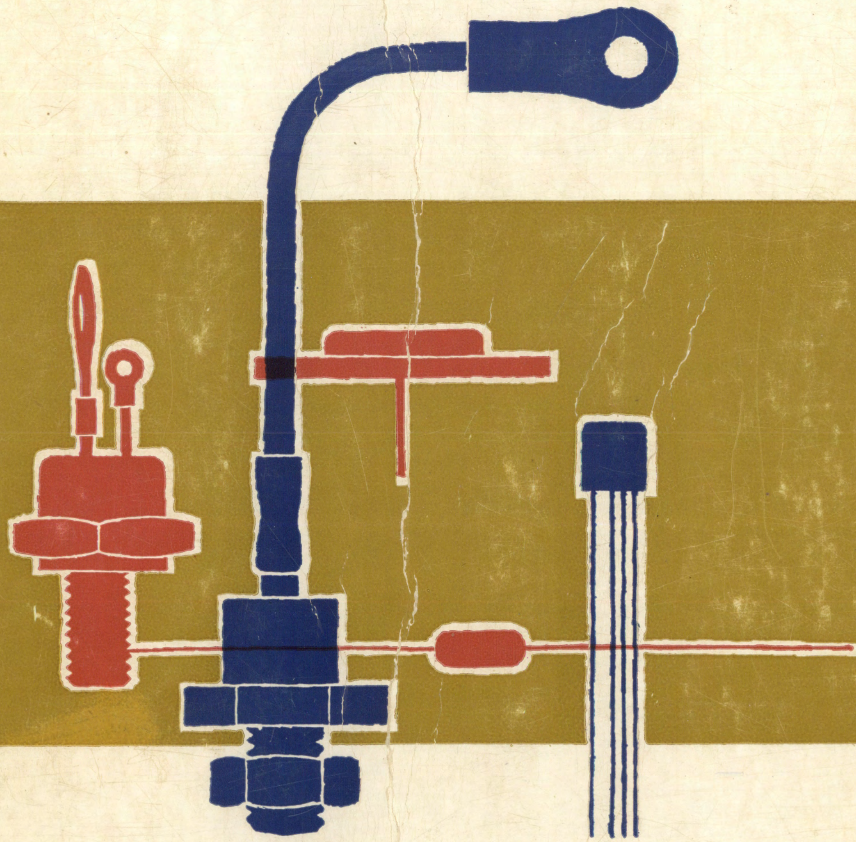
OCTOBER 1966

PHILIPS SEMICONDUCTOR HANDBOOK

Part 2



ELECTRONIC COMPONENTS AND MATERIALS DIVISION

SEMICONDUCTOR HANDBOOK

OCTOBER 1966

Part 2

FOR INDEX OF TYPENUMBERS SEE PART 1

General section

Diodes

Thyristors
(Silicon controlled rectifiers)

Rectifier Stacks

Transistors

Photoelectric devices

Integrated circuits

Accessories

Supplement (latest data)

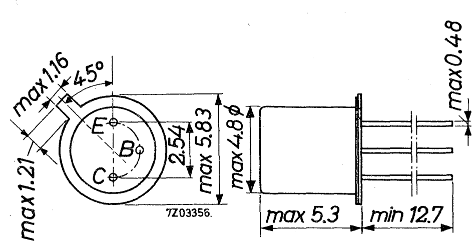
A.F. PLANAR EPITAXIAL TRANSISTOR

N-P-N silicon transistor in a TO-18 metal envelope with the collector connected to the case.
The BC107 is intended for a multitude of high gain low power applications, in particular for use in driver stages of hi-fi equipment and in the jungle of television receivers.

QUICK REFERENCE DATA				
Collector-emitter voltage (open base)	V_{CEO}	max.	45	V
Collector current (peak value)	I_{CM}	max.	100	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	300	mW
Junction temperature	T_j	max.	175	°C
Small signal current gain at T_j = 25 °C				
I_C = 2 mA; V_{CE} = 5 V; f = 1 kHz	h_{fe}	125 to 500		
Transition frequency				
I_C = 0.5 mA; V_{CE} = 5 V	f_T	typ.	85	MHz
Noise figure				
I_C = 200 μA; V_{CE} = 5 V				
R_S = 2 kΩ; f = 1 kHz				
Bandwidth 200 Hz	F	typ.	4.5	dB

MECHANICAL DATA Dimensions in mm

TO-18
Collector connected to case



7Z3 0067

RATINGS (Limiting values) [1]

Voltages

Collector-emitter voltage (open base)	V_{CEO}	max.	45	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	V

Currents

Collector current (d.c.)	I_C	max.	100	mA
Collector current (peak value)	I_{CM}	max.	100	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	$R_{th\ j-a}$	=	0.5	°C/mW
From junction to case	$R_{th\ j-c}$	=	0.2	°C/mW

CHARACTERISTICS T_j = 25 °C unless otherwise specified

Base-emitter voltage at T_{amb} = 25 °C [2]

I_C = 2 mA; V_{CE} = 5 V	V_{BE}	typ.	650	mV
			600 to 700	mV

Collector-emitter saturation voltage

I_C = 10 mA; I_B = 1 mA	V_{CEsat}	typ.	100	mV
I_C = 100 mA; I_B = 10 mA	V_{CEsat}	typ.	200	mV

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

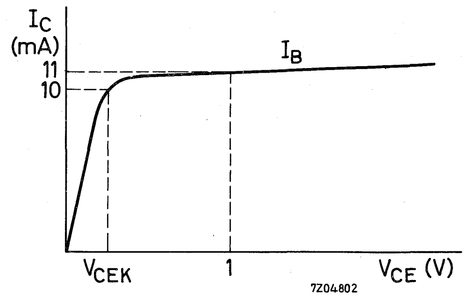
[2]) V_{BE} decreases with about 2 mV/°C at increasing temperature.

7Z3 0641

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

Knee voltage

I_C = 10 mA; I_B = value for which I_C = 11 mA at V_{CE} = 1 V	V_{CEK}	typ.	300	mV
		<	600	mV



D.C. current gain

I_C = 10 μA; V_{CE} = 5 V	h_{FE}	>	40	
		typ.	130	
I_C = 2 mA; V_{CE} = 5 V	h_{FE}	typ.	210	
			110 to 435	
I_C = 10 mA; V_{CE} = 5 V	h_{FE}	typ.	250	

Collector capacitance at f = 1 MHz

$I_E = I_e$ = 0; V_{CB} = 5 V	C_c	typ.	4.5	pF

Transition frequency

I_C = 0.5 mA; V_{CE} = 5 V	f_T	typ.	85	MHz
I_C = 10 mA; V_{CE} = 5 V	f_T	typ.	250	MHz

Noise figure at f = 1 kHz

I_C = 200 μA; V_{CE} = 5 V; R_S = 2 kΩ

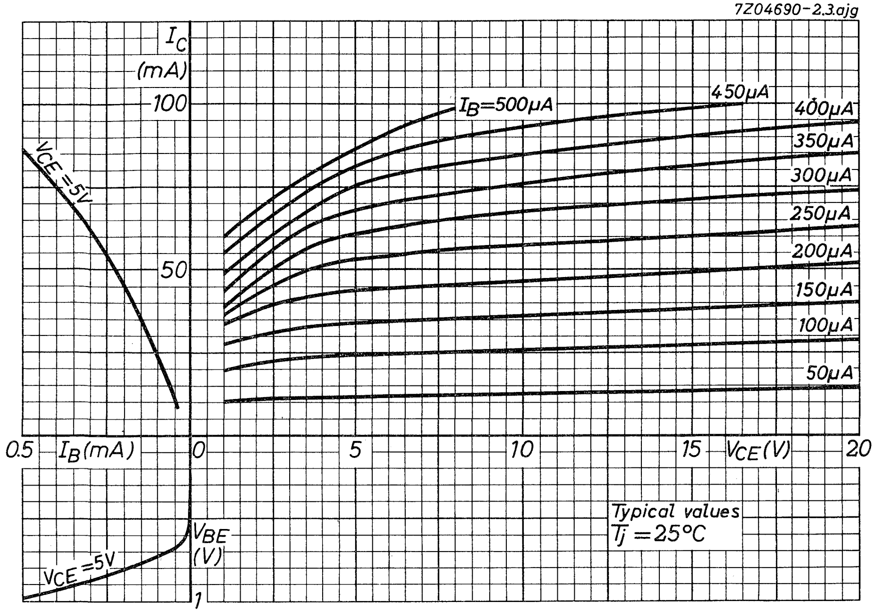
Bandwidth 200 Hz	F	typ.	4.5	dB

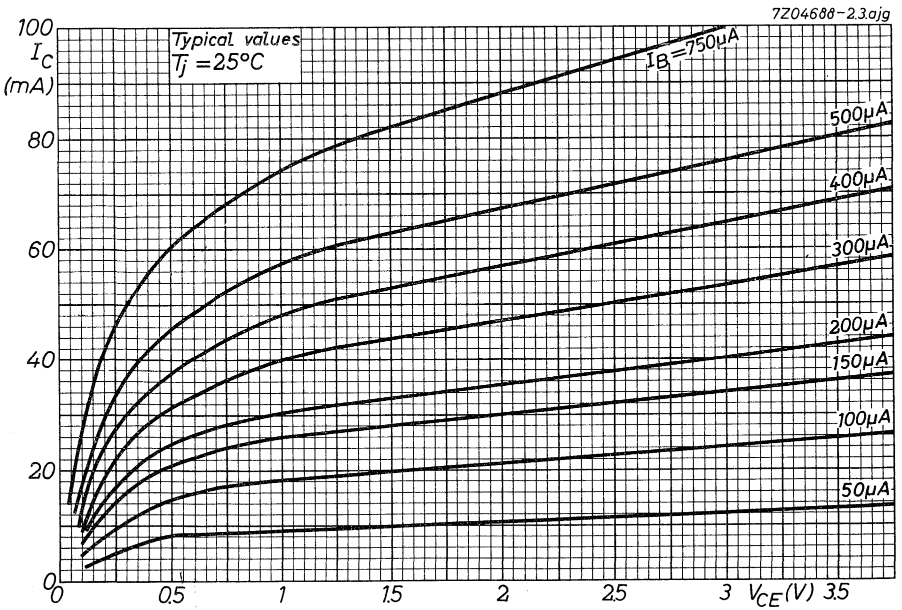
h parameters at f = 1 kHz

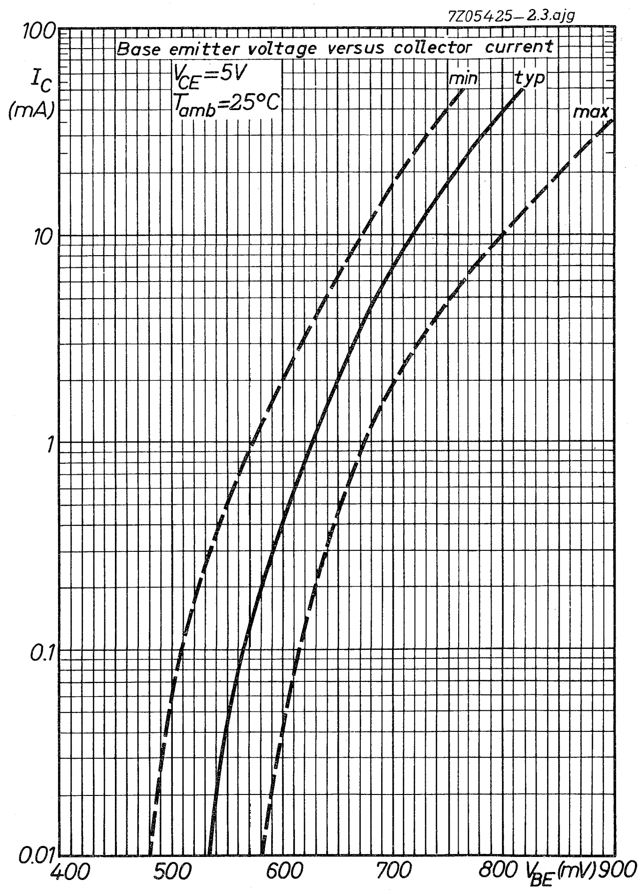
I_C = 2 mA; V_{CE} = 5 V

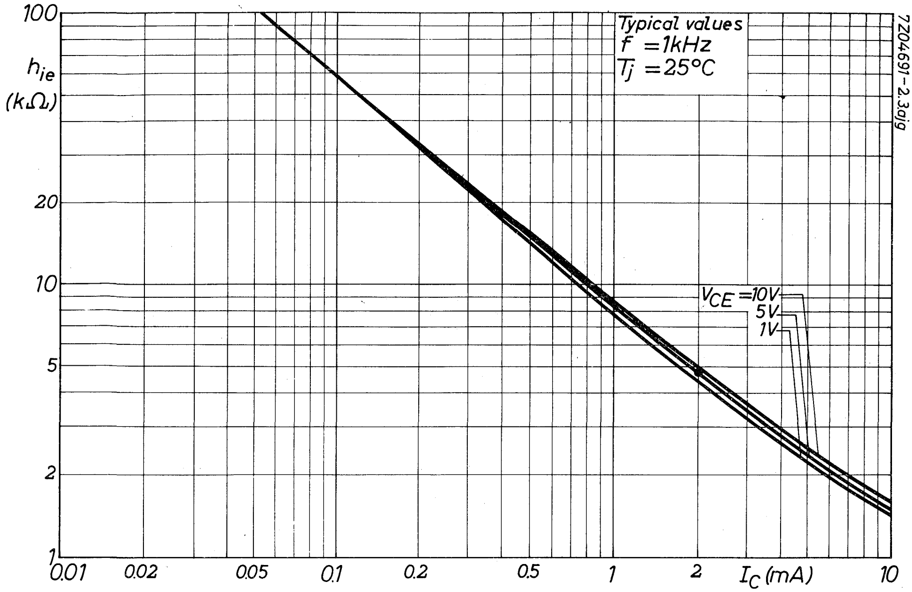
Input impedance	h_{ie}	typ.	4.8	kΩ
Reverse voltage transfer	h_{re}	typ.	2.5	10^{-4}
Small signal current gain	h_{fe}	typ.	300	
			125 to 500	
Output admittance	h_{oe}	typ.	22	$\mu\Omega^{-1}$

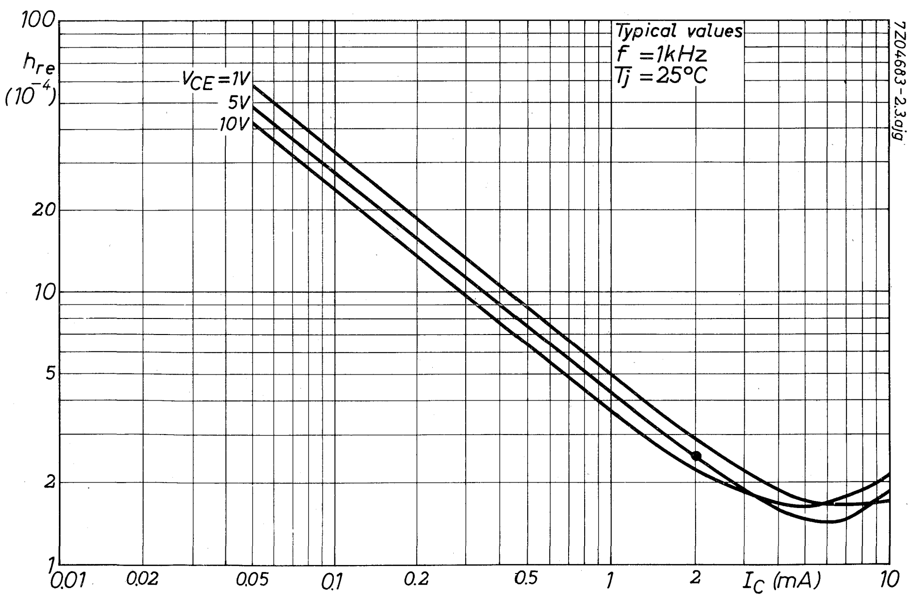
7Z3 0642

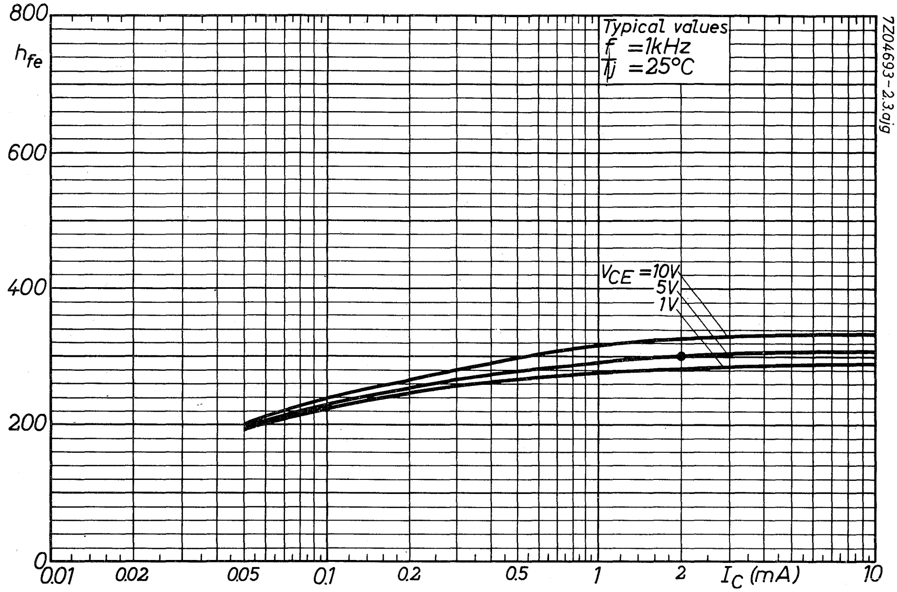

7Z04690-2.3.ajg
I_C
(mA)
100
50
I_B=500μA
450μA
400μA
350μA
300μA
250μA
200μA
150μA
100μA
50μA
V_{CE}=5V
0.5
I_B(mA)
0
5
10
15
V_{CE}(V)
20
Typical values
T_j = 25°C
V_{BE}
(V)
1
V_{CE}=5V

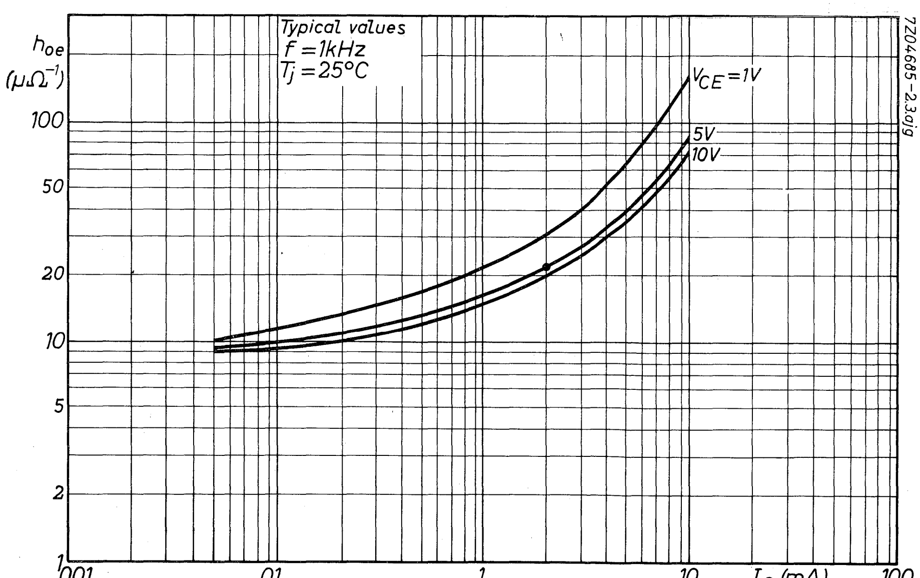

7Z04688-2.3.ajg
100
I_C
(mA)
80
60
40
20
0
Typical values
T_j = 25°C
I_B=750μA
500μA
400μA
300μA
200μA
150μA
100μA
50μA
0
0.5
1
1.5
2
2.5
3
V_{CE}(V)
3.5

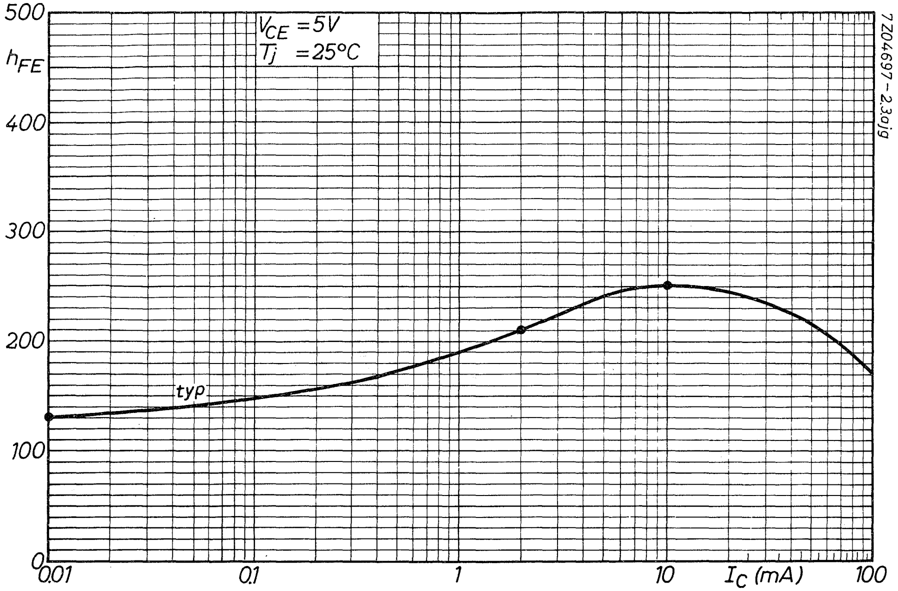

7Z05425–2.3.ajg
Base emitter voltage versus collector current
V_{CE}=5V
T_{amb}=25°C
min
typ
max
100
10
1
0.1
0.01
I_C (mA)
400
500
600
700
800
900
V_{BE} (mV)

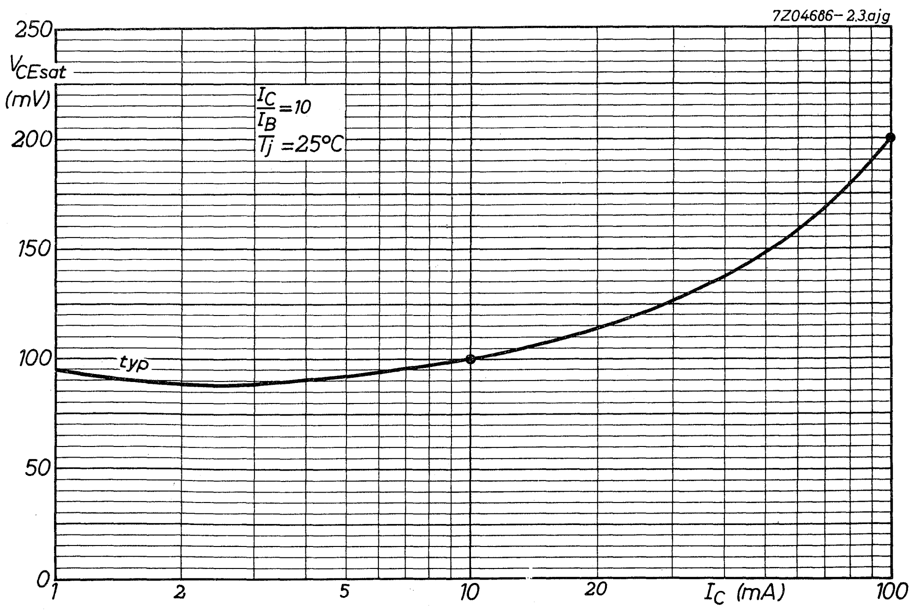

100
h_{ie}
(kΩ)
20
10
5
2
1
0.01
0.02
0.05
0.1
0.2
0.5
1
2
I_C (mA)
10
Typical values
f = 1kHz
T_j = 25°C
V_{CE} = 10V
5V
1V
7Z04691-2.3aig


100
h_{re}
(10^{-4})
20
10
5
2
1
0.01
0.02
0.05
0.1
0.2
0.5
1
2
I_C (mA)
10
Typical values
f = 1kHz
T_j = 25°C
V_{CE} = 1V
5V
10V
7Z04683-2.3aig


800
600
400
200
0
h_{fe}
Typical values
f = 1kHz
Tj = 25°C
V_{CE} = 10V
5V
1V
0.01
0.02
0.05
0.1
0.2
0.5
1
2
I_C (mA)
10
7Z04693-2.3.aig


h_{oe}
($\mu\Omega^{-1}$)
100
50
20
10
5
2
1
Typical values
f = 1kHz
Tj = 25°C
V_{CE} = 1V
5V
10V
0.01
0.1
1
10
I_C (mA)
100
7Z04685-2.3.aig


500
h_{FE}
400
300
200
100
0
V_{CE} = 5V
T_j = 25°C
typ
0.01
0.1
1
10
I_C (mA)
100
7Z04697−2.3ajg


7Z04686−2.3ajg
250
V_{CEsat}
(mV)
200
150
100
50
0
$\frac{I_C}{I_B}$=10
T_j =25°C
typ
1
2
5
10
20
I_C (mA)
100

A.F. PLANAR EPITAXIAL TRANSISTOR

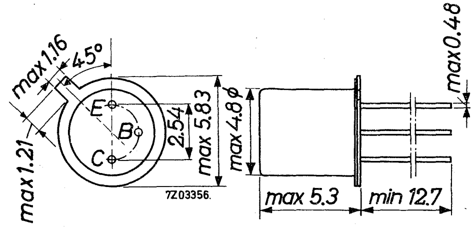
N-P-N silicon transistor in a TO-18 metal envelope with the collector connected to the case.
The BC108 is a low power general purpose transistor with high gain, suitable for a multitude of low voltage applications such as audio preamplifiers, driver stages, a.g.c. and jungles.

QUICK REFERENCE DATA				
Collector-emitter voltage (open base)	V_{CEO}	max.	20	V
Collector current (peak value)	I_{CM}	max.	100	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	300	mW
Junction temperature	T_j	max.	175	°C
Small signal current gain at T_j = 25 °C				
I_C = 2 mA; V_{CE} = 5 V; f = 1 kHz	h_{fe}	125 to 500		
Transition frequency				
I_C = 0.5 mA; V_{CE} = 5 V	f_T	typ.	85	MHz
Noise figure				
I_C = 200 µA; V_{CE} = 5 V				
R_S = 2 kΩ; f = 1 kHz				
Bandwidth 200 Hz	F	typ.	4.5	dB

MECHANICAL DATA

Dimensions in mm

TO-18
Collector connected to case



7Z3 0068

RATINGS (Limiting values) [1]

Voltages

Collector-emitter voltage (open base)	V_{CEO}	max.	20	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	V

Currents

Collector current (d.c.)	I_C	max.	100	mA
Collector current (peak value)	I_{CM}	max.	100	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	$R_{th\ j\text{-}c}$	=	0.2	°C/mW

CHARACTERISTICS T_j = 25 °C unless otherwise specified

Base-emitter voltage at T_{amb} = 25 °C [2]

I_C = 2 mA; V_{CE} = 5 V	V_{BE}	typ.	650	mV
			600 to 700	mV

Collector-emitter saturation voltage

I_C = 10 mA; I_B = 1 mA	V_{CEsat}	typ.	100	mV
I_C = 100 mA; I_B = 10 mA	V_{CEsat}	typ.	200	mV

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

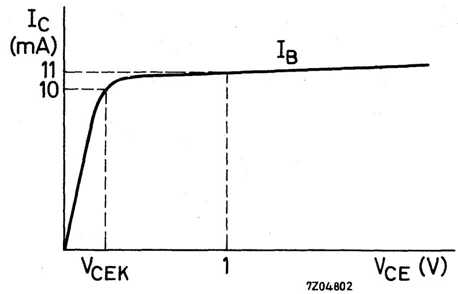
[2] V_{BE} decreases with about 2 mV/°C at increasing temperature.

7Z3 0643

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

Knee voltage

$I_C = 10$ mA; I_B = value for which $I_C = 11$ mA at $V_{CE} = 1$ V	V_{CEK}	typ.	300	mV
		<	600	mV



D.C. current gain

$I_C = 10\ \mu A$; $V_{CE} = 5$ V	h_{FE}	>	40	
		typ.	130	
$I_C = 2$ mA; $V_{CE} = 5$ V	h_{FE}	typ.	210	
			110 to 435	
$I_C = 10$ mA; $V_{CE} = 5$ V	h_{FE}	typ.	250	

Collector capacitance at f = 1 MHz

$I_E = I_e = 0$; $V_{CB} = 5$ V	C_c	typ.	4.5	pF

Transition frequency

$I_C = 0.5$ mA; $V_{CE} = 5$ V	f_T	typ.	85	MHz
$I_C = 10$ mA; $V_{CE} = 5$ V	f_T	typ.	250	MHz

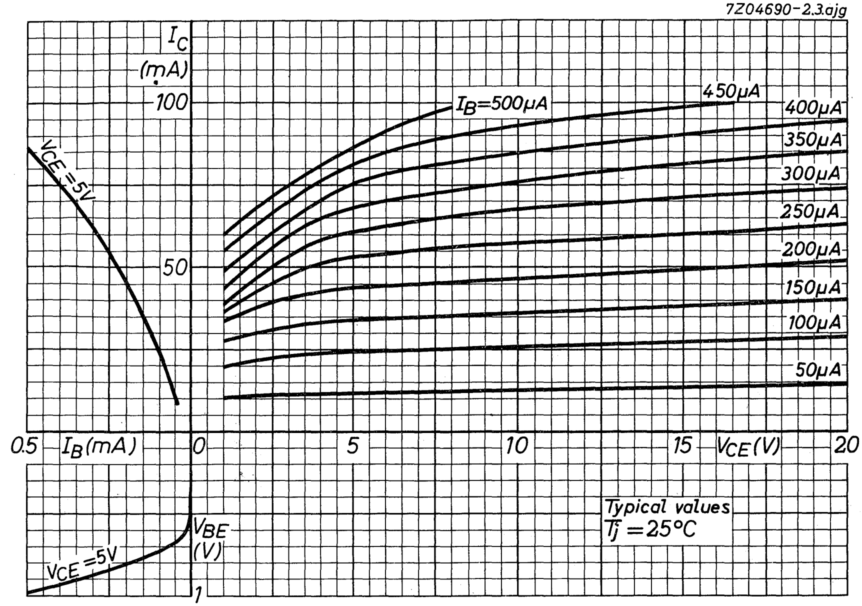
Noise figure at f = 1 kHz

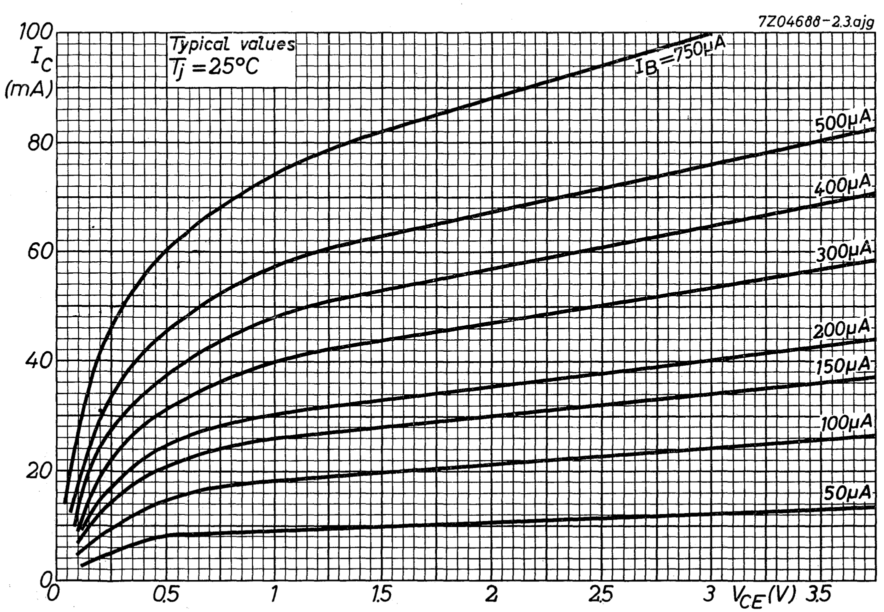
$I_C = 200\ \mu A$; $V_{CE} = 5$ V; $R_S = 2\ k\Omega$				
Bandwidth 200 Hz	F	typ.	4.5	dB

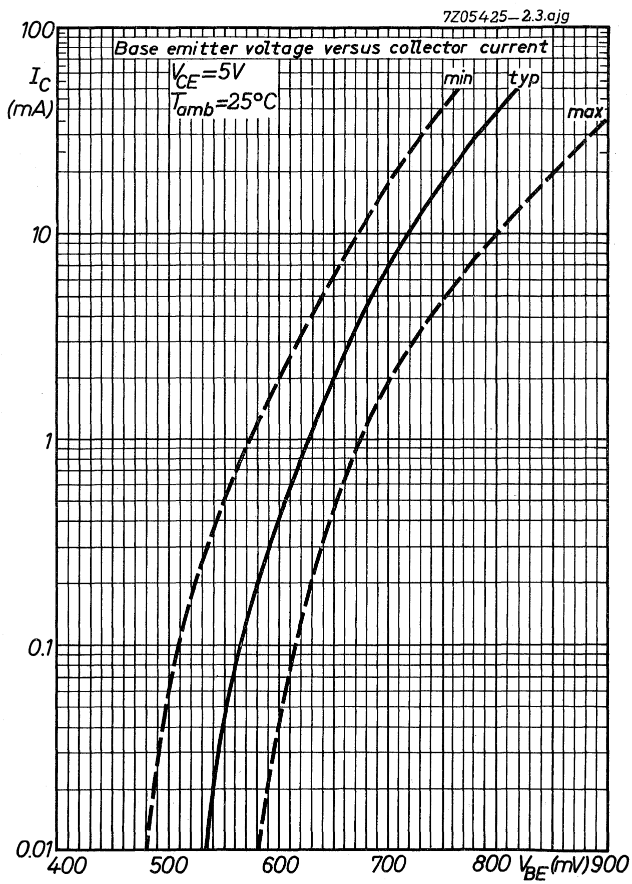
h parameters at f = 1 kHz

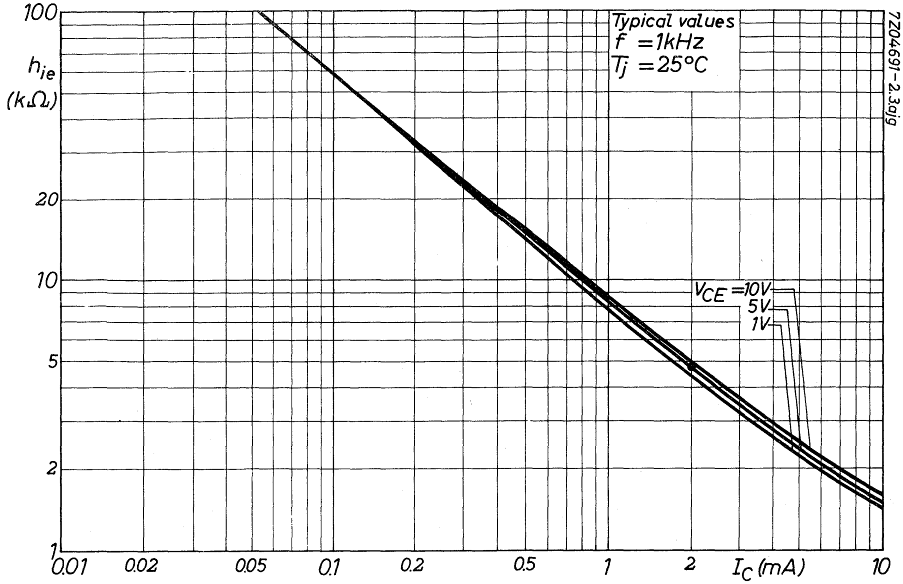
$I_C = 2$ mA; $V_{CE} = 5$ V				
Input impedance	h_{ie}	typ.	4.8	kΩ
Reverse voltage transfer	h_{re}	typ.	2.5	10^{-4}
Small signal current gain	h_{fe}	typ.	300	
			125 to 500	
Output admittance	h_{oe}	typ.	22	$\mu\Omega^{-1}$

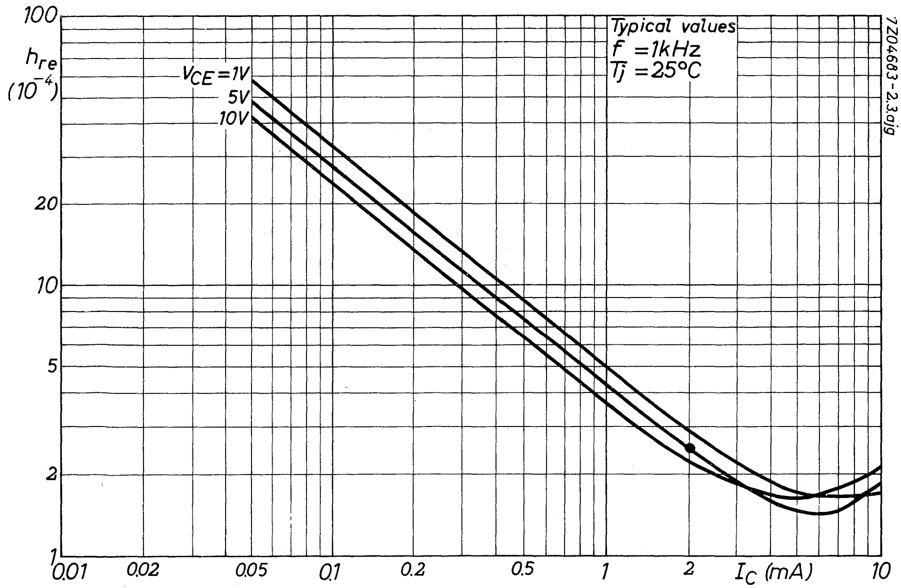
7Z3 0642

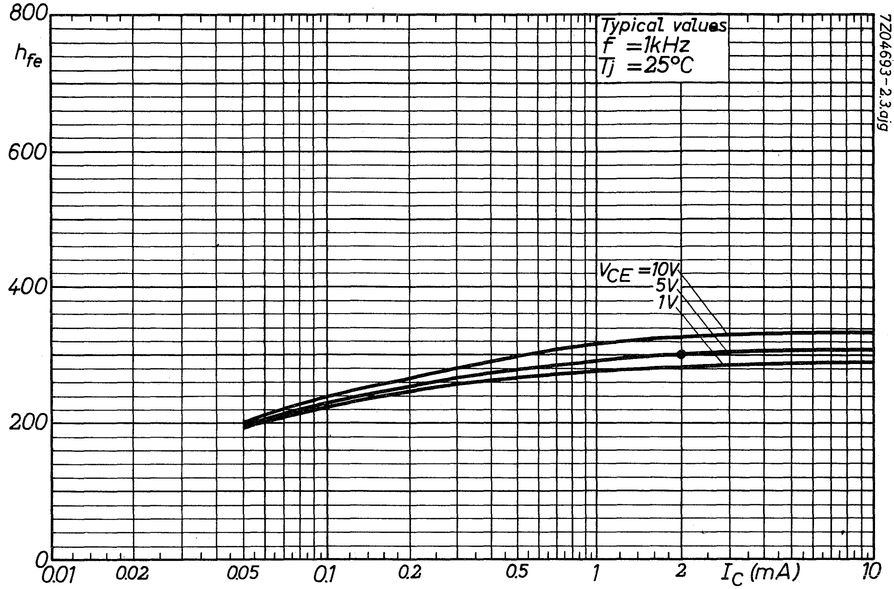

7Z04690-2.3.ajg
I_C (mA)
100
50
I_B=500μA
450μA
400μA
350μA
300μA
250μA
200μA
150μA
100μA
50μA
V_{CE}=5V
0.5
I_B(mA)
0
5
10
15
V_{CE}(V)
20
Typical values
T_j =25°C
V_{BE} (V)
V_{CE}=5V
1


7Z04688-2.3.ajg
100
I_C (mA)
80
60
40
20
0
Typical values
T_j =25°C
I_B=750μA
500μA
400μA
300μA
200μA
150μA
100μA
50μA
0
0.5
1
1.5
2
2.5
3
V_{CE}(V)
3.5

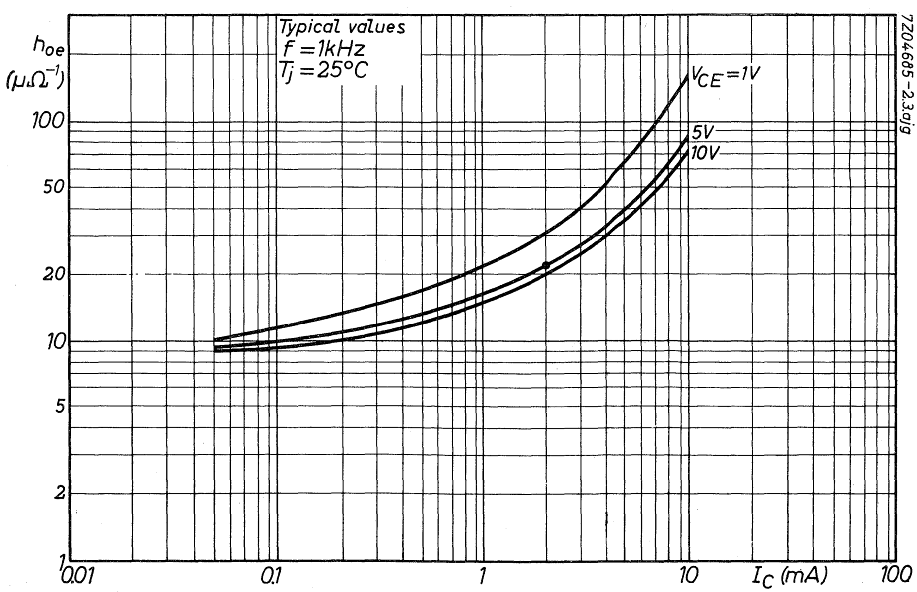

7Z05425–2.3.ajg
Base emitter voltage versus collector current
V_{CE}=5V
T_{amb}=25°C
I_C
(mA)
100
10
1
0.1
0.01
min
typ
max
400
500
600
700
800
900
V_{BE}(mV)


Typical values
f = 1kHz
Tj = 25°C
7Z04691-2.3aig
h_ie
(kΩ)
100
20
10
5
2
1
V_CE = 10V
5V
1V
0.01
0.02
0.05
0.1
0.2
0.5
1
2
I_C (mA)
10

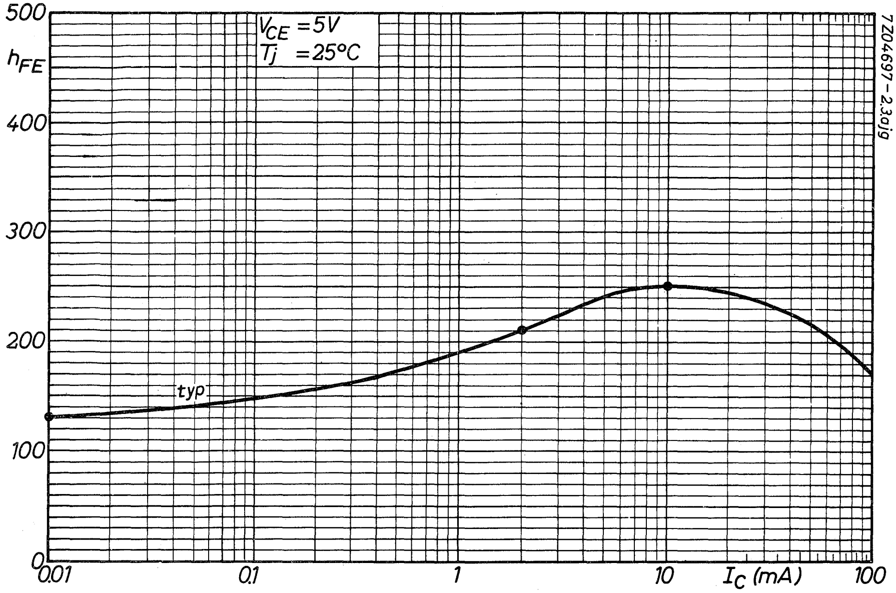

Typical values
f = 1kHz
Tj = 25°C
7Z04683-2.3aig
h_re
(10^-4)
100
20
10
5
2
1
V_CE = 1V
5V
10V
0.01
0.02
0.05
0.1
0.2
0.5
1
2
I_C (mA)
10

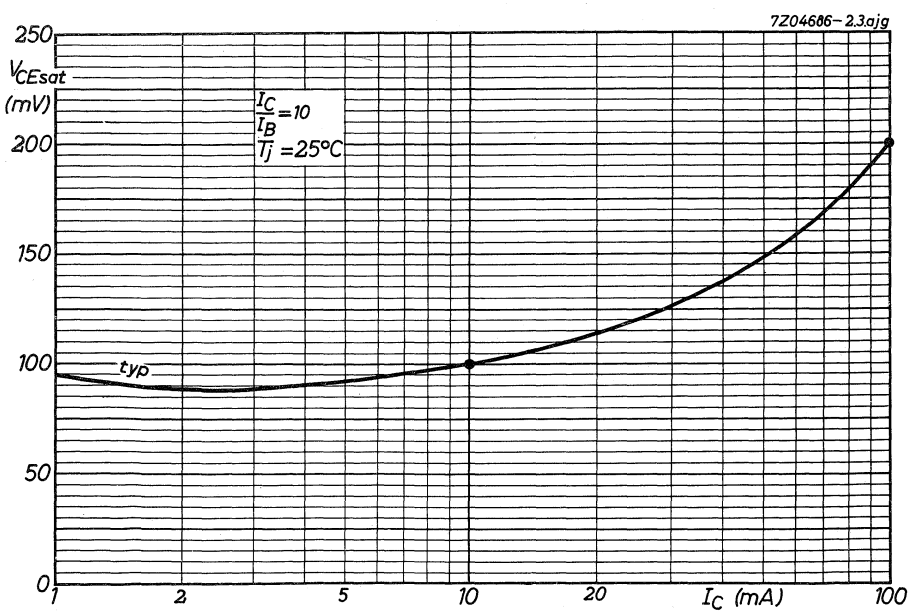


800
h_{fe}
600
400
200
0
Typical values
f = 1kHz
Tj = 25°C
V_{CE} = 10V
5V
1V
0.01
0.02
0.05
0.1
0.2
0.5
1
2
I_C (mA)
10
7Z04693-2.3aig



h_{oe}
(μΩ^{-1})
100
50
20
10
5
2
1
Typical values
f = 1kHz
Tj = 25°C
V_{CE} = 1V
5V
10V
0.01
0.1
1
10
I_C (mA)
100
7Z04685-2.3aig


7Z04697–2.3ajg
V_{CE} = 5V
T_j = 25°C
h_{FE}
500
400
300
200
100
0
typ
0.01
0.1
1
10
100
I_C (mA)


7Z04686–2.3.ajg
V_{CEsat}
(mV)
$\frac{I_C}{I_B}$ = 10
T_j = 25°C
250
200
150
100
50
0
typ
1
2
5
10
20
100
I_C (mA)

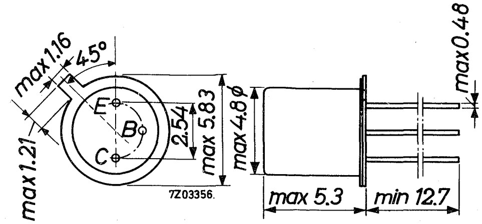
A.F. PLANAR EPITAXIAL TRANSISTOR

N-P-N silicon transistor in a TO-18 metal envelope with the collector connected to the case.
The BC109 is intended for general purpose high gain low power applications, primarily for low noise input stages in tape recorders and other audio frequency equipment.

QUICK REFERENCE DATA				
Collector-emitter voltage (open base)	V_{CEO}	max.	20	V
Collector current (peak value)	I_{CM}	max.	100	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	300	mW
Junction temperature	T_j	max.	175	°C
Small signal current gain at T_j = 25 °C				
I_C = 2 mA; V_{CE} = 5 V; f = 1 kHz	h_{fe}	240 to 900		
Transition frequency				
I_C = 0.5 mA; V_{CE} = 5 V	f_T	typ.	95	MHz
Noise figure				
I_C = 200 μA; V_{CE} = 5 V; R_S = 2 kΩ				
f = 30 Hz to 15 kHz	F	<	4	dB

MECHANICAL DATA Dimensions in mm

TO-18
Collector connected to case



7Z3 0069

RATINGS (Limiting values) [1])

Voltages

Collector-emitter voltage (open base)	V_{CEO}	max.	20	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	V

Currents

Collector current (d.c.)	I_C	max.	100	mA
Collector current (peak value)	I_{CM}	max.	100	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	$R_{th\ j\text{-}c}$	=	0.2	°C/mW

CHARACTERISTICS T_j = 25 °C unless otherwise specified

Base-emitter voltage at T_{amb} = 25 °C [2])

I_C = 2 mA; V_{CE} = 5 V	V_{BE}	typ.	650	mV
			600 to 700	mV

Collector-emitter saturation voltage

I_C = 10 mA; I_B = 1 mA	V_{CEsat}	typ.	100	mV
I_C = 100 mA; I_B = 10 mA	V_{CEsat}	typ.	200	mV

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

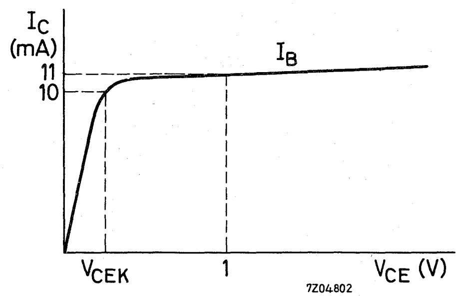
2) V_{BE} decreases with about 2 mV/°C at increasing temperature.

7Z3 0643

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

Knee voltage

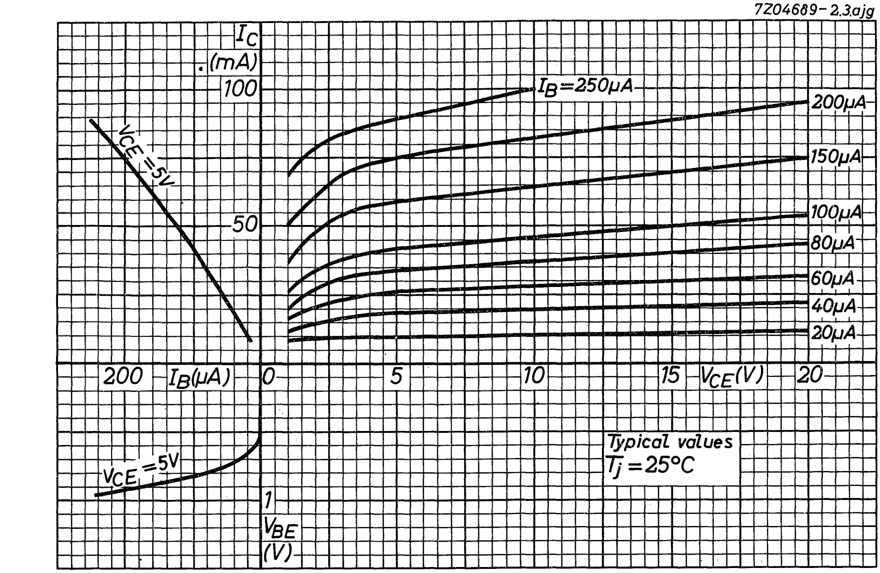
I_C = 10 mA; I_B = value for which I_C = 11 mA at V_{CE} = 1 V	V_{CEK}	typ.	300	mV
		<	600	mV



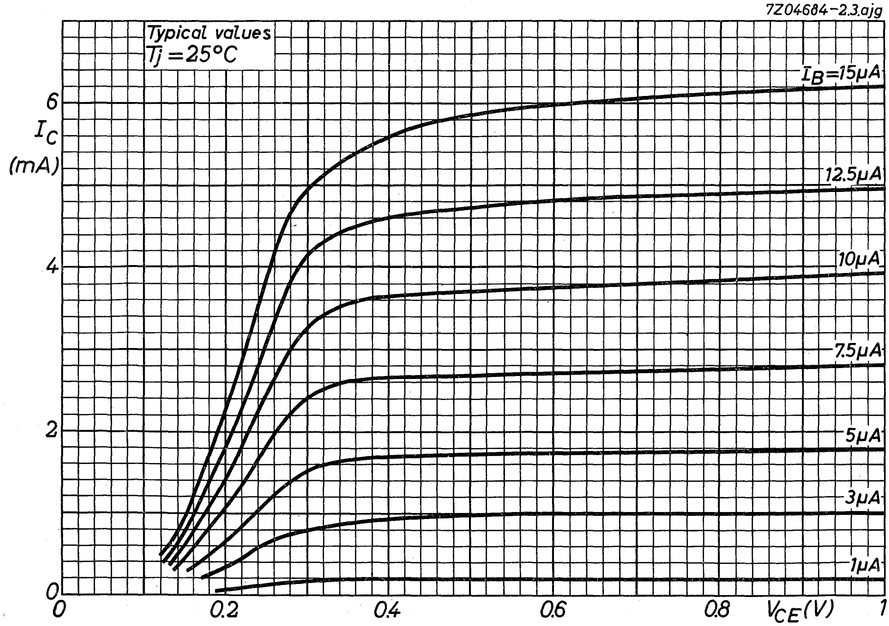
D.C. current gain				
I_C = 10 μA; V_{CE} = 5 V	h_{FE}	>	100	
		typ.	300	
I_C = 2 mA; V_{CE} = 5 V	h_{FE}	typ.	400	
		210 to	800	
I_C = 10 mA; V_{CE} = 5 V	h_{FE}	typ.	450	
Collector capacitance at f = 1 MHz				
I_E = I_e = 0; V_{CB} = 5 V	C_c	typ.	4.5	pF
Transition frequency				
I_C = 0.5 mA; V_{CE} = 5 V	f_T	typ.	95	MHz
I_C = 10 mA; V_{CE} = 5 V	f_T	typ.	300	MHz
Noise figure				
I_C = 200 μA; V_{CE} = 5 V; R_S = 2 kΩ				
f = 30 Hz to 15 kHz	F	<	4	dB
h parameters at f = 1 kHz				
I_C = 2 mA; V_{CE} = 5 V				
Input impedance	h_{ie}	typ.	7.3	kΩ
Reverse voltage transfer	h_{re}	typ.	3.5	10^{-4}
Small signal current gain	h_{fe}	typ.	500	
		240 to	900	
Output admittance	h_{oe}	typ.	40	$\mu\Omega^{-1}$

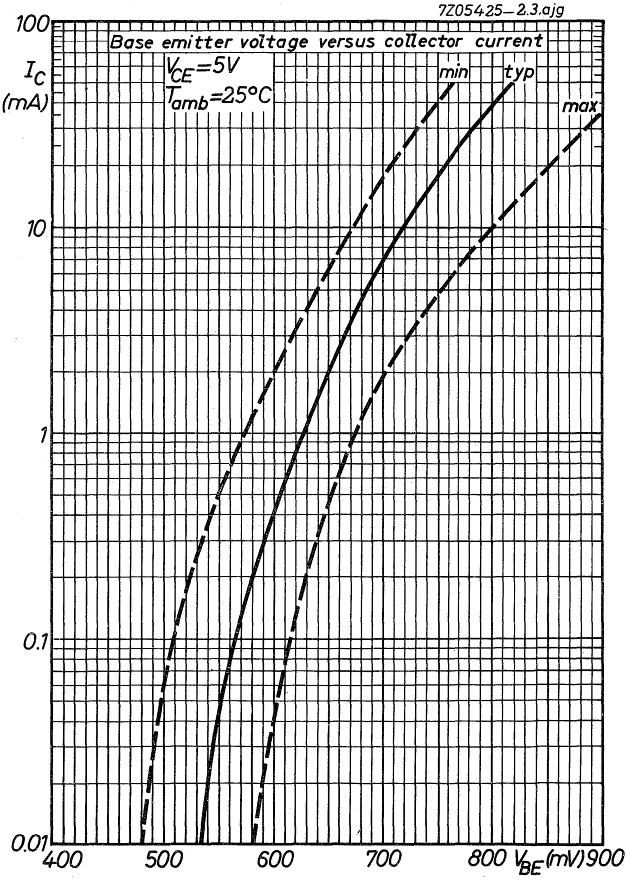
7Z3 0644

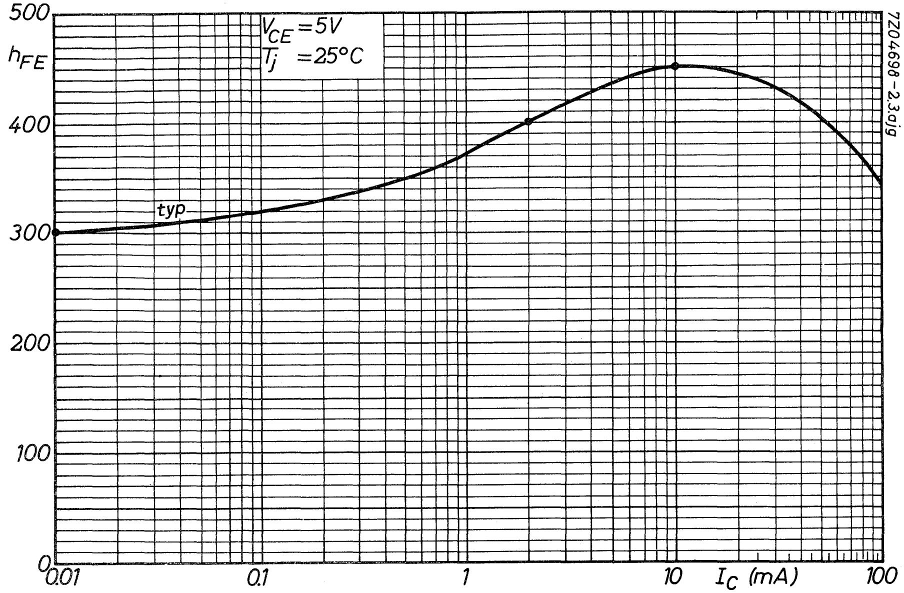
7Z04689-2.3.ajg



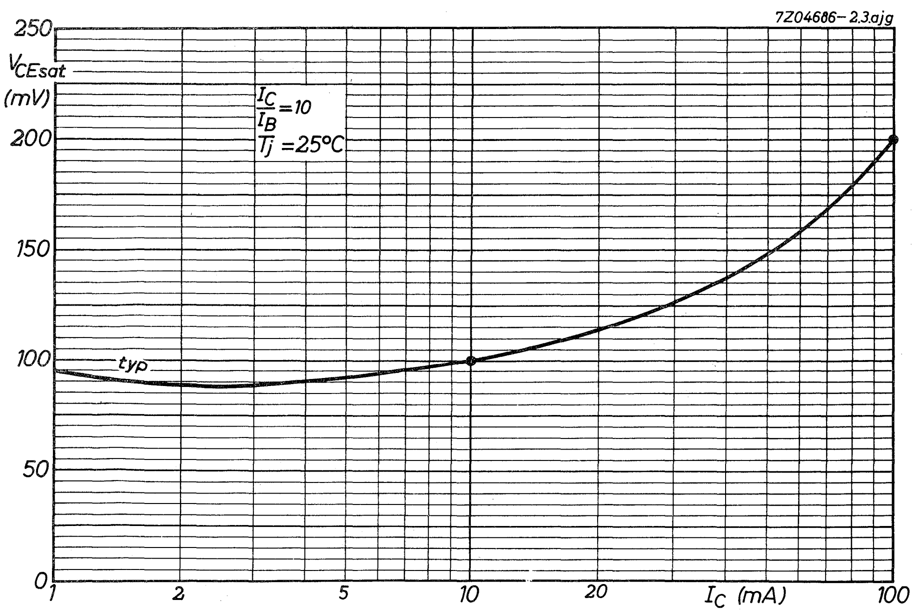
7Z04684-2.3.ajg



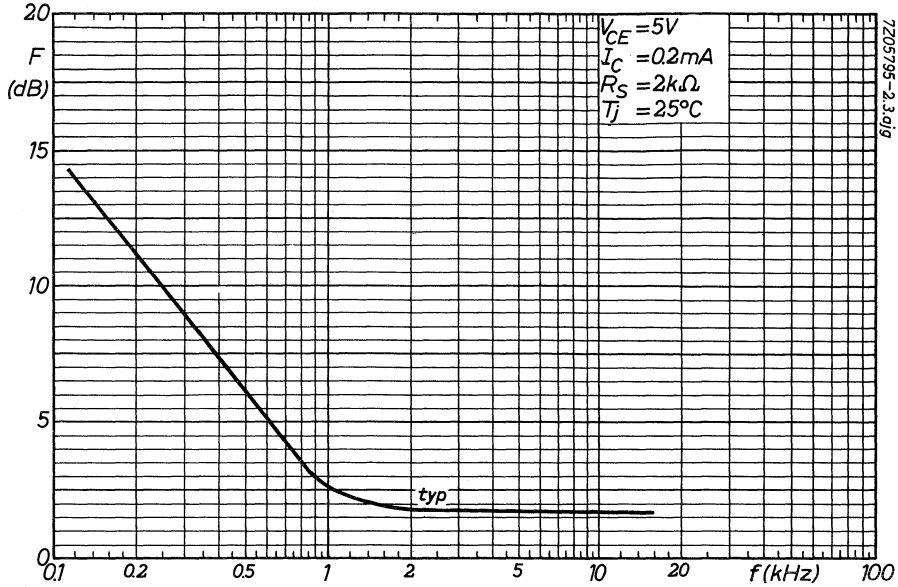

7Z05425—2.3.ajg
Base emitter voltage versus collector current
V_{CE}=5V
T_{amb}=25°C
I_C
(mA)
100
10
1
0.1
0.01
400
500
600
700
800
V_{BE}(mV)
900
min
typ
max



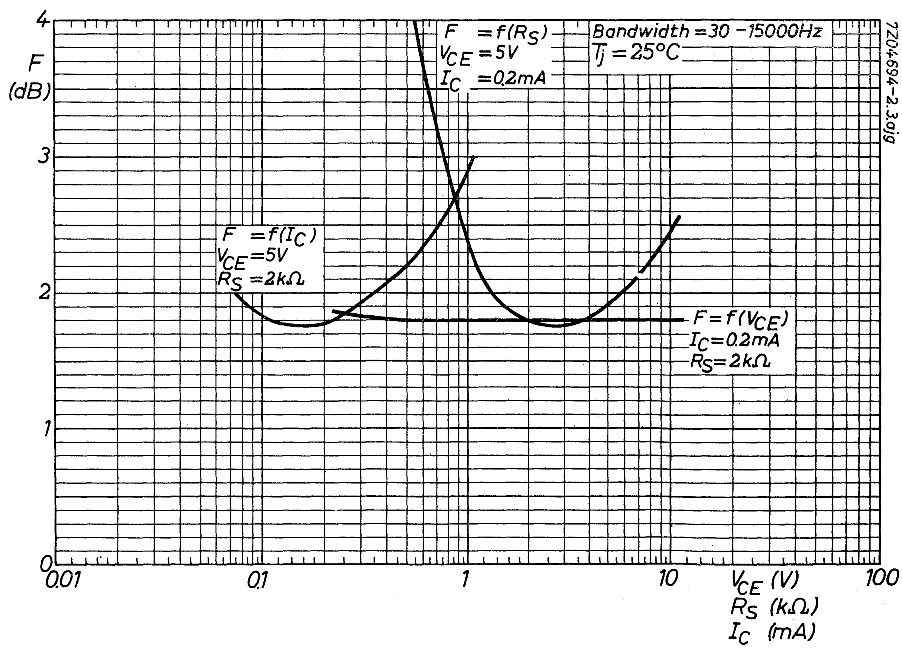
7Z04698–2.3.ajg
500
h_{FE}
400
300
200
100
0
0.01
0.1
1
10
100
I_C (mA)
V_{CE} = 5V
T_j = 25°C
typ



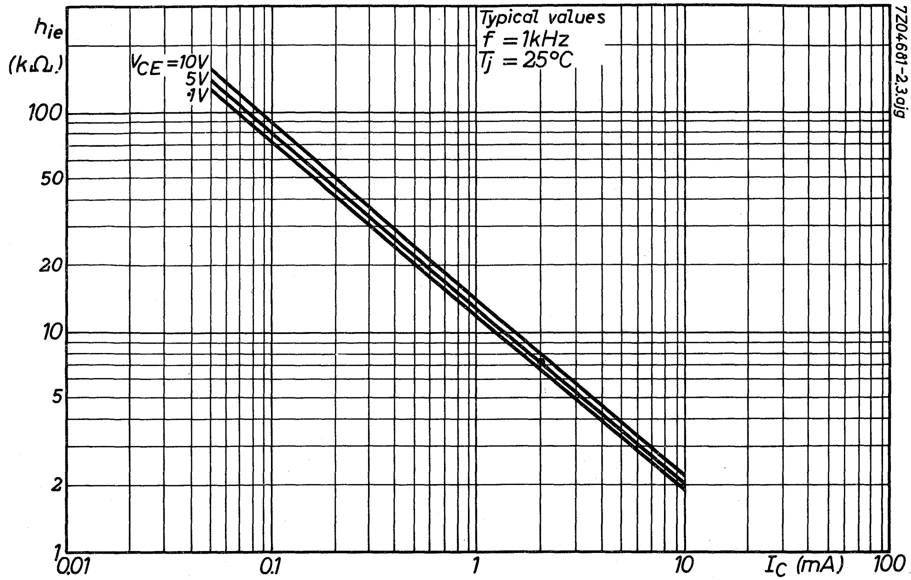
7Z04686–2.3.ajg
250
V_{CEsat}
(mV)
200
150
100
50
0
1
2
5
10
20
100
I_C (mA)
$\frac{I_C}{I_B}$ = 10
T_j = 25°C
typ

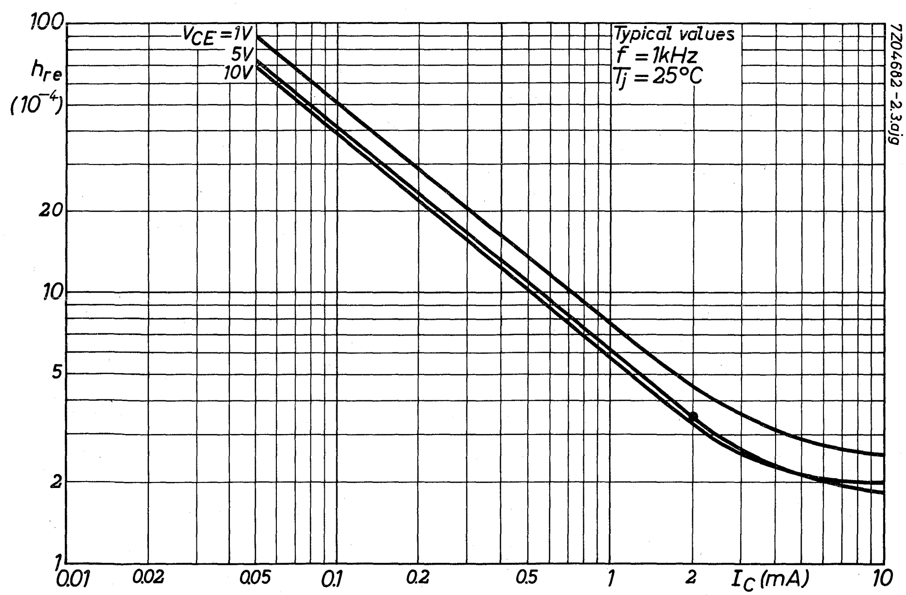


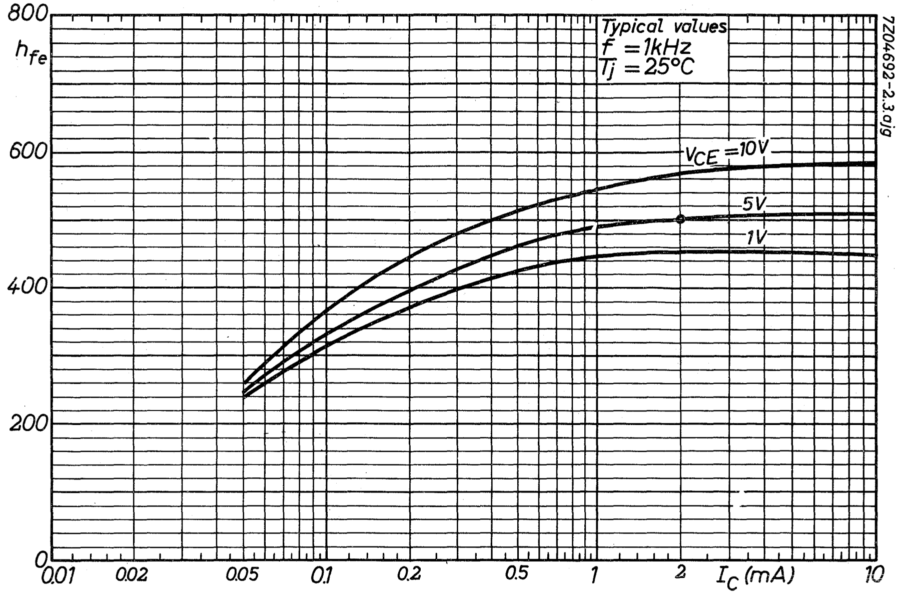
F (dB)
V_{CE} = 5V
I_C = 0.2mA
R_S = 2kΩ
T_j = 25°C
typ
f (kHz)
7Z05795-2.3.a/g

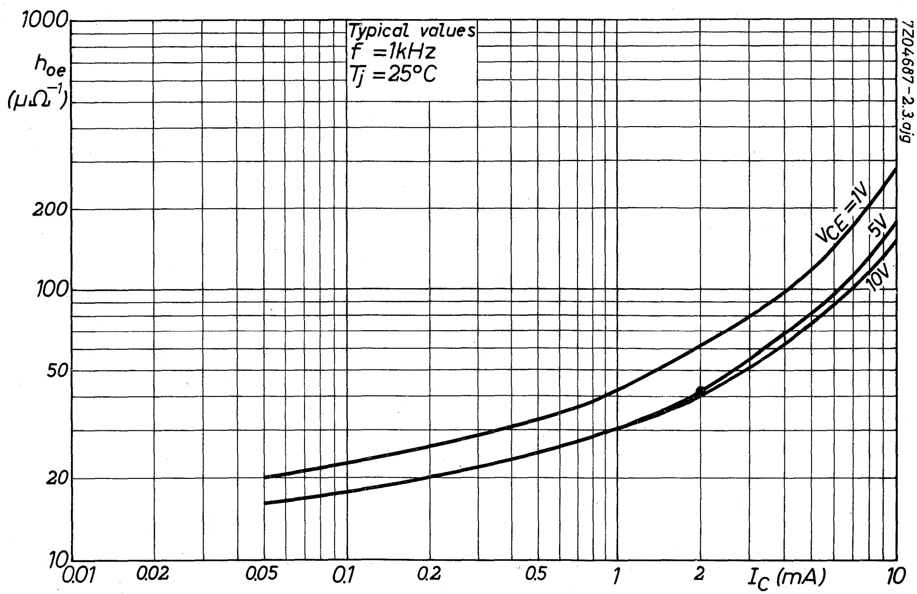


F (dB)
F = f(R_S)
V_{CE} = 5V
I_C = 0.2mA
Bandwidth = 30 − 15000Hz
T_j = 25°C
F = f(I_C)
V_{CE} = 5V
R_S = 2kΩ
F = f(V_{CE})
I_C = 0.2mA
R_S = 2kΩ
V_{CE} (V)
R_S (kΩ)
I_C (mA)
7Z04694-2.3.a/g


Typical values
f = 1kHz
Tj = 25°C
hie
(kΩ)
VCE = 10V
5V
1V
100
50
20
10
5
2
1
0.01
0.1
1
10
IC (mA)
100
7Z04681-2.3.aig


Typical values
f = 1kHz
Tj = 25°C
hre
(10⁻⁴)
VCE = 1V
5V
10V
100
20
10
5
2
1
0.01
0.02
0.05
0.1
0.2
0.5
1
2
IC (mA)
10
7Z04682-2.3.aig


800
h_{fe}
600
400
200
0
Typical values
f = 1kHz
T_j = 25°C
V_{CE} = 10V
5V
1V
0.01
0.02
0.05
0.1
0.2
0.5
1
2
I_C (mA)
10
7Z04692-2.3.aig


1000
h_{oe}
($\mu\Omega^{-1}$)
200
100
50
20
10
Typical values
f = 1kHz
T_j = 25°C
V_{CE} = 1V
5V
10V
0.01
0.02
0.05
0.1
0.2
0.5
1
2
I_C (mA)
10
7Z04687-2.3.aig

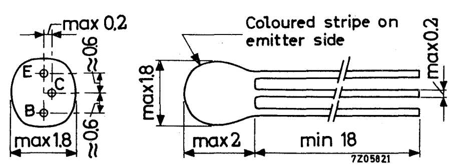
SILICON PLANAR EPITAXIAL TRANSISTOR

N-P-N transistor in a microminiature plastic envelope. The BC112 is designed for hearing aids, watches and other equipment where small size is of paramount importance.

QUICK REFERENCE DATA

			red	yellow	green	
Collector-base voltage (open emitter)	V_{CBO}	max.	20	20	20	V
Collector-emitter voltage (open base)	V_{CEO}	max.	20	20	20	V
Collector current (d.c.)	I_C	max.	50	50	50	mA
Total power dissipation up to T_{amb} = 45 °C	P_{tot}	max.	50	50	50	mW
Junction temperature	T_j	max.	125	125	125	°C
D.C. current gain at T_j = 25 °C						
I_C = 0.2 mA; V_{CE} = 0.5 V	h_{FE}	>	80	140	280	
		<	200	350	550	
Noise figure at R_S = 2 kΩ						
I_C = 0.2 mA; V_{CE} = 0.5 V						
Bandwidth: f = 30 Hz to 15 kHz	F	typ.	2	1.5	2	dB
		<	-	4	-	dB

MECHANICAL DATA Dimensions in mm



MOUNTING INSTRUCTIONS

To avoid damaging the transistor, welded or soldered connections must be made with care; the following general recommendations should be observed:

1. The temperature of the soldering iron must be less than 250 °C and the soldering time less than 3 seconds.
2. To keep the heat capacity low, the smallest possible amount of solder should be used.
3. If the plastic capsule of the transistor makes contact with any other structure, care must be taken that its temperature never exceeds 125 °C.

7Z3 0652

RATINGS (Limiting values) [1])

Voltages

Collector-base voltage (open emitter)	V_{CBO}	max.	20	V
Collector-emitter voltage (open base)	V_{CEO}	max.	20	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4	V

Currents

Collector current (d.c.)	I_C	max.	50	mA
Collector current (peak value)	I_{CM}	max.	50	mA

Power dissipation

Total power dissipation up to T_{amb} = 45 $^{\circ}C$	P_{tot}	max.	50	mW

Temperatures

Storage temperature	T_{stg}		−55 to 125	$^{\circ}C$
Junction temperature	T_j	max.	125	$^{\circ}C$

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	1.6	$^{\circ}C/mW$

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

7Z3 0653

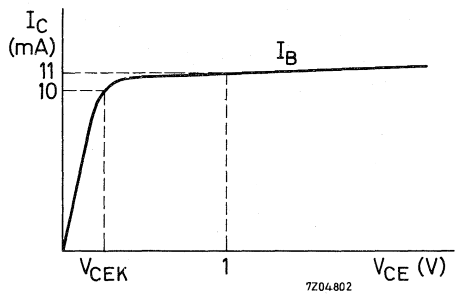
CHARACTERISTICS $T_j = 25\ ^oC$ unless otherwise specified

Base-emitter voltage

$I_C = 0.2$ mA; $V_{CE} = 0.5$ V	V_{BE}	typ. 570	mV
$I_C = 2$ mA; $V_{CE} = 1$ V	V_{BE}	typ. 650	mV

Knee voltage

$I_C = 10$ mA; I_B = value for which $I_C = 11$ mA at $V_{CE} = 1$ V	V_{CEK}	typ. 275	mV



Collector capacitance at f = 1 MHz

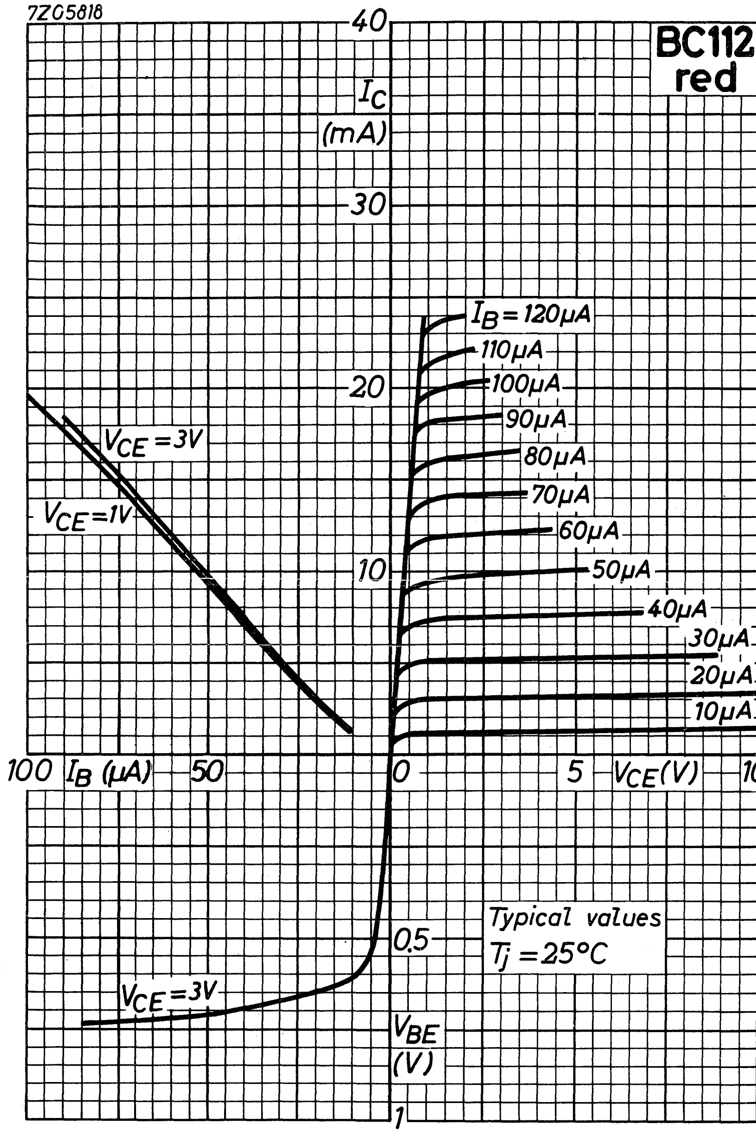
$I_E = I_e = 0$; $V_{CB} = 5$ V	C_c	typ. 4	pF

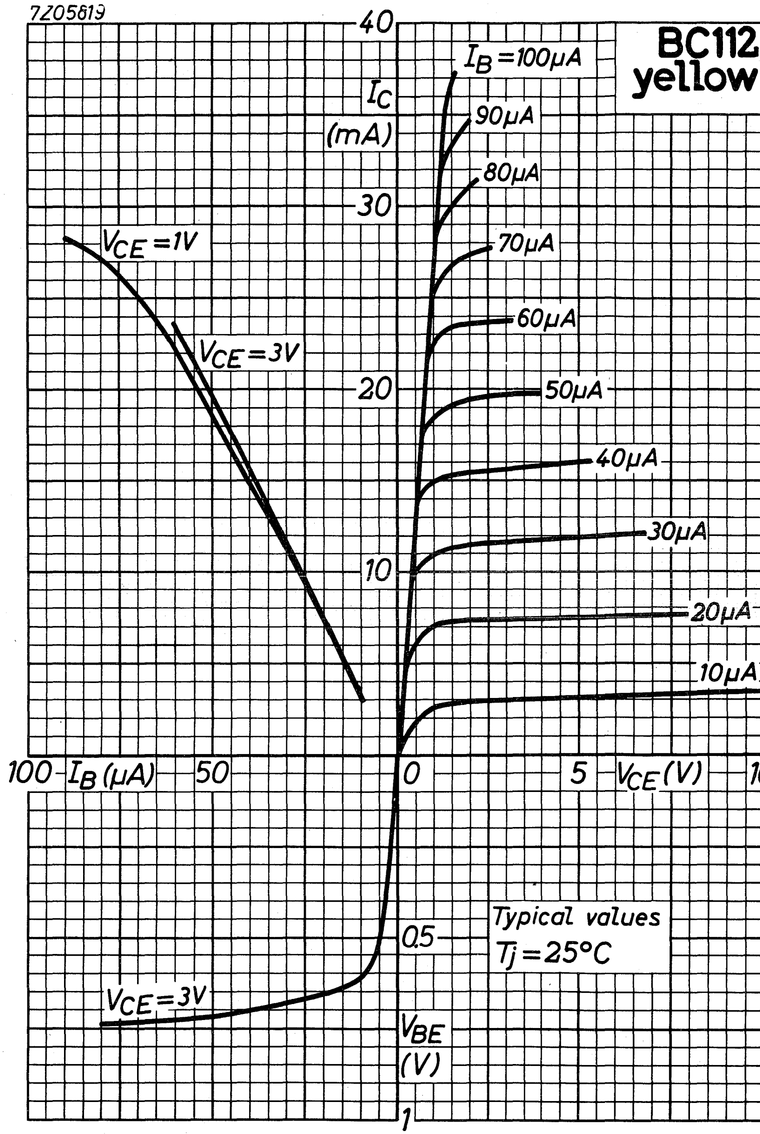
Transition frequency

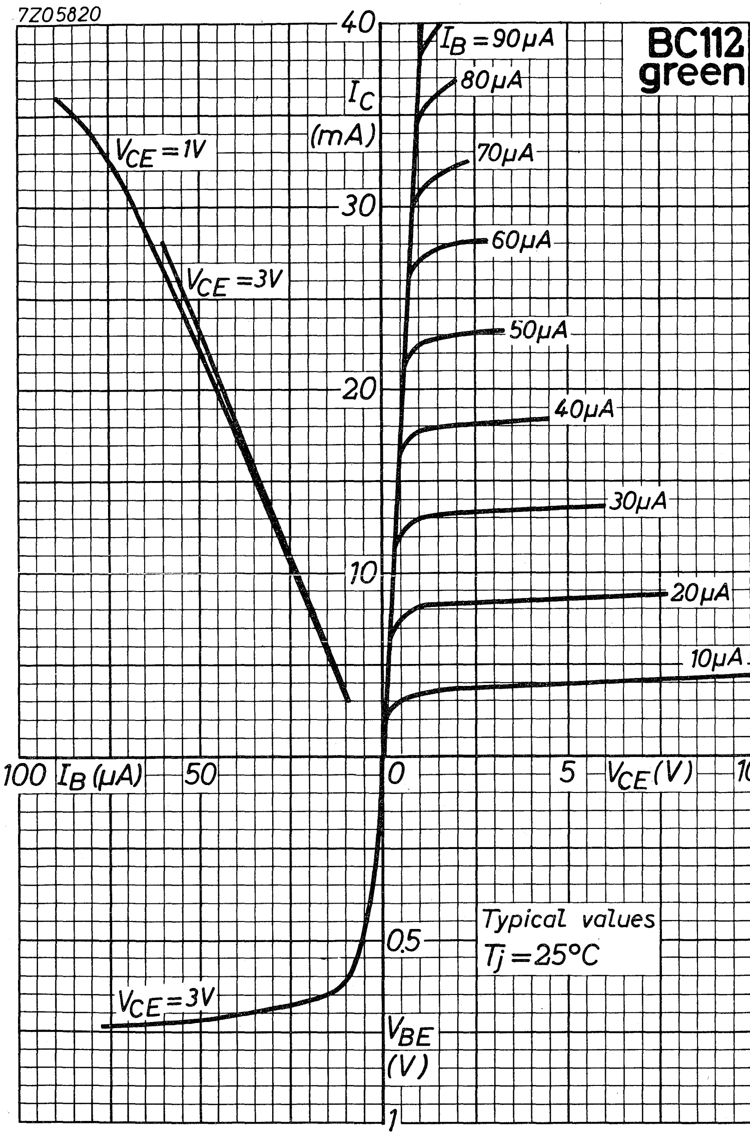
$I_C = 2$ mA; $V_{CE} = 5$ V	f_T	typ. 150	MHz

D.C. current gain		red	yellow	green	
$I_C = 0.2$ mA; $V_{CE} = 0.5$ V	h_{FE}	typ. 115 80 to 200	220 140 to 350	380 280 to 550	
$I_C = 2$ mA; $V_{CE} = 1$ V	h_{FE}	> 100	140	280	
Noise figure					
$I_C = 0.2$ mA; $V_{CE} = 5$ V; $R_S = 2$ kΩ Bandwidth: f = 30 Hz to 15 kHz	F	typ. 2 < -	1.5 4	2 -	dB dB
h parameters at f = 1 kHz					
$I_C = 0.2$ mA; $V_{CE} = 0.5$ V					
Input impedance	h_{ie}	typ. 20	30	45	kΩ
Reverse voltage transfer	h_{re}	typ. 15	25	40	10^{-4}
Small signal current gain	h_{fe}	typ. 130	220	380	
Output admittance	h_{oe}	typ. 15	20	35	$\mu\Omega^{-1}$

7Z3 0654


7Z05818
BC112
red
I_C
(mA)
40
30
20
10
$I_B = 120 \mu A$
110μA
100μA
90μA
80μA
70μA
60μA
50μA
40μA
30μA
20μA
10μA
$V_{CE} = 3V$
$V_{CE} = 1V$
100
I_B (μA)
50
0
5
V_{CE}(V)
10
$V_{CE} = 3V$
0.5
V_{BE}
(V)
1
Typical values
$T_j = 25°C$


7Z05819
BC112
yellow
I_C (mA)
40
30
20
10
I_B = 100µA
90µA
80µA
70µA
60µA
50µA
40µA
30µA
20µA
10µA
V_{CE} = 1V
V_{CE} = 3V
100
I_B (µA)
50
0
5
V_{CE} (V)
10
0.5
1
V_{BE} (V)
V_{CE} = 3V
Typical values
T_j = 25°C


7Z05820
BC112
green
40
30
20
10
I_C
(mA)
$I_B = 90 \mu A$
80μA
70μA
60μA
50μA
40μA
30μA
20μA
10μA
$V_{CE} = 1V$
$V_{CE} = 3V$
100
I_B (μA)
50
0
5
V_{CE} (V)
10
Typical values
$T_j = 25°C$
0.5
$V_{CE} = 3V$
V_{BE}
(V)
1

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 °C to +150 °C
Junction temperature	T_j = max.	150 °C

THERMAL DATA

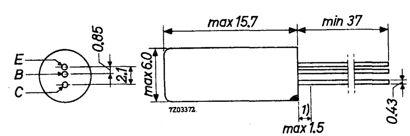
Thermal resistance between junction and ambience

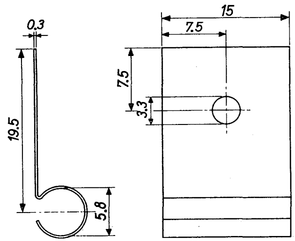
without cooling fin in free air	K = max.	0.4 °C/mW
with cooling fin on heat sink of 70x70x1.6 mm aluminium	K = max.	0.3 °C/mW
Thermal resistance between junction and case	K = max.	0.25 °C/mW

[1]) At $+V_{BE}$ > 500 mV. At $-I_C$ = 200 mA $-V_{CE}$ = max. 24 V

7Z2 1048

Dimensions in mm The red dot indicates the collector





Cooling fin

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN

$T_j = 25\ ^\circ C$

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

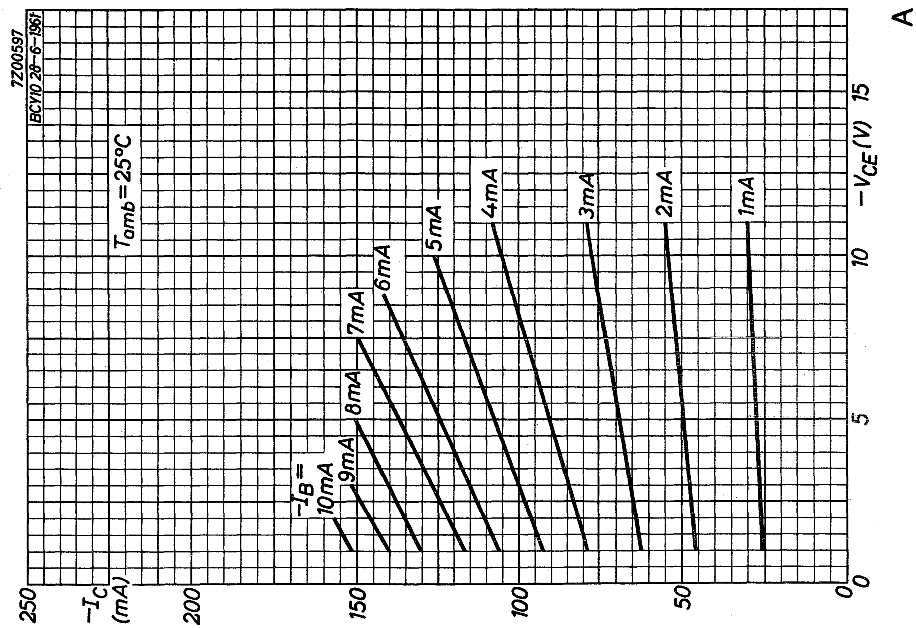
1) Not tinned

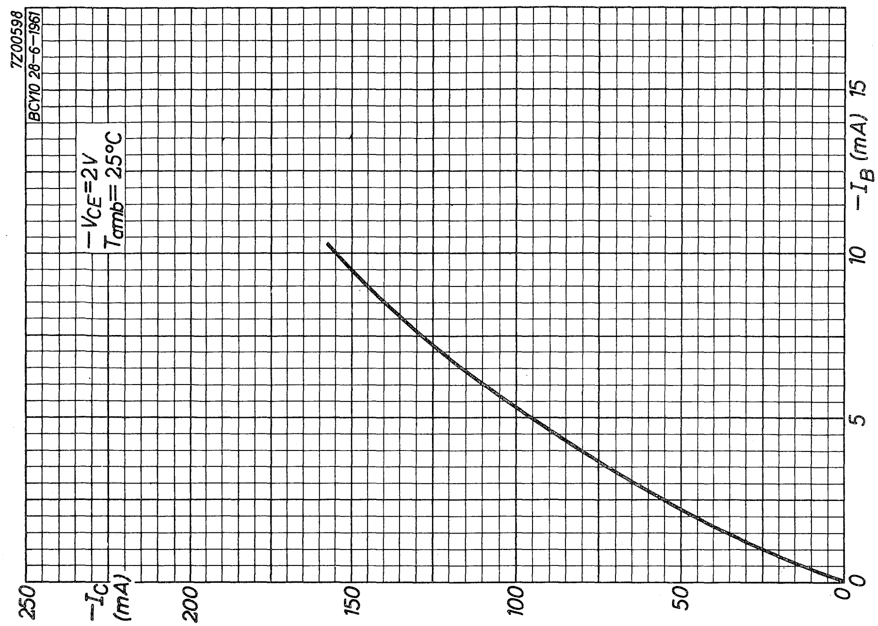
7Z2 1049

Parameters

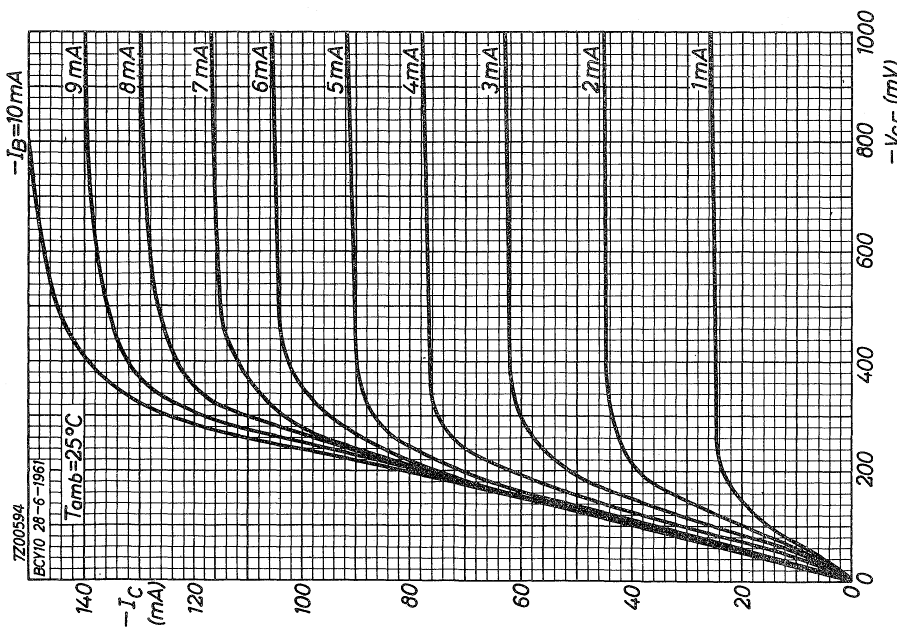
Collector voltage	$-V_{CE}$ =	6 V
Collector current	$-I_C$ =	1 mA
Intrinsic base resistance	$r_{bb'}$ =	100 Ω
Frequency at which $\|h_{fe}\| = 1$	f_1 =	1.5 Mc/s
Collector voltage	$-V_{CE}$ =	6 V
Collector current	$-I_C$ =	10 mA
Current amplification factor at low frequencies	h_{fe} =	40
Collector voltage	$-V_{CE}$ =	6 V
Emitter current	I_E =	0 mA
Feedback capacitance	$c_{b'c}$ =	90 pF

7Z2 1050

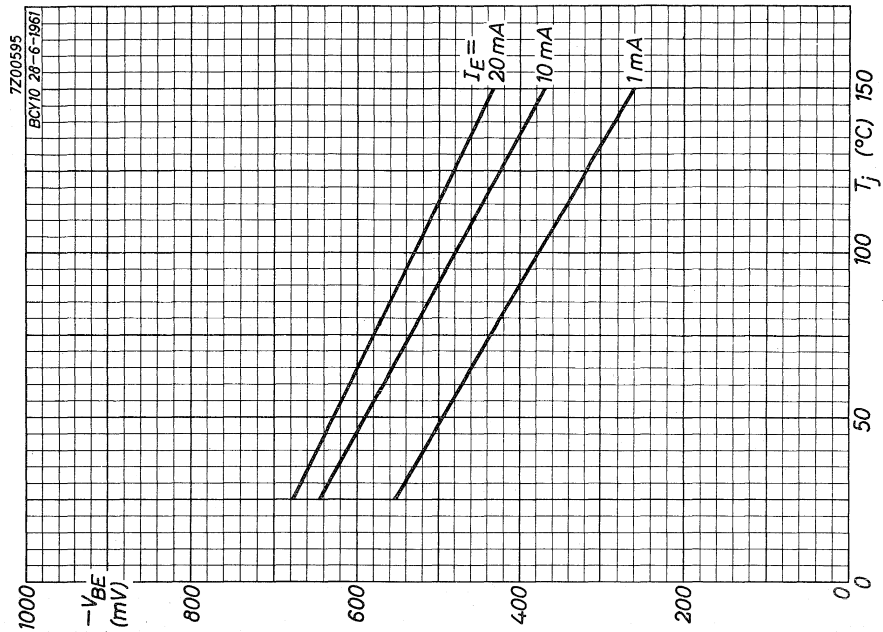

7Z00597
BCY10 28-6-1961
$T_{amb} = 25°C$
$-I_B =$
10mA
9mA
8mA
7mA
6mA
5mA
4mA
3mA
2mA
1mA
$-I_C$ (mA)
250
200
150
100
50
0
0
5
10
15
$-V_{CE}$ (V)
A


7Z00598
BCY10 28-6-1961
−V_CE=2V
T_amb= 25°C
−I_B (mA)
0
5
10
15
−I_C (mA)
0
50
100
150
200
250

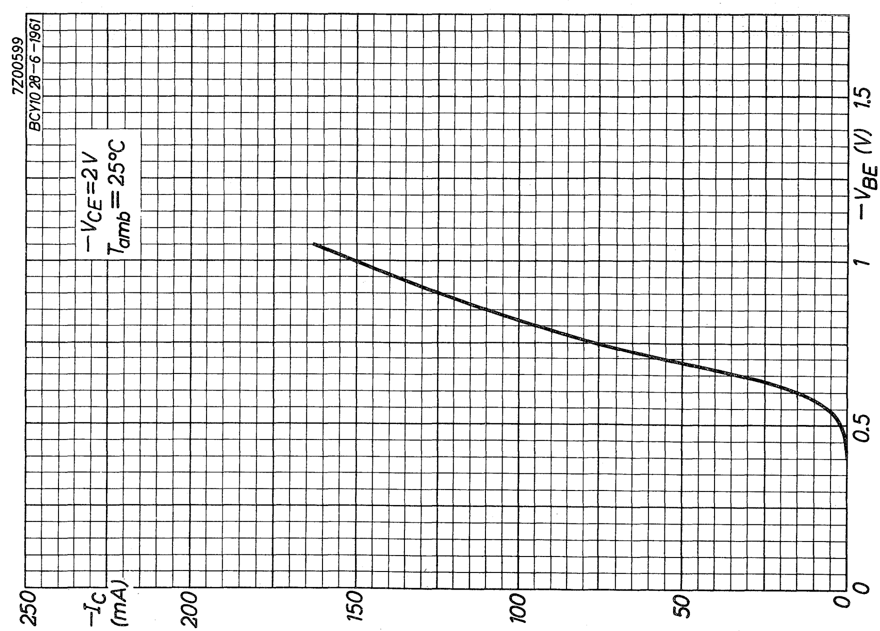
C


7Z00594
BCY10 28-6-1961
T_amb=25°C
−I_B=10mA
9 mA
8 mA
7 mA
6mA
5mA
4mA
3mA
2mA
1mA
−V_CE (mV)
0
200
400
600
800
1000
−I_C (mA)
0
20
40
60
80
100
120
140

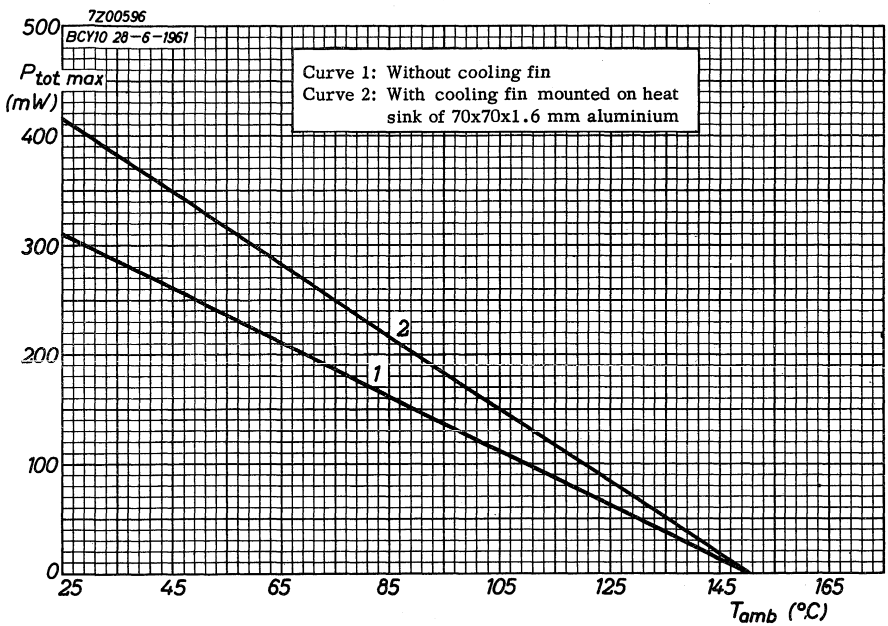
B


7Z00595
BCY10 28-6-1961
I_E = 20 mA
10 mA
1 mA
$-V_{BE}$ (mV)
1000
800
600
400
200
0
T_j (°C)
0
50
100
150

E


7Z00599
BCY10 28-6-1961
$-V_{CE}$=2 V
T_{amb}=25°C
$-I_C$ (mA)
250
200
150
100
50
0
$-V_{BE}$ (V)
0
0.5
1
1.5

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
$P_{tot\ max}$
(mW)
400
300
200
100
0
25
45
65
85
105
125
145
165
T_{amb} (°C)
2
1

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. 250 mA (t_{av} = max. 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. 250 mA (t_{av} = max. 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

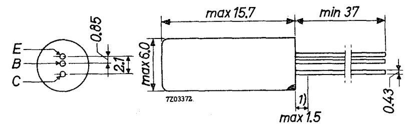
Thermal resistance between junction and ambience

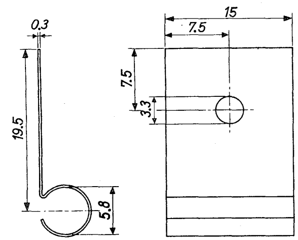
without cooling fin in free air	K = max. 0.4 °C/mW
with cooling fin on heat sink of 70x70x1.6 mm aluminium	K = max. 0.3 °C/mW

Thermal resistance between junction and case	K = max. 0.25 °C/mW

[1]) At $+V_{BE}$ > 500 mV.

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

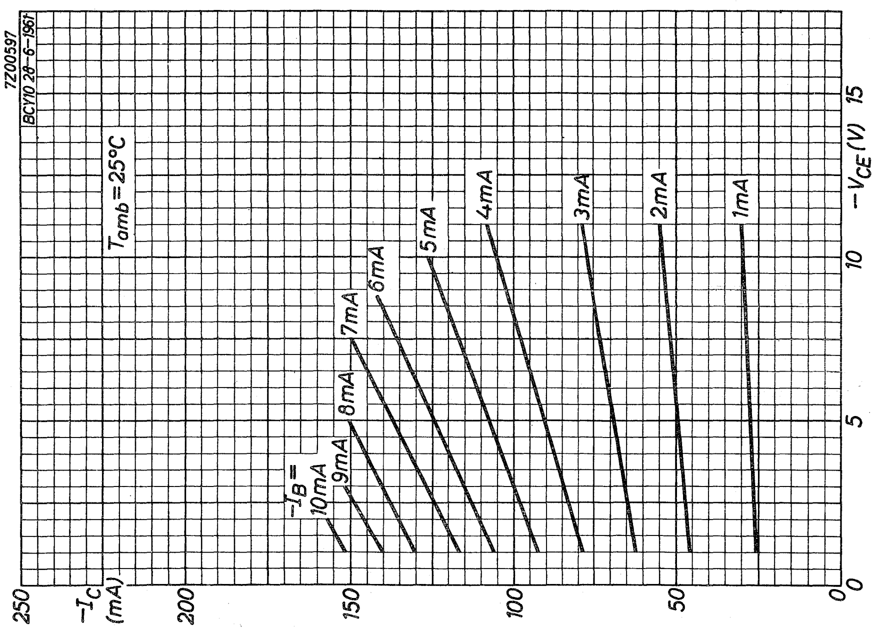
1) Not tinned

7Z2 1049   2.

Parameters

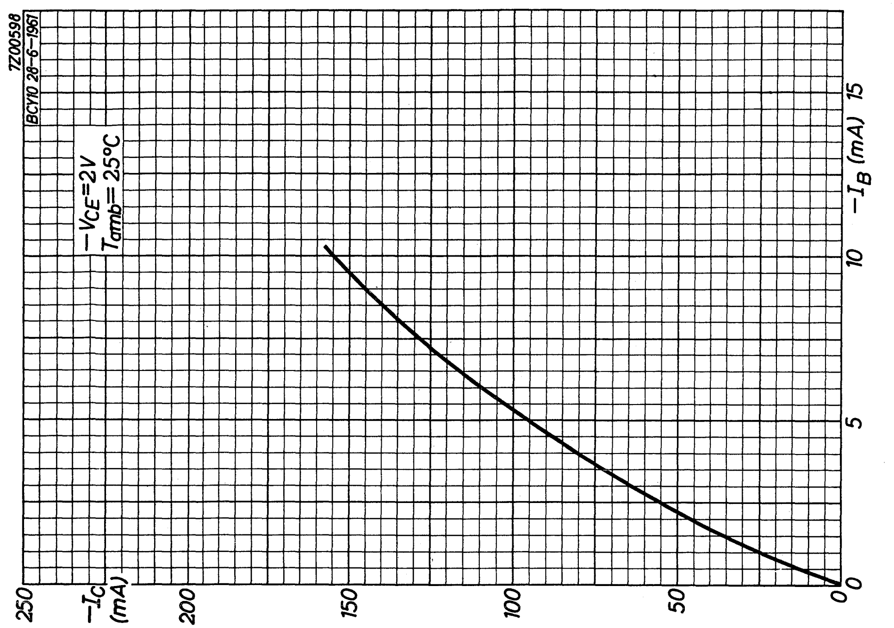
Collector voltage	$-V_{CE}$	= 6 V
Collector current	$-I_C$	= 1 mA
Intrinsic base resistance	$r_{bb'}$	= 100 Ω
Frequency at which $\|h_{fe}\|$ = 1	f_1	= 1.5 Mc/s
Collector voltage	$-V_{CE}$	= 6 V
Collector current	$-I_C$	= 10 mA
Current amplification factor at low frequencies	h_{fe}	= 40
Collector voltage	$-V_{CE}$	= 6 V
Emitter current	I_E	= 0 mA
Feedback capacitance	$c_{b'c}$	≦ 90 pF

7Z2 1050   3.

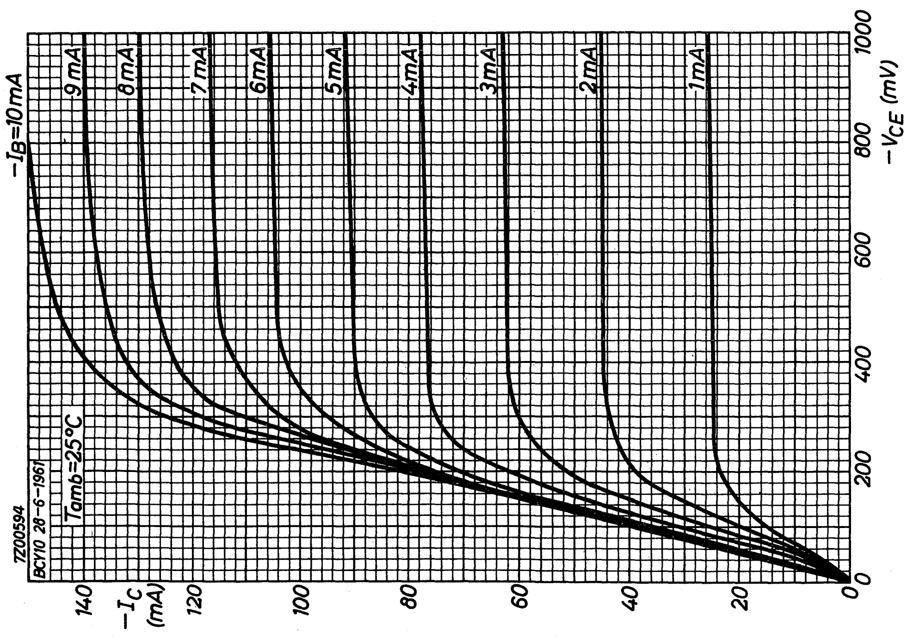


7Z00597
BCY10 28-6-1961
T_{amb} = 25°C
$-I_B$ =
10mA
9mA
8mA
7mA
6mA
5mA
4mA
3mA
2mA
1mA
$-I_C$ (mA)
250
200
150
100
50
0
0
5
10
15
$-V_{CE}$ (V)

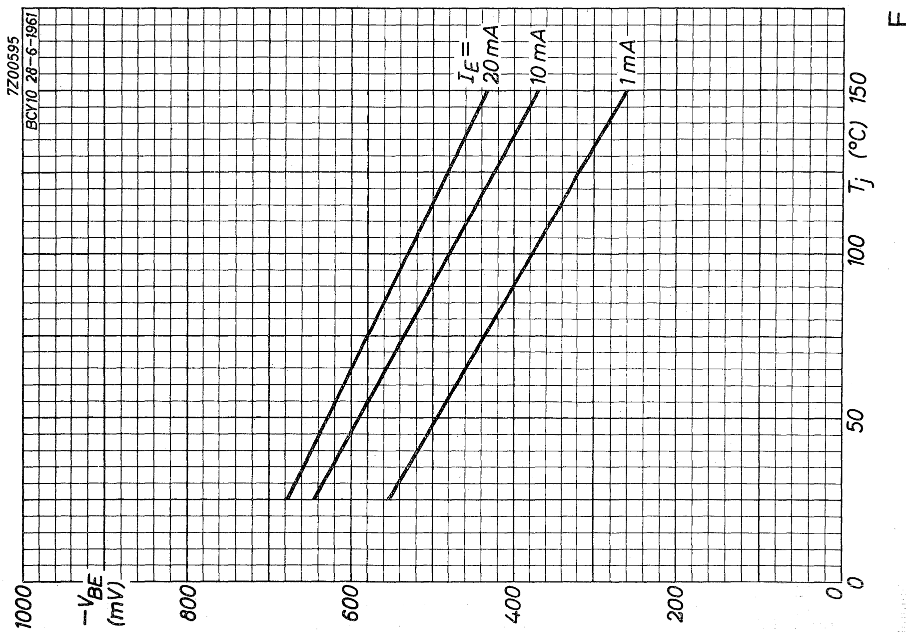
A

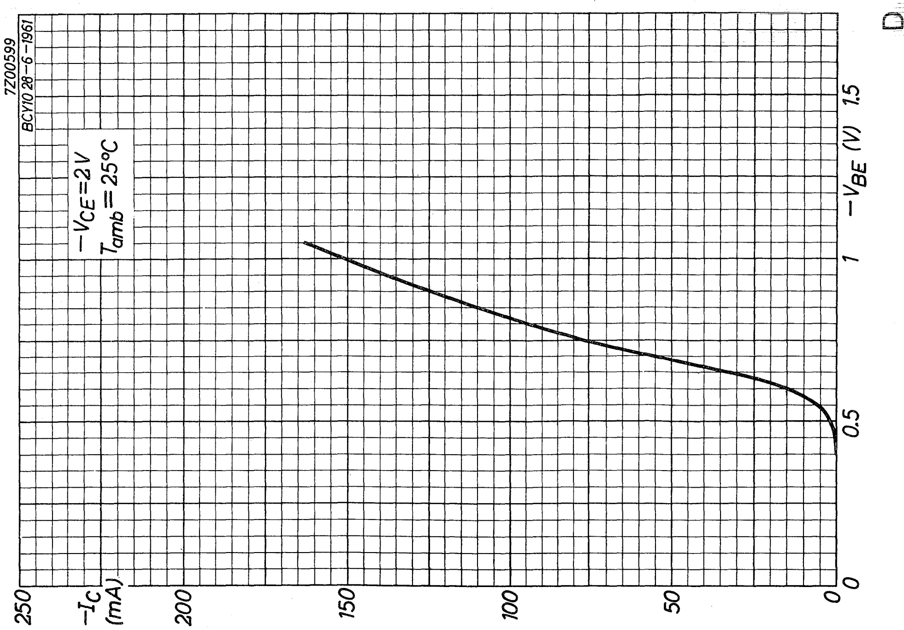

7Z00598
BCY10 28-6-1961
$-V_{CE}$=2V
T_{amb}= 25°C
$-I_C$ (mA)
250
200
150
100
50
0
0
5
10
15
$-I_B$ (mA)

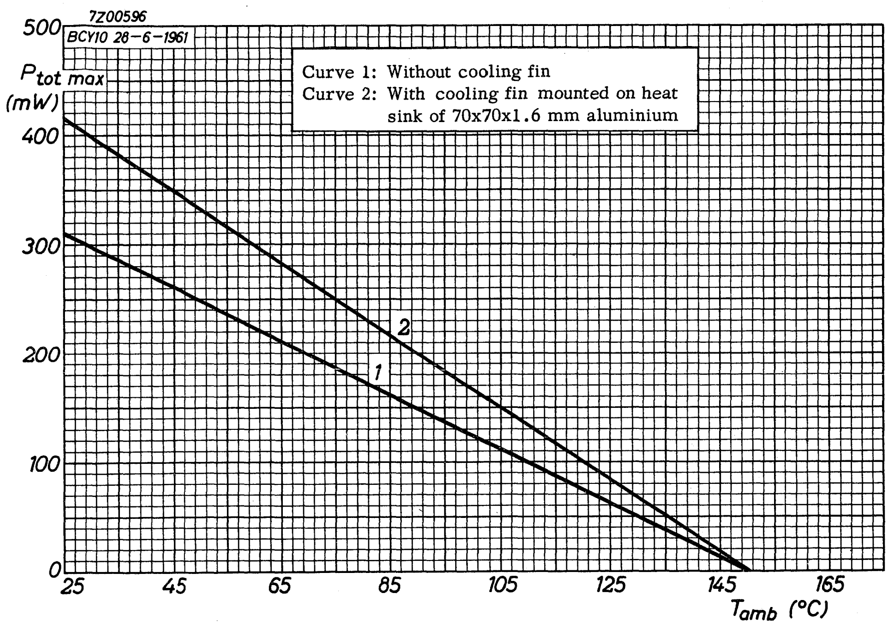
C


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
500
400
300
200
100
0
Ptot max (mW)
Curve 1: Without cooling fin
Curve 2: With cooling fin mounted on heat sink of 70x70x1.6 mm aluminium
2
1
25
45
65
85
105
125
145
165
Tamb (°C)

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. 250 mA (t_{av} = max. 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. 250 mA (t_{av} = max. 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

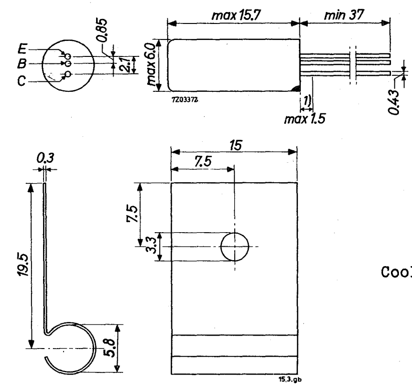
Thermal reistance between junction and ambience

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

Dimensions in mm The red dot indicates the collector



Cooling fin

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN

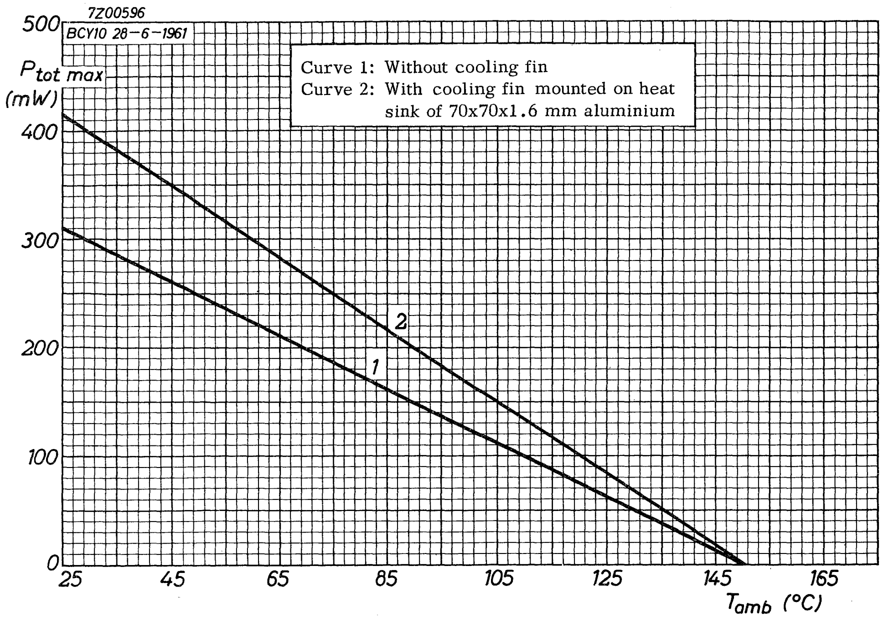
T_j = 25 °C

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



3.

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

7Z2 1064

P-N-P SILICON TRANSISTORS

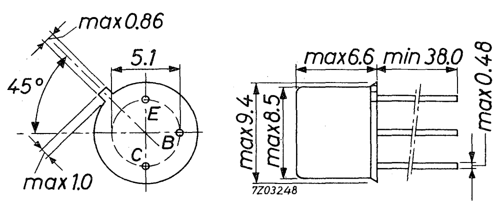
Silicon alloy p-n-p transistors in TO-5 metal case with insulated leads for relay switching, resistor logic circuits and general industrial applications.

QUICK REFERENCE DATA

			BCY 30	BCY 31	BCY 32	BCY 33	BCY 34	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	64	64	64	32	32	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	50	50	50	25	25	V
Collector current (peak value)	$-I_{CM}$	max.	100	100	100	100	100	mA
Total power dissipation up to T_{case} = 62.5 °C	P_{tot}	max.	250	250	250	250	250	mW
Junction temperature	T_j	max.	150	150	150	150	150	°C
Small signal current gain f = 1 kHz; T_j = 25 °C; $-I_C$ = 1 mA; $-V_{CE}$ = 6 V	h_{fe}	typ.	25	35	55	25	35	
Transition frequency $-I_C$ = 1 mA; $-V_{CE}$ = 6 V	f_T	typ.	1.2	1.7	2.5	1.5	2.4	MHz
Thermal resistance	$R_{th\ j\text{-}a}$	=	0.5	0.5	0.5	0.5	0.5	°C/mW

MECHANICAL DATA Dimensions in mm

TO-5 metal case;
leads insulated from the case



7Z3 0684

RATINGS (Limiting values) [1]

Voltages

			BCY 30	BCY 31	BCY 32	BCY 33	BCY 34	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	64	64	64	32	32	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	50	50	50	25	25	V
Collector-emitter voltage (cut-off; see page F)	$-V_{CEX}$	max.	64	64	64	32	32	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	45	45	32	16	16	V

Currents

Collector current (d.c. or average over any 20 ms period)	$-I_C$	max.	50	mA
Collector current (peak value)	$-I_{CM}$	max.	100	mA
Base current (d.c. or average over any 20 ms period)	$-I_B$	max.	15	mA
Base current (peak value)	$-I_{BM}$	max.	50	mA

Power dissipation

Total power dissipation up to T_{case} = 62.5 °C	P_{tot}	max.	250	mW

Temperatures

Storage temperature	T_{stg}		-55 to +150	°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

From junction to ambient in free air without cooling clip	$R_{th\ j-a}$	=	0.5	°C/mW
From junction to case	$R_{th\ j-c}$	=	0.35	°C/mW

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

7Z3 0685

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

Collector cut-off current

$I_E = 0$; $-V_{CB} = 6$ V	$-I_{CBO}$	typ.	1.0	nA
		<	50	nA

Emitter cut-off current

$I_C = 0$; $-V_{EB} = 6$ V	$-I_{EBO}$	typ.	1.0	nA
		<	50	nA
$I_C = 0$; $-V_{EB} = 6$ V; $T_j = 100$ °C	$-I_{EBO}$	typ.	0.1	μA
		<	2.5	μA

Saturation voltages

$-I_C = 20$ mA; $-I_B = 3$ mA	$-V_{CEsat}$	typ.	160	mV
		<	550	mV
	$-V_{BEsat}$	typ.	0.8	V
		<	1.25	V

Collector capacitance

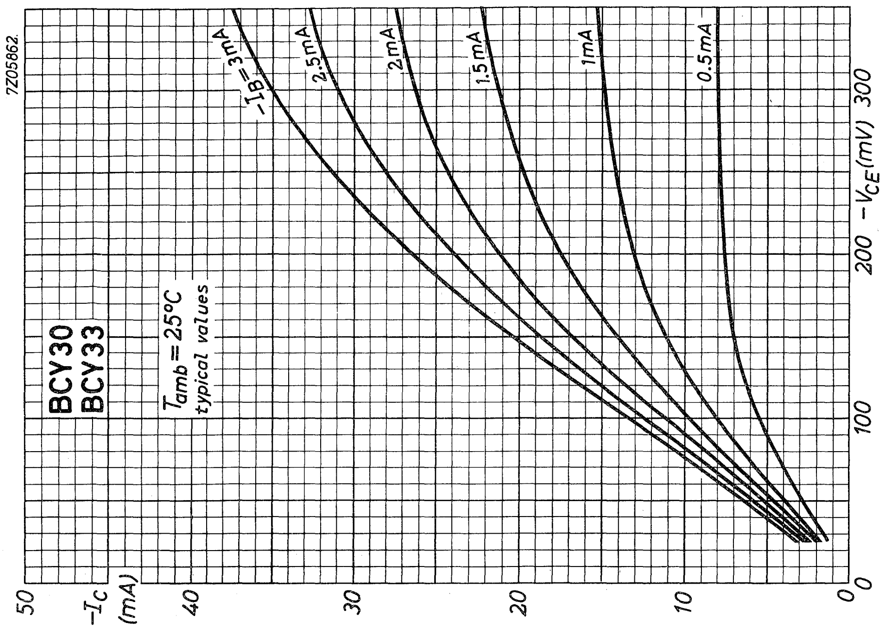
$I_E = I_e = 0$; $-V_{CB} = 6$ V	C_c	>	15	pF
		typ.	28	pF
		<	60	pF

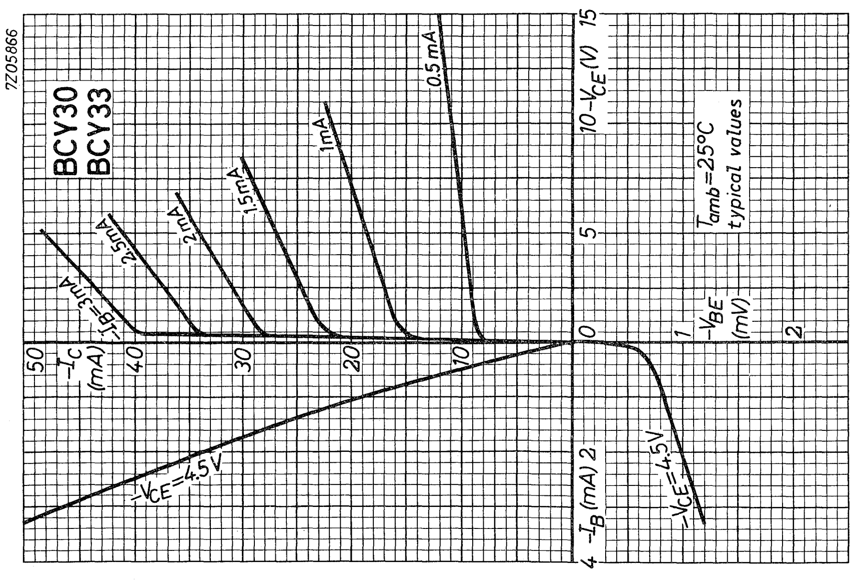
Noise figure at f = 1 kHz

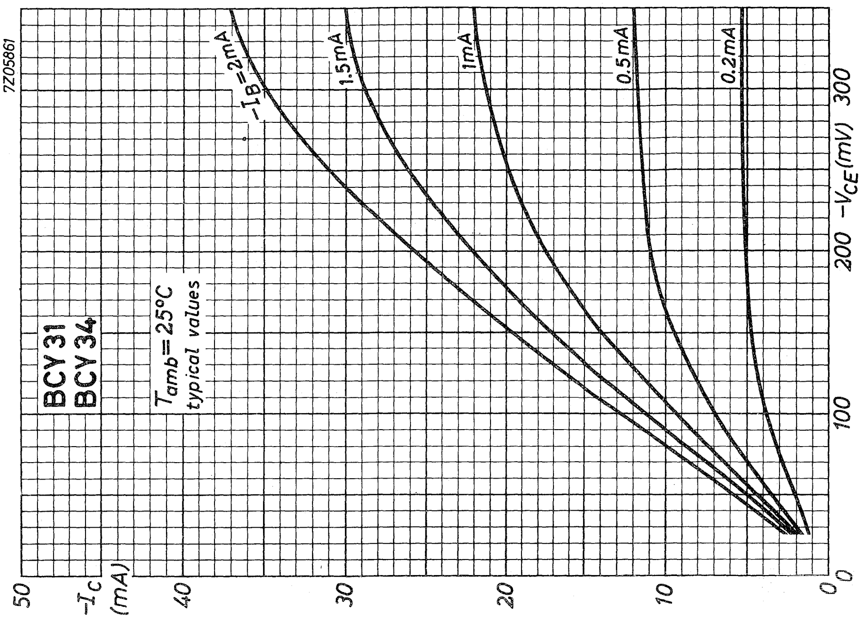
$I_E = 500$ μA; $-V_{CE} = 2$ V; $R_S = 500$ Ω	F	typ.	8.0	dB
		<	20	dB

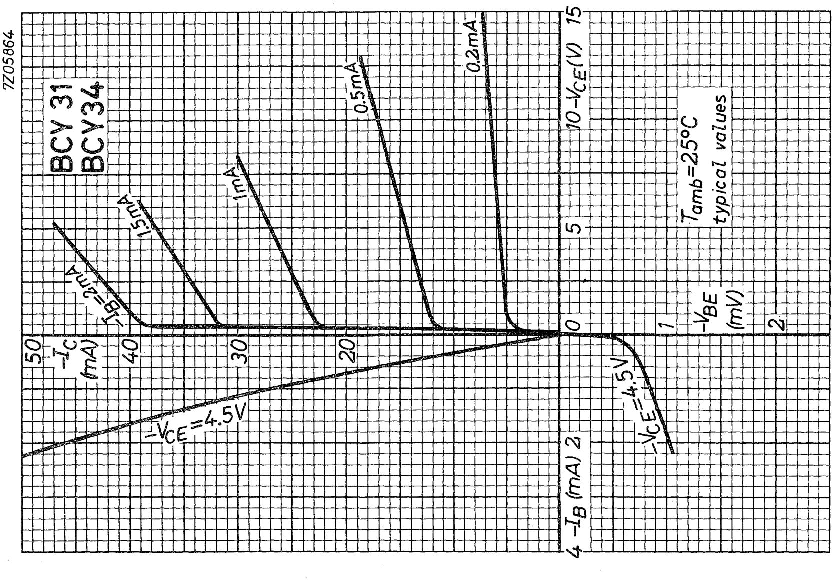
			BCY 30	BCY 31	BCY 32	BCY 33	BCY 34	
D.C. current gain								
$-I_C = 20$ mA; $-V_{CE} = 4.5$ V	h_{FE}	>	10	15	20	10	15	
		typ.	18	28	35	18	28	
		<	35	60	70	35	60	
Small signal current gain								
$-I_C = 1$ mA; $-V_{CE} = 6$ V; f = 1 kHz	h_{fe}	>	15	25	35	15	25	
		typ.	25	35	55	25	35	
		<	35	60	80	35	60	
Feedback impedance								
$-I_C = 1$ mA; $-V_{CE} = 6$ V; f = 1 kHz	$\|z_{rb}\|$	typ.	160	220	230	190	235	Ω
		<	500	500	500	500	500	Ω
Transition frequency								
$-I_C = 1$ mA; $-V_{CE} = 6$ V	f_T	>	0.25	0.25	0.25	0.4	0.6	MHz
		typ.	1.2	1.7	2.5	1.5	2.4	MHz

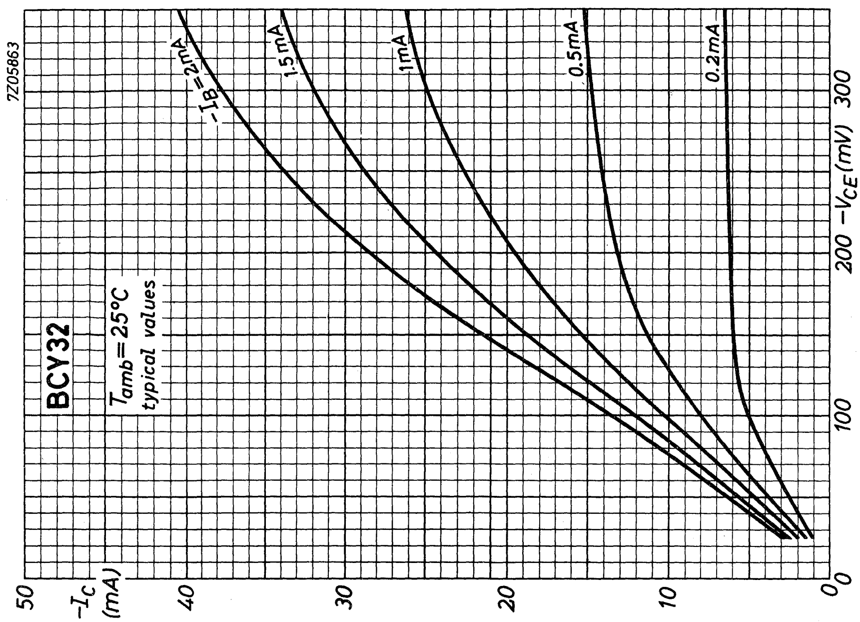
7Z3 0686

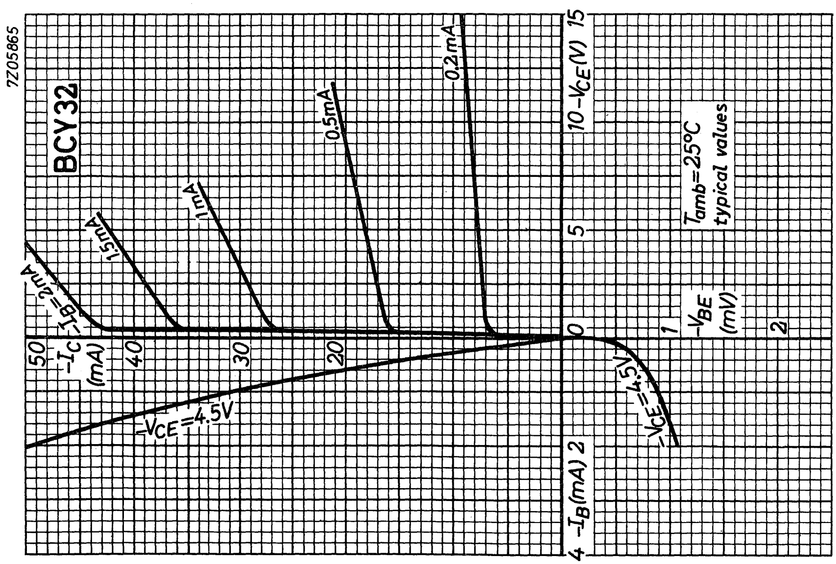

7Z05862
BCY30
BCY33
T_{amb} = 25°C
typical values
$-I_B$ = 3mA
2.5mA
2mA
1.5mA
1mA
0.5mA
$-I_C$ (mA)
0
10
20
30
40
50
$-V_{CE}$ (mV)
100
200
300

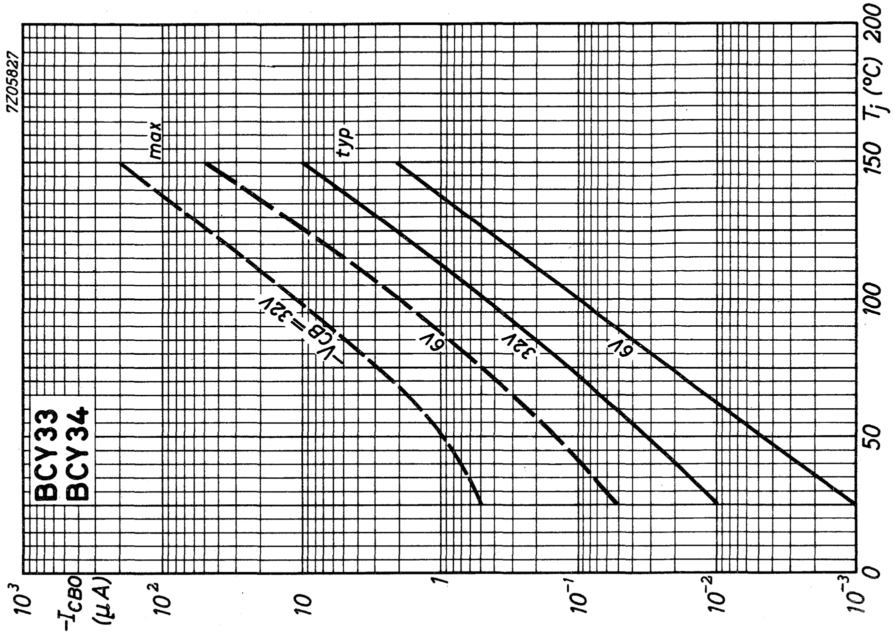

7Z05866
BCY30
BCY33
T_{amb} = 25°C
typical values
$-I_B$ = 3mA
2.5mA
2mA
1.5mA
1mA
0.5mA
$-I_C$ (mA)
50
40
30
20
10
0
5
10 $-V_{CE}$ (V)
15
$-V_{BE}$ (mV)
1
2
$-I_B$ (mA) 2
4
$-V_{CE}$ = 4.5V
$-V_{CE}$ = 4.5V

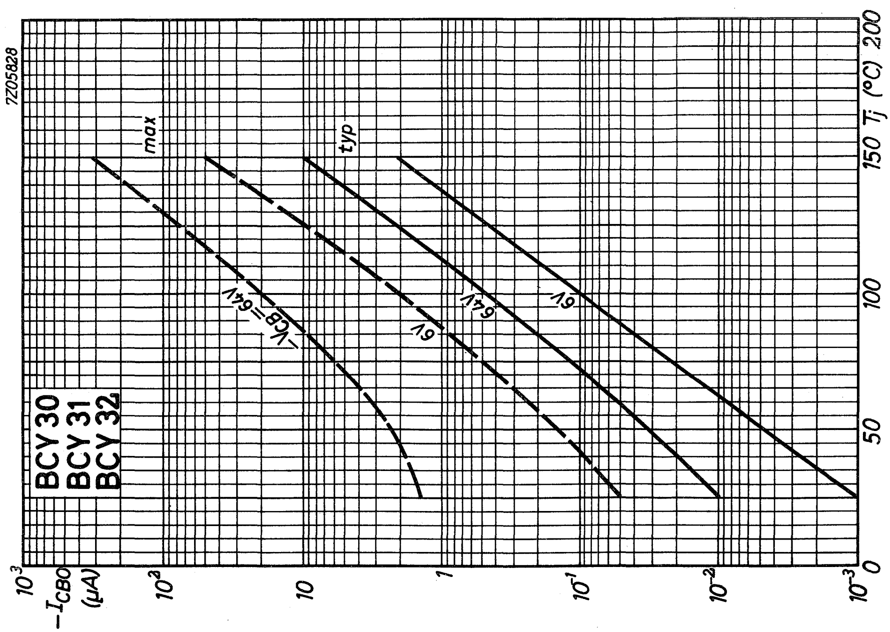

7Z05861
BCY 31
BCY 34
T_{amb}=25°C
typical values
$-I_B$=2mA
1.5mA
1mA
0.5mA
0.2mA
$-I_C$ (mA)
50
40
30
20
10
0
0
100
200
300
$-V_{CE}$(mV)

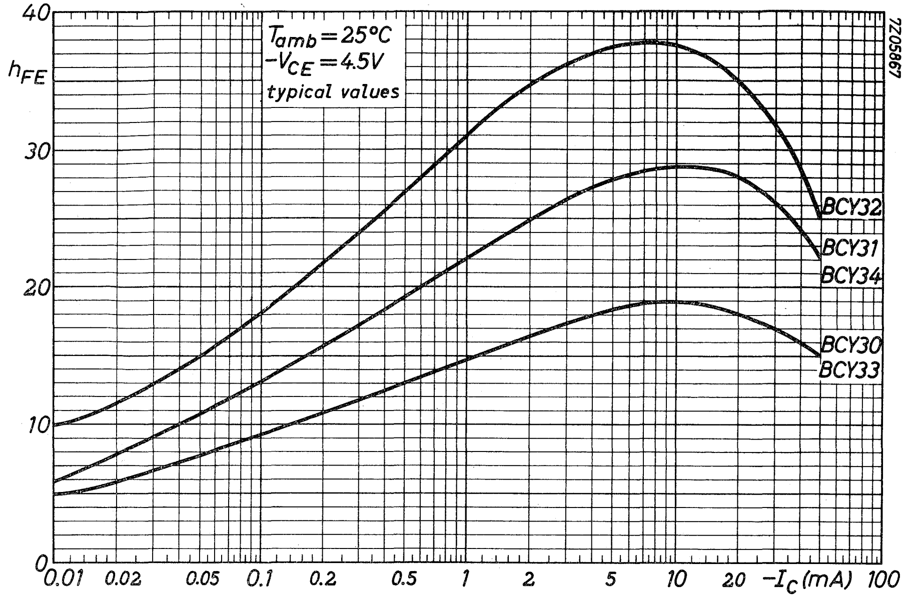

7Z05864
BCY 31
BCY34
T_{amb}=25°C
typical values
$-I_B$=2mA
1.5mA
1mA
0.5mA
0.2mA
$-I_C$ (mA)
50
40
30
20
0
5
10 $-V_{CE}$(V) 15
$-V_{CE}$=4.5V
$-V_{CE}$=4.5V
1
$-V_{BE}$ (mV)
2
4 $-I_B$ (mA) 2


7Z05863
BCY32
T_{amb}=25°C
typical values
$-I_B$=2mA
1.5mA
1mA
0.5mA
0.2mA
$-I_C$ (mA)
50
40
30
20
10
0
0
100
200
300
$-V_{CE}$ (mV)

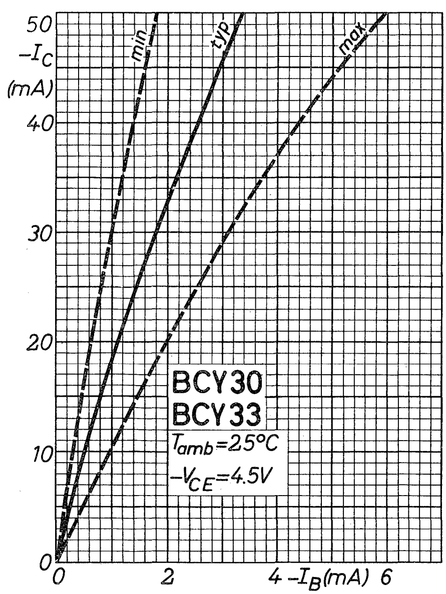

7Z05865
BCY32
T_{amb}=25°C
typical values
$-I_B$=2mA
1.5mA
1mA
0.5mA
0.2mA
$-I_C$ (mA)
50
40
30
20
0
5
10
15
$-V_{CE}$ (V)
$-V_{BE}$ (mV)
1
2
$-V_{CE}$=4.5V
$-V_{CE}$=4.5V
2
4
$-I_B$ (mA)


7Z05827
BCY33
BCY34
max
typ
$-V_{CB} = 32V$
6V
32V
6V
$-I_{CBO}$ (μA)
10^3
10^2
10
1
10^{-1}
10^{-2}
10^{-3}
0
50
100
150
200
T_j (°C)

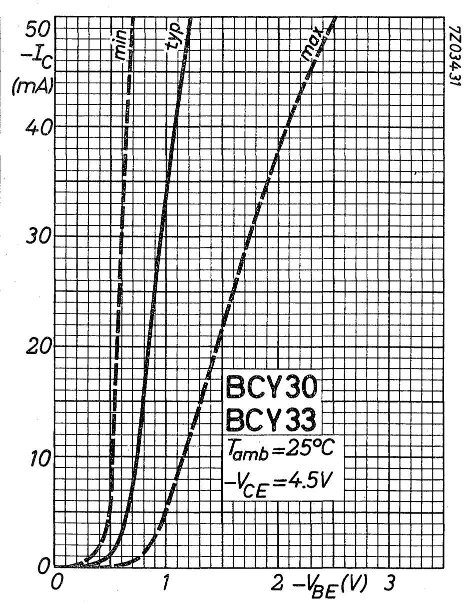

7Z05828
BCY30
BCY31
BCY32
max
typ
$-V_{CB} = 64V$
6V
64V
6V
$-I_{CBO}$ (μA)
10^3
10^2
10
1
10^{-1}
10^{-2}
10^{-3}
0
50
100
150
200
T_j (°C)



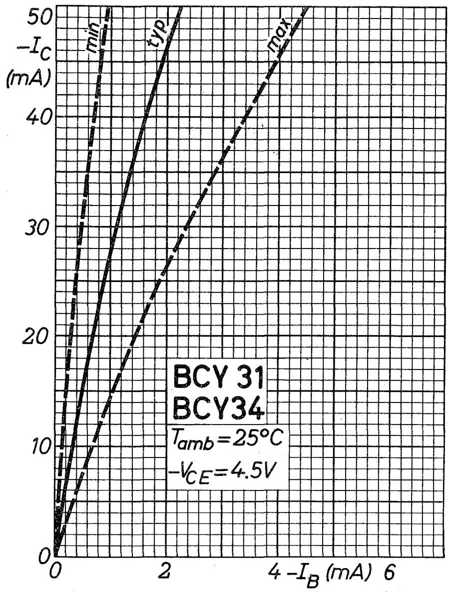
7Z05867
$T_{amb} = 25°C$
$-V_{CE} = 4.5V$
typical values
h_{FE}
BCY32
BCY31
BCY34
BCY30
BCY33
$-I_C$ (mA)

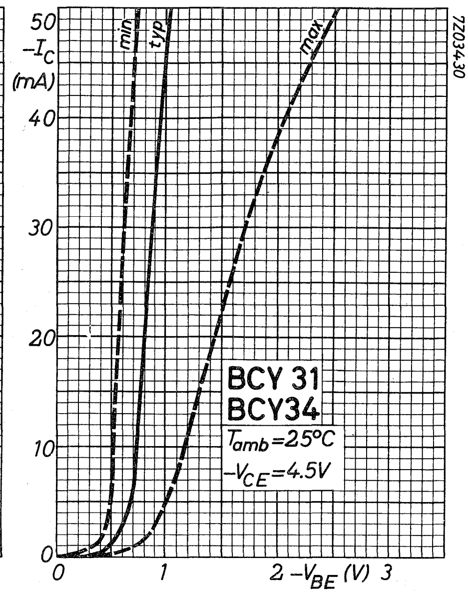


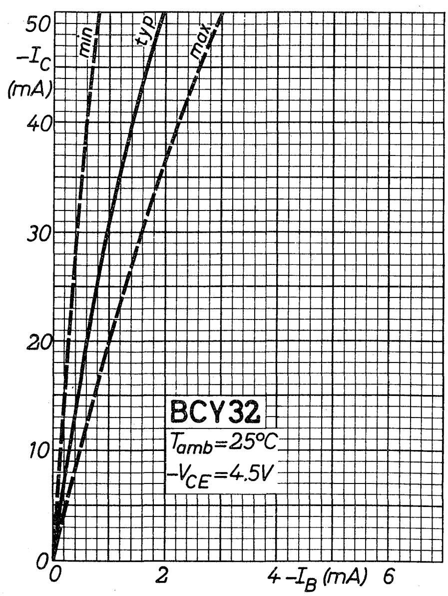
min
typ
max
$-I_C$ (mA)
BCY30
BCY33
$T_{amb} = 25°C$
$-V_{CE} = 4.5V$
$-I_B$ (mA)

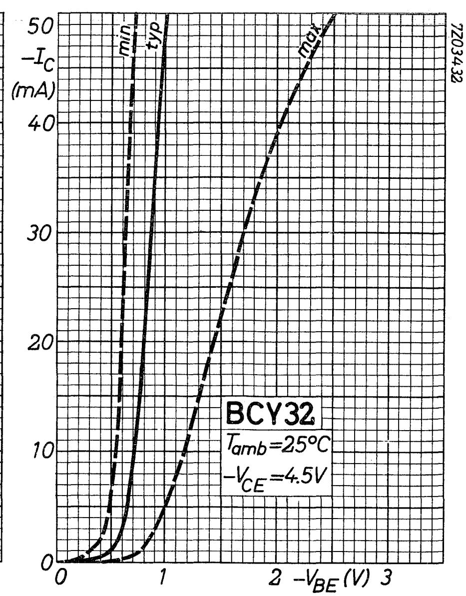


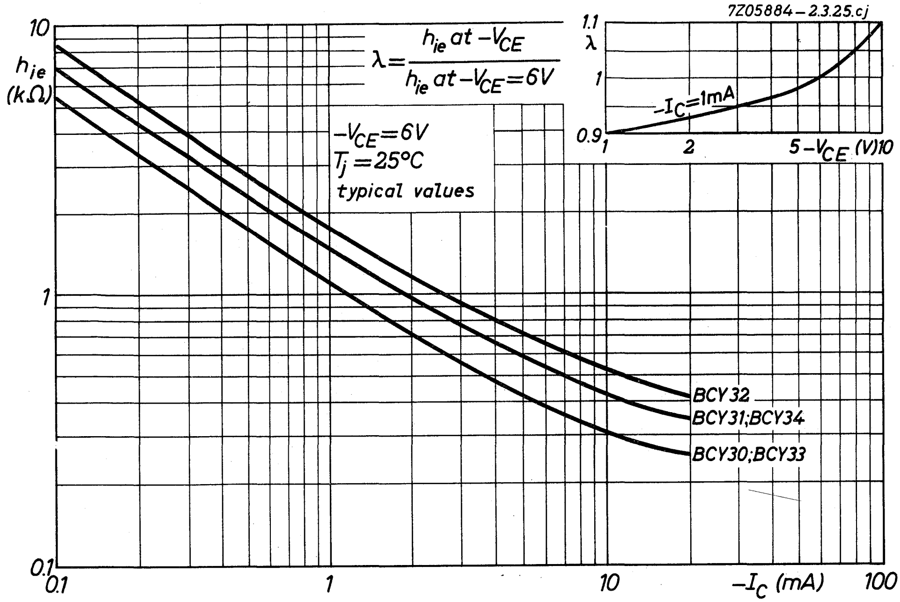
7Z03431
min
typ
max
$-I_C$ (mA)
BCY30
BCY33
$T_{amb} = 25°C$
$-V_{CE} = 4.5V$
$-V_{BE}$ (V)

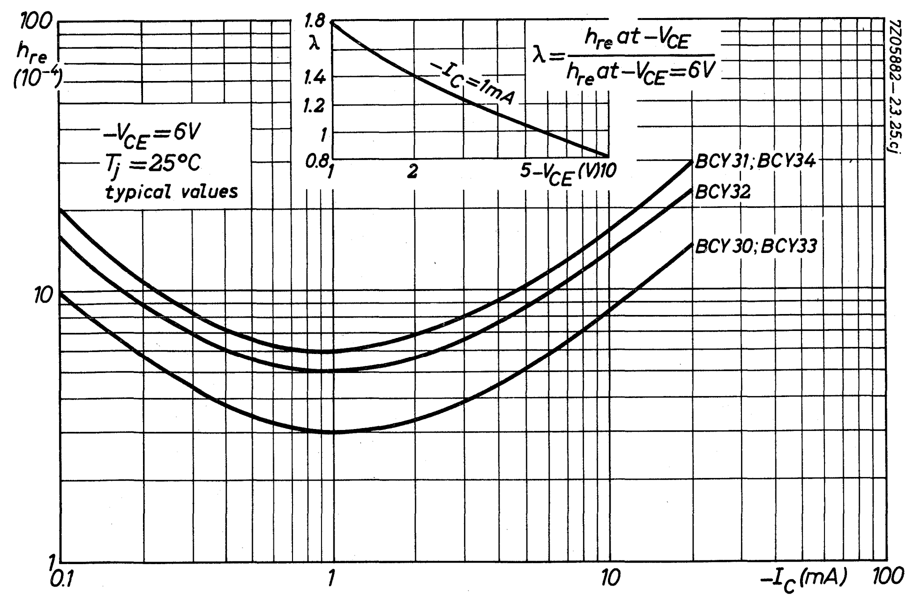

50
$-I_C$
(mA)
40
30
20
10
0
0
2
4 $-I_B$ (mA) 6
min
typ
max
BCY 31
BCY34
T_{amb}=25°C
$-V_{CE}$=4.5V

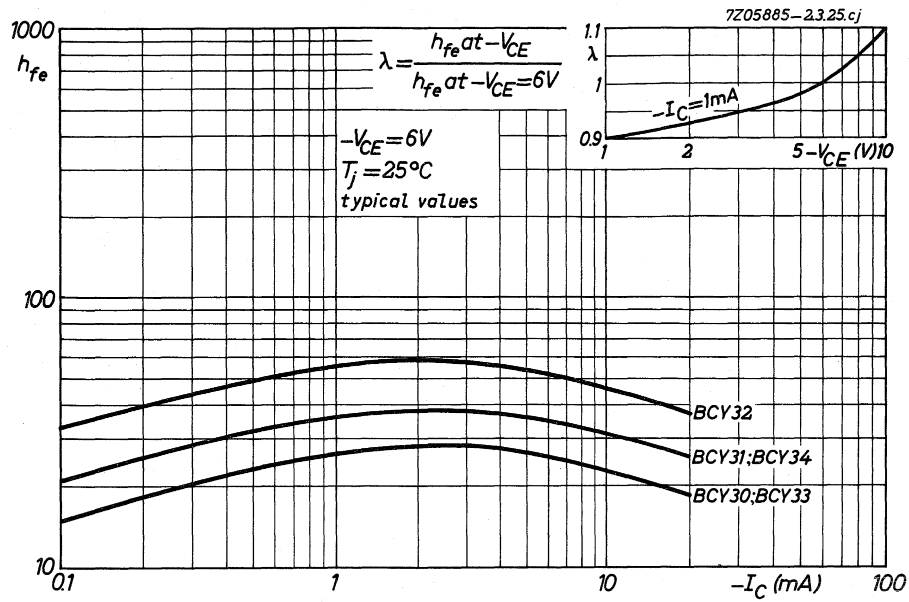

50
$-I_C$
(mA)
40
30
20
10
0
0
1
2 $-V_{BE}$ (V) 3
min
typ
max
BCY 31
BCY34
T_{amb}=25°C
$-V_{CE}$=4.5V
7Z03430

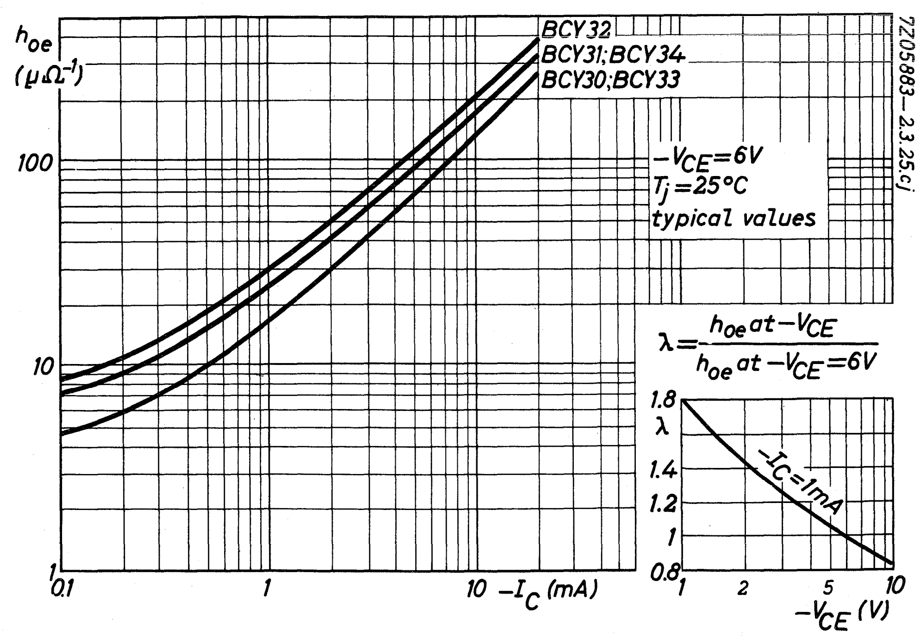

50
$-I_C$
(mA)
40
30
20
10
0
0
2
4 $-I_B$ (mA) 6
min
typ
max
BCY32
T_{amb}=25°C
$-V_{CE}$=4.5V

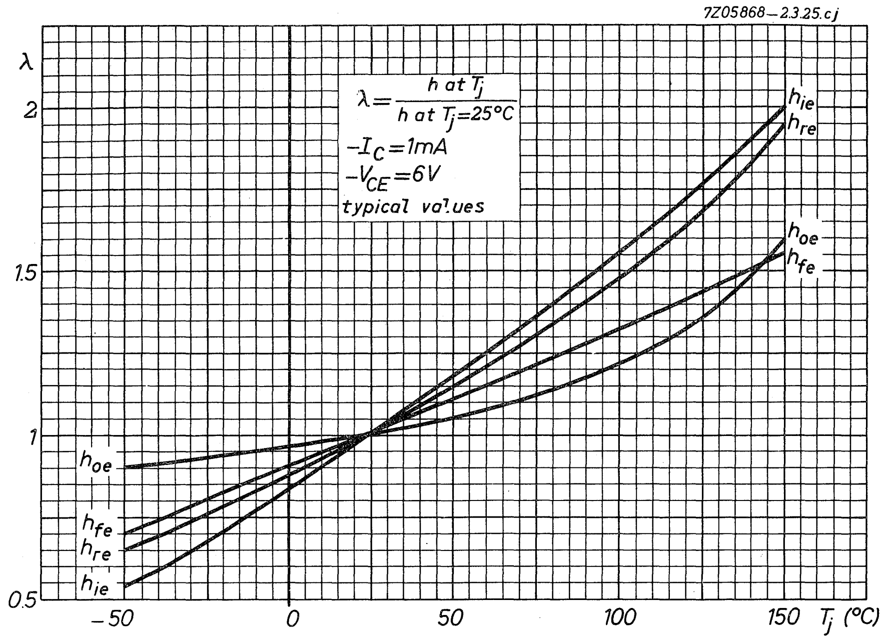

50
$-I_C$
(mA)
40
30
20
10
0
0
1
2 $-V_{BE}$ (V) 3
min
typ
max
BCY32
T_{amb}=25°C
$-V_{CE}$=4.5V
7Z03432

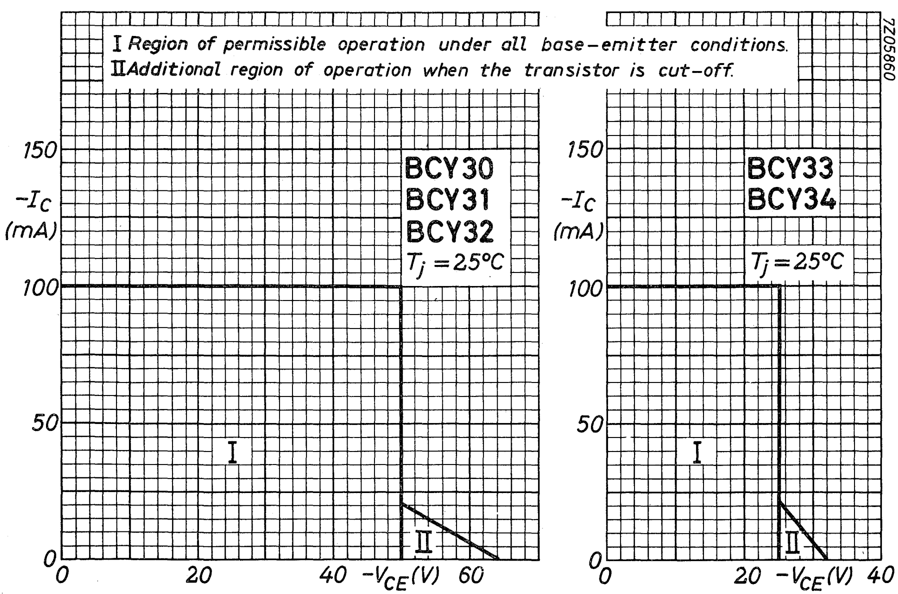

7Z05884–2.3.25.cj
10
h_{ie}
(kΩ)
1
0.1
0.1
1
10
$-I_C$ (mA)
100
$\lambda = \frac{h_{ie} \text{ at } -V_{CE}}{h_{ie} \text{ at } -V_{CE} = 6V}$
$-V_{CE} = 6V$
$T_j = 25°C$
typical values
1.1
λ
1
0.9
1
2
5 $-V_{CE}$ (V) 10
$-I_C = 1mA$
BCY32
BCY31;BCY34
BCY30;BCY33


7Z05882–2.3.25.cj
100
h_{re}
(10^{-4})
10
1
0.1
1
10
$-I_C$ (mA)
100
$-V_{CE} = 6V$
$T_j = 25°C$
typical values
1.8
λ
1.4
1.2
1
0.8
1
2
5 $-V_{CE}$ (V) 10
$-I_C = 1mA$
$\lambda = \frac{h_{re} \text{ at } -V_{CE}}{h_{re} \text{ at } -V_{CE} = 6V}$
BCY31; BCY34
BCY32
BCY30; BCY33


7Z05885–2.3.25.cj
1000
h_{fe}
100
10
0.1
1
10
$-I_C$ (mA)
100
$\lambda = \frac{h_{fe} \text{ at } -V_{CE}}{h_{fe} \text{ at } -V_{CE} = 6V}$
$-V_{CE} = 6V$
$T_j = 25°C$
typical values
BCY32
BCY31;BCY34
BCY30;BCY33
1.1
λ
1
0.9
$-I_C = 1mA$
1
2
5
$-V_{CE}$ (V)
10


7Z05883–2.3.25.cj
h_{oe}
$(\mu\Omega^{-1})$
100
10
1
0.1
1
10
$-I_C$ (mA)
BCY32
BCY31;BCY34
BCY30;BCY33
$-V_{CE} = 6V$
$T_j = 25°C$
typical values
$\lambda = \frac{h_{oe} \text{ at } -V_{CE}}{h_{oe} \text{ at } -V_{CE} = 6V}$
1.8
λ
1.4
1.2
1
0.8
$-I_C = 1mA$
1
2
5
10
$-V_{CE}$ (V)


7Z05868—2.3.25.cj
λ
$\lambda = \frac{h \text{ at } T_j}{h \text{ at } T_j = 25°C}$
$-I_C = 1mA$
$-V_{CE} = 6V$
typical values
h_{ie}
h_{re}
h_{oe}
h_{fe}
2
1.5
1
0.5
−50
0
50
100
150
T_j (°C)


7Z05860
I Region of permissible operation under all base-emitter conditions.
II Additional region of operation when the transistor is cut-off.
BCY30
BCY31
BCY32
$T_j = 25°C$
BCY33
BCY34
$T_j = 25°C$
$-I_C$ (mA)
150
100
50
0
I
II
20
40
60
$-V_{CE}$ (V)

P-N-P SILICON TRANSISTORS

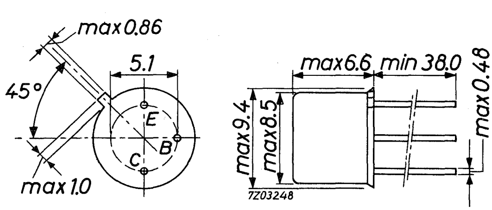
P-N-P alloy transistors in a TO-5 metal envelope with the base connected to the case. They are intended for relay switching, resistor logic circuits and general industrial applications.

QUICK REFERENCE DATA

			BCY 38	BCY 39	BCY 40	BCY 54	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	32	64	32	50	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	24	60	24	50	V
Collector current (peak value)	$-I_{CM}$	max.	500	500	500	500	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	410	410	410	410	mW
Junction temperature	T_j	max.	150	150	150	150	°C
D.C. current gain at T_{amb} = 25 °C							
$-I_C$ = 150 mA; $-V_{CE}$ = 1 V	h_{FE}	>	10	10	15	12	
		<	30	50	120	70	
Transition frequency							
$-I_C$ = 1 mA; $-V_{CE}$ = 6 V	f_T	typ.	1.5	1.5	2.5	2.0	MHz

MECHANICAL DATA Dimensions in mm

TO-5
Base connected to case



7Z3 0715

RATINGS (Limiting values) [1])

Voltages

			BCY 38	BCY 39	BCY 40	BCY 54	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	32	64	32	50	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	24	60	24	50	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	12	12	12	12	V

Currents

Collector current (d.c. or average over any 20 ms period)	$-I_C$	max.	250	mA
Collector current (peak value)	$-I_{CM}$	max.	500	mA
Base current (d.c.)	$-I_B$	max.	125	mA
Base current	$-I_{BM}$	max.	125	mA

Power dissipation

Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	410	mW

Temperatures

Storage temperature	T_{stg}		-55 to +150	°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	0.3	°C/mW
From junction to case	$R_{th\ j\text{-}c}$	=	0.12	°C/mW

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

7Z3 0716

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

Collector cut-off current

$I_E = 0$; $-V_{CB} = 6$ V	$-I_{CBO}$	typ.	1	nA
		<	100	nA
$I_E = 0$; $-V_{CB} = 6$ V; $T_j = 100$ °C	$-I_{CBO}$	typ.	0.1	µA
		<	2.5	µA

Emitter cut-off current

$I_C = 0$; $-V_{EB} = 6$ V	$-I_{EBO}$	typ.	1	nA
		<	100	nA
$I_C = 0$; $-V_{EB} = 6$ V; $T_j = 100$ °C	$-I_{EBO}$	typ.	0.1	µA
		<	2.5	µA

			BCY38	BCY39	BCY40	BCY54	
Base current							
$V_{CB} = 0$; $I_E = 150$ mA	$-I_B$	>	5	3	1.25	2	mA
		<	14	14	9	12	mA
Base-emitter voltage							
$-I_C = 150$ mA; $-V_{CE} = 1$ V	$-V_{BE}$	typ.	1.5	1.5	1.4	1.4	V
		<	1.9	1.9	1.9	1.9	V
Saturation voltages							
$-I_C = 150$ mA; $-I_B = 15$ mA	$-V_{CEsat}$	typ.	580	460	440	440	mV
		<	1100	1100	1100	1100	mV
D.C. current gain							
		>	12	12	22	20	
$-I_C = 30$ mA; $-V_{CE} = 1$ V	h_{FE}	typ.	20	30	35	35	
		<	-	-	-	100	
		>	10	10	15	12	
$-I_C = 150$ mA; $-V_{CE} = 1$ V	h_{FE}	typ.	13	19	23	23	
		<	30	50	120	70	
		>	-	-	10	-	
$-I_C = 300$ mA; $-V_{CE} = 6$ V [1]	h_{FE}	typ.	10	15	18	18	

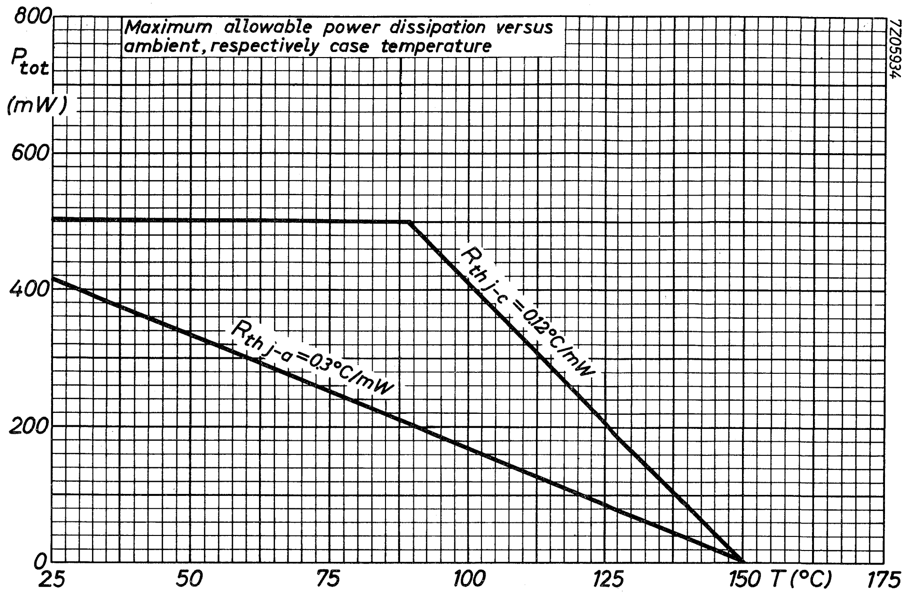
[1]) Measured under pulsed conditions to prevent excessive dissipation.

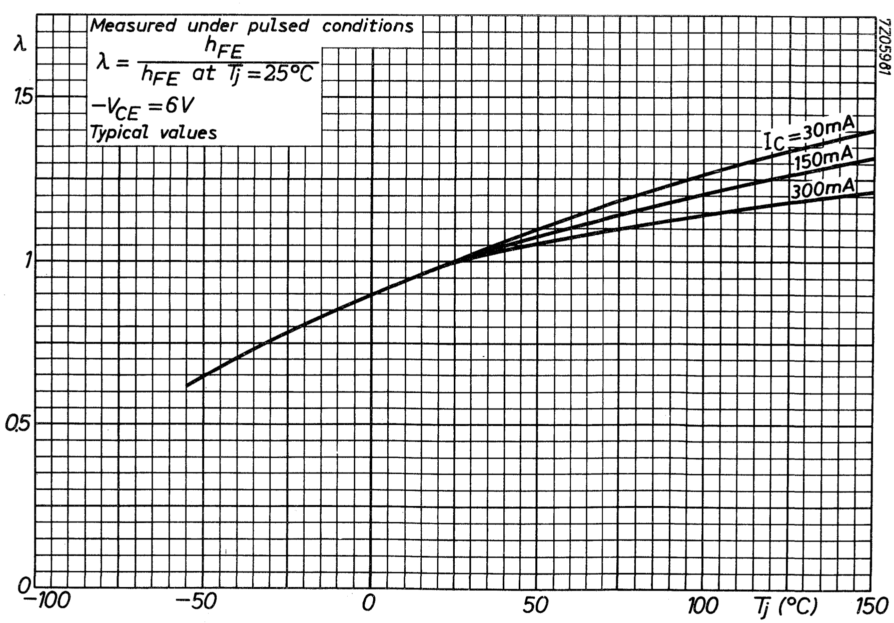
7Z3 0717

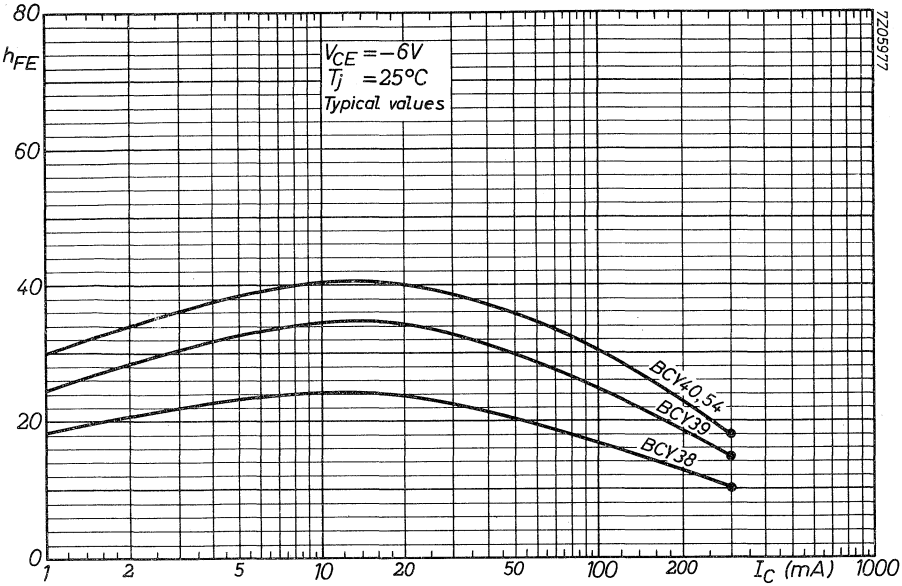
CHARACTERISTICS (continued) T_{amb} = 25 °C unless otherwise specified

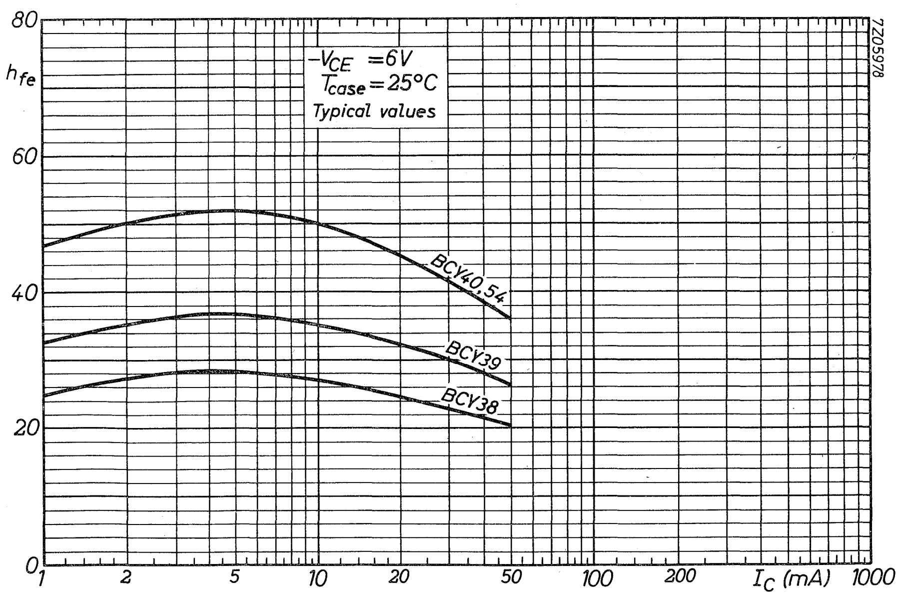
			BCY38	BCY39	BCY40	BCY54	
Collector capacitance at f = 0.5 MHz							
$I_E = I_e = 0$; $-V_{CB}$ = 6 V	C_c	typ.	60	60	60	60	pF
		<	150	150	150	150	pF
Transition frequency							
$-I_C$ = 1 mA; $-V_{CE}$ = 6 V	f_T	>	0.45	0.45	0.85	0.45	MHz
		typ.	1.5	1.5	2.5	2.0	MHz
Feedback impedance at f = 0.5 MHz							
$-I_C$ = 1 mA; $-V_{CE}$ = 6 V	$\|z_{rb}\|$	typ.	100	110	140	130	Ω
		<	250	250	250	250	Ω
Noise figure at f = 1 kHz							
$-I_C$ = 500 μA; $-V_{CE}$ = 2 V; R_S = 500 Ω	F	typ.	8	8	8	8	dB
		<	20	20	20	20	dB
Small signal current gain at f = 1 kHz							
$-I_C$ = 10 mA; $-V_{CE}$ = 6 V	h_{fe}	>	15	15	30	20	
		typ.	27	35	50	50	
		<	100	100	160	120	

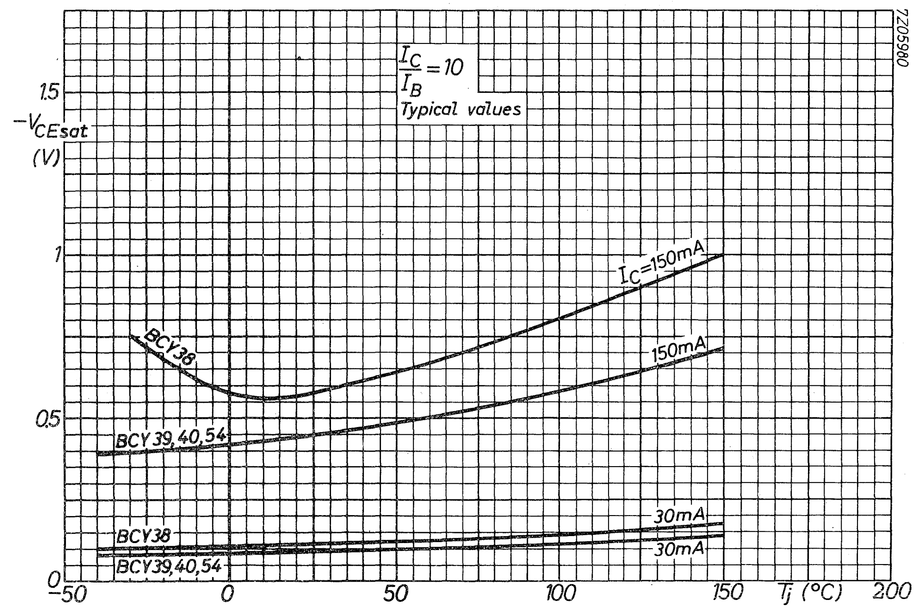
7Z3 0718

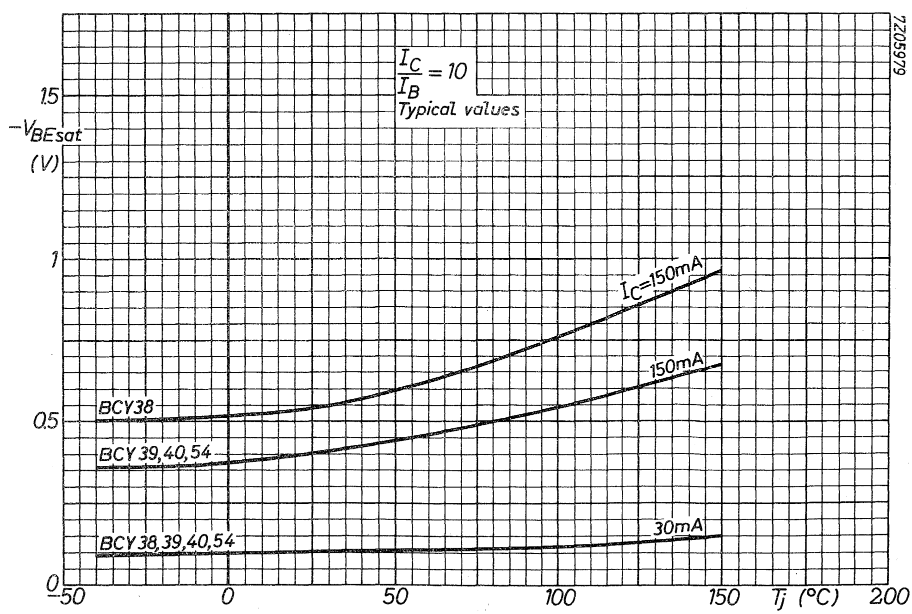

Maximum allowable power dissipation versus ambient, respectively case temperature
7Z05934
P_{tot} (mW)
800
600
400
200
0
25
50
75
100
125
150
175
T (°C)
$R_{th\ j\text{-}c}$ = 0.12°C/mW
$R_{th\ j\text{-}a}$ = 0.3°C/mW

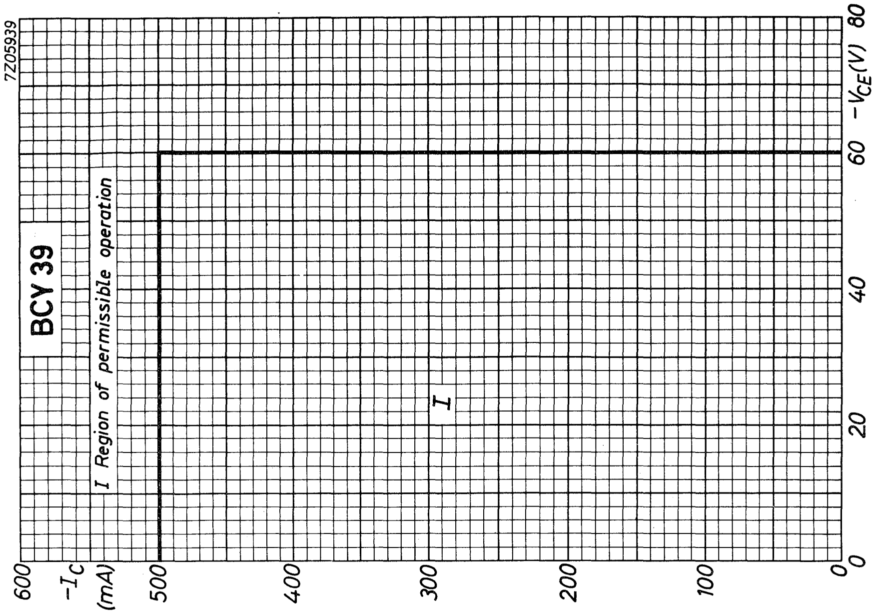

Measured under pulsed conditions
$\lambda = \frac{h_{FE}}{h_{FE} \text{ at } T_j = 25°C}$
$-V_{CE} = 6V$
Typical values
7Z05981
λ
1.5
1
0.5
0
−100
−50
0
50
100
150
T_j (°C)
I_C = 30mA
150mA
300mA

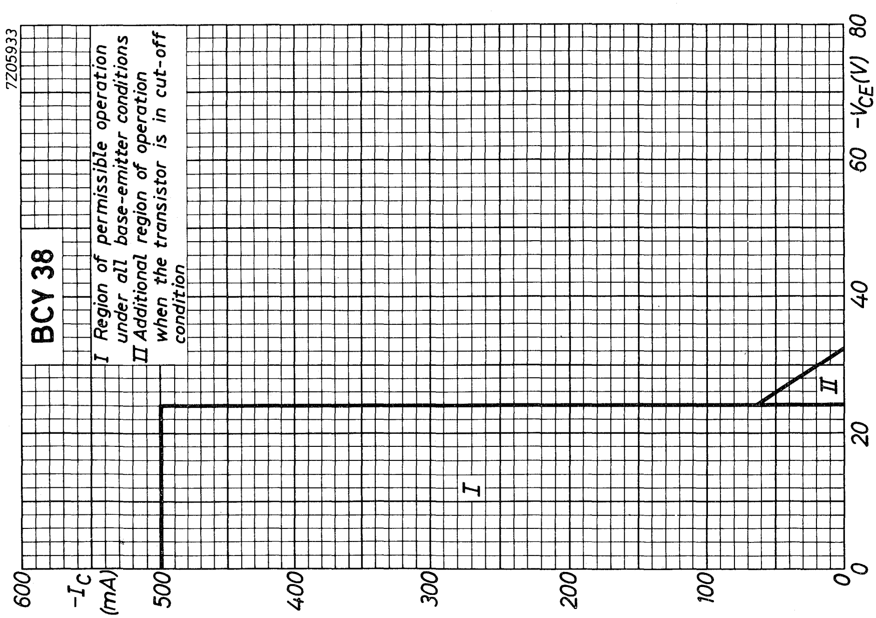

7Z05977
h_{FE}
$V_{CE} = -6V$
$T_j = 25°C$
Typical values
BCY40,54
BCY39
BCY38
I_C (mA)
80
60
40
20
0
1
2
5
10
20
50
100
200
1000

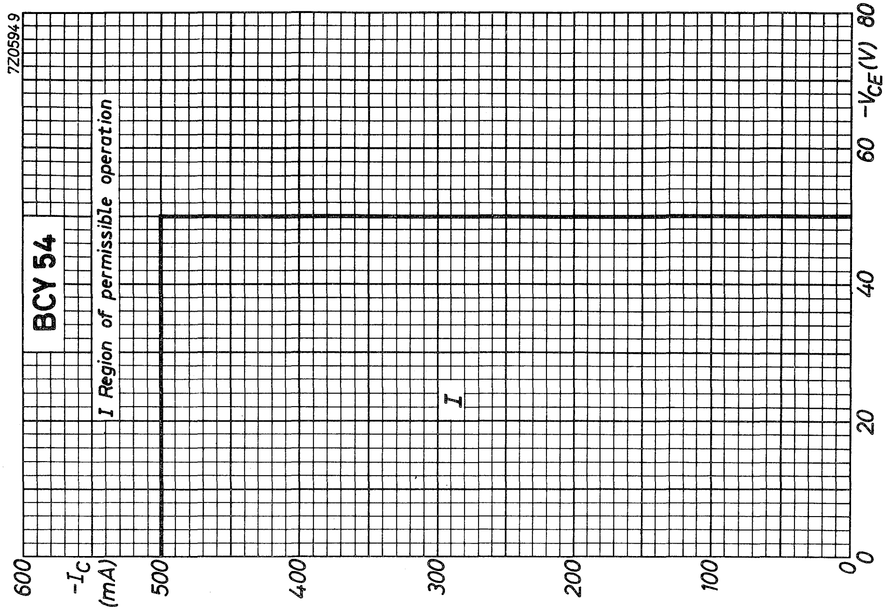

7Z05978
h_{fe}
$-V_{CE} = 6V$
$T_{case} = 25°C$
Typical values
BCY40,54
BCY39
BCY38
I_C (mA)
80
60
40
20
0
1
2
5
10
20
50
100
200
1000

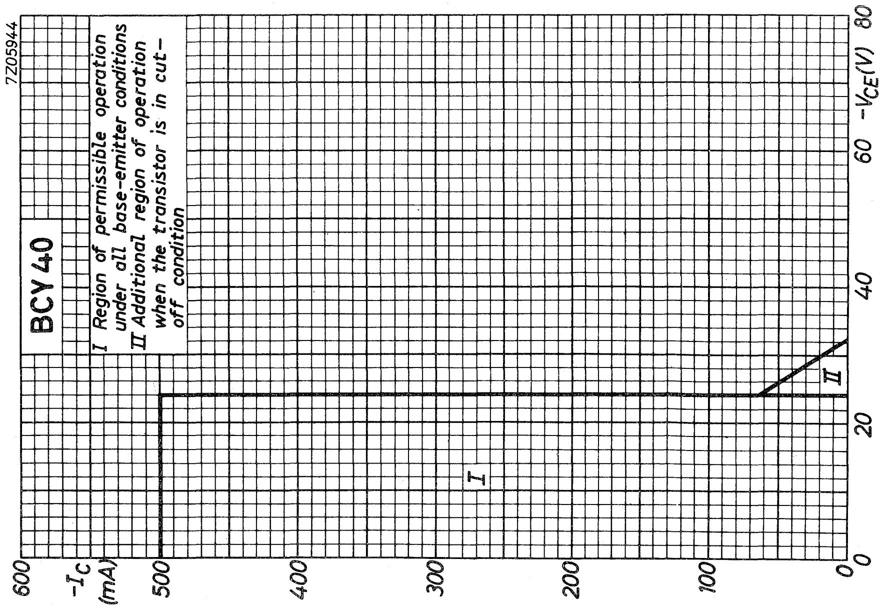

7Z05980
$\frac{I_C}{I_B} = 10$
Typical values
1.5
$-V_{CEsat}$
(V)
1
0.5
0
−50
0
50
100
150
T_j (°C)
200
I_C=150mA
BCY38
150mA
BCY39,40,54
30mA
BCY38
30mA
BCY39,40,54

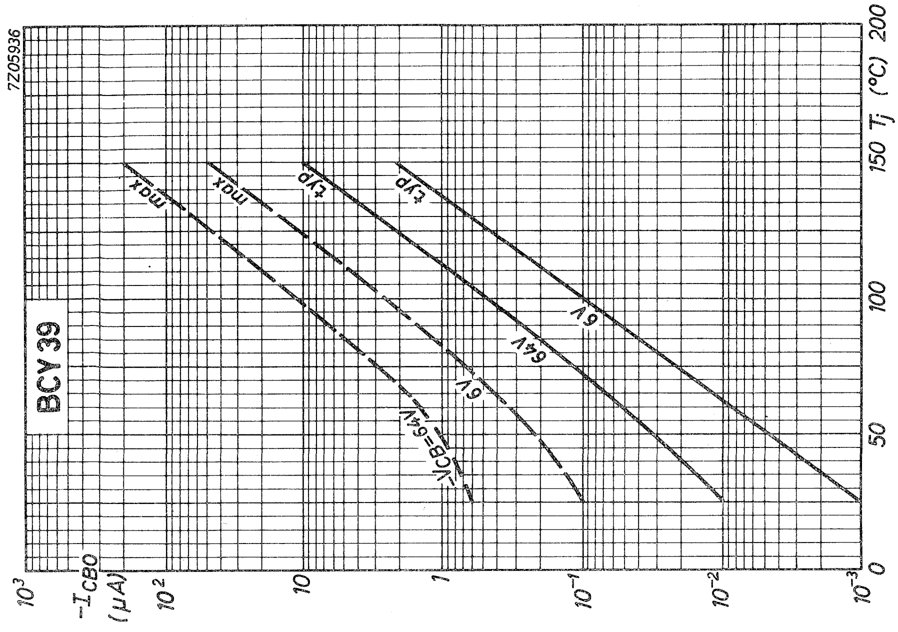

7Z05979
$\frac{I_C}{I_B} = 10$
Typical values
1.5
$-V_{BEsat}$
(V)
1
0.5
0
−50
0
50
100
150
T_j (°C)
200
I_C=150mA
150mA
BCY38
BCY39,40,54
30mA
BCY38,39,40,54

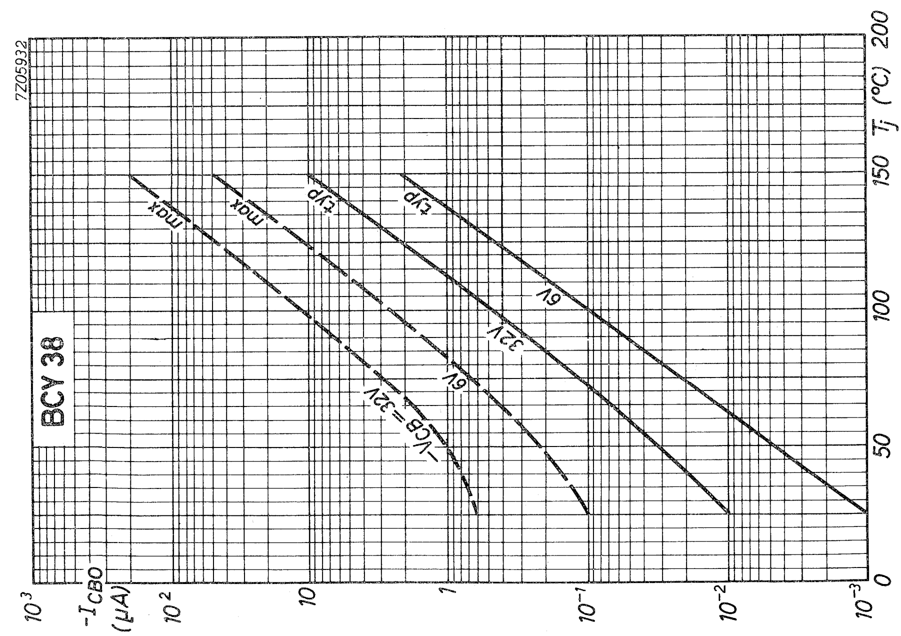

7Z05939
BCY 39
I Region of permissible operation
I
$-I_C$ (mA)
600
500
400
300
200
100
0
0
20
40
60
80
$-V_{CE}$(V)

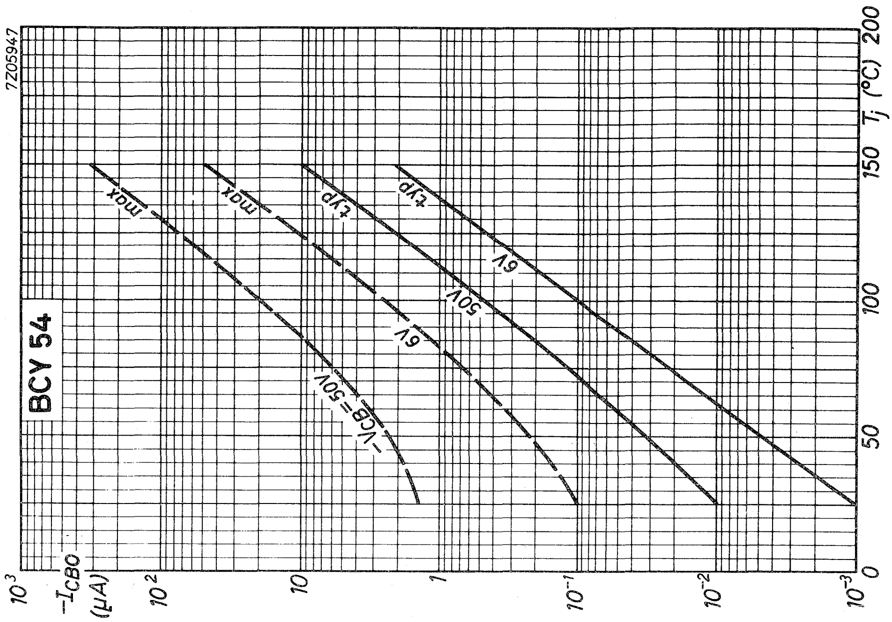

7Z05933
BCY 38
I Region of permissible operation under all base-emitter conditions
II Additional region of operation when the transistor is in cut-off condition
I
II
$-I_C$ (mA)
600
500
400
300
200
100
0
0
20
40
60
80
$-V_{CE}$(V)

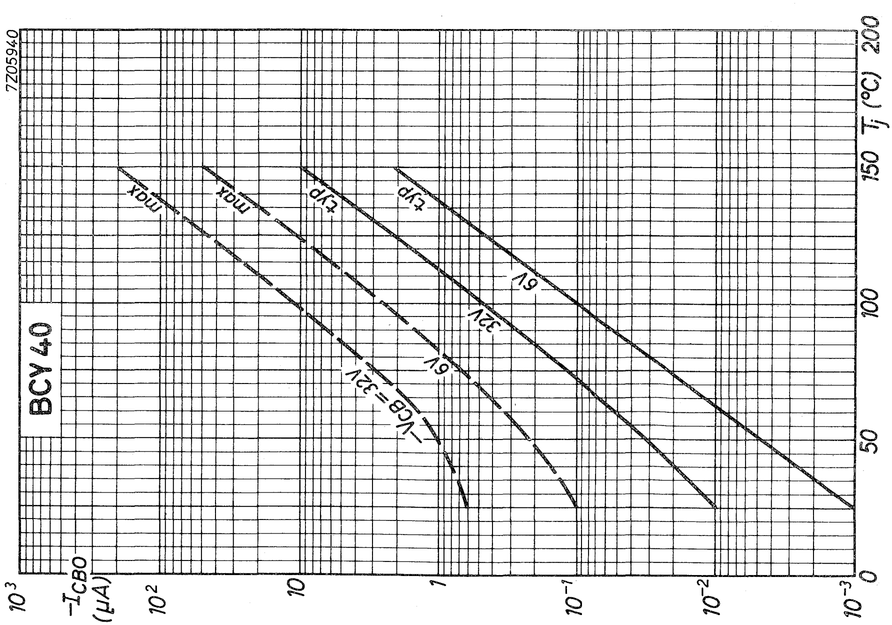

7Z05949
BCY 54
I Region of permissible operation
I
600
$-I_C$ (mA)
500
400
300
200
100
0
0
20
40
60
80
$-V_{CE}$(V)

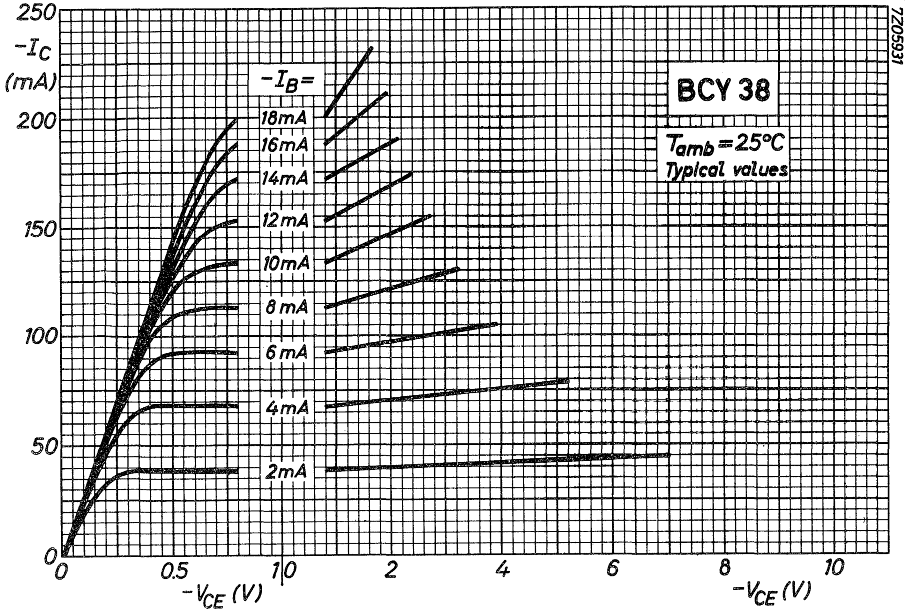

7Z05944
BCY 40
I Region of permissible operation under all base-emitter conditions
II Additional region of operation when the transistor is in cut-off condition
I
II
600
$-I_C$ (mA)
500
400
300
200
100
0
0
20
40
60
80
$-V_{CE}$(V)

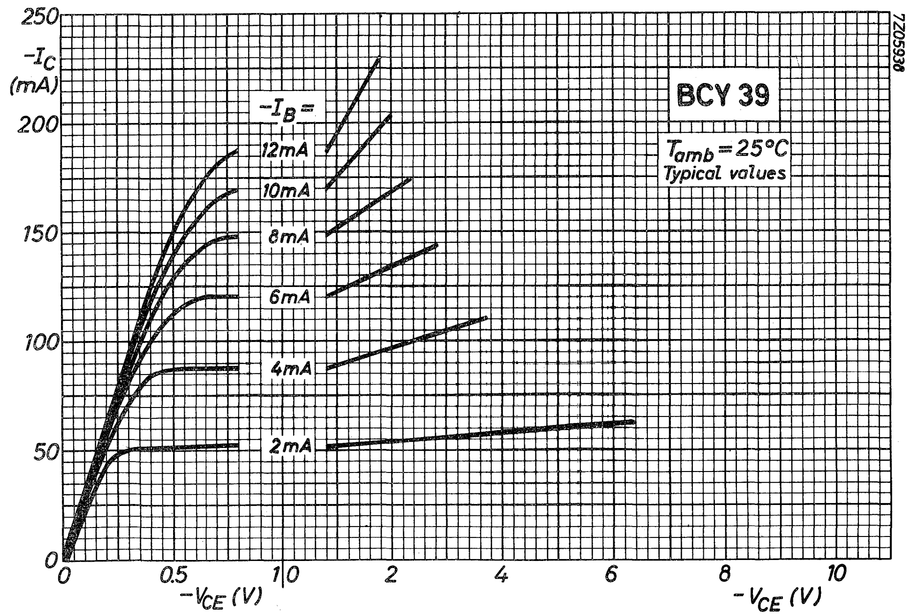

BCY 39
7Z05936
$-I_{CBO}$ (μA)
10^3
10^2
10
1
10^{-1}
10^{-2}
10^{-3}
0
50
100
150
200
T_j (°C)
max
max
typ
typ
$-V_{CB}$=64V
6V
64V
6V

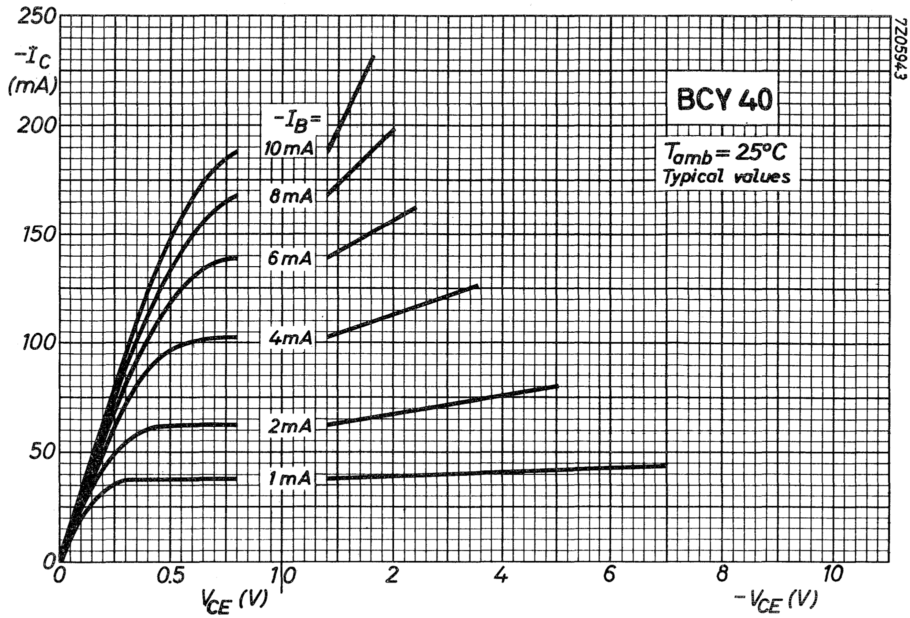

BCY 38
7Z05932
$-I_{CBO}$ (μA)
10^3
10^2
10
1
10^{-1}
10^{-2}
10^{-3}
0
50
100
150
200
T_j (°C)
max
max
typ
typ
$-V_{CB}$ = 32V
6V
32V
6V

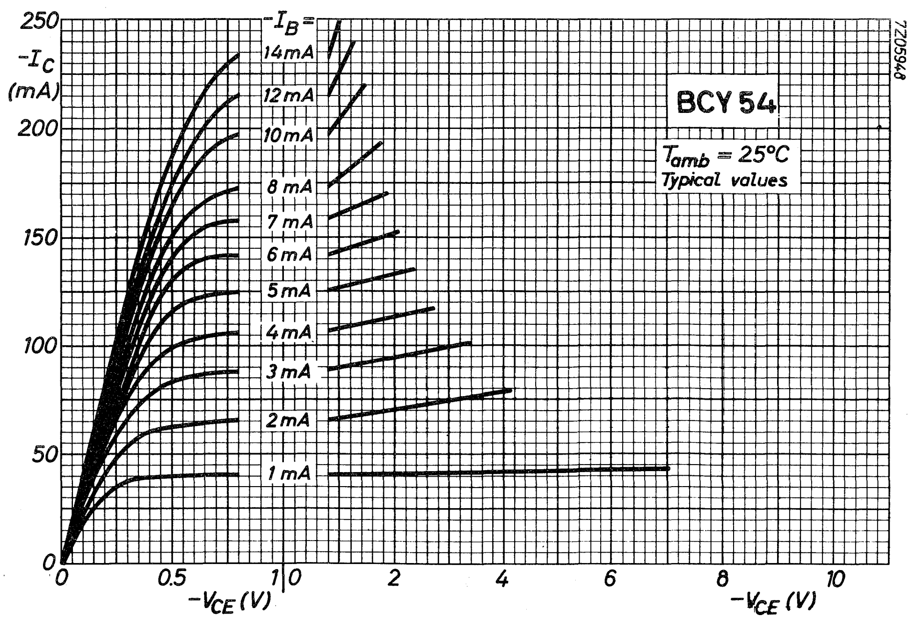

7Z05947
BCY 54
$-I_{CBO}$ (μA)
10^3
10^2
10
1
10^{-1}
10^{-2}
10^{-3}
0
50
100
150
200
T_j (°C)
max
max
typ
typ
$-V_{CB}$ = 50V
6V
50V
6V

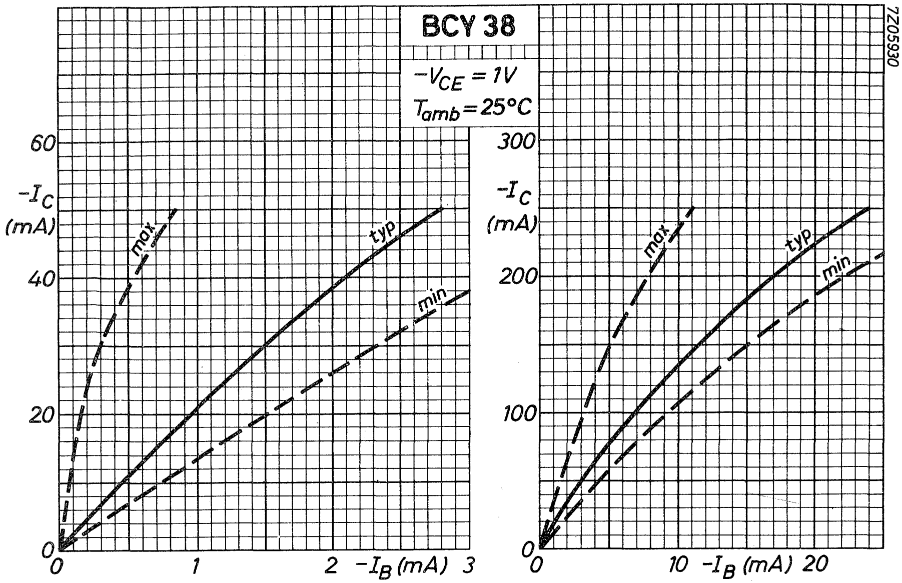

7Z05940
BCY 40
$-I_{CBO}$ (μA)
10^3
10^2
10
1
10^{-1}
10^{-2}
10^{-3}
0
50
100
150
200
T_j (°C)
max
max
typ
typ
$-V_{CB}$ = 32V
6V
32V
6V

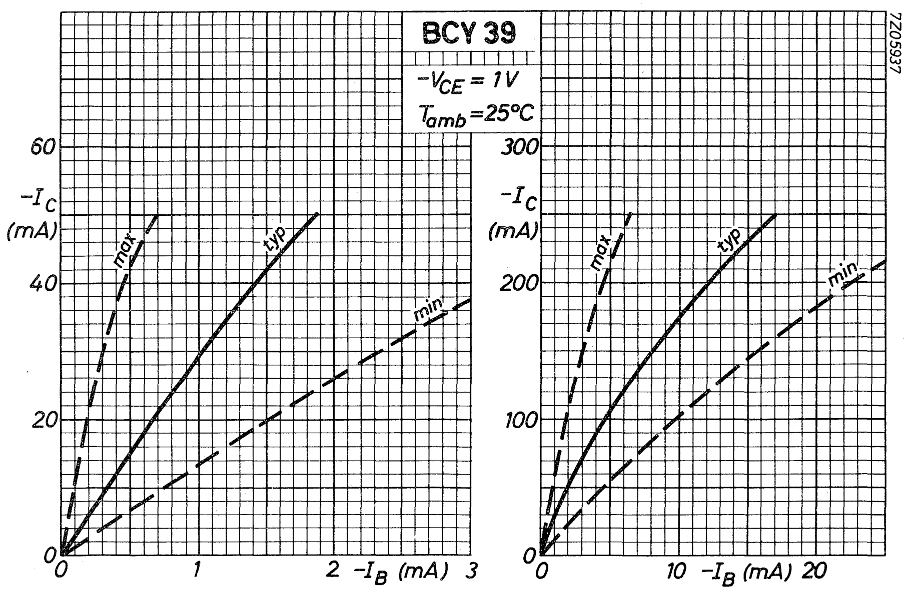

250
$-I_C$
(mA)
200
150
100
50
0
$-I_B=$
18mA
16mA
14mA
12mA
10mA
8 mA
6 mA
4mA
2mA
BCY 38
$T_{amb} = 25°C$
Typical values
7Z05931
0
0.5
1
0
2
4
6
8
10
$-V_{CE}$ (V)
$-V_{CE}$ (V)

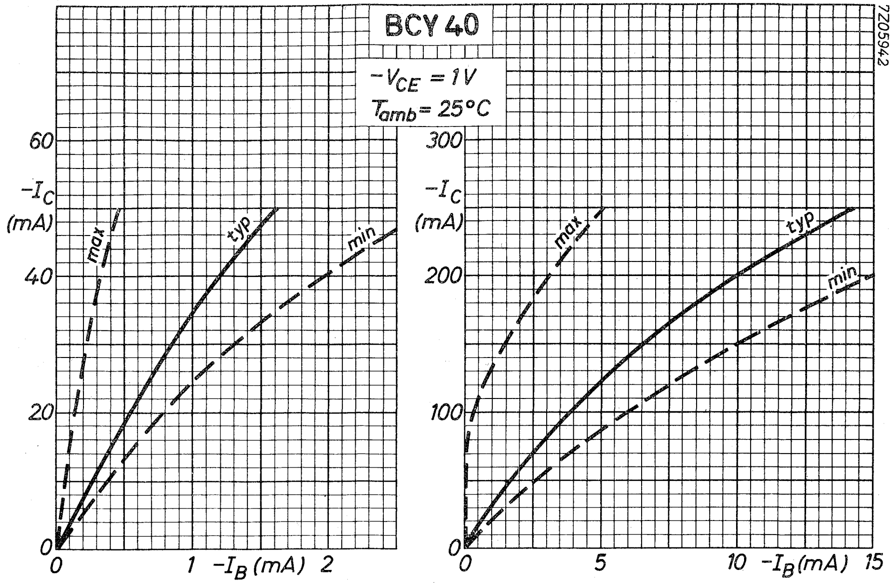

250
$-I_C$
(mA)
200
150
100
50
0
$-I_B=$
12mA
10mA
8mA
6mA
4mA
2mA
BCY 39
$T_{amb} = 25°C$
Typical values
7Z05936
0
0.5
1
0
2
4
6
8
10
$-V_{CE}$ (V)
$-V_{CE}$ (V)

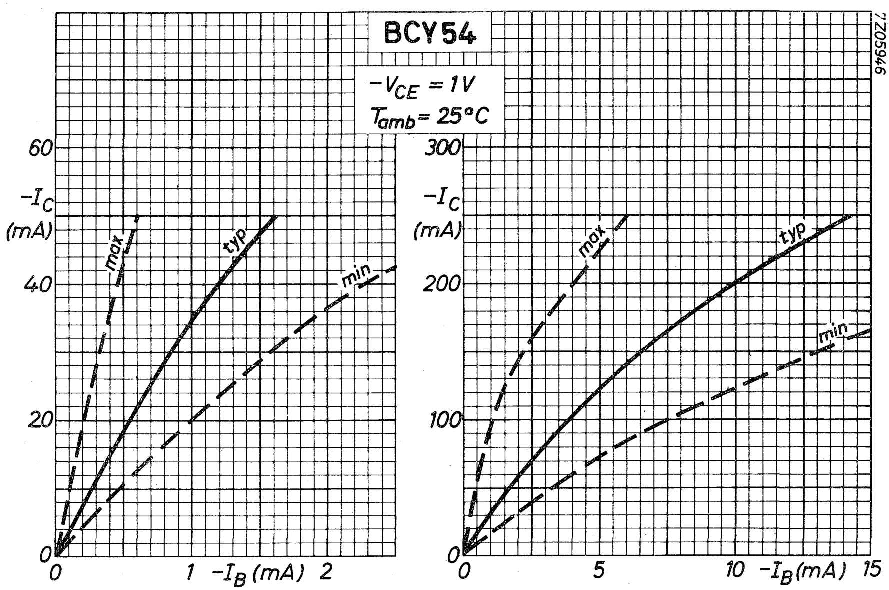

250
$-I_C$
(mA)
200
150
100
50
0
$-I_B=$
10 mA
8 mA
6 mA
4mA
2mA
1 mA
BCY 40
$T_{amb} = 25°C$
Typical values
7Z05943
0
0.5
1.0
2
4
6
8
10
V_{CE} (V)
$-V_{CE}$ (V)

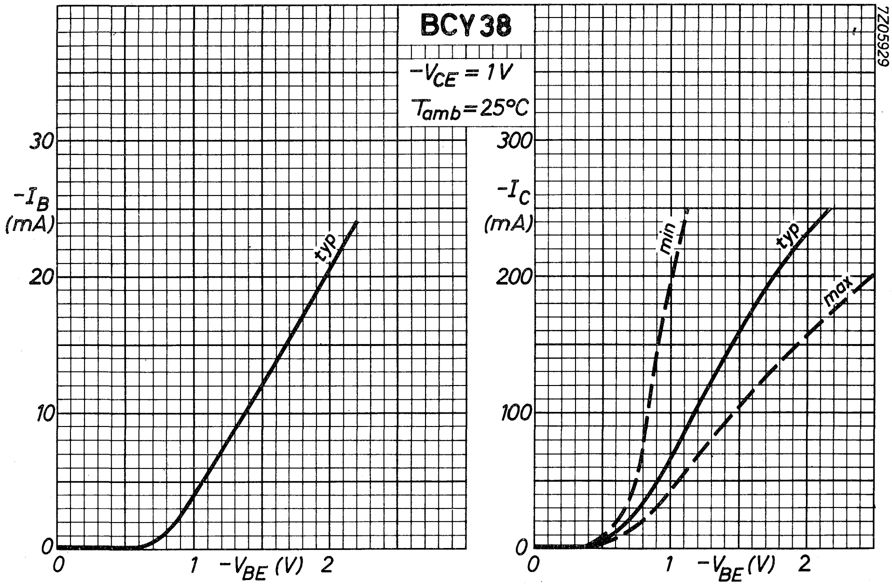

250
$-I_C$
(mA)
200
150
100
50
0
$-I_B=$
14mA
12 mA
10 mA
8 mA
7 mA
6 mA
5 mA
4 mA
3 mA
2 mA
1 mA
BCY 54
$T_{amb} = 25°C$
Typical values
7Z05948
0
0.5
1.0
2
4
6
8
10
$-V_{CE}$ (V)
$-V_{CE}$ (V)

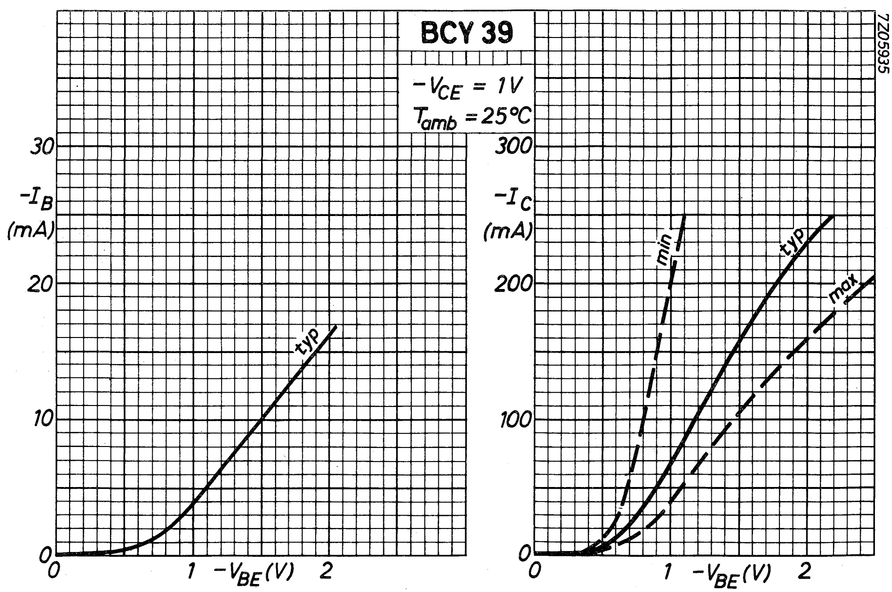

BCY 38
7Z05930
$-V_{CE}$ = 1V
T_{amb} = 25°C
$-I_C$ (mA)
max
typ
min
60
40
20
0
0
1
2
3
$-I_B$ (mA)
300
200
100
0
0
10
20
$-I_B$ (mA)

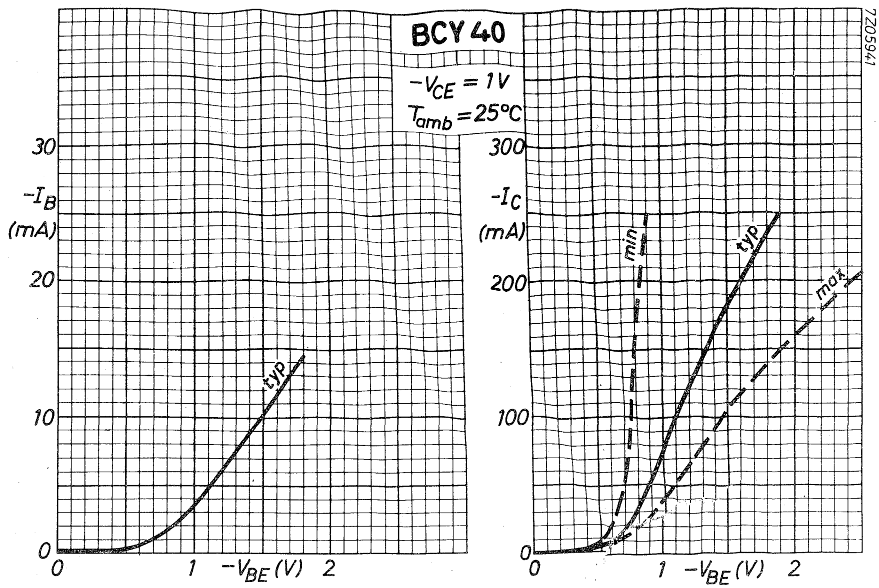

BCY 39
7Z05937
$-V_{CE}$ = 1V
T_{amb} = 25°C
$-I_C$ (mA)
max
typ
min
60
40
20
0
0
1
2
3
$-I_B$ (mA)
300
200
100
0
0
10
20
$-I_B$ (mA)

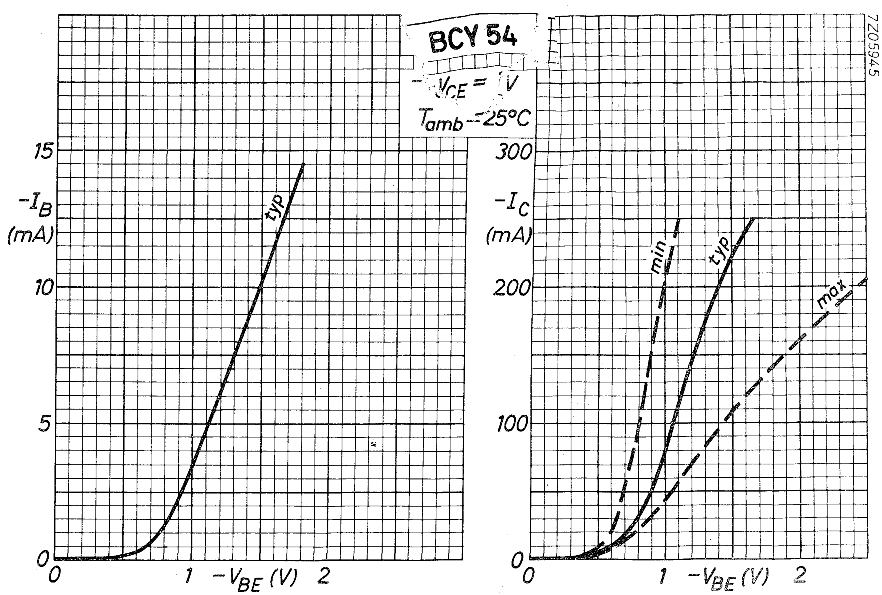

BCY40
7Z05942
$-V_{CE}$ = 1 V
T_{amb} = 25 °C
$-I_C$ (mA)
0
20
40
60
100
200
300
max
typ
min
0
1
$-I_B$ (mA)
2
5
10
15

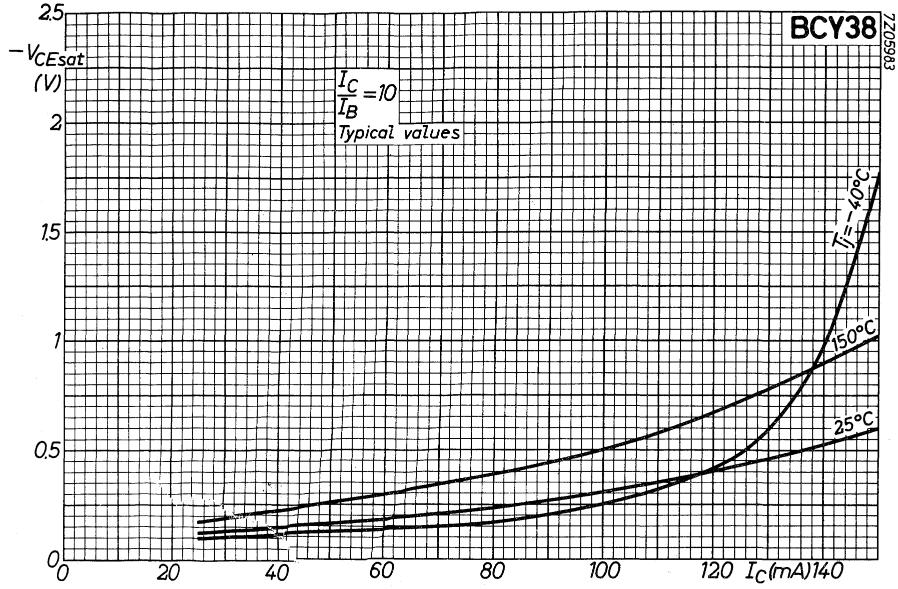

BCY54
7Z05946
$-V_{CE}$ = 1 V
T_{amb} = 25 °C
$-I_C$ (mA)
0
20
40
60
100
200
300
max
typ
min
0
1
$-I_B$ (mA)
2
5
10
15

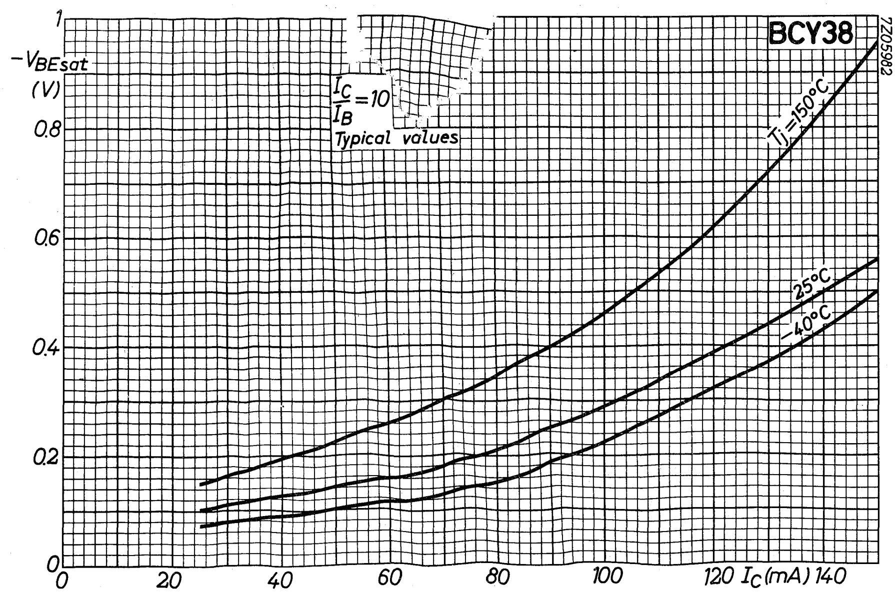

BCY 38
$-V_{CE} = 1V$
$T_{amb} = 25°C$
$-I_B$ (mA)
$-I_C$ (mA)
$-V_{BE}$ (V)
typ
min
max
0
10
20
30
100
200
300
1
2
7Z05929

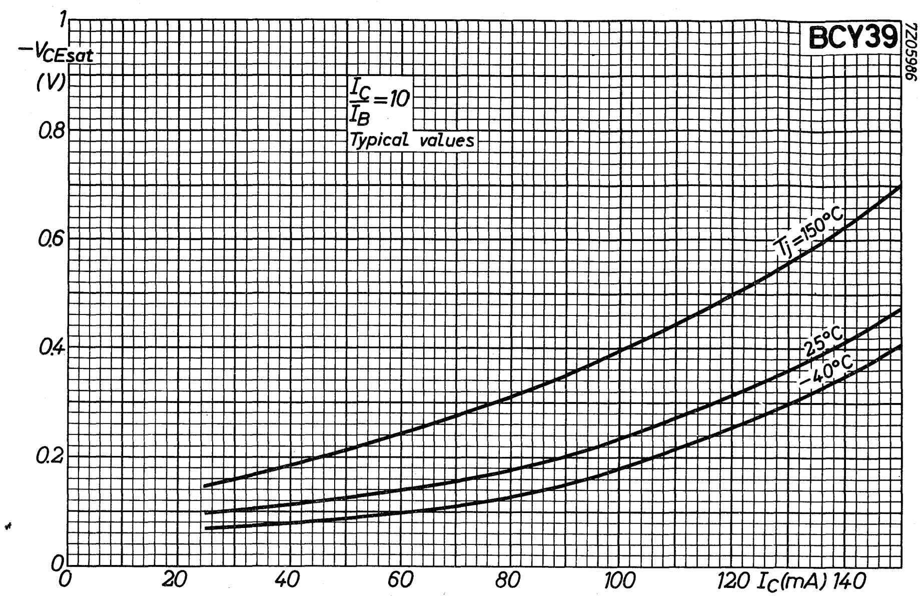

BCY 39
$-V_{CE} = 1V$
$T_{amb} = 25°C$
$-I_B$ (mA)
$-I_C$ (mA)
$-V_{BE}$ (V)
typ
min
max
0
10
20
30
100
200
300
1
2
7Z05935

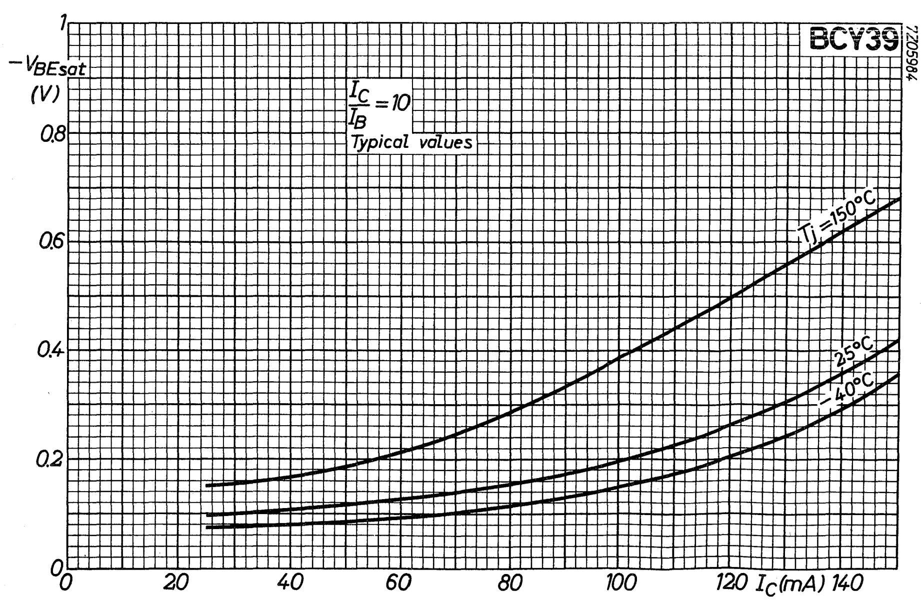

BCY 40
$-V_{CE} = 1V$
$T_{amb} = 25°C$
7Z05941
$-I_B$ (mA)
$-I_C$ (mA)
$-V_{BE}$ (V)
typ
min
max
0
1
2
10
20
30
100
200
300

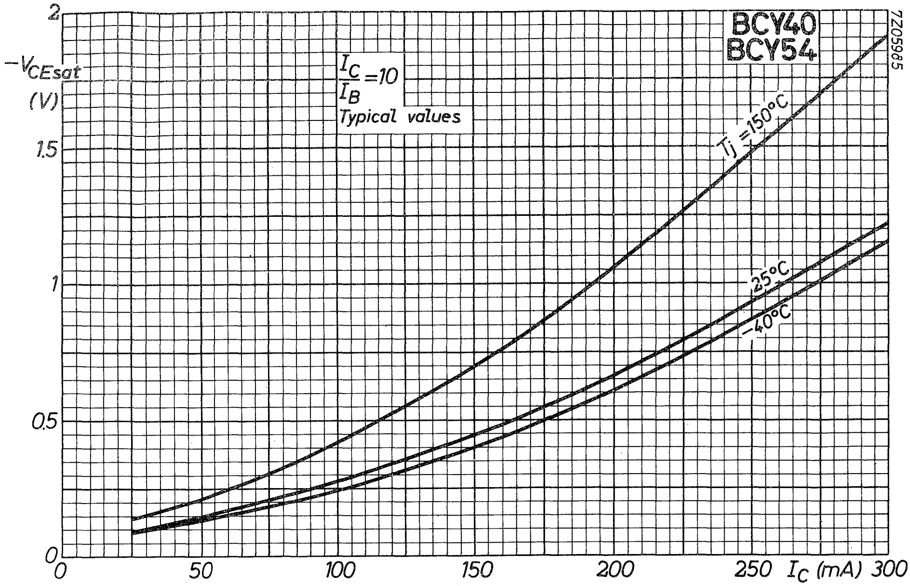

BCY 54
$-V_{CE} = 1V$
$T_{amb} = 25°C$
7Z05945
$-I_B$ (mA)
$-I_C$ (mA)
$-V_{BE}$ (V)
typ
min
max
0
1
2
5
10
15
100
200
300

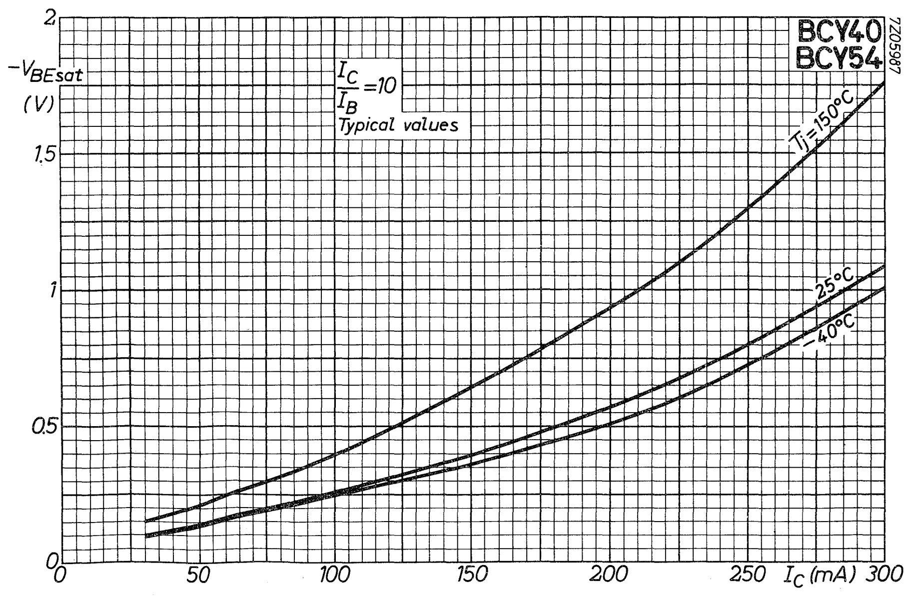

BCY38
7Z05983
$-V_{CEsat}$ (V)
$\frac{I_C}{I_B}=10$
Typical values
$T_j=-40°C$
150°C
25°C
2.5
2
1.5
1
0.5
0
0
20
40
60
80
100
120
I_C (mA) 140


BCY38
7Z05982
$-V_{BEsat}$ (V)
$\frac{I_C}{I_B}=10$
Typical values
$T_j=150°C$
25°C
−40°C
1
0.8
0.6
0.4
0.2
0
0
20
40
60
80
100
120
I_C (mA) 140

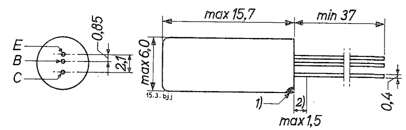

BCY39
7205986
$-V_{CEsat}$ (V)
$\frac{I_C}{I_B}=10$
Typical values
$T_j=150°C$
25°C
−40°C
1
0.8
0.6
0.4
0.2
0
0
20
40
60
80
100
120
140
I_C(mA)


BCY39
7205984
$-V_{BEsat}$ (V)
$\frac{I_C}{I_B}=10$
Typical values
$T_j=150°C$
25°C
−40°C
1
0.8
0.6
0.4
0.2
0
0
20
40
60
80
100
120
140
I_C(mA)


BCY40
BCY54
7Z05985
$-V_{CEsat}$
(V)
$\frac{I_C}{I_B}=10$
Typical values
$T_j=150°C$
25°C
−40°C
0
0.5
1
1.5
2
0
50
100
150
200
250
I_C (mA)
300


BCY40
BCY54
7Z05987
$-V_{BEsat}$
(V)
$\frac{I_C}{I_B}=10$
Typical values
$T_j=150°C$
25°C
−40°C
0
0.5
1
1.5
2
0
50
100
150
200
250
I_C (mA)
300

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
Lagerungstemperatur = −55 °C/+150 °C

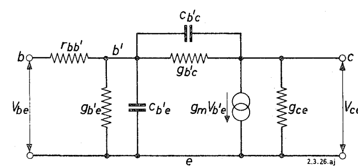
[1]) The red dot indicates the collector
Le point rouge indique le collecteur
Der rote Punkt bezeichnet den Kollektoranschluss
[2]) Not tinned; non étamé; nicht verzinnt

Thermal data. Junction temperature rise to ambient temperature in free air $K \leq 0.5$ °C/mW
Données thermiques. Augmentation de la température de la jonction au regard de la température de l'ambiance à l'air libre $K \leq 0,5$ °C/mW
Thermische Daten. Temperaturerhöhung in Bezug auf die Umgebungstemperatur in freier Luft $K \leq 0,5$ °C/mW

Characteristics
Caractéristiques
Kenndaten

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

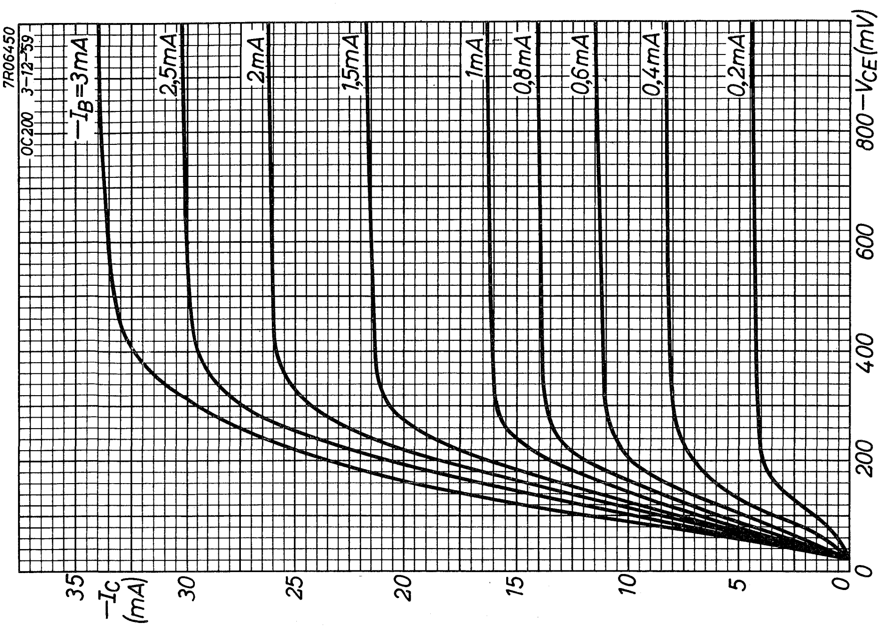
$-I_{CBO}$	($-V_{CB}$ = 10 V)	= 0,001 µA	< 0,1 µA
$-I_{CBO}$	($-V_{CB}$ = 10 V; T_j = 100 °C)	= 0,1 µA	< 10 µA
$-I_{EBO}$	($-V_{EB}$ = 10 V)	= 0,001 µA	< 0,1 µA
$-I_{EBO}$	($-V_{EB}$ = 10 V; T_j = 100 °C)	= 0,1 µA	< 10 µA
$-V_{CE}$	($-I_C$ = 7 mA; $-I_B$ = 1 mA)	= 130 mV	< 320 mV
F	($-V_{CE}$ = 2 V; $-I_C$ = 0,5 mA)	= 8,0 dB[1])	



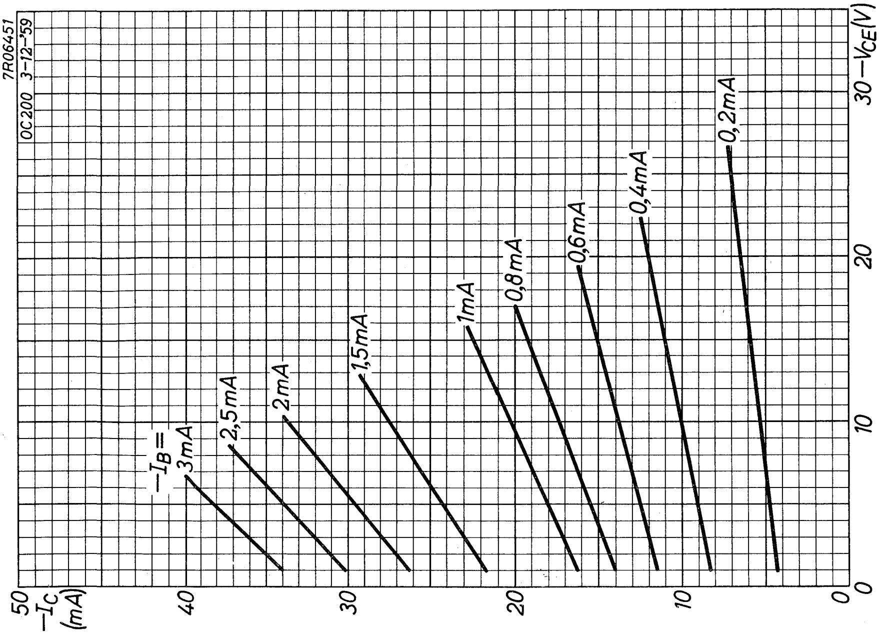
Measured at / Mesuré à / Gemessen bei {$-V_{CE}$ = 6 V; $-I_C$ = 1 mA}

		Min.	Max.
$r_{bb'}$	= 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 °C}	=	> 10	

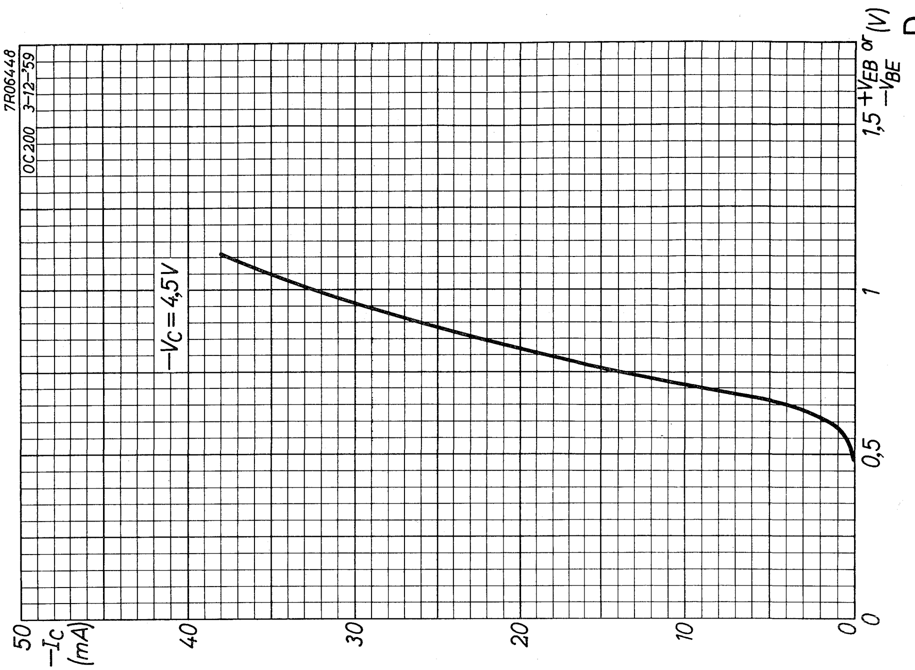
[1]) Noise factor measured at f = 1 kc/s with an input source impedance of 500 Ω
Facteur de bruit mesuré à f = 1 kHz avec une impédance de source d'entrée de 500 Ω
Rauschzahl gemessen bei f = 1 kHz mit einer Impedanz der Eingangsspannungsquelle von 500 Ω

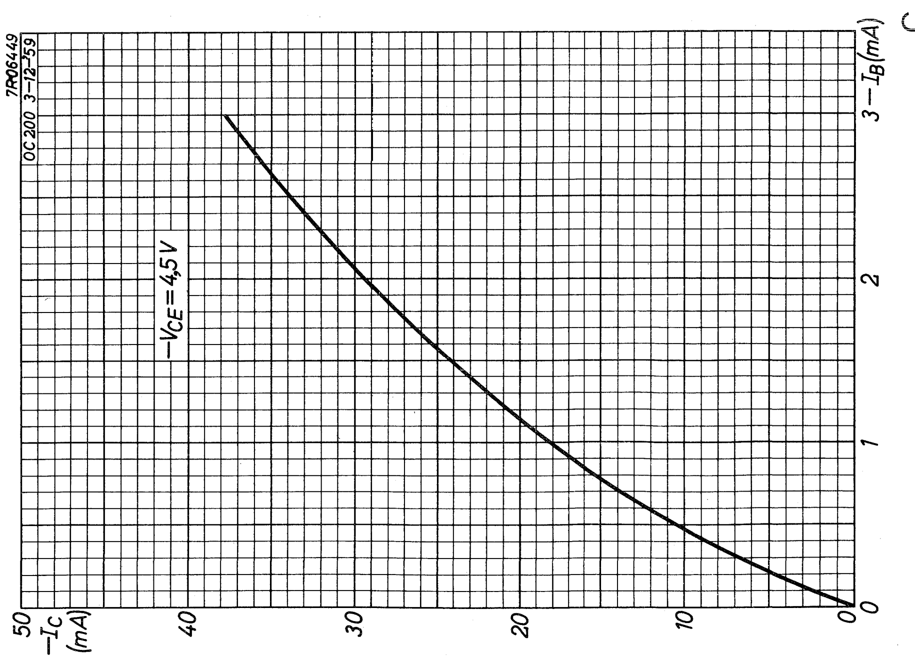

OC200
7R06450
3-12-59
−I_B=3mA
2,5mA
2mA
1,5mA
1mA
0,8mA
0,6mA
0,4mA
0,2mA
800 −V_CE(mV)
600
400
200
0
−I_C (mA)
35
30
25
20
15
10
5
0

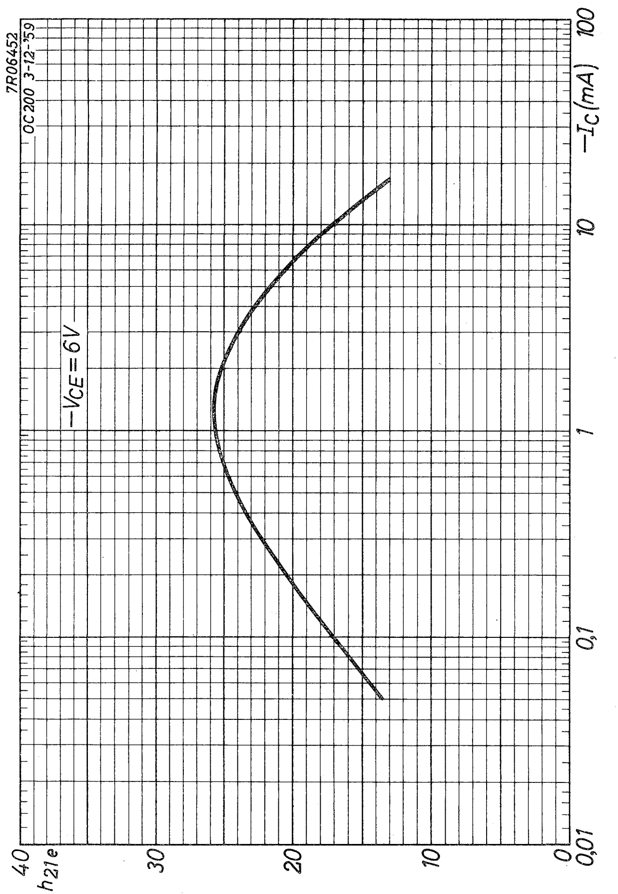
B


OC200
7R06451
3-12-59
−I_B= 3mA
2,5mA
2mA
1,5mA
1mA
0,8mA
0,6mA
0,4mA
0,2mA
30 −V_CE(V)
20
10
0
50 −I_C (mA)
40
30
20
10
0

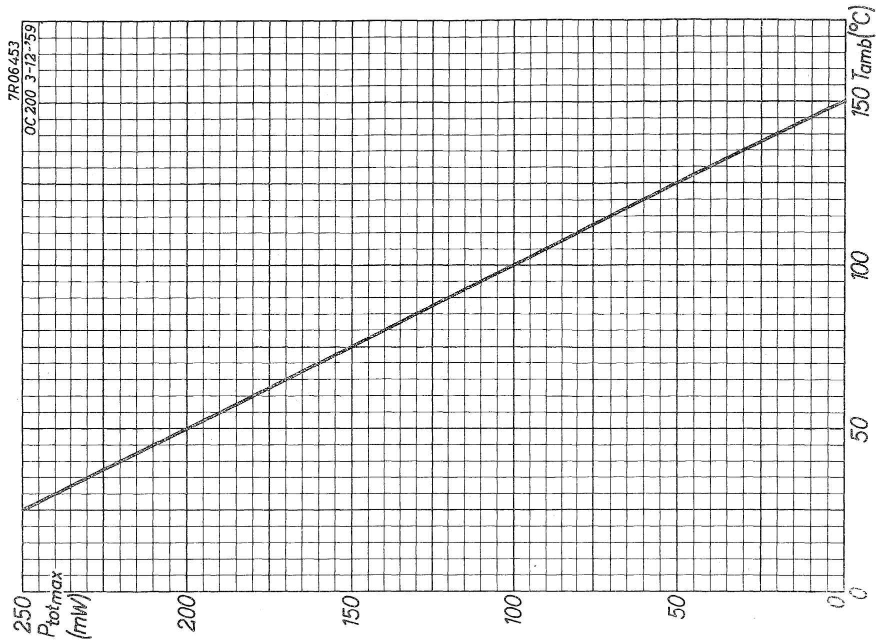
A

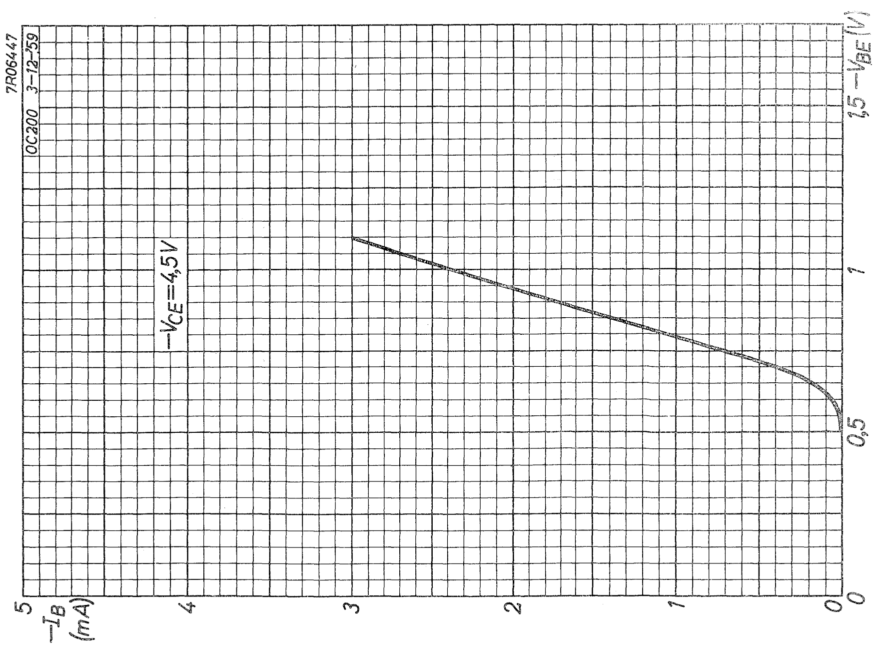

7R06448
OC200 3-12-'59
−V_C = 4,5V
1,5 +V_EB or −V_BE (V)
1
0,5
0
50 −I_C (mA)
40
30
20
10
0
D


7R06449
OC200 3-12-'59
−V_CE = 4,5V
3 −I_B (mA)
2
1
0
50 −I_C (mA)
40
30
20
10
0
C


7R06452
OC200 3-12-'59
$-V_{CE}=6V$
$-I_C$ (mA)
h_{21e}
40
30
20
10
0
0,01
0,1
1
10
100

E


7R06453
OC200 3-12-'59
250
Ptotmax
(mW)
200
150
100
50
0
0
50
100
150 Tamb(°C)
G


7R06447
OC200 3-12-'59
5
−IB
(mA)
4
3
2
1
0
0
0,5
1
1,5 −VBE (V)
−VCE=4,5V

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

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.

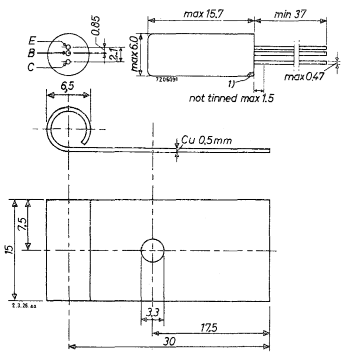
Résistance thermique entre les jonctions et l'ambiance à l'air libre

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

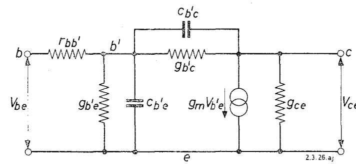
Cooling fin
Ailette de refroidissement
Kühlschelle

1) The red dot indicates the collector
Le point rouge indique le collecteur
Der rote Punkt bezeichnet den Kollektoranschluss

Characteristics
Caractéristiques
Kenndaten

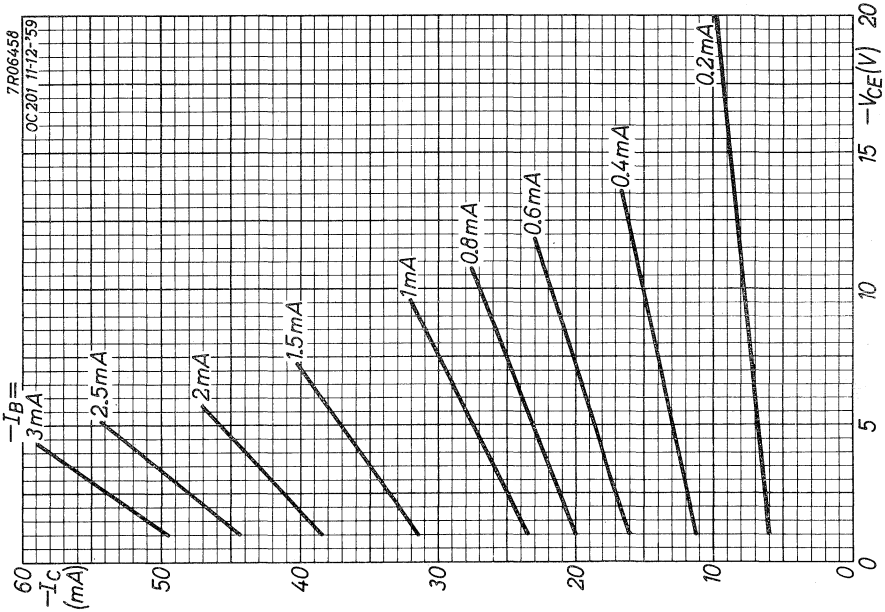
T_j = 25 °C { unless otherwise specified / sauf indication différente / wenn nicht anders angegeben

$-I_{CBO}(-V_{CB}$ = 10 V)	= 0,001 µA	< 0,1 µA
$-I_{CBO}(-V_{CB}$ = 10 V; T_j = 100 °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 °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)	

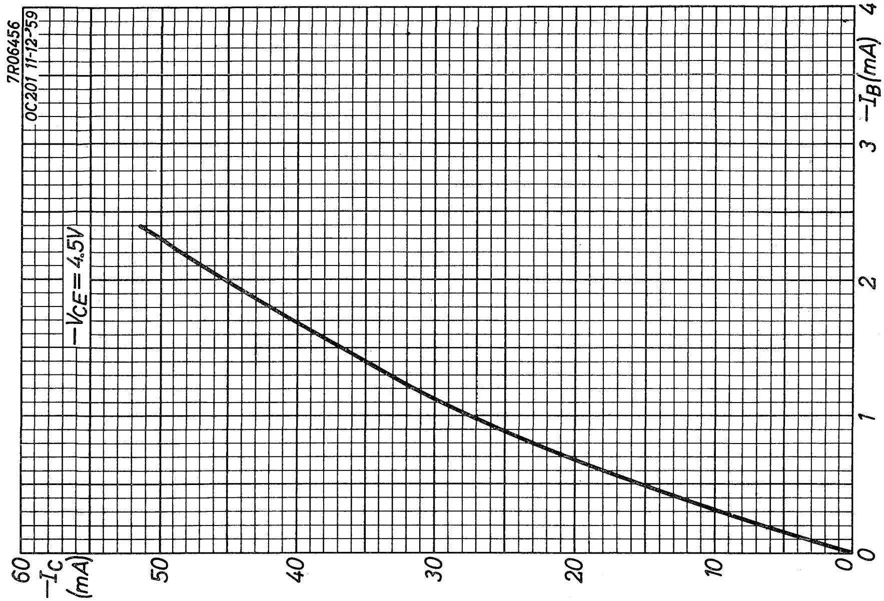


Measured at / Mesuré à / Gemessen bei			Min.	Max.	
$-V_{CE}$	=	6			V
$-I_C$	=	1			mA
$r_{bb'}$	=	125		<350	Ω
$c_{b'c}$	=	50		< 80	pF
$f_{\alpha b}$	=	1,5	>1,0		Mc/s
h_{fe} (f = 1 kc/s)	=	35	> 25	< 60	

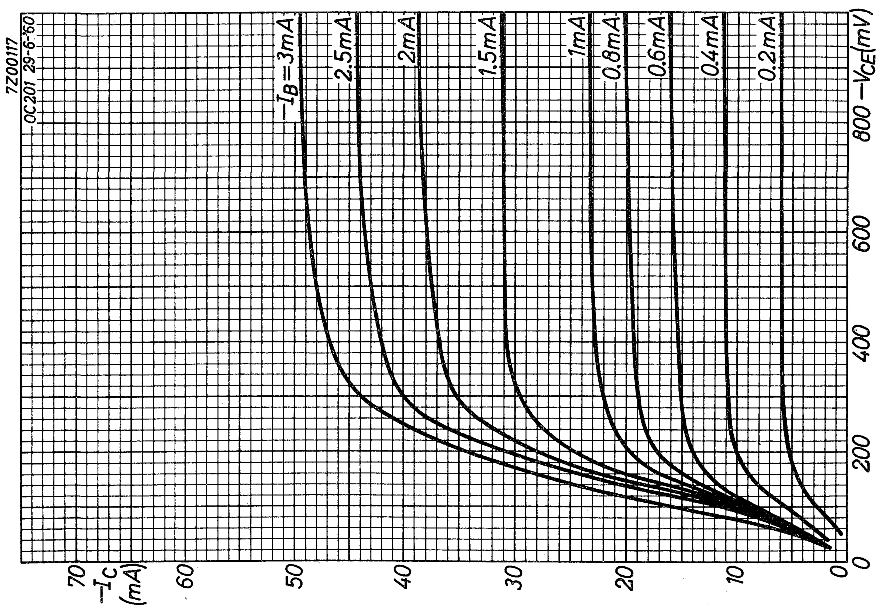
1) Noise factor measured at f = 1 kc/s with an input source impedance of 500 Ω
Facteur de bruit mesuré à f = 1 kHz avec une impédance de source d'entrée de 500 Ω
Rauschzahl gemessen bei f = 1 kHz mit einer Impedanz der Eingangsspannungsquelle von 500 Ω


7R06458
OC 201 11-12-'59
$-I_B$ =
3mA
2.5mA
2mA
1.5mA
1mA
0.8mA
0.6mA
0.4mA
0.2mA
$-I_C$ (mA)
60
50
40
30
20
10
0
0
5
10
15
20
$-V_{CE}$ (V)

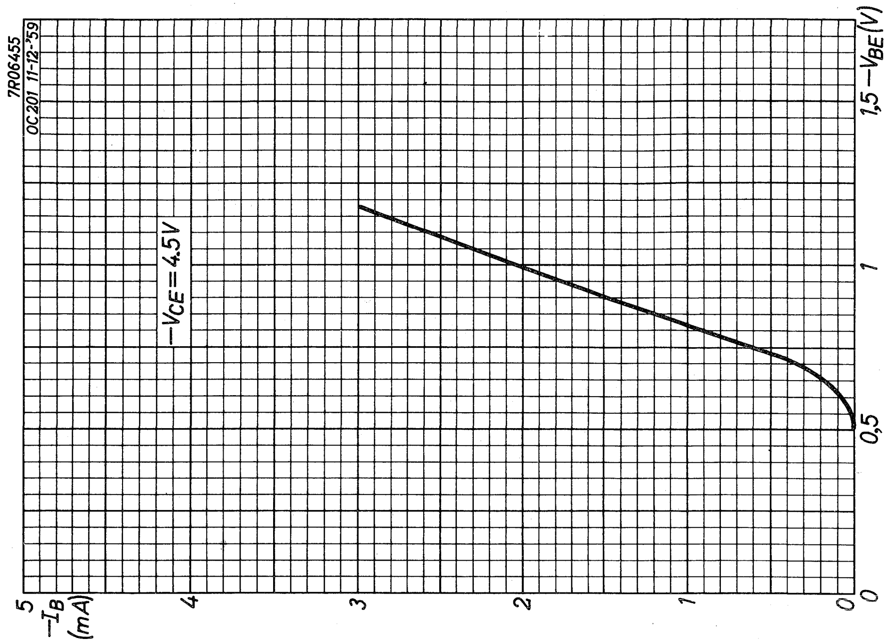
A


7R06456
OC201 11-12-'59
−V_CE = 4.5V
−I_B (mA)
−I_C (mA)

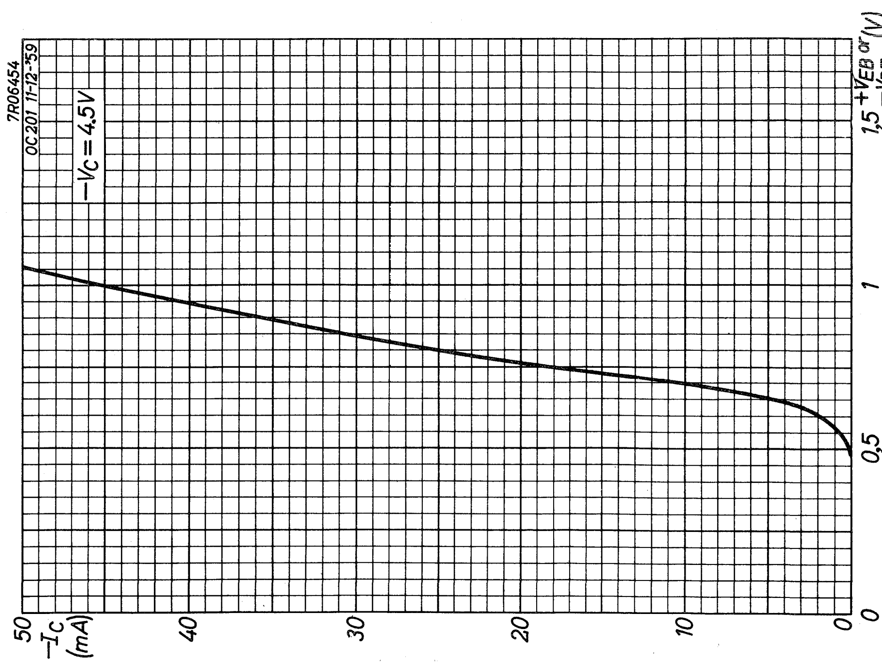
C


7Z00117
OC201 29-6-'60
−I_B=3mA
2.5mA
2mA
1.5mA
1mA
0.8mA
0.6mA
0.4mA
0.2mA
−V_CE (mV)
−I_C (mA)

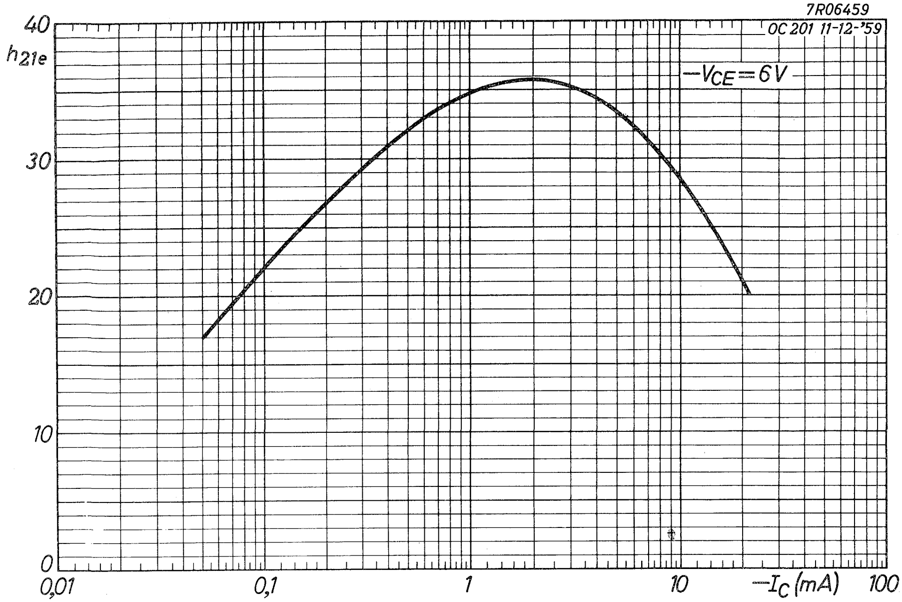
B


7R06455
OC201 11-12-'59
−V_CE = 4.5V
5
−I_B
(mA)
4
3
2
1
0
0
0,5
1
1,5 −V_BE (V)

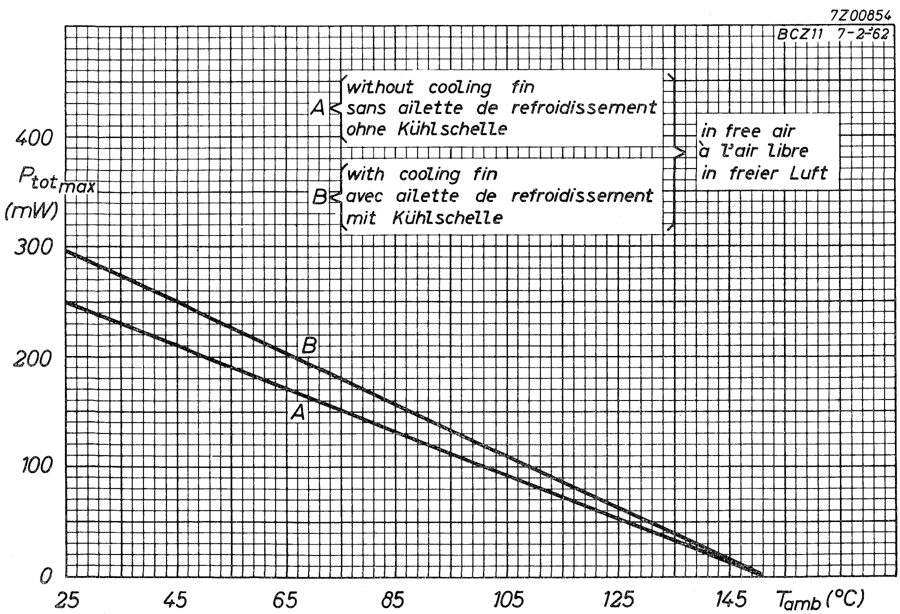
E


7R06454
OC201 11-12-'59
−V_C = 4.5V
50
−I_C
(mA)
40
30
20
10
0
0
0,5
1
1,5 +V_EB or −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
$-I_C$ (mA)
100

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

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

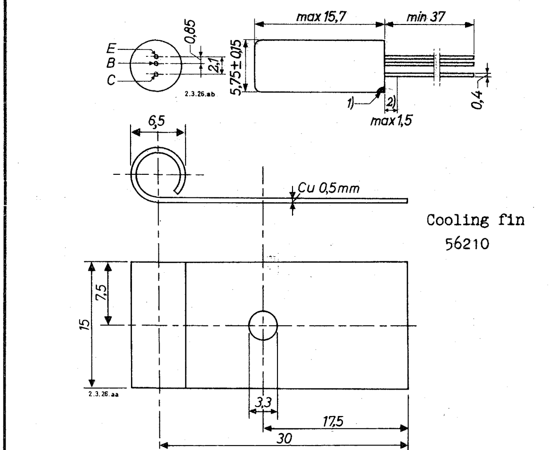
THERMAL DATA

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 1.

