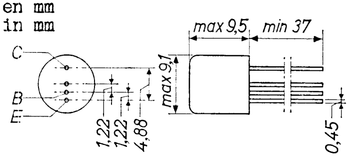
2.2.1962

GERMANIUM p-n-p ALLOY TRANSISTOR for use in high-speed industrial switching applications and in digital computers, particularly as pulse generator for a ferrite store

TRANSISTOR ALLIÉ AU GERMANIUM du type p-n-p pour utilisation dans les applications industrielles de commutation à grande vitesse et dans les machines à calculer numériques, notamment comme générateur d'impulsions pour une mémoire à ferrite

p-n-p-GERMANIUM-LEGIERUNGSTRANSISTOR zur Verwendung für industrielle Schaltzwecke hoher Geschwindigkeit und in numerischen Rechenmaschinen, besonders als Impulsgenerator für einen Ferritspeicher

Dimensions in mm
Dimensions en mm
Abmessungen in mm



Limiting values (Absolute max. values)
Caractéristiques limites (Valeurs max. absolues)
Grenzdaten (Absolute Maximalwerte)

$-V_{CB}$	= max. 50 V
$-V_{CE}$ ($+V_{BE} > 500$ mV)	= max. 50 V [1]
$-V_{EB}$	= max. 15 V
$-I_C$ (t_{av} = max. 20 msec)	= max. 0,5 A
$-I_{CM}$	= max. 2,0 A
P_{tot}	see page H / voir page H / siehe Seite H
Storage temperature / Température d'emmagasinage / Lagerungstemperatur	= -55°C/+75°C
T_j	= max. 90 °C

[1] See also page G
Voir aussi page G
Siehe auch Seite G

Thermal data. Thermal resistance from junction to ambience in free air K = max. 0.22 °C/mW
junction to case K = max. 0.06 °C/mW

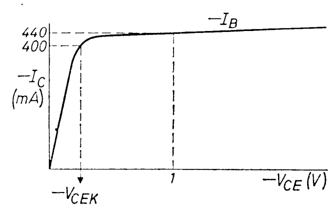
Données thermiques. Résistance thermique entre les jonctions et l'ambiance à l'air libre K = max. 0,22 °C/mW
entre les jonctions et le boîtier K = max. 0,06 °C/mW

Thermische Daten. Wärmewiderstand zwischen Kristall und Umgebung in freier Luft K = max. 0,22 °C/mW
zwischen Kristall und Gehäuse K = max. 0,06 °C/mW

Characteristics range values for equipment design
Gammes de valeurs des caractéristiques pour l'étude d'équipements
Kenndatenbereiche für Gerätentwurf T_j = 25 °C

$-V_{CB}$ = 10 V		
$-I_{CBO}$ = 20 µA < 100 µA	$-V_{CE}$ = 2 V	$-I_C$ = 100 mA
	$-V_{BE}$ = 0,27 V < 0,35 V	
$-V_{EB}$ = 12 V		
$-I_{EBO}$ = 20 µA < 100 µA	$-V_{CE}$ = 6 V	$-I_C$ = 100 mA
$-V_{CE}$ = 50 V	h_{FE} = 160 > 50	
V_{BE} = 1,5 V		
$-I_C$ = 0,25 mA < 2 mA		

Collector knee voltage
Tension de coude du collecteur
Kniespannung des Kollektors



$-I_C$ = 400 mA

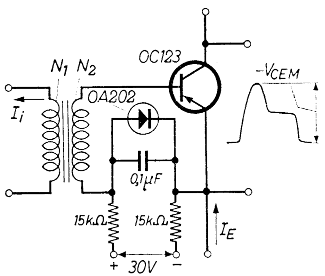
$-I_B$ = the value at which $-I_C$ = 440 mA when $-V_{CE}$ = 1 V
la valeur à laquelle $-I_C$ = 440 mA si $-V_{CE}$ = 1 V
der Wert bei dem $-I_C$ = 440 mA wenn $-V_{CE}$ = 1 V

$-V_{CEK}$ = 0,35 V

Typical parameters
Paramètres types
Kenngrössen

$-V_{CE}$		= 2 V
$-I_C$		= 100 mA
$r_{bb'}$	intrinsic base resistance résistance de base intrinsèque innere Basiswiderstand	= 80 Ω [1]
f_1	frequency at which $\|h_{fe}\| = 1$ fréquence à laquelle $\|h_{fe}\| = 1$ Frequenz bei der $\|h_{fe}\| = 1$	= 1,5 Mc/s
g_m	intrinsic transconductance transconductance intrinsèque innere Steilheit	= 4,0 mA/V
$-V_{CE}$		= 6 V
I_E		= 0 mA
$C_{b'c}$	feedback capacitance capacité de réaction Rückwirkungskapazität	= 170 pF

Operating characteristics for gating large current pulses
Caractéristiques d'utilisation comme porte pour des impulsions de courant élevé
Betriebsdaten als Tor für grosse Stromimpulse



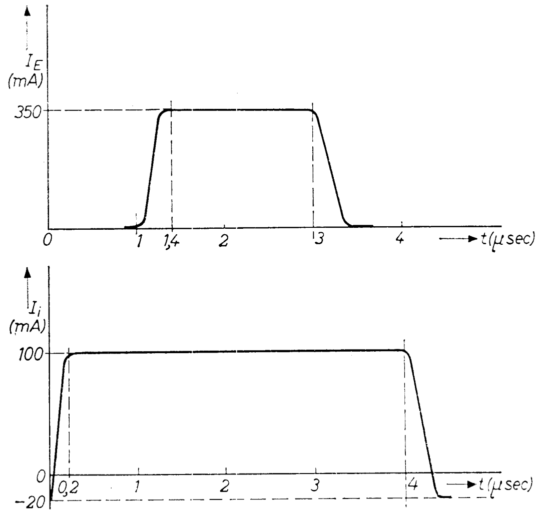
$N_1 = N_2 =$ 30 turns / 30 spires / 30 Windungen

$-V_{CEM} = 2,4\ V < 3,0\ V$

[1]) When the transistor is used under pulsed conditions, the intrinsic base resistance is considerably reduced
Si le transistor est utilisé avec des impulsions, la résistance de base intrinsèque est diminuée considérablement
Wenn der Transistor mit Impulsen betrieben wird, ist der innere Basiswiderstand stark verringert

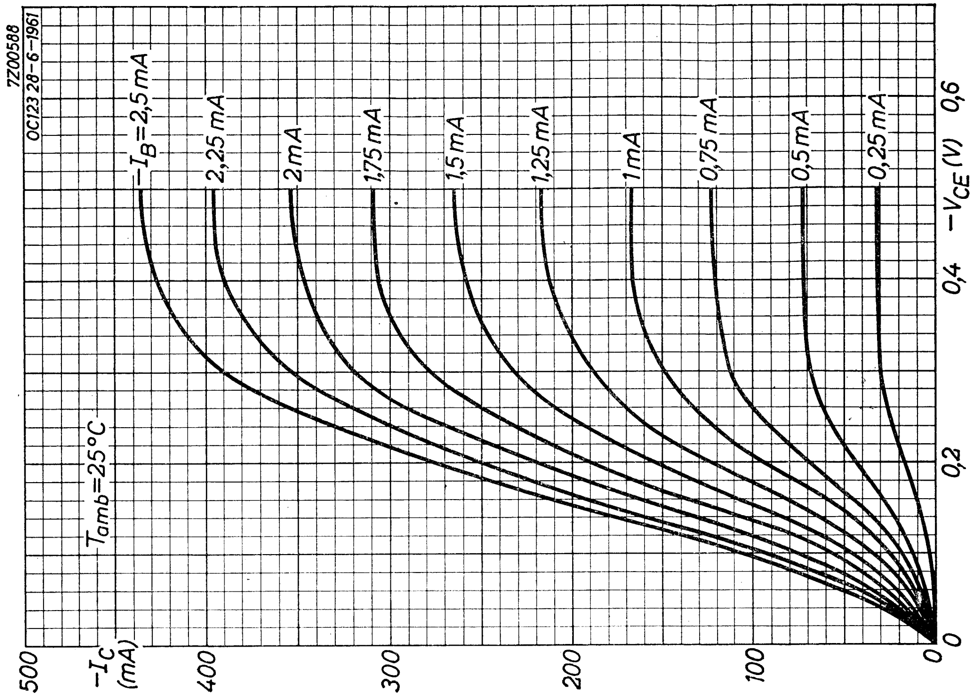
7Z2 0997

Operating characteristics for gating large current pulses (continued)
Caractéristiques d'utilisation comme porte pour des impulsions de courant élevé (suite)
Betriebsdaten als Tor für grosse Stromimpulse (Fortsetzung)

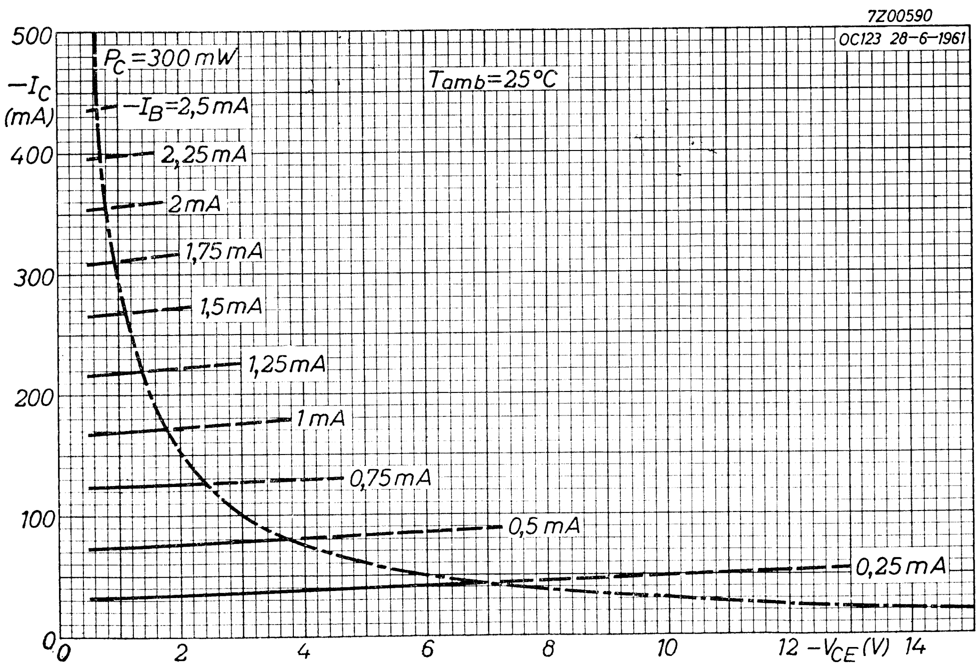


The base current pulse is applied 1 μsec before the gating pulse to ensure that the transistor is fully bottomed and $-V_{CEM}$ is kept to a minimum
L'impulsion de courant de base est appliquée 1 μsec avant l'impulsion de courant d'émetteur pour assurer que le transistor est surexcité complètement et $-V_{CEM}$ est tenue au minimum
Der Basisstromimpuls wird 1 μSek vor dem Emitterstromimpuls zugeführt, damit der Transistor ganz übersteuert und $-V_{CEM}$ so klein wie möglich gehalten werden

7Z2 0998

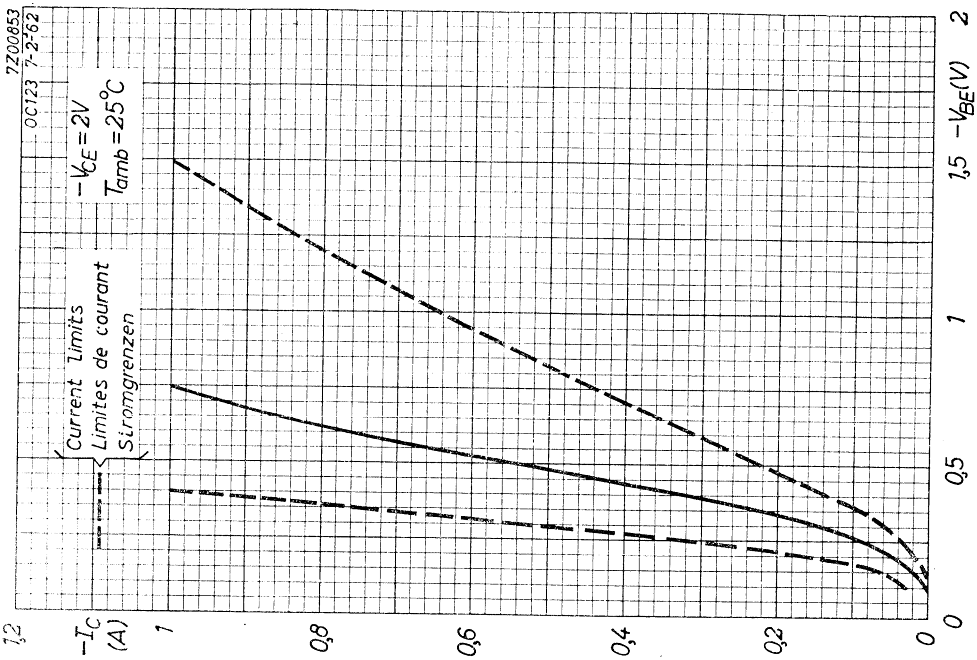

7Z00588
OC123 28-6-1961
T_{amb}=25°C
$-I_B$=2,5 mA
2,25 mA
2 mA
1,75 mA
1,5 mA
1,25 mA
1 mA
0,75 mA
0,5 mA
0,25 mA
$-V_{CE}$ (V)
0,6
0,4
0,2
0
$-I_C$ (mA)
500
400
300
200
100
0

B

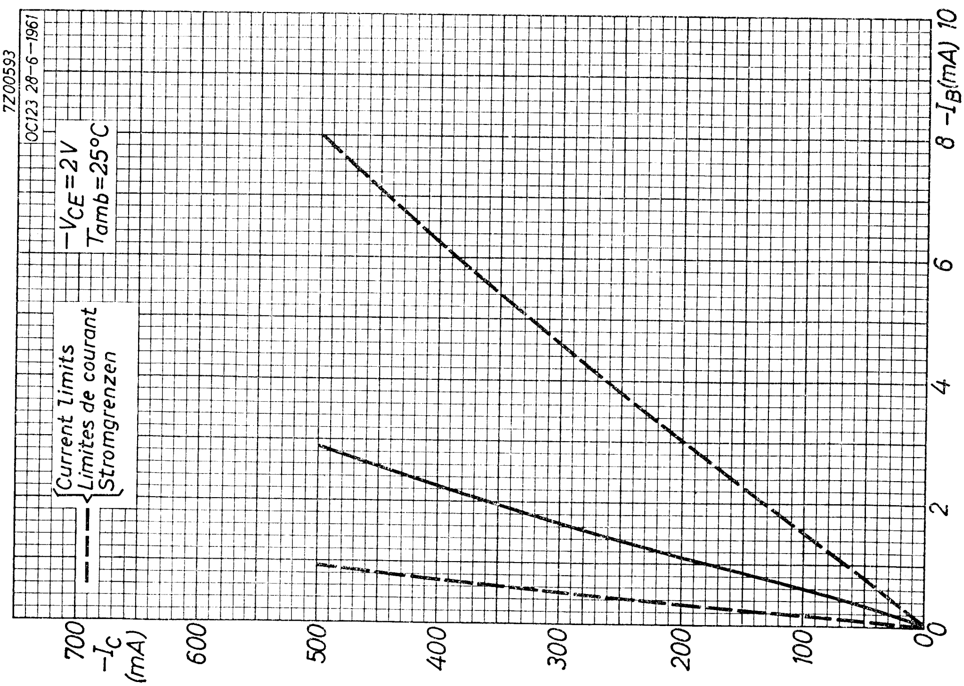

7Z00590
OC123 28-6-1961
P_C = 300 mW
T_{amb}=25°C
$-I_B$=2,5 mA
2,25 mA
2 mA
1,75 mA
1,5 mA
1,25 mA
1 mA
0,75 mA
0,5 mA
0,25 mA
$-I_C$ (mA)
500
400
300
200
100
0
0
2
4
6
8
10
12 $-V_{CE}$ (V) 14

A

2.2.1962

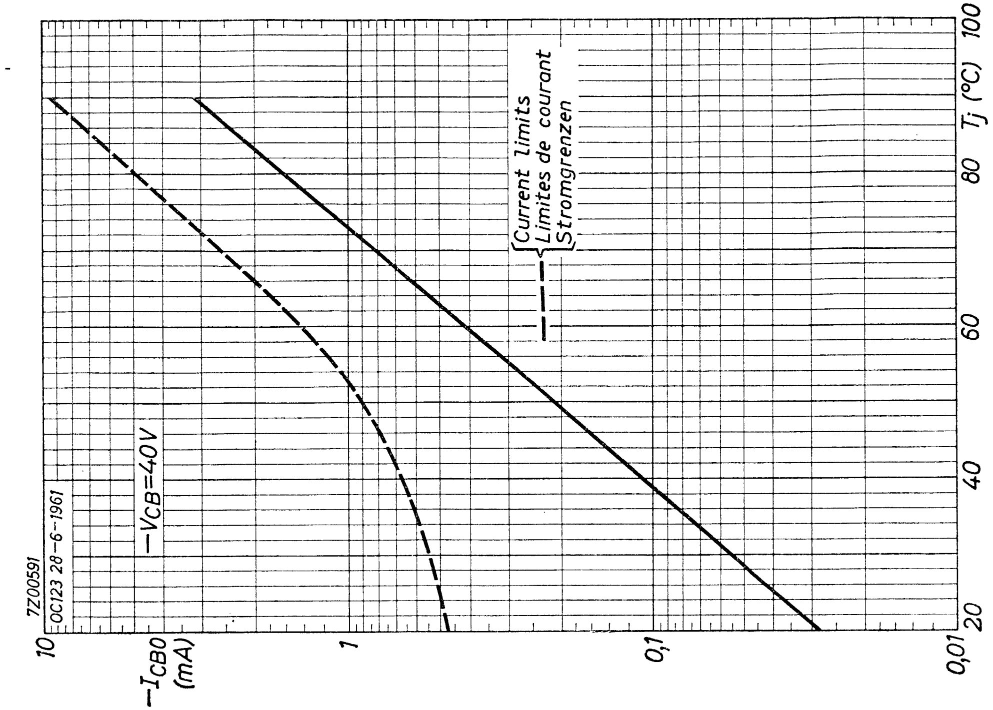

7Z00853
OC123 7-2-'62
−V_CE = 2V
T_amb = 25°C
Current Limits
Limites de courant
Stromgrenzen
−I_C (A)
1,2
1
0,8
0,6
0,4
0,2
0
0
0,5
1
1,5
2
−V_BE(V)

D

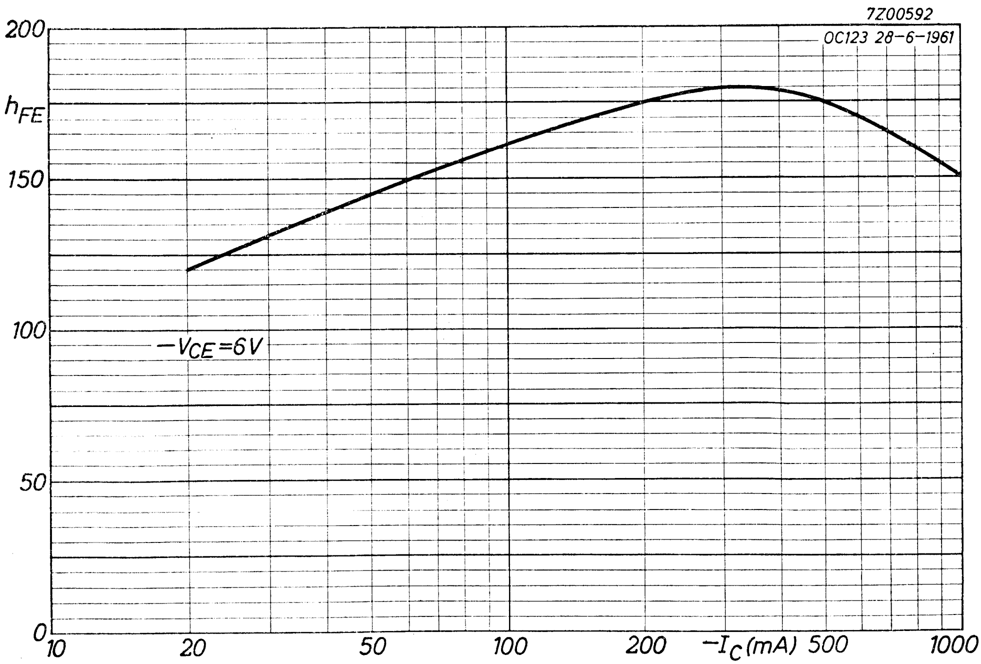

7Z00593
OC123 28-6-1961
−V_CE = 2V
T_amb = 25°C
Current Limits
Limites de courant
Stromgrenzen
−I_C (mA)
700
600
500
400
300
200
100
0
0
2
4
6
8
10
−I_B (mA)

C

F

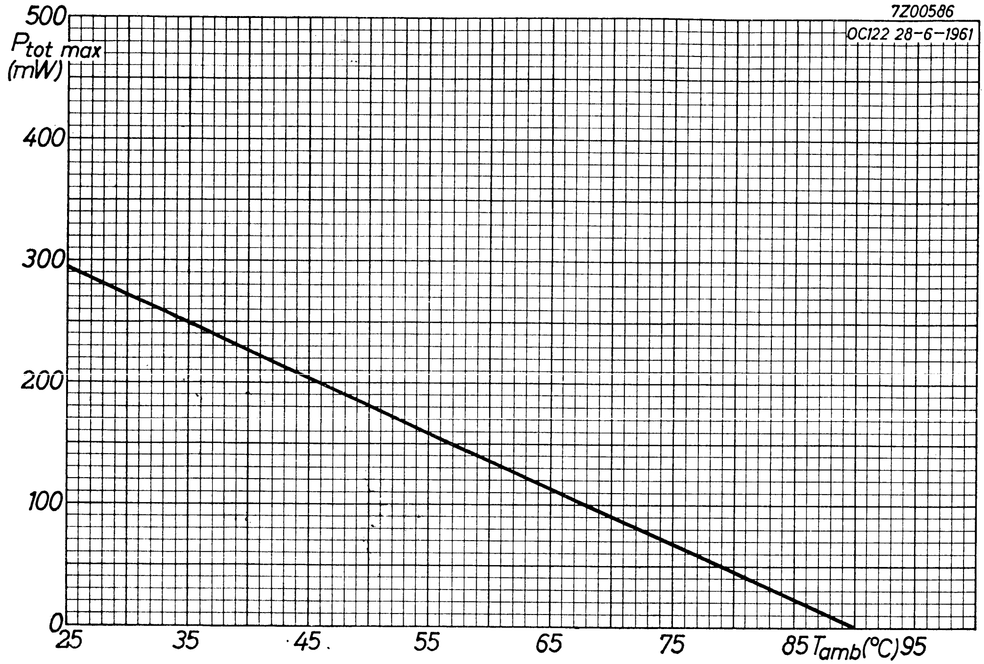

7Z00591
OC123 28-6-1961
−VCB=40V
Current limits
Limites de courant
Stromgrenzen
Tj (°C)
100
80
60
40
20
10
1
0,1
0,01
−ICBO (mA)

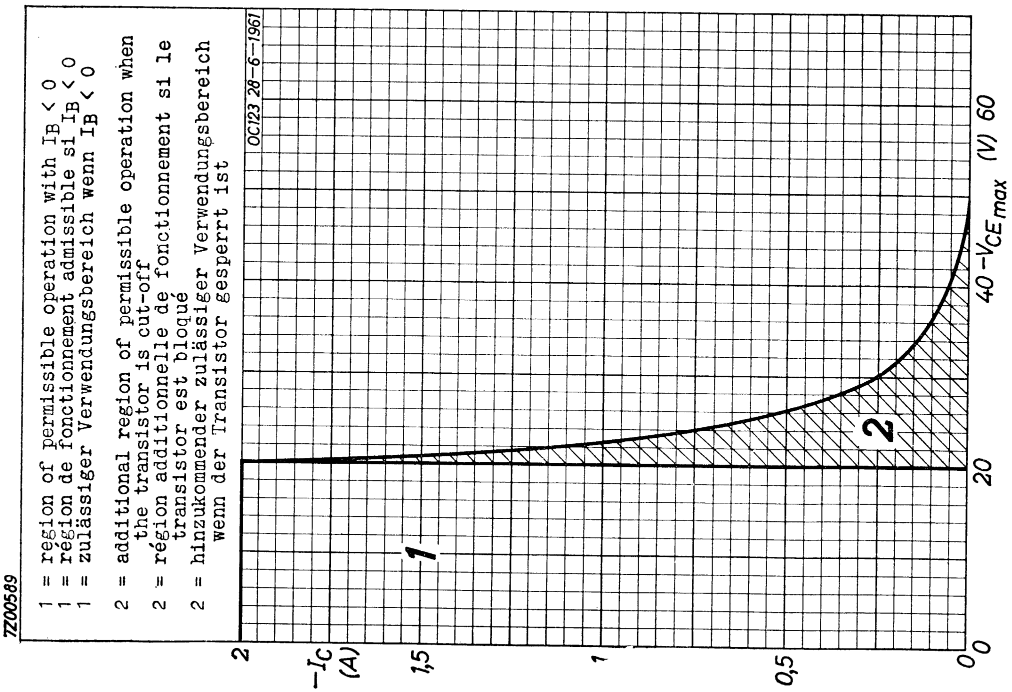
E


7Z00592
OC123 28-6-1961
hFE
200
150
100
50
0
−VCE=6V
10
20
50
100
200
−IC (mA)
500
1000

2.2.1962

H

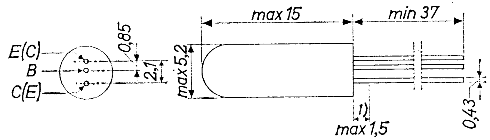

7Z00586
OC122 28-6-1961
$P_{tot\,max}$ (mW)
500
400
300
200
100
0
25
35
45
55
65
75
85
T_{amb} (°C)
95


7Z00589
OC123 28-6-1961
1 = region of permissible operation with $I_B < 0$
1 = région de fonctionnement admissible si $I_B < 0$
1 = zulässiger Verwendungsbereich wenn $I_B < 0$
2 = additional region of permissible operation when the transistor is cut-off
2 = région additionnelle de fonctionnement si le transistor est bloqué
2 = hinzukommender zulässiger Verwendungsbereich wenn der Transistor gesperrt ist
1
2
$-I_C$ (A)
2
1,5
1
0,5
0
$-V_{CE\,max}$ (V)
0
20
40
60

GERMANIUM JUNCTION TRANSISTOR of the n-p-n type with symmetrical structure in all-glass construction for high-current, high-speed computer switching applications
TRANSISTOR AU GERMANIUM À JONCTIONS du type n-p-n, de structure symétrique et en construction tout-verre pour application comme commutateur de grande vitesse à courant élevé dans les machines à calculer.
n-p-n GERMANIUM-FLÄCHENTRANSISTOR symmetrischer Struktur in Allglastechnik für Schaltzwecke grosser Geschwindigkeit und hoher Ströme in Rechenmaschinen.

Dimensions in mm
Dimensions en mm
Abmessungen in mm

The red dot indicates the preferred collector side
Le point rouge indique le côté préféré du collecteur
Der rote Punkt bezeichnet die bevorzugte Kollektorseite



Limiting values (Absolute max. values)
Caractéristiques limites (Valeurs max. absolues)
Grenzdaten (Absolute Maximalwerte)

V_{CB} = max. 20 V	I_C	= max.	250 mA
V_{CE} = max. 20 V[2])	$-I_E$	= max.	250 mA
V_{EB} = max. 20 V	I_{BM}	= max.	250 mA
T_j = max. 75 °C	$I_B(t_{av}$ = max. 20 msec)	= max.	40 mA

$$P_{tot} = \text{max.}\ \frac{T_{j\,max} - T_{amb}}{K}$$

Storage temperature
Température d'emmagasinage = $-55\ ^{\circ}C/+75^{\circ}C$
Lagerungstemperatur

1) Not tinned
Non-étamé
Nicht verzinnt

2) See page 2; voir page 2; siehe Seite 2

Thermal data. Thermal resistance

from junction to ambience in free air	K	≦	0.35 °C/mW
from junction to case with infinite heat sink	K	≦	0.2 °C/mW

Données thermiques. Résistance thermique

entre les jonctions et l'ambiance à l'air libre	K	≦	0,35 °C/mW
entre les jonctions et le boîtier avec plaque de refroidissement infinie	K	≦	0,2 °C/mW

Thermische Daten. Wärmewiderstand

zwischen Kristall und Umgebung in freier Luft	K	≦	0,35 °C/mW
zwischen Kristall und Gehäuse mit unendlich grosser Kühlplatte	K	≦	0,2 °C/mW

1) Page 1, Seite 1.
This value is permissible at $-V_{BE} \geqq 0.2$ V. See also page E. During switch-off transients with inductive load, it may occur that $V_{CE} > 15$ V. This is permitted, provided the inductive load is less than 250 µH and $0.2\ V < -V_{BE} < 2\ V$.
Cette valeur est permise à $-V_{BE} \geqq 0,2$ V. Voir aussi page E. Pendant les phénomènes transitoires accompagnant la mise hors circuit à charge inductive il peut se présenter que $V_{CE} > 15$ V. Ceci est permis, si la charge inductive est moins de 250 µH et $0,2\ V < -V_{BE} < 2\ V$.
Dieser Wert ist erlaubt wenn $-V_{BE} \geqq 0,2$ V. Siehe auch Seite E. Während der Ausgleichsvorgänge nach dem Ausschalten mit induktiver Belastung kann es vorkommen dass $V_{CE} > 15$ V. Dies ist erlaubt wenn die induktive Belastung kleiner als 250 µH ist und $0,2\ V < -V_{BE} < 2\ V$.

Characteristics
Caractéristiques
Kenndaten

T_{amb} = 25 °C

V_{CB} = 5 V			$-I_E$ = 200 mA		
I_{CBO} = 0,3 µA	< 3 µA		V_{CB} = 0 V		
			I_B = 6,0 mA	< 13,5 mA	
V_{EB} = 5 V					
I_{EBO} = 0,3 µA	< 3 µA		$-I_E$ = 200 mA		
			V_{CB} = 0 V		
$-I_E$ = 15 mA			$-V_{EB}$ = 350 mV	< 750 mV	
V_{CB} = 0 V					
I_B = 350 µA	> 180 µA < 715 µA				

V_{PT} {punch through voltage / tension de perforation / Durchschlagsspannung} > 20 V

Characteristics range values for equipment design
Gammes de valeurs des caractéristiques pour l'étude d'équipements
Kenndatenbereiche für Gerätentwurf

T_{amb} = 25 °C {unless otherwise specified / sauf indication différente / wenn nicht anders angegeben}

V_{CB} = 5 V		V_{EB} = 5 V	
T_{amb} = 60 °C		T_{amb} = 60 °C	
I_{CBO} = 6 µA	< 35 µA	I_{EBO} = 6 µA	< 35 µA
V_{CB} = 20 V		V_{EB} = 20 V	
T_{amb} = 60 °C		T_{amb} = 60 °C	
I_{CBO} = 7 µA	< 100 µA	I_{EBO} = 7 µA	< 100 µA
I_C = 7,5 mA		I_C = 7,5 mA	
I_B = 0,38 mA		I_B = 0,38 mA	
V_{CE} = 50 mV	< 175 mV	V_{BE} = 200 mV	< 300 mV
I_C = 50 mA		I_C = 50 mA	
I_B = 3,1 mA		I_B = 3,1 mA	
V_{CE} = 60 mV	< 220 mV	V_{BE} = 300 mV	< 500 mV

Characteristics range values for equipment design (continued)
Gammes de valeurs des caractéristiques pour l'étude d'équipements (suite)
Kenndatenbereiche für Gerätentwurf (Fortsetzung)

T_{amb} = 25 °C

I_C = 250 mA		V_{CB} = 5 V	
V_{EB} = 2 V		$-I_E$ = 3 mA	
V_{CE} =	> 15 V[1]	f = 0,5 Mc/s	
		$c_{b'c}$ = 20 pF	< 30 pF
V_{CB} = 5 V			
$-I_E$ = 3 mA		V_{CB} = 5 V	
f_1 [2] = 6 Mc/s	> 3,5 Mc/s	$-I_E$ = 1 mA	
		f = 1 kc/s	
		F = 5 dB	< 18 dB

Transient behaviour
Phénomènes transitoires
Ausgleichsvorgänge

Time constant with current feed
Constante de temps avec alimentation par courant
Zeitkonstante mit Stromspeisung

V_{CE} = 0,75 V
I_{CM} = 200 mA
τ_c [3] = 1,3 µsec < 1,75 µsec

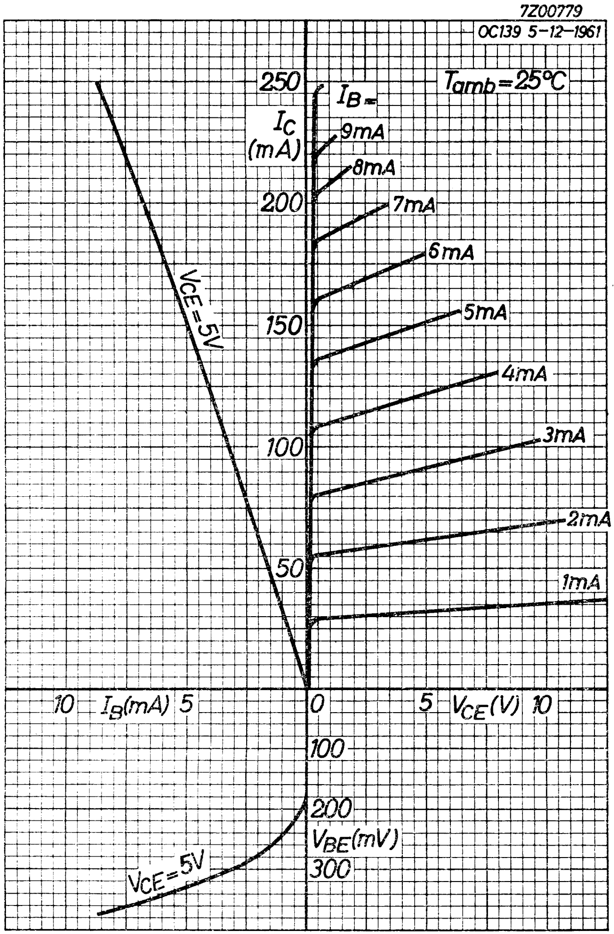
Time constant with voltage feed
Constante de temps avec alimentation par tension
Zeitkonstante mit Spannungsspeisung

V_{CE} = 5 V
I_{CM} = 1 mA
τ_v = 0,1 µsec < 0,15 µsec

1) Measured with pulses to prevent excessive dissipation
Mesuré avec des impulsions pour prévenir une dissipation excessive
Zur Vermeidung einer übermässigen Verlustleistung gemessen mit Impulsen

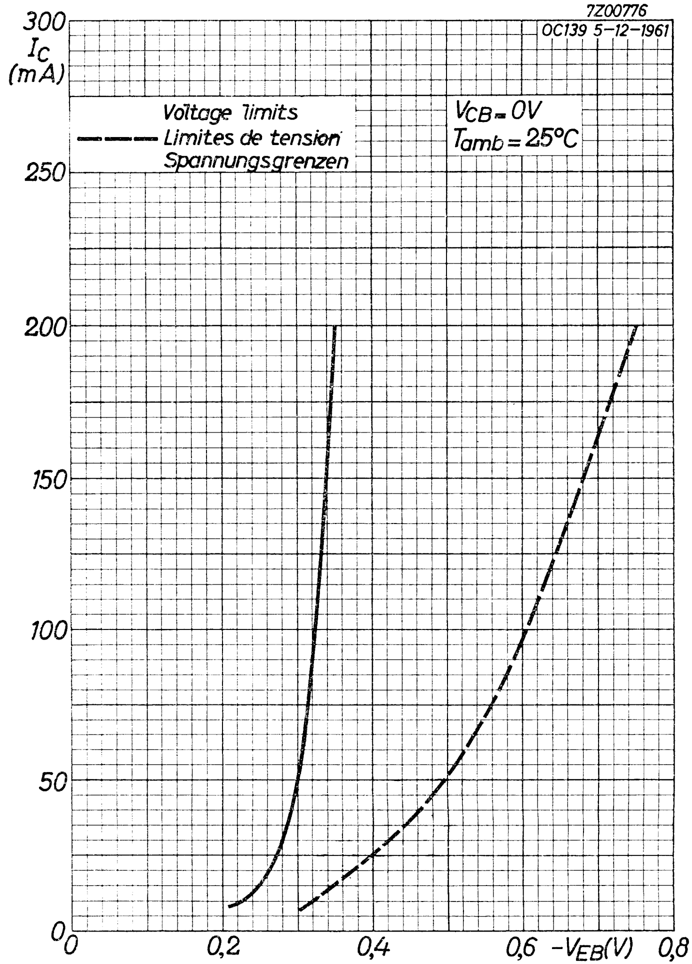
2) Frequency at which $|h_{fe}| = 1$
Fréquence à laquelle $|h_{fe}| = 1$
Frequenz bei der $|h_{fe}| = 1$

3) With normal and inverted connections
Avec connexions normales et interverties
Mit normalen und umgekehrten Anschlüssen



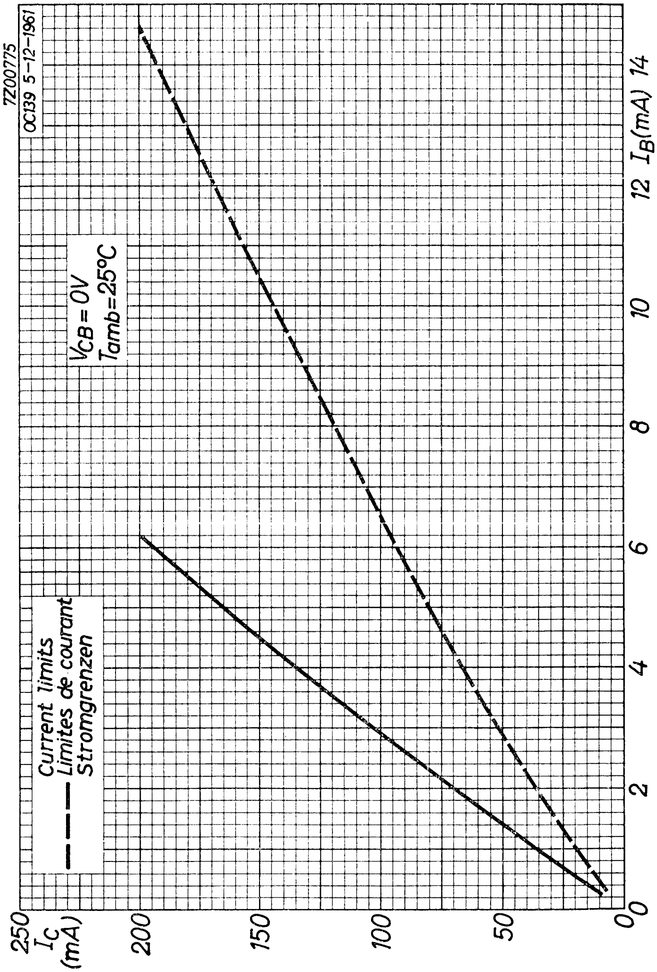
7Z00779
OC139 5-12-1961
Tamb=25°C
IB=
9mA
8mA
7mA
6mA
5mA
4mA
3mA
2mA
1mA
IC (mA)
250
200
150
100
50
VCE=5V
10
IB(mA)
5
0
5
VCE(V)
10
100
200
VBE(mV)
300
VCE=5V

A

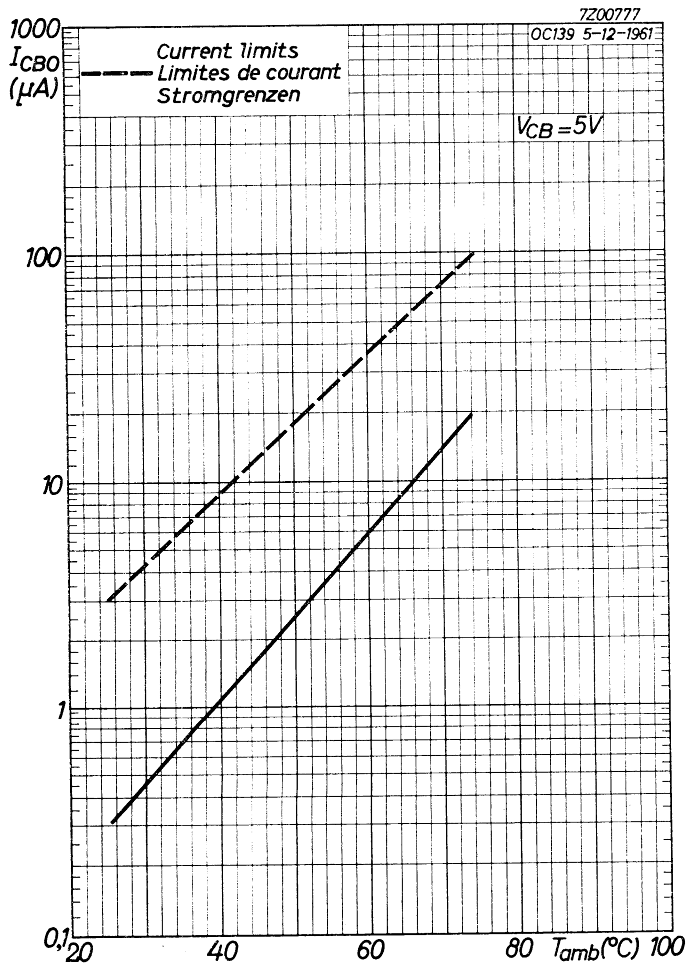


7Z00776
OC139 5-12-1961
300
IC (mA)
250
200
150
100
50
0
Voltage limits
Limites de tension
Spannungsgrenzen
VCB=0V
Tamb=25°C
0
0,2
0,4
0,6
-VEB(V)
0,8

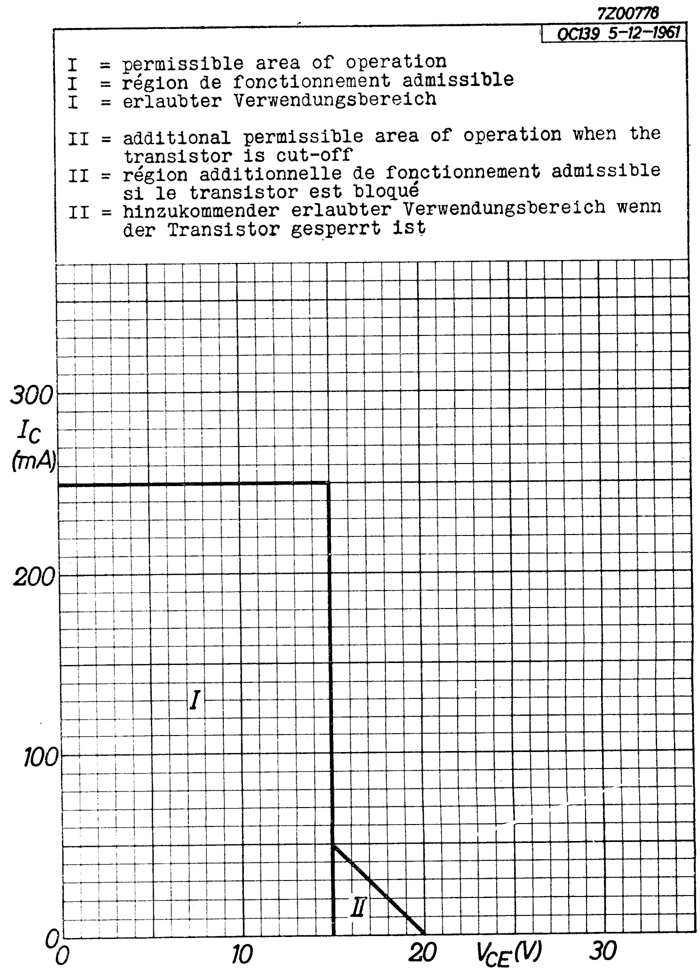
B



7Z00775
OC139 5-12-1961
Current limits
Limites de courant
Stromgrenzen
$V_{CB} = 0V$
$T_{amb} = 25°C$
I_C (mA)
250
200
150
100
50
0
I_B (mA)
0
2
4
6
8
10
12
14


7Z00777
OC139 5-12-1961
1000
I_{CBO}
(μA)
Current limits
Limites de courant
Stromgrenzen
V_{CB} = 5V
100
10
1
0,1
20
40
60
80
T_{amb}(°C)
100

D

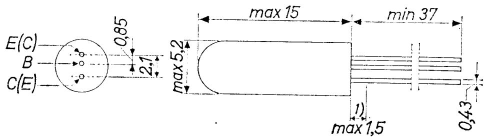

7Z00778
OC139 5-12-1961
I = permissible area of operation
I = région de fonctionnement admissible
I = erlaubter Verwendungsbereich
II = additional permissible area of operation when the transistor is cut-off
II = région additionnelle de fonctionnement admissible si le transistor est bloqué
II = hinzukommender erlaubter Verwendungsbereich wenn der Transistor gesperrt ist
300
I_C
(mA)
200
100
0
I
II
0
10
20
V_{CE}(V)
30

E

GERMANIUM JUNCTION TRANSISTOR of the n-p-n type with symmetrical structure in all-glass construction for high-current, high-speed computer switching applications
TRANSISTOR AU GERMANIUM À JONCTIONS du type n-p-n, de structure symétrique et en construction tout-verre pour application comme commutateur de grande vitesse à courant élevé dans les machines à calculer.
n-p-n GERMANIUM-FLÄCHENTRANSISTOR symmetrischer Struktur in Allglastechnik für Schaltzwecke grosser Geschwindigkeit und hoher Ströme in Rechenmaschinen.

Dimensions in mm
Dimensions en mm
Abmessungen in mm

The red dot indicates the preferred collector side
Le point rouge indique le côté préféré du collecteur
Der rote Punkt bezeichnet die bevorzugte Kollektorseite



Limiting values (Absolute max. values)
Caractéristiques limites (Valeurs max. absolues)
Grenzdaten (Absolute Maximalwerte)

V_{CB} = max. 20 V	I_C	= max. 400 mA
V_{CE} = max. 20 V 2)	$-I_E$	= max. 400 mA
V_{EB} = max. 20 V	I_{BM}	= max. 400 mA
T_j = max. 75 °C	I_B(t_{av} = max. 20 msec)	= max. 40 mA

$$P_{tot} = \text{max.} \frac{T_{j\,max} - T_{amb}}{K}$$

Storage temperature
Température d'emmagasinage = −55 °C/+75 °C
Lagerungstemperatur

1) Not tinned
Non-étamé
Nicht verzinnt

2) See page 2; voir page 2; siehe Seite 2

Thermal data. Thermal resistance

from junction to ambience in free air	K ≦	0.35 °C/mW
from junction to case with infinite heat sink	K ≦	0.2 °C/mW

Données thermiques. Résistance thermique

entre les jonctions et l'ambiance à l'air libre	K ≦	0,35 °C/mW
entre les jonctions et le boîtier avec plaque de refroidissement infinie	K ≦	0,2 °C/mW

Thermische Daten. Wärmewiderstand

zwischen Kristall und Umgebung in freier Luft	K ≦	0,35 °C/mW
zwischen Kristall und Gehäuse mit unendlich grosser Kühlplatte	K ≦	0,2 °C/mW

1) Page 1, Seite 1.
This value is permissible at $-V_{BE} \geqq 0.2$ V. See also page E. During switch-off transients with inductive load, it may occur that $V_{CE} > 15$ V. This is permitted, provided the inductive load is less than 250 µH and $0.2\ V < -V_{BE} < 2\ V$.
Cette valeur est permise à $-V_{BE} \geqq 0,2$ V. Voir aussi page E. Pendant les phénomènes transitoires accompagnant la mise hors circuit à charge inductive il peut se présenter que $V_{CE} > 15$ V. Ceci est permis, si la charge inductive est moins de 250 µH et $0,2\ V < -V_{BE} < 2\ V$.
Dieser Wert ist erlaubt wenn $-V_{BE} \geqq 0,2$ V. Siehe auch Seite E. Während der Ausgleichsvorgänge nach dem Ausschalten mit induktiver Belastung kann es vorkommen dass $V_{CE} > 15$ V. Dies ist erlaubt wenn die induktive Belastung kleiner als 250 µH ist und $0,2\ V < -V_{BE} < 2\ V$.

Characteristics
Caractéristiques T_{amb} = 25 °C
Kenndaten

V_{CB} = 5 V			$-I_E$ = 200 mA		
I_{CBO} = 0,3 µA	< 3 µA		V_{CB} = 0 V		
			I_B = 3,0 mA	< 5,6 mA	
V_{EB} = 5 V			$-I_C$ = 200 mA		
I_{EBO} = 0,3 µA	< 3 µA		V_{EB} = 0 V		
			I_B = 5,0 mA	< 9,5 mA	
$-I_E$ = 15 mA			$-I_E$ = 200 mA		
V_{CB} = 0 V			V_{CB} = 0 V		
I_B = 200 µA	> 100 µA < 295 µA		$-V_{EB}$ = 320 mV	< 600 mV	

V_{PT} {punch through voltage / tension de perforation / Durchschlagsspannung} > 20 V

Characteristics range values for equipment design
Gammes de valeurs des caractéristiques pour l'étude d'équipements
Kenndatenbereiche für Gerätentwurf

T_{amb} = 25 °C {unless otherwise specified / sauf indication différente / wenn nicht anders angegeben}

V_{CB} = 5 V		V_{EB} = 5 V	
T_{amb} = 60 °C		T_{amb} = 60 °C	
I_{CBO} = 6 µA	< 35 µA	I_{EBO} = 6 µA	< 35 µA
V_{CB} = 20 V		V_{EB} = 20 V	
T_{amb} = 60 °C		T_{amb} = 60 °C	
I_{CBO} = 7 µA	< 100 µA	I_{EBO} = 7 µA	< 100 µA
I_C = 7,5 mA		I_C = 7,5 mA	
I_B = 0,165 mA		I_B = 0,165 mA	
V_{CE} = 60 mV	< 175 mV	V_{BE} = 200 mV	< 250 mV
I_C = 50 mA		I_C = 50 mA	
I_B = 1,25 mA		I_B = 1,25 mA	
V_{CE} = 70 mV	< 220 mV	V_{BE} = 250 mV	< 380 mV
I_C = 400 mA		I_C = 400 mA	
I_B = 20 mA		I_B = 20 mA	
V_{CE} = 150 mV	< 370 mV	V_{BE} = 450 mV	< 900 mV

Characteristics range values for equipment design (continued)
Gammes de valeurs des caractéristiques pour l'étude d'équipements (suite)
Kenndatenbereiche für Gerätentwurf (Fortsetzung)

T_{amb} = 25 °C

I_C = 400 mA		V_{CB} = 5 V	
V_{EB} = 2 V		$-I_E$ = 3 mA	
V_{CE} =	> 15 V [1]	f = 0,5 Mc/s	
		$c_{b'c}$ = 20 pF	< 30 pF
V_{CB} = 5 V			
$-I_E$ = 3 mA		V_{CB} = 5 V	
f_1 [2] = 12 Mc/s	> 4,5 Mc/s	$-I_E$ = 1 mA	
		f = 1 kc/s	
		F = 5 dB	< 18 dB

Transient behaviour
Phénomènes transitoires
Ausgleichsvorgänge

Time constant with current feed
Constante de temps avec alimentation par courant
Zeitkonstante mit Stromspeisung

V_{CE} = 0,75 V
I_{CM} = 200 mA
τ_c [3] = 1,3 µsec < 1,75 µsec

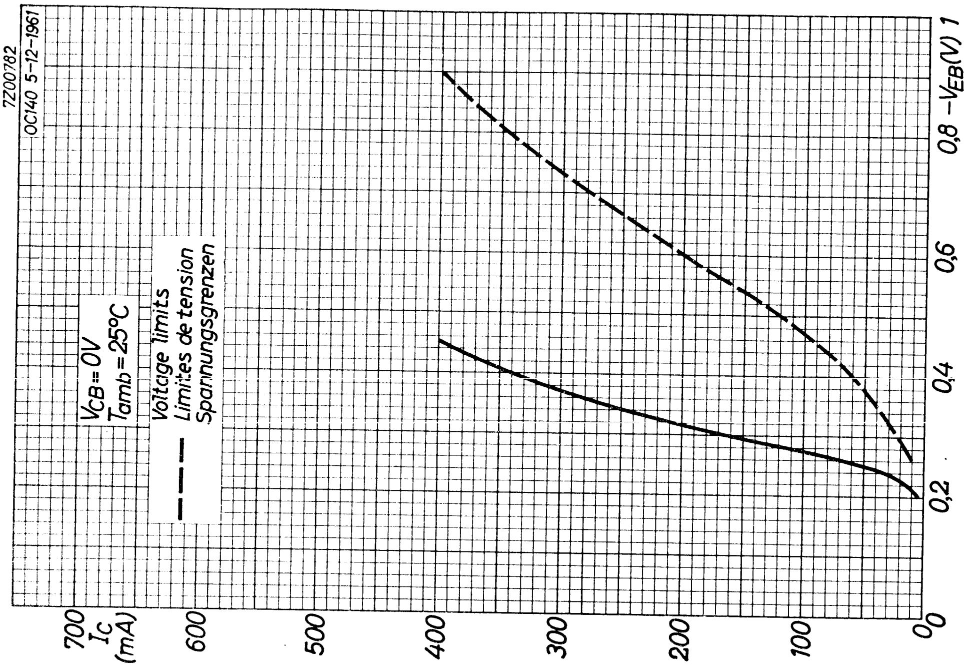
Time constant with voltage feed
Constante de temps avec alimentation par tension
Zeitkonstante mit Spannungsspeisung

V_{CE} = 5 V
I_{CM} = 1 mA
τ_v = 0,1 µsec < 0,15 µsec

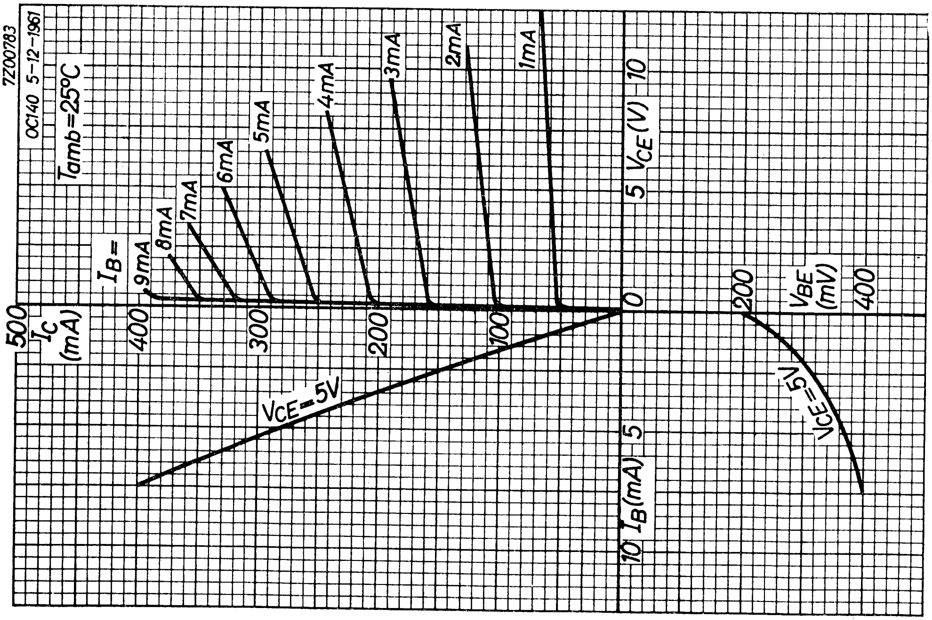
[1] Measured with pulses to prevent excessive dissipation
Mesuré avec des impulsions pour prévenir une dissipation excessive
Zur Vermeidung einer übermässigen Verlustleistung gemessen mit Impulsen

[2] Frequency at which $|h_{fe}|$ = 1
Fréquence à laquelle $|h_{fe}|$ = 1
Frequenz bei der $|h_{fe}|$ = 1

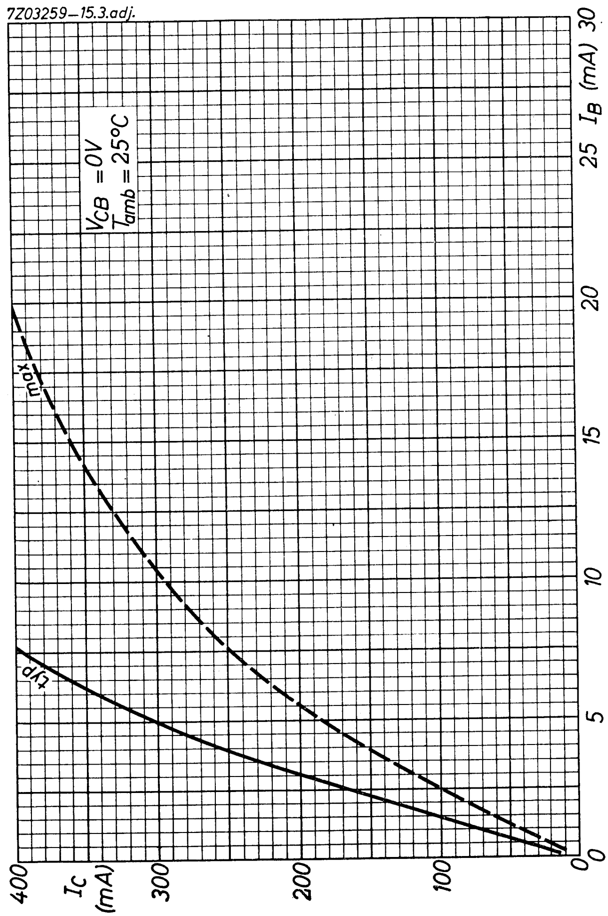
[3] With normal and inverted connections
Avec connexions normales et interverties
Mit normalen und umgekehrten Anschlüssen


7Z00782
OC140 5-12-1961
V_{CB} = 0V
T_{amb} = 25°C
Voltage limits
Limites de tension
Spannungsgrenzen
I_C (mA)
700
600
500
400
300
200
100
0
0
0,2
0,4
0,6
0,8
1
$-V_{EB}$(V)

B

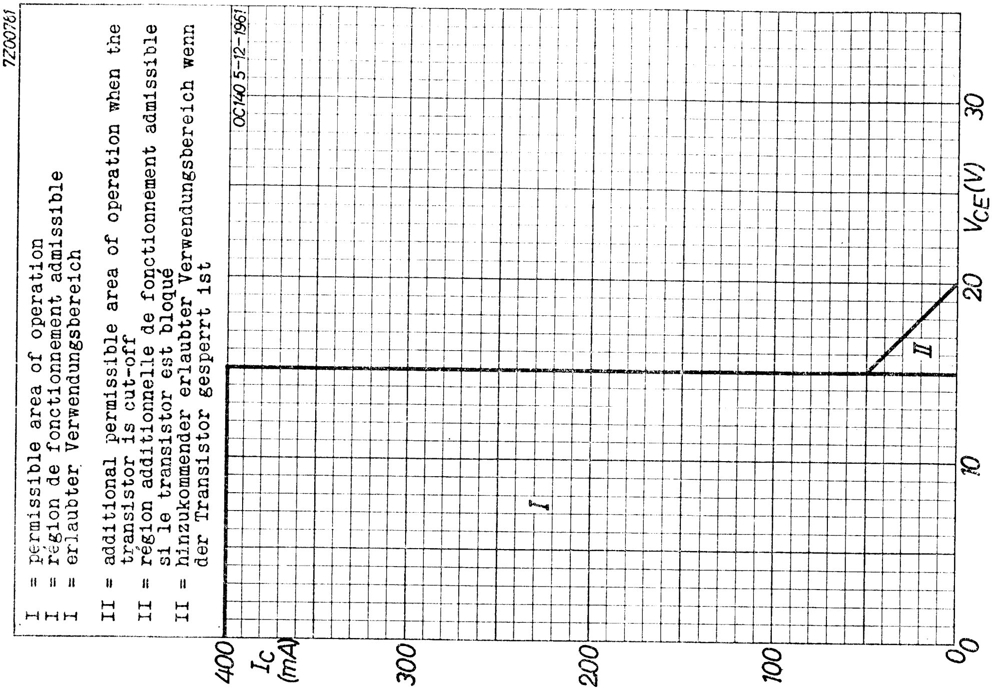

7Z00783
OC140 5-12-1961
T_{amb} = 25°C
I_B =
9mA
8mA
7mA
6mA
5mA
4mA
3mA
2mA
1mA
I_C (mA)
500
400
300
200
100
0
5
10
V_{CE}(V)
V_{CE} = 5V
I_B(mA)
V_{BE} (mV)
200
400
V_{CE} = 5V

A

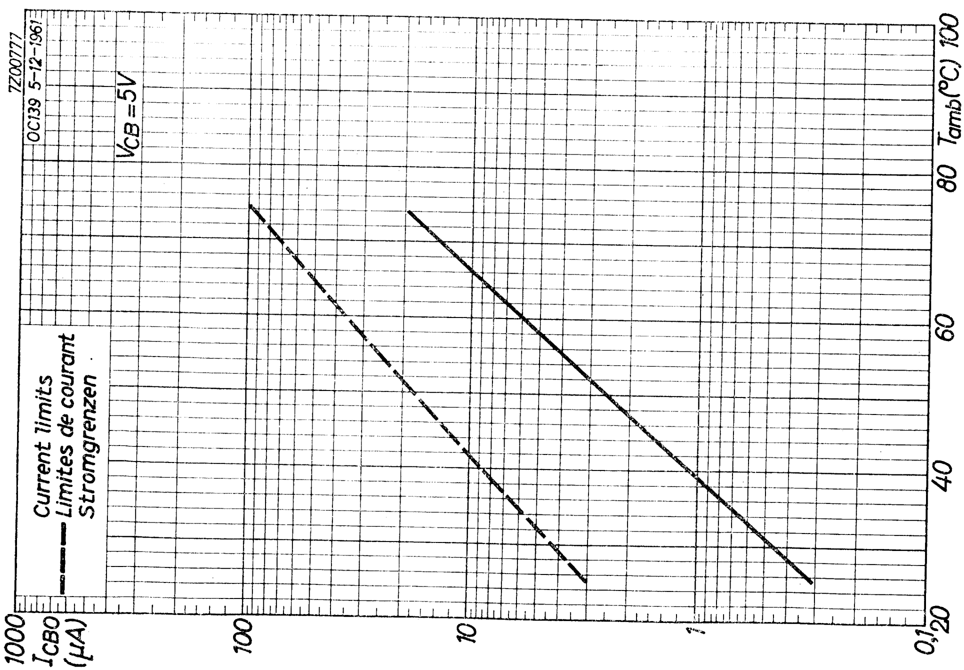

7Z03259—15.3.adj.
V_{CB} = 0V
T_{amb} = 25°C
max
typ
I_C (mA)
400
300
200
100
0
0
5
10
15
20
25
30
I_B (mA)

3.3.1965

C


7Z00761
OC140 5-12-1961
I = permissible area of operation
I = région de fonctionnement admissible
I = erlaubter Verwendungsbereich
II = additional permissible area of operation when the transistor is cut-off
II = région additionnelle de fonctionnement admissible si le transistor est bloqué
II = hinzukommender erlaubter Verwendungsbereich wenn der Transistor gesperrt ist
I
II
I_C (mA)
400
300
200
100
0
0
10
20
30
V_{CE}(V)

E


7Z00777
OC139 5-12-1961
V_{CB} = 5V
Current limits
Limites de courant
Stromgrenzen
I_{CBO} (µA)
1000
100
10
1
0,1
20
40
60
80
100
T_{amb}(°C)

D

GERMANIUM JUNCTION TRANSISTOR of the n-p-n type with symmetrical structure in all-glass construction for high-current, high-speed computer switching applications

TRANSISTOR AU GERMANIUM À JONCTIONS du type n-p-n, de structure symétrique et en construction tout-verre pour application comme commutateur de grande vitesse à courant élevé dans les machines à calculer.

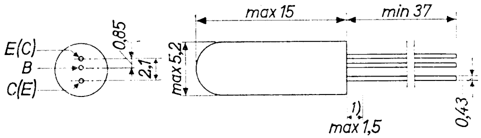
n-p-n GERMANIUM-FLÄCHENTRANSISTOR symmetrischer Struktur in Allglastechnik für Schaltzwecke grosser Geschwindigkeit und hoher Ströme in Rechenmaschinen.

Dimensions in mm
Dimensions en mm
Abmessungen in mm

The red dot indicates the preferred collector side

Le point rouge indique le côté préféré du collecteur

Der rote Punkt bezeichnet die bevorzugte Kollektorseite



Limiting values (Absolute max. values)
Caractéristiques limites (Valeurs max. absolues)
Grenzdaten (Absolute Maximalwerte)

V_{CB} = max. 20 V	I_C		= max. 400 mA
V_{CE} = max. 20 V [2])	$-I_E$		= max. 400 mA
V_{EB} = max. 20 V	I_{BM}		= max. 400 mA
T_j = max. 75 °C	$I_B(t_{av}$ = max. 20 msec)		= max. 40 mA

$$P_{tot} = \text{max.} \frac{T_{j\,max} - T_{amb}}{K}$$

Storage temperature
Température d'emmagasinage = -55 °C/+75 °C
Lagerungstemperatur

[1]) Not tinned
Non-étamé
Nicht verzinnt

[2]) See page 2; voir page 2; siehe Seite 2

Thermal data. Thermal resistance

from junction to ambience in free air	K ≦	0.35 °C/mW
from junction to case with infinite heat sink	K ≦	0.2 °C/mW

Données thermiques. Résistance thermique

entre les jonctions et l'ambiance à l'air libre	K ≦	0,35 °C/mW
entre les jonctions et le boîtier avec plaque de refroidissement infinie	K ≦	0,2 °C/mW

Thermische Daten. Wärmewiderstand

zwischen Kristall und Umgebung in freier Luft	K ≦	0,35 °C/mW
zwischen Kristall und Gehäuse mit unendlich grosser Kühlplatte	K ≦	0,2 °C/mW

[1]) Page 1, Seite 1.

This value is permissible at $-V_{BE} \geqq 0.2$ V. See also page E. During switch-off transients with inductive load, it may occur that $V_{CE} > 15$ V. This is permitted, provided the inductive load is less than 250 µH and $0.2 \text{ V} < -V_{BE} < 2$ V.

Cette valeur est permise à $-V_{BE} \geqq 0,2$ V. Voir aussi page E. Pendant les phénomènes transitoires accompagnant la mise hors circuit à charge inductive il peut se présenter que $V_{CE} > 15$ V. Ceci est permis, si la charge inductive est moins de 250 µH et $0,2 \text{ V} < -V_{BE} < 2$ V.

Dieser Wert ist erlaubt wenn $-V_{BE} \geqq 0,2$ V. Siehe auch Seite E. Während der Ausgleichsvorgänge nach dem Ausschalten mit induktiver Belastung kann es vorkommen dass $V_{CE} > 15$ V. Dies ist erlaubt wenn die induktive Belastung kleiner als 250 µH ist und $0,2 \text{ V} < -V_{BE} < 2$ V.

