

PHILIPS

Data handbook



Electronic
components
and materials

Semiconductors and integrated circuits

Part 3 November 1971

High frequency transistors

Switching transistors

Accessories

SEMICONDUCTORS AND INTEGRATED CIRCUITS

Part 3

November 1971

General

High frequency transistors

Switching transistors

Accessories



DATA HANDBOOK SYSTEM

To provide you with a comprehensive source of information on electronic components, subassemblies and materials, our Data Handbook System is made up of three series of handbooks, each comprising several parts.

The three series, identified by the colours noted, are:

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

The several parts contain all pertinent data available at the time of publication, and each is revised and reissued annually; the contents of each series are summarized on the following pages.

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

ELECTRON TUBES (BLUE SERIES)

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

Part 1		January 1971
Transmitting tubes (Tetrodes, Pentodes)	Associated accessories	
Part 2		March 1971
Tubes for microwave equipment		
Part 3		March 1970
Special Quality tubes	Miscellaneous devices	
Part 4		April 1971
Receiving tubes		
Part 5		May 1971
Cathode-ray tubes	Photoconductive devices	
Photo tubes	Associated accessories	
Camera tubes		
Part 6		June 1971
Photomultiplier tubes	Radiation counter tubes	
Channel electron multipliers	Semiconductor radiation detectors	
Scintillators	Neutron generator tubes	
Photoscintillators	Photo diodes	
	Associated accessories	
Part 7		July 1971
Voltage stabilizing and reference tubes	Thyratrons	
Counter, selector, and indicator tubes	Ignitrons	
Trigger tubes	Industrial rectifying tubes	
Switching diodes	High-voltage rectifying tubes	
Part 8		August 1971
T. V. Picture tubes		
Part 9		January 1971
Transmitting tubes (Triodes)	Associated accessories	
Tubes for R. F. heating (Triodes)		

August 1971

SEMICONDUCTORS AND INTEGRATED CIRCUITS (RED SERIES)

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

Part 1	Diodes and Thyristors	September 1971
General	Thyristors, diacs, triacs	
Signal diodes	Rectifier stacks	
Variable capacitance diodes	Accessories	
Voltage regulator diodes	Heatsinks	
Rectifier diodes		
Part 2	Low frequency; Deflection	October 1971
General	Deflection transistors	
Low frequency transistors (low power)	Accessories	
Low frequency power transistors		
Part 3	High frequency; Switching	November 1971
General	Switching transistors	
High frequency transistors	Accessories	
Part 4	Special types	December 1970
General	Beam lead devices for	
Transmitting transistors	thick- and thin-film circuits	
Microwave devices	Photo devices	
Field effect transistors	Accessories	
Dual transistors		
Microminiature devices for		
thick- and thin-film circuits		
Part 5	Integrated Circuits	March 1971
General	Linear integrated circuits	
Digital integrated circuits		
DTL (FC family)		
TTL (FJ family)		
MOS (FD family)		

COMPONENTS AND MATERIALS (GREEN SERIES)

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

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

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

Part 2 Resistors, Capacitors **December 1970**

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

Part 3 Radio, Audio, Television **February 1971**

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

Part 4 Magnetic Materials, Piezoelectric Ceramics **April 1971**

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

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

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

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

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

Part 7 Circuit Blocks **September 1971**

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

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

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

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General

Type designation

Rating systems

Letter symbols

PRO ELECTRON TYPE DESIGNATION CODE

FOR SEMICONDUCTOR DEVICES

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

The type designation consists of:

TWO LETTERS FOLLOWED BY A SERIAL NUMBER

The first letter gives an indication of the material

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

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

Multiples of similar devices as well as multiples consisting of a main device and an auxiliary device are designated according to the code for discrete devices described above.

Multiples of dissimilar devices of other nature are designated by the second letter G.

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

- A Detection diode, switching diode, mixer diode
- B Variable capacitance diode
- C Transistor for a.f. applications ($R_{th\ j-mb} > 15\ ^\circ C/W$)
- D Power transistor for a.f. applications ($R_{th\ j-mb} \leq 15\ ^\circ C/W$)
- E Tunnel diode
- F Transistor for h.f. applications ($R_{th\ j-mb} > 15\ ^\circ C/W$)
- G Multiple of dissimilar devices (see note on page 1); Miscellaneous
- H Magnetic sensitive diode; Field probe
- K Hall generator in an open magnetic circuit, e.g. magnetogram or signal probe
- L Power transistor for h.f. applications ($R_{th\ j-mb} \leq 15\ ^\circ C/W$)
- M Hall generator in a closed electrically energised magnetic circuit, e.g. Hall modulator or multiplier
- P Radiation sensitive device¹⁾
- Q Radiation generating device
- R Electrically triggered controlling and switching device having a breakdown characteristic ($R_{th\ j-mb} > 15\ ^\circ C/W$)
- S Transistor for switching applications ($R_{th\ j-mb} > 15\ ^\circ C/W$)
- T Electrically, or by means of light, triggered controlling and switching power device having a breakdown characteristic ($R_{th\ j-mb} \leq 15\ ^\circ C/W$)¹⁾
- U Power transistor for switching applications ($R_{th\ j-mb} \leq 15\ ^\circ C/W$)
- X Multiplier diode, e.g. varactor, step recovery diode
- Y Rectifying diode, booster diode, efficiency diode¹⁾
- Z Voltage reference or voltage regulator diode¹⁾

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

The serial number consists of:

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

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

VERSION LETTER

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



EXAMPLES

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

TYPE DESIGNATION FOR A RANGE OF SEMICONDUCTOR DEVICES

The type designation of a range of variants of:

- a) voltage reference or voltage regulator diodes (second letter Z)
- b) rectifying diodes (second letter Y)
- c) thyristors (second letter T)
- d) radiation detectors

distinctly belonging to one basic type may be qualified by a suffix part which is clearly separated from the basic part by a dash (-)

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

The suffix part consists of:

- a) for voltage reference or voltage regulator diodes

one letter followed by the typical zener voltage and where appropriate the letter R ¹⁾

The first letter indicates the nominal tolerance of the zener voltage in %

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

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

- b) for rectifying diodes

a number and where appropriate the letter R ¹⁾

The number generally indicates the maximum repetitive peak reverse voltage
For controlled avalanche types it indicates the maximum crest working reverse voltage

- c) for thyristors

a number and where appropriate the letter R ¹⁾

The number generally indicates either the maximum repetitive peak reverse voltage or the maximum repetitive peak off-state voltage, whichever is lower
For controlled avalanche types it indicates the maximum crest working reverse voltage

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

d) for radiation detectors

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

EXAMPLES

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



RATING SYSTEMS

ACCORDING TO I.E.C. PUBLICATION 134

1. DEFINITIONS OF TERMS USED

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

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

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

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

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

Note: Limiting conditions may be either maxima or minima.

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

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

2. ABSOLUTE MAXIMUM RATING SYSTEM

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

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

p.t.o.

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

3. DESIGN MAXIMUM RATING SYSTEM

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

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

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

4. DESIGN CENTRE RATING SYSTEM

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

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

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

NOTE

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

LETTER SYMBOLS



LETTER SYMBOLS FOR SEMICONDUCTOR DEVICES

excluding rectifier diodes, thyristors and integrated circuits

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

QUANTITY SYMBOLS

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

Examples: i , v , p

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

Examples: I , V , P

SUBSCRIPTS FOR QUANTITY SYMBOLS

1. Total values are indicated by upper case subscripts.

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

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

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

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

For maximum (peak) values : M or m

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

For d.c. values : no additional subscript

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

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

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

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

5. Examples of the application of the rules:

Figure 1 represents a transistor collector current, consisting of a direct current and a signal, as a function of time.

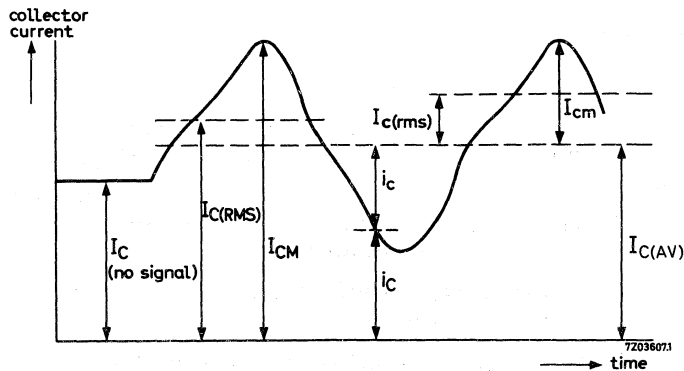


Fig.1

CONVENTIONS FOR SUBSCRIPT SEQUENCE1. Currents

For transistors the first subscript indicates the terminal carrying the current (conventional current flow from the external circuit into the terminal is positive)

For diodes a forward current (conventional current flow into the anode terminal) is represented by the subscript F or f; a reverse current (conventional current flow out of the anode terminal) is represented by the subscript R or r.

2. Voltages

For transistors normally, two subscripts are used to indicate the points between which the voltage is measured. The first subscript indicates one terminal point and the second the reference terminal.

Where there is no possibility of confusion, the second subscript may be omitted.

For diodes a forward voltage (anode positive with respect to cathode) is represented by the subscript F or f and a reverse voltage (anode negative with respect to cathode) by the subscript R or r.

3. Supply voltages

Supply voltages may be indicated by repeating the terminal subscript.

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

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

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

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

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

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

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

ELECTRICAL PARAMETER SYMBOLS

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

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

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

$$\text{Examples: } H_1, Z_o, H_F, Y_R$$

SUBSCRIPTS FOR PARAMETER SYMBOLS

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

$$\text{Examples: } h_{IB}, h_{FE}$$

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

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

$$\text{Examples: } h_{ib}, z_{ob}$$

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

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

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

Notes 1) The voltage and current symbols in matrix notation are indicated by a single digit subscript.

The subscript 1 = input; the subscript 2 = output

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

4. The second subscript identifies the circuit configuration.

e = common emitter

c = common collector

b = common base

j = common terminal, general

Examples: (common base)

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

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

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

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

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

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

LIST OF LETTER SYMBOLS IN ALPHABETICAL ORDER

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

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

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

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

LETTER SYMBOLS

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

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

LETTER SYMBOLS

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

High frequency transistors



RULES FOR SOLDERING LEADS OF PLASTIC "T-PACK" ENVELOPE

Transistors in T-pack envelope may be mounted with leads flat (Fig. 1) or bent (Fig. 2). Different soldering procedures apply for the different styles of mounting.

Flat-lead mounting

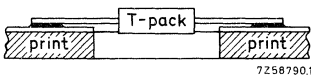


Fig. 1. Flat-lead mounting

Avoid putting any force on the leads during or just after soldering.

Solder the three leads one at a time, not simultaneously.

Proceed from one lead to the adjacent one, not to the opposite one.

Solder temperature, maximum: 300 °C
 Solder time, maximum: 5 s
 Solder-to-case distance, minimum: 2 mm

Bent-lead mounting

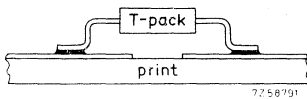


Fig. 2. Bent-lead mounting

If leads are bent, all three may be soldered simultaneously if desired.

Solder temperature, maximum: 300 °C
 Soldering time, maximum: 10 s

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

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

- Diameter of mounting hole in heatsink: 4.1 mm (+0.05, -0.00)
- Heatsink to be at least 3 mm thick.
Attachment to a thinner heatsink may damage the mounting stud.
- Heatsink surfaces at the mounting hole to be flat, parallel, and free of burrs or oxidation.
- Mounting nut torque: 8.0 kg cm (+0.5, -0.0)
If security against vibration is required, use a locking compound such as Lock-tite. Do not use washers; they impair the heat transfer.
- Recommend distance from the top surface of heatsink to surface of printed wiring board: 2.9 mm (+0.0, -0.2)
Tension in the transistor leads sets the limit on spacing between heatsink and printed wiring board; in general, the leads can withstand more pull in the downward than in the upward direction.
- Solder the leads to the connection pads with resin-cored lead-tin solder, using an iron of normal temperature. Soldering iron temperatures as high as 350 °C are safely tolerable; the transistor can withstand an interior temperature of 250 °C for about ten minutes.
The leads may be tinned, if required, by dipping them into a solder bath at about 230 °C; each lead may be dipped up to its full length. A flux of the quality of Super-Safe is recommended; after tinning, surplus flux should be rinsed away in tap water.

GERMANIUM ALLOY DIFFUSED TRANSISTORS

P-N-P transistors in TO-7 metal envelopes with the shield lead connected to the case.

RATING (Limiting value according to the Absolute Maximum System as defined in IEC publication 134).

Total power dissipation up to $T_{amb} = 45\text{ }^{\circ}\text{C}$ P_{tot} max. 75 mW

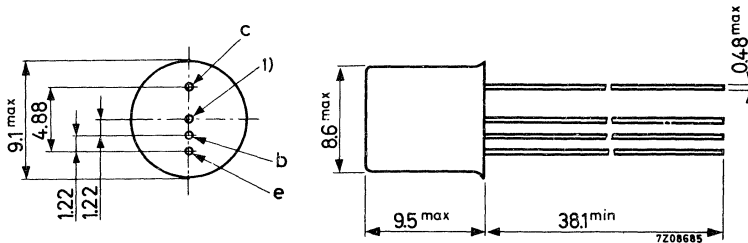
THERMAL RESISTANCE

From junction to ambient in free air $R_{th\ j-a} = 0.6\text{ }^{\circ}\text{C/mW}$

MECHANICAL DATA

Dimensions in mm

TO-7



l) = shield lead (connected to case)

 THE AF114 TO 117 HAVE BEEN SUPERSEDED BY THE AF124 TO 127 (SAME CRYSTAL IN TO-72 ENVELOPE). FOR DATA AND CURVES REFER TO THE LATTER.

ALLOY-DIFFUSED GERMANIUM TRANSISTOR

P-N-P transistor in a TO-7 metal envelope with a shield lead connected to the case. The transistor is intended for medium power, high voltage and high frequency applications.

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

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	70 V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	20 V
Collector-emitter voltage $R_B/R_E < 0.1$	$-V_{CEX}$	max.	70 V
Collector current (d.c.)	$-I_C$	max.	30 mA
Base current	$-I_B$	max.	3 mA
Reverse base current	I_B	max.	1 mA
Total power dissipation up to $T_{amb} = 45^\circ C$ with cooling fin 56207	P_{tot}	max.	375 mW
Storage temperature	T_{stg}		- 55 to +75 °C
Junction temperature: continuous	T_j	max.	75 °C
incidentally	T_j	max.	90 °C

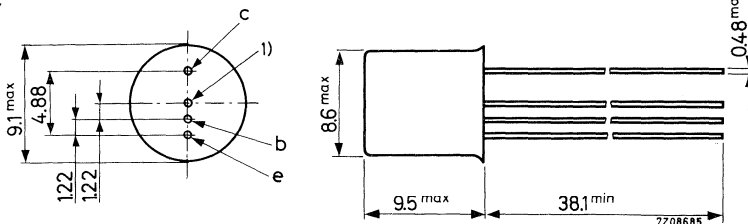
THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	0.25 °C/mW
From junction to ambient with cooling fin	$R_{th\ j-a}$	=	0.12 °C/mW

MECHANICAL DATA

Dimensions in mm

TO-7



l) = shield lead (connected to case)

Accessory available: 56207

FOR NEW DESIGN THE SUCCESSOR TYPES BF336 to 338
(N-P-N) ARE RECOMMENDED

CHARACTERISTICS

T_{amb} 25 °C unless otherwise specified

Collector cut-off current

$I_E = 0; -V_{CB} = 70 \text{ V}$	$-I_{CBO}$	<	60 μA
$I_E = 0; -V_{CB} = 70 \text{ V}; T_j = 90 \text{ }^\circ\text{C}$	$-I_{CBO}$	<	1.6 mA

Base current

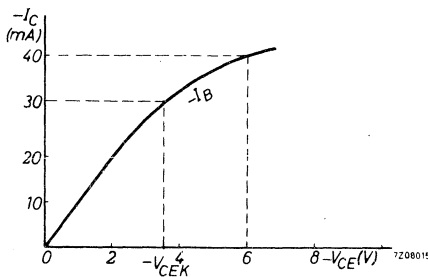
$-I_C = 10 \text{ mA}; -V_{CE} = 2 \text{ V}$	$-I_B$	typ.	55 μA
		<	275 μA

Base-emitter voltage

$-I_C = 10 \text{ mA}; -V_{CE} = 2 \text{ V}$	$-V_{BE}$	<	375 mV
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Knee voltage

$-I_C = 30 \text{ mA}; -I_B = \text{value for which}$		typ.	3.5 V
$-I_C = 40 \text{ mA at } -V_{CE} = 6 \text{ V}$	$-V_{CEK}$	<	5 V



Feedback capacitance at $f = 10.7 \text{ MHz}$

$-I_C = 10 \text{ mA}; -V_{CE} = 6 \text{ V}$	$-C_{re}$	typ.	1.8 pF
		<	2.3 pF

Frequency at which $|h_{fe}| = 1$

$I_E = 10 \text{ mA}; -V_{CB} = 6 \text{ V}$	f_1	>	125 MHz
		typ.	175 MHz

Feedback impedance at $f = 2 \text{ MHz}$

$I_E = 10 \text{ mA}; -V_{CB} = 6 \text{ V}$	$ z_{rb} $	typ.	30 Ω
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Transfer admittance at $f = 10.7 \text{ MHz}$

$-I_C = 10 \text{ mA}; -V_{CE} = 6 \text{ V}$	$ y_{fe} $	>	100 mA/V
		typ.	130 mA/V

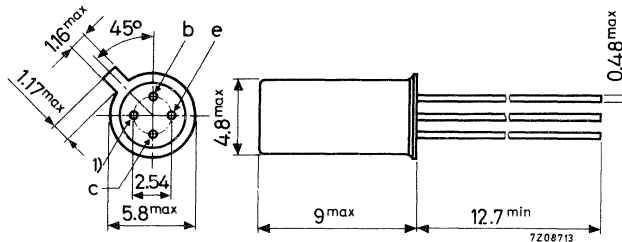
R.F. GERMANIUM ALLOY-DIFFUSED TRANSISTOR

P-N-P transistor in a metal envelope with insulated leads and a shield lead connected to the case. It is intended for application at frequencies up to 100 MHz.

QUICK REFERENCE DATA			
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	25 V
Collector-emitter voltage $R_B/R_E < 100$; $R_E > 200 \Omega$	$-V_{CER}$	max.	25 V
Collector current (peak value)	$-I_{CM}$	max.	15 mA
Total power dissipation up to $T_{amb} = 45^\circ C$	P_{tot}	max.	140 mW
Junction temperature, incidentally	T_j	max.	$90^\circ C$
Feedback capacitance at $f = 0.45$ MHz $-I_C = 1$ mA; $-V_{CE} = 10$ V	$-C_{re}$	typ.	450 fF
Transition frequency $-I_C = 3$ mA; $-V_{CE} = 10$ V	f_T	typ.	270 MHz
Transfer admittance at $f = 35$ MHz $-I_C = 3$ mA; $-V_{CE} = 10$ V	$ y_{fe} $	typ.	80 mA/V

MECHANICAL DATA

Dimensions in mm



1) = shield lead (connected to case)

Accessories available: 56246, 56263

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)VoltagesCollector-base voltage (open emitter) $-V_{CBO}$ max. 25 VCollector-emitter voltage
 $R_B/R_E < 100$; $R_E > 200 \Omega$ $-V_{CER}$ max. 25 VCurrentsCollector current (d. c.) $-I_C$ max. 10 mACollector current (peak value) $-I_{CM}$ max. 15 mAReverse emitter current $-I_E$ max. 1 mAPower dissipationTotal power dissipation up to $T_{amb} = 45 \text{ }^{\circ}\text{C}$
with cooling clip 56263 P_{tot} max. 140 mWTemperaturesStorage temperature T_{stg} -55 to +75 $^{\circ}\text{C}$ Junction temperature: continuous T_j max. 75 $^{\circ}\text{C}$ incidentally T_j max. 90 $^{\circ}\text{C}$ **THERMAL RESISTANCE**From junction to ambient in free air $R_{th \text{ j-a}}$ = 0.45 $^{\circ}\text{C}/\text{mW}$ From junction to case $R_{th \text{ j-c}}$ = 0.22 $^{\circ}\text{C}/\text{mW}$ From junction to ambient with cooling
clip 56263 $R_{th \text{ j-a}}$ = 0.32 $^{\circ}\text{C}/\text{mW}$

CHARACTERISTICS

$T_{amb} = 25\text{ }^{\circ}\text{C}$ unless otherwise specified

Collector cut-off current

$I_E = 0; -V_{CB} = 10\text{ V}$	$-I_{CBO}$	typ. <	1.2 μA 8 μA
$I_E = 0; -V_{CB} = 10\text{ V}; T_j = 75\text{ }^{\circ}\text{C}$	$-I_{CBO}$	<	150 μA

Base current

$-I_C = 3\text{ mA}; -V_{CE} = 10\text{ V}$	$-I_B$	typ. <	40 μA 100 μA
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Base-emitter voltage

$-I_C = 3\text{ mA}; -V_{CE} = 10\text{ V}$	$-V_{BE}$	typ.	320 mV 280 to 380 mV
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Feedback capacitance at $f = 0.45\text{ MHz}$

$-I_C = 1\text{ mA}; -V_{CE} = 10\text{ V}$	$-C_{re}$	typ.	450 fF ¹⁾ 250 to 650 fF ¹⁾
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Transition frequency

$-I_C = 3\text{ mA}; -V_{CE} = 10\text{ V}$	f_T	typ.	270 MHz
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Noise figure at $f = 100\text{ MHz}$ ²⁾

$I_E = 2\text{ mA}; -V_{CB} = 5\text{ V}$	F	typ. <	4.5 dB 6 dB
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y parameters at $f = 0.45\text{ MHz}$ (common emitter) ³⁾

$-I_C = 2\text{ mA}; -V_{CE} = 5\text{ V}$			
Input conductance	g_{ie}	typ.	0.8 mA/V
Input capacitance	C_{ie}	typ.	45 pF
Feedback admittance	$ y_{re} $	typ.	1.7 $\mu\text{A/V}$
Phase angle of feedback admittance	φ_{re}	typ.	270°
Transfer admittance	$ y_{fe} $	typ.	73 mA/V
Phase angle of transfer admittance	φ_{fe}	typ.	0
Output conductance	g_{oe}	typ.	0.8 $\mu\text{A/V}$
Output capacitance	C_{oe}	typ.	2.7 pF

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

2) To obtain minimum noise figure the terminating admittance at the input of the transistor shall be $Y_S = (11-6j)\text{ mA/V}$

3) Length of leads between bottom of transistor and measuring jig is 5 mm

CHARACTERISTICS (continued)

 $T_{amb} = 25^{\circ}\text{C}$ y parameters at $f = 5.5\text{ MHz}$ (common emitter) ¹⁾ $-I_C = 2\text{ mA}; -V_{CE} = 5\text{ V}$

Input conductance	g_{ie}	typ.	1.0 mA/V
Input capacitance	C_{ie}	typ.	45 pF
Feedback admittance	$ y_{re} $	typ.	21 $\mu\text{A/V}$
Phase angle of feedback admittance	φ_{re}	typ.	270°
Transfer admittance	$ y_{fe} $	typ.	71 mA/V
Phase angle of transfer admittance	φ_{fe}	typ.	350°
Output conductance	g_{oe}	typ.	5 $\mu\text{A/V}$
Output capacitance	C_{oe}	typ.	2.6 pF

y parameters at $f = 10.7\text{ MHz}$ (common emitter) ¹⁾ $-I_C = 2\text{ mA}; -V_{CE} = 5\text{ V}$

Input conductance	g_{ie}	typ.	1.3 mA/V
Input capacitance	C_{ie}	typ.	45 pF
Feedback admittance	$ y_{re} $	typ.	40 $\mu\text{A/V}$
Phase angle of feedback admittance	φ_{re}	typ.	270°
Transfer admittance	$ y_{fe} $	typ.	70 mA/V
Phase angle of transfer admittance	φ_{fe}	typ.	347°
Output conductance	g_{oe}	typ.	13 $\mu\text{A/V}$
Output capacitance	C_{oe}	typ.	2.5 pF

y parameters at $f = 35\text{ MHz}$ (common emitter) ¹⁾ $-I_C = 3\text{ mA}; -V_{CE} = 10\text{ V}$

Input conductance	g_{ie}	typ.	6.5 mA/V
Input capacitance	C_{ie}	typ.	35 pF
Feedback admittance	$ y_{re} $	typ.	100 $\mu\text{A/V}$
Phase angle of feedback admittance	φ_{re}	typ.	260°
Transfer admittance	$ y_{fe} $	typ.	80 mA/V
Phase angle of transfer admittance	φ_{fe}	typ.	322°
Output conductance	g_{oe}	typ.	100 $\mu\text{A/V}$
Output capacitance	C_{oe}	typ.	1.8 pF

1) Length of leads between bottom of transistor and measuring jig is 5 mm.

CHARACTERISTICS (continued)

T_{amb} = 25 °C

y parameters at f = 100 MHz (common base)¹⁾

I_E = 2 mA; -V_{CB} = 5 V

Input conductance	g _{ib}	typ.	32 mA/V
Input capacitance	-C _{ib}	typ.	35 pF
Feedback admittance	y _{rb}	typ.	320 μA/V
Phase angle of feedback admittance	φ _{rb}	typ.	240°
Transfer admittance	y _{fb}	typ.	34 mA/V
Phase angle of transfer admittance	φ _{fb}	typ.	110°
Output conductance	g _{ob}	typ.	250 μA/V
Output capacitance	C _{ob}	typ.	1.6 pF

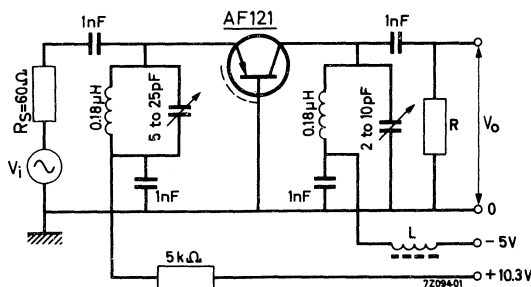
Transducer gain

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

I_E = 2 mA; -V_{CB} = 5 V; f = 100 MHz

G_{tr} > typ. 17 dB
 typ. 19 dB

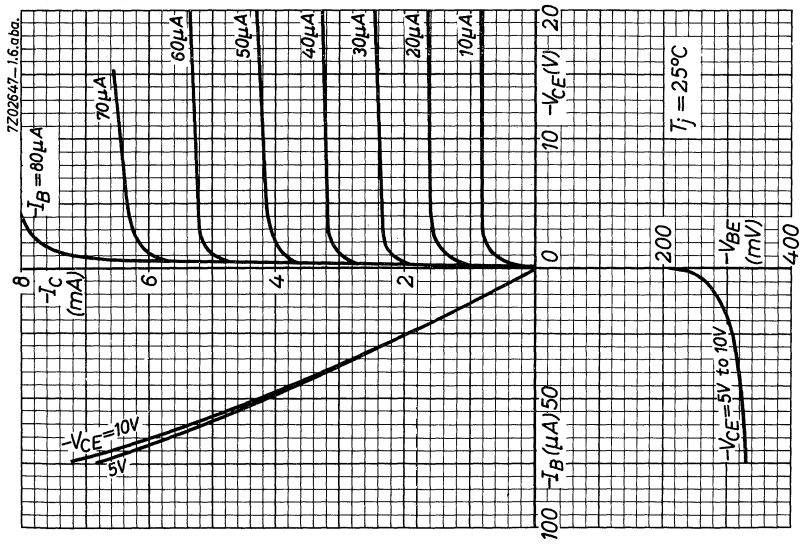
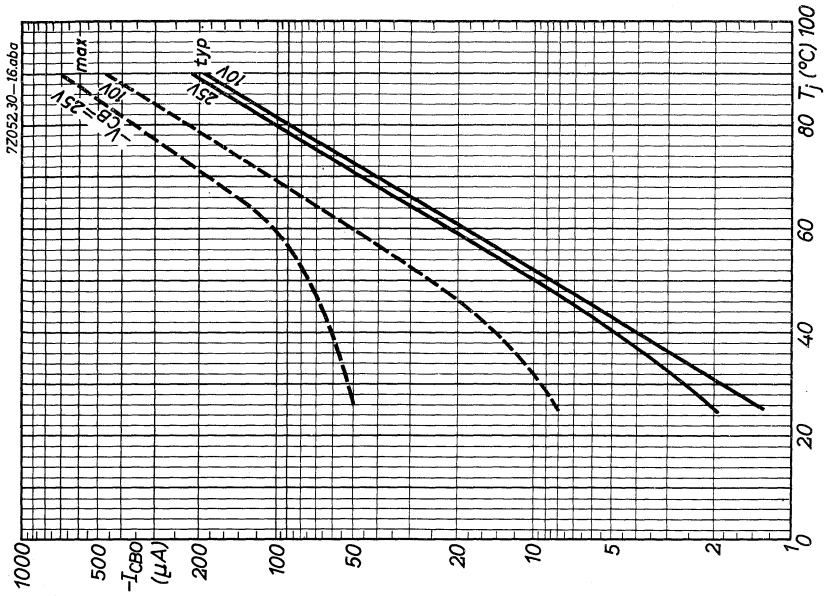
Basic circuit for measuring the transducer gain



The resistor R is chosen such that the total load, consisting of R and the tuned circuit in parallel, R_L = 3.3 kΩ

L is a ferrite wide-band choke

¹⁾ Length of leads between bottom of transistor and measuring jig is 5 mm.



GERMANIUM ALLOY DIFFUSED TRANSISTOR

P-N-P transistor in a TO-72 metal envelope with a shield lead connected to the case. It has low noise and high power gain up to frequencies of 100 MHz and is intended for use as r.f. amplifier in f.m. receivers.

RATINGS (Limiting values)¹⁾

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	32 V
Collector-emitter voltage ($Z_B/Z_E < 15$)	$-V_{CER}$	max.	32 V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	15 V
Collector current (d.c.)	$-I_C$	max.	10 mA
Base current (d.c.)	$ I_B $	max.	1 mA
Reverse emitter current	$-I_E$	max.	1 mA
Total power dissipation up to $T_{amb} = 45^\circ C$	P_{tot}	max.	60 mW
Storage temperature	T_{stg}		-55 to $+75^\circ C$
Junction temperature: continuous	T_j	max.	$75^\circ C$
incidentally	T_j	max.	$90^\circ C$

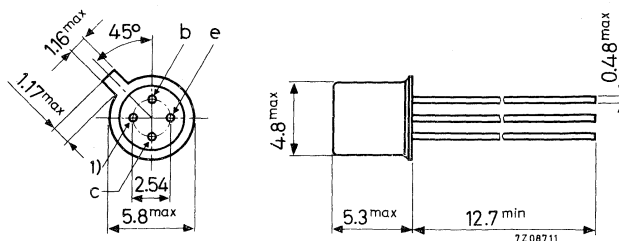
THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	$0.75^\circ C/mW$
From junction to case	$R_{th\ j-c}$	=	$0.4^\circ C/mW$

MECHANICAL DATA

Dimensions in mm

TO-72



1) = shield lead (connected to case)

Accessories available: 56246, 56263

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

CHARACTERISTICS

$T_{amb} = 25\text{ }^{\circ}\text{C}$ unless otherwise specified

Collector cut-off current

$$I_E = 0; -V_{CB} = 6\text{ V}$$

$$-I_{CBO} \begin{array}{l} \text{typ. } 1.2\ \mu\text{A} \\ < 8\ \mu\text{A} \end{array}$$

$$I_E = 0; -V_{CB} = 6\text{ V}; T_j = 75\text{ }^{\circ}\text{C}$$

$$-I_{CBO} \begin{array}{l} \text{typ. } 90\ \mu\text{A} \\ < 180\ \mu\text{A} \end{array}$$

Base current

$$I_E = 1\text{ mA}; -V_{CB} = 6\text{ V}$$

$$-I_B \begin{array}{l} \text{typ. } 7\ \mu\text{A} \\ < 25\ \mu\text{A} \end{array}$$

Base-emitter voltage

$$-I_C = 1\text{ mA}; -V_{CE} = 6\text{ V}$$

$$-V_{BE} \begin{array}{l} \text{typ. } 270\ \text{mV} \\ 210\text{ to } 330\ \text{mV} \end{array}$$

Small signal current gain at $f = 1\text{ kHz}$

$$-I_C = 1\text{ mA}; -V_{CE} = 6\text{ V}$$

$$h_{fe} \begin{array}{l} \text{typ. } 150 \end{array}$$

Feedback capacitance at $f = 450\text{ kHz}$

$$-I_C = 1\text{ mA}; -V_{CE} = 6\text{ V}$$

$$-C_{re} \begin{array}{l} \text{typ. } 1.5\ \text{pF} \end{array}$$

y parameters at $f = 100\text{ MHz}$ (common base)

$$I_E = 1\text{ mA}; -V_{CB} = 6\text{ V } ^1)$$

Input conductance

$$g_{ib} \begin{array}{l} \text{typ. } 15\ \text{m}\Omega^{-1} \end{array}$$

Input capacitance

$$-C_{ib} \begin{array}{l} \text{typ. } 5\ \text{pF} \end{array}$$

Feedback admittance

$$|y_{rb}| \begin{array}{l} \text{typ. } 0.45\ \text{m}\Omega^{-1} \end{array}$$

Phase angle of feedback admittance

$$\varphi_{rb} \begin{array}{l} \text{typ. } 250^{\circ} \end{array}$$

Transfer admittance

$$|y_{fb}| \begin{array}{l} \text{typ. } 16\ \text{m}\Omega^{-1} \end{array}$$

Phase angle of transfer admittance

$$\varphi_{fb} \begin{array}{l} \text{typ. } 95^{\circ} \end{array}$$

Output conductance

$$g_{ob} \begin{array}{l} \text{typ. } 0.3\ \text{m}\Omega^{-1} \end{array}$$

Output capacitance

$$C_{ob} \begin{array}{l} \text{typ. } 2.5\ \text{pF} \end{array}$$

Feedback impedance at $f = 2\text{ MHz}$

$$I_E = 1\text{ mA}; -V_{CB} = 6\text{ V}$$

$$|z_{rb}| \begin{array}{l} \text{typ. } 20\ \Omega \end{array}$$

¹⁾ Length of leads between transistor bottom and measuring jig: 5 mm

CHARACTERISTICS (continued)

$T_{amb} = 25\text{ }^{\circ}\text{C}$ unless otherwise specified

Transition frequency

$I_E = 1\text{ mA}; -V_{CB} = 6\text{ V}$ f_T typ. 75 MHz

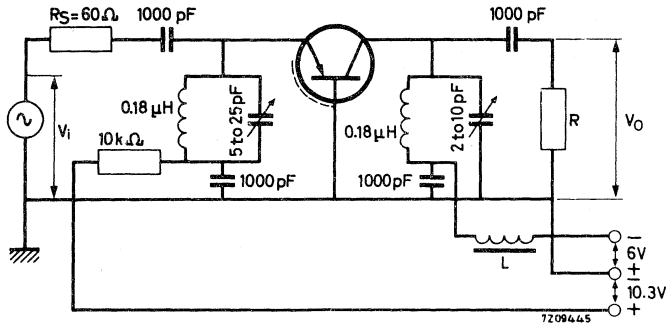
Noise figure at $f = 100\text{ MHz}$

$I_E = 1\text{ mA}; -V_{CB} = 6\text{ V}; R_S = 60\text{ }\Omega$ F typ. 8 dB
< 9.5 dB

Power gain at $f = 100\text{ MHz}$

$G_p = \frac{V_o^2}{V_i^2} \cdot \frac{4 R_S}{R_l} = 0.073 \frac{V_o^2}{V_i^2}$ G_p > 12.5 dB
typ. 14 dB

Test circuit

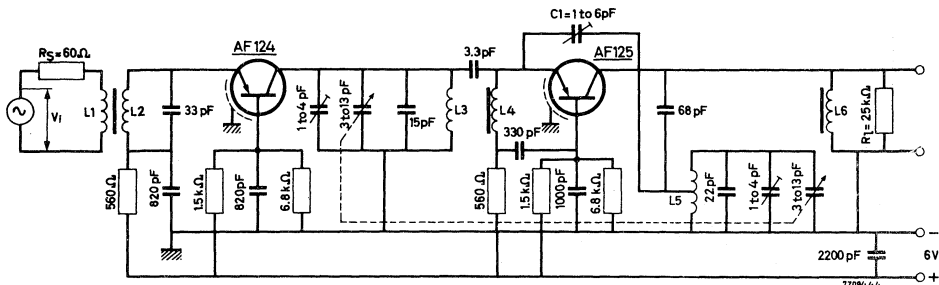


R is chosen such that the total load impedance R_l consisting of R and the tuned circuit in parallel is $3.3\text{ k}\Omega$.

L = ferrite bead

APPLICATION INFORMATION

Front-end unit of a f.m. tuner

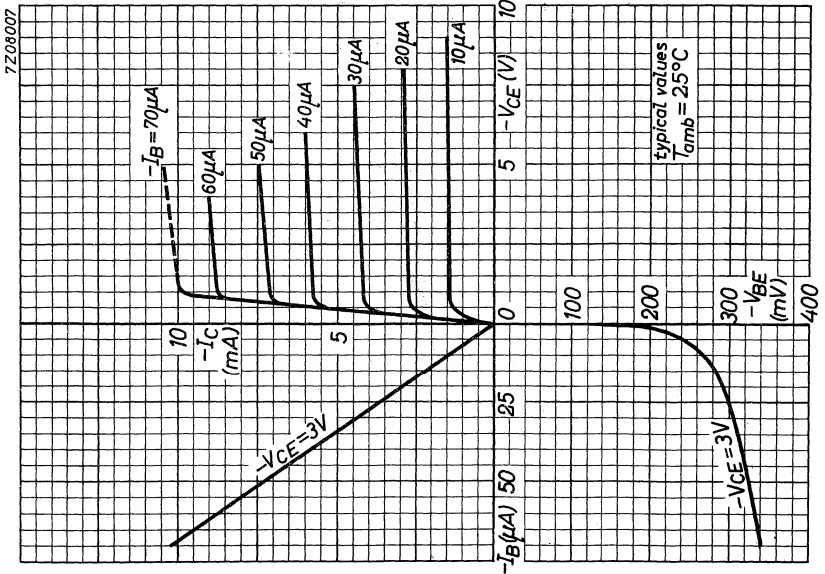
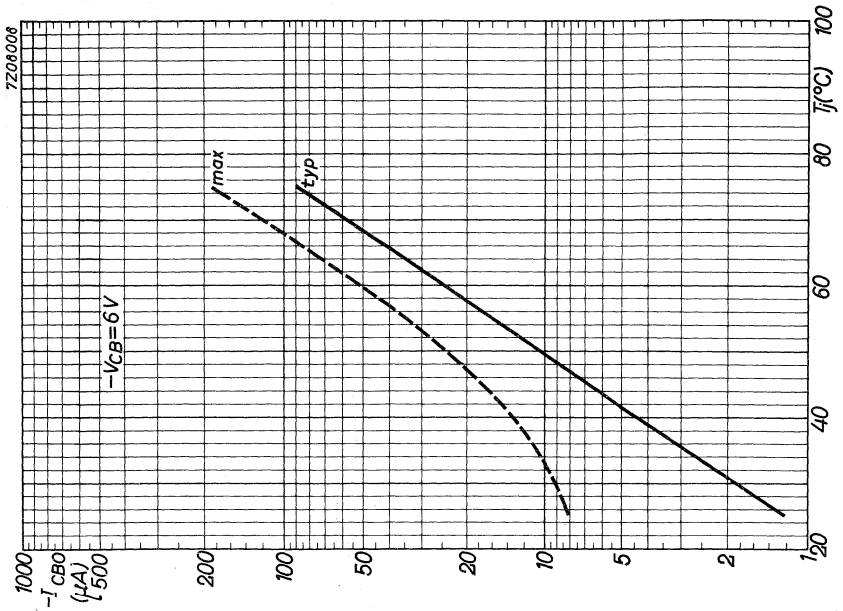


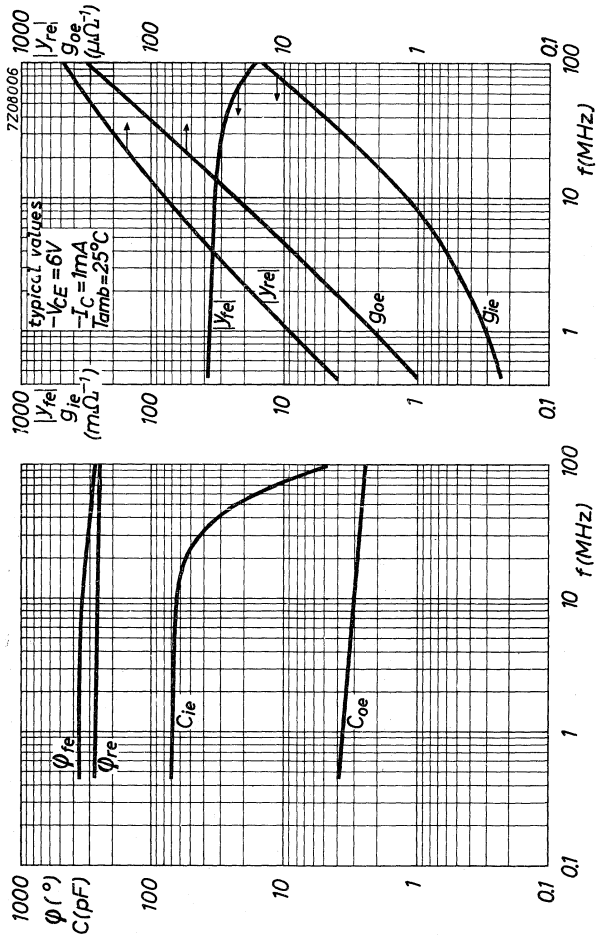
The oscillator voltage at the emitter of the AF 125 should be adjusted to 80 mV by means of C1 at a battery voltage $V_S = 4$ V

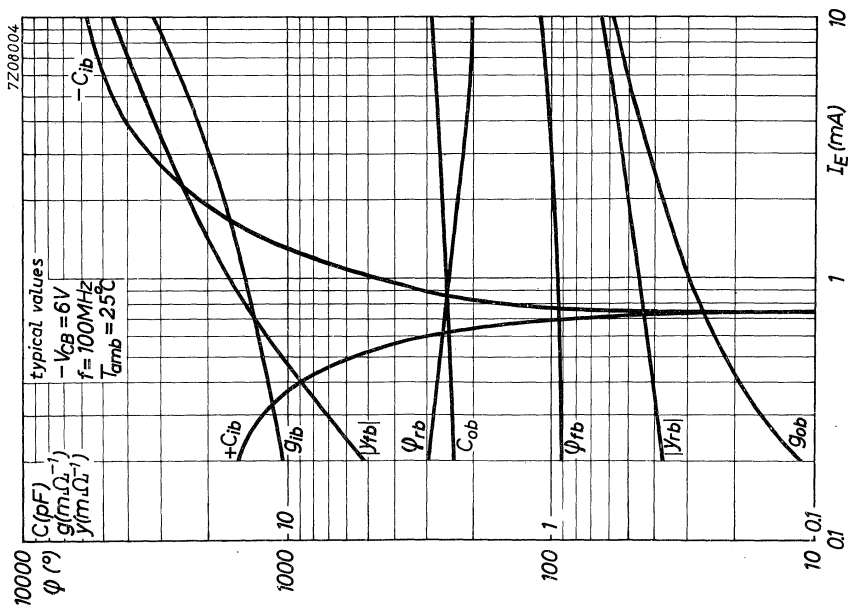
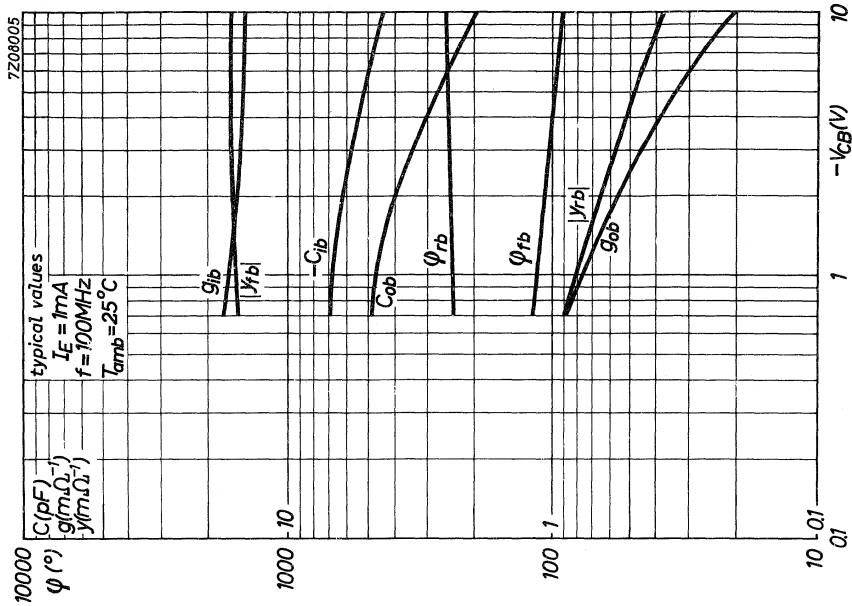
- L1 = 4.5 turns enamelled Cu wire (0.3 mm), wound between L₂.
- L2 = 4 turns enamelled Cu wire (1 mm), winding pitch 2 mm, inductance 0.18 μ H, unloaded Q-factor 60 to 80.
- L3 = 3.25 turns silvered Cu wire (1 mm), winding pitch 2 mm, inductance 0.086 μ H, unloaded Q-factor 200.
- L4 = 6 turns enamelled Cu wire (0.5 mm), closely wound, inductance 0.65 μ H.
- L5 = 2.5 turns silvered Cu wire (1 mm), winding pitch 2 mm, inductance 0.062 μ H, unloaded Q-factor > 200; tap at 1.125 turns from earth.
- L6 = 18 turns enamelled Cu wire (36 x 0.03), soldering graded, stranded, open covered, closely wound; inductance 2.9 μ H; unloaded Q-factor 120; loaded Q-factor with 25 k Ω : 60.

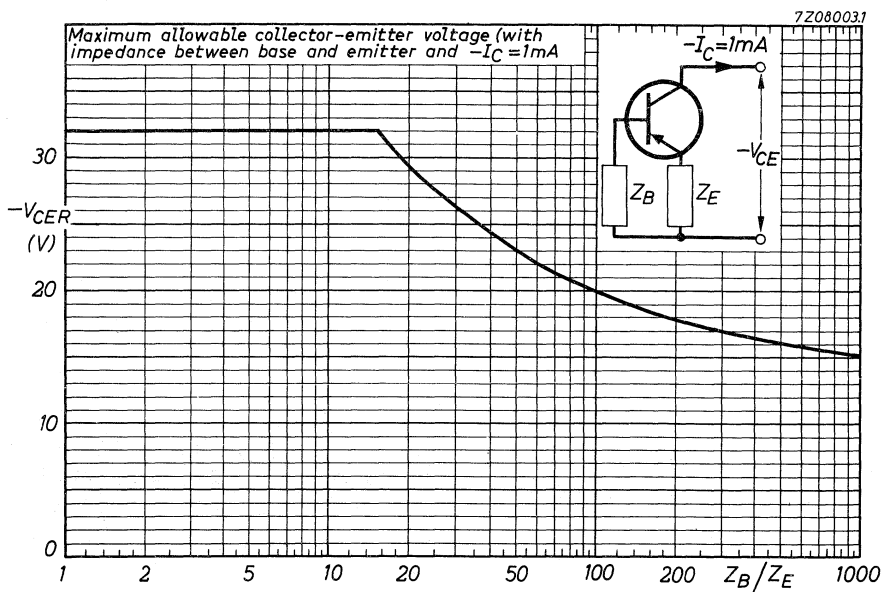
Frequency range	f	87 to 101 MHz
Collector current AF124	$-I_C$	1.4 mA
	$-I_C$	1.5 mA
Total power gain	G_p	> 24 dB
		typ. 28 dB
Noise figure	F	typ. 8 dB
		< 9.5 dB
Oscillator voltage at aerial terminals		typ. 1.5 mV
Image rejection		typ. 27 dB

The shift of the oscillator frequency as a function of the battery voltage is about 50 kHz from 6 to 5 V and about 100 kHz from 5 to 4 V.









GERMANIUM ALLOY DIFFUSED TRANSISTOR

P-N-P transistor in a TO-72 metal envelope with a shield lead connected to the case. It has a high conversion gain up to frequencies of 100 MHz and is intended for use as r.f. amplifiers and mixer-oscillator in short-wave receivers up to 27 MHz.

RATINGS (Limiting values) ¹⁾

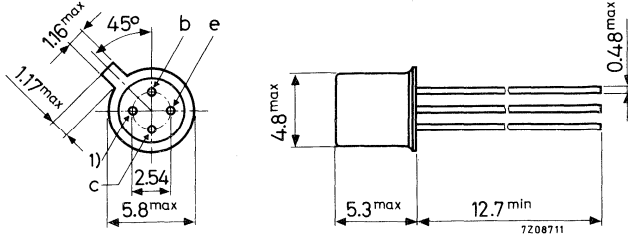
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	32 V
Collector-emitter voltage ($Z_B/Z_E < 15$)	$-V_{CER}$	max.	32 V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	15 V
Collector current (d.c.)	$-I_C$	max.	10 mA
Base current (d.c.)	$ I_B $	max.	1 mA
Reverse emitter current	$-I_E$	max.	1 mA
Total power dissipation up to $T_{amb} = 45^\circ C$	P_{tot}	max.	60 mW
Storage temperature	T_{stg}		-55 to +75 °C
Junction temperature: continuous	T_j	max.	75 °C
		incidentally	max.

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	0.75 °C/mW
From junction to case	$R_{th\ j-c}$	=	0.4 °C/mW

MECHANICAL DATA

TO-72



1) = shield lead (connected to case)

Accessories available: 56246, 56263

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

CHARACTERISTICS

$T_{amb} = 25\text{ }^{\circ}\text{C}$ unless otherwise specified

Collector cut-off current

$I_E = 0; -V_{CB} = 6\text{ V}$

$-I_{CBO}$	typ.	1.2 μA
	<	8 μA

$I_E = 0; -V_{CB} = 6\text{ V}; T_j = 75\text{ }^{\circ}\text{C}$

$-I_{CBO}$	typ.	90 μA
	<	180 μA

Base current

$I_E = 1\text{ mA}; -V_{CB} = 6\text{ V}$

$-I_B$	typ.	7 μA
	<	25 μA

Base-emitter voltage

$-I_C = 1\text{ mA}; -V_{CE} = 6\text{ V}$

$-V_{BE}$	typ.	270 mV
		210 to 330 mV

Small signal current gain at $f = 1\text{ kHz}$

$-I_C = 1\text{ mA}; -V_{CE} = 6\text{ V}$

h_{fe}	typ.	150
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Feedback capacitance at $f = 450\text{ kHz}$

$-I_C = 1\text{ mA}; -V_{CE} = 6\text{ V}$

$-C_{re}$	typ.	1.5 pF
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y parameters ¹⁾

$I_E = 1\text{ mA}; -V_{CB} = 6\text{ V}$ at $f = 100\text{ MHz}$

Input conductance	g_{ib}	typ.	15 $\text{m}\Omega^{-1}$
Input capacitance	$-C_{ib}$	typ.	5 pF
Feedback admittance	$ y_{rb} $	typ.	0.45 $\text{m}\Omega^{-1}$
Phase angle of feedback admittance	φ_{rb}	typ.	250°
Transfer admittance	$ y_{fb} $	typ.	15 $\text{m}\Omega^{-1}$
Phase angle of transfer admittance	φ_{fb}	typ.	95°
Output conductance	g_{ob}	typ.	0.35 $\text{m}\Omega^{-1}$
Output capacitance	C_{ob}	typ.	25 pF

$-I_C = 1\text{ mA}; -V_{CE} = 6\text{ V}$

		$f = 10.7$	0.45 MHz
Input conductance	g_{ie}	typ.	1.3 0.25 $\text{m}\Omega^{-1}$
Input capacitance	C_{ie}	typ.	65 70 pF
Feedback admittance	$ y_{re} $	typ.	80 4 $\mu\Omega^{-1}$
Phase angle of feedback admittance	φ_{re}	typ.	260° 270°
Transfer admittance	$ y_{fe} $	typ.	34 37 $\text{m}\Omega^{-1}$
Phase angle of transfer admittance	φ_{fe}	typ.	335° 0
Output conductance	g_{oe}	typ.	25 1.0 $\mu\Omega^{-1}$
Output capacitance	C_{oe}	typ.	3.0 4 pF

¹⁾ Length of leads between transistor bottom and measuring jig: 5 mm.

CHARACTERISTICS (continued)

$T_{amb} = 25\text{ }^{\circ}\text{C}$ unless otherwise specified

Feedback impedance at $f = 2\text{ MHz}$

$I_E = 1\text{ mA}; -V_{CB} = 6\text{ V}$ $|z_{rb}|$ typ. 25 Ω

Transition frequency

$I_E = 1\text{ mA}; -V_{CB} = 6\text{ V}$ f_T typ. 75 MHz

Noise figure at $I_E = 1\text{ mA}; -V_{CB} = 6\text{ V}$

$R_S = 60\ \Omega; f = 100\text{ MHz}$ F typ. 9.5 dB

$R_S = 200\ \Omega; f = 10.7\text{ MHz}$ F typ. 3.0 dB

$R_S = 500\ \Omega; f = 1\text{ MHz}$ F typ. 1.5 dB
< 3 dB

Conversion noise figure at $I_E = 1\text{ mA}; -V_{CB} = 6\text{ V}$

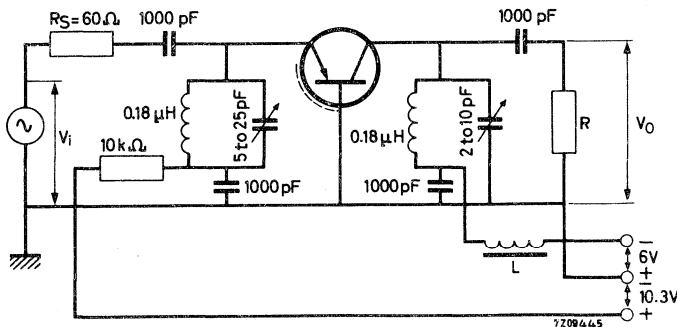
$R_S = 500\ \Omega; f = 1\text{ MHz}$ F_C typ. 3 dB
< 5 dB

$R_S = 2\text{ k}\Omega; f = 200\text{ kHz}$ F_C typ. 4 dB
< 7 dB

Power gain at $f = 100\text{ MHz}$

$G_p = \frac{V_o^2}{V_i^2} \cdot \frac{4R_S}{R_\ell} = 0.073 \frac{V_o^2}{V_i^2}$ G_p > 10 dB
typ. 13 dB

Test circuit:

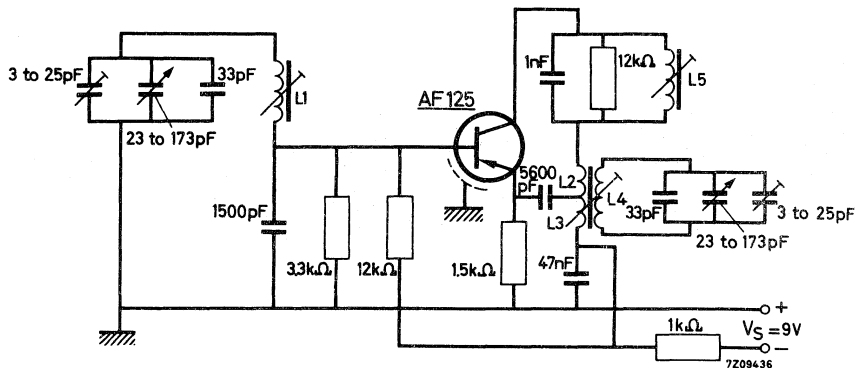


R is chosen such that the total load impedance R_ℓ consisting of R and the tuned circuit in parallel is 3.3 k Ω .

L = ferrite bead

APPLICATION INFORMATION

1. Front-end unit of a f.m. tuner see AF124
2. Self-oscillating mixer stage (15.1 to 26.1 MHz)



L_1 = 5.5 turns enamelled Cu wire (0.25 mm), closely wound on coil former with diameter of 7 mm; inductance $0.59 \mu\text{H}$; unloaded Q-factor 100 at $f = 15 \text{ MHz}$ and 115 at $f = 26 \text{ MHz}$.

L_2 = 1.25 turns enamelled Cu wire (0.25 mm), wound in L_4 at earth side.

L_3 = 1 turn enamelled Cu wire (0.25 mm), wound in L_4 at earth side.

L_4 = 6.5 turns enamelled Cu wire (0.9 mm), closely wound on coil former with diameter of 7 mm; inductance $0.46 \mu\text{H}$; unloaded Q-factor 110 at $f = 15 \text{ MHz}$ and $f = 26 \text{ MHz}$

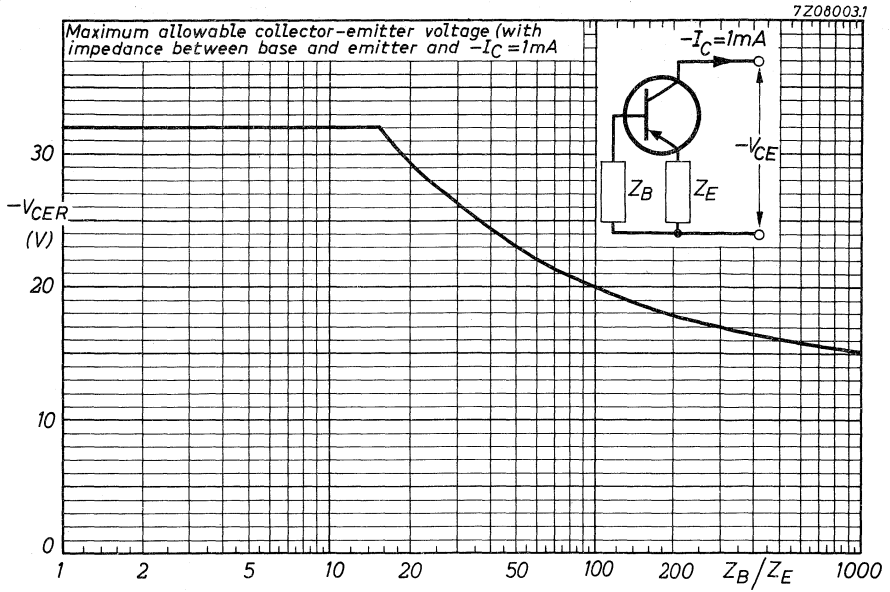
L_5 = Inductance $125 \mu\text{H}$; unloaded Q-factor 140.

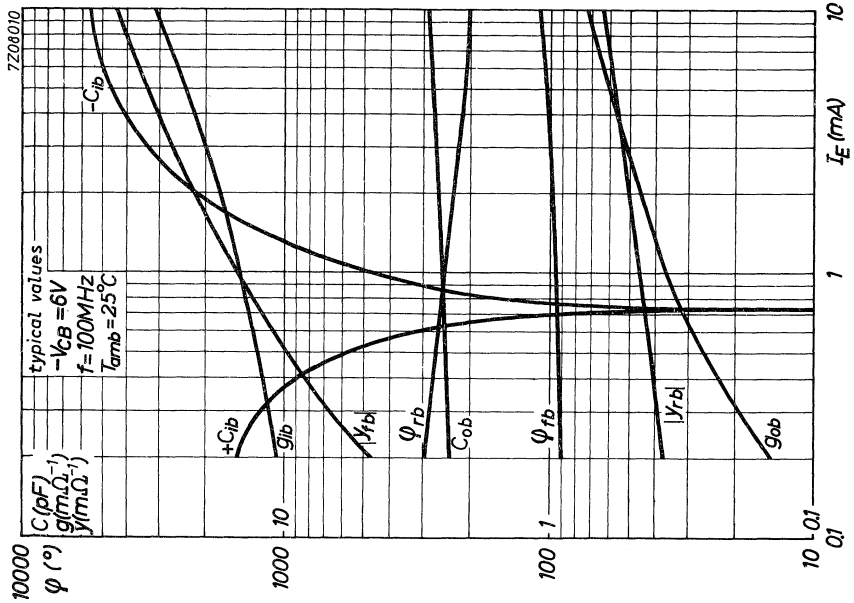
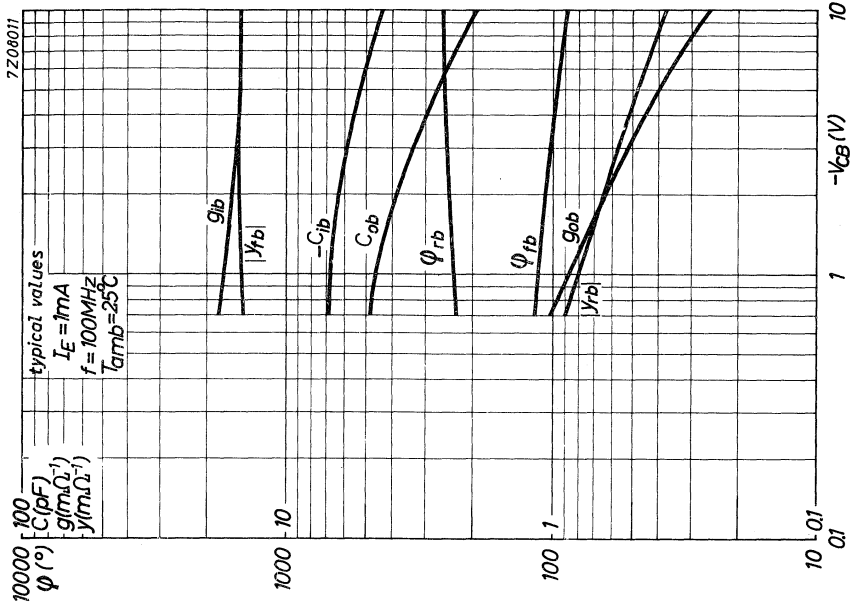
Battery voltage	V_S	=	9 V
Collector-emitter voltage	$-V_{CE}$	=	6 V
Emitter current	I_E	=	1 mA

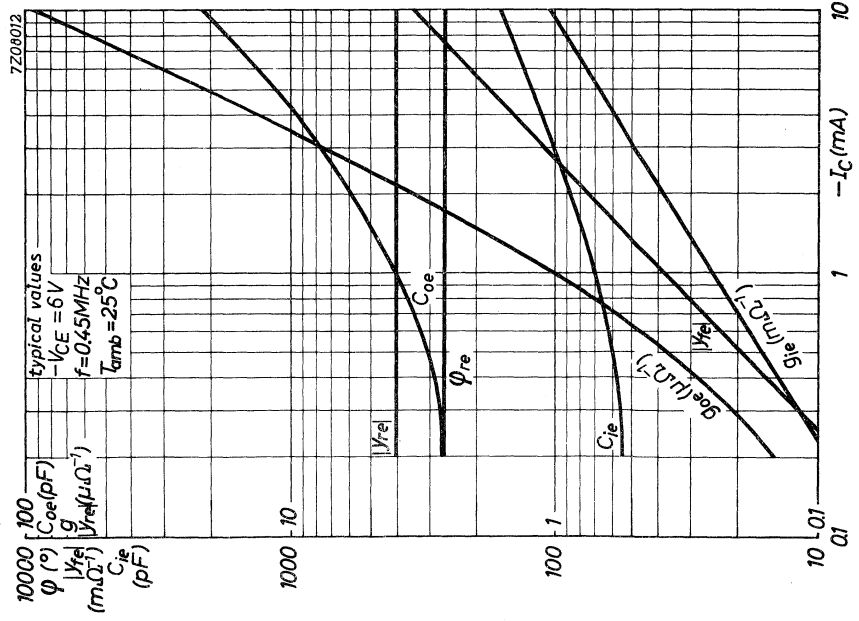
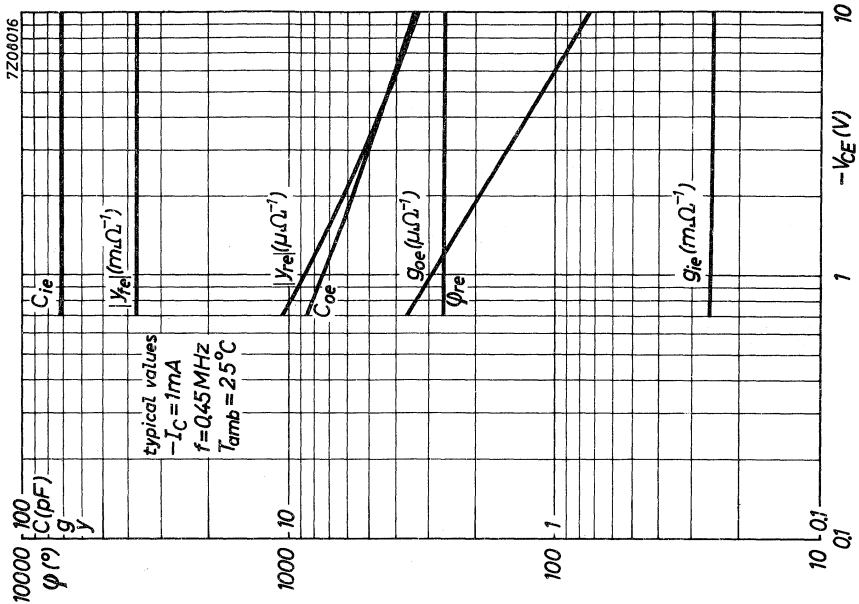
	$f = 15$	20	26 MHz
Oscillator voltage between emitter and earth	V_{osc} typ. 0.11	0.14	0.15 V

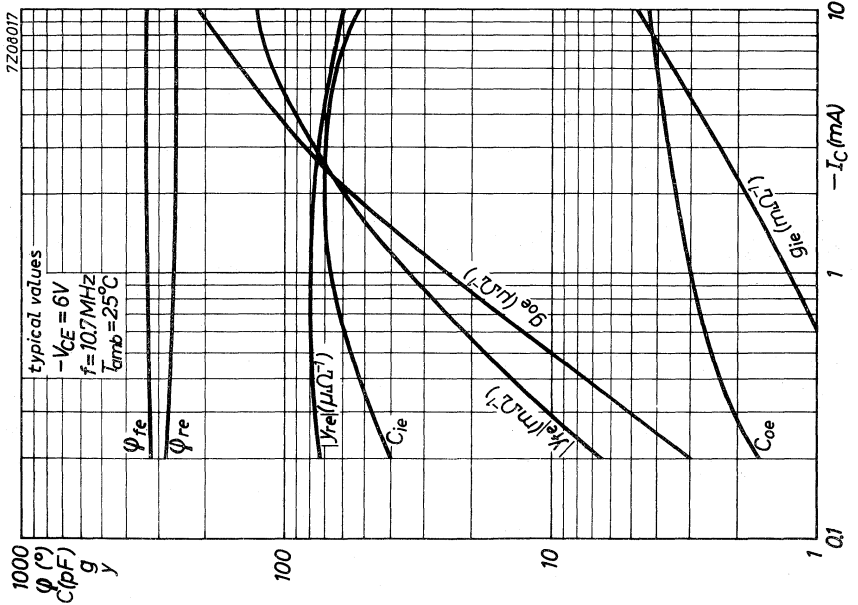
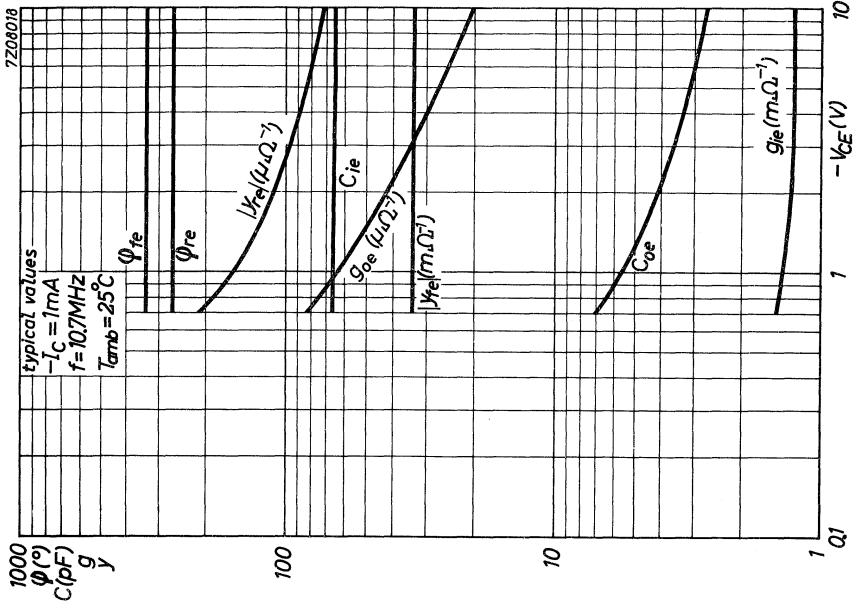
Frequency shift by a battery voltage variation from 9 to 6 V	Δf_{osc} typ. 3	2	10 kHz
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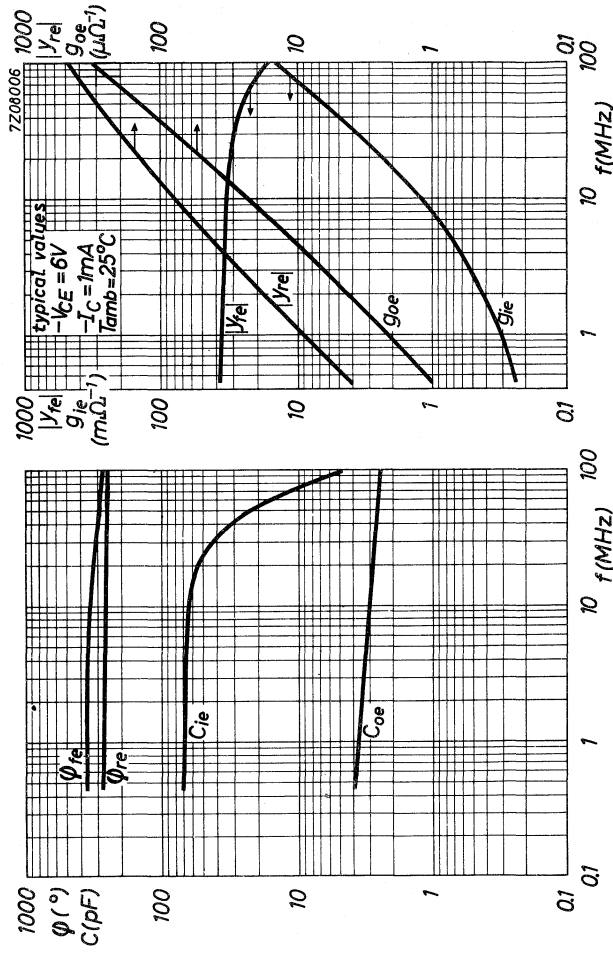
Conversion gain, defined as the ratio between the i.f. power in a $10 \text{ k}\Omega$ load (the total i.f. impedance in the collector circuit) and the available r.f. power in the aerial circuit	$\frac{P_o}{P_i}$ typ. 26	23	20 dB
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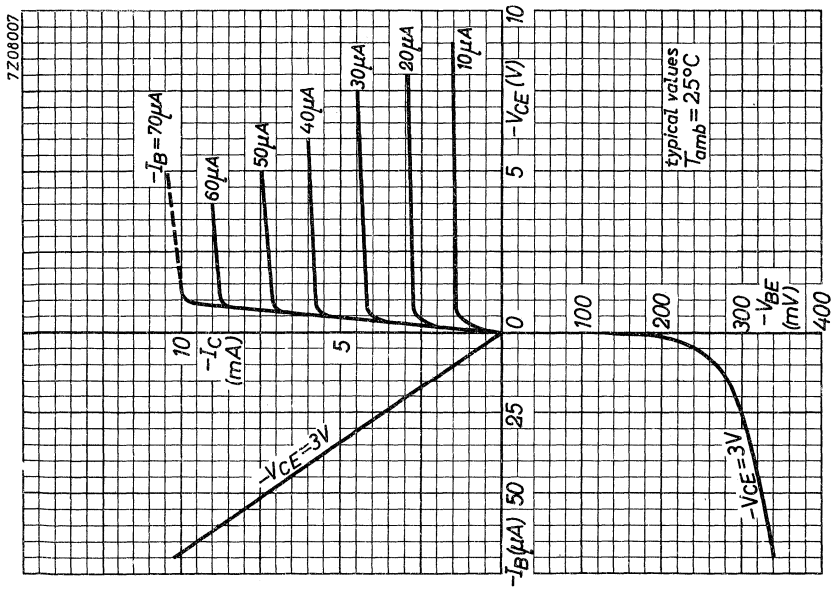
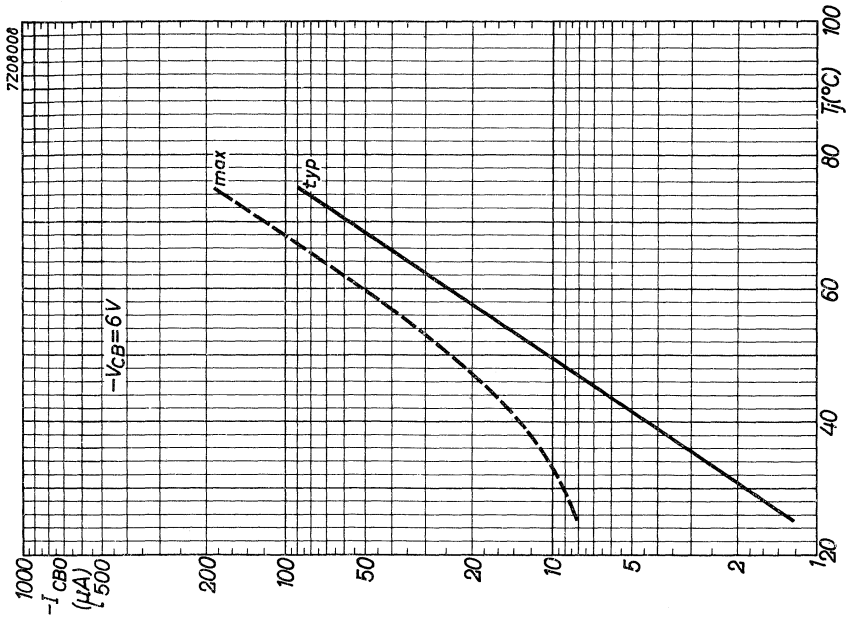












GERMANIUM ALLOY DIFFUSED TRANSISTOR

P-N-P transistor in a TO-72 metal envelope with a shield lead connected to the case. It has low output conductance and low collector capacitance at 10.7 MHz and low noise and good a.g.c. performance for use as i.f. amplifier in a.m. and f.m. receivers and as amplifier and mixer-oscillator in short-wave receivers up to 16 MHz.