Dimensions in mm The red dot indicates the collector



[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 2.

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

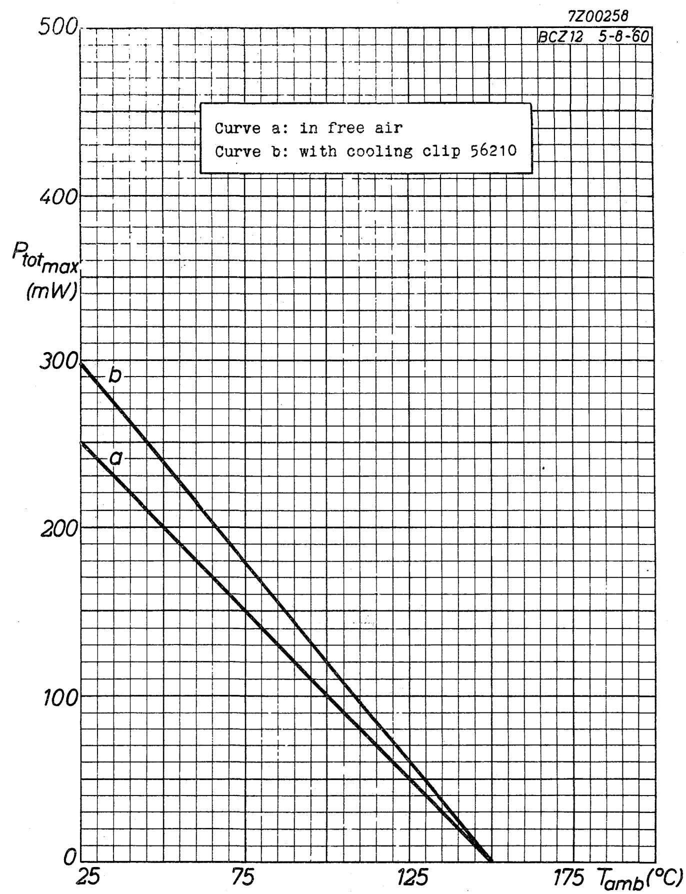
Measured at $-V_{CE}$ = 6 V; $-I_C$ = 1 mA

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)

7Z2 1742

3.



A

SILICON A.F. TRANSISTORS

P-N-P silicon alloy transistors in a subminiature metal envelope for a.f. applications.

RATINGS (Limiting values) [1])

Voltages

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	20	V
Collector-emitter voltage (R_{BE} < 100 kΩ)	$-V_{CER}$	max.	20	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	20	V

Current

Collector current	$-I_C$	max.	10	mA

Power dissipation

Total power dissipation up to T_{amb} = 50 °C	P_{tot}	max.	85	mW

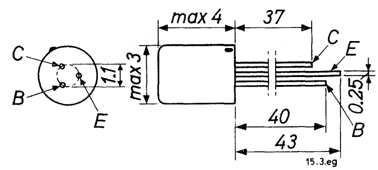
Temperatures

Storage temperature	T_{stg}	max.	125	°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	1.2	°C/mW

MECHANICAL DATA Dimensions in mm



The red dot indicates the collector

[1]) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.
7Z3 0713

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

Collector cut-off current					
$I_E = 0$; $-V_{CB} = 12$ V		$-I_{CBO}$	<	0.01	μA
$I_E = 0$; $-V_{CB} = 12$ V; $T_j = 100$ °C		$-I_{CBO}$	<	0.5	μA
Emitter cut-off current					
$I_C = 0$; $-V_{EB} = 12$ V		$-I_{EBO}$	<	0.01	μA
$I_C = 0$; $-V_{EB} = 12$ V; $T_j = 100$ °C		$-I_{EBO}$	<	0.5	μA
Base current					
$I_E = 10$ mA; $-V_{CB} = 2$ V		$-I_B$	typ.	340	μA
			<	770	μA
Base-emitter voltage					
$I_E = 0.1$ mA; $-V_{CB} = 2$ V		$-V_{BE}$	typ.	520	mV
			<	610	mV
$I_E = 10$ mA; $-V_{CB} = 2$ V		$-V_{BE}$	typ.	710	mV
			<	850	mV
Saturation voltage					
$-I_C = 10$ mA; $-I_B = 1.1$ mA		$-V_{CEsat}$	<	0.25	V
Collector capacitance					
$I_E = I_e = 0$; $-V_{CB} = 6$ V		C_c	typ.	25	pF
			<	40	pF
Transition frequency					
$I_E = 1$ mA; $-V_{CB} = 6$ V		f_T	>	0.5	MHz
			typ.	1.5	MHz
Noise figure at f = 1 kHz					
$I_E = 0.5$ mA; $-V_{CB} = 2$ V; $R_S = 500\ \Omega$		F	typ.	5	dB
			<	10	dB
Small signal current gain					
$I_E = 1$ mA; $-V_{CB} = 2$ V	BCZ13	h_{fe}	typ.	25	
				15 to 40	
	BCZ14	h_{fe}	typ.	55	
				30 to 90	

7Z3 0714

SILICON DIFFUSED POWER TRANSISTORS

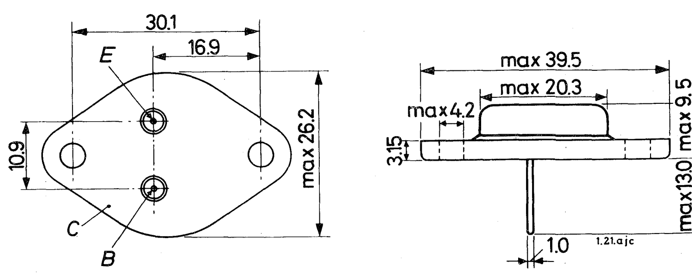
N-P-N transistors in a TO-3 metal envelope with the collector connected to the case. The BDY10 and BDY11 are primarily intended for high and medium power audio frequency applications. Moreover they are extremely suitable for d.c. converters and solenoid drivers. These electrically robust transistors are, to a very high degree, free of second breakdown.

QUICK REFERENCE DATA

			BDY10	BDY11	
Collector-base voltage (open emitter)	V_{CBO}	max.	50	100	V
Collector-emitter voltage (open base)	V_{CEO}	max.	40	70	V
Collector current (peak value)	I_{CM}	max.	4		A
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	125		W
Junction temperature	T_j	max.	175		°C
D.C. current gain at T_j = 25 °C					
I_C = 2 A; V_{CE} = 2 V	h_{FE}		10 to 50		
Cut-off frequency					
I_C = 0.2 A; V_{CE} = 5 V	f_{hfe}	typ.	10		kHz

MECHANICAL DATA Dimensions in mm

TO-3
Collector connected to case



Mounting accessories can be supplied under type number 56201.

7Z3 0748

RATINGS (Limiting values) [1])

Voltages		BDY10	BDY11	
Collector-base voltage (open emitter)	V_{CBO}	max. 50	100	V
Collector-emitter voltage (open base)	V_{CEO}	max. 40	70	V
Collector-emitter voltage with $V_{BE} = 0$	V_{CES}	max. 50	100	V
Emitter-base voltage (open collector)	V_{EBO}	max. 5	5	V

Currents

Collector current (d.c.)	I_C	max.	2	A
Collector current (peak value)	I_{CM}	max.	4	A

Power dissipation

Total power dissipation up to $T_{amb} = 25\ ^{o}C$	P_{tot}	max.	125	W

Temperatures

Storage temperature	T_{stg}		−55 to +175	^{o}C
Junction temperature	T_j	max.	175	^{o}C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	40	$^{o}C/W$
From junction to mounting base	$R_{th\ j\text{-}mb}$	=	1	$^{o}C/W$
From mounting base to heatsink	$R_{th\ mb\text{-}h}$	=	0.2	$^{o}C/W$
From mounting base to heatsink with lead washer and mica washer (Type number 56201)	$R_{th\ mb\text{-}h}$	=	0.5	$^{o}C/W$

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

7Z3 0749

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

Collector cut-off current					
$I_E = 0$; $V_{CB} = 50$ V	BDY10	I_{CBO}	typ.	10	µA
			<	300	µA
$I_E = 0$; $V_{CB} = 100$ V	BDY11	I_{CBO}	typ.	4.5	µA
			<	300	µA
$I_E = 0$; $V_{CB} = V_{CBOmax}$; $T_j = 175\ ^{o}C$		I_{CBO}	typ.	2	mA
			<	30	mA
$V_{EB} = 0$; $V_{CB} = V_{CBOmax}$		I_{CES}	<	1	mA
Emitter cut-off current					
$I_C = 0$; $V_{EB} = 5$ V		I_{EBO}	typ.	0.5	nA
			<	1	mA
$I_C = 0$; $V_{EB} = 5$ V; $T_j = 175\ ^{o}C$		I_{EBO}	typ.	65	µA
			<	30	mA
Base-emitter voltage					
$I_C = 0.2$ A; $V_{CE} = 2$ V		V_{BE}	<	1.5	V
$I_C = 2$ A; $V_{CE} = 2$ V		V_{BE}	typ.	1.2	V
			<	3	V
Saturation voltage					
$I_C = 2$ A; $I_B = 0.4$ A		V_{CEsat}	<	0.7	V
Emitter-base floating voltage					
$I_E = 0$; $V_{CB} = V_{CBOmax}$; $T_j = 150\ ^{o}C$		V_{EBfl}	<	1	V

7Z3 0750

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

D.C. current gain

$I_C = 0.2\ A;\ V_{CE} = 2\ V$	h_{FE}	> 20 typ. 100	
$I_C = 2\ A;\ V_{CE} = 2\ V$	h_{FE}	typ. 25 10 to 50	
$I_C = 4\ A;\ V_{CE} = 2\ V$	h_{FE}	typ. 10	1)

Collector capacitance at f = 1 MHz

$I_E = I_e = 0;\ V_{CB} = 20\ V$	C_c	typ. 350 < 500	pF pF

Transition frequency

$I_C = 0.2\ A;\ V_{CE} = 5\ V$	f_T	> 1	MHz

Cut-off frequency

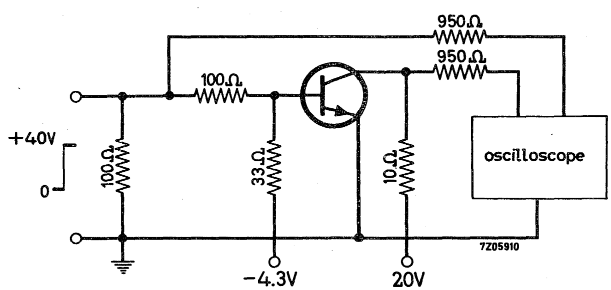
$I_C = 0.2\ A;\ V_{CE} = 5\ V$	f_{hfe}	> 6 typ. 10	kHz kHz

Switching times

$I_C = 2\ A;\ I_B = -I_{BM} = 200\ mA$

Delay time	t_d	typ. 0.25	μs
Rise time	t_r	typ. 4	μs
Storage time	t_s	typ. 1.5	μs
Fall time	t_f	typ. 3	μs

Test circuit:



Pulse generator:

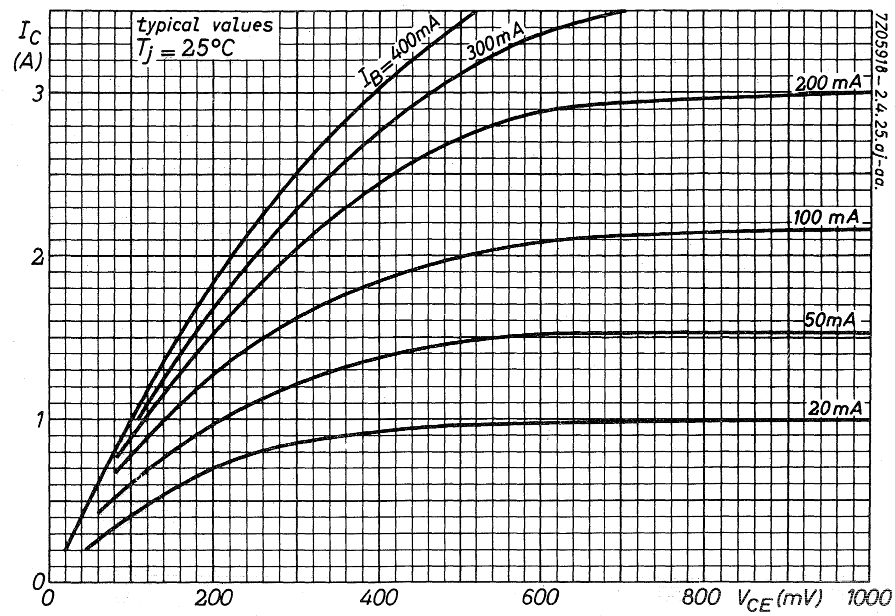
Pulse duration	t	=	15 μs
Duty cycle	δ	=	0.015
Rise time	t_r	≤	10 ns

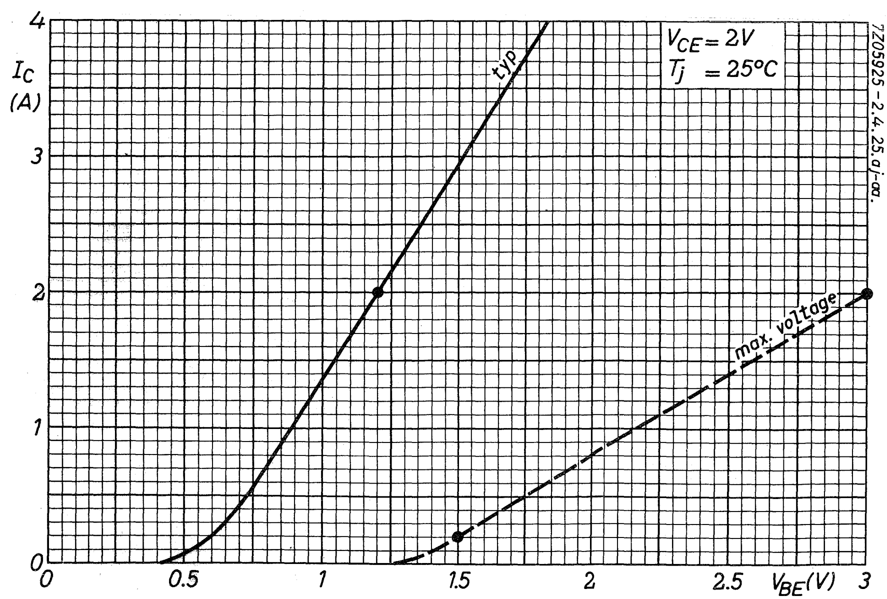
Oscilloscope:

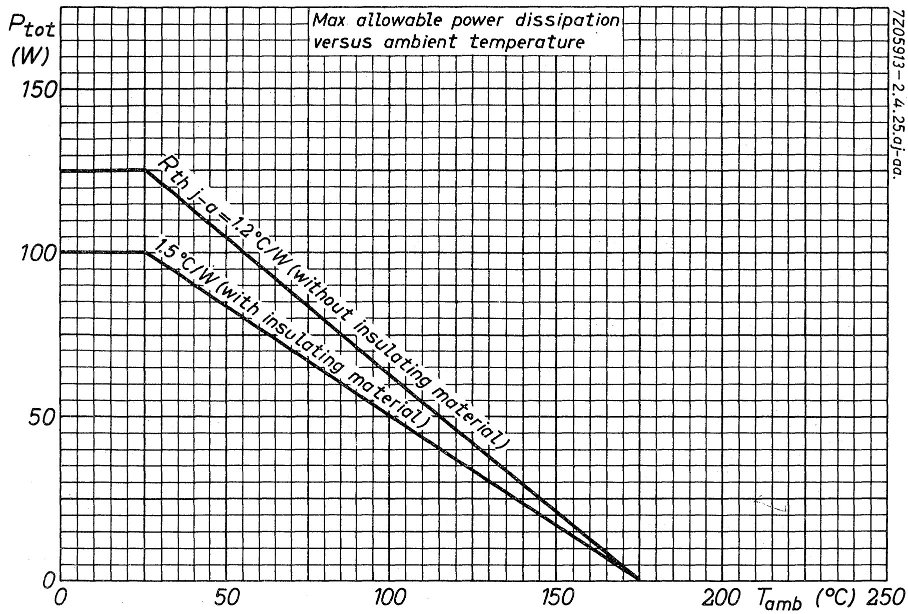
Rise time	t_r	≤	10 ns
Input impedance		=	50 Ω

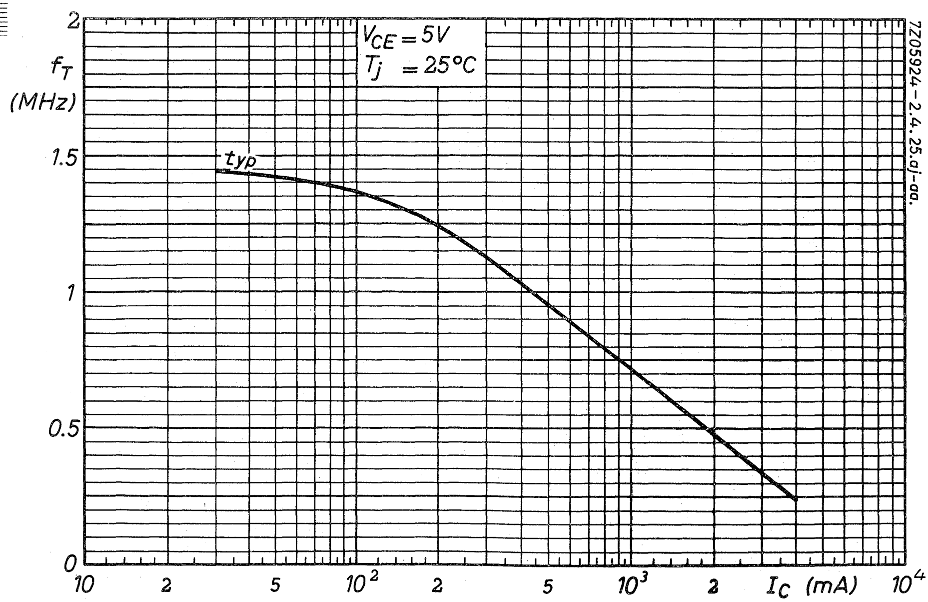
1) Measured under pulsed conditions to avoid excessive dissipation. Pulse duration t = 100 ms; duty cycle $\delta < 0.02$

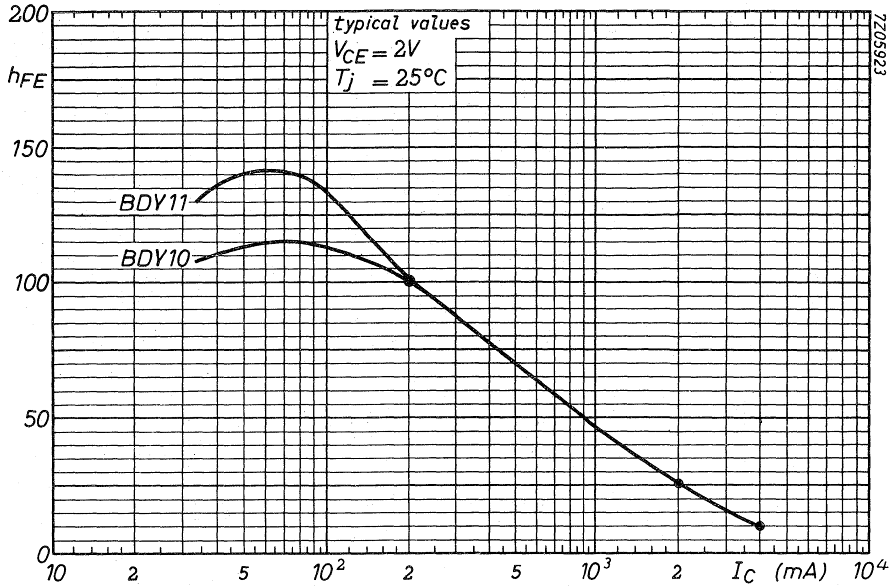
7Z3 0751

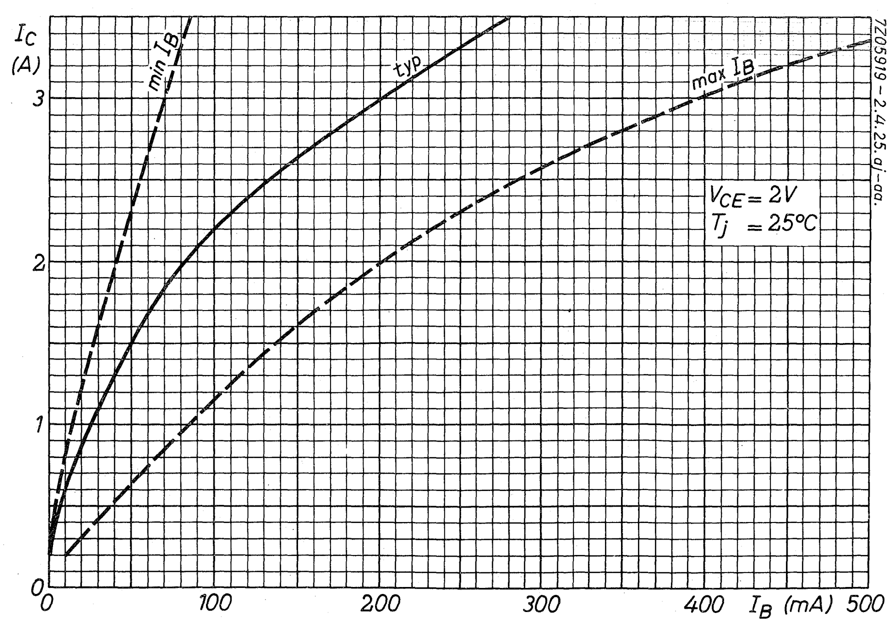

typical values
$T_j = 25°C$
I_C (A)
I_B=400mA
300mA
200 mA
100 mA
50mA
20mA
0
1
2
3
0
200
400
600
800
V_{CE} (mV)
1000
7Z05918-2.4.25.aj-aa.

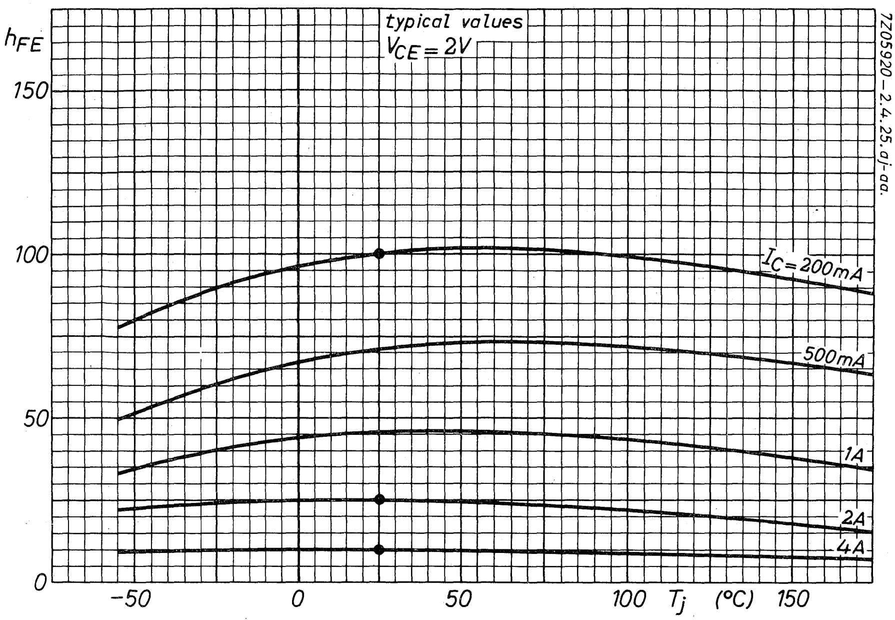

V_{CE}= 2V
T_j = 25°C
I_C (A)
typ
max. voltage
0
1
2
3
4
0
0.5
1
1.5
2
2.5
V_{BE}(V)
3
7Z05925-2.4.25.aj-aa.

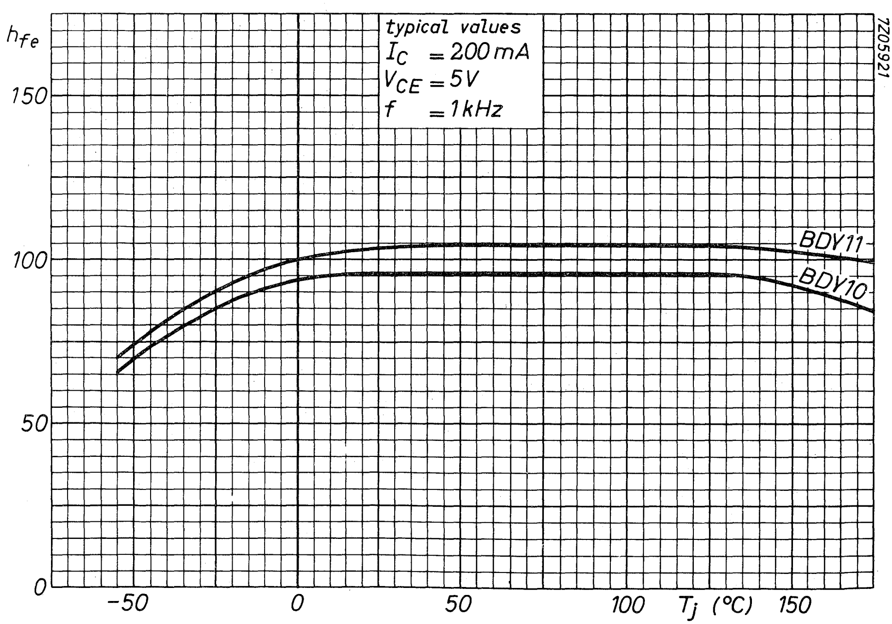

Max allowable power dissipation versus ambient temperature
P_{tot} (W)
150
100
50
0
0
50
100
150
200
T_{amb} (°C)
250
$R_{th\ j-a}$ = 1.2°C/W (without insulating material)
1.5°C/W (with insulating material)
7Z05913-2.4.25.aj-aa.

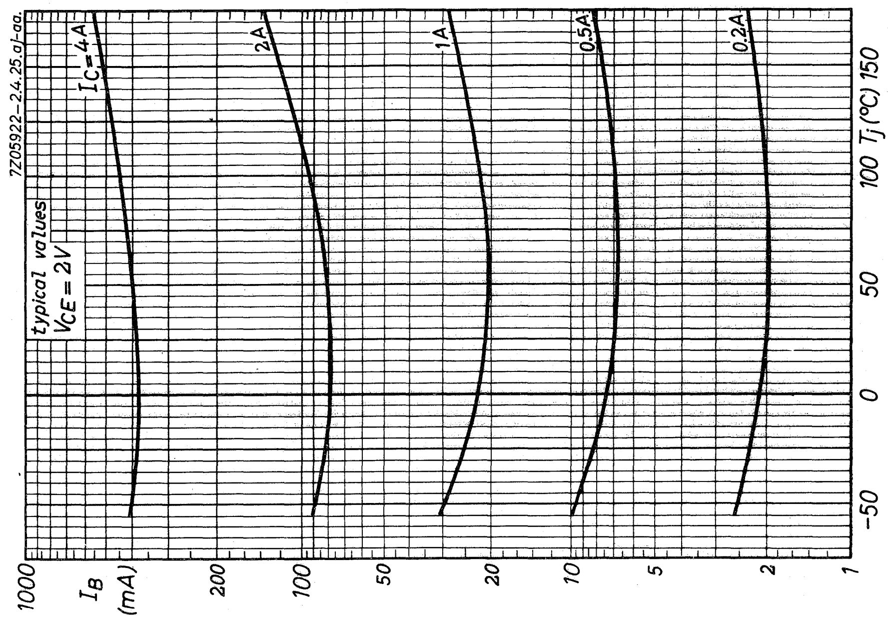

V_{CE} = 5V
T_j = 25°C
f_T (MHz)
2
1.5
1
0.5
0
typ
10
2
5
10^2
2
5
10^3
2
I_C (mA)
10^4
7Z05924-2.4.25.aj-aa.

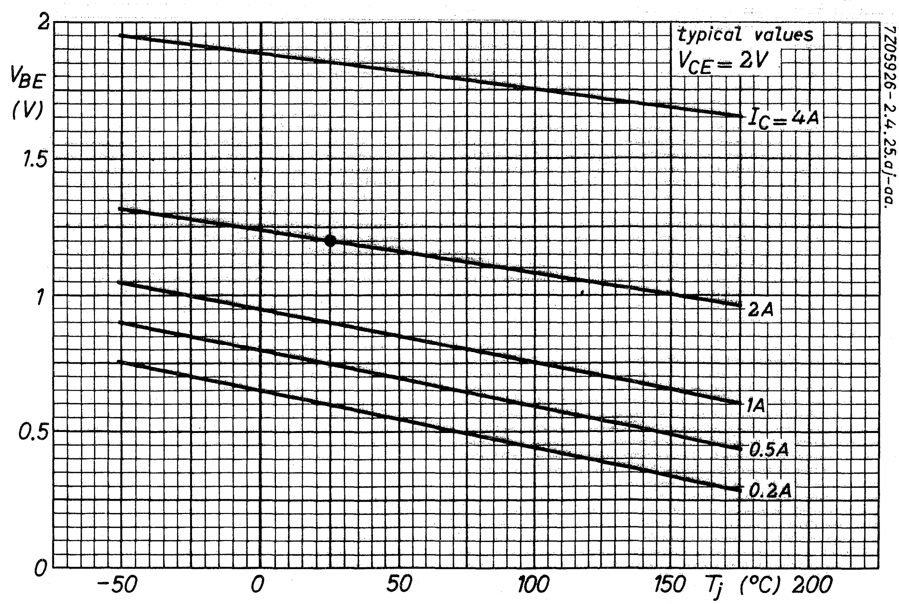

typical values
$V_{CE} = 2V$
$T_j = 25°C$
7Z05923
200
h_{FE}
150
100
50
0
BDY11
BDY10
10
2
5
10^2
2
5
10^3
2
I_C (mA)
10^4

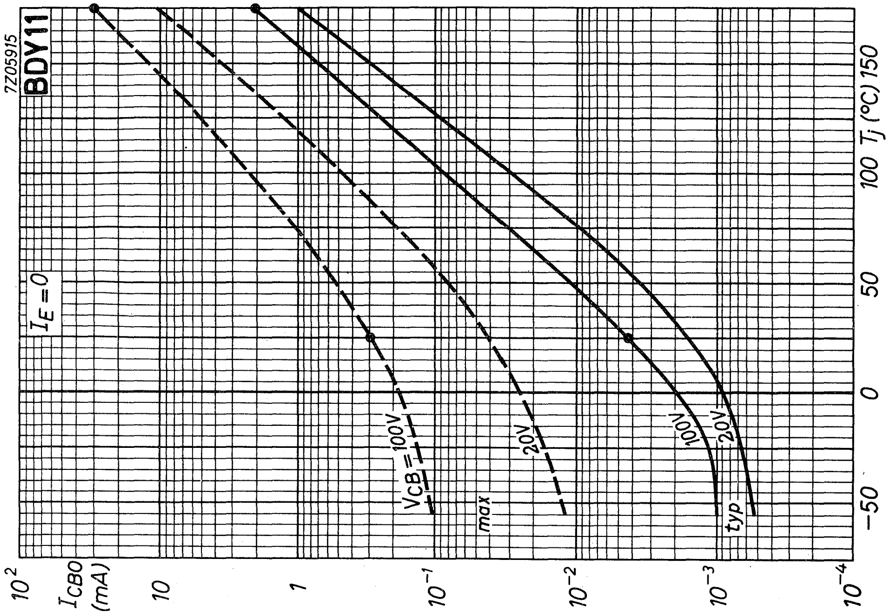

I_C
(A)
3
2
1
0
min I_B
typ
max I_B
$V_{CE} = 2V$
$T_j = 25°C$
7Z05919 - 2.4.25. aj-aa.
0
100
200
300
400
I_B (mA)
500

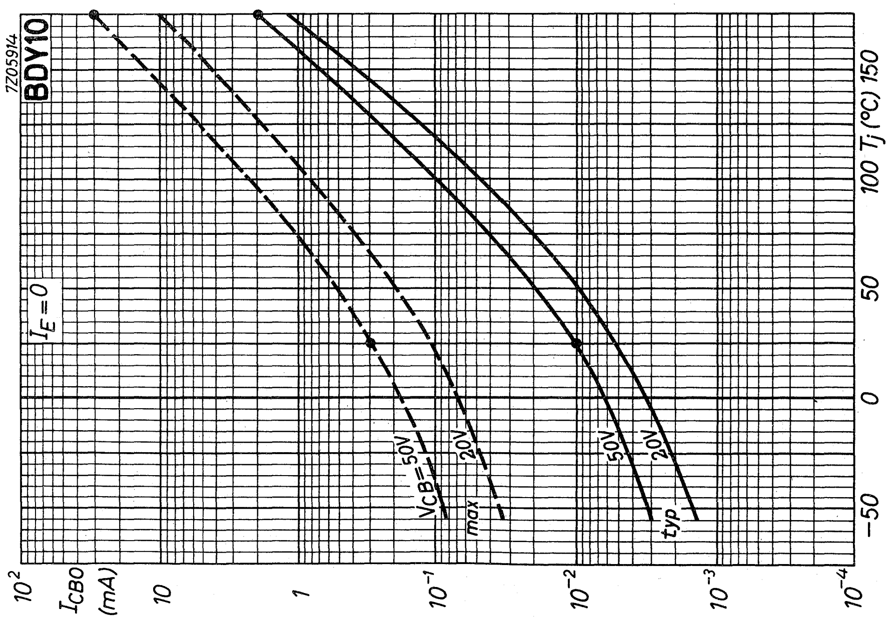

typical values
$V_{CE} = 2V$
h_{FE}
150
100
50
0
$I_C = 200mA$
500mA
1A
2A
4A
-50
0
50
100
T_j (°C)
150
7Z05920 – 2.4.25.aj-aa.

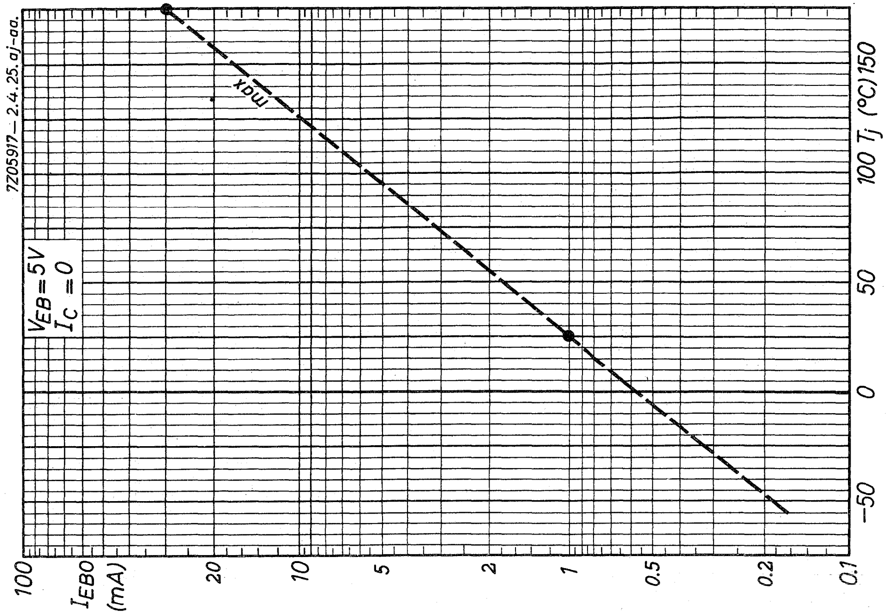

typical values
$I_C = 200 mA$
$V_{CE} = 5V$
$f = 1kHz$
h_{fe}
150
100
50
0
BDY11
BDY10
-50
0
50
100
T_j (°C)
150
7Z05921

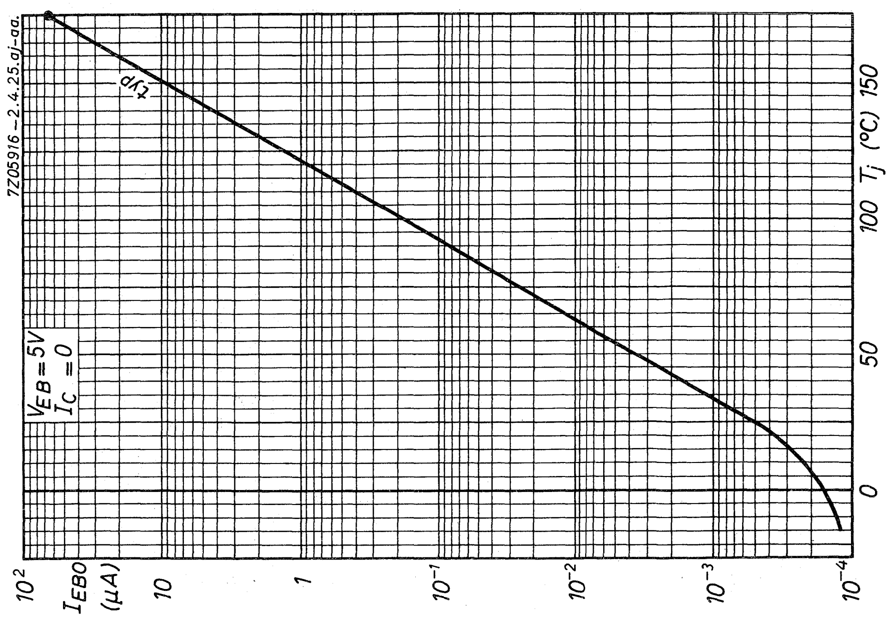

7Z05922-2.4.25.aj-aa.
typical values
V_{CE} = 2V
I_C = 4A
2A
1A
0.5A
0.2A
T_j (°C)
150
100
50
0
−50
1000
I_B (mA)
200
100
50
20
10
5
2
1

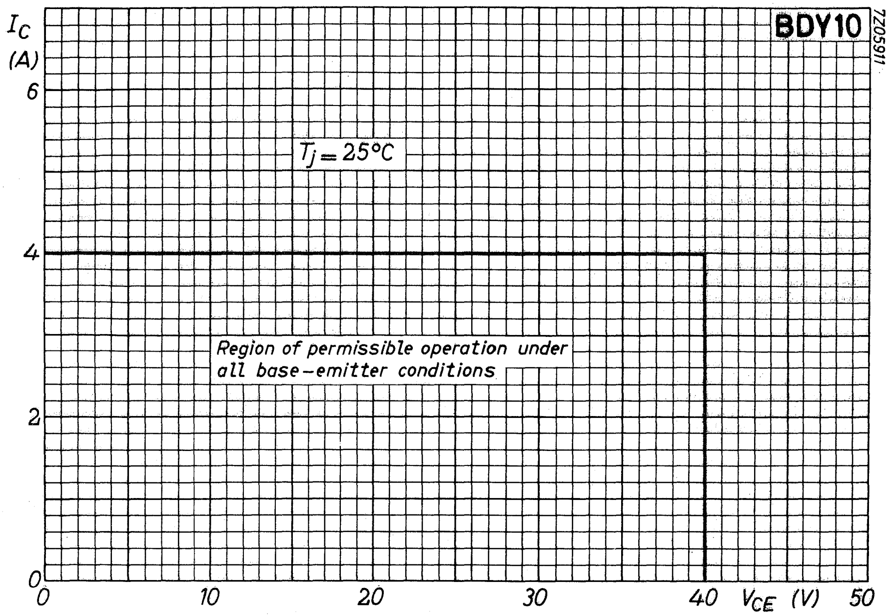

V_{BE} (V)
2
1.5
1
0.5
0
typical values
V_{CE}= 2V
I_C=4A
2A
1A
0.5A
0.2A
7Z05926-2.4.25.aj-aa.
−50
0
50
100
150
T_j (°C)
200

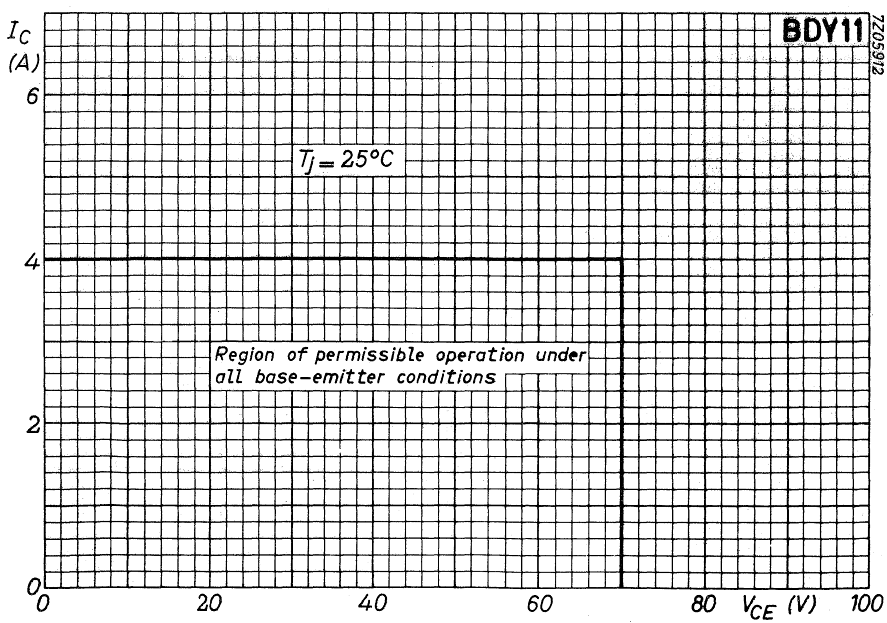

7Z05915
BDY11
$I_E = 0$
I_{CBO} (mA)
10^2
10
1
10^{-1}
10^{-2}
10^{-3}
10^{-4}
$V_{CB} = 100V$
20V
max
100V
20V
typ
−50
0
50
100
150
T_j (°C)


7Z05914
BDY10
$I_E = 0$
I_{CBO} (mA)
10^2
10
1
10^{-1}
10^{-2}
10^{-3}
10^{-4}
$V_{CB} = 50V$
20V
max
50V
20V
typ
−50
0
50
100
150
T_j (°C)


7Z05917 — 2.4.25.aj-aa.
$V_{EB} = 5V$
$I_C = 0$
max
I_{EBO} (mA)
100
20
10
5
2
1
0.5
0.2
0.1
−50
0
50
100
T_j (°C)
150


7Z05916 — 2.4.25.aj-aa.
$V_{EB} = 5V$
$I_C = 0$
typ
I_{EBO} (μA)
10^2
10
1
10^{-1}
10^{-2}
10^{-3}
10^{-4}
0
50
100
T_j (°C)
150


I_C
(A)
6
4
2
0
BDY10
7Z05911
$T_j = 25°C$
Region of permissible operation under
all base-emitter conditions
0
10
20
30
40
V_{CE} (V)
50


I_C
(A)
6
4
2
0
BDY11
7Z05912
$T_j = 25°C$
Region of permissible operation under
all base-emitter conditions
0
20
40
60
80
V_{CE} (V)
100

SILICON PLANAR EPITAXIAL TRANSISTOR

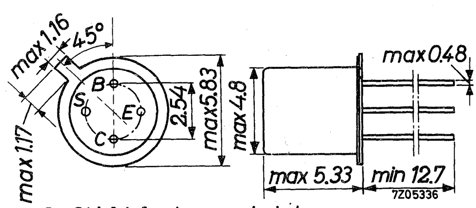
N-P-N transistor in TO-72 metal case with insulated electrodes and a shield lead connected to the case. It is meant for a.m. and f.m. application, primarily for use in car radios.

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.	145	mW
Junction temperature	T_j	max.	175	°C
Transition frequency				
I_C = 1 mA; V_{CE} = 10 V	f_T	typ.	230	MHz
Noise figure				
I_C = 1 mA; V_{CE} = 10 V				
f = 1 MHz; G_S = 3.3 mΩ^{-1}	F	typ.	1.2	dB
f = 100 MHz; G_S = 10 mΩ^{-1}	F	typ.	3.6	dB

MECHANICAL DATA

Dimensions in mm

TO-72
insulated electrodes



S=Shield lead connected to case

7Z3 0355

RATINGS (Limiting values) [1])

Voltages

Collector-base voltage (open emitter)	V_{CBO}	max.	50	V
Collector-emitter voltage (open base) (See also page C)	V_{CEO}	max.	30	V
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
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.	145	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	$R_{th\ j\text{-}a}$	=	0.9	°C/mW

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

7Z3 0356

CHARACTERISTICS 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
I_C = 20 mA; V_{CE} = 2 V	V_{BE}	<	1.1	V
Feedback capacitance at f = 0.45 MHz				
I_C = 1 mA; V_{CE} = 10 V	$-C_{re}$	typ.	0.65	pF
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	
Transition frequency				
I_C = 1 mA; V_{CE} = 10 V	f_T	typ.	230	MHz
Noise figure at I_C = 1 mA; V_{CE} = 10 V				
f = 0.2 MHz; G_S = 3.3 mΩ^{-1}	F	typ.	1.2	dB
f = 1 MHz; G_S = 20 mΩ^{-1}	F	typ.	3.5	dB
f = 1 MHz; G_S = 3.3 mΩ^{-1}	F	typ.	1.2	dB
f = 100 MHz; G_S = 10 mΩ^{-1}	F	typ.	3.6	dB
Conversion noise figure at I_C = 1 mA; V_{CE} = 10 V				
f = 0.2 MHz; G_S = 2 mΩ^{-1}	F_c	typ.	2.5	dB
f = 1 MHz; G_S = 2 mΩ^{-1}	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.

7Z3 0357

CHARACTERISTICS (continued) T_j = 25 °C

y parameters at f = 0.45 MHz (common emitter)
I_C = 1 mA; V_{CE} = 10 V

Input conductance	g_{ie}	typ.	0.4	$m\Omega^{-1}$
Input capacitance	C_{ie}	typ.	25	pF
Feedback admittance	$\|y_{re}\|$	typ.	1.8	$\mu\Omega^{-1}$
Phase angle of feedback admittance	φ_{re}	typ.	270°	
Transfer admittance	$\|y_{fe}\|$	typ.	35	$m\Omega^{-1}$
Phase angle of transfer admittance	φ_{fe}	typ.	0	
Output conductance	g_{oe}	typ.	4	$\mu\Omega^{-1}$
Output capacitance	C_{oe}	typ.	1.4	pF

y parameters at f = 100 MHz (common base)
$-I_E$ = 1 mA; V_{CB} = 10 V

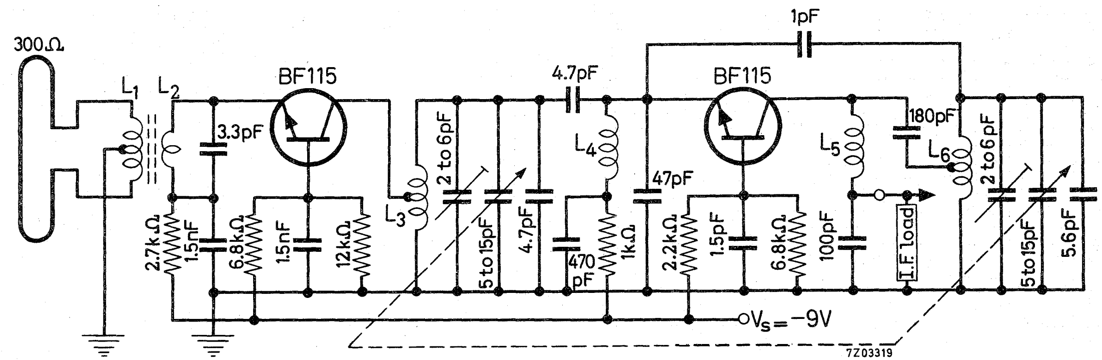
Input conductance	g_{ib}	typ.	33	$m\Omega^{-1}$
Input capacitance	$-C_{ib}$	typ.	6	pF
Feedback admittance	$\|y_{rb}\|$	typ.	0.22	$m\Omega^{-1}$
Phase angle of feedback admittance	φ_{rb}	typ.	273°	
Transfer admittance	$\|y_{fb}\|$	typ.	33	$m\Omega^{-1}$
Phase angle of transfer admittance	φ_{fb}	typ.	150°	
Output conductance	g_{ob}	typ.	10	$\mu\Omega^{-1}$
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.

7Z3 0358

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

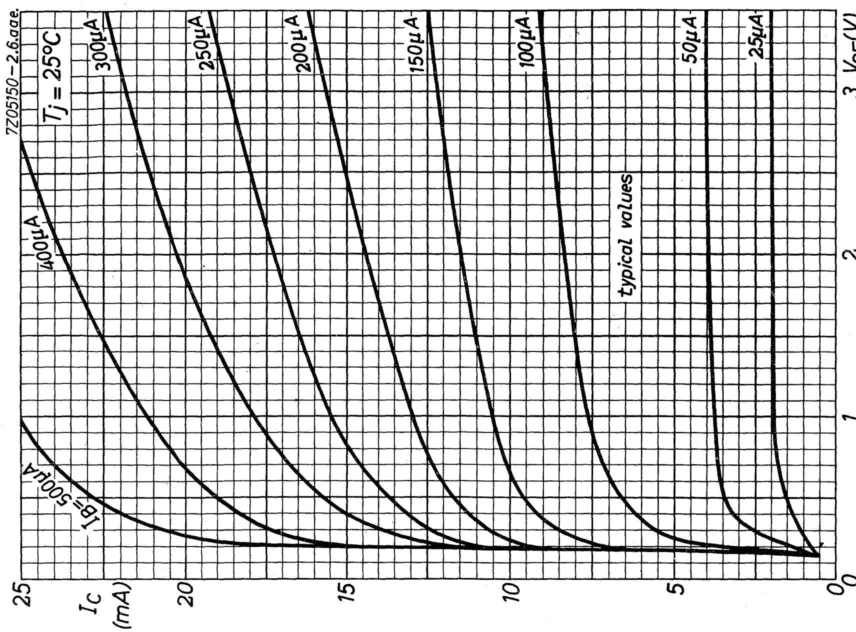
L_5 = 14 turns stranded wire (36 x 0.03) on coil former 3016/02 with ferroxcube core K 512002 (4 D)

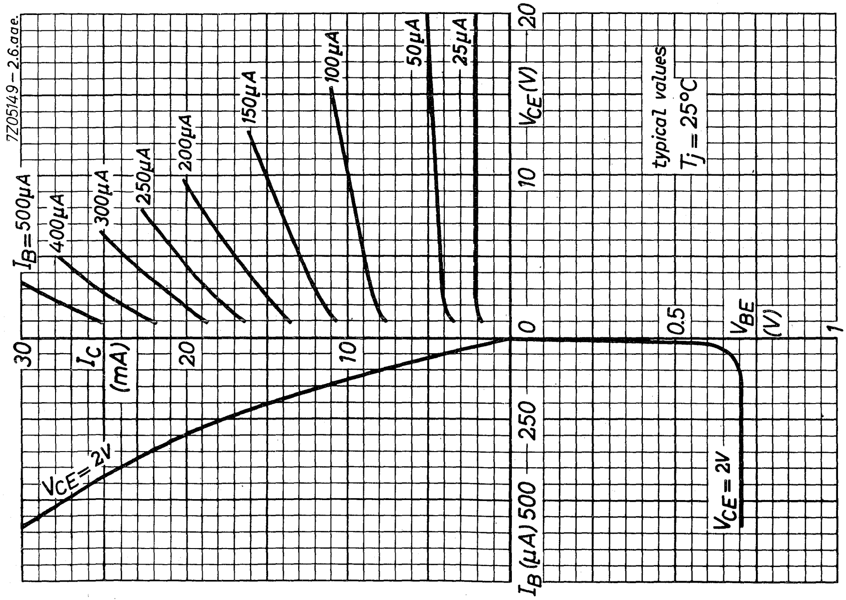
L_6 = 6 turns enamelled Cu wire (1 mm); winding pitch 1 mm; tap at 3 turns from earth side; d = 7 mm

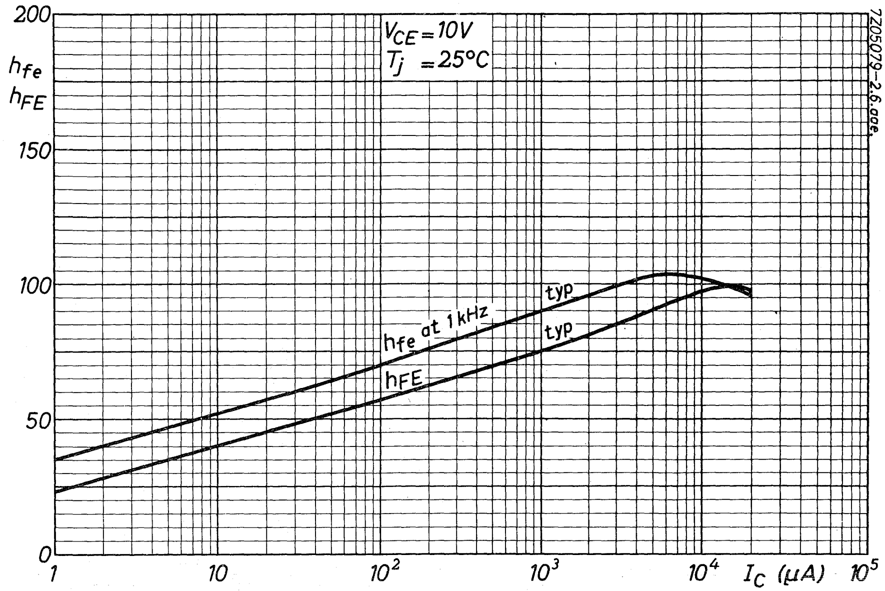
PERFORMANCE

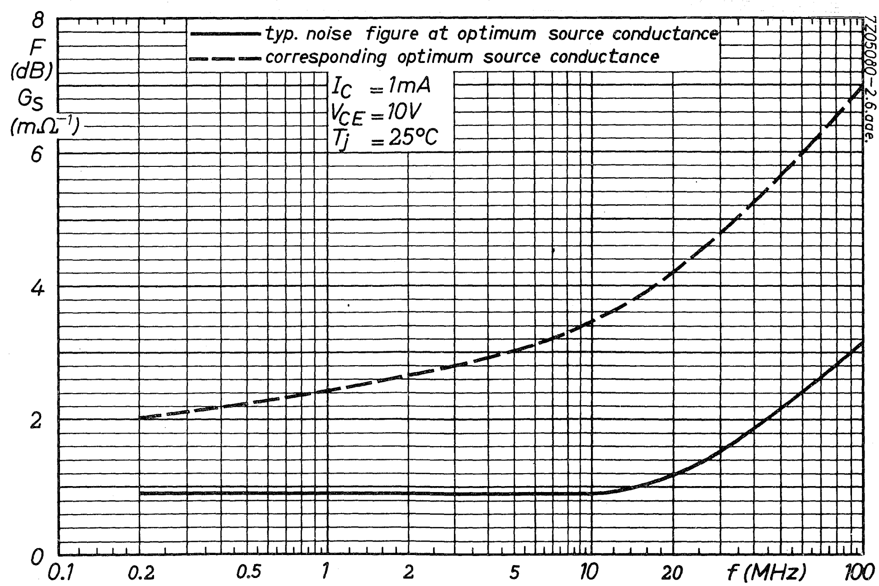
Transducer gain at an I.F. load of 470 Ω	G_{tr}	typ.	24	dB
Noise figure	F	typ.	4.5	dB
Spurious response				
repeat spot suppression		typ.	55	dB
double beat suppression		typ.	57	dB
Image response		typ.	35	dB
Frequency drift oscillator at ΔV_S = 2 V	Δf_{osc}	typ.	10	kHz
		<	15	kHz

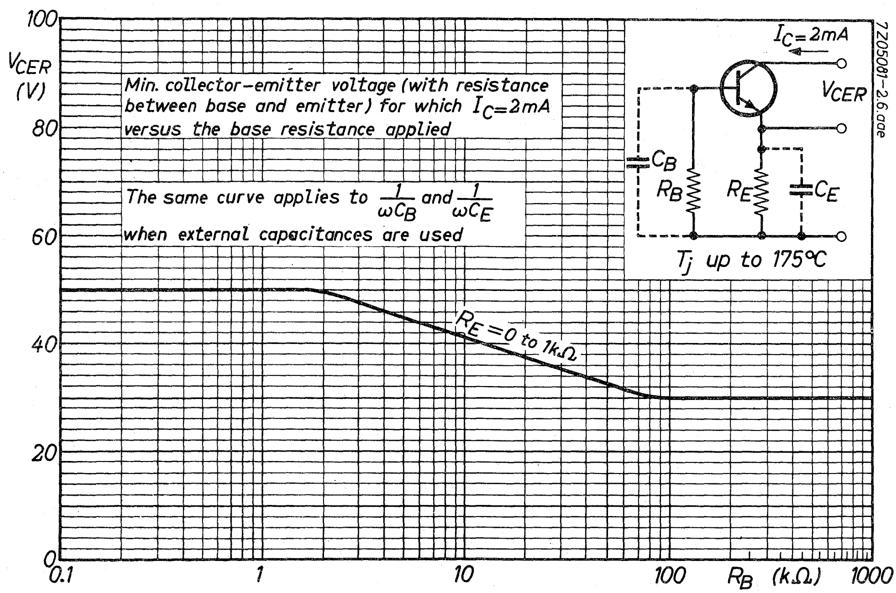
7Z3 0359


7Z05150 – 2.6.aae.
T_j = 25°C
typical values
I_B = 500μA
400μA
300μA
250μA
200μA
150μA
100μA
50μA
25μA
I_C (mA)
V_{CE} (V)
0
5
10
15
20
25
1
2
3


7Z05149 – 2.6.aae.
typical values
T_j = 25°C
I_B = 500μA
400μA
300μA
250μA
200μA
150μA
100μA
50μA
25μA
I_C (mA)
V_{CE} (V)
V_{BE} (V)
I_B (μA)
V_{CE} = 2V
V_{CE} = 2V
0
10
20
30
0.5
1
250
500


7Z05079–2.6.aae.
V_{CE} = 10V
T_j = 25°C
h_{fe}
h_{FE}
h_{fe} at 1 kHz
typ
h_{FE}
typ
200
150
100
50
0
1
10
10^2
10^3
10^4
I_C (μA)
10^5


7Z05080–2.6.aae.
typ. noise figure at optimum source conductance
corresponding optimum source conductance
I_C = 1mA
V_{CE} = 10V
T_j = 25°C
F (dB)
G_S (mΩ^{-1})
8
6
4
2
0
0.1
0.2
0.5
1
2
5
10
20
f (MHz)
100


100
V_{CER} (V)
80
60
40
20
0
0.1
1
10
100
R_B (kΩ)
1000
Min. collector-emitter voltage (with resistance between base and emitter) for which $I_C = 2\,mA$ versus the base resistance applied
The same curve applies to $\frac{1}{\omega C_B}$ and $\frac{1}{\omega C_E}$ when external capacitances are used
$R_E = 0$ to 1kΩ
$I_C = 2mA$
V_{CER}
C_B
R_B
R_E
C_E
T_j up to 175°C
7Z05081-2.6.aae

SILICON PLANAR TRANSISTOR

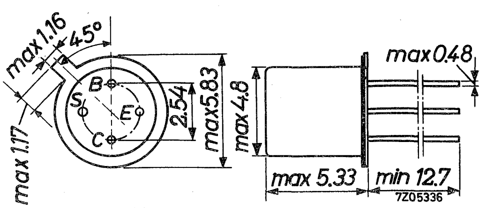
N-P-N transistor in a TO-72 metal envelope with a very low feedback capacitance. This transistor is intended for use in forward gain control stages in video intermediate frequency amplifiers of television receivers.

QUICK REFERENCE DATA				
Collector-base voltage (open emitter)	V_{CBO}	max.	40	V
Collector-emitter voltage (open base)	V_{CEO}	max.	30	V
Collector current (d.c.)	I_C	max.	25	mA
Total power dissipation up to T_{amb} = 45 °C	P_{tot}	max.	130	mW
Junction temperature	T_j	max.	175	°C
Transition frequency				
I_C = 4 mA; V_{CE} = 10 V	f_T	typ.	350	MHz
Feedback capacitance at f = 10.7 MHz				
I_C = 1 mA; V_{CE} = 10 V	$-C_{re}$	typ.	0.15	pF
Max. unilateralised power gain				
I_C = 4 mA; V_{CE} = 10 V; f = 35 MHz	G_{UM}	typ.	42	dB
Gain control range	ΔG_{tr}	typ.	60	dB

MECHANICAL DATA

Dimensions in mm

TO-72



S=Shield lead connected to case

7Z3 0402

RATINGS (Limiting values) [1])

Voltages

Collector-base voltage (open emitter)	V_{CBO}	max.	40	V
Collector-emitter voltage (open base) (See also page B)	V_{CEO}	max.	30	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4	V

Currents

Collector current (d.c.)	I_C	max.	25	mA
Collector current (peak value)	I_{CM}	max.	25	mA

Power dissipation

Total power dissipation up to T_{amb} = 45 °C	P_{tot}	max.	130	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	$R_{th\ j\text{-}a}$		1.0	°C/mW

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

7Z3 0032

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

Base current				
I_C = 4 mA; V_{CE} = 10 V	I_B	typ.	70	μA
		<	150	μA
Base-emitter voltage				
I_C = 4 mA; V_{CE} = 10 V	V_{BE}	typ.	700	mV [1])
Feedback capacitance at f = 10.7 MHz				
I_C = 1 mA; V_{CE} = 10 V	$-C_{re}$	typ.	150	fF [2])
Transition frequency				
I_C = 4 mA; V_{CE} = 10 V	f_T	typ.	350	MHz
Noise figure at f = 35 MHz				
I_C = 4 mA; V_{CE} = 10 V; G_S = 10 mΩ^{-1}	F	typ.	3	dB
y parameters at f = 35 MHz				
I_C = 4 mA; V_{CE} = 10 V				
Input conductance	g_{ie}	typ.	4.8	mΩ^{-1}
Input capacitance	C_{ie}	typ.	45	pF
Feedback admittance	$\lvert y_{re}\rvert$	typ.	37	$\mu\Omega^{-1}$
Phase angle of feedback admittance	φ_{re}	typ.	268°	
Transfer admittance	$\lvert y_{fe}\rvert$	typ.	95	mΩ^{-1}
Phase angle of transfer admittance	φ_{fe}	typ.	337°	
Output conductance	g_{oe}	typ.	30	$\mu\Omega^{-1}$
Output capacitance	C_{oe}	typ.	1.2	pF
Maximum unilateralised power gain				
$G_{UM} = \frac{\lvert y_{fe}\rvert^2}{4\, g_{ie}\, g_{oe}}$				
I_C = 4 mA; V_{CE} = 10 V; f = 35 MHz	G_{UM}	typ.	42	dB

[1]) V_{BE} decreases with about 1.7 mV/°C at increasing temperature

[2]) 1 fF = 1 femtofarad = 10^{-15} F

7Z3 0033

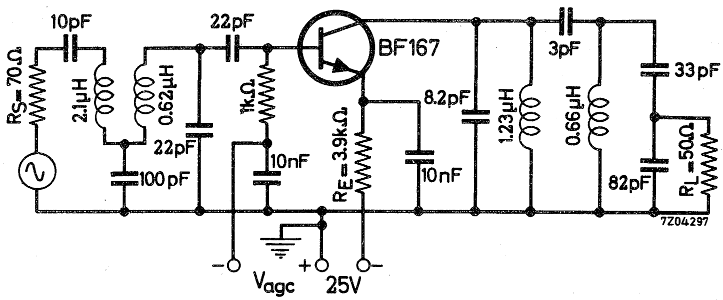
APPLICATION INFORMATION

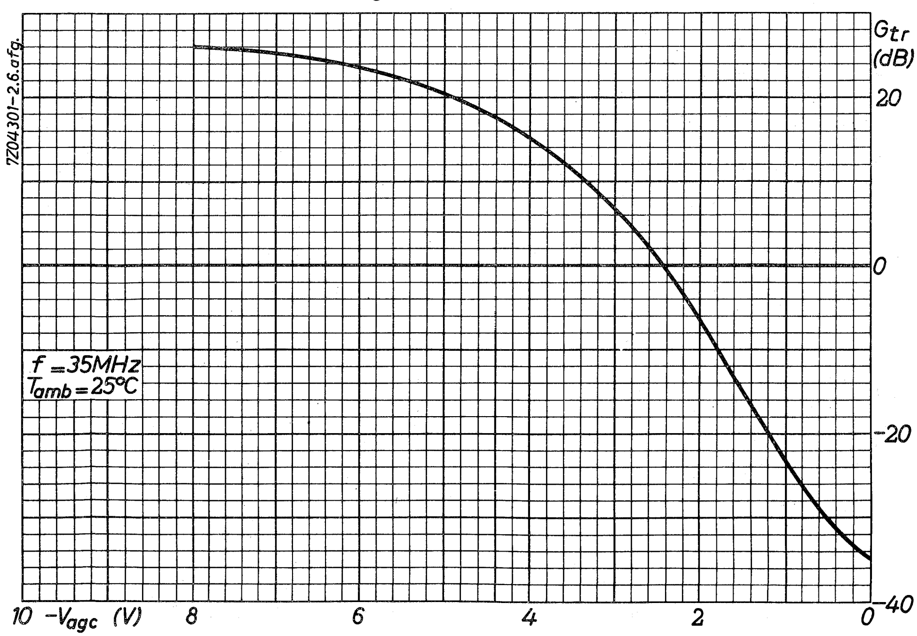
First stage of an intermediate frequency amplifier with a BF167 transistor.
(Basic circuit with voltage gain control).

Transducer gain

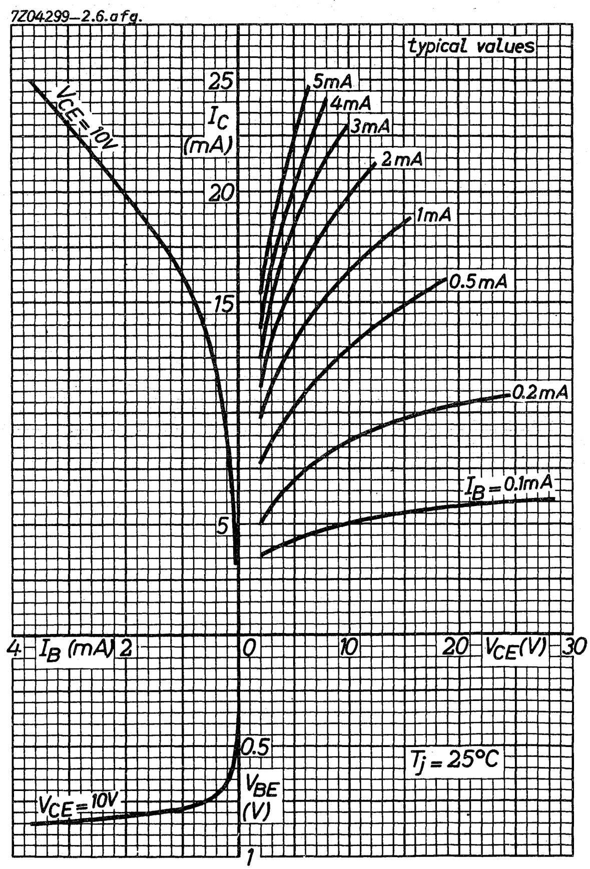
$$G_{tr} = \frac{\text{output power in load } R_L}{\text{available power from source with } R_S}$$

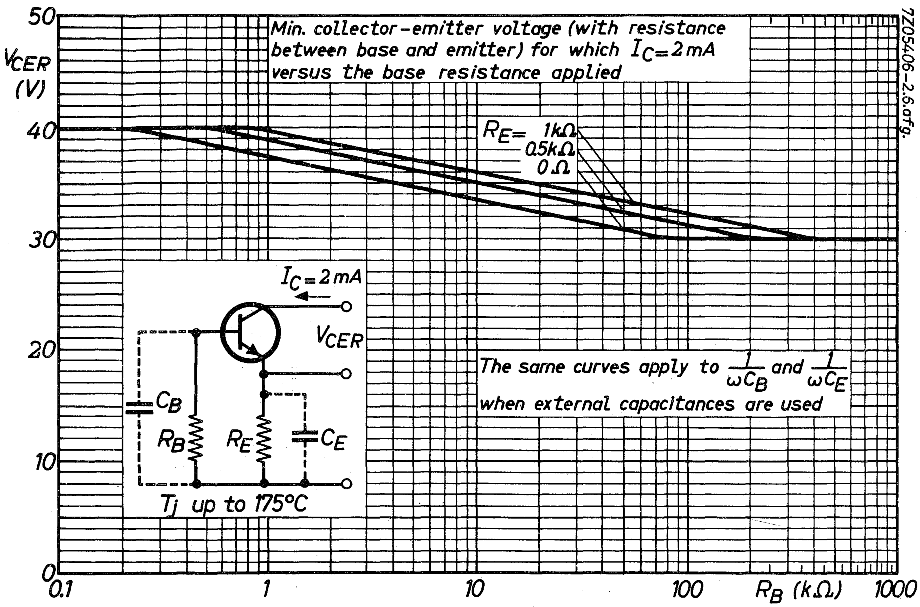
I_C = 4 mA; f = 35 MHz	G_{tr}	typ.	26	dB
Gain control range	ΔG_{tr}	typ.	60	dB

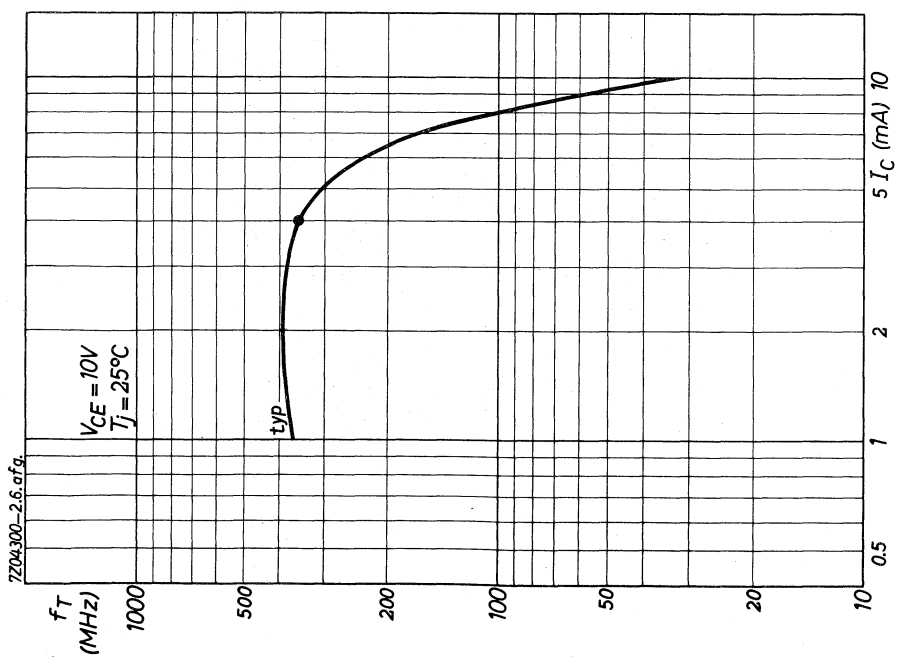




7Z3 0034


7Z04299—2.6.afg.
typical values
25
20
15
5
I_C (mA)
5mA
4mA
3mA
2mA
1mA
0.5mA
0.2mA
I_B=0.1mA
V_{CE}=10V
4
I_B (mA)
2
0
10
20
V_{CE}(V)
30
0.5
V_{BE} (V)
1
T_j = 25°C
V_{CE}=10V


7Z05406-2.6.afg.
Min. collector-emitter voltage (with resistance between base and emitter) for which $I_C = 2\,mA$ versus the base resistance applied
V_{CER} (V)
R_E = 1kΩ
0.5kΩ
0 Ω
$I_C = 2\,mA$
V_{CER}
C_B
R_B
R_E
C_E
T_j up to 175°C
The same curves apply to $\frac{1}{\omega C_B}$ and $\frac{1}{\omega C_E}$ when external capacitances are used
R_B (kΩ)


7Z04300-2.6.afg.
$V_{CE} = 10V$
$T_j = 25°C$
typ
I_C (mA)
f_T (MHz)

SILICON PLANAR EPITAXIAL TRANSISTOR

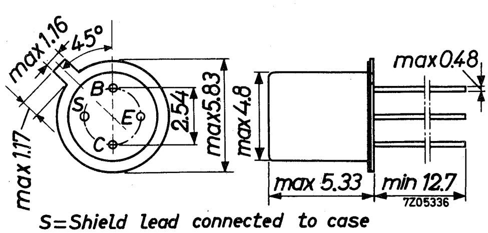
N-P-N transistor in a TO-72 metal envelope with a very low feedback capacitance. This transistor is intended for use in video intermediate frequency amplifiers, in particular for the output stages.

QUICK REFERENCE DATA				
Collector-base voltage (open emitter)	V_{CBO}	max.	40	V
Collector-emitter voltage (open base)	V_{CEO}	max.	25	V
Collector current (d.c.)	I_C	max.	25	mA
Total power dissipation up to T_{amb} = 45 °C	P_{tot}	max.	260	mW
Junction temperature	T_j	max.	175	°C
Transition frequency				
I_C = 5 mA; V_{CE} = 10 V	f_T	typ.	550	MHz
Feedback capacitance at f = 10.7 MHz				
I_C = 1 mA; V_{CE} = 10 V	$-C_{re}$	typ.	0.23	pF
Max. unilateralised power gain				
I_C = 7 mA; V_{CE} = 10 V; f = 35 MHz	G_{UM}	typ.	42.5	dB
Output voltage in the circuit of page 4	V_O	typ.	7.7	V

MECHANICAL DATA

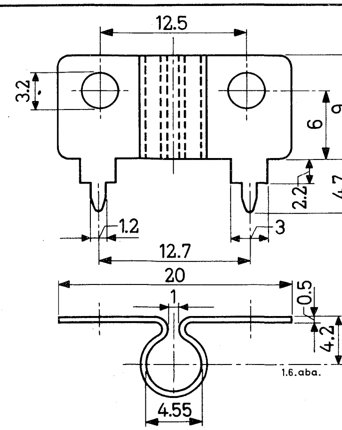
Dimensions in mm

TO-72



S=Shield lead connected to case

7Z3 0414



Cooling fin 56263

RATINGS (Limiting values) [1])

Voltages

Collector-base voltage (open emitter)	V_{CBO}	max.	40	V
Collector-emitter voltage (open base) (See also page A)	V_{CEO}	max.	25	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4	V

Currents

Collector current (d.c.)	I_C	max.	25	mA
Collector current (peak value)	I_{CM}	max.	25	mA

Power dissipation

Total power dissipation up to T_{amb} = 45 °C with cooling fin No. 56263 [2])	P_{tot}	max.	260	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	$R_{th\ j\text{-}a}$	=	0.65	°C/mW
From junction to ambient with cooling fin No. 56263	$R_{th\ j\text{-}a}$	=	0.5	°C/mW

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

[2]) Peak power dissipation see page A.

7Z3 0196

CHARACTERISTICS

T_{amb} = 25 °C unless otherwise specified

Base current				
I_C = 7 mA; V_{CE} = 10 V	I_B	typ.	80	μA
		<	185	μA
Base-emitter voltage				
I_C = 7 mA; V_{CE} = 10 V	V_{BE}	typ.	740	mV [1]
		<	900	mV
Feedback capacitance at f = 10.7 MHz				
I_C = 1 mA; V_{CE} = 10 V	$-C_{re}$	typ.	230	fF [2]
Transition frequency				
I_C = 5 mA; V_{CE} = 10 V	f_T	typ.	550	MHz
y parameters at f = 35 MHz				
I_C = 7 mA; V_{CE} = 10 V				
Input conductance	g_{ie}	typ.	4.5	$m\Omega^{-1}$
Input capacitance	C_{ie}	typ.	45	pF
Feedback admittance	$\lvert y_{re} \rvert$	typ.	55	$\mu\Omega^{-1}$
Phase angle of feedback admittance	φ_{re}	typ.	266°	
Transfer admittance	$\lvert y_{fe} \rvert$	typ.	145	$m\Omega^{-1}$
Phase angle of transfer admittance	φ_{fe}	typ.	338°	
Output conductance	g_{oe}	typ.	65	$\mu\Omega^{-1}$
Output capacitance	C_{oe}	typ.	2.1	pF

Maximum unilateralised power gain

$$G_{UM} = \frac{\lvert y_{fe} \rvert^2}{4\, g_{ie}\, g_{oe}}$$

I_C = 7 mA; V_{CE} = 10 V; f = 35 MHz	G_{UM}	typ.	42.5	dB

[1]) V_{BE} decreases with about 1.7 mV/°C at increasing temperature

[2]) 1 fF = 1 femtofarad = 10^{-15} F

7Z3 0197

APPLICATION INFORMATION

Output stage of an intermediate frequency amplifier with a BF173 transistor.

Output voltage of the i.f. output stage

Voltage across the detector load R_L = 2.7 kΩ
for 30% synchronisation pulse compression

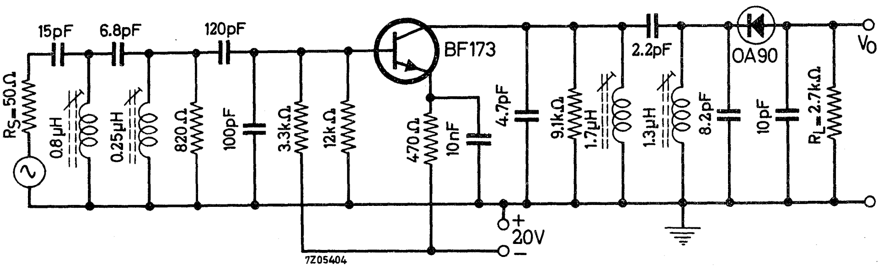
f = 38.9 MHz; I_C = 7.2 mA; V_{CE} = 16.6 V	V_O	>	6	V
		typ.	7.7	V

Transducer gain

$$G_{tr} = \frac{\text{output power in load } R_L}{\text{available power from source with } R_S}$$

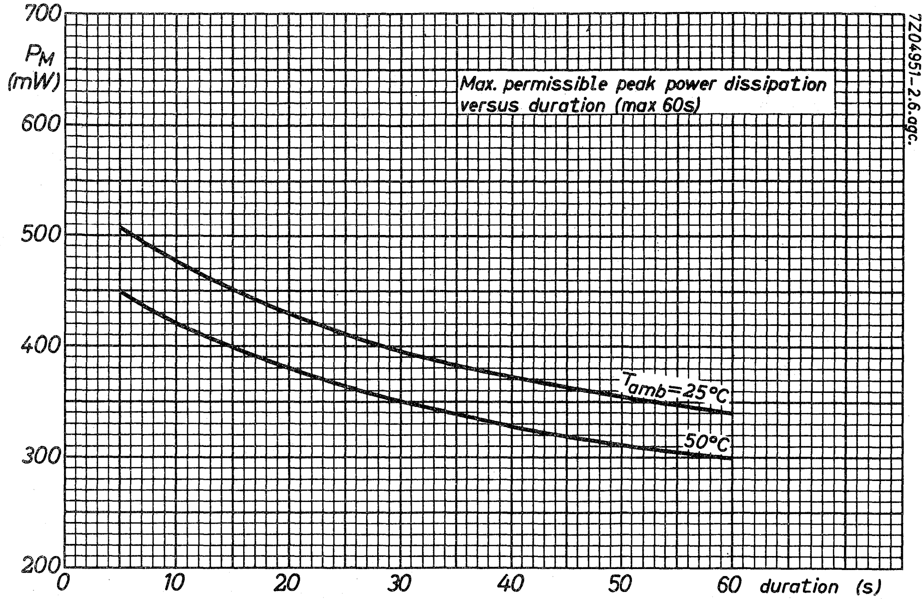
f = 36.4 MHz; I_C = 7.2 mA; V_{CE} = 16.6 V	G_{tr}	typ.	26	dB

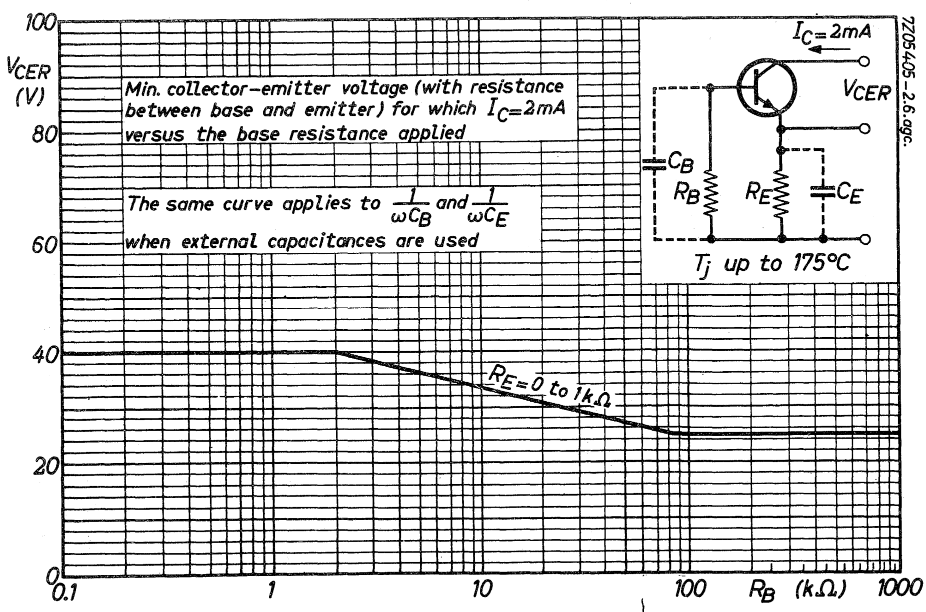
Tuning frequency for all tuned circuits is 37 MHz

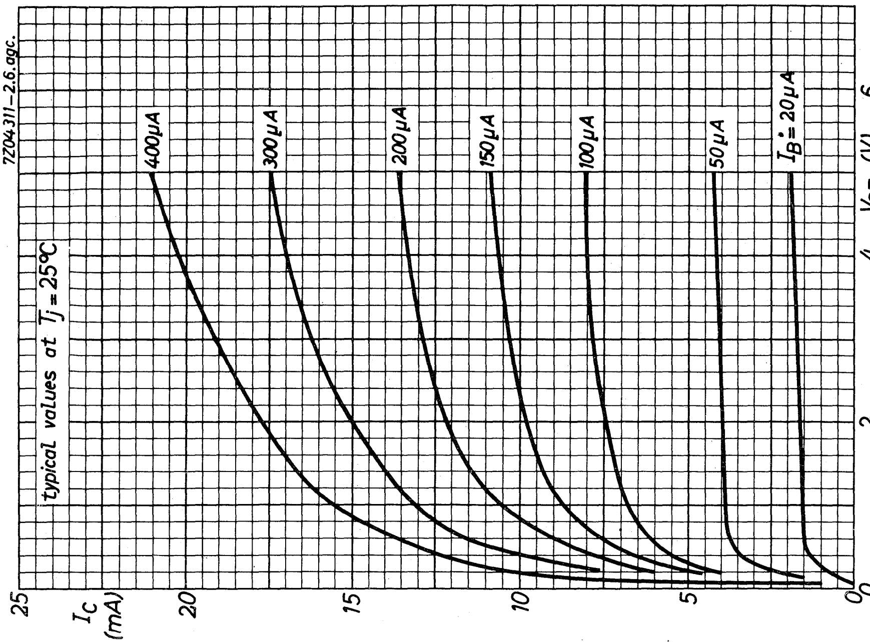


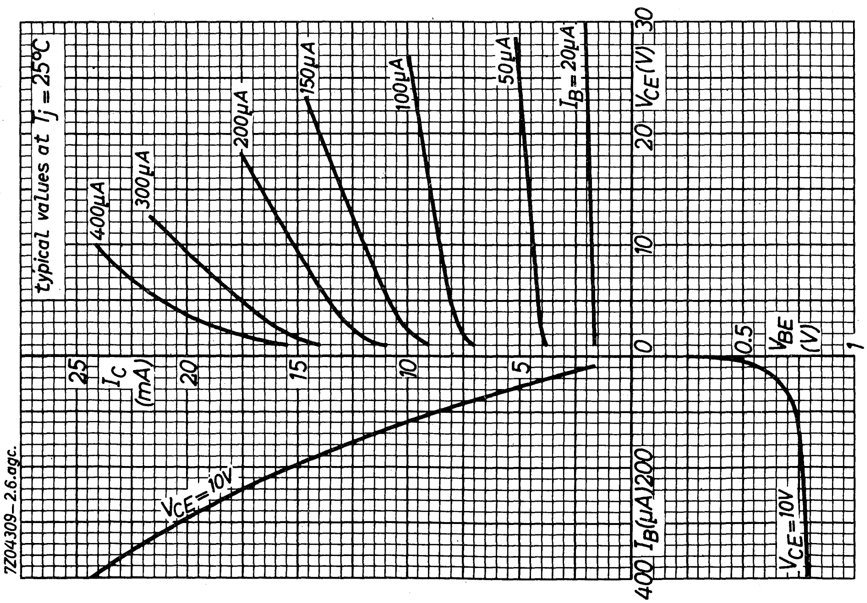
For further information please refer to
application information bulletin AI249

7Z3 0415


700
P_M
(mW)
600
500
400
300
200
0
10
20
30
40
50
60
duration (s)
Max. permissible peak power dissipation versus duration (max 60s)
T_{amb}=25°C
50°C
7Z04951-2.6.agc.


100
V_{CER}
(V)
80
60
40
20
0
0.1
1
10
100
R_B (kΩ)
1000
Min. collector-emitter voltage (with resistance between base and emitter) for which I_C=2mA versus the base resistance applied
The same curve applies to $\frac{1}{\omega C_B}$ and $\frac{1}{\omega C_E}$ when external capacitances are used
R_E=0 to 1kΩ
I_C=2mA
V_{CER}
C_B
R_B
R_E
C_E
T_j up to 175°C
7Z05405-2.6.agc.


7204311-2.6.agc.
typical values at $T_j = 25°C$
$I_B = 20 \mu A$
50 μA
100 μA
150 μA
200 μA
300 μA
400 μA
I_C (mA)
V_{CE} (V)
0
5
10
15
20
25
2
4
6


7204309-2.6.agc.
typical values at $T_j = 25°C$
$I_B = 20 \mu A$
50 μA
100 μA
150 μA
200 μA
300 μA
400 μA
I_C (mA)
V_{CE} (V)
I_B (μA)
V_{BE} (V)
$V_{CE} = 10V$
$V_{CE} = 10V$
0
10
20
30
5
10
15
20
25
200
400
0.5
1

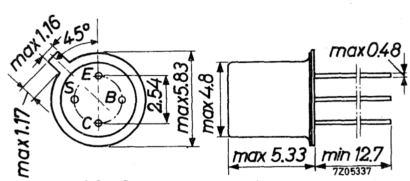
SILICON PLANAR TRANSISTOR

N-P-N transistor in a TO-72 metal envelope with insulated electrodes and a shield lead connected to the case. The BF180 is primarily intended for application in a forward gain controlled pre-amplifier in u.h.f. and integrated television tuners.

QUICK REFERENCE DATA				
Collector-base voltage (open emitter)	V_{CBO}	max.	30	V
Collector-emitter voltage (open base)	V_{CEO}	max.	20	V
Collector current (d.c.)	I_C	max.	20	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	150	mW
Junction temperature	T_j	max.	175	°C
Transition frequency				
I_C = 2 mA; V_{CE} = 10 V	f_T	typ.	675	MHz
Feedback capacitance at f = 10.7 MHz				
I_C = 1 mA; V_{CE} = 10 V	$-C_{re}$	typ.	280	fF
Max. unilateralised power gain				
$-I_E$ = 2 mA; V_{CB} = 10 V; f = 200 MHz	G_{UM}	typ.	24	dB
$-I_E$ = 2 mA; V_{CB} = 10 V; f = 900 MHz	G_{UM}	typ.	12	dB
Noise figure at optimum source admittance				
$-I_E$ = 2 mA; V_{CB} = 10 V; f = 200 MHz	F	typ.	2.5	dB
$-I_E$ = 2 mA; V_{CB} = 10 V; f = 800 MHz	F	typ.	5.7	dB

MECHANICAL DATA Dimensions in mm

TO-72



S=Shield lead connected to case

7Z3 0725

RATINGS (Limiting values) [1]

Voltages

Collector-base voltage (open emitter)	V_{CBO}	max.	30	V
Collector-emitter voltage (open base)	V_{CEO}	max.	20	V
Emitter-base voltage (open collector)	V_{EBO}	max.	3	V

Currents

Collector current (d.c.)	I_C	max.	20	mA
Collector current (peak value)	I_{CM}	max.	20	mA

Power dissipation

Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	150	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	$R_{th\ j\text{-}a}$	=	1	°C/mW

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

7Z3 0726

FOR FURTHER INFORMATION REFER TO THE SUPPLEMENT

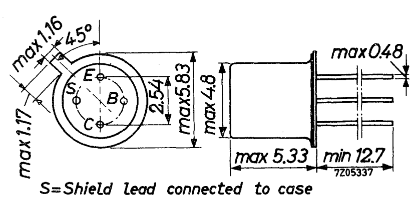
SILICON PLANAR TRANSISTOR

N-P-N transistor in a TO-72 metal envelope with insulated electrodes and a shield lead connected to the case. The BF181 is primarily intended for application as self-oscillating mixer in the u.h.f. band.

QUICK REFERENCE DATA				
Collector-base voltage (open emitter)	V_{CBO}	max.	30	V
Collector-emitter voltage (open base)	V_{CEO}	max.	20	V
Collector current (d.c.)	I_C	max.	20	mA
Total power dissipation up to T_{amb} = 25 ^oC	P_{tot}	max.	150	mW
Junction temperature	T_j	max.	175	^oC
Transition frequency				
I_C = 2 mA; V_{CE} = 10 V	f_T	typ.	600	MHz
Feedback capacitance at f = 10.7 MHz				
I_C = 1 mA; V_{CE} = 10 V	$-C_{re}$	typ.	280	fF
Max. unilateralised power gain				
$-I_E$ = 2 mA; V_{CB} = 10 V; f = 900 MHz	G_{UM}	typ.	11	dB
Noise figure at optimum source admittance				
$-I_E$ = 2 mA; V_{CB} = 10 V; f = 900 MHz	F	typ.	6.8	dB

MECHANICAL DATA Dimensions in mm

TO-72



7Z3 0727

RATINGS (Limiting values) [1]

Voltages

Collector-base voltage (open emitter)	V_{CBO}	max.	30	V
Collector-emitter voltage (open base)	V_{CEO}	max.	20	V
Emitter-base voltage (open collector)	V_{EBO}	max.	3	V

Currents

Collector current (d.c.)	I_C	max.	20	mA
Collector current (peak value)	I_{CM}	max.	20	mA

Power dissipation

Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	150	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	$R_{th\ j\text{-}a}$	=	1	°C/mW

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

7Z3 0726

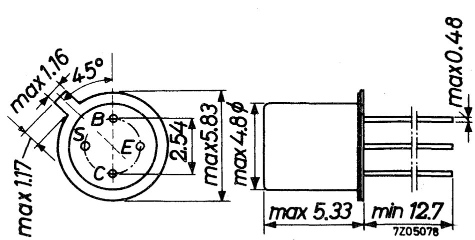
SILICON PLANAR EPITAXIAL TRANSISTOR

N-P-N transistor in TO-72 metal case with insulated electrodes and a shield lead connected to the case. The BF184 is intended for a.m. and f.m. application, primarily for i.f. amplifiers and gain controlled a.m. input stages of mains fed receivers.

QUICK REFERENCE DATA				
Collector-base voltage (open emitter)	V_{CBO}	max.	30	V
Collector-emitter voltage (open base)	V_{CEO}	max.	20	V
Collector current (d.c.)	I_C	max.	30	mA
Total power dissipation up to T_{amb} = 45 °C	P_{tot}	max.	145	mW
Junction temperature	T_j	max.	175	°C
D.C. current gain at T_j = 25 °C				
I_C = 1 mA; V_{CE} = 10 V	h_{FE}	typ.	115	
Transition frequency				
I_C = 1 mA; V_{CE} = 10 V	f_T	typ.	300	MHz

MECHANICAL DATA Dimensions in mm

TO-72
Insulated electrodes



S=Shield lead connected to case

7Z3 0271

RATINGS (Limiting values) [1])

Voltages

Collector-base voltage (open emitter)	V_{CBO}	max.	30	V
Collector-emitter voltage (open base) (See also sheet B)	V_{CEO}	max.	20	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	V

Currents

Collector current (d.c.)	I_C	max.	30	mA
Collector current (peak value)	I_{CM}	max.	30	mA

Power dissipation

Total power dissipation up to T_{amb} = 45 °C	P_{tot}	max.	145	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	$R_{th\ j\text{-}a}$	=	0.9	°C/mW

CHARACTERISTICS T_j = 25 °C unless otherwise specified

Base-emitter voltage [2])

I_C = 1 mA; V_{CE} = 10 V	V_{BE}		0.65 to 0.74	V

Feedback capacitance at f = 0.45 MHz

I_C = 1 mA; V_{CE} = 10 V	$-C_{re}$	typ.	0.65	pF

D.C. current gain

I_C = 1 mA; V_{CE} = 10 V	h_{FE}	75 to	750	
		typ.	115	

Transition frequency

I_C = 1 mA; V_{CE} = 10 V	f_T	typ.	300	MHz

Conversion noise figure at f = 1 MHz

I_C = 1 mA; V_{CE} = 10 V; G_S = 2 mΩ^{-1}	F_c	typ.	3.5	dB

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

[2]) V_{BE} decreases with about 1.7 mV/°C at increasing temperature. 7Z3 0272

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

y parameters at f = 0.45 MHz (common emitter)

I_C = 1 mA; V_{CE} = 10 V

Input conductance	g_{ie}	typ.	0.3	$m\Omega^{-1}$
Input capacitance	C_{ie}	typ.	25	pF
Feedback admittance	$\lvert y_{re} \rvert$	typ.	1.5	$\mu\Omega^{-1}$
Phase angle of feedback admittance	φ_{re}	typ.	270°	
Transfer admittance	$\lvert y_{fe} \rvert$	typ.	35	$m\Omega^{-1}$
Phase angle of transfer admittance	φ_{fe}	typ.	0	
Output conductance	g_{oe}	typ.	4	$\mu\Omega^{-1}$
Output capacitance	C_{oe}	typ.	1.4	pF

y parameters at f = 10.7 MHz (common emitter)

I_C = 1 mA; V_{CE} = 10 V

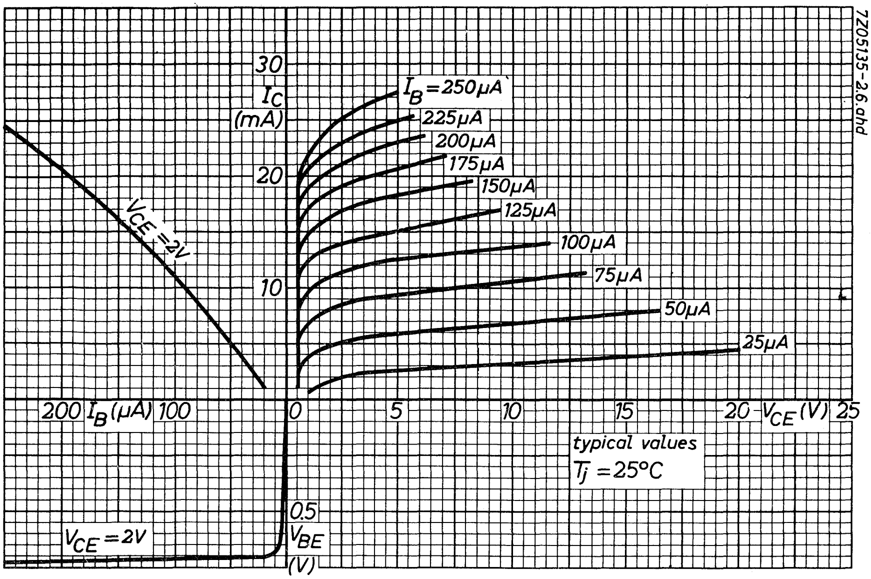
Input conductance	g_{ie}	typ.	0.45	$m\Omega^{-1}$
Input capacitance	C_{ie}	typ.	25	pF
Feedback admittance	$\lvert y_{re} \rvert$	typ.	38	$\mu\Omega^{-1}$
Phase angle of feedback admittance	φ_{re}	typ.	270°	
Transfer admittance	$\lvert y_{fe} \rvert$	typ.	35	$m\Omega^{-1}$
Phase angle of transfer admittance	φ_{fe}	typ.	355°	
Output conductance	g_{oe}	typ.	5.5	$\mu\Omega^{-1}$
Output capacitance	C_{oe}	typ.	1.6	pF

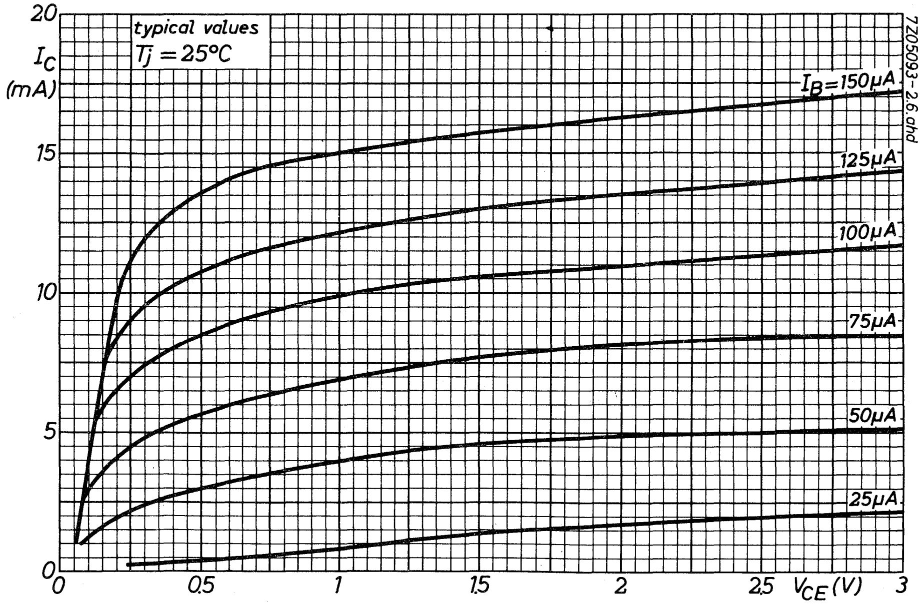
y parameters at f = 35 MHz (common emitter)

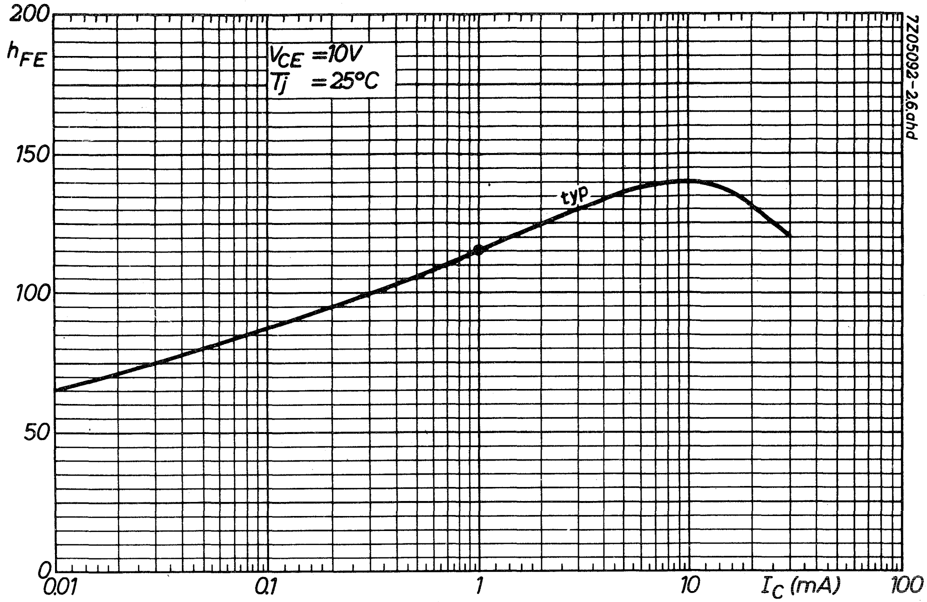
I_C = 1 mA; V_{CE} = 10 V

Input conductance	g_{ie}	typ.	0.85	$m\Omega^{-1}$
Input capacitance	C_{ie}	typ.	19	pF
Feedback admittance	$\lvert y_{re} \rvert$	typ.	125	$\mu\Omega^{-1}$
Phase angle of feedback admittance	φ_{re}	typ.	270°	
Transfer admittance	$\lvert y_{fe} \rvert$	typ.	35	$m\Omega^{-1}$
Phase angle of transfer admittance	φ_{fe}	typ.	345°	
Output conductance	g_{oe}	typ.	6	$\mu\Omega^{-1}$
Output capacitance	C_{oe}	typ.	1.6	pF

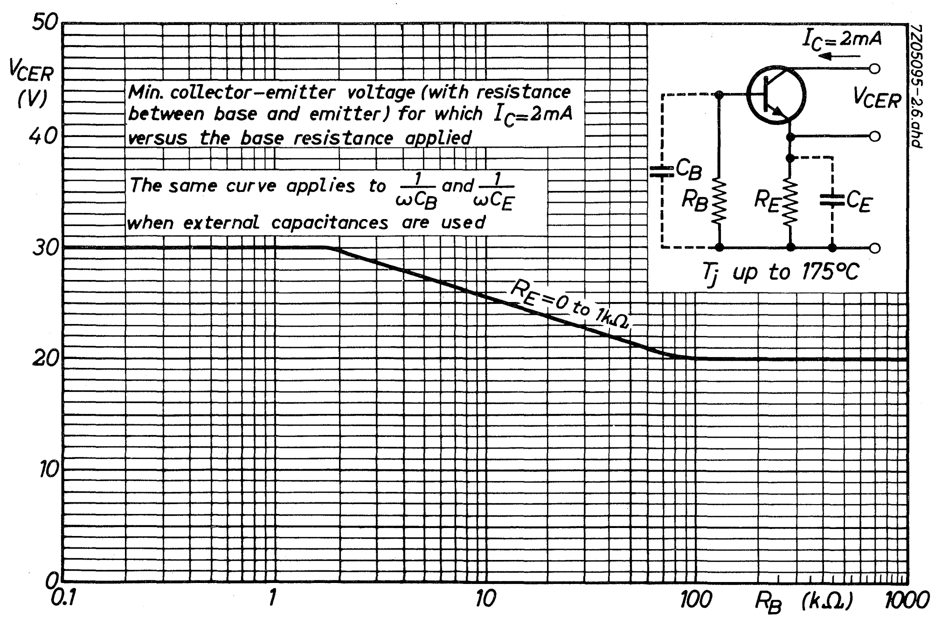
7Z3 0273


7Z05135-2.6.ahd
30
I_C
(mA)
20
10
$I_B = 250\mu A$
225μA
200μA
175μA
150μA
125μA
100μA
75μA
50μA
25μA
$V_{CE} = 2V$
200 I_B (μA) 100
0 5 10 15 20 V_{CE} (V) 25
typical values
$T_j = 25°C$
0.5
V_{BE}
(V)
$V_{CE} = 2V$


7Z05093-2.6.ahd
20
I_C
(mA)
15
10
5
0
typical values
$T_j = 25°C$
$I_B = 150\mu A$
125μA
100μA
75μA
50μA
25μA
0 0.5 1 1.5 2 2.5 V_{CE} (V) 3



7Z05092-2.6.ahd
200
h_{FE}
150
100
50
0
V_{CE} =10V
T_j =25°C
typ
0.01
0.1
1
10
I_C (mA)
100



7Z05095-2.6.ahd
50
V_{CER}
(V)
40
30
20
10
0
Min. collector-emitter voltage (with resistance between base and emitter) for which I_C=2mA versus the base resistance applied
The same curve applies to $\frac{1}{\omega C_B}$ and $\frac{1}{\omega C_E}$ when external capacitances are used
R_E=0 to 1kΩ
I_C=2mA
V_{CER}
C_B
R_B
R_E
C_E
T_j up to 175°C
0.1
1
10
100
R_B (kΩ)
1000

SILICON PLANAR EPITAXIAL TRANSISTOR

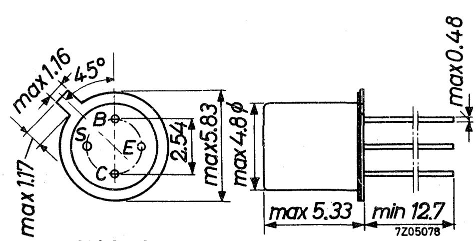
N-P-N transistor in TO-72 metal case with insulated electrodes and a shield lead connected to the case. The BF185 is intended for low noise a.m. and f.m. application, primarily for use as preamplifier or mixer-oscillator in portable receivers and car radios.

QUICK REFERENCE DATA				
Collector-base voltage (open emitter)	V_{CBO}	max.	30	V
Collector-emitter voltage (open base)	V_{CEO}	max.	20	V
Collector current (d.c.)	I_C	max.	30	mA
Total power dissipation up to T_{amb} = 45 °C	P_{tot}	max.	145	mW
Junction temperature	T_j	max.	175	°C
D.C. current gain at T_j = 25 °C				
I_C = 1 mA; V_{CE} = 10 V	h_{FE}	typ.	67	
Transition frequency				
I_C = 1 mA; V_{CE} = 10 V	f_T	typ.	220	MHz
Noise figure at f = 100 MHz				
I_C = 1 mA; V_{CE} = 10 V; G_S = 10 mΩ^{-1}	F	typ.	3.6	dB
Conversion noise figure				
I_C = 1 mA; V_{CE} = 10 V f = 1 MHz; G_S = 2 mΩ^{-1}	F_c	typ.	2.5	dB

MECHANICAL DATA Dimensions in mm

TO-72

Insulated electrodes



S=Shield lead connected to case

7Z3 0274

RATINGS (Limiting values) [1]

Voltages

Collector-base voltage (open emitter)	V_{CBO}	max.	30	V
Collector-emitter voltage (open base) (See also sheet B)	V_{CEO}	max.	20	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	V

Currents

Collector current (d.c.)	I_C	max.	30	mA
Collector current (peak value)	I_{CM}	max.	30	mA

Power dissipation

Total power dissipation up to T_{amb} = 45 °C	P_{tot}	max.	145	mW

Temperatures

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

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	0.9	°C/mW

CHARACTERISTICS T_j = 25 °C unless otherwise specified

Base-emitter voltage [2]

I_C = 1 mA; V_{CE} = 10 V	V_{BE}		0.65 to 0.74	V

Feedback capacitance at f = 0.45 MHz

I_C = 1 mA; V_{CE} = 10 V	$-C_{re}$	typ.	0.65	pF

D.C. current gain

I_C = 1 mA; V_{CE} = 10 V	h_{FE}		34 to 140	
		typ.	67	

Transition frequency

I_C = 1 mA; V_{CE} = 10 V	f_T	typ.	220	MHz

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

[2]) V_{BE} decreases with about 1.7 mV/°C at increasing temperature. 7Z3 0275

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

Noise figure				
I_C = 1 mA; V_{CE} = 10 V				
f = 1 MHz; G_S = 20 $m\Omega^{-1}$	F	typ.	3.5	dB
f = 100 MHz; G_S = 10 $m\Omega^{-1}$	F	typ.	3.6	dB
Conversion noise figure at I_C = 1 mA; V_{CE} = 10 V				
f = 0.2 MHz; G_S = 2 $m\Omega^{-1}$	F_c	typ.	2.5	dB
f = 1 MHz; G_S = 2 $m\Omega^{-1}$	F_c	typ.	2.5	dB
y parameters at f = 0.45 MHz (common emitter)				
I_C = 1 mA; V_{CE} = 10 V				
Input conductance	g_{ie}	typ.	0.4	$m\Omega^{-1}$
Input capacitance	C_{ie}	typ.	25	pF
Feedback admittance	$\lvert y_{re} \rvert$	typ.	1.5	$\mu\Omega^{-1}$
Phase angle of feedback admittance	φ_{re}	typ.	270°	
Transfer admittance	$\lvert y_{fe} \rvert$	typ.	35	$m\Omega^{-1}$
Phase angle of transfer admittance	φ_{fe}	typ.	0	
Output conductance	g_{oe}	typ.	4	$\mu\Omega^{-1}$
Output capacitance	C_{oe}	typ.	1.4	pF
y parameters at f = 10.7 MHz (common emitter)				
I_C = 1 mA; V_{CE} = 10 V				
Input conductance	g_{ie}	typ.	0.55	$m\Omega^{-1}$
Input capacitance	C_{ie}	typ.	29	pF
Feedback admittance	$\lvert y_{re} \rvert$	typ.	38	$\mu\Omega^{-1}$
Phase angle of feedback admittance	φ_{re}	typ.	270°	
Transfer admittance	$\lvert y_{fe} \rvert$	typ.	35	$m\Omega^{-1}$
Phase angle of transfer admittance	φ_{fe}	typ.	355°	
Output conductance	g_{oe}	typ.	4.5	$\mu\Omega^{-1}$
Output capacitance	C_{oe}	typ.	1.6	pF

NOTE

All small signal quantities have been measured with a length of leads between the bottom of the transistor and measuring jig of 3 mm.

7Z3 0276

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

y parameters at f = 35 MHz (common emitter)

I_C = 1 mA; V_{CE} = 10 V

Input conductance	g_{ie}	typ.	1.1	$m\Omega^{-1}$
Input capacitance	C_{ie}	typ.	22	pF
Feedback admittance	$\|y_{re}\|$	typ.	125	$\mu\Omega^{-1}$
Phase angle of feedback admittance	φ_{re}	typ.	270°	
Transfer admittance	$\|y_{fe}\|$	typ.	35	$m\Omega^{-1}$
Phase angle of transfer admittance	φ_{fe}	typ.	345°	
Output conductance	g_{oe}	typ.	5	$\mu\Omega^{-1}$
Output capacitance	C_{oe}	typ.	1.6	pF

y parameters at f = 100 MHz (common emitter)

I_C = 1 mA; V_{CE} = 10 V

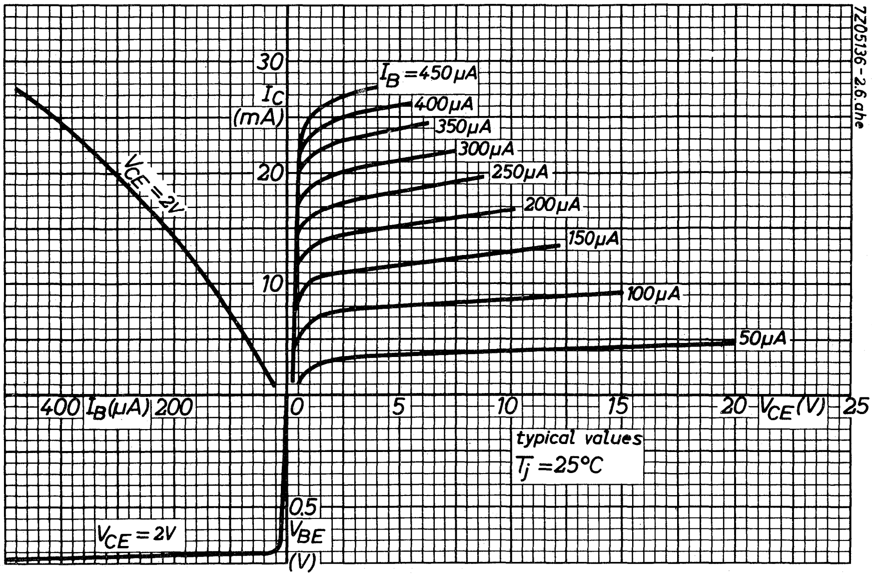
Input conductance	g_{ie}	typ.	6	$m\Omega^{-1}$
Input capacitance	C_{ie}	typ.	21	pF
Feedback admittance	$\|y_{re}\|$	typ.	380	$\mu\Omega^{-1}$
Phase angle of feedback admittance	φ_{re}	typ.	265°	
Transfer admittance	$\|y_{fe}\|$	typ.	33	$m\Omega^{-1}$
Phase angle of transfer admittance	φ_{fe}	typ.	325°	
Output conductance	g_{oe}	typ.	12	$\mu\Omega^{-1}$
Output capacitance	C_{oe}	typ.	1.6	pF

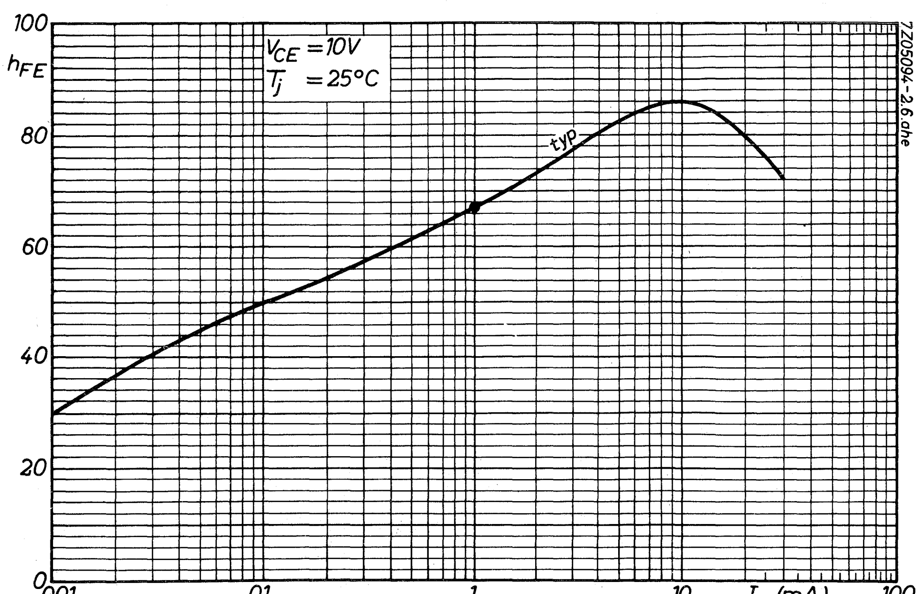
y parameters at f = 100 MHz (common emitter)

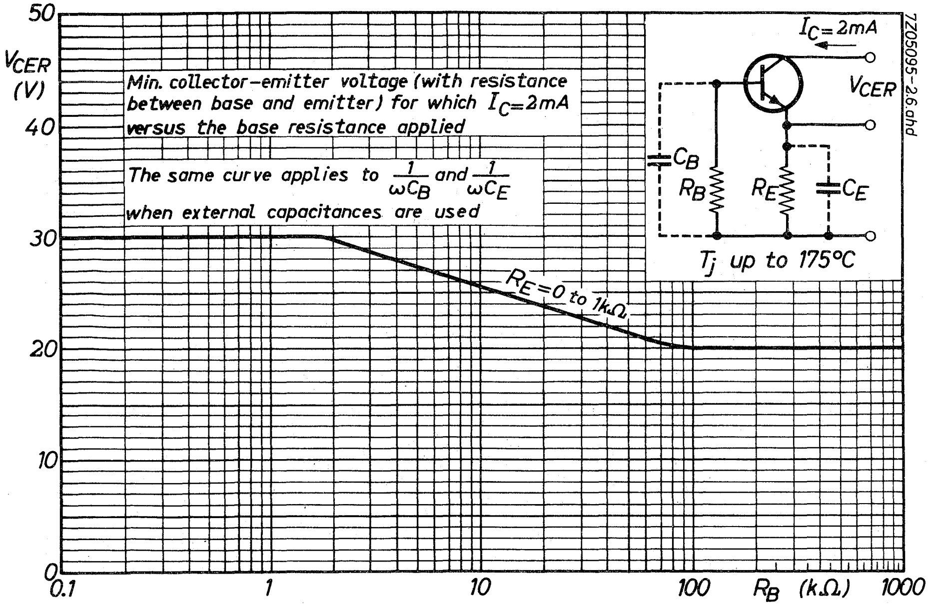
$-I_E$ = 1 mA; V_{CB} = 10 V

Input conductance	g_{ib}	typ.	33	$m\Omega^{-1}$
Input capacitance	C_{ib}	typ.	6	pF
Feedback admittance	$\|y_{rb}\|$	typ.	255	$\mu\Omega^{-1}$
Phase angle of feedback admittance	φ_{rb}	typ.	271°	
Transfer admittance	$\|y_{fb}\|$	typ.	33	$m\Omega^{-1}$
Phase angle of transfer admittance	φ_{fb}	typ.	150°	
Output conductance	g_{ob}	typ.	12	$\mu\Omega^{-1}$
Output capacitance	C_{ob}	typ.	1.6	pF

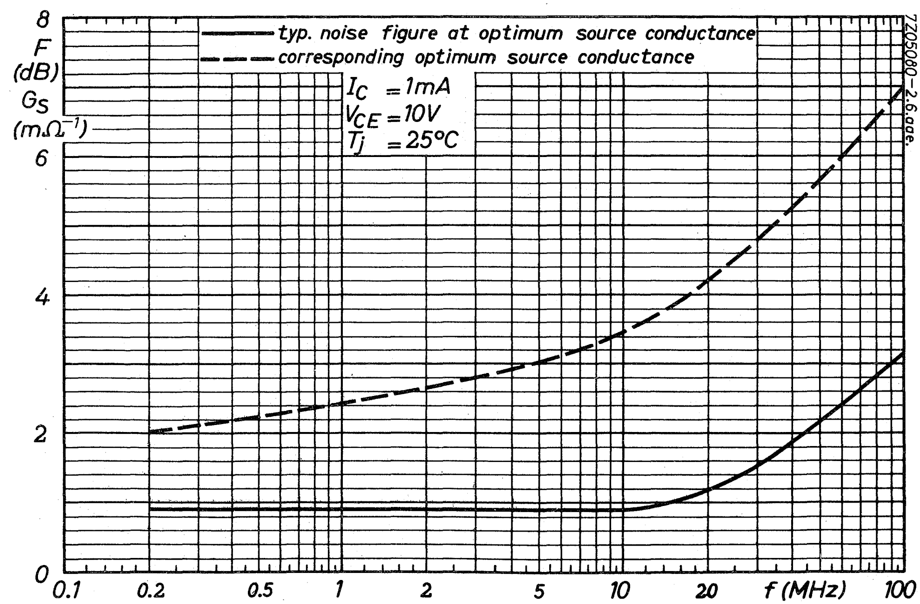
7Z3 0277


7Z05136-2.6.ahe
30
I_C (mA)
20
10
I_B = 450 μA
400 μA
350 μA
300 μA
250 μA
200 μA
150 μA
100 μA
50 μA
V_{CE} = 2V
400 I_B (μA) 200
0 5 10 15 20 V_{CE} (V) 25
typical values
T_j = 25°C
0.5
V_{BE} (V)
V_{CE} = 2V


7Z05094-2.6.ahe
100
h_{FE}
80
60
40
20
0
V_{CE} = 10V
T_j = 25°C
typ
0.01 0.1 1 10 I_C (mA) 100



Min. collector-emitter voltage (with resistance between base and emitter) for which $I_C = 2mA$ versus the base resistance applied
The same curve applies to $\frac{1}{\omega C_B}$ and $\frac{1}{\omega C_E}$ when external capacitances are used
V_{CER} (V)
$R_E = 0$ to $1k\Omega$
$I_C = 2mA$
C_B
R_B
R_E
C_E
V_{CER}
T_j up to 175°C
R_B (kΩ)
7Z05095-2.6.ahd



typ. noise figure at optimum source conductance
corresponding optimum source conductance
$I_C = 1mA$
$V_{CE} = 10V$
$T_j = 25°C$
F (dB)
G_S ($m\Omega^{-1}$)
f (MHz)
7Z05080-2.6.aae.

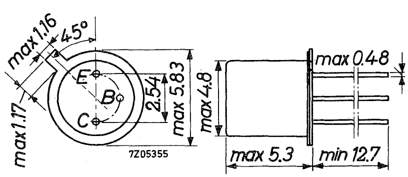
SILICON PLANAR EPITAXIAL TRANSISTOR

N-P-N silicon planar epitaxial transistor in a TO-18 metal envelope with the collector connected to the case. The BFX43 is primarily intended for the output stages of aerial amplifiers in band I to III (up to 230 MHz).

QUICK REFERENCE DATA				
Collector-base voltage (open emitter)	V_{CBO}	max.	30	V
Collector-emitter voltage (open base)	V_{CEO}	max.	15	V
Collector current (peak value)	I_{CM}	max.	250	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	360	mW
Junction temperature	T_j	max.	200	°C
Transition frequency				
I_C = 10 mA; V_{CE} = 10 V	f_T	>	500	MHz
I_C = 50 mA; V_{CE} = 10 V	f_T	>	500	MHz
Output voltage at d_{im} = −30 dB				
I_C = 40 mA; V_{CE} = 10 V; R_L = 37.5 Ω				
f_p = 202 MHz; f_q = 205 MHz; $f_{(2q-p)}$ = 208 MHz	V_o	>	0.8	V

MECHANICAL DATA Dimensions in mm

TO-18
Collector connected to case



7Z3 0728

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
Collector-emitter voltage with $V_{BE} = 0$	V_{CES}	max.	30	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4	V

Currents

Collector current (d.c. or average over any 20 ms period)	I_C	max.	125	mA
Collector current (peak value)	I_{CM}	max.	250	mA

Power dissipation

Total power dissipation up to $T_{amb} = 25\ ^oC$	P_{tot}	max.	360	mW

Temperatures

Storage temperature	T_{stg}		−65 to +200	^oC
Junction temperature	T_j	max.	200	^oC

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	0.48	$^oC/mW$
From junction to ambient with cooling clip 56263	$R_{th\ j-a}$	=	0.28	$^oC/mW$
From junction to case	$R_{th\ j-c}$	=	0.145	$^oC/mW$

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

7Z3 0729

SILICON PLANAR EPITAXIAL TRANSISTOR

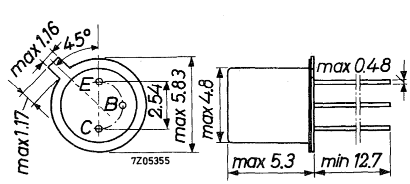
N-P-N transistor in a TO-18 metal envelope with the collector connected to the case. The BFX44 is primarily intended for use as a low distortion common base linear output amplifier, capable of delivering an output voltage swing of at least 20 V across a 400 Ω load at frequencies up to 150 MHz (e.g. as required for the output stage of a d.c. to 150 MHz vertical amplifier of a wide band oscilloscope)

QUICK REFERENCE DATA				
Collector-base voltage (open emitter)	V_{CBO}	max.	40	V
Collector-emitter voltage (R_{BE} = 10 Ω)	V_{CER}	max.	23	V
Collector current (peak value)	I_{CM}	max.	250	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	360	mW
Junction temperature	T_j	max.	200	°C
Transition frequency				
I_C = 10 mA; V_{CE} = 10 V	f_T	>	500	MHz
I_C = 100 mA; V_{CE} = 3 V	f_T	>	300	MHz

MECHANICAL DATA Dimensions in mm

TO-18

Collector connected to case



7Z3 0702

RATINGS (Limiting values) [1]

Voltages

Collector-base voltage (open emitter)	V_{CBO}	max.	40	V
Collector-emitter voltage (open base)	V_{CEO}	max.	15	V
Collector-emitter voltage with R_{BE} = 10 Ω	V_{CER}	max.	23	V
Collector-emitter voltage with V_{BE} = 0	V_{CES}	max.	40	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4	V

Currents

Collector current (d.c. or average over any 20 ms period)	I_C	max.	125	mA
Collector current (peak value)	I_{CM}	max.	250	mA

Power dissipation

Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	360	mW

Temperatures

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

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	0.48	°C/mW
From junction to ambient with cooling clip 56263	$R_{th\ j-a}$	=	0.28	°C/mW
From junction to case	$R_{th\ j-c}$	=	0.145	°C/mW

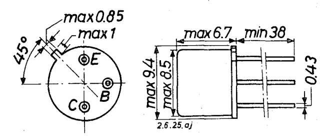
[1]) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

7Z3 0703

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

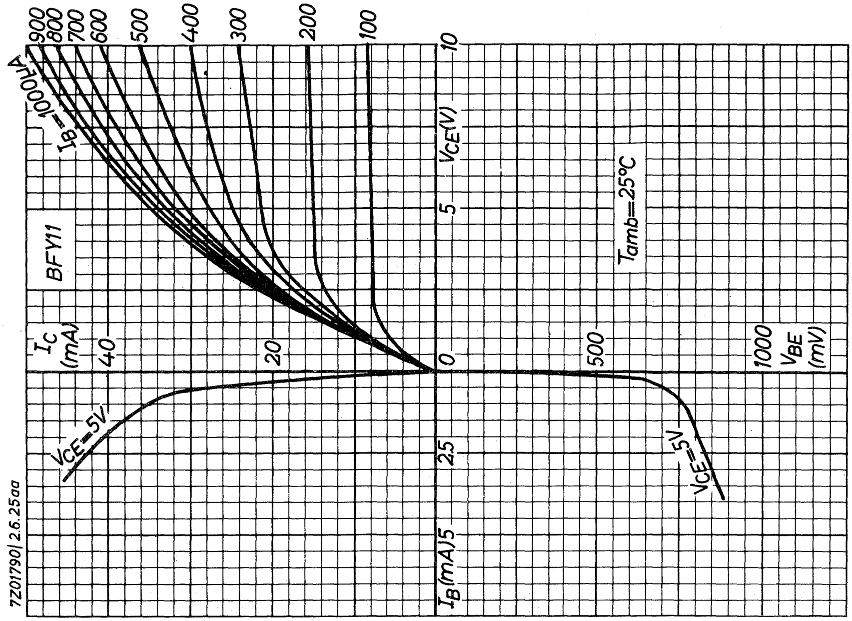
Frequency at which $\lvert h_{fe}\rvert$ = 1 at V_{CB} = 10 V; $-I_E$ = 5 mA	f_1	> 60 = 120	Mc/s Mc/s
Noise figure at V_{CB} = 10 V; $-I_E$ = 5 mA; f = 0.45 Mc/s	F	= 20 < 40	dB dB
Output capacitance at V_{CB} = 10 V; I_E = 0 mA	c_c	< 3	pF

Small-signal parameters of BFY10 and BFY11 at

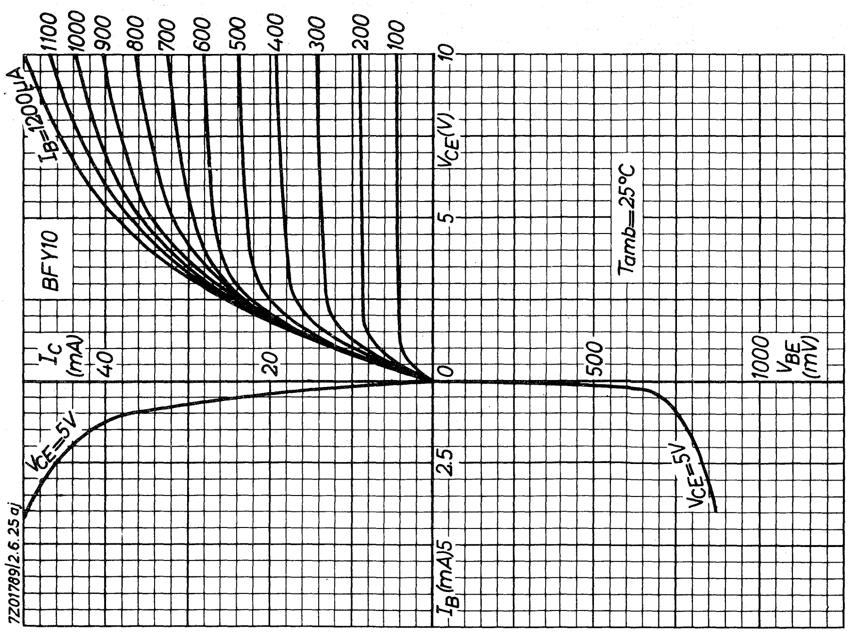
V_{CB} = 10 V; $-I_E$ = 5 mA; f = 35 Mc/s

	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

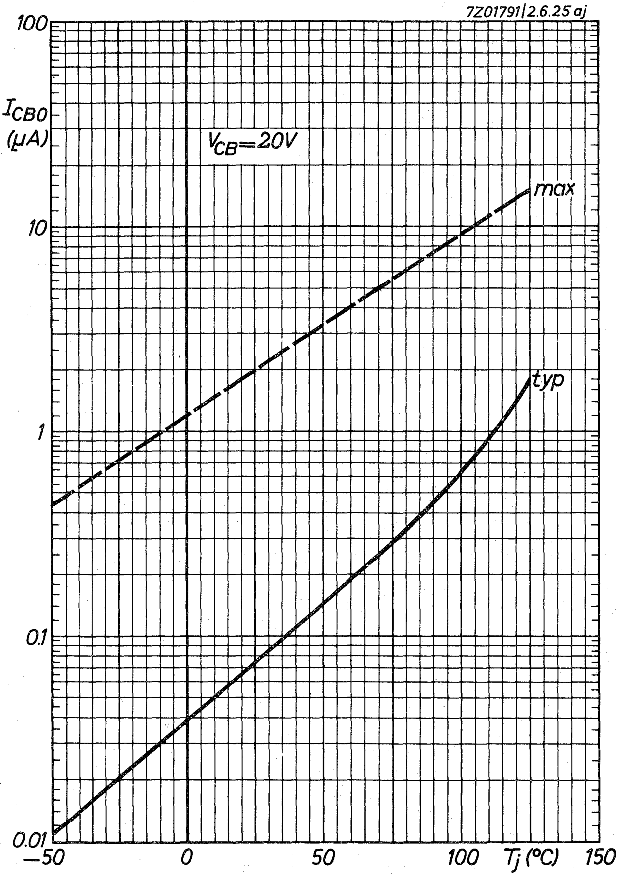
7Z2 2343


BFY11
I_B=1000µA
900
800
700
600
500
400
300
200
100
I_C (mA)
40
20
0
5
10
V_CE(V)
T_amb=25°C
500
1000
V_BE (mV)
V_CE=5V
V_CE=5V
2.5
I_B(mA)5
7Z01790|2.6.25aa

B


BFY10
I_B=1200µA
1100
1000
900
800
700
600
500
400
300
200
100
I_C (mA)
40
20
0
5
10
V_CE(V)
T_amb=25°C
500
1000
V_BE (mV)
V_CE=5V
V_CE=5V
2.5
I_B(mA)5
7Z01789|2.6.25aj

A


7Z01791|2.6.25 aj
100
I_{CBO}
(µA)
V_{CB}=20V
max
10
typ
1
0.1
0.01
−50
0
50
100
T_j (°C)
150

C

SILICON PLANAR EPITAXIAL TRANSISTORS

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

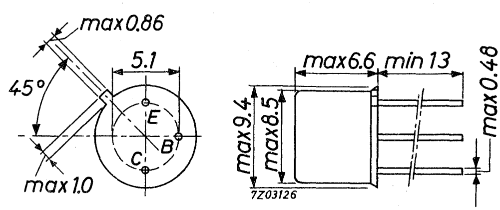
QUICK REFERENCE DATA

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

MECHANICAL DATA

TO-39

Collector connected to case



7Z3 0769

RATINGS (Limiting values) [1]

			BFY44	BFY70	
Voltages					
Collector-base voltage (open emitter)	V_{CBO}	max.	80	60	V
Collector-emitter voltage (open base)	V_{CEO}	max.	60	40	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4	4	V
Currents					
Collector current (d.c.)	I_C	max.	1.0		A
Collector current (peak value)	I_{CM}	max.	1.0		A
Base current (d.c.)	I_B	max.	0.2		A
Base current (peak value)	I_{BM}	max.	0.2		A
Power dissipation					
Total power dissipation up to $T_{case} = 25\,^oC$	P_{tot}	max.	5		W [2]
Temperatures					
Storage temperature	T_{stg}	−65 to	+200		^oC
Junction temperature	T_j	max.	200		^oC

THERMAL RESISTANCE

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

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

[2]) See also page F

7Z3 0770

CHARACTERISTICS T_j = 25 °C unless otherwise specified

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

Saturation voltages

			BFY44, BFY70	
$I_C = 500$ mA; $I_B = 100$ mA	V_{CEsat}	typ.	0.4	V
		<	0.7	V
	V_{BEsat}	typ.	1.0	V
		<	1.5	V

7Z3 0771

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

D.C. current gain

$I_C = 150$ mA; $V_{CE} = 10$ V	h_{FE}	typ.	20	
$I_C = 500$ mA; $V_{CE} = 5$ V	h_{FE}	>	5	
		typ.	20	

Collector capacitance at f = 1 MHz

$I_E = I_e = 0$	BFY44 : $V_{CB} = 40$ V	C_c	typ.	7	pF
			<	12	pF
$I_E = I_e = 0$	BFY70 : $V_{CB} = 28$ V	C_c	typ.	7	pF
			<	14	pF

Transition frequency

$I_C = 100$ mA; $V_{CE} = 10$ V	f_T	typ.	210	MHz

Feedback time constant at f = 10.7 MHz

$-I_E = 30$ mA; $V_{CB} = 20$ V	$\left\|\frac{h_{rb}}{\omega}\right\|$	typ.	18	ps
		<	35	ps

y parameters at f = 180 MHz (common base) $T_{amb} = 25\ ^oC$

$-I_E = 150$ mA; $V_{CB} = 24$ V

Input conductance	g_{ib}	typ.	48	$m\Omega^{-1}$
Input capacitance	$-C_{ib}$	typ.	120	pF
Transfer admittance	$\|y_{fb}\|$	typ.	98	$m\Omega^{-1}$
Phase angle of transfer admittance	φ_{fb}	typ.	62^o	
Output conductance	g_{ob}	typ.	4.3	$m\Omega^{-1}$
Output capacitance	C_{ob}	typ.	13.5	pF

y parameters at f = 180 MHz (common emitter)

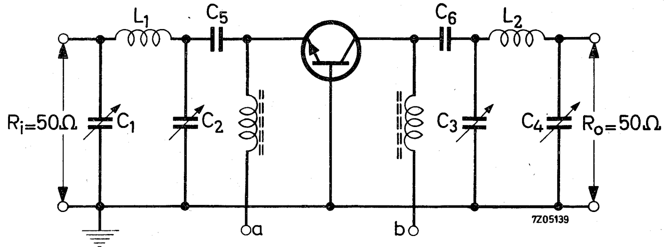
$I_C = 150$ mA; $V_{CE} = 24$ V

Input conductance	g_{ie}	typ.	96	$m\Omega^{-1}$
Input capacitance	$-C_{ie}$	typ.	32	pF

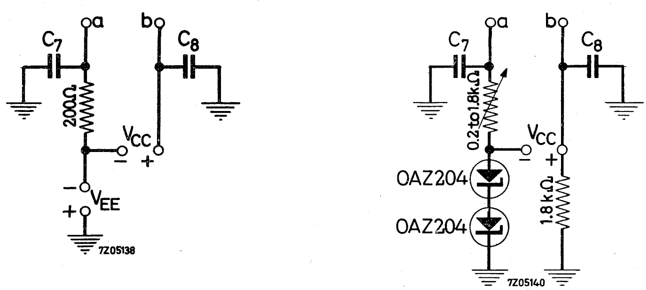
7Z3 0772

APPLICATION INFORMATION

A. Amplifier circuit



Different methods of biasing



Components	f = 100 MHz	f = 180 MHz
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, C_6, C_7, C_8	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

Performance in common base configuration (see pages A/C)

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

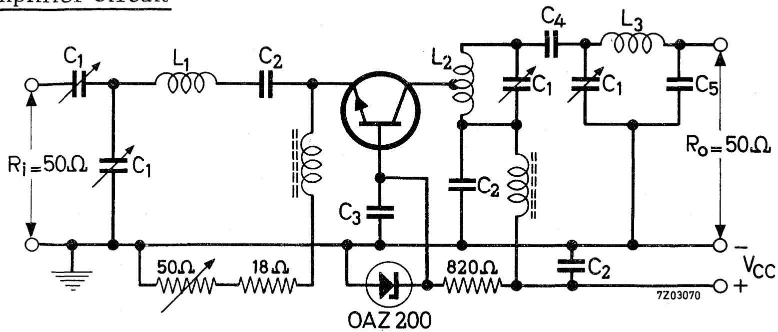
BFY70: V_{CE} = 28 V; P_i = 0.3 W

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

7Z30773

APPLICATION INFORMATION (continued)

B. Amplifier circuit

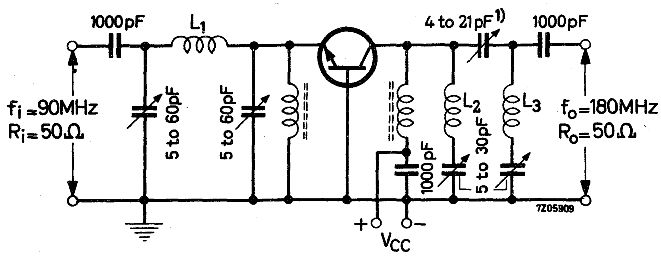


Components	f = 80 MHz	f = 165 MHz
C_1	60 pF	25 pF
C_2	680 pF	100 pF
C_3	680 pF	82 pF
C_4	4.7 pF	2.2 pF
C_5	82 pF	33 pF
L_1	2 turns Cu wire (1 mm); d = 10 mm	straight Cu wire (1 mm); length 40 mm
L_2	3 turns enamelled Cu wire (1.5 mm); d = 12 mm	2 turns Cu wire (1 mm); d = 10 mm
Tap	1.2 turn from cold 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

7Z3 0774

APPLICATION INFORMATION (continued)

C. Frequency doubler 90-180 MHz



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

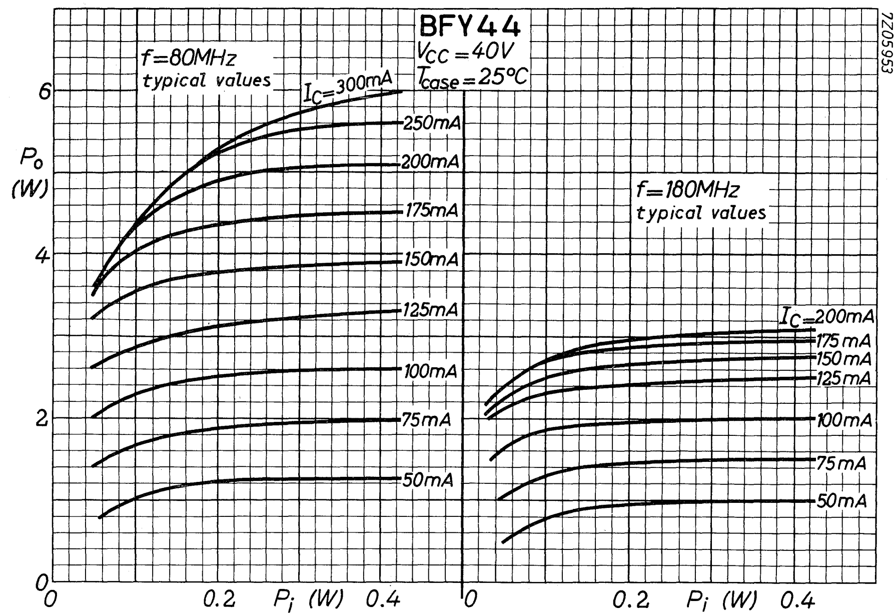
Typical performance

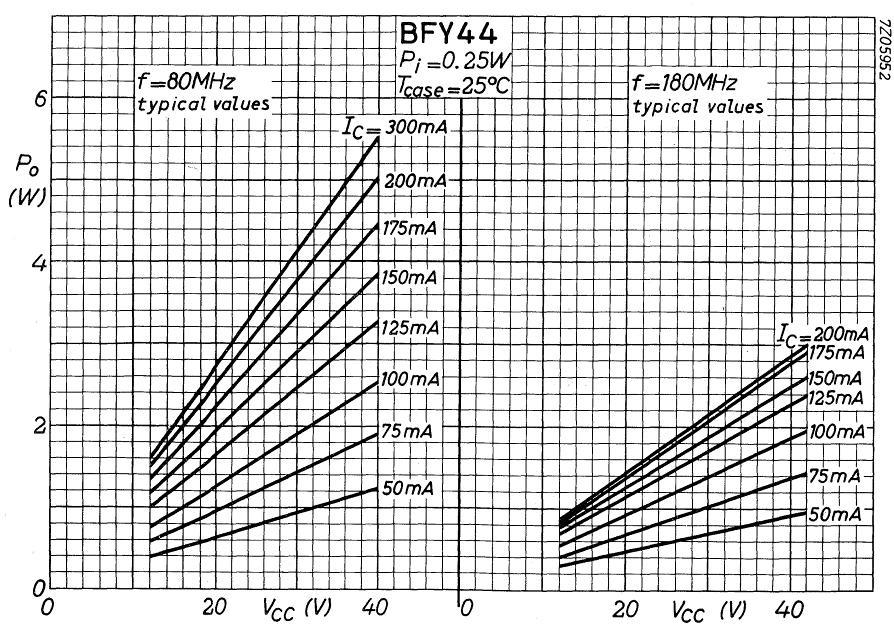
V_{CE} (V)	I_C (mA)	P_i = (mW) f_i = 90 MHz	P_o (mW) f_o = 180 MHz	G_p (dB)	η (%)
40[2]	110	130	920	8.5	21
30	94	110	700	8.0	25
20	82	110	460	6.2	28

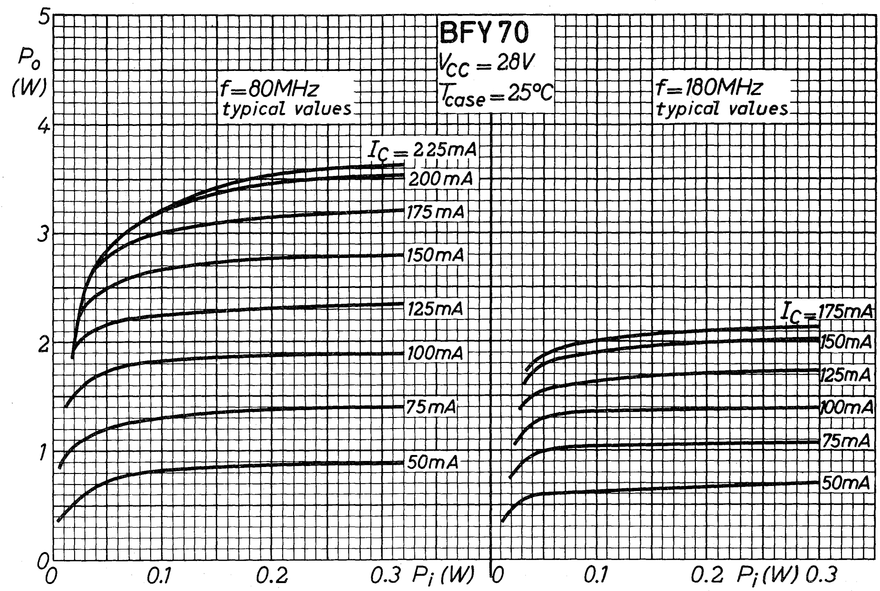
1) Variable ceramic capacitor
2) V_{CE} = 40 V is for BFY44 only

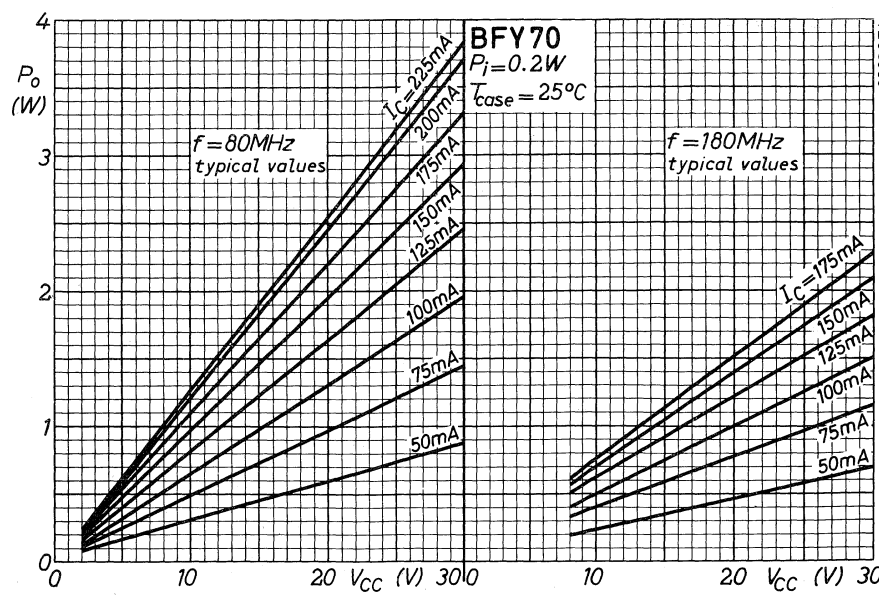
FOR MORE INFORMATION SEE APPLICATION INFORMATION BULLETIN AI518

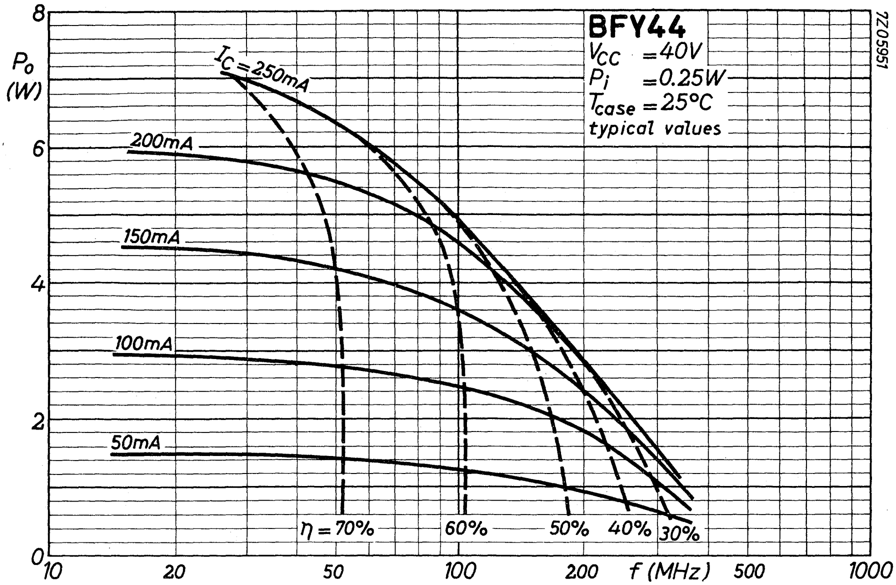
7Z3 0775

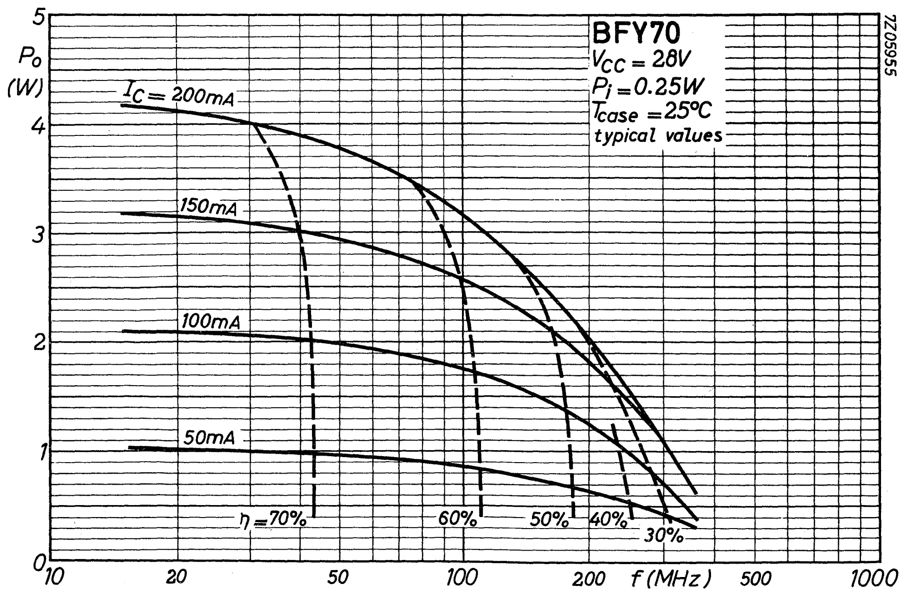

BFY44
V_{CC} = 40V
T_{case} = 25°C
f=80MHz
typical values
f=180MHz
typical values
I_C=300mA
250mA
200mA
175mA
150mA
125mA
100mA
75mA
50mA
I_C=200mA
175 mA
150 mA
125 mA
100mA
75 mA
50mA
P_o (W)
P_i (W)
0
0.2
0.4
2
4
6
7Z05953

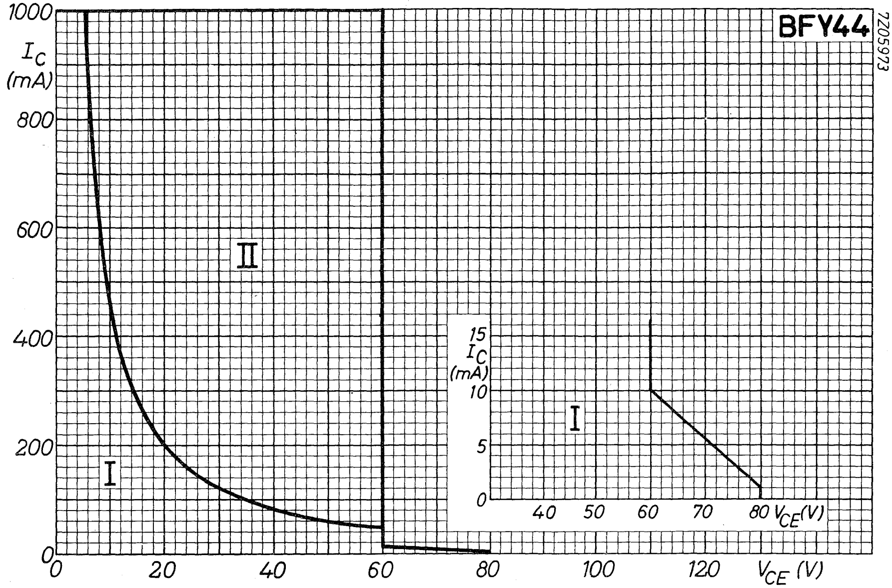

BFY44
P_i = 0.25W
T_{case} = 25°C
f=80MHz
typical values
f=180MHz
typical values
I_C= 300mA
200mA
175mA
150mA
125mA
100mA
75mA
50mA
I_C=200mA
175mA
150mA
125mA
100mA
75mA
50mA
P_o (W)
V_{CC} (V)
0
20
40
2
4
6
7Z05952

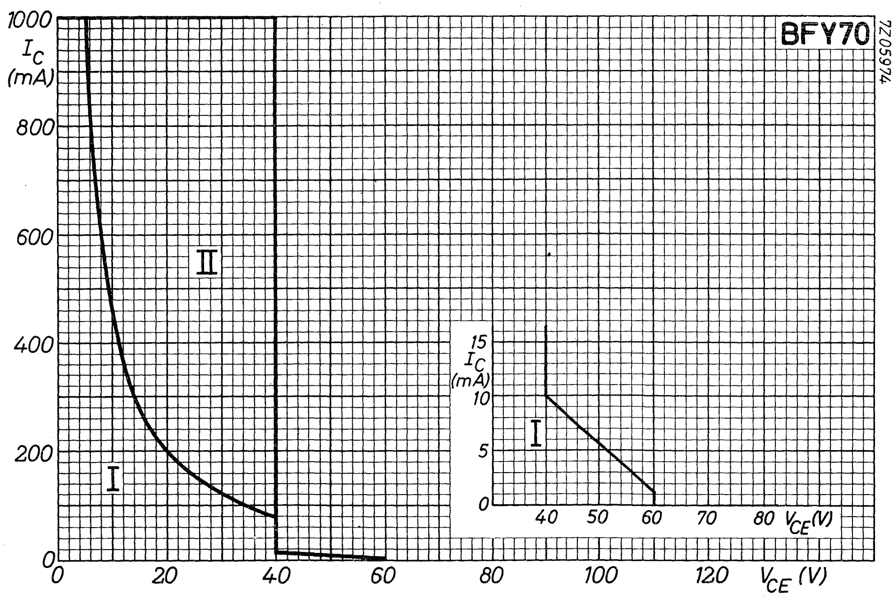

BFY 70
V_{CC} = 28V
T_{case} = 25°C
f=80MHz
typical values
f=180MHz
typical values
P_o
(W)
I_C = 225mA
200 mA
175 mA
150mA
125mA
100mA
75mA
50mA
I_C=175mA
150mA
125mA
100mA
75mA
50mA
0.1
0.2
0.3
P_i (W)
7Z05954

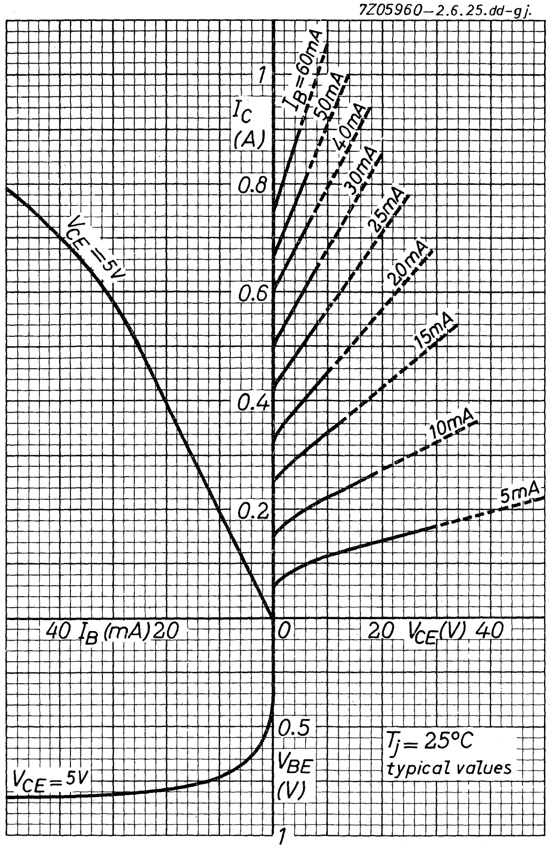

BFY 70
P_i=0.2W
T_{case} = 25°C
f=80MHz
typical values
f=180MHz
typical values
P_o
(W)
I_C=225mA
200mA
175mA
150mA
125mA
100mA
75mA
50mA
I_C=175mA
150mA
125mA
100mA
75mA
50mA
10
20
V_{CC} (V)
30
7Z05956

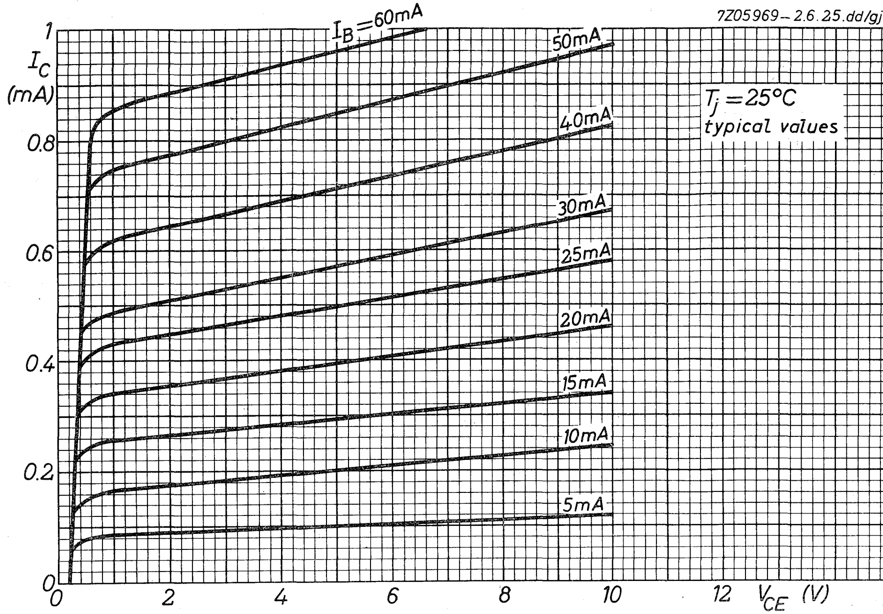

BFY44
V_{CC} = 40V
P_i = 0.25W
T_{case} = 25°C
typical values
7Z05951
P_o (W)
I_C = 250mA
200mA
150mA
100mA
50mA
η = 70%
60%
50%
40%
30%
f (MHz)
0
2
4
6
8
10
20
50
100
200
500
1000

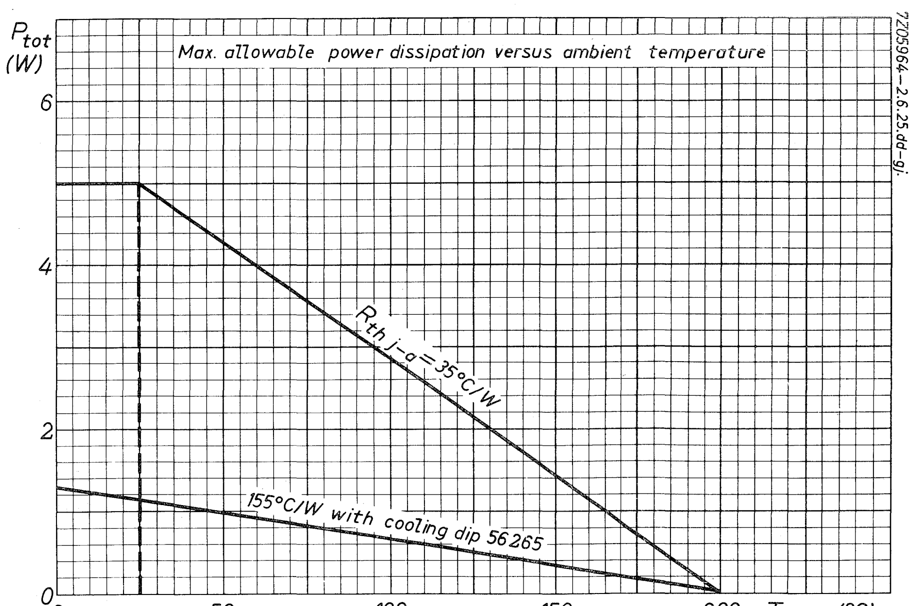

BFY70
V_{CC} = 28V
P_i = 0.25W
T_{case} = 25°C
typical values
7Z05955
P_o (W)
I_C = 200mA
150mA
100mA
50mA
η = 70%
60%
50%
40%
30%
f (MHz)
0
1
2
3
4
5
10
20
50
100
200
500
1000

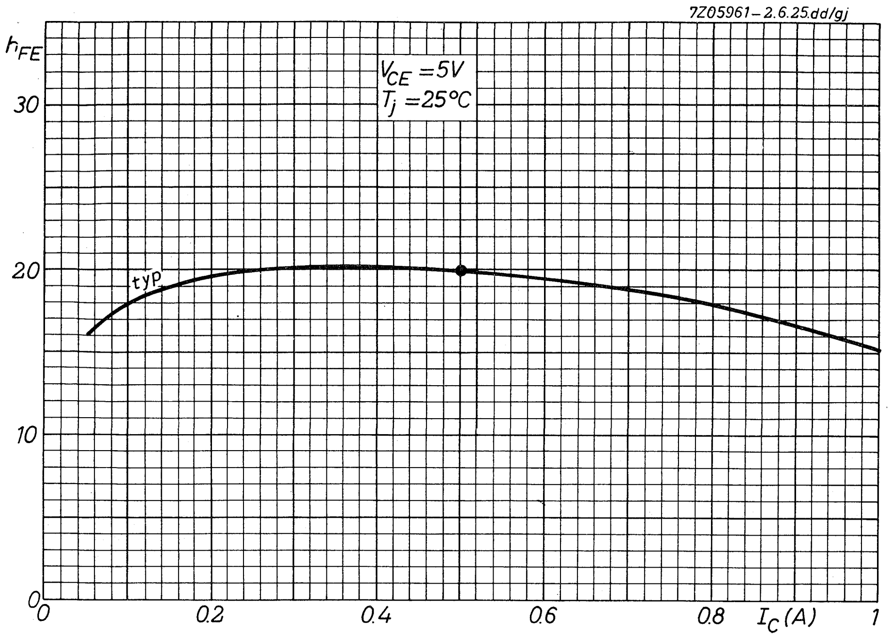

BFY44
7Z05973
1000
I_C (mA)
800
600
400
200
0
0
20
40
60
80
100
120
V_{CE} (V)
II
I
15
I_C (mA)
10
5
0
I
40
50
60
70
80
V_{CE}(V)

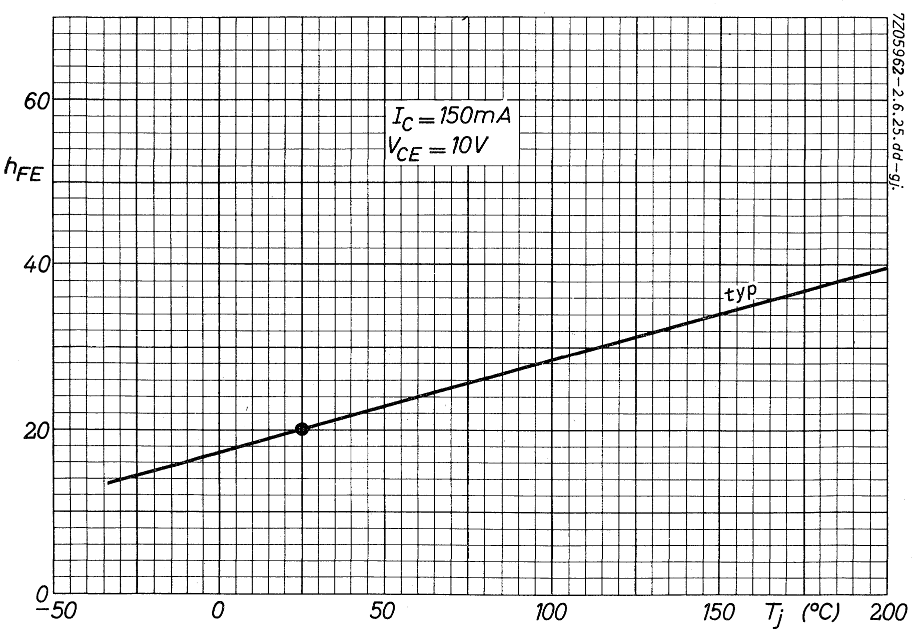

BFY70
7Z05974
1000
I_C (mA)
800
600
400
200
0
0
20
40
60
80
100
120
V_{CE} (V)
II
I
15
I_C (mA)
10
5
0
I
40
50
60
70
80
V_{CE}(V)

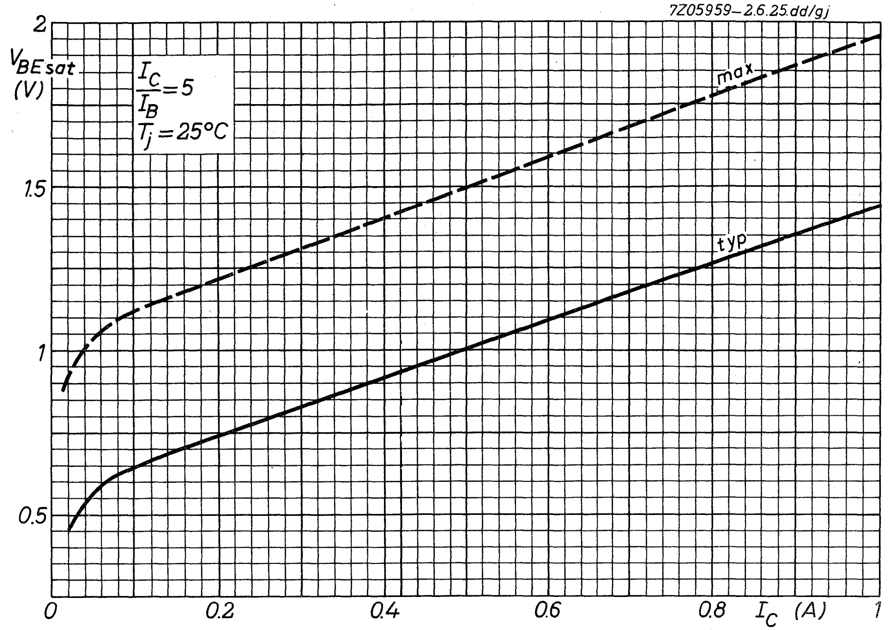

7Z05960–2.6.25.dd-gj.
I_C (A)
1
0.8
0.6
0.4
0.2
I_B=60mA
50mA
40mA
30mA
25mA
20mA
15mA
10mA
5mA
V_{CE}=5V
40 I_B (mA) 20
0
20 V_{CE}(V) 40
0.5
V_{BE} (V)
1
V_{CE}=5V
T_j= 25°C
typical values

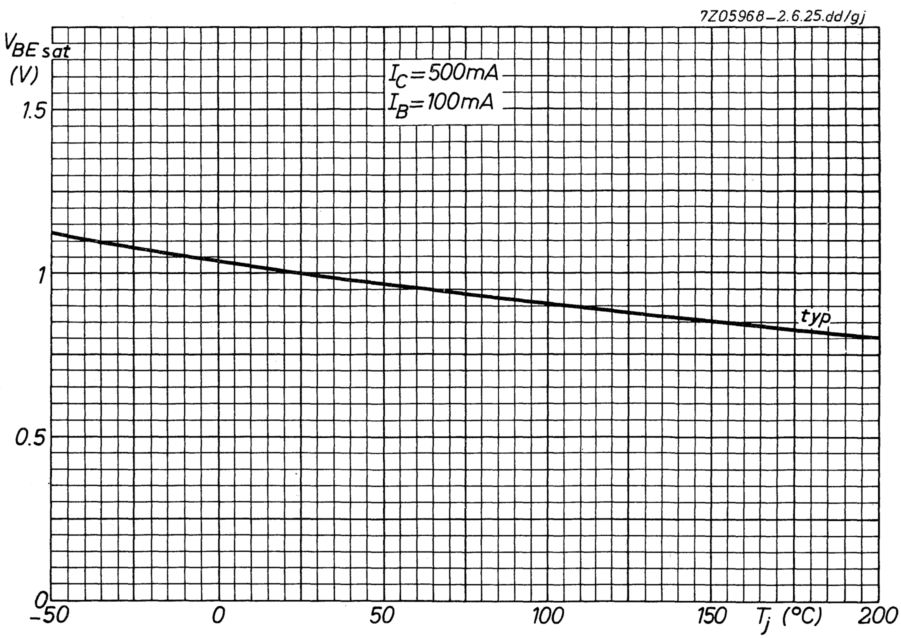

7Z05969–2.6.25.dd/gj
I_B = 60mA
50mA
40mA
30mA
25mA
20mA
15mA
10mA
5mA
I_C
(mA)
1
0.8
0.6
0.4
0.2
0
T_j = 25°C
typical values
0
2
4
6
8
10
12
V_{CE} (V)

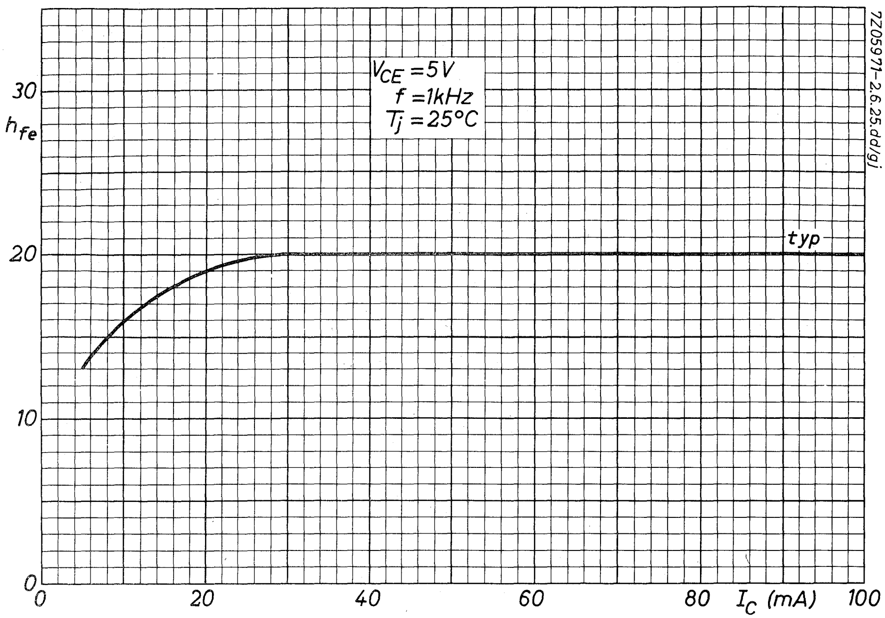

7Z05964–2.6.25.dd–gj.
P_{tot}
(W)
6
4
2
0
Max. allowable power dissipation versus ambient temperature
$R_{th\ j-a}$ = 35°C/W
155°C/W with cooling dip 56265
0
50
100
150
200
T_{amb} (°C)

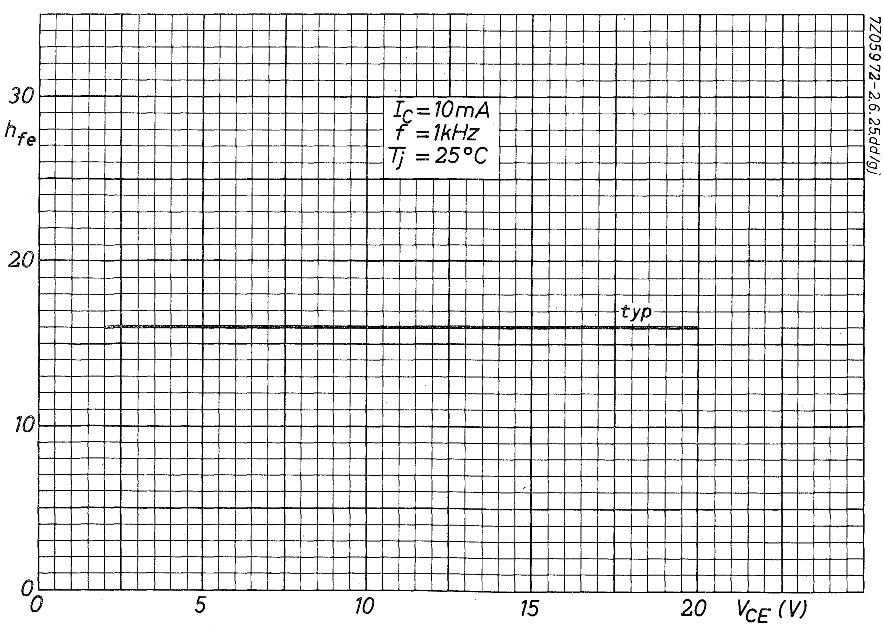

7Z05961–2.6.25.dd/gj
h_{FE}
V_{CE} = 5V
T_j = 25°C
typ
30
20
10
0
0
0.2
0.4
0.6
0.8
I_C (A)
1

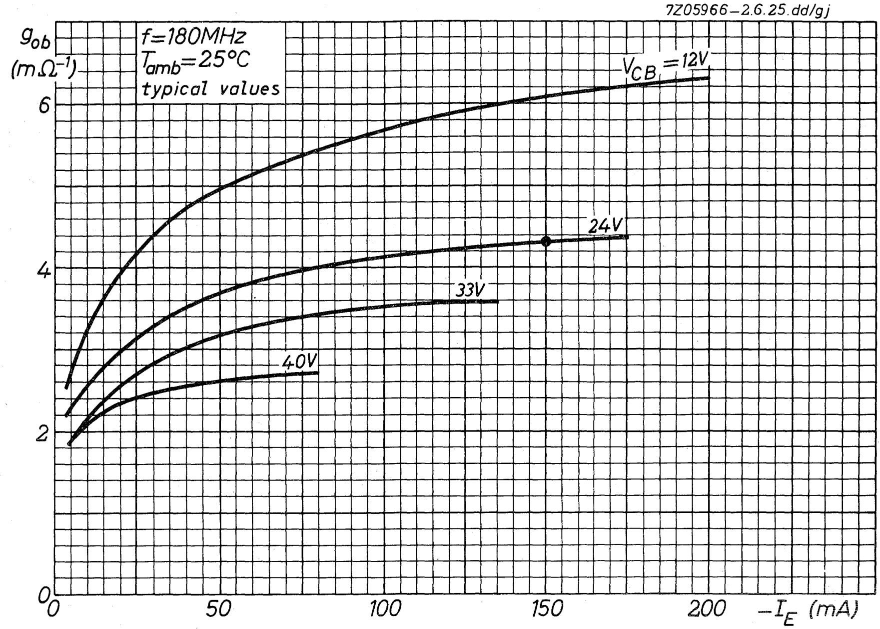

7Z05962–2.6.25.dd–gj.
h_{FE}
I_C = 150mA
V_{CE} = 10V
typ
60
40
20
0
−50
0
50
100
150
T_j (°C)
200

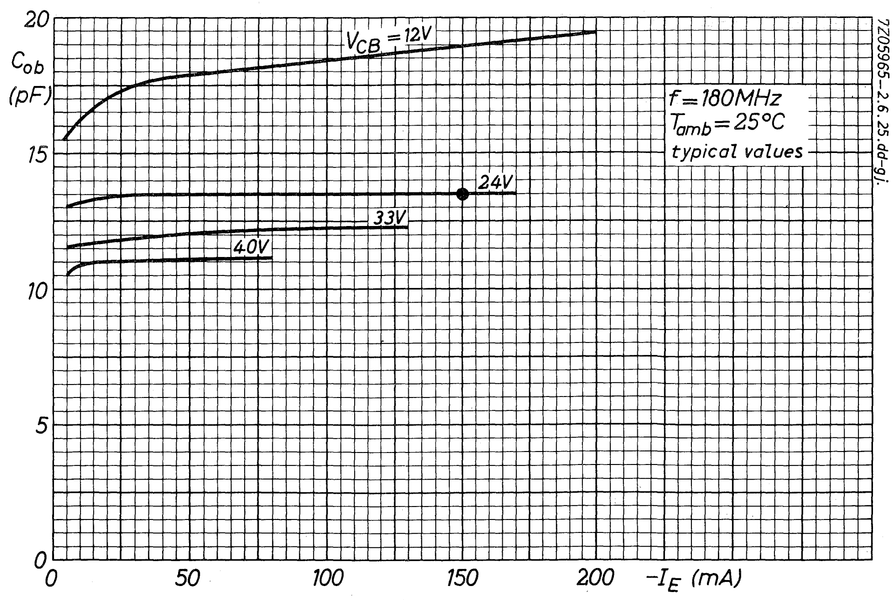

7Z05959-2.6.25.dd/gj
V_{BEsat} (V)
2
1.5
1
0.5
$\frac{I_C}{I_B}=5$
$T_j=25°C$
max
typ
0
0.2
0.4
0.6
0.8
1
I_C (A)

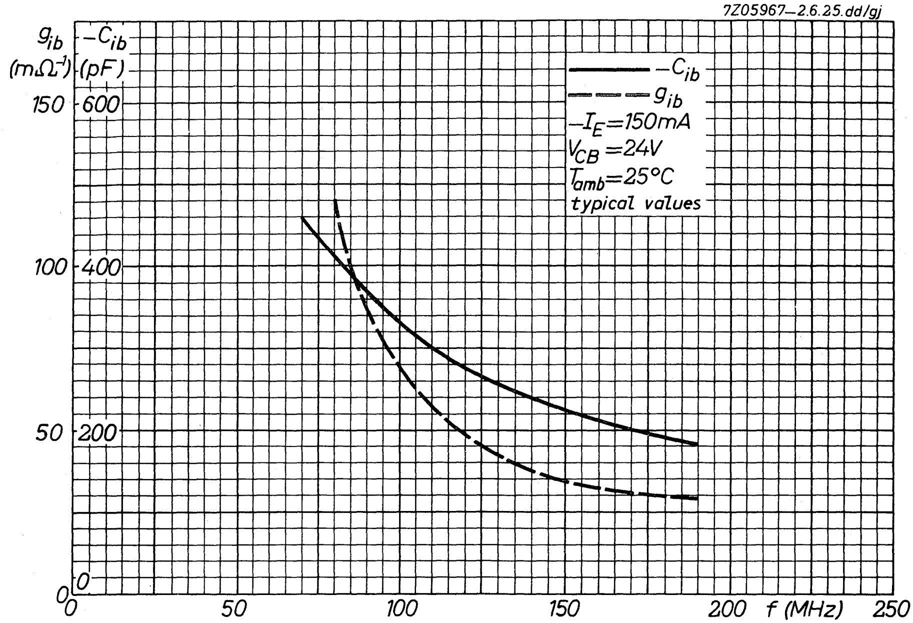

7Z05968-2.6.25.dd/gj
$V_{BE sat}$ (V)
1.5
1
0.5
0
$I_C=500mA$
$I_B=100mA$
typ
-50
0
50
100
150
200
T_j (°C)

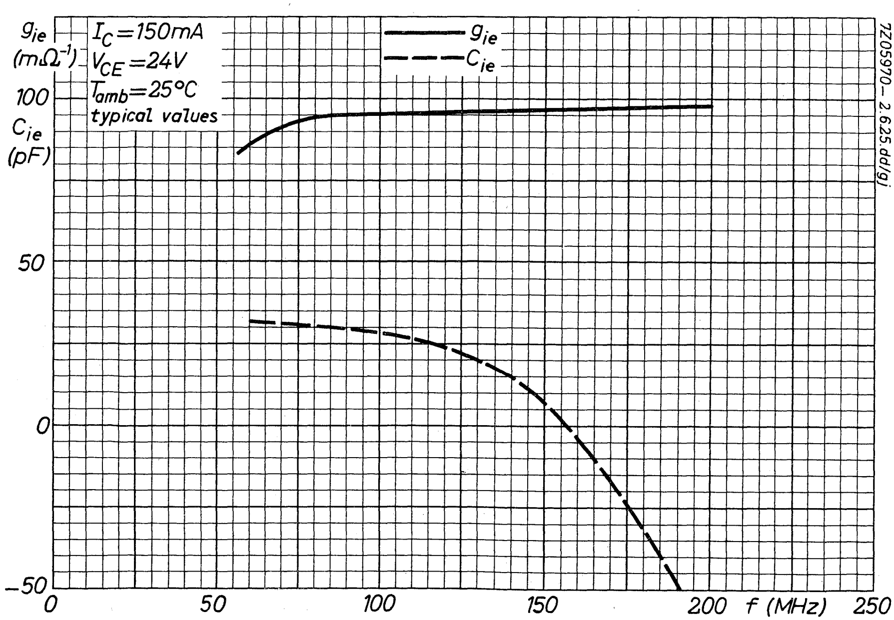

V_{CE} = 5 V
f = 1 kHz
T_j = 25 °C
typ
30
h_{fe}
20
10
0
0
20
40
60
80
I_C (mA)
100
7Z05971-2.6.25.dd/gj

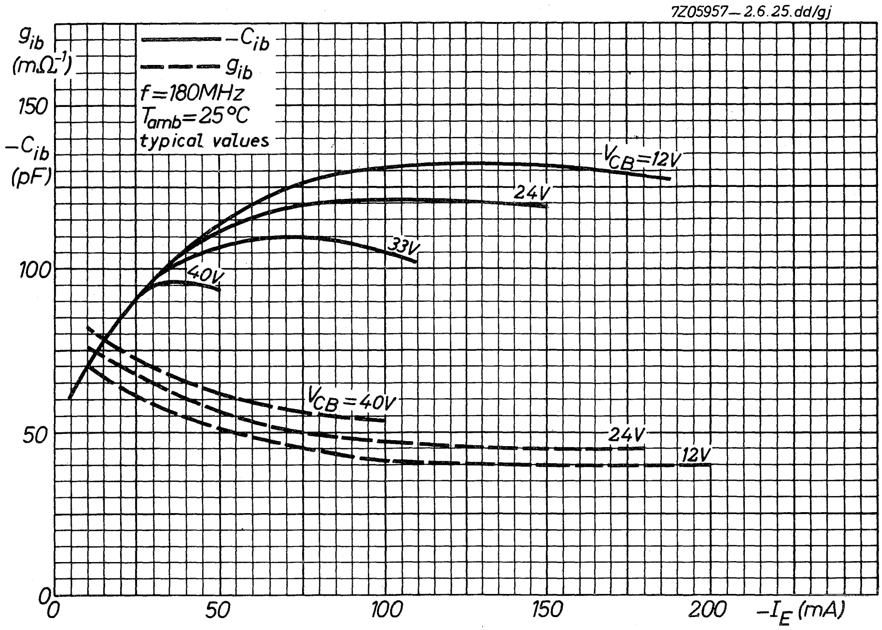

I_C = 10 mA
f = 1 kHz
T_j = 25 °C
typ
30
h_{fe}
20
10
0
0
5
10
15
20
V_{CE} (V)
7Z05972-2.6.25dd/gj

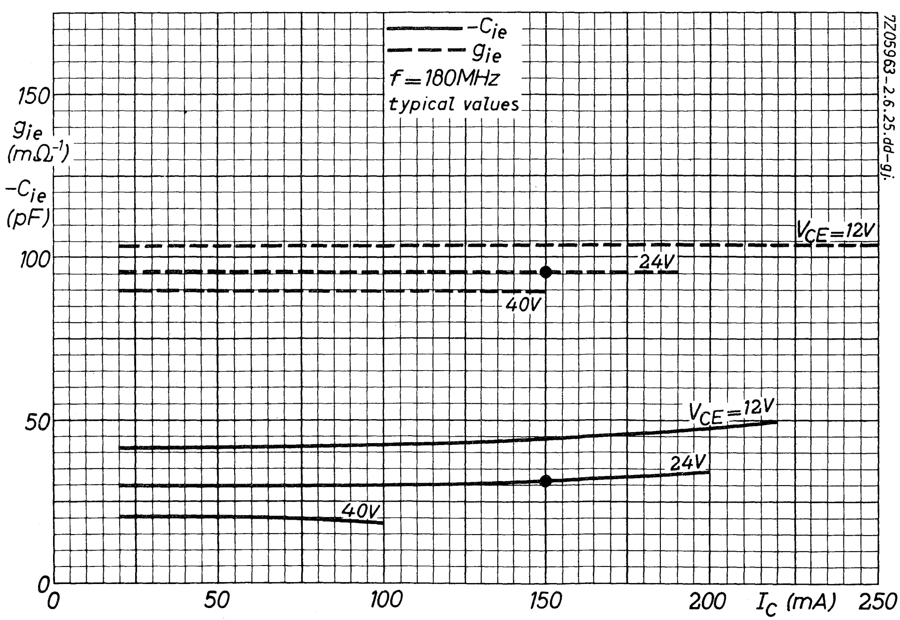

7Z05966–2.6.25.dd/gj
g_{ob}
($m\Omega^{-1}$)
f=180MHz
T_{amb}=25°C
typical values
V_{CB}=12V
24V
33V
40V
6
4
2
0
0
50
100
150
200
$-I_E$ (mA)

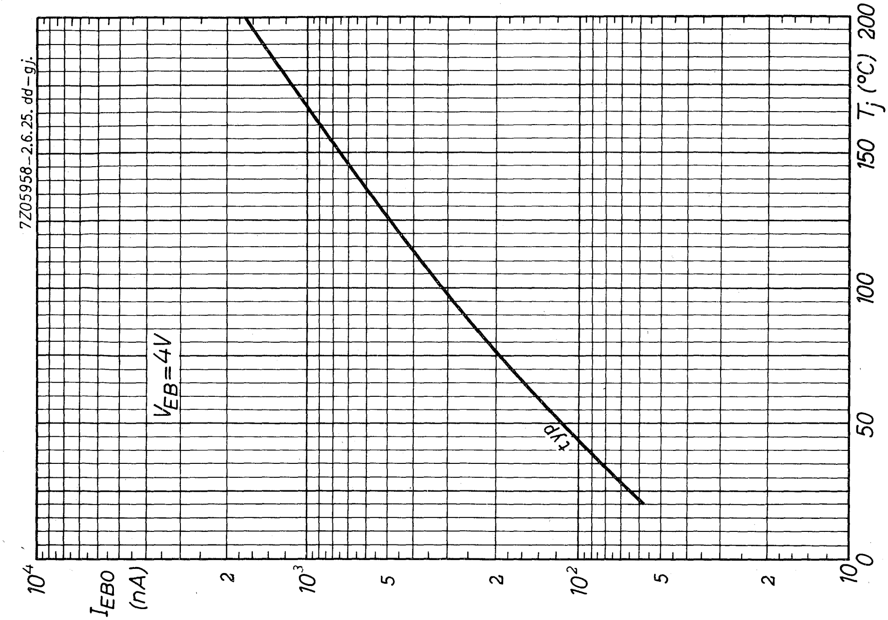

20
C_{ob}
(pF)
15
10
5
0
V_{CB}=12V
f=180MHz
T_{amb}=25°C
typical values
24V
33V
40V
0
50
100
150
200
$-I_E$ (mA)
7Z05965–2.6.25.dd-gj.

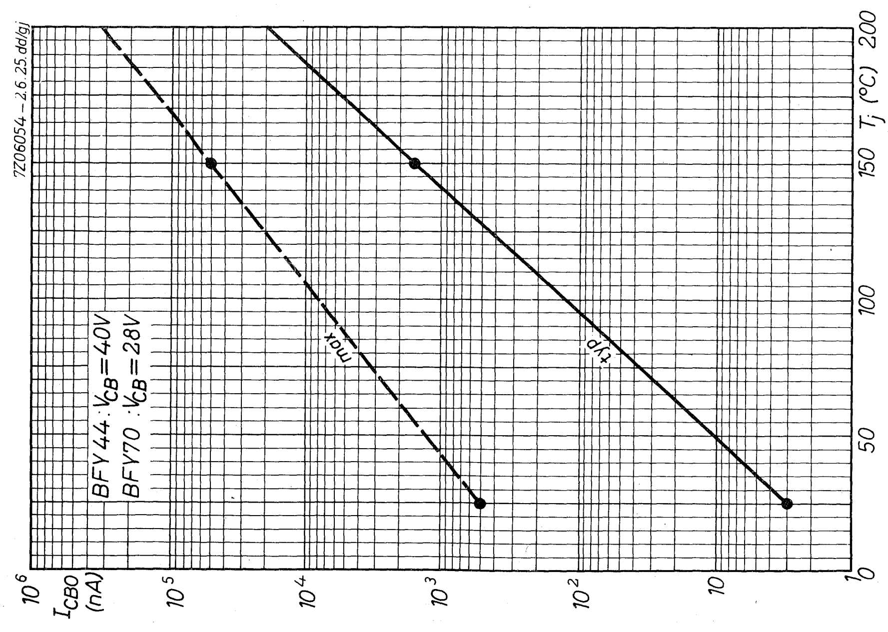

7Z05967–2.6.25.dd/gj
g_{ib} ($m\Omega^{-1}$)
$-C_{ib}$ (pF)
150
600
100
400
50
200
0
0
$-C_{ib}$
g_{ib}
$-I_E$=150mA
V_{CB}=24V
T_{amb}=25°C
typical values
0
50
100
150
200
f (MHz)
250


7Z05970– 2.6.25.dd/gj
g_{ie} ($m\Omega^{-1}$)
100
C_{ie} (pF)
50
0
–50
I_C=150mA
V_{CE}=24V
T_{amb}=25°C
typical values
g_{ie}
C_{ie}
0
50
100
150
200
f (MHz)
250


7Z05957—2.6.25.dd/gj
g_{ib} ($m\Omega^{-1}$)
$-C_{ib}$ (pF)
$-C_{ib}$
g_{ib}
f = 180 MHz
T_{amb} = 25 °C
typical values
V_{CB} = 12 V
24 V
33 V
40 V
V_{CB} = 40 V
24 V
12 V
0
50
100
150
0
50
100
150
200
$-I_E$ (mA)


7Z05963-2.6.25.dd-gj.
g_{ie} ($m\Omega^{-1}$)
$-C_{ie}$ (pF)
$-C_{ie}$
g_{ie}
f = 180 MHz
typical values
V_{CE} = 12 V
24 V
40 V
V_{CE} = 12 V
24 V
40 V
0
50
100
150
0
50
100
150
200
I_C (mA)
250


7Z05958-2.6.25.dd-gj.
$V_{EB} = 4V$
typ
I_{EBO} (nA)
T_j (°C)
10^4
2
10^3
5
2
10^2
5
2
10
0
50
100
150
200


7Z06054-2.6.25.dd/gj
BFY44 : $V_{CB} = 40V$
BFY70 : $V_{CB} = 28V$
max
typ
I_{CBO} (nA)
T_j (°C)
10^6
10^5
10^4
10^3
10^2
10
1
0
50
100
150
200

SILICON PLANAR EPITAXIAL TRANSISTORS

N-P-N transistors in TO-5 metal case with the collector connected to the case. These transistors are intended for general purpose industrial applications.

QUICK REFERENCE DATA

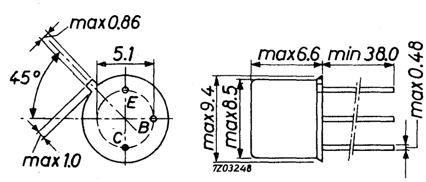
			BFY50	BFY51	BFY52	
Collector-base voltage (open emitter)	V_{CBO}	max.	80	60	40	V
Collector-emitter voltage (open base)	V_{CEO}	max.	35	30	20	V
Collector current (peak value)	I_{CM}	max.	1	1	1	A
Total dissipation up to T_{amb} = 25 °C	P_{tot}	max.	800	800	800	mW
Junction temperature	T_j	max.	200	200	200	°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	MHz
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



7Z3 0054

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	$R_{th\ j\text{-}a}$	=	0.22	°C/mW
From junction to case	$R_{th\ j\text{-}c}$	=	0.035	°C/mW

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

7Z3 0055

CHARACTERISTICS T_j = 25 °C unless otherwise specified

Conditions	Symbol		BFY50	BFY51	BFY52	
Collector cut-off current						
I_E = 0; V_{CB} = 60 V	I_{CBO}	typ.	2			nA
		<	50			nA
I_E = 0; V_{CB} = 40 V	I_{CBO}	typ.		2		nA
		<		50		nA
I_E = 0; V_{CB} = 30 V	I_{CBO}	typ.			2	nA
		<			50	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
		<	50	50	50	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
Base current						
$-I_E$ = 150 mA; V_{CB} = 6 V	I_B	<	4.85	3.65	2.45	mA
Saturation voltages						
I_C = 150 mA; I_B = 15 mA	V_{CEsat}	typ.	0.14	0.14	0.14	V
		<	0.20	0.35	0.35	V
	V_{BEsat}	typ.	0.95	0.95	0.95	V
I_C = 1 A; I_B = 100 mA [1]	V_{CEsat}	typ.	0.7	0.7	0.7	V
		<	1.0	1.6	1.6	V
	V_{BEsat}	typ.	1.5	1.5	1.5	V
		<	2.0	2.0	2.0	V

[1]) Measured under pulsed conditions to avoid excessive dissipation with a lead length of 1 cm.

7Z3 0056

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

			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 kHz						
$I_E = I_e = 0$; 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	MHz
		typ.	100	110	120	MHz
h parameters at f = 1 kHz						
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}
Small signal current gain	h_{fe}	typ.	45	60	120	
Output admittance	h_{oe}	typ.	30	35	70	$\mu\Omega^{-1}$
I_C = 1 mA; V_{CE} = 6 V						
Small signal current gain	h_{fe}	>	10	30	30	
		typ.	32	42	84	

[1]) Measured under pulsed conditions to avoid excessive dissipation.

7Z3 0057

MEASUREMENT OF SWITCHING TIMES

Fig. 1 : Circuit diagram

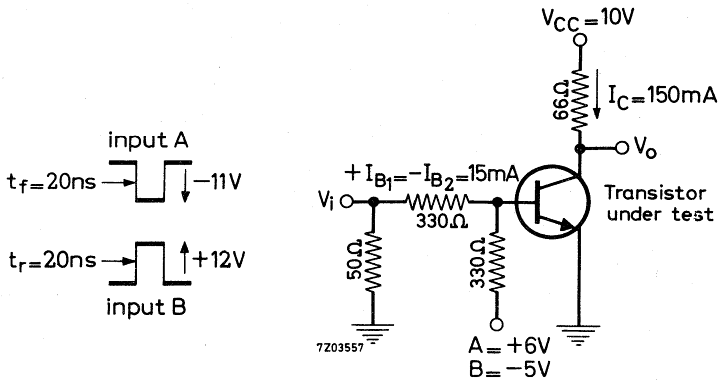
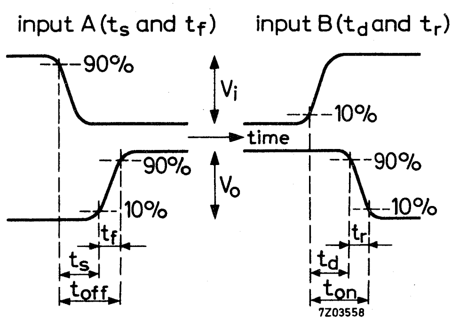


Fig. 2 : Waveforms



Equipment: Pulse generator (rise time = 20 ns)
Double beam or dual trace oscilloscope
(rise time = 14 ns)

7Z3 0058

OPERATING NOTES (Dissipation and heatsink considerations)

1. Steady-state conditions

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

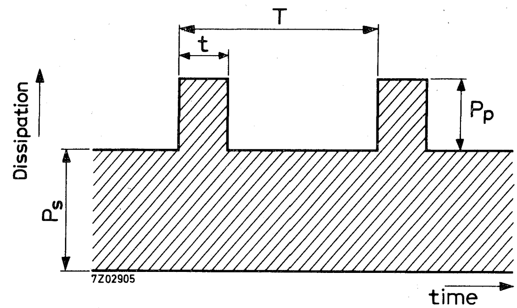
$$P_{s\,max.} = \frac{T_{j\,max.} - T_{amb}}{R_{th\,j\text{-}a}}$$

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.

2. Pulse conditions (rectangular pulses)



The maximum allowable pulse power P_p is given by the formula

$$P_p = \frac{(T_{j\,max.} - T_{amb}) - (P_S \cdot R_{th\,j\text{-}a})}{R_{th\,t} + \delta \cdot R_{th\,c\text{-}a}}$$

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 ^{o}C. 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 ^{o}C/W (from page C)

7Z3 0059

OPERATING NOTES (continued)

$$P_{p\,max} = \frac{(200-65) - (0.35 \times 220)}{15.5 + 0.2\ (220-35)}$$

$$= \frac{135 - 77}{15.5 + 37} = 1.1\ \text{W}$$

The peak pulse dissipation of 1.1 W is therefore allowed provided that the voltage and current ratings of the device are not exceeded.

3. 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

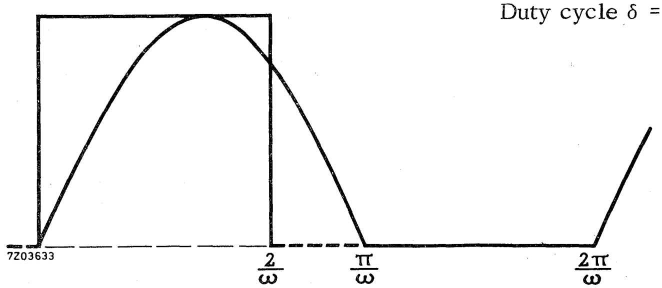
The following example illustrates how to find the maximum permissible peak dissipation of a BFY52 operating in a class "B" circuit at 1 kHz. The device is mounted on a heatsink of thermal resistance equal to 50 °C/W and at an ambient temperature not exceeding 100 °C. Assuming that the waveform is sinusoidal 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,

$$t = \frac{2}{\omega} = \frac{2}{2\pi \times 10^3} = 0.318\ \text{ms}$$

$$\text{Duty cycle } \delta = \frac{2/\omega}{2\pi/\omega} = \frac{1}{\pi}$$



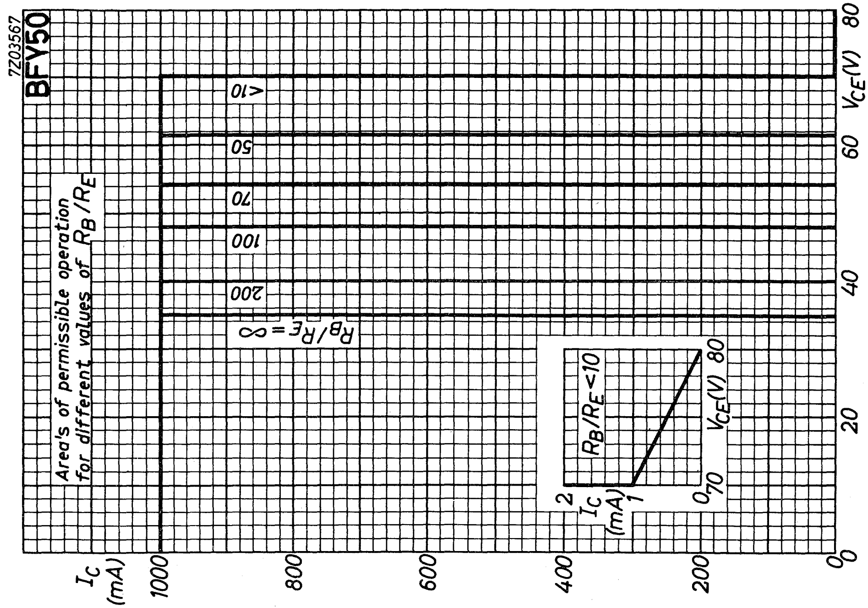
From page C: $R_{th\,t0}$ = 6.8 °C/W $R_{th\,s}$ = 35 °C/W

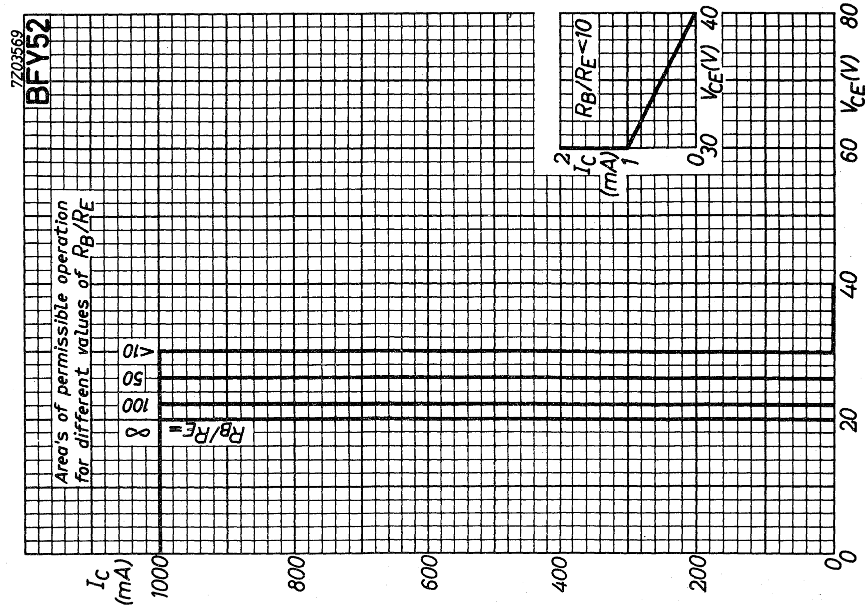
$$R_{th\,t}\ (\text{at } \delta = 0.318) = 6.8 + 0.318\ (35-6.8) = 15.8\ ^{\circ}\text{C/W}$$

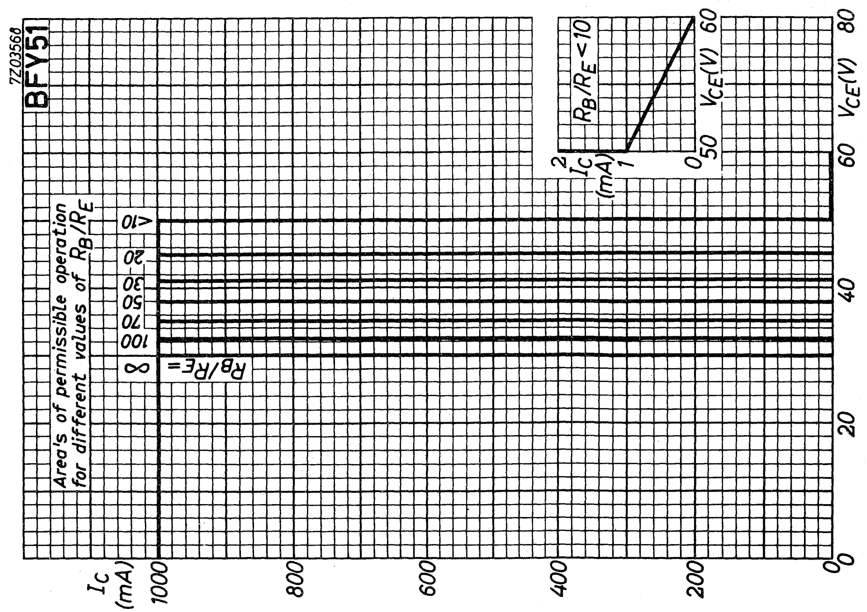
$$P_{p\,max} = \frac{(200-100) - 0}{15.8 + 0.318 \times 50} = 3.15\ \text{W}$$

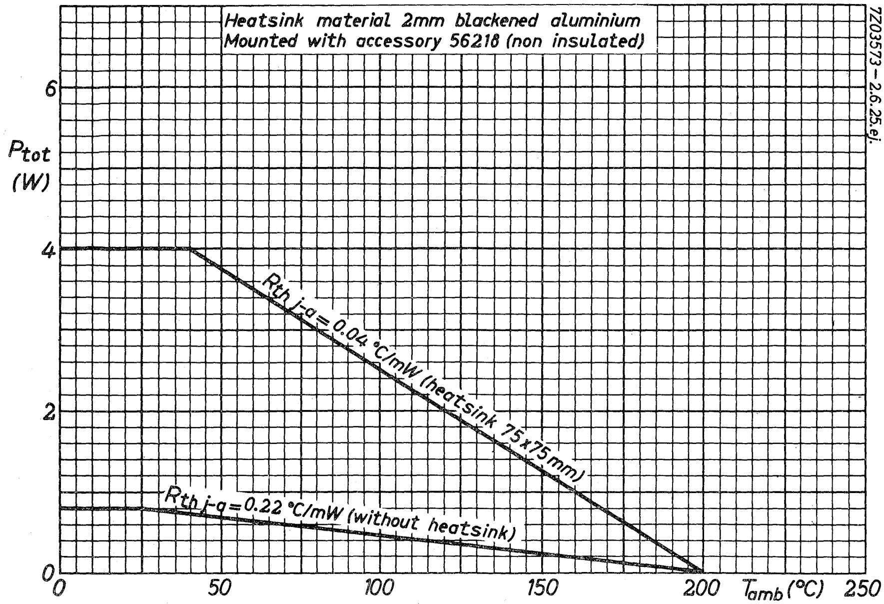
A peak power of 3.15 W is therefore permissible provided that the voltage and current ratings of the device are not exceeded.

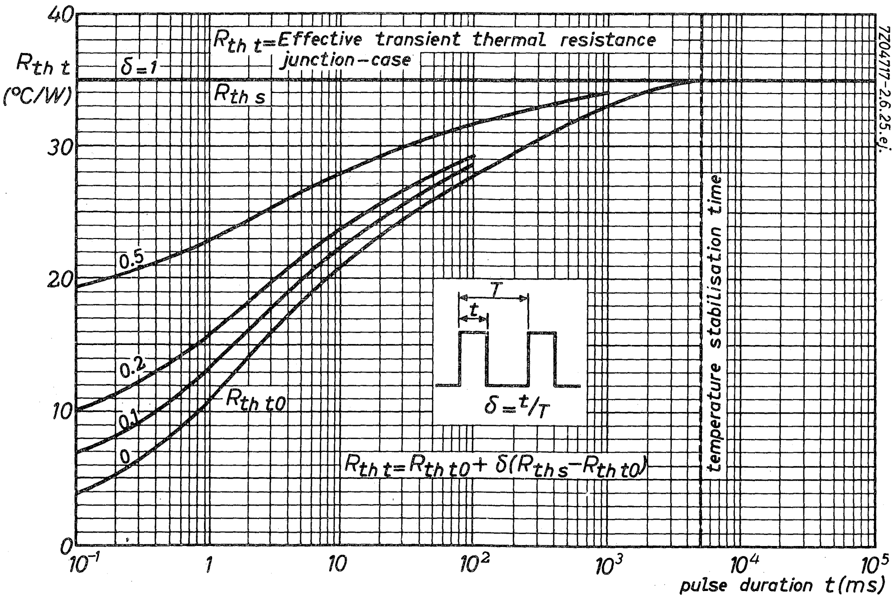
7Z3 0060

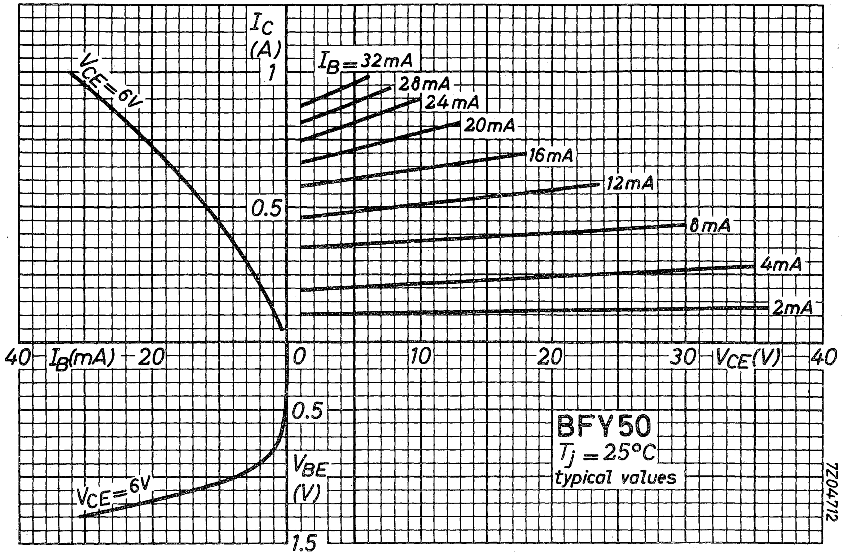

7Z03567
BFY50
Area's of permissible operation
for different values of RB/RE
<10
50
70
100
200
RB/RE = ∞
RB/RE<10
IC (mA)
VCE(V)
0
20
40
60
80
1000
800
600
400
200
2
1
70


7Z03569
BFY52
Area's of permissible operation for different values of R_B/R_E
$R_B/R_E=$
∞
100
50
<10
I_C (mA)
1000
800
600
400
200
0
0
20
40
60
80
V_{CE}(V)
$R_B/R_E<10$
2
1
0
30
40

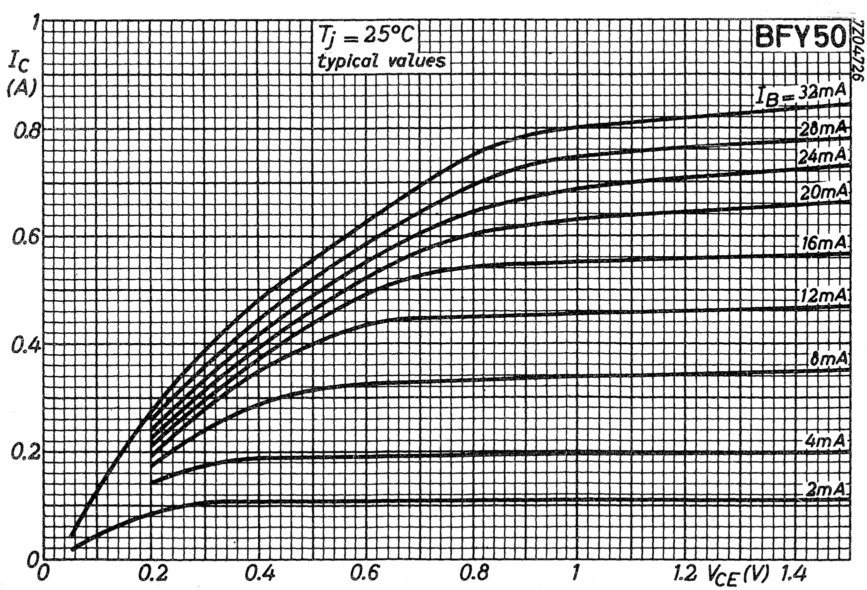

7Z03568
BFY51
Area's of permissible operation for different values of R_B/R_E
$R_B/R_E=$
∞
100
70
50
30
20
<10
I_C (mA)
1000
800
600
400
200
0
0
20
40
60
80
V_{CE}(V)
$R_B/R_E<10$
2
1
0
50
60


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

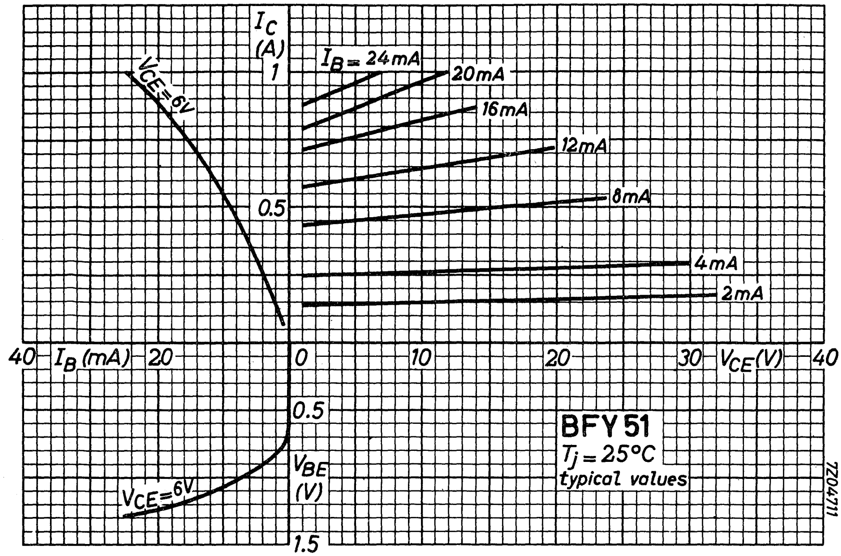

Rth t = Effective transient thermal resistance junction – case
7Z04717 – 2.6.25.ej.
Rth t (°C/W)
40
30
20
10
0
δ = 1
Rth s
0.5
0.2
0.1
0
Rth t0
T
t
δ = t/T
Rth t = Rth t0 + δ(Rth s – Rth t0)
temperature stabilisation time
10⁻¹
1
10
10²
10³
10⁴
10⁵
pulse duration t(ms)



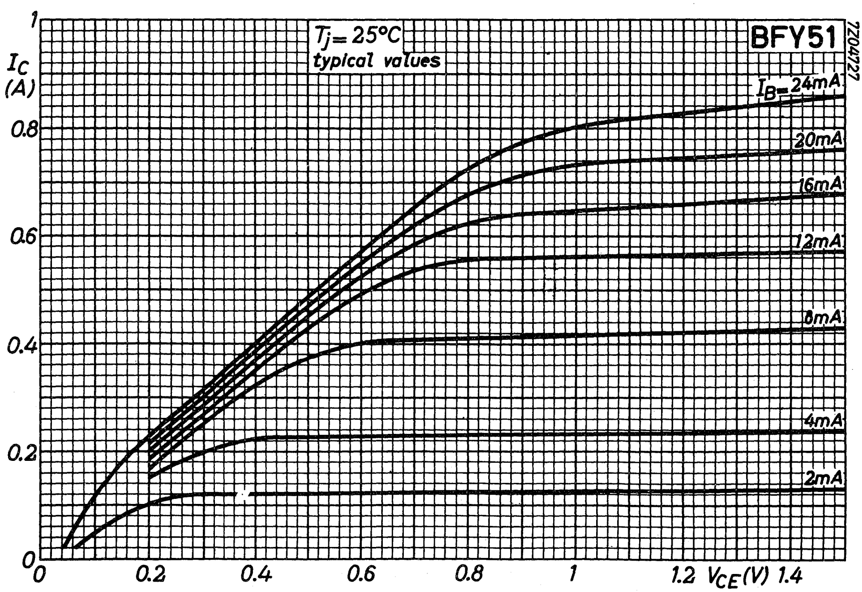
I_C (A)
1
0.5
I_B=32mA
28mA
24mA
20mA
16mA
12mA
8mA
4mA
2mA
V_{CE}=6V
40
I_B(mA)
20
0
10
20
30
V_{CE}(V)
40
0.5
V_{BE} (V)
1.5
V_{CE}=6V
BFY50
T_j = 25°C
typical values
7Z04712



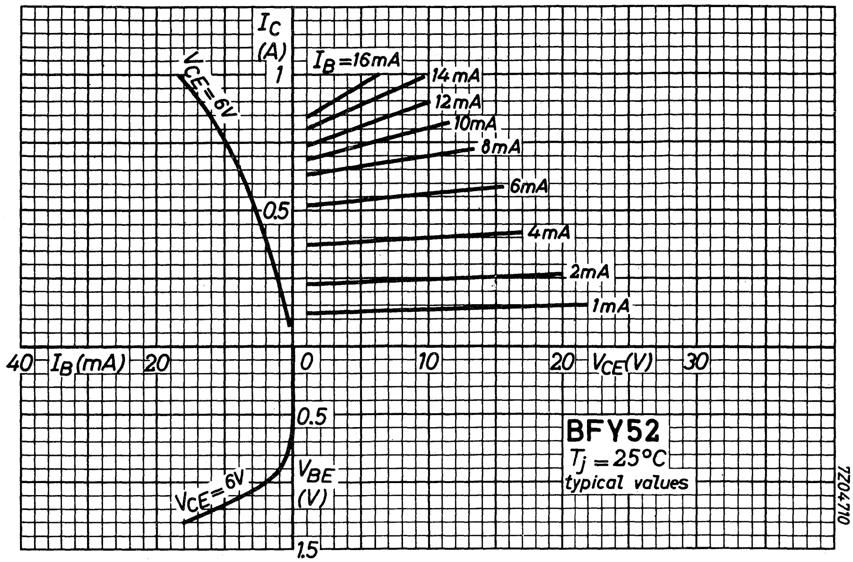
I_C (A)
1
0.8
0.6
0.4
0.2
0
T_j = 25°C
typical values
BFY50
7Z04726
I_B=32mA
28mA
24mA
20mA
16mA
12mA
8mA
4mA
2mA
0
0.2
0.4
0.6
0.8
1
1.2
V_{CE}(V)
1.4



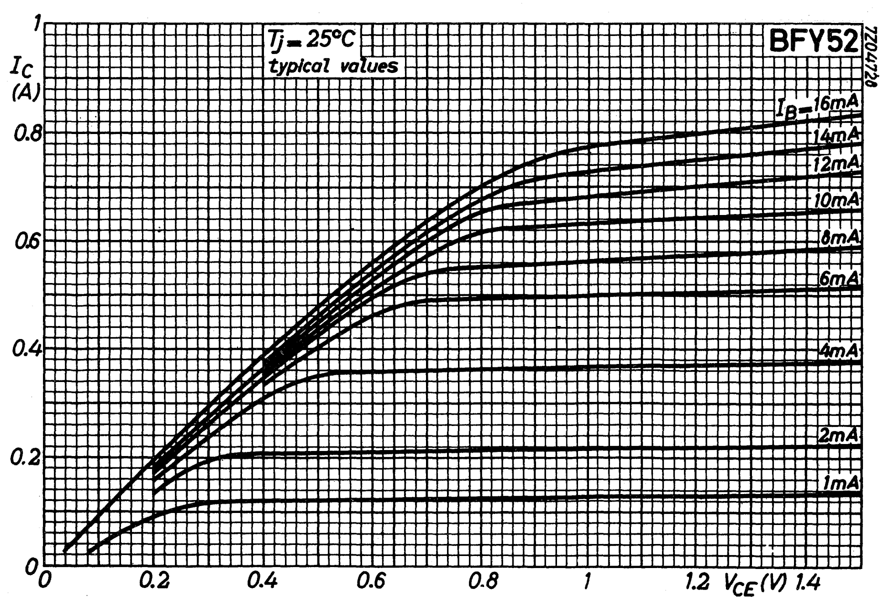
I_C (A)
1
0.5
I_B = 24mA
20mA
16mA
12mA
8mA
4mA
2mA
V_{CE}=6V
40
I_B (mA)
20
0
10
20
30
V_{CE}(V)
40
0.5
V_{BE} (V)
1.5
V_{CE}=6V
BFY51
T_j = 25°C
typical values
7Z04711



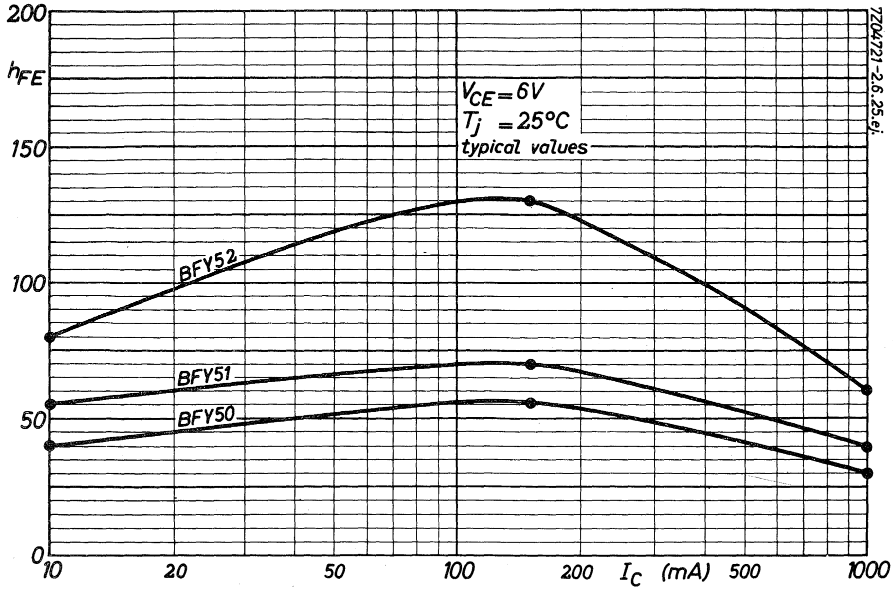
1
I_C (A)
0.8
0.6
0.4
0.2
0
T_j = 25°C
typical values
BFY51
7Z04727
I_B=24mA
20mA
16mA
12mA
8mA
4mA
2mA
0
0.2
0.4
0.6
0.8
1
1.2 V_{CE}(V) 1.4

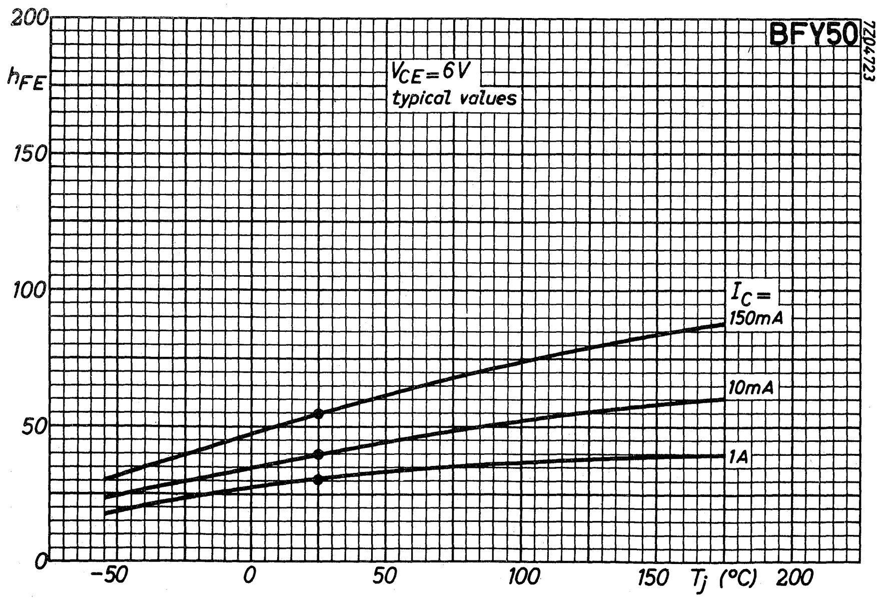


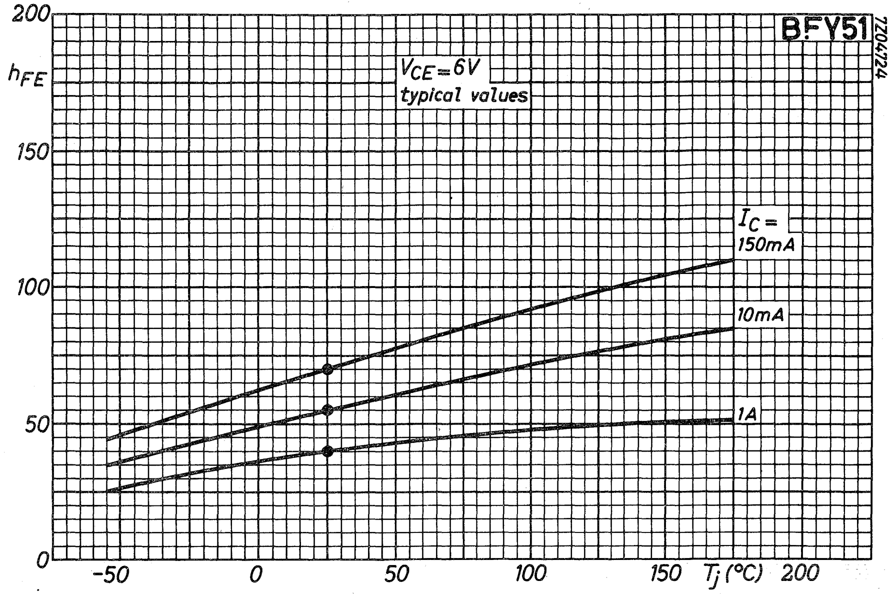
I_C (A)
1
0.5
I_B =16mA
14mA
12mA
10mA
8mA
6mA
4mA
2mA
1mA
V_{CE}=6V
40 I_B(mA) 20
0 10 20 V_{CE}(V) 30
0.5
V_{BE} (V)
1.5
V_{CE}=6V
BFY52
T_j = 25°C
typical values
7Z04710

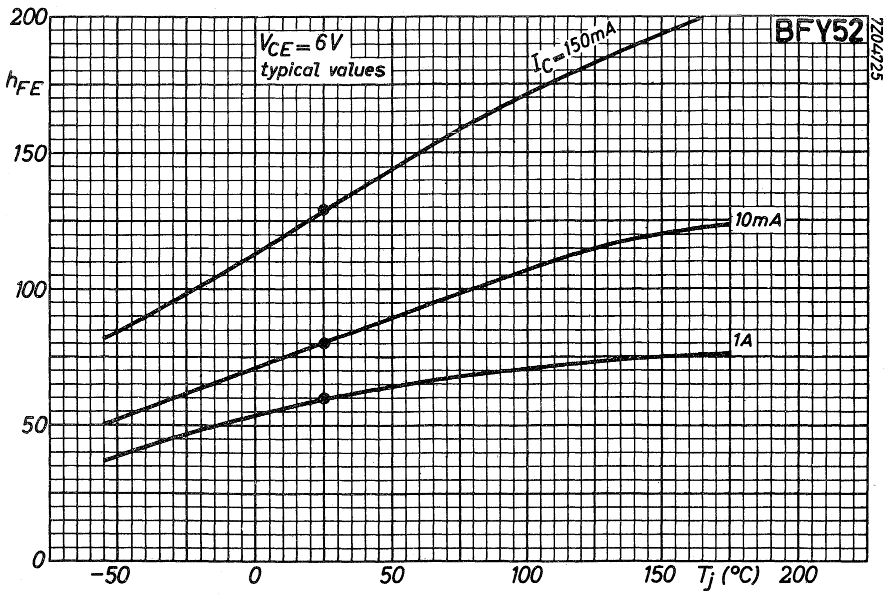


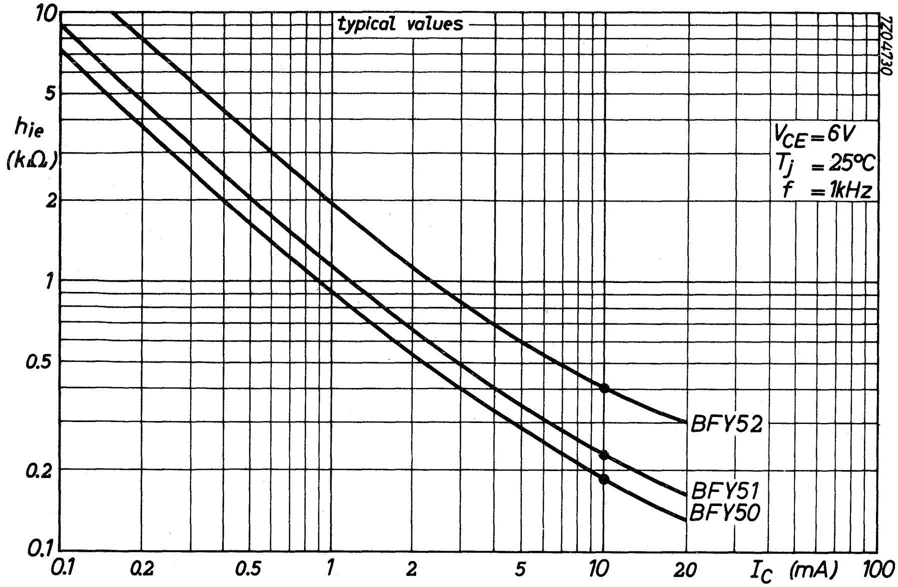
1
I_C (A)
0.8
0.6
0.4
0.2
0
T_j = 25°C
typical values
BFY52
7Z04728
I_B=16mA
14mA
12mA
10mA
8mA
6mA
4mA
2mA
1mA
0 0.2 0.4 0.6 0.8 1 1.2 V_{CE}(V) 1.4

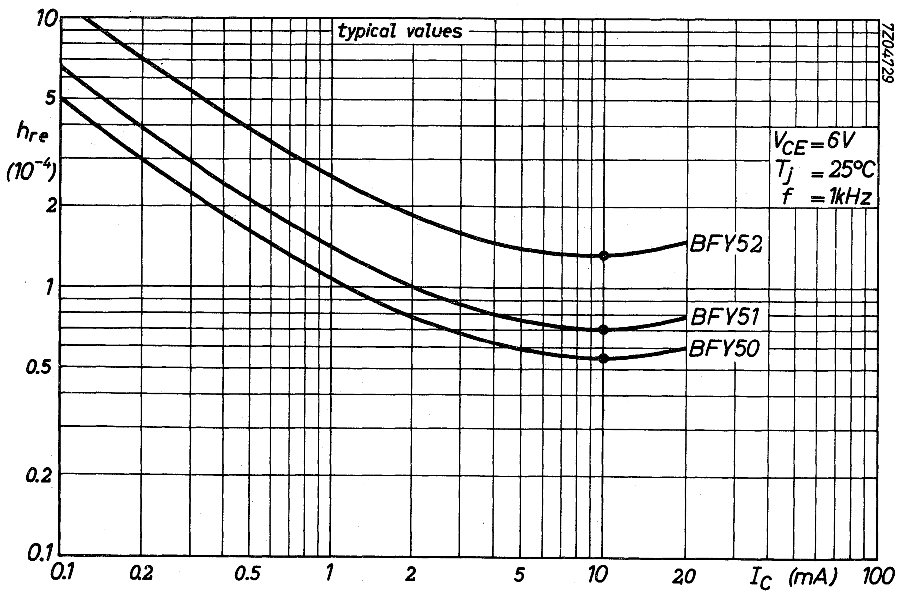

200
h_{FE}
150
100
50
0
$V_{CE} = 6V$
$T_j = 25°C$
typical values
BFY52
BFY51
BFY50
10
20
50
100
200
I_C (mA)
500
1000
7Z04721-2.6.25.ej.

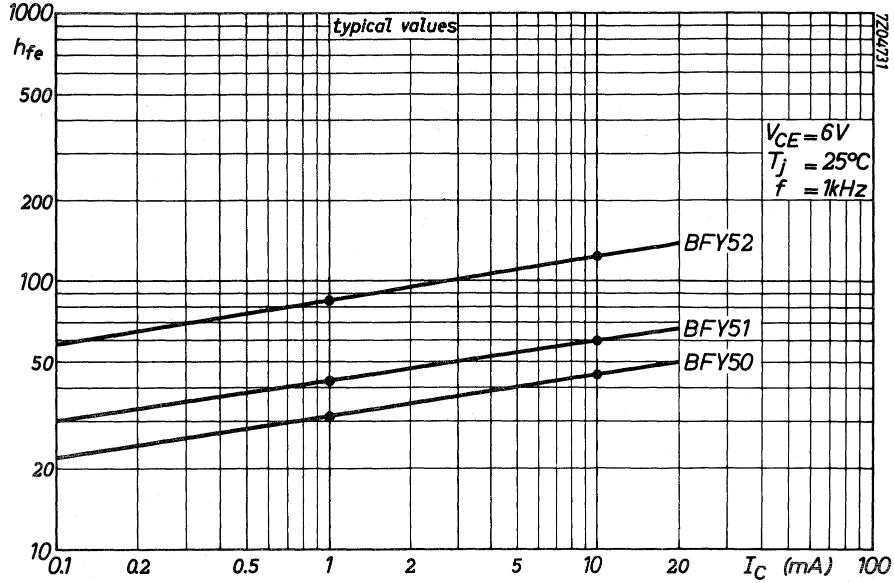

BFY50
7Z04723
200
h_{FE}
150
100
50
0
$V_{CE} = 6V$
typical values
$I_C =$
150mA
10mA
1A
−50
0
50
100
150
T_j (°C)
200

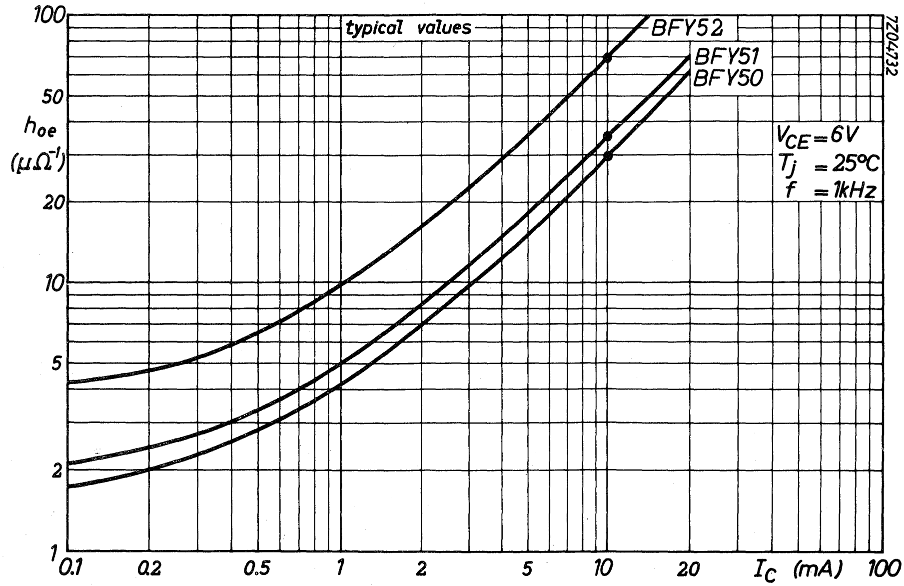

BFY51
7Z04724
h_{FE}
$V_{CE} = 6V$
typical values
$I_C =$ 150mA
10mA
1A
200
150
100
50
0
-50
0
50
100
150
T_j (°C)
200

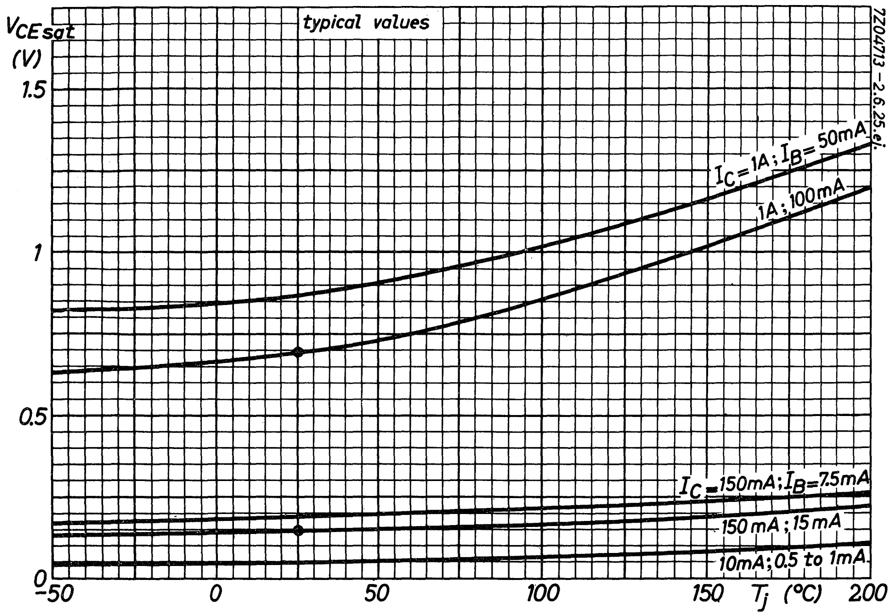

BFY52
7Z04725
h_{FE}
$V_{CE} = 6V$
typical values
$I_C = 150mA$
10mA
1A
200
150
100
50
0
-50
0
50
100
150
T_j (°C)
200

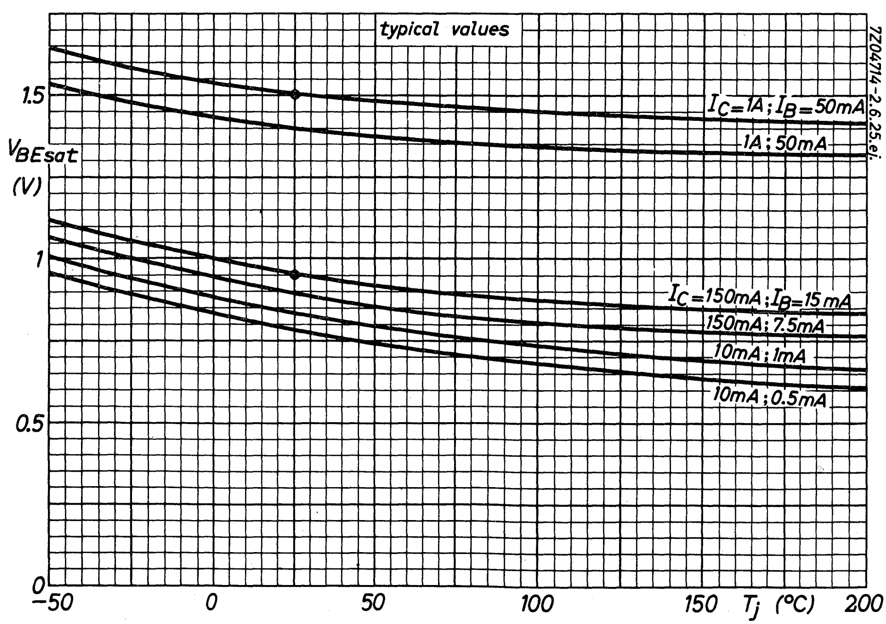

typical values
7204730
h_{ie} (kΩ)
V_{CE} = 6V
T_j = 25°C
f = 1kHz
BFY52
BFY51
BFY50
10
5
2
1
0.5
0.2
0.1
0.1 0.2 0.5 1 2 5 10 20 100
I_C (mA)

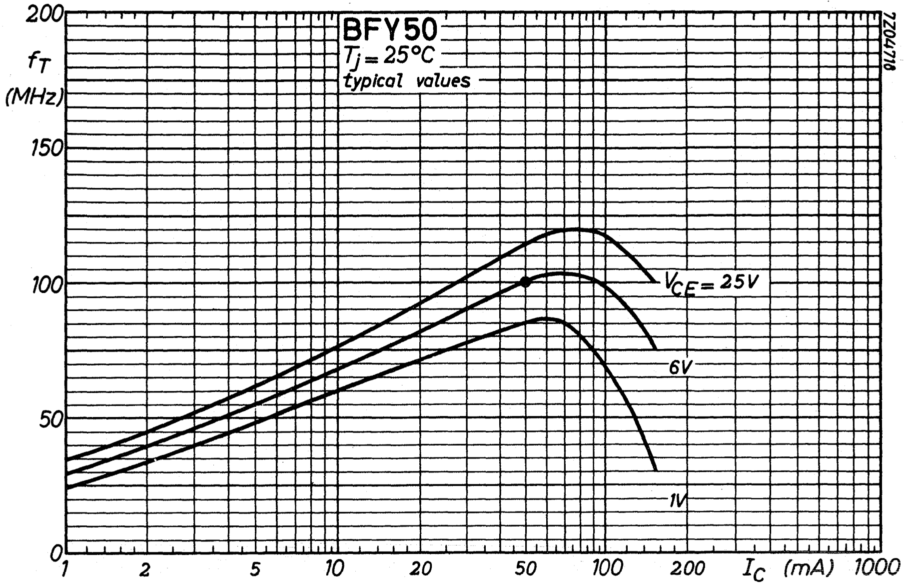

typical values
7204729
h_{re} (10^{-4})
V_{CE} = 6V
T_j = 25°C
f = 1kHz
BFY52
BFY51
BFY50
10
5
2
1
0.5
0.2
0.1
0.1 0.2 0.5 1 2 5 10 20 100
I_C (mA)

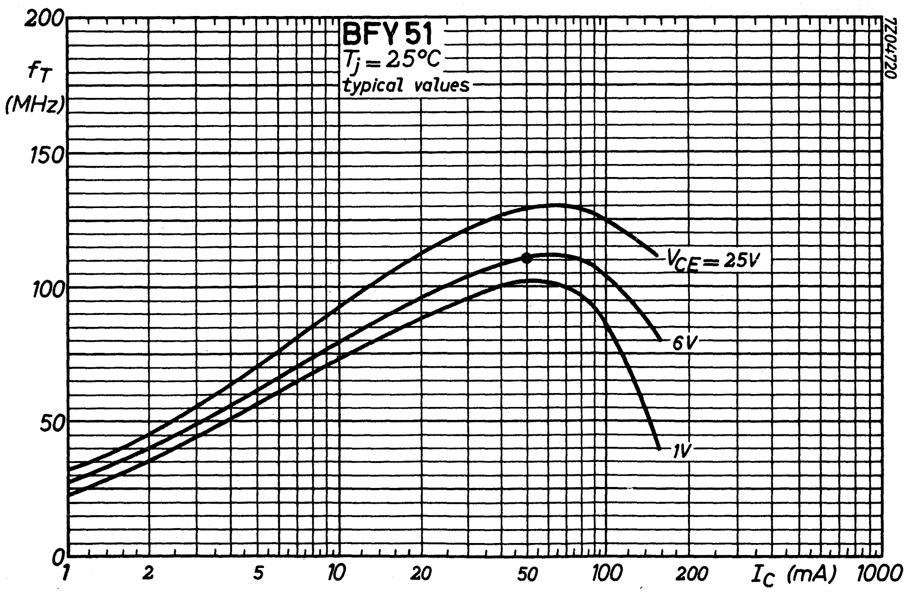

1000
500
200
100
50
20
10
h_{fe}
typical values
7Z04731
V_{CE} = 6V
T_j = 25°C
f = 1kHz
BFY52
BFY51
BFY50
0.1
0.2
0.5
1
2
5
10
20
I_C (mA)
100

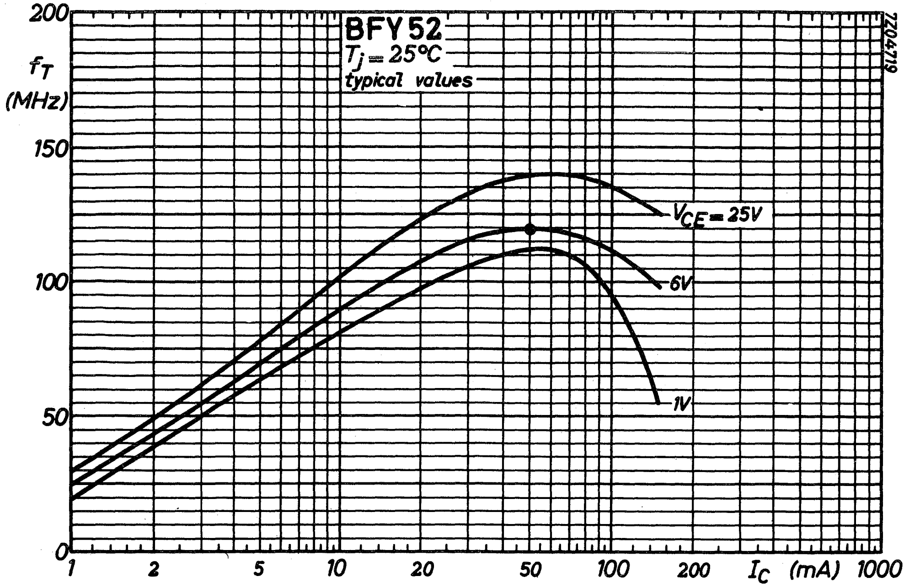

100
50
20
10
5
2
1
h_{oe}
($\mu\Omega^{-1}$)
typical values
7Z04732
BFY52
BFY51
BFY50
V_{CE} = 6V
T_j = 25°C
f = 1kHz
0.1
0.2
0.5
1
2
5
10
20
I_C (mA)
100

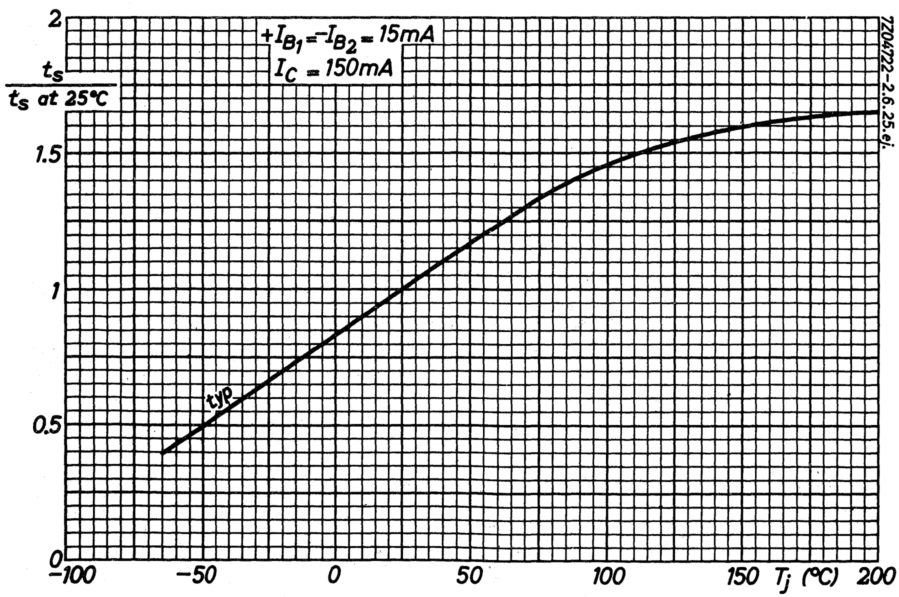

typical values
VCEsat (V)
7Z04713 -2.6.25.ei.
1.5
1
0.5
0
-50
0
50
100
150
200
Tj (°C)
IC = 1A ; IB = 50mA
1A ; 100mA
IC = 150mA ; IB = 7.5mA
150 mA ; 15 mA
10mA ; 0.5 to 1mA

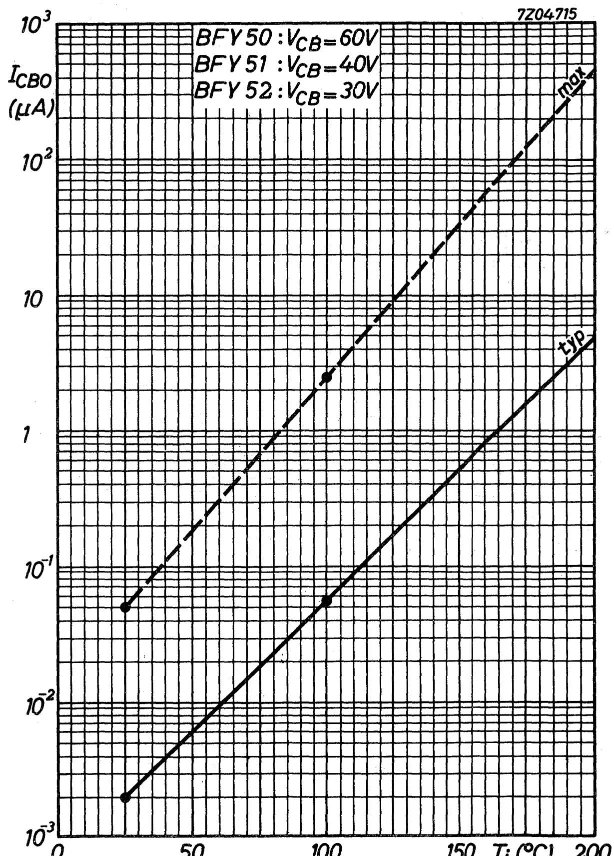

typical values
VBEsat (V)
7Z04714 -2.6.25.ei.
1.5
1
0.5
0
-50
0
50
100
150
200
Tj (°C)
IC = 1A ; IB = 50mA
1A ; 50mA
IC = 150mA ; IB = 15 mA
150mA ; 7.5mA
10mA ; 1mA
10mA ; 0.5mA

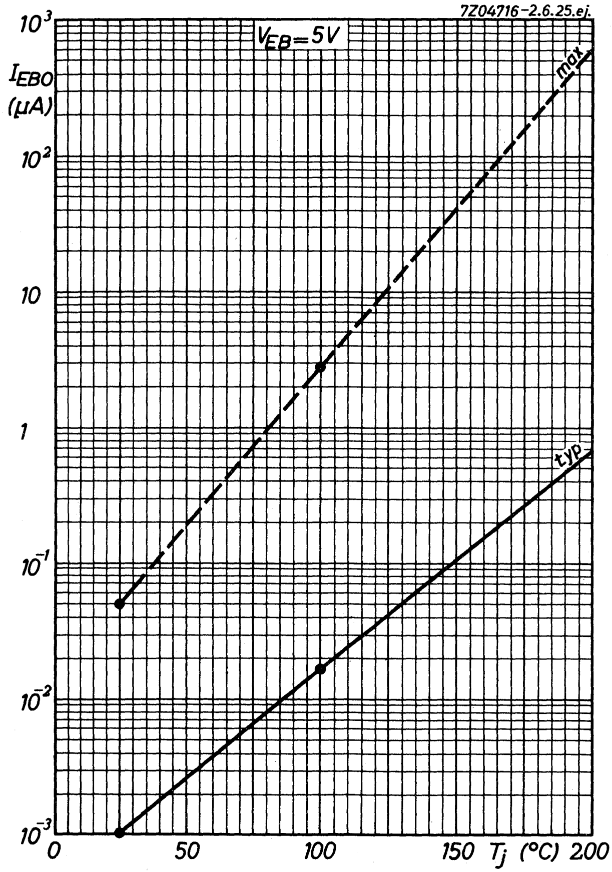

BFY50
$T_j = 25°C$
typical values
f_T (MHz)
200
150
100
50
0
1
2
5
10
20
50
100
200
I_C (mA)
1000
$V_{CE} = 25V$
6V
1V
7Z04718


BFY51
$T_j = 25°C$
typical values
f_T (MHz)
200
150
100
50
0
1
2
5
10
20
50
100
200
I_C (mA)
1000
$V_{CE} = 25V$
6V
1V
7Z04720


BFY 52
$T_j = 25°C$
typical values
f_T (MHz)
200
150
100
50
0
$V_{CE} = 25V$
6V
1V
1
2
5
10
20
50
100
200
I_C (mA)
1000
7Z04719


$+I_{B1} = -I_{B2} = 15mA$
$I_C = 150mA$
$\frac{t_s}{t_s \text{ at } 25°C}$
2
1.5
1
0.5
0
typ
−100
−50
0
50
100
150
T_j (°C)
200
7Z04722-2.6.25.ei.