Characteristics
Caractéristiques T_{amb} = 25 °C
Kenndaten

V_{CB} = 5 V		$-I_E$ = 200 mA	
I_{CBO} = 0,3 µA	< 3 µA	V_{CB} = 0 V	
		I_B = 1,5 mA	< 4,0 mA
V_{EB} = 5 V		$-I_C$ = 200 mA	
I_{EBO} = 0,3 µA	< 3 µA	V_{EB} = 0 V	
		I_B = 5,0 mA	< 9,5 mA
$-I_E$ = 15 mA		$-I_E$ = 200 mA	
V_{CB} = 0 V		V_{CB} = 0 V	
I_B = 100 µA	> 75 µA < 185 µA	$-V_{EB}$ = 320 mV	< 450 mV

V_{PT} { punch through voltage / tension de perforation / Durchschlagsspannung } > 20 V

Characteristics range values for equipment design
Gammes de valeurs des caractéristiques pour l'étude d'équipements
Kenndatenbereiche für Gerätentwurf

T_{amb} = 25 °C { unless otherwise specified / sauf indication différente / wenn nicht anders angegeben }

V_{CB} = 5 V		V_{EB} = 5 V	
T_{amb} = 60 °C		T_{amb} = 60 °C	
I_{CBO} = 6 µA	< 35 µA	I_{EBO} = 6 µA	< 35 µA
V_{CB} = 20 V		V_{EB} = 20 V	
T_{amb} = 60 °C		T_{amb} = 60 °C	
I_{CBO} = 7 µA	< 100 µA	I_{EBO} = 7 µA	< 100 µA
I_C = 7,5 mA		I_C = 7,5 mA	
I_B = 0,094 mA		I_B = 0,094 mA	
V_{CE} = 60 mV	< 175 mV	V_{BE} = 180 mV	< 250 mV
I_C = 50 mA		I_C = 50 mA	
I_B = 0,75 mA		I_B = 0,75 mA	
V_{CE} = 70 mV	< 220 mV	V_{BE} = 230 mV	< 340 mV
I_C = 400 mA		I_C = 400 mA	
I_B = 13,3 mA		I_B = 20 mA	
V_{CE} = 150 mV	< 370 mV	V_{BE} = 400 mV	< 700 mV

Characteristics range values for equipment design (continued)
Gammes de valeurs des caractéristiques pour l'étude d'équipements (suite)
Kenndatenbereiche für Gerätentwurf (Fortsetzung)

T_{amb} = 25 °C

I_C = 400 mA		V_{CB} = 5 V	
V_{EB} = 2 V		$-I_E$ = 3 mA	
V_{CE} =	> 15 V[1]	f = 0,5 Mc/s	
		$c_{b'c}$ = 20 pF	< 30 pF
V_{CB} = 5 V		V_{CB} = 5 V	
$-I_E$ = 3 mA		$-I_E$ = 1 mA	
f_1[2] = 20 Mc/s	> 9 Mc/s	f = 1 kc/s	
		F = 5 dB	< 18 dB

Transient behaviour
Phénomènes transitoires
Ausgleichsvorgänge

Time constant with current feed
Constante de temps avec alimentation par courant
Zeitkonstante mit Stromspeisung

V_{CE} = 0,75 V
I_{CM} = 200 mA
τ_c[3] = 1,3 µsec < 1,75 µsec

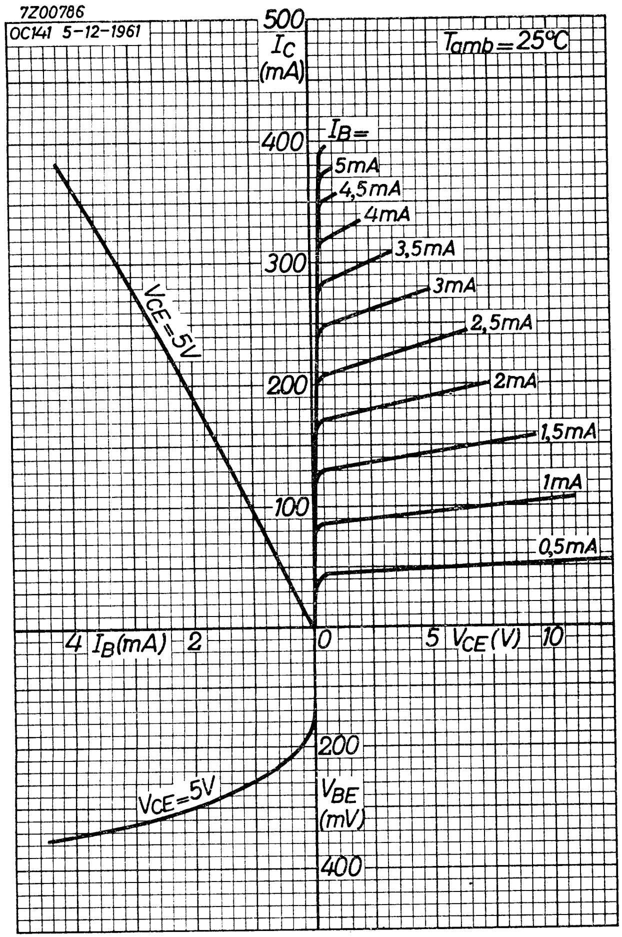
Time constant with voltage feed
Constante de temps avec alimentation par tension
Zeitkonstante mit Spannungsspeisung

V_{CE} = 5 V
I_{CM} = 1 mA
τ_v = 0,1 µsec < 0,15 µsec

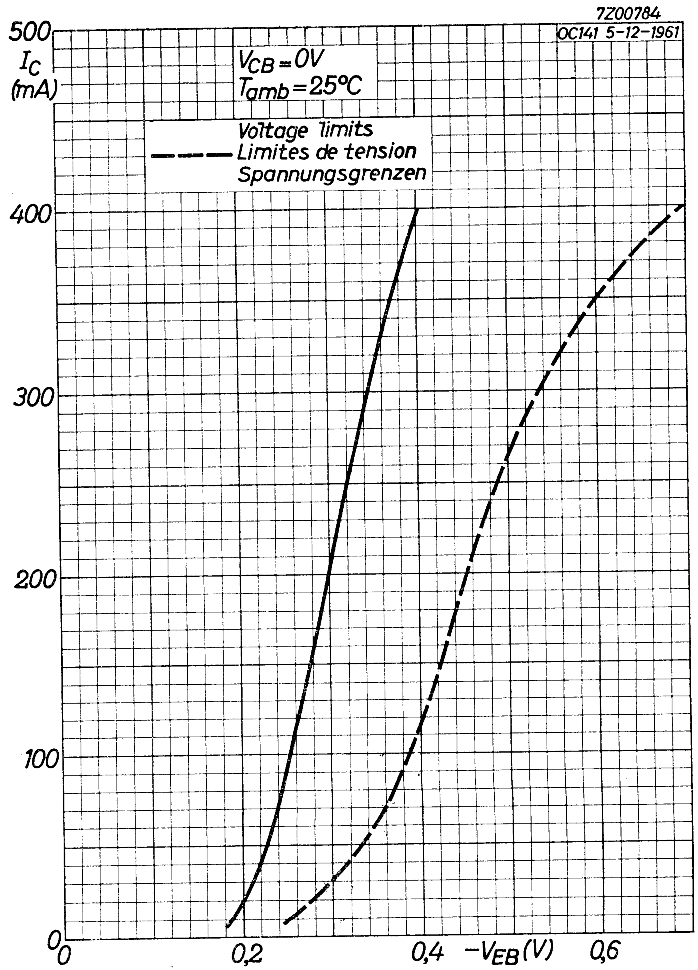
1) Measured with pulses to prevent excessive dissipation
Mesuré avec des impulsions pour prévenir une dissipation excessive
Zur Vermeidung einer übermässigen Verlustleistung gemessen mit Impulsen

2) Frequency at which $|h_{fe}|$ = 1
Fréquence à laquelle $|h_{fe}|$ = 1
Frequenz bei der $|h_{fe}|$ = 1

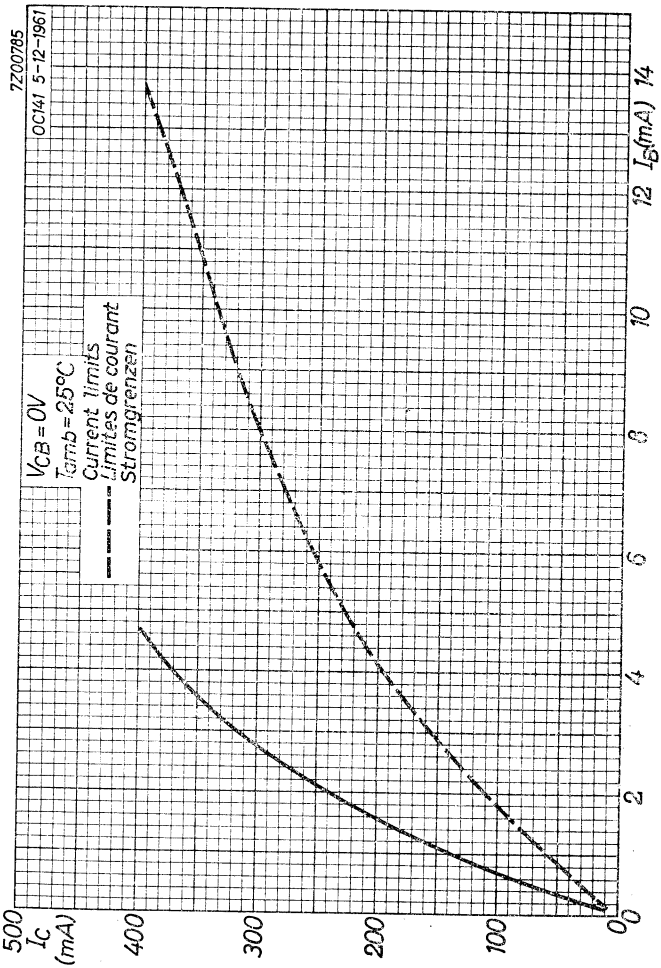
3) With normal and inverted connections
Avec connexions normales et interverties
Mit normalen und umgekehrten Anschlüssen


7Z00786
OC141 5-12-1961
T_{amb} = 25°C
I_C (mA)
500
400
300
200
100
I_B =
5mA
4,5mA
4mA
3,5mA
3mA
2,5mA
2mA
1,5mA
1mA
0,5mA
V_{CE} = 5V
4
I_B (mA)
2
0
5
V_{CE} (V)
10
200
V_{BE} (mV)
400
V_{CE} = 5V

A

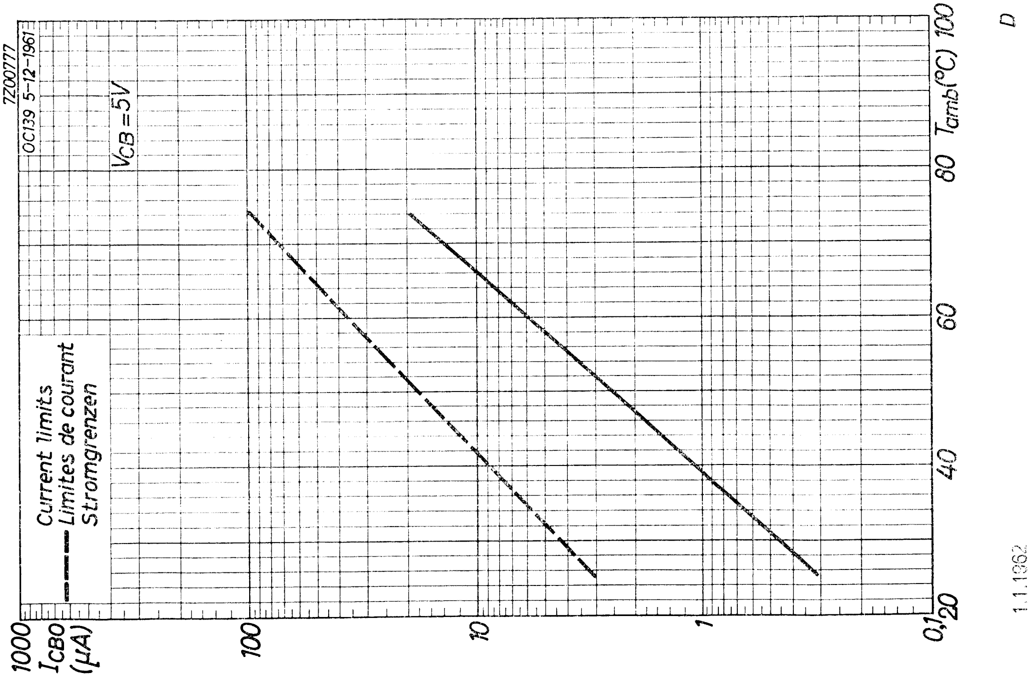

7Z00784
OC141 5-12-1961
V_{CB} = 0V
T_{amb} = 25°C
Voltage limits
Limites de tension
Spannungsgrenzen
I_C (mA)
500
400
300
200
100
0
0
0,2
0,4
$-V_{EB}$ (V)
0,6

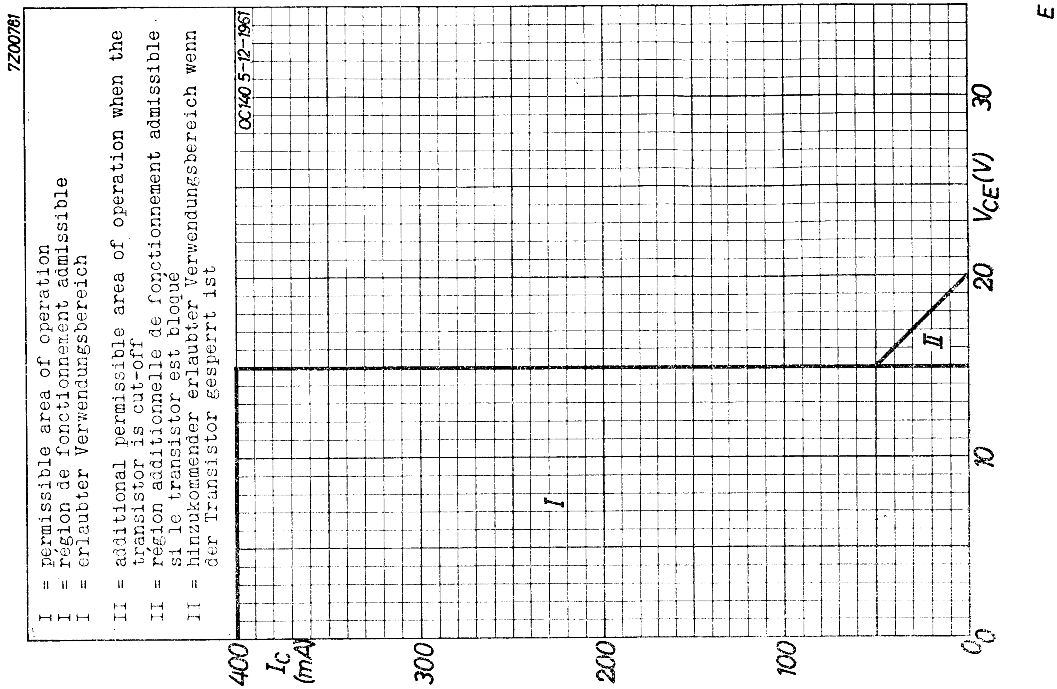
B


7Z00785
OC141 5-12-1961
V_{CB} = 0V
T_{amb} = 25°C
Current limits
Limites de courant
Stromgrenzen
I_C (mA)
500
400
300
200
100
0
0
2
4
6
8
10
12
14
I_B (mA)

1.1.1962

C


7Z00777
OC139 5-12-1961
Current limits
Limites de courant
Stromgrenzen
V_{CB}=5V
I_{CBO} (μA)
1000
100
10
1
0,1
20
40
60
80
100
T_{amb}(°C)
D


7Z00781
OC140 5-12-1961
I = permissible area of operation
I = région de fonctionnement admissible
I = erlaubter Verwendungsbereich
II = additional permissible area of operation when the transistor is cut-off
II = région additionnelle de fonctionnement admissible si le transistor est bloqué
II = hinzukommender erlaubter Verwendungsbereich wenn der Transistor gesperrt ist
I
II
I_C (mA)
400
300
200
100
0
0
10
20
30
V_{CE}(V)
E

R.F. GERMANIUM TRANSISTORS

Germanium alloy-diffused transistors of the p-n-p type in TO-7 metal case. These transistors have a low collector capacitance and high transconductance at high frequencies.

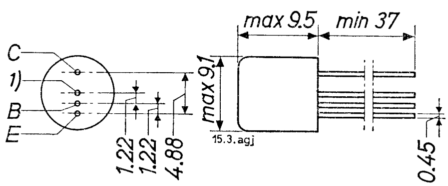
LIMITING VALUES (Absolute max. values)

Collector-base voltage	$-V_{CB}$	max.	20	V
Collector current (d.c. and average)	$-I_C$	max.	10	mA
Total dissipation up to T_{amb} = 45 °C	P_{tot}	max.	50	mW
Junction temperature: continuous	T_j	max.	75	°C
incidentally	T_j	max.	90	°C

CHARACTERISTICS

Frequency at which $\lvert h_{fe} \rvert = 1$				
$-I_C = 1$ mA; $-V_{CE} = 6$ V	f_1	typ.	70	Mc/s

MECHANICAL DATA Dimensions in mm



[1]) Shield lead connected to case

7Z2 3182

AUDIO FREQUENCY PACKAGE

The package 40809 consists of 4 transistors, namely an AC127, an AC128 and a matched pair AC127/AC128, intended for application in audio frequency d.c.-coupled amplifiers with complementary output stages with power outputs up to 1200 mW.

The matched pair AC127/AC128 (NPN/PNP, marked 3) consists of two transistors with high values of the d.c. amplification factor h_{FE}.

The AC128 (PNP, marked 2) should be used in the driver stage.

The AC127 (NPN, marked 1) is meant for use in the pre-amplifier stage.

FOR THE DATA OF THE INDIVIDUAL TRANSISTORS PLEASE REFER TO THE DATA SHEETS OF THE AC127 AND THE AC128

APPLICATIONS

On the following pages four circuits are described in detail

QUICK REFERENCE DATA

Circuit		I	II	III	IV	
Supply voltage	V_S	6	6	9	9	V
Maximum output power (d_{tot} = 10%)	$P_{o\ max}$	350	700	650	1200	mW
Required input voltage (P_o = 50 mW) [1]						
without feedback	$V_{i\ eff}$	1.8	2.1	1.0	1.2	mV
with 6 dB feedback	$V_{i\ eff}$	3.5	5.0	2.5	2.0	mV

[1]) Spread of input sensitivity < 3 dB

7Z2 2731

TYPICAL OPERATION CHARACTERISTICS (f = 1 kc/s)

Circuit		I	II	III	IV	
Supply voltage	V_S	6	6	9	9	V
Max. output power at d_{tot} = 10%	$P_{o\,max}$	350	700	650	1200	mW
Input voltage at P_o = 50 mW						
without feedback	$V_{i\,eff}$	1.8	2.1	1.0	1.2	mV
with 6 dB feedback	$V_{i\,eff}$	3.5	5.0	2.5	2.0	mV
Input voltage at P_o = max.						
without feedback	$V_{i\,eff}$	5.3	8.6	4.6	5.6	mV
with 6 dB feedback	$V_{i\,eff}$	10.7	20.7	10.4	10.2	mV
Zero signal collector currents [1] of transistors 3	$\lvert I_C \rvert$	4	5	3	5	mA
Collector current peak at $P_{o\,max}$	I_{CM}	260	500	300	470	mA
Collector current of the driver transistor 2	$-I_C$	4.6	8.3	5.4	7.7	mA
Midtap voltage at B	V	3.3	3.6	4.9	4.9	V
Typical input resistance at A						
without feedback	R_i	3.8	6.0	3.3	2.8	kΩ
with 6 dB feedback	R_i	7.3	11.5	6.4	4.3	kΩ

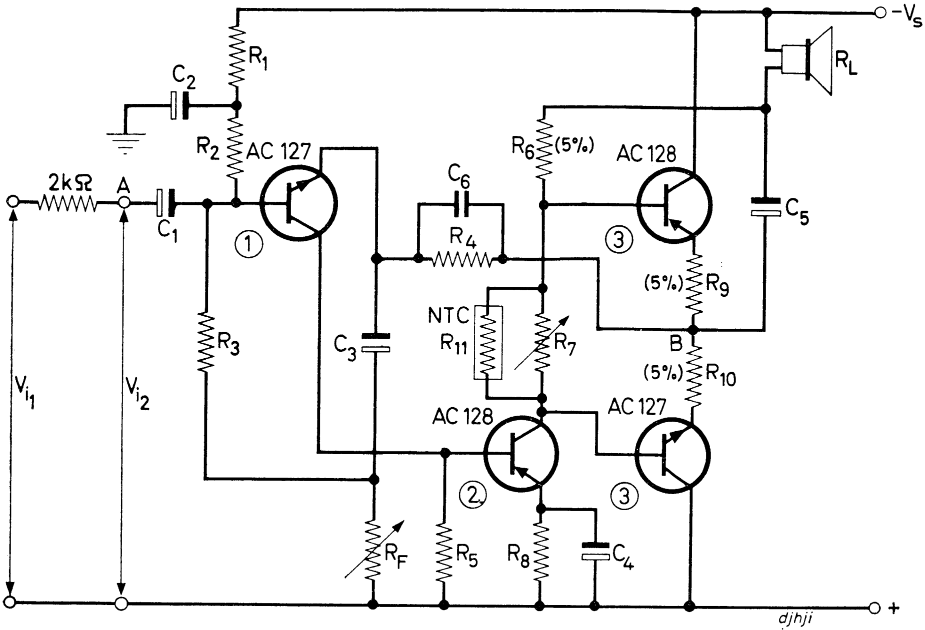
Stable continuous operation is ensured up to T_{amb} = 45 °C, provided the output transistors are mounted as indicated in the following table

	I	II	III	IV
AC127	A	C	B	C
AC128	A	A	A	B

A = without cooling fin or heatsink in free air
B = with cooling fin (code no.56227)
C = with cooling fin (code no.56227) mounted on a 1.5 mm aluminium heatsink of at least 12.5 cm²

[1]) To be adjusted with R_7

7Z2 2732

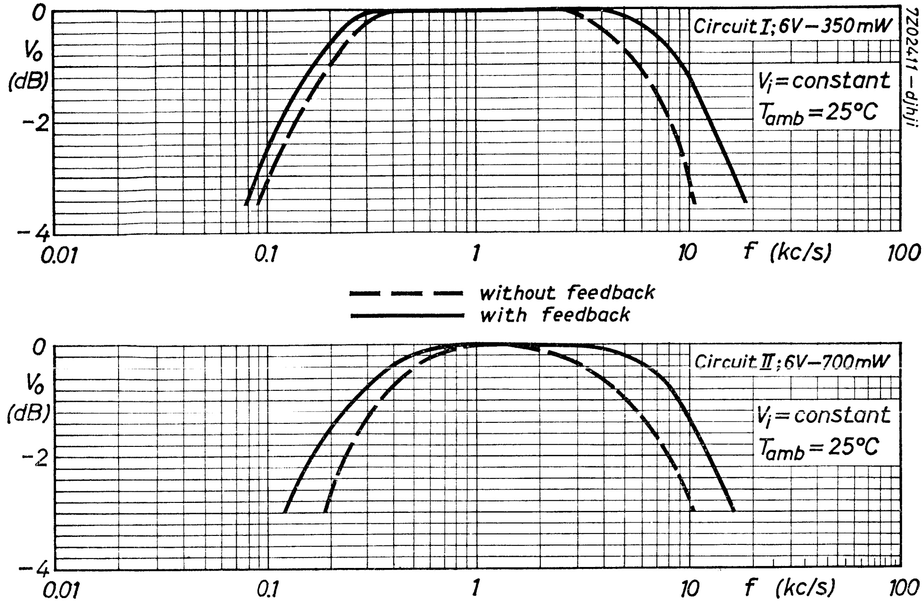


List of components

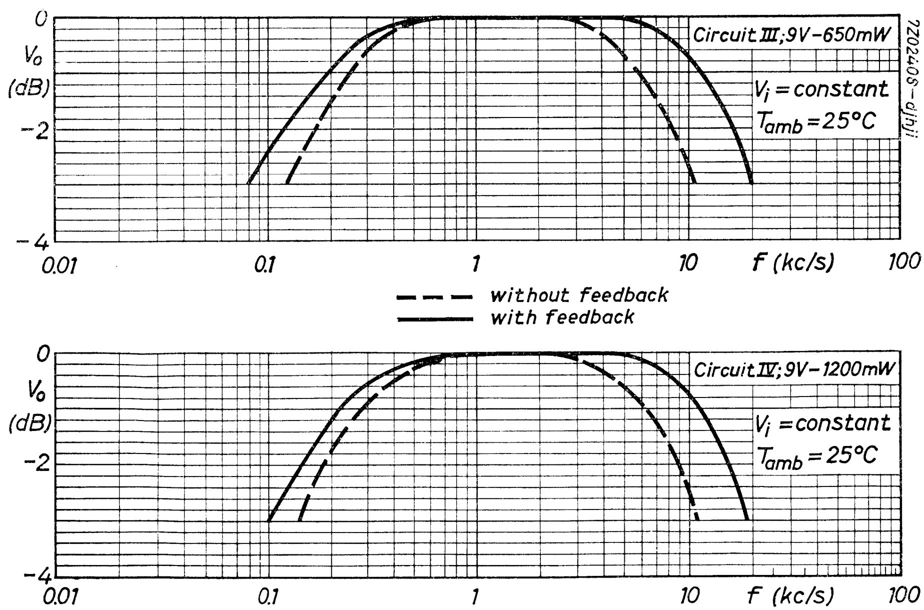
Circuit	I	II	III	IV	
R_1	1.2	2.7	6.8	2.2	kΩ
R_2	22	18	33	18	kΩ
R_3	15	15	22	15	kΩ
R_4	2.2	2.2	3.3	2.2	kΩ
R_5	1.5	2.2	1.8	1.5	kΩ
R_6 (5%)	560	270	750	510	Ω
R_7	100	75	75	100	Ω
R_8	68	75	100	39	Ω
$R_9 = R_{10}$ (5%)	1.5	0	2.4	0	Ω
R_{11} (NTC)	0	130	0	130	Ω
R_L	8	4	10	8	Ω
without feedback R_F	0	0	0	0	
with 6 dB feedback R_F	5.6	12	5.6	2.7	Ω
C_1	6.4	6.4	6.4	6.4	μF
C_2	100	100	100	100	μF
C_3	320	125	320	400	μF
C_4	200	160	125	200	μF
C_5	400	1000	320	400	μF
C_6	0	3900	0	0	pF

Tolerance of resistors: 10%, unless otherwise specified

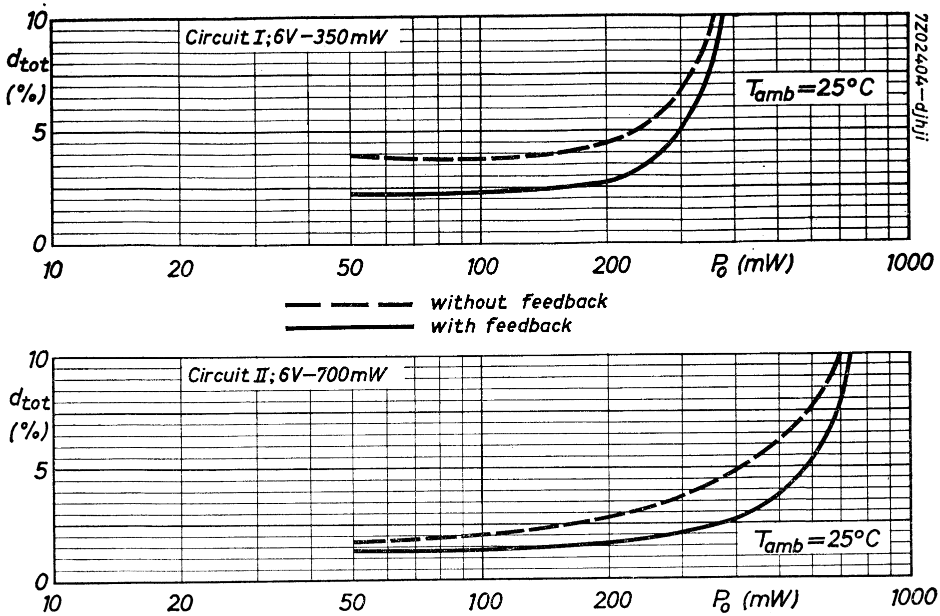
7Z2 2733

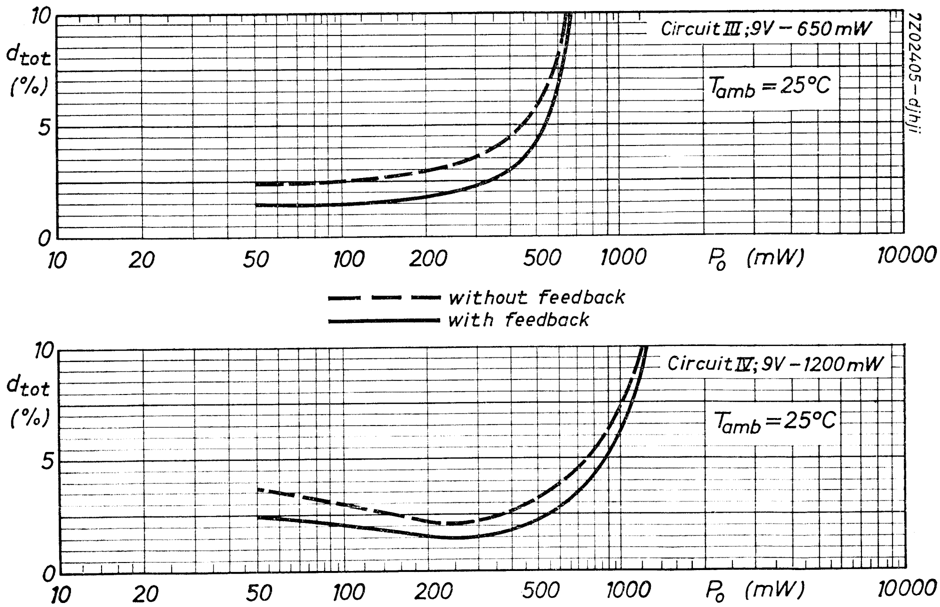


0
V_o
(dB)
-2
-4
0.01
0.1
1
10
f (kc/s)
100
Circuit I; 6V–350mW
V_i = constant
T_{amb} = 25°C
7Z02411 – djhji
without feedback
with feedback
Circuit II; 6V–700mW



0
V_o
(dB)
-2
-4
0.01
0.1
1
10
f (kc/s)
100
Circuit III; 9V–650mW
V_i = constant
T_{amb} = 25°C
7Z02408–djhji
without feedback
with feedback
Circuit IV; 9V–1200mW


Circuit I; 6V – 350mW
T_{amb} = 25°C
7Z02404 – d/hji
d_{tot} (%)
10
5
0
10
20
50
100
200
P_o (mW)
1000
without feedback
with feedback
Circuit II; 6V – 700mW
T_{amb} = 25°C
d_{tot} (%)
10
5
0
10
20
50
100
200
P_o (mW)
1000

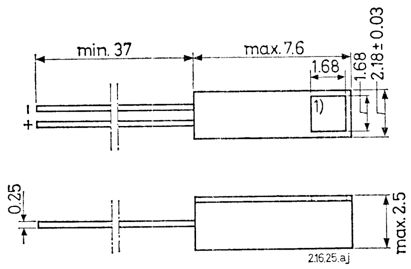

Circuit III; 9V – 650mW
T_{amb} = 25°C
7Z02405 – d/hji
d_{tot} (%)
10
5
0
10
20
50
100
200
500
1000
P_o (mW)
10000
without feedback
with feedback
Circuit IV; 9V – 1200mW
T_{amb} = 25°C
d_{tot} (%)
10
5
0
10
20
50
100
200
500
1000
P_o (mW)
10000

Photoelectric semiconductor devices

SILICON PHOTOVOLTAIC CELL

Silicon photovoltaic cell for use in tape and card readers

Dimensions in mm



1) Sensitive area

QUICK REFERENCE DATA

Sensitive area		=	2.8 mm^2
Short-circuit current at E = 2000 lux	$-I_S$	=	32 μA
Peak spectral response	λ	=	0.8 μm
Junction temperature	T_j	= max.	100 °C

LIMITING VALUES (Absolute max. values)

Forward current	I	= max.	10 mA
Reverse voltage	−V	= max.	1 V
Temperatures			
Storage temperature	T_s	=	−20 °C to 100 °C
Junction temperature	T_j	= max.	100 °C

7Z2 2549

CHARACTERISTICS T_{amb} = 25 °C

Dark reverse current at −V = 1 V	$-I_d$ = 0.35 μA		< 10 μA
Short-circuit current at E = 2000 lux, colour temperature = 2700 °K	$-I_S$ =	32 μA	> 15 μA < 50 μA

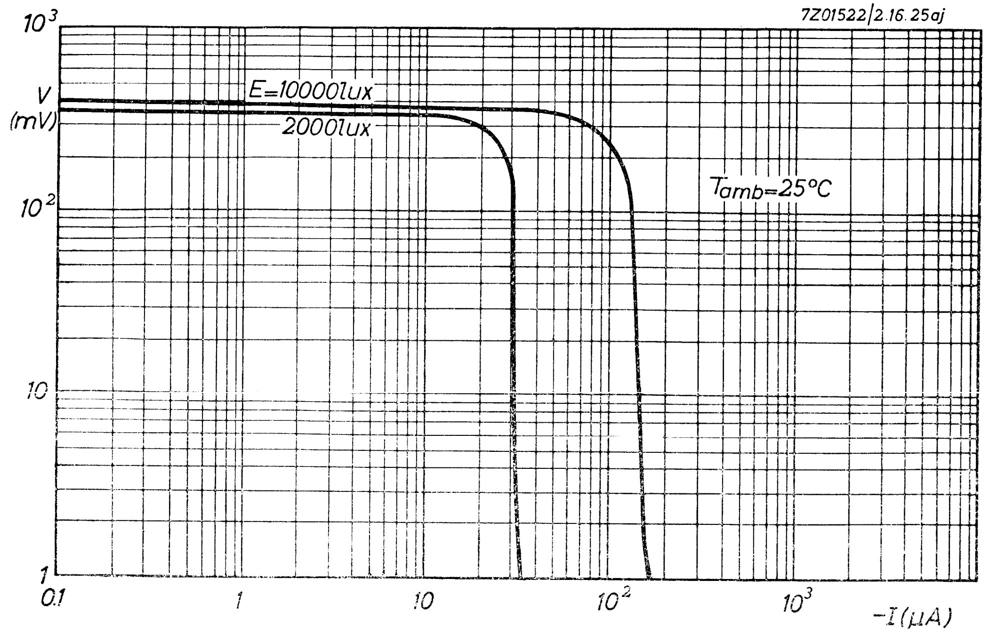
CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN

Sensitive area		=	2.8 mm^2
Peak spectral response	λ	=	0.8 μm
Short circuit current at E = 10 000 lux, colour temperature = 2700 °K	$-I_S$	=	160 μA
Dark reverse current −V = 1 V; T_{amb} = 75 °C	$-I_d$	<	30 μA
Capacitance at V = 0	c	<	1000 pF

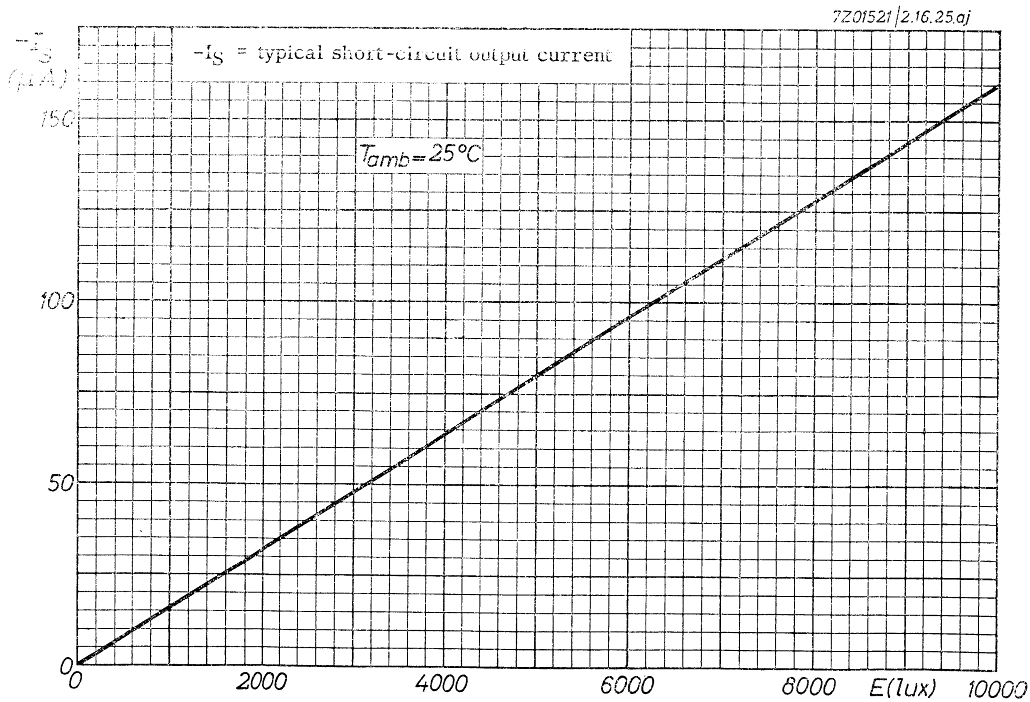
OPERATING NOTES

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

7Z2 2550

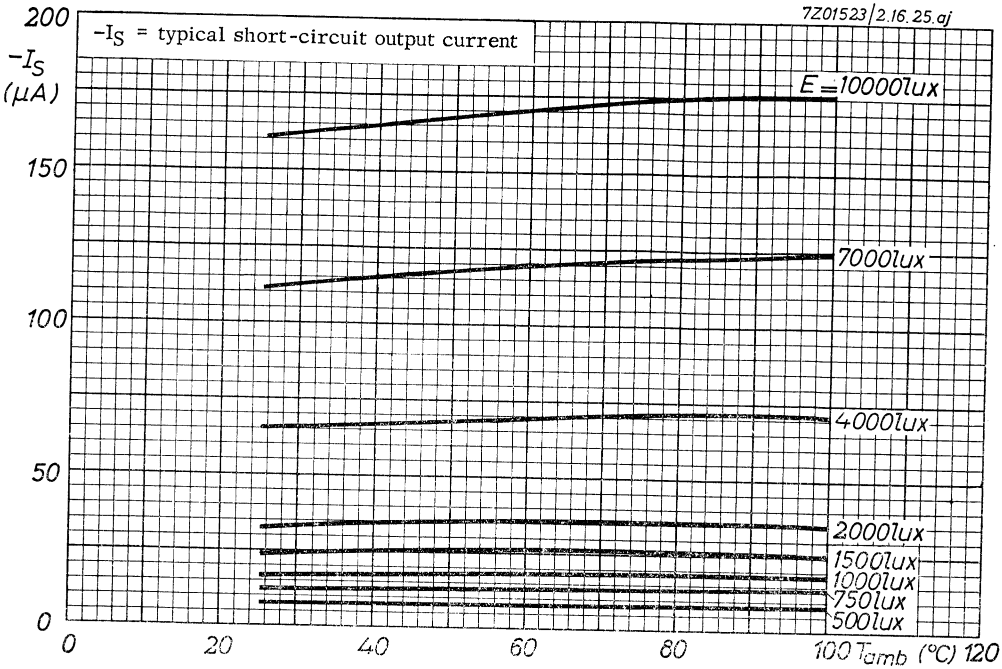

7Z01522|2.16.25aj
10^3
V
(mV)
E=10000lux
2000lux
T_{amb}=25°C
10^2
10
1
0.1
1
10
10^2
10^3
−I(μA)

A

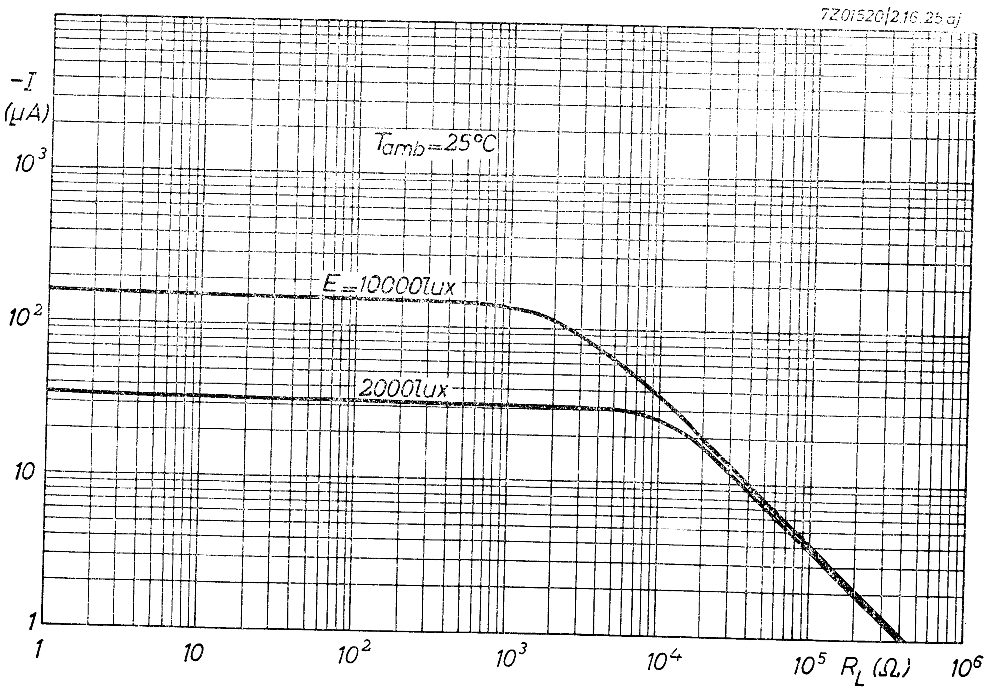

7Z01521|2.16.25aj
$-I_S$ = typical short-circuit output current
$-I_S$
(μA)
150
T_{amb}=25°C
100
50
0
0
2000
4000
6000
8000
E(lux)
10000

B

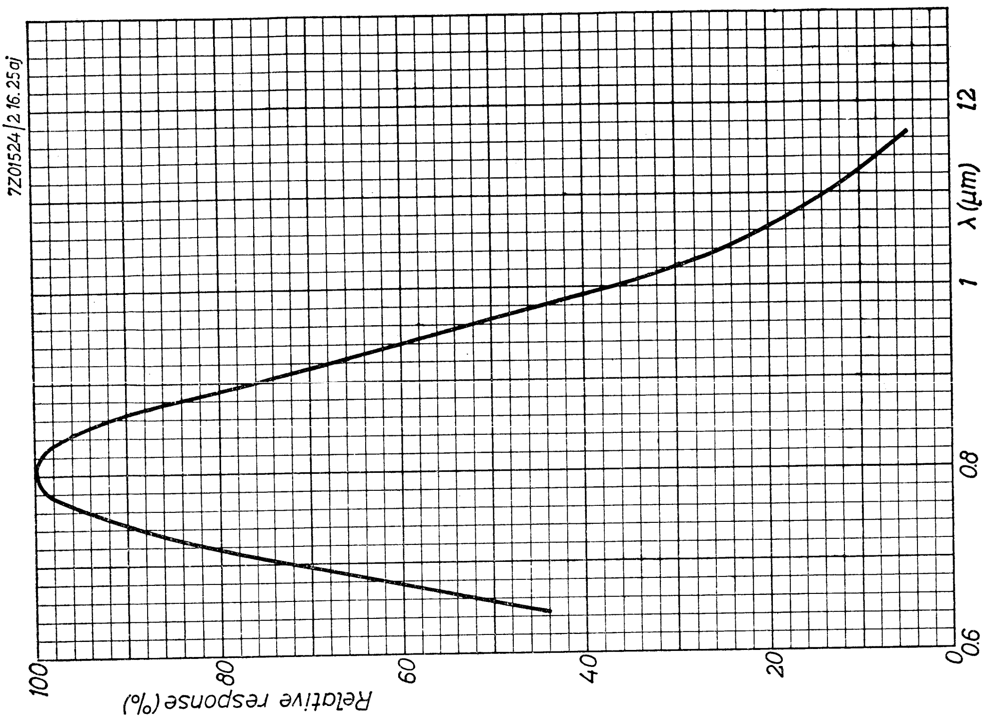
6.6.1964


7Z01523/2.16.25.aj
−IS = typical short-circuit output current
−IS
(μA)
200
150
100
50
0
E = 10000lux
7000lux
4000lux
2000lux
1500lux
1000lux
750lux
500lux
0
20
40
60
80
100
Tamb (°C)
120

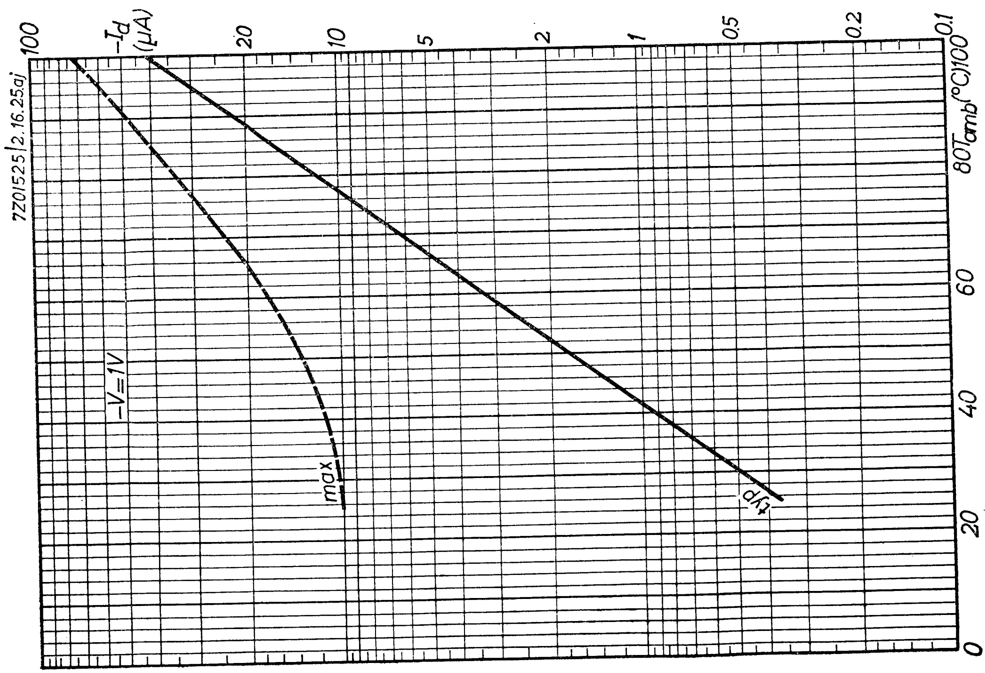
C


7Z01520/2.16.25.aj
−I
(μA)
Tamb = 25°C
E = 10000lux
2000lux
1
10
10²
10³
10⁴
10⁵
10⁶
RL (Ω)

D


7Z01524/2.16.25aj
λ (μm)
0.6
0.8
1
1.2
Relative response (%)
0
20
40
60
80
100

F


7Z01525/2.16.25aj
$-I_d$ (μA)
100
20
10
5
2
1
0.5
0.2
0.1
T_{amb} (°C)
0
20
40
60
80
100
−V=1V
max
typ

E

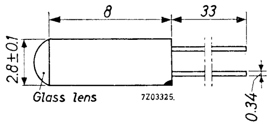
6.6.1964

General purpose GERMANIUM PHOTODIODE, sealed in a metal case
PHOTODIODE AU GERMANIUM, conçue pour usages généraux, enfermée dans un cylindre de métal
GERMANIUM-PHOTODIODE in Metallgehäuse für allgemeine Verwendungszwecke

The symbols used in these data are those normally used for semi-conductors. See List of Symbols for Semi-Conductors
Les symboles utilisés pour les données suivantes sont ceux utilisés normalement pour les semi-conducteurs. Voir la Liste de Symboles pour Semi-Conducteurs
Die für diese Daten verwendeten Symbole sind die für die Halbleiter üblichen. Siehe die Symbolenliste für Halbleiter

Dimensions in mm
Dimensions en mm
Abmessungen in mm

The green dot indicates the position of the anode (negative pole of the battery)
Le point vert marque la position de l'anode (pôle négatif de la batterie)
Der grüne Punkt indiziert die Anodenseite (negativer Pol der Batterie)



Average photosensitive area Surface sensible à la lumière moyenne Lichtempfindliche Fläche		1	mm^2

Characteristics
Caractéristiques $T_{amb} = 25\ ^oC$
Kenndaten

Illumination Éclairement Beleuchtungsstärke	=	100	lux
Colour temperature Température de couleur Farbtemperatur	=	2500	^oK
$-I_D$	>	5	µA
$-V_D$	=	0,5-30	V
Internal impedance Impédance interne Innenwiderstand		3	MΩ

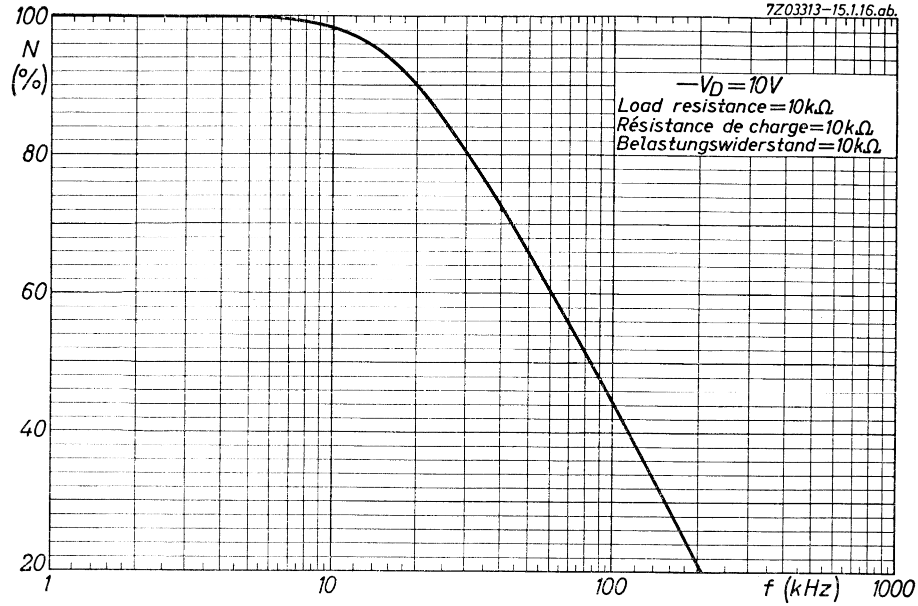
Characteristics (continued)
Caractéristiques (suite)
Kenndaten (Fortsetzung)

$-V_D$	=	10	V
Dark current Courant d'obscurité Dunkelstrom	<	15	µA
$-V_D$	=	10	V
f	=	1	kc/s
B	=	1	c/s
Noise of the dark current Bruit du courant d'obscurité Rauschen des Dunkelstroms	<	3×10^{-12}	A
$-V_D$	=	10	V
Cut-off frequency Fréquence de coupure [1]) Grenzfrequenz	=	50	kc/s
Max. spectral response Réponse spectrale maximum à Max. spektrale Empfindlichkeit bei	λ =	1,55	µ
Zero spectral response at Seuil de réponse à Grenze der Empfindlichkeit bei	λ =	2,0	µ

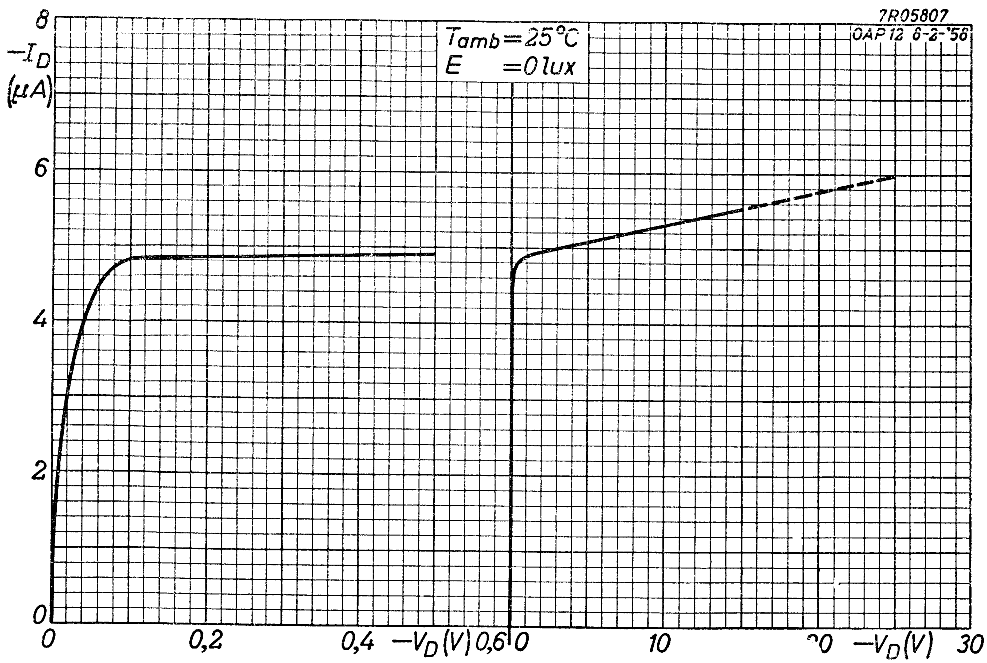
Limiting values (Absolute max. values)
Caractéristiques limites (Valeurs max. absolues)
Grenzdaten (Absolute Maximalwerte)

$-V_D$	= max.	30	V
$-I_D$	= max.	3	mA
W_D	= max.	30	mW

1) Frequency at which the sensitivity is half the sensitivity at 1 kc/s
Fréquence à laquelle la sensibilité est la moitié de la sensibilité à 1 kHz
Frequenz bei der die Empfindlichkeit die Hälfte der Empfindlichkeit bei 1 kHz ist

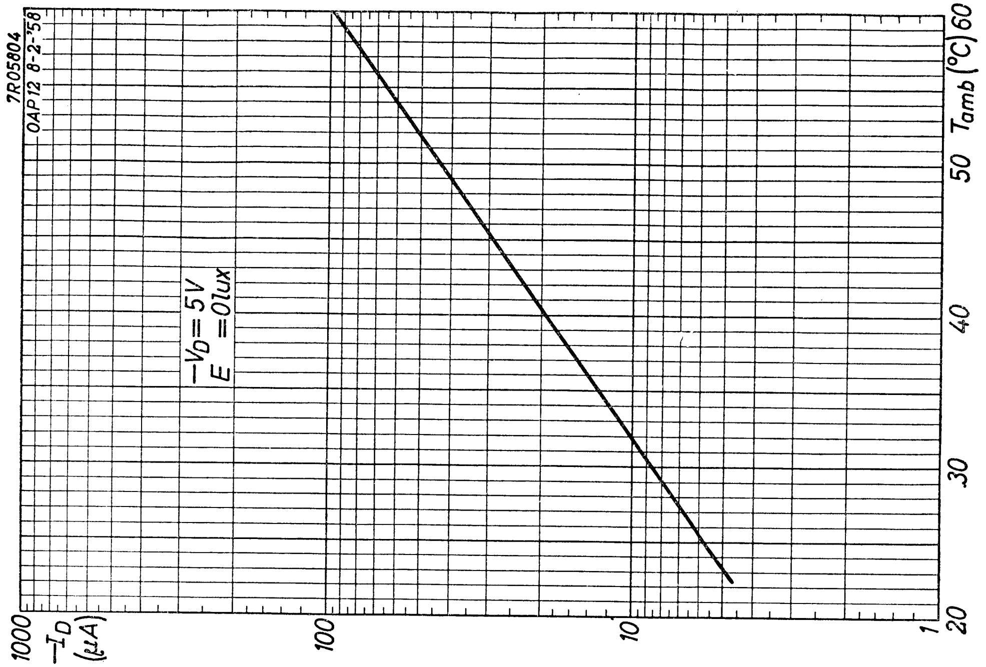

7Z03313-15.1.16.ab.
N (%)
100
80
60
40
20
1
10
100
1000
f (kHz)
$-V_D = 10V$
Load resistance = 10kΩ
Résistance de charge = 10kΩ
Belastungswiderstand = 10kΩ

A

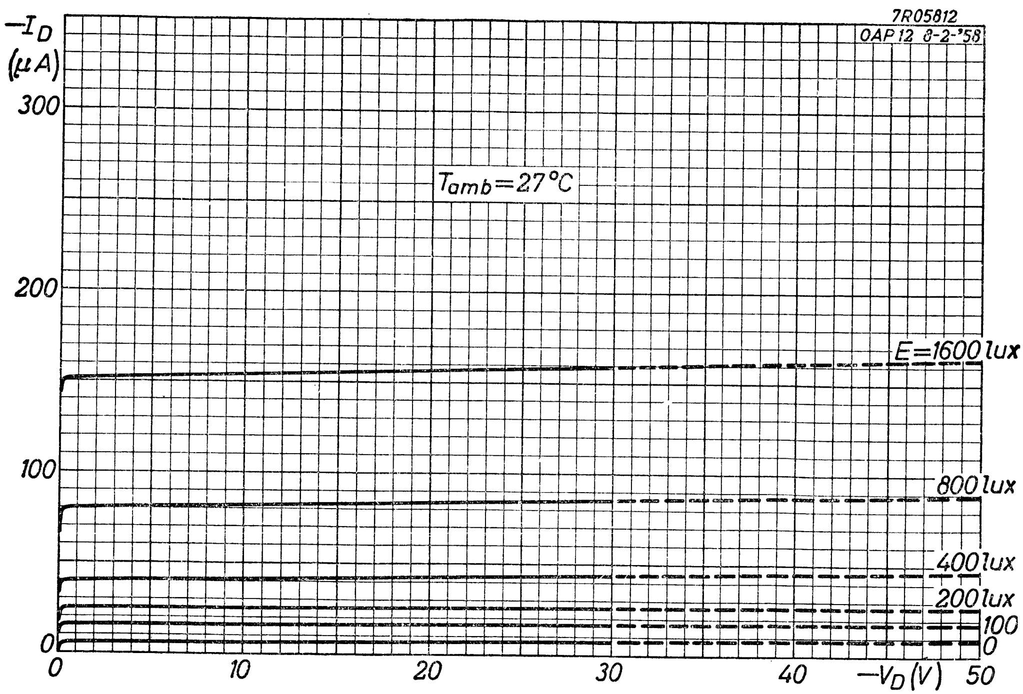

7R05807
OAP 12 8-2-'58
$-I_D$ (μA)
8
6
4
2
0
0,2
0,4
0,6
10
30
$-V_D$ (V)
$T_{amb} = 25°C$
E = 0 lux

B

3.3.1965

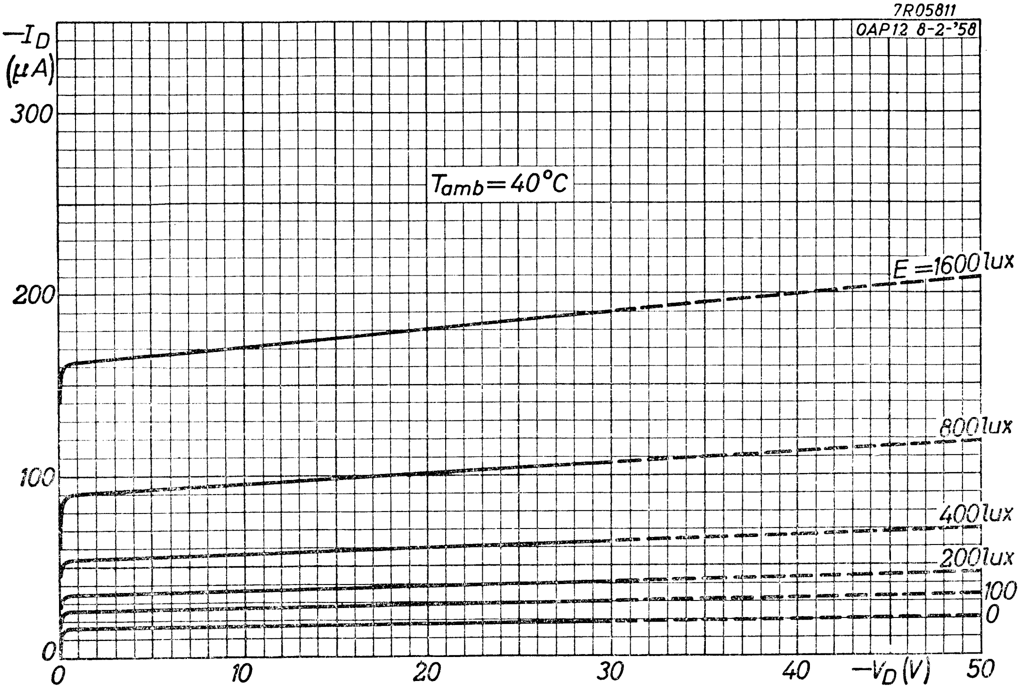

7R05804
OAP 12 8-2-'58
$-V_D = 5V$
$E = 0 lux$
$-I_D$ (μA)
1000
100
10
1
T_{amb} (°C)
20
30
40
50
60

C

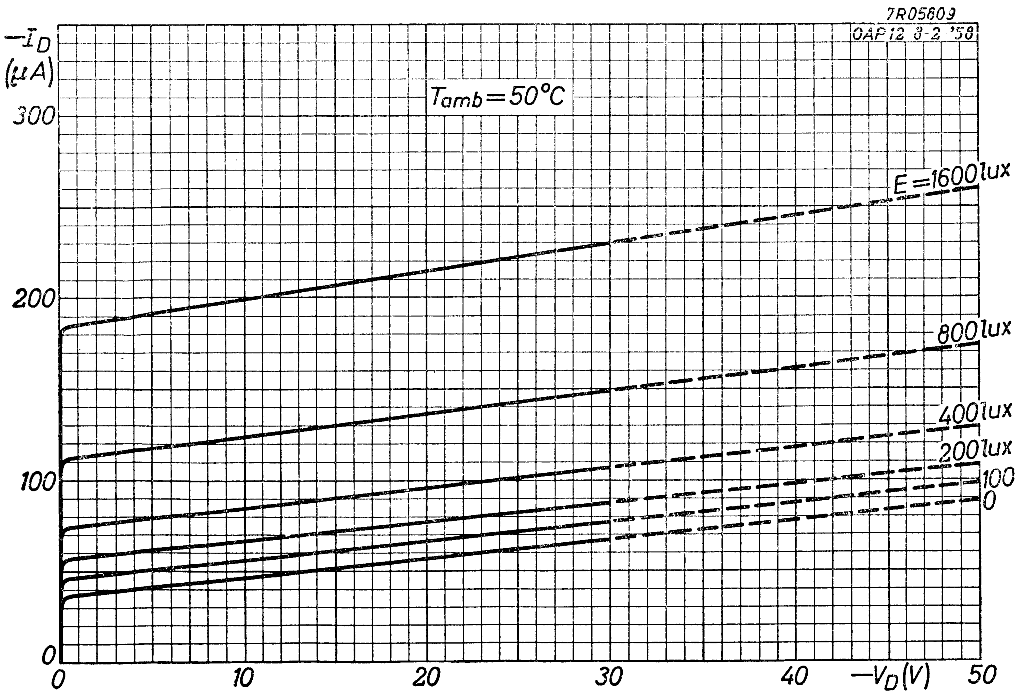

7R05812
OAP 12 8-2-'58
$-I_D$ (μA)
300
200
100
0
$T_{amb} = 27°C$
E=1600 lux
800 lux
400 lux
200 lux
100
0
0
10
20
30
40
50
$-V_D$ (V)

D

6.6.1958

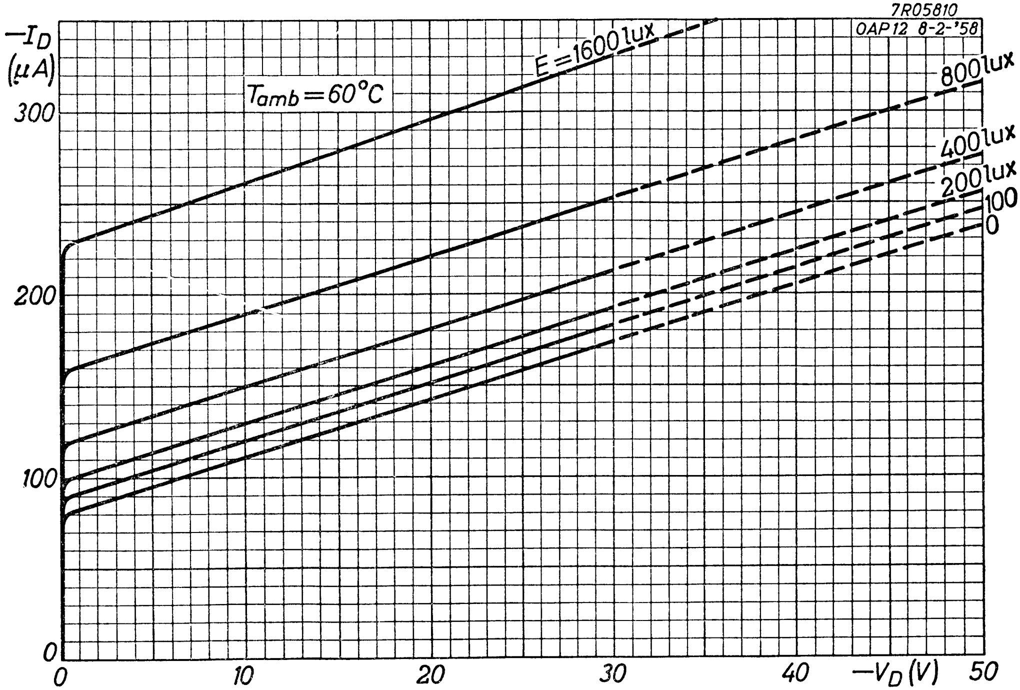

7R05811
OAP12 8-2-'58
$-I_D$ (μA)
300
200
100
0
$T_{amb}=40°C$
E =1600 lux
800 lux
400 lux
200 lux
100
0
0
10
20
30
40
$-V_D$(V)
50

E

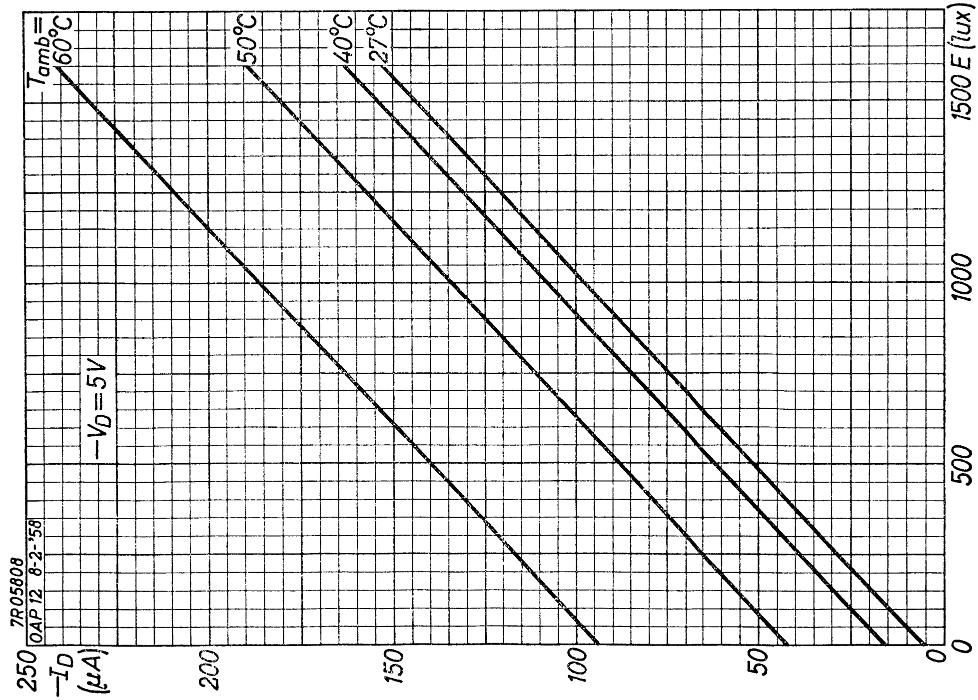

7R05809
OAP12 8-2-'58
$-I_D$ (μA)
300
200
100
0
$T_{amb}=50°C$
E =1600 lux
800 lux
400 lux
200 lux
100
0
0
10
20
30
40
$-V_D$(V)
50