RATINGS (Limiting values)¹⁾

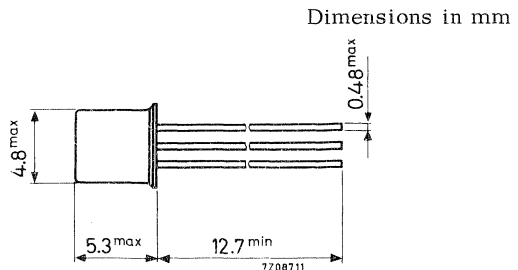
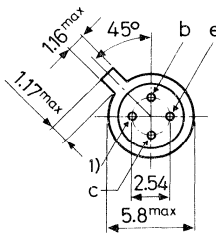
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	32 V
Collector-emitter voltage ($Z_B/Z_E < 15$)	$-V_{CER}$	max.	32 V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	15 V
Collector current (d.c.)	$-I_C$	max.	10 mA
Base current (d.c.)	$ I_B $	max.	1 mA
Reverse emitter current	$-I_E$	max.	1 mA
Total power dissipation up to $T_{amb} = 45^\circ C$	P_{tot}	max.	60 mW
Storage temperature	T_{stg}		-55 to +75 °C
Junction temperature : continuous	T_j	max.	75 °C
	T_j	max.	90 °C
incidentally			

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th j-a}$	=	0.75 °C/mW
From junction to case	$R_{th j-c}$	=	0.4 °C/mW

MECHANICAL DATA

TO-72



Dimensions in mm

1) = shield lead (connected to case)

Accessories available: 56246, 56263

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

CHARACTERISTICS

$T_{amb} = 25\text{ }^{\circ}\text{C}$ unless otherwise specified

Collector cut-off current

$I_E = 0; -V_{CB} = 6\text{ V}$

$-I_{CBO}$ typ. 1.2 μA
< 8 μA

$I_E = 0; -V_{CB} = 6\text{ V}; T_j = 75\text{ }^{\circ}\text{C}$

$-I_{CBO}$ typ. 90 μA
< 180 μA

Base current

$I_E = 1\text{ mA}; -V_{CB} = 6\text{ V}$

$-I_B$ typ. 7 μA
< 25 μA

Base-emitter voltage

$-I_C = 1\text{ mA}; -V_{CE} = 6\text{ V}$

$-V_{BE}$ typ. 270 mV
210 to 330 mV

Small signal current gain at $f = 1\text{ kHz}$

$-I_C = 1\text{ mA}; -V_{CE} = 6\text{ V}$

h_{fe} typ. 150

Feedback capacitance at $f = 450\text{ kHz}$

$-I_C = 1\text{ mA}; -V_{CE} = 6\text{ V}$

$-C_{re}$ typ. 1.5 pF

y parameters (common emitter)

$-I_C = 1\text{ mA}; -V_{CE} = 6\text{ V}^1)$

Input conductance
Input capacitance
Feedback admittance
Phase angle of feedback admittance
Transfer admittance
Phase angle of transfer admittance
Output conductance
Output capacitance

	$f = 10.7 \quad \quad 0.45 \text{ MHz}$	
g_{ie}	typ. 1.7	0.25 $\text{m}\Omega^{-1}$
C_{ie}	typ. 60	70 pF
$ y_{re} $	typ. 100	4.0 $\mu\Omega^{-1}$
φ_{re}	typ. 260°	270°
$ y_{fe} $	typ. 32	37 $\text{m}\Omega^{-1}$
φ_{fe}	typ. 335°	0
g_{oe}	typ. 40	1.0 $\mu\Omega^{-1}$
C_{oe}	typ. 3.5	4.0 pF

Feedback impedance at $f = 2\text{ MHz}$

$I_E = 1\text{ mA}; -V_{CB} = 6\text{ V}$

$|z_{rb}|$ typ. 27 Ω

¹⁾ Length of leads between transistor bottom and measuring jig : 5 mm

CHARACTERISTICS (continued)

$T_{amb} = 25\text{ }^{\circ}\text{C}$ unless otherwise specified

Transition frequency

$I_E = 1\text{ mA}; -V_{CB} = 6\text{ V}$

f_T typ. 75 MHz

Noise figure at $I_E = 1\text{ mA}; -V_{CB} = 6\text{ V}$

$R_S = 60\text{ }\Omega; f = 10.7\text{ MHz}$

F typ. 3.0 dB
< 4.5 dB

$R_S = 500\text{ }\Omega; f = 1\text{ MHz}$

F typ. 1.5 dB
< 3.0 dB

Conversion noise figure

$I_E = 1\text{ mA}; -V_{CB} = 6\text{ V}$

$R_S = 500\text{ }\Omega; f = 1\text{ MHz}$

F_c typ. 3 dB
< 5 dB

$R_S = 2\text{ k}\Omega; f = 200\text{ kHz}$

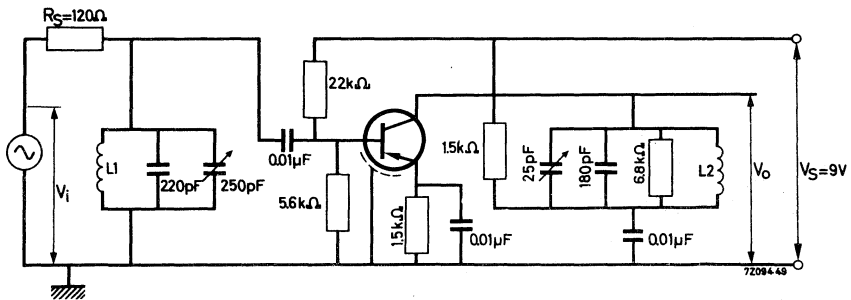
F_c typ. 4 dB
< 7 dB

Power gain at $f = 10.7\text{ MHz}$

$G_p = \frac{V_o^2}{V_i^2} \cdot \frac{4 R_S}{R_1} = 0.1 \frac{V_o^2}{V_i^2}$

G_p > 19 dB
typ. 25 dB

Test circuit:



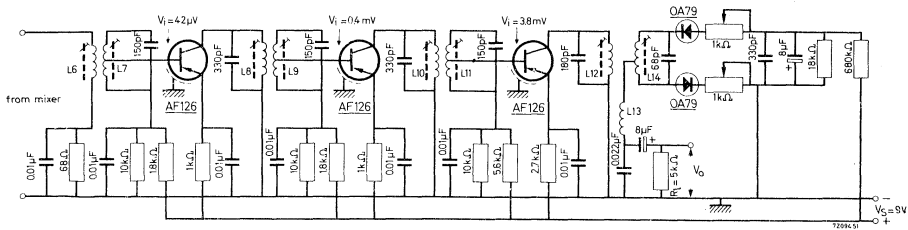
Total collector resistance $R_1 = 4.8\text{ k}\Omega$

$L_1 = 0.5\text{ }\mu\text{H};$ unloaded Q-factor 100

$L_2 = 2.47\text{ }\mu\text{H};$ unloaded Q-factor 100

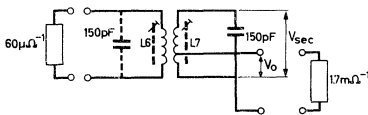
APPLICATION INFORMATION

I.F. amplifier for 10.7 MHz



Emitter current of each transistor $I_E = 1.0 \text{ mA}$

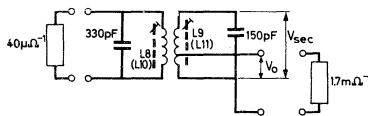
Coil data :



$$L6 = 1.4 \mu\text{H}; Q_0 \geq 120; Q_L = 70$$

$$L7 = 1.4 \mu\text{H}; Q_0 \geq 110; Q_L = 92$$

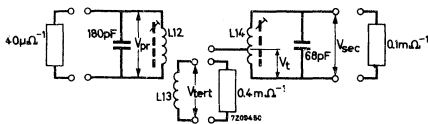
$$kQ_L = 1.25 \quad \frac{V_o}{V_{sec}} = 0.1$$



$$L8 = L10 = 0.67 \mu\text{H}; Q_0 \geq 110; Q_L = 92$$

$$L9 = L11 = 1.4 \mu\text{H}; Q_0 \geq 110; Q_L = 92$$

$$kQ_L = 1.25 \quad \frac{V_o}{V_{sec}} = 0.1$$

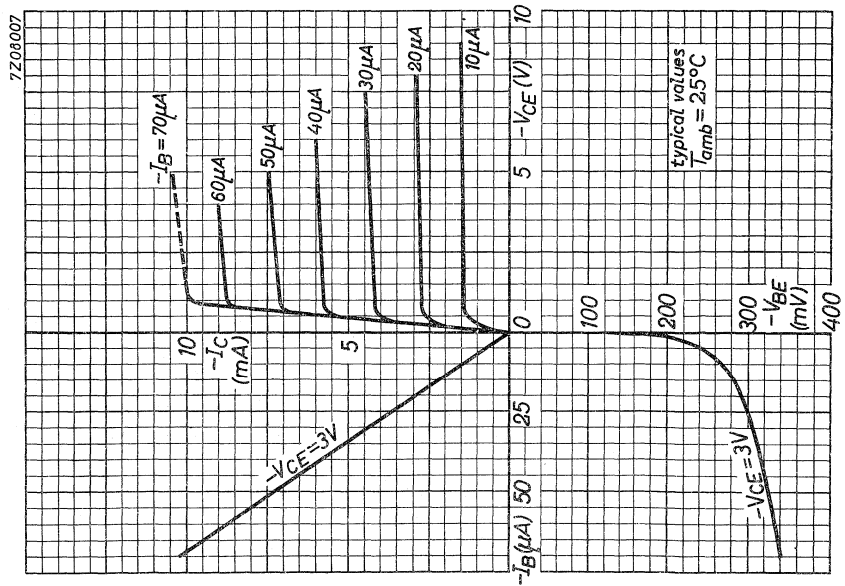
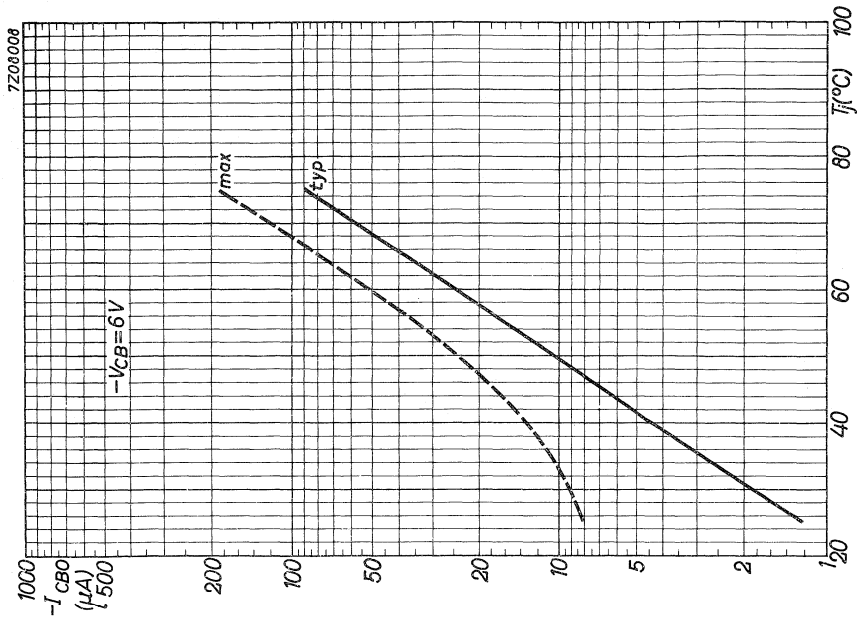


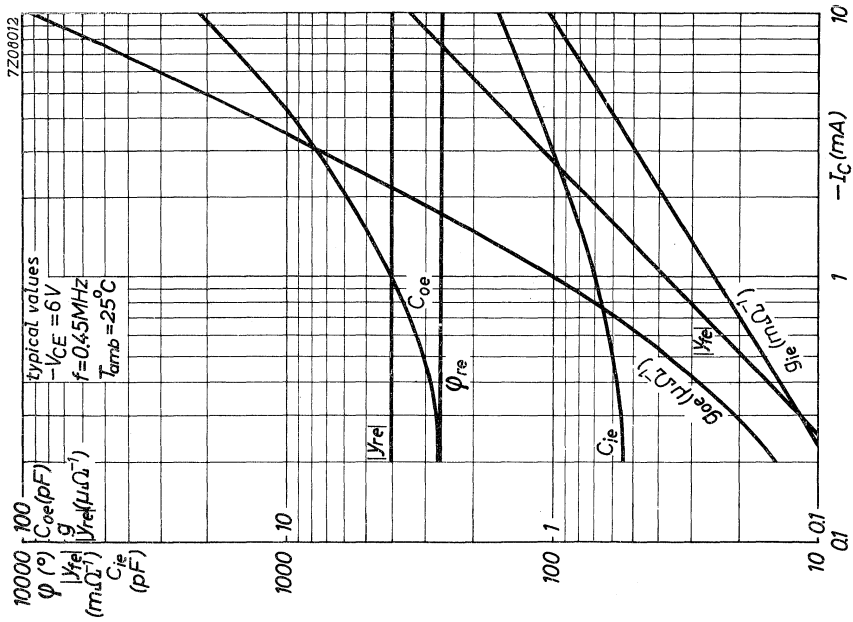
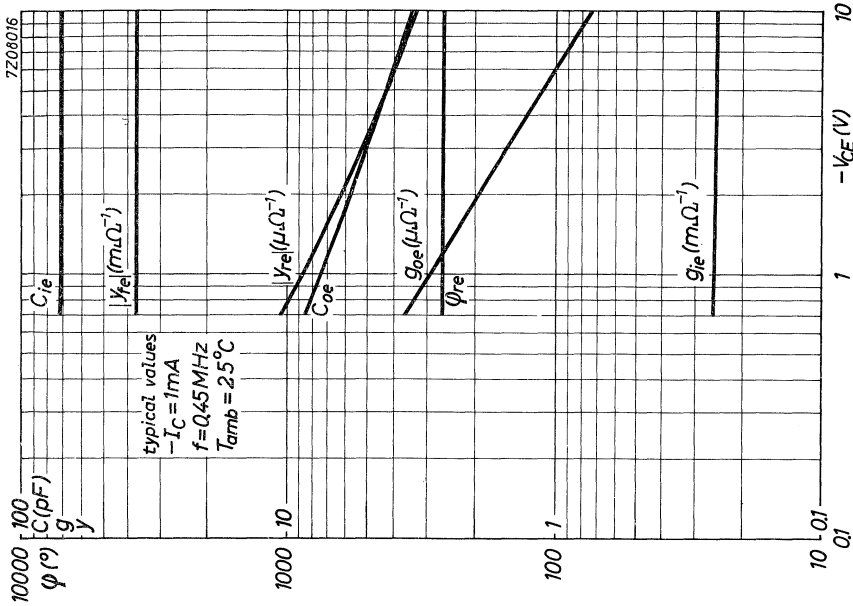
$$L12 = 1.2 \mu\text{H}; Q_0 = 90$$

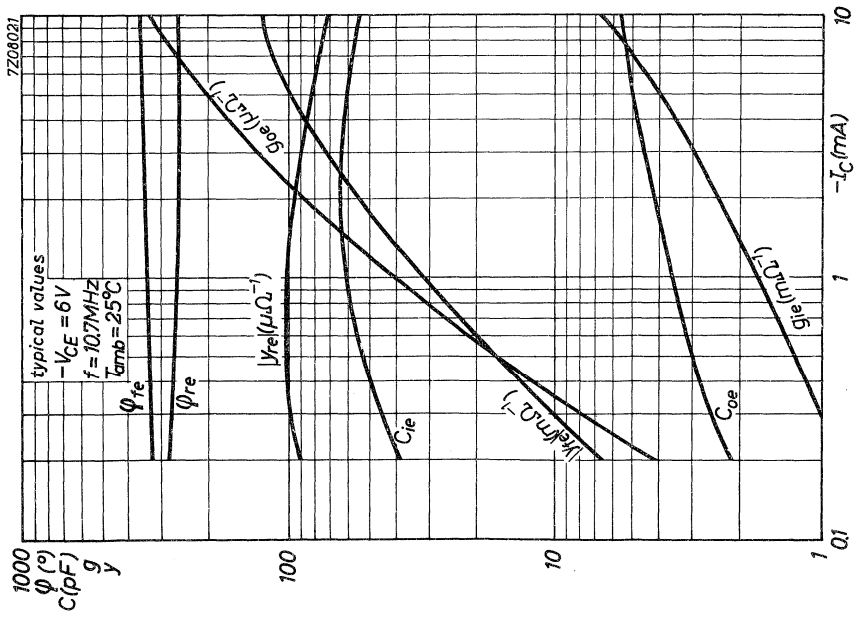
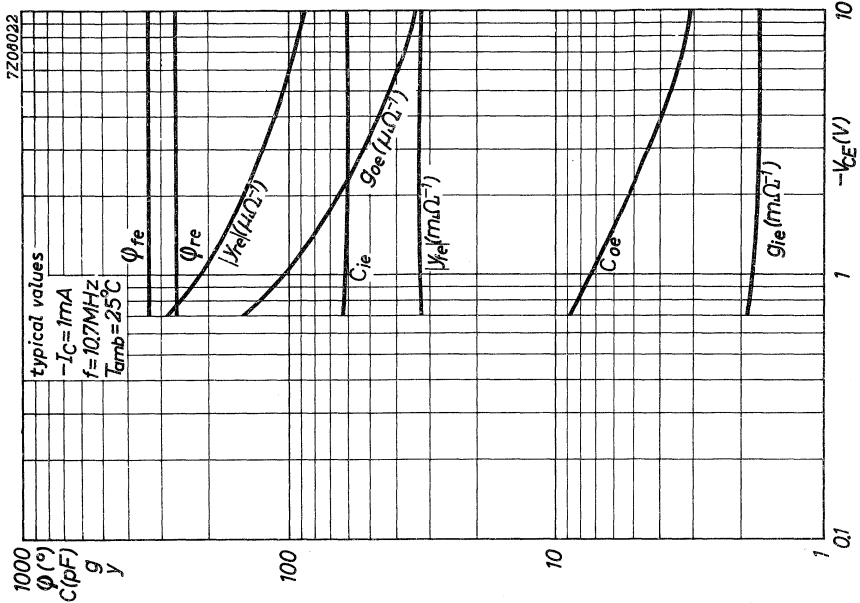
$$L14 = 3.05 \mu\text{H}; Q_0 = 90 \quad (\text{bifilarly wound})$$

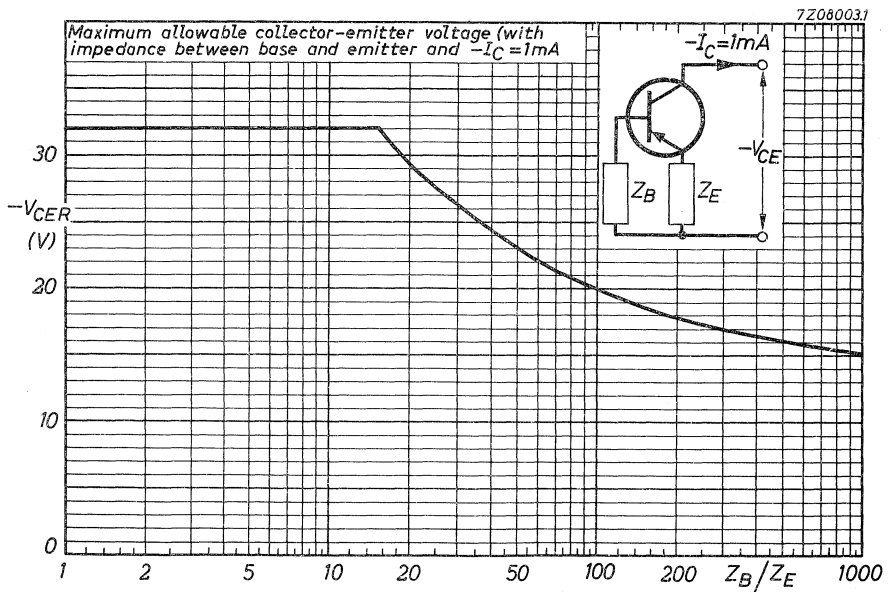
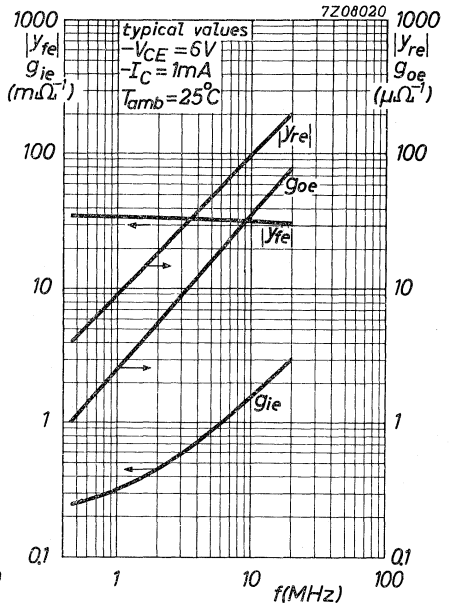
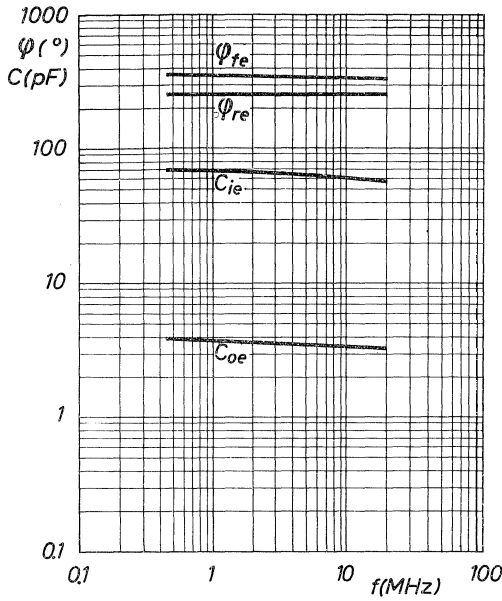
$$kQ_L = 0.7$$

$$\frac{V_{tert}}{V_{pr}} = 0.45; \frac{V_t}{V_{sec}} = 0.5$$









CHARACTERISTICS

$T_{amb} = 25\text{ }^{\circ}\text{C}$ unless otherwise specified

Collector cut-off current

$I_E = 0; -V_{CB} = 6\text{ V}$

$-I_{CBO}$	typ.	1.2 μA
	<	8 μA

$I_E = 0; -V_{CB} = 6\text{ V}; T_j = 75\text{ }^{\circ}\text{C}$

$-I_{CBO}$	typ.	90 μA
	<	180 μA

Base current

$I_E = 1\text{ mA}; -V_{CB} = 6\text{ V}$

$-I_B$	typ.	7 μA
	<	25 μA

Base-emitter voltage

$-I_C = 1\text{ mA}; -V_{CE} = 6\text{ V}$

$-V_{BE}$	typ.	270 mV
		210 to 330 mV

Small signal current gain at $f = 1\text{ kHz}$

$-I_C = 1\text{ mA}; -V_{CE} = 6\text{ V}$

h_{fe}	typ.	150
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Feedback capacitance at $f = 450\text{ kHz}$

$-I_C = 1\text{ mA}; -V_{CE} = 6\text{ V}$

$-C_{re}$	typ.	1.5 pF
-----------	------	--------

y parameters at $f = 0.45\text{ MHz}$ (common emitter)

$-I_C = 1\text{ mA}; -V_{CE} = 6\text{ V}^1)$

Input conductance

g_{ie}	typ.	0.25 $\text{m}\Omega^{-1}$
----------	------	----------------------------

Input capacitance

C_{ie}	typ.	70 pF
----------	------	-------

Feedback admittance

$ y_{re} $	typ.	4.0 $\mu\Omega^{-1}$
------------	------	----------------------

Phase angle of feedback admittance

φ_{re}	typ.	270°
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Transfer admittance

$ y_{fe} $	typ.	37 $\text{m}\Omega^{-1}$
------------	------	--------------------------

Phase angle of transfer admittance

φ_{fe}	typ.	0
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Output conductance

g_{oe}	typ.	1.0 $\mu\Omega^{-1}$
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Output capacitance

C_{oe}	typ.	4.0 pF
----------	------	--------

Feedback impedance at $f = 2\text{ MHz}$

$I_E = 1\text{ mA}; -V_{CB} = 6\text{ V}$

$ z_{rb} $	typ.	35 Ω
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¹⁾ Length of leads between transistor bottom and measuring jig : 5 mm

CHARACTERISTICS (continued)

$T_{amb} = 25\text{ }^\circ\text{C}$ unless otherwise specified

Transition frequency

$I_E = 1\text{ mA}; -V_{CB} = 6\text{ V}$

f_T typ. 75 MHz

Noise figure at $f = 1.0\text{ MHz}$

$I_E = 1\text{ mA}; -V_{CB} = 6\text{ V}; R_S = 500\text{ }\Omega$

F typ. 1.5 dB
< 3 dB

Conversion noise figure

$I_E = 1\text{ mA}; -V_{CB} = 6\text{ V}$

$R_S = 500\text{ }\Omega; f = 1\text{ MHz}$

F_C typ. 3 dB
< 5 dB

$R_S = 2\text{ k}\Omega; f = 200\text{ kHz}$

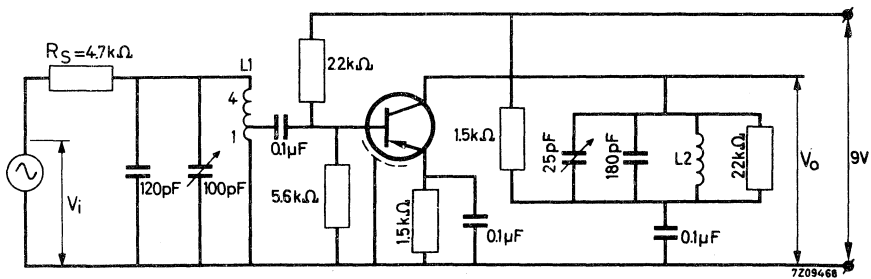
F_C typ. 4 dB
< 7 dB

Power gain at $f = 0.45\text{ MHz}$

$$G_p = \frac{V_o^2}{V_i^2} \cdot \frac{4 R_S}{R_1} = 0.94 \frac{V_o^2}{V_i^2}$$

G_p > 40 dB
typ. 42 dB

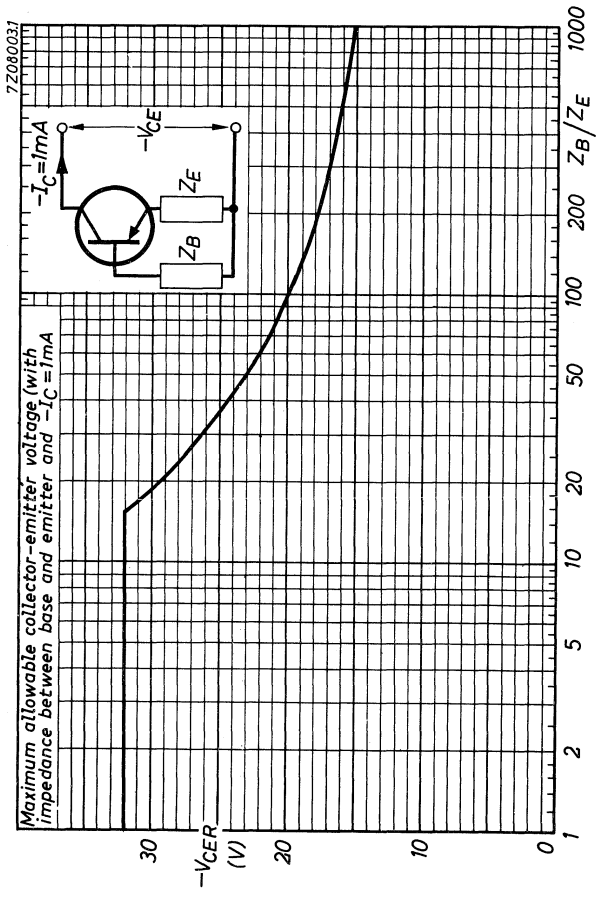
Test circuit :

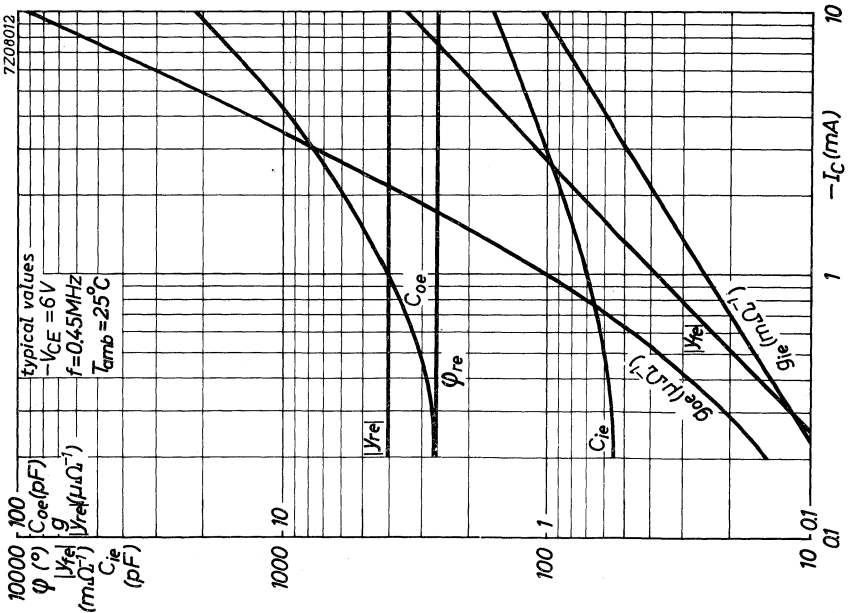
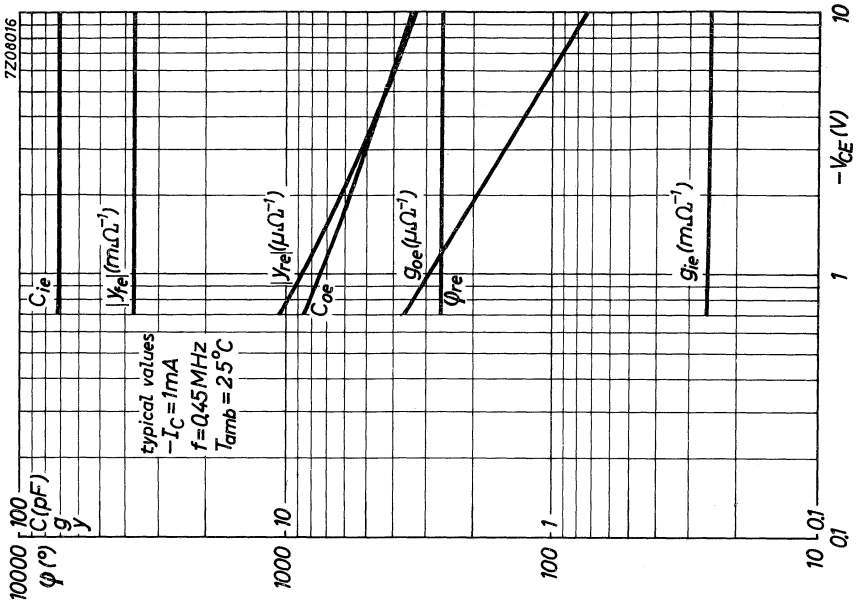


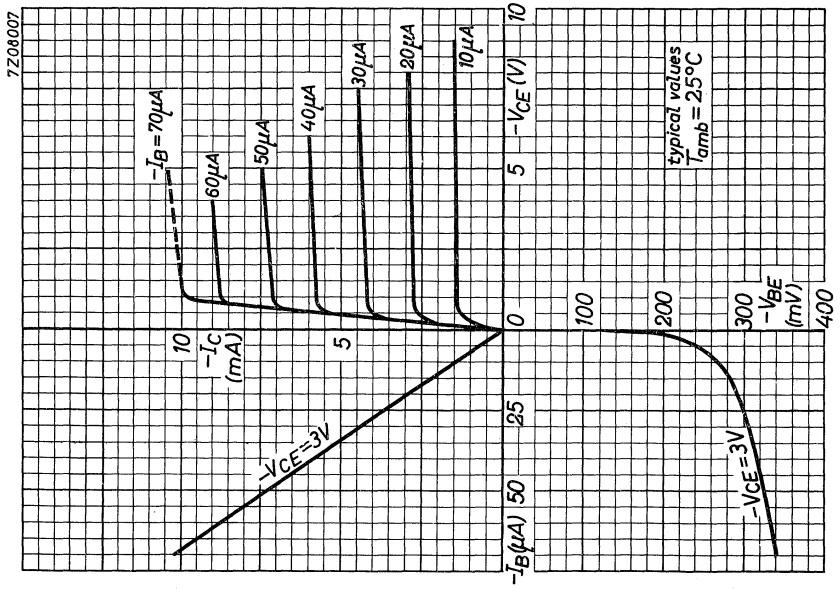
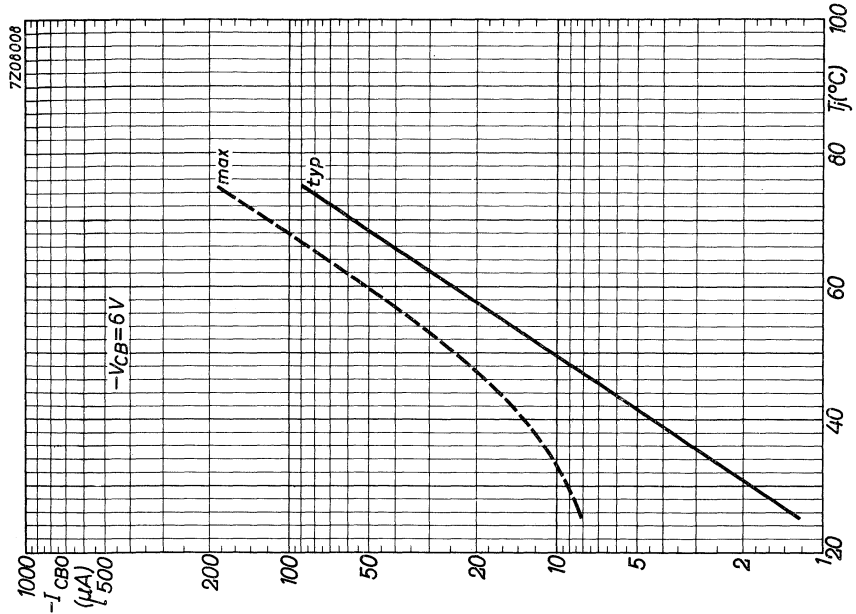
Total collector resistance $R_L = 20\text{ k}\Omega$

$L1 = 625\text{ }\mu\text{H}$; unloaded Q-factor 140; tap at 0.2

$L2 = 625\text{ }\mu\text{H}$; unloaded Q-factor 140







U.H.F. GERMANIUM MESA TRANSISTOR

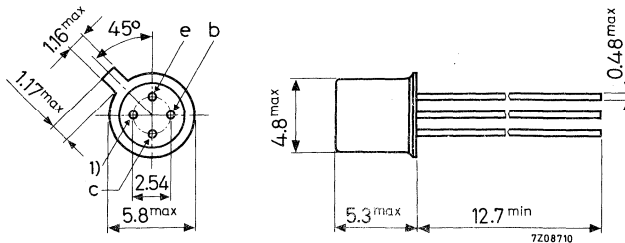
P-N-P transistor in a TO-72 metal envelope, primarily intended for use in pre-amplifier, mixer or oscillator circuits up to frequencies of 860 MHz.

QUICK REFERENCE DATA			
Collector-base voltage (open emitter)	$-V_{CBO}$	max. 20	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max. 15	V
Collector current (d.c.)	$-I_C$	max. 10	mA
Total power dissipation up to $T_{amb} = 45\text{ }^{\circ}\text{C}$	P_{tot}	max. 60	mW
Junction temperature	T_j	max. 90	$^{\circ}\text{C}$
Transition frequency			
$-I_C = 1.5\text{ mA}; -V_{CE} = 12\text{ V}$	f_T	typ. 550	MHz
Max. unilateralised power gain			
$I_E = 1.5\text{ mA}; -V_{CB} = 12\text{ V}; f = 800\text{ MHz}$	GUM	typ. 11.5	dB
Noise figure			
$I_E = 1.5\text{ mA}; -V_{CB} = 12\text{ V}; f = 800\text{ MHz}; R_S = 60\text{ }\Omega$	F	typ. 7	dB

MECHANICAL DATA

Dimensions in mm

TO-72



1) = shield lead (connected to case)

Accessories available: 56246, 56263

RATINGS (Limiting values) ¹⁾

Voltages

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	20 V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	15 V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	0.3 V

Currents

Collector current (d.c.)	$-I_C$	max.	10 mA
Collector current (peak value)	$-I_{CM}$	max.	10 mA

Power dissipation

Total power dissipation up to $T_{amb} = 45^\circ\text{C}$	P_{tot}	max.	60 mW
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Temperatures

Storage temperature	T_{stg}	-30 to +75	$^\circ\text{C}$
Junction temperature	T_j	max.	90 $^\circ\text{C}$

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	0.75 $^\circ\text{C}/\text{mW}$
From junction to case	$R_{th\ j-c}$	=	0.40 $^\circ\text{C}/\text{mW}$

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

CHARACTERISTICS

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

Collector cut-off current

$I_E = 0; -V_{CB} = 20\text{ V}$	$-I_{CBO}$	typ. 0.5 μA < 8 μA
$I_B = 0; -V_{CE} = 15\text{ V}$	$-I_{CEO}$	< 500 μA

Emitter cut-off current

$I_C = 0; -V_{EB} = 0.3\text{ V}$	$-I_{EBO}$	typ. 2 μA < 100 μA
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Base current

$I_E = 1.5\text{ mA}; -V_{CB} = 12\text{ V}$	$-I_B$	typ. 30 μA < 150 μA
$I_E = 2\text{ mA}; -V_{CB} = 6\text{ V}$	$-I_B$	typ. 36 μA
$I_E = 5\text{ mA}; -V_{CB} = 6\text{ V}$	$-I_B$	typ. 66 μA

Emitter-base voltage

$I_E = 1.5\text{ mA}; -V_{CB} = 12\text{ V}$	V_{EB}	typ. 380 mV 320 to 430 mV
$I_E = 2\text{ mA}; -V_{CB} = 6\text{ V}$	V_{EB}	typ. 380 mV 320 to 430 mV
$I_E = 5\text{ mA}; -V_{CB} = 6\text{ V}$	V_{EB}	typ. 405 mV 360 to 450 mV

Transition frequency

$-I_C = 1.5\text{ mA}; -V_{CE} = 12\text{ V}$	f_T	typ. 550 MHz
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Reverse transfer time constant

$I_E = 1.5\text{ mA}; -V_{CB} = 12\text{ V}; f = 2.5\text{ MHz}$	$r_{bb'} \cdot C_{bc}$	typ. 3 ps
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Feedback capacitance at $f = 450\text{ kHz}$

$-I_C = 1.5\text{ mA}; -V_{CE} = 12\text{ V}$	$-C_{re}$	typ. 250 fF ¹⁾
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Noise figure at $R_S = 60\ \Omega$

$I_E = 1.5\text{ mA}; -V_{CB} = 12\text{ V}; f = 800\text{ MHz}$	F	typ. 7 dB < 8.2 dB
$f = 860\text{ MHz}$	F	typ. 7.5 dB < 8.8 dB

¹⁾ 1 fF = 1 femtofarad = 10^{-15} F

CHARACTERISTICS (continued)

 $T_j = 25\text{ }^\circ\text{C}$ unless otherwise specifiedy parameters at $f = 800\text{ MHz}$ ¹⁾

$$I_E = 1.5\text{ mA}; -V_{CB} = 12\text{ V}$$

Input conductance	g_{ib}	typ. 7	$\text{m}\Omega^{-1}$
Input capacitance	$-C_{ib}$	typ. 2.2	pF
Input susceptance	$-\omega C_{ib}$	typ. 11	$\text{m}\Omega^{-1}$
Feedback admittance	$ y_{rb} $	typ. 0.4	$\text{m}\Omega^{-1}$
Phase angle of feedback admittance	φ_{rb}	typ. 240	$^\circ$
Transfer admittance	$ y_{fb} $	typ. 14	$\text{m}\Omega^{-1}$
Phase angle of transfer admittance	φ_{fb}	typ. 35	$^\circ$
Output conductance	g_{ob}	typ. 0.5	$\text{m}\Omega^{-1}$
Output capacitance	C_{ob}	typ. 1.5	pF

y parameters at $f = 200\text{ MHz}$ ¹⁾

$$I_E = 1.5\text{ mA}; -V_{CB} = 12\text{ V}$$

Input conductance	g_{ib}	typ. 28	$\text{m}\Omega^{-1}$
Input capacitance	$-C_{ib}$	typ. 19	pF
Input susceptance	$-\omega C_{ib}$	typ. 24	$\text{m}\Omega^{-1}$
Feedback admittance	$ y_{rb} $	typ. 0.17	$\text{m}\Omega^{-1}$
Phase angle of feedback admittance	φ_{rb}	typ. 250	$^\circ$
Transfer admittance	$ y_{fb} $	typ. 37	$\text{m}\Omega^{-1}$
Phase angle of transfer admittance	φ_{fb}	typ. 126	$^\circ$
Output conductance	g_{ob}	typ. 90	$\mu\Omega^{-1}$
Output capacitance	C_{ob}	typ. 1.5	pF

Maximum unilateralised power gain

$$G_{UM} = \frac{|y_{fb}|^2}{4 g_{ib} g_{ob}}$$

$$I_E = 1.5\text{ mA}; -V_{CB} = 12\text{ V}; f = 800\text{ MHz} \quad G_{UM} \quad \text{typ. } 11.5 \text{ dB}$$

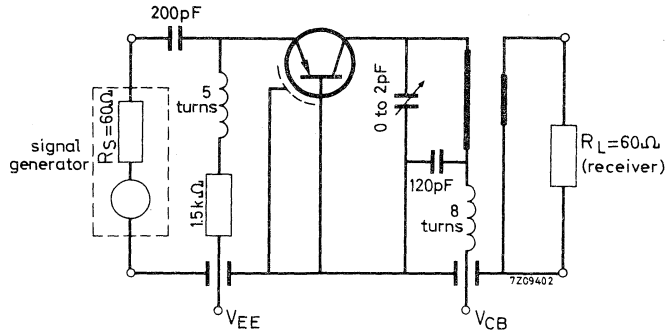
¹⁾ Measured with a lead length of 5 mm.

CHARACTERISTICS (continued)

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

Transducer gain

Basic circuit for measuring the transducer gain G_{tr} .



Total effective collector resistance $R_C = 1.4\text{ k}\Omega$

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

$I_E = 1.5\text{ mA}$; $-V_{CB} = 12\text{ V}$

$f = 800\text{ MHz}$

$G_{tr} > 9\text{ dB}$
typ. 11 dB

$f = 860\text{ MHz}$

$G_{tr} > 7.5\text{ dB}$
typ. 10 dB

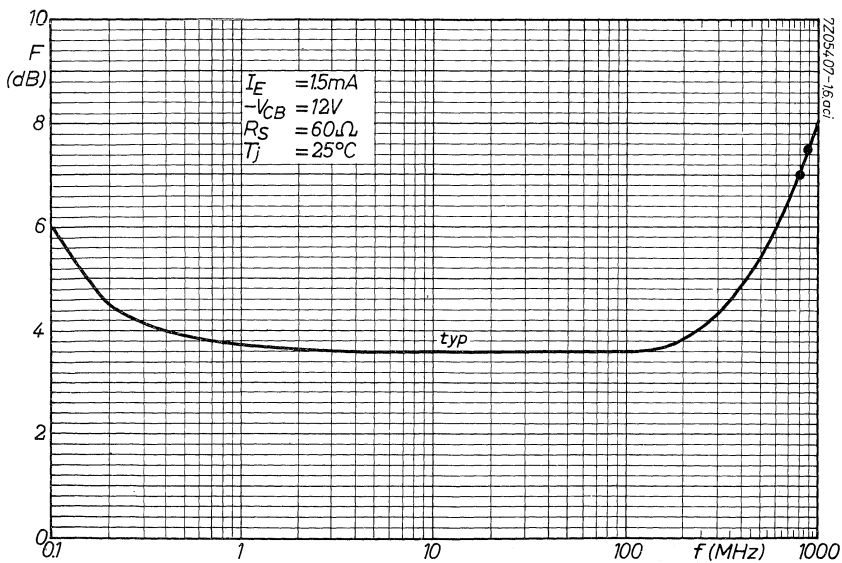
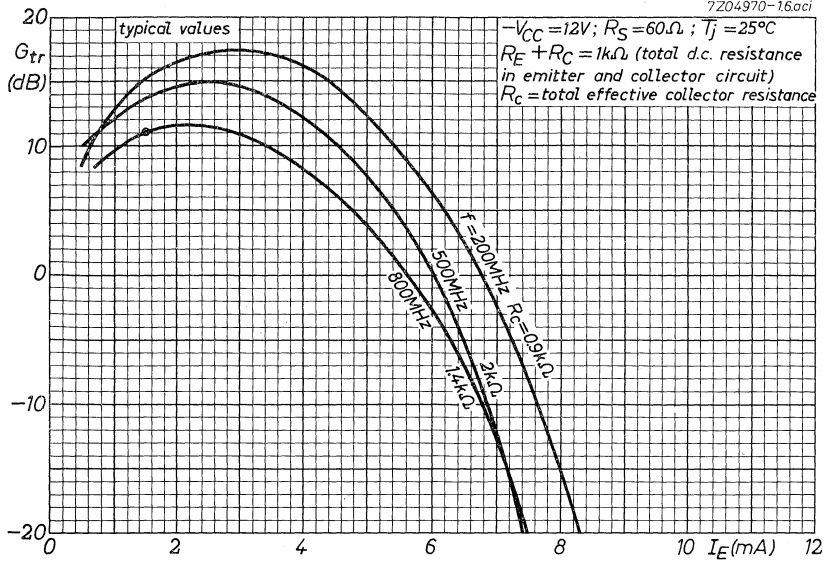
Reverse transducer gain

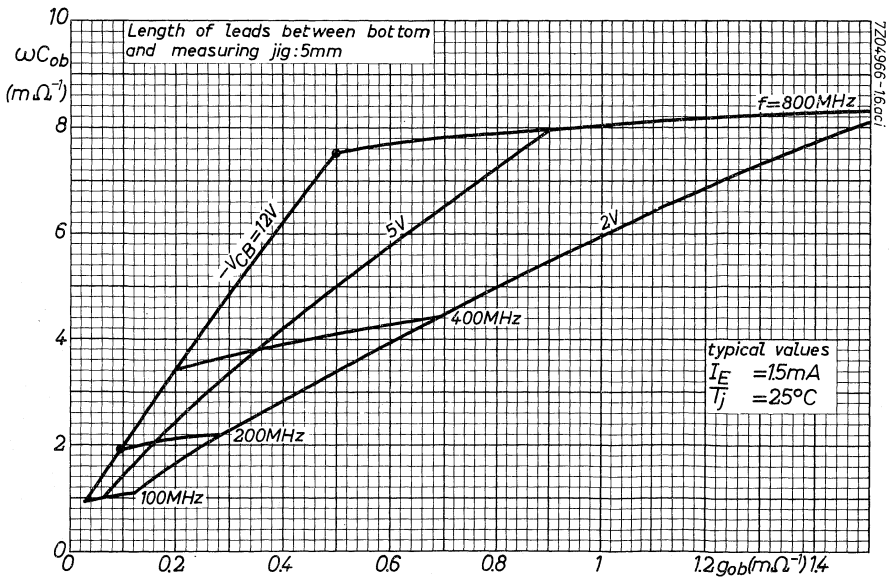
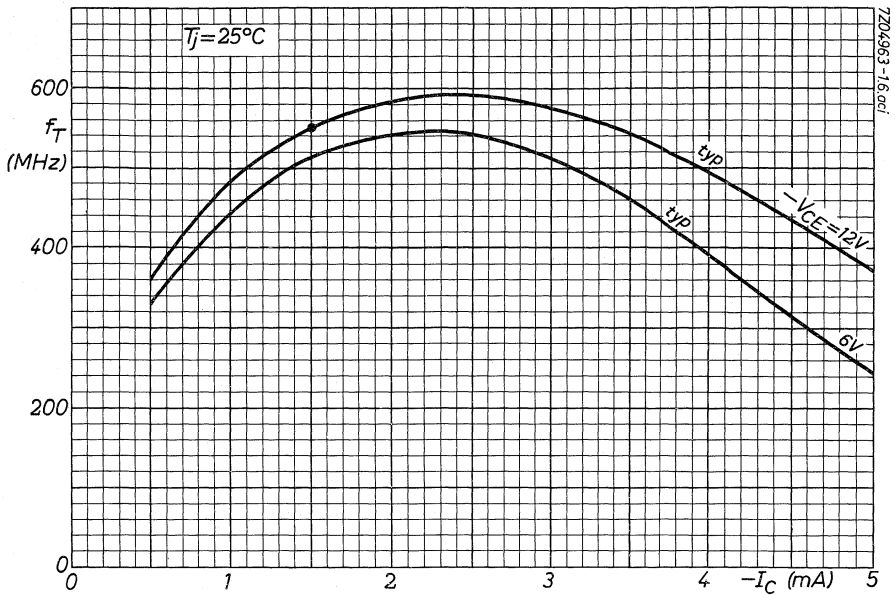
$I_E = 1.5\text{ mA}$; $-V_{CB} = 12\text{ V}$; $f = 800\text{ MHz}$

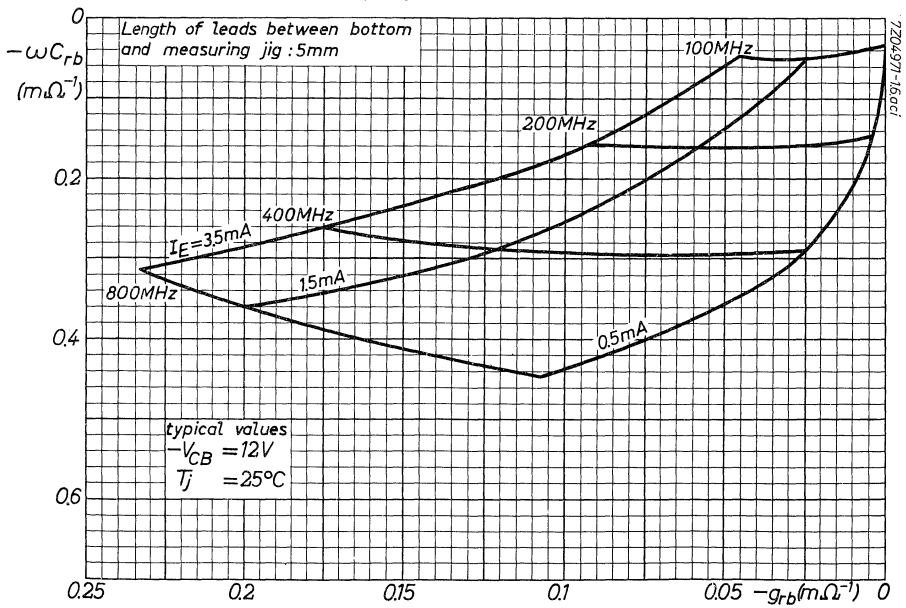
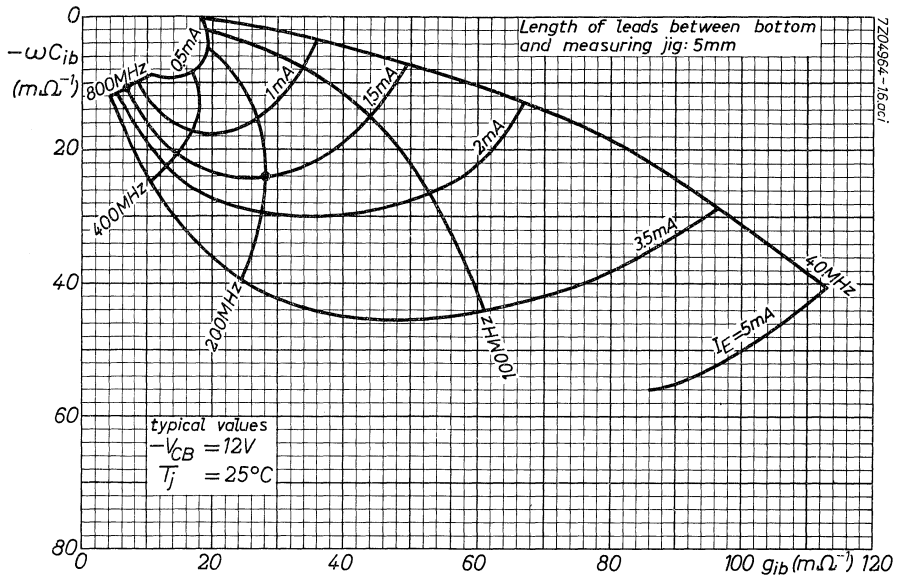
$G_{tr\text{ rev}}$ typ. -23 dB

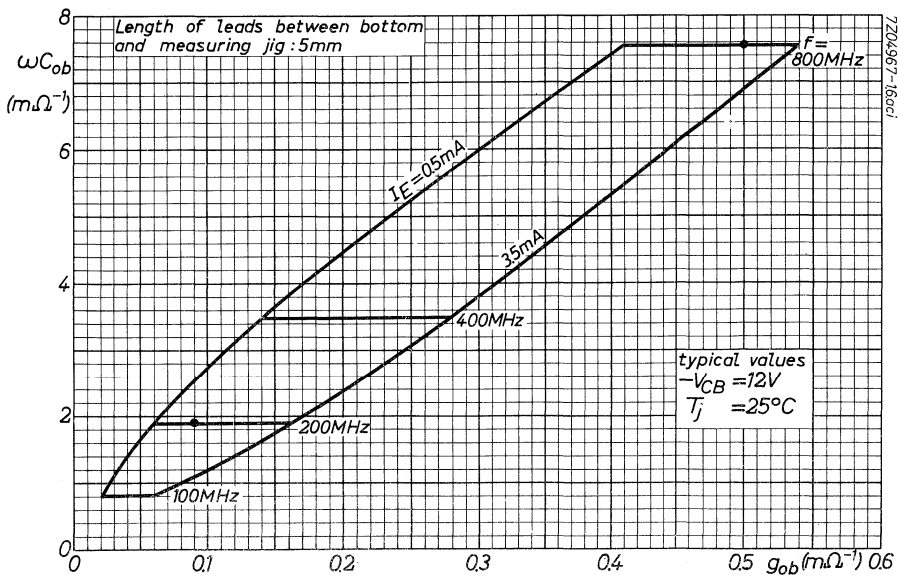
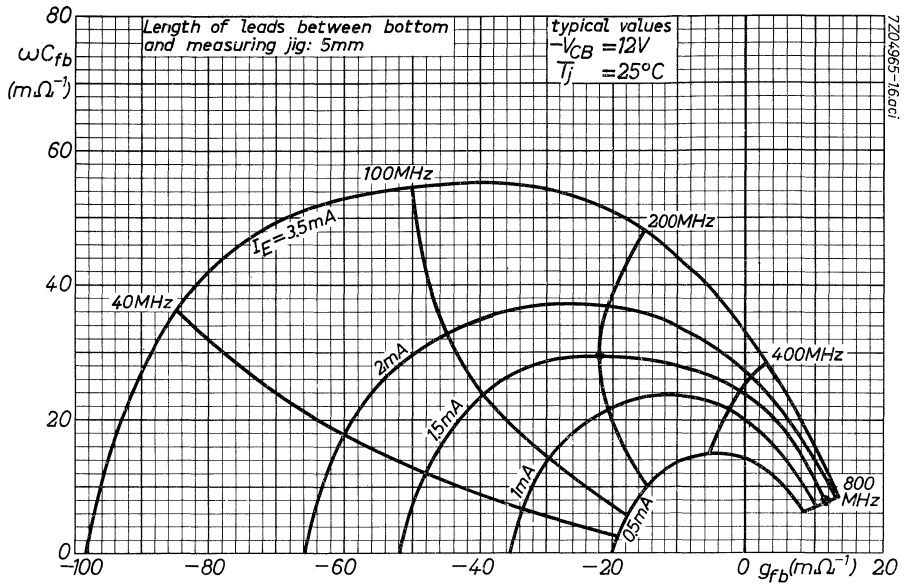
The reverse transducer gain is measured in the above circuit, with the signal generator and the load (receiver) interchanged.

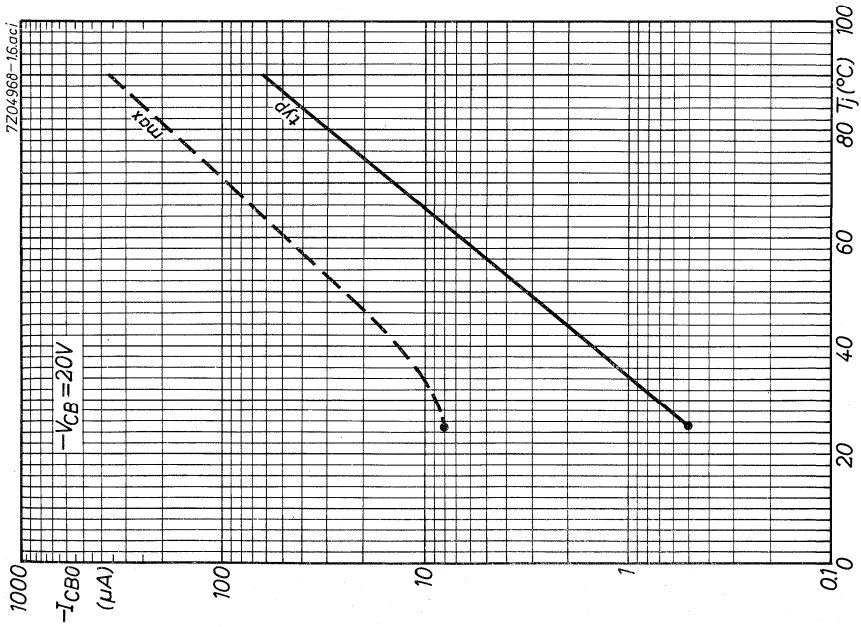
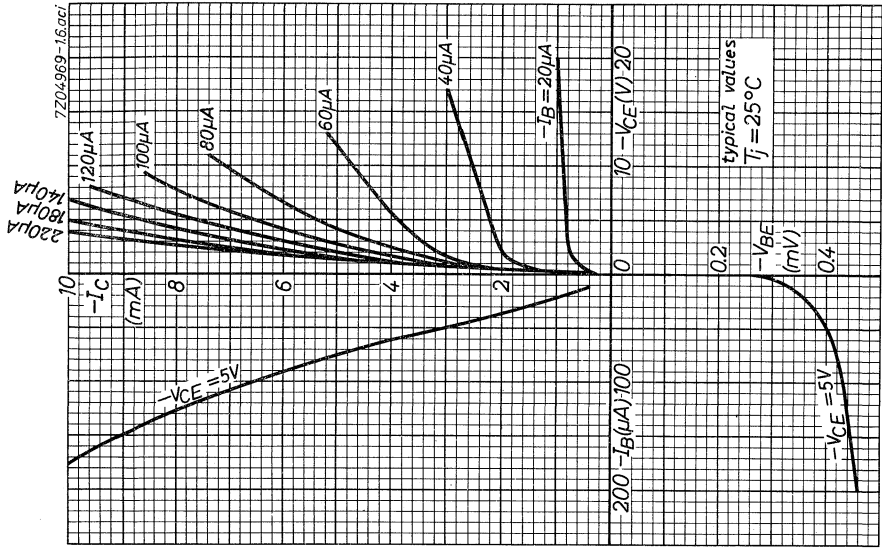
7204970-16aci











R.F. GERMANIUM ALLOY DIFFUSED TRANSISTOR

P-N-P transistor in a TO-12 metal envelope with a shield lead connected to the case. The AF178 is primarily intended for application in v.h.f. amplifier-, oscillator- and converter circuits. It has a low noise and a high gain up to frequencies of 260 MHz.

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

Collector-base voltage (open-emitter)	$-V_{CBO}$	max.	25 V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	0.5 V
Collector current (d.c.)	$-I_C$	max.	10 mA
Base current (d.c.)	$-I_B$	max.	1 mA
Total power dissipation up to $T_{amb} = 45\text{ }^{\circ}\text{C}$	P_{tot}	max.	75 mW
Storage temperature	T_{stg}	-55 to +75	$^{\circ}\text{C}$
Junction temperature: continuous	T_j	max.	75 $^{\circ}\text{C}$
	T_j	max.	90 $^{\circ}\text{C}$

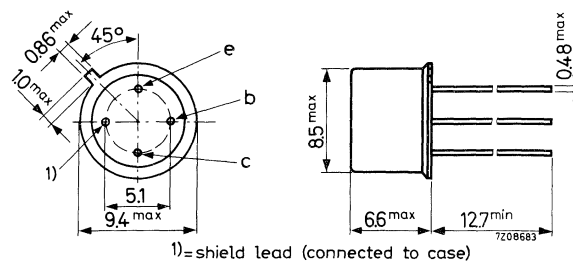
THERMAL RESISTANCE

From junction to ambient in free air $R_{th\ j-a} = 0.6\text{ }^{\circ}\text{C/mW}$

MECHANICAL DATA

Dimensions in mm

TO-12



1) = shield lead (connected to case)

Accessories available: 56245, 56265

FOR NEW DESIGN THE SUCCESSOR TYPES BF182; BF183 (N-P-N) OR
AF139 (P-N-P) ARE RECOMMENDED

$T_{amb} = 25\text{ }^{\circ}\text{C}$ unless otherwise specified

CHARACTERISTICS

Collector cut-off current

$I_E = 0; -V_{CB} = 12\text{ V}$ $-I_{CBO} < 10\text{ }\mu\text{A}$

$I_E = 0; -V_{CB} = 25\text{ V}$ $-I_{CBO} < 50\text{ }\mu\text{A}$

Base current

$-I_C = 1\text{ mA}; -V_{CE} = 12\text{ V}$ $-I_B < 50\text{ }\mu\text{A}$

Base-emitter voltage

$-I_C = 1\text{ mA}; -V_{CE} = 12\text{ V}$ $-V_{BE} \text{ 220 to 360 mV}$

Feedback capacitance at $f = 0.45\text{ MHz}$

$-I_C = 1\text{ mA}; -V_{CE} = 12\text{ V}$ $-C_{re} \text{ typ. } 0.8\text{ pF}$

Transition frequency

$I_E = 1\text{ mA}; -V_{CB} = 12\text{ V}$ $f_T \text{ typ. } 180\text{ MHz}$

Feedback impedance at $f = 2\text{ MHz}$

$I_E = 1\text{ mA}; -V_{CB} = 12\text{ V}$ $|z_{rb}| \text{ typ. } 10\text{ }\Omega$

Small signal current gain at $f = 1\text{ kHz}$

$-I_C = 1\text{ mA}; -V_{CE} = 12\text{ V}$ $h_{fe} > 20$

Noise figure at $f = 200\text{ MHz}$

$-I_C = 1\text{ mA}; -V_{CE} = 12\text{ V}; R_S = 30\text{ }\Omega$ $F \text{ typ. } 6\text{ dB}$
 $< 7.5\text{ dB}$

U.H.F GERMANIUM MESA TRANSISTOR

P-N-P transistor in a TO-72 metal envelope, primarily intended for use in pre-amplifier, mixer or oscillator circuits up to frequencies of 890 MHz.

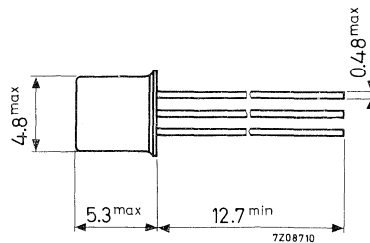
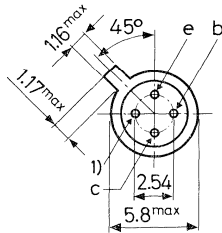
QUICK REFERENCE DATA

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	20 V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	15 V
Collector current (d.c.)	$-I_C$	max.	15 mA
Total power dissipation up to $T_{amb} = 45\text{ }^{\circ}\text{C}$	P_{tot}	max.	60 mW
Junction temperature	T_j	max.	90 $^{\circ}\text{C}$
Transition frequency			
$-I_C = 2\text{ mA}; -V_{CE} = 10\text{ V}$	f_T	typ.	650 MHz
Max. unilateralised power gain			
$I_E = 2\text{ mA}; -V_{CB} = 10\text{ V}; f = 800\text{ MHz}$	G_{UM}	typ.	17 dB
Noise figure			
$I_E = 2\text{ mA}; -V_{CB} = 10\text{ V}$			
$G_S = 16.7\text{ m}\Omega^{-1}; B_S = 0$			
$f = 200\text{ MHz}$	F	typ.	3 dB
$f = 800\text{ MHz}$	F	typ.	5 dB

MECHANICAL DATA

Dimensions in mm

TO-72



1) = shield lead (connected to case)

Accessories available: 56246, 56263

RATINGS (Limiting values) ¹⁾

Voltages

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	20	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	15	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	0.3	V

Currents

Collector current (d.c.)	$-I_C$	max.	15	mA
Collector current (peak value)	$-I_{CM}$	max.	15	mA

Power dissipation

Total power dissipation up to $T_{amb} = 45\text{ }^{\circ}\text{C}$	P_{tot}	max.	60	mW
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Temperatures

Storage temperature	T_{stg}	-30 to +75	$^{\circ}\text{C}$
Junction temperature	T_j	max.	90 $^{\circ}\text{C}$

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	0.75	$^{\circ}\text{C}/\text{mW}$
From junction to case	$R_{th\ j-c}$	=	0.40	$^{\circ}\text{C}/\text{mW}$

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

CHARACTERISTICS

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

Collector cut-off current

$V_{EB} = 0; -V_{CB} = 20\text{ V}$

$-I_{CBS}$ typ. 0.5 μA
< 8 μA

$I_B = 0; -V_{CE} = 15\text{ V}$

$-I_{CEO}$ < 500 μA

Emitter cut-off current

$I_C = 0; -V_{EB} = 0.3\text{ V}$

$-I_{EBO}$ < 100 μA

Base current

$I_E = 2\text{ mA}; -V_{CB} = 10\text{ V}$

$-I_B$ typ. 60 μA
< 200 μA

$I_E = 5\text{ mA}; -V_{CB} = 5\text{ V}$

$-I_B$ typ. 167 μA

$I_E = 10\text{ mA}; -V_{CB} = 2\text{ V}$

$-I_B$ < 1 mA

Emitter-base voltage

$I_E = 2\text{ mA}; -V_{CB} = 10\text{ V}$

V_{EB} typ. 350 mV

$I_E = 5\text{ mA}; -V_{CB} = 5\text{ V}$

V_{EB} typ. 400 mV

Transition frequency

$-I_C = 2\text{ mA}; -V_{CE} = 10\text{ V}$

f_T typ. 650 MHz

Feedback capacitance at $f = 1\text{ MHz}$

$-I_C = 2\text{ mA}; -V_{CE} = 10\text{ V}$

$-C_{re}$ typ. 230 fF ¹⁾

Noise figure

$I_E = 2\text{ mA}; -V_{CB} = 10\text{ V}$

$G_S = 16.7\text{ m}\Omega^{-1}; B_S = 0$

$f = 200\text{ MHz}$

F typ. 3 dB

$f = 800\text{ MHz}$

F typ. 5 dB
< 6 dB

$f = 900\text{ MHz}$

F typ. 6 dB
< 7 dB

Maximum unilateralised power gain

$$G_{UM} = \frac{|y_{fb}|^2}{4 g_{ib}g_{ob}}$$

$I_E = 2\text{ mA}; -V_{CB} = 10\text{ V}; f = 800\text{ MHz}$

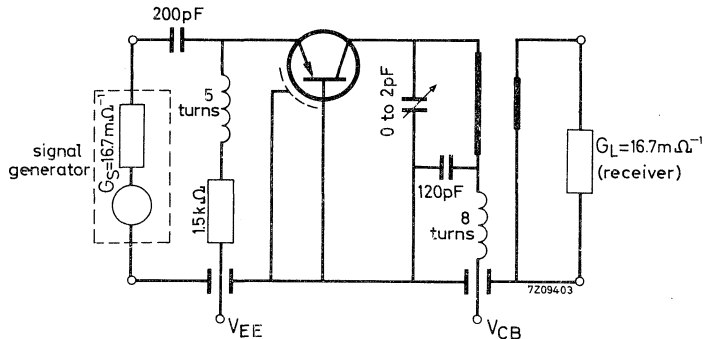
G_{UM} typ. 17 dB

¹⁾ 1 fF = 1 femtofarad = 10^{-15} F

CHARACTERISTICS (continued)

Transducer gain at $T_{amb} = 25\text{ }^\circ\text{C}$

Basic circuit for measuring the transducer gain G_{tr} at $f = 800$ and 900 MHz.

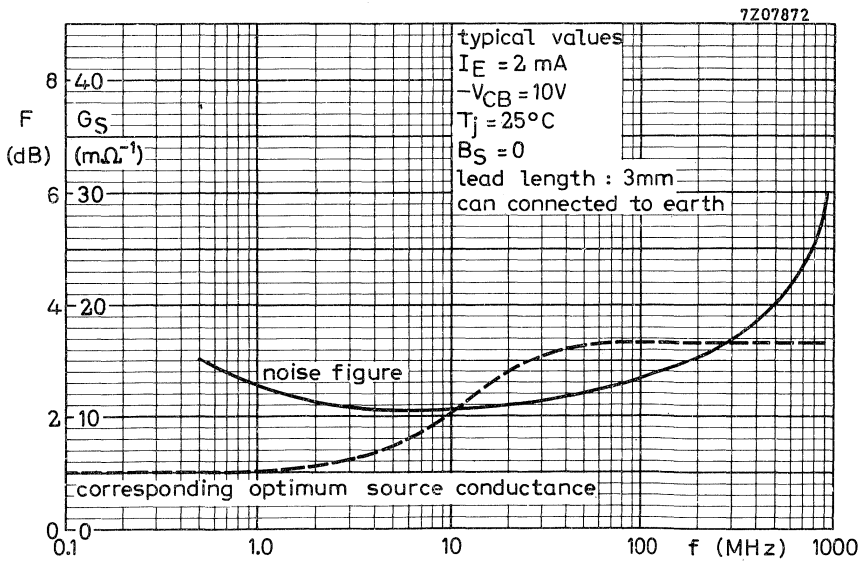
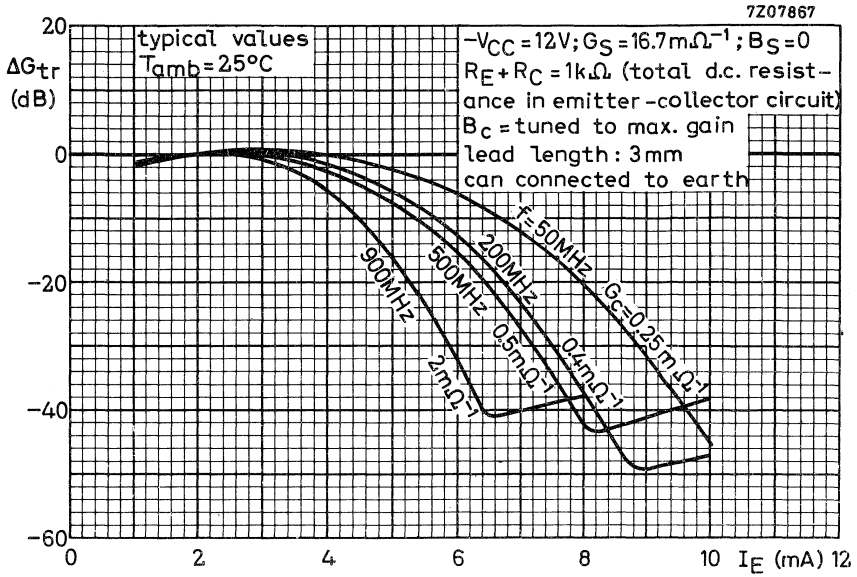


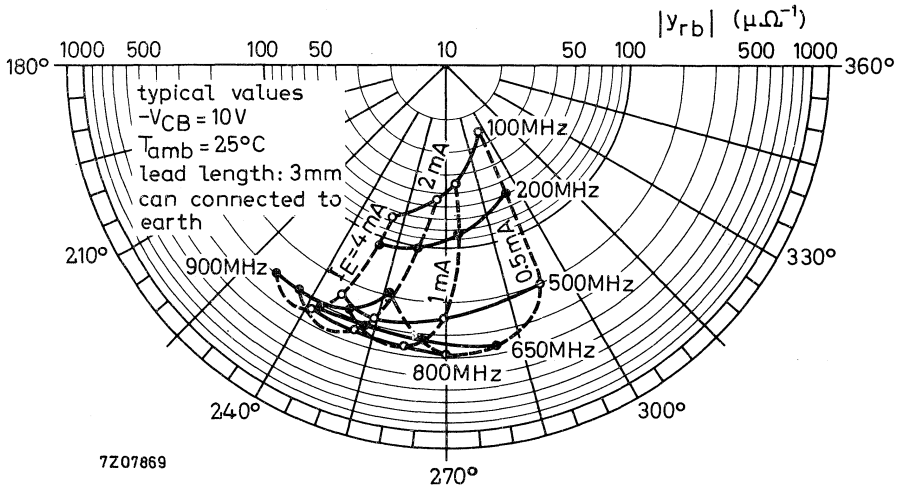
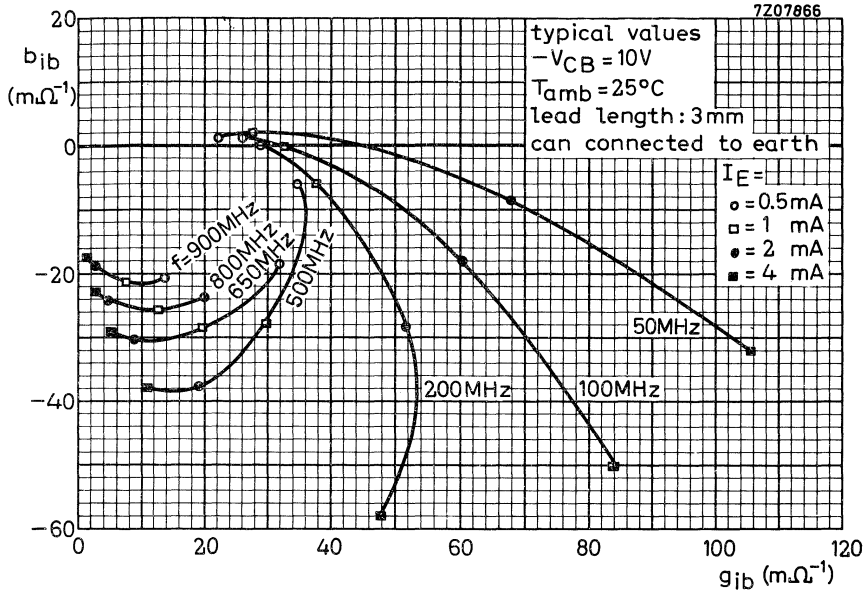
$$G_{tr} = \frac{\text{output power in load } G_L}{\text{available power from source } G_S}$$

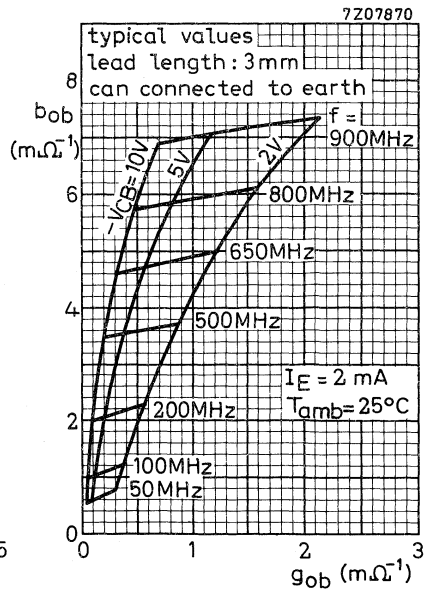
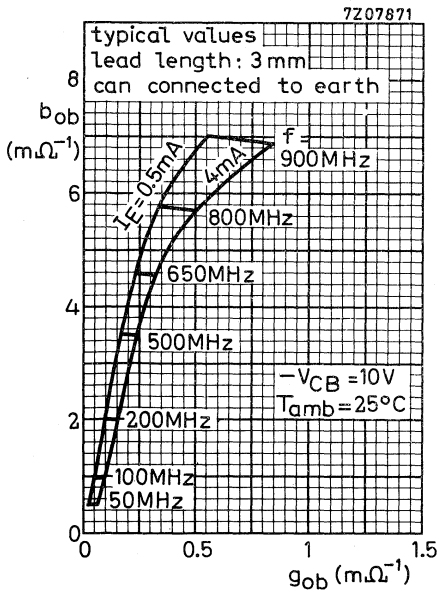
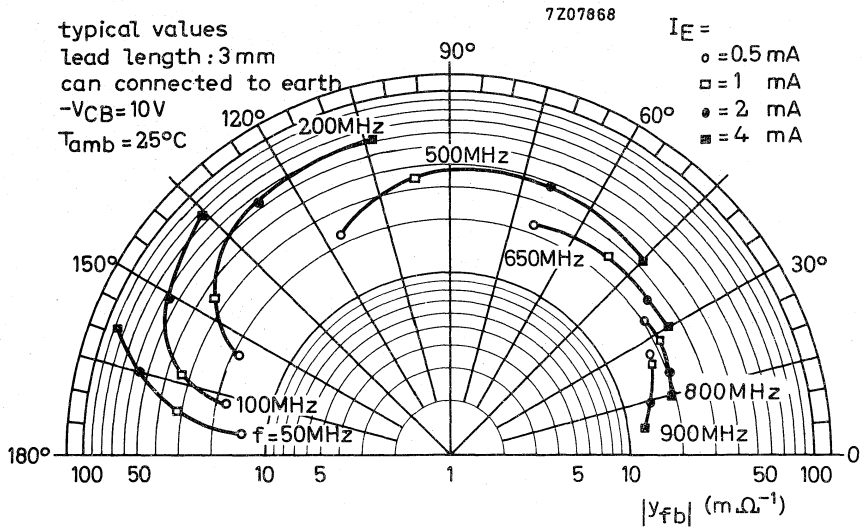
$I_E = 2\text{ mA}$; $-V_{CB} = 10\text{ V}$; lead length: 3 mm ; can connected to earth.

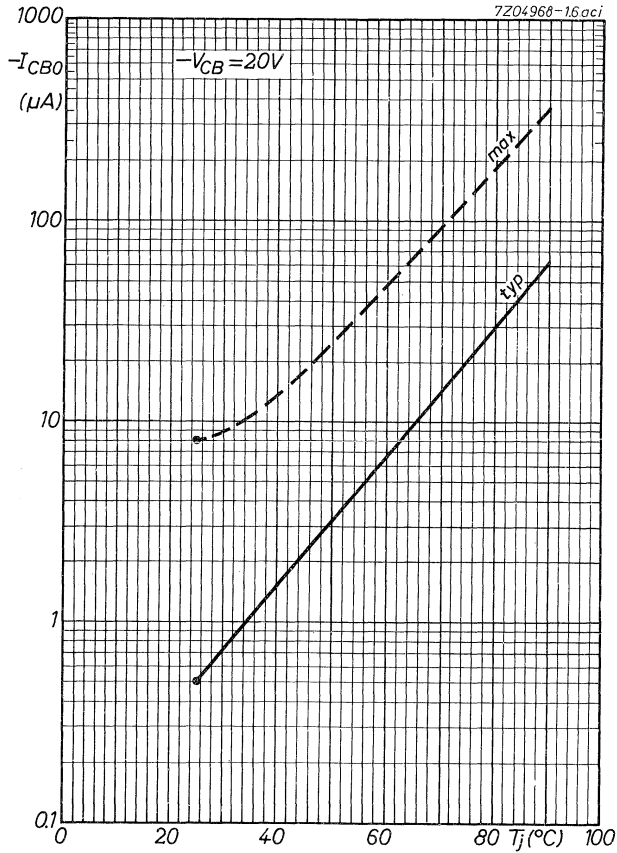
$f = 50\text{ MHz}$; $G_C = 0.25\text{ m}\Omega^{-1}$	G_{tr} typ. 22.5 dB
$f = 200\text{ MHz}$; $G_C = 0.4\text{ m}\Omega^{-1}$	G_{tr} typ. 21.5 dB
$f = 500\text{ MHz}$; $G_C = 0.5\text{ m}\Omega^{-1}$	G_{tr} typ. 18 dB
$f = 800\text{ MHz}$; $G_C = 0.5\text{ m}\Omega^{-1}$	$G_{tr} > 11.5\text{ dB}$ typ. 14 dB
$G_C = 2\text{ m}\Omega^{-1}$	$G_{tr} > 9\text{ dB}$ typ. 11.5 dB
$f = 900\text{ MHz}$; $G_C = 0.5\text{ m}\Omega^{-1}$	G_{tr} typ. 12.5 dB
$G_C = 2\text{ m}\Omega^{-1}$	G_{tr} typ. 10.5 dB

G_C = total effective collector conductance.









U.H.F. GERMANIUM MESA TRANSISTOR

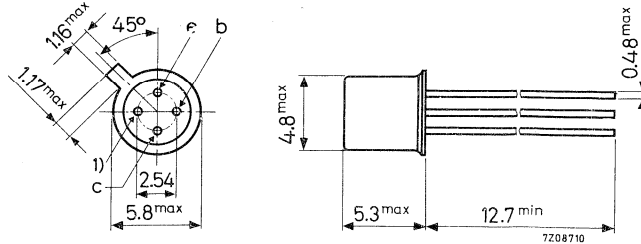
P-N-P-transistor in a TO-72 metal envelope, primarily intended for use in pre-amplifier or mixer circuits up to frequencies of 890 MHz.