7Z04715
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}
max
typ
0
50
100
150
T_j (°C)
200


7Z04716-2.6.25.ej.
$V_{EB}=5V$
I_{EBO} (μA)
10^3
10^2
10
1
10^{-1}
10^{-2}
10^{-3}
max
typ
0
50
100
150
200
T_j (°C)

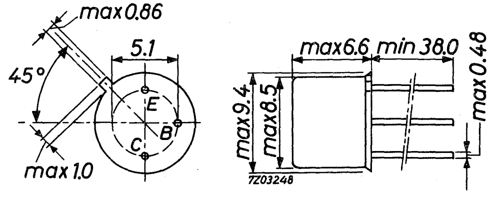
SILICON PLANAR EPITAXIAL TRANSISTOR

N-P-N transistor 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 power 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	MHz
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



7Z3 0426

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

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

7Z3 0076

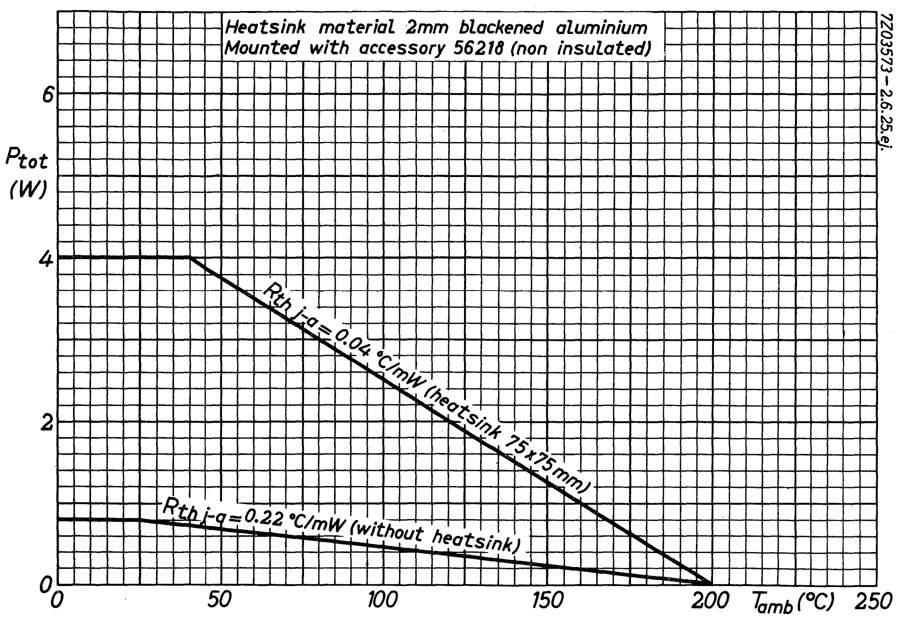
CHARACTERISTICS T_j = 25 °C unless otherwise specified

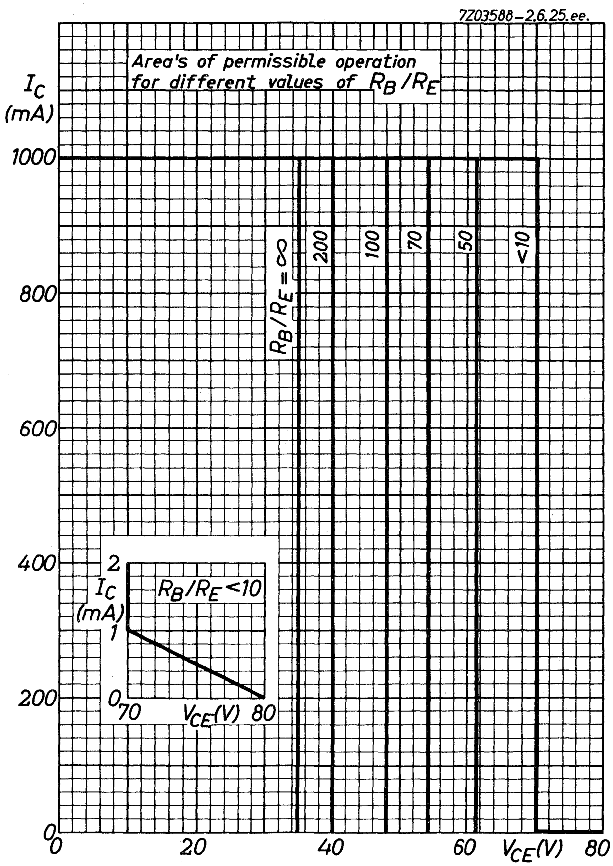
Collector cut-off current				
$I_E = 0$; $V_{CB} = 60$ V	I_{CBO}	<	10	nA
$I_E = 0$; $V_{CB} = 60$ V; $T_j = 150$ °C	I_{CBO}	<	10	μA
Emitter cut-off current				
$I_C = 0$; $V_{EB} = 5$ V	I_{EBO}	<	10	nA
Saturation voltages				
$I_C = 150$ mA; $I_B = 15$ mA	V_{CEsat}	<	0.2	V
$I_C = 1$ A; $I_B = 100$ mA [1][2]	V_{CEsat}	<	1.0	V
	V_{BEsat}	<	1.6	V
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	
Feedback time constant				
$I_C = 10$ mA; $V_{CB} = 10$ V; f = 4 MHz	$r_{b'}C_c$	<	800	ps
Collector capacitance at f = 500 kHz				
$I_E = I_e = 0$; $V_{CB} = 10$ V	C_c	<	12	pF
Emitter capacitance at f = 500 kHz				
$I_C = I_c = 0$; $V_{EB} = 0.5$ V	C_e	<	80	pF
Transition frequency				
$I_C = 50$ mA; $V_{CE} = 10$ V	f_T	>	60	MHz

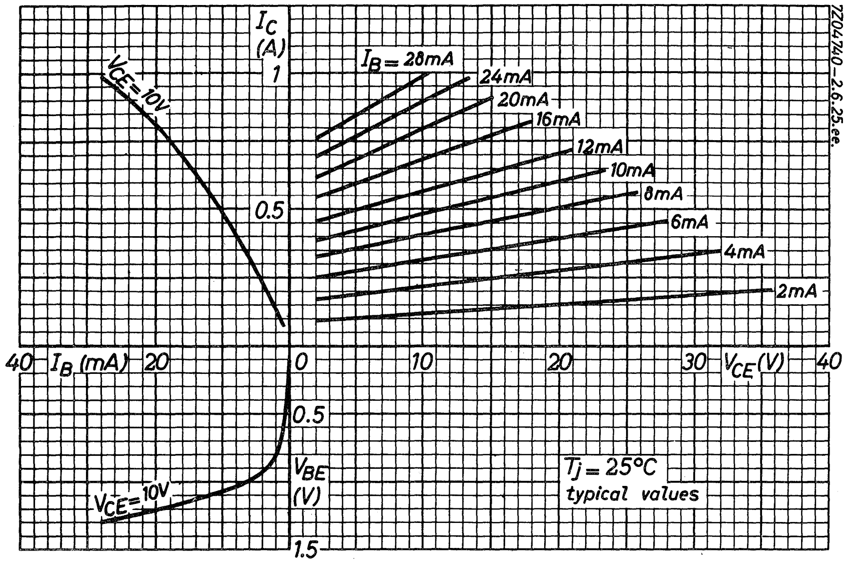
[1]) Measured with a lead length of 1 cm.

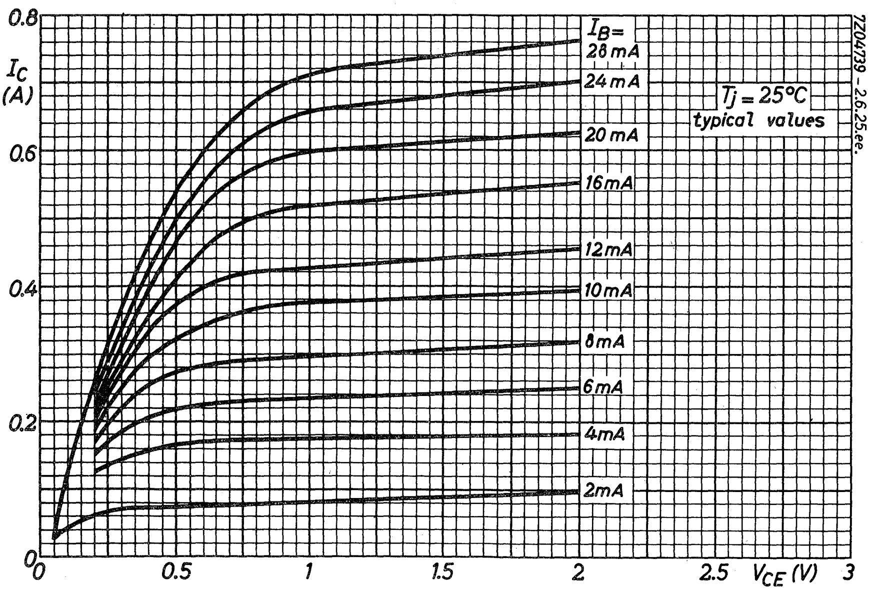
[2]) Measured under pulsed conditions to avoid excessive dissipation.
Pulse duration = 300 μs; duty cycle $\delta < 0.01$

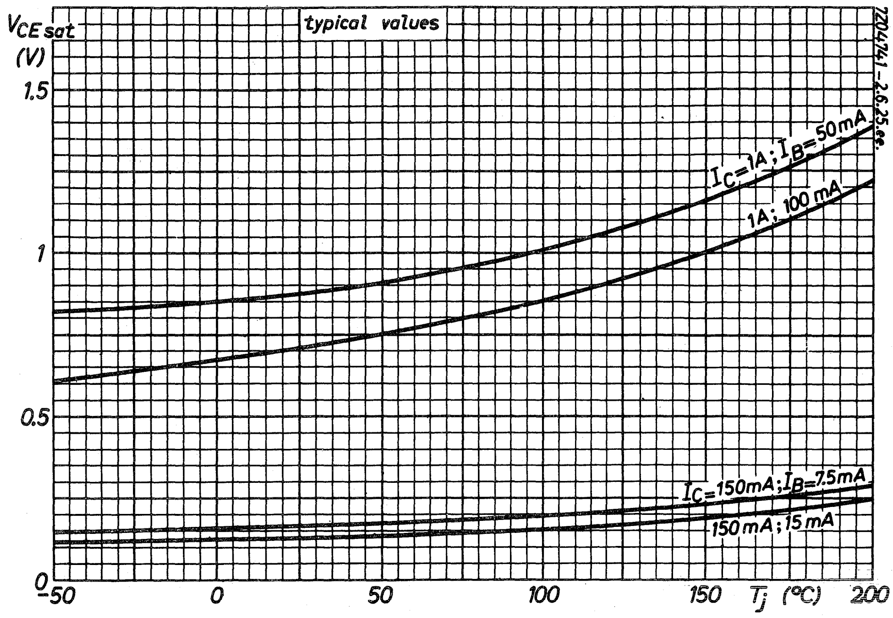
7Z3 0077


Heatsink material 2mm blackened aluminium
Mounted with accessory 56218 (non insulated)
7203573 - 2.6.25.ej.
Ptot
(W)
6
4
2
0
Rth j-a = 0.04 °C/mW (heatsink 75x75 mm)
Rth j-a = 0.22 °C/mW (without heatsink)
0
50
100
150
200
Tamb (°C)
250

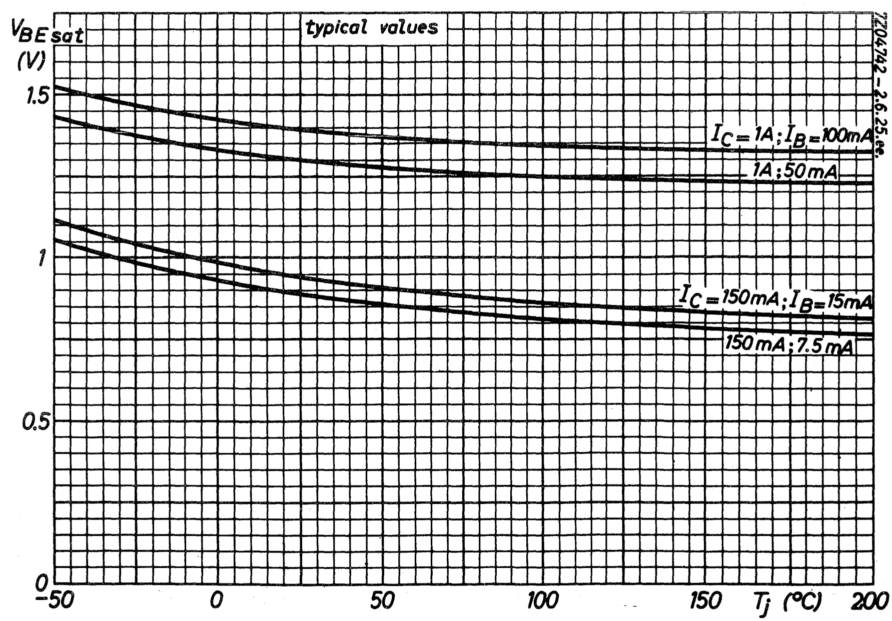

7Z03588-2.6.25.ee.
Area's of permissible operation for different values of R_B/R_E
I_C (mA)
1000
800
600
400
200
0
$R_B/R_E = \infty$
200
100
70
50
<10
0
20
40
60
V_{CE}(V)
80
2
I_C (mA)
1
0
R_B/R_E<10
70
V_{CE}(V)
80


7Z04740 – 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
V_{CE} = 10V
T_j = 25°C
typical values

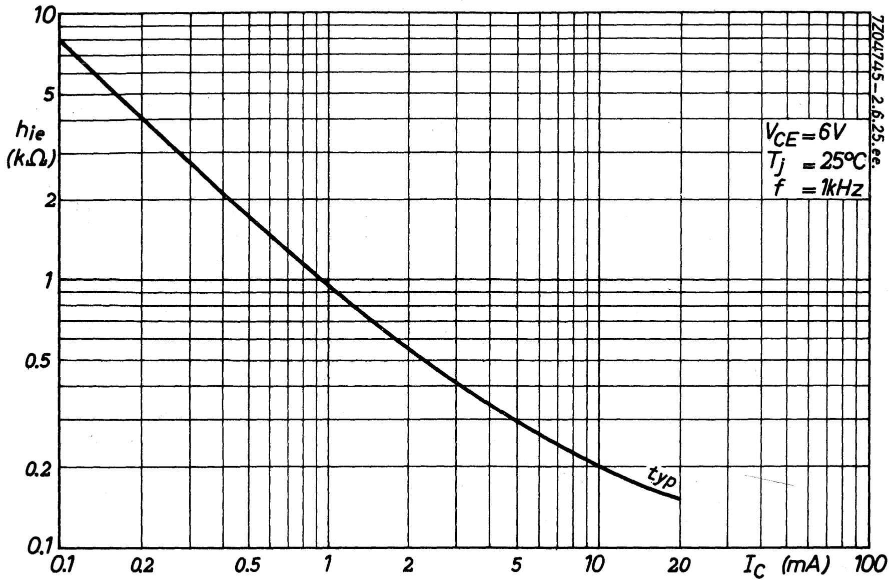

7Z04739 – 2.6.25.ee.
0.8
I_C (A)
0.6
0.4
0.2
0
I_B = 28 mA
24 mA
20 mA
16 mA
12 mA
10 mA
8 mA
6 mA
4 mA
2 mA
T_j = 25°C
typical values
0
0.5
1
1.5
2
2.5
V_{CE} (V)
3

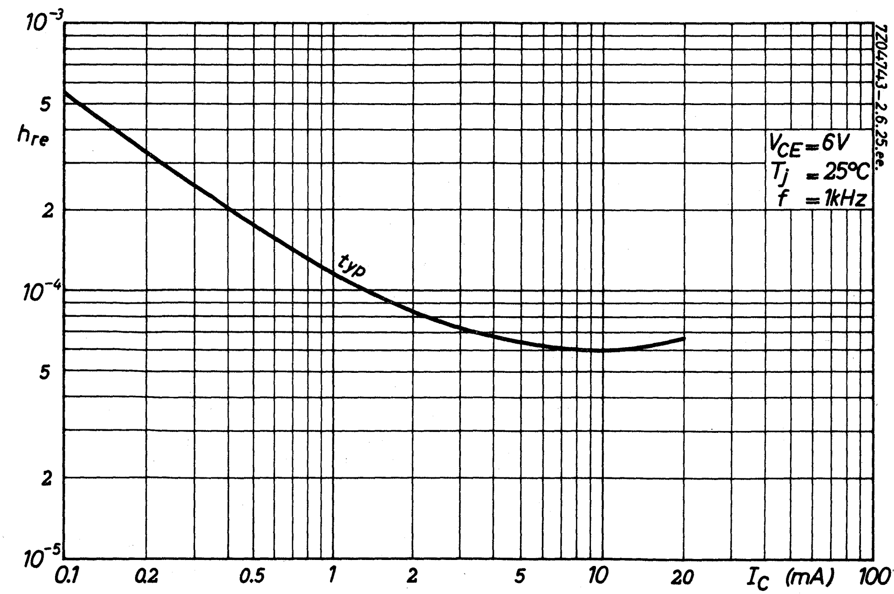


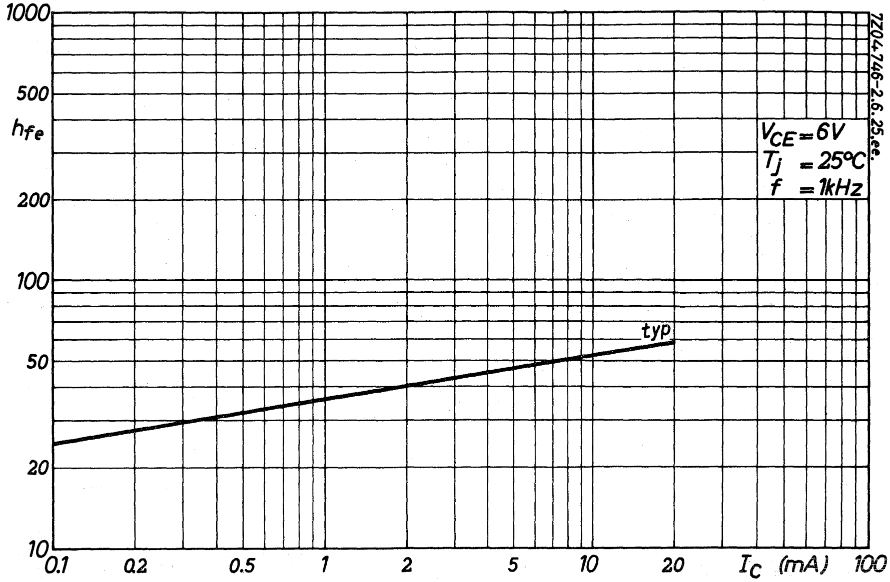
$V_{CE sat}$ (V)
typical values
7Z04741 - 2.6.25.ee.
I_C = 1A; I_B = 50 mA
1A; 100 mA
I_C = 150mA; I_B = 7.5mA
150 mA; 15 mA
1.5
1
0.5
0
-50
0
50
100
150
T_j (°C)
200

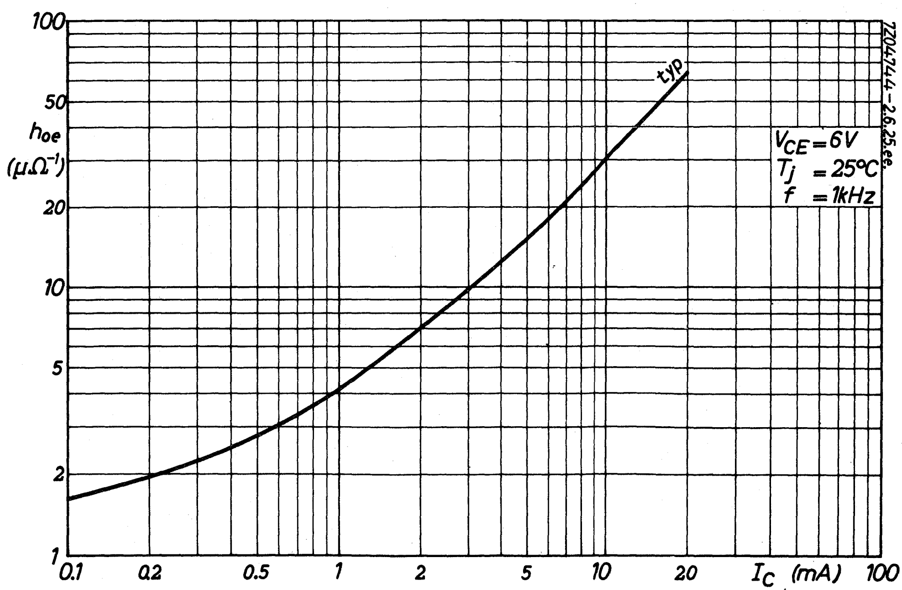


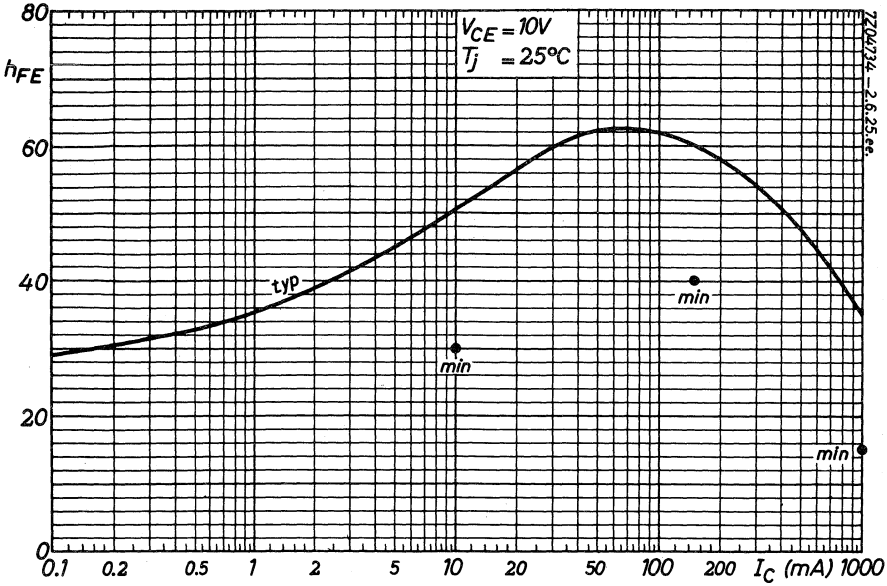
$V_{BE sat}$ (V)
typical values
7Z04742 - 2.6.25.ee.
I_C = 1A; I_B = 100mA
1A; 50 mA
I_C = 150mA; I_B = 15mA
150 mA; 7.5 mA
1.5
1
0.5
0
-50
0
50
100
150
T_j (°C)
200

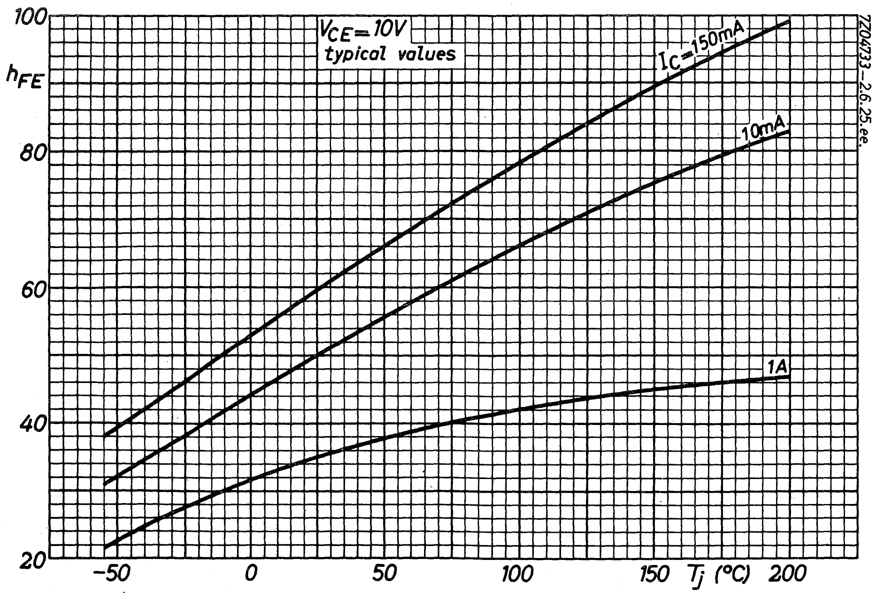

7Z04745-2.6.25.ee.
10
5
h_{ie}
(kΩ)
2
1
0.5
0.2
0.1
V_{CE} = 6V
T_j = 25°C
f = 1kHz
typ
0.1
0.2
0.5
1
2
5
10
20
I_C (mA)
100

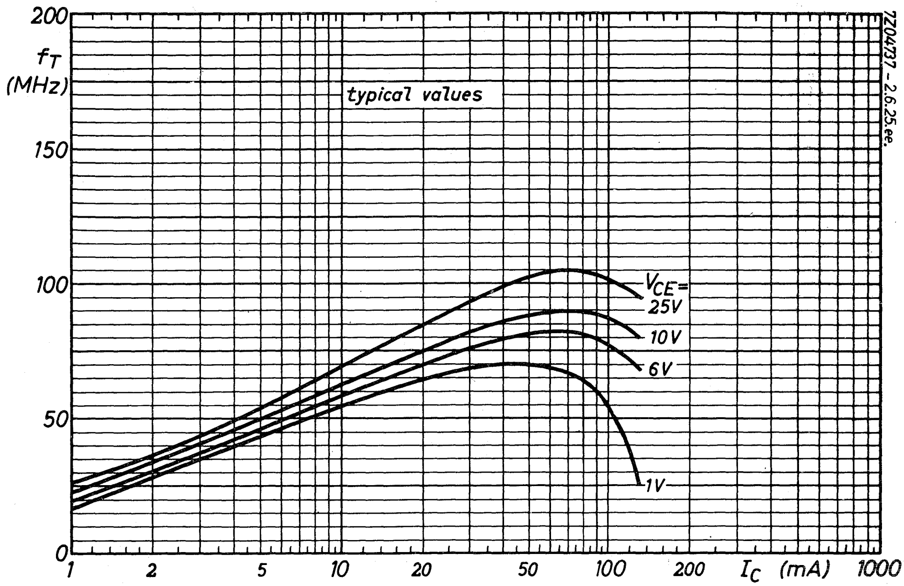

7Z04743-2.6.25.ee.
10^{-3}
5
h_{re}
2
10^{-4}
5
2
10^{-5}
V_{CE} = 6V
T_j = 25°C
f = 1kHz
typ
0.1
0.2
0.5
1
2
5
10
20
I_C (mA)
100

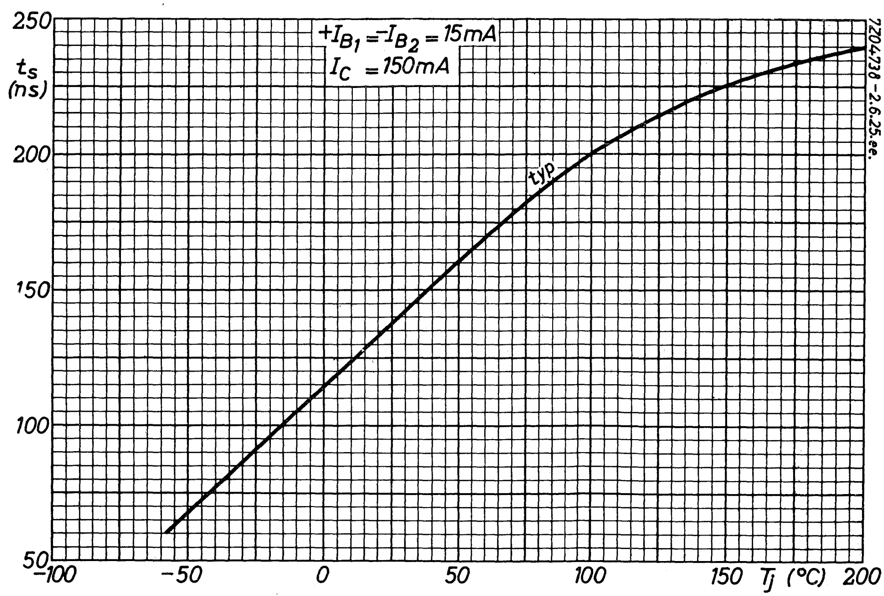

1000
500
h_{fe}
200
100
50
20
10
0.1
0.2
0.5
1
2
5
10
20
I_C (mA)
100
typ
V_{CE} = 6V
T_j = 25°C
f = 1kHz
7Z04746-2.6.25.ee.

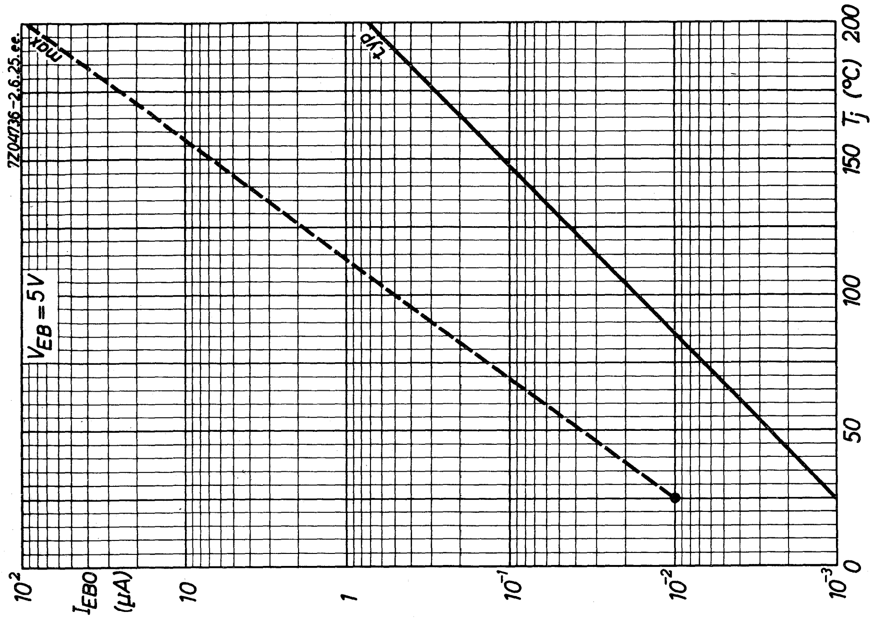

100
50
h_{oe}
($\mu\Omega^{-1}$)
20
10
5
2
1
0.1
0.2
0.5
1
2
5
10
20
I_C (mA)
100
typ
V_{CE} = 6V
T_j = 25°C
f = 1kHz
7Z04744-2.6.25.ee.

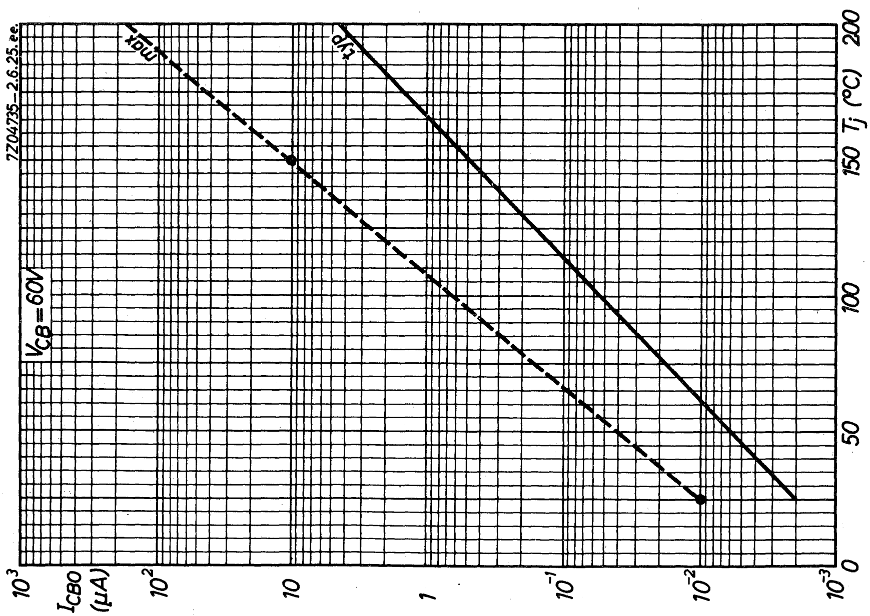

V_{CE} = 10V
T_j = 25°C
h_{FE}
typ
min
min
min
7Z04734 – 2.6.25.ee.
80
60
40
20
0
0.1
0.2
0.5
1
2
5
10
20
50
100
200
I_C (mA)
1000


V_{CE} = 10V
typical values
h_{FE}
I_C = 150mA
10mA
1A
7Z04733 – 2.6.25.ee.
100
80
60
40
20
–50
0
50
100
150
T_j (°C)
200


200
f_T
(MHz)
typical values
150
100
50
0
1
2
5
10
20
50
100
200
I_C (mA)
1000
V_{CE}=
25V
10V
6V
1V
7Z04737 - 2.6.25.ee.


250
t_s
(ns)
$+I_{B1} = -I_{B2} = 15mA$
$I_C = 150mA$
200
150
100
50
typ
-100
-50
0
50
100
150
T_j (°C)
200
7Z04738 - 2.6.25.ee.


7Z04736-2.6.25.ee.
$V_{EB} = 5V$
max
typ
I_{EBO} (μA)
10^2
10
1
10^{-1}
10^{-2}
10^{-3}
0
50
100
150
200
T_j (°C)


7Z04735-2.6.25.ee.
$V_{CB} = 60V$
max
typ
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 TRANSISTORS

N-P-N double diffused transistors in a TO-5 metal envelope with the collector connected to the case. They are intended for use in a wide variety of applications, such as d.c. and high frequency amplifiers and switching applications.

QUICK REFERENCE DATA

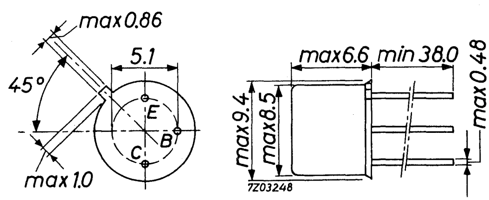
			BFY67	BFY68	
Collector-base voltage (open emitter)	V_{CBO}	max.	75	75	V
Collector-emitter voltage ($R_{BE} < 10\,\Omega$)	V_{CER}	max.	50	50	V
Collector current (peak value)	I_{CM}	max.	1	1	A
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	0.8	0.8	W
Junction temperature	T_j	max.	200	200	°C
D.C. current gain					
I_C = 0.1 mA; V_{CE} = 10 V	h_{FE}	typ.	32	76	
I_C = 10 mA; V_{CE} = 10 V	h_{FE}	typ.	73	148	
I_C = 150 mA; V_{CE} = 10 V	h_{FE}	typ.	62	135	
Transition frequency					
I_C = 50 mA; V_{CE} = 10 V	f_T	typ.	127	135	MHz
Total switching time $t_d + t_r + t_f$	t_{tot}	<	30	30	ns

MECHANICAL DATA

Dimensions in mm

Collector connected to case

TO-5



7Z3 0427

RATINGS (Limiting values) [1])

Voltages

Collector-base voltage (open emitter)	V_{CBO}	max.	75	V
Collector-emitter voltage (open base)	V_{CEO}	max.	30	V [2])
Collector-emitter voltage (R_{BE} < 10 Ω)	V_{CER}	max.	50	V [2])
Emitter-base voltage (open collector)	V_{EBO}	max.	7	V

Currents

Collector current (d.c. or average over any 20 ms period)	I_C	max.	0.5	A
Collector current (peak value)	I_{CM}	max.	1	A

Power dissipation

Total power dissipation 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	$R_{th\ j-a}$	=	220	°C/W
From junction to case	$R_{th\ j-c}$	=	58	°C/W

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

[2]) See page H.

7Z3 0209

CHARACTERISTICS T_j = 25 °C unless otherwise specified

			BFY67	BFY68	
Collector cut-off current					
$I_E = 0$; $V_{CB} = 60$ V	I_{CBO}	typ.	2	2	nA
		<	10	10	nA
$I_E = 0$; $V_{CB} = 60$ V; $T_j = 150$ °C	I_{CBO}	<	10	10	μA
Emitter cut-off current					
$I_C = 0$; $V_{EB} = 5$ V	I_{EBO}	<	10	5	nA
$I_C = 0$; $V_{EB} = 5$ V; $T_j = 150$ °C	I_{EBO}	<	5	5	μA
Collector-emitter sustaining voltage					
$I_C = 100$ mA; $R_{BE} < 10\ \Omega$	$V_{CERsust}$	>	50	50	V [1]
Base-emitter voltage					
$I_C = 1$ mA; $V_{CE} = 5$ V	V_{BE}	<	0.9	0.9	V
Saturation voltages					
$I_C = 150$ mA; $I_B = 15$ mA	V_{CEsat}	typ.	1.3	1.1	V [1]
		<	1.5	1.5	V [1]
	V_{BEsat}	<	1.3	1.3	V [1]
D.C. current gain					
$I_C = 0.1$ mA; $V_{CE} = 10$ V	h_{FE}	>	20	35	
		typ.	32	76	
$I_C = 10$ mA; $V_{CE} = 10$ V	h_{FE}	>	35	75	[1]
		typ.	73	148	[1]
$I_C = 150$ mA; $V_{CE} = 10$ V	h_{FE}	>	40	100	[1]
		typ.	62	135	[1]
		<	120	300	[1]
$I_C = 500$ mA; $V_{CE} = 10$ V	h_{FE}	>	20	40	[1]
		typ.	43	80	[1]
$I_C = 10$ mA; $V_{CE} = 10$ V; $T_j = -55$ °C	h_{FE}	>	20	35	[1]

[1]) Measured under pulse conditions to avoid excessive dissipation.
Pulse duration t < 300 μs, duty cycle δ < 0.01

7Z3 0211

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

			BFY67	BFY68	
h parameters at f = 1 kHz					
$-I_E$ = 1 mA; V_{CB} = 5 V					
Input impedance	h_{ib}	>	24	24	Ω
		<	34	34	Ω
Reverse voltage transfer	h_{rb}	<	3	5	10^{-4}
Output admittance	h_{ob}	>	0.1	0.1	$\mu\Omega^{-1}$
		<	0.5	0.5	$\mu\Omega^{-1}$
$-I_E$ = 5 mA; V_{CB} = 10 V					
Input impedance	h_{ib}	>	4	4	Ω
		<	8	8	Ω
Reverse voltage transfer	h_{rb}	<	3	5	10^{-4}
Output admittance	h_{ob}	>	0.1	0.1	$\mu\Omega^{-1}$
		<	1.0	1.0	$\mu\Omega^{-1}$
Small signal current gain					
I_C = 1 mA; V_{CE} = 5 V	h_{fe}	>	30	50	
		<	100	200	
I_C = 5 mA; V_{CE} = 10 V	h_{fe}	>	35	70	
		<	130	300	
Transition frequency					
I_C = 50 mA; V_{CE} = 10 V	f_T	>	60	70	MHz
		typ.	127	135	MHz
Collector capacitance at f = 1 MHz					
$I_E = I_e$ = 0; V_{CB} = 10 V	C_c	<	25	25	pF
Emitter capacitance at f = 1 MHz					
$I_C = I_c$ = 0; V_{EB} = 0.5 V	C_e	<	80	80	pF
Noise figure at f = 1 kHz					
I_C = 0.3 mA; V_{CE} = 10 V	F	typ.	4.8	3.5	dB
R_S = 510 Ω ; Bandwidth: 200 Hz		<	12	8	dB

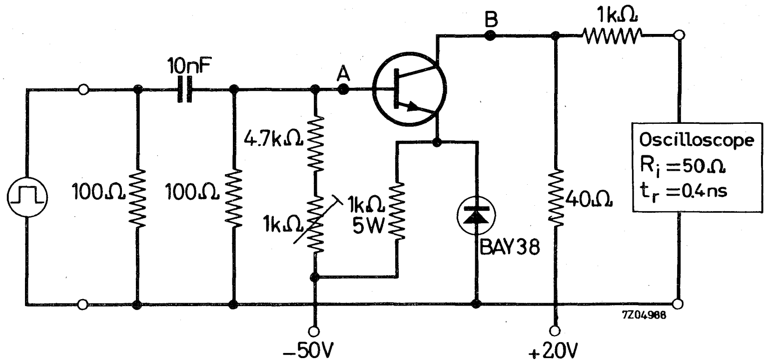
7Z3 0212

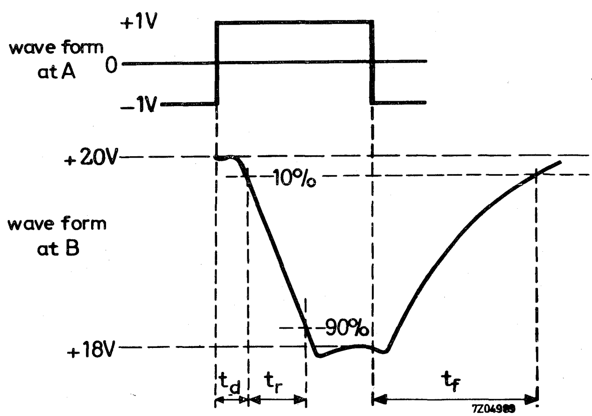
CHARACTERISTICS (continued) T_j = 25 °C unless otherwise specified

Total switching time

$t_{tot} = t_d + t_r + t_f$ t_{tot} < 30 ns

Measuring circuit:





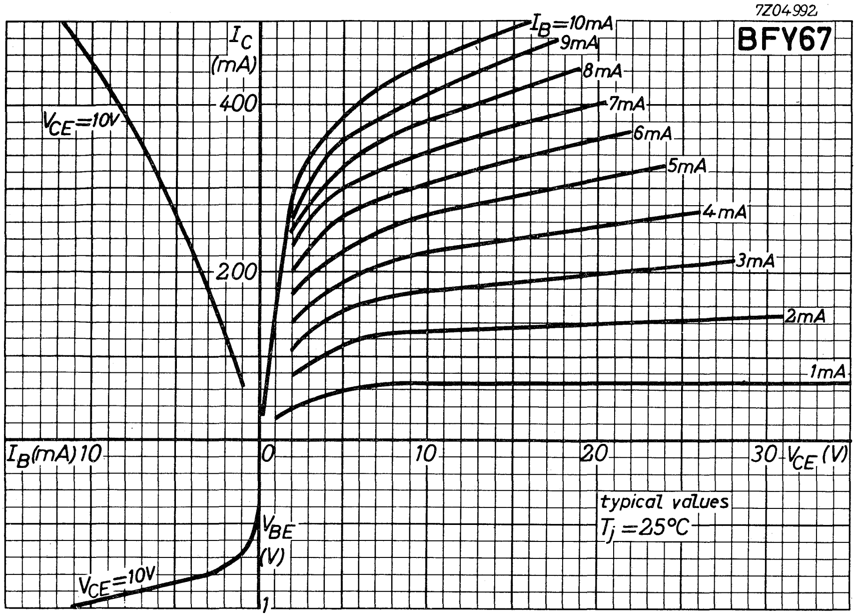
Input pulse:

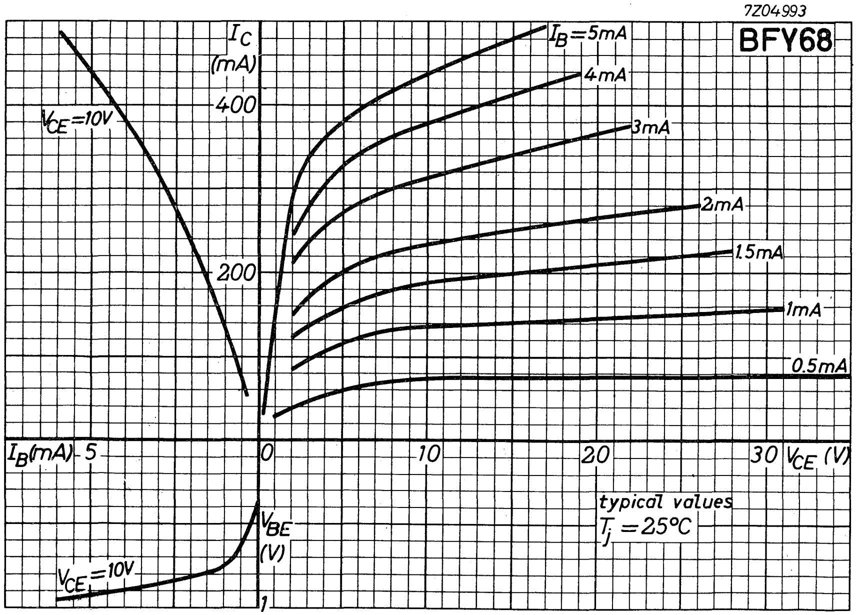
Pulse duration t_p = 15 ns

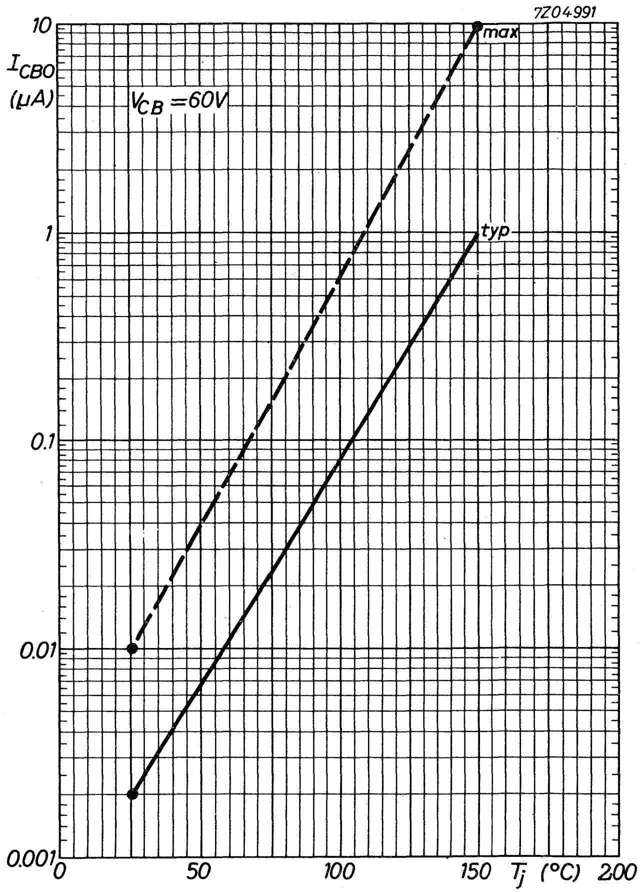
Rise time t_r < 1 ns

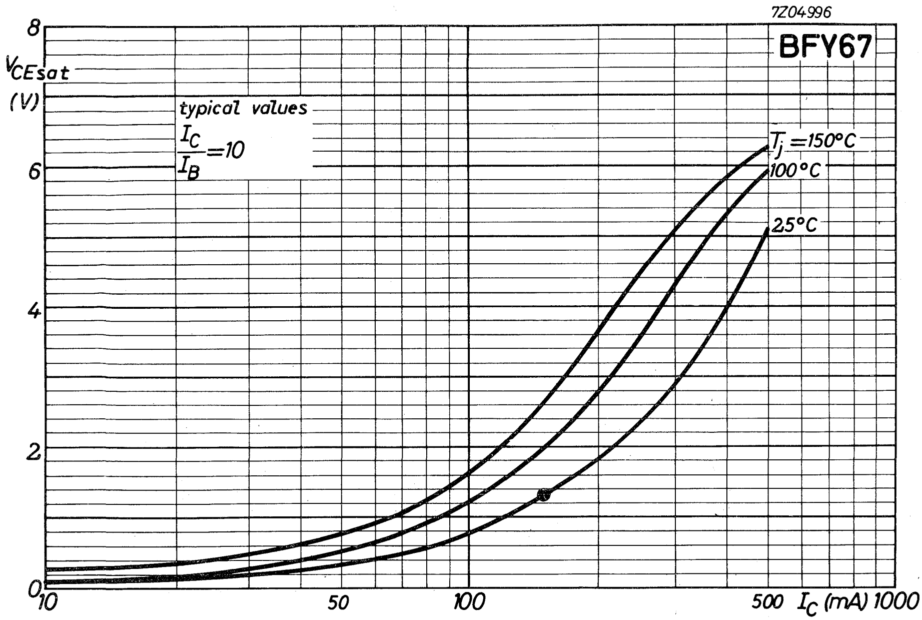
Duty cycle δ < 0.02

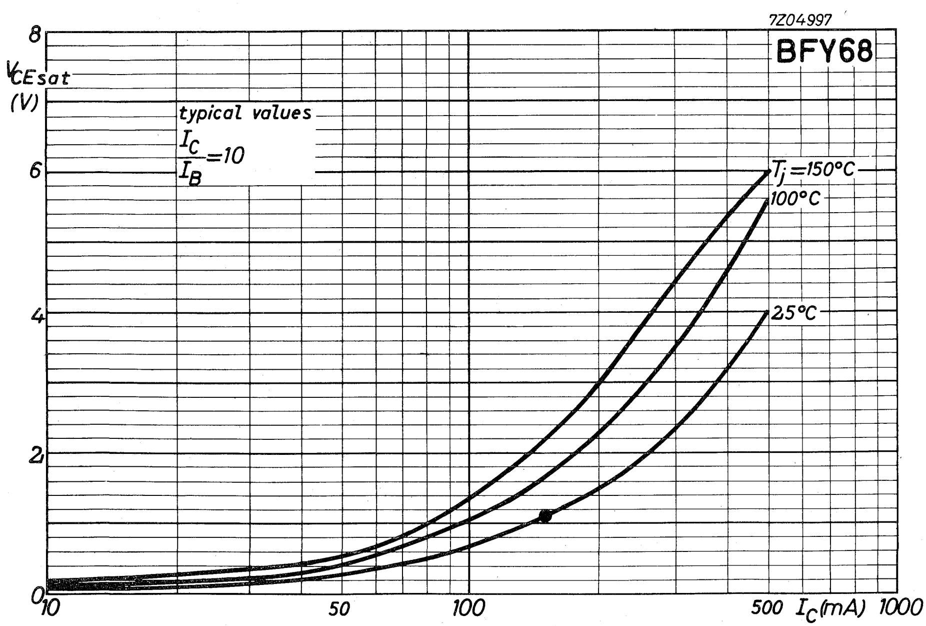
7Z3 0213

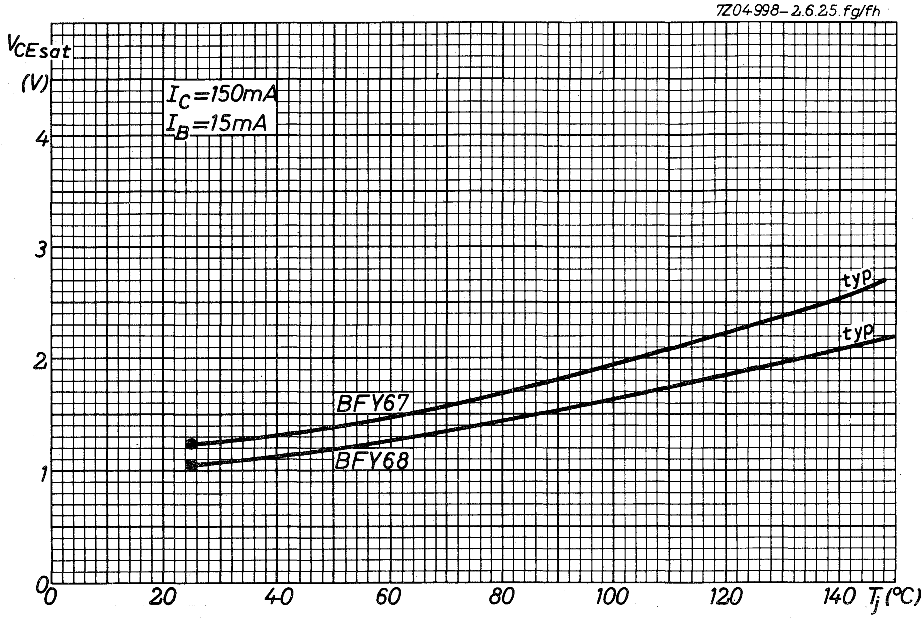

7Z04992
BFY67
I_C (mA)
400
200
I_B=10mA
9mA
8mA
7mA
6mA
5mA
4mA
3mA
2mA
1mA
V_{CE}=10V
I_B(mA) 10
0
10
20
30
V_{CE} (V)
typical values
T_j = 25°C
V_{BE} (V)
V_{CE}=10V
1

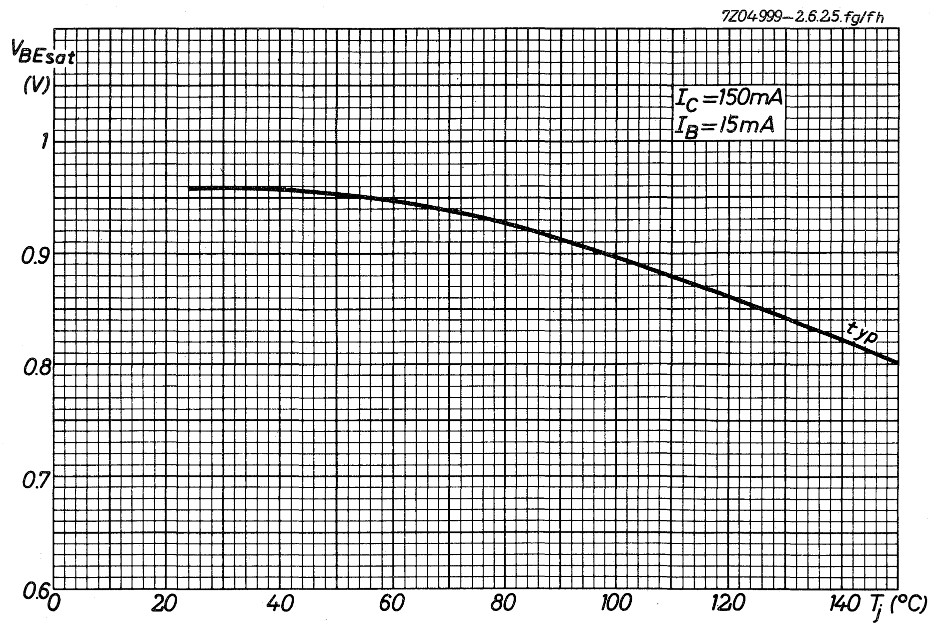

7Z04993
BFY68
I_C (mA)
400
200
I_B=5mA
4mA
3mA
2mA
1.5mA
1mA
0.5mA
V_{CE}=10V
I_B(mA) 5
0
10
20
30
V_{CE} (V)
typical values
T_j = 25°C
V_{BE} (V)
V_{CE}=10V
1

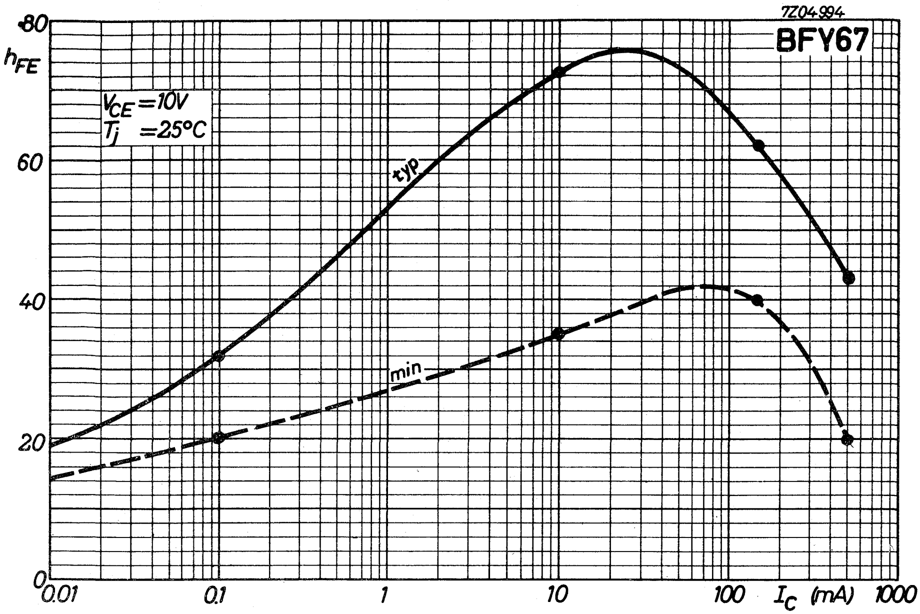

7Z04991
10
I_{CBO}
(μA)
V_{CB} = 60V
max
1
typ
0.1
0.01
0.001
0
50
100
150
T_j (°C)
200

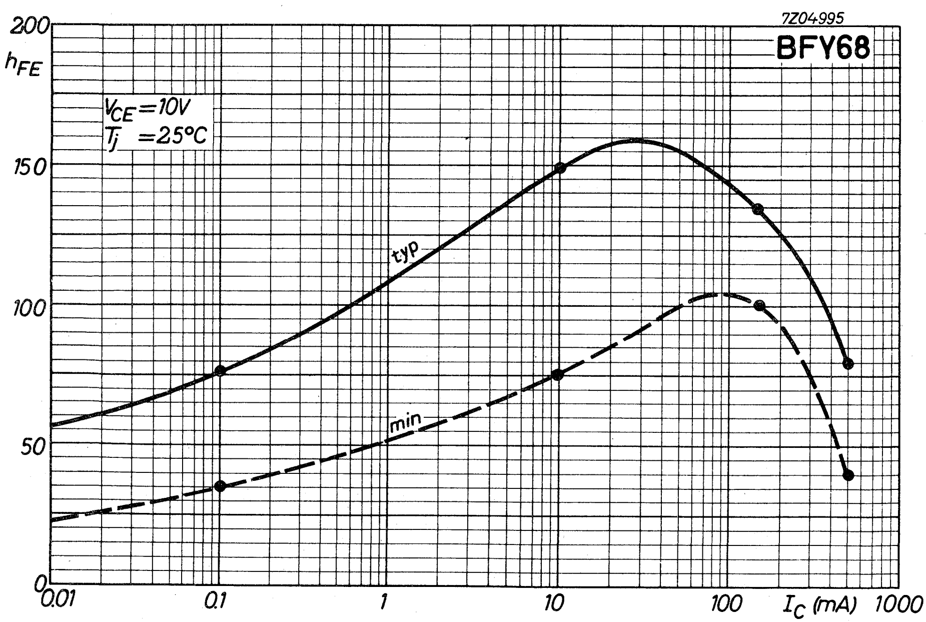

7Z04996
BFY67
V_{CEsat} (V)
typical values
$\frac{I_C}{I_B}=10$
$T_j=150°C$
100°C
25°C
0
2
4
6
8
10
50
100
500
I_C (mA)
1000

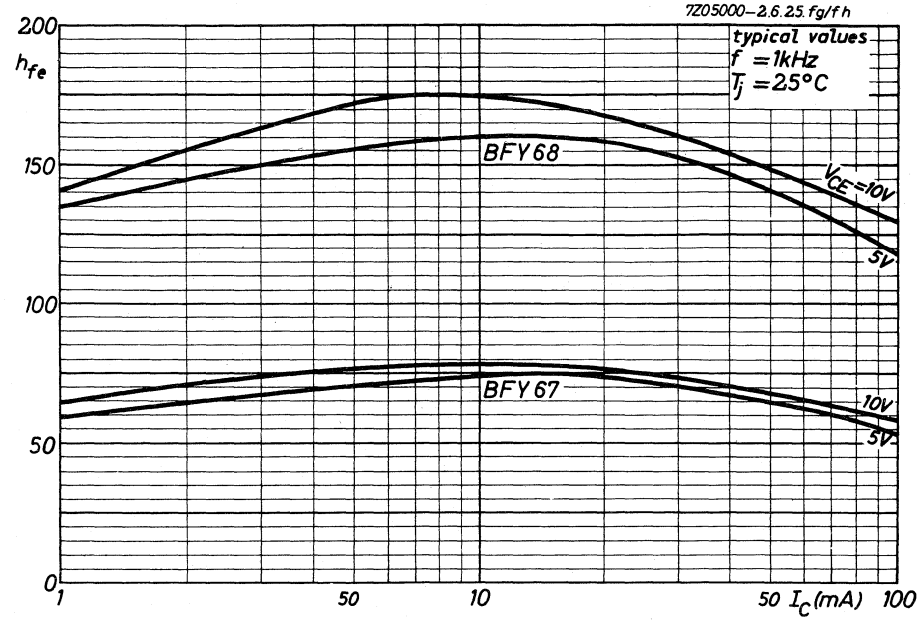

7Z04997
BFY68
V_{CEsat} (V)
typical values
$\frac{I_C}{I_B}=10$
$T_j=150°C$
100°C
25°C
0
2
4
6
8
10
50
100
500
I_C (mA)
1000

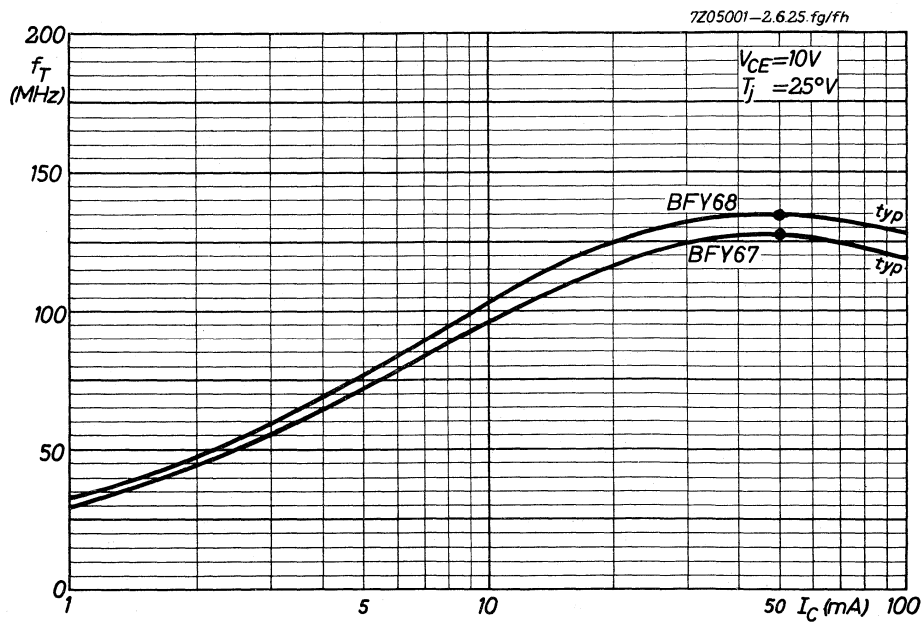

7Z04998–2.6.2.5.fg/fh
V_{CEsat} (V)
I_C=150mA
I_B=15mA
4
3
2
1
0
typ
typ
BFY67
BFY68
0
20
40
60
80
100
120
140 T_j (°C)

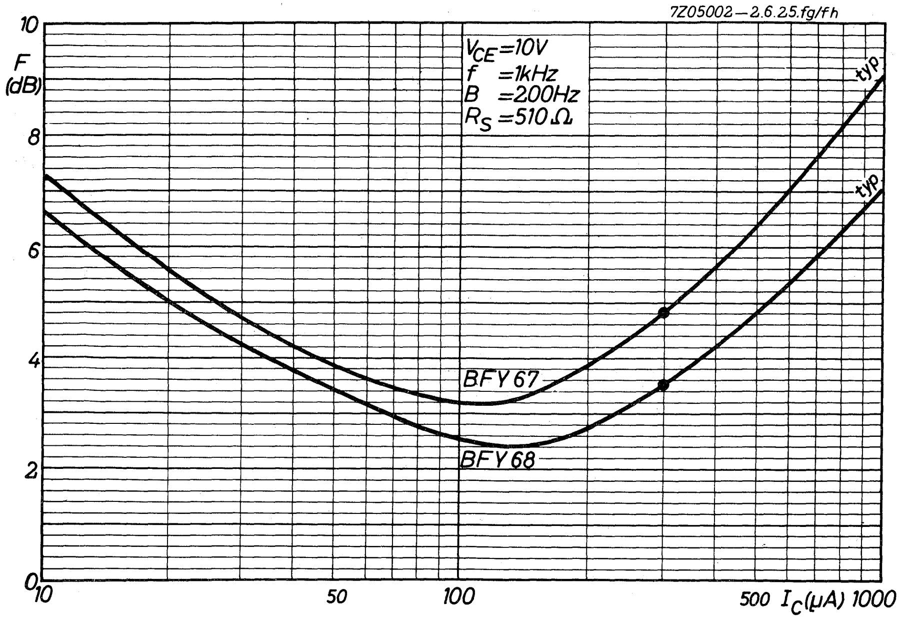

7Z04999–2.6.2.5.fg/fh
V_{BEsat} (V)
I_C=150mA
I_B=15mA
1
0.9
0.8
0.7
0.6
typ
0
20
40
60
80
100
120
140 T_j (°C)

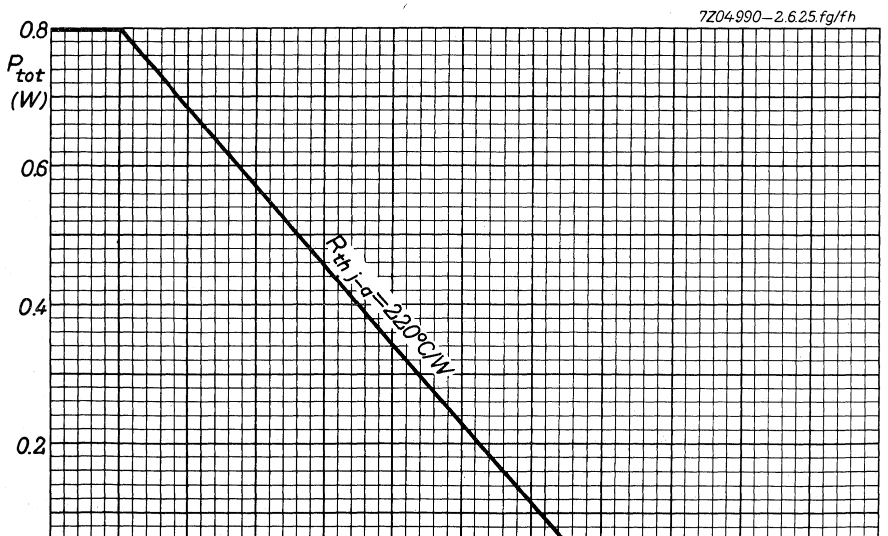

7Z04994
BFY67
80
h_{FE}
V_{CE} = 10V
T_j = 25°C
60
typ
40
min
20
0
0.01
0.1
1
10
100
I_C (mA)
1000

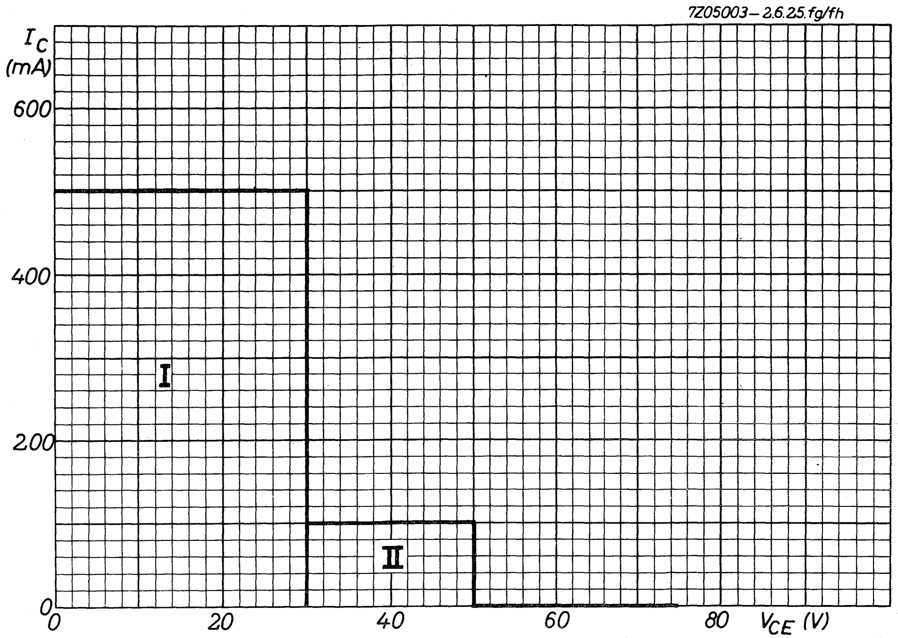

7Z04995
BFY68
200
h_{FE}
V_{CE} = 10V
T_j = 25°C
150
typ
100
min
50
0
0.01
0.1
1
10
100
I_C (mA)
1000


7Z05000–2.6.25.fg/fh
typical values
f = 1kHz
T_j = 25°C
200
h_{fe}
150
100
50
0
BFY68
V_{CE}=10V
5V
BFY 67
10V
5V
1
50
10
50 I_C(mA) 100


7Z05001–2.6.25.fg/fh
V_{CE}=10V
T_j =25°V
200
f_T
(MHz)
150
100
50
0
BFY68
typ
BFY67
typ
1
5
10
50 I_C (mA) 100


7Z05002—2.6.25.fg/fh
F
(dB)
V_{CE}=10V
f =1kHz
B =200Hz
R_S =510 Ω
typ
typ
BFY 67
BFY 68
0
2
4
6
8
10
10
50
100
500
I_C(μA) 1000


7Z04990—2.6.25.fg/fh
P_{tot}
(W)
0.8
0.6
0.4
0.2
0
$R_{th\ j-a}$=220°C/W
0
50
100
150
200
250
T_{amb}(°C)



I = region of permissible operation under all base-emitter conditions

II = additional region of operation when the transistor is cut-off with $R_B < 10\ \Omega$

7Z3 0210

SILICON PLANAR EPITAXIAL TRANSISTOR

For data of this transistor please refer to the BFY44.

7Z3 0458

SILICON PLANAR EPITAXIAL TRANSISTOR

N-P-N transistor in a TO-72 metal envelope, with insulated electrodes and a shield lead connected to the case. It has a very low noise, low intermodulation distortion and a high transition frequency and is primarily intended for military and industrial application such as:

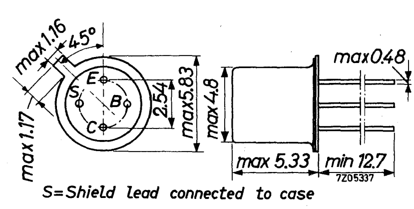
- low noise wideband amplifiers e.g. vertical amplifiers up to 250 MHz for oscilloscopes.
- r.f. amplifiers and mixers for communication equipment up to 470 MHz.
- microwave telephony link systems, wideband 70 MHz i.f. amplifiers.
- wideband radar 60 MHz i.f. amplifiers.
- pre- and driver stages of v.h.f. amplifiers.
- television distribution amplifiers from 40 to 230 MHz.

QUICK REFERENCE DATA

Collector-base voltage (open emitter)	V_{CBO}	max.	30	V
Collector-emitter voltage (open base)	V_{CEO}	max.	15	V
Collector current (peak value)	I_{CM}	max.	50	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	200	mW
Junction temperature	T_j	max.	200	°C
Feedback capacitance at f = 1 MHz I_C = 2 mA; V_{CE} = 5 V	$-C_{re}$	<	0.8	pF
Transition frequency I_C = 2 mA; V_{CE} = 5 V	f_T	>	1.0	GHz
I_C = 25 mA; V_{CE} = 5 V	f_T	>	1.3	GHz
Noise figure at f = 500 MHz I_C = 2 mA; V_{CE} = 5 V; R_S = 50 Ω	F	<	5	dB

MECHANICAL DATA Dimensions in mm

TO-72
insulated electrodes



7Z3 0379

RATINGS (Limiting values) [1])

Voltages

Collector-base voltage (open emitter)	V_{CBO}	max.	30	V
Collector-emitter voltage (open base) I_C = 10 mA	V_{CEO}	max.	15	V
Emitter-base voltage (open collector)	V_{EBO}	max.	2.5	V

Currents

Collector current (d.c. or average over any 100 μs period)	I_C	max.	25	mA
Collector current (peak value)	I_{CM}	max.	50	mA

Power dissipation

Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	200	mW

Temperatures

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

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	0.88	°C/mW
From junction to case	$R_{th\ j-c}$	=	0.58	°C/mW

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

7Z3 0380

CHARACTERISTICS T_j = 25 °C unless otherwise specified

Collector cut-off current				
I_E = 0 V; V_{CB} = 15 V	I_{CBO}	<	10	nA
V_{BE} = 0; V_{CE} = 15 V	I_{CES}	<	10	μA
Collector-emitter sustaining voltage				
I_B = 0; I_C = 10 mA	$V_{CEO sust}$	>	15	V
D.C. current gain				
I_C = 2 mA; V_{CE} = 1 V	h_{FE}		25 to 150	
I_C = 25 mA; V_{CE} = 1 V	h_{FE}		20 to 125	
Transition frequency [1]				
I_C = 2 mA; V_{CE} = 5 V	f_T	>	1.0	GHz
I_C = 25 mA; V_{CE} = 5 V	f_T	>	1.3	GHz
Collector capacitance at f = 1 MHz [2]				
I_E = I_e = 0; V_{CB} = 10 V	C_c	<	1.5	pF
Emitter capacitance at f = 1 MHz				
I_C = I_c = 0; V_{EB} = 0.5 V	C_e	<	2	pF
Feedback capacitance at f = 1 MHz				
I_C = 2 mA; V_{CE} = 5 V	$-C_{re}$	<	0.8	pF
Collector-base time constant at f = 10.7 MHz				
I_E = 2 mA; V_{CB} = 5 V	$r_{bb'}C_{b'c}$		2 to 12	ps
Noise figure [1]				
I_C = 2 mA; V_{CE} = 5 V				
f = 100 kHz; optimum source resistance	F	<	4	dB
f = 200 MHz; optimum source impedance	F	<	3.5	dB
f = 500 MHz; R_S = 50 Ω	F	<	5	dB

[1]) Shield lead grounded.

[2]) Shield lead not connected.

7Z3 0381

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

y parameters at f = 500 MHz (common emitter)

I_C = 2 mA; V_{CE} = 5 V

Input conductance	g_{ie}	typ.	16	$m\Omega^{-1}$
Input capacitance	C_{ie}	typ.	3.75	pF
Feedback admittance	$\|y_{re}\|$	typ.	1.55	$m\Omega^{-1}$
Phase angle of feedback admittance	φ_{re}	typ.	258°	
Transfer admittance	$\|y_{fe}\|$	typ.	45	$m\Omega^{-1}$
Phase angle of transfer admittance	φ_{fe}	typ.	285°	
Output conductance	g_{oe}	typ.	0.19	$m\Omega^{-1}$
Output capacitance	C_{oe}	typ.	1.9	pF

Maximum unilateralised power gain

$$G_{UM} = \frac{|y_{fe}|^2}{4 g_{ie} g_{oe}}$$

I_C = 2 mA; V_{CE} = 5 V; f = 500 MHz — G_{UM} typ. 22 dB

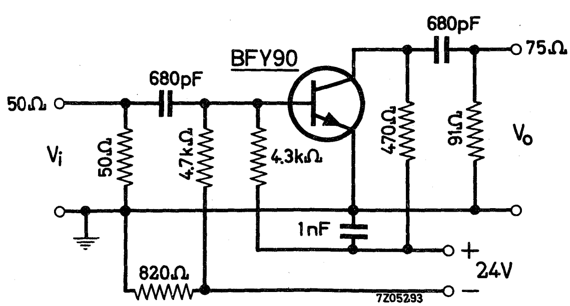
Intermodulation distortion

I_C = 14 mA; V_{CE} = 6 V; R_L = 37.5 Ω

V_o = 100 mV at f_p = 183 MHz

V_o = 100 mV at f_q = 200 MHz
measured at $f_{(2q-p)}$ = 217 MHz — d_{im} typ. −53 dB

Test circuit



7Z3 0755

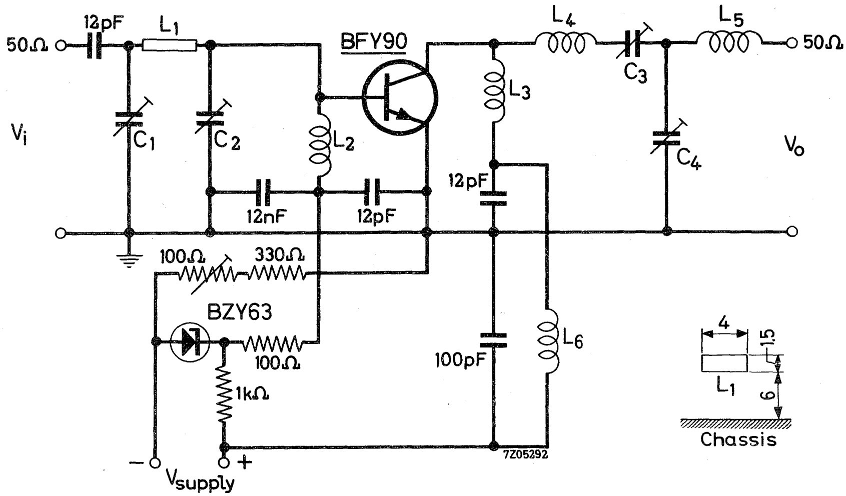
CHARACTERISTICS (continued) T_j = 25 °C unless otherwise specified

Output power at f = 500 MHz [1])

I_C = 22.5 mA; V_{CE} = 13.5 V

P_i = 25 mW; T_{case} = 25 °C P_o > 175 mW

Test circuit



Components

C_1	16 pF air gap trimmer
C_2, C_3, C_4	6 pF ceramic trimmer
L_1	copper strip 20 x 4 x 1.5 mm
L_2, L_6	10 turns enamelled Cu wire (0.7 mm); d = 4 mm
L_3	1 turn Cu wire (1 mm); d = 8 mm
L_4, L_5	1 turn Cu wire (1 mm); d = 7 mm

[1]) Care must be taken to reduce the steady state current when no h.f. signal is applied.

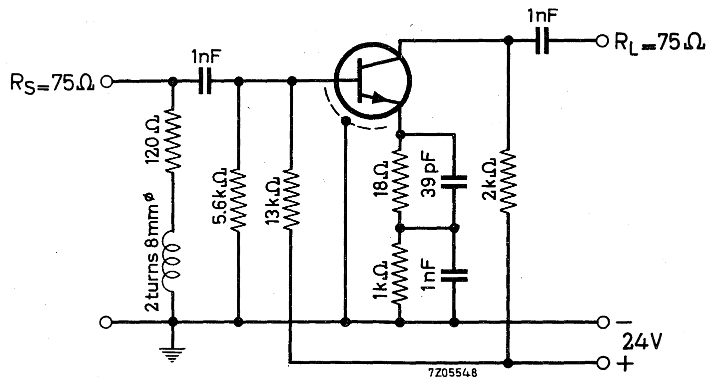
7Z3 0383

APPLICATION INFORMATION

The use of the BFY90 as broadband transistor.

Because of its high f_T and small capacitances the BFY90 is suitable for application in broadband amplifiers. Moreover it has a very low intermodulation distortion.

1. Pre stage.



Performance

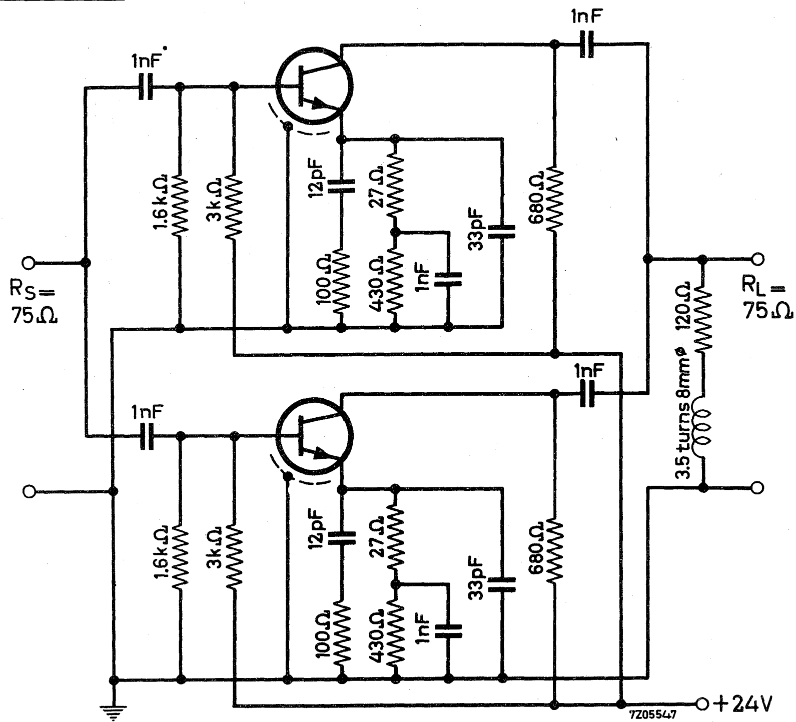
I_C = 6 mA; V_{CE} = 6 V; T_{amb} = 25 °C

Frequency range			25 to 250	MHz
Tranducer gain	G_{tr}		10.4 to 11.0	dB
Voltage standing wave ratio at input				
R_L = 75 Ω	V.S.W.R.	typ.	1.8	
Noise figure at f = 30 MHz	F	typ.	6.2	dB
f = 100 MHz	F	typ.	7.2	dB
f = 200 MHz	F	typ.	6.4	dB
Intermodulation distortion				
V_o = 20 mV at f_p = 183 MHz				
V_o = 20 mV at f_q = 200 MHz				
measured at $f_{(2q-p)}$ = 217 MHz	d_{im}	typ.	-70	dB

7Z3 0756

APPLICATION INFORMATION (continued)

2. Final stage.

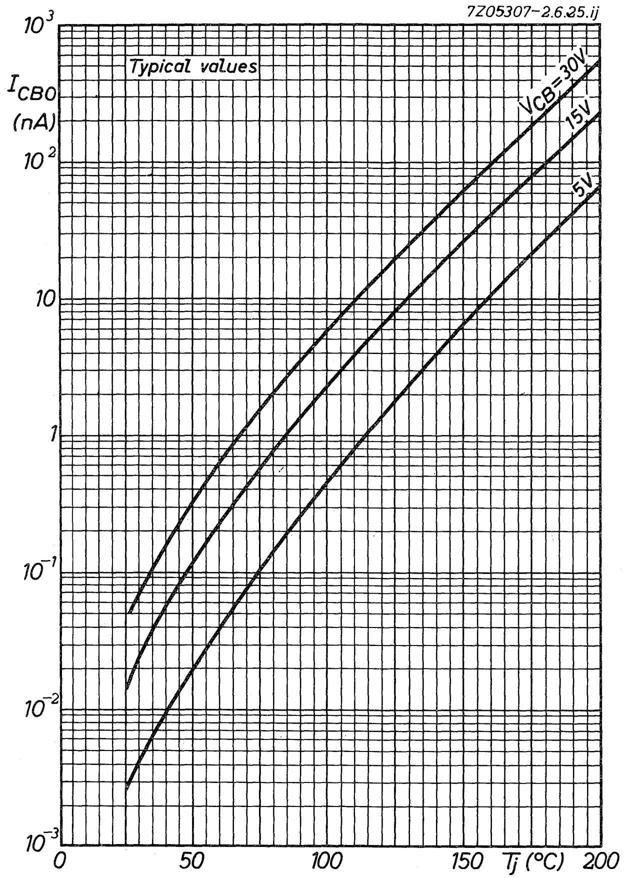


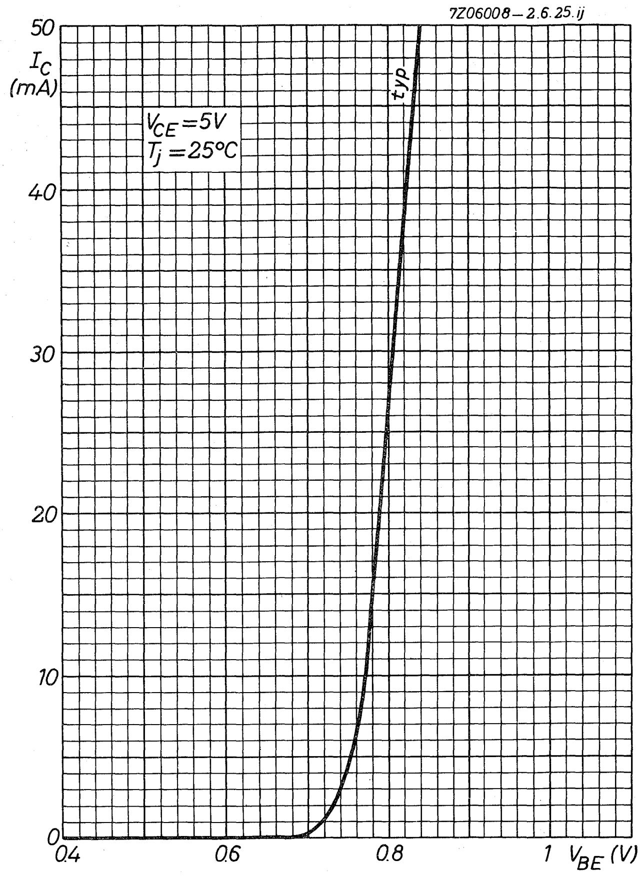
Performance

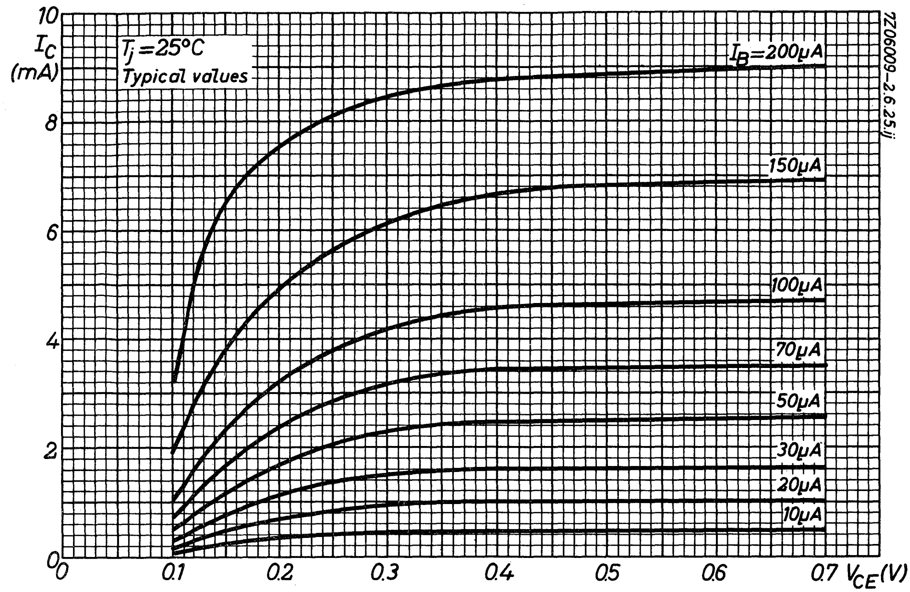
I_C = 15 mA; V_{CE} = 6 V; T_{amb} = 25 °C

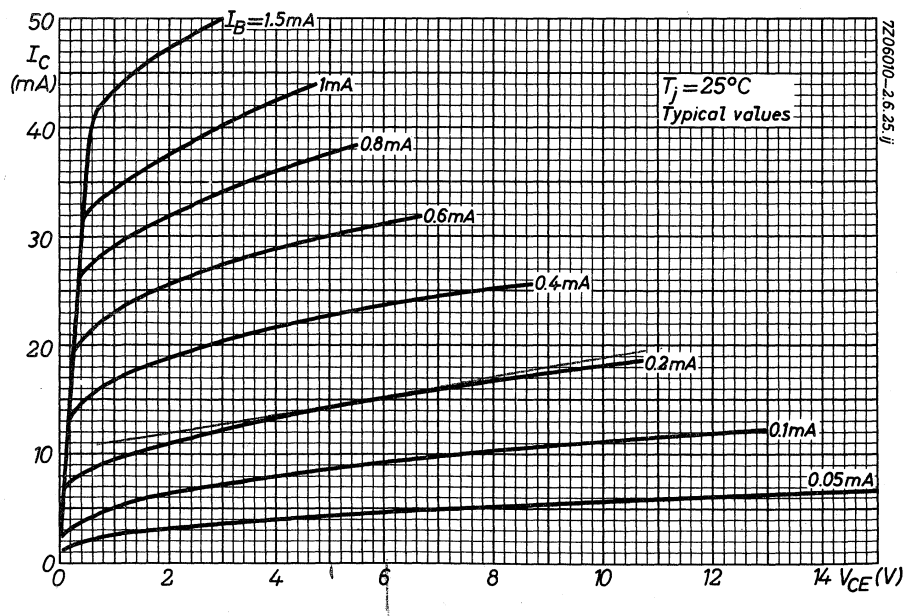
Frequency range			25 to 250	MHz
Transducer gain	G_{tr}		12.7 to 13.3	dB
Voltage standing wave ratio at output				
R_S = 75	V.S.W.R.	typ.	2.0	
Intermodulation distortion				
V_o = 100 mV at f_p = 183 MHz				
V_o = 100 mV at f_q = 200 MHz				
measured at $f_{(2q-p)}$ = 217 MHz	d_{im}	typ.	−69	dB

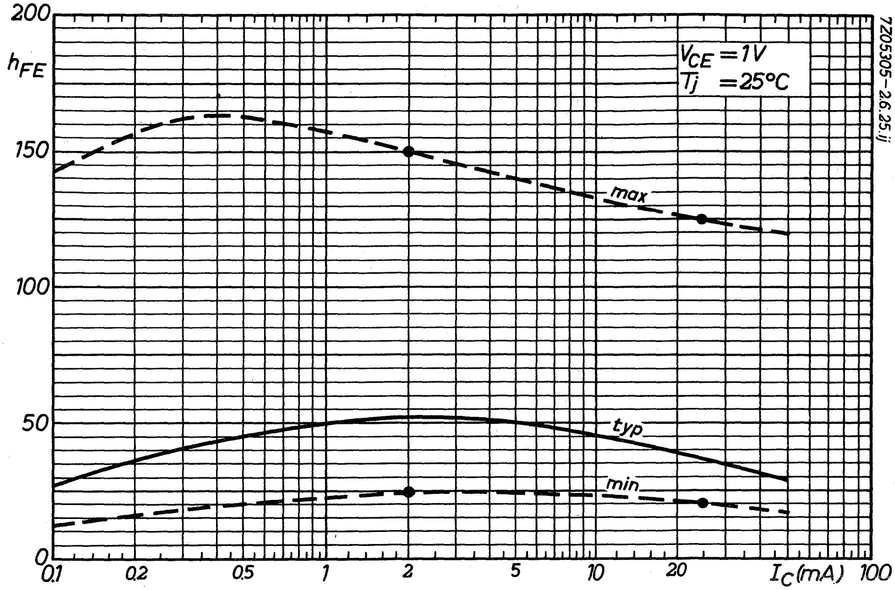
7Z3 0757

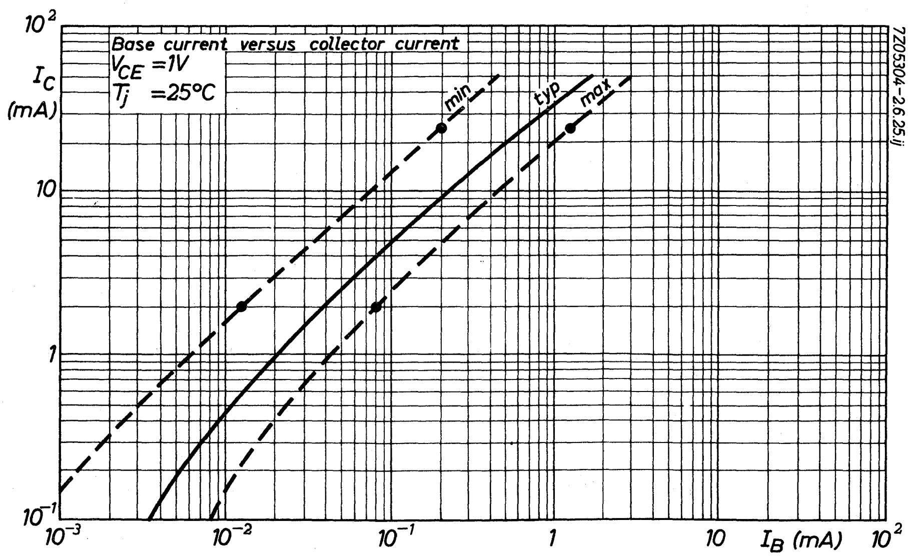

7Z05307–2.6.25.ij
Typical values
I_{CBO} (nA)
10^3
10^2
10
1
10^{-1}
10^{-2}
10^{-3}
V_{CB}=30V
15V
5V
0
50
100
150
T_j (°C)
200

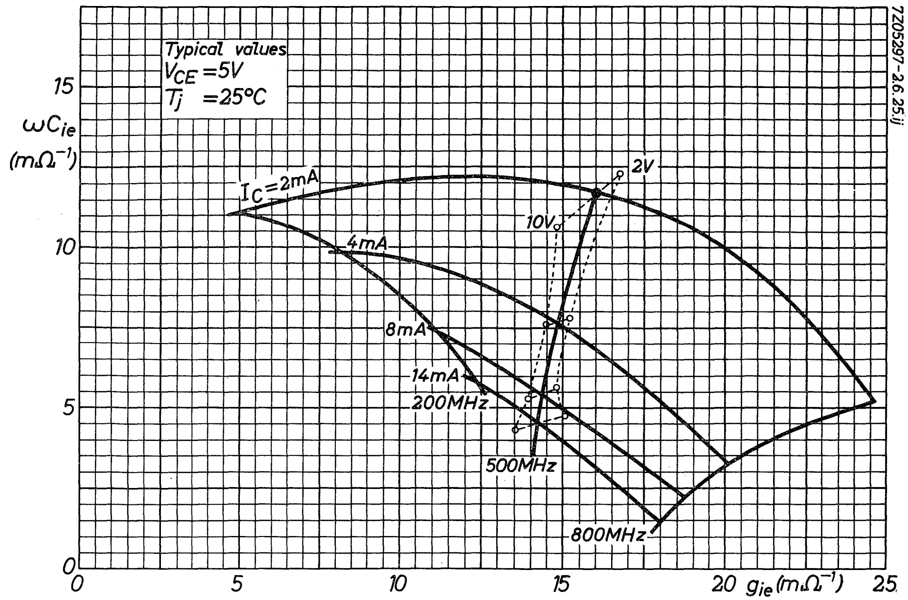

7Z06008 – 2.6.25.ij
50
I_C
(mA)
V_{CE} = 5V
T_j = 25°C
typ
40
30
20
10
0
0.4
0.6
0.8
1
V_{BE} (V)

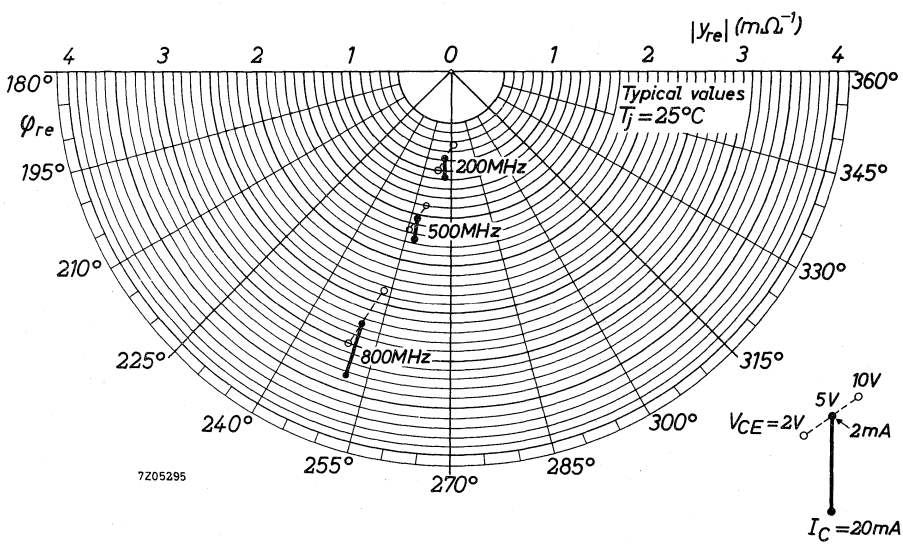

10
I_C
(mA)
$T_j = 25°C$
Typical values
$I_B = 200 \mu A$
150μA
100μA
70μA
50μA
30μA
20μA
10μA
7Z06009–2.6.25.ii
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7 V_{CE}(V)
8
6
4
2

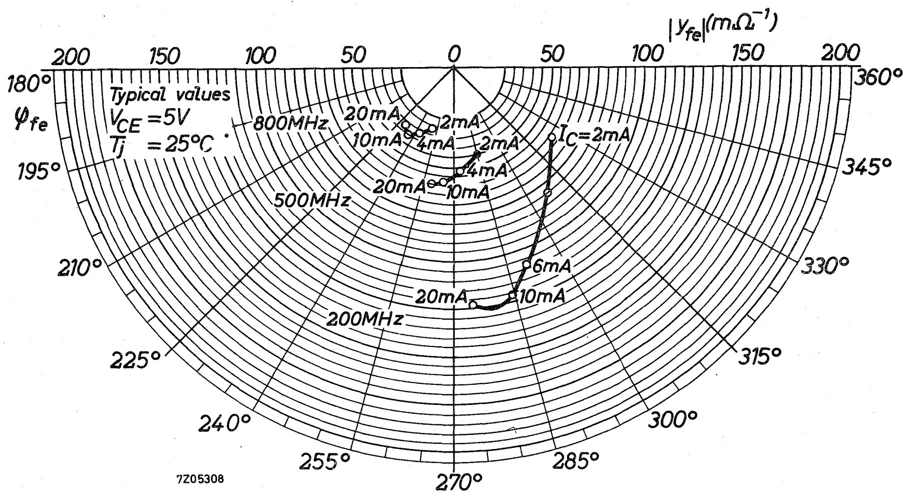

50
I_C
(mA)
$I_B = 1.5 mA$
1mA
0.8mA
0.6mA
0.4mA
0.2mA
0.1mA
0.05mA
$T_j = 25°C$
Typical values
7Z06010–2.6.25.ii
40
30
20
10
0
2
4
6
8
10
12
14 V_{CE}(V)

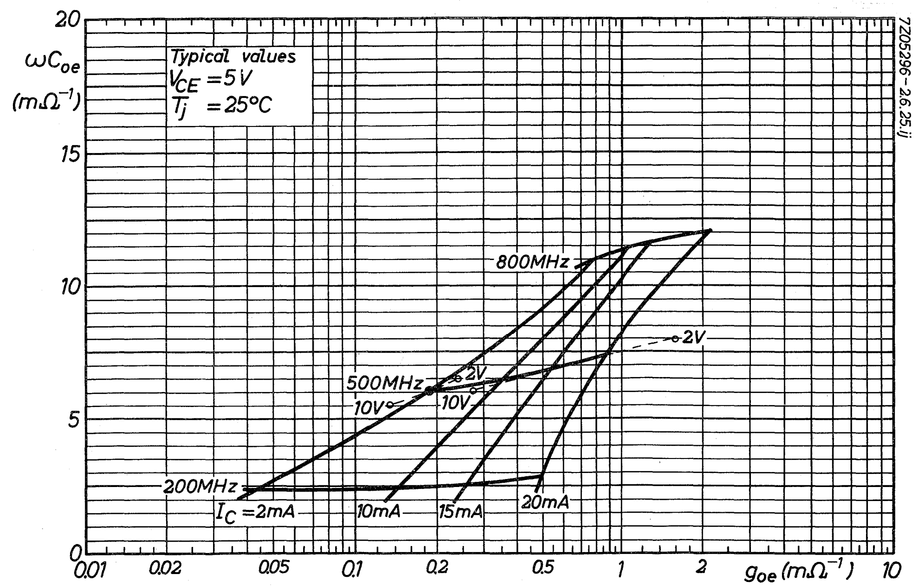

200
h_{FE}
150
100
50
0
0.1
0.2
0.5
1
2
5
10
20
I_C(mA)
100
V_{CE} = 1V
T_j = 25°C
max
typ
min
7Z05305−2.6.25.ij

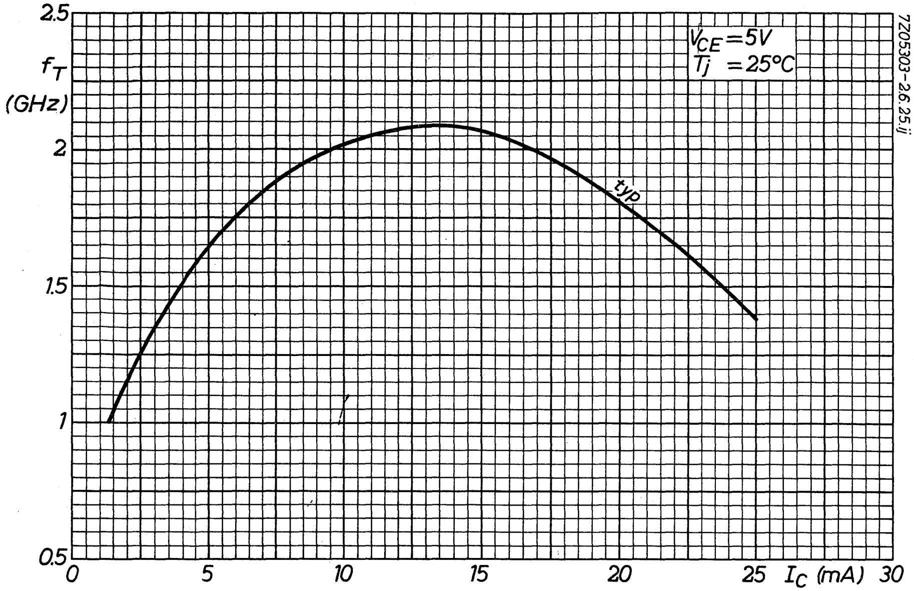

Base current versus collector current
V_{CE} = 1V
T_j = 25°C
10^2
I_C
(mA)
10
1
10^{-1}
10^{-3}
10^{-2}
10^{-1}
1
10
I_B (mA)
10^2
min
typ
max
7Z05304−2.6.25.ij

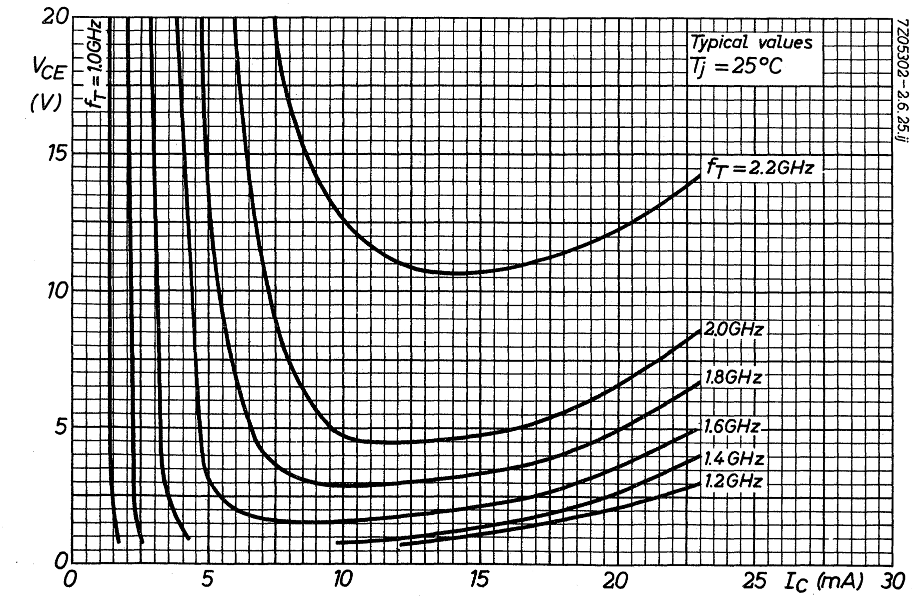

7Z05297-2.6.25.ij
Typical values
V_{CE} = 5V
T_j = 25°C
ωC_{ie}
($m\Omega^{-1}$)
15
10
5
0
0
5
10
15
20
25
g_{ie} ($m\Omega^{-1}$)
I_C = 2mA
4mA
8mA
14mA
200MHz
500MHz
800MHz
2V
10V

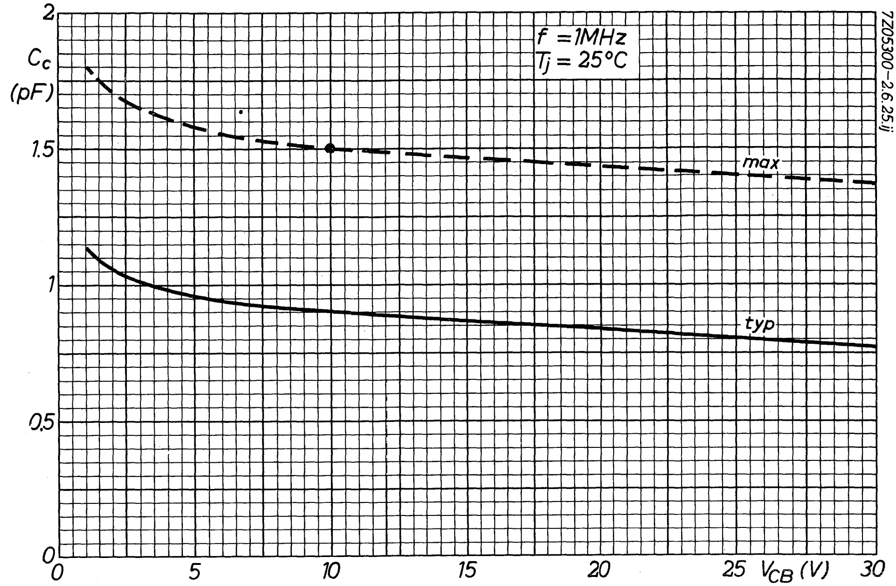

$|y_{re}|$ ($m\Omega^{-1}$)
4
3
2
1
0
1
2
3
4
Typical values
T_j = 25°C
φ_{re}
180°
195°
210°
225°
240°
255°
270°
285°
300°
315°
330°
345°
360°
200MHz
500MHz
800MHz
7Z05295
10V
5V
V_{CE} = 2V
2mA
I_C = 20mA

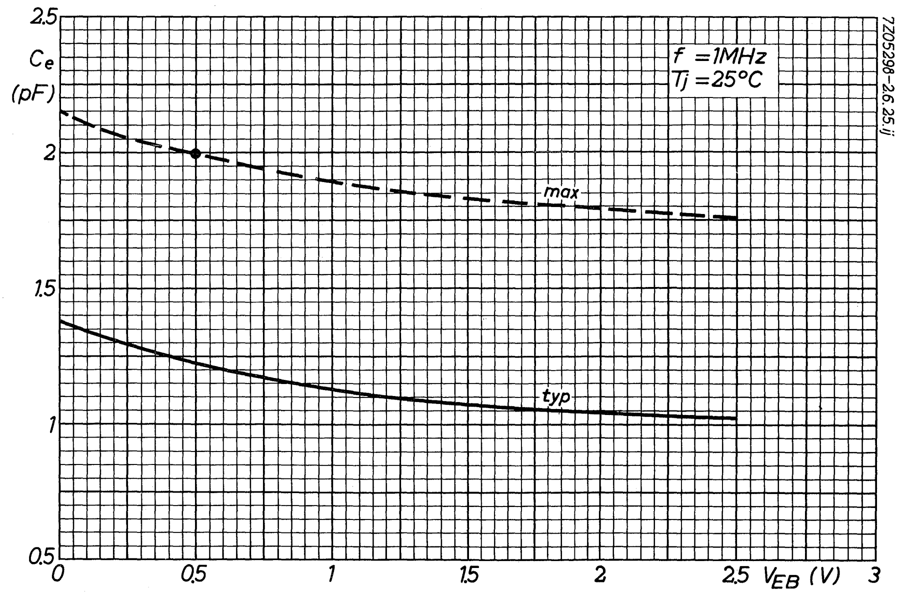

$|y_{fe}|$ (mΩ^{-1})
200 150 100 50 0 50 100 150 200
180° 195° 210° 225° 240° 255° 270° 285° 300° 315° 330° 345° 360°
φ_{fe}
Typical values
V_{CE} = 5 V
T_j = 25 °C
800MHz
500MHz
200MHz
I_C = 2mA
2mA
4mA
6mA
10mA
20mA
7Z05308

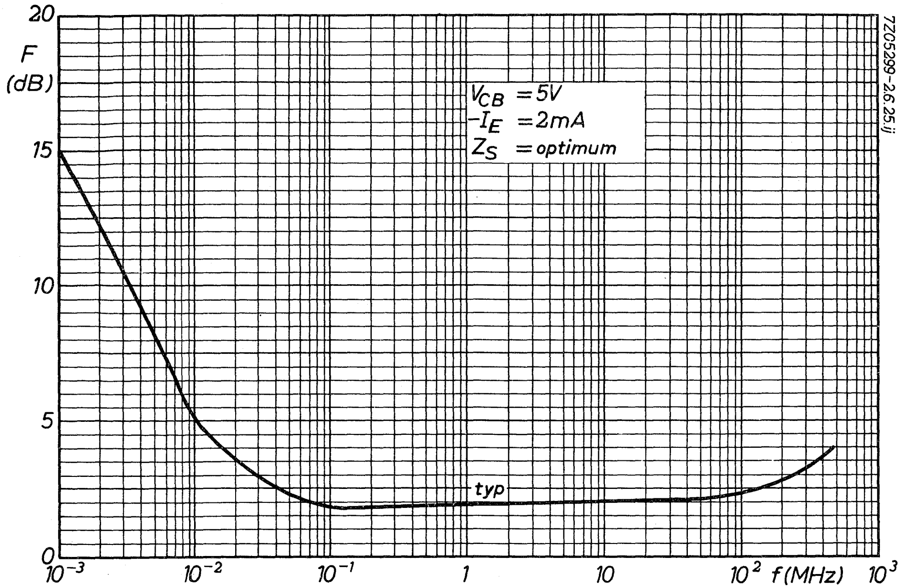

ωC_{oe} (mΩ^{-1})
20 15 10 5 0
Typical values
V_{CE} = 5 V
T_j = 25 °C
800MHz
500MHz
200MHz
2V
10V
I_C = 2mA
10mA
15mA
20mA
0.01 0.02 0.05 0.1 0.2 0.5 1 2 10
g_{oe} (mΩ^{-1})
7Z05296 - 26.25.ij

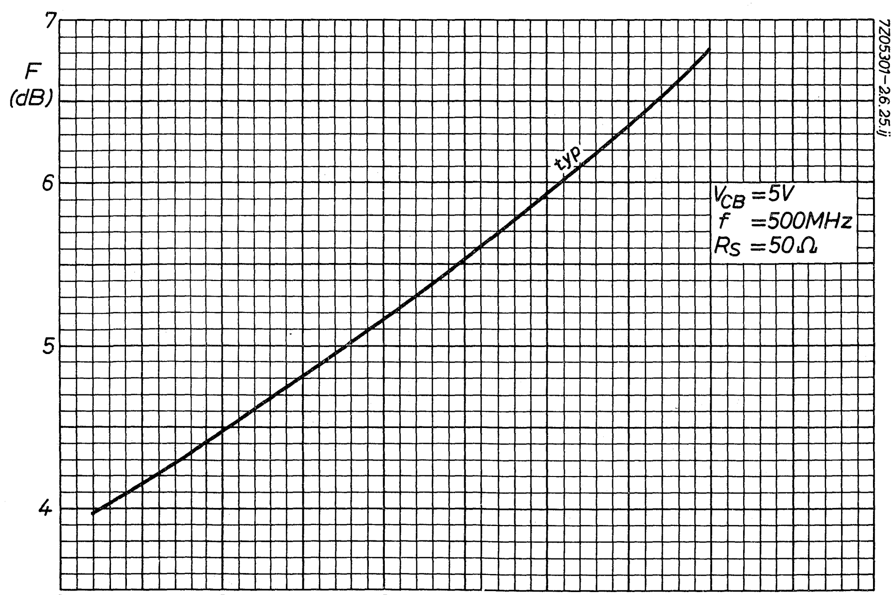

7Z05303-2.6.25.ij
V_{CE} = 5V
T_j = 25°C
f_T
(GHz)
typ
I_C (mA)
0
5
10
15
20
25
30
0.5
1
1.5
2
2.5


7Z05302-2.6.25.ij
Typical values
T_j = 25°C
V_{CE}
(V)
f_T = 1.0GHz
f_T = 2.2GHz
2.0GHz
1.8GHz
1.6GHz
1.4 GHz
1.2GHz
I_C (mA)
0
5
10
15
20
25
30
0
5
10
15
20


2
Cc
(pF)
1.5
1
0.5
0
0
5
10
15
20
25
VCB (V)
30
f = 1MHz
Tj = 25°C
max
typ
7Z05300-2.6.25.ij


2.5
Ce
(pF)
2
1.5
1
0.5
0
0.5
1
1.5
2
2.5
VEB (V)
3
f = 1MHz
Tj = 25°C
max
typ
7Z05298-2.6.25.ij


20
F
(dB)
15
10
5
0
V_{CB} = 5V
$-I_E$ = 2mA
Z_S = optimum
typ
10^{-3}
10^{-2}
10^{-1}
1
10
10^2 f (MHz)
10^3
7Z05299-26.25.ij

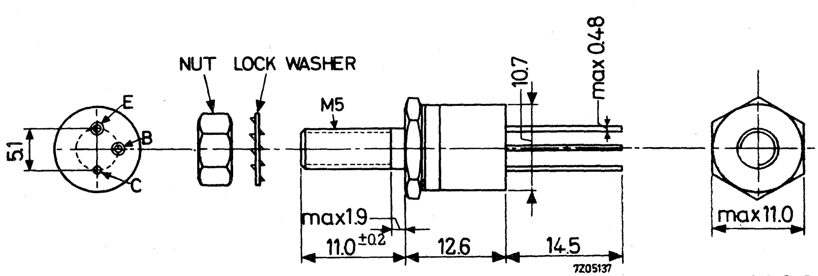

7
F
(dB)
6
5
4
typ
V_{CB} = 5V
f = 500MHz
R_S = 50 Ω
0
5
10
15
20 $-I_E$ (mA)
25
7Z05301-26.25.ij

SILICON PLANAR EPITAXIAL TRANSISTOR

N-P-N transistor in a metal envelope. All electrodes are electrically insulated from the stud.
The BLY17 is intended for high frequency and high power applications, primarily for use in the transmitting field.

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

MECHANICAL DATA Dimensions in mm



7Z3 0261

RATINGS (Limiting values) [1])

Voltages

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

Currents

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

Power dissipation

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

Temperatures

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

THERMAL RESISTANCE

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

CHARACTERISTICS T_j = 25 °C unless otherwise specified

Collector cut-off current

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

Emitter cut-off current

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

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

7Z3 0262

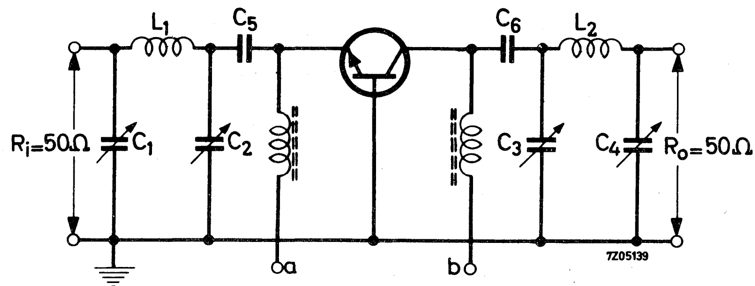
CHARACTERISTICS (continued) T_j = 25 °C unless otherwise specified

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

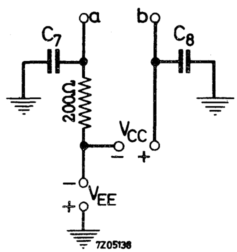
7Z3 0263

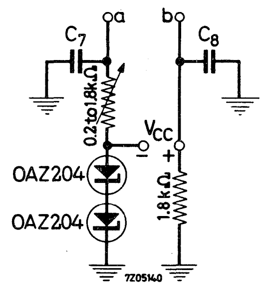
APPLICATION INFORMATION

Amplifier circuit



Different methods of biasing





Components	f = 100 MHz	f = 180 MHz
C_1, C_2, C_3, C_4	25 pF	25 pF
C_5, C_6, C_7, C_8	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

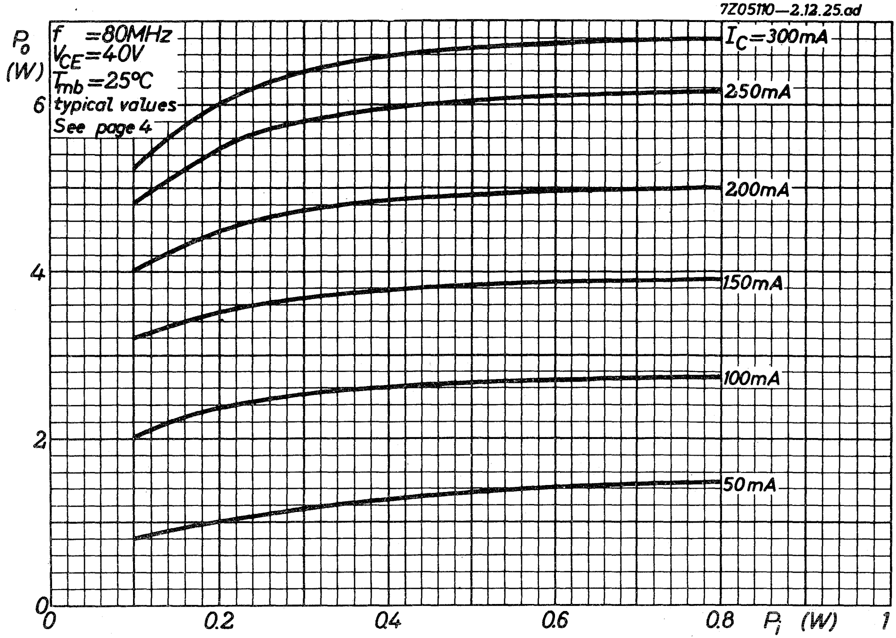
Performance in common base configuration (see pages A/C)

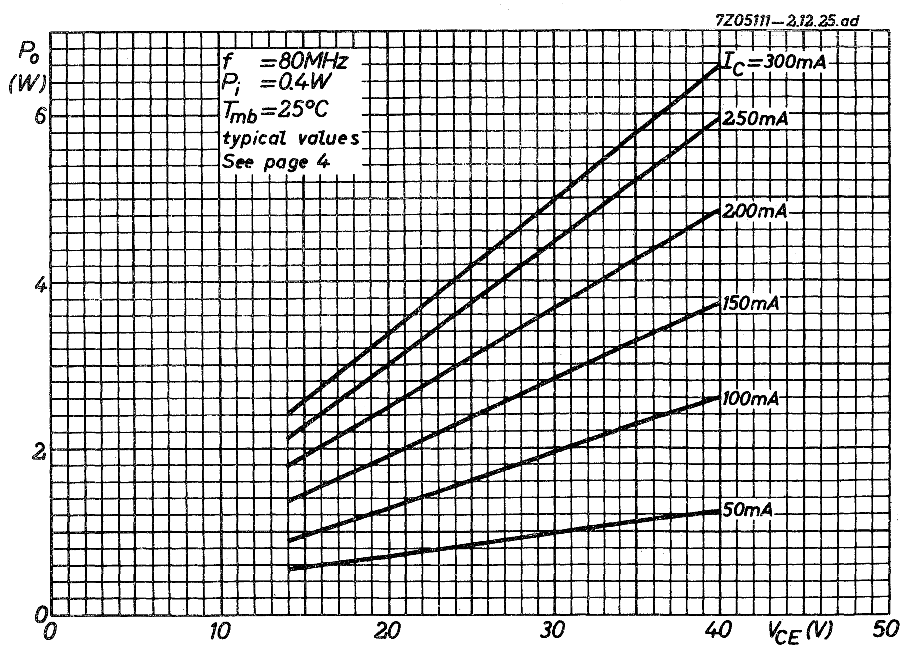
V_{CE} = 40 V; P_i = 0.625 W

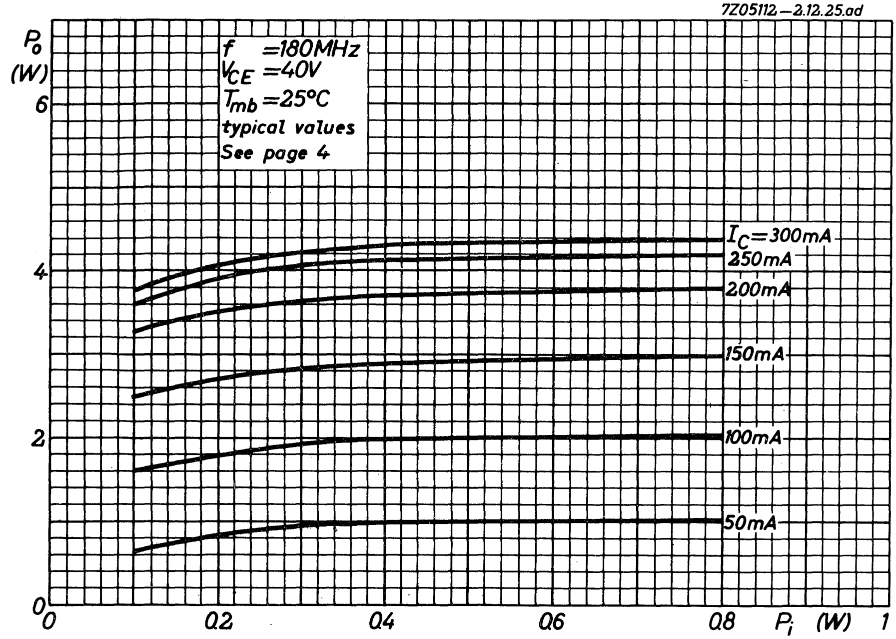
f = 180 MHz; T_{mb} = 25 °C

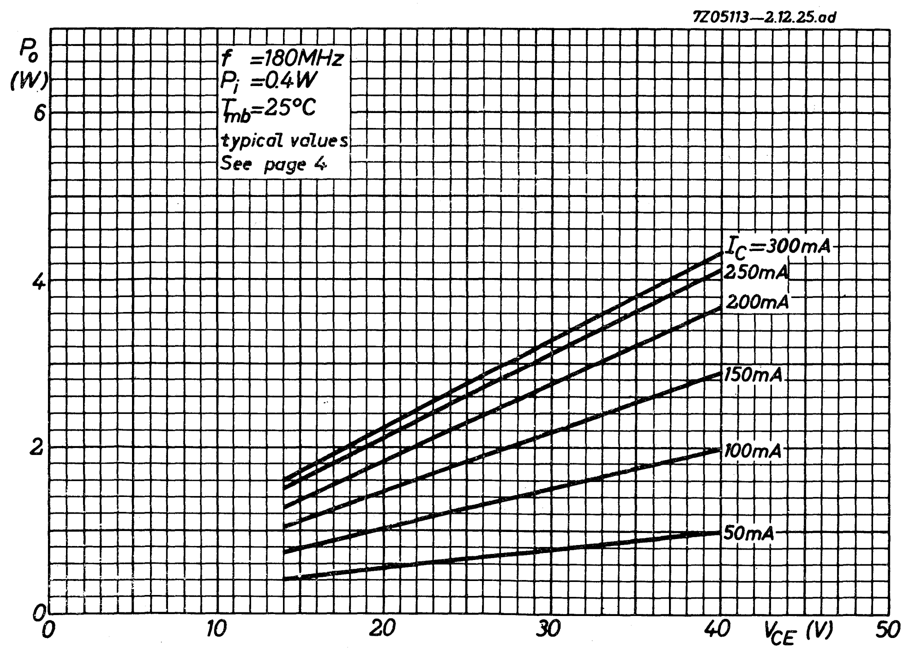
Output power	P_o	>	3.0	W
		typ.	3.6	W
Power gain	G_p	>	6.8	dB
		typ.	7.6	dB
Collector efficiency	η	>	40	%
		typ.	48	%

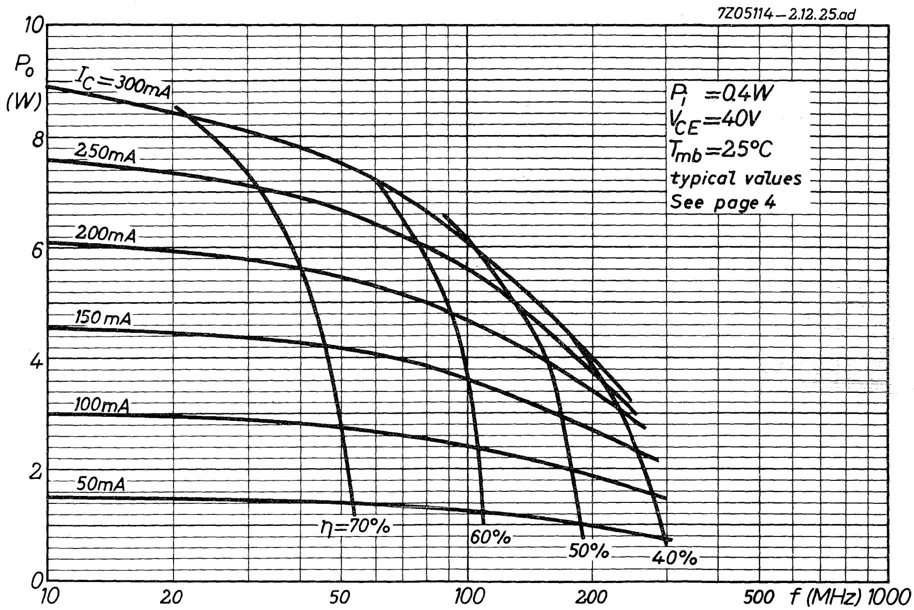
7Z3 0264

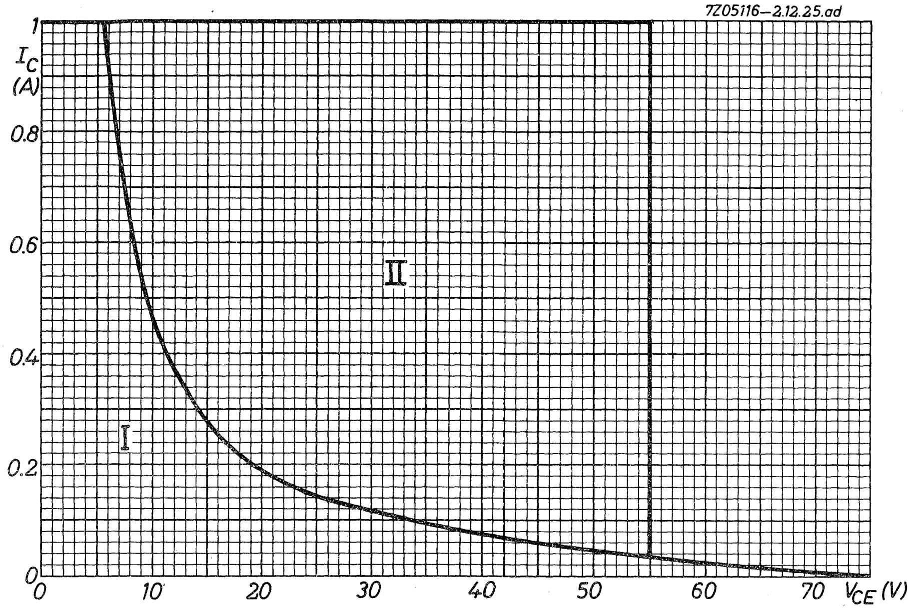

7Z05110—2.12.25.ad
P_o (W)
f = 80MHz
V_{CE} = 40V
T_{mb} = 25°C
typical values
See page 4
I_C = 300mA
250mA
200mA
150mA
100mA
50mA
0
2
4
6
0
0.2
0.4
0.6
0.8
P_i (W)
1


7Z05111—2.12.25.ad
P_o (W)
f = 80MHz
P_i = 0.4W
T_{mb} = 25°C
typical values
See page 4
I_C = 300mA
250mA
200mA
150mA
100mA
50mA
0
2
4
6
0
10
20
30
40
V_{CE} (V)
50


7Z05112—2.12.25.ad
P_o (W)
f =180MHz
V_{CE} =40V
T_{mb} =25°C
typical values
See page 4
I_C=300mA
250mA
200mA
150mA
100mA
50mA
0
2
4
6
0
0.2
0.4
0.6
0.8
P_i (W)
1


7Z05113—2.12.25.ad
P_o (W)
f =180MHz
P_i =0.4W
T_{mb}=25°C
typical values
See page 4
I_C=300mA
250mA
200mA
150mA
100mA
50mA
0
2
4
6
0
10
20
30
40
V_{CE} (V)
50


7Z05114–2.12.25.ad
10
P_o
(W)
8
6
4
2
0
I_C=300mA
250mA
200mA
150 mA
100mA
50mA
η=70%
60%
50%
40%
P_i =0.4W
V_{CE}=40V
T_{mb}=25°C
typical values
See page 4
10
20
50
100
200
500
f (MHz)
1000

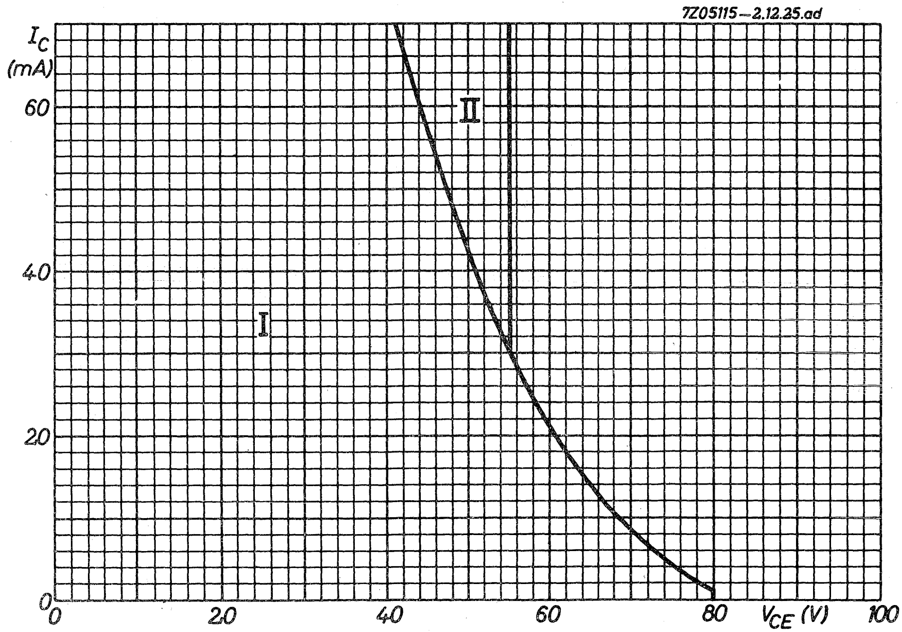


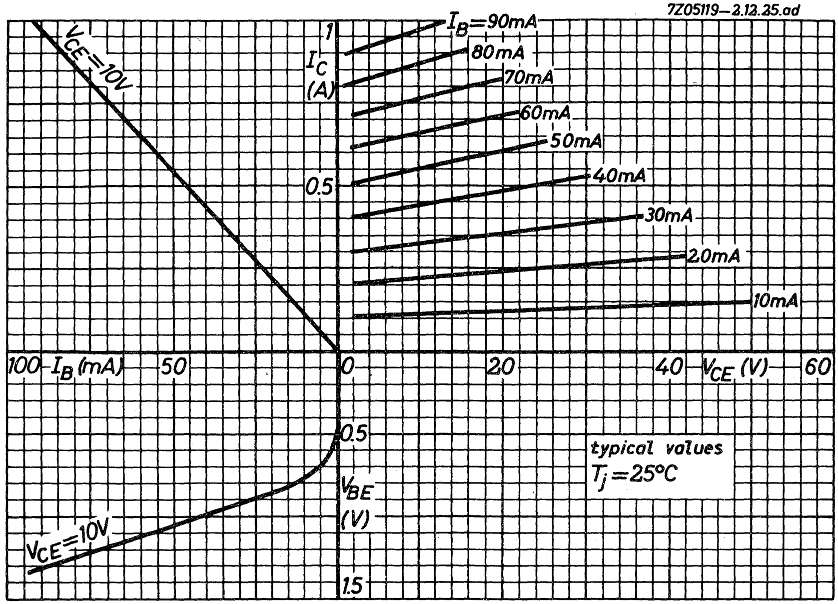
I = Region of permissible operation at all frequencies, including d.c.

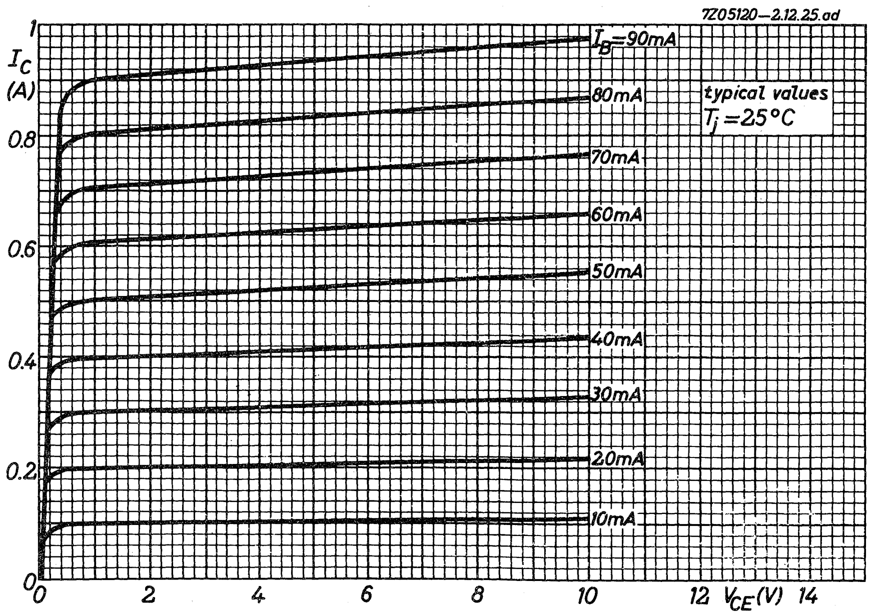
II = Additional region of operation at f ≥ 1 MHz.
When operating in region II, care must be taken to reduce the steady state current before removing the signal. This may be achieved by an appropriate bias in class A, B or C.

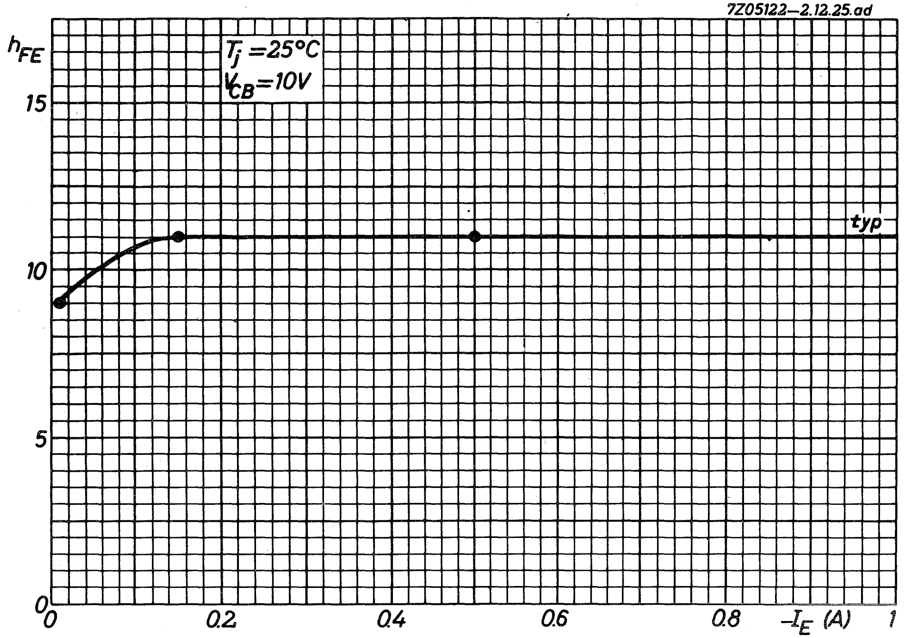
The graph at page E is an enlargement of the lower part.

7Z3 0266

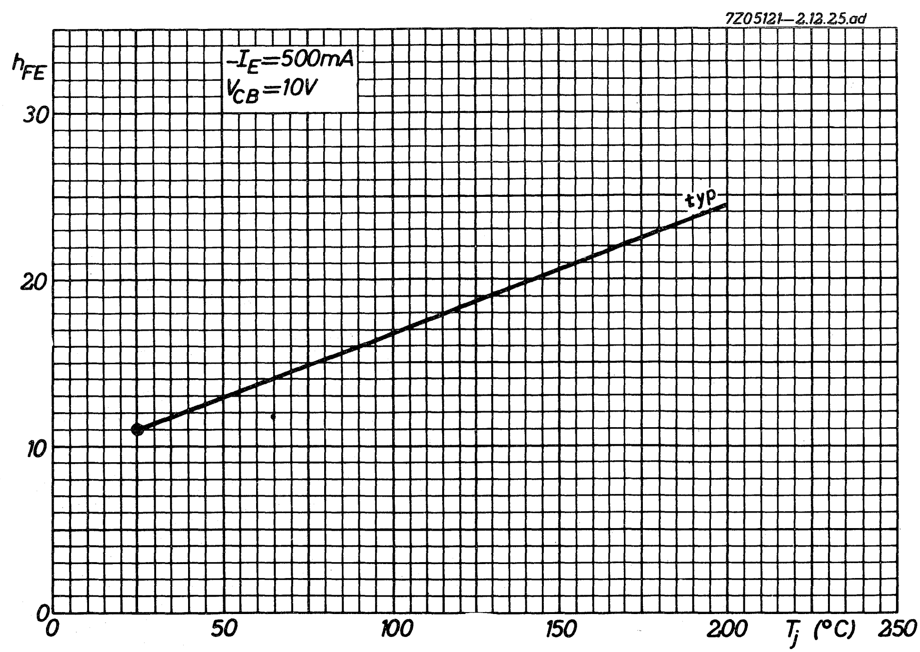

7Z05115—2.12.25.ad
I_C
(mA)
60
40
20
0
0
20
40
60
80
V_{CE} (V)
100
II
I


7Z05119—2.12.25.ad
V_{CE}=10V
I_C (A)
1
0.5
I_B=90mA
80mA
70mA
60mA
50mA
40mA
30mA
20mA
10mA
100
I_B (mA)
50
0
20
40
V_{CE} (V)
60
0.5
V_{BE} (V)
1.5
V_{CE}=10V
typical values
T_j=25°C

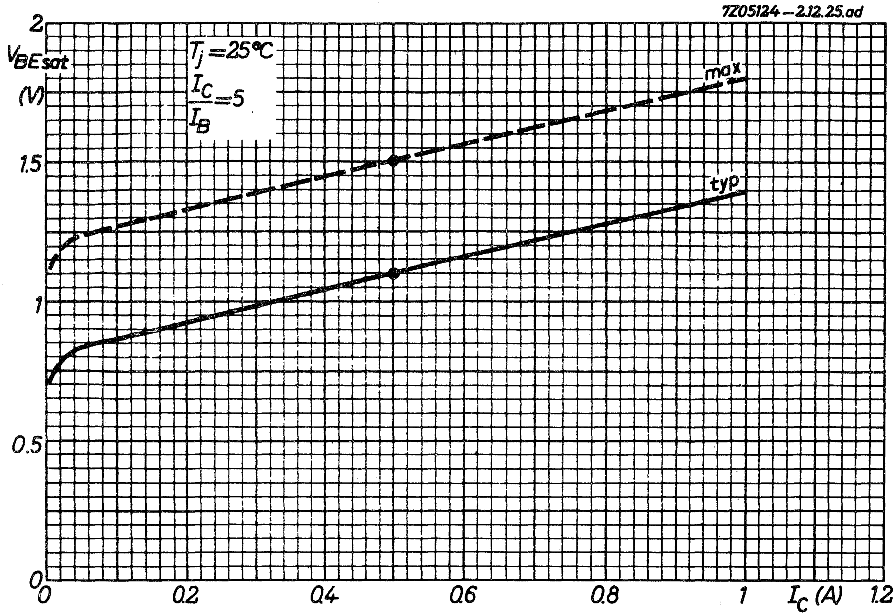

7Z05120—2.12.25.ad
I_C (A)
1
0.8
0.6
0.4
0.2
0
I_B=90mA
80mA
70mA
60mA
50mA
40mA
30mA
20mA
10mA
typical values
T_j=25°C
0
2
4
6
8
10
12
V_{CE}(V)
14

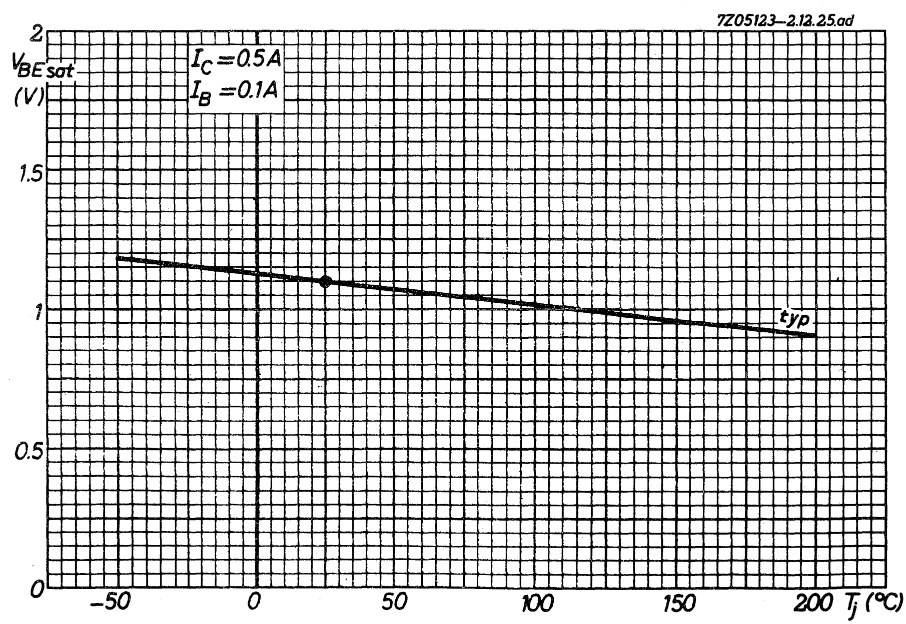


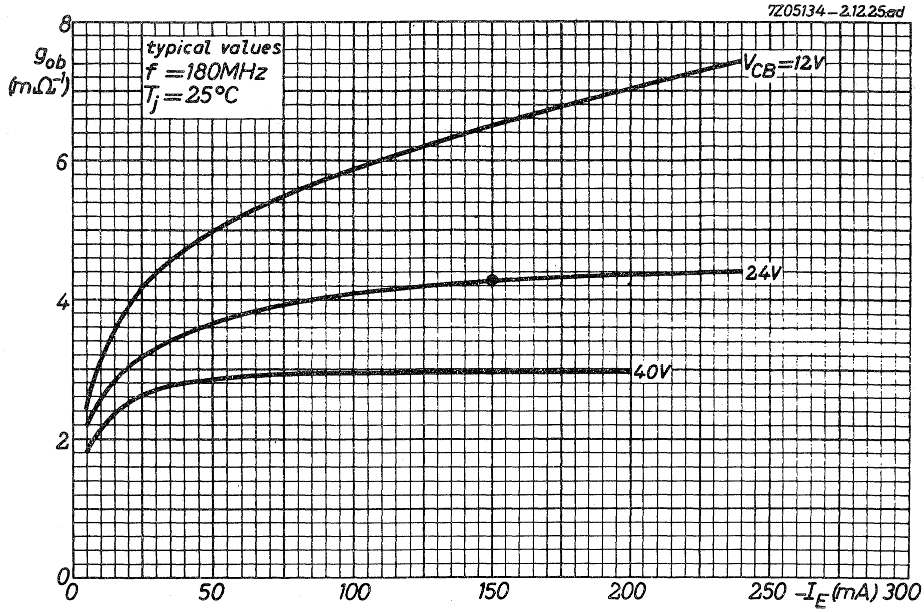
7Z05122—2.12.25.ad
h_{FE}
T_j =25°C
V_{CB}=10V
typ
15
10
5
0
0
0.2
0.4
0.6
0.8
$-I_E$ (A)
1

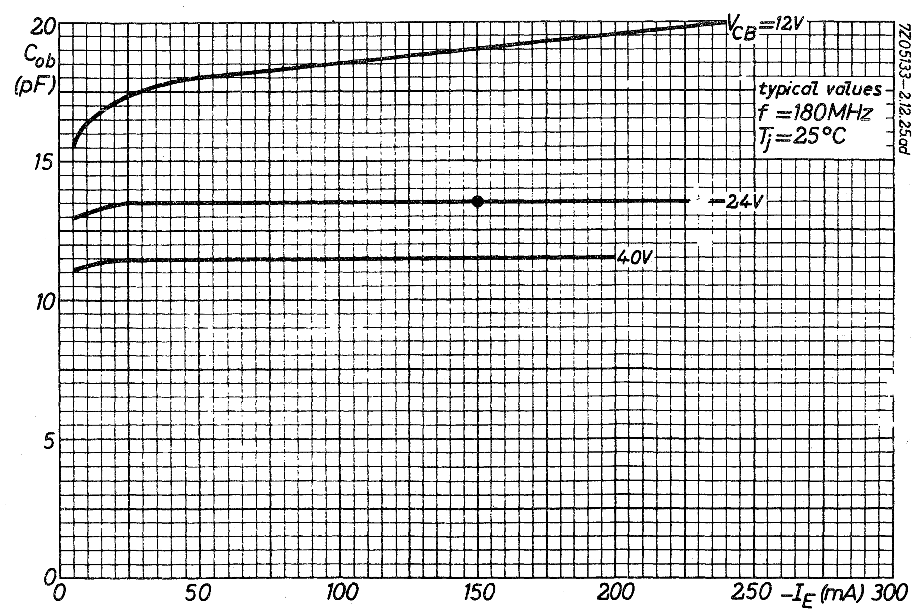


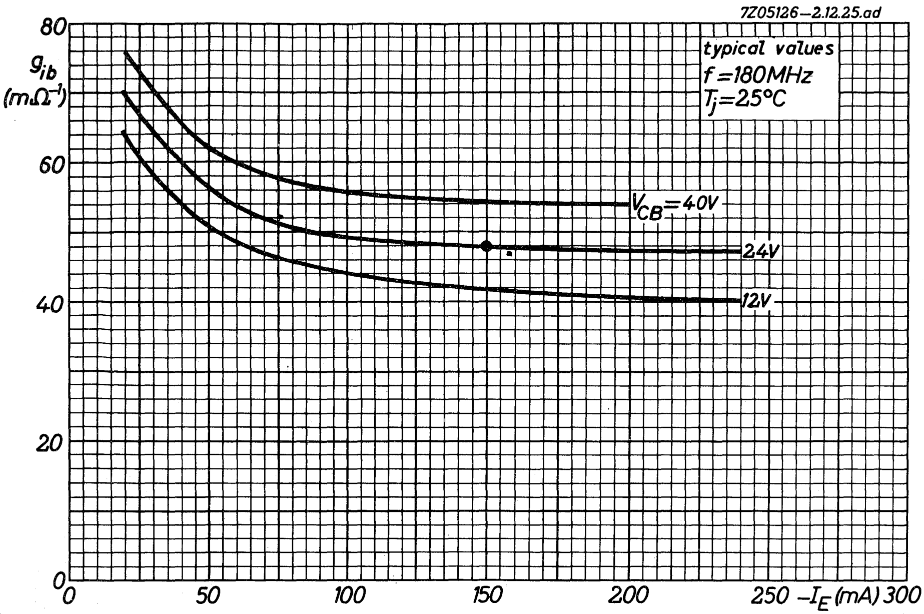
7Z05121—2.12.25.ad
h_{FE}
$-I_E$=500mA
V_{CB}=10V
typ
30
20
10
0
0
50
100
150
200
T_j (°C)
250

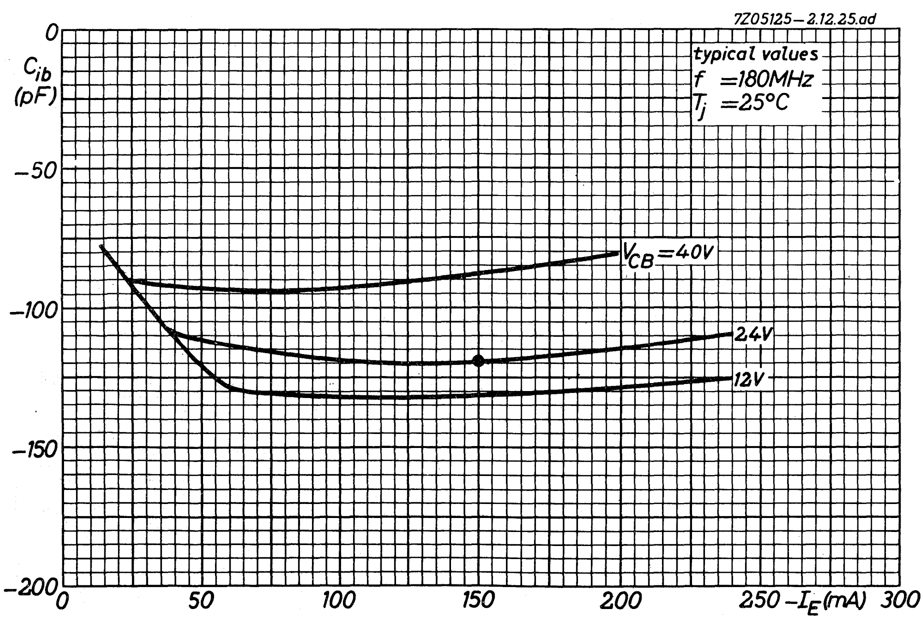

7Z05124—2.12.25.ad
V_{BEsat} (V)
$T_j = 25\,°C$
$\frac{I_C}{I_B} = 5$
max
typ
I_C (A)
0
0.5
1
1.5
2
0.2
0.4
0.6
0.8
1.2

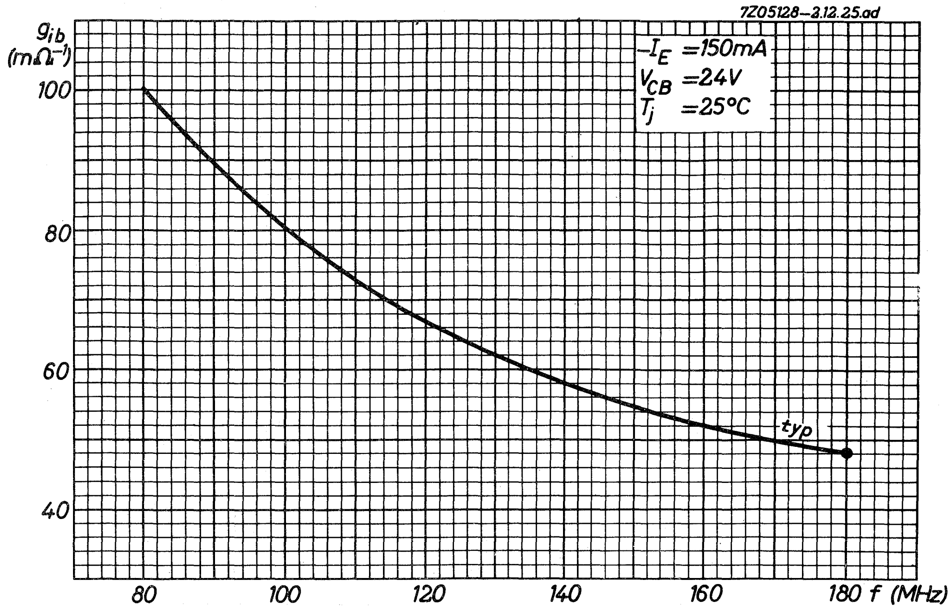

7Z05123—2.12.25.ad
V_{BEsat} (V)
$I_C = 0.5\,A$
$I_B = 0.1\,A$
typ
T_j (°C)
0
0.5
1
1.5
2
−50
50
100
150
200

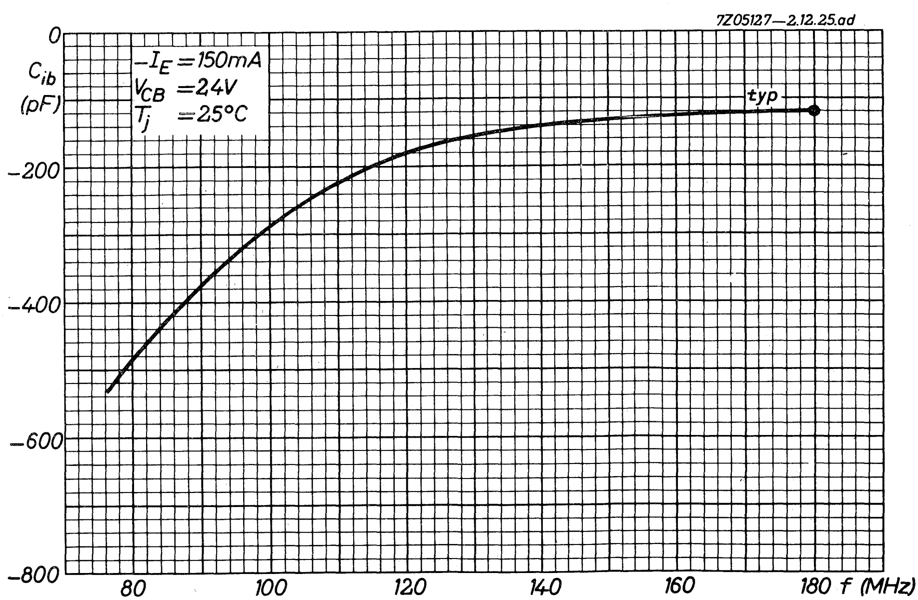

7Z05134–2.12.25ad
typical values
f = 180MHz
T_j = 25°C
g_{ob} ($m\Omega^{-1}$)
8
6
4
2
0
0
50
100
150
200
250
300
$-I_E$ (mA)
V_{CB} = 12V
24V
40V

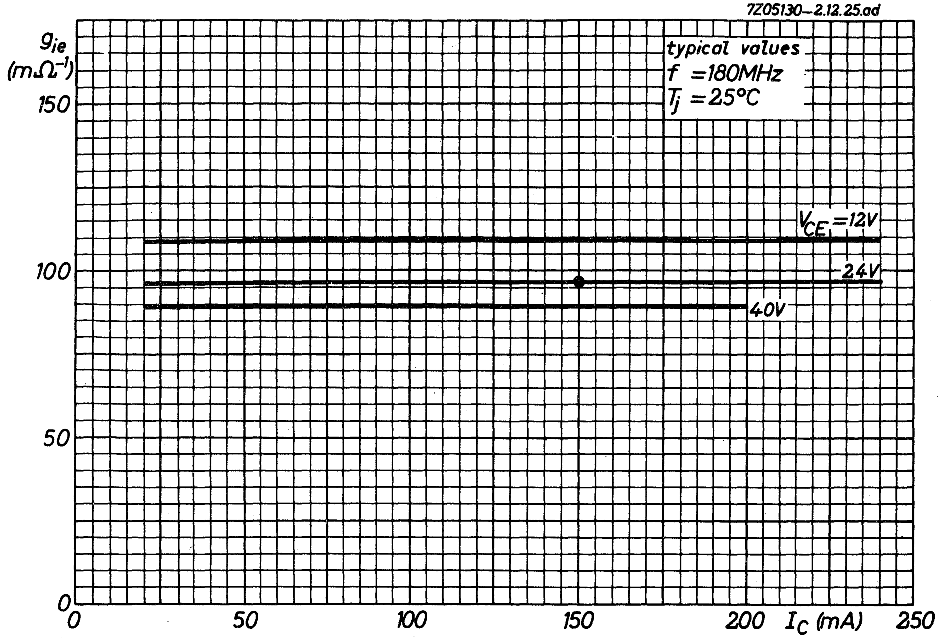

7Z05133–2.12.25ad
typical values
f = 180MHz
T_j = 25°C
C_{ob} (pF)
20
15
10
5
0
0
50
100
150
200
250
300
$-I_E$ (mA)
V_{CB} = 12V
24V
40V

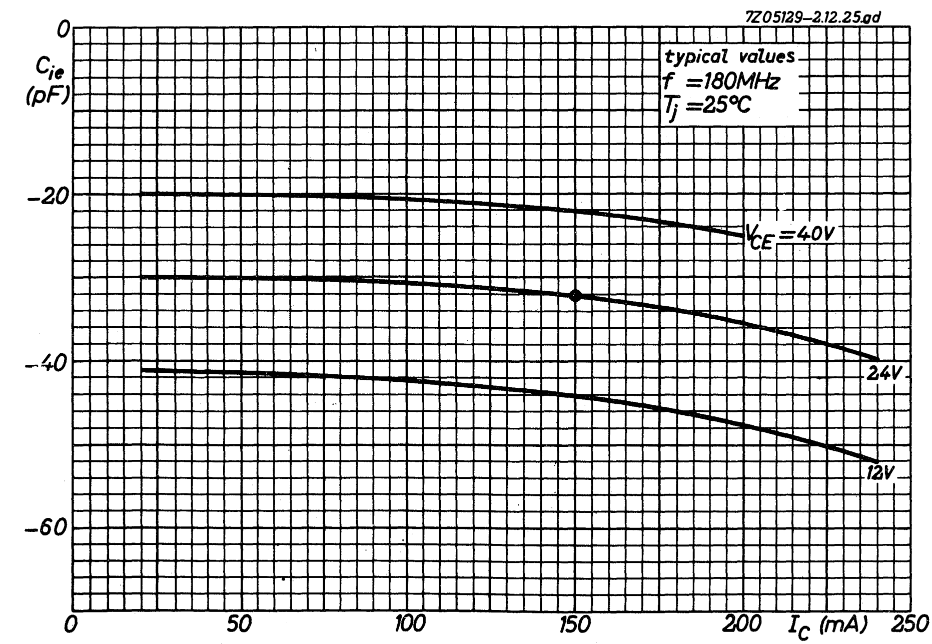

7Z05126—2.12.25.ad
typical values
f = 180MHz
T_j = 25°C
g_{ib}
($m\Omega^{-1}$)
80
60
40
20
0
V_{CB} = 40V
24V
12V
0
50
100
150
200
250
$-I_E$ (mA)
300

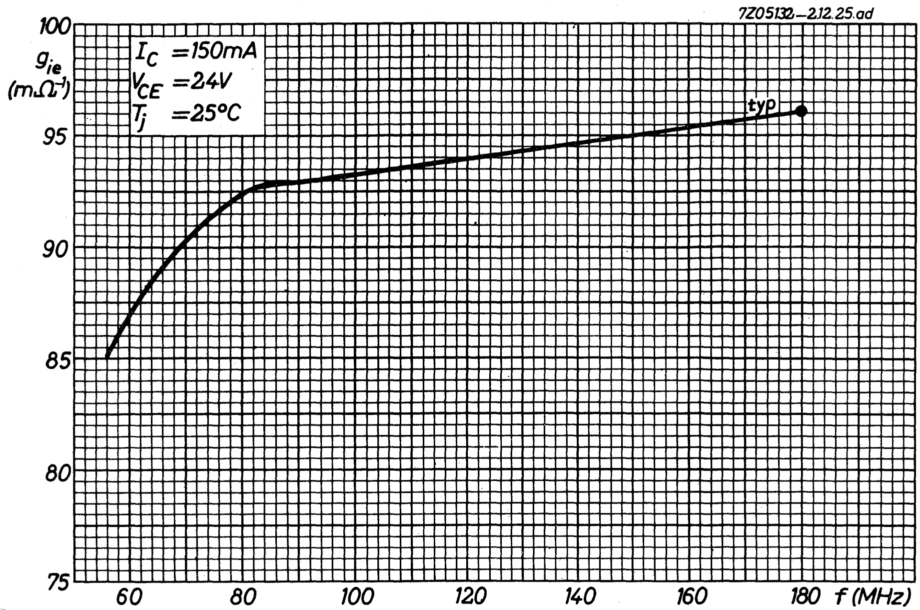

7Z05125—2.12.25.ad
typical values
f = 180MHz
T_j = 25°C
C_{ib}
(pF)
0
−50
−100
−150
−200
V_{CB} = 40V
24V
12V
0
50
100
150
200
250
$-I_E$ (mA)
300

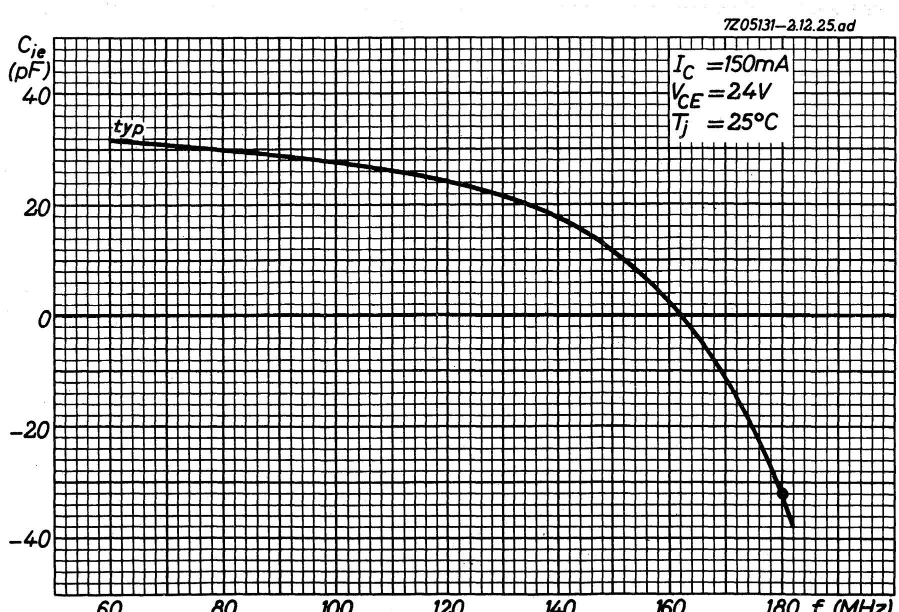

7Z05128-2.12.25.ad
g_{ib} $(m\Omega^{-1})$
100
80
60
40
$-I_E$ = 150mA
V_{CB} = 24V
T_j = 25°C
typ
80
100
120
140
160
180 f (MHz)

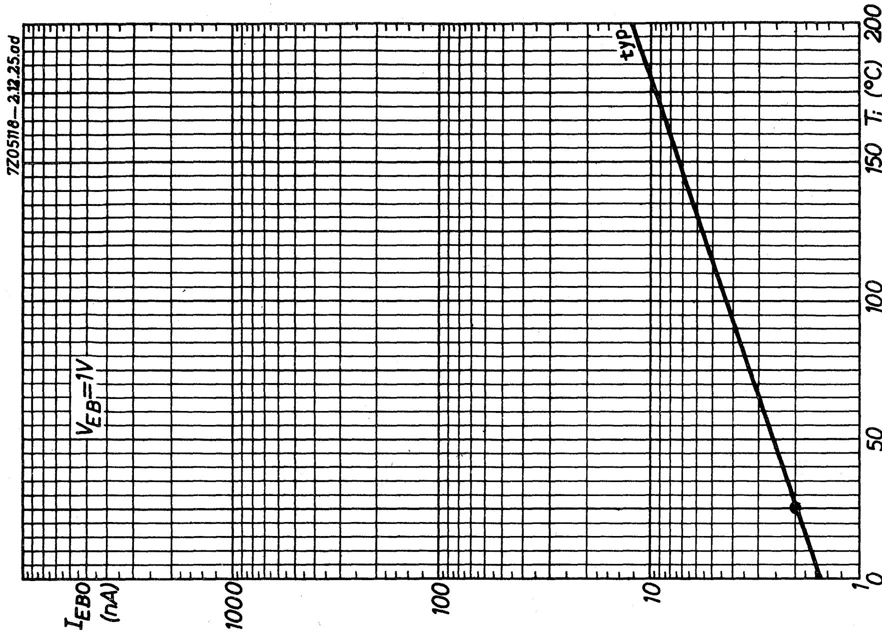

7Z05127-2.12.25.ad
0
C_{ib} (pF)
−200
−400
−600
−800
$-I_E$ = 150mA
V_{CB} = 24V
T_j = 25°C
typ
80
100
120
140
160
180 f (MHz)

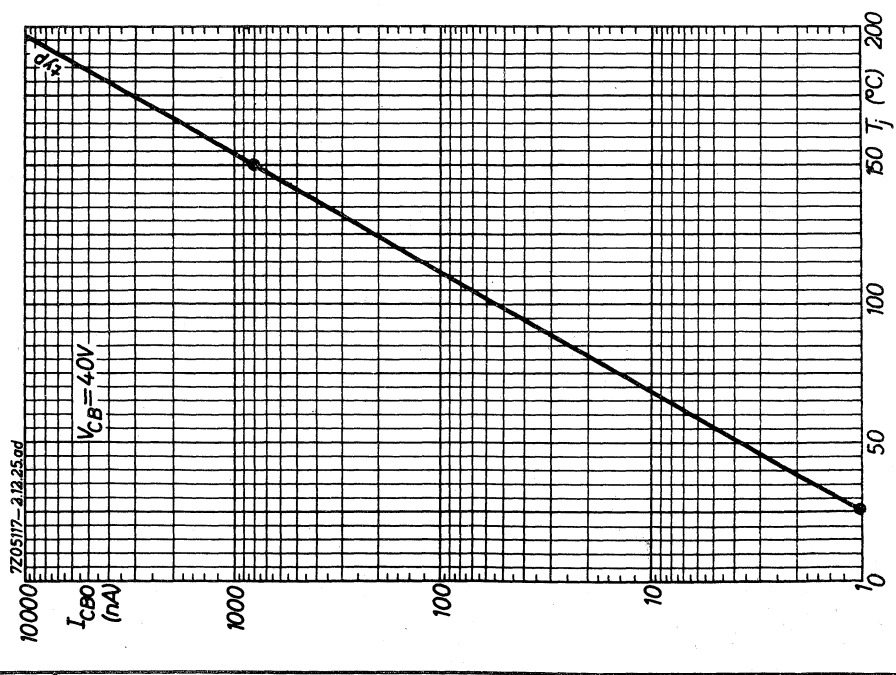

7Z05130–2.12.25.ad
g_{ie}
$(m\Omega^{-1})$
150
100
50
0
typical values
f = 180MHz
T_j = 25°C
V_{CE} = 12V
24V
40V
0
50
100
150
200
I_C (mA)
250


7Z05129–2.12.25.ad
C_{ie}
(pF)
0
−20
−40
−60
typical values
f = 180MHz
T_j = 25°C
V_{CE} = 40V
24V
12V
0
50
100
150
200
I_C (mA)
250


7Z05132–2.12.25.ad
100
g_{ie}
($m\Omega^{-1}$)
95
90
85
80
75
I_C =150mA
V_{CE} =24V
T_j =25°C
typ
60
80
100
120
140
160
180
f (MHz)


7Z05131–2.12.25.ad
C_{ie}
(pF)
40
20
0
−20
−40
I_C =150mA
V_{CE} =24V
T_j =25°C
typ
60
80
100
120
140
160
180
f (MHz)


7Z05118–2.12.25.ad
V_{EB}=1V
typ
I_{EBO} (nA)
1000
100
10
1
0
50
100
150
200
T_j (°C)


7Z05117–2.12.25.ad
V_{CB}=40V
typ
I_{CBO} (nA)
10000
1000
100
10
1
0
50
100
150
200
T_j (°C)

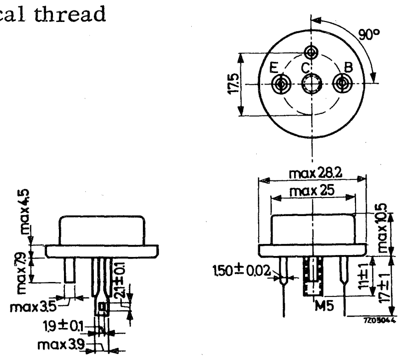
TRIPLE DIFFUSED SILICON PLANAR TRANSISTOR

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

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

MECHANICAL DATA
Except for the metrical thread conforming to TO-36

Dimensions in mm



Torque on nut: max. 22 cm kg

7Z3 0215

RATINGS (Limiting values) [1]

Voltages

Collector-base voltage (open emitter)	V_{CBO}	max.	100	V
Collector-emitter voltage ($R_{BE} \leq 10\ \Omega$)	V_{CER}	max.	100	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4	V

Currents

Collector current (d.c.) (see also page E)	I_C	max.	10	A
Collector current (peak value)	I_{CM}	max.	10	A
Base current (d.c. or average over any 20 ms period)	I_B	max.	2	A

Power dissipation

Total power dissipation up to T_{mb} = 25 °C $f \geq 0.5$ MHz (see page F)	P_{tot}	max.	100	W

Temperatures

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

THERMAL RESISTANCE

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

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

7Z3 0216

CHARACTERISTICS

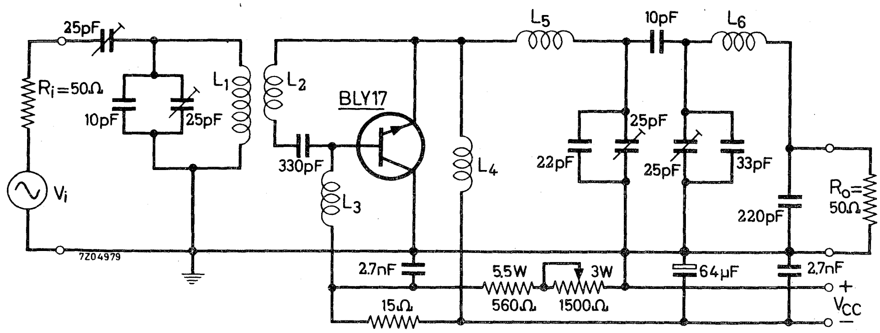
T_j = 25 °C unless otherwise specified

Collector cut-off current				
$I_E = 0$; $V_{CB} = 40$ V	I_{CBO}	typ. <	0.1 10	mA mA
$I_E = 0$; $V_{CB} = 40$ V; $T_j = 150$ °C	I_{CBO}	typ. <	0.2 50	mA mA
$I_E = 0$; $V_{CB} = 100$ V	I_{CBO}	typ. <	0.6 20	mA mA
$I_E = 0$; $V_{CB} = 100$ V; $T_j = 150$ °C	I_{CBO}	typ. <	1 80	mA mA
$V_{CE} = 80$ V; $R_{BE} = 10\ \Omega$	I_{CER}	typ. <	0.3 50	mA mA
$V_{CE} = 80$ V; $R_{BE} = 10\ \Omega$; $T_j = 150$ °C	I_{CER}	typ. <	1 100	mA mA
Emitter cut-off current				
$I_C = 0$; $V_{EB} = 4$ V	I_{EBO}	typ. <	0.03 100	mA mA
Saturation voltages				
$I_C = 10$ A; $I_B = 2$ A	V_{CEsat}	typ. <	0.5 2.0	V V
	V_{BEsat}	typ. <	1.2 3.0	V V
D.C. current gain				
$-I_E = 1$ A; $V_{CB} = 0$	h_{FE}	> typ.	5 25	
$-I_E = 5$ A; $V_{CB} = 0$	h_{FE}	> typ.	5 13	
$-I_E = 10$ A; $V_{CB} = 0$	h_{FE}	> typ.	5 9	
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; $V_{CB} = 40$ V	C_c	typ. <	100 150	pF pF
Transition frequency				
$I_C = 1.5$ A; $V_{CE} = 10$ V	f_T	> typ.	50 70	MHz MHz
Feedback time constant at f = 10 MHz				
$-I_E = 1.5$ A; $V_{CB} = 10$ V	$\left\|\frac{h_{rb}}{\omega}\right\|$	typ.	140	ps

7Z3 0217

APPLICATION INFORMATION

Linear amplifier circuit for 'single side band'



COIL DATA

L_1 = 8 turns enamelled Cu wire (1.2 mm); d = 12 mm

L_2 = 2 turns enamelled Cu wire (1.2 mm); d = 12 mm
L_2 is coupled to the 'cold' side of L_1.

L_3 = 40 turns enamelled Cu wire (0.3 mm); d = 6 mm

L_4 = 27 turns enamelled Cu wire (0.45 mm); d = 6 mm

L_5 = 10 turns enamelled Cu wire (1.2 mm); d = 12 mm

L_6 = 9 turns enamelled Cu wire (1.2 mm); d = 12 mm

PERFORMANCE V_{CE} = 40 V; f = 28 MHz; T_{mb} = 25 °C

Peak envelope power		P.E.P.		20	W
Intermodulation distortion	of the third order	d_3	typ.	−32	dB
	of the fifth order	d_5	typ.	−32	dB
Power gain		G_p	typ.	8	dB
Collector current	without drive [1]	I_C		60	mA
	with full drive [2]	I_{CAV}	typ.	880	mA

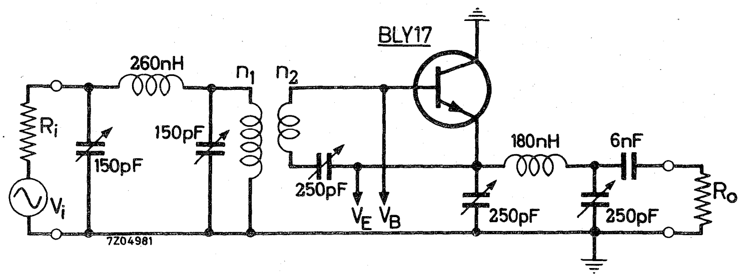
[1] Adjustable with the variable resistor.

[2] Corresponding with a P.E.P. of 20 W.

7Z3 0218

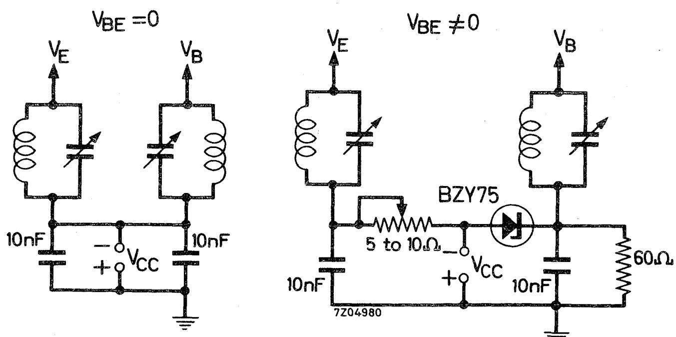
APPLICATION INFORMATION (continued)

Amplifier circuit



n_1 = 6 turns (2 mm); d = 20 mm } closely coupled
n_2 = 2 turns (2 mm); d = 20 mm

Alternative methods of biasing



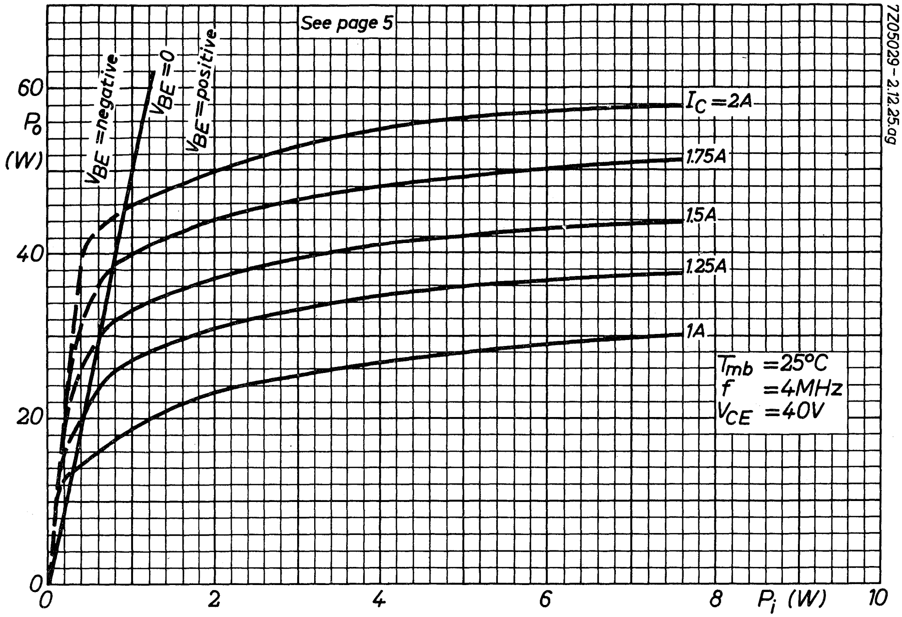
PERFORMANCE in common emitter configuration (see page A/D)

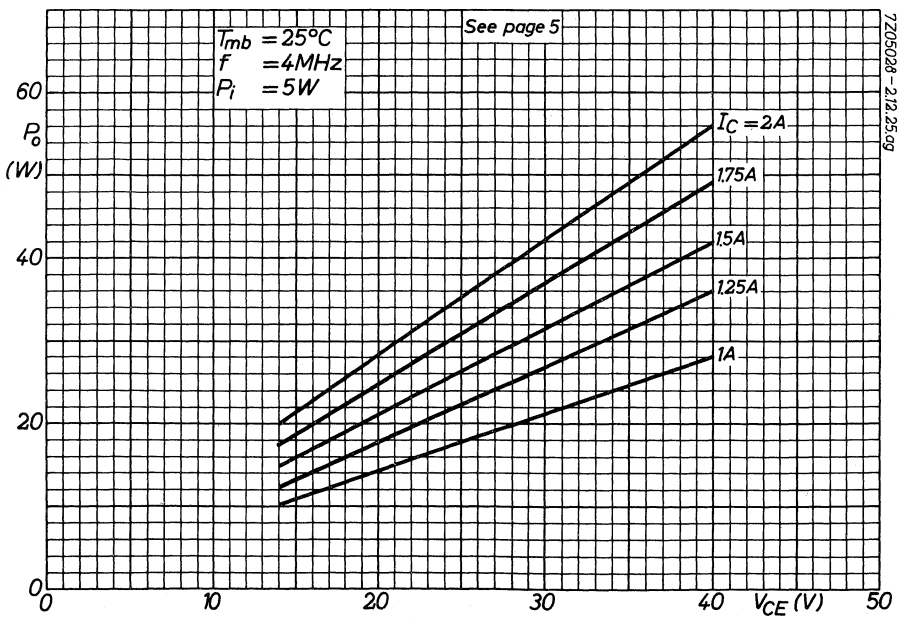
V_{CE} = 40 V ; V_{BE} = 0

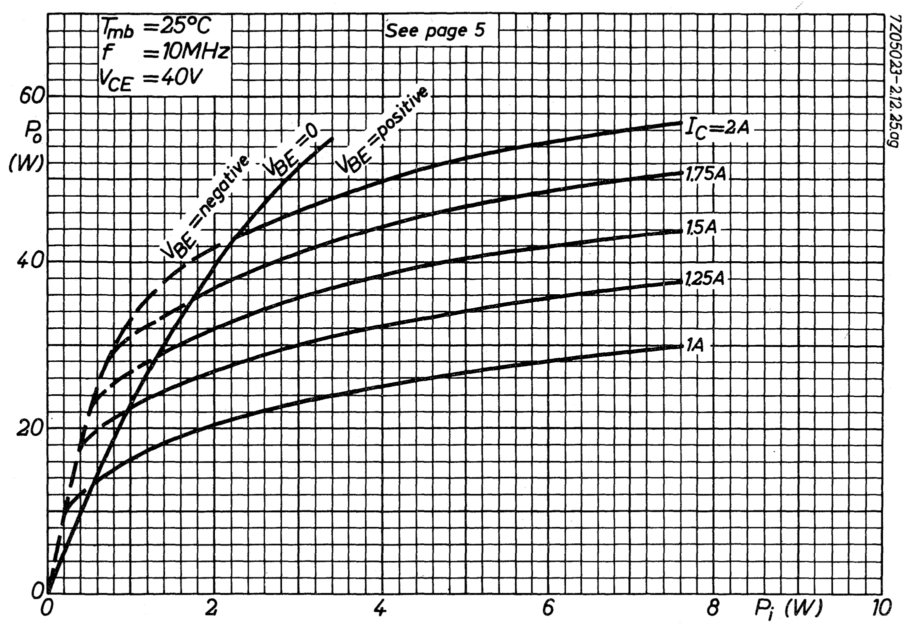
P_i = 7.5 W; f = 30 MHz; T_{mb} = 25 °C

Output power	P_o	>	30	W
		typ.	40	W
Power gain	G_p	>	6	dB
		typ.	7.5	dB
Collector efficiency	η	>	40	%
		typ.	55	%

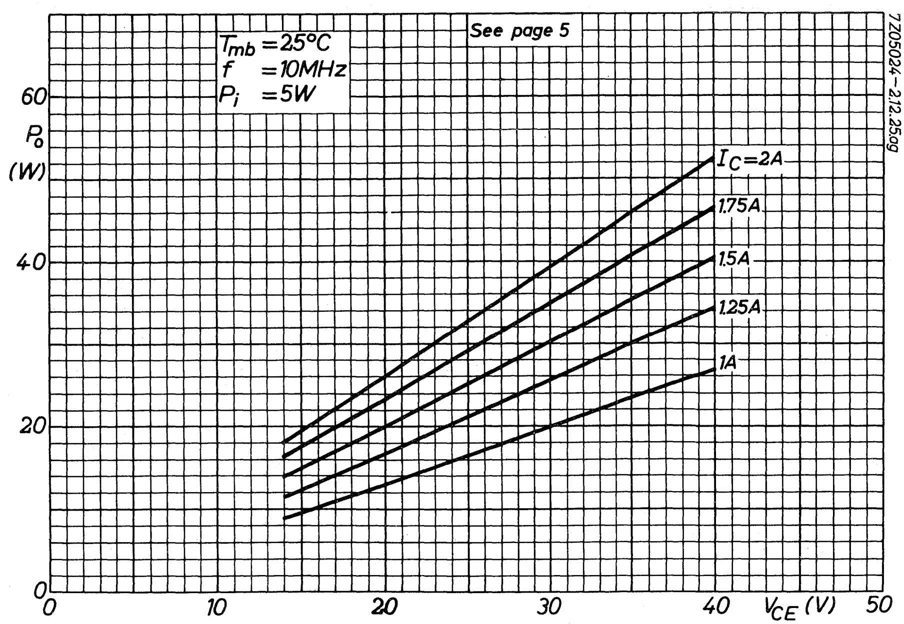
7Z3 0219


See page 5
7Z05029 - 2.12.25.ag
60
P_o
(W)
40
20
0
0
2
4
6
8
10
P_i (W)
V_{BE} =negative
V_{BE} =0
V_{BE} =positive
I_C =2A
1.75A
1.5A
1.25A
1A
T_{mb} =25°C
f =4MHz
V_{CE} =40V

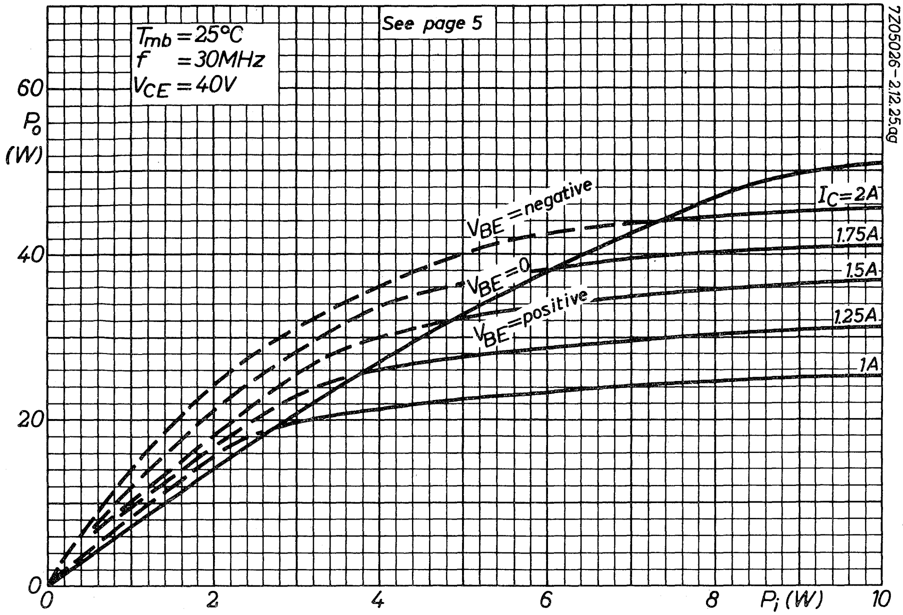

See page 5
7Z05028 - 2.12.25.ag
T_{mb} =25°C
f =4MHz
P_i =5W
60
P_o
(W)
40
20
0
0
10
20
30
40
50
V_{CE} (V)
I_C =2A
1.75A
1.5A
1.25A
1A



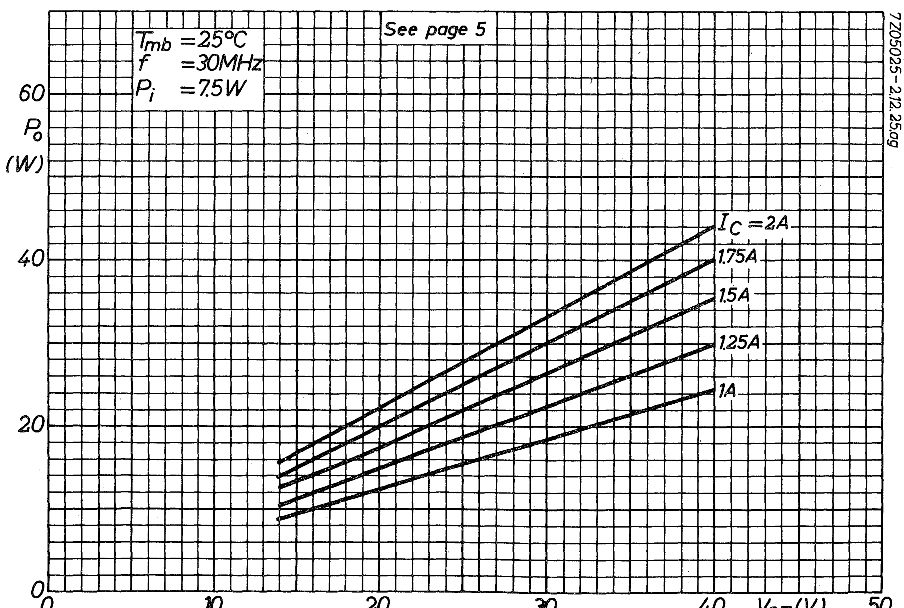
T_{mb} = 25°C
f = 10MHz
V_{CE} = 40V
See page 5
7Z05023-2.12.25.og
60
P_o
(W)
40
20
0
V_{BE} = negative
V_{BE} = 0
V_{BE} = positive
I_C = 2A
1.75A
1.5A
1.25A
1A
0
2
4
6
8
P_i (W)
10



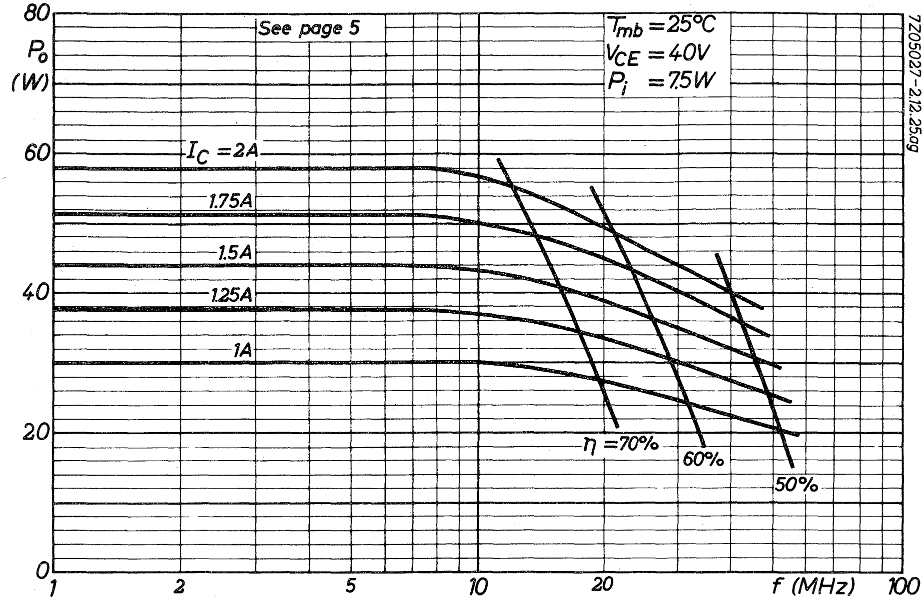
T_{mb} = 25°C
f = 10MHz
P_i = 5W
See page 5
7Z05024-2.12.25.og
60
P_o
(W)
40
20
0
I_C = 2A
1.75A
1.5A
1.25A
1A
0
10
20
30
40
V_{CE} (V)
50



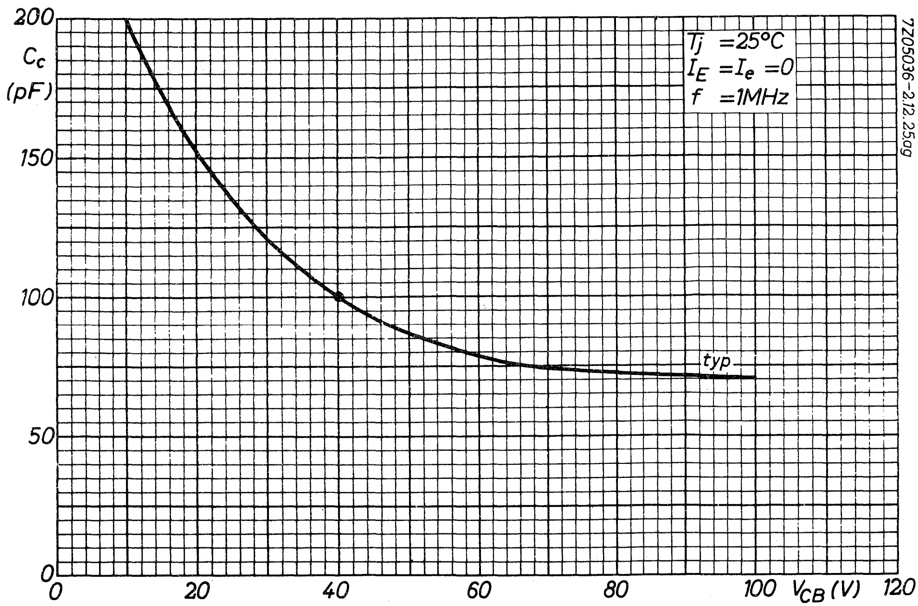
See page 5
T_{mb} = 25°C
f = 30MHz
V_{CE} = 40V
P_o (W)
P_i (W)
V_{BE}=negative
V_{BE}=0
V_{BE}=positive
I_C=2A
1.75A
1.5A
1.25A
1A
7Z05026-2.12.25ag



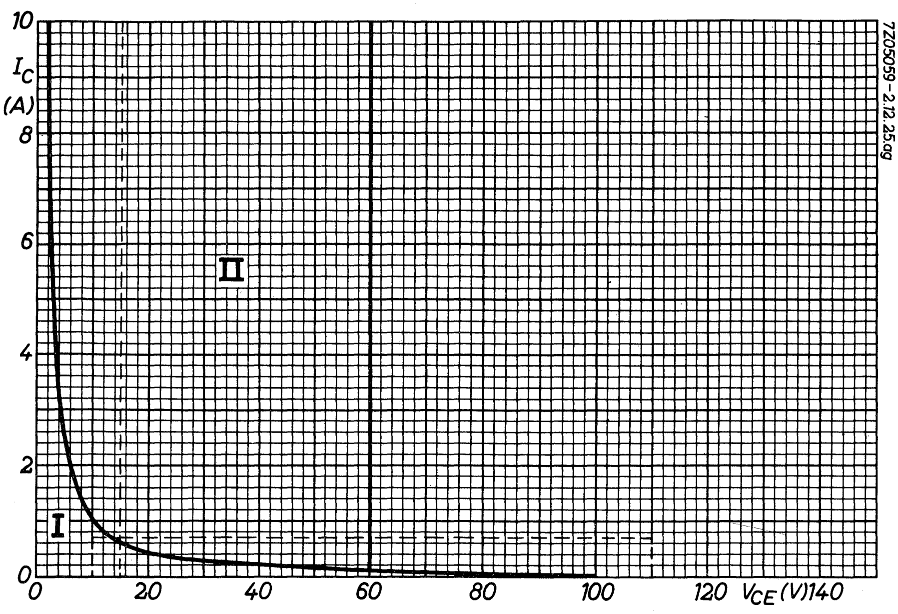
See page 5
T_{mb} = 25°C
f = 30MHz
P_i = 7.5W
P_o (W)
V_{CE} (V)
I_C = 2A
1.75A
1.5A
1.25A
1A
7Z05025-2.12.25ag



80
P_o
(W)
60
40
20
0
See page 5
T_{mb} = 25°C
V_{CE} = 40V
P_i = 7.5W
I_C = 2A
1.75A
1.5A
1.25A
1A
η = 70%
60%
50%
1
2
5
10
20
f (MHz)
100
7Z05027-2.12.25ag



200
C_c
(pF)
150
100
50
0
T_j = 25°C
I_E = I_e = 0
f = 1MHz
typ
0
20
40
60
80
100
V_{CB} (V)
120
7Z05036-2.12.25ag

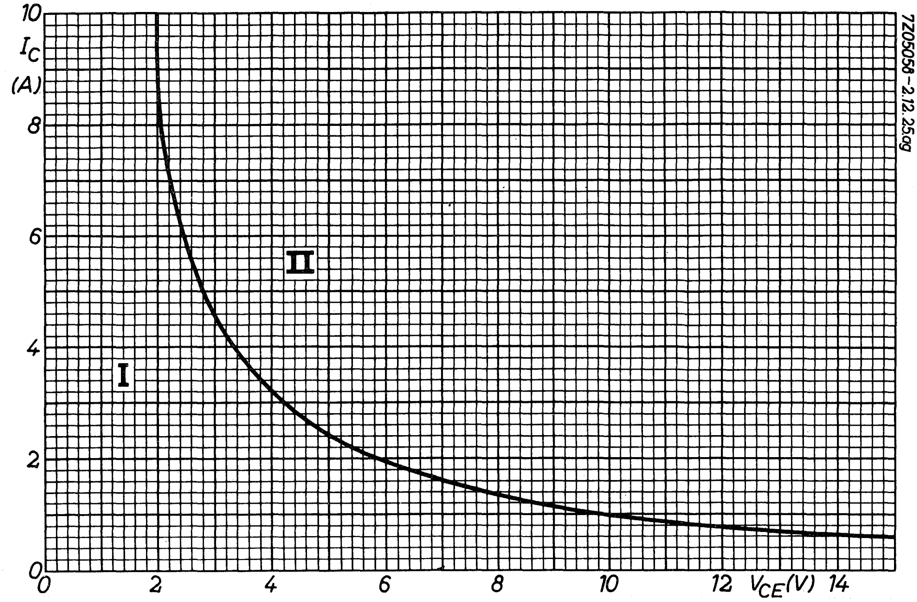


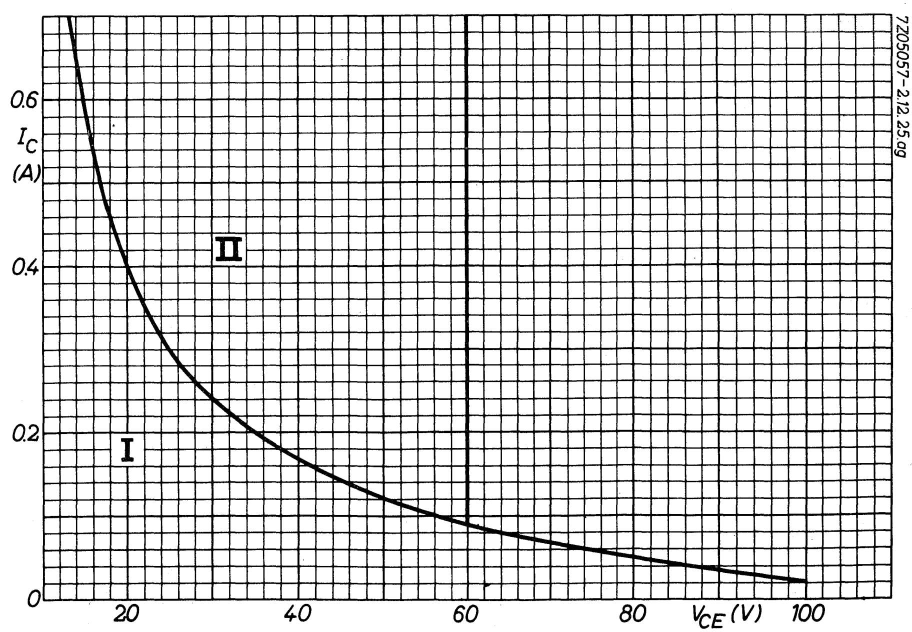
I = Region of permissible operation at all frequencies, including d.c.

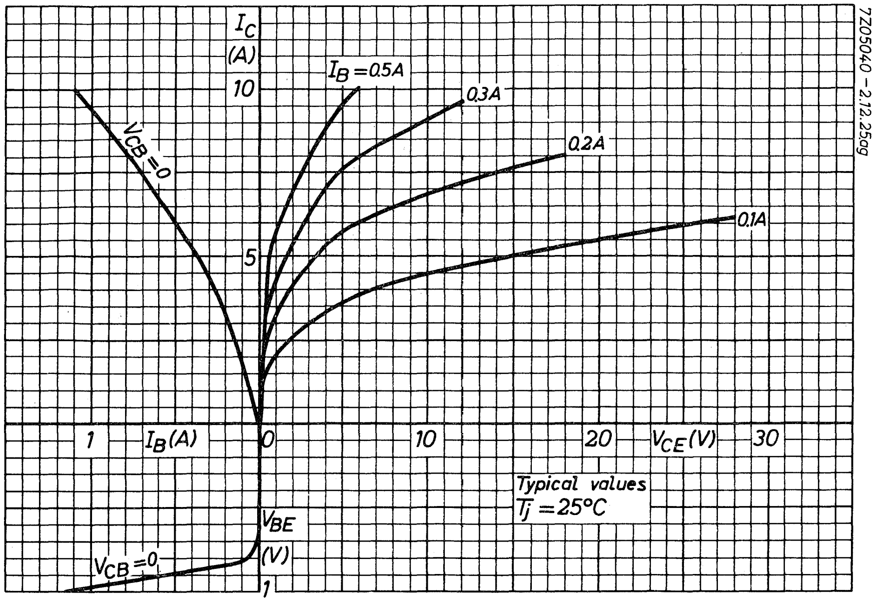
II = Additional region of operation at f ≥ 0.5 MHz.
When operating in region II, care must be taken to reduce the steady state current before removing the signal. This may be achieved by an appropriate bias in class A, B or C.

The graphs at page F are enlargements of the left hand part and the lower part respectively.

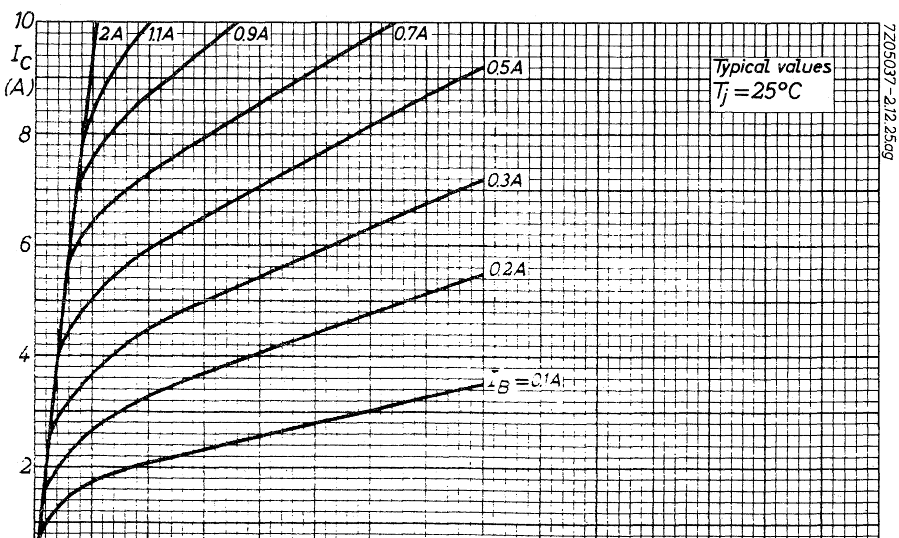
7Z3 0225


10
I_C
(A)
8
6
4
2
0
II
I
0
2
4
6
8
10
12
V_{CE}(V)
14
7Z05058-2.12.25ag

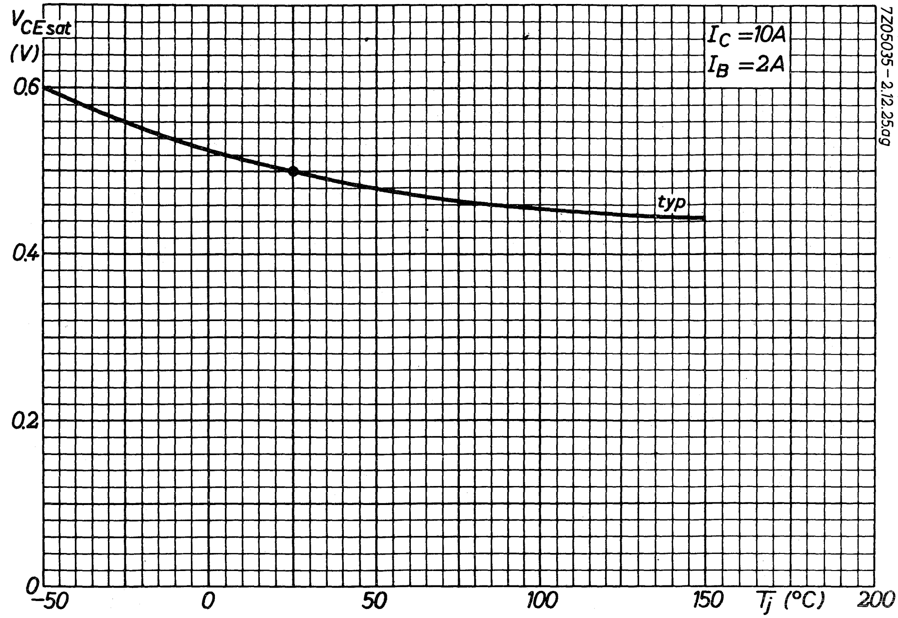

0.6
I_C
(A)
0.4
0.2
0
II
I
20
40
60
80
V_{CE} (V)
100
7Z05057-2.12.25ag

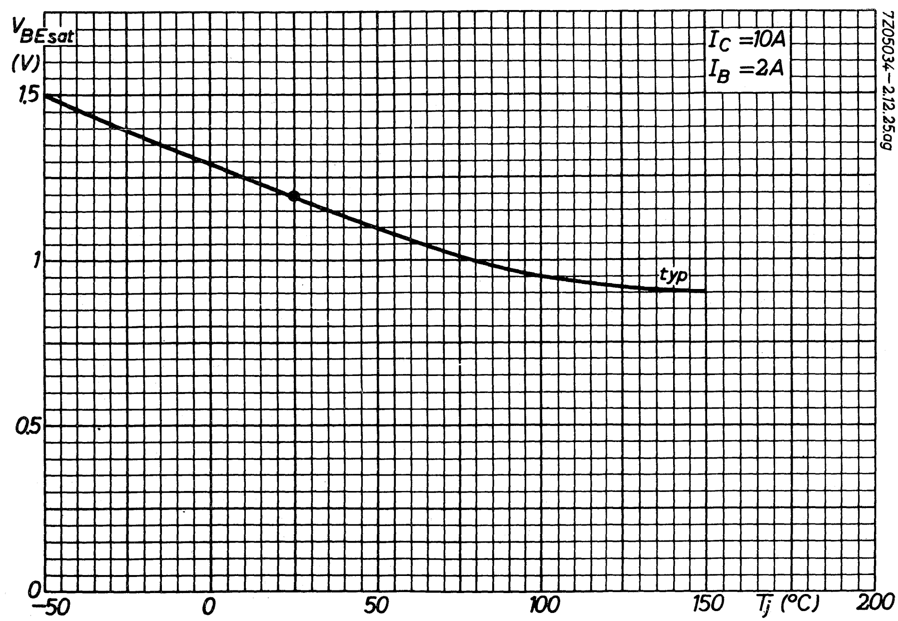


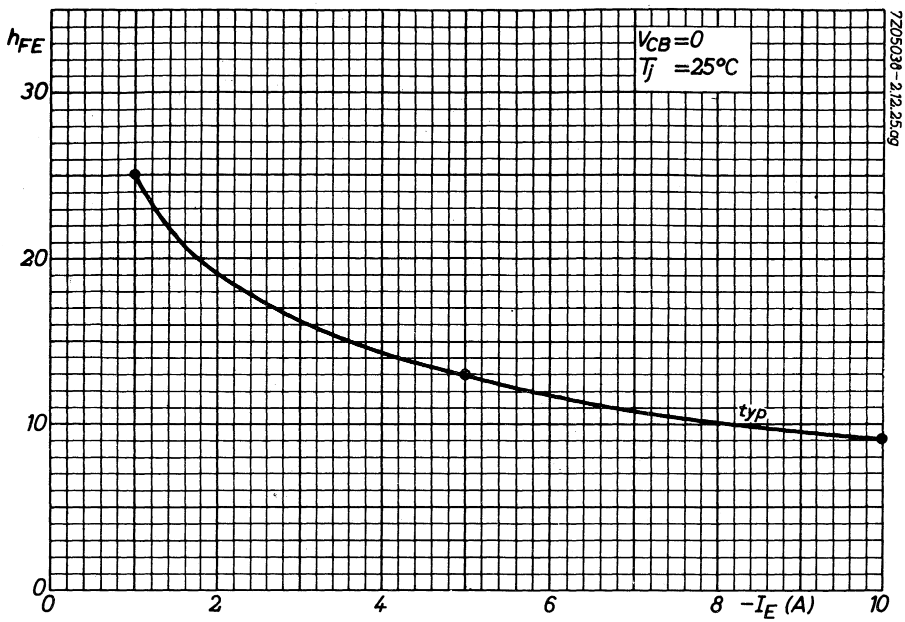
I_C (A)
10
5
I_B = 0.5A
0.3A
0.2A
0.1A
V_{CB} = 0
1
I_B (A)
0
10
20
V_{CE} (V)
30
Typical values
T_j = 25°C
V_{BE} (V)
V_{CB} = 0
1
7Z05040 – 2.12.25ag



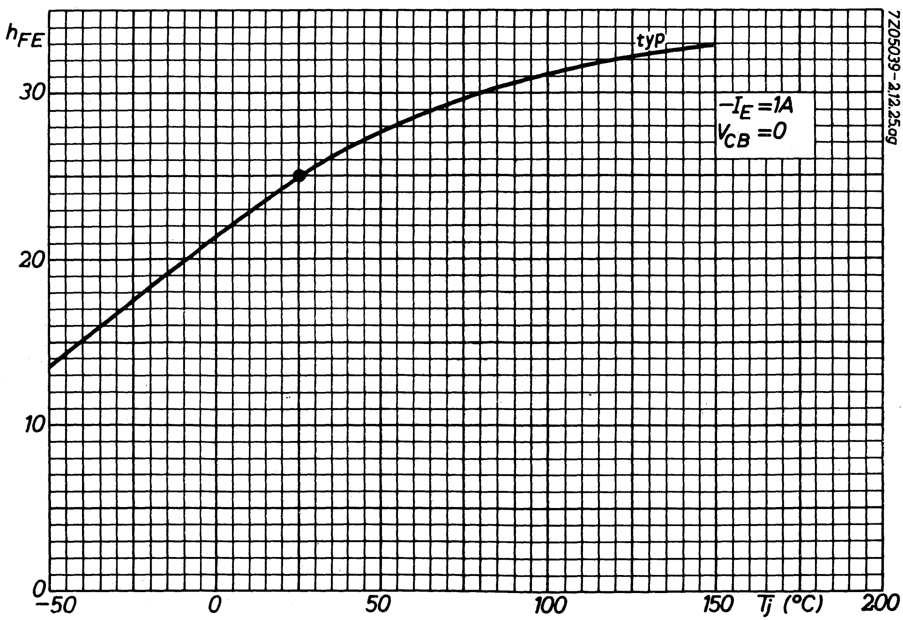
I_C (A)
10
8
6
4
2
0
2A
1.1A
0.9A
0.7A
0.5A
0.3A
0.2A
Typical values
T_j = 25°C
0
1
2
3
4
5
6
V_{CE} (V)
7
7Z05037 – 2.12.25ag


V_{CEsat}
(V)
0.6
0.4
0.2
0
−50
0
50
100
150
200
T_j (°C)
I_C =10A
I_B =2A
typ
7Z05035 − 2.12.25ag

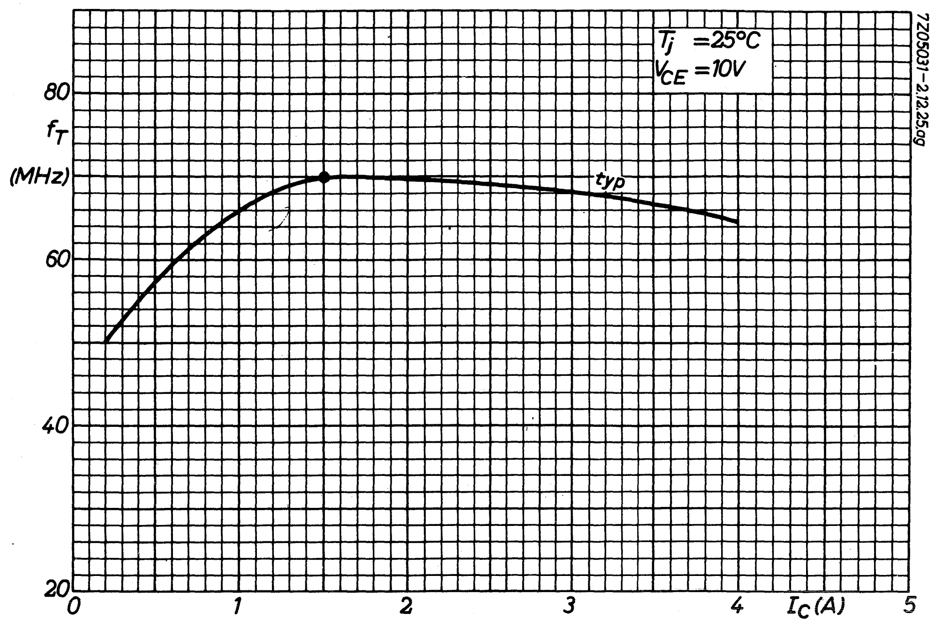

V_{BEsat}
(V)
1.5
1
0.5
0
−50
0
50
100
150
200
T_j (°C)
I_C =10A
I_B =2A
typ
7Z05034 − 2.12.25ag



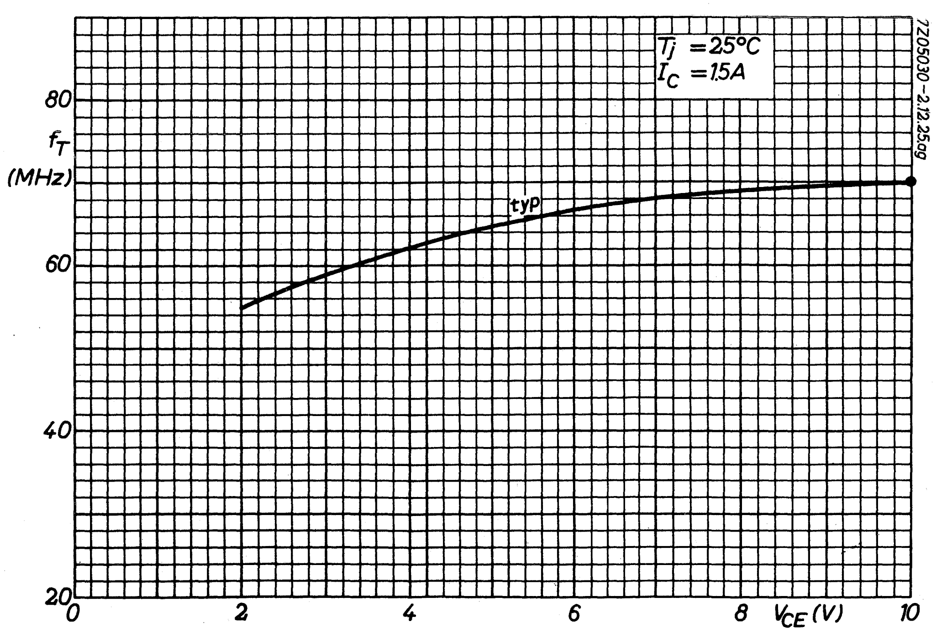
h_{FE}
30
20
10
0
0
2
4
6
8
$-I_E$ (A)
10
$V_{CB}=0$
T_j =25°C
typ
7Z05036-2.12.25.ag



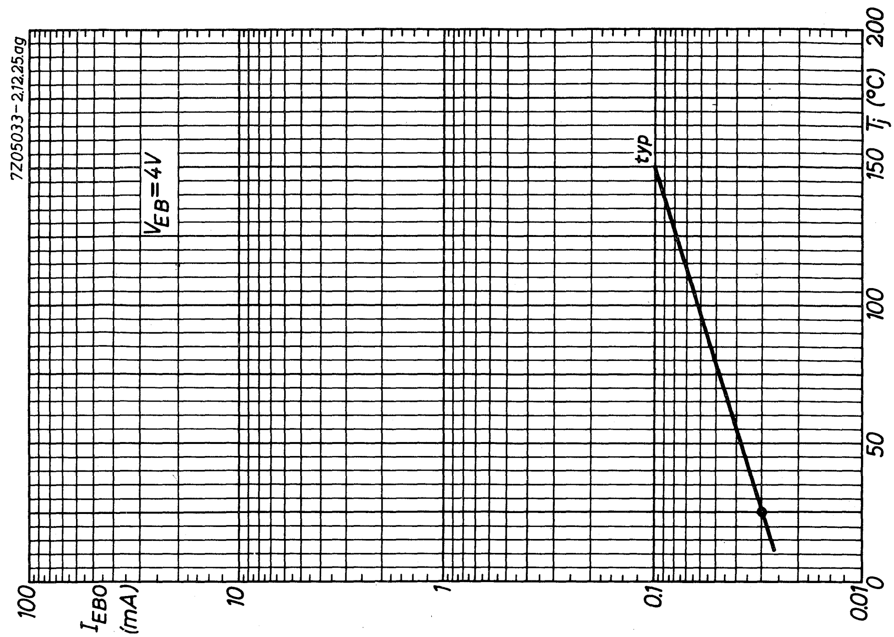
h_{FE}
30
20
10
0
−50
0
50
100
150
T_j (°C)
200
$-I_E$ =1A
V_{CB} =0
typ
7Z05039-2.12.25.ag

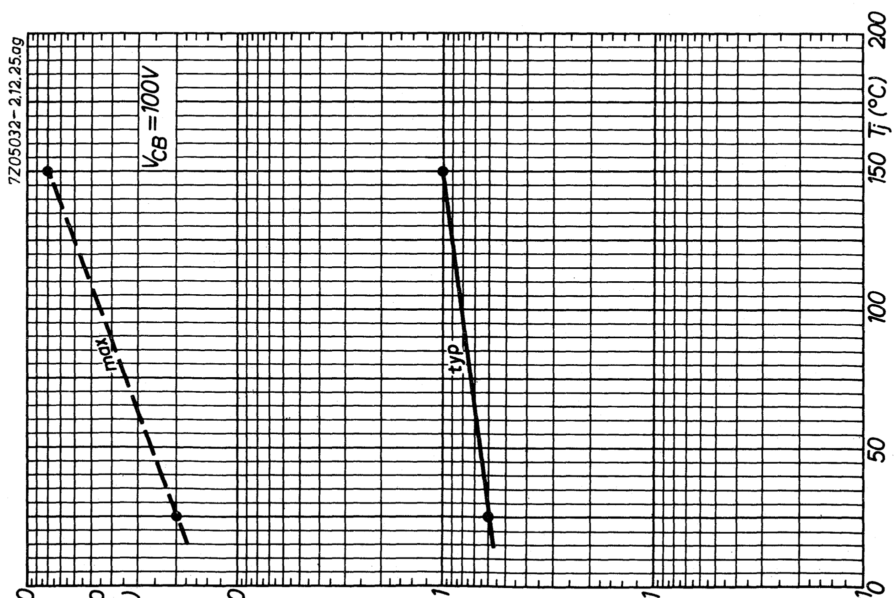


7Z05031-2.12.25.og
T_j =25°C
V_{CE} =10V
80
f_T
(MHz)
60
40
20
typ
0
1
2
3
4
I_C (A)
5



7Z05030-2.12.25.og
T_j =25°C
I_C =1.5A
80
f_T
(MHz)
60
40
20
typ
0
2
4
6
8
V_{CE} (V)
10


7Z05033-2.12.25.ag
$V_{EB}=4V$
typ
I_{EBO} (mA)
100
10
1
0.1
0.01
0
50
100
150
200
T_j (°C)


7Z05032-2.12.25.ag
$V_{CB}=100V$
max
typ
I_{CBO} (mA)
100
10
1
0.1
0.01
0
50
100
150
200
T_j (°C)

VERY HIGH SPEED SWITCHING TRANSISTORS

N-P-N silicon planar epitaxial transistors in a TO-18 metal envelope with the collector connected to the case. The BSX19 and BSX20 are primarily intended for very high speed saturated switching.

QUICK REFERENCE DATA

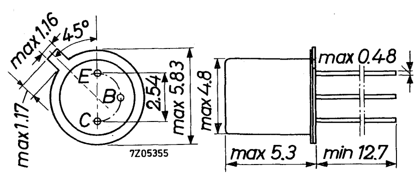
			BSX19	BSX20	
Collector-base voltage (open emitter)	V_{CBO}	max.	40	40	V
Collector-emitter voltage (open base)	V_{CEO}	max.	15	15	V
Collector-emitter voltage (V_{BE} = 0)	V_{CES}	max.	40	40	V
Collector current (peak value)	I_{CM}	max.	500	500	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	360	360	mW
D.C. current gain at T_j = 25 °C					
I_C = 10 mA; V_{CE} = 1 V	h_{FE}		20 to 60	40 to 120	
I_C = 100 mA; V_{CE} = 2 V	h_{FE}	>	10	20	
Transition frequency					
I_C = 10 mA; V_{CE} = 10 V	f_T	>	400	500	MHz
Storage time					
$I_C = I_B = -I_{BM}$ = 10 mA	t_s	<	10	13	ns

MECHANICAL DATA

Dimensions in mm

TO-18

Collector connected to case



7Z3 0522

RATINGS (Limiting values) [1])

Voltages

Collector-base voltage (open emitter)	V_{CBO}	max.	40	V
Collector-emitter voltage (open base)	V_{CEO}	max.	15	V
Collector-emitter voltage with $V_{BE} = 0$	V_{CES}	max.	40	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4.5	V

Current

Collector current (peak value; $t = 10\ \mu s$)	I_{CM}	max.	500	mA

Power dissipation

Total power dissipation up to $T_{amb} = 25\ ^oC$	P_{tot}	max.	360	mW

Temperatures

Storage temperature	T_{stg}	-65 to +200		^oC
Junction temperature	T_j	max.	200	^oC

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	0.48	$^oC/mW$
From junction to case	$R_{th\ j-c}$	=	0.15	$^oC/mW$

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

7Z3 0523

CHARACTERISTICS $T_j = 25\ ^oC$ unless otherwise specified

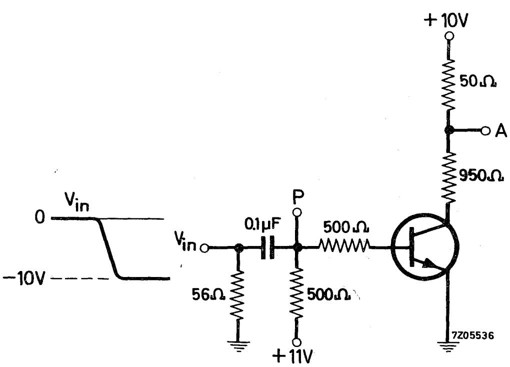
Collector cut-off current				
$I_E = 0$; $V_{CB} = 20$ V	I_{CBO}	<	400	nA
$I_E = 0$; $V_{CB} = 20$ V; $T_j = 150\ ^oC$	I_{CBO}	<	30	μA
$V_{BE} = 0$; $V_{CE} = 15$ V; $T_j = 55\ ^oC$	I_{CES}	<	0.40	μA
$V_{BE} = 0$; $V_{CE} = 40$ V	I_{CES}	<	1.0	μA
Emitter cut-off current				
$I_C = 0$; $V_{EB} = 4.5$ V	I_{EBO}	<	10	μA
Currents at reverse biased emitter junction				
$V_{CE} = 15$ V; $-V_{BE} = 3$ V; $T_j = 55\ ^oC$	I_{CEX}	<	0.60	μA
	$-I_{BEX}$	<	0.60	μA
Sustaining voltages				
$I_C = 10$ mA; $I_B = 0$	$V_{CEOsust}$	>	15	V
$I_C = 10$ mA; $R_{BE} = 10\ \Omega$	$V_{CERsust}$	>	20	V
Base-emitter voltage (see also page B)				
$I_C = 30\ \mu$A; $V_{CE} = 20$ V; $T_j = 100\ ^oC$	V_{BE}	>	0.35	V
Saturation voltages				
$I_C = 10$ mA; BSX19: $I_B = 0.3$ mA; BSX20: $I_B = 0.6$ mA	V_{CEsat}	<	0.3	V
$I_C = 10$ mA; $I_B = 1$ mA	V_{CEsat}	<	0.25	V
	V_{BEsat}	0.70 to	0.85	V
$I_C = 100$ mA; $I_B = 10$ mA	V_{CEsat}	<	0.60	V
	V_{BEsat}	<	1.50	V
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; $V_{CB} = 5$ V	C_c	<	4	pF
Emitter capacitance at f = 1 MHz				
$I_C = I_c = 0$; $V_{EB} = 1$ V	C_e	<	4.5	pF

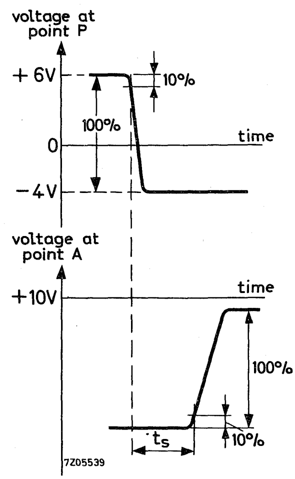
7Z3 0524

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

		BSX19	BSX20	
D.C. current gain				
I_C = 10 mA; V_{CE} = 1 V	h_{FE}	20 to 60	40 to 120	
I_C = 10 mA; V_{CE} = 1 V; T_j = −55 °C	h_{FE}	> 10	20	
I_C = 100 mA; V_{CE} = 2 V	h_{FE}	> 10	20	
Transition frequency				
I_C = 10 mA; V_{CE} = 10 V	f_T	> 400	500	MHz
		typ. 500	600	MHz
Switching times				
Storage time (see also pages N and O)				
$I_C = I_B = -I_{BM}$ = 10 mA	t_s	typ. 5	6	ns
		< 10	13	ns

Test circuit:





Pulse generator:

Rise time	t_r	<	1	ns
Pulse duration	t	>	300	ns
Duty cycle	δ	<	0.02	
Source impedance	R_S	=	50	Ω

Oscilloscope:

Input impedance	R_i	=	50	Ω
Rise time	t_r	<	1	ns

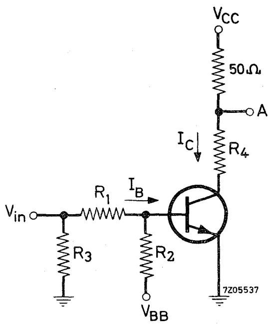
7Z3 0525

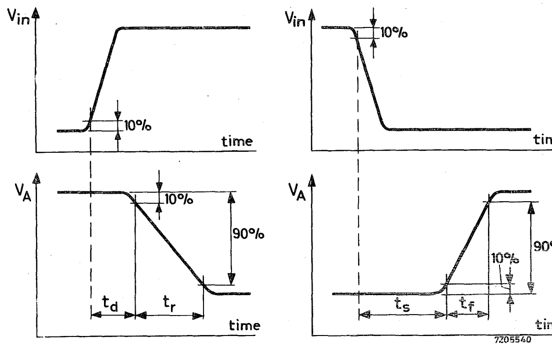
CHARACTERISTICS (continued) T_j = 25 °C unless otherwise specified

Switching times

Turn on time (see also page K) when switched from $-V_{BE}$ = 1.5 V to I_C = 10 mA; I_B = 3 mA		t_{on}	<	12	ns
Turn off time (see also pages L and M) when switched from I_C = 10 mA; I_B = 3 mA to cut-off with $-I_{BM}$ = 1.5 mA	BSX19	t_{off}	<	15	ns
	BSX20	t_{off}	<	18	ns

Test circuit:





Pulse generator:

Rise time	t_r	<	1	ns
Pulse duration	t	>	300	ns
Duty cycle	δ	<	0.02	
Source impedance	R_S	=	50	Ω

Oscilloscope:

Input impedance	R_i	=	50	Ω
Rise time	t_r	<	1	ns

							turn on time			turn off time	
I_C (mA)	I_B (mA)	$-I_{BM}$ (mA)	V_{CC} (V)	R_1;R_2 (kΩ)	R_3 (Ω)	R_4 (Ω)	$-V_{BB}$ (V)	$-V_{BE}$ (V)	V_{in} (V)	V_{BB} (V)	$-V_{in}$ (V)
10	3	1.5	3	3.3	50	220	3.0	1.5	15	12.0	15
100	40	20	6	0.33	56	0	4.5	2.25	20	15.3	20

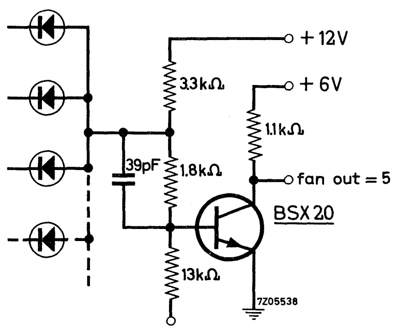
Note

$-I_{BM}$ is the reverse current that can flow during switching off. The indicated $-I_{BM}$ is determined and limited by the applied cut-off voltage and series resistance.

7Z3 0526

APPLICATION INFORMATION

NAND gate circuit (Diode Transistor Logic)



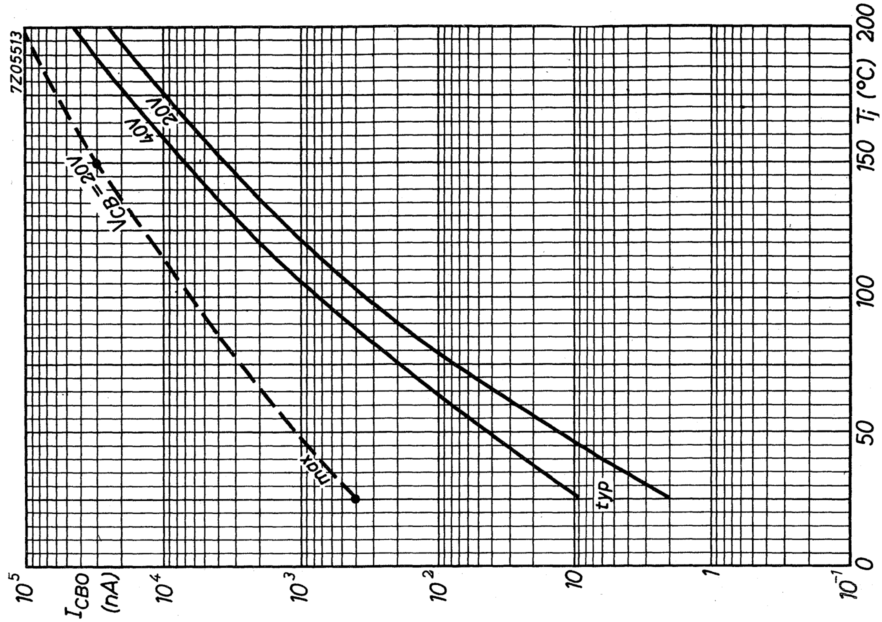
Delay time per stage; fan in = 5 t_d typ. 15 ns

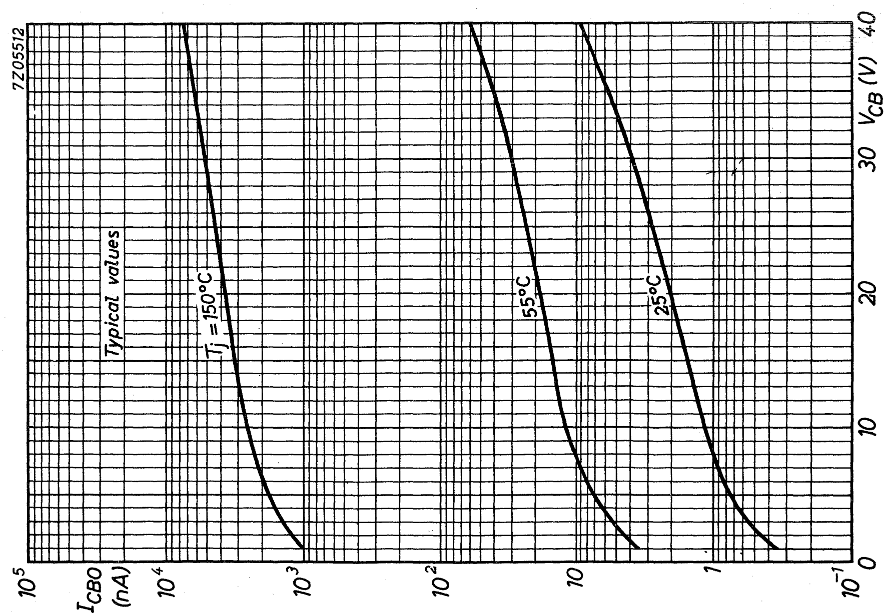
Note

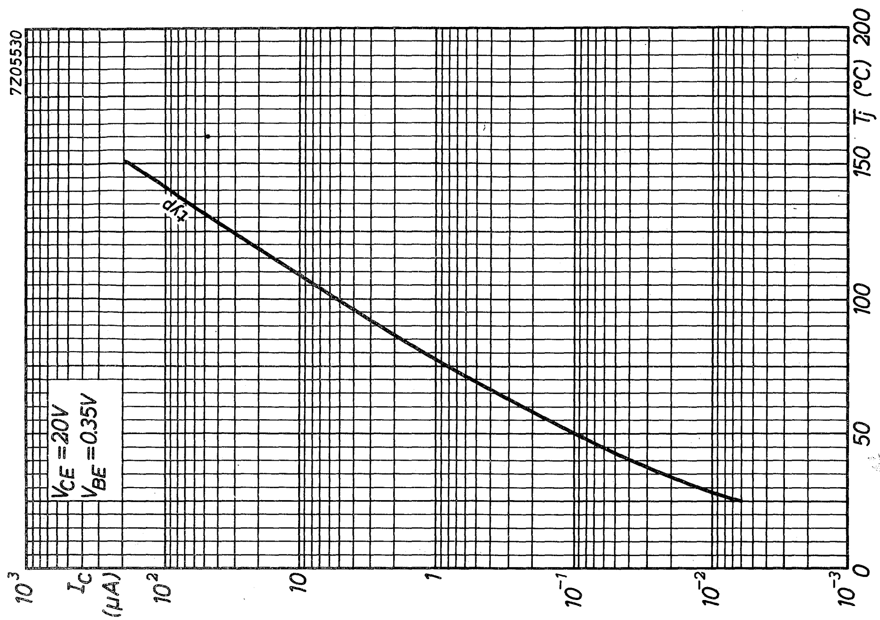
Fan out = 5 means: The circuit may be loaded by maximum 5 circuits, each presenting a load identical to that of one input branch of the circuit itself.