F

6.6.1958

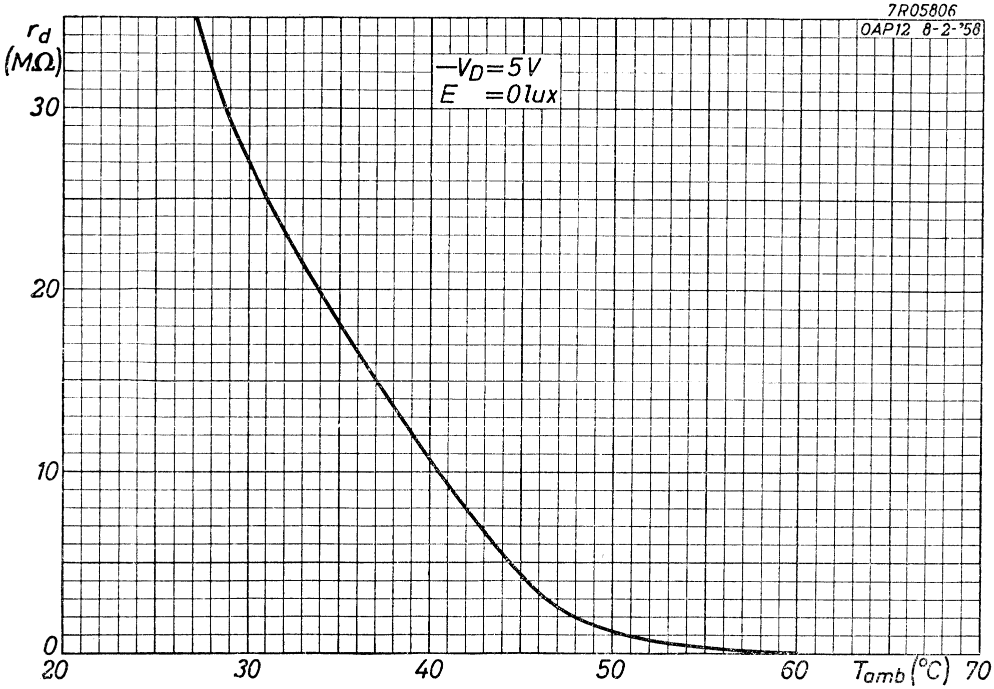

7R05810
OAP12 8-2-'58
$-I_D$ (μA)
300
200
100
0
$T_{amb}=60°C$
E=1600 lux
800 lux
400 lux
200 lux
100
0
10
20
30
40
50
$-V_D$ (V)

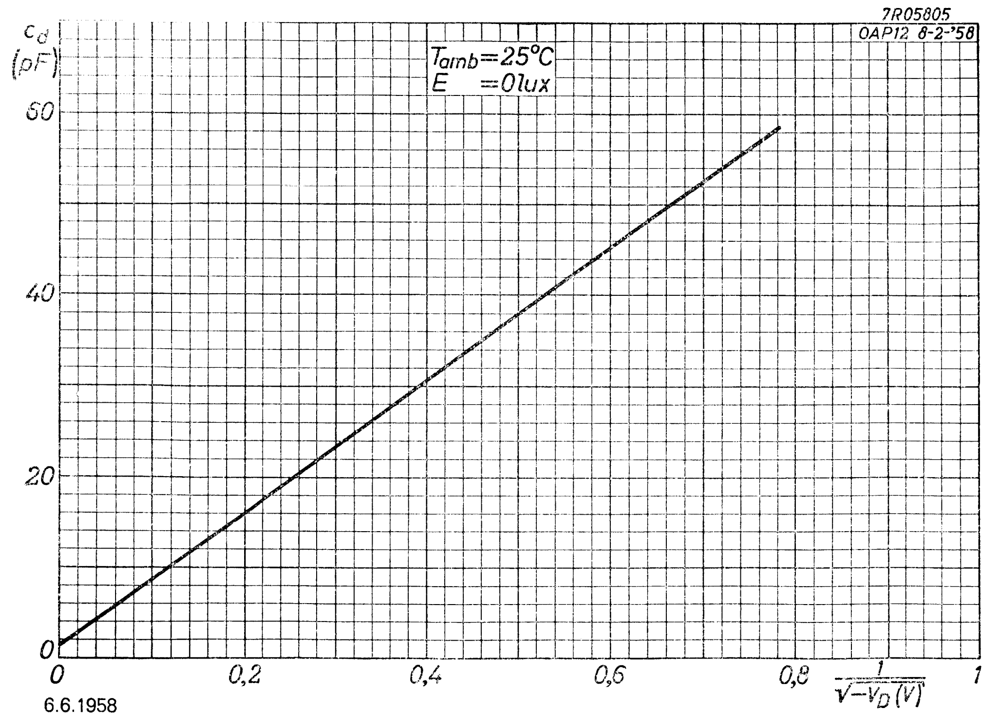
G


T_{amb}=
60°C
50°C
40°C
27°C
$-V_D=5V$
7R05808
OAP12 8-2-'58
250
$-I_D$ (μA)
200
150
100
50
0
0
500
1000
1500 E (lux)

H

6.6.1958


7R05806
OAP12 8-2-'58
r_d
(MΩ)
$-V_D = 5V$
E = 0lux
30
20
10
0
20
30
40
50
60
T_{amb} (°C)
70


7R05805
OAP12 8-2-'58
c_d
(pF)
$T_{amb} = 25°C$
E = 0lux
60
40
20
0
0
0,2
0,4
0,6
0,8
$\frac{1}{\sqrt{-V_D}(V)}$
1

GERMANIUM PHOTO-TRANSISTOR

Germanium photo-transistor of the p-n-p alloy type, intended for general purposes

LIMITING VALUES (Absolute max. values) at T_{amb} = 45 °C

Collector

Voltage (base reference)

Average	$-V_{CB}$	= max.	15 V
Peak	$-V_{CBM}$	= max.	15 V

Voltage (emitter reference)

Average	$-V_{CE}$	See page H
Peak	$-V_{CEM}$	See page H

Current

Average	$-I_C$	= max.	20 mA
Peak	$-I_{CM}$	= max.	20 mA

Dissipation P_C = max. $\frac{65 - T_{amb}}{0.4}$ mW

See also page G

Temperatures

Junction	T_j	= max.	65 °C
Storage	T_s	= max.	65 °C

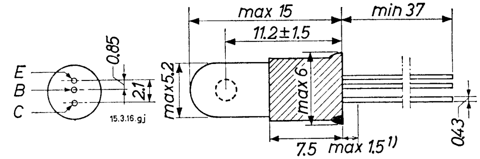
THERMAL DATA

Thermal resistance from junction to ambience in free air K = max. 0.4 °C/mW

7Z2 2364

MECHANICAL DATA (Dimensions in mm)

The red dot indicates the collector



The preferred direction of incident light is perpendicular to the plane of the leads, and is on the side of the bulb bearing the type number

CHARACTERISTICS at T_{amb} = 25 °C

Dark current at

$-V_{CE}$ = 4.5 V; I_B = 0 μA — $-I_{CEO}$ < 325 μA

Cut-off frequency for modulated light — $f_{max.}$ = 3 kc/s

Collector current at

$-V_{CE}$ = 2 V with uniform illumination of 75 ft. candle (807 lux) with preferred direction of incident light, colour temperature of the light source 2700 °K — $-I_C$ > 750 μA

Sensitivity

with sensitive area of 7 mm^2 — N > 130 mA/lumen

Spectral response

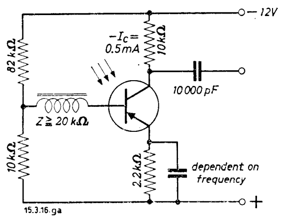
Peak at	λ	=	1.43 μm
Cut-off at	λ	=	1.9 μm

[1]) Not tinned

7Z2 2365

OPERATING CHARACTERISTICS

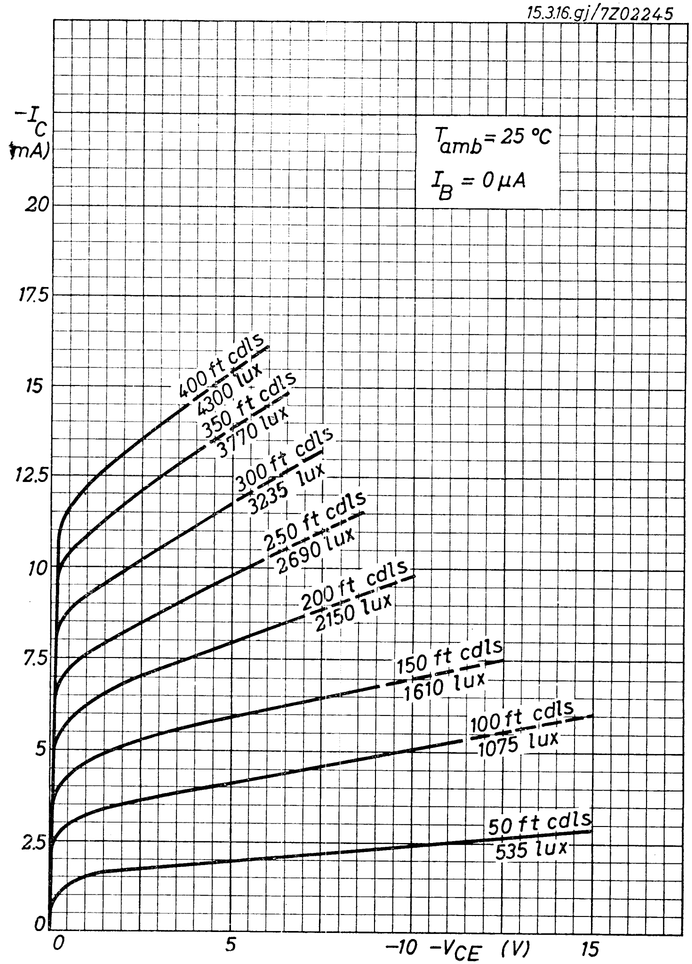
Circuit diagram



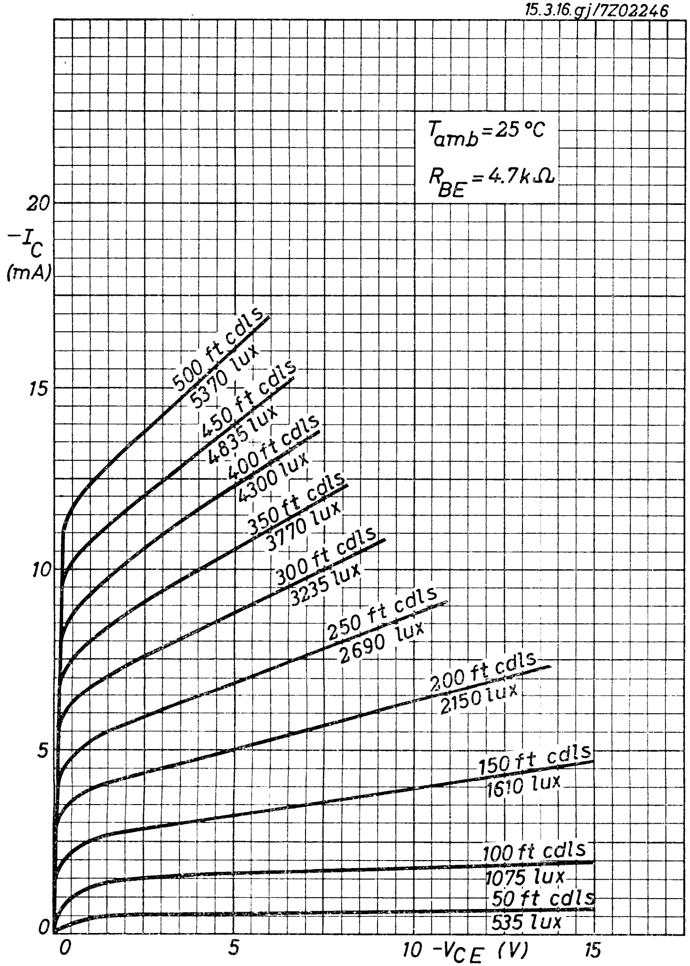
Note

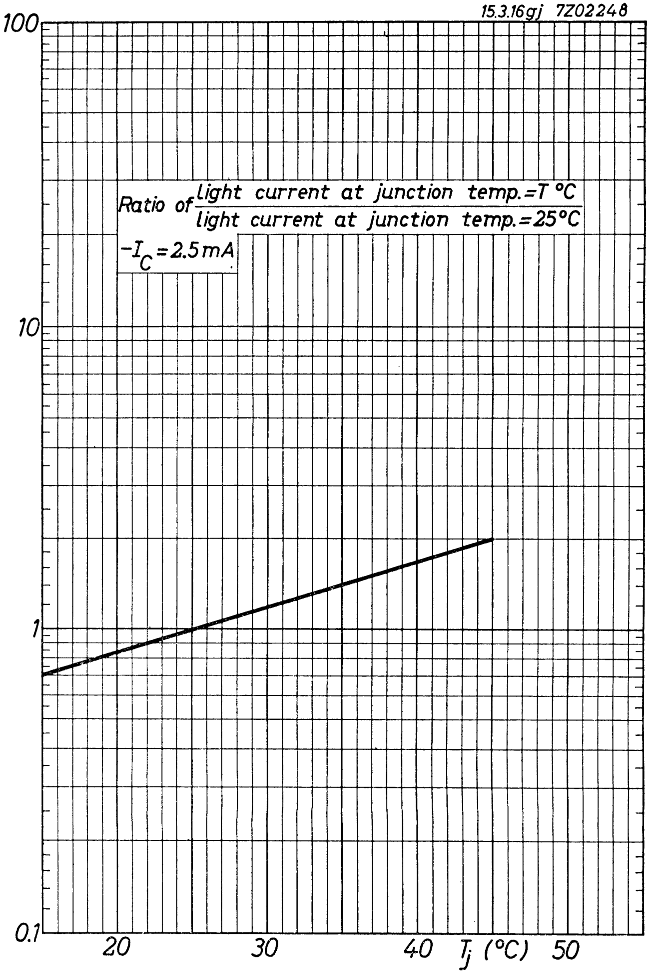
Photo-transistors are inherently sensitive to temperature variations, which result in variations of the output current which cannot be distinguished from the light signal. This is particularly so with an open circuit base connection, when thermal runaway is most likely to occur; for operation at elevated voltage and temperature the use of an external base emitter resistance is essential.

The function of this is to improve the light to dark current ratio by causing a much greater proportional decrease in dark current. It is recommended that for this purpose an N.T.C. type resistor is used, the value required depending on the maximum ambient temperature and light level.



7Z2 2366


15.3.16.gj/7Z02246
T_{amb} = 25 °C
R_{BE} = 4.7 kΩ
$-I_C$ (mA)
$-V_{CE}$ (V)
500 ft cdls 5370 lux
450 ft cdls 4835 lux
400 ft cdls 4300 lux
350 ft cdls 3770 lux
300 ft cdls 3235 lux
250 ft cdls 2690 lux
200 ft cdls 2150 lux
150 ft cdls 1610 lux
100 ft cdls 1075 lux
50 ft cdls 535 lux

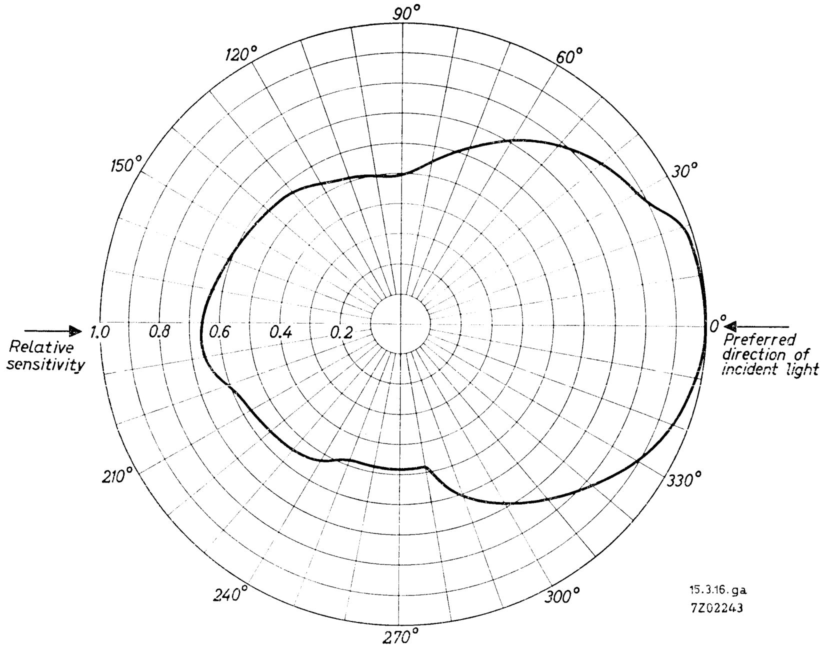

15.3.16gj 7Z02248
Ratio of $\frac{\text{light current at junction temp.} = T\ °C}{\text{light current at junction temp.} = 25\ °C}$
$-I_C$ = 2.5 mA
T_j (°C)

2.2.1964

B

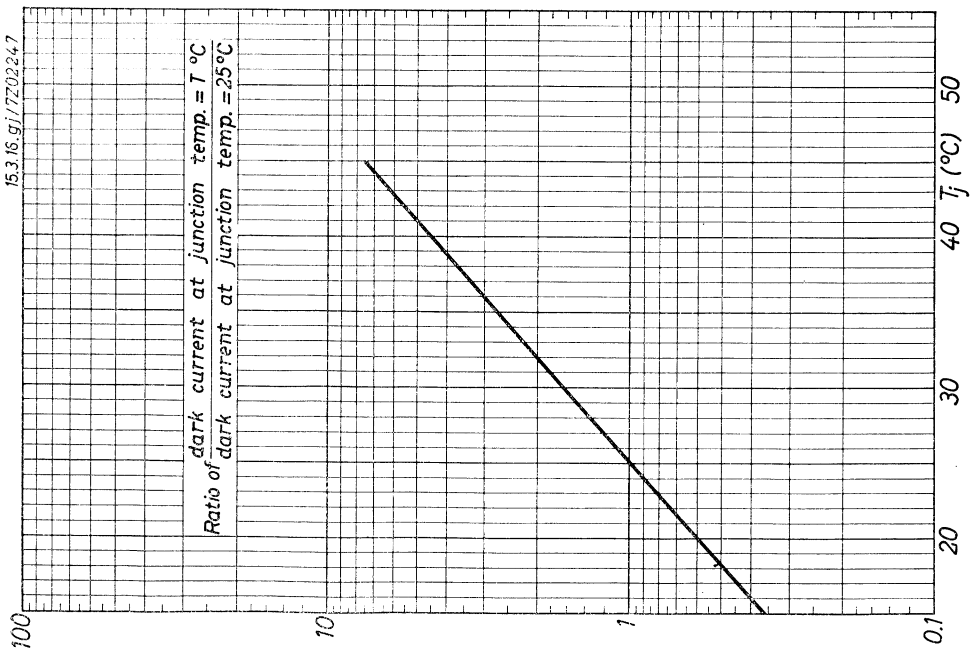
C

E

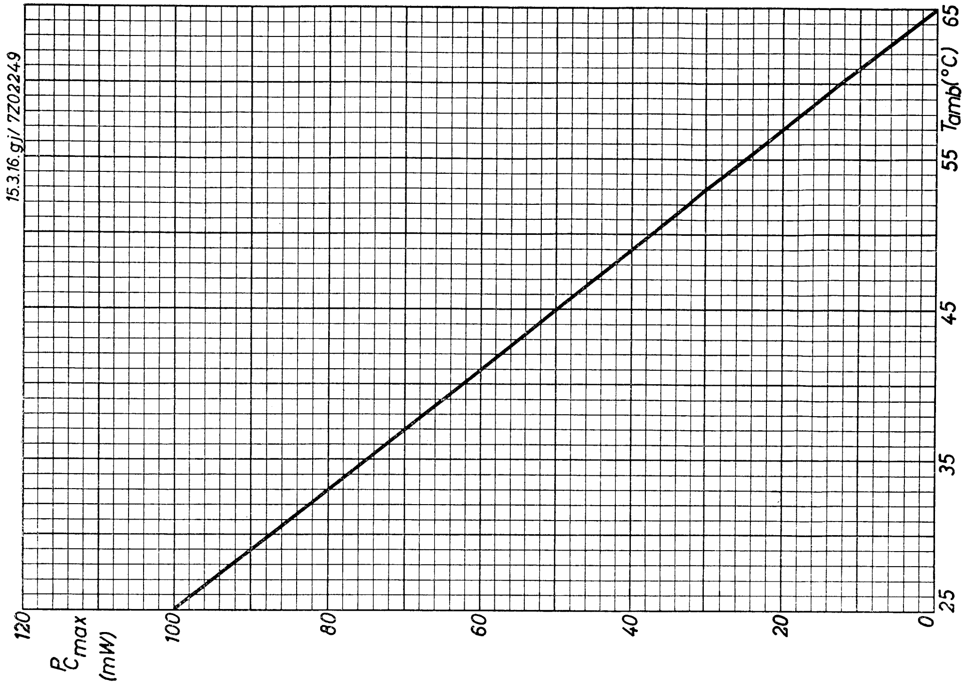


90°
120°
60°
150°
30°
1.0
0.8
0.6
0.4
0.2
Relative sensitivity
0°
Preferred direction of incident light
210°
330°
240°
300°
270°
15.3.16.ga
7Z02243

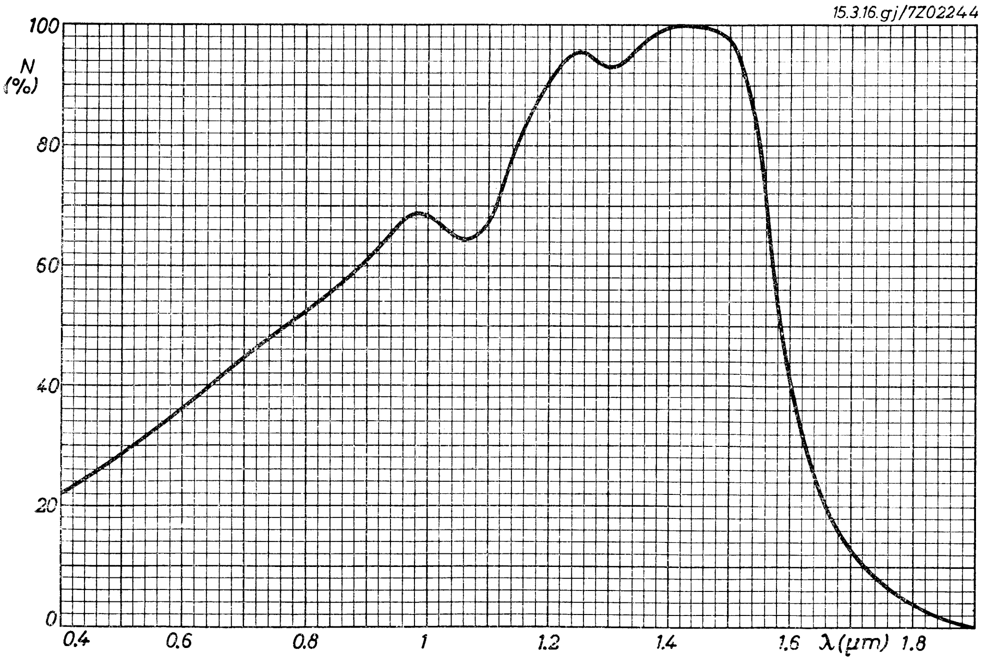
D



15.3.16.gj/7Z02247
Ratio of dark current at junction temp. = T °C / dark current at junction temp. = 25°C
T_j (°C)
20
30
40
50
100
10
1
0.1

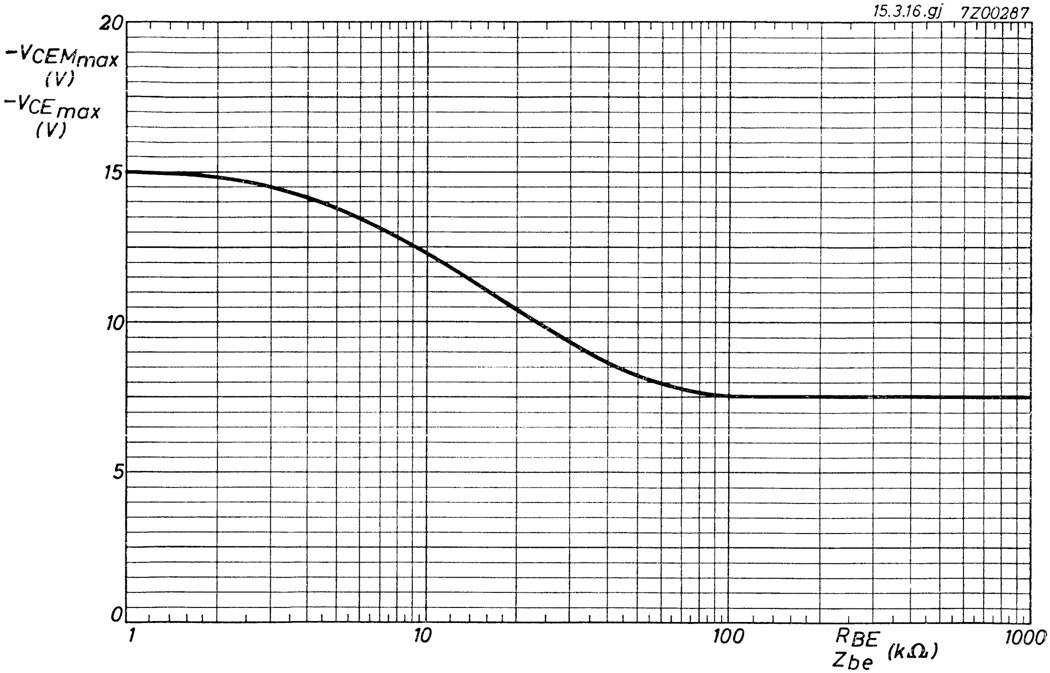

15.3.16.gj/7Z02249
120
100
80
60
40
20
0
$P_{C\,max}$ (mW)
25
35
45
55
65
T_{amb}(°C)

G


15.3.16.gj/7Z02244
N (%)
100
80
60
40
20
0
0.4
0.6
0.8
1
1.2
1.4
1.6
λ(μm)
1.8

F

2.2.1964


15.3.16.gj 7Z00287
20
$-V_{CEMmax}$
(V)
$-V_{CEmax}$
(V)
15
10
5
0
1
10
100
1000
R_{BE}
Z_{be} (kΩ)

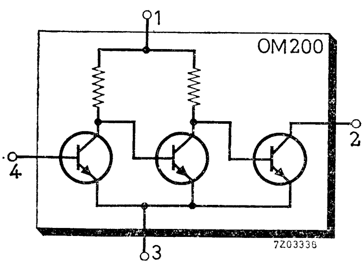
Integrated circuits

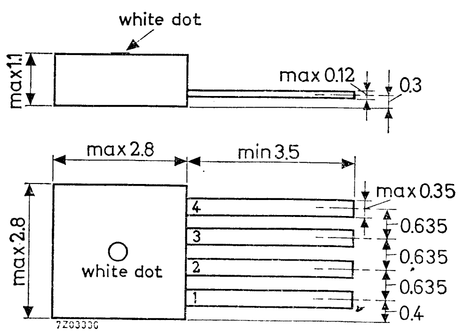
INTEGRATED CIRCUIT
AMPLIFIER FOR IN THE EAR HEARING AID

Monolithic semiconductor integrated-circuit amplifier in a plastic envelope, primarily intended for in the ear hearing aids.

QUICK REFERENCE DATA				
For meaning of symbols: see page 3 fig.1.				
Supply voltage	V_{1-3}	max.	5	V
Output current	I_2	max.	5	mA
In a practical circuit as given at page 3 fig.1:				
Total supply current	I_{tot}	typ.	1	mA
Transducer gain	Φ_{tr}	>	75	dB
		typ.	80	dB
Power output at d_{tot} = 10 %	P_o	>	0.2	mW
Frequency cut-off (−3 dB)	f_c	>	20	kc/s
Total device dissipation	P_{tot}	max.	25	mW

MECHANICAL DATA Dimensions in mm





The sealing of the plastic envelope withstands the accelerated damp heat test of IEC recommendation 68 (test D, severity IV, 6 cycles).

7Z2 3173

RATINGS (Limiting values) [1]
(for meaning of symbols see page 3, fig.1)

Voltages				
Supply voltage	V_{1-3}	max.	5	V
Output voltage	V_{2-3}	max.	5	V [2]
Input voltage	$-V_{4-3}$	max.	5	V
Currents				
Output current	I_2	max.	5	mA
Input current	I_4	max.	5	mA
Dissipation				
Total device dissipation (See page A)	P_{tot}	max.	25	mW
Temperatures				
Storage temperature	T_{stg}	−20 to +80		°C
Ambient temperature	T_{amb}	max.	80	°C

CHARACTERISTIC RANGE VALUES FOR EQUIPMENT DESIGN
at V_{1-3} = 1.3 V and T_{amb} = 25 °C unless otherwise specified
I_2 see fig.1

Supply current (no signal)	I_{tot}	<	1.2	mA
	I_1	typ.	0.34	mA
Transducer gain [3] at f = 1 kc/s	Φ_{tr}	>	75	dB
		typ.	80	dB
V_{1-3} = 1.3 V; T_{amb} = −10 °C	Φ_{tr}	typ.	78	dB
V_{1-3} = 1.1 V; T_{amb} = 25 °C	Φ_{tr}	typ.	76	dB

---

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

[2] This value may be exceeded during inductive switch-off for transient energies < 10 μWs.

[3] The transducer gain is defined as the ratio of the output power in the load of Z = 1.5 kΩ and the available input power of the source with R_S = 5 kΩ

$$\Phi_{tr} = \frac{P_o}{V_i^2/4R_S}$$

7Z2 3174

CHARACTERISTIC RANGE VALUES FOR EQUIPMENT DESIGN (continued)
at V_{1-3} = 1.3 V and T_{amb} = 25 °C unless otherwise specified
I_2 see figure 1

Total distortion at f = 1 kc/s				
P_o = 100 μW	d_{tot}	typ.	4	%
		<	6	%
P_o = 200 μW	d_{tot}	<	10	%
Noise figure at R_S = 5 kΩ				
bandwidth = 400 to 3200 c/s	F	<	6	dB
Frequency cut-off (−3 dB)	f_c	>	20	kc/s
Value of R_F to adjust I_2 at 0.7 mA	R_F	>	50	kΩ
		typ.	300	kΩ
		<	700	kΩ

I_2 = 0.7 mA,
adjusted by means of R_F.
V_{1-3} = 1.3 V; T_{amb} = 25 °C.

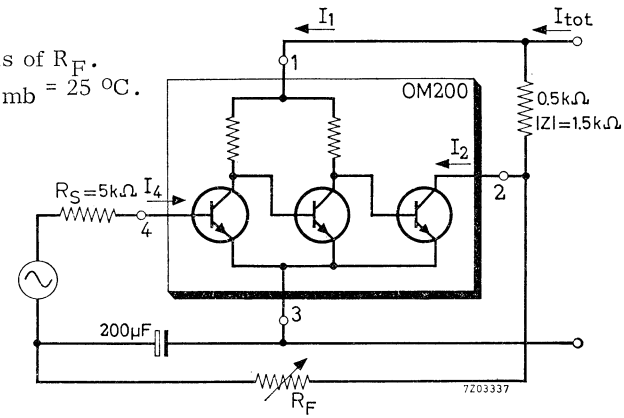


Fig.1

SOLDERING RECOMMENDATION

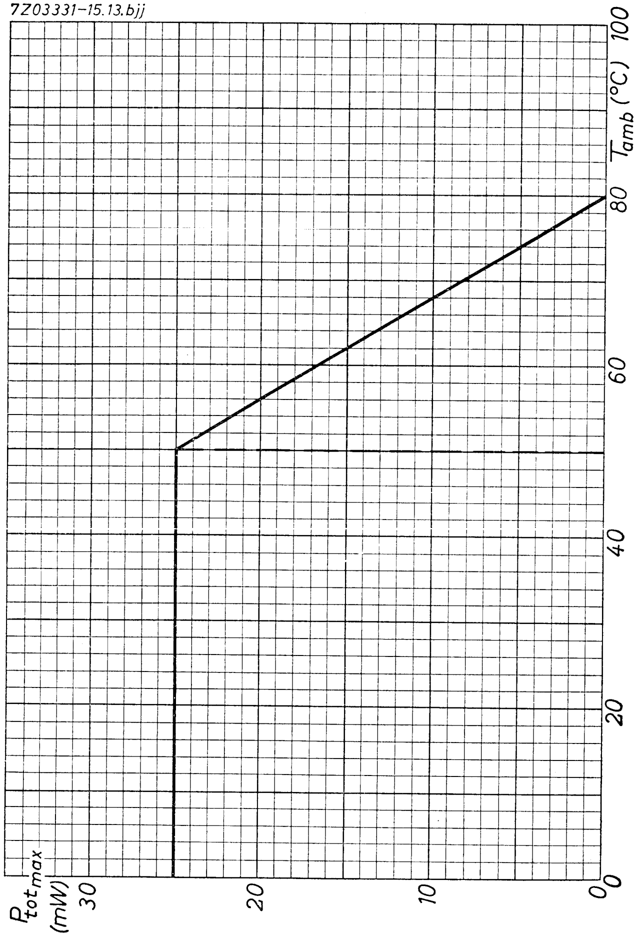
A: Iron soldering

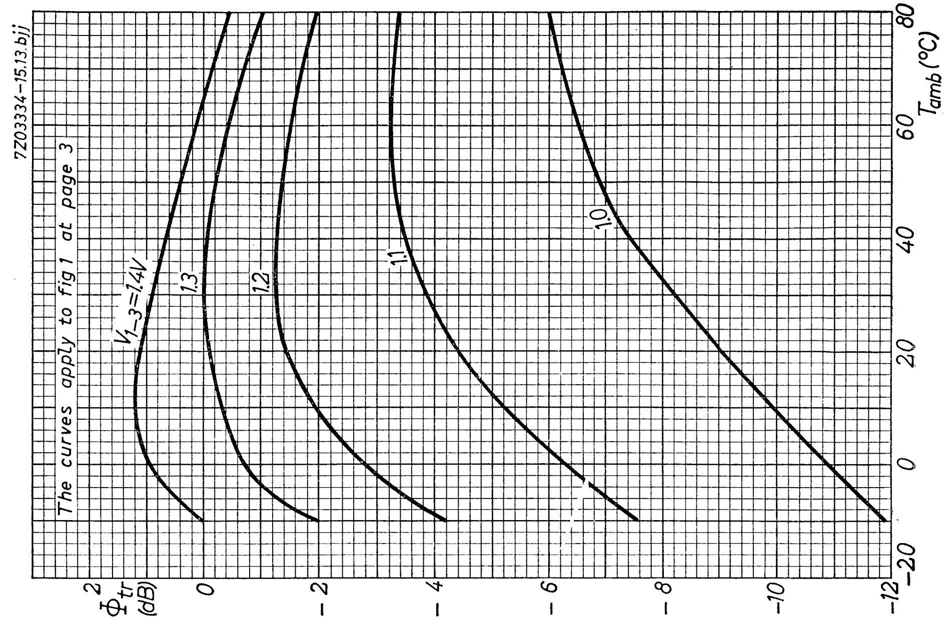
At a maximum iron temperature of 300 °C the maximum permissible soldering time is 3 seconds, provided the soldering spot is at least 0.5 mm from the seal and the leads are not soldered at the same time. Soldering in immediate subsequence is allowed.

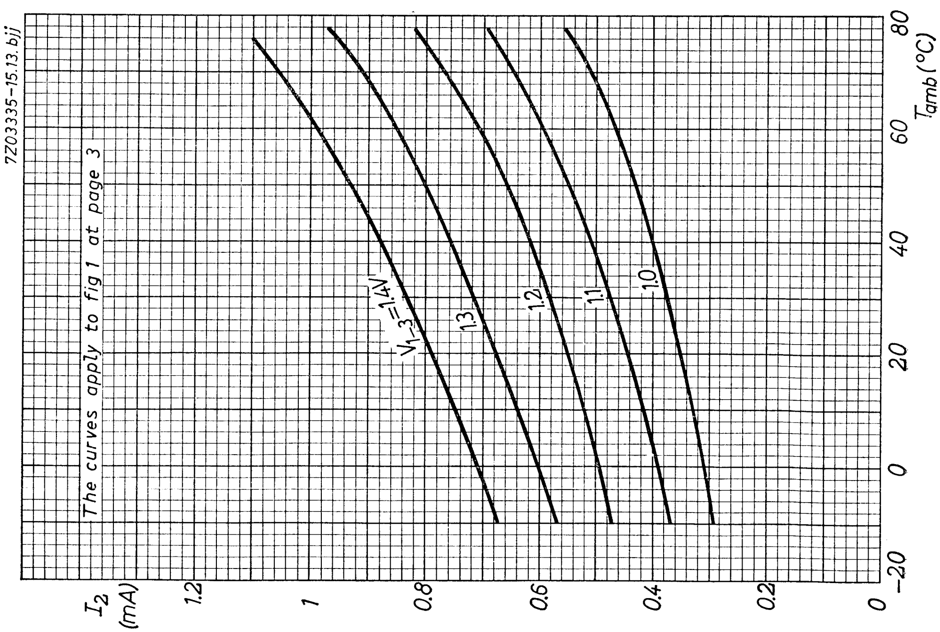
B: Dip soldering

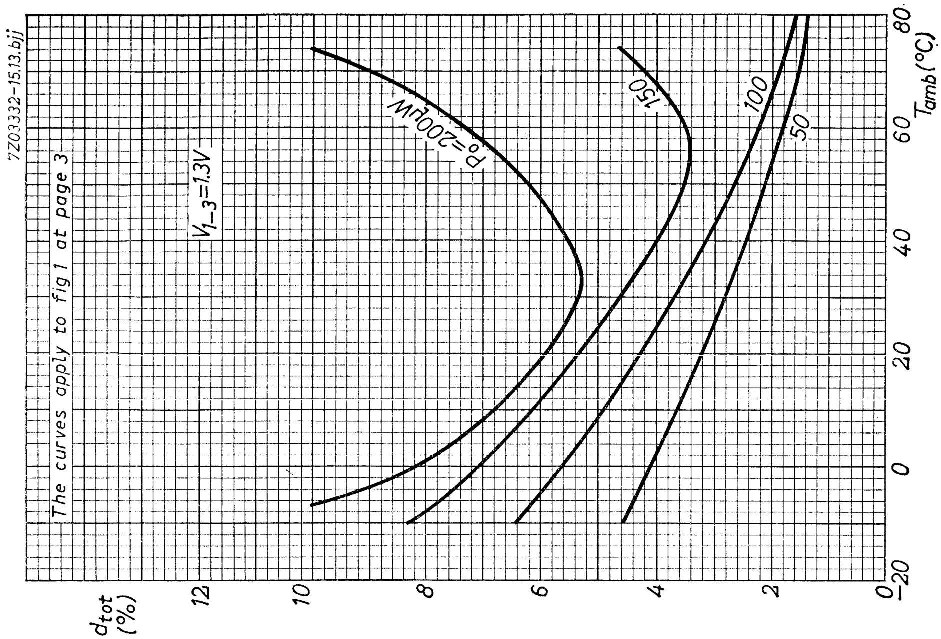
At a maximum solder temperature of 250 °C the maximum permissible soldering time is 3 seconds, provided the soldering spot is at least 0.5 mm from the seal.

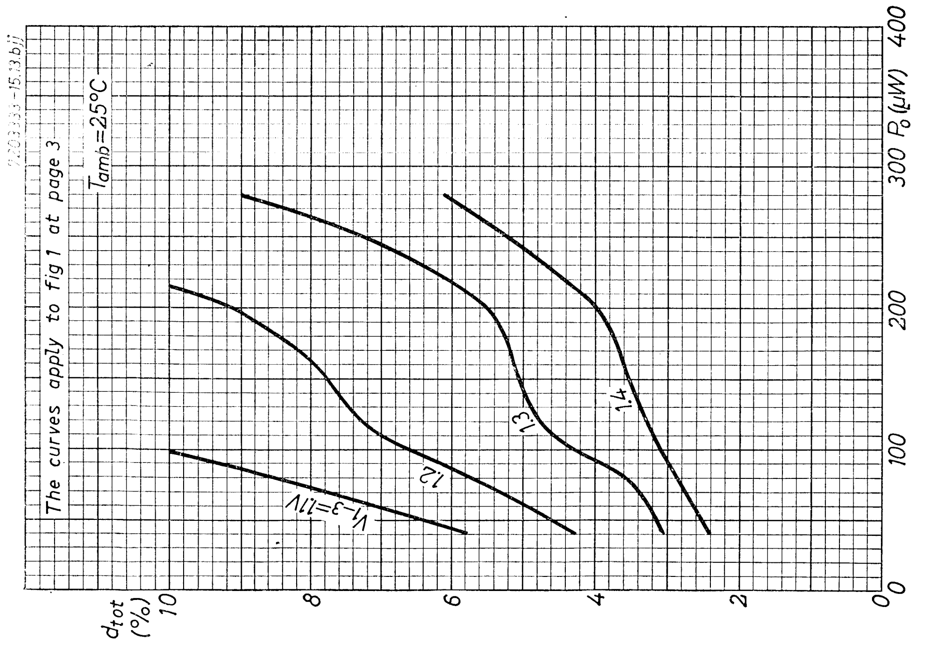
7Z2 3175


7Z03331-15.13.bjj
T_{amb} (°C)
100
80
60
40
20
0
$P_{tot\,max}$ (mW)
30
20
10
0


7Z03334-15.13.bjj
The curves apply to fig 1 at page 3
Φ_{tr} (dB)
2
0
−2
−4
−6
−8
−10
−12
V_{1-3}=1.4V
1.3
1.2
1.1
1.0
−20
0
20
40
60
80
T_{amb} (°C)


7Z03335-15.13.bjj
The curves apply to fig 1 at page 3
I_2 (mA)
1.2
1
0.8
0.6
0.4
0.2
0
V_{1-3}=1.4V
1.3
1.2
1.1
1.0
−20
0
20
40
60
80
T_{amb} (°C)


7Z03332-15.13.bjj
The curves apply to fig 1 at page 3
V_{1-3}=1.3V
P_o=200μW
150
100
50
d_{tot} (%)
12
10
8
6
4
2
0
−20
0
20
40
60
80
T_{amb} (°C)


7Z03333-15.13.bjj
The curves apply to fig 1 at page 3
T_{amb}=25°C
V_{1-3}=1.1V
1.2
1.3
1.4
d_{tot} (%)
10
8
6
4
2
0
0
100
200
300
400
P_o (μW)

Accessories

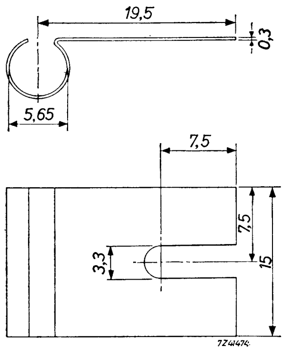
Mounting accessories

General heatsink considerations

Heatsinks

COOLING FIN

Dimensions in mm

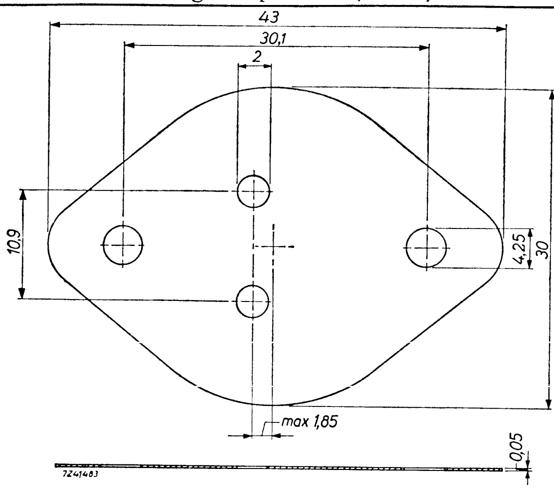


Fin material: brass, nickel plated

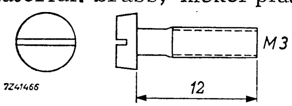
7Z2 3316

Type 56201 consists of the following components (1 to 7) Dimensions in mm

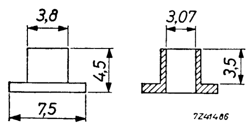
1.
1 mica washer



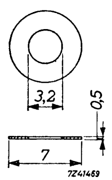
2.
2 cheese head screws, slotted
Material: brass, nickel plated



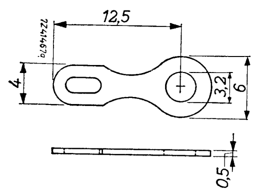
3.
2 Philite insulating bushes



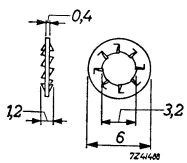
4.
3 plain washers
Material: brass, nickel plated



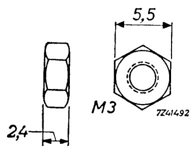
5.
1 solder tag



6.
2 serrated lock washers,
internal teeth
Material: steel, nickel plated



7.
hexagon nuts
Material: brass, nickel plated



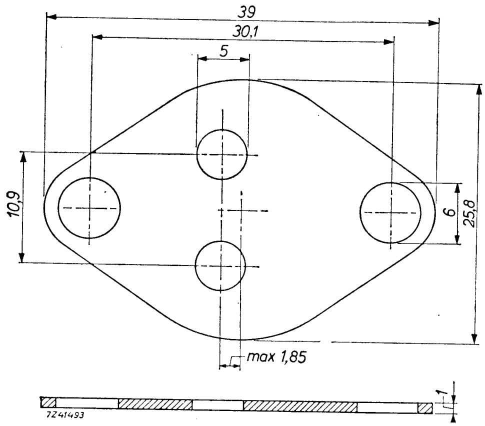
7Z2 3317

5.5.1965

Type 56201a consists of items 1 and 3 only (see 56201)

Type 56201b is a lead washer

Dimensions in mm



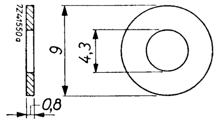
Type 56201c consists of item 3 only (see 56201)

Type 56201d consists of item 1 only (see 56201)

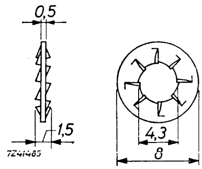
7Z2 3318

Type 56202 consists of the following components (1 to 3) — Dimensions in mm

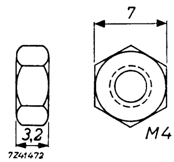
1.
1 plain washer
Material: brass, nickel plated



2.
1 serrated lock washer, internal teeth
Material: steel, nickel plated

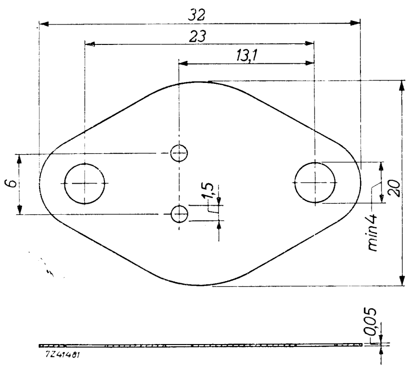


3.
1 hexagon nut
Material: brass, nickel plated

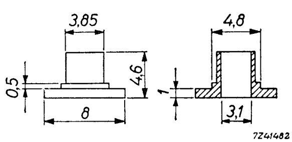


Type 56203 consists of the following components (1 to 2) — Dimensions in mm

1.
1 mica washer

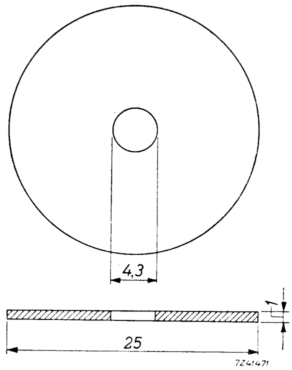


2.
2 Philite insulating bushes



Type 56204 is an aluminium cooling plate

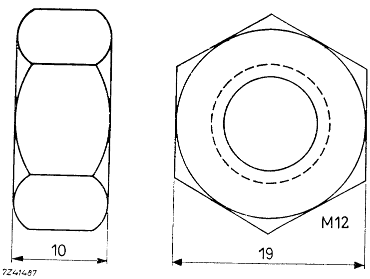
Dimensions in mm



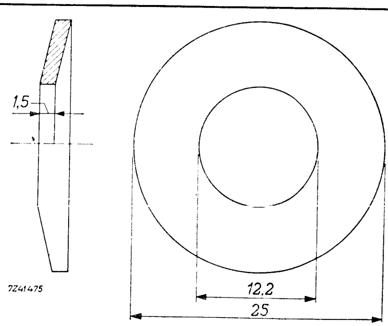
Type 56206 consists of the following components (1 to 2)

Dimensions in mm

1.
1 hexagon nut
Material: brass, nickel plated



2.
1 dish spring
Material: steel, nickel plated

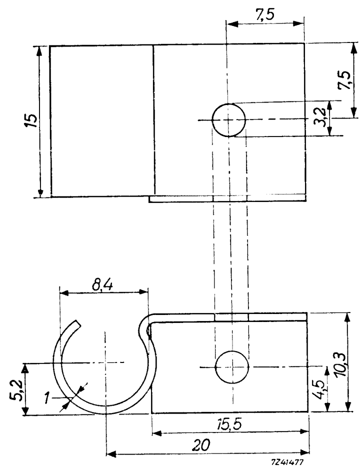


7Z2 3320

COOLING FINS

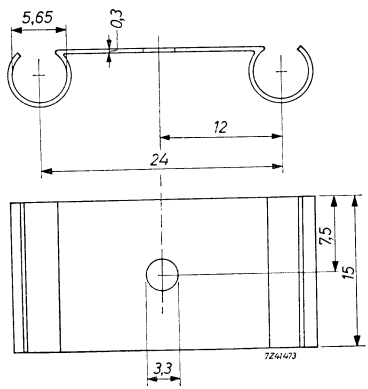
Dimensions in mm

56207



Material: aluminium, blackened

56208

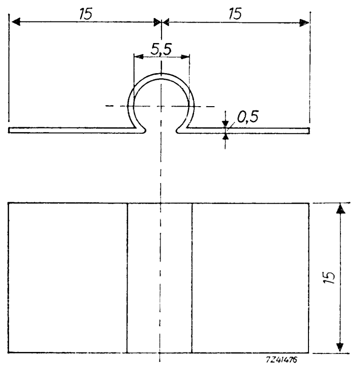


Material: brass, nickel plated

COOLING FINS

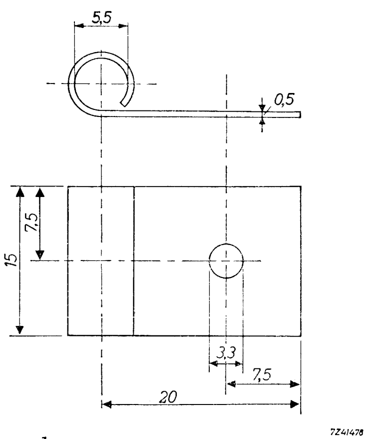
56209

Dimensions in mm



Material: brass, nickel plated

56210

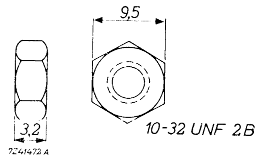


Material: brass, nickel plated

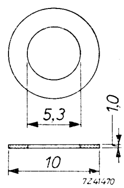
7Z2 3322

Type 56212 consists of the following components (1 to 3) Dimensions in mm

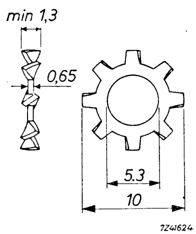
1.
1 hexagon nut
Material: brass, nickel plated



2.
1 plain washer
Material: brass, nickel plated

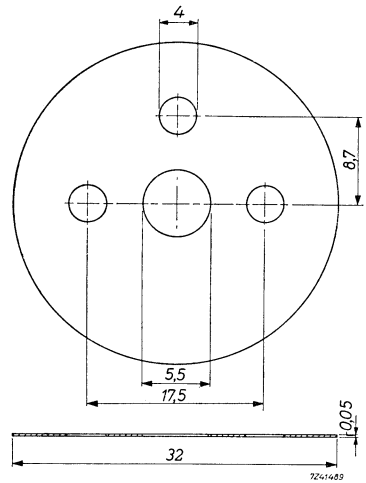


3.
1 lock washer, external teeth
Material: steel, nickel plated

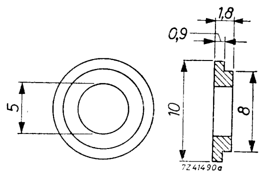


Type 56213 consists of the following components (1 to 5)   Dimensions in mm

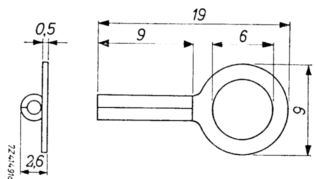
1\.
1 mica washer



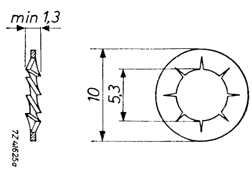
2\.
2 Philite insulating rings



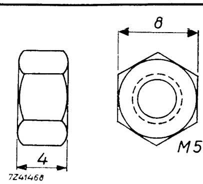
3\.
1 cable lug
Material: brass, nickel plated



4\.
1 lock washer, internal teeth
Material: steel, nickel plated



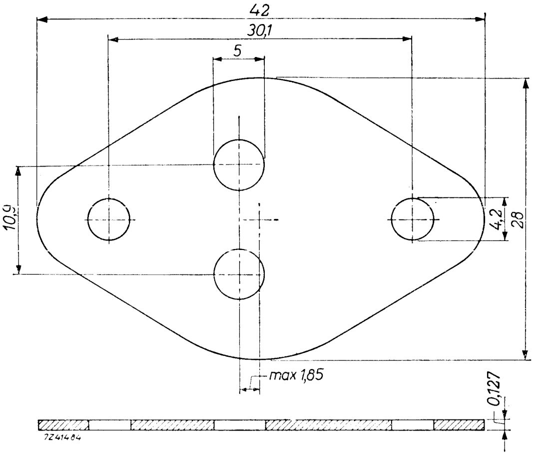
5\.
1 hexagon nut
Material: brass, nickel plated



7Z2 3324

Type 56214 is a lead washer

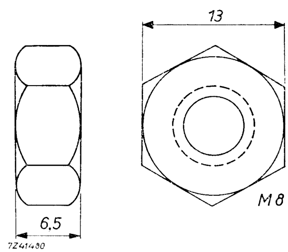
Dimensions in mm



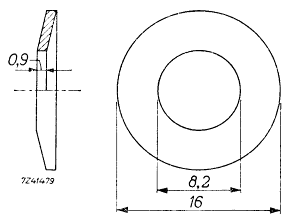
Type 56215 consists of the following components (1 to 2)

Dimensions in mm

1.
1 hexagon nut
Material: brass, nickel plated

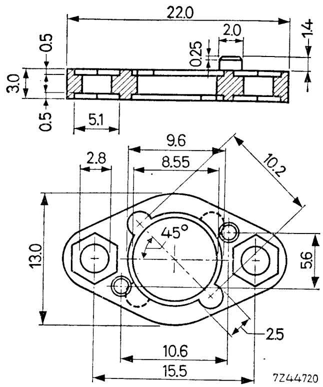


2.
1 dish spring
Material: steel, nickel plated

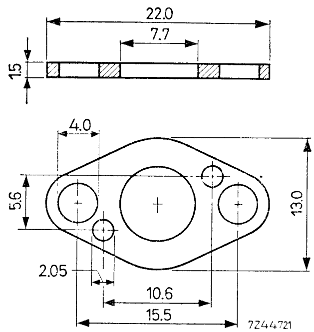


Type 56218 consists of the following components (1 to 3) Dimensions in mm

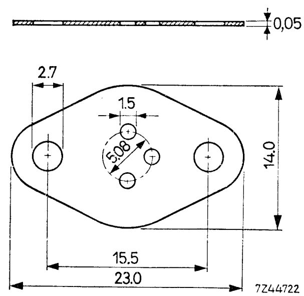
1.
1 top clamping washer
of insulating material



2.
1 bottom clamping washer
Material: brass, tin plated



3.
1 mica washer



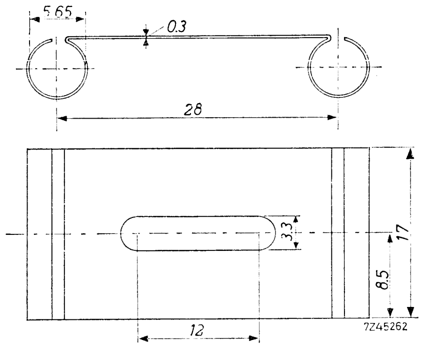
7Z2 3326

COOLING FINS

Dimensions in mm

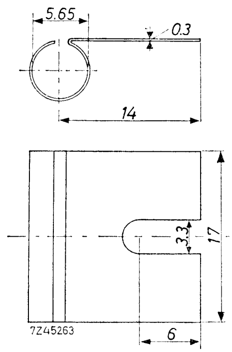
56226

Material:
brass, nickel plated



56227

Material:
brass, nickel plated

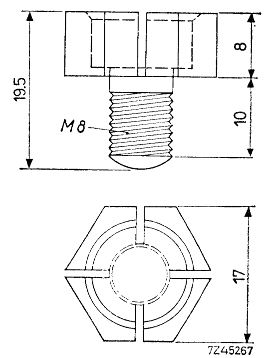


MOUNTING ADAPTOR

Type 56232 consists of the following components (1 to 3) Dimensions in mm

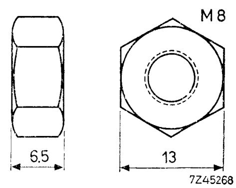
1.

1 mounting adaptor



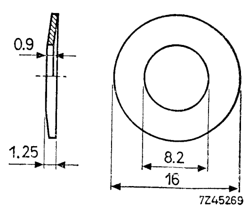
2.

1 hexagon nut
Material: brass, nickel plated



3.

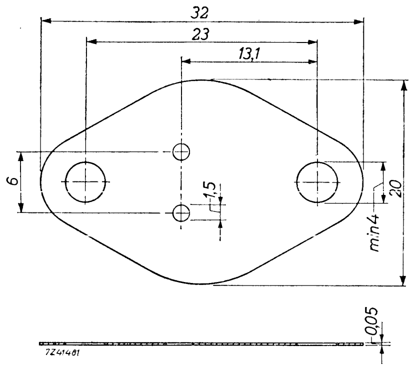
1 dish spring
Material: steel, nickel plated



Types 56239 and 56240 consist of the following components (1 to 2)

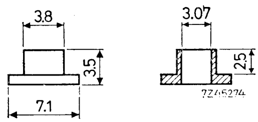
Dimensions in mm

1.
1 mica washer
(both types)



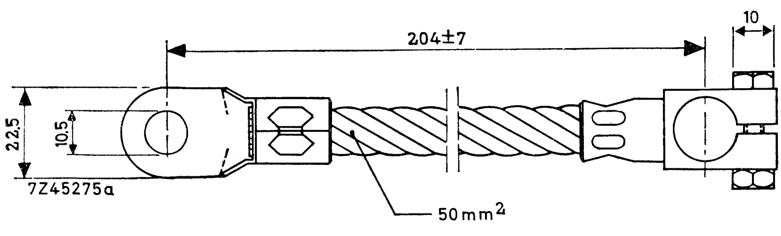
2.
56239: 2 philite insulating bushes

56240: 3 philite insulating bushes



Type 56243 is a flexible top lead

Dimensions in mm

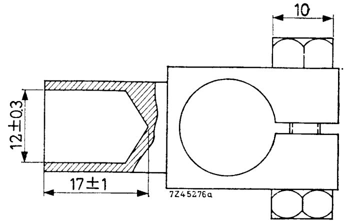


7Z2 3329

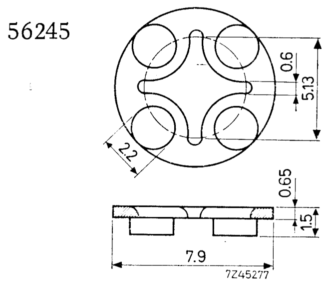
5.5.1965

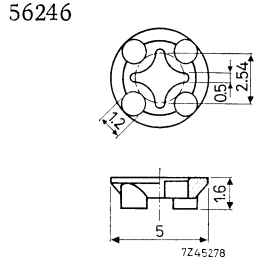
Type 56244 is a clamp

Dimensions in mm

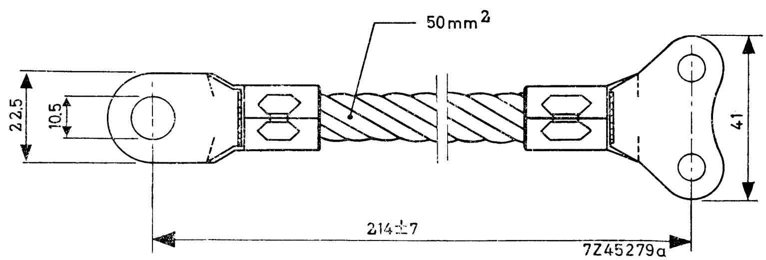


Types 56245 and 56246 are distance disks of insulating material





Type 56247 is a flexible base lead

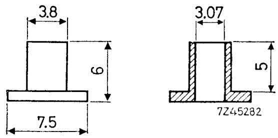


7Z2 3330

5.5.1965

Type 56261 consists of 2 Philite insulating bushes

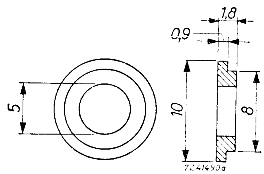
Dimensions in mm



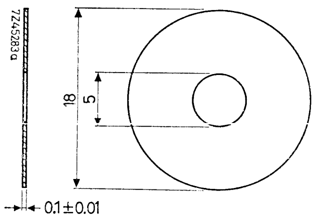
Type 56262 consists of the following components (1 to 2)

Dimensions in mm

1.
1 Philite insulating ring



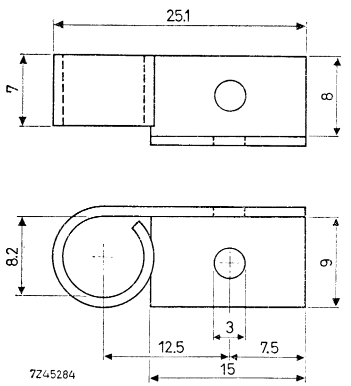
2.
1 mica washer



Type 56265 is a cooling and mounting clip

Dimensions in mm

Material:
aluminium, blackened



GENERAL HEATSINK CONSIDERATIONS

INTRODUCTION

Semiconductor rectifier diodes, thyristors and zener diodes for medium and high power have power losses which cannot be sufficiently transferred to the ambient air by these devices themselves. To prevent excessive junction temperatures the heat transfer capacity has to be improved.
This is achieved by heatsinks, which transfer the dissipated heat from the semiconductor junction to the ambient air by convection and radiation.

A flat metal plate is the simplest form of a heat transfer medium, but it is not the most efficient form for all conditions. In most cases a more complex form of heatsink will have advantages with regard to cost, size and weight.

This chapter offers, apart from information on heat transfer and the mechanical construction of assemblies, useful indications on how to take advantage of reverse-polarity diodes, etc., and, finally, the technical data on three types of heatsink with examples of calculation.

HEAT TRANSFER PATH

In a silicon rectifier the heat is generated inside the silicon wafer. From there the heat flows mainly to the base of the device and then via the heatsink to the surrounding air. The heat flow through heat conductors is analogous to the flow of electric current through electrical conductors. In this analogy the thermal resistance (K in $^{o}C/W$) corresponds with the electrical resistance (R in Ω).

Fig.1 shows the heat path from the junction to the ambient air as a series connection of three thermal resistances:

K_{j-mb} : The thermal resistance from junction to mounting base. Its value can be found in the data sheets of the relevant semiconductor device.

K_{mb-h} : The contact thermal resistance. This is the thermal resistance from mounting base to heatsink, resulting from the contact area being limited and the contact itself being imperfect. Its value can also be found in the data sheets.

K_{h-a} : The thermal resistance of the heatsink. This is the thermal resistance between the contact surface and the ambient air.

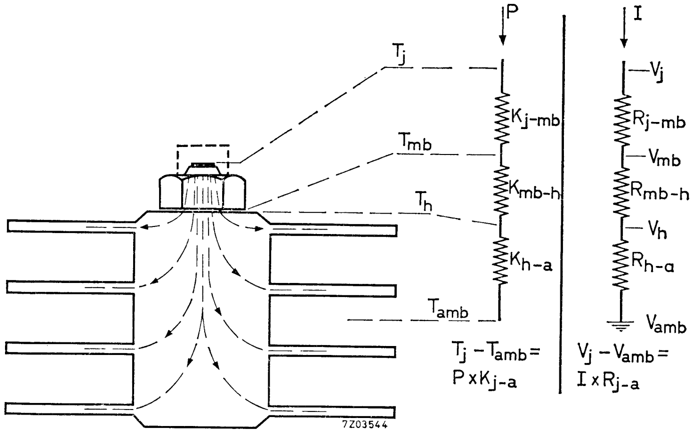
Once the heat has been transferred from heatsink to ambient, cool air must replace the heated air.

According to fig.1 the following formula can be used in heatsink calculations:

$$T_j - T_{amb} = P \times (K_{j-mb} + K_{mb-h} + K_{h-a})$$

7Z2 3310

Fig.1 Analogy between heat conduction and electric conduction



MEANS TO IMPROVE HEAT TRANSFER

The contact thermal resistance can be made as small as possible by using:

1. a large contact area
2. plane contact surfaces by proper machining, grinding, etc. Heatsinks should be blanked or made burr-free after punching or drilling holes
3. sufficient pressure by applying at least the rated minimum torque. Use a torque spanner
4. silicon grease to fill up air pockets. A thin layer of air has a much higher resistance to heat flow than a thin film of grease

The thermal resistance of the heatsink can be reduced by:

1. painting or anodising the surface, which improves heat transfer by radiation
2. higher speed of the cooling air
3. larger size of the heatsink

The air flow can be obtained in the simplest way by natural convection. Any obstruction should be avoided. Therefore fins should be placed vertically, air intake and outlet apertures should be as large as possible. Ample spacing between heatsinks and adjacent structures and provisions to obtain a chimney effect also improve the air flow.

If free convection is not sufficient to remove the heat, a blower or a fan must be used. Forced air cooling also permits a substantially smaller heatsink.