QUICK REFERENCE DATA			
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	20 V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	15 V
Collector current (d.c.)	$-I_C$	max.	15 mA
Total power dissipation up to $T_{amb} = 45^\circ\text{C}$	P_{tot}	max.	60 mW
Junction temperature	T_j	max.	90 $^\circ\text{C}$
Transition frequency $-I_C = 2\text{ mA}; -V_{CE} = 10\text{ V}$	f_T	typ.	780 MHz
Transducer gain at $I_E = 2\text{ mA}; -V_{CB} = 10\text{ V}$ $f = 800\text{ MHz}; G_C = 0.5\text{ m}\Omega^{-1}$	G_{tr}	typ.	15 dB
$f = 900\text{ MHz}; G_C = 2\text{ m}\Omega^{-1}$	G_{tr}	typ.	12 dB
Noise figure $I_E = 2\text{ mA}; -V_{CB} = 10\text{ V}$ $G_S = 16.7\text{ m}\Omega^{-1}; B_S = 0$ $f = 800\text{ MHz}$	F	<	5 dB
$f = 900\text{ MHz}$	F	<	6 dB

MECHANICAL DATA

Dimensions in mm

TO-72



1) = shield lead (connected to case)

Accessories available: 56246, 56263

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

Voltages

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	20 V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	15 V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	0.3 V

Currents

Collector current (d.c.)	$-I_C$	max.	15 mA
Collector current (peak value)	$-I_{CM}$	max.	15 mA

Power dissipation

Total power dissipation up to $T_{amb} = 45\text{ }^\circ\text{C}$	P_{tot}	max.	60 mW
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Temperatures

Storage temperature	T_{stg}	-30 to +75	$^\circ\text{C}$
Junction temperature	T_j	max.	90 $^\circ\text{C}$

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	0.75 $^\circ\text{C}/\text{mW}$
From junction to case	$R_{th\ j-c}$	=	0.40 $^\circ\text{C}/\text{mW}$

CHARACTERISTICS

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

Collector cut-off current

$V_{EB} = 0; -V_{CB} = 20\text{ V}$	$-I_{CBS}$	typ.	0.5 μA
		<	8 μA
$I_B = 0; -V_{CE} = 15\text{ V}$	$-I_{CEO}$	<	500 μA

Emitter cut-off current

$I_C = 0; -V_{EB} = 0.3\text{ V}$	$-I_{EBO}$	<	100 μA
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Base current

$I_E = 2\text{ mA}; -V_{CB} = 10\text{ V}$	$-I_B$	typ.	60 μA
		<	200 μA
$I_E = 5\text{ mA}; -V_{CB} = 5\text{ V}$	$-I_B$	typ.	167 μA
$I_E = 10\text{ mA}; -V_{CB} = 2\text{ V}$	$-I_B$	<	1 mA

CHARACTERISTICS (continued)

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

Emitter-base voltage

$I_E = 2\text{ mA}; -V_{CB} = 10\text{ V}$ V_{EB} typ. 350 mV

$I_E = 5\text{ mA}; -V_{CB} = 5\text{ V}$ V_{EB} typ. 400 mV

Transition frequency

$-I_C = 2\text{ mA}; -V_{CE} = 10\text{ V}$ f_T typ. 780 MHz

Feedback capacitance at $f = 1\text{ MHz}$

$-I_C = 2\text{ mA}; -V_{CE} = 10\text{ V}$ $-C_{re}$ typ. 200 fF

Noise figure

$I_E = 2\text{ mA}; -V_{CB} = 10\text{ V}$

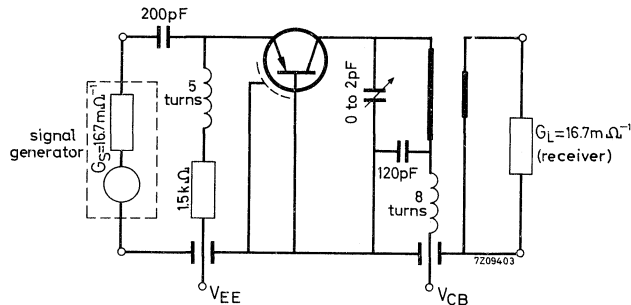
$G_S = 16.7\text{ m}\Omega^{-1}; B_S = 0$

$f = 800\text{ MHz}$ F < 5 dB

$f = 900\text{ MHz}$ F < 6 dB

Transducer gain at $T_{amb} = 25\text{ }^\circ\text{C}$

Basic circuit for measuring the transducer gain G_{tr} at $f = 800$ and 900 MHz .



$$G_{tr} \text{ in dB} = 10 \log \frac{\text{output power in load } G_L}{\text{available power from source } G_S}$$

$I_E = 2\text{ mA}; -V_{CB} = 10\text{ V};$ lead length: 3 mm; can connected to earth.

$f = 800\text{ MHz}; G_C = 0.5\text{ m}\Omega^{-1}$
 $G_C = 2\text{ m}\Omega^{-1}$

G_{tr} typ. 15 dB

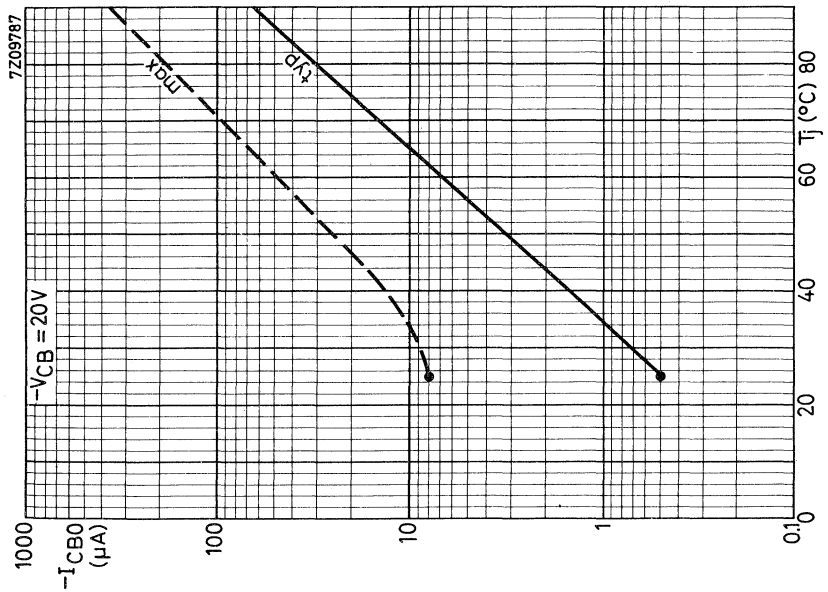
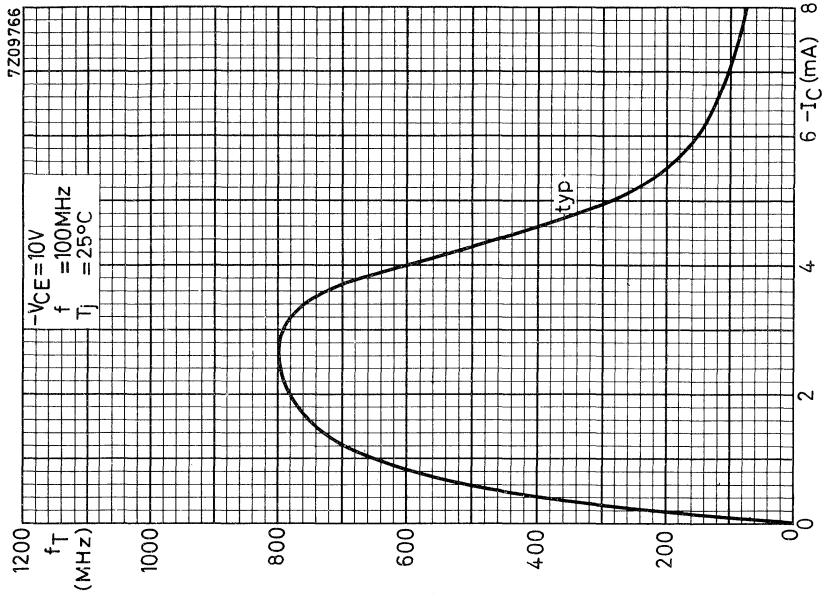
G_{tr} typ. 12.5 dB

$f = 900\text{ MHz}; G_C = 2\text{ m}\Omega^{-1}$

$G_{tr} > 11\text{ dB}$

typ. 12 dB

$G_C =$ total effective collector conductance.



U.H.F. GERMANIUM MESA TRANSISTOR

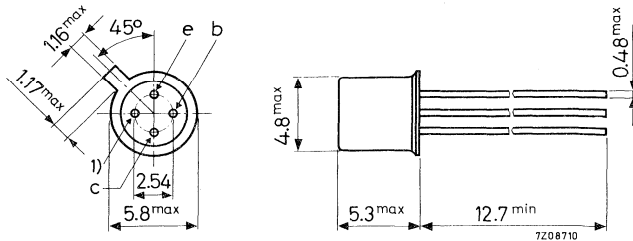
P-N-P transistor in a TO-72 metal envelope with the shield lead connected to the case, intended for mixer and oscillator circuits in variable capacitance tuners up to frequencies of 890 MHz.

QUICK REFERENCE DATA			
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	20 V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	15 V
Collector current (d. c.)	$-I_C$	max.	10 mA
Total power dissipation up to $T_{amb} = 45\text{ }^\circ\text{C}$	P_{tot}	max.	60 mW
Junction temperature	T_j	max.	90 $^\circ\text{C}$
Transition frequency at $f = 100\text{ MHz}$ $-I_C = 2\text{ mA}$; $-V_{CE} = 10\text{ V}$	f_T	typ.	650 MHz
Transducer gain at $f = 800\text{ MHz}$ (common base) $I_E = 2\text{ mA}$; $-V_{CB} = 10\text{ V}$ $G_S = 16.7\text{ m}\Omega^{-1}$; $G_L = 0.5\text{ mA/V}$	G_{tr}	typ.	14 dB
Noise figure $I_E = 2\text{ mA}$; $-V_{CB} = 10\text{ V}$ $G_S = 16.7\text{ m}\Omega^{-1}$; $B_S = 0$; $f = 200\text{ MHz}$	F	typ.	4.5 dB
$f = 800\text{ MHz}$	F	typ.	5.5 dB

MECHANICAL DATA

Dimensions in mm

TO-72



1) = shield lead (connected to case)

Accessories available: 56246; 56263

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

Voltages

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	20 V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	15 V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	0.3 V

Current

Collector current (d.c.)	$-I_C$	max.	10 mA
Collector current (peak value)	$-I_{CM}$	max.	10 mA

Power dissipation

Total power dissipation up to $T_{amb} = 45\text{ }^{\circ}\text{C}$	P_{tot}	max.	60 mW
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Temperatures

Storage temperature	T_{stg}	-30 to +75	$^{\circ}\text{C}$
Junction temperature	T_j	max.	90 $^{\circ}\text{C}$

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	0.75 $^{\circ}\text{C}/\text{mW}$
From junction to case	$R_{th\ j-c}$	=	0.4 $^{\circ}\text{C}/\text{mW}$

CHARACTERISTICS

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

Collector cut-off current

$V_{EB} = 0; -V_{CB} = 20\text{ V}$

$-I_{CBS}$ typ. $0.5\text{ }\mu\text{A}$
 $< 8\text{ }\mu\text{A}$

$I_B = 0; -V_{CE} = 15\text{ V}$

$-I_{CEO}$ $< 500\text{ }\mu\text{A}$

Emitter cut-off current

$I_C = 0; -V_{EB} = 0.3\text{ V}$

$-I_{EBO}$ $< 100\text{ }\mu\text{A}$

Base current

$-I_C = 2\text{ mA}; -V_{CE} = 10\text{ V}$

$-I_B$ typ. $80\text{ }\mu\text{A}$
 $< 200\text{ }\mu\text{A}$

Emitter-base voltage

$-I_C = 2\text{ mA}; -V_{CE} = 10\text{ V}$

$-V_{BE}$ typ. 370 mV

D.C. current gain

$-I_C = 2\text{ mA}; -V_{CE} = 10\text{ V}$

h_{FE} > 10
typ. 25

Transition frequency

$-I_C = 2\text{ mA}; -V_{CE} = 10\text{ V}$

f_T typ. 650 MHz

Feedback capacitance at $f = 1\text{ MHz}$

$-I_C = 1\text{ mA}; -V_{CE} = 10\text{ V}$

$-C_{re}$ typ. 260 fF

Noise figure

$I_E = 2\text{ mA}; -V_{CB} = 10\text{ V}$

$G_S = 16.7\text{ mA/V}; B_S = 0; f = 200\text{ MHz}$
 $f = 800\text{ MHz}$

F typ. 4.5 dB
F typ. 5.5 dB

Transducer gain at $f = 800\text{ MHz}$ (common base) ¹⁾

Gain in dB = $10 \log \frac{\text{output power in load } G_L}{\text{available power from source } G_S}$

$I_E = 2\text{ mA}; -V_{CB} = 10\text{ V}; G_S = 16.7\text{ mA/V}$

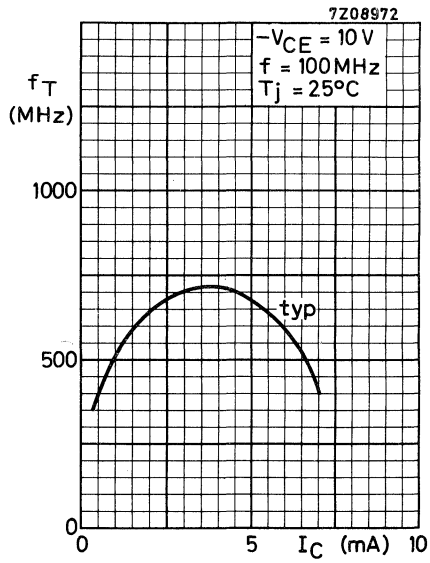
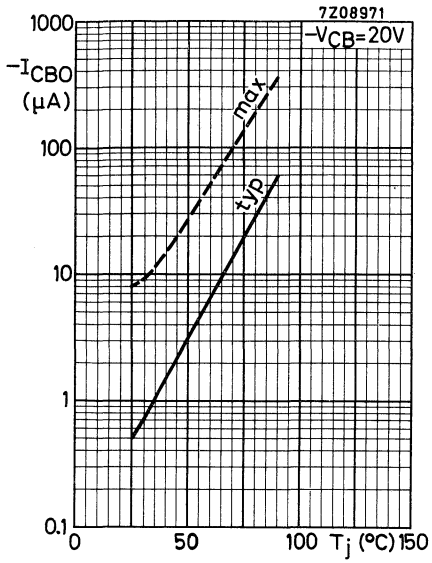
$G_L = 0.5\text{ mA/V}$

G_{tr} typ. 14 dB

$G_L = 2\text{ mA/V}$

G_{tr} typ. 12 dB

¹⁾ Length of leads is 3 mm from can to earth.



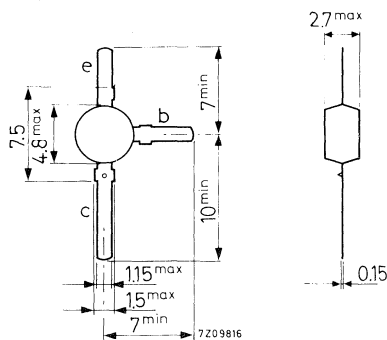
U.H.F. GERMANIUM SEMIPLANAR TRANSISTOR

P-N-P transistor in a plastic envelope, primarily intended for use in pre-amplifier or mixer circuits up to frequencies of 890 MHz.

QUICK REFERENCE DATA			
Collector-base voltage ($V_{BE} = 0$)	$-V_{CBS}$	max.	20 V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	15 V
Collector current (d.c.)	$-I_C$	max.	10 mA
Total power dissipation up to $T_{amb} = 50^\circ\text{C}$	P_{tot}	max.	60 mW
Junction temperature	T_j	max.	90 $^\circ\text{C}$
Transition frequency at $f = 100$ MHz $-I_C = 2$ mA; $-V_{CE} = 10$ V	f_T	typ.	780 MHz
Transducer gain at $-I_C = 2$ mA; $-V_{CE} = 10$ V $f = 900$ MHz; $G_C = 2$ mA/V	G_{tr}	typ.	12 dB
Noise figure $I_E = 2$ mA; $-V_{CB} = 10$ V $G_S = 16.7$ mA/V; $B_S = 0$ $f = 900$ MHz	F	<	6 dB

MECHANICAL DATA

Dimensions in mm



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

Voltages

Collector-base voltage ($V_{BE} = 0$)	$-V_{CBS}$	max.	20 V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	15 V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	0.3 V

Currents

Collector current (d.c.)	$-I_C$	max.	10 mA
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Power dissipation

Total power dissipation up to $T_{amb} = 50^{\circ}C$	P_{tot}	max.	60 mW
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Temperatures

Storage temperature	T_{stg}	-30 to +75	$^{\circ}C$
Junction temperature	T_j	max.	90 $^{\circ}C$

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	0.6 $^{\circ}C/mW$
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CHARACTERISTICS

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

Collector cut-off current

$-V_{CB} = 20\ V; V_{EB} = 0$	$-I_{CBS}$	typ.	0.8 μA
		<	15 μA
$-V_{CE} = 15\ V; I_B = 0$	$-I_{CEO}$	<	500 μA

Emitter cut-off current

$I_C = 0; -V_{EB} = 0.3\ V$	$-I_{EBO}$	<	100 μA
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D.C. current gain

$-I_C = 2\ mA; -V_{CE} = 10\ V$	h_{FE}	>	10
$-I_C = 10\ mA; -V_{CE} = 2\ V$	h_{FE}	>	10

CHARACTERISTICS (continued)

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

Base-emitter voltage

$-I_C = 2 \text{ mA}; -V_{CE} = 10 \text{ V}$ $-V_{BE}$ typ. 350 mV

Transition frequency at $f = 100 \text{ MHz}$

$-I_C = 2 \text{ mA}; -V_{CE} = 10 \text{ V}$ f_T typ. 780 MHz

Feedback capacitance at $f = 0.45 \text{ MHz}$

$-I_C = 2 \text{ mA}; -V_{CE} = 10 \text{ V}$ $-C_{re}$ typ. 400 fF

Output capacitance at $f = 900 \text{ MHz}$

$-I_C = 2 \text{ mA}; -V_{CE} = 10 \text{ V}$ C_{oe} typ. 500 fF

Noise figure

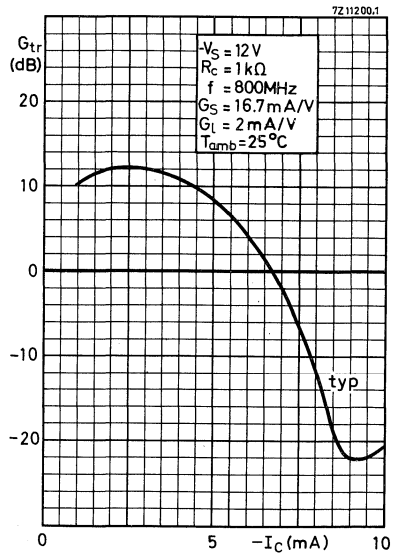
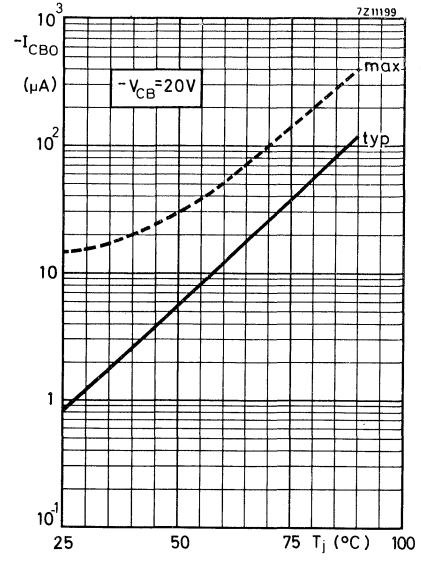
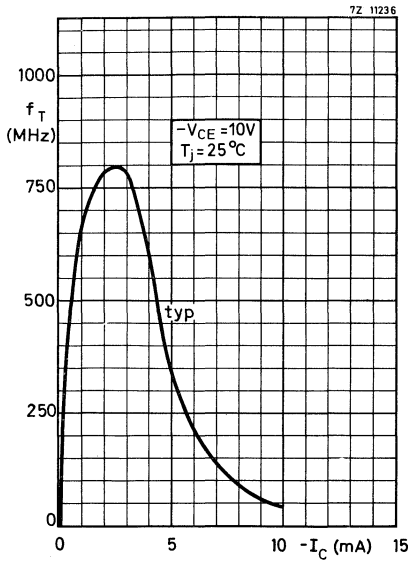
$-I_C = 2 \text{ mA}; -V_{CE} = 10 \text{ V}$
 $G_S = 16.7 \text{ mA/V}; B_S = 0$ $f = 900 \text{ MHz}$ F < 6 dB

Transducer gain at $T_{amb} = 25^\circ\text{C}$

$$G_{tr} \text{ in dB} = 10 \log \frac{\text{output power in load } G_L}{\text{available power from source } G_S}$$

$-I_C = 2 \text{ mA}; -V_{CE} = 10 \text{ V}$
 $f = 900 \text{ MHz}; G_c = 2 \text{ m}\Omega^{-1}; G_S = 16.7 \text{ mA/V}$ G_{tr} > 10.5 dB
typ. 12 dB

$G_c =$ total effective collector conductance.



U.H.F. GERMANIUM MESA TRANSISTOR

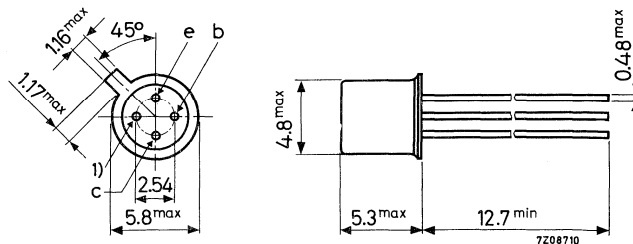
P-N-Ptransistor in a TO-72 metal envelope, primarily intended for use in pre-amplifier, mixer or oscillator circuits up to frequencies of 860 MHz.

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 $T_{amb} = 45^\circ\text{C}$	P_{tot}	max.	60 mW
Junction temperature	T_j	max.	90 $^\circ\text{C}$
Transition frequency			
$-I_C = 1.5\text{ mA}; -V_{CE} = 12\text{ V}$	f_T	typ.	550 MHz
Max. unilateralised power gain			
$I_E = 1.5\text{ mA}; -V_{CB} = 12\text{ V}; f = 800\text{ MHz}$	G_{UM}	typ.	11.5 dB
Noise figure			
$I_E = 1.5\text{ mA}; -V_{CB} = 12\text{ V};$ $f = 800\text{ MHz}; R_S = 60\ \Omega$	F	typ.	7 dB

MECHANICAL DATA

Dimensions in mm

TO-72



1) = shield lead (connected to case)

Accessories available: 56246, 56263

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 $T_{amb} = 45\text{ }^{\circ}\text{C}$	P_{tot}	max.	60 mW
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Temperatures

Storage temperature	T_{stg}	-30 to +75	$^{\circ}\text{C}$
Junction temperature	T_j	max.	90 $^{\circ}\text{C}$

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	0.75 $^{\circ}\text{C}/\text{mW}$
From junction to case	$R_{th\ j-c}$	=	0.40 $^{\circ}\text{C}/\text{mW}$

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

CHARACTERISTICS

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

Collector cut-off current

$I_E = 0; -V_{CB} = 20\text{ V}$	$-I_{CBO}$	typ. 0.7 μA < 3 μA
$I_E = 0; -V_{CB} = 20\text{ V}; T_j = 60\text{ }^\circ\text{C}$	$-I_{CBO}$	typ. 7 μA < 30 μA
$I_B = 0; -V_{CE} = 15\text{ V}$	$-I_{CEO}$	< 500 μA

Emitter cut-off current

$I_C = 0; -V_{EB} = 0.5\text{ V}$	$-I_{EBO}$	typ. 4 μA < 100 μA
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Base current

$I_E = 1.5\text{ mA}; -V_{CB} = 12\text{ V}$	$-I_B$	typ. 25 μA < 150 μA
$I_E = 2\text{ mA}; -V_{CB} = 6\text{ V}$	$-I_B$	typ. 31 μA
$I_E = 5\text{ mA}; -V_{CB} = 6\text{ V}$	$-I_B$	typ. 56 μA

Emitter-base voltage

$I_E = 1.5\text{ mA}; -V_{CB} = 12\text{ V}$	V_{EB}	typ. 380 mV 320 to 430 mV
$I_E = 2\text{ mA}; -V_{CB} = 6\text{ V}$	V_{EB}	typ. 380 mV 320 to 430 mV
$I_E = 5\text{ mA}; -V_{CB} = 6\text{ V}$	V_{EB}	typ. 405 mV 360 to 450 mV

Transition frequency

$-I_C = 1.5\text{ mA}; -V_{CE} = 12\text{ V}$	f_T	typ. 550 MHz
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Reverse transfer time constant

$I_E = 1.5\text{ mA}; -V_{CB} = 12\text{ V}; f = 2.5\text{ MHz}$	$r_{bb'} \cdot C_{b'c}$	typ. 3 ps
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Feedback capacitance at $f = 450\text{ kHz}$

$-I_C = 1.5\text{ mA}; -V_{CE} = 12\text{ V}$	$-C_{re}$	typ. 250 fF ¹⁾
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¹⁾ 1 fF = 1 femtofarad = 10^{-15} F

CHARACTERISTICS (continued)

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

y parameters at $f = 800\text{ MHz}$ ¹⁾

$I_E = 1.5\text{ mA}; -V_{CB} = 12\text{ V}$

Input conductance	g_{ib}	typ.	7 $\text{m}\Omega^{-1}$
Input susceptance	$-b_{ib}$	typ.	11 $\text{m}\Omega^{-1}$
Input capacitance	$-C_{ib}$	typ.	2.2 pF
Feedback admittance	$ y_{rb} $	typ.	0.4 $\text{m}\Omega^{-1}$
Phase angle of feedback admittance	φ_{rb}	typ.	240°
Transfer admittance	$ y_{fb} $	typ.	14 $\text{m}\Omega^{-1}$
Phase angle of transfer admittance	φ_{fb}	typ.	35°
Output conductance	g_{ob}	typ.	0.5 $\text{m}\Omega^{-1}$
Output capacitance	C_{ob}	typ.	1.5 pF

Maximum unilateralised power gain

$$G_{UM} = \frac{|y_{fb}|^2}{4 g_{ib}g_{ob}}$$

$I_E = 1.5\text{ mA}; -V_{CB} = 12\text{ V}; f = 800\text{ MHz}$ G_{UM} typ. 11.5 dB

¹⁾ Measured with a lead length of 5 mm.

CHARACTERISTICS (continued)

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

Transducer gain

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

$I_E = 1.5\text{ mA}; -V_{CB} = 12\text{ V}; f = 800\text{ MHz}$

G_{tr} > 10.2 dB
typ. 11 dB

Reverse transducer gain

$I_E = 1.5\text{ mA}; -V_{CB} = 12\text{ V}; f = 800\text{ MHz}$

$G_{tr\text{ rev}}$ typ. -23 dB

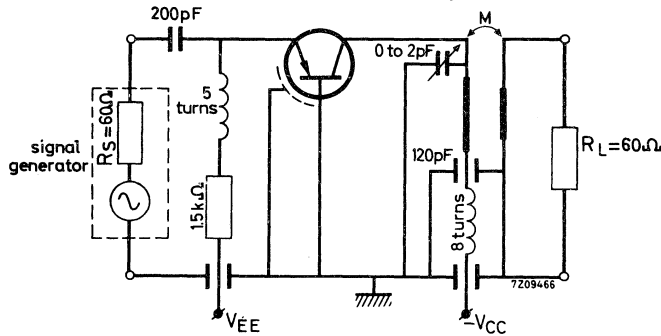
The reverse transducer gain is measured in the circuit below, with load and source (including R_S) interchanged.

Noise figure

$I_E = 1.5\text{ mA}; -V_{CB} = 12\text{ V}; f = 800\text{ MHz}$

F typ. 7 dB
< 8 dB

Basic circuit for measuring the transducer gain G_{tr} and the noise figure F.



Total effective collector resistance $R_C = 1.4\text{ k}\Omega$

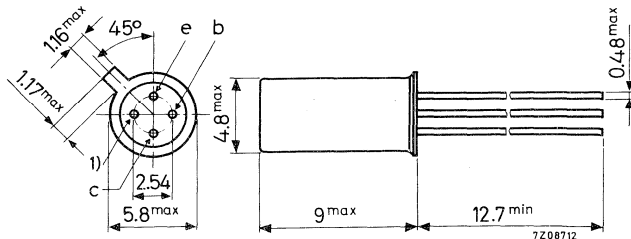
U.H.F. GERMANIUM EPITAXIAL MESA TRANSISTOR

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 $T_{amb} = 30\text{ }^\circ\text{C}$	P_{tot}	max.	140 mW
Junction temperature	T_j	max.	90 $^\circ\text{C}$
Transition frequency			
$-I_C = 6\text{ mA}; -V_{CE} = 12\text{ V}$	f_T	typ.	700 MHz
Transducer gain at $T_j = 70\text{ }^\circ\text{C}$			
$I_E = 4\text{ mA}; -V_{CB} = 20\text{ V}; f = 800\text{ MHz}$	G_{TR}	typ.	12 dB
Noise figure			
$I_E = 1.5\text{ mA}; -V_{CB} = 12\text{ V};$ $f = 800\text{ MHz}; R_S = 60\ \Omega$	F	typ.	7 dB

MECHANICAL DATA

Dimensions in mm



1) = shield lead (connected to case)

Accessories available: 56246, 56263

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

Voltages

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	32 V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	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 $T_{amb} = 30\text{ }^\circ\text{C}$ with cooling fin No. 56263	P_{tot}	max.	140 mW
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Temperatures

Storage temperature	T_{stg}	-30 to +75	$^\circ\text{C}$
Junction temperature	T_j	max.	90 $^\circ\text{C}$

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	0.55 $^\circ\text{C}/\text{mW}$
From junction to ambient with cooling fin No. 56263	$R_{th\ j-a}$	=	0.42 $^\circ\text{C}/\text{mW}$
From junction to case	$R_{th\ j-c}$	=	0.32 $^\circ\text{C}/\text{mW}$

CHARACTERISTICS

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

Transition frequency

$-I_C = 6\text{ mA}; -V_{CE} = 12\text{ V}$	f_T	typ.	700 MHz
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Noise figure at $f = 800\text{ MHz}$

$I_E = 1.5\text{ mA}; -V_{CB} = 12\text{ V}; R_S = 60\ \Omega$	F	typ.	7 dB
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Transducer gain

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

$I_E = 4\text{ mA}; -V_{CB} = 20\text{ V};$ $f = 800\text{ MHz}; T_j = 70\text{ }^\circ\text{C}$	G_{tr}	>	10 dB
		typ.	12 dB

GERMANIUM ALLOY DIFFUSED TRANSISTOR

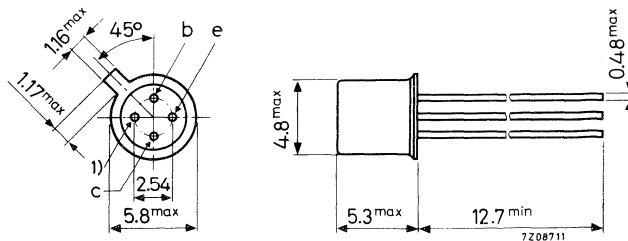
P-N-P transistor in a TO-72 metal envelope with a shield lead connected to the case. The transistor is intended for v.h.f. operation up to 200 MHz.

QUICK REFERENCE DATA		
Collector-base voltage (open emitter)	$-V_{CB0}$	max. 20 V
Collector-emitter voltage (open base)	$-V_{CEO}$	max. 10 V
Collector current (d.c.)	$-I_C$	max. 10 mA
Total power dissipation up to $T_{amb} = 25\text{ }^\circ\text{C}$	P_{tot}	max. 85 mW
Junction temperature	T_j	max. 75 $^\circ\text{C}$
Transition frequency	f_T	typ. 180 MHz
$-I_C = 1\text{ mA}; -V_{CE} = 6\text{ V}$		
Noise figure	F	typ. 6.0 dB
$-I_C = 1\text{ mA}; -V_{CE} = 12\text{ V}$ $f = 200\text{ MHz}; R_S = 30\text{ }\Omega$		

MECHANICAL DATA

Dimensions in mm

TO-72



1) = shield lead (connected to case)

Accessories available: 56246, 56263

RATINGS (Limiting values) 1)Voltages

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	20 V
Collector-emitter voltage ($+V_{BE} = 0.5 \text{ V}$)			
$-I_C$ up to 10 mA	$-V_{CEX}$	max.	20 V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	10 V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	0.5 V

Currents

Collector current (d.c.)	$-I_C$	max.	10 mA
Base current (d.c.)	$-I_B$	max.	1.0 mA
Emitter current (d.c.)	I_E	max.	10 mA
Reverse emitter current (d.c.)	$-I_E$	max.	1.0 mA

Power dissipation

Total power dissipation up to $T_{amb} = 25 \text{ }^\circ\text{C}$	P_{tot}	max.	85 mW
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Temperatures

Storage temperature	T_{stg}	-55 to +75	$^\circ\text{C}$
Junction temperature, continuous	T_j	max.	75 $^\circ\text{C}$
incidentally	T_j	max.	90 $^\circ\text{C}$

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th \text{ j-a}}$	=	0.6 $^\circ\text{C}/\text{mW}$
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1) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

CHARACTERISTICS

$T_{amb} = 25\text{ }^{\circ}\text{C}$ unless otherwise specified

Collector cut-off current

$I_E = 0; -V_{CB} = 6\text{ V}$

$-I_{CBO}$	typ.	1.0 μA
	<	6.0 μA

$I_E = 0; -V_{CB} = 20\text{ V}$

$-I_{CBO}$	typ.	2.6 μA
	<	50 μA

Emitter cut-off current

$I_C = 0; -V_{EB} = 0.5\text{ V}$

$-I_{EBO}$	typ.	2.0 μA
	<	27 μA

Base-emitter voltage

$-I_C = 1\text{ mA}; -V_{CE} = 6\text{ V}$

$-V_{BE}$	typ.	310 mV
		220 to 380 mV

$-I_C = 10\text{ mA}; -V_{CE} = 2\text{ V}$

$-V_{BE}$	typ.	380 mV
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D.C. current gain

$-I_C = 1\text{ mA}; -V_{CE} = 6\text{ V}$

h_{FE}	>	20
	typ.	60

$-I_C = 10\text{ mA}; -V_{CE} = 2\text{ V}$

h_{FE}	>	25
	typ.	60

Transition frequency

$-I_C = 1\text{ mA}; -V_{CE} = 6\text{ V}$

f_T	>	135 MHz
	typ.	180 MHz

Feedback impedance at $f = 2\text{ MHz}$

$-I_C = 1\text{ mA}; -V_{CE} = 6\text{ V}$

$ z_{rb} $	typ.	10 Ω
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Small signal current gain at $f = 1\text{ kHz}$

$-I_C = 1\text{ mA}; -V_{CE} = 6\text{ V}$

h_{fe}	>	20
	typ.	70

Feedback capacitance at $f = 450\text{ kHz}$

$-I_C = 1\text{ mA}; -V_{CE} = 6\text{ V}$

$-C_{re}$	typ.	1.0 pF
	<	1.5 pF

Noise figure

$-I_C = 1\text{ mA}; -V_{CE} = 12\text{ V}$
 $f = 200\text{ MHz}; R_S = 30\text{ }\Omega$

F	typ.	6.0 dB
	<	7.5 dB

CHARACTERISTICS (continued)

$T_{amb} = 25\text{ }^{\circ}\text{C}$ unless otherwise specified

y parameters at $f = 200\text{ MHz}$ (common emitter)

$-I_C = 1\text{ mA}$; $-V_{CE} = 12\text{ V}$ 1)

Input conductance	g_{ie}	typ. 28	$\text{m}\Omega^{-1}$
Input capacitance	C_{ie}	typ. 13	pF
Feedback admittance	$ y_{re} $	typ. 500	$\mu\Omega^{-1}$
Phase angle of feedback admittance	φ_{re}	typ. 250	$^{\circ}$
Transfer admittance	$ y_{fe} $	typ. 34	$\text{m}\Omega^{-1}$
Phase angle of transfer admittance	φ_{fe}	typ. 292	$^{\circ}$
Output conductance	g_{oe}	typ. 220	$\mu\Omega^{-1}$
Output capacitance	C_{oe}	typ. 2.0	pF

y parameters at $f = 100\text{ MHz}$ (common emitter)

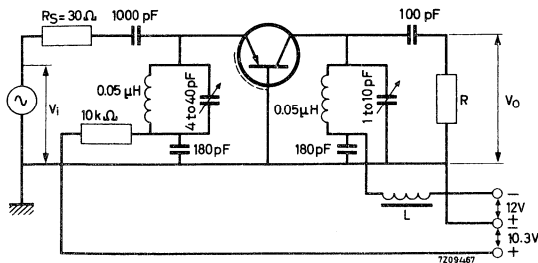
$I_E = 1\text{ mA}$; $-V_{CB} = 10\text{ V}$ 1)

Input conductance	g_{ib}	typ. 32.5	$\text{m}\Omega^{-1}$
Input capacitance	$-C_{ib}$	typ. 10	pF
Feedback admittance	$ y_{rb} $	typ. 410	$\mu\Omega^{-1}$
Phase angle of feedback admittance	φ_{rb}	typ. 280	$^{\circ}$
Transfer admittance	$ y_{fb} $	typ. 30	$\text{m}\Omega^{-1}$
Phase angle of transfer admittance	φ_{fb}	typ. 115	$^{\circ}$
Output conductance	g_{ob}	typ. 220	$\mu\Omega^{-1}$
Output capacitance	C_{ob}	typ. 2.0	pF

Power gain

G_p	>	10	dB
	typ.	13	dB

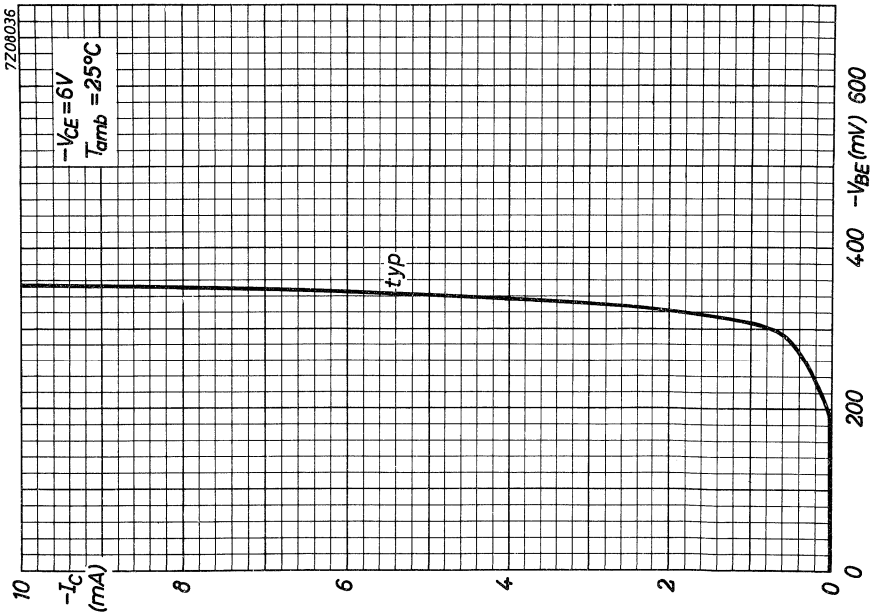
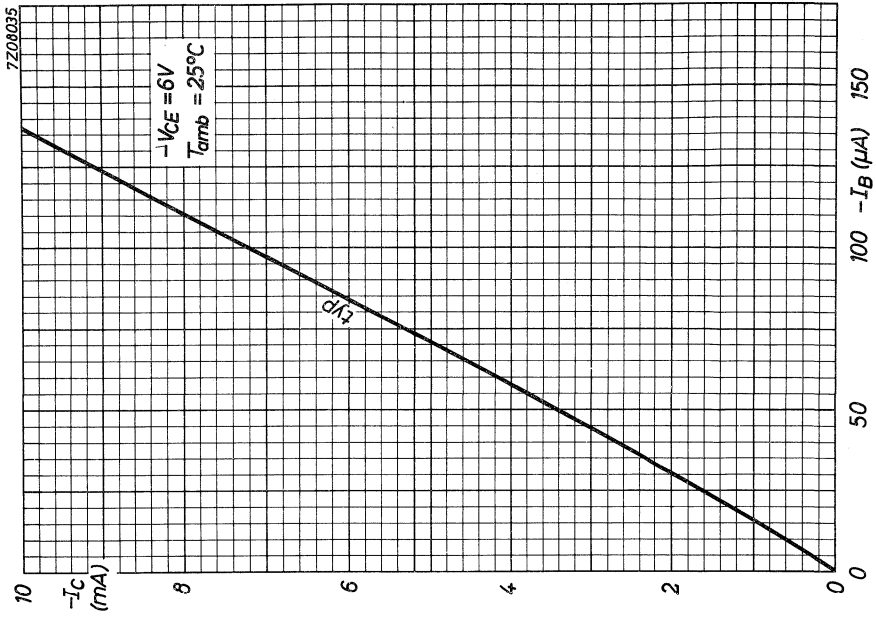
Test circuit:



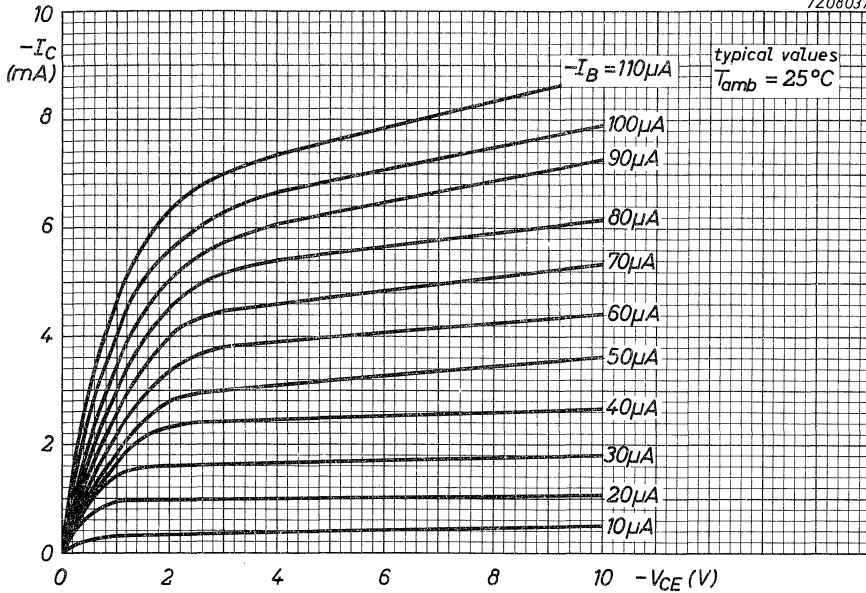
R is chosen such that the total load impedance R_L (R and the tuned circuit in parallel) is $2\text{ k}\Omega$.

L = ferrite bead

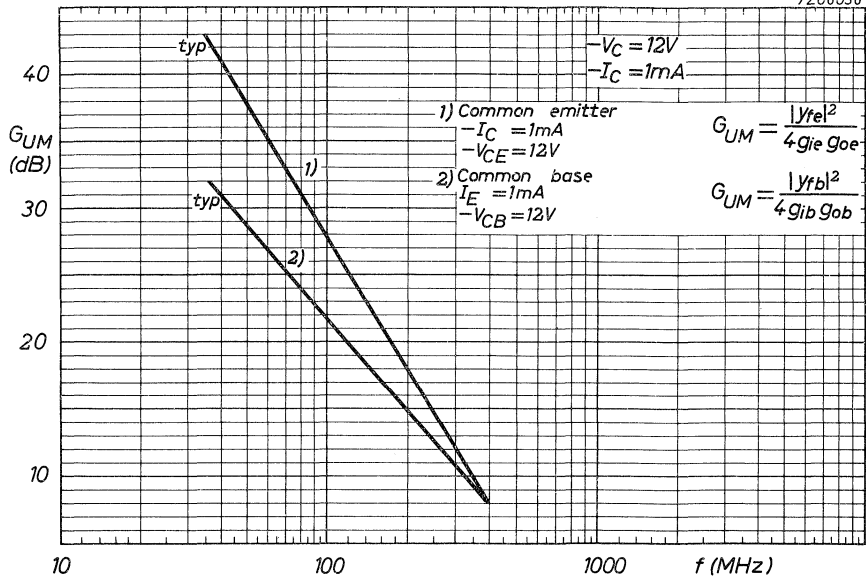
1) Measured with a length of leads between transistor bottom and measuring jig of 5 mm.

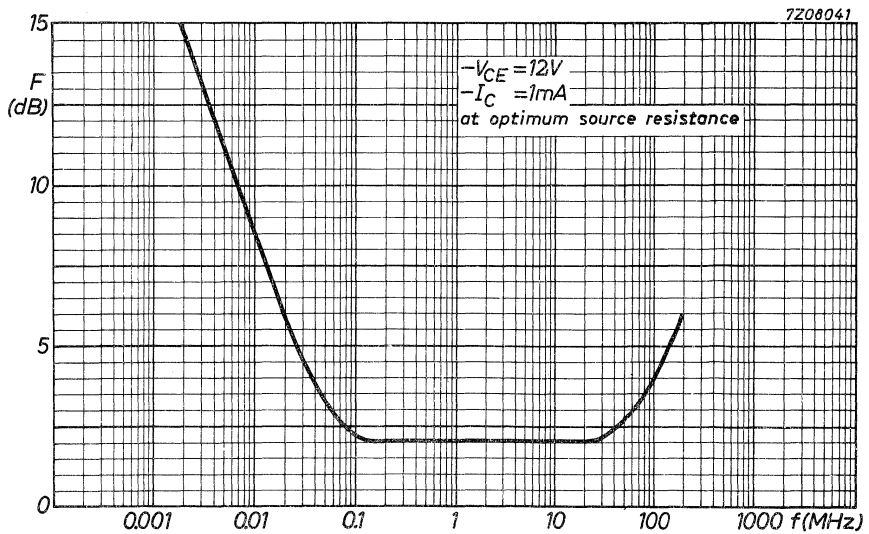
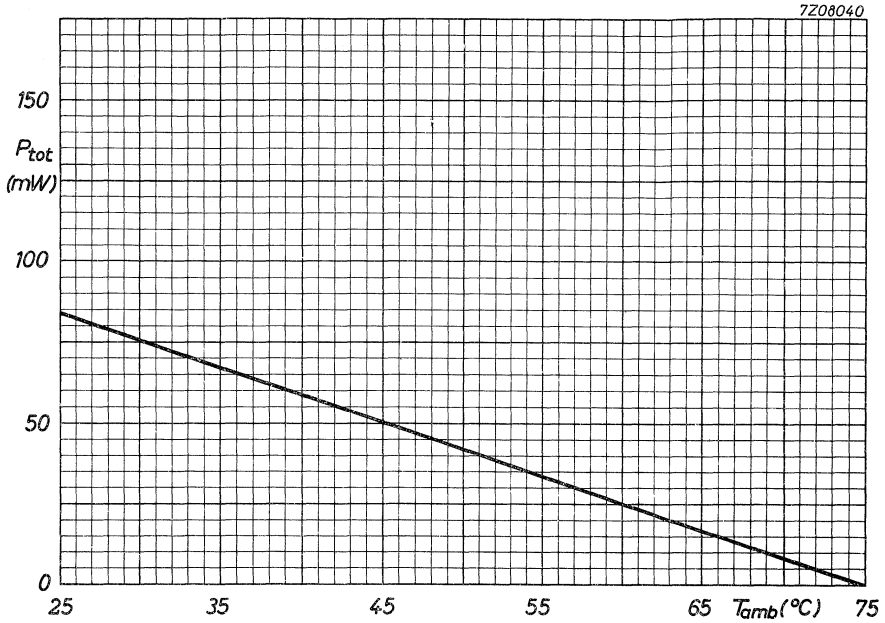


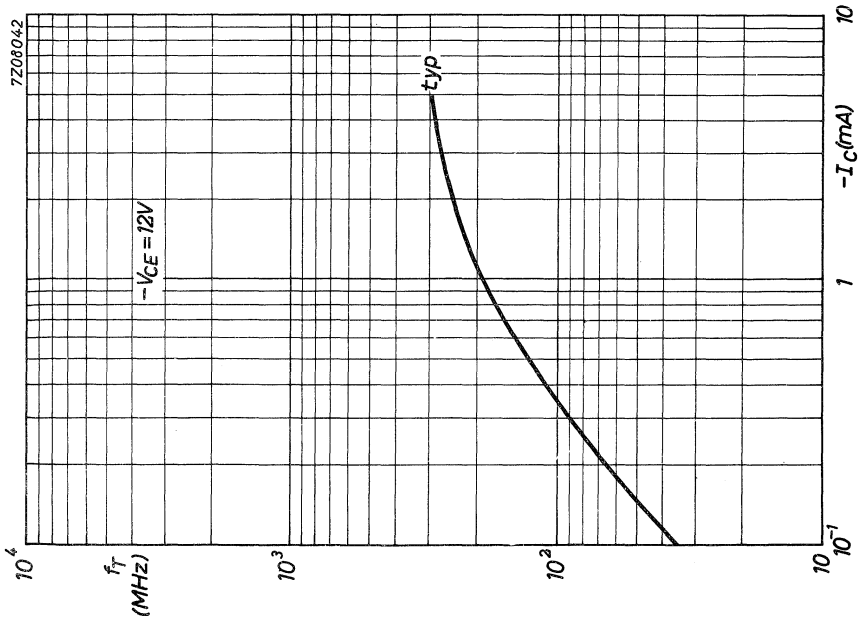
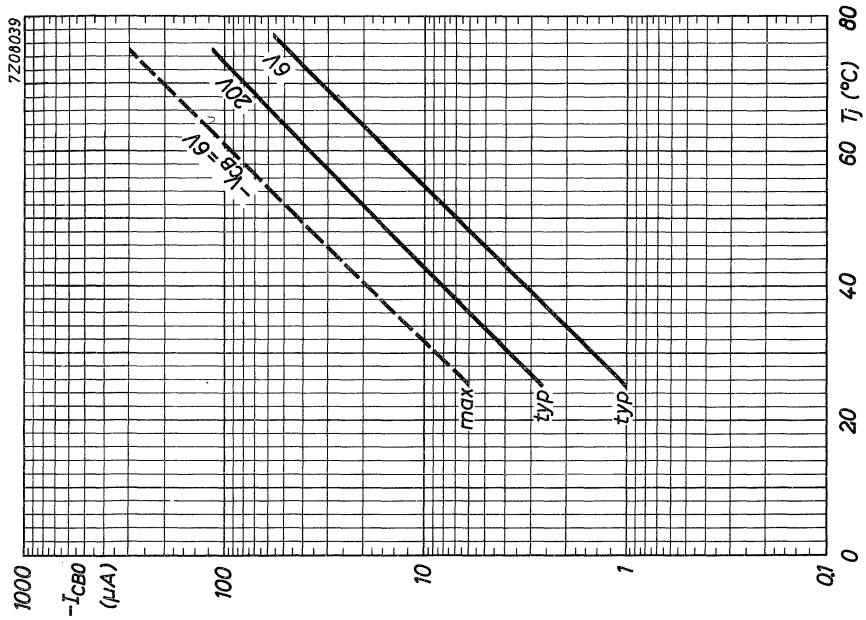
7Z08037

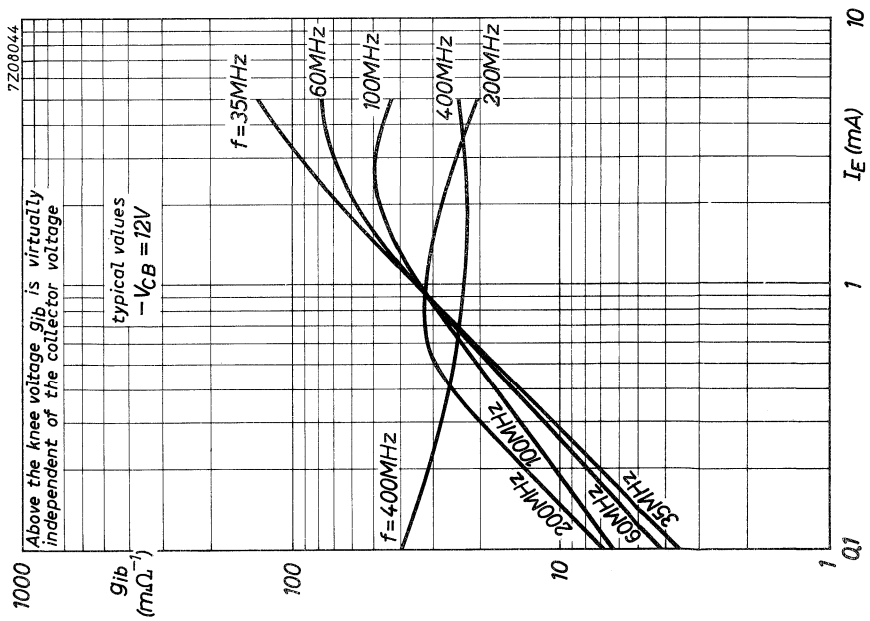
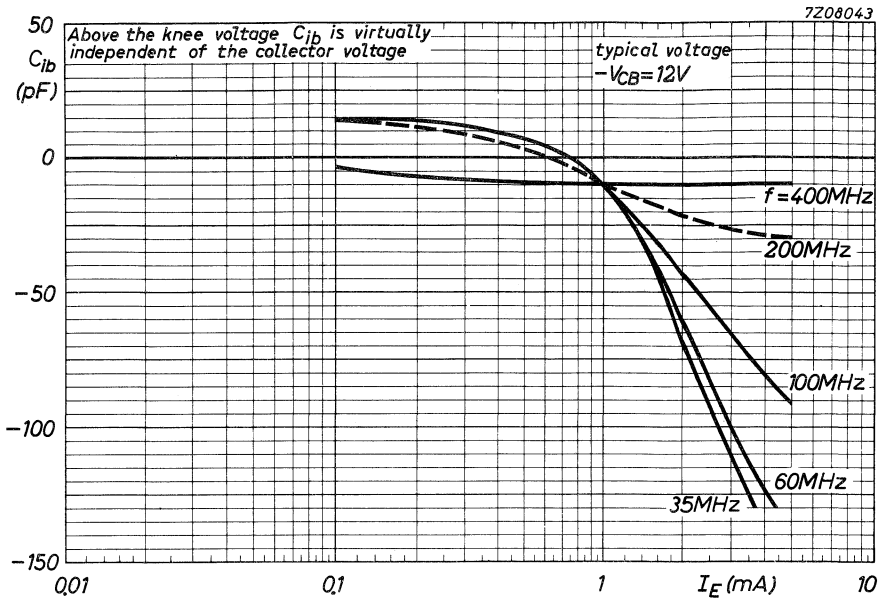


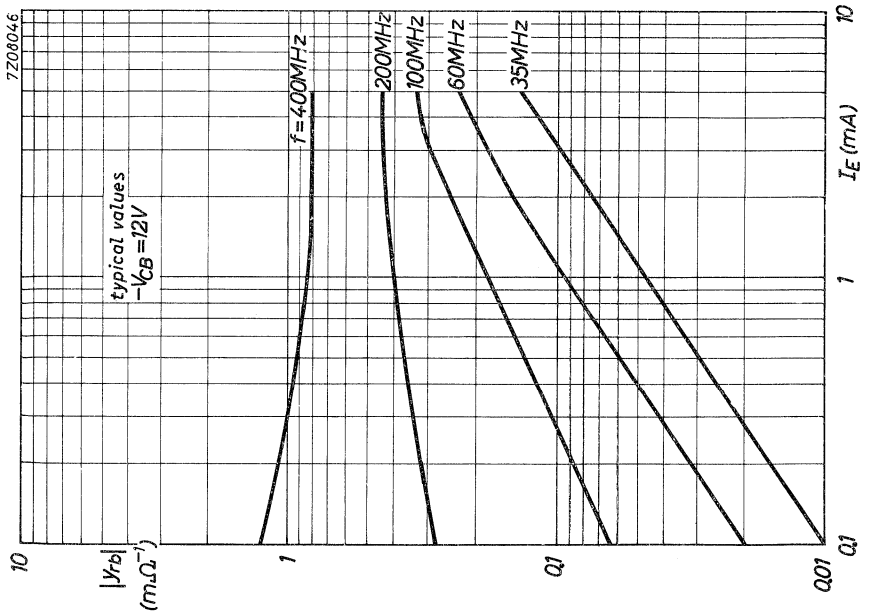
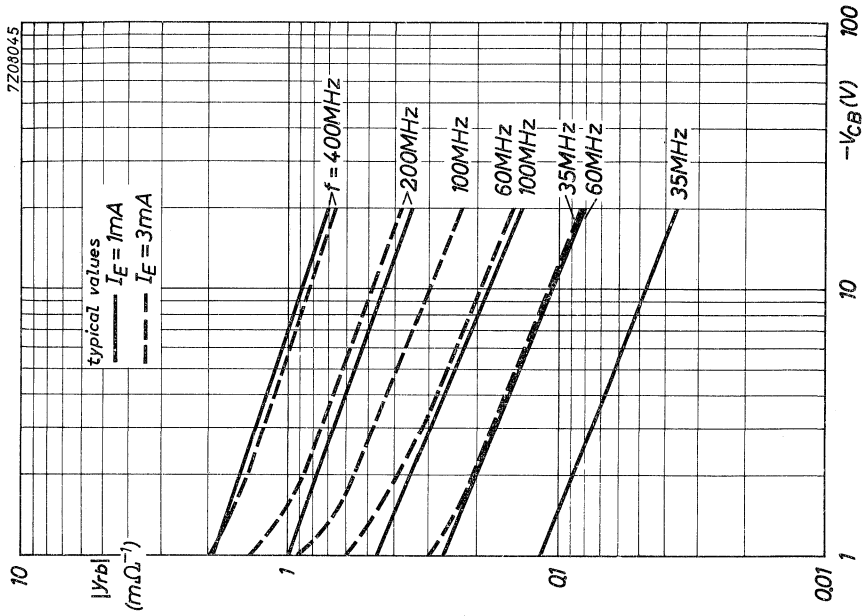
7Z08038

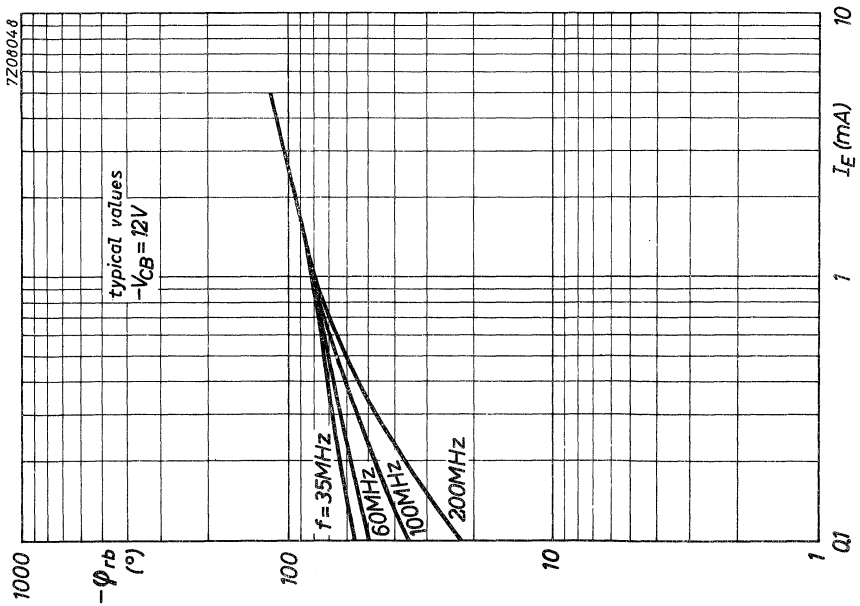
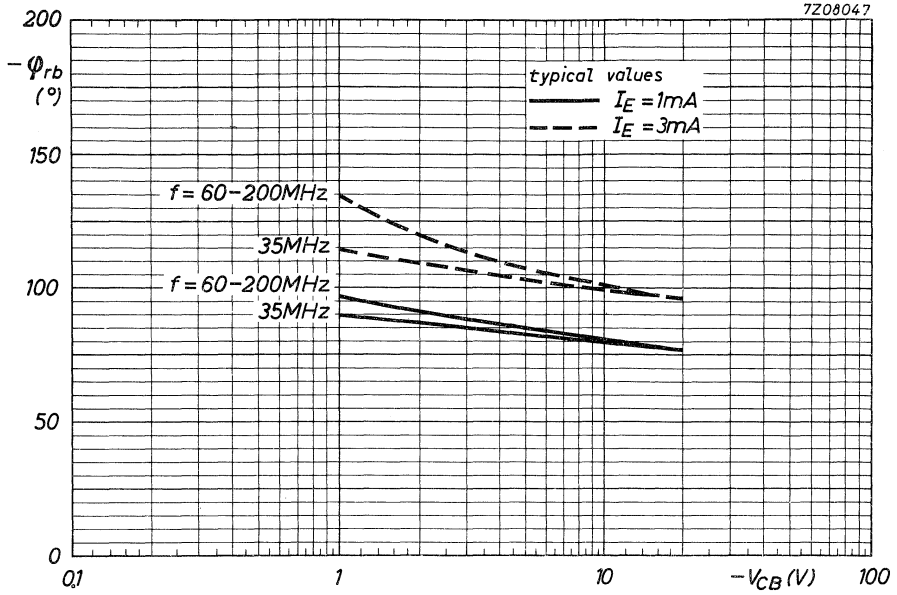


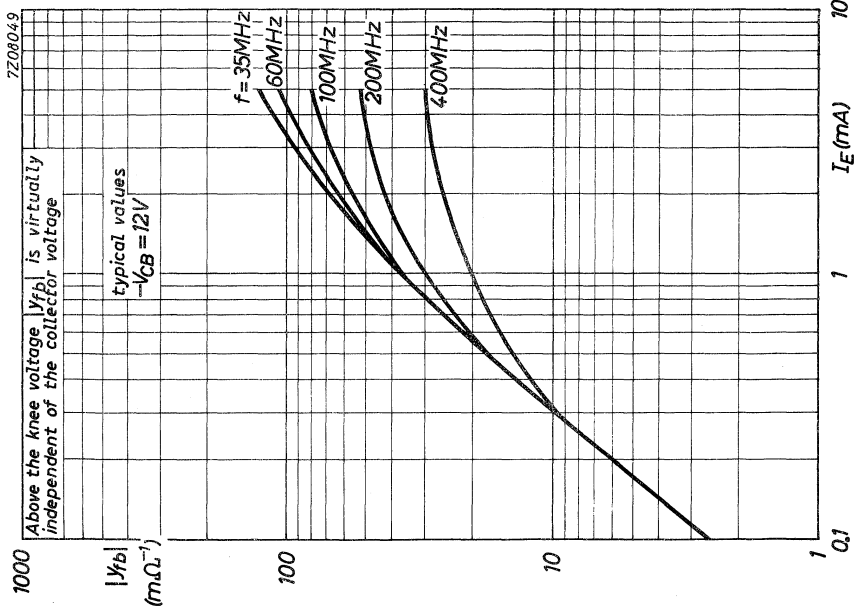
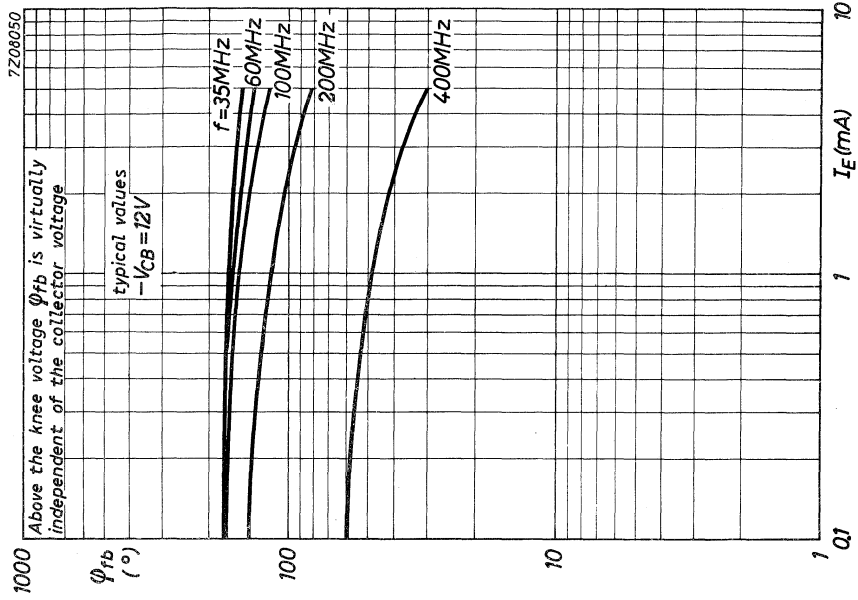


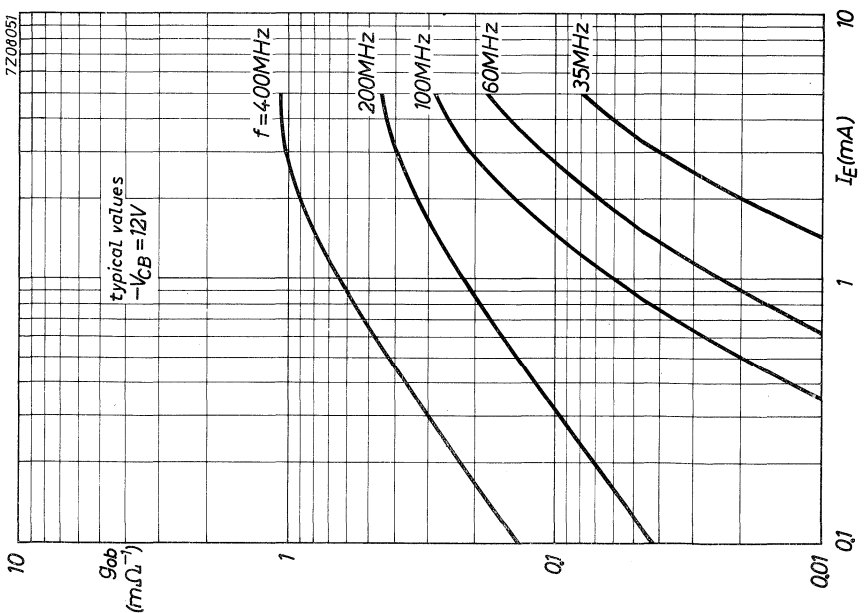
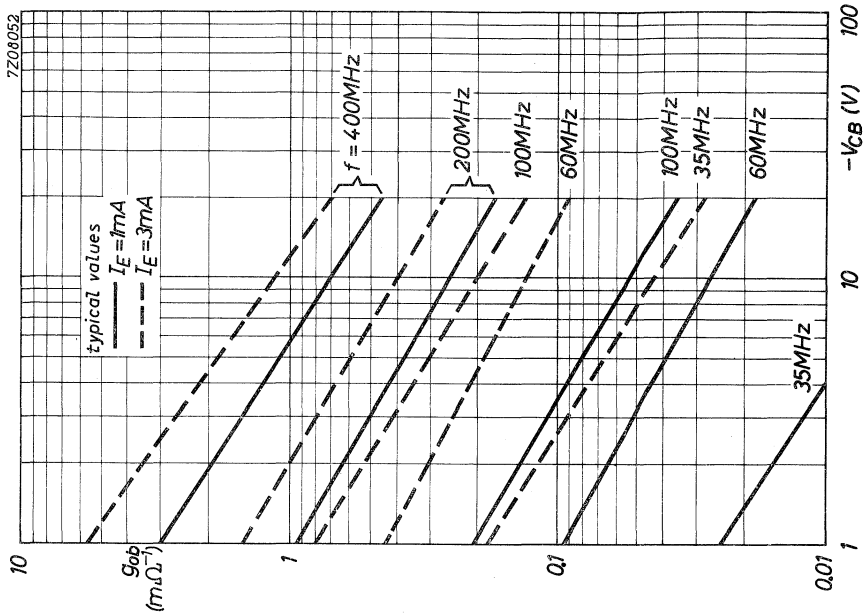




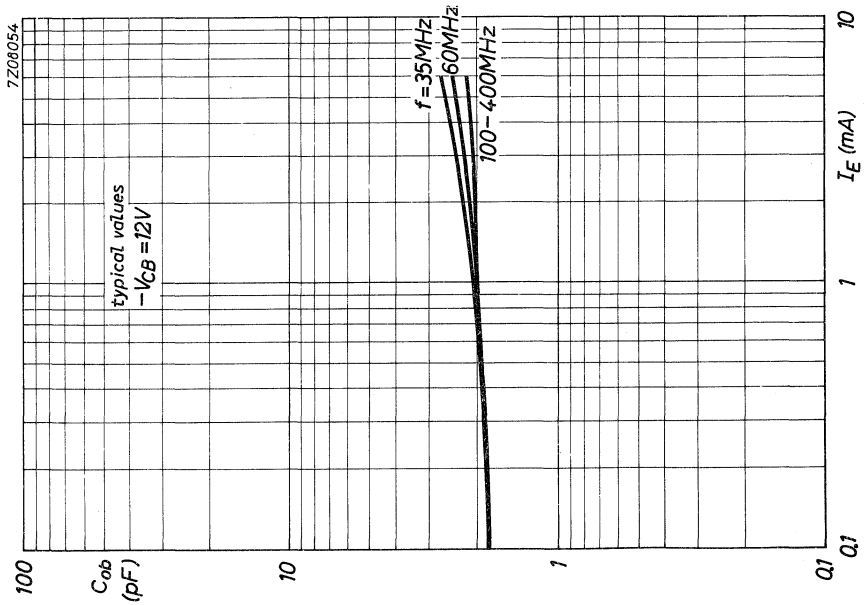
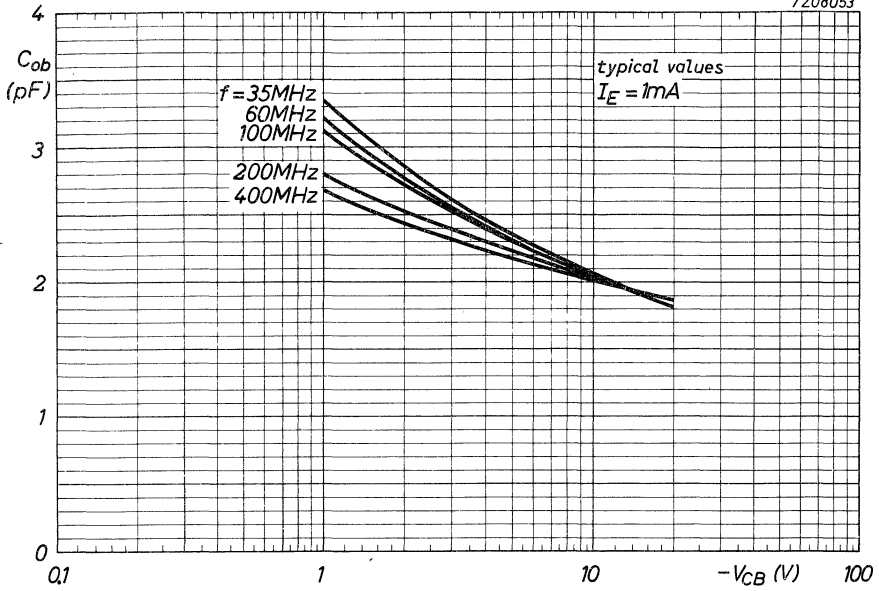


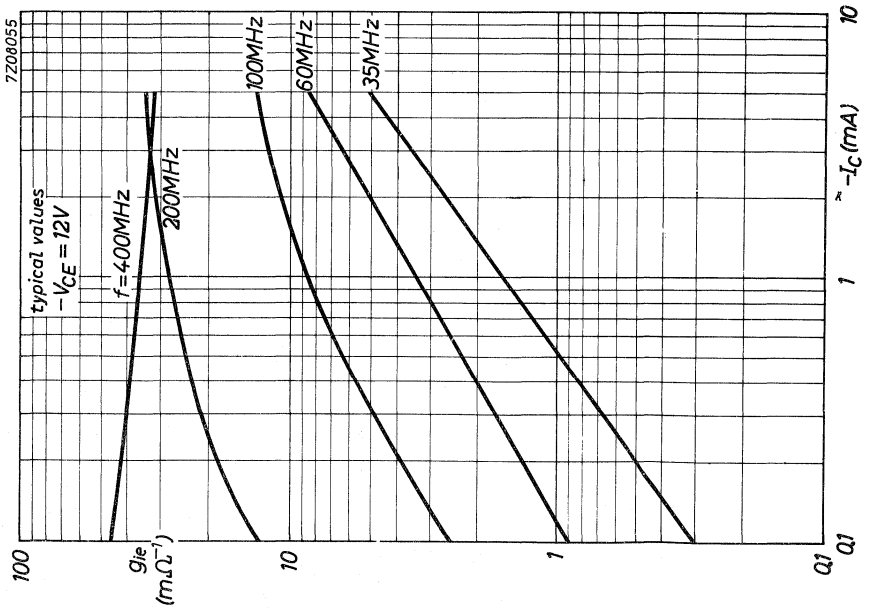
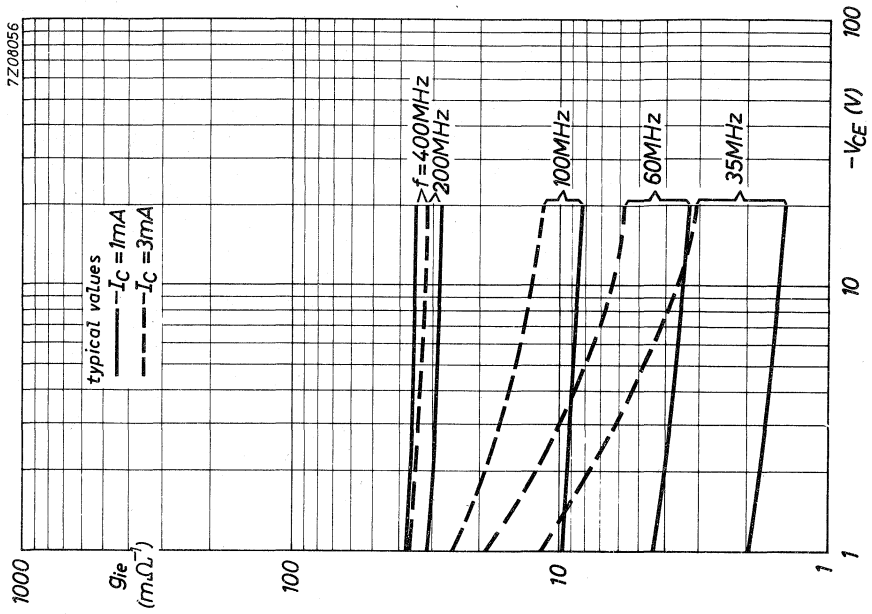




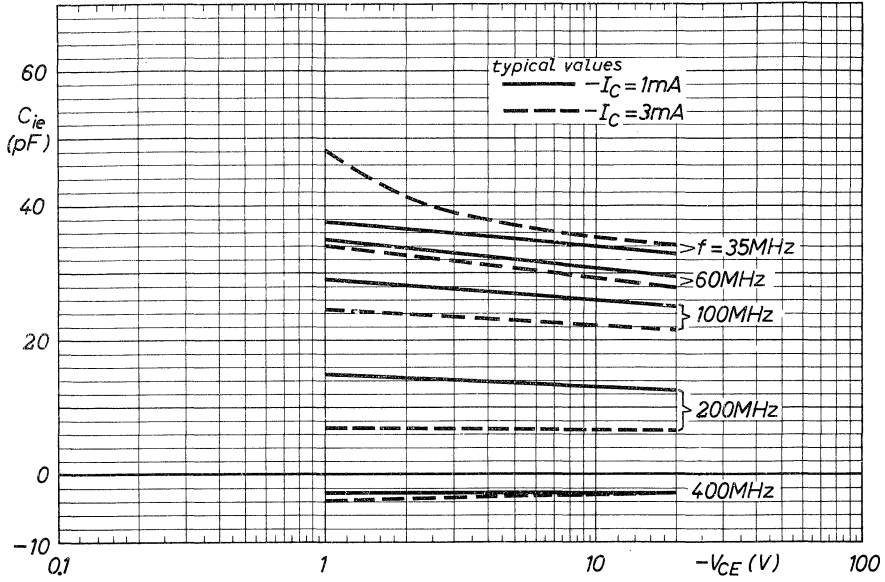


7Z08053

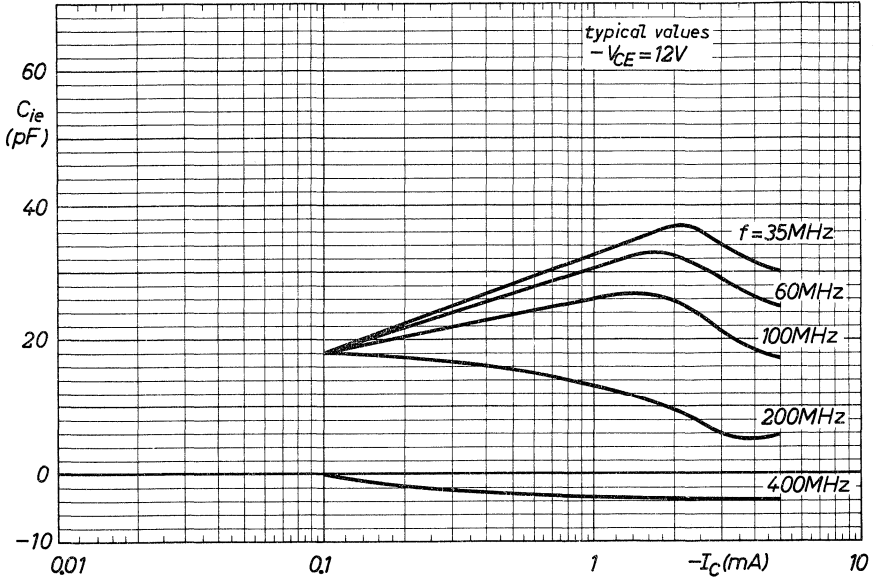


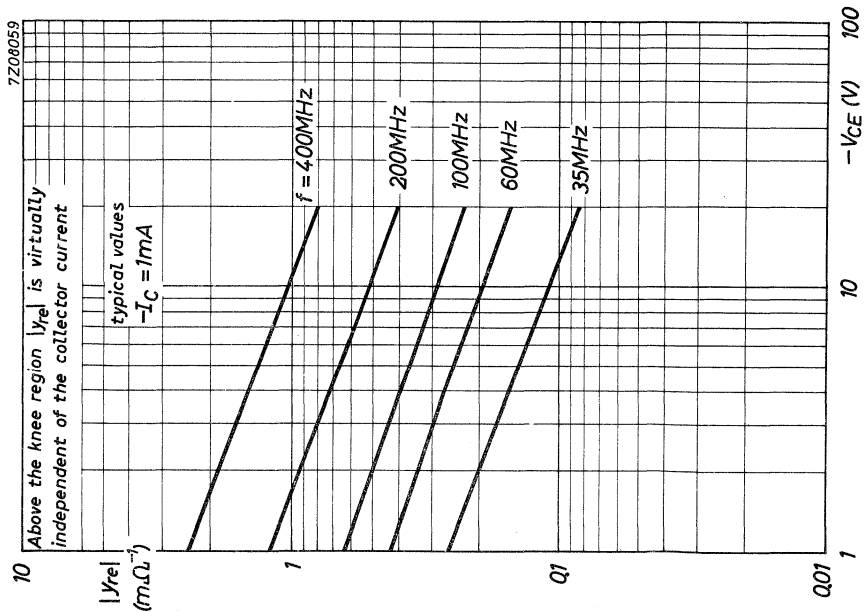
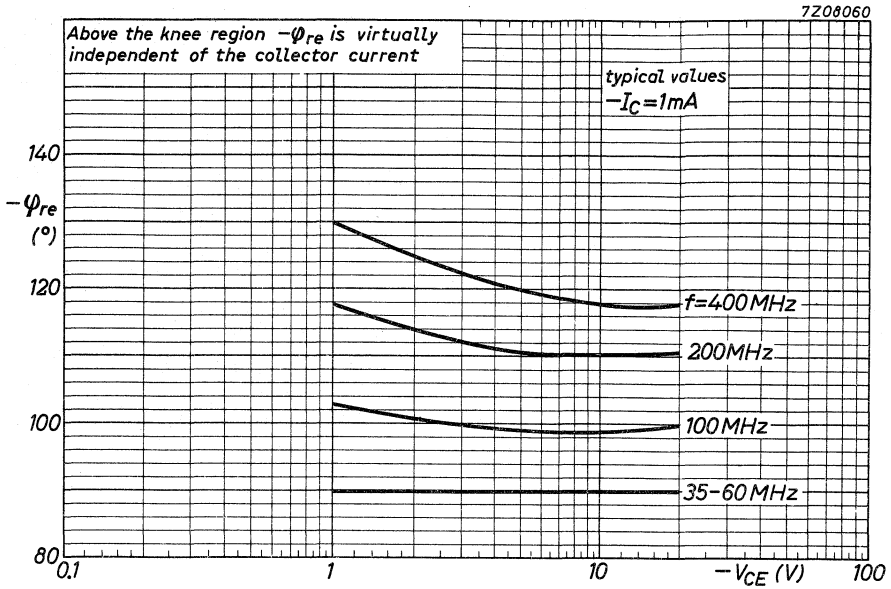


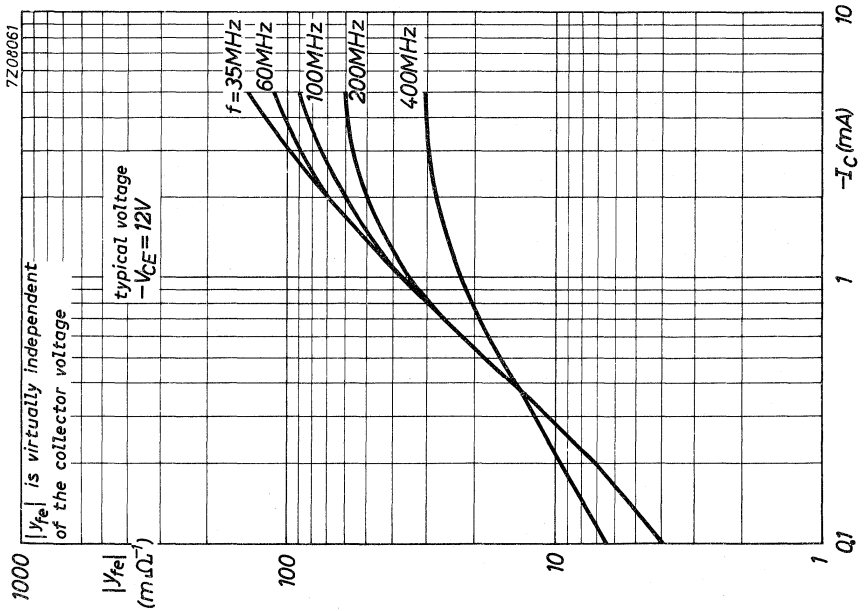
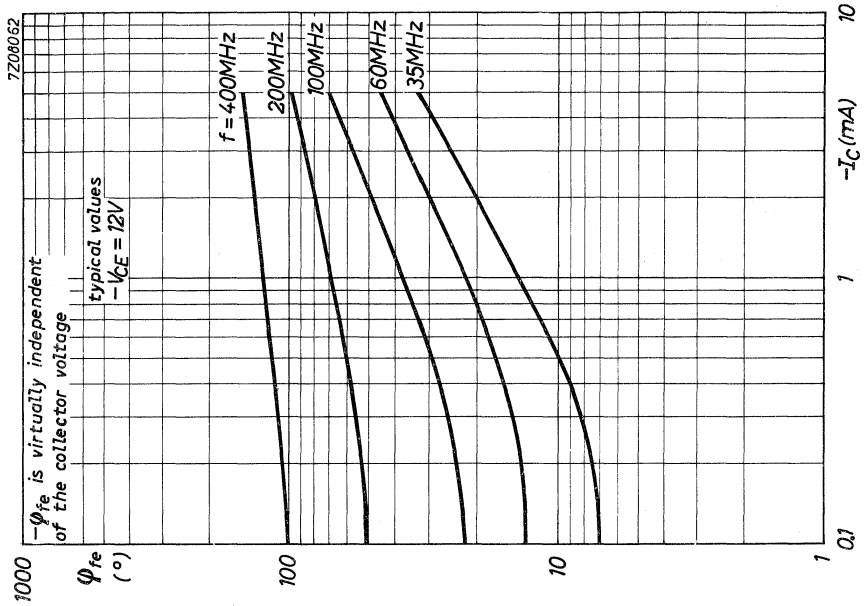
7Z08058



7Z08057







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 same transistor is available in lock-fit encapsulation under the type number BF194 or BF195. It is intended for general broadcast and television.