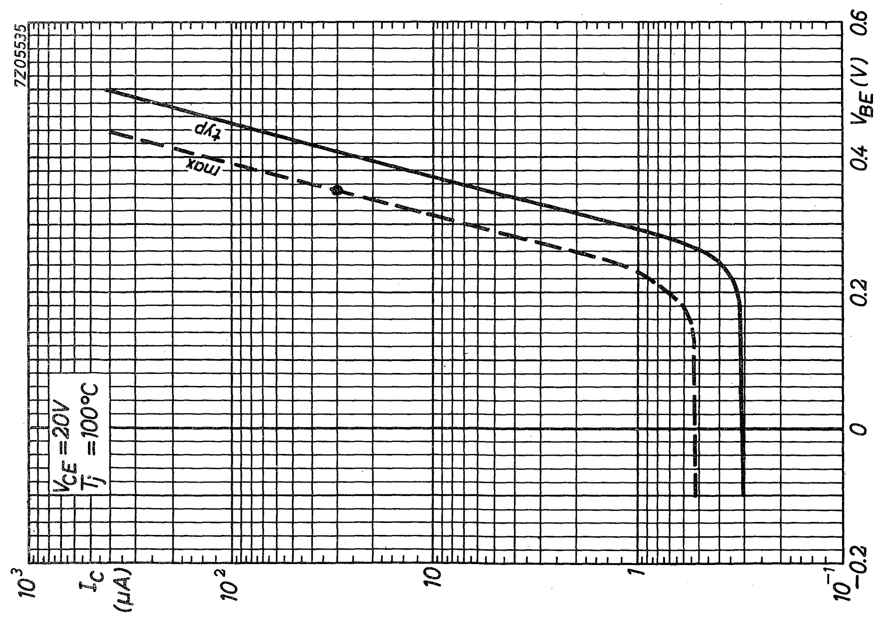
For further information please refer to application information bulletin AI819

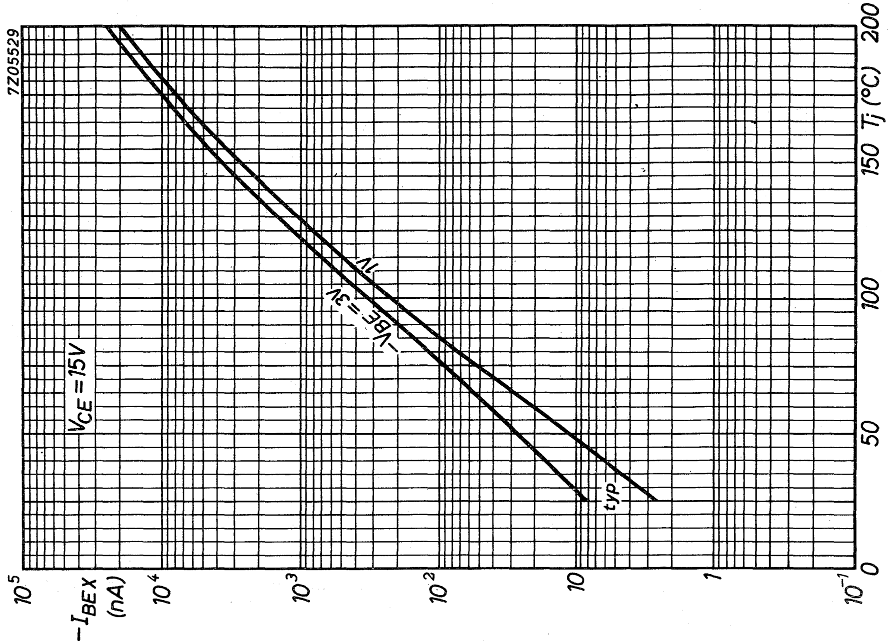
7Z3 0527

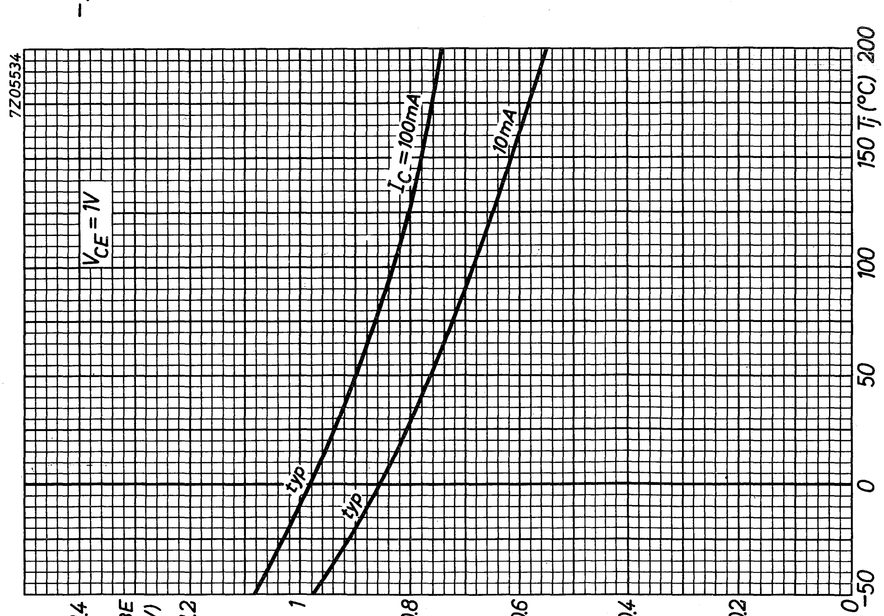

7Z05513
I_{CBO} (nA)
10^5
10^4
10^3
10^2
10
1
10^{-1}
0
50
100
150
200
T_j (°C)
V_{CB} = 20V
40V
20V
max
typ

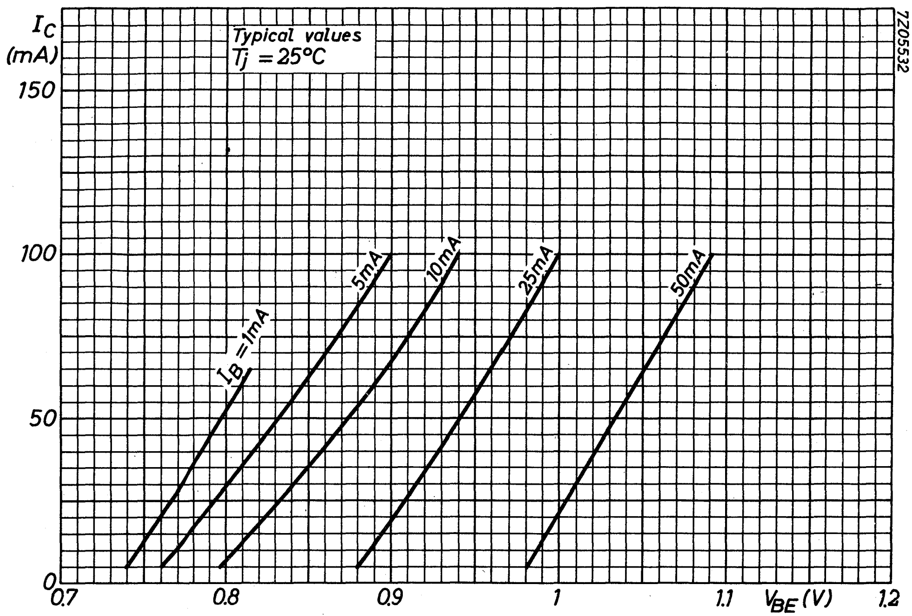

7Z05512
I_{CBO} (nA)
10^5
10^4
10^3
10^2
10
1
10^{-1}
Typical values
T_j = 150°C
55°C
25°C
0
10
20
30
40
V_{CB} (V)

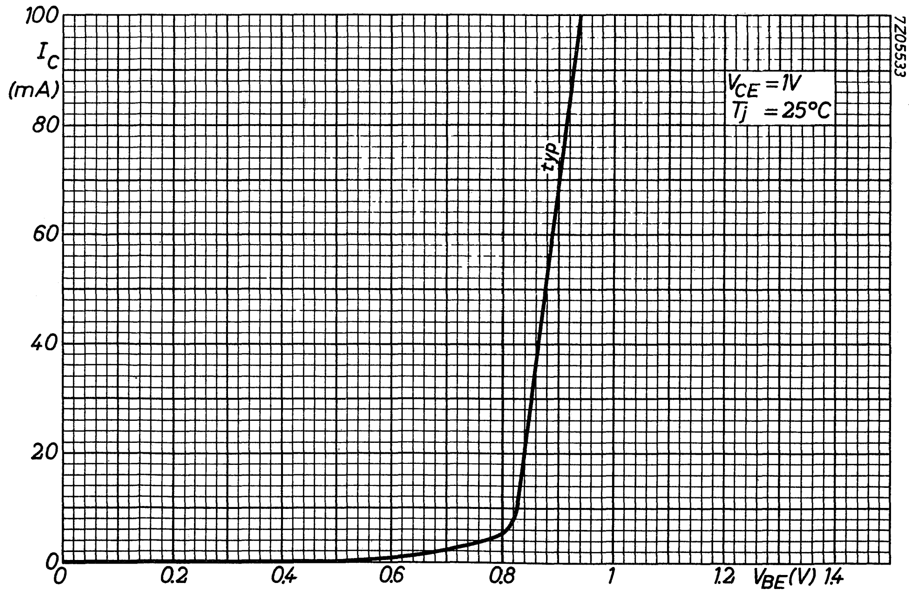

7Z05530
V_{CE} = 20V
V_{BE} = 0.35V
typ
I_C
(μA)
10^3
10^2
10
1
10^{-1}
10^{-2}
10^{-3}
0
50
100
150
200
T_j (°C)

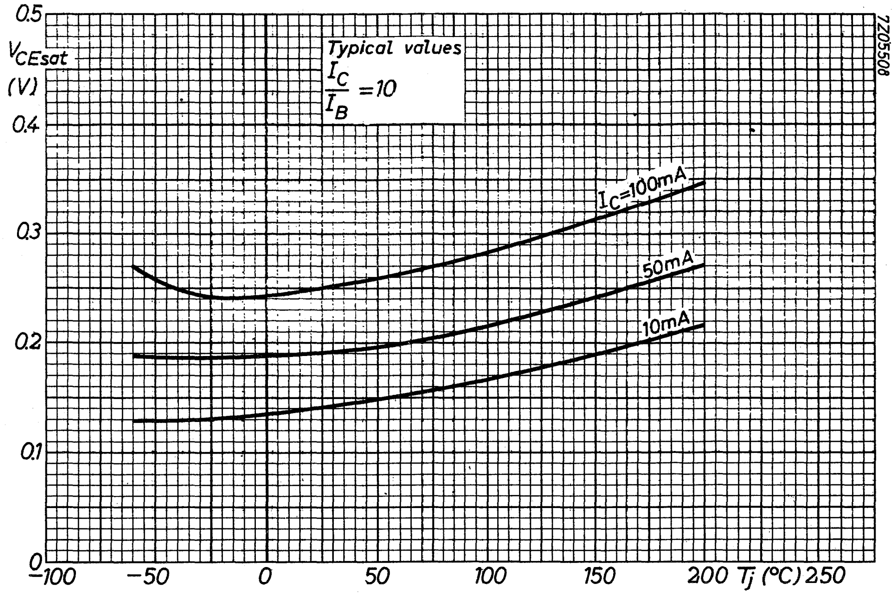

7Z05535
V_{CE} = 20V
T_j = 100°C
typ
max
I_C
(μA)
10^3
10^2
10
1
10^{-1}
−0.2
0
0.2
0.4
0.6
V_{BE} (V)

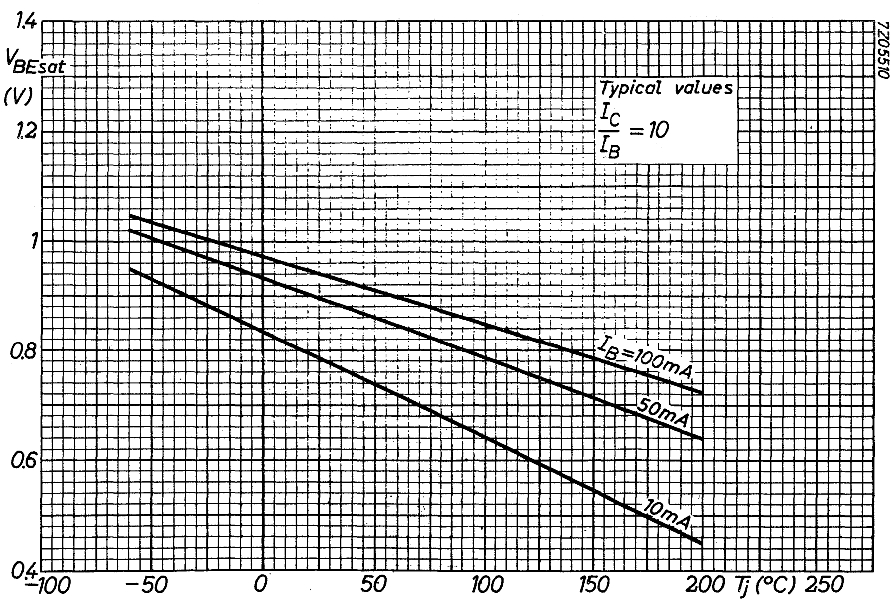

7Z05529
$V_{CE} = 15V$
$-V_{BE} = 3V$
1V
typ
$-I_{BEX}$ (nA)
10^5
10^4
10^3
10^2
10
1
10^{-1}
0
50
100
150
200
T_j (°C)

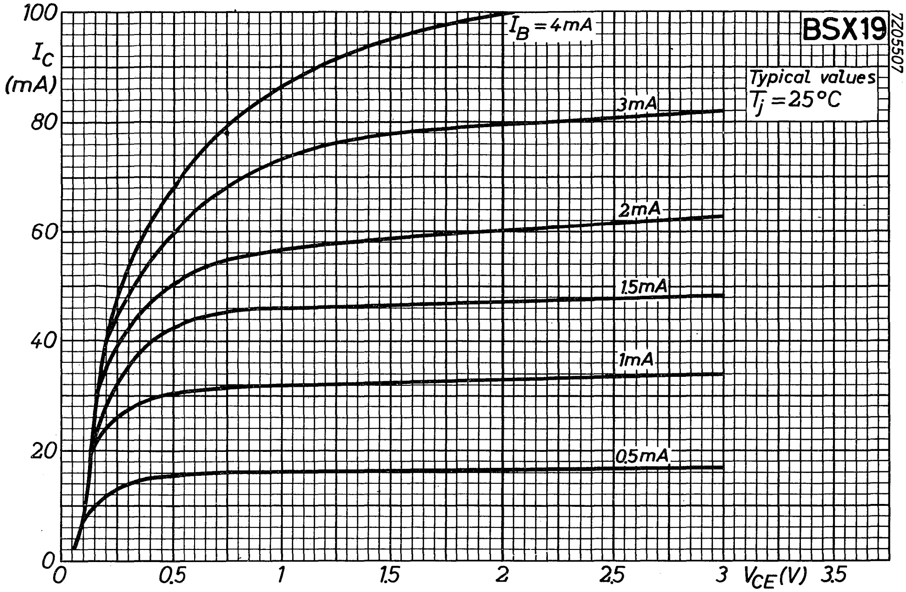

7Z05534
$V_{CE} = 1V$
$I_C = 100mA$
10mA
typ
typ
V_{BE} (V)
1.4
1.2
1
0.8
0.6
0.4
0.2
0
−50
0
50
100
150
200
T_j (°C)

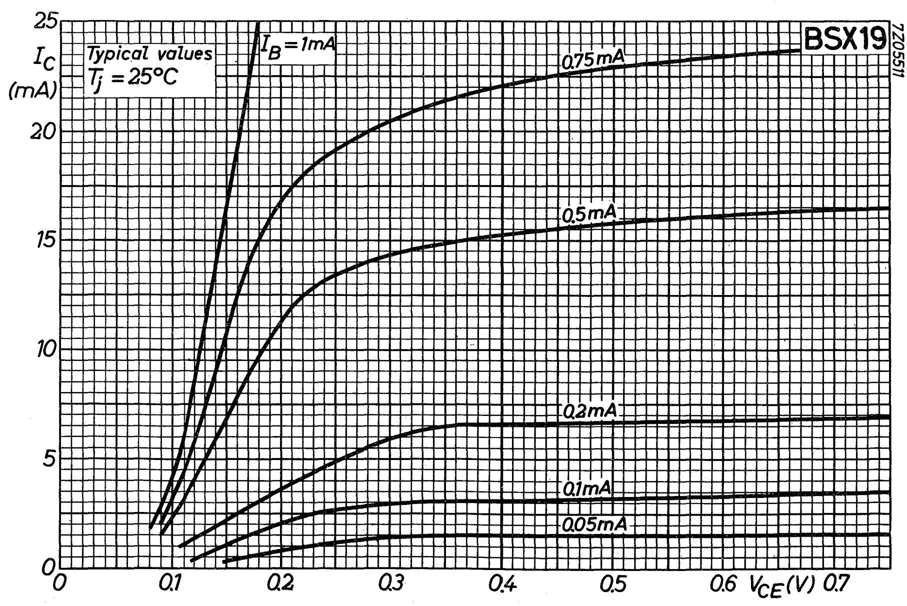

Typical values
T_j = 25°C
I_C (mA)
150
100
50
0
0.7
0.8
0.9
1
1.1
1.2
V_{BE} (V)
I_B = 1mA
5mA
10mA
25mA
50mA
7Z05532

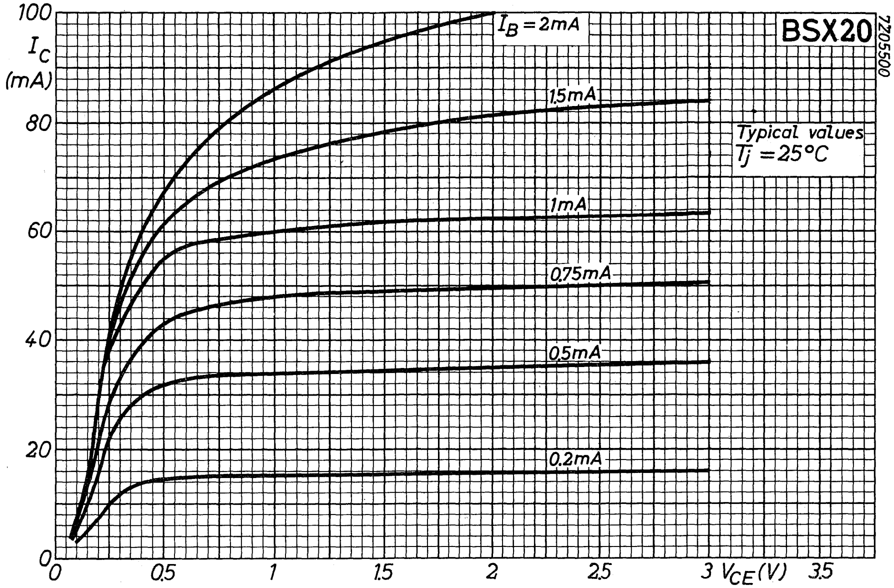

V_{CE} = 1V
T_j = 25°C
I_C (mA)
100
80
60
40
20
0
0
0.2
0.4
0.6
0.8
1
1.2
1.4
V_{BE} (V)
typ
7Z05533

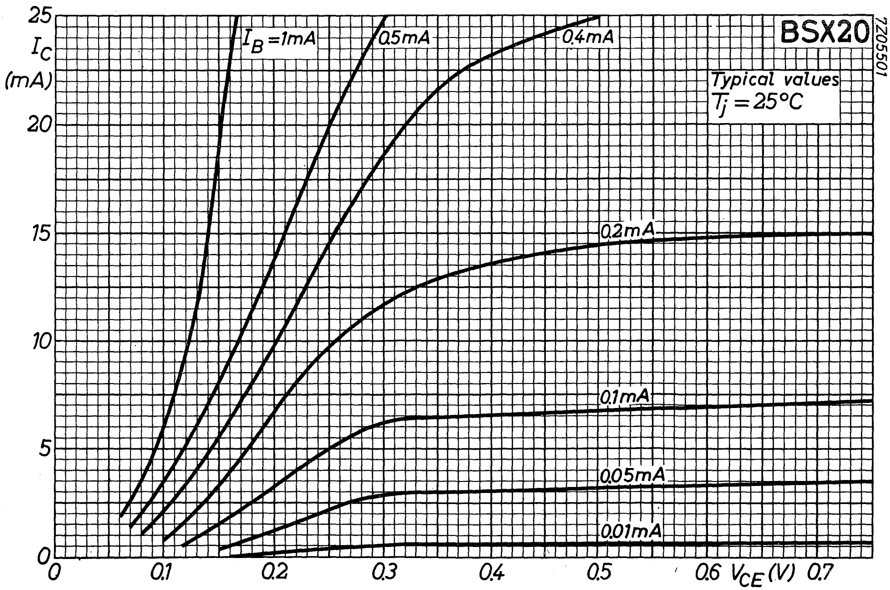

0.5
V_{CEsat}
(V)
0.4
0.3
0.2
0.1
0
Typical values
$\frac{I_C}{I_B} = 10$
I_C=100mA
50mA
10mA
−100
−50
0
50
100
150
200
T_j (°C)
250
7Z05508

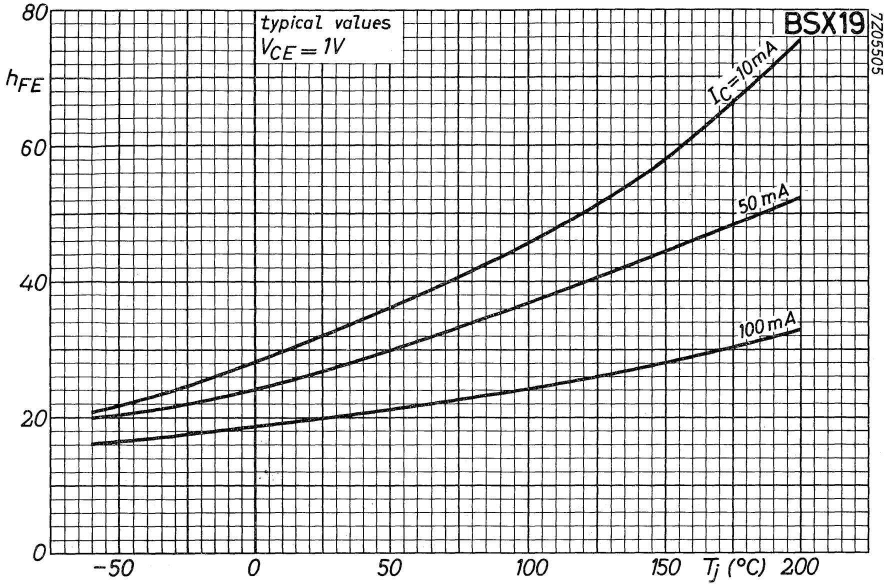

1.4
V_{BEsat}
(V)
1.2
1
0.8
0.6
0.4
Typical values
$\frac{I_C}{I_B} = 10$
I_B=100mA
50mA
10mA
−100
−50
0
50
100
150
200
T_j (°C)
250
7Z05510

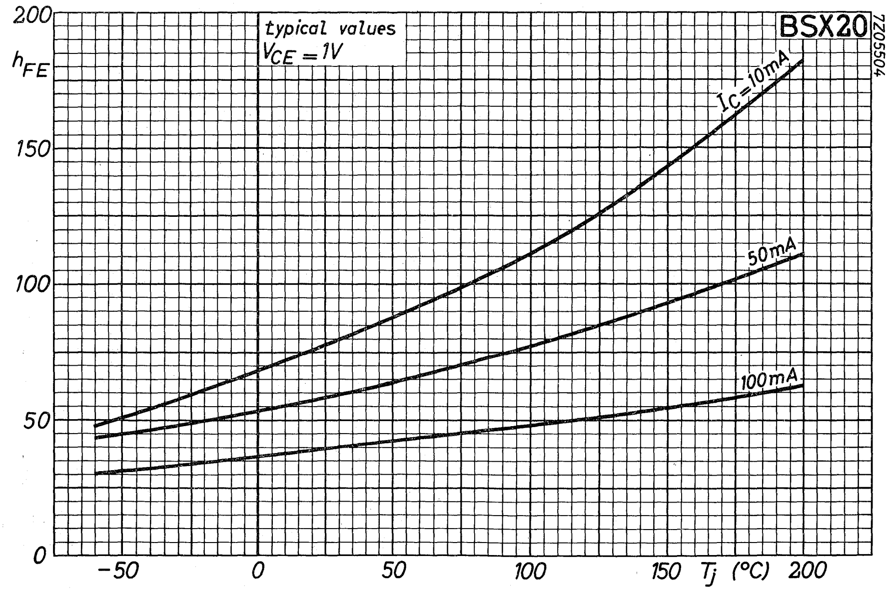

BSX19
7Z05507
Typical values
$T_j = 25°C$
I_C (mA)
$I_B = 4mA$
3mA
2mA
1.5mA
1mA
0.5mA
V_{CE} (V)
100
80
60
40
20
0
0
0.5
1
1.5
2
2.5
3
3.5

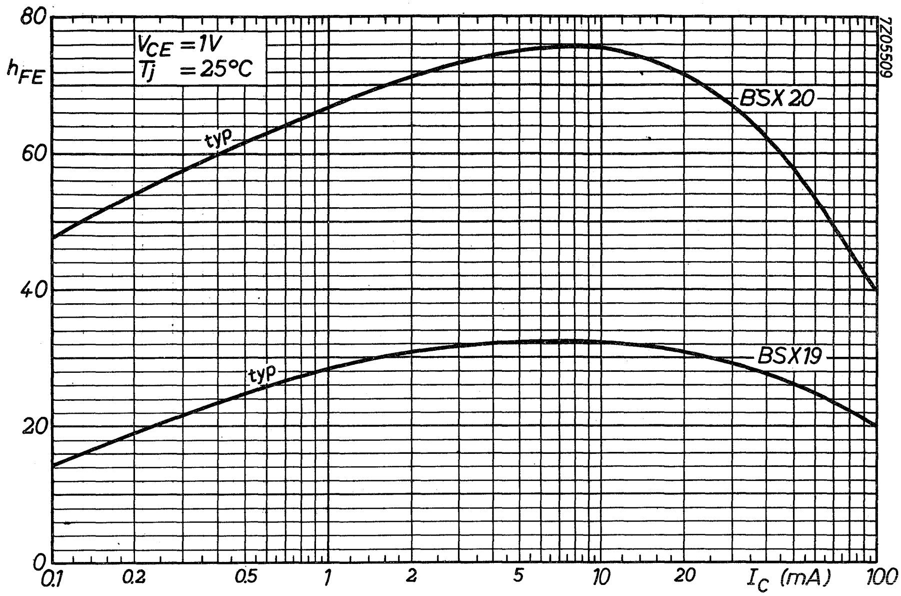

BSX19
7Z05511
Typical values
$T_j = 25°C$
I_C (mA)
$I_B = 1mA$
0.75mA
0.5mA
0.2mA
0.1mA
0.05mA
V_{CE} (V)
25
20
15
10
5
0
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7

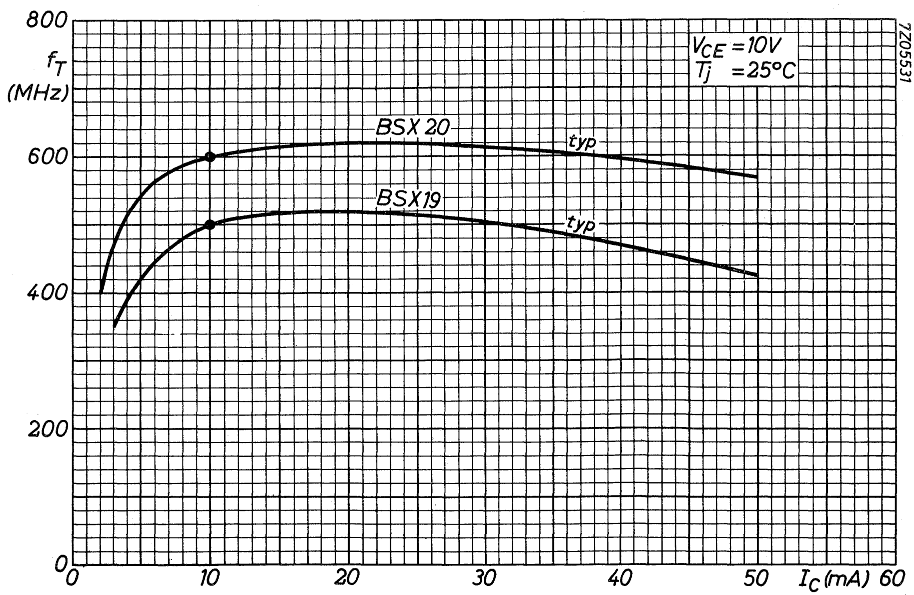

100
I_C
(mA)
80
60
40
20
0
0
0.5
1
1.5
2
2.5
3 V_{CE}(V)
3.5
I_B = 2mA
1.5mA
1mA
0.75mA
0.5mA
0.2mA
BSX20
7Z05500
Typical values
T_j = 25°C

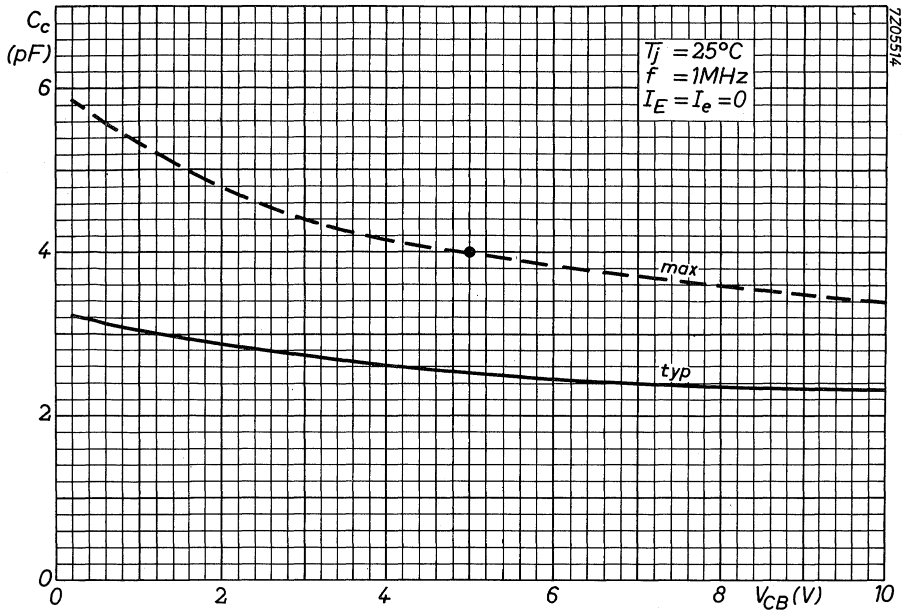

25
I_C
(mA)
20
15
10
5
0
0
0.1
0.2
0.3
0.4
0.5
0.6 V_{CE}(V)
0.7
I_B = 1mA
0.5mA
0.4mA
0.2mA
0.1mA
0.05mA
0.01mA
BSX20
7Z05501
Typical values
T_j = 25°C

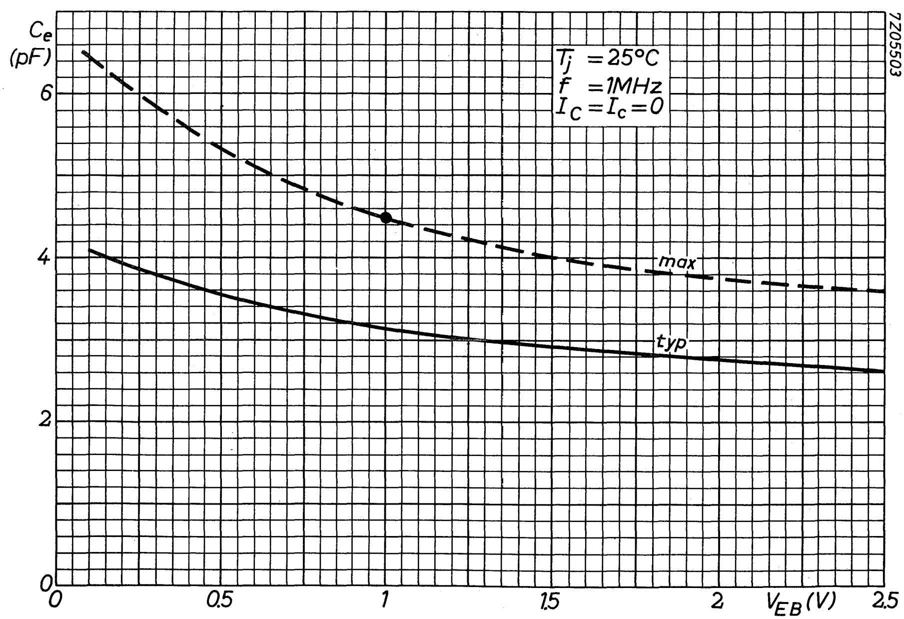

typical values
$V_{CE} = 1V$
BSX19
7Z05505
h_{FE}
80
60
40
20
0
$I_C = 10mA$
50 mA
100 mA
−50
0
50
100
150
T_j (°C)
200

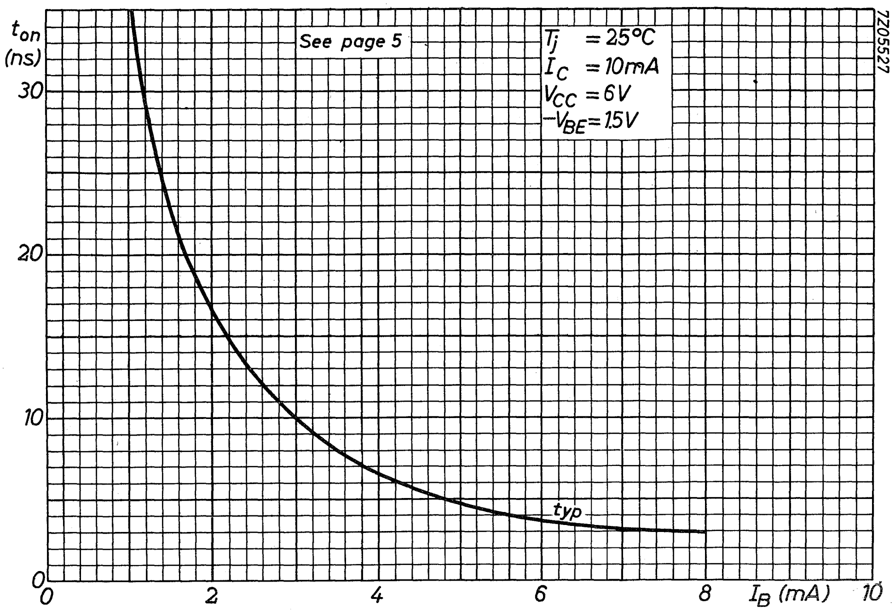

typical values
$V_{CE} = 1V$
BSX20
7Z05504
h_{FE}
200
150
100
50
0
$I_C = 10mA$
50mA
100mA
−50
0
50
100
150
T_j (°C)
200

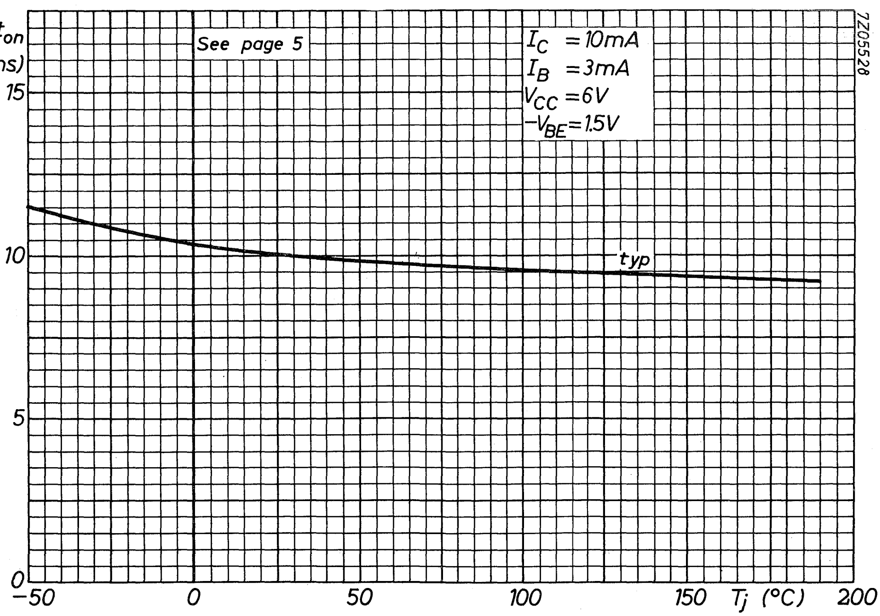

7Z05509
V_{CE} = 1V
T_j = 25°C
h_{FE}
80
60
40
20
0
typ
BSX 20
typ
BSX19
0.1
0.2
0.5
1
2
5
10
20
I_C (mA)
100

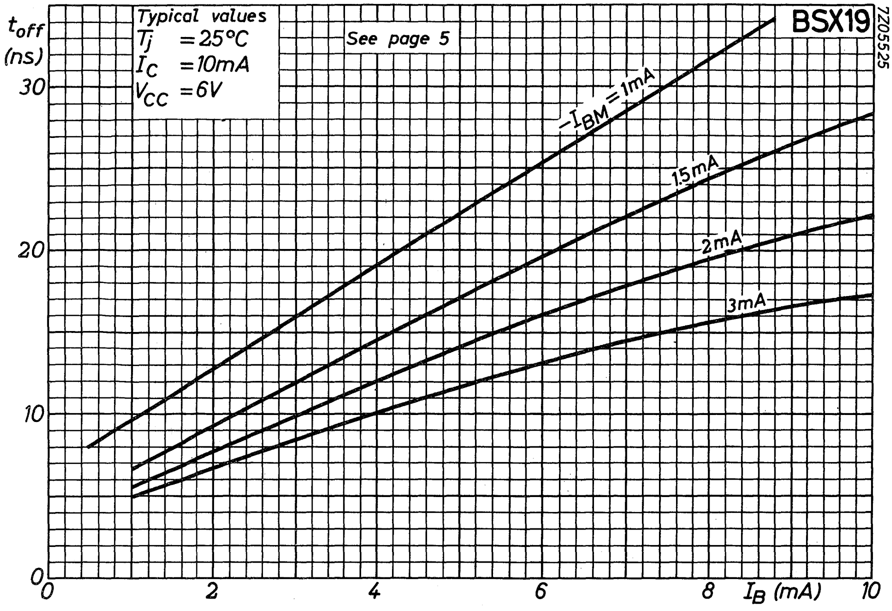

7Z05531
V_{CE} = 10V
T_j = 25°C
f_T
(MHz)
800
600
400
200
0
BSX 20
typ
BSX19
typ
0
10
20
30
40
50
I_C(mA)
60

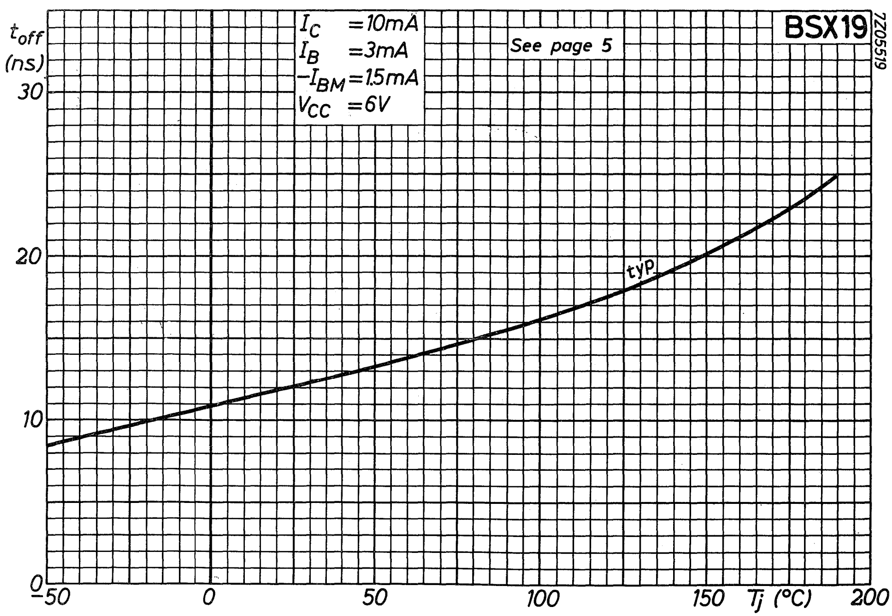

C_c
(pF)
6
4
2
0
0
2
4
6
8
10
V_{CB} (V)
T_j = 25°C
f = 1MHz
$I_E = I_e = 0$
max
typ
7Z05514

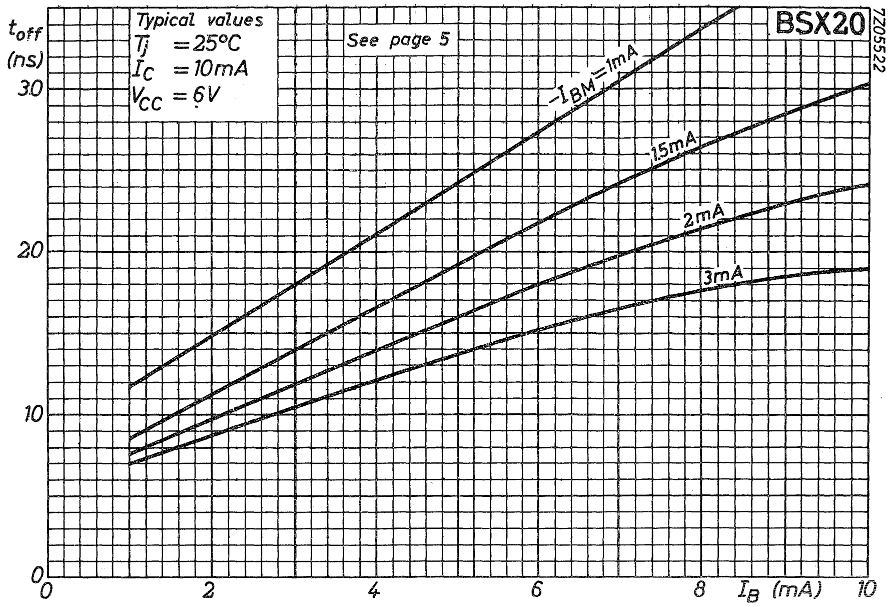

C_e
(pF)
6
4
2
0
0
0.5
1
1.5
2
2.5
V_{EB} (V)
T_j = 25°C
f = 1MHz
$I_C = I_c = 0$
max
typ
7Z05503

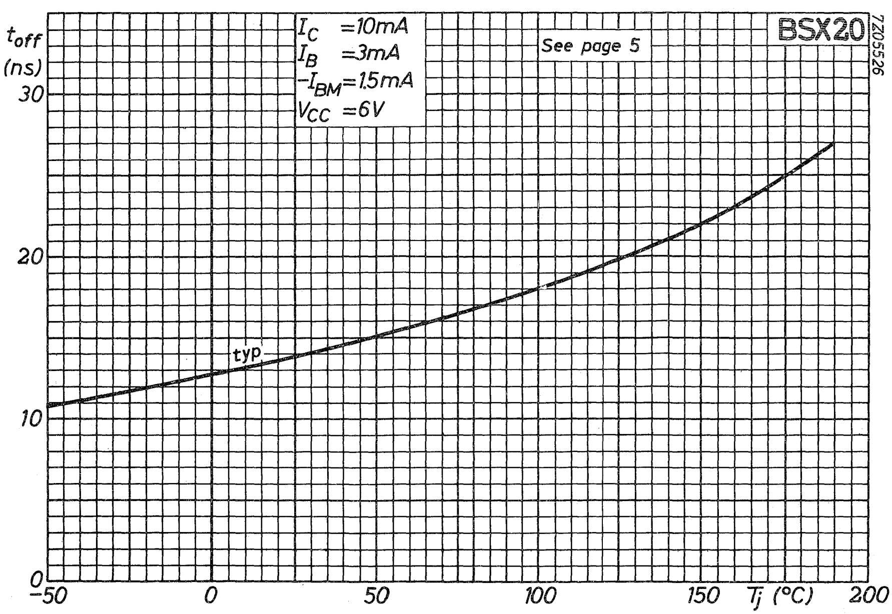

t_{on} (ns)
30
20
10
0
0
2
4
6
8
10
I_B (mA)
See page 5
T_j = 25°C
I_C = 10mA
V_{CC} = 6V
$-V_{BE}$ = 1.5V
typ
7Z05527

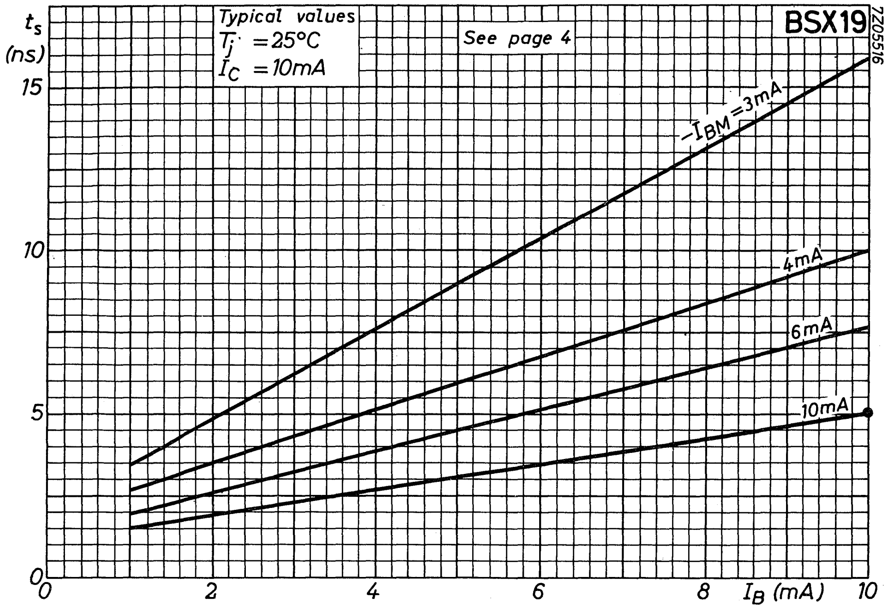

t_{on} (ns)
15
10
5
0
−50
0
50
100
150
200
T_j (°C)
See page 5
I_C = 10mA
I_B = 3mA
V_{CC} = 6V
$-V_{BE}$ = 1.5V
typ
7Z05528

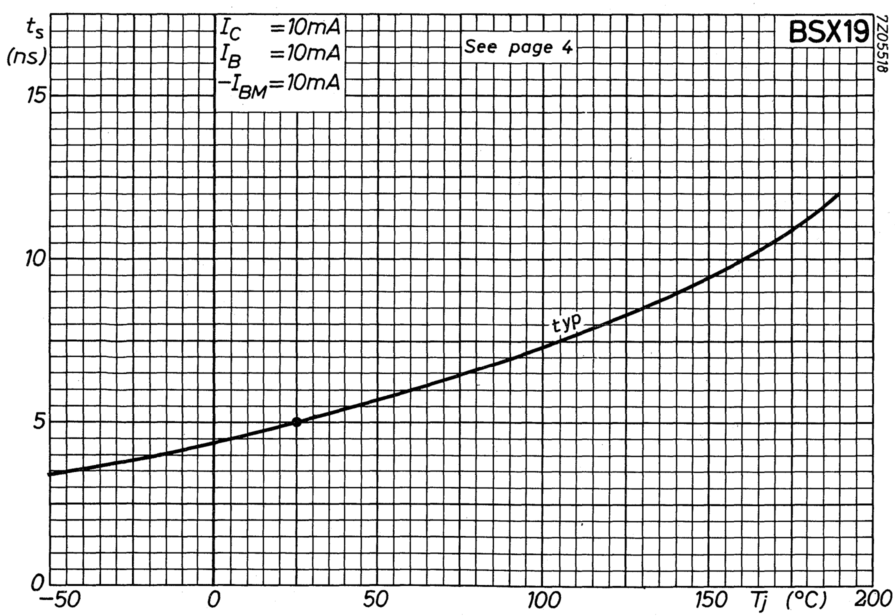

t_{off} (ns)
30
20
10
0
Typical values
T_j = 25°C
I_C = 10mA
V_{CC} = 6V
See page 5
BSX19
7Z05525
$-I_{BM}$ = 1mA
1.5mA
2mA
3mA
0
2
4
6
8
I_B (mA)
10

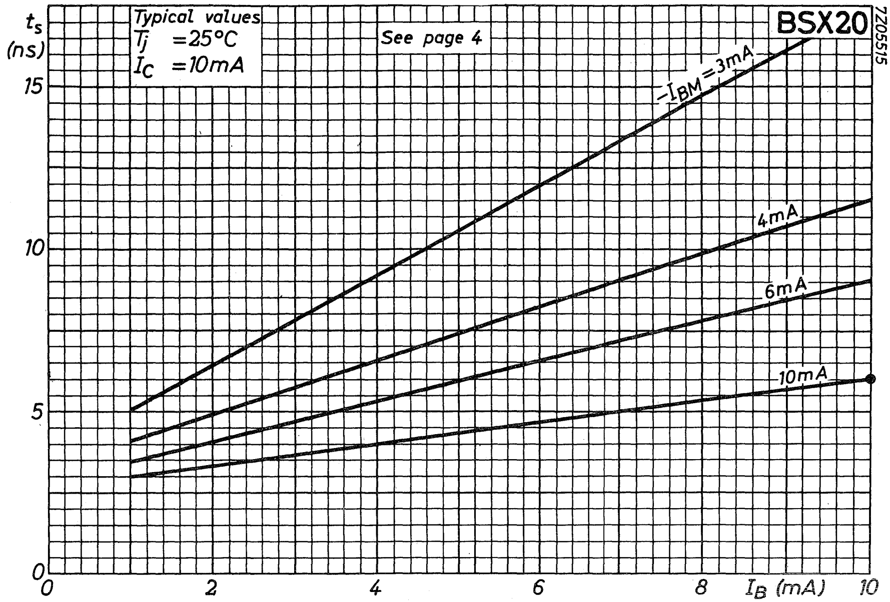

t_{off} (ns)
30
20
10
0
I_C = 10mA
I_B = 3mA
$-I_{BM}$ = 1.5mA
V_{CC} = 6V
See page 5
BSX19
7Z05519
typ
-50
0
50
100
150
T_j (°C)
200

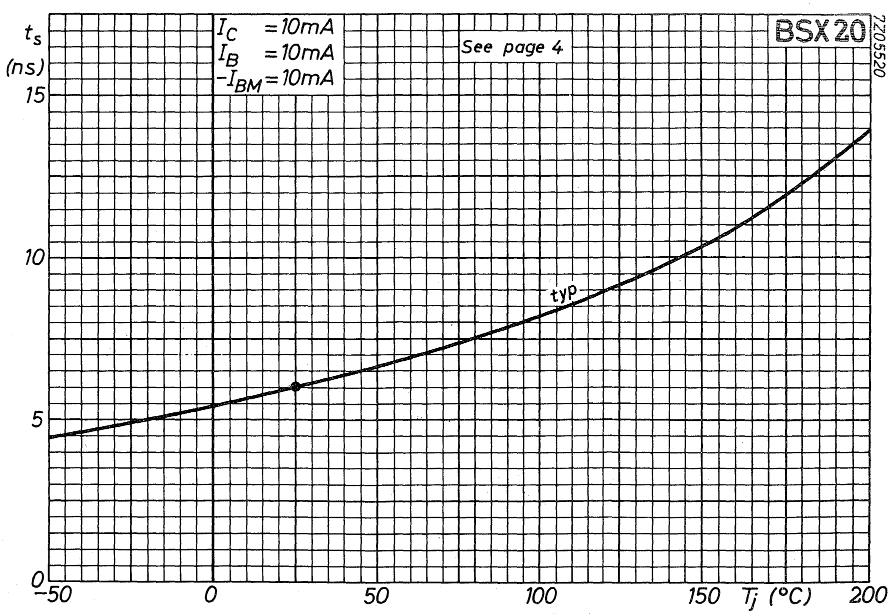

Typical values
T_j = 25°C
I_C = 10mA
V_{CC} = 6V
See page 5
BSX20
7Z05522
t_{off} (ns)
30
20
10
0
$-I_{BM}$=1mA
1.5mA
2mA
3mA
0
2
4
6
8
I_B (mA)
10


I_C = 10mA
I_B = 3mA
$-I_{BM}$ = 1.5mA
V_{CC} = 6V
See page 5
BSX20
7Z05526
t_{off} (ns)
30
20
10
0
typ
−50
0
50
100
150
T_j (°C)
200


Typical values
$T_j = 25°C$
$I_C = 10mA$
See page 4
BSX19
7Z05516
t_s (ns)
$-I_{BM} = 3mA$
4mA
6mA
10mA
I_B (mA)


$I_C = 10mA$
$I_B = 10mA$
$-I_{BM} = 10mA$
See page 4
BSX19
7Z05518
t_s (ns)
typ
T_j (°C)


Typical values
T_j = 25°C
I_C = 10mA
See page 4
BSX20
7Z05515
t_s (ns)
0
5
10
15
$-I_{BM}$ = 3mA
4mA
6mA
10mA
0
2
4
6
8
I_B (mA)
10


I_C = 10mA
I_B = 10mA
$-I_{BM}$ = 10mA
See page 4
BSX20
7Z05520
t_s (ns)
0
5
10
15
typ
−50
0
50
100
150
T_j (°C)
200

SILICON DOUBLE DIFFUSED MESA TRANSISTOR

N-P-N transistor in a TO-18 metal envelope, with the collector connected to the case.
It is primarily intended for driving numerical indicator tubes.

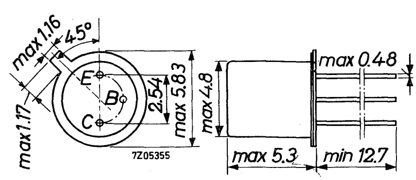
QUICK REFERENCE DATA

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 °C	P_{tot}	max.	300	mW
Junction temperature	T_j	max.	175	°C
D.C. current gain at T_j = 25 °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	MHz

NOTE: 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.

MECHANICAL DATA Dimensions in mm

TO-18
Collector connected to case



7Z3 0335

RATINGS (Limiting values) [1]

Voltages

Collector-base voltage (open emitter)	V_{CBO}	max.	120	V	[2]
Collector-emitter voltage (open base)	V_{CEO}	max.	80	V	[2]
Emitter-base voltage (open collector)	V_{EBO}	max.	5	V	

Currents

Collector current (d.c. or average over any 20 ms period)	I_C	max.	50	mA	
Collector current (peak value)	I_{CM}	max.	50	mA	[3]
Emitter current (d.c. or 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	$R_{th\ j-a}$	=	0.5	°C/mW
From junction to case	$R_{th\ j-c}$	=	0.15	°C/mW

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

[2]) 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.

[3]) The transistor can withstand a capacitive load of 500 pF, combined with a collector-base voltage of max. 150 V before switching on. 7Z3 0336

CHARACTERISTICS T_j = 25 °C unless otherwise specified

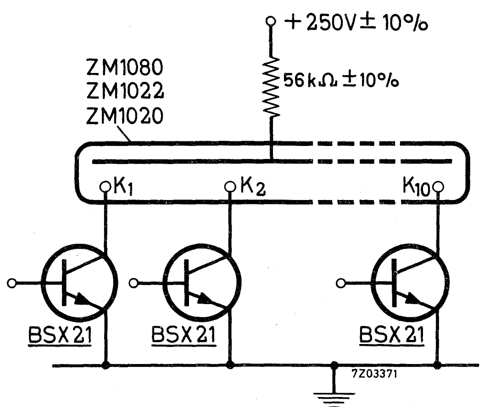
Collector cut-off current				
$I_E = 0$; V_{CB} = 50 V	I_{CBO}	typ.	0.5	μA
$I_E = 0$; V_{CB} = 120 V	I_{CBO}	<	40	μA
Emitter cut-off current				
$I_C = 0$; V_{EB} = 3 V	I_{EBO}	typ.	0.1	μA
Collector current at reverse biased emitter junction				
V_{CE} = 80 V; $-V_{BE}$ = 1 V; T_j = 85 °C	I_{CEX}	typ.	3	μA
		<	20	μA
Collector-emitter sustaining voltage				
I_C = 4 mA; $I_B = 0$	$V_{CEOsust}$	>	80	V
Base-emitter voltage				
I_C = 4 mA; V_{CE} = 3 V	V_{BE}	typ.	0.7	V
		<	0.9	V
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
D.C. current gain				
I_C = 1 mA; V_{CE} = 3 V	h_{FE}	typ.	25	
I_C = 4 mA; V_{CE} = 3 V	h_{FE}	>	20	
		typ.	40	
I_C = 10 mA; V_{CE} = 3 V	h_{FE}	typ.	32	
I_C = 20 mA; V_{CE} = 3 V	h_{FE}	typ.	7	

7Z3 0337

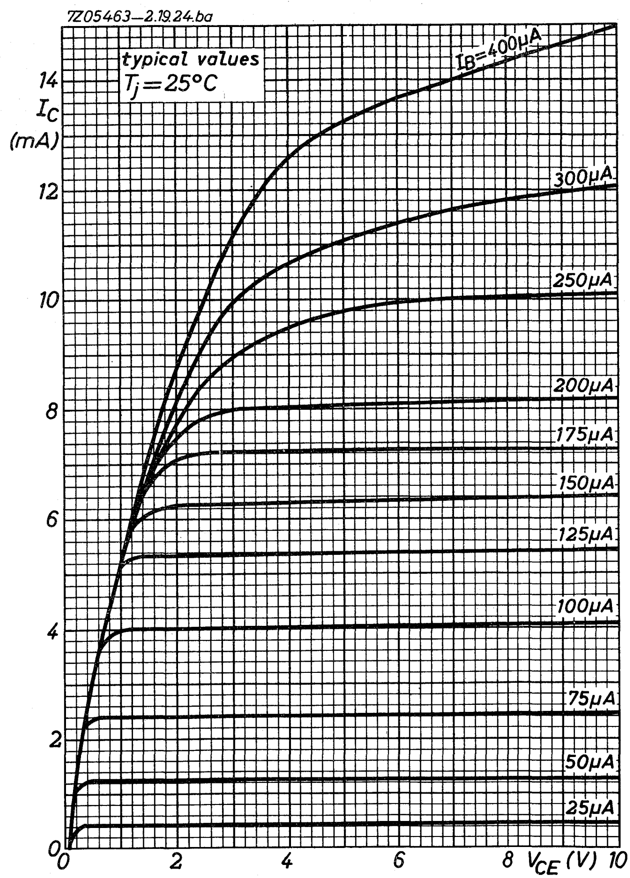
CHARACTERISTICS (continued) T_j = 25 °C unless otherwise specified

Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; $V_{CB} = 10$ V	C_c	typ.	3.6	pF
Emitter capacitance at f = 1 MHz				
$I_C = I_c = 0$; $V_{EB} = 1$ V	C_e	typ.	8.5	pF
Transition frequency				
$I_C = 4$ mA; $V_{CE} = 10$ V	f_T	>	60	MHz
		typ.	120	MHz

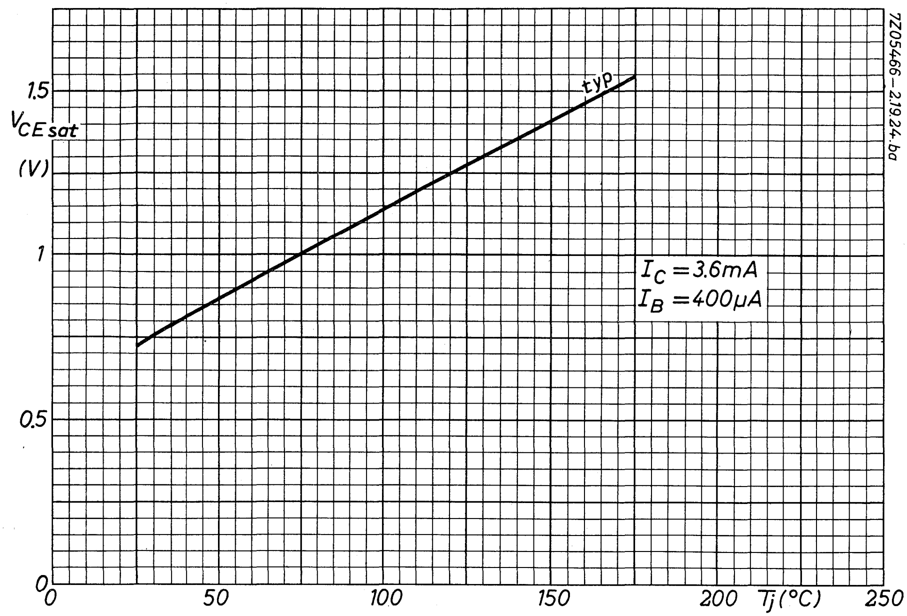
Practical circuit

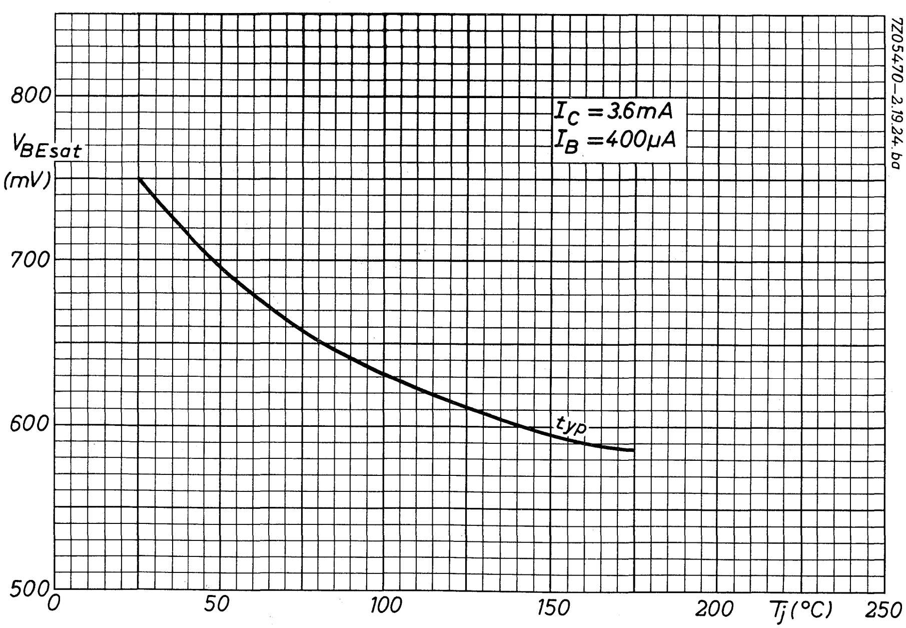


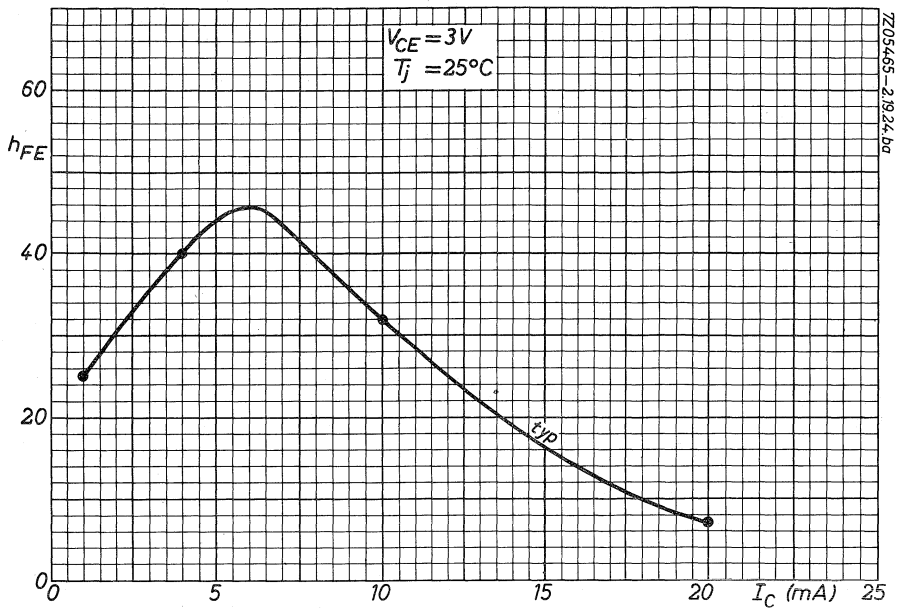
7Z3 0338

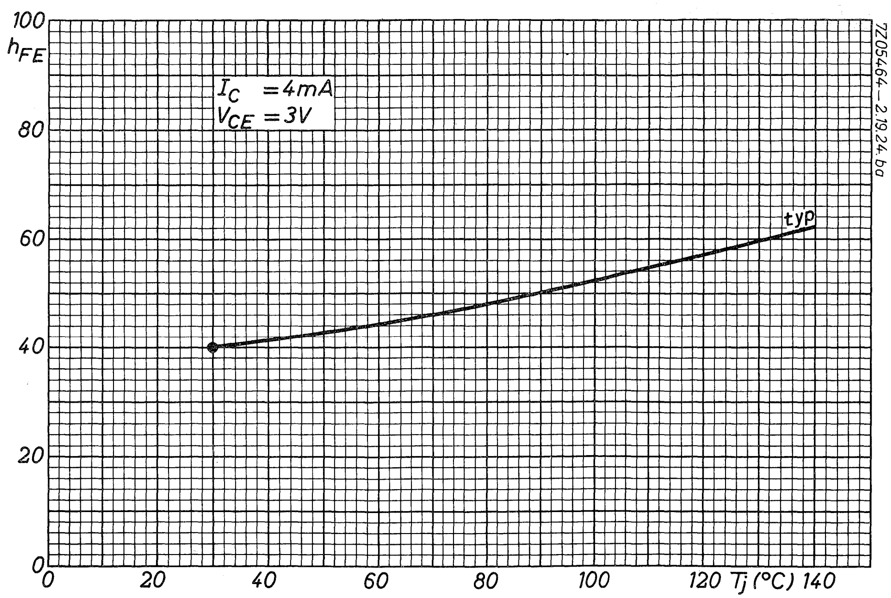


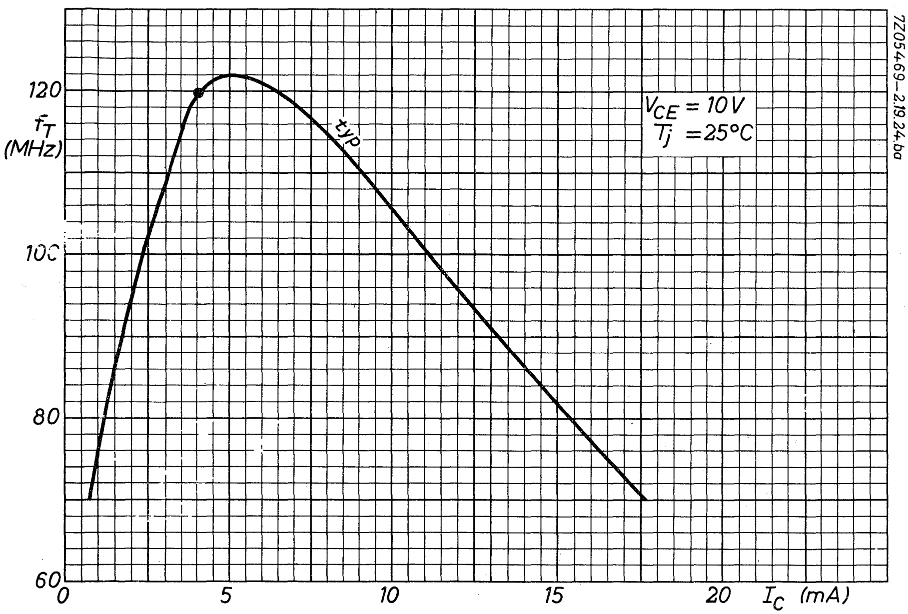
7Z05463—2.19.24.ba
typical values
$T_j = 25°C$
I_B=400μA
300μA
250μA
200μA
175μA
150μA
125μA
100μA
75μA
50μA
25μA
I_C (mA)
V_{CE} (V)
0
2
4
6
8
10
12
14

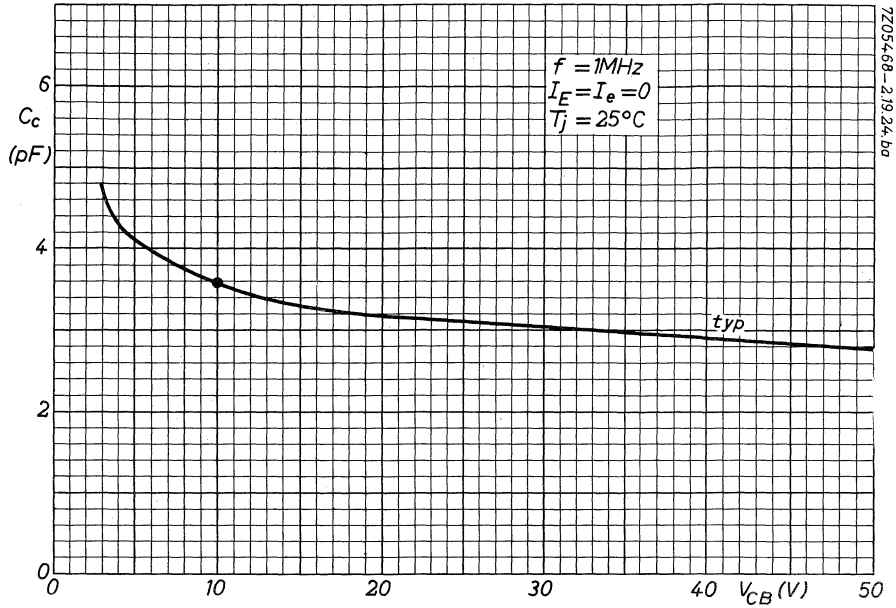

1.5
V_{CEsat}
(V)
1
0.5
0
0
50
100
150
200
T_j (°C)
250
typ
I_C = 3.6mA
I_B = 400μA
7Z05466–2.19.24.ba

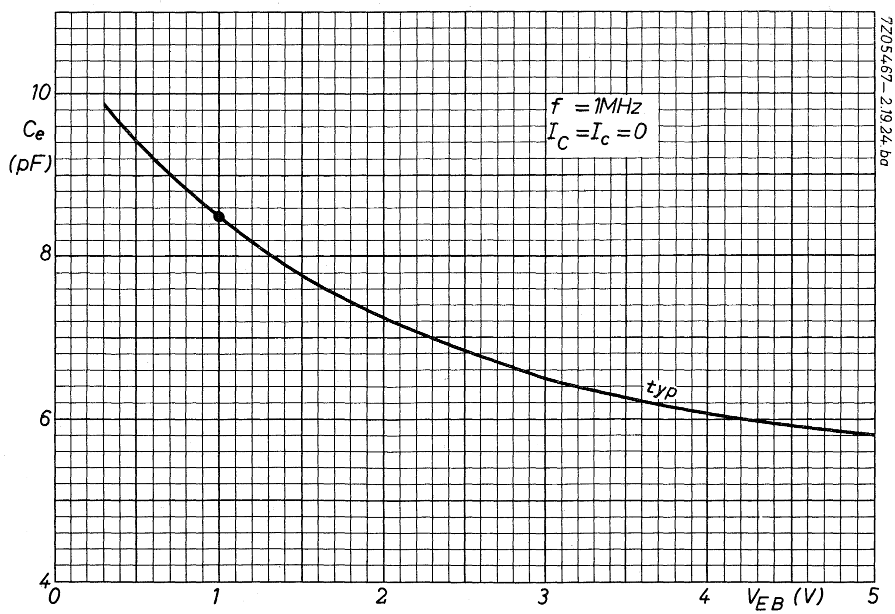

800
V_{BEsat}
(mV)
700
600
500
0
50
100
150
200
T_j (°C)
250
typ
I_C = 3.6mA
I_B = 400μA
7Z05470–2.19.24.ba

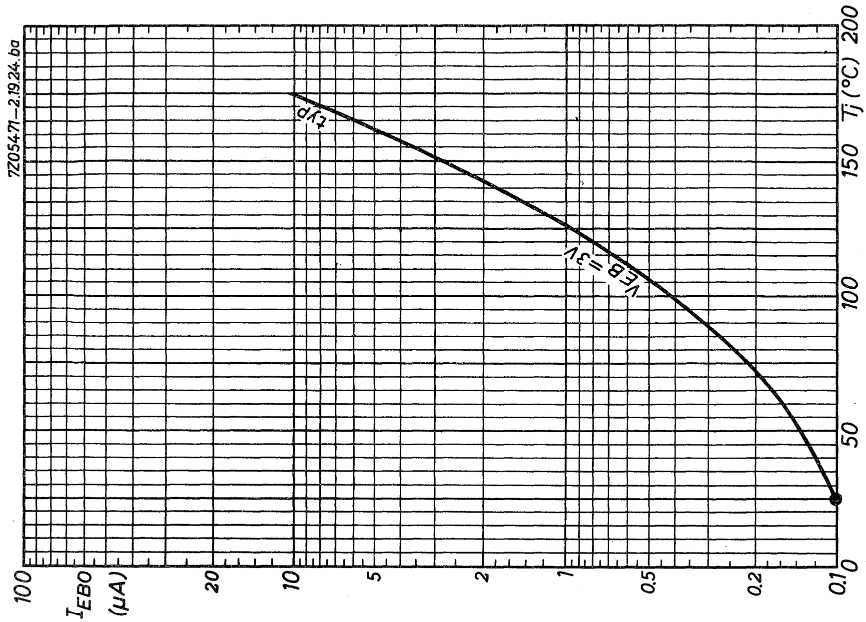

V_{CE} = 3V
T_j = 25°C
7Z05465–2.19.24.ba
60
h_{FE}
40
20
0
0
5
10
15
20
I_C (mA)
25
typ

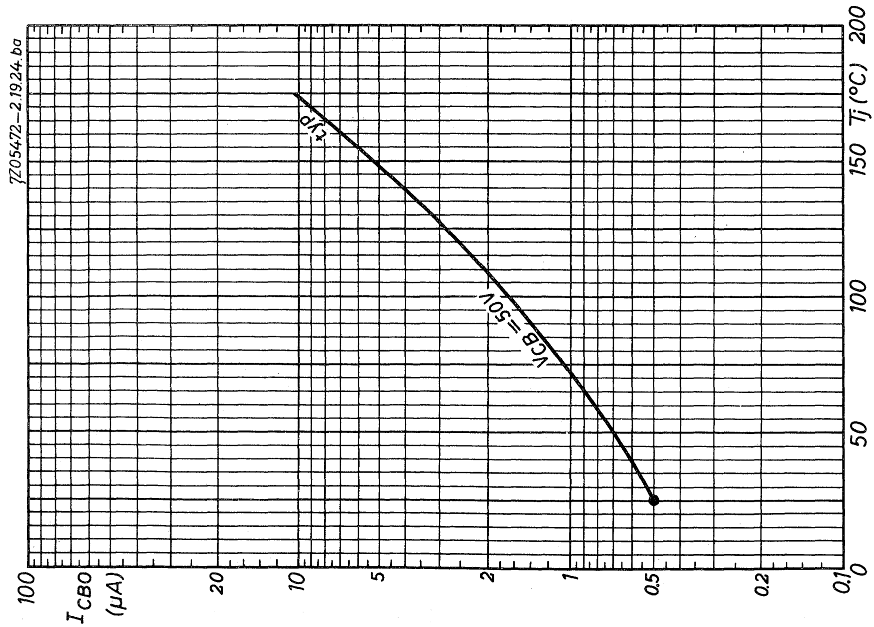

100
h_{FE}
I_C = 4mA
V_{CE} = 3V
7Z05464–2.19.24.ba
80
60
40
20
0
0
20
40
60
80
100
120
T_j (°C)
140
typ


7Z05469-2.19.24.ba
120
f_T
(MHz)
100
80
60
0
5
10
15
20
I_C (mA)
typ
V_{CE} = 10 V
T_j = 25°C


7Z05468–2.19.24.ba
f = 1MHz
$I_E = I_e = 0$
$T_j = 25°C$
C_c
(pF)
6
4
2
0
0
10
20
30
40
V_{CB} (V)
50
typ


7Z05467–2.19.24.ba
f = 1MHz
$I_C = I_c = 0$
10
C_e
(pF)
8
6
4
0
1
2
3
4
V_{EB} (V)
5
typ


7Z05471–2.19.24.ba
typ
VEB = 3V
100
IEBO
(μA)
20
10
5
2
1
0.5
0.2
0.1
0
50
100
150
200
Tj (°C)


7Z05472–2.19.24.ba
typ
VCB = 50V
100
ICBO
(μA)
20
10
5
2
1
0.5
0.2
0.1
0
50
100
150
200
Tj (°C)

SILICON PLANAR EPITAXIAL TRANSISTOR

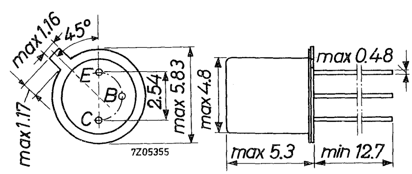
N-P-N transistor in a TO-18 metal envelope with the collector connected to the case.
The BSX44 is primarily intended for ultra high speed saturated logic applications.

QUICK REFERENCE DATA				
Collector-base voltage (open emitter)	V_{CBO}	max.	15	V
Collector-emitter voltage (open base)	V_{CEO}	max.	6	V
Collector current (peak value)	I_{CM}	max.	200	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	300	mW
Junction temperature	T_j	max.	200	°C
Collector-emitter saturation voltage				
I_C = 50 mA; I_B = 5 mA	V_{CEsat}	<	450	mV
D.C. current gain at T_j = 25 °C				
I_C = 20 mA; V_{CE} = 0.4 V	h_{FE}		30 to 150	
I_C = 100 mA; V_{CE} = 1 V	h_{FE}	>	10	
Transition frequency				
I_C = 20 mA; V_{CE} = 2 V	f_T	>	600	MHz
Storage time				
I_C = I_B = $-I_{BM}$ = 5 mA	t_s	<	6	ns

MECHANICAL DATA

Dimensions in mm

TO-18
Collector connected to case



7Z3 0561

RATINGS (Limiting values) [1])

Voltages

Collector-base voltage (open emitter)	V_{CBO}	max.	15	V
Collector-emitter voltage (open base)	V_{CEO}	max.	6	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4	V

Current

Collector current (peak value)	I_{CM}	max.	200	mA

Power dissipation

Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	300	mW

Temperatures

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

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	0.58	°C/mW
From junction to case	$R_{th\ j\text{-}c}$	=	0.2	°C/mW

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

7Z3 0562

CHARACTERISTICS T_j = 25 °C unless otherwise specified

Collector cut-off currents

$I_E = 0$; $V_{CB} = 5$ V	I_{CBO}	typ.	1	nA
		<	50	nA
$I_E = 0$; $V_{CB} = 5$ V; $T_j = 150$ °C	I_{CBO}	typ.	3	μA
		<	5	μA
$I_E = 0$; $V_{CB} = 15$ V	I_{CBO}	<	10	μA
$V_{BE} = 0.3$ V; $V_{CE} = 5$ V; $T_j = 100$ °C	I_{CEX}	typ.	0.8	μA
		<	25	μA

Emitter cut-off currents

$I_C = 0$; $V_{EB} = 1$ V	I_{EBO}	typ.	0.1	nA
		<	50	nA
$I_C = 0$; $V_{EB} = 1$ V; $T_j = 150$ °C	I_{EBO}	typ.	0.03	μA
		<	5	μA
$I_C = 0$; $V_{EB} = 4$ V	I_{EBO}	<	10	μA

Sustaining voltages

$I_C = 10$ mA; $I_B = 0$	$V_{CEOsust}$	>	6	V
$I_C = 100$ μA; $V_{EB} = 0$	$V_{CESsust}$	>	10	V

Saturation voltages

$I_C = 20$ mA; $I_B = 0.66$ mA	V_{CEsat}	100 to 400	mV
	V_{BEsat}	0.80 to 1.00	V
$I_C = 50$ mA; $I_B = 5$ mA	V_{CEsat}	150 to 450	mV
	V_{BEsat}	0.85 to 1.30	V

D.C. current gain

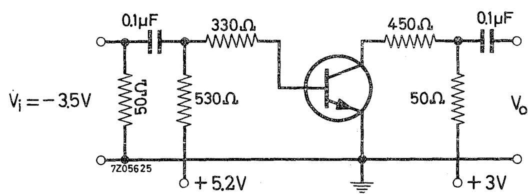
$I_C = 1$ mA; $V_{CE} = 300$ mV	h_{FE}	>	20
		typ.	80
$I_C = 20$ mA; $V_{CE} = 400$ mV	h_{FE}	typ.	70
			30 to 150
$I_C = 50$ mA; $V_{CE} = 500$ mV	h_{FE}	>	20
		typ.	45
$I_C = 100$ mA; $V_{CE} = 1$ V	h_{FE}	>	10
		typ.	25
$I_C = 20$ mA; $V_{CE} = 400$ mV; $T_j = -55$ °C	h_{FE}	>	15
		typ.	35

7Z3 0563

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

Collector capacitance at f = 1 MHz				
$I_E = I_e = 0;\ V_{CB} = 5$ V	C_c	typ.	2	pF
		<	3	pF
Emitter capacitance at f = 1 MHz				
$I_C = I_c = 0;\ V_{EB} = 0.5$ V	C_e	typ.	1.75	pF
		<	2.5	pF
Transition frequency				
$I_C = 20$ mA; $V_{CE} = 2$ V	f_T	>	600	MHz
		typ.	740	MHz
Switching times				
Storage time (See page E)				
$I_C = I_B = -I_{BM} = 5$ mA	t_s	typ.	3.8	ns
		<	6	ns

Test circuit:



Pulse generator:				
Pulse duration	t	>	300	ns
Rise time	t_r	<	1	ns
Duty cycle	δ	<	0.02	
Output resistance	R_o	=	50	Ω

Oscilloscope:				
Input impedance	R_i	=	50	Ω
Rise time	t_r	<	1	ns

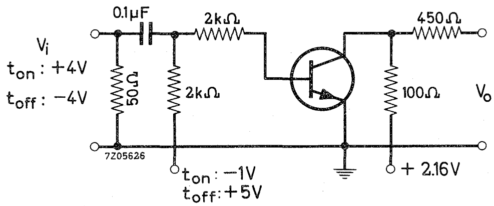
7Z3 0564

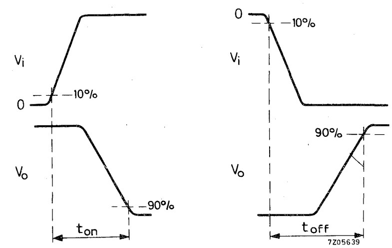
CHARACTERISTICS (continued) T_j = 25 °C unless otherwise specified

Switching times

Turn on time when switched from $-V_{BE}$ = 1 V to I_C = 20 mA; I_B = 1 mA	t_{on}	typ.	13.2	ns
		<	20	ns
Turn off time when switched from I_C = 20 mA; I_B = 1 mA to cut-off with $-I_{BM}$ = 1 mA [1])	t_{off}	typ.	9	ns
		<	15	ns

Test circuit:



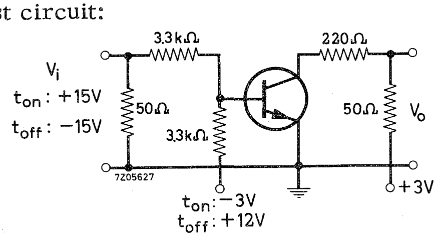


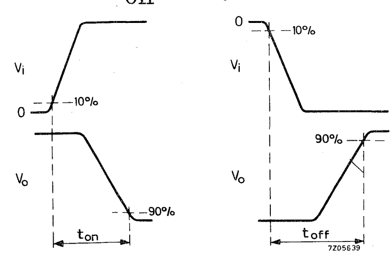
Pulse generator:				
Pulse duration	t	>	300	ns
Rise time	t_r	<	1	ns
Duty cycle	δ	<	0.02	
Output impedance	R_o	=	50	Ω

Oscilloscope:				
Input impedance	R_i	=	50	Ω
Rise time	t_r	<	1	ns

Turn on time when switched from $-V_{BE}$ = 1.5 V to I_C = 10 mA; I_B = 3 mA	t_{on}	typ.	6	ns
Turn off time when switched from I_C = 10 mA; I_B = 3 mA to cut-off with $-I_{BM}$ = 1.5 mA [1])	t_{off}	typ.	8	ns

Test circuit:



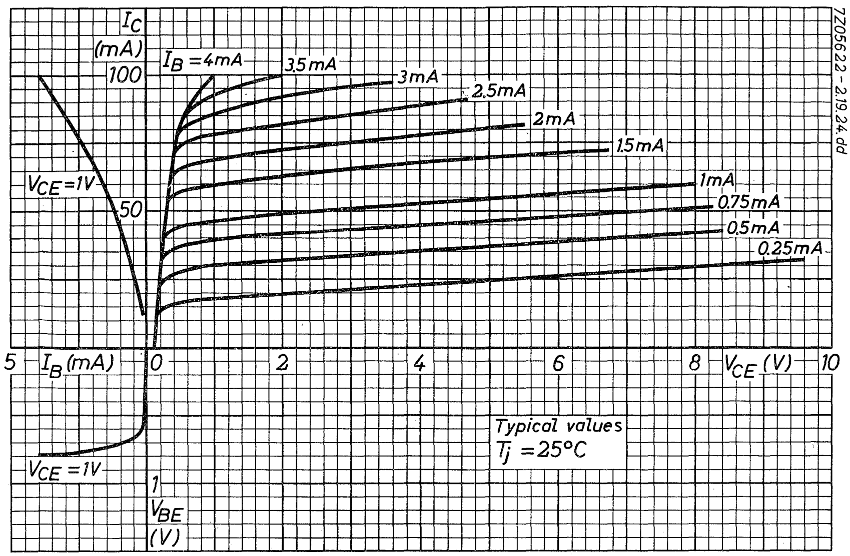


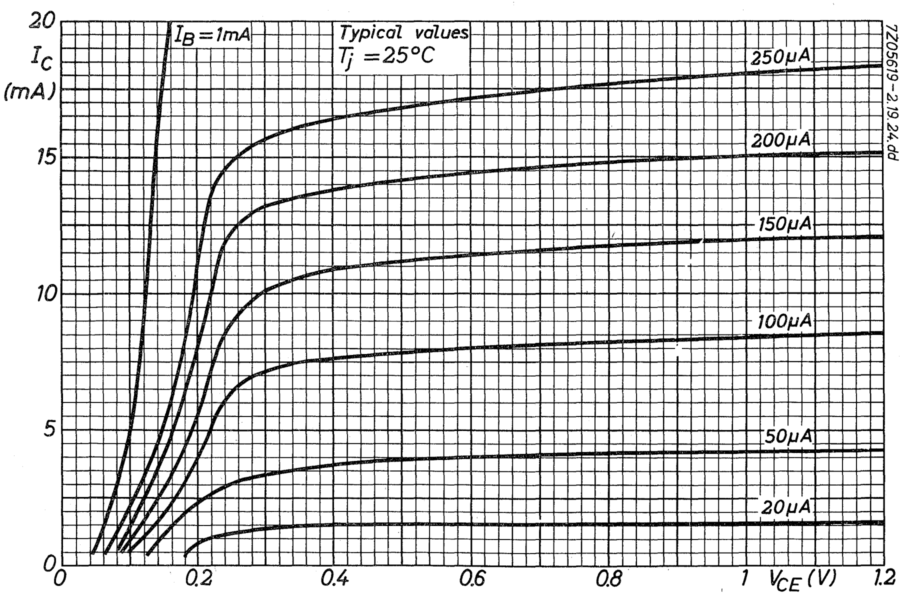
Pulse generator:				
Pulse duration	t	>	300	ns
Rise time	t_r	<	1	ns
Duty cycle	δ	<	0.02	
Output impedance	R_o	=	50	Ω

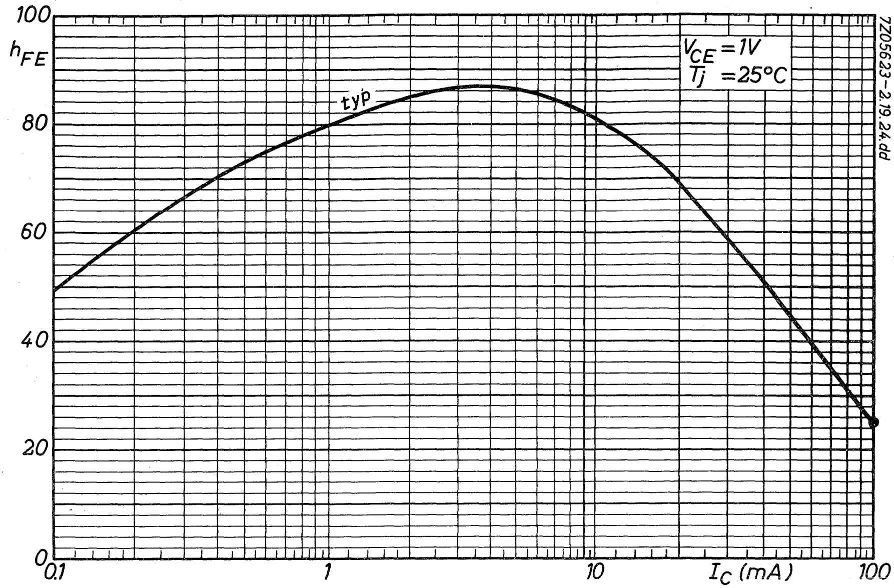
Oscilloscope:				
Input impedance	R_i	=	50	Ω
Rise time	t_r	<	1	ns

[1]) $-I_{BM}$ is the reverse current that can flow during switching off. The indicated $-I_{BM}$ is determined and limited by the applied cut-off voltage and the series resistance.

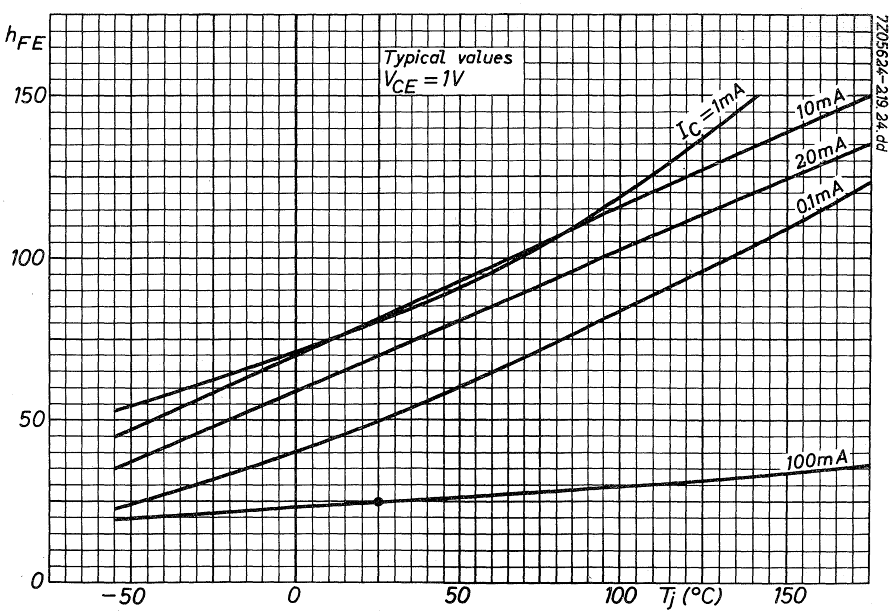
7Z3 0565


7Z05622-2.19.24.dd
I_C (mA)
100
50
I_B = 4mA
3.5mA
3mA
2.5mA
2mA
1.5mA
1mA
0.75mA
0.5mA
0.25mA
V_{CE} = 1V
5
I_B (mA)
0
2
4
6
8
V_{CE} (V)
10
Typical values
T_j = 25°C
V_{CE} = 1V
1
V_{BE} (V)

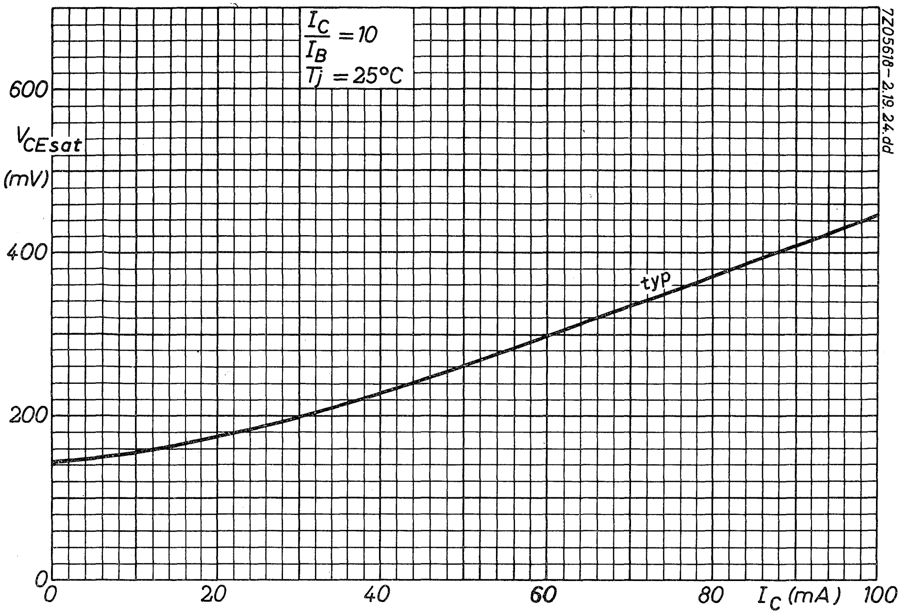

7Z05619-2.19.24.dd
20
I_C (mA)
15
10
5
0
I_B = 1mA
Typical values
T_j = 25°C
250µA
200µA
150µA
100µA
50µA
20µA
0
0.2
0.4
0.6
0.8
1
V_{CE} (V)
1.2



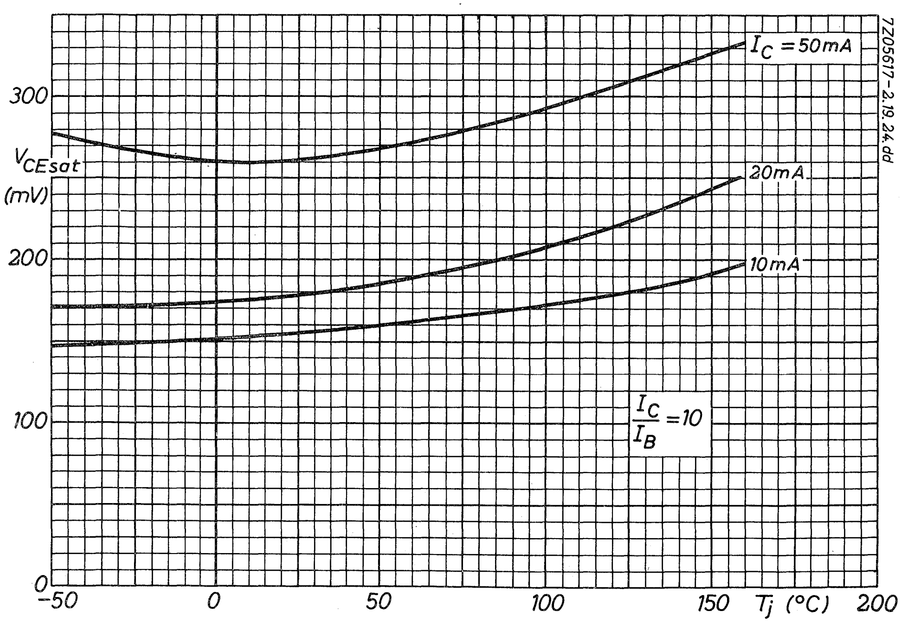
100
h_{FE}
80
60
40
20
0
0.1
1
10
I_C (mA)
100
V_{CE} = 1V
T_j = 25°C
typ
7Z05623-2.19.24.dd



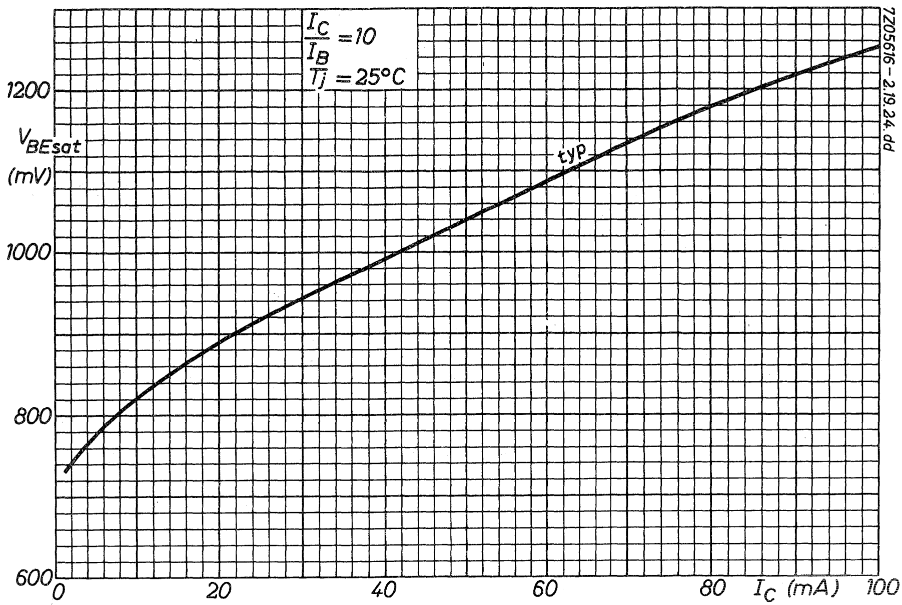
h_{FE}
150
100
50
0
−50
0
50
100
T_j (°C)
150
Typical values
V_{CE} = 1V
I_C = 1mA
10mA
20mA
0.1mA
100mA
7Z05624-2.19.24.dd

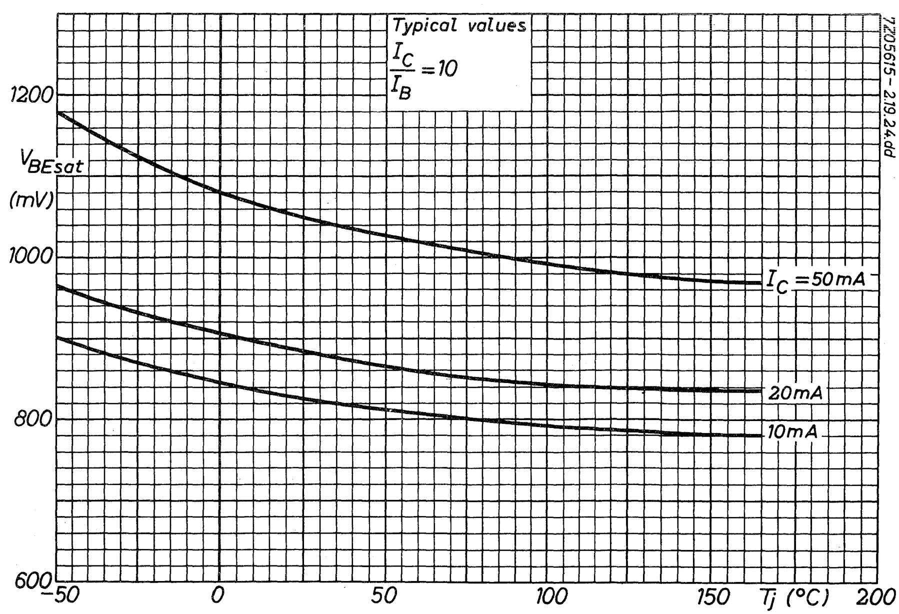


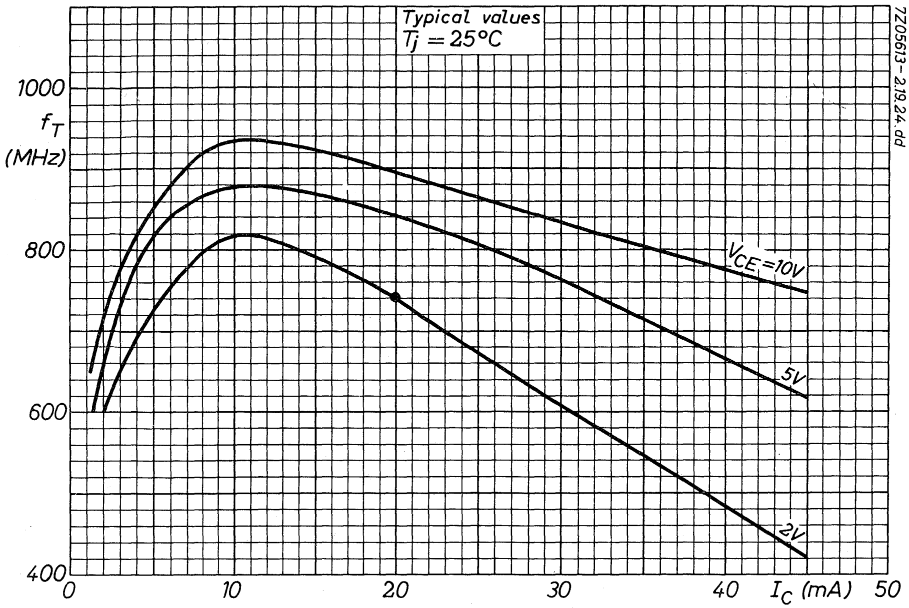
$\frac{I_C}{I_B}=10$
$T_j = 25°C$
7Z05618-2.19.24.dd
600
V_{CEsat}
(mV)
400
200
0
typ
0
20
40
60
80
I_C (mA)
100

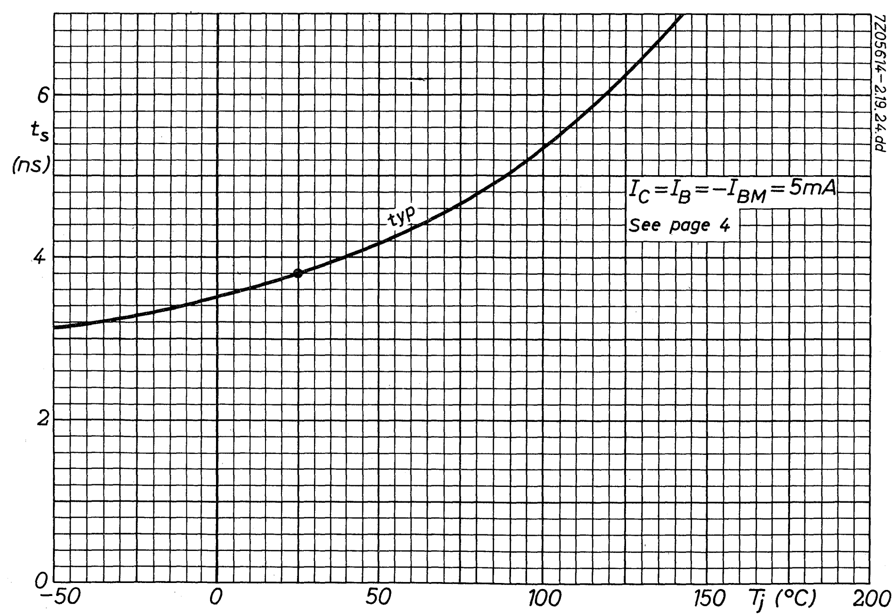


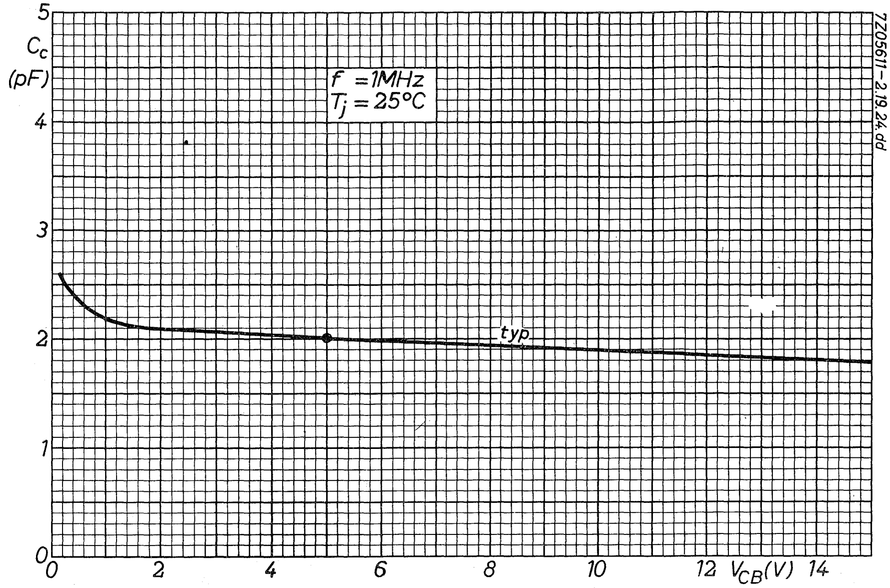
7Z05617-2.19.24.dd
$I_C = 50mA$
20mA
10mA
300
V_{CEsat}
(mV)
200
100
0
$\frac{I_C}{I_B}=10$
−50
0
50
100
150
T_j (°C)
200

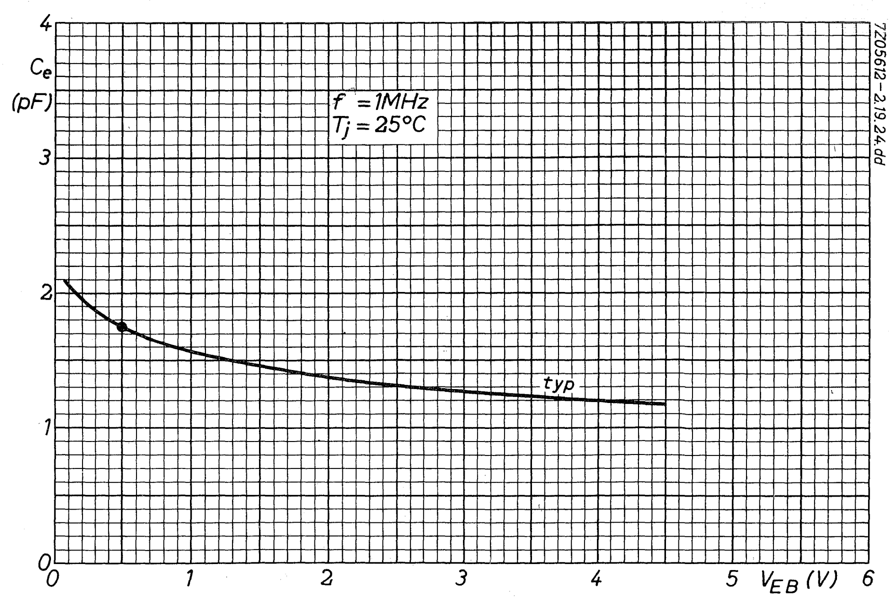

$\frac{I_C}{I_B} = 10$
$T_j = 25°C$
typ
1200
V_{BEsat}
(mV)
1000
800
600
0
20
40
60
80
I_C (mA)
100
7Z05616 – 2.19.24.dd

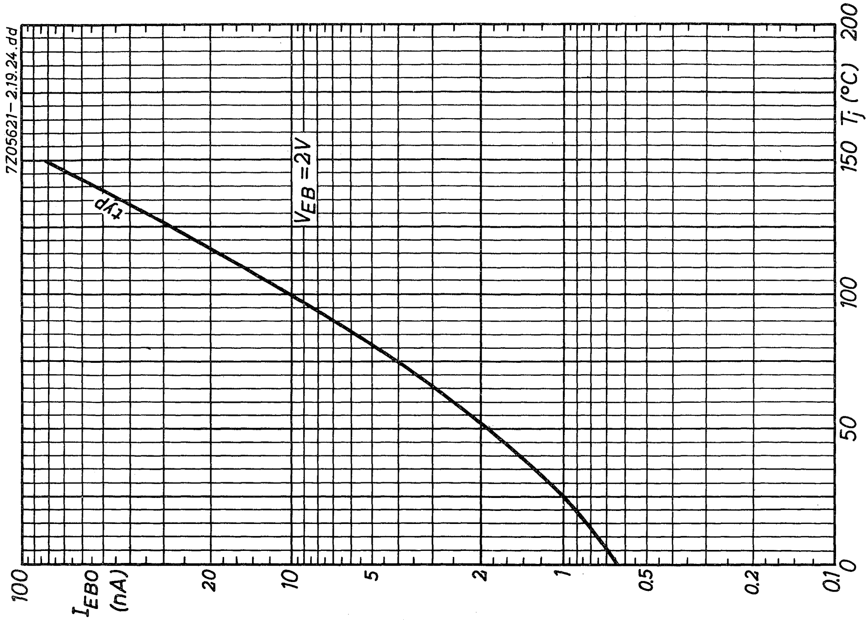

Typical values
$\frac{I_C}{I_B} = 10$
1200
V_{BEsat}
(mV)
1000
800
600
I_C = 50 mA
20 mA
10 mA
−50
0
50
100
150
T_j (°C)
200
7Z05615 – 2.19.24.dd

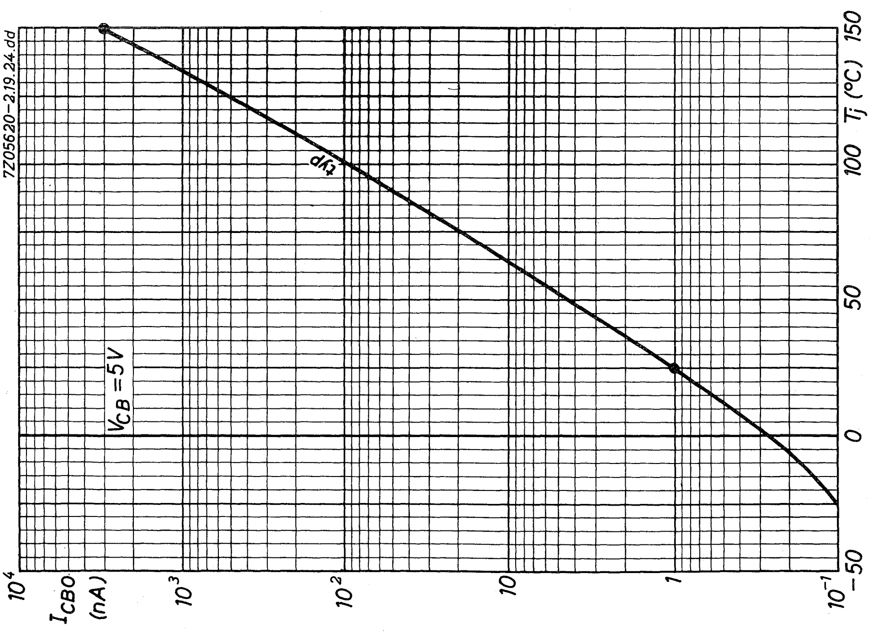

Typical values
$T_j = 25°C$
7Z05613–2.19.24.dd
1000
f_T
(MHz)
800
600
400
0
10
20
30
40
I_C (mA)
50
V_{CE}=10V
5V
2V


7Z05614–2.19.24.dd
6
t_s
(ns)
4
2
0
−50
0
50
100
150
T_j (°C)
200
typ
$I_C = I_B = -I_{BM} = 5mA$
See page 4


5
C_c
(pF)
4
3
2
1
0
f = 1MHz
T_j = 25°C
typ
0
2
4
6
8
10
12
V_{CB}(V)
14
7Z05611–2.19.24.dd


4
C_e
(pF)
3
2
1
0
f = 1MHz
T_j = 25°C
typ
0
1
2
3
4
5
V_{EB} (V)
6
7Z05612–2.19.24.dd

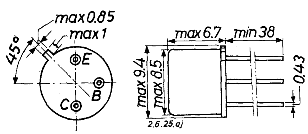

7Z05621-2.19.24.dd
$V_{EB} = 2V$
typ
I_{EBO} (nA)
100
20
10
5
2
1
0.5
0.2
0.1
0
50
100
150
200
T_j (°C)


7Z05620-2.19.24.dd
$V_{CB} = 5V$
typ
I_{CBO} (nA)
10^4
10^3
10^2
10
1
10^{-1}
−50
0
50
100
150
T_j (°C)

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

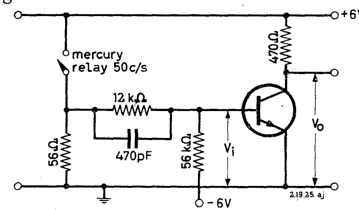
		BSY10	BSY11	
Collector leakage current at V_{CB} = 20 V; I_E = 0 mA; T_{amb} = 125 °C	I_{CBO}		< 15	μA
Collector voltage at I_C = 100 μA; I_B = 0 mA	V_{CEO}	> 30	> 25	V
I_C = 50 μA; V_{BE} = -1 V	V_{CE}	> 60	> 45	V
I_C = 50 μA; I_E = 0 mA	V_{CBO}	> 60	> 45	V
Base emitter voltage at V_{CB} = 5 V; $-I_E$ = 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 $\lvert h_{fe}\rvert$ = 1 at V_{CB} = 10 V; $-I_E$ = 5 mA	f_1	> 60		Mc/s
		= 180		Mc/s
Noise figure at V_{CB} = 10 V; $-I_E$ = 5 mA	F	= 20		dB
		< 40		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

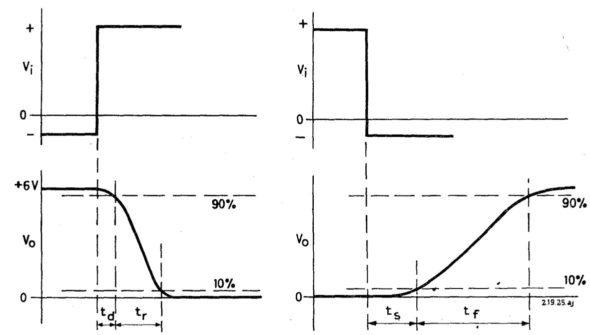
CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN
(continued)

Switching characteristics at T_{amb} = 25 °C

Measuring circuit:



Oscilloscope: C_i < 20 pF; R_i > 1 MΩ



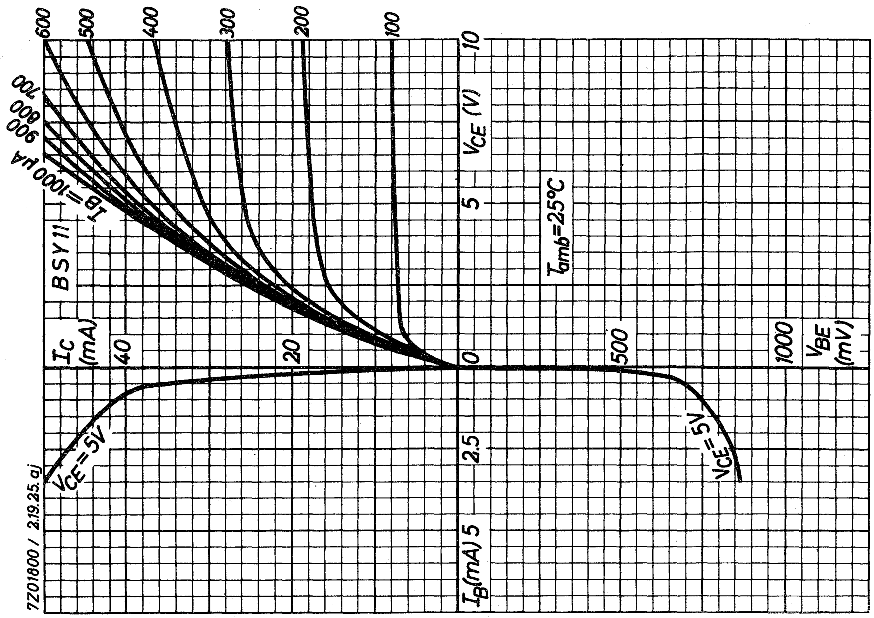
Delay time	t_d =	4.7 nsec
Rise time	t_r =	13 nsec
Storage time	t_s =	35 nsec
Fall time	t_f =	75 nsec

Turn-on time ≈ $t_d + t_r$

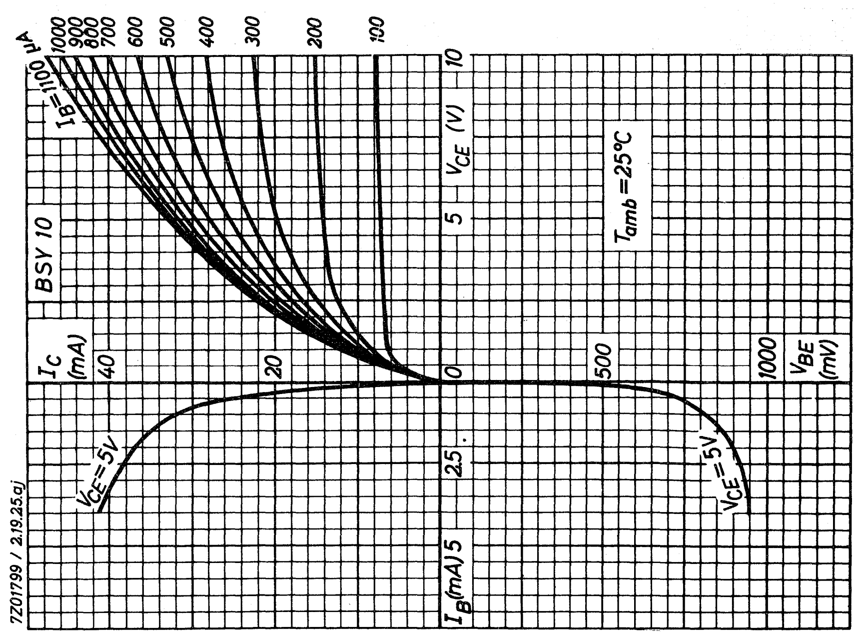
Turn-off time = $t_s + t_f$

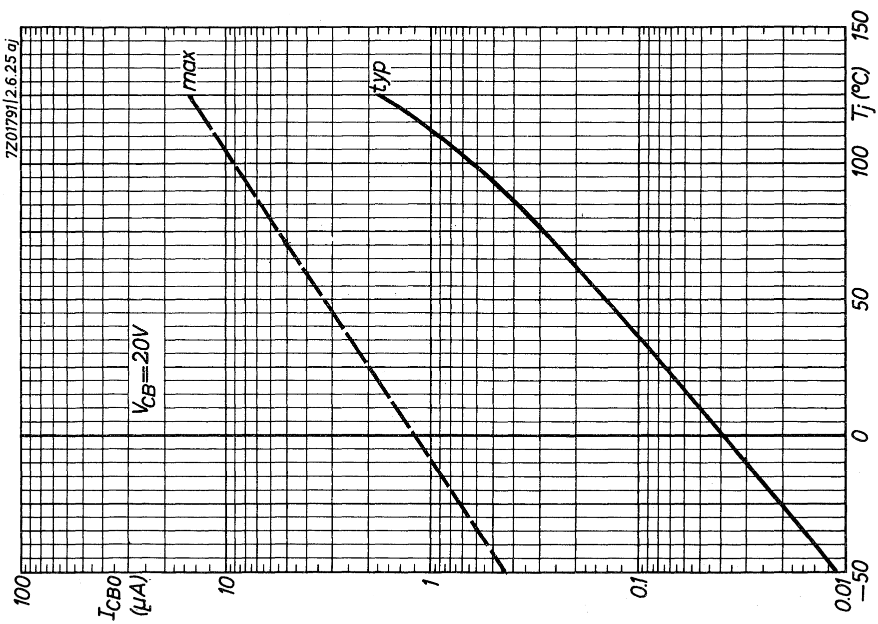
7Z2 2347

B


BSY11
I_C (mA)
V_{CE} (V)
T_{amb}=25°C
I_B=1000 µA
900
800
700
600
500
400
300
200
100
40
20
0
5
10
500
1000
V_{BE} (mV)
V_{CE}=5V
V_{CE}=5V
2.5
I_B(mA) 5
7Z01800 / 2.19.25.aj

A


BSY 10
I_C (mA)
V_{CE} (V)
T_{amb}=25°C
I_B=1100 µA
1000
900
800
700
600
500
400
300
200
100
40
20
0
5
10
500
1000
V_{BE} (mV)
V_{CE}=5V
V_{CE}=5V
2.5
I_B(mA) 5
7Z01799 / 2.19.25.aj


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

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

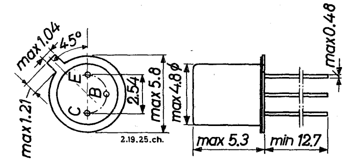
1) $-I_{BM}$ is the reverse current peak that occurs during switching off.

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 °C

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 °C unless otherwise specified

Collector current at I_E = 0 V_{CB} = 20 V; T_j = 150 °C (See also page E)	I_{CBO}	< 10 μA
Collector current at V_{BE} = 0 V_{CE} = 15 V; T_j = 55 °C	I_C	< 0.4 μA
Collector current at V_{CE} = 10 V; V_{BE} = 0.35 V T_j = 100 °C (See also pages G, H)	I_C	< 30 μA
Emitter current at I_C = 0 V_{EB} = 5 V; T_j = 150 °C	I_{EBO}	< 10 μA
Base current at V_{CE} = 15 V; $-V_{BE}$ = 3 V T_j = 55 °C (See also page F)	$-I_B$	< 0.6 μA

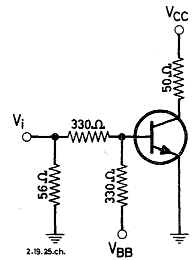
7Z2 2545

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN (continued) T_j = 25 °C 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

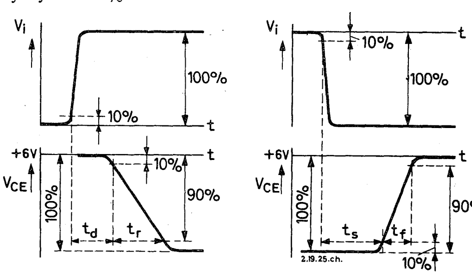
t_{on} and t_{off} circuit



V_i: rise time < 1 nsec

pulse width > 60 nsec

duty cycle = 2%



7Z2 2546

SWITCHING CHARACTERISTICS (continued)

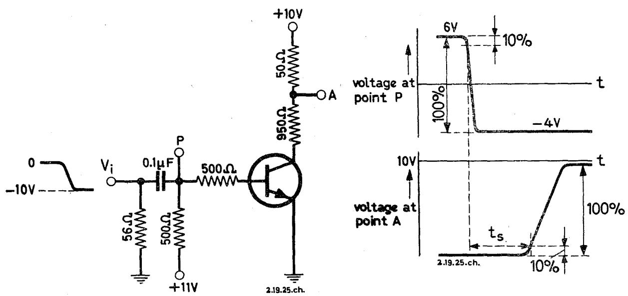
Turn on time (see figure page 4 and page X)

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)



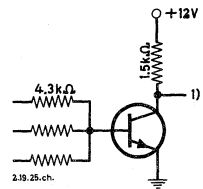
$I_C = I_B = -I_{BM}$ = 10 mA t_s = 8 nsec < 16 nsec

$-I_{BM}$ 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

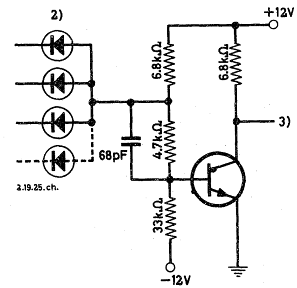
TYPICAL PULSE CIRCUITS

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.

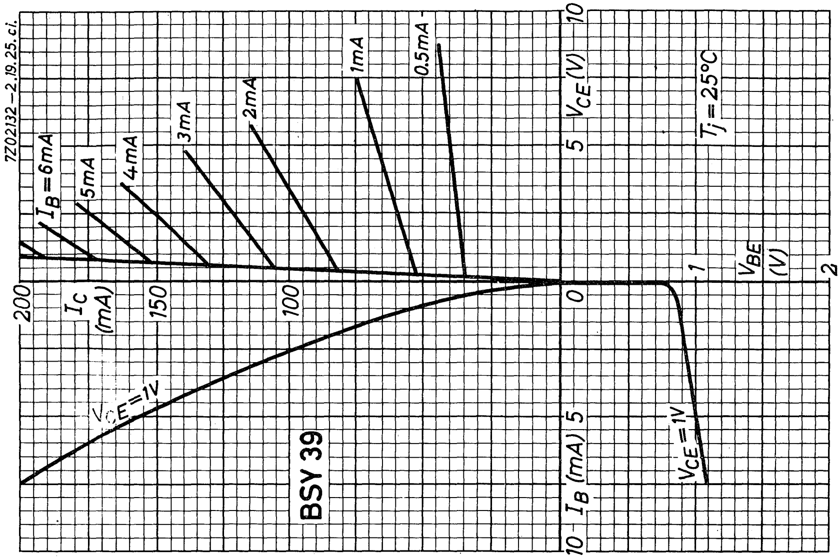
---

1) fan in = fan out = 3

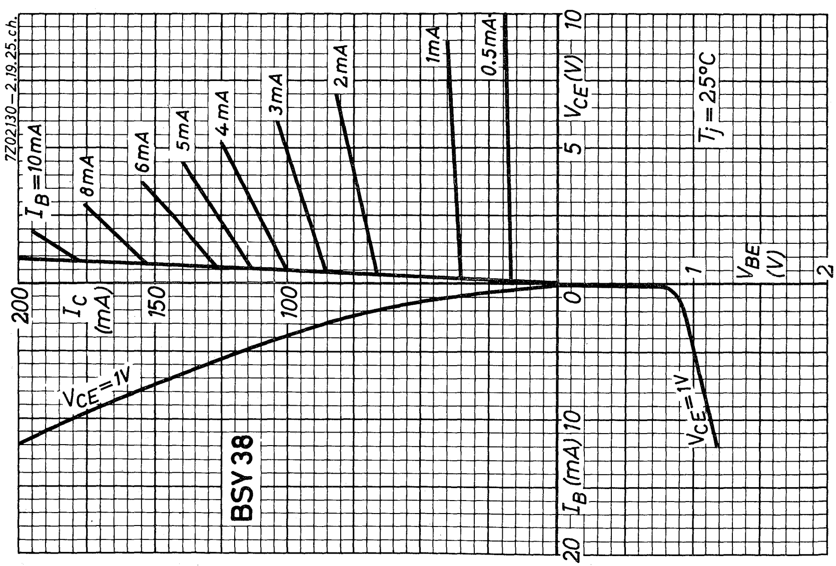
2) fast silicon epitaxial logic diodes; fan in = 10

3) fan out for BSY38 = 5; fan out for BSY39 = 7

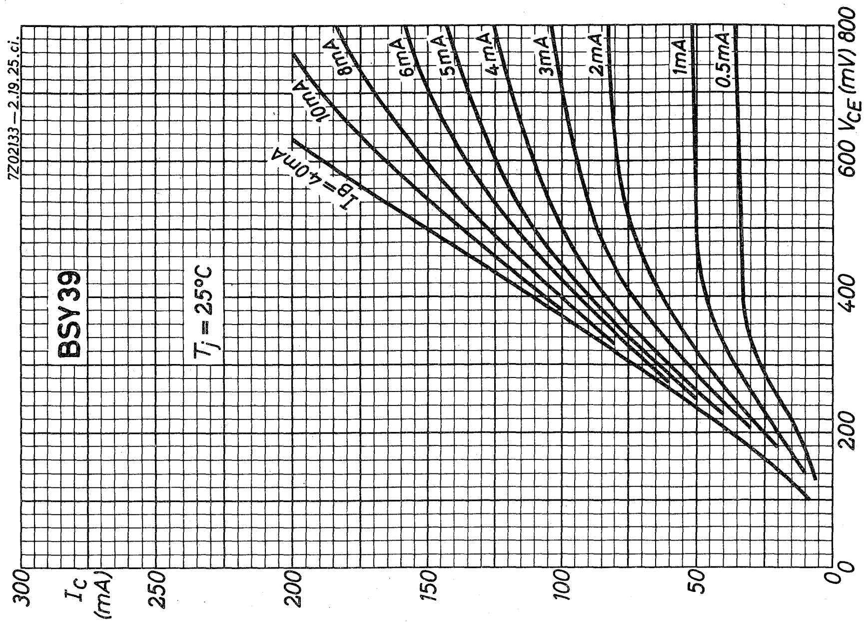
7Z2 2548


7Z02132–2.19.25.cl.
I_B=6mA
5mA
4mA
3mA
2mA
1mA
0.5mA
V_{CE}(V)
T_j=25°C
V_{BE} (V)
I_C (mA)
V_{CE}=1V
BSY 39
I_B (mA)
V_{CE}=1V

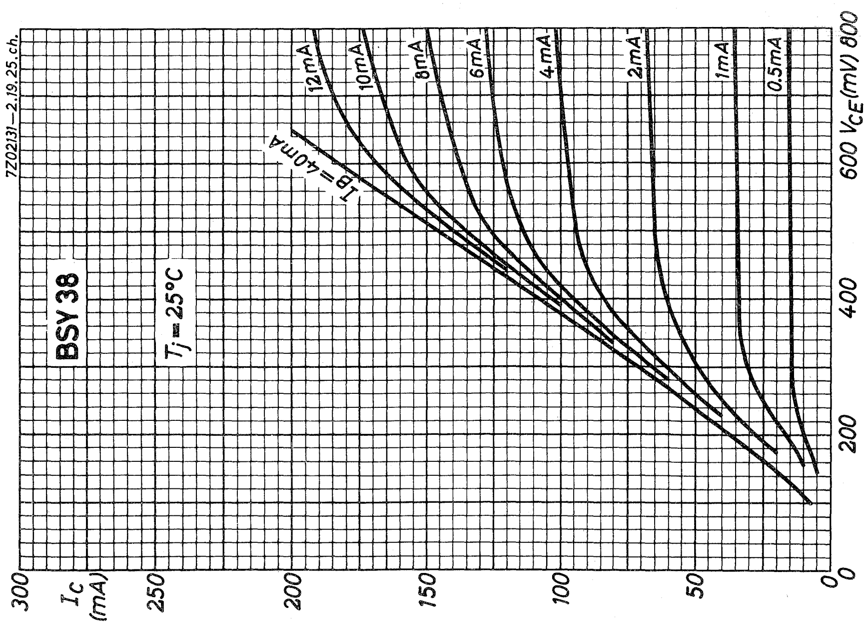
B


7Z02130–2.19.25.ch.
I_B=10mA
8mA
6mA
5mA
4mA
3mA
2mA
1mA
0.5mA
V_{CE}(V)
T_j=25°C
V_{BE} (V)
I_C (mA)
V_{CE}=1V
BSY 38
I_B (mA)
V_{CE}=1V

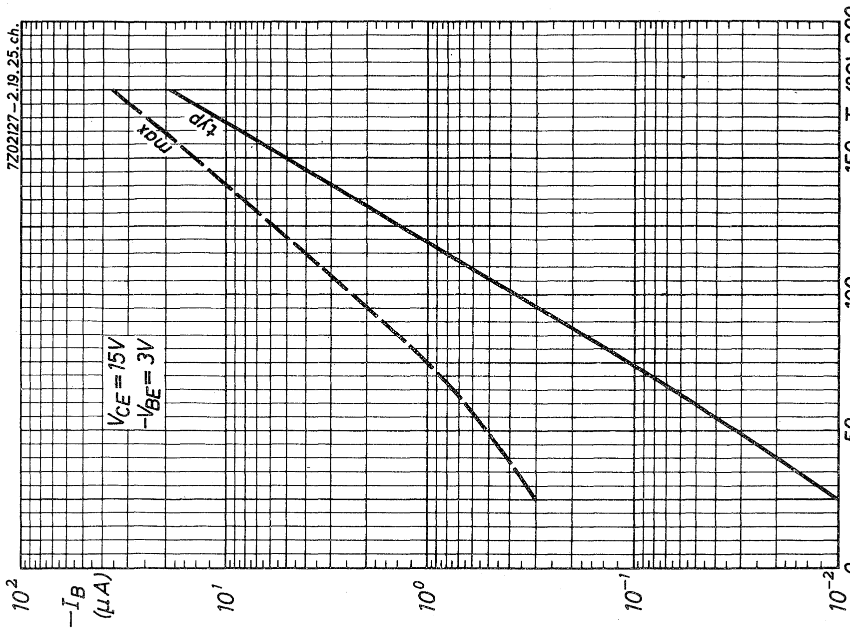
A


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

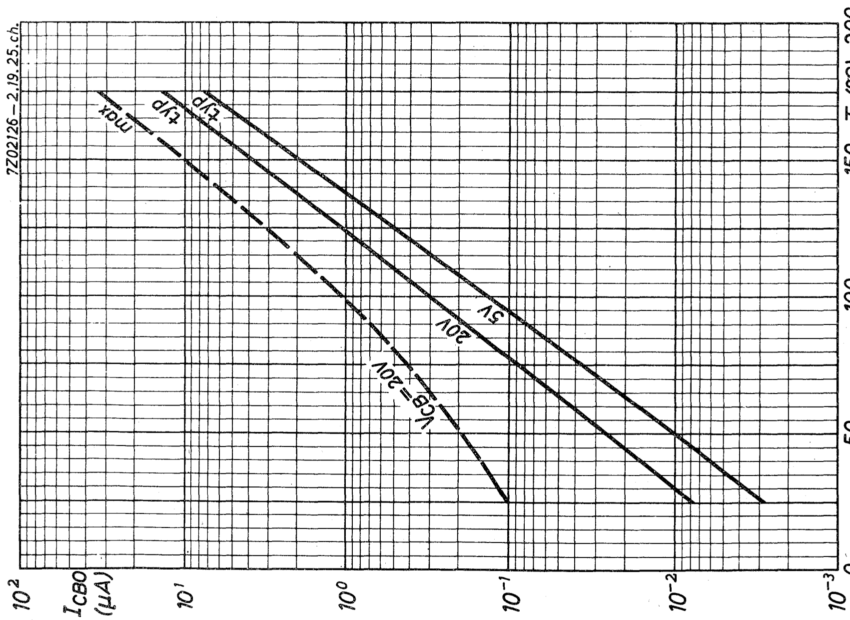
D


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

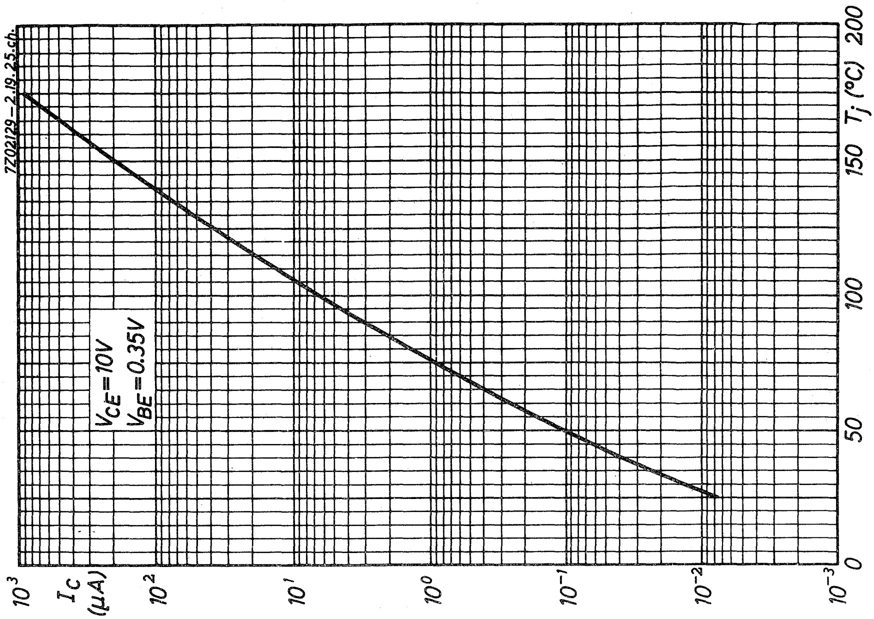
C


7Z02127–2.19.25.ch.
typ
max
V_{CE} = 15V
$-V_{BE}$ = 3V
$-I_B$ (μA)
10^2
10^1
10^0
10^{-1}
10^{-2}
T_j (°C)
0
50
100
150
200

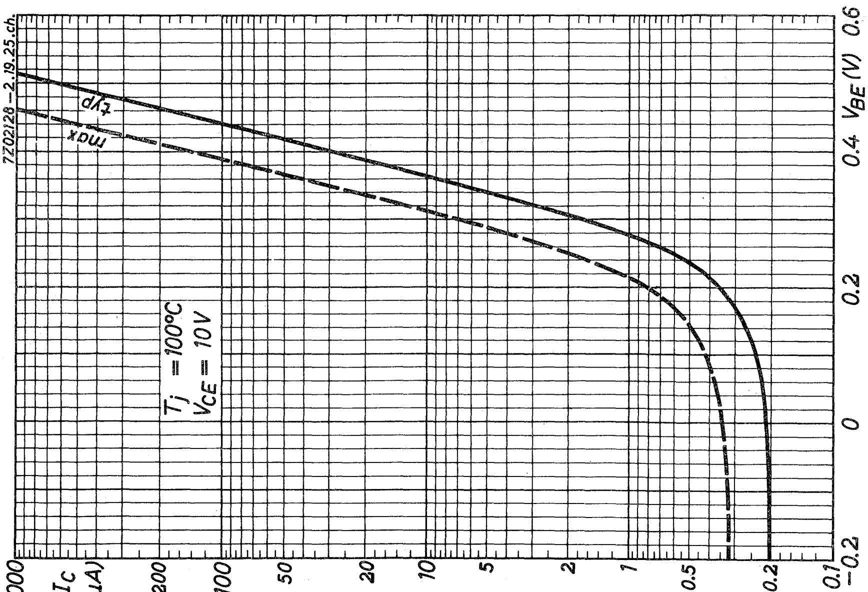
F


7Z02126–2.19.25.ch.
max
typ
typ
5V
20V
V_{CB} = 20V
I_{CBO} (μA)
10^2
10^1
10^0
10^{-1}
10^{-2}
10^{-3}
T_j (°C)
0
50
100
150
200

E

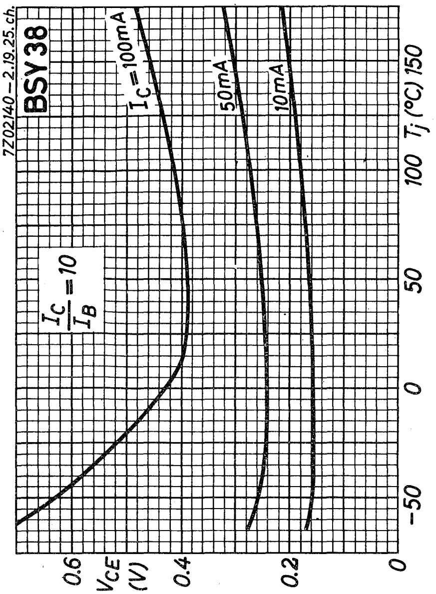


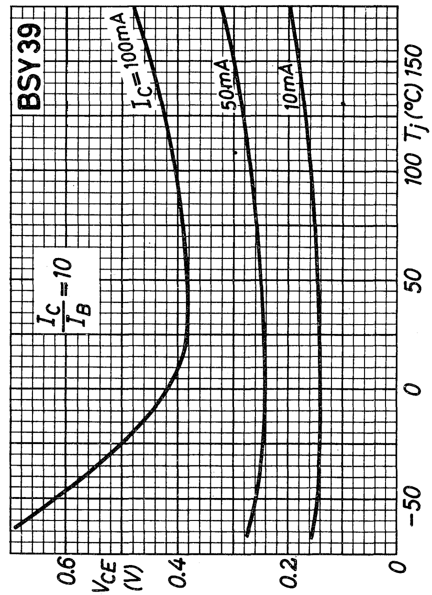
H

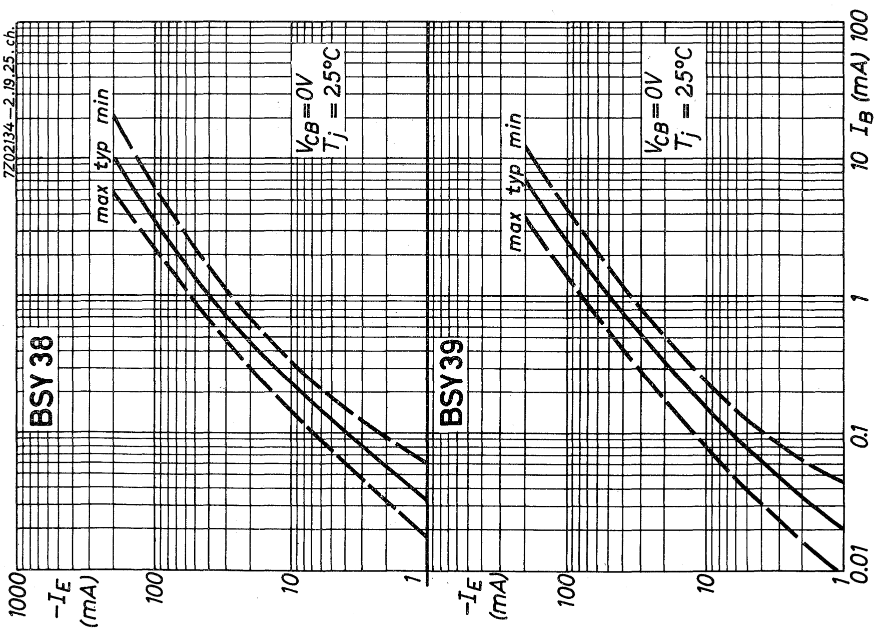


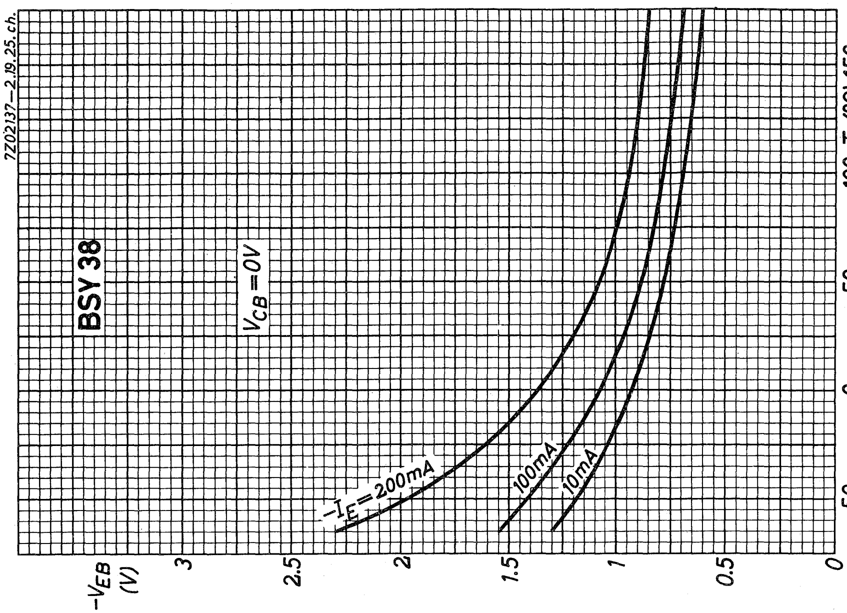
G

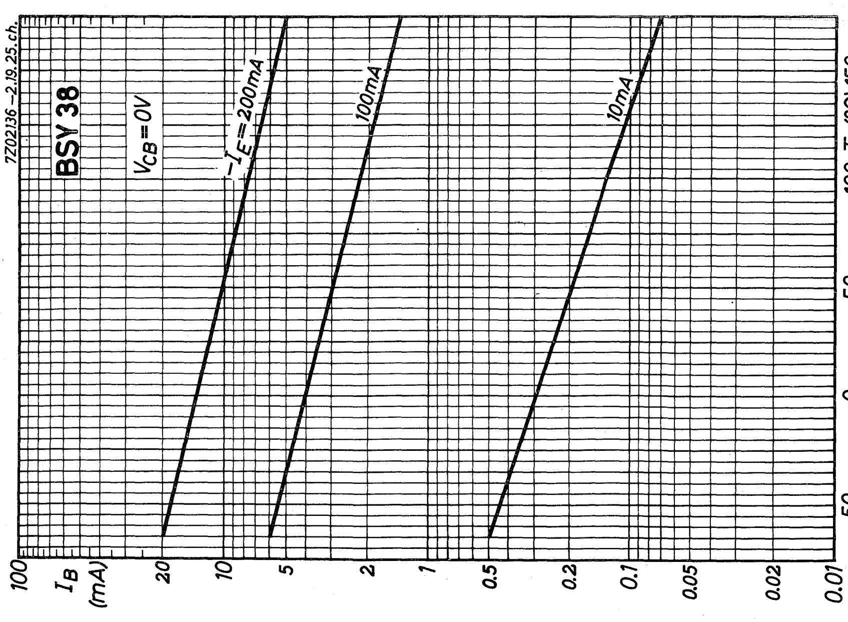
TENTATIVE DATA

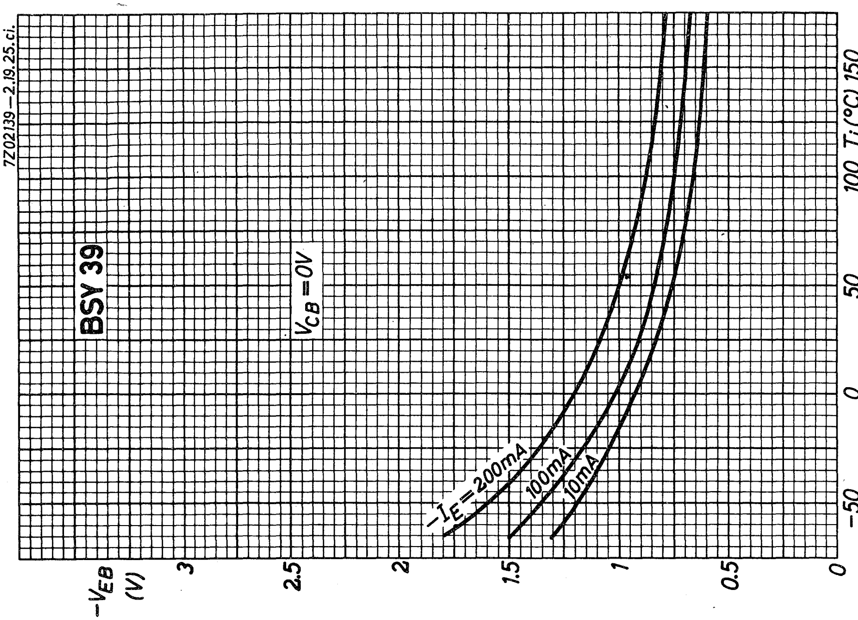

7Z02140—2.19.25.ch.
BSY38
I_C=100mA
50mA
10mA
$\frac{I_C}{I_B}=10$
V_{CE} (V)
0.6
0.4
0.2
0
−50
0
50
100
150
T_j (°C)


BSY39
I_C=100mA
50mA
10mA
$\frac{I_C}{I_B}=10$
V_{CE} (V)
0.6
0.4
0.2
0
−50
0
50
100
150
T_j (°C)

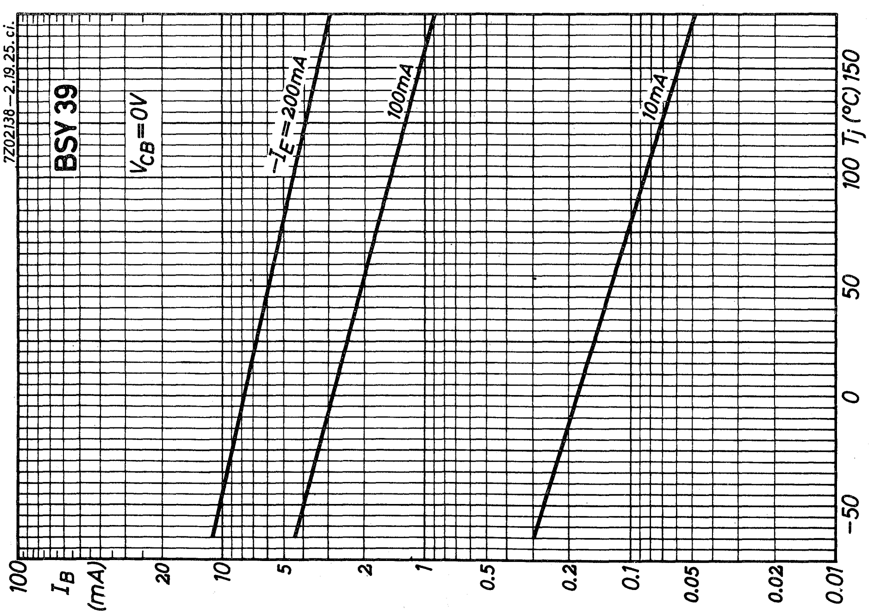

7Z02134—2.19.25.ch.
BSY38
BSY39
max
typ
min
V_{CB}=0V
T_j = 25°C
$-I_E$ (mA)
1000
100
10
1
0.01
0.1
1
10
100
I_B (mA)


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

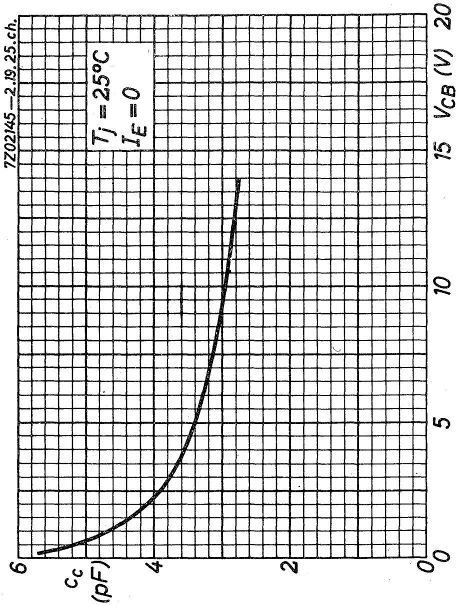

7Z02136—2.19.25.ch.
BSY 38
V_{CB}=0V
$-I_E$=200mA
100mA
10mA
100
I_B (mA)
20
10
5
2
1
0.5
0.2
0.1
0.05
0.02
0.01
−50
0
50
100 T_j (°C) 150

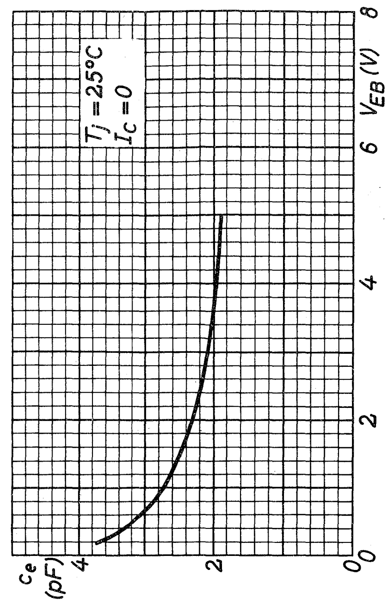

7Z02139—2.19.25.ci.
BSY 39
V_{CB}=0V
$-I_E$=200mA
100mA
10mA
$-V_{EB}$
(V)
3
2.5
2
1.5
1
0.5
0
−50
0
50
100 T_j (°C) 150

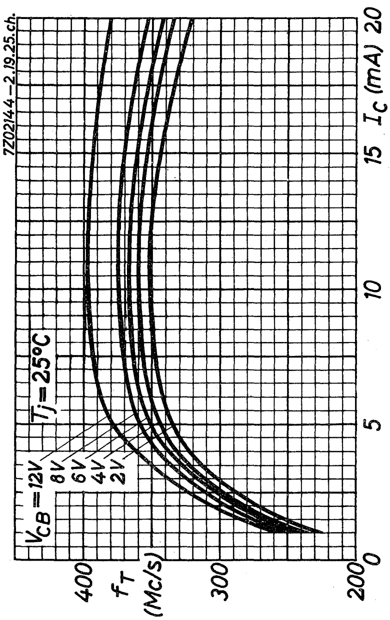
N

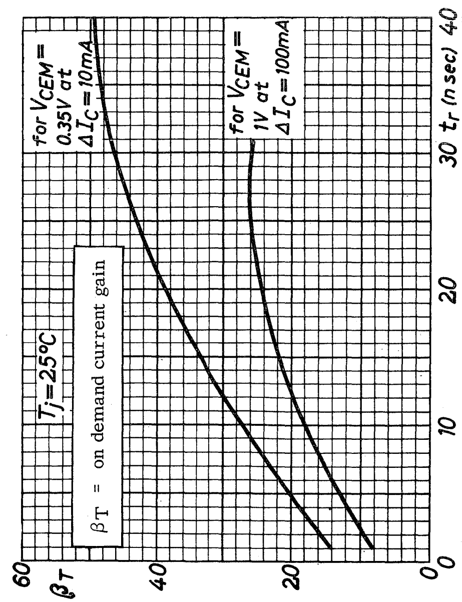

7Z02138—2.19.25.ci.
BSY 39
V_{CB}=0V
$-I_E$=200mA
100mA
10mA
100
I_B
(mA)
20
10
5
2
1
0.5
0.2
0.1
0.05
0.02
0.01
−50
0
50
100 T_j (°C) 150

M


7Z02145—2.19.25.ch.
$T_j = 25°C$
$I_E = 0$
C_c (pF)
6
4
2
0
0
5
10
15
20
V_{CB} (V)

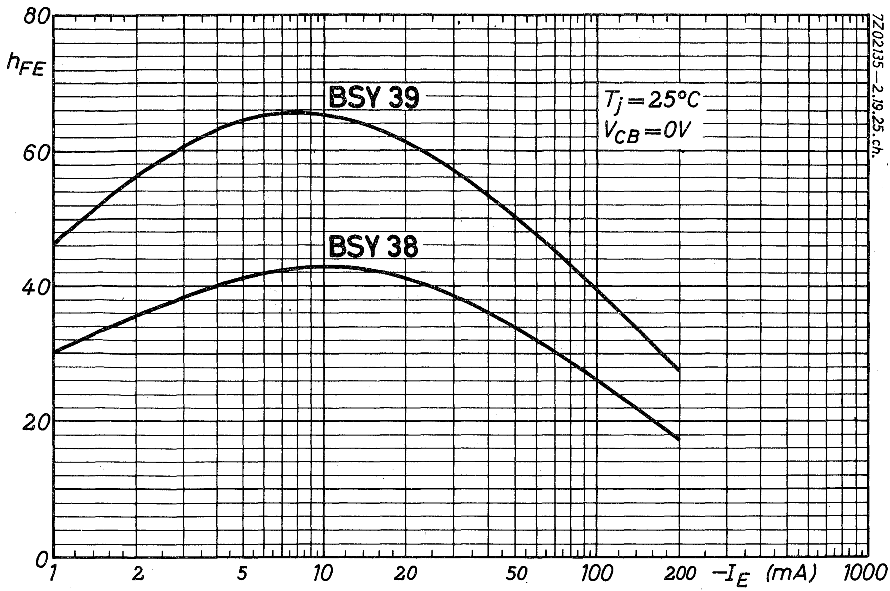

$T_j = 25°C$
$I_C = 0$
C_e (pF)
4
2
0
0
2
4
6
8
V_{EB} (V)


7Z02144—2.19.25.ch.
$T_j = 25°C$
$V_{CB} = 12V$
8V
6V
4V
2V
f_T (Mc/s)
400
300
200
0
5
10
15
20
I_C (mA)

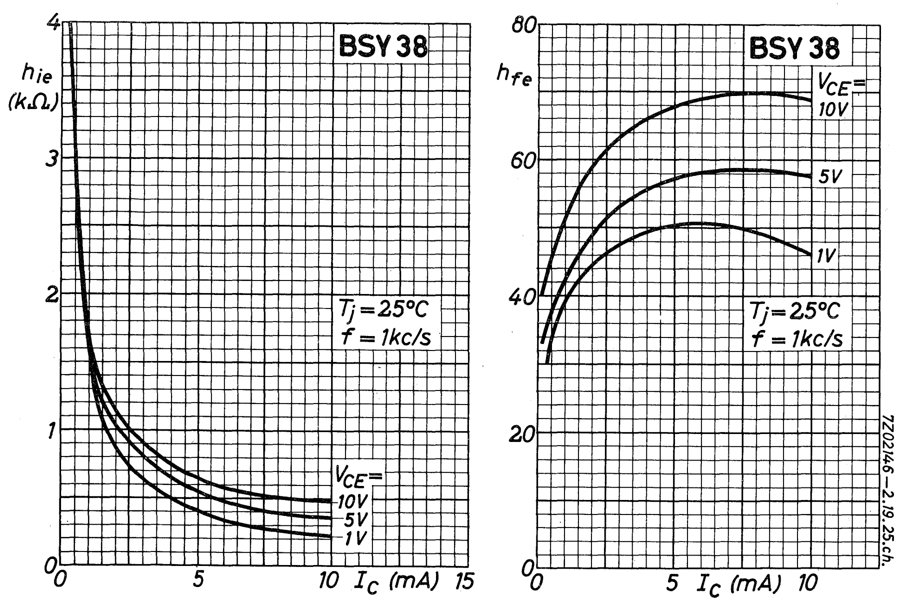

$T_j = 25°C$
β_T = on demand current gain
for V_{CEM} = 0.35V at ΔI_C = 10mA
for V_{CEM} = 1V at ΔI_C = 100mA
β_T
60
40
20
0
0
10
20
30
40
t_r (n sec)

P

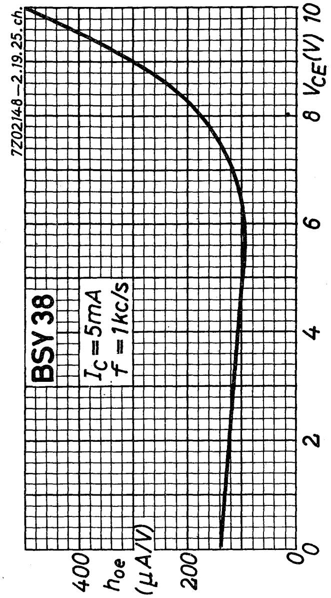
O

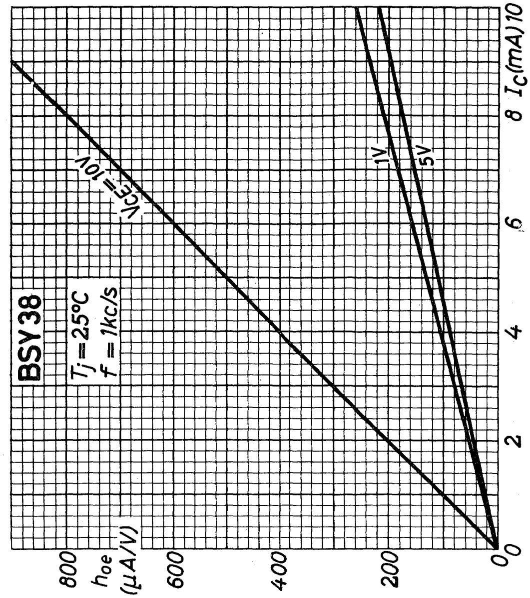

80
h_{FE}
60
40
20
0
BSY 39
BSY 38
$T_j = 25°C$
$V_{CB} = 0V$
1
2
5
10
20
50
100
200
$-I_E$ (mA)
1000
7Z02135—2.19.25.ch.

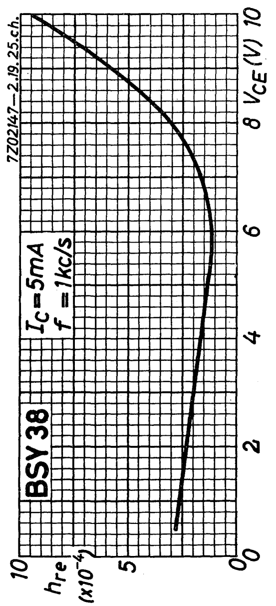
Q

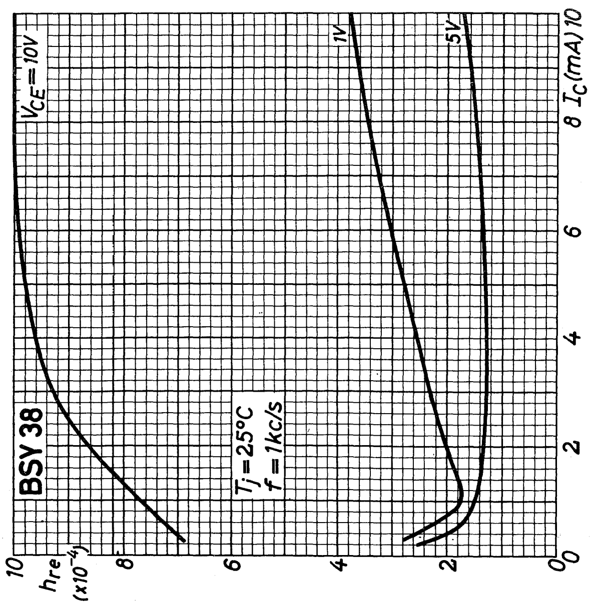

4
h_{ie}
(kΩ)
3
2
1
0
BSY 38
$T_j = 25°C$
f = 1kc/s
V_{CE} =
10V
5V
1V
0
5
10
I_C (mA)
15
80
h_{fe}
60
40
20
0
BSY 38
V_{CE} =
10V
5V
1V
$T_j = 25°C$
f = 1kc/s
0
5
I_C (mA)
10
7Z02146—2.19.25.ch.

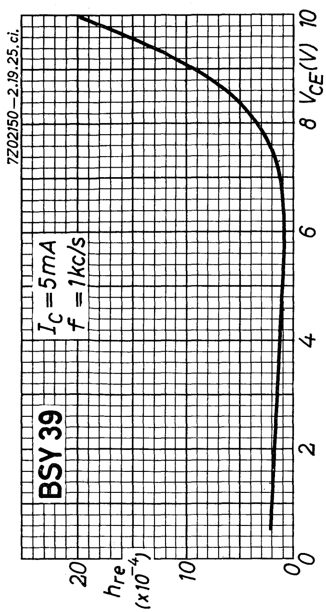
R

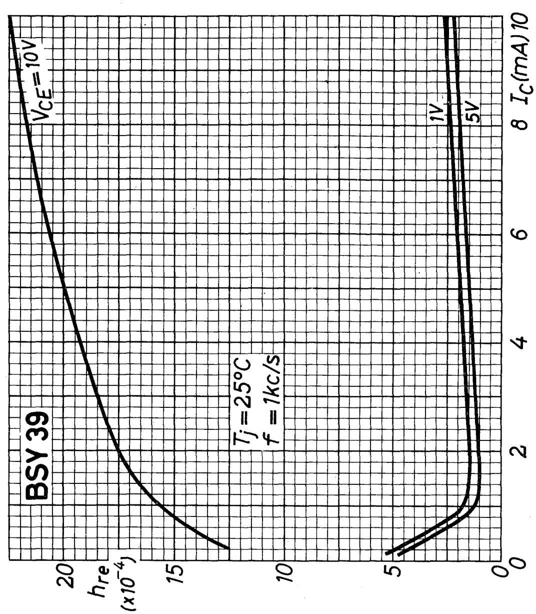

7Z02148—2.19.25.ch.
BSY 38
I_C = 5mA
f = 1kc/s
h_{oe} (μA/V)
V_{CE}(V)


BSY 38
T_j = 25°C
f = 1kc/s
h_{oe} (μA/V)
V_{CE} = 10V
1V
5V
I_C(mA)

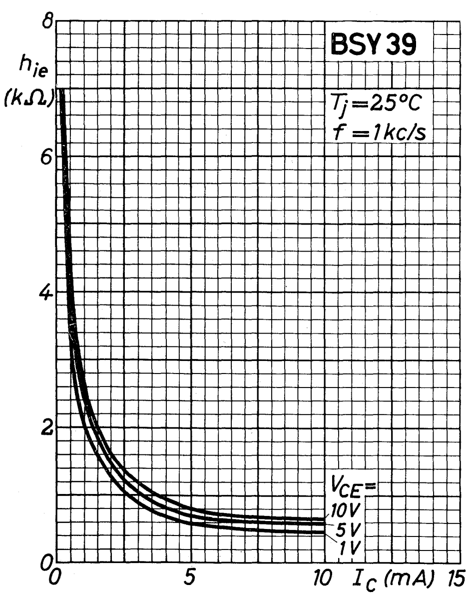

7Z02147—2.19.25.ch.
BSY 38
I_C = 5mA
f = 1kc/s
h_{re} (x10⁻⁴)
V_{CE}(V)

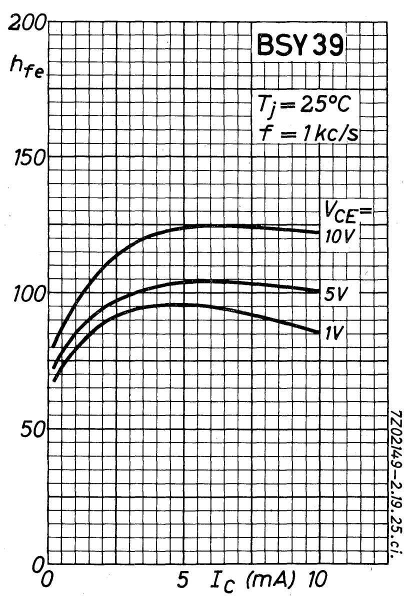

BSY 38
T_j = 25°C
f = 1kc/s
h_{re} (x10⁻⁴)
V_{CE} = 10V
1V
5V
I_C(mA)


7Z02150–2.19.25.ci.
BSY 39
I_C = 5 mA
f = 1 kc/s
V_{CE}(V)
h_{re} (x10⁻⁴)
0
2
4
6
8
10
20
10
0

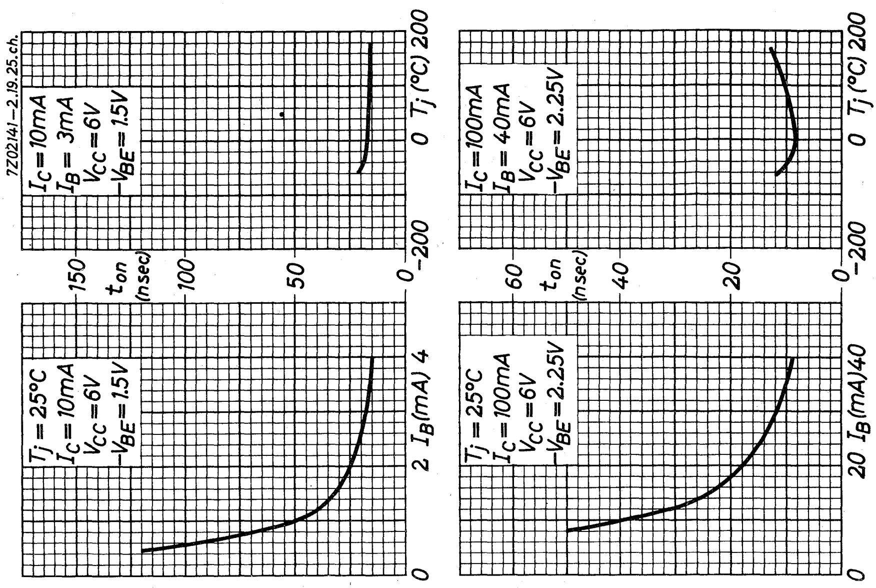

BSY 39
V_{CE} = 10 V
T_j = 25°C
f = 1 kc/s
1V
5V
I_C(mA)
h_{re} (x10⁻⁴)
20
15
10
5
0

V

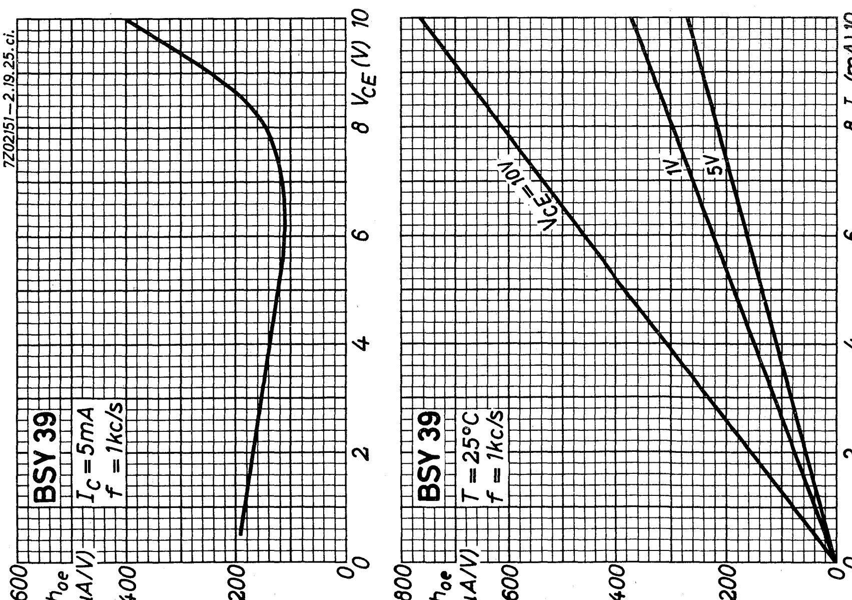

BSY 39
T_j = 25°C
f = 1 kc/s
h_{ie} (kΩ)
V_{CE} =
10 V
5 V
1 V
I_C (mA)
0
5
10
15
2
4
6
8


BSY 39
T_j = 25°C
f = 1 kc/s
h_{fe}
V_{CE} =
10 V
5 V
1 V
I_C (mA)
0
5
10
50
100
150
200
7Z02149–2.19.25.ci.

U

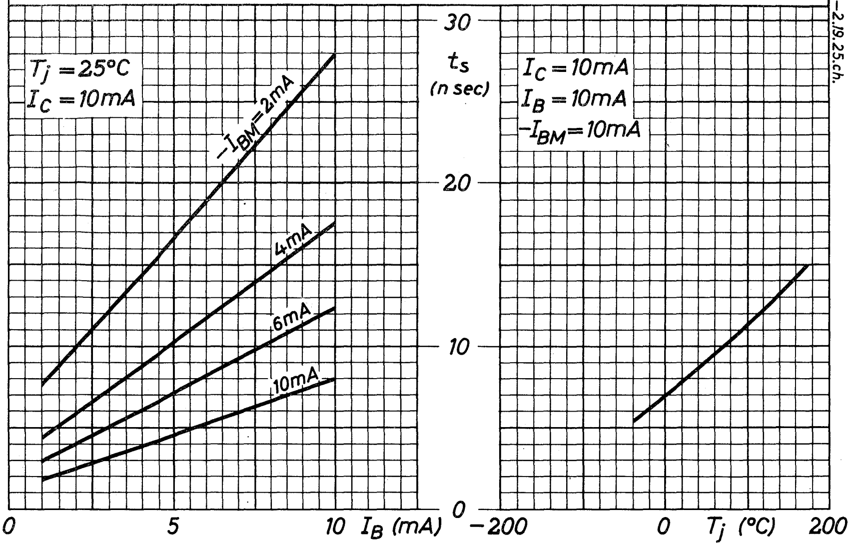

7Z02141–2.19.25.ch.
$T_j = 25°C$
$I_C = 10mA$
$V_{CC} = 6V$
$-V_{BE} = 1.5V$
t_{on} (nsec)
150
100
50
0
2 I_B (mA) 4
$I_C = 10mA$
$I_B = 3mA$
$V_{CC} = 6V$
$-V_{BE} = 1.5V$
−200
0 T_j (°C) 200
$T_j = 25°C$
$I_C = 100mA$
$V_{CC} = 6V$
$-V_{BE} = 2.25V$
60
40
20
20 I_B (mA) 40
$I_C = 100mA$
$I_B = 40mA$
$V_{CC} = 6V$
$-V_{BE} = 2.25V$

X

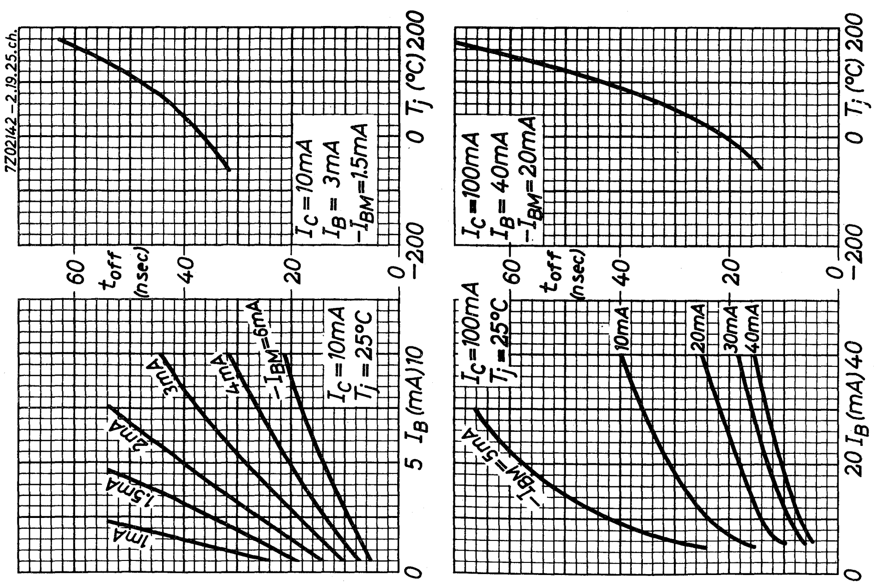

7Z02151–2.19.25.ci.
BSY 39
$I_C = 5mA$
$f = 1kc/s$
h_{oe} (μA/V)
600
400
200
0
2
4
6
8 V_{CE} (V) 10
BSY 39
T = 25°C
f = 1kc/s
800
$V_{CE} = 10V$
1V
5V
8 I_C (mA) 10

W

$-I_{BM}$ 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.



Z



Y

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)	$-V_{CE}$ (t_{av}	= max. 24 V [1] = max. 20 msec)
Peak voltage (emitter reference)	$-V_{CEM}$	= max. 32 V [1]
Voltage (base reference; averaging time = max. 20 msec)	$-V_{CB}$ (t_{av}	= max. 36 V = max. 20 msec)
Peak voltage (base reference)	$-V_{CBM}$	= max. 47 V
Current (averaging time = max. 20 msec)	$-I_C$ (t_{av}	= max. 1 A = max. 20 msec)
Peak current	$-I_{CM}$	= max. 2 A

Emitter

Reverse voltage (base reference; averaging time = max. 20 msec)	$-V_{EB}$ (t_{av}	= max. 12 V = max. 20 msec)
Peak reverse voltage	$-V_{EBM}$	= max. 15 V
Current (averaging time = max. 20 msec)	I_E (t_{av}	= max. 1.2 A = max. 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

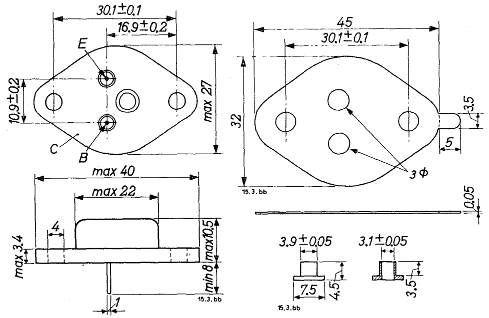
Thermal resistance from junction to transistor bottom	K	= 3 °C/W
Thermal resistance from transistor bottom to heat sink		
with mica insulation	K	= 0.5 °C/W
without insulation	K	= 0.2 °C/W

[1] See pages D and E

7Z2 1219 1.

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; $-I_C$ = 1 A) = 1.0 V < 2.0 V

D.C. current amplification factor

h_{FE} ($-V_{CE}$ = 2 V; $-I_C$ = 100 mA) = 200

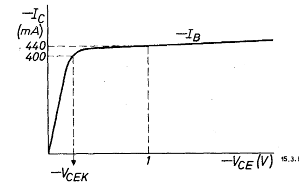
h_{FE} ($-V_{CE}$ = 2 V; $-I_C$ = 1 A) = 150 > 50

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

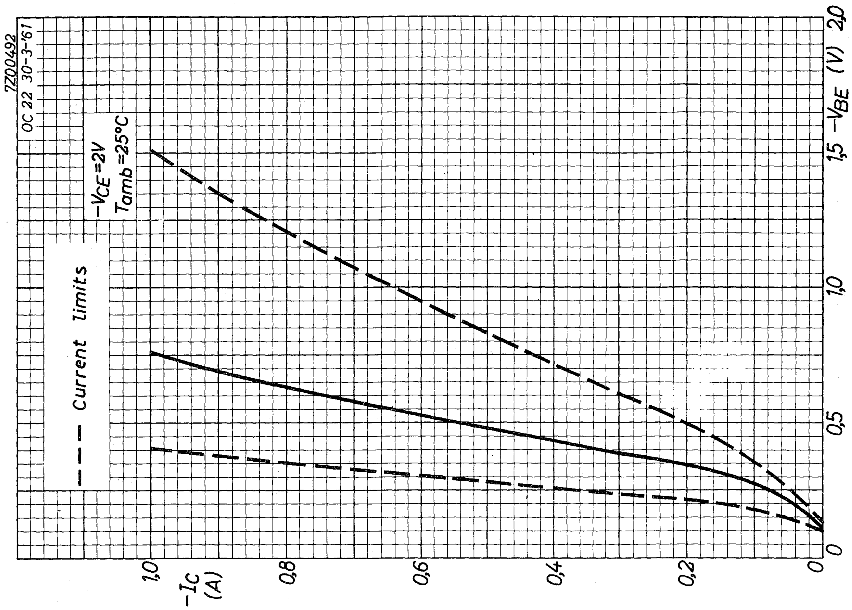


$-V_{CEK}$ = 0.4 V < 0.6 V

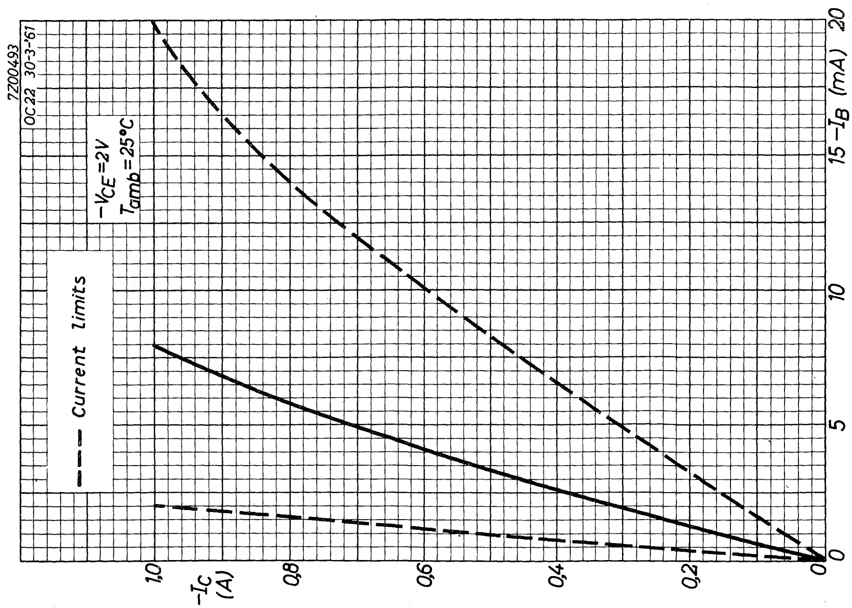
Parameters

Measured at

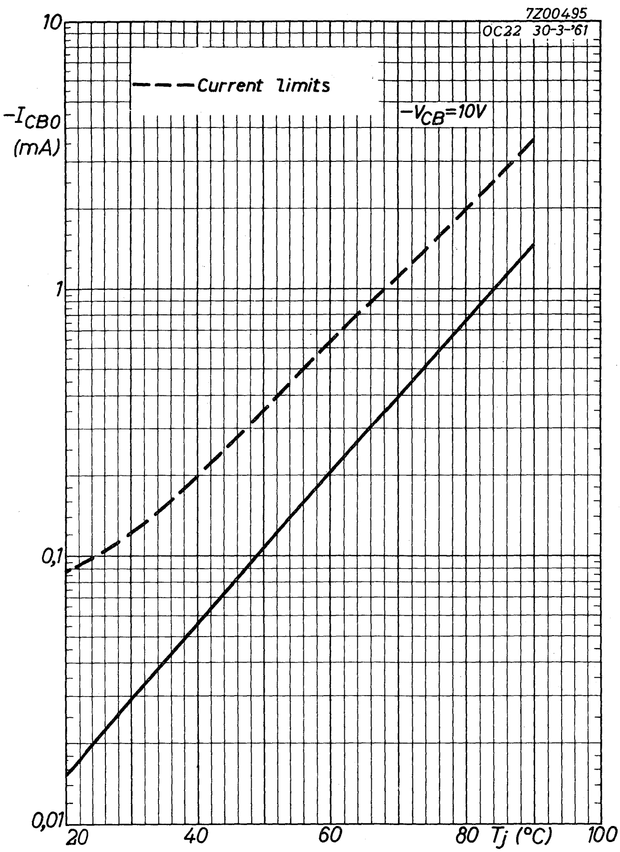
Collector voltage	$-V_{CE}$	= 2 V
Collector current	$-I_C$	= 400 mA
Transistor bottom temperature	T_m	= 25 °C
Intrinsic base resistance	$r_{bb'}$	= 100 Ω
Feedback capacitance	$c_{b'c}$	= 170 pF
Cut-off frequency	$f_{\alpha b}$	= 2.5 Mc/s
Intrinsic transconductance	g_m	= 16 A/V
Current amplification factor at low frequencies	h_{fe}	= 180


7Z00492
OC 22 30-3-'61
$-V_{CE}$=2V
T_{amb}=25°C
Current limits
$-I_C$ (A)
$-V_{BE}$ (V)
0
0,2
0,4
0,6
0,8
1,0
0,5
1,0
1,5
2,0

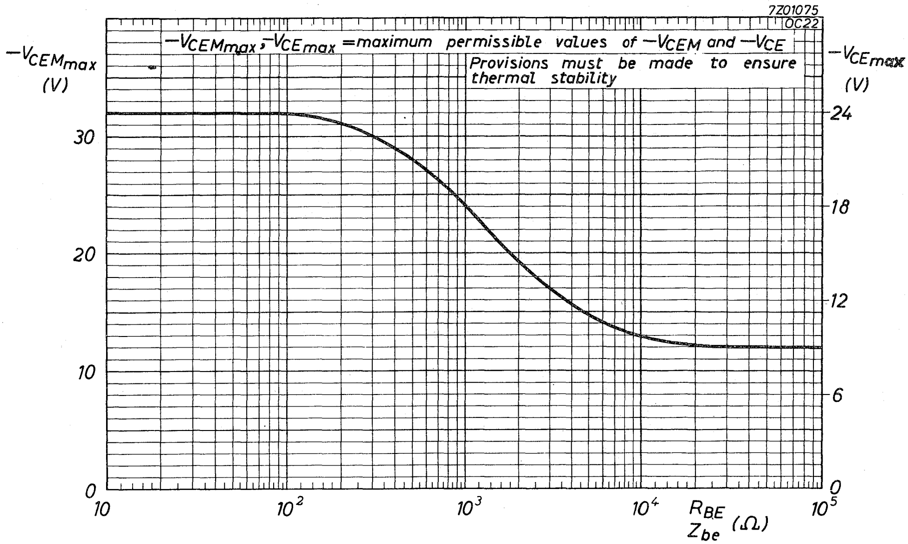
B


7Z00493
OC 22 30-3-'61
$-V_{CE}$=2V
T_{amb}=25°C
Current limits
$-I_C$ (A)
$-I_B$ (mA)
0
0,2
0,4
0,6
0,8
1,0
5
10
15
20

A

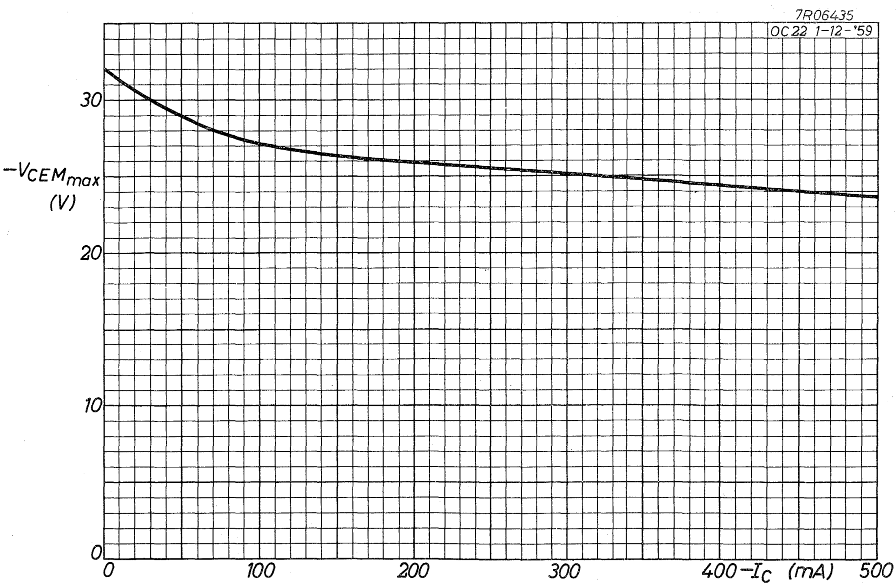

7Z00495
OC22 30-3-'61
Current limits
$-I_{CBO}$ (mA)
$-V_{CB}$=10V
10
1
0,1
0,01
20
40
60
80
100
T_j (°C)

C



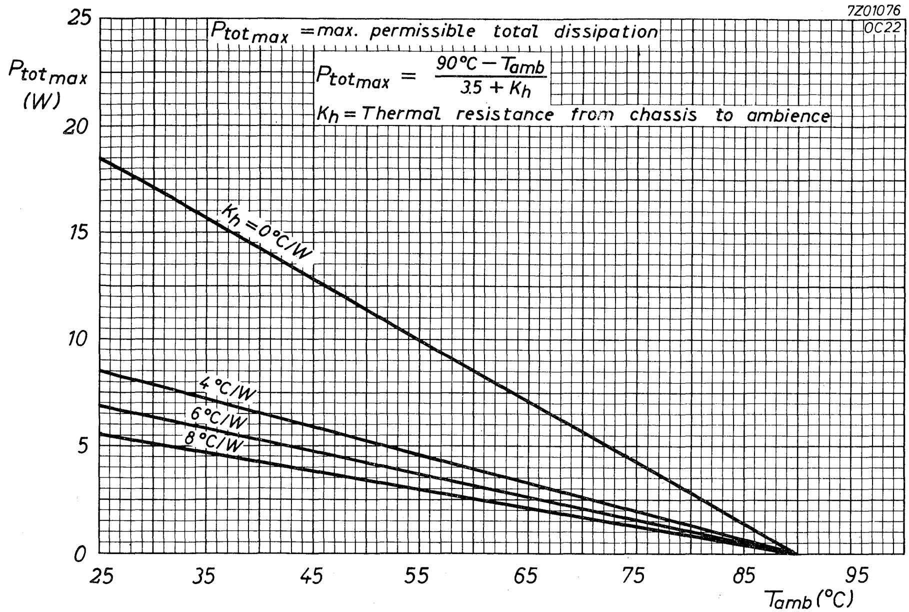
7Z01075
OC22
$-V_{CEMmax}$, $-V_{CEmax}$ = maximum permissible values of $-V_{CEM}$ and $-V_{CE}$
Provisions must be made to ensure thermal stability
$-V_{CEMmax}$ (V)
$-V_{CEmax}$ (V)
30
20
10
0
24
18
12
6
0
10
10^2
10^3
10^4
10^5
R_{BE} Z_{be} (Ω)

D

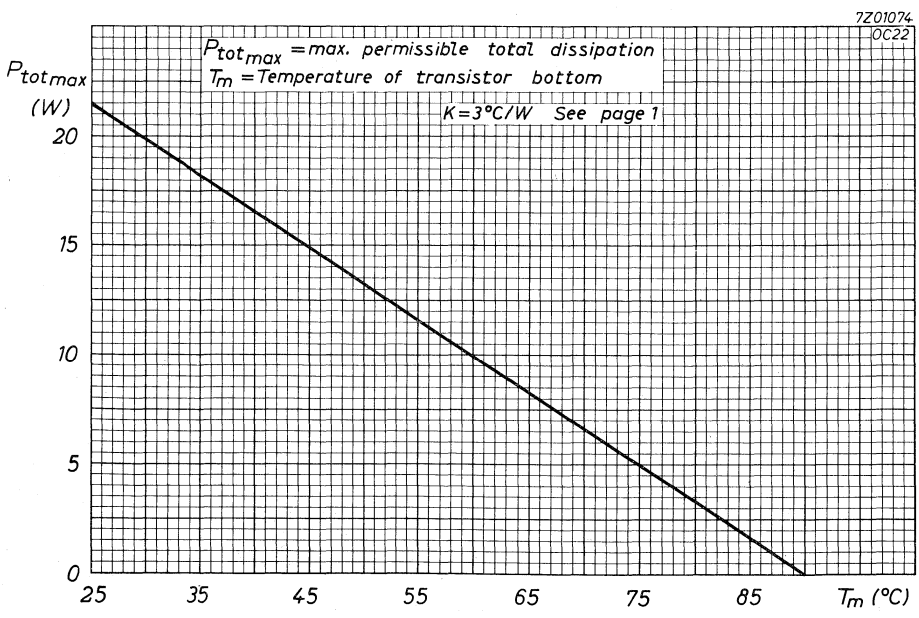


7R06435
OC 22 1-12-'59
$-V_{CEMmax}$ (V)
30
20
10
0
0
100
200
300
400
500
$-I_C$ (mA)

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)
25
20
15
10
5
0
25
35
45
55
65
75
85
95

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)
20
15
10
5
0
25
35
45
55
65
75
85
T_m (°C)

G

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)	$-V_{CE}$ (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.	55 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

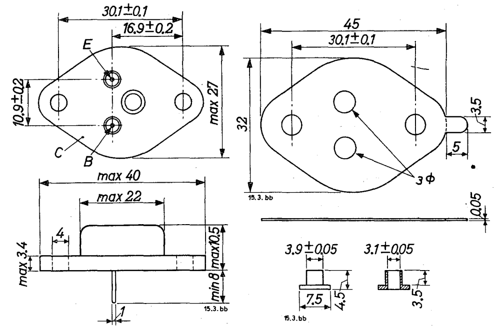
Thermal resistance from junction to transistor bottom	K	=	3 °C/W
Thermal resistance from transistor bottom to heat sink			
with mica insulation	K	=	0.5 °C/W
without insulation	K	=	0.2 °C/W

[1]) See pages D and E

7Z2 1222

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

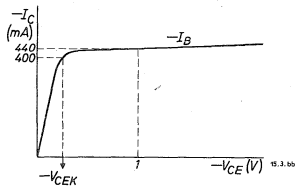
7Z2 1223

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



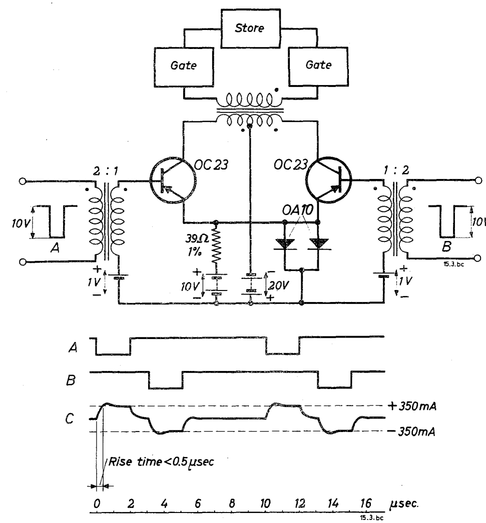
$-V_{CEK}$ = 0.35 V < 0.6 V

Parameters

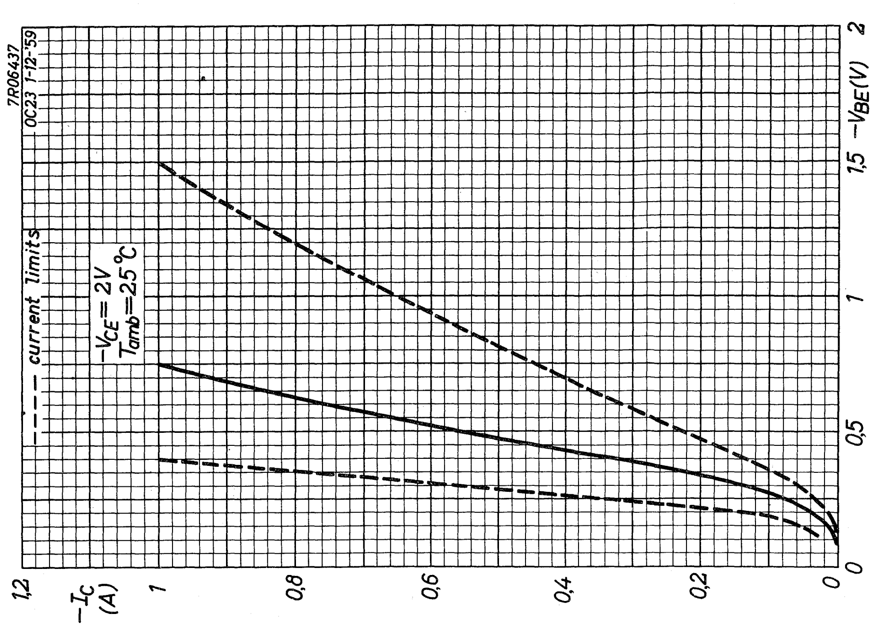
Measured at

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

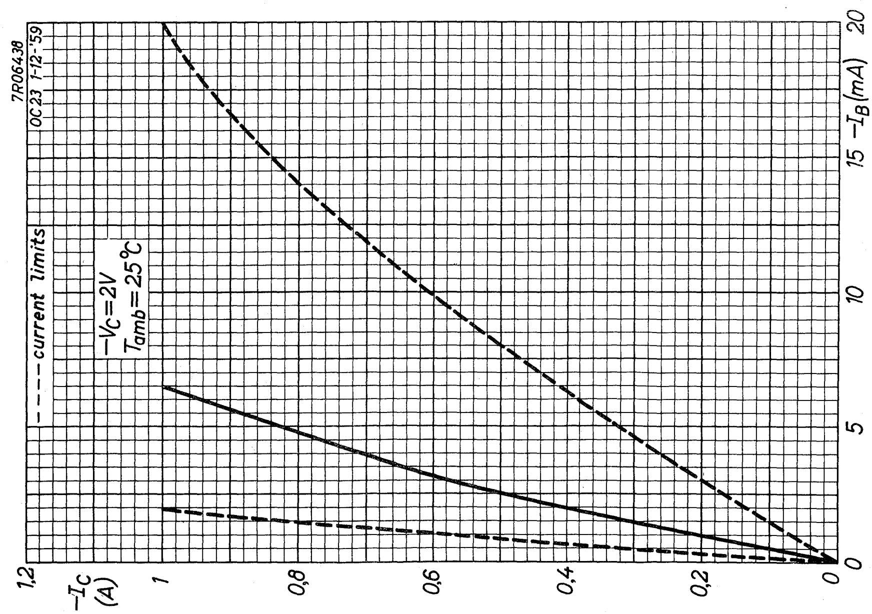
OPERATING CHARACTERISTICS for typical pulse amplifier driving a ferrite store



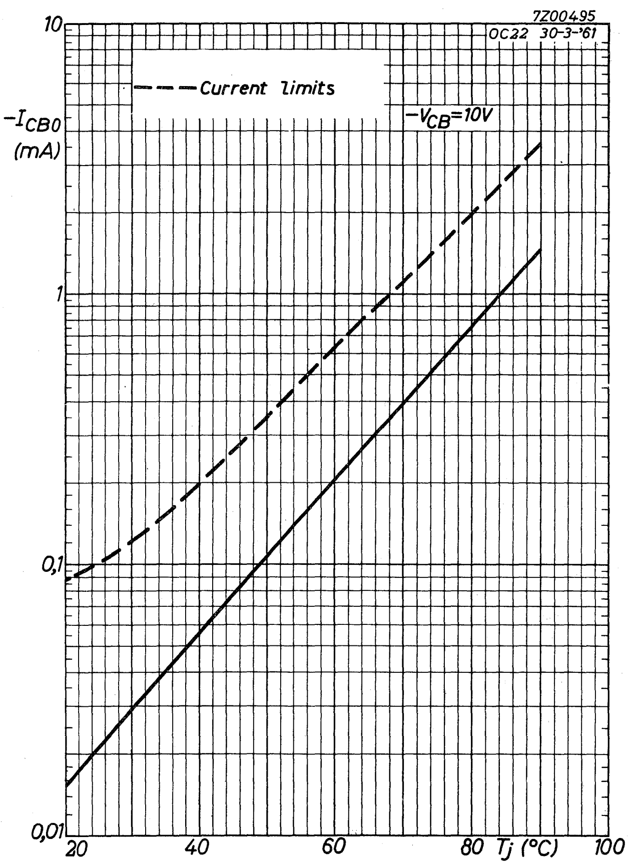
Output transformer. Three windings, each of 30 turns, wound together for minimum leakage inductance on a standard former, enclosed in a pair of ferroxcube cores FX1561


7R06437
OC23 1-12-'59
---- current limits
-VCE=2V
Tamb=25°C
-IC (A)
1,2
1
0,8
0,6
0,4
0,2
0
0,5
1
1,5
2
-VBE(V)

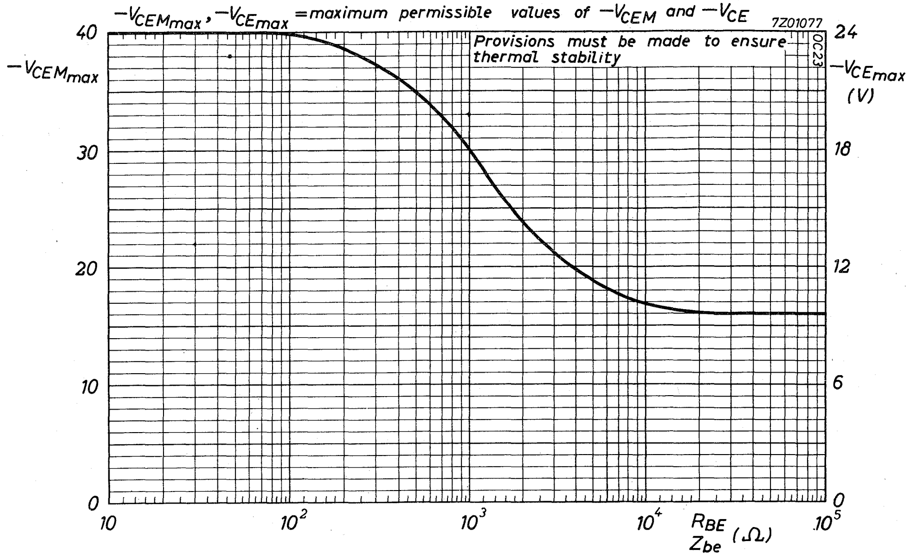
B


7R06438
OC23 1-12-'59
---- current limits
-VC=2V
Tamb=25°C
-IC (A)
1,2
1
0,8
0,6
0,4
0,2
0
5
10
15
20
-IB(mA)

A

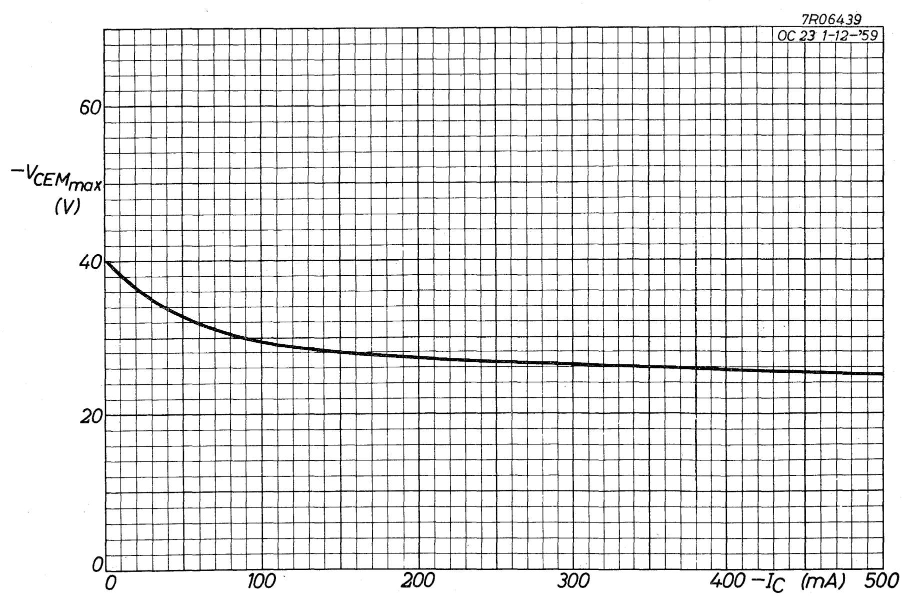

7Z00495
OC22 30-3-'61
Current limits
$-V_{CB}$=10V
$-I_{CBO}$ (mA)
10
1
0,1
0,01
20
40
60
80
100
T_j (°C)

C



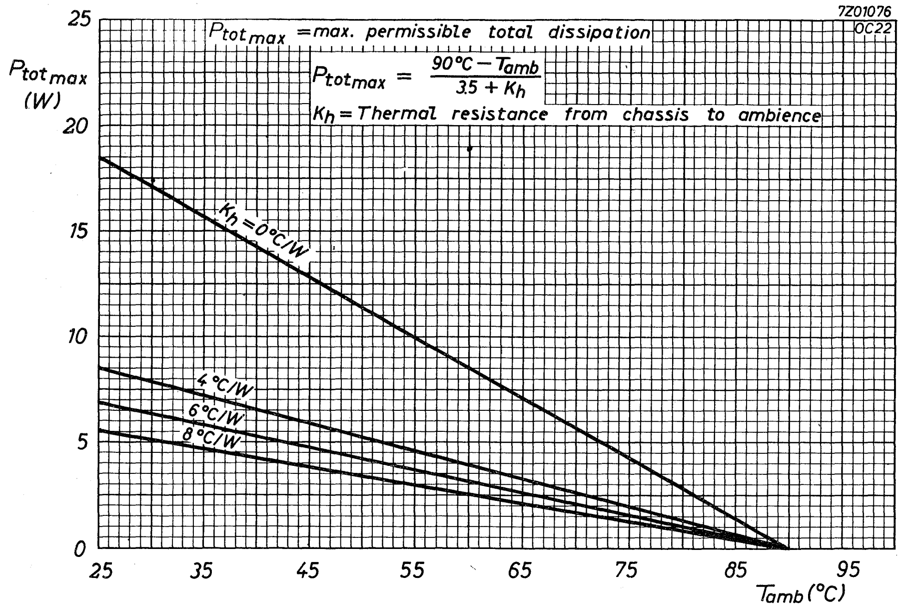
$-V_{CEMmax}$, $-V_{CEmax}$ = maximum permissible values of $-V_{CEM}$ and $-V_{CE}$
7Z01077
Provisions must be made to ensure thermal stability
OC23
40
30
20
10
0
$-V_{CEMmax}$
24
18
12
6
0
$-V_{CEmax}$ (V)
10
10^2
10^3
10^4
10^5
R_{BE} Z_{be} (Ω)

D

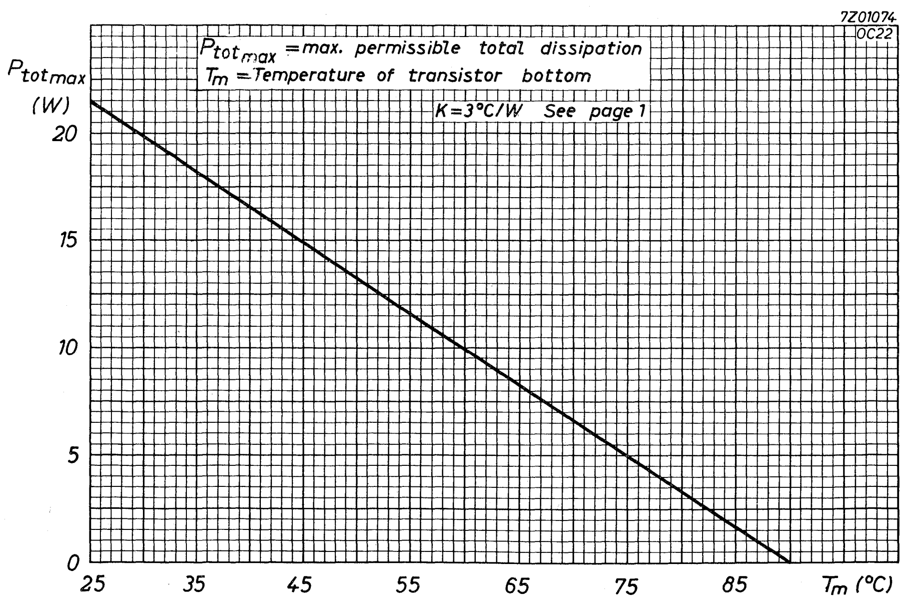


7R06439
OC 23 1-12-'59
60
40
20
0
$-V_{CEMmax}$ (V)
0
100
200
300
400
500
$-I_C$ (mA)

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)
25
20
15
10
5
0
25
35
45
55
65
75
85
95

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)
20
15
10
5
0
25
35
45
55
65
75
85
T_m (°C)

G

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

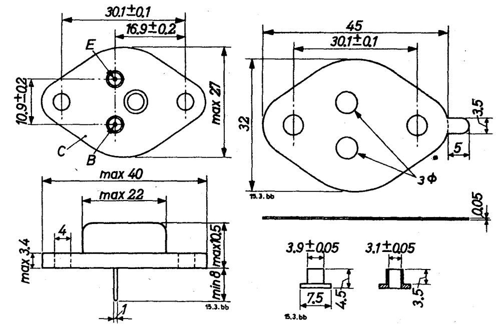
Thermal resistance from junction to transistor bottom	K	=	3 °C/W
Thermal resistance from transistor bottom to heat sink			
with mica insulation	K	=	0.5 °C/W
without insulation	K	=	0.2 °C/W

[1]) See pages D and E

7Z2 1226 1.

Dimensions in mm

Mica insulation



Insulation bush

CHARACTERISTICS at T_j = 25 °C

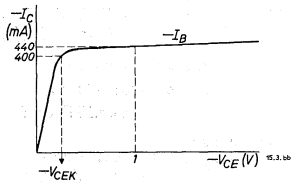
Collector current at I_E = 0 mA				
$-I_{CBO}$ ($-V_{CB}$ = 10 V; I_E = 0 mA)	=	30 µA	<	100 µA
Emitter current at I_C = 0 mA				
$-I_{EBO}$ ($-V_{EB}$ = 10 V; I_C = 0 mA)	=	20 µA	<	100 µA
Collector bottoming voltage				
$-V_{CE}$ ($-I_C$ = 1 A; $-I_B$ = 30 mA)	=	0.4 V		
Collector current				
$-I_C$ ($-V_{CE}$ = 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 2.

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

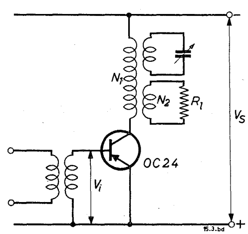
Parameters

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

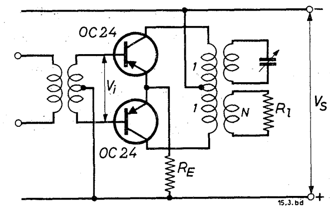
OPERATING CHARACTERISTICS as R.F. class B amplifier (continued)

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

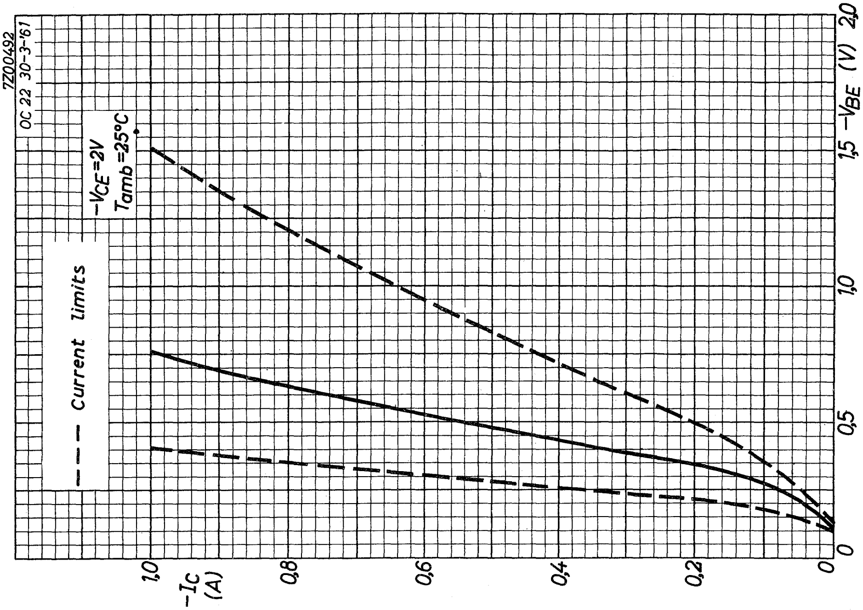
T_{amb} = 25 °C



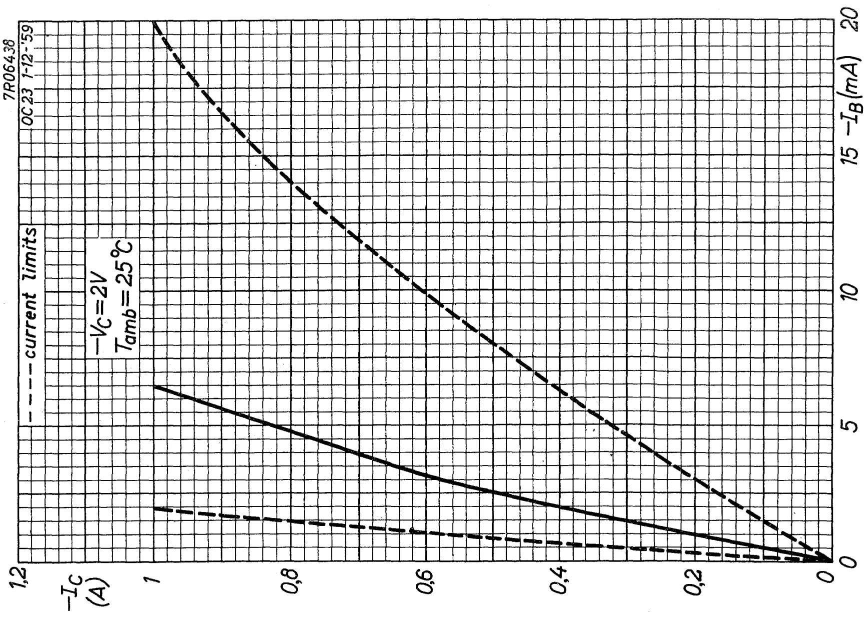
Transformer ratio (1:1):N = (1+1):2

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

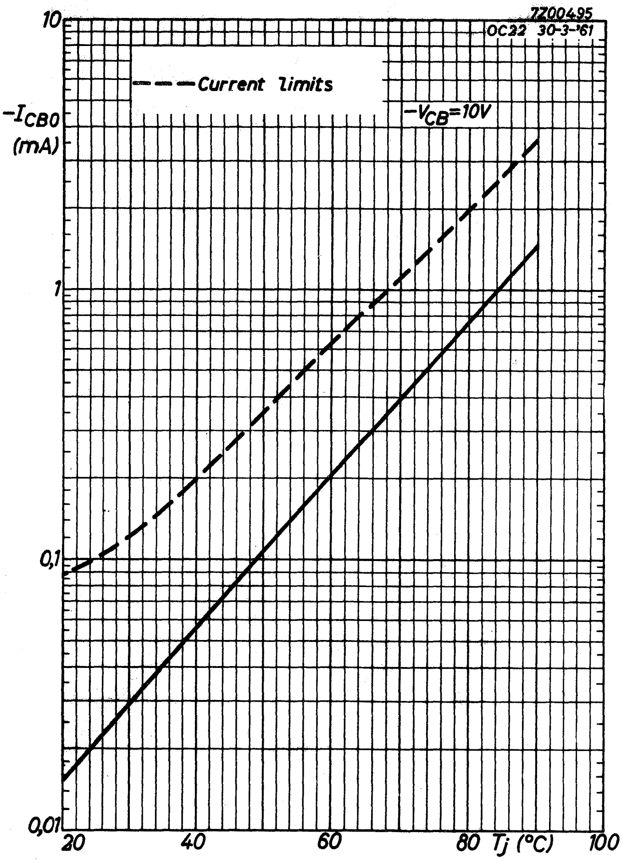
For operation up to an ambient temperature of 55 °C, the thermal resistance of each heat sink should be less than 4.5 °C/W


7Z00492
OC 22 30-3-'61
– – – current limits
$-V_{CE}$=2V
T_{amb}=25°C
$-I_C$ (A)
1,0
0,8
0,6
0,4
0,2
0
0,5
1,0
1,5
2,0
$-V_{BE}$ (V)

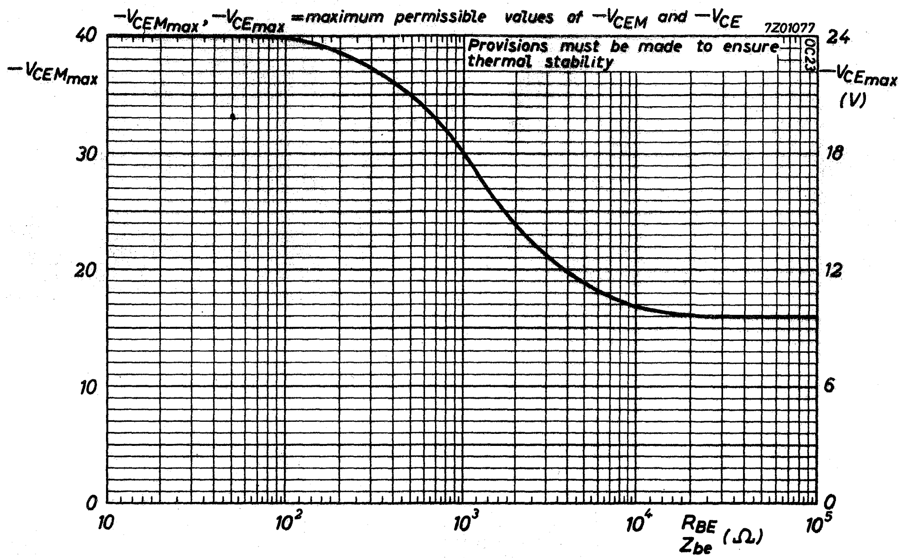
B


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)

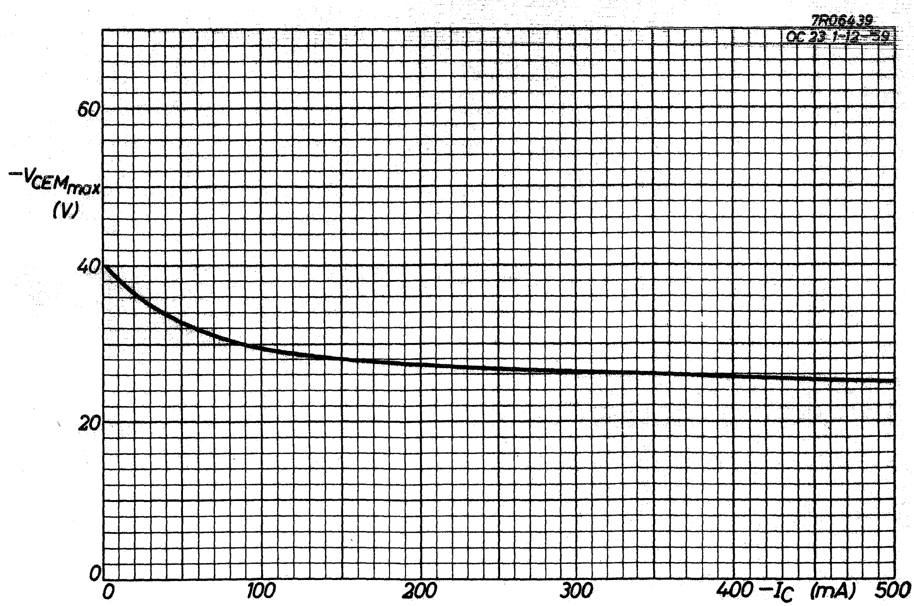
A


7Z00495
OC22 30-3-'61
Current limits
$-V_{CB}=10V$
$-I_{CBO}$ (mA)
10
1
0,1
0,01
20
40
60
80
100
T_j (°C)

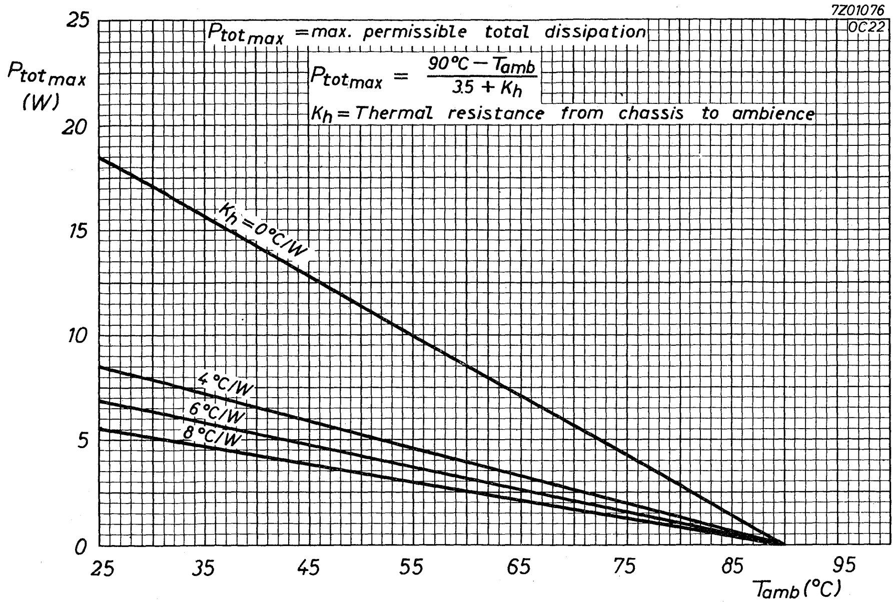
C


$-V_{CEMmax}$, $-V_{CEmax}$ = 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)

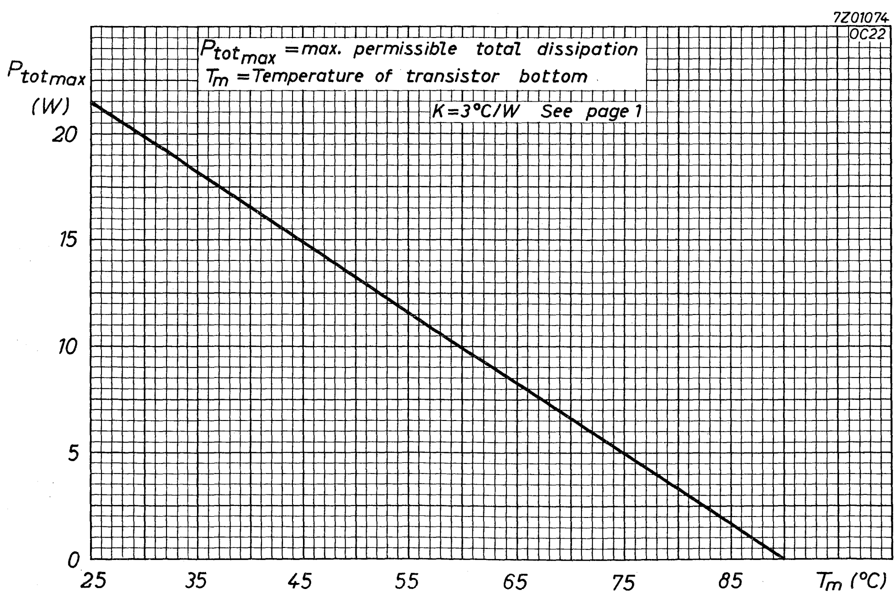
D


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
$P_{tot\,max}$ = 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)
0
5
10
15
20
25
25
35
45
55
65
75
85
95

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)
0
5
10
15
20
25
35
45
55
65
75
85

G

GERMANIUM POWER TRANSISTOR

P-N-P transistor 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.

RATINGS (Limiting values) [1])

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	40	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	20	V
Collector current	$-I_C$	max.	3.5	A
Total dissipation up to T_{mb} = 75 °C	P_{tot}	max.	12.5	W
Junction temperature	T_j	max.	90	°C

CHARACTERISTICS T_j = 25 °C

D.C. current gain

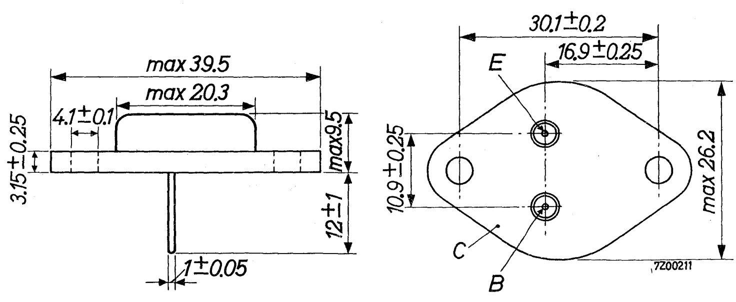
$-I_C$ = 30 mA; $-V_{CE}$ = 14 V	h_{FE}	20 to 75
$-I_C$ = 1 A; $-V_{CE}$ = 1 V	h_{FE}	20 to 55
$-I_C$ = 3 A; $-V_{CE}$ = 1 V	h_{FE}	15 to 45

Cut-off frequency

$-I_C$ = 1 A; $-V_{CE}$ = 6 V	f_{hfe}	typ.	4.5	kHz

MECHANICAL DATA Dimensions in mm

TO-3



1) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.
7Z3 0206

GERMANIUM POWER TRANSISTOR

P-N-P transistor 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.

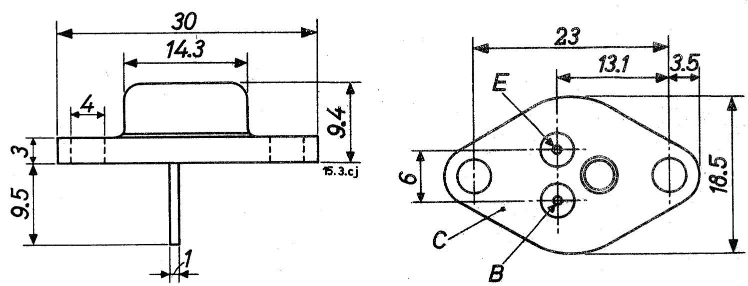
RATINGS (Limiting values) [1])

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	32	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	16	V
Collector-emitter voltage with $R_{BE} < 500\ \Omega$	$-V_{CER}$	max.	32	V
Collector current (d.c. and average)	$-I_C$	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	kHz

MECHANICAL DATA Dimensions in mm



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

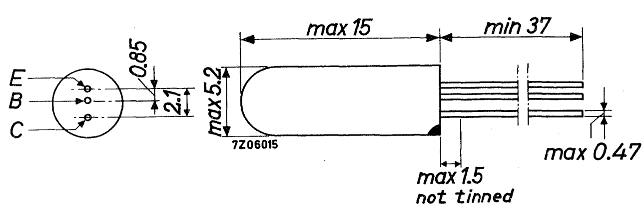
7Z3 0360

GERMANIUM H.F. TRANSISTORS

P-N-P germanium transistor in all-glass construction. It is intended primarily for converter and mixer-oscillator applications.

QUICK REFERENCE DATA					
Collector-base voltage (open emitter)		$-V_{CBO}$	max.	15	V
Collector-emitter voltage (open base)		$-V_{CEO}$	max.	5	V
Collector current (peak value)		$-I_{CM}$	max.	10	mA
Total power dissipation up to T_{amb} = 25 °C		P_{tot}	max.	85	mW
Thermal resistance from junction to ambient		$R_{th\ j\text{-}a}$	=	0.6	°C/mW
Cut-off frequency					
$-I_C$ = 1 mA; $-V_{CE}$ = 6 V	OC44	f_{hfb}	>	7.5	MHz
			typ.	15	MHz
	OC45	f_{hfb}	>	3	MHz
			typ.	12	MHz

MECHANICAL DATA Dimensions in mm



The red dot indicates the collector

7Z3 0752

RATINGS (Limiting values) [1])

Voltages

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	15	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	5	V
Collector-emitter voltage with $R_{BE} < 1.5$ kΩ	$-V_{CER}$	max.	15	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	12	V

Currents

Collector current (d.c. or average over any 20 ms period)	$-I_C$	max.	5	mA
Collector current (peak value)	$-I_{CM}$	max.	10	mA

Power dissipation

Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	85	mW

Temperatures

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

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\,j\text{-}a}$	=	0.6	°C/mW

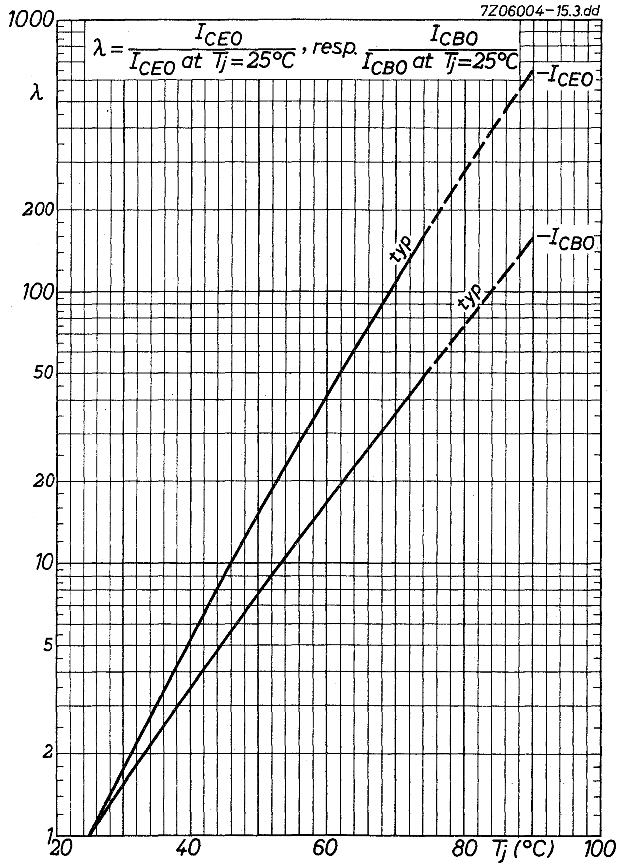
[1]) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

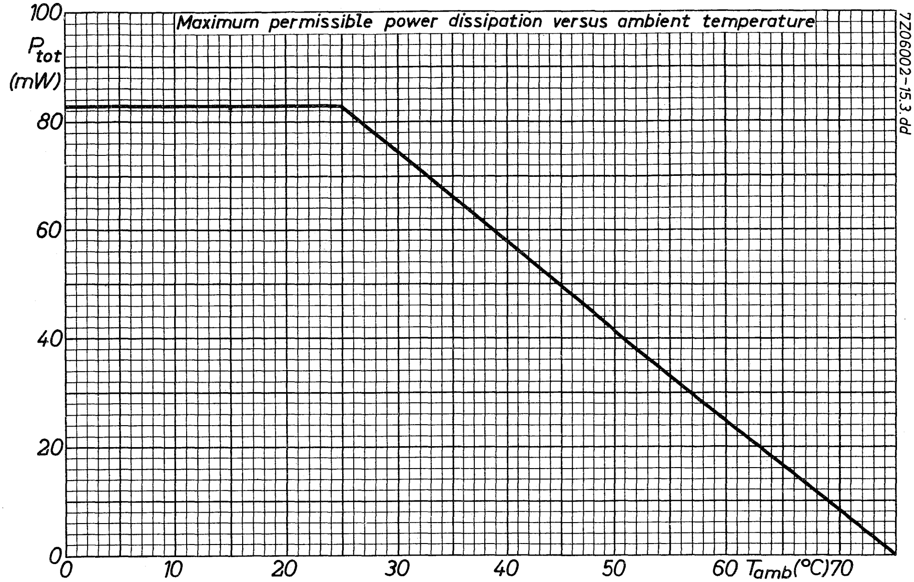
7Z3 0753

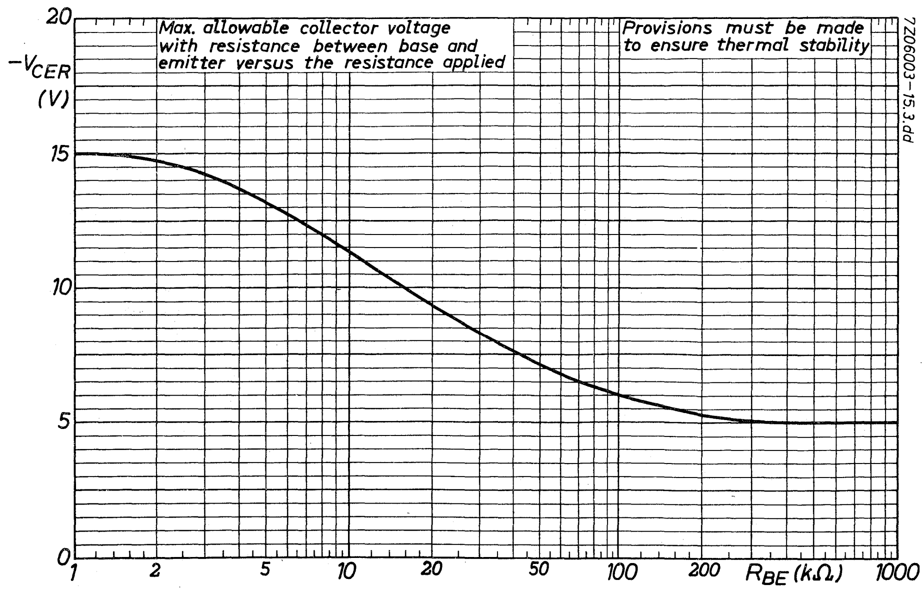
CHARACTERISTICS T_{amb} = 25 °C unless otherwise specified

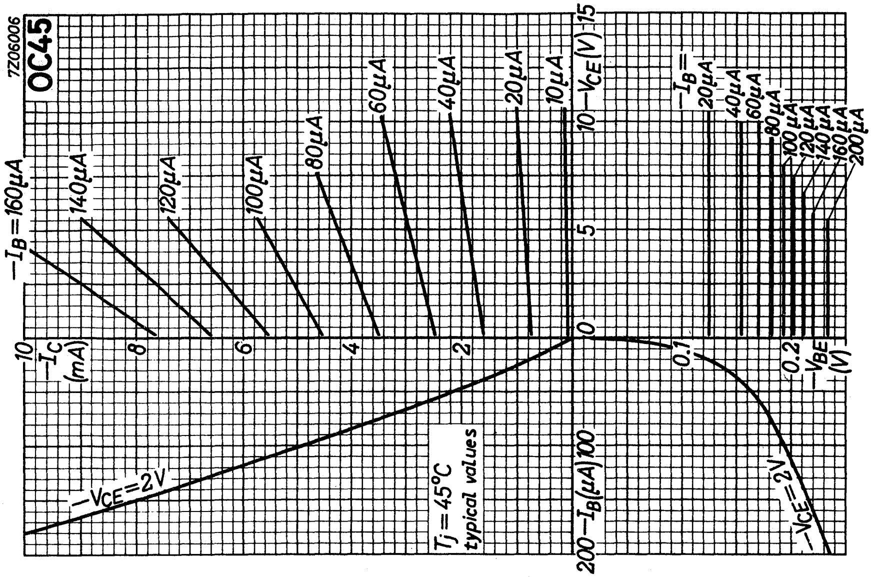
		OC44		OC45	
Collector cut-off currents					
$I_E = 0; -V_{CB} = 2$ V	$-I_{CBO}$	typ.	0.5	0.5	μA
		<	2.0	2.0	μA
$I_E = 0; -V_{CB} = 15$ V	$-I_{CBO}$	<	10	10	μA
$I_B = 0; -V_{CE} = 2$ V	$-I_{CEO}$	typ.	25	12	μA
		<	75	40	μA
Emitter cut-off current					
$I_C = 0; -V_{EB} = 2$ V	$-I_{EBO}$	typ.	0.4	0.4	μA
		<	2.0	2.0	μA
$I_C = 0; -V_{EB} = 12$ V	$-I_{EBO}$	<	40	40	μA
Base-emitter voltage					
$-I_C = 1$ mA; $-V_{CE} = 6$ V	$-V_{BE}$	typ.	150	170	mV
		125 to	185	145 to 195	mV
Collector-base capacitance at f = 450 kHz					
$-I_C = 1$ mA; $-V_{CE} = 6$ V	$C_{b'c}$	typ.	10.5	10.5	pF
		7 to	14	7 to 14	pF
D.C. current gain					
$-I_C = 1$ mA; $-V_{CE} = 6$ V	h_{FE}	typ.	100	50	
		45 to	225	25 to 125	
Cut-off frequency					
$I_E = 1$ mA; $-V_{CB} = 6$ V	f_{hfb}	>	7.5	3	MHz
		typ.	15	12	MHz
Base-resistance at f = 450 kHz					
$-I_C = 1$ mA; $-V_{CE} = 6$ V	$r_{bb'}$	typ.	110	75	Ω
		<	250	200	Ω
y parameters at f = 450 kHz (common emitter)					
$-I_C = 1$ mA; $-V_{CE} = 6$ V					
Input conductance	g_{ie}	typ.	0.6	1	mΩ^{-1}
Input capacitance	C_{ie}	typ.	500	800	pF
Feedback admittance	$\lvert y_{re}\rvert$	typ.	2	2	μΩ^{-1}
Transfer admittance	$\lvert y_{fe}\rvert$	typ.	30	28	mΩ^{-1}
Output conductance	g_{oe}	typ.	25	20	μΩ^{-1}
Output capacitance	C_{oe}	typ.	40	40	pF

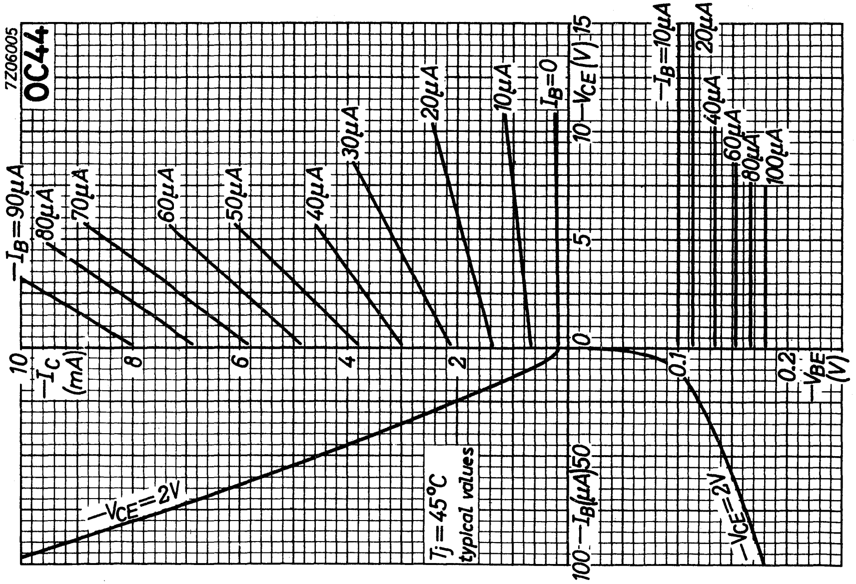
7Z3 0754


7Z06004−15.3.dd
λ = I_CEO / I_CEO at Tj = 25°C , resp. I_CBO / I_CBO at Tj = 25°C
λ
1000
200
100
50
20
10
5
2
1
20
40
60
80
100
Tj (°C)
−I_CEO
−I_CBO
typ
typ


Maximum permissible power dissipation versus ambient temperature
100
P_{tot}
(mW)
80
60
40
20
0
0
10
20
30
40
50
60 T_{amb}(°C)70
7Z06002-15.3.dd


Max. allowable collector voltage with resistance between base and emitter versus the resistance applied
Provisions must be made to ensure thermal stability
20
$-V_{CER}$
(V)
15
10
5
0
1
2
5
10
20
50
100
200
R_{BE} (kΩ)
1000
7Z06003-15.3.dd


OC45
7Z06006
$-I_B$=160µA
140µA
120µA
100µA
80µA
60µA
40µA
20µA
10µA
$-V_{CE}$(V)
$-I_C$ (mA)
$-V_{CE}$=2V
T_j=45°C
typical values
$-I_B$(µA)
$-V_{BE}$ (V)
$-I_B$=
20µA
40µA
60µA
80µA
100µA
120µA
140µA
160µA
200µA


OC44
7Z06005
$-I_B$=90µA
80µA
70µA
60µA
50µA
40µA
30µA
20µA
10µA
I_B=0
$-V_{CE}$(V)
$-I_C$ (mA)
$-V_{CE}$=2V
T_j=45°C
typical values
$-I_B$(µA)
$-V_{BE}$ (V)
$-I_B$=10µA
20µA
40µA
60µA
80µA
100µA

GERMANIUM SWITCHING TRANSISTORS

Germanium p-n-p transistors in all glass construction for medium current, high speed, computer switching applications.

RATINGS (Limiting values) [1])

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	20	V
Collector-emitter voltage with $+V_{BE} > 0.2$ V	$-V_{CEX}$	max.	20	V
Collector current (d.c. and average)	$-I_C$	max.	100	mA
Collector current (peak value)	$-I_{CM}$	max.	125	mA
Base current (d.c. and average)	$-I_B$	max.	15	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	80	mW
Junction temperature: continuous	T_j	max.	75	°C
incidentally	T_j	max.	90	°C

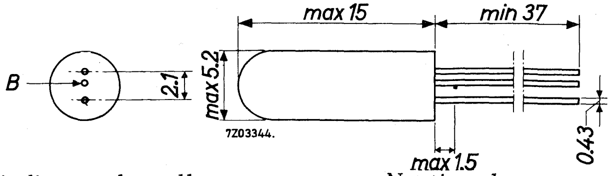
THERMAL RESISTANCE

From junction to ambient in free air $R_{th\ j-a}$ = 0.6 °C/mW

CHARACTERISTICS at T_j = 25 °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 MHz	> 4.5 MHz

MECHANICAL DATA Dimensions in mm



The red dot indicates the collector

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

7Z3 0204

L.F. TRANSISTOR

Germanium alloy p-n-p transistor in a hermetically sealed-in subminiature metal case. It is intended for use in pre-stages of hearing aids.

RATINGS (Limiting values) [1])

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	7	V
Collector-emitter voltage with $R_{BE} < 10\ k\Omega$	$-V_{CER}$	max.	7	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	3	V
Collector current (d.c. or average)	$-I_C$	max.	5	mA
Collector current (peak value)	$-I_{CM}$	max.	10	mA
Total power dissipation up to $T_{amb} = 45\ ^oC$	P_{tot}	max.	20	mW
Junction temperature	T_j	max.	75	^oC

THERMAL RESISTANCE

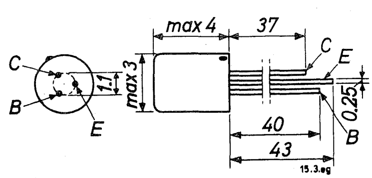
From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	1.5	$^oC/mW$

CHARACTERISTICS at $T_{amb} = 25\ ^oC$

Collector cut-off currents				
$I_E = 0;\ -V_{CB} = 2\ V$	$-I_{CBO}$	typ.	1.5	μA
$I_B = 0;\ -V_{CE} = 0.5\ V$	$-I_{CEO}$	<	100	μA
$I_B = 0;\ -V_{CE} = 0.5\ V;\ T_{amb} = 35\ ^oC$	$-I_{CEO}$	<	300	μA
Emitter cut-off current				
$I_C = 0;\ -V_{EB} = 2\ V$	$-I_{EBO}$	typ.	1.5	μA
Base current				
$-I_C = 0.25\ mA;\ -V_{CE} = 0.5\ V$	$-I_B$	typ.	8	μA
Base-emitter voltage				
$-I_C = 0.25\ mA;\ -V_{CE} = 0.5\ V$	$-V_{BE}$	typ.	120	mV
Small signal current gain				
$-I_C = 0.25\ mA;\ -V_{CE} = 0.5\ V$	h_{fe}	>	20	
		typ.	35	
Cut-off frequency				
$-I_C = 0.25\ mA;\ -V_{CE} = 0.5\ V$	f_{hfe}	>	10	kHz
Noise figure				
$I_E = 0.5\ mA;\ -V_{CB} = 2\ V$	F	<	10	dB

MECHANICAL DATA

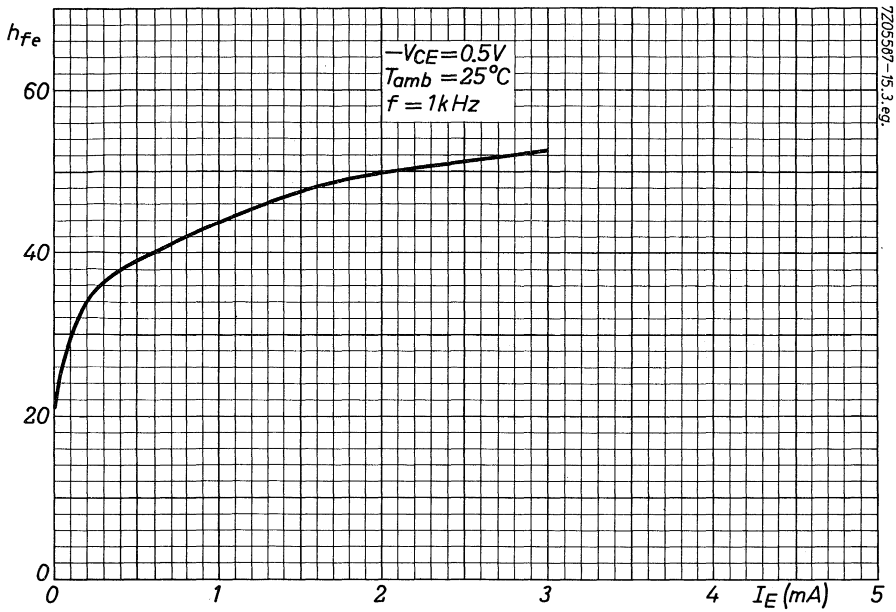
Dimensions in mm

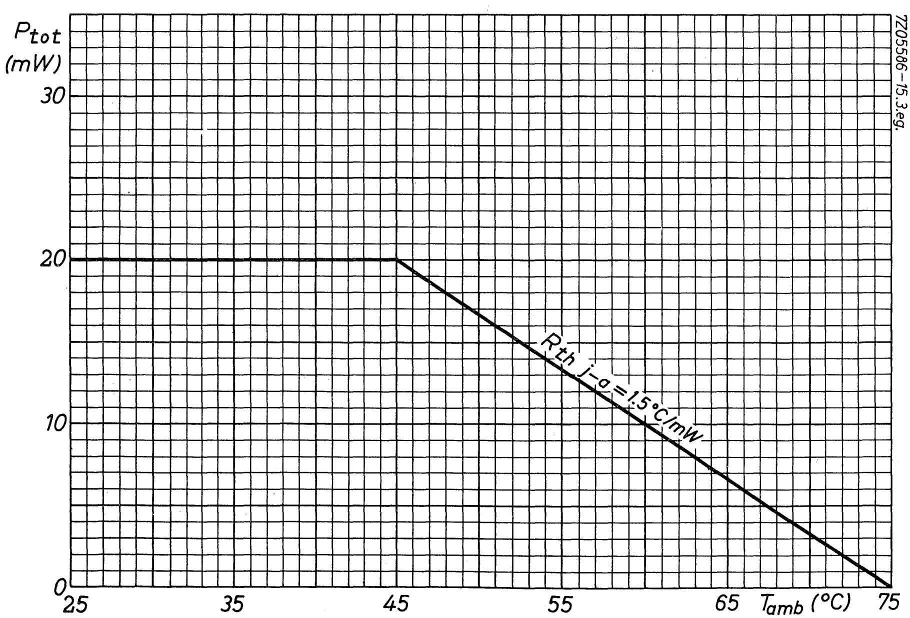


The red dot indicates the collector

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

7Z3 0747

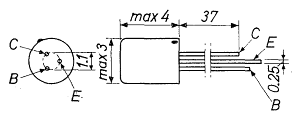

7Z05567-15.3.eg.
h_{fe}
$-V_{CE} = 0.5V$
$T_{amb} = 25°C$
$f = 1kHz$
60
40
20
0
0
1
2
3
4
I_E (mA)
5


7Z05566-15.3.eg.
P_{tot}
(mW)
30
20
10
0
$R_{th\ j\text{-}a} = 1.5°C/mW$
25
35
45
55
65
T_{amb} (°C)
75

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

7Z2 2349 1.

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

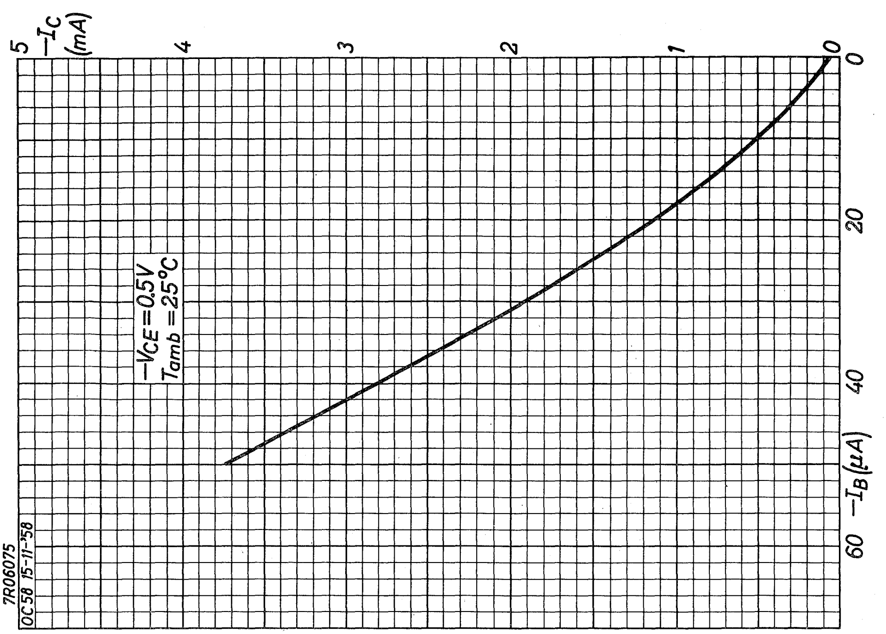
h-parameter measured at f = 1 kc/s
paramètre h mesuré à f = 1 kHz
h-Parameter gemessen bei f = 1 kHz

$-I_B$	= 4,5		µA
$-V_{BE}$	= 120		mV
h_{21e}	= 55	> 30	
$f_{\alpha e}$	=	> 10 kc/s	

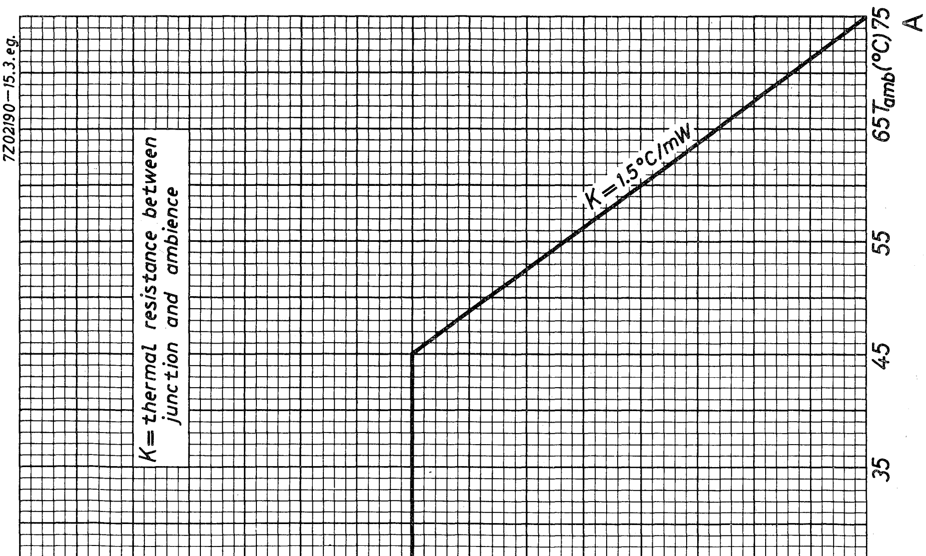
Junction temperature
Température de la jonction
Kristalltemperatur

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

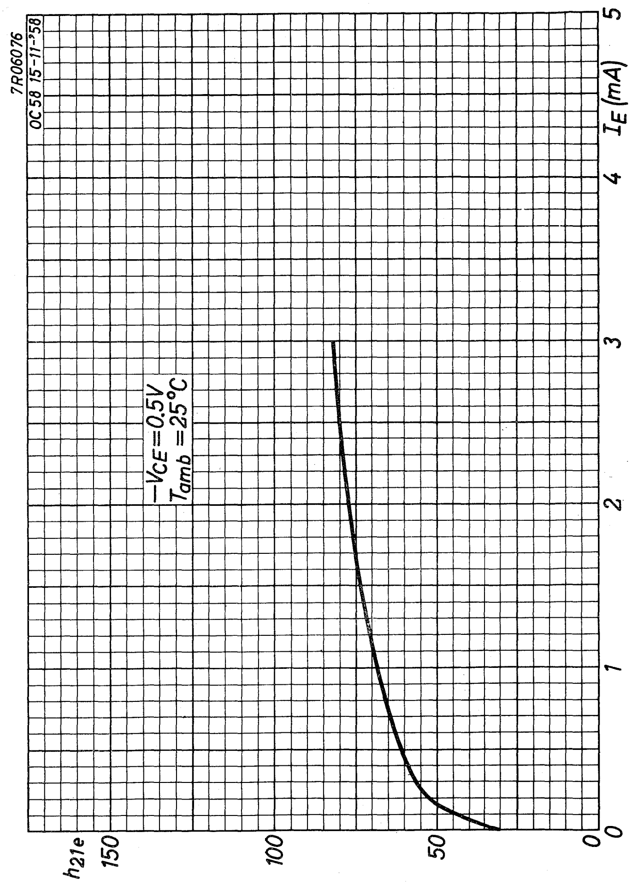
938 3364 2.



$-I_C$ (mA)
5
4
3
2
1
0
$-V_{CE}=0.5V$
$T_{amb}=25°C$
7R06075
OC58 15-11-'58
0
20
40
60
$-I_B$ (μA)
B



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
25
35
45
55
65
75
T_{amb}(°C)
A

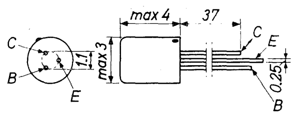

7R06076
OC 58 15-11-'58
$-V_{CE}=0.5V$
$T_{amb}=25°C$
h_{21e}
150
100
50
0
0
1
2
3
4
5
I_E (mA)

C

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

7Z2 2349

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

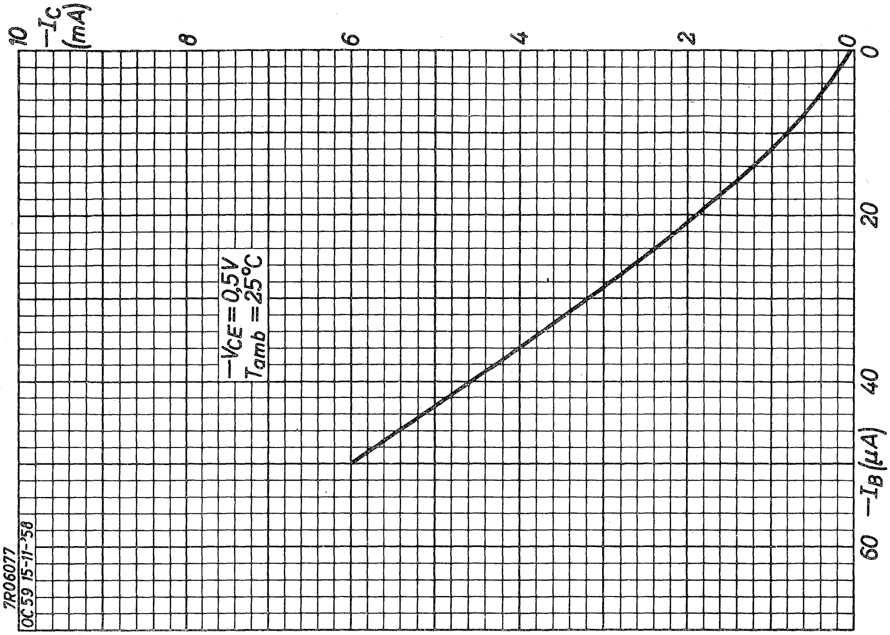
h-parameter measured at f = 1 kc/s
paramètre h mesuré à f = 1 kHz
h-Parameter gemessen bei f = 1 kHz

$-I_B$	= 3,5		µA
$-V_{BE}$	= 120		mV
h_{21e}	= 80	> 50	
$f_{\alpha e}$	=	> 10 kc/s	

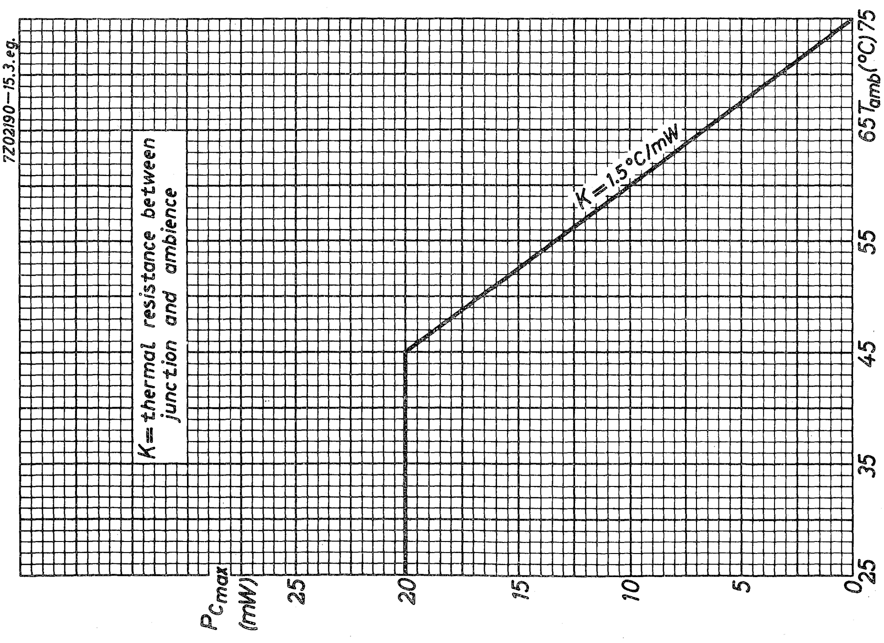
Junction temperature
Température de la jonction
Kristalltemperatur

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

7Z2 3048

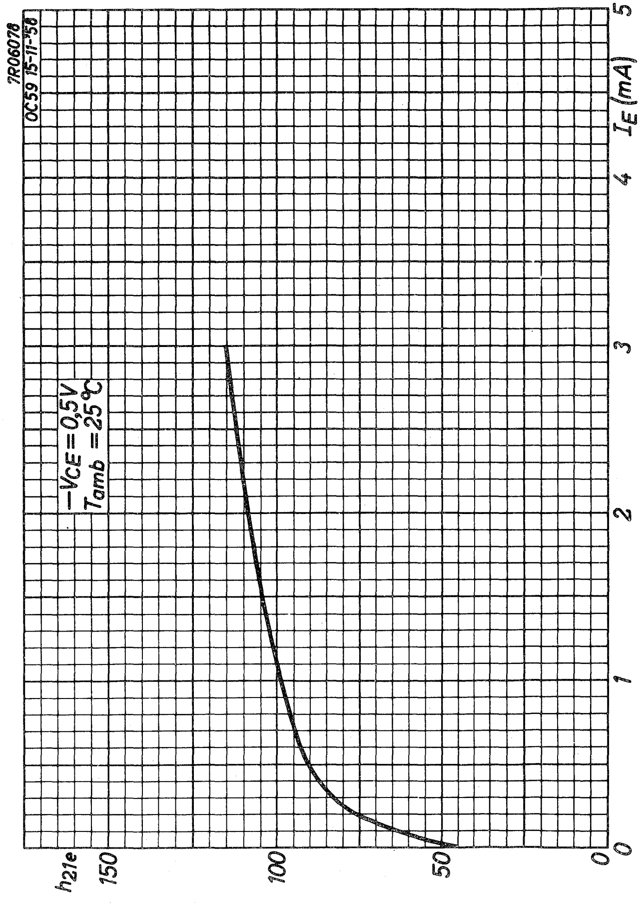

10
8
6
4
2
0
$-I_C$ (mA)
0
20
40
60
$-I_B$ (μA)
$-V_{CE}$ = 0,5V
T_{amb} = 25°C
7R06077
OC59 15-11-'58

B


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
25
35
45
55
65
75
T_{amb} (°C)

A

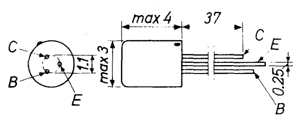
C


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)

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
Kenndaten
T_{amb} = 25 °C

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

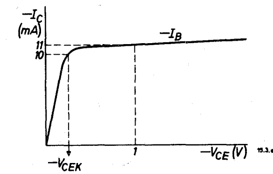
7Z2 2350 1.

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

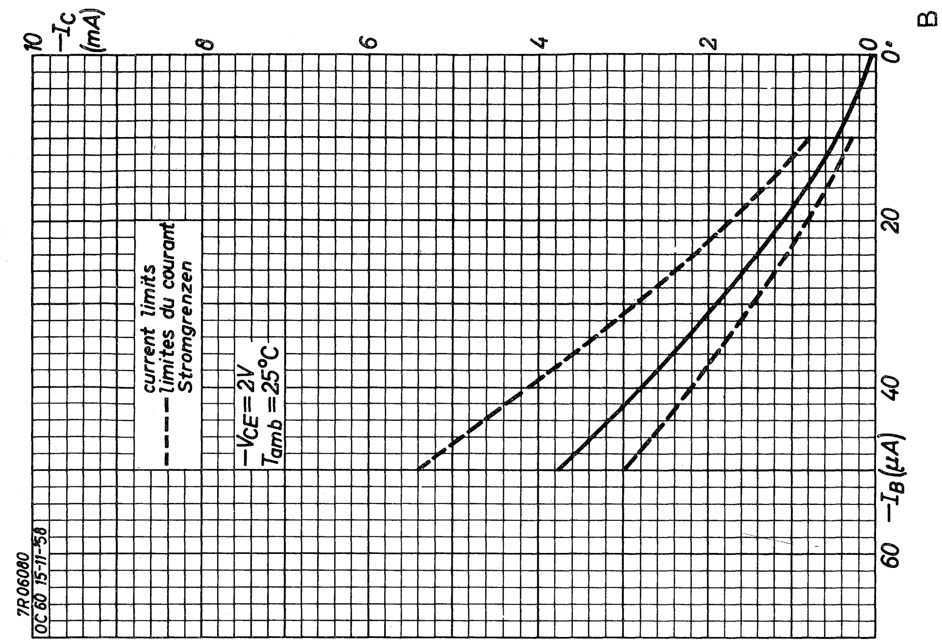
$-I_B$ = the value at which $-I_C$ = 11 mA when $-V_{CE}$ = 1 V
la valeur à laquelle $-I_C$ = 11 mA si $-V_{CE}$ = 1 V
der Wert bei dem $-I_C$ = 11 mA wenn $-V_{CE}$ = 1 V

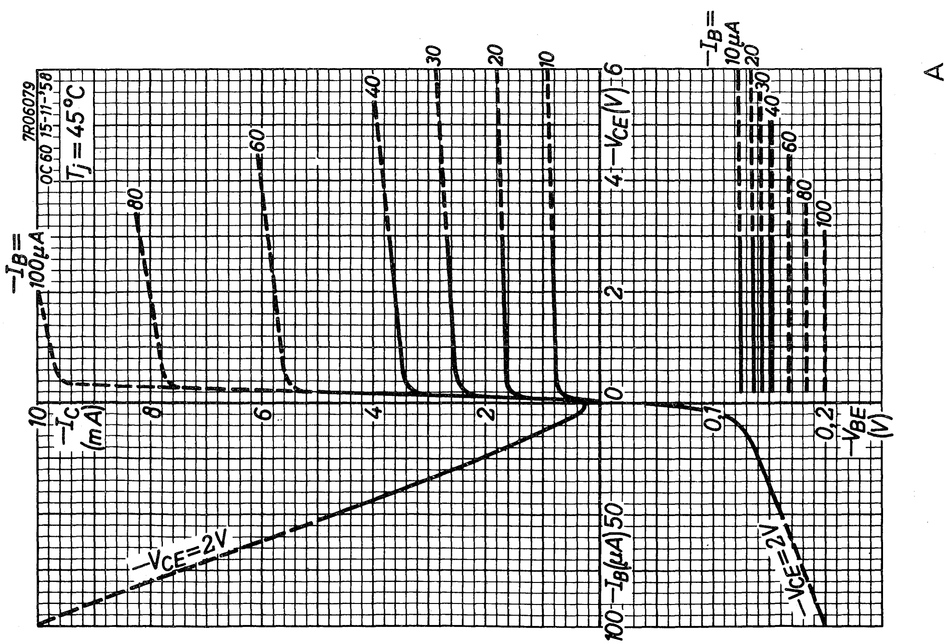
$-V_{CEK}$ = 0,18 V < 0,25 V

Junction temperature
Température de la jonction
Kristalltemperatur

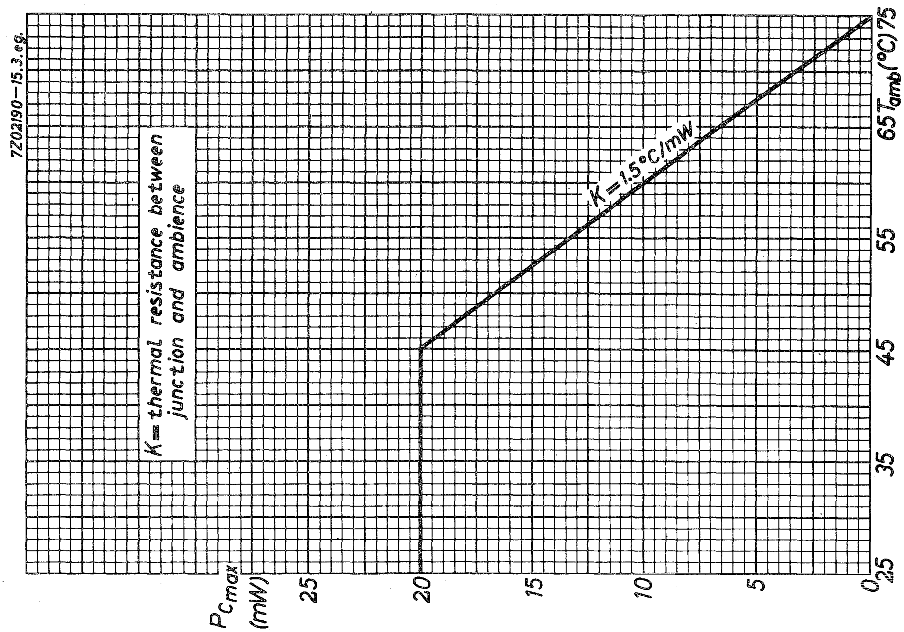
Junction temperature rise in free air
Augmentation de la température de la jonction en l'air libre
Temperaturerhöhung des Kristalls in freier Luft
K ≦ 1,5 °C/mW

938 3367 2.

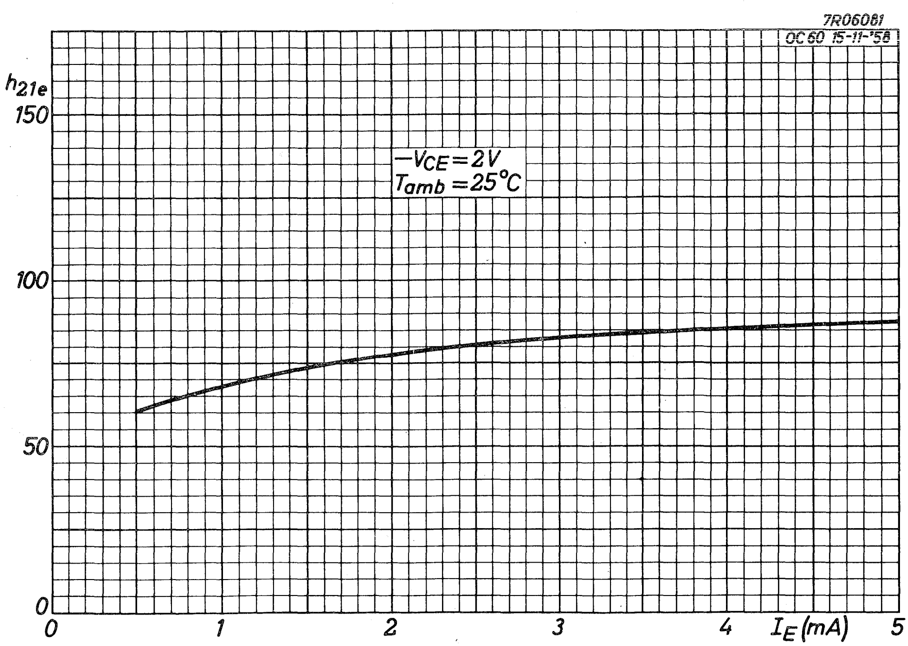

B
$-I_C$ (mA)
10
8
6
4
2
0
current limits
limites du courant
Stromgrenzen
$-V_{CE}=2V$
$T_{amb}=25°C$
7R06080
OC 60 15-11-58
$-I_B$ (μA)
0
20
40
60


A
7R06079
OC 60 15-11-58
$T_j = 45°C$
$-I_B=$ 100μA
80
60
40
30
20
10
$-V_{CE}$(V)
6
4
2
0
$-I_C$ (mA)
10
8
6
4
2
$-I_B=$ 10μA
20
30
40
60
80
100
0,1
0,2
$-V_{BE}$ (V)
$-V_{CE}=2V$
$-V_{CE}=2V$
100
$-I_B$(μA)
50

D


7Z02190-15.3.eg.
K = thermal resistance between junction and ambience
K = 1.5 °C/mW
25 35 45 55 65 T_{amb}(°C) 75
$P_{C max}$ (mW)
25 20 15 10 5 0

C


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)

GERMANIUM P-N-P TRANSISTOR

P-N-P transistor in all glass construction for general purpose applications.

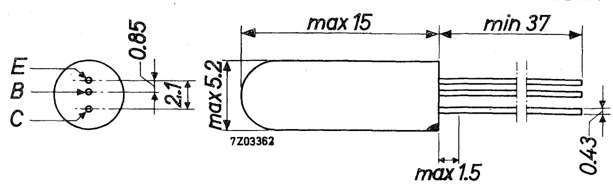
RATINGS (Limiting values) [1])

Collector-emitter voltage at $+V_{BE} > 0.1$ V	$-V_{CEX}$	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	kHz

MECHANICAL DATA Dimensions in mm



Not tinned

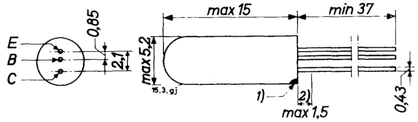
The red dot indicates the collector.