INSULATED MOUNTING

In bridge rectifiers it may be desirable to insulate a diode electrically from its heatsink by means of a mica or teflon washer. As a consequence the contact thermal resistance will be about 10 times that of the case without insulation. Since the total thermal resistance has a fixed maximum value for given values of P and T_{amb} (see previous section), the increase of K_{mb-h} has to be compensated by a considerable reduction of K_{h-a} (e.g. by using a much larger heatsink).

Furthermore, the creepage distances along the insulator may be too small for the high voltages occurring between diode and heatsink. In fig.2 the creepage distances A and B can be made sufficiently large; but C and D will always be small.

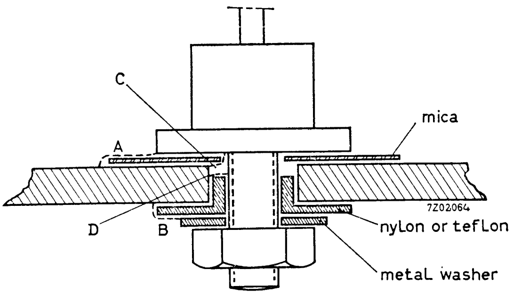


Fig.2 Creepage distances at an insulated diode
(C and D are the critical ones)

CONSTRUCTION OF ASSEMBLIES

In the previous sections some details have been given regarding the proper way of connecting a diode to a heatsink, positioning of heatsinks, etc.

For better current sharing of parallel-connected diodes a good thermal coupling of the devices is needed, which reduces differences in the forward characteristics. Two series-connected diodes should have a good thermal coupling in view of the reverse characteristics.

Thermal coupling can be obtained by mounting two diodes on one heatsink. On a plain cooling fin the two diodes should be mounted according to fig.3, on an extruded aluminium heatsink according to fig.4. A distance between the two diodes equal to one third of the heatsink length provides sufficient thermal coupling. For the electrical connection it is preferred to use a copper strip with a thickness of 1 mm. Mounting two diodes on one heatsink also saves mounting cost.

A flat plate with two diodes should have twice the area necessary for a separately mounted diode.
An extruded aluminium heatsink with two diodes should have twice the length necessary for a separately mounted diode.

7Z2 3312

An electrical series connection of two diodes mounted on one heatsink can be obtained by using diodes of different polarity. Figs.5, 6 and 7 show how the combination of normal and reverse-polarity diodes simplifies the assembly of single-phase and three-phase bridge rectifiers.

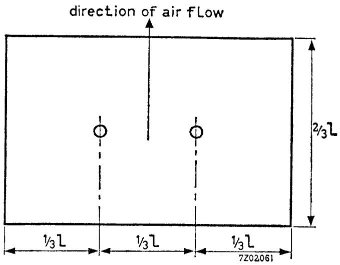


Fig.3. Dimensioning of a plain cooling fin with two diodes

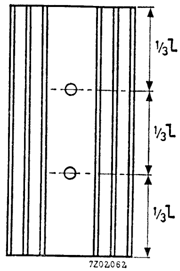


Fig.4. Extruded aluminium heat-sink with two diodes

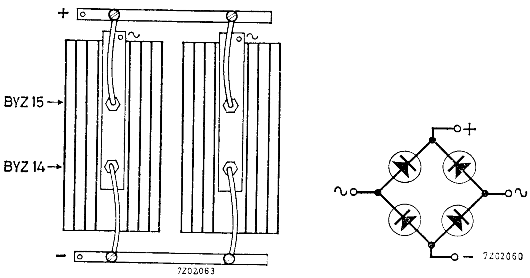


Fig.5. Single-phase full-wave bridge rectifier with diodes of different polarity on extruded aluminium heatsinks

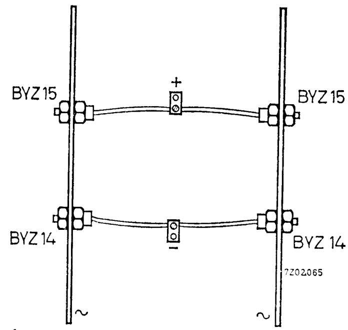


Fig.6. Single-phase full-wave bridge rectifier with diodes of different polarity on plain cooling fins (Top view)

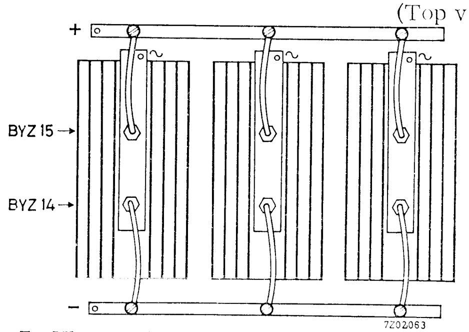


Fig.7. Three-phase full-wave bridge rectifier with diodes of different polarity on extruded aluminium heatsinks

FLAT COOLING FINS

The nomogram on next page gives the relation for vertically mounted, flat, blackened cooling fins of 3 mm aluminium between the following variables: fin size, velocity of the cooling air, heatsink thermal resistance, type of diode mounted on the fin and, in the case of free convection cooling, the power dissipation of the diode.
The nomogram should not be used when a diode is insulated from the heatsink.

METHOD OF USING THE NOMOGRAM TO FIND THE REQUIRED HEATSINK AREA.

a. Free convection cooling

Assume given the type of diode, the power dissipated and the calculated max. value of the heatsink thermal resistance.

Draw a straight line through the thermal resistance value on scale 3, from the point on line 2 that corresponds with the free convection point of the diode used, to the vertical line 4. Then move horizontally to the free convection line. The intersection of the vertical through this point with the horizontal through the power dissipation value on scale 1 gives the required heatsink area (interpolate between the values of the lines 6).

Example:

An example has been drawn in the nomogram for a BYX13 diode, dissipating 17.5 W at an ambient temperature of 73 °C. According to the data sheets a heatsink thermal resistance of 3 °C/W is required.
The nomogram shows that the heatsink area shall be 125 cm^2.

b. Forced cooling

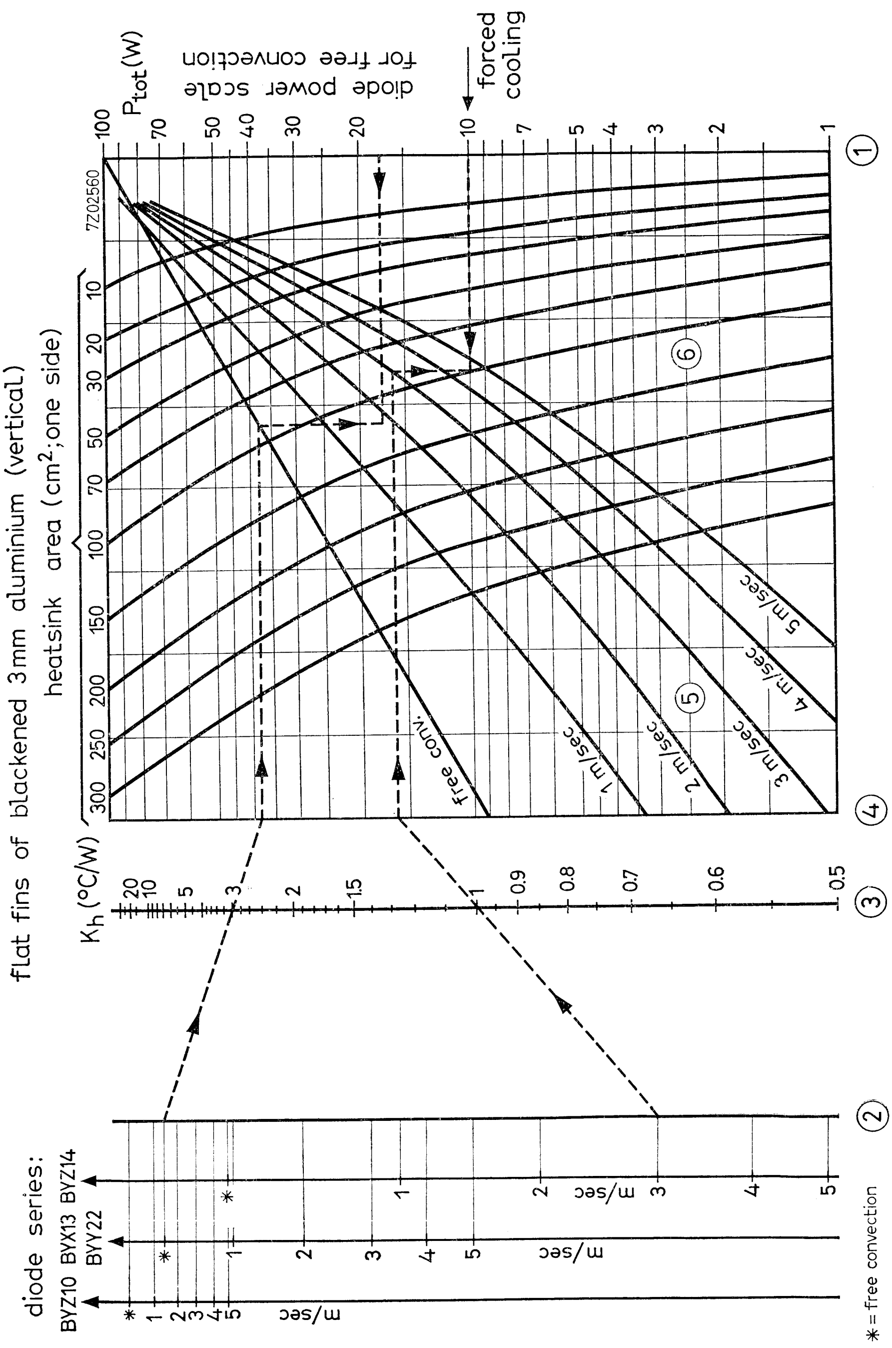
Assume given by the type of diode, the calculated max. value of the heatsink thermal resistance and the velocity of the cooling air.

Draw a straight line through the thermal resistance value on scale 3, from the point on line 2 that corresponds with both the air speed and the type of diode, to the vertical line 4. Then move horizontally to the appropriate line for the air speed (lines 5) and from there vertically to the intersection with the horizontal line through the arrow "forced cooling" at scale 1. This intersection gives the required heatsink area (interpolate between the values of the lines 6).

Example:

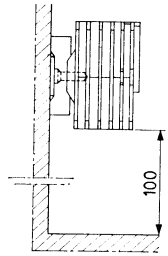
In the nomogram an example has been drawn for a BYZ14 diode, for which a required thermal resistance between mounting base and ambient of 1.15 °C/W has been calculated and which will be cooled with a forced velocity of 3 m/sec.
Since the contact thermal resistance is 0.15 °C/W, the heatsink thermal resistance should be 1 °C/W. The nomogram shows that the required heatsink area is 100 cm^2.

7Z2 3314

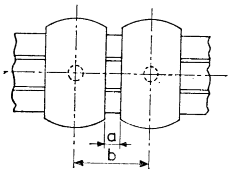

flat fins of blackened 3mm aluminium (vertical)
heatsink area (cm²; one side)
7Z02560
P_{tot}(W)
diode power scale for free convection
forced cooling
K_h (°C/W)
free conv.
1 m/sec
2 m/sec
3 m/sec
4 m/sec
5 m/sec
diode series:
BYZ10
BYX13 BYY22
BYZ14
m/sec
* = free convection

MOUNTING INSTRUCTIONS FOR DIE-CAST HEATSINKS

1. At free convection cooling or forced air flow < 0.5 m/sec the heatsinks should be mounted with the fins vertical and with a distance to the chassis bottom > 100 mm.

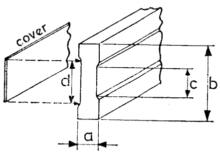


2. At forced air flow > 0.5 m/sec the heatsinks may be mounted in any position.
3. Minimum distance between heatsinks in a row.



Heatsink	Distance (mm) a	b
56219/35	> 5	> 25
56228/38	> 5	> 40
56221/36	> 10	> 50
56223/37	> 10	> 50

4. The rectifier devices should be fixed to their heatsinks with the torques specified in the relevant published data. Use a torque spanner.
5. For insulated mounting of heatsinks two sizes of mounting strips made of insulating material are available.

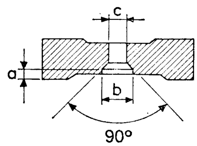


Strip	Dimensions (mm) a	b	c	d	Weight (g) (with cover)
56233	10	36	14.1	22	330
56234	13.5	50	20.1	28	615

Length 750 mm

MOUNTING INSTRUCTIONS FOR DIE-CAST HEATSINKS (continued)

6. Mounting holes to be made in the strips:



Heatsink	Strip	Dimensions in mm a	b	c
56219/35	56233	< 1.5	7.5	4.3
56228/38	56234	< 1.5	10.2	6.3
56221/36	56234	< 1.5	10.2	6.3
56223/37	56234	< 1.5	10.2	6.3

COOLING CHARACTERISTICS OF DIE-CAST HEATSINKS

The cooling characteristics may be derived from the nomogram on page 10, the use of which is different for free convection cooling and for forced air cooling.

A. Free convection cooling

- Start from the dissipated power on the right hand scale. (This value can be found in the data sheets from the graph showing P_{tot} as a function of the average current I_D).
- Trace horizontally to the line for the heatsink under consideration.
- Trace vertically to the line for free convection cooling.
- Trace horizontally to the left hand scale and read the thermal resistance of the heatsink.

(See example 1 on page 9)

B. Forced air cooling

- Start from the appropriate arrow forced air cooling at the right hand scale.
- Trace horizontally to the line for the heatsink under consideration.
- Trace vertically to the line for the air speed that will be used.
- Trace horizontally to the left hand scale and read the thermal resistance of the heatsink.

(See example 2 on page 9)

EXAMPLES OF CALCULATION

1. Calculation of the maximum allowable ambient temperature

A diode, type BYZ10, having a dissipation (P_{tot}) of 5.5 W [1]) will be used on a heatsink type 56235 with free convection cooling.

The graph on page 10 shows that the thermal resistance of the heatsink (K_h) will be 11 °C/W.

The data of the diode show:

Maximum junction temperature	$T_{j\,max}$	=	150	°C
Thermal resistance from junction to base of the diode	K_{j-m}	=	6	°C/W
Thermal resistance from diode base to heatsink	K_{m-h}	=	0.6	°C/W

From the formula $T_{amb\,max} = T_{j\,max} - P_{tot} \times K_{tot}$ it follows that the maximum allowable ambient temperature will be:

$$T_{amb\,max} = 150 - 5.5 \times (11 + 6 + 0.6) = 53\ ^{o}C$$

2. Calculation of the air speed

A diode, type BYZ14, having a dissipation (P_{tot}) of 40 W [1]) will be used on a heatsink, type 56237, with forced air cooling at an ambient temperature of 45 °C.

The data of the diode show that $T_{j\,max} = 150$ °C, and K_{j-m} and K_{m-h} are 1 °C/W and 0.15 °C/W respectively.

From the formula $K_{tot} \leq \frac{T_{j\,max} - T_{amb}}{P_{tot}}$ it follows that

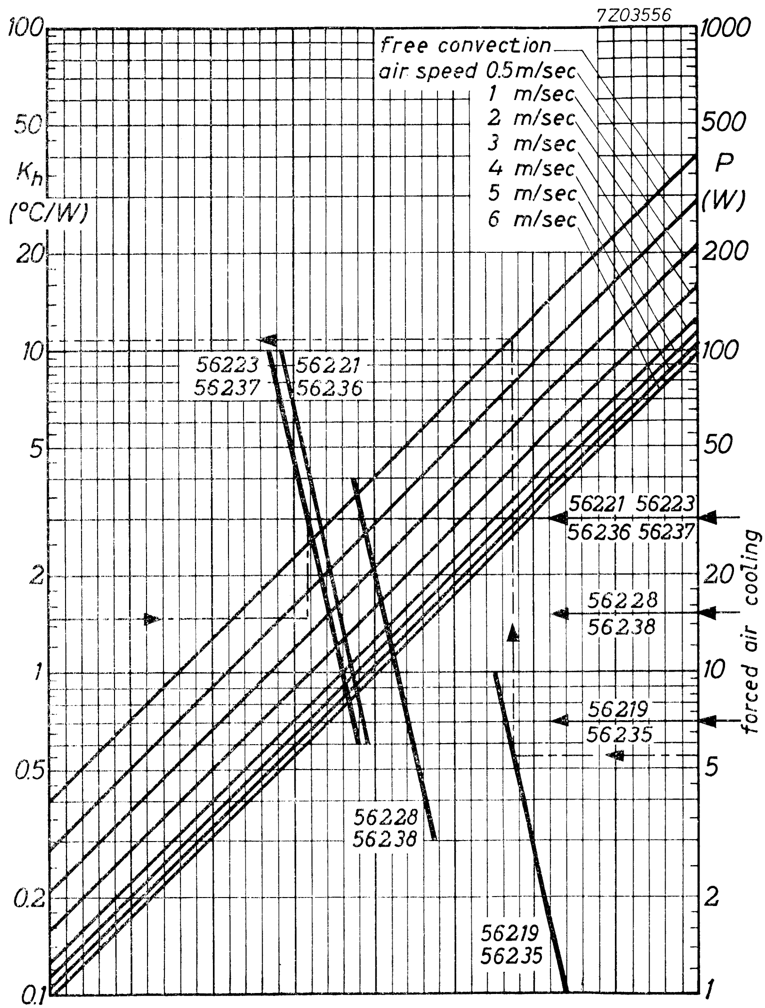
$$K_{j-m} + K_{m-h} + K_h \leq \frac{150 - 45}{40} = 2.63\ ^{o}C/W \text{ and hence}$$

$$K_h \leq 2.63 - 1 - 0.15 = 1.48\ ^{o}C/W$$

The graph on page 10 shows that a minimum air speed of 0.8 m/sec must be applied.

[1]) The power value can be found in the diode data sheets from the graph showing P_{tot} as a function of the average current I_D.

7Z2 3342



7Z03556
100
50
K_h
(°C/W)
20
10
5
2
1
0.5
0.2
0.1
1000
500
P
(W)
200
100
50
20
10
5
2
1
free convection
air speed 0.5m/sec
1 m/sec
2 m/sec
3 m/sec
4 m/sec
5 m/sec
6 m/sec
56223
56237
56221
56236
56228
56238
56219
56235
56221 56223
56236 56237
56228
56238
56219
56235
forced air cooling

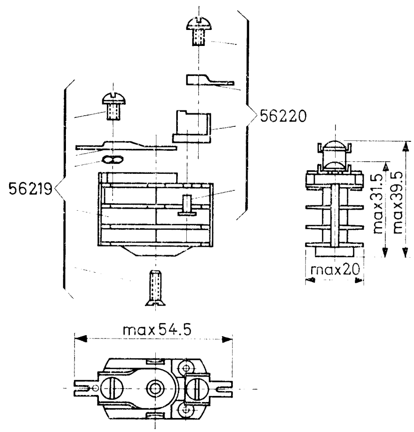
DIE-CAST HEATSINK

Die-cast heatsink of aluminium alloy, painted black, with 10-32-UNF tap hole for rectifier device.

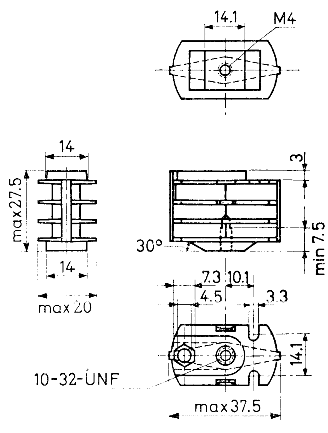
Type 56219 = heatsink + fixing material
Type 56220 = insulated mounting support
Type 56235 = complete heatsink, 56219 + 56220

Composition

Dimensions in mm



Heatsink body



Weight 56219: 29 g
56235: 35 g

For mounting instructions and cooling characteristics see General Heatsink Considerations page 7 to 10

7Z2 3343

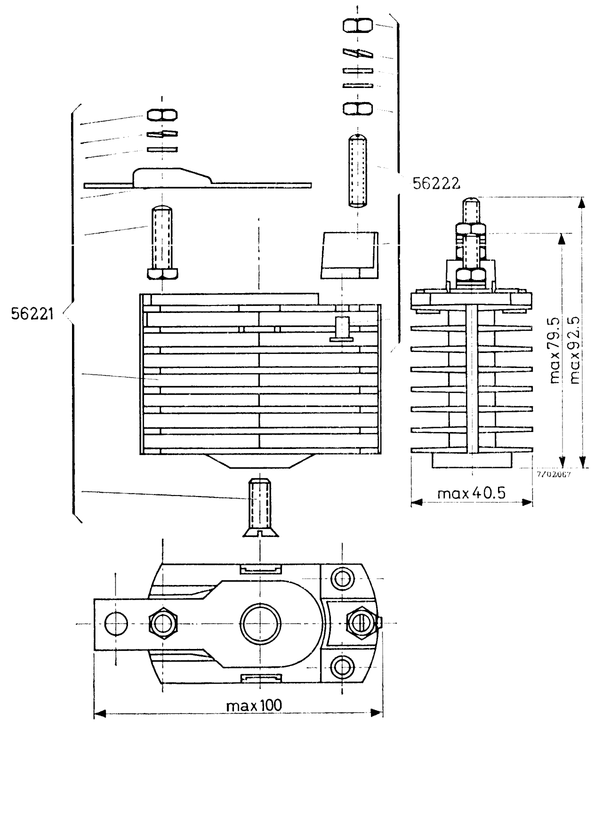
DIE-CAST HEATSINK

Die-cast heatsink of aluminium alloy, painted black, with M8 tap hole for rectifier device.

Type 56221 = heatsink + fixing material
Type 56222 = insulated mounting support
Type 56236 = complete heatsink, 56221 + 56222

Composition

Dimensions in mm

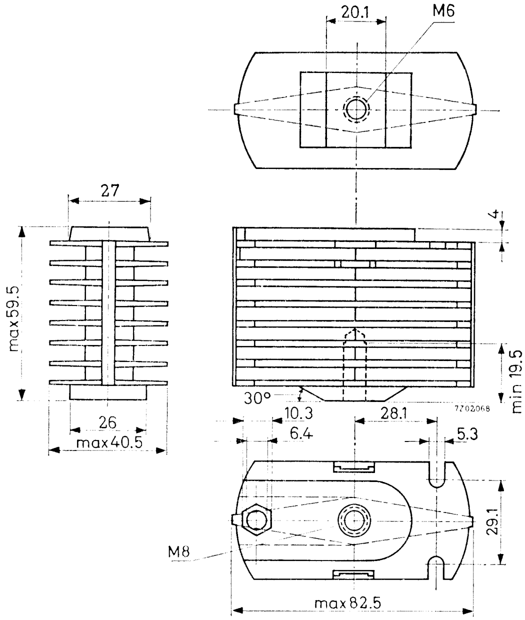


7Z2 3344

5.5.1965

Heatsink body

Dimensions in mm



Weight

56221 : 266 g
56236 : 285 g

For mounting instructions and cooling characteristics

see General Heatsink Considerations, page 7 to 10

7Z2 3345

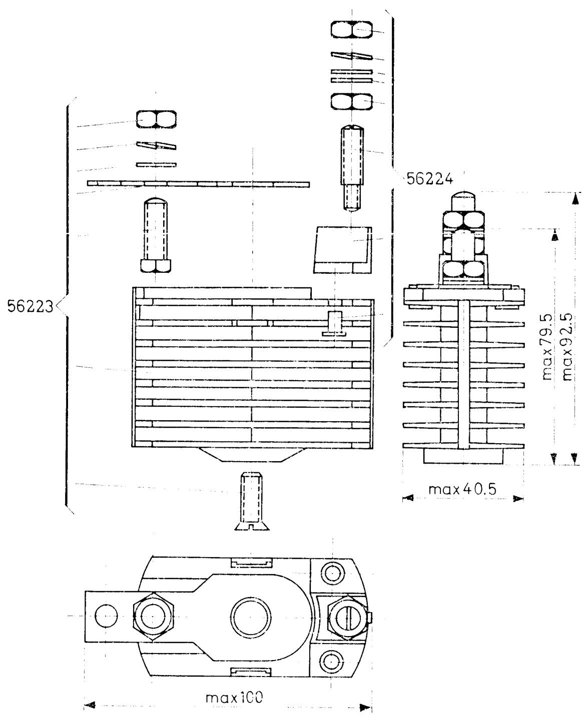
DIE-CAST HEATSINK

Die-cast heatsink of aluminium alloy, painted black, with M12 tap hole for rectifier device.

Type 56223 = heatsink + fixing material
Type 56224 = insulated mounting support
Type 56237 = complete heatsink, 56223 + 56224

Composition

Dimensions in mm

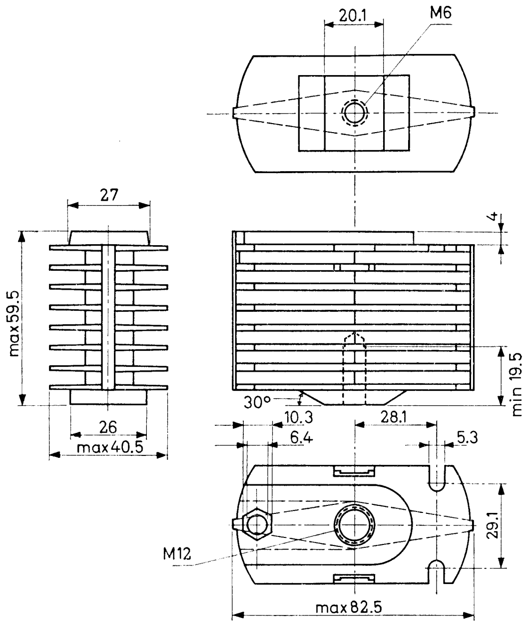


7Z2 3346

5.5.1965

Heatsink body

Dimensions in mm



Weight

56233: 260 g
56237: 300 g

For mounting instructions and cooling characteristics

see General Heatsink Considerations, page 7 to 10

7Z2 3347

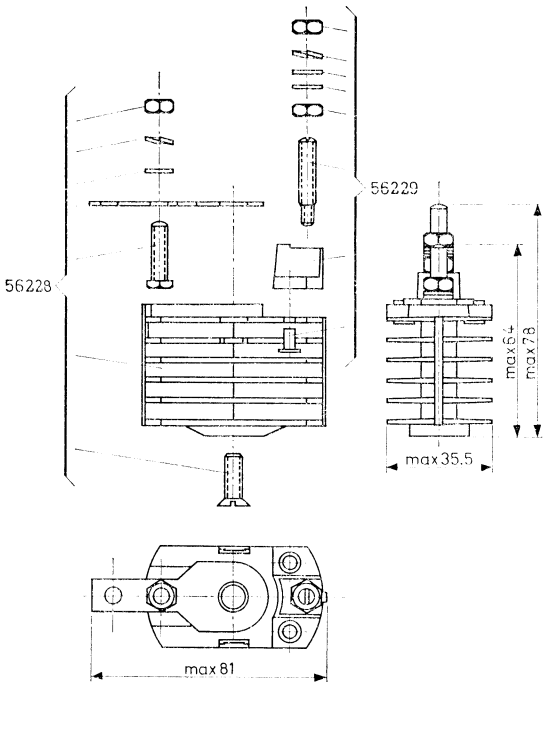
DIE-CAST HEATSINK

Die-cast heatsink of aluminium alloy, painted black, with M8 tap hole for rectifier device.

Type 56228 = heatsink + fixing material
Type 56229 = insulated mounting support
Type 56238 = complete heatsink, 56228 + 56229

Composition

Dimensions in mm

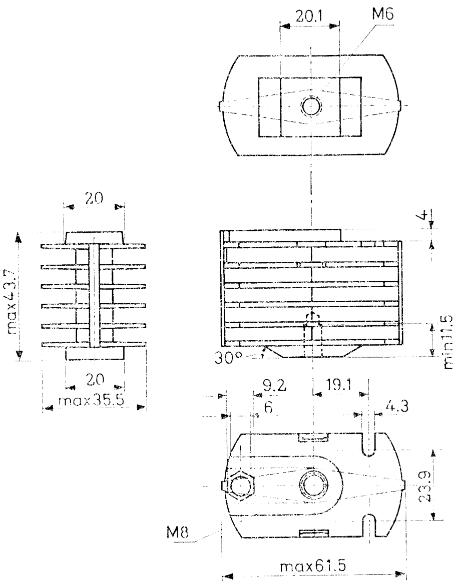


7Z2 3348

5.5.1965

Heatsink body

Dimensions in mm



Weight

56228 : 120 g
56238 : 130 g

For mounting instructions and cooling characteristics

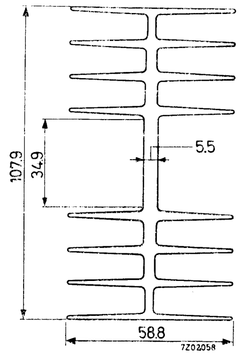
see General Heatsink Considerations, page 7 to 10

7Z2 3349

EXTRUDED ALUMINIUM HEATSINK

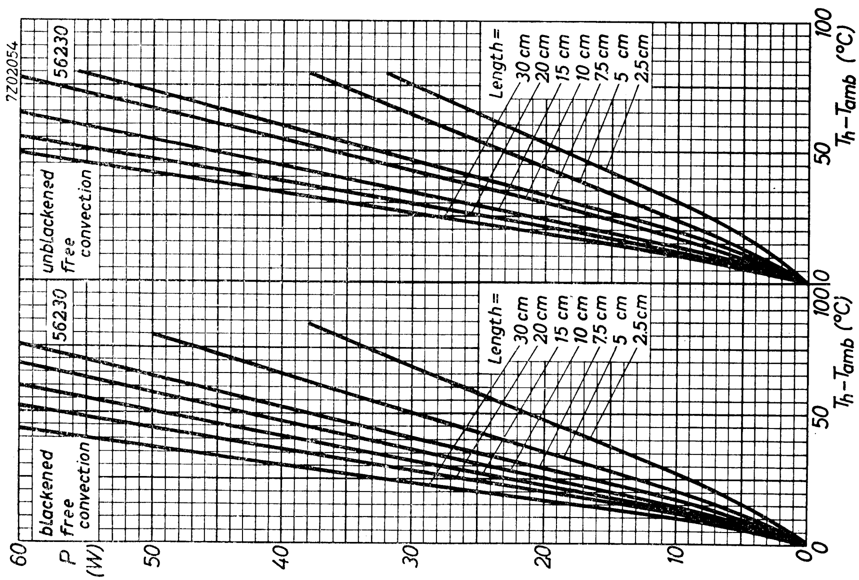
Extruded aluminium heatsink, supplied in lengths of 150 cm and unpainted.

Dimensions in mm



Weight:
4 kg per 1.5 m

Total input power versus rise above ambient temperature for various lengths:



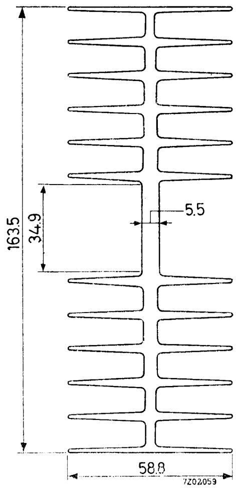
7Z2 3350

5.5.1965

EXTRUDED ALUMINIUM HEATSINK

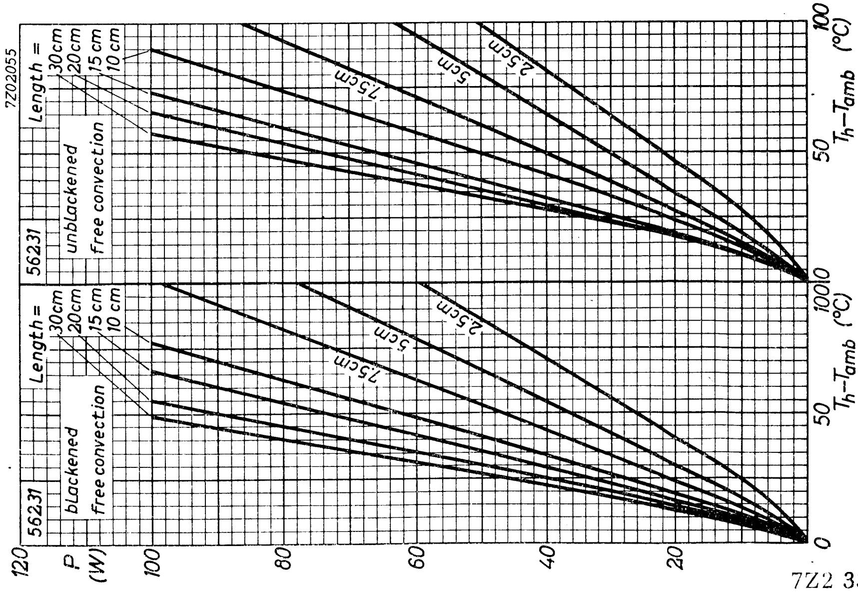
Extruded aluminium heatsink, supplied in lengths of 150 cm and unpainted.

Dimensions in mm



Weight:
6 kg per 1.5 m

Total input power versus rise above ambient temperature for various lengths:



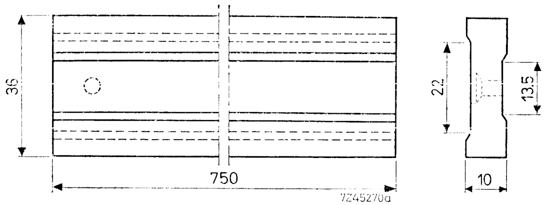
7Z2 3351

5.5.1965

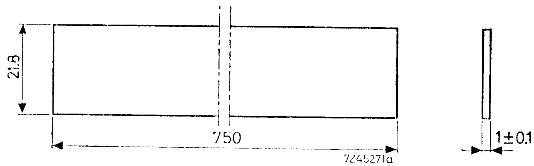
MOUNTING STRIPS

Type 56233 consists of the following components (1 to 2) Dimensions in mm

1.
1 mounting strip of insulating material

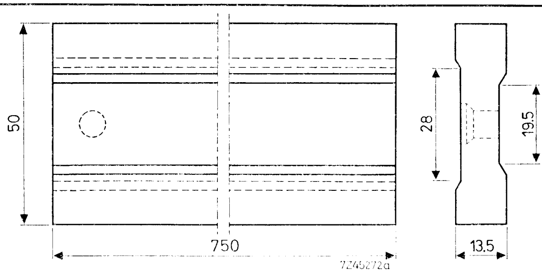


2.
1 insulating plate

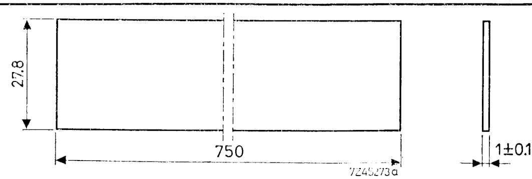


Type 56234 consists of the following components (1 to 2) Dimensions in mm

1.
1 mounting strip of insulating material



2.
1 insulating plate



DIE-CAST HEATSINKS

Types 56235 to 56238 are the complete heatsinks consisting of Heatsink + Insulated Mounting support as shown in the table below:

Complete heatsink	=	Heatsink proper	+	Insulated Mounting support
56235	=	56219	+	56220
56236	=	56221	+	56222
56237	=	56223	+	56224
56238	=	56228	+	56229

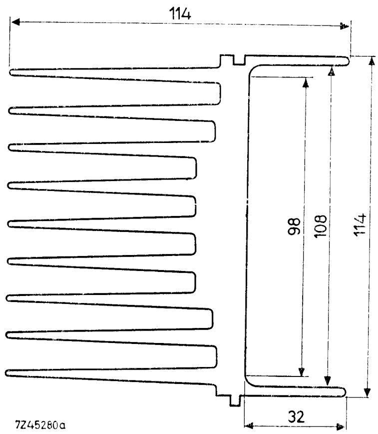
For composition and dimensions please refer to 56219 etc.

7Z2 3353

EXTRUDED ALUMINIUM HEATSINK

Extruded aluminium heatsink, supplied in lengths of 100 cm and unpainted.

Dimensions in mm



7Z2 3354

5.5.1965

Supplement (latest data)

INDEX TO THE SUPPLEMENT

[1]) The modified system of letter symbols has been used in the data comprised in the Supplement only.
For older data sheets please refer to the chapter "Symbols for Semiconductors" in the General Section.

7Z2 3461

LETTER SYMBOLS FOR SEMICONDUCTOR DEVICES
excluding power diodes and thyristors

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

QUANTITY SYMBOLS

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

   Examples: i, v, p

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

   Examples: I, V, P

SUBSCRIPTS FOR QUANTITY SYMBOLS

1. Total values are indicated by upper case subscripts.

   Examples: I_C, I_{CM}, I_{CAV}, i_C, V_{EB}

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

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

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

   For maximum (peak) values : M or m

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

   For d.c. values : no additional subscript

   For root-mean-square values : (rms)

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

7Z2 3356

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

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

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

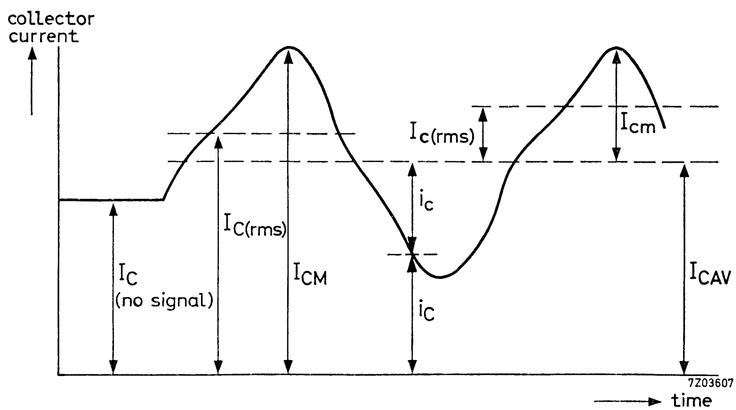


Fig. 1

7Z2 3357

CONVENTIONS FOR SUBSCRIPT SEQUENCE

1. Currents

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

2. Voltages

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

3. Supply voltages

Supply voltages may be indicated by repeating the terminal subscript.

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

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

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

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

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

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

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

7Z2 3358

ELECTRICAL PARAMETER SYMBOLS

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

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

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

   Examples: H_i, Z_o, H_F, Y_R

SUBSCRIPTS FOR PARAMETER SYMBOLS

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

   Examples: h_{IB}, h_{FE}

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

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

   Examples: h_{ib}, z_{ob}

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

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

   Examples:
   $$V_1 = h_i I_1 + h_r V_2$$
   $$I_2 = h_f I_1 + h_o V_2$$

Notes 1) The voltage and current symbols in matrix notation are indicated by a single digit subscript.
The subscript 1 = input; the subscript 2 = output
2) The voltages and currents in these equations may be complex quantities.

7Z2 3359

4. The second subscript identifies the circuit configuration.

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

Examples: (common base)

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

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

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

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

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

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

7Z2 3360

LIST OF LETTER SYMBOLS IN ALPHABETICAL ORDER

Letter symbol	Definition
C_c 1)	Collector capacitance (emitter open-circuited to a.c. and d.c.)
C_d 1)	Diode capacitance
C_e 1)	Emitter capacitance (collector open-circuited to a.c. and d.c.)
C_{ib}, C_{ie}, C_{ob}, C_{oe} 1)	See y parameters
d	Distorsion
F	Noise figure
f	Frequency
f_{hfb}, f_{hfe}, f_{yfe}	Cut-off frequency (frequency at which the parameter indicated by the subscript is 0.7 of its low frequency value)
f_T	Transition frequency (Gain-bandwidth product)
g_{ie}, g_{ib}, g_{oe}, g_{ob}	See y parameters
G_p	Power gain
h_{FB}, h_{FC}, h_{FE}	Static value of the forward current transfer ratio or D.C. current gain (output voltage held constant)
h_{fb}, h_{fc}, h_{fe}	Small-signal value of the forward current transfer ratio or Small-signal current gain (output short-circuited to a.c.)
h_{IB}, h_{IC}, h_{IE}	Static value of the input resistance (output voltage held constant)
h_{ib}, h_{ic}, h_{ie}	Small-signal value of the input impedance (output short-circuited to a.c.)
h_{OB}, h_{OC}, h_{OE}	Static value of the output conductance (input current held constant)
h_{ob}, h_{oc}, h_{oe}	Small-signal value of the output admittance (input open-circuited to a.c.)

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

7Z2 3361

Letter symbol	Definition
h_{RB}, h_{RC}, h_{RE}	Static value of the reverse voltage transfer ratio (input current held constant)
h_{rb}, h_{rc}, h_{re}	Small-signal value of the reverse voltage transfer ratio (input open-circuited to a.c.)
I_B, I_C, I_E	Total d.c. (or average) current
I_b, I_c, I_e	Varying component of the current
i_B, i_C, i_E	Instantaneous total value of the current
i_b, i_c, i_e	Instantaneous value of the varying component of the current
I_{BAV}, I_{CAV}, I_{EAV}	Total average current (to distinguish between average and d.c. when necessary)
I_{BEX}, I_{CEX}	Total base, respectively collector current in a specified circuit. These symbols are commonly used in case of a reverse biased emitter junction
I_{BM}, I_{CM}, I_{EM}	Maximum (peak) value of the total current
I_{bm}, I_{cm}, I_{em}	Maximum (peak) value of the varying component of the current
I_{CBO}	Collector cut-off current (open emitter)
I_{CEO}	Collector cut-off current (open base)
I_{CBS} or I_{CES}	Collector cut-off current (emitter short-circuited to base)
I_{EBO}	Emitter cut-off current (open collector)
I_F	Total forward current of a diode (d.c. or average)
i_F	Instantaneous total value of the forward current of a diode
I_{FAV}	Total average forward current of a diode (to distinguish between average and d.c. when necessary)
I_{FM}	Peak forward current of a diode
I_i, I_o	Input, respectively output current of a specified circuit
I_R	Total reverse (cut-off) current of a diode
i_R	Instantaneous total value of the reverse current of a diode

7Z2 3362

Letter symbol	Definition
I_{RRM}	Repetitive peak reverse current of a diode
I_{RSM}	Non repetitive peak reverse current of a diode
I_Z	Zener current (d.c. or average)
I_{ZM}	Peak zener current
I_{ZS}	Non repetitive zener current
P_i, P_o	Input, respectively output power of a specified circuit
P_{tot}	Total power dissipation in the device
P_Z	Zener power dissipation
P_{ZM}	Peak zener power dissipation
P_{ZSM}	Non repetitive peak zener power dissipation
Q_s	Recovered charge
r_D	Diode (internal) series resistance
R_{th}	Thermal resistance
$R_{th\ j\text{-}a}$	Thermal resistance from junction to ambient
$R_{th\ j\text{-}mb}$	Thermal resistance from junction to mounting base
$R_{th\ j\text{-}c}$	Thermal resistance from junction to case
$R_{th\ mb\text{-}h}$	Thermal resistance from mounting base to heatsink
r_Z	Dynamic-slope resistance of a zener diode
S_Z	Temperature coefficient of the operating voltage of a zener diode
T_{amb}	Ambient temperature
T_{case}	Case temperature
t_d	Delay time
t_f	Fall time
t_{fr}	Forward recovery time of a diode
T_j	Junction temperature
t_{off}	Turn off time ($t_{off} = t_s + t_f$)
t_{on}	Turn on time ($t_{on} = t_d + t_r$)

7Z2 3421

Letter symbol	Definition
t_r	Rise time
t_{rr}	Reverse recovery time of a diode
t_s	Storage time
T_{stg}	Storage temperature
V_{BB}, V_{CC}, V_{EE}	Supply voltage
V_{BE}, V_{CB}, V_{CE}, V_{EB}	Total value of the voltage (d.c. or average)
V_{be}, V_{cb}, V_{ce}, V_{eb}	Varying component of the voltage
v_{BE}, v_{CB}, v_{CE}, v_{EB}	Instantaneous value of the total voltage
v_{be}, v_{cb}, v_{ce}, v_{eb}	Instantaneous value of the varying component of the voltage
V_{BEfl}	Base-emitter floating voltage (open base)
V_{BEsat}, V_{CEsat}	Saturation voltage at specified bottoming conditions
$V_{(BR)}$	Breakdown voltage
$V_{(BR)CBO}$, $V_{(BR)CEO}$, $V_{(BR)EBO}$	Breakdown voltage between the terminal indicated by the first subscript and the reference terminal (second subscript) when the third terminal is open circuited
$V_{(BR)CER}$	Collector-emitter breakdown voltage with a specified resistance between emitter and base
$V_{(BR)CES}$	Collector-emitter breakdown voltage with the emitter short circuited to the base
V_{CBO}, V_{CEO}, V_{EBO}	Voltage of the terminal indicated by the first subscript w.r.t. the reference terminal (second subscript) with the third terminal open circuited
V_{CEK}	Knee voltage at specified conditions
V_{CER}	Collector-emitter voltage with a specified resistance between emitter and base
V_{CES}	Collector-emitter voltage with the emitter short circuited to the base
$V_{CE.sust}$	Collector-emitter sustaining voltage under the condition, indicated by the third subscript
V_{CEX}	Collector-emitter voltage in a specified circuit. This symbol is commonly used to indicate a reverse biased emitter junction

7Z2 3422

Letter symbol	Definition	
V_{EBfl}	Emitter-base floating voltage (open emitter)	
V_F	Continuous forward voltage of a diode	
V_{FM}	Peak forward voltage of a diode	
V_i, V_o	Input, respectively output voltage of a specified circuit	
V_{pt}	Punch through voltage	
V_R	Continuous reverse voltage of a diode	
V_{RM}	Peak reverse voltage of a diode	
V_{RSM}	Non repetitive peak reverse voltage of a diode	
V_Z	Operating voltage (zener voltage) of a zener diode	
y_{ib}, y_{ie}	Input admittance	Output short circuited to a.c.
g_{ib}, g_{ie}	Input conductance	Output short circuited to a.c.
C_{ib}, C_{ie}	Input capacitance	Output short circuited to a.c.
φ_{ib}, φ_{ie}	Phase angle of input admittance	Output short circuited to a.c.
y_{fb}, y_{fe}	Transfer admittance	Output short circuited to a.c.
g_{fb}, g_{fe}	Transfer conductance	Output short circuited to a.c.
C_{fb}, C_{fe}	Transfer capacitance	Output short circuited to a.c.
φ_{fb}, φ_{fe}	Phase angle of transfer admittance	Output short circuited to a.c.
y_{ob}, y_{oe}	Output admittance	Input short circuited to a.c.
g_{ob}, g_{oe}	Output conductance	Input short circuited to a.c.
C_{ob}, C_{oe}	Output capacitance	Input short circuited to a.c.
φ_{ob}, φ_{oe}	Phase angle of output admittance	Input short circuited to a.c.
y_{rb}, y_{re}	Feedback admittance	Input short circuited to a.c.
g_{rb}, g_{re}	Feedback conductance	Input short circuited to a.c.
C_{rb}, C_{re}	Feedback capacitance	Input short circuited to a.c.
φ_{rb}, φ_{re}	Phase angle of feedback admittance	Input short circuited to a.c.

7Z2 3423

SYMMETRICAL
N-P-N SWITCHING TRANSISTORS

Symmetrical germanium alloy transistors of the n-p-n type in TO-5 metal envelope with the base connected to the case intended for high current medium speed switching applications.

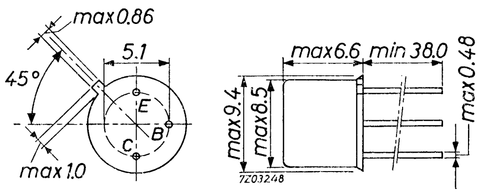
QUICK REFERENCE DATA

			ASY73	ASY74	ASY75	
Collector-base voltage (open emitter)	V_{CBO}	max.	30	30	30	V
Collector-emitter voltage (open base)	V_{CEO}	max.	15	15	15	V [1])
Collector-current (d.c. and average)	I_C	max.	400	400	400	mA
Total dissipation up to T_{amb} = 25 °C	P_{tot}	max.	140	140	140	mW
Junction temperature	T_j	max.	75	75	75	°C
D.C. current gain at T_j = 25 °C						
$-I_E$ = 200 mA; V_{CB} = 0	h_{FE}		> 20	> 35	> 50	
$-I_C$ = 200 mA; V_{EB} = 0	h_{FC}		> 12	> 20	> 20	
Transition frequency at $-I_E$ = 3 mA; V_{CB} = 5 V	f_T		> 4	> 6	> 10	Mc/s
Desaturation time constant at I_B = 1 mA; I_C = 0	τ_s		<1.75	<1.75	<1.75	µs

MECHANICAL DATA

Dimensions in mm

TO-5
Base connected to case



[1]) See page I

7Z2 3382

RATINGS (Limiting values) [1])

Voltages

Collector-base voltage (open-emitter)	V_{CBO}	max.	30	V
Collector-emitter voltage (open base)	V_{CEO}	max.	15	V [2])
Collector-emitter voltage with $-V_{BE}$ = 0.2 V	V_{CEX}	max.	20	V [2])
Emitter-base voltage (open collector)	V_{EBO}	max.	30	V

Currents

Collector current (d.c. and average over any 20 ms period)	I_C	max.	400	mA
Emitter current (d.c. and average over any 20 ms period)	$-I_E$	max.	400	mA
Base current (d.c. and average over any 20 ms period)	I_B	max.	40	mA
Base current (peak value)	I_{BM}	max.	400	mA

Power dissipation

Total steady state power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	140	mW

Temperatures

Storage temperature	T_{stg}		-55 to 85	°C
Operating junction temperature	T_j	max.	75	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	0.35	°C/mW
From junction to case	$R_{th\ j-c}$	=	0.2	°C/mW

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

[2]) For switch-off transients with inductive load see page I

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CHARACTERISTIC RANGE VALUES FOR EQUIPMENT DESIGN

T_j = 25 °C unless otherwise specified

Collector cut-off current				
at V_{CB} = 5 V; I_E = 0	I_{CBO}	<	3	μA
at $V_{CB} = V_{CBOmax.}$; T_j = 55 °C	I_{CBO}	<	100	μA
Emitter cut-off current				
at V_{EB} = 5 V; I_C = 0	I_{EBO}	<	3	μA
at $V_{EB} = V_{EBOmax.}$; T_j = 55 °C	I_{EBO}	<	100	μA
Currents at reverse biased emitter junction				
at V_{CE} = 20 V; $-V_{BE}$ = 0.2 V; T_j = 55 °C	I_{CEX}	<	50	μA
at $-V_{BE}$ = 20 V; V_{CB} = 20 V; T_j = 55 °C	$-I_{BEX}$	<	50	μA
Saturation voltages				
ASY73. I_C = 50 mA; I_B = 2.5 mA	V_{CEsat}	<	0.22	V
I_C = 200 mA; I_B = 10 mA	V_{CEsat}	<	0.30	V
I_E = 200 mA; I_B = 16.5 mA	V_{ECsat}	<	0.30	V
I_C = 50 mA; I_B = 3 mA	$V_{BE\,sat}$	<	0.50	V
I_C = 200 mA; I_B = 12 mA	$V_{BE\,sat}$	<	0.90	V
ASY74. I_C = 50 mA; I_B = 1.25 mA	V_{CEsat}	<	0.22	V
I_C = 200 mA; I_B = 5.7 mA	V_{CEsat}	<	0.30	V
I_C = 400 mA; I_B = 20 mA	V_{CEsat}	<	0.37	V
I_E = 200 mA; I_B = 10 mA	V_{ECsat}	<	0.30	V
I_C = 50 mA; I_B = 1.5 mA	$V_{BE\,sat}$	<	0.38	V
I_C = 200 mA; I_B = 7 mA	$V_{BE\,sat}$	<	0.70	V
I_C = 400 mA; V_{CB} = 0	$V_{BE\,sat}$	<	0.90	V
ASY75. I_C = 50 mA; I_B = 0.75 mA	V_{CEsat}	<	0.22	V
I_C = 200 mA; I_B = 4 mA	V_{CEsat}	<	0.30	V
I_C = 400 mA; I_B = 13.5 mA	V_{CEsat}	<	0.37	V
I_E = 200 mA; I_B = 10 mA	V_{ECsat}	<	0.30	V
I_C = 50 mA; I_B = 0.95 mA	$V_{BE\,sat}$	<	0.34	V
I_C = 200 mA; I_B = 5 mA	$V_{BE\,sat}$	<	0.60	V
I_C = 400 mA; V_{CB} = 0	$V_{BE\,sat}$	<	0.70	V
Collector-emitter sustaining voltage				
I_C = 10 mA; I_B = 0	V_{CEsust}	>	15	V

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3.3.1965

CHARACTERISTIC RANGE VALUES FOR EQUIPMENT DESIGN (continued)

T_j = 25 °C unless otherwise specified

Punch-through voltage	V_{pt}	>	20	V
Floating potential				
$I_E = 0$; $V_{CB} = 20$ V; $T_j = 55$ °C	V_{EBfl}	<	180	mV
$I_C = 0$; $V_{CB} = 20$ V; $T_j = 55$ °C	V_{CBfl}	<	180	mV
D.C. current gain				
ASY73. at $V_{CB} = 0$; $-I_E$ = 50 mA	h_{FE}	>	25	
$-I_E$ = 200 mA	h_{FE}	>	20	
at $V_{EB} = 0$; $-I_C$ = 200 mA	h_{FC}	>	12	
ASY74. at $V_{CB} = 0$; $-I_E$ = 50 mA	h_{FE}	>	40	
$-I_E$ = 200 mA	h_{FE}	>	35	
$-I_E$ = 400 mA	h_{FE}	>	20	
at $V_{EB} = 0$; $-I_C$ = 200 mA	h_{FC}	>	20	
ASY75. at $V_{CB} = 0$; $-I_E$ = 50 mA	h_{FE}	>	65	
$-I_E$ = 200 mA	h_{FE}	>	50	
$-I_E$ = 400 mA	h_{FE}	>	30	
at $V_{EB} = 0$; $-I_C$ = 200 mA	h_{FC}	>	20	
Switching parameters				
Desaturation time constant I_B = 1 mA; $I_C = 0$	τ_s	<	1.75	µs
Current-feed time constant I_{CM} = 200 mA; V_{CE} = 0.75 V	τ_c	<	1.75	µs
Voltage-feed time constant I_{CM} = 1 mA; V_{CE} = 5 V	τ_v	<	0.20	µs
Collector capacitance at f = 1 Mc/s				
V_{CB} = 5 V; $I_E = I_c = 0$	c_c	<	30	pF
Emitter capacitance at f = 1 Mc/s				
V_{EB} = 5 V; $I_C = I_c = 0$	c_e	<	30	pF
Transition frequency				
V_{CB} = 5 V; $-I_E$ = 3 mA, ASY73	f_T	>	4	Mc/s
V_{CB} = 5 V; $-I_E$ = 3 mA, ASY74	f_T	>	6	Mc/s
V_{CB} = 5 V; $-I_E$ = 3 mA, ASY75	f_T	>	10	Mc/s

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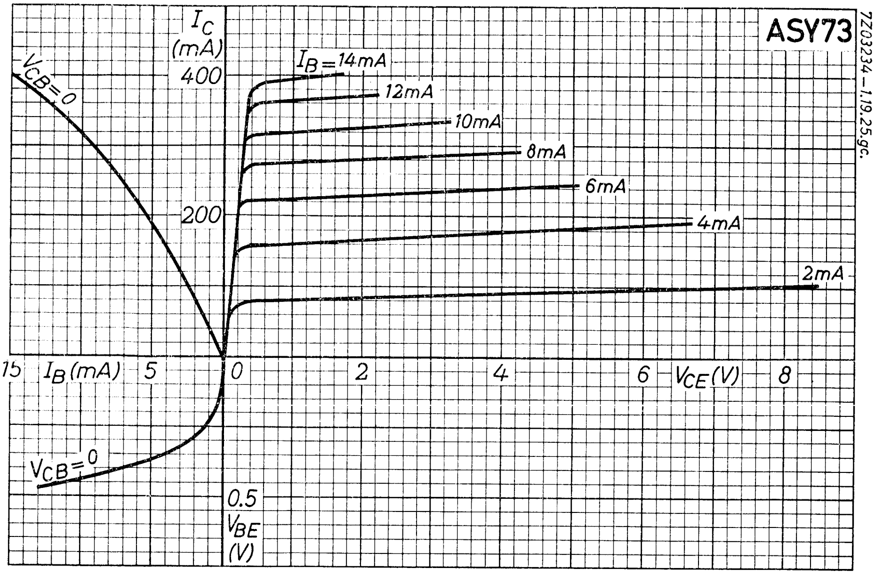
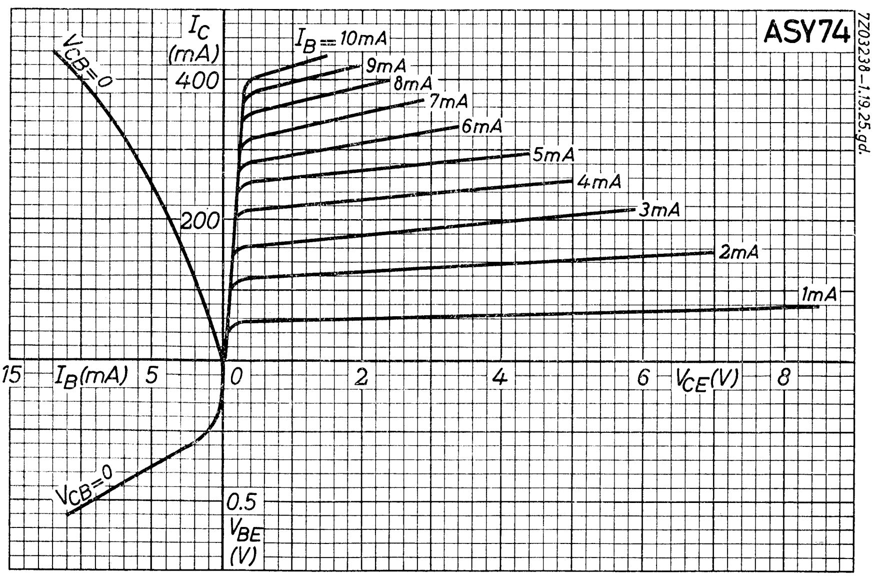
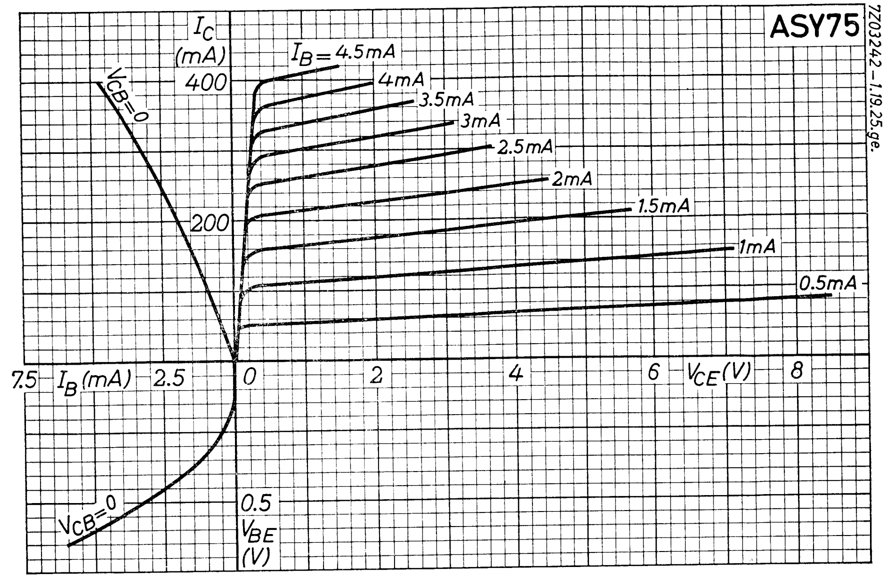
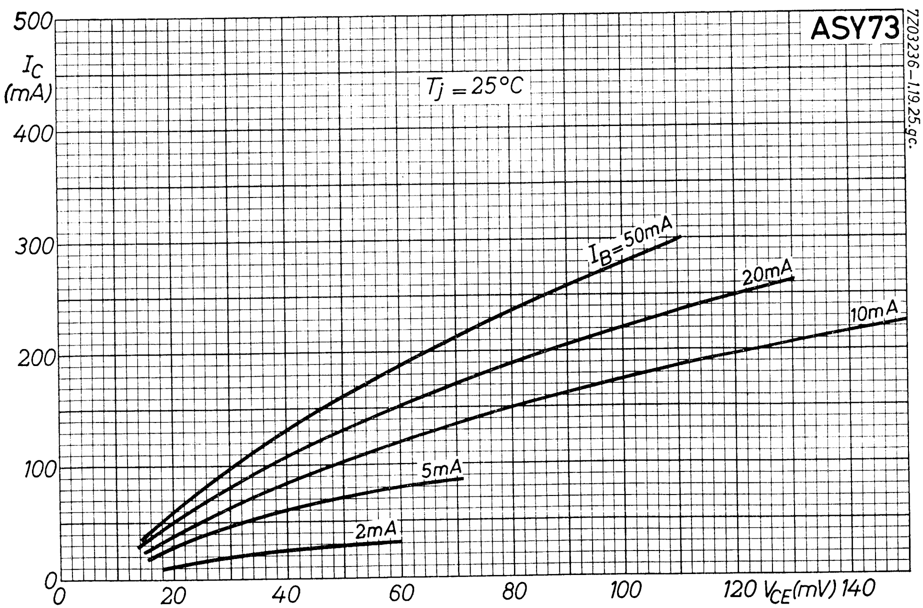

ASY73
7Z03234-1.19.25.gc.
I_C (mA)
400
200
I_B=14mA
12mA
10mA
8mA
6mA
4mA
2mA
V_{CB}=0
15
I_B(mA)
5
0
2
4
6
V_{CE}(V)
8
V_{CB}=0
0.5
V_{BE} (V)

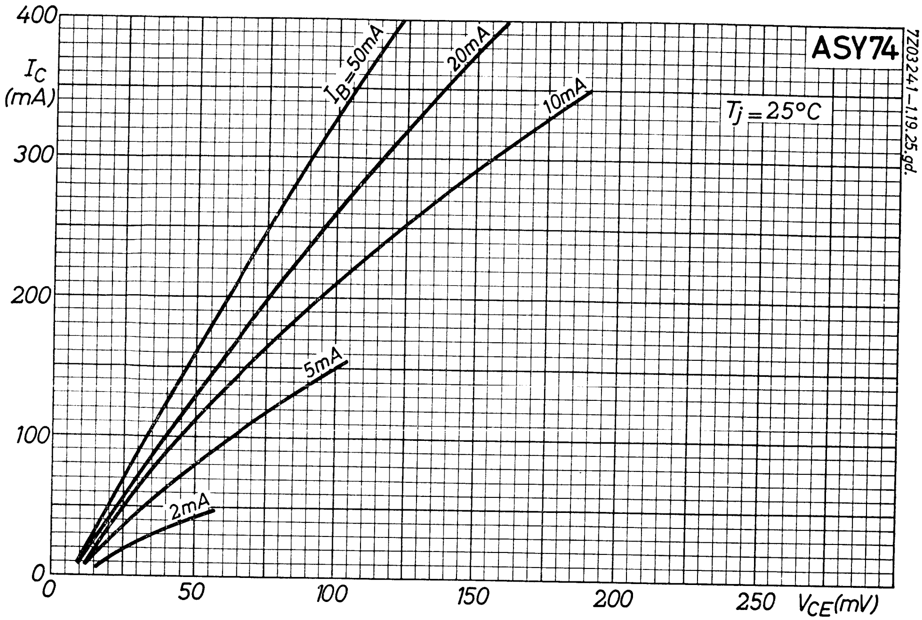

ASY74
7Z03238-1.19.25.gd.
I_C (mA)
400
200
I_B=10mA
9mA
8mA
7mA
6mA
5mA
4mA
3mA
2mA
1mA
V_{CB}=0
15
I_B(mA)
5
0
2
4
6
V_{CE}(V)
8
V_{CB}=0
0.5
V_{BE} (V)

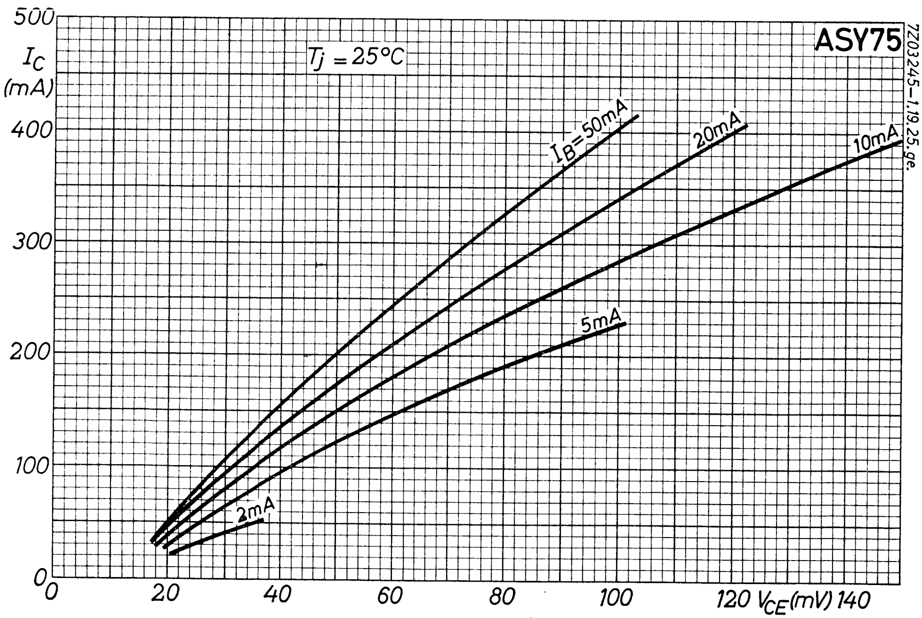

ASY75
7Z03242–1.19.25.ge.
I_C (mA)
400
200
I_B = 4.5mA
4mA
3.5mA
3mA
2.5mA
2mA
1.5mA
1mA
0.5mA
V_{CB}=0
7.5
I_B (mA)
2.5
0
2
4
6
V_{CE}(V)
8
0.5
V_{BE} (V)

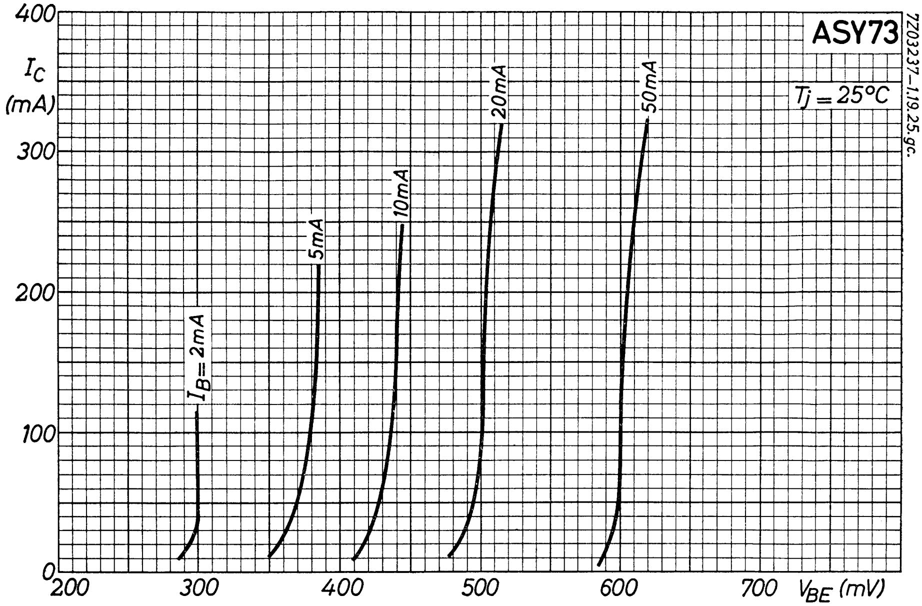

ASY73
7Z03236–1.19.25.gc.
500
I_C (mA)
400
300
200
100
0
T_j = 25°C
I_B=50mA
20mA
10mA
5mA
2mA
0
20
40
60
80
100
120 V_{CE}(mV) 140