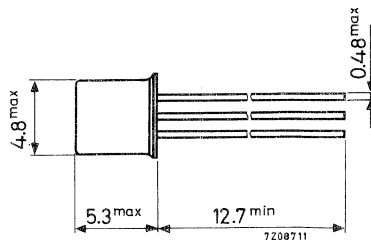
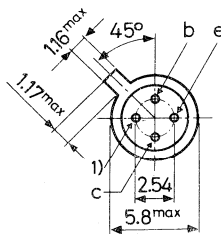
QUICK REFERENCE DATA

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 $T_{amb} = 45^\circ C$	P_{tot}	max. 145 mW
Junction temperature	T_j	max. 175 $^\circ C$
Transition frequency	f_T	typ. 230 MHz
$I_C = 1 \text{ mA}; V_{CE} = 10 \text{ V}$		
Noise figure		
$I_C = 1 \text{ mA}; V_{CE} = 10 \text{ V}$		
$f = 1 \text{ MHz}; G_S = 3.3 \text{ m}\Omega^{-1}$	F	typ. 1.2 dB
$f = 100 \text{ MHz}; G_S = 10 \text{ m}\Omega^{-1}$	F	typ. 4 dB

MECHANICAL DATA

Dimensions in mm

TO-72



1) = shield lead (connected to case)

Accessories available: 56246, 56263.

FOR NEW DESIGN THE SUCCESSOR TYPES
BF194 OR BF195 ARE RECOMMENDED

RATINGS (Limiting values) ¹⁾

Voltages

Collector-base voltage (open emitter)	V_{CBO}	max.	50 V
Collector-emitter voltage (open base) (See also page 5)	V_{CEO}	max.	30 V
Collector-emitter voltage (see page 5)	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 $T_{amb} = 45^\circ C$	P_{tot}	max.	145 mW
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Temperatures

Storage temperature	T_{stg}	-65 to +175	$^\circ C$
Junction temperature	T_j	max.	175 $^\circ C$

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	0.9 $^\circ C/mW$
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¹⁾ Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

CHARACTERISTICS

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

Emitter-base voltage 1)

$-I_E = 1\text{ mA}; V_{CB} = 10\text{ V}$	$-V_{EB}$	0.65 to 0.74	V
$-I_E = 20\text{ mA}; V_{CB} = 2\text{ V}; T_{amb} = 25\text{ }^\circ\text{C}$	$-V_{EB}$	<	1.0 V

Feedback capacitance at $f = 0.45\text{ MHz}$

$I_C = 1\text{ mA}; V_{CE} = 10\text{ V}$	$-C_{re}$	typ.	0.65 pF
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D.C. current gain

$I_C = 1\text{ mA}; V_{CE} = 10\text{ V}$	h_{FE}	45 to	165
$I_C = 20\text{ mA}; V_{CE} = 2\text{ V}$	h_{FE}	>	40

Transition frequency

$I_C = 1\text{ mA}; V_{CE} = 10\text{ V}$	f_T	typ.	230 MHz
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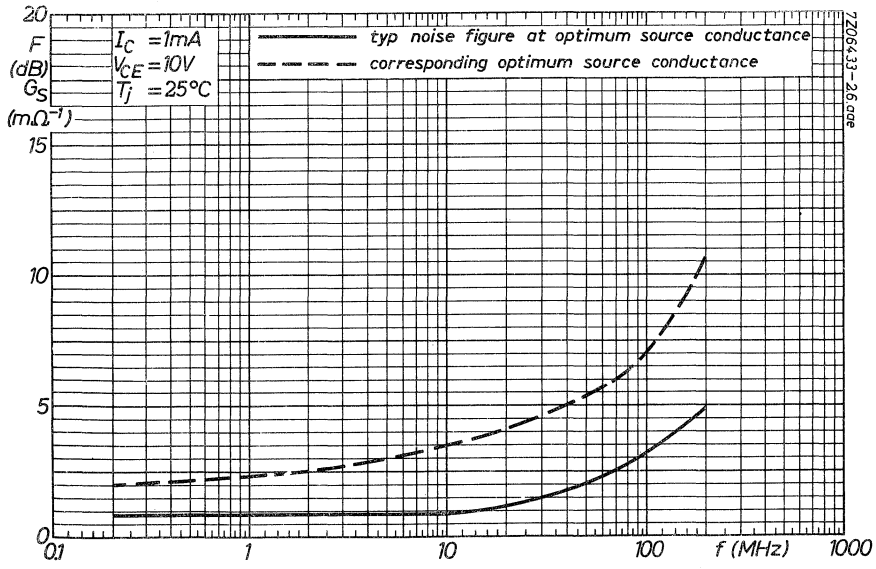
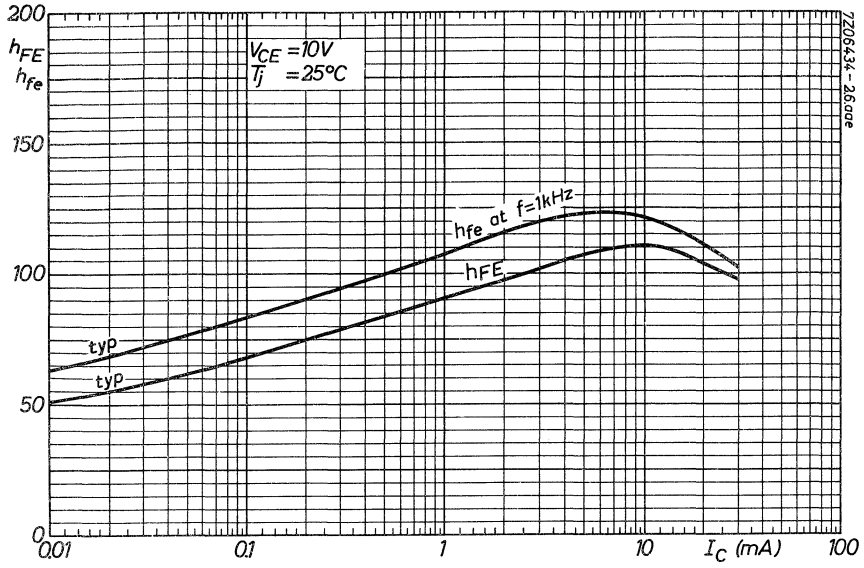
Noise figure at $I_C = 1\text{ mA}; V_{CE} = 10\text{ V}$

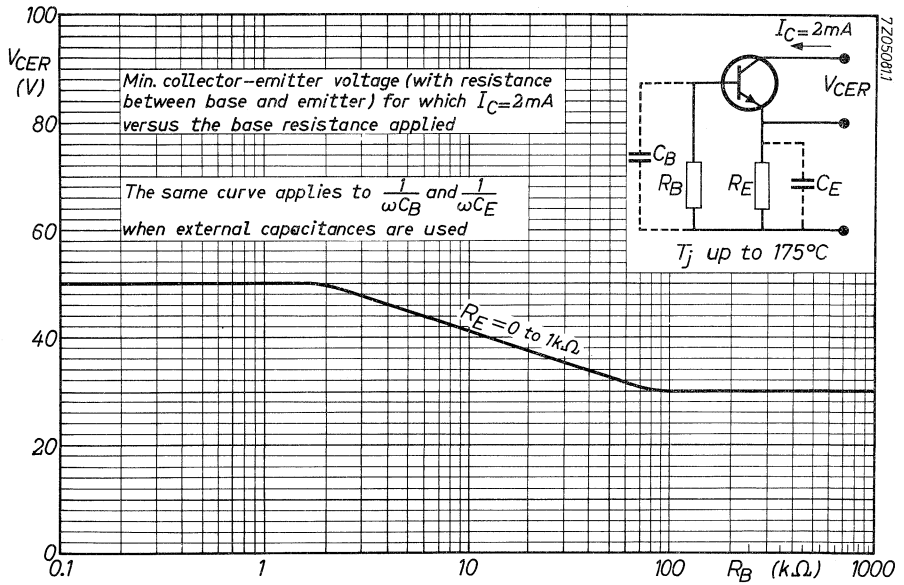
$f = 0.2\text{ MHz}; G_S = 3.3\text{ m}\Omega^{-1}$	F	typ.	1.5 dB
$f = 1\text{ MHz}; G_S = 20\text{ m}\Omega^{-1}$	F	typ.	3.5 dB
$f = 1\text{ MHz}; G_S = 3.3\text{ m}\Omega^{-1}$	F	typ.	1.2 dB
$f = 100\text{ MHz}; G_S = 10\text{ m}\Omega^{-1}$	F	typ.	4 dB

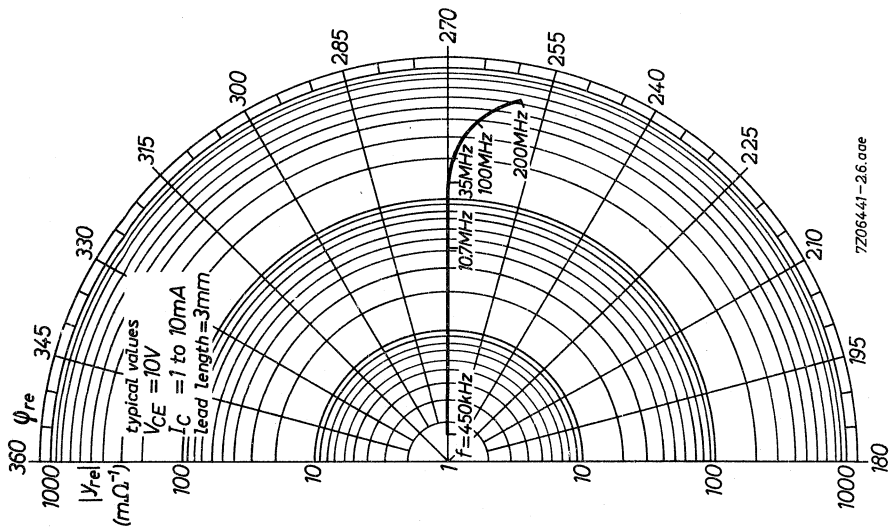
Conversion noise figure at $I_C = 1\text{ mA}; V_{CE} = 10\text{ V}$

$f = 0.2\text{ MHz}; G_S = 1\text{ m}\Omega^{-1}$	F_c	typ.	3.5 dB
$f = 1\text{ MHz}; G_S = 2\text{ m}\Omega^{-1}$	F_c	typ.	2.5 dB

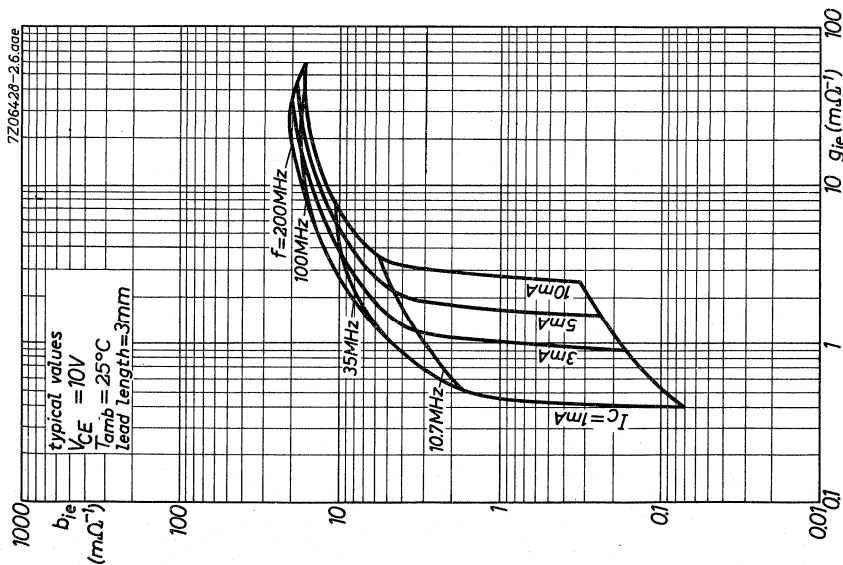
1) $-V_{EB}$ decreases by about $1.7\text{ mV}/^\circ\text{C}$ with increasing temperature.



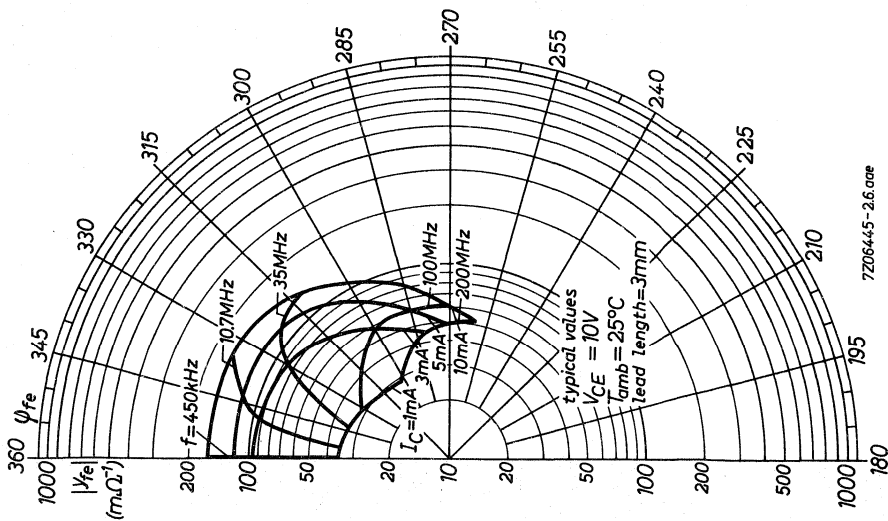
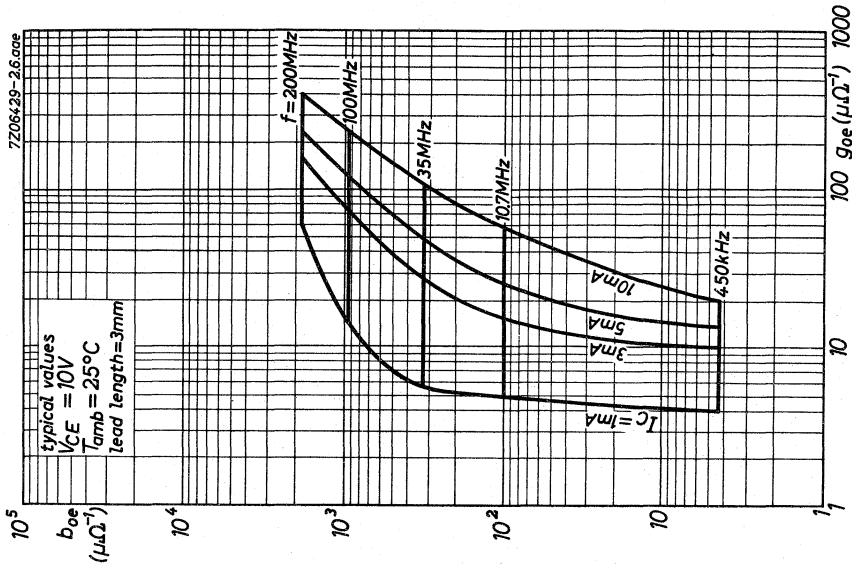


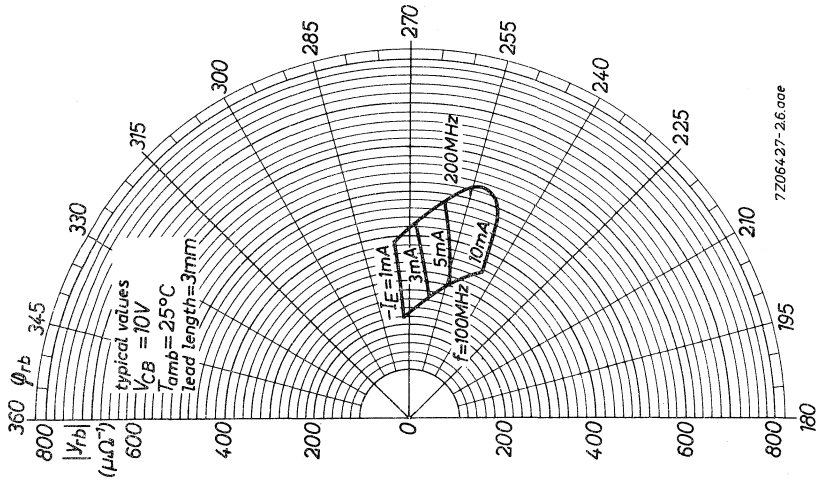


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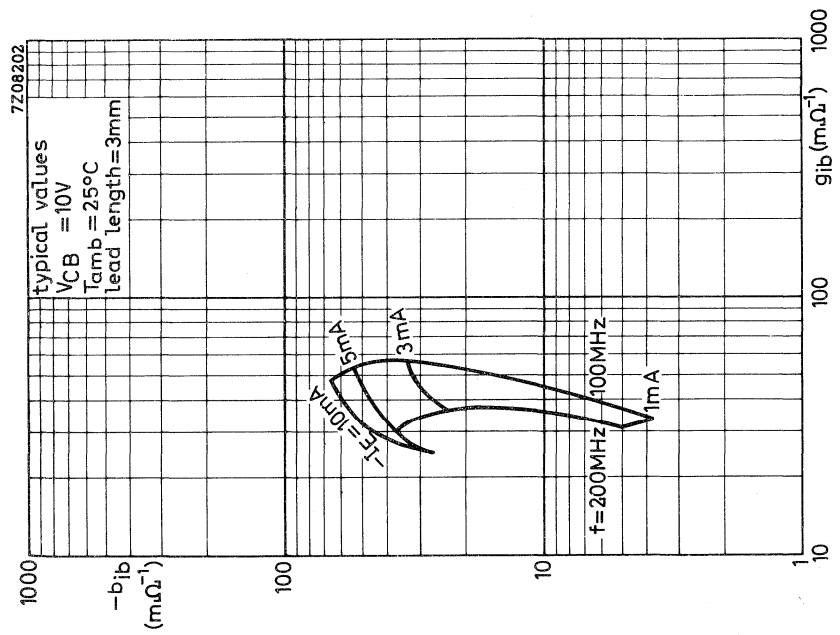


72064-28-2.6.00e

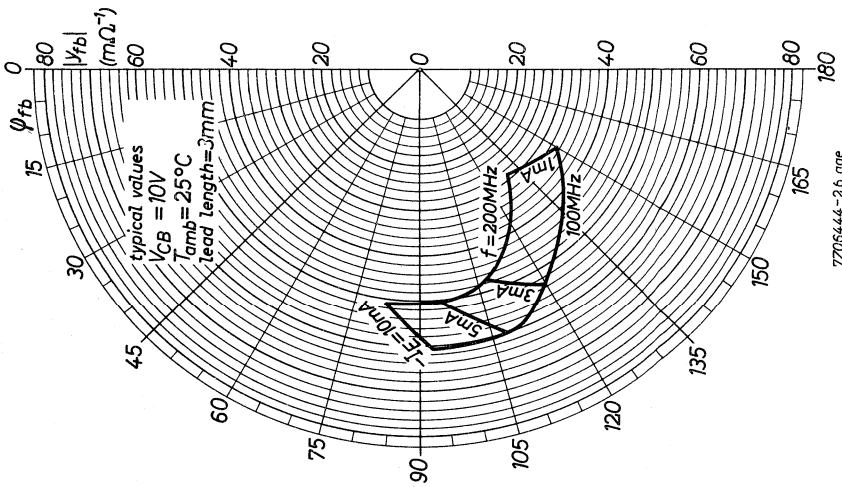
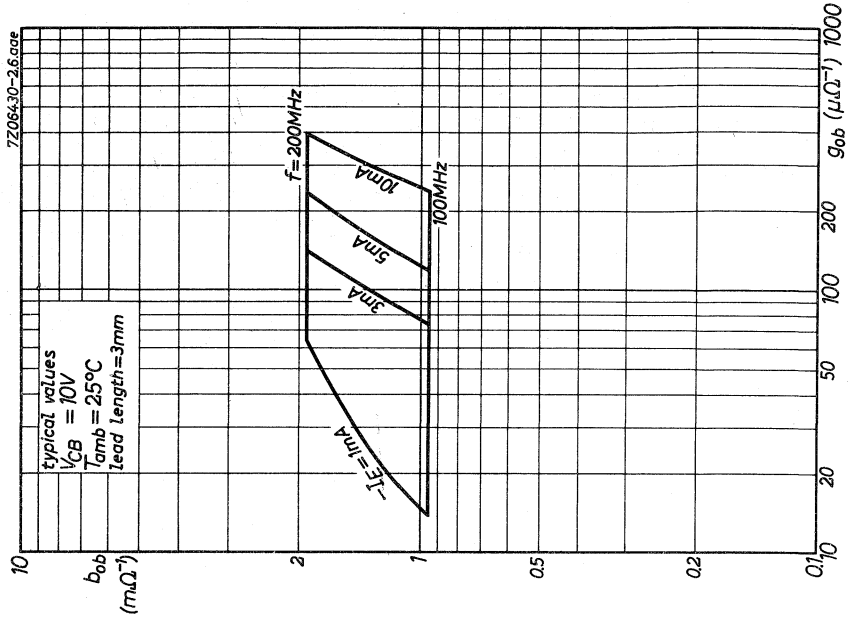


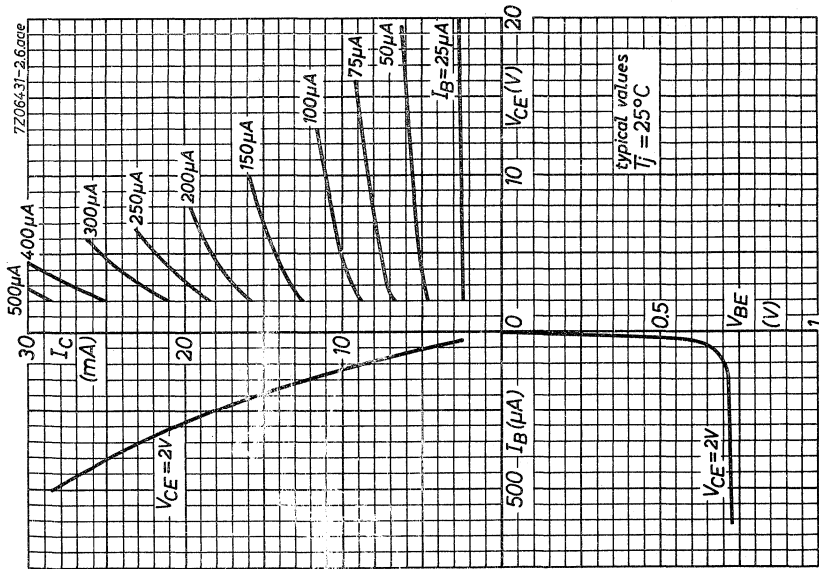
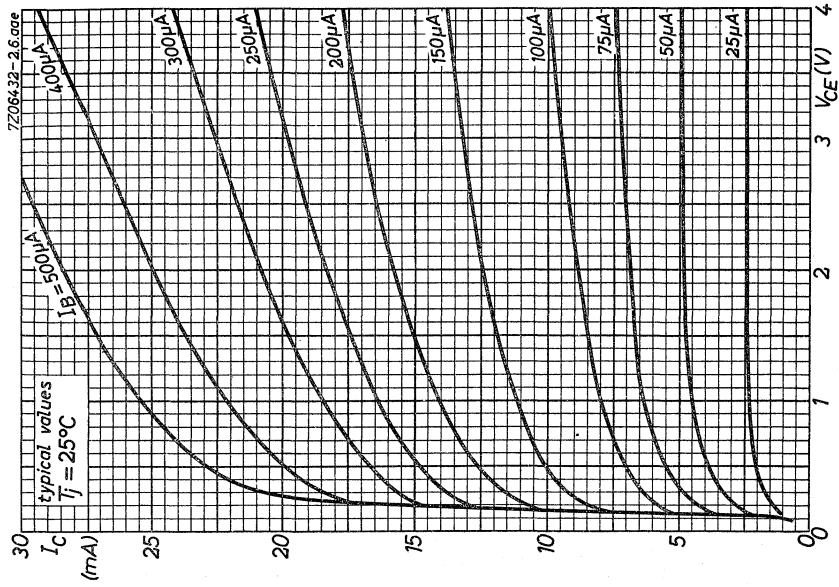


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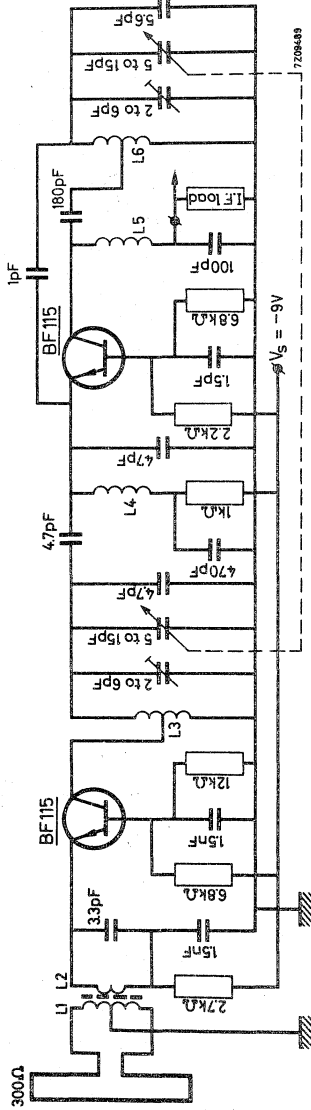
7Z08202





APPLICATION INFORMATION

F.M. Tuner with 2 x BF115



COIL DATA

- L1 = 5 turns; L2 = 2 turns
- L1 and L2 on twin bead K 505006/IZ2
- L3 = 4.5 turns enamelled Cu wire; winding pitch 1 mm; tap at 2.5 turns from earth side; d = 7 mm
- L4 = 15 turns enamelled Cu wire, close wound; d = 4 mm
- L5 = 14 turns stranded wire (36 x 0.03) on coil former 3016/02 with ferroxcube core K 512002 (4 D)
- L6 = 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
 - Noise figure
 - Spurious response repeat spot suppression double beat suppression
 - Image response
 - Frequency drift $\Delta V_S = 2 V$
- | | | |
|------------------|------|--------|
| C_{tr} | typ. | 24 dB |
| F | typ. | 4.5 dB |
| | typ. | 55 dB |
| | typ. | 57 dB |
| | typ. | 35 dB |
| Δf_{osc} | typ. | 10 kHz |
| | < | 15 kHz |



SILICON PLANAR TRANSISTOR

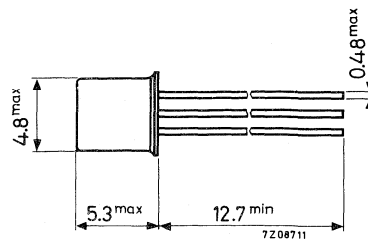
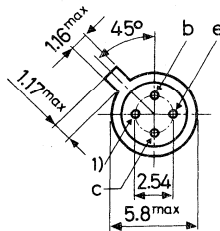
N-P-N transistor in a TO-72 metal envelope with a shield lead connected to the case; the same transistor is available in lock-fit encapsulation under the type-number BF196. It has a very low feedback capacitance and is intended for use in forward gain control stages in video intermediate frequency amplifiers 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 $T_{amb} = 45^\circ\text{C}$	P_{tot}	max. 130 mW
Junction temperature	T_j	max. 175 $^\circ\text{C}$
Transition frequency		
$I_C = 4 \text{ mA}; V_{CE} = 10 \text{ V}$	f_T	typ. 350 MHz
Feedback capacitance at $f = 10.7 \text{ MHz}$		
$I_C = 1 \text{ mA}; V_{CE} = 10 \text{ V}$	$-C_{re}$	typ. 0.15 pF
Max. unilateralised power gain		
$I_C = 4 \text{ mA}; V_{CE} = 10 \text{ V}; f = 35 \text{ MHz}$	G_{UM}	typ. 42 dB
Gain control range	ΔG_{Tr}	typ. 60 dB

MECHANICAL DATA

Dimensions in mm

TO-72



l) = shield lead (connected to case)

Accessories available: 56246, 56263

FOR NEW DESIGN THE SUCCESSOR TYPE BF196 IS RECOMMENDED

RATINGS (Limiting values) ¹⁾

Voltages

Collector-base voltage (open emitter)	V_{CBO}	max.	40 V
Collector-emitter voltage (open base) (See also page 5)	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 $T_{amb} = 45^\circ C$	P_{tot}	max.	130 mW
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Temperatures

Storage temperature	T_{stg}	-65 to +175	$^\circ C$
Junction temperature	T_j	max.	175 $^\circ C$

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	1.0	$^\circ C/mW$
--------------------------------------	---------------	-----	---------------

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

CHARACTERISTICS

$T_{amb} = 25\text{ }^{\circ}\text{C}$ unless otherwise specified

Base current

$I_C = 4\text{ mA}; V_{CE} = 10\text{ V}$	I_B	typ. 70 μA < 150 μA
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Base-emitter voltage

$I_C = 4\text{ mA}; V_{CE} = 10\text{ V}$	V_{BE}	typ. 700 mV 1)
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Feedback capacitance at $f = 10.7\text{ MHz}$

$I_C = 1\text{ mA}; V_{CE} = 10\text{ V}$	$-C_{re}$	typ. 150 fF 2)
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Transition frequency

$I_C = 4\text{ mA}; V_{CE} = 10\text{ V}$	f_T	typ. 350 MHz
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Noise figure at $f = 35\text{ MHz}$

$I_C = 4\text{ mA}; V_{CE} = 10\text{ V}; G_S = 10\text{ m}\Omega^{-1}; B_S = 0$	F	typ. 3 dB
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y parameters at $f = 35\text{ MHz}$

$I_C = 4\text{ mA}; V_{CE} = 10\text{ V}$		
Input conductance	g_{ie}	typ. 4.8 $\text{m}\Omega^{-1}$
Input capacitance	C_{ie}	typ. 45 pF
Feedback admittance	$ y_{re} $	typ. 37 $\mu\Omega^{-1}$
Phase angle of feedback admittance	ϕ_{re}	typ. 268 $^{\circ}$
Transfer admittance	$ y_{fe} $	typ. 95 $\text{m}\Omega^{-1}$
Phase angle of transfer admittance	ϕ_{fe}	typ. 337 $^{\circ}$
Output conductance	g_{oe}	typ. 30 $\mu\Omega^{-1}$
Output capacitance	C_{oe}	typ. 1.2 pF

Maximum unilateralised power gain

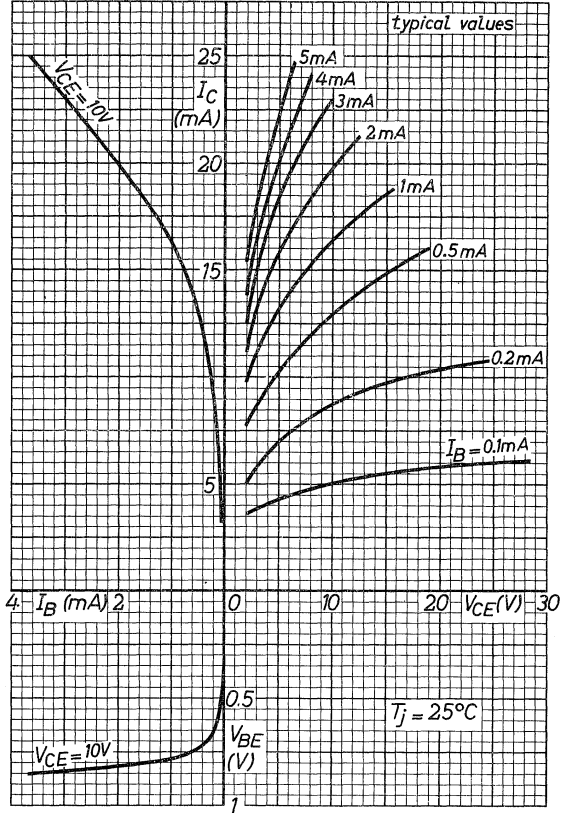
$$GUM = \frac{|y_{fe}|^2}{4 g_{ie} g_{oe}}$$

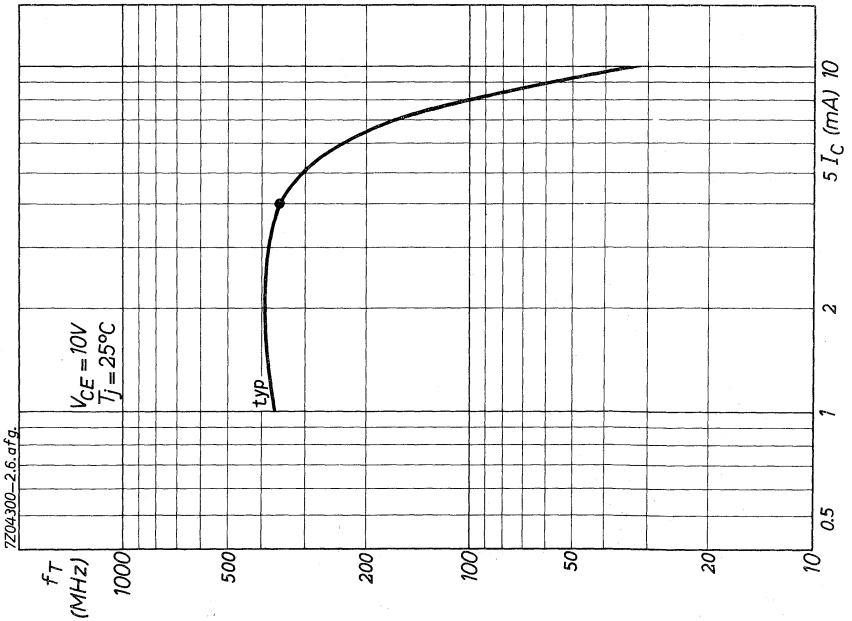
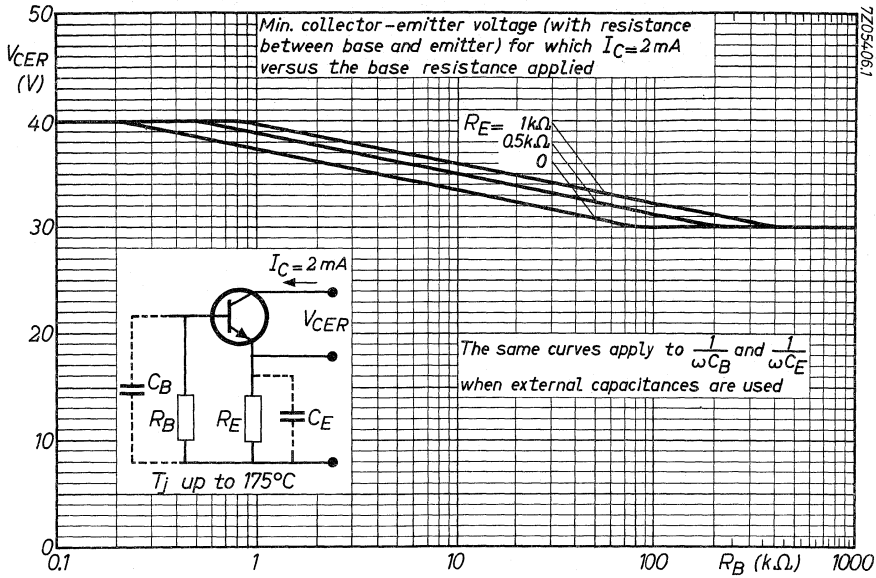
$I_C = 4\text{ mA}; V_{CE} = 10\text{ V}; f = 35\text{ MHz}$	GUM	typ. 42 dB
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1) V_{BE} decreases with about 1.7 mV/ $^{\circ}\text{C}$ at increasing temperature

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

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APPLICATION INFORMATION

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

Transducer gain

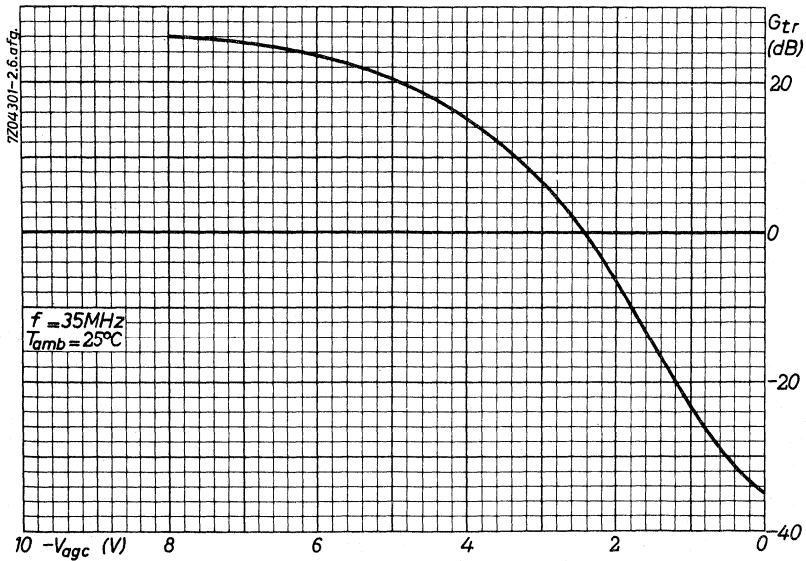
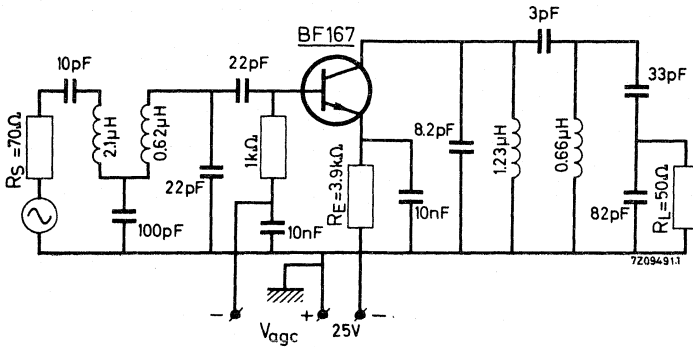
$$G_{tr} = \frac{\text{output power in load } R_L}{\text{available power from source with } R_S}$$

$I_C = 4 \text{ mA}; f = 35 \text{ MHz}$

G_{tr} typ. 26 dB

Gain control range

ΔG_{tr} typ. 60 dB



SILICON PLANAR EPITAXIAL TRANSISTOR

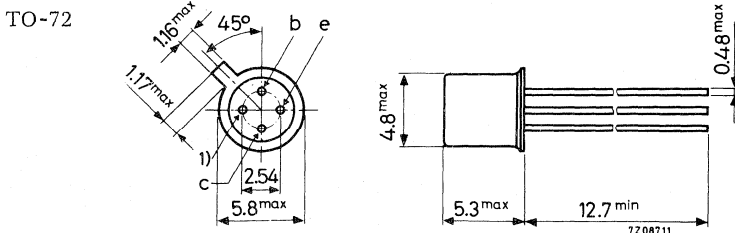
N-P-N transistor in a TO-72 metal envelope with a shield lead connected to the case; the same transistor is available in lock-fit encapsulation under the type-number BF197. It has a very low feedback capacitance and is intended for use in video intermediate frequency amplifiers, in particular for the 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 $T_{amb} = 45\text{ }^\circ\text{C}$	P_{tot}	max. 260 mW
Junction temperature	T_j	max. 175 $^\circ\text{C}$
Transition frequency	f_T	typ. 550 MHz
$I_C = 5\text{ mA}; V_{CE} = 10\text{ V}$		
Feedback capacitance at $f = 10.7\text{ MHz}$		
$I_C = 1\text{ mA}; V_{CE} = 10\text{ V}$	$-C_{re}$	typ. 0.23 pF
Max. unilateralised power gain		
$I_C = 7\text{ mA}; V_{CE} = 10\text{ V}; f = 35\text{ MHz}$	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



l) = shield lead (connected to case)

Accessories available: 56246, 56263

FOR NEW DESIGN THE SUCCESSOR TYPE BF197 IS RECOMMENDED

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 $T_{amb} = 45\text{ }^{\circ}\text{C}$ with cooling fin No. 56263 ²⁾	P_{tot}	max.	260 mW
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Temperatures

Storage temperature	T_{stg}	-65 to +175	$^{\circ}\text{C}$
Junction temperature	T_j	max.	175 $^{\circ}\text{C}$

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	0.65 $^{\circ}\text{C}/\text{mW}$
From junction to ambient with cooling fin No. 56263	$R_{th\ j-a}$	=	0.5 $^{\circ}\text{C}/\text{mW}$

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

²⁾ Peak power dissipation see page 5.

CHARACTERISTICS

$T_{amb} = 25\text{ }^{\circ}\text{C}$ unless otherwise specified

Base current

$I_C = 7\text{ mA}; V_{CE} = 10\text{ V}$

I_B typ. 80 μA
< 185 μA

Base-emitter voltage

$I_C = 7\text{ mA}; V_{CE} = 10\text{ V}$

V_{BE} typ. 740 mV ¹⁾
< 900 mV

Feedback capacitance at $f = 10.7\text{ MHz}$

$I_C = 1\text{ mA}; V_{CE} = 10\text{ V}$

$-C_{re}$ typ. 230 fF ²⁾

Transition frequency

$I_C = 5\text{ mA}; V_{CE} = 10\text{ V}$

f_T typ. 550 MHz

y parameters at $f = 35\text{ MHz}$

$I_C = 7\text{ mA}; V_{CE} = 10\text{ V}$

Input conductance

g_{ie} typ. 4.5 $\text{m}\Omega^{-1}$

Input capacitance

C_{ie} typ. 45 pF

Feedback admittance

$|y_{re}|$ typ. 55 $\mu\Omega^{-1}$

Phase angle of feedback admittance

φ_{re} typ. 266°

Transfer admittance

$|y_{fe}|$ typ. 145 $\text{m}\Omega^{-1}$

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

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

$I_C = 7\text{ mA}; V_{CE} = 10\text{ V}; f = 35\text{ MHz}$

G_{UM} typ. 42.5 dB

1) V_{BE} decreases with about 1.7 mV/ $^{\circ}\text{C}$ at increasing temperature

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

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 $R_L = 2.7 \text{ k}\Omega$
for 30% synchronisation pulse compression

$f = 38.9 \text{ MHz}$; $I_C = 7.2 \text{ mA}$; $V_{CE} = 16.6 \text{ V}$

$V_O > 6 \text{ V}$
typ. 7.7 V

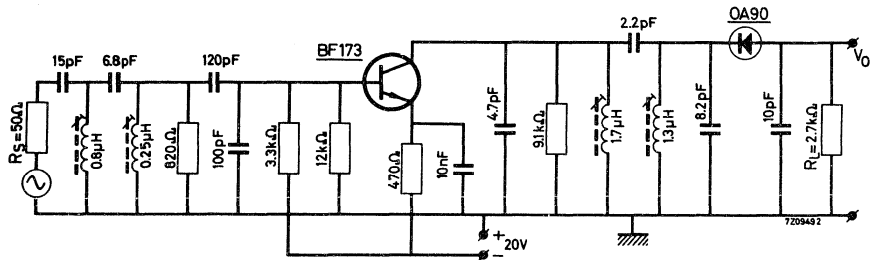
Transducer gain

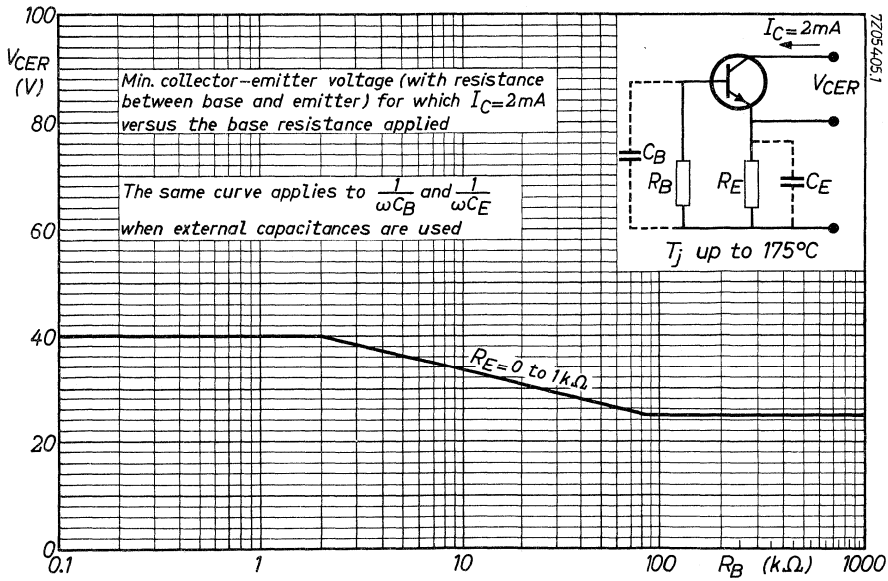
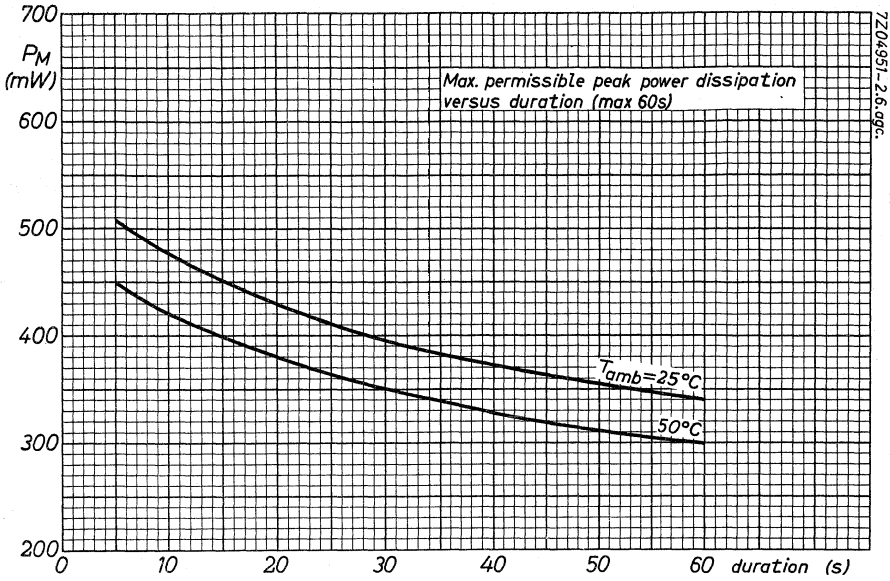
$$G_{tr} = \frac{\text{output power in load } R_L}{\text{available power from source with } R_S}$$

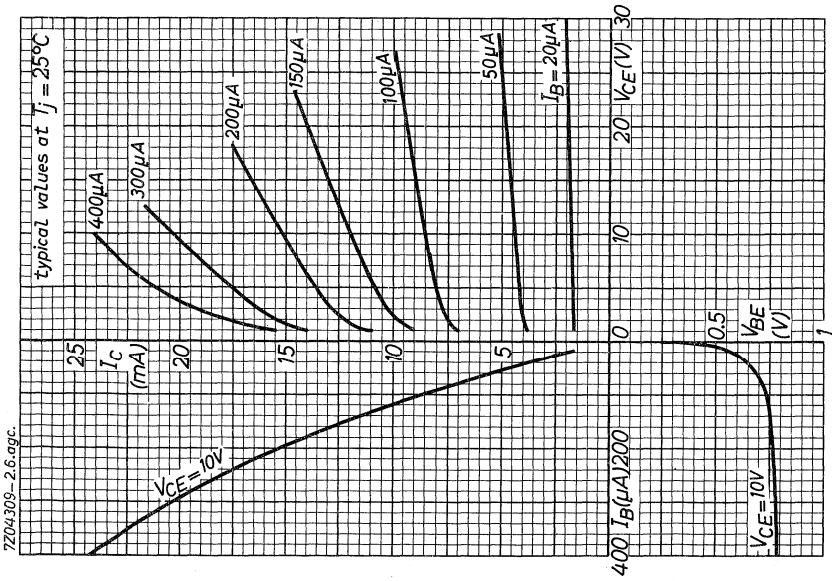
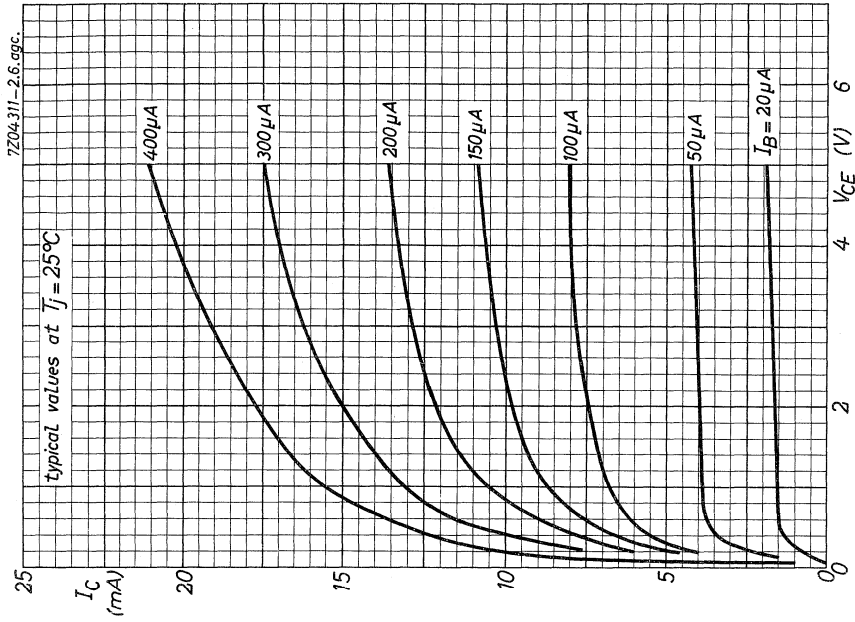
$f = 36.4 \text{ MHz}$; $I_C = 7.2 \text{ mA}$; $V_{CE} = 16.6 \text{ V}$

G_{tr} typ. 26 dB

Tuning frequency for all tuned circuits is 37 MHz







VIDEO OUTPUT TRANSISTORS

N-P-N transistors in a TO-39 metal envelope with the collector connected to the case.

The BF177 is intended for tiny-vision black and white television receivers.

The BF178 and BF179 for application in large screen black and white television receivers.

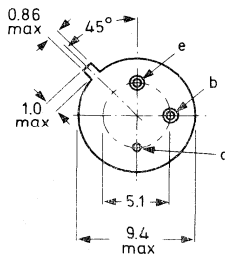
QUICK REFERENCE DATA

		BF177	BF178	BF179
Collector-base voltage (open emitter)	V_{CBO} max.	100	185	250 V
Collector-emitter voltage (open base)	V_{CEO} max.	60	115	115 V
Collector current (peak value)	I_{CM} max.	50	50	50 mA
Total power dissipation up to $T_{amb} = 65\text{ }^{\circ}\text{C}$	P_{tot} max.	0.6	0.6	0.6 W
	P_{tot} max.		1.7	1.7 W
up to $T_{mb} = 130\text{ }^{\circ}\text{C}$				
Junction temperature	T_j max.	200	200	200 $^{\circ}\text{C}$
D.C. current gain at $T_j = 25\text{ }^{\circ}\text{C}$				
$I_C = 15\text{ mA}; V_{CE} = 10\text{ V}$	h_{FE} >	20		
$I_C = 20\text{ mA}; V_{CE} = 15\text{ V}$	h_{FE} >			20
$I_C = 30\text{ mA}; V_{CE} = 20\text{ V}$	h_{FE} >		20	
Transition frequency				
$I_C = 10\text{ mA}; V_{CE} = 10\text{ V}$	f_T typ.	120	120	120 MHz
Feedback capacitance				
$I_C = 10\text{ mA}; V_{CE} = 20\text{ V}$	$-C_{re}$ typ.	1.8	1.8	1.8 pF

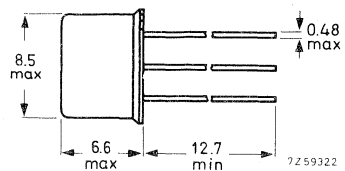
MECHANICAL DATA

TO-39

Collector connected to case



Dimensions in mm



Accessories available: 56218; 56245; 56265

FOR NEW DESIGN THE SUCCESSOR TYPES BF336 to 338
ARE RECOMMENDED

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

Voltages

		BF177	BF178	BF179	
Collector-base voltage (open emitter)	V_{CBO}	max. 100	185	250	V ¹⁾
Collector-emitter voltage ($R_B \leq 1 \text{ k}\Omega$)	V_{CER}	max. 100	185	250	V ¹⁾
Collector-emitter voltage (open base)					
$I_C = 4 \text{ mA}$	V_{CEO}	max. 60	115	115	V
Emitter-base voltage (open collector)	V_{EBO}	max. 5	5	5	V

Currents

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

Power dissipation

Total power dissipation					
up to $T_{amb} = 65 \text{ }^\circ\text{C}$ in free air	P_{tot}	max. 0.6	0.6	0.6	W
up to $T_{mb} = 130 \text{ }^\circ\text{C}$	P_{tot}	max.	1.7	1.7	W

Temperatures

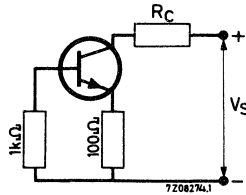
Storage temperature	T_{stg}	-55 to +175	$^\circ\text{C}$	
Junction temperature	T_j	max. 200	$^\circ\text{C}$	

THERMAL RESISTANCE

		BF177	BF178	BF179	
From junction to ambient in free air	$R_{th \text{ j-a}}$	= 220	220	220	$^\circ\text{C/W}$
From junction to mounting base	$R_{th \text{ j-mb}}$	=	40	40	$^\circ\text{C/W}$

CHARACTERISTICS

Collector cut-off current at $T_j = 200 \text{ }^\circ\text{C}$	I_{CER}	typ. 0.03	0.05	0.10	mA
		< 4	4	4	mA



	V_S	R_C
BF177	100 V	3.9 kΩ
BF178	165 V	3.9 kΩ
BF179	260 V	10 kΩ

at $V_{CERmax}; T_j = 25 \text{ }^\circ\text{C}$ $I_{CER} < 1 \text{ mA}$

¹⁾ During switching on, a supply voltage of 1.2 times the rated V_{CER} value is permitted.

The current must be limited so that maximum dissipation and maximum junction temperature are not exceeded (see page 6).

CHARACTERISTICS (continued)

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

Base current

$I_C = 15\text{ mA}; V_{CE} = 10\text{ V}$

BF177

I_B

typ. 0.36 mA
< 0.75 mA

$I_C = 20\text{ mA}; V_{CE} = 15\text{ V}$

BF179

I_B

typ. 0.45 mA
< 1.0 mA

$I_C = 30\text{ mA}; V_{CE} = 20\text{ V}$

BF178

I_B

typ. 0.72 mA
< 1.5 mA

Base-emitter voltage ¹⁾

$I_C = 15\text{ mA}; V_{CE} = 10\text{ V}$ for BF177

$I_C = 20\text{ mA}; V_{CE} = 15\text{ V}$ for BF179

$I_C = 30\text{ mA}; V_{CE} = 20\text{ V}$ for BF178

V_{BE}

typ. 0.75 V
< 1.2 V

High frequency knee voltage at $T_j = 150\text{ }^\circ\text{C}$

BF177: $I_C = 15\text{ mA}$

V_{CEK}

typ. 10 V

BF179: $I_C = 20\text{ mA}$

V_{CEK}

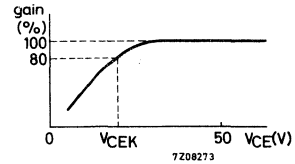
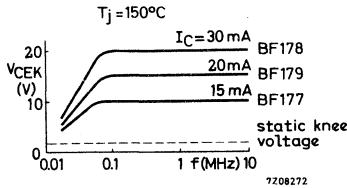
typ. 15 V

BF178: $I_C = 30\text{ mA}$

V_{CEK}

typ. 20 V

The high frequency knee voltage of a transistor is that value of the collector-emitter voltage at which the small signal gain, measured in a practical circuit, has dropped to 80% of the gain at $V_{CE} = 50\text{ V}$. A further decrease of the collector-emitter voltage results in a rapid increase of the distortion of the signal.



Feedback capacitance at $f = 0.5\text{ MHz}$

$I_C = 10\text{ mA}; V_{CE} = 20\text{ V}$

$-C_{re}$

typ. 1.8 pF
< 3.5 pF

Feedback time constant at $f = 10\text{ MHz}$

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

$r_{bb} \cdot C_b \cdot c$

typ. 25 ps
< 100 ps

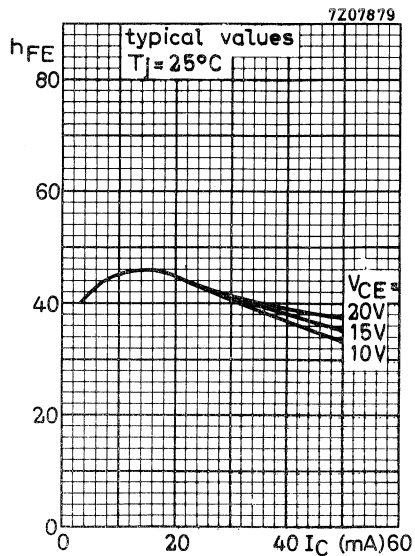
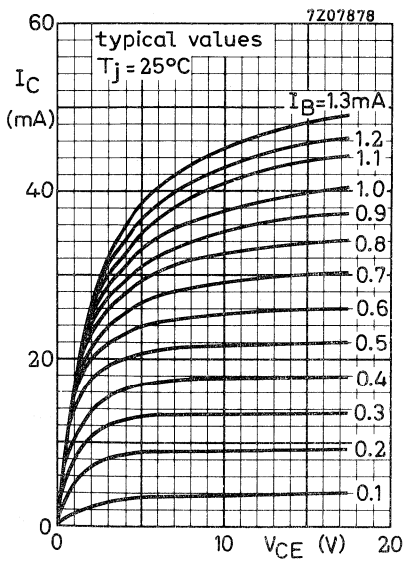
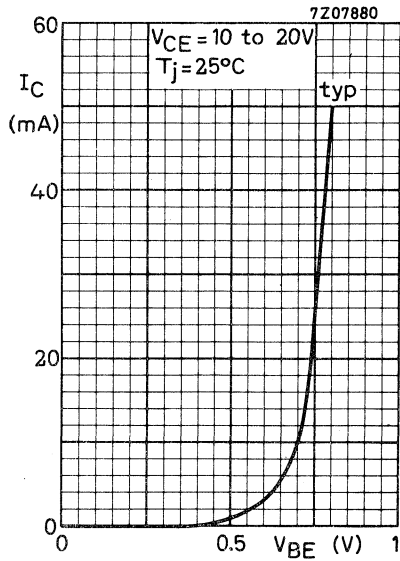
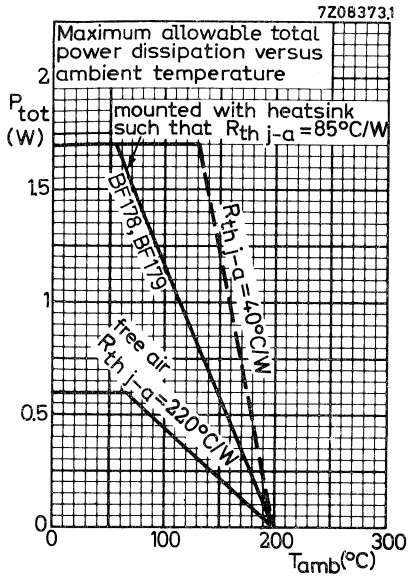
Transition frequency

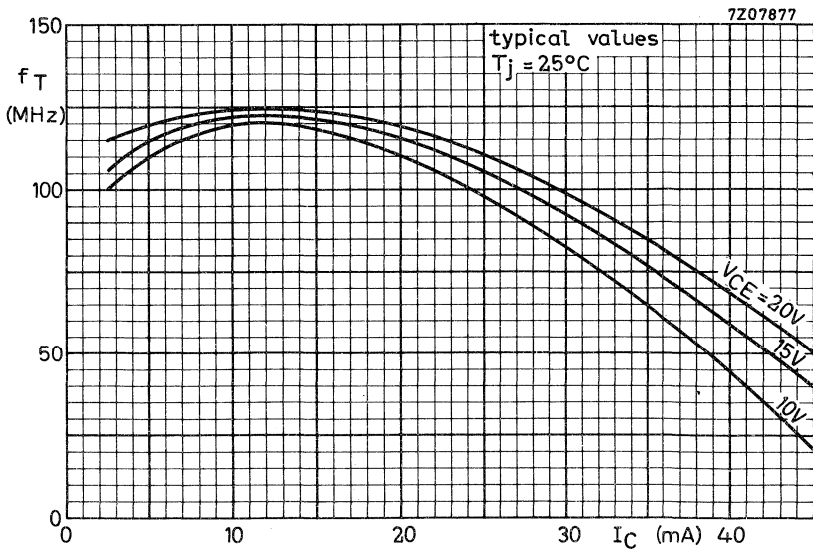
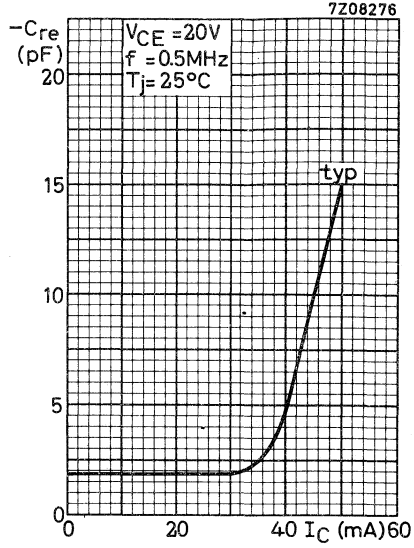
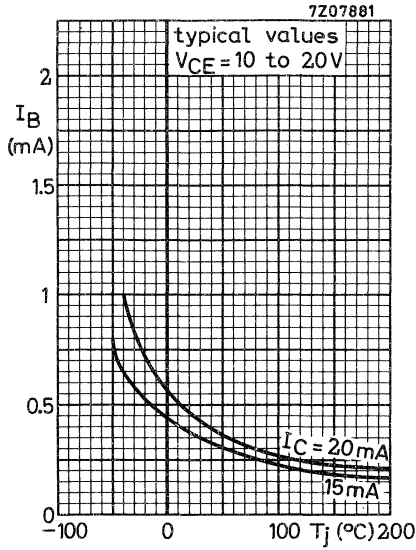
$I_C = 10\text{ mA}; V_{CE} = 10\text{ V}$

f_T

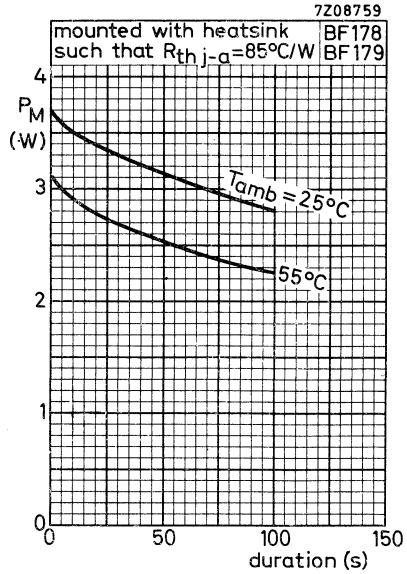
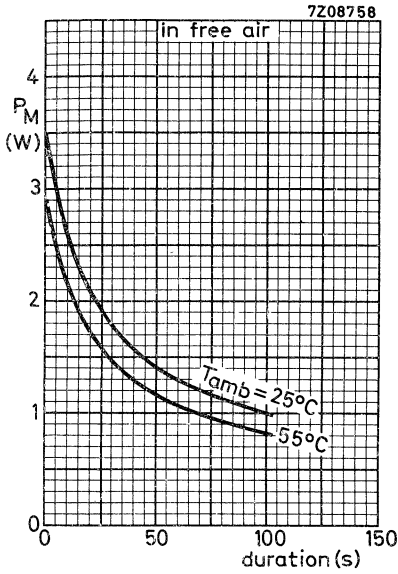
typ. 120 MHz

¹⁾ V_{BE} decreases by about $1.6\text{ mV}/^\circ\text{C}$ with increasing temperature.





maximum allowable peak power dissipation versus duration



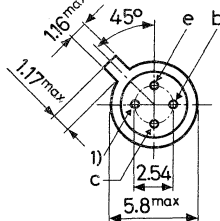
SILICON PLANAR TRANSISTOR

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.

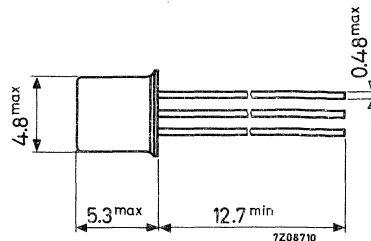
QUICK REFERENCE DATA			
Collector-base voltage (open emitter)	V_{CBO}	max.	30 V
Collector-emitter voltage (open base)	V_{CEO}	max.	20 V
Collector current (d.c.)	I_C	max.	20 mA
Total power dissipation up to $T_{amb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	150 mW
Junction temperature	T_j	max.	175 $^\circ\text{C}$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

MECHANICAL DATA

TO-72



Dimensions in mm



Accessories available: 56246, 56263.

1) = shield lead (connected to case)

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 $T_{amb} = 25\text{ }^{\circ}\text{C}$	P_{tot}	max.	150 mW
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Temperatures

Storage temperature	T_{stg}	-65 to +175	$^{\circ}\text{C}$
Junction temperature	T_j	max.	175 $^{\circ}\text{C}$

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	1 $^{\circ}\text{C}/\text{mW}$
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¹⁾ Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

CHARACTERISTICS

$T_{amb} = 25\text{ }^{\circ}\text{C}$ unless otherwise specified

Base current

$-I_E = 2\text{ mA}; V_{CB} = 10\text{ V}$	I_B	typ. 45 μA < 150 μA
$-I_E = 12\text{ mA}; V_{CB} = 7\text{ V}$	I_B	< 2.2 mA

Emitter-base voltage

$-I_E = 2\text{ mA}; V_{CB} = 10\text{ V}$	$-V_{EB}$	typ. 0.75 V
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Feedback capacitance at $f = 10.7\text{ MHz}$

$I_C = 1\text{ mA}; V_{CE} = 10\text{ V}$	$-C_{re}$	typ. 280 fF ¹⁾
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Transition frequency

$I_C = 2\text{ mA}; V_{CE} = 10\text{ V}$	f_T	typ. 675 MHz
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Noise figure ²⁾

$-I_E = 2\text{ mA}; V_{CB} = 10\text{ V};$ $G_S = 40\text{ m}\Omega^{-1}; B_S = 0; f = 200\text{ MHz}$	F	typ. 4.5 dB
$-I_E = 2\text{ mA}; V_{CB} = 10\text{ V};$ $G_S = 10\text{ m}\Omega^{-1}; B_S = 0; f = 800\text{ MHz}$	F	typ. 7.0 dB < 9.5 dB

Maximum unilateralised power gain ²⁾

$$G_{UM} = \frac{|y_{fb}|^2}{4 g_{ib} g_{ob}}$$

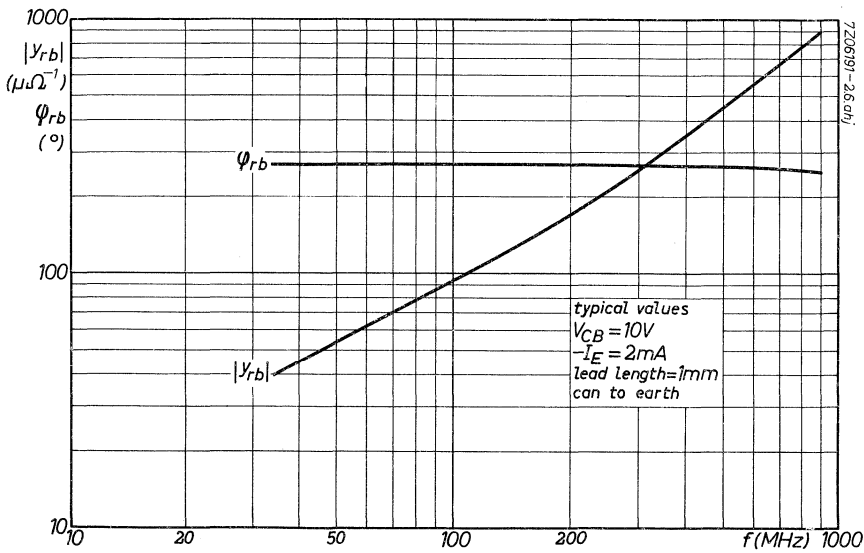
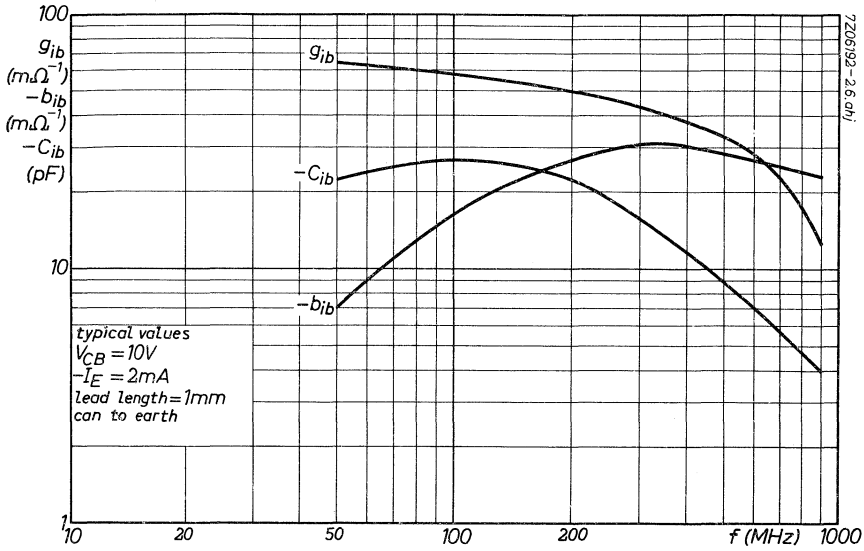
$-I_E = 2\text{ mA}; V_{CB} = 10\text{ V}; f = 50\text{ MHz}$	G_{UM}	> 32 dB
$-I_E = 2\text{ mA}; V_{CB} = 10\text{ V}; f = 200\text{ MHz}$	G_{UM}	typ. 24 dB
$-I_E = 2\text{ mA}; V_{CB} = 10\text{ V}; f = 500\text{ MHz}$	G_{UM}	typ. 14 dB
$-I_E = 2\text{ mA}; V_{CB} = 10\text{ V}; f = 900\text{ MHz}$	G_{UM}	typ. 12 dB

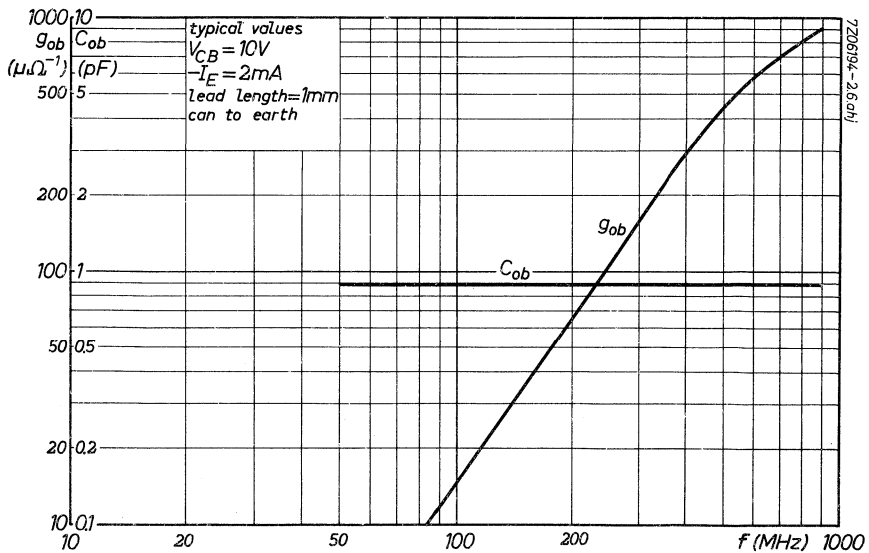
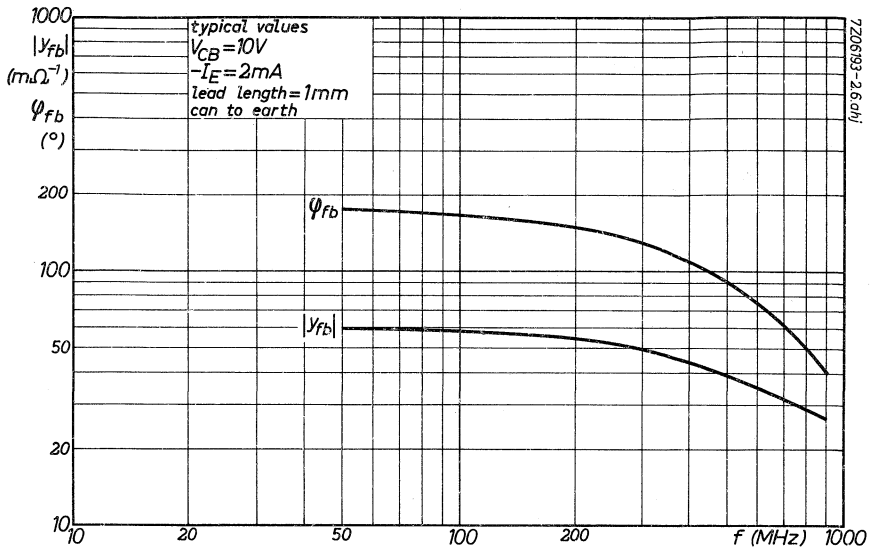
Transducer gain ²⁾

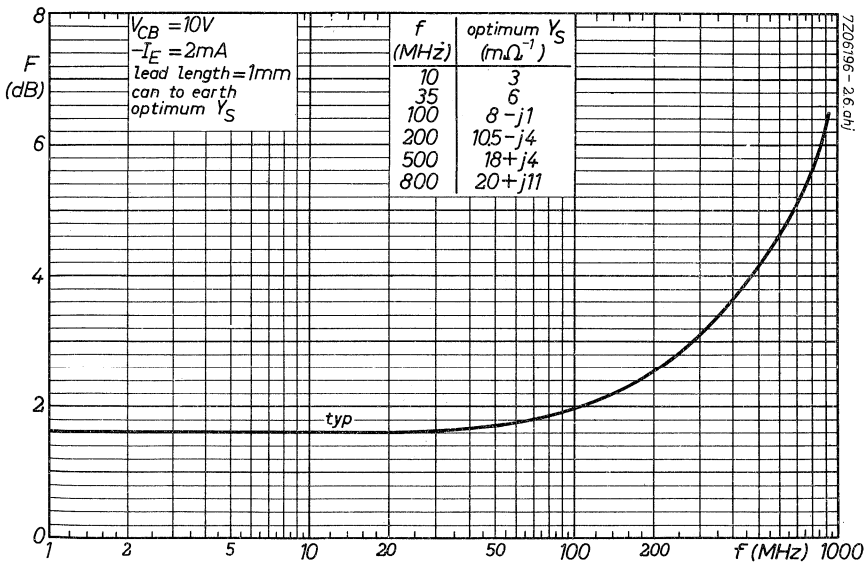
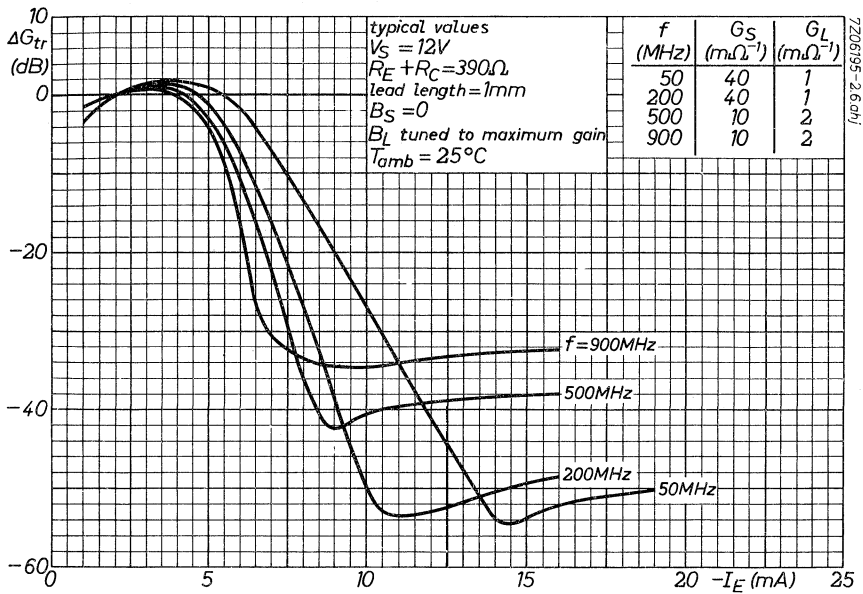
$-I_E = 2\text{ mA}; V_{CB} = 10\text{ V}; f = 200\text{ MHz};$ $G_S = 40\text{ m}\Omega^{-1}; B_S = 0$ $G_L = 1\text{ m}\Omega^{-1}; B_L : \text{tuned}$	G_{tr}	typ. 16.5 dB
$-I_E = 2\text{ mA}; V_{CB} = 10\text{ V}; f = 900\text{ MHz};$ $G_S = 20\text{ m}\Omega^{-1}; B_S = 0$ $G_L = 2\text{ m}\Omega^{-1}; B_L : \text{tuned}$	G_{tr}	> 7.5 dB typ. 9 dB

¹⁾ 1 fF = 1 femtofarad = 10^{-15} F

²⁾ Common base configuration, metal envelope contacted to earth directly, external lead length: 1 mm.