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

7Z3 0169

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 = -55/+75 °C
Lagerungstemperatur

1) The red dot indicates the collector
Le point rouge marque le collecteur
Der rote Punkt indiziert den Kollektor

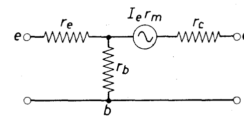
2) Not tinned; non-étamé; nicht verzinnt

3) 4) See page 2; voir page 2; siehe Seite 2

7Z2 0343

Characteristics
Caractéristiques T_{amb} = 25 °C
Kenndaten

Common base; Base à la masse; Basisschaltung



			Min.	Max.	
Measured at / Mesuré à / Gemessen bei: $-V_{CB}$	=	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 $V_{BE} \geqq 0.1$ V. See also page M

Ces valeurs sont admissibles à $V_{BE} \geqq 0,1$ V. Voir aussi page M

Diese Werte sind erlaubt bei $V_{BE} \geqq 0,1$ 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

939 2391

11.11.1960

Characteristics (continued)
Caractéristiques (continuation)
Kenndaten (Fortsetzung)

T_{amb} = 25 °C

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

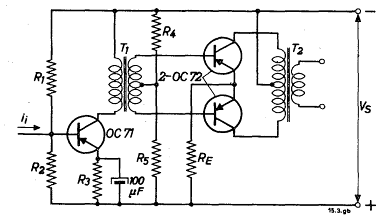
Junction temperature rise in free air
Augmentation de la température de la jonction en l'air libre
Temperaturerhöhung des Kristalls in freier Luft

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

T_{amb} = 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)

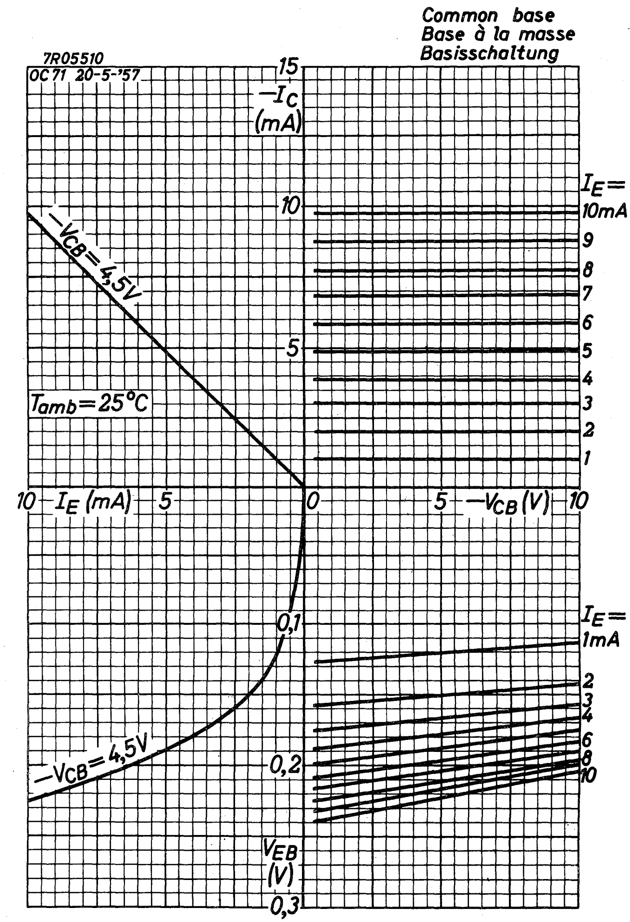
T_{amb} = 25 °C

B. 2-OC 72 without cooling fin
2-OC 72 sans ailettes de refroidissement
2-OC 72 ohne Kühlschellen

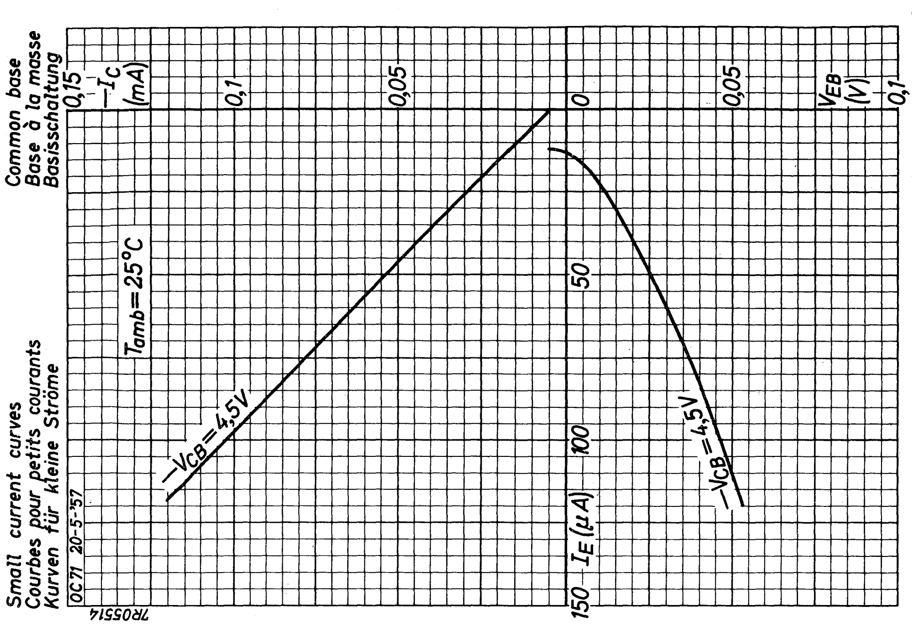
V_S	=	6	4,5	V
$-V_{CE}$	=	4,5	3	V
I_E	=	4,8	6,5	mA
R_1	=	8,2	6,8	kΩ
R_2	=	2,7	2,2	kΩ
R_3	=	220	120	Ω
I_{bm} (P_o[1]) = 50 mW)	=	14	23	µA
I_{1m} (P_o[1]) = 50 mW)	=	17,5	31	µA
N_{pr}/N_{sec}[2])	=	$\frac{1,35}{1+1}$	$\frac{1,0}{1+1}$	

[1]) Output power of the push-pull output stage
Puissance de sortie de l'étage de sortie push-pull
Ausgangsleistung der Gegentaktendstufe

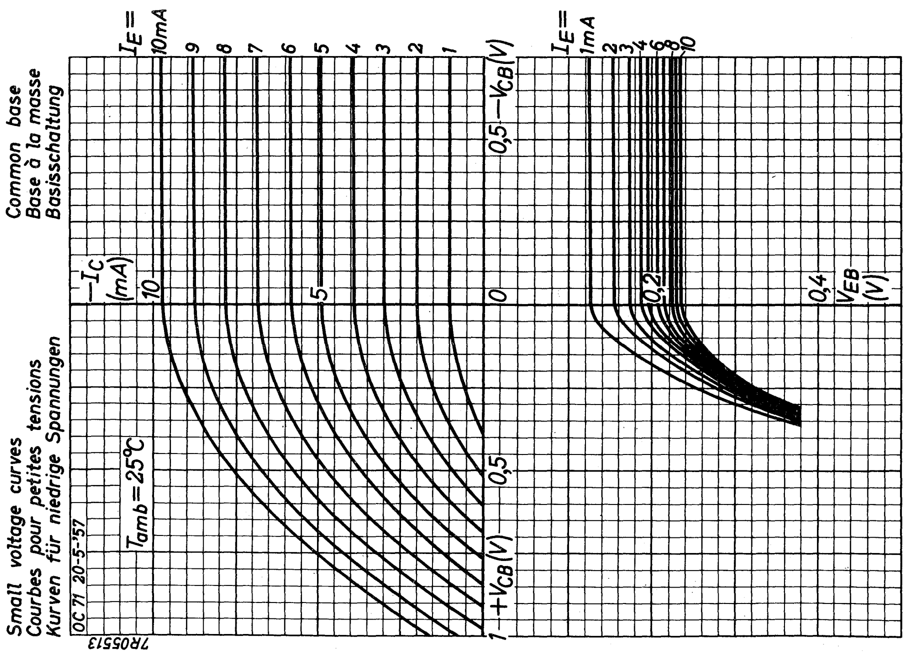
[2]) Transformer ratio of the driver transformer
Rapport de transformation du transformateur intermédiaire
Transformationsverhältnis des Treibertransformators



A

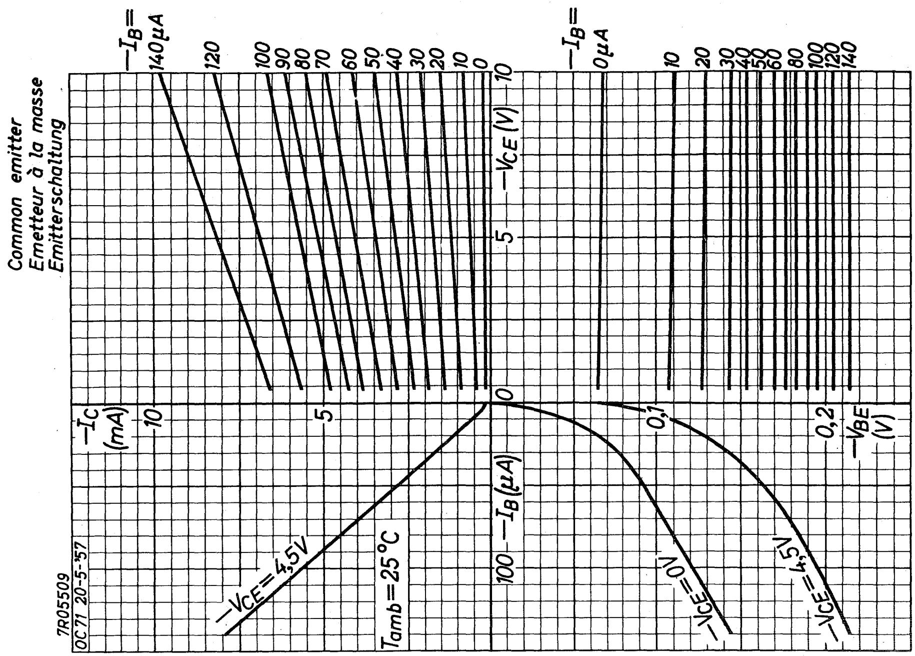

Common base
Base à la masse
Basisschaltung
Small current curves
Courbes pour petits courants
Kurven für kleine Ströme
OC71 20-5-'57
7R05514
T_{amb}=25°C
$-I_C$ (mA)
0,15
0,1
0,05
0
0,05
V_{EB} (V)
0,1
50
100
150
I_E (μA)
$-V_{CB}$=4,5V
$-V_{CB}$=4,5V

C

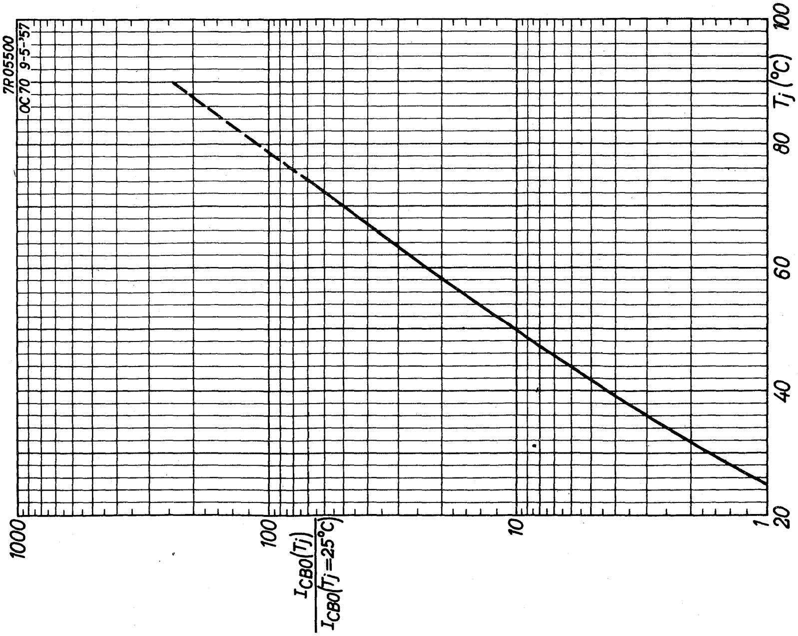

Common base
Base à la masse
Basisschaltung
Small voltage curves
Courbes pour petites tensions
Kurven für niedrige Spannungen
OC71 20-5-'57
7R05513
T_{amb}=25°C
I_E=
10mA
9
8
7
6
5
4
3
2
1
$-I_C$ (mA)
10
5
0
0,5
1
0,5
$-V_{CB}$(V)
$+V_{CB}$(V)
I_E=
1mA
2
3
4
6
8
10
0,2
0,4
V_{EB} (V)

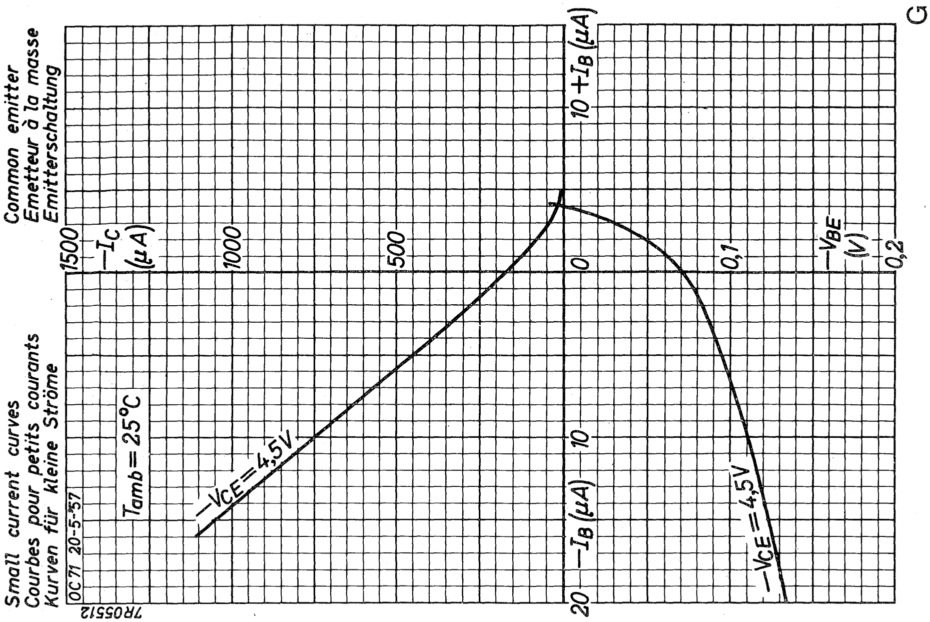
B

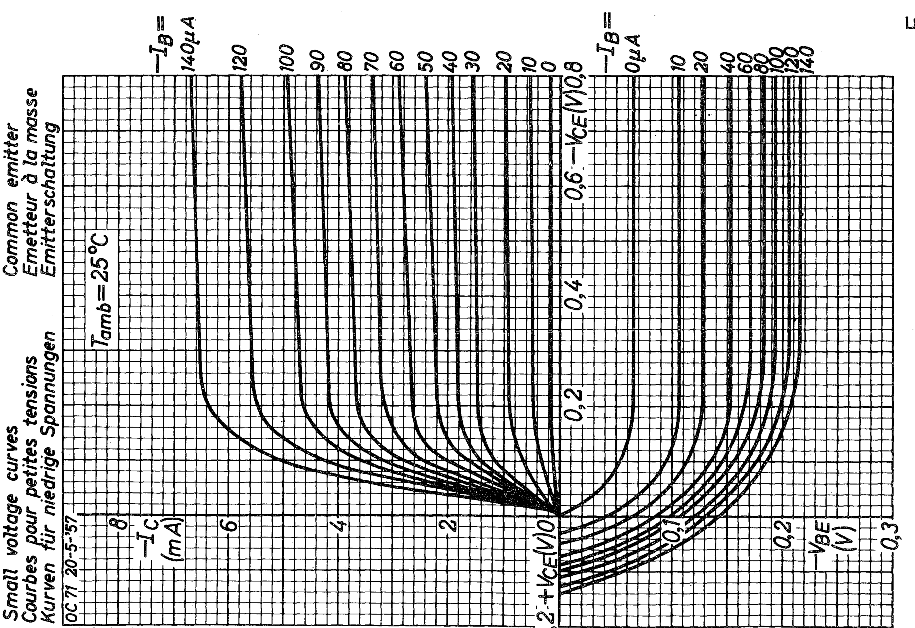
E

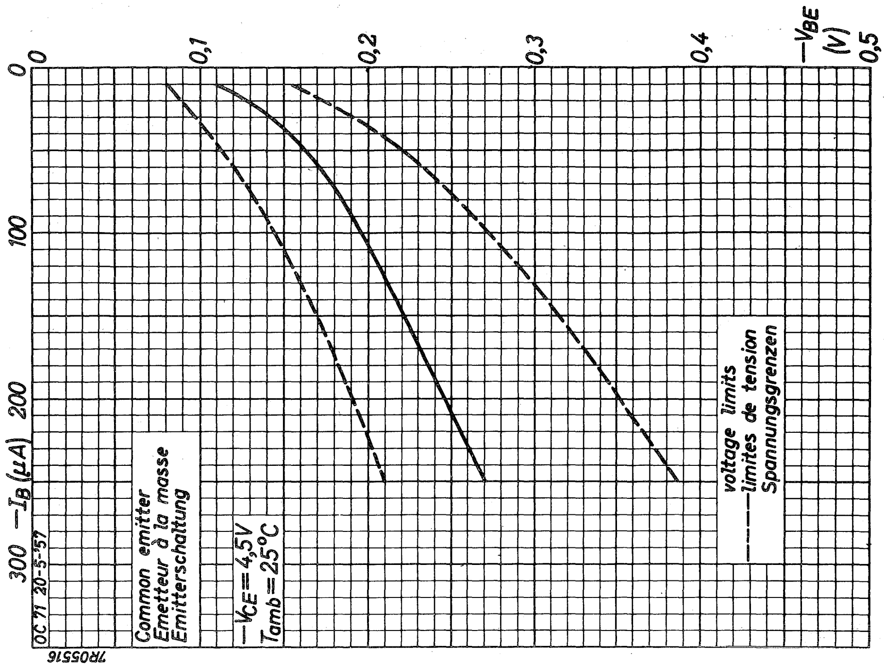

Common emitter
Emetteur à la masse
Emitterschaltung
$-I_B$=
140 μA
120
100
90
80
70
60
50
40
30
20
10
0
$-I_B$=
0 μA
10
20
30
40
50
60
80
100
120
140
$-V_{CE}$ (V)
10
5
0
$-I_C$ (mA)
10
5
0,1
0,2
$-V_{BE}$ (V)
$-I_B$ (μA)
100
$-V_{CE}$=4,5V
T_{amb}=25°C
$-V_{CE}$=0V
$-V_{CE}$=4,5V
7R05509
OC71 20-5-'57

D

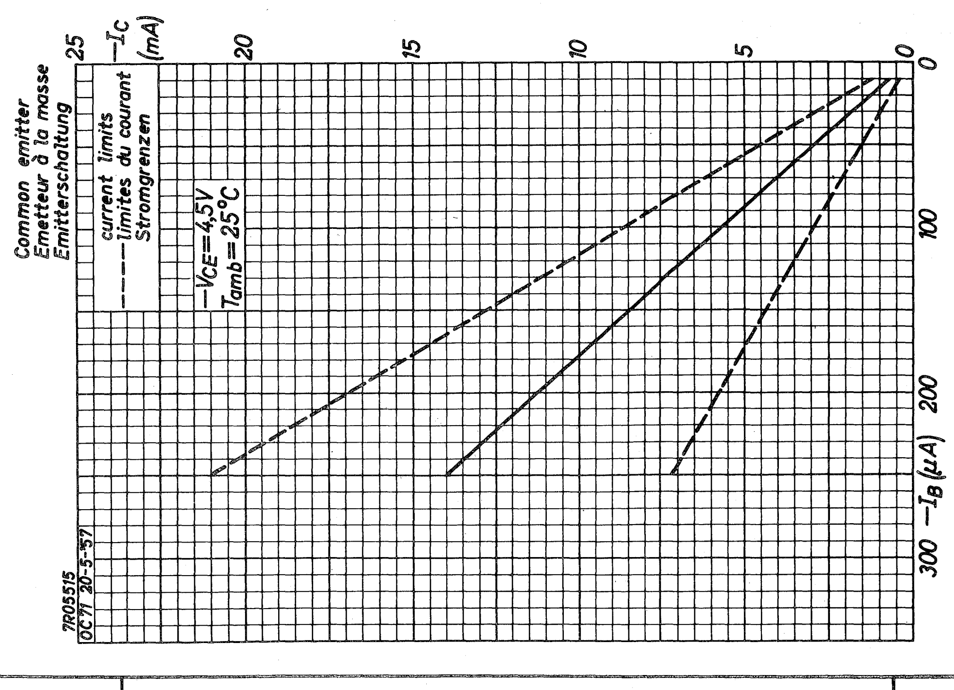

7R05500
OC70 9-5-'57
1000
100
10
1
$\frac{I_{CBO}(T_j)}{I_{CBO}(T_j=25°C)}$
20
40
60
80
100
T_j (°C)


Small current curves
Courbes pour petits courants
Kurven für kleine Ströme
Common emitter
Emetteur à la masse
Emitterschaltung
OC 71 20-5-57
7R05512
$T_{amb}=25°C$
$-V_{CE}=4,5V$
$-V_{CE}=4,5V$
$-I_C$ (μA)
1500
1000
500
0
10
20
$-I_B$ (μA)
10 $+I_B$ (μA)
0,1
0,2
$-V_{BE}$ (V)
G

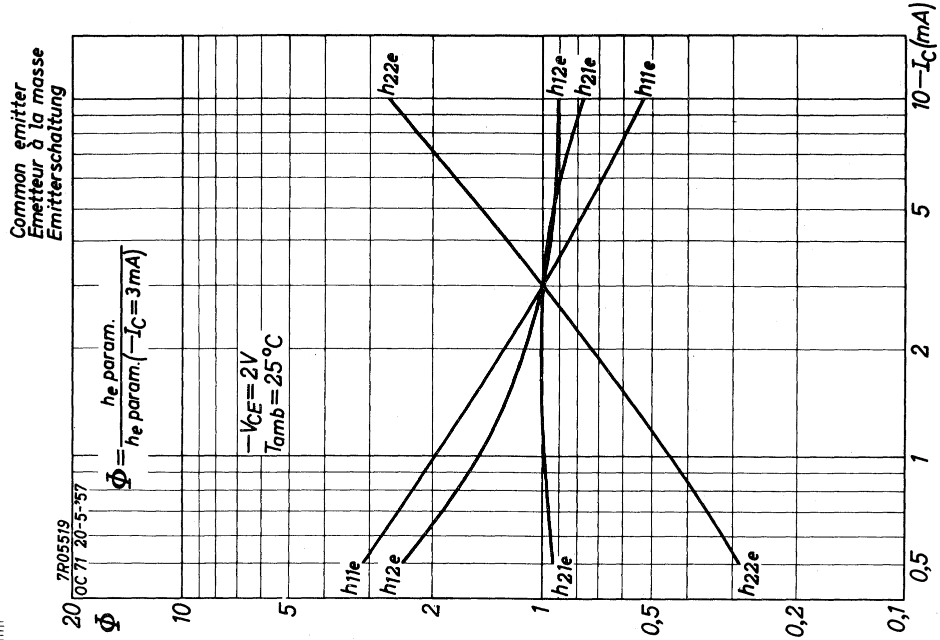

Small voltage curves
Courbes pour petites tensions
Kurven für niedrige Spannungen
Common emitter
Emetteur à la masse
Emitterschaltung
OC 71 20-5-57
7R05511
$T_{amb}=25°C$
$-I_B=$ 140 μA
120
100
90
80
70
60
50
40
30
20
10
0
$-I_B=$ 0 μA
10
20
40
60
80
100
120
140
$-I_C$ (mA)
8
6
4
2
0
0,2
0,4
0,6
0,8
$-V_{CE}$ (V)
0,2 $+V_{CE}$ (V)
0,1
0,2
0,3
$-V_{BE}$ (V)
F



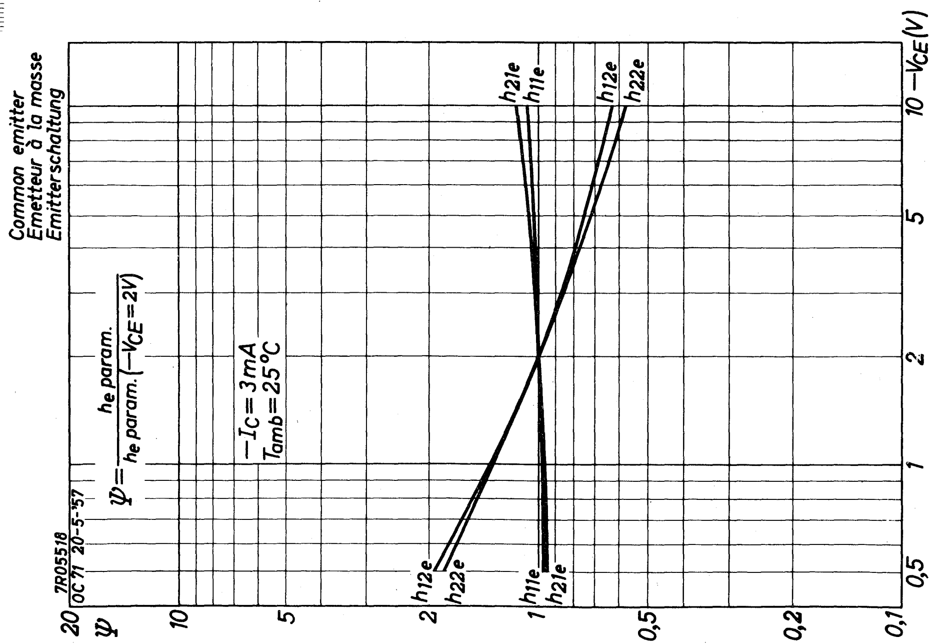
0
0,1
0,2
0,3
0,4
0,5
−V_BE (V)
0
100
200
300
−I_B (μA)
Common emitter
Emetteur à la masse
Emitterschaltung
−V_CE = 4,5V
Tamb = 25°C
voltage limits
limites de tension
Spannungsgrenzen
OC 71 20-5-'57
7R05516



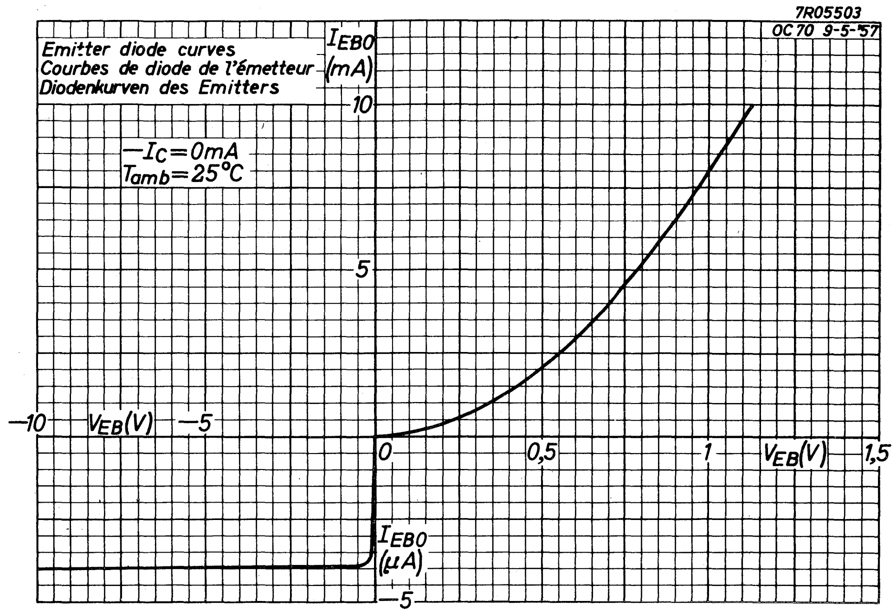
25
20
15
10
5
0
−I_C (mA)
0
100
200
300
−I_B (μA)
Common emitter
Emetteur à la masse
Emitterschaltung
current limits
limites du courant
Stromgrenzen
−V_CE = 4,5V
Tamb = 25°C
7R05515
OC71 20-5-'57


Common emitter
Emetteur à la masse
Emitterschaltung
$\Phi = \frac{h_e \text{ param.}}{h_e \text{ param.} (-I_C = 3\,mA)}$
$-V_{CE} = 2V$
$T_{amb} = 25°C$
7R05519
OC 71 20-5-'57
h22e
h12e
h21e
h11e
Φ
20
10
5
2
1
0,5
0,2
0,1
$10 - I_C (mA)$

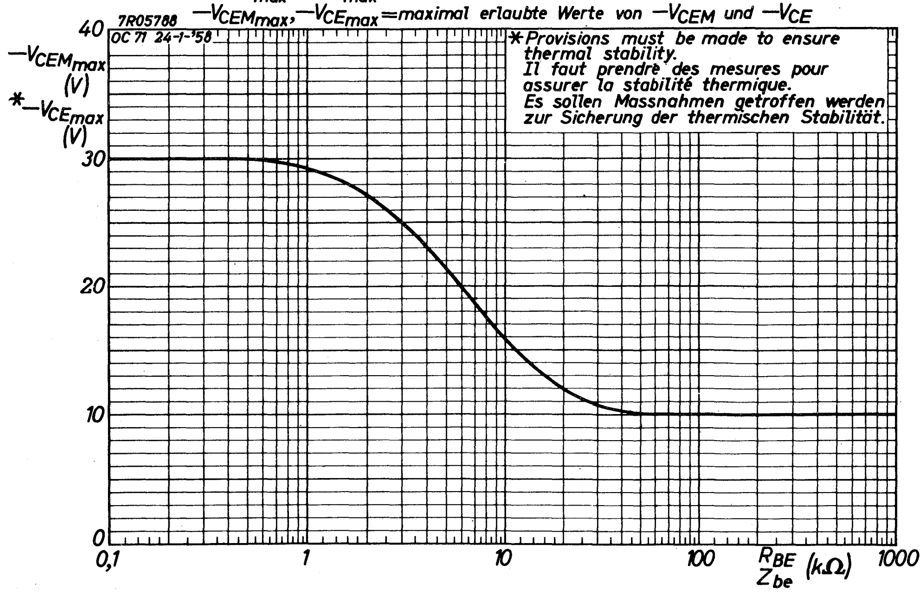
K


Common emitter
Emetteur à la masse
Emitterschaltung
$\Psi = \frac{h_e \text{ param.}}{h_e \text{ param.} (-V_{CE} = 2V)}$
$-I_C = 3\,mA$
$T_{amb} = 25°C$
7R05518
OC 71 20-5-'57
h21e
h11e
h12e
h22e
Ψ
20
10
5
2
1
0,5
0,2
0,1
$10 - V_{CE} (V)$

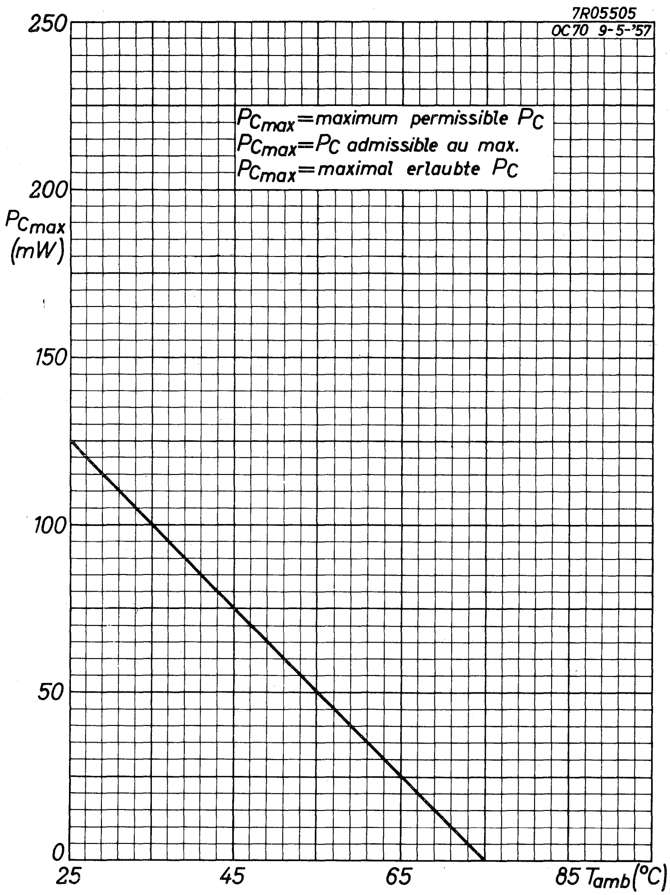
J



$-V_{CEMmax}$, $-V_{CEmax}$ = 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

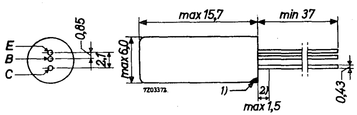

7R05505
OC70 9-5-'57
$P_{C_{max}}$=maximum permissible P_C
$P_{C_{max}}$=P_C admissible au max.
$P_{C_{max}}$=maximal erlaubte P_C
250
200
$P_{C_{max}}$ (mW)
150
100
50
0
25
45
65
85 T_{amb}(°C)

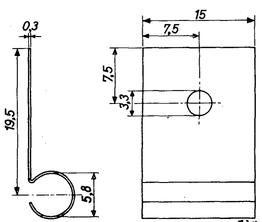
N

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

939 2347 1.

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]
$-V_{CE}$, $-V_{CEM}$: See page C / Voir page C / Siehe S. C	$-I_C$	(t_{av}=max.20 msec)	= max.125 mA	[2]
	$\|I_{CM}\|$		= 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

7Z2 2353 2.

Characteristics
Caractéristiques T_{amb} = 25 °C
Kenndaten

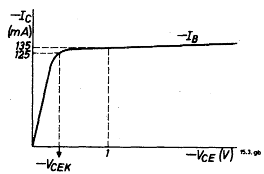
Common_base; Base_à_la masse; Basisschaltung

			Min.	Max.
$-I_{CBO}$	($-V_{CB}$ = 10 V)	= 4,5		<10 µA
$-I_{EBO}$	($-V_{EB}$ = 10 V)	= 4,5		<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

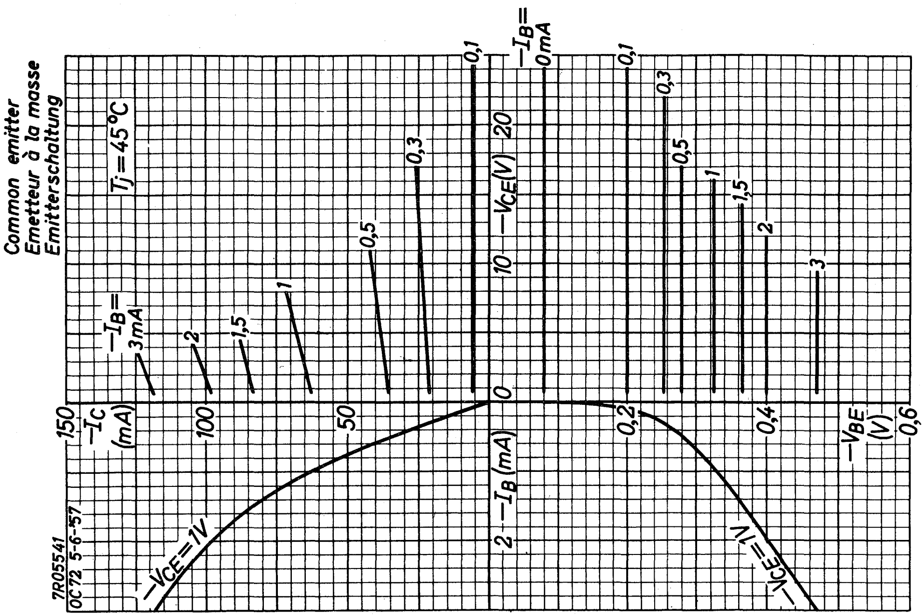
Characteristics of matched pair 2-OC72
Caractéristiques d'une paire jumelle 2-OC72 T_{amb} = 25 °C
Kenndaten eines Transistorpaars 2-OC72

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

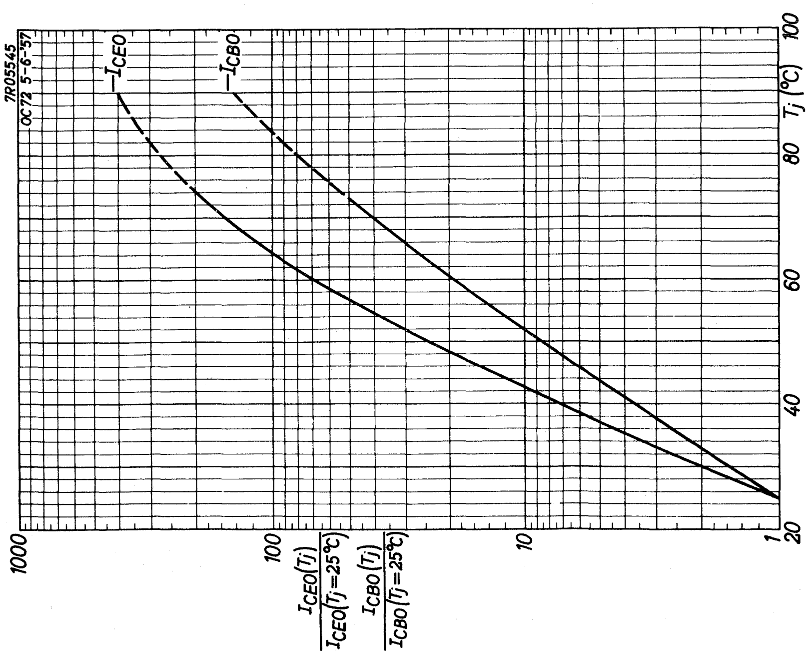
Rapport de α_{FE} des deux transistrons à I_E = 80 mA et à I_E = 10 mA 1,15 >1,0 <1,3

Verhältnis von α_{FE} beider Transistoren bei I_E = 80 mA und bei I_E = 10 mA 1,15 >1,0 <1,3

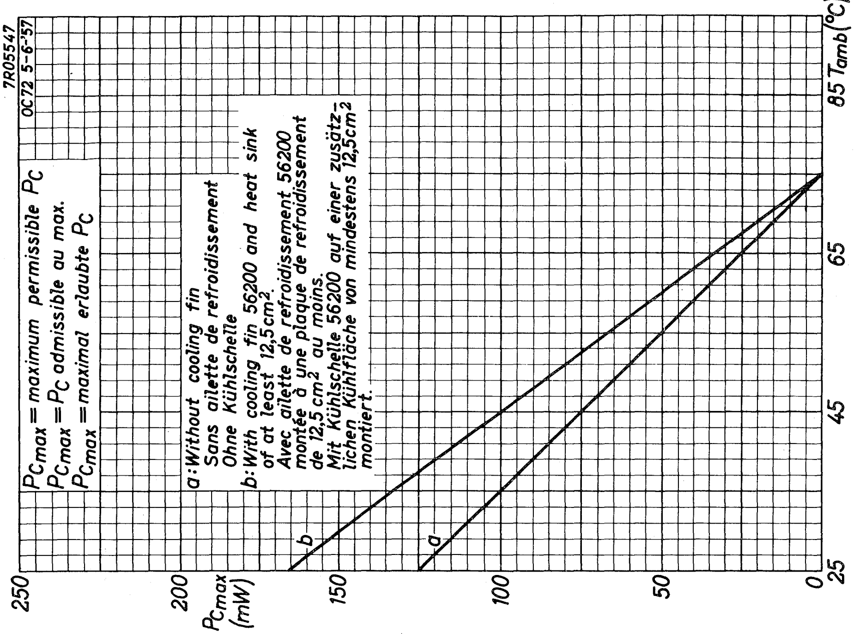
B


Common emitter
Emetteur à la masse
Emitterschaltung
$T_j=45°C$
$-I_B=$ 0 mA
0,1
0,3
0,5
1
1,5
2
3
$-I_B=$ 3 mA
$-V_{CE}(V)$
0
10
20
$-I_C$ (mA)
150
100
50
$-V_{BE}$ (V)
0,2
0,4
0,6
$-I_B$ (mA)
2
$-V_{CE}=1V$
7R05541
OC72 5-6-'57

A

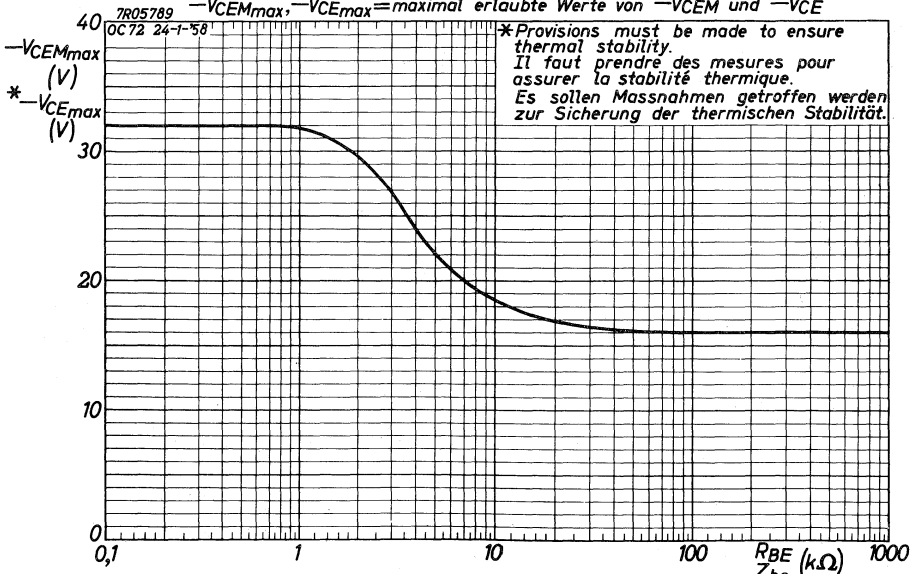

7R05545
OC72 5-6-'57
$-I_{CEO}$
$-I_{CBO}$
T_j (°C)
20
40
60
80
100
1
10
100
1000
$\frac{I_{CEO}(T_j)}{I_{CEO}(T_j=25°C)}$
$\frac{I_{CBO}(T_j)}{I_{CBO}(T_j=25°C)}$

D



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 $-V_{CE}$



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.

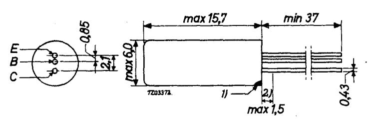
TYPE 2-OC74 consists of 2 transistors OC74 selected for operation in a class B circuit with low distortion and low spread in base-emitter voltages

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.

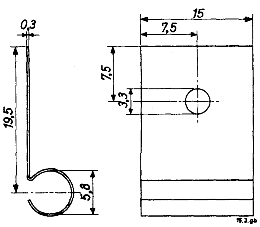
LE TYPE 2-OC74 est composé de 2 transistors OC74 sélectionnés pour fonctionnement en circuit classe B avec distorsion faible et avec dispersion faible sur les tensions base-émetteur

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 / Lagerungstemperatur = $-55\,^{\circ}C/+75\,^{\circ}C$

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

7Z2 0192

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}

7Z2 0193

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

T_{amb} = 25 °C

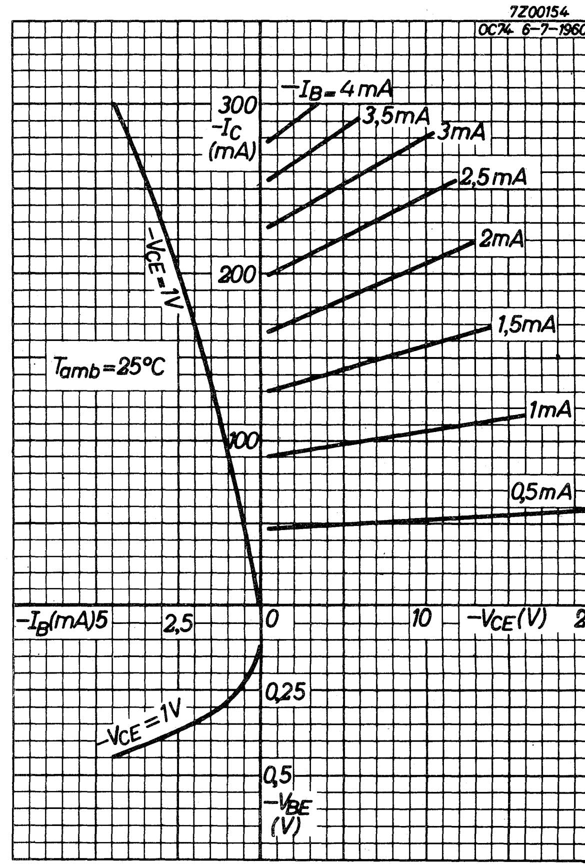
		I	II	
V_S	=	9		V
R_C	=	27		Ω 1)
$\frac{h_{fe}(-I_C = 300\ mA)}{h_{fe_{max}}}$	=	0,45		

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

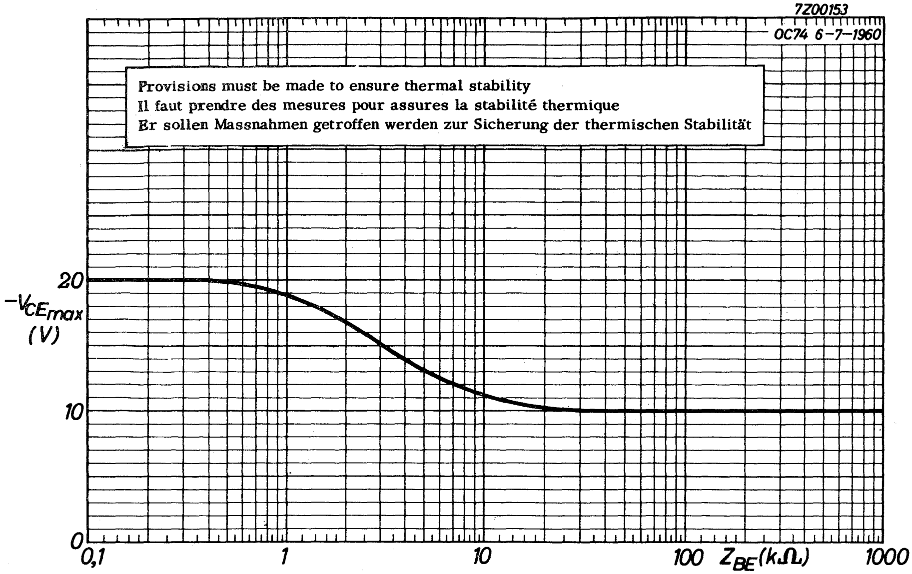
		I	II	
$-V_{CE}$	=	6		V
$-I_C$	=	50		mA
$\frac{h_{FE}(1)}{h_{FE}(2)}$	=	1,15	< 1,3	
$-V_{CE}$	=	1		V
$-I_C$	=	300		mA
$\frac{h_{FE}(1)}{h_{FE}(2)}$	=	1,15	< 1,3	

1) Collector resistor, for A.C. short-circuited
Résistance extérieure du collecteur, en court-circuit pour courant alternatif
Ausserer Kollektorwiderstand, für Wechselstrom kurzgeschlossen

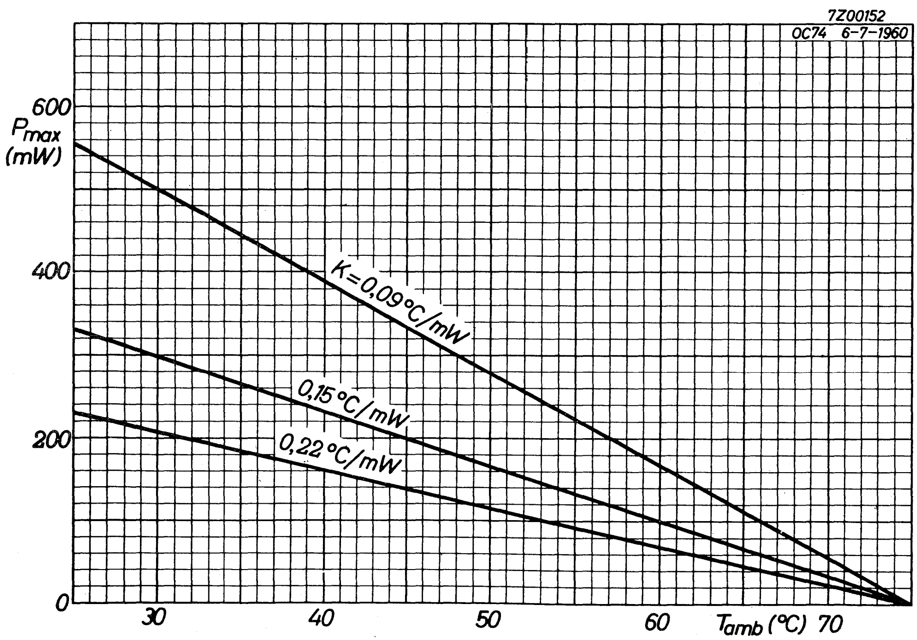
7Z2 0194



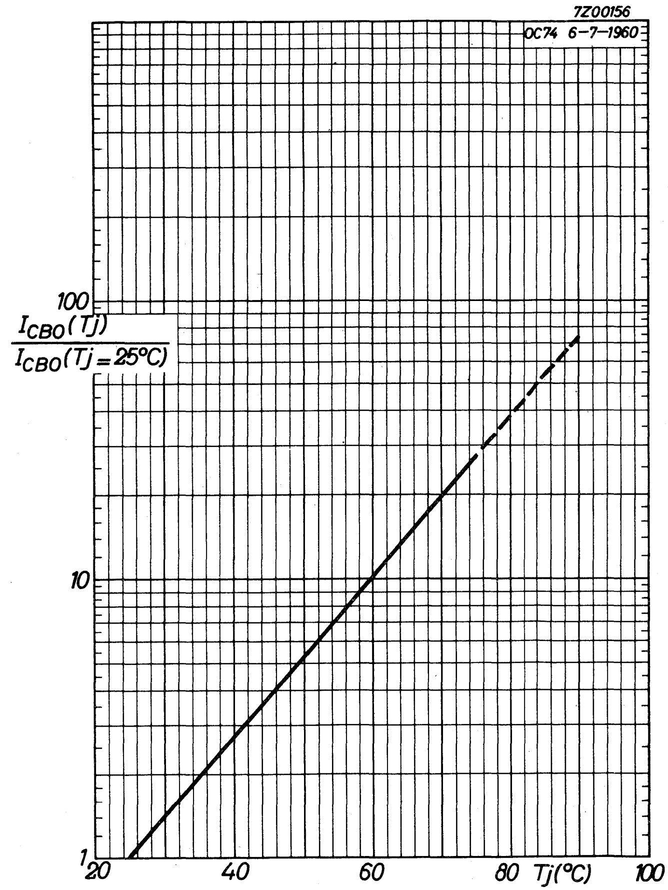
A


7Z00153
OC74 6-7-1960
Provisions must be made to ensure thermal stability
Il faut prendre des mesures pour assures 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

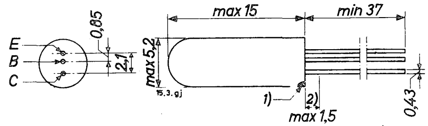
C


7Z00156
OC74 6-7-1960
100
10
1
$\frac{I_{CBO}(Tj)}{I_{CBO}(Tj=25°C)}$
20
40
60
80
Tj(°C)
100

D

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]
$-I_C$ (tav = max. 20 msec)	= max. 10 mA
$-I_{CM}$	= max. 50 mA
P_C	See page B / Voir page B / Siehe Seite B
I_E (tav = max. 20 msec)	= max. 15 mA
I_{EM}	= max. 70 mA
$-I_B$ (tav = 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

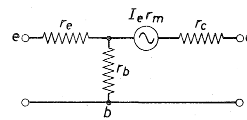
[1]) The red dot indicates the collector
Le point rouge marque le collecteur
Der rote Punkt indiziert den Kollektor

[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 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

2.2.1964

Characteristics (continued)
Caractéristiques (continuation)
Kenndaten (Fortsetzung)

Common emitter; Emetteur à la masse; Emitterschaltung

Measured at / Mésuré 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

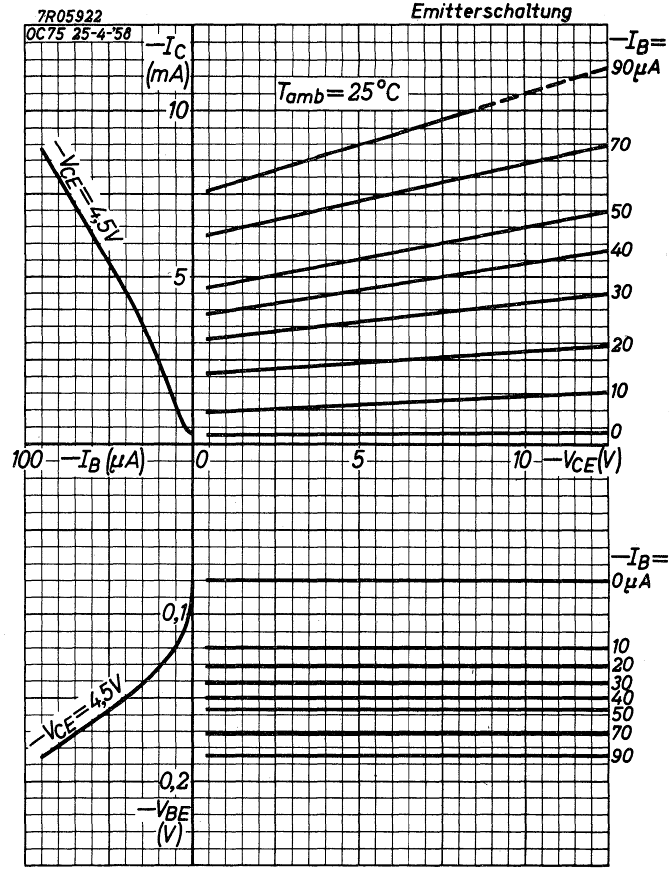
Junction temperature rise in free air
Augmentation de la température de la jonction en l'air libre
Temperaturerhöhung des Kristalls in freier Luft
$K \leqq 0{,}4$ °C/mW

---

[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

7Z2 0293

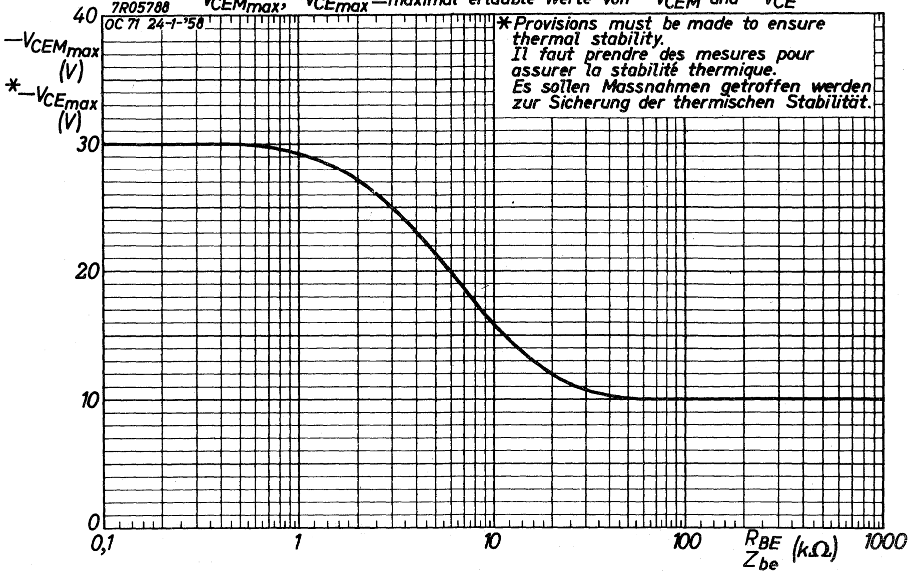
Common emitter
Emetteur à la masse
Emitterschaltung



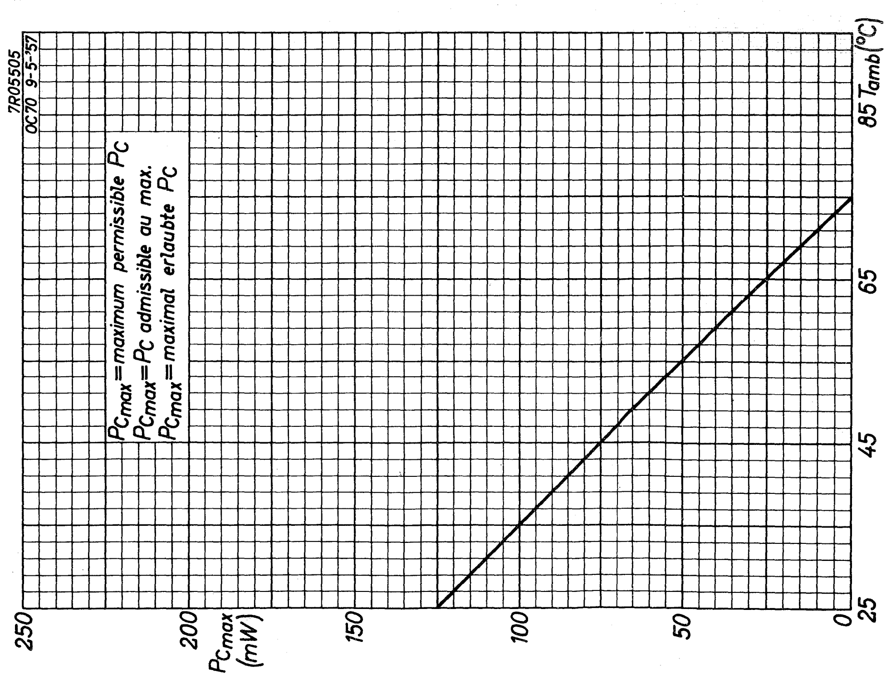
A

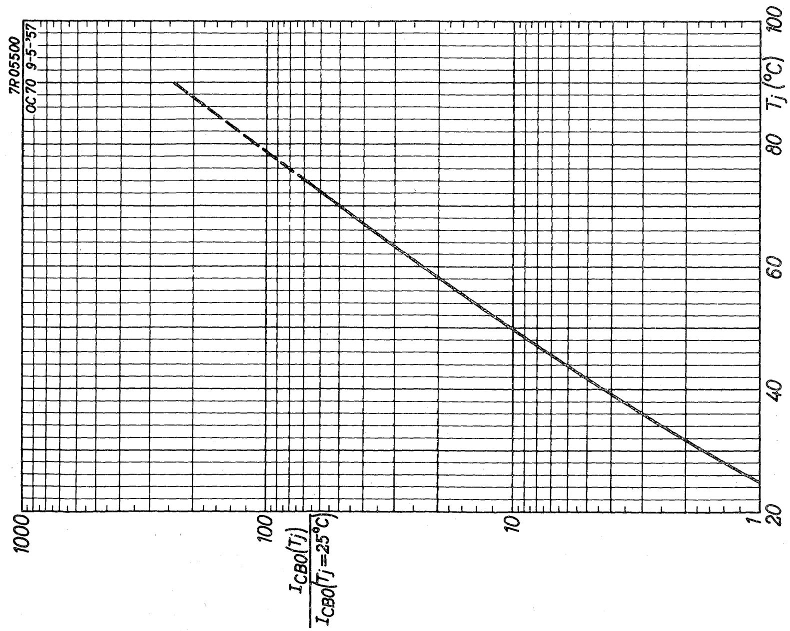
C

—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}



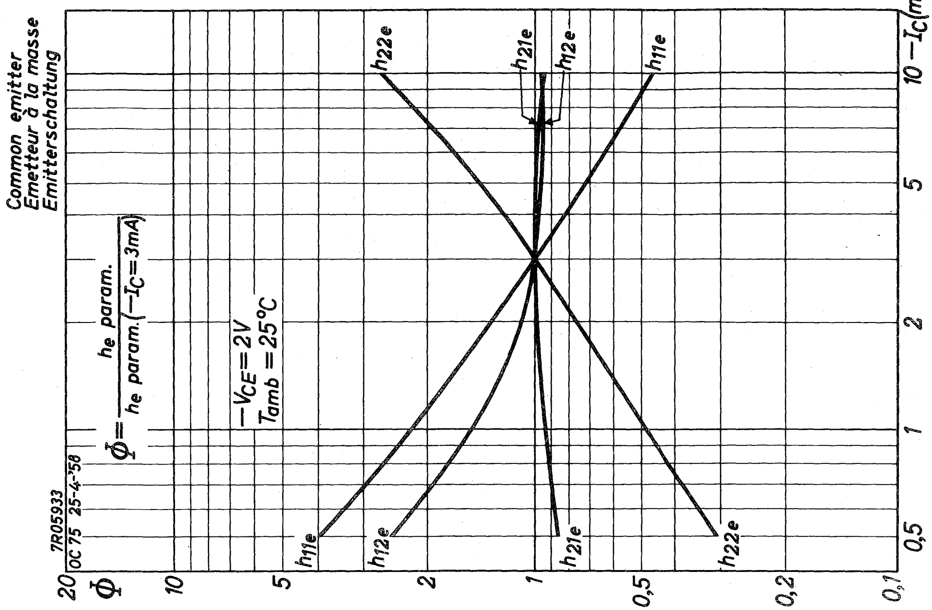
B



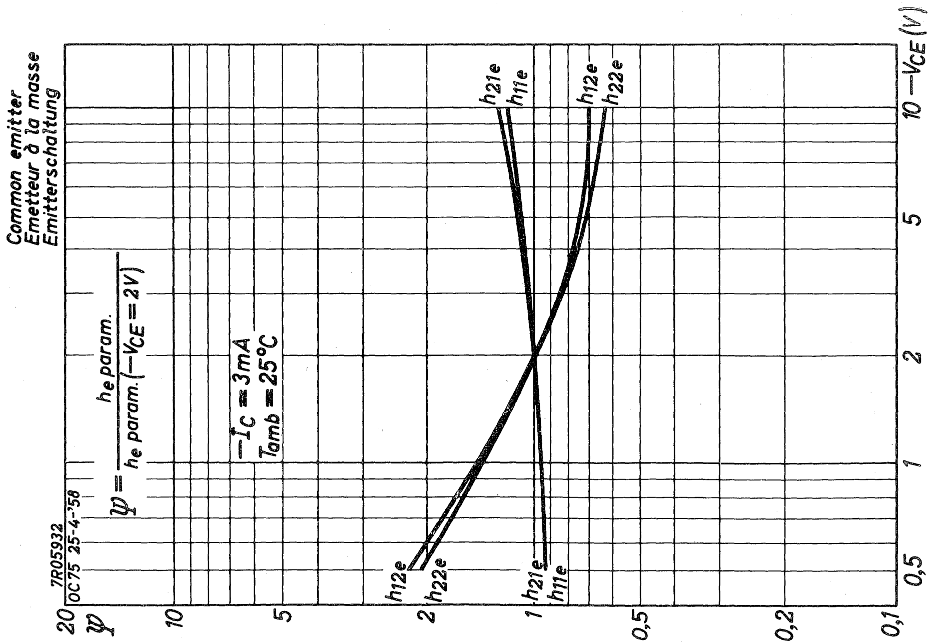

7R05500
OC70 9-5-'57
Tj (°C)
100
80
60
40
20
1000
100
10
1
ICBO(Tj) / ICBO(Tj=25°C)

D

F


Common emitter
Emetteur à la masse
Emitterschaltung
Φ = he param. / he param. (−IC=3mA)
−VCE=2V
Tamb =25°C
7R05933 25-4-'58
OC 75
h11e
h12e
h21e
h22e
Φ
20
10
5
2
1
0,5
0,2
0,1
0,5
1
2
5
10 −IC(mA)

E

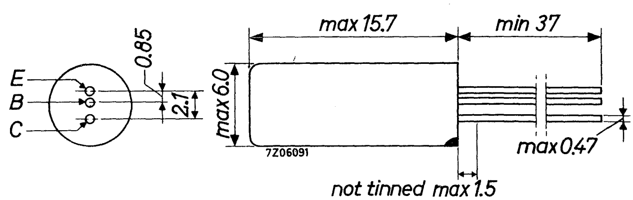

Common emitter
Emetteur à la masse
Emitterschaltung
Ψ = he param. / he param. (−VCE=2V)
−IC = 3mA
Tamb = 25°C
7R05932 25-4-'58
OC 75
h12e
h22e
h21e
h11e
Ψ
20
10
5
2
1
0,5
0,2
0,1
0,5
1
2
5
10 −VCE (V)

GERMANIUM SWITCHING TRANSISTOR

P-N-P transistor in all glass envelope with metal cover. It is primarily intended for switching and pulse-oscillating circuits such as d.c. converters.

QUICK REFERENCE DATA				
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	32	V
Collector-emitter voltage ($R_{BE} < 1$ kΩ)	$-V_{CER}$	max.	32	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	16	V
Collector current (peak value)	$-I_{CM}$	max.	250	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	165	mW
D.C. current gain				
$-I_C$ = 10 mA; $-V_{CE}$ = 5.4 V	h_{FE}		45 to 330	
Cut-off frequency				
I_E = 10 mA; $-V_{CB}$ = 6 V	f_{hfb}	>	350	kHz

MECHANICAL DATA Dimensions in mm



The red dot indicates the collector

7Z3 0722

RATINGS (Limiting values) [1]

Voltages

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	32	V
Collector-emitter voltage ($R_{BE} < 1\ k\Omega$)	$-V_{CER}$	max.	32	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	16	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	10	V

Currents

Collector current (d.c.)	$-I_C$	max.	125	mA
Collector current (peak value)	$-I_{CM}$	max.	250	mA
Base current (d.c.)	$-I_B$	max.	20	mA
Base current (peak value)	$-I_{BM}$	max.	125	mA
Reverse base current (peak value)	$+I_{BM}$	max.	125	mA

Power dissipation

Total power dissipation up to T_{amb} = 25 °C

without cooling fin	P_{tot}	max.	125	mW
with cooling fin 56200 on a heatsink of at least 12.5 cm^2	P_{tot}	max.	165	mW

Temperatures

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

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	0.4	°C/mW
From junction to ambient with cooling fin 56200 on a heatsink of at least 12.5 cm^2	$R_{th\ j\text{-}a}$	=	0.3	°C/mW

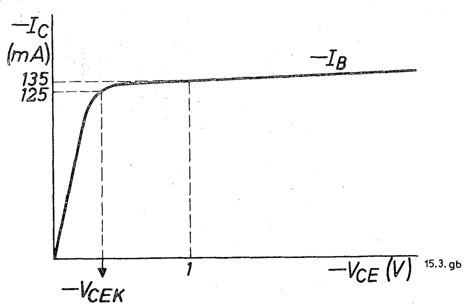
[1]) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

7Z3 0723

CHARACTERISTICS

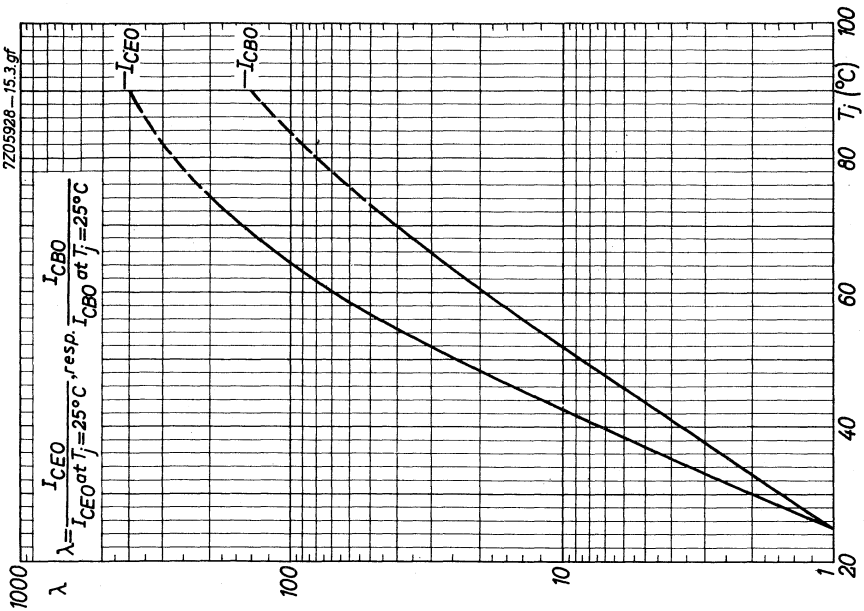
T_{amb} = 25 °C unless otherwise specified

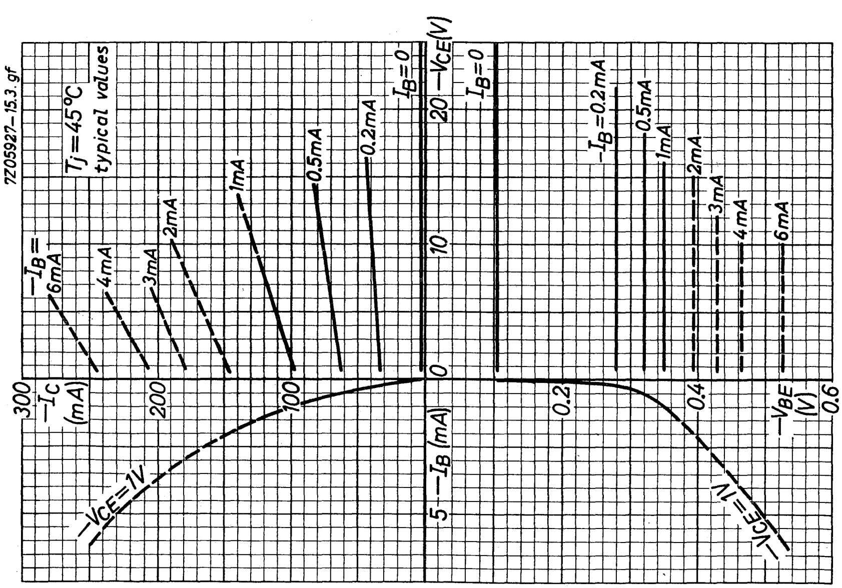
Collector cut-off current		
$I_E = 0$; $-V_{CB} = 10$ V	$-I_{CBO}$	typ. 4.5 μA < 10 μA
$I_B = 0$; $-V_{CE} = 6$ V	$-I_{CEO}$	typ. 200 μA < 600 μA
$+V_{BE} = 0.5$ V; $-V_{CE} = 30$ V	$-I_{CEX}$	typ. 7.5 μA < 15 μA
Emitter cut-off current		
$I_C = 0$; $-V_{EB} = 10$ V	$-I_{EBO}$	typ. 4.5 μA < 8 μA
Base-emitter voltage		
$I_E = 80$ mA; $-V_{CE} = 0.7$ V	$-V_{BE}$	< 0.45 V
$I_E = 125$ mA; $-V_{CE} = 0.7$ V	$-V_{BE}$	< 0.70 V
Knee voltage		
$-I_C = 125$ mA; $-I_B$ = value for which $-I_C = 135$ mA at $-V_{CE} = 1$ V	$-V_{CEK}$	typ. 0.3 V < 0.4 V



D.C. current gain		
$-I_C = 10$ mA; $-V_{CE} = 5.4$ V	h_{FE}	45 to 330
$-I_C = 80$ mA; $-V_{CE} = 0.7$ V	h_{FE}	30 to 230
$-I_C = 125$ mA; $-V_{CE} = 0.7$ V	h_{FE}	25 to 170
$-I_C = 250$ mA; $-V_{CE} = 1$ V	h_{FE}	15 to 125
Cut-off frequency		
$I_E = 10$ mA; $-V_{CB} = 6$ V	f_{hfb}	> 350 kHz typ. 900 kHz
Noise figure at f = 1 kHz		
$I_E = 0.5$ mA; $-V_{CE} = 2$ V; $R_S = 500\ \Omega$	F	typ. 8 dB < 15 dB

7Z3 0724


7Z05928–15.3.gf
λ
1000
100
10
1
20
40
60
80
100
Tj (°C)
−ICEO
−ICBO
λ = ICEO / ICEO at Tj=25°C, resp. ICBO / ICBO at Tj=25°C

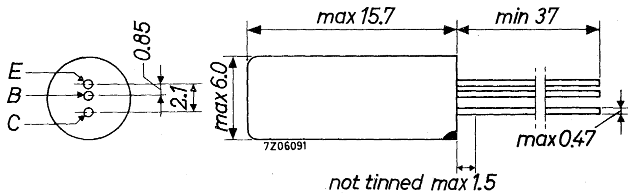

7Z05927–15.3.gf
Tj = 45°C
typical values
−IB = 6mA
4mA
3mA
2mA
1mA
0.5mA
0.2mA
IB=0
−IC (mA)
300
200
100
0
10
20
−VCE(V)
5
−IB (mA)
−VCE=1V
IB=0
−IB=0.2mA
0.5mA
1mA
2mA
3mA
4mA
6mA
0.2
0.4
0.6
−VBE (V)
−VCE=1V

GERMANIUM SWITCHING TRANSISTOR

P-N-P transistor in all glass envelope with metal cover. It is primarily intended for switching and pulse-oscillating circuits such as d.c. converters.

QUICK REFERENCE DATA				
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60	V
Collector-emitter voltage (R_{BE} < 400 Ω)	$-V_{CER}$	max.	60	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	15	V
Collector current (peak value)	$-I_{CM}$	max.	250	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	165	mW
D.C. current gain $-I_C$ = 10 mA; $-V_{CE}$ = 5.4 V	h_{FE}	45 to	330	
Cut-off frequency I_E = 10 mA; $-V_{CB}$ = 6 V	f_{hfb}	>	350	kHz

MECHANICAL DATA Dimensions in mm



The red dot indicates the collector

7Z3 0730

RATINGS (limiting values) [1])

Voltages

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60	V
Collector-emitter voltage ($R_{BE} < 400\ \Omega$)	$-V_{CER}$	max.	60	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	15	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	10	V

Currents

Collector current (d.c.)	$-I_C$	max.	125	mA
Collector current (peak value)	$-I_{CM}$	max.	250	mA
Base current (d.c.)	$-I_B$	max.	20	mA
Base current (peak value)	$-I_{BM}$	max.	125	mA
Reverse base current (peak value)	$+I_{BM}$	max.	125	mA

Power dissipation

Total power dissipation up to T_{amb} = 25 °C				
without cooling fin	P_{tot}	max.	125	mW
with cooling fin 56200 on a heatsink of at least 12.5 cm^2	P_{tot}	max.	165	mW

Temperatures

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

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	0.4	°C/mW
From junction to ambient with cooling fin 56200 on a heatsink of at least 12.5 cm^2	$R_{th\ j-a}$	=	0.3	°C/mW

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

7Z3 0731

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

Collector cut-off current

$I_E = 0$; $-V_{CB} = 10$ V	$-I_{CBO}$	typ.	4.5	μA
		<	10	μA
$I_B = 0$; $-V_{CE} = 6$ V	$-I_{CEO}$	typ.	200	μA
		<	600	μA
$+V_{BE} = 0.5$ V; $-V_{CE} = 60$ V	$-I_{CEX}$	typ.	15	μA
		<	30	μA

Emitter cut-off current

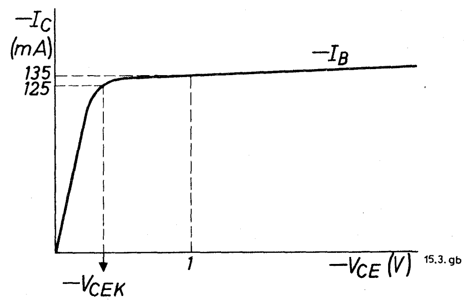
$I_C = 0$; $-V_{EB} = 10$ V	$-I_{EBO}$	typ.	4.5	μA
		<	10	μA

Base-emitter voltage

$I_E = 80$ mA; $-V_{CE} = 0.7$ V	$-V_{BE}$	<	0.45	V
$I_E = 125$ mA; $-V_{CE} = 0.7$ V	$-V_{BE}$	<	0.70	V

Knee voltage

$-I_C = 125$ mA; $-I_B$ = value for which $-I_C = 135$ mA at $-V_{CE} = 1$ V	$-V_{CEK}$	<	0.4	V



D.C. current gain

$-I_C = 10$ mA; $-V_{CE} = 5.4$ V	h_{FE}	>	45
$-I_C = 80$ mA; $-V_{CE} = 0.7$ V	h_{FE}	>	30
$-I_C = 125$ mA; $-V_{CE} = 0.7$ V	h_{FE}	>	25
$-I_C = 250$ mA; $-V_{CE} = 1$ V	h_{FE}	>	15

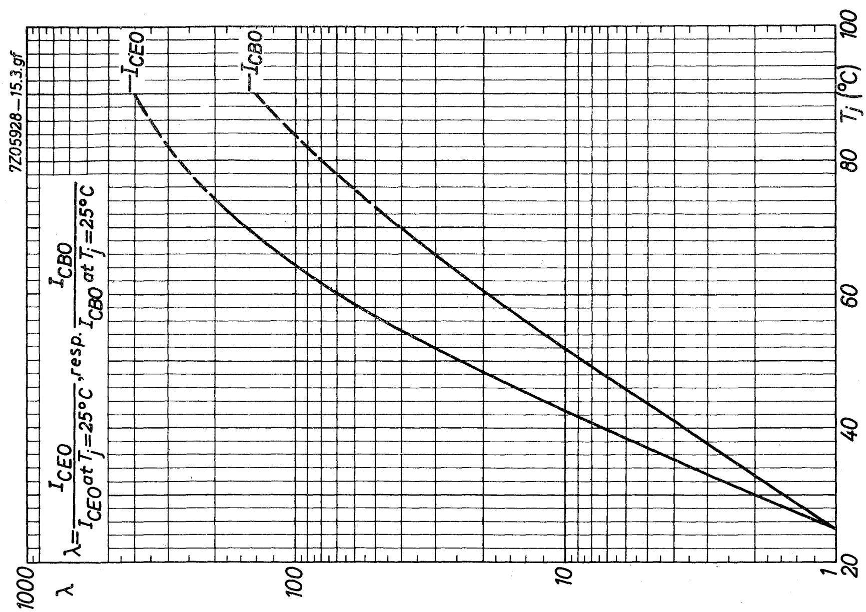
Cut-off frequency

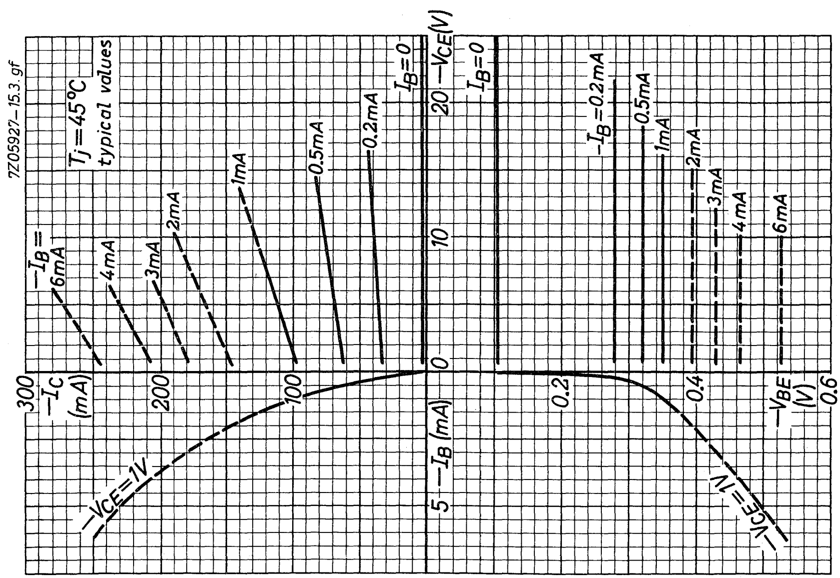
$I_E = 10$ mA; $-V_{CB} = 6$ V	f_{hfb}	>	350	kHz

Noise figure at f = 1 kHz

$I_E = 0.5$ mA; $-V_{CE} = 2$ V; $R_S = 500\ \Omega$	F	<	15	dB

7Z3 0732


7Z05928–15.3.gf
λ = $\frac{I_{CEO}}{I_{CEO} \text{ at } T_j = 25°C}$, resp. $\frac{I_{CBO}}{I_{CBO} \text{ at } T_j = 25°C}$
I_{CEO}
I_{CBO}
λ
1000
100
10
1
20
40
60
80
100
T_j (°C)


7Z05927–15.3.gf
T_j = 45°C
typical values
$-I_B$ =
6mA
4mA
3mA
2mA
1mA
0.5mA
0.2mA
I_B = 0
$-V_{CE}$(V)
I_B = 0
$-I_B$ = 0.2mA
0.5mA
1mA
2mA
3mA
4mA
6mA
$-I_C$ (mA)
300
200
100
0
10
20
0.2
0.4
0.6
$-V_{BE}$ (V)
5
$-I_B$ (mA)
$-V_{CE}$ = 1V
$-V_{CE}$ = 1V

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.

RATINGS (Limiting values) [1])

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	26	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	13	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	$R_{th\ j\text{-}a}$	=	0.22	°C/mW

CHARACTERISTICS

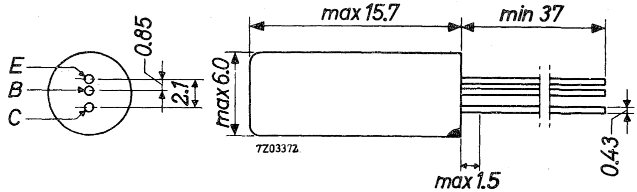
D.C. current gain at T_j = 25 °C

$-I_C$ = 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	kHz
		>	8	kHz

MECHANICAL DATA Dimensions in mm



Not tinned

The red dot indicates the collector.

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

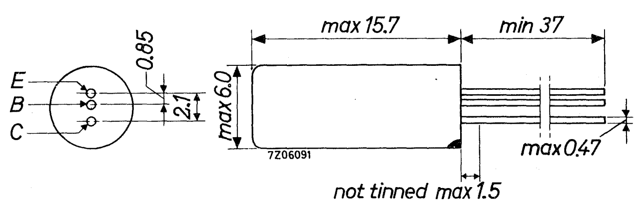
7Z3 0170

GERMANIUM SWITCHING TRANSISTOR

P-N-P transistor in all glass envelope with metal cover, primarily intended for switching and pulse-oscillating circuits.

QUICK REFERENCE DATA				
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	32	V
Collector-emitter voltage (V_{BE} = 0)	$-V_{CES}$	max.	32	V
Collector current (peak value)	$-I_{CM}$	max.	600	mA
Total power dissipation up to T_{amb} = 40 °C	P_{tot}	max.	550	mW
D.C. current gain				
$-I_C$ = 50 mA; $-V_{CE}$ = 6 V	h_{FE}	typ.	180	
Cut-off frequency				
I_E = 50 mA; $-V_{CB}$ = 6 V	f_{hfb}	typ.	2	MHz

MECHANICAL DATA Dimensions in mm



The red dot indicates the collector

7Z3 0733

RATINGS (Limiting values) [1]

Voltages

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	32	V
Collector-emitter voltage (V_{BE} = 0)	$-V_{CES}$	max.	32	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	20	V

Currents

Collector current (d.c. or average over any 50 ms period)	$-I_C$	max.	300	mA
Collector current (peak value)	$-I_{CM}$	max.	600	mA
Base current (d.c. or average over any 50 ms period)	$-I_B$	max.	40	mA
Base current (peak value)	$-I_{BM}$	max.	200	mA

Power dissipation

Total power dissipation up to T_{amb} = 40 °C	P_{tot}	max.	550	mW

Temperatures

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

THERMAL RESISTANCE

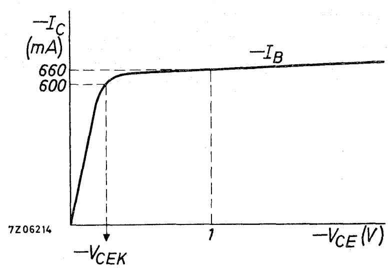
From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	0.22	°C/mW
From junction to ambient with cooling fin 56200 on a heatsink of at least 12.5 cm²	$R_{th\ j\text{-}a}$	=	0.09	°C/mW

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

7Z3 0734

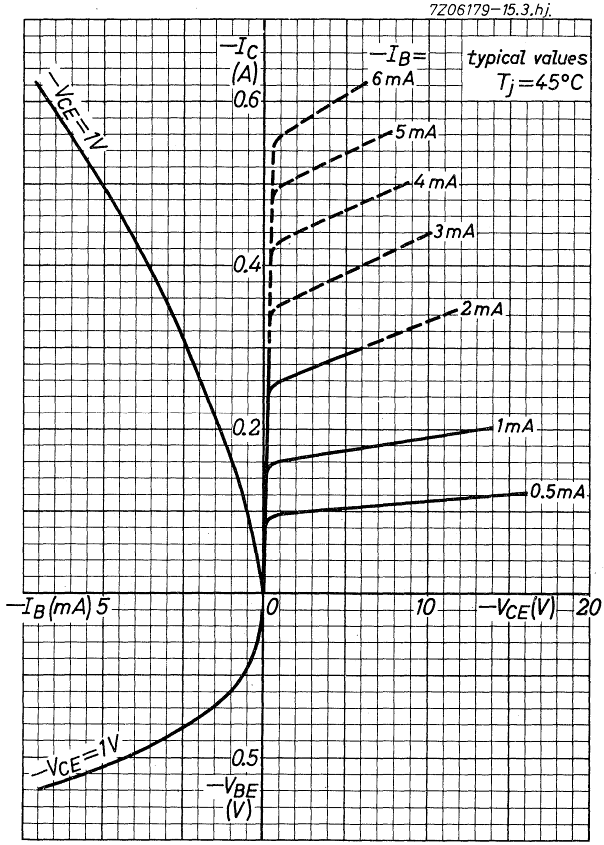
CHARACTERISTICS T_{amb} = 25 °C unless otherwise specified

Collector cut-off current				
$I_E = 0$; $-V_{CB} = 12$ V	$-I_{CBO}$	typ. <	10 20	μA μA
$I_E = 0$; $-V_{CB} = 12$ V; $T_{amb} = 60$ °C	$-I_{CBO}$	<	330	μA
Emitter cut-off current				
$I_C = 0$; $-V_{EB} = 6$ V	$-I_{EBO}$	typ. <	6 20	μA μA
Sustaining voltage				
$-I_C = 600$ mA; $V_{BE} = 0$	$-V_{CESsust}$	>	32	V
Base-emitter voltage				
$-I_C = 600$ mA; $V_{CB} = 0$	$-V_{BE}$	typ.	0.6	V
Knee voltage				
$-I_C = 600$ mA; $-I_B$ = value for which $-I_C = 660$ mA at $-V_{CE} = 1$ V	$-V_{CEK}$	typ. <	0.4 0.9	V V



Emitter-base floating voltage				
$I_E = 0$; $-V_{CB} = 32$ V	V_{EBfl}	<	0.55	V
D.C. current gain				
$-I_C = 50$ mA; $-V_{CE} = 6$ V	h_{FE}	typ.	180	
$-I_C = 600$ mA; $-V_{CB} = 0$	h_{FE}	typ.	85	
Cut-off frequency				
$I_E = 50$ mA; $-V_{CB} = 6$ V	f_{hfb}	typ.	2	MHz
Feedback impedance at f = 0.5 MHz				
$I_E = 1$ mA; $-V_{CE} = 6$ V	$\lvert z_{rb} \rvert$	typ.	60	Ω

7Z3 0735

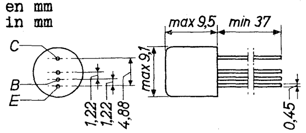

7Z06179-15.3.hj.
$-I_C$ (A)
$-I_B$=
typical values
T_j=45°C
6 mA
5 mA
4 mA
3 mA
2 mA
1 mA
0.5 mA
0.6
0.4
0.2
$-V_{CE}$=1V
$-I_B$ (mA) 5
0
10
$-V_{CE}$ (V)
20
$-V_{CE}$=1V
0.5
$-V_{BE}$ (V)

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

7Z2 2359

<u>Thermal data.</u> Thermal resistance from

junction to ambience in free air	K = max. 0.22 °C/mW
junction to case	K = max. 0.06 °C/mW

<u>Données thermiques.</u> 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

<u>Thermische Daten.</u> 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

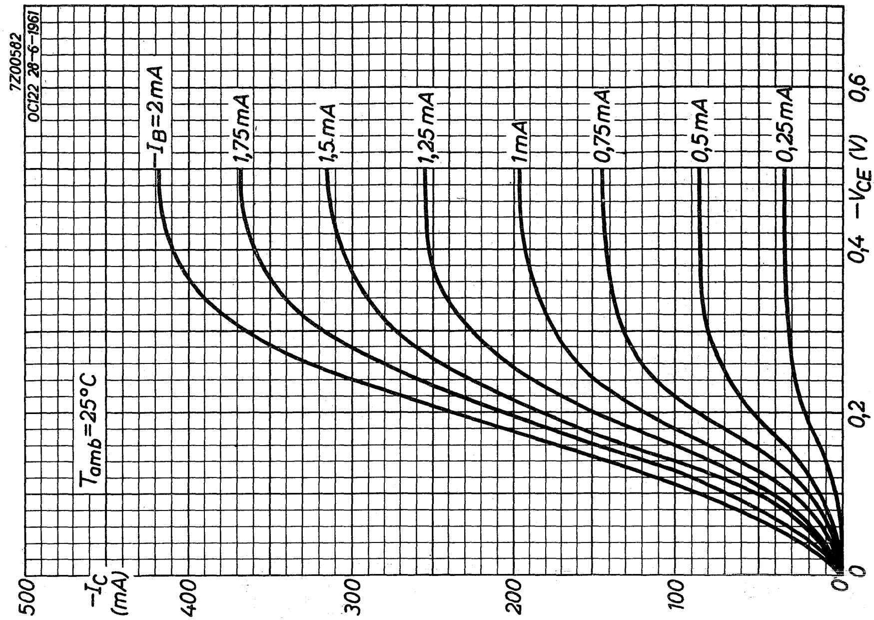
$-V_{CB}$	= 24 V		$-V_{CE}$	= 2 V	
$-I_{CBO}$	= 40 µA	< 150 µA	$-I_C$	= 100 mA	
			$-V_{BE}$	= 0,27 V	< 0,35 V
$-V_{CB}$	= 32 V				
$-I_{CBO}$	= 50 µA	< 350 µA	$-V_{CE}$	= 6 V	
			$-I_C$	= 100 mA	
$-V_{EB}$	= 10 V		h_{FE}	= 180	> 50
$-I_{EBO}$	= 20 µA	< 100 µA			

$-V_{CE}$		= 2 V
$-I_C$		= 100 mA
$r_{bb'}$	intrinsic base resistance résistance de base intrinsèque innere Basiswiderstand	= 80 Ω
f_1	frequency at which $\|h_{fe}\|$ = 1 fréquence à laquelle $\|h_{fe}\|$ = 1 Frequenz bei der $\|h_{fe}\|$ = 1	= 1,3 Mc/s
g_m	intrinsic transconductance transconductance intrinsèque innere Steilheit	= 4,0 mA/V

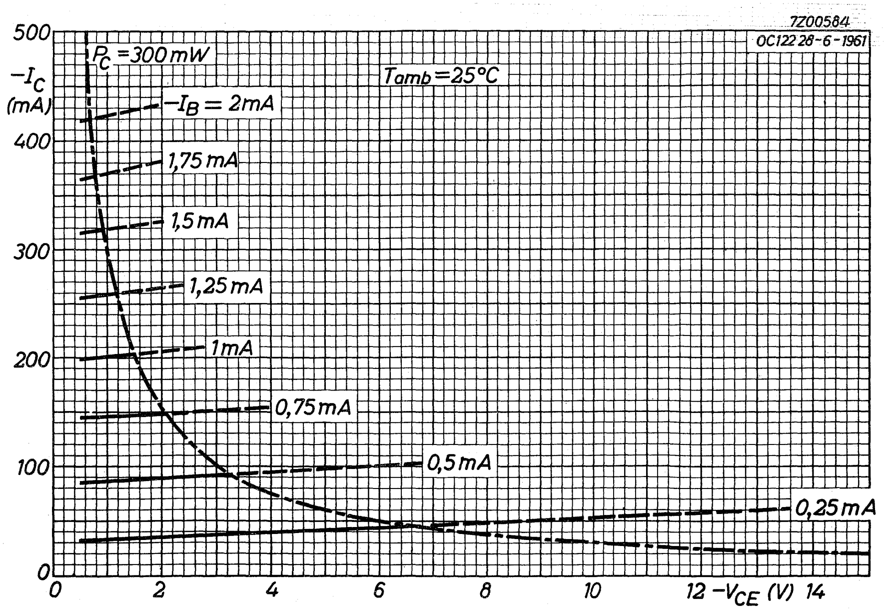
$-V_{CE}$		= 6 V
I_E		= 0 mA
$C_{b'c}$	feedback capacitance capacité de réaction Rückwirkungskapazität	= 170 pF

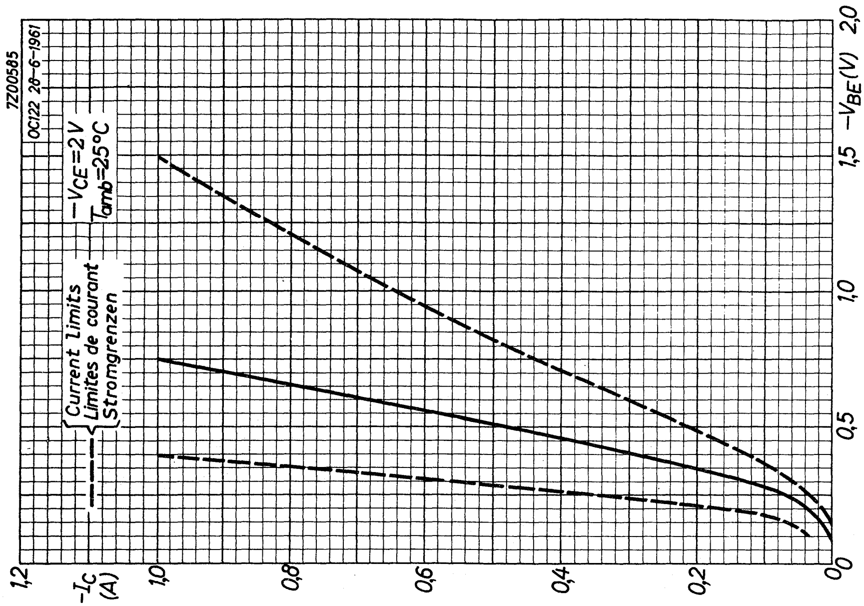
7Z2 0994 2.

B

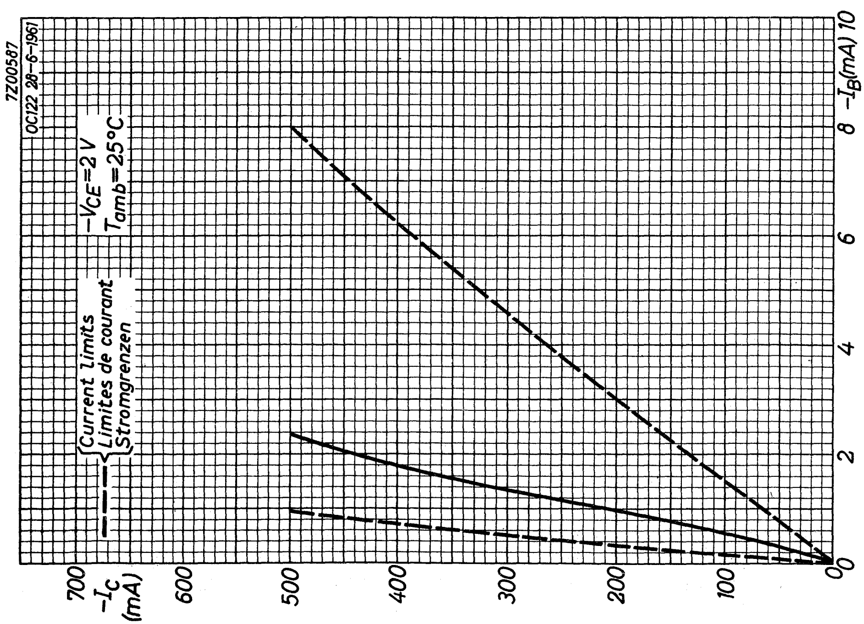

7Z00582
OC122 28-6-1961
−IB=2mA
1,75mA
1,5mA
1,25mA
1mA
0,75mA
0,5mA
0,25mA
Tamb=25°C
−IC (mA)
500
400
300
200
100
0
0
0,2
0,4
0,6
−VCE (V)

A

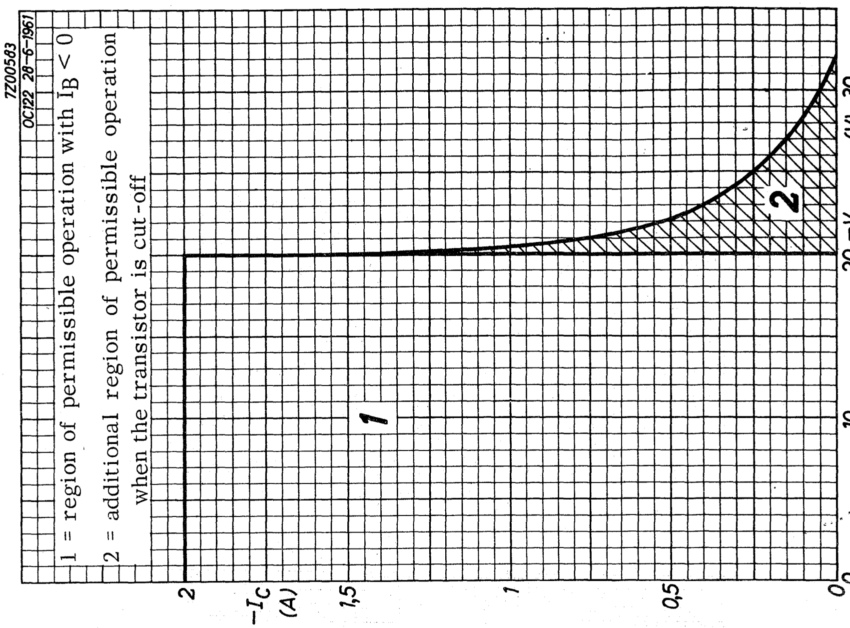

7Z00584
OC122 28-6-1961
PC=300mW
Tamb=25°C
−IB = 2mA
1,75 mA
1,5 mA
1,25 mA
1 mA
0,75 mA
0,5 mA
0,25 mA
−IC (mA)
500
400
300
200
100
0
0
2
4
6
8
10
12 −VCE (V) 14


7Z00585
OC122 28-6-1961
Current limits
Limites de courant
Stromgrenzen
−V_CE=2 V
T_amb=25°C
−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

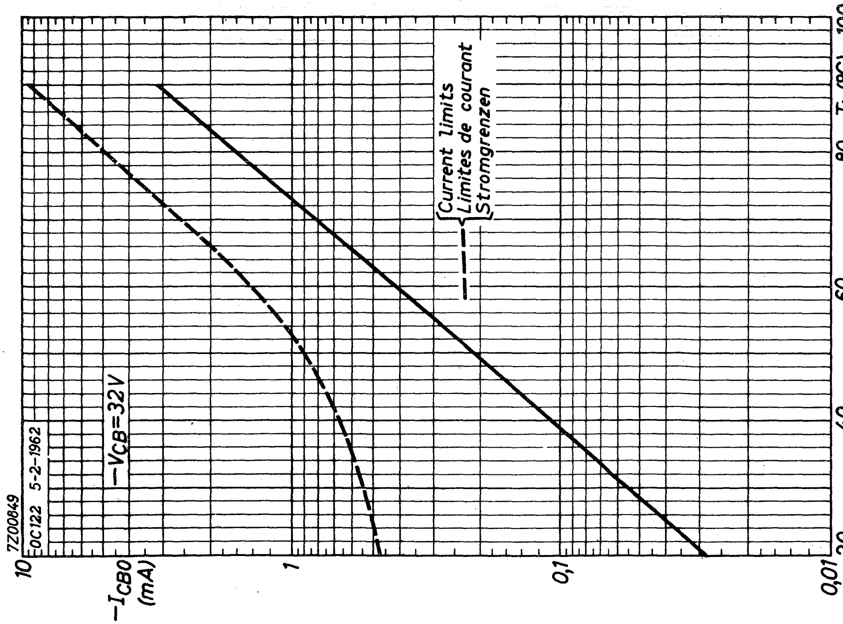

7Z00587
OC122 28-6-1961
Current limits
Limites de courant
Stromgrenzen
−V_CE=2 V
T_amb=25°C
−I_C (mA)
700
600
500
400
300
200
100
0
0
2
4
6
8
10
−I_B(mA)

C



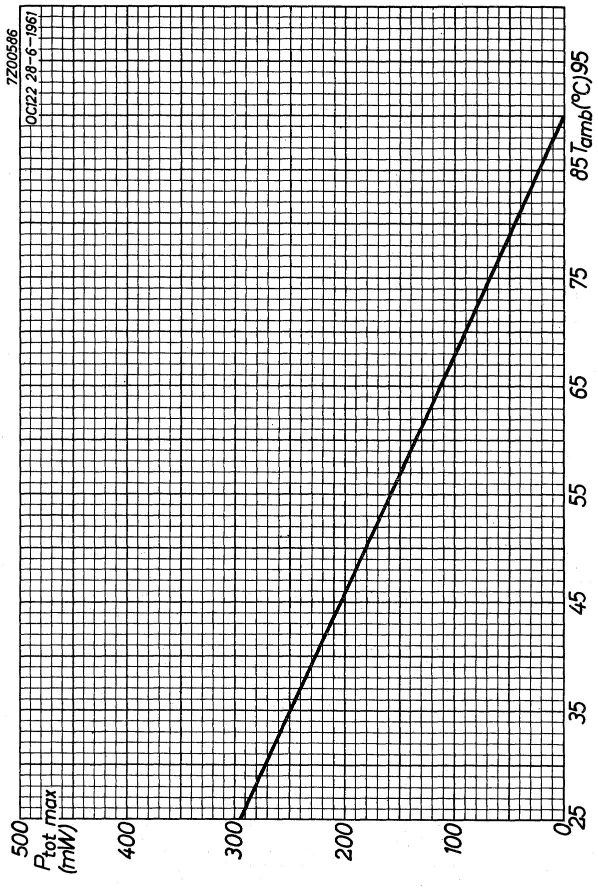
7Z00583
OC122 28-6-1961
1 = region of permissible operation with $I_B < 0$
2 = additional region of permissible operation when the transistor is cut-off
1
2
$-I_C$ (A)
2
1,5
1
0,5
0
0
10
20
30
$-V_{CEmax}$ (V)

F



7Z00849
OC122 5-2-1962
$-V_{CB}=32V$
Current limits
Limites de courant
Stromgrenzen
$-I_{CBO}$ (mA)
10
1
0,1
0,01
20
40
60
80
100
T_j (°C)

E


7Z00586
OC122 28-6-1961
Ptot max
(mW)
500
400
300
200
100
0
25
35
45
55
65
75
85
95
Tamb(°C)

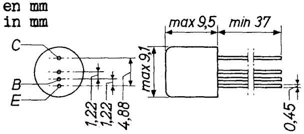
G

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	=	$-55^{\circ}C/+75^{\circ}C$
T_j	= max.	90 °C

[1]) See also page G
Voir aussi page G
Siehe auch Seite G

7Z2 2360

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

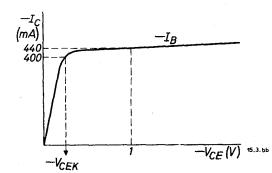
Thermische Daten. Wärmewiderstand

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			$-V_{CE}$ =	2 V	
$-I_{CBO}$ = 20 µA	< 100 µA		$-I_C$ =	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

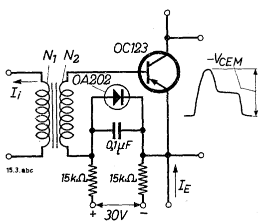
$-V_{CEK}$ = 0,35 V

7Z2 0996

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

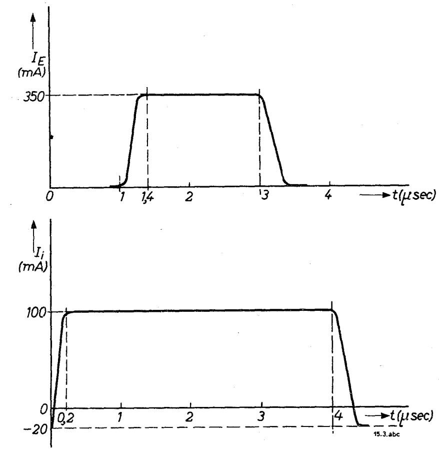


$N_1 = N_2 =$ 30 turns / 30 spires / 30 Windungen

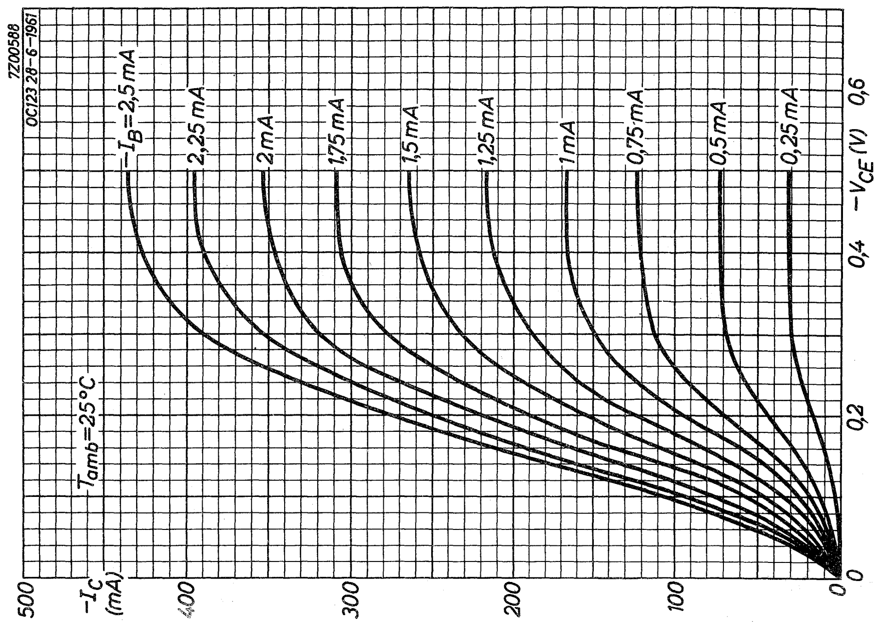
$-V_{CEM} = 2{,}4\ V < 3{,}0\ V$

[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

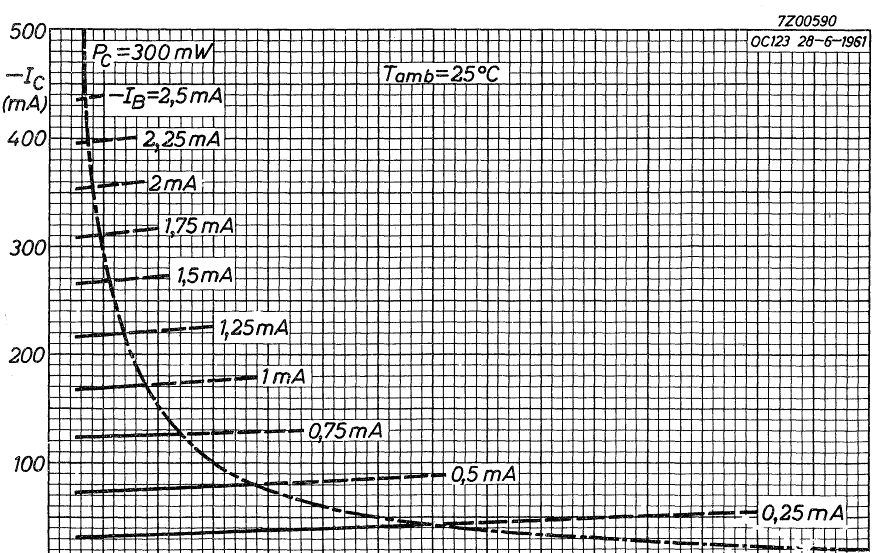
Operating characteristics for gating large current pulses (continued)
Caractéristiques d'utilisation comme porte pour des impulsions de courant élevé (suite)
Betriebsdaten als Tor für grosse Stromimpulse (Fortsetzung)



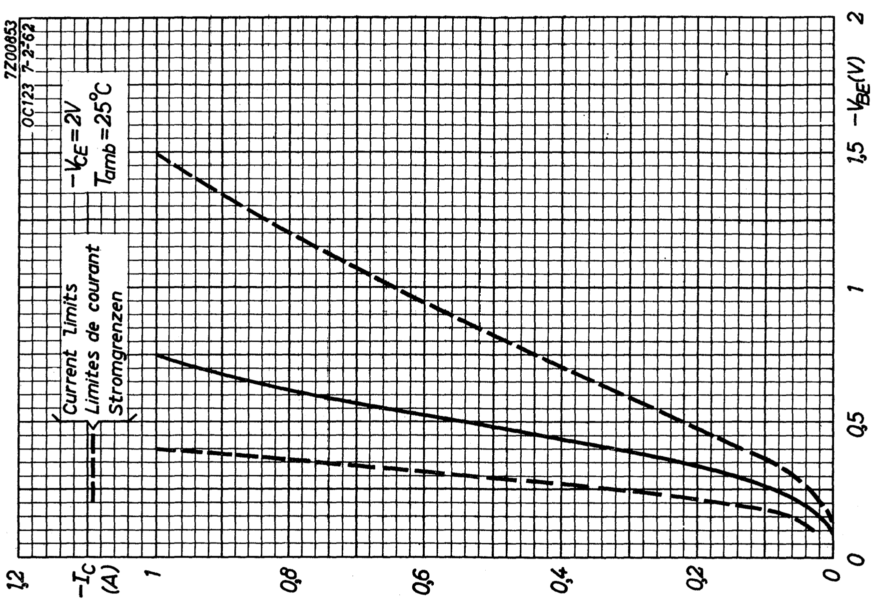
The base current pulse is applied 1 μsec before the gating pulse to ensure that the transistor is fully bottomed and $-V_{CEM}$ is kept to a minimum
L'impulsion de courant de base est appliquée 1 μsec avant l'impulsion de courant d'émetteur pour assurer que le transistor est surexcité complètement et $-V_{CEM}$ 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


7Z00588
OC123 28-6-1961
$-I_B$=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
T_{amb}=25°C
$-I_C$ (mA)
500
400
300
200
100
0
$-V_{CE}$ (V)
0,2
0,4
0,6

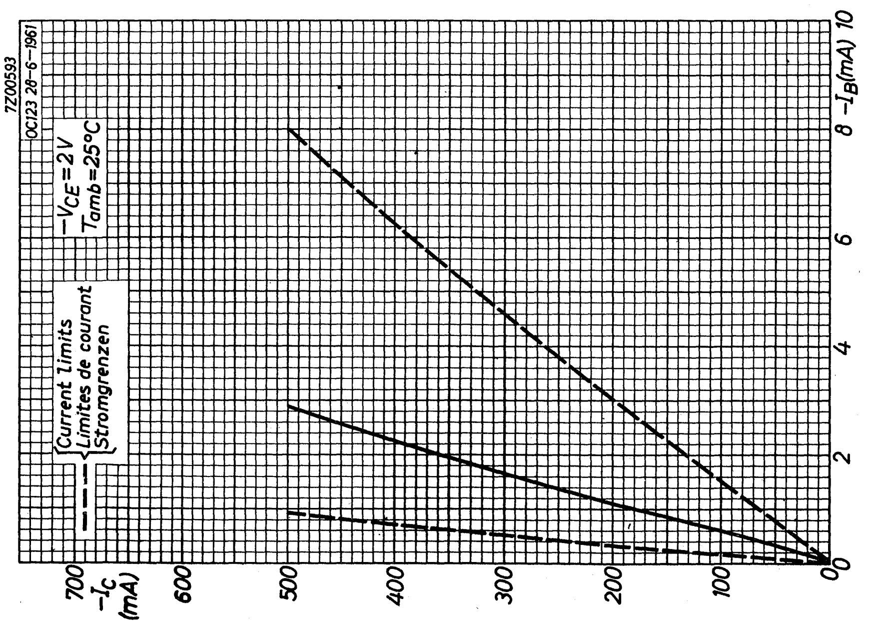
B


7Z00590
OC123 28-6-1961
P_C=300 mW
$-I_B$=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
T_{amb}=25°C
$-I_C$ (mA)
500
400
300
200
100
0
2
4
6
8
10
12
$-V_{CE}$ (V)
14

A

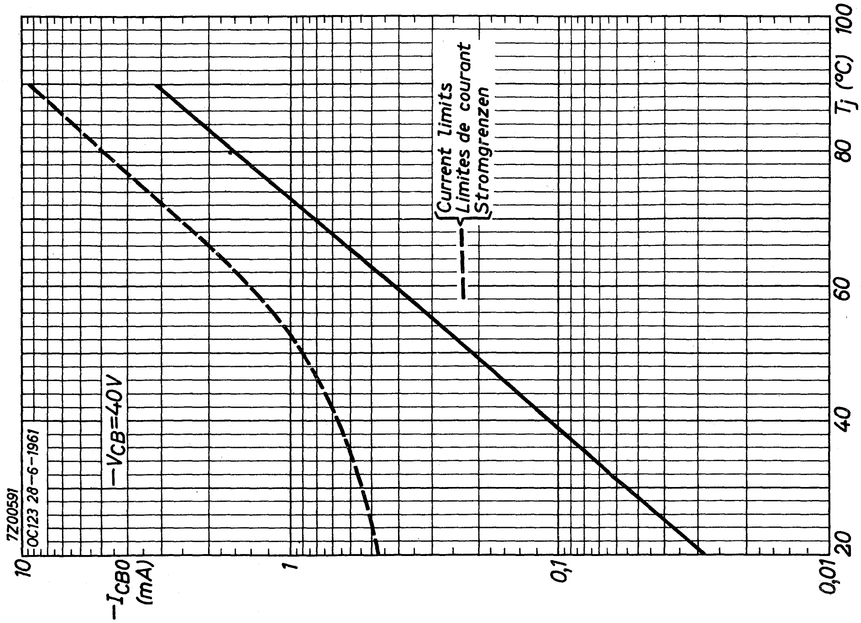

7Z00853
OC123 7-2-'62
−VCE=2V
Tamb=25°C
Current limits
Limites de courant
Stromgrenzen
−IC (A)
1,2
1
0,8
0,6
0,4
0,2
0
0
0,5
1
1,5
2
−VBE(V)

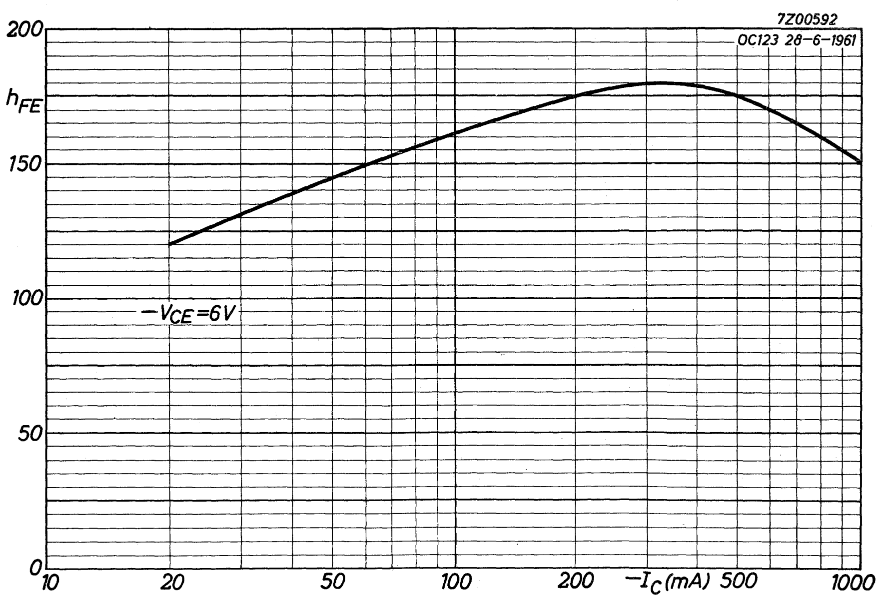
D


7Z00593
OC123 28-6-1961
−VCE=2V
Tamb=25°C
Current limits
Limites de courant
Stromgrenzen
−IC (mA)
700
600
500
400
300
200
100
0
0
2
4
6
8
10
−IB(mA)

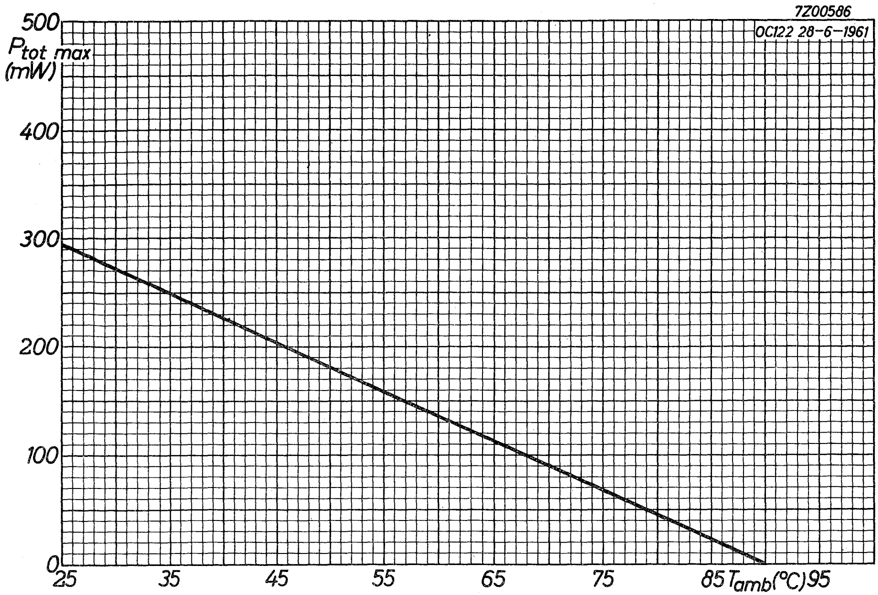
C

F

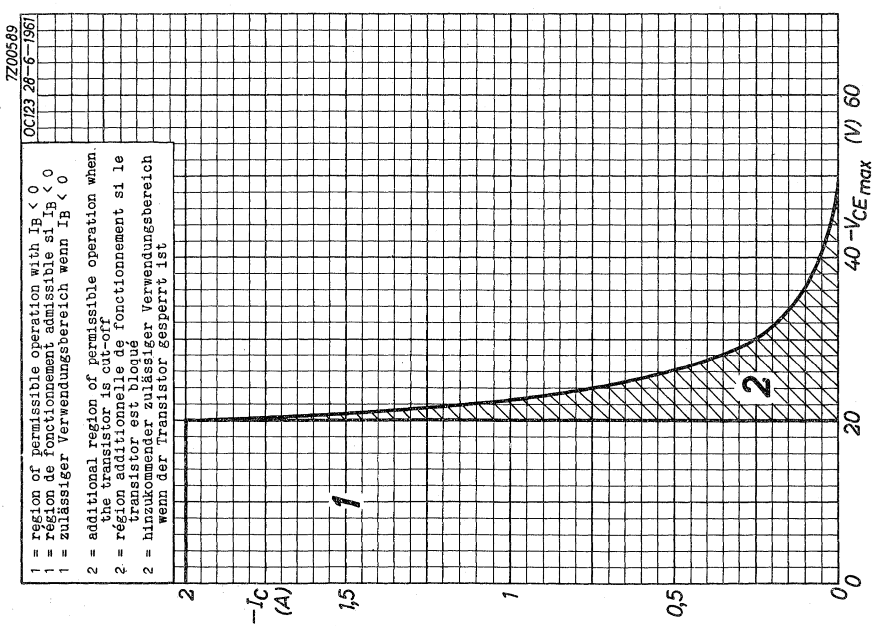

7Z00591
OC123 28-6-1961
−VCB=40V
Current limits
Limites de courant
Stromgrenzen
Tj (°C)
20
40
60
80
100
−ICBO (mA)
10
1
0,1
0,01


7Z00592
OC123 28-6-1961
hFE
200
150
100
50
0
−VCE=6V
10
20
50
100
200
−IC (mA)
500
1000

E


7Z00586
OC122 28-6-1961
500
$P_{tot\ max}$ (mW)
400
300
200
100
0
25
35
45
55
65
75
85 T_{amb}(°C) 95

H


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
$-V_{CE\ max}$ (V)
60
40
20
0
$-I_C$ (A)
2
1,5
1
0,5
0

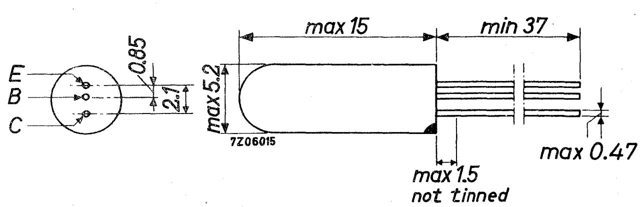
G

SYMMETRICAL SWITCHING TRANSISTOR

N-P-N germanium transistor with symmetrical structure in all glass construction. It is intended for high current, high speed computer switching applications.

QUICK REFERENCE DATA				
Collector-base voltage (open emitter)	V_{CBO}	max.	20	V
Emitter-base voltage (open collector)	V_{EBO}	max.	20	V
Collector-emitter voltage ($-V_{BE} > 2$ V)	V_{CEX}	max.	20	V
Collector current (d.c. or average)	I_C	max.	250	mA
Total power dissipation up to $T_{amb} = 25$ °C	P_{tot}	max.	145	mW
Junction temperature	T_j	max.	75	°C
D.C. current gain at $T_{amb} = 25$ °C				
$I_C = 15$ mA; $V_{CB} = 0$	h_{FE}		20 to 84	
Transition frequency				
$I_C = 3$ mA; $V_{CE} = 5$ V	f_T	>	3.5	MHz

MECHANICAL DATA Dimensions in mm



The red dot indicates the collector

7Z3 0736

RATINGS (Limiting values) [1])

Voltages

Collector-base voltage (open emitter)	V_{CBO}	max.	20	V
Collector-emitter voltage with $-V_{BE} > 2$ V	V_{CEX}	max.	20	V
Emitter-base voltage (open collector)	V_{EBO}	max.	20	V

Currents

Collector current (d.c. or average over any 20 ms period)	I_C	max.	250	mA
Emitter current (d.c. or average over any 20 ms period)	$-I_E$	max.	250	mA
Base current (d.c. or average over any 20 ms period)	I_B	max.	40	mA
Base current (peak value)	I_{BM}	max.	250	mA

Power dissipation

Total power dissipation up to $T_{amb} = 25\ ^oC$	P_{tot}	max.	145	mW

Temperatures

Storage temperature	T_{stg}		-55 to +75	^oC
Junction temperature	T_j	max.	75	^oC

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	0.35	$^oC/mW$
From junction to case	$R_{th\ j-c}$	=	0.20	$^oC/mW$

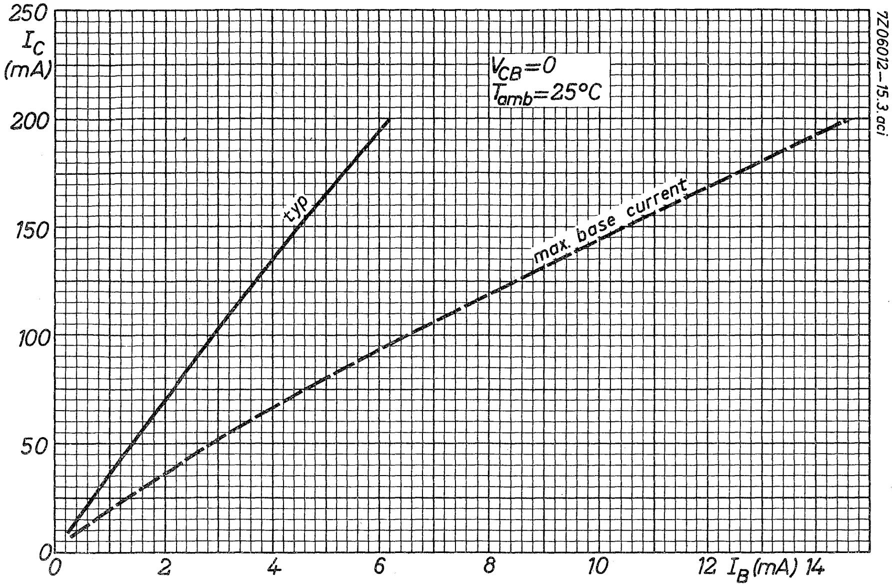
[1]) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

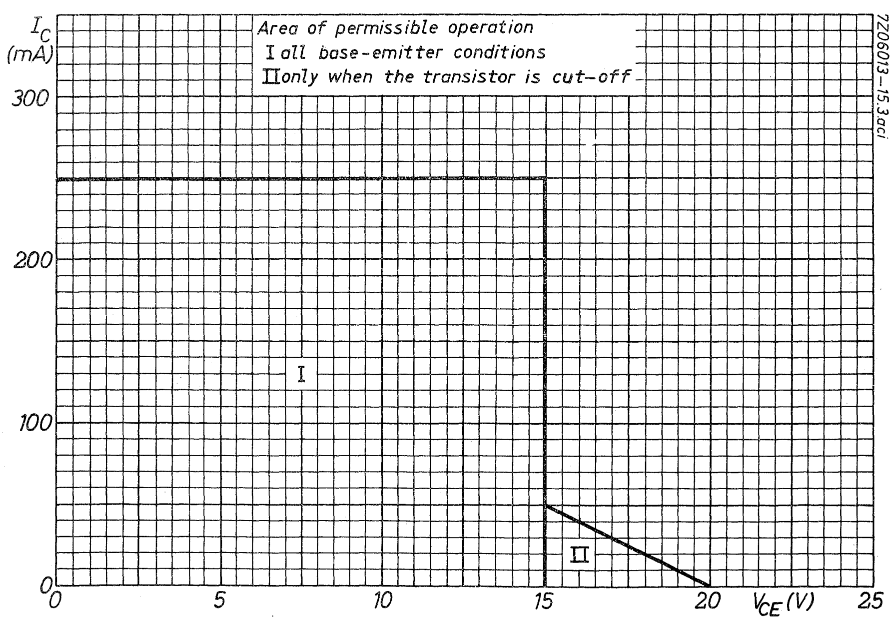
7Z3 0737

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

Collector cut-off current				
$I_E = 0$; $V_{CB} = 5$ V	I_{CBO}	typ.	0.3	μA
		<	3	μA
$I_E = 0$; $V_{CB} = 5$ V; $T_j = 60$ °C	I_{CBO}	typ.	6	μA
		<	35	μA
$I_E = 0$; $V_{CB} = 20$ V; $T_j = 60$ °C	I_{CBO}	<	100	μA
Emitter cut-off current				
$I_C = 0$; $V_{EB} = 5$ V	I_{EBO}	typ.	0.3	μA
		<	3	μA
$I_C = 0$; $V_{EB} = 5$ V; $T_j = 60$ °C	I_{EBO}	typ.	6	μA
		<	35	μA
$I_C = 0$; $V_{EB} = 20$ V; $T_j = 60$ °C	I_{EBO}	<	100	μA
Sustaining voltage				
I_C 250 mA; $-V_{BE} = 2$ V	$V_{CEXsust}$	>	15	V
Base-emitter voltage				
$I_C = 200$ mA; $V_{CB} = 0$	V_{BE}	<	750	mV
Saturation voltages				
$I_C = 8.5$ mA; $I_B = 0.38$ mA	V_{CEsat}	<	175	mV
$I_C = 50$ mA; $I_B = 3.1$ mA	V_{CEsat}	typ.	60	mV
		<	220	mV
	V_{BEsat}	typ.	300	mV
		<	500	mV
Punch-through voltage	V_{pt}	>	20	V
D.C. current gain				
$I_C = 15$ mA; $V_{CB} = 0$	h_{FE}		20 to 84	
$I_C = 200$ mA; $V_{CB} = 0$	h_{FE}	>	15	
Transition frequency				
$I_C = 3$ mA; $V_{CE} = 5$ V	f_T	typ.	6	MHz
		>	3.5	MHz
Switching parameters				
Current-drive time constant $I_{CM} = 200$ mA; $V_{CE} = 0.75$ V	τ_c	<	1.75	μs
Voltage-drive time constant $I_{CM} = 1$ mA; $V_{CE} = 5$ V	τ_v	<	0.15	μs

7Z3 0738


250
I_C (mA)
200
150
100
50
0
0
2
4
6
8
10
12 I_B (mA) 14
$V_{CB}=0$
$T_{amb}=25°C$
typ
max. base current
7Z06012–15.3.aci

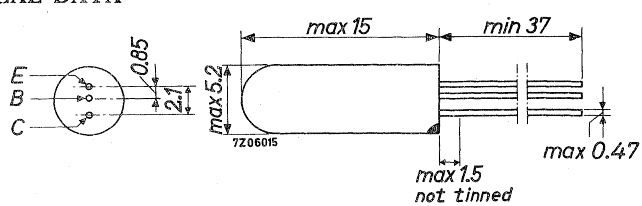

I_C (mA)
300
200
100
0
0
5
10
15
20
V_{CE} (V)
25
Area of permissible operation
I all base-emitter conditions
II only when the transistor is cut-off
I
II
7Z06013–15.3.aci

SYMMETRICAL SWITCHING TRANSISTOR

N-P-N germanium transistor with symmetrical structure in all glass construction. It is intended for high current, high speed computer switching applications.

QUICK REFERENCE DATA				
Collector-base voltage (open emitter)	V_{CBO}	max.	20	V
Emitter-base voltage (open collector)	V_{EBO}	max.	20	V
Collector-emitter voltage ($-V_{BE} > 2$ V)	V_{CEX}	max.	20	V
Collector current (d.c. or average)	I_C	max.	400	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	145	mW
Junction temperature	T_j	max.	75	°C
D.C. current gain at T_{amb} = 25 °C				
I_C = 15 mA; V_{CB} = 0	h_{FE}	50 to 150		
Transition frequency				
I_C = 3 mA; V_{CE} = 5 V	f_T	>	4.5	MHz

MECHANICAL DATA Dimensions in mm



The red dot indicates the collector

7Z3 0739

RATINGS (Limiting values) [1])

Voltages

Collector-base voltage (open emitter)	V_{CEO}	max.	20	V
Collector-emitter voltage with $-V_{BE} > 2$ V	V_{CEX}	max.	20	V
Emitter-base voltage (open collector)	V_{EBO}	max.	20	V

Currents

Collector current (d.c. or average over any 20 ms period)	I_C	max.	400	mA
Emitter current (d.c. or average over any 20 ms period)	$-I_E$	max.	400	mA
Base current (d.c. or average over any 20 ms period)	I_B	max.	40	mA
Base current (peak value)	I_{BM}	max.	400	mA

Power dissipation

Total power dissipation up to $T_{amb} = 25\ ^oC$	P_{tot}	max.	145	mW

Temperatures

Storage temperature	T_{stg}		−55 to + 75	^oC
Junction temperature	T_j	max.	75	^oC

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	0.35	^oC/mW
From junction to case	$R_{th\ j\text{-}c}$	=	0.20	^oC/mW

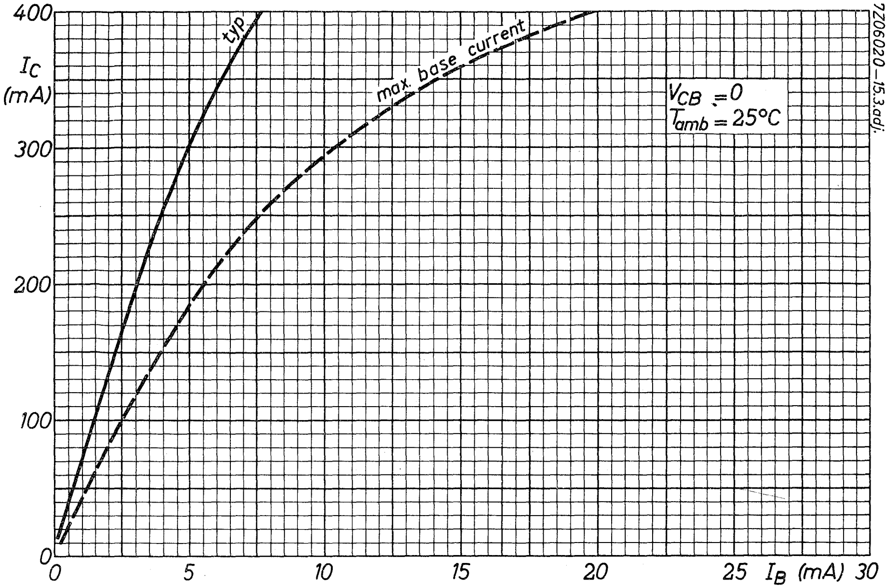
1) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

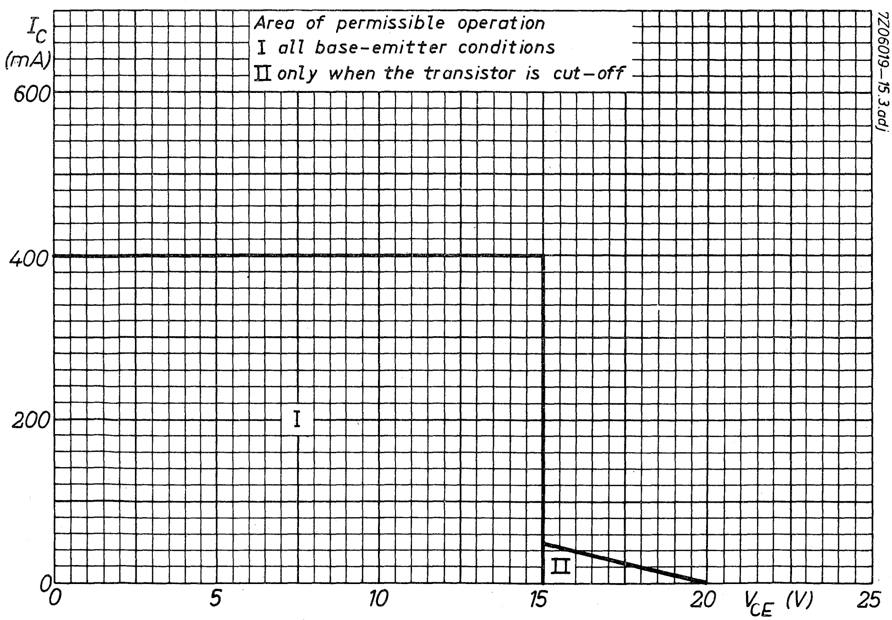
7Z3 0740

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

Collector cut-off current				
I_E = 0; V_{CB} = 5 V	I_{CBO}	typ. <	0.3 3	μA μA
I_E = 0; V_{CB} = 5 V; T_j = 60 °C	I_{CBO}	typ. <	6 35	μA μA
I_E = 0; V_{CB} = 20 V; T_j = 60 °C	I_{CBO}	<	100	μA
Emitter cut-off current				
I_C = 0; V_{EB} = 5 V	I_{EBO}	typ. <	0.3 3	μA μA
I_C = 0; V_{EB} = 5 V; T_j = 60 °C	I_{EBO}	typ. <	6 35	μA μA
I_C = 0; V_{EB} = 20 V; T_j = 60 °C	I_{EBO}	<	100	μA
Sustaining voltage				
I_C = 400 mA; $-V_{BE}$ = 2 V	$V_{CEXsust}$	>	15	V
Base-emitter voltage				
I_C = 200 mA; V_{CB} = 0	V_{BE}	<	600	mV
Saturation voltages				
I_C = 7.5 mA; I_B = 0.165 mA	V_{CEsat} V_{BEsat}	< <	175 250	mV mV
I_C = 50 mA; I_B = 1.25 mA	V_{CEsat} V_{BEsat}	< <	220 380	mV mV
I_C = 400 mA; I_B = 20 mA	V_{CEsat} V_{BEsat}	< <	370 900	mV mV
Punch-through voltage	V_{pt}	>	20	V
D.C. current gain				
I_C = 15 mA; V_{CB} = 0	h_{FE}	50 to 150		
I_C = 200 mA; V_{CB} = 0	h_{FE}	36 to 67		
I_E = 200 mA; V_{EB} = 0	h_{FC}	>	21	
Transition frequency				
I_C = 3 mA; V_{CE} = 5 V	f_T	typ. >	12 4.5	MHz MHz
Switching parameters				
Current-drive time constant I_{CM} = 200 mA; V_{CE} = 0.75 V	τ_c	<	1.75	μs
Voltage-drive time constant I_{CM} = 1 mA; V_{CE} = 5 V	τ_v	<	0.15	μs

7Z3 0741


400
I_C
(mA)
300
200
100
0
0
5
10
15
20
25
I_B (mA)
30
typ
max base current
V_{CB} = 0
T_{amb} = 25°C
7Z06020—15.3.adj.


I_C
(mA)
600
400
200
0
0
5
10
15
20
V_{CE} (V)
25
Area of permissible operation
I all base-emitter conditions
II only when the transistor is cut-off
I
II
7Z06019—15.3.adj.

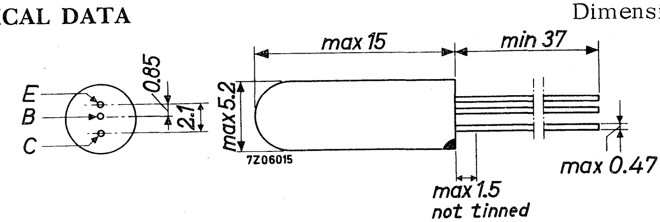
SYMMETRICAL SWITCHING TRANSISTOR

N-P-N germanium transistor with symmetrical structure in all glass construction. It is intended for high current, high speed computer switching applications.

QUICK REFERENCE DATA			
Collector-base voltage (open emitter)	V_{CBO}	max. 20	V
Emitter-base voltage (open collector)	V_{EBO}	max. 20	V
Collector-emitter voltage ($-V_{BE} > 2$ V)	V_{CEX}	max. 20	V
Collector current (d.c. or average)	I_C	max. 400	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max. 145	mW
Junction temperature	T_j	max. 75	°C
D.C. current gain at T_{amb} = 25 °C			
I_C = 15 mA; V_{CB} = 0	h_{FE}	80 to 200	
Transition frequency			
I_C = 3 mA; V_{CE} = 5 V	f_T	> 9	MHz

MECHANICAL DATA

Dimensions in mm



The red dot indicates the collector

7Z3 0742

RATINGS (Limiting values) [1]

Voltages

Collector-base voltage (open emitter)	V_{CEO}	max.	20	V
Collector-emitter voltage with $-V_{BE} > 2$ V	V_{CEX}	max.	20	V
Emitter-base voltage (open collector)	V_{EBO}	max.	20	V

Currents

Collector current (d.c. or average over any 20 ms period)	I_C	max.	400	mA
Emitter current (d.c. or average over any 20 ms period)	$-I_E$	max.	400	mA
Base current (d.c. or average over any 20 ms period)	I_B	max.	40	mA
Base current (peak value)	I_{BM}	max.	400	mA

Power dissipation

Total power dissipation up to $T_{amb} = 25$ °C	P_{tot}	max.	145	mW

Temperatures

Storage temperature	T_{stg}		−55 to −175	°C
Junction temperature	T_j	max.	75	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	0.35	°C/mW
From junction to case	$R_{th\ j\text{-}c}$	=	0.20	°C/mW

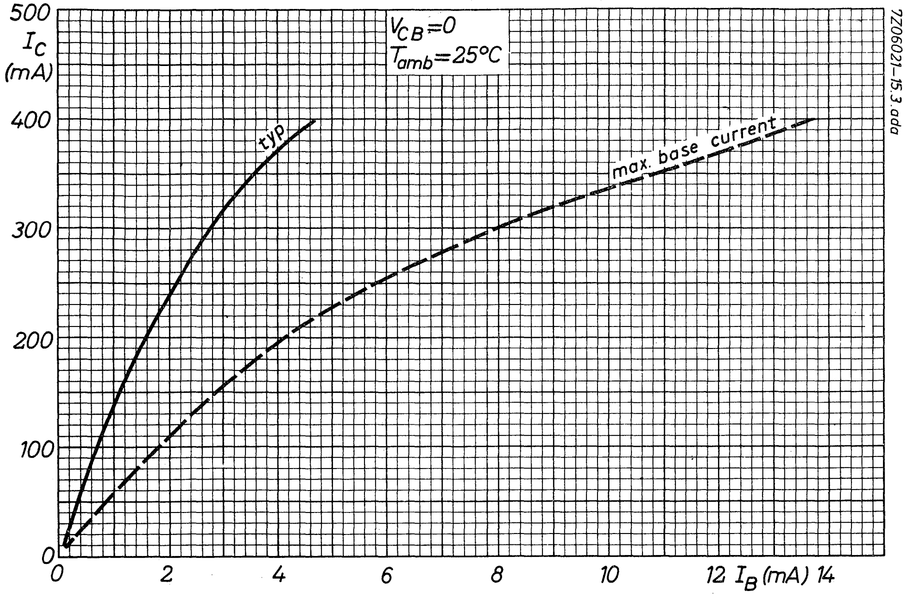
1) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

7Z3 0740

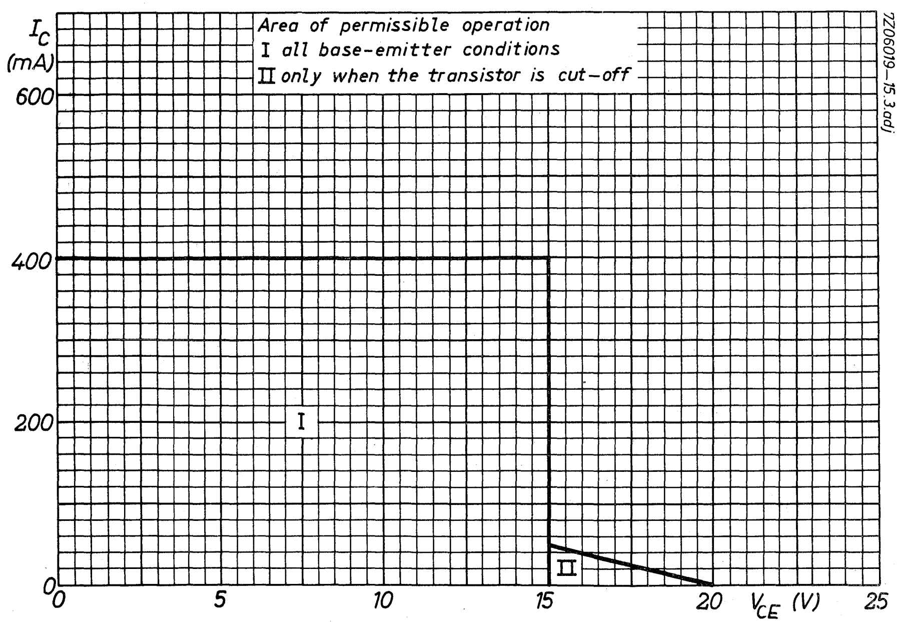
CHARACTERISTICS T_{amb} = 25 °C unless otherwise specified

Collector cut-off current				
I_E = 0; V_{CB} = 5 V	I_{CBO}	typ. <	0.3 3	μA μA
I_E = 0; V_{CB} = 5 V; T_j = 60 °C	I_{CBO}	typ. <	6 35	μA μA
I_E = 0; V_{CB} = 20 V; T_j = 60 °C	I_{CBO}	<	100	μA
Emitter cut-off current				
I_C = 0; V_{EB} = 5 V	I_{EBO}	typ. <	0.3 3	μA μA
I_C = 0; V_{EB} = 5 V; T_j = 60 °C	I_{EBO}	typ. <	6 35	μA μA
I_C = 0; V_{EB} = 20 V; T_j = 60 °C	I_{EBO}	typ.	100	μA
Sustaining voltage				
I_C = 400 mA; $-V_{BE}$ = 2 V	$V_{CEXsust}$	>	15	V
Base-emitter voltage				
I_C = 200 mA; V_{CB} = 0	V_{BE}	<	450	mV
Saturation voltages				
I_C = 7.5 mA; I_B = 0.094 mA	V_{CEsat} V_{BEsat}	< <	175 250	mV mV
I_C = 50 mA; I_B = 0.75 mA	V_{CEsat} V_{BEsat}	< <	220 340	mV mV
I_C = 400 mA; I_B = 13.3 mA	V_{CEsat}	<	370	mV
I_C = 400 mA; I_B = 20 mA	V_{BEsat}	<	700	mV
Punch-through voltage	V_{pt}	>	20	V
D.C. current gain				
I_C = 15 mA; V_{CB} = 0	h_{FE}	80 to 200		
I_C = 200 mA; V_{CB} = 0	h_{FE}	50 to 134		
I_E = 200 mA; V_{EB} = 0	h_{FC}	>	21	
Transition frequency				
I_C = 3 mA; V_{CE} = 5 V	f_T	typ. <	20 9	MHz MHz
Switching parameters				
Current-drive time constant I_{CM} = 200 mA; V_{CE} = 0.75 V	τ_c	<	1.75	μs
Voltage-drive time constant I_{CM} = 1 mA; V_{CE} = 5 V	τ_v	<	0.15	μs

7Z3 0743



$V_{CB}=0$
$T_{amb}=25°C$
I_C (mA)
typ
max. base current
I_B (mA)
7Z06021-15.3.ada



Area of permissible operation
I all base-emitter conditions
II only when the transistor is cut-off
I_C (mA)
I
II
V_{CE} (V)
7Z06019-15.3.adj

R.F. GERMANIUM TRANSISTORS

P-N-P alloy-diffused transistors in TO-7 metal case. The OC169, OC170 and OC171 have a low collector capacitance and high transconductance at high frequencies.

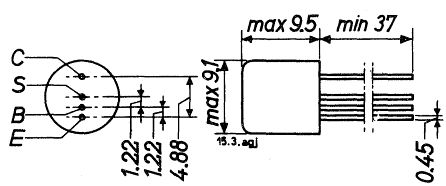
RATINGS (Limiting values) [1])

Collector-base voltage (open emitter)	$-V_{CBO}$	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

Transition frequency				
$-I_C$ = 1 mA; $-V_{CE}$ = 6 V	f_T	typ.	70	MHz

MECHANICAL DATA Dimensions in mm



TO-7
Shield connected to case

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

7Z3 0171

SILICON PLANAR EPITAXIAL TRANSISTORS

N-P-N transistors in a TO-18 metal envelope with the collector connected to the case. The 2N706A and 2N753 are primarily intended for low-power high-speed saturated switching application in industrial service.

QUICK REFERENCE DATA

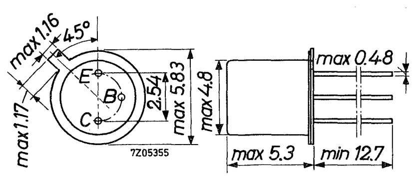
Collector-base voltage (open emitter)		V_{CBO}	max.	25	V
Collector-emitter voltage (open base)		V_{CEO}	max.	15	V
Collector current (d.c.)		I_C	max.	50	mA
Total power dissipation up to T_{amb} = 25 °C		P_{tot}	max.	300	mW
Junction temperature		T_j	max.	175	°C
D.C. current gain at T_j = 25 °C					
I_C = 10 mA; V_{CE} = 1 V	2N706A	h_{FE}	20 to	60	
	2N753	h_{FE}	40 to	120	
Transition frequency					
I_C = 10 mA; V_{CE} = 10 V		f_T	>	200	MHz
Storage time					
I_C = I_B = $-I_{BM}$ = 10 mA	2N706A	t_s	<	25	ns
	2N753	t_s	<	35	ns

MECHANICAL DATA

Dimensions in mm

TO-18

Collector connected to case



7Z3 0418

RATINGS (Limiting values) [1]

Voltages

Collector-base voltage (open emitter)	V_{CBO}	max.	25	V
Collector-emitter voltage (open base)	V_{CEO}	max.	15	V
Collector-emitter voltage at $R_{BE} \leq 10\,\Omega$	V_{CER}	max.	20	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	V

Current

Collector current (d.c. or average over any 20 ms period)	I_C	max.	50	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	$R_{th\ j\text{-}a}$	=	0.5	^oC/mW
From junction to case	$R_{th\ j\text{-}c}$	=	0.15	^oC/mW

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

7Z3 0419

CHARACTERISTICS $T_j = 25\ ^oC$ unless otherwise specified

Collector cut-off current					
$I_E = 0$; $V_{CB} = 15$ V		I_{CBO}	<	0.5	μA
$I_E = 0$; $V_{CB} = 25$ V		I_{CBO}	<	10	μA
$I_E = 0$; $V_{CB} = 15$ V; $T_j = 150\ ^oC$		I_{CBO}	<	30	μA
$V_{CE} = 20$ V; $R_{BE} = 100$ kΩ		I_{CER}	<	10	μA
Emitter cut-off current					
$I_C = 0$; $V_{EB} = 5$ V		I_{EBO}	<	10	μA
Sustaining voltages [1]					
$I_C = 10$ mA; $I_B = 0$		$V_{CEOsust}$	>	15	V
$I_C = 10$ mA; $R_{BE} = 10$ Ω		$V_{CERsust}$	>	20	V
Saturation voltages					
$I_C = 10$ mA; $I_B = 1$ mA		V_{CEsat}	<	0.6	V
		V_{BEsat}	0.7 to 0.9		V
D.C. current gain					
$I_C = 10$ mA; $V_{CE} = 1$ V	2N706A	h_{FE}	20 to 60		
	2N753	h_{FE}	40 to 120		
Collector capacitance at f = 1 MHz					
$I_E = I_e = 0$; $V_{CB} = 5$ V		C_c	<	5	pF
Transition frequency					
$I_C = 10$ mA; $V_{CE} = 10$ V		f_T	>	200	MHz

[1] Measured under pulsed conditions to avoid excessive dissipation
Pulse duration t = 300 μs; duty cycle $\delta \leqq 0.02$

7Z3 0420

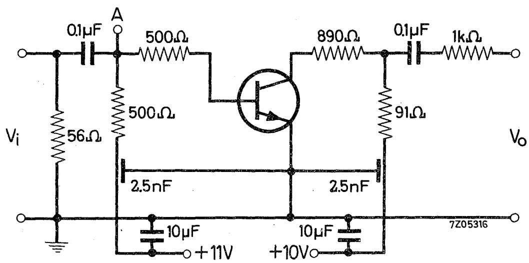
CHARACTERISTICS (continued) T_j = 25 °C unless otherwise specified

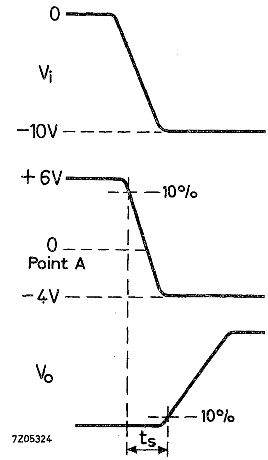
Storage time

$I_C = I_B = -I_{BM} = 10$ mA

2N706A	t_s	<	25	ns
2N753	t_s	<	35	ns

Test circuit: [1])





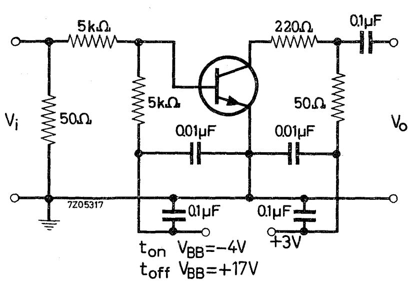
Turn on time

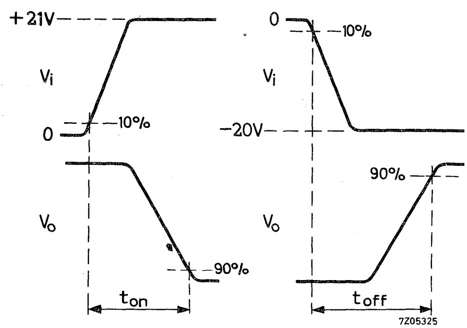
I_C = 10 mA; I_B = 3 mA; $-V_{BE}$ = 2 V t_{on} < 40 ns

Turn off time

I_C = 10 mA; I_B = 3 mA; $-I_{BM}$ = 1 mA t_{off} < 75 ns

Test circuit: [1])





[1]) Pulse generator:

Pulse duration	t	>	400	ns
Duty cycle	δ	<	0.02	
Rise time	t_r	<	1	ns
Source impedance	R_S	=	50	Ω

Oscilloscope:

Rise time	t_r	<	1	ns
Probe impedance		=	2	kΩ

7Z3 0421

SILICON PLANAR EPITAXIAL TRANSISTOR

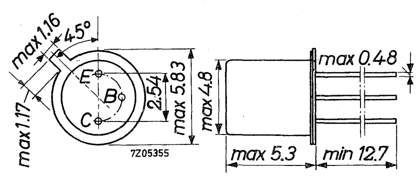
N-P-N transistor in a TO-18 metal envelope with the collector connected to the case. The 2N708 is primarily intended for use in very high-speed saturated switching and v.h.f. amplification.

QUICK REFERENCE DATA				
Collector-base voltage (open emitter)	V_{CBO}	max.	40	V
Collector-emitter voltage (open base)	V_{CEO}	max.	15	V
Collector current (peak value)	I_{CM}	max.	500	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	360	mW
Junction temperature	T_j	max.	200	°C
D.C. current gain at T_j = 25 °C				
I_C = 10 mA; V_{CE} = 1 V	h_{FE}	30 to 120		
Transition frequency				
I_C = 10 mA; V_{CE} = 10 V	f_T	>	300	MHz
Storage time				
$I_C = I_B = -I_{BM}$ = 10 mA	t_s	<	25	ns

MECHANICAL DATA Dimensions in mm

TO-18

Collector connected to case



7Z3 0422

RATINGS (Limiting values) [1]

Voltages

Collector-base voltage (open emitter)	V_{CBO}	max.	40	V
Collector-emitter voltage (open base)	V_{CEO}	max.	15	V
Collector-emitter voltage with $R_{BE} < 10\ \Omega$	V_{CER}	max.	20	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	V

Current

Collector current (peak value; t = 10 μs)	I_{CM}	max.	500	mA

Power dissipation

Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	360	mW

Temperatures

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

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	0.48	°C/mW
From junction to case	$R_{th\ j-c}$	=	0.145	°C/mW

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

7Z3 0423

CHARACTERISTICS T_j = 25 °C unless otherwise specified

Collector cut-off current				
I_E = 0; V_{CB} = 20 V	I_{CBO}	<	25	nA
I_E = 0; V_{CB} = 20 V; T_j = 150 °C	I_{CBO}	<	15	μA
V_{CE} = 20 V; V_{BE} = 0.25 V; T_j = 125 °C	I_{CEX}	<	10	μA
Emitter cut-off current				
I_C = 0; V_{EB} = 4 V	I_{EBO}	<	0.1	μA
Sustaining voltages [1]				
I_C = 30 mA; I_B = 0	$V_{CEOsust}$	>	15	V
I_C = 30 mA; $R_B \leq 10\ \Omega$	$V_{CERsust}$	>	20	V
Saturation voltages				
I_C = 10 mA; I_B = 1 mA	V_{CEsat}	<	0.4	V
	V_{BEsat}	0.72 to	0.80	V
I_C = 7 mA; I_B = 0.7 mA; T_j = −55 to +125 °C	V_{CEsat}	<	0.4	V
I_C = 7 mA; I_B = 0.7 mA; T_j = −55 °C	V_{BEsat}	<	0.9	V
D.C. current gain				
I_C = 0.5 mA; V_{CE} = 1 V	h_{FE}	>	15	
I_C = 10 mA; V_{CE} = 1 V	h_{FE}	30 to	120	
I_C = 10 mA; V_{CE} = 1 V; T_j = −55 °C	h_{FE}	>	15	
Collector capacitance at f = 1 MHz				
I_E = I_e = 0; V_{CB} = 10 V	C_c	<	6	pF
Transition frequency				
I_C = 10 mA; V_{CE} = 10 V	f_T	>	300	MHz
Real part of small signal input impedance				
I_C = 10 mA; V_{CE} = 10 V; f = 300 MHz	$R_e(h_{ie})$	<	50	Ω

1) Measured under pulsed conditions to avoid excessive dissipation.
Pulse duration t = 300 μs; duty cycle δ < 0.01

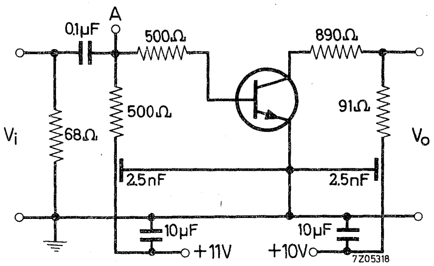
7Z3 0424

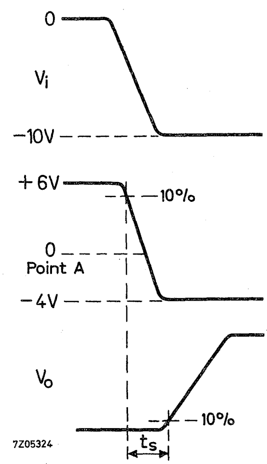
CHARACTERISTICS (continued) T_j = 25 °C unless otherwise specified

Storage time

$I_C = I_B = -I_{BM}$ = 10 mA t_s < 25 ns

Test circuit:





Pulse generator:

Pulse duration	t	≥ 400 ns
Duty cycle	δ	≤ 0.02
Rise time	t_r	≤ 1 ns
Source impedance	R_S	= 50 Ω

Oscilloscope:

Rise time t_r < 1 ns
High impedance probe

7Z3 0425

SILICON PLANAR EPITAXIAL TRANSISTORS

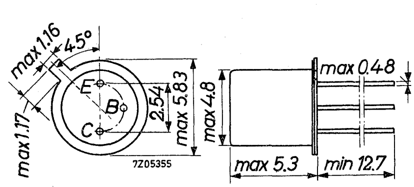
N-P-N transistor in a TO-18 metal envelope with the collector connected to the case.

The 2N709 is primarily intended for use in ultra-high speed saturated logic applications.

QUICK REFERENCE DATA				
Collector-base voltage (open emitter)	V_{CBO}	max.	15	V
Collector-emitter voltage (open base)	V_{CEO}	max.	6	V
Collector current (peak value)	I_{CM}	max.	200	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	0.3	W
Junction temperature	T_j	max.	200	°C
D.C. current gain at T_j = 25 °C				
I_C = 10 mA; V_{CE} = 0.5 V	h_{FE}		20 to 120	
Transition frequency				
I_C = 5 mA; V_{CE} = 4 V; f = 100 MHz	f_T	>	600	MHz
Storage time				
$I_C = I_B = -I_{BM}$ = 5 mA	t_s	<	6	ns

MECHANICAL DATA Dimensions in mm

TO-18



7Z3 0557

RATINGS (Limiting values) [1]

Voltages

Collector-base voltage (open emitter)	V_{CBO}	max.	15	V
Collector-emitter voltage (open base)	V_{CEO}	max.	6	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4	V

Current

Collector current (peak value)	I_{CM}	max.	200	mA

Power dissipation

Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	300	mW

Temperatures

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

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\,j-a}$	=	0.58	°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 IEC publication 134.

7Z3 0558

CHARACTERISTICS T_j = 25 °C unless otherwise specified

Collector cut-off current				
$I_E = 0$; $V_{CB} = 5$ V	I_{CBO}	<	50	nA
$I_E = 0$; $V_{CB} = 5$ V; $T_j = 150$ °C	I_{CBO}	<	5	μA
Sustaining voltage [1]				
$I_C = 10$ mA; $I_B = 0$	$V_{CEOsust}$	>	6	V
Saturation voltages				
$I_C = 3$ mA; $I_B = 0.15$ mA	V_{CEsat}	<	0.3	V
	V_{BEsat}	0.70 to	0.85	V
D.C. current gain				
$I_C = 10$ mA; $V_{CE} = 0.5$ V	h_{FE}	20 to	120	
$I_C = 10$ mA; $V_{CE} = 0.5$ V; $T_j = -55$ °C	h_{FE}	>	10	
$I_C = 30$ mA; $V_{CE} = 1$ V	h_{FE}	>	15	
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; $V_{CB} = 5$ V	C_c	<	3	pF
Emitter capacitance at f = 1 MHz				
$I_C = I_c = 0$; $V_{EB} = 0.5$ V	C_e	<	2	pF
Transition frequency				
$I_C = 5$ mA; $V_{CE} = 4$ V; f = 100 MHz	f_T	>	600	MHz

[1]) Measured under pulsed conditions to avoid excessive dissipation. Pulse duration t = 300 μs; duty cycle $\delta \leq 0.01$

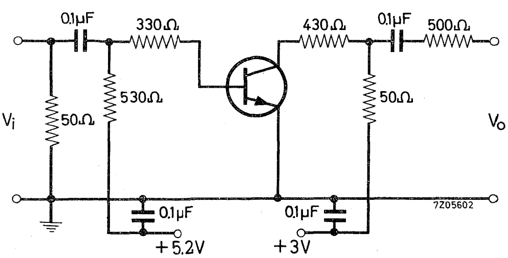
7Z3 0559

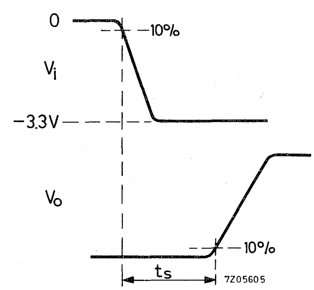
CHARACTERISTICS (continued) $T_j = 25\ ^oC$ unless otherwise specified

Switching times

Turn on time $I_C = 10$ mA; $I_B = 2$ mA; $-V_{BE} = 1$ V	t_{on}	<	15	ns
Turn off time $I_C = 10$ mA; $I_B = 1$ mA; $-I_{BM} = 1$ mA	t_{off}	<	15	ns

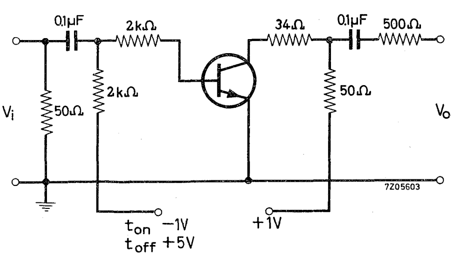
Test circuit:

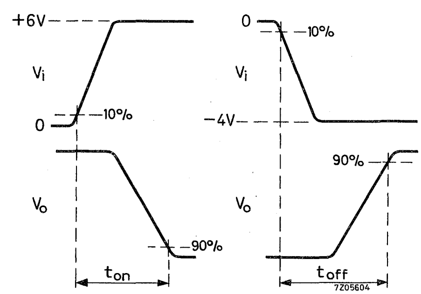




Storage time $I_C = I_B = -I_{BM} = 5$ mA	t_s	<	6	ns

Test circuit:





7Z3 0560

SILICON PLANAR EPITAXIAL TRANSISTORS

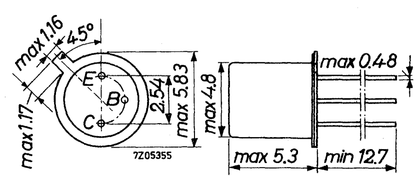
N-P-N transistors in a TO-18 metal envelope with the collector connected to the case. The 2N743 and 2N744 are primarily intended for low-power very high-speed saturated switching applications in industrial service.

QUICK REFERENCE DATA					
Collector-base voltage (open emitter)		V_{CBO}	max.	20	V
Collector-emitter voltage (open base)		V_{CEO}	max.	12	V
Collector current (d.c.)		I_C	max.	200	mA
Total power dissipation up to $T_{amb} = 25\ ^oC$		P_{tot}	max.	300	mW
Junction temperature		T_j	max.	175	^oC
D.C. current gain at $T_j = 25\ ^oC$					
$I_C = 10$ mA; $V_{CE} = 0.35$ V	2N743	h_{FE}	20 to	60	
	2N744	h_{FE}	40 to	120	
Transition frequency					
$I_C = 10$ mA; $V_{CE} = 10$ V		f_T	>	300	MHz
Storage time					
$I_C = I_B = -I_{BM} = 10$ mA	2N743	t_s	<	14	ns
	2N744	t_s	<	18	ns

MECHANICAL DATA Dimensions in mm

TO-18

Collector connected to case



7Z3 0428

RATINGS (Limiting values) [1]

Voltages

Collector-base voltage (open emitter)	V_{CBO}	max.	20	V
Collector-emitter voltage (open base)	V_{CEO}	max.	12	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	V

Current

Collector current (d.c. or average over any 20 ms period)	I_C	max.	200	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] Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

7Z3 0429

CHARACTERISTICS T_j = 25 °C unless otherwise specified

Collector cut-off current				
$I_E = 0$; $V_{CB} = 20$ V	I_{CBO}	<	1	μA
$V_{BE} = 0$; $V_{CE} = 20$ V	I_{CES}	<	1	μA
$V_{BE} = 0$; $V_{CE} = 20$ V; $T_j = 170$ °C	I_{CES}	<	100	μA
$V_{BE} = 0.35$ V; $V_{CE} = 10$ V; $T_j = 100$ °C	I_{CEX}	<	30	μA
Emitter cut-off current				
$I_C = 0$; $V_{EB} = 5$ V	I_{EBO}	<	10	μA
Sustaining voltage				
$I_C = 10$ mA; $I_B = 0$	$V_{CEOsust}$	>	12	V 1)
Saturation voltages				
$I_C = 10$ mA; $I_B = 1$ mA; $T_j = 170$ °C	V_{CEsat}	<	0.35	V
$I_C = 100$ mA; $I_B = 10$ mA; $T_j = 170$ °C	V_{CEsat}	<	1	V 1)
$I_C = 10$ mA; $I_B = 1$ mA	V_{BEsat}	0.65 to 0.85		V
$I_C = 10$ mA; $I_B = 1$ mA; $T_j = -55$ °C	V_{BEsat}	<	1.1	V
$I_C = 100$ mA; $I_B = 10$ mA	V_{BEsat}	<	1.5	V 1)
$I_C = 100$ mA; $I_B = 10$ mA; $T_j = -55$ °C	V_{BEsat}	<	1.6	V 1)
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; $V_{CB} = 5$ V	C_c	<	5	pF
Transition frequency				
$I_C = 10$ mA; $V_{CE} = 10$ V	f_T	>	300	MHz

D.C. current gain		2N743	2N744
$I_C = 1$ mA; $V_{CE} = 0.25$ V	h_{FE}	> 10	20
$I_C = 10$ mA; $V_{CE} = 0.35$ V	h_{FE}	20 to 60	40 to 120
$I_C = 10$ mA; $V_{CE} = 0.35$ V; $T_j = -55$ °C	h_{FE}	> 10	20
$I_C = 100$ mA; $V_{CE} = 1$ V	h_{FE}	> 10	20 1)

1) Measured under pulsed conditions to avoid excessive dissipation
Pulse duration t = 300 μs; duty cycle $\delta \leq 0.02$

7Z3 0430

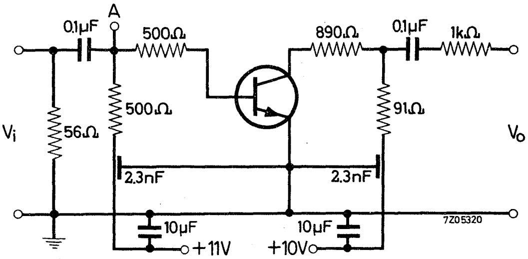
CHARACTERISTICS (continued) T_j = 25 °C unless otherwise specified

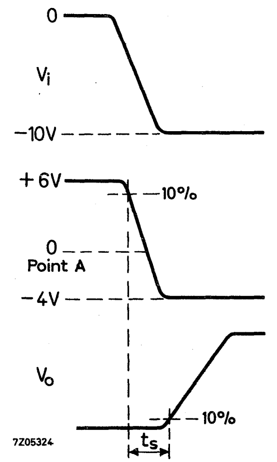
Storage time

$I_C = I_B = -I_{BM}$ = 10 mA

2N743	t_s	<	14	ns
2N744	t_s	<	18	ns

Test circuit:





Pulse generator:

Pulse duration	t	≥	300	ns
Duty cycle	δ	≤	0.02	
Rise time	t_r	≤	1	ns
Source impedance	R_S	=	50	Ω

Oscilloscope:

Rise time	t_r	≤	1	ns
Input impedance	R_i	=	50	Ω

7Z3 0431

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

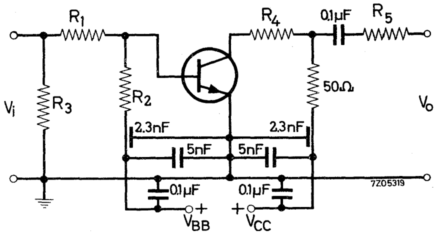
Turn on time

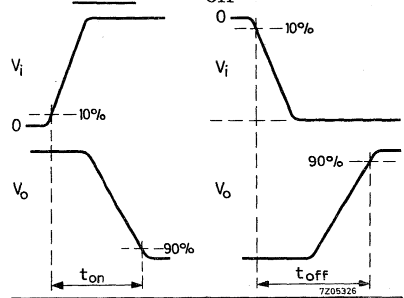
I_C = 10 mA; I_B = 3 mA; $-V_{BE}$ = 1.5 V	t_{on}	<	16	ns
I_C = 100 mA; I_B = 40 mA; $-V_{BE}$ = 2.4 V	t_{on}	<	12	ns

Turn off time

I_C = 10 mA; I_B = 3 mA; $-I_{BM}$ = 1.5 mA		t_{off}	<	24	ns
I_C = 100 mA; I_B = 40 mA; $-I_{BM}$ = 20 mA	2N743	t_{off}	<	40	ns
	2N744	t_{off}	<	45	ns

Test circuit:





I_C (mA)	I_B (mA)	V_{CC} (V)	R_1 (kΩ)	R_2 (kΩ)	R_3 (Ω)	R_4 (Ω)	R_5 (kΩ)	turn on $-V_{BB}$ (V)	turn on $-V_{BE}$ (V)	turn on V_i (V)	turn off V_{BB} (V)	turn off $-I_{BM}$ (mA)	turn off $-V_i$ (V)
10	3	3	3.3	3.3	50	220	0	3	1.5	15	12	1.5	15
100	40	6	0.33	0.33	56	0	1	4.5	2.4	20	15.3	20	20

Pulse generator:

Pulse duration	t	≥	400	ns
Duty cycle	δ	≤	0.02	
Rise time	t_r	≤	1	ns
Source impedance	R_S	=	50	Ω

Oscilloscope:

Rise time	t_r	≤	1	ns
Input impedance	R_i	=	50	Ω

7Z3 0528

SILICON PLANAR EPITAXIAL TRANSISTOR

For data of this transistor please refer to the 2N706A

7Z3 0459

SILICON PLANAR EPITAXIAL TRANSISTOR

N-P-N transistor in a TO-18 metal envelope with the collector connected to the case. The 2N914 is primarily intended for use in very high-speed saturated switching and v.h.f. amplification.

QUICK REFERENCE DATA

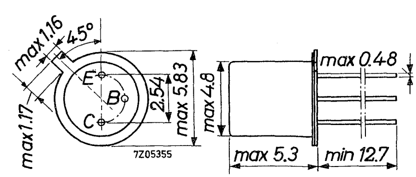
Collector-base voltage (open emitter)	V_{CBO}	max.	40	V
Collector-emitter voltage (open base)	V_{CEO}	max.	15	V
Collector current (peak value)	I_{CM}	max.	500	mA
Total power dissipation up to $T_{amb} = 25\ ^oC$	P_{tot}	max.	360	mW
Junction temperature	T_j	max.	200	^oC
D.C. current gain at $T_j = 25\ ^oC$				
$I_C = 10$ mA; $V_{CE} = 1$ V	h_{FE}	30 to	120	
Transition frequency				
$I_C = 20$ mA; $V_{CE} = 10$ V	f_T	>	300	MHz
Storage time				
$I_C = I_B = -I_{BM} = 20$ mA	t_s	<	20	ns

MECHANICAL DATA

Dimensions in mm

TO-18

Collector connected to case



7Z3 0460

RATINGS (Limiting values) [1]

Voltages

Collector-base voltage (open emitter)	V_{CBO}	max.	40	V
Collector-emitter voltage (open base)	V_{CEO}	max.	15	V
Collector-emitter voltage with $R_{BE} \leq 10\ \Omega$	V_{CER}	max.	20	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	V

Current

Collector current (peak value; t = 10 μs)	I_{CM}	max.	500	mA

Power dissipation

Total power dissipation up to $T_{amb} = 25\ ^oC$	P_{tot}	max.	360	mW

Temperatures

Storage temperature	T_{stg}	-65 to +200		^oC
Junction temperature	T_j	max.	200	^oC

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	0.48	$^oC/mW$
From junction to case	$R_{th\ j\text{-}c}$	=	0.145	$^oC/mW$

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

7Z3 0461

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current				
$I_E = 0$; $V_{CB} = 20$ V	I_{CBO}	<	25	nA
$I_E = 0$; $V_{CB} = 20$ V; $T_j = 150$ °C	I_{CBO}	<	15	μA
$V_{CE} = 20$ V; $V_{BE} = 0.25$ V; $T_j = 125$ °C	I_{CEX}	<	10	μA
Emitter cut-off current				
$I_C = 0$; $V_{EB} = 4$ V	I_{EBO}	<	0.1	μA
Sustaining voltages 1)				
$I_C = 30$ mA; $I_B = 0$	$V_{CEOsust}$	>	15	V
$I_C = 30$ mA; $R_B \leq 10\ \Omega$	$V_{CERsust}$	>	20	V
Saturation voltages				
$I_C = 200$ mA; $I_B = 20$ mA	V_{CEsat}	<	0.7	V
$I_C = 10\ I_B$; $I_B = 0.1$ to 2 mA; $T_j = -55$ to $+125$ °C	V_{CEsat}	<	0.25	V
$I_C = 10$ mA; $I_B = 1$ mA	V_{BEsat}		0.7 to 0.8	V
D.C. current gain 1)				
$I_C = 500$ mA; $V_{CE} = 5$ V	h_{FE}	>	10	
$I_C = 10$ mA; $V_{CE} = 1$ V	h_{FE}		30 to 120	
$I_C = 10$ mA; $V_{CE} = 1$ V; $T_j = -55$ °C	h_{FE}	>	12	
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; $V_{CB} = 10$ V	C_c	<	6	pF
Emitter capacitance at f = 1 MHz				
$I_C = I_c = 0$; $V_{EB} = 0.5$ V	C_e	<	9	pF
Transition frequency				
$I_C = 20$ mA; $V_{CE} = 10$ V	f_T	>	300	MHz

1) Measured under pulsed conditions to avoid excessive dissipation
Pulse duration t = 300 μs; duty cycle $\delta \leq 0.01$

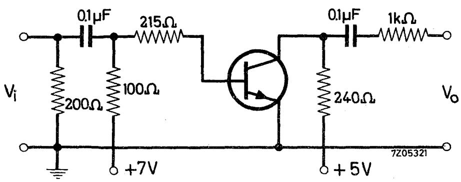
7Z3 0462

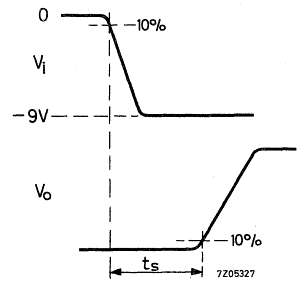
CHARACTERISTICS (continued) T_j = 25 °C unless otherwise specified

Storage time

$I_C = I_B = -I_{BM}$ = 20 mA t_s < 20 ns

Test circuit: [1])





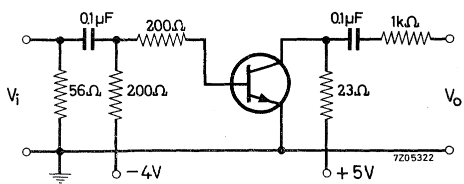
Turn on time

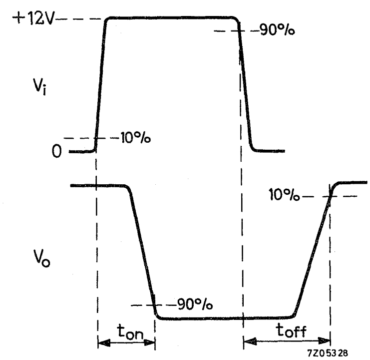
I_C = 200 mA; I_B = 35 mA; $-V_{BE}$ = 4 V t_{on} < 40 ns

Turn off time

I_C = 200 mA; I_B = 35 mA; $-I_{BM}$ = 25 mA t_{off} < 40 ns

Test circuit: [1])





[1]) Pulse generator:

Pulse duration	t	=	100	ns
Duty cycle	δ	≤	0.02	
Source impedance	R_S	=	50	Ω

Rise and fall time sufficiently fast so that doubling their values does not affect the measured results within the required accuracy.

Oscilloscope:

Rise time	t_r	<	1	ns
Input impedance	R_i	=	50	Ω

7Z3 0463

SILICON PLANAR EPITAXIAL TRANSISTOR

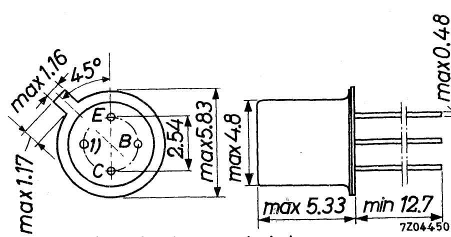
N-P-N transistor in TO-72 metal envelope with insulated electrodes and a shield lead connected to the case. The 2N918 is primarily intended for low power amplifiers and oscillators in the v.h.f. and u.h.f. ranges for industrial service.

QUICK REFERENCE DATA

Collector-base voltage (open emitter)	V_{CBO}	max.	30	V
Collector-emitter voltage (open base)	V_{CEO}	max.	15	V
Collector current (d.c.)	I_C	max.	20	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	200	mW
Junction temperature	T_j	max.	200	°C
Transition frequency I_C = 4 mA; V_{CE} = 10 V	f_T	>	600	MHz
Maximum unilaterised power gain I_C = 6 mA; V_{CE} = 12 V; f = 200 MHz	G_{UM}	typ	36	dB
Noise figure at f = 60 MHz I_C = 1 mA; V_{CE} = 6 V; R_S = 400 Ω	F	<	6	dB

MECHANICAL DATA Dimensions in mm

TO-72
Insulated electrodes



1) Shield lead connected to case

7Z3 0535

RATINGS (Limiting values) [1])

Voltages

Collector-base voltage (open emitter)	V_{CBO}	max.	30	V
Collector-emitter voltage (open base) I_C = 3 mA	V_{CEO}	max.	15	V
Emitter-base voltage (open collector)	V_{EBO}	max.	3	V

Currents

Collector current (d.c.)	I_C	max.	50	mA

Power dissipation

Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	200	mW

Temperatures

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

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	0.88	°C/mW
From junction to case	$R_{th\ j-c}$	=	0.58	°C/mW

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

7Z3 0662

CHARACTERISTICS T_j = 25 °C unless otherwise specified
All measurements taken with ungrounded shield lead

Collector cut-off current

$I_E = 0$; $V_{CB} = 15$ V	I_{CBO}	<	10	nA
$I_E = 0$; $V_{CB} = 15$ V; $T_j = 150$ °C	I_{CBO}	<	1	μA

Saturation voltages

$I_C = 10$ mA; $I_B = 1$ mA	V_{CEsat}	<	0.4	V
	V_{BEsat}	<	1	V

D.C. current gain

$I_C = 3$ mA; $V_{CE} = 1$ V	h_{FE}	>	20	

Collector capacitance at f = 140 kHz

$I_E = I_e = 0$; $V_{CB} = 10$ V	C_c	<	1.7	pF
$I_E = I_e = 0$; $V_{CB} = 0$	C_c	<	3.0	pF

Emitter capacitance at f = 140 kHz

$I_C = I_c = 0$; $V_{EB} = 0.5$ V	C_e	<	2.0	pF

Transition frequency

$I_C = 4$ mA; $V_{CE} = 10$ V	f_T	>	600	MHz

Noise figure at f = 60 MHz

$I_C = 1$ mA; $V_{CE} = 6$ V; $R_S = 400\ \Omega$	F	<	6	dB

Oscillator power output at f = 500 MHz

$I_E = 8$ mA; $V_{CB} = 15$ V	P_o	>	30	mW

Maximum unilateralised power gain

$$G_{UM} = \frac{|y_{fe}|^2}{4 g_{ie} g_{oe}}$$

$I_C = 6$ mA; $V_{CE} = 12$ V; f = 200 MHz	G_{UM}	typ.	36	dB

7Z3 0269

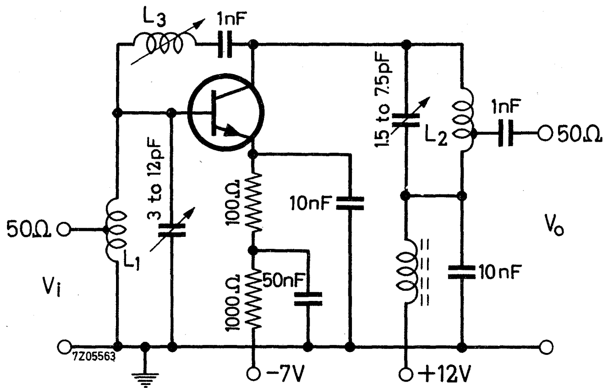
CHARACTERISTICS (continued) $T_j = 25\ ^oC$

Available power gain at f = 200 mHz

I_C = 6 mA G_p > 15 dB

Basic circuit for measuring the available neutralised power gain

Grounded shield lead



L_1 = 3.5 turns tinned Cu wire, 1.3 mm
d = 8 mm; length = 11 mm

Tap at ≈ 2 turns from earth side

L_2 = 8 turns tinned Cu wire, 1.3 mm
d = 3 mm; length = 22 mm

Tap at 1 turn from earth side

L_3 = 0.4 to 0.65 μH

7Z3 0270

SILICON N-P-N PLANAR TRANSISTORS

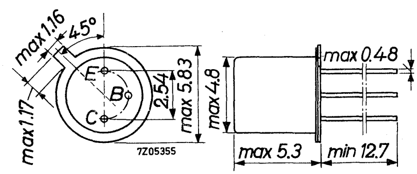
N-P-N transistors in a TO-18 metal envelope with the collector connected to the case.
These devices are primarily intended for use in high performance, low level, low noise amplifier applications both for direct current and for frequencies of up to 100 MHz

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	MHz
Noise figure (f = 10 Hz to 15 kHz)					
I_C = 10 μA; V_{CE} = 5 V; R_S = 10 kΩ	F	typ.	2.5	2	dB
		<	4	3	dB

MECHANICAL DATA Dimensions in mm

TO-18
Collector connected to case



7Z3 0647

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 °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	$R_{th\ j-a}$	=	0.5	°C/mW
From junction to case	$R_{th\ j-c}$	=	0.25	°C/mW

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

7Z3 0648

CHARACTERISTICS $T_j = 25\ ^oC$ unless otherwise specified

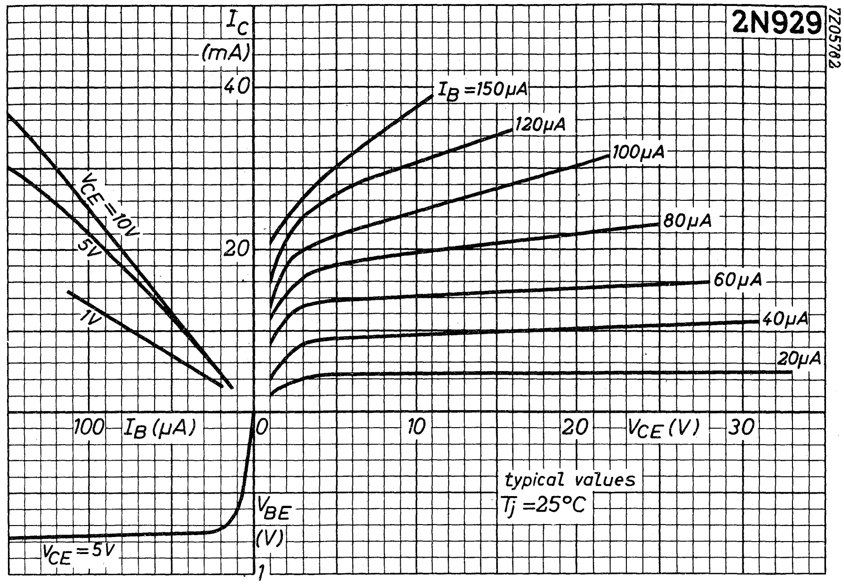
Collector cut-off current				
$I_E = 0$; $V_{CB} = 45$ V		I_{CBO}	< 10	nA
$I_B = 0$; $V_{CE} = 5$ V		I_{CEO}	< 2	nA
$V_{EB} = 0$; $V_{CB} = 45$ V		I_{CES}	< 10	nA
Emitter cut-off current				
$I_C = 0$; $V_{EB} = 5$ V		I_{EBO}	< 10	nA
Base current				
$-I_E = 10$ mA; $V_{CB} = 5$ V	2N929	I_B	< 100	μA
	2N930	I_B	< 50	μA
Emitter-base voltage				
$-I_E = 0.5$ mA; $V_{CB} = 5$ V		$-V_{EB}$	0.6 to 0.8	V
Saturation voltages				
$I_C = 10$ mA; $I_B = 0.5$ mA		V_{CEsat}	< 1	V
		V_{BEsat}	0.6 to 1	V

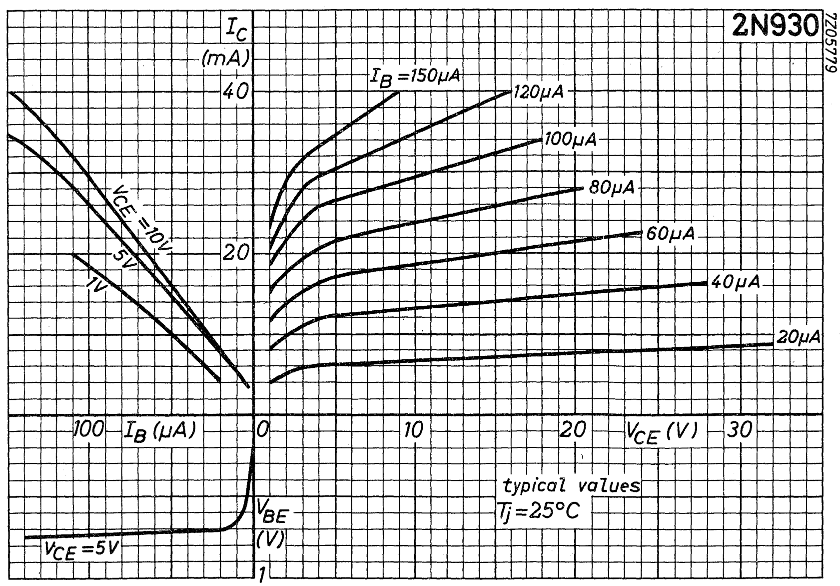
D.C. current gain		2N929	2N930	
$I_C = 10\ \mu$A; $V_{CE} = 5$ V	h_{FE}	40 to 120	100 to 300	
$I_C = 10\ \mu$A; $V_{CE} = 5$ V; $T_j = -55\ ^oC$	h_{FE}	> 10	> 20	
$I_C = 500\ \mu$A; $V_{CE} = 5$ V	h_{FE}	> 60	> 150	
$I_C = 10$ mA; $V_{CE} = 5$ V	h_{FE}	100 to 350	200 to 600	
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; $V_{CB} = 5$ V	C_c	< 8	< 8	pF
Transition frequency				
$I_C = 0.5$ mA; $V_{CE} = 5$ V	f_T	> 50	> 50	MHz
Cut-off frequency				
$I_C = 0.5$ mA; $V_{CE} = 5$ V	f_{hfe}	> 200	> 100	kHz

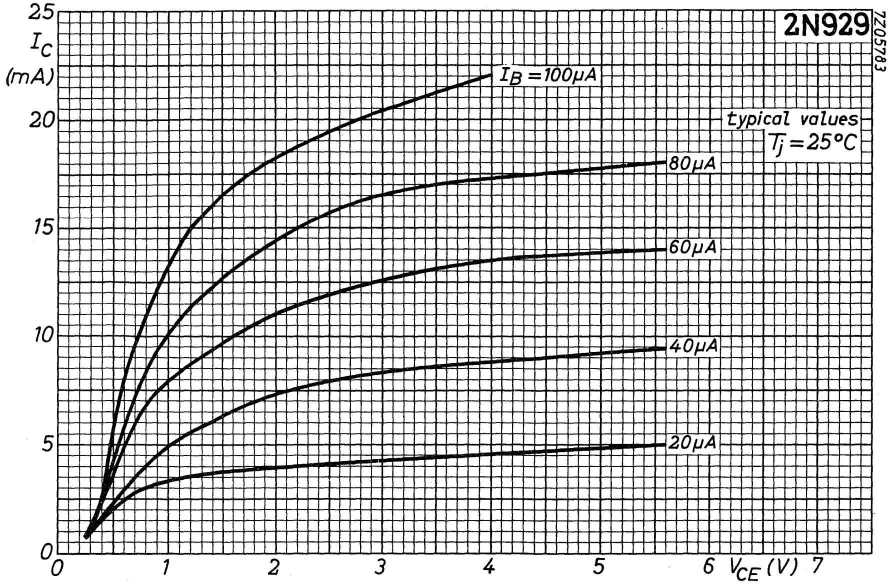
7Z3 0649

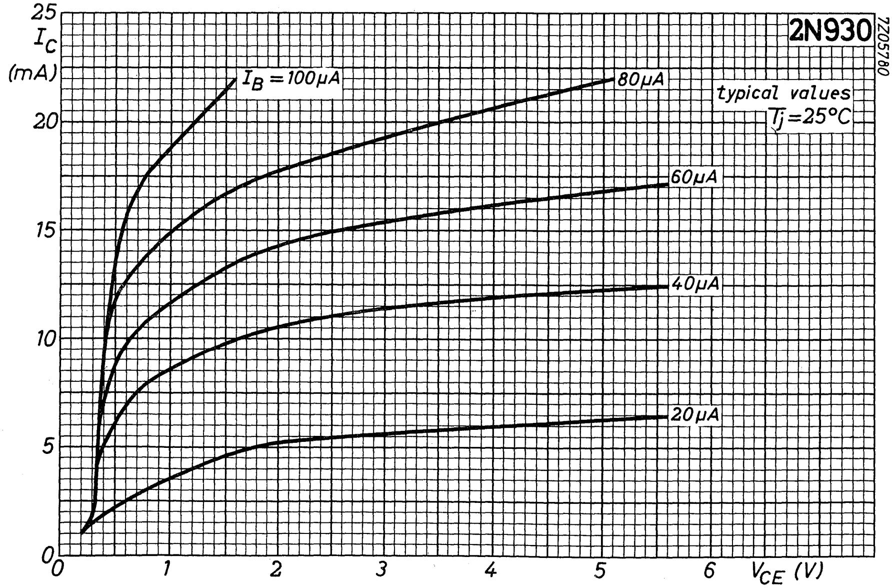
CHARACTERISTICS (continued) T_j = 25 °C unless otherwise specified

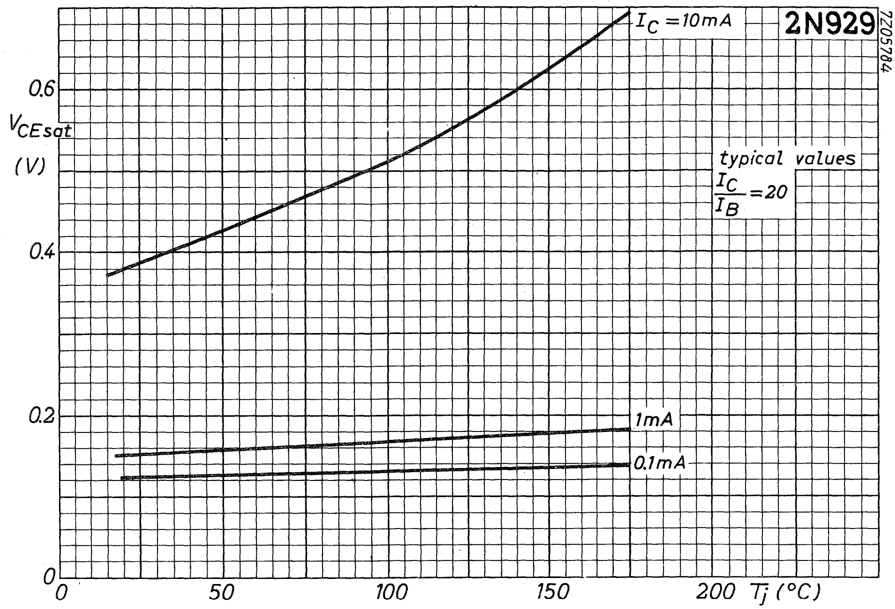
		2N929	2N930	
Noise figure (f = 10 Hz to 15 kHz)				
I_C = 10 μA; V_{CE} = 5 V; R_S = 10 kΩ	F	typ. 2.5	2	dB
		< 4	3	dB
h parameters at f = 1 kHz				
I_C = 1 mA; V_{CE} = 5 V				
Input impedance	h_{ie}	typ. 5.0	10.0	kΩ
Reverse voltage transfer	h_{re}	typ. 2.5	5.5	10^{-4}
Small signal current gain	h_{fe}	typ. 200	350	
		60 to 350	150 to 600	
Output admittance	h_{oe}	typ. 14	25	$\mu\Omega^{-1}$

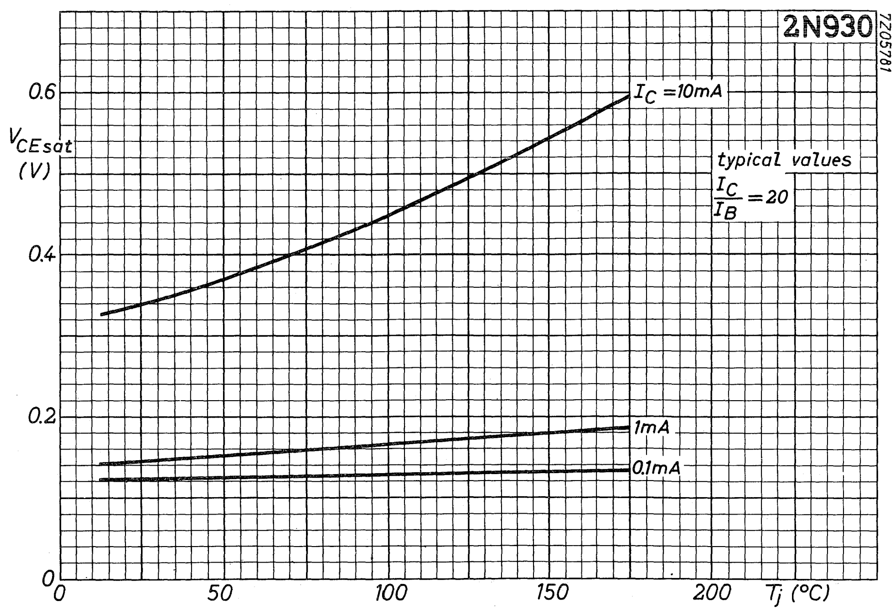

2N929
7Z05762
I_C
(mA)
40
20
I_B =150μA
120μA
100μA
80μA
60μA
40μA
20μA
V_{CE} =10V
5V
1V
100
I_B (μA)
0
10
20
V_{CE} (V)
30
typical values
T_j =25°C
V_{BE}
(V)
1
V_{CE} =5V

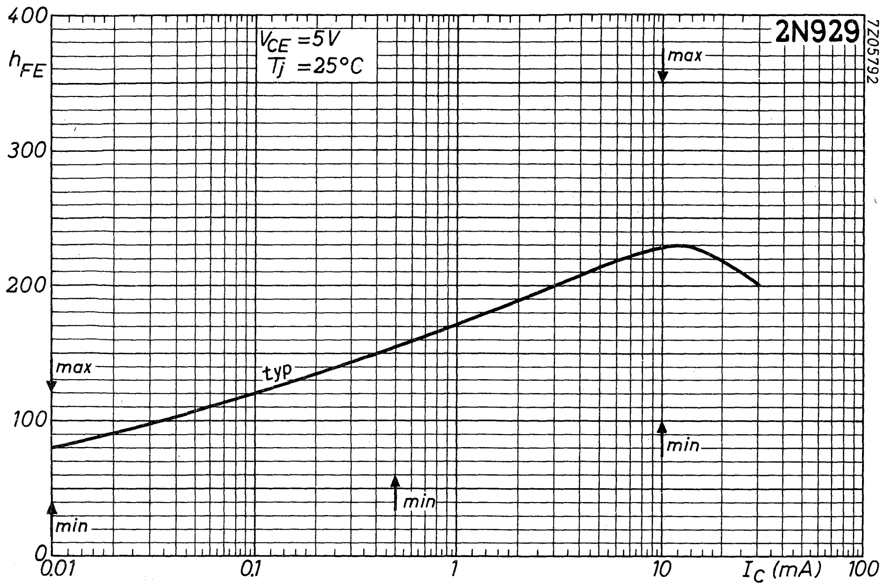

2N930
7Z05779
I_C
(mA)
40
20
I_B =150μA
120μA
100μA
80μA
60μA
40μA
20μA
V_{CE} =10V
5V
1V
100
I_B (μA)
0
10
20
V_{CE} (V)
30
typical values
T_j=25°C
V_{BE}
(V)
1
V_{CE} =5V

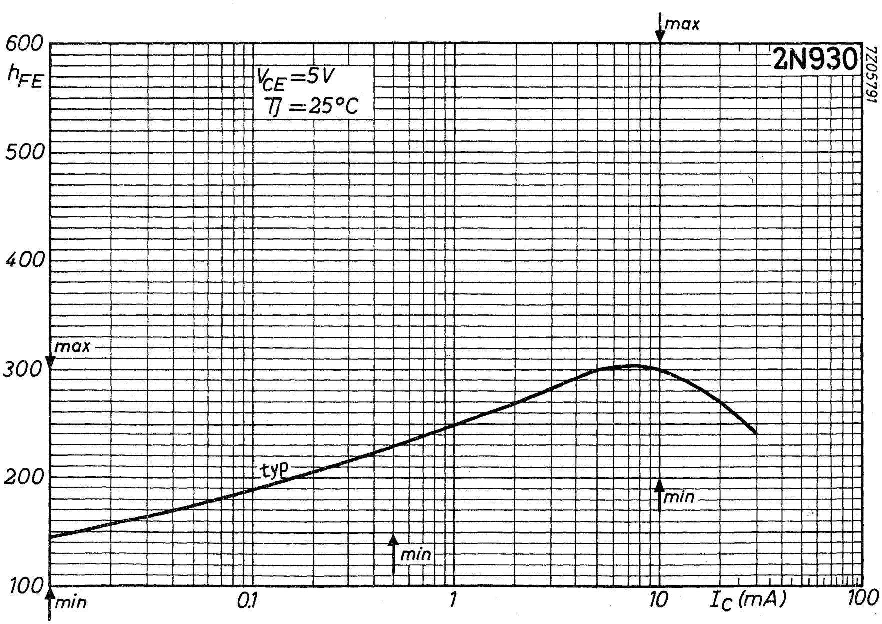

25
I_C
(mA)
20
15
10
5
0
0
1
2
3
4
5
6
V_CE (V)
7
2N929
7Z05783
I_B = 100μA
typical values
T_j = 25°C
80μA
60μA
40μA
20μA

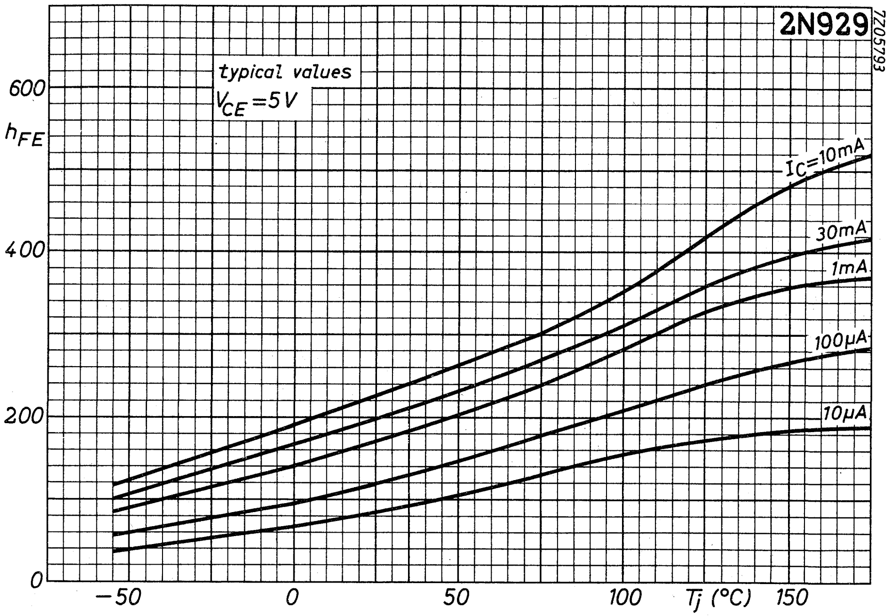

25
I_C
(mA)
20
15
10
5
0
0
1
2
3
4
5
6
V_CE (V)
2N930
7Z05780
I_B = 100μA
80μA
typical values
T_j = 25°C
60μA
40μA
20μA

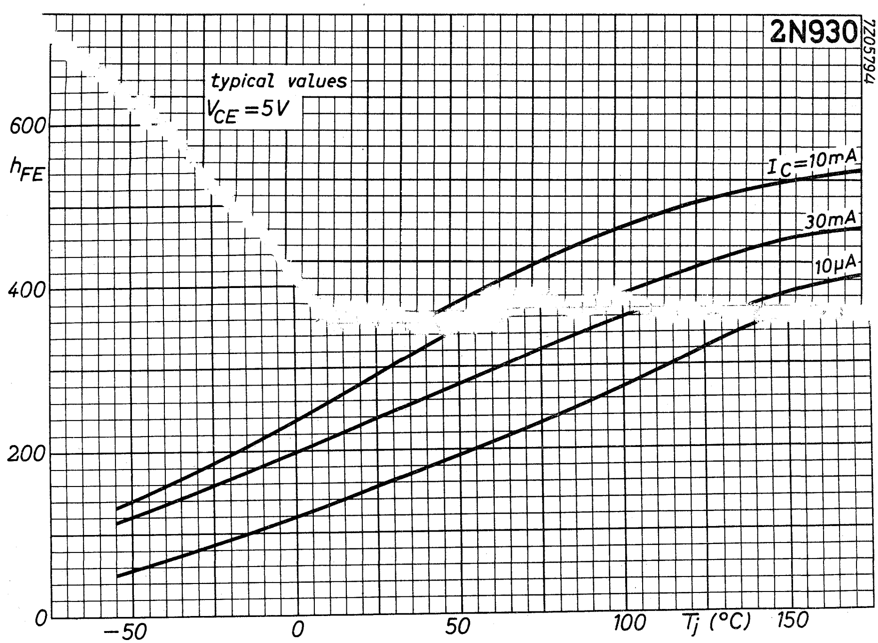

2N929
7Z05784
I_C =10mA
1mA
0.1mA
typical values
$\frac{I_C}{I_B}$ =20
V_{CEsat} (V)
0.6
0.4
0.2
0
0
50
100
150
200
T_j (°C)

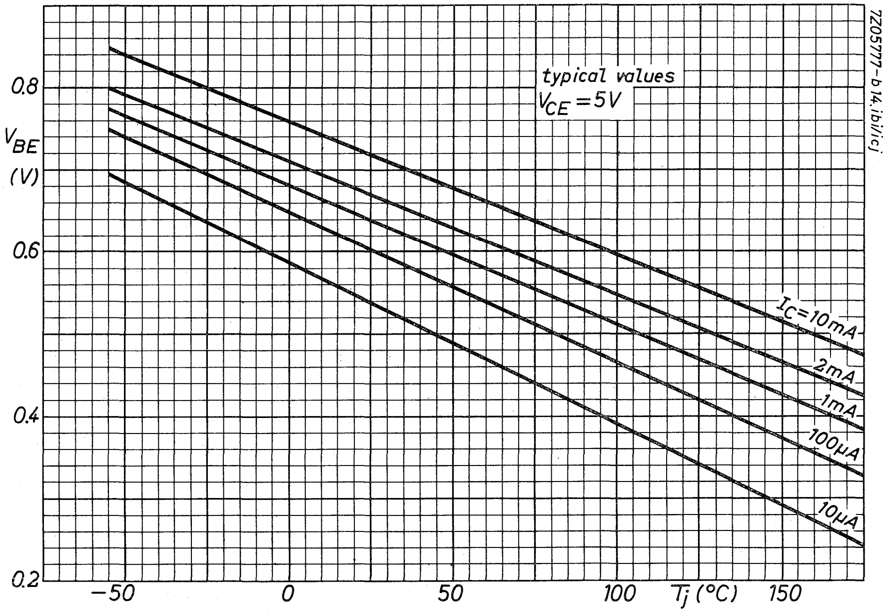

2N930
7Z05781
I_C =10mA
1mA
0.1mA
typical values
$\frac{I_C}{I_B}$ =20
V_{CEsat} (V)
0.6
0.4
0.2
0
0
50
100
150
200
T_j (°C)

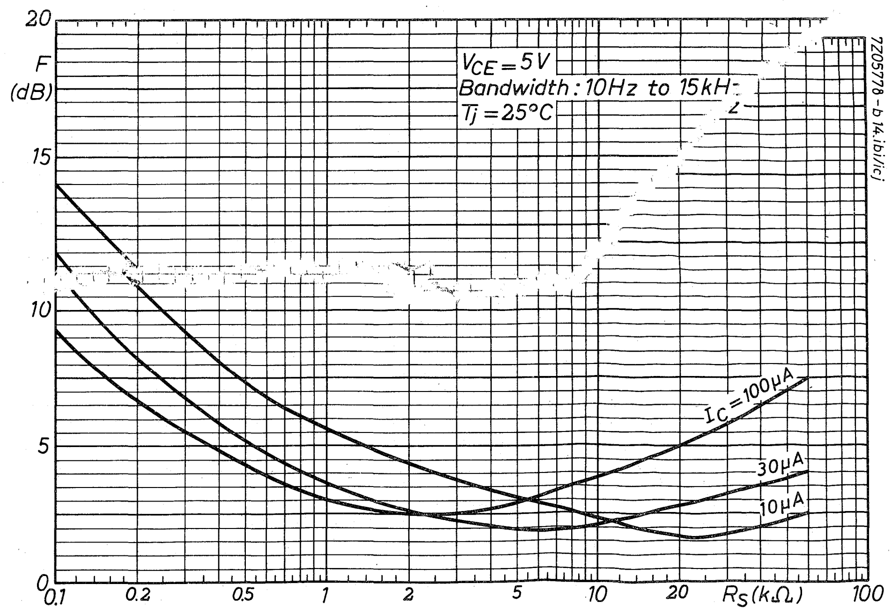

400
h_{FE}
300
200
100
0
V_{CE} = 5 V
T_j = 25°C
2N929
7Z05792
max
max
typ
min
min
min
0.01
0.1
1
10
I_C (mA)
100

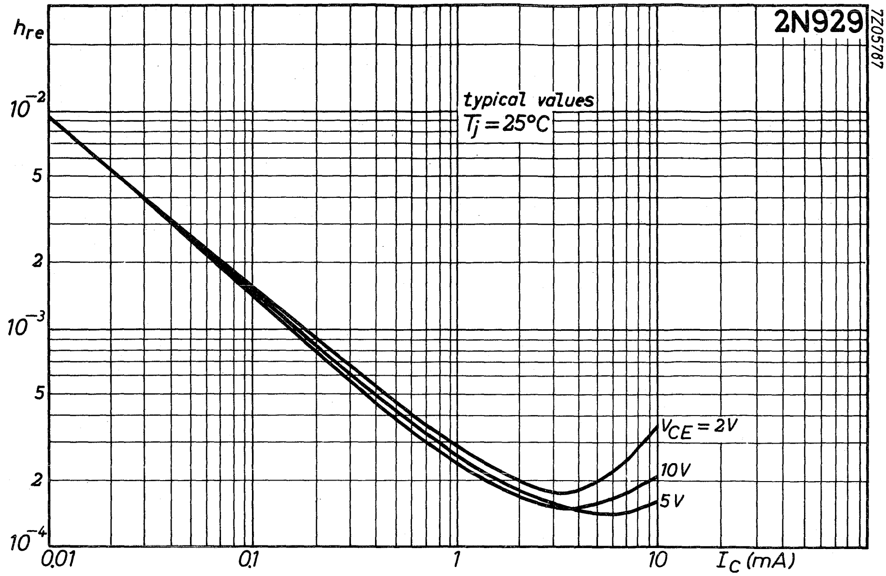

600
h_{FE}
500
400
300
200
100
V_{CE} = 5 V
T_j = 25°C
2N930
7Z05791
max
max
typ
min
min
min
0.1
1
10
I_C (mA)
100

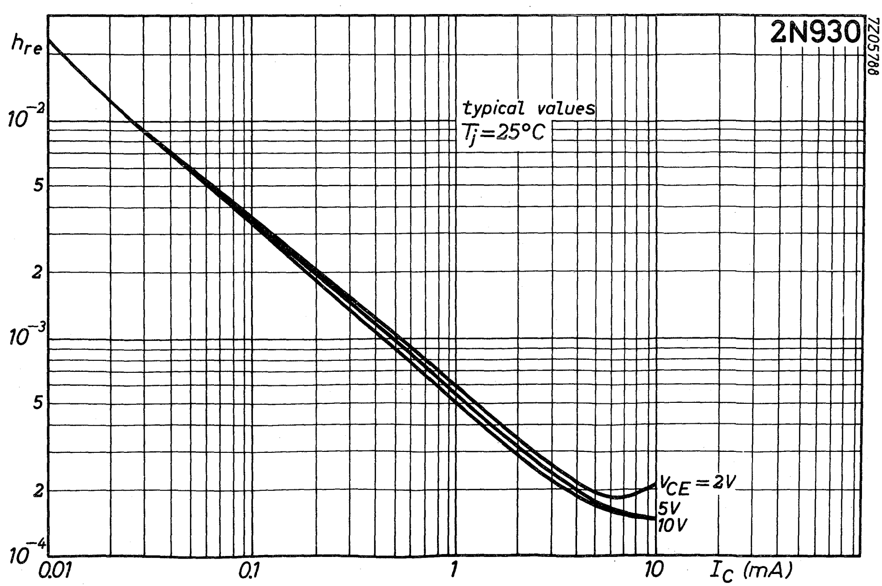

2N929
7Z05793
typical values
V_{CE} = 5 V
600
h_{FE}
400
200
0
I_C=10mA
30mA
1mA
100μA
10μA
−50
0
50
100
T_j (°C)
150

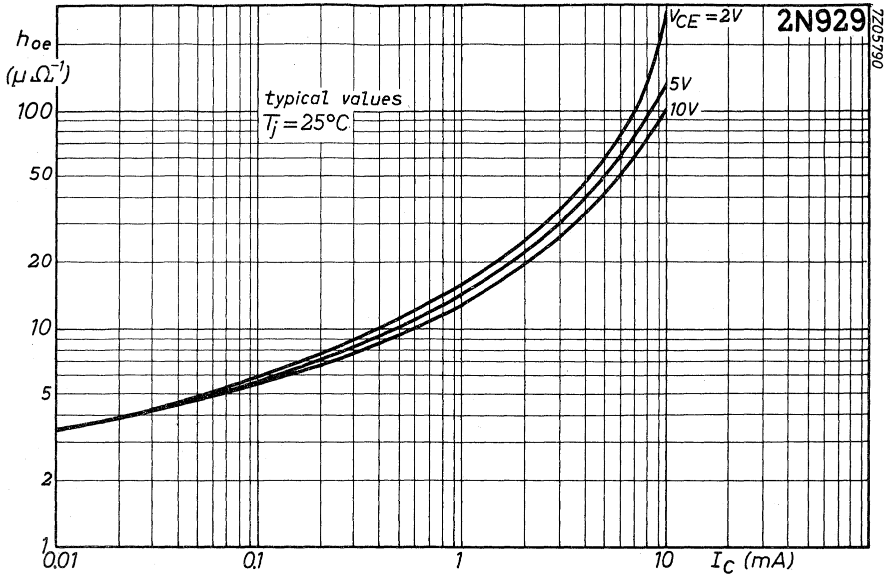

2N930
7Z05794
typical values
V_{CE} = 5 V
600
h_{FE}
400
200
0
I_C=10mA
30mA
10μA
−50
0
50
100
T_j (°C)
150

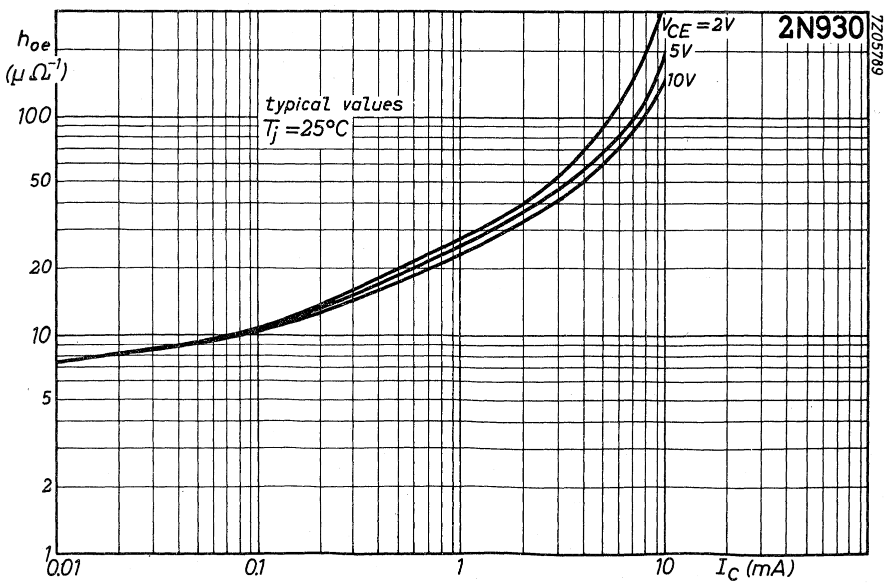

7Z05777-b14.ibi/ic
typical values
$V_{CE} = 5V$
V_{BE} (V)
0.8
0.6
0.4
0.2
I_C=10mA
2mA
1mA
100μA
10μA
−50
0
50
100
T_j (°C)
150

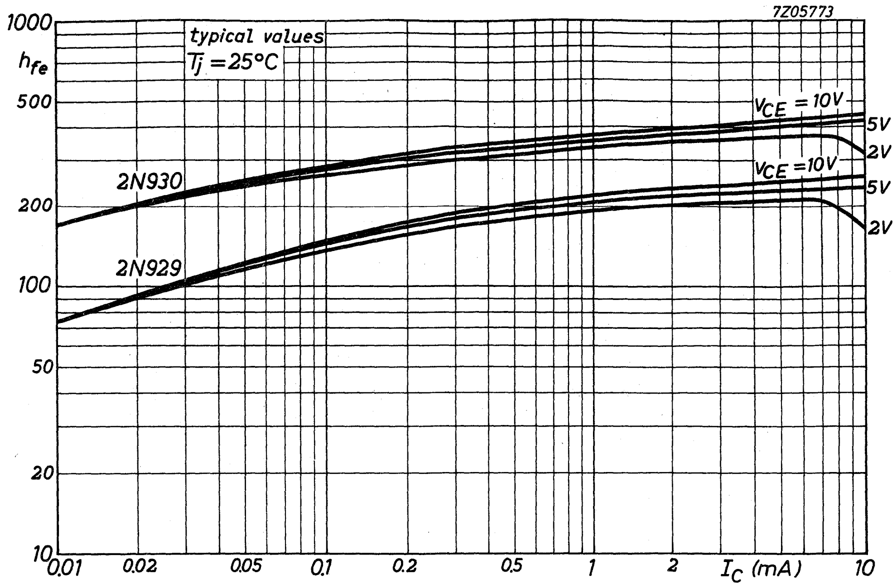

7Z05778-b14.ibi/ic
$V_{CE} = 5V$
Bandwidth: 10Hz to 15kHz
T_j = 25°C
F (dB)
20
15
10
5
0
I_C = 100μA
30μA
10μA
0.1
0.2
0.5
1
2
5
10
20
R_S (kΩ)
100

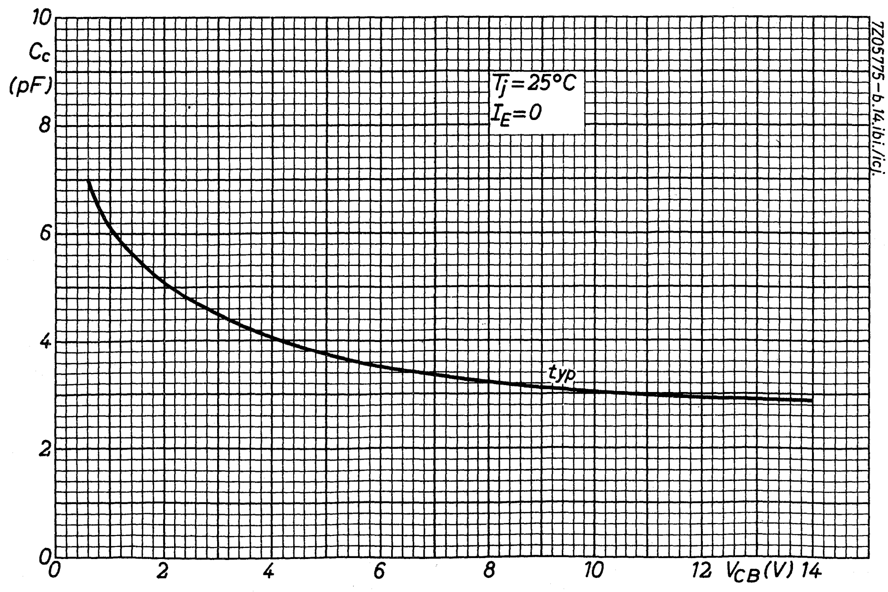

2N929
7Z05787
h_{re}
10^{-2}
5
2
10^{-3}
5
2
10^{-4}
typical values
$T_j = 25°C$
$V_{CE} = 2V$
10V
5V
0.01
0.1
1
10
I_C (mA)

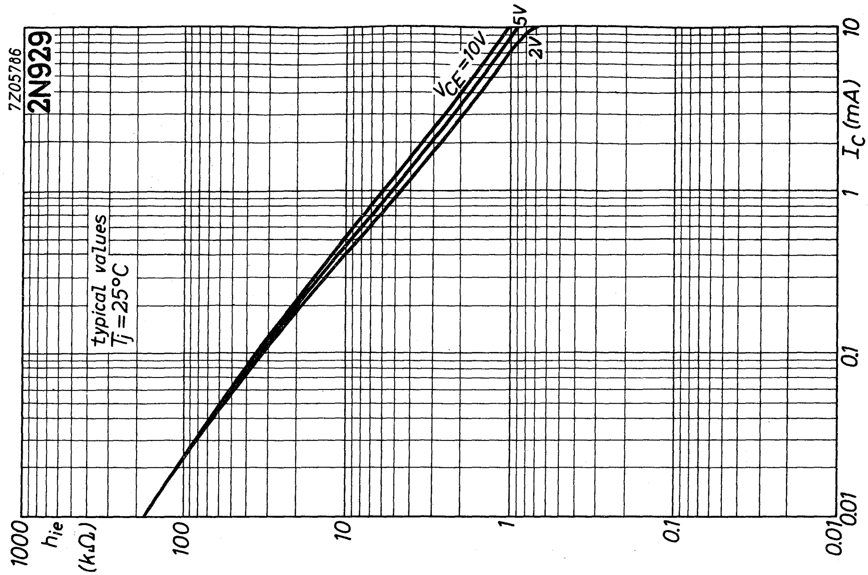

2N930
7Z05788
h_{re}
10^{-2}
5
2
10^{-3}
5
2
10^{-4}
typical values
$T_j = 25°C$
$V_{CE} = 2V$
5V
10V
0.01
0.1
1
10
I_C (mA)

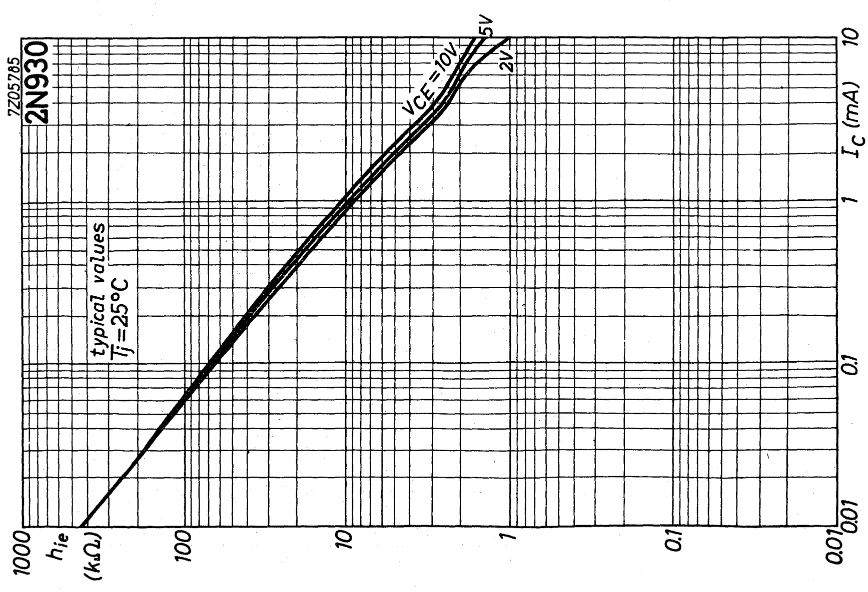

2N929
7205790
h_{oe}
$(\mu\Omega^{-1})$
typical values
$T_j = 25 °C$
$V_{CE} = 2V$
5V
10V
100
50
20
10
5
2
1
0.01
0.1
1
10
I_C (mA)

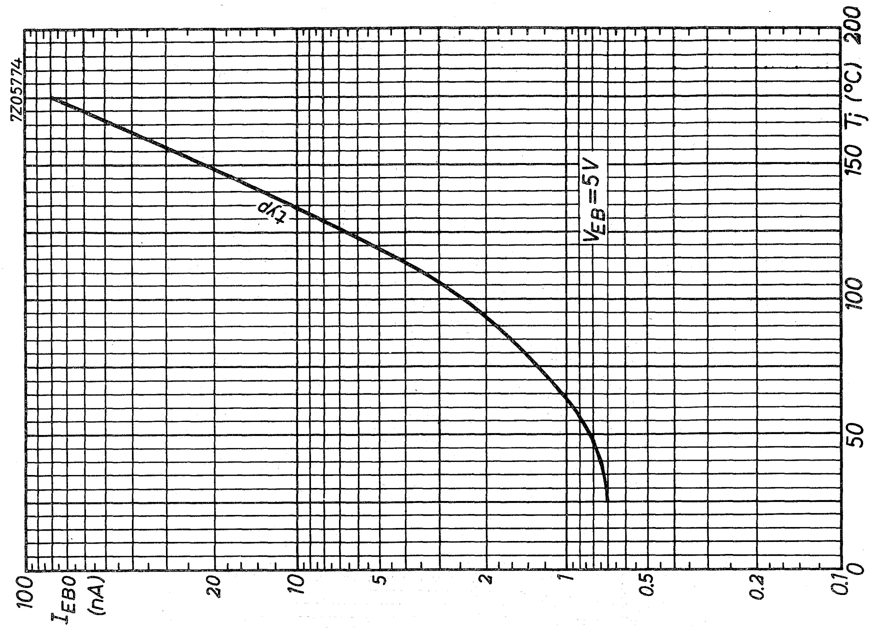

2N930
7205789
h_{oe}
$(\mu\Omega^{-1})$
typical values
$T_j = 25 °C$
$V_{CE} = 2V$
5V
10V
100
50
20
10
5
2
1
0.01
0.1
1
10
I_C (mA)

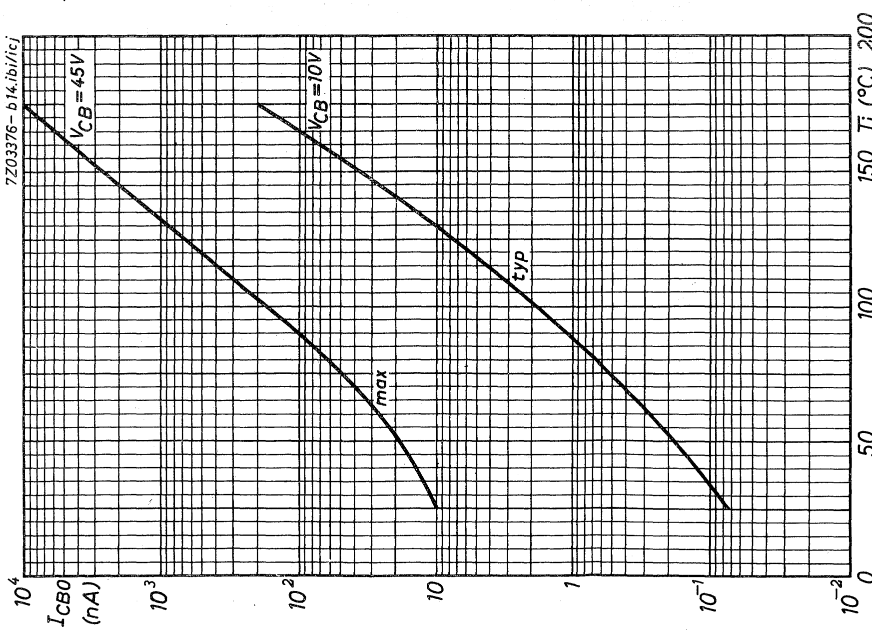

7Z05773
typical values
$T_j = 25°C$
1000
h_{fe}
500
200
100
50
20
10
2N930
2N929
$V_{CE} = 10V$
5V
2V
$V_{CE} = 10V$
5V
2V
0.01
0.02
0.05
0.1
0.2
0.5
1
2
I_C (mA)
10

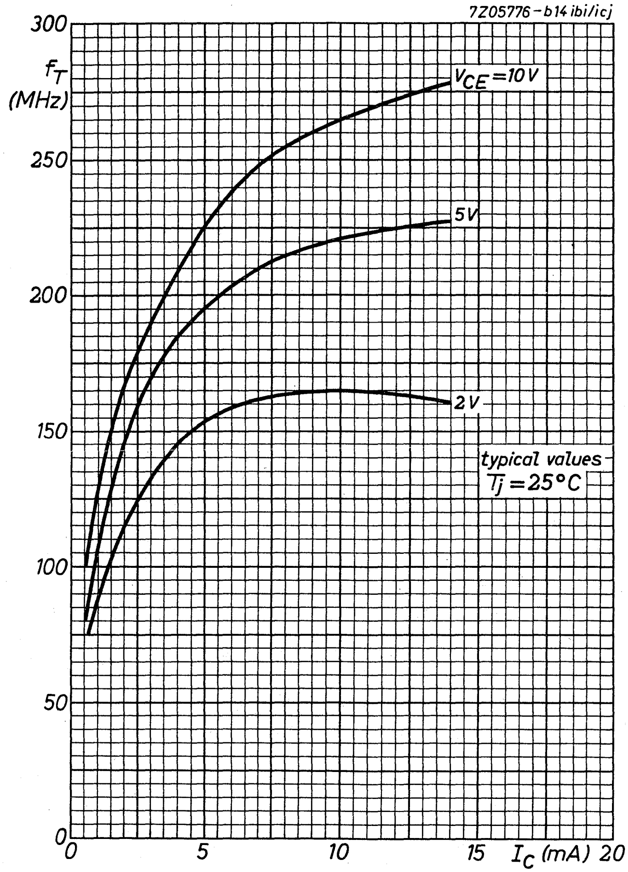

7Z05775–b.14.ibi./ici.
10
C_c
(pF)
8
6
4
2
0
$T_j = 25°C$
$I_E = 0$
typ
0
2
4
6
8
10
12
V_{CB}(V)
14


7Z05786
2N929
typical values
Tj = 25°C
VCE = 10V
5V
2V
IC (mA)
hie (kΩ)
1000
100
10
1
0.1
0.01
0.01
0.1
1
10


7Z05785
2N930
typical values
Tj = 25°C
VCE = 10V
5V
2V
IC (mA)
hie (kΩ)
1000
100
10
1
0.1
0.01
0.01
0.1
1
10


7Z05774
I_{EBO} (nA)
100
20
10
5
2
1
0.5
0.2
0.1
typ
$V_{EB}=5V$
0
50
100
150
200
T_j (°C)


7Z03376-b14.ibi/icj
I_{CBO} (nA)
10^4
10^3
10^2
10
1
10^{-1}
10^{-2}
$V_{CB}=45V$
max
$V_{CB}=10V$
typ
0
50
100
150
200
T_j (°C)


7Z05776-b14 ibi/icj
300
f_T
(MHz)
250
200
150
100
50
0
0
5
10
15
I_C (mA)
20
V_{CE}=10 V
5 V
2 V
typical values
T_j = 25 °C

GERMANIUM ALLOYED TRANSISTORS

N-P-N transistors in a TO-5 metal envelope with the base connected to the case. These general purpose transistors are primarily intended for medium current medium speed computer logic applications.

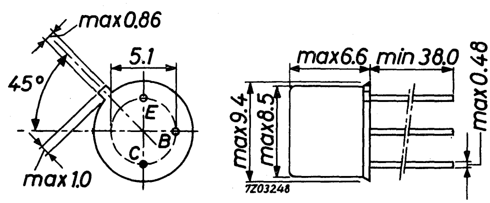
QUICK REFERENCE DATA

			2N1302	1304	1306	1308	
Collector-base voltage (open emitter)	V_{CBO}	max.	25	25	25	25	V
Collector-emitter voltage (open base)	V_{CEO}	max.	25	20	15	15	V
Collector current (peak value)	I_{CM}	max.	300	300	300	300	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	150	150	150	150	mW
Junction temperature	T_j	max.	85	85	85	85	°C
D.C. current gain at T_j = 25 °C; I_C = 10 mA; V_{CE} = 1 V	h_{FE}	>	20	40	60	80	
Saturation voltage I_C = 10 mA; $I_B = \frac{I_C}{h_{FEmin}}$	V_{CEsat}	<	0.2	0.2	0.2	0.2	V
Transition frequency I_C = 1 mA; V_{CE} = 5 V	f_T	typ.	10	15	20	30	MHz
Turn on time ($t_d + t_r$)	t_{on}	typ.	285	270	225	220	ns
Turn off time ($t_s + t_f$)	t_{off}	typ.	865	850	815	790	ns

MECHANICAL DATA

Dimensions in mm

TO-5
Base connected to case



7Z3 0039

RATINGS (Limiting values) [1]

Voltages

			2N1302	1304	1306	1308	
Collector-base voltage (open emitter)	V_{CBO}	max.	25	25	25	25	V
Collector-emitter voltage (open base)	V_{CEO}	max.	25	20	15	15	V
Emitter-base voltage (open collector)	V_{EBO}	max.	25	25	25	25	V

Currents

Collector current (d.c. or average over any 20 ms period)	I_C	max.	200	mA
Collector current (peak value)	I_{CM}	max.	300	mA

Power dissipation

Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	150	mW

Temperatures

Storage temperature	T_{stg}		−65 to +100	°C
Junction temperature	T_j	max.	85	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\,j\text{-}a}$	=	0.4	°C/mW
From junction to case	$R_{th\,j\text{-}c}$	=	0.2	°C/mW

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

7Z3 0040

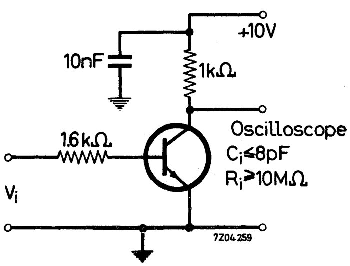
CHARACTERISTICS T_j = 25 °C unless otherwise specified

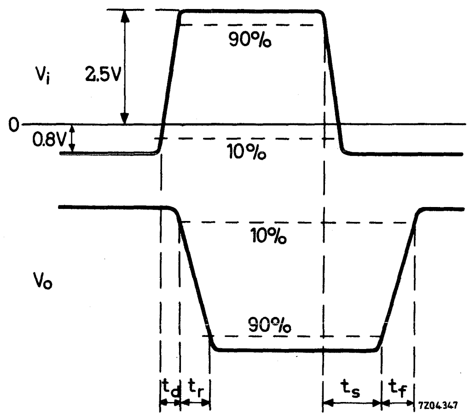
			2N1302	1304	1306	1308	
Collector cut-off current							
I_E = 0; V_{CB} = 25 V	I_{CBO}	typ.	3	3	3	3	µA
		<	6	6	6	6	µA
Emitter cut-off current							
I_C = 0; V_{EB} = 25 V	I_{EBO}	typ.	2.2	2.2	2.2	2.2	µA
		<	6	6	6	6	µA
Collector current at reverse biased emitter junction							
$-V_{BE}$ = 0.2 V; T_j = 55 °C							
V_{CE} = 20 V	I_{CEX}	<	50	50			µA
V_{CE} = 15 V	I_{CEX}	<			50	50	µA
Saturation voltages							
		>	0.15	0.15	0.15	0.15	V
I_C = 10 mA; I_B = 0.5 mA	V_{BEsat}	typ.	0.30	0.25	0.24	0.23	V
		<	0.40	0.35	0.35	0.35	V
	V_{CEsat}	typ.	0.1				V
		<	0.2				V
I_C = 10 mA; I_B = 0.25 mA	V_{CEsat}	typ.		0.1			V
		<		0.2			V
I_C = 10 mA; I_B = 0.17 mA	V_{CEsat}	typ.			0.1		V
		<			0.2		V
I_C = 10 mA; I_B = 0.13 mA	V_{CEsat}	typ.				0.1	V
		<				0.2	V
Punch through voltage	V_{pt}	>	25	20	15	15	V
D.C. current gain							
		>	20	40	60	80	
I_C = 10 mA; V_{CE} = 1 V	h_{FE}	typ.	50	70	100	150	
		<		100	200	300	
		>	10	15	20	20	
I_C = 200 mA; V_{CE} = 0.35 V	h_{FE}	typ.	48	65	95	145	
Collector capacitance at f = 1 MHz							
$I_E = I_e$ = 0; V_{CB} = 5 V	C_c	typ.	12	12	12	12	pF
		<	20	20	20	20	pF
Emitter capacitance at f = 1 MHz							
$I_C = I_c$ = 0; V_{EB} = 5 V	C_e	typ.	8	8	8	8	pF
Transition frequency							
		>	3	5	10	15	MHz
I_C = 1 mA; V_{CE} = 5 V	f_T	typ.	10	15	20	30	MHz

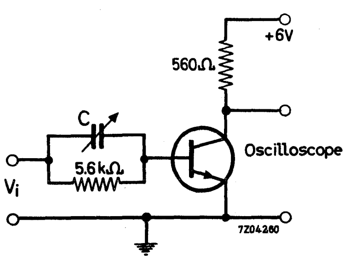
7Z3 0041

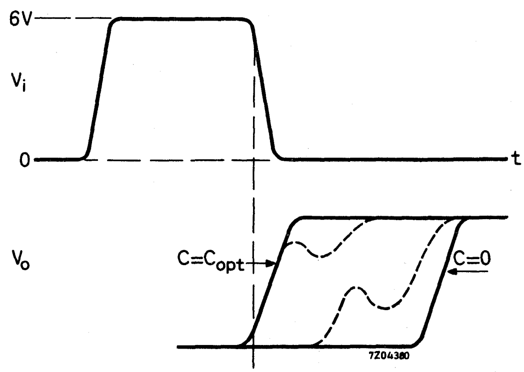
CHARACTERISTICS (continued) T_j = 25 °C unless otherwise specified

			2N1302	1304	1306	1308	
Switching times							
delay time	t_d	typ.	65	60	55	55	ns
rise time	t_r	typ.	220	210	170	165	ns
storage time	t_s	typ.	500	500	500	500	ns
fall time	t_f	typ.	365	350	315	290	ns
Recovered charge	Q_s	typ.	800	700	650	600	pC



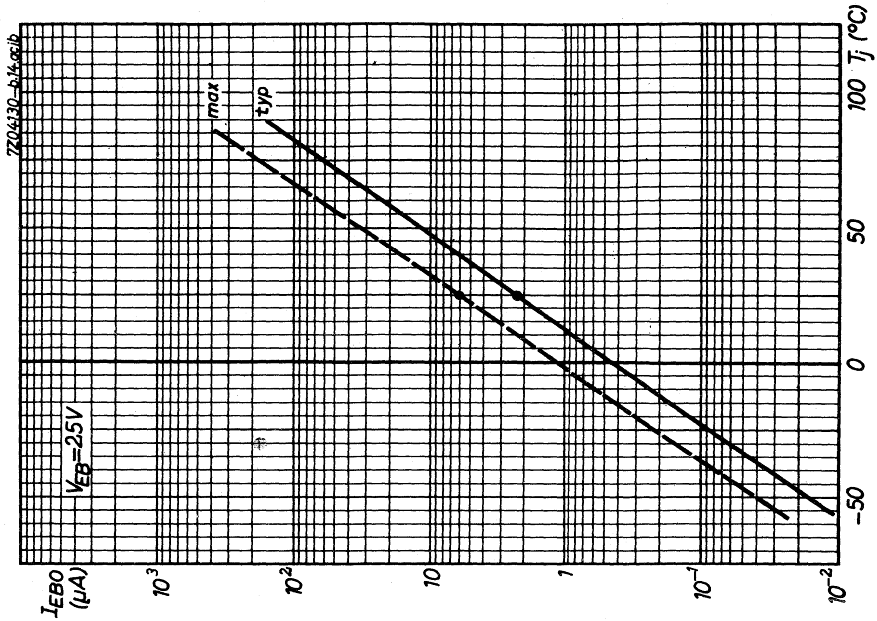


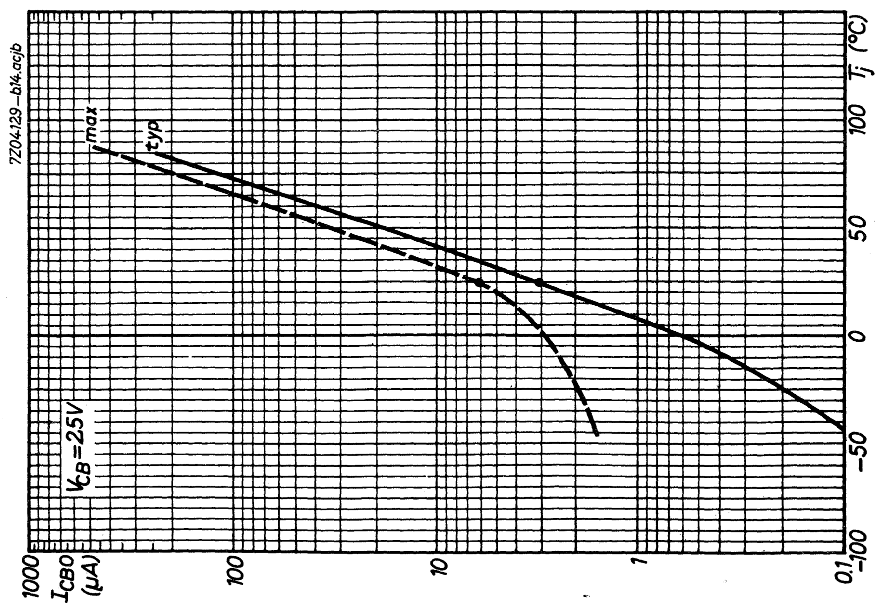


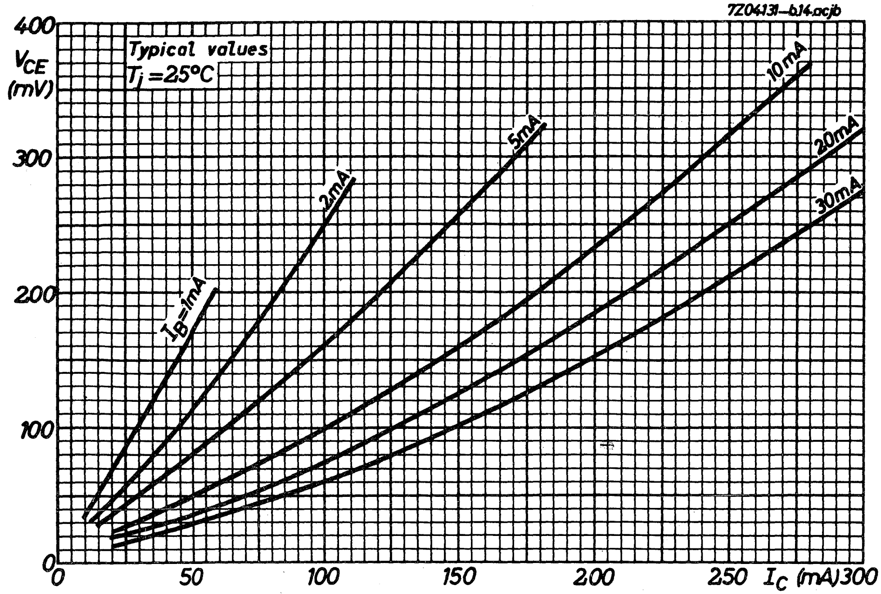


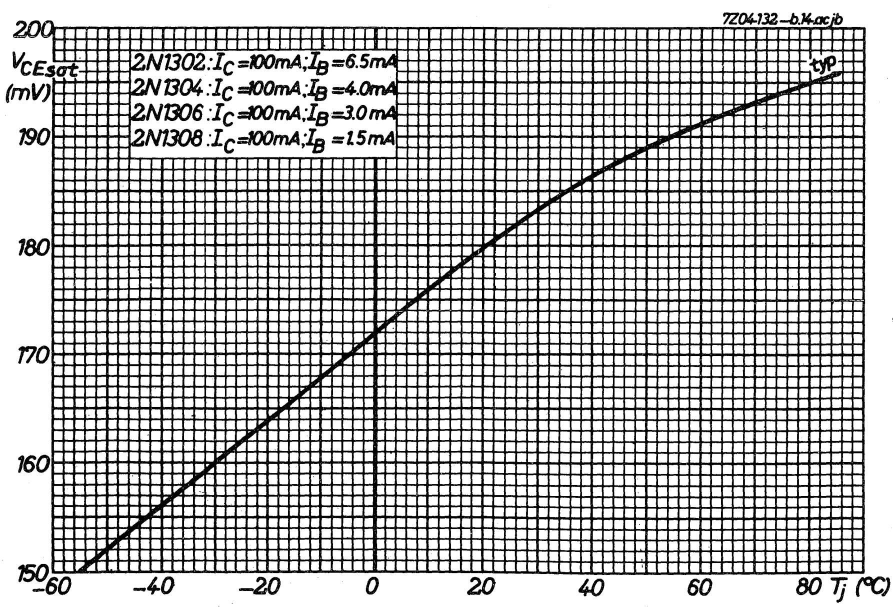
Adjust C from zero to C_{opt}
$Q_s = C_{opt} \cdot V_i$

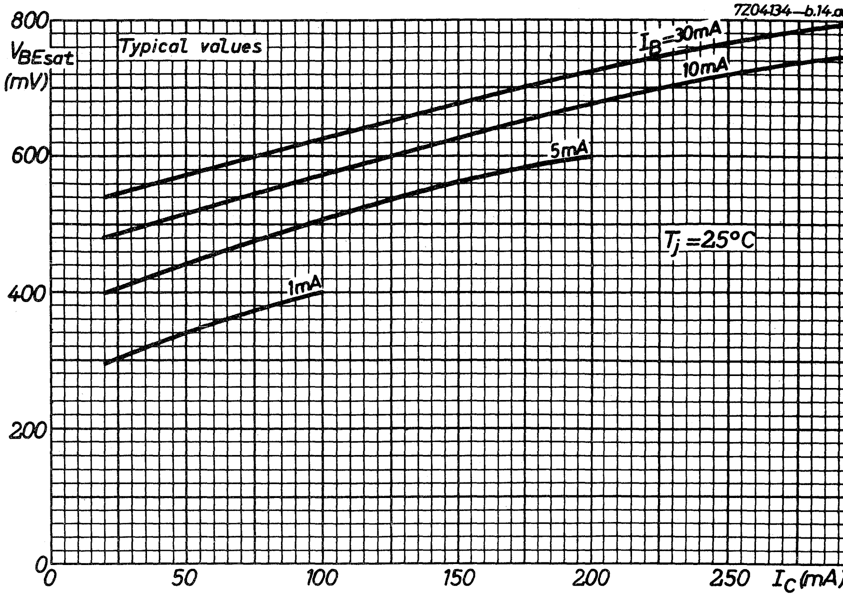
7Z3 0042

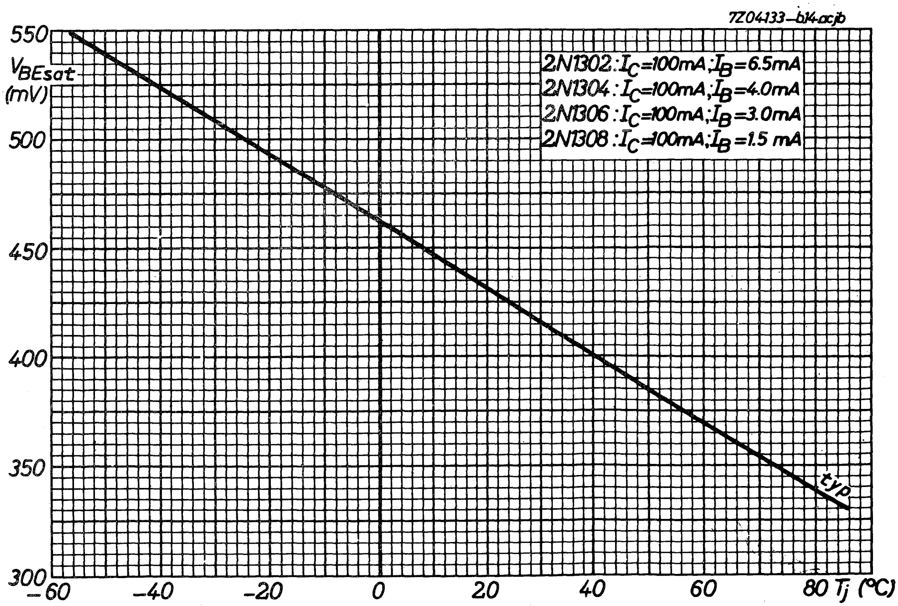

7Z04130–b14.acjb
max
typ
V_{EB}=25V
I_{EBO} (µA)
10^3
10^2
10
1
10^{-1}
10^{-2}
T_j (°C)
100
50
0
−50

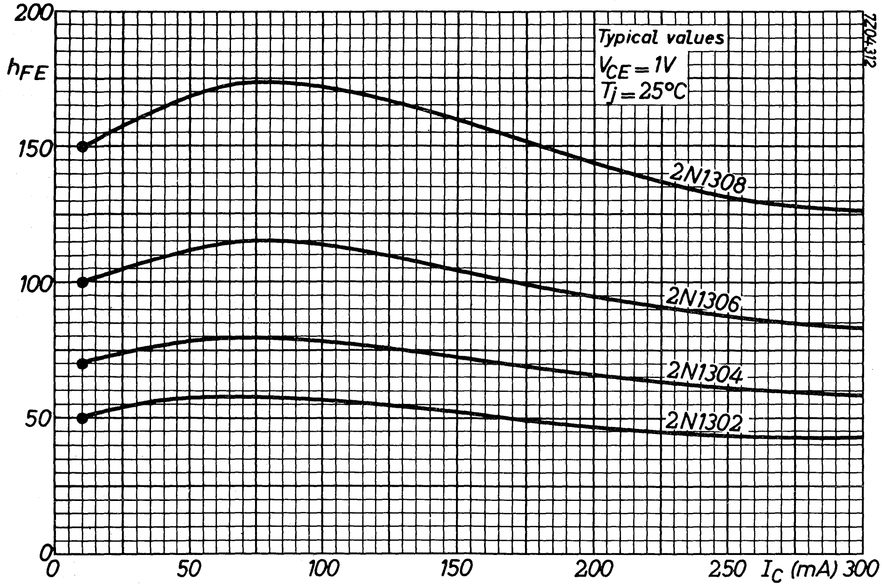

7Z04129–b14.acjb
max
typ
V_{CB}=25V
I_{CBO} (µA)
1000
100
10
1
0.1
T_j (°C)
100
50
0
−50
−100

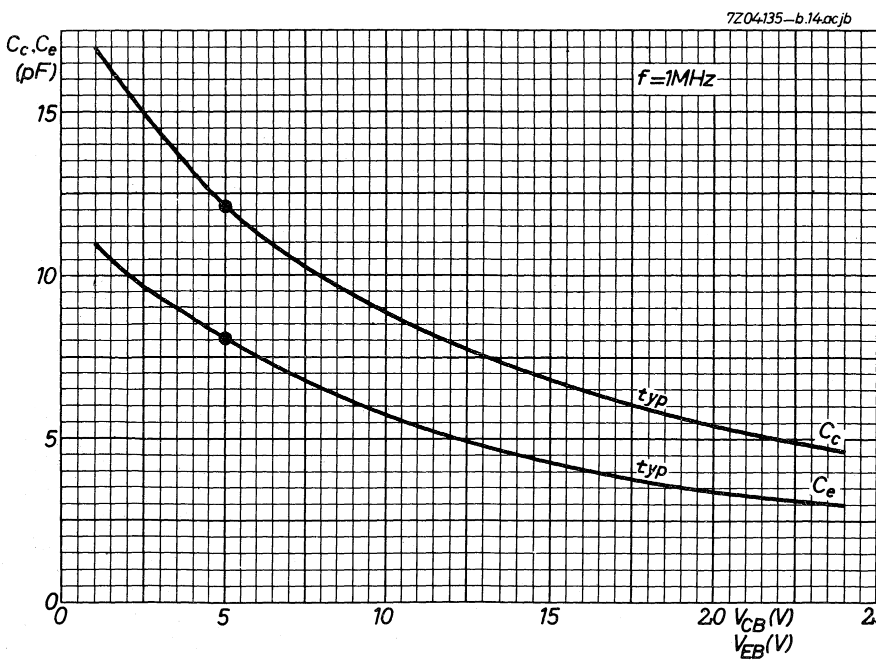

7Z04131–b.14.acjb
Typical values
T_j = 25°C
V_{CE} (mV)
400
300
200
100
0
I_B=1mA
2mA
5mA
10mA
20mA
30mA
0
50
100
150
200
250
I_C (mA) 300

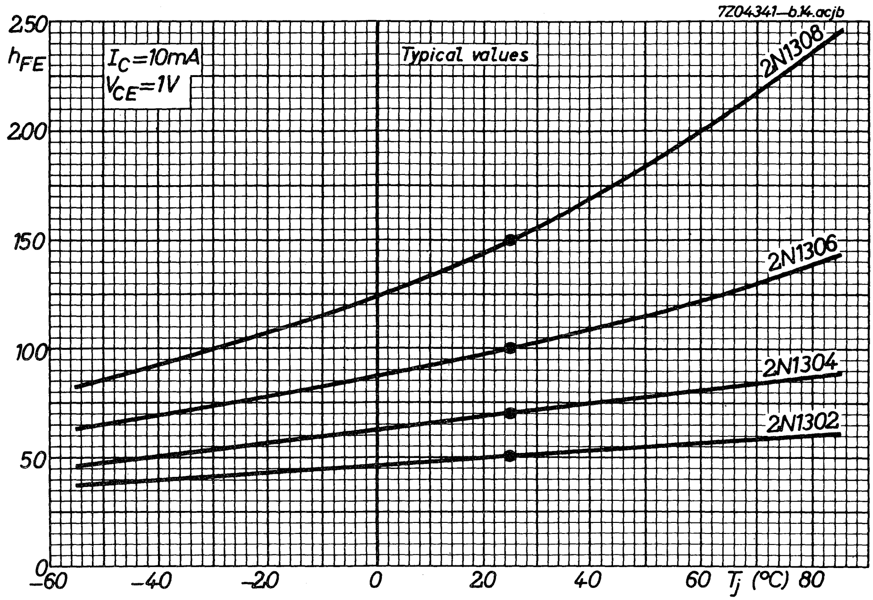

7Z04132–b.14.acjb
V_{CEsat} (mV)
2N1302: I_C =100mA; I_B =6.5mA
2N1304: I_C =100mA; I_B =4.0mA
2N1306: I_C =100mA; I_B =3.0mA
2N1308: I_C =100mA; I_B =1.5mA
typ
200
190
180
170
160
150
−60
−40
−20
0
20
40
60
80 T_j (°C)

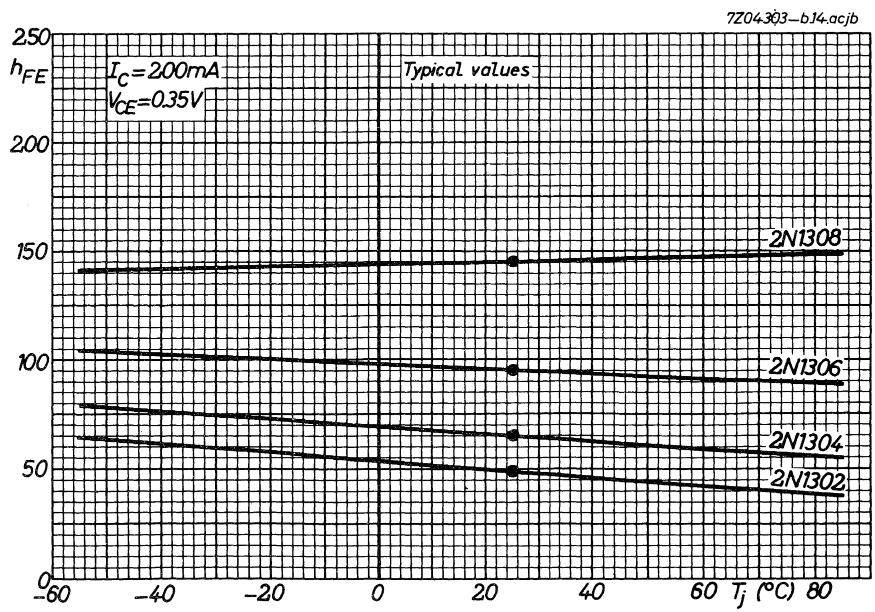

7Z04134–b.14.acjb
Typical values
V_{BEsat} (mV)
800
600
400
200
0
I_B=30mA
10mA
5mA
1mA
T_j=25°C
0
50
100
150
200
250
I_C (mA)


7Z04133–b14.acjb
V_{BEsat} (mV)
550
500
450
400
350
300
2N1302 : I_C=100mA; I_B=6.5mA
2N1304 : I_C=100mA; I_B=4.0mA
2N1306 : I_C=100mA; I_B=3.0mA
2N1308 : I_C=100mA; I_B=1.5 mA
typ
−60
−40
−20
0
20
40
60
80
T_j (°C)


7Z04312
Typical values
$V_{CE} = 1V$
$T_j = 25°C$
h_{FE}
200
150
100
50
0
2N1308
2N1306
2N1304
2N1302
0
50
100
150
200
250
I_C (mA)
300


7Z04135—b.14.acjb
C_c, C_e
(pF)
15
10
5
0
f=1MHz
typ
typ
C_c
C_e
0
5
10
15
20
25
V_{CB}(V)
V_{EB}(V)


7Z04341—b14.acjb
250
h_{FE}
200
150
100
50
0
I_C=10mA
V_{CE}=1V
Typical values
2N1308
2N1306
2N1304
2N1302
−60
−40
−20
0
20
40
60
T_j (°C)
80


7Z04303—b14.acjb
250
h_{FE}
200
150
100
50
0
I_C=200mA
V_{CE}=0.35V
Typical values
2N1308
2N1306
2N1304
2N1302
−60
−40
−20
0
20
40
60
T_j (°C)
80

GERMANIUM ALLOYED TRANSISTORS

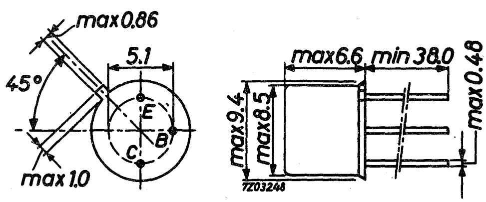
P-N-P transistors in a TO-5 metal envelope with the base connected to the case. These general purpose transistors are primarily intended for medium current medium speed computer logic applications.

QUICK REFERENCE DATA

			2N1303	1305	1307	1309	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	30	30	30	30	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	25	20	15	15	V
Collector current (peak value)	$-I_{CM}$	max.	300	300	300	300	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	150	150	150	150	mW
Junction temperature	T_j	max.	85	85	85	85	°C
D.C. current gain at T_j = 25°C; $-I_C$ = 10 mA; $-V_{CE}$ = 1 V	h_{FE}	>	20	40	60	80	
Saturation voltage $-I_C$ = 10 mA; $-I_B = \frac{-I_C}{h_{FEmin}}$	$-V_{CEsat}$	<	0.2	0.2	0.2	0.2	V
Transition frequency $-I_C$ = 1 mA; $-V_{CE}$ = 5 V	f_T	typ.	5	10	15	20	MHz
Turn on time ($t_d + t_r$)	t_{on}	typ.	360	255	230	200	ns
Turn off time ($t_s + t_f$)	t_{off}	typ.	1300	1150	1050	1050	ns

MECHANICAL DATA Dimensions in mm

TO-5
Base connected to case



7Z3 0043

RATINGS (Limiting values) [1]

Voltages

			2N1303	1305	1307	1309	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	30	30	30	30	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	25	20	15	15	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	25	25	25	25	V

Currents

Collector current (d.c. or average over any 20 ms period)	$-I_C$	max.	200	mA
Collector current (peak value)	$-I_{CM}$	max.	300	mA

Power dissipation

Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	150	mW

Temperatures

Storage temperature	T_{stg}		-65 to +100	°C
Junction temperature	T_j	max.	85	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\,j-a}$	=	0.4	°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 IEC publication 134.