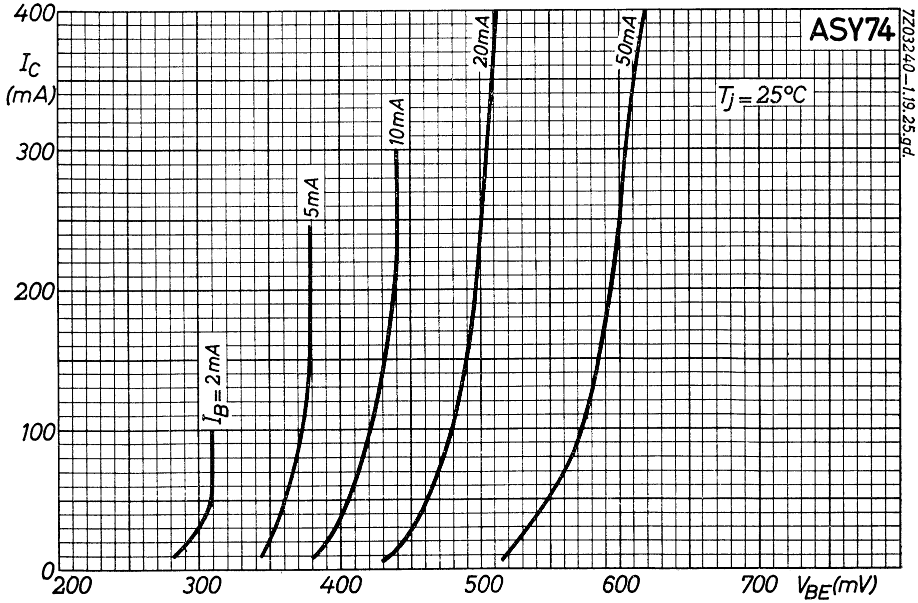
3.3.1965

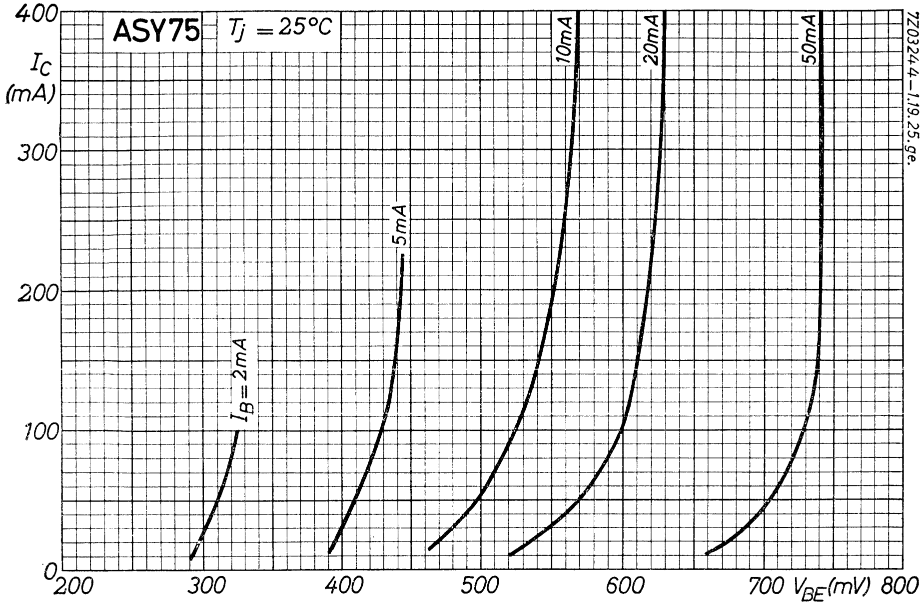
B

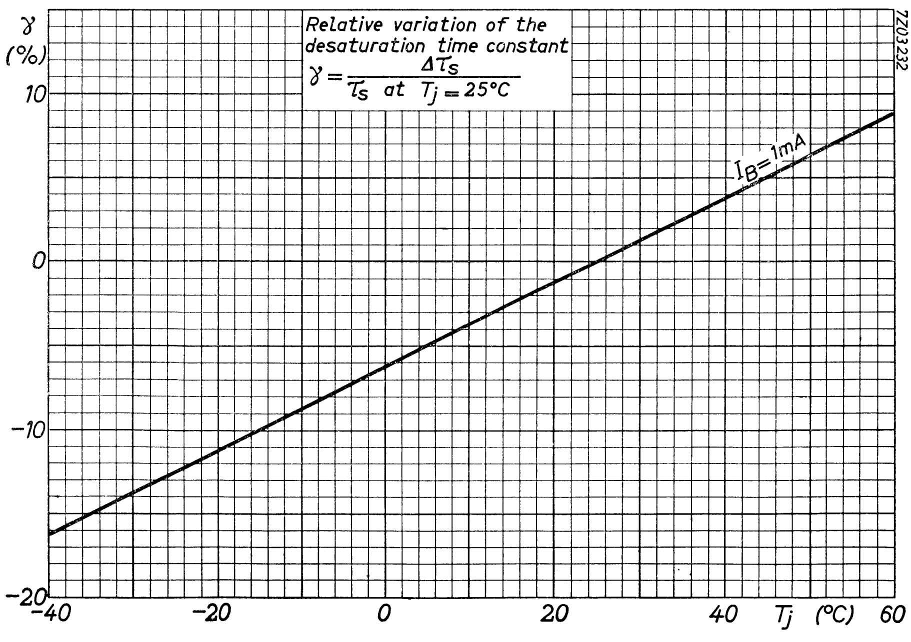

ASY74
7Z03241-1.19.25.gd.
I_C (mA)
$T_j = 25°C$
I_B=50mA
20mA
10mA
5mA
2mA
400
300
200
100
0
0
50
100
150
200
250
V_{CE}(mV)

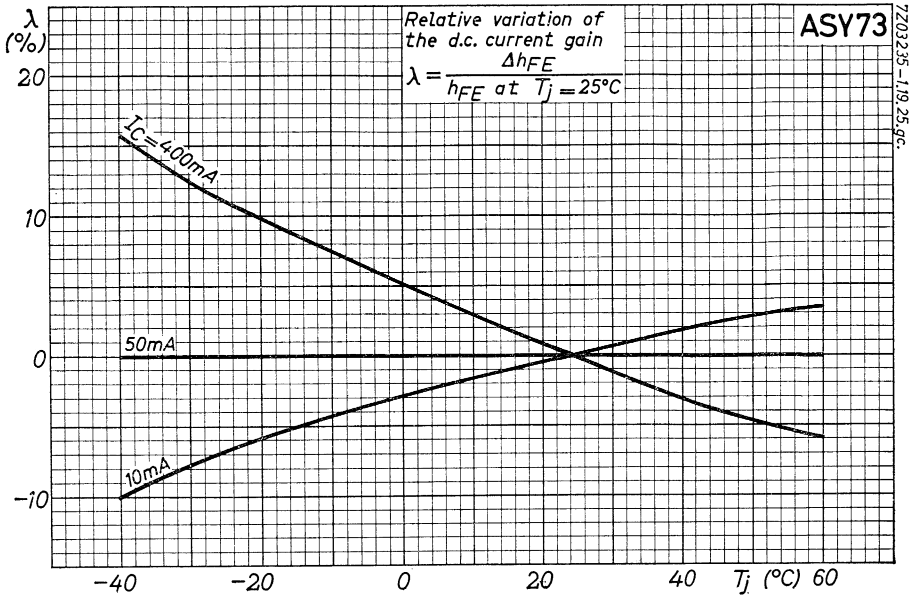

ASY75
7Z03245-1.19.25.ge.
I_C (mA)
$T_j = 25°C$
I_B=50mA
20mA
10mA
5mA
2mA
500
400
300
200
100
0
0
20
40
60
80
100
120
V_{CE}(mV)
140

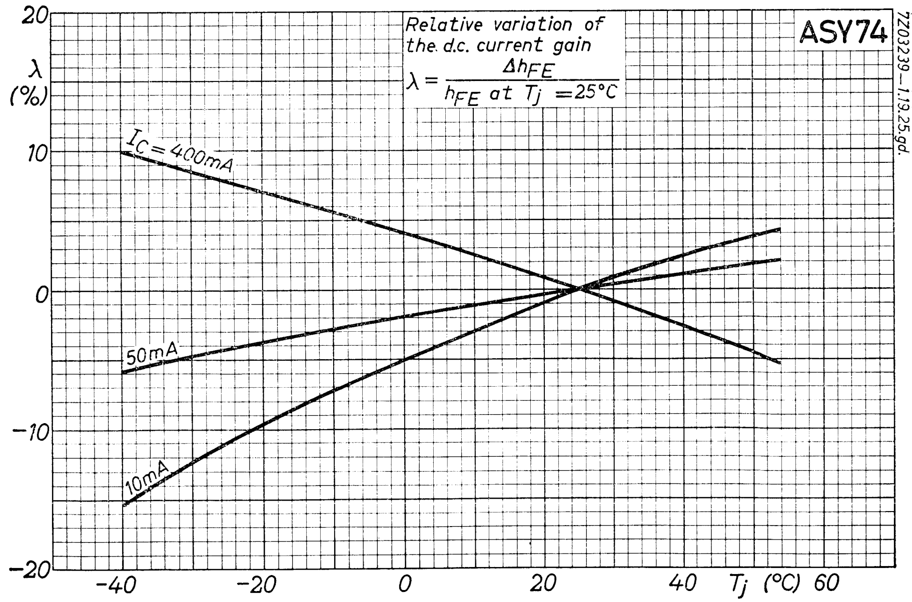

ASY73
$T_j = 25°C$
7Z03237–1.19.25.gc.
I_C (mA)
400
300
200
100
0
$I_B = 2mA$
5mA
10mA
20mA
50mA
200
300
400
500
600
700
V_{BE} (mV)

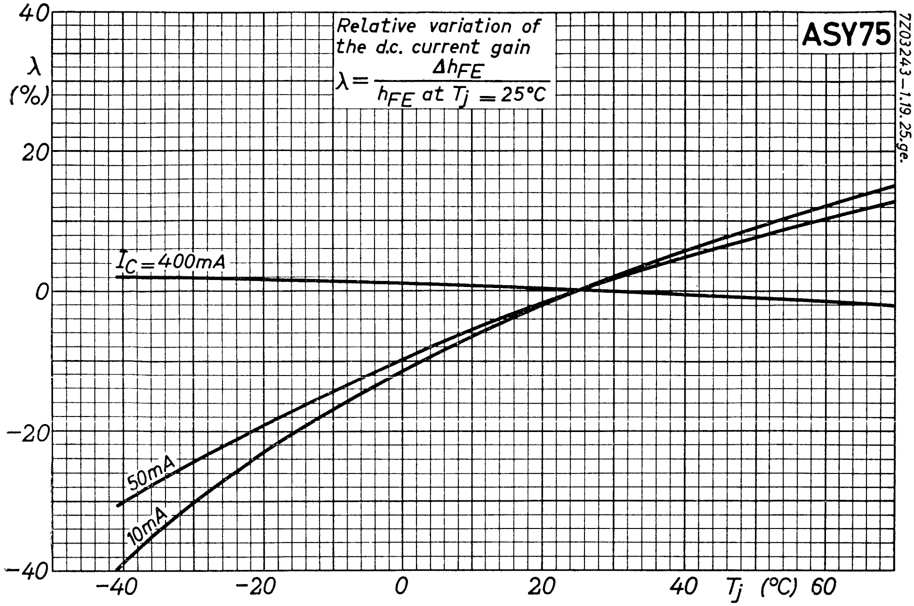

ASY74
$T_j = 25°C$
7Z03240–1.19.25.gd.
I_C (mA)
400
300
200
100
0
$I_B = 2mA$
5mA
10mA
20mA
50mA
200
300
400
500
600
700
V_{BE} (mV)


ASY75
$T_j = 25°C$
I_C (mA)
400
300
200
100
0
$I_B = 2mA$
5mA
10mA
20mA
50mA
200
300
400
500
600
700
V_{BE}(mV)
800
7Z03244-1.19.25.ge.

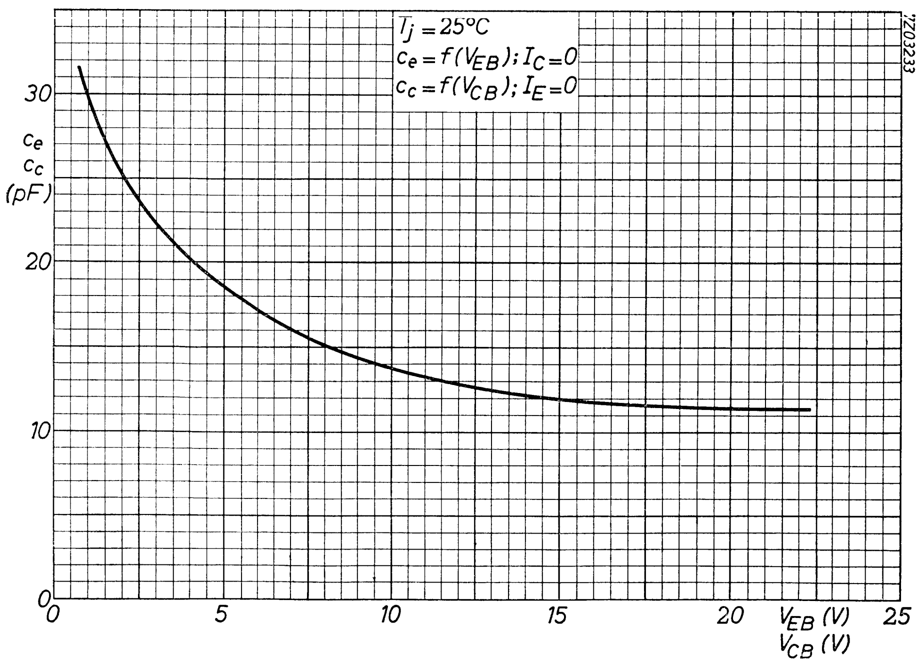

Relative variation of the
desaturation time constant
$\gamma = \frac{\Delta\tau_s}{\tau_s \text{ at } T_j = 25°C}$
γ
(%)
10
0
−10
−20
I_B=1mA
−40
−20
0
20
40
T_j (°C)
60
7Z03232


Relative variation of
the d.c. current gain
$\lambda = \frac{\Delta h_{FE}}{h_{FE} \text{ at } T_j = 25°C}$
ASY73
7Z03235–1.19.25.gc.
λ
(%)
20
10
0
−10
I_C = 400mA
50mA
10mA
−40
−20
0
20
40
T_j (°C)
60

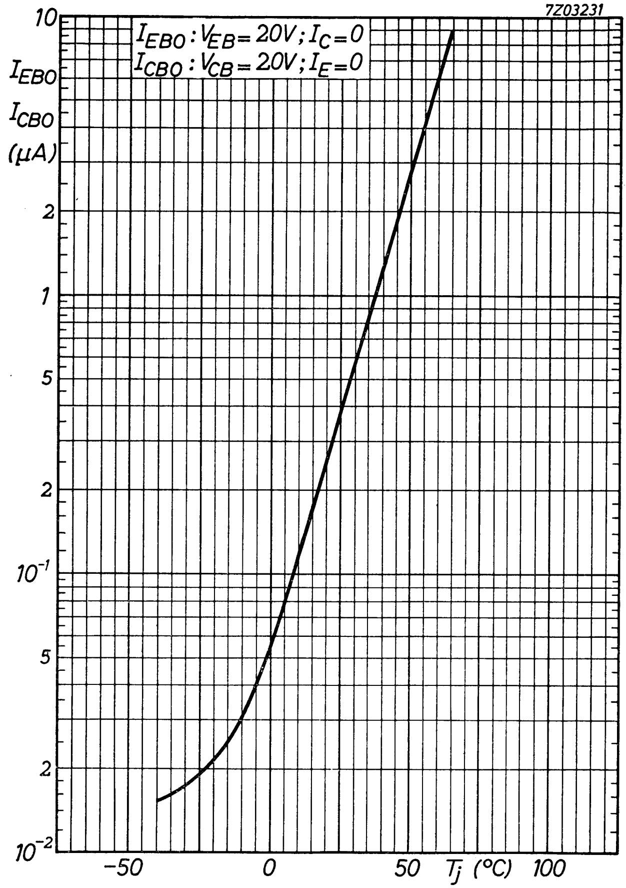

Relative variation of
the d.c. current gain
$\lambda = \frac{\Delta h_{FE}}{h_{FE} \text{ at } T_j = 25°C}$
ASY74
7Z03239–1.19.25.gd.
λ
(%)
20
10
0
−10
−20
I_C = 400mA
50mA
10mA
−40
−20
0
20
40
T_j (°C)
60

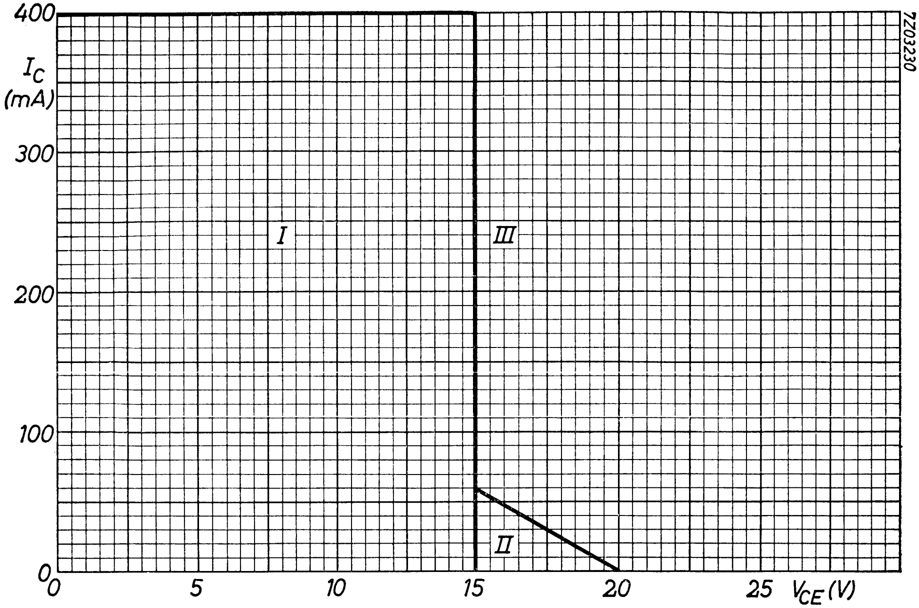


Relative variation of the d.c. current gain
$\lambda = \frac{\Delta h_{FE}}{h_{FE} \text{ at } T_j = 25°C}$
ASY75
7Z03243-1.19.25.ge.
λ (%)
40
20
0
−20
−40
I_C = 400mA
50mA
10mA
−40
−20
0
20
40
T_j (°C)
60



T_j = 25°C
$c_e = f(V_{EB})$; $I_C = 0$
$c_c = f(V_{CB})$; $I_E = 0$
7Z03233
c_e
c_c
(pF)
30
20
10
0
0
5
10
15
20
V_{EB} (V)
V_{CB} (V)
25


7Z03231
I_{EBO} : V_{EB} = 20V ; I_C = 0
I_{CBO} : V_{CB} = 20V ; I_E = 0
10
I_{EBO}
I_{CBO}
(μA)
2
1
5
2
10^{-1}
5
2
10^{-2}
−50
0
50
T_j (°C)
100



NOTES

I permissible region of operation under all base-emitter conditions

II additional region of operation when the transistor is cut-off

III during switching-off with inductive loads voltages, higher than those indicated by area I and area II, are allowed, provided the inductive load is less than 250 μH and $0.2\ V < -V_{BE} < 2\ V$

7Z2 3096

P-N-P GERMANIUM POWER TRANSISTOR

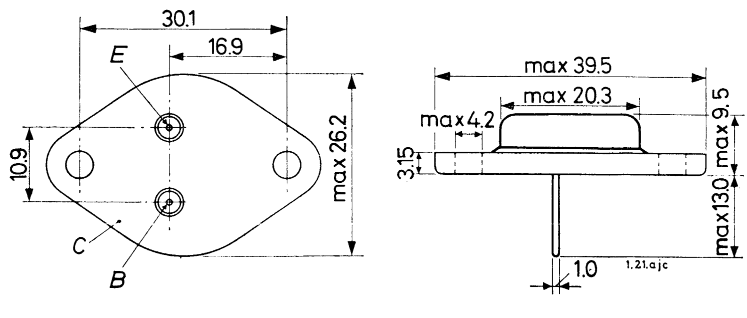
Germanium alloy-diffused power transistor of the p-n-p type in TO-3 metal case, primarily intended for use in line-deflection output circuits of television receivers.

QUICK REFERENCE DATA				
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	155	V
Collector-emitter voltage ($+V_{BE}$ = 1 V)	$-V_{CEX}$	max.	155	V
Collector current (peak value)	$-I_{CM}$	max.	10	A
Total dissipation up to T_{mb} = 85 °C	P_{tot}	max.	10	W
Junction temperature	T_j	max.	90	°C
Emitter-base breakdown voltage $-I_E$ = 100 mA (open collector)	$-V_{(BR)EBO}$	>	4	V
D.C. current gain at T_j = 25 °C $-I_C$ = 10 A; $-V_{CE}$ = 1 V	h_{FE}	>	15	
Transition frequency at T_j = 25 °C $-I_C$ = 0.5 A; $-V_{CE}$ = 2 V	f_T	typ.	15	Mc/s
Fall time	t_f	<	1.7	μs
Thermal resistance	$R_{th\ j\text{-}mb}$	=	1.5	°C/W

MECHANICAL DATA Dimensions in mm

TO-3

Collector connected to case



Accessories see page 5 7Z2 3412

RATINGS (Limiting values) [1]

Voltages

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	155	V
Collector-emitter voltage with $+V_{BE}$ = 1 V (See also page A)	$-V_{CEX}$	max.	155	V

Currents

Collector current (d.c.)	$-I_C$	max.	10	A
Collector current (peak value)	$-I_{CM}$	max.	10	A [2]
Emitter current (d.c.)	I_E	max.	12.5	A
Emitter current (peak value)	I_{EM}	max.	12.5	A
Base current (d.c.)	$-I_B$	max.	2.5	A
Base current (peak value)	$-I_{BM}$	max.	2.5	A
Reverse base current (d.c.)	$+I_B$	max.	0.1	A
Reverse base current (peak value) t = max. 5 μs	$+I_{BM}$	max.	2.5	A

Power dissipation (See also page B)

Total power dissipation up to T_{mb} = 85 °C	P_{tot}	max.	10	W

Temperatures

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

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j-mb}$	=	1.5	°C/W
From mounting base to heatsink without mica washer	$R_{th\ mb-h}$	=	0.2	°C/W
with mica washer	$R_{th\ mb-h}$	=	0.5	°C/W

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

[2] Non repetitive peak collector current: 20 A

7Z2 3413

CHARACTERISTICS T_j = 25 °C

Collector cut-off current				
$I_E = 0$; $-V_{CB} = 155$ V	$-I_{CBO}$	<	10	mA
Base-emitter voltage				
$I_E = 10$ A; $-V_{CB} = 0.5$ V	$-V_{BE}$	<	0.75	V
D.C. current gain				
$-I_C = 10$ A; $-V_{CE} = 1$ V	h_{FE}	>	15	
Emitter-base breakdown voltage				
$I_C = 0$; $-I_E = 100$ mA	$-V_{(BR)EBO}$	>	4	V

CHARACTERISTIC RANGE VALUES FOR EQUIPMENT DESIGN

T_j = 25 °C unless otherwise specified

Collector cut-off current				
$I_E = 0$; $-V_{CB} = 155$ V; $T_j = 100$ °C	$-I_{CBO}$	<	60	mA
Collector-emitter saturation voltage				
(See also page D)				
$-I_C = 10$ A; $-I_B = 0.8$ A	$-V_{CEsat}$	<	0.7	V
Transition frequency				
$-I_C = 0.5$ A; $-V_{CE} = 2$ V	f_T	typ.	15	Mc/s
Switching times for $-I_C = 10$ A when switched from $-I_B = 0.8$ A to $V_{BE} = 4$ V (See also page 4 and page E)				
Storage time	t_s	<	3	μs
Fall time	t_f	<	1.7	μs

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MEASUREMENT OF SWITCHING TIMES

Fig.1: Circuit diagram

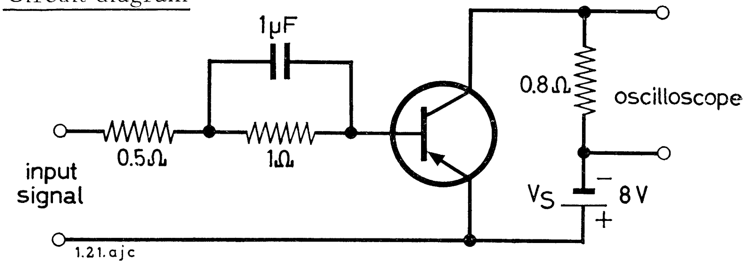


Fig.2: Input signal

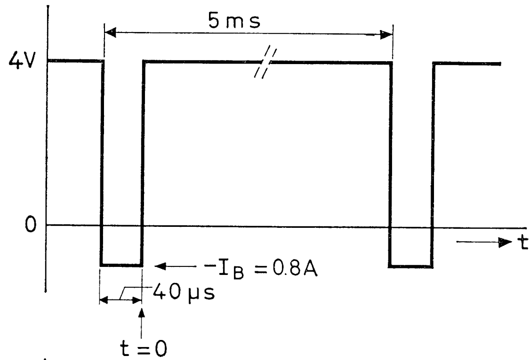
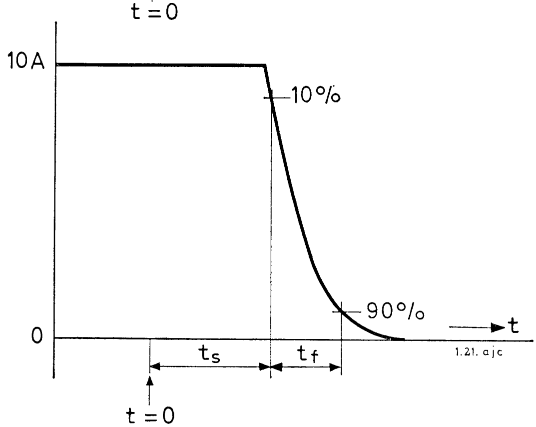


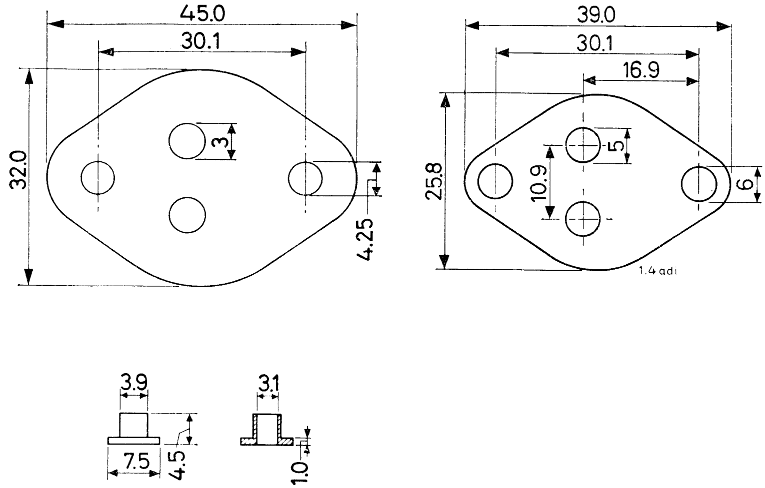
Fig.3: Output signal



7Z2 3415

7.7.1965

ACCESSORIES

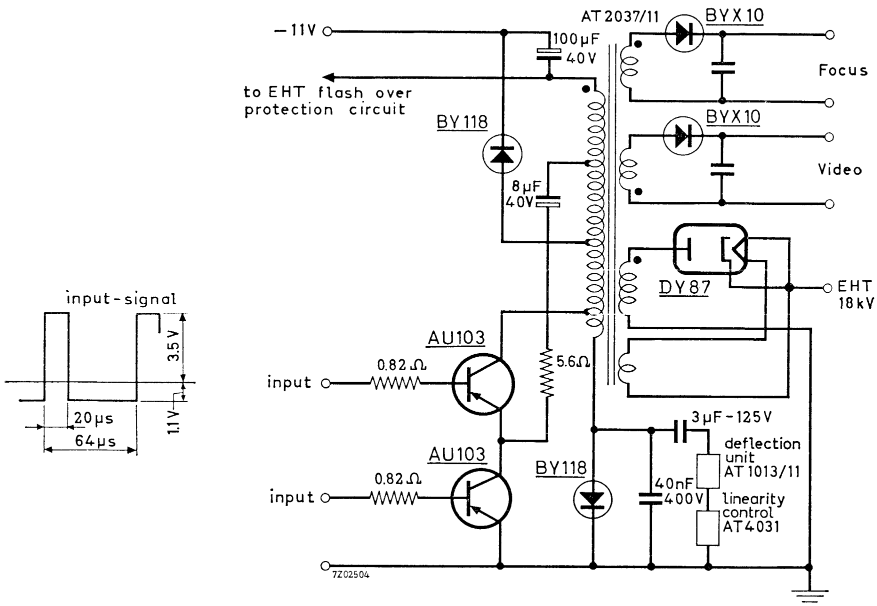


Codenumber 56201a
Mica insulation (50 μm)
and insulation tubes

Codenumber 56201b
Lead washer (1 mm)

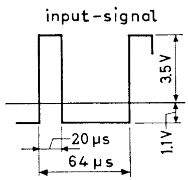
7Z2 3416

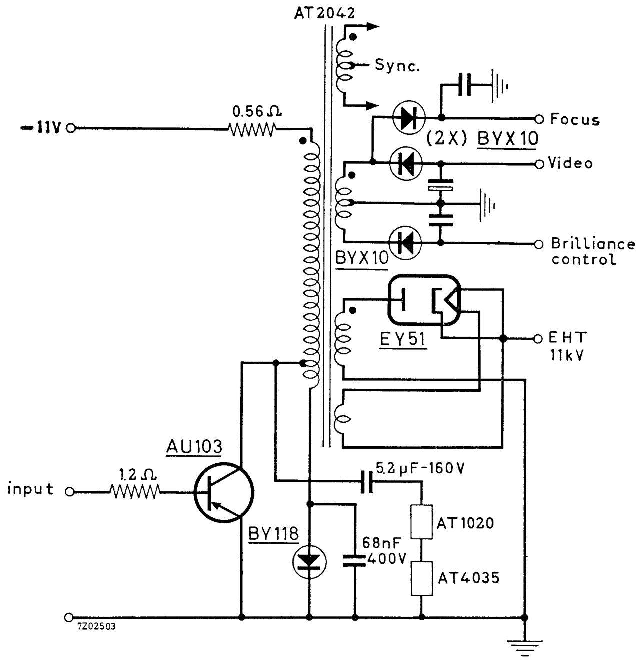
APPLICATION INFORMATION



Circuit I : Typical parallel-series efficiency circuit for 110° deflection with an E.H.T. of 18 kV and a flyback ratio of 18%

APPLICATION INFORMATION (continued)

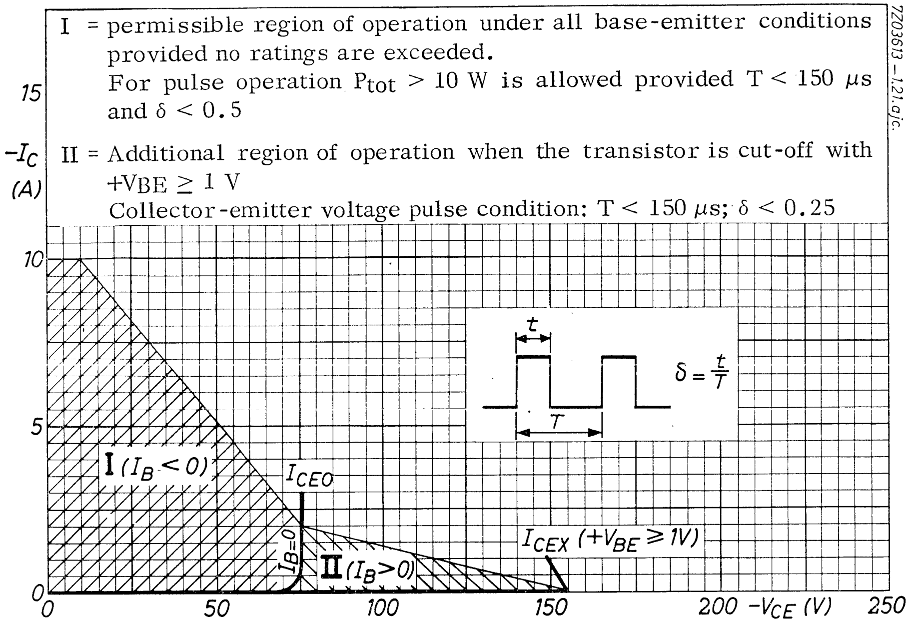


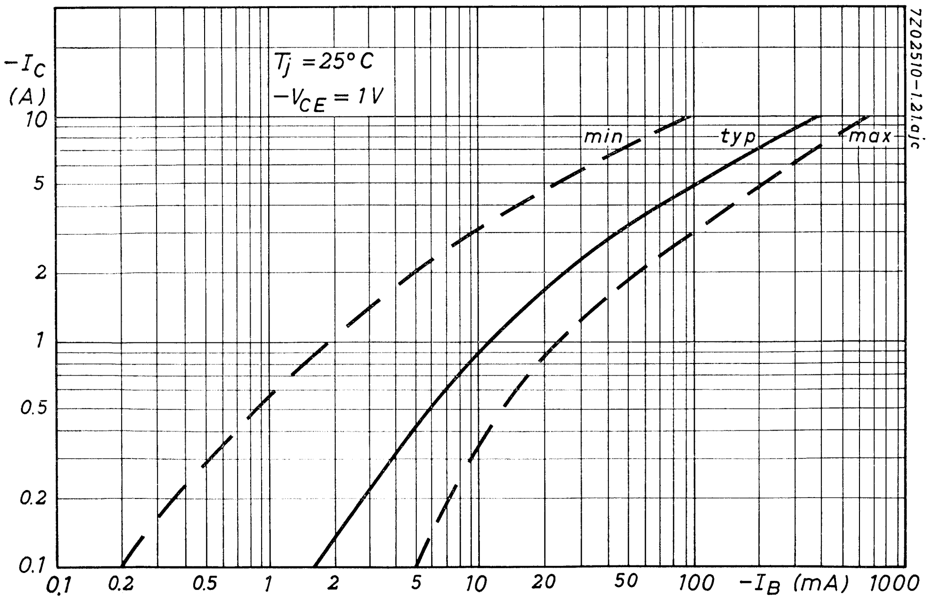


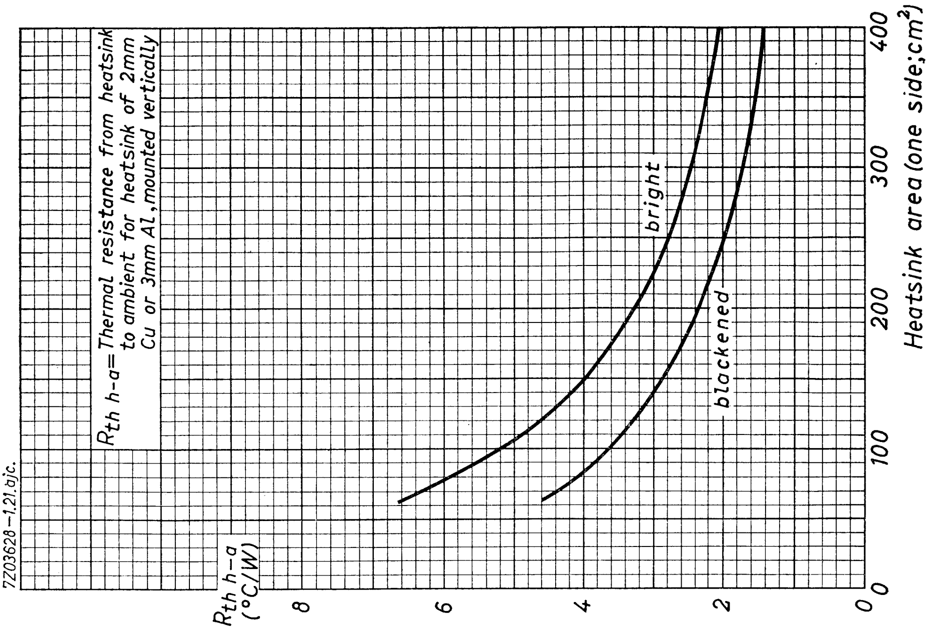
Circuit II: Typical parallel efficiency circuit for 90° deflection with an E.H.T. of 11 kV and a flyback ratio of 17.5%

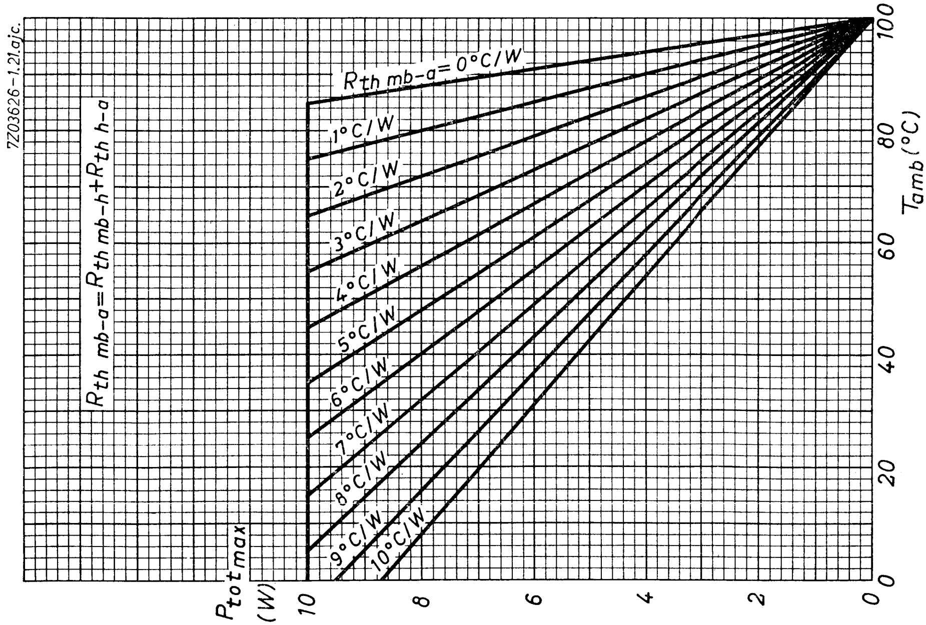
MORE INFORMATION IS AVAILABLE IN
APPLICATION INFORMATION
BULLETINS AI 242 AND AI 243

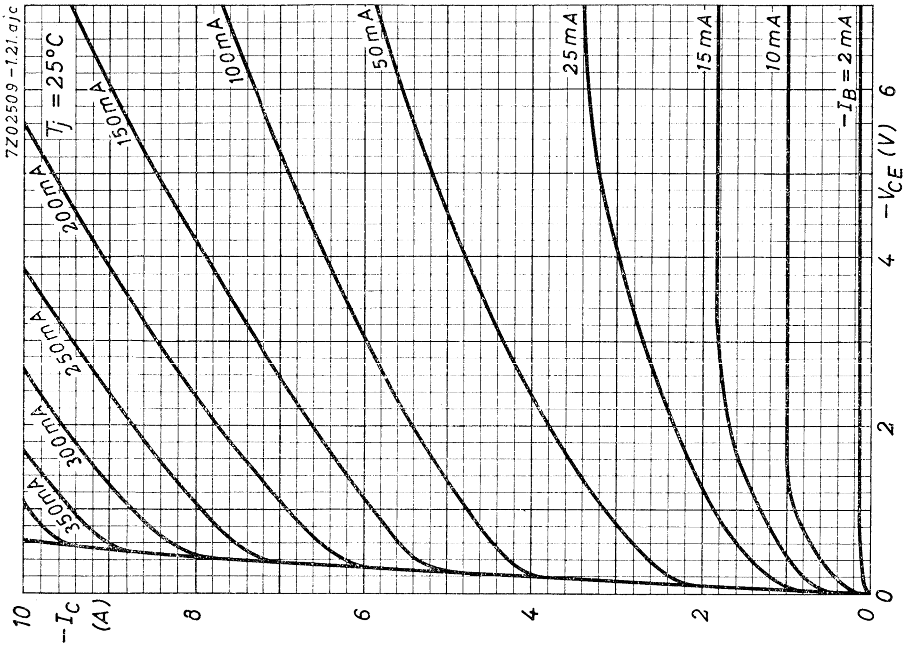
7Z2 3418

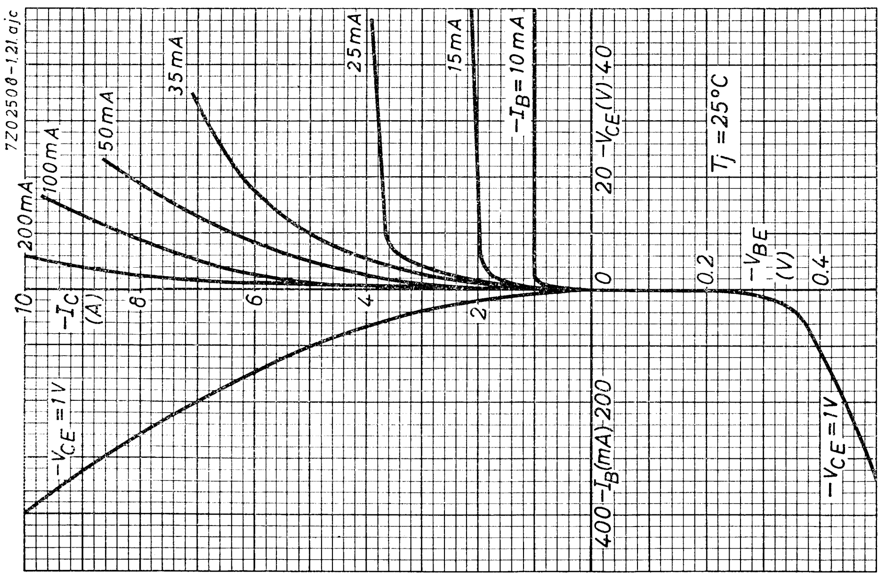

I = permissible region of operation under all base-emitter conditions provided no ratings are exceeded.
For pulse operation Ptot > 10 W is allowed provided T < 150 μs and δ < 0.5
II = Additional region of operation when the transistor is cut-off with +VBE ≥ 1 V
Collector-emitter voltage pulse condition: T < 150 μs; δ < 0.25
7Z03613-1.21.a/c.
15
−IC
(A)
10
5
0
I (IB < 0)
ICEO
IB=0
II (IB>0)
ICEX (+VBE ≥ 1V)
t
T
δ = t/T
0
50
100
150
200 −VCE (V)
250

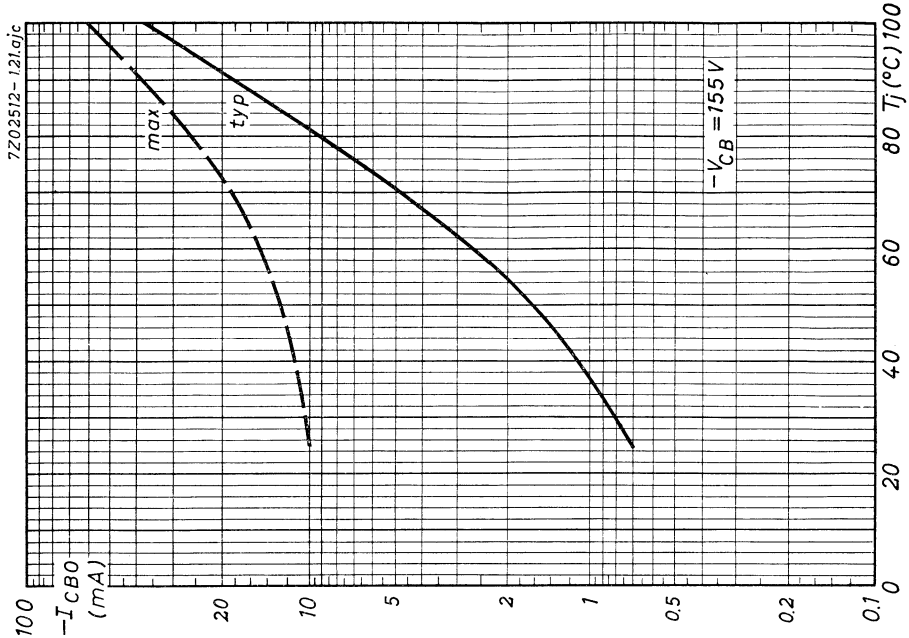

7Z02510-1.21.a/c
−IC
(A)
10
5
2
1
0.5
0.2
0.1
Tj = 25° C
−VCE = 1 V
min
typ
max
0.1
0.2
0.5
1
2
5
10
20
50
100
−IB (mA)
1000

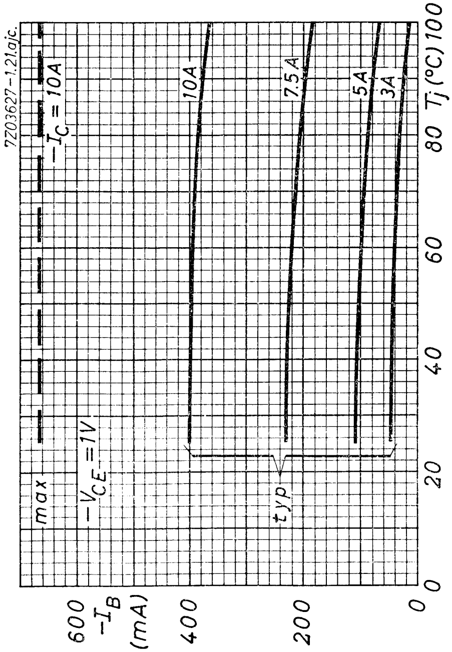

7Z03628-1.21.ajc.
R th h-a = Thermal resistance from heatsink to ambient for heatsink of 2mm Cu or 3mm Al, mounted vertically
bright
blackened
R th h-a (°C/W)
8
6
4
2
0
0
100
200
300
400
Heatsink area (one side; cm²)

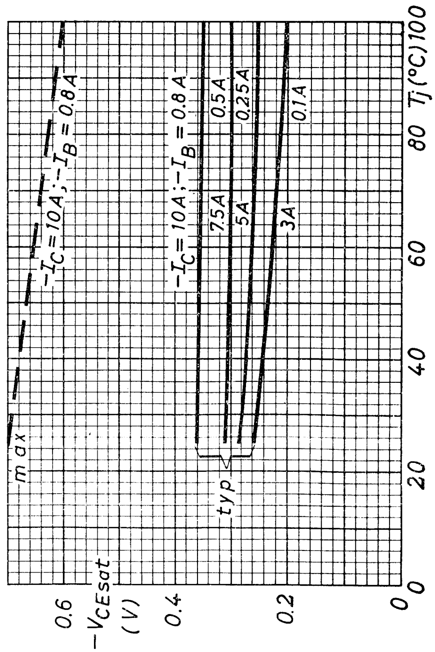

7Z03626-1.21.ajc.
R th mb-a = R th mb-h + R th h-a
R th mb-a = 0°C/W
1°C/W
2°C/W
3°C/W
4°C/W
5°C/W
6°C/W
7°C/W
8°C/W
9°C/W
10°C/W
P tot max (W)
10
8
6
4
2
0
0
20
40
60
80
100
T amb (°C)

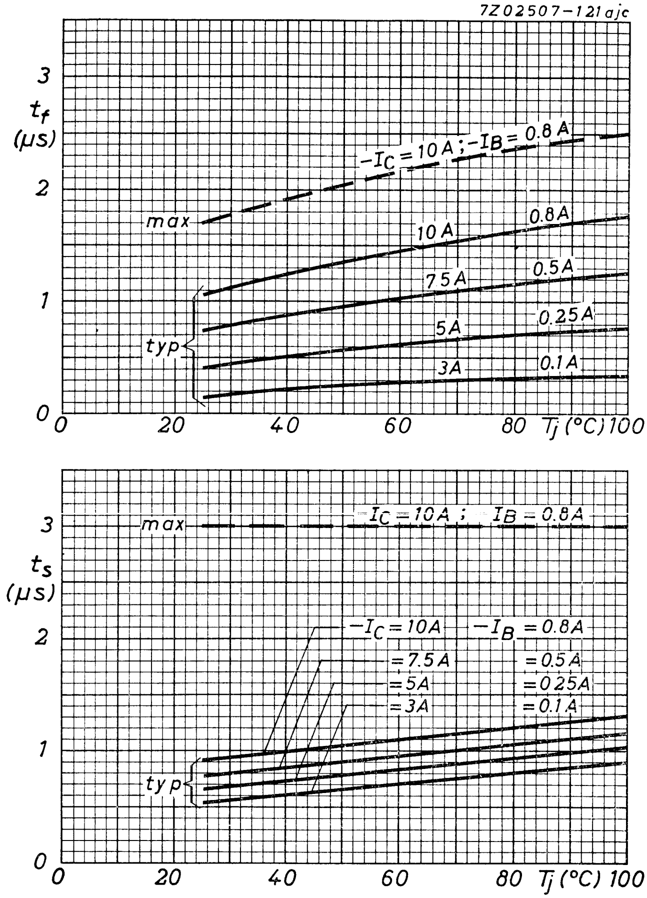

7Z02509-1.21.ajc
$T_j = 25°C$
$-I_B = 2\,mA$
10 mA
15 mA
25 mA
50 mA
100 mA
150 mA
200 mA
250 mA
300 mA
350 mA
$-I_C$ (A)
$-V_{CE}$ (V)
0
2
4
6
8
10


7Z02508-1.21.ajc
$T_j = 25°C$
$-I_B = 10\,mA$
15 mA
25 mA
35 mA
50 mA
100 mA
200 mA
$-I_C$ (A)
$-V_{CE}$ (V)
$-I_B$ (mA)
$-V_{BE}$ (V)
$-V_{CE} = 1V$
$-V_{CE} = 1V$
0
2
4
6
8
10
20
40
200
400
0.2
0.4


7Z02512 - 1.21.ajc
$-I_{CBO}$ (mA)
100
20
10
5
2
1
0.5
0.2
0.1
max
typ
$-V_{CB} = 155\,V$
0
20
40
60
80
100
T_j (°C)


7Z03627 - 1.21.ajc.
$-I_B$ (mA)
600
400
200
0
max
$-I_C = 10\,A$
$-V_{CE} = 1\,V$
10A
7.5A
5A
3A
typ
0
20
40
60
80
100
T_j (°C)


$-V_{CEsat}$ (V)
0.6
0.4
0.2
0
max
$-I_C = 10\,A; -I_B = 0.8\,A$
$-I_C = 10\,A; -I_B = 0.8\,A$
7.5A
5A
3A
0.5A
0.25A
0.1A
typ
0
20
40
60
80
100
T_j (°C)



7Z02507-121ajc
t_f (μs)
$-I_C = 10A; -I_B = 0.8A$
max
10 A
0.8A
7.5A
0.5A
5A
0.25A
3A
0.1A
typ
T_j (°C)
max
$-I_C = 10A$; $-I_B = 0.8A$
t_s (μs)
$-I_C = 10A$
$-I_B = 0.8A$
$= 7.5A$
$= 0.5A$
$= 5A$
$= 0.25A$
$= 3A$
$= 0.1A$
typ
T_j (°C)

E

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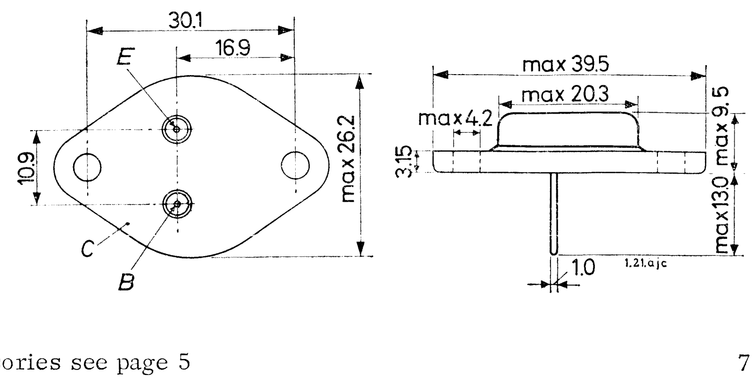
P-N-P GERMANIUM POWER TRANSISTOR

Germanium alloy-diffused power transistor of the p-n-p type in TO-3 metal case, primarily intended for use in line-deflection output circuits of television receivers.

QUICK REFERENCE DATA				
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	185	V
Collector-emitter voltage ($+V_{BE}$ = 1 V)	$-V_{CEX}$	max.	185	V
Collector current (peak value)	$-I_{CM}$	max.	12	A
Total dissipation up to T_{mb} = 77.5 °C	P_{tot}	max.	15	W
Junction temperature	T_j	max.	90	°C
Emitter-base breakdown voltage $-I_E$ = 100 mA (open collector)	$-V_{(BR)EBO}$	>	4	V
D.C. current gain at T_j = 25 °C $-I_C$ = 12 A; $-V_{CE}$ = 1 V	h_{FE}	>	14	
Transition frequency at T_j = 25 °C $-I_C$ = 0.5 A; $-V_{CE}$ = 2 V	f_T	typ.	15	Mc/s
Fall time	t_f	<	1.8	μs
Thermal resistance	$R_{th\ j\text{-}mb}$	=	1.5	°C/W

MECHANICAL DATA Dimensions in mm

TO-3
Collector connected to case



Accessories see page 5 7Z2 3433

RATINGS (Limiting values) [1])

Voltages

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	185	V
Collector-emitter voltage with $+V_{BE}$ = 1 V (See also page A)	$-V_{CEX}$	max.	185	V

Currents

Collector current (d.c.)	$-I_C$	max.	12	A
Collector current (peak value)	$-I_{CM}$	max.	12	A [2])
Emitter current (d.c.)	I_E	max.	14.5	A
Emitter current (peak value)	I_{EM}	max.	15.5	A
Base current (d.c.)	$-I_B$	max.	2.5	A
Base current (peak value)	$-I_{BM}$	max.	3.5	A
Reverse base current (d.c.)	$+I_B$	max.	0.1	A
Reverse base current (peak value) t = max. 5 μs	$+I_{BM}$	max.	3.0	A

Power dissipation (See also page A)

Total power dissipation up to T_{mb} = 77.5 °C	P_{tot}	max.	15	W

Temperatures

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

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	1.5	°C/W
From mounting base to heatsink with lead washer, without mica washer	$R_{th\ mb\text{-}h}$	=	0.2	°C/W
with lead washer and mica washer	$R_{th\ mb\text{-}h}$	=	0.5	°C/W

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

2) Non repetitive peak collector current: 25 A.

7Z2 3434

CHARACTERISTICS

T_j = 25 °C

Collector cut-off current				
$I_E = 0$; $-V_{CB} = 185$ V	$-I_{CBO}$	<	10	mA
Base-emitter voltage				
$I_E = 10$ A; $-V_{CB} = 0.5$ V	$-V_{BE}$	<	0.75	V
D.C. current gain				
$-I_C = 10$ A; $-V_{CE} = 1$ V	h_{FE}	>	15	
Emitter-base breakdown voltage				
$I_C = 0$; $-I_E = 100$ mA	$-V_{(BR)EBO}$	>	4	V

CHARACTERISTIC RANGE VALUES FOR EQUIPMENT DESIGN

T_j = 25 °C unless otherwise specified

Collector cut-off current				
$I_E = 0$; $-V_{CB} = 185$ V; $T_j = 100$ °C	$-I_{CBO}$	<	60	mA
Base-emitter voltage				
$-I_C = 12$ A; $-V_{CE} = 1$ V	$-V_{BE}$	<	0.95	V
Saturation voltages (See also page D)				
$-I_C = 12$ A; $-I_B = 1.3$ A	$-V_{CEsat}$	<	0.85	V
	$-V_{BEsat}$	<	0.85	V
D.C. current gain				
$-I_C = 12$ A; $-V_{CE} = 1$ V	h_{FE}	>	14	
Transition frequency				
$-I_C = 0.5$ A; $-V_{CE} = 2$ V	f_T	typ.	15	Mc/s
Switching times for $-I_C = 12$ A when switched from $-I_B = 1.3$ A to $+V_{BE} = 4$ V (See also page 4 and page E)				
Storage time	t_s	<	3	μs
Fall time	t_f	<	1.8	μs

7Z2 3435

MEASUREMENT OF SWITCHING TIMES

Fig. 1: Circuit diagram

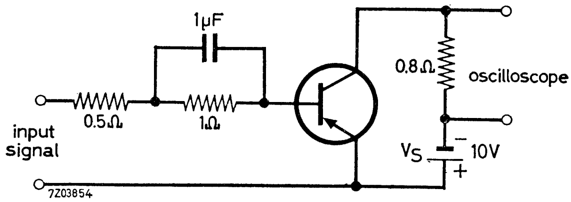


Fig. 2: Input signal

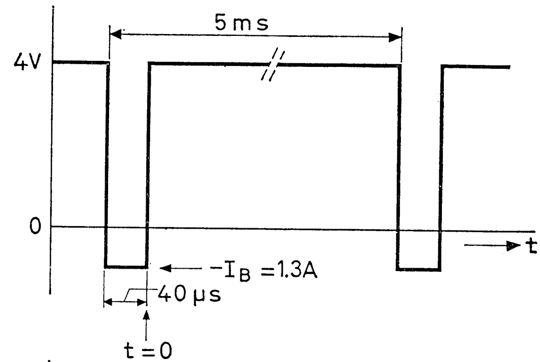
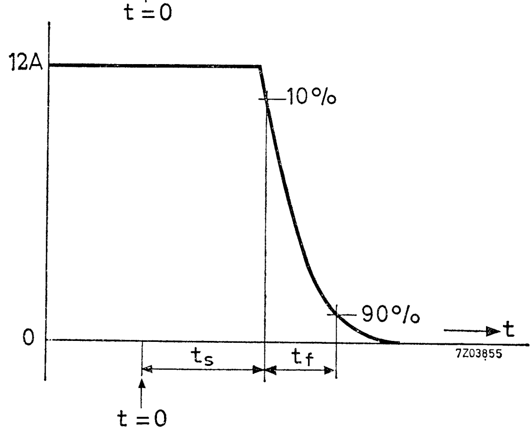


Fig. 3: Ouput signal



7Z2 3436

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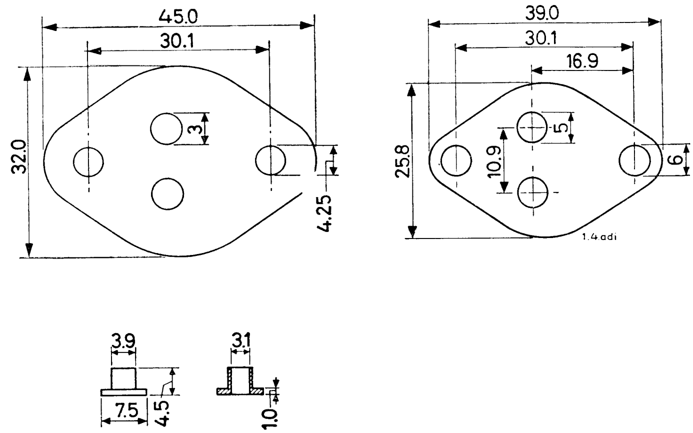
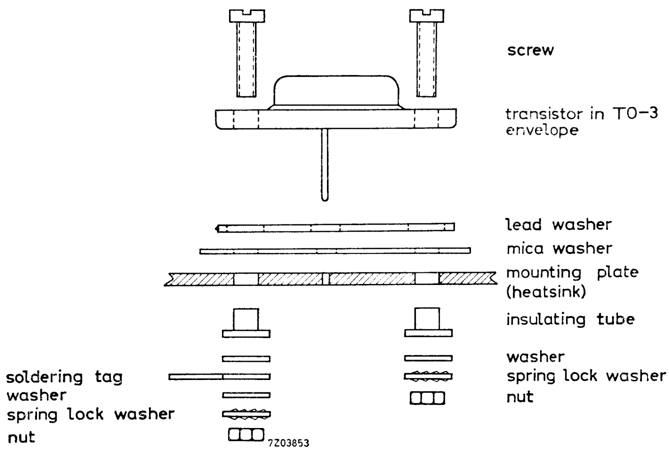
ACCESSORIES



Codenumber 56201a
Mica insulation (50 μm)
and insulation tubes

Codenumber 56201b
Lead washer (1 mm)

MOUNTING INSTRUCTIONS



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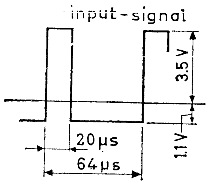
1) For non-insulated mounting, remove mica washer

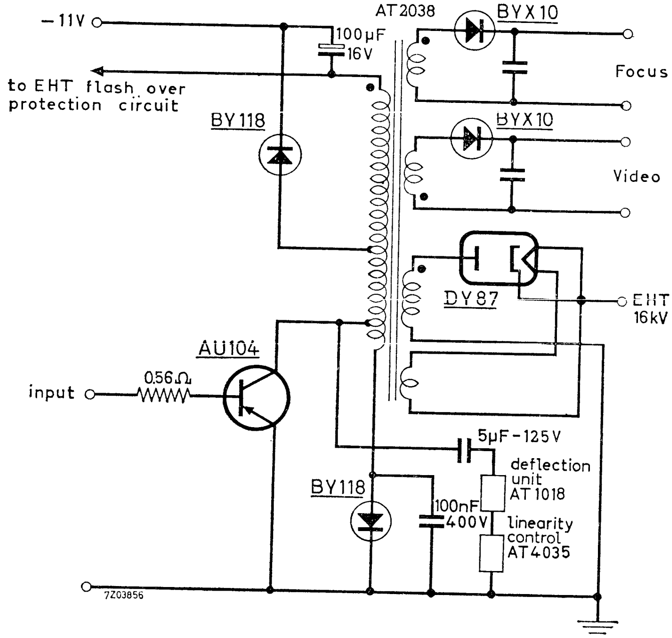
2) Maximum torque on nut: 5 cmKg.

3) For better heat transfer to the heatsink, use heatsink compound between the contact surfaces (e.g. Dow Corning 340).