SILICON PLANAR TRANSISTOR

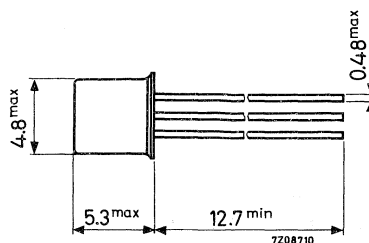
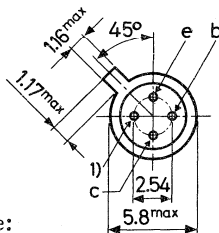
N-P-N transistor in a TO-72 metal envelope with insulated electrodes and a shield lead connected to the case. The BF181 is primarily intended for application as self-oscillating mixer in the u.h.f. band.

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 $T_{amb} = 25\text{ }^\circ\text{C}$	P_{tot}	max. 150 mW
Junction temperature	T_j	max. 175 $^\circ\text{C}$
Transition frequency	f_T	typ. 600 MHz
$I_C = 2\text{ mA}; V_{CE} = 10\text{ V}$		
Feedback capacitance at $f = 10.7\text{ MHz}$	$-C_{re}$	typ. 280 fF
$I_C = 1\text{ mA}; V_{CE} = 10\text{ V}$		
Max. unilateralised power gain	G_{UM}	typ. 11 dB
$-I_E = 2\text{ mA}; V_{CB} = 10\text{ V}; f = 900\text{ MHz}$		
Noise figure at optimum source admittance	F	typ. 6.8 dB
$-I_E = 2\text{ mA}; V_{CB} = 10\text{ V}; f = 900\text{ MHz}$		

MECHANICAL DATA

Dimensions in mm

TO-72



Accessories available:
56246, 56263

1) = shield lead (connected to case)

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 $T_{amb} = 25\text{ }^{\circ}\text{C}$	P_{tot}	max.	150 mW
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Temperatures

Storage temperature	T_{stg}	-65 to +175	$^{\circ}\text{C}$
Junction temperature	T_j	max.	175 $^{\circ}\text{C}$

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	1 $^{\circ}\text{C}/\text{mW}$
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¹⁾ Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

CHARACTERISTICS

$T_{amb} = 25\text{ }^{\circ}\text{C}$ unless otherwise specified

Base current

$-I_E = 2\text{ mA}; V_{CB} = 10\text{ V}$ I_B typ. 70 μA
 $< 150\text{ } \mu\text{A}$

Emitter-base voltage

$-I_E = 2\text{ mA}; V_{CB} = 10\text{ V}$ $-V_{EB}$ typ. 0.75 V

Feedback capacitance at $f = 10.7\text{ MHz}$

$I_C = 1\text{ mA}; V_{CE} = 10\text{ V}$ $-C_{re}$ typ. 280 fF ¹⁾

Transition frequency

$I_C = 2\text{ mA}; V_{CE} = 10\text{ V}$ f_T typ. 600 MHz

y parameters at $f = 35\text{ MHz}$ ²⁾

$-I_E = 2\text{ mA}; V_{CB} = 10\text{ V}$
 Output conductance g_{ob} typ. 10 $\mu\Omega^{-1}$
 Output capacitance C_{ob} typ. 0.9 pF

Maximum unilateralised power gain ²⁾

$$G_{UM} = \frac{|y_{fb}|^2}{4 g_{ib} g_{ob}}$$

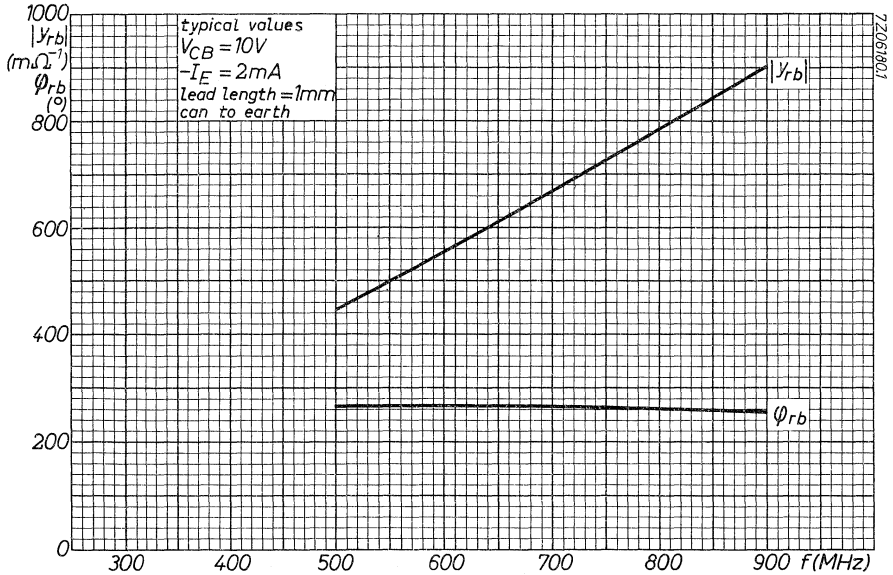
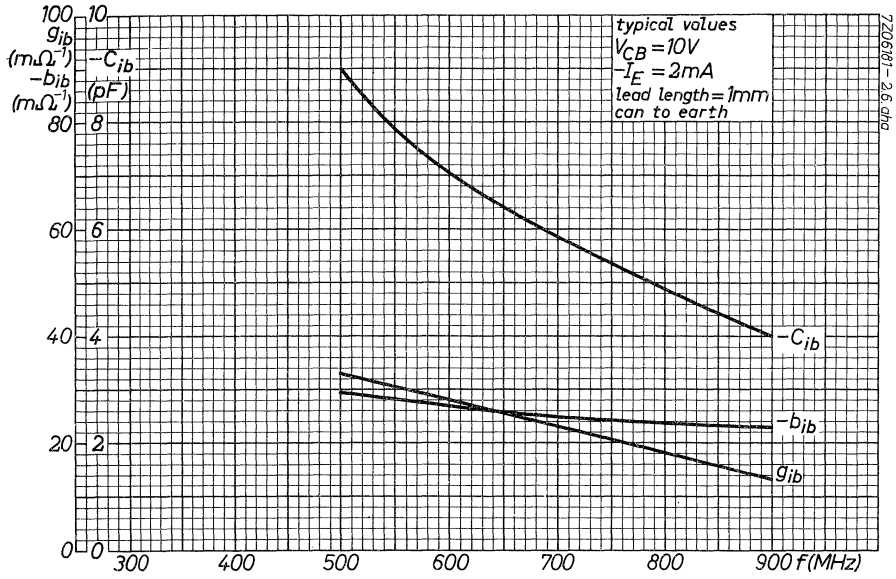
$-I_E = 2\text{ mA}; V_{CB} = 10\text{ V}; f = 500\text{ MHz}$ G_{UM} typ. 13.5 dB
 $-I_E = 2\text{ mA}; V_{CB} = 10\text{ V}; f = 900\text{ MHz}$ G_{UM} typ. 11 dB

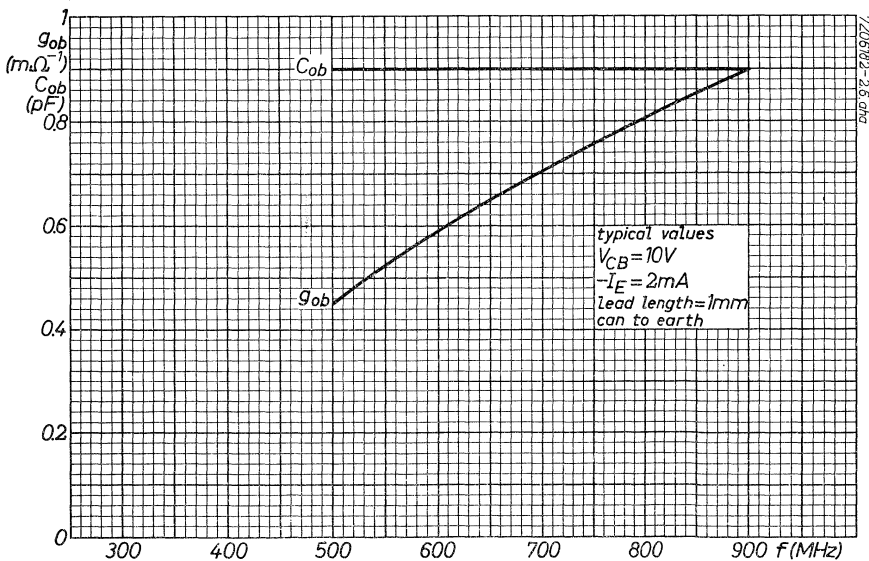
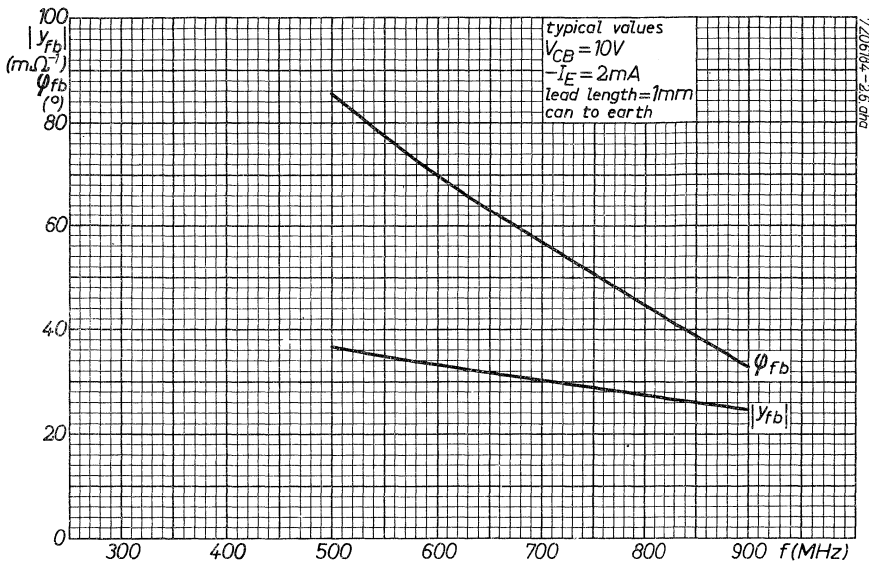
Transducer gain ²⁾

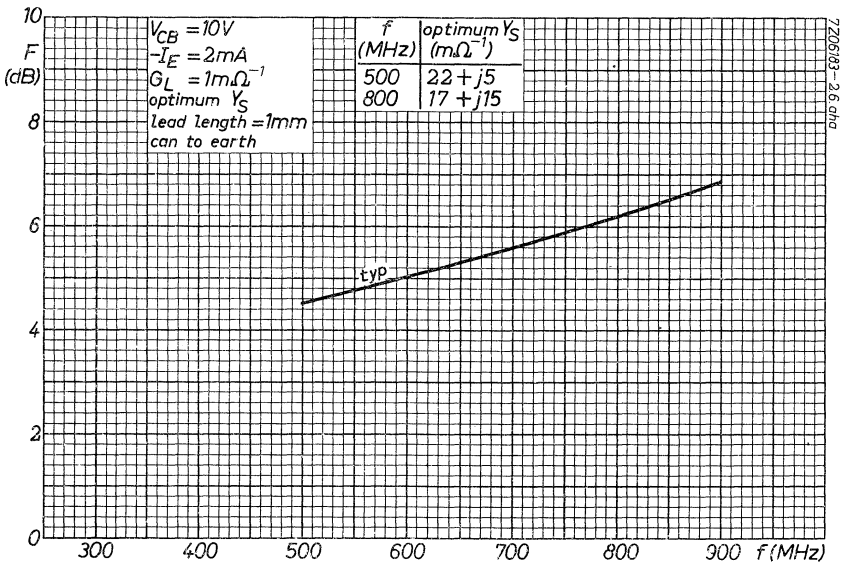
$-I_E = 2\text{ mA}; V_{CB} = 10\text{ V}; f = 900\text{ MHz};$
 $G_S = 20\text{ m}\Omega^{-1}; B_S = 0$
 $G_L = 2\text{ m}\Omega^{-1}; B_L : \text{tuned}$ G_{tr} typ. 8 dB

¹⁾ 1 fF = 1 femtofarad = 10^{-15} F .

²⁾ Common base configuration, metal envelope contacted to earth directly, external lead length: 1 mm.







U.H.F. 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 BF182 is primarily intended for application as separate mixer in integrated television tuners.

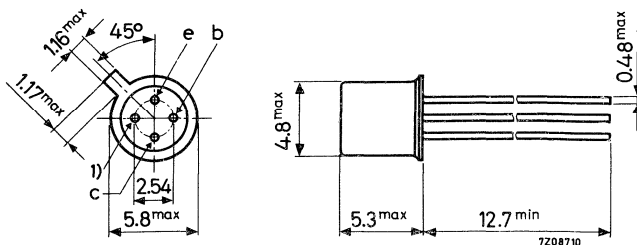
QUICK REFERENCE DATA

Collector-base voltage (open emitter)	V_{CBO}	max.	25 V
Collector-emitter voltage (open base)	V_{CEO}	max.	20 V
Collector current (d.c.)	I_C	max.	15 mA
Total power dissipation up to $T_{amb} = 25^\circ\text{C}$	P_{tot}	max.	150 mW
Junction temperature	T_j	max.	175 $^\circ\text{C}$
Transition frequency	f_T	typ.	650 MHz
$I_C = 2 \text{ mA}; V_{CE} = 10 \text{ V}$			
Max. unilaterised power gain	G_{UM}	typ.	11 dB
$-I_E = 2 \text{ mA}; V_{CB} = 10 \text{ V}; f = 900 \text{ MHz}$			
Noise figure at optimum source admittance	F	typ.	7.4 dB
$-I_E = 2 \text{ mA}; V_{CB} = 10 \text{ V}; f = 800 \text{ MHz}$			

MECHANICAL DATA

Dimensions in mm

TO-72



1) = shield lead (connected to case)

Accessories available: 56246, 56263

RATINGS (Limiting values) ¹⁾

Voltages

Collector-base voltage (open emitter)	V_{CBO}	max.	25 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.	15 mA
Collector current (peak value)	I_{CM}	max.	15 mA

Power dissipation

Total power dissipation up to $T_{amb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	150 mW
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Temperatures

Storage temperature	T_{stg}	-65 to +175	$^\circ\text{C}$
Junction temperature	T_j	max.	175 $^\circ\text{C}$

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	1 $^\circ\text{C}/\text{mW}$
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CHARACTERISTICS

$T_{amb} = 25\text{ }^\circ\text{C}$ unless otherwise specified

Base current

$-I_E = 2\text{ mA}; V_{CB} = 10\text{ V}$	I_B	typ.	100 μA
		<	200 μA

Emitter-base voltage ²⁾

$-I_E = 2\text{ mA}; V_{CB} = 10\text{ V}$	$-V_{EB}$	typ.	770 mV
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Transition frequency

$I_C = 2\text{ mA}; V_{CE} = 10\text{ V}$	f_T	typ.	650 MHz
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Feedback capacitance at $f = 10.7\text{ MHz}$

$I_C = 1\text{ mA}; V_{CE} = 10\text{ V}$	$-C_{re}$	typ.	330 fF
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1) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

2) $-V_{EB}$ decreases by about 1.6 mV/ $^\circ\text{C}$ with increasing temperature.

CHARACTERISTICS (continued)

$T_{amb} = 25\text{ }^{\circ}\text{C}$ unless otherwise specified

Output conductance at $f = 35\text{ MHz}$

$-I_E = 2\text{ mA}; V_{CB} = 10\text{ V}$

g_{ob} typ. $8\text{ }\mu\Omega^{-1}$

Transducer gain at $f = 900\text{ MHz}$ (common base) 1)

$-I_E = 2\text{ mA}; V_{CB} = 10\text{ V}$
 $G_S = 20\text{ m}\Omega^{-1}; G_L = 2\text{ m}\Omega^{-1}$

G_{tr} > 8 dB
 typ. 10 dB

Max. unilateralised power gain

$$G_{UM} = \frac{|y_{fb}|^2}{4 g_{ib}g_{ob}}$$

$-I_E = 2\text{ mA}; V_{CB} = 10\text{ V}; f = 500\text{ MHz}$

G_{UM} typ. 15 dB

$-I_E = 2\text{ mA}; V_{CB} = 10\text{ V}; f = 900\text{ MHz}$

G_{UM} typ. 11 dB

Noise figure at optimum source admittance

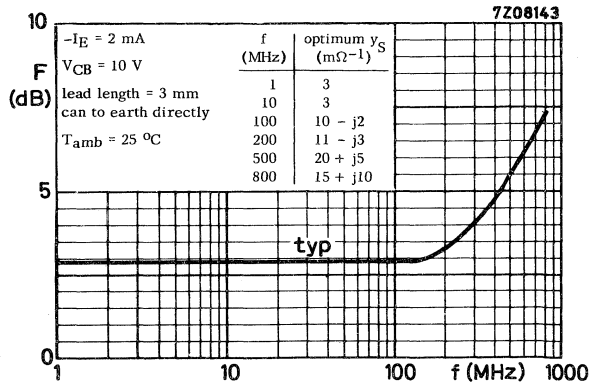
$-I_E = 2\text{ mA}; V_{CB} = 10\text{ V}; f = 200\text{ MHz}$

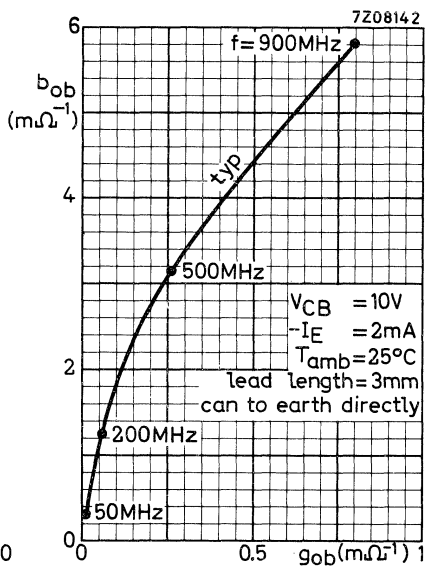
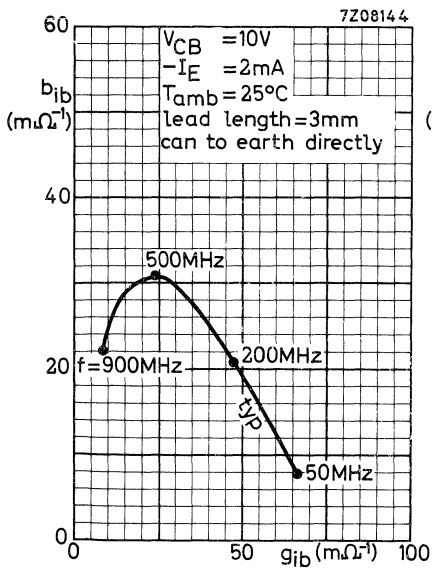
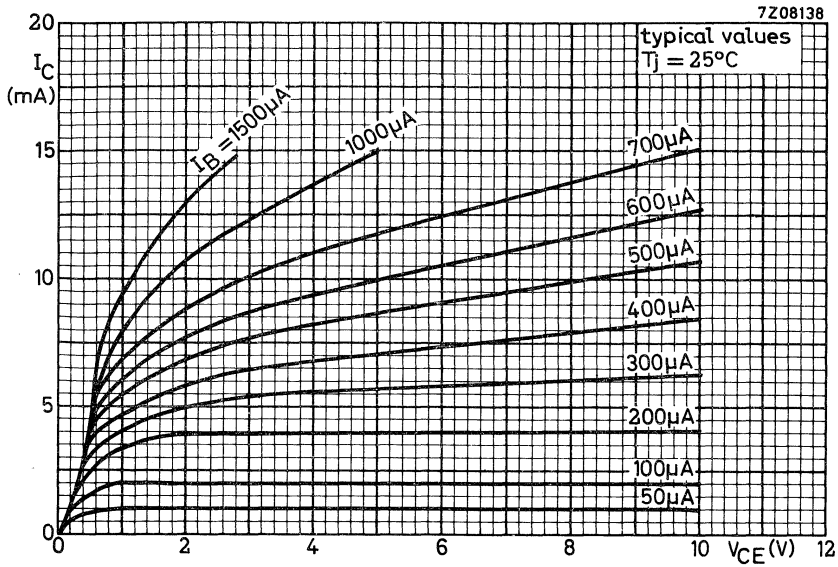
F typ. 3.3 dB

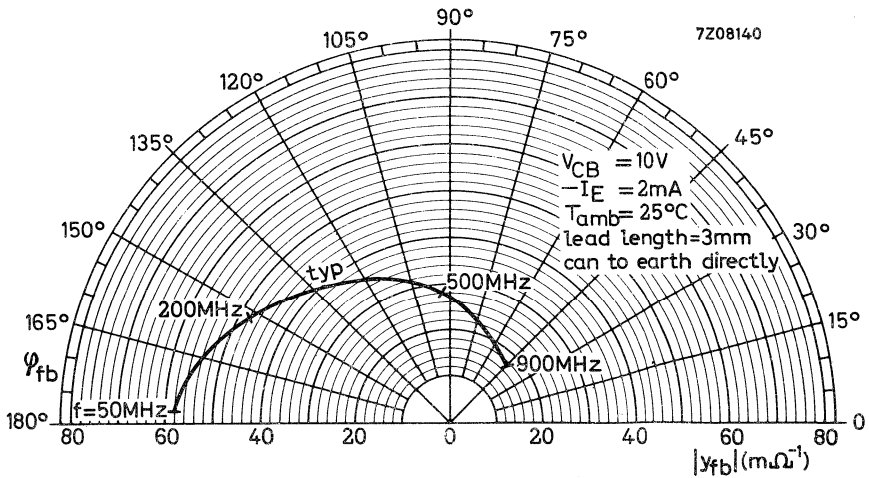
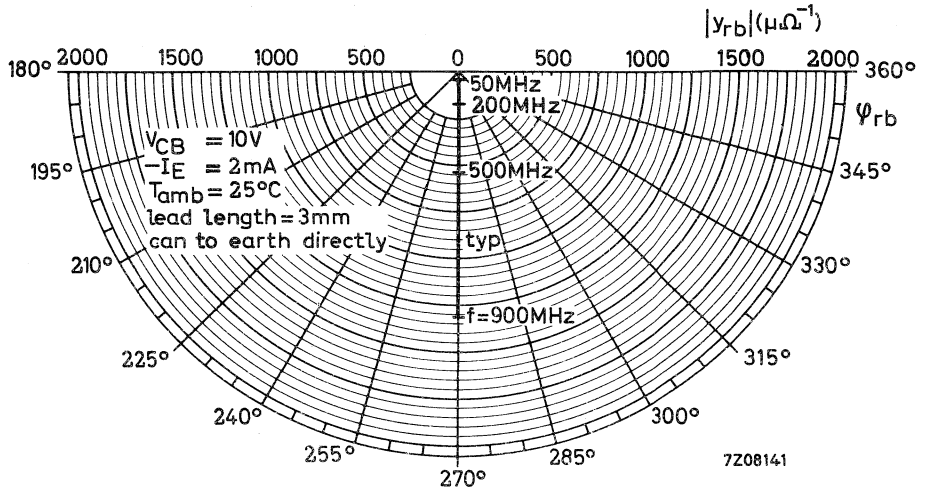
$-I_E = 2\text{ mA}; V_{CB} = 10\text{ V}; f = 800\text{ MHz}$

F typ. 7.4 dB

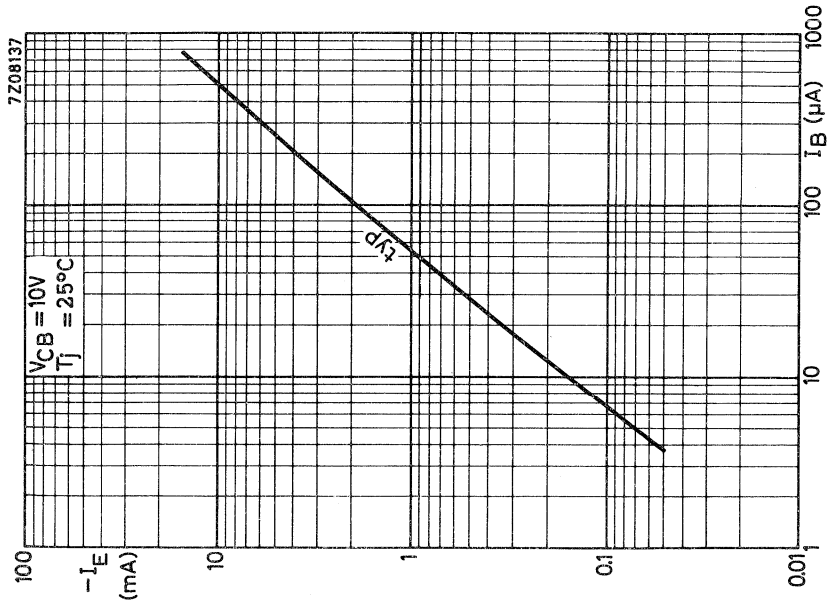
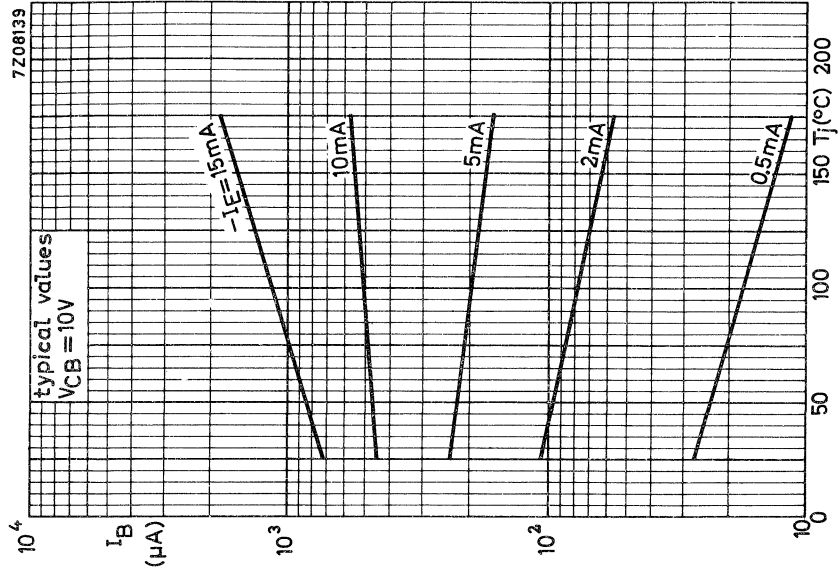
1) Envelope connected to earth directly, lead length = 3 mm.







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U.H.F. SILICON PLANAR TRANSISTOR

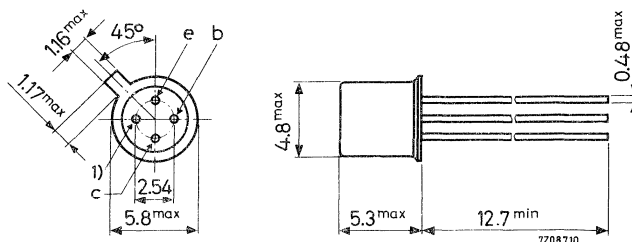
N-P-N transistor in a TO-72 metal envelope with insulated electrodes and a shield lead connected to the case. The BF183 is primarily intended for application in integrated television tuners as local oscillator with excellent frequency stability.

QUICK REFERENCE DATA			
Collector-base voltage (open emitter)	V_{CBO}	max.	25 V
Collector-emitter voltage (open base)	V_{CEO}	max.	20 V
Collector current (d.c.)	I_C	max.	15 mA
Total power dissipation up to $T_{amb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	150 mW
Junction temperature	T_j	max.	175 $^\circ\text{C}$
Transition frequency	f_T	typ.	800 MHz
$I_C = 3\text{ mA}; V_{CE} = 10\text{ V}$			
Max. uniliteralised power gain	G_{UM}	typ.	13 dB
$-I_E = 3\text{ mA}; V_{CB} = 10\text{ V}; f = 900\text{ MHz}$			

MECHANICAL DATA

Dimensions in mm

TO-72



1) = shield lead (connected to case)

Accessories available: 56246, 56263

RATINGS (Limiting values) ¹⁾Voltages

Collector-base voltage (open emitter)	V_{CBO}	max.	25 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.	15 mA
Collector current (peak value)	I_{CM}	max.	15 mA

Power dissipation

Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}$	P_{tot}	max.	150 mW
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Temperatures

Storage temperature	T_{stg}	-65 to +175	$^{\circ}\text{C}$
Junction temperature	T_j	max.	175 $^{\circ}\text{C}$

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	1 $^{\circ}\text{C}/\text{mW}$
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¹⁾ Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

CHARACTERISTICS

$T_{amb} = 25\text{ }^{\circ}\text{C}$ unless otherwise specified

Base-current

$-I_E = 3\text{ mA}; V_{CB} = 10\text{ V}$

I_B typ. 125 μA
< 300 μA

Emitter-base voltage ¹⁾

$-I_E = 3\text{ mA}; V_{CB} = 10\text{ V}$

$-V_{EB}$ typ. 770 mV

Transition frequency

$I_C = 3\text{ mA}; V_{CE} = 10\text{ V}$

f_T typ. 800 MHz

Feedback capacitance at $f = 10.7\text{ MHz}$

$I_C = 1\text{ mA}; V_{CE} = 10\text{ V}$

$-C_{re}$ typ. 330 fF

Transducer gain at $f = 900\text{ MHz}$ (common base) ²⁾

$-I_E = 3\text{ mA}; V_{CB} = 10\text{ V}$
 $G_S = 20\text{ m}\Omega^{-1}; G_L = 2\text{ m}\Omega^{-1}$

G_{tr} > 8.5 dB
typ. 12 dB

Max. unilateralised power gain

$$G_{UM} = \frac{|y_{fb}|^2}{4 g_{ib} g_{ob}}$$

$-I_E = 3\text{ mA}; V_{CB} = 10\text{ V}; f = 500\text{ MHz}$

G_{UM} typ. 16 dB

$-I_E = 3\text{ mA}; V_{CB} = 10\text{ V}; f = 900\text{ MHz}$

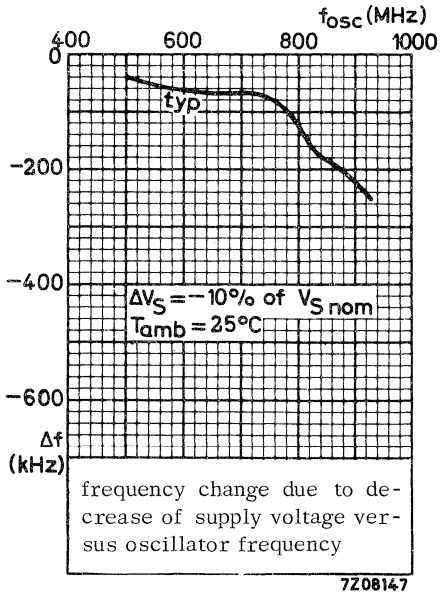
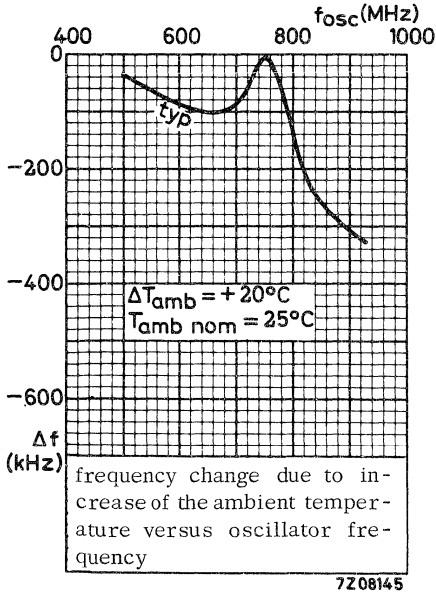
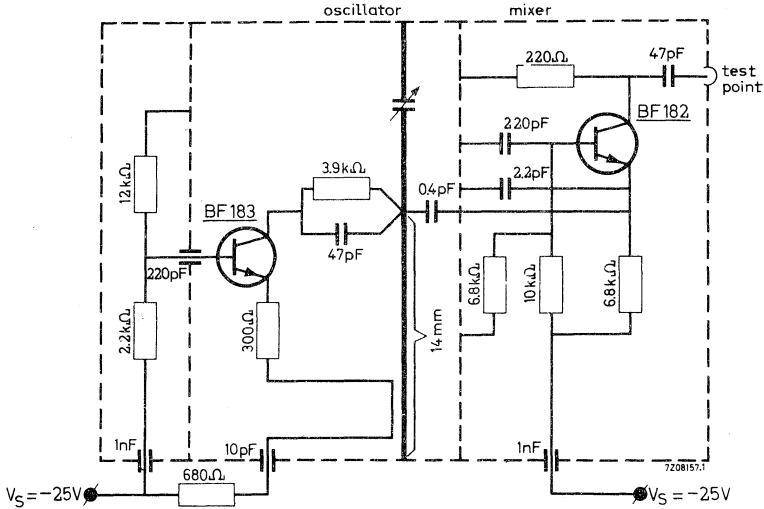
G_{UM} typ. 13 dB

1) $-V_{EB}$ decreases by about 1.6 mV/ $^{\circ}\text{C}$ with increasing temperature.

2) Envelope connected to earth directly, lead length = 3 mm.

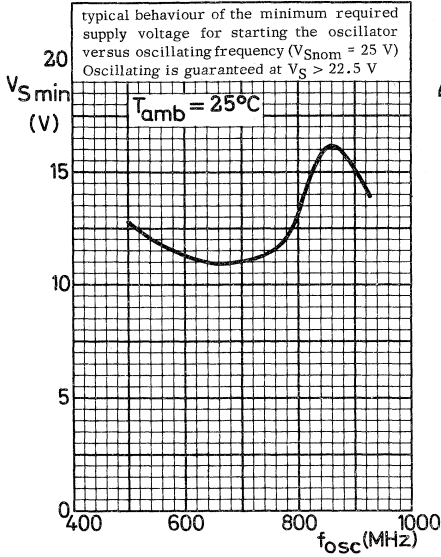
APPLICATION INFORMATION

Oscillator circuit with simplified mixer stage

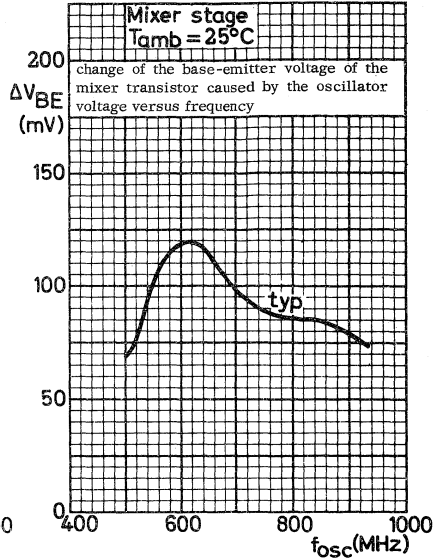


APPLICATION INFORMATION bulletin available on request

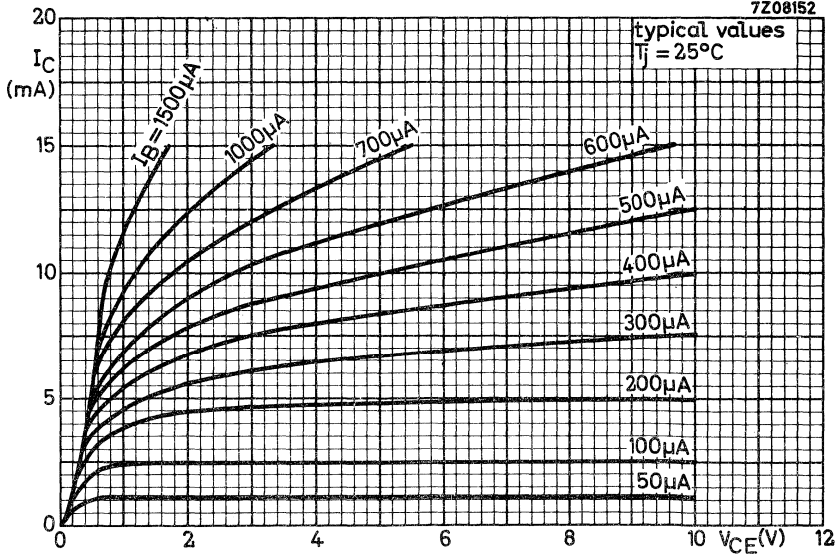
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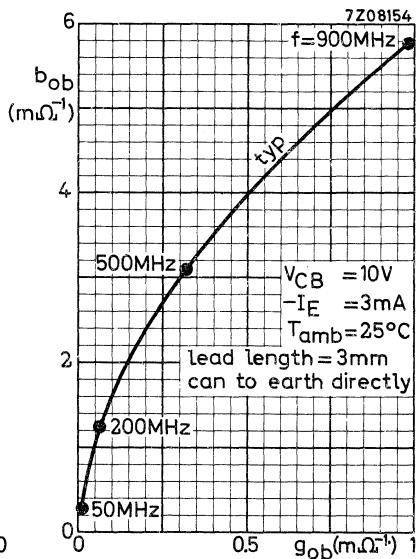
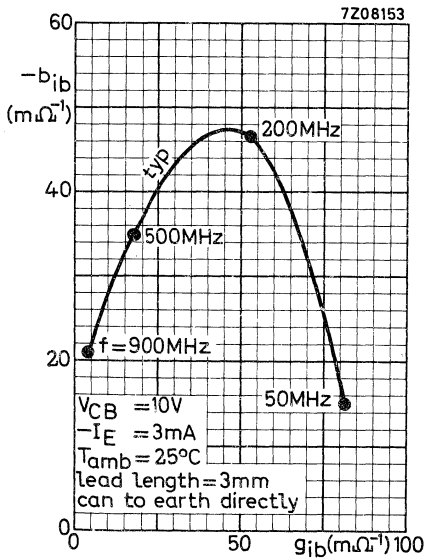
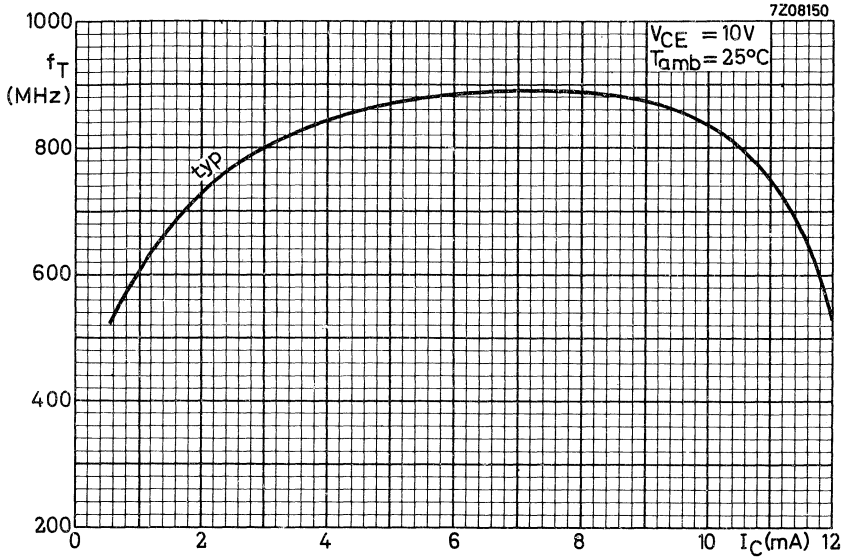


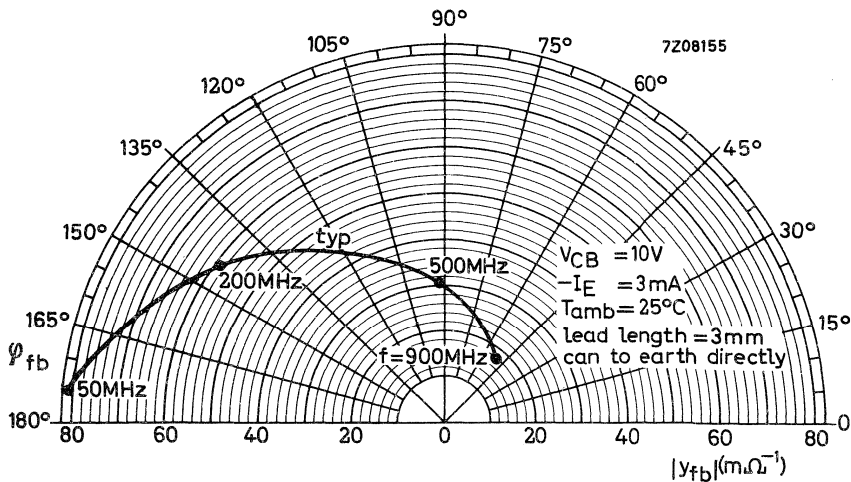
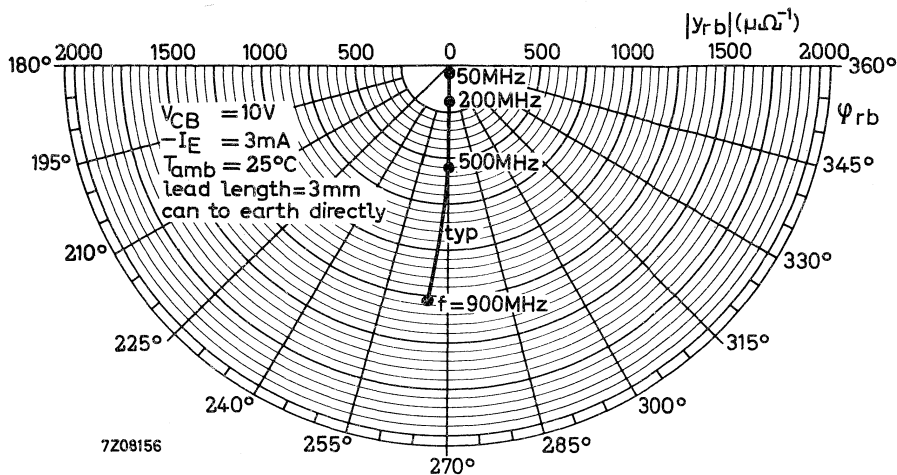
7Z08148

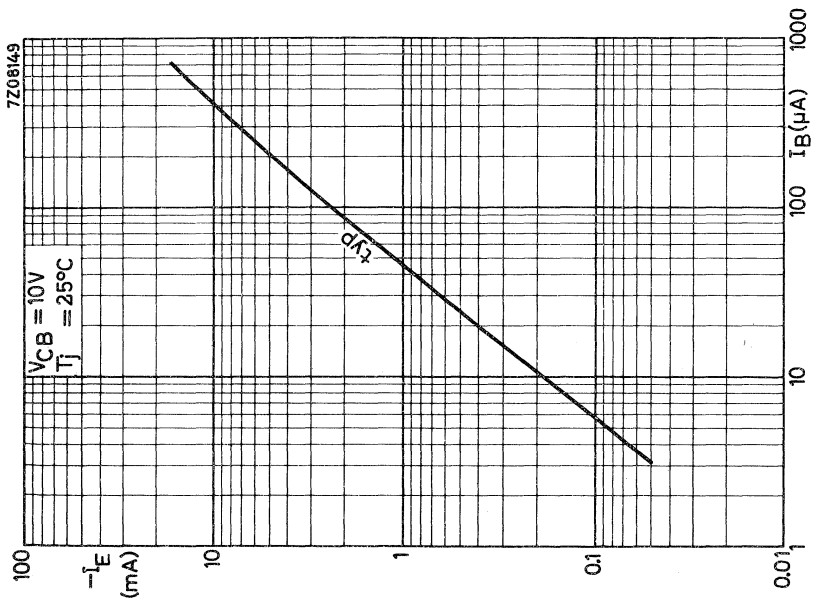
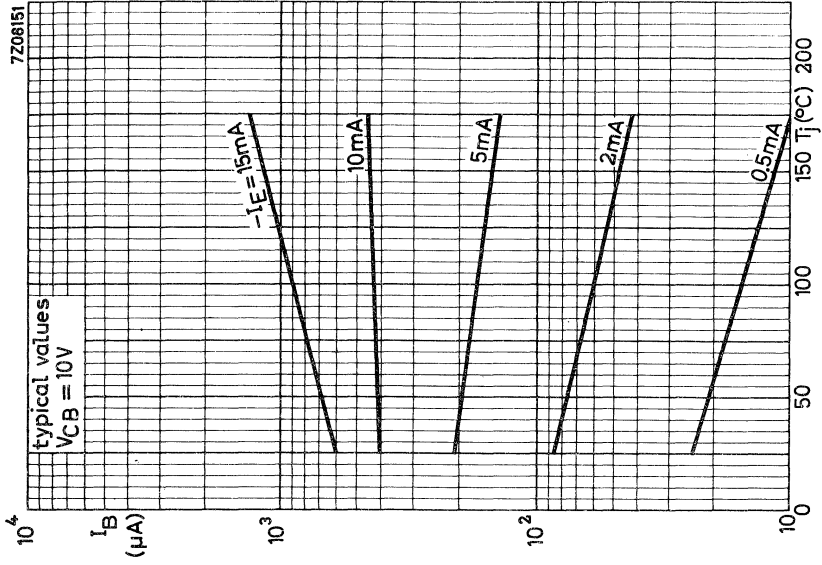


7Z08152









SILICON PLANAR EPITAXIAL TRANSISTOR

N-P-N transistor in a TO-72 metal case with insulated electrodes and a shield lead connected to the case; the same transistor is available in lock-fit encapsulation under the type number BF194.

The BF184 is intended for h.f. applications in radio and television receivers; it is especially recommended for f.m. tuners, low noise a.m. mixer-oscillators with high source impedance and i.f. amplifiers in a.m./f.m. receivers where a high current gain is of importance.

QUICK REFERENCE DATA

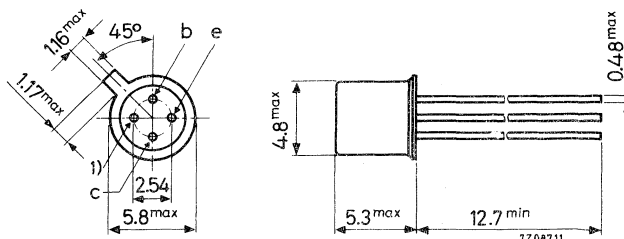
Collector-base voltage (open emitter)	V_{CBO}	max. 30 V
Collector-emitter voltage (open base)	V_{CEO}	max. 20 V
Collector current (d.c.)	I_C	max. 30 mA
Total power dissipation up to $T_{amb} = 45^\circ\text{C}$	P_{tot}	max. 145 mW
Junction temperature	T_j	max. 175 $^\circ\text{C}$
D.C. current gain at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

MECHANICAL DATA

Dimensions in mm

TO-72

Insulated electrodes



l) = shield lead (connected to case)

Accessories available: 56246, 56263.

FOR NEW DESIGN THE SUCCESSOR TYPES BF194 OR BF254 ARE RECOMMENDED

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

Voltages

Collector-base voltage (open emitter)	V_{CBO}	max.	30 V
Collector-emitter voltage (open base) (See also sheet 4)	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 $T_{amb} = 45\text{ }^{\circ}\text{C}$	P_{tot}	max.	145 mW
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Temperatures

Storage temperature	T_{stg}	-65 to +175	$^{\circ}\text{C}$
Junction temperature	T_j	max.	175 $^{\circ}\text{C}$

THERMAL RESISTANCE

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

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

Base-emitter voltage ¹⁾

$I_C = 1\text{ mA}; V_{CE} = 10\text{ V}$	V_{BE}	0.65 to 0.74	V
$I_C = 20\text{ mA}; V_{CE} = 2\text{ V}$	V_{BE}	<	1.0 V

Feedback capacitance at $f = 0.45\text{ MHz}$

$I_C = 1\text{ mA}; V_{CE} = 10\text{ V}$	$-C_{re}$	typ.	0.65 pF
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D.C. current gain

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

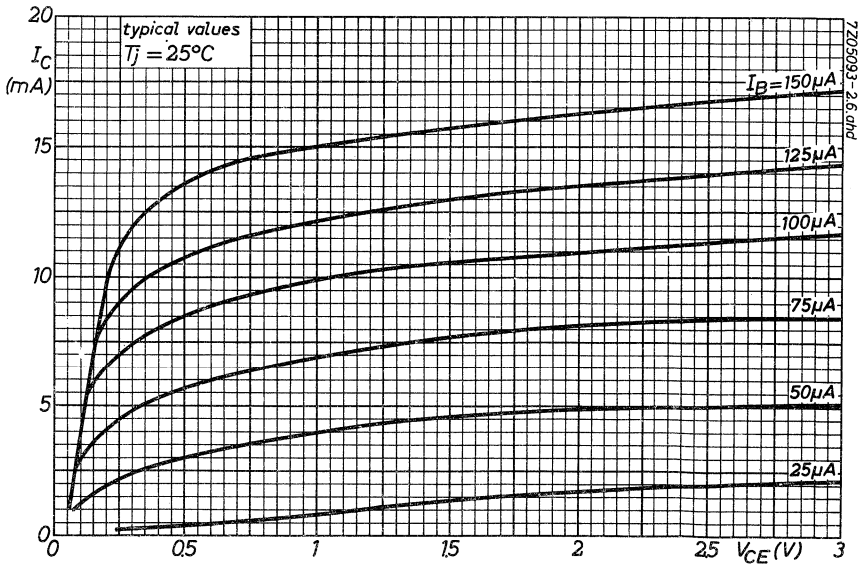
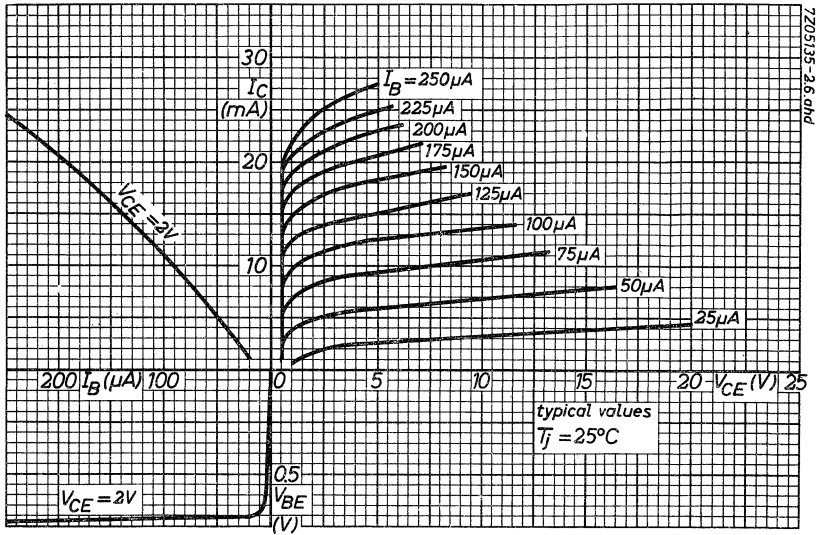
Transition frequency

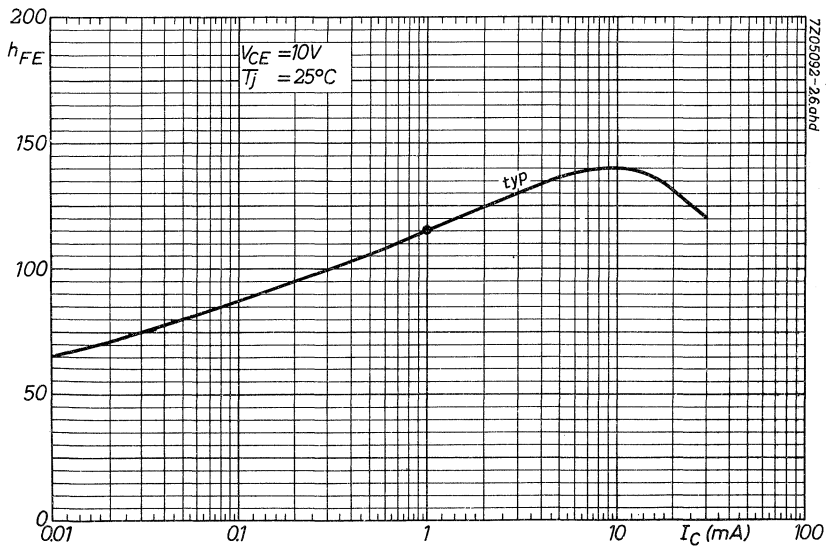
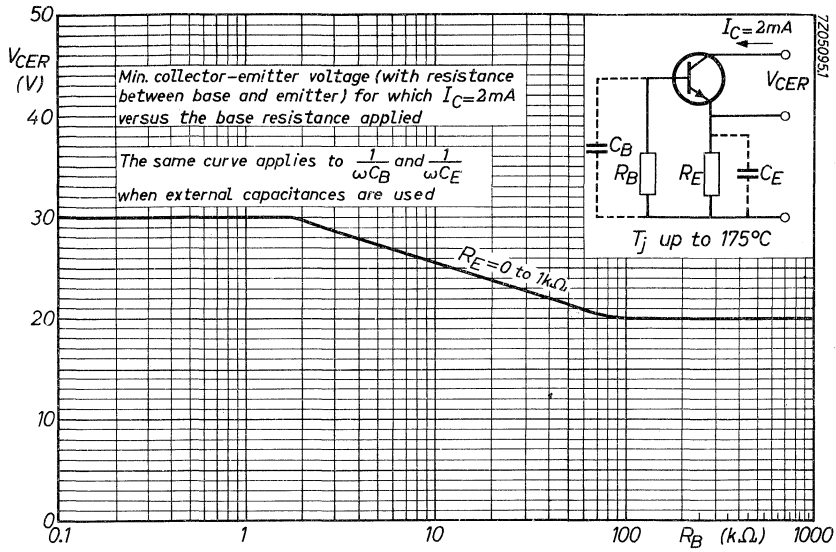
$I_C = 1\text{ mA}; V_{CE} = 10\text{ V}$	f_T	typ.	300 MHz
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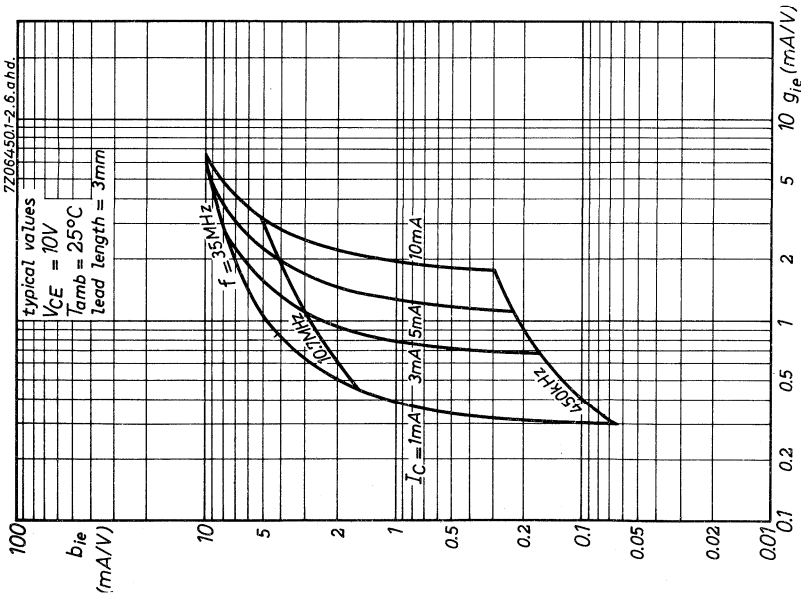
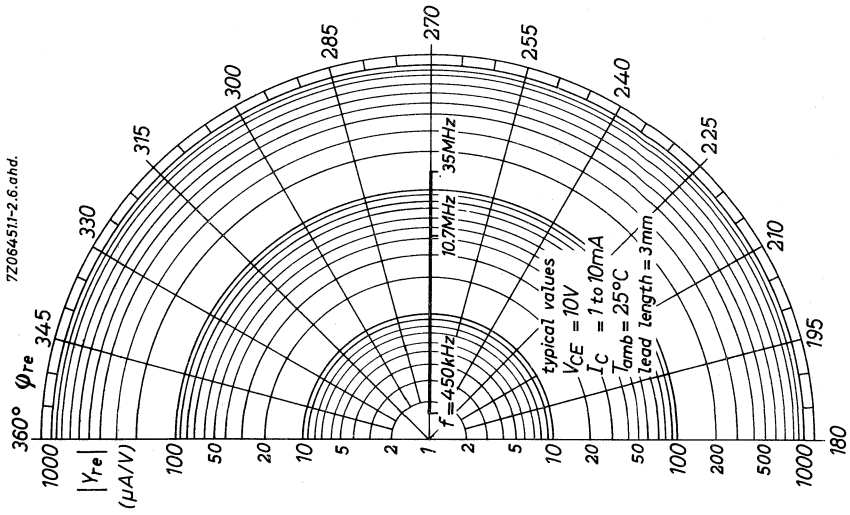
Conversion noise figure

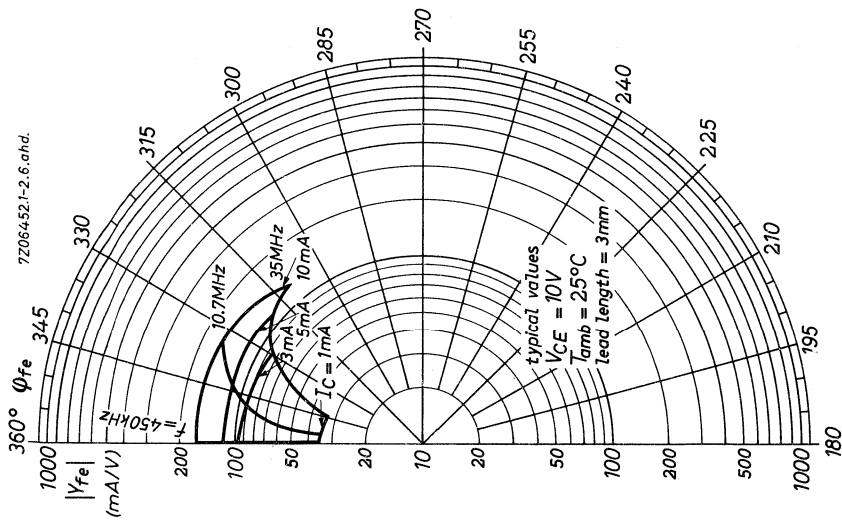
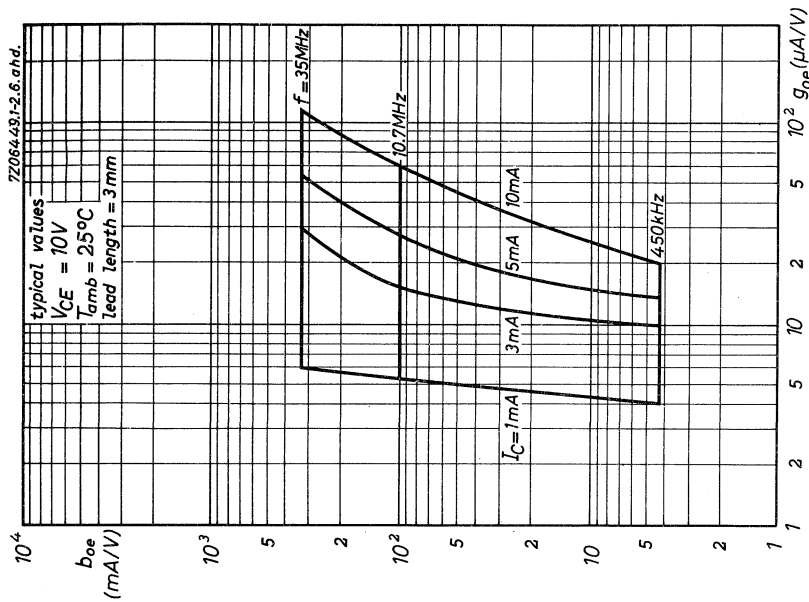
$I_C = 1\text{ mA}; V_{CE} = 10\text{ V}$	F_C	typ.	3 dB
$G_S = 0.6\text{ mA/V}; f = 0.2\text{ MHz}$	F_C	typ.	2 dB
$G_S = 1.2\text{ mA/V}; f = 1.0\text{ MHz}$			

¹⁾ V_{BE} decreases with about 1.7 mV/ $^{\circ}\text{C}$ at increasing temperature.









SILICON PLANAR EPITAXIAL TRANSISTOR

N-P-N transistor in a TO-72 metal case with insulated electrodes and a shield lead connected to the case; the same transistor is available in lock-fit encapsulation under the type number BF195.

The BF185 is intended for h.f. applications in radio and television receivers; it is especially recommended for f.m. tuners, i.f. amplifiers in a.m./f.m. receivers where a low transistor output conductance is of importance, a.m. input stages of carradios where a low noise figure at low source impedance is required.

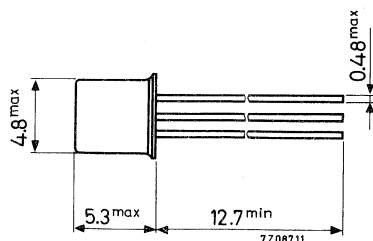
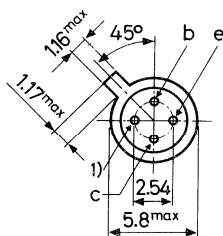
QUICK REFERENCE DATA

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 $T_{amb} = 45\text{ }^{\circ}\text{C}$	P_{tot}	max.	145 mW
Junction temperature	T_j	max.	175 $^{\circ}\text{C}$
D.C. current gain at $T_j = 25\text{ }^{\circ}\text{C}$ $I_C = 1\text{ mA}; V_{CE} = 10\text{ V}$	h_{FE}	typ.	67
Transition frequency $I_C = 1\text{ mA}; V_{CE} = 10\text{ V}$	f_T	typ.	220 MHz
Noise figure at $f = 100\text{ MHz}$ $I_C = 1\text{ mA}; V_{CE} = 10\text{ V}; G_S = 10\text{ mA/V}$	F	typ.	4 dB

MECHANICAL DATA

Dimensions in mm

TO-72



1) = shield lead (connected to case)

Accessories available: 56246, 56263.

FOR NEW DESIGN THE SUCCESSOR TYPES BF195 OR BF255 ARE RECOMMENDED

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

Voltages

Collector-base voltage (open emitter)	V_{CBO}	max.	30 V
Collector-emitter voltage (open base) (See also sheet 8)	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 $T_{amb} = 45\text{ }^{\circ}\text{C}$	P_{tot}	max.	145 mW
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Temperatures

Storage temperature	T_{stg}	-65 to +175	$^{\circ}\text{C}$
Junction temperature	T_j	max.	175 $^{\circ}\text{C}$

THERMAL RESISTANCE

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

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

Base-emitter voltage ¹⁾

$I_C = 1\text{ mA}; V_{CE} = 10\text{ V}$	V_{BE}	0.65 to 0.74	V
$I_C = 20\text{ mA}; V_{CE} = 2\text{ V}$	V_{BE}	<	1.0 V

Feedback capacitance at $f = 0.45\text{ MHz}$

$I_C = 1\text{ mA}; V_{CE} = 10\text{ V}$	$-C_{re}$	typ.	0.65 pF
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D.C. current gain

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

Transition frequency

$I_C = 1\text{ mA}; V_{CE} = 10\text{ V}$	f_T	typ.	220 MHz
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¹⁾ V_{BE} decreases with about 1.7 mV/ $^{\circ}\text{C}$ at increasing temperature.

CHARACTERISTICS (continued)

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

Noise figure

$I_C = 1\text{ mA}; V_{CE} = 10\text{ V}$

$f = 0.2\text{ MHz}; G_S = 5\text{ mA/V}$

F typ. 2 dB

$f = 1\text{ MHz}; G_S = 20\text{ mA/V}$

F typ. 3.5 dB

$f = 100\text{ MHz}; G_S = 10\text{ mA/V}$

F typ. 4 dB

y parameters at $f = 100\text{ MHz}$ (common base)

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

Input conductance

g_{ib} typ. 33 mA/V

Input capacitance

$-C_{ib}$ typ. 5.5 pF

Feedback admittance

$|y_{rb}|$ typ. 220 mA/V

Phase angle of feedback admittance

ϕ_{rb} typ. 273°

Transfer admittance

$|y_{fb}|$ typ. 33 mA/V

Phase angle of transfer admittance

ϕ_{fb} typ. 150°

Output conductance

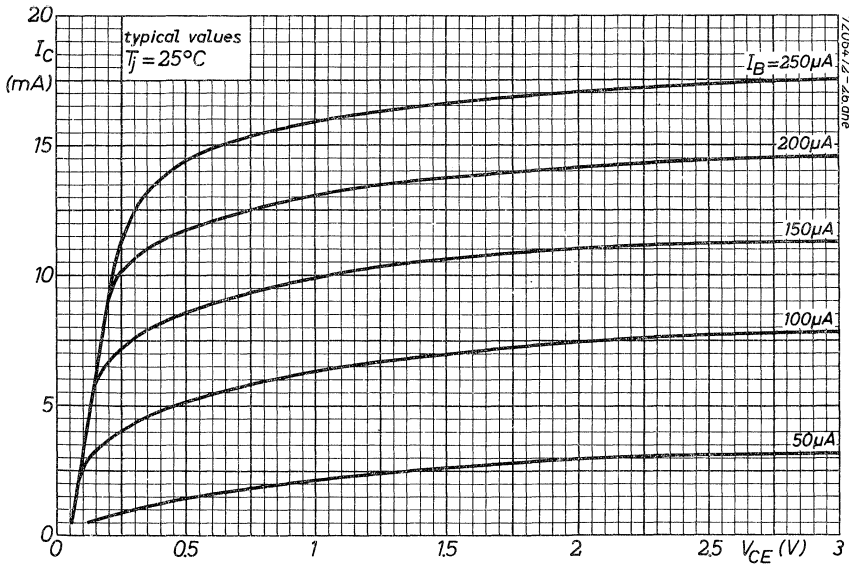
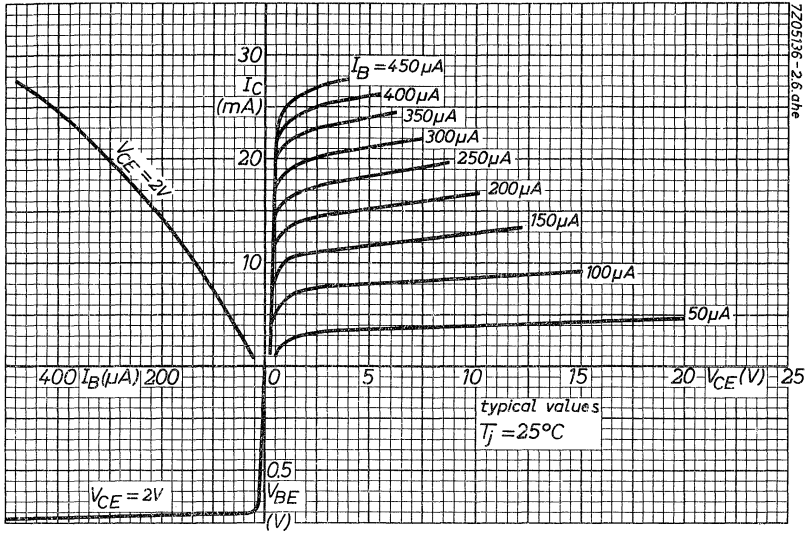
g_{ob} typ. 12 mA/V

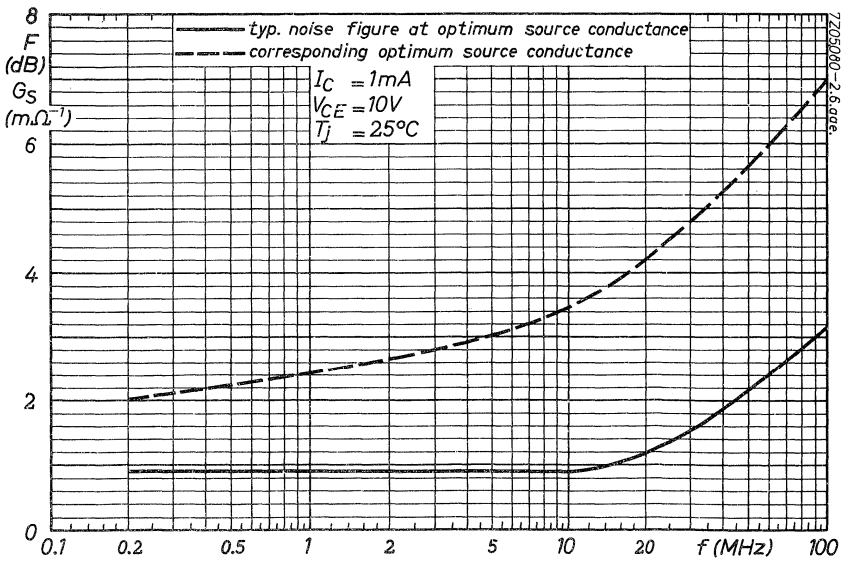
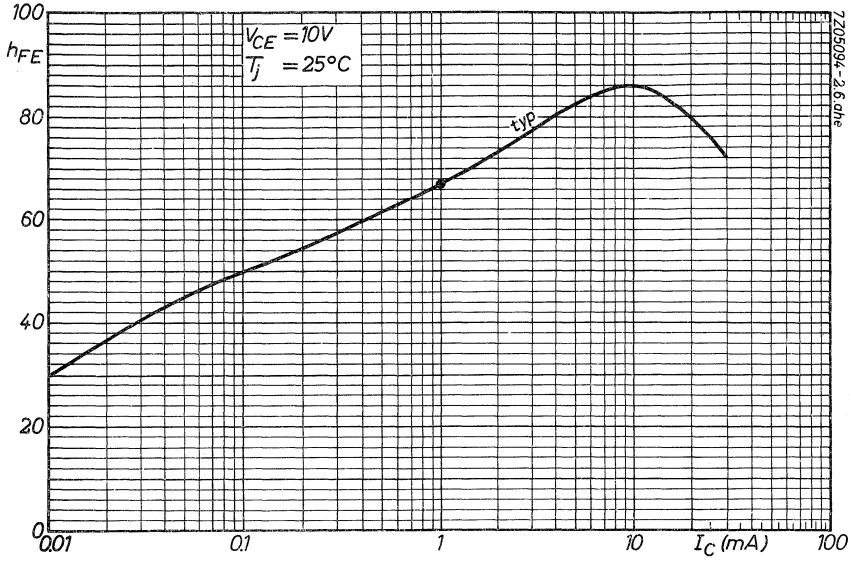
Output capacitance

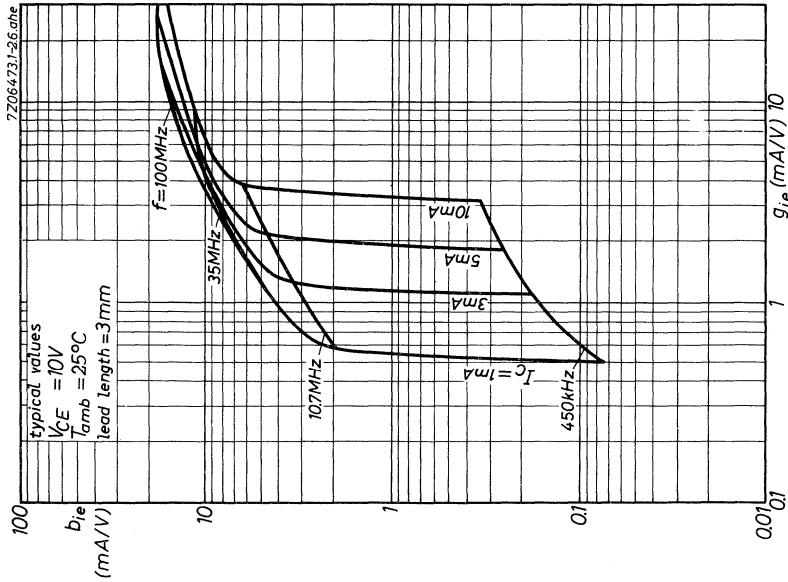
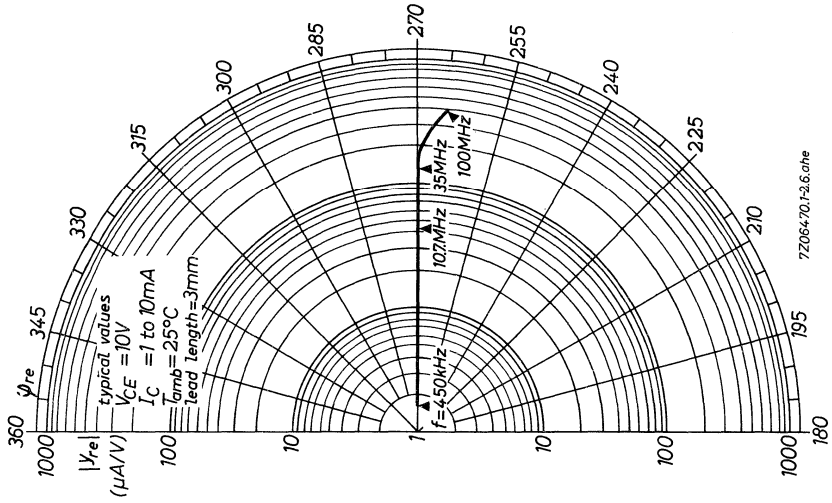
C_{ob} typ. 1.5 pF

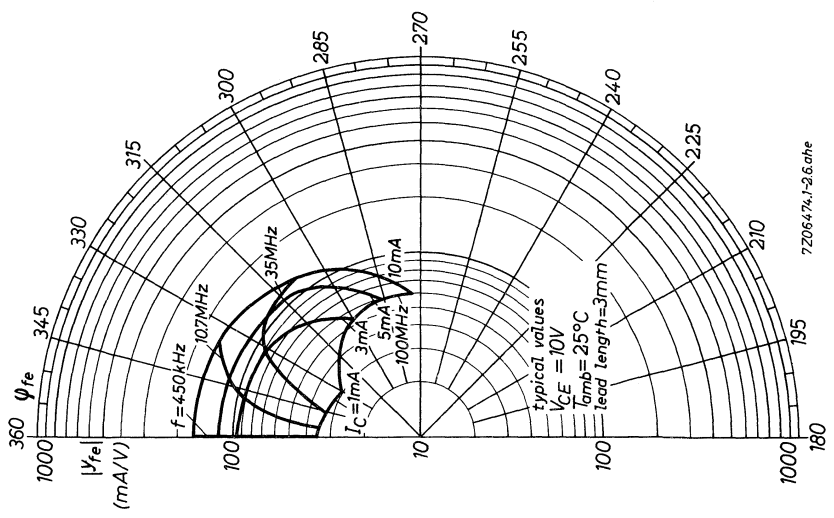
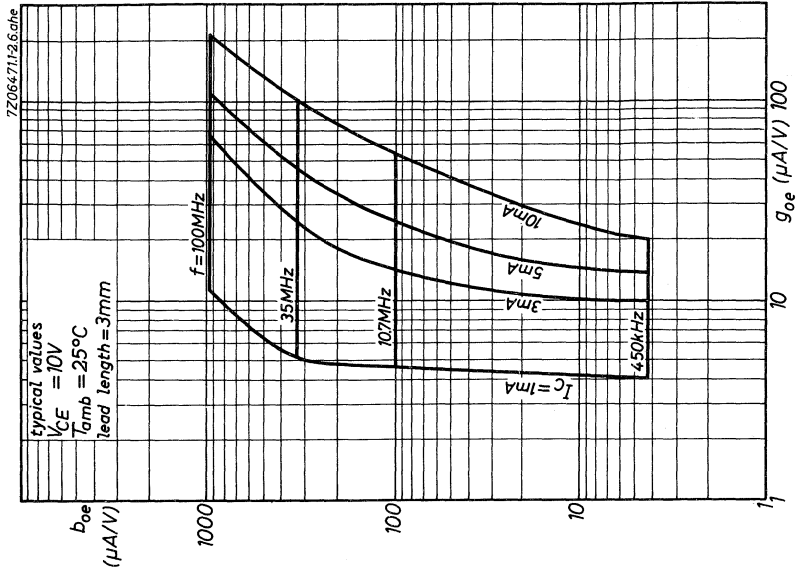
NOTE

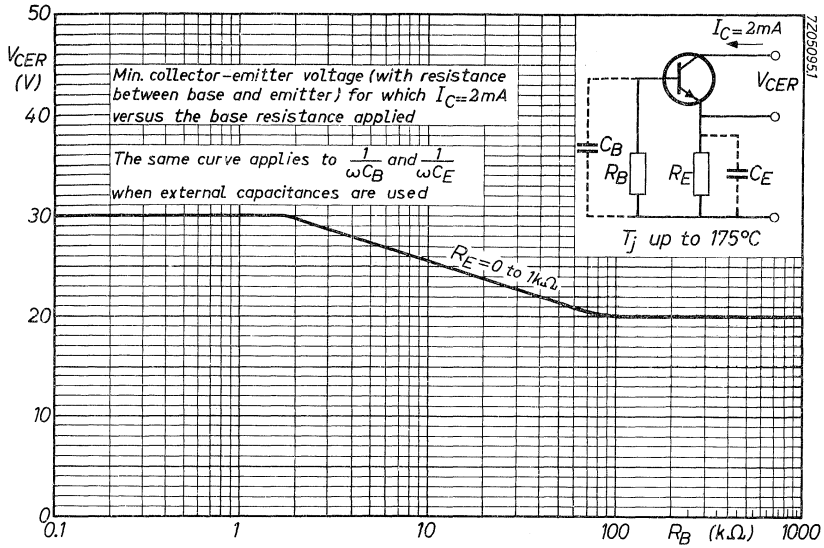
All small signal quantities have been measured with a length of leads between the bottom of the transistor and measuring jig of 3 mm.