7Z3 0044

CHARACTERISTICS

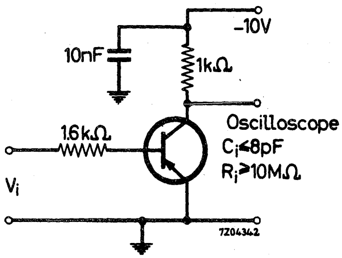
T_j = 25 °C unless otherwise specified

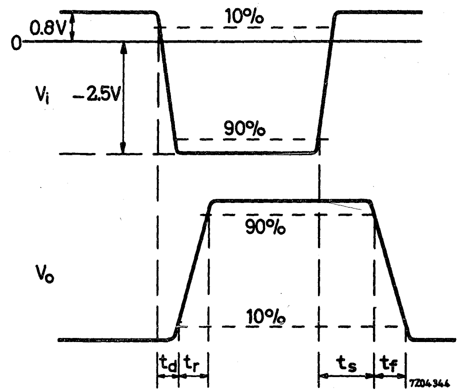
			2N1303	1305	1307	1309	
Collector cut-off current I_E = 0; $-V_{CB}$ = 25 V	$-I_{CBO}$	typ.	3	3	3	3	µA
		<	6	6	6	6	µA
Emitter cut-off current I_C = 0; $-V_{EB}$ = 25 V	$-I_{EBO}$	typ.	1.7	1.7	1.7	1.7	µA
		<	6	6	6	6	µA
Collector current at reverse biased emitter junction $-V_{CE}$ = 15 V; $+V_{BE}$ = 0.2 V T_j = 55 °C	$-I_{CEX}$	<	50	50	50	50	µA
Saturation voltages		>	0.15	0.15	0.15	0.15	V
$-I_C$ = 10 mA; $-I_B$ = 0.5 mA	$-V_{BEsat}$	typ.	0.30	0.25	0.24	0.23	V
		<	0.40	0.35	0.35	0.35	V
	$-V_{CEsat}$	typ.	0.1				V
		<	0.2				V
$-I_C$ = 10 mA; $-I_B$ = 0.25 mA	$-V_{CEsat}$	typ.		0.1			V
		<		0.2			V
$-I_C$ = 10 mA; $-I_B$ = 0.17 mA	$-V_{CEsat}$	typ.			0.1		V
		<			0.2		V
$-I_C$ = 10 mA; $-I_B$ = 0.13 mA	$-V_{CEsat}$	typ.				0.1	V
		<				0.2	V
Punch through voltage	V_{pt}	>	25	20	15	15	V
D.C. current gain		>	20	40	60	80	
$-I_C$ = 10 mA; $-V_{CE}$ = 1 V	h_{FE}	typ.	50	70	100	150	
		<		100	200	300	
$-I_C$ = 200 mA; $-V_{CE}$ = 0.35 V	h_{FE}	>	10	15	20	20	
		typ.	35	55	90	130	
Collector capacitance at f = 1 MHz $I_E = I_e$ = 0; $-V_{CB}$ = 5 V	C_c	typ.	10	10	10	10	pF
		<	20	20	20	20	pF
Emitter capacitance at f = 1 MHz $I_C = I_c$ = 0; $-V_{EB}$ = 5 V	C_e	typ.	7	7	7	7	pF
Transition frequency $-I_C$ = 1 mA; $-V_{CE}$ = 5 V	f_T	>	3	5	10	15	MHz
		typ.	5	10	15	20	MHz

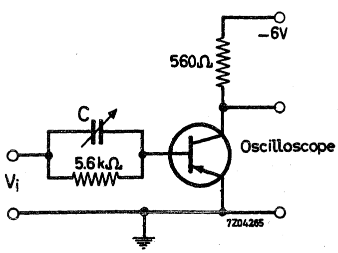
7Z3 0045

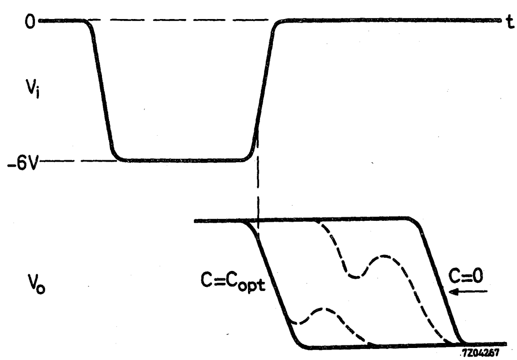
CHARACTERISTICS (continued) T_j = 25 °C unless otherwise specified

			2N1303	1305	1307	1309	
Switching times							
delay time	t_d	typ.	60	55	50	45	ns
rise time	t_r	typ.	300	200	180	155	ns
storage time	t_s	typ.	700	700	700	700	ns
fall time	t_f	typ.	600	450	350	350	ns
Recovered charge	Q_s	typ.	1000	1000	1000	1000	pC



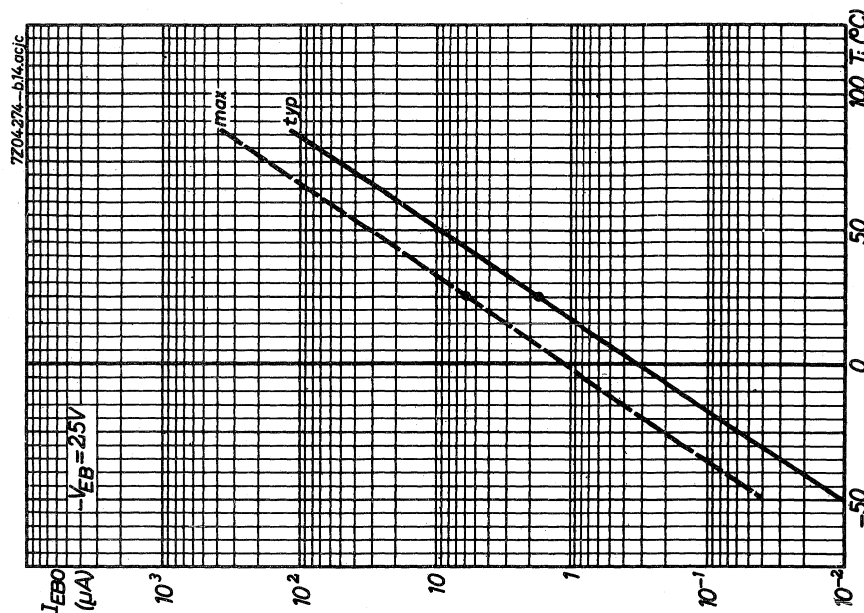


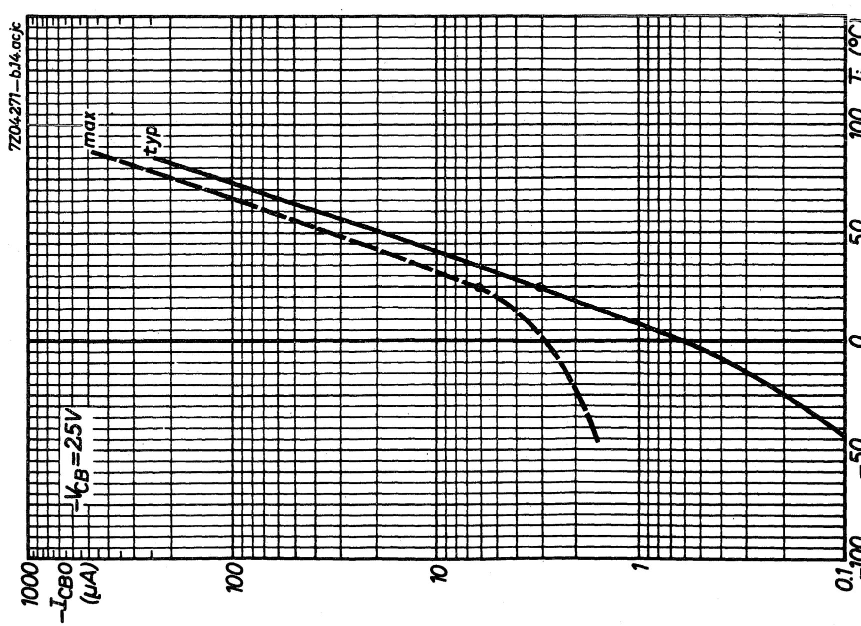


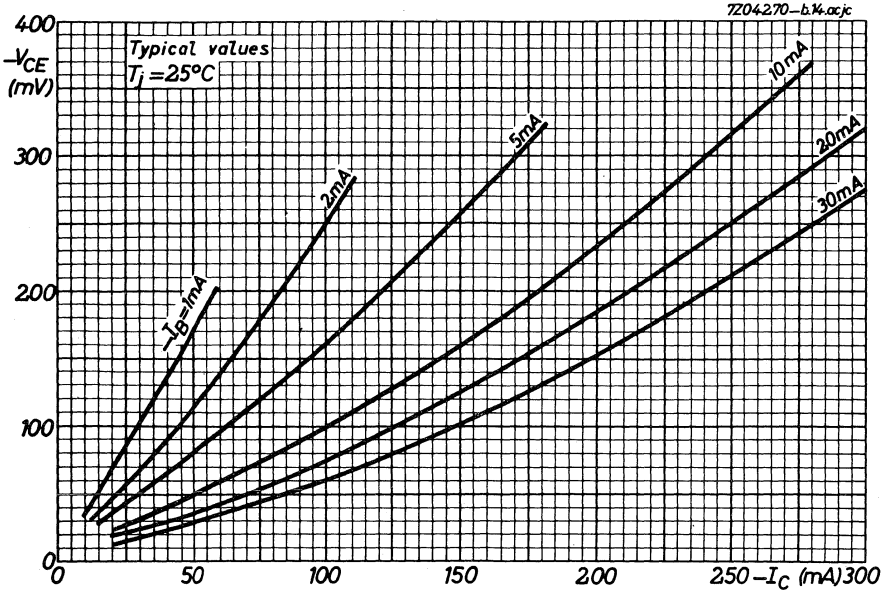


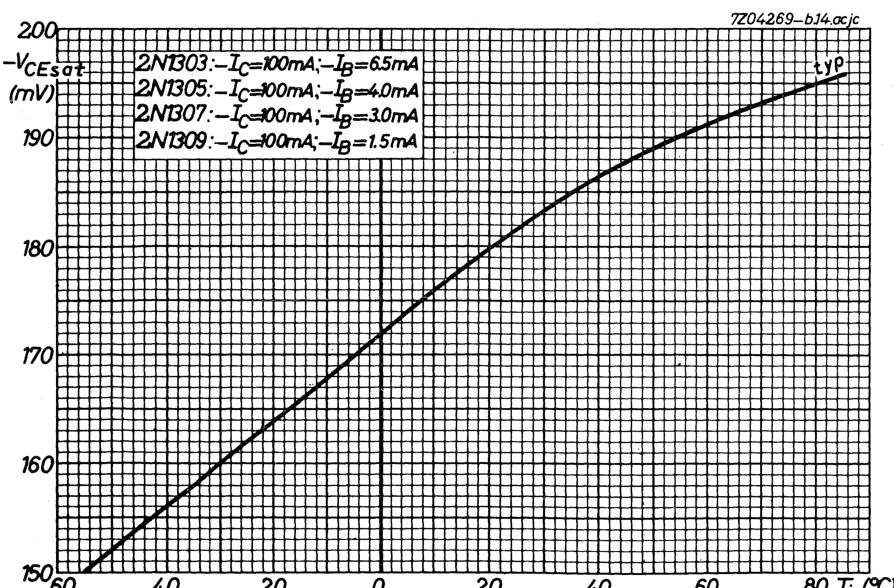
Adjust C from zero to C_{opt}
$Q_s = C_{opt} \cdot V_i$

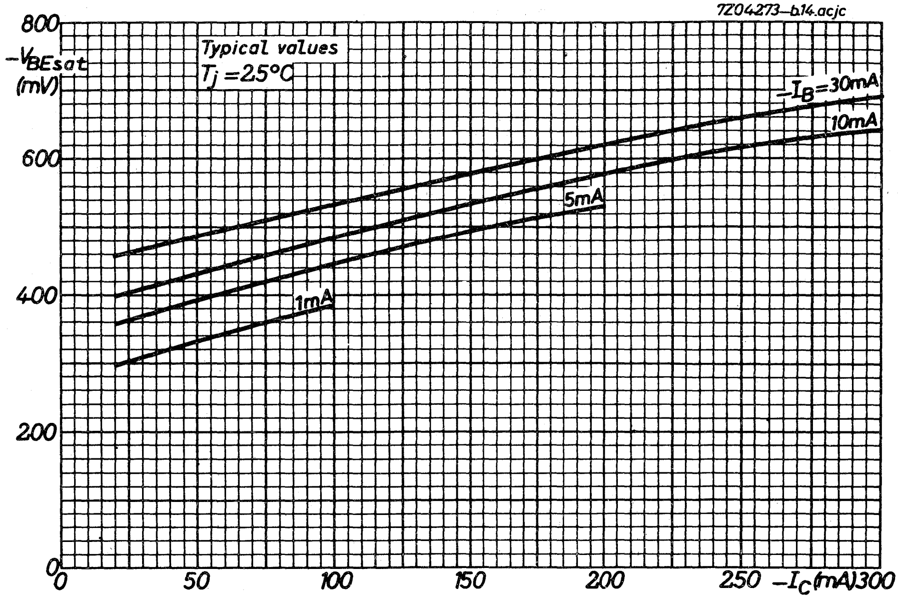
7Z3 0046

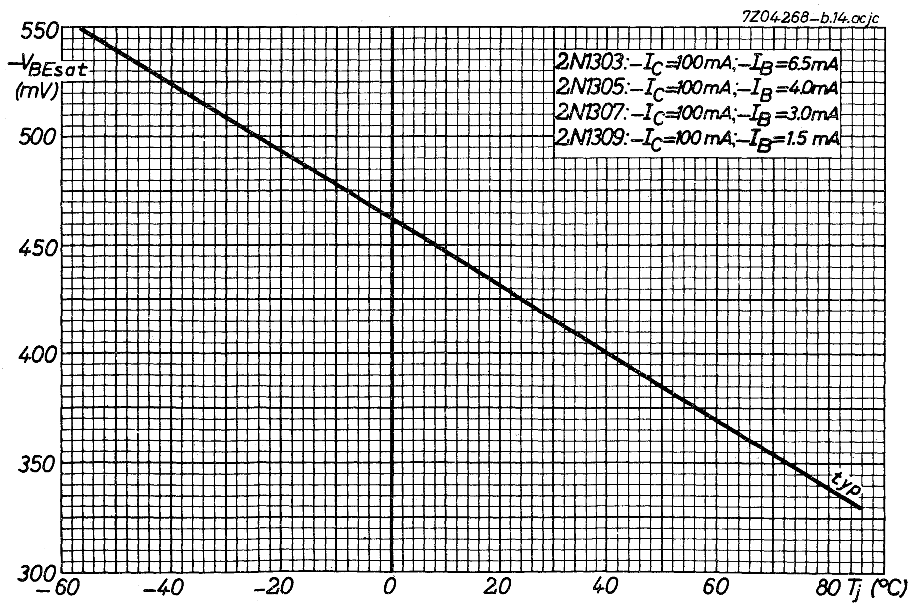

7Z04274–b14.acjc
$-I_{EBO}$ (μA)
10^3
10^2
10
1
10^{-1}
10^{-2}
$-V_{EB}$=25V
max
typ
-50
0
50
100
T_j (°C)

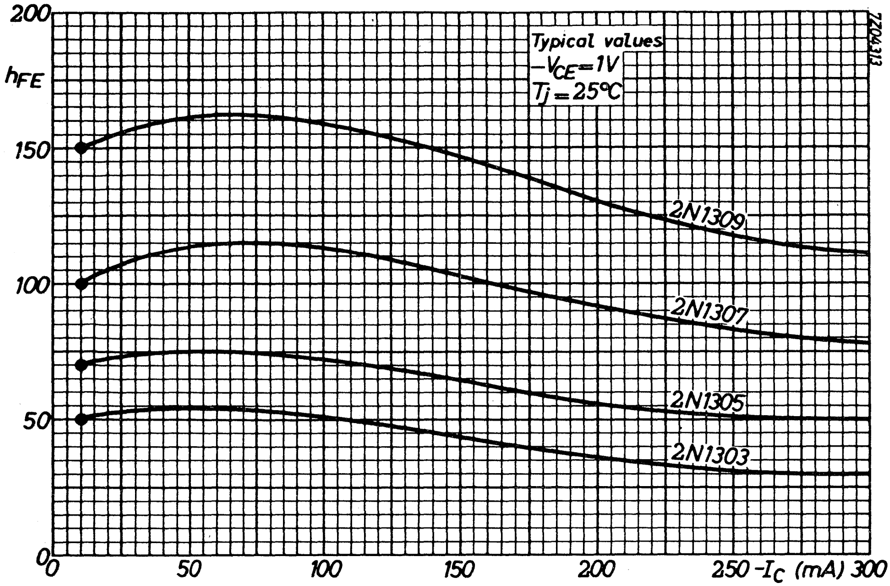

7Z04271–b14.acjc
1000
$-I_{CBO}$ (μA)
100
10
1
0.1
$-V_{CB}$=25V
max
typ
-100
-50
0
50
100
T_j (°C)

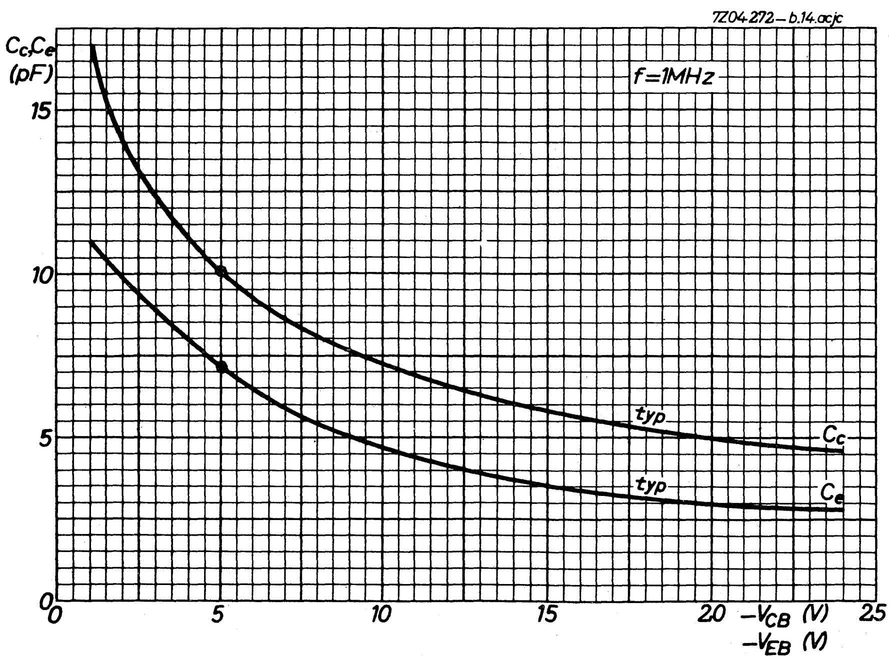

7Z04270-b.14.acjc
Typical values
$T_j = 25°C$
$-V_{CE}$ (mV)
400
300
200
100
0
$-I_B = 1mA$
2mA
5mA
10 mA
20mA
30mA
0
50
100
150
200
250
$-I_C$ (mA)
300

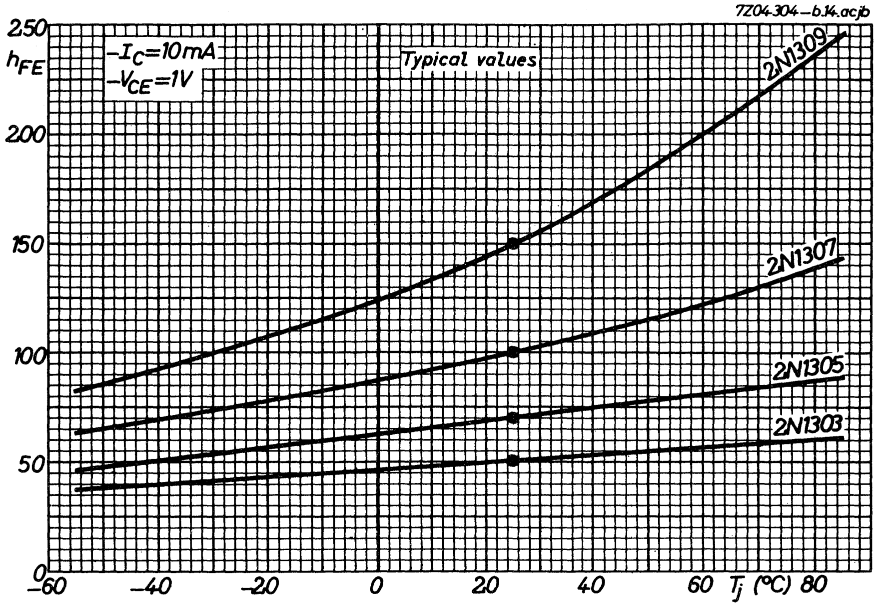

7Z04269-b.14.acjc
$-V_{CEsat}$ (mV)
200
190
180
170
160
150
2N1303: $-I_C$=100mA; $-I_B$=6.5mA
2N1305: $-I_C$=100mA; $-I_B$=4.0mA
2N1307: $-I_C$=100mA; $-I_B$=3.0mA
2N1309: $-I_C$=100mA; $-I_B$=1.5mA
typ
−60
−40
−20
0
20
40
60
80
T_j (°C)

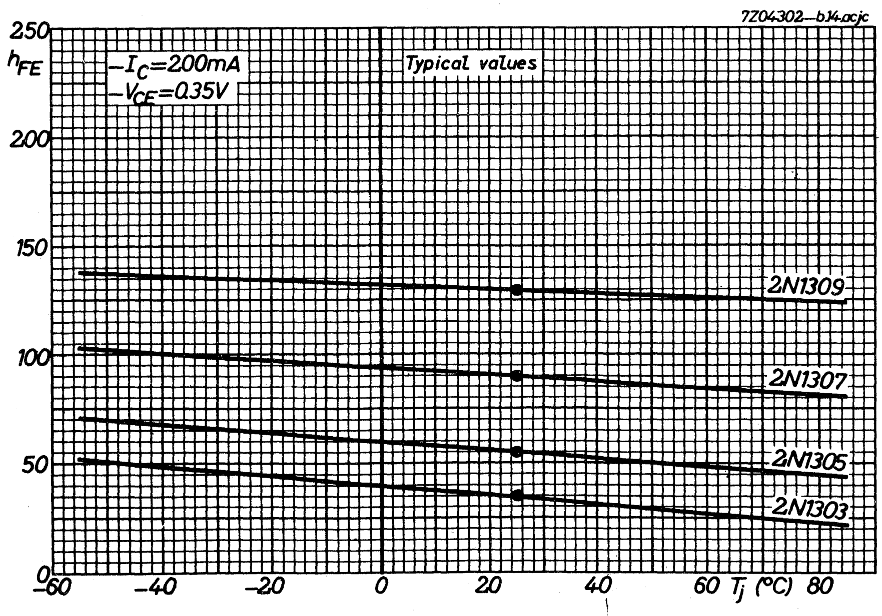

7Z04273–b.14.acjc
800
$-V_{BEsat}$
(mV)
600
400
200
0
Typical values
$T_j = 25°C$
$-I_B = 30mA$
10mA
5mA
1mA
0
50
100
150
200
250
$-I_C$ (mA)
300


7Z04268–b.14.acjc
550
$-V_{BEsat}$
(mV)
500
450
400
350
300
2N1303: $-I_C$=100mA; $-I_B$=6.5mA
2N1305: $-I_C$=100mA; $-I_B$=4.0mA
2N1307: $-I_C$=100mA; $-I_B$=3.0mA
2N1309: $-I_C$=100 mA; $-I_B$=1.5 mA
typ
−60
−40
−20
0
20
40
60
80
T_j (°C)


7Z04313
Typical values
$-V_{CE} = 1V$
$T_j = 25°C$
h_{FE}
200
150
100
50
0
2N1309
2N1307
2N1305
2N1303
0
50
100
150
200
250
$-I_C$ (mA)
300


7Z04272—b.14.acjc
C_c, C_e
(pF)
f=1MHz
15
10
5
0
typ
C_c
typ
C_e
0
5
10
15
20
$-V_{CB}$ (V)
$-V_{EB}$ (V)
25


7Z04304—b.14.acjb
250
h_{FE}
200
150
100
50
0
$-I_C$=10mA
$-V_{CE}$=1V
Typical values
2N1309
2N1307
2N1305
2N1303
−60
−40
−20
0
20
40
60
T_j (°C)
80


7Z04302—b14.acjc
250
h_{FE}
200
150
100
50
0
$-I_C$=200mA
$-V_{CE}$=0.35V
Typical values
2N1309
2N1307
2N1305
2N1303
−60
−40
−20
0
20
40
60
T_j (°C)
80

SILICON PLANAR TRANSISTOR

N-P-N double diffused transistor in a TO-5 metal envelope with the collector connected to the case. The 2N1613 is intended for use in a wide variety of applications, such as d.c. and high frequency amplifiers and switching applications.

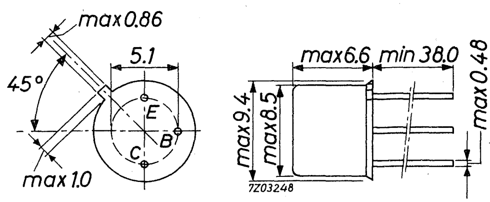
QUICK REFERENCE DATA

Collector-base voltage (open emitter)	V_{CBO}	max.	75	V
Collector-emitter voltage ($R_{BE} < 10\,\Omega$)	V_{CER}	max.	50	V
Collector current (peak value)	I_{CM}	max.	1	A
Total power dissipation up to $T_{amb} = 25\,^oC$	P_{tot}	max.	0.8	W
Junction temperature	T_j	max.	200	^oC
D.C. current gain				
I_C = 0.1 mA; V_{CE} = 10 V	h_{FE}	>	20	
I_C = 10 mA; V_{CE} = 10 V	h_{FE}	>	35	
I_C = 150 mA; V_{CE} = 10 V	h_{FE}	40 to	120	
Transition frequency				
I_C = 50 mA; V_{CE} = 10 V	f_T	>	60	MHz

MECHANICAL DATA Dimensions in mm

Collector connected to case

TO-5



7Z3 0758

RATINGS (Limiting values) [1]

Voltages

Collector-base voltage (open emitter)	V_{CBO}	max.	75	V
Collector-emitter voltage ($R_{BE} < 10\,\Omega$)	V_{CER}	max.	50	V
Emitter-base voltage (open collector)	V_{EBO}	max.	7	V

Current

Collector current (peak value)	I_{CM}	max.	1	A

Power dissipation

Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	0.8	W
up to T_{case} = 100 °C	P_{tot}	max.	1.7	W
up to T_{case} = 25 °C	P_{tot}	max.	3.0	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	$R_{th\,j\text{-}a}$	=	220	°C/W
From junction to case	$R_{th\,j\text{-}c}$	=	58	°C/W

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

7Z3 0759

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

Collector cut-off current				
$I_E = 0$; $V_{CB} = 60$ V	I_{CBO}	<	10	nA
$I_E = 0$; $V_{CB} = 60$ V; $T_{amb} = 150$ °C	I_{CBO}	<	10	μA
Emitter cut-off current				
$I_C = 0$; $V_{EB} = 5$ V	I_{EBO}	<	10	nA
Collector-emitter sustaining voltage				
$I_C = 100$ mA; $R_{BE} < 10\ \Omega$	$V_{CERsust}$	>	50	V [1]
Saturation voltages				
$I_C = 150$ mA; $I_B = 15$ mA	V_{CEsat}	<	1.5	V [1]
	V_{BEsat}	<	1.3	V [1]
D.C. current gain				
$I_C = 0.1$ mA; $V_{CE} = 10$ V	h_{FE}	>	20	
$I_C = 10$ mA; $V_{CE} = 10$ V	h_{FE}	>	35	[1]
$I_C = 150$ mA; $V_{CE} = 10$ V	h_{FE}		40 to 120	[1]
$I_C = 500$ mA; $V_{CE} = 10$ V	h_{FE}	>	20	[1]
$I_C = 10$ mA; $V_{CE} = 10$ V; $T_{amb} = -55$ °C	h_{FE}	>	20	
h parameters at f = 1 kHz				
$-I_E = 1$ mA; $V_{CB} = 5$ V				
Input impedance	h_{ib}		24 to 34	Ω
Reverse voltage transfer	h_{rb}	<	3	10^{-4}
Output admittance	h_{ob}		0.1 to 0.5	$\mu\Omega^{-1}$
$-I_E = 5$ mA; $V_{CB} = 10$ V				
Input impedance	h_{ib}		4 to 8	Ω
Reverse voltage transfer	h_{rb}	<	3	10^{-4}
Output admittance	h_{ob}		0.1 to 1.0	$\mu\Omega^{-1}$
Small signal current gain				
$I_C = 1$ mA; $V_{CE} = 5$ V	h_{fe}		30 to 100	
$I_C = 5$ mA; $V_{CE} = 10$ V	h_{fe}		35 to 150	

[1] Measured under pulse conditions to avoid excessive dissipation.
Pulse duration $t < 300\ \mu s$, duty cycle $\delta < 0.01$

7Z3 0760

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

Transition frequency				
I_C = 50 mA; V_{CE} = 10 V	f_T	>	60	MHz
Collector capacitance at f = 1 MHz				
I_E = I_e = 0; V_{CB} = 10 V	C_c	<	25	pF
Emitter capacitance at f = 1 MHz				
I_C = I_c = 0; V_{EB} = 0.5 V	C_e	<	80	pF
Noise figure at f = 1 kHz				
I_C = 0.3 mA; V_{CE} = 10 V R_S = 510 Ω; Bandwidth: 200 Hz	F	<	12	dB

7Z3 0761

SILICON PLANAR TRANSISTOR

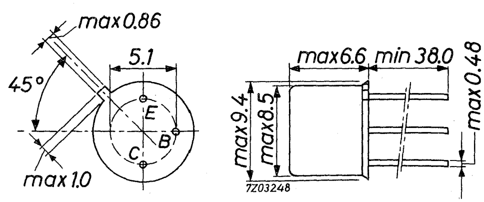
N-P-N double diffused transistor in a TO-5 metal envelope with the collector connected to the case. The 2N1711 is intended for use in a wide variety of applications, such as d.c. and high frequency amplifiers and switching applications.

QUICK REFERENCE DATA				
Collector-base voltage (open emitter)	V_{CBO}	max.	75	V
Collector-emitter voltage ($R_{BE} < 10\,\Omega$)	V_{CER}	max.	50	V
Collector current (peak value)	I_{CM}	max.	1	A
Total power dissipation up to $T_{amb} = 25\,^oC$	P_{tot}	max.	0.8	W
Junction temperature	T_j	max.	200	^oC
D.C. current gain				
$I_C = 0.1$ mA; $V_{CE} = 10$ V	h_{FE}	>	35	
$I_C = 10$ mA; $V_{CE} = 10$ V	h_{FE}	>	75	
$I_C = 150$ mA; $V_{CE} = 10$ V	h_{FE}	100 to 300		
Transition frequency				
$I_C = 50$ mA; $V_{CE} = 10$ V	f_T	>	70	MHz

MECHANICAL DATA Dimensions in mm

Collector connected to case

TO-5



7Z3 0762

RATINGS (Limiting values) [1]

Voltages

Collector-base voltage (open emitter)	V_{CBO}	max.	75	V
Collector-emitter voltage ($R_{BE} < 10\ \Omega$)	V_{CER}	max.	50	V
Emitter-base voltage (open collector)	V_{EBO}	max.	7	V

Current

Collector current (peak value)	I_{CM}	max.	1	A

Power dissipation

Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	0.8	W
up to T_{case} = 100 °C	P_{tot}	max.	1.7	W
up to T_{case} = 25 °C	P_{tot}	max.	3.0	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	$R_{th\ j-a}$	=	220	°C/W
From junction to case	$R_{th\ j-c}$	=	58	°C/W

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

7Z3 0763

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

Collector cut-off current				
$I_E = 0$; $V_{CB} = 60$ V	I_{CBO}	<	10	nA
$I_E = 0$; $V_{CB} = 60$ V; $T_{amb} = 150$ °C	I_{CBO}	<	10	μA
Emitter cut-off current				
$I_C = 0$; $V_{EB} = 5$ V	I_{EBO}	<	5	nA
Collector-emitter sustaining voltage				
$I_C = 100$ mA; $R_{BE} < 10\ \Omega$	$V_{CERsust}$	>	50	V [1]
Saturation voltages				
$I_C = 150$ mA; $I_B = 15$ mA	V_{CEsat}	<	1.5	V [1]
	V_{BEsat}	<	1.3	V [1]
D.C. current gain				
$I_C = 10\ \mu A$; $V_{CE} = 10$ V	h_{FE}	>	20	
$I_C = 0.1$ mA; $V_{CE} = 10$ V	h_{FE}	>	35	
$I_C = 10$ mA; $V_{CE} = 10$ V	h_{FE}	>	75	[1]
$I_C = 150$ mA; $V_{CE} = 10$ V	h_{FE}		100 to 300	[1]
$I_C = 500$ mA; $V_{CE} = 10$ V	h_{FE}	>	40	[1]
$I_C = 10$ mA; $V_{CE} = 10$ V; $T_{amb} = -55$ °C	h_{FE}	>	35	
h parameters at f = 1 kHz				
$-I_E = 1$ mA; $V_{CB} = 5$ V				
Input impedance	h_{ib}		24 to 34	Ω
Reverse voltage transfer	h_{rb}	<	5	10^{-4}
Output admittance	h_{ob}		0.1 to 0.5	$\mu\Omega^{-1}$
$-I_E = 5$ mA; $V_{CB} = 10$ V				
Input impedance	h_{ib}		4 to 8	Ω
Reverse voltage transfer	h_{rb}	<	5	10^{-4}
Output admittance	h_{ob}		0.1 to 1.0	$\mu\Omega^{-1}$
Small signal current gain				
$I_C = 1$ mA; $V_{CE} = 5$ V	h_{fe}		50 to 200	
$I_C = 5$ mA; $V_{CE} = 10$ V	h_{fe}		70 to 300	

[1]) Measured under pulse conditions to avoid excessive dissipation.
Pulse duration $t < 300\ \mu s$, duty cycle $\delta < 0.01$

7Z3 0764

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

Transition frequency

I_C = 50 mA; V_{CE} = 10 V	f_T	>	70	MHz

Collector capacitance at f = 1 MHz

$I_E = I_e = 0$; V_{CB} = 10 V	C_c	<	25	pF

Emitter capacitance at f = 1 MHz

$I_C = I_c = 0$; V_{EB} = 0.5 V	C_e	<	80	pF

Noise figure at f = 1 kHz

I_C = 0.3 mA; V_{CE} = 10 V R_S = 510 Ω; Bandwidth: 200 Hz	F	<	8	dB

7Z3 0765

SILICON PLANAR EPITAXIAL TRANSISTORS

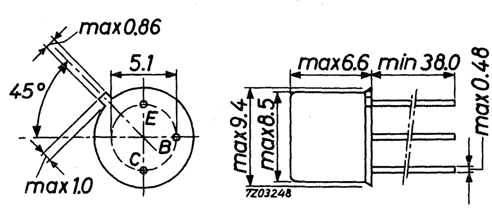
N-P-N transistors in a TO-5 metal envelope with the collector connected to the case. The 2N2218 and 2N2219 are primarily intended for high speed switching circuits and d.c. to u.h.f. amplifiers.

QUICK REFERENCE DATA				
Collector-base voltage (open emitter)	V_{CBO}	max.	60	V
Collector-emitter voltage (open base)	V_{CEO}	max.	30	V
Collector current (d.c.)	I_C	max.	0.8	A
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	0.8	W
Junction temperature	T_j	max.	175	°C
Transition frequency				
I_C = 20 mA; V_{CE} = 20 V	f_T	>	250	MHz
D.C. current gain at T_j = 25 °C			2N2218	2N2219
I_C = 0.1 mA; V_{CE} = 10 V	h_{FE}	>	50	35
I_C = 10 mA; V_{CE} = 10 V	h_{FE}	>	35	75
I_C = 500 mA; V_{CE} = 10 V	h_{FE}	>	20	30

MECHANICAL DATA Dimensions in mm

TO-5

Collector connected to case



7Z3 0529

RATINGS (Limiting values) [1])

Voltages

Collector-base voltage (open emitter)	V_{CBO}	max.	60	V
Collector-emitter voltage (open base)	V_{CEO}	max.	30	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	V

Current

Collector current (d.c.)	I_C	max.	0.8	A

Power dissipation

Total power dissipation 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.	175	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	0.19	°C/mW
From junction to case	$R_{th\ j-c}$	=	0.05	°C/mW

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

7Z3 0530

CHARACTERISTICS $T_j = 25\ ^oC$ unless otherwise specified

Collector cut-off current				
$I_E = 0$; $V_{CB} = 50$ V	I_{CBO}	<	10	nA
$I_E = 0$; $V_{CB} = 50$ V; $T_j = 150\ ^oC$	I_{CBO}	<	10	μA
Emitter cut-off current				
$I_C = 0$; $V_{EB} = 3$ V	I_{EBO}	<	10	nA
Sustaining voltage				
$I_C = 10$ mA; $I_B = 0$	$V_{CEOsust}$	>	30	V
Saturation voltages 1)				
$I_C = 150$ mA; $I_B = 15$ mA	V_{CEsat}	<	0.4	V
	V_{BEsat}	<	1.3	V
$I_C = 500$ mA; $I_B = 50$ mA	V_{CEsat}	<	1.6	V
	V_{BEsat}	<	2.6	V
Transition frequency				
$I_C = 20$ mA; $V_{CE} = 20$ V	f_T	>	250	MHz
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; $V_{CB} = 10$ V	C_c	<	8	pF
Real part of input impedance				
$I_C = 20$ mA; $V_{CE} = 20$ V; f = 300 MHz	$Re(h_{ie})$	<	60	Ω

D.C. current gain			2N2218	2N2219
$I_C = 0.1$ mA; $V_{CE} = 10$ V	h_{FE}	>	20	35
$I_C = 1$ mA; $V_{CE} = 10$ V	h_{FE}	>	25	50
$I_C = 10$ mA; $V_{CE} = 10$ V	h_{FE}	>	35	75
$I_C = 150$ mA; $V_{CE} = 10$ V 1)	h_{FE}		40 to 120	100 to 300
$I_C = 500$ mA; $V_{CE} = 10$ V 1)	h_{FE}	>	20	30
$I_C = 150$ mA; $V_{CE} = 1$ V	h_{FE}	>	20	50

1) Measured under pulsed conditions to avoid excessive dissipation.
Pulse duration $t \leq 300\ \mu s$; duty cycle $\delta \leq 0.01$.

7Z3 0531

SILICON PLANAR EPITAXIAL TRANSISTORS

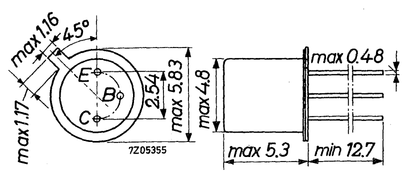
N-P-N transistors in a TO-18 metal envelope with the collector connected to the case. The 2N2221 and 2N2222 are primarily intended for high speed switching circuits and d.c. to u.h.f. amplifiers.

QUICK REFERENCE DATA

Collector-base voltage (open emitter)	V_{CBO}	max.	60		V
Collector-emitter voltage (open base)	V_{CEO}	max.	30		V
Collector current (d.c.)	I_C	max.	0.8		A
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	0.5		W
Junction temperature	T_j	max.	175		°C
Transition frequency					
I_C = 20 mA; V_{CE} = 20 V	f_T	>	250		MHz
D.C. current gain at T_j = 25 °C			2N2221	2N2222	
I_C = 0.1 mA; V_{CE} = 10 V	h_{FE}	>	20	35	
I_C = 10 mA; V_{CE} = 10 V	h_{FE}	>	35	75	
I_C = 0.5 A ; V_{CE} = 10 V	h_{FE}	>	20	30	

MECHANICAL DATA Dimensions in mm

TO-18



7Z3 0532

RATINGS (Limiting values) [1])

Voltages

Collector-base voltage (open emitter)	V_{CBO}	max.	60	V
Collector-emitter voltage (open base)	V_{CEO}	max.	30	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	V

Current

Collector current (d.c.)	I_C	max.	0.8	A

Power dissipation

Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	0.5	W

Temperatures

Storage temperature	T_{stg}		−65 to +200	°C
Junction temperature	T_j	max.	175	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	0.30	°C/mW
From junction to case	$R_{th\ j\text{-}c}$	=	0.083	°C/mW

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

7Z3 0533

CHARACTERISTICS T_j = 25 °C unless otherwise specified

Collector cut-off current				
$I_E = 0$; $V_{CB} = 50$ V	I_{CBO}	<	10	nA
$I_E = 0$; $V_{CB} = 50$ V; $T_j = 150$ °C	I_{CBO}	<	10	µA
Emitter cut-off current				
$I_C = 0$; $V_{EB} = 3$ V	I_{EBO}	<	10	nA
Sustaining voltages				
$I_C = 10$ mA; $I_B = 0$	$V_{CEOsust}$	>	30	V
Saturation voltages [1]				
$I_C = 150$ mA; $I_B = 15$ mA	V_{CEsat}	<	0.4	V
	V_{BEsat}	<	1.3	V
$I_C = 0.5$ A ; $I_B = 50$ mA	V_{CEsat}	<	1.6	V
	V_{BEsat}	<	2.6	V
Transition frequency				
$I_C = 20$ mA; $V_{CE} = 20$ V	f_T	>	250	MHz
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; $V_{CB} = 10$ V	C_c	<	8	pF
Real part of input impedance				
$I_C = 20$ mA; $V_{CE} = 20$ V; f = 300 MHz	Re (h_{ie})	<	60	Ω

D.C. current gain

			2N2221	2N2222
$I_C = 0.1$ mA; $V_{CE} = 10$ V	h_{FE}	>	20	35
$I_C = 1$ mA; $V_{CE} = 10$ V	h_{FE}	>	25	50
$I_C = 10$ mA; $V_{CE} = 10$ V	h_{FE}	>	35	75
$I_C = 150$ mA; $V_{CE} = 10$ V [1]	h_{FE}		40 to 120	100 to 300
$I_C = 500$ mA; $V_{CE} = 10$ V [1]	h_{FE}	>	20	30
$I_C = 150$ mA; $V_{CE} = 1$ V	h_{FE}	>	20	30

[1]) Measured under pulsed conditions to avoid excessive dissipation.
Pulse duration $t \leq 300$ µs; duty cycle $\delta \leq 0.01$.

7Z3 0534

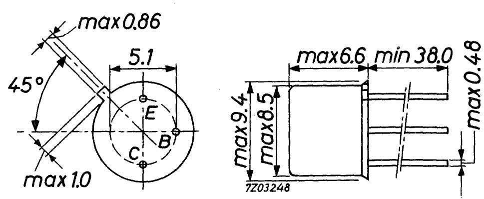
SILICON PLANAR EPITAXIAL TRANSISTOR

N-P-N transistor in a TO-5 metal envelope 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. or average)	I_C	max.	1	A
Total power 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 to 120		
Transition frequency				
I_C = 50 mA; V_{CE} = 10 V	f_T	>	60	MHz
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



7Z3 0766

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

Current

Collector current (d.c. or average over any 20 ms period)	I_C	max.	1	A

Power dissipation

Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	0.8	W
up to T_{case} = 100 °C	P_{tot}	max.	2.8	W
up to T_{case} = 25 °C	P_{tot}	max.	5.0	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

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

7Z3 0767

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

Collector cut-off current				
$I_E = 0$; $V_{CB} = 60$ V	I_{CBO}	<	10	nA
$I_E = 0$; $V_{CB} = 60$ V; $T_{amb} = 150$ °C	I_{CBO}	<	10	μA
Emitter cut-off current				
$I_C = 0$; $V_{EB} = 5$ V	I_{EBO}	<	10	nA
Sustaining voltage				
$I_C = 30$ mA; $I_B = 0$ [2]	$V_{CEOsust}$	>	35	V
Saturation voltages				
$I_C = 150$ mA; $I_B = 15$ mA	V_{CEsat}	<	0.2	V
$I_C = 1$ A; $I_B = 100$ mA [1][2]	V_{CEsat}	<	1.0	V
	V_{BEsat}	<	1.6	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	
Feedback time constant				
$I_C = 10$ mA; $V_{CB} = 10$ V; f = 4 MHz	$r_b'C_c$	<	800	ps
Collector capacitance at f = 500 kHz				
$I_E = I_e = 0$; $V_{CB} = 10$ V	C_c	<	12	pF
Emitter capacitance at f = 500 kHz				
$I_C = I_c = 0$; $V_{EB} = 0.5$ V	C_e	<	80	pF
Transition frequency				
$I_C = 50$ mA; $V_{CE} = 10$ V	f_T	>	60	MHz

[1]) Measured with a lead length of 1 cm.

[2]) Measured under pulsed conditions to avoid excessive dissipation.
Pulse duration t = 300 μs; duty cycle $\delta < 0.01$

7Z3 0768

SILICON PLANAR EPITAXIAL TRANSISTORS

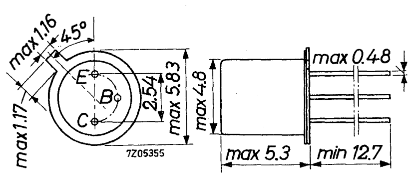
N-P-N transistors in a TO-18 metal envelope with the collector connected to the case. The 2N2368 and 2N2369 are primarily intended for use in very high-speed saturated switching and v.h.f. amplification.

QUICK REFERENCE DATA					
Collector-base voltage (open emitter)		V_{CBO}	max.	40	V
Collector-emitter voltage (open base)		V_{CEO}	max.	15	V
Collector current (peak value)		I_{CM}	max.	500	mA
Total power dissipation up to $T_{amb} = 25\ ^oC$		P_{tot}	max.	360	mW
Junction temperature		T_j	max.	200	^oC
D.C. current gain at $T_j = 25\ ^oC$					
$I_C = 10$ mA; $V_{CE} = 1$ V	2N2368	h_{FE}	20 to	60	
	2N2369	h_{FE}	40 to	120	
Transition frequency					
$I_C = 10$ mA; $V_{CE} = 10$ V	2N2368	f_T	>	400	MHz
	2N2369	f_T	>	500	MHz
Storage time					
$I_C = I_B = -I_{BM} = 10$ mA	2N2368	t_s	<	10	ns
	2N2369	t_s	<	13	ns

MECHANICAL DATA Dimensions in mm

TO-18

Collector connected to case



7Z3 0464

RATINGS (Limiting values) [1]

Voltages

Collector-base voltage (open emitter)	V_{CBO}	max.	40	V
Collector-emitter voltage (open base)	V_{CEO}	max.	15	V
Collector-emitter voltage with V_{BE} = 0	V_{CES}	max.	40	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4.5	V

Current

Collector current (peak value; t = 10 μs)	I_{CM}	max.	500	mA

Power dissipation

Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	360	mW

Temperatures

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

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	0.48	°C/mW
From junction to case	$R_{th\ j\text{-}c}$	=	0.145	°C/mW

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

7Z3 0465

CHARACTERISTICS T_j = 25 °C unless otherwise specified

Collector cut-off current				
I_E = 0; V_{CB} = 20 V	I_{CBO}	<	0.4	μA
I_E = 0; V_{CB} = 20 V; T_j = 150 °C	I_{CBO}	<	30	μA
Sustaining voltage [1]				
I_C = 10 mA; I_B = 0	$V_{CEOsust}$	>	15	V [1]
Saturation voltages				
I_C = 10 mA; I_B = 1 mA	V_{CEsat}	<	0.25	V
	V_{BEsat}		0.7 to 0.85	V
Collector capacitance at f = 140 kHz				
$I_E = I_e$ = 0; V_{CB} = 5 V	C_c	<	4	pF

D.C. current gain [1]			2N2368	2N2369	
I_C = 10 mA; V_{CE} = 1 V	h_{FE}		20 to 60	40 to 120	
I_C = 10 mA; V_{CE} = 1 V; T_j = −55 °C	h_{FE}	>	10	20	
I_C = 100 mA; V_{CE} = 2 V	h_{FE}	>	10	20	
Transition frequency					
I_C = 10 mA; V_{CE} = 10 V	f_T	>	400	500	MHz

[1]) Measured under pulsed conditions to avoid excessive dissipation
Pulse duration t = 300 μs; duty cycle δ = 0.01

7Z3 0466

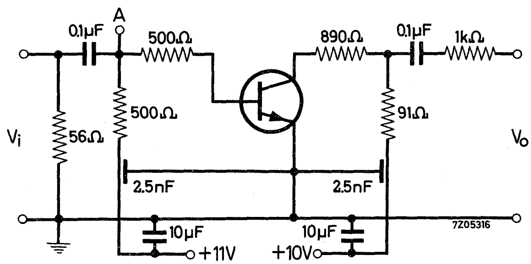
CHARACTERISTICS (continued) T_j = 25 °C unless otherwise specified

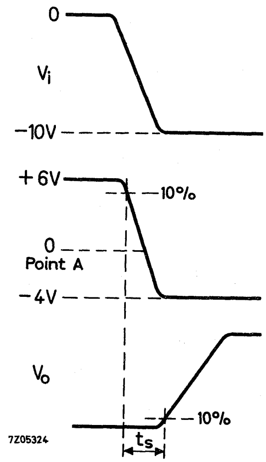
Storage time

$I_C = I_B = -I_{BM} = 10$ mA

2N2368	t_s	<	10	ns
2N2369	t_s	<	13	ns

Test circuit: [1]





Turn onttime

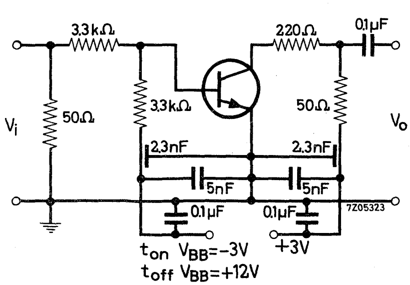
I_C = 10 mA; I_B = 3 mA; $-V_{BE}$ = 1.5 V t_{on} < 12 ns

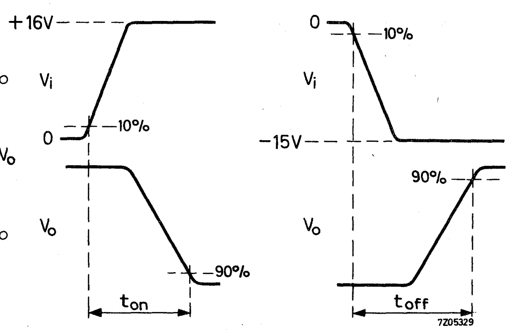
Turn off time

I_C = 10 mA; I_B = 3 mA; $-I_{BM}$ = 1.5 mA

2N2368	t_{off}	<	15	ns
2N2369	t_{off}	<	18	ns

Test circuit: [1]





1) Pulse generator:

Pulse duration	t	≥	300	ns
Duty cycle	δ	≤	0.02	
Rise time	t_r	≤	1	ns
Source impedance	R_S	=	50	Ω

Oscilloscope:

Rise time	t_r	≤	1	ns
Input impedance	R_i	=	50	Ω

7Z3 0467

SILICON PLANAR EPITAXIAL TRANSISTOR

N-P-N transistor in a TO-18 metal envelope with the collector connected to the case. The 2N2369A is primarily intended for low-power very high-speed saturated switching applications in industrial service.

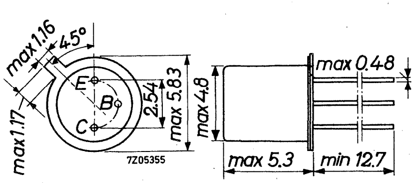
QUICK REFERENCE DATA				
Collector-base voltage (open emitter)	V_{CBO}	max.	40	V
Collector-emitter voltage (open base)	V_{CEO}	max.	15	V
Collector current (peak value)	I_{CM}	max.	500	mA
Total power dissipation up to $T_{amb} = 25\ ^oC$	P_{tot}	max.	360	mW
Junction temperature	T_j	max.	200	^oC
D.C. current gain at $T_j = 25\ ^oC$				
$I_C = 10$ mA; $V_{CE} = 1$ V	h_{FE}		40 to 120	
Transition frequency				
$I_C = 10$ mA; $V_{CE} = 10$ V	f_T	>	500	MHz
Storage time				
$I_C = I_B = -I_{BM} = 10$ mA	t_s	<	13	ns

MECHANICAL DATA

Dimensions in mm

TO-18

Collector connected to case



7Z3 0468

RATINGS (Limiting values) [1]

Voltages

Collector-base voltage (open emitter)	V_{CBO}	max.	40	V
Collector-emitter voltage (open base) I_C = 0.01 to 10 mA	V_{CEO}	max.	15	V
Collector-emitter voltage with $V_{BE} = 0$	V_{CES}	max.	40	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4.5	V

Currents

Collector currents (d.c. or average over any 20 ms period)	I_C	max.	200	mA
Collector current (peak value; t = 10 μs)	I_{CM}	max.	500	mA

Power dissipation

Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	360	mW

Temperatures

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

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	0.48	°C/mW
From junction to case	$R_{th\ j-c}$	=	0.145	°C/mW

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

7Z3 0469

CHARACTERISTICS T_j = 25 °C unless otherwise specified

Collector cut-off current				
V_{BE} = 0; V_{CE} = 20 V	I_{CES}	<	0.4	μA
I_E = 0; V_{CB} = 20 V; T_j = 150 °C	I_{CBO}	<	30	μA
Base current				
V_{BE} = 0; V_{CE} = 20 V	$-I_{BEX}$	<	0.4	μA
Sustaining voltage [1]				
I_C = 10 mA; I_B = 0	$V_{CEOsust}$	>	15	V
Saturation voltages				
I_C = 10 mA; I_B = 1 mA	V_{CEsat}	<	0.2	V
	V_{BEsat}	0.7 to 0.85		V
I_C = 30 mA; I_B = 3 mA	V_{CEsat}	<	0.25	V
	V_{BEsat}	<	1.15	V
I_C = 100 mA; I_B = 10 mA	V_{CEsat}	<	0.5	V
	V_{BEsat}	<	1.6	V
I_C = 10 mA; I_B = 1 mA; T_j = 125 °C	V_{CEsat}	<	0.3	V
	V_{BEsat}	>	0.59	V
I_C = 10 mA; I_B = 1 mA; T_j = −55 °C	V_{BEsat}	<	1.02	V
D.C. current gain [1]				
I_C = 10 mA; V_{CE} = 1 V	h_{FE}	40 to	120	
I_C = 30 mA; V_{CE} = 0.4 V	h_{FE}	>	30	
I_C = 100 mA; V_{CE} = 1 V	h_{FE}	>	20	
I_C = 10 mA; V_{CE} = 1 V; T_j = −55 °C	h_{FE}	>	20	
Collector capacitance at f = 140 kHz				
I_E = I_e = 0; V_{CB} = 5 V	C_c	<	4	pF
Transition frequency				
I_C = 10 mA; V_{CE} = 10 V	f_T	>	500	MHz

[1]) Measured under pulsed conditions to avoid excessive dissipation
Pulse duration t = 300 μs; duty cycle $\delta < 0.01$

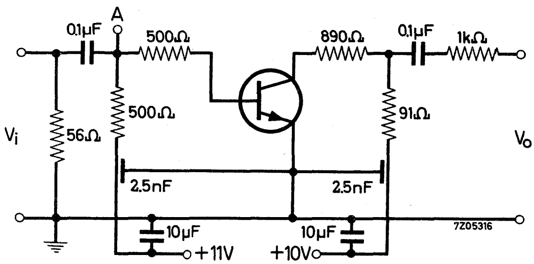
7Z3 0470

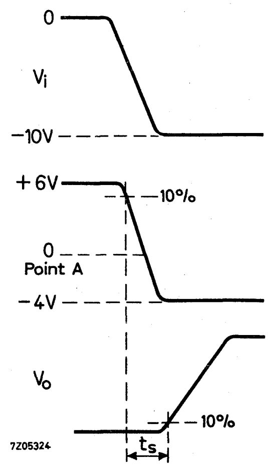
CHARACTERISTICS (continued) T_j = 25 °C unless otherwise specified

Storage time

$I_C = I_B = -I_{BM}$ = 10 mA t_s < 13 ns

Test circuit: [1])





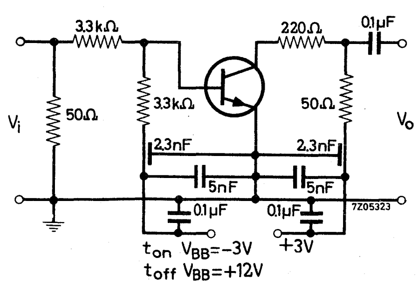
Turn on time

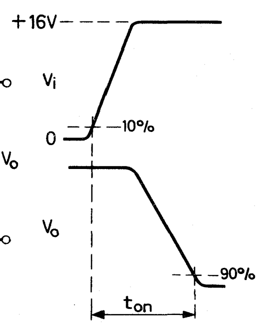
I_C = 10 mA; I_B = 3 mA; $-V_{BE}$ = 1.5 V t_{on} < 12 ns

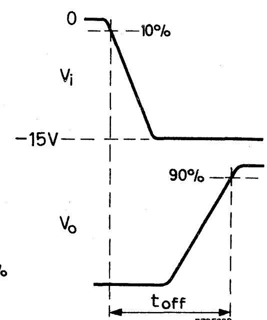
Turn off time

I_C = 10 mA; I_B = 3 mA; $-I_{BM}$ = 1.5 mA t_{off} < 18 ns

Test circuit: [1])







[1]) Pulse generator:

Pulse duration	$t \geq$	300 ns
Duty cycle	$\delta \leq$	0.02
Rise time	$t_r \leq$	1 ns
Source impedance	R_S =	50 Ω

Oscilloscope:

Rise time	$t_r \leq$	1 ns
Input impedance	R_i =	50 Ω

7Z3 0471

SILICON PLANAR TRANSISTORS

N-P-N transistors in a TO-18 metal envelope with the collector connected to the case.
These transistors are primarily intended for use in high performance, low level, low noise amplifier applications both for d.c. and frequencies up to 100 MHz.

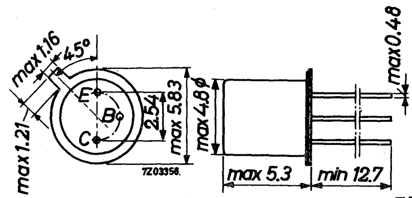
QUICK REFERENCE DATA

			2N2483	2N2484	
Collector-base voltage (open emitter)	V_{CBO}	max.	60	60	V
Collector-emitter voltage (open base)	V_{CEO}	max.	60	60	V
Collector current (peak value)	I_{CM}	max.	50	50	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	360	360	mW
Junction temperature	T_j	max.	200	200	°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 500	
I_C = 1 mA; V_{CE} = 5 V	h_{FE}	>	175	250	
I_C = 10 mA; V_{CE} = 5 V	h_{FE}	<	500	800	
Transition frequency					
I_C = 0.5 mA; V_{CE} = 5 V	f_T	typ.	80	80	MHz
Noise figure					
I_C = 10 μA; V_{CE} = 5 V; R_S = 10 kΩ					
Bandwidth: 15.7 kHz	F	<	4	3	dB

MECHANICAL DATA Dimensions in mm

TO-18

Collector connected to case



7Z3 0088

RATINGS (Limiting values) [1]

Voltages

Collector-base voltage (open emitter)	V_{CBO}	max.	60	V
Collector-emitter voltage (open base)	V_{CEO}	max.	60	V
Emitter-base voltage (open collector)	V_{EBO}	max.	6	V

Currents

Collector current (peak value)	I_{CM}	max.	50	mA

Power dissipation

Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	360	mW

Temperatures

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

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	0.48	°C/mW
From junction to case	$R_{th\ j\text{-}c}$	=	0.15	°C/mW

CHARACTERISTICS T_j = 25 °C unless otherwise specified

Collector cut-off current

$I_E = 0$; $V_{CB} = 45$ V	I_{CBO}	<	10	nA
$I_E = 0$; $V_{CB} = 45$ V; $T_j = 150$ °C	I_{CBO}	<	10	μA

Emitter cut-off current

$I_C = 0$; $V_{EB} = 5$ V	I_{EBO}	<	10	nA

Base-emitter voltage

$I_C = 0.1$ mA; $V_{CE} = 5$ V	V_{BE}		0.5 to 0.7	V

Collector-emitter saturation voltage

$I_C = 1$ mA; $I_B = 0.1$ mA	V_{CEsat}	<	350	mV

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

7Z3 0089

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

			2N2483	2N2484	
D.C. current gain					
I_C = 1 µA; V_{CE} = 5 V	h_{FE}	>		30	
I_C = 10 µA; V_{CE} = 5 V	h_{FE}		40 to 120	100 to 500	
I_C = 10 µA; V_{CE} = 5 V; T_j = −55 °C	h_{FE}	>	10	20	
I_C = 100 µA; V_{CE} = 5 V	h_{FE}	>	75	175	
I_C = 500 µA; V_{CE} = 5 V	h_{FE}	>	100	200	
I_C = 1 mA; V_{CE} = 5 V	h_{FE}	>	175	250	
I_C = 10 mA; V_{CE} = 5 V [1]	h_{FE}	<	500	800	
Collector capacitance at f = 1 MHz					
I_E = I_e = 0; V_{CB} = 5 V	C_c	<	6	6	pF
Emitter capacitance at f = 1 MHz					
I_C = I_c = 0; V_{EB} = 0.5 V	C_e	<	6	6	pF
Transition frequency					
I_C = 50 µA; V_{CE} = 5 V	f_T	>	12	15	MHz
I_C = 500 µA; V_{CE} = 5 V	f_T	>	60	60	MHz
		typ.	80	80	MHz
Noise figure					
I_C = 10 µA; V_{CE} = 5 V; R_S = 10 kΩ					
f = 100 Hz; bandwidth 20 Hz	F	<	15	10	dB
f = 1 kHz; bandwidth 200 Hz	F	<	4	3	dB
f = 10 kHz; bandwidth 2 kHz	F	<	3	2	dB
Wide band: bandwidth 15.7 kHz	F	<	4	3	dB
h parameters at f = 1 kHz					
I_C = 1 mA; V_{CE} = 5 V					
Input impedance	h_{ie}		1.5 to 13	3.5 to 24	kΩ
Reverse voltage transfer	h_{re}	<	8	8	10^{-4}
Small signal current gain	h_{fe}		80 to 450	150 to 900	
Output admittance	h_{oe}	<	30	40	$\mu\Omega^{-1}$

[1] Measured under pulsed conditions to prevent excessive dissipation.
Pulse duration t < 300 µs; duty cycle δ < 0.01

7Z3 0090

SILICON PLANAR EPITAXIAL TRANSISTORS

N-P-N transistors in a TO-72 metal envelope with insulated electrodes and a shield lead connected to the case.
They are primarily intended for low power r.f. amplifiers and oscillators in the v.h.f. and u.h.f. ranges for industrial services.

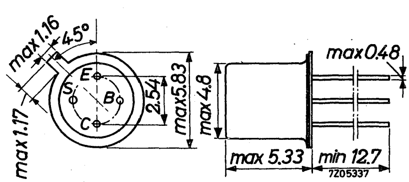
QUICK REFERENCE DATA

			2N3570	3571	3572	
Collector-base voltage (open emitter)	V_{CBO}	max.	30	25	25	V
Collector-emitter voltage (open base)	V_{CEO}	max.	15	15	13	V
Collector current (d.c.)	I_C	max.	50	50	50	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	200	200	200	mW
Junction temperature	T_j	max.	200	200	200	°C
Feedback capacitance at f = 1 MHz; I_E = 0 ; V_{CB} = 6 V	$-C_{re}$	<	0.75	0.85	0.85	pF
Transition frequency; I_C = 5 mA; V_{CE} = 6 V	f_T	>	1.5	1.2	1.0	GHz
		<	2.4	2.4	2.4	GHz
Noise figure; $-I_E$ = 2 mA; V_{CB} = 6 V; f = 1 GHz; R_S = 50 Ω	F	<	7			dB
f = 450 MHz; R_S = 100 Ω	F	<		4	6	dB

MECHANICAL DATA Dimensions in mm

TO-72

Insulated electrodes



S=Shield lead connected to case

7Z3 0376

RATINGS (Limiting values) [1])

Voltages

			2N3570	3571	3572	
Collector-base voltage (open emitter)	V_{CBO}	max.	30	25	25	V
Collector-emitter voltage (open base) I_C = 15 mA	V_{CEO}	max.	15	15	13	V
Emitter-base voltage (open collector)	V_{EBO}	max.	3	3	3	V

Current

Collector current (d.c.)	I_C	max.	50	mA

Power dissipation

Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	200	mW

Temperatures

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

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	0.88	°C/mW
From junction to case	$R_{th\ j\text{-}c}$	=	0.50	°C/mW

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

7Z3 0377

CHARACTERISTICS $T_j = 25\ ^oC$ unless otherwise specified

The shield lead is grounded for all measurements except for C_{re}

			2N3570	3571	3572	
Collector cut-off current						
$I_E = 0$; $V_{CB} = 6$ V	I_{CBO}	<	10	10	10	nA
$I_E = 0$; $V_{CB} = 6$ V; $T_j = 150\ ^oC$	I_{CBO}	<	1	1	1	μA
D.C. current gain						
$I_C = 5$ mA; $V_{CE} = 6$ V	h_{FE}	>	20	20	20	
		<	150	200	300	
Small signal current gain						
$I_C = 5$ mA; $V_{CE} = 6$ V; f = 1 kHz	h_{fe}	>	20	20	20	
		<	200	250	350	
Collector-base time constant						
$-I_E = 5$ mA; $V_{CB} = 6$ V; f = 10.7 MHz	$r_{bb'}C_{b'c}$	>	1	1	1	ps
		<	8	10	13	ps
Feedback capacitance						
$I_E = 0$; $V_{CB} = 6$ V; f = 1 MHz	$-C_{re}$	<	0.75	0.85	0.85	pF
Transition frequency						
$I_C = 5$ mA; $V_{CE} = 6$ V	f_T	>	1.5	1.2	1.0	GHz
		<	2.4	2.4	2.4	GHz
Noise figure						
$-I_E = 2$ mA; $V_{CB} = 6$ V						
f = 1 GHz; $R_S = 50\ \Omega$	F	<	7			dB
f = 450 MHz; $R_S = 100\ \Omega$	F	<		4	6	dB

7Z3 0378

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 drive 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	$V_{i(rms)}$	1.8	2.1	1.0	1.2	mV
with 6 dB feedback	$V_{i(rms)}$	3.5	5.0	2.5	2.0	mV

[1]) Spread of input sensitivity < 3 dB

7Z3 0444

TYPICAL OPERATION CHARACTERISTICS (f = 1 kHz)

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	$V_{i(rms)}$	1.8	2.1	1.0	1.2	mV
with 6 dB feedback	$V_{i(rms)}$	3.5	5.0	2.5	2.0	mV
Input voltage at P_o = max.						
without feedback	$V_{i(rms)}$	5.3	8.6	4.6	5.6	mV
with 6 dB feedback	$V_{i(rms)}$	10.7	20.7	10.4	10.2	mV
Zero signal collector currents [1] of transistors 3	$\|I_C\|$	4	5	3	5	mA
Collector peak current 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

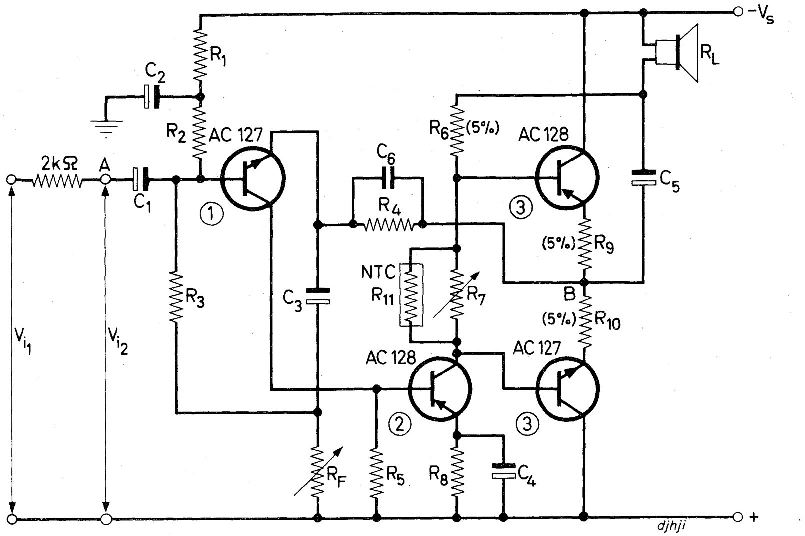
Stable continuous operation is ensured up to T_{amb} = 45 °C, provided the output transistors are mounted as indicated in the following table

	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 (Type No.56227)
C = with cooling fin (Type No.56227) mounted on a 1.5 mm aluminium heatsink of at least 12.5 cm^2

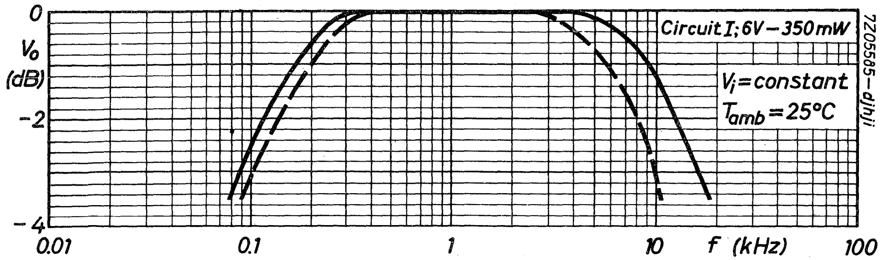
[1]) To be adjusted with R_7

7Z3 0445



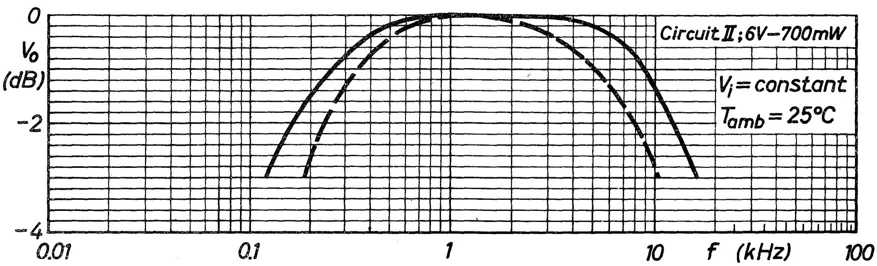
List of components	Circuit	I	II	III	IV	
	R_1	1.2	2.7	6.8	2.2	kΩ
	R_2	22	18	33	18	kΩ
	R_3	15	15	22	15	kΩ
	R_4	2.2	2.2	3.3	2.2	kΩ
	R_5	1.5	2.2	1.8	1.5	kΩ
	R_6 (5%)	560	270	750	510	Ω
	R_7	100	75	75	100	Ω
	R_8	68	75	100	39	Ω
	$R_9 = R_{10}$ (5%)	1.5	0	2.4	0	Ω
	R_{11} (NTC)	-	130	-	130	Ω
	R_L	8	4	10	8	Ω
without 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
Tolerance of resistors:	C_2	100	100	100	100	μF
10 % unless otherwise	C_3	320	125	320	400	μF
specified	C_4	200	160	125	200	μF
	C_5	400	1000	320	400	μF
	C_6	-	3900	-	-	pF

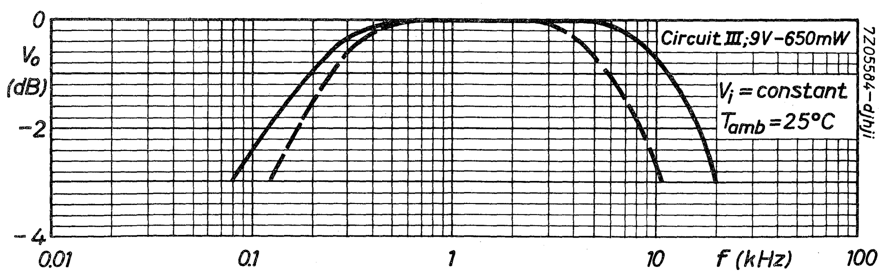
7Z3 0446



Normalised output voltage versus frequency

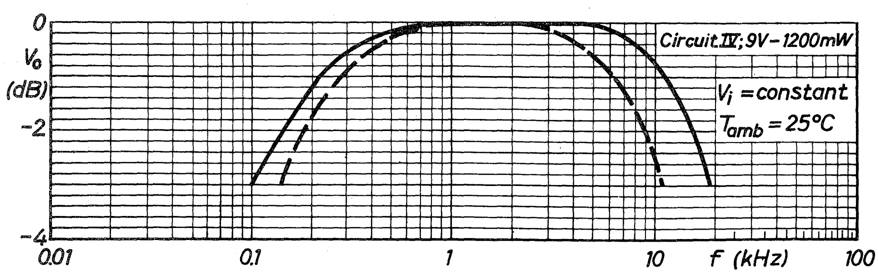
without feedback
with feedback

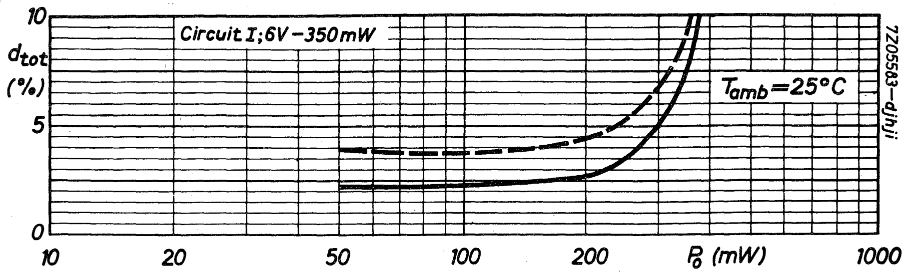




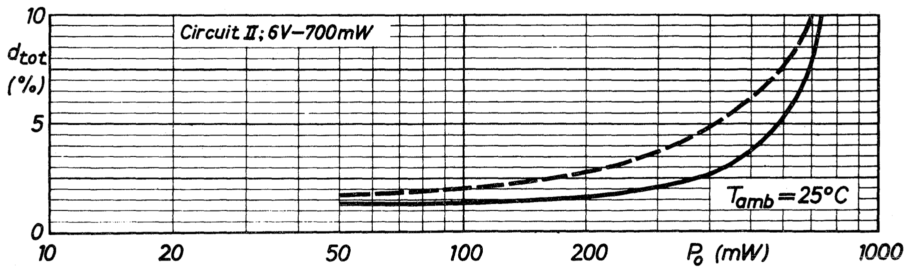
Normalised output voltage versus frequency

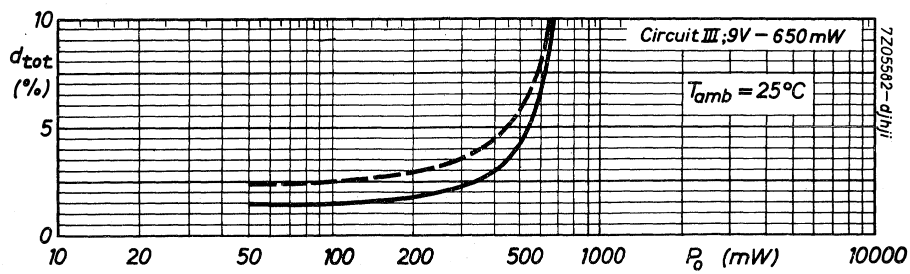
without feedback
with feedback



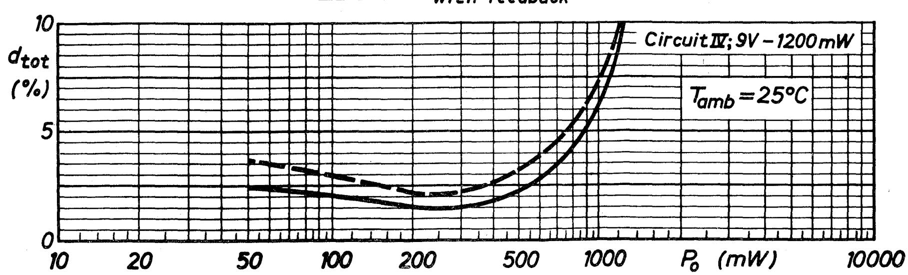


Typical values — — — without feedback
——— with feedback





Typical values — — — without feedback
——— with feedback

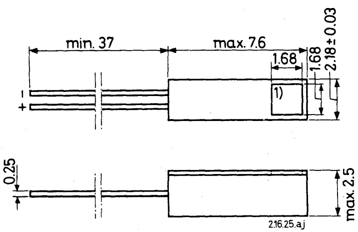


Photoelectric devices

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

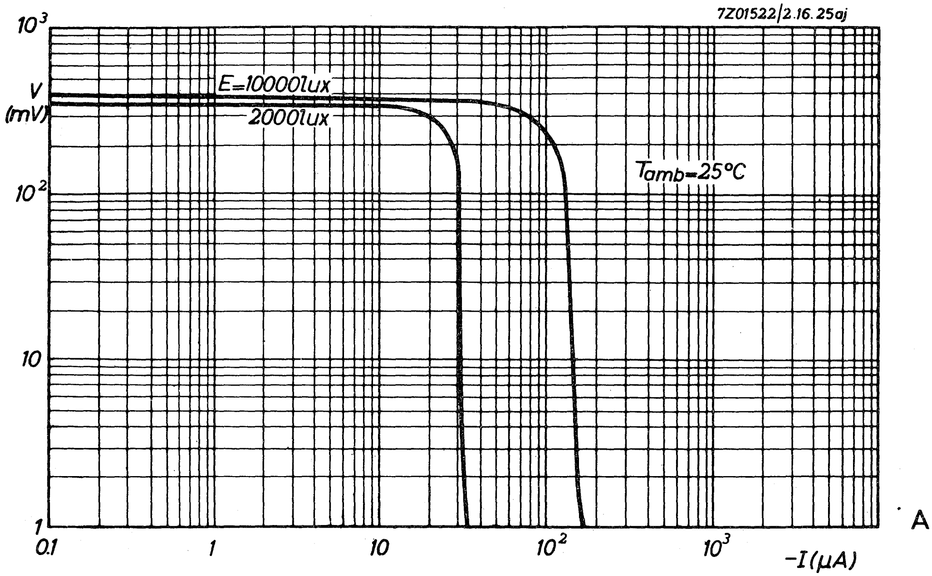
CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN

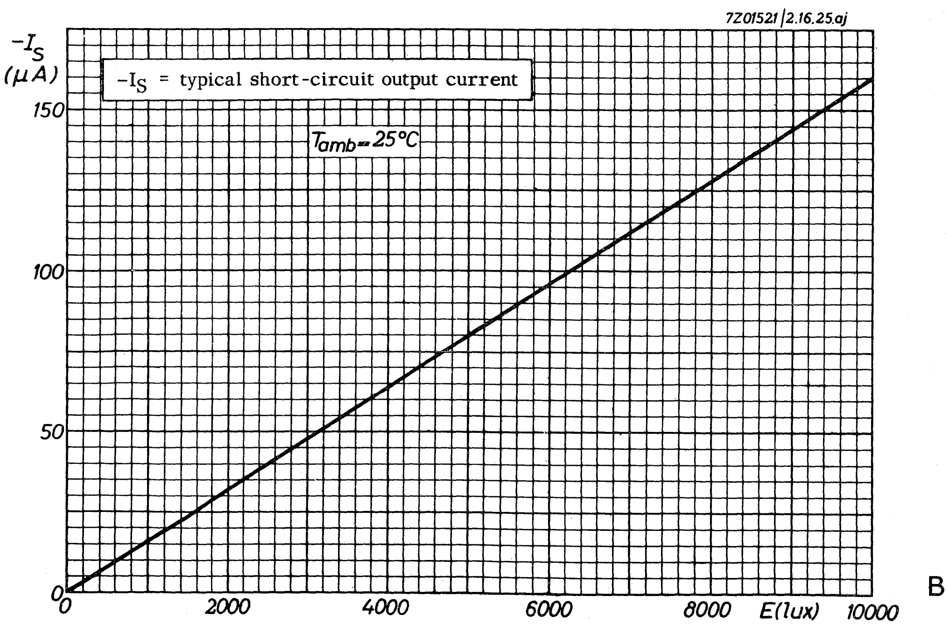
Sensitive area		=	2.8 mm^2
Peak spectral response	λ	=	0.8 μm
Short circuit current at E = 10 000 lux colour temperature = 2700 °K	$-I_S$	=	160 μA
Dark reverse current −V = 1 V; T_{amb} = 75 °C	$-I_d$	<	30 μA
Capacitance at V = 0	c	<	1000 pF

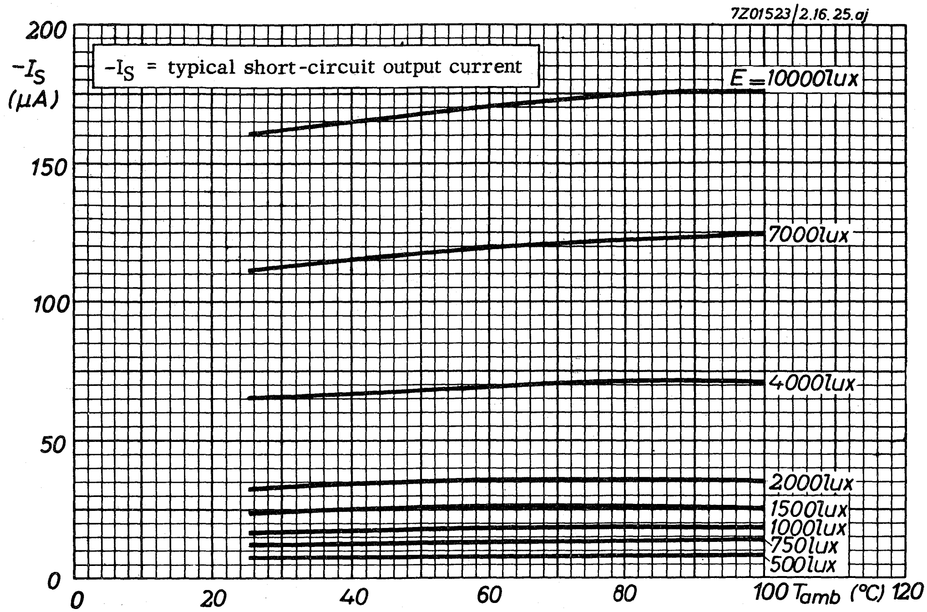
OPERATING NOTES

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.

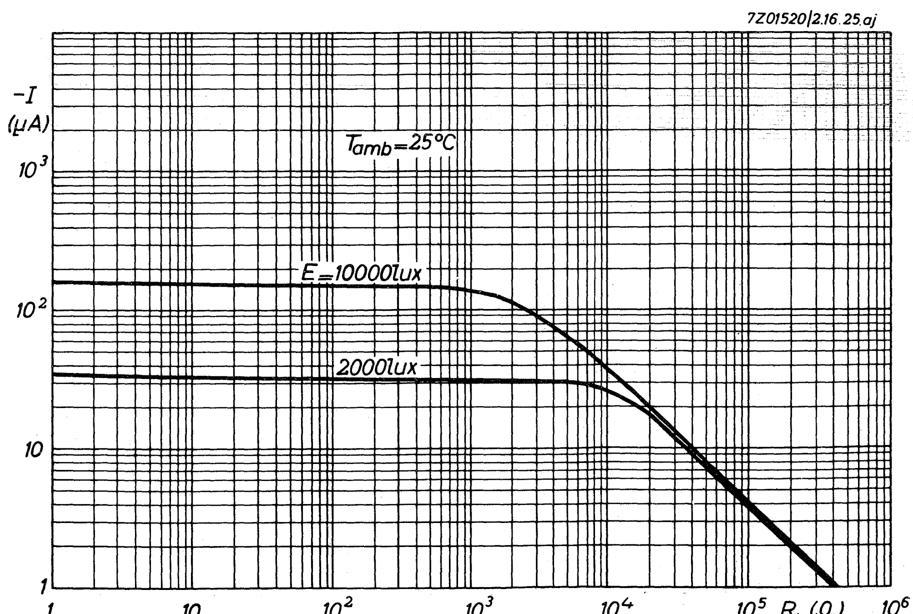
7Z2 2550


7Z01522/2.16.25aj
V (mV)
E=10000lux
2000lux
Tamb=25°C
-I(μA)
A

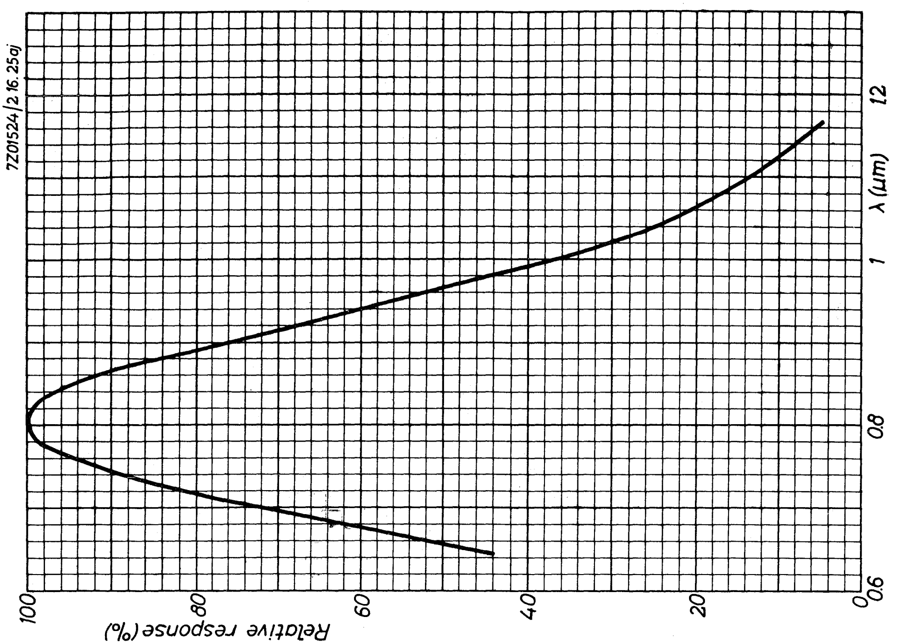

7Z01521/2.16.25aj
-IS (μA)
-IS = typical short-circuit output current
Tamb=25°C
E(lux)
B


7Z01523/2.16.25.aj
$-I_S$ = typical short-circuit output current
$-I_S$ (μA)
200
150
100
50
0
E = 10000 lux
7000 lux
4000 lux
2000 lux
1500 lux
1000 lux
750 lux
500 lux
0
20
40
60
80
100
120
T_{amb} (°C)

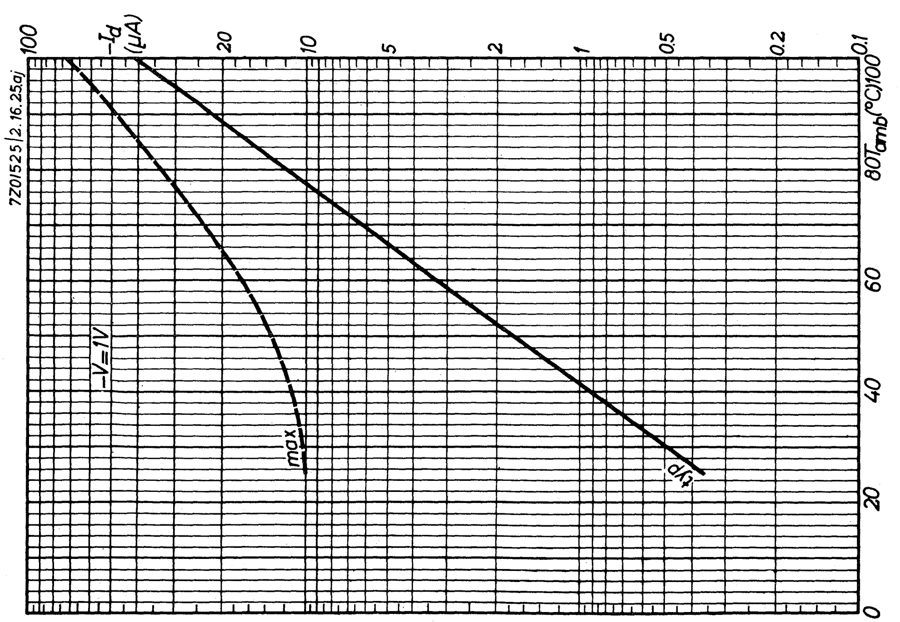
C


7Z01520/2.16.25.aj
$-I$ (μA)
10^3
10^2
10
1
T_{amb} = 25 °C
E = 10000 lux
2000 lux
1
10
10^2
10^3
10^4
10^5
10^6
R_L (Ω)

D


7Z01524/2.16.25aj
Relative response (%)
100
80
60
40
20
0
0.6
0.8
1
12
λ (μm)

F


7Z01525/2.16.25aj
$-I_d$ (μA)
100
20
10
5
2
1
0.5
0.2
0.1
−V=1V
max
typ
0
20
40
60
80
100
T_{amb} (°C)

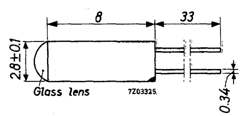
E

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 °C
Kenndaten

Illumination Éclairement Beleuchtungsstärke	=	100 lux
Colour temperature Température de couleur Farbtemperatur	=	2500 °K
$-I_D$	>	5 µA
$-V_D$	=	0,5-30 V
Internal impedance Impédance interne Innenwiderstand		3 MΩ

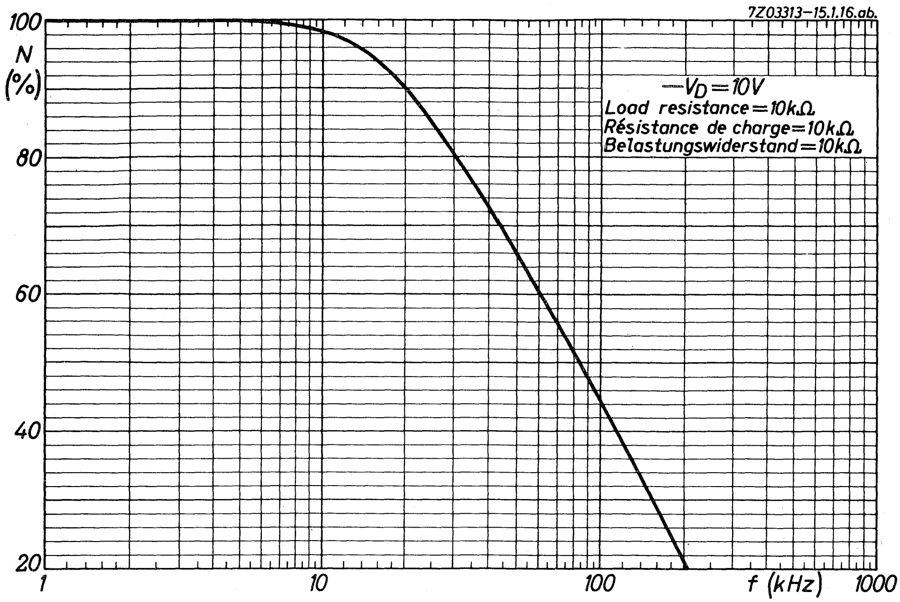
Characteristics (continued)
Caractéristiques (suite)
Kenndaten (Fortsetzung)

$-V_D$	=	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	<	3x10^{-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

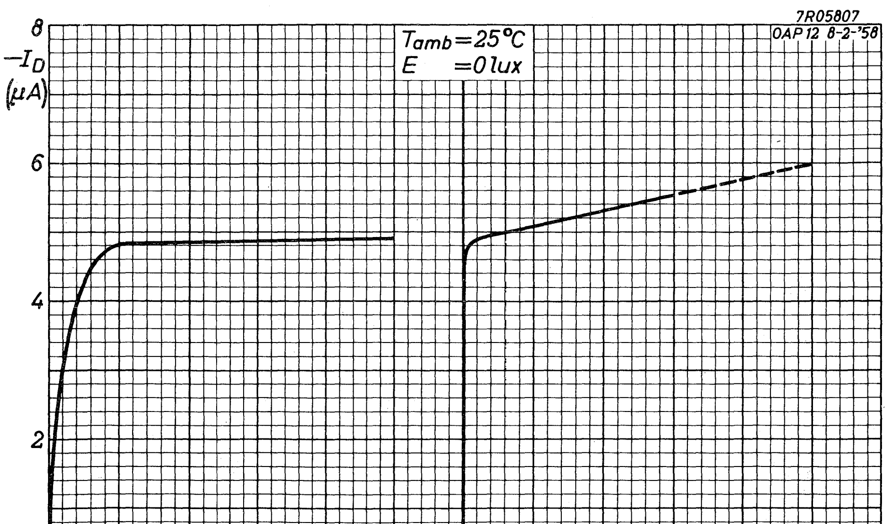
Limiting values (Absolute max. values)
Caractéristiques limites (Valeurs max. absolues)
Grenzdaten (Absolute Maximalwerte)

$-V_D$	= 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

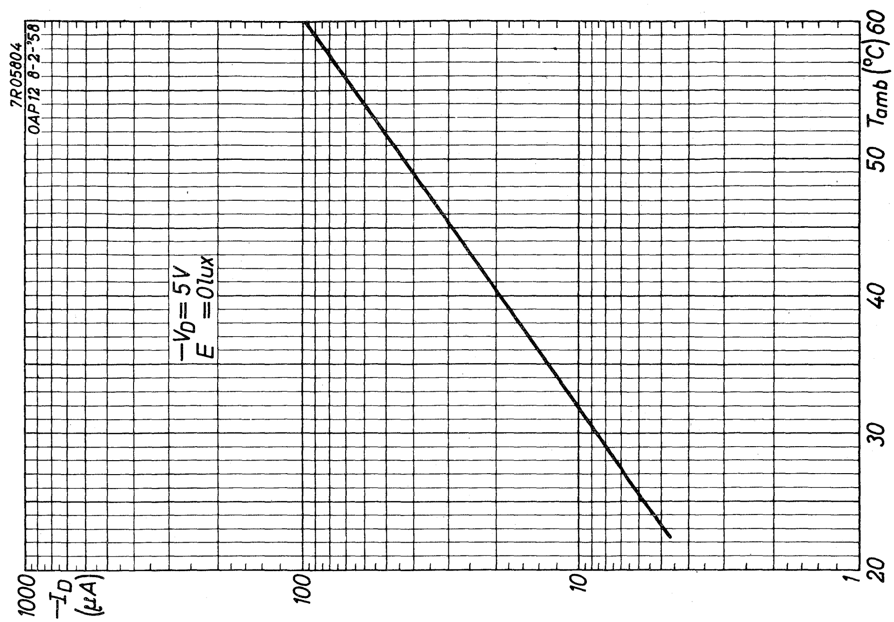

7Z03313–15.1.16.ab.
100
N
(%)
80
60
40
20
1
10
100
f (kHz)
1000
$-V_D = 10V$
Load resistance = 10kΩ
Résistance de charge = 10kΩ
Belastungswiderstand = 10kΩ

A

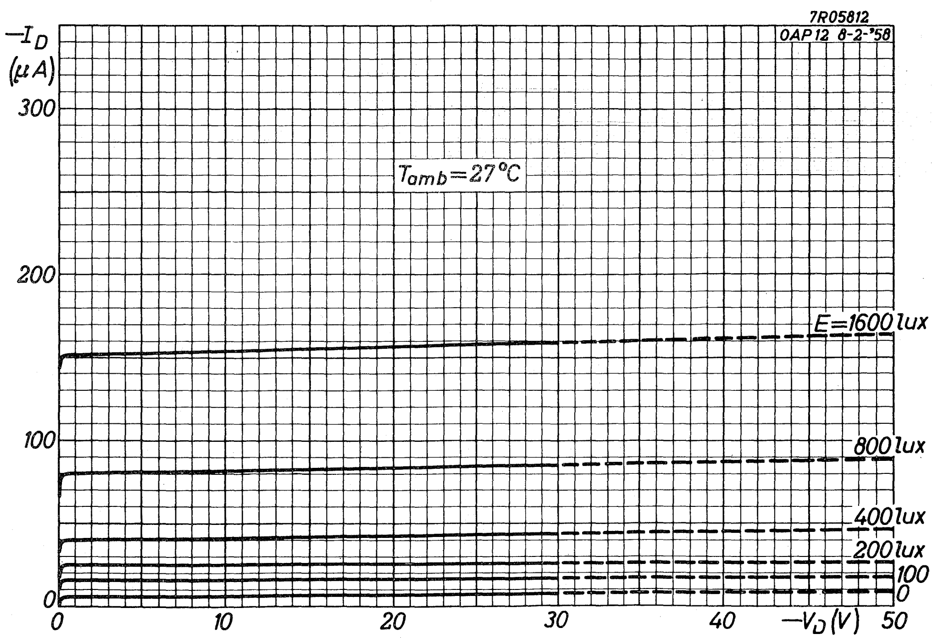

7R05807
OAP 12 8-2-'58
8
$-I_D$
(μA)
6
4
2
0
0
0,2
0,4
$-V_D$ (V)
0,6
0
10
20
$-V_D$ (V)
30
$T_{amb} = 25°C$
E = 0 lux

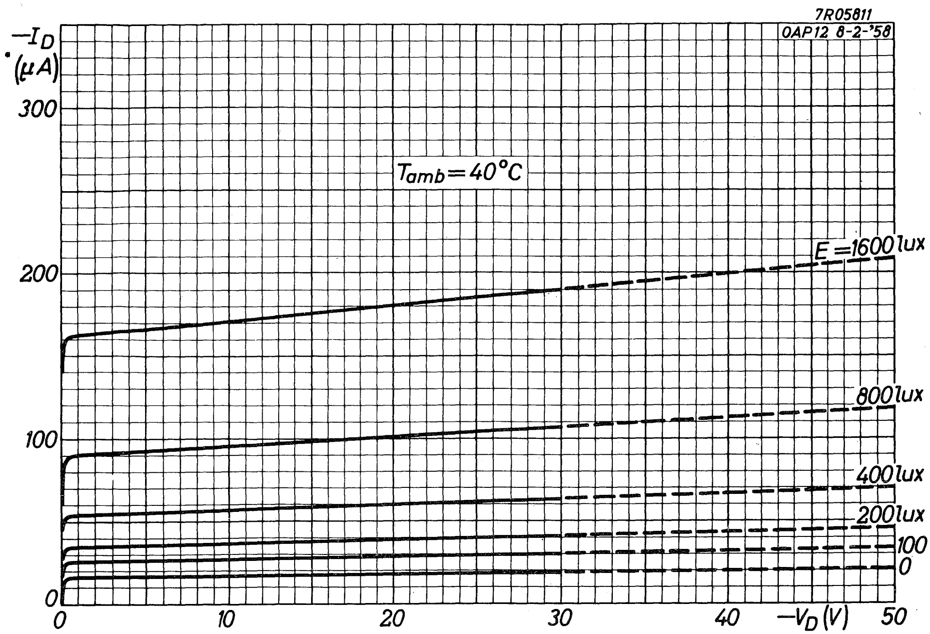
B

C

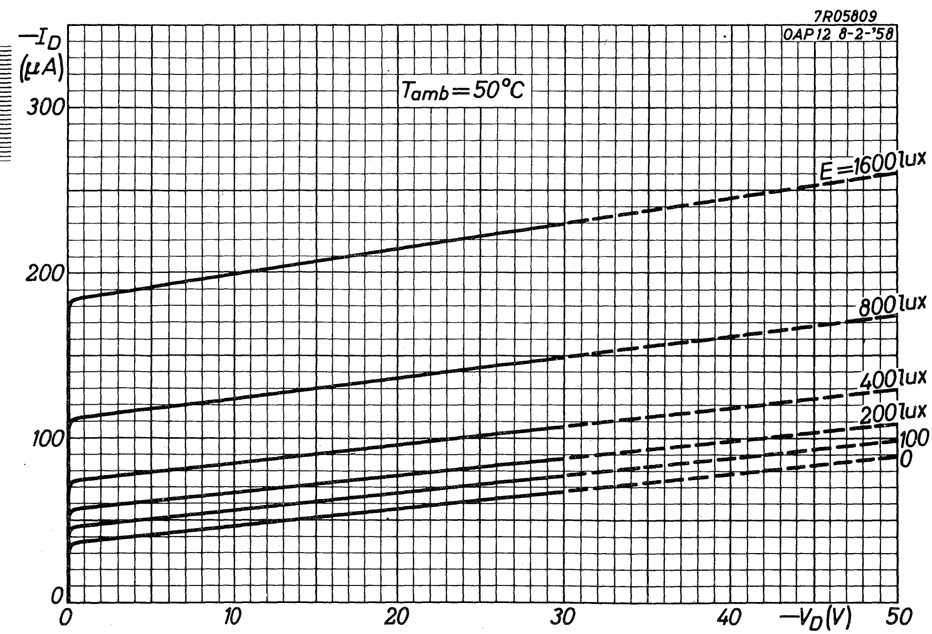

7R05804
OAP12 8-2-'58
$-V_D = 5V$
$E = 0 lux$
T_{amb} (°C)
60
50
40
30
20
1000
$-I_D$ (μA)
100
10
1

D

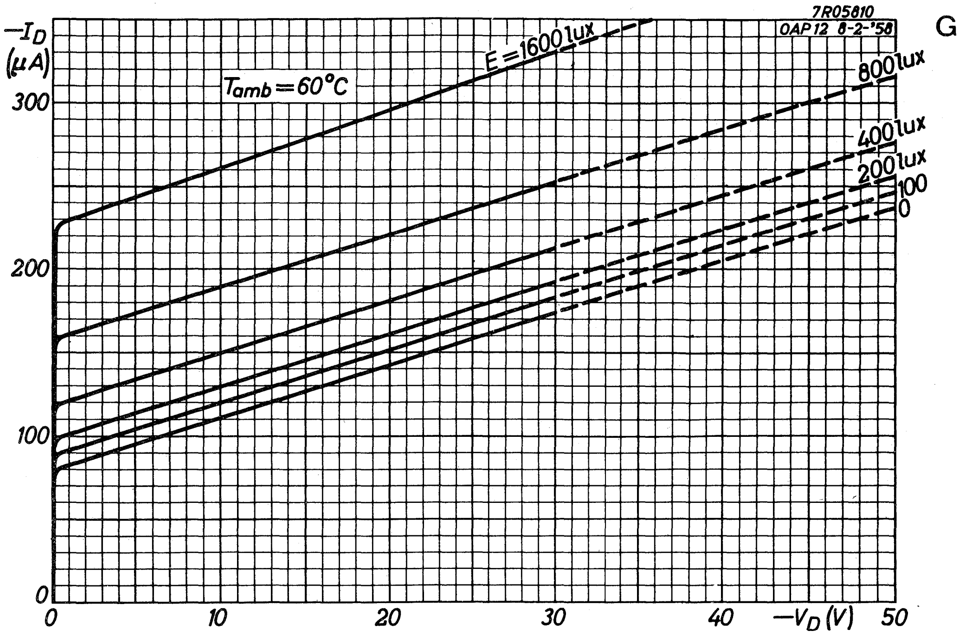

7R05812
OAP12 8-2-'58
$-I_D$ (μA)
300
200
100
0
$T_{amb} = 27°C$
E=1600 lux
800 lux
400 lux
200 lux
100
0
10
20
30
40
$-V_D$ (V)
50

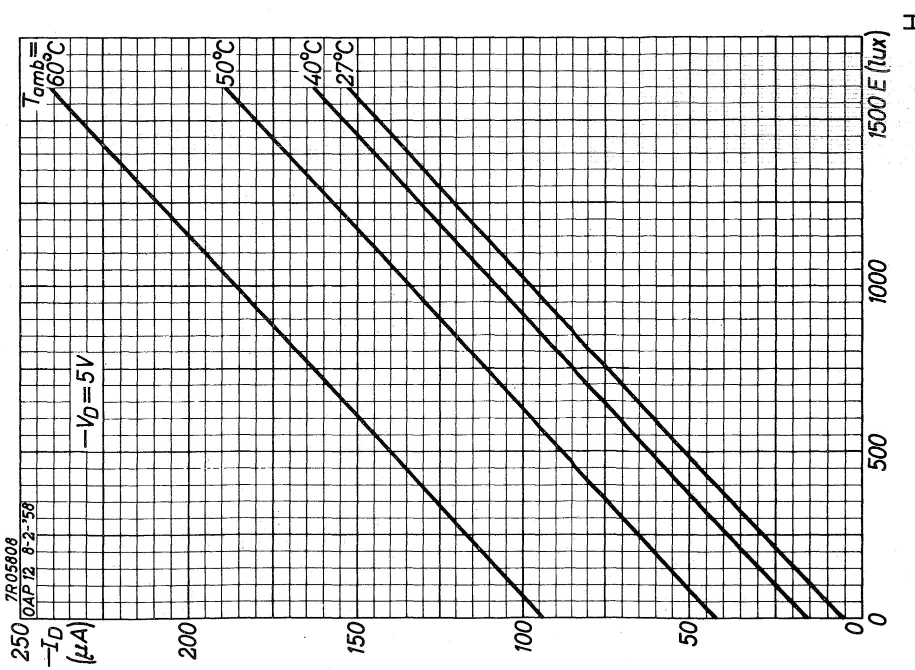

7R05811
OAP12 8-2-'58
$-I_D$
(μA)
300
200
100
0
$T_{amb}=40°C$
E=1600 lux
800 lux
400 lux
200 lux
100
0
0
10
20
30
40
$-V_D(V)$
50

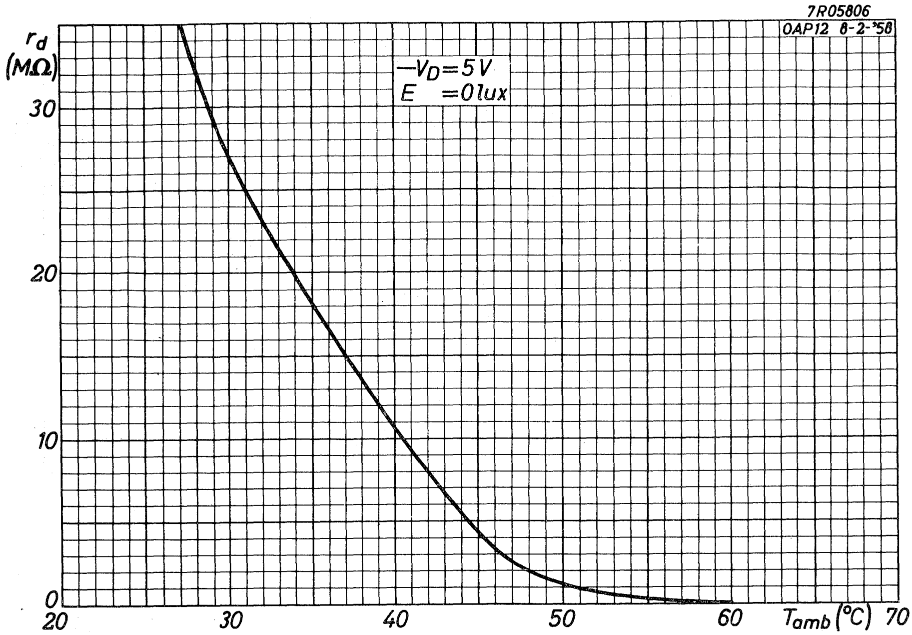
E


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

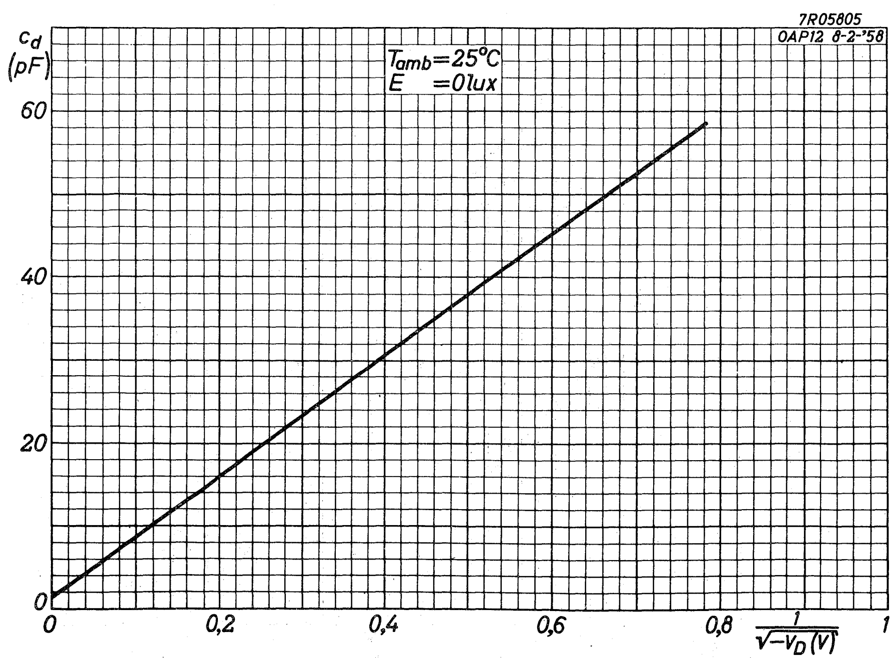
F


7R05810
OAP 12 8-2-'58
G
$-I_D$
(μA)
300
200
100
0
0
10
20
30
40
$-V_D$ (V)
50
T_{amb}=60°C
E=1600 lux
800 lux
400 lux
200 lux
100
0


H
T_{amb}=
60°C
50°C
40°C
27°C
$-V_D$=5V
7R05808
OAP 12 8-2-'58
1500 E (lux)
1000
500
0
250
$-I_D$
(μA)
200
150
100
50
0


7R05806
OAP12 8-2-'58
r_d (MΩ)
30
20
10
0
$-V_D = 5\,V$
$E = 0\,lux$
20
30
40
50
60
T_{amb} (°C)
70

I


7R05805
OAP12 8-2-'58
c_d (pF)
60
40
20
0
$T_{amb} = 25°C$
$E = 0\,lux$
0
0,2
0,4
0,6
0,8
$\frac{1}{\sqrt{-V_D\,(V)}}$
1

J

2.2.1964

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

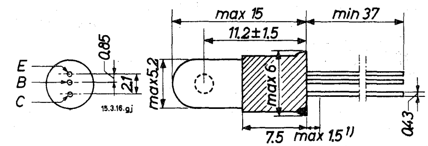
THERMAL DATA

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

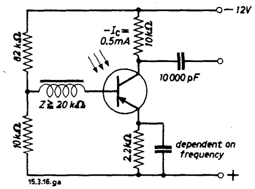
Dark current at			
$-V_{CE}$ = 4.5 V; I_B = 0 μA	$-I_{CEO}$	<	325 μA
Cut-off frequency for modulated light	$f_{max.}$	=	3 kc/s
Collector current at			
$-V_{CE}$ = 2 V with uniform illumination of 75 ft. candle (807 lux) with preferred direction of incident light, colour temperature of the light source 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

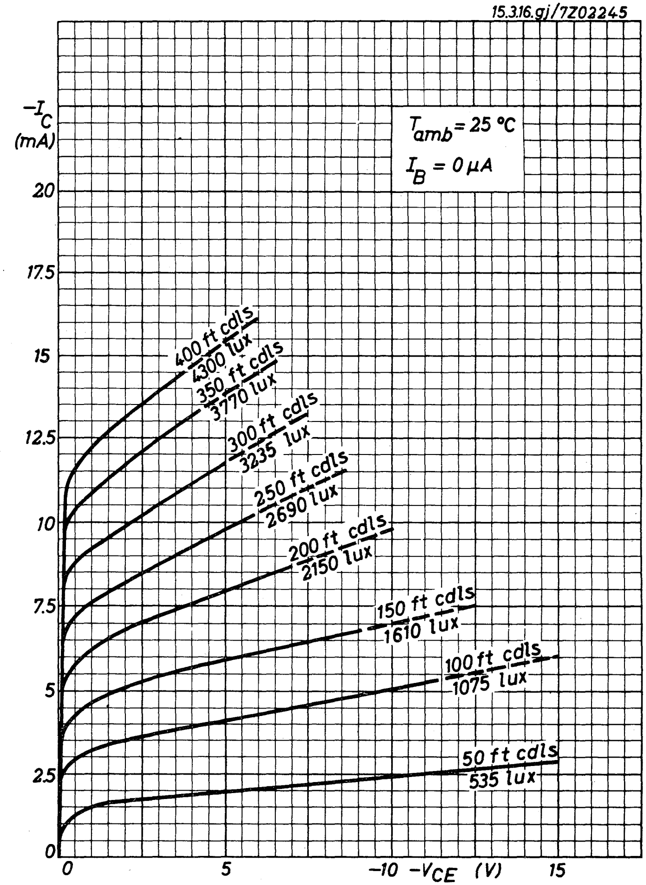
Circuit diagram



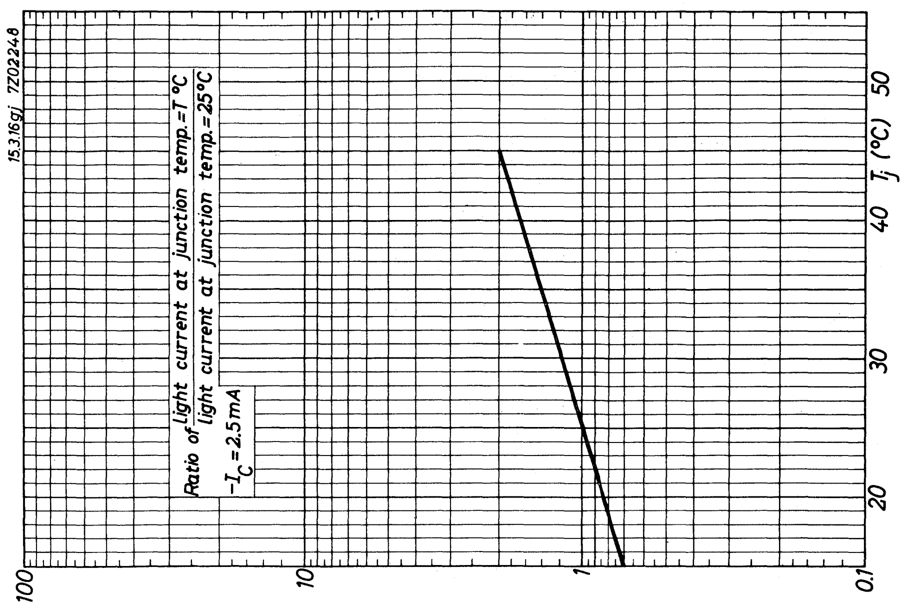
Note

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.

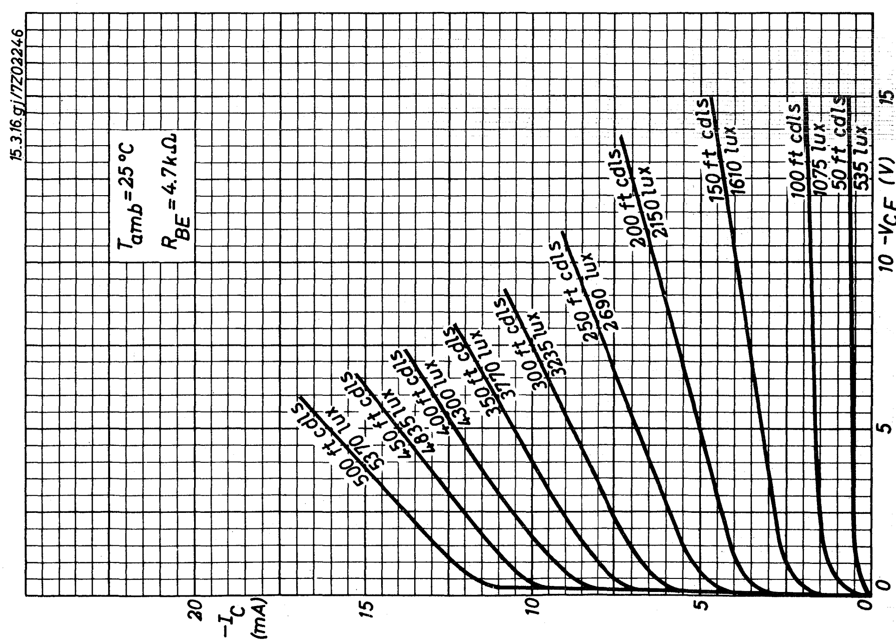
7Z2 2366



A

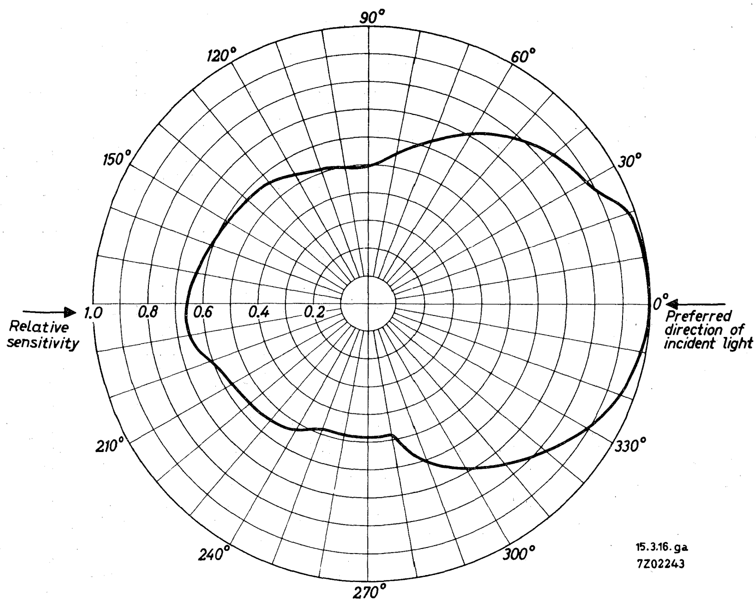

15.3.16gj 7Z02248
Ratio of light current at junction temp.=T °C / light current at junction temp.=25°C
$-I_C = 2.5\,mA$
100
10
1
0.1
20
30
40
50
T_j (°C)

C

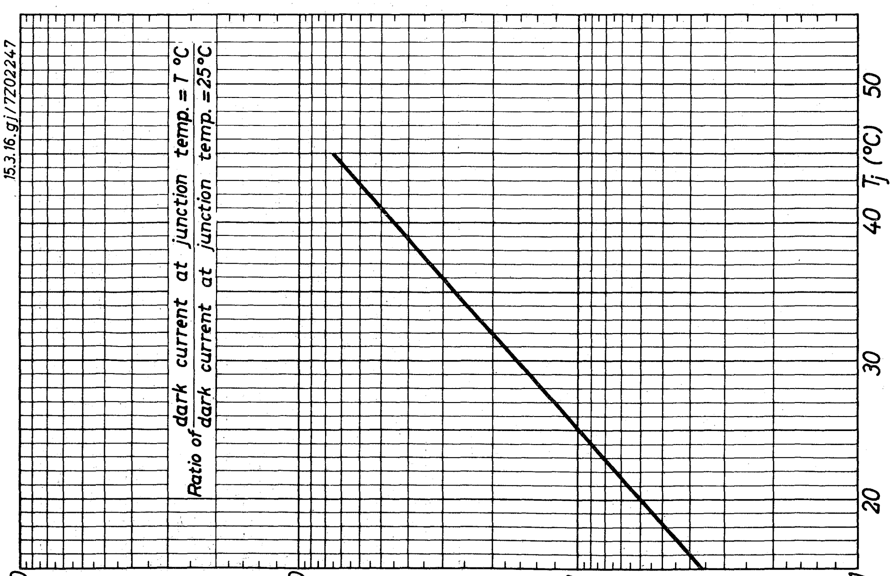

15.3.16.gj/7Z02246
$T_{amb} = 25\,°C$
$R_{BE} = 4.7\,k\Omega$
500 ft cdls
5370 lux
450 ft cdls
4835 lux
400 ft cdls
4300 lux
350 ft cdls
3770 lux
300 ft cdls
3235 lux
250 ft cdls
2690 lux
200 ft cdls
2150 lux
150 ft cdls
1610 lux
100 ft cdls
1075 lux
50 ft cdls
535 lux
20
$-I_C$ (mA)
15
10
5
0
0
5
10
15
$-V_{CE}$ (V)

B

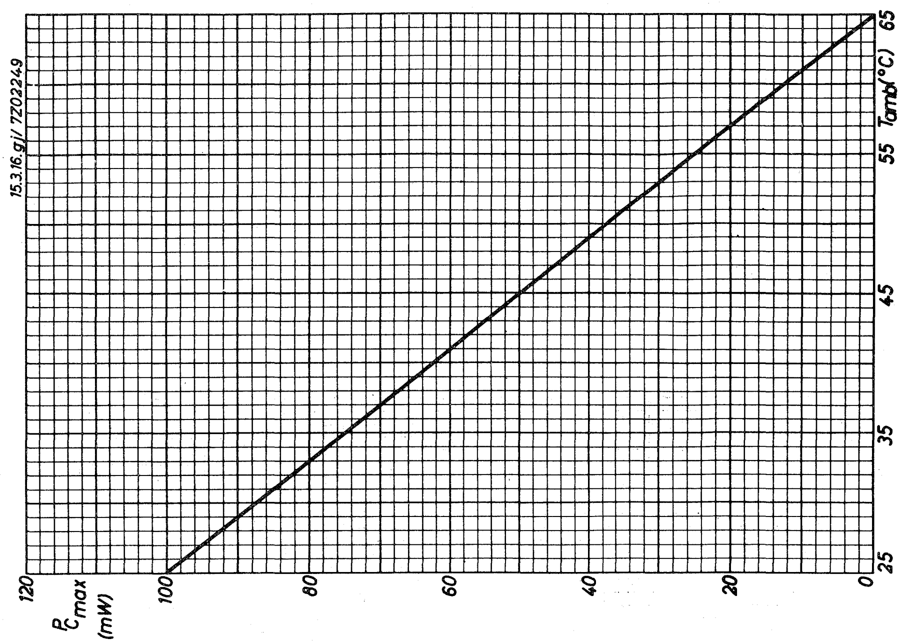
E

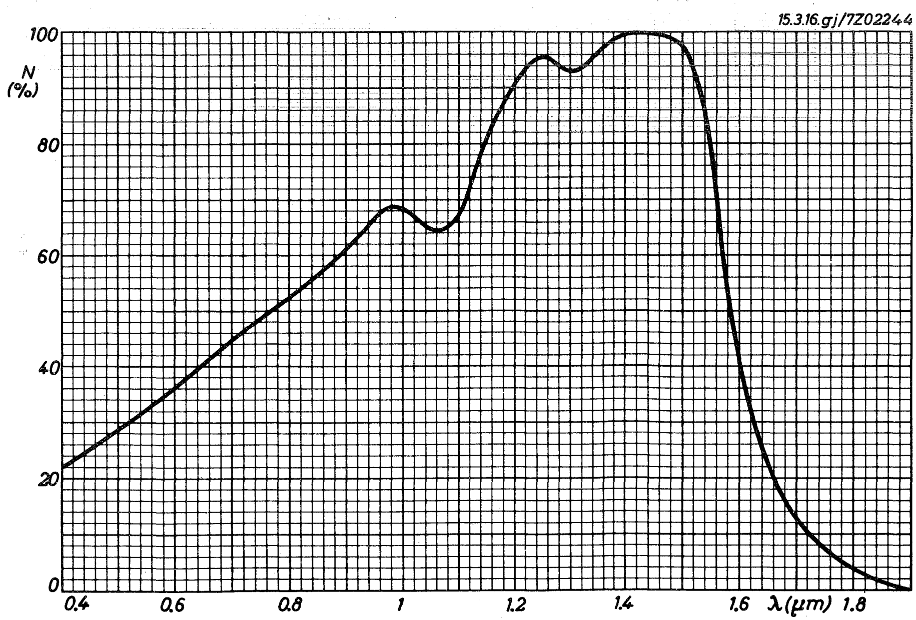

90°
120°
60°
150°
30°
1.0
0.8
0.6
0.4
0.2
0°
Relative sensitivity
Preferred direction of incident light
210°
330°
240°
300°
270°
15.3.16.ga
7Z02243

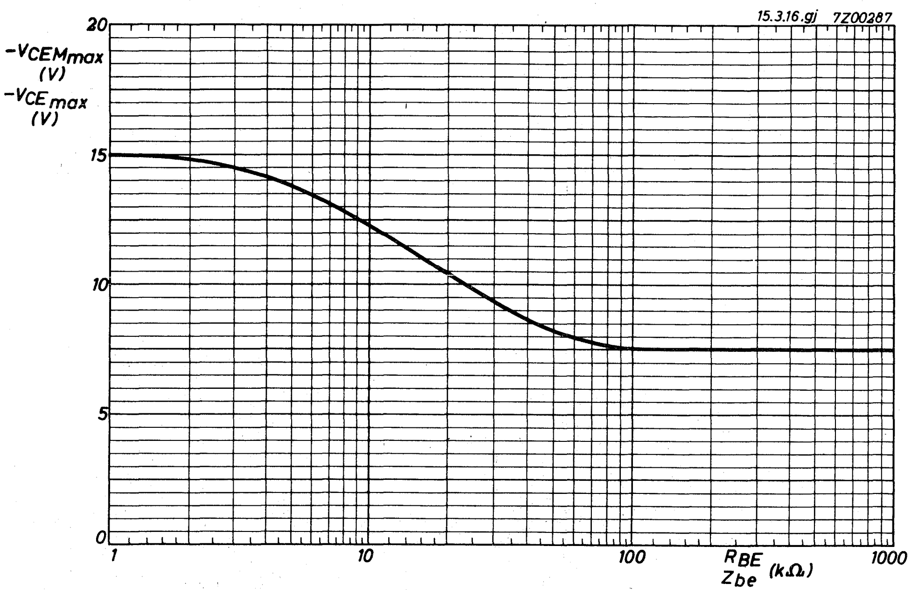
D


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

G


15.3.16.gj/ 7Z02249
T_{amb} (°C)
65
55
45
35
25
120
100
80
60
40
20
0
$P_{C max}$ (mW)


15.3.16.gj/7Z02244
100
N (%)
80
60
40
20
0
0.4
0.6
0.8
1
1.2
1.4
1.6
λ (μm)
1.8


15.3.16.gj 7Z00287
$-V_{CEMmax}$ (V)
$-V_{CEmax}$ (V)
20
15
10
5
0
1
10
100
1000
R_{BE} Z_{be} (kΩ)

H

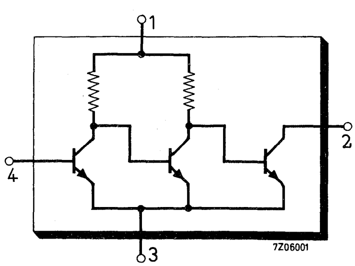
Integrated circuits

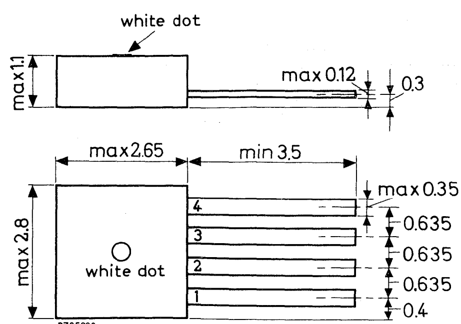
INTEGRATED CIRCUIT
AMPLIFIER FOR IN THE EAR HEARING AID

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
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	25	mW
In a practical circuit as given at page 3 fig. 1:				
Total supply current	I_{tot}	typ.	1	mA
Transducer gain	G_{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	kHz

MECHANICAL DATA Dimensions in mm





The sealing of the plastic envelope withstands the accelerated damp heat test of IEC recommendation 68-2 (test D, severity IV, 6 cycles). 7Z3 0744

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

Power dissipation

Total power dissipation (See page C)	P_{tot}	max.	25	mW

Temperatures

Storage temperature	T_{stg}	−20 to +80		°C
Ambient temperature	T_{amb}	max.	80	°C

CHARACTERISTICS at $V_{1-3} = 1.3$ V and $T_{amb} = 25$ °C unless otherwise specified
I_2 see figure 1

Supply current (no signal)	I_{tot}	<	1.2	mA
	I_1	typ.	0.34	mA
Transducer gain [3] at f = 1 kHz	G_{tr}	>	75	dB
		typ.	80	dB
$V_{1-3} = 1.3$ V; $T_{amb} = -10$ °C	G_{tr}	typ.	78	dB
$V_{1-3} = 1.1$ V; $T_{amb} = 25$ °C	G_{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

$$G_{tr} = \frac{P_o}{V_i^2/4R_S}$$

7Z3 0745

FOR FURTHER INFORMATION REFER TO A1128

CHARACTERISTICS (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 kHz				
P_o = 100 μW	d_{tot}	typ.	4	%
		<	6	%
P_o = 200 μW	d_{tot}	<	10	%
Noise figure at R_S = 5 kΩ				
Bandwidth f = 400 to 3200 Hz	F	<	6	dB
Frequency cut-off (−3 dB)	f_c	>	20	kHz
		>	50	kΩ
Value of R_F to adjust I_2 at 0.7 mA	R_F	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.

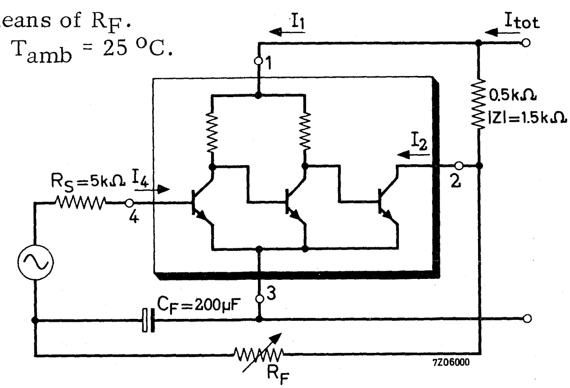


Fig. 1

SOLDERING RECOMMENDATION

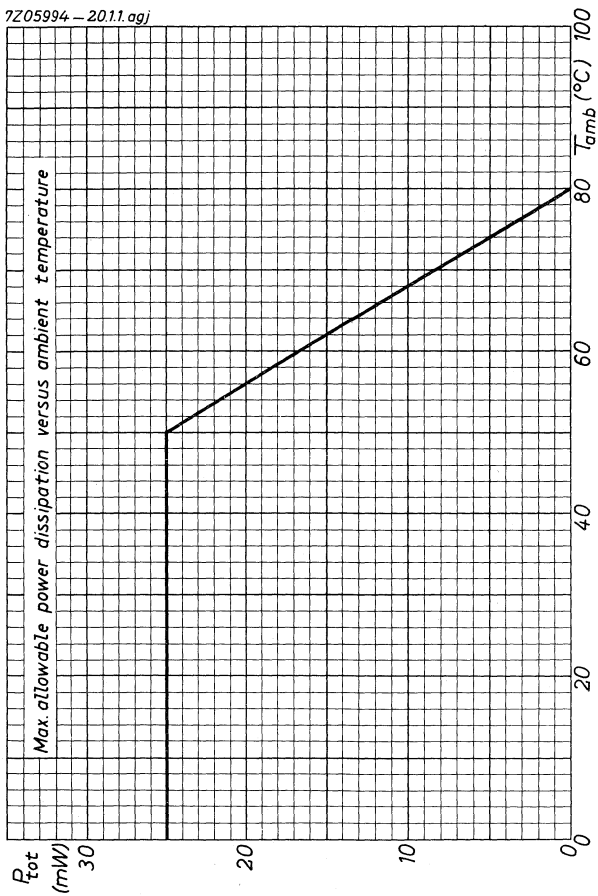
A: Iron soldering

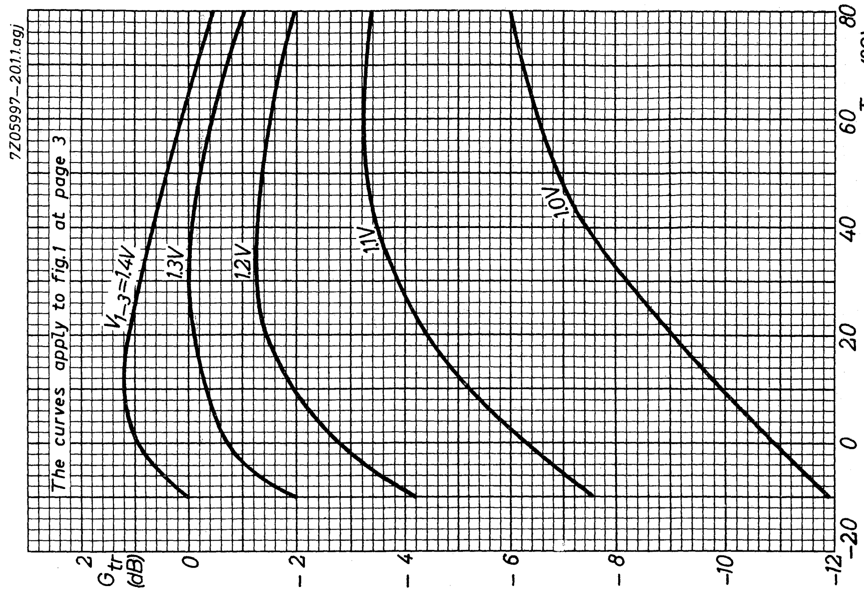
At a maximum iron temperature of 300 °C the maximum permissible soldering time is 3 seconds, provided the soldering spot is at least 0.5 mm from the seal and the leads are not soldered at the same time. Soldering in immediate subsequence is allowed.

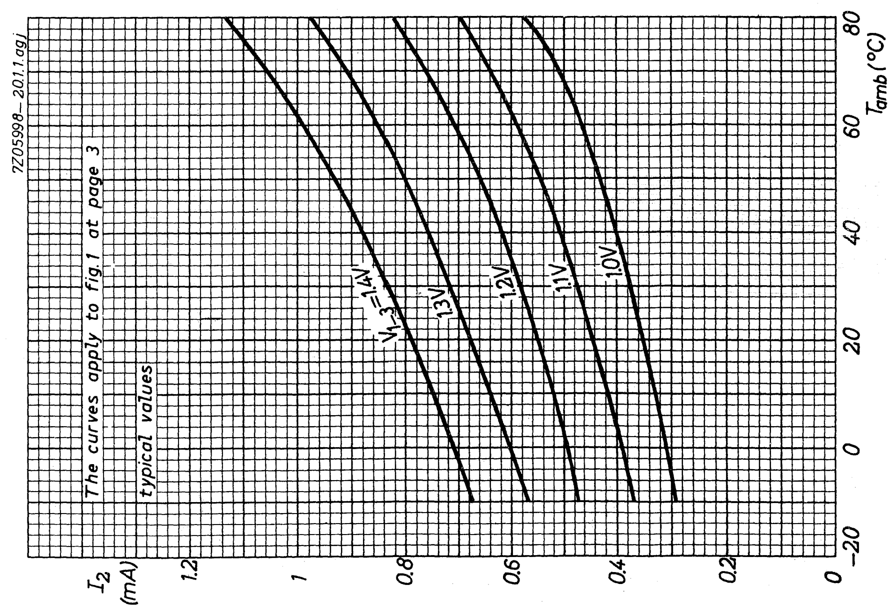
B: Dip soldering

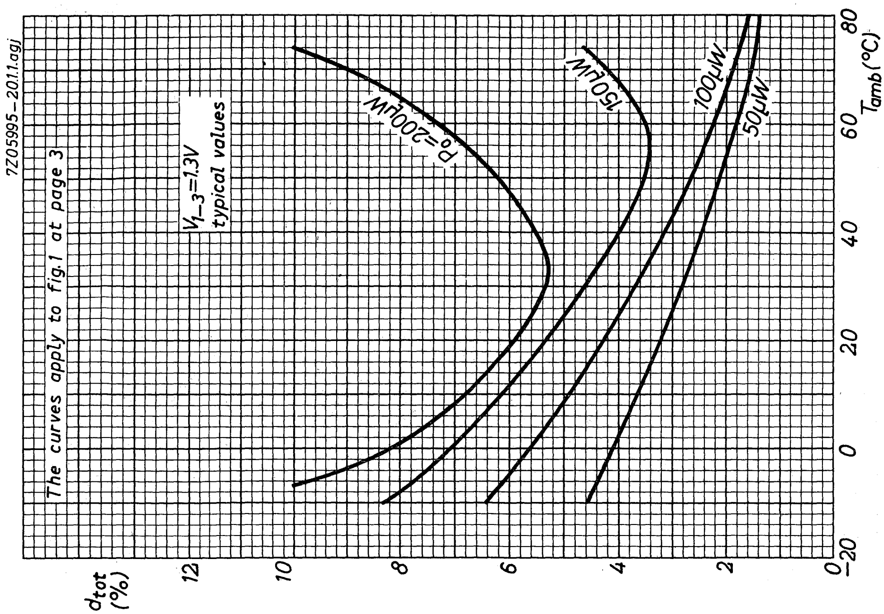
At a maximum solder temperature of 250 °C the maximum permissible soldering time is 3 seconds, provided the soldering spot is at least 0.5 mm from the seal.

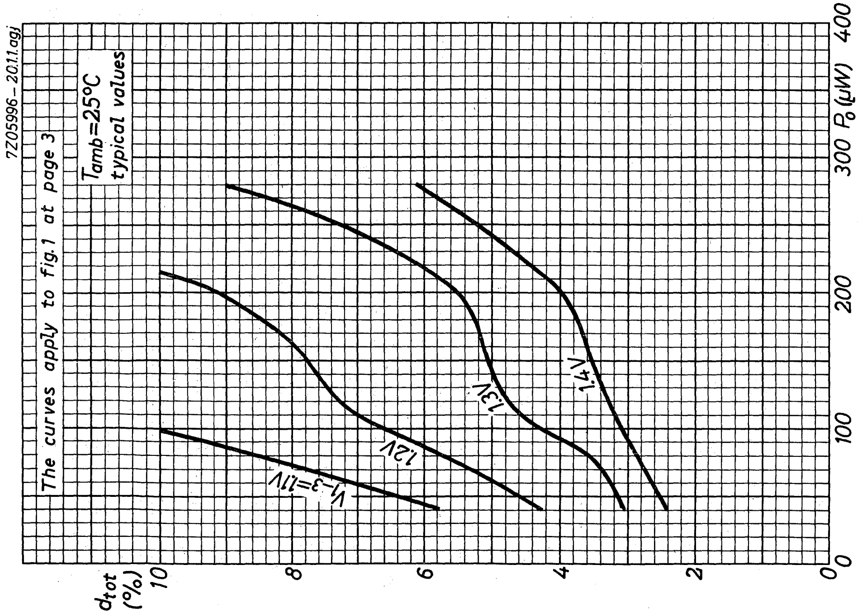
7Z3 0746


7Z05994 – 20.1.1.agj
Max. allowable power dissipation versus ambient temperature
Ptot (mW)
30
20
10
0
0
20
40
60
80
100
Tamb (°C)


7Z05997—20.1.1.agj
The curves apply to fig.1 at page 3
V_{1-3}=1.4V
1.3V
1.2V
1.1V
1.0V
G_{tr} (dB)
2
0
−2
−4
−6
−8
−10
−12
−20
0
20
40
60
80
T_{amb} (°C)


7Z05998—20.1.1.agj
The curves apply to fig.1 at page 3
typical values
V_{1-3}=1.4V
1.3V
1.2V
1.1V
1.0V
I_2 (mA)
1.2
1
0.8
0.6
0.4
0.2
0
−20
0
20
40
60
80
T_{amb} (°C)


7Z05995-20.1.1.agj
The curves apply to fig.1 at page 3
V_{1-3}=1.3V
typical values
P_o=200μW
150μW
100μW
50μW
d_{tot}
(%)
12
10
8
6
4
2
0
−20
0
20
40
60
80
T_{amb}(°C)


7Z05996-20.1.1.agj
The curves apply to fig.1 at page 3
T_{amb}=25°C
typical values
V_{1-3}=1.1V
1.2V
1.3V
1.4V
d_{tot}
(%)
10
8
6
4
2
0
0
100
200
300
400
P_o(μW)

Accessories

TABLE OF CONTENTS

	Pages
Table of contents	1
Index of type numbers	2- 3
Mounting accessories	5-23
Heatsinks	25-89
1. General	26-31
Selection Guide	32-33
2. Flat heatsinks	35-40
3. Diecast heatsinks	41-73
4. Heatsink extrusions	75-89

7Z3 0477

INDEX OF TYPE NUMBERS

Type number	Description	Pages
56200	Cooling fin	5
56201	Set of mounting accessories	6
56201a	Mica washer + insulating bushes	7
56201b	Lead washer	7
56201c	Insulating bush	7
56201d	Mica washer	7
56202	Plain washer + lock washer + nut	8
56203	Mica washer + insulating bushes	8
56204	Cooling plate	9
56206	Nut + dish spring	9
56207	Cooling fin	10
56208	Cooling fin	10
56209	Cooling fin	11
56210	Cooling fin	11
56212	Plain washer + lock washer + nut	12
56213	Set of mounting accessories	13
56214	Lead washer	14
56215	Nut + dish spring	14
56218	Clamping washers + mica washer	15
56219	Diecast heatsink	45
56220	Mounting support	45
56221	Diecast heatsink	46
56222	Mounting support	46
56223	Diecast heatsink	47
56224	Mounting support	47
56226	Cooling fin	16
56227	Cooling fin	16
56228	Diecast heatsink	48
56229	Mounting support	48
56230	Heatsink extrusion	76-77
56231	Heatsink extrusion	78-79
56232	Mounting adaptor	17
56233	Mounting strip	49
56234	Mounting strip	49
56235 to 56238	Diecast heatsinks + mounting supports	51

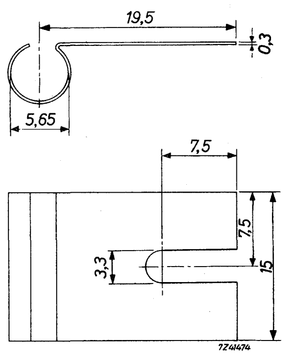
7Z3 0478

Type number	Description	Pages
56239	Mica washer + insulating bushes	18
56240	Mica washer + insulating bushes	18
56243	Flexible top lead	18
56244	Clamp	19
56245	Distance disk	19
56246	Distance disk	19
56247	Flexible base lead	19
56248	Diecast heatsink for two devices	52-55
56249	Insulator	52
56250	Complete heatsink for two devices	52-55
56251	Diecast heatsink	56-57
56252	Insulator	56
56253	Complete heatsink	56-57
56254	Diecast heatsink	58-59
56255	Insulator	58
56256	Complete heatsink	58-59
56257	Insulator	60
56258	Complete heatsink	60-61
56259	Heatsink extrusion	80-83
56261	Insulating bushes	20
56262	Mica washer + insulating ring	20
56263	Cooling fin	21
56264	Mica washer + insulating ring	22
56265	Cooling and mounting clip	22
56266	Diecast heatsink	62-63
56267	Insulator	62
56268	Complete heatsink	62-63
56269	Diecast heatsink	64-65
56270	Insulator	64
56271	Complete heatsink	64-65
56272	Diecast heatsink	60-61; 66-67
56273	Insulator	66
56274	Complete heatsink	66-67
56275	Diecast heatsink	68-69
56276	Insulator	68
56277	Complete heatsink	68-69
56280	Diecast heatsink	70-71
56283	Diecast heatsink	72-73
56289	Cooling fin	23
56290	Heatsink extrusion	84-85
56293	Heatsink extrusion	86-89

7Z3 0479

COOLING FIN

Dimensions in mm

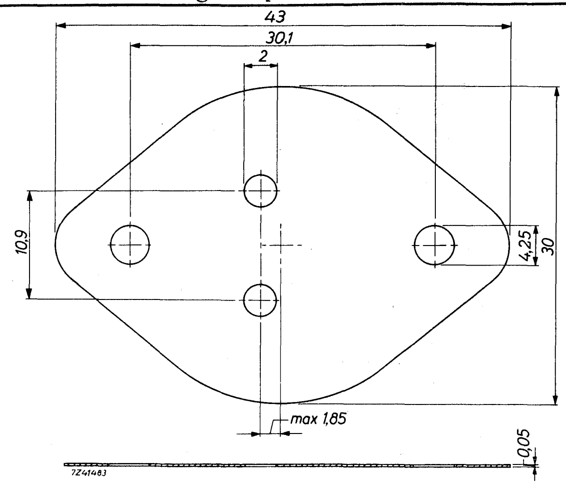


Fin material: brass, nickel plated

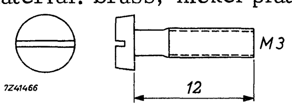
7Z3 0480

Type 56201 consists of the following components (1 to 7) Dimensions in mm

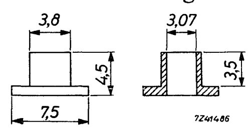
1.
1 mica washer



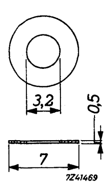
2.
2 cheese head screws, slotted
Material: brass, nickel plated



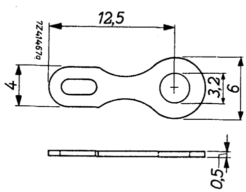
3.
2 Philite insulating bushes



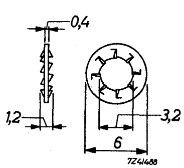
4.
3 plain washers
Material: brass, nickel plated



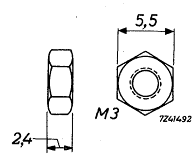
5.
1 solder tag



6.
2 serrated lock washers,
internal teeth
Material: steel, nickel plated



7.
2 hexagon nuts
Material: brass, nickel plated

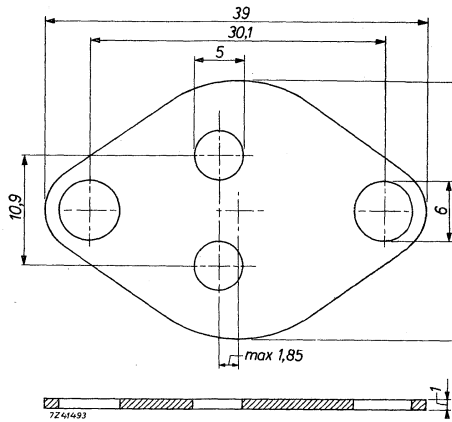


7Z3 0481

Type 56201a consists of items 1 and 3 only (see 56201)

Type 56201b is a lead washer

Dimensions in mm



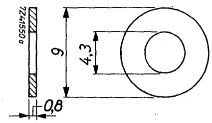
Type 56201c consists of only one insulating bush of item 3 (see 56201)

Type 56201d consists of item 1 only (see 56201)

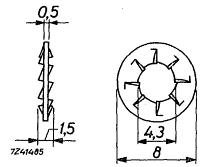
7Z3 0482

Type 56202 consists of the following components (1 to 3) Dimensions in mm

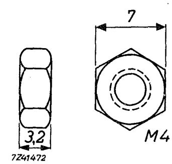
1.
1 plain washer
Material: brass, nickel plated



2.
1 serrated lock washer, internal teeth
Material: steel, nickel plated

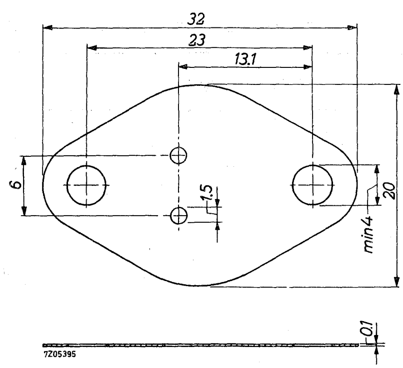


3.
1 hexagon nut
Material: brass, nickel plated

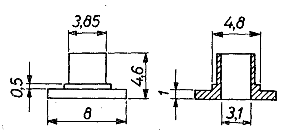


Type 56203 consists of the following components (1 to 2) Dimensions in mm

1.
1 mica washer



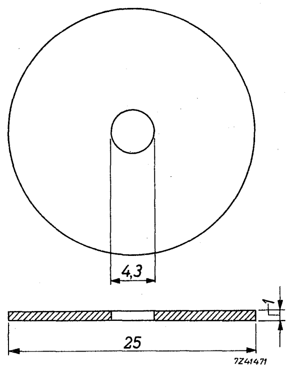
2.
2 Philite insulating bushes



7Z3 0483

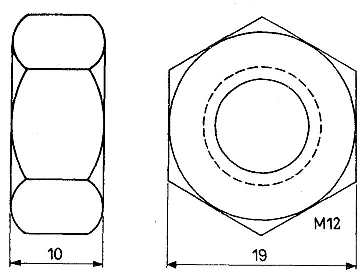
Type 56204 is an aluminium cooling plate

Dimensions in mm

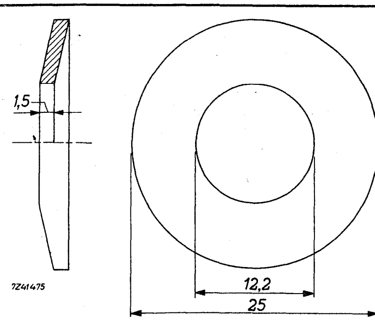


Type 56206 consists of the following components (1 to 2) Dimensions in mm

1.
1 hexagon nut
Material: brass, nickel plated



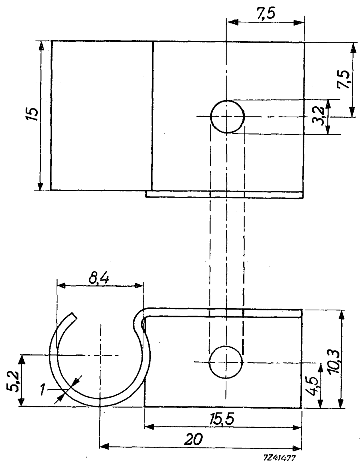
2.
1 dish spring
Material: steel, nickel plated



7Z3 0484

COOLING FINS

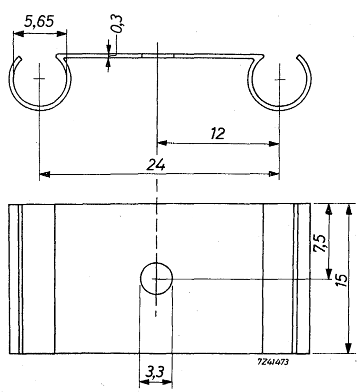
56207



Dimensions in mm

Material: aluminium, blackened

56208



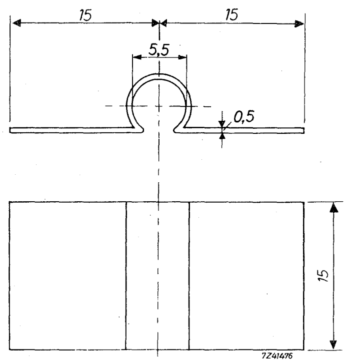
Material: brass, nickel plated

7Z3 0485

COOLING FINS

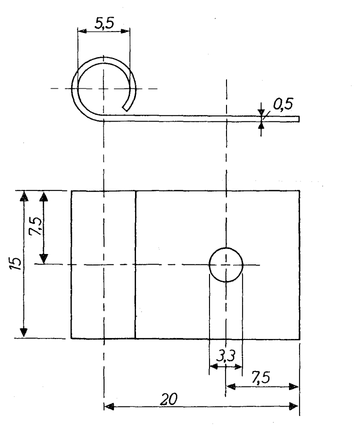
56209

Dimensions in mm



Material: brass, nickel plated

56210

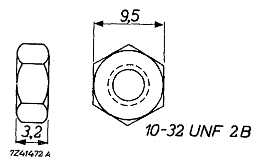


Material: brass, nickel plated

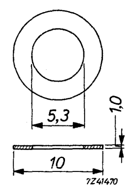
7Z3 0486

Type 56212 consists of the following components (1 to 3) Dimensions in mm

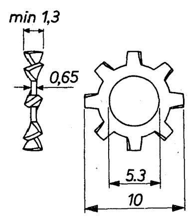
1.
1 hexagon nut
Material: brass, nickel plated



2.
1 plain washer
Material: brass, nickel plated



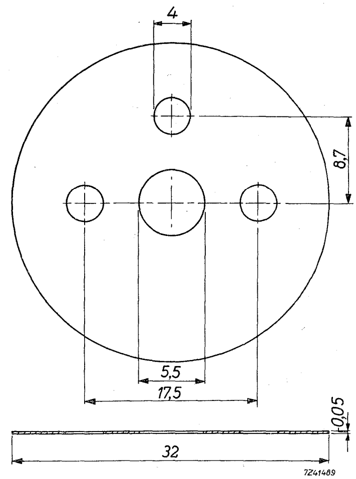
3.
1 lock washer, external teeth
Material: steel, nickel plated



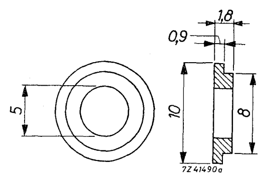
7Z3 0487

Type 56213 consists of the following components (1 to 5) Dimensions in mm

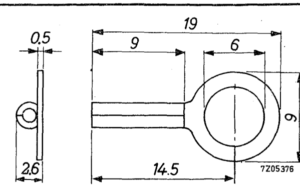
1.
1 mica washer



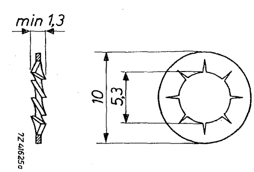
2.
1 Philite insulating ring



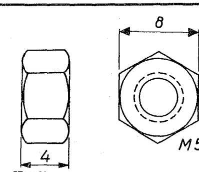
3.
1 cable lug
Material: brass, nickel plated



4.
1 lock washer, internal teeth
Material: steel, nickel plated



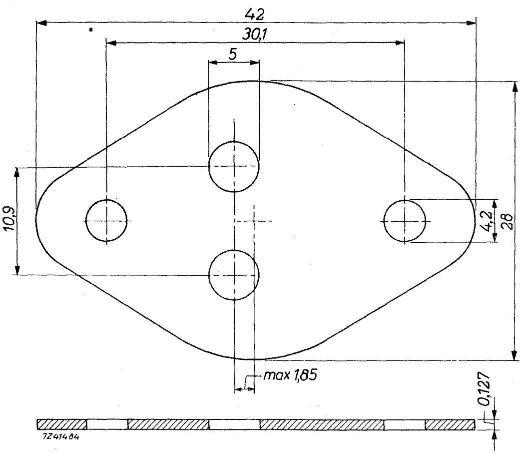
5.
1 hexagon nut
Material: brass, nickel plated



7Z3 0488

Type 56214 is a lead washer

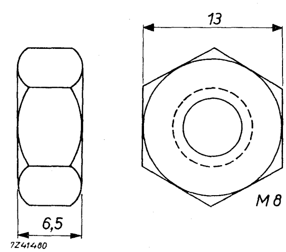
Dimensions in mm



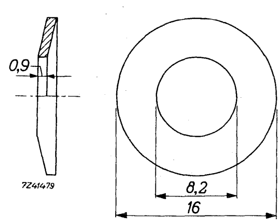
Type 56215 consists of the following components (1 to 2)

Dimensions in mm

1.
1 hexagon nut
Material: brass, nickel plated



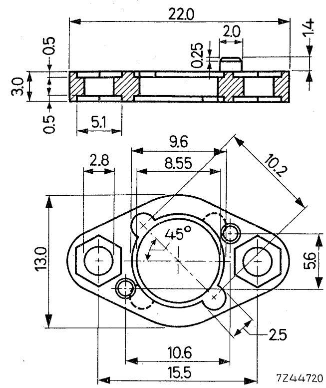
2.
1 dish spring
Material: steel, nickel plated



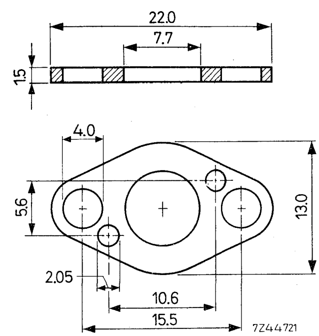
7Z3 0489

Type 56218 consists of the following components (1 to 3)   Dimensions in mm

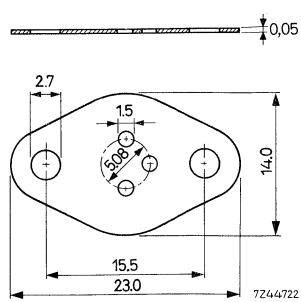
1.
1 top clamping washer
of insulating material



2.
1 bottom clamping washer
Material: brass, tin plated



3.
1 mica washer



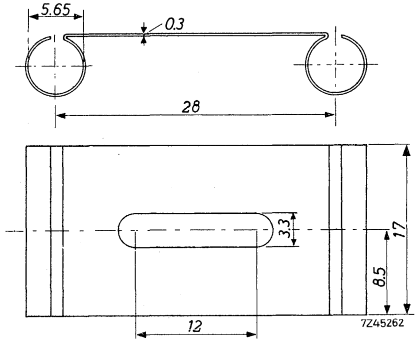
7Z3 0490

COOLING FINS

Dimensions in mm

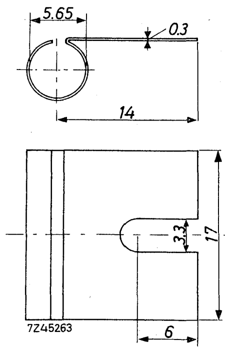
56226

Material:
brass, nickel plated



56227

Material:
brass, nickel plated

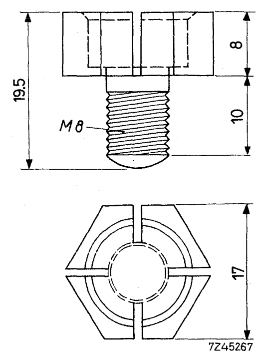


7Z3 0491

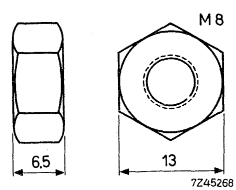
MOUNTING ADAPTOR

Type 56232 consists of the following components (1 to 3) Dimensions in mm

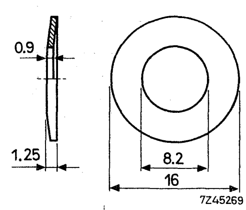
1.
1 mounting adaptor



2.
1 hexagon nut
Material: brass, nickel plated



3.
1 dish spring
Material: steel, nickel plated



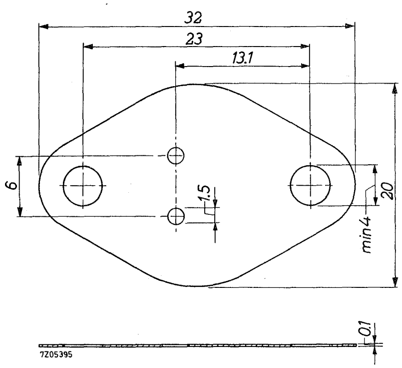
7Z3 0492

Types 56239 and 56240 consist of the following components (1 to 2)

Dimensions in mm

1.

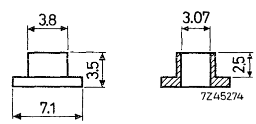
1 mica washer
(both types)



2.

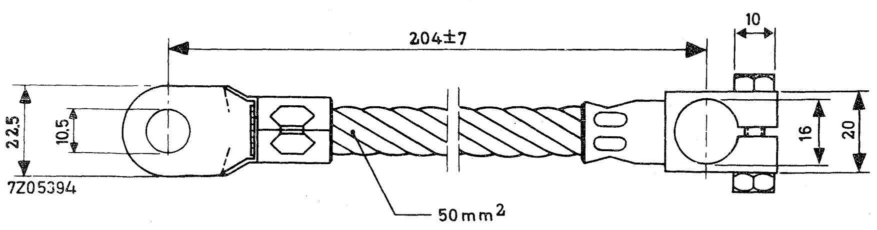
56239: 2 philite insulating bushes

56240: 3 philite insulating bushes



Type 56243 is a flexible top lead

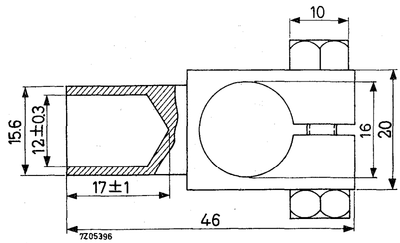
Dimensions in mm



7Z3 0493

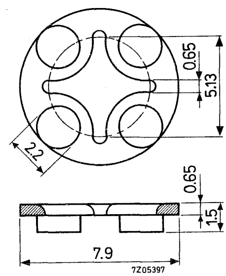
Type 56244 is a clamp

Dimensions in mm

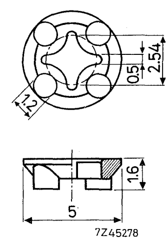


Types 56245 and 56246 are distance disks of insulating material

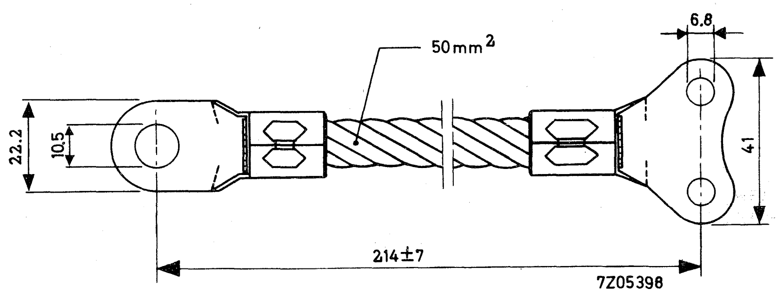
56245



56246

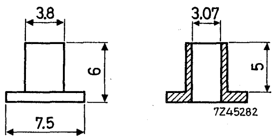


Type 56247 is a flexible base lead



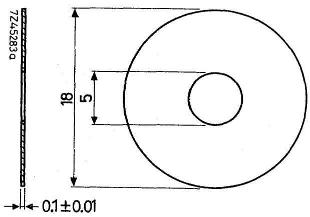
7Z3 0494

Type 56261 consists of 2 Philite insulating bushes | Dimensions in mm

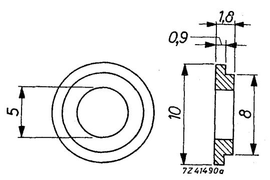


Type 56262 consists of the following components (1 to 2) | Dimensions in mm

1.
1 mica washer



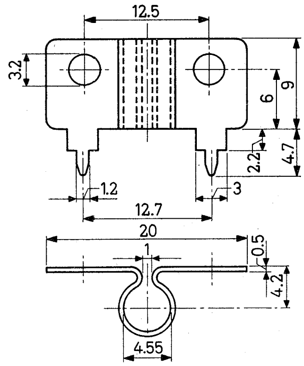
2.
1 Philite insulating ring



7Z3 0495

COOLING FIN

Dimensions in mm

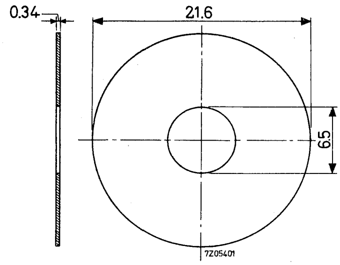


Material: brass, tin plated

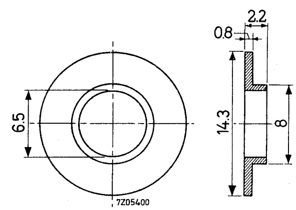
7Z3 0496

Type 56264 consists of the following components (1 to 2) Dimensions in mm

1.
1 mica washer

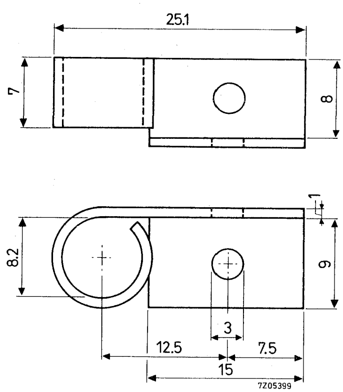


2.
1 insulating ring



Type 56265 is a cooling and mounting clip Dimensions in mm

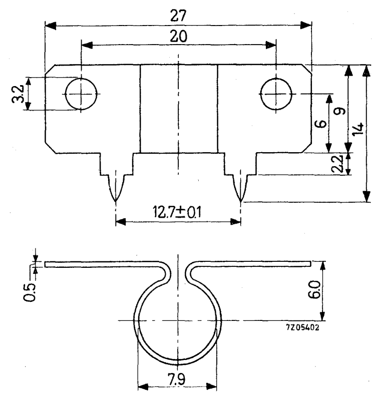
Material:
aluminium, blackened



7Z3 0497

COOLING FIN

Dimensions in mm



Material: brass, tin plated

7Z3 0498

HEATSINKS

1. GENERAL pp. 26 to 33

2. FLAT HEATSINKS pp. 35 to 40

3. DIECAST HEATSINKS pp. 41 to 73

4. HEATSINK EXTRUSIONS pp. 75 to 89

GENERAL

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 (R_{th} 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:

$R_{th\ j\text{-}mb}$: The thermal resistance from junction to mounting base. Its value can be found in the data sheets of the relevant semiconductor device.

$R_{th\ mb\text{-}h}$: 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.

$R_{th\ h\text{-}a}$: The thermal resistance of the heatsink. This is the thermal resistance between the contact surface and the ambient air.

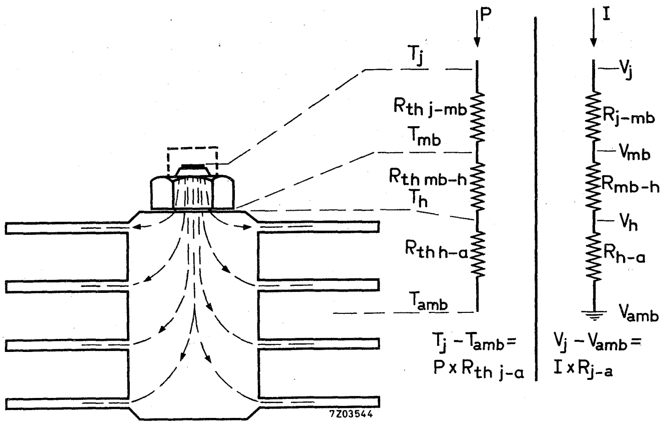
Once the heat has been transferred from heatsink to ambient, cool air must replace the heated air.

According to fig.1 the following formula can be used in heatsink calculations:

$$T_j - T_{amb} = P \times (R_{th\ j\text{-}mb} + R_{th\ mb\text{-}h} + R_{th\ h\text{-}a})$$

7Z3 0079

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 (e.g. Dow Corning 340)

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.

7Z3 0080

INSULATED MOUNTING

In bridge rectifiers it may be desirable to insulate a diode electrically from its heatsink by means of a mica or teflon wahser. 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 $R_{th\ mb\text{-}h}$ has to be compensated by a considerable reduction of $R_{th\ h\text{-}a}$ (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.

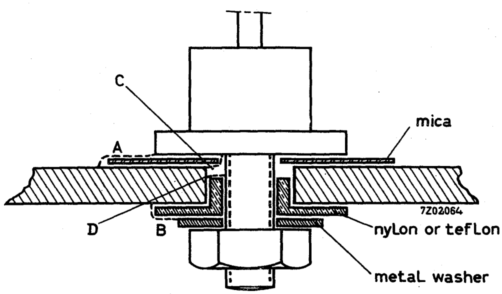


Fig.2 Creepage distances at an insulated diode
(C and D are the critical ones)

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. 7Z3 0081

An electrical series connection of two diodes mounted on one heatsink can be obtained by using diodes of different polarity. Figs. 5, 6, 7 and 8 show how the combination of normal and reverse-polarity diodes simplifies the assembly of single phase and three phase bridge rectifiers.

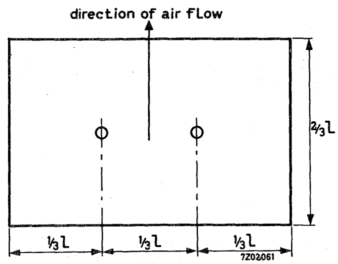


Fig.3. Dimensioning of a plain cooling fin with two diodes

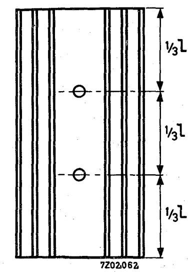


Fig.4. Extruded aluminium heatsink with two diodes

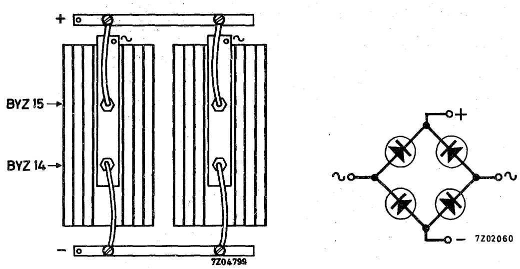


Fig.5. Single phase full wave rectifier with diodes of different polarity on extruded aluminium heatsinks

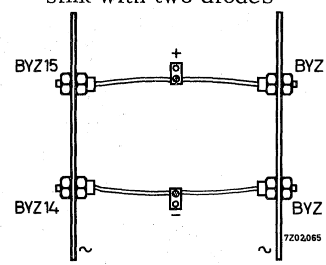


Fig.6. Single phase full wave rectifier with diodes of different polarity on plain cooling fins (Top view)

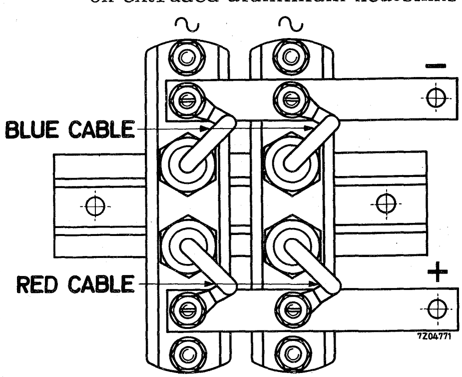


Fig.8. Single phase full wave rectifier with diodes of different polarity (red cable: reverse polarity; blue cable: normal polarity) on two double heatsinks 56250

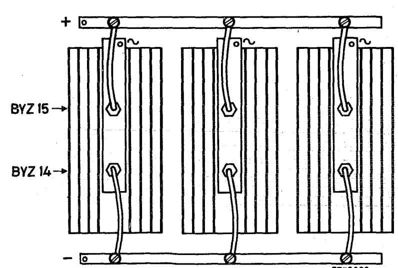


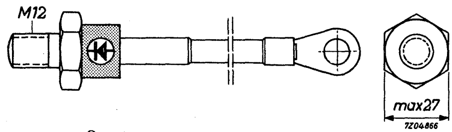
Fig.7. Three phase full wave rectifier with diodes of different polarity on extruded aluminium heatsinks

7Z3 0082

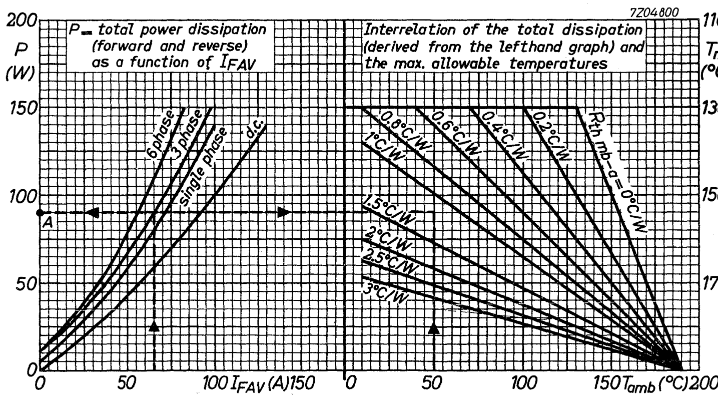
EXAMPLES OF HEATSINK CALCULATION

1. Devices without controlled avalanche properties.

Assume that the diode of which the outlines are shown, is used in a three phase 50 Hz rectifier circuit at T_{amb} = 50 °C.
Further assume: average forward current per diode I_{FAV} = 65 A
contact thermal resistance $R_{th\ mb\text{-}h}$ = 0.1 °C/mW.



From the data of the diode the graph to be used is shown below.



From the lefthand graph it follows that P_{tot} = 90 W per diode (point A).
From the righthand graph it follows that $R_{th\ mb\text{-}a} \approx$ 1.2 °C/W.
Thus $R_{th\ h\text{-}a} = R_{th\ mb\text{-}a} - R_{th\ mb\text{-}h}$ = (1.2 - 0.1) °C/W = 1.1 °C/W.
This may be achieved by different types of heatsinks as shown below.

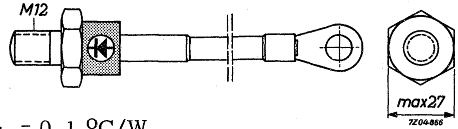
Type	Free convection	Forced cooling
flat, blackened bright	– –	125 cm^2; 2 m/s or 300 cm^2; 1 m/s 175 cm^2; 2 m/s
diecast 56274 56280	– applicable	≈ 1.5 m/s
extrusion 56230 bright blackened 56231 bright blackened	 l = 12 cm l = 8 cm l = 7 cm l = 5 cm [1])	 l = 5 cm [1]); 1 m/s l = 5 cm [1]); 1 m/s

[1]) Practical minimum length

7Z3 0100

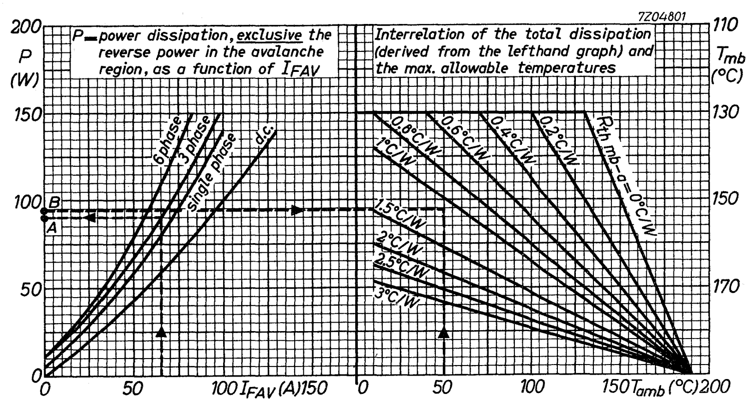
2. Devices with controlled avalanche properties.

Assume that the diode of which the outlines are shown, is used in a three phase 50 Hz rectifier circuit at T_{amb} = 50 °C.



Further assume: average forward current per diode I_{FAV} = 65 A
contact thermal resistance $R_{th\ mb\text{-}h}$ = 0.1 °C/W
repetitive peak reverse power in the avalanche region (t = 10 μs)
P_{RRM} = 8 kW (per diode).

From the data of this diode the graph to be used is shown below.



From the lefthand graph it follows that P_{tot} = 90 W per diode (point A).
The average reverse power in the avalanche region, averaged over any cycle, follows from $P_{RAV} = \delta \times P_{RRM}$, where the duty cycle $\delta = \frac{10\ \mu s}{10\ ms} = 0.0005$.

Thus P_{RAV} = 0.0005 x 8 kW = 4 W.

Therefore the total device power dissipation P_{tot} = 90 + 4 = 94 W (point B).
From the righthand graph it follows that $R_{th\ mb\text{-}a} \approx 1.1$ °C/W.
Hence the heatsink thermal resistance should be:

$$R_{th\ h\text{-}a} = R_{th\ mb\text{-}a} - R_{th\ mb\text{-}h} = (1.1 - 0.1)\ ^\circ C/W = 1\ ^\circ C/W.$$

A table of applicable heatsinks, similar to that on the foregoing page, can be derived for this case.

7Z3 0500

SELECTION GUIDE FOR DIODES

To simplify the selection of heatsinks, the table below indicates for each die-cast heatsink the diodes for which it may be used.
For extruded heatsinks the most suitable combinations are given.
As an additional guide, the outlines of the appropriate diodes are shown beside the heatsink data.

	BYZ10-13 BYZ16-19	BYX13 BYY22	BYX25 BYX30	BYX20 1) BYX21 1) BYX28 1) BYY20 1) BYY21 1)	BYZ14	BYX23 BYX32	BYX14 BYX27 BYX33
Diecast							
56248 56250					●	●	
56266 56268	●						
56269 56271		●		●			
56272 56274					●	●	
56275 56277		●		●			
56280					●	●	
56283							●
Extrusions							
56230 56231		●	●	●	●		
56259 56293					●	●	●
56290	●	●	●	●			

1) With adaptor 56232

7Z3 0501

SELECTION GUIDE FOR THYRISTORS

To simplify the selection of heatsinks, the table below indicates for each die-cast heatsink the thyristors for which it may be used.
For extruded heatsinks the most suitable combinations are given.
As an additional guide, the outlines of the appropriate thyristors are shown beside the heatsink data.

	BTY79 BTY80 BTY81	BTX35 BTY87	BTX36 BTY91	BTX12 BTX13	BTX37 BTY95	BTX38 BTY99
Diecast						
56248 56250				●[1]		
56251 56253		●	●			
56254 56256	●					
56272 56258				●		
56280				●		
Extrusions						
56230 56231		●	●	●	●	●
56259 56293				●	●	●
56290	●	●	●			

[1] Only on 56248 + 56257

7Z3 0103

FLAT HEATSINKS

7Z3 0104

FLAT HEATSINKS

For vertically mounted, flat, blackened cooling fins of 3 mm aluminium, the nomogram on next page gives the relation 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. Explicit graphs of R_{th} versus heatsink area are shown on pages 38 to 40. Nomogram and graphs 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 that the type of diode, the power dissipated and the calculated max. value of the heatsink thermal resistance are given.

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

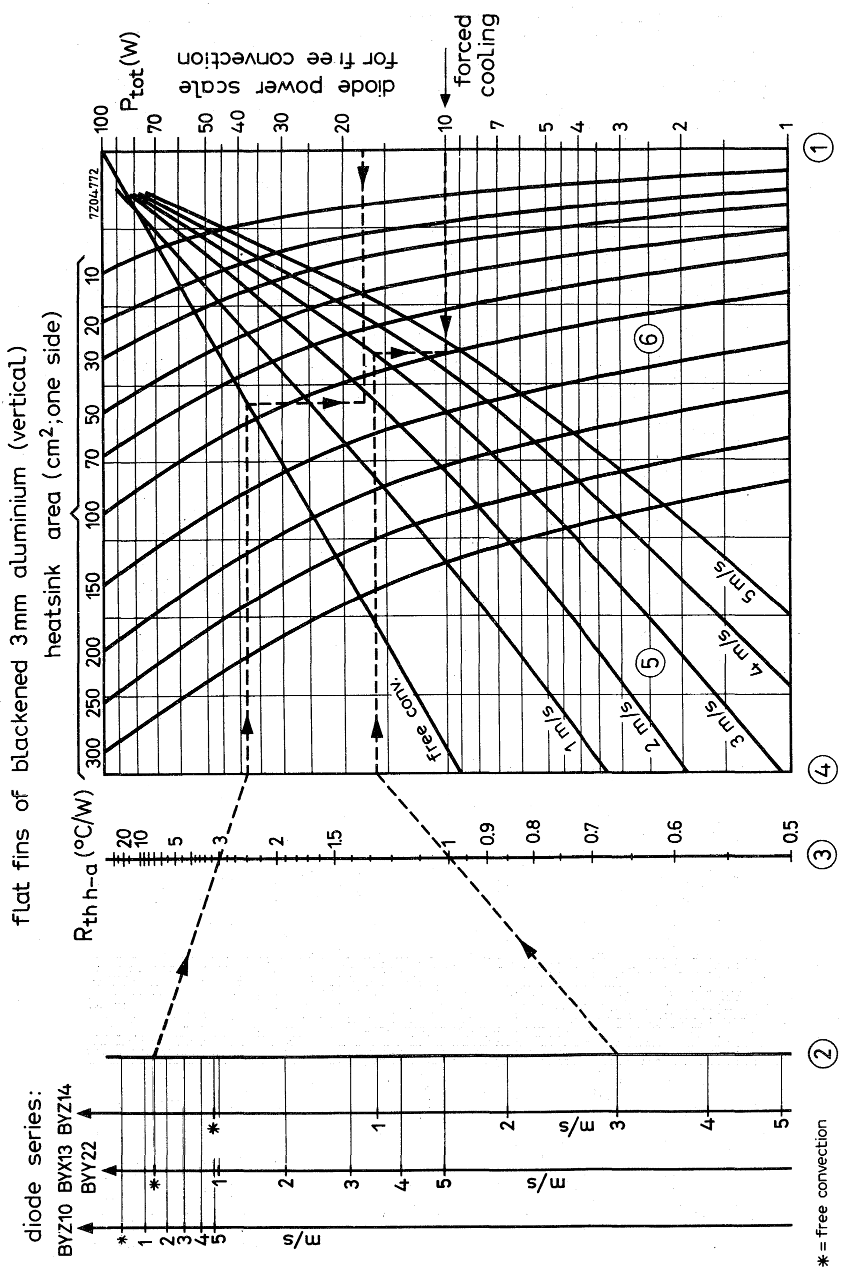
Assume that the type of diode, the calculated max. value of the heatsink thermal resistance and the velocity of the cooling are given.

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).

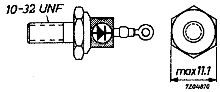
Example:

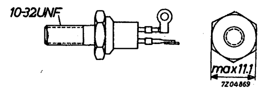
In the nomogram an example has been drawn for a BYZ14 diode, for which a required thermal resistance between mounting base and ambient of 1.15 °C/W has been calculated and which will be cooled with a forced velocity of 3 m/ s.
Since the contact thermal resistance is 0.15 °C/W, the heatsink thermal resistance should be 1 °C/W. The nomogram shows that the required heatsink area is 100 cm^2.

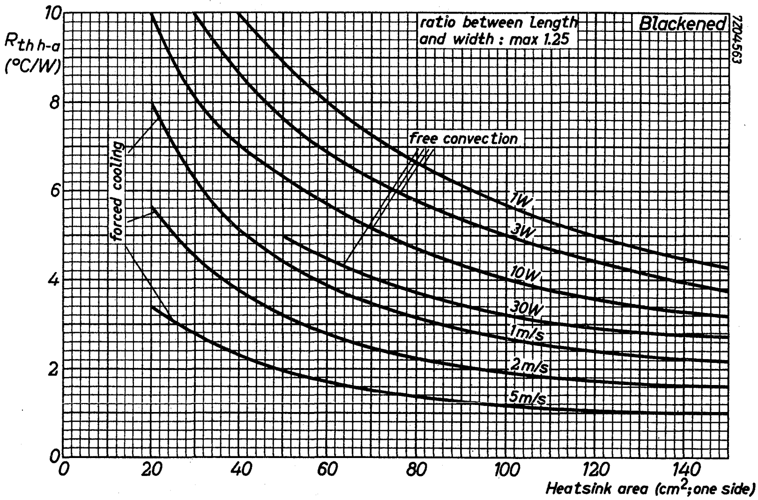
7Z3 0651

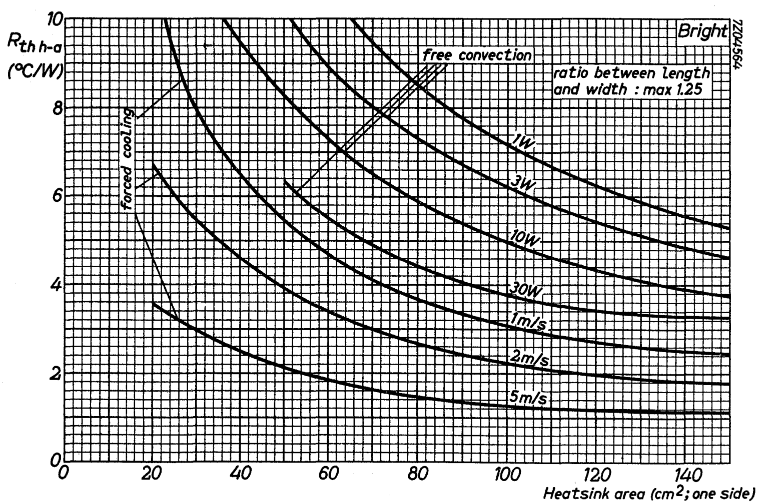

flat fins of blackened 3mm aluminium (vertical)
heatsink area (cm²; one side)
10 20 30 50 70 100 150 200 250 300
P_{tot}(W)
diode power scale for free convection
100 70 50 40 30 20 10 7 5 4 3 2 1
forced cooling
7Z04772
free conv.
1 m/s
2 m/s
3 m/s
4 m/s
5 m/s
$R_{th\,h-a}$ (°C/W)
20 10 5 3 2 1.5 1 0.9 0.8 0.7 0.6 0.5
diode series:
BYZ10
BYX13 BYY22
BYZ14
m/s
* = free convection
1
2
3
4
5
6

Thermal resistance of flat heatsinks of 2 mm copper or 3 mm aluminium.
The graphs are valid for the combination of device and heatsink.



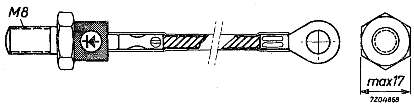


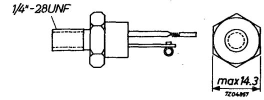


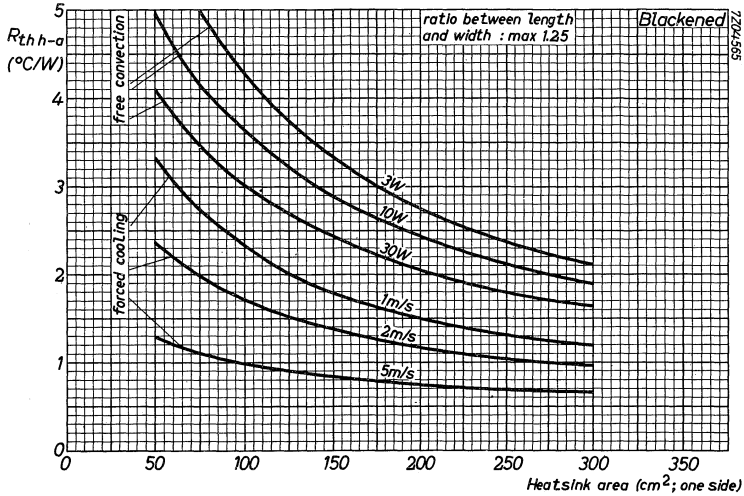


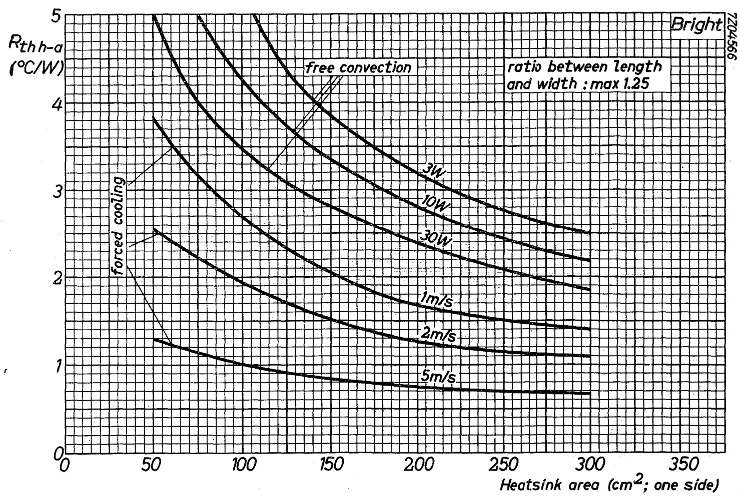
7Z3 0107

Thermal resistance of flat heatsinks of 2 mm copper or 3 mm aluminium.
The graphs are valid for the combination of device and heatsink.



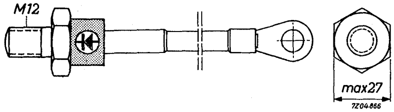


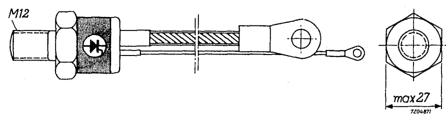


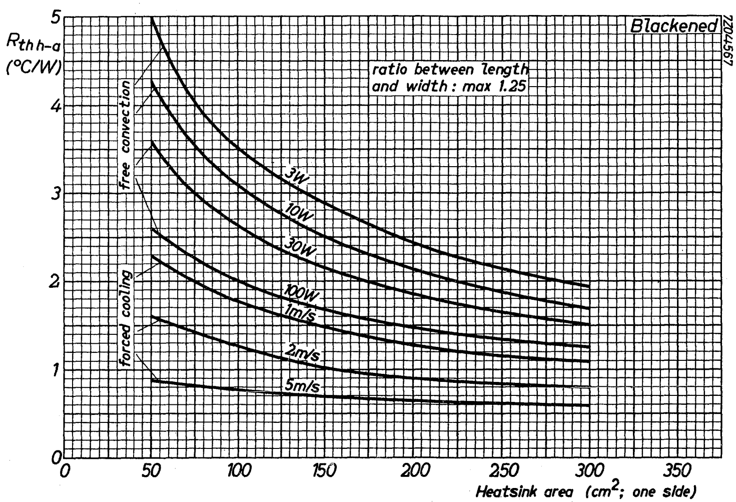


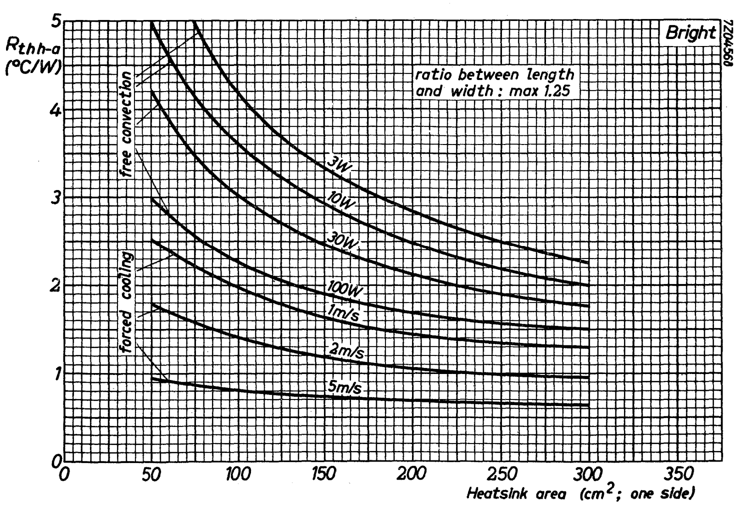
7Z3 0108

Thermal resistance of flat heatsinks of 2 mm copper or 3 mm aluminium.
The graphs are valid for the combination of device and heatsink.







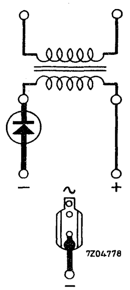
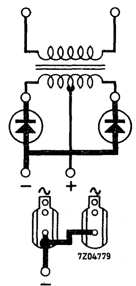
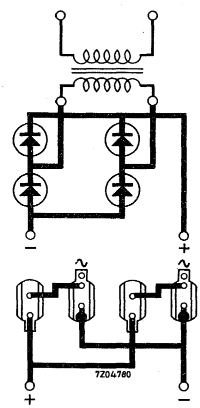
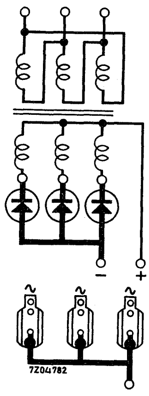


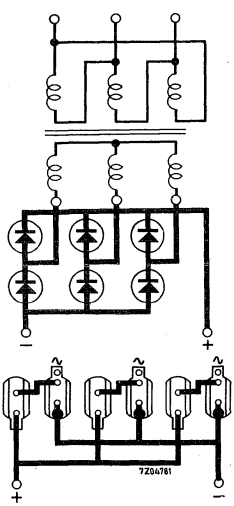
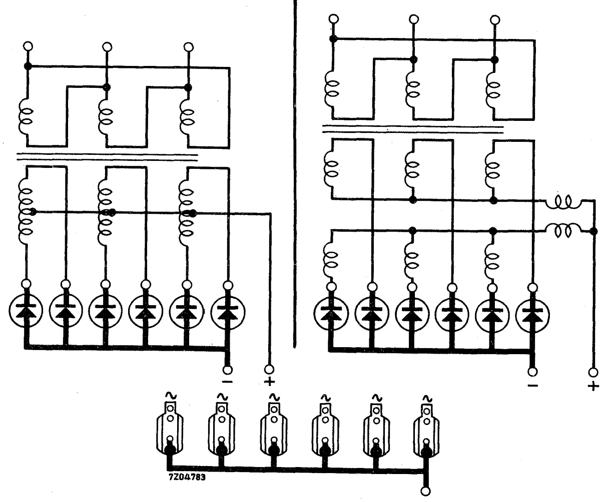
7Z3 0109

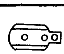
DIECAST HEATSINKS

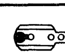
7Z3 0110

RECTIFIER CIRCUITS ON SINGLE HEATSINKS

Single phase half wave	Two phase half wave	Single phase full wave (Single phase bridge)	Three phase half wave (Three phase star)
			

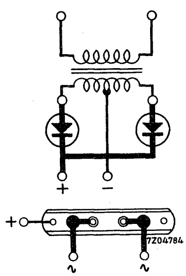
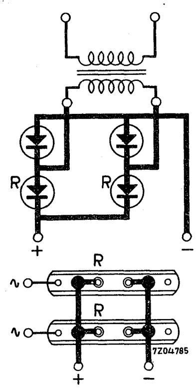
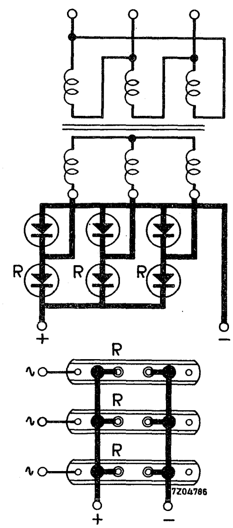
Three phase full wave (Three phase bridge)	Six phase half wave (Six phase star)	Three phase double Y with interphase transformer
		

Diecast heatsink without insulator 

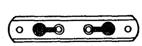
Diecast heatsink with insulator 

7Z3 0111

RECTIFIER CIRCUITS ON DOUBLE HEATSINKS

Two phase half wave	Single phase full wave (Single phase bridge)	Three phase full wave (Three phase bridge)
		

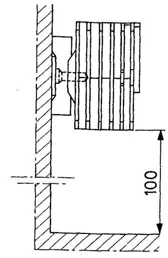
R = Reverse polarity diode

Diecast heatsink 56250 

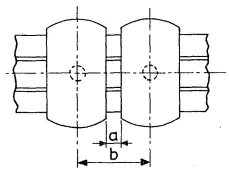
7Z3 0112

MOUNTING INSTRUCTION FOR DIECAST HEATSINKS

1. At free convection cooling or forced air flow <0.5 m/s the heatsinks should be mounted with the fins vertical and with a distance to the chassis bottom > 100 mm.

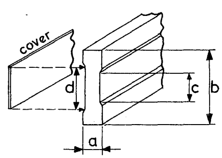


2. At forced air flow > 0.5 m/s the heatsinks may be mounted in any position.
3. Minimum distance between heatsinks in a row.



Heatsink	Distance (mm) a	b
56254/56/66/68	> 5.0	>25.0
56275/77	> 5.0	>40.0
56248/50/51/53	>10.0	>50.0
56258/69/71/72/74	>10.0	>50.0

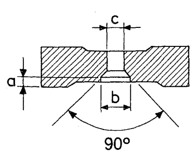
4. The rectifier devices should be fixed to their heatsinks with the torques specified in the relevant published data. Use a torque spanner.
5. For insulated mounting of heatsinks two sizes of mounting strips made of insulating material are available.



Strip	Dimensions (mm) a	b	c	d	Weight (g) (with cover)
56233	10.0	36	14.1	22	330
56234	13.5	50	20.1	28	615

Length 750 mm

6. Mounting holes to be made in the strips:



Heatsink	Strip	Dimensions in mm a	b	c
56254/56/66/68	56233	< 1.5	7.5	4.3
56251/53/58/69/71	56234	< 1.3	10.2	6.3
56272/74/75/77	56234	< 1.3	10.2	6.3
56248/50	56234	< 1.8	13.8	8.3

7Z3 0113

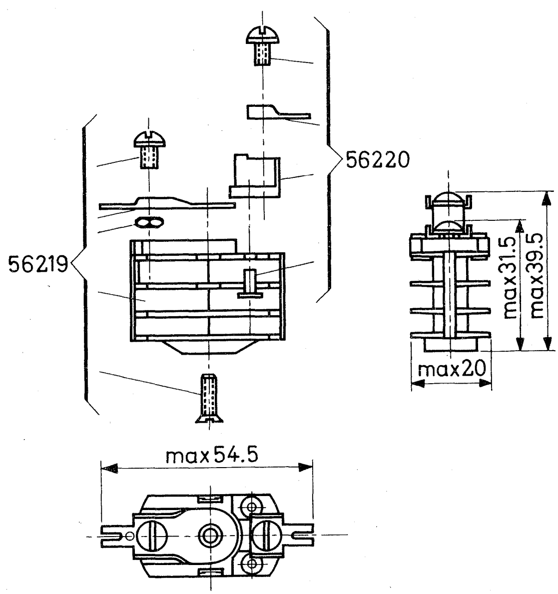
DIECAST HEATSINK

Diecast 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



Replaced by 56266, 56267 and 56268

7Z3 0502

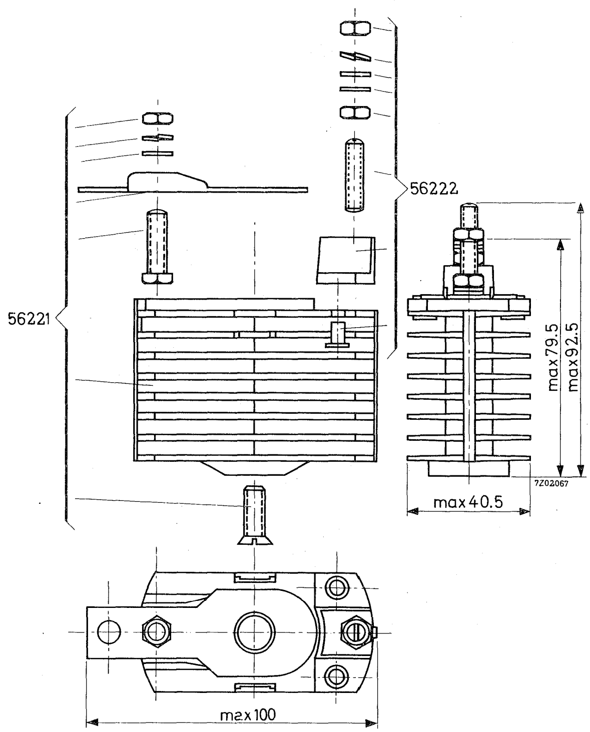
DIECAST HEATSINK

Diecast 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



Replaced by 56269, 56270 and 56271

7Z3 0503

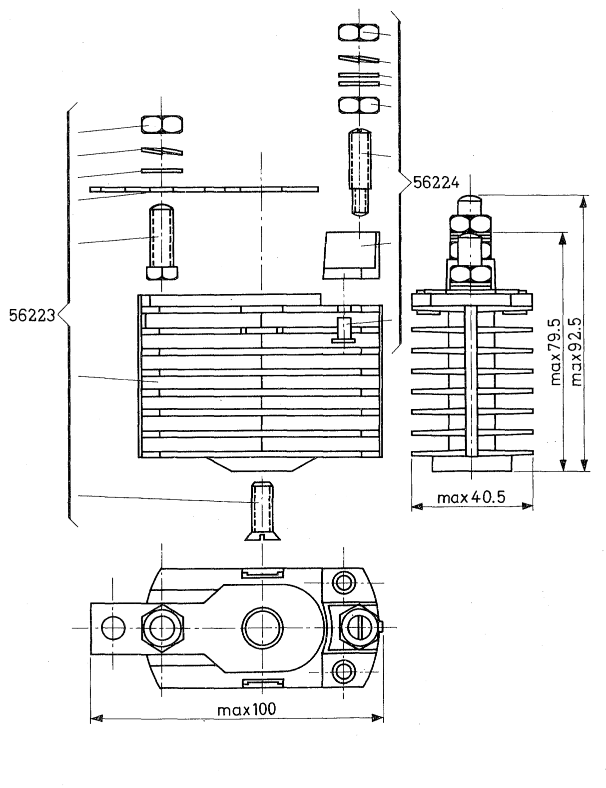
DIECAST HEATSINK

Diecast 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



Replaced by 56272, 56273 and 56274

7Z3 0504

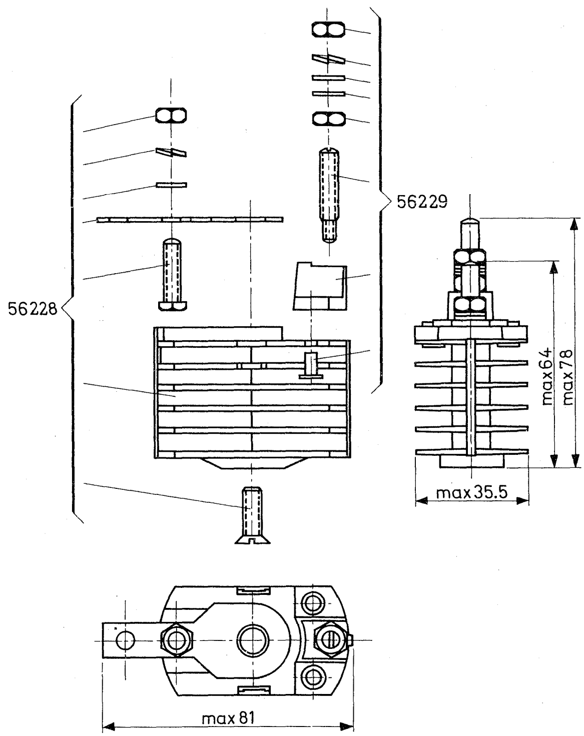
DIECAST HEATSINK

Diecast 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



Replaced by 56275, 56276 and 56277

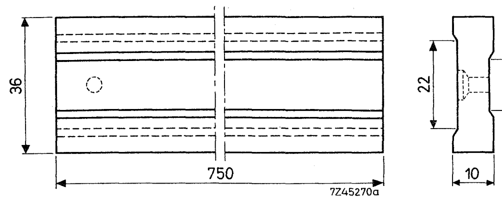
7Z3 0505

MOUNTING STRIPS

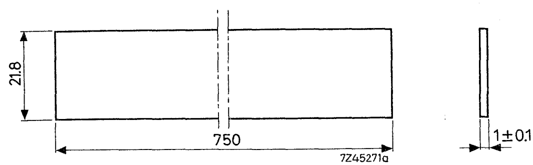
Type 56233 consists of the following components (1 to 2) Dimensions in mm

1.
1 mounting strip of insulating material

Weight with cover: 330 g



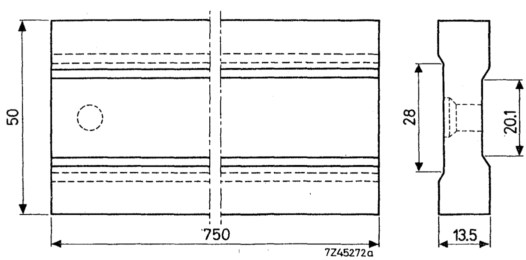
2.
1 insulating plate



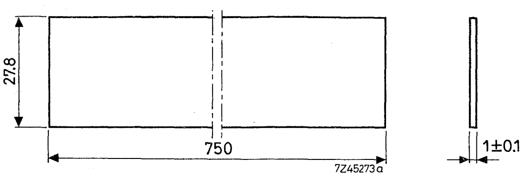
Type 56234 consists of the following components (1 to 2) Dimensions in mm

1.
1 mounting strip of insulating material

Weight with cover: 615 g



2.
1 insulating plate



7Z3 0114

DIECAST 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.

7Z3 0506

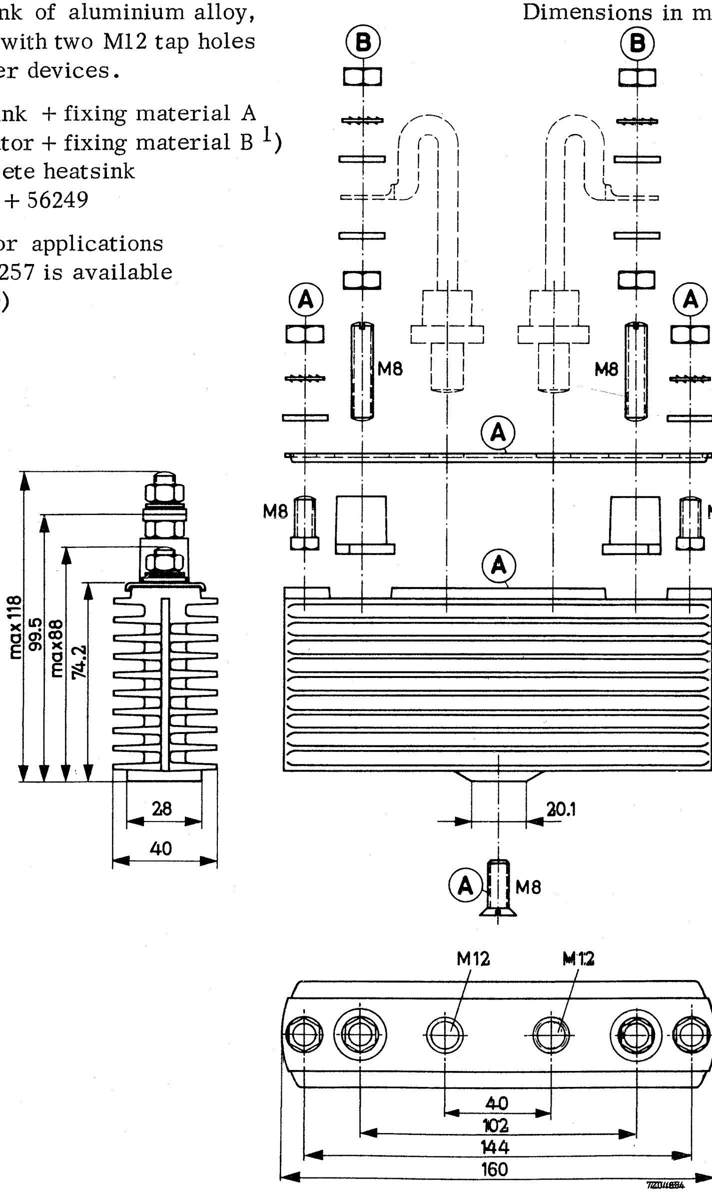
DIECAST HEATSINK FOR TWO DEVICES

Diecast heatsink of aluminium alloy, painted black, with two M12 tap holes for two rectifier devices.

56248 = heatsink + fixing material A
56249 = insulator + fixing material B [1])
56250 = complete heatsink
56248 + 56249

[1]) For thyristor applications insulator 56257 is available (see page 60)

Dimensions in mm

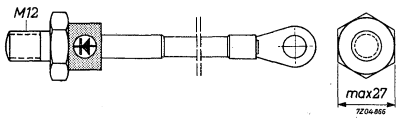


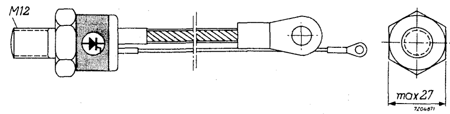
Weight

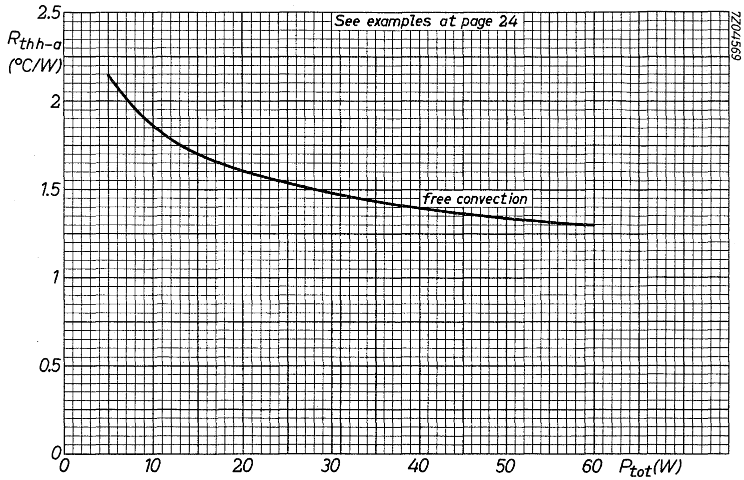
56248 : 640 g
56249 : 90 g
56250 : 730 g

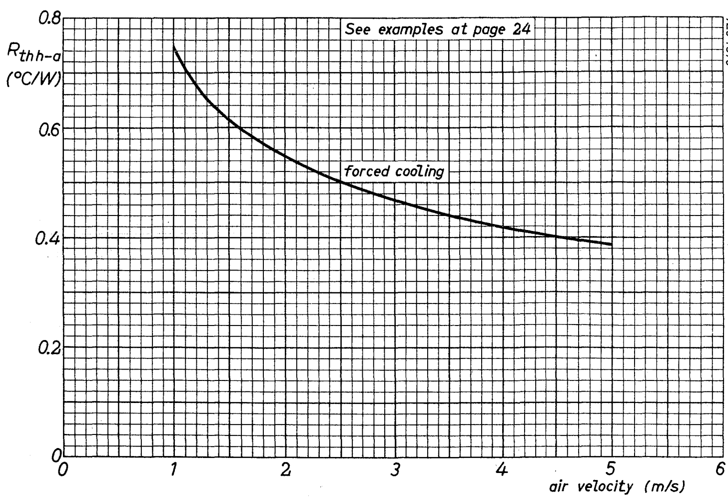
7Z3 0507

The graphs are valid for the combination of device and heatsink.









7Z3 0116

Calculations for the double heatsink 56248 or 56250

For equal devices at equal conditions the maximum allowable mounting base temperature shall be calculated. After subtraction of the temperature drop caused by the contact thermal resistance the required heatsink thermal resistance can be determined.

For two different devices (with different $T_{j\ max}$, power dissipation and contact thermal resistance) the lower of the two maximum allowable mounting base temperatures shall be taken, after which the same procedure is followed.

Examples

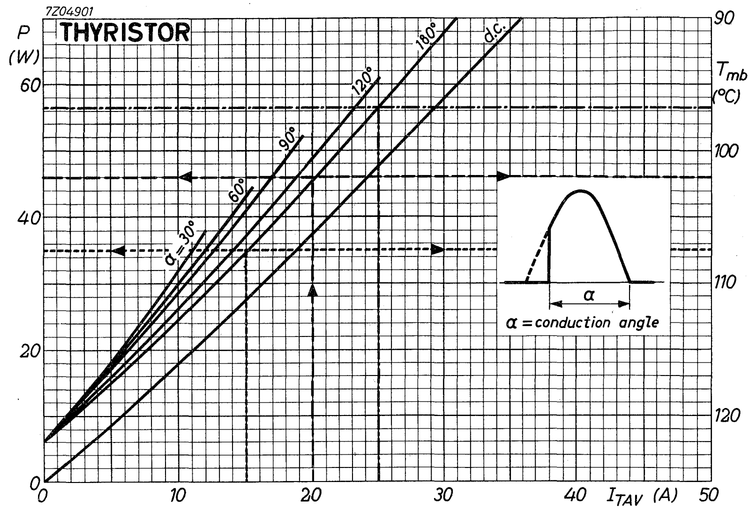
Consider a thyristor T and a diode D, used in single phase application ($\alpha = 180^{o}$), of which the curves to be used are shown on the next page. For all examples the contact thermal resistance $R_{th\ mb\text{-}h} = 0.1\ ^{o}C/W$.
In the table below, three different examples have been worked out.

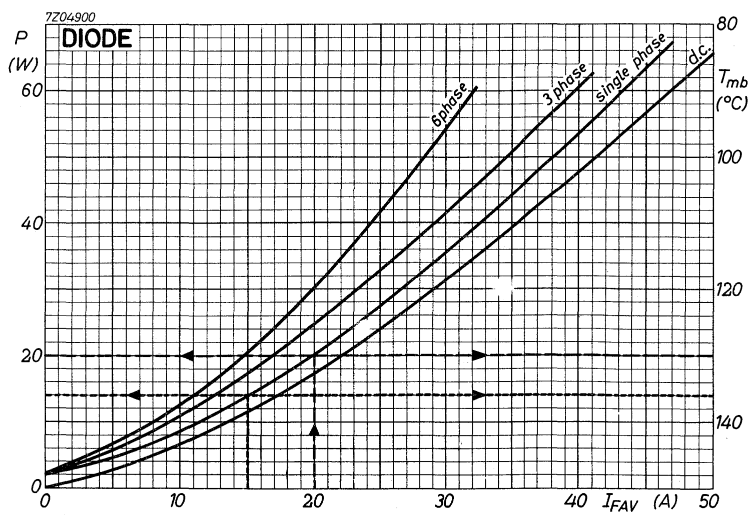
	$T_1 + D_2$	$T_1 + D_2$	$T_1 + T_2$
Given: T_{amb}	30 °C	50 °C	45 °C
I_{AV}	15 A	20 A	25 A
From page 25			
P_1	35 W	46 W	56.5 W
P_2	14 W	20 W	56.5 W
$P_{tot} = P_1 + P_2$	49 W	66 W	113 W
$T_{mb\ 1}$ max.	107.5 °C	102 °C	96.5 °C
$T_{mb\ 2}$ max.	136 °C	130 °C	96.5 °C
$P_1 \times R_{th\ mb\text{-}h} = \Delta T_{mb\text{-}h}$	3.5 °C	4.6 °C	5.7 °C
Maximum T_h	104 °C	97.4 °C	90.8 °C
T_{amb}	30 °C	50 °C	45 °C
Max. $\Delta T_{h\text{-}a}$	74 °C	47.4 °C	45.8 °C
$\frac{\text{Max. } \Delta T_{h\text{-}a}}{P_{tot}} =$	$\frac{74}{49} =$	$\frac{47.4}{66} =$	$\frac{45.8}{113} =$
Max. $R_{th\ h\text{-}a}$	1.5 °C/W	0.72 °C/W	0.4 °C/W
From graphs on page 23 it follows:	Possible with free convection. 50 W: 1.35 °C/W	Only with forced cooling. At least 1.1 m/s	Only with forced cooling. At least 4.5 m/s

7Z3 0508

Calculations for the double heatsink 56248 or 56250 (continued)

The two graphs below give the power dissipation and the maximum allowable mounting base temperature versus the average forward current, for the thyristor T and the diode D, respectively.





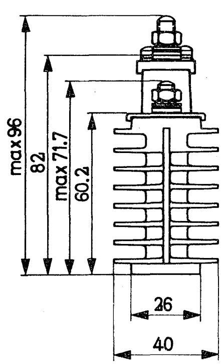
7Z3 0118

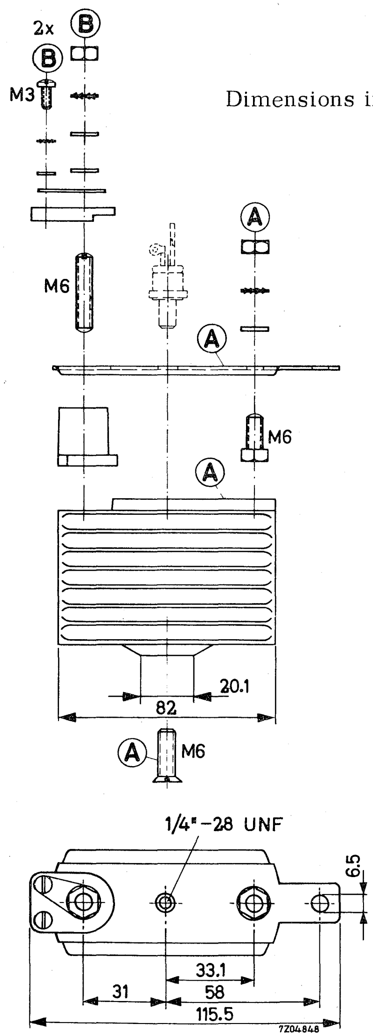
DIECAST HEATSINK

Diecast heatsink of aluminium alloy, painted black, with 1/4"-28 UNF tap hole for rectifier device.

56251 = heatsink + fixing material A
56252 = insulator + fixing material B
56253 = complete heatsink
56251 + 56252

Dimensions in mm



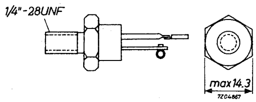


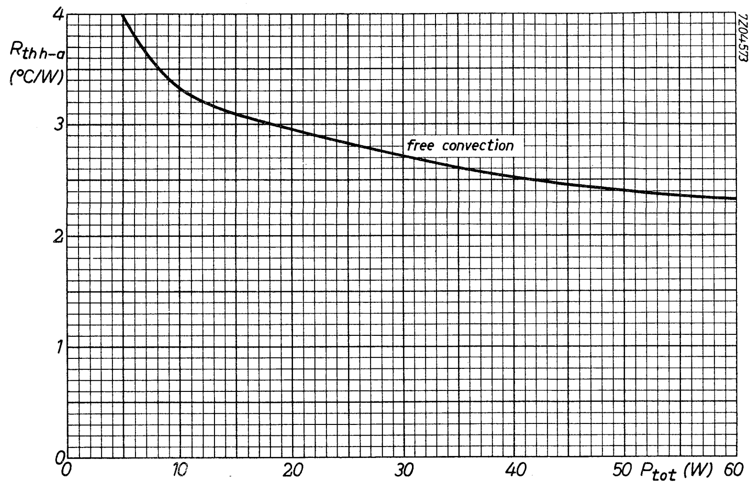
Weight

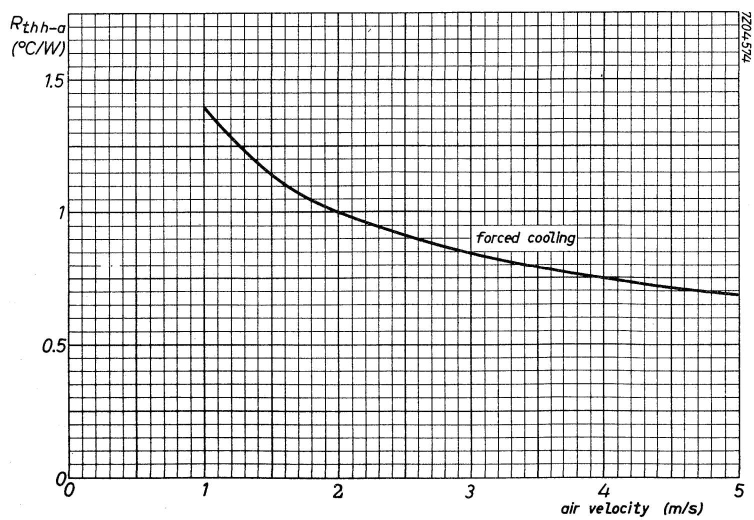
56251: 265 g
56252: 40 g
56253: 305 g

7Z3 0119

The graphs are valid for the combination of thyristor and heatsink.







7Z3 0120

DIECAST HEATSINK

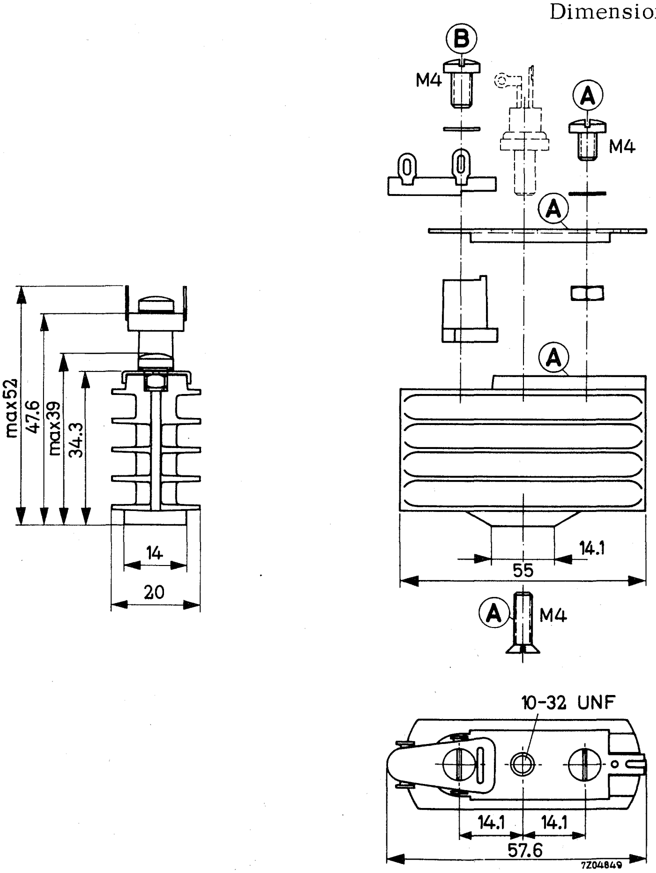
Diecast heatsink of aluminium alloy, painted black, with 10-32 UNF tap hole for rectifier device.

56254 = heatsink + fixing material A
56255 = insulator + fixing material B
56256 = complete heatsink 56254 + 56255

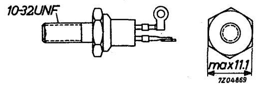
Dimensions in mm

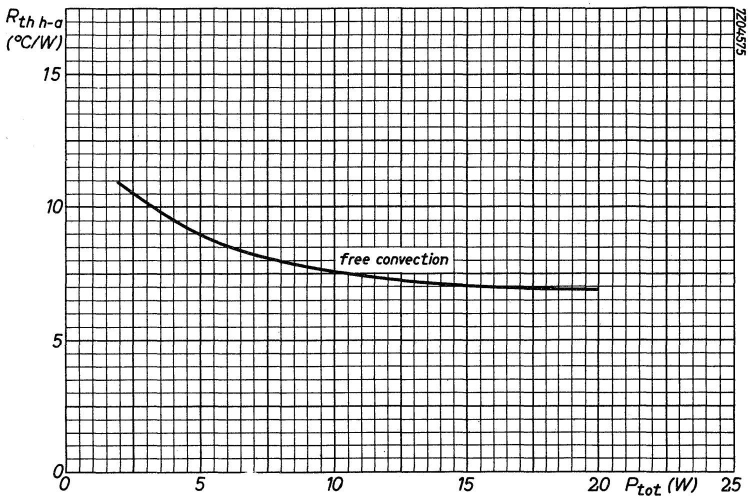
Weight:

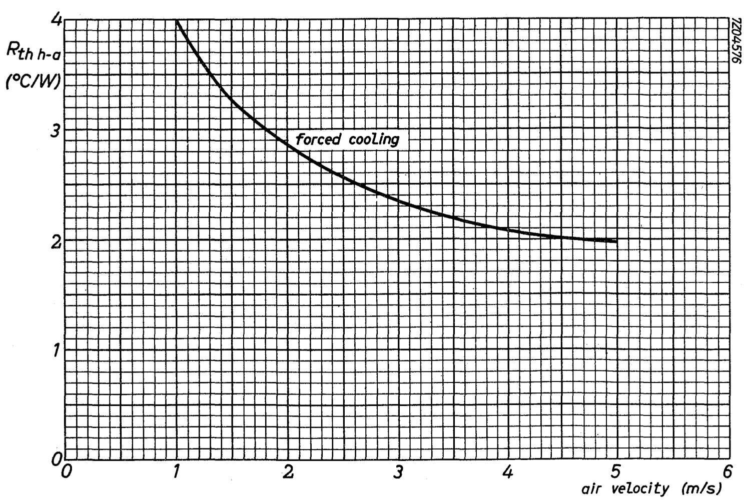
56254: 50 g
56255: 5 g
56256: 55 g



The graphs are valid for the combination of thyristor and heatsink.







7Z3 0122

DIECAST HEATSINK

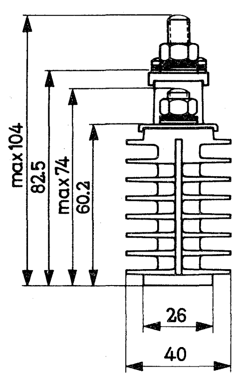
Diecast heatsink of aluminium alloy, painted black, with M12 tap hole for rectifier device.

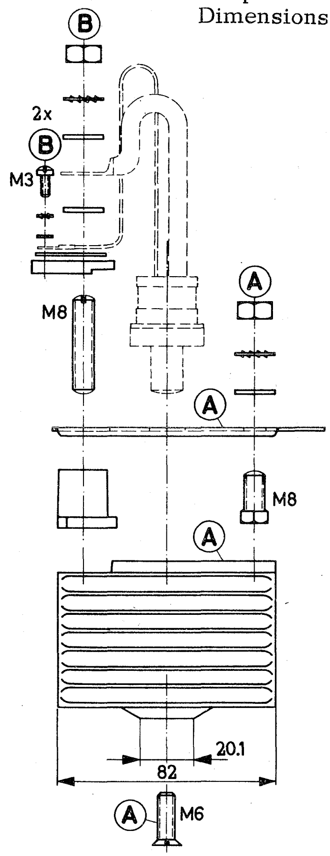
Dimensions in mm

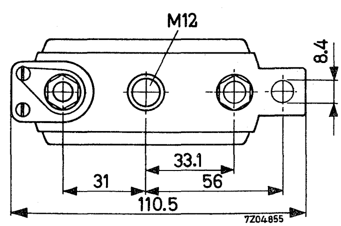
56272 = heatsink + fixing material A
56257 = insulator + fixing material B
56258 = complete heatsink 56272 + 56257

<u>Weight</u>

56272: 250 g
56257: 40 g
56258: 290 g

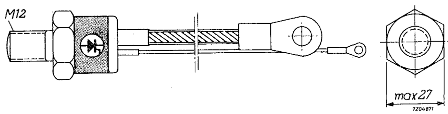


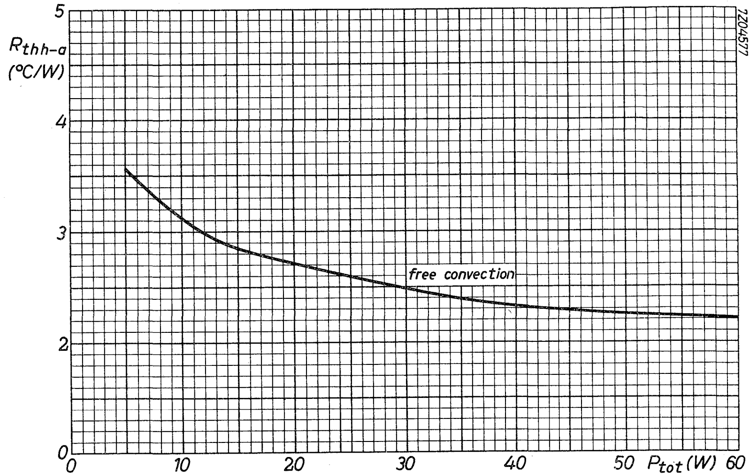


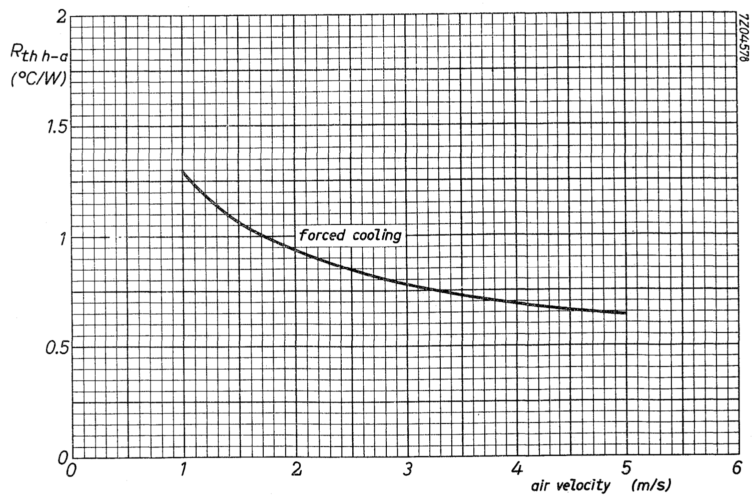


7Z3 0123

The graphs are valid for the combination of thyristor and heatsink.







7Z3 0124

DIECAST HEATSINK

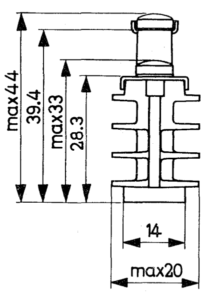
Diecast heatsink of aluminium alloy, painted black, with 10-32 UNF tap hole for rectifier device.

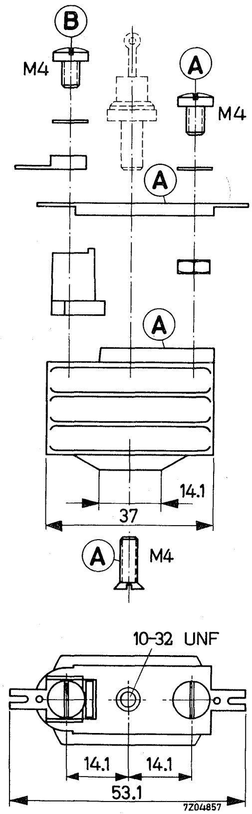
56266 = heatsink + fixing material A
56267 = insulator + fixing material B
56268 = complete heatsink 56266 + 56267

Dimensions in mm

Weight

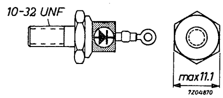
56266 : 28 g
56267 : 5 g
56268 : 33 g

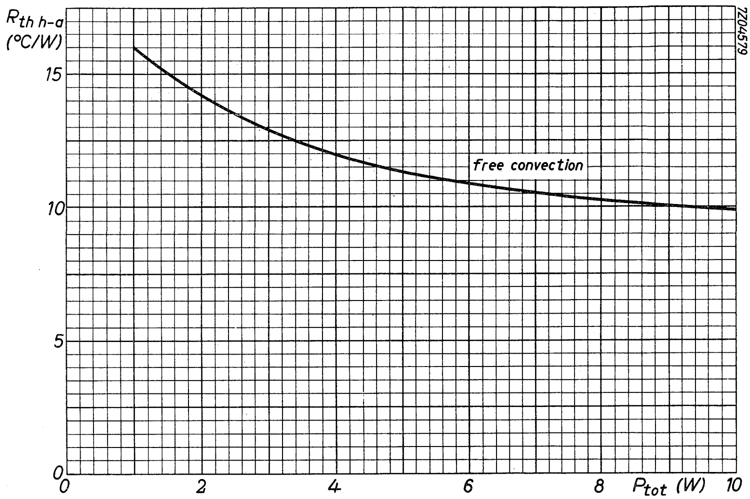


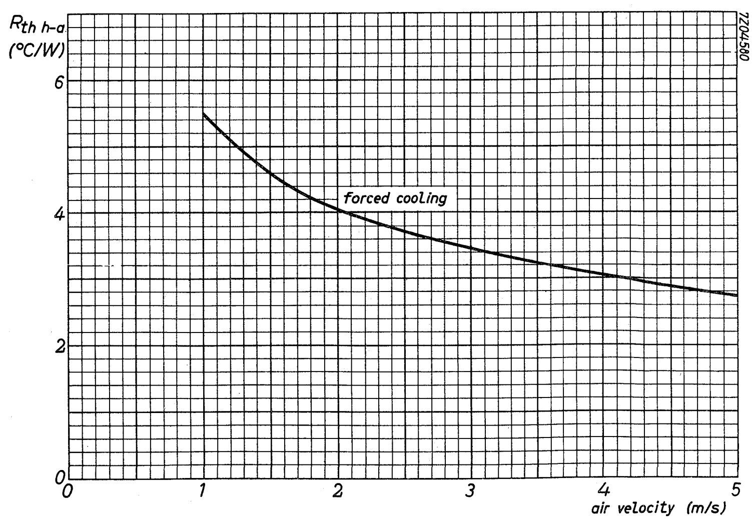


7Z3 0125

The graphs are valid for the combination of diode and heatsink.







7Z3 0126

DIECAST HEATSINK

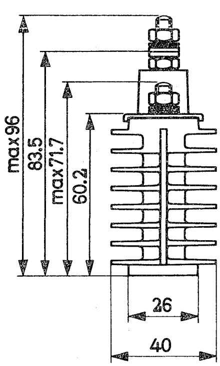
Diecast heatsink of aluminium alloy, painted black, with M8 tap hole for rectifier device.

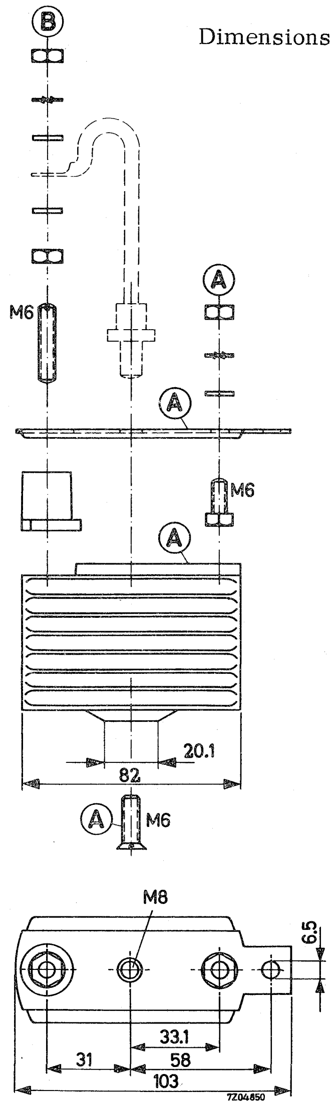
56269 = heatsink + fixing material (A)
56270 = insulator + fixing material (B)
56271 = complete heatsink 56269 + 56270

Weight

56269 : 245 g
56270 : 25 g
56271 : 270 g

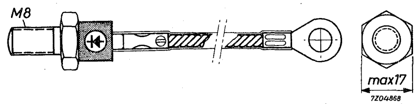
Dimensions in mm

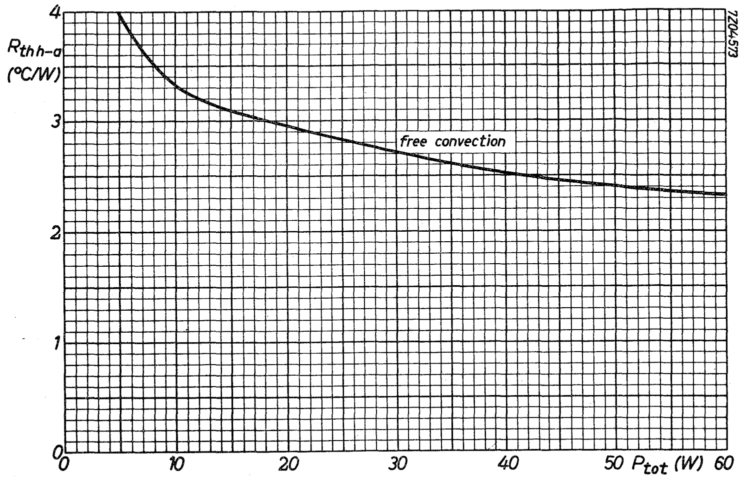


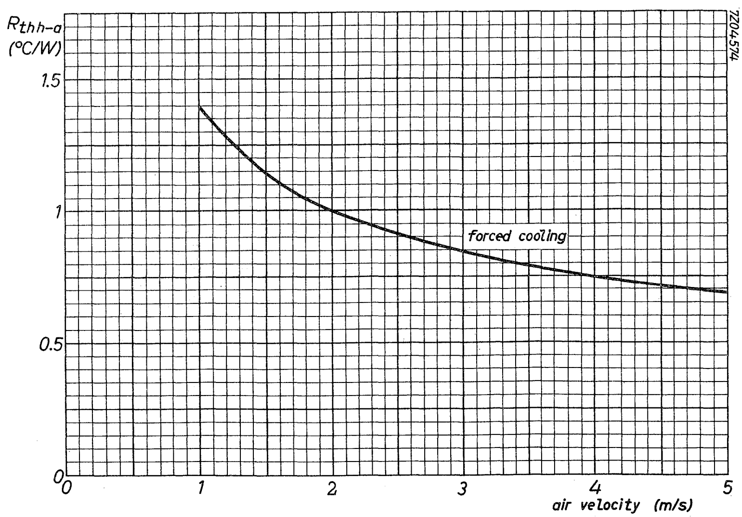


7Z3 0127

The graphs are valid for the combination of diode and heatsink.







7Z3 0128

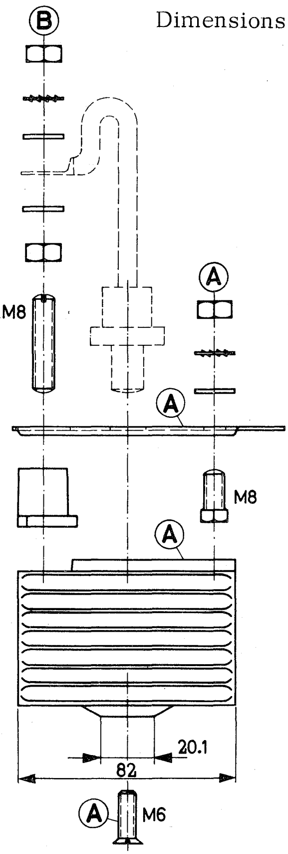
DIECAST HEATSINK

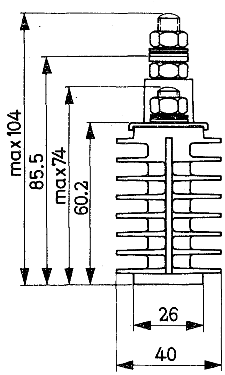
Diecast heatsink of aluminium alloy, painted black, with M12 tap hole for rectifier device.

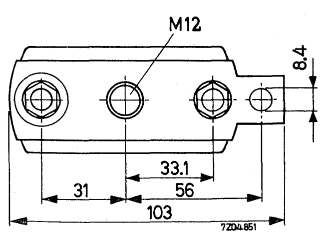
56272 = heatsink + fixing material (A)
56273 = insulator + fixing material (B)
56274 = complete heatsink 56272 + 56273

Weight
56272 : 250 g
56273 : 45 g
56274 : 295 g

Dimensions in mm

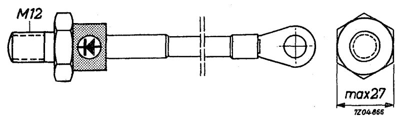


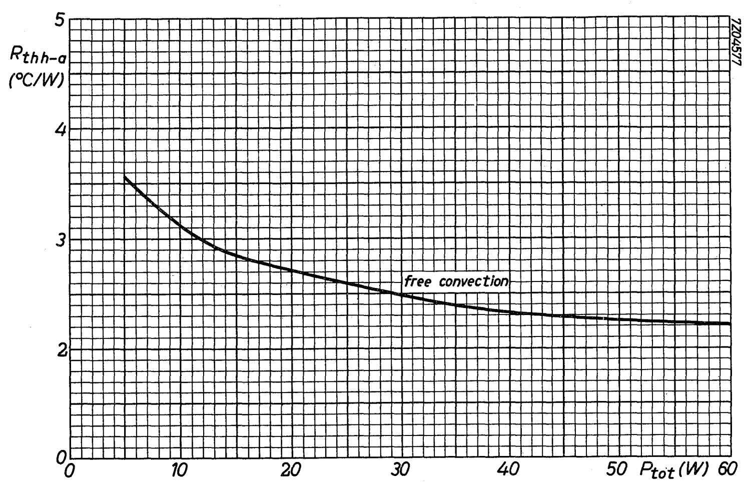


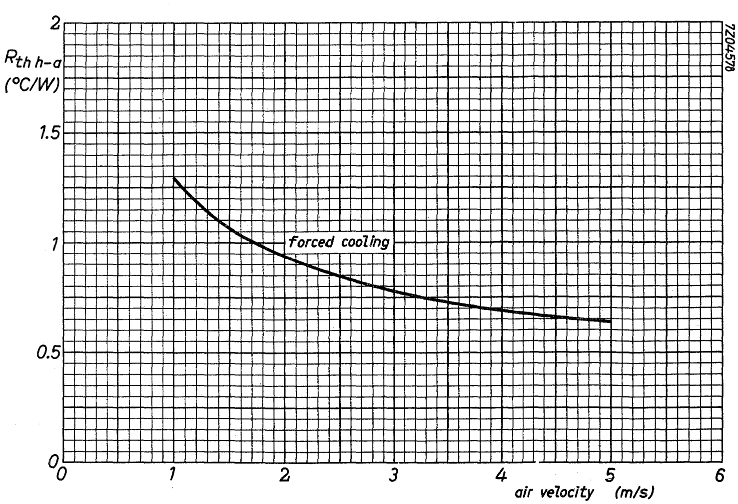


7Z3 0129

The graphs are valid for the combination of diode and heatsink.







7Z3 0130

DIECAST HEATSINK

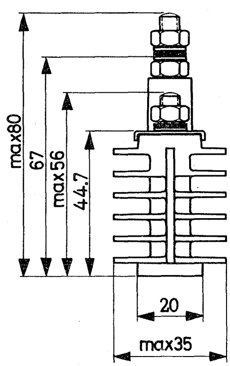
Diecast heatsink of aluminium alloy, painted black, with M8 tap hole for rectifier device.

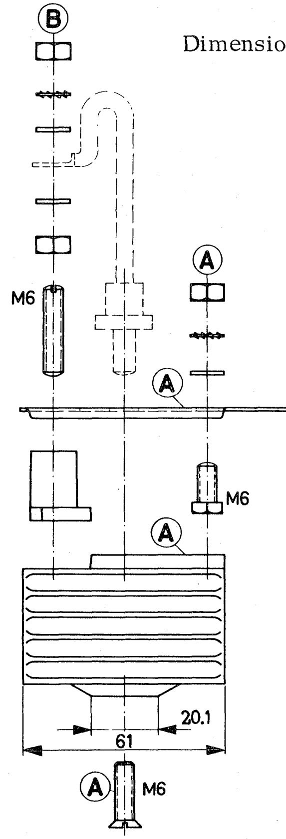
Dimensions in mm

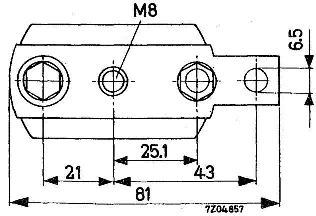
56275 = heatsink + fixing material A
56276 = insulator + fixing material B
56277 = complete heatsink 56275 + 56276

Weight

56275 : 115 g
56276 : 20 g
56277 : 135 g

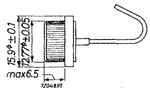




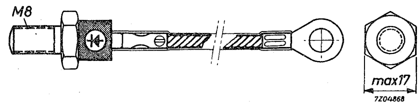


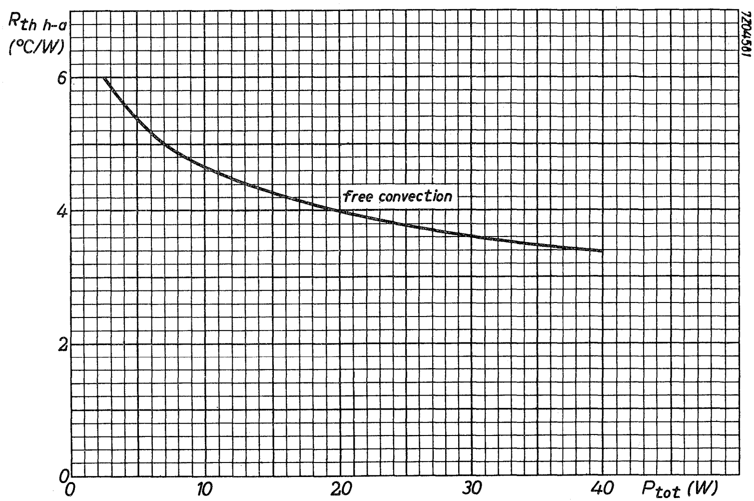
7Z3 0131

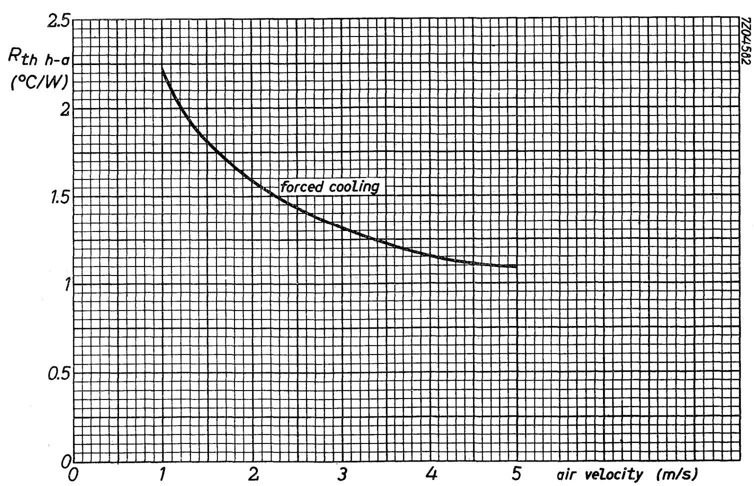
The graphs are valid for the combination of diode and heatsink.



With mounting adaptor 56232







7Z3 0132

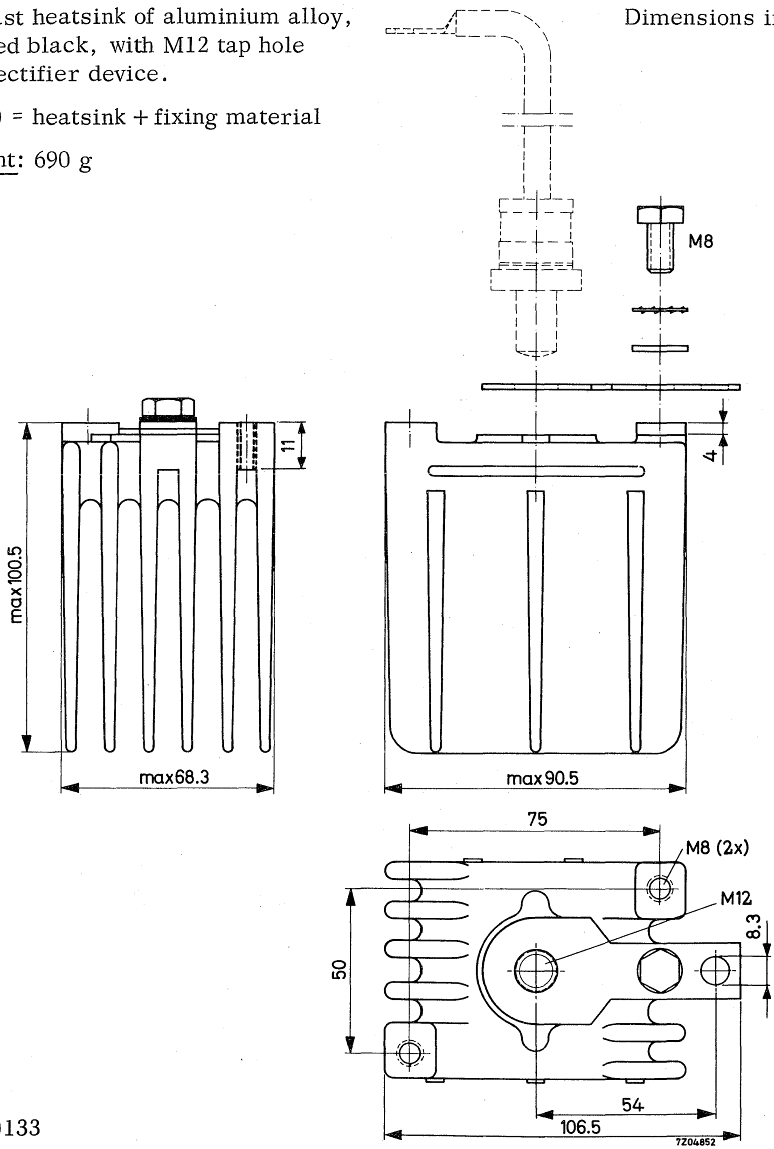
DIECAST HEATSINK

Diecast heatsink of aluminium alloy, painted black, with M12 tap hole for rectifier device.

56280 = heatsink + fixing material

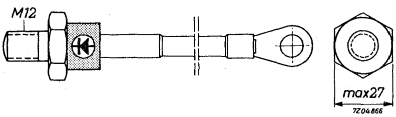
Weight: 690 g

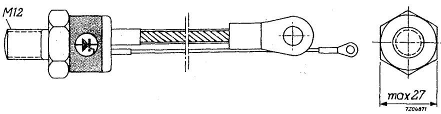
Dimensions in mm

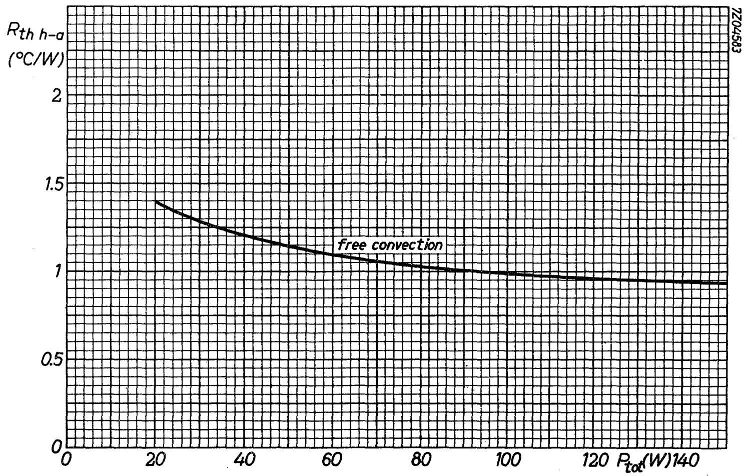


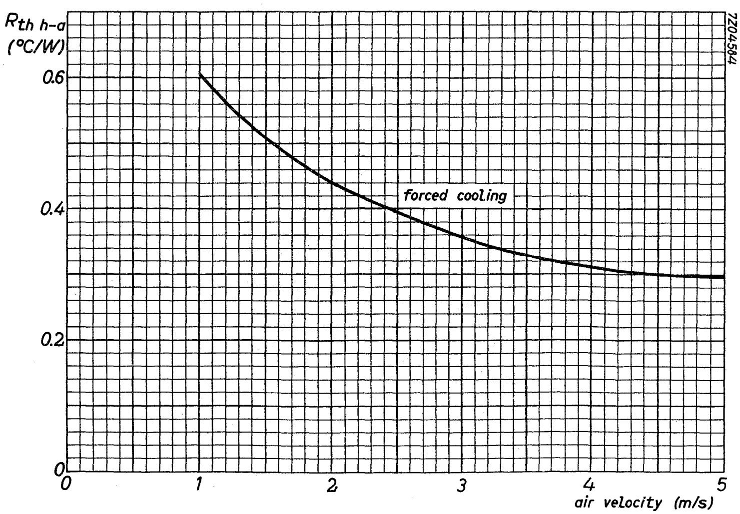
7Z3 0133

The graphs are valid for the combination of device and heatsink.









7Z3 0134

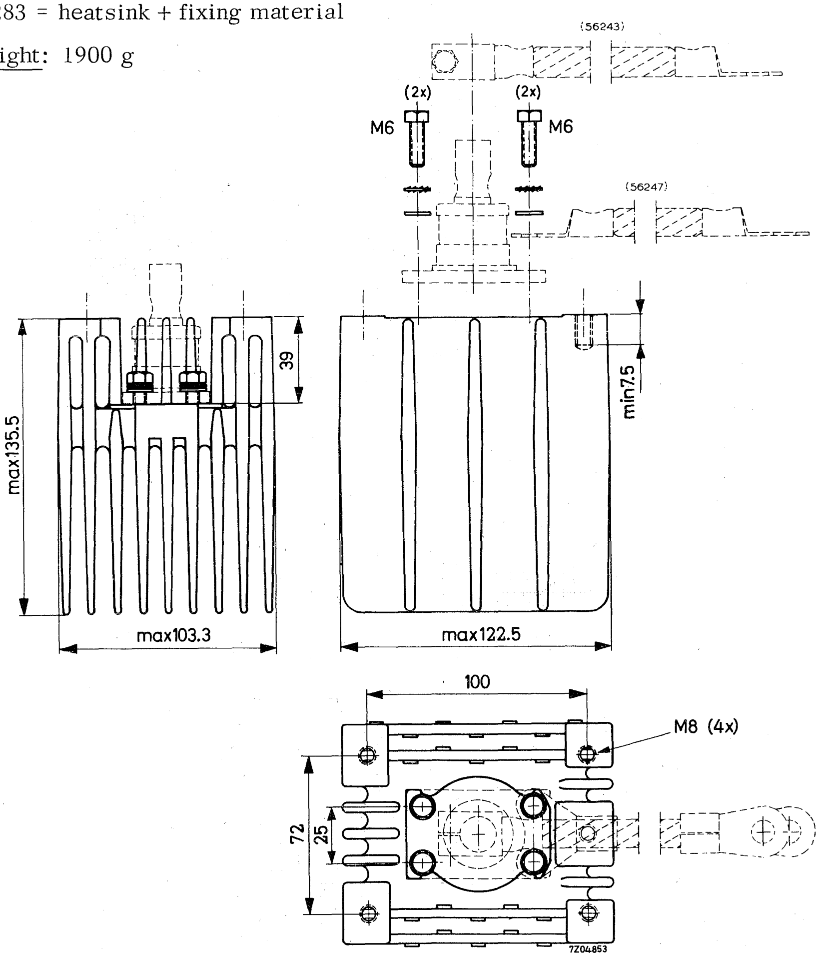
DIECAST HEATSINK

Diecast heatsink of aluminium alloy, painted black, intended for devices with flat mounting base.