4) For maximum cooling, the heatsink should be mounted vertically. 7Z2 3437

APPLICATION INFORMATION





Typical parallel-series efficiency circuit for 110° deflection with an E.H.T. of 16 kV and a flyback ratio of 19.5 %

<u>MORE INFORMATION IS AVAILABLE IN</u>
<u>APPLICATION INFORMATION</u>
<u>BULLETINS AI 241, AI 244 AND AI 245</u>

7Z2 3438

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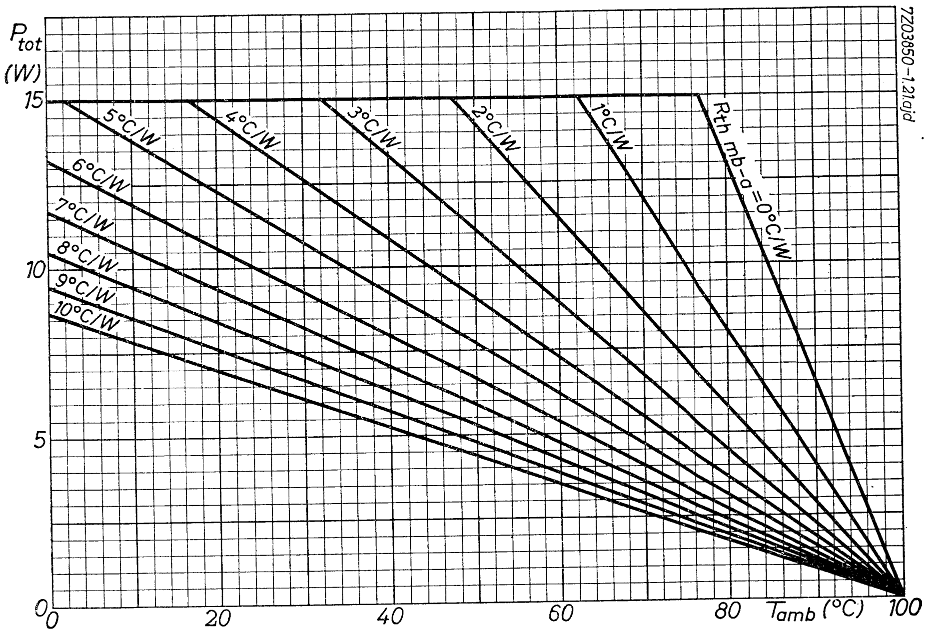
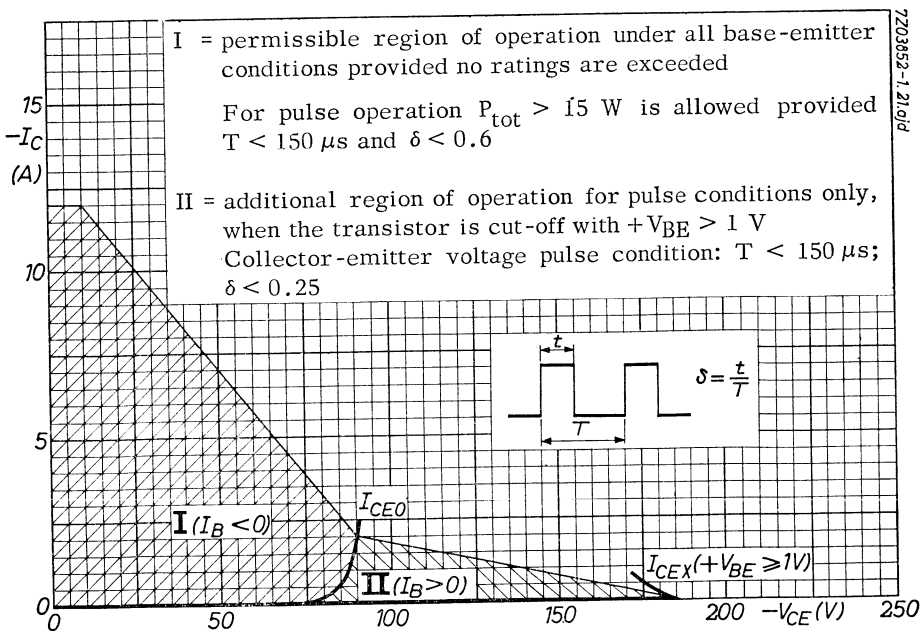
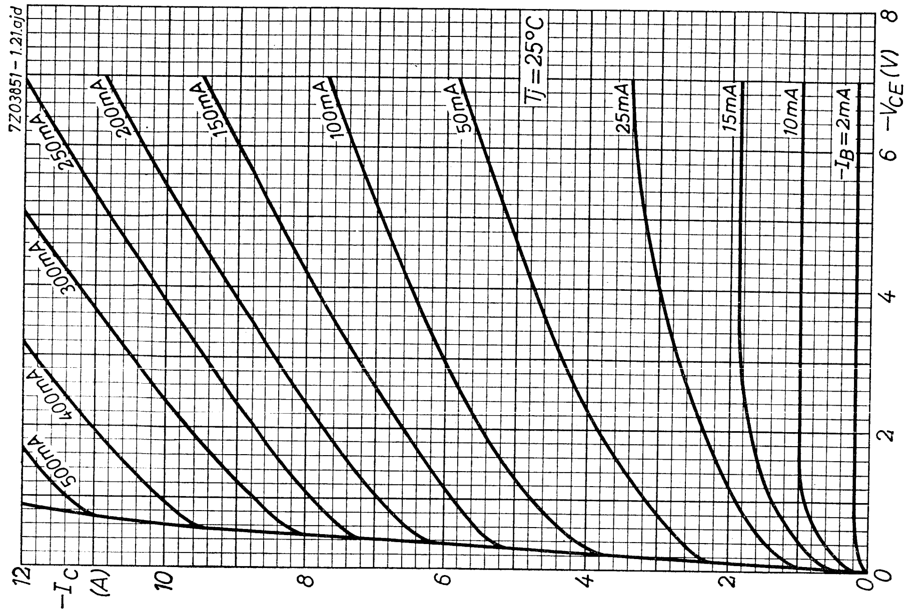
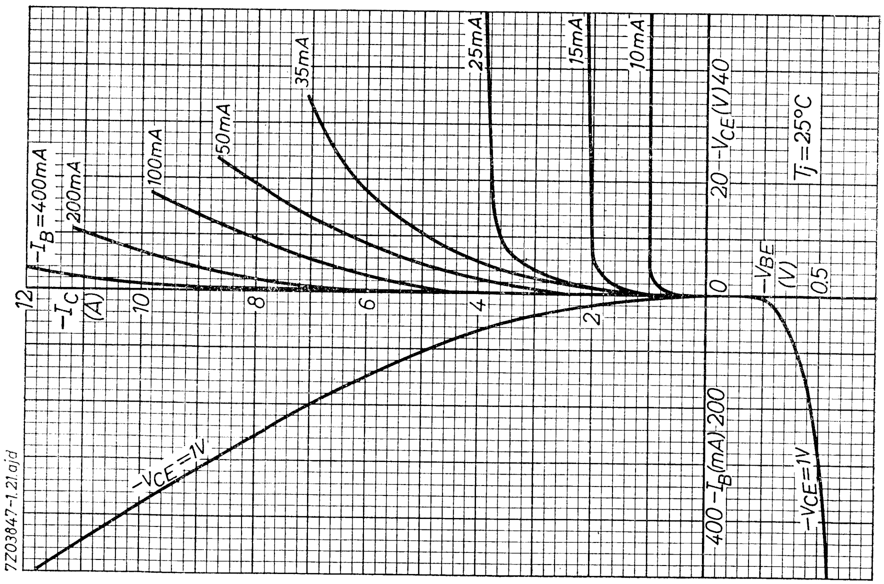
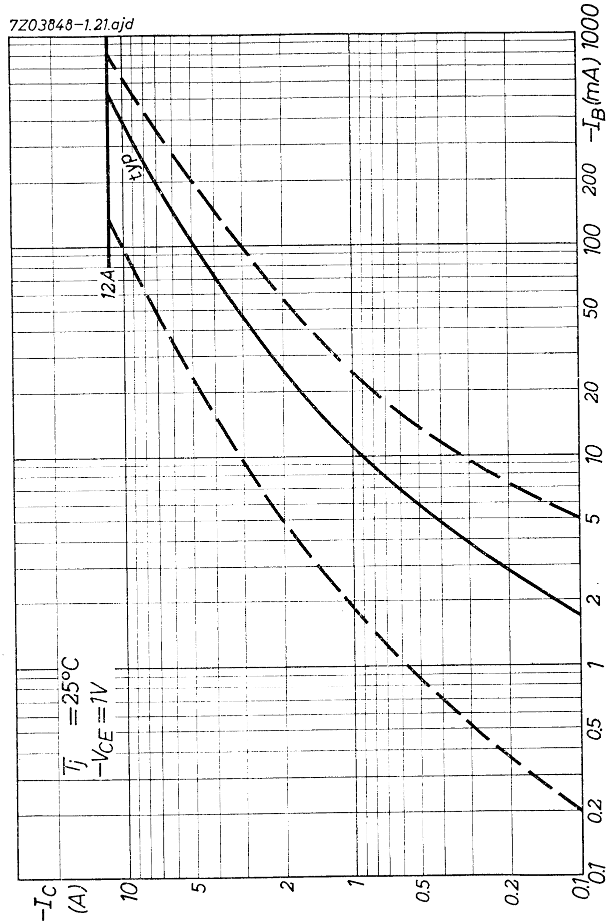
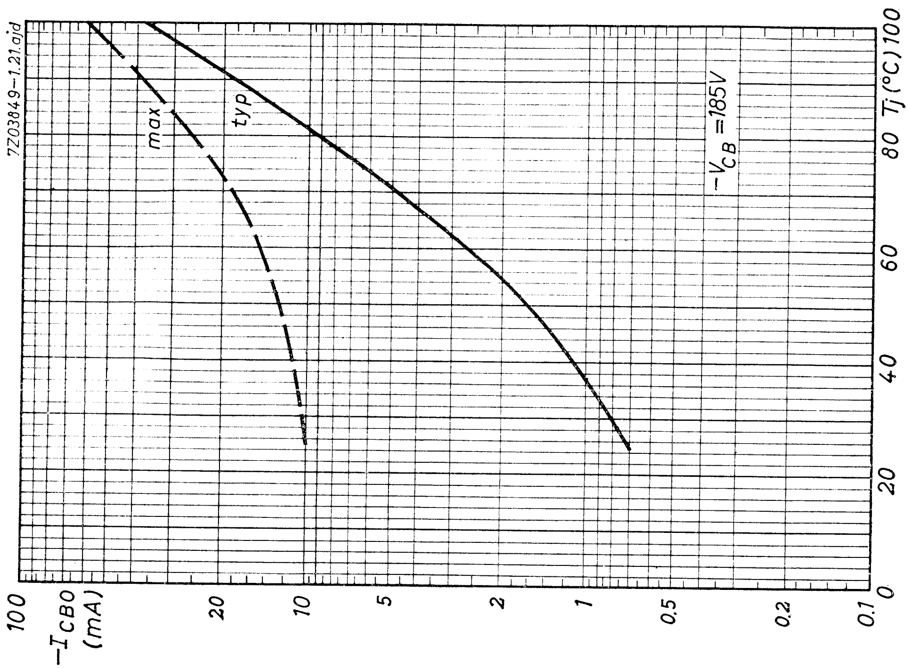

7Z03850-1.21ajd
P_{tot} (W)
15
10
5
0
0
20
40
60
80
T_{amb} (°C)
100
5°C/W
4°C/W
3°C/W
2°C/W
1°C/W
Rth mb-a = 0°C/W
6°C/W
7°C/W
8°C/W
9°C/W
10°C/W

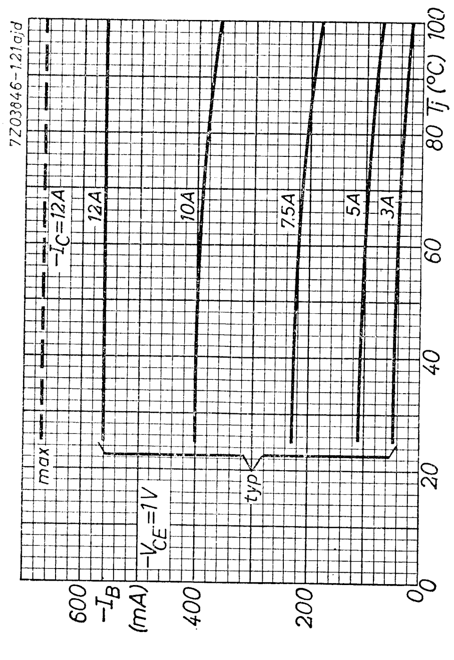

7Z03852-1.21ajd
I = permissible region of operation under all base-emitter conditions provided no ratings are exceeded
For pulse operation P_{tot} > 15 W is allowed provided T < 150 μs and δ < 0.6
II = additional region of operation for pulse conditions only, when the transistor is cut-off with $+V_{BE}$ > 1 V
Collector-emitter voltage pulse condition: T < 150 μs; δ < 0.25
t
T
$\delta = \frac{t}{T}$
$-I_C$ (A)
15
10
5
0
0
50
100
150
200
250
$-V_{CE}$ (V)
I_{CEO}
I (I_B < 0)
II (I_B > 0)
I_{CEX} ($+V_{BE}$ ≥ 1V)

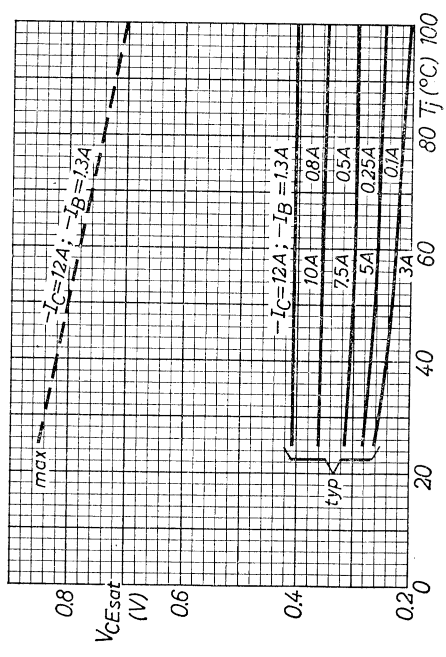

7Z03851 - 1.21.ajd
$T_j = 25°C$
$-I_C$ (A)
$-V_{CE}$ (V)
$-I_B = 2mA$
10mA
15mA
25mA
50mA
100mA
150mA
200mA
250mA
300mA
400mA
500mA

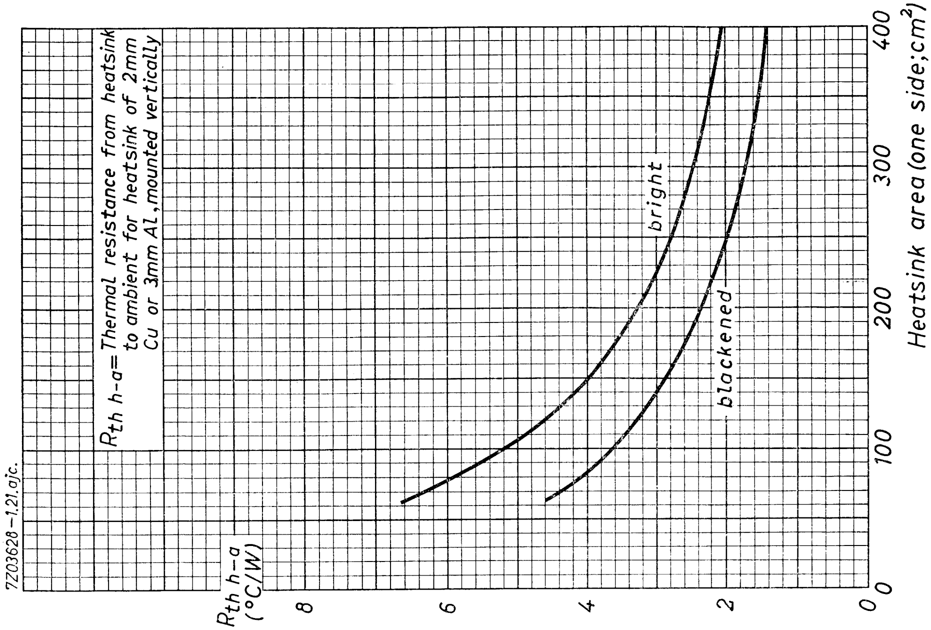

7Z03847-1.21.ajd
$T_j = 25°C$
$-I_C$ (A)
$-V_{CE}$ (V)
$-I_B$ (mA)
$-V_{BE}$ (V)
$-I_B = 400mA$
200mA
100mA
50mA
35mA
25mA
15mA
10mA
$-V_{CE} = 1V$
$-V_{CE} = 1V$

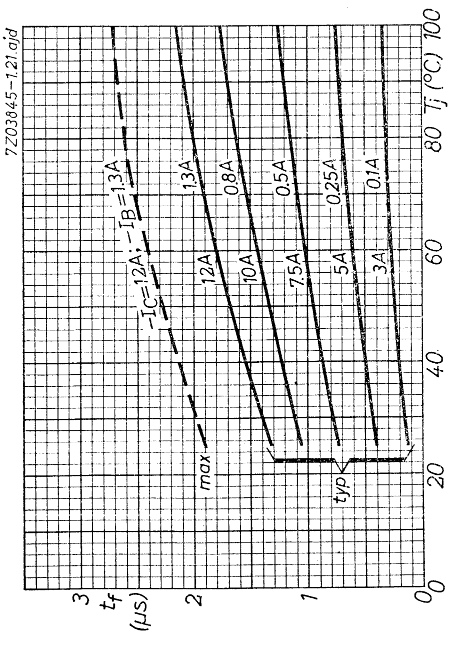

7Z03848-1.21.ajd
$-I_B$ (mA)
1000
200
100
50
20
10
5
2
1
0.5
0.2
0.1
$-I_C$ (A)
10
5
2
1
0.5
0.2
0.1
typ
12A
T_j = 25°C
$-V_{CE}$ = 1V

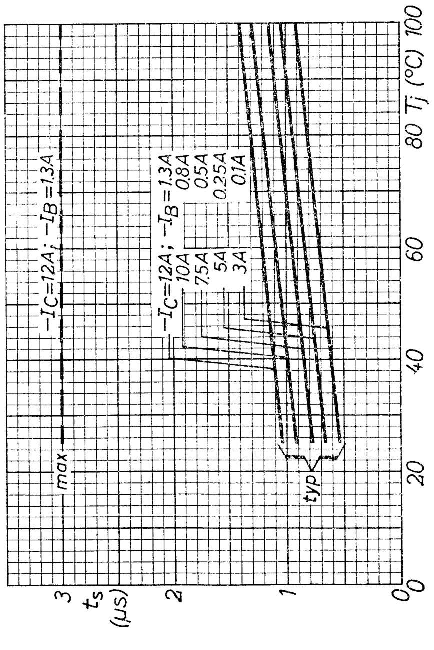

7Z03849-1.21.ajd
$-I_{CBO}$ (mA)
100
20
10
5
2
1
0.5
0.2
0.1
max
typ
$-V_{CB}$ =185V
0
20
40
60
80
100
Tj (°C)


7Z03846-1.21.ajd
600
$-I_B$ (mA)
400
200
0
$-I_C$=12A
max
12A
10A
7.5A
5A
3A
typ
$-V_{CE}$=1V
0
20
40
60
80
100
Tj (°C)


0.8
V_{CEsat} (V)
0.6
0.4
0.2
$-I_C$=12A; $-I_B$=1.3A
max
$-I_C$=12A; $-I_B$=1.3A
0.8A
0.5A
0.25A
0.1A
10A
7.5A
5A
3A
typ
0
20
40
60
80
100
Tj (°C)


7Z03628-1.21.ajc.
Rth h-a = Thermal resistance from heatsink to ambient for heatsink of 2mm Cu or 3mm Al, mounted vertically
Rth h-a (°C/W)
bright
blackened
Heatsink area (one side; cm²)
0
100
200
300
400
0
2
4
6
8


7Z03845-1.21.ajd
tf (μs)
-IC=12A; -IB=1.3A
12A 1.3A
10A 0.8A
7.5A 0.5A
5A 0.25A
3A 0.1A
max
typ
Tj (°C)
0
20
40
60
80
100
1
2
3


ts (μs)
-IC=12A; -IB=1.3A
-IC=12A; -IB=1.3A
10A 0.8A
7.5A 0.5A
5A 0.25A
3A 0.1A
max
typ
Tj (°C)
0
20
40
60
80
100
1
2
3

SILICON PLANAR EPITAXIAL TRANSISTOR

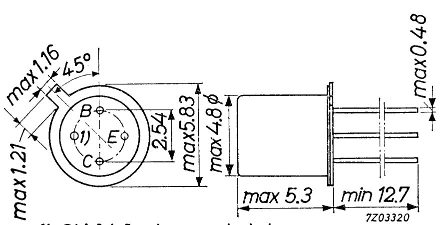
Transistor of the n-p-n type in TO-18 metal case with insulated leads and a shield lead connected to the case. It is meant for a.m. and f.m. application, primarily for use in car radios.

QUICK REFERENCE DATA				
Collector-base voltage (open emitter)	V_{CBO}	max.	50	V
Collector-emitter voltage (open base)	V_{CEO}	max.	30	V
Collector current (peak value)	I_{CM}	max.	30	mA
Total dissipation up to T_{amb} = 45 °C	P_{tot}	max.	140	mW
Junction temperature	T_j	max.	175	°C
Transition frequency				
I_C = 1 mA; V_{CE} = 10 V	f_T	typ.	230	Mc/s
Noise figure				
I_C = 1 mA; V_{CE} = 10 V				
f = 1 Mc/s; G_S = 3.3 mA/V	F	typ.	1.2	dB
f = 100 Mc/s; G_S = 10 mA/V	F	typ.	3.6	dB

MECHANICAL DATA

Dimensions in mm

TO-18 metal case
insulated leads



1) Shield lead connected to case

7Z2 3111

RATINGS (Limiting values) [1]

Voltages

Collector-base voltage (open emitter)	V_{CBO}	max.	50	V
Collector-emitter voltage (resistive termination of the base)	V_{CER}	max.	50	V [2]
Emitter-base voltage (open collector)	V_{EBO}	max.	5	V

Currents

Collector current (d.c.)	I_C	max.	30	mA
Collector current (peak value)	I_{CM}	max.	30	mA
Emitter current (d.c.)	$-I_E$	max.	31	mA
Emitter current (peak value)	$-I_{EM}$	max.	31	mA
Base current (d.c.)	I_B	max.	1	mA
Base current (peak value)	I_{BM}	max.	1	mA

Power dissipation

Total power dissipation up to T_{amb} = 45 °C	P_{tot}	max.	140	mW

Temperatures

Storage temperature	T_{stg}	-55 to +175		°C
Junction temperature	T_j	max.	175	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	0.9	°C/mW

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

[2]) See also page C.

7Z2 3112

CHARACTERISTICS T_j = 25 °C unless otherwise specified

Base-emitter voltage

I_C = 20 mA; V_{CE} = 2 V	V_{BE}	<	1.1	V

D.C. current gain

I_C = 1 mA; V_{CE} = 10 V	h_{FE}	45 to	165	
I_C = 20 mA; V_{CE} = 2 V	h_{FE}	>	40	

CHARACTERISTIC RANGE VALUES FOR EQUIPMENT DESIGN

T_j = 25 °C unless otherwise specified

Base-emitter voltage [1])

I_C = 1 mA; V_{CE} = 10 V	V_{BE}	0.65 to 0.74		V

Feedback capacitance at f = 0.45 Mc/s

I_C = 1 mA; V_{CE} = 10 V	c_{re}	typ.	0.6	pF
		<	0.7	pF

Transition frequency

I_C = 1 mA; V_{CE} = 10 V	f_T	typ.	230	Mc/s

Noise figure at I_C = 1 mA; V_{CE} = 10 V

f = 0.2 Mc/s; G_S = 3.3 mA/V	F	typ.	1.2	dB
f = 1 Mc/s; G_S = 20 mA/V	F	typ.	3.5	dB
f = 1 Mc/s; G_S = 3.3 mA/V	F	typ.	1.2	dB
f = 100 Mc/s; G_S = 10 mA/V	F	typ.	3.6	dB

Conversion noise figure at I_C = 1 mA; V_{CE} = 10 V

f = 0.2 Mc/s; G_S = 2 mA/V	F_c	typ.	2.5	dB
f = 1 Mc/s; G_S = 2 mA/V	F_c	typ.	2.5	dB

NOTE

All small signal quantities have been measured with a length of leads between the bottom of the transistor and the measuring-jig of 3 mm.

---

[1]) V_{BE} decreases with about 1.7 mV/°C at increasing temperature

CHARACTERISTIC RANGE VALUES FOR EQUIPMENT DESIGN (continued)

T_j = 25 °C

y parameters in common emitter configuration
f = 0.45 Mc/s; I_C = 1 mA; V_{CE} = 10 V

Input conductance	g_{ie}	typ.	0.4	mA/V
Input capacitance	c_{ie}	typ.	25	pF
Feedback admittance	$\|y_{re}\|$	typ.	1.5	μA/V
Phase angle of feedback admittance	φ_{re}	typ	270°	
Transfer admittance	$\|y_{fe}\|$	typ.	35	mA/V
Phase angle of transfer admittance	φ_{fe}	typ.	0°	
Output conductance	g_{oe}	typ.	4	μA/V
Output capacitance	c_{oe}	typ.	1.4	pF

y parameters in common base configuration
f = 100 Mc/s; $-I_E$ = 1 mA; V_{CB} = 10 V

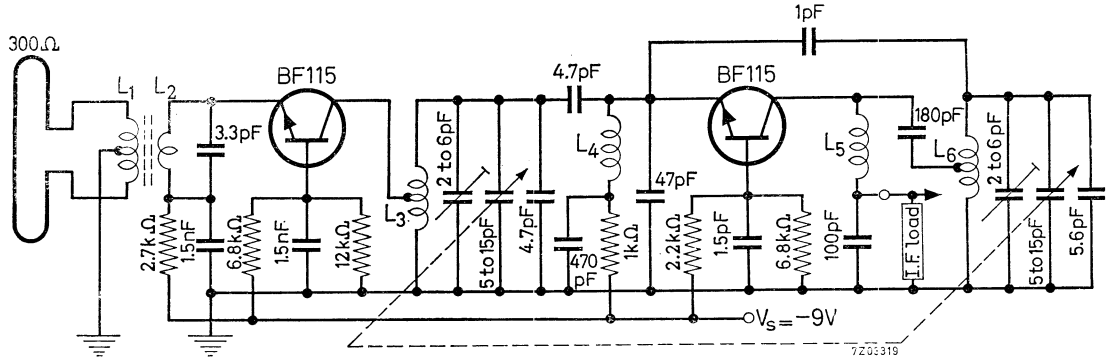
Input conductance	g_{ib}	typ.	33	mA/V
Input capacitance	$-c_{ib}$	typ.	6	pF
Feedback admittance	$\|y_{rb}\|$	typ.	0.22	mA/V
Phase angle of feedback admittance	φ_{rb}	typ.	273°	
Transfer admittance	$\|y_{fb}\|$	typ.	33	mA/V
Phase angle of transfer admittance	φ_{fb}	typ.	150°	
Output conductance	g_{ob}	typ.	10	μA/V
Output capacitance	c_{ob}	typ.	1.5	pF

NOTE

All small signal quantities have been measured with a length of leads between the bottom of the transistor and the measuring-jig of 3 mm.

7Z2 3114

APPLICATION INFORMATION



COIL DATA

L_1 = 5 turns; L_2 = 2 turns
L_1 and L_2 on twin bead K 505006/IZ2

L_3 = 4.5 turns enamelled Cu wire; winding pitch 1 mm; tap at 2.5 turns from earth side; d = 7 mm

L_4 = 15 turns enamelled Cu wire, close wounded; d = 4 mm

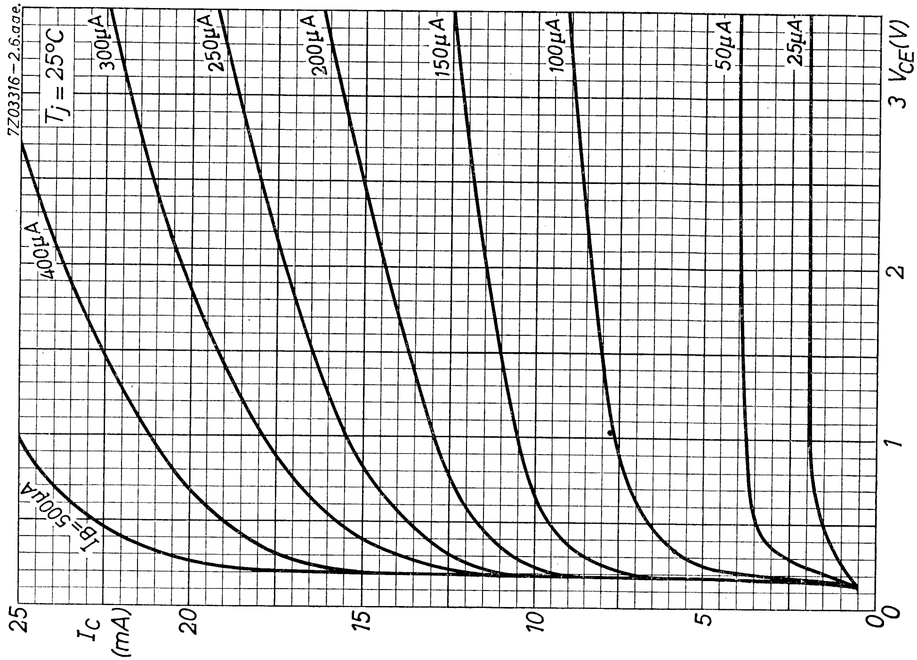
L_5 = 14 turns stranded wire (36 x 0.03) on coil former 3016/02 with ferroxcube core K 512002 (4 D)

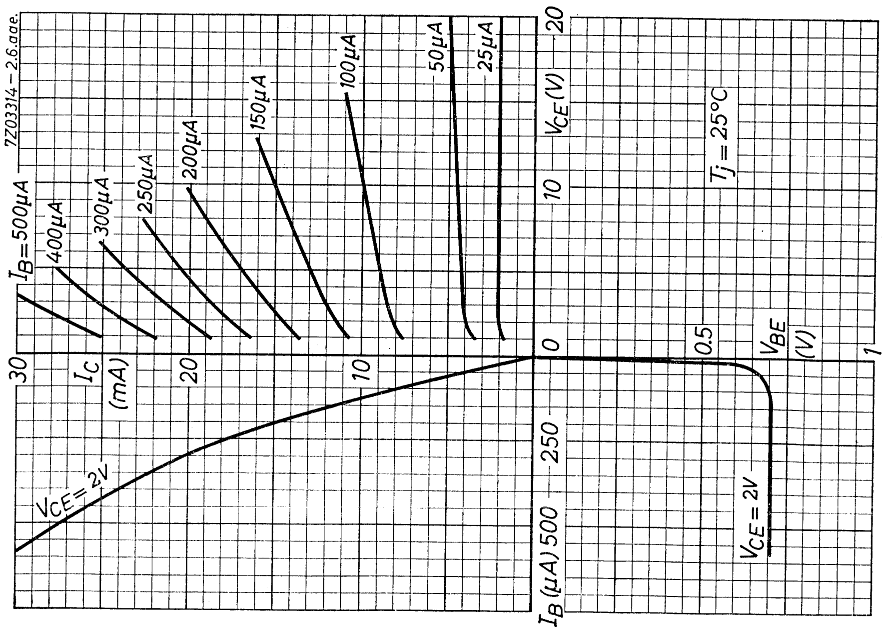
L_6 = 6 turns enamelled Cu wire (1 mm); winding pitch 1 mm; tap at 3 turns from earth side; d = 7 mm

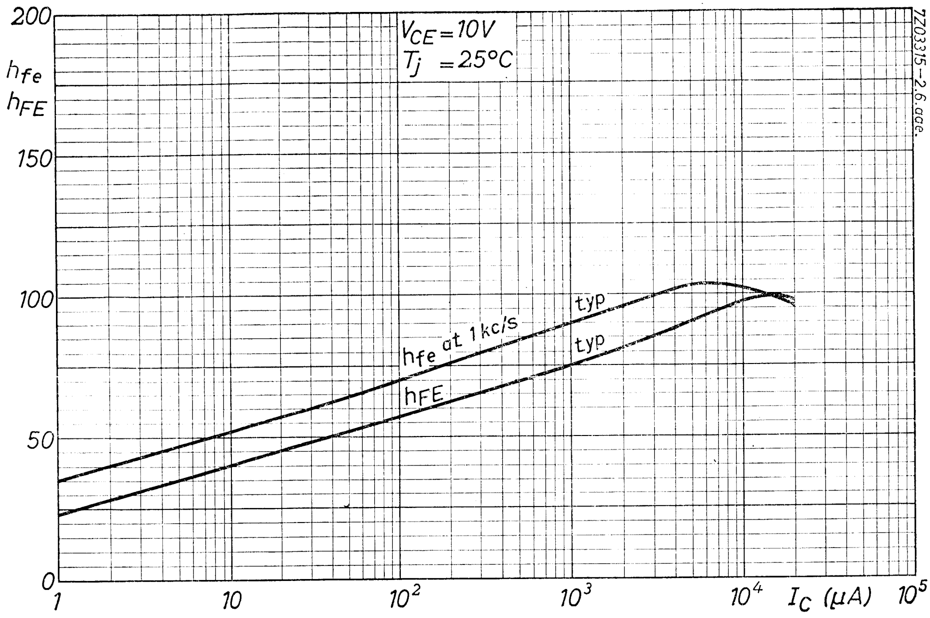
PERFORMANCE

Transducer gain at an I.F. load of 470 Ω	Φ_{tr}	typ.	24	dB
Noise figure	F	typ.	4.5	dB
Spurious response				
repeat spot suppression		typ.	55	dB
double beat suppression		typ.	57	dB
Image response		typ.	35	dB
Frequency drift oscillator at ΔV_S = 2 V	Δf_{osc}	typ.	10	kc/s
		<	15	kc/s

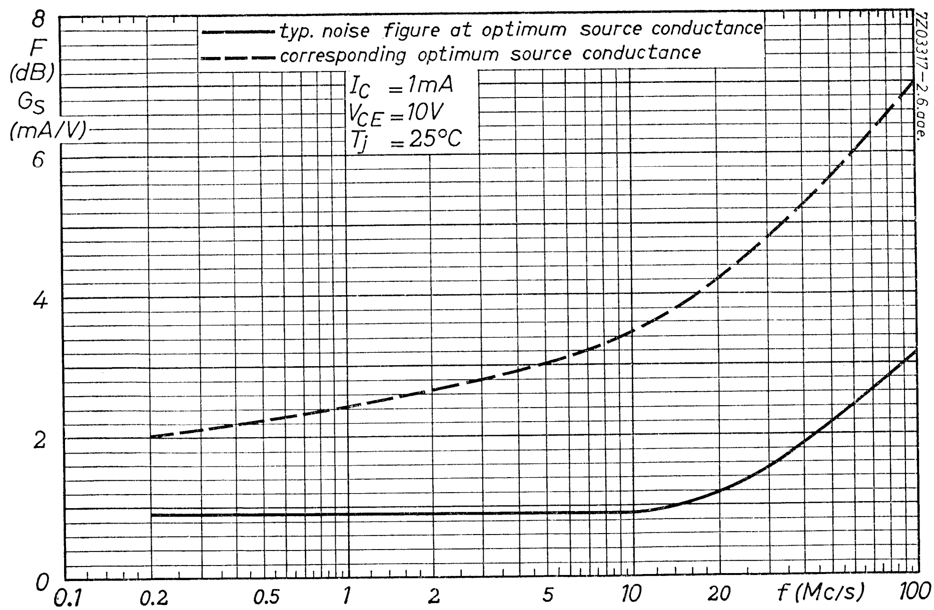
7Z2 3115


7Z03316–2.6.aae.
Tj = 25°C
IB = 500µA
400µA
300µA
250µA
200µA
150µA
100µA
50µA
25µA
IC (mA)
25
20
15
10
5
0
0
1
2
3 VCE(V)

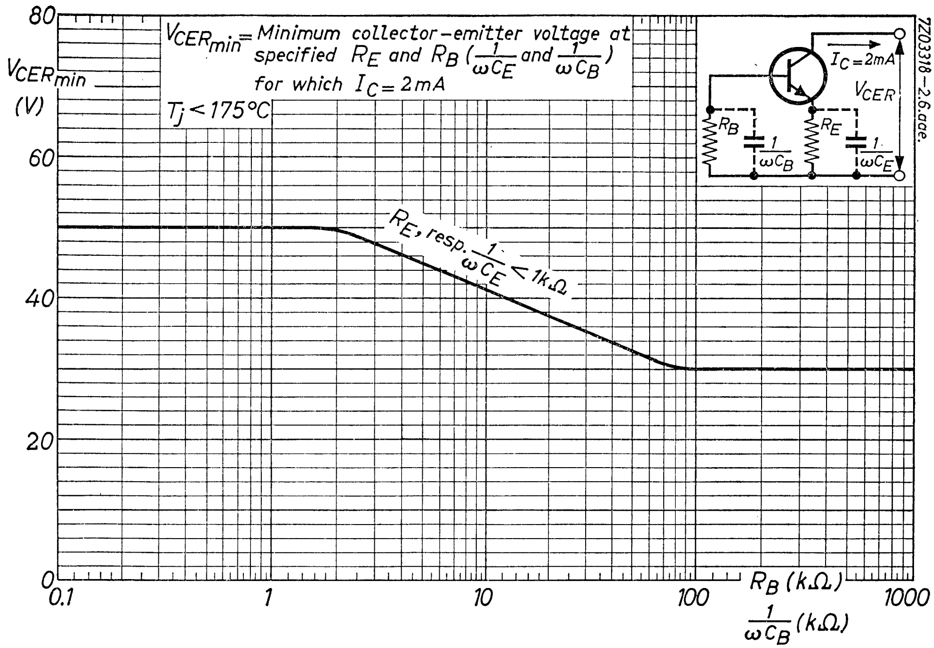

7Z03314–2.6.aae.
IB=500µA
400µA
300µA
250µA
200µA
150µA
100µA
50µA
25µA
VCE(V)
0
10
20
IC (mA)
30
20
10
VCE = 2V
IB (µA) 500
250
Tj = 25°C
VBE (V)
0.5
1
VCE = 2V



200
h_{fe}
h_{FE}
150
100
50
0
1
10
10^2
10^3
10^4
I_C (μA)
10^5
V_{CE} = 10V
T_j = 25°C
typ
h_{fe} at 1 kc/s
typ
h_{FE}
7Z03315-2.6.aae.



8
F
(dB)
G_S
(mA/V)
6
4
2
0
0.1
0.2
0.5
1
2
5
10
20
f (Mc/s)
100
typ. noise figure at optimum source conductance
corresponding optimum source conductance
I_C = 1mA
V_{CE} = 10V
T_j = 25°C
7Z03317-2.6.aae.



80
60
40
20
0
V_{CERmin}
(V)
V_{CERmin} = Minimum collector-emitter voltage at specified R_E and R_B ($\frac{1}{\omega C_E}$ and $\frac{1}{\omega C_B}$) for which $I_C = 2 mA$
$T_j < 175°C$
R_E, resp. $\frac{1}{\omega C_E} < 1k\Omega$
$I_C = 2mA$
V_{CER}
R_B
$\frac{1}{\omega C_B}$
R_E
$\frac{1}{\omega C_E}$
7Z03318-2.6.aae.
0.1
1
10
100
1000
R_B (kΩ)
$\frac{1}{\omega C_B}$ (kΩ)

SILICON PLANAR EPITAXIAL TRANSISTORS

Silicon planar epitaxial transistors of the n-p-n type in TO-5 metal case with the collector connected to the case.
These transistors are intended for general purpose industrial applications.

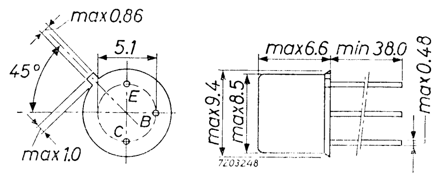
QUICK REFERENCE DATA

			BFY50	BFY51	BFY52	
Collector-base voltage (open emitter)	V_{CBO}	max.	80	60	40	V
Collector-emitter voltage (open base)	V_{CEO}	max.	35	30	20	V
Collector current (peak value)	I_{CM}	max.	1	1	1	A
Total dissipation up to T_{amb} = 25 °C	P_{tot}	max.	800	800	800	mW
Junction temperature	T_j	max.	200	200	200	°C
D.C. current gain at T_j = 25 °C						
I_C = 150 mA; V_{CE} = 6 V	h_{FE}	typ.	55	70	130	
Transition frequency						
I_C = 50 mA; V_{CE} = 6 V	f_T	typ.	100	110	120	Mc/s
Collector-emitter saturation voltage						
I_C = 150 mA; I_B = 15 mA	V_{CEsat}	<	0.2	0.35	0.35	V

MECHANICAL DATA Dimensions in mm

TO-5

Collector connected to case



7Z2 3366

RATINGS (Limiting values) [1]

Voltages

			BFY50	BFY51	BFY52	
Collector-base voltage (open emitter)	V_{CBO}	max.	80	60	40	V
Collector-emitter voltage (open base)	V_{CEO}	max.	35	30	20	V
Emitter-base voltage (open collector)	V_{EBO}	max.	6	6	6	V

Currents

Collector current (d.c.)	I_C	max.	1	A
Collector current (peak value)	I_{CM}	max.	1	A
Emitter current (d.c.)	$-I_E$	max.	1	A
Emitter current (peak value)	$-I_{EM}$	max.	1	A

Power dissipation (See also page C)

Total power dissipation up to T_{amb} = 40 °C	P_{tot}	max.	4	W
Total power dissipation without cooling fin up to T_{amb} = 25 °C	P_{tot}	max.	0.8	W

Temperatures

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

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	0.22	°C/mW
From junction to case	$R_{th\ j-c}$	=	0.035	°C/mW

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

7Z2 3367

CHARACTERISTICS T_j = 25 °C

			BFY50	BFY51	BFY52	
Collector cut-off current						
I_E = 0; V_{CB} = 60 V	I_{CBO}	<	50			nA
I_E = 0; V_{CB} = 40 V	I_{CBO}	<		50		nA
I_E = 0; V_{CB} = 30 V	I_{CBO}	<			50	nA
Emitter cut-off current						
I_C = 0; V_{EB} = 5 V	I_{EBO}	<	50	50	50	nA
Base current						
$-I_E$ = 150 mA; V_{CB} = 6 V	I_B	<	4.85	3.65	2.45	mA
Collector-emitter saturation voltage						
I_C = 150 mA; I_B = 15 mA	V_{CEsat}	<	0.2	0.35	0.35	V

CHARACTERISTIC RANGE VALUES FOR EQUIPMENT DESIGN

T_j = 25 °C unless otherwise specified

			BFY50	BFY51	BFY52	
Collector cut-off current						
I_E = 0; V_{CB} = 60 V	I_{CBO}	typ.	2			nA
I_E = 0; V_{CB} = 40 V	I_{CBO}	typ.		2		nA
I_E = 0; V_{CB} = 30 V	I_{CBO}	typ.			2	nA
I_E = 0; V_{CB} = 60 V; T_j = 100 °C	I_{CBO}	typ.	55			nA
		<	2.5			μA
I_E = 0; V_{CB} = 40 V; T_j = 100 °C	I_{CBO}	typ.		55		nA
		<		2.5		μA
I_E = 0; V_{CB} = 30 V; T_j = 100 °C	I_{CBO}	typ.			55	nA
		<			2.5	μA
Emitter cut-off current						
I_C = 0; V_{EB} = 5 V	I_{EBO}	typ.	1	1	1	nA
I_C = 0; V_{EB} = 5 V; T_j = 100 °C	I_{EBO}	typ.	16	16	16	nA
		<	2.8	2.8	2.8	μA
Saturation voltages						
I_C = 150 mA; I_B = 15 mA	V_{CEsat}	typ.	0.14	0.14	0.14	V
	V_{BEsat}	typ.	0.95	0.95	0.95	V
I_C = 1 A; I_B = 100 mA [1][2]	V_{CEsat}	typ.	0.7	0.7	0.7	V
		<	1	1.6	1.6	V
	V_{BEsat}	typ.	1.5	1.5	1.5	V
		<	2	2	2	V

7Z2 3368

CHARACTERISTIC RANGE VALUES FOR EQUIPMENT DESIGN (continued)

T_j = 25 °C

			BFY50	BFY51	BFY52	
D.C. current gain						
I_C = 10 mA; V_{CE} = 6 V	h_{FE}	>	20	30	30	
		typ.	40	55	80	
I_C = 150 mA; V_{CE} = 6 V [1]	h_{FE}	>	30	40	60	
		typ.	55	70	130	
I_C = 1 A; V_{CE} = 6 V [1]	h_{FE}	>	15	15	15	
		typ.	30	40	60	
Switching times (See also page 5)						
I_C = 150 mA; $+I_{B1} = -I_{B2}$ = 15 mA						
delay time	t_d	typ.	25	25	25	ns
rise time	t_r	typ.	30	30	30	ns
storage time	t_s	typ.	140	160	220	ns
fall time	t_f	typ.	35	35	40	ns
Collector capacitance at f = 500 kc/s						
$I_E = I_e$ = 0; V_{CB} = 12 V	c_c	typ.	7	7	7	pF
		<	12	12	12	pF
Transition frequency						
I_C = 50 mA; V_{CE} = 6 V	f_T	>	60	50	50	Mc/s
		typ.	100	110	120	Mc/s
h parameters at f = 1 kc/s						
I_C = 10 mA; V_{CE} = 6 V						
Input impedance	h_{ie}	typ.	180	220	400	Ω
Reverse voltage transfer ratio	h_{re}	typ.	55	70	130	10^{-6}
Forward current gain	h_{fe}	typ.	45	60	120	
Output admittance	h_{oe}	typ.	30	35	70	μA/V
I_C = 1 mA; V_{CE} = 6 V						
Forward current gain	h_{fe}	>	10	30	30	
		typ.	30	45	90	

[1]) Measured under pulsed conditions to avoid excessive dissipation.

[2]) Measured with a lead length of 1 cm.

7Z2 3369

MEASUREMENT OF SWITCHING TIMES

Fig. 1 : Circuit diagram

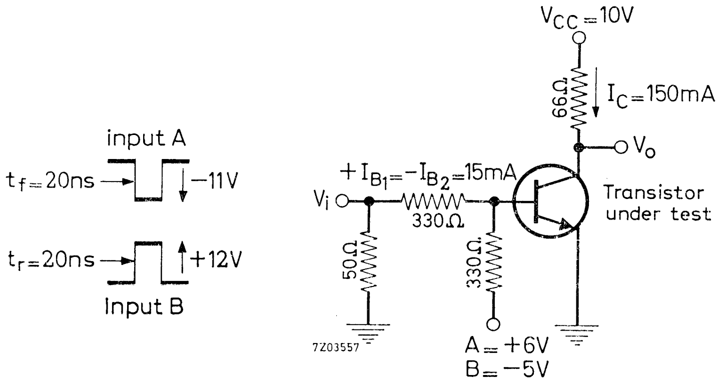
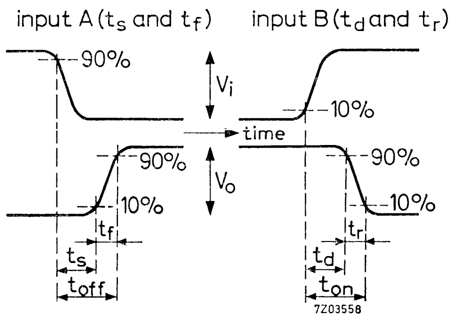


Fig. 2 : Waveforms



Equipment: Pulse generator (rise time = 20 ns)
Double beam or dual trace oscilloscope
(rise time = 14 ns)

OPERATING NOTES

Dissipation and heatsink considerations

a. Steady-state conditions

The max. allowable steady-state dissipation P_S is given by the relationship

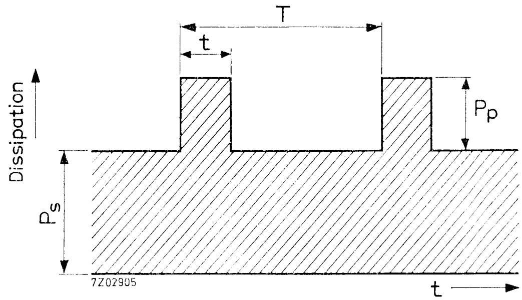
$$P_{s\,max.} = \frac{T_{j\,max.} - T_{amb}}{R_{th\,j\text{-}a}}$$

where $T_{j\,max.}$ is the maximum permissible operating junction temperature,

T_{amb} is the ambient temperature,

$R_{th\,j\text{-}a}$ is the total thermal resistance between junction and ambient.

b. Pulse conditions (rectangular pulses)



The maximum allowable pulse power P_p is given by the formula

$$P_p = \frac{(T_{j\,max.} - T_{amb}) - (P_s \,.\, R_{th\,j\text{-}a})}{R_{th\,t} + \delta \,.\, R_{th\,c\text{-}a}}$$

where P_s is the steady-state dissipation, excluding that in the pulses,

$R_{th\,t}$ is the effective transient thermal resistance of the device between junction and case and is a function of the pulse duration t and duty cycle δ (see page C),

δ is the duty cycle and is equal to the pulse duration t divided by the periodic time T,

$R_{th\,c\text{-}a}$ is the total thermal resistance between case and ambient.

EXAMPLE

The following example shows how to calculate the maximum permissible peak dissipation of a BFY50 mounted in free air at a temperature not exceeding 65 ^oC. The steady-state dissipation under the bottomed condition is 350 mW, the pulse width is 1 ms and the duty cycle is 0.2.

The transient thermal resistance $R_{th\,t}$ = 15.5 $^oC/W$ (from page C)

7Z2 3371

EXAMPLE (continued)

$$P_{p\,max} = \frac{(200-65) - (0.35 \times 220)}{15.5 + 0.2\ (220-35)}$$

$$= \frac{135 - 77}{15.5 + 37} = 1.1\ W$$

The peak pulse dissipation of 1.1 W is therefore allowed provided that the voltage and current ratings of the device are not exceeded.

c. Pulse conditions (other than rectangular)
For sinusoidal and irregular shaped waveforms, the power pulse is converted to an equivalent rectangular pulse of the same average and peak values, and treated as in the previous section.

EXAMPLE

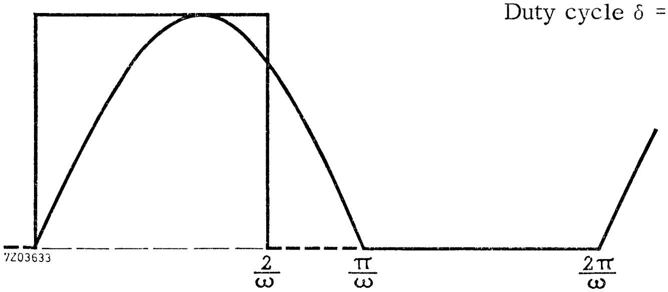
The following example illustrates how to find the maximum permissible peak dissipation of a BFY52 operating in a class "B" circuit at 1 kc/s. The device is mounted on a heatsink of thermal resistance equal to 50 °C/W and at an ambient temperature not exceeding 100 °C. Assuming that the waveform is sinusoidal for half period and zero for the other half,

$$\text{Average of sinewave over half cycle} = \frac{2\,P_p}{\pi}$$

Therefore equivalent rectangular pulse width of same amplitude and average value,

$$t = \frac{2}{\omega} = \frac{2}{2\,\pi \times 10^3} = 0.318\ ms$$

$$\text{Duty cycle } \delta = \frac{2/\omega}{2\pi/\omega} = \frac{1}{\pi}$$



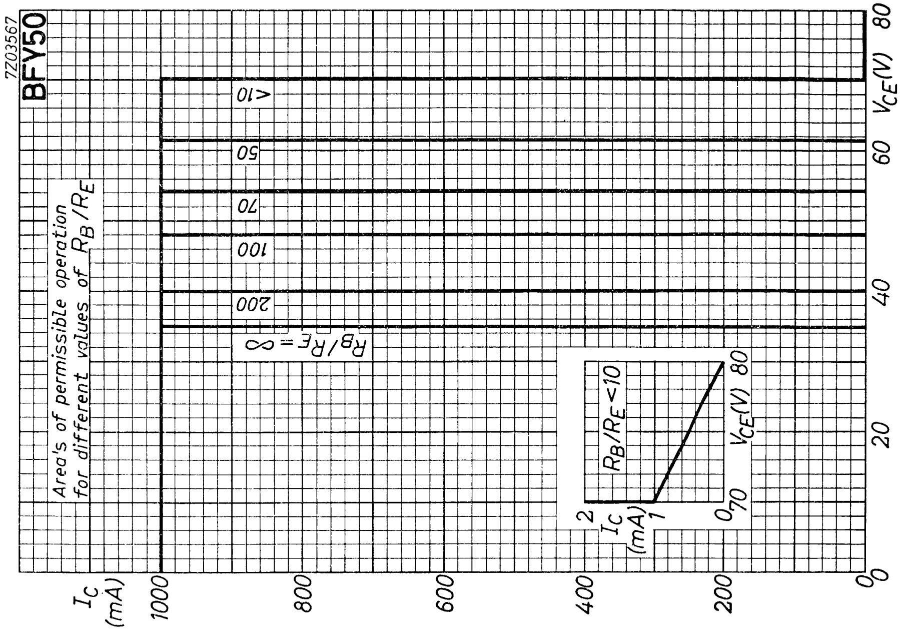
From page C: $R_{th\,to} = 6.8\ ^{o}C/W$ $R_{th\,s} = 35\ ^{o}C/W$

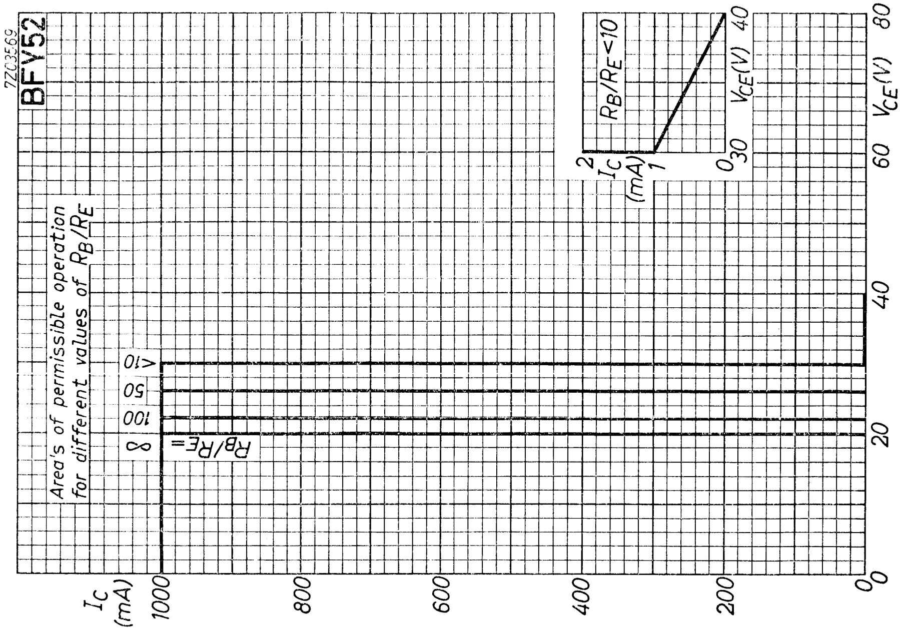
$$R_{th\,t} \text{ at } \delta = 0.318 = (35-6.8).(0.318 + 6.8) = 15.8\ ^{o}C/W$$

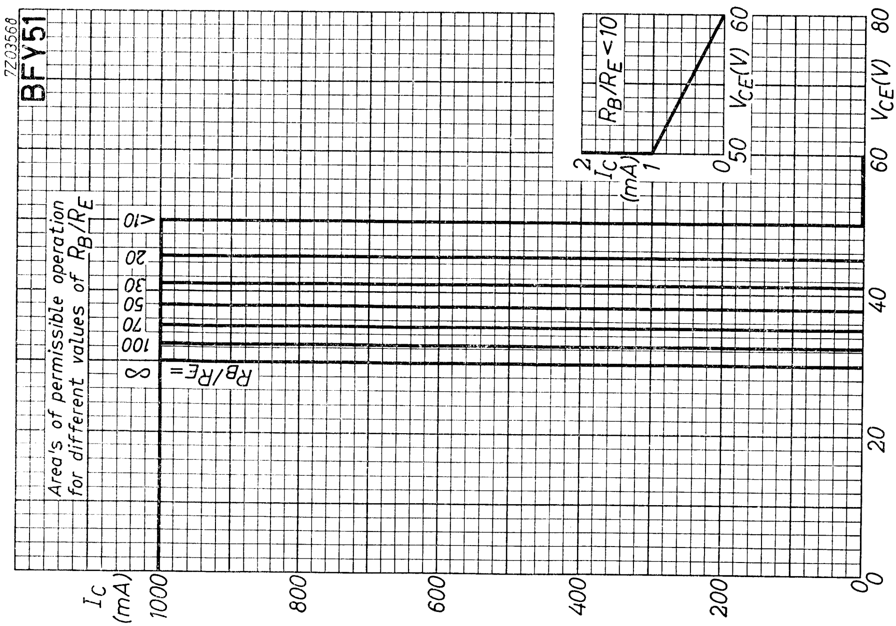
$$P_{p\,max} = \frac{(200-100) - 0}{15.8 + 0.318 \times 50} = 3.15\ W$$

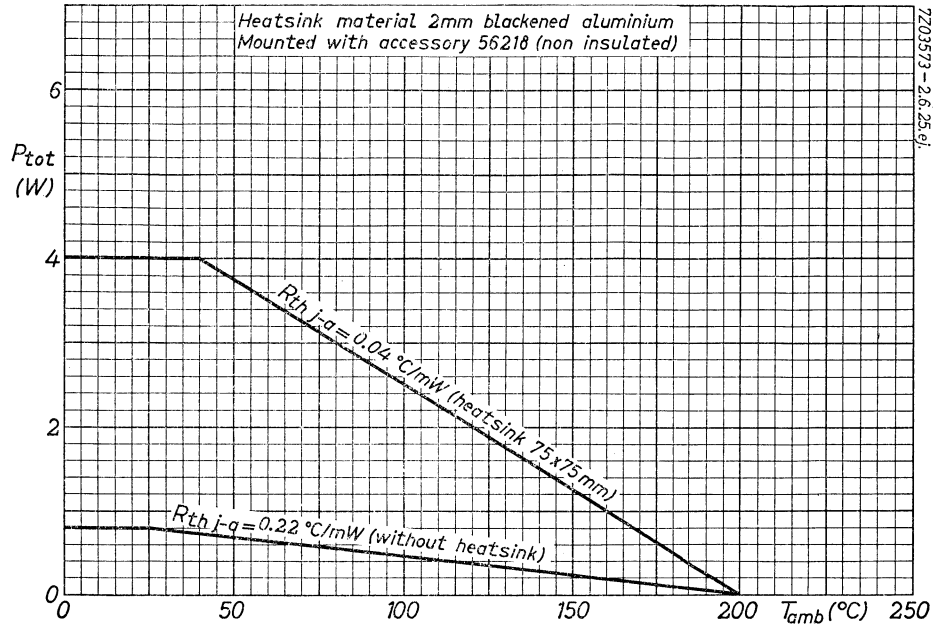
A peak power of 3.15 W is therefore permissible provided that the voltage and current ratings of the device are not exceeded.

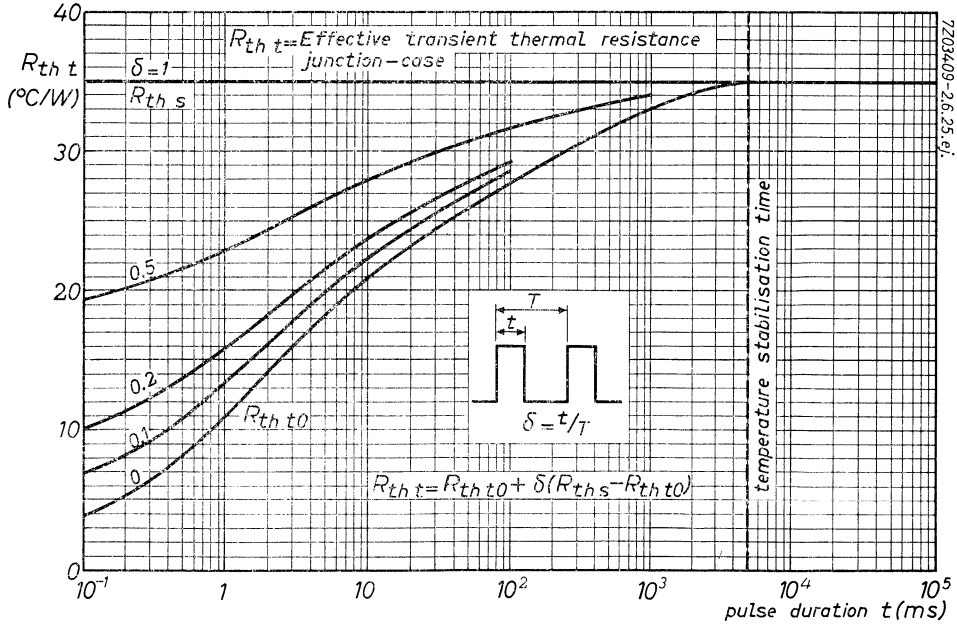
7Z2 3372

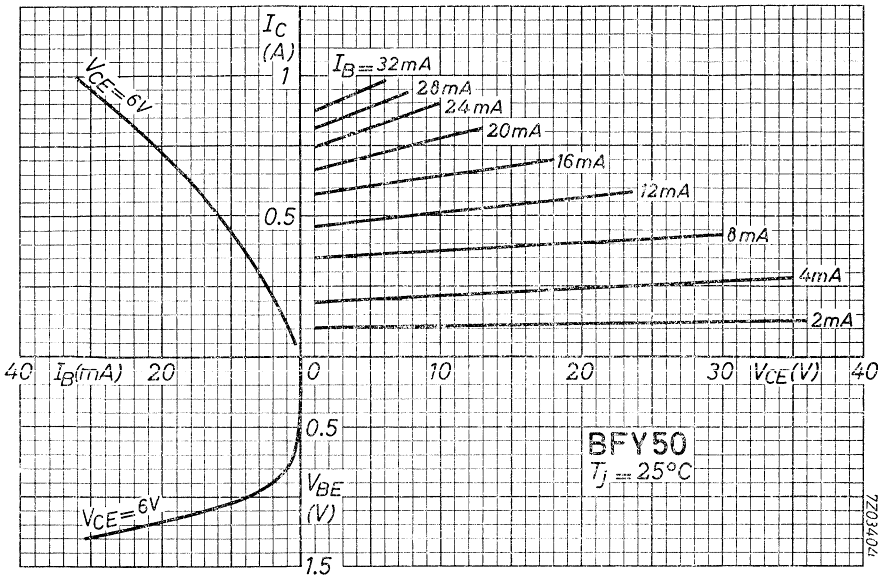

7Z03567
BFY50
Area's of permissible operation
for different values of R_B/R_E
<10
50
70
100
200
$R_B/R_E = \infty$
$R_B/R_E<10$
I_C (mA)
V_{CE}(V)
2
1
0
70
80
1000
800
600
400
200
0
20
40
60
80

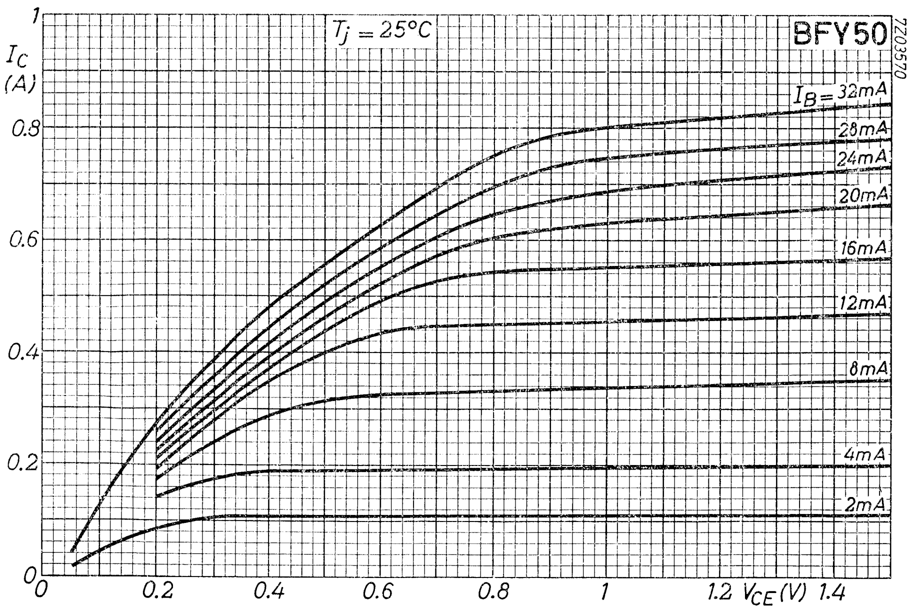

7Z03569
BFY52
Area's of permissible operation
for different values of R_B/R_E
$R_B/R_E=$
∞
100
50
<10
$R_B/R_E<10$
I_C (mA)
$V_{CE}(V)$
2
1
0
30
40
1000
800
600
400
200
0
0
20
40
60
80

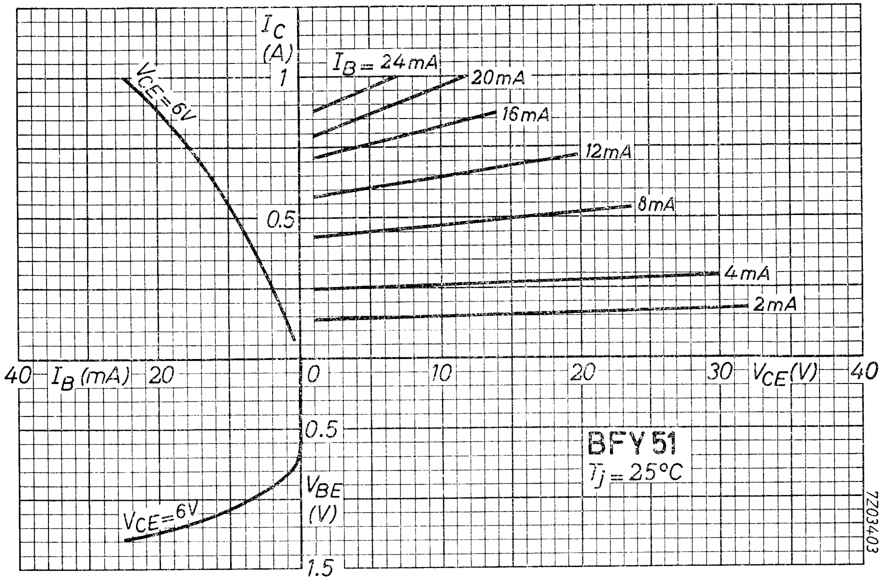

7Z03568
BFY51
Area's of permissible operation
for different values of R_B/R_E
$R_B/R_E=$
∞
100
70
50
30
20
<10
$R_B/R_E<10$
I_C (mA)
$V_{CE}(V)$
2
1
0
50
60
1000
800
600
400
200
0
0
20
40
60
80


Heatsink material 2mm blackened aluminium
Mounted with accessory 56218 (non insulated)
7Z03573-2.6.25.ej.
Ptot (W)
6
4
2
0
Rth j-a = 0.04 °C/mW (heatsink 75x75mm)
Rth j-a = 0.22 °C/mW (without heatsink)
0
50
100
150
200
Tamb (°C)
250

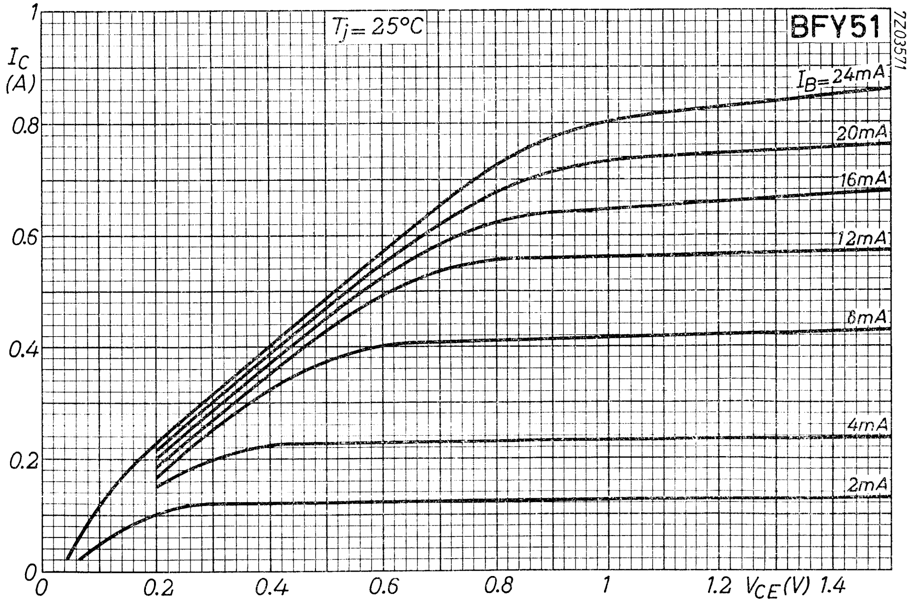

Rth t = Effective transient thermal resistance junction-case
7Z03409-2.6.25.ej.
Rth t (°C/W)
40
30
20
10
0
δ = 1
Rth s
0.5
0.2
0.1
0
Rth t0
T
t
δ = t/T
Rth t = Rth t0 + δ(Rth s − Rth t0)
temperature stabilisation time
10⁻¹
1
10
10²
10³
10⁴
10⁵
pulse duration t(ms)


I_C (A)
1
0.5
I_B = 32mA
28mA
24mA
20mA
16mA
12mA
8mA
4mA
2mA
V_{CE} = 6V
40
I_B(mA)
20
0
10
20
30
V_{CE}(V)
40
0.5
V_{BE} (V)
1.5
V_{CE} = 6V
BFY50
T_j = 25°C
7Z03404

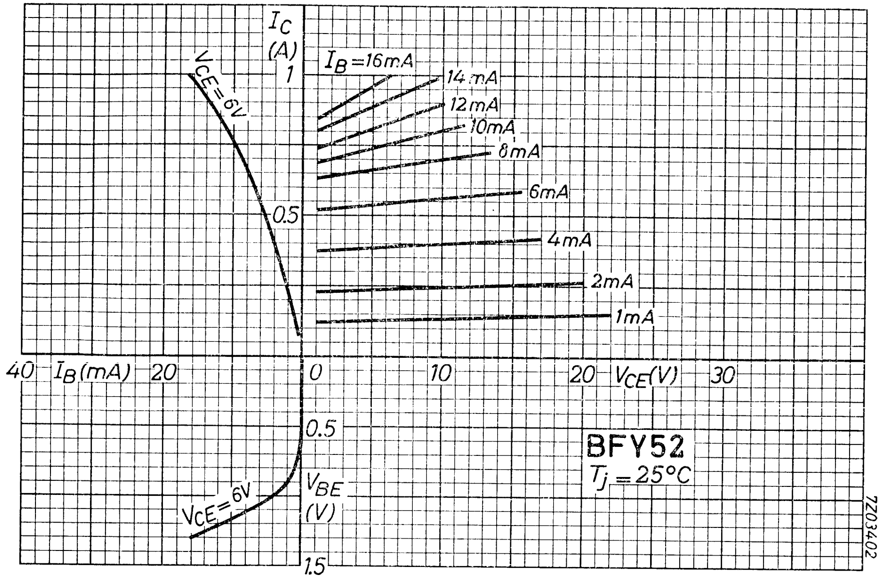

1
I_C (A)
0.8
0.6
0.4
0.2
0
T_j = 25°C
BFY50
7Z03570
I_B = 32mA
28mA
24mA
20mA
16mA
12mA
8mA
4mA
2mA
0
0.2
0.4
0.6
0.8
1
1.2
V_{CE}(V)
1.4