SILICON PLANAR EPITAXIAL TRANSISTOR

N-P-N transistor in a plastic envelope with stiff, self-locking pins suitable for use with standard printed boards.

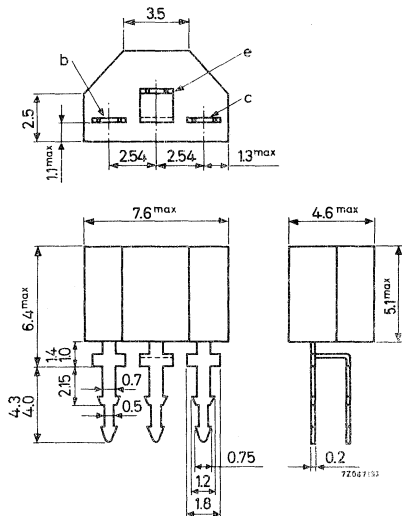
The BF194 is intended for h.f. applications in radio and television receivers; it is especially recommended for f.m. tuners, low noise a.m. mixer-oscillators with high source impedance and i.f. amplifiers in a.m./f.m. receivers where a high current gain is of importance.

QUICK REFERENCE DATA

Collector-base voltage (open emitter)	V_{CBO}	max.	30	V
Collector-emitter voltage (open base)	V_{CEO}	max.	20	V
Collector current (d.c.)	I_C	max.	30	mA
Total power dissipation up to $T_{amb} = 25^\circ\text{C}$	P_{tot}	max.	250	mW
Junction temperature	T_j	max.	125	$^\circ\text{C}$
D.C. current gain at $T_j = 25^\circ\text{C}$ $I_C = 1\text{ mA}; V_{CE} = 10\text{ V}$	h_{FE}	typ.	115	
Transition frequency $I_C = 1\text{ mA}; V_{CE} = 10\text{ V}$	f_T	typ.	260	MHz
Noise figure at $f = 100\text{ MHz}$ $I_C = 1\text{ mA}; V_{CE} = 10\text{ V}; G_S = 10\text{ m}\Omega^{-1}$	F	typ.	4	dB
Conversion noise figure at $f = 1\text{ MHz}$ $I_C = 1\text{ mA}; V_{CE} = 10\text{ V}; G_S = 1.2\text{ m}\Omega^{-1}$	F_c	typ.	2	dB

MECHANICAL DATA

Dimensions in mm



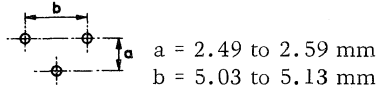
The envelope fulfils the accelerated damp heat test described in IEC publication 68-2 (test D, severity IV, 6 cycles).

MOUNTING INSTRUCTIONS

1. Thickness of printed board: max. 1.1 mm
Hole diameter 0.77 to 0.83 mm
2. Thickness of printed board: max. 1.7 mm
Hole diameter 1.25 to 1.35 mm



Bore plan



NOTE

For iron soldering or for dip soldering, the iron temperature or solder temperature may go up to 300 °C for a maximum of 3 seconds, with the transistor lock-fitted on printed boards in either of the possible mounting positions.

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

Voltages

Collector-base voltage (open emitter)	V_{CBO}	max.	30 V
Collector-emitter voltage (open base) (See also page 4)	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 $T_{amb} = 25 \text{ }^\circ\text{C}$	P_{tot}	max.	250 mW
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Temperatures

Storage temperature	T_{stg}	-65 to +125	°C
Junction temperature	T_j	max.	125 °C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th \text{ j-a}}$	=	0.4 °C/mW
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CHARACTERISTICS

$T_j = 25\text{ }^\circ\text{C}$

Base-emitter voltage 1)

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

Base current

$I_C = 1\text{ mA}; V_{CE} = 10\text{ V}$ I_B 4.5 to 15 μA
typ. 8.7 μA

Feedback capacitance at $f = 0.45\text{ MHz}$

$I_C = 1\text{ mA}; V_{CE} = 10\text{ V}$ $-C_{re}$ typ. 0.95 pF

Transition frequency

$I_C = 1\text{ mA}; V_{CE} = 10\text{ V}$ f_T typ. 260 MHz

Noise figure

$I_C = 1\text{ mA}; V_{CE} = 10\text{ V}$
 $G_S = 2\text{ m}\Omega^{-1}; f = 0.2\text{ MHz}$ F typ. 1.5 dB
 $G_S = 1.5\text{ m}\Omega^{-1}; f = 1.0\text{ MHz}$ F typ. 1.2 dB
 $G_S = 10\text{ m}\Omega^{-1}; f = 100\text{ MHz}$ F typ. 4 dB

Conversion noise figure

$I_C = 1\text{ mA}; V_{CE} = 10\text{ V}$
 $G_S = 0.6\text{ m}\Omega^{-1}; f = 0.2\text{ MHz}$ F_c typ. 3 dB
 $G_S = 1.2\text{ m}\Omega^{-1}; f = 1.0\text{ MHz}$ F_c typ. 2 dB

y parameters at $f = 100\text{ MHz}$ (common base)

$I_C = 1\text{ mA}; V_{CE} = 10\text{ V}$ (lead length = 3 mm)

Input conductance	g_{ib}	typ.	36 $\text{m}\Omega^{-1}$
Input susceptance	$-b_{ib}$	typ.	3 $\text{m}\Omega^{-1}$
Feedback admittance	$ y_{rb} $	typ.	450 $\mu\Omega^{-1}$
Phase angle of feedback admittance	φ_{rb}	typ.	272°
Transfer admittance	$ y_{fb} $	typ.	33 $\text{m}\Omega^{-1}$
Phase angle of transfer admittance	φ_{fb}	typ.	146°
Output conductance	g_{ob}	typ.	22 $\mu\Omega^{-1}$
Output susceptance	b_{ob}	typ.	1.1 $\text{m}\Omega^{-1}$

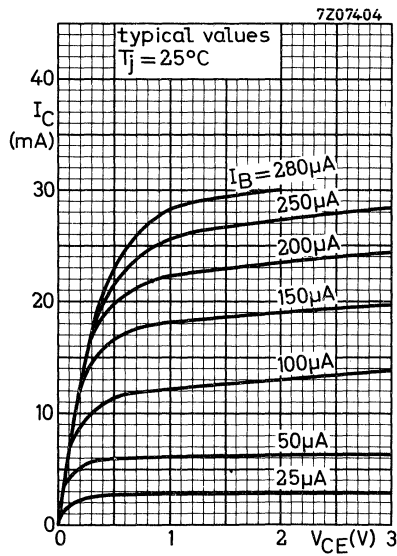
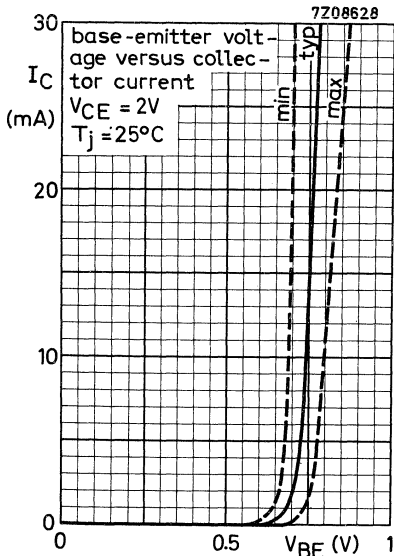
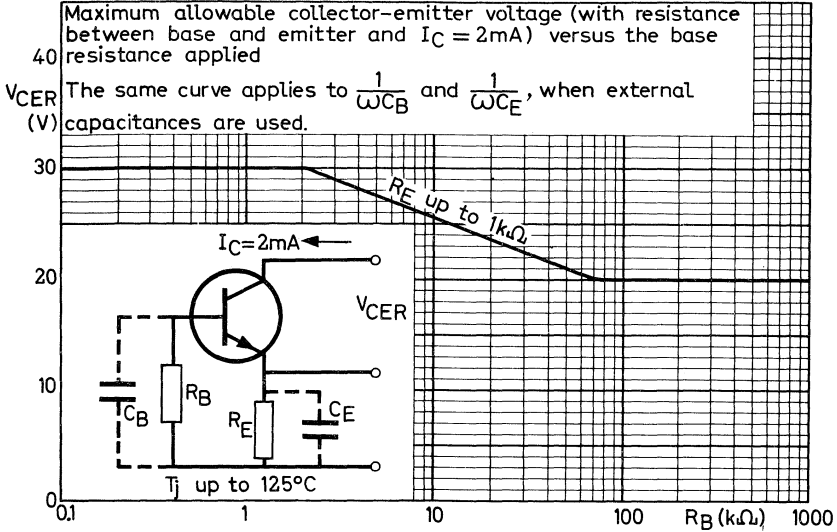
y parameters (common emitter)

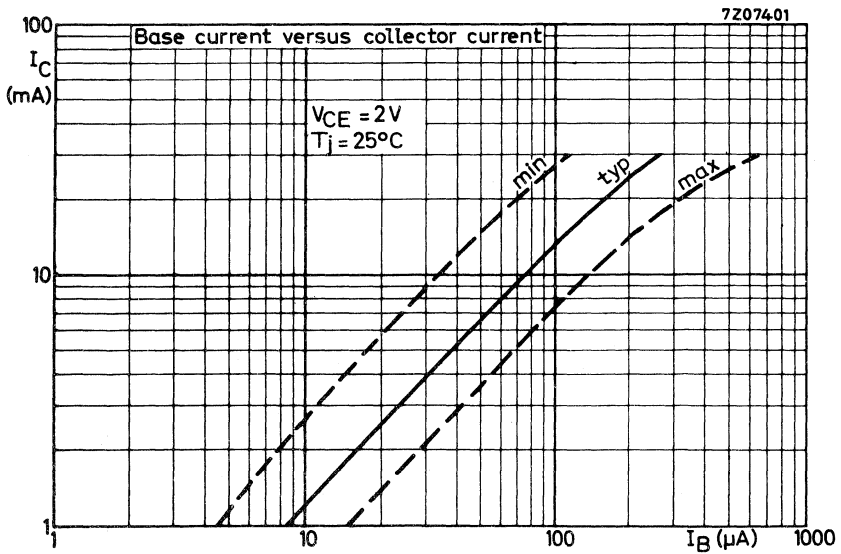
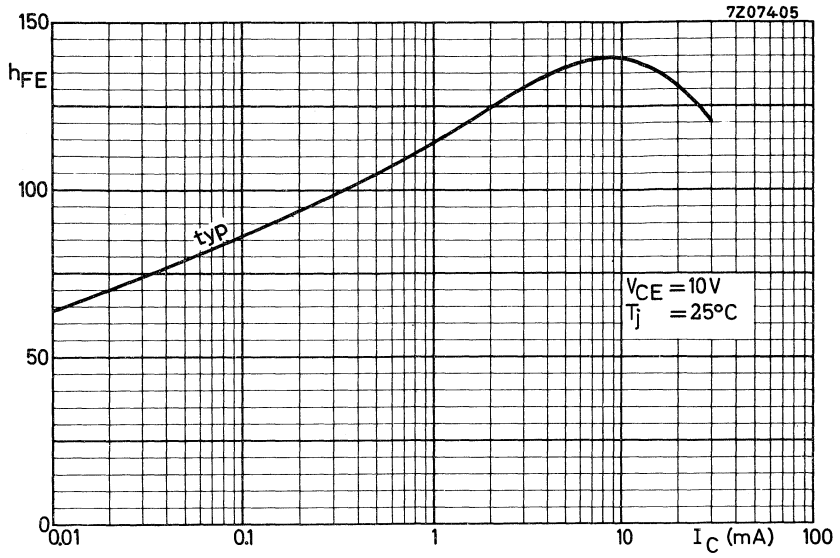
$I_C = 1\text{ mA}; V_{CE} = 10\text{ V}$ (lead length = 3 mm)

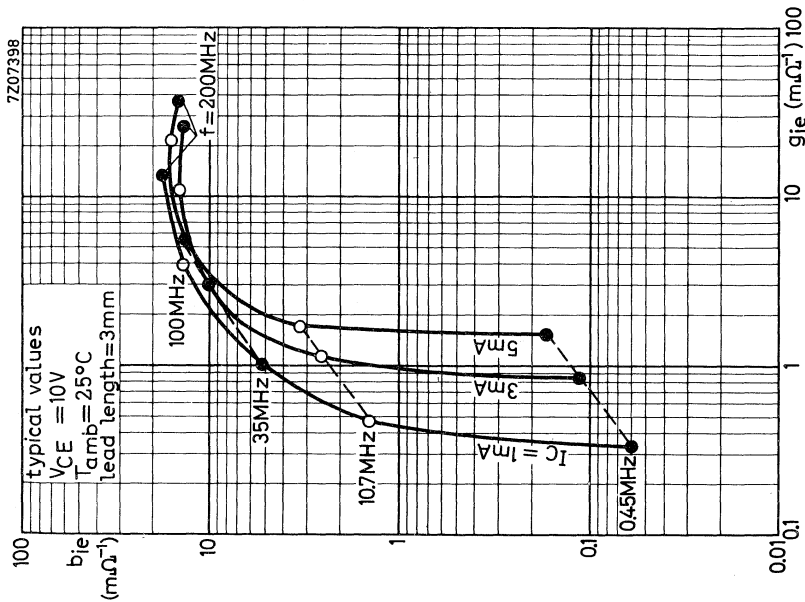
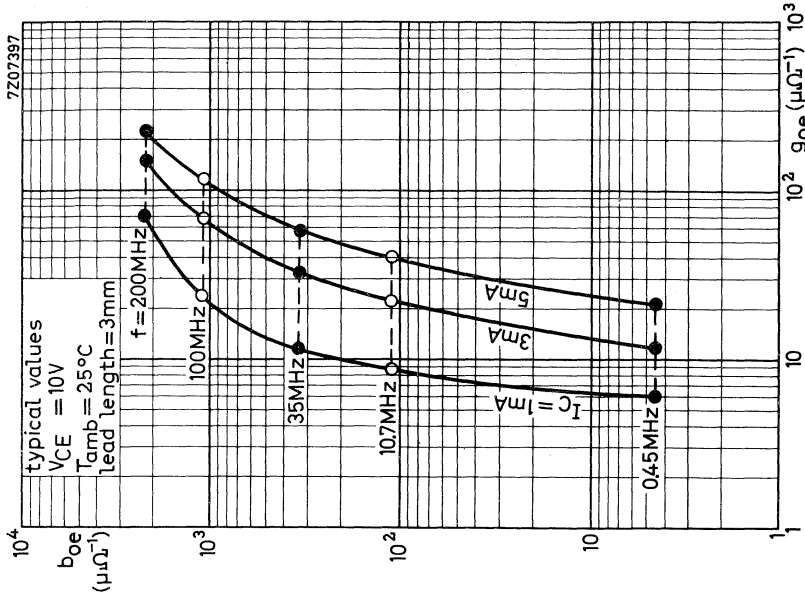
	$f = 10.7\text{ MHz}$	$f = 0.45\text{ MHz}$
Input conductance	$g_{ie} < 0.64$	0.54 $\text{m}\Omega^{-1}$
Output conductance	$g_{oe} < 13.5$	11.5 $\mu\Omega^{-1}$

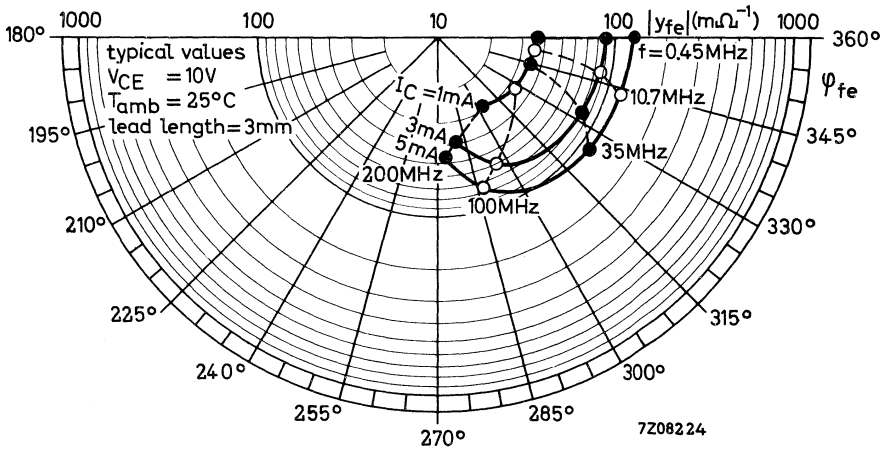
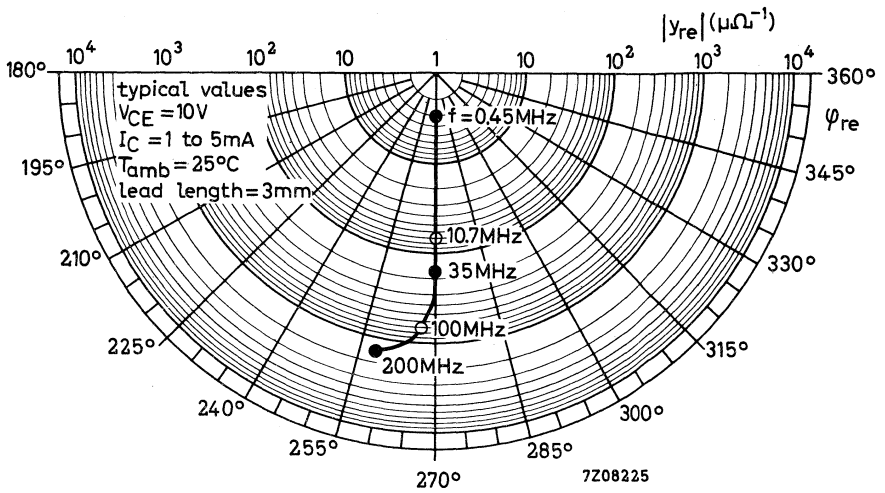
1) V_{BE} decreases by about 1.7 mV/ $^\circ\text{C}$ with increasing temperature.

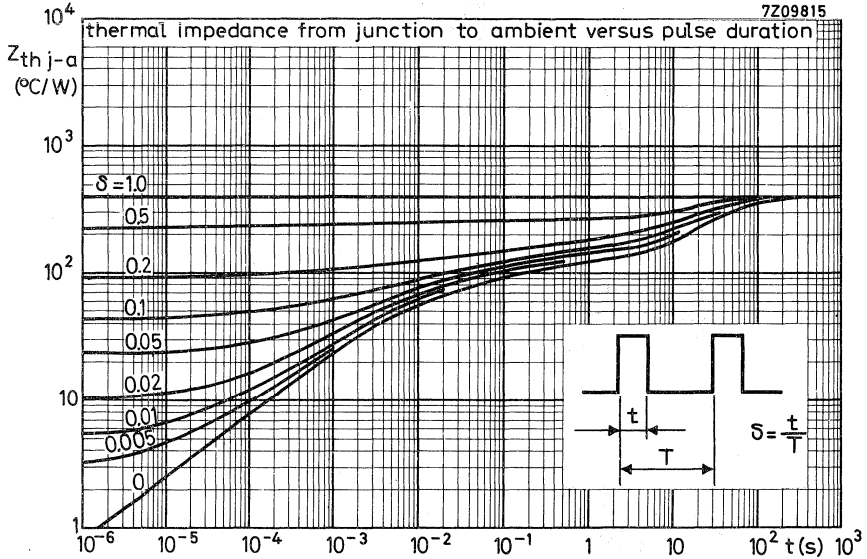
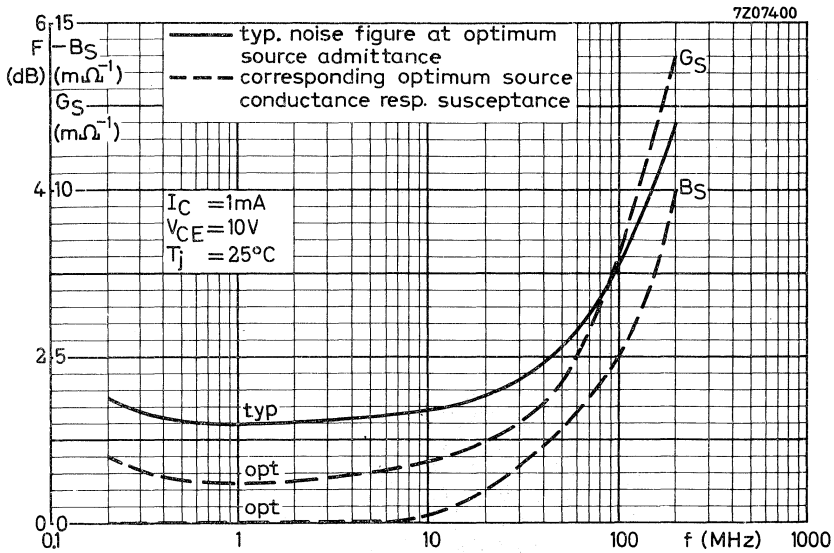
7208228.1











SILICON PLANAR EPITAXIAL TRANSISTOR

N-P-N transistor in a plastic envelope with stiff self-locking pins suitable for use with standard printed boards.

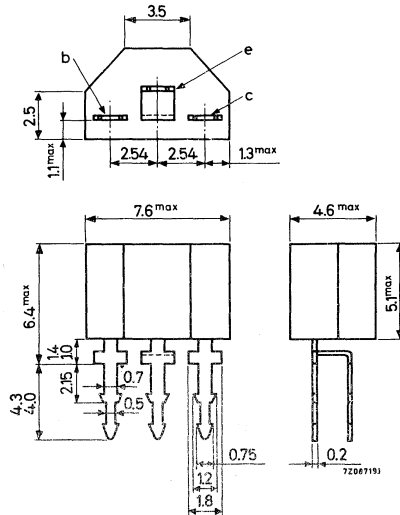
The BF195 is intended for h.f. applications in radio and television receivers; it is especially recommended for f.m. tuners, i.f. amplifiers in a.m./f.m. receivers where a low transistor output conductance is of importance, a.m. input stages of carradios where a low noise figure at low source impedance is required.

QUICK REFERENCE DATA

Collector-base voltage (open emitter)	V_{CBO}	max.	30	V
Collector-emitter voltage (open base)	V_{CEO}	max.	20	V
Collector current (d.c.)	I_C	max.	30	mA
Total power dissipation up to $T_{amb} = 25^\circ\text{C}$	P_{tot}	max.	250	mW
Junction temperature	T_j	max.	125	$^\circ\text{C}$
D.C. current gain at $T_j = 25^\circ\text{C}$ $I_C = 1\text{ mA}; V_{CE} = 10\text{ V}$	h_{FE}	typ.	67	
Transition frequency $I_C = 1\text{ mA}; V_{CE} = 10\text{ V}$	f_T	typ.	200	MHz
Noise figure $I_C = 1\text{ mA}; V_{CE} = 10\text{ V}$ $G_S = 20\text{ m}\Omega^{-1}; f = 1\text{ MHz}$	F	typ.	3.5	dB
$G_S = 10\text{ m}\Omega^{-1}; f = 100\text{ MHz}$	F	typ.	4	dB

MECHANICAL DATA

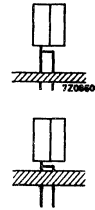
Dimensions in mm



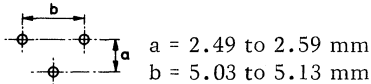
The envelope fulfils the accelerated damp heat test described in IEC publication 68-2 (test D, severity IV, 6 cycles).

MOUNTING INSTRUCTIONS

1. Thickness of printed board: max. 1.1 mm
Hole diameter 0.77 to 0.83 mm
2. Thickness of printed board: max. 1.7 mm
Hole diameter 1.25 to 1.35 mm



Bore plan



NOTE

For iron soldering or for dip soldering, the iron temperature or solder temperature may go up to 300 °C for a maximum of 3 seconds, with the transistor locked-fitted on printed boards in either of the possible mounting positions.

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

Voltages

Collector-base voltage (open emitter)	V_{CB0}	max.	30 V
Collector-emitter voltage (open base) (See also page 4)	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 $T_{amb} = 25\text{ °C}$	P_{tot}	max.	250 mW
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Temperatures

Storage temperature	T_{stg}	-65 to +125 °C
Junction temperature	T_j	max. 125 °C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	0.4 °C/mW
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CHARACTERISTICS

$T_j = 25\text{ }^\circ\text{C}$

Base-emitter voltage ¹⁾

$I_C = 1\text{ mA}; V_{CE} = 10\text{ V}$

V_{BE} 0.65 to 0.74 V

Base current

$I_C = 1\text{ mA}; V_{CE} = 10\text{ V}$

I_B 8 to 28 μA
typ. 15 μA

Feedback capacitance at $f = 0.45\text{ MHz}$

$I_C = 1\text{ mA}; V_{CE} = 10\text{ V}$

$-C_{re}$ typ. 0.95 pF

Transition frequency

$I_C = 1\text{ mA}; V_{CE} = 10\text{ V}$

f_T typ. 200 MHz

Noise figure

$I_C = 1\text{ mA}; V_{CE} = 10\text{ V}$

$G_S = 20\text{ m}\Omega^{-1}; f = 1\text{ MHz}$

F typ. 3.5 dB

$G_S = 10\text{ m}\Omega^{-1}; f = 100\text{ MHz}$

F typ. 4 dB

Conversion noise figure

$I_C = 1\text{ mA}; V_{CE} = 10\text{ V}$

$G_S = 1.2\text{ m}\Omega^{-1}; f = 0.2\text{ MHz}$

F_C typ. 4 dB

$G_S = 1.5\text{ m}\Omega^{-1}; f = 1\text{ MHz}$

F_C typ. 2.5 dB

y parameters at $f = 100\text{ MHz}$ (common base)

$I_C = 1\text{ mA}; V_{CE} = 10\text{ V}$ (lead length = 3 mm)

Input conductance

g_{ib} typ. 38 $\text{m}\Omega^{-1}$

Input susceptance

$-b_{ib}$ typ. 1 $\text{m}\Omega^{-1}$

Feedback admittance

$|y_{rb}|$ typ. 440 $\mu\Omega^{-1}$

Phase angle of feedback admittance

φ_{rb} typ. 275^o

Transfer admittance

$|y_{fb}|$ typ. 34 $\text{m}\Omega^{-1}$

Phase angle of transfer admittance

φ_{fb} typ. 140^o

Output conductance

g_{ob} typ. 12 $\mu\Omega^{-1}$

Output susceptance

b_{ob} typ. 1.1 $\text{m}\Omega^{-1}$

y parameters (common emitter)

$I_C = 1\text{ mA}; V_{CE} = 10\text{ V}$ (lead length = 3 mm) $f = 10.7\text{ MHz}$ | $f = 0.45\text{ MHz}$

Input conductance

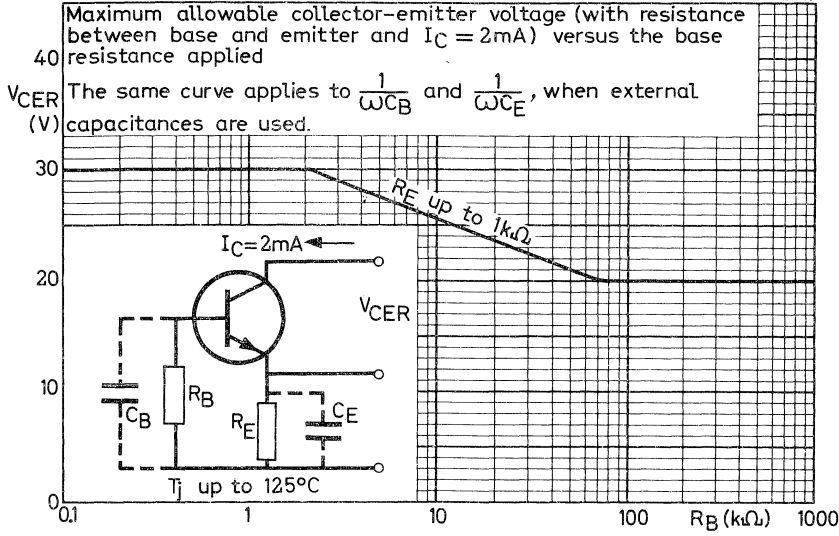
$g_{ie} < 0.96$ | 0.86 $\text{m}\Omega^{-1}$

Output conductance

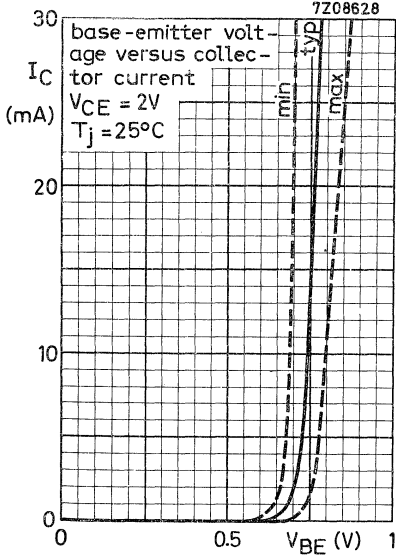
$g_{oe} < 9.5$ | 7.0 $\mu\Omega^{-1}$

1) V_{BE} decreases by about 1.7 mV/^oC with increasing temperature.

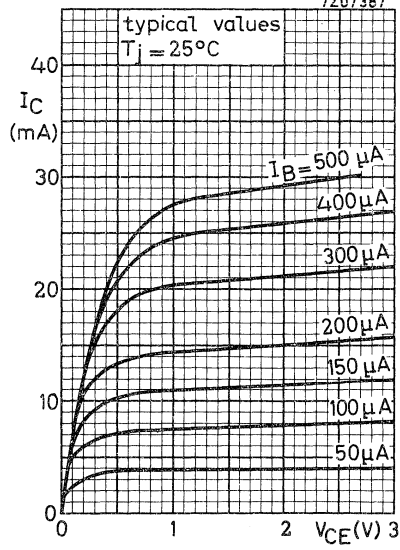
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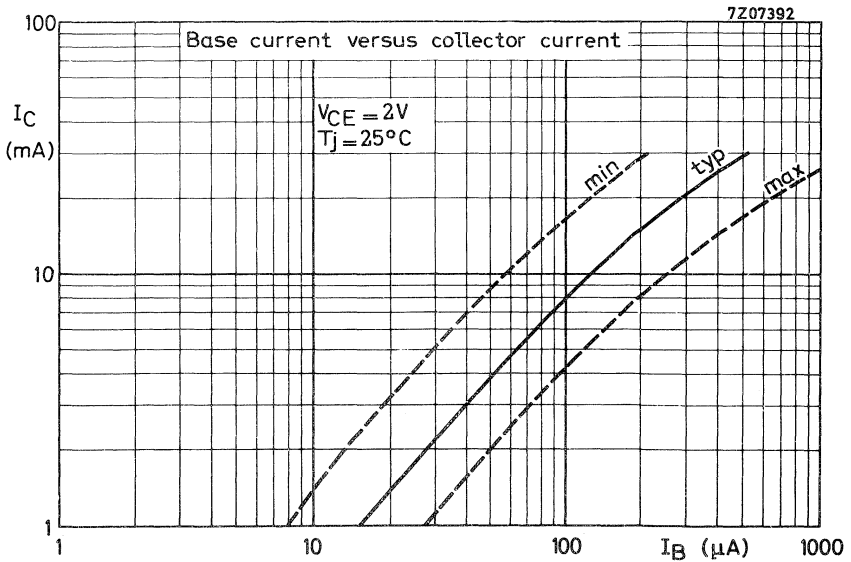
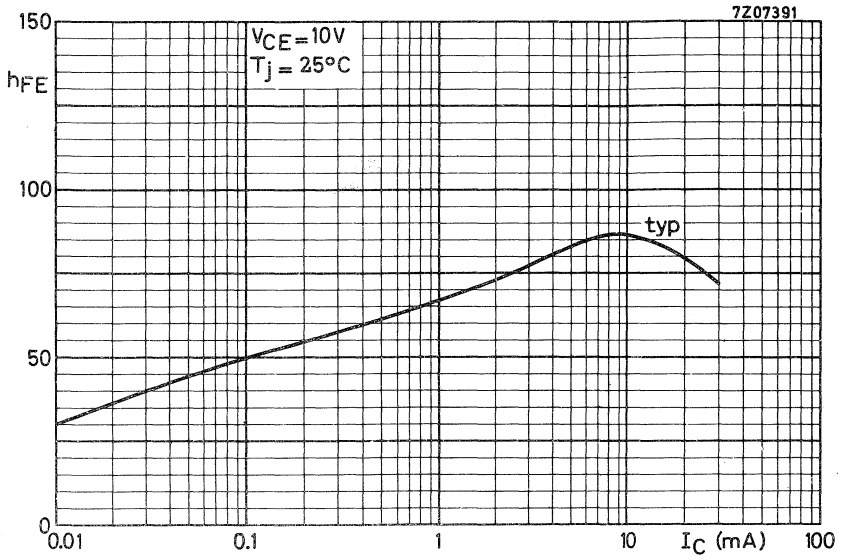


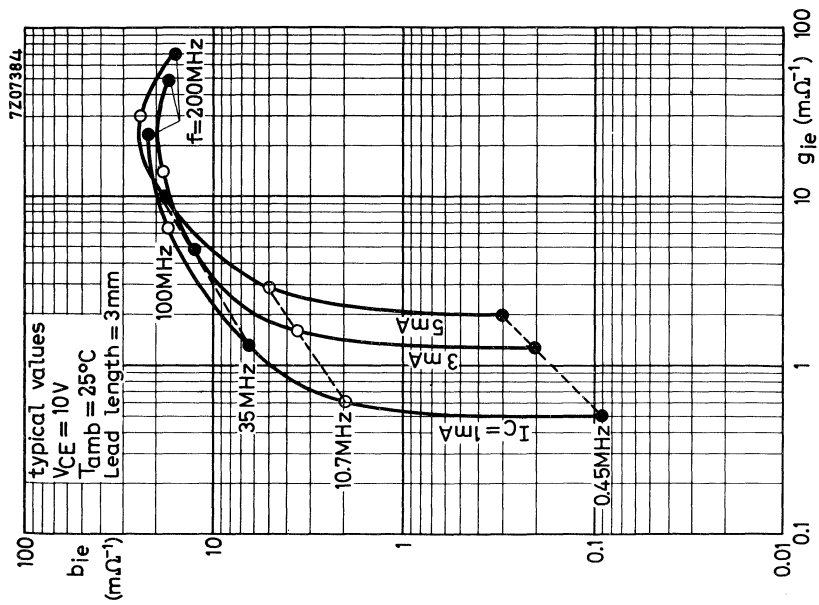
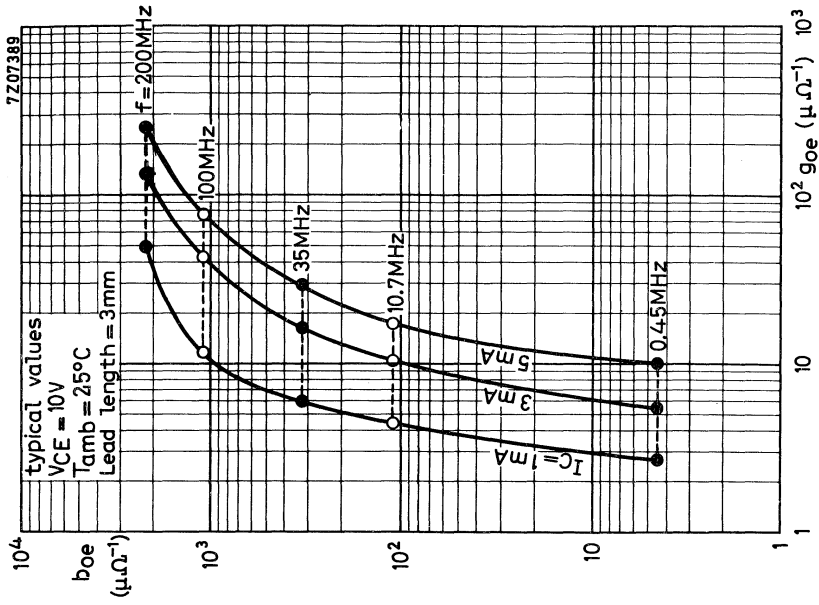
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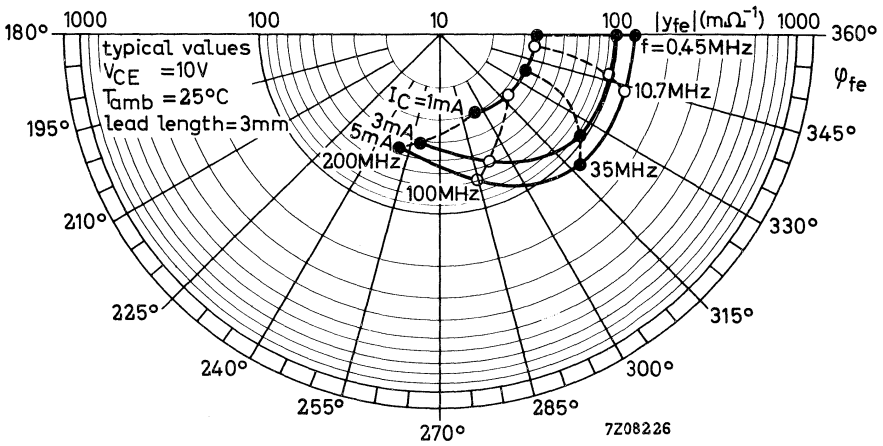
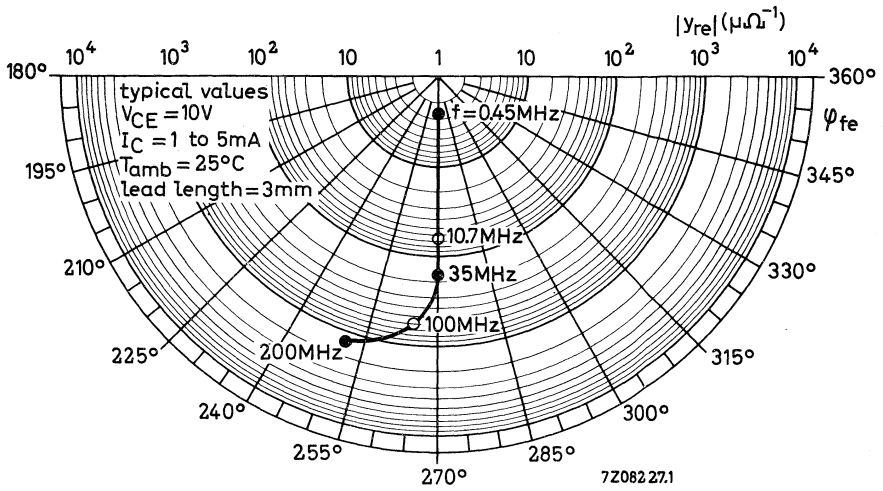


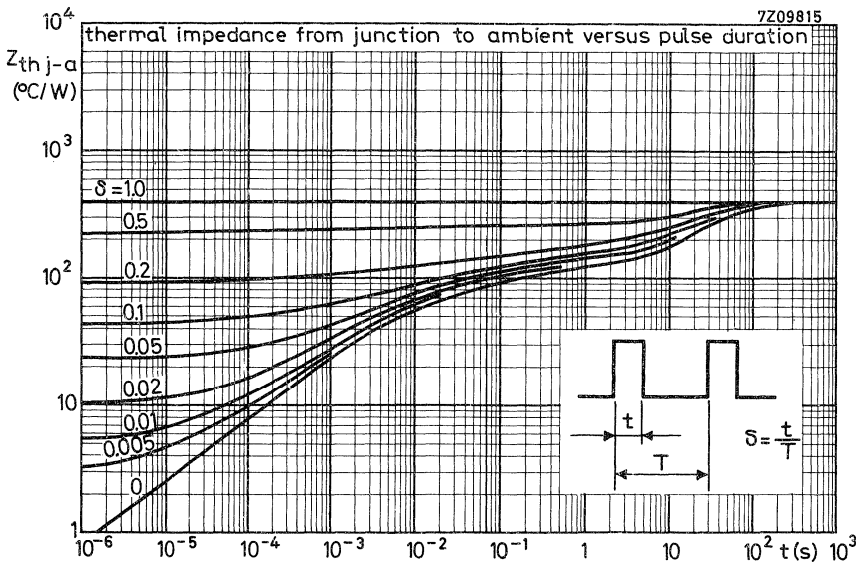
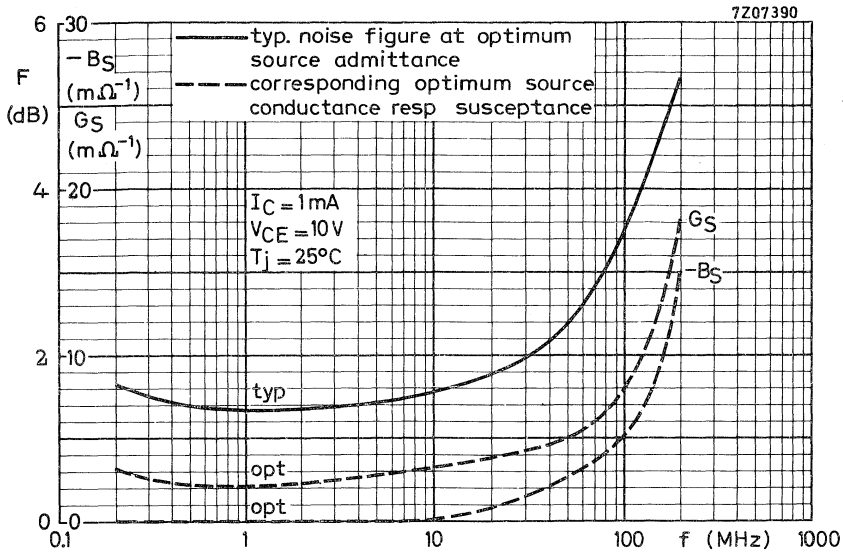
7Z07387











SILICON PLANAR TRANSISTOR

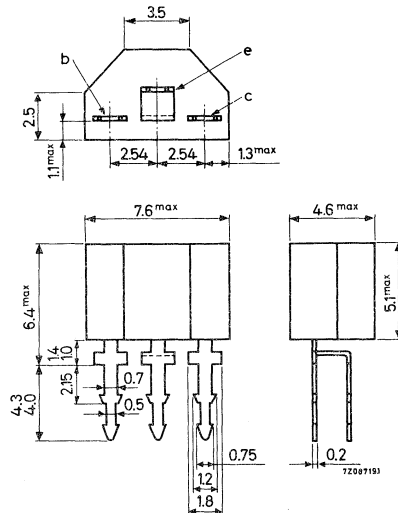
N-P-N transistor in a plastic envelope with stiff self-locking pins suitable for use with standard printed boards. The transistor has a very low feedback capacitance and is intended for use in the forward gain control stage of the television i. f. amplifier.

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 $T_{amb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	250 mW
Junction temperature	T_j	max.	125 $^\circ\text{C}$
Transition frequency at $f = 100\text{ MHz}$ $I_C = 4\text{ mA}; V_{CE} = 10\text{ V}$	f_T	typ.	400 MHz
Feedback capacitance at $f = 10.7\text{ MHz}$ $I_C = 1\text{ mA}; V_{CE} = 10\text{ V}$	$-C_{re}$	typ.	200 fF
Max. unilateralised power gain $I_C = 4\text{ mA}; V_{CE} = 10\text{ V}; f = 35\text{ MHz}$ $f = 45\text{ MHz}$	GUM	typ.	42 dB
	GUM	typ.	39 dB
Gain control range	ΔG_{tr}	typ.	60 dB

MECHANICAL DATA

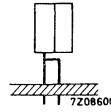
Dimensions in mm



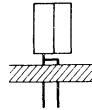
The envelope fulfils the accelerated damp heat test described in IEC publication 68-2 (test D, severity IV, 6 cycles).

MOUNTING INSTRUCTIONS

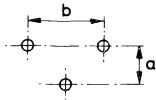
1. Thickness of printed board: max. 1.1 mm
Hole diameter 0.77 to 0.83 mm



2. Thickness of printed board: max. 1.7 mm
Hole diameter 1.25 to 1.35 mm



Bore plan



a = 2.49 to 2.59 mm
b = 5.03 to 5.13 mm

RATINGS (Limiting values) ¹⁾

Voltages

Collector-base voltage (open emitter)	V_{CBO}	max.	40 V
Collector-emitter voltage (open base)	V_{CEO}	max.	30 V ²⁾
Emitter-base voltage (open collector)	V_{EBO}	max.	4 V

Currents

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

Power dissipation

Total power dissipation up to $T_{amb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	250 mW
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Temperatures

Storage temperature	T_{stg}	-65 to +125	$^\circ\text{C}$
Junction temperature	T_j	max.	125 $^\circ\text{C}$

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	0.4 $^\circ\text{C}/\text{mW}$
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1) Limiting values according to the Absolute Maximum System as defined in IEC publication 134 .

2) See also page 6 .

CHARACTERISTICS

$T_{amb} = 25\text{ }^{\circ}\text{C}$ unless otherwise specified

Base current at about 50 dB gain control

$I_C = 6\text{ mA}; V_{CE} = 2\text{ V}$	$I_B < 270\text{ }\mu\text{A}$
$I_C = 15\text{ mA}; V_{CE} = 5\text{ V}$	$I_B < 1.5\text{ mA}$

Base current

$I_C = 4\text{ mA}; V_{CE} = 10\text{ V}$	I_B typ. $60\text{ }\mu\text{A}$
	$I_B < 150\text{ }\mu\text{A}$

Base-emitter voltage 1)

$I_C = 4\text{ mA}; V_{CE} = 10\text{ V}$	V_{BE} typ. 750 mV
	$V_{BE} < 840\text{ mV}$

Feedback capacitance at $f = 10.7\text{ MHz}$

$I_C = 1\text{ mA}; V_{CE} = 10\text{ V}$	$-C_{re}$ typ. 200 fF
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Transition frequency at $f = 100\text{ MHz}$

$I_C = 4\text{ mA}; V_{CE} = 10\text{ V}$	f_T typ. 400 MHz
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Noise figure

$I_C = 4\text{ mA}; V_{CE} = 10\text{ V}$	F typ. 3 dB
$G_S = 10\text{ m}\Omega^{-1}; f = 35\text{ MHz}; B_S = 0$	

y parameters (common emitter)

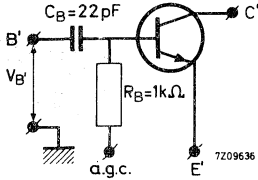
$I_C = 4\text{ mA}; V_{CE} = 10\text{ V}$ (mounted according to instruction 2, see page 2)

		$f = 35 \quad 45\text{ MHz}$	
Input conductance	g_{ie} typ.	3.2	4.8 $\text{m}\Omega^{-1}$
Input capacitance	C_{ie} typ.	37	35 pF
Feedback admittance	$ y_{re} $ typ.	47	60 $\mu\Omega^{-1}$
Phase angle of feedback admittance	φ_{re} typ.	268°	268°
Transfer admittance	$ y_{fe} $ typ.	105	100 $\text{m}\Omega^{-1}$
Phase angle of transfer admittance	φ_{fe} typ.	340°	340°
Output conductance	g_{oe} typ.	50	60 $\mu\Omega^{-1}$
Output capacitance	C_{oe} typ.	1.3	1.3 pF
<u>Maximum unilateralised power gain</u>			
$G_{UM} \text{ (in dB)} = 10 \log \frac{ y_{fe} ^2}{4g_{ie}g_{oe}}$			
$I_C = 4\text{ mA}; V_{CE} = 10\text{ V}$	G_{UM} typ.	42	39 dB

1) V_{BE} decreases by about $1.7\text{ mV}/^{\circ}\text{C}$ with increasing temperature.

Equivalent gain control transistor

To ensure an almost constant input admittance and an output conductance that varies little with gain control, we recommend that where a BF196 is used in a gain controlled i.f. stage, a series base capacitor of 22 pF and a bias resistor of 1 kΩ be used.

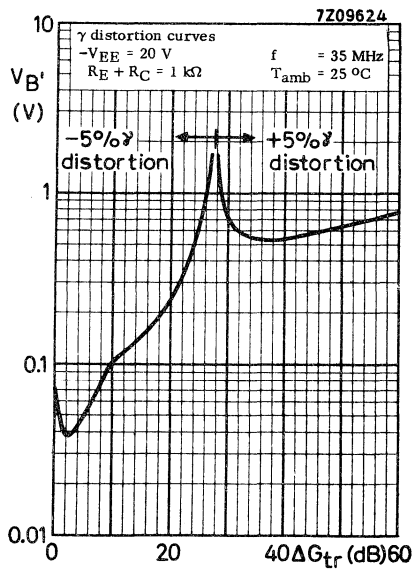
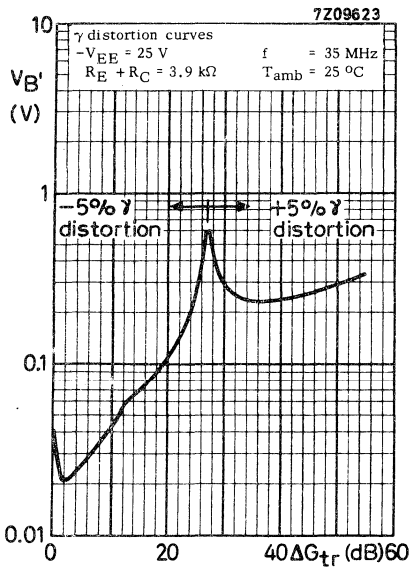


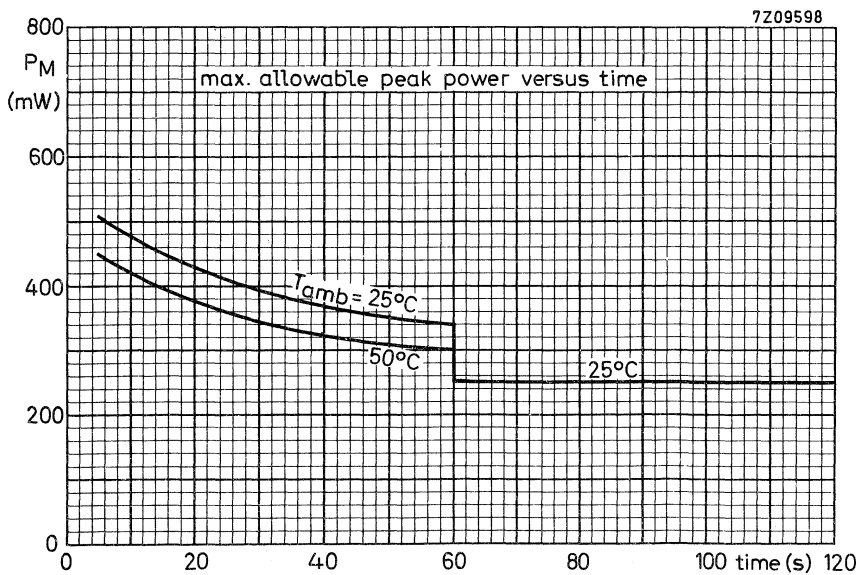
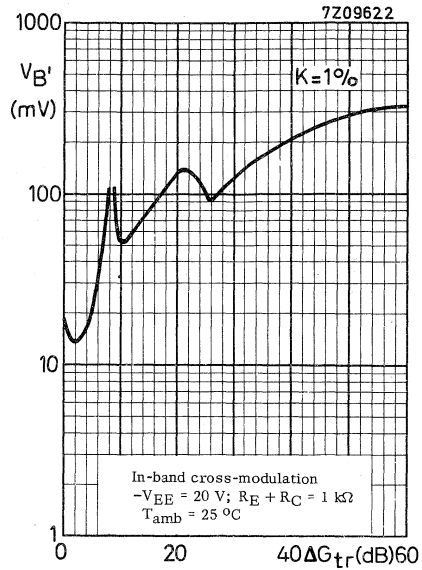
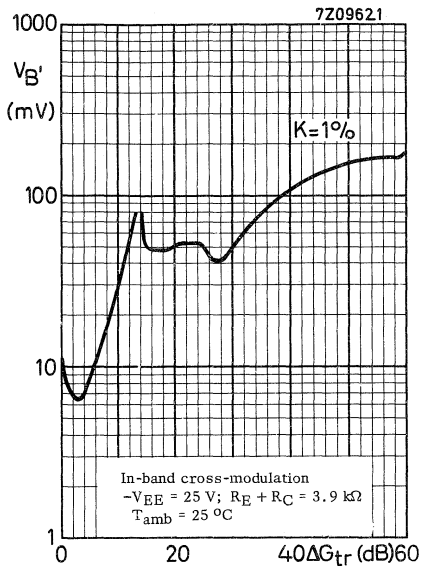
The transistor with these additional components is effectively an "equivalent transistor" for gain control purposes, the signal handling capability of which may be expressed in terms of voltage. (Without these components the varying input admittance means that the signal handling capability can only be expressed in terms of power).

The signal handling capability of the equivalent transistor as a function of ΔG_{tr} (the reduction in transducer gain with gain control) will be found on pages 4 and 5.

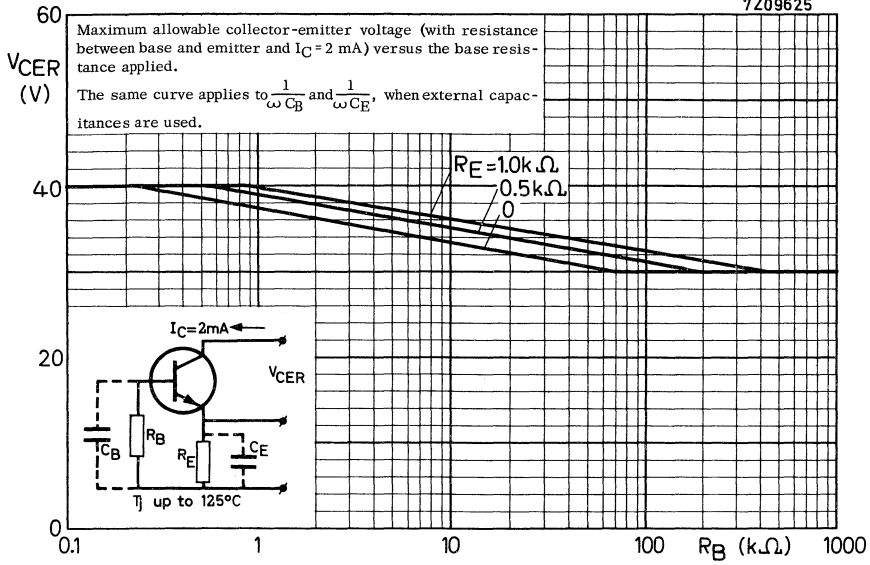
- a. Voltage versus ΔG_{tr} curves for a γ distortion of 5% are below.
- b. Voltage versus ΔG_{tr} curves for an in-band cross modulation factor of 1% are on page 5.

Graphs of the y-parameters are on pages 8 to 11.

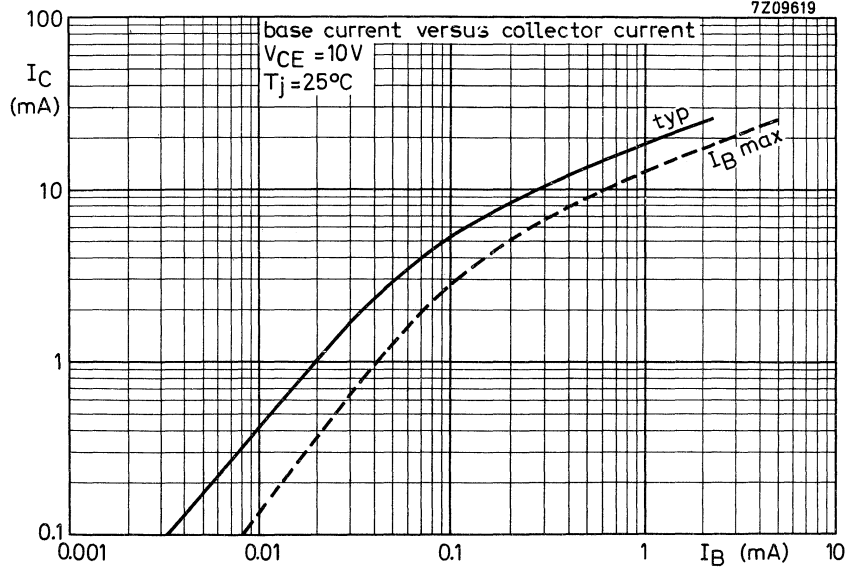


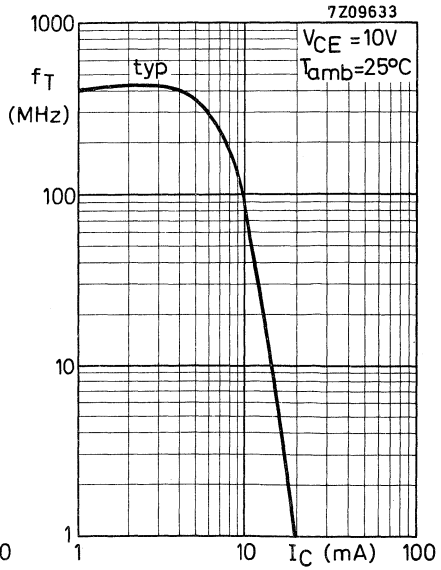
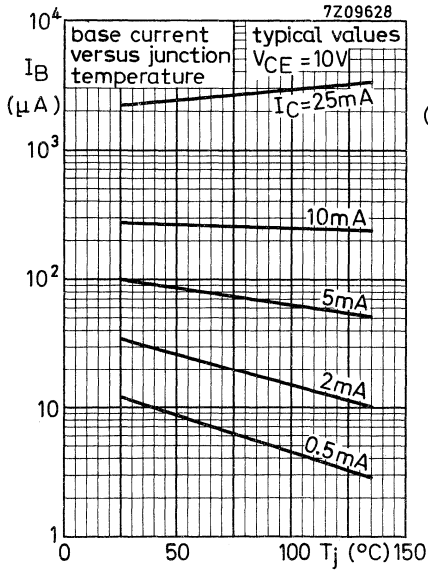
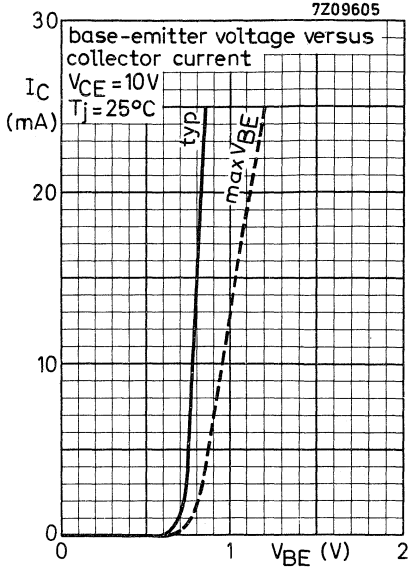
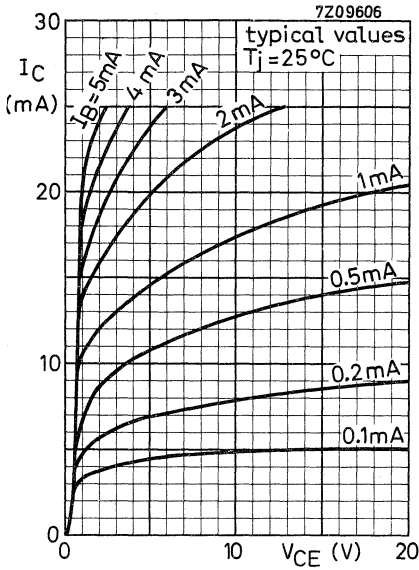


7Z09625

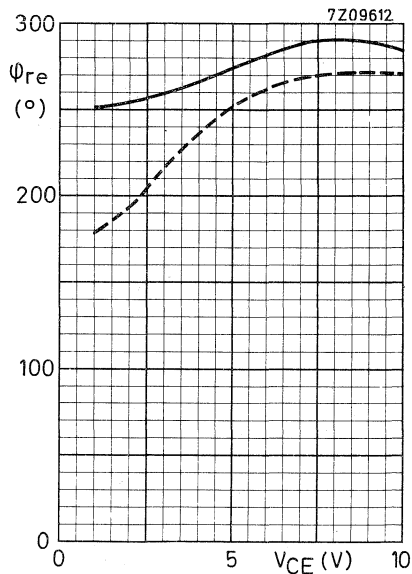
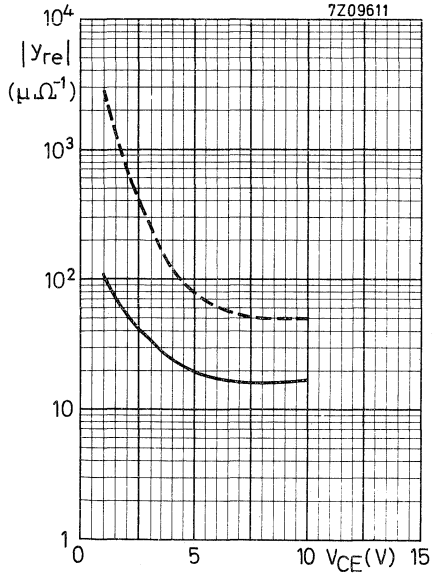
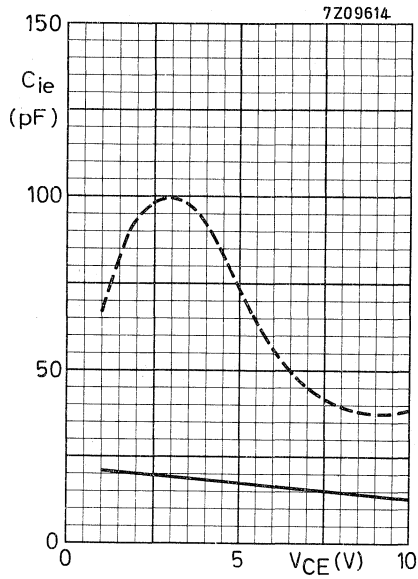
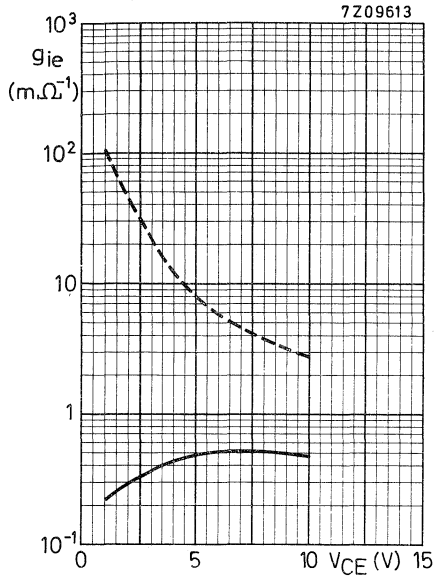


7Z09619



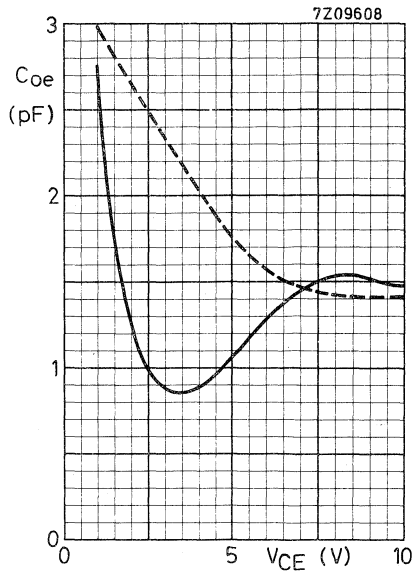
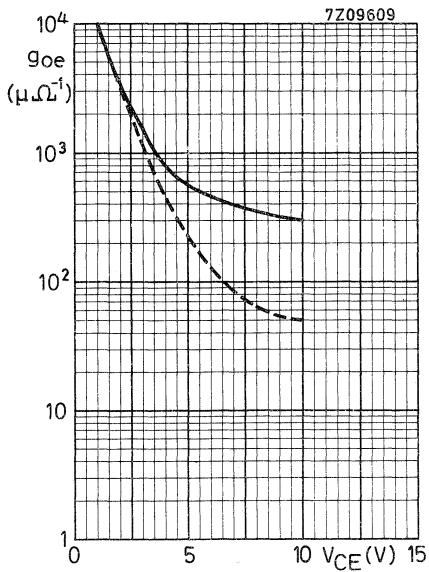
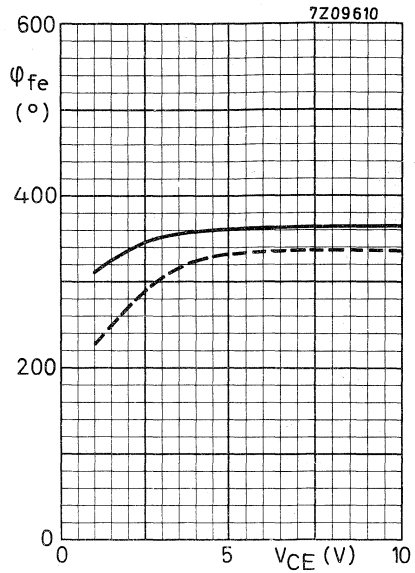
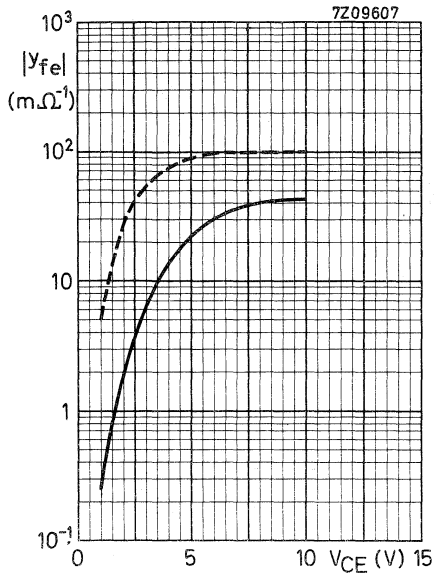


Voltage control; $-V_{EE} = 25 \text{ V}$; $R_E + R_C = 3.9 \text{ k}\Omega$; $f = 35 \text{ MHz}$



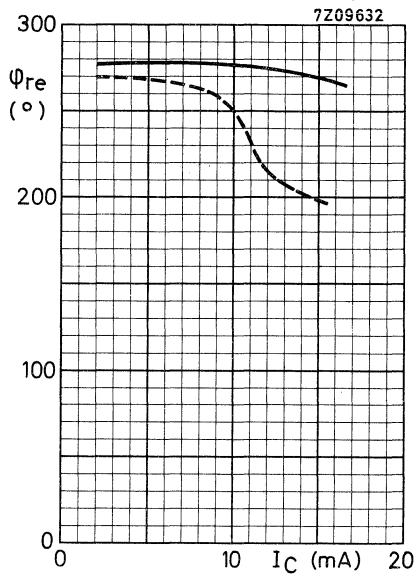
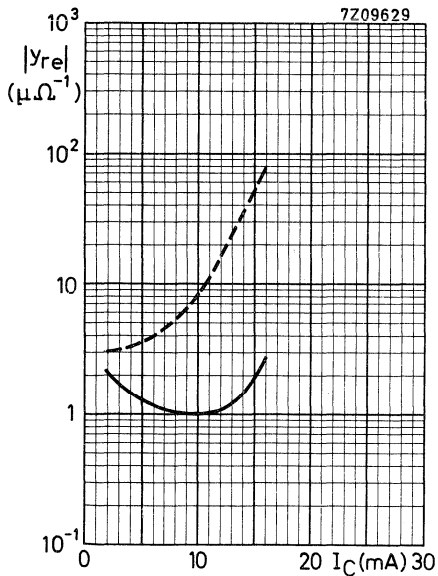
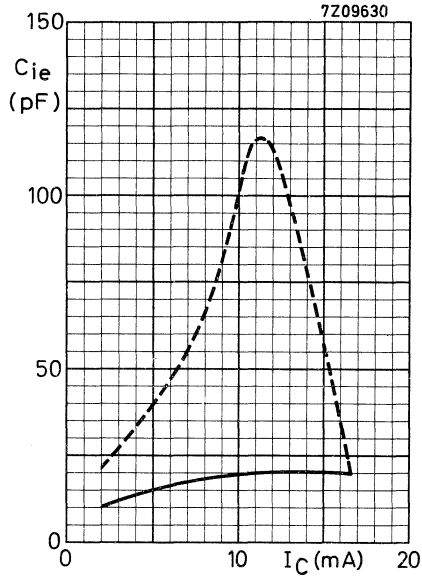
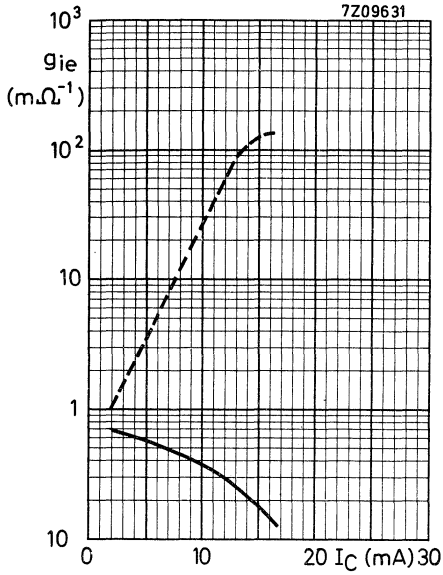
y-parameters of the equivalent gain control transistor, including base capacitor and base resistor as shown on page 4 (dashed curves apply to the transistor only).

Voltage control; $-V_{EE} = 25 \text{ V}$; $R_E + R_C = 3.9 \text{ k}\Omega$; $f = 35 \text{ MHz}$



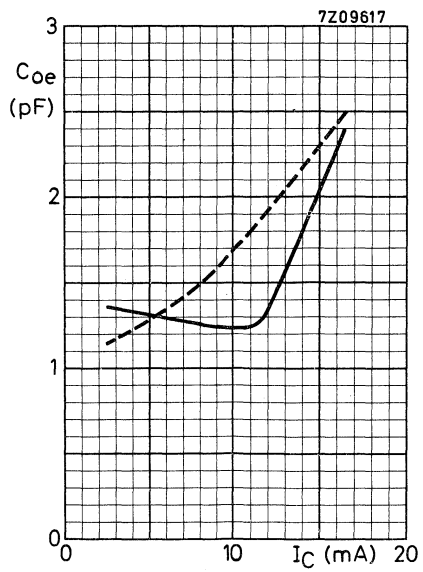
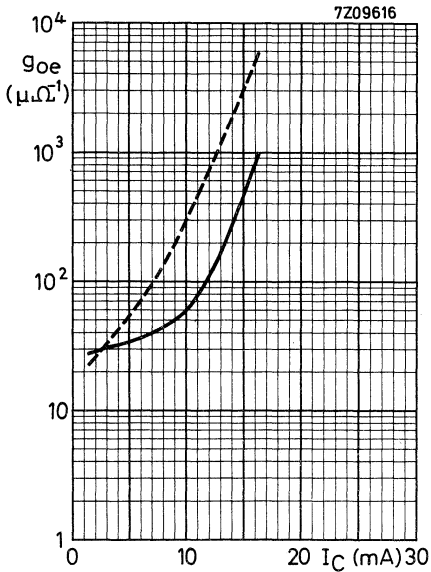
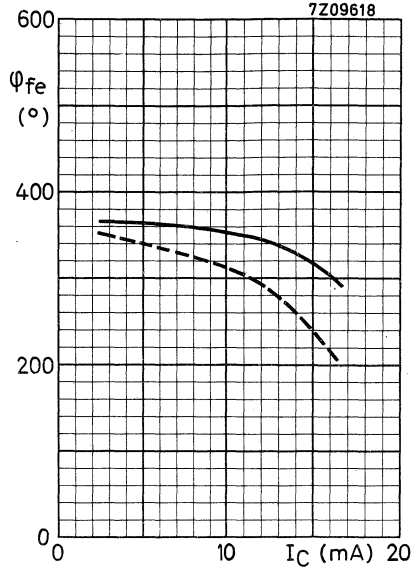
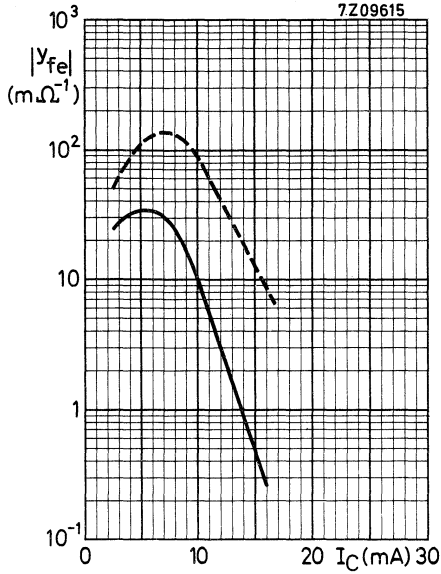
y-parameters of the equivalent gain control transistor, including base capacitor and base resistor as shown on page 4 (dashed curves apply to the transistor only).

Current control; $-V_{EE} = 20 \text{ V}$; $R_E + R_C = 1 \text{ k}\Omega$; $f = 35 \text{ MHz}$



y-parameters of the equivalent gain control transistor, including base capacitor and base resistor as shown on page 4 (dashed curves apply to the transistor only).

Current control; $-V_{EE} = 20 \text{ V}$; $R_E + R_C = 1 \text{ k}\Omega$; $f = 35 \text{ MHz}$

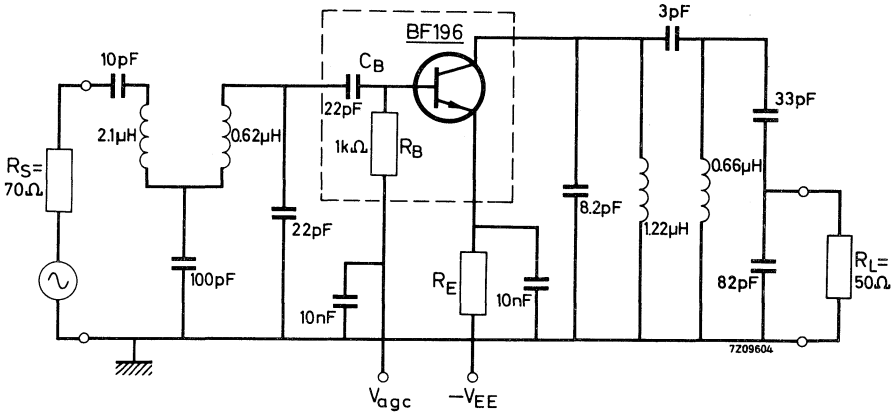


y-parameters of the equivalent gain control transistor, including base capacitor and base resistor as shown on page 4 (dashed curves apply to the transistor only).

APPLICATION INFORMATION

First stage of an i.f. amplifier ¹⁾

Basic circuit with voltage gain control: $R_E + R_C = 3.9 \text{ k}\Omega$; $-V_{EE} = 25 \text{ V}$
 current gain control: $R_E + R_C = 1 \text{ k}\Omega$; $-V_{EE} = 20 \text{ V}$



Transducer gain

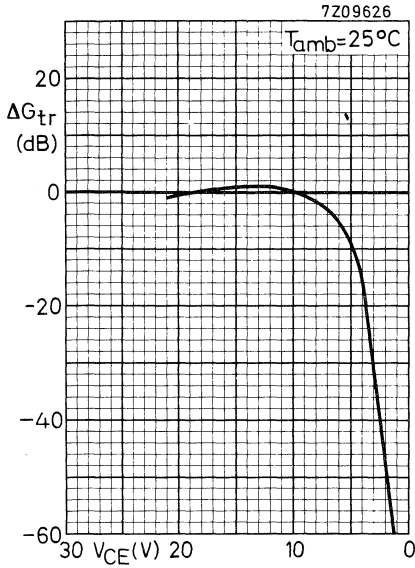
$$G_{tr} \text{ (in dB)} = 10 \log \frac{\text{output power in load } R_L}{\text{available power from source } R_S}$$

$f = 36.4 \text{ MHz}$; $I_C = 4 \text{ mA}$; $R_E + R_C = 3.9 \text{ k}\Omega$; $-V_{EE} = 25 \text{ V}$ G_{tr} typ. 25.5 dB

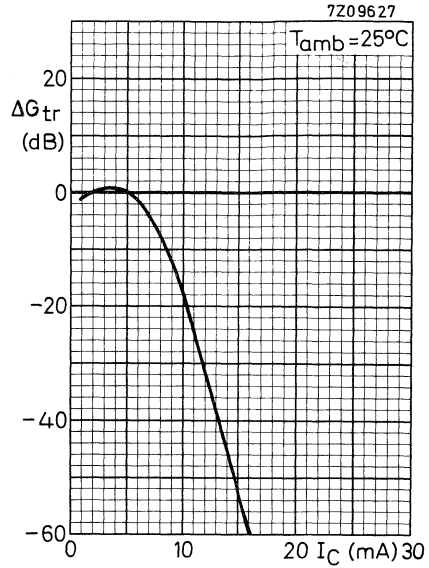
Gain control range (see also upper graphs next page) ΔG_{tr} typ. 60 dB

¹⁾ Application information bulletins are available on request.

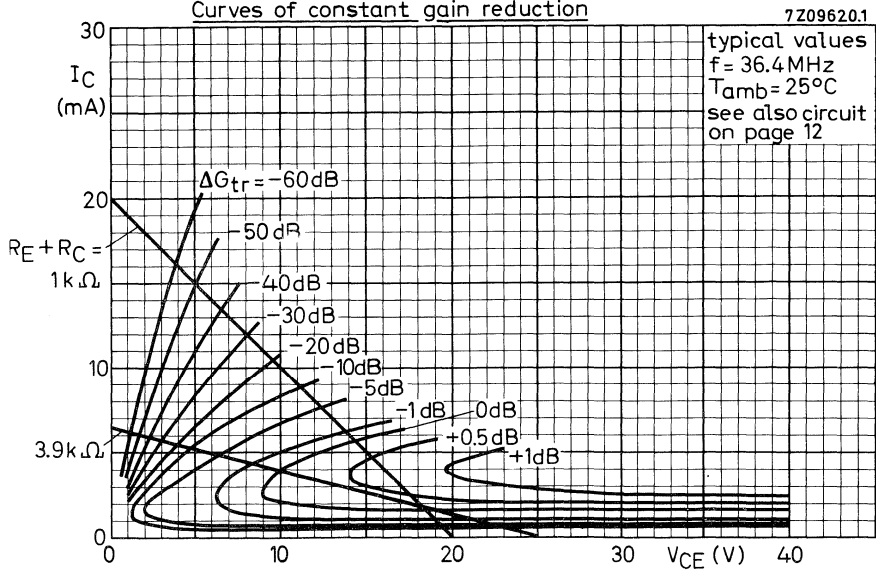
voltage gain control



current gain control



Curves of constant gain reduction



SILICON PLANAR TRANSISTOR

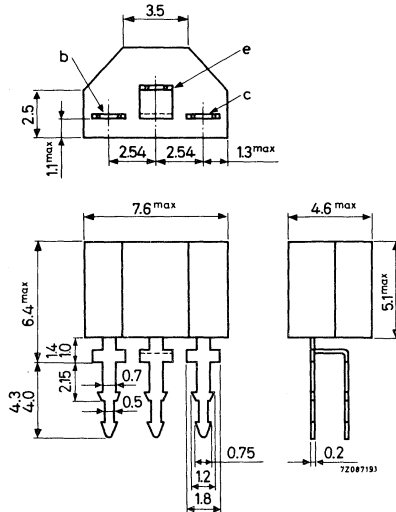
N-P-N transistor in a plastic envelope with stiff self-locking pins suitable for use with standard printed boards.