56283 = heatsink + fixing material

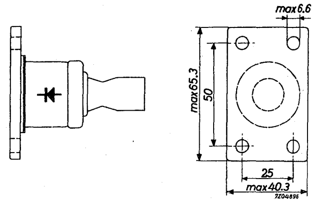
Weight: 1900 g

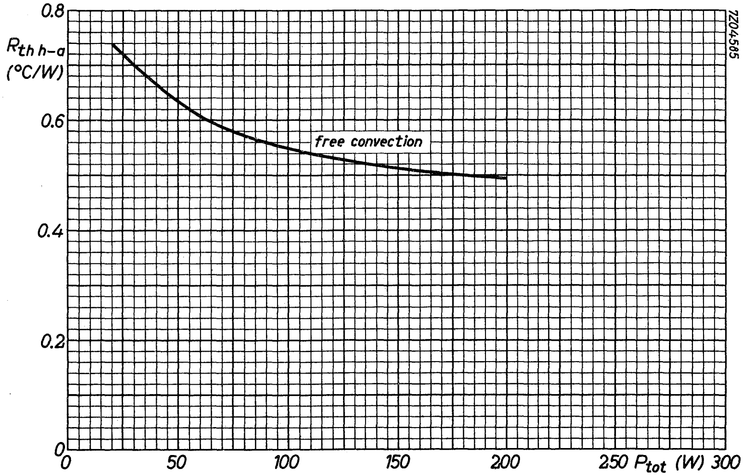
Dimensions in mm

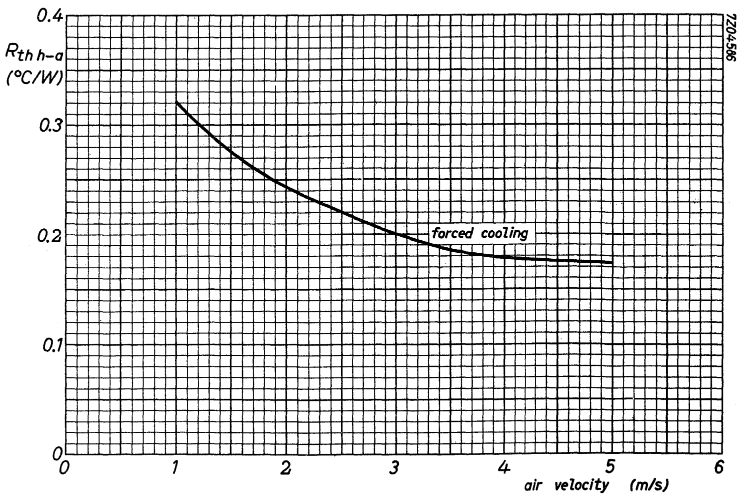


7Z3 0135

The graphs are valid for the combination of diode and heatsink.







7Z3 0136

HEATSINK EXTRUSIONS

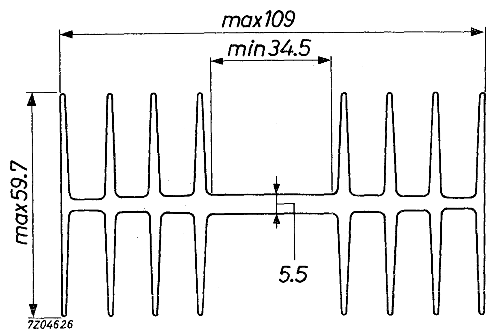
7Z3 0137

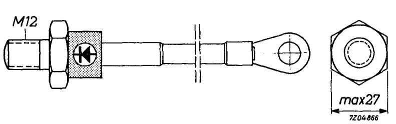
EXTRUDED ALUMINIUM HEATSINK

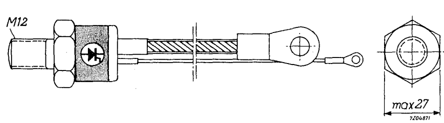
Extruded heatsink of aluminium alloy.
The extrusion is supplied unpainted, in lengths of 1.5 m.

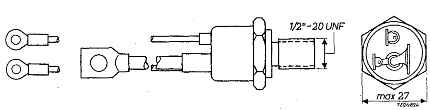
Weight: 4 kg per 1.5 m.

Dimensions in mm



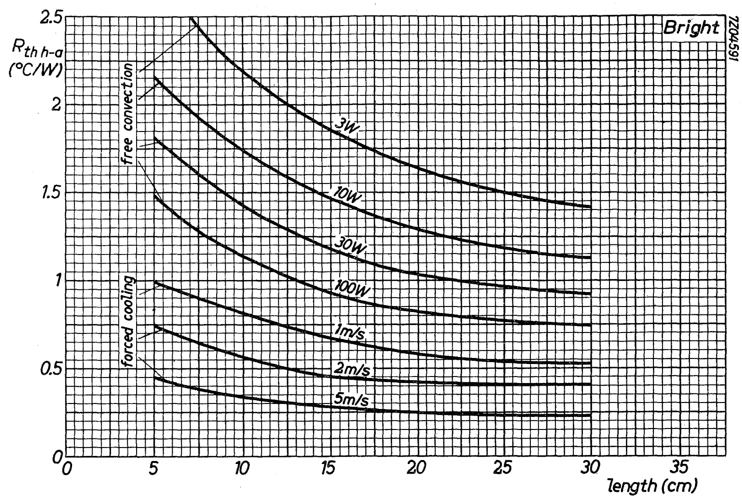


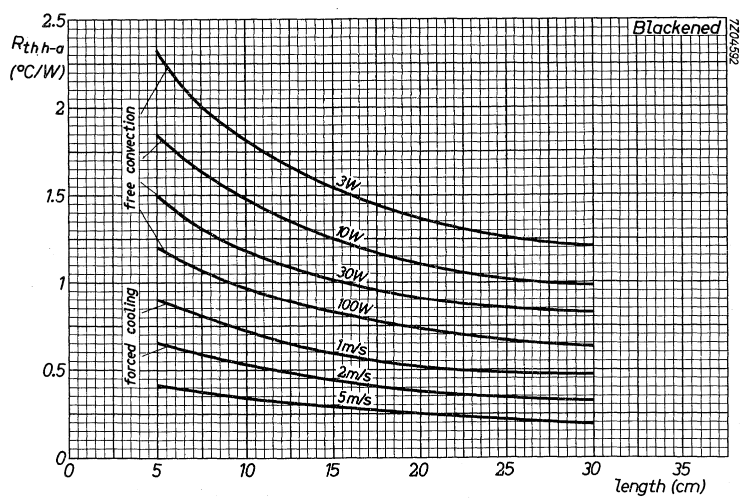




7Z3 0138

The graphs are valid for the combination of rectifier device and heatsink.





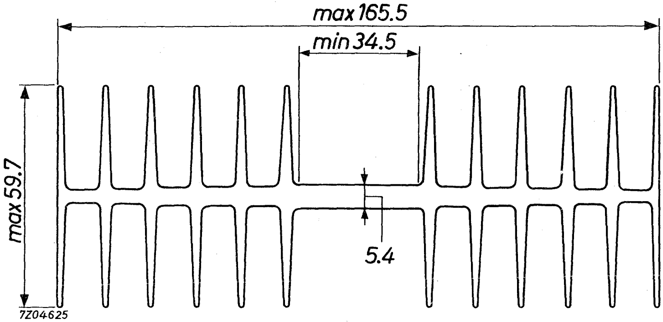
7Z3 0139

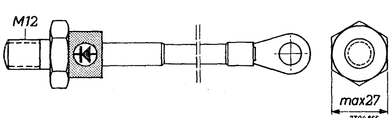
EXTRUDED ALUMINIUM HEATSINK

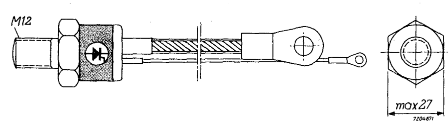
Extruded heatsink of aluminium alloy.
The extrusion is supplied unpainted, in lengths of 1.5 m.

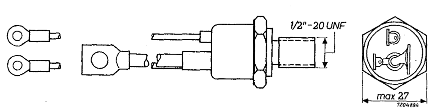
Weight: 6 kg per 1.5 m.

Dimensions in mm



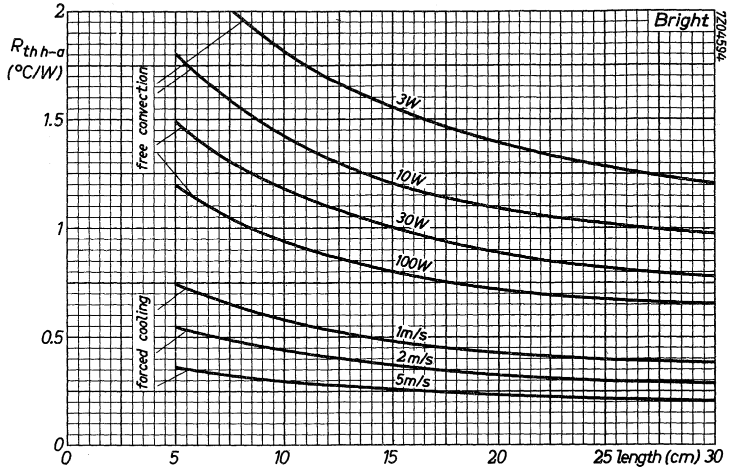


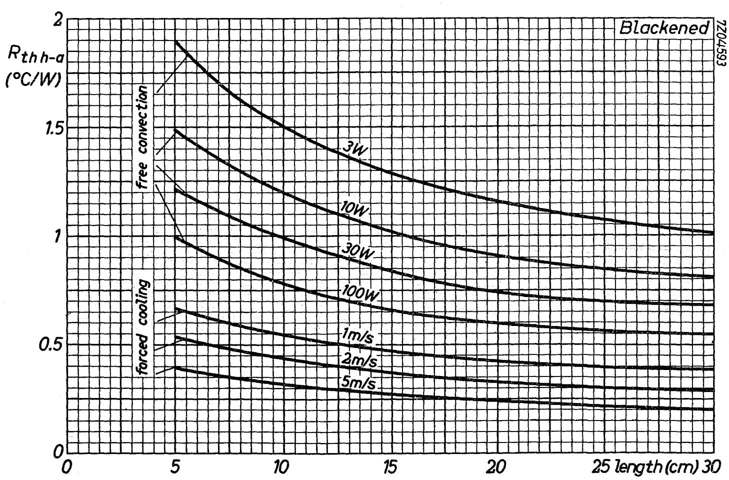




7Z3 0140

The graphs are valid for the combination of rectifier device and heatsink.



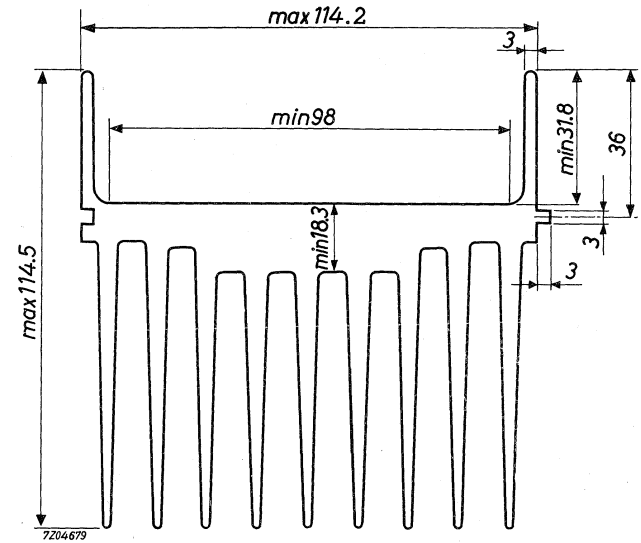


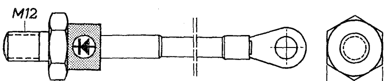
7Z3 0141

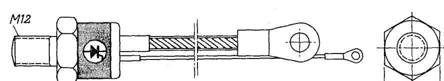
EXTRUDED ALUMINIUM HEATSINK

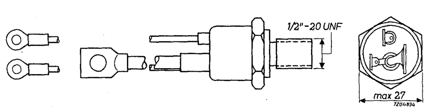
Extruded heatsink of aluminium alloy.
The extrusion is supplied unpainted, in lengths of 1.0 m.

Weight: 10.8 kg per 1.0 m. Dimensions in mm



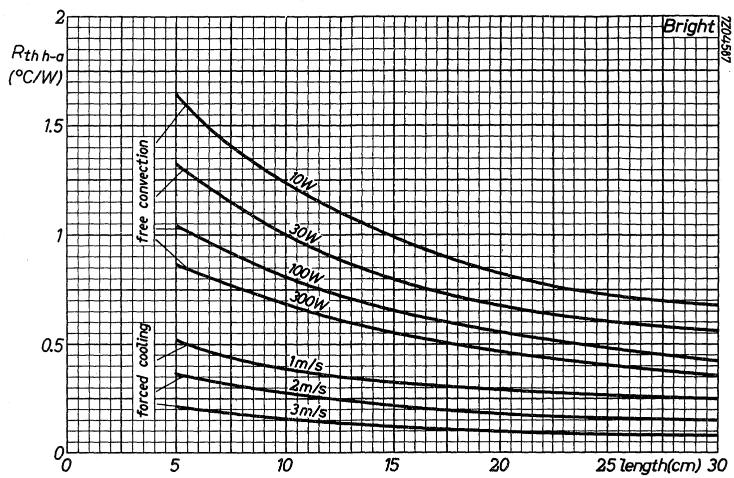


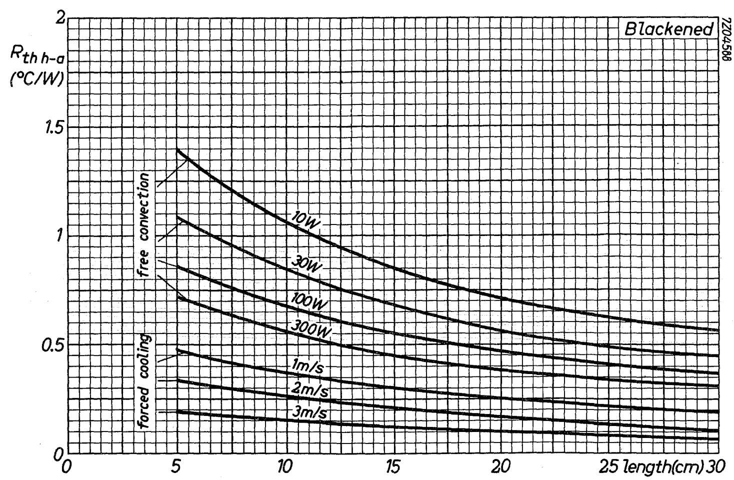




7Z3 0142

The graphs are valid for the combination of rectifier device and heatsink.
For devices with a flat base see page 83.





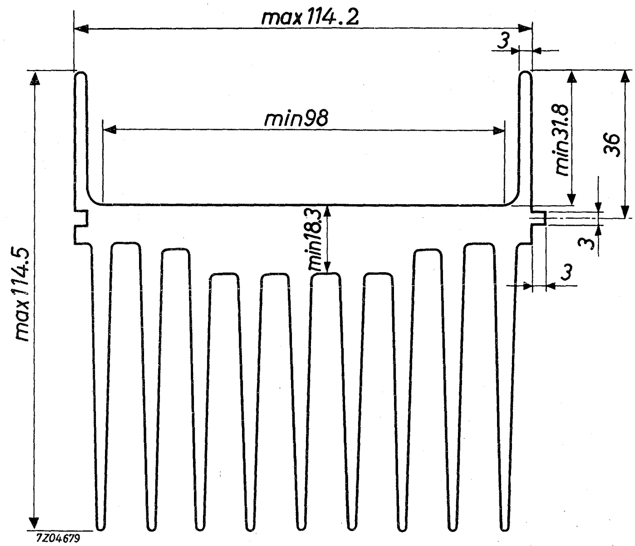
7Z3 0509

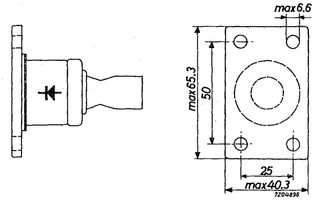
EXTRUDED ALUMINIUM HEATSINK

Extruded heatsink of aluminium alloy.
The extrusion is supplied unpainted, in lengths of 1.0 m.

Weight: 10.8 kg per 1.0 m.

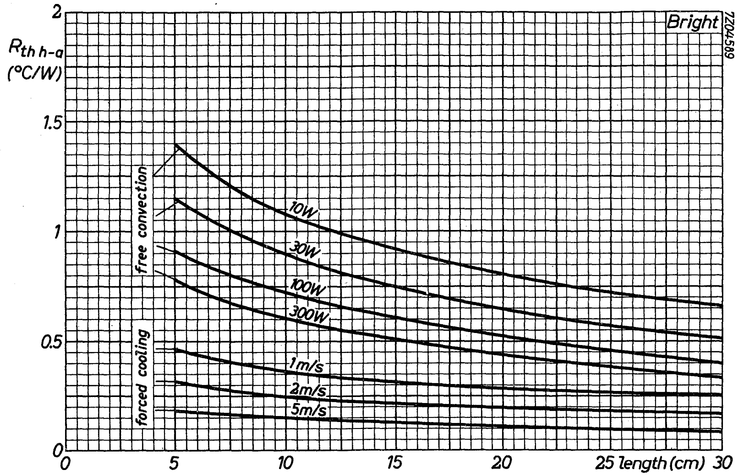
Dimensions in mm

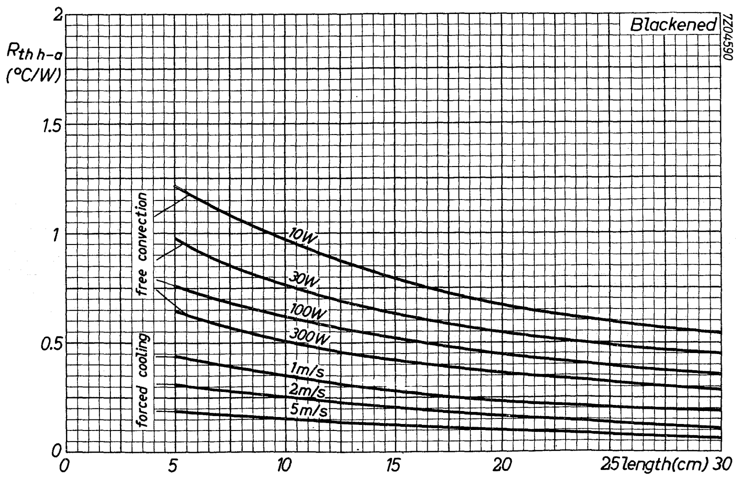




7Z3 0144

The graphs are valid for the combination of rectifier device and heatsink.
For devices with threaded studs see page 81.





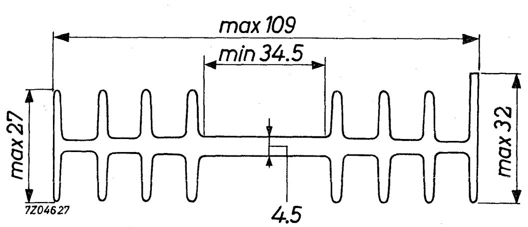
7Z3 0510

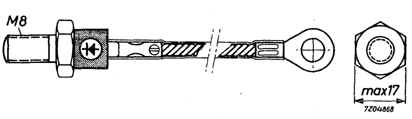
EXTRUDED ALUMINIUM HEATSINK

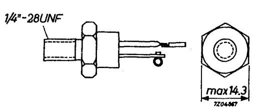
Extruded heatsink of aluminium alloy.
The extrusion is supplied unpainted, in lengths of 1.5 m.

Weight: 2.4 kg per 1.5 m.

Dimensions in mm

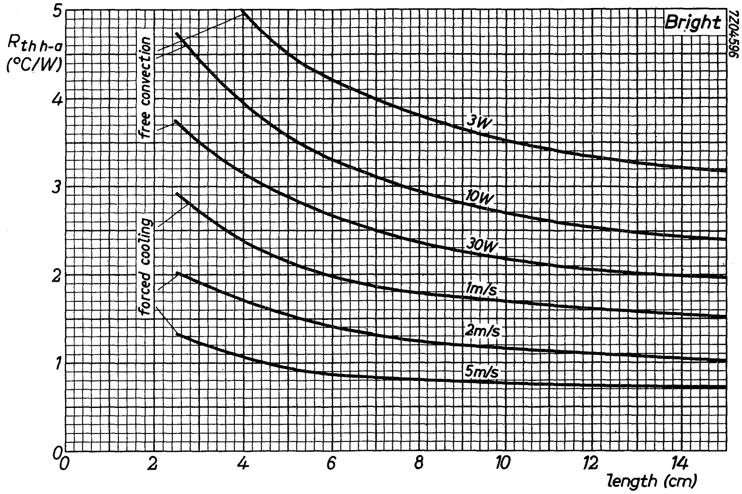


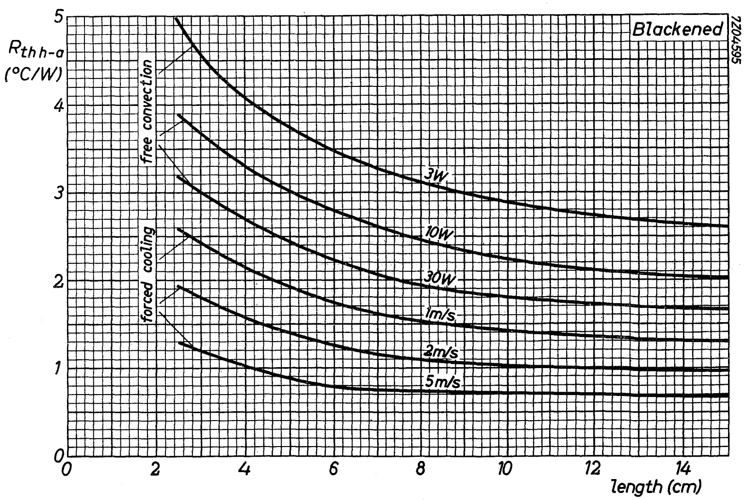




7Z3 0146

The graphs valid for the combination of rectifier device and heatsinks.



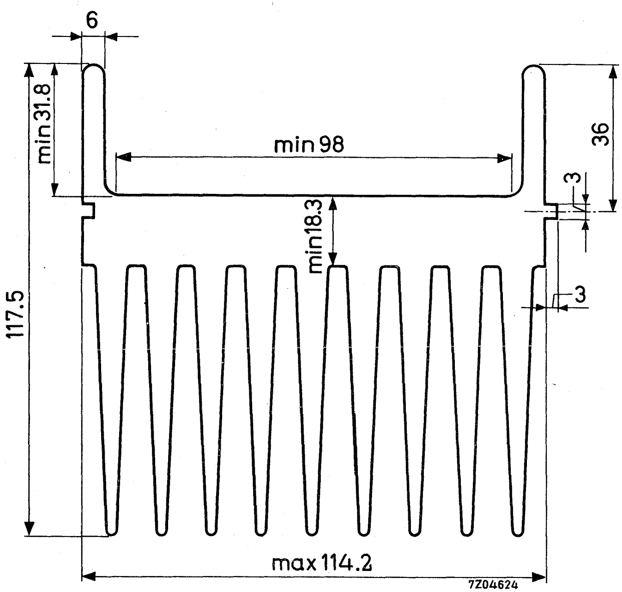


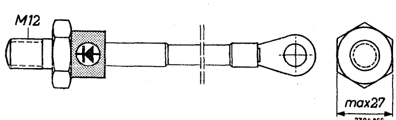
7Z3 0147

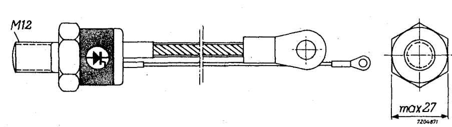
EXTRUDED ALUMINIUM HEATSINK

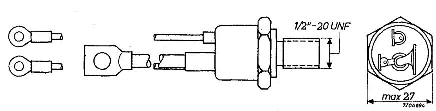
Extruded heatsink of aluminium alloy.
The extrusion is supplied unpainted, in lengths of 1.5 m.

Weight: 16.2 kg per 1.5 m. Dimensions in mm



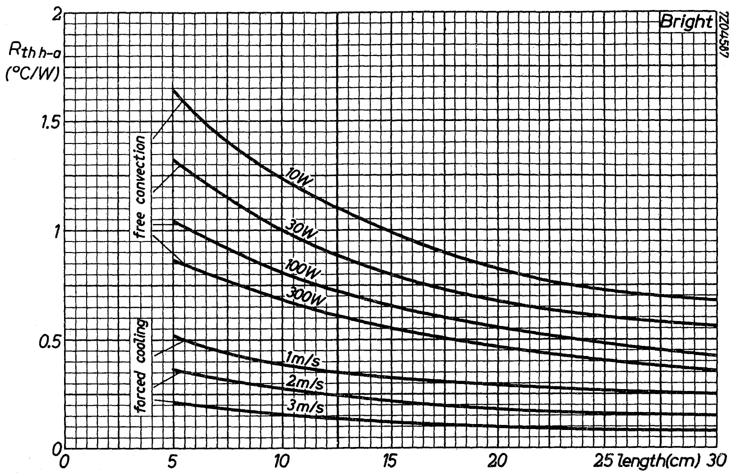


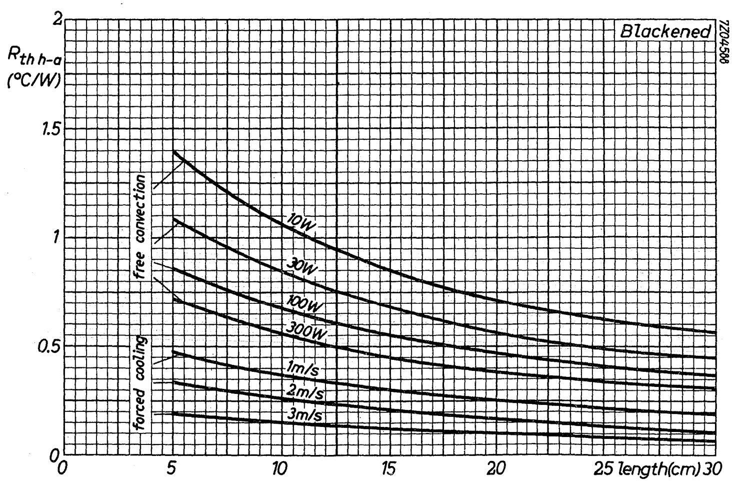




7Z3 0148

The graphs are valid for the combination of rectifier device and heatsink.
For devices with a flat base see page 89.





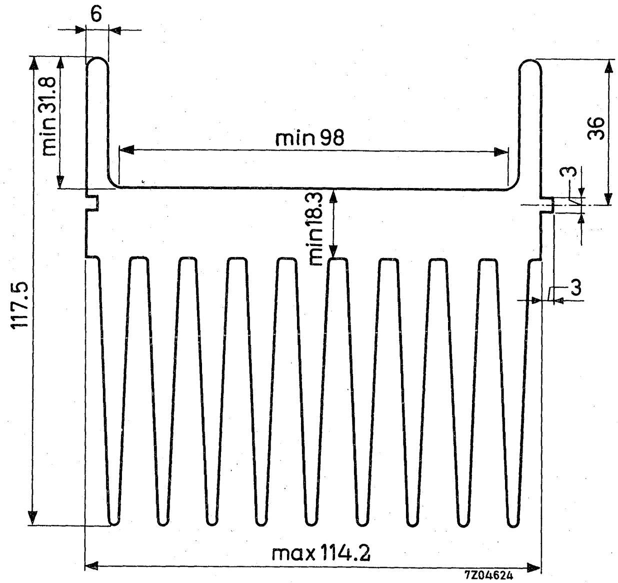
7Z3 0511

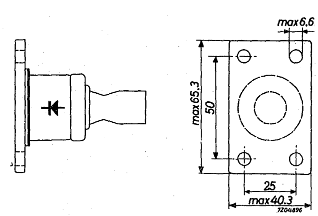
EXTRUDED ALUMINIUM HEATSINK

Extruded heatsink of aluminium alloy.
The extrusion is supplied unpainted, in lengths of 1.5 m.

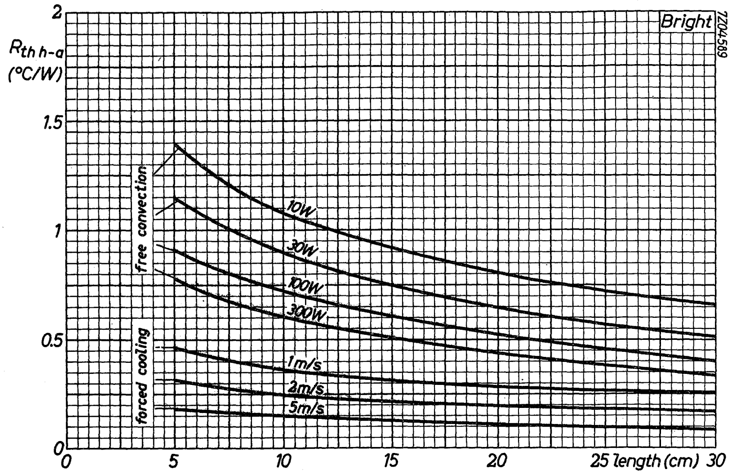
Weight: 16.2 kg per 1.5 m.

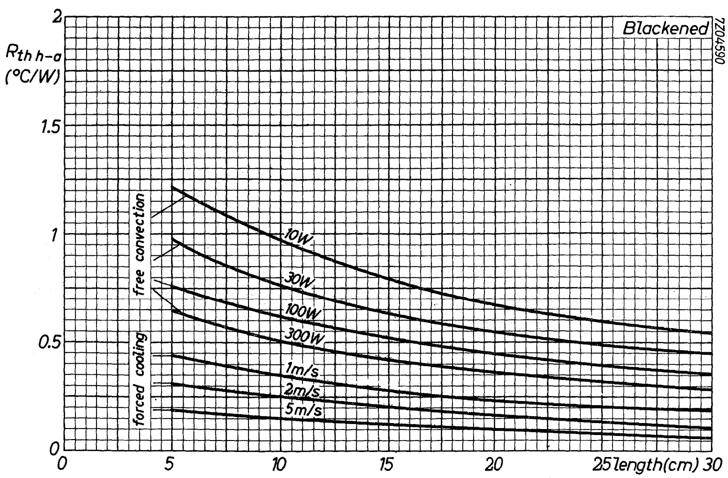
Dimensions in mm





The graphs are valid for the combination of rectifier device and heatsink.
For devices with threaded studs see page 87.





7Z3 0163

Supplement (latest data)

INDEX TO THE SUPPLEMENT

Type number	Pages	Date
Diodes		
BA145	1-4; A-D	7-7-1966
BA148	1-5; A-I	8-8-1966
BAX13	1-4; A-F	6-6-1966
BYX21series	1-3; A	7-7-1966
BYX28series	1-4; A-D	7-7-1966
BYX30series	1-4; A-F	7-7-1966
Thyristors		
BTY79series (Revision)	1-6; A-D	7-7-1966
Transistors		
AC130	1-2	6-6-1966
AFY16	1-5; A-E	6-6-1966
AFY40	1-4; A-D	6-6-1966
BF109	1-2	6-6-1966
BF115 (Revision)	1-4; A-G	8-8-1966
BF180	1-3; A-C	6-6-1966
BF181	1-3; A-C	6-6-1966
BF184	1-2; A-D	8-8-1966
BF185	1-3; A-E	8-8-1966
BFX43	1-5; A-H	6-6-1966
BFX44	1-4; A-I	7-7-1966
BSX19; BSX20 (Revision)	1-6; A-R	7-7-1966
2N2475	1-4	6-6-1966

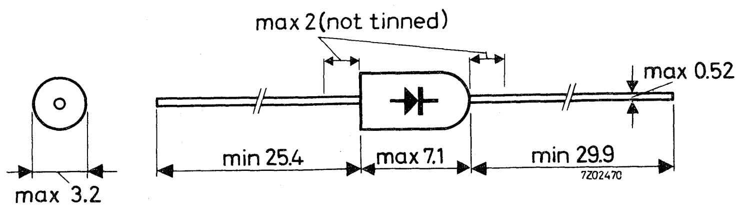
HIGH SPEED SILICON DIODE

Double diffused diode in a DO-14 plastic envelope primarily intended for use in clamp circuits of colour difference amplifiers in television receivers.

QUICK REFERENCE DATA				
Crest working reverse voltage	V_{RWM}	max.	300	V
Average forward current	I_{FAV}	max.	10	mA
Non repetitive peak forward current half sine wave; t = 10 ms	I_{FSM}	max.	1000	mA
Junction temperature	T_j	max.	125	^oC
Thermal resistance from junction to ambient	$R_{th\ j\text{-}a}$	=	0.2	$^oC/mW$
Recovered charge when switched from I_F = 10 mA to V_R = 2 V with $-\frac{dI}{dt}$ = 5 mA/μs; T_j = 25 ^oC	Q_s	<	0.4	nC

MECHANICAL DATA

Dimensions in mm



DO-14 plastic envelope

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

7Z3 0815

RATINGS (Limiting values) [1])

Voltages

Crest working reverse voltage	V_{RWM}	max.	300	V
Repetitive peak reverse voltage	V_{RRM}	max.	350	V
Non repetitive peak reverse voltage ($t < 1$ ms)	V_{RSM}	max.	350	V

Currents

Forward current (d.c.)	I_F	max.	10	mA
Average forward current (averaged over any 20 ms period)	I_{FAV}	max.	10	mA
Repetitive peak forward current	I_{FRM}	max.	100	mA
Non repetitive peak forward current half sine wave; t = 10 ms	I_{FSM}	max.	1000	mA
Repetitive peak reverse current	I_{RRM}	max.	50	mA

Temperatures

Storage temperature	T_{stg}	-65 to +125		^oC
Junction temperature	T_j	max.	125	^oC

THERMAL RESISTANCE

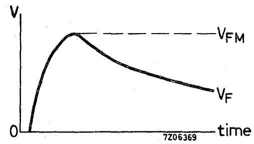
From junction to ambient	$R_{th\ j-a}$	=	0.2	$^oC/mW$

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

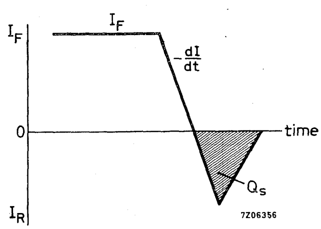
7Z3 0816

CHARACTERISTICS $T_j = 25\ ^oC$ unless otherwise specified

Forward voltage at $I_F = 100$ mA; $T_j = 75\ ^oC$	V_F	<	1.0	V
Reverse current at $V_R = 300$ V; $T_j = 75\ ^oC$	I_R	<	10	μA
Diode capacitance at f = 1 MHz				
$V_R = 150$ V; $T_j = 25\ ^oC$ to $125\ ^oC$	C_d	typ.	4.0	pF
Switching characteristics				
Forward recovery voltage				
$I_F = 100$ mA; $t_r = 50$ ns	V_{FM}	<	3.0	V



Recovered charge when switched from				
$I_F = 10$ mA to $V_R = 2$ V with				
$-\frac{dI}{dt} = 5$ mA/μs	Q_s	<	0.4	nC



MOUNTING INSTRUCTIONS

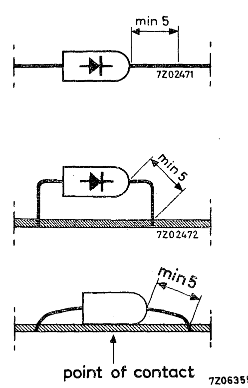
Iron soldering

At a max. iron temperature of 300 ^oC, the max. permissible soldering time is 3 s, provided the soldering spot is at least 5 mm from the seal.

Dip soldering

At a max. solder temperature of 300 ^oC, the max. permissible soldering time is 3 s, provided the soldering spot is at least 5 mm from the seal.

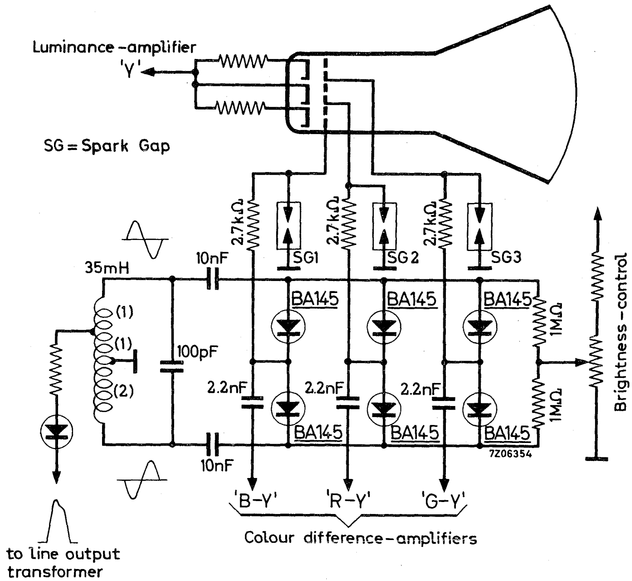
Note: If during soldering the diode is in contact with the printed board the maximum permissible temperature of the point of contact is 125 ^oC.



7Z3 0817

APPLICATION INFORMATION

Clamp circuit for colour difference amplifiers in television receivers.

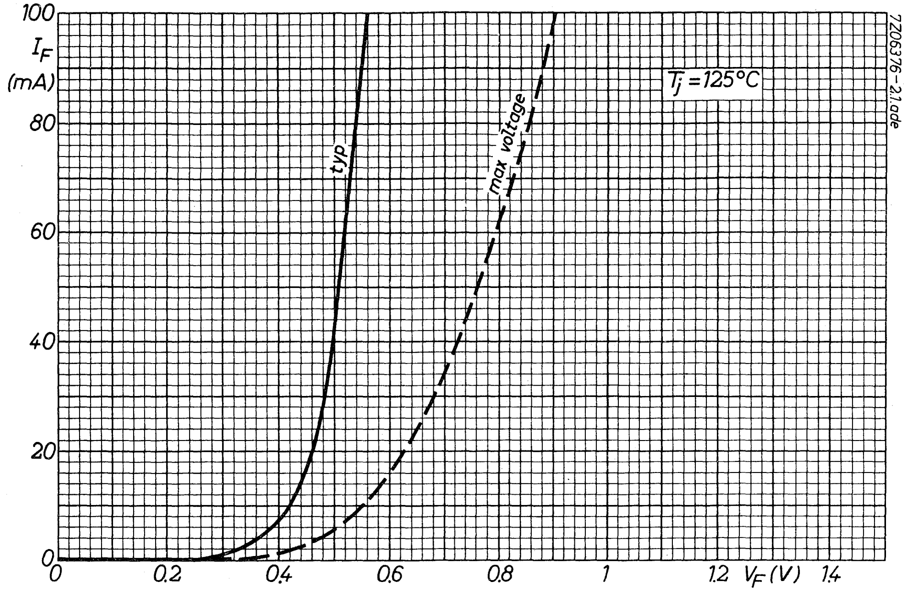


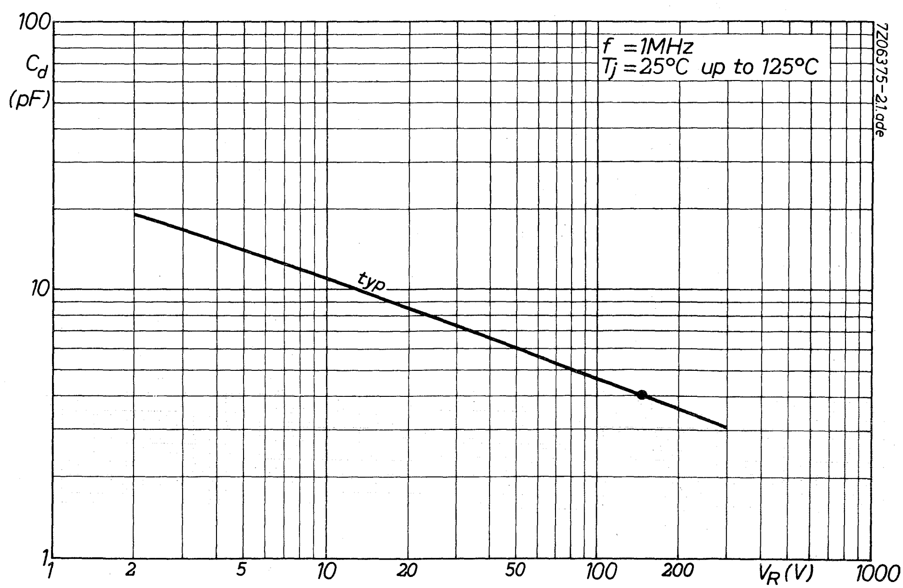
Up to $T_{amb} = 65^oC$ the differences in clamping levels in the circuit will be less than 1 V.

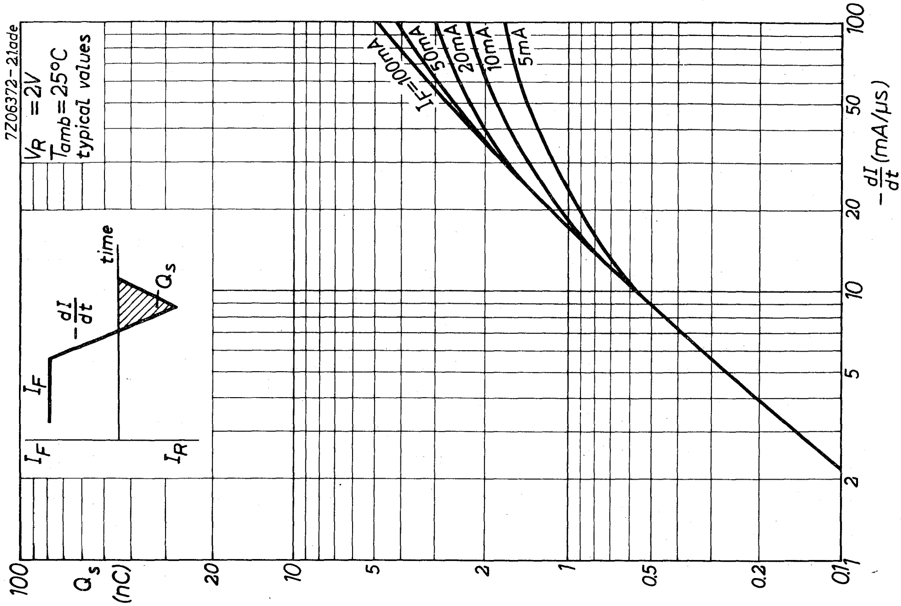
When in a picture tube flash-over occurs, it is possible that high voltage peaks appear at the control grid. These voltage peaks can damage the diodes in the clamp circuit. Protection of the diodes is obtained by means of a spark gap with breakover voltage of < 3000 V and a resistor of 2.7 kΩ.

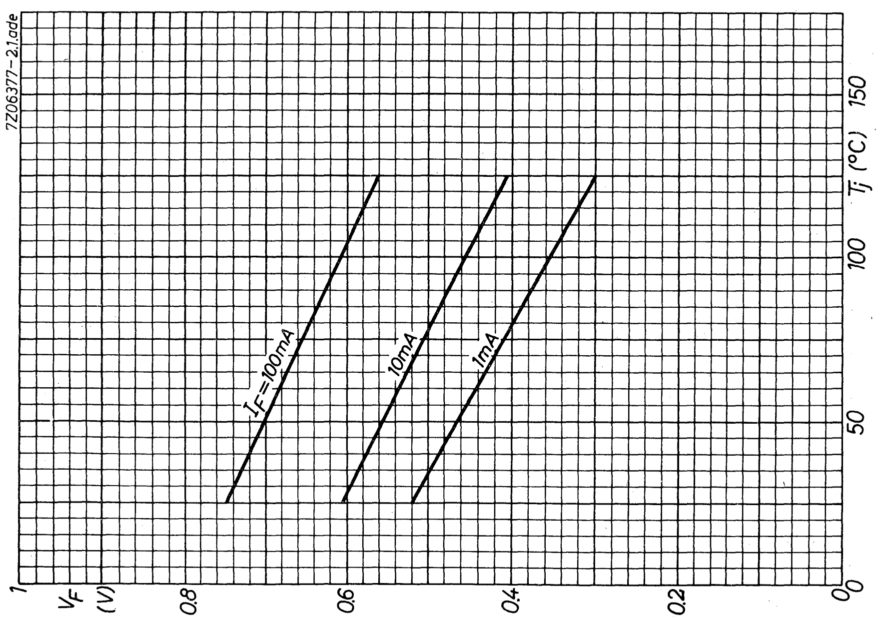
For further information please refer to application information bulletin AI262

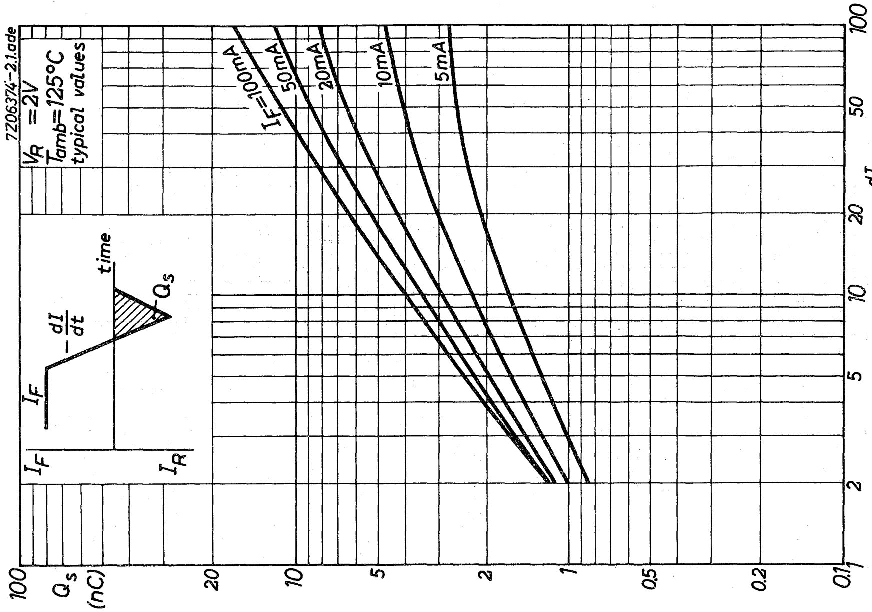
7Z3 0818

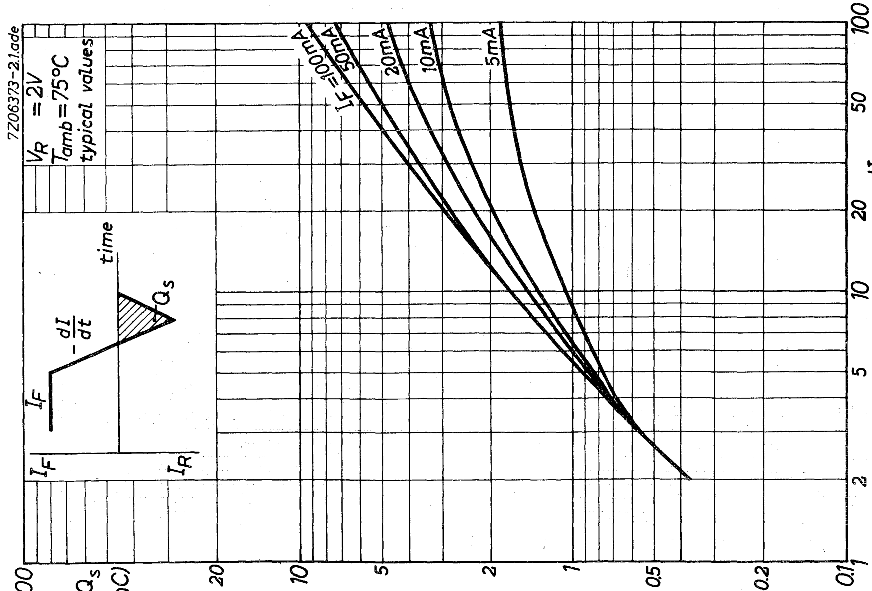

100
I_F
(mA)
80
60
40
20
0
0
0.2
0.4
0.6
0.8
1
1.2
V_F (V)
1.4
typ
max voltage
T_j = 125°C
7Z06376-2.1.ade

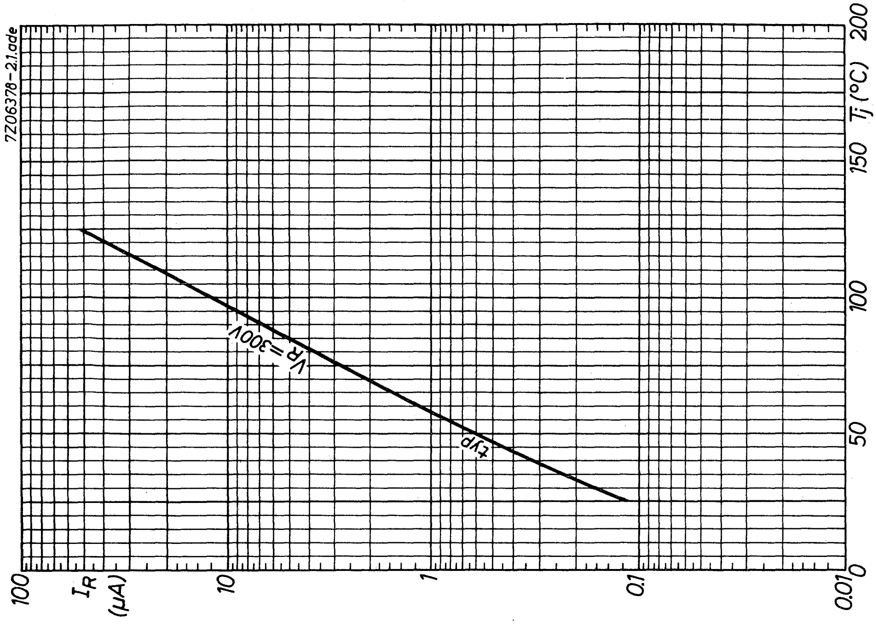

100
C_d
(pF)
10
1
1
2
5
10
20
50
100
200
V_R (V)
1000
typ
f = 1MHz
T_j = 25°C up to 125°C
7Z06375-2.1.ade

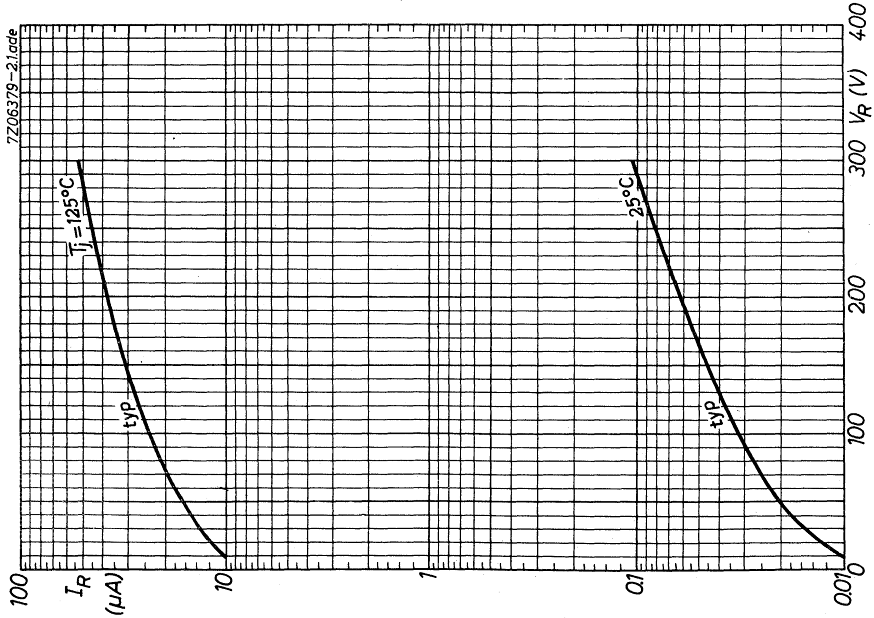

7Z06372-2.1ade
V_R = 2V
T_{amb} = 25°C
typical values
I_F = 100mA
50mA
20mA
10mA
5mA
Q_s
(nC)
$-\frac{dI}{dt}$ (mA/μs)
time
I_F
I_R
Q_s
100
20
10
5
2
1
0.5
0.2
0.1
2
5
10
20
50
100


7Z06377-2.1ade
V_F
(V)
I_F = 100mA
10mA
1mA
T_j (°C)
1
0.8
0.6
0.4
0.2
0
0
50
100
150


7Z06374-2.1.ade
V_R = 2V
T_amb = 125°C
typical values
I_F = 100mA
50mA
20mA
10mA
5mA
I_F
I_R
time
−dI/dt
Q_s
Q_s (nC)
−dI/dt (mA/μs)


7Z06373-2.1.ade
V_R = 2V
T_amb = 75°C
typical values
I_F = 100mA
50mA
20mA
10mA
5mA
I_F
I_R
time
−dI/dt
Q_s
Q_s (nC)
−dI/dt (mA/μs)


7Z06378-2.1.ade
Tj (°C)
IR (μA)
VR = 300V
typ
0
50
100
150
200
100
10
1
0.1
0.01

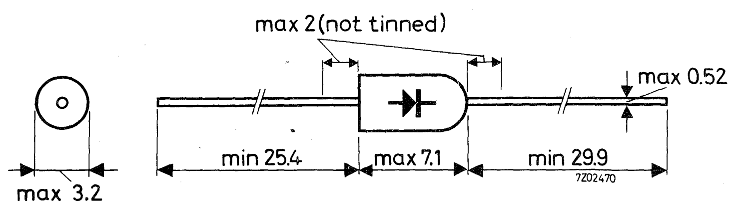

7Z06379-2.1.ade
VR (V)
IR (μA)
Tj = 125°C
25°C
typ
typ
0
100
200
300
400
100
10
1
0.1
0.01

HIGH SPEED SILICON DIODE

Double diffused general purpose diode in a DO-14 plastic envelope for use as line phase detector, clamping diode, scan rectifier for the supply of the small signal parts in television receivers etc.

QUICK REFERENCE DATA				
Crest working reverse voltage	V_{RWM}	max.	300	V
Average forward current	I_{FAV}	max.	0.3	A
Non repetitive peak forward current half sine wave; t = 10 ms	I_{FSM}	max.	15	A
Junction temperature	T_j	max.	125	^oC
Thermal resistance from junction to ambient	$R_{th\ j\text{-}a}$	=	0.2	$^oC/mW$
Recovered charge when switched from I_F = 10 mA to V_R = 2 V with $-\frac{dI}{dt}$ = 5 mA/μs; T_j = 25 ^oC	Q_s	<	0.8	nC

MECHANICAL DATA Dimensions in mm



DO-14 plastic envelope

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

7Z3 0853

RATINGS (Limiting values)[1])

Voltages

Crest working reverse voltage	V_{RWM}	max.	300	V
Repetitive peak reverse voltage	V_{RRM}	max.	350	V
Non repetitive peak reverse voltage ($t < 10$ ms)	V_{RSM}	max.	350	V

Currents

Average forward current (averaged over any 20 ms period)	I_{FAV}	max.	0.3	A
Repetitive peak forward current	I_{FRM}	max.	2.0	A
Non repetitive peak forward current half sine wave; $t = 10$ ms	I_{FSM}	max.	15	A
Repetitive peak reverse current	I_{RRM}	max.	0.5	A

Temperatures

Storage temperature	T_{stg}		−65 to +125	^oC
Junction temperature	T_j	max.	125	^oC

THERMAL RESISTANCE

From junction to ambient	$R_{th\ j\text{-}a}$	=	0.2	$^oC/mW$

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

7Z3 0854

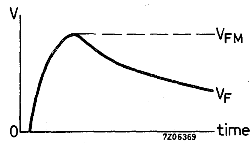
CHARACTERISTICS

T_j = 25 °C unless otherwise specified

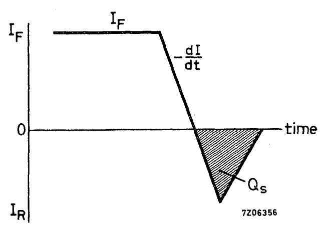
Forward voltage at I_F = 2 A	V_F	<	1.5	V
Reverse current at V_R = 300 V; T_j = 125 °C	I_R	<	200	μA
Diode capacitance at f = 1 MHz V_R = 150 V; T_j = 25 °C to 125 °C	C_d	typ.	4.0	pF

Switching characteristics

Forward recovery voltage I_F = 100 mA; t_r = 50 ns	V_{FM}	<	3.0	V



Recovered charge when switched from I_F = 10 mA to V_R = 2 with $-\frac{dI}{dt}$ = 5 mA/μs	Q_s	<	0.8	nC



MOUNTING INSTRUCTIONS

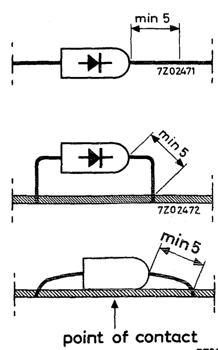
Iron soldering

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

Dip soldering

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

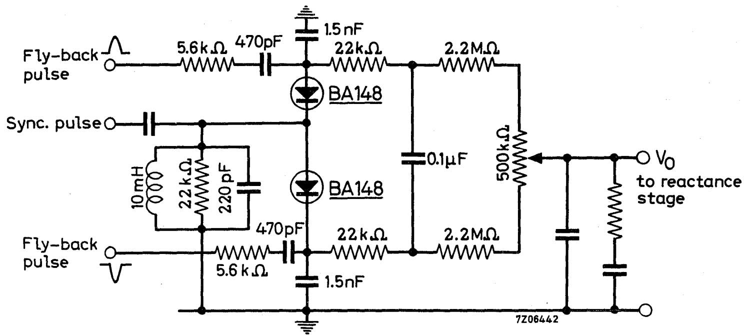
Note: if during soldering the diode is in contact with the printed board the maximum permissible temperature of the point of contact is 125 °C.



7Z3 0855

APPLICATION INFORMATION

Self catching line phase detector

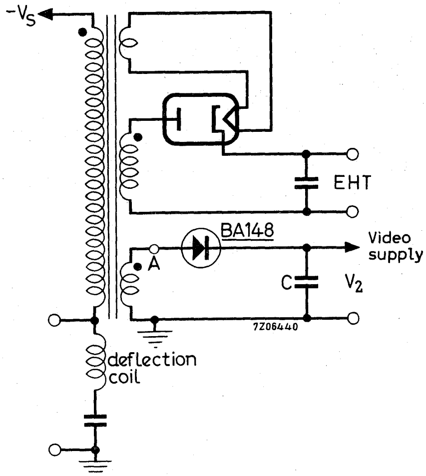


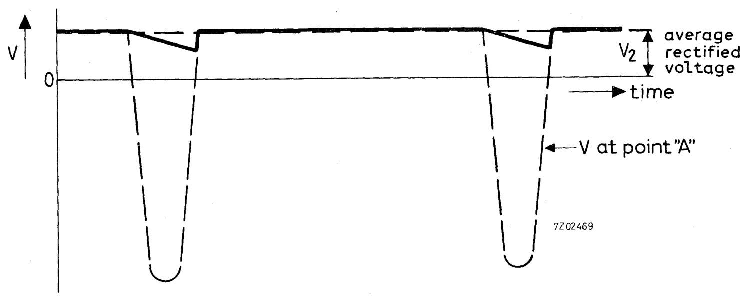
In the high impedance type of a line phase detector shown in the circuit diagram the BA148 is very well applicable owing to its high speed and low leakage properties.

7Z3 0856

APPLICATION INFORMATION (continued)

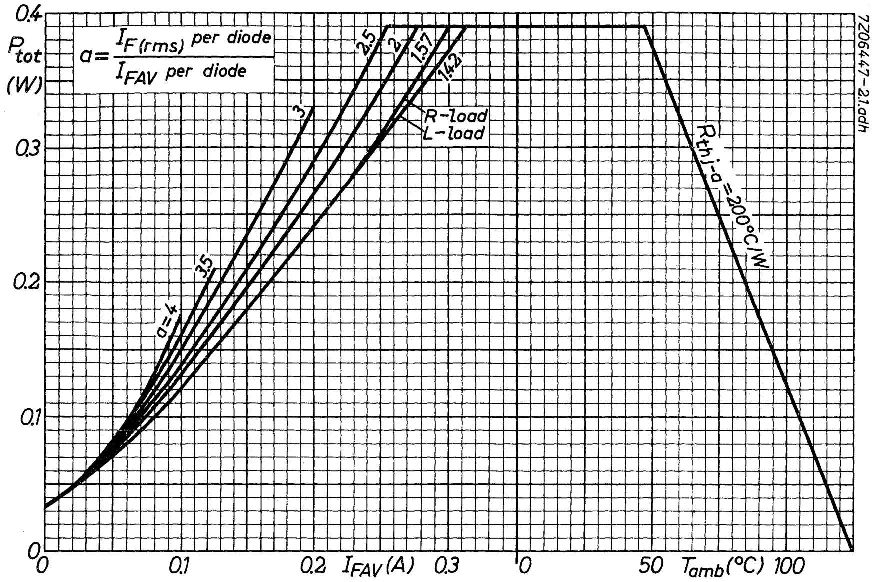
Low voltage power supply of the line output stage of a television receiver.





By means of an extra winding on the line output transformer and a BA148 a supply voltage up to 30 V can be obtained for the low voltage parts of a television receiver. The rectifier is conductive during the scan cycle, which facilitates an output voltage which is essentially stable and has a low source impedance.

7Z3 0857

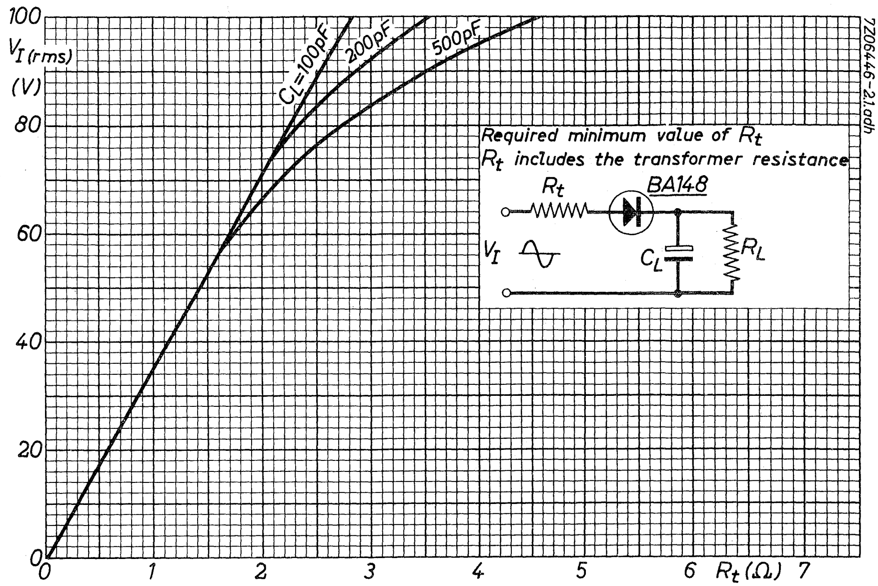


From the left hand graph the total power dissipation can be found as a function of the average forward current.

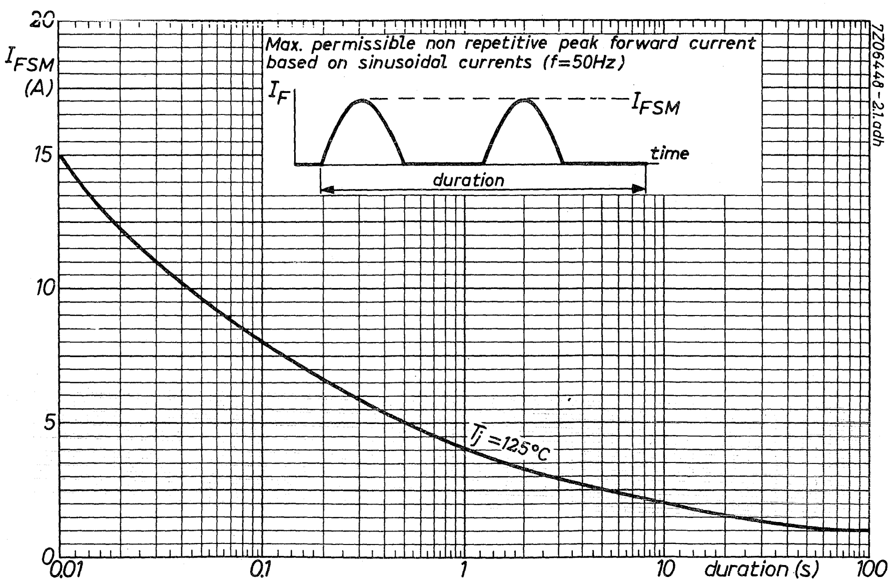
The parameter $a = \frac{I_{F(rms)} \text{ per diode}}{I_{FAV} \text{ per diode}}$ depends on $\omega R_L C_L$ and $\frac{R_t + r_{diff.}}{R_L}$ and can be found from existing graphs.

See for instance "Power rectification with silicon diodes".
Once the power dissipation is known, the max. permissible ambient temperature follows from the right hand graph.

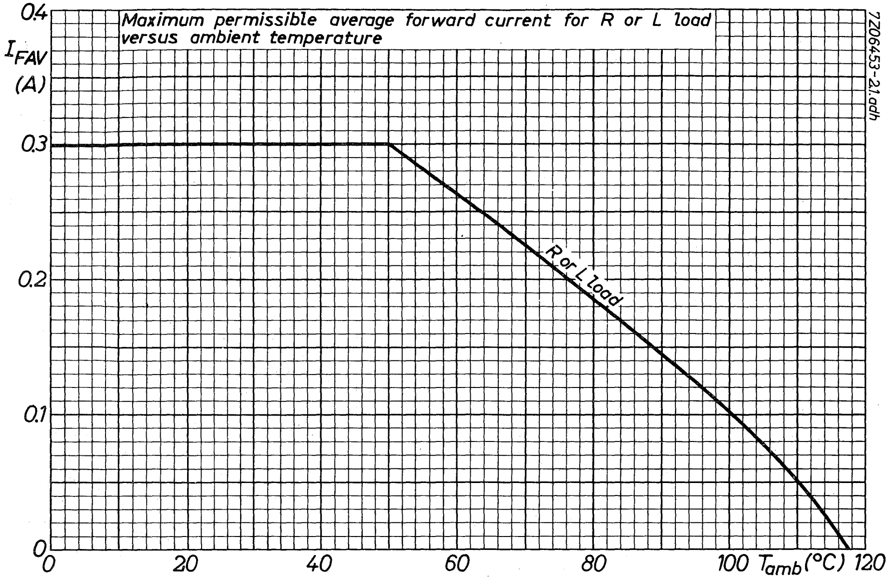
For the series resistance, added to limit the initial peak rectifier current, the required minimum value can be found from the upper graph at page B.
$r_{diff.}$ is shown at page G, upper figure. 7Z3 0858

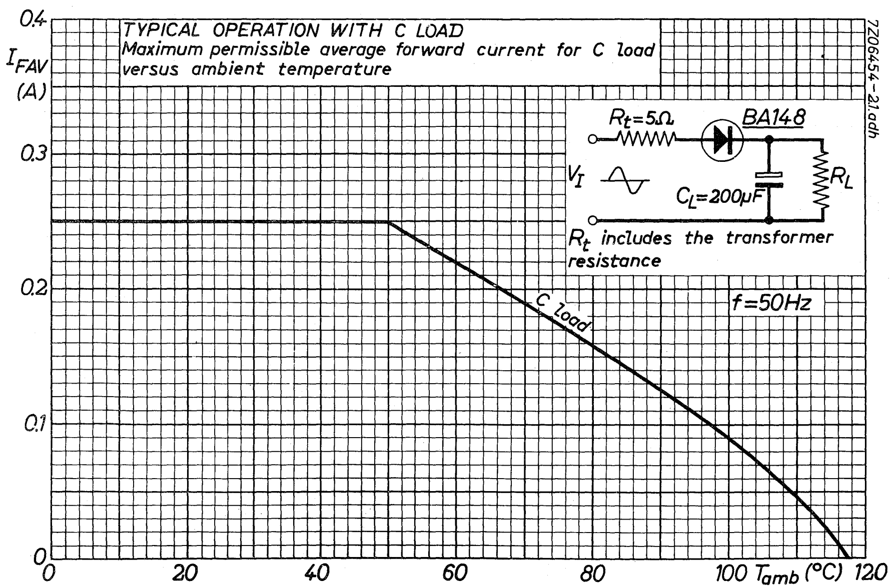


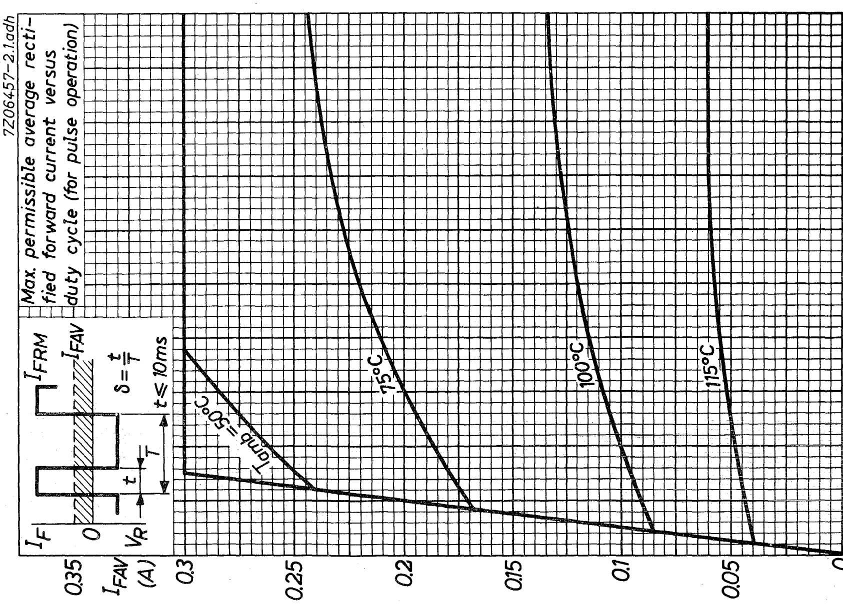
100
$V_{I(rms)}$
(V)
80
60
40
20
0
0
1
2
3
4
5
6
$R_t(\Omega)$
7
C_L=100pF
200pF
500pF
Required minimum value of R_t
R_t includes the transformer resistance
R_t
BA148
V_I
C_L
R_L
7Z06446-2.1.adh

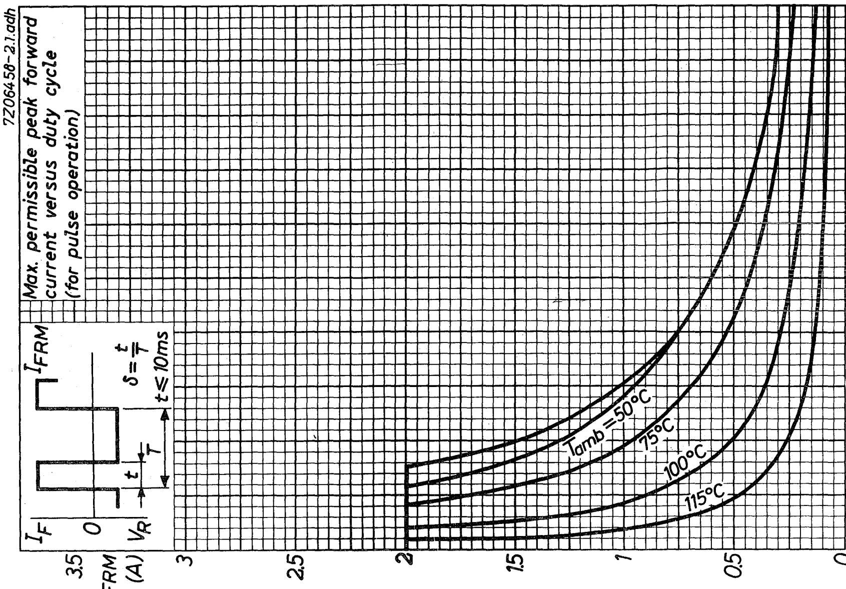


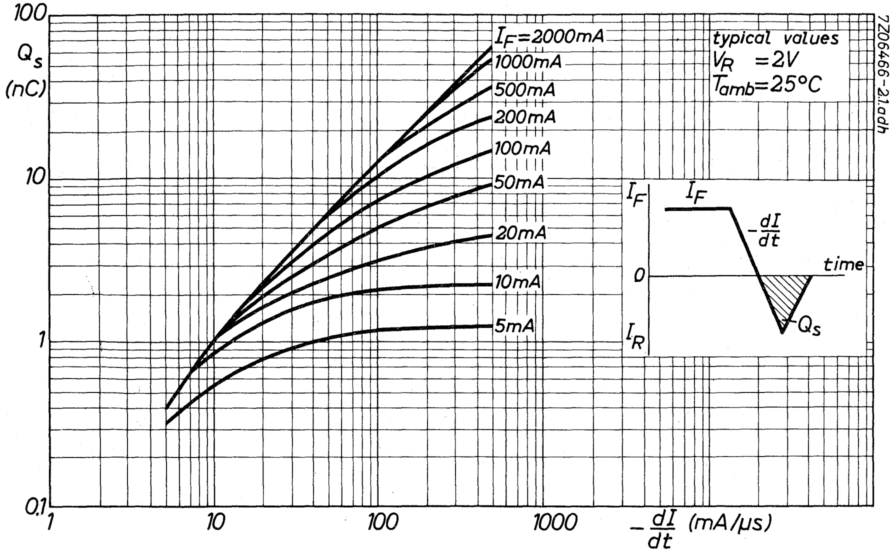
20
I_{FSM}
(A)
15
10
5
0
0.01
0.1
1
10
duration (s)
100
Max. permissible non repetitive peak forward current
based on sinusoidal currents (f=50Hz)
I_F
I_{FSM}
time
duration
T_j=125°C
7Z06448-2.1.adh

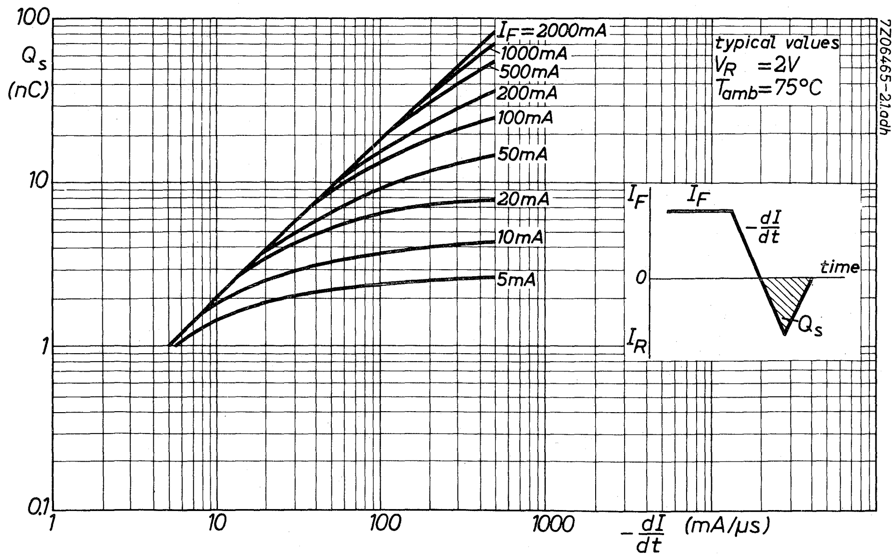

Maximum permissible average forward current for R or L load versus ambient temperature
7Z06453-2.1.adh
0.4
I_{FAV}
(A)
0.3
0.2
0.1
0
0
20
40
60
80
100
T_{amb} (°C)
120
R or L load

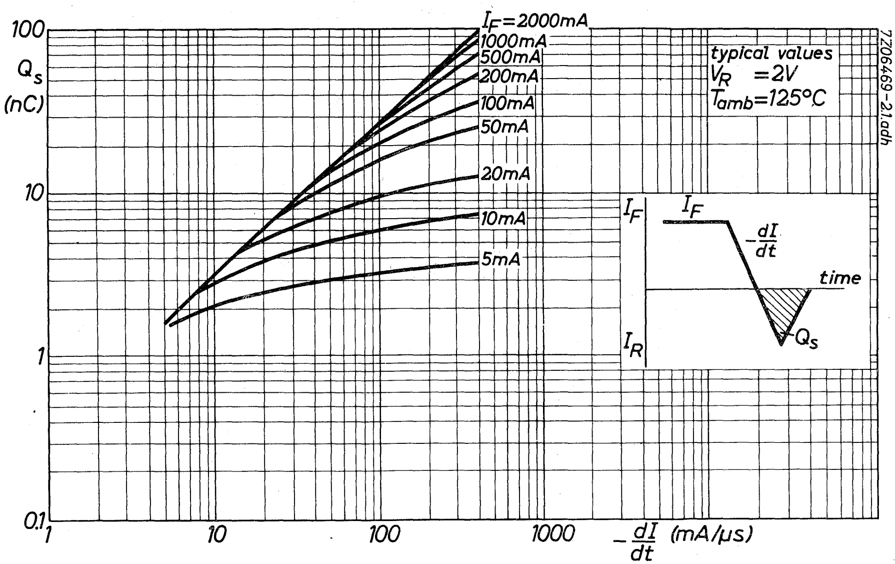

TYPICAL OPERATION WITH C LOAD
Maximum permissible average forward current for C load versus ambient temperature
7Z06454-2.1.adh
0.4
I_{FAV}
(A)
0.3
0.2
0.1
0
0
20
40
60
80
100
T_{amb} (°C)
120
R_t=5Ω
BA148
V_I
C_L=200µF
R_L
R_t includes the transformer resistance
f=50Hz
C load


7206457-2.1.adh
Max. permissible average rectified forward current versus duty cycle (for pulse operation)
I_F
0
V_R
I_{FRM}
I_{FAV}
t
T
$\delta = \frac{t}{T}$
$t \leq 10ms$
I_{FAV} (A)
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
$T_{amb} = 50°C$
75°C
100°C
115°C
0.2
0.4
0.6
0.8
δ
1

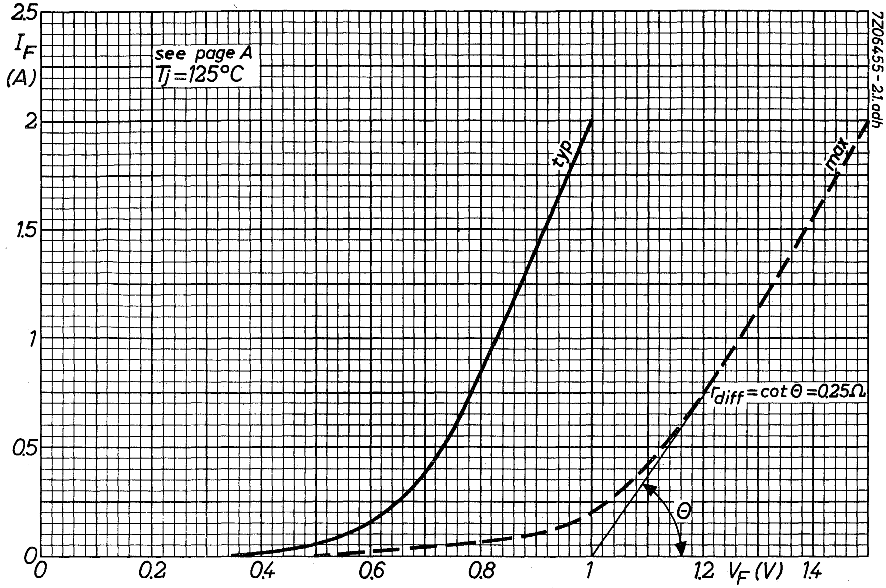

7206458-2.1.adh
Max. permissible peak forward current versus duty cycle (for pulse operation)
I_F
0
V_R
I_{FRM}
t
T
$\delta = \frac{t}{T}$
$t \leq 10ms$
I_{FRM} (A)
3.5
3
2.5
2
1.5
1
0.5
0
$T_{amb} = 50°C$
75°C
100°C
115°C
0.2
0.4
0.6
0.8
δ
1


100
Qs
(nC)
10
1
0.1
1
10
100
1000
-dI/dt (mA/µs)
IF=2000mA
1000mA
500mA
200mA
100mA
50mA
20mA
10mA
5mA
typical values
VR = 2V
Tamb=25°C
IF
IF
-dI/dt
0
time
IR
Qs
7Z06466-2.1.adh

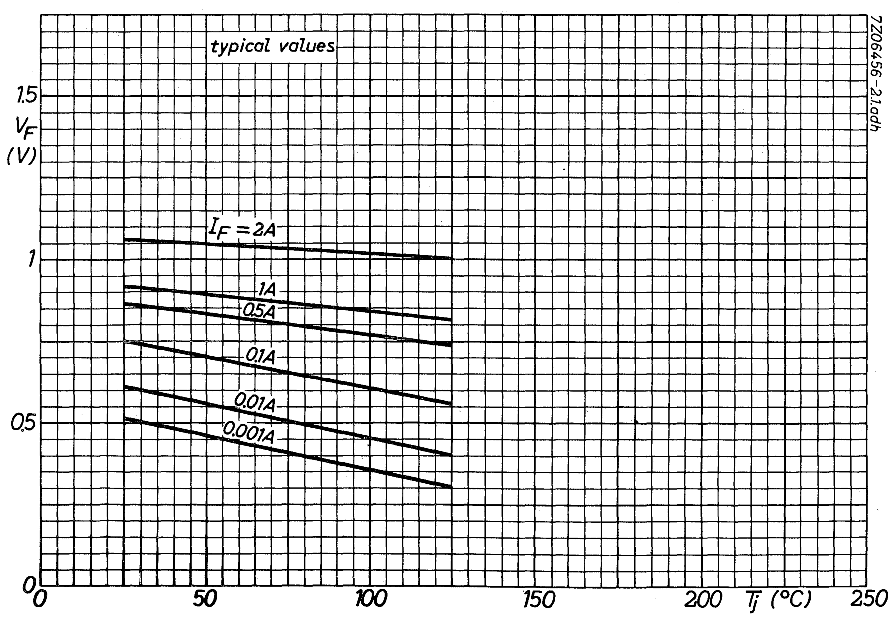

100
Qs
(nC)
10
1
0.1
1
10
100
1000
-dI/dt (mA/µs)
IF=2000mA
1000mA
500mA
200mA
100mA
50mA
20mA
10mA
5mA
typical values
VR = 2V
Tamb=75°C
IF
IF
-dI/dt
0
time
IR
Qs
7Z06465-2.1.adh



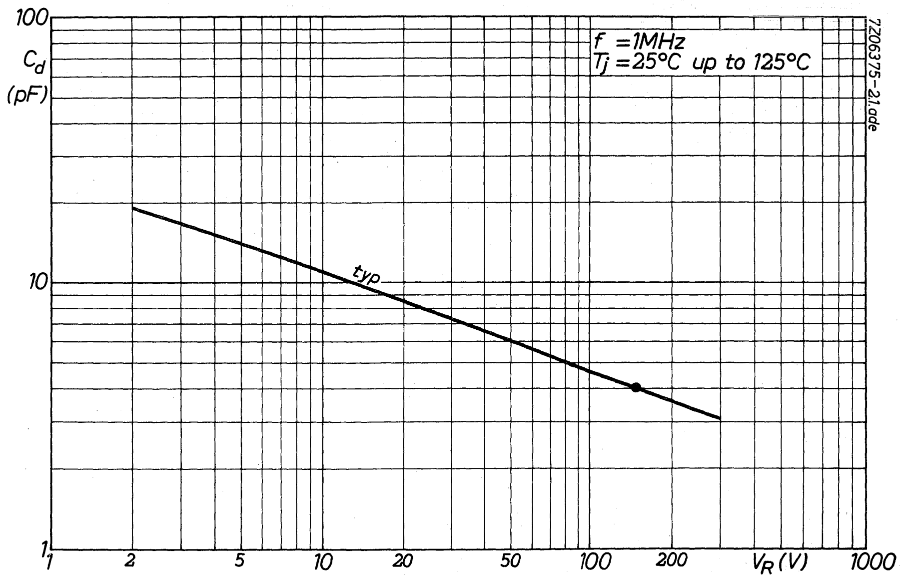
100
Q_s
(nC)
10
1
0.1
1
10
100
1000
$-\frac{dI}{dt}$ (mA/µs)
I_F=2000mA
1000mA
500mA
200mA
100mA
50mA
20mA
10mA
5mA
typical values
V_R =2V
T_{amb}=125°C
7Z06469-2.1.adh
I_F
I_F
$-\frac{dI}{dt}$
time
Q_s
I_R

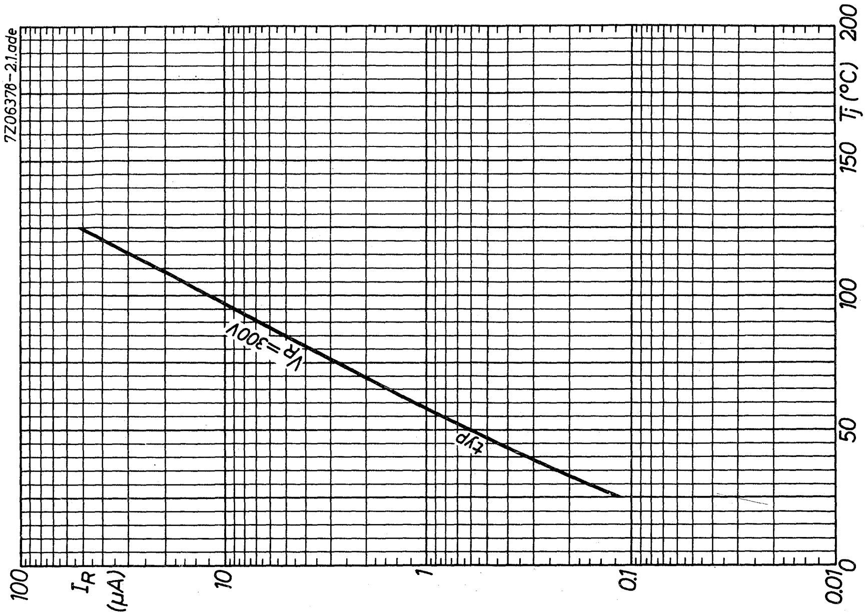


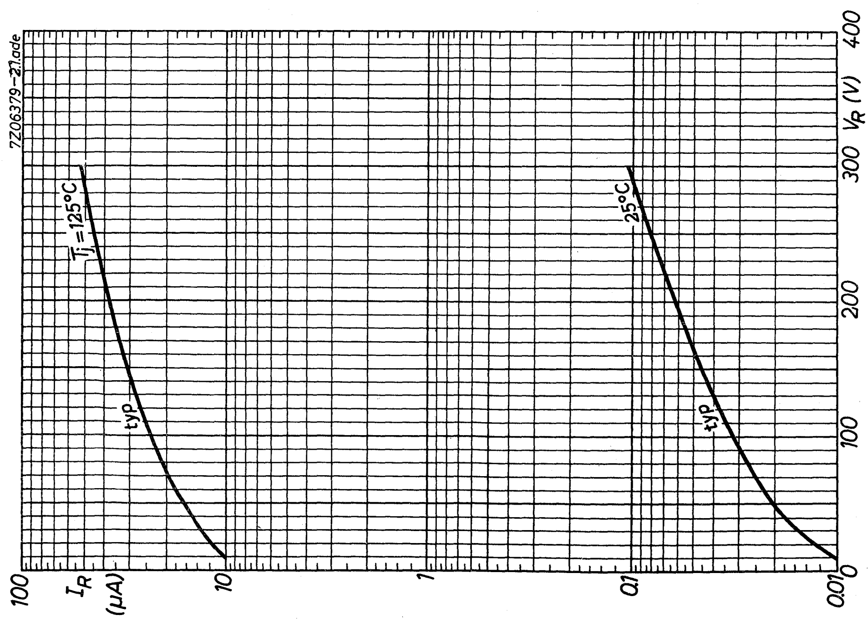
2.5
I_F
(A)
see page A
T_j = 125°C
7Z06455-2.1.adh
2
typ
max
1.5
1
r_{diff} = cot Θ = 0.25Ω
0.5
Θ
0
0
0.2
0.4
0.6
0.8
1
1.2
V_F (V)
1.4



typical values
7Z06456-2.1.adh
1.5
V_F
(V)
I_F = 2A
1
1A
0.5A
0.1A
0.01A
0.001A
0.5
0
0
50
100
150
200
T_j (°C)
250


100
C_d
(pF)
10
1
f = 1MHz
T_j = 25°C up to 125°C
typ
1
2
5
10
20
50
100
200
V_R (V)
1000
7Z06375-2.1.ade


7Z06378-2.1.ade
I_R (μA)
100
10
1
0.1
0.01
T_j (°C)
0
50
100
150
200
V_R = 300V
typ

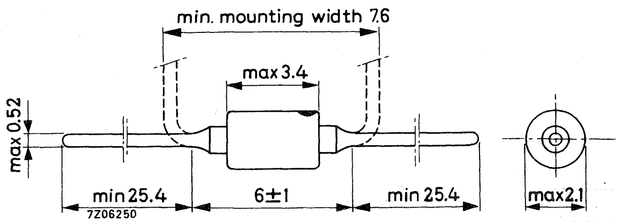

7Z06379-2.1.ade
I_R (μA)
100
10
1
0.1
0.01
V_R (V)
0
100
200
300
400
T_j = 125°C
typ
25°C
typ

SILICON OXIDE PASSIVATED DIODE

Whiskerless diode in a molybdenum hard glass subminiature envelope. The BAX13 is primarily intended for fast logic applications.

QUICK REFERENCE DATA				
Continuous reverse voltage	V_R	max.	25	V
Repetitive peak reverse voltage	V_{RRM}	max.	40	V
Repetitive peak forward current	I_{FRM}	max.	150	mA
Thermal resistance from junction to ambient	$R_{th\ j-a}$	=	0.60	$^oC/mW$
Forward voltage at I_F = 20 mA	V_F	<	1.0	V
Reverse recovery time when switched from I_F = 10 mA to V_R = 6 V; R_L = 100 Ω measured at I_R = 1 mA	t_{rr}	<	4	ns
Recovered charge when switched from I_F = 10 mA to V_R = 5 V R_L = 500 Ω	Q_s	<	45	pC

MECHANICAL DATA Dimensions in mm



The coloured dot indicates the cathode side

7Z3 0795

RATINGS (Limiting values) [1])

Voltages

Continuous reverse voltage	V_R	max.	25	V
Repetitive peak reverse voltage	V_{RRM}	max.	40	V

Currents

Average rectified forward current (averaged over any 20 ms period)	I_{FAV}	max.	75	mA [2])
Forward current (d.c.)	I_F	max.	75	mA
Repetitive peak forward current	I_{FRM}	max.	150	mA
Non repetitive peak forward current t = 1 μs	I_{FSM}	max.	2000	mA
t = 1 s	I_{FSM}	max.	500	mA

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	$R_{th\ j\text{-}a}$	=	0.60	°C/mW

CHARACTERISTICS T_j = 25 °C unless otherwise specified

Forward voltage

I_F = 2 mA	V_F	<	0.7	V
I_F = 10 mA; T_j = 100 °C	V_F	<	0.8	V
I_F = 20 mA	V_F	<	1.0	V [3])
I_F = 75 mA	V_F	<	1.53	V [3])

Reverse current

V_R = 10 V	I_R	<	25	nA
V_R = 10 V; T_j = 150 °C	I_R	<	15	μA
V_R = 25 V	I_R	<	50	nA
V_R = 25 V; T_j = 150 °C	I_R	<	25	μA

Diode capacitance (see also page C)

V_R = 0; f = 1 MHz	C_d	<	3	pF

---

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

2) For sinusoidal operation see page A. For pulse operation see page B.

3) Measured under pulsed conditions to prevent excessive dissipation.

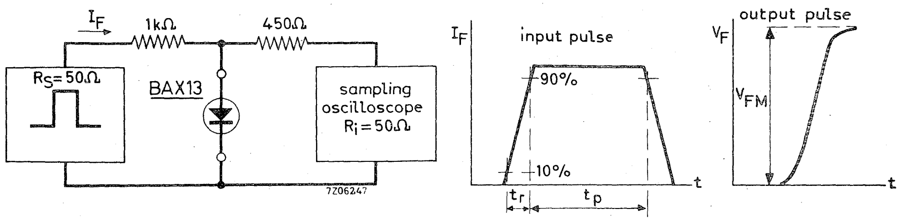
7Z3 0796

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

Forward recovery voltage (see also page C)

At t_r > 20 ns, V_{FM} will not exceed V_F corresponding to I_F = 1 to 75 mA

Test circuit:



Current pulse: Rise time t_r = 20 ns Oscilloscope:

Pulse duration t_p = 120 ns Rise time t_r = 0.35 ns

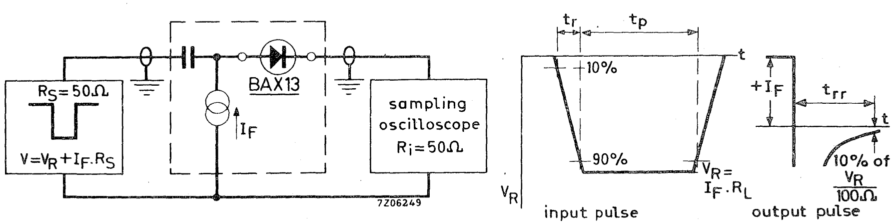
Duty cycle δ = 0.01

Circuit capacitance C < 1 pF (C = Oscilloscope + parasitical capacitance)

Reverse recovery time when switched from

I_F = 10 mA to V_R ; R_L = 100 Ω (see also page D)
measured at I_R = 1 mA; switched to V_R = 1 V t_{rr} < 6 ns
V_R = 6 V t_{rr} < 4 ns

Test circuit:



Reverse pulse: Rise time t_r = 0.6 ns Oscilloscope:

Pulse duration t_p = 100 ns Rise time t_r = 0.35 ns

Duty cycle δ = 0.05

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

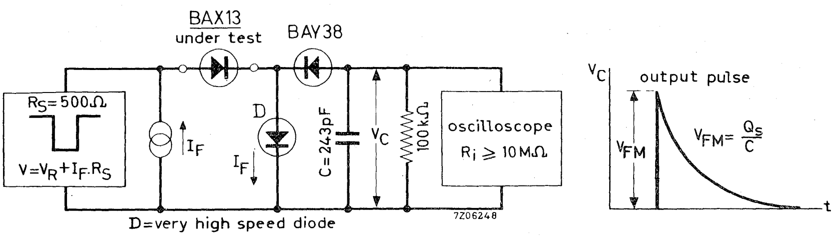
7Z3 0797

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

Recovered charge when switched from

I_F = 10 mA to V_R = 5 V; R_L = 500 Ω | Q_s | < | 45 | pC

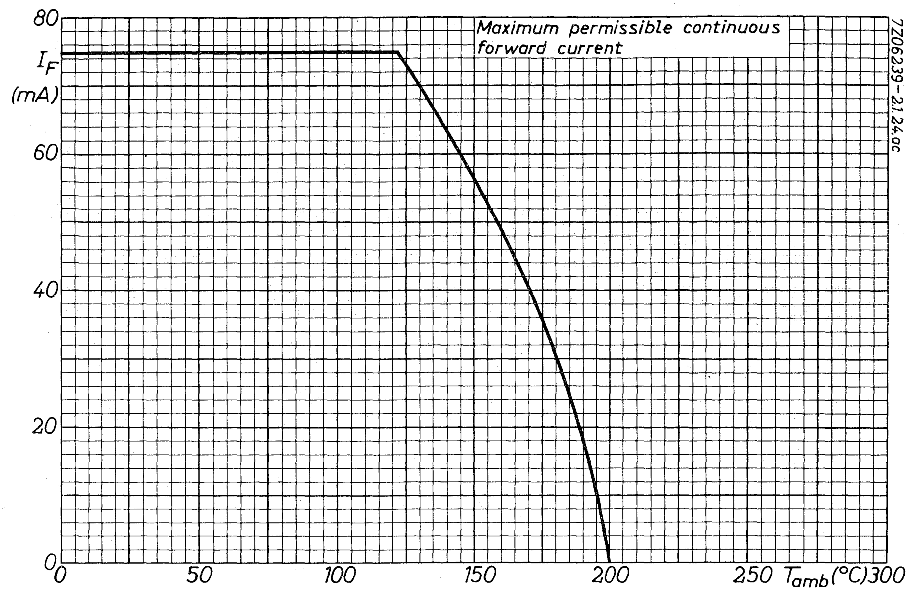
Test circuit:

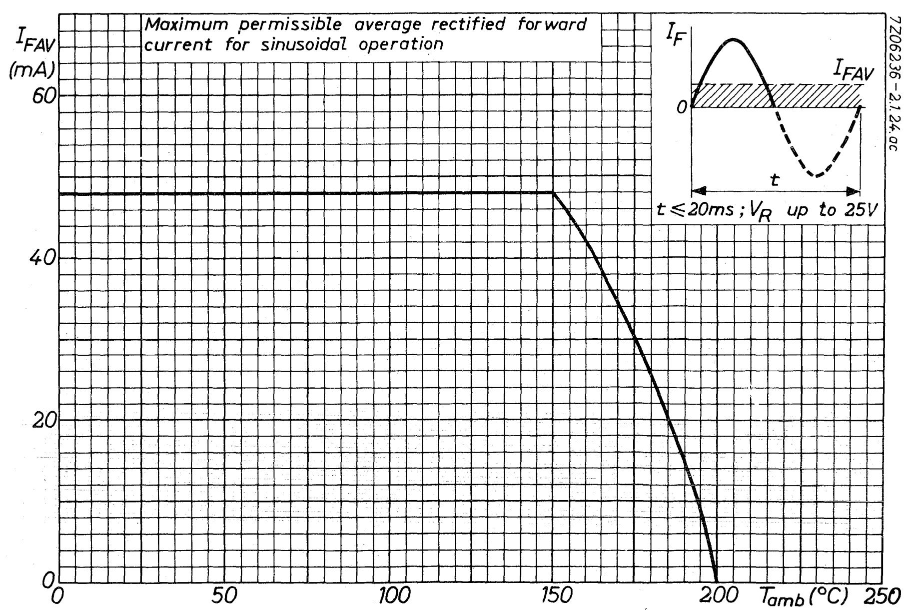


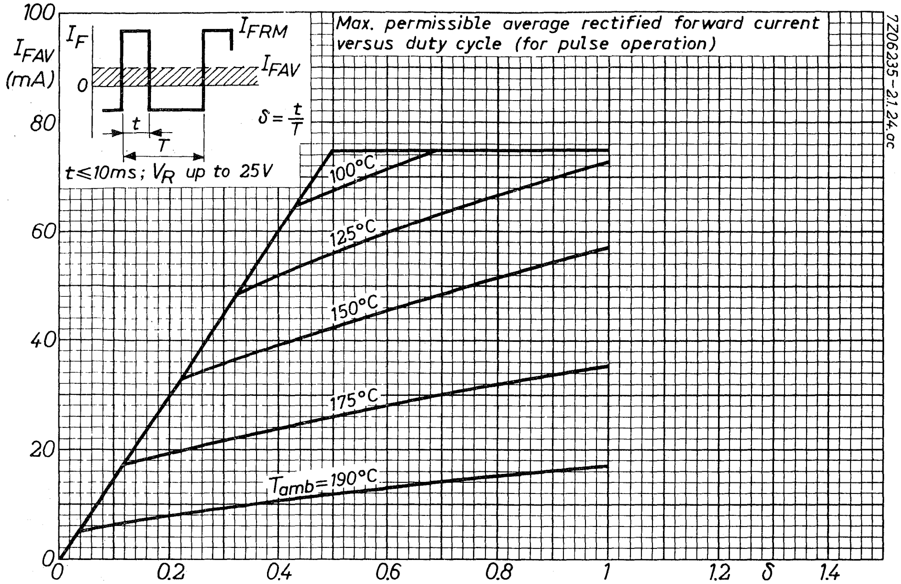
Reverse pulse:	Rise time	t_r	=	2 ns
	Pulse duration	t_p	=	400 ns
	Duty cycle	δ	=	0.02

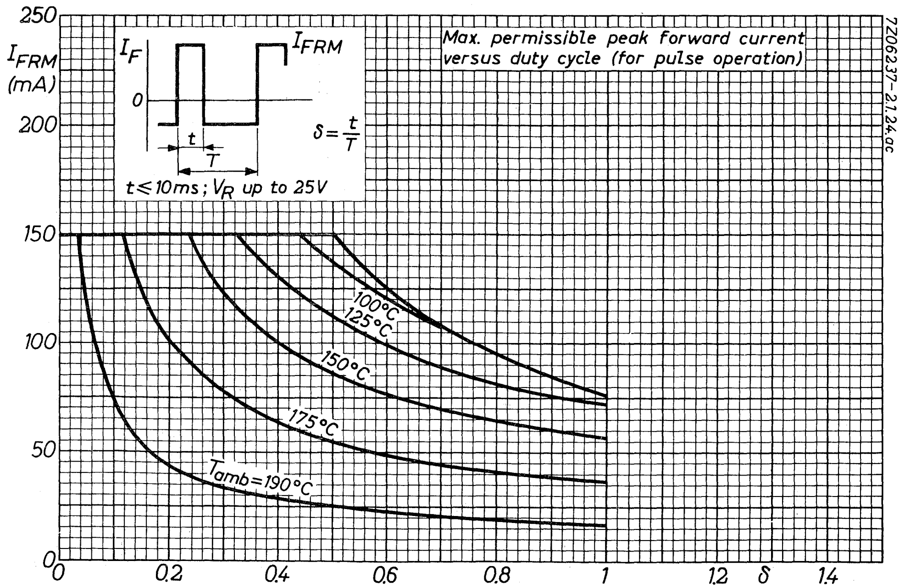
Circuit capacitance C < 7 pF (C = Oscilloscope + parasitical capacitance)

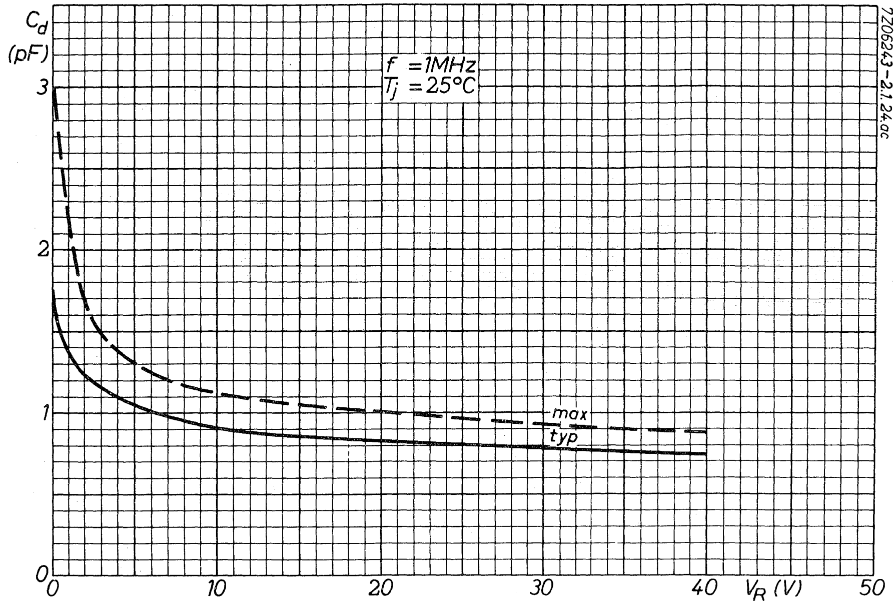
7Z3 0798

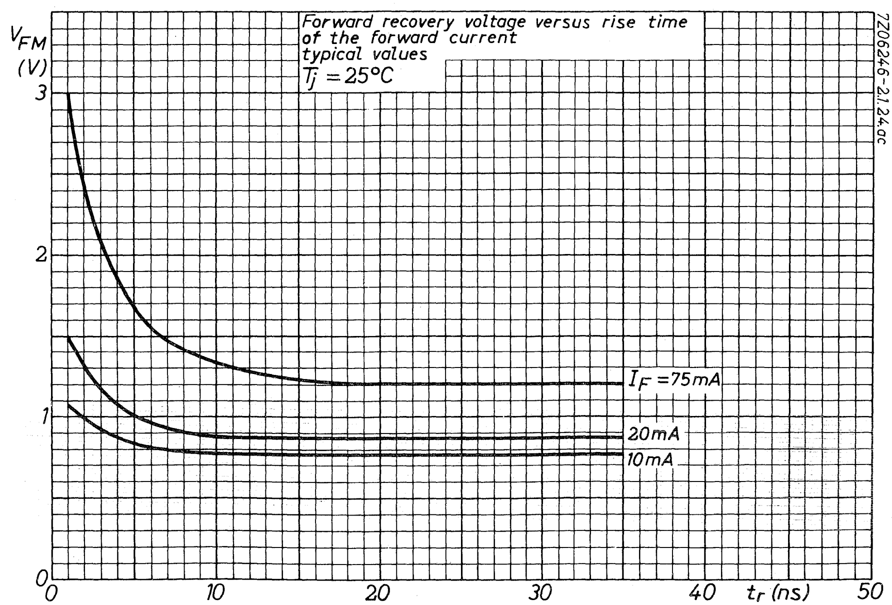

Maximum permissible continuous forward current
I_F (mA)
80
60
40
20
0
0
50
100
150
200
250
T_{amb} (°C)
300
7Z06239-2.1.24.ac

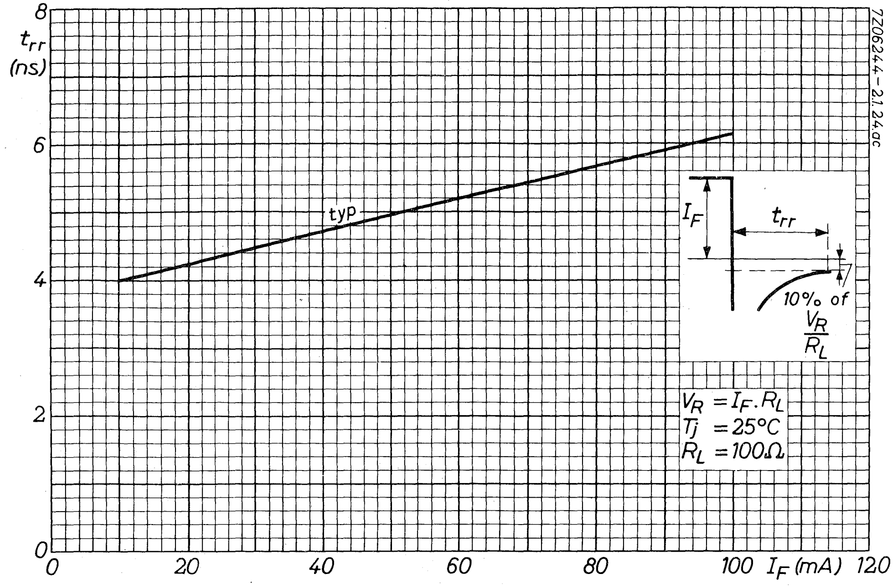

Maximum permissible average rectified forward current for sinusoidal operation
I_{FAV} (mA)
60
40
20
0
0
50
100
150
200
T_{amb} (°C)
250
I_F
I_{FAV}
0
t
$t \leq 20ms$; V_R up to 25V
7Z06236-2.1.24.ac

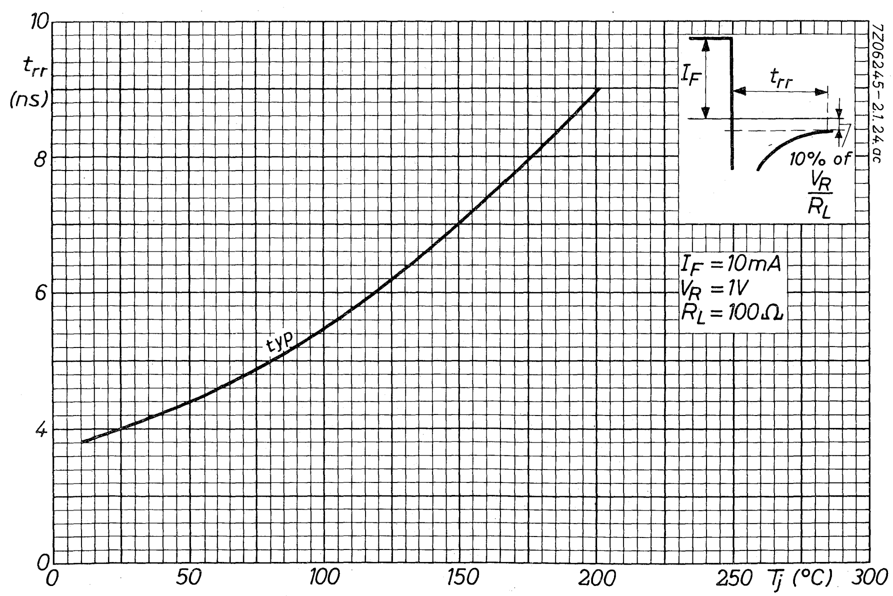

Max. permissible average rectified forward current versus duty cycle (for pulse operation)
7Z06235-2.1.24.ac
I_{FAV} (mA)
I_F
I_{FRM}
I_{FAV}
$\delta = \frac{t}{T}$
$t \leq 10ms$; V_R up to 25V
100°C
125°C
150°C
175°C
T_{amb}=190°C
0
20
40
60
80
100
0.2
0.4
0.6
0.8
1
1.2
δ
1.4

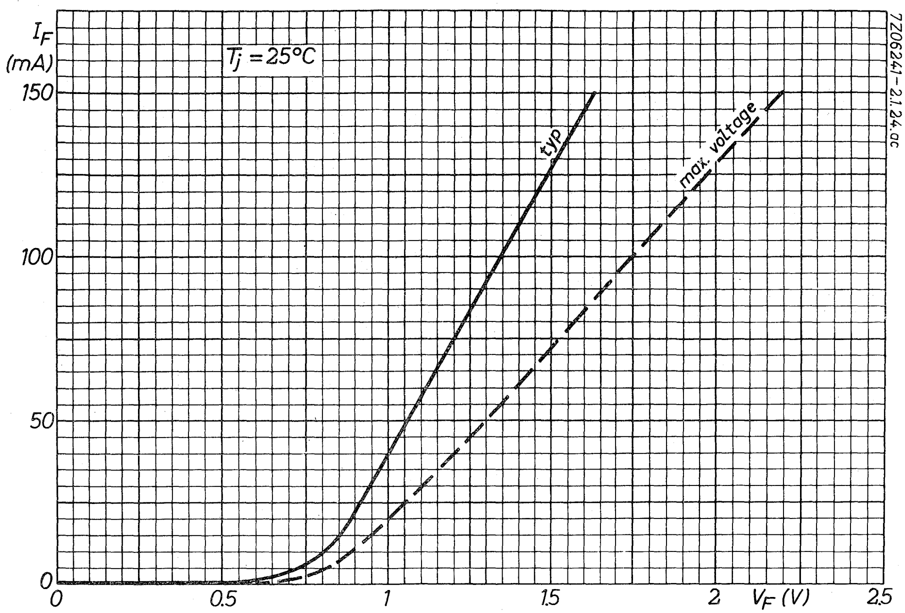

Max. permissible peak forward current versus duty cycle (for pulse operation)
7Z06237-2.1.24.ac
I_{FRM} (mA)
I_F
I_{FRM}
$\delta = \frac{t}{T}$
$t \leq 10ms$; V_R up to 25V
100°C
125°C
150°C
175°C
T_{amb}=190°C
0
50
100
150
200
250
0.2
0.4
0.6
0.8
1
1.2
δ
1.4

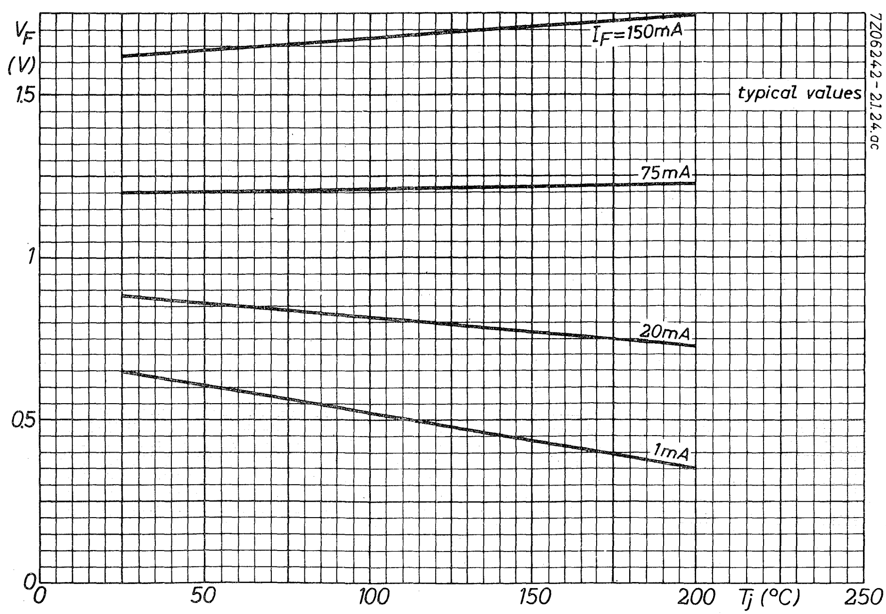

7Z06243-2.1.24.ac
C_d (pF)
f = 1MHz
T_j = 25°C
max
typ
0 10 20 30 40 50
V_R (V)
0 1 2 3

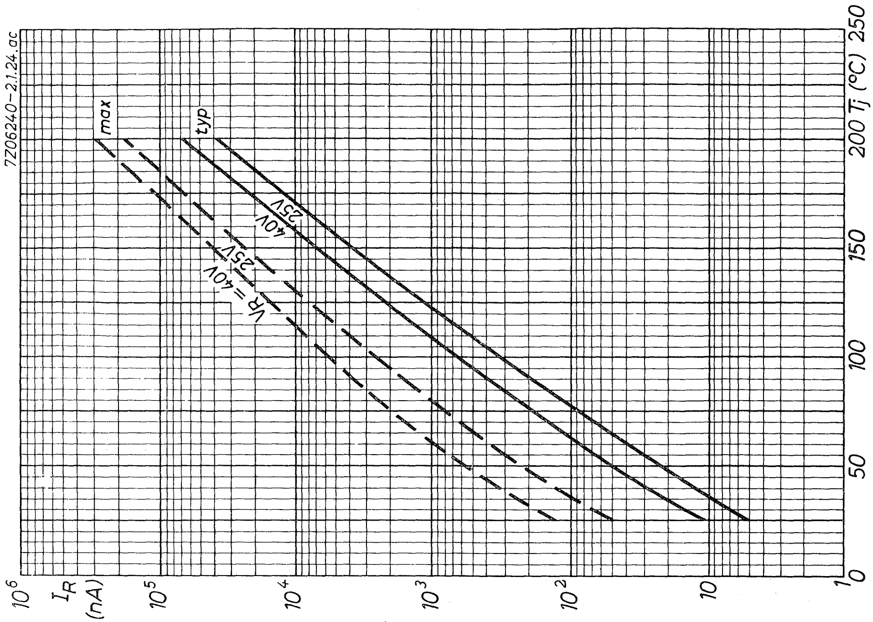

7Z06246-2.1.24.ac
V_{FM} (V)
Forward recovery voltage versus rise time of the forward current typical values
T_j = 25°C
I_F = 75mA
20mA
10mA
0 10 20 30 40 50
t_r (ns)
0 1 2 3

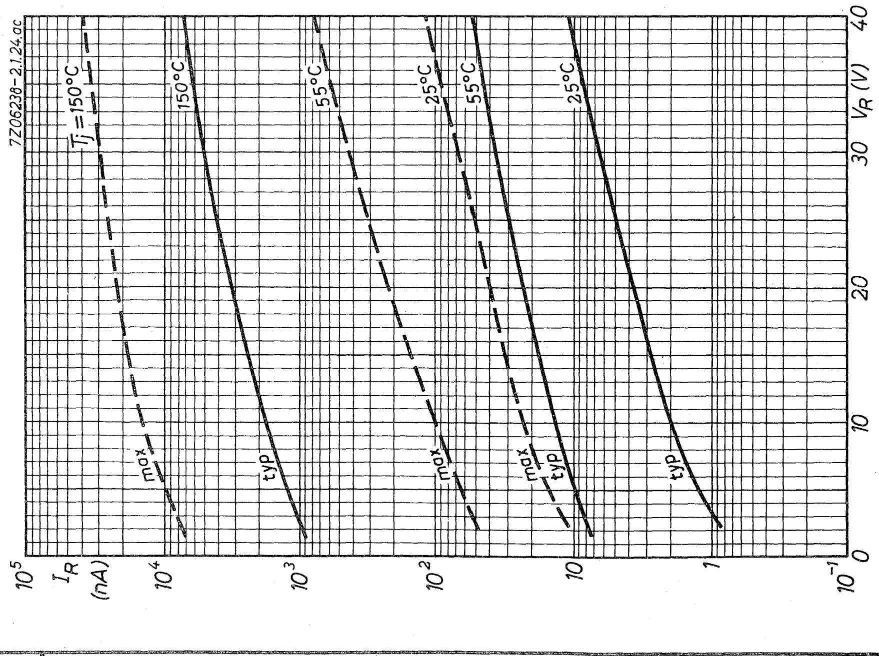

8
t_{rr}
(ns)
6
4
2
0
typ
I_F
t_{rr}
10% of
$\frac{V_R}{R_L}$
$V_R = I_F . R_L$
$T_j = 25°C$
$R_L = 100Ω$
0
20
40
60
80
100
I_F (mA)
120
7Z06244 – 2.1.24.ac


10
t_{rr}
(ns)
8
6
4
0
typ
I_F
t_{rr}
10% of
$\frac{V_R}{R_L}$
$I_F = 10mA$
$V_R = 1V$
$R_L = 100Ω$
0
50
100
150
200
250
T_j (°C)
300
7Z06245 – 2.1.24.ac


I_F
(mA)
$T_j = 25°C$
150
100
50
0
typ
max. voltage
0
0.5
1
1.5
2
V_F (V)
2.5
7Z06241-2.1.24.ac


V_F
(V)
1.5
1
0.5
0
I_F=150mA
typical values
75mA
20mA
1mA
0
50
100
150
200
T_j (°C)
250
7Z06242-2.1.24.ac


7Z06240-2.1.24.ac
max
typ
V_R = 40V
25V
40V
25V
I_R (nA)
10^6
10^5
10^4
10^3
10^2
10
1
0
50
100
150
200
250
T_j (°C)

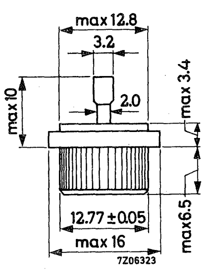

7Z06238-2.1.24.ac
T_j = 150°C
150°C
55°C
25°C
55°C
25°C
max
typ
max
max
typ
typ
I_R (nA)
10^5
10^4
10^3
10^2
10
1
10^{-1}
0
10
20
30
40
V_R (V)

SILICON POWER DIODES

Silicon diodes in a metal envelope, primarily intended as rectifiers in generating systems of motor cars.
The diodes can be press-mounted or soldered at the bottom.
The series consists of the following types:
Normal polarity (stud cathode): BYX21-100 and BYX21-200.
Reverse polarity (stud anode) : BYX21-100R and BYX21-200R.

QUICK REFERENCE DATA					
			BYX21-100(R)	200(R)	
Crest working reverse voltage	V_{RWM}	max.	50	100	V
Average forward current	I_{FAV}	max.	25		A
Non repetitive peak forward current t = 10 ms	I_{FSM}	max.	250		A
Junction temperature	T_j	max.	175		^oC
Thermal resistance from junction to case	$R_{th\ j-c}$	=	1.5		$^oC/W$

MECHANICAL DATA Dimensions in mm



Marked in red : Cathode connected to case
BYX21-100 and BYX21-200

Marked in blue: Anode connected to case
BYX21-100R and BYX21-200R

For mounting instructions see page 3

Force to seat the diode for good heat transfer: 350 kg

Maximum force : 900 kg

7Z3 0819

All information applies to frequencies up to 1000 Hz

RATINGS (Limiting values) [1]

Voltages			BYX21-100(R)	200(R)	
Continuous reverse voltage	V_R	max.	45	90	V
Crest working reverse voltage	V_{RWM}	max.	50	100	V
Repetitive peak reverse voltage	V_{RRM}	max.	100	200	V
Non repetitive peak reverse voltage ($t < 10$ ms)	V_{RSM}	max.	100	200	V

Currents				
Forward current (d.c.)	I_F	max.	25	A
Average forward current (averaged over any 20 ms period)	I_{FAV}	max.	25	A
Repetitive peak forward current	I_{FRM}	max.	80	A
Non repetitive peak forward current $t = 10$ ms	I_{FSM}	max.	250	A

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

THERMAL RESISTANCE

From junction to case	$R_{th\ j\text{-}c}$	=	1.5	°C/W
From case to heatsink				
press mounted	$R_{th\ c\text{-}h}$	=	0.5	°C/W
soldered	$R_{th\ c\text{-}h}$	=	0.2	°C/W

CHARACTERISTICS

Forward voltage at $T_j = 25$ °C				
$I_F = 80$ A	V_F	<	1.60	V [2]
Reverse current at $T_j = 125$ °C				
$V_R = 45$ V; BYX21-100(R)	I_R	<	6	mA
$V_R = 90$ V; BYX21-200(R)	I_R	<	3	mA

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

2) Measured under pulsed conditions to prevent excessive dissipation.

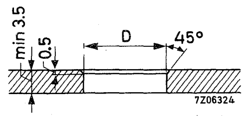
7Z3 0820

MOUNTING INSTRUCTIONS Dimensions in mm

PRESS MOUNTING

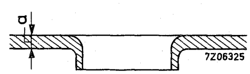
A. Flat heatsink without raised border

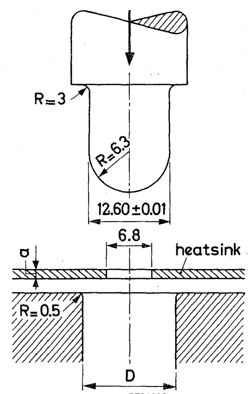
Diameter of hole in heatsink: from 12.61 to 12.66 mm
(Diameter required depends on hardness of heatsink material)
Thermal resistance from case to heatsink: $R_{th\ c\text{-}h} = 0.5\ ^{o}C/W$



B. Flat heatsink with raised border (Copper or aluminium)

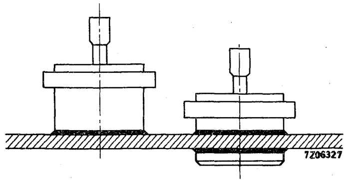
a (mm)	D (mm)	$R_{th\ c\text{-}h}$ ($^{o}C/W$)
3.00	17.50 ± 0.03	0.25
2.00	15.50 ± 0.03	0.35
1.50	14.50 ± 0.03	0.45



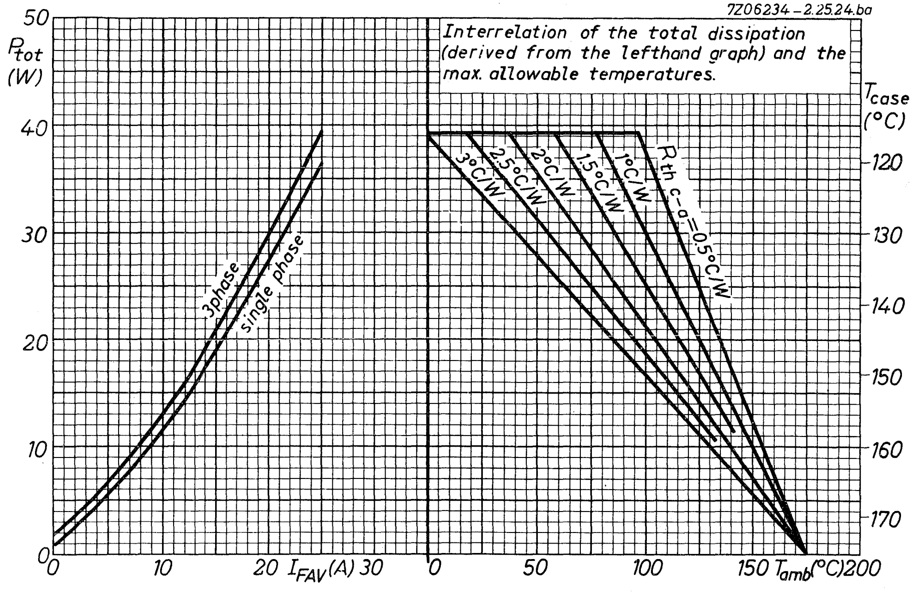


MOUNTING BY SOLDERING

Soldering temperature	T	max. 235	^{o}C
Soldering time	t	max. 30	s
Thermal resistance from case to heatsink	$R_{th\ c\text{-}h}$	= 0.2	$^{o}C/W$



7Z3 0859


7Z06234–2.25.24.ba
Interrelation of the total dissipation (derived from the lefthand graph) and the max. allowable temperatures.
Ptot (W)
50
40
30
20
10
0
0
10
20
IFAV (A)
30
3phase
single phase
0
50
100
150
Tamb (°C)
200
Tcase (°C)
120
130
140
150
160
170
3°C/W
2.5°C/W
2°C/W
1.5°C/W
1°C/W
Rth c-a=0.5°C/W

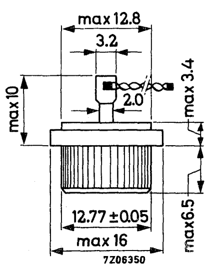
SILICON POWER DIODES

Silicon diodes in a metal envelope for rectifier applications.
The diodes can be press-mounted, soldered at the bottom or mounted with an adaptor.
The series consists of the following types:
Normal polarity (stud cathode): BYX28-200 and BYX28-400.
Reverse polarity (stud anode) : BYX28-200R and BYX28-400R.

QUICK REFERENCE DATA

			BYX28-200(R)	400(R)	
Crest working reverse voltage	V_{RWM}	max.	100	200	V
Average forward current	I_{FAV}	max.	25		A
Non repetitive peak forward current t = 10 ms	I_{FSM}	max.	300		A
Junction temperature	T_j	max.	175		^oC
Thermal resistance from junction to case	$R_{th\ j-c}$	=	1.5		$^oC/W$

MECHANICAL DATA Dimensions in mm



Marked in red : Cathode connected to case
BYX28-200 and BYX28-400

Marked in blue: Anode connected to case
BYX28-200R and BYX28-400R

For mounting instructions see pages 3 and 4

Force to seat the diode for good heat transfer: 350 kg

Maximum force : 900 kg

Not delivered with the device: Mounting adaptor 56232

7Z3 0822

All information applies to frequencies up to 1000 Hz

RATINGS (Limiting values) [1]

Voltages			BYX28-200(R)	400(R)	
Continuous reverse voltage	V_R	max.	90	180	V
Crest working reverse voltage	V_{RWM}	max.	100	200	V
Repetitive peak reverse voltage	V_{RRM}	max.	200	400	V
Non repetitive peak reverse voltage (t < 10 ms)	V_{RSM}	max.	200	400	V

Currents				
Forward current (d.c.)	I_F	max.	25	A
Average forward current (averaged over any 20 ms period)	I_{FAV}	max.	25	A
Repetitive peak forward current	I_{FRM}	max.	80	A
Non repetitive peak forward current t = 10 ms; see page B	I_{FSM}	max.	300	A

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

THERMAL RESISTANCE

From junction to case	$R_{th\ j\text{-}c}$	=	1.5	°C/W
From case to heatsink				
press mounted	$R_{th\ c\text{-}h}$	=	0.5	°C/W
soldered	$R_{th\ c\text{-}h}$	=	0.2	°C/W
mounted with adaptor 56232	$R_{th\ c\text{-}h}$	=	1.1	°C/W

CHARACTERISTICS T_j = 25 °C unless otherwise specified

Forward voltage at I_F = 80 A	V_F	<	1.45	V [2]
Reverse current at T_j = 125 °C				
V_R = 90 V; BYX28-200(R)	I_R	<	3.0	mA
V_R = 180 V; BYX28-400(R)	I_R	<	1.5	mA

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

[2]) Measured under pulsed conditions to prevent excessive dissipation.

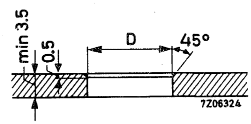
7Z3 0823

MOUNTING INSTRUCTIONS Dimensions in mm

PRESS MOUNTING

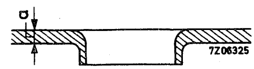
A. Flat heatsink without raised border

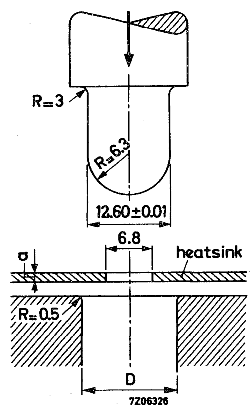
Diameter of hole in heatsink: from 12.61 to 12.66 mm
(Diameter required depends on hardness of heatsink material)
Thermal resistance from case to heatsink: $R_{th\ c\text{-}h}$ = 0.5 °C/W



B. Flat heatsink with raised border (Copper or aluminium)

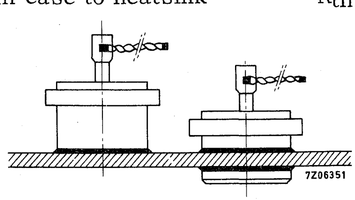
a (mm)	D (mm)	$R_{th\ c\text{-}h}$ (°C/W)
3.00	17.50 ± 0.03	0.25
2.00	15.50 ± 0.03	0.35
1.50	14.50 ± 0.03	0.45





MOUNTING BY SOLDERING

Soldering temperature	T	max. 235	°C
Soldering time	t	max. 30	s
Thermal resistance from case to heatsink	$R_{th\ c\text{-}h}$	= 0.2	°C/W



7Z3 0860

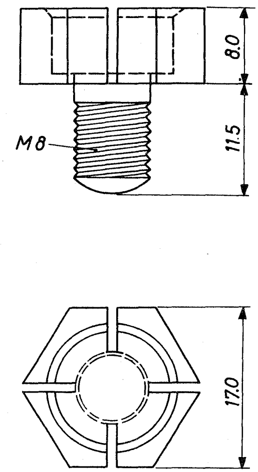
MOUNTING INSTRUCTIONS (continued)

Dimensions in mm

Mounting adaptor 56232

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

Thermal resistance from case to heatsink: $R_{th\ c\text{-}h} = 1.1\ ^{o}C/W$

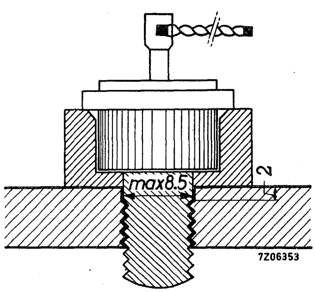


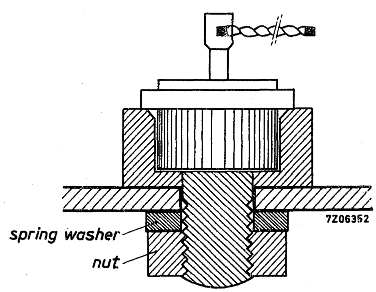
Mounting method 1

Torque on nut:	min.	80 cm kg
	max.	130 cm kg

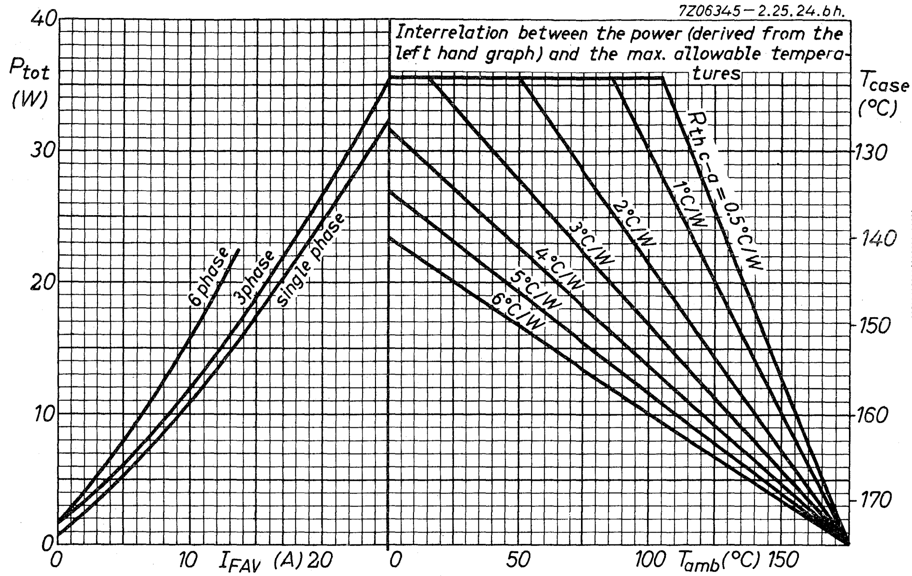
Mounting method 2

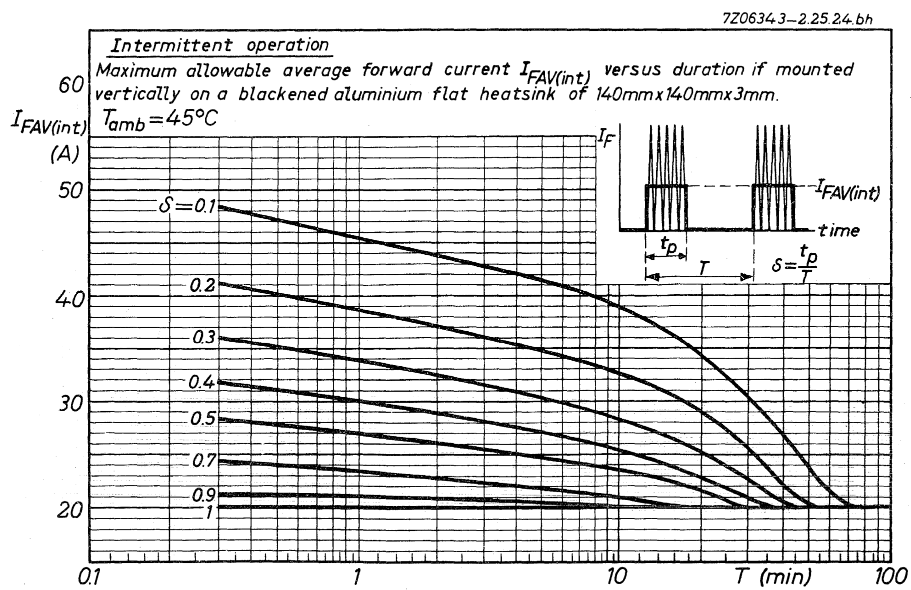
Diameter of hole in heatsink:	max.	8.5 mm
Torque on nut :	min.	60 cm kg
	max.	100 cm kg

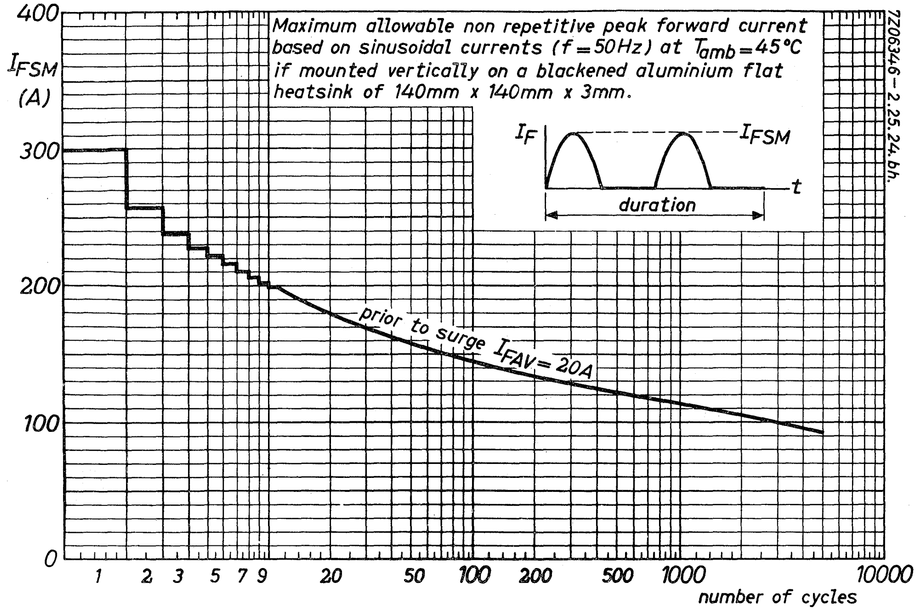


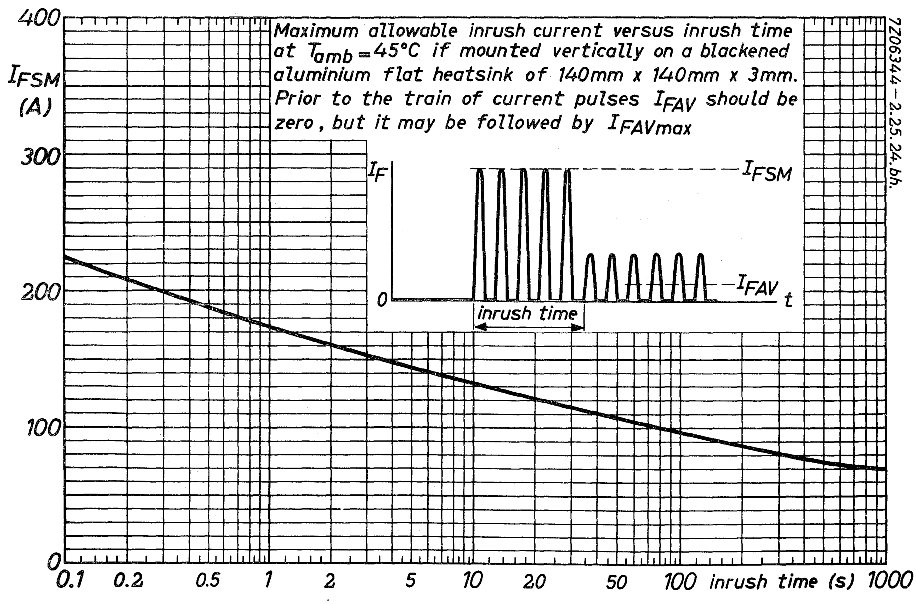


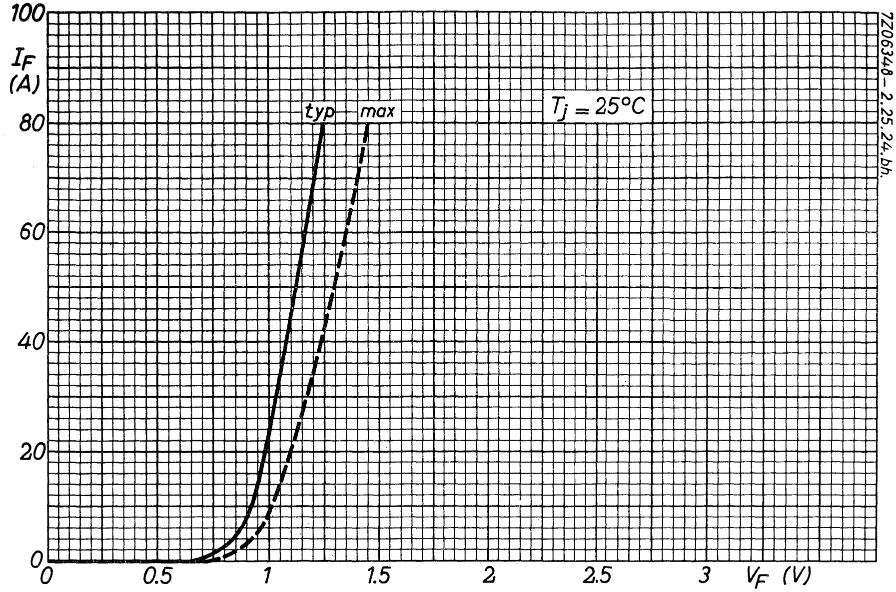
7Z3 0861

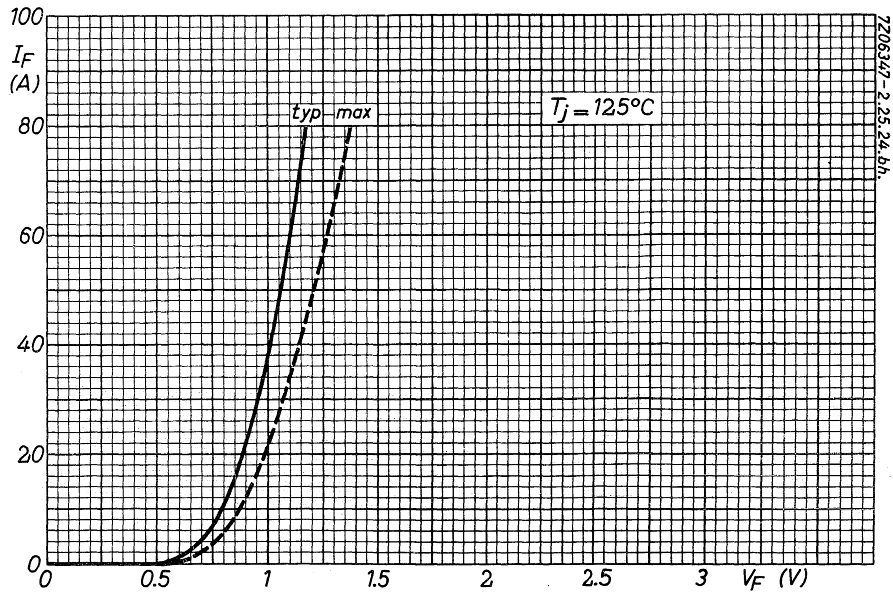

7Z06345–2.25.24.bh.
Interrelation between the power (derived from the left hand graph) and the max. allowable temperatures
P_{tot} (W)
40
30
20
10
0
6 phase
3 phase
single phase
0
10
I_{FAV} (A)
20
0
50
100
T_{amb}(°C)
150
T_{case} (°C)
130
140
150
160
170
$R_{th\,c-a}$ = 0.5°C/W
1°C/W
2°C/W
3°C/W
4°C/W
5°C/W
6°C/W

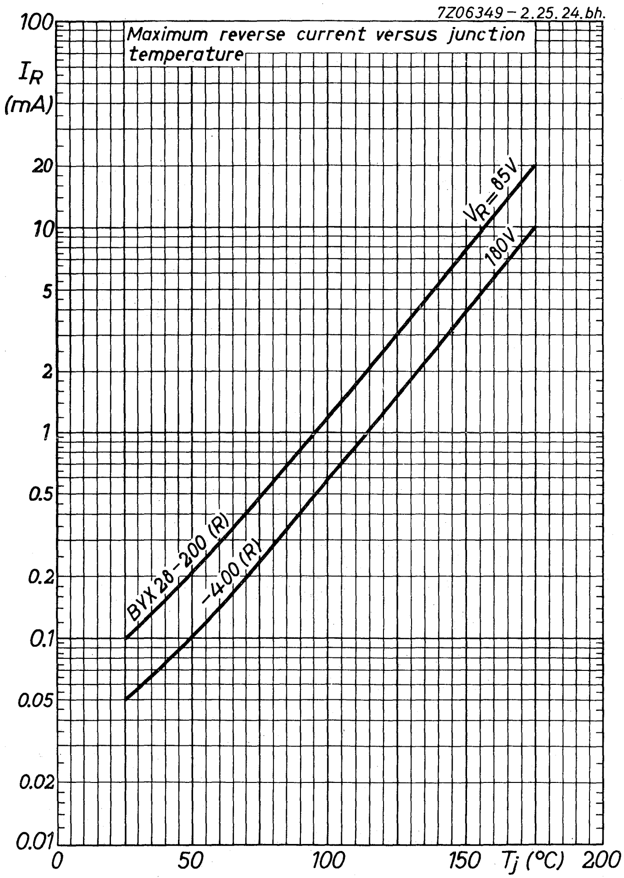

7Z06343–2.25.24.bh
Intermittent operation
Maximum allowable average forward current $I_{FAV(int)}$ versus duration if mounted vertically on a blackened aluminium flat heatsink of 140mm x 140mm x 3mm.
T_{amb} = 45°C
$I_{FAV(int)}$ (A)
60
50
40
30
20
δ = 0.1
0.2
0.3
0.4
0.5
0.7
0.9
1
I_F
$I_{FAV(int)}$
time
t_p
T
$\delta = \frac{t_p}{T}$
0.1
1
10
T (min)
100


Maximum allowable non repetitive peak forward current based on sinusoidal currents (f = 50Hz) at T_{amb} = 45 °C if mounted vertically on a blackened aluminium flat heatsink of 140mm x 140mm x 3mm.
I_F
I_{FSM}
t
duration
prior to surge I_{FAV} = 20A
I_{FSM} (A)
400
300
200
100
0
1
2
3
5
7
9
20
50
100
200
500
1000
10000
number of cycles
7Z06346 – 2.25.24.bh.


Maximum allowable inrush current versus inrush time at T_{amb} = 45°C if mounted vertically on a blackened aluminium flat heatsink of 140mm x 140mm x 3mm. Prior to the train of current pulses I_{FAV} should be zero, but it may be followed by I_{FAVmax}
I_F
I_{FSM}
0
I_{FAV}
t
inrush time
I_{FSM} (A)
400
300
200
100
0
0.1
0.2
0.5
1
2
5
10
20
50
100
inrush time (s)
1000
7Z06344 – 2.25.24.bh.


100
I_F
(A)
80
60
40
20
0
typ
max
$T_j = 25°C$
0
0.5
1
1.5
2
2.5
3
V_F (V)
7Z06348–2.25.24.bh.


100
I_F
(A)
80
60
40
20
0
typ
max
$T_j = 125°C$
0
0.5
1
1.5
2
2.5
3
V_F (V)
7Z06347–2.25.24.bh.


7Z06349 – 2.25.24.bh.
Maximum reverse current versus junction temperature
I_R (mA)
100
20
10
5
2
1
0.5
0.2
0.1
0.05
0.02
0.01
0
50
100
150
200
T_j (°C)
V_R = 85V
180V
BYX 28 – 200 (R)
– 400 (R)

HIGH SPEED
POWER DIODES WITH CONTROLLED AVALANCHE

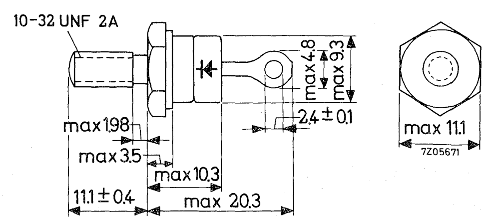
Diffused silicon diodes in a DO-4 metal envelope, capable of absorbing transients. They are primarily intended for use in high frequency power supplies, thyristor inverters and multi-phase power rectifier applications.
The series consists of the following types:
Normal polarity (stud cathode): BYX30-200 to BYX30-500
Reverse polarity (stud anode) : BYX30-200R to BYX30-500R.

QUICK REFERENCE DATA

			BYX30-200(R)	300(R)	400(R)	500(R)	
Crest working reverse voltage	V_{RWM}	max.	200	300	400	500	V
Average forward current	I_{FAV}	max.		14			A
Non repetitive peak forward current; t = 10 ms	I_{FSM}	max.		250			A
Repetitive peak reverse power t = 10 μs; T_j = 150 ^oC	P_{RRM}	max.		5.5			kW
Non repetitive peak reverse power; t = 10 μs; T_j = 25 ^oC	P_{RSM}	max.		18			kW
Junction temperature	T_j	max.		150			^oC
Thermal resistance from junction to mounting base	$R_{th\ j-mb}$	=		1.3			$^oC/W$
Reverse recovery time $I_F = I_R$ = 2 A	t_{rr}	<		0.35			μs

MECHANICAL DATA Dimensions in mm

Supplied with the device: Nut, metal washer, metal lock washer
DO-4



Net weight : 5.6 g
With accessories: 7.5 g
Diameter of hole in heatsink: max. 5.2 mm

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

7Z3 0811

All information applies to frequencies up to 50 kHz

RATINGS (Limiting values) [1])

Voltages [2])

		BYX30-200(R)	300(R)	400(R)	500(R)	
Continuous reverse voltage	V_R	max. 200	300	400	500	V
Crest working reverse voltage	V_{RWM}	max. 200	300	400	500	V

Currents

Average forward current (averaged over any 20 ms period)	I_{FAV}	max.	14	A
Forward current (d.c.)	I_F	max.	17	A
Repetitive peak forward current	I_{FRM}	max.	310	A
Non repetitive peak forward current t = 10 ms (see also page C)	I_{FSM}	max.	250	A
Repetitive peak reverse current (during turn-off)	I_{RRM}	max.	20	A

Reverse power dissipation

Reverse power (d.c. or average over any 20 ms period) See also page B	P_R	max.	30	A
Repetitive peak reverse power at f = 50 Hz square wave; t = 10 μs; T_j = 150 °C	P_{RRM}	max.	5.5	kW
Non repetitive peak reverse power (square wave) See also page B t = 10 μs; T_j = 25 °C	P_{RSM}	max.	18	kW
T_j = 150 °C	P_{RSM}	max.	5.5	kW

Temperatures

Storage temperature	T_{stg}		−55 to +150	°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	50	°C/W
From junction to mounting base	$R_{th\ j\text{-}mb}$	=	1.3	°C/W
From mounting base to heatsink	$R_{th\ mb\text{-}h}$	=	0.5	°C/W

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

[2]) To ensure thermal stability: $R_{th\ j\text{-}a}$ < 2.5 °C/W (d.c.) or < 5 °C/W (a.c.) For smaller heatsinks $T_{j\ max.}$ should be derated. For a.c. see page A.
For d.c.: if $R_{th\ j\text{-}a}$ = 5 °C/W, then $T_{j\ max.}$ = 135 °C,
if $R_{th\ j\text{-}a}$ = 10 °C/W, then $T_{j\ max.}$ = 120 °C.

7Z3 0812

CHARACTERISTICS

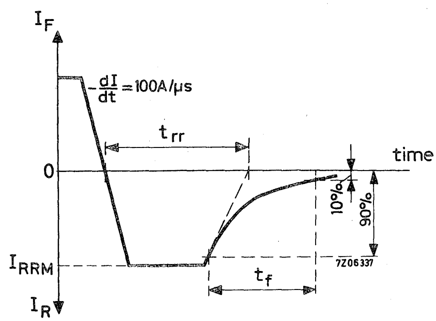
T_j = 25 °C unless otherwise specified

		BYX30-200(R)	300(R)	400(R)	500(R)	
Forward voltage at I_F = 50 A [1]	V_F	< 3.2	3.2	3.2	3.2	V
Reverse breakdown voltage I_R = 5 mA; see page D	$V_{(BR)R}$	> 250	375	500	625	V
		< 515	640	770	900	V
Reverse current at T_j = 125 °C V_R = V_{RWMmax}.	I_R	< 4.0	4.0	4.0	3.5	mA

Recovered charge when switched from
I_F = 2 A to V_R = 30 V;
I_R limited to I_{RRM} = 2 A; $-\frac{dI}{dt}$ = 100 A/μs — Q_s < 0.70 μC

Reverse recovery time when switched from
I_F = 2 A to V_R = 30 V;
I_R limited to I_{RRM} = 2 A; $-\frac{dI}{dt}$ = 100 A/μs — t_{rr} < 0.35 μs

Fall time under all conditions — t_f < 0.30 μs



OPERATING NOTES FOR REPETITIVE CONDITIONS

1. Square wave operation
When I_F has been flowing sufficiently long for steady state to be established, there will be a charge due to minority carriers present. Before the device can block in the reverse direction this charge must be extracted. This extraction takes the form of a reverse transient (see figure above). The majority of the power dissipation due to the reverse transient occurs during t_f as the rectifier gradually becomes reverse biased, and the mean power will be proportional to the operating frequency. The mean value of this power loss may, for all practical purposes be taken to be approximately equal to

$$5.10^{-8}.V_{RWM}.I_{RRM}.\text{frequency}$$

p.t.o.

[1]) Measured under pulsed conditions to prevent excessive dissipation.

7Z3 0813

OPERATING NOTES FOR REPETITIVE CONDITIONS (continued)

2. Sine wave operation.
Power loss in sine wave operation will be considerable less due to the much slower rate of change of the applied voltage (and consequent lower values of I_{RRM}), so that power loss due to reverse recovery may be safely ignored for frequencies up to 50 kHz.

EXAMPLE (Determination of the heatsink thermal resistance)

Assume a diode, used in a single phase, 50 Hz rectifier circuit at an ambient temperature of 40 °C. The average forward current I_{FAV} = 6 A (per diode). Furthermore assume a repetitive peak reverse power in the avalanche region P_{RRM} = 3 kW (per diode) during 40 microseconds.

From the upper graph at page A it follows that in a single phase rectifier circuit at I_{FAV} = 6 A the average forward power + average leakage power = 15 W per diode (point A). The average reverse power in the avalanche region, averaged over any cycle, follows from:

$$P_{RAV} = \delta \times P_{RRM}, \text{ where the duty cycle } \delta = \frac{40\ \mu s}{20\ ms} = 0.002$$

Thus: $P_{RAV} = 0.002 \times 3\ kW = 6\ W$. According to operating note 2 the power losses due to reverse recovery may be neglected.

Therefore the total device power dissipation P_{tot} = 15 + 6 = 21 W (point B). From the graph follows a maximum permissible mounting base temperature T_{mb} = 123 °C (point C).

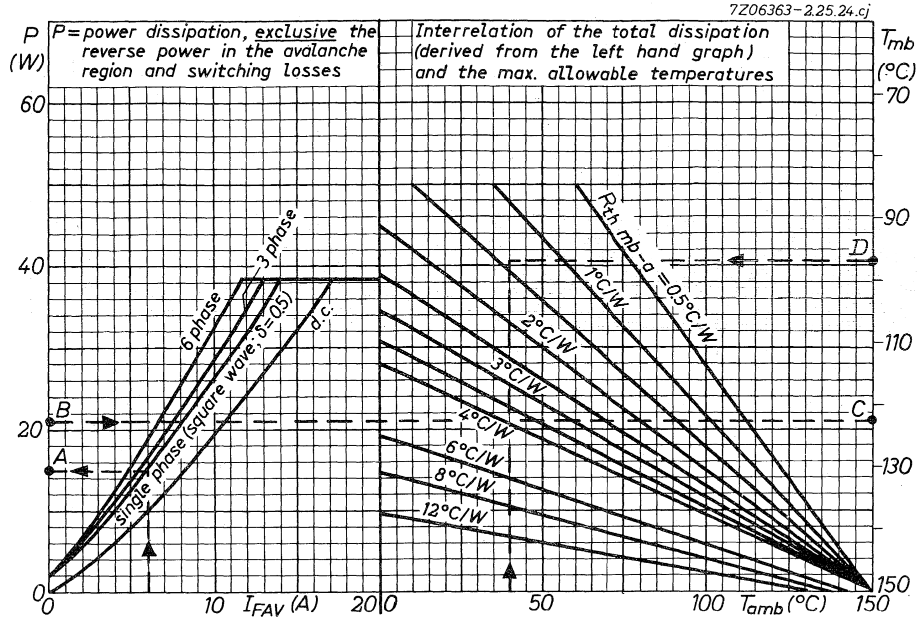
However, to avoid excessive peak junction temperatures resulting from the pulse character of the repetitive peak reverse power in the avalanche region, this value of the mounting base temperature should be decreased as follows: If the repetitive peak reverse power in the avalanche region is 3 kW; t = 40 μs; f = 50 Hz, the maximum allowable junction temperature should be 124 °C instead of 150 °C (see the lower graph at page A).
Therefore the mounting base temperature should be decreased with 150 - 124 = 26 °C as well.

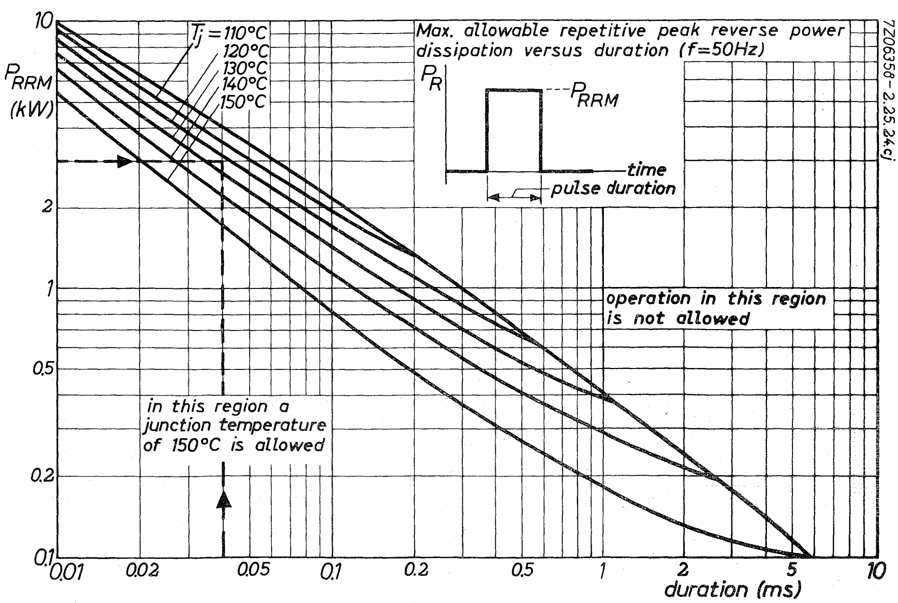
So the maximum allowable mounting base temperature is 123 - 26 = 97 °C (point D).

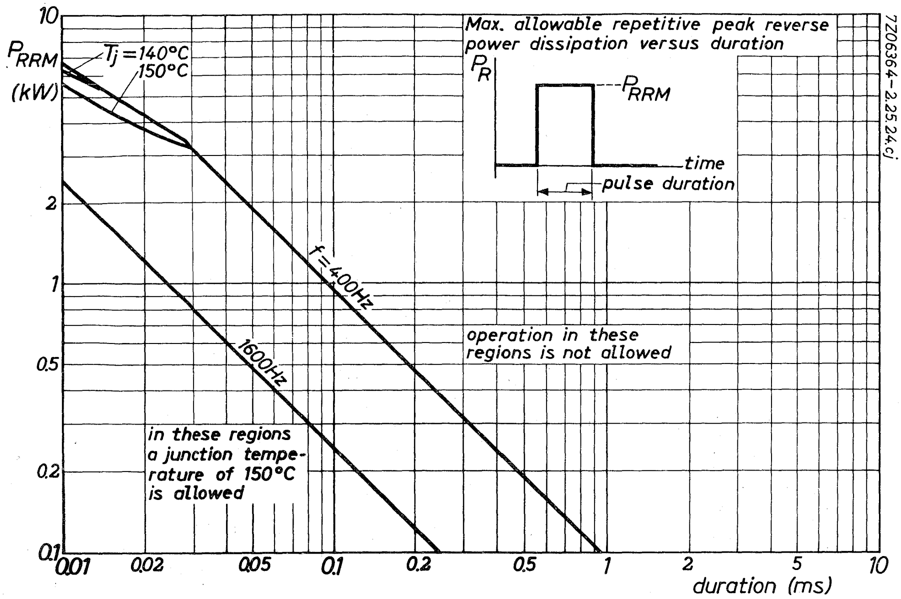
Then from the upper graph at page A it follows that at T_{amb} = 40 °C, the required thermal resistance $R_{th\ mb\text{-}a} \approx 1.4$ °C/W.
Hence the heatsink thermal resistance should be:

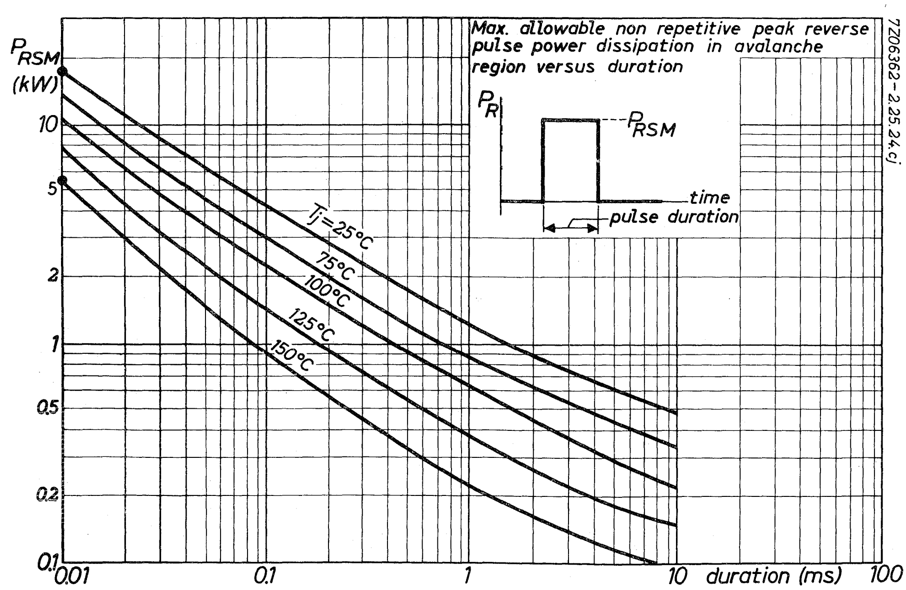
$$R_{th\ h\text{-}a} = R_{th\ mb\text{-}a} - R_{th\ mb\text{-}h} = (1.4 - 0.5)\ ^{o}C/W = 0.9\ ^{o}C/W.$$

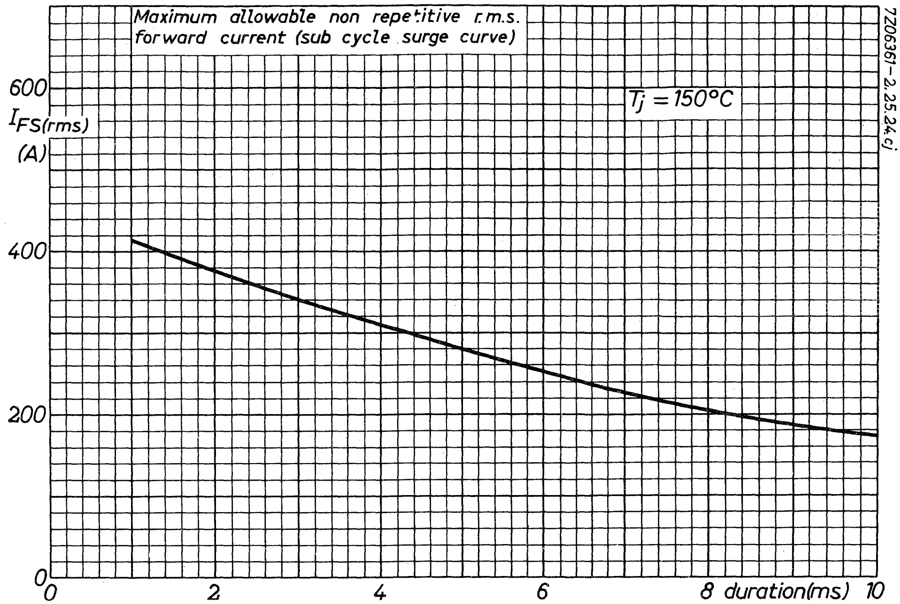
7Z3 0814

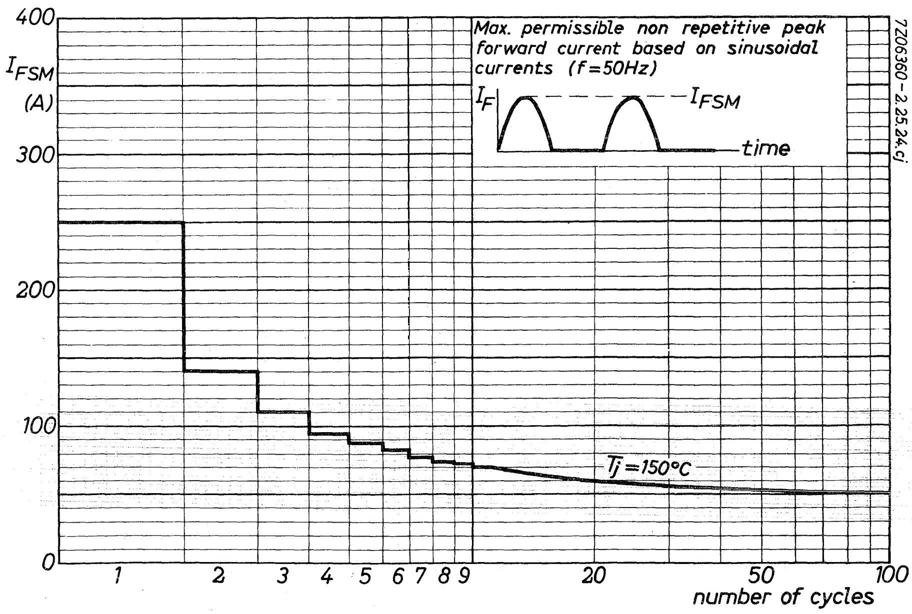

7Z06363-2.25.24.cj
P (W)
P = power dissipation, exclusive the reverse power in the avalanche region and switching losses
Interrelation of the total dissipation (derived from the left hand graph) and the max. allowable temperatures
T_{mb} (°C)
60
40
20
0
70
90
110
130
150
6 phase
3 phase
single phase (square wave; δ=0.5)
d.c.
$R_{th\ mb-a}$ = 0.5°C/W
1°C/W
2°C/W
3°C/W
4°C/W
6°C/W
8°C/W
12°C/W
A
B
C
D
0
10
I_{FAV} (A)
20
0
50
100
T_{amb} (°C)
150

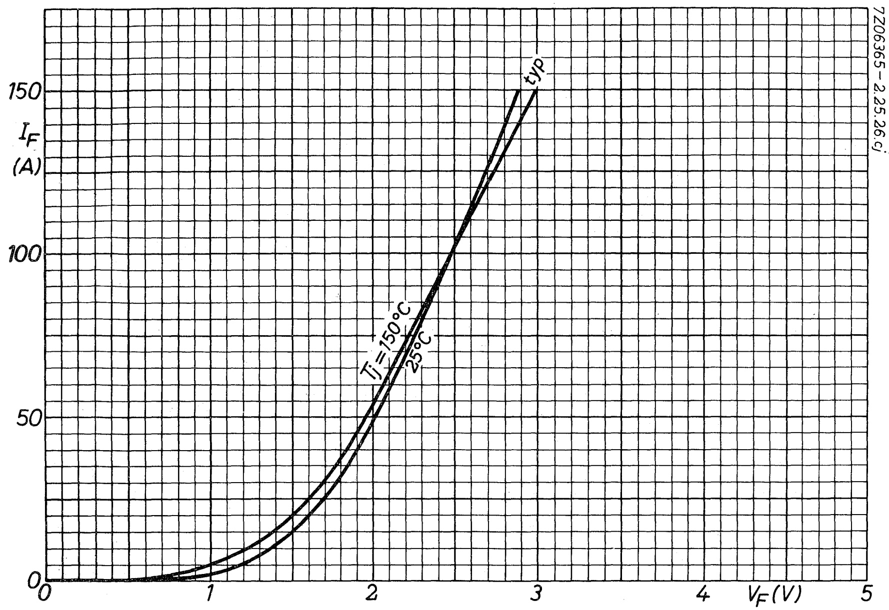

7Z06358-2.25.24.cj
P_{RRM} (kW)
10
2
1
0.5
0.2
0.1
T_j = 110°C
120°C
130°C
140°C
150°C
Max. allowable repetitive peak reverse power dissipation versus duration (f=50Hz)
P_R
P_{RRM}
time
pulse duration
operation in this region is not allowed
in this region a junction temperature of 150°C is allowed
0.01
0.02
0.05
0.1
0.2
0.5
1
2
5
10
duration (ms)

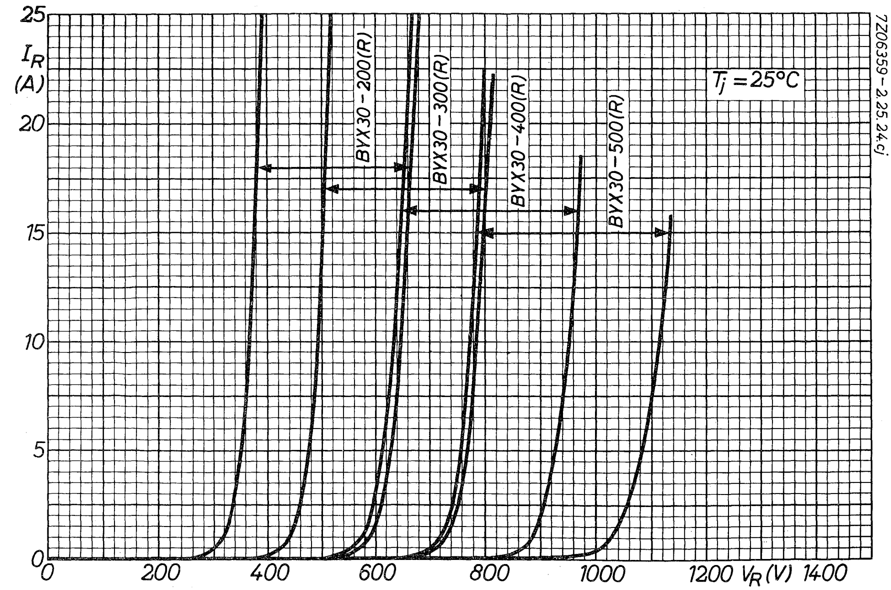

Max. allowable repetitive peak reverse power dissipation versus duration
7Z06364-2.25.24.cj
P_{RRM} (kW)
T_j = 140°C
150°C
P_R
P_{RRM}
time
pulse duration
f = 400Hz
1600Hz
operation in these regions is not allowed
in these regions a junction temperature of 150°C is allowed
10
2
1
0.5
0.2
0.1
0.01
0.02
0.05
0.1
0.2
0.5
1
2
5
10
duration (ms)

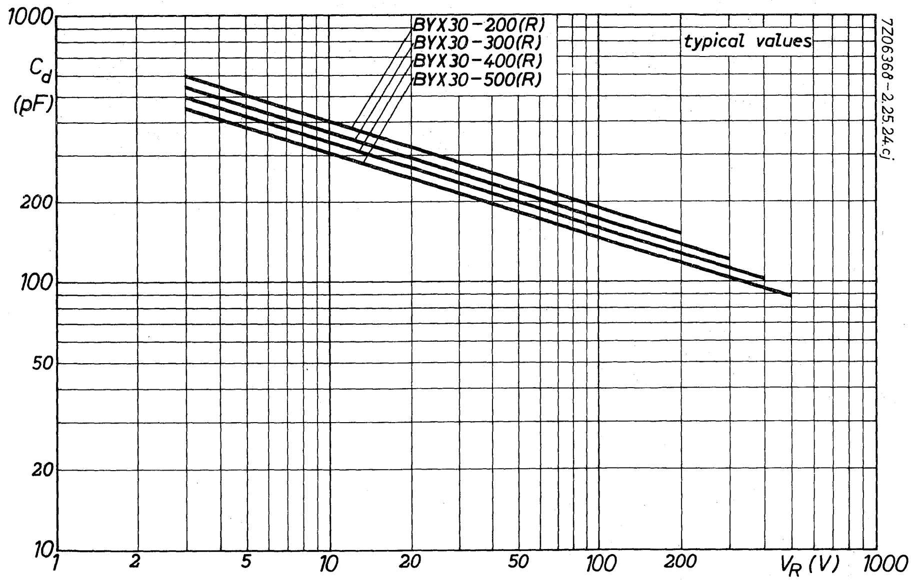

Max. allowable non repetitive peak reverse pulse power dissipation in avalanche region versus duration
7Z06362-2.25.24.cj
P_{RSM} (kW)
P_R
P_{RSM}
time
pulse duration
T_j = 25°C
75°C
100°C
125°C
150°C
10
5
2
1
0.5
0.2
0.1
0.01
0.1
1
10
duration (ms)
100

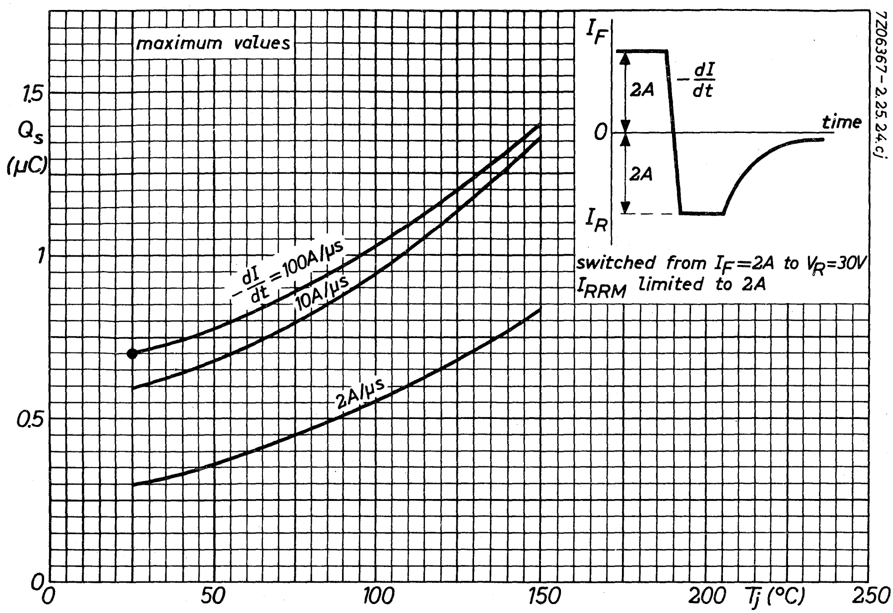

Maximum allowable non repetitive r.m.s. forward current (sub cycle surge curve)
$T_j = 150°C$
600
$I_{FS(rms)}$
(A)
400
200
0
0
2
4
6
8 duration(ms) 10
7Z06361-2.25.24.cj

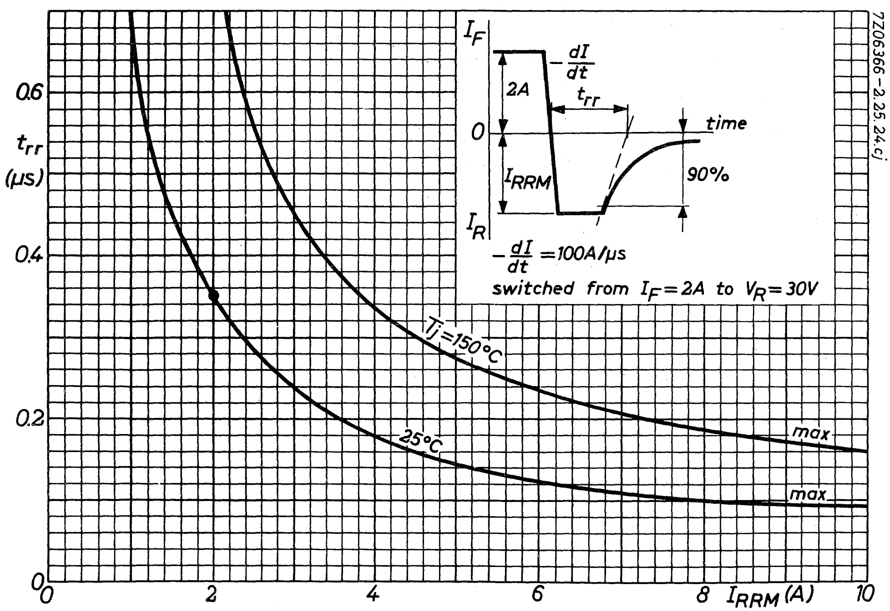

Max. permissible non repetitive peak forward current based on sinusoidal currents (f=50Hz)
I_F
I_{FSM}
time
T_j=150°C
400
I_{FSM}
(A)
300
200
100
0
1
2
3
4
5
6
7
8
9
20
50
100
number of cycles
7Z06360-2.25.24.cj


I_F
(A)
150
100
50
0
0
1
2
3
4
V_F (V)
5
typ
$T_j = 150°C$
25°C
7Z06365 - 2.25.26.cj


25
I_R
(A)
20
15
10
5
0
0
200
400
600
800
1000
1200
V_R (V)
1400
$T_j = 25°C$
BYX30 - 200(R)
BYX30 - 300(R)
BYX30 - 400(R)
BYX30 - 500(R)
7Z06359 - 2.25.24.cj


1000
C_d
(pF)
200
100
50
20
10
1
2
5
10
20
50
100
200
1000
V_R (V)
BYX30-200(R)
BYX30-300(R)
BYX30-400(R)
BYX30-500(R)
typical values
7Z06368-2.25.24.cj


maximum values
1.5
Q_s
(μC)
1
0.5
0
0
50
100
150
200
T_j (°C)
250
$-\frac{dI}{dt}$ = 100A/μs
10A/μs
2A/μs
I_F
2A
$-\frac{dI}{dt}$
0
time
2A
I_R
switched from I_F=2A to V_R=30V
I_{RRM} limited to 2A
7Z06367-2.25.24.c)


0.6
t_{rr}
(μs)
0.4
0.2
0
0
2
4
6
8
I_{RRM} (A)
10
T_j=150°C
25°C
max
max
I_F
2A
$-\frac{dI}{dt}$
t_{rr}
0
time
I_{RRM}
90%
I_R
$-\frac{dI}{dt}$ = 100A/μs
switched from I_F=2A to V_R=30V
7Z06366-2.25.24.c)

P-GATE SILICON THYRISTORS

P-gate thyristors in a metal envelope. They are intended for power control and power switching applications.
The series consists of the following reverse polarity types (stud anode):
BTY79-100R, BTY79-200R, BTY79-300R, BTY79-400R,
BTY79-500R, BTY79-600R, BTY79-700R and BTY79-800R.

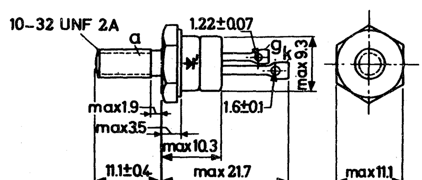
QUICK REFERENCE DATA

		BTY79-100R	200R	300R	400R	500R	600R	700R	800R	
Crest working reverse voltage	V_{RWM} max.	100	200	300	400	500	600	700	800	V
Crest working off-state voltage	V_{DWM} max.	100	200	300	400	500	600	700	800	V

Average forward current	I_{TAV}	max.	6.4	A
Non repetitive peak forward current (t = 10 ms)	I_{TSM}	max.	50	A
Junction temperature	T_j	max.	125	^oC
Thermal resistance from junction to mounting base	$R_{th\ j\text{-}mb}$	=	3.0	$^oC/W$

MECHANICAL DATA Dimensions in mm

Supplied with the device: Nut, metal washer and metal lock washer.



Net weight : 5.6 g
With accessories: 7.5 g

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

Diameter of hole in heatsink: max. 5.2 mm

7Z3 0807

All information applies to frequencies up to 400 Hz.

RATINGS (Limiting values) [1])

ANODE TO CATHODE

Voltages [2])		BTY79-100R	200R	300R	400R	500R	600R	700R	800R	
Continuous reverse voltage	V_R max.	100	200	300	400	500	600	700	800	V
Crest working reverse voltage	V_{RWM} max.	100	200	300	400	500	600	700	800	V
Repetitive peak reverse voltage	V_{RRM} max.	100	200	300	400	500	600	700	800	V
Non repetitive peak reverse voltage ($t < 5$ ms)	V_{RSM} max.	150	300	400	500	600	720	850	960	V
Continuous off-state voltage	V_D max.	100	200	300	400	500	600	700	800	V
Crest working off-state voltage	V_{DWM} max.	100	200	300	400	500	600	700	800	V
Repetitive peak off-state voltage	V_{DRM} max.	100	200	300	400	500	600	700	800	V
Non rep. peak off-state voltage	V_{DSM} max.	500	500	500	500	850	850	850	850	V [3])

Currents

Average forward current (averaged over any 20 ms period)	I_{TAV}	max.	6.4	A
Forward current (d.c.)	I_T	max.	10	A
Repetitive peak forward current	I_{TRM}	max.	50	A
Non repetitive peak forward current ($t = 10$ ms) See page D	I_{TSM}	max.	50	A
Repetitive peak reverse current (during turn-off)	I_{RRM}	max.	5	A

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

2) These ratings apply to a gate voltage range of -5 to $+0.25$ V. To ensure thermal stability: $R_{th\ j-a} \leqq 6$ °C/W (d.c.) or $\leqq 12$ °C/W (a.c.)

3) This voltage may be applied without damage but the thyristor may switch into the on-state. Care should be taken that no current ratings are exceeded.

7Z3 0808

RATINGS (Limiting values) (continued)

GATE TO CATHODE

Voltages

Forward peak voltage	V_{FGM}	max.	10	V
Reverse peak voltage	V_{RGM}	max.	5	V

Current

Forward peak current	I_{FGM}	max.	2	A

Power dissipation

Average power dissipation (averaged over any 20 ms period)	P_{GAV}	max.	0.5	W
Peak power dissipation	P_{GM}	max.	5	W

TEMPERATURES

Storage temperature	T_{stg}	-55 to +125		^oC
Junction temperature	T_j	max.	125	^oC

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	3.0	$^oC/W$
From mounting base to heatsink	$R_{th\ mb\text{-}h}$	=	0.5	$^oC/W$
From mounting base to heatsink with mica washer	$R_{th\ mb\text{-}h}$	=	4.0	$^oC/W$

7Z3 0657

CHARACTERISTICS T_j = 125 °C unless otherwise specified

ANODE TO CATHODE

Voltages			BTY79-100R	200R	300R	400R	500R	600R	700R	800R	
Forward on-state voltage [1]) I_T = 20 A; T_j = 25 °C	V_T	<	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	V
Forward breakover voltage	$V_{(BO)}$	>	100	200	300	400	500	600	700	800	V
Rate of rise of forward voltage not to trigger the device	$\frac{dV_D}{dt}$	typ.	100	100	100	100	100	100	100	100	V/μs
Rate of rise of forward voltage not to trigger any device	$\frac{dV_D}{dt}$	<	20	20	20	20	20	20	20	20	V/μs
Currents											
Reverse current [2]) $V_R = V_{RWMmax.}$	I_R	<	5	5	5	5	2.5	2.5	2.5	2.5	mA
Off-state current $V_D = D_{DWMmax.}$	I_D	<	5	5	5	5	2.5	2.5	2.5	2.5	mA

Holding current I_H typ. 10 mA

GATE TO CATHODE

Voltages

Voltage to trigger all devices V_D = 6 V; T_j = 25 °C	V_{GT}	>	2.5	V
Voltage not to trigger any device	V_{GD}	<	0.25	V

Current

Current to trigger all devices V_D = 6 V; T_j = 25 °C	I_{GT}	>	25	mA

1) Measured under pulsed conditions to prevent excessive dissipation.

2) These I_R values apply to a gate voltage range of −5 to +0.25 V.

7Z3 0809

SWITCHING CHARACTERISTICS (See also page D)

Turn on time when switched from V_D = 50 V to I_T = 10 A				
Gate source 3 V, 20 Ω, T_j = 125 °C	t_{on}	typ.	3.0	µs
Turn off time when switched from I_T = 10 A to I_R = 5 A				
dV_D/dt = 20 V/µs; T_j = 125 °C	t_{off}	typ.	15	µs
		<	25	µs

7Z3 0659

OPERATING NOTES

1. When there is a possibility that transient voltages, caused by the stored energy in the transformer core, will exceed the maximum permissible non repetitive peak reverse voltage, a damping circuit across the transformer should be applied.
   Either a series RC circuit or a voltage dependent resistor may be used. Suitable component values for an RC circuit across the transformer primary or secondary may be calculated as follows:

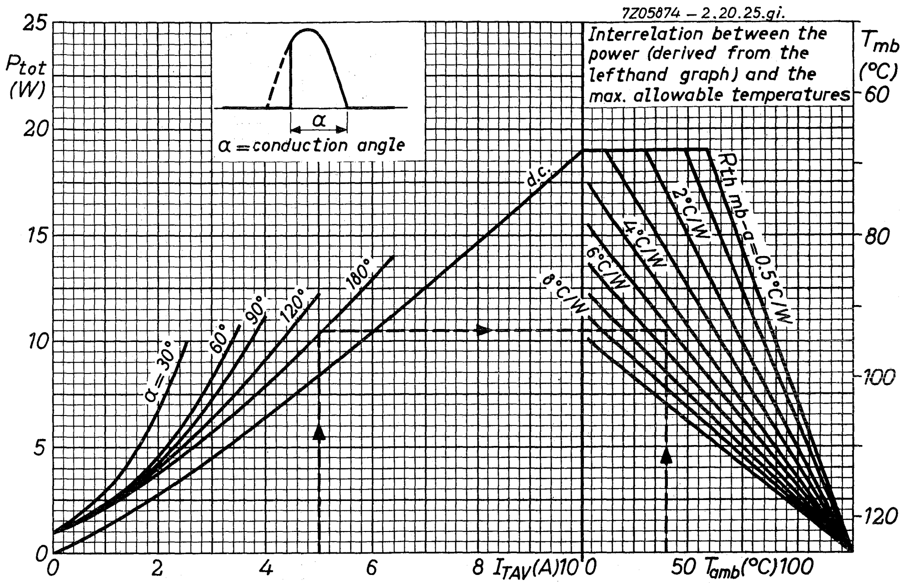
$\frac{V_{RSM}}{V_{RWM}}$	RC across primary of transformer		RC across secondary of transformer	
	C (μF)	R (Ω)	C (μF)	R (Ω)
2.0	$200\frac{I_{mag}}{V_1}$	$\frac{150}{C}$	$225\frac{I_{mag}T^2}{V_1}$	$\frac{200}{C}$
1.5	$400\frac{I_{mag}}{V_1}$	$\frac{225}{C}$	$450\frac{I_{mag}T^2}{V_1}$	$\frac{275}{C}$
1.25	$550\frac{I_{mag}}{V_1}$	$\frac{260}{C}$	$620\frac{I_{mag}T^2}{V_1}$	$\frac{310}{C}$
1.0	$800\frac{I_{mag}}{V_1}$	$\frac{300}{C}$	$900\frac{I_{mag}T^2}{V_1}$	$\frac{350}{C}$

   where I_{mag} = 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 = V_1/V_2
   V_{RWM} stands for the actually applied crest working reverse voltage.

2. In order to prevent the thyristors from being damaged by surge currents higher than those mentioned in the curve at page D a fast fuse is recommended.

3. The gate and cathode connectors should not be bent; they should be soldered into the circuit so there is no strain on them.
   During soldering the heat conduction to the junction should be kept to a minimum by using a thermal shunt.

7Z3 0810



EXAMPLE (Determination of the heatsink thermal resistance)

Assume the thyristor used in a 50 Hz single phase full wave rectifier circuit (conduction angle α = 180°) at T_{amb} = 40 °C.
The average forward current (per thyristor) I_{TAV} = 5 A.

From the left hand part of the graph above it follows that at I_{TAV} = 5 A and α = 180° the average forward power + average leakage power = 10.5 W per thyristor.

From the right hand part follows the thermal resistance, required for P_{tot} = 10.5 W at T_{amb} = 40 °C.

$$R_{th\ mb\text{-}a} \approx 5.2\ ^{\circ}C/W$$

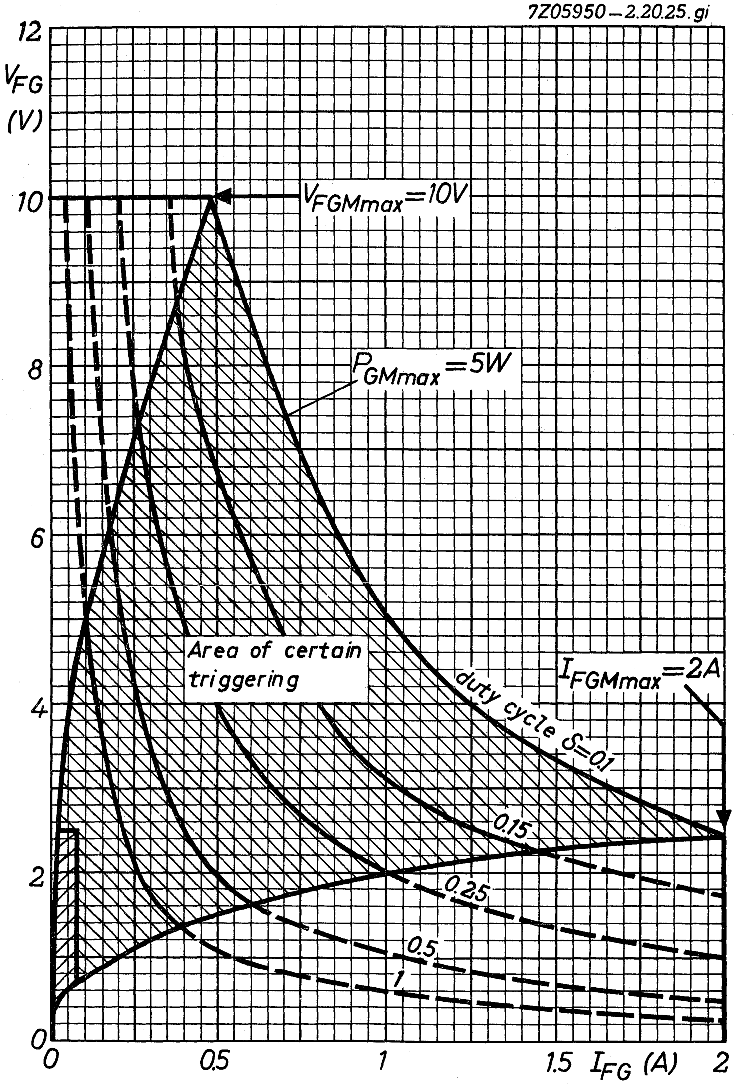
The contact thermal resistance $R_{th\ mb\text{-}h}$ = 0.5 °C/W

Hence the heatsink thermal resistance should be:

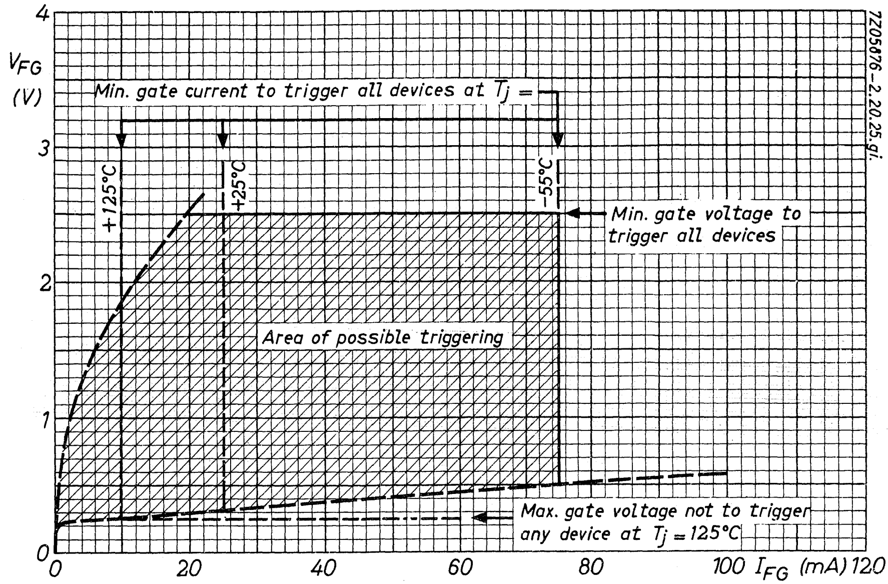
$$R_{th\ h\text{-}a} = R_{th\ mb\text{-}a} - R_{th\ mb\text{-}h} = (5.2 - 0.5)\ ^{\circ}C/W = 4.7\ ^{\circ}C/W$$

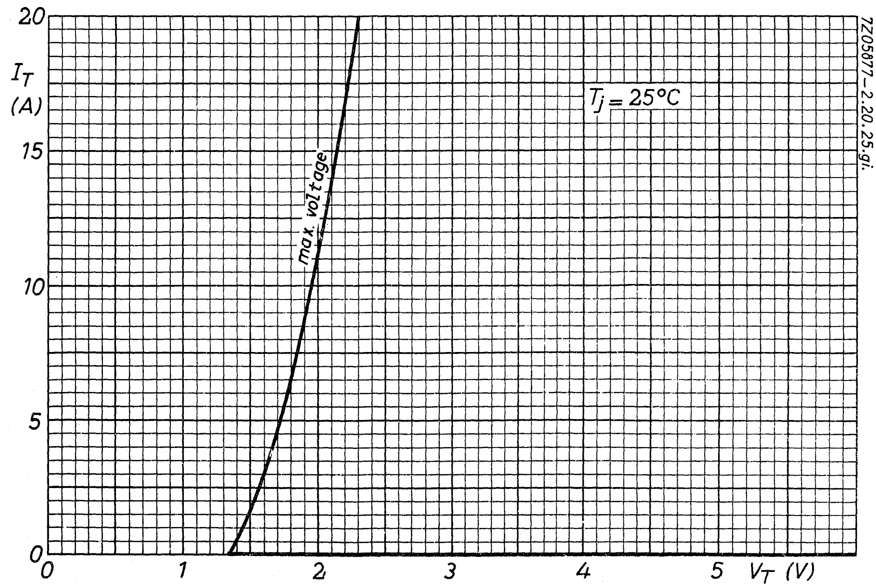
Alternatively, when the heatsink and $R_{th\ h\text{-}a}$ are known, the maximum permissible ambient temperature can be found.

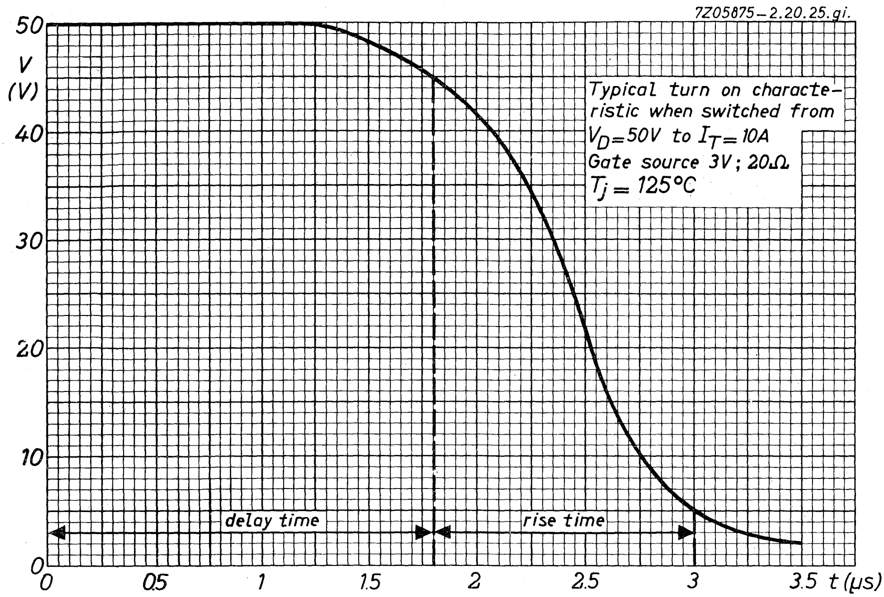
7Z3 0661

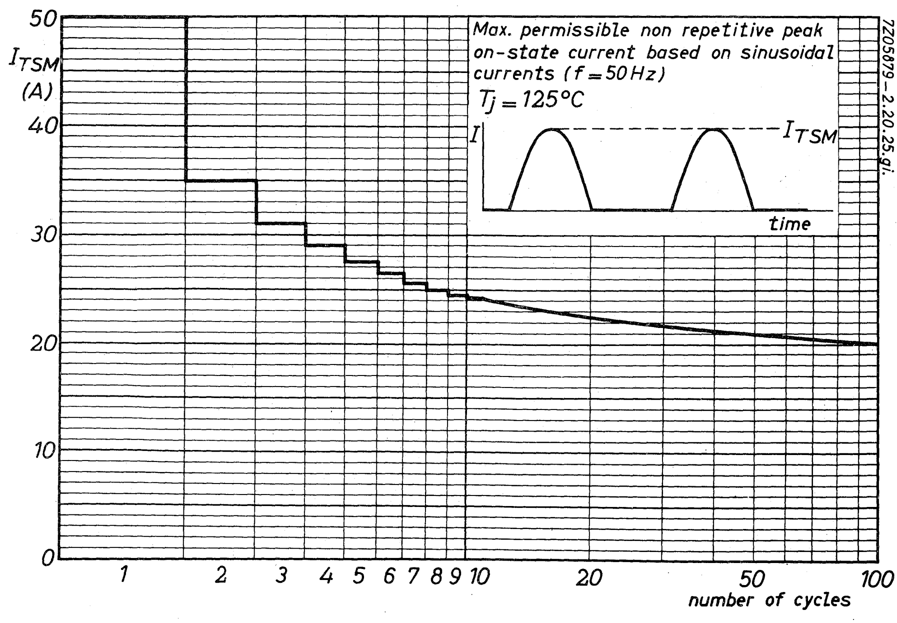


Gate characteristics with curves P_{GAV}=0.5W


7Z05676-2.20.25.gi.
V_{FG} (V)
Min. gate current to trigger all devices at T_j =
+125°C
+25°C
−55°C
Min. gate voltage to trigger all devices
Area of possible triggering
Max. gate voltage not to trigger any device at T_j = 125°C
I_{FG} (mA)


7Z05677-2.20.25.gi.
I_T (A)
T_j = 25°C
max. voltage
V_T (V)


7Z05875–2.20.25.gi.
Typical turn on characteristic when switched from $V_D = 50V$ to $I_T = 10A$
Gate source 3V; 20Ω
$T_j = 125°C$
V
(V)
50
40
30
20
10
0
delay time
rise time
0
0.5
1
1.5
2
2.5
3
3.5
t (μs)


7Z05879–2.20.25.gi.
Max. permissible non repetitive peak on-state current based on sinusoidal currents (f = 50 Hz)
$T_j = 125°C$
I
I_{TSM}
time
I_{TSM}
(A)
50
40
30
20
10
0
1
2
3
4
5
6
7
8
9
10
20
50
100
number of cycles

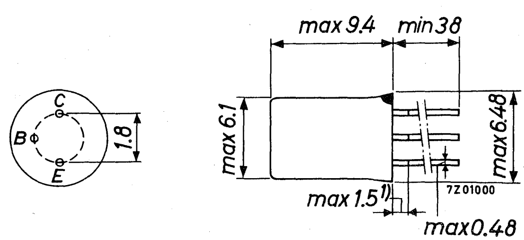
SYMMETRICAL GERMANIUM TRANSISTOR

N-P-N transistor in a TO-1 metal envelope. The AC130 is primarily intended for use in horizontal deflection synchronisation circuits.

QUICK REFERENCE DATA				
Collector-base voltage (open emitter)	V_{CBO}	max.	20	V
Collector-emitter voltage (open base)	V_{CEO}	max.	10	V
Collector current (d.c.)	I_C	max.	100	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	145	mW
Junction temperature	T_j	max.	90	°C
D.C. current gain at T_j = 25 °C				
I_C = 10 mA; V_{CE} = 1 V	h_{FE}	>	25	
		typ.	65	
Transition frequency				
I_C = 10 mA; V_{CE} = 1 V	f_T	>	2	MHz

MECHANICAL DATA Dimensions in mm

TO-1



[1]) Not tinned

The coloured dot indicates the collector.

Because of its very good symmetrical properties the collector and emitter can be connected interchangeably.

7Z3 0803

RATINGS (Limiting values) [1]

Voltages

Collector-base voltage (open emitter)	V_{CBO}	max.	20	V
Collector-emitter voltage (open base)	V_{CEO}	max.	10	V
Collector-emitter voltage with $R_{BE} \leq 10\ k\Omega$	V_{CER}	max.	15	V

Current

Collector current (d.c.)	I_C	max.	100	mA

Power dissipation

Total power dissipation up to $T_{amb} = 25\ ^oC$	P_{tot}	max.	145	mW

Temperatures

Storage temperature	T_{stg}		-55 to +90	^oC
Junction temperature	T_j	max.	90	^oC

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	0.45	$^oC/mW$

CHARACTERISTICS $T_j = 25\ ^oC$ unless otherwise specified

Collector cut-off current				
$I_E = 0$; $V_{CB} = 20$ V	I_{CBO}	<	3	μA
$I_E = 0$; $V_{CB} = 20$ V; $T_j = 60\ ^oC$	I_{CBO}	<	35	μA
Emitter-base voltage [2]				
$-I_E = 10$ mA; $V_{CB} = 0$	$-V_{EB}$	<	250	mV
Saturation voltages				
$I_C = 10$ mA; $I_B = 1$ mA	V_{CEsat}	typ.	15	mV
	V_{BEsat}	typ.	245	mV
D.C. current gain				
$I_C = 10$ mA; $V_{CE} = 1$ V	h_{FE}	>	25	
		typ.	65	
Ratio between h_{FE} and h_{FC} for each individual transistor	$\frac{h_{FE}}{h_{FC}}$	typ.	1	
			0.5 to 2	
Collector capacitance at f = 450 kHz				
$I_E = I_e = 0$; $V_{CB} = 10$ V	C_c	typ.	10	pF
		<	25	pF
Transition frequency				
$I_C = 10$ mA; $V_{CE} = 1$ V	f_T	>	2	MHz

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

[2] $-V_{EB}$ decreases with about 2.2 mV/^oC at increasing temperature.

7Z3 0804

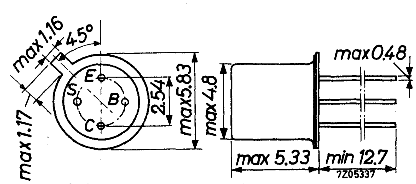
U.H.F. GERMANIUM MESA TRANSISTOR

P-N-Ptransistor in a TO-72 metal envelope, primarily intended for use in pre-amplifier, mixer or oscillator circuits up to frequencies of 860 MHz.

QUICK REFERENCE DATA				
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	30	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	25	V
Collector current (d.c.)	$-I_C$	max.	8	mA
Total power dissipation up to T_{amb} = 45 °C	P_{tot}	max.	60	mW
Junction temperature	T_j	max.	90	°C
Transition frequency				
$-I_C$ = 1.5 mA; $-V_{CE}$ = 12 V	f_T	typ.	550	MHz
Max. unilateralised power gain				
I_E = 1.5 mA; $-V_{CB}$ = 12 V; f = 800 MHz	G_{UM}	typ.	11.5	dB
Noise figure				
I_E = 1.5 mA; $-V_{CB}$ = 12 V;				
f = 800 MHz; R_S = 60 Ω	F	typ.	7	dB

MECHANICAL DATA Dimensions in mm

TO-72



S=Shield lead connected to case

7Z3 0790

RATINGS (Limiting values) [1])

Voltages

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	30	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	25	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	0.5	V

Currents

Collector current (d.c.)	$-I_C$	max.	8	mA
Collector current (peak value)	$-I_{CM}$	max.	8	mA

Power dissipation

Total power dissipation up to T_{amb} = 45 °C	P_{tot}	max.	60	mW

Temperatures

Storage temperature	T_{stg}		−30 to +75	°C
Junction temperature	T_j	max.	90	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	0.75	°C/mW
From junction to case	$R_{th\ j-c}$	=	0.40	°C/mW

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

7Z3 0791

CHARACTERISTICS T_j = 25 °C unless otherwise specified

Collector cut-off current				
$I_E = 0$; $-V_{CB} = 20$ V	$-I_{CBO}$	typ. <	0.7 3	μA μA
$I_E = 0$; $-V_{CB} = 20$ V; $T_j = 60$ °C	$-I_{CBO}$	typ. <	7 30	μA μA
$I_B = 0$; $-V_{CE} = 15$ V	$-I_{CEO}$	<	500	μA
Emitter cut-off current				
$I_C = 0$; $-V_{EB} = 0.5$ V	$-I_{EBO}$	typ. <	4 100	μA μA
Base current				
$I_E = 1.5$ mA; $-V_{CB} = 12$ V	$-I_B$	typ. <	25 150	μA μA
$I_E = 2$ mA; $-V_{CB} = 6$ V	$-I_B$	typ.	31	μA
$I_E = 5$ mA; $-V_{CB} = 6$ V	$-I_B$	typ.	56	μA
Emitter-base voltage				
$I_E = 1.5$ mA; $-V_{CB} = 12$ V	V_{EB}	typ. 320 to	380 430	mV mV
$I_E = 2$ mA; $-V_{CB} = 6$ V	V_{EB}	typ. 320 to	380 430	mV mV
$I_E = 5$ mA; $-V_{CB} = 6$ V	V_{EB}	typ. 360 to	405 450	mV mV
Transition frequency				
$-I_C = 1.5$ mA; $-V_{CE} = 12$ V	f_T	typ.	550	MHz
Reverse transfer time constant				
$I_E = 1.5$ mA; $-V_{CB} = 12$ V; f = 2.5 MHz	$r_{bb'} \cdot C_{b'c}$	typ.	3	ps
Feedback capacitance at f = 450 kHz				
$-I_C = 1.5$ mA; $-V_{CE} = 12$ V	$-C_{re}$	typ.	250	fF [1]

[1] 1 fF = 1 femtofarad = 10^{-15} F

7Z3 0792

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

y parameters at f = 800 MHz [1])

I_E = 1.5 mA; $-V_{CB}$ = 12 V

Input conductance	g_{ib}	typ.	7	$m\Omega^{-1}$
Input susceptance	$-b_{ib}$	typ.	11	$m\Omega^{-1}$
Input capacitance	$-C_{ib}$	typ.	2.2	pF
Feedback admittance	$\lvert y_{rb} \rvert$	typ.	0.4	$m\Omega^{-1}$
Phase angle of feedback admittance	φ_{rb}	typ.	240°	
Transfer admittance	$\lvert y_{fb} \rvert$	typ.	14	$m\Omega^{-1}$
Phase angle of transfer admittance	φ_{fb}	typ.	35°	
Output conductance	g_{ob}	typ.	0.5	$m\Omega^{-1}$
Output capacitance	C_{ob}	typ.	1.5	pF

Maximum unilateralised power gain

$$G_{UM} = \frac{|y_{fb}|^2}{4\, g_{ib} g_{ob}}$$

I_E = 1.5 mA; $-V_{CB}$ = 12 V; f = 800 MHz	G_{UM}	typ.	11.5	dB

1) Measured with a lead length of 5 mm.

7Z3 0793

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

Transducer gain

$$G_{tr} = \frac{\text{output power in load } R_L}{\text{available power from source } R_S}$$

I_E = 1.5 mA; $-V_{CB}$ = 12 V; f = 800 MHz	G_{tr}	>	10.2	dB
		typ.	11	dB

Reverse transducer gain

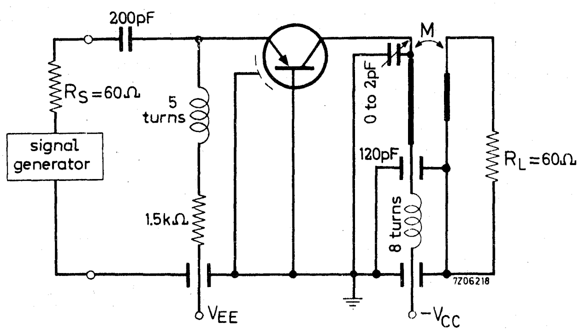
I_E = 1.5 mA; $-V_{CB}$ = 12 V; f = 800 MHz	$G_{tr\ rev}$	typ.	−23	dB

The reverse transducer gain is measured in the circuit below, with load and source (including R_S) interchanged.

Noise figure

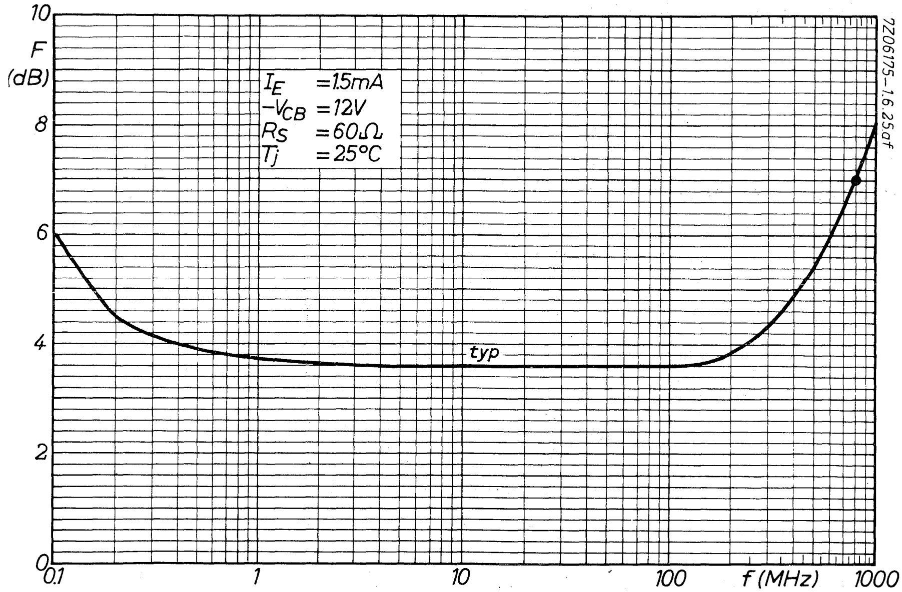
I_E = 1.5 mA; $-V_{CB}$ = 12 V; f = 800 MHz	F	typ.	7	dB
		<	8	dB

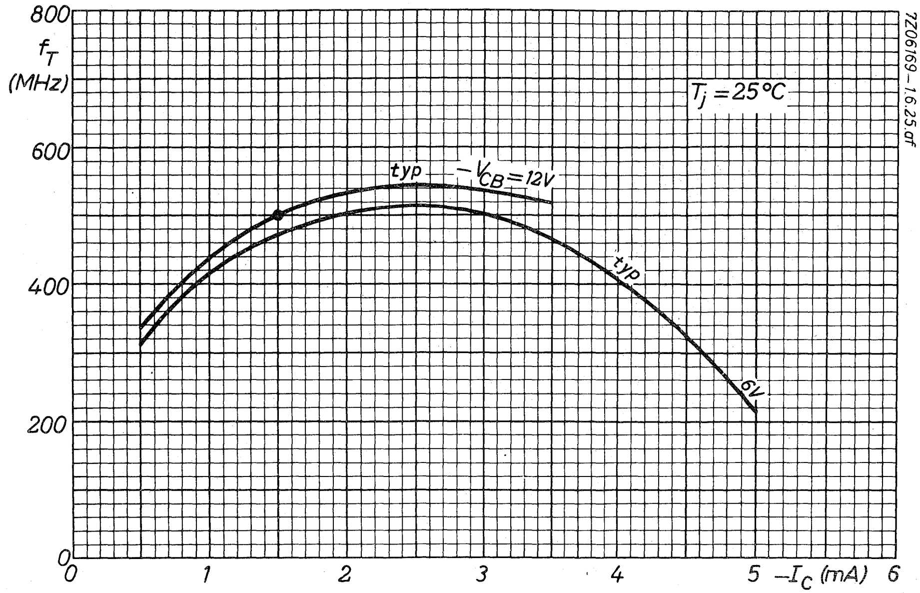
Basic circuit for measuring the transducer gain G_{tr} and the noise figure F.

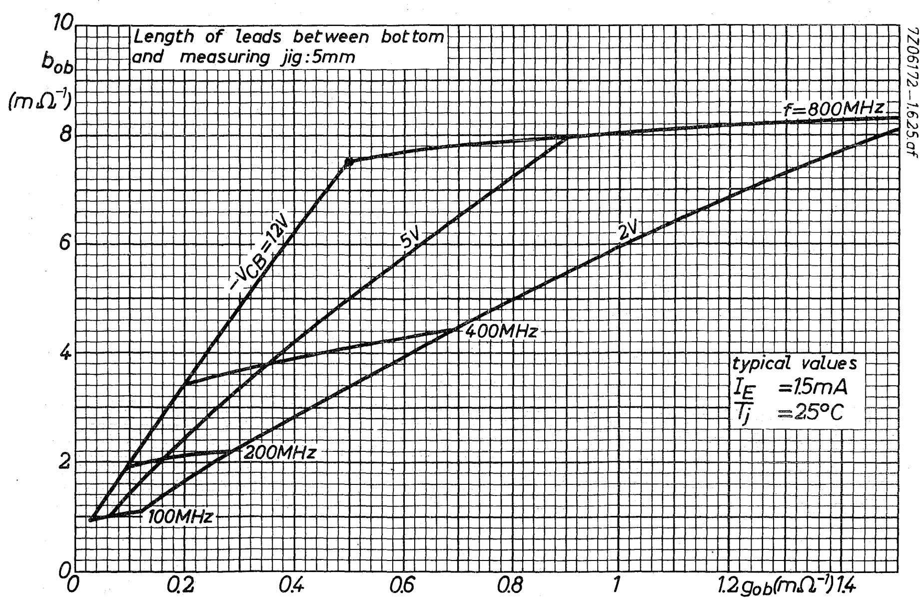


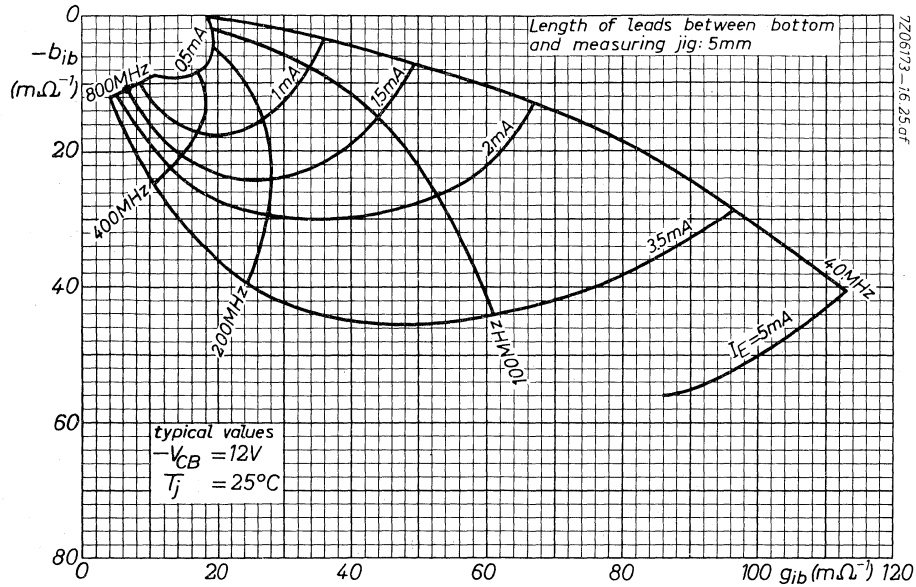
Total effective collector resistance R_c = 1.4 kΩ

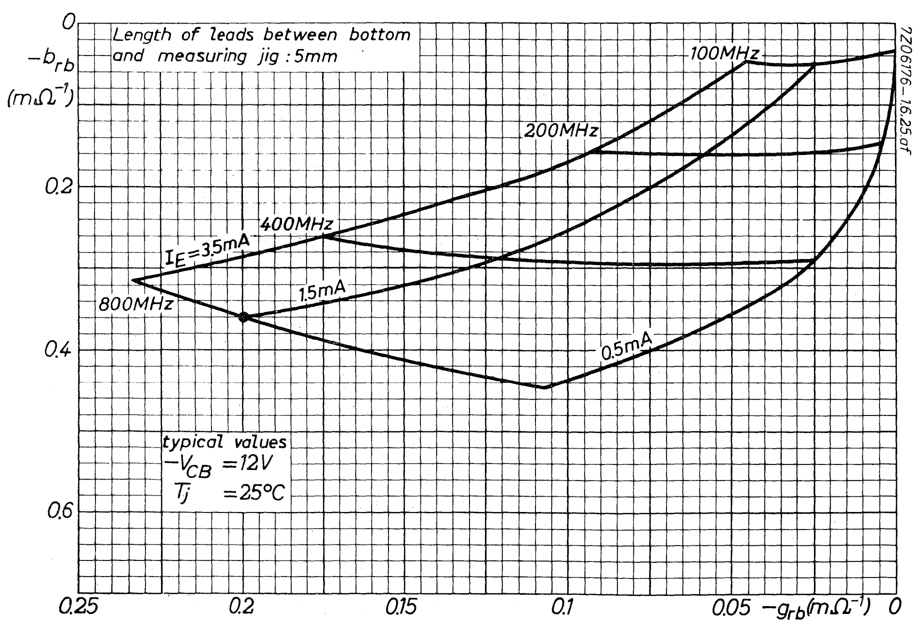
7Z3 0794

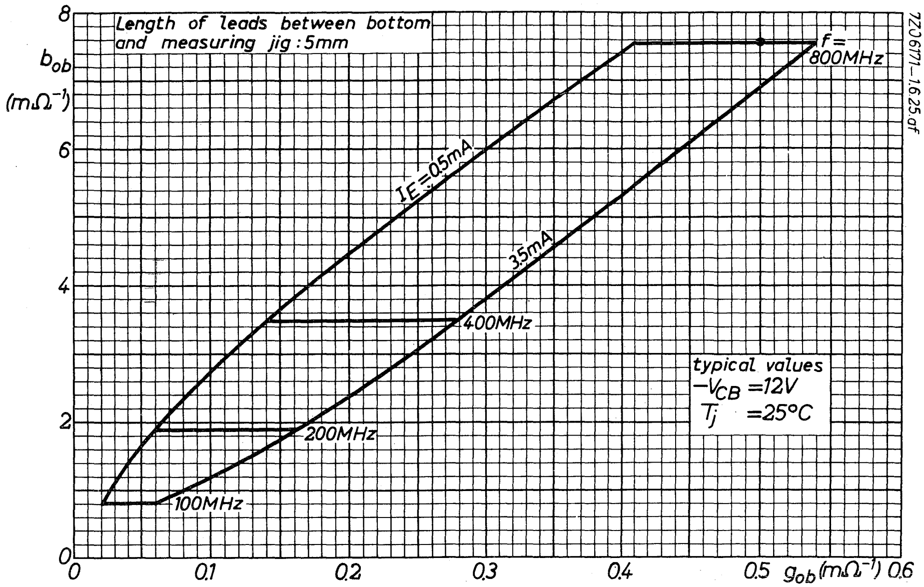

10
F
(dB)
8
6
4
2
0
I_E = 1.5mA
$-V_{CB}$ = 12V
R_S = 60Ω
T_j = 25°C
typ
0.1
1
10
100
f (MHz)
1000
7Z06175-1.6.25af

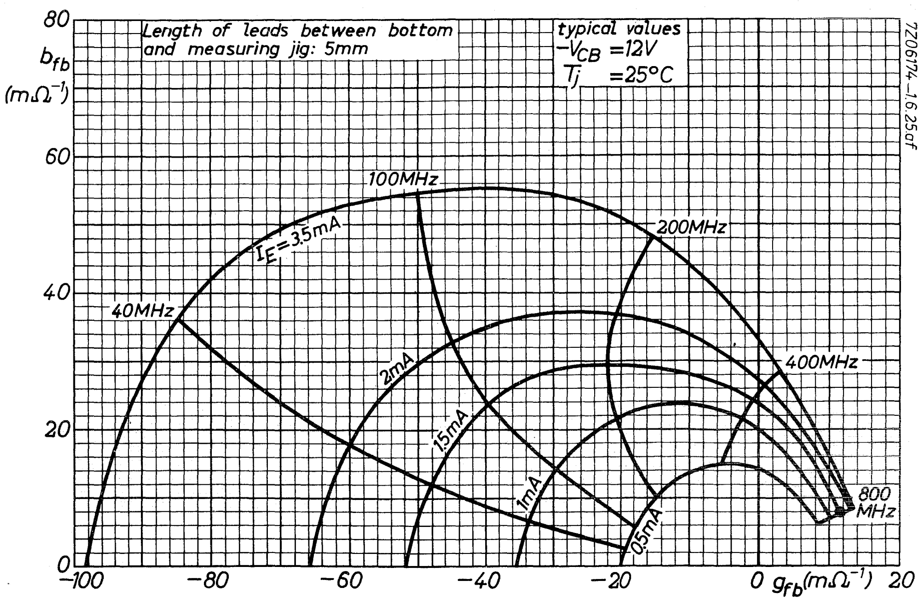

800
f_T
(MHz)
600
400
200
0
$T_j = 25°C$
typ
$-V_{CB} = 12V$
typ
6V
0
1
2
3
4
5
$-I_C$ (mA)
6
7Z06169–1.6.25.af

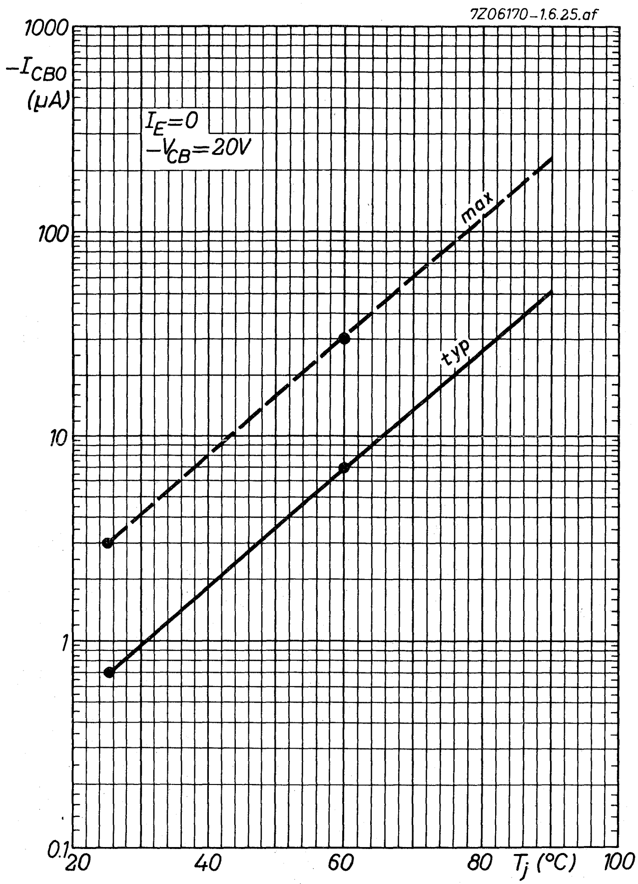

10
b_{ob}
$(m\Omega^{-1})$
8
6
4
2
0
Length of leads between bottom and measuring jig: 5mm
f=800MHz
$-V_{CB}=12V$
5V
2V
400MHz
200MHz
100MHz
typical values
I_E =1.5mA
T_j =25°C
0
0.2
0.4
0.6
0.8
1
1.2
g_{ob} $(m\Omega^{-1})$
1.4
7Z06172–1.6.25.af


Length of leads between bottom and measuring jig: 5mm
7Z06173-16.25.af
$-b_{ib}$ $(m\Omega^{-1})$
g_{ib} $(m\Omega^{-1})$
800MHz
0.5mA
1mA
1.5mA
2mA
3.5mA
I_E=5mA
400MHz
200MHz
100MHz
40MHz
typical values
$-V_{CB}$ = 12V
T_j = 25°C
0
20
40
60
80
100
120


Length of leads between bottom and measuring jig : 5mm
7Z06176-16.25.af
$-b_{rb}$ $(m\Omega^{-1})$
$-g_{rb}$ $(m\Omega^{-1})$
100MHz
200MHz
400MHz
800MHz
I_E=3.5mA
1.5mA
0.5mA
typical values
$-V_{CB}$ = 12V
T_j = 25°C
0
0.2
0.4
0.6
0.25
0.15
0.1
0.05


Length of leads between bottom and measuring jig : 5mm
b_{ob} ($m\Omega^{-1}$)
I_E = 0.5mA
3.5mA
f = 800MHz
400MHz
200MHz
100MHz
typical values
$-V_{CB}$ = 12V
T_j = 25°C
g_{ob} ($m\Omega^{-1}$)
7Z06171-1.6.25af


Length of leads between bottom and measuring jig: 5mm
typical values
$-V_{CB}$ = 12V
T_j = 25°C
b_{fb} ($m\Omega^{-1}$)
100MHz
200MHz
400MHz
40MHz
800 MHz
I_E = 3.5mA
2mA
1.5mA
1mA
0.5mA
g_{fb} ($m\Omega^{-1}$)
7Z06174-1.6.25af


7Z06170–1.6.25.af
1000
$-I_{CBO}$
(μA)
$I_E=0$
$-V_{CB}=20V$
100
max
typ
10
1
0.1
20
40
60
80
T_j (°C)
100

U.H.F. GERMANIUM EPITAXIAL MESA TRANSISTOR

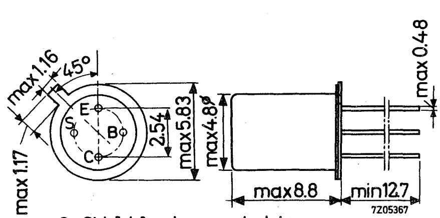
P-N-P transistor in a metal envelope, with insulated electrodes and a shield lead connected to the case. It is primarily intended for use in output stages of aerial amplifiers up to frequencies of 860 MHz.

QUICK REFERENCE DATA				
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	32	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	20	V
Collector current (d.c.)	$-I_C$	max.	20	mA
Total power dissipation up to T_{amb} = 30 °C	P_{tot}	max.	140	mW
Junction temperature	T_j	max.	90	°C
Transition frequency				
$-I_C$ = 6 mA; $-V_{CE}$ = 12 V	f_T	typ.	700	MHz
Transducer gain at T_j = 70 °C				
I_E = 4 mA; $-V_{CB}$ = 20 V; f = 800 MHz	G_{tr}	typ.	12	dB
Noise figure				
I_E = 1.5 mA; $-V_{CB}$ = 12 V;				
f = 800 MHz; R_S = 60 Ω	F	typ.	7	dB

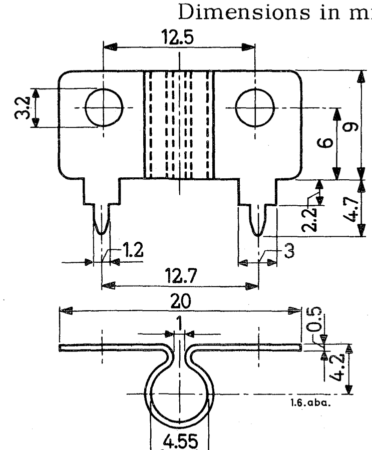
MECHANICAL DATA

Dimensions in mm

insulated electrodes



S=Shield lead connected to case



Cooling fin: 56263

7Z3 0799

RATINGS (Limiting values) [1])

Voltages

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	32	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	20	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	0.3	V

Currents

Collector current (d.c.)	$-I_C$	max.	20	mA
Collector current (peak value)	$-I_{CM}$	max.	20	mA

Power dissipation

Total power dissipation up to T_{amb} = 30 °C with cooling fin No. 56263	P_{tot}	max.	140	mW

Temperatures

Storage temperature	T_{stg}		-30 to +75	°C
Junction temperature	T_j	max.	90	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	0.55	°C/mW
From junction to ambient with cooling fin No. 56263	$R_{th\ j-a}$	=	0.42	°C/mW
From junction to case	$R_{th\ j-c}$	=	0.32	°C/mW

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

7Z3 0800

CHARACTERISTICS T_j = 25 °C unless otherwise specified

Collector cut-off currents				
$I_E = 0$; $-V_{CB} = 20$ V	$-I_{CBO}$	typ.	0.5	μA
		<	8	μA
$I_E = 0$; $-V_{CB} = 20$ V; $T_j = 60$ °C	$-I_{CBO}$	<	50	μA
$I_B = 0$; $-V_{CE} = 20$ V	$-I_{CEO}$	<	1	mA
Emitter cut-off current				
$I_C = 0$; $-V_{EB} = 0.3$ V	$-I_{EBO}$	typ.	2	μA
		<	100	μA
Base current				
$I_E = 1.5$ mA; $-V_{CB} = 12$ V	$-I_B$	typ.	30	μA
		<	150	μA
$I_E = 4$ mA; $-V_{CB} = 20$ V	$-I_B$	<	400	μA
Emitter-base voltage				
$I_E = 1.5$ mA; $-V_{CB} = 12$ V	V_{EB}	typ.	380	mV
		320 to	430	mV
$I_E = 4$ mA; $-V_{CB} = 20$ V	V_{EB}	typ.	400	mV
		360 to	450	mV
Feedback capacitance at f = 450 kHz				
$-I_C = 1$ mA; $-V_{CE} = 12$ V	$-C_{re}$	typ.	250	fF [1])
Feedback time constant				
$I_E = 1$ mA; $-V_{CB} = 12$ V; f = 2.5 MHz	$r_{bb'} \cdot C_{b'c}$	typ.	3	ps
		<	6	ps
Transition frequency				
$-I_C = 1.5$ mA; $-V_{CE} = 12$ V	f_T	typ.	550	MHz
$-I_C = 6$ mA; $-V_{CE} = 12$ V	f_T	typ.	700	MHz
Emitter capacitance at f = 1 MHz				
$I_C = I_c = 0$; $-V_{EB} = 0.15$ V	C_e	typ.	3.5	pF
Base resistance				
I_E = value for which $C_{ib} = 0$; $-V_{CB} = 12$ V; f = 50 MHz	r_b	typ.	60	Ω
		<	100	Ω

[1]) 1 fF = 1 femtofarad = 10^{-15} F

7Z3 0801

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

Noise figure at f = 800 MHz

I_E = 1.5 mA; $-V_{CB}$ = 12 V; R_S = 60 Ω	F	typ.	7	dB

Transducer gain

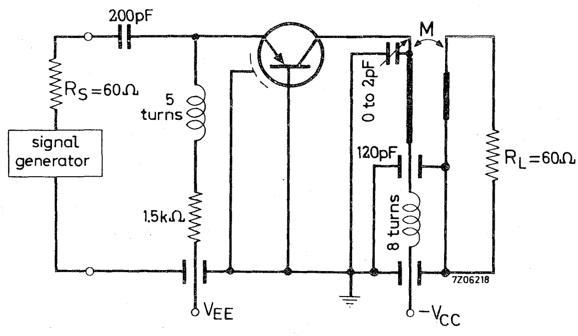
$$G_{tr} = \frac{\text{output power in load } R_L}{\text{available power from source } R_S}$$

I_E = 4 mA; $-V_{CB}$ = 20 V; f = 800 MHz; T_j = 70 °C	G_{tr}	>	10	dB
		typ.	12	dB

Output power

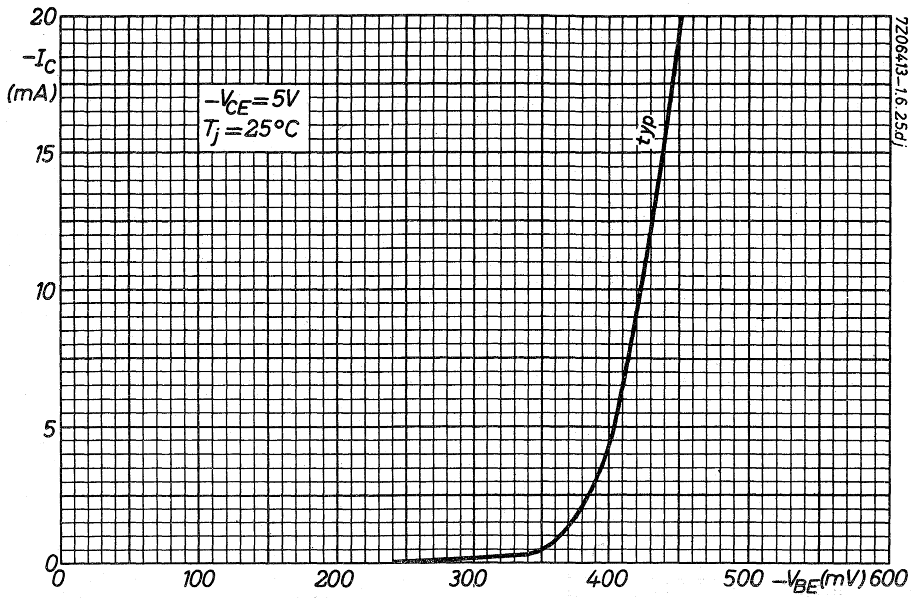
d_{im} = −30 dB; I_E = 4 mA; $-V_{CB}$ = 20 V; f = 800 MHz; T_j = 70 °C	P_o	>	1.5	mW
		typ.	2.7	mW

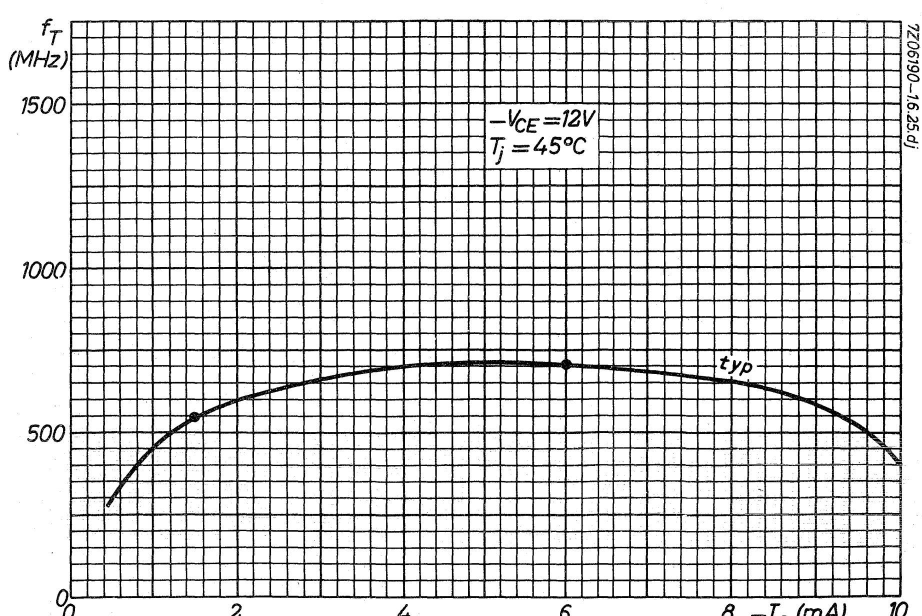
Basic circuit for measuring the transducer gain G_{tr} and the output power P_o

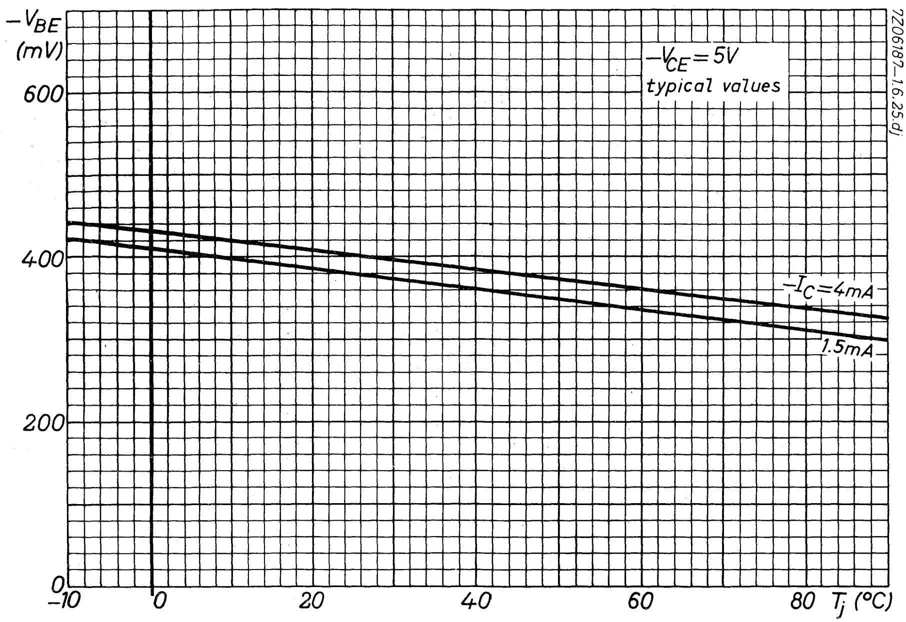


Total effective collector resistance R_c = 1.4 kΩ

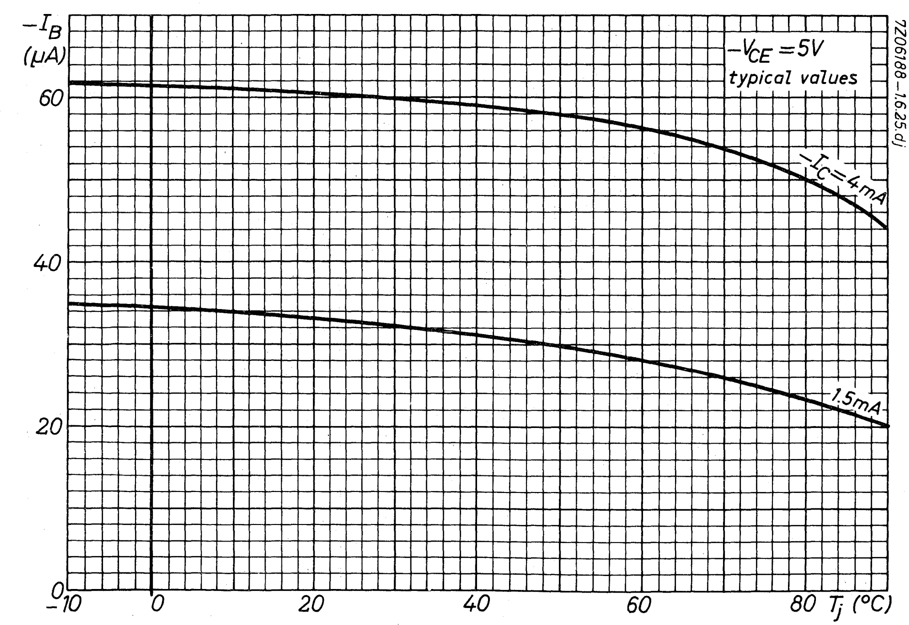
7Z3 0802


20
$-I_C$
(mA)
$-V_{CE}=5V$
$T_j=25°C$
typ
15
10
5
0
0
100
200
300
400
500 $-V_{BE}$(mV) 600
7Z06413-1.6.25dj

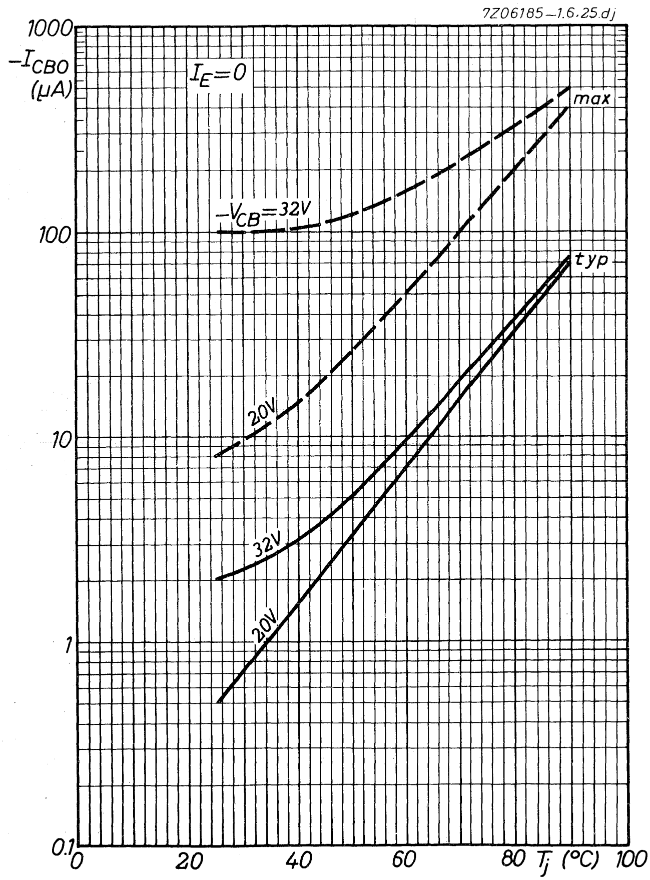

f_T
(MHz)
1500
1000
500
0
$-V_{CE}=12V$
$T_j=45°C$
typ
0
2
4
6
8 $-I_C$ (mA)
10
7Z06190-1.6.25dj

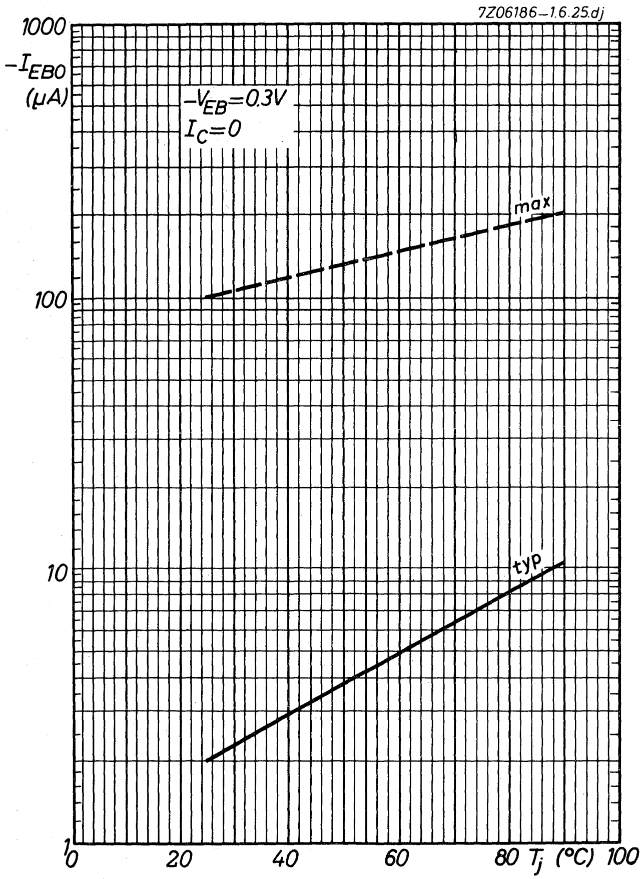


$-V_{BE}$ (mV)
600
400
200
0
−10
0
20
40
60
80
T_j (°C)
$-V_{CE} = 5V$
typical values
$-I_C = 4mA$
1.5mA
7Z06187–1.6.25.dj



$-I_B$ (μA)
60
40
20
0
−10
0
20
40
60
80
T_j (°C)
$-V_{CE} = 5V$
typical values
$-I_C = 4mA$
1.5mA
7Z06188–1.6.25.dj


7Z06185—1.6.25.dj
1000
$-I_{CBO}$ (µA)
$I_E = 0$
max
$-V_{CB} = 32V$
100
typ
20V
10
32V
20V
1
0.1
0
20
40
60
80
T_j (°C)
100


7Z06186–1.6.25.dj
1000
$-I_{EBO}$
(µA)
$-V_{EB}$=0.3V
I_C=0
max
100
10
typ
1
0
20
40
60
80
T_j (°C)
100

SILICON MESA TRANSISTOR

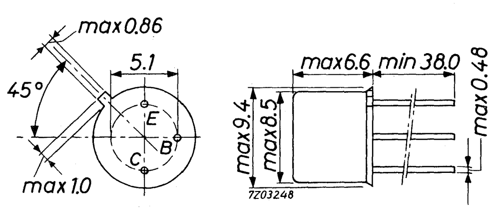
N-P-N transistor in a TO-5 metal envelope with the collector connected to the case. The BF109 is primarily intended for application in television video output stages.

QUICK REFERENCE DATA				
Collector-base voltage (open emitter)	V_{CBO}	max.	135	V
Collector-emitter voltage (open base)	V_{CEO}	max.	110	V
Collector current (d.c.)	I_C	max.	50	mA
Total power dissipation up to T_{amb} = 55 °C with cooling clip No. 56265	P_{tot}	max.	1.2	W
Junction temperature	T_j	max.	175	°C
D.C. current gain at T_j = 25 °C				
I_C = 10 mA; V_{CE} = 10 V	h_{FE}	>	20	
Transition frequency				
I_C = 10 mA; V_{CE} = 10 V	f_T	typ.	135	MHz

MECHANICAL DATA Dimensions in mm

TO-5

Collector connected to case



7Z3 0805

RATINGS (Limiting values) [1])

Voltages

Collector-base voltage (open emitter)	V_{CBO}	max.	135	V
Collector-emitter voltage (open base)	V_{CEO}	max.	110	V
Collector-emitter voltage with $-V_{BE} > 0$	V_{CEX}	max.	135	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	V

Current

Collector current (d.c.)	I_C	max.	50	mA

Power dissipation

Total power dissipation up to T_{amb} = 55 °C with cooling clip No.56265 and a heatsink of 12.5 cm^2	P_{tot}	max.	1.2	W

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	$R_{th\ j\text{-}a}$	=	250	°C/W
From junction to case	$R_{th\ j\text{-}c}$	=	60	°C/W
From junction to ambient with cooling clip No.56265 and a heatsink of 12.5 cm^2	$R_{th\ j\text{-}a}$	=	100	°C/W

CHARACTERISTICS T_j = 25 °C unless otherwise specified

Base-emitter voltage [2])				
I_C = 10 mA; V_{CE} = 10 V	V_{BE}	typ.	0.75	V
Feedback capacitance at f = 1 MHz				
I_C = 0; V_{CE} = 10 V	$-C_{re}$	<	3	pF
Collector capacitance f = 1 MHz				
$I_E = I_e$ = 0; V_{CB} = 10 V	C_c	<	4	pF
D.C. current gain				
I_C = 10 mA; V_{CE} = 10 V	h_{FE}	>	20	
		typ.	40	
Feedback time constant f = 5 MHz				
$-I_E$ = 10 mA; V_{CB} = 10 V	$\frac{\lvert h_{rb} \rvert}{\omega}$	<	350	ps
Transition frequency				
I_C = 10 mA; V_{CE} = 10 V	f_T	>	80	MHz
		typ.	135	MHz

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

[2]) V_{BE} decreases with about 2 mV/°C at increasing temperature.

7Z3 0806

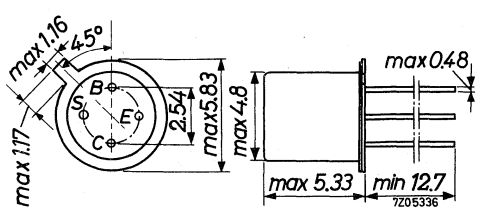
SILICON PLANAR EPITAXIAL TRANSISTOR

N-P-N transistor in TO-72 metal case with insulated electrodes and a shield lead connected to the case. It is intended for general broadcast and television.

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 (d.c.)	I_C	max.	30	mA
Total power dissipation up to $T_{amb} = 45\ ^oC$	P_{tot}	max.	145	mW
Junction temperature	T_j	max.	175	^oC
Transition frequency				
$I_C = 1$ mA; $V_{CE} = 10$ V	f_T	typ.	230	MHz
Noise figure				
$I_C = 1$ mA; $V_{CE} = 10$ V				
f = 1 MHz; $G_S = 3.3\ m\Omega^{-1}$	F	typ.	1.2	dB
f = 100 MHz; $G_S = 10\ m\Omega^{-1}$	F	typ.	4	dB

MECHANICAL DATA Dimensions in mm

TO-72
insulated electrodes



S=Shield lead connected to case

7Z3 0837

RATINGS (Limiting values) [1])

Voltages

Collector-base voltage (open emitter)	V_{CBO}	max.	50	V
Collector-emitter voltage (open base) (See also page C)	V_{CEO}	max.	30	V
Collector-emitter voltage (see page C)	V_{CER}	max.	50	V
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

Power dissipation

Total power dissipation up to T_{amb} = 45 °C	P_{tot}	max.	145	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	$R_{th\ j\text{-}a}$	=	0.9	°C/mW

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

7Z3 0838

CHARACTERISTICS T_j = 25 °C unless otherwise specified

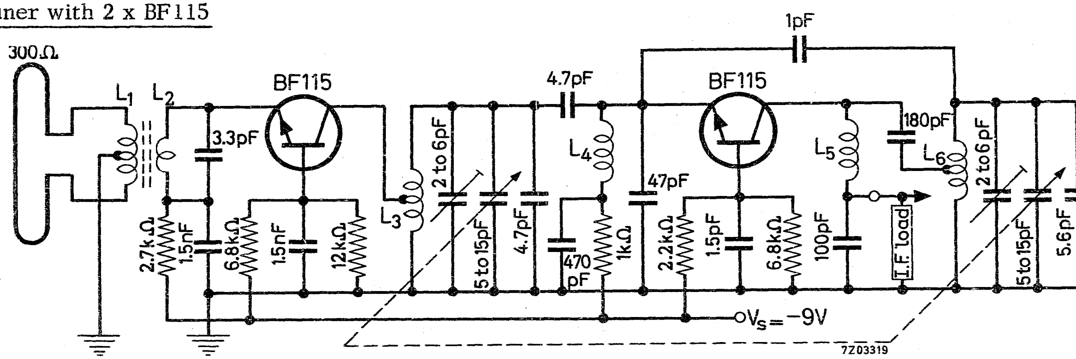
Emitter-base voltage [1]				
$-I_E$ = 1 mA; V_{CB} = 10 V	$-V_{EB}$	0.65 to 0.74		V
$-I_E$ = 20 mA; V_{CB} = 2 V; T_{amb} = 25 °C	$-V_{EB}$	<	1.0	V
Feedback capacitance at f = 0.45 MHz				
I_C = 1 mA; V_{CE} = 10 V	$-C_{re}$	typ.	0.65	pF
D.C. current gain				
I_C = 1 mA; V_{CE} = 10 V	h_{FE}	45 to	65	
I_C = 20 mA; V_{CE} = 2 V	h_{FE}	>	40	
Transition frequency				
I_C = 1 mA; V_{CE} = 10 V	f_T	typ.	230	MHz
Noise figure at I_C = 1 mA; V_{CE} = 10 V				
f = 0.2 MHz; G_S = 3.3 $m\Omega^{-1}$	F	typ.	1.5	dB
f = 1 MHz; G_S = 20 $m\Omega^{-1}$	F	typ.	3.5	dB
f = 1 MHz; G_S = 3.3 $m\Omega^{-1}$	F	typ.	1.2	dB
f = 100 MHz; G_S = 10 $m\Omega^{-1}$	F	typ.	4	dB
Conversion noise figure at I_C = 1 mA; V_{CE} = 10 V				
f = 0.2 MHz; G_S = 1 $m\Omega^{-1}$	F_c	typ.	3.5	dB
f = 1 MHz; G_S = 2 $m\Omega^{-1}$	F_c	typ.	2.5	dB

[1] $-V_{EB}$ decreases with about 1.7 mV/°C at increasing temperature.