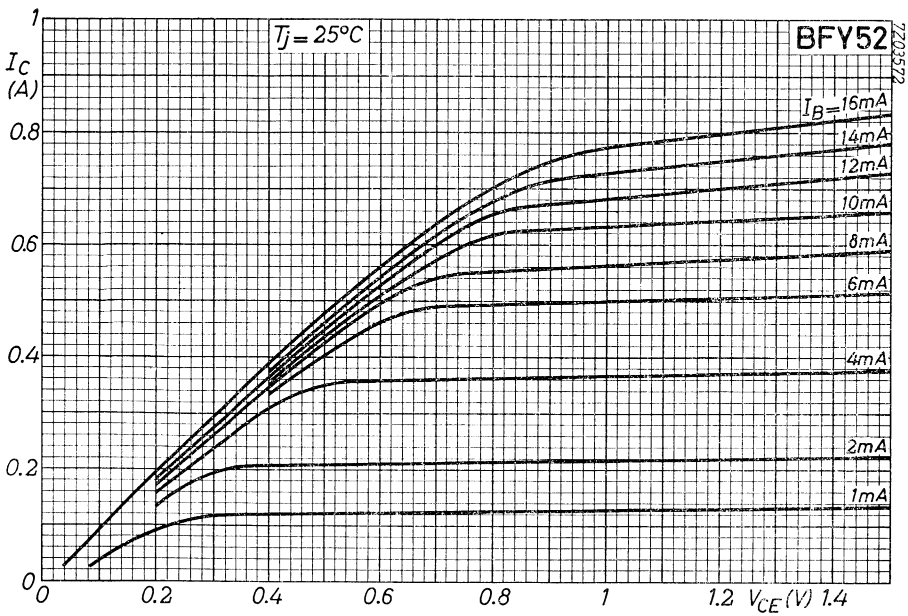


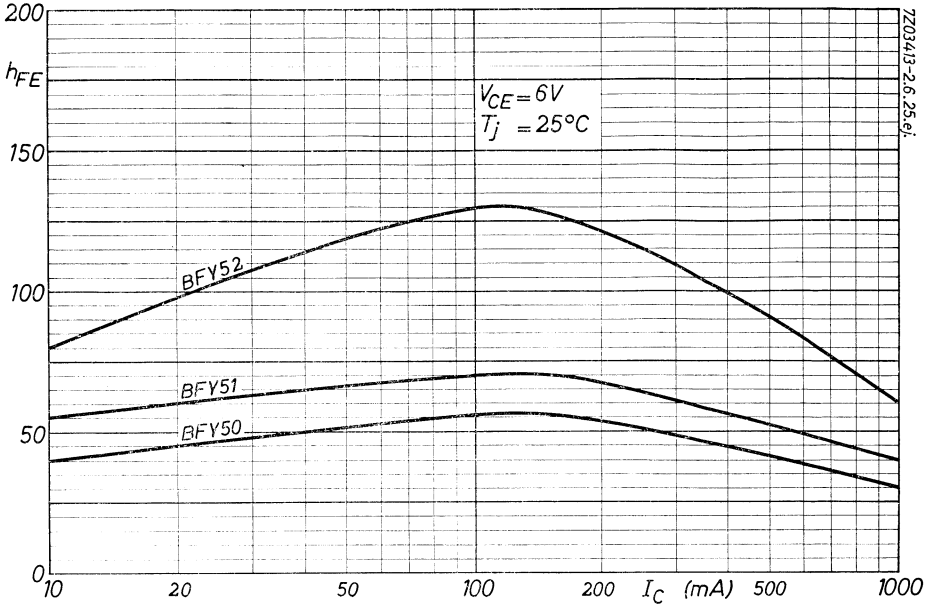
I_C (A)
1
0.5
I_B = 24mA
20mA
16mA
12mA
8mA
4mA
2mA
V_{CE} = 6V
40
I_B (mA)
20
0
10
20
30
V_{CE} (V)
40
0.5
V_{BE} (V)
1.5
BFY 51
T_j = 25°C
7Z03403

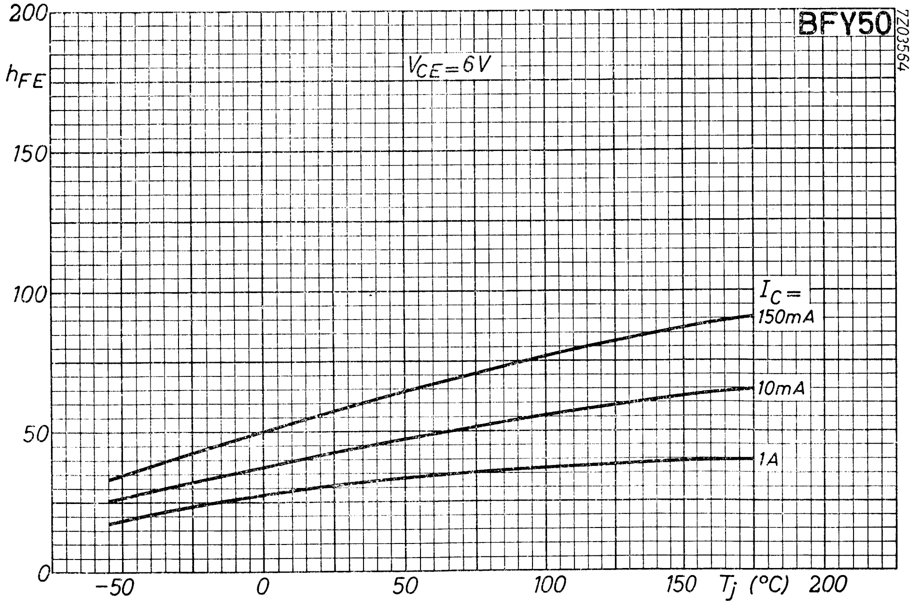


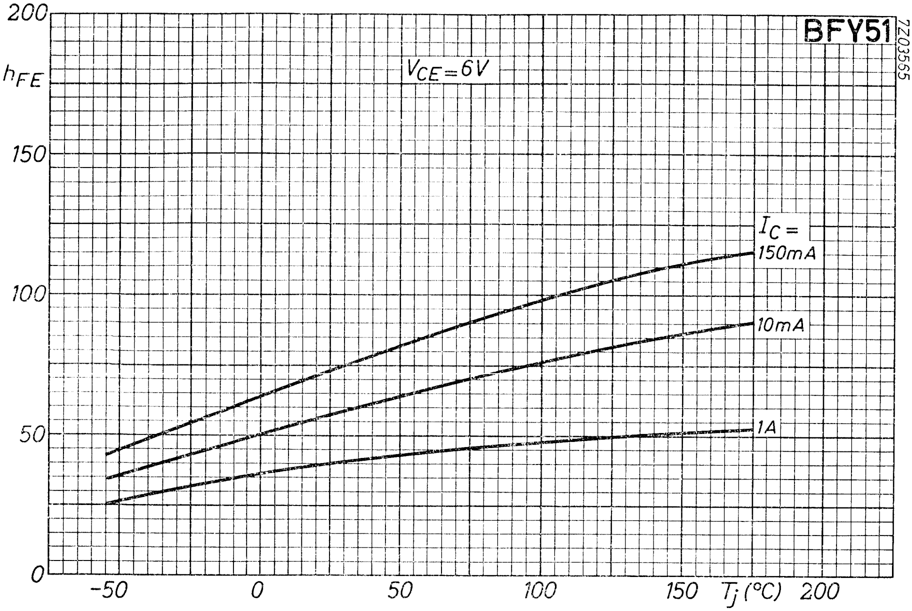
1
I_C (A)
0.8
0.6
0.4
0.2
0
T_j = 25°C
BFY51
7Z03571
I_B = 24mA
20mA
16mA
12mA
8mA
4mA
2mA
0
0.2
0.4
0.6
0.8
1
1.2
V_{CE} (V)
1.4

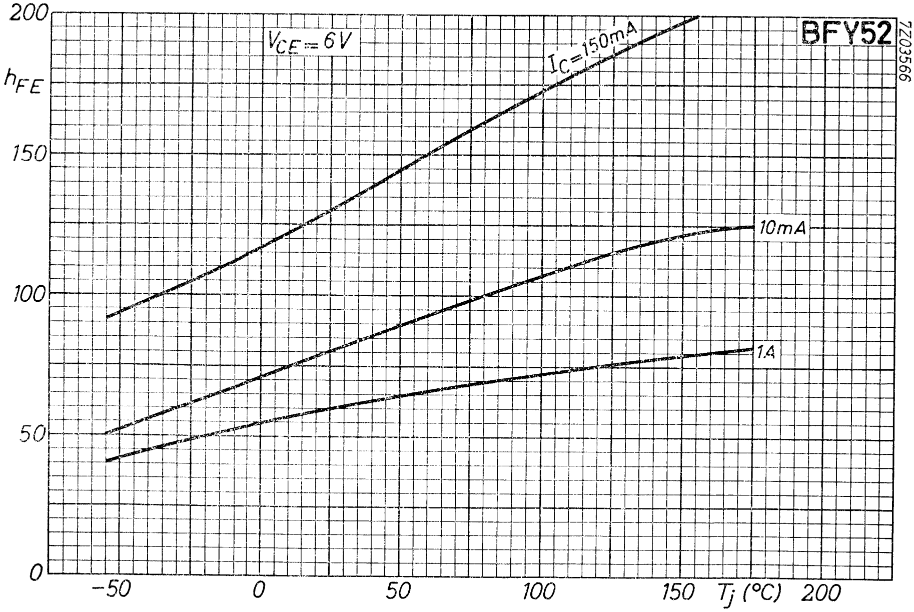

I_C
(A)
1
0.5
I_B=16mA
14mA
12mA
10mA
8mA
6mA
4mA
2mA
1mA
V_CE=6V
40
I_B(mA)
20
0
10
20
V_CE(V)
30
0.5
V_BE
(V)
1.5
V_CE=6V
BFY52
T_j=25°C
7Z03402

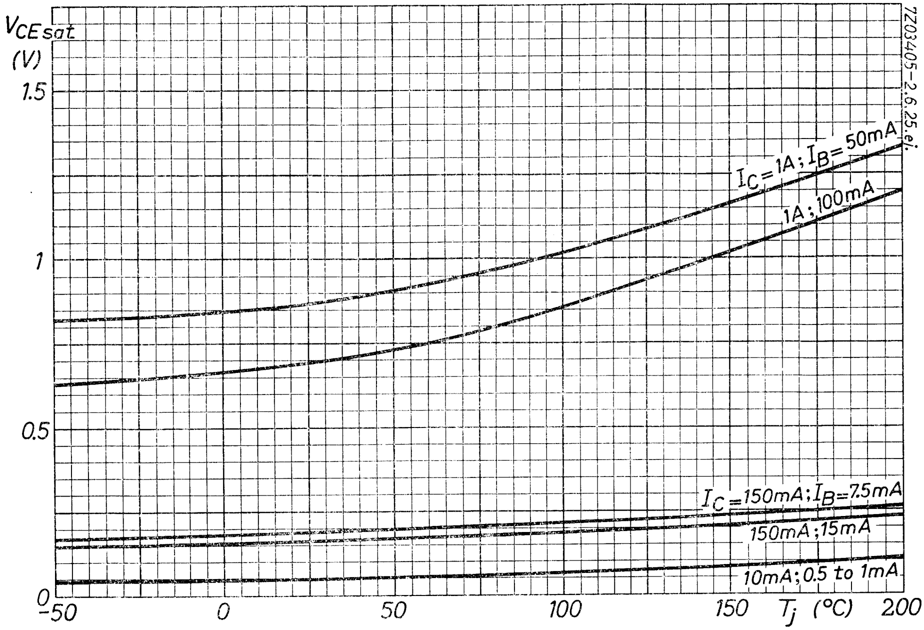

1
I_C
(A)
0.8
0.6
0.4
0.2
0
T_j=25°C
BFY52
7Z03572
I_B=16mA
14mA
12mA
10mA
8mA
6mA
4mA
2mA
1mA
0
0.2
0.4
0.6
0.8
1
1.2
V_CE(V)
1.4


200
h_{FE}
150
100
50
0
10
20
50
100
200
I_C (mA)
500
1000
$V_{CE} = 6V$
$T_j = 25°C$
BFY52
BFY51
BFY50
7Z03413-2.6.25.ej.

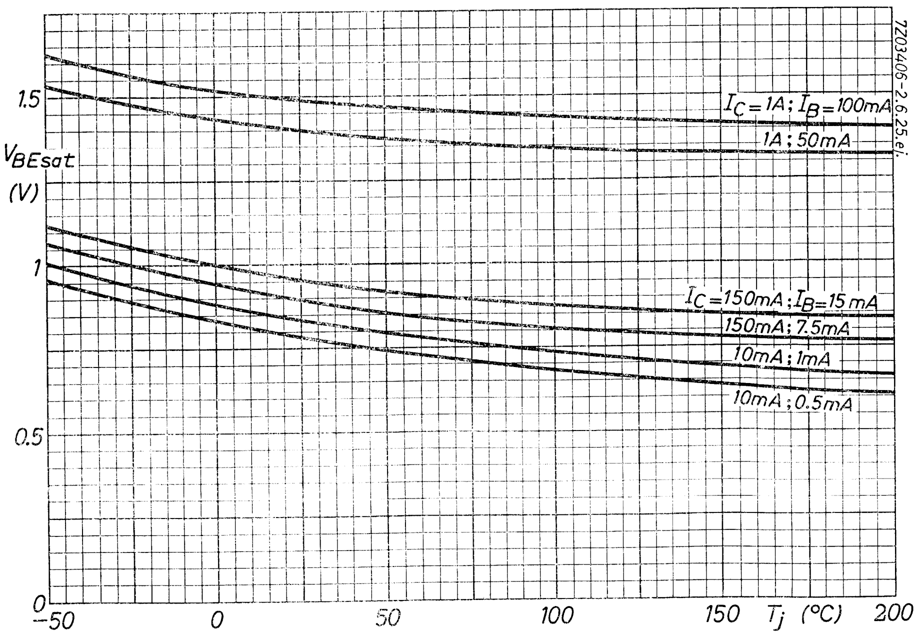

200
h_{FE}
150
100
50
0
−50
0
50
100
150
T_j (°C)
200
BFY50
7Z03564
$V_{CE} = 6V$
$I_C =$
150mA
10mA
1A


BFY51
7Z03565
$V_{CE}=6V$
h_{FE}
$I_C=$
150mA
10mA
1A
200
150
100
50
0
-50
0
50
100
150
T_j (°C)
200

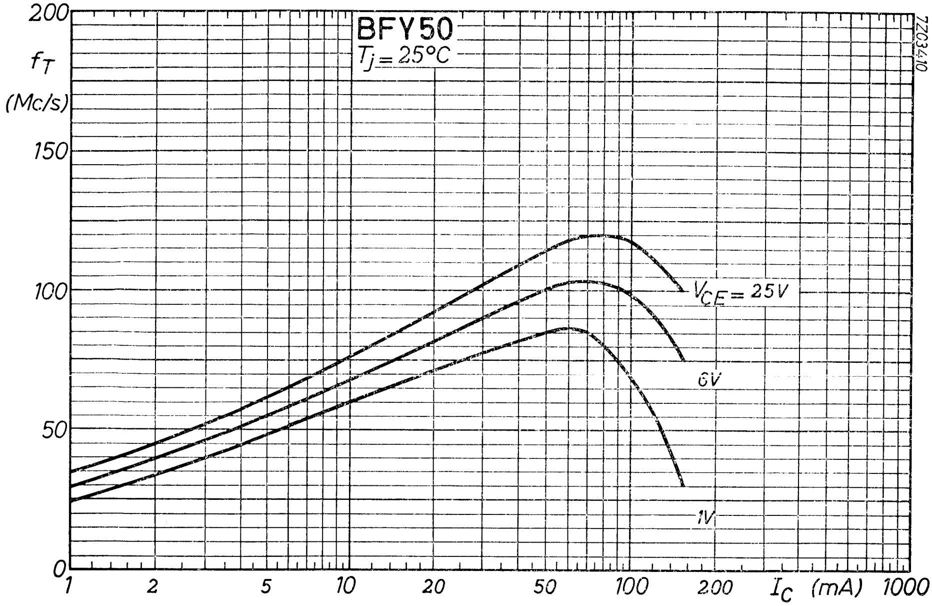

BFY52
7Z03566
$V_{CE}=6V$
h_{FE}
$I_C=150mA$
10mA
1A
200
150
100
50
0
-50
0
50
100
150
T_j (°C)
200

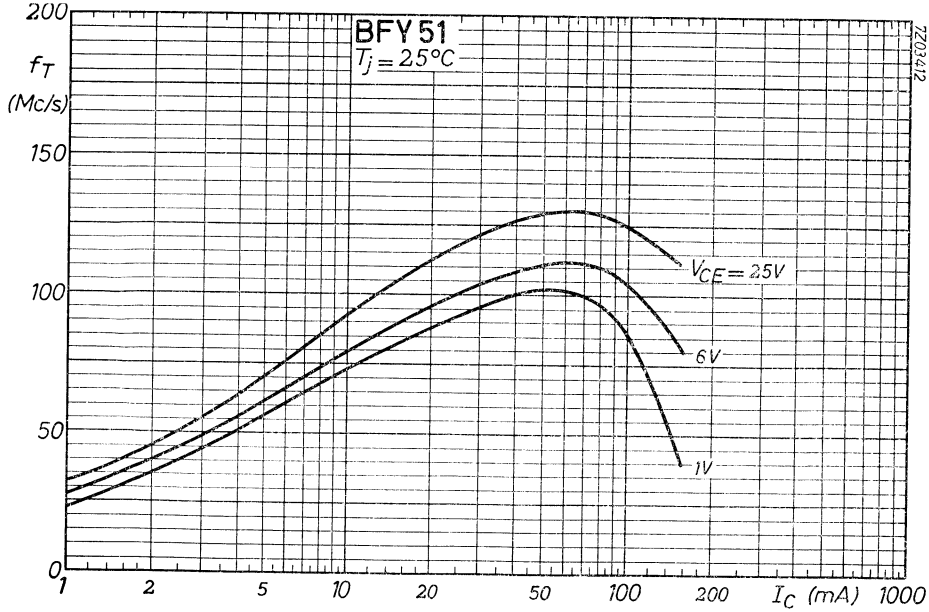


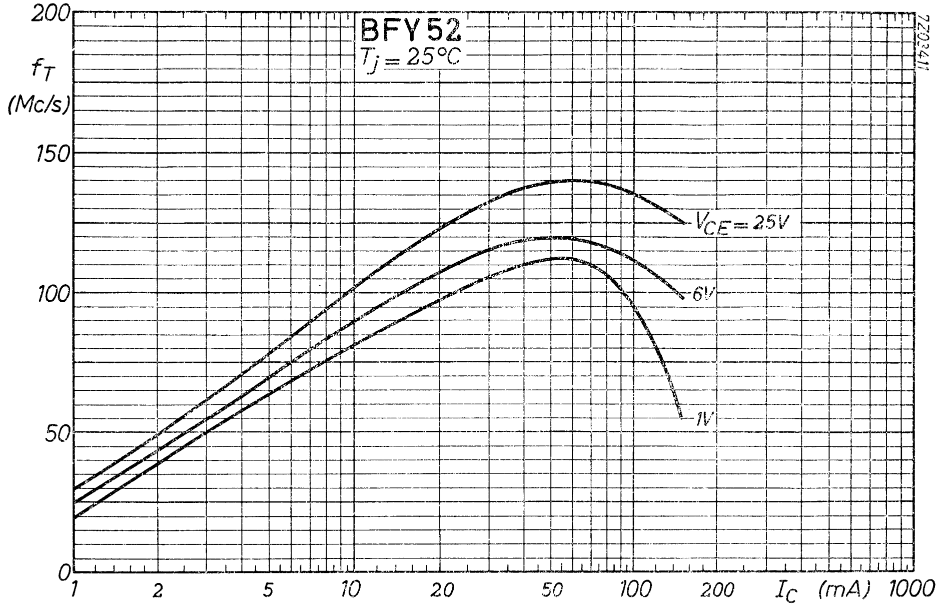
V_CEsat (V)
1.5
1
0.5
0
-50
0
50
100
150
T_j (°C)
200
I_C = 1A; I_B = 50mA
1A; 100mA
I_C = 150mA; I_B = 7.5mA
150mA; 15mA
10mA; 0.5 to 1mA
7Z03405-2.6.25.ej.

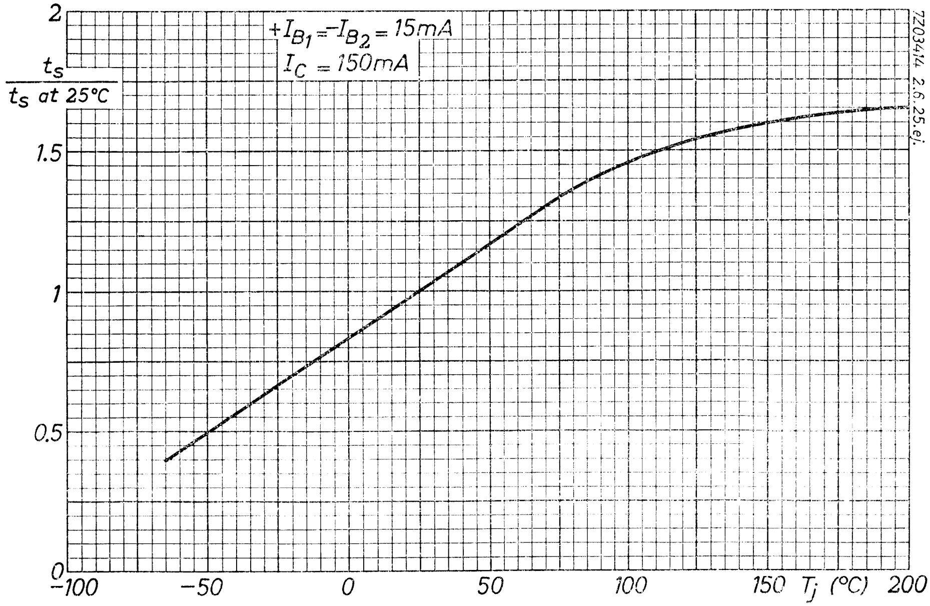


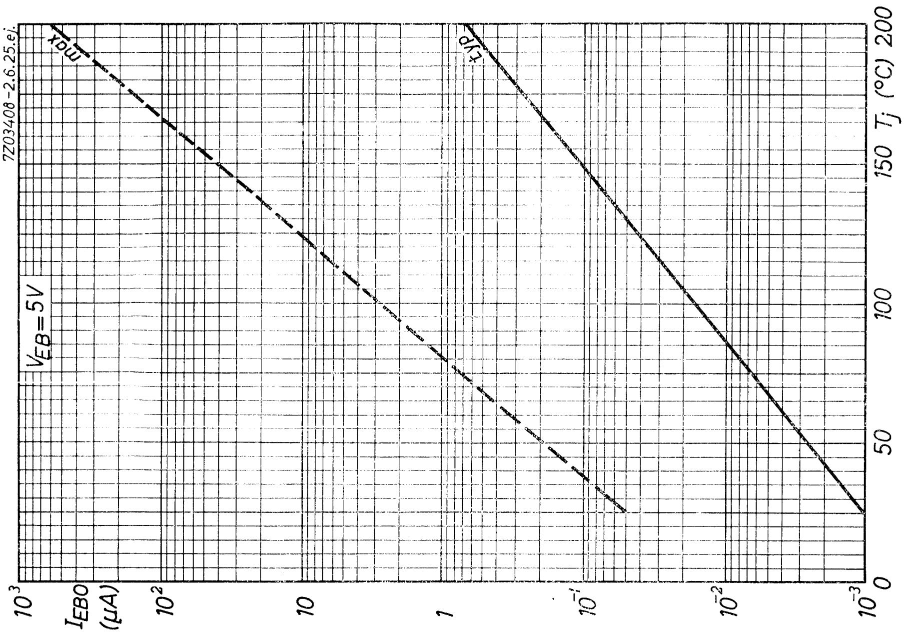
V_BEsat (V)
1.5
1
0.5
0
-50
0
50
100
150
T_j (°C)
200
I_C = 1A; I_B = 100mA
1A; 50mA
I_C = 150mA; I_B = 15 mA
150mA; 7.5mA
10mA; 1mA
10mA; 0.5mA
7Z03406-2.6.25.ej.

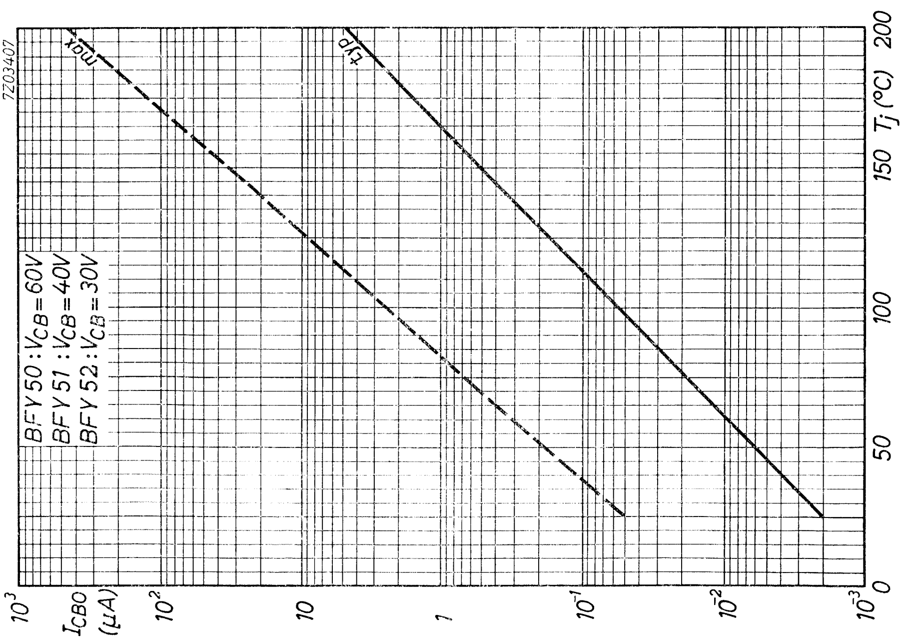

BFY50
$T_j = 25°C$
f_T (Mc/s)
200
150
100
50
0
1
2
5
10
20
50
100
200
I_C (mA)
1000
$V_{CE} = 25V$
6V
1V
7Z03410


BFY51
$T_j = 25°C$
f_T (Mc/s)
200
150
100
50
0
1
2
5
10
20
50
100
200
I_C (mA)
1000
$V_{CE} = 25V$
6V
1V
7Z03412


BFY 52
$T_j = 25°C$
f_T (Mc/s)
200
150
100
50
0
1
2
5
10
20
50
100
200
1000
I_C (mA)
$V_{CE} = 25V$
6V
1V
7Z03411


$+I_{B1} = -I_{B2} = 15mA$
$I_C = 150mA$
$\frac{t_s}{t_s \text{ at } 25°C}$
2
1.5
1
0.5
0
−100
−50
0
50
100
150
200
T_j (°C)
7Z03414 2.6.25.el.


7Z03408-2.6.25.ej.
max
typ
V_{EB}=5V
I_{EBO} (μA)
10^3
10^2
10
1
10^{-1}
10^{-2}
10^{-3}
0
50
100
150
200
T_j (°C)


7Z03407
max
typ
BFY 50 : V_{CB}=60V
BFY 51 : V_{CB}=40V
BFY 52 : V_{CB}=30V
I_{CBO} (μA)
10^3
10^2
10
1
10^{-1}
10^{-2}
10^{-3}
0
50
100
150
200
T_j (°C)

SILICON PLANAR EPITAXIAL TRANSISTOR

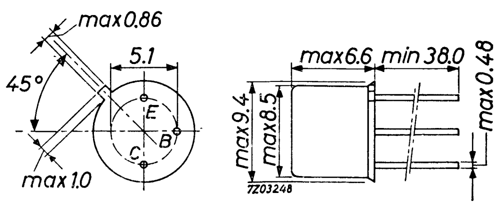
Silicon planar epitaxial transistor of the n-p-n type in TO-5 metal case with the collector connected to the case. It is primarily intended for use in high frequency and very high frequency oscillators and amplifiers as well as for output stages of servo amplifiers.

QUICK REFERENCE DATA				
Collector-base voltage (open emitter)	V_{CBO}	max.	80	V
Collector-emitter voltage (open base)	V_{CEO}	max.	35	V
Collector current (d.c.)	I_C	max.	1	A
Total dissipation up to T_{amb} = 25 °C	P_{tot}	max.	800	mW
Junction temperature	T_j	max.	200	°C
D.C. current gain at T_j = 25 °C				
I_C = 150 mA; V_{CE} = 10 V	h_{FE}	>	40	
Transition frequency				
I_C = 50 mA; V_{CE} = 10 V	f_T	>	60	Mc/s
Collector-emitter saturation voltage				
I_C = 1 A; I_B = 100 mA	V_{CEsat}	<	1	V

MECHANICAL DATA

Dimensions in mm

TO-5
Collector connected to case



7Z2 3383

RATINGS (Limiting values) [1])

Voltages

Collector-base voltage (open emitter)	V_{CBO}	max.	80	V
Collector-emitter voltage (open base)	V_{CEO}	max.	35	V
Emitter-base voltage (open collector)	V_{EBO}	max.	7	V

Currents

Collector current (d.c.)	I_C	max.	1	A
Collector current (peak value)	I_{CM}	max.	1	A
Emitter current (d.c.)	$-I_E$	max.	1	A
Emitter current (peak value)	$-I_{EM}$	max.	1	A

Power dissipation (See also page A)

Total power dissipation up to T_{amb} = 40 °C	P_{tot}	max.	4	W
Total power dissipation without cooling fin up to T_{amb} = 25 °C	P_{tot}	max.	0.8	W

Temperatures

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

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	0.22	°C/mW
From junction to case	$R_{th\ j\text{-}c}$	0.035	°C/mW

CHARACTERISTICS T_j = 25 °C

Collector cut-off current				
$I_E = 0$; V_{CB} = 60 V	I_{CBO}	<	10	nA
Emitter cut-off current				
$I_C = 0$; V_{EB} = 5 V	I_{EBO}	<	10	nA
Base current				
I_C = 150 mA; V_{CB} = 10 V	I_B	<	3.65	mA
Collector-emitter saturation voltage				
I_C = 150 mA; I_B = 15 mA	V_{CEsat}	<	0.2	V

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

7Z2 3384

CHARACTERISTIC RANGE VALUES FOR EQUIPMENT DESIGN

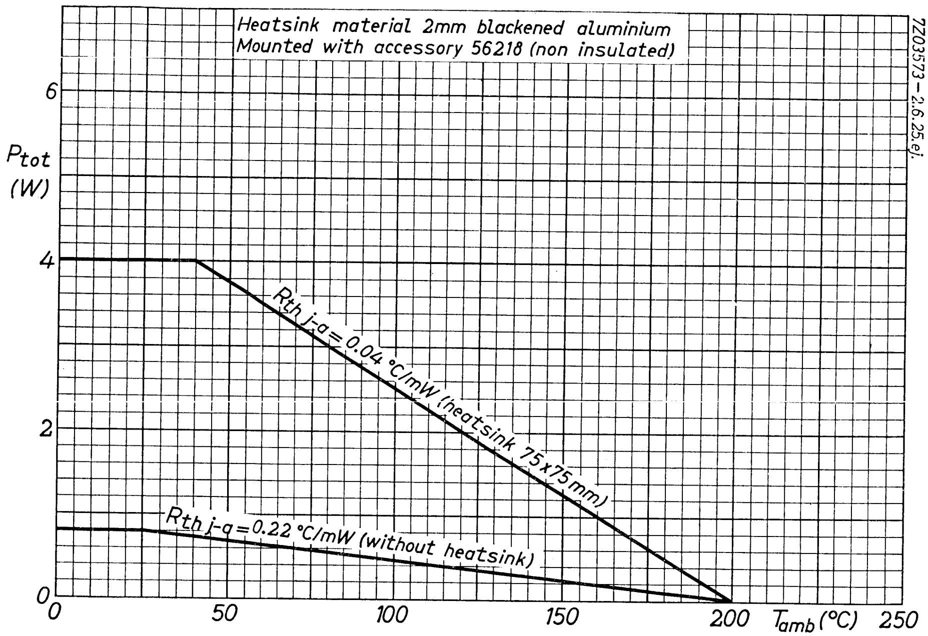
T_j = 25 °C unless otherwise specified

Collector cut-off current				
$I_E = 0$; $V_{CB} = 60$ V; $T_j = 150$ °C	I_{CBO}	<	10	μA
Saturation voltages				
$I_C = 1$ A; $I_B = 100$ mA [1][2]	V_{CEsat}	<	1.0	V
	V_{BEsat}	<	1.6	V
Collector-emitter sustaining voltage				
$I_C = 30$ mA; $I_B = 0$ [2]	$V_{CEOsust}$	>	35	V
D.C. current gain [2]				
$I_C = 10$ mA; $V_{CE} = 10$ V	h_{FE}	>	30	
$I_C = 150$ mA; $V_{CE} = 10$ V	h_{FE}		40 to 120	
$I_C = 1$ A ; $V_{CE} = 10$ V	h_{FE}	>	15	
Collector-base time constant				
$I_C = 10$ mA; $V_{CB} = 10$ V; f = 4 Mc/s	$r_{b'}c_c$	<	800	ps
Collector capacitance at f = 500 kc/s				
$I_E = I_e = 0$; $V_{CB} = 10$ V	c_c	<	12	pF
Emitter capacitance at f = 500 kc/s				
$I_C = I_c = 0$; $V_{EB} = 0.5$ V	c_e	<	80	pF
Transition frequency				
$I_C = 50$ mA; $V_{CE} = 10$ V	f_T	>	60	Mc/s

[1]) Measured with a lead length of 1 cm.

[2]) Measured under pulsed conditions to avoid excessive dissipation.
Pulse width ≈ 300 μs; duty cycle δ < 0.01

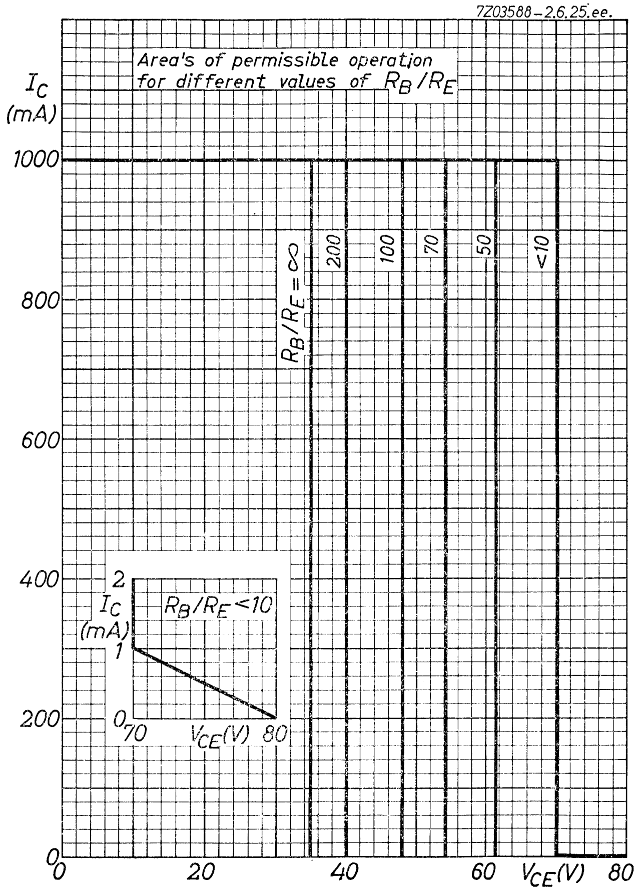
7Z2 3385

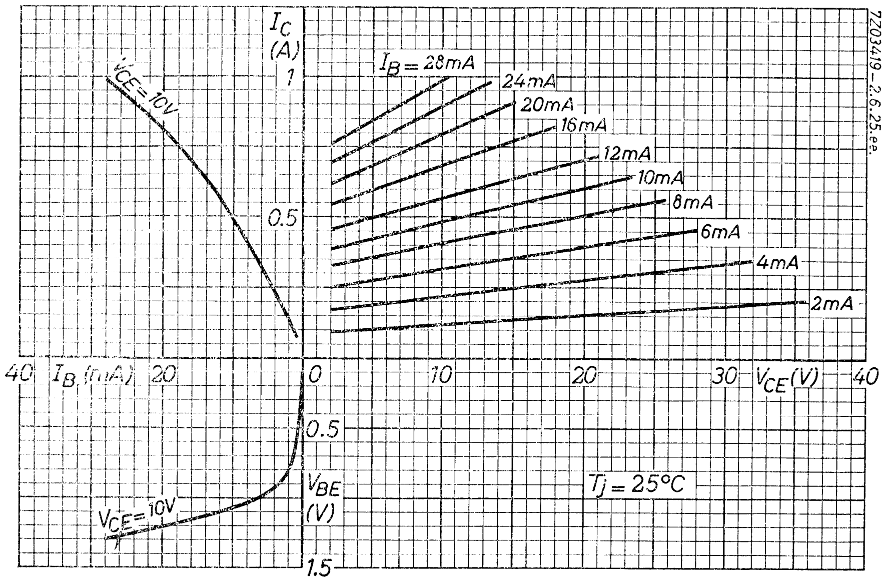


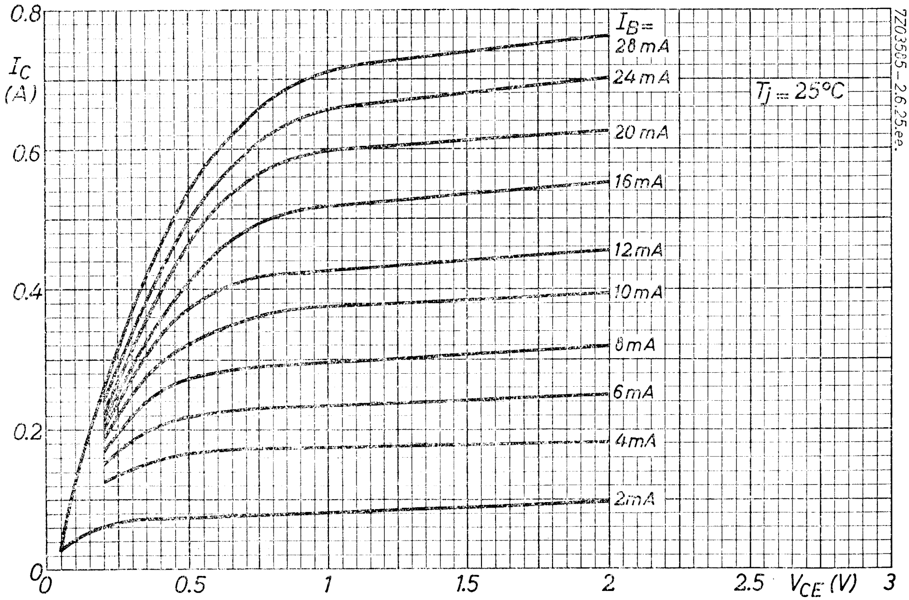
Heatsink material 2mm blackened aluminium
Mounted with accessory 56218 (non insulated)
7Z03573-2.6.25.ej.
Ptot
(W)
6
4
2
0
Rth j-a = 0.04 °C/mW (heatsink 75x75mm)
Rth j-a = 0.22 °C/mW (without heatsink)
0
50
100
150
200
Tamb (°C)
250

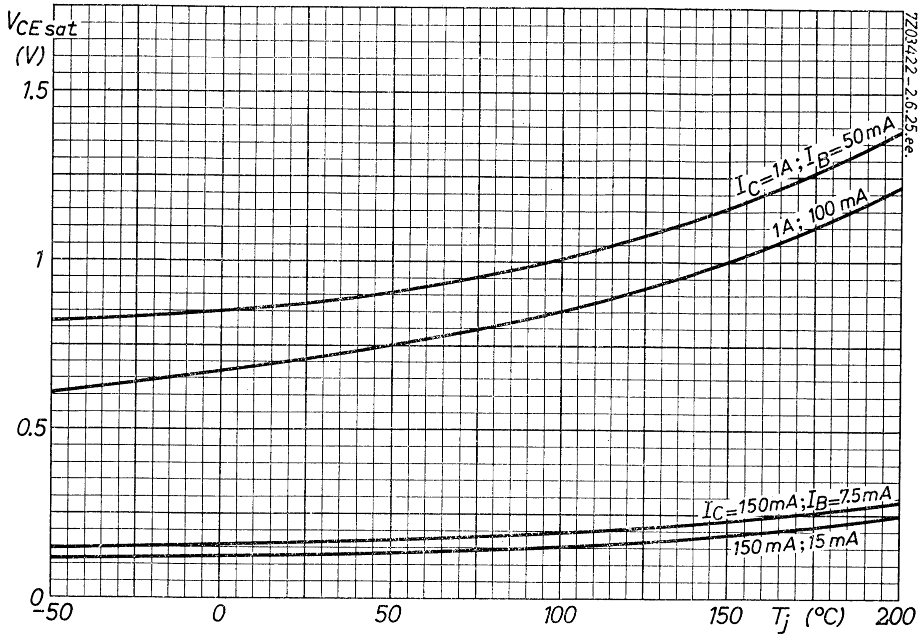
A

6.6.1965

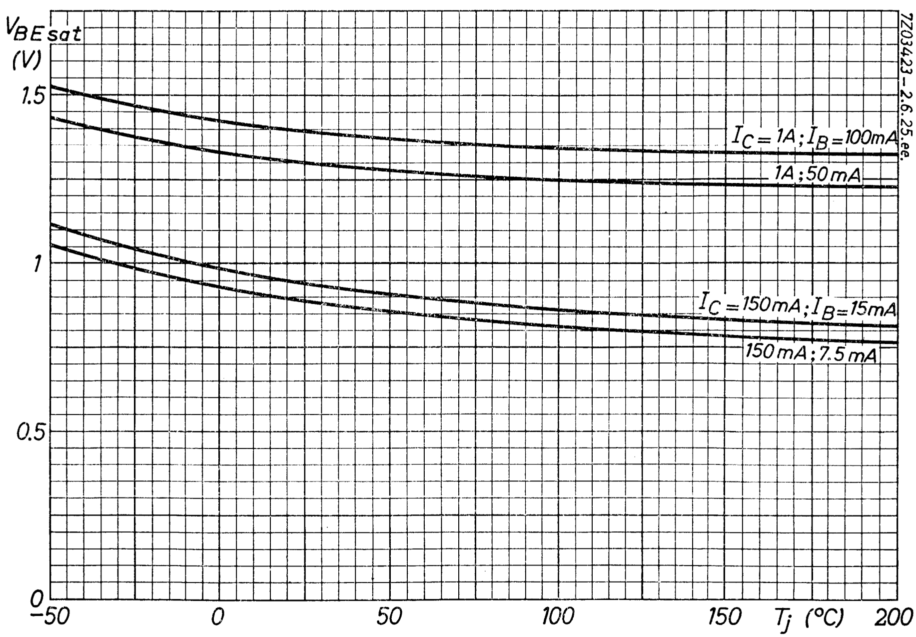

7Z03588-2.6.25.ee.
Area's of permissible operation for different values of R_B/R_E
I_C (mA)
1000
800
600
400
200
0
0
20
40
60
V_{CE}(V)
80
$R_B/R_E = \infty$
200
100
70
50
<10
2
I_C (mA)
R_B/R_E<10
1
0
70
V_{CE}(V)
80


7Z03419 – 2.6.25.ee.
I_C (A)
1
0.5
I_B = 28mA
24mA
20mA
16mA
12mA
10mA
8mA
6mA
4mA
2mA
V_{CE} = 10V
40
I_B (mA)
20
0
10
20
30
V_{CE} (V)
40
0.5
V_{BE} (V)
1.5
T_j = 25°C

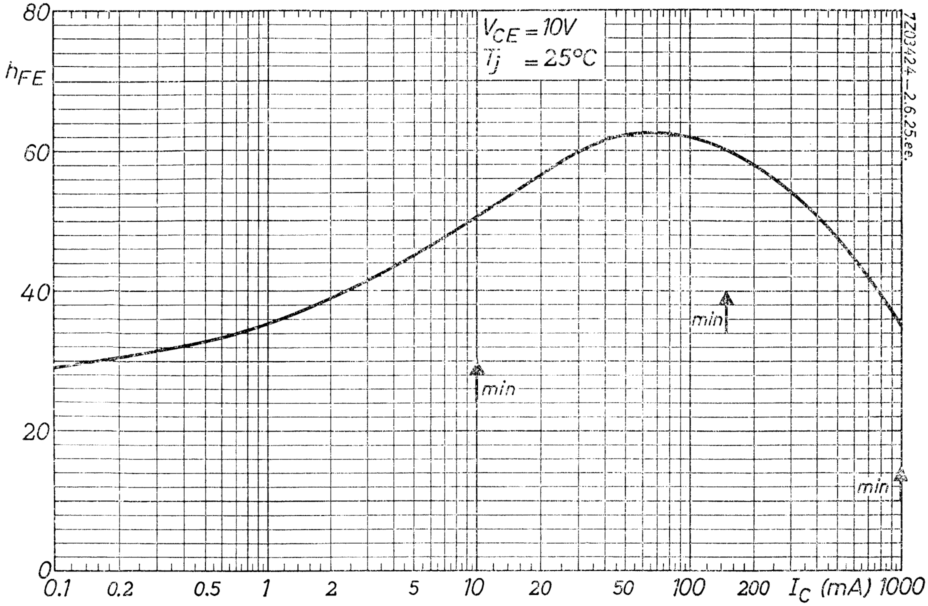

7Z03585 – 2.6.25.ee.
0.8
I_C (A)
0.6
0.4
0.2
0
I_B = 28 mA
24 mA
20 mA
16 mA
12 mA
10 mA
8 mA
6 mA
4 mA
2 mA
T_j = 25°C
0
0.5
1
1.5
2
2.5
V_{CE} (V)
3



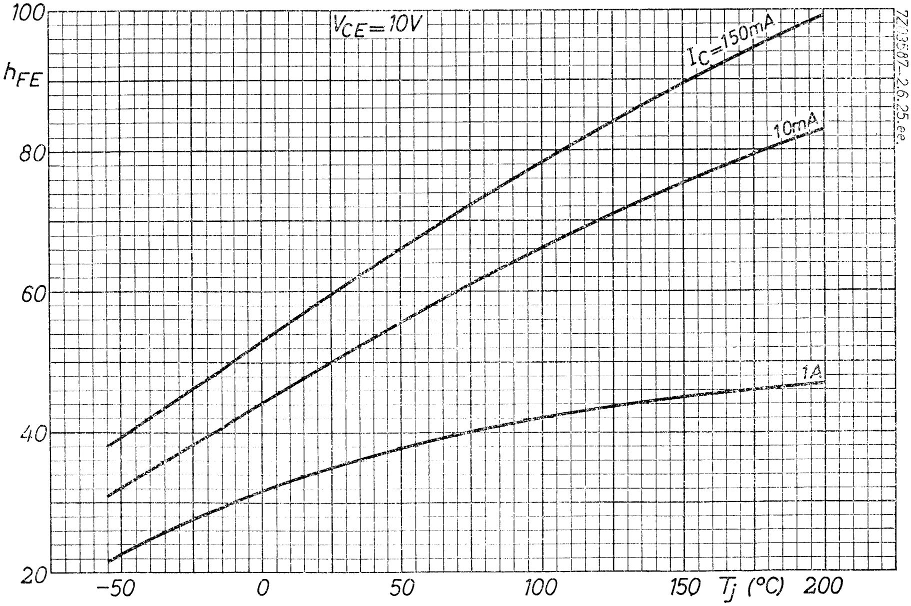
V_{CEsat} (V)
1.5
1
0.5
0
-50
0
50
100
150
T_j (°C)
200
I_C=1A; I_B=50mA
1A; 100 mA
I_C=150mA; I_B=7.5mA
150mA; 15mA
7Z03422-2.6.25.ee.



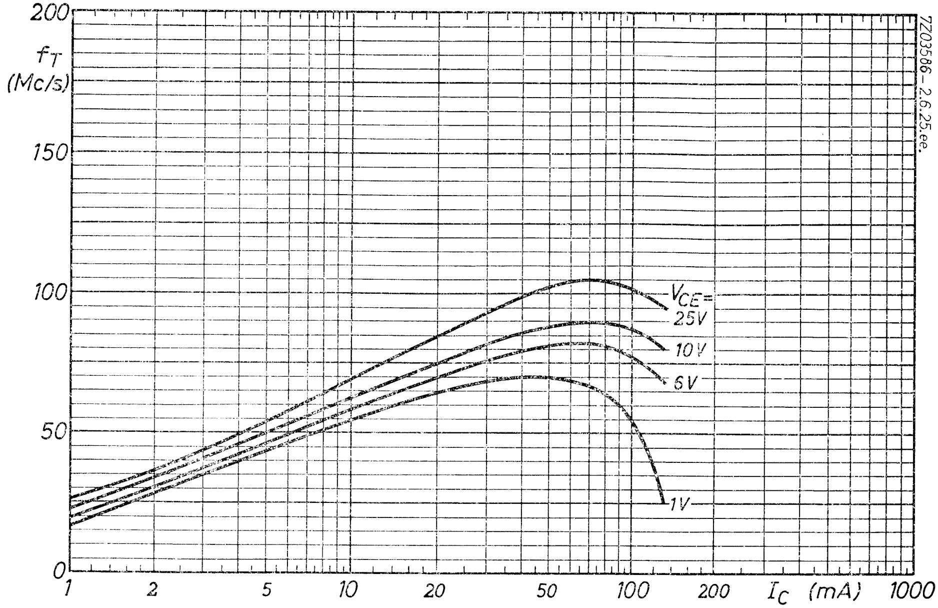
V_{BEsat} (V)
1.5
1
0.5
0
-50
0
50
100
150
T_j (°C)
200
I_C=1A; I_B=100mA
1A; 50mA
I_C=150mA; I_B=15mA
150mA; 7.5mA
7Z03423-2.6.25.ee.

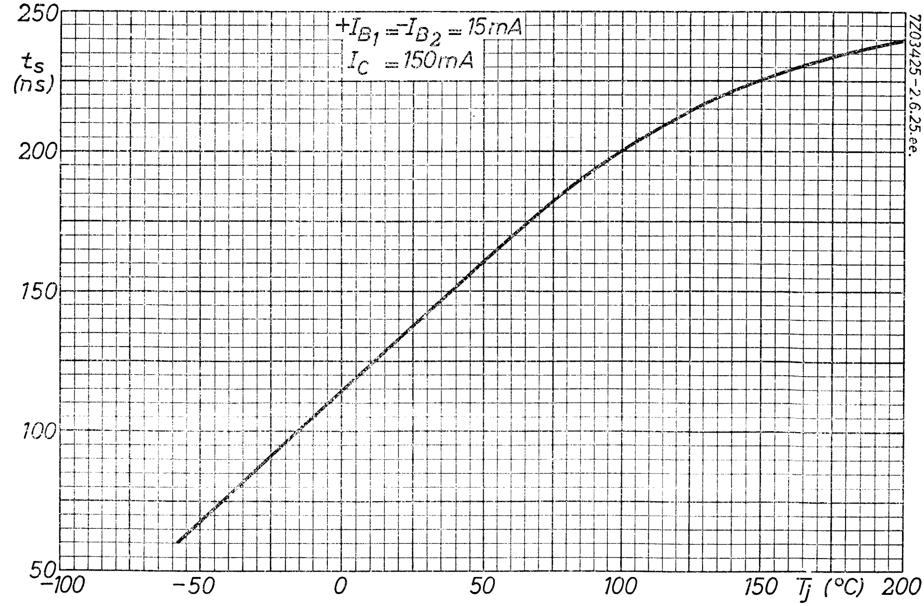


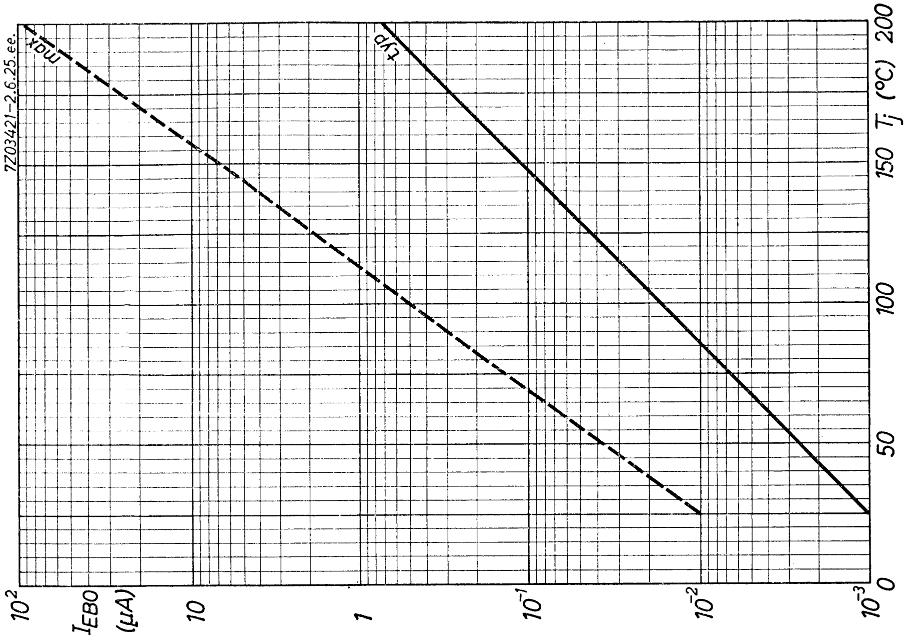
80
60
40
20
0
h_{FE}
$V_{CE} = 10V$
$T_j = 25°C$
7Z03424–2.6.25.ee.
min
min
min
0.1
0.2
0.5
1
2
5
10
20
50
100
200
I_C (mA)
1000

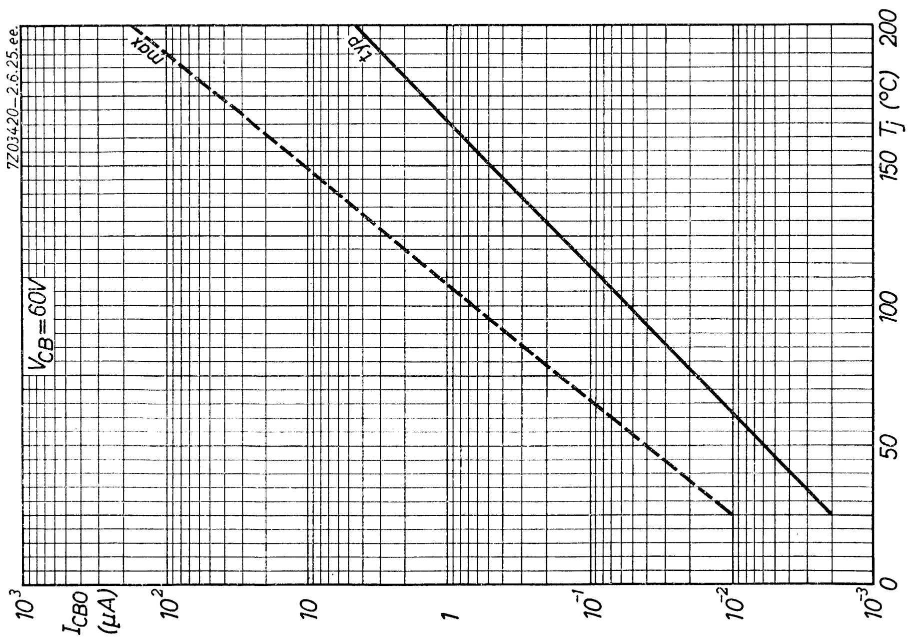


100
80
60
40
20
h_{FE}
$V_{CE}=10V$
$I_C=150mA$
10mA
1A
−50
0
50
100
150
T_j (°C)
200


200
f_T
(Mc/s)
150
100
50
0
1
2
5
10
20
50
100
200
I_C (mA)
1000
V_{CE}=
25V
10V
6V
1V
7Z03586-2.6.25.ee.


250
t_s
(ns)
200
150
100
50
−100
−50
0
50
100
150
T_j (°C)
200
$+I_{B1} = -I_{B2} = 15mA$
$I_C = 150mA$
7Z03425-2.6.25.ee.


7Z03421–2.6.25.ee.
max
typ
T_j (°C)
200
150
100
50
0
10^2
I_{EBO} (μA)
10
1
10^{-1}
10^{-2}
10^{-3}


7Z03420–2.6.25.ee.
$V_{CB} = 60V$
max
typ
T_j (°C)
200
150
100
50
0
10^3
I_{CBO} (μA)
10^2
10
1
10^{-1}
10^{-2}
10^{-3}

SILICON N-P-N
DOUBLE DIFFUSED MESA TRANSISTOR

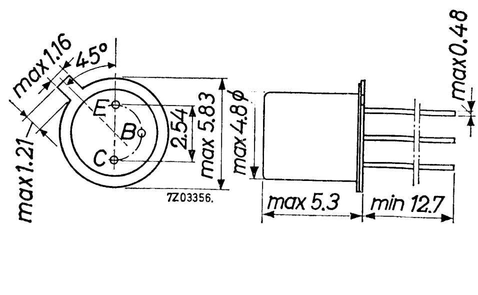
Silicon double diffused mesa transistor of the n-p-n type in TO-18 metal case, with the collector connected to the case.
It is primarily intended for driving numerical indicator tubes.

QUICK REFERENCE DATA				
Collector-base voltage (open emitter)	V_{CBO}	max.	120	V
Collector-emitter voltage (open base)	V_{CEO}	max.	80	V
Collector current (peak value)	I_{CM}	max.	50	mA
Total power dissipation up to $T_{amb} = 25\ ^{o}C$	P_{tot}	max.	300	mW
Junction temperature	T_j	max.	175	^{o}C
D.C. current gain at $T_j = 25\ ^{o}C$				
$I_C = 4$ mA; $V_{CE} = 3$ V	h_{FE}	>	20	
Transition frequency				
$I_C = 4$ mA; $V_{CE} = 10$ V	f_T	>	60	Mc/s

NOTE: The BSX21 may be operated in the breakdown region up to $V_{CE} = 160$ V, provided P_{tot} at $T_{amb} = 85\ ^{o}C$ does not exceed 100 mW.

MECHANICAL DATA Dimensions in mm

TO-18
Collector connected to case



7Z2 3218

RATINGS (Limiting values) [3]

Voltages

Collector-base voltage (open emitter)	V_{CBO}	max.	120	V	[1]
Collector-emitter voltage (open base)	V_{CEO}	max.	80	V	[1]
Emitter-base voltage (open collector)	V_{EBO}	max.	5	V	

Currents

Collector current (d.c. and average over any 20 ms period)	I_C	max.	50	mA	
Collector current (peak value)	I_{CM}	max.	50	mA	[2]
Emitter current (d.c. and average over any 20 ms period)	I_E	max.	50	mA	
Emitter current (peak value)	I_{EM}	max.	50	mA	

Power dissipation

Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	300	mW

Temperatures

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

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\,j\text{-}a}$	=	0.5	°C/mW
From junction to case	$R_{th\,j\text{-}c}$	=	0.15	°C/mW

[1]) The BSX21 may be operated in the breakdown region up to V_{CE} = 160 V, provided P_{tot} at T_{amb} = 85 °C does not exceed 100 mW.

[2]) The transistor can withstand a capacitive load of 500 pF, combined with a collector-base voltage of max. 150 V before switching on.