The BF197 has a very low feedback capacitance and is intended for use in the output stage of a television video i.f. amplifier.

QUICK REFERENCE DATA			
Collector-base voltage (open emitter)	V_{CB0}	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 $T_{amb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	250 mW
Junction temperature	T_j	max.	125 $^\circ\text{C}$
Transition frequency at $f = 100\text{ MHz}$ $I_C = 5\text{ mA}; V_{CE} = 10\text{ V}$	f_T	typ.	550 MHz
Feedback capacitance at $f = 10.7\text{ MHz}$ $I_C = 1\text{ mA}; V_{CE} = 10\text{ V}$	$-C_{re}$	typ.	300 fF
Max. unilateralised power gain $I_C = 7\text{ mA}; V_{CE} = 10\text{ V}; f = 35\text{ MHz}$	G_{UM}	typ.	43 dB
$f = 45\text{ MHz}$	G_{UM}	typ.	41 dB
Video detector output voltage	V_O	typ.	7.7 V

MECHANICAL DATA

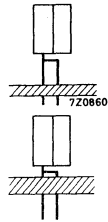
Dimensions in mm



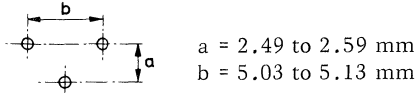
The envelope fulfils the accelerated damp heat test described in IEC publication 68-2 (test D, severity IV, 6 cycles).

MOUNTING INSTRUCTIONS

1. Thickness of printed board: max. 1.1 mm
Hole diameter 0.77 to 0.83 mm
2. Thickness of printed board: max. 1.7 mm
Hole diameter 1.25 to 1.35 mm



Bore plan



RATINGS (Limiting values) 1)

Voltages

Collector-base voltage (open emitter)	V_{CBO}	max.	40 V
Collector-emitter voltage (open base)	V_{CEO}	max.	25 V 2)
Emitter-base voltage (open collector)	V_{EBO}	max.	4 V

Currents

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

Power dissipation

Total power dissipation up to $T_{amb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	250 mW
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Temperatures

Storage temperature	T_{stg}	-65 to +125	$^\circ\text{C}$
Junction temperature	T_j	max.	125 $^\circ\text{C}$

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	0.4 $^\circ\text{C}/\text{mW}$
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1) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

2) See also page 4.

CHARACTERISTICS

$T_{amb} = 25\text{ }^{\circ}\text{C}$ unless otherwise specified

Base current

$I_C = 7\text{ mA}; V_{CE} = 10\text{ V}$

I_B typ. 60 μA
< 185 μA

Base-emitter voltage ¹⁾

$I_C = 7\text{ mA}; V_{CE} = 10\text{ V}$

V_{BE} typ. 750 mV
< 900 mV

Feedback capacitance at $f = 10.7\text{ MHz}$

$I_C = 1\text{ mA}; V_{CE} = 10\text{ V}$

$-C_{re}$ typ. 300 fF

Transition frequency at $f = 100\text{ MHz}$

$I_C = 5\text{ mA}; V_{CE} = 10\text{ V}$

f_T typ. 550 MHz

y parameters (common emitter)

$I_C = 7\text{ mA}; V_{CE} = 10\text{ V}$ (mounted according to instruction 2, see page 2)

		f = 35 45 MHz	
Input conductance	g_{ie}	typ. 4.5	5.5 $\text{m}\Omega^{-1}$
Input capacitance	C_{ie}	typ. 45	45 pF
Feedback admittance	$ y_{re} $	typ. 67	86 $\mu\Omega^{-1}$
Phase angle of feedback admittance	φ_{re}	typ. 268°	268°
Transfer admittance	$ y_{fe} $	typ. 170	155 $\text{m}\Omega^{-1}$
Phase angle of transfer admittance	φ_{fe}	typ. 338°	335°
Output conductance	g_{oe}	typ. 85	95 $\mu\Omega^{-1}$
Output capacitance	C_{oe}	typ. 1.8	1.8 pF

Maximum unilateralised power gain

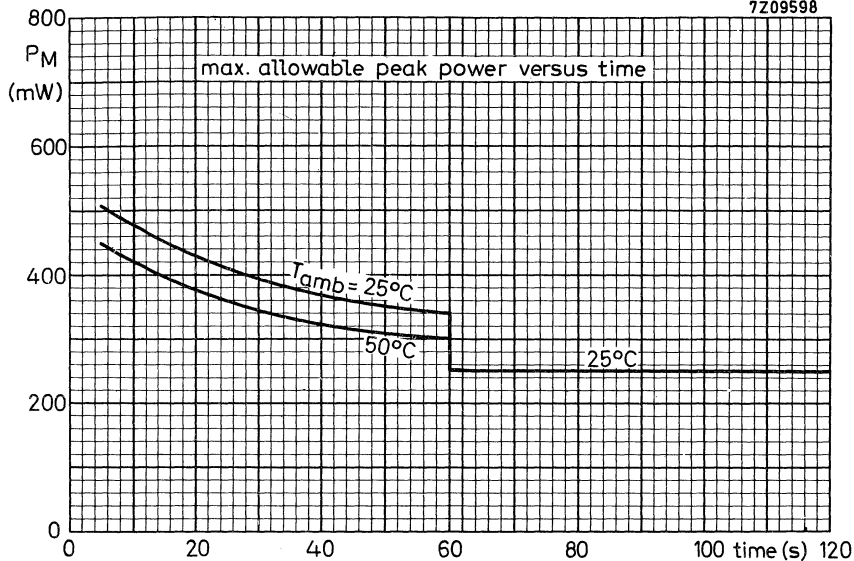
$$G_{UM} (\text{in dB}) = 10 \log \frac{|y_{fe}|^2}{4g_{ie}g_{oe}}$$

$I_C = 7\text{ mA}; V_{CE} = 10\text{ V}$

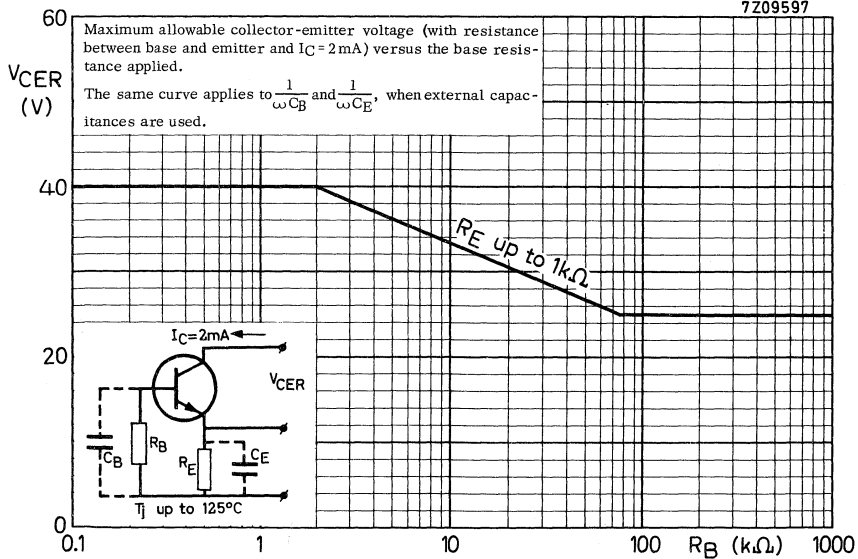
G_{UM} typ. 43 | 41 dB

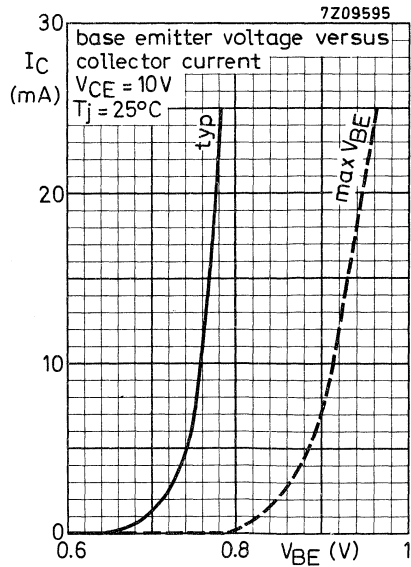
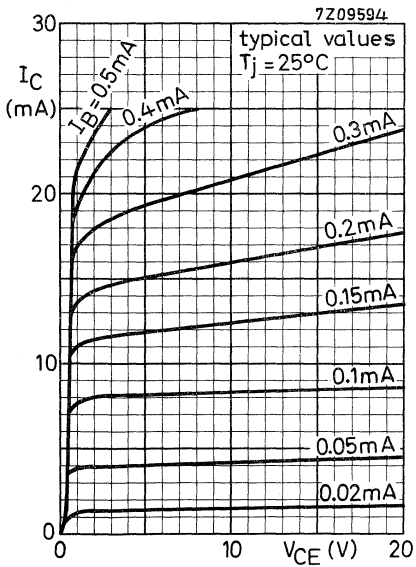
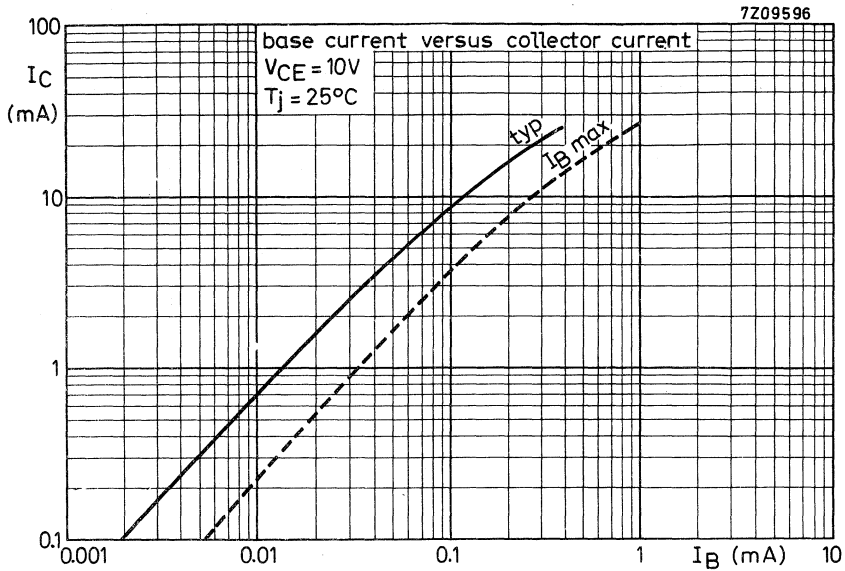
1) V_{BE} decreases by about 1.7 mV/°C with increasing temperature.

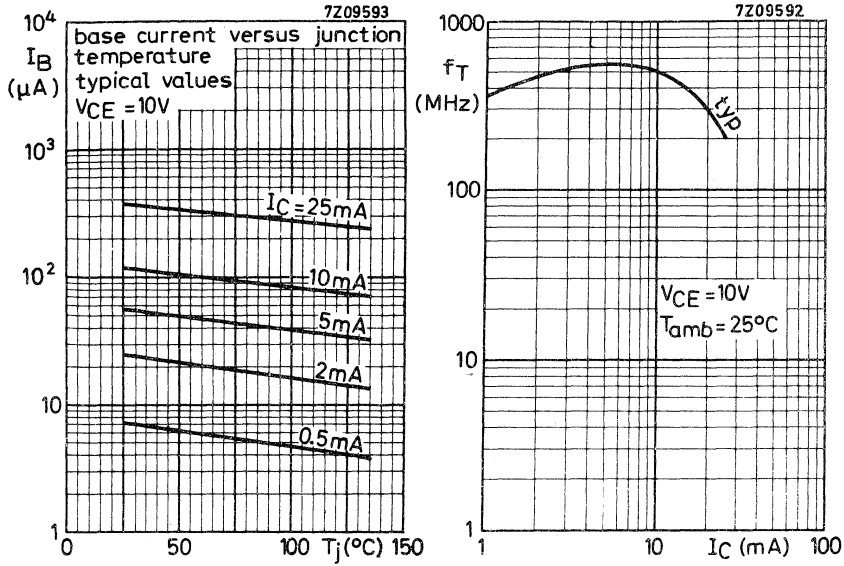
7Z09598



7Z09597

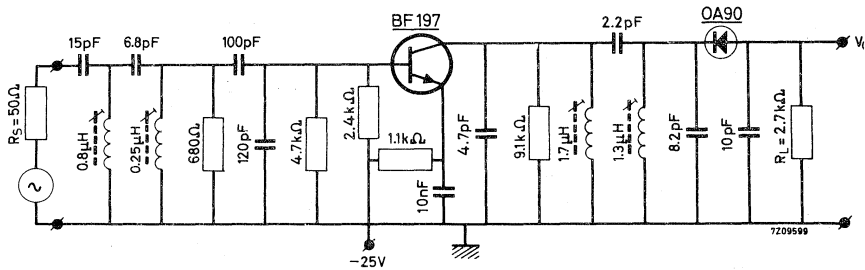






APPLICATION INFORMATION

Output stage of a television video i.f. amplifier with the BF197 transistor, follow by a video detector circuit. 1)



1) Application information bulletins are available on request.

APPLICATION INFORMATION (continued)

Video detector output voltage at $f = 38.9$ MHz ¹⁾

$I_C = 7.2$ mA; $V_{CE} = 16.6$ V

V_O > 6 V
typ. 7.7 V

Transducer gain at $f = 36.4$ MHz

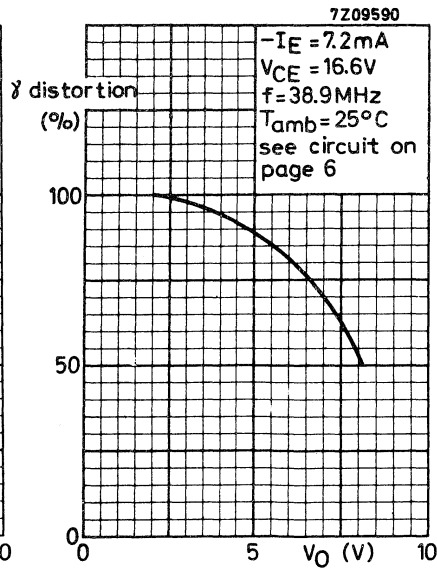
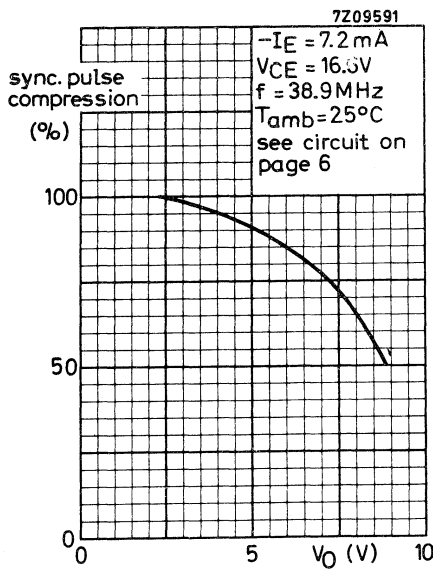
$$G_{tr} \text{ (in dB)} = 10 \log \frac{\text{output power in load } R_L}{\text{available power from source with } R_S}$$

$I_C = 7.2$ mA; $V_{CE} = 16.6$ V

G_{tr} typ. 25.5 dB

Tuning frequency for all tuned circuits is 37 MHz

¹⁾ The output voltage V_O is defined as the voltage across the 2.7 k Ω detector load R_L for 30% synchronisation pulse compression.



SILICON PLANAR TRANSISTOR

N-P-N transistor in a plastic envelope.

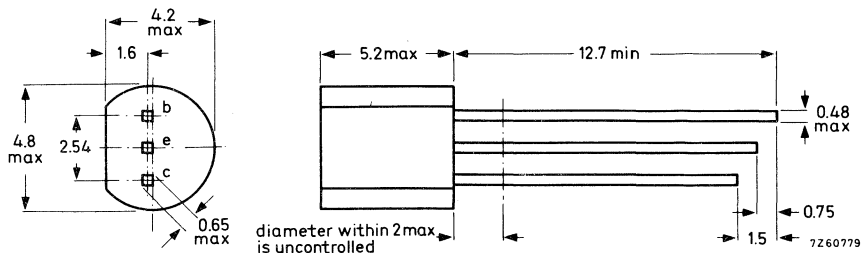
The BF198 has a very low feedback capacitance and is intended for use in the forward gain control stage of the television i. f. amplifier.

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 $T_{amb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	500	mW
Junction temperature	T_j	max.	150	$^\circ\text{C}$
Transition frequency at $f = 100\text{ MHz}$ $I_C = 4\text{ mA}; V_{CE} = 10\text{ V}$	f_T	typ.	400	MHz
Feedback capacitance at $f = 10.7\text{ MHz}$ $I_C = 1\text{ mA}; V_{CE} = 10\text{ V}$	$-C_{re}$	typ.	200	fF
Max. unilateralized power gain $I_C = 4\text{ mA}; V_{CE} = 10\text{ V}; f = 35\text{ MHz}$	G_{UM}	typ.	42	dB
$f = 45\text{ MHz}$	G_{UM}	typ.	39	dB
Gain control range	ΔG_{tr}	typ.	60	dB

MECHANICAL DATA

Dimensions in mm



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

Voltages

Collector-base voltage (open emitter)	V_{CBO}	max.	40	V
Collector-emitter voltage (open base)	V_{CEO}	max.	30	V ¹⁾
Emitter-base voltage (open collector)	V_{EBO}	max.	4	V

Currents

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

Power dissipation

Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}$	P_{tot}	max.	500	mW
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Temperatures

Storage temperature	T_{stg}	-65 to +150	$^{\circ}\text{C}$
Junction temperature	T_j	max. 150	$^{\circ}\text{C}$

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	0.25	$^{\circ}\text{C}/\text{mW}$
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¹⁾ See also page 6.

CHARACTERISTICS

$T_{amb} = 25\text{ }^{\circ}\text{C}$ unless otherwise specified

Base current at about 50 dB gain control

$I_C = 6\text{ mA}; V_{CE} = 2\text{ V}$	I_B	<	270	μA
$I_C = 15\text{ mA}; V_{CE} = 5\text{ V}$	I_B	<	1.5	mA

Base current

$I_C = 4\text{ mA}; V_{CE} = 10\text{ V}$	I_B	typ.	60	μA
		<	150	μA

Base-emitter voltage ¹⁾

$I_C = 4\text{ mA}; V_{CE} = 10\text{ V}$	V_{BE}	typ.	760	mV
		<	850	mV

Feedback capacitance at $f = 10.7\text{ MHz}$

$I_C = 1\text{ mA}; V_{CE} = 10\text{ V}$	$-C_{re}$	typ.	200	fF
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Transition frequency at $f = 100\text{ MHz}$

$I_C = 4\text{ mA}; V_{CE} = 10\text{ V}$	f_T	typ.	400	MHz
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Noise figure

$I_C = 4\text{ mA}; V_{CE} = 10\text{ V}$ $G_S = 10\text{ mA/V}; f = 35\text{ MHz}; B_S = 0$	F	typ.	3	dB
---	-----	------	---	-------------

y parameters (common emitter)

$I_C = 4\text{ mA}; V_{CE} = 10\text{ V}$

			$f = 35$	45	MHz
Input conductance	g_{ie}	typ.	3.2	4.8	mA/V
Input capacitance	C_{ie}	typ.	37	35	pF
Feedback admittance	$ y_{re} $	typ.	47	60	$\mu\text{A/V}$
Phase angle of feedback admittance	ϕ_{re}	typ.	268°	268°	
Transfer admittance	$ y_{fe} $	typ.	105	100	mA/V
Phase angle of transfer admittance	ϕ_{fe}	typ.	340°	340°	
Output conductance	g_{oe}	typ.	50	60	$\mu\text{A/V}$
Output capacitance	C_{oe}	typ.	1.3	1.3	pF

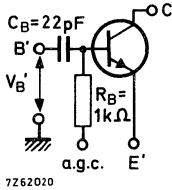
Maximum unilateralized power gain

G_{UM} (in dB) = $10 \log \frac{ y_{fe} ^2}{4g_{ie}g_{oe}}$	G_{UM}	typ.	42	39	dB
$I_C = 4\text{ mA}; V_{CE} = 10\text{ V}$					

¹⁾ V_{BE} decreases by about $1.7\text{ mV}/^{\circ}\text{C}$ with increasing temperature.

Equivalent gain control transistor

To ensure an almost constant input admittance and an output conductance that varies little with gain control, we recommend that where a BF198 is used in a gain controlled i.f. stage, a series base capacitor of 22 pF and a bias resistor of 1 kΩ be used.

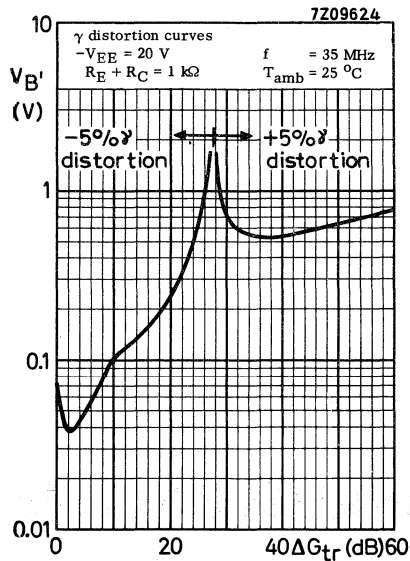
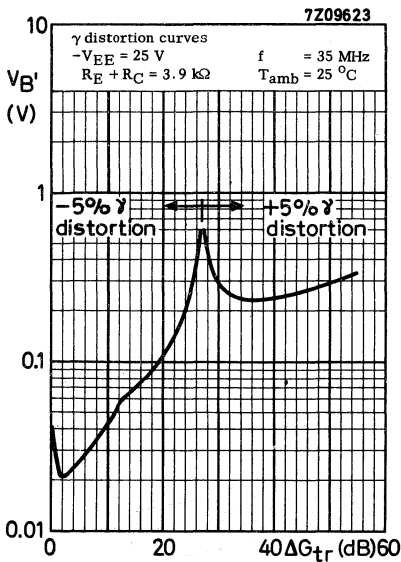


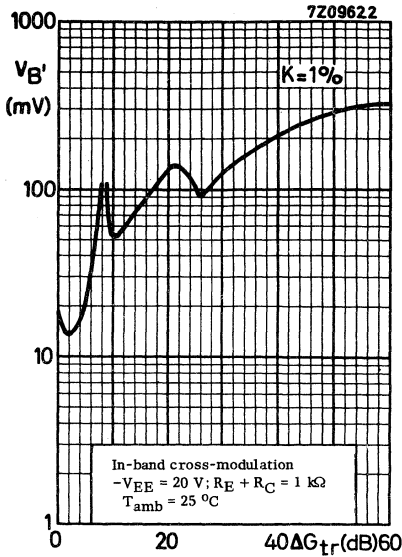
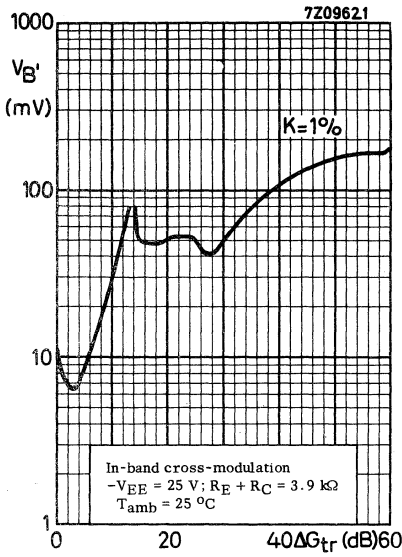
The transistor with these additional components is effectively an "equivalent transistor" for gain control purposes, the signal handling capability of which may be expressed in terms of voltage. (Without these components the varying input admittance means that the signal handling capability can only be expressed in terms of power).

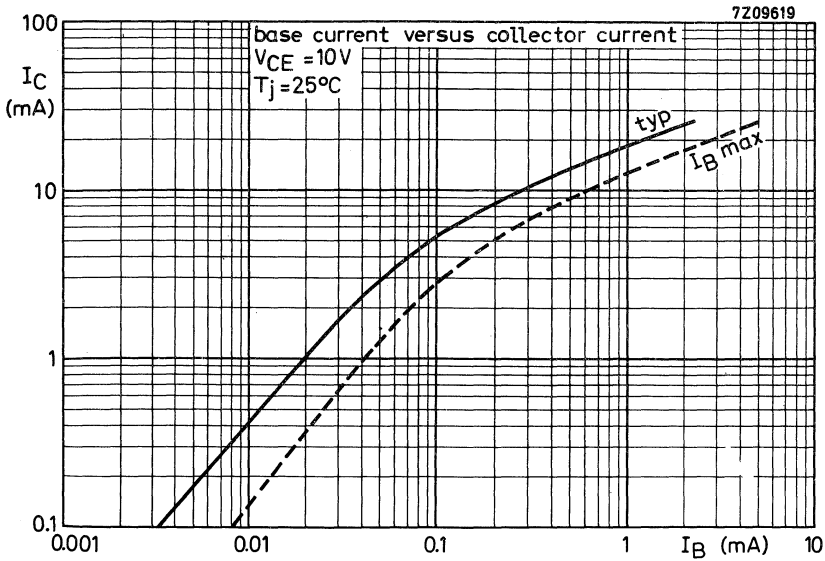
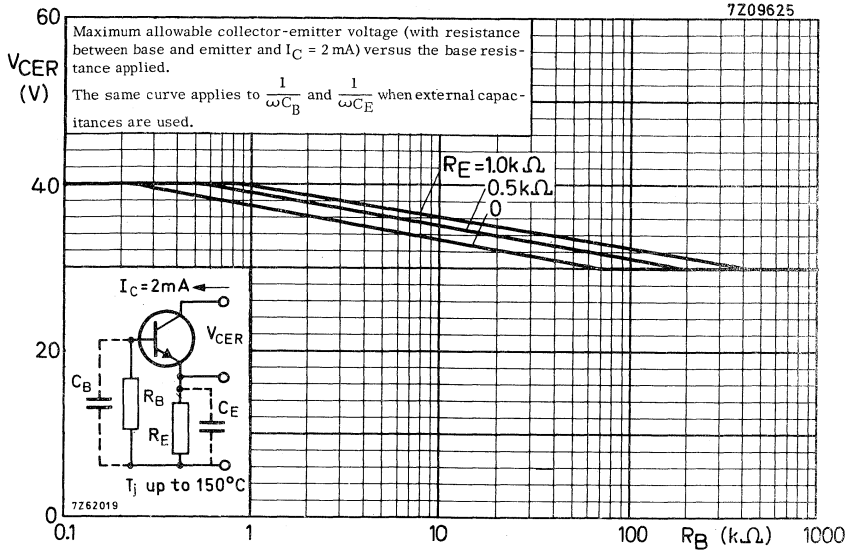
The signal handling capability of the equivalent transistor as a function of ΔG_{TR} (the reduction in transducer gain with gain control) will be found on pages 4 and 5.

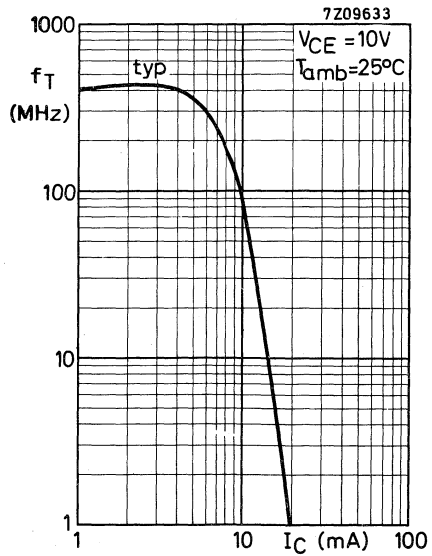
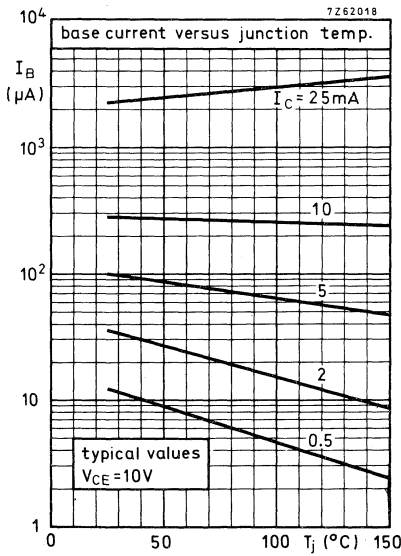
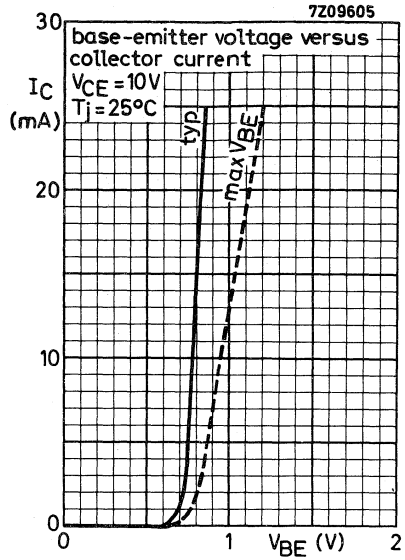
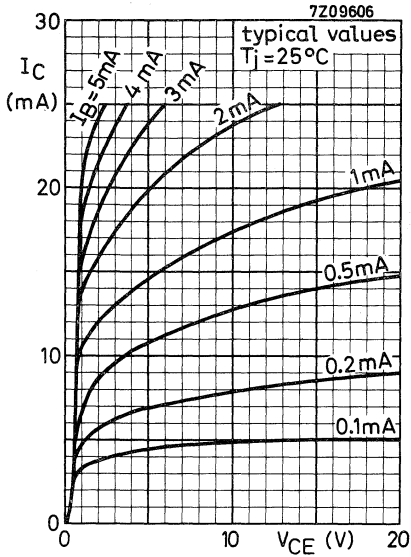
- a. Voltage versus ΔG_{TR} curves for a γ distortion of 5% are below.
- b. Voltage versus ΔG_{TR} curves for an in-band cross modulation factor of 1% are on page 5.

Graphs of the y-parameters are on pages 8 to 11.

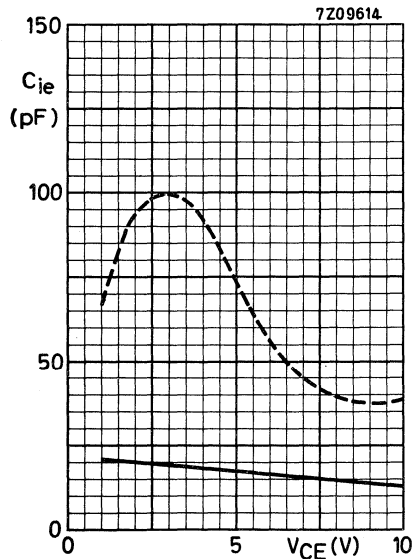
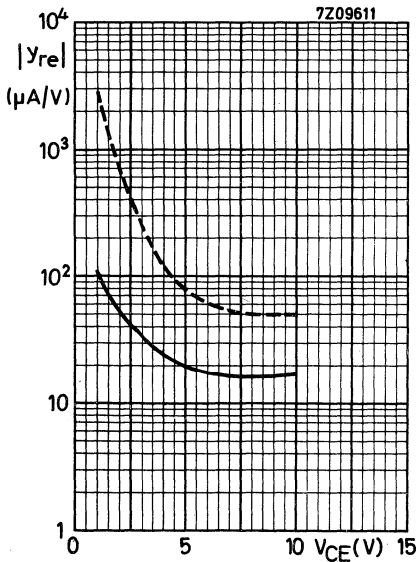
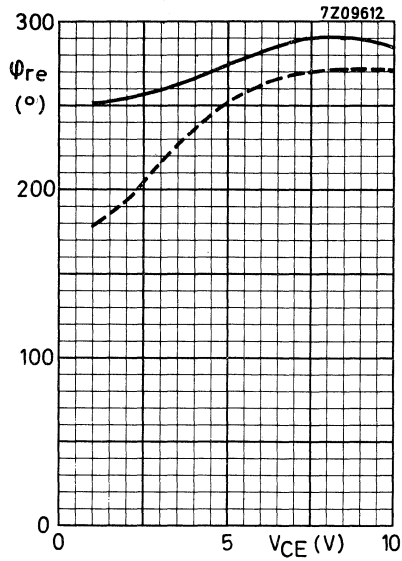
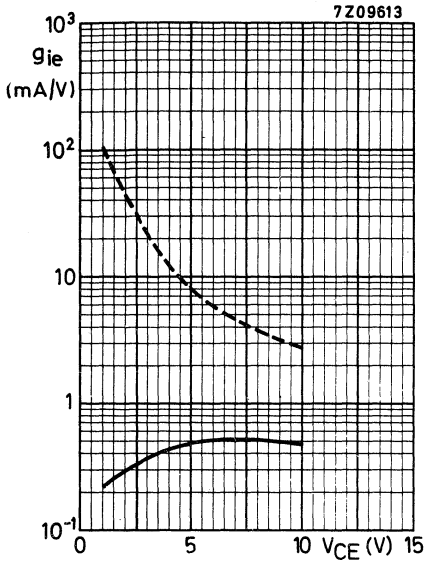






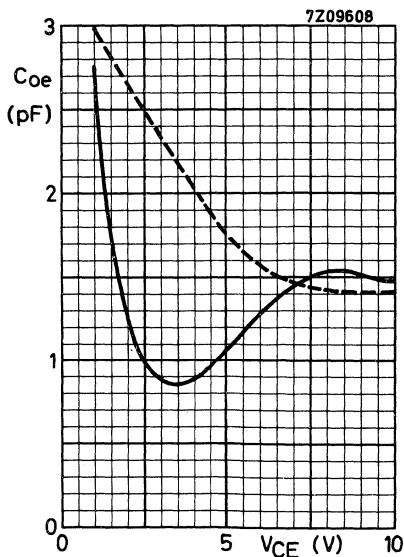
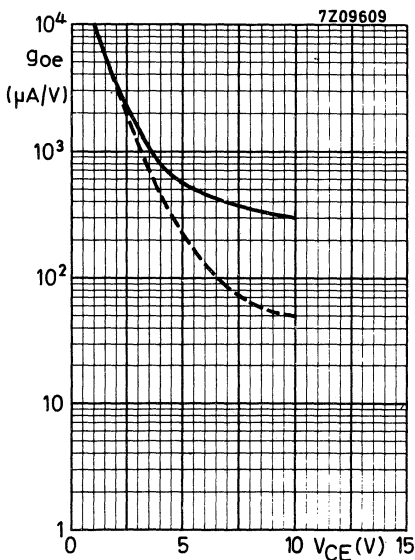
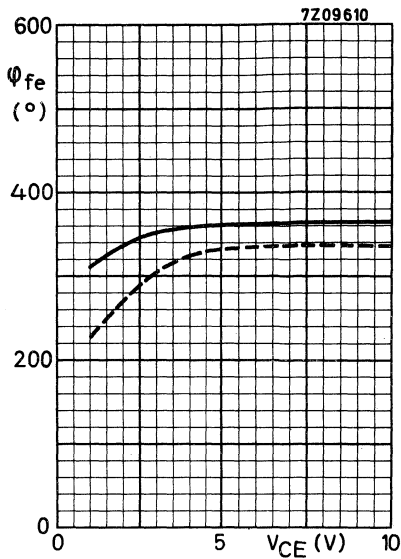
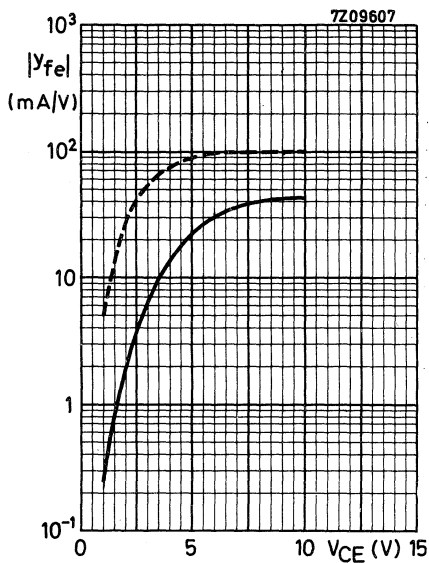


Voltage control; $-V_{EE} = 25 \text{ V}$; $R_E + R_C = 3.9 \text{ k}\Omega$; $f = 35 \text{ MHz}$



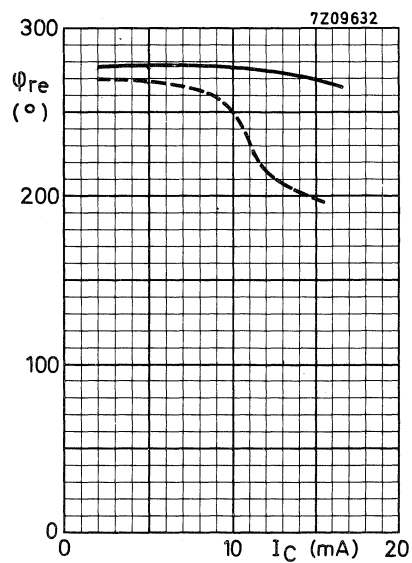
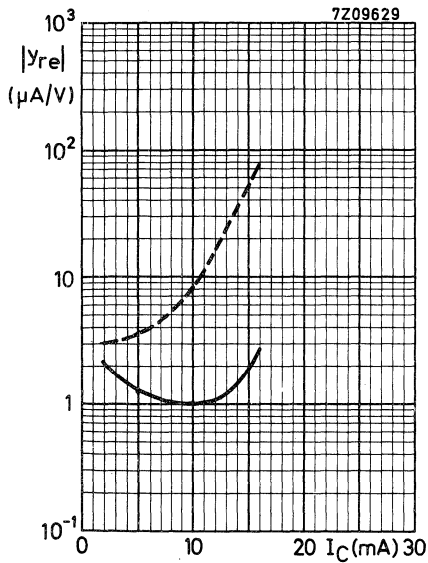
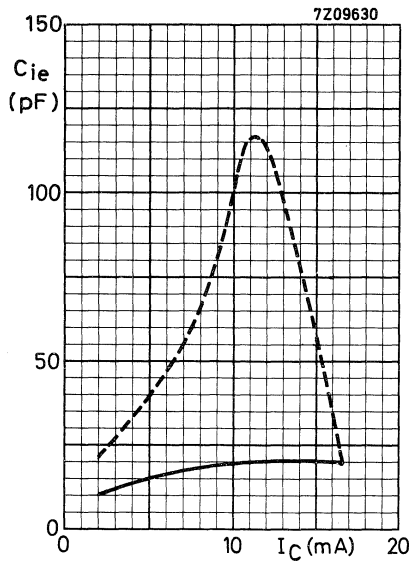
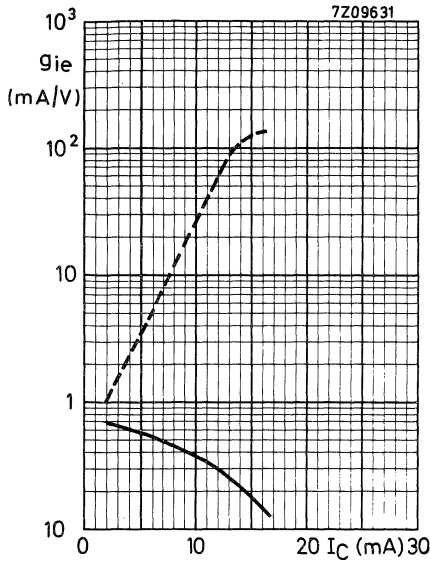
y-parameters of the equivalent gain control transistor, including base capacitor and base resistor as shown on page 4 (dashed curves apply to the transistor only).

Voltage control; $-V_{EE} = 25 \text{ V}$; $R_E + R_C = 3.9 \text{ k}\Omega$; $f = 35 \text{ MHz}$



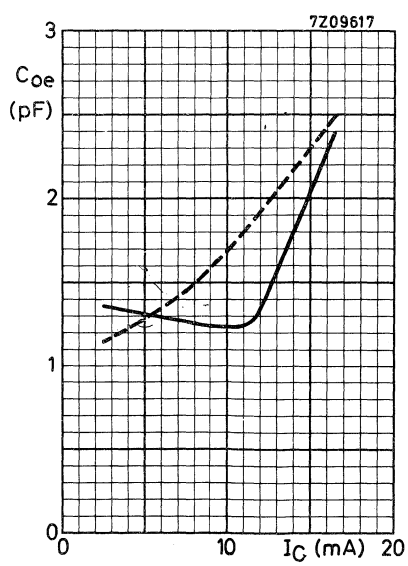
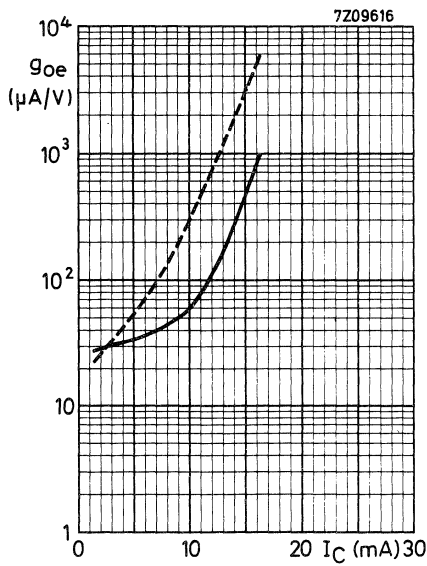
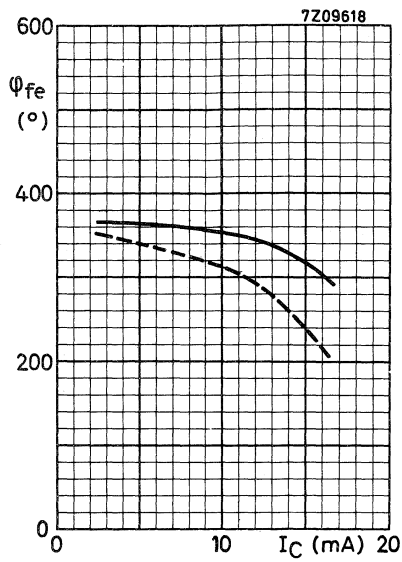
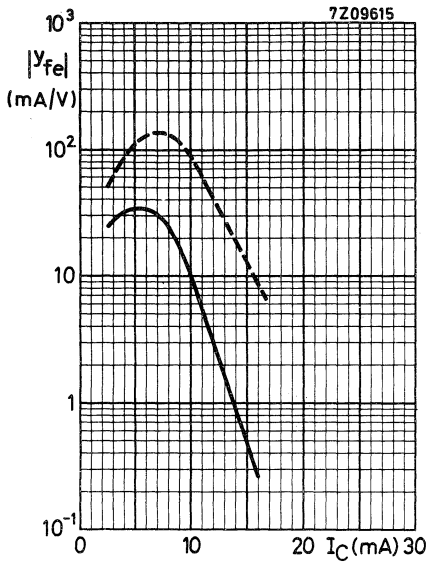
y-parameters of the equivalent gain control transistor, including base capacitor and base resistor as shown on page 4 (dashed curves apply to the transistor only).

Current control; $-V_{EE} = 20 \text{ V}$; $R_E + R_C = 1 \text{ k}\Omega$; $f = 35 \text{ MHz}$



y-parameters of the equivalent gain control transistor, including base capacitor and base resistor as shown on page 4 (dashed curves apply to the transistor only).

Current control; $-V_{EE} = 20\text{ V}$; $R_E + R_C = 1\text{ k}\Omega$; $f = 35\text{ MHz}$



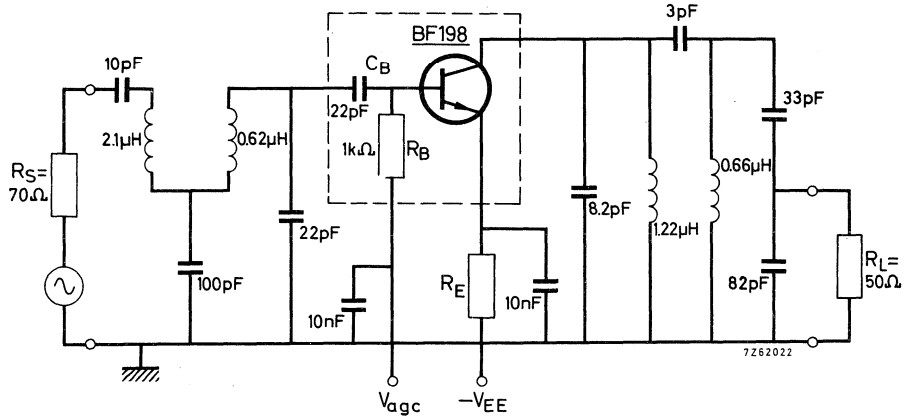
y-parameters of the equivalent gain control transistor, including base capacitor and base resistor as shown on page 4 (dashed curves apply to the transistor only).

APPLICATION INFORMATION

First stage of an i. f. amplifier

Basic circuit with voltage gain control: $R_E + R_C = 3.9 \text{ k}\Omega$; $-V_{EE} = 25 \text{ V}$

current gain control: $R_E + R_C = 1 \text{ k}\Omega$; $-V_{EE} = 20 \text{ V}$



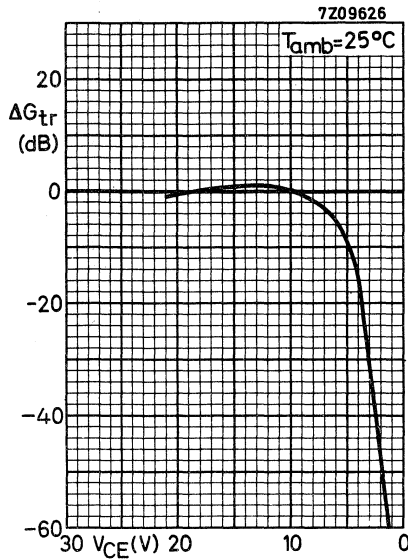
Transducer gain

$$G_{tr} \text{ (in dB)} = 10 \log \frac{\text{output power in load } R_L}{\text{available power from source } R_S}$$

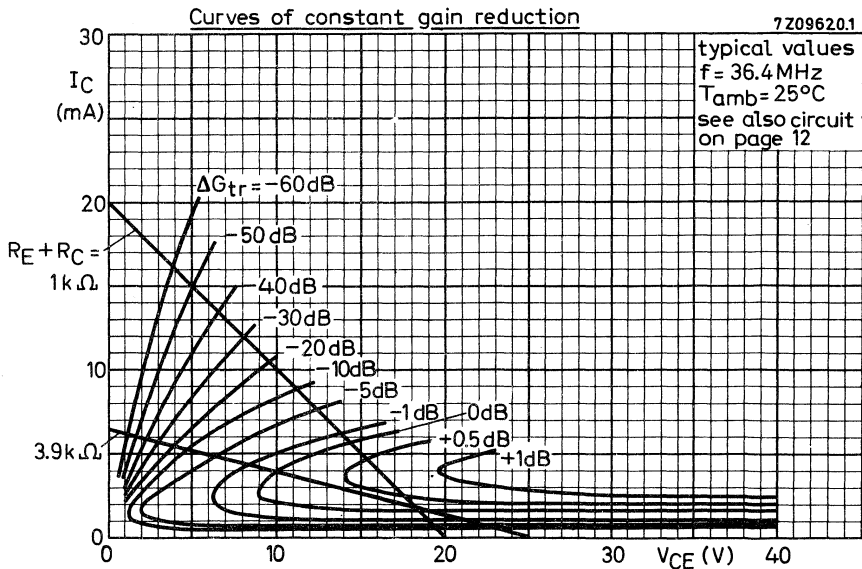
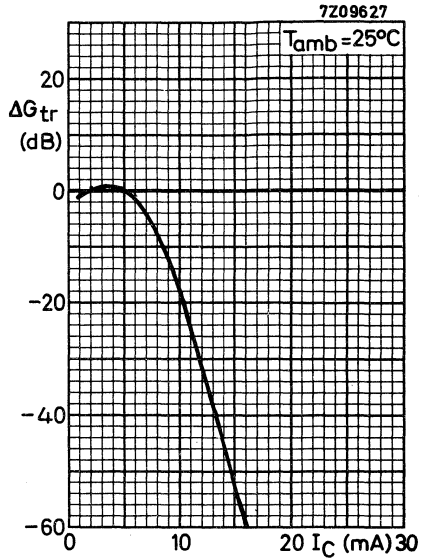
$f = 36.4 \text{ MHz}$; $I_C = 4 \text{ mA}$; $R_E + R_C = 3.9 \text{ k}\Omega$; $-V_{EE} = 25 \text{ V}$ G_{tr} typ. 25.5 dB

Gain control range (see also upper graphs next page) ΔG_{tr} typ. 60 dB

Voltage gain control



Current gain control



SILICON PLANAR TRANSISTOR

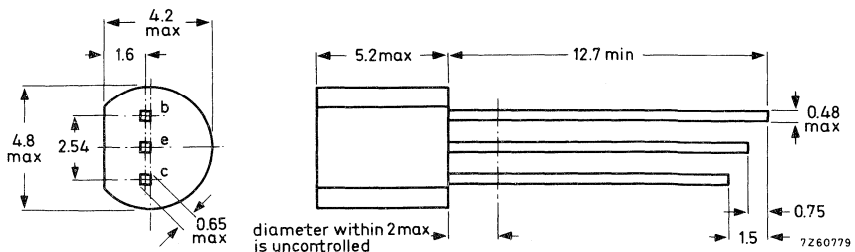
N-P-N transistor in a plastic envelope.

The BF199 has a very low feedback capacitance and is intended for use in the output stage of a television video i. f. amplifier.

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 $T_{amb} = 25\text{ }^\circ\text{C}$	P_{tot}	max. 500 mW
Junction temperature	T_j	max. 150 $^\circ\text{C}$
Transition frequency at $f = 100\text{ MHz}$ $I_C = 5\text{ mA}; V_{CE} = 10\text{ V}$	f_T	typ. 550 MHz
Feedback capacitance at $f = 10.7\text{ MHz}$ $I_C = 1\text{ mA}; V_{CE} = 10\text{ V}$	$-C_{re}$	typ. 300 fF
Max. unilateralized power gain $I_C = 7\text{ mA}; V_{CE} = 10\text{ V}; f = 35\text{ MHz}$ $f = 45\text{ MHz}$	G_{UM} G_{UM}	typ. 43 dB typ. 41 dB
Video detector output voltage	V_O	typ. 7.7 V

MECHANICAL DATA

Dimensions in mm



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

Voltages

Collector-base voltage (open emitter)	V _{CBO}	max.	40	V
Collector-emitter voltage (open base)	V _{CEO}	max.	25	V ¹⁾
Emitter-base voltage (open collector)	V _{EBO}	max.	4	V

Currents

Collector current (d. c.)	I _C	max.	25	mA
Collector current (peak value)	I _{CM}	max.	25	mA

Power dissipation

Total power dissipation up to T _{amb} = 25 °C	P _{tot}	max.	500	mW
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Temperatures

Storage temperature	T _{stg}	-65 to +150	°C
Junction temperature	T _j	max. 150	°C

THERMAL RESISTANCE

From junction to ambient in free air	R _{th j-a}	=	0.25	°C/mW
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1) See also page 4

CHARACTERISTICS

$T_{amb} = 25^{\circ}C$ unless otherwise specified

Base current

$I_C = 7 \text{ mA}; V_{CE} = 10 \text{ V}$	I_B	typ.	60	μA
		<	185	μA

Base-emitter voltage ¹⁾

$I_C = 7 \text{ mA}; V_{CE} = 10 \text{ V}$	V_{BE}	typ.	775	mV
		<	925	mV

Feedback capacitance at $f = 10.7 \text{ MHz}$

$I_C = 1 \text{ mA}; V_{CE} = 10 \text{ V}$	$-C_{re}$	typ.	300	fF
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Transition frequency at $f = 100 \text{ MHz}$

$I_C = 5 \text{ mA}; V_{CE} = 10 \text{ V}$	f_T	typ.	550	MHz
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y parameters (common emitter)

$I_C = 7 \text{ mA}; V_{CE} = 10 \text{ V}$

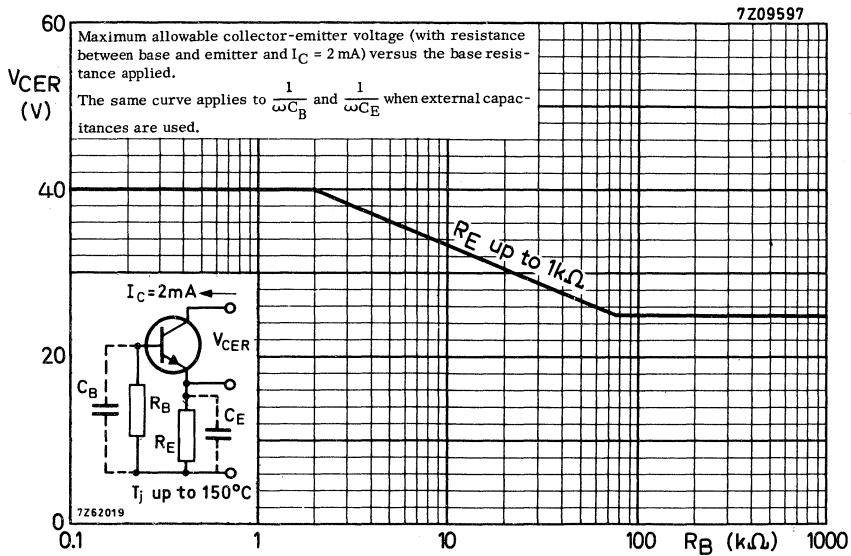
			<u>f = 35 45 MHz</u>	
Input conductance	g_{ie}	typ.	4.5	5.5 mA/V
Input capacitance	C_{ie}	typ.	45	45 pF
Feedback admittance	$ y_{re} $	typ.	67	86 $\mu A/V$
Phase angle of feedback admittance	ϕ_{re}	typ.	268°	268°
Transfer admittance	$ y_{fe} $	typ.	170	155 mA/V
Phase angle of transfer admittance	ϕ_{fe}	typ.	338°	335°
Output conductance	g_{oe}	typ.	85	95 $\mu A/V$
Output capacitance	C_{oe}	typ.	1.8	1.8 pF

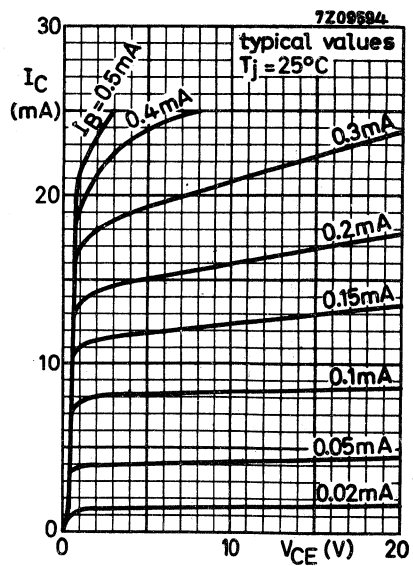
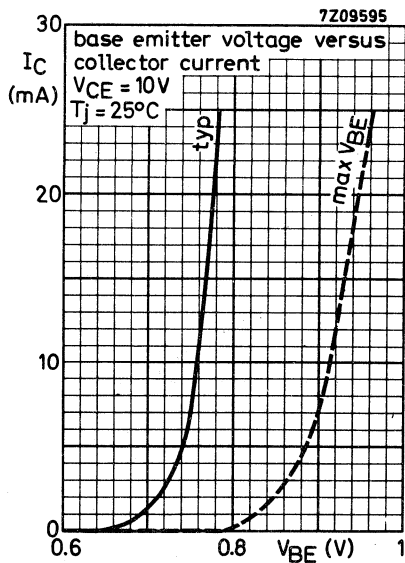
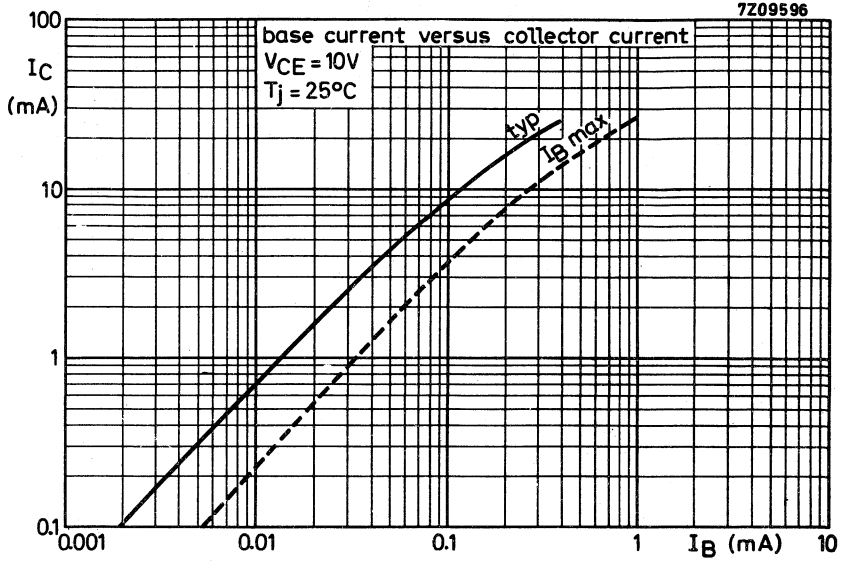
Maximum unilateralized power gain

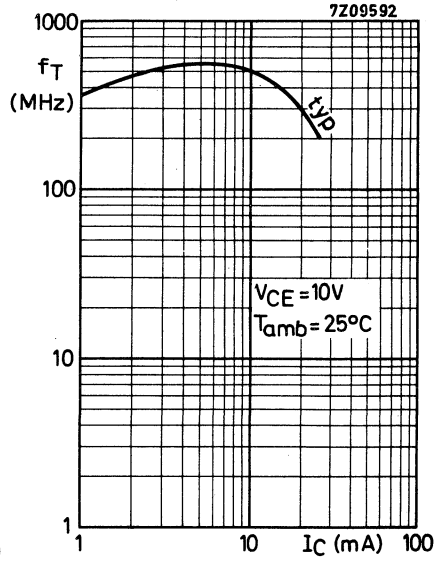
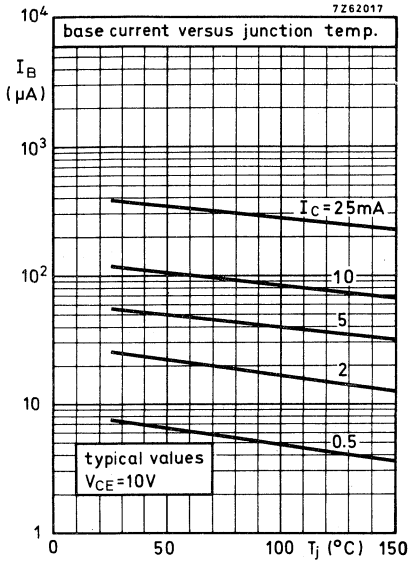
$$G_{UM} \text{ (in dB)} = 10 \log \frac{|y_{fe}|^2}{4g_{ie}g_{oe}}$$

$I_C = 7 \text{ mA}; V_{CE} = 10 \text{ V}$	G_{UM}	typ.	43	41 dB
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¹⁾ V_{BE} decreases by about $1.7 \text{ mV}/^{\circ}C$ with increasing temperature.

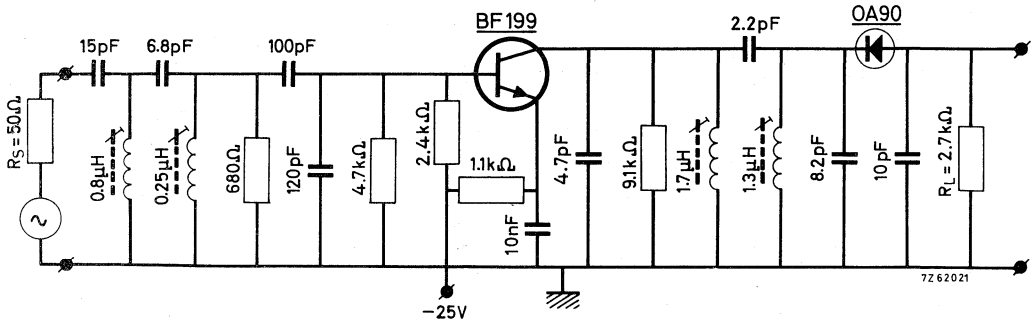






APPLICATION INFORMATION

Output stage of television video i. f. amplifier with the BF199 transistor, followed by a video detector circuit.



APPLICATION INFORMATION (continued)

Video detector output voltage at $f = 38.9 \text{ MHz}$ ¹⁾

$I_C = 7.2 \text{ mA}; V_{CE} = 16.6 \text{ V}$

V_O > 6 V
typ. 7.7 V

Transducer gain at $f = 36.4 \text{ MHz}$

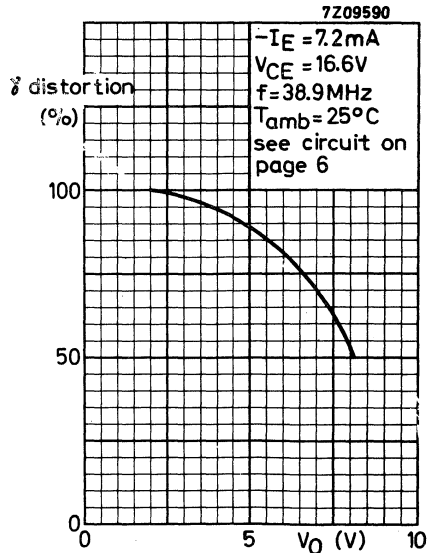
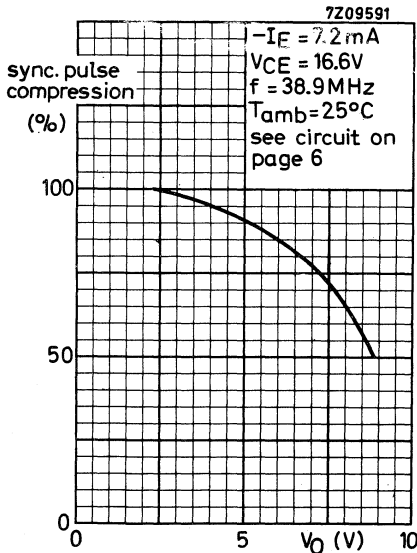
$$G_{tr} \text{ (in dB)} = 10 \log \frac{\text{output power in load } R_L}{\text{available power from source with } R_S}$$

$I_C = 7.2 \text{ mA}; V_{CE} = 16.6 \text{ V}$

G_{tr} typ. 25.5 dB

Tuning frequency for all tuned circuits is 37 MHz

¹⁾ The output voltage V_O is defined as the voltage across the $2.7 \text{ k}\Omega$ detector load R_L for 30% synchronisation pulse compression.



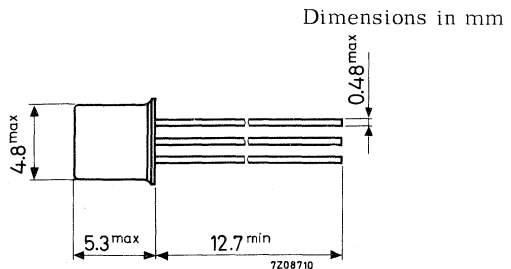
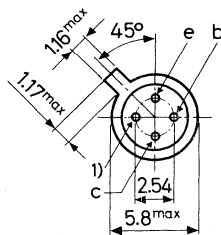
SILICON PLANAR TRANSISTOR

N-P-N transistor in a TO-72 metal envelope with insulated electrodes and a shield lead connected to the case. The BF200 is primarily intended for application in a forward gain controlled pre-amplifier in v.h.f. television tuners and f.m. 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 $T_{amb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	150 mW
Junction temperature	T_j	max.	175 $^\circ\text{C}$
Transition frequency			
$-I_E = 3\text{ mA}; V_{CB} = 10\text{ V}$	f_T	typ.	650 MHz
Max. unilateralised power gain			
$-I_E = 3\text{ mA}; V_{CB} = 10\text{ V}; f = 50\text{ MHz}$	G_{UM}	typ.	30 dB
$f = 200\text{ MHz}$	G_{UM}	typ.	22 dB
Noise figure at optimum source admittance			
$-I_E = 2\text{ mA}; V_{CB} = 10\text{ V}; f = 100\text{ MHz}$	F	typ.	2 dB
$-I_E = 3\text{ mA}; V_{CB} = 10\text{ V}; f = 200\text{ MHz}$	F	typ.	2.7 dB

MECHANICAL DATA

TO-72



1) = shield lead (connected to case)

Accessories available: 56246, 56263

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
Collector-emitter voltage ($R_{BE} \leq 1 \text{ k}\Omega$)	V_{CER}	max.	30 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 $T_{amb} = 25 \text{ }^\circ\text{C}$	P_{tot}	max.	150 mW
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Temperatures

Storage temperature	T_{stg}	-65 to +175	$^\circ\text{C}$
Junction temperature	T_j	max.	175 $^\circ\text{C}$

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th \text{ j-a}}$	=	1 $^\circ\text{C/mW}$
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¹⁾ Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

CHARACTERISTICS

$T_{amb} = 25^{\circ}C$ unless otherwise specified

Base current

$-I_E = 3 \text{ mA}; V_{CB} = 10 \text{ V}$	I_B	typ. 100 μA < 200 μA
$-I_E = 12 \text{ mA}; V_{CB} = 7 \text{ V}$	I_B	< 2.2 mA

Emitter-base voltage

$-I_E = 3 \text{ mA}; V_{CB} = 10 \text{ V}$	$-V_{EB}$	typ. 0.75 V
$-I_E = 12 \text{ mA}; V_{CB} = 7 \text{ V}$	$-V_{EB}$	< 1.0 V

Transition frequency

$-I_E = 3 \text{ mA}; V_{CB} = 10 \text{ V}$	f_T	typ. 650 MHz
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Feedback capacitance at $f = 10.7 \text{ MHz}$

$I_C = 1 \text{ mA}; V_{CE} = 10 \text{ V}$	$-C_{re}$	typ. 280 fF ¹⁾
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Noise figure at optimum source admittance

$-I_E = 3 \text{ mA}; V_{CB} = 10 \text{ V}; f = 50 \text{ MHz}$	F	typ. 1.9 dB
$f = 200 \text{ MHz}$	F	typ. 2.7 dB
$-I_E = 2 \text{ mA}; V_{CB} = 10 \text{ V}; f = 100 \text{ MHz}$	F	typ. 2.0 dB

Maximum unilateralised power gain ²⁾

$$GUM = \frac{|y_{fb}|^2}{4 g_{ib} g_{ob}}$$

$-I_E = 3 \text{ mA}; V_{CB} = 10 \text{ V}; f = 50 \text{ MHz}$	GUM	typ. 30 dB
$f = 200 \text{ MHz}$	GUM	typ. 22 dB
$-I_E = 2 \text{ mA}; V_{CB} = 10 \text{ V}; f = 100 \text{ MHz}$	GUM	typ. 28 dB

1) 1 fF = 1 femtofarad = 10^{-15} F .

2) Common base configuration, metal envelope connected to earth directly, external lead length = 3 mm.

CHARACTERISTICS (continued)

$T_{amb} = 25\text{ }^{\circ}\text{C}$ unless otherwise specified

y parameters at $f = 100\text{ MHz}$ (common emitter)

$I_C = 2\text{ mA}; V_{CE} = 10\text{ V}$

Input conductance	g_{ie}	typ.	5	$\text{m}\Omega^{-1}$
Input capacitance	C_{ie}	typ.	16	pF
Feedback admittance	$ y_{re} $	typ.	0.16	$\text{m}\Omega^{-1}$
Phase angle of feedback admittance	φ_{re}	typ.	270	$^{\circ}$
Transfer admittance	$ y_{fe} $	typ.	56	$\text{m}\Omega^{-1}$
Phase angle of transfer admittance	φ_{fe}	typ.	340	$^{\circ}$
Output conductance	g_{oe}	typ.	15	$\mu\Omega^{-1}$
Output capacitance	C_{oe}	typ.	0.9	pF

y parameters at $f = 50\text{ MHz}$ (common base)

$-I_E = 3\text{ mA}; V_{CB} = 10\text{ V}$

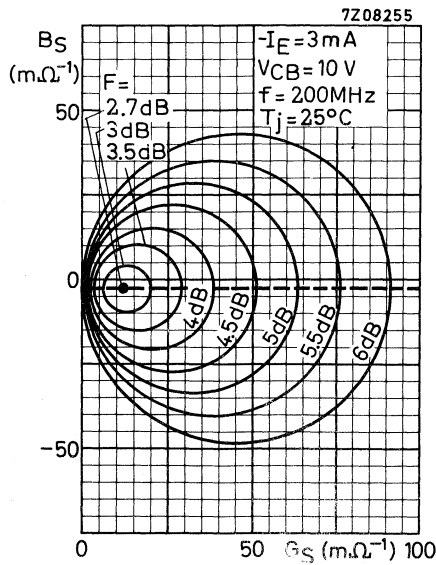
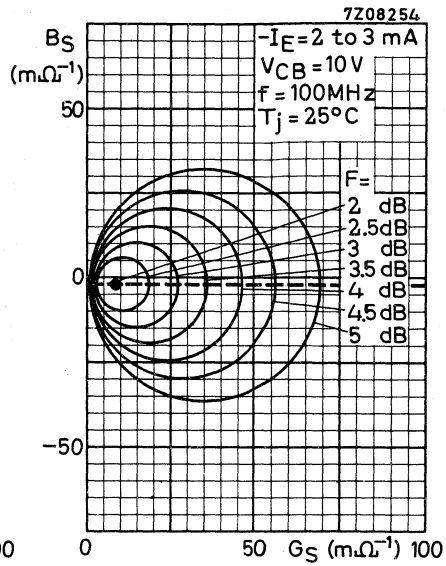
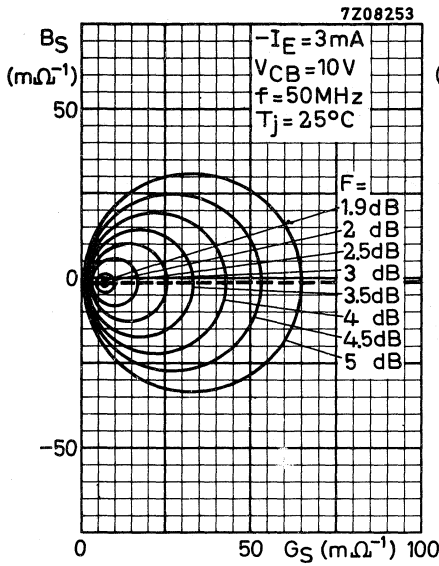
Input conductance	g_{ib}	typ.	85	$\text{m}\Omega^{-1}$
Input susceptance	$-b_{ib}$	typ.	15	$\text{m}\Omega^{-1}$
Feedback admittance	$ y_{rb} $	typ.	55	$\mu\Omega^{-1}$
Phase angle of feedback admittance	φ_{rb}	typ.	270	$^{\circ}$
Transfer admittance	$ y_{fb} $	typ.	85	$\text{m}\Omega^{-1}$
Phase angle of transfer admittance	φ_{fb}	typ.	165	$^{\circ}$
Output conductance	g_{ob}	typ.	15	$\mu\Omega^{-1}$
Output susceptance	b_{ob}	typ.	280	$\mu\Omega^{-1}$

y parameters at $f = 200\text{ MHz}$ (common base)

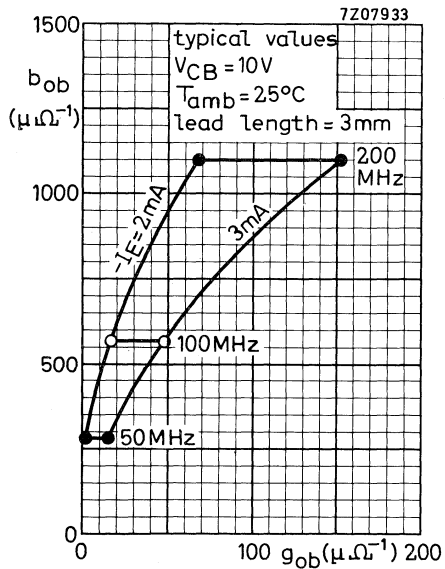
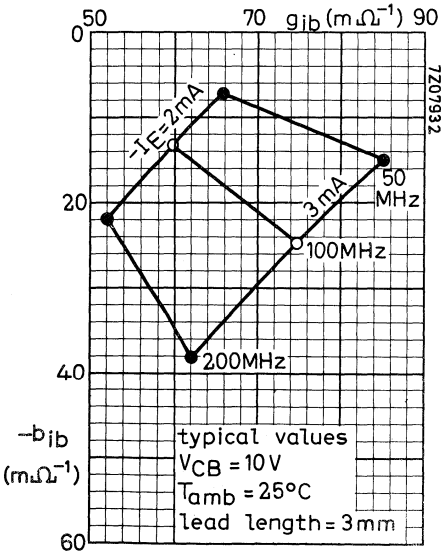
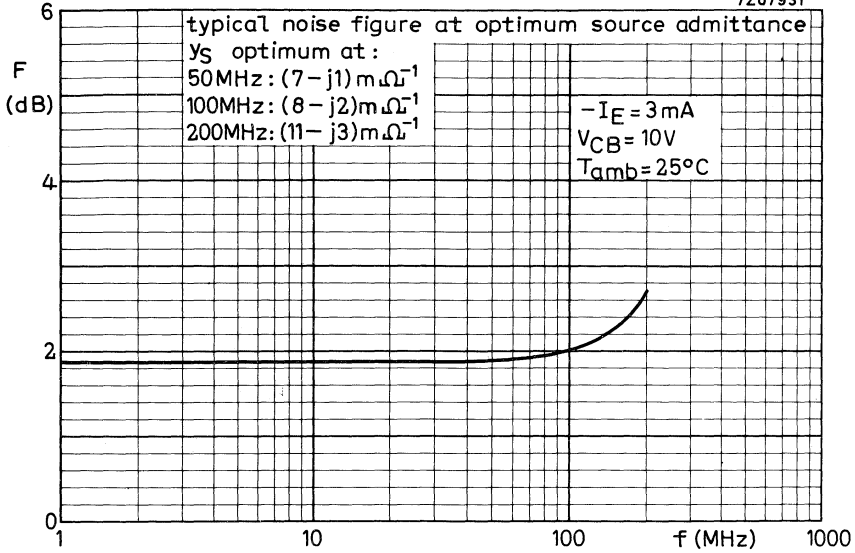
$-I_E = 3\text{ mA}; V_{CB} = 10\text{ V}$

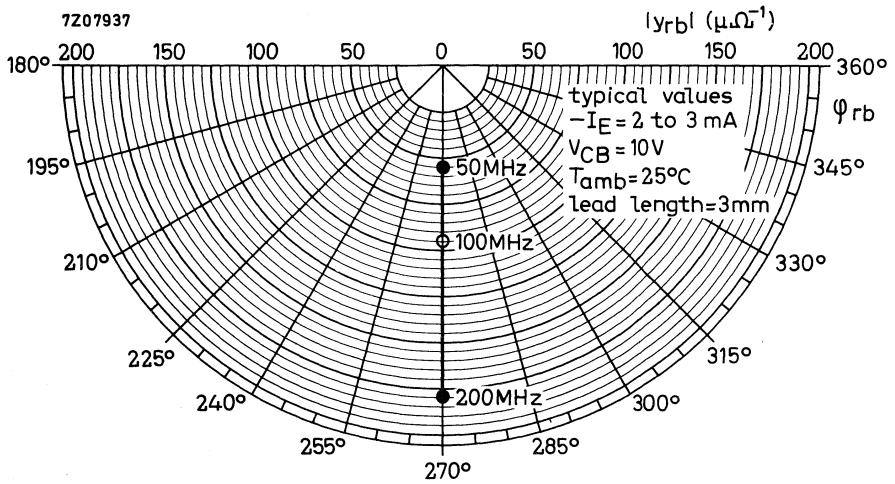
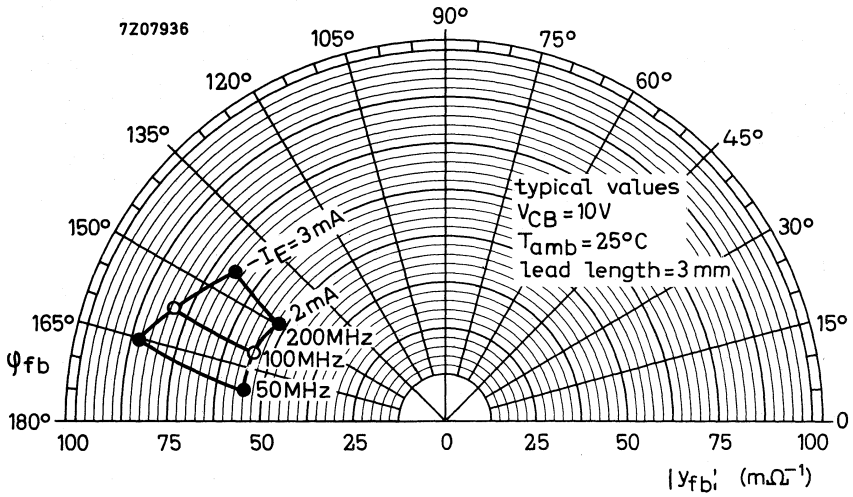
Input conductance	g_{ib}	typ.	62	$\text{m}\Omega^{-1}$
Input susceptance	$-b_{ib}$	typ.	38	$\text{m}\Omega^{-1}$
Feedback admittance	$ y_{rb} $	typ.	180	$\mu\Omega^{-1}$
Phase angle of feedback admittance	φ_{rb}	typ.	270	$^{\circ}$
Transfer admittance	$ y_{fb} $	typ.	70	$\text{m}\Omega^{-1}$
Phase angle of transfer admittance	φ_{fb}	typ.	145	$^{\circ}$
Output conductance	g_{ob}	typ.	150	$\mu\Omega^{-1}$
Output susceptance	b_{ob}	typ.	1.1	$\text{m}\Omega^{-1}$

circles of constant noise figure

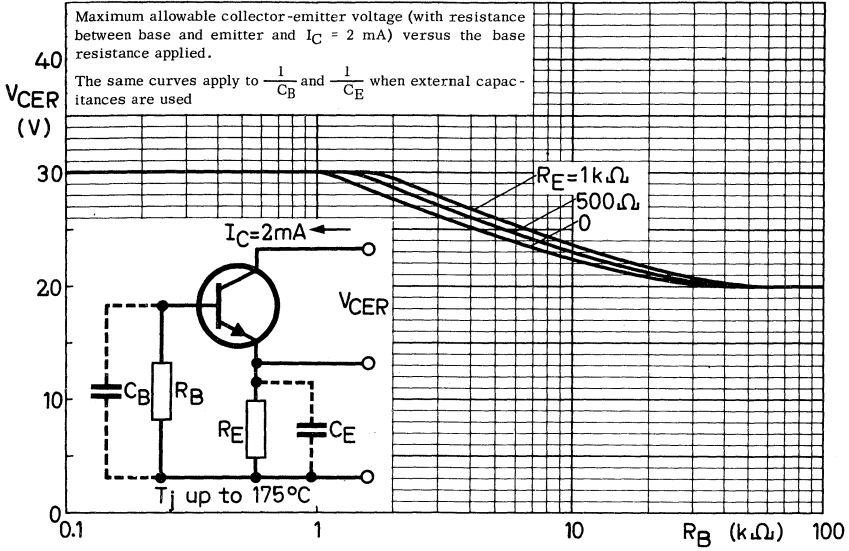


7Z07931



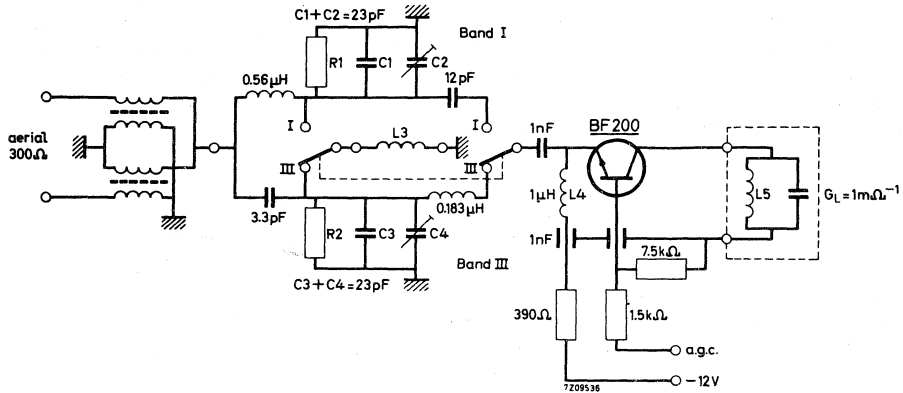


7207919



APPLICATION INFORMATION

1. R.F. stage for v.h.f. television tuner



Resistors R_1 and R_2 should be chosen so that the 3 dB bandwidth of the unloaded input circuit is 3.0 MHz with the aerial and transistor input terminals short-circuited.