7Z3 0839

APPLICATION INFORMATION

F.M. Tuner with 2 x BF115



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

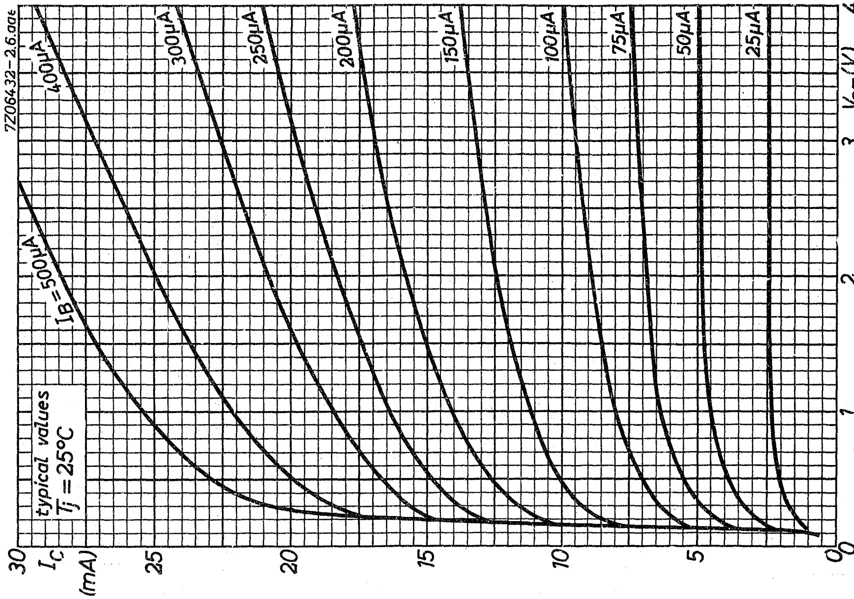
L_5 = 14 turns stranded wire (36 x 0.03) on coil former 3016/02 with ferroxcube core K 512002 (4 D)

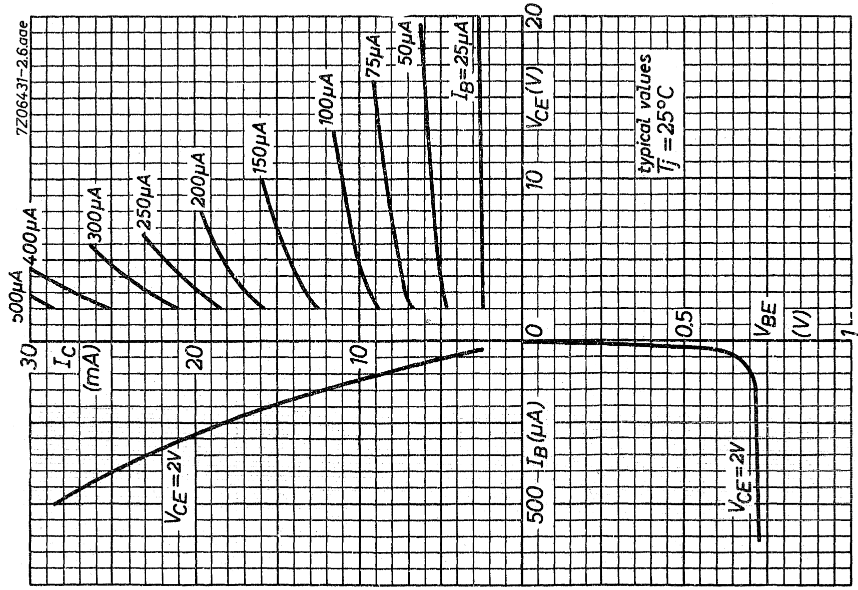
L_6 = 6 turns enamelled Cu wire (6 mm); winding pitch 1 mm; tap at 3 turns from earth side; d = 7 mm

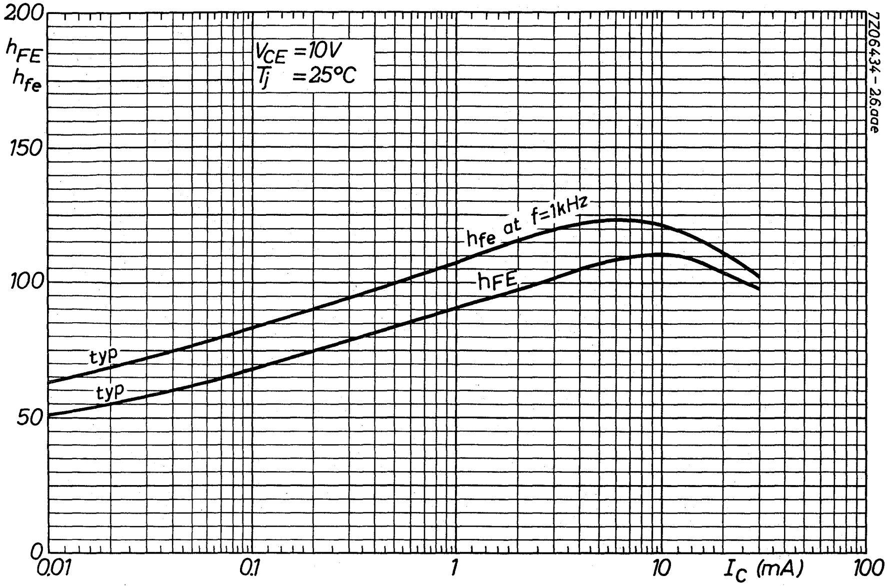
PERFORMANCE

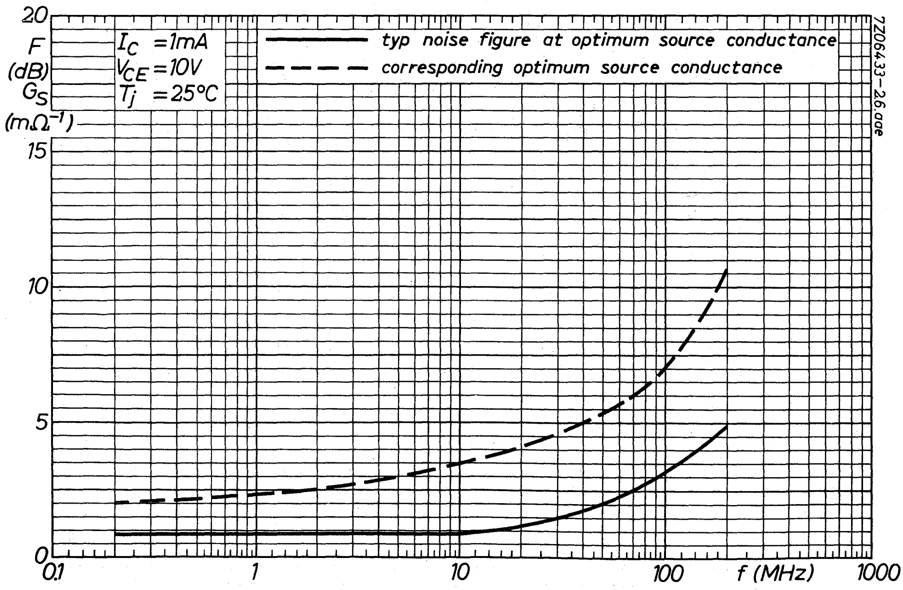
Transducer gain at an I.F. load of 470 Ω	G_{tr}	typ.	24	dB
Noise figure	F	typ.	4.5	dB
Spurious response				
repeat spot suppression		typ.	55	dB
double beat suppression		typ.	57	dB
Image response		typ.	35	dB
Frequency drift $\Delta V_S = 2$ V	Δf_{osc}	typ.	10	kHz
		<	15	kHz

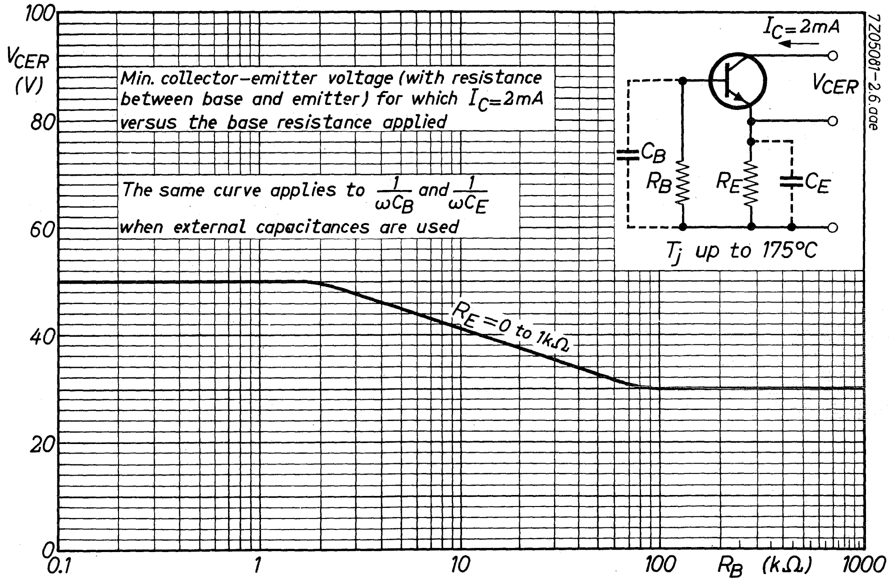
7Z3 0840


7Z06432-2.6.aae
typical values
$T_j = 25°C$
I_C (mA)
V_{CE} (V)
$I_B = 500\mu A$
400μA
300μA
250μA
200μA
150μA
100μA
75μA
50μA
25μA

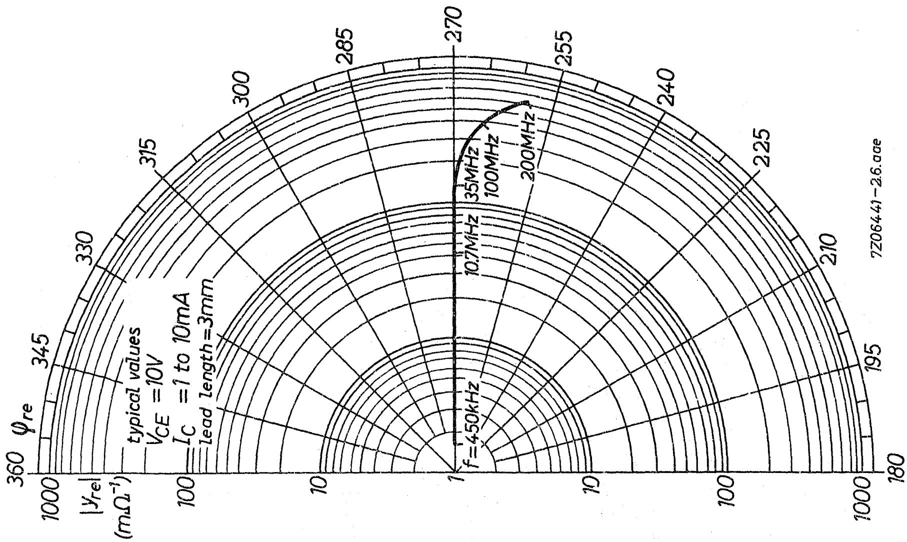

7Z06431-2.6.aae
typical values
$T_j = 25°C$
I_C (mA)
V_{CE} (V)
V_{BE} (V)
I_B (μA)
$V_{CE} = 2V$
$V_{CE} = 2V$
500μA
400μA
300μA
250μA
200μA
150μA
100μA
75μA
50μA
$I_B = 25\mu A$

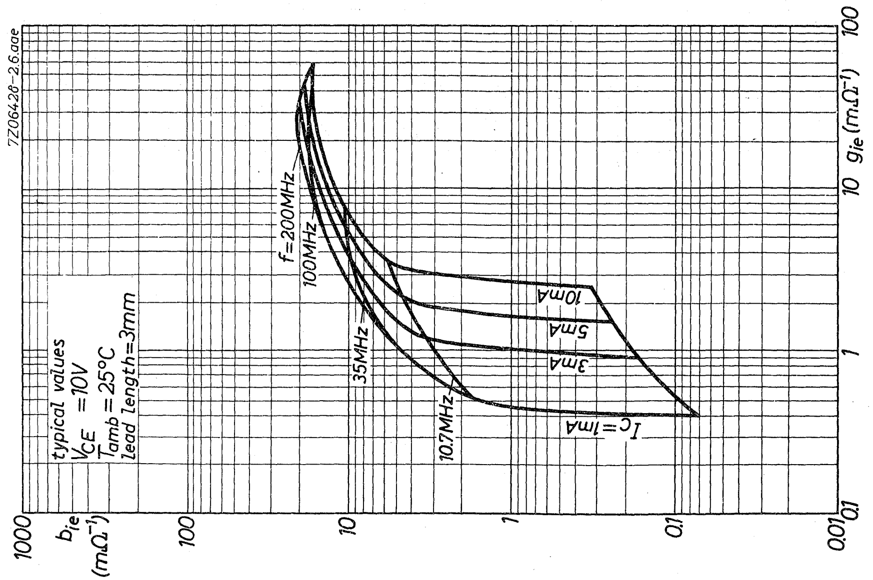

200
h_{FE}
h_{fe}
150
100
50
0
V_{CE} = 10V
T_j = 25°C
h_{fe} at f=1kHz
h_{FE}
typ
typ
0.01
0.1
1
10
I_C (mA)
100
7Z06434-26.aae

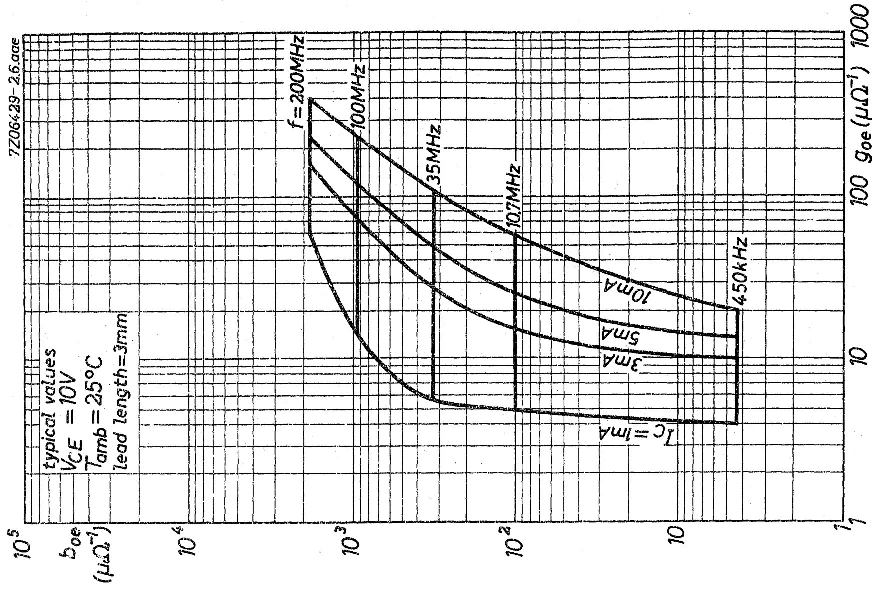

20
F
(dB)
G_S
($m\Omega^{-1}$)
15
10
5
0
I_C = 1mA
V_{CE} = 10V
T_j = 25°C
typ noise figure at optimum source conductance
corresponding optimum source conductance
0.1
1
10
100
f (MHz)
1000
7Z06433-26.aae

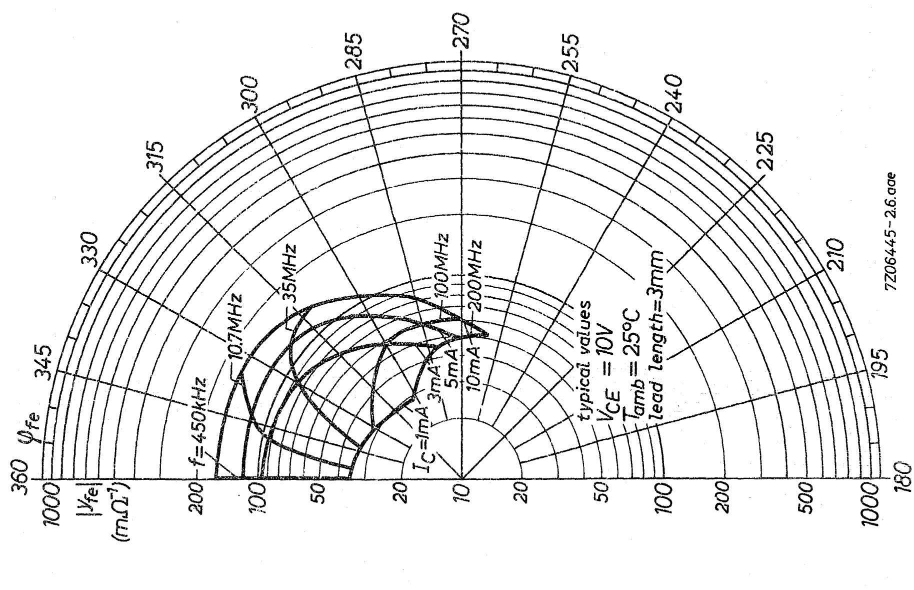


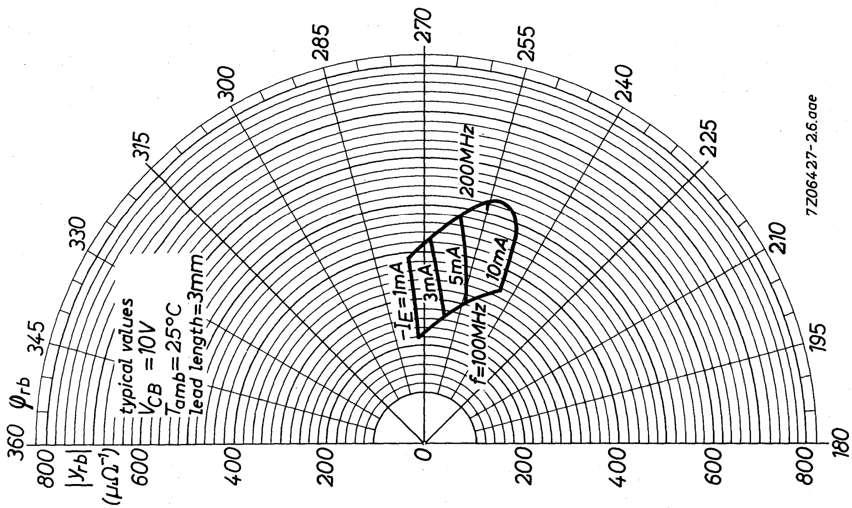
100
80
60
40
20
0
V_{CER} (V)
Min. collector-emitter voltage (with resistance between base and emitter) for which I_C=2mA versus the base resistance applied
The same curve applies to $\frac{1}{\omega C_B}$ and $\frac{1}{\omega C_E}$ when external capacitances are used
I_C=2mA
V_{CER}
C_B
R_B
R_E
C_E
T_j up to 175°C
R_E =0 to 1kΩ
7Z05081−2.6.aae
0.1
1
10
100
1000
R_B (kΩ)

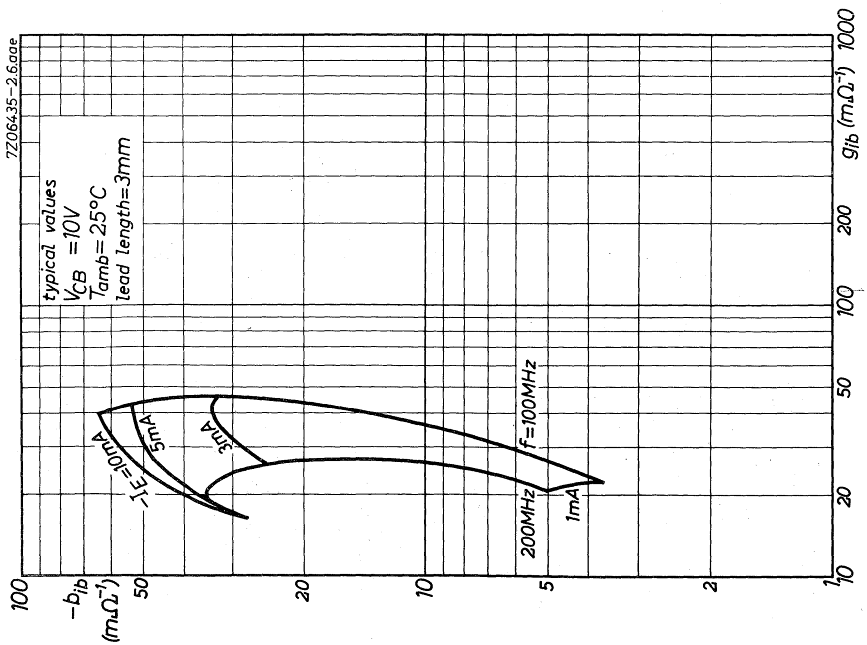

typical values
V_{CE} = 10V
I_C = 1 to 10mA
lead length = 3mm
φ_{re}
$|y_{re}|$ ($m\Omega^{-1}$)
f = 450kHz
10.7MHz
35MHz
100MHz
200MHz
360
345
330
315
300
285
270
255
240
225
210
195
180
1000
100
10
1
10
100
1000
7Z06441−2.6.aae

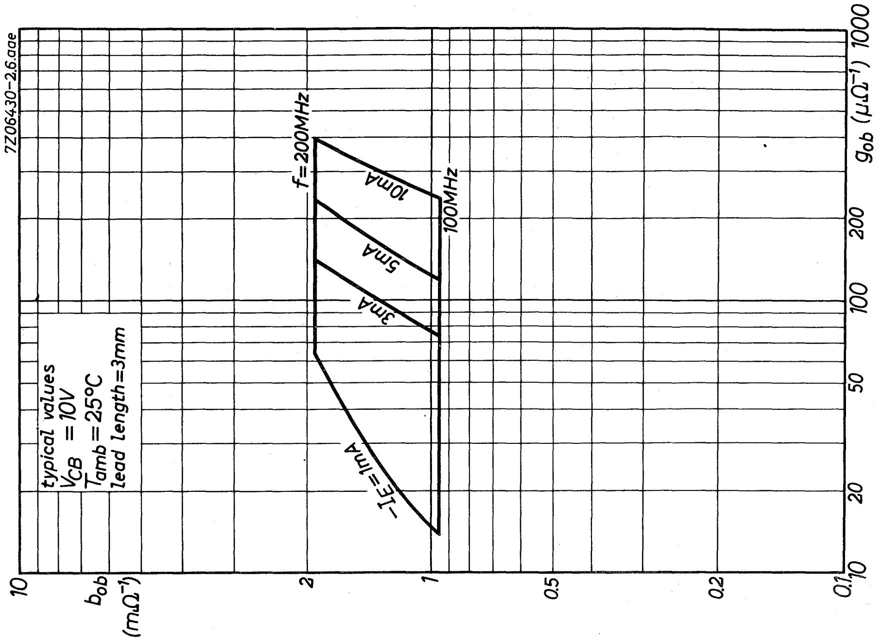

typical values
V_{CE} = 10V
T_{amb} = 25°C
lead length = 3mm
b_{ie} ($m\Omega^{-1}$)
g_{ie} ($m\Omega^{-1}$)
f = 200MHz
100MHz
35MHz
10.7MHz
10mA
5mA
3mA
I_C = 1mA
1000
100
10
1
0.1
0.01
0.1
1
10
100
7Z06428−2.6.aae

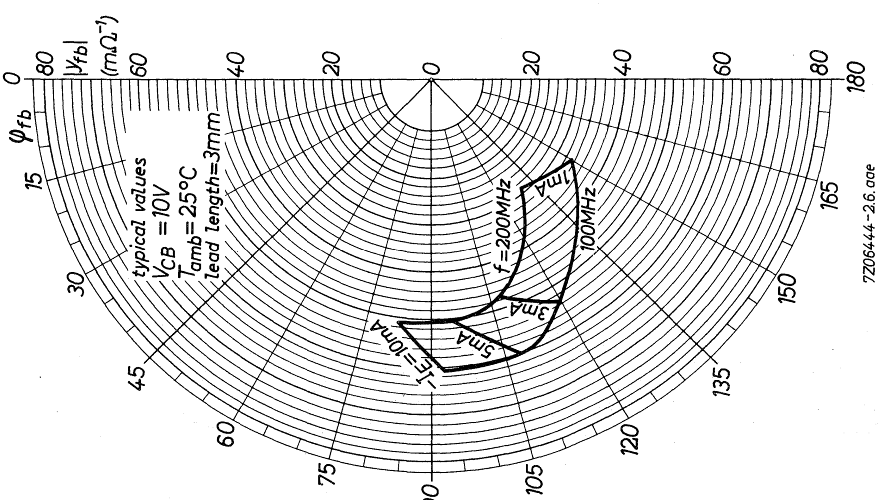

7Z06429-2.6.aae
typical values
V_{CE} = 10V
T_{amb} = 25°C
lead length = 3mm
f = 200MHz
100MHz
35MHz
10.7MHz
450kHz
10mA
5mA
3mA
I_C = 1mA
b_{oe} ($\mu\Omega^{-1}$)
g_{oe} ($\mu\Omega^{-1}$)


7Z06445-2.6.aae
typical values
V_{CE} = 10V
T_{amb} = 25°C
lead length = 3mm
f = 450kHz
10.7MHz
35MHz
100MHz
200MHz
I_C = 1mA
3mA
5mA
10mA
φ_{fe}
$|y_{fe}|$ ($m\Omega^{-1}$)


typical values
V_{CB} = 10V
T_{amb} = 25°C
lead length = 3mm
φ_{rb}
$|y_{rb}|$ ($\mu\Omega^{-1}$)
360 345 330 315 300 285 270 255 240 225 210 195 180
800 600 400 200 0 200 400 600 800
$-I_E$=1mA
3mA
5mA
10mA
f=100MHz
200MHz
7Z06427-2.6.aae


typical values
V_{CB} = 10V
T_{amb} = 25°C
lead length = 3mm
$-b_{ib}$ ($m\Omega^{-1}$)
100 50 20 10 5 2 1
g_{ib} ($m\Omega^{-1}$)
10 20 50 100 200 1000
$-I_E$=10mA
5mA
3mA
1mA
f=100MHz
200MHz
7Z06435-2.6.aae


7Z06430-2.6.aae
typical values
V_{CB} = 10V
T_{amb} = 25°C
lead length = 3mm
f = 200MHz
100MHz
10mA
5mA
3mA
$-I_E$ = 1mA
b_{ob} ($m\Omega^{-1}$)
g_{ob} ($\mu\Omega^{-1}$)
10
2
1
0.5
0.2
0.1
10
20
50
100
200
1000


7Z06444-2.6.aae
typical values
V_{CB} = 10V
T_{amb} = 25°C
lead length = 3mm
φ_{fb}
$|y_{fb}|$ ($m\Omega^{-1}$)
f = 200MHz
100MHz
1mA
3mA
5mA
$-I_E$ = 10mA
0
15
30
45
60
75
90
105
120
135
150
165
180
80
60
40
20
0
20
40
60
80

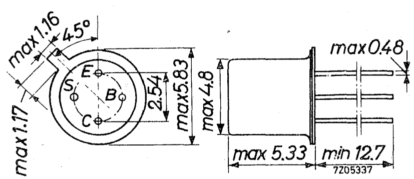
SILICON PLANAR TRANSISTOR

N-P-N transistor in a TO-72 metal envelope with insulated electrodes and a shield lead connected to the case. The BF180 is primarily intended for application in a forward gain controlled pre-amplifier in u.h.f. and integrated television tuners.

QUICK REFERENCE DATA				
Collector-base voltage (open emitter)	V_{CBO}	max.	30	V
Collector-emitter voltage (open base)	V_{CEO}	max.	20	V
Collector current (d.c.)	I_C	max.	20	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	150	mW
Junction temperature	T_j	max.	175	°C
Transition frequency				
I_C = 2 mA; V_{CE} = 10 V	f_T	typ.	675	MHz
Feedback capacitance at f = 10.7 MHz				
I_C = 1 mA; V_{CE} = 10 V	$-C_{re}$	typ.	280	fF
Max. unilateralised power gain				
$-I_E$ = 2 mA; V_{CB} = 10 V; f = 200 MHz	G_{UM}	typ.	24	dB
$-I_E$ = 2 mA; V_{CB} = 10 V; f = 900 MHz	G_{UM}	typ.	12	dB
Noise figure at optimum source admittance				
$-I_E$ = 2 mA; V_{CB} = 10 V; f = 200 MHz	F	typ.	2.5	dB
$-I_E$ = 2 mA; V_{CB} = 10 V; f = 800 MHz	F	typ.	5.7	dB

MECHANICAL DATA — Dimensions in mm

TO-72



S=Shield lead connected to case

7Z3 0725

RATINGS (Limiting values) [1]

Voltages

Collector-base voltage (open emitter)	V_{CBO}	max.	30	V
Collector-emitter voltage (open base)	V_{CEO}	max.	20	V
Emitter-base voltage (open collector)	V_{EBO}	max.	3	V

Currents

Collector current (d.c.)	I_C	max.	20	mA
Collector current (peak value)	I_{CM}	max.	20	mA

Power dissipation

Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	150	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	$R_{th\ j\text{-}a}$	=	1	°C/mW

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

7Z3 0726

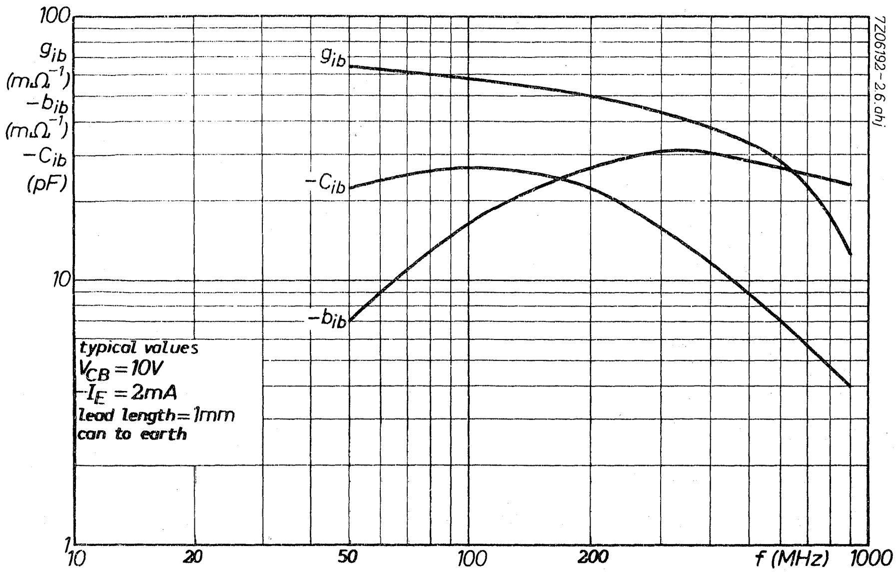
CHARACTERISTICS T_{amb} = 25 °C unless otherwise specified

Base current				
$-I_E$ = 2 mA; V_{CB} = 10 V	I_B	typ. <	45 150	μA μA
$-I_E$ = 12 mA; V_{CB} = 7 V	I_B	<	2.2	mA
Emitter-base voltage				
$-I_E$ = 2 mA; V_{CB} = 10 V	$-V_{EB}$	typ.	0.75	V
Feedback capacitance at f = 10.7 MHz				
I_C = 1 mA; V_{CE} = 10 V	$-C_{re}$	typ.	280	fF [1]
Transition frequency				
I_C = 2 mA; V_{CE} = 10 V	f_T	typ.	675	MHz
Noise figure [2]				
$-I_E$ = 2 mA; V_{CB} = 10 V; G_S = 40 mΩ^{-1}; B_S = 0; f = 200 MHz	F	typ.	4.5	dB
$-I_E$ = 2 mA; V_{CB} = 10 V; G_S = 10 mΩ^{-1}; B_S = 0; f = 800 MHz	F	typ. <	7.0 9.5	dB dB
Maximum unilaterised power gain [2]				
$G_{UM} = \frac{\lvert y_{fb} \rvert^2}{4\, g_{ib}\, g_{ob}}$				
$-I_E$ = 2 mA; V_{CB} = 10 V; f = 50 MHz	G_{UM}	>	32	dB
$-I_E$ = 2 mA; V_{CB} = 10 V; f = 200 MHz	G_{UM}	typ.	24	dB
$-I_E$ = 2 mA; V_{CB} = 10 V; f = 500 MHz	G_{UM}	typ.	14	dB
$-I_E$ = 2 mA; V_{CB} = 10 V; f = 900 MHz	G_{UM}	typ.	12	dB
Transducer gain [2]				
$-I_E$ = 2 mA; V_{CB} = 10 V; f = 200 MHz; G_S = 40 mΩ^{-1}; B_S = 0; G_L = 1 mΩ^{-1}; B_L : tuned	G_{tr}	typ.	16.5	dB
$-I_E$ = 2 mA; V_{CB} = 10 V; f = 900 MHz; G_S = 20 mΩ^{-1}; B_S = 0; G_L = 2 mΩ^{-1}; B_L : tuned	G_{tr}	> typ.	7.5 9	dB dB

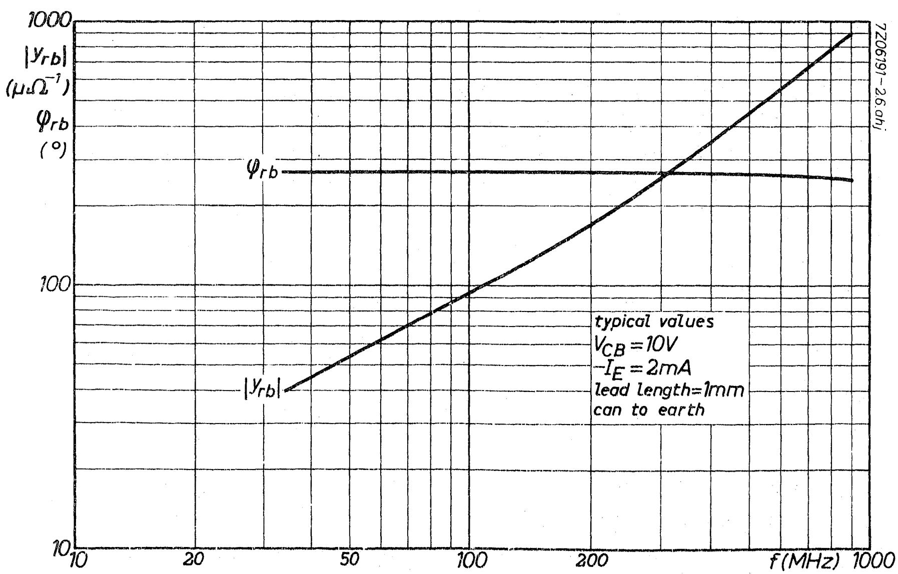
[1] 1 fF = 1 femtofarad = 10^{-15} F

[2] Common base configuration, metal envelope contacted to earth directly, external lead length: 1 mm.

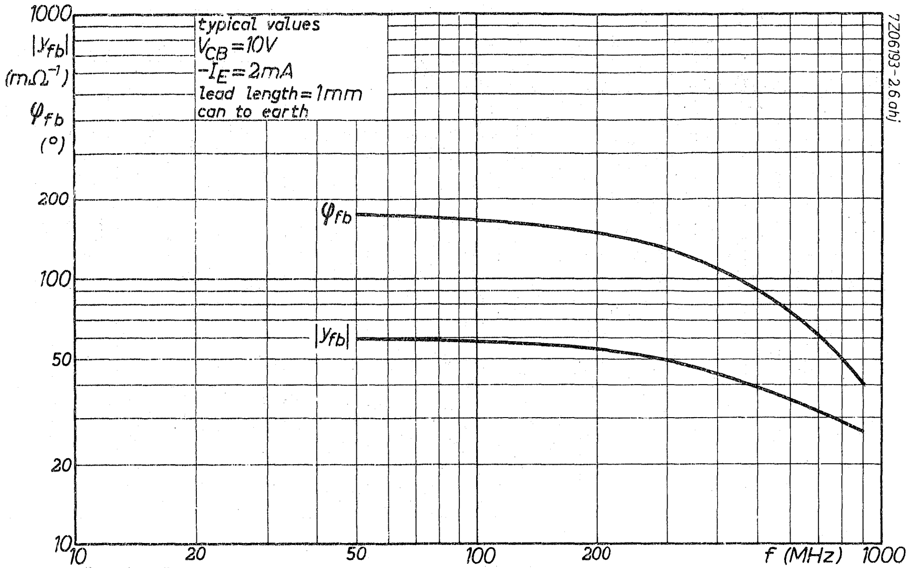
7Z3 0784

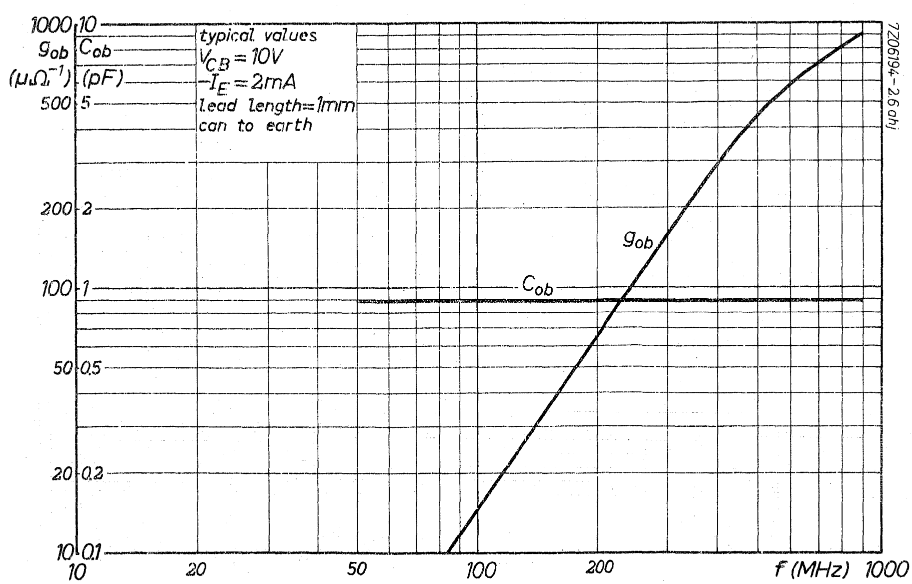


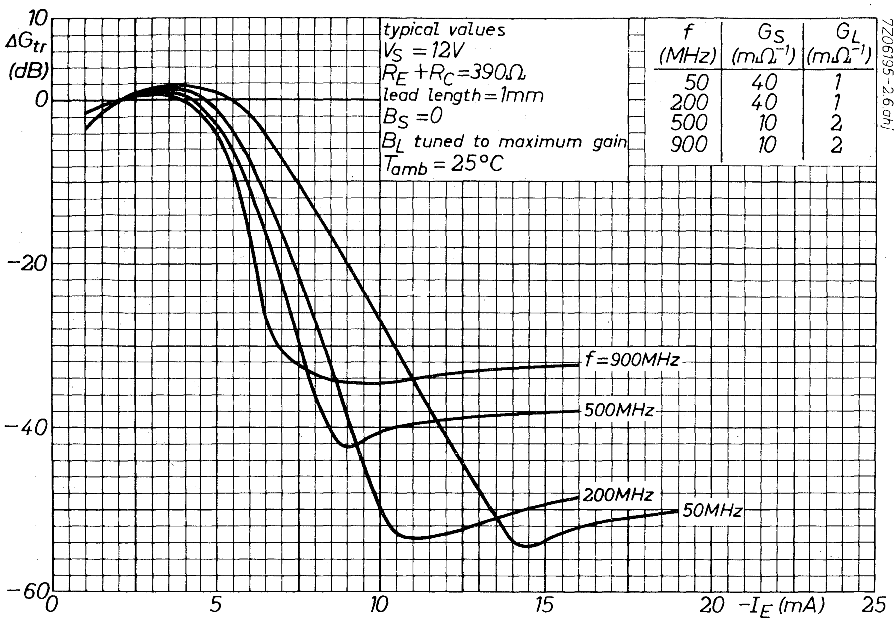
100
g_{ib}
($m\Omega^{-1}$)
$-b_{ib}$
($m\Omega^{-1}$)
$-C_{ib}$
(pF)
10
1
g_{ib}
$-C_{ib}$
$-b_{ib}$
typical values
$V_{CB} = 10V$
$-I_E = 2mA$
lead length=1mm
can to earth
10
20
50
100
200
f (MHz)
1000
7Z06192-2.6.ahj

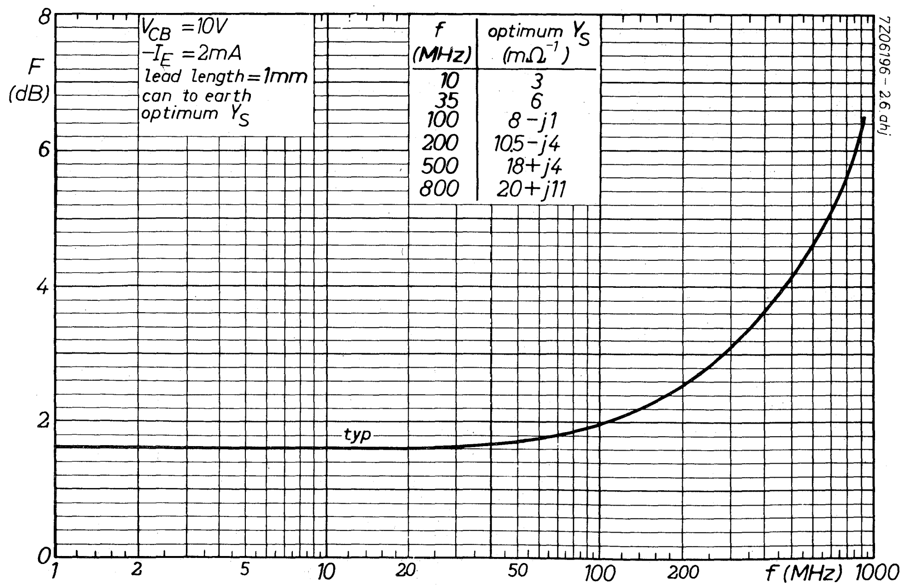


1000
$|y_{rb}|$
($\mu\Omega^{-1}$)
φ_{rb}
(°)
100
10
φ_{rb}
$|y_{rb}|$
typical values
$V_{CB} = 10V$
$-I_E = 2mA$
lead length=1mm
can to earth
10
20
50
100
200
f (MHz)
1000
7Z06191-2.6.ahj


1000
$|y_{fb}|$
$(m\Omega^{-1})$
φ_{fb}
(°)
200
100
50
20
10
typical values
V_{CB} = 10V
$-I_E$ = 2mA
lead length = 1mm
can to earth
φ_{fb}
$|y_{fb}|$
10
20
50
100
200
f (MHz)
1000
7Z06193-2.6ahj


1000
g_{ob}
$(\mu\Omega^{-1})$
500
200
100
50
20
10
10
C_{ob}
(pF)
5
2
1
0.5
0.2
0.1
typical values
V_{CB} = 10V
$-I_E$ = 2mA
lead length = 1mm
can to earth
g_{ob}
C_{ob}
10
20
50
100
200
f (MHz)
1000
7Z06194-2.6ahj


10
ΔGtr
(dB)
0
−20
−40
−60
0
5
10
15
20
−IE (mA)
25
typical values
VS = 12V
RE + RC = 390Ω
lead length = 1mm
BS = 0
BL tuned to maximum gain
Tamb = 25°C
f (MHz) | GS (mΩ⁻¹) | GL (mΩ⁻¹)
50 | 40 | 1
200 | 40 | 1
500 | 10 | 2
900 | 10 | 2
f = 900MHz
500MHz
200MHz
50MHz
7Z06195-2.6.ahj


8
F
(dB)
6
4
2
0
1
2
5
10
20
50
100
200
f (MHz)
1000
VCB = 10V
−IE = 2mA
lead length = 1mm
can to earth
optimum YS
f (MHz) | optimum YS (mΩ⁻¹)
10 | 3
35 | 6
100 | 8 − j1
200 | 10.5 − j4
500 | 18 + j4
800 | 20 + j11
typ
7Z06196-2.6.ahj

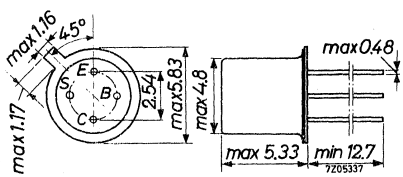
SILICON PLANAR TRANSISTOR

N-P-N transistor in a TO-72 metal envelope with insulated electrodes and a shield lead connected to the case. The BF181 is primarily intended for application as self-oscillating mixer in the u.h.f. band.

QUICK REFERENCE DATA				
Collector-base voltage (open emitter)	V_{CBO}	max.	30	V
Collector-emitter voltage (open base)	V_{CEO}	max.	20	V
Collector current (d.c.)	I_C	max.	20	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	150	mW
Junction temperature	T_j	max.	175	°C
Transition frequency				
I_C = 2 mA; V_{CE} = 10 V	f_T	typ.	600	MHz
Feedback capacitance at f = 10.7 MHz				
I_C = 1 mA; V_{CE} = 10 V	$-C_{re}$	typ.	280	fF
Max. unilateralised power gain				
$-I_E$ = 2 mA; V_{CB} = 10 V; f = 900 MHz	G_{UM}	typ.	11	dB
Noise figure at optimum source admittance				
$-I_E$ = 2 mA; V_{CB} = 10 V; f = 900 MHz	F	typ.	6.8	dB

MECHANICAL DATA Dimensions in mm

TO-72



S=Shield lead connected to case

7Z3 0727

RATINGS (Limiting values) [1]

Voltages

Collector-base voltage (open emitter)	V_{CBO}	max.	30	V
Collector-emitter voltage (open base)	V_{CEO}	max.	20	V
Emitter-base voltage (open collector)	V_{EBO}	max.	3	V

Currents

Collector current (d.c.)	I_C	max.	20	mA
Collector current (peak value)	I_{CM}	max.	20	mA

Power dissipation

Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	150	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	$R_{th\ j\text{-}a}$	=	1	°C/mW

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

7Z3 0726

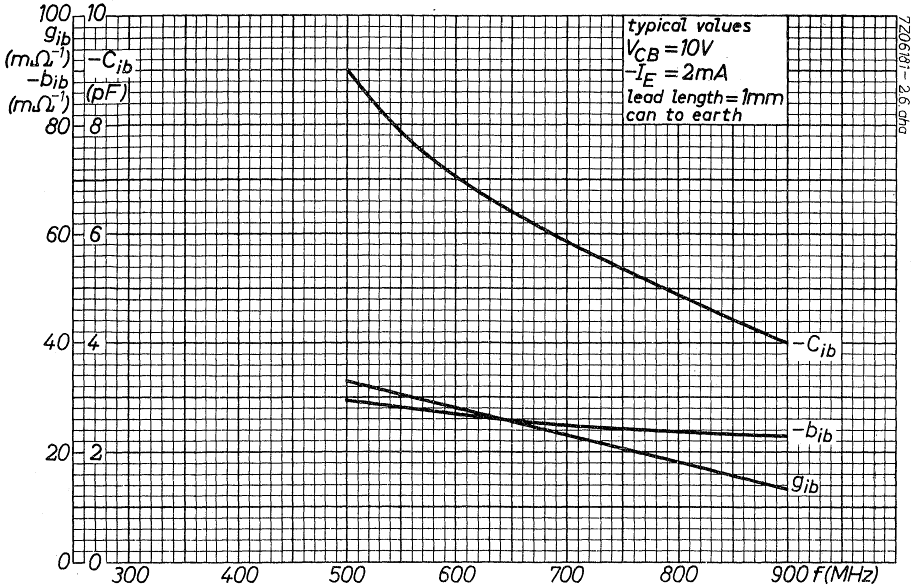
CHARACTERISTICS T_{amb} = 25 °C unless otherwise specified

Base current				
$-I_E$ = 2 mA; V_{CB} = 10 V	I_B	typ.	70	μA
		<	150	μA
Emitter-base voltage				
$-I_E$ = 2 mA; V_{CB} = 10 V	$-V_{EB}$	typ.	0.75	V
Feedback capacitance at f = 10.7 MHz				
I_C = 1 mA; V_{CE} = 10 V	$-C_{re}$	typ.	280	fF [1]
Transition frequency				
I_C = 2 mA; V_{CE} = 10 V	f_T	typ.	600	MHz
y parameters at f = 35 MHz [2]				
$-I_E$ = 2 mA; V_{CB} = 10 V				
Output conductance	g_{ob}	<	10	$\mu\Omega^{-1}$
Output capacitance	C_{ob}	typ.	0.9	pF
Maximum unilateralised power gain [2]				
$G_{UM} = \frac{\lvert y_{fb}\rvert^2}{4\, g_{ib}\, g_{ob}}$				
$-I_E$ = 2 mA; V_{CB} = 10 V; f = 500 MHz	G_{UM}	typ.	13.5	dB
$-I_E$ = 2 mA; V_{CB} = 10 V; f = 900 MHz	G_{UM}	typ.	11	dB
Transducer gain [2]				
$-I_E$ = 2 mA; V_{CB} = 10 V; f = 900 MHz;				
G_S = 20 mΩ^{-1}; B_S = 0				
G_L = 2 mΩ^{-1}; B_L : tuned	G_{tr}	typ.	8	dB

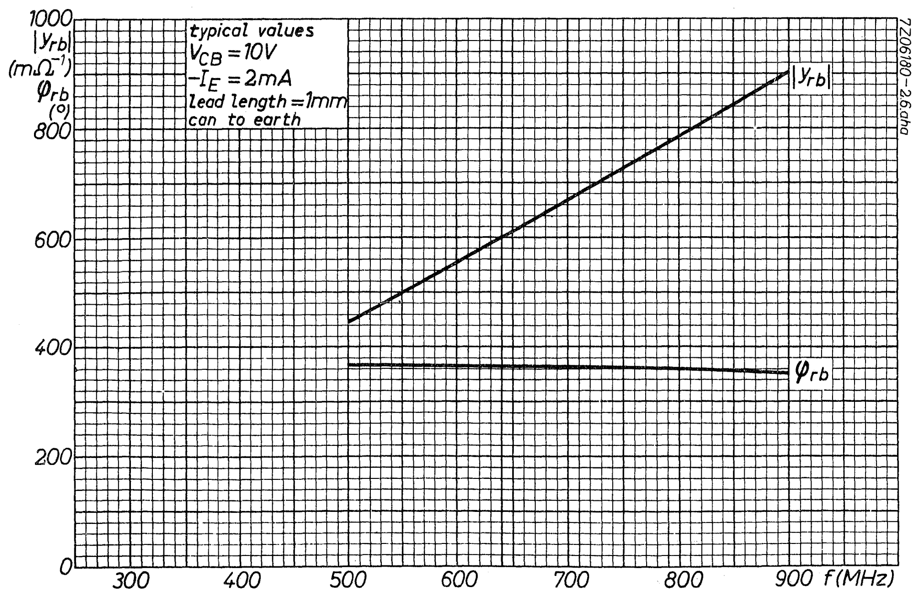
1) 1 fF = 1 femtofarad = 10^{-15} F.

2) Common base configuration, metal envelope contacted to earth directly, external lead length: 1 mm.

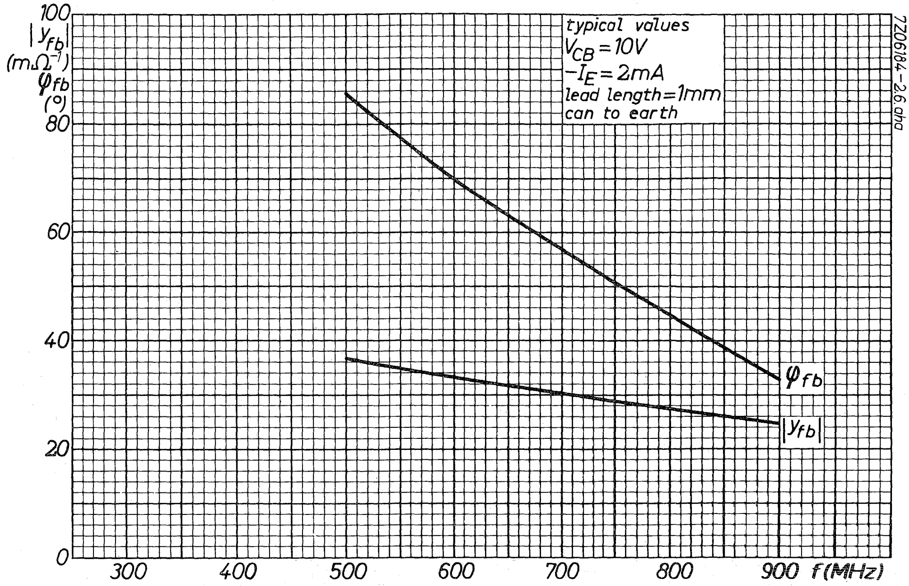
7Z3 0785

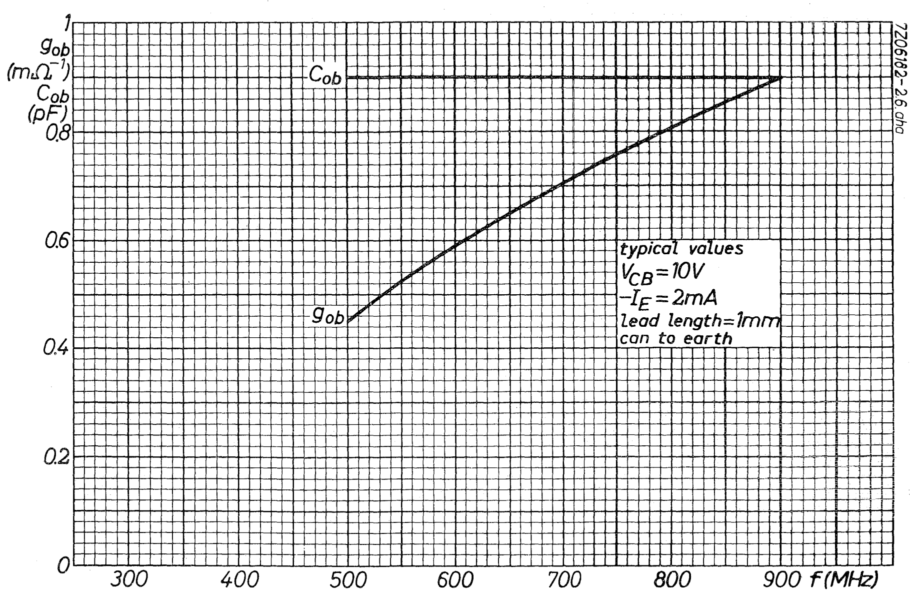


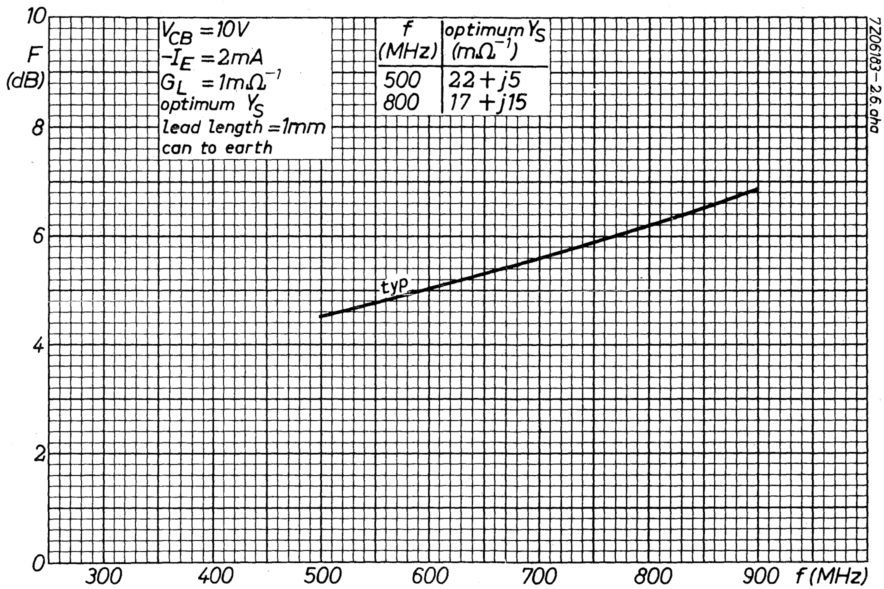
typical values
V_{CB} = 10V
$-I_E$ = 2mA
lead length = 1mm
can to earth
7Z06181-2.6.aha
100
g_{ib}
($m\Omega^{-1}$)
$-b_{ib}$
($m\Omega^{-1}$)
80
60
40
20
0
10
$-C_{ib}$
(pF)
8
6
4
2
0
$-C_{ib}$
$-b_{ib}$
g_{ib}
300
400
500
600
700
800
900
f (MHz)



typical values
V_{CB} = 10V
$-I_E$ = 2mA
lead length = 1mm
can to earth
7Z06180-2.6.aha
1000
$|y_{rb}|$
($m\Omega^{-1}$)
φ_{rb}
(°)
800
600
400
200
0
$|y_{rb}|$
φ_{rb}
300
400
500
600
700
800
900
f (MHz)


100
$|y_{fb}|$
$(m\Omega^{-1})$
φ_{fb}
(°)
80
60
40
20
0
300
400
500
600
700
800
900 f(MHz)
typical values
$V_{CB} = 10V$
$-I_E = 2mA$
lead length=1mm
can to earth
φ_{fb}
$|y_{fb}|$
7Z06184-2.6.aha


1
g_{ob}
$(m\Omega^{-1})$
C_{ob}
(pF)
0.8
0.6
0.4
0.2
0
300
400
500
600
700
800
900 f(MHz)
C_{ob}
g_{ob}
typical values
$V_{CB} = 10V$
$-I_E = 2mA$
lead length=1mm
can to earth
7Z06182-2.6.aha


7Z06183–2.6.aha
V_{CB} = 10V
$-I_E$ = 2mA
G_L = 1mΩ^{-1}
optimum Y_S
lead length = 1mm
can to earth
f (MHz) | optimum Y_S (mΩ^{-1})
500 | 22 + j5
800 | 17 + j15
typ
F (dB)
10
8
6
4
2
0
300
400
500
600
700
800
900
f (MHz)

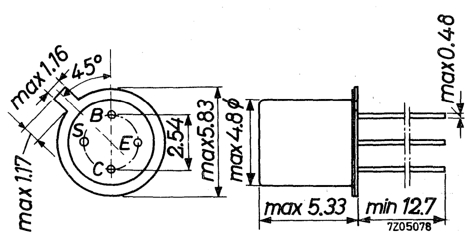
SILICON PLANAR EPITAXIAL TRANSISTOR

N-P-N transistor in TO-72 metal case with insulated electrodes and a shield lead connected to the case. The BF184 is intended for a.m. and f.m. application, primarily for i.f. amplifiers and gain controlled a.m. input stages of mains fed receivers.

QUICK REFERENCE DATA				
Collector-base voltage (open emitter)	V_{CBO}	max.	30	V
Collector-emitter voltage (open base)	V_{CEO}	max.	20	V
Collector current (d.c.)	I_C	max.	30	mA
Total power dissipation up to T_{amb} = 45 °C	P_{tot}	max.	145	mW
Junction temperature	T_j	max.	175	°C
D.C. current gain at T_j = 25 °C				
I_C = 1 mA; V_{CE} = 10 V	h_{FE}	typ.	115	
Transition frequency				
I_C = 1 mA; V_{CE} = 10 V	f_T	typ.	300	MHz

MECHANICAL DATA Dimensions in mm

TO-72
Insulated electrodes



S=Shield lead connected to case

7Z3 0271

RATINGS (Limiting values) [1])

Voltages

Collector-base voltage (open emitter)	V_{CBO}	max.	30	V
Collector-emitter voltage (open base) (See also sheet B)	V_{CEO}	max.	20	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	V

Currents

Collector current (d.c.)	I_C	max.	30	mA
Collector current (peak value)	I_{CM}	max.	30	mA

Power dissipation

Total power dissipation up to T_{amb} = 45 °C	P_{tot}	max.	145	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	$R_{th\ j-a}$	=	0.9	°C/mW

CHARACTERISTICS T_j = 25 °C unless otherwise specified

Base-emitter voltage [2])

I_C = 1 mA; V_{CE} = 10 V	V_{BE}		0.65 to 0.74	V
I_C = 20 mA; V_{CE} = 2 V	V_{BE}	<	1.0	V

Feedback capacitance at f = 0.45 MHz

I_C = 1 mA; V_{CE} = 10 V	$-C_{re}$	typ.	0.65	pF

D.C. current gain

I_C = 1 mA; V_{CE} = 10 V	h_{FE}		75 to 750	
		typ.	115	

Transition frequency

I_C = 1 mA; V_{CE} = 10 V	f_T	typ.	300	MHz

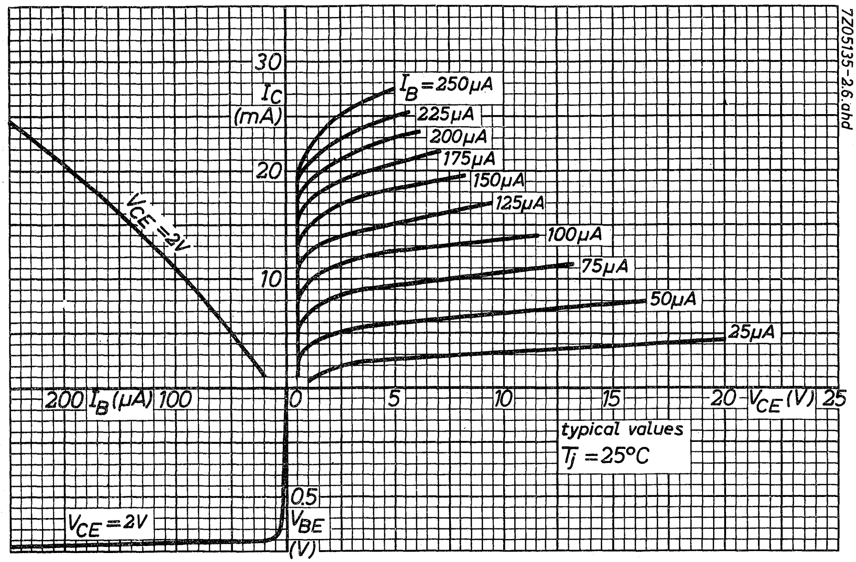
Conversion noise figure

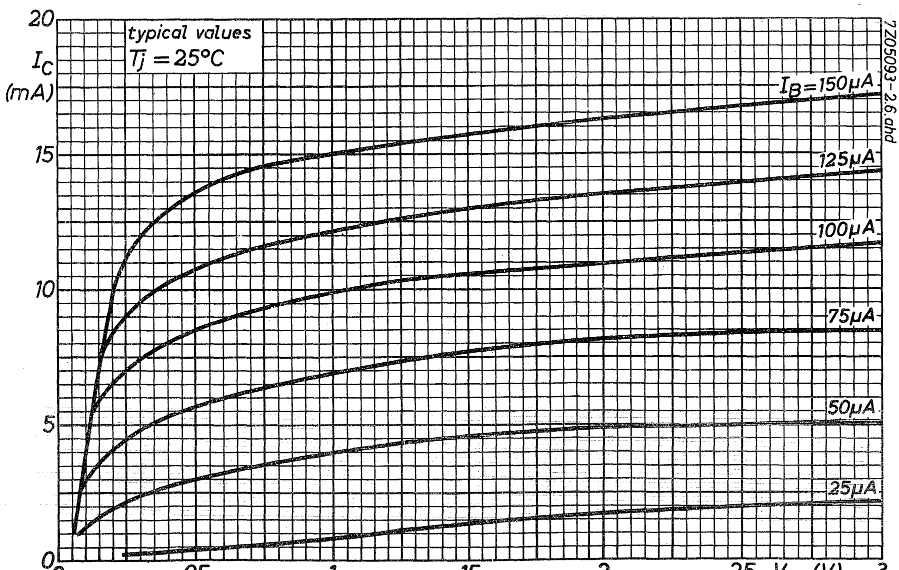
I_C = 1 mA; V_{CE} = 10 V

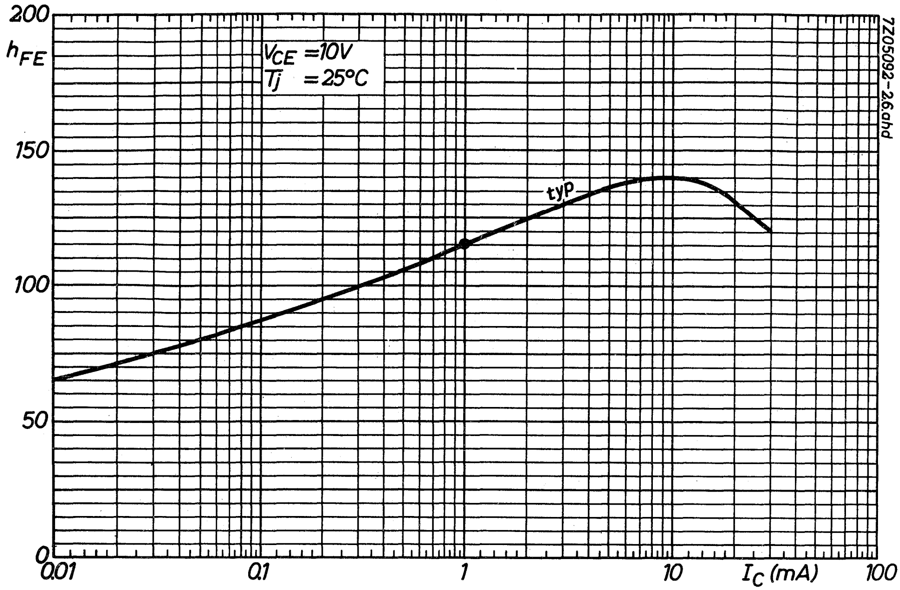
G_S = 0.6 mΩ^{-1}; f = 0.2 MHz	F_c	typ.	3	dB
G_S = 1.2 mΩ^{-1}; f = 1.0 MHz	F_c	typ.	2	dB

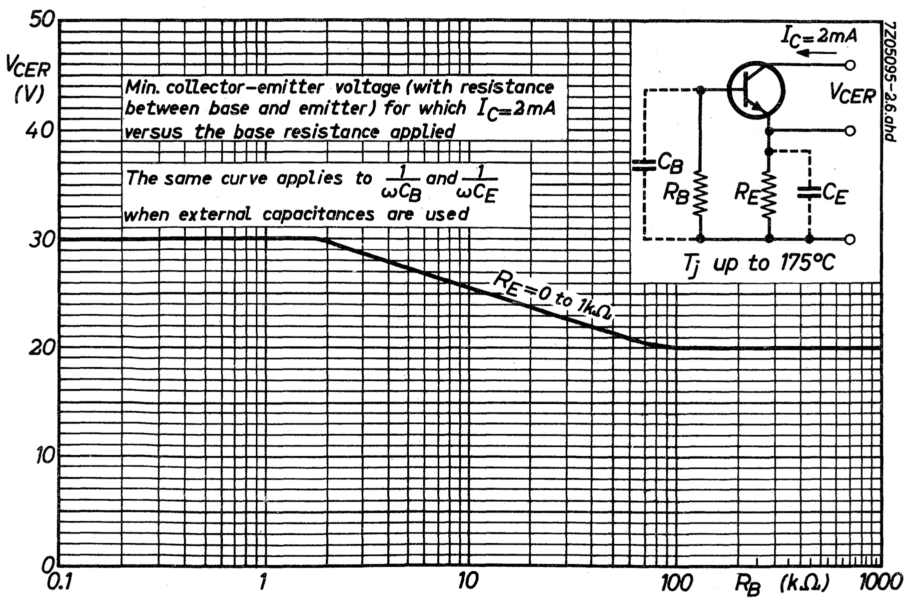
1) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

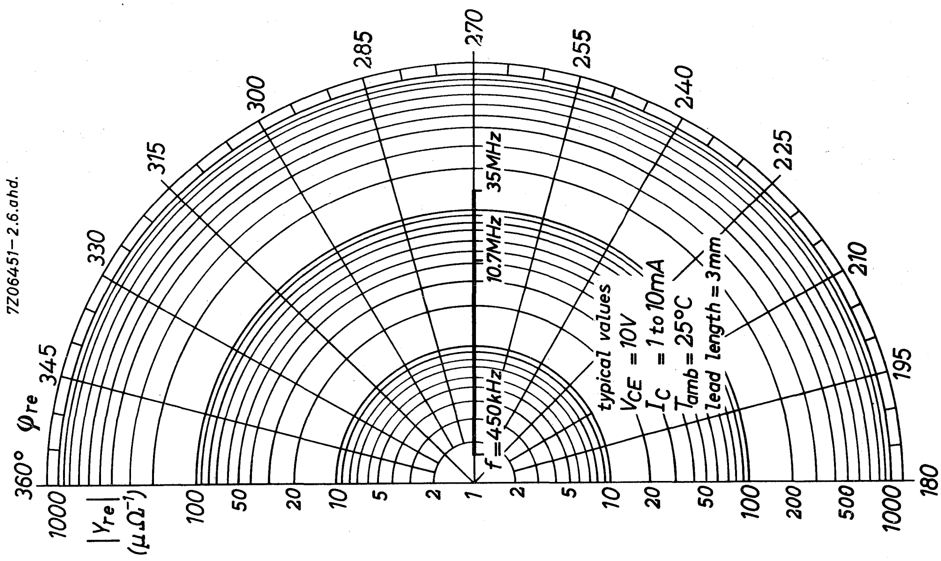
2) V_{BE} decreases with about 1.7 mV/°C at increasing temperature. 7Z3 0849


30
I_C (mA)
20
10
I_B = 250μA
225μA
200μA
175μA
150μA
125μA
100μA
75μA
50μA
25μA
V_{CE} = 2V
200 I_B (μA) 100
0
5
10
15
20 V_{CE} (V) 25
typical values
T_j = 25°C
0.5
V_{BE} (V)
V_{CE} = 2V
7Z05135-2.6.ahd

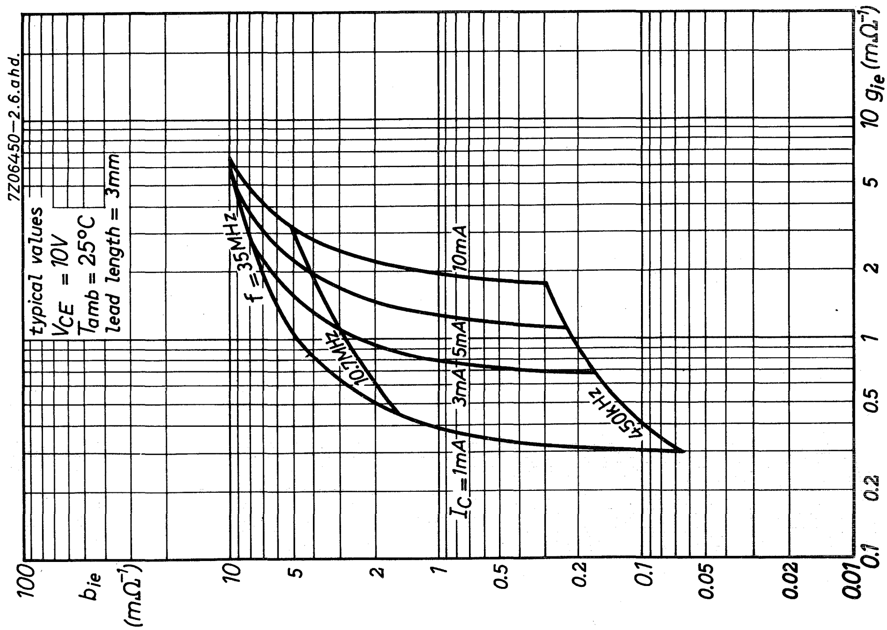

20
I_C (mA)
15
10
5
0
typical values
T_j = 25°C
I_B = 150μA
125μA
100μA
75μA
50μA
25μA
0
0.5
1
1.5
2
2.5 V_{CE} (V) 3
7Z05093-2.6.ahd


200
h_{FE}
V_{CE} =10V
T_j =25°C
150
typ
100
50
0
0.01
0.1
1
10
I_C (mA)
100
7Z05092-2.6.ahd

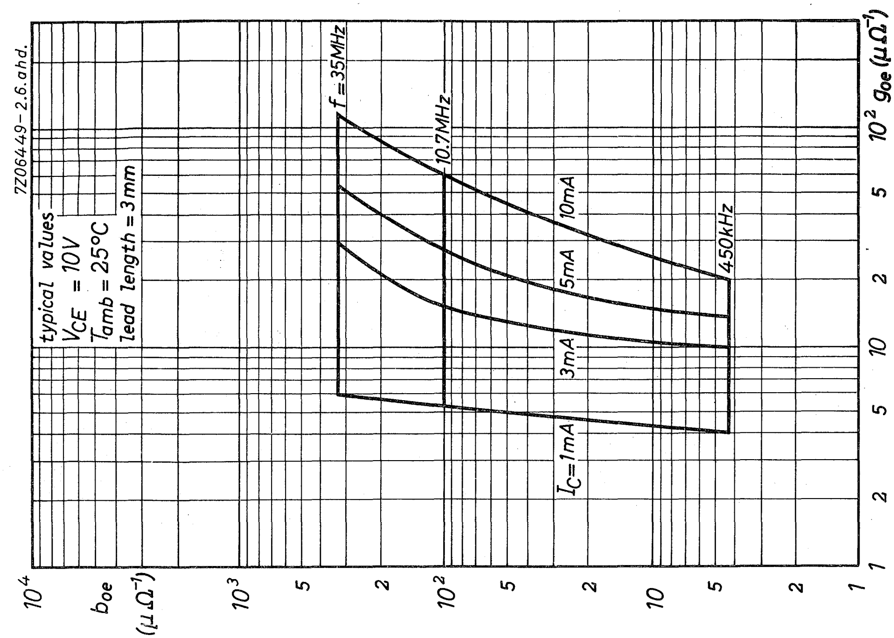

50
V_{CER}
(V)
40
30
20
10
0
Min. collector-emitter voltage (with resistance between base and emitter) for which I_C=2mA versus the base resistance applied
The same curve applies to $\frac{1}{\omega C_B}$ and $\frac{1}{\omega C_E}$ when external capacitances are used
R_E=0 to 1kΩ
I_C= 2mA
V_{CER}
C_B
R_B
R_E
C_E
T_j up to 175°C
0.1
1
10
100
R_B (kΩ)
1000
7Z05095-2.6.ahd

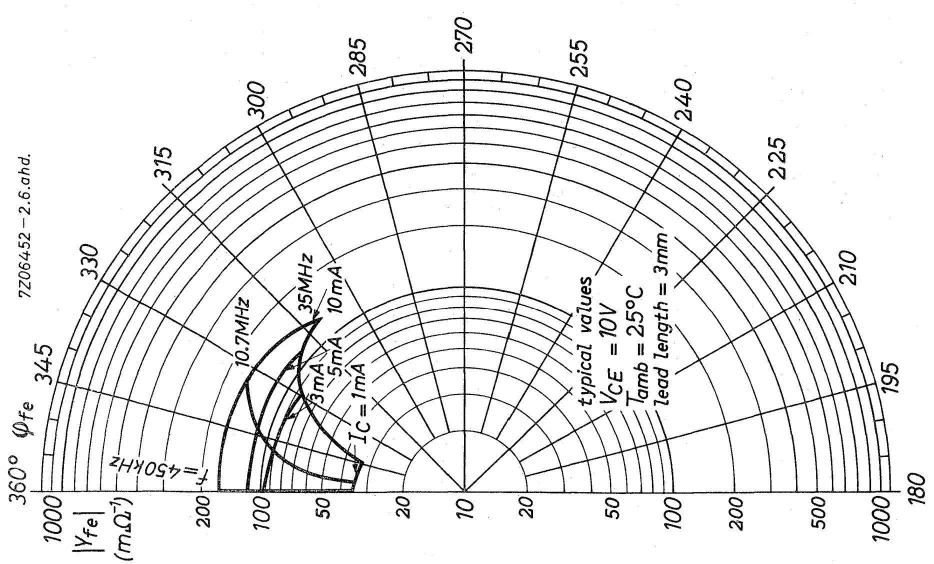


7Z06451-2.6.ahd.
typical values
V_{CE} = 10V
I_C = 1 to 10mA
T_{amb} = 25°C
lead length = 3mm
f = 450kHz
10.7MHz
35MHz
φ_{re}
$|y_{re}|$ ($\mu\Omega^{-1}$)



7Z06450-2.6.ahd.
typical values
V_{CE} = 10V
T_{amb} = 25°C
lead length = 3mm
f = 35MHz
10.7MHz
450kHz
I_C = 1mA
3mA
5mA
10mA
b_{ie} ($m\Omega^{-1}$)
g_{ie} ($m\Omega^{-1}$)


7Z06449–2.6.ahd.
typical values
V_{CE} = 10V
T_{amb} = 25°C
lead length = 3mm
f = 35MHz
10.7MHz
450kHz
10mA
5mA
3mA
I_C=1mA
10^2 g_{oe} ($\mu\Omega^{-1}$)
b_{oe} ($\mu\Omega^{-1}$)
10^4
10^3
10^2


7Z06452 – 2.6.ahd.
typical values
V_{CE} = 10V
T_{amb} = 25°C
lead length = 3mm
35MHz
10.7MHz
f=450kHz
10mA
5mA
3mA
I_C = 1mA
360° φ_{fe}
$|Y_{fe}|$ (mΩ^{-1})
345
330
315
300
285
270
255
240
225
210
195
180

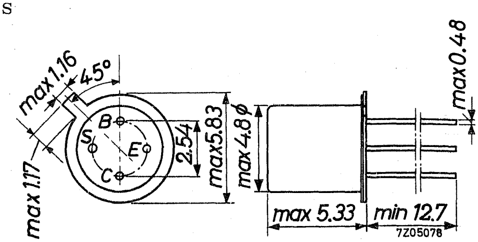
SILICON PLANAR EPITAXIAL TRANSISTOR

N-P-N transistor in TO-72 metal case with insulated electrodes and a shield lead connected to the case. The BF185 is intended for low noise a.m. and f.m. application, primarily for use as preamplifier or mixer-oscillator in portable receivers and car radios.

QUICK REFERENCE DATA				
Collector-base voltage (open emitter)	V_{CBO}	max.	30	V
Collector-emitter voltage (open base)	V_{CEO}	max.	20	V
Collector current (d.c.)	I_C	max.	30	mA
Total power dissipation up to T_{amb} = 45 °C	P_{tot}	max.	145	mW
Junction temperature	T_j	max.	175	°C
D.C. current gain at T_j = 25 °C				
I_C = 1 mA; V_{CE} = 10 V	h_{FE}	typ.	67	
Transition frequency				
I_C = 1 mA; V_{CE} = 10 V	f_T	typ.	220	MHz
Noise figure at f = 100 MHz				
I_C = 1 mA; V_{CE} = 10 V; G_S = 10 mΩ^{-1}	F	typ.	4	dB

MECHANICAL DATA Dimensions in mm

TO-72
Insulated electrodes



S=Shield lead connected to case

7Z3 0850

RATINGS (Limiting values) [1])

Voltages

Collector-base voltage (open emitter)	V_{CBO}	max.	30	V
Collector-emitter voltage (open base) (See also sheet B)	V_{CEO}	max.	20	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	V

Currents

Collector current (d.c.)	I_C	max.	30	mA
Collector current (peak value)	I_{CM}	max.	30	mA

Power dissipation

Total power dissipation up to T_{amb} = 45 °C	P_{tot}	max.	145	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	$R_{th\ j\text{-}a}$	=	0.9	°C/mW

CHARACTERISTICS T_j = 25 °C unless otherwise specified

Base-emitter voltage [2])				
I_C = 1 mA; V_{CE} = 10 V	V_{BE}	0.65 to 0.74		V
I_C = 20 mA; V_{CE} = 2 V	V_{BE}	<	1.0	V
Feedback capacitance at f = 0.45 MHz				
I_C = 1 mA; V_{CE} = 10 V	$-C_{re}$	typ.	0.65	pF
D.C. current gain				
I_C = 1 mA; V_{CE} = 10 V	h_{FE}	34 to	140	
		typ.	67	
Transition frequency				
I_C = 1 mA; V_{CE} = 10 V	f_T	typ.	220	MHz

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

[2]) V_{BE} decreases with about 1.7 mV/°C at increasing temperature. 7Z3 0851

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

Noise figure

I_C = 1 mA; V_{CE} = 10 V			
f = 0.2 MHz; G_S = 5 mΩ^{-1}	F	typ. 2	dB
f = 1 MHz; G_S = 20 mΩ^{-1}	F	typ. 3.5	dB
f = 100 MHz; G_S = 10 mΩ^{-1}	F	typ. 4	dB

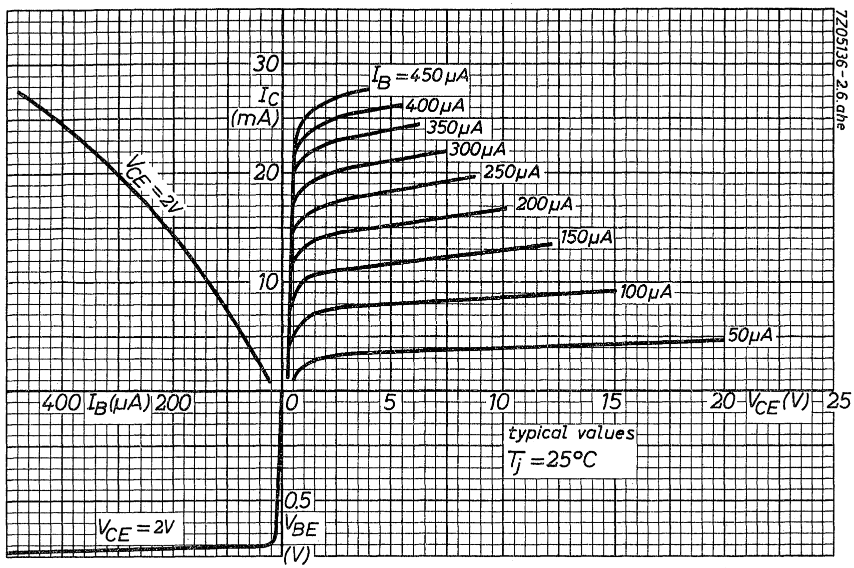
y parameters at f = 100 MHz (common base)

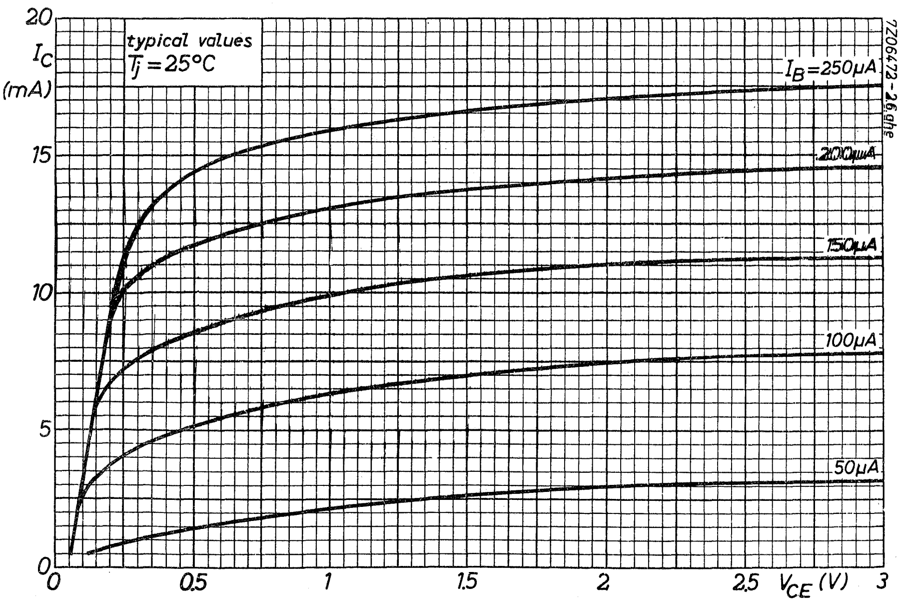
$-I_E$ = 1 mA; V_{CB} = 10 V			
Input conductance	g_{ib}	typ. 33	mΩ^{-1}
Input capacitance	$-C_{ib}$	typ. 5.5	pF
Feedback admittance	$\lvert y_{rb}\rvert$	typ. 220	$\mu\Omega^{-1}$
Phase angle of feedback admittance	φ_{rb}	typ. 273°	
Transfer admittance	$\lvert y_{fb}\rvert$	typ. 33	mΩ^{-1}
Phase angle of transfer admittance	φ_{fb}	typ. 150°	
Output conductance	g_{ob}	typ. 12	$\mu\Omega^{-1}$
Output capacitance	C_{ob}	typ. 1.5	pF

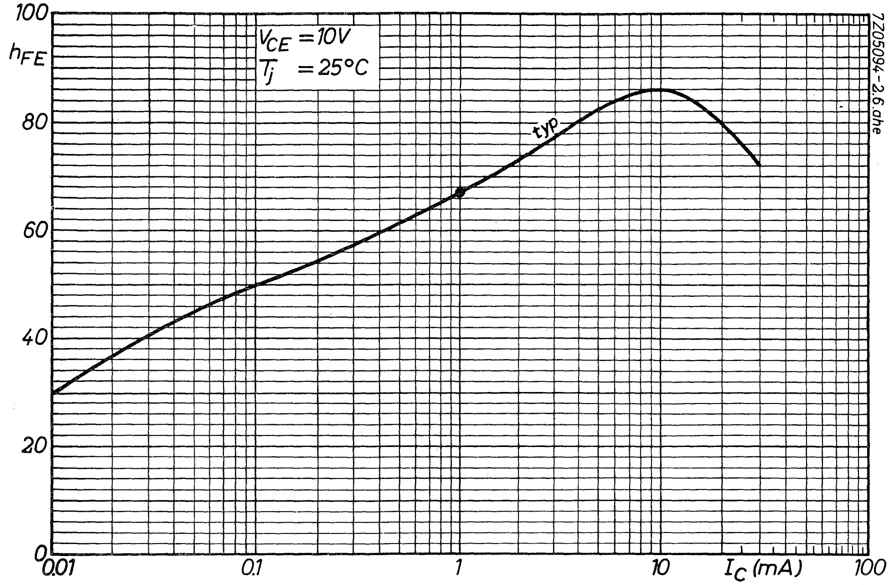
NOTE

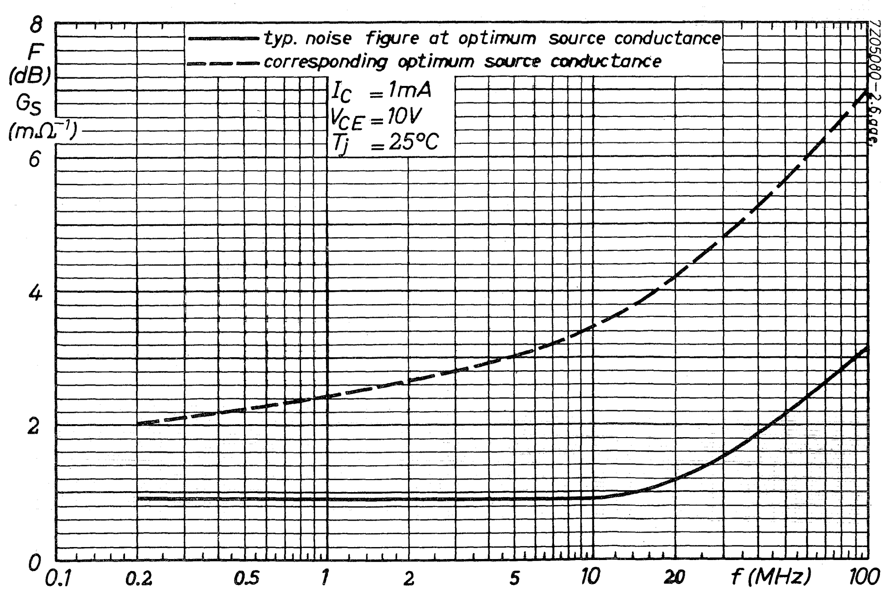
All small signal quantities have been measured with a length of leads between the bottom of the transistor and measuring jig of 3 mm.

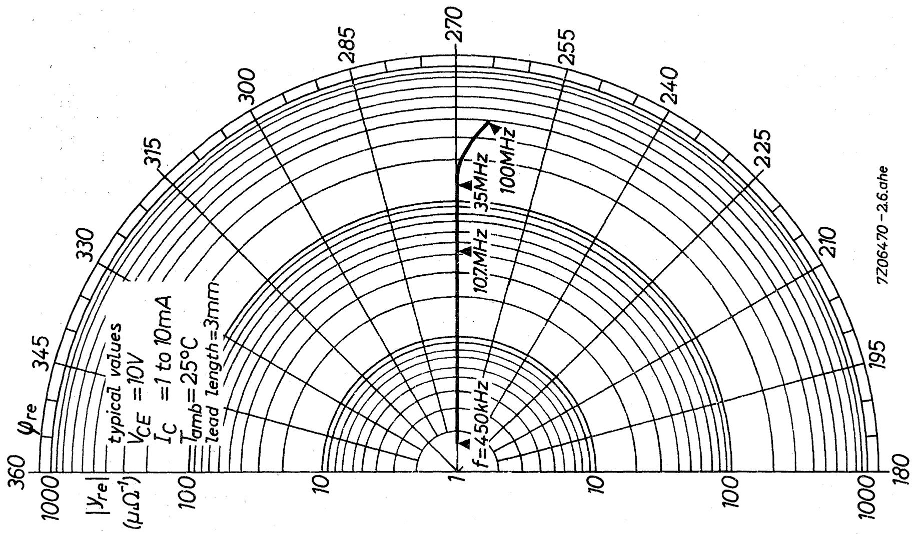
7Z3 0852

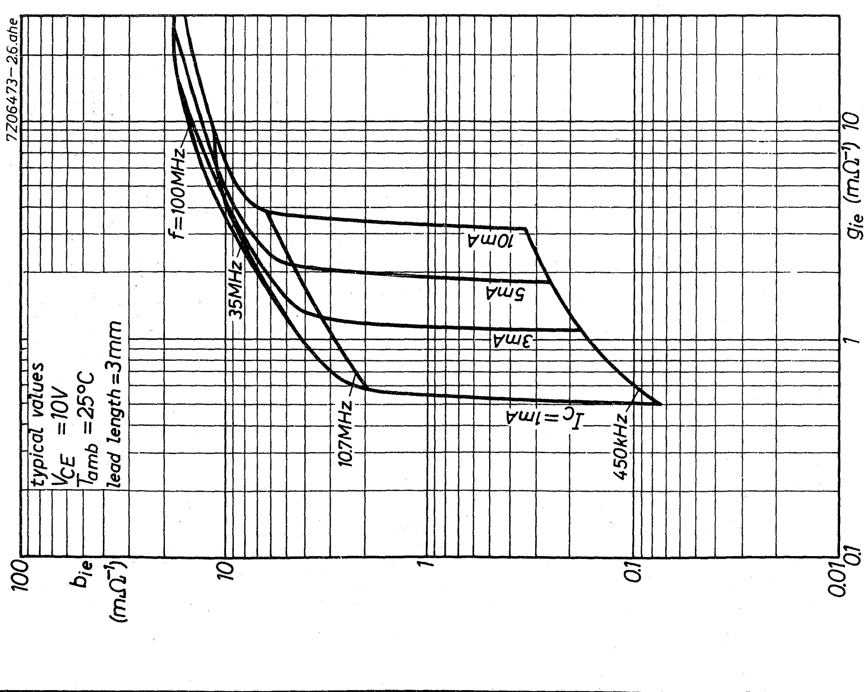

7Z05136-2.6.ahe
30
I_C
(mA)
20
10
I_B = 450 μA
400 μA
350 μA
300 μA
250 μA
200 μA
150 μA
100 μA
50 μA
V_{CE} = 2V
400 I_B(μA) 200
0
5
10
15
20 V_{CE} (V) 25
typical values
T_j = 25°C
0.5
V_{BE}
(V)
V_{CE} = 2V

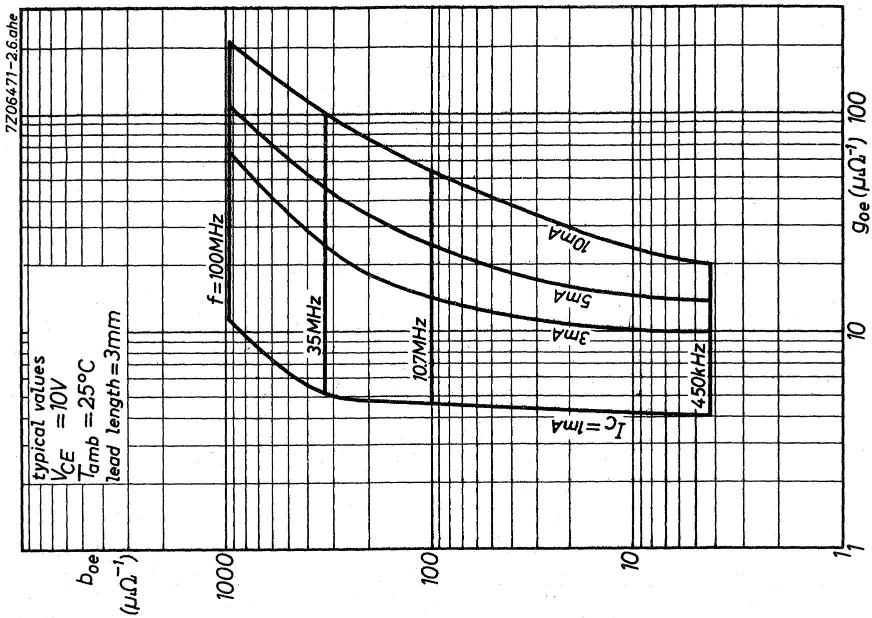

7Z06472-2.6.ahe
20
I_C
(mA)
15
10
5
0
typical values
T_j = 25°C
I_B=250μA
200μA
150μA
100μA
50μA
0
0.5
1
1.5
2
2.5 V_{CE} (V) 3

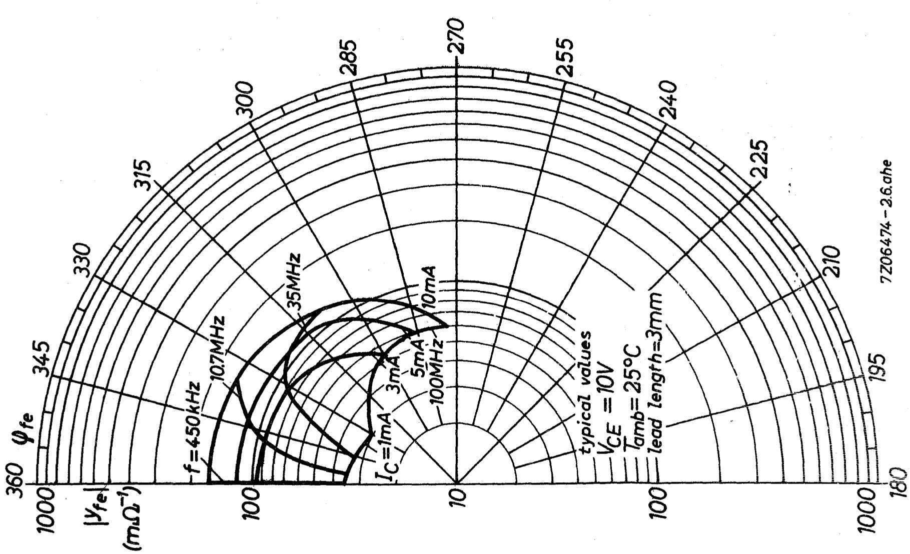

100
h_{FE}
80
60
40
20
0
0.01
0.1
1
10
I_C (mA)
100
V_{CE} = 10V
T_j = 25°C
typ
7Z05094-2.6.ahe

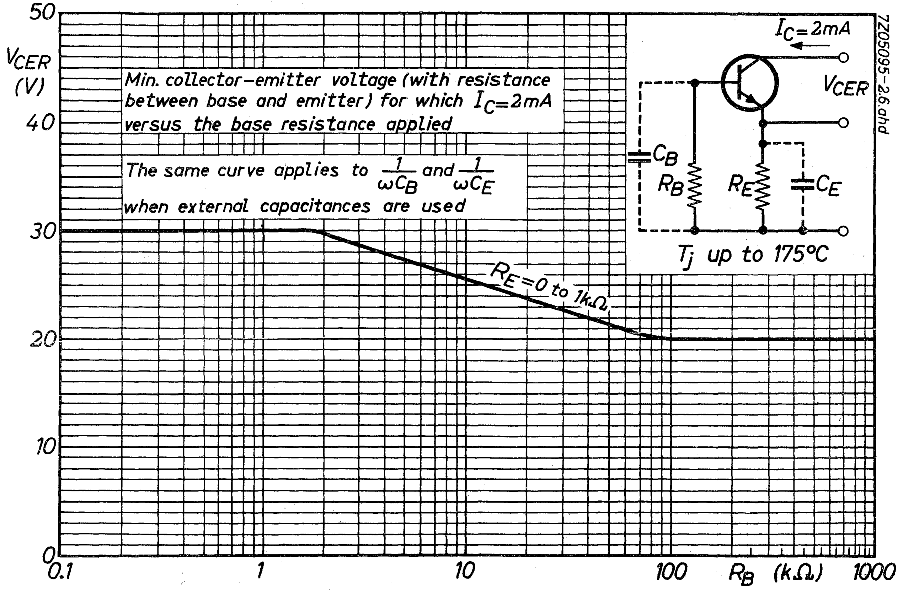

8
F
(dB)
G_S
$(m\Omega^{-1})$
6
4
2
0
0.1
0.2
0.5
1
2
5
10
20
f (MHz)
100
typ. noise figure at optimum source conductance
corresponding optimum source conductance
I_C = 1mA
V_{CE} = 10V
T_j = 25°C


φre
360
345
330
315
300
285
270
255
240
225
210
195
180
|yre| (μΩ⁻¹)
1000
100
10
1
10
100
1000
typical values
VCE = 10V
IC = 1 to 10mA
Tamb = 25°C
lead length = 3mm
f = 450kHz
10.7MHz
35MHz
100MHz
7Z06470-2.6.ahe


bie (mΩ⁻¹)
100
10
1
0.1
0.01
0.1
1
10
gie (mΩ⁻¹)
typical values
VCE = 10V
Tamb = 25°C
lead length = 3mm
f = 100MHz
35MHz
10.7MHz
450kHz
10mA
5mA
3mA
IC = 1mA
7Z06473-2.6.ahe


7Z06471-2.6.ahe
typical values
V_{CE} = 10V
T_{amb} = 25°C
lead length = 3mm
f = 100MHz
35MHz
10.7MHz
450kHz
10mA
5mA
3mA
I_C = 1mA
b_{oe} ($\mu\Omega^{-1}$)
1000
100
10
1
g_{oe} ($\mu\Omega^{-1}$)


7Z06474-2.6.ahe
φ_{fe}
360
345
330
315
300
285
270
255
240
225
210
195
180
$|y_{fe}|$ ($m\Omega^{-1}$)
1000
100
10
f = 450kHz
10.7MHz
35MHz
10mA
5mA
3mA
100MHz
I_C = 1mA
typical values
V_{CE} = 10V
T_{amb} = 25°C
lead length = 3mm


50
40
30
20
10
0
V_{CER} (V)
0.1
1
10
100
1000
R_B (kΩ)
Min. collector-emitter voltage (with resistance between base and emitter) for which I_C=2mA versus the base resistance applied
The same curve applies to $\frac{1}{\omega C_B}$ and $\frac{1}{\omega C_E}$ when external capacitances are used
R_E=0 to 1kΩ
I_C=2mA
V_{CER}
C_B
R_B
R_E
C_E
T_j up to 175°C
7Z05095-2.6.ahd

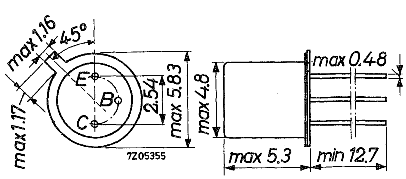
SILICON PLANAR EPITAXIAL TRANSISTOR

N-P-N silicon planar epitaxial transistor in a TO-18 metal envelope with the collector connected to the case. The BFX43 is primarily intended for the output stages of aerial amplifiers in band I to III (up to 230 MHz).

QUICK REFERENCE DATA				
Collector-base voltage (open emitter)	V_{CBO}	max.	30	V
Collector-emitter voltage (open base)	V_{CEO}	max.	15	V
Collector current (peak value)	I_{CM}	max.	250	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	360	mW
Junction temperature	T_j	max.	200	°C
Transition frequency				
I_C = 10 mA; V_{CE} = 10 V	f_T	>	500	MHz
I_C = 50 mA; V_{CE} = 10 V	f_T	>	500	MHz
Output voltage at d_{im} = −30 dB				
I_C = 40 mA; V_{CE} = 10 V; R_L = 37.5 Ω				
f_p = 202 MHz; f_q = 205 MHz; $f_{(2q-p)}$ = 208 MHz	V_o	>	0.8	V

MECHANICAL DATA Dimensions in mm

TO-18
Collector connected to case



7Z3 0728

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
Collector-emitter voltage with $V_{BE} = 0$	V_{CES}	max.	30	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4	V

Currents

Collector current (d.c. or average over any 20 ms period)	I_C	max.	125	mA
Collector current (peak value)	I_{CM}	max.	250	mA

Power dissipation

Total power dissipation up to $T_{amb} = 25$ °C	P_{tot}	max.	360	mW

Temperatures

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

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	0.48	°C/mW
From junction to ambient with cooling clip 56263	$R_{th\ j\text{-}a}$	=	0.28	°C/mW
From junction to case	$R_{th\ j\text{-}c}$	=	0.145	°C/mW

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

7Z3 0729

CHARACTERISTICS T_j = 25 °C unless otherwise specified

Collector cut-off current				
$I_E = 0$; $V_{CB} = 20$ V	I_{CBO}	<	100	nA
$I_E = 0$; $V_{CB} = 20$ V; $T_j = 150$ °C	I_{CBO}	<	20	μA
Emitter cut-off current				
$I_C = 0$; $V_{EB} = 2$ V	I_{EBO}	<	50	nA
$I_C = 0$; $V_{EB} = 2$ V; $T_j = 150$ °C	I_{EBO}	<	20	μA
Sustaining voltage				
$I_C = 10$ mA; $I_B = 0$	$V_{CEOsust}$	>	15	V
Saturation voltages				
$I_C = 100$ mA; $I_B = 10$ mA	V_{CEsat}	<	0.60	V
	V_{BEsat}	<	1.50	V
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; $V_{CB} = 5$ V	C_c	<	4	pF
Emitter capacitance at f = 1 MHz				
$I_C = I_c = 0$; $V_{EB} = 0.5$ V	C_e	<	4.5	pF
D.C. current gain				
$I_C = 10$ mA; $V_{CE} = 1$ V	h_{FE}	20 to 60		
$I_C = 100$ mA; $V_{CE} = 1$ V	h_{FE}	>	12	
Transition frequency				
$I_C = 10$ mA; $V_{CE} = 10$ V	f_T	>	500	MHz
$I_C = 50$ mA; $V_{CE} = 10$ V	f_T	>	500	MHz

7Z3 0778

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

y parameters at I_C = 40 mA; V_{CE} = 10 V (common emitter)

f = 35 MHz

Input conductance	g_{ie}	typ.	16	$m\Omega^{-1}$
Input susceptance	b_{ie}	typ.	13	$m\Omega^{-1}$
Input capacitance	C_{ie}	typ.	60	pF
Feedback admittance	$\|y_{re}\|$	typ.	0.44	$m\Omega^{-1}$
Phase angle of feedback admittance	φ_{re}	typ.	269°	
Transfer admittance	$\|y_{fe}\|$	typ.	275	$m\Omega^{-1}$
Phase angle of transfer admittance	φ_{fe}	typ.	306°	
Output conductance	g_{oe}	typ.	1	$m\Omega^{-1}$
Output capacitance	C_{oe}	typ.	6.8	pF

f = 100 MHz

Input conductance	g_{ie}	typ.	22	$m\Omega^{-1}$
Input susceptance	b_{ie}	typ.	12.5	$m\Omega^{-1}$
Input capacitance	C_{ie}	typ.	20	pF
Feedback admittance	$\|y_{re}\|$	typ.	1.2	$m\Omega^{-1}$
Phase angle of feedback admittance	φ_{re}	typ.	266°	
Transfer admittance	$\|y_{fe}\|$	typ.	108	$m\Omega^{-1}$
Phase angle of transfer admittance	φ_{fe}	typ.	282°	
Output conductance	g_{oe}	typ.	1.6	$m\Omega^{-1}$
Output capacitance	C_{oe}	typ.	4.5	pF

f = 200 MHz

Input conductance	g_{ie}	typ.	32.5	$m\Omega^{-1}$
Input susceptance	b_{ie}	typ.	16.5	$m\Omega^{-1}$
Input capacitance	C_{ie}	typ.	13	pF
Feedback admittance	$\|y_{re}\|$	typ.	2.25	$m\Omega^{-1}$
Phase angle of feedback admittance	φ_{re}	typ.	260°	
Transfer admittance	$\|y_{fe}\|$	typ.	75	$m\Omega^{-1}$
Phase angle of transfer admittance	φ_{fe}	typ.	260°	
Output conductance	g_{oe}	typ.	1.8	$m\Omega^{-1}$
Output capacitance	C_{oe}	typ.	3.7	pF

CHARACTERISTICS (continued)

Output voltage

dim = −30 dB

I_C = 40 mA; V_{CE} = 10 V; R_L = 37.5 Ω;

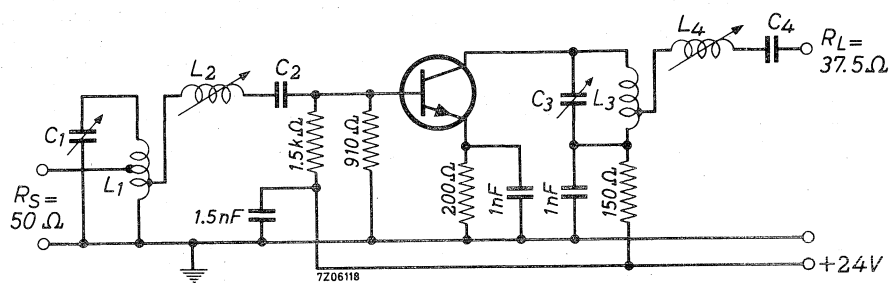
f_p = 202 MHz; f_q = 205 MHz; $f_{(2q-p)}$ = 208 MHz V_o > 0.8 V

Transducer gain

$$G_{tr} = \frac{\text{output power in load } R_L}{\text{available power from source } R_S}$$

I_C = 40 mA; V_{CE} = 10 V; f = 202 MHz G_{tr} typ. 10 dB

Basic circuit for measuring intermodulation distortion and transducer gain.

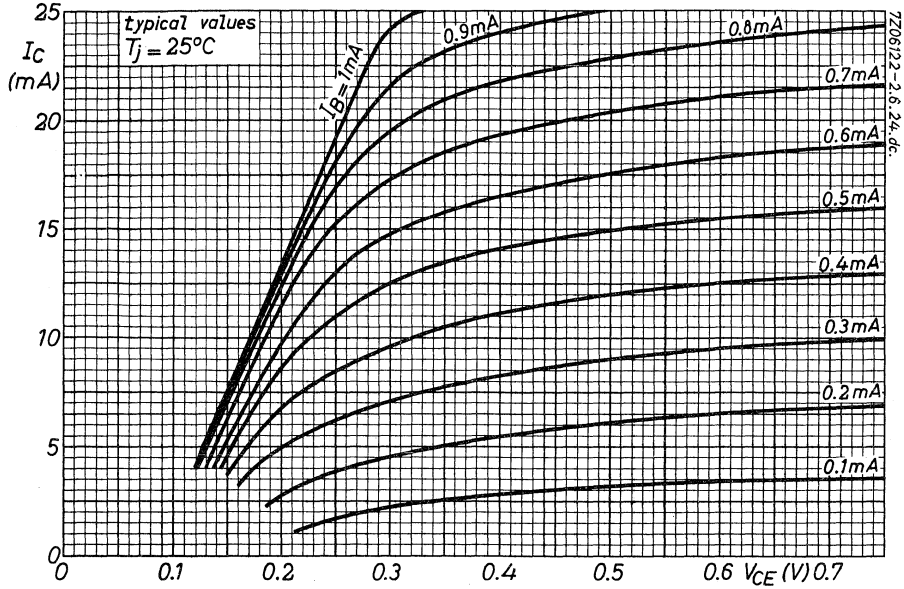


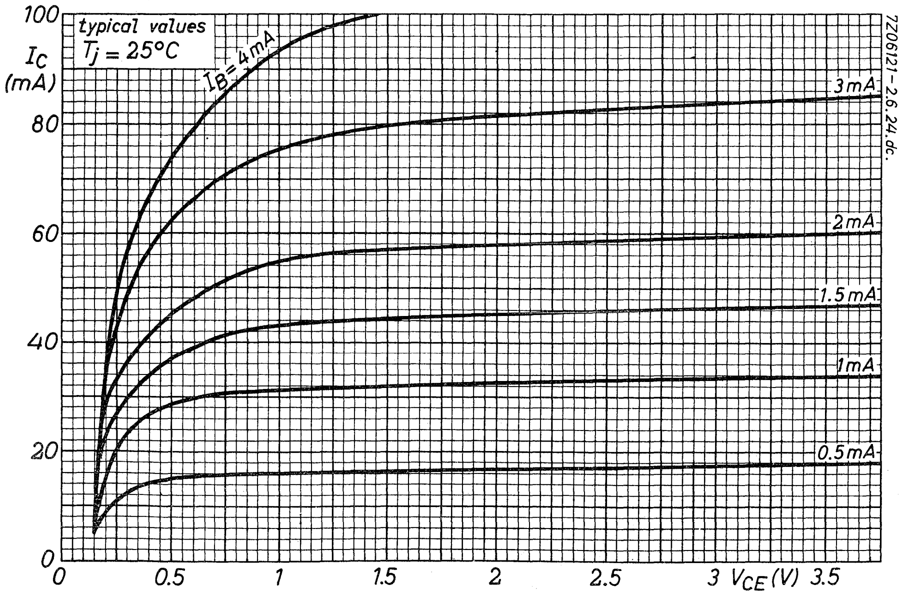
Components

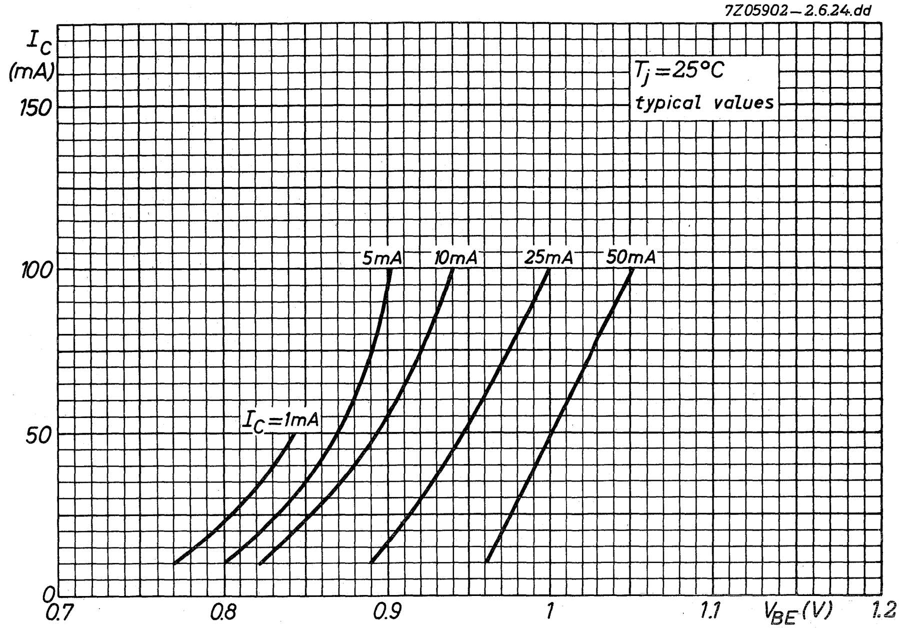
C_1	20 pF trimmer
C_2	2.7 pF ceramic
C_3	20 pF trimmer
C_4	1.8 pF ceramic
L_1	3 turns 1.5 mm wire; d = 8 mm, length = 6 mm. Taps at 0.5 and 1.25 turns from earth side.
L_2	5.5 turns 1 mm wire; d = 8 mm, length = 10 mm.
L_3	3 turns 1.5 mm wire; d = 8 mm, length = 6 mm. Tap at 0.75 turn from earth side.
L_4	8.5 turns 1 mm wire; d = 8 mm, length = 16 mm.

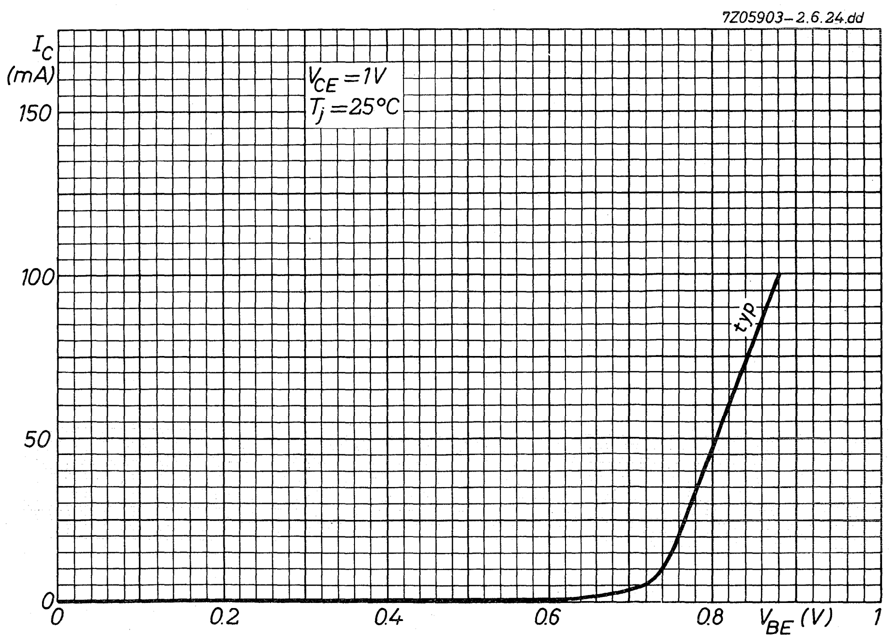
During measurements the transistor has been mounted on heatsink No.56263 in order to keep $T_j \leq 200\ ^{o}C$.

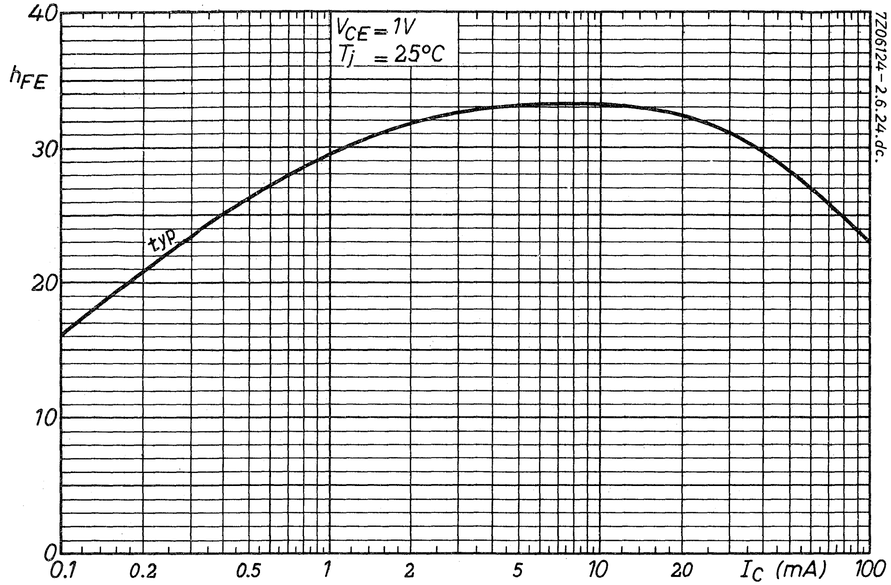
7Z3 0780


typical values
$T_j = 25°C$
I_C (mA)
25
20
15
10
5
0
0
0.1
0.2
0.3
0.4
0.5
0.6
V_{CE} (V)
0.7
$I_B = 1mA$
0.9mA
0.8mA
0.7mA
0.6mA
0.5mA
0.4mA
0.3mA
0.2mA
0.1mA
7Z06122-2.6.24.dc.

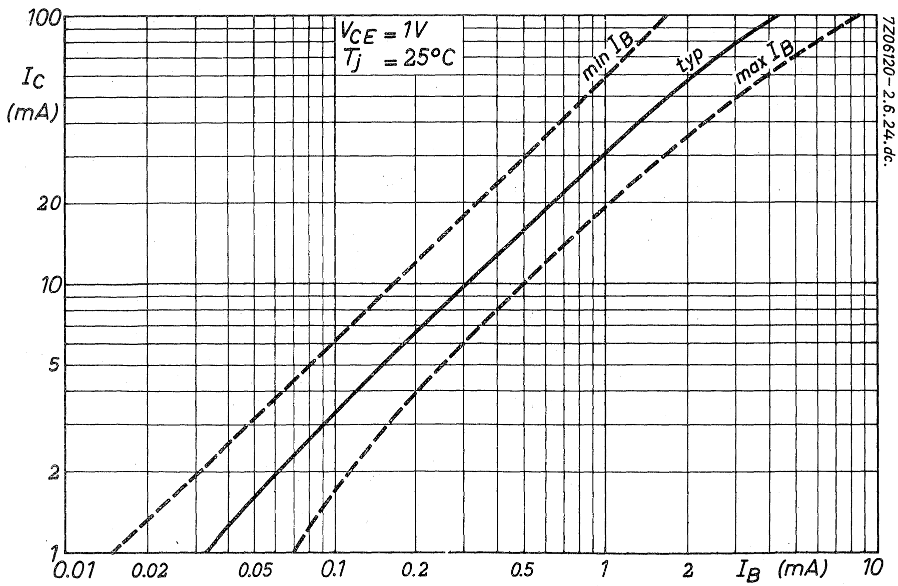

typical values
$T_j = 25°C$
I_C (mA)
100
80
60
40
20
0
0
0.5
1
1.5
2
2.5
3
V_{CE} (V)
3.5
$I_B = 4mA$
3mA
2mA
1.5mA
1mA
0.5mA
7Z06121-2.6.24.dc.


7Z05902—2.6.24.dd
I_C (mA)
150
100
50
0
0.7
0.8
0.9
1
1.1
1.2
V_{BE} (V)
$T_j = 25°C$
typical values
5mA
10mA
25mA
50mA
$I_C = 1mA$

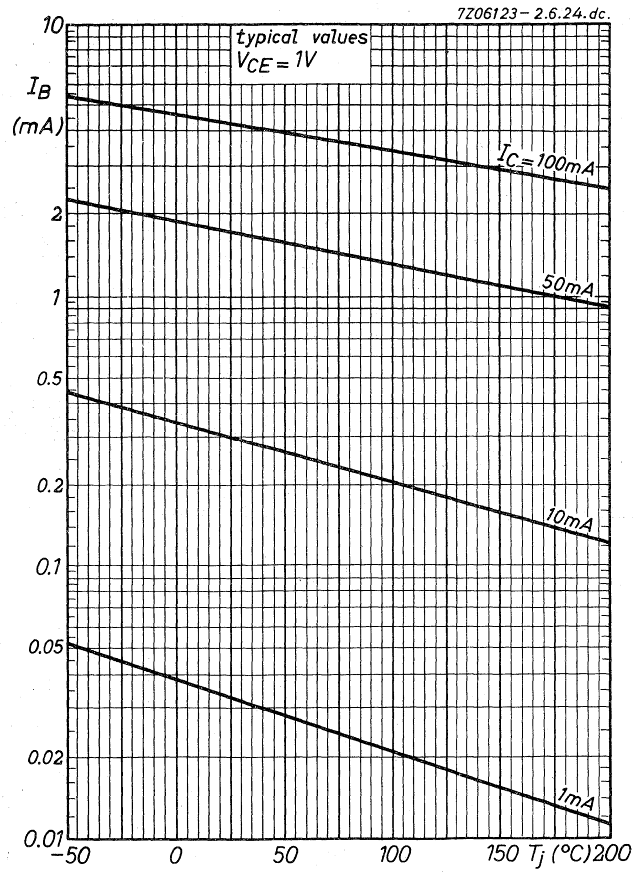

7Z05903—2.6.24.dd
I_C (mA)
150
100
50
0
0
0.2
0.4
0.6
0.8
1
V_{BE} (V)
$V_{CE} = 1V$
$T_j = 25°C$
typ



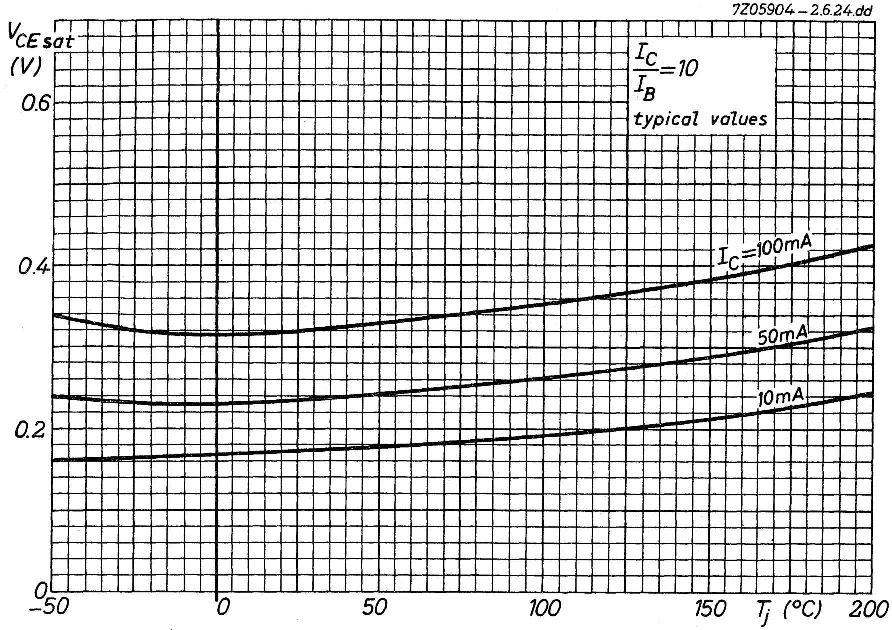
40
30
20
10
0
h_{FE}
V_{CE} = 1V
T_j = 25°C
typ
7Z06124 - 2.6.24.dc.
0.1
0.2
0.5
1
2
5
10
20
I_C (mA)
100



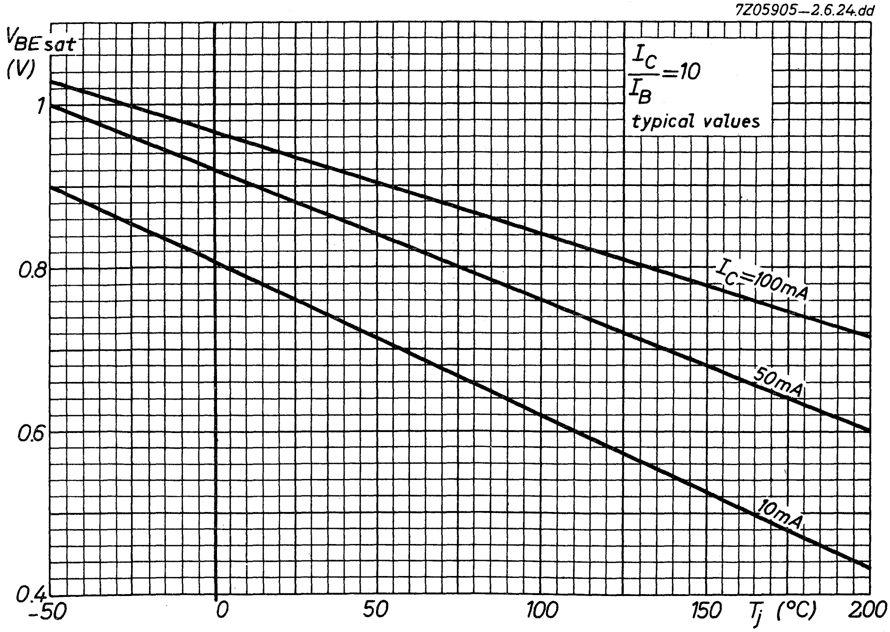
100
20
10
5
2
1
I_C (mA)
V_{CE} = 1V
T_j = 25°C
min I_B
typ
max I_B
7Z06120 - 2.6.24.dc.
0.01
0.02
0.05
0.1
0.2
0.5
1
2
I_B (mA)
10

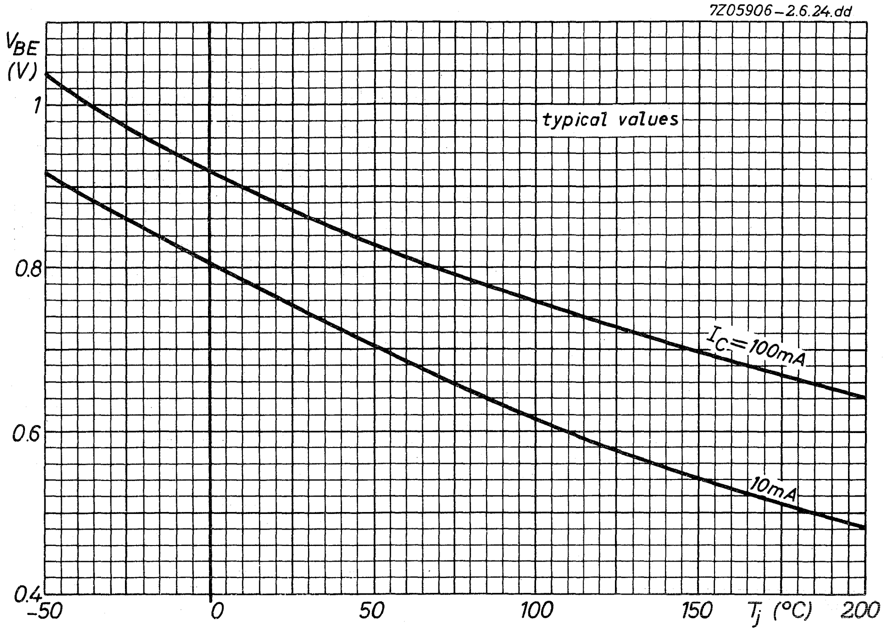

7Z06123 – 2.6.24.dc.
typical values
$V_{CE} = 1V$
I_B (mA)
10
2
1
0.5
0.2
0.1
0.05
0.02
0.01
$I_C = 100mA$
50mA
10mA
1mA
−50
0
50
100
150
T_j (°C)
200

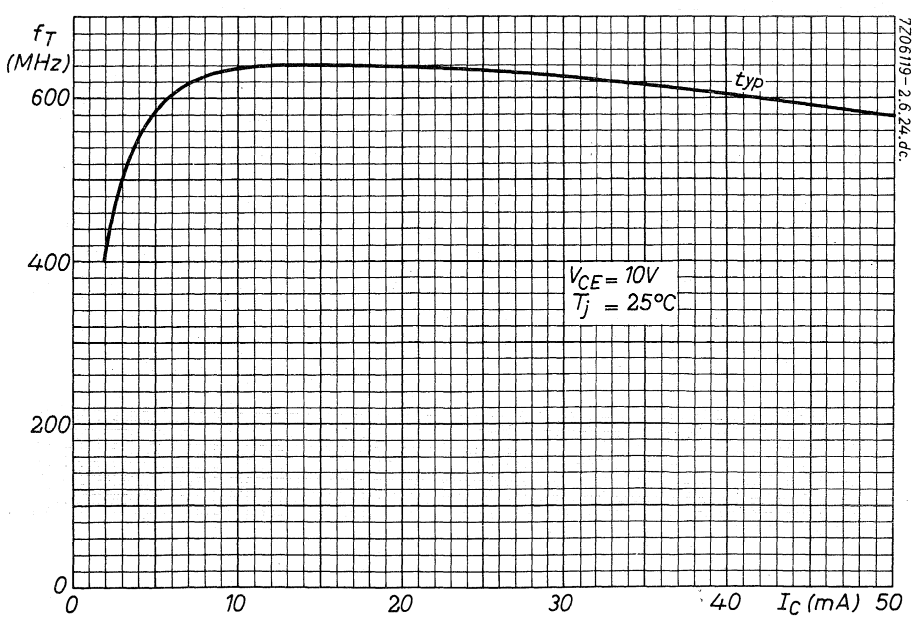
7Z05904 – 2.6.24.dd

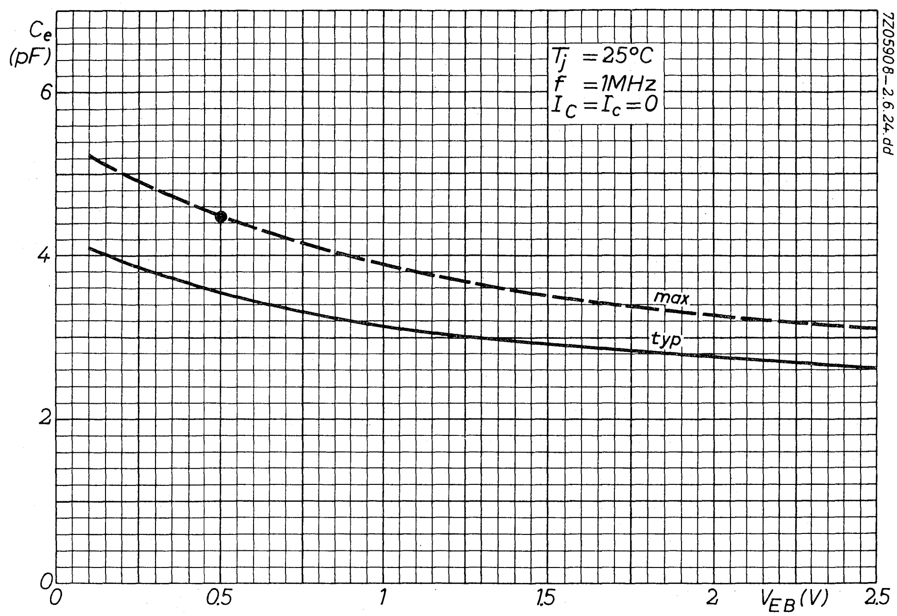


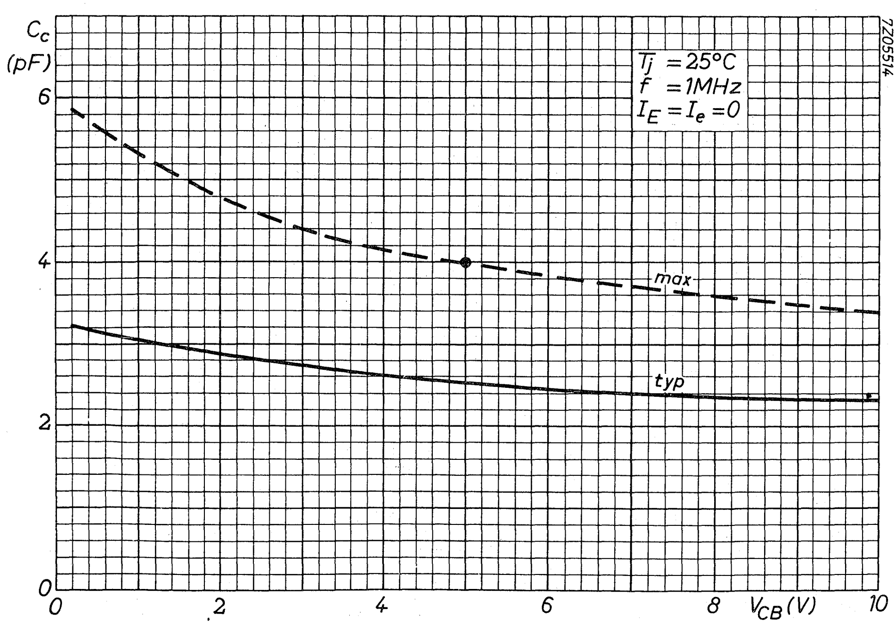
7Z05905–2.6.24.dd

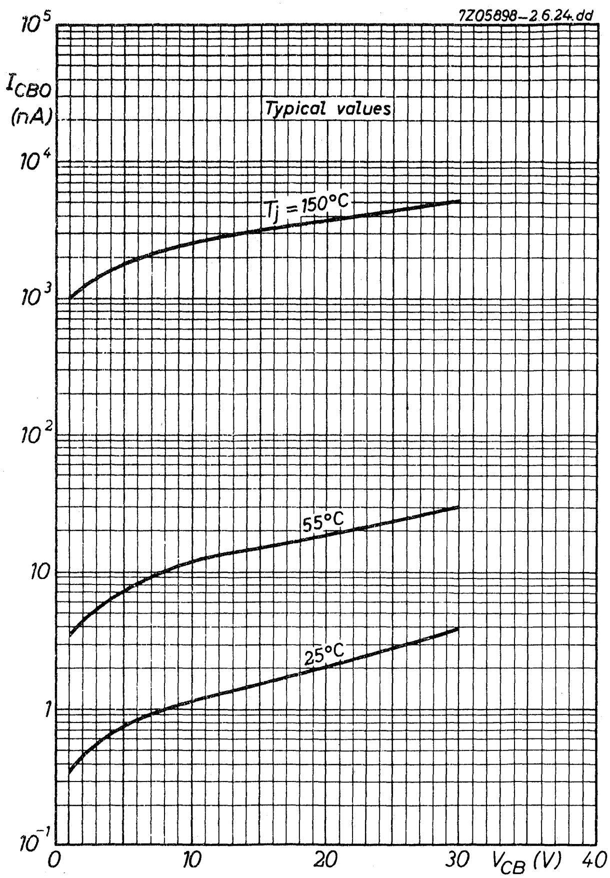



7Z05906–2.6.24.dd
V_{BE} (V)
1
0.8
0.6
0.4
typical values
I_C=100mA
10mA
-50
0
50
100
150
200
T_j (°C)


7Z06119–2.6.24.dc.
f_T (MHz)
600
400
200
0
typ
V_{CE} = 10V
T_j = 25°C
0
10
20
30
40
50
I_C (mA)


7Z05908-2.6.24.dd
C_e (pF)
T_j = 25°C
f = 1MHz
$I_C = I_c = 0$
max
typ
0
0.5
1
1.5
2
2.5
V_{EB}(V)
6
4
2
0


7Z05514
C_c (pF)
T_j = 25°C
f = 1MHz
$I_E = I_e = 0$
max
typ
0
2
4
6
8
10
V_{CB}(V)
6
4
2
0


7Z05898-2.6.24.dd
I_{CBO} (nA)
Typical values
$T_j = 150°C$
55°C
25°C
10^5
10^4
10^3
10^2
10
1
10^{-1}
0
10
20
30
V_{CB} (V)
40

SILICON PLANAR EPITAXIAL TRANSISTOR

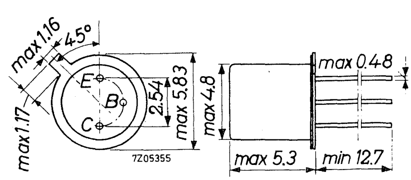
N-P-N transistor in a TO-18 metal envelope with the collector connected to the case. The BFX44 is primarily intended for use as a low distortion common base linear output amplifier, capable of delivering an output voltage swing of at least 20 V across a 400 Ω load at frequencies up to 150 MHz (e.g. as required for the output stage of a d.c. to 150 MHz vertical amplifier of a wide band oscilloscope)

QUICK REFERENCE DATA				
Collector-base voltage (open emitter)	V_{CBO}	max.	40	V
Collector-emitter voltage (R_{BE} = 10 Ω)	V_{CER}	max.	23	V
Collector current (peak value)	I_{CM}	max.	250	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	360	mW
Junction temperature	T_j	max.	200	°C
Transition frequency				
I_C = 10 mA; V_{CE} = 10 V	f_T	>	500	MHz
I_C = 100 mA; V_{CE} = 3 V	f_T	>	300	MHz

MECHANICAL DATA Dimensions in mm

TO-18

Collector connected to case



7Z3 0702

RATINGS (Limiting values) [1]

Voltages

Collector-base voltage (open emitter)	V_{CBO}	max.	40	V
Collector-emitter voltage (open base)	V_{CEO}	max.	15	V
Collector-emitter voltage with R_{BE} = 10 Ω	V_{CER}	max.	23	V
Collector-emitter voltage with V_{BE} = 0	V_{CES}	max.	40	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4	V

Currents

Collector current (d.c. or average over any 20 ms period)	I_C	max.	125	mA
Collector current (peak value)	I_{CM}	max.	250	mA

Power dissipation

Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	360	mW

Temperatures

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

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	0.48	°C/mW
From junction to ambient with cooling clip 56263	$R_{th\ j-a}$	=	0.28	°C/mW
From junction to case	$R_{th\ j-c}$	=	0.145	°C/mW

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

7Z3 0703

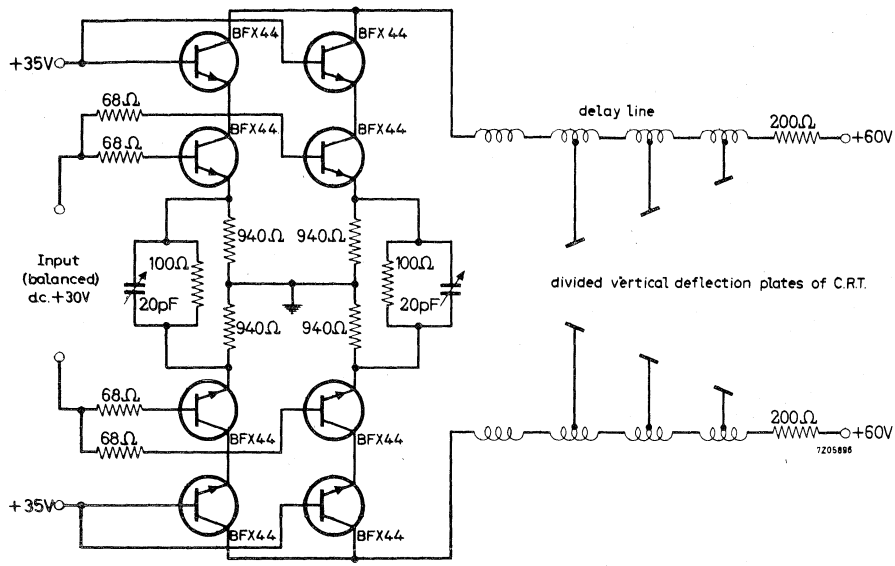
CHARACTERISTICS T_j = 25 °C unless otherwise specified

Collector cut-off current				
$I_E = 0$; $V_{CB} = 20$ V	I_{CBO}	max.	100	nA
$I_E = 0$; $V_{CB} = 20$ V; $T_j = 150$ °C	I_{CBO}	max.	20	µA
Emitter cut-off current				
$I_C = 0$; $V_{EB} = 2$ V	I_{EBO}	max.	50	nA
$I_C = 0$; $V_{EB} = 2$ V; $T_j = 150$ °C	I_{EBO}	max.	20	µA
Sustaining voltages				
$I_C = 10$ mA; $I_B = 0$	$V_{CEOsust}$	>	15	V
$I_C = 10$ mA; $R_{BE} = 10\ \Omega$	$V_{CERsust}$	>	23	V
Saturation voltages				
$I_C = 100$ mA; $I_B = 10$ mA	V_{CEsat}	<	0.6	V
	V_{BEsat}	<	1.5	V
D.C. current gain				
$I_C = 10$ mA; $V_{CE} = 1$ V	h_{FE}	40 to 120		
$I_C = 100$ mA; $V_{CE} = 1$ V	h_{FE}	>	20	
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; $V_{CE} = 5$ V	C_c	<	4	pF
Emitter capacitance at f = 1 MHz				
$I_C = I_c = 0$; $V_{EB} = 0.5$ V	C_e	<	4.5	pF
Transition frequency				
$I_C = 10$ mA; $V_{CE} = 10$ V	f_T	>	500	MHz
$I_C = 100$ mA; $V_{CE} = 3$ V	f_T	>	300	MHz
Feedback time constant				
$-I_E = 1$ mA; $V_{CB} = 5$ V; f = 10.7 MHz	$r_{bb'}C_{b'c}$	<	40	ps
Storage time				
$I_C = I_B = -I_{BM} = 10$ mA	t_s	<	30	ns

7Z3 0704

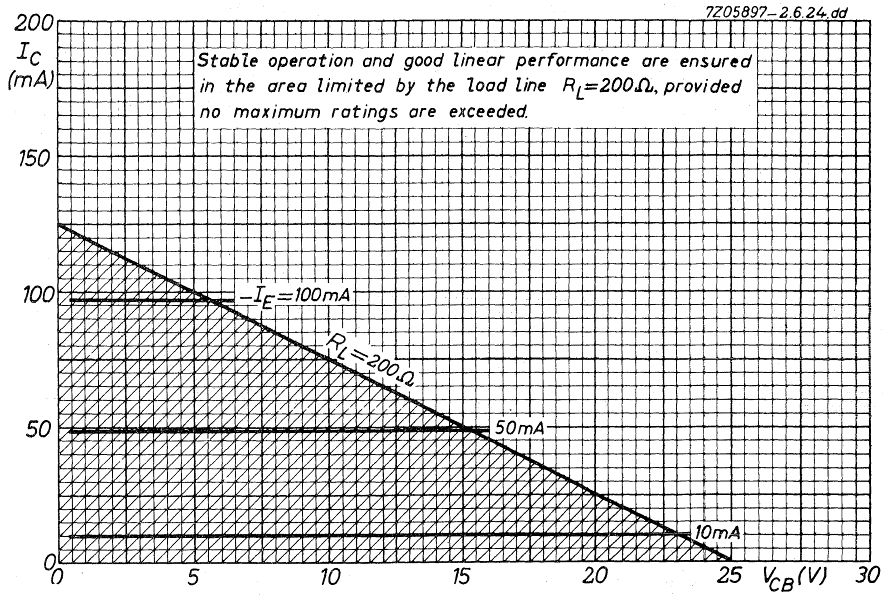
APPLICATION INFORMATION

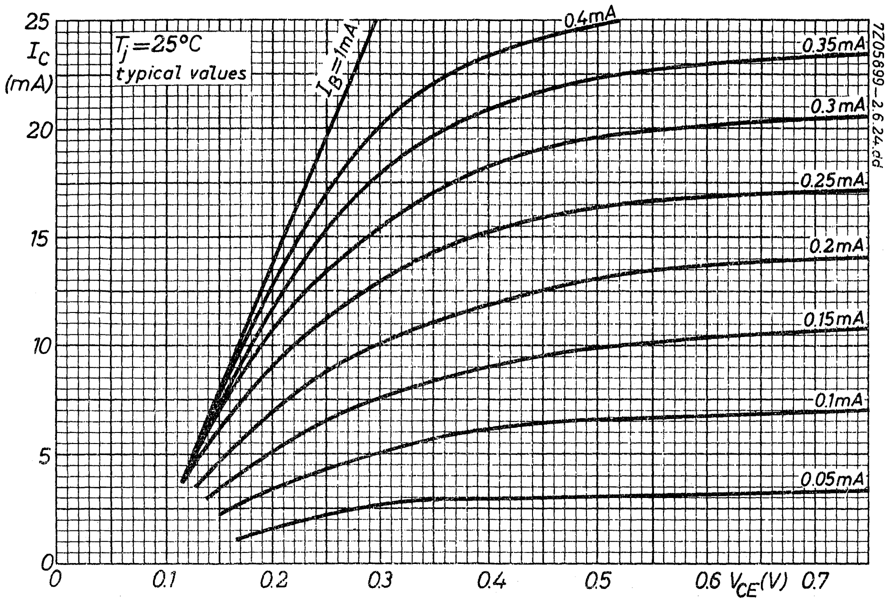
Vertical deflection stage of a wide band oscilloscope.

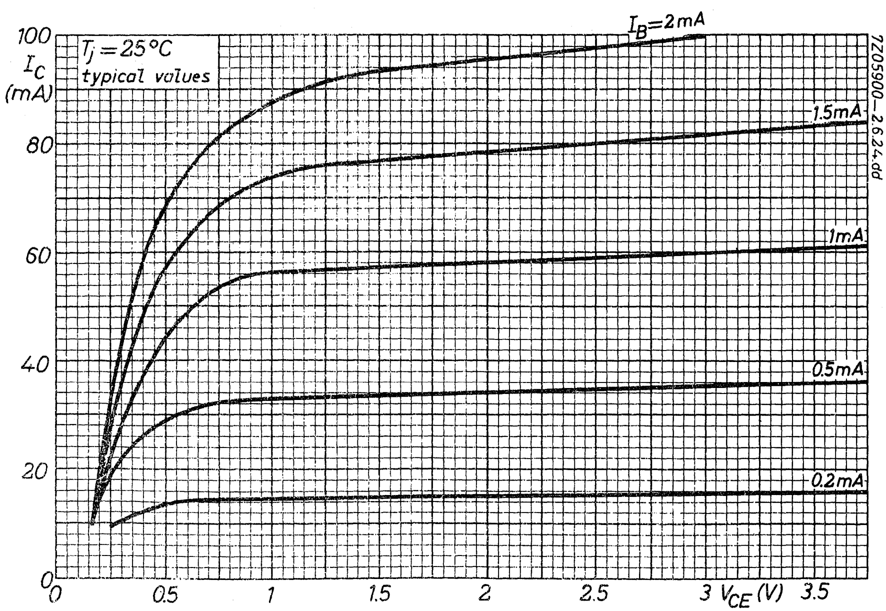


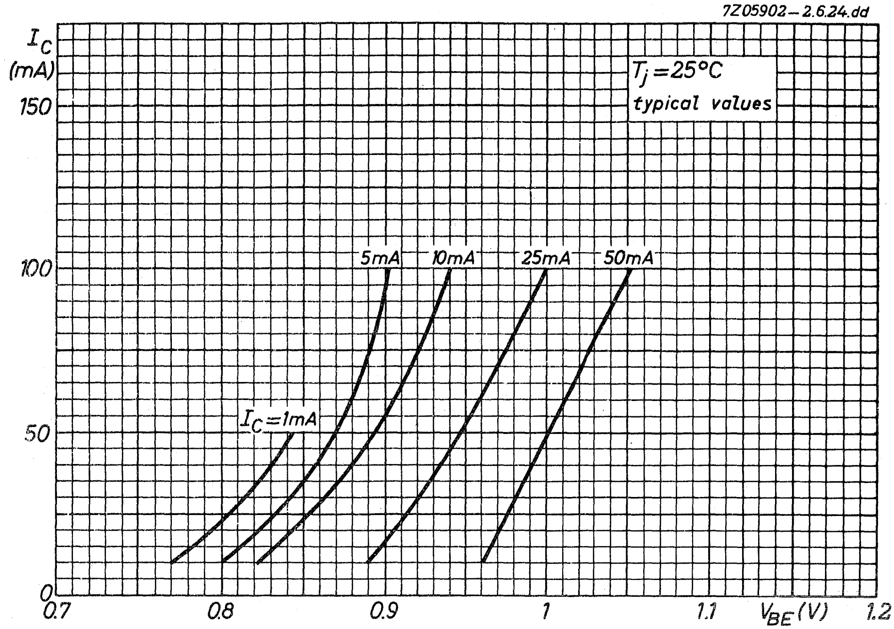
This circuit is capable of delivering an output voltage swing of at least 40 V (typ. 45 V) with a rise time of typ. 2.2 ns.

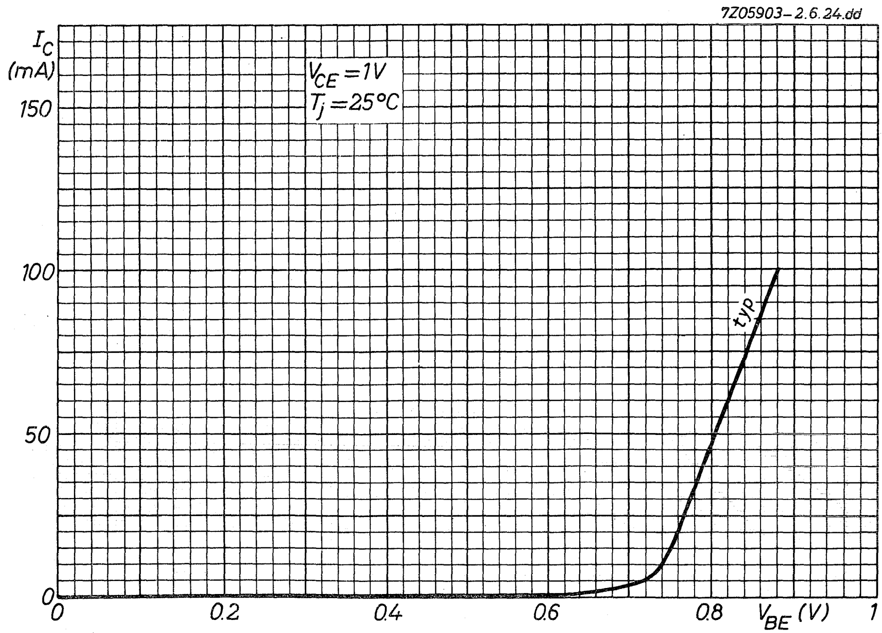
7Z3 0776

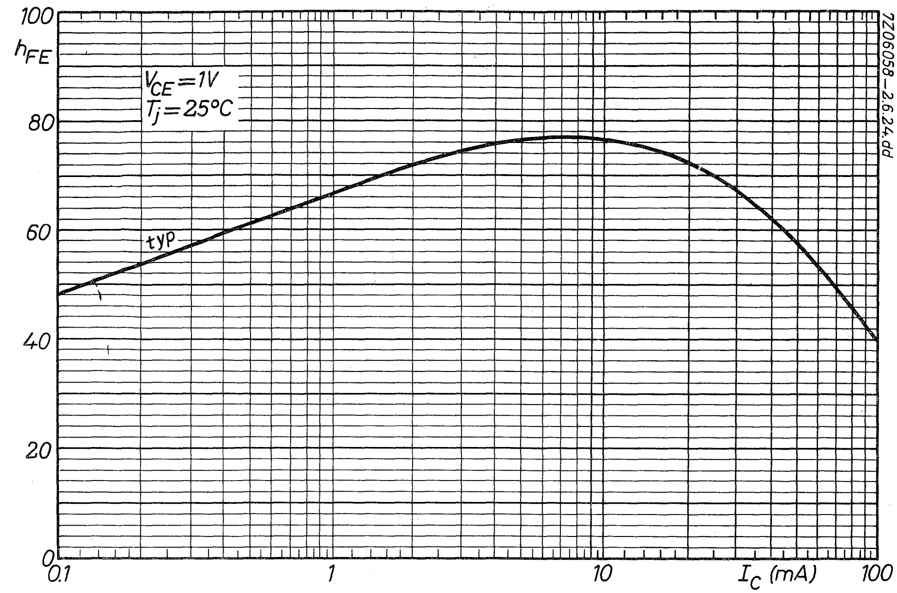

7Z05897–2.6.24.dd
200
I_C
(mA)
150
100
50
0
0
5
10
15
20
25
V_{CB} (V)
30
Stable operation and good linear performance are ensured in the area limited by the load line $R_L = 200\,\Omega$, provided no maximum ratings are exceeded.
$-I_E = 100$ mA
$R_L = 200\,\Omega$
50mA
10mA

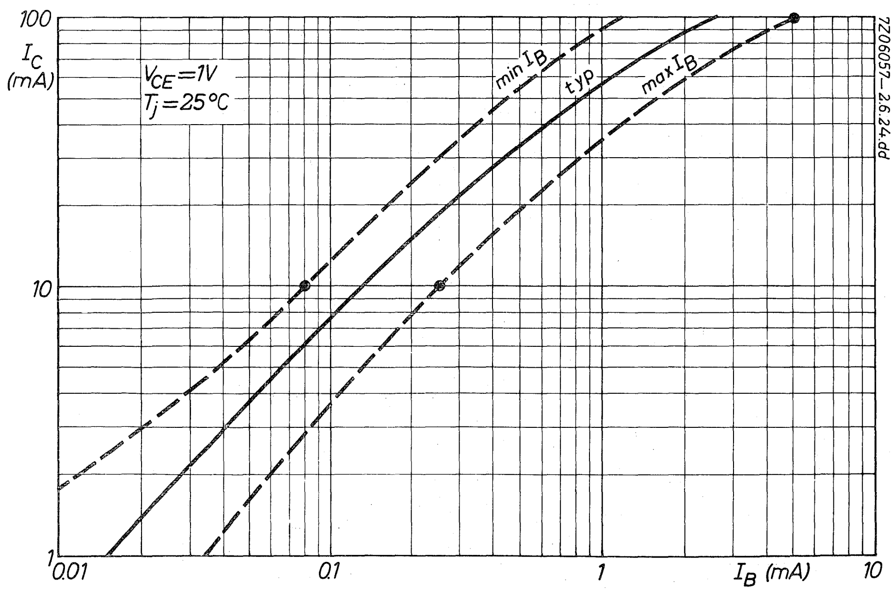

25
I_C
(mA)
20
15
10
5
0
0
0.1
0.2
0.3
0.4
0.5
0.6 V_{CE}(V)
0.7
T_j=25°C
typical values
I_B=1mA
0.4mA
0.35mA
0.3mA
0.25mA
0.2mA
0.15mA
0.1mA
0.05mA
7Z05899–2.6.24.dd

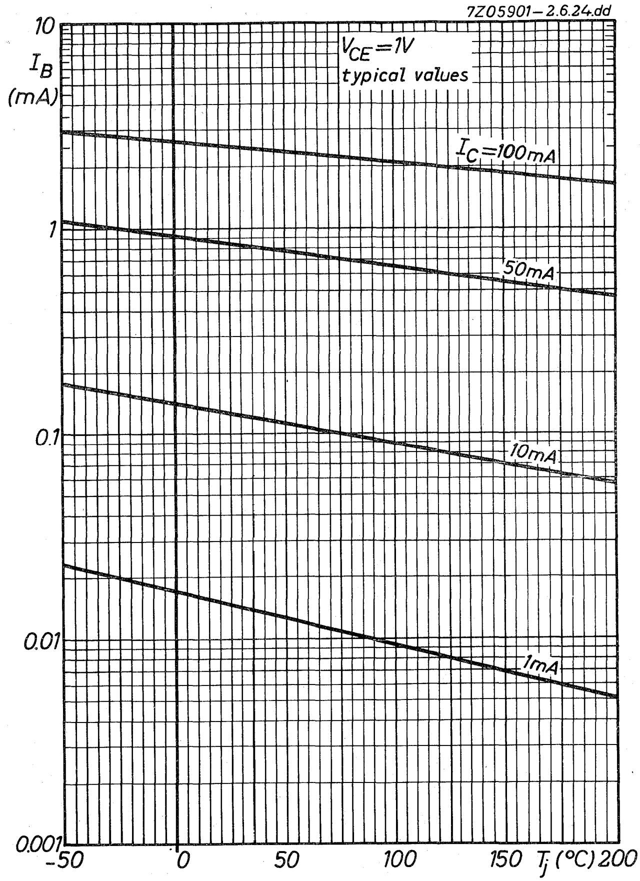

100
I_C
(mA)
80
60
40
20
0
0
0.5
1
1.5
2
2.5
3 V_{CE}(V)
3.5
T_j=25°C
typical values
I_B=2mA
1.5mA
1mA
0.5mA
0.2mA
7Z05900–2.6.24.dd

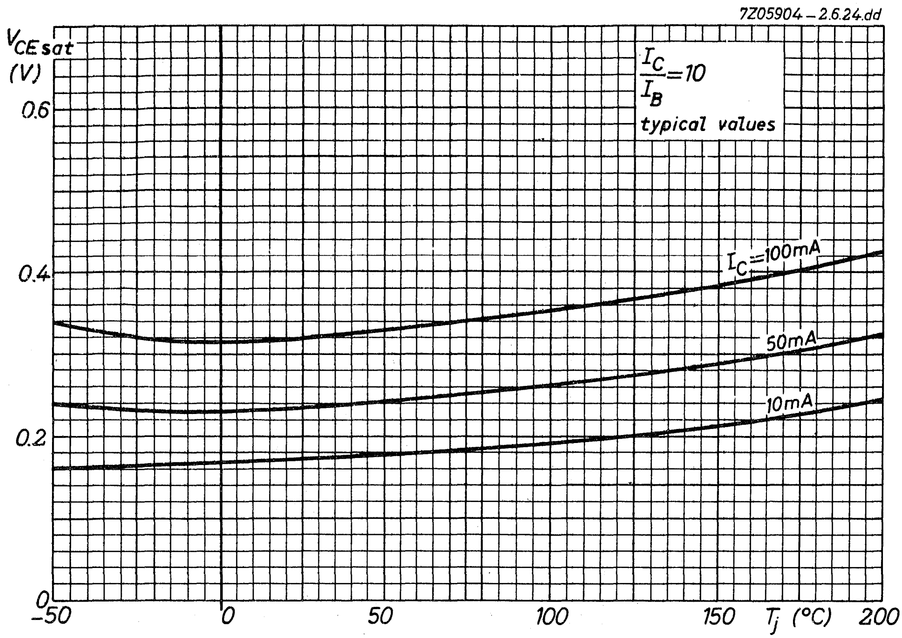

7Z05902–2.6.24.dd
I_C (mA)
150
100
50
0
$T_j = 25°C$
typical values
5mA
10mA
25mA
50mA
$I_C = 1mA$
0.7
0.8
0.9
1
1.1
V_{BE} (V)
1.2

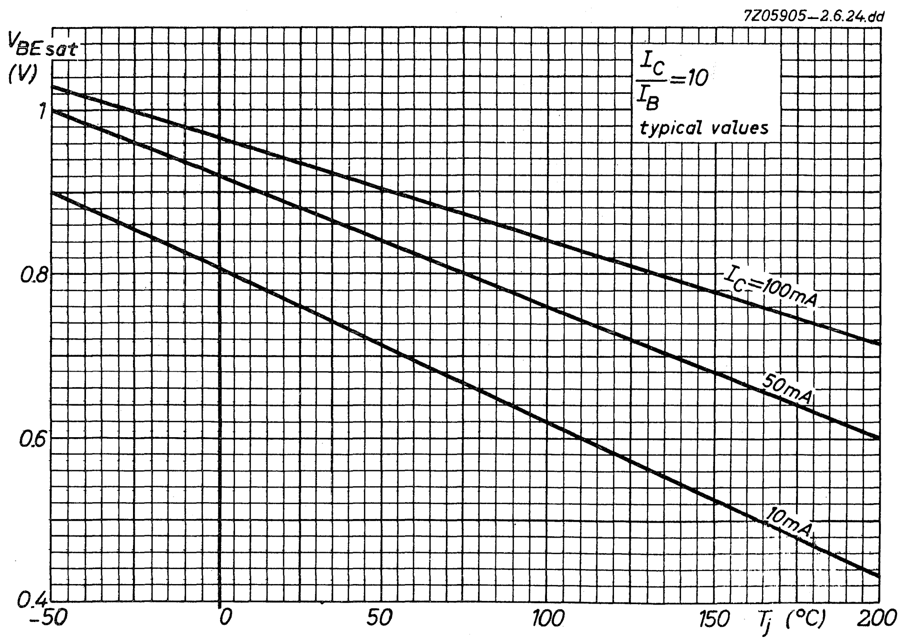

7Z05903–2.6.24.dd
I_C (mA)
150
100
50
0
$V_{CE} = 1V$
$T_j = 25°C$
typ
0
0.2
0.4
0.6
0.8
V_{BE} (V)
1

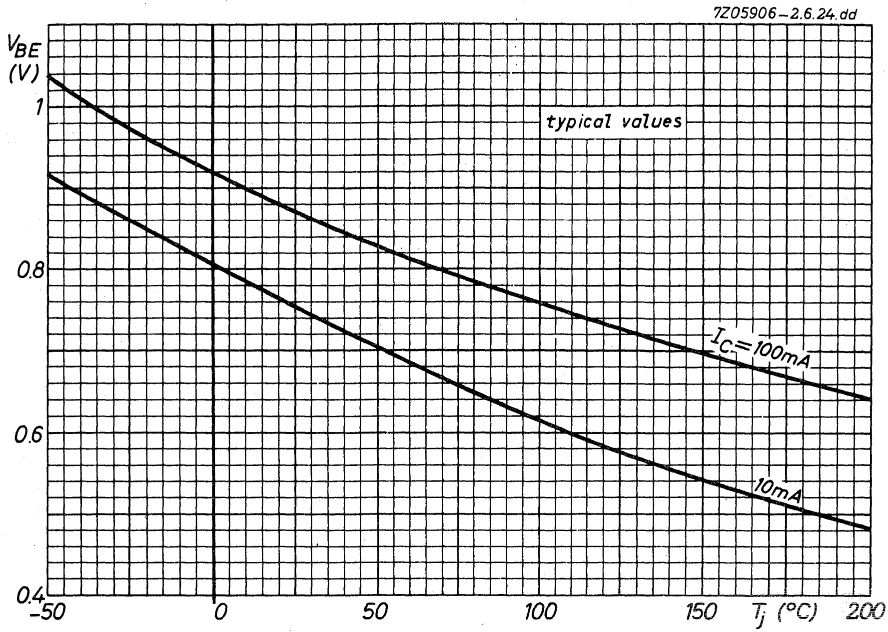

100
h_{FE}
$V_{CE}=1V$
$T_j=25°C$
80
60
typ
40
20
0
0.1
1
10
I_C (mA)
100
7Z06058–2.6.24.dd

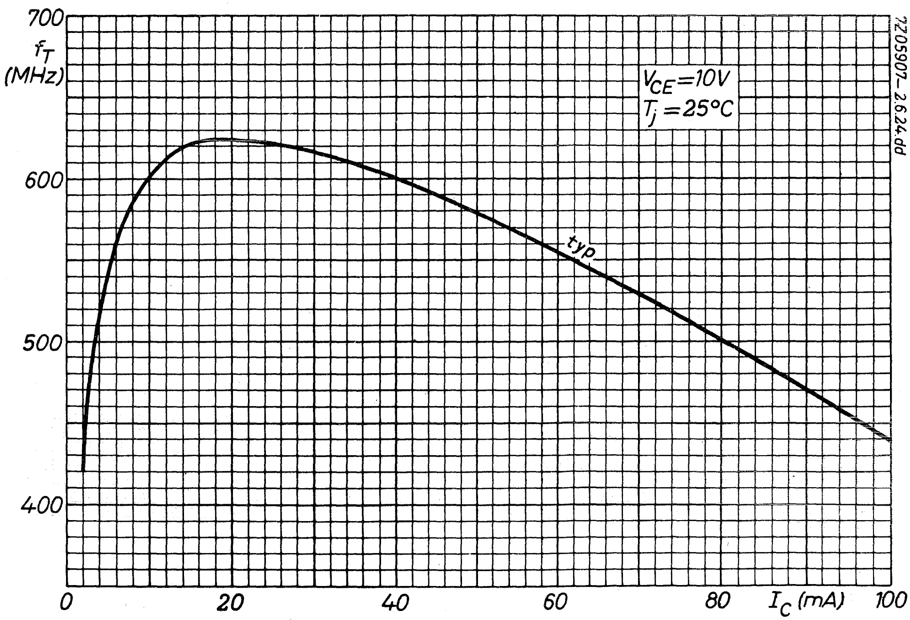

100
I_C
(mA)
$V_{CE}=1V$
$T_j=25°C$
min I_B
typ
max I_B
10
1
0.01
0.1
1
I_B (mA)
10
7Z06057–2.6.24.dd

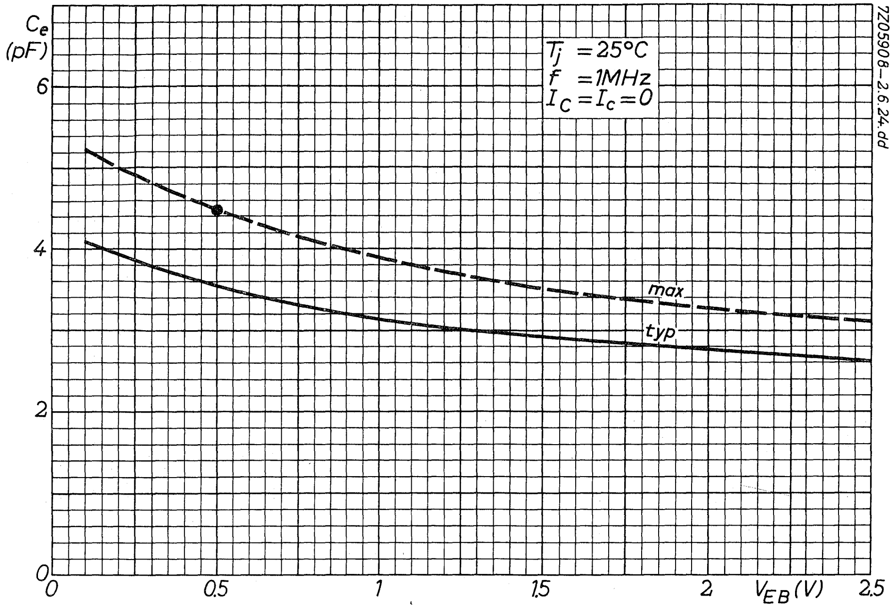

7Z05901–2.6.24.dd
10
I_B
(mA)
V_{CE} = 1V
typical values
I_C = 100mA
1
50mA
0.1
10mA
0.01
1mA
0.001
−50
0
50
100
150
T_j (°C)
200

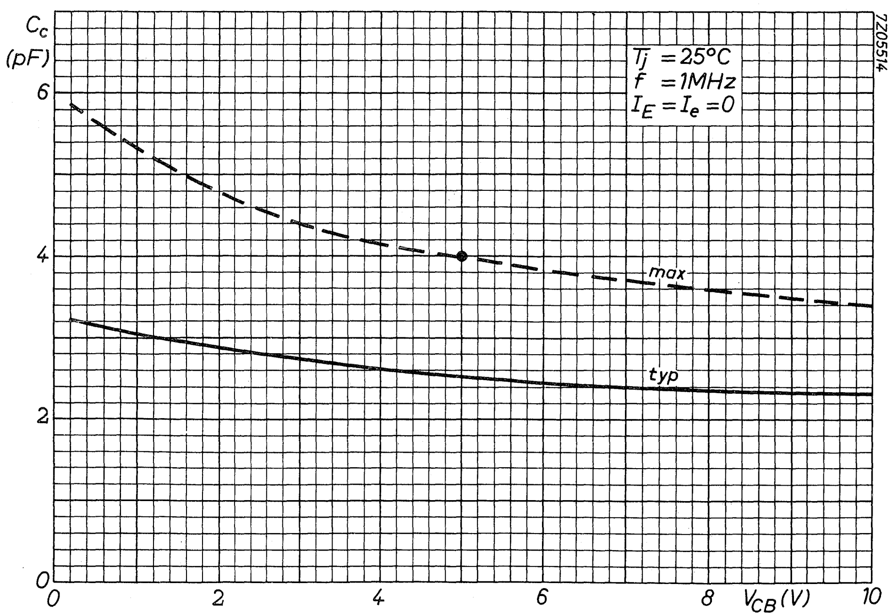

7Z05904–2.6.24.dd
V_{CEsat} (V)
0.6
0.4
0.2
0
-50
0
50
100
150
200
T_j (°C)
$\frac{I_C}{I_B}=10$
typical values
I_C=100mA
50mA
10mA

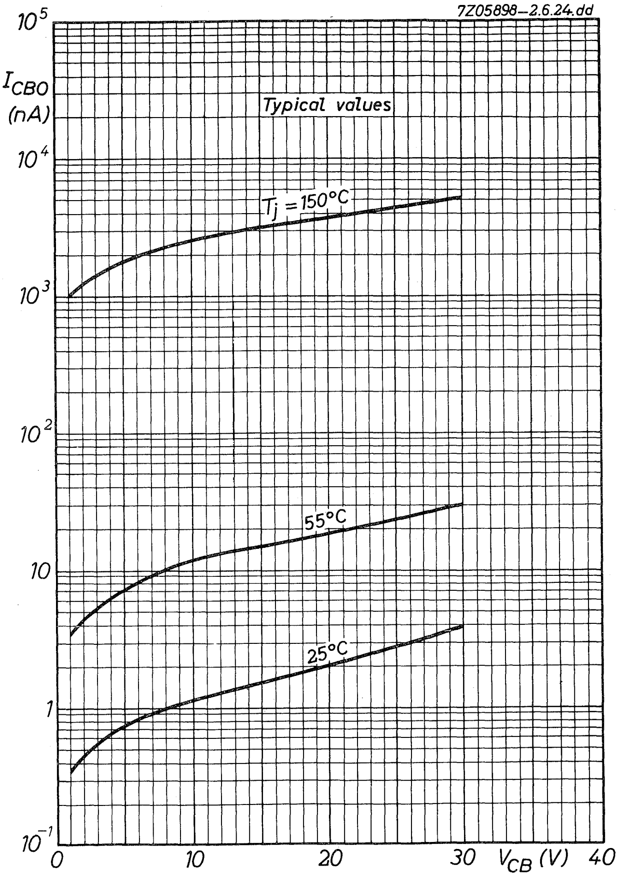

7Z05905–2.6.24.dd
V_{BEsat} (V)
1
0.8
0.6
0.4
-50
0
50
100
150
200
T_j (°C)
$\frac{I_C}{I_B}=10$
typical values
I_C=100mA
50mA
10mA


7Z05906–2.6.24.dd
V_{BE} (V)
1
0.8
0.6
0.4
typical values
I_C=100mA
10mA
-50
0
50
100
150
T_j (°C)
200


7Z05907–2.6.24.dd
700
f_T (MHz)
600
500
400
V_{CE}=10V
T_j =25°C
typ
0
20
40
60
80
I_C (mA)
100


C_e
(pF)
6
4
2
0
0
0.5
1
1.5
2
V_{EB} (V)
2.5
T_j = 25°C
f = 1MHz
$I_C = I_c = 0$
max
typ
7Z05908–2.6.24.dd


C_c
(pF)
6
4
2
0
0
2
4
6
8
V_{CB} (V)
10
T_j = 25°C
f = 1MHz
$I_E = I_e = 0$
max
typ
7Z05514


7Z05898–2.6.24.dd
10^5
I_{CBO}
(nA)
Typical values
10^4
T_j = 150°C
10^3
10^2
55°C
10
25°C
1
10^{-1}
0
10
20
30
V_{CB} (V)
40

VERY HIGH SPEED SWITCHING TRANSISTORS

N-P-N silicon planar epitaxial transistors in a TO-18 metal envelope with the collector connected to the case. The BSX19 and BSX20 are primarily intended for very high speed saturated switching.

QUICK REFERENCE DATA

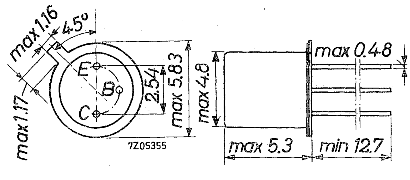
			BSX19	BSX20	
Collector-base voltage (open emitter)	V_{CBO}	max.	40	40	V
Collector-emitter voltage (open base)	V_{CEO}	max.	15	15	V
Collector-emitter voltage (V_{BE} = 0)	V_{CES}	max.	40	40	V
Collector current (peak value)	I_{CM}	max.	500	500	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	360	360	mW
D.C. current gain at T_j = 25 °C					
I_C = 10 mA; V_{CE} = 1 V	h_{FE}		20 to 60	40 to 120	
I_C = 100 mA; V_{CE} = 2 V	h_{FE}	>	10	20	
Transition frequency					
I_C = 10 mA; V_{CE} = 10 V	f_T	>	400	500	MHz
Storage time					
$I_C = I_B = -I_{BM}$ = 10 mA	t_s	<	10	13	ns

MECHANICAL DATA

Dimensions in mm

TO-18

Collector connected to case



7Z3 0522

RATINGS (Limiting values) [1]

Voltages

Collector-base voltage (open emitter)	V_{CBO}	max.	40	V
Collector-emitter voltage (open base)	V_{CEO}	max.	15	V
Collector-emitter voltage with V_{BE} = 0	V_{CES}	max.	40	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4.5	V

Current

Collector current (peak value; t = 10 μs)	I_{CM}	max.	500	mA

Power dissipation

Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	360	mW

Temperatures

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

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	0.48	°C/mW
From junction to case	$R_{th\ j-c}$	=	0.15	°C/mW

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

7Z3 0523

CHARACTERISTICS T_j = 25 °C unless otherwise specified

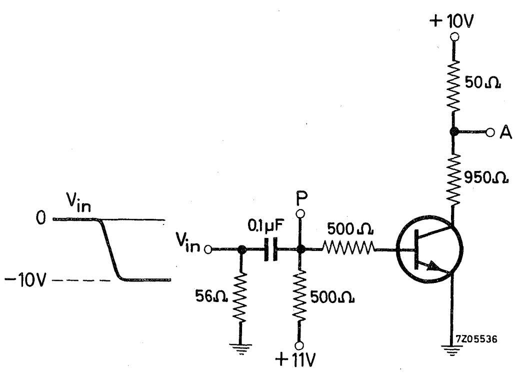
Collector cut-off current				
$I_E = 0$; $V_{CB} = 20$ V	I_{CBO}	<	400	nA
$I_E = 0$; $V_{CB} = 20$ V; $T_j = 150$ °C	I_{CBO}	<	30	μA
$V_{BE} = 0$; $V_{CE} = 15$ V; $T_j = 55$ °C	I_{CES}	<	0.40	μA
$V_{BE} = 0$; $V_{CE} = 40$ V	I_{CES}	<	1.0	μA
Emitter cut-off current				
$I_C = 0$; $V_{EB} = 4.5$ V	I_{EBO}	<	10	μA
Currents at reverse biased emitter junction				
$V_{CE} = 15$ V; $-V_{BE} = 3$ V; $T_j = 55$ °C	I_{CEX}	<	0.60	μA
	$-I_{BEX}$	<	0.60	μA
Sustaining voltages				
$I_C = 10$ mA; $I_B = 0$	$V_{CEOsust}$	>	15	V
$I_C = 10$ mA; $R_{BE} = 10\ \Omega$	$V_{CERsust}$	>	20	V
Base-emitter voltage (see also page B)				
$I_C = 30$ μA; $V_{CE} = 20$ V; $T_j = 100$ °C	V_{BE}	>	0.35	V
Saturation voltages				
$I_C = 10$ mA; BSX19: $I_B = 0.6$ mA; BSX20: $I_B = 0.3$ mA	V_{CEsat}	<	0.3	V
$I_C = 10$ mA; $I_B = 1$ mA	V_{CEsat}	<	0.25	V
	V_{BEsat}		0.70 to 0.85	V
$I_C = 100$ mA; $I_B = 10$ mA	V_{CEsat}	<	0.60	V
	V_{BEsat}	<	1.50	V
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; $V_{CB} = 5$ V	C_c	<	4	pF
Emitter capacitance at f = 1 MHz				
$I_C = I_c = 0$; $V_{EB} = 1$ V	C_e	<	4.5	pF

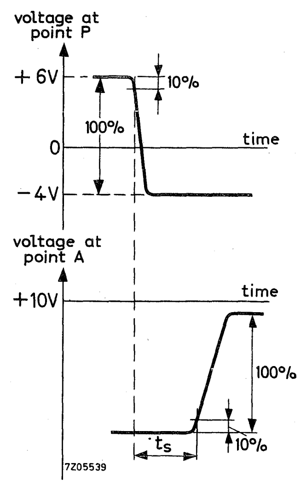
7Z3 0524

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

		BSX19	BSX20	
D.C. current gain				
I_C = 10 mA; V_{CE} = 1 V	h_{FE}	20 to 60	40 to 120	
I_C = 10 mA; V_{CE} = 1 V; T_j = −55 °C	h_{FE}	> 10	20	
I_C = 100 mA; V_{CE} = 2 V	h_{FE}	> 10	20	
Transition frequency				
I_C = 10 mA; V_{CE} = 10 V	f_T	> 400	500	MHz
		typ. 500	600	MHz
Switching times				
Storage time (see also pages P and Q)				
$I_C = I_B = -I_{BM}$ = 10 mA	t_s	typ. 5	6	ns
		< 10	13	ns

Test circuit:





Pulse generator:

Rise time	t_r	<	1	ns
Pulse duration	t	>	300	ns
Duty cycle	δ	<	0.02	
Source impedance	R_S	=	50	Ω

Oscilloscope:

Input impedance	R_i	=	50	Ω
Rise time	t_r	<	1	ns

7Z3 0835

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

Switching times

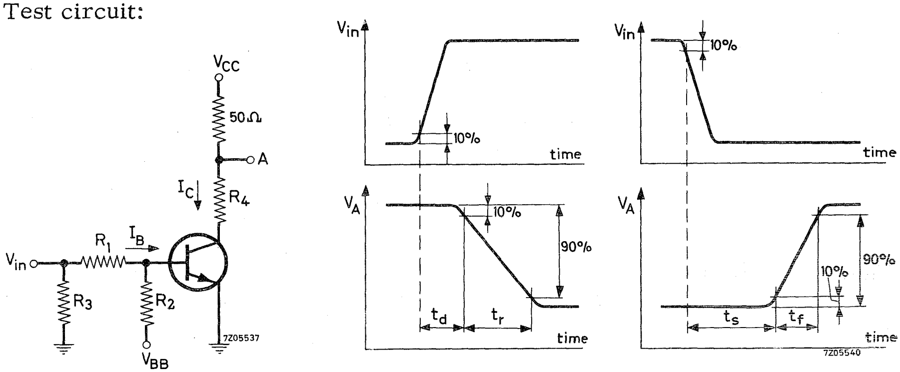
Turn on time (see also pages J and K)

from $-V_{BE}$ = 1.5 V to I_C = 10 mA; I_B = 3 mA		t_{on}	<	12	ns
from $-V_{BE}$ = 2.25 V to I_C = 100 mA; I_B = 40 mA		t_{on}	<	7	ns

Turn off time (see also pages L to O)

from I_C = 10 mA; I_B = 3 mA	BSX19	t_{off}	<	15	ns
to cut-off with $-I_{BM}$ = 1.5 mA	BSX20	t_{off}	<	18	ns
from I_C = 100 mA; I_B = 40 mA to cut-off	BSX19	t_{off}	<	18	ns
with $-I_{BM}$ = 20 mA	BSX20	t_{off}	<	21	ns

Test circuit:



Pulse generator:

Rise time	t_r	<	1	ns
Pulse duration	t	>	300	ns
Duty cycle	δ	<	0.02	
Source impedance	R_S	=	50	Ω

Oscilloscope:

Input impedance	R_i	=	50	Ω
Rise time	t_r	<	1	ns

							turn on time			turn off time	
I_C (mA)	I_B (mA)	$-I_{BM}$ (mA)	V_{CC} (V)	R_1;R_2 (kΩ)	R_3 (Ω)	R_4 (Ω)	$-V_{BB}$ (V)	$-V_{BE}$ (V)	V_{in} (V)	V_{BB} (V)	$-V_{in}$ (V)
10	3	1.5	3	3.3	50	220	3.0	1.5	15	12.0	15
100	40	20	6	0.33	56	0	4.5	2.25	20	15.3	20

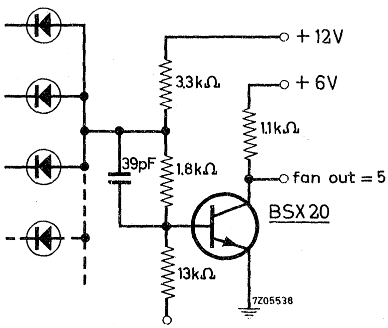
Note

$-I_{BM}$ is the reverse current that can flow during switching off. The indicated $-I_{BM}$ is determined and limited by the applied cut-off voltage and series resistance.

7Z3 0836

APPLICATION INFORMATION

NAND gate circuit (Diode Transistor Logic)



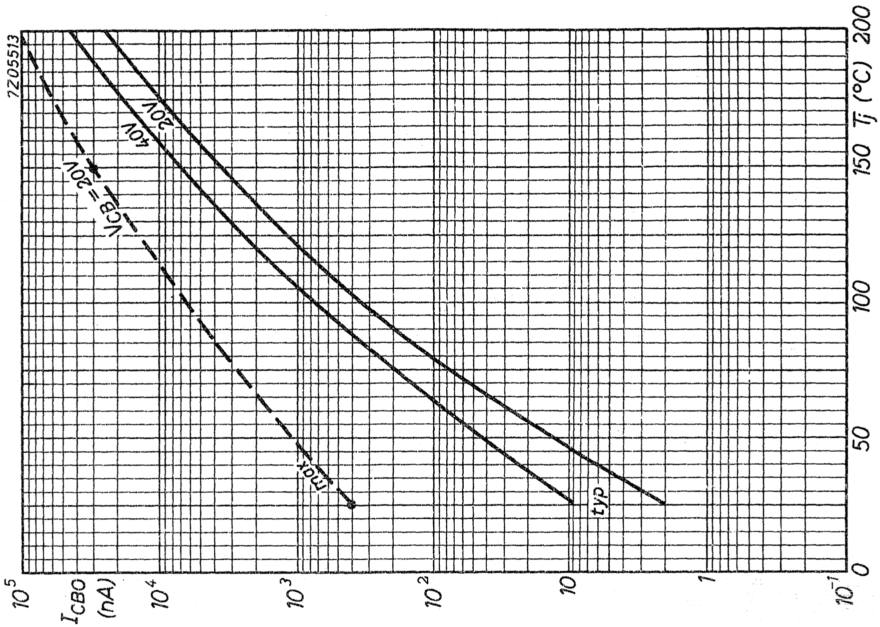
Delay time per stage; fan in = 5 t_d typ. 15 ns

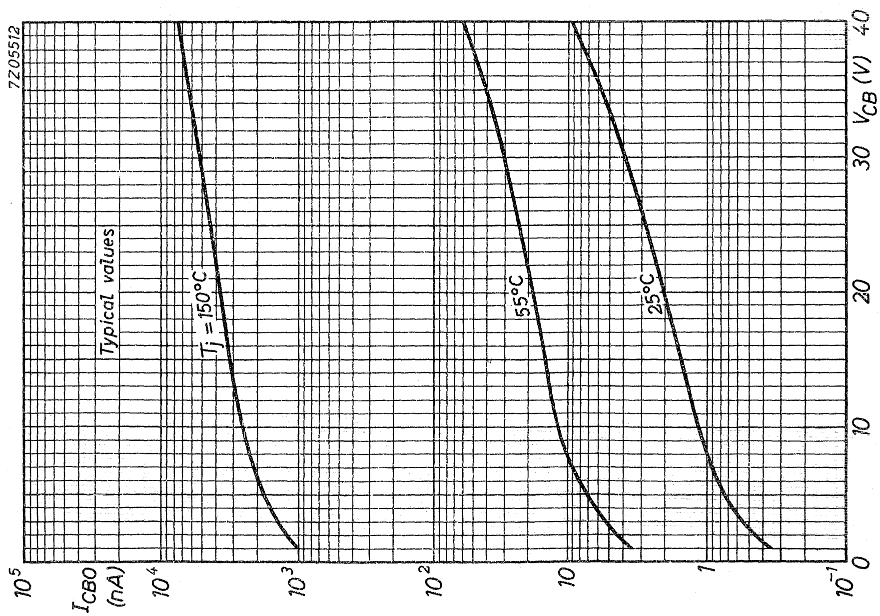
Note

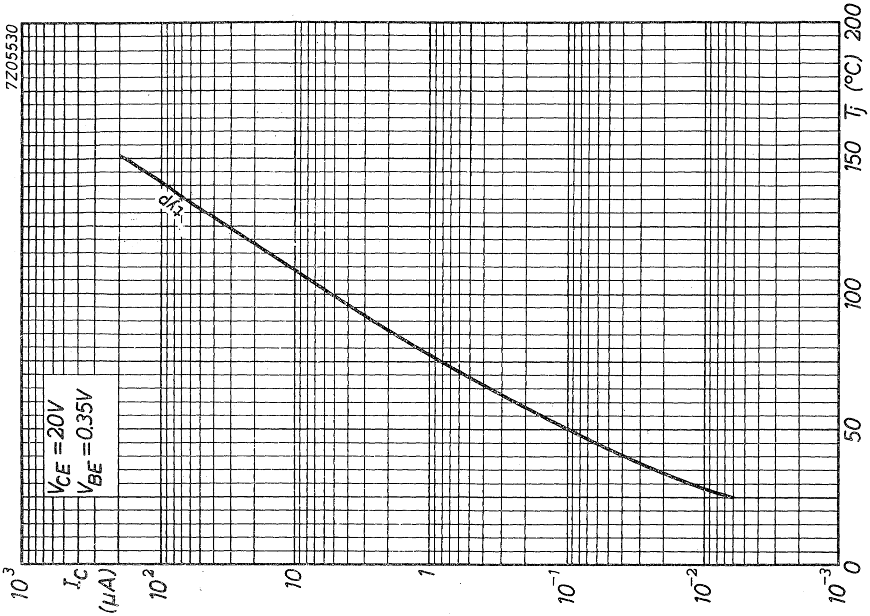
Fan out = 5 means: The circuit may be loaded by maximum 5 circuits, each presenting a load identical to that of one input branch of the circuit itself.

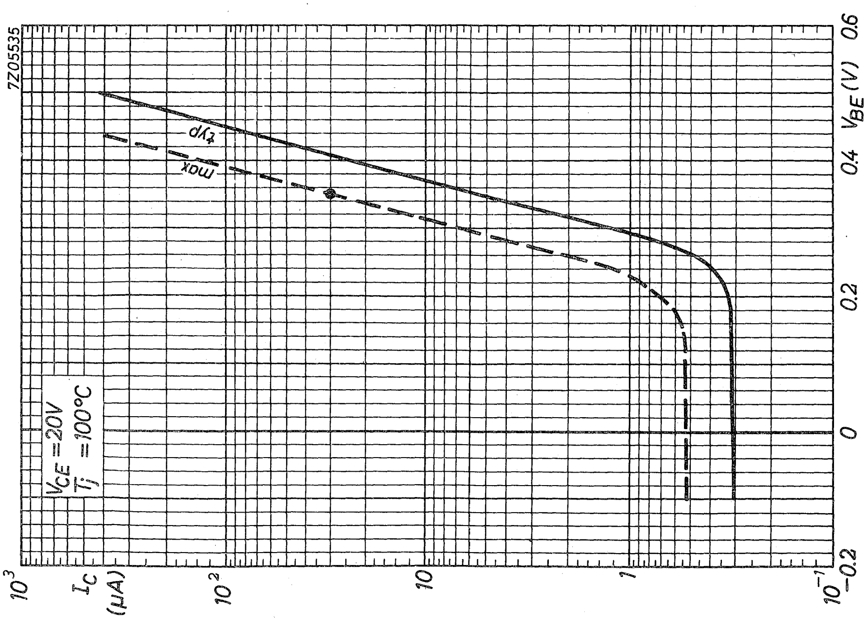
For further information please refer to application information bulletin AI819

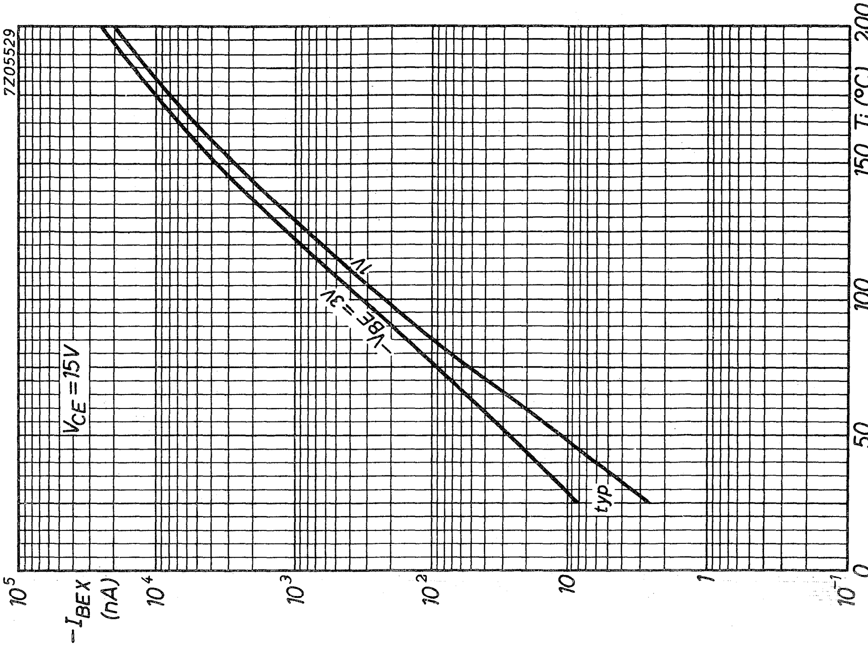
7Z3 0527

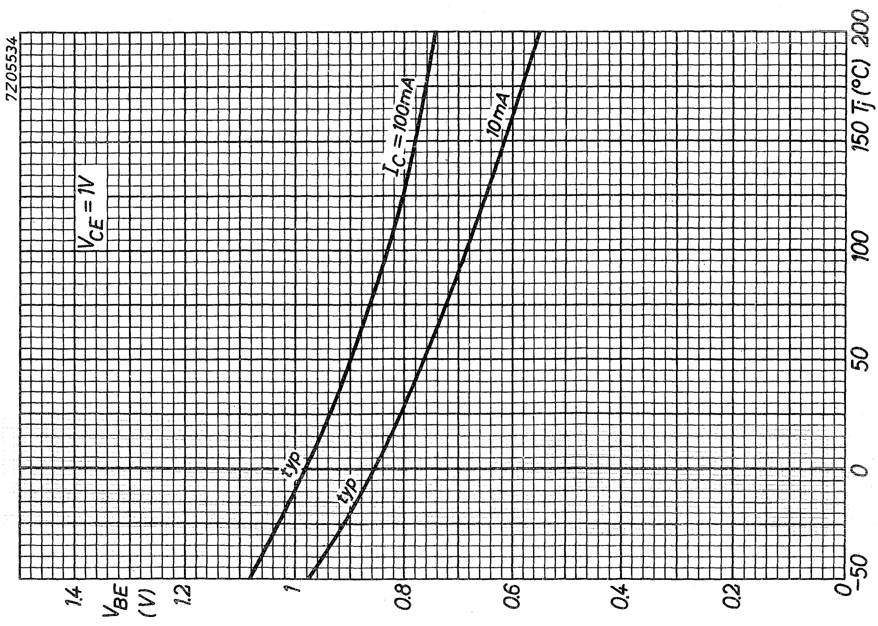

7Z05513
ICBO (nA)
Tj (°C)
VCB = 20V
40V
20V
max
typ
10^5
10^4
10^3
10^2
10
1
10^-1
0
50
100
150
200

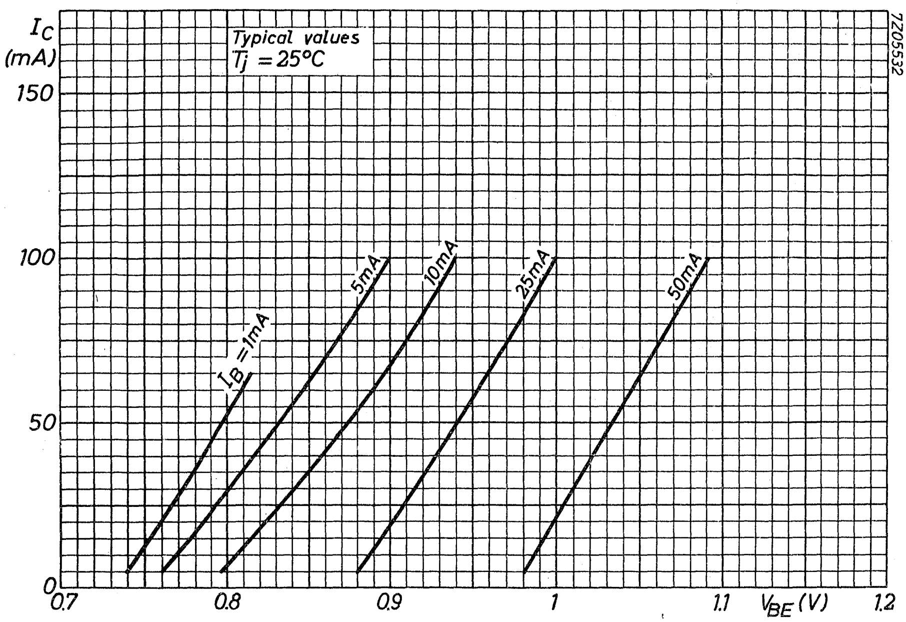

7Z05512
Typical values
ICBO (nA)
VCB (V)
Tj = 150°C
55°C
25°C
10^5
10^4
10^3
10^2
10
1
10^-1
0
10
20
30
40

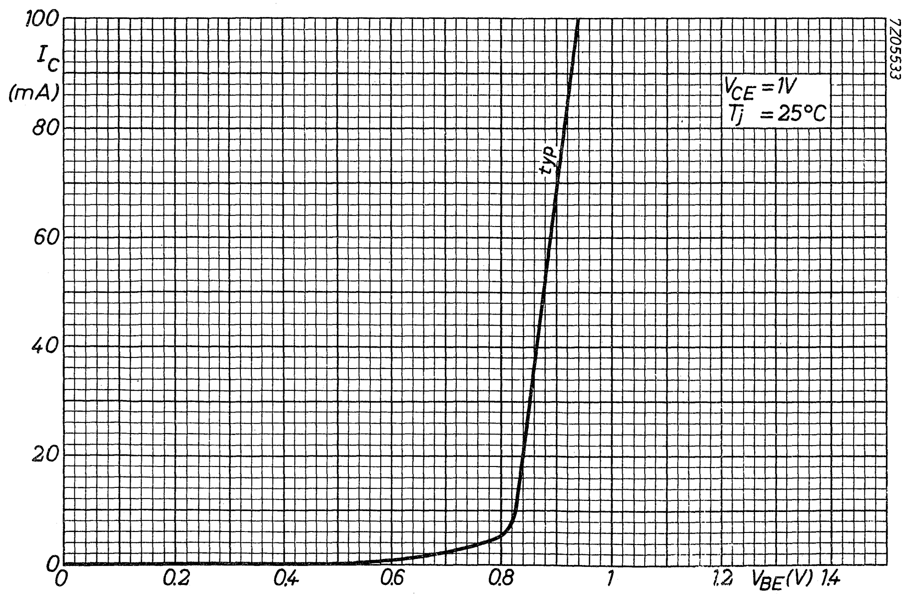

7Z05530
$V_{CE} = 20V$
$V_{BE} = 0.35V$
typ
I_C (μA)
10^3
10^2
10
1
10^{-1}
10^{-2}
10^{-3}
0
50
100
150
200
T_j (°C)

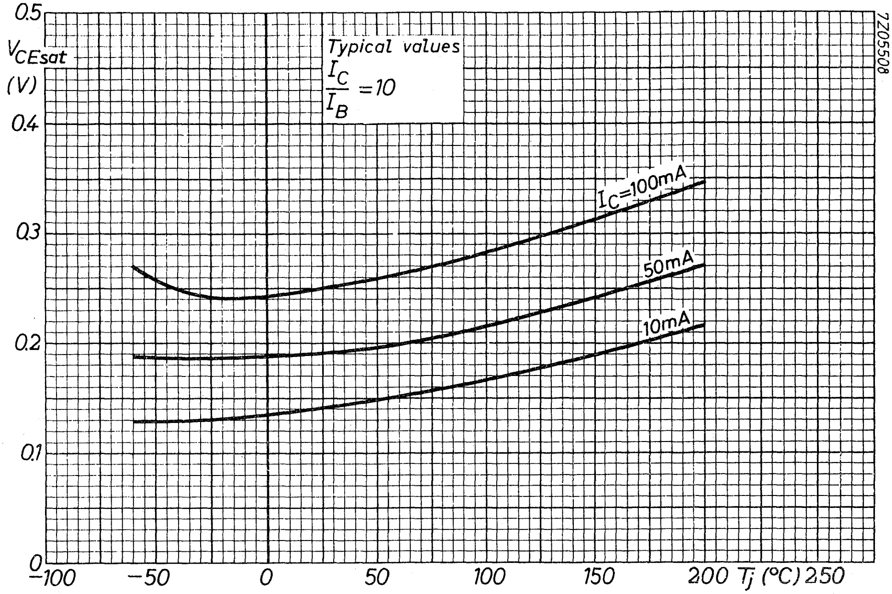

7Z05535
$V_{CE} = 20V$
$T_j = 100°C$
typ
max
I_C (μA)
10^3
10^2
10
1
10^{-1}
−0.2
0
0.2
0.4
0.6
V_{BE} (V)

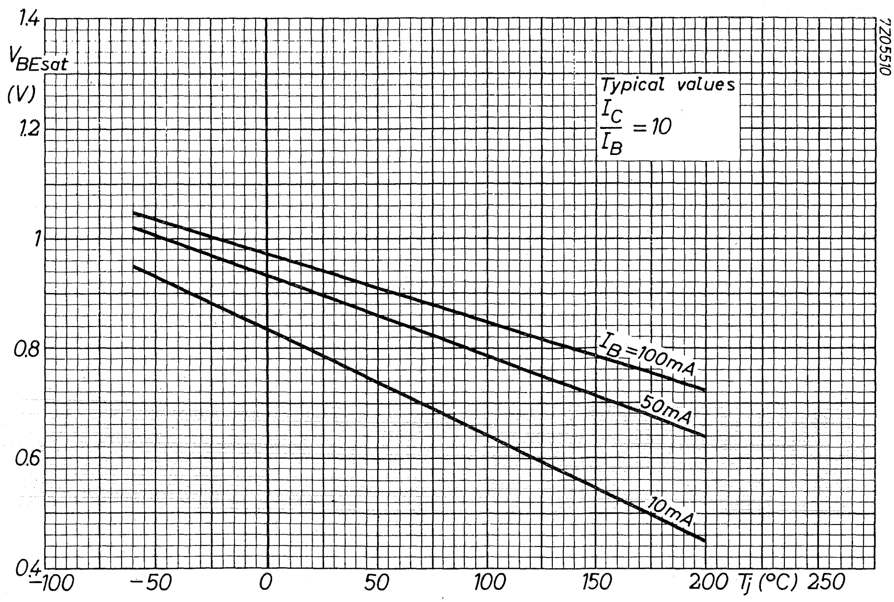

7Z05529
$V_{CE} = 15V$
$-V_{BE} = 3V$
1V
typ
$-I_{BEX}$ (nA)
10^5
10^4
10^3
10^2
10
1
10^{-1}
0
50
100
150
200
T_j (°C)

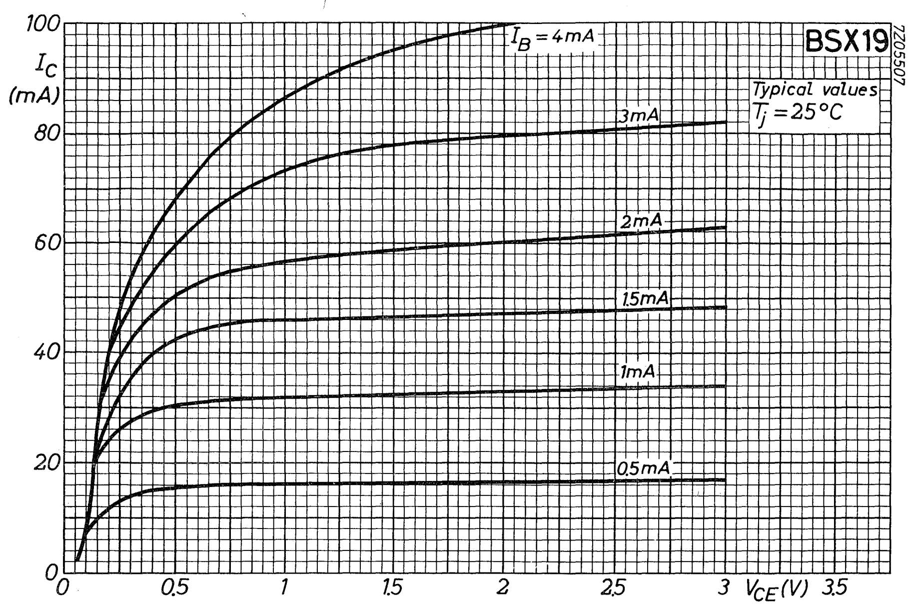

7Z05534
$V_{CE} = 1V$
$I_C = 100mA$
10mA
typ
typ
V_{BE} (V)
1.4
1.2
1
0.8
0.6
0.4
0.2
0
−50
0
50
100
150
200
T_j (°C)

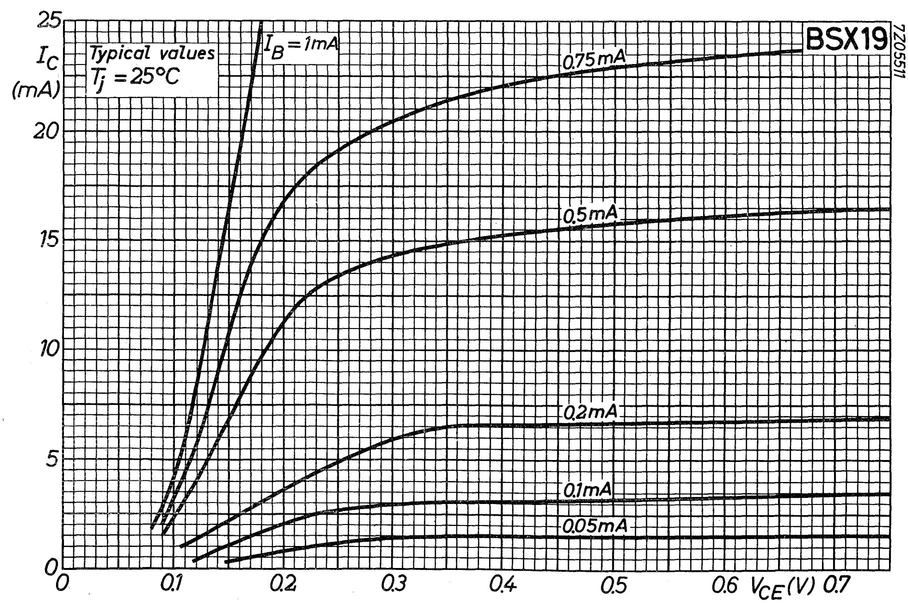

I_C
(mA)
150
100
50
0
Typical values
T_j = 25°C
I_B = 1mA
5mA
10mA
25mA
50mA
0.7
0.8
0.9
1
1.1
V_{BE} (V)
1.2
7Z05532

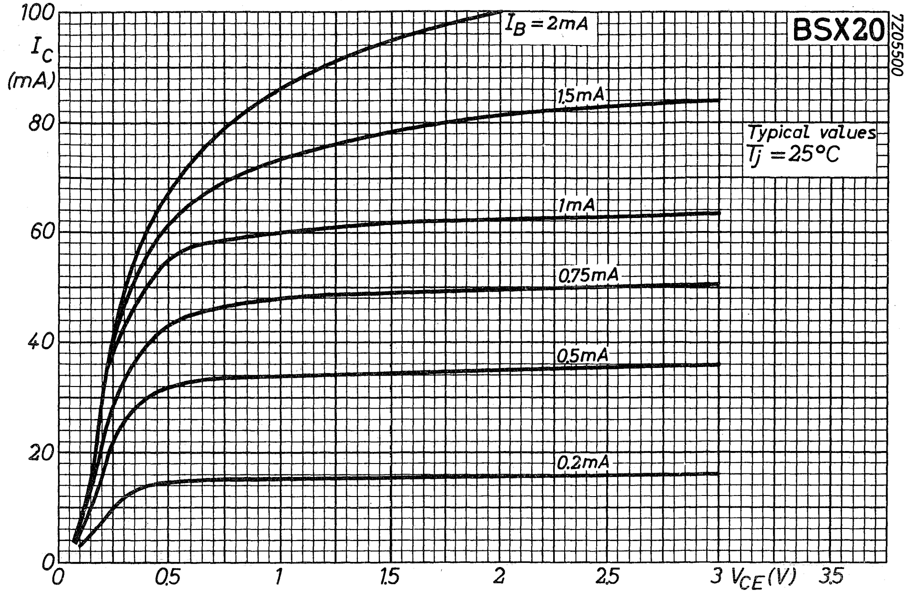

100
I_C
(mA)
80
60
40
20
0
V_{CE} = 1V
T_j = 25°C
typ
0
0.2
0.4
0.6
0.8
1
1.2
V_{BE}(V)
1.4
7Z05533

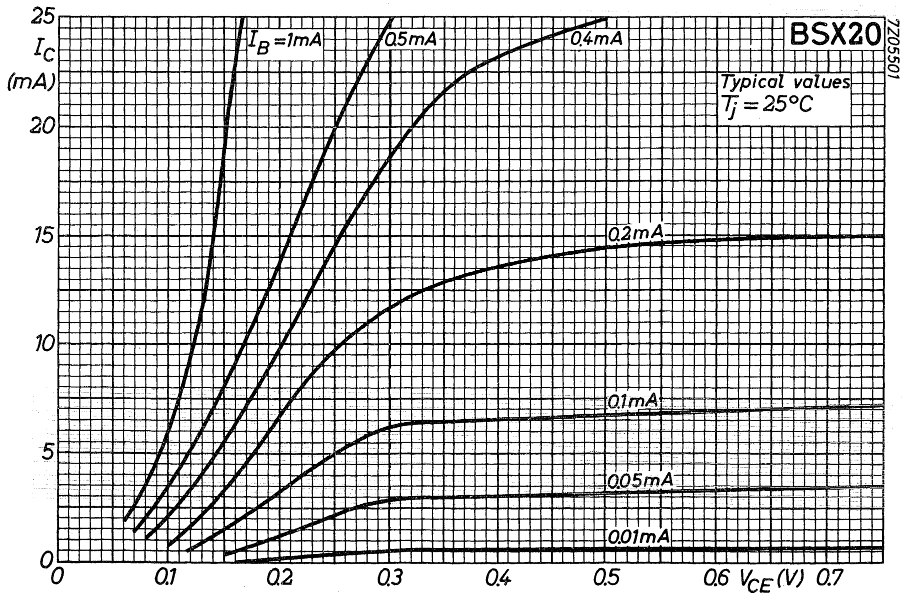

0.5
V_{CEsat}
(V)
0.4
0.3
0.2
0.1
0
Typical values
$\frac{I_C}{I_B} = 10$
I_C=100mA
50mA
10mA
−100
−50
0
50
100
150
200
T_j (°C)
250
7Z05508

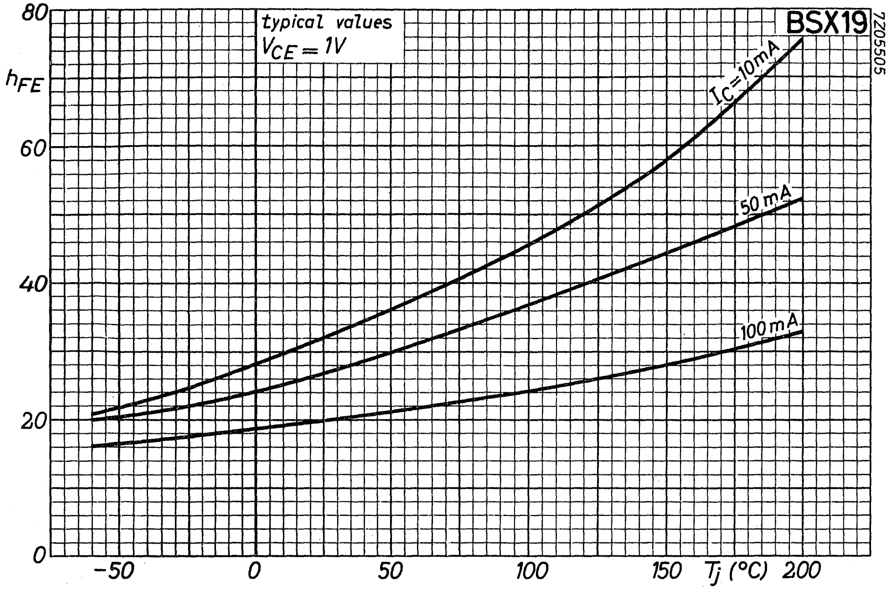

1.4
V_{BEsat}
(V)
1.2
1
0.8
0.6
0.4
Typical values
$\frac{I_C}{I_B} = 10$
I_B=100mA
50mA
10mA
−100
−50
0
50
100
150
200
T_j (°C)
250
7Z05510

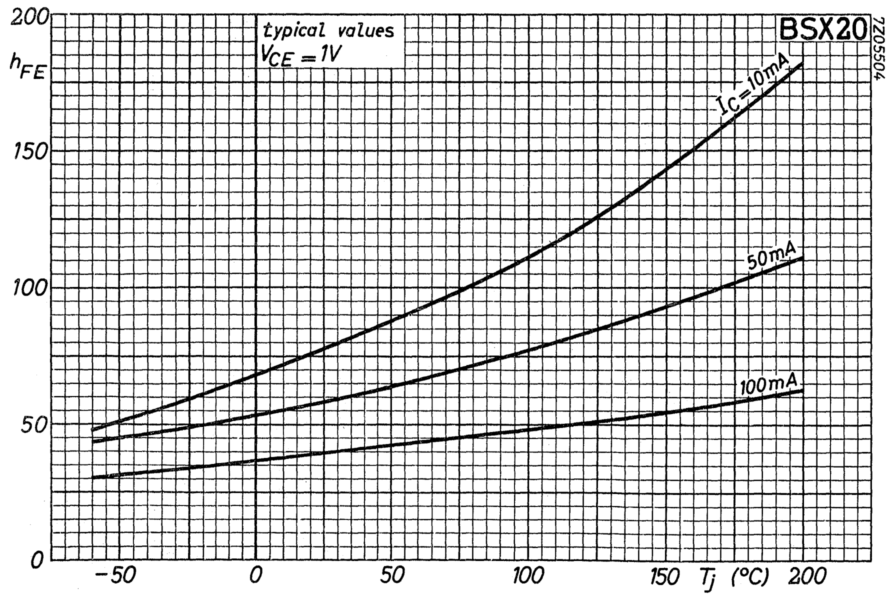

BSX19
7Z05507
Typical values
$T_j = 25°C$
$I_B = 4mA$
3mA
2mA
1.5mA
1mA
0.5mA
100
I_C
(mA)
80
60
40
20
0
0
0.5
1
1.5
2
2.5
3
$V_{CE}(V)$
3.5

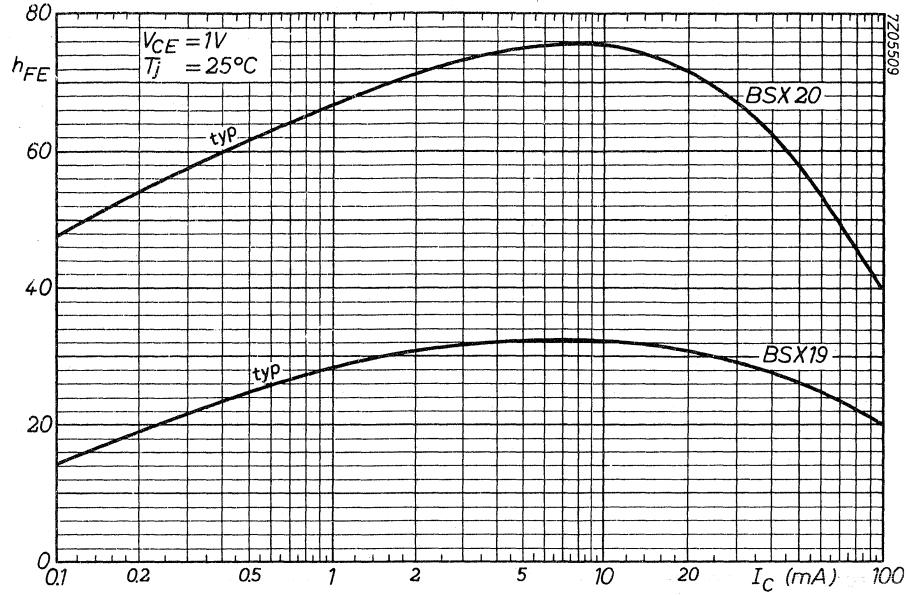

BSX19
7Z05511
Typical values
$T_j = 25°C$
$I_B = 1mA$
0.75mA
0.5mA
0.2mA
0.1mA
0.05mA
25
I_C
(mA)
20
15
10
5
0
0
0.1
0.2
0.3
0.4
0.5
0.6
$V_{CE}(V)$
0.7

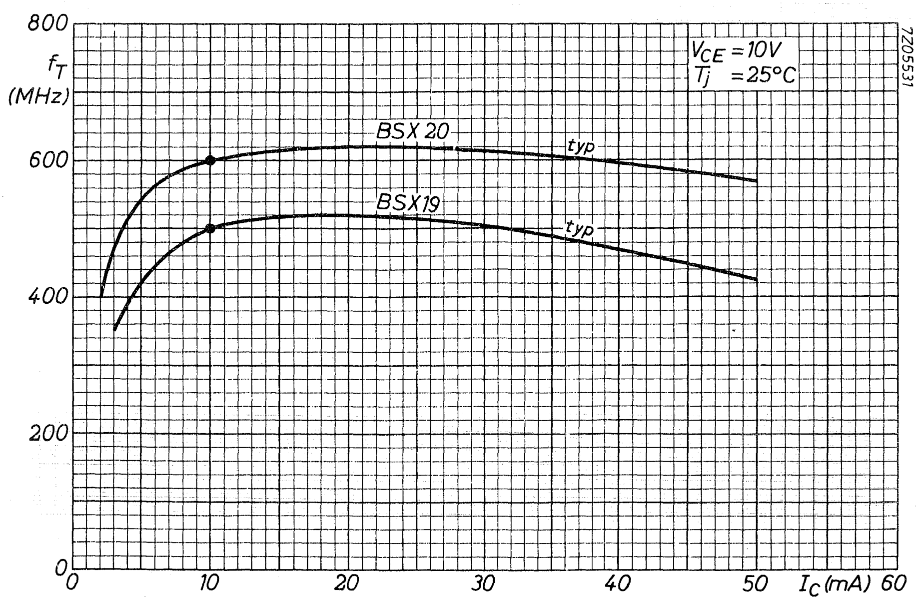

BSX20
7Z05500
100
I_C
(mA)
80
60
40
20
0
$I_B = 2mA$
1,5mA
1mA
0,75mA
0,5mA
0,2mA
Typical values
$T_j = 25°C$
0
0,5
1
1,5
2
2,5
3 V_{CE} (V)
3,5

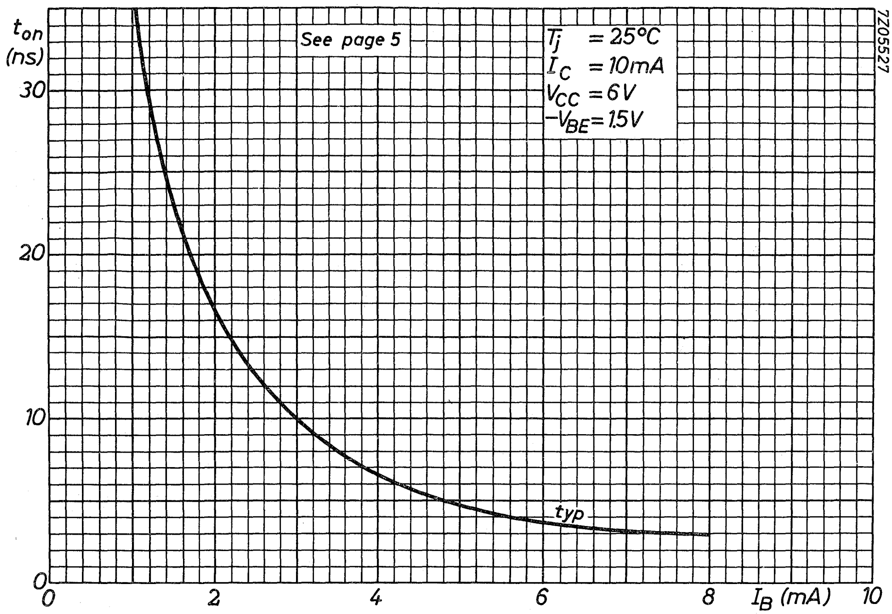

BSX20
7Z05501
25
I_C
(mA)
20
15
10
5
0
$I_B = 1mA$
0,5mA
0,4mA
0,2mA
0,1mA
0,05mA
0,01mA
Typical values
$T_j = 25°C$
0
0,1
0,2
0,3
0,4
0,5
0,6 V_{CE} (V)
0,7

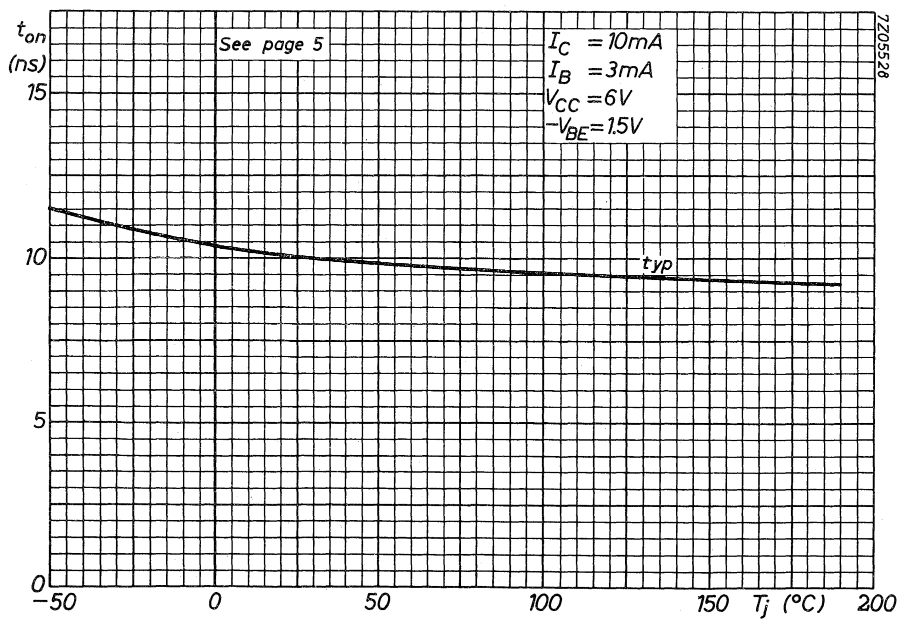

typical values
$V_{CE} = 1V$
BSX19
7Z05505
h_{FE}
80
60
40
20
0
$I_C = 10 mA$
50 mA
100 mA
−50
0
50
100
150
T_j (°C)
200

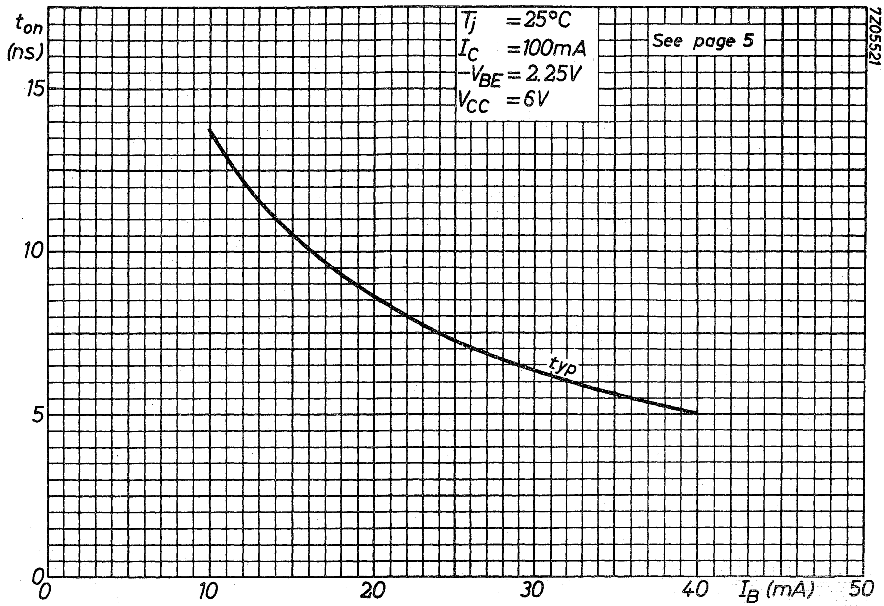

typical values
$V_{CE} = 1V$
BSX20
7Z05504
h_{FE}
200
150
100
50
0
$I_C = 10 mA$
50 mA
100 mA
−50
0
50
100
150
T_j (°C)
200

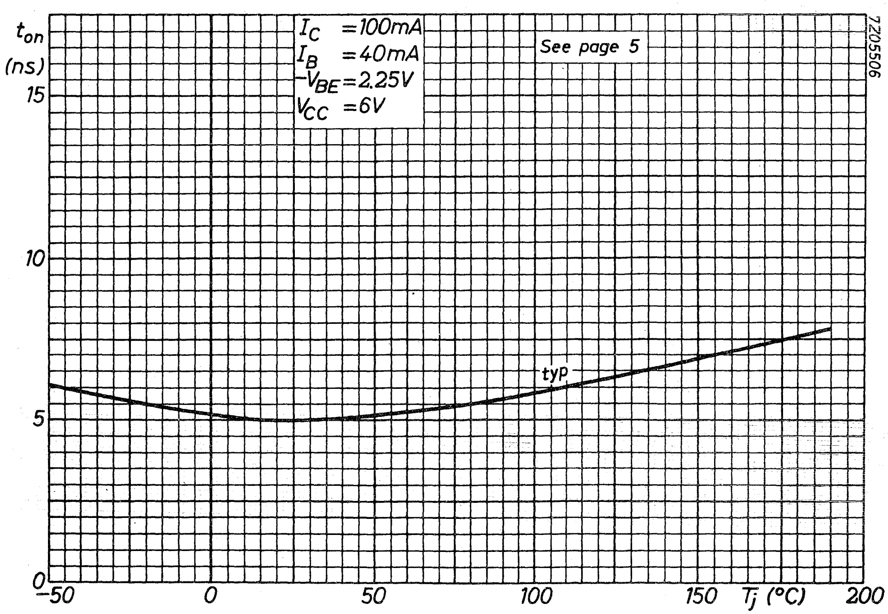

80
h_{FE}
60
40
20
0
V_{CE} = 1V
T_j = 25°C
7Z05509
typ
BSX 20
typ
BSX19
0.1
0.2
0.5
1
2
5
10
20
I_C (mA)
100

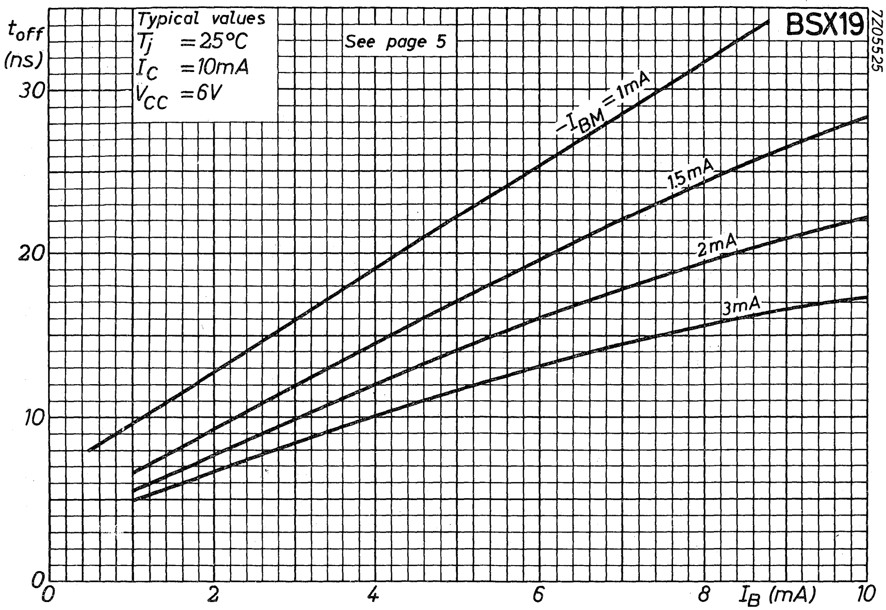

800
f_T
(MHz)
600
400
200
0
V_{CE} = 10V
T_j = 25°C
7Z05531
BSX 20
typ
BSX19
typ
0
10
20
30
40
50
I_C(mA)
60

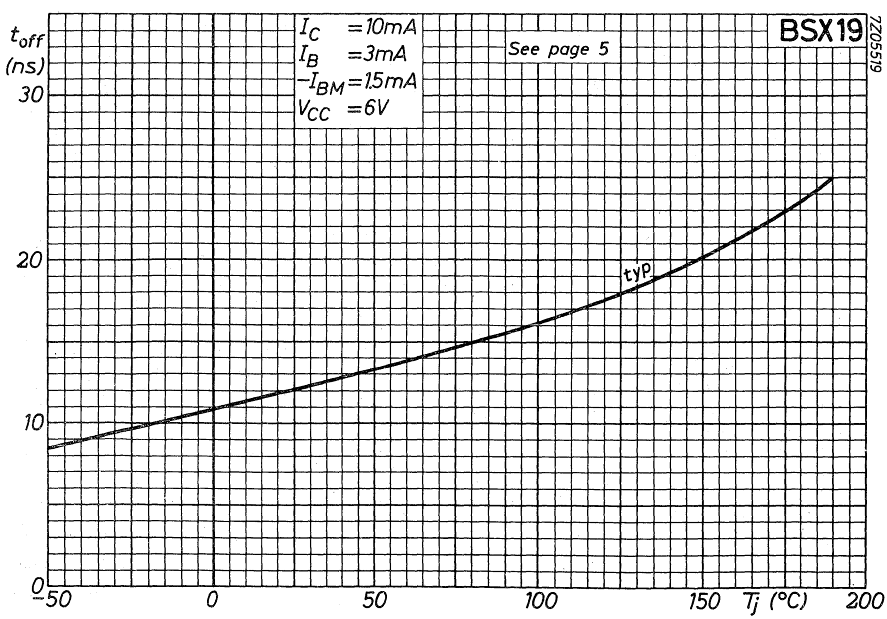

t_{on} (ns)
30
20
10
0
See page 5
T_j = 25°C
I_C = 10mA
V_{CC} = 6V
$-V_{BE}$ = 1.5V
typ
0
2
4
6
8
I_B (mA)
10
7Z05527

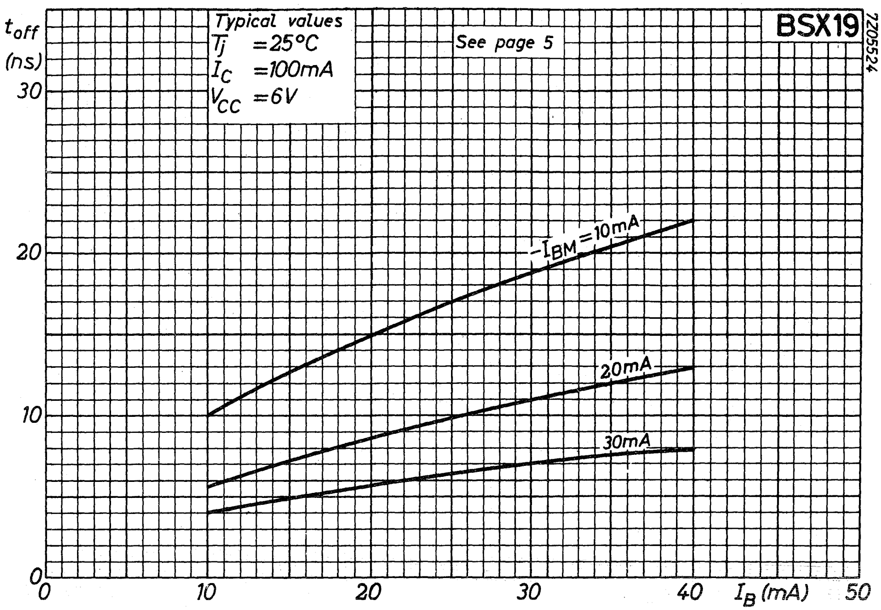

t_{on} (ns)
15
10
5
0
See page 5
I_C = 10mA
I_B = 3mA
V_{CC} = 6V
$-V_{BE}$ = 1.5V
typ
−50
0
50
100
150
T_j (°C)
200
7Z05528

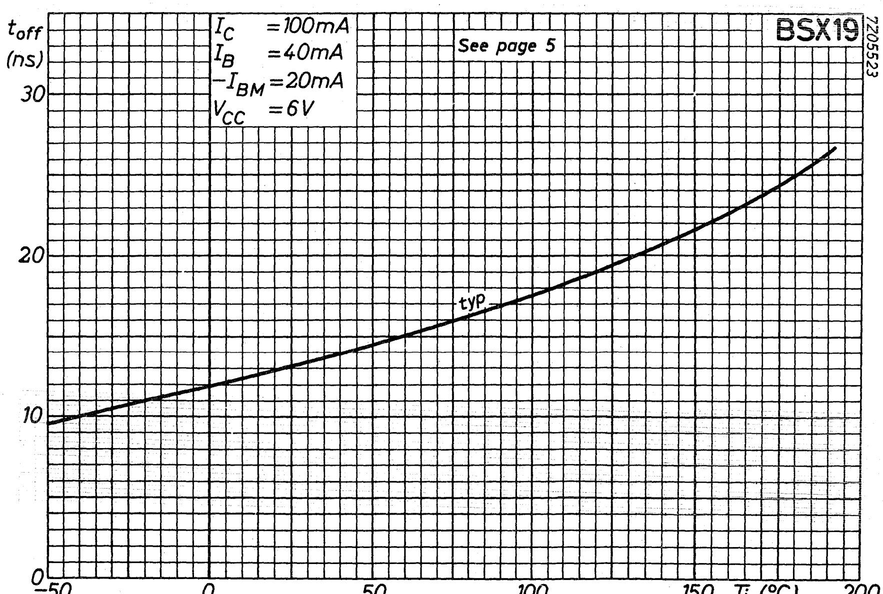

t_{on} (ns)
T_j = 25°C
I_C = 100mA
$-V_{BE}$ = 2.25V
V_{CC} = 6V
See page 5
7205521
typ
I_B (mA)
0
5
10
15
0
10
20
30
40
50

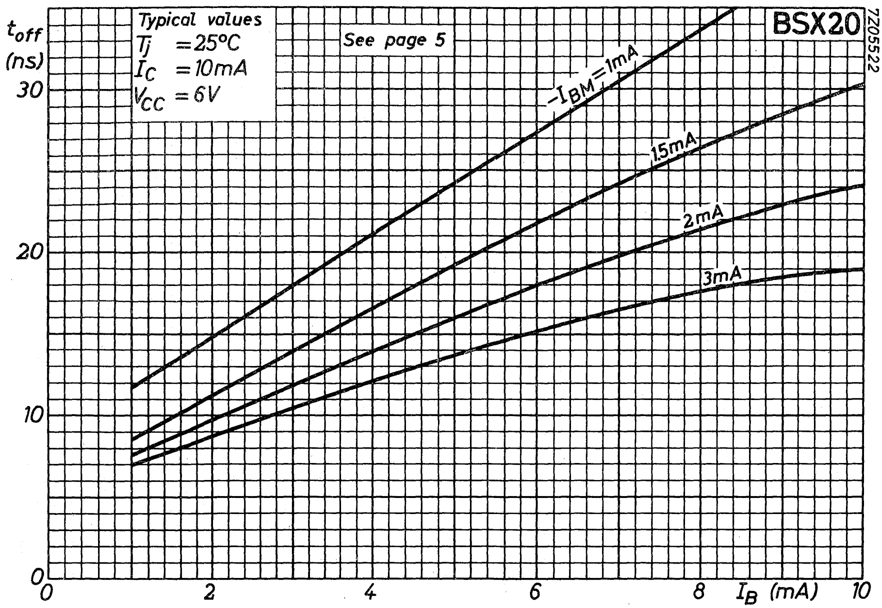

t_{on} (ns)
I_C = 100mA
I_B = 40mA
$-V_{BE}$ = 2.25V
V_{CC} = 6V
See page 5
7205506
typ
T_j (°C)
0
5
10
15
−50
0
50
100
150
200

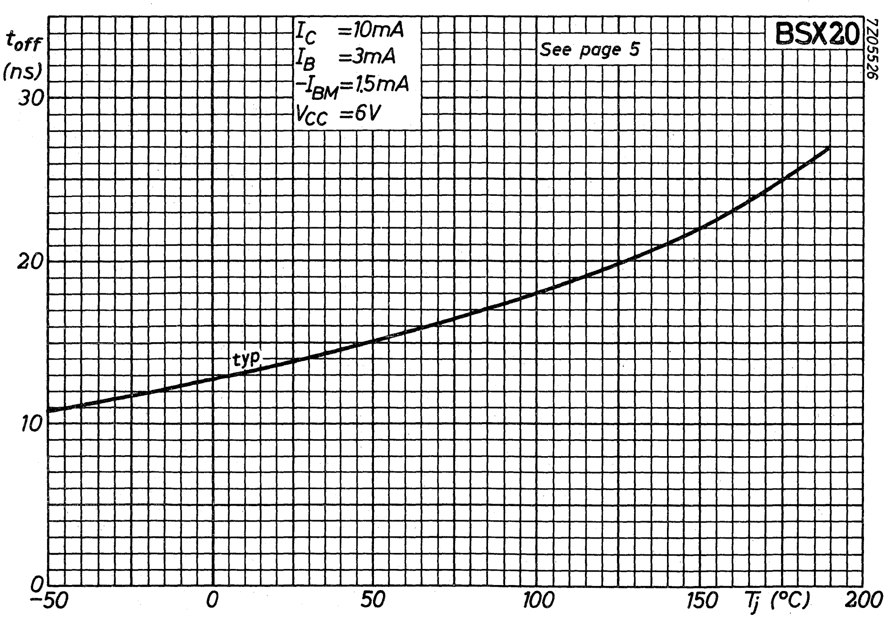

Typical values
T_j = 25°C
I_C = 10mA
V_{CC} = 6V
See page 5
BSX19
7Z05525
t_{off} (ns)
$-I_{BM}$ = 1mA
1.5mA
2mA
3mA
I_B (mA)
0
2
4
6
8
10
10
20
30

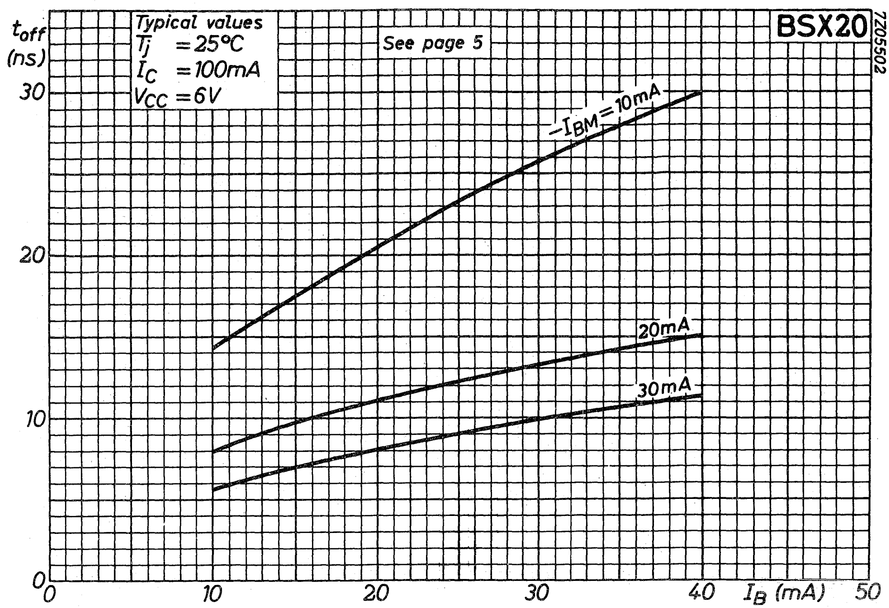

I_C = 10mA
I_B = 3mA
$-I_{BM}$ = 1.5mA
V_{CC} = 6V
See page 5
BSX19
7Z05519
t_{off} (ns)
typ
T_j (°C)
−50
0
50
100
150
200
10
20
30

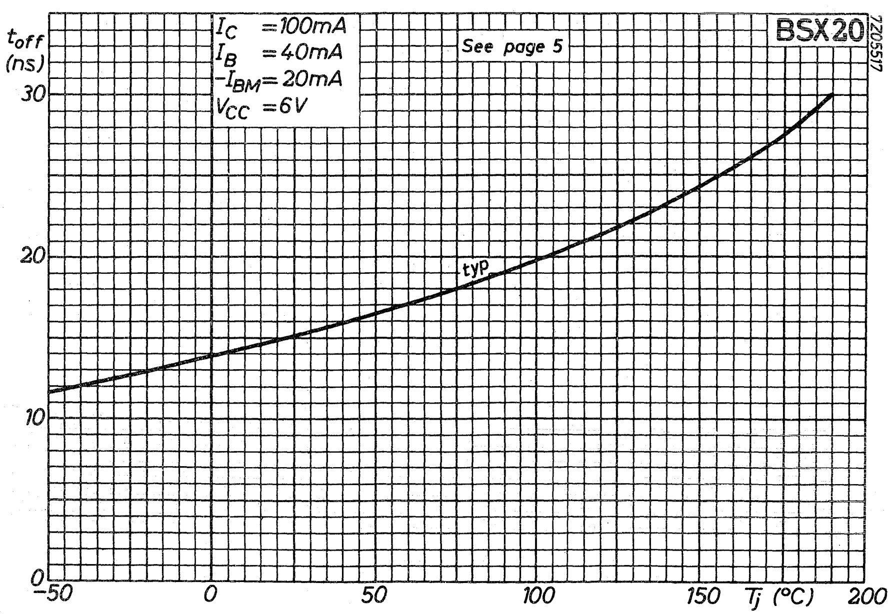

t_{off} (ns)
Typical values
T_j = 25°C
I_C = 100mA
V_{CC} = 6V
See page 5
BSX19
7Z05524
$-I_{BM}$ = 10mA
20mA
30mA
0
10
20
30
40
50
I_B (mA)

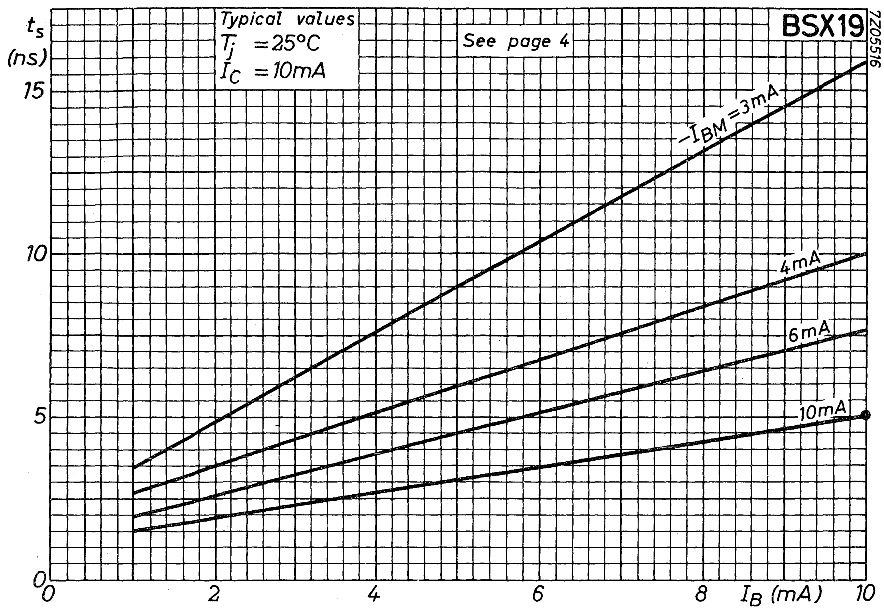

t_{off} (ns)
I_C = 100mA
I_B = 40mA
$-I_{BM}$ = 20mA
V_{CC} = 6V
See page 5
BSX19
7Z05523
typ
−50
0
50
100
150
200
T_j (°C)

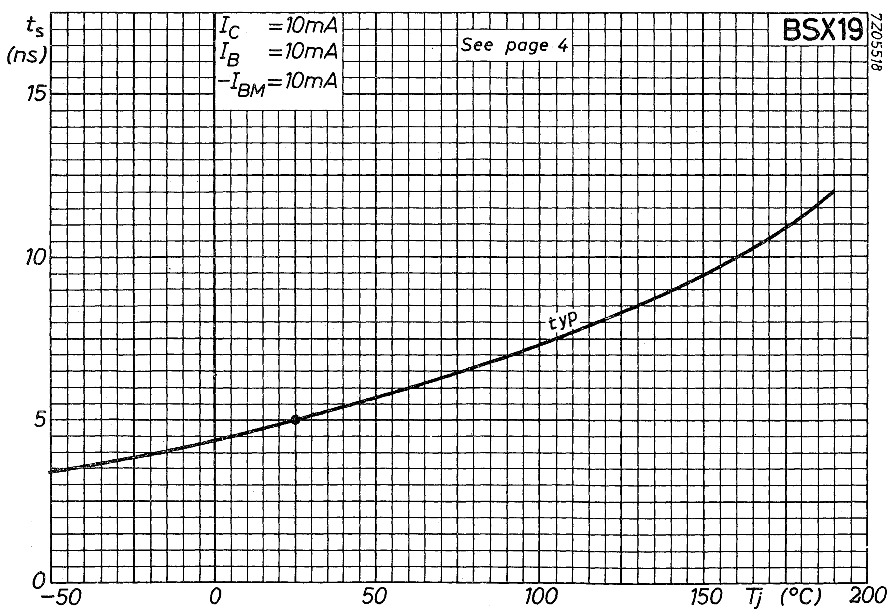

BSX20
7Z05522
Typical values
T_j = 25°C
I_C = 10mA
V_{CC} = 6V
See page 5
t_{off}
(ns)
30
20
10
0
0
2
4
6
8
I_B (mA)
10
$-I_{BM}$=1mA
1.5mA
2mA
3mA

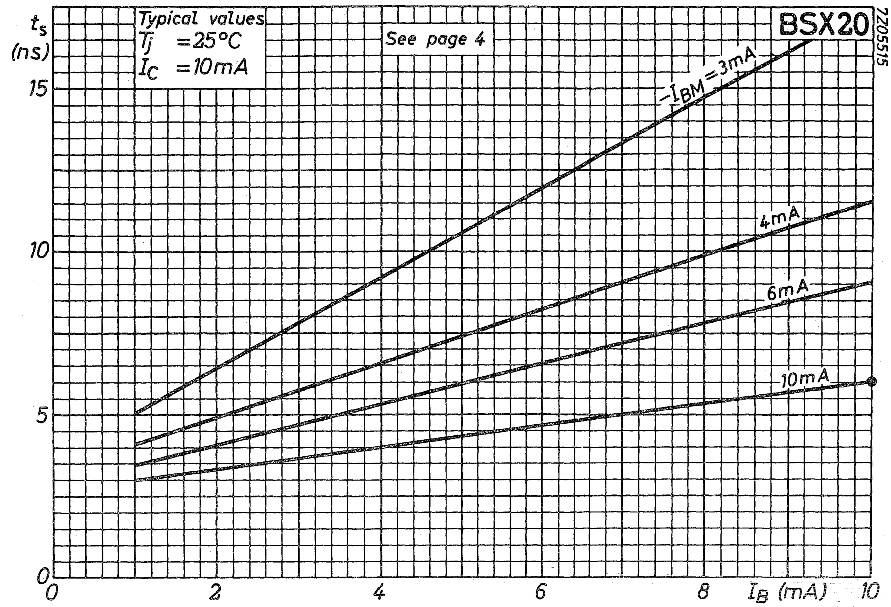

BSX20
7Z05526
I_C = 10mA
I_B = 3mA
$-I_{BM}$=1.5mA
V_{CC} = 6V
See page 5
t_{off}
(ns)
30
20
10
0
−50
0
50
100
150
T_j (°C)
200
typ

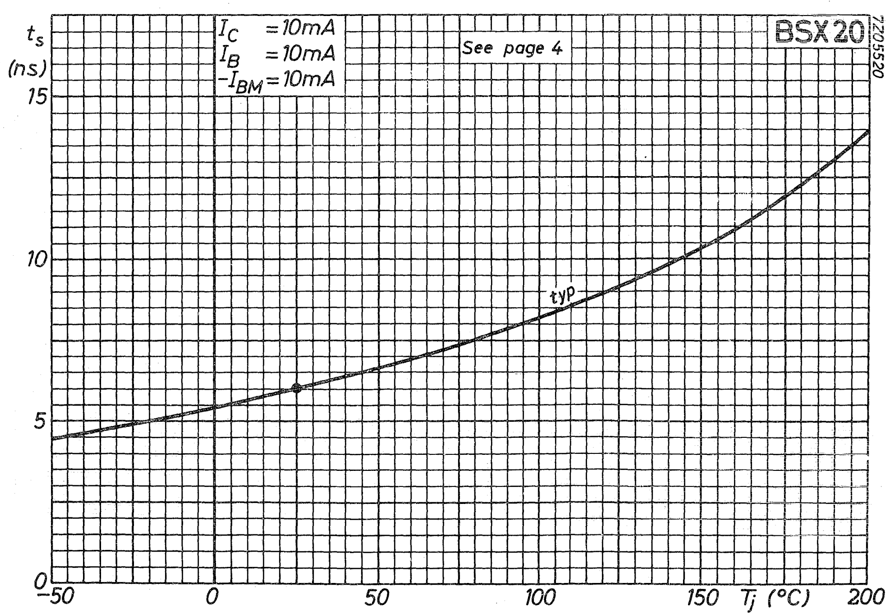

Typical values
T_j = 25°C
I_C = 100mA
V_{CC} = 6V
See page 5
BSX20
7Z05502
t_{off} (ns)
$-I_{BM}$ = 10mA
20mA
30mA
0
10
20
30
40
50
I_B (mA)

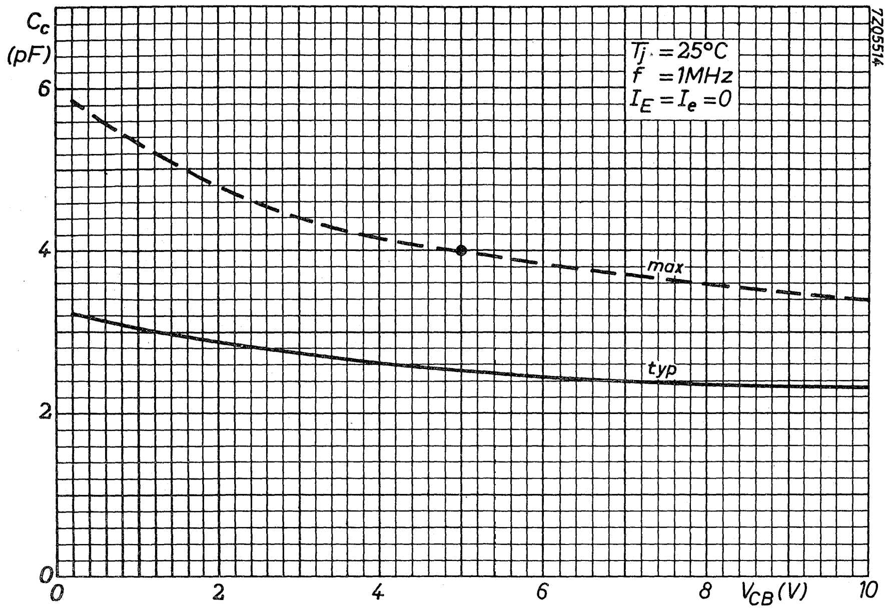

I_C = 100mA
I_B = 40mA
$-I_{BM}$ = 20mA
V_{CC} = 6V
See page 5
BSX20
7Z05517
t_{off} (ns)
typ
0
10
20
30
−50
0
50
100
150
200
T_j (°C)

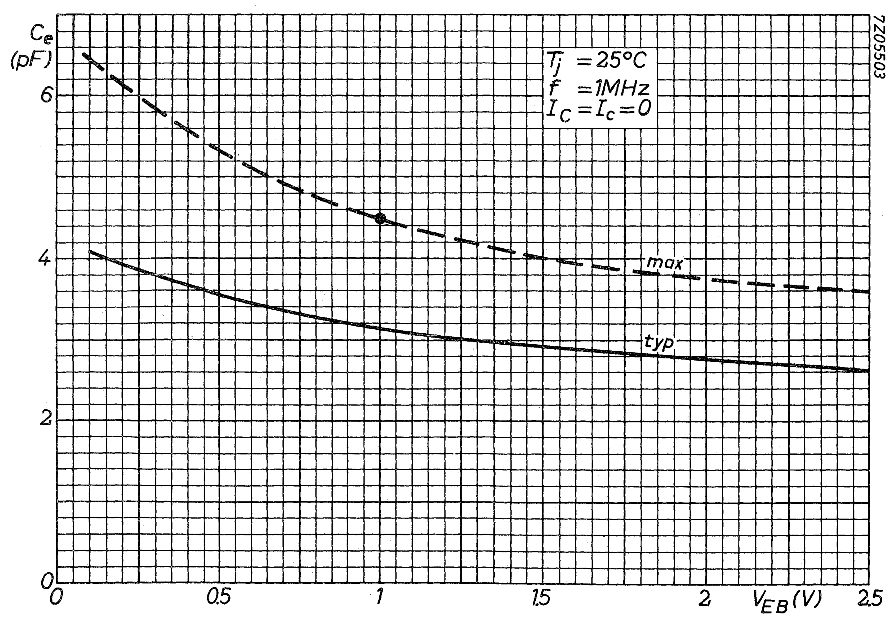

t_s (ns)
Typical values
T_j = 25°C
I_C = 10mA
See page 4
BSX19
7205516
$-I_{BM}$=3mA
4mA
6mA
10mA
I_B (mA)
0
2
4
6
8
10
5
15


t_s (ns)
I_C = 10mA
I_B = 10mA
$-I_{BM}$=10mA
See page 4
BSX19
7205518
typ
T_j (°C)
−50
0
50
100
150
200
5
10
15


Typical values
T_j = 25°C
I_C = 10mA
See page 4
BSX20
7205515
t_s (ns)
$-I_{BM}$ = 3mA
4mA
6mA
10mA
I_B (mA)
0
2
4
6
8
10
5
10
15


I_C = 10mA
I_B = 10mA
$-I_{BM}$ = 10mA
See page 4
BSX20
7205520
t_s (ns)
typ
T_j (°C)
−50
0
50
100
150
200
5
10
15


C_c (pF)
6
4
2
0
0
2
4
6
8
V_{CB} (V)
10
T_j = 25°C
f = 1MHz
$I_E = I_e = 0$
max
typ
7Z05514


C_e (pF)
6
4
2
0
0
0.5
1
1.5
2
V_{EB} (V)
2.5
T_j = 25°C
f = 1MHz
$I_C = I_c = 0$
max
typ
7Z05503

SILICON PLANAR EPITAXIAL TRANSISTOR

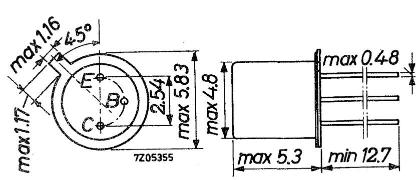
N-P-N transistor in a TO-18 metal envelope with the collector connected to the case.
The 2N2475 is primarily intended for high speed, low power saturated switching applications.

QUICK REFERENCE DATA				
Collector-base voltage (open emitter)	V_{CBO}	max.	15	V
Collector-emitter voltage (open base)	V_{CEO}	max.	6	V
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	300	mW
Junction temperature	T_j	max.	200	°C
D.C. current gain at T_j = 25 °C				
I_C = 20 mA; V_{CE} = 0.4 V	h_{FE}		30 to 150	
Transition frequency				
I_C = 20 mA; V_{CE} = 2 V	f_T	>	600	MHz
Storage time				
$I_C = I_B = -I_{BM}$ = 5 mA	t_s	<	6	ns

MECHANICAL DATA

Dimensions in mm

TO-18
Collector connected to case



7Z3 0786

RATINGS (Limiting values) [1])

Voltages

Collector-base voltage (open emitter)	V_{CBO}	max.	15	V
Collector-emitter voltage (open base)	V_{CEO}	max.	6	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4	V

Power dissipation

Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	300	mW
Total power dissipation up to T_{case} = 100 °C	P_{tot}	max.	500	mW

Temperatures

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

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	0.58	°C/mW
From junction to case	$R_{th\ j\text{-}c}$	=	0.2	°C/mW

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

Collector cut-off current

$I_E = 0$; $V_{CB} = 5$ V	I_{CBO}	<	50	nA
$I_E = 0$; $V_{CB} = 5$ V; $T_{amb} = 150$ °C	I_{CBO}	<	5	μA

Emitter cut-off current

$I_C = 0$; $V_{EB} = 4$ V	I_{EBO}	<	10	μA

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

7Z3 0787

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

Sustaining voltages [1]				
I_C = 10 mA; I_B = 0	$V_{CEOsust}$	>	6	V
Saturation voltages				
I_C = 20 mA; I_B = 0.66 mA	V_{CEsat}	<	400	mV
	V_{BEsat}	0.80 to 1.00		V
D.C. current gain				
I_C = 1 mA; V_{CE} = 300 mV	h_{FE}	>	20	
I_C = 20 mA; V_{CE} = 400 mV	h_{FE}	30 to 150		
I_C = 50 mA; V_{CE} = 500 mV	h_{FE}	>	20	
I_C = 20 mA; V_{CE} = 400 mV; T_{amb} = −55 °C	h_{FE}	>	15	
Collector capacitance at f = 120 to 140 kHz				
$I_E = I_e$ = 0; V_{CB} = 5 V	C_c	<	3	pF
Emitter capacitance at f = 120 to 140 kHz				
$I_C = I_c$ = 0; V_{EB} = 0.5 V	C_e	<	2.5	pF
Transition frequency				
I_C = 20 mA; V_{CE} = 2 V	f_T	>	600	MHz

[1]) Measured under pulsed conditions.
Pulse duration t ≤ 6 ms; duty cycle $\delta \leq 0.3$

7Z3 0788

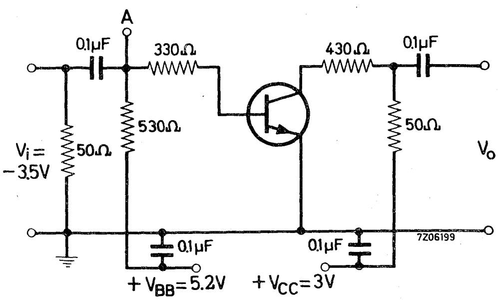
CHARACTERISTICS (continued) T_{amb} = 25 °C unless otherwise specified

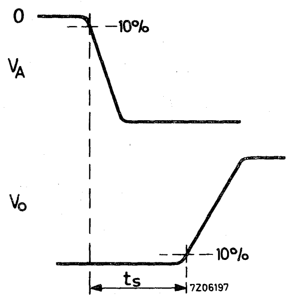
Switching times

Storage time

$I_C = I_B = -I_{BM}$ = 5 mA	t_s	<	6	ns

Test circuit:





Pulse generator:

Pulse duration	t	>	300	ns
Rise time	t_r	<	1	ns
Duty cycle	δ	<	0.02	
Output impedance	R_o	=	50	Ω

Oscilloscope:

Rise time	t_r	<	1	ns
Input capacitance				
(with shunt resistance		>	1	kΩ)
	C_i	<	2.5	pF

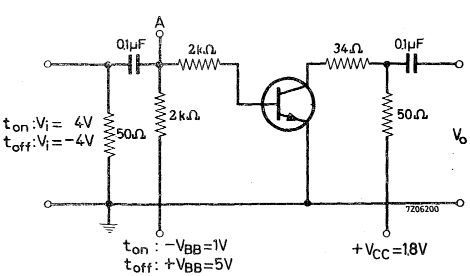
Turn on time when switched to

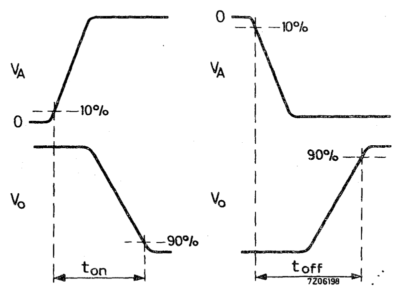
I_C = 20 mA; $I_{B1} = -I_{B2}$ = 1 mA	t_{on}	<	20	ns

Turn off time when switched from

I_C = 20 mA; $I_{B1} = -I_{B2}$ = 1 mA	t_{off}	<	15	ns

Test circuit:





Pulse generator:

Pulse duration	t	>	300	ns
Rise time	t_r	<	1	ns
Duty cycle	δ	<	0.02	
Output impedance	R_o	=	50	Ω

Oscilloscope:

Rise time	t_r	<	0.5	ns
Input capacitance				
(with shunt resistance		>	1	kΩ)
	C_i	<	2.5	pF

General section

Diodes

Thyristors
(Silicon controlled rectifiers)

Rectifier Stacks

Transistors

Photoelectric devices

Integrated circuits

Accessories

Supplement (latest data)

Printed in Holland
29/151/B/E