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

7Z2 3219

CHARACTERISTICS T_j = 25 °C unless otherwise specified

Collector cut-off current				
at I_E = 0; V_{CB} = 120 V	I_{CBO}	<	40	μA
Emitter cut-off current				
at I_C = 0; V_{EB} = 5 V	I_{EBO}	<	40	μA
D.C. current gain				
at I_C = 4 mA; V_{CE} = 3 V	h_{FE}	>	20	
		typ.	40	
Base-emitter voltage				
at I_C = 4 mA; V_{CE} = 3 V	V_{BE}	typ.	0.7	V
		<	0.9	V

CHARACTERISTIC RANGE VALUES FOR EQUIPMENT DESIGN
T_j = 25 °C unless otherwise specified

Collector cut-off current				
at I_E = 0; V_{CB} = 50 V	I_{CBO}	typ.	0.5	μA
Emitter cut-off current				
at I_C = 0; V_{EB} = 3 V	I_{EBO}	typ.	0.1	μA
Collector current at reverse biased emitter junction				
at V_{CE} = 80 V; $-V_{BE}$ = 1 V; T_j = 85 °C	I_{CEX}	typ.	3	μA
		<	20	μA
Saturation voltages				
I_C = 1 mA; I_B = 100 μA	V_{CEsat}	typ.	0.25	V
	V_{BEsat}	typ.	0.67	V
I_C = 10 mA; I_B = 1 mA	V_{CEsat}	typ.	1.80	V
	V_{BEsat}	typ.	0.90	V
Collector-emitter sustaining voltage				
I_C = 4 mA; I_B = 0	V_{CEsust}	>	80	V

7Z2 3220

CHARACTERISTIC RANGE VALUES FOR EQUIPMENT DESIGN (continued)

T_j = 25 °C unless otherwise specified

D.C. current gain

I_C = 1 mA; V_{CE} = 3 V	h_{FE}	typ.	25	
I_C = 10 mA; V_{CE} = 3 V	h_{FE}	typ.	32	
I_C = 20 mA; V_{CE} = 3 V	h_{FE}	typ.	7	

Collector capacitance at f = 1 Mc/s

$I_E = I_e = 0$; V_{CB} = 10 V	c_c	typ.	3.6	pF

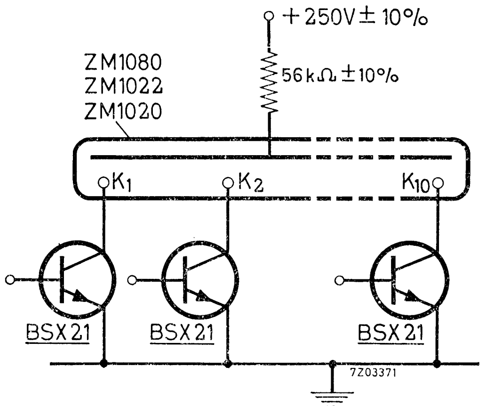
Emitter capacitance at f = 1 Mc/s

$I_C = I_c = 0$; V_{EB} = 1 V	c_e	typ.	8.5	pF

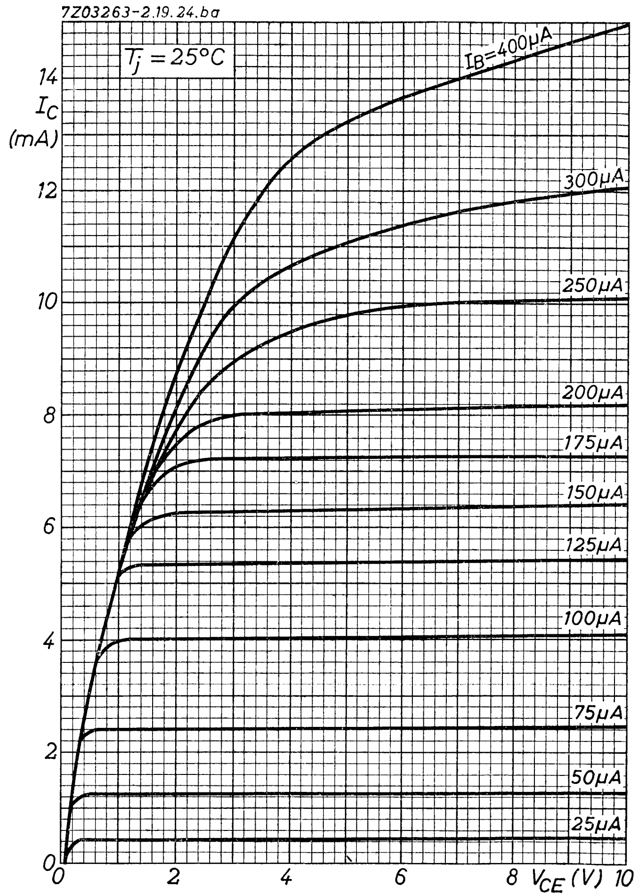
Transition frequency

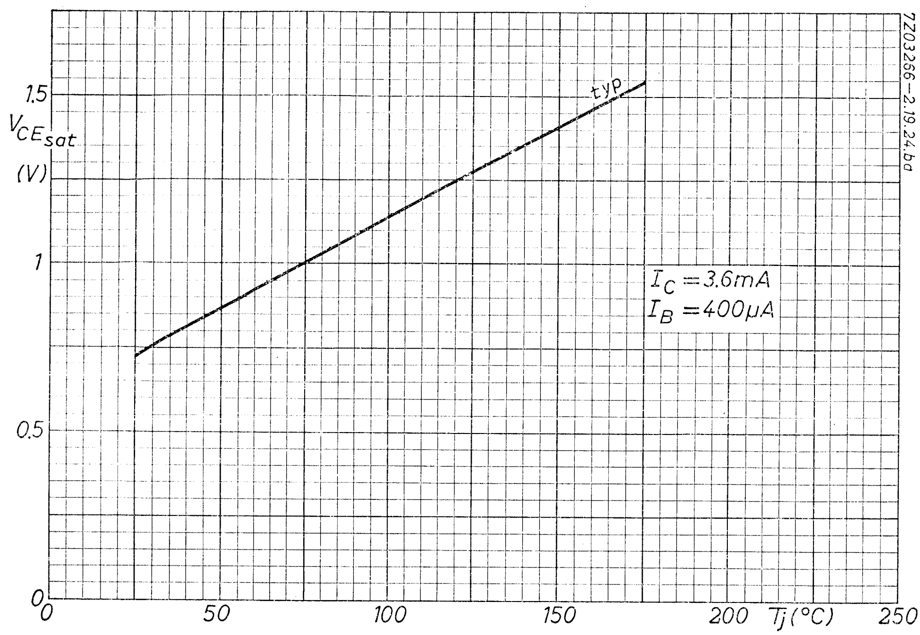
I_C = 4 mA; V_{CE} = 10 V	f_T	>	60	Mc/s
		typ.	120	Mc/s

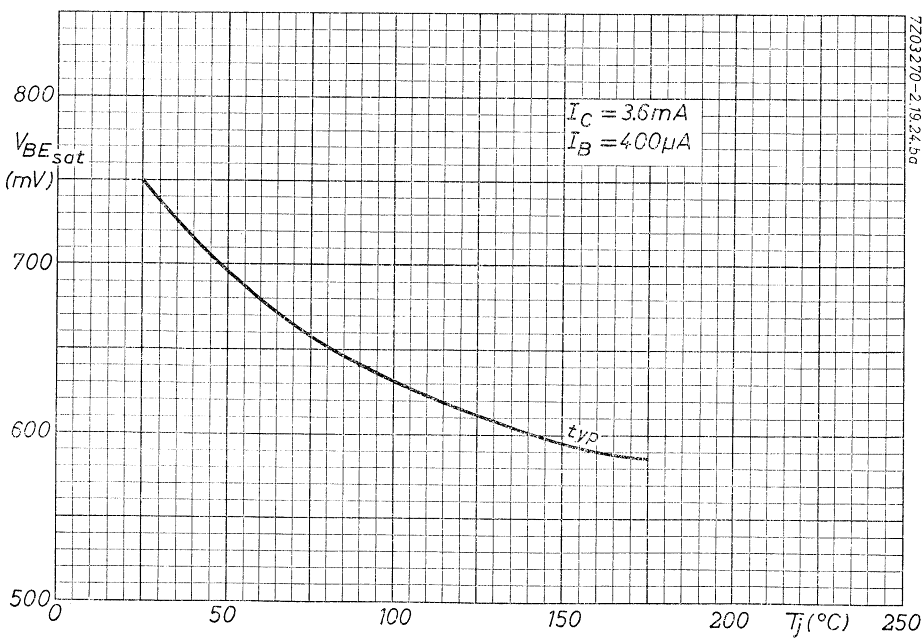
Practical circuit

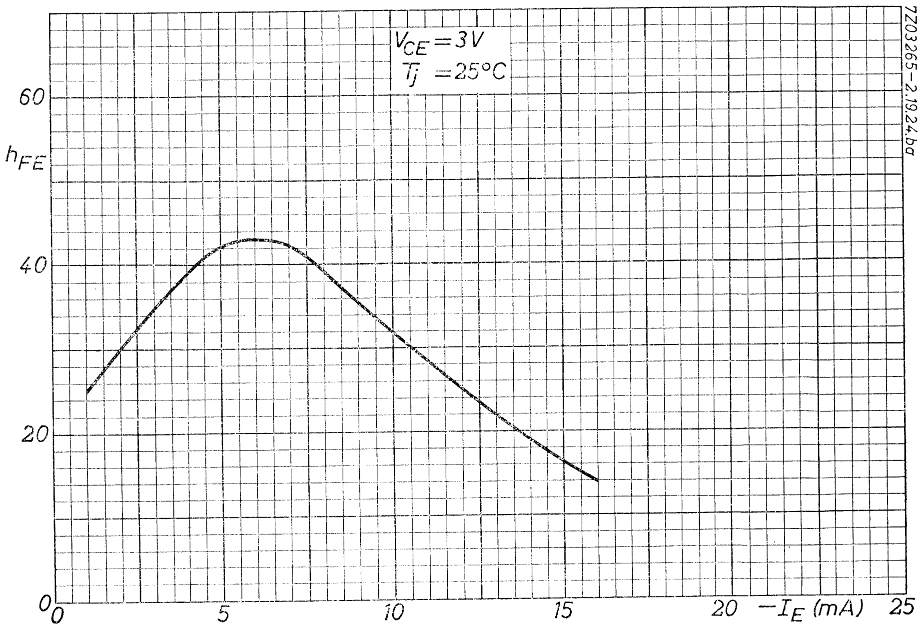


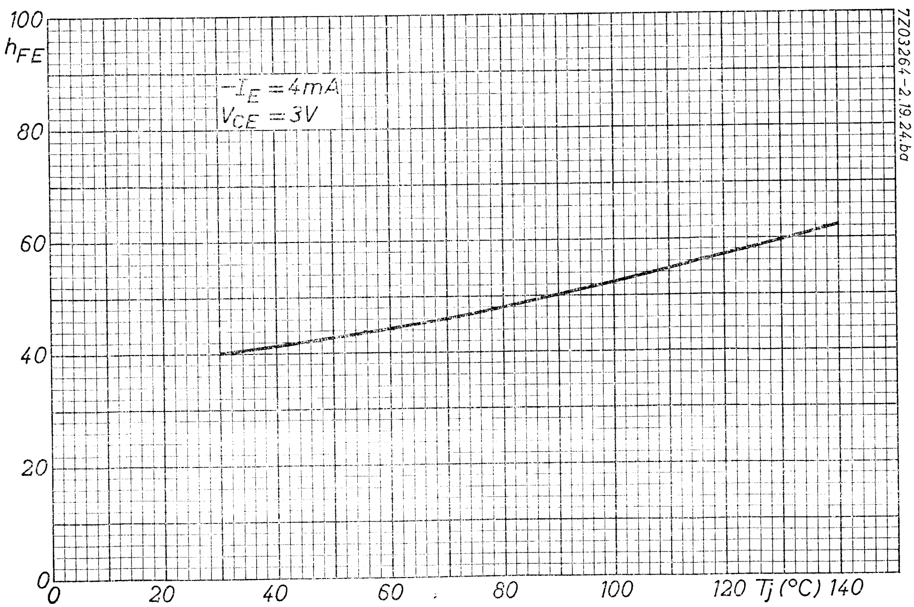
7Z2 3221

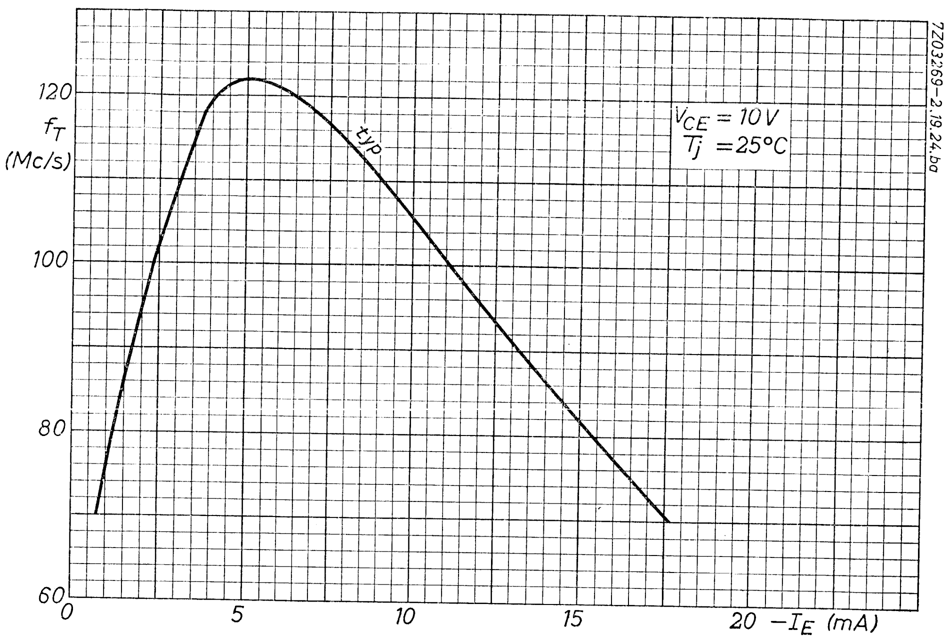

7Z03263-2.19.24.ba
$T_j = 25°C$
$I_B = 400 \mu A$
300μA
250μA
200μA
175μA
150μA
125μA
100μA
75μA
50μA
25μA
I_C (mA)
0
2
4
6
8
10
12
14
V_{CE} (V)
0
2
4
6
8
10


1.5
$V_{CE_{sat}}$
(V)
1
0.5
0
0
50
100
150
200
250
T_j (°C)
typ
$I_C = 3.6 mA$
$I_B = 400 \mu A$
7Z03266-2.19.24.ba


800
$V_{BE_{sat}}$
(mV)
700
600
500
0
50
100
150
200
250
T_j (°C)
typ
$I_C = 3.6 mA$
$I_B = 400 \mu A$
7Z03270-2.19.24.ba


$V_{CE} = 3V$
$T_j = 25°C$
7Z03265-2.19.24.ba
60
h_{FE}
40
20
0
0
5
10
15
20
$-I_E$ (mA)
25

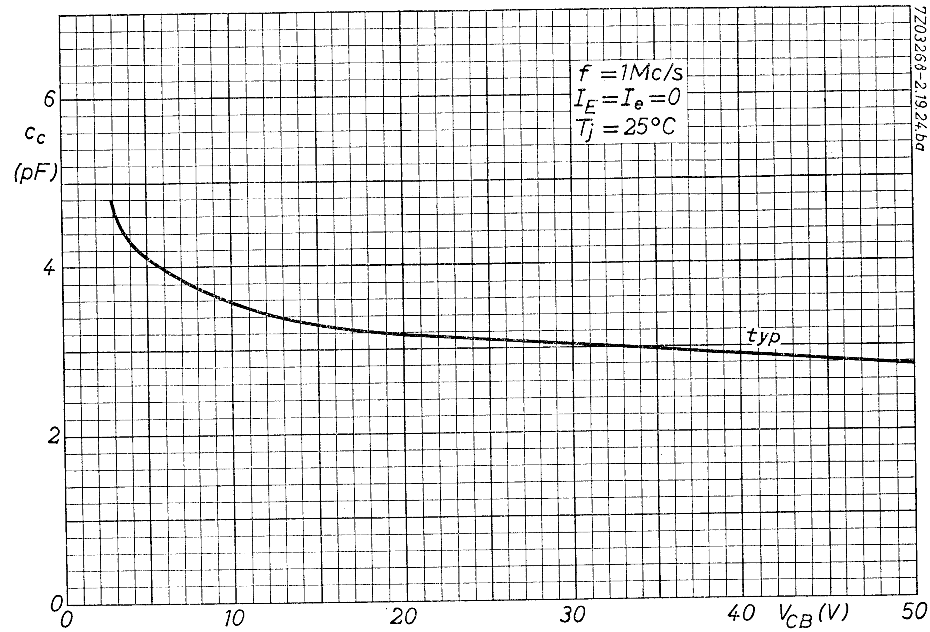

100
h_{FE}
$-I_E = 4mA$
$V_{CE} = 3V$
7Z03264-2.19.24.ba
80
60
40
20
0
0
20
40
60
80
100
120
T_j (°C)
140

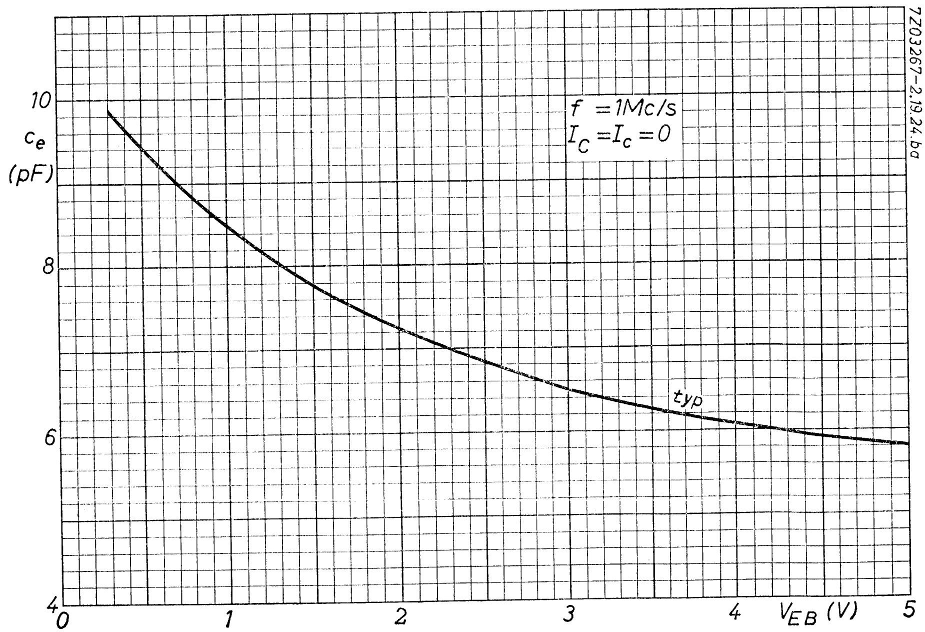


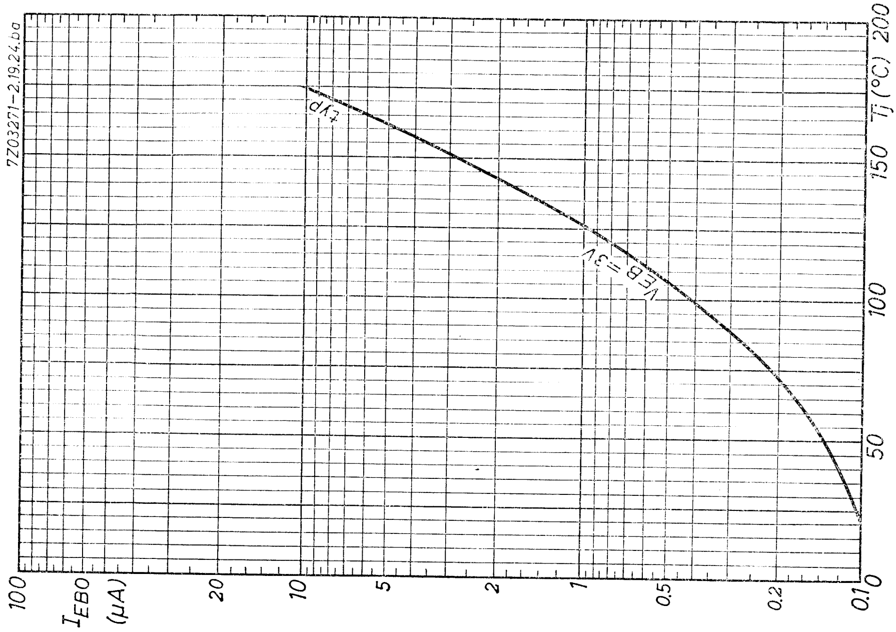
7Z03269-2.19.24.ba
120
f_T
(Mc/s)
100
80
60
0
5
10
15
20 $-I_E$ (mA)
typ
V_{CE} = 10 V
T_j = 25°C

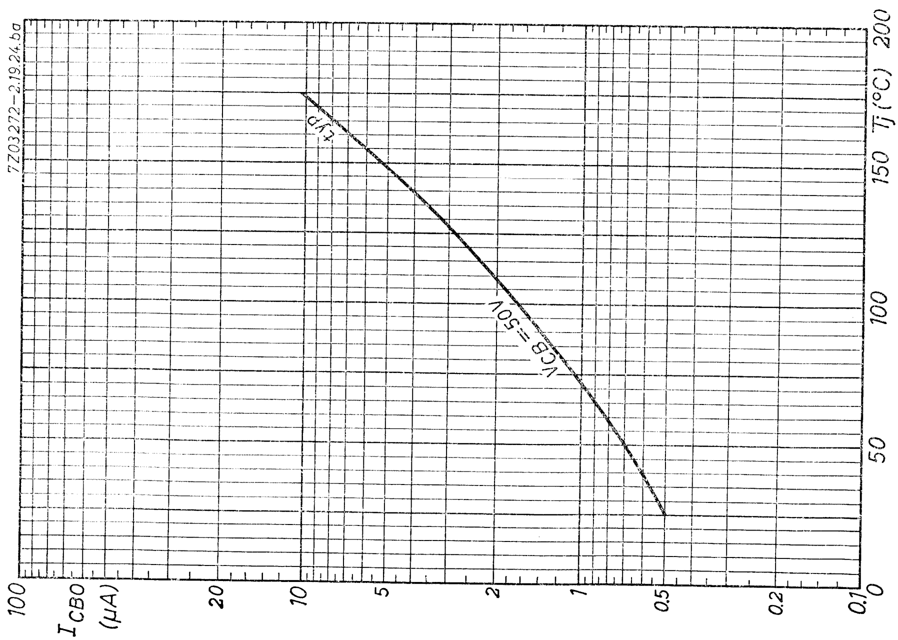
D

5.5.1965


7Z03268-2.19.24.ba
f = 1Mc/s
$I_E = I_e = 0$
$T_j = 25°C$
c_c
(pF)
6
4
2
0
typ
0
10
20
30
40
V_{CB} (V)
50


7Z03267-2.19.24.ba
f = 1Mc/s
$I_C = I_c = 0$
c_e
(pF)
10
8
6
4
typ
0
1
2
3
4
V_{EB} (V)
5


7Z03271–2.19.24.ba
typ
VEB = 3V
Tj (°C)
0
50
100
150
200
IEBO (μA)
100
20
10
5
2
1
0.5
0.2
0.1


7Z03272–2.19.24.ba
typ
VCB = 50V
Tj (°C)
0
50
100
150
200
ICBO (μA)
100
20
10
5
2
1
0.5
0.2
0.1

F

5.5.1965

SILICON N-P-N PLANAR TRANSISTORS

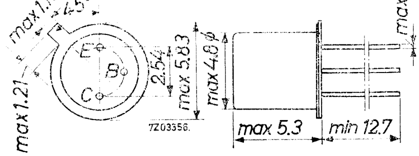
Silicon planar transistors of the n-p-n type in TO-18 metal case with the collector connected to the case.
These devices are primarily intended for use in high performance, low level, low noise amplifier applications both for direct current and for frequencies of up to 100 Mc/s

QUICK REFERENCE DATA

			2N929	2N930	
Collector-base voltage (open emitter)	V_{CBO}	max.	45	45	V
Collector-emitter voltage (open base)	V_{CEO}	max.	45	45	V
Collector current (peak value)	I_{CM}	max.	60	60	mA
Total dissipation up to T_{amb} = 25 °C	P_{tot}	max.	300	300	mW
Junction temperature	T_j	max.	175	175	°C
D.C. current gain at T_j = 25 °C					
I_C = 10 μA; V_{CE} = 5 V	h_{FE}		40 to 120	100 to 300	
I_C = 10 mA; V_{CE} = 5 V	h_{FE}		100 to 350	200 to 600	
Transition frequency					
I_C = 0.5 mA; V_{CE} = 5 V	f_T	typ.	80	80	Mc/s
Noise figure (bandwidth 10 c/s to 15 kc/s)					
I_C = 10 μA; V_{CE} = 5 V; R_S = 10 kΩ	F	typ.	2.5	2	dB
		<	4	3	dB

MECHANICAL DATA

TO-18
Collector connected to case



7Z2 3258

RATINGS (Limiting values) [1]

Voltages

Collector-base voltage (open emitter)	V_{CBO}	max.	45	V
Collector-emitter voltage (open base)	V_{CEO}	max.	45	V
Collector-emitter voltage at $V_{EB} = 0$	V_{CES}	max.	45	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	V

Currents

Collector current (d.c. or average over any 50 ms period)	I_C	max.	30	mA
Collector current (peak value)	I_{CM}	max.	60	mA
Emitter current (d.c. or average over any 50 ms period)	$-I_E$	max.	35	mA
Emitter current (peak value)	$-I_{EM}$	max.	70	mA

Power dissipation

Total power dissipation up to $T_{amb} = 25\ ^oC$	P_{tot}	max.	300	mW

Temperatures

Storage temperature	T_{stg}		-65 to +175	^oC
Junction temperature	T_j	max.	175	^oC

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	0.5	$^oC/mW$
From junction to case	$R_{th\ j-c}$	=	0.25	$^oC/mW$

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

7Z2 3259

CHARACTERISTICS $T_j = 25\ ^oC$

Collector cut-off current

$I_E = 0$; $V_{CB} = 45$ V	I_{CBO}	<	10	nA

Emitter cut-off current

$I_C = 0$; $V_{EB} = 5$ V	I_{EBO}	<	10	nA

Emitter-base voltage

$I_E = 0.5$ mA; $V_{CB} = 5$ V	V_{EB}	0.6 to 0.8	V

Base current

$I_E = 10$ mA; $V_{CB} = 5$ V	2N929	I_B	<	100	μA
	2N930	I_B	<	50	μA

CHARACTERISTIC RANGE VALUES FOR EQUIPMENT DESIGN $T_j = 25\ ^oC$

Collector cut-off current

$V_{EB} = 0$; $V_{CB} = 45$ V	I_{CES}	<	10	nA

Saturation voltages

$I_C = 10$ mA; $I_B = 0.5$ mA	V_{CEsat}	< 1	V
	V_{BEsat}	0.6 to 1	V

		2N929	2N930	
D.C. current gain				
$I_C = 10\ \mu A$; $V_{CE} = 5$ V	h_{FE}	40 to 120	100 to 300	
$I_C = 10$ mA; $V_{CE} = 5$ V	h_{FE}	100 to 350	200 to 600	
Collector capacitance at f = 1 Mc/s				
$I_E = I_e = 0$; $V_{CB} = 5$ V	c_c	< 8	< 8	pF
Transition frequency				
$I_C = 0.5$ mA; $V_{CE} = 5$ V	f_T	> 50	> 50	Mc/s
Cut-off frequency				
$I_C = 0.5$ mA; $V_{CE} = 5$ V	f_{hfe}	> 200	> 100	kc/s

7Z2 3260

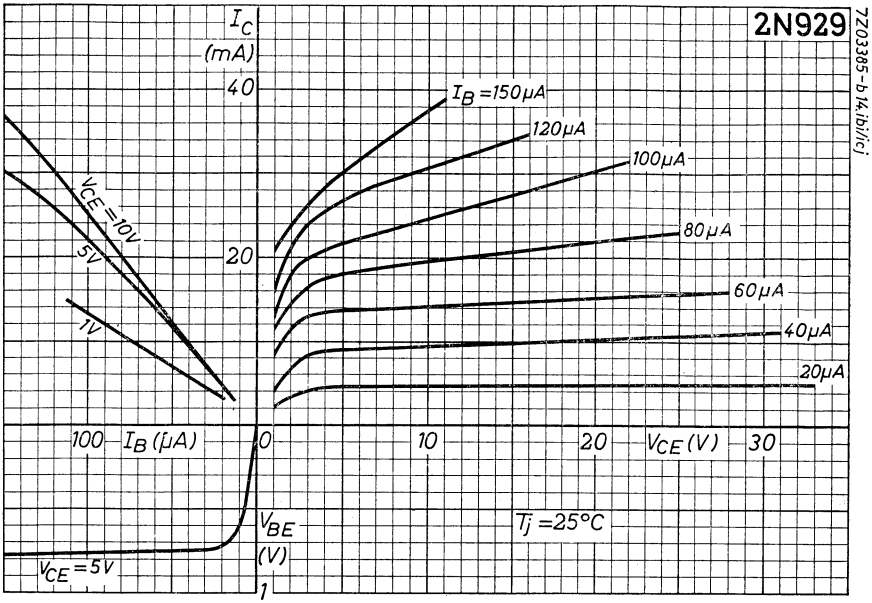
CHARACTERISTIC RANGE VALUES FOR EQUIPMENT DESIGN (continued)

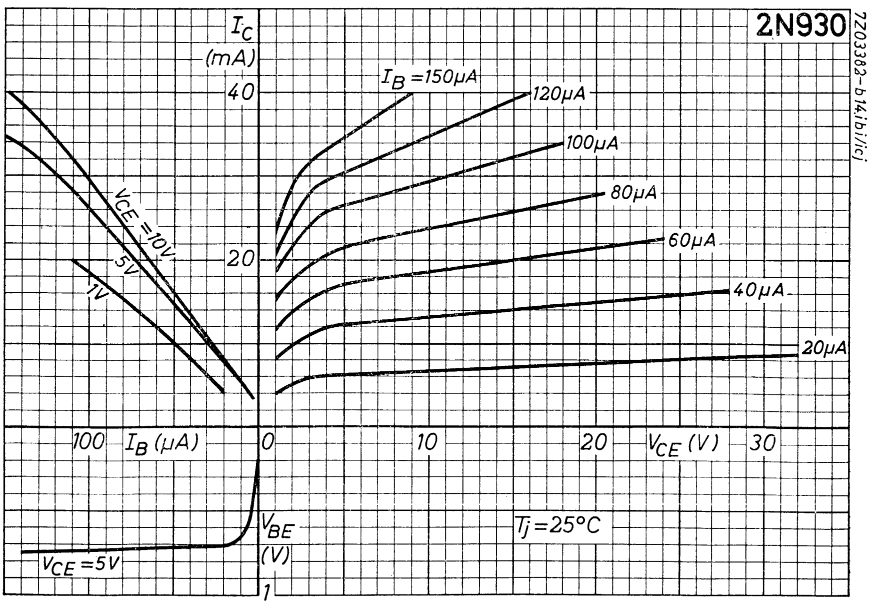
T_j = 25 °C

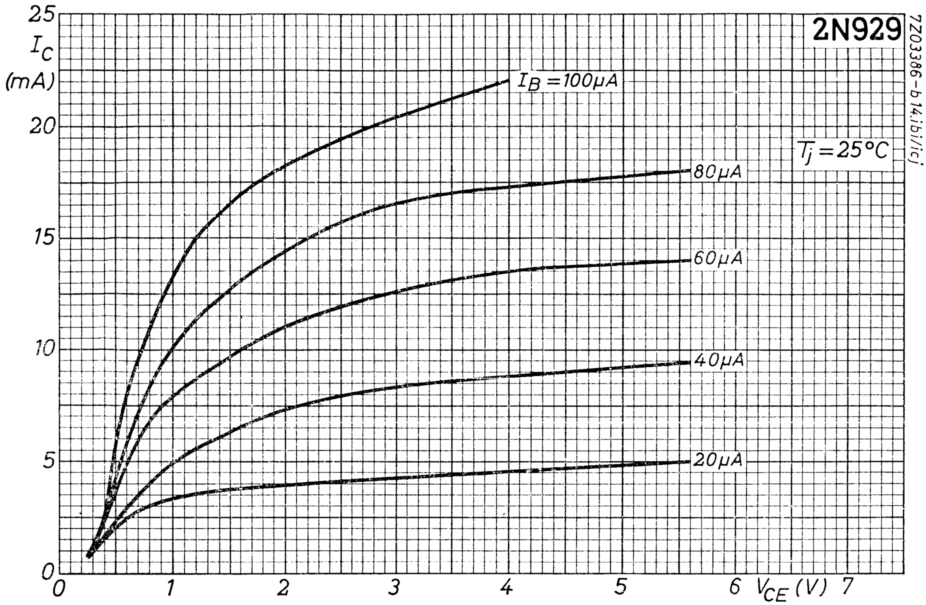
h parameters at f = 1 kc/s

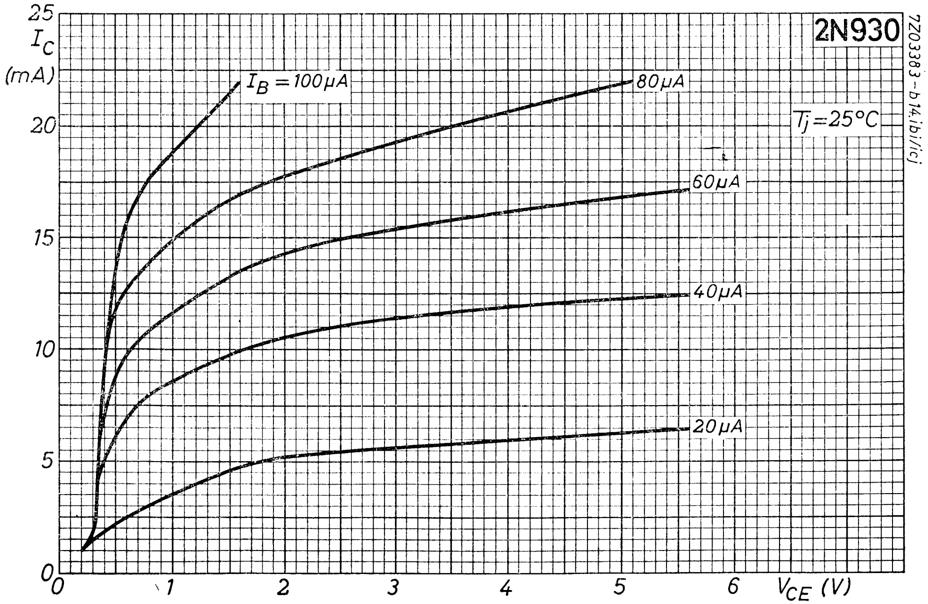
		2N929	2N930	
I_C = 1 mA; V_{CE} = 5 V				
Input impedance	h_{ie}	typ. 5.0	10.0	kΩ
Reverse voltage transfer	h_{re}	typ. 2.5	5.5	10^{-4}
Forward current gain	h_{fe}	typ. 200 60 to 350	350 150 to 600	
Output admittance	h_{oe}	typ. 14	25	μA/V
Noise figure (bandwidth 10 c/s to 15 kc/s)				
I_C = 10 μA; V_{CE} = 5 V; R_S = 10 kΩ	F	typ. 2.5 < 4	2 < 3	dB dB

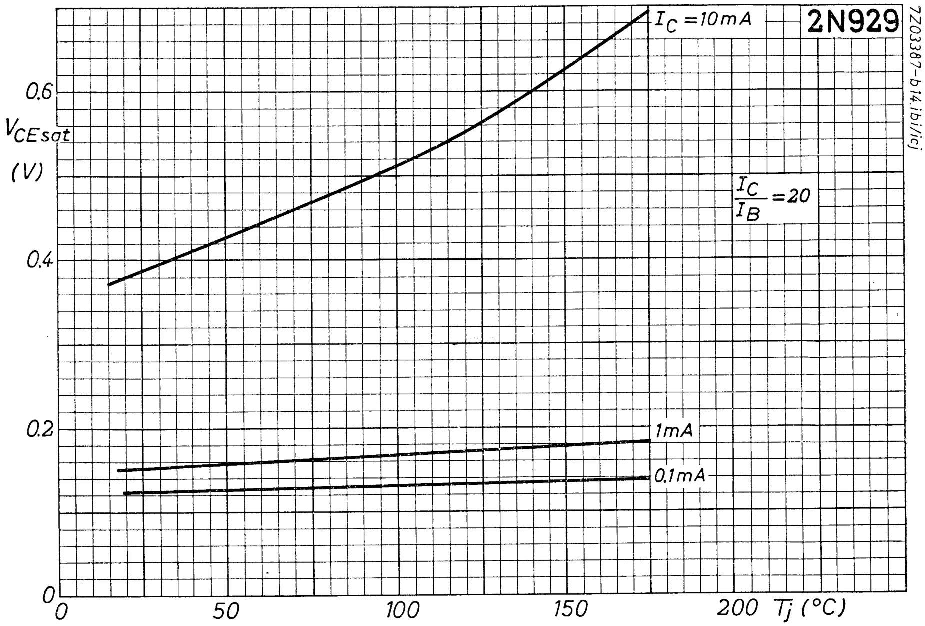
7Z2 3261

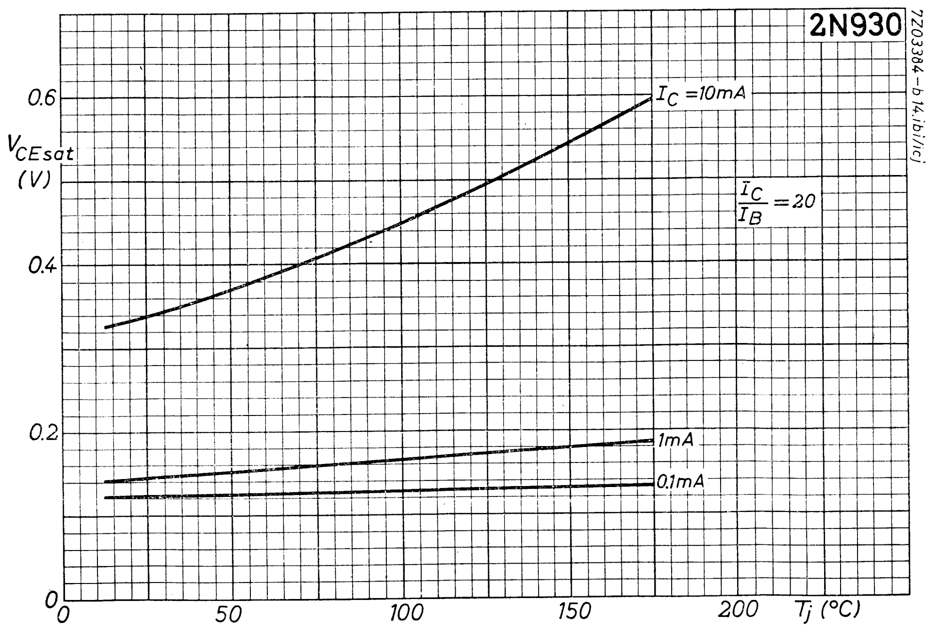

2N929
7Z03385-b14.(ib/ic)
I_C (mA)
40
20
I_B =150μA
120μA
100μA
80μA
60μA
40μA
20μA
V_{CE} =10V
5V
1V
100
I_B (μA)
0
10
20
V_{CE} (V)
30
V_{BE} (V)
1
T_j =25°C
V_{CE} =5V

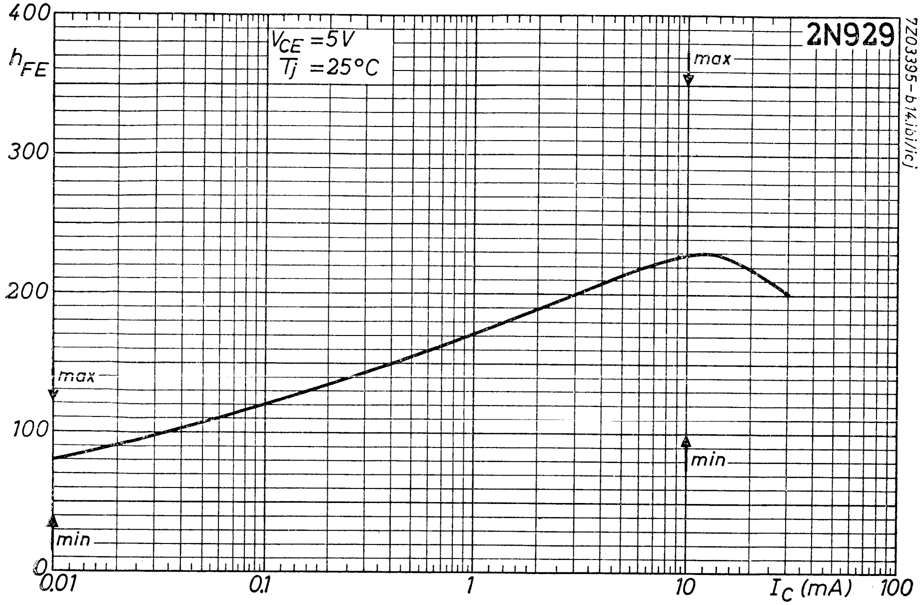

2N930
7Z03382-b14.(ib/ic)
I_C (mA)
40
20
I_B =150μA
120μA
100μA
80μA
60μA
40μA
20μA
V_{CE} =10V
5V
1V
100
I_B (μA)
0
10
20
V_{CE} (V)
30
V_{BE} (V)
1
T_j=25°C
V_{CE} =5V

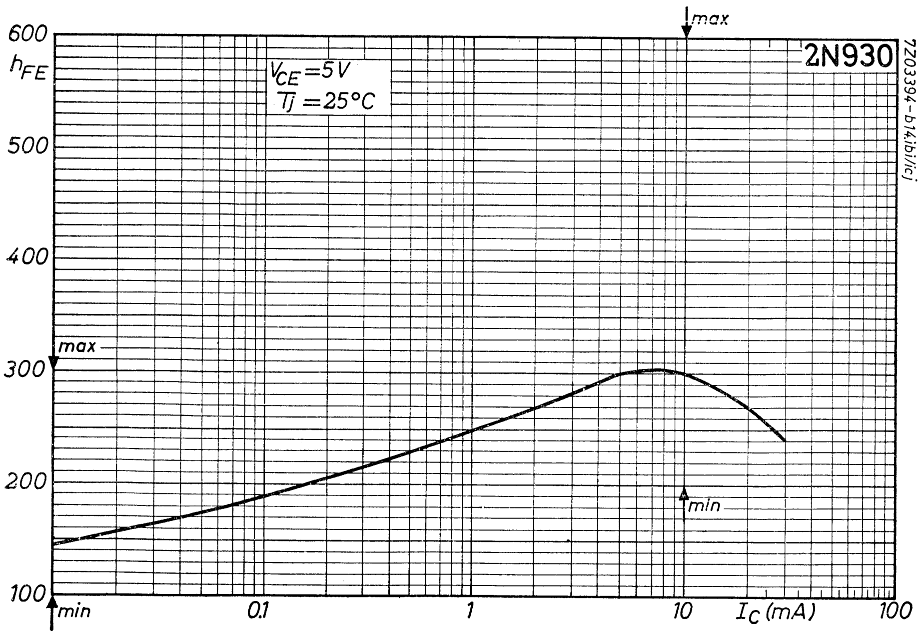

25
I_C
(mA)
20
15
10
5
0
0
1
2
3
4
5
6
7
V_{CE} (V)
2N929
7Z03386-b14.ibi/ic)
I_B = 100μA
80μA
60μA
40μA
20μA
T_j = 25°C

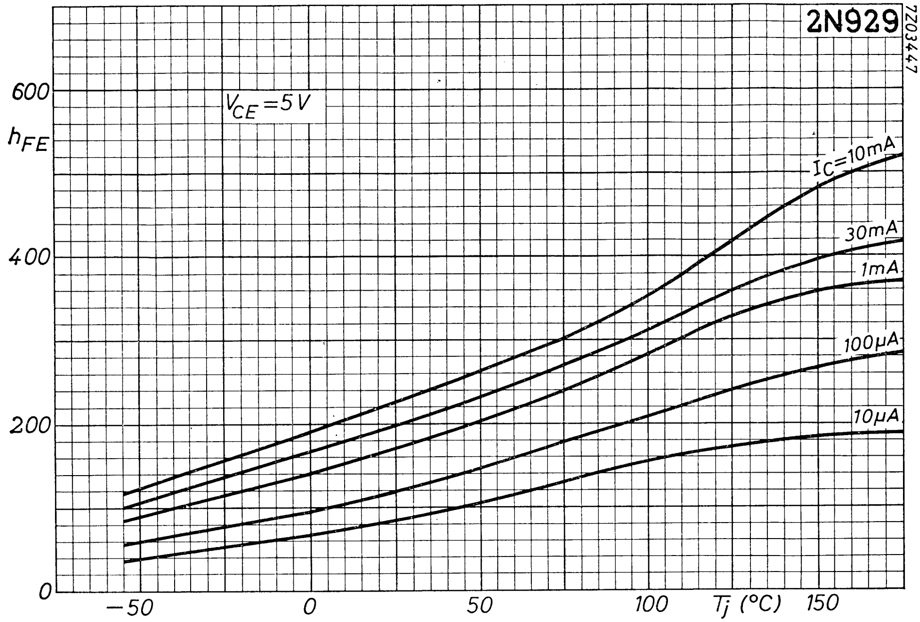

25
I_C
(mA)
20
15
10
5
0
0
1
2
3
4
5
6
V_{CE} (V)
2N930
7Z03383-b14.ibi/ic)
I_B = 100μA
80μA
60μA
40μA
20μA
T_j = 25°C

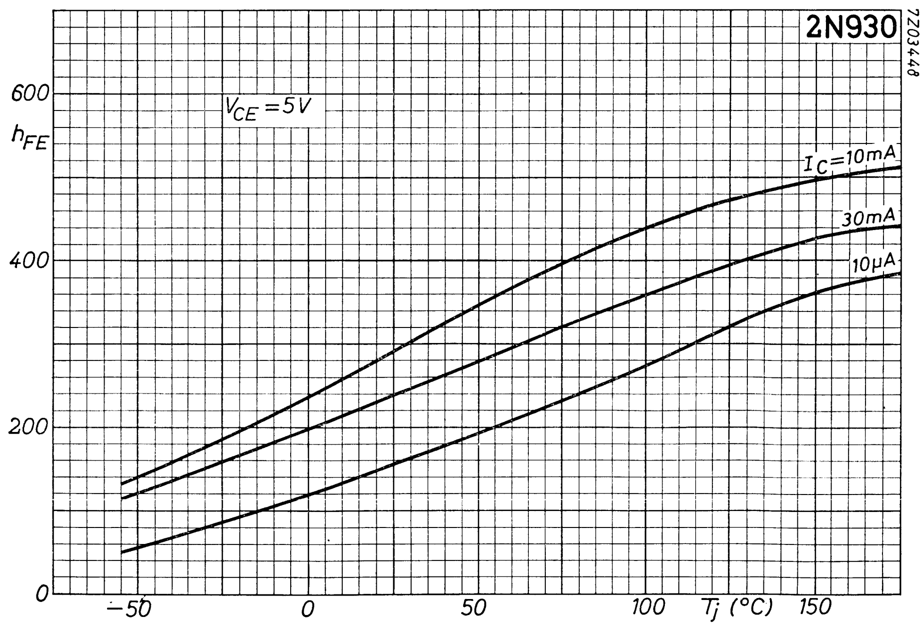

2N929
7Z03387-b14.ibi/ic)
I_C =10mA
1mA
0.1mA
$\frac{I_C}{I_B}$ =20
V_{CEsat} (V)
0.6
0.4
0.2
0
0
50
100
150
200
T_j (°C)

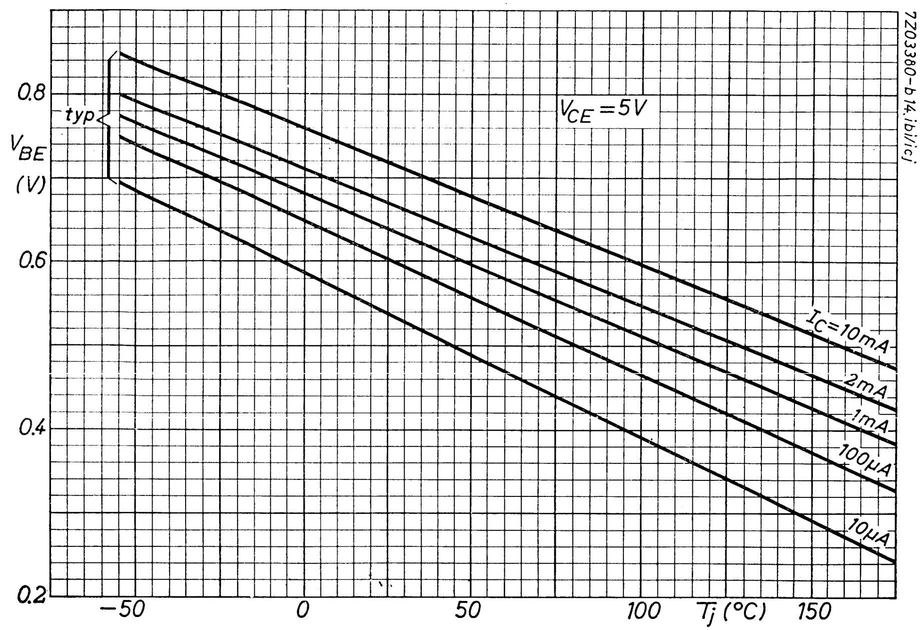

2N930
7Z03384-b14.ibi/ic)
I_C =10mA
1mA
0.1mA
$\frac{I_C}{I_B}$ =20
V_{CEsat} (V)
0.6
0.4
0.2
0
0
50
100
150
200
T_j (°C)

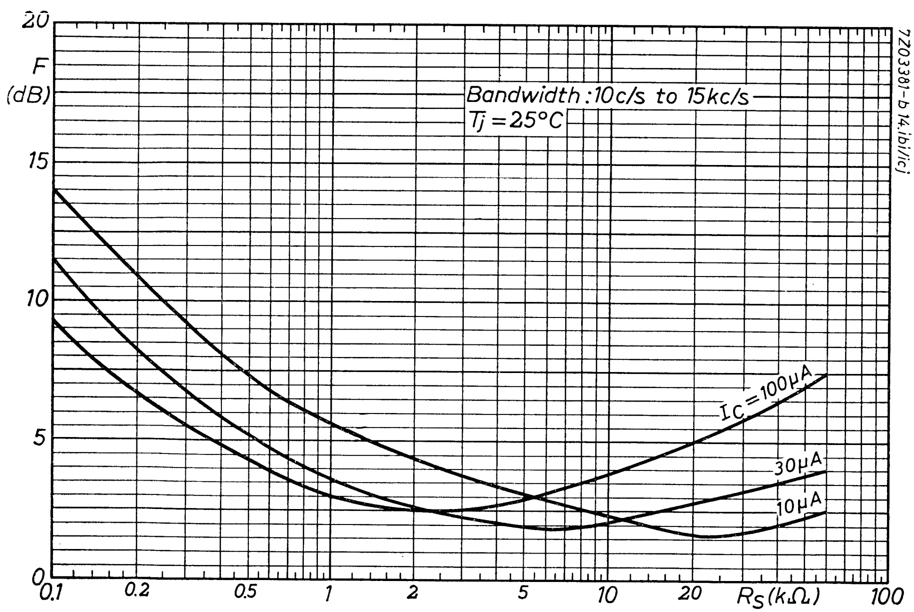

400
h_{FE}
300
200
100
0
V_{CE} =5V
Tj =25°C
2N929
max
min
max
min
0.01
0.1
1
10
I_C (mA)
100
7Z03395-b14.ibi/ic)

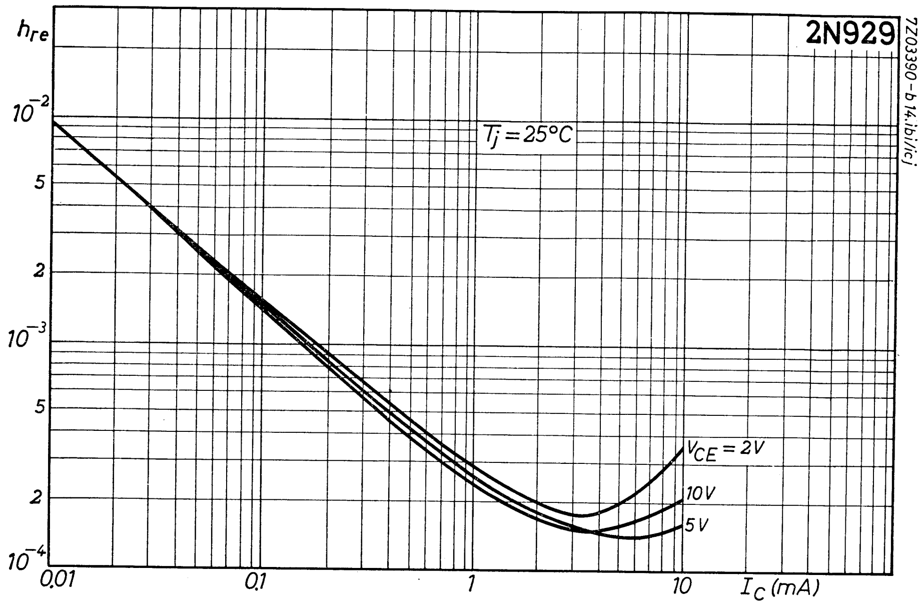

600
h_{FE}
500
400
300
200
100
V_{CE}=5V
Tj =25°C
2N930
max
min
max
min
0.1
1
10
I_C (mA)
100
7Z03394-b14.ibi/ic)

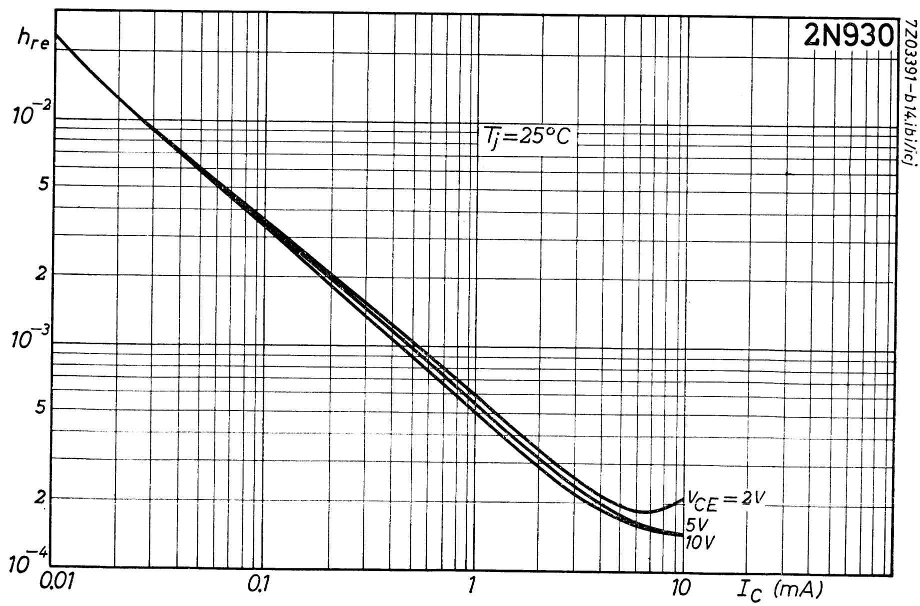

2N929
7Z03447
V_{CE} = 5 V
h_{FE}
600
400
200
0
I_C = 10mA
30mA
1mA
100μA
10μA
−50
0
50
100
T_j (°C)
150

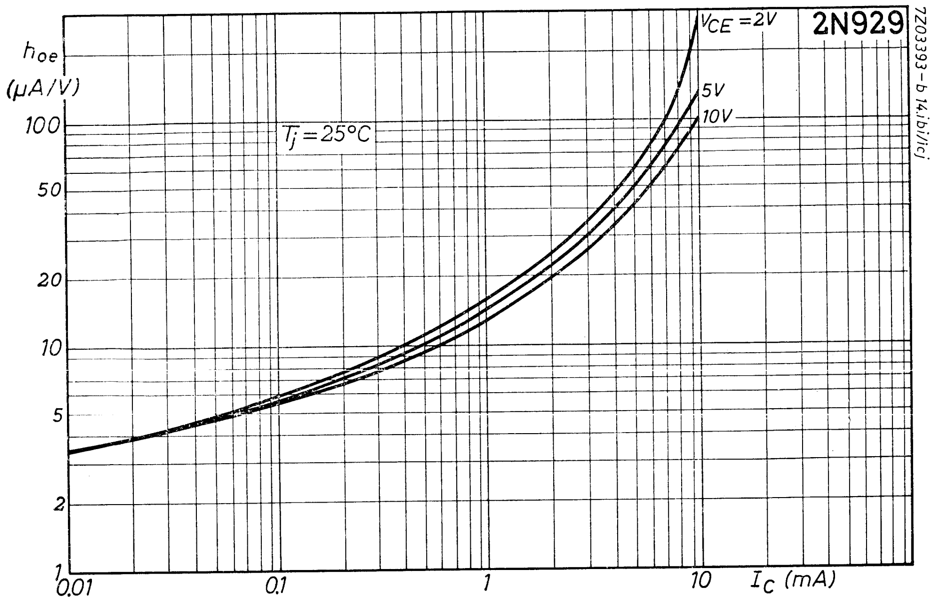

2N930
7Z03448
V_{CE} = 5 V
h_{FE}
600
400
200
0
I_C = 10mA
30mA
10μA
−50
0
50
100
T_j (°C)
150

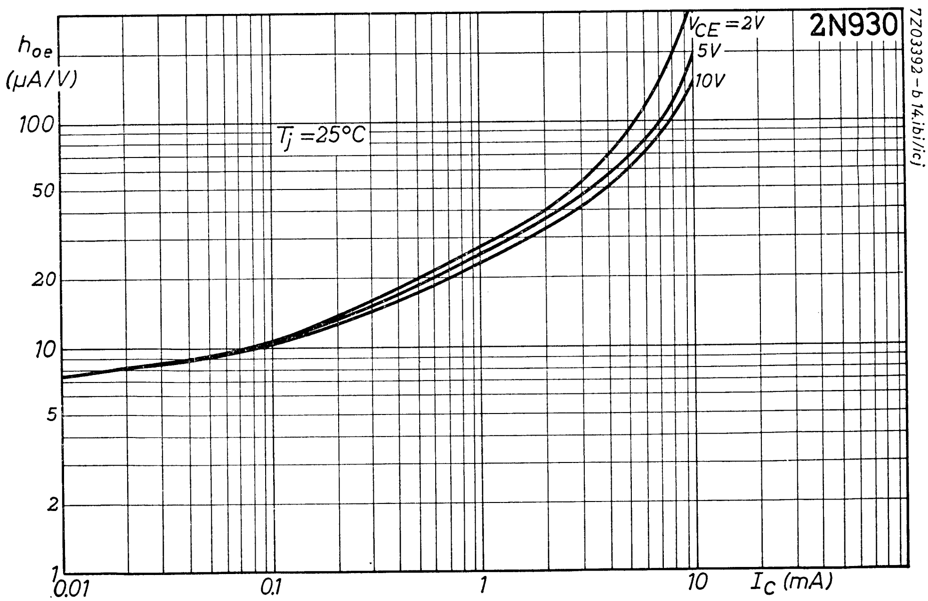

7Z03380-b14.ibi/ic)
0.8
typ
V_{BE}
(V)
0.6
0.4
0.2
$V_{CE} = 5V$
I_C=10mA
2mA
1mA
100μA
10μA
−50
0
50
100
T_j (°C)
150

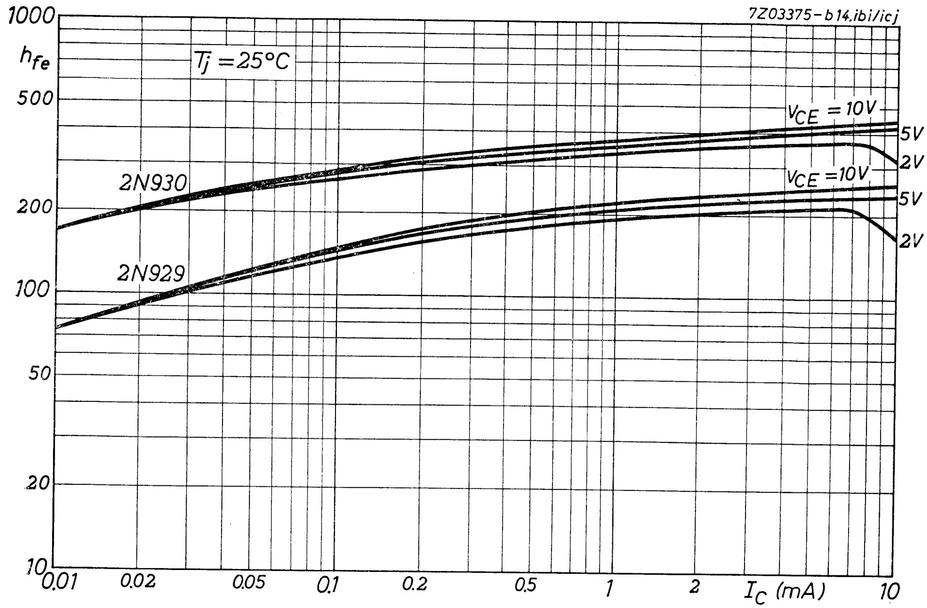

7Z03381-b14.ibi/ic)
20
F
(dB)
15
10
5
0
Bandwidth: 10c/s to 15kc/s
T_j = 25°C
I_C = 100μA
30μA
10μA
0.1
0.2
0.5
1
2
5
10
20
R_S (kΩ)
100

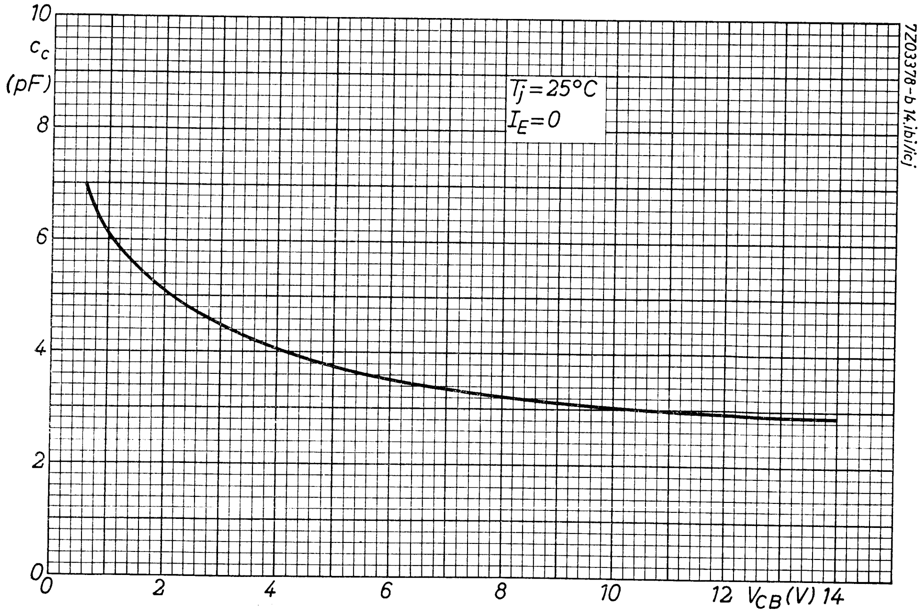

2N929
7Z03390-b14.ibi/ic)
h_{re}
10^{-2}
5
2
10^{-3}
5
2
10^{-4}
$T_j = 25°C$
$V_{CE} = 2V$
10 V
5 V
0,01
0,1
1
10
I_C (mA)

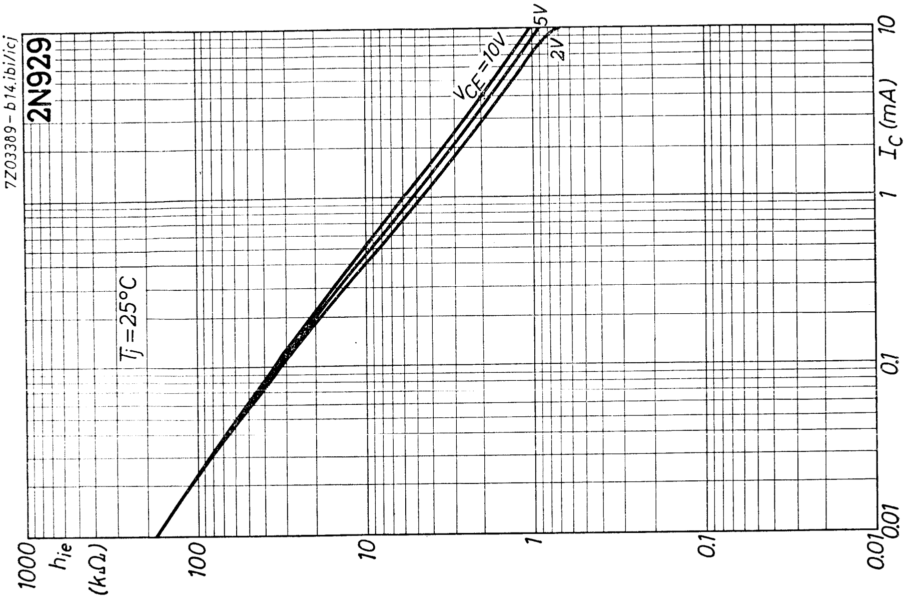

2N930
7Z03391-b14.ibi/ic)
h_{re}
10^{-2}
5
2
10^{-3}
5
2
10^{-4}
$T_j = 25°C$
$V_{CE} = 2V$
5V
10V
0,01
0,1
1
10
I_C (mA)

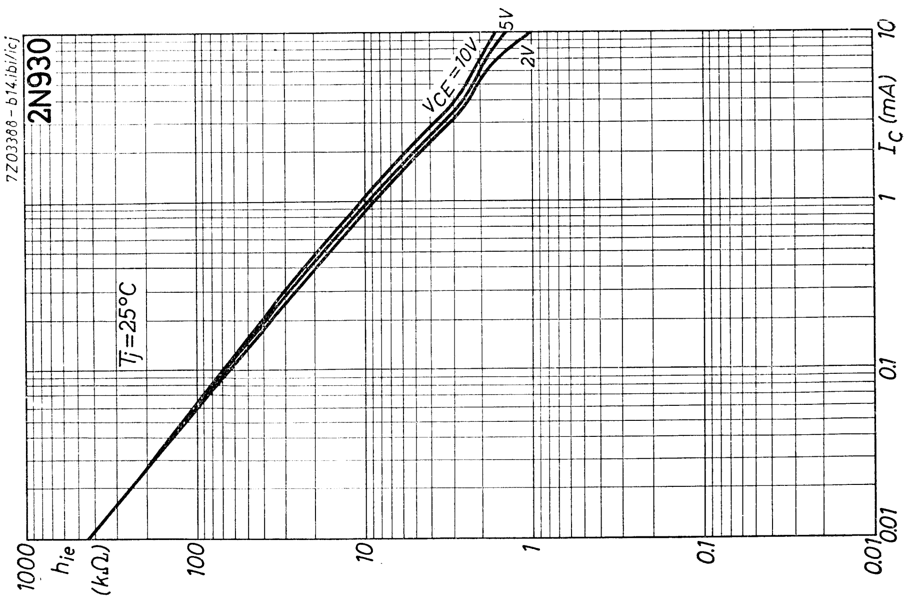

h_{oe} (μA/V)
100
50
20
10
5
2
1
0.01
0.1
1
10
I_C (mA)
T_j = 25°C
V_{CE} = 2V
5V
10V
2N929
7Z03393-b 14.ibi/ici

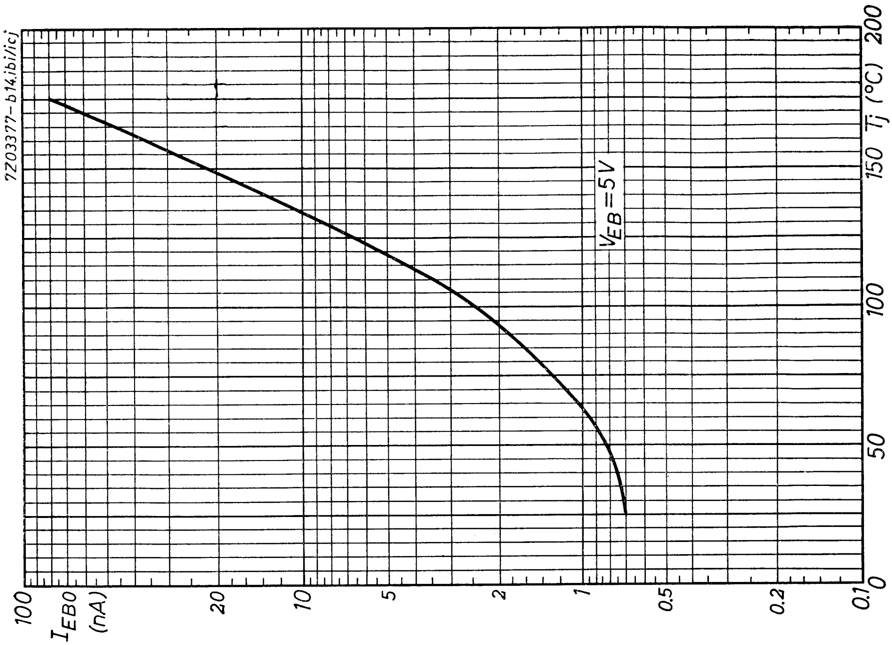

h_{oe} (μA/V)
100
50
20
10
5
2
1
0.01
0.1
1
10
I_C (mA)
T_j = 25°C
V_{CE} = 2V
5V
10V
2N930
7Z03392-b 14.ibi/ici

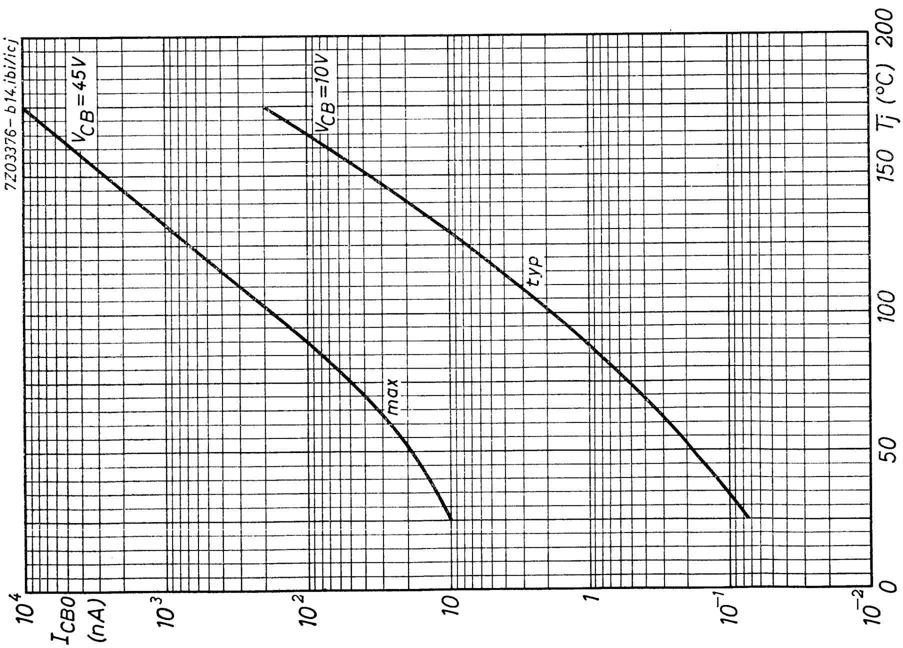

7Z03375-b14.ibi/icj
1000
hfe
500
200
100
50
20
10
Tj =25°C
2N930
2N929
VCE =10V
5V
2V
VCE =10V
5V
2V
0.01
0.02
0.05
0.1
0.2
0.5
1
2
IC (mA)
10

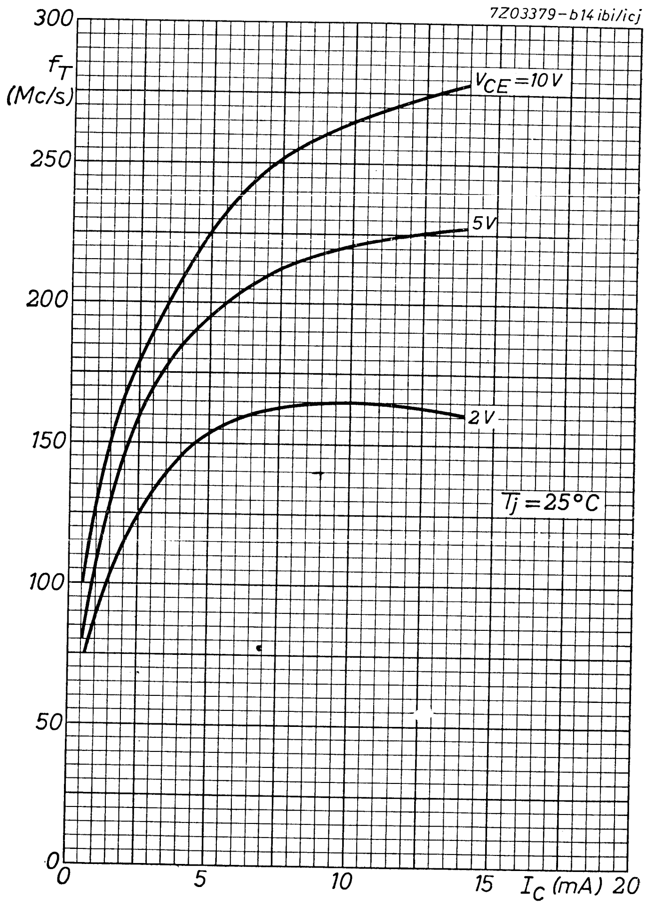

10
cc
(pF)
8
6
4
2
0
7Z03378-b14.ibi/icj
Tj=25°C
IE=0
0
2
4
6
8
10
12
VCB(V)
14


7Z03389-b14.ibl/icj
2N929
T_j=25°C
V_{CE}=10V
5V
2V
h_{ie} (kΩ)
1000
100
10
1
0.1
0.01
I_C (mA)
10
1
0.1
0.01


7Z03388-b14.ibl/icj
2N930
T_j=25°C
V_{CE}=10V
5V
2V
h_{ie} (kΩ)
1000
100
10
1
0.1
0.01
I_C (mA)
10
1
0.1
0.01


7Z03377–b14.ibi/icj
I_{EBO} (nA)
100
20
10
5
2
1
0.5
0.2
0.1
$V_{EB} = 5\,V$
T_j (°C)
0
50
100
150
200


7Z03376–b14.ibi/icj
I_{CBO} (nA)
10^4
10^3
10^2
10
1
10^{-1}
10^{-2}
$V_{CB} = 45\,V$
max
$V_{CB} = 10\,V$
typ
T_j (°C)
0
50
100
150
200


7Z03379-b14 ibi/icj
300
f_T
(Mc/s)
250
200
150
100
50
0
V_{CE} = 10 V
5 V
2 V
T_j = 25°C
0
5
10
15
I_C (mA)
20

SILICON PLANAR EPITAXIAL TRANSISTOR

For data of the transistor 2N2297 please refer to the data sheets of the BFY55 in the Supplement.

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