Inductors L_3 and L_5 to be selected for each channel.

PERFORMANCE at $T_{amb} = 25\text{ }^\circ\text{C}$ (see circuit above)

Transducer gain

$$G_{tr} = \frac{\text{output power in load } G_L}{\text{available power from aerial}}$$

$-I_E = 3\text{ mA}; f = 50\text{ MHz}$

G_{tr} typ. 13 dB

$-I_E = 3\text{ mA}; f = 200\text{ MHz}$

G_{tr} typ. 13 dB

Noise figure

$f = 50\text{ MHz}$

F typ. 4.9 dB

$f = 200\text{ MHz}$

F typ. 5.2 dB

Voltage standing wave ratio over the entire gain control range, measured at the vision carrier frequency

V.S.W.R. < 4

APPLICATION INFORMATION (continued)

Signal-handling capability (see next page)

In-channel cross-modulation curves of the tuner (see upper graphs); showing the interfering signal e.m.f. (in a 300 Ω aerial) that will cause a cross-modulation factor of 1% (K), plotted against ΔG_{tr} , the reduction in transducer gain caused by gain control. The broken lines indicate the signal level, assuming that gain control starts when desired aerial signal reaches 2 mV.

Measuring conditions

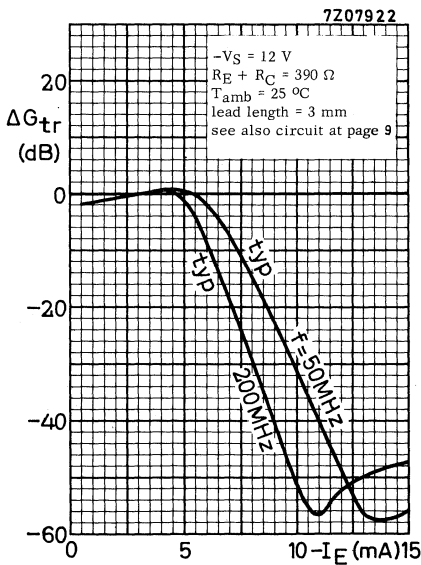
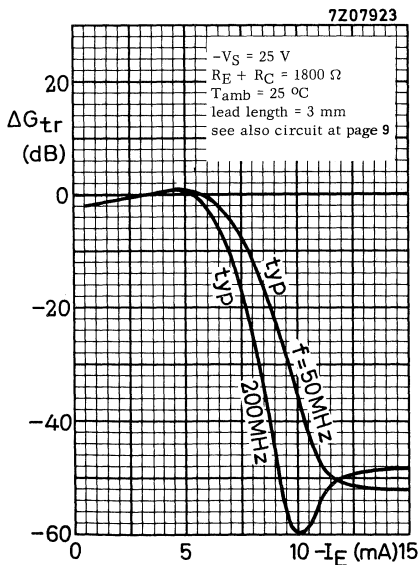
Desired signal at vision carrier frequency and interference signal at sound carrier frequency. Interference signal modulated with 4 kHz (modulation depth 100%).

In-band cross-modulation curves of the tuner; showing the interfering signal e.m.f. (in a 300 Ω aerial) that will cause a cross-modulation factor of 1% (K), plotted against ΔG_{tr} , the reduction in transducer gain caused by gain control.

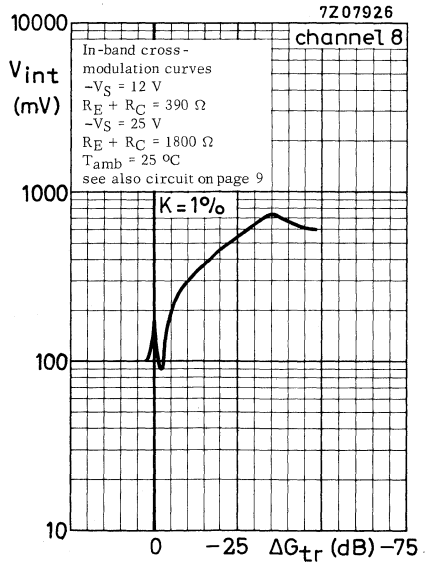
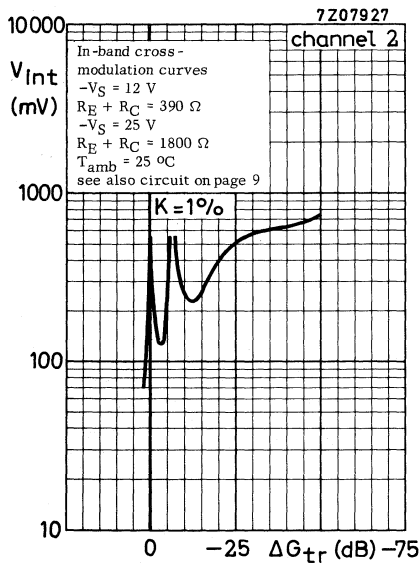
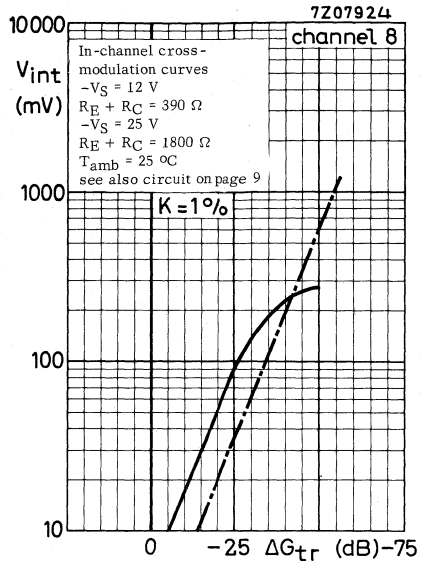
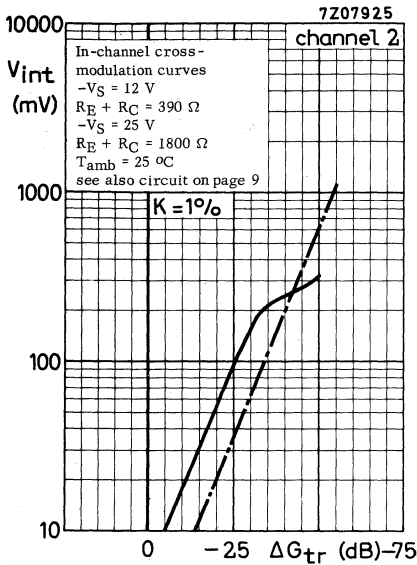
Measuring conditions

Desired signal at the vision carrier frequency and interference signal, 14 MHz above the desired signal. Interference signal modulated with 4 kHz (modulation depth 100%).

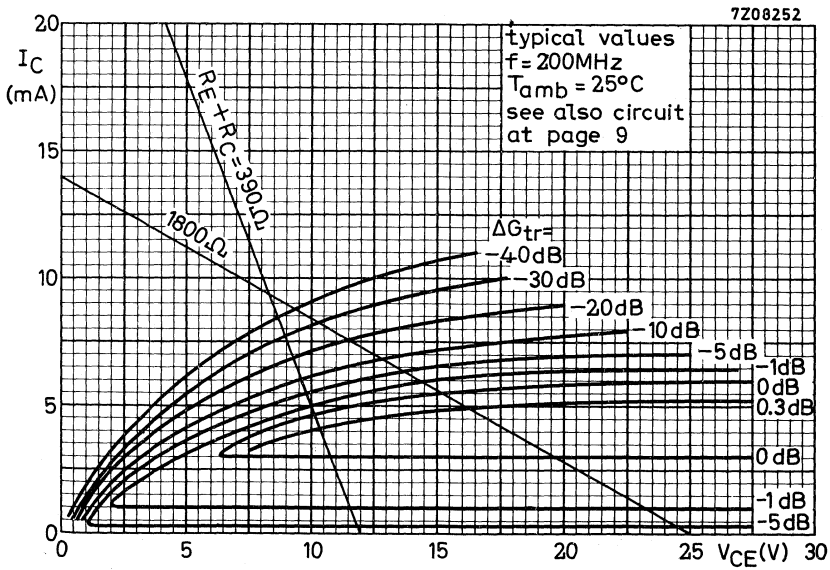
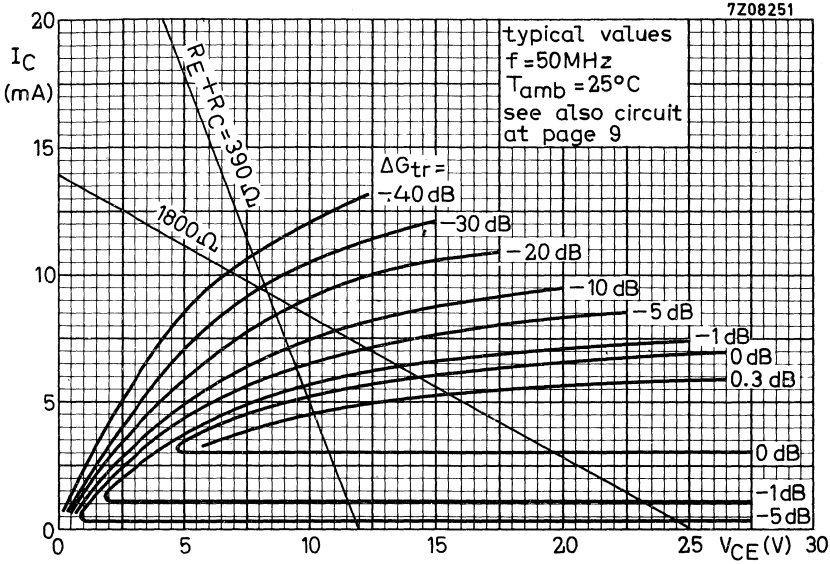
 APPLICATION INFORMATION bulletins available on request



APPLICATION INFORMATION (continued)

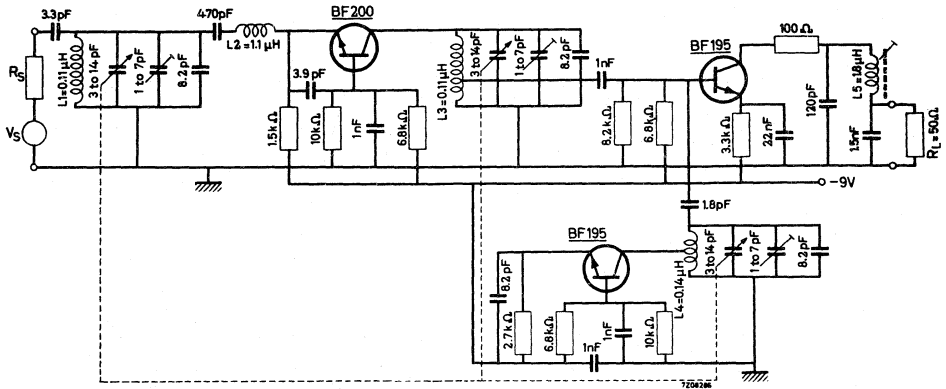


APPLICATION INFORMATION (continued)
curves of constant gain reduction



APPLICATION INFORMATION (continued)

2. F.M. tuner with a BF200 in the pre-amplifier stage.



Coil data:

L1 = 4 turns enamelled Cu wire (1 mm); int. diam. 8 mm; winding pitch 2 mm; air;
 $Q_0 = 200$; $Q_L = 50$

L2 = 22 turns closely wound enamelled Cu wire (0.2 mm); int. diam. 4 mm; $Q_0 = 150$
 L3 = 4 turns enamelled Cu wire (1 mm); int. diam. 8 mm; winding pitch 2 mm; air;
 mixer base tap 3/4 turns from earth-side; $Q_0 = 200$; $Q_L = 100$

L4 = 4.5 turns enamelled Cu wire (1 mm); int. diam. 8 mm; winding pitch 2 mm; air;
 oscillator collector tap 3.5 turns from earth-side; $Q_0 = 200$

L5 = 11 turns enamelled Cu wire (0.2 mm); winding pitch 0.4 mm; $Q_0 = 150$

Coil former AP3016/02

Ferroxcube core 3122 104 93041

Can AP3015/02

Ferroxcube frame AP3014/02

APPLICATION INFORMATION (continued)

Typical performance of the f.m. tuner at $T_{amb} = 25\text{ }^{\circ}\text{C}$; $f = 98\text{ MHz}$ (oscillator frequency lower than tuning frequency)

Noise figure

F 4.5 dB

Transducer gain $G_{tr} = \frac{\text{output power in load}}{\text{available power from source}}$

G_{tr} 33 dB

Image rejection

65 dB

Double beat suppression ($V_S = 1\text{ }\mu\text{V}$; emf; $R_S = 50\text{ }\Omega$)

85 dB

Repeat spot suppression ($V_S = 1\text{ }\mu\text{V}$; emf; $R_S = 50\text{ }\Omega$)

87 dB

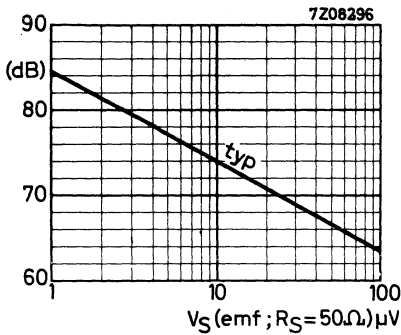
Oscillator frequency variation at $\Delta V_B = 2\text{ V}$

$\Delta f_{osc} < 20\text{ kHz}$

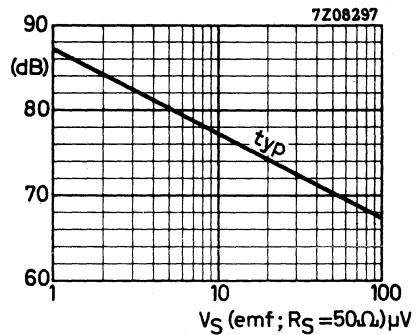
Signal handling for $\Delta f_{osc} = 20\text{ kHz}$ (emf; $R_S = 50\text{ }\Omega$)

$> 1\text{ V}$

Double beat suppression



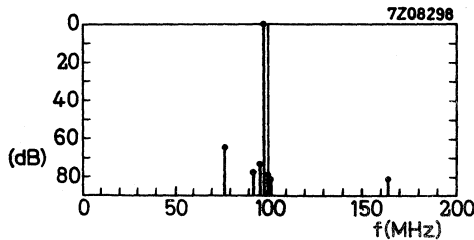
Repeat spot suppression



Spurious response suppression

Tuner adjusted to $f = 98\text{ MHz}$.

Reference level of wanted source signal: $8\text{ }\mu\text{V}$ (emf; $R_S = 50\text{ }\Omega$) = 0 dB.



SILICON PLANAR EPITAXIAL TRANSISTOR

N-P-N transistor in a plastic envelope.

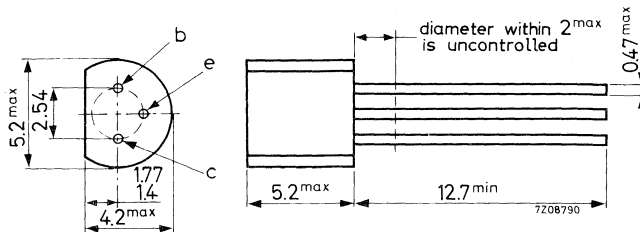
The BF254 is intended for h.f. applications in radio and television receivers; it is especially recommended for f.m. tuners, low noise a.m. mixer-oscillators with high source impedance and i.f. amplifiers in a.m./f.m. receivers where a high current gain is of importance.

QUICK REFERENCE DATA

Collector-base voltage (open emitter)	V_{CBO}	max.	30 V
Collector-emitter voltage (open base)	V_{CEO}	max.	20 V
Collector current (d.c.)	I_C	max.	30 mA
Total power dissipation up to $T_{amb} = 25^\circ\text{C}$	P_{tot}	max.	300 mW
Junction temperature	T_j	max.	125 $^\circ\text{C}$
D.C. current gain at $T_j = 25^\circ\text{C}$ $I_C = 1\text{ mA}; V_{CE} = 10\text{ V}$	h_{FE}	typ.	115
Transition frequency at $f = 35\text{ MHz}$ $I_C = 1\text{ mA}; V_{CE} = 10\text{ V}$	f_T	typ.	260 MHz
Noise figure at $f = 100\text{ MHz}$ $I_C = 1\text{ mA}; V_{CE} = 10\text{ V}; G_S = 10\text{ m}\Omega^{-1}$	F	typ.	4 dB
Conversion noise figure at $f = 1\text{ MHz}$ $I_C = 1\text{ mA}; V_{CE} = 10\text{ V}; G_S = 1.2\text{ m}\Omega^{-1}$	F_c	typ.	2 dB

MECHANICAL DATA

Dimensions in mm



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

Voltages

Collector-base voltage (open emitter)	V_{CBO}	max.	30 V
Collector-emitter voltage (open base) (See also page 4)	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 $T_{amb} = 25^\circ\text{C}$	P_{tot}	max.	300 mW
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Temperatures

Storage temperature	T_{stg}	-65 to +125	$^\circ\text{C}$
Junction temperature	T_j	max.	125 $^\circ\text{C}$

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	0.33 $^\circ\text{C}/\text{mW}$
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CHARACTERISTICS

$T_j = 25\text{ }^\circ\text{C}$

Base-emitter voltage ¹⁾

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

Base current

$I_C = 1\text{ mA}; V_{CE} = 10\text{ V}$ I_B typ. 8.7 μA
4.5 to 15 μA

Feedback capacitance at $f = 0.45\text{ MHz}$

$I_C = 1\text{ mA}; V_{CE} = 10\text{ V}$ $-C_{re}$ typ. 0.85 pF

Transition frequency at $f = 35\text{ MHz}$

$I_C = 1\text{ mA}; V_{CE} = 10\text{ V}$ f_T typ. 260 MHz

Noise figure

$I_C = 1\text{ mA}; V_{CE} = 10\text{ V}$
 $G_S = 2\text{ m}\Omega^{-1}; f = 0.2\text{ MHz}$ F typ. 1.5 dB

$G_S = 1.5\text{ m}\Omega^{-1}; f = 1.0\text{ MHz}$ F typ. 1.2 dB

$G_S = 10\text{ m}\Omega^{-1}; f = 100\text{ MHz}$ F typ. 4 dB

Conversion noise figure

$I_C = 1\text{ mA}; V_{CE} = 10\text{ V}$
 $G_S = 0.6\text{ m}\Omega^{-1}; f = 0.2\text{ MHz}$ F_c typ. 3 dB

$G_S = 1.2\text{ m}\Omega^{-1}; f = 1.0\text{ MHz}$ F_c typ. 2 dB

y parameters at $f = 100\text{ MHz}$ (common base)

$I_C = 1\text{ mA}; V_{CE} = 10\text{ V}$ (lead length = 3 mm)

Input conductance	g_{ib}	typ.	36 $\text{m}\Omega^{-1}$
Input susceptance	$-b_{ib}$	typ.	3 $\text{m}\Omega^{-1}$
Feedback admittance	$ y_{rb} $	typ.	410 $\mu\Omega^{-1}$
Phase angle of feedback admittance	φ_{rb}	typ.	272°
Transfer admittance	$ y_{fb} $	typ.	33 $\text{m}\Omega^{-1}$
Phase angle of transfer admittance	φ_{fb}	typ.	146°
Output conductance	g_{ob}	typ.	22 $\mu\Omega^{-1}$
Output susceptance	b_{ob}	typ.	1.1 $\text{m}\Omega^{-1}$

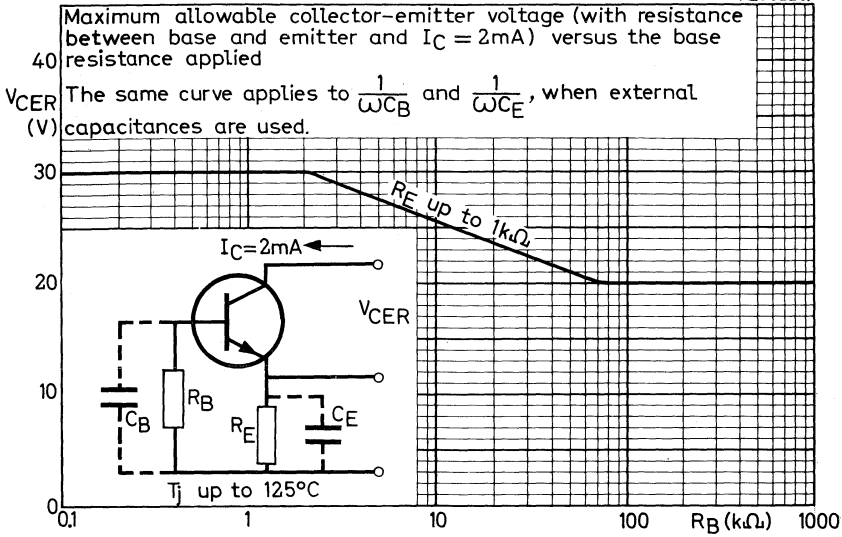
y parameters (common emitter)

$I_C = 1\text{ mA}; V_{CE} = 10\text{ V}$ (lead length = 3 mm)

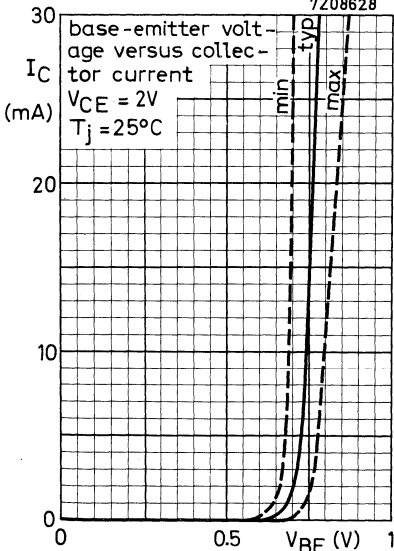
	$f = 10.7\text{ MHz}$	$f = 0.45\text{ MHz}$
Input conductance	$g_{ie} < 0.64$	0.54 $\text{m}\Omega^{-1}$
Output conductance	$g_{oe} < 13.5$	11.5 $\mu\Omega^{-1}$

¹⁾ V_{BE} decreases by about 1.7 mV/ $^\circ\text{C}$ with increasing temperature.

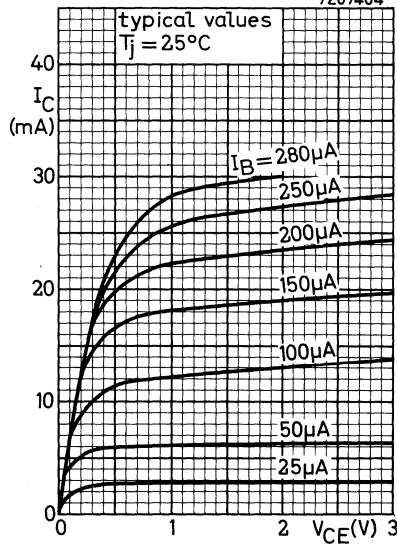
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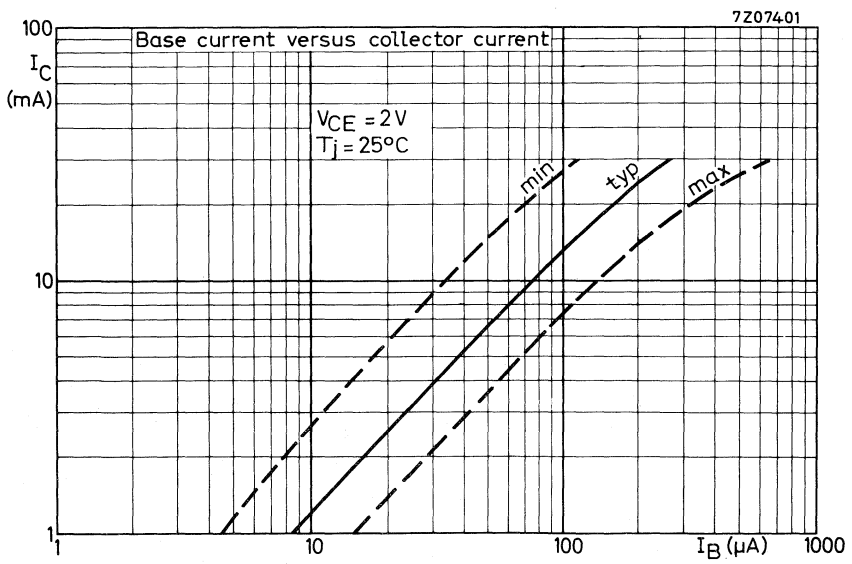
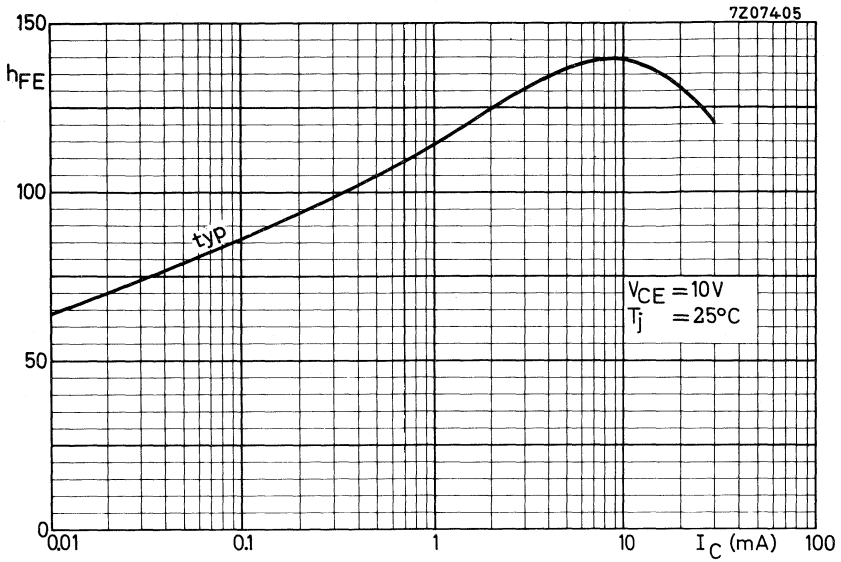


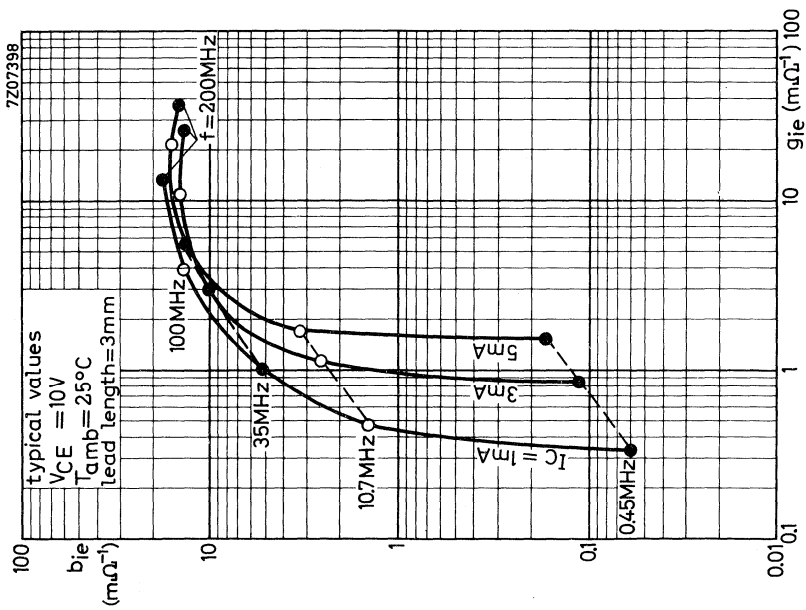
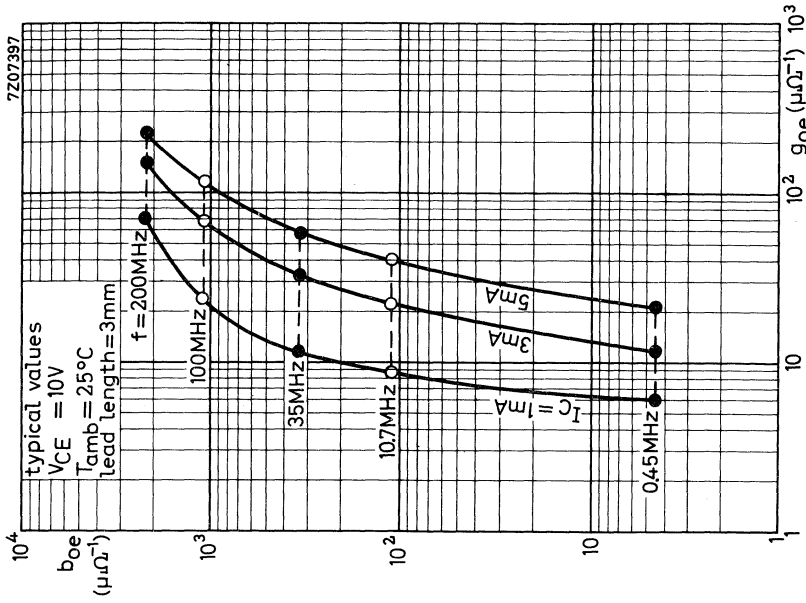
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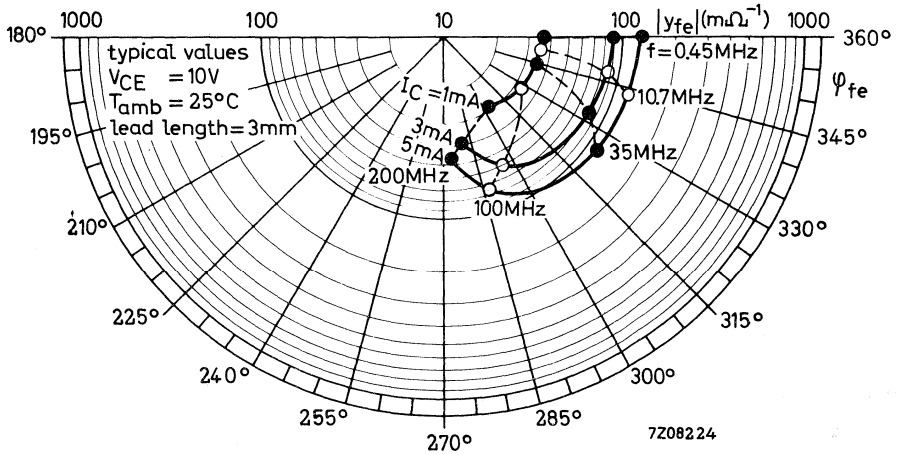
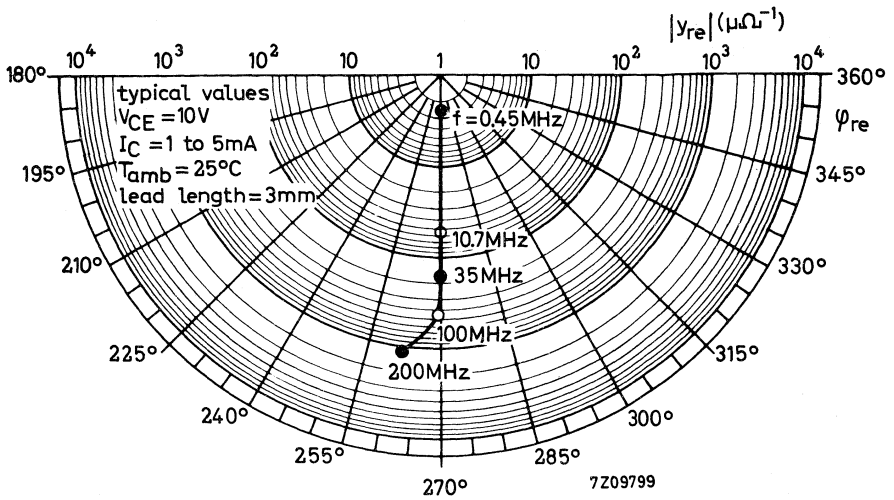


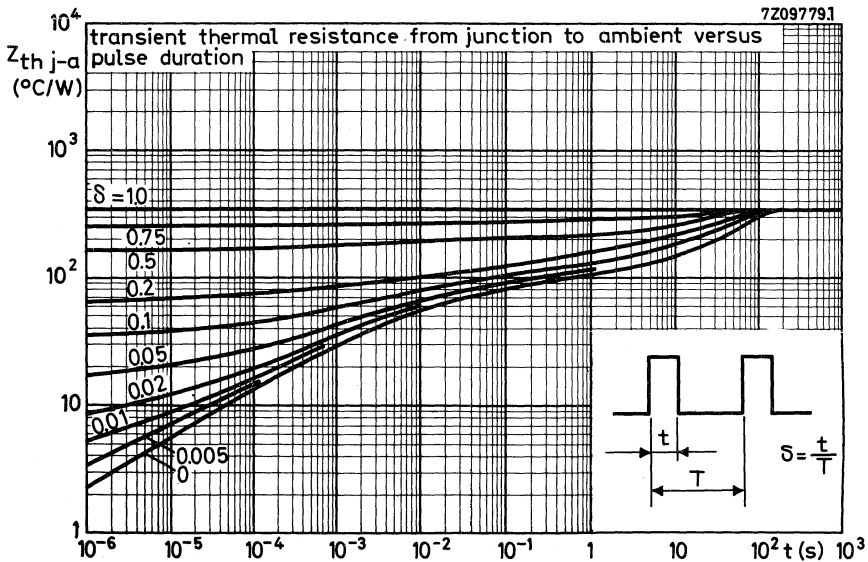
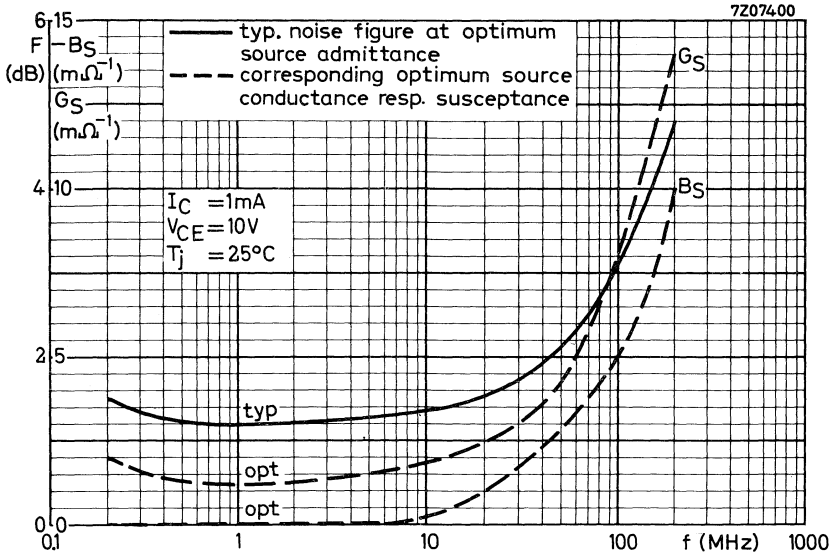
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SILICON PLANAR EPITAXIAL TRANSISTOR

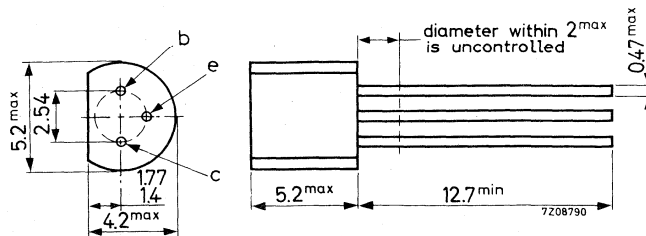
N-P-N transistor in a plastic envelope.

The BF255 is intended for h.f. applications in radio and television receivers; it is especially recommended for f.m. tuners, i.f. amplifiers in a.m./f.m. receivers where a low transistor output conductance is of importance, a.m. input stages of carradios where a low noise figure at low source impedance is required.

QUICK REFERENCE DATA			
Collector-base voltage (open emitter)	V_{CBO}	max.	30 V
Collector-emitter voltage (open base)	V_{CEO}	max.	20 V
Collector current (d.c.)	I_C	max.	30 mA
Total power dissipation up to $T_{amb} = 25^\circ C$	P_{tot}	max.	300 mW
Junction temperature	T_j	max.	125 $^\circ C$
D.C. current gain at $T_j = 25^\circ C$ $I_C = 1 \text{ mA}; V_{CE} = 10 \text{ V}$	h_{FE}	typ.	67
Transition frequency at $f = 35 \text{ MHz}$ $I_C = 1 \text{ mA}; V_{CE} = 10 \text{ V}$	f_T	typ.	200 MHz
Noise figure $I_C = 1 \text{ mA}; V_{CE} = 10 \text{ V}$ $G_S = 20 \text{ m}\Omega^{-1}; f = 1 \text{ MHz}$	F	typ.	3.5 dB
$G_S = 10 \text{ m}\Omega^{-1}; f = 100 \text{ MHz}$	F	typ.	4 dB

MECHANICAL DATA

Dimensions in mm



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

Collector-base voltage (open emitter)	V_{CBO}	max.	30 V
Collector-emitter voltage (open base) (See also page 4)	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 $T_{amb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	300 mW
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Temperatures

Storage temperature	T_{stg}	-65 to +125	$^\circ\text{C}$
Junction temperature	T_j	max.	125 $^\circ\text{C}$

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	0.33 $^\circ\text{C}/\text{mW}$
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CHARACTERISTICS

$T_j = 25\text{ }^\circ\text{C}$

Base-emitter voltage ¹⁾

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

Base current

$I_C = 1\text{ mA}; V_{CE} = 10\text{ V}$ I_B typ. 15 μA
8 to 28 μA

Feedback capacitance at $f = 0.45\text{ MHz}$

$I_C = 1\text{ mA}; V_{CE} = 10\text{ V}$ $-C_{re}$ typ. 0.85 pF

Transition frequency at $f = 35\text{ MHz}$

$I_C = 1\text{ mA}; V_{CE} = 10\text{ V}$ f_T typ. 200 MHz

Noise figure

$I_C = 1\text{ mA}; V_{CE} = 10\text{ V}$
 $G_S = 20\text{ m}\Omega^{-1}; f = 1\text{ MHz}$ F typ. 3.5 dB

$G_S = 10\text{ m}\Omega^{-1}; f = 100\text{ MHz}$ F typ. 4 dB

Conversion noise figure

$I_C = 1\text{ mA}; V_{CE} = 10\text{ V}$
 $G_S = 1.2\text{ m}\Omega^{-1}; f = 0.2\text{ MHz}$ F_C typ. 4 dB

$G_S = 1.5\text{ m}\Omega^{-1}; f = 1\text{ MHz}$ F_C typ. 2.5 dB

y parameters at $f = 100\text{ MHz}$ (common base)

$I_C = 1\text{ mA}; V_{CE} = 10\text{ V}$ (lead length = 3 mm)

Input conductance	g_{ib}	typ.	38 $\text{m}\Omega^{-1}$
Input susceptance	$-b_{ib}$	typ.	1 $\text{m}\Omega^{-1}$
Feedback admittance	$ y_{rb} $	typ.	400 $\mu\Omega^{-1}$
Phase angle of feedback admittance	φ_{rb}	typ.	275°
Transfer admittance	$ y_{fb} $	typ.	34 $\text{m}\Omega^{-1}$
Phase angle of transfer admittance	φ_{fb}	typ.	140°
Output conductance	g_{ob}	typ.	12 $\mu\Omega^{-1}$
Output susceptance	b_{ob}	typ.	1.1 $\text{m}\Omega^{-1}$

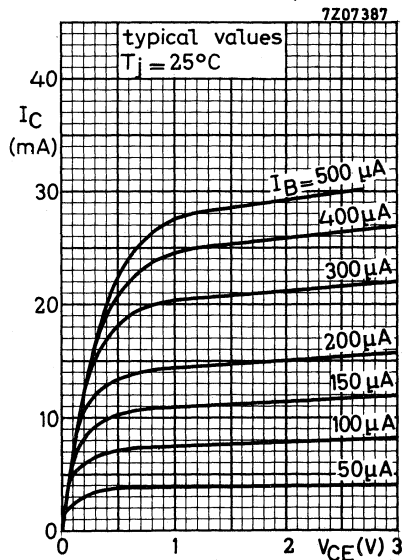
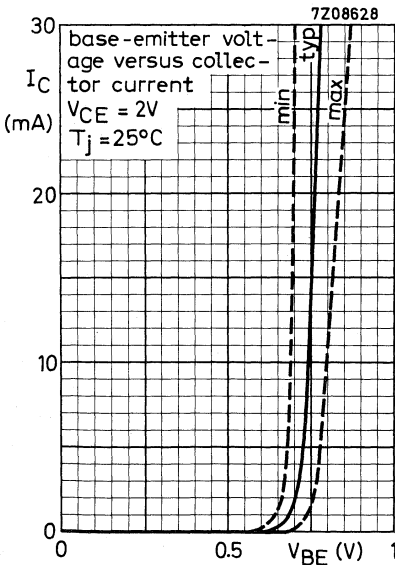
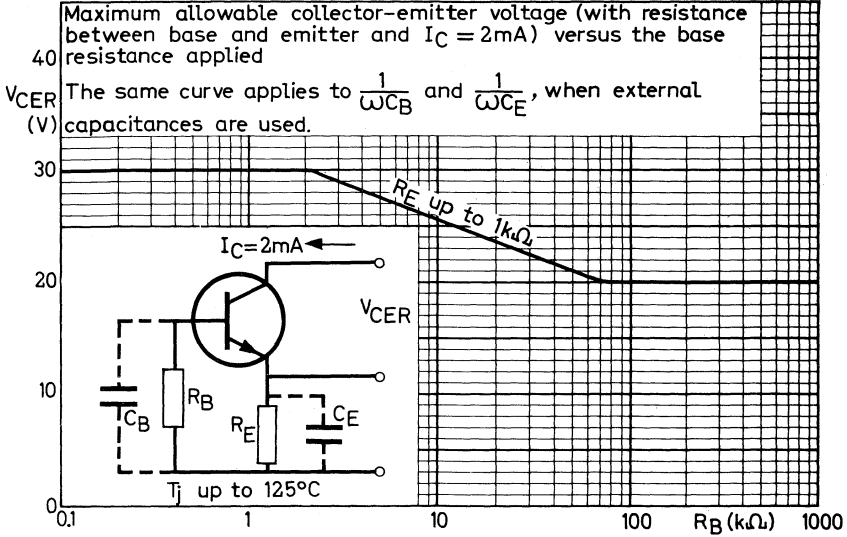
y parameters (common emitter)

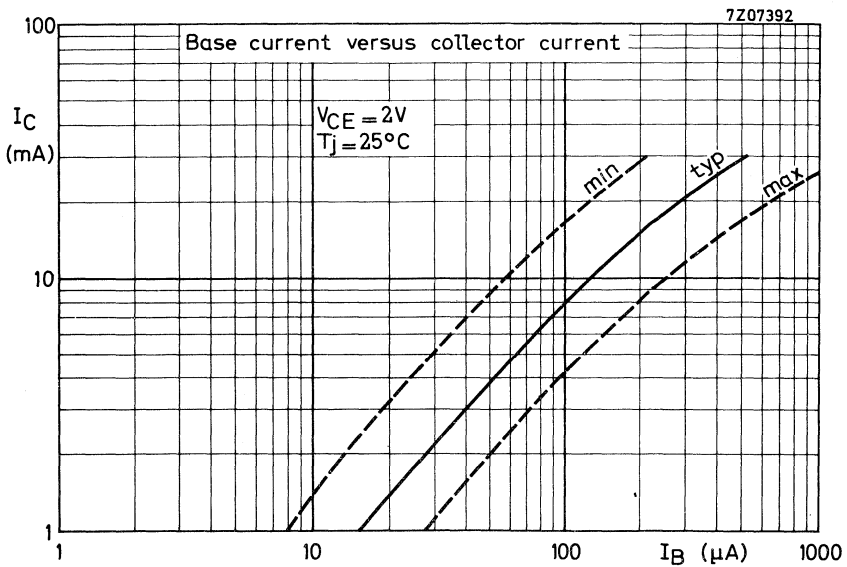
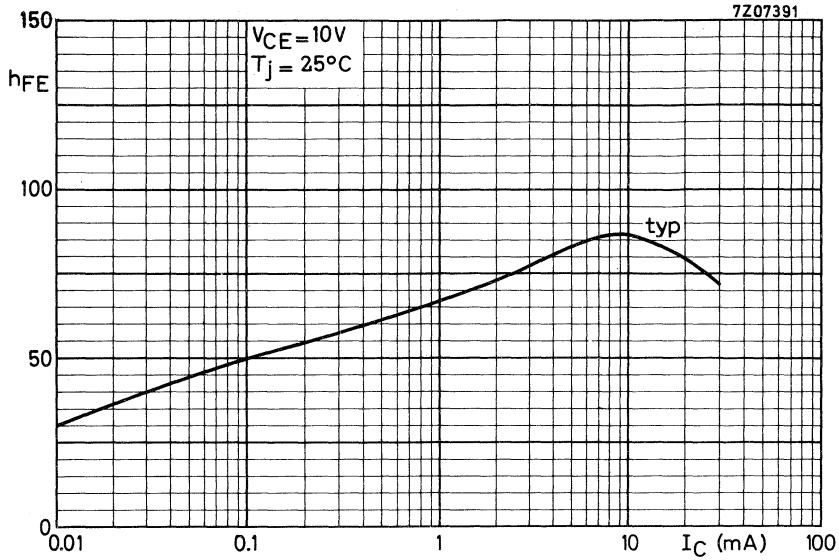
$I_C = 1\text{ mA}; V_{CE} = 10\text{ V}$ (lead length = 3 mm)

		$f = 10.7\text{ MHz}$	$f = 0.45\text{ MHz}$
Input conductance	g_{ie}	< 0.96	0.86 $\text{m}\Omega^{-1}$
Output conductance	g_{oe}	< 9.5	7.0 $\mu\Omega^{-1}$

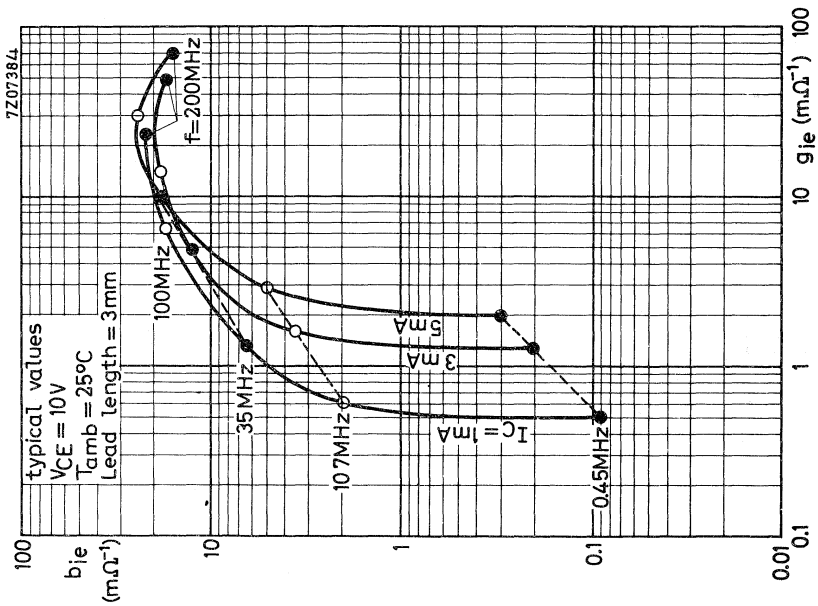
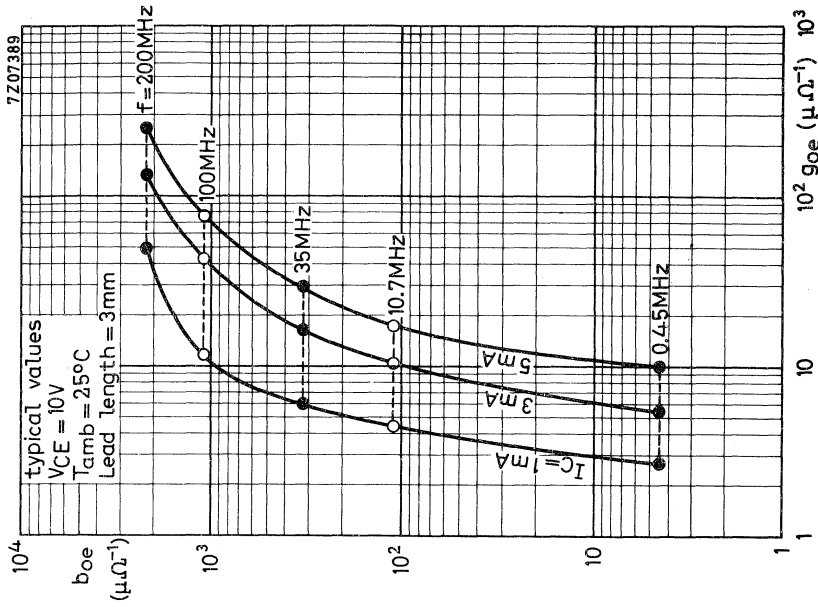
¹⁾ V_{BE} decreases by about 1.7 mV/°C with increasing temperature.

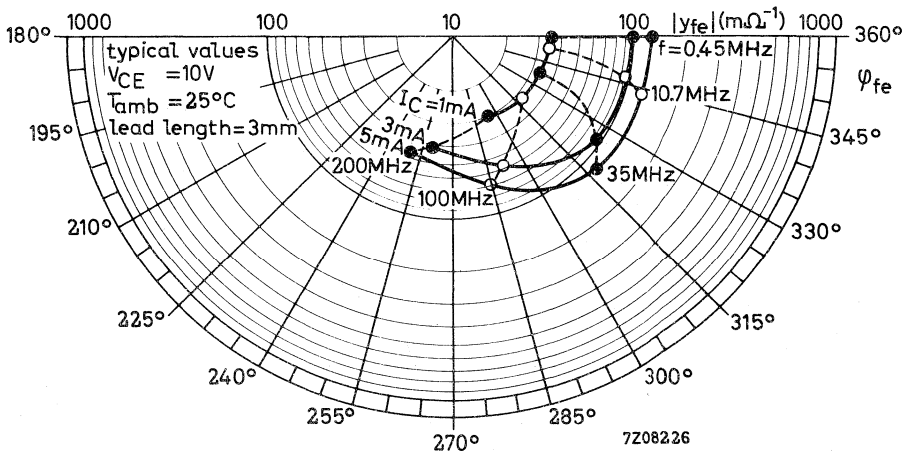
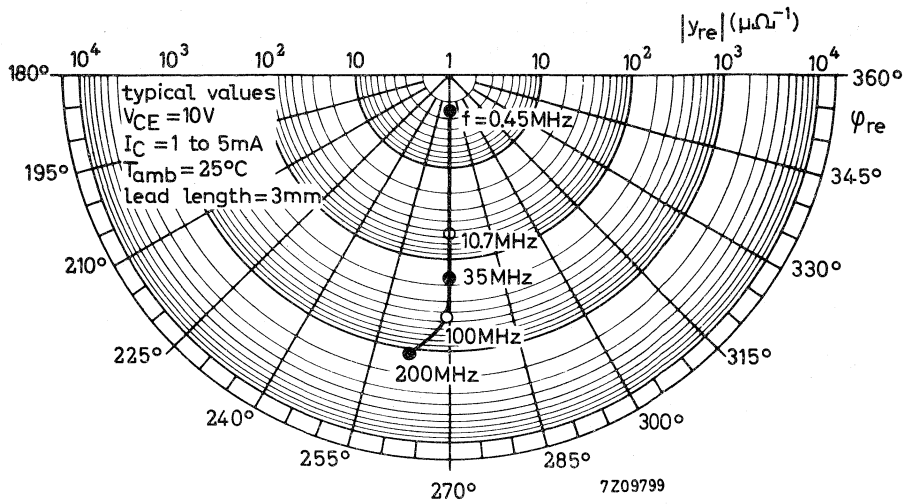
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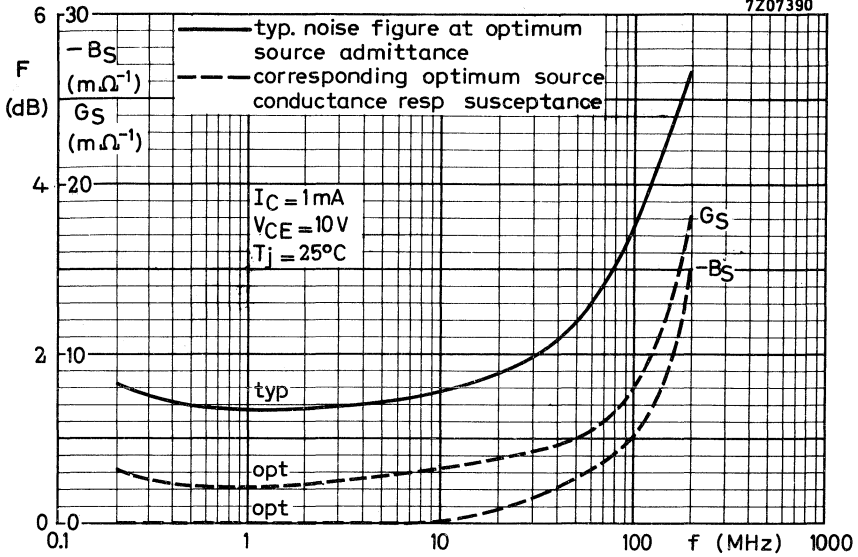


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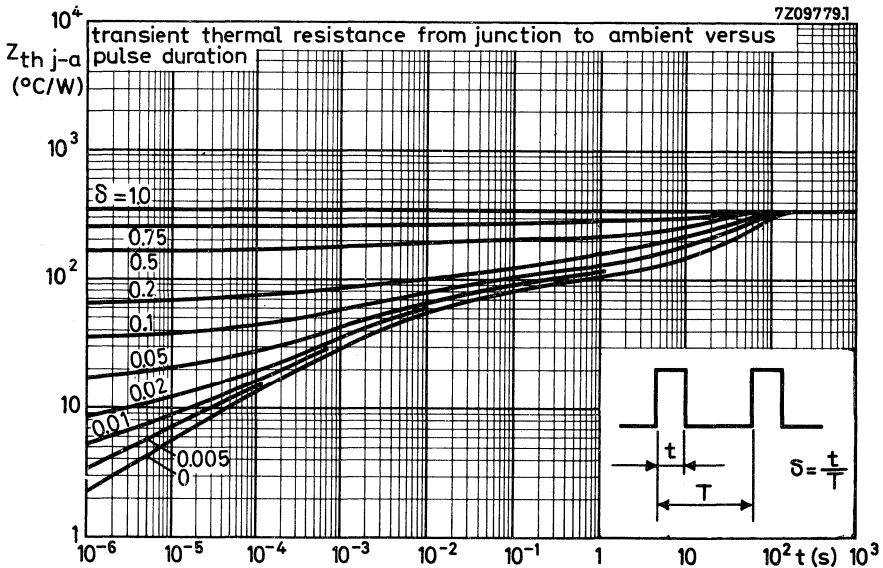




7Z07390



7Z09779.1



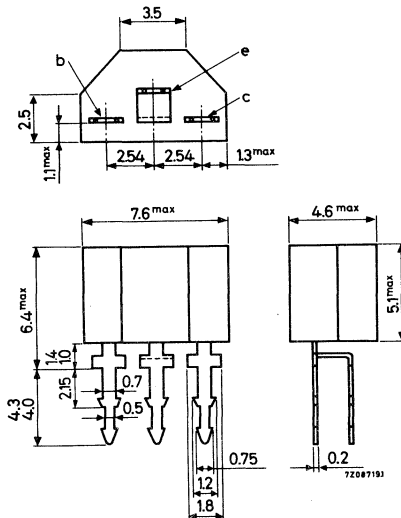
SILICON PLANAR EPITAXIAL TRANSISTORS

N-P-N transistors in a plastic envelope with stiff, self-locking pins suitable for use with standard printed boards. The transistors are recommended for a.m. mixers and i.f. amplifiers in a.m./f.m. 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 $T_{amb} = 25^\circ\text{C}$	P_{tot}	max.	250 mW
Junction temperature	T_j	max.	125 $^\circ\text{C}$
D. C. current gain at $T_j = 25^\circ\text{C}$ $I_C = 1\text{ mA}; V_{CE} = 10\text{ V}$	h_{FE}		BF334 BF335
		>	65 35
	<	220 125	
Transition frequency at $f = 100\text{ MHz}$ $I_C = 1\text{ mA}; V_{CE} = 10\text{ V}$	f_T	typ.	430 370 MHz
Transfer admittance at $f = 10.7\text{ MHz}$ $I_C = 1\text{ mA}; V_{CE} = 10\text{ V}$	$ y_{fe} $	typ.	36 36 $\text{m}\Omega^{-1}$

MECHANICAL DATA

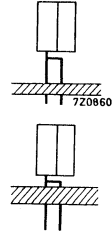
Dimensions in mm



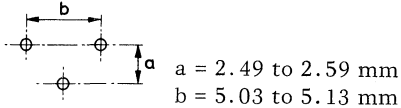
The envelope fulfils the accelerated damp heat test described in IEC publication 68-2 (test D, severity IV, 6 cycles).

MOUNTING INSTRUCTIONS

1. Thickness of printed board: max. 1.1 mm
Hole diameter 0.77 to 0.83 mm
2. Thickness of printed board: max. 1.7 mm
Hole diameter 1.25 to 1.35 mm



Bore plan



NOTE

For iron soldering or for dip soldering, the iron temperature or solder temperature may go up to 300 °C for a maximum of 3 seconds, with the transistor lockfitted on printed boards in either of the possible mounting positions.

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

Voltages

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

Current

Collector current (d.c.)	I_C	max.	25 mA
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Power dissipation

Total power dissipation up to $T_{amb} = 25\text{ °C}$	P_{tot}	max.	250 mW
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Temperatures

Storage temperature	T_{stg}	-55 to +125 °C
Junction temperature	T_j	max. 125 °C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	0.4 °C/mW
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CHARACTERISTICS

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

Collector cut-off current

$I_E = 0; V_{CB} = 20\text{ V}$ $I_{CBO} < 50\text{ nA}$

$I_E = 0; V_{CB} = 40\text{ V}$ $I_{CBO} < 10\text{ }\mu\text{A}$

Emitter cut-off current

$I_C = 0; V_{EB} = 4\text{ V}$ $I_{EBO} < 10\text{ }\mu\text{A}$

Base-emitter voltage

$I_C = 1\text{ mA}; V_{CE} = 10\text{ V}$ V_{BE} typ. 0.75 V

Base current

		BF334	BF335
$I_C = 1\text{ mA}; V_{CE} = 10\text{ V}$	$I_B >$	4.5	8 μA
	$I_B <$	15	28 μA

Feedback capacitance at $f = 0.45\text{ MHz}$

$I_C = 1\text{ mA}; V_{CE} = 10\text{ V}$ $-C_{re} < 0.3$ 0.3 pF

Transition frequency at $f = 100\text{ MHz}$

$I_C = 1\text{ mA}; V_{CE} = 10\text{ V}$ f_T typ. 430 370 MHz

Noise figure

$I_C = 1\text{ mA}; V_{CE} = 10\text{ V}$
 $R_S = 500\text{ }\Omega; f = 0.2\text{ MHz}$ F typ. 1.5 2.0 dB

D.C. current gain

$I_C = 1\text{ mA}; V_{CE} = 10\text{ V}$	$h_{FE} >$	65	35
	$h_{FE} <$	220	125

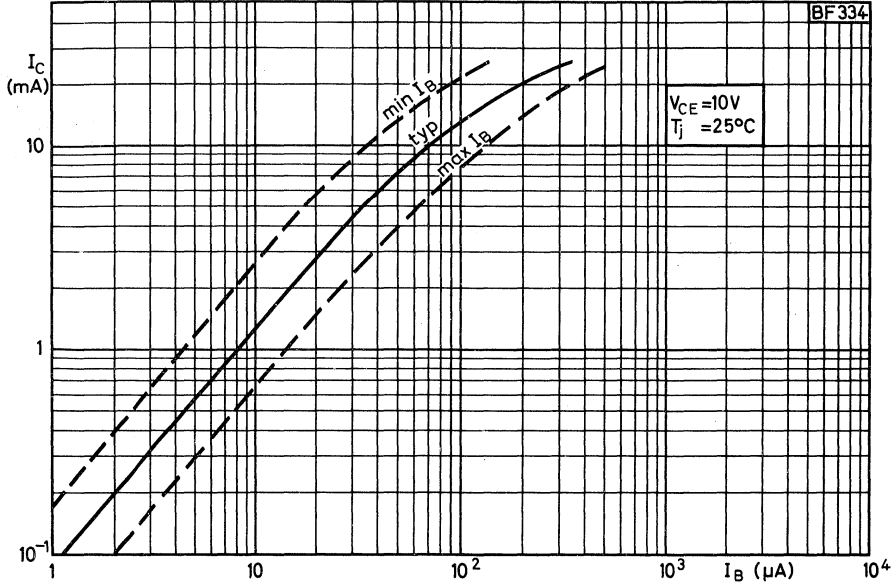
y parameters (common emitter)

		$f = 0.45$	10.7 MHz
Input conductance	g_{ie}	typ. 0.45	0.55 $\text{m}\Omega^{-1}$
Input susceptance	$-b_{ie}$	typ. 0.06	1.35 $\text{m}\Omega^{-1}$
Input capacitance	C_{ie}	typ. 20	20 pF
Feedback admittance	$ y_{re} $	typ. 0.75	18 $\mu\Omega^{-1}$
Phase angle of feedback admittance	ϕ_{re}	typ. 270	270°
Transfer admittance	$ y_{fe} $	typ. 36	36 $\text{m}\Omega^{-1}$
Phase angle of transfer admittance	ϕ_{fe}	typ. 0°	0°
Output conductance	g_{oe}	typ. 3 (<6)	5 $\mu\Omega^{-1}$
Output susceptance	b_{oe}	typ. 2.8	67 $\mu\Omega^{-1}$
Output capacitance	C_{oe}	typ. 1	1 pF

BF334
BF335

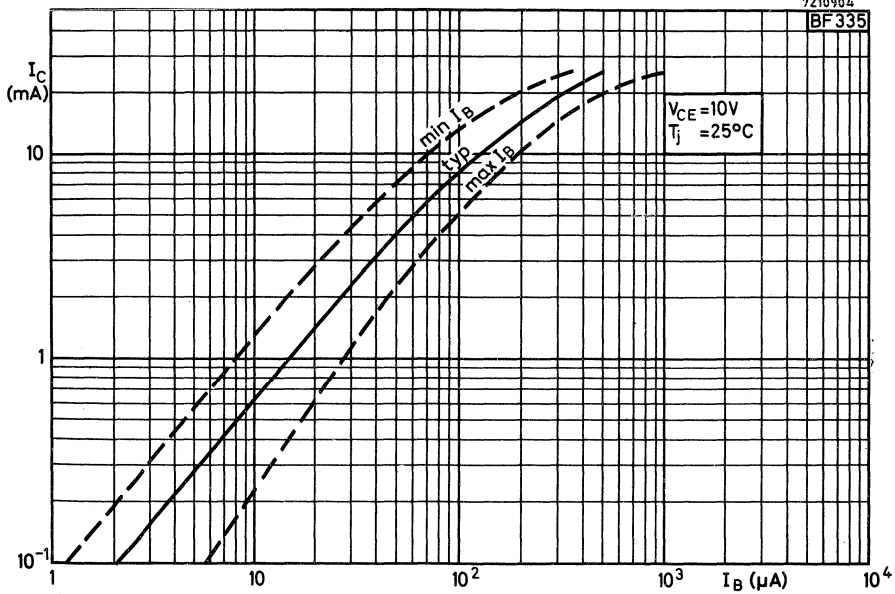
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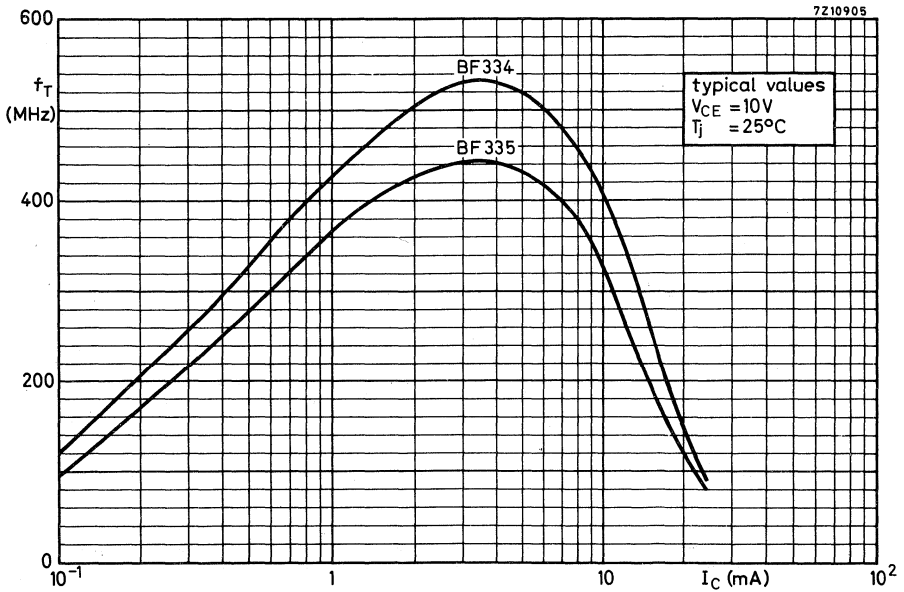
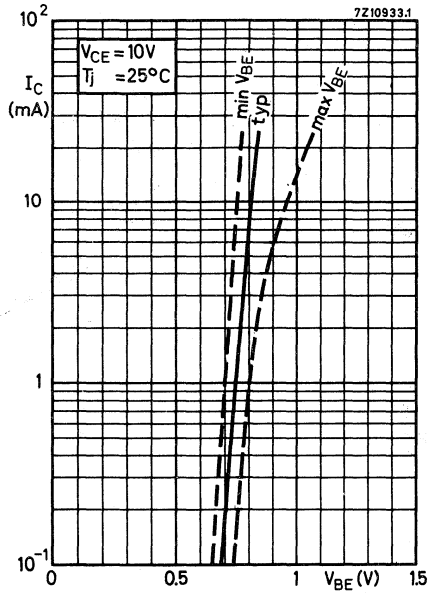
BF334



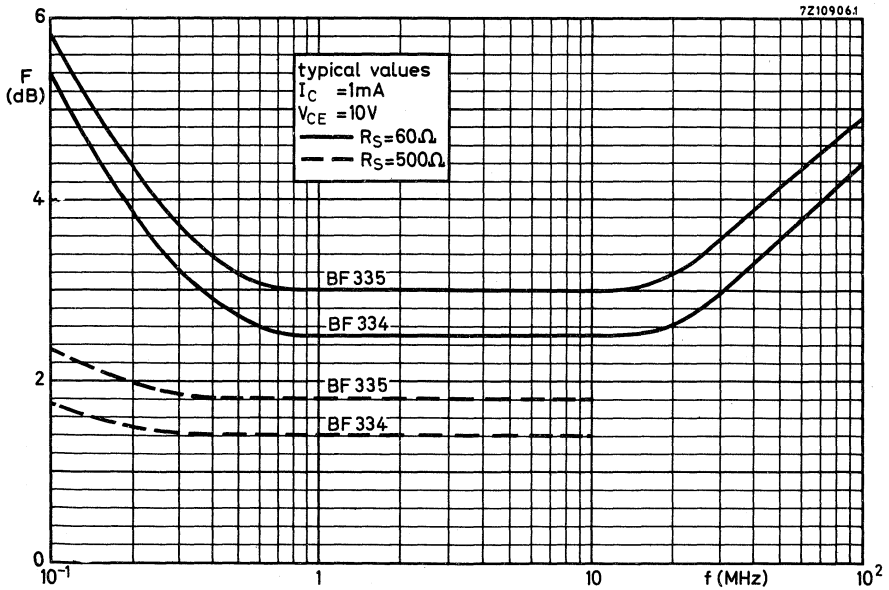
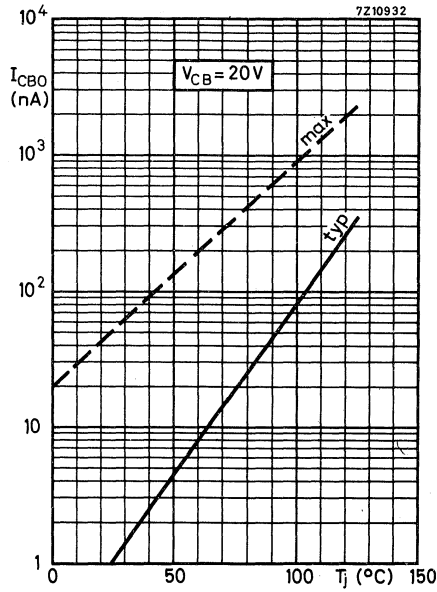
7210904

BF335





BF334
BF335



N-P-N SILICON PLANAR TRANSISTORS FOR VIDEO OUTPUT STAGES

N-P-N transistors in a TO-39 metal envelope with the collector connected to the case. The transistors are intended for video amplifiers in black-and-white and in colour television receivers.

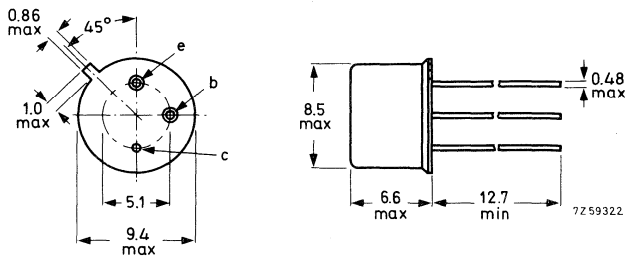
QUICK REFERENCE DATA					
		BF336	BF337	BF338	
Collector-base voltage (open emitter)	V_{CBO} max.	185	250	300	V
Collector-emitter voltage (open base)	V_{CEO} max.	180	200	225	V
Collector current (d.c.)	I_C max.	100		mA	
Total power dissipation up to $T_{mb} = 140^\circ\text{C}$	P_{tot} max.	3.0		W	
Junction temperature	T_j max.	200		$^\circ\text{C}$	
D.C. current gain at $T_j = 25^\circ\text{C}$ $I_C = 30\text{ mA}; V_{CE} = 10\text{ V}$	h_{FE}	> 20			
Transition frequency $I_C = 30\text{ mA}; V_{CE} = 20\text{ V}$	f_T	> 80		MHz	
Feedback capacitance at $f = 0.5\text{ MHz}$ $I_C = 10\text{ mA}; V_{CE} = 20\text{ V}$	$-C_{re}$	< 3.5		pF	

MECHANICAL DATA

Dimensions in mm

TO-39

Collector connected to case



Max. lead diameter is guaranteed only for 12.7 mm

Accessories supplied on request: 56218; 56245; 56265

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

Voltages

		BF336	BF337	BF338	
Collector-base voltage (open emitter)	V_{CBO}	max. 185	250	300	V
Collector-emitter voltage ($R_{BE} \leq 1 \text{ k}\Omega$) $I_C = 1 \text{ mA}$; up to $T_j = 150 \text{ }^\circ\text{C}$	V_{CER}	max. 185	250	300	V
Collector-emitter voltage (open base) $I_C = 4 \text{ mA}$	V_{CEO}	max. 180	200	225	V
Emitter-base voltage (open collector) $I_E = 0.1 \text{ mA}$	V_{EBO}	max. 5	5	5	V

Currents

Collector current (d. c.)	I_C	max.	100	mA
Collector current (peak value)	I_{CM}	max.	100	mA ¹⁾
Base current (peak value)	I_{BM}	max.	20	mA

Power dissipation

Total power dissipation up to $T_{mb} = 140 \text{ }^\circ\text{C}$	P_{tot}	max.	3.0	W
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Temperatures

Storage temperature	T_{stg}	-65 to +200	$^\circ\text{C}$
Junction temperature	T_j	max. 200	$^\circ\text{C}$

THERMAL RESISTANCE

From junction to ambient	$R_{th \text{ j-a}}$	=	220	$^\circ\text{C/W}$
From junction to mounting base	$R_{th \text{ j-mb}}$	=	20	$^\circ\text{C/W}$
From junction to case	$R_{th \text{ j-c}}$	=	25	$^\circ\text{C/W}$

¹⁾ For drive applications in horizontal deflection circuits:

- a. The collector peak current may be 200 mA under following conditions:
 $t_p = 0.5 \text{ } \mu\text{s}$; $T = 64 \text{ } \mu\text{s}$; $V_{CE} \leq 90 \text{ V}$; $T_{amb} = 55 \text{ }^\circ\text{C}$
- b. The collector peak current may be 150 mA under following conditions:
 $t_p = 27 \text{ } \mu\text{s}$; $T = 64 \text{ } \mu\text{s}$; $V_{CE} \leq 9 \text{ V}$; $T_{amb} = 55 \text{ }^\circ\text{C}$

CHARACTERISTICS

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

Collector cut-off current at $R_{BE} = 1\text{ k}\Omega$

$V_{CE} = 150\text{ V}$ for BF336 }
 $V_{CE} = 200\text{ V}$ for BF337 }
 $V_{CE} = 250\text{ V}$ for BF338 }

I_{CER} typ. 10 nA
 < 100 μA

Base-emitter voltage

$I_C = 30\text{ mA}; V_{CE} = 10\text{ V}$

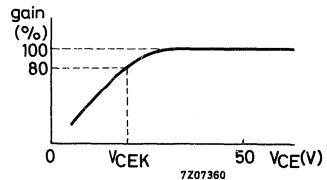
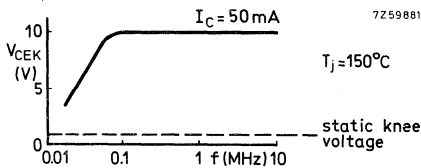
V_{BE} typ. 0.7 V
 < 1.2 V

High frequency knee voltage at $T_j = 150\text{ }^\circ\text{C}$

$I_C = 50\text{ mA}$

V_{CEK} typ. 10 V

The high frequency knee voltage of a transistor is that value of the collector-emitter voltage at which the small signal gain, measured in a practical circuit, has dropped to 80% of the gain at $V_{CE} = 50\text{ V}$. A further decrease of the collector-emitter voltage results in a rapid increase of the distortion of the signal.



D.C. current gain

$I_C = 30\text{ mA}; V_{CE} = 10\text{ V}$

h_{FE} > 20
 typ. 60

Feedback capacitance at $f = 0.5\text{ MHz}$

$I_C = 10\text{ mA}; V_{CE} = 20\text{ V}$

$-C_{re}$ typ. 3.0 pF
 < 3.5 pF

Feedback time constant at $f = 10\text{ MHz}$

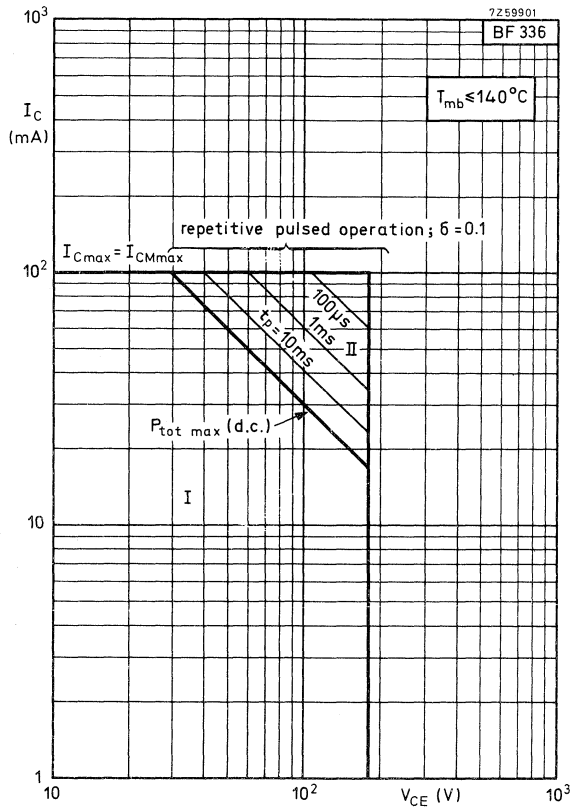
$I_E = 30\text{ mA}; V_{CB} = 20\text{ V}$

$r_{bb}'C_{b'c}$ typ. 30 ps
 < 100 ps

Transition frequency at $f = 100\text{ MHz}$

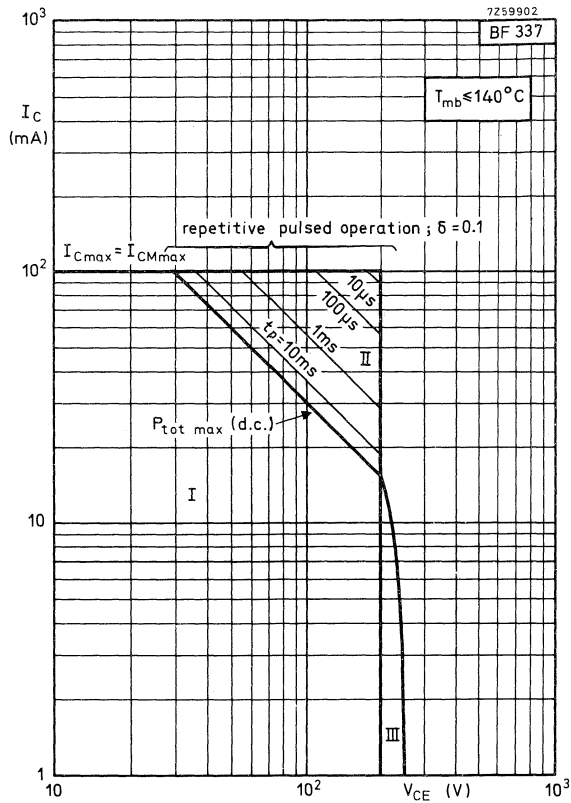
$I_C = 30\text{ mA}; V_{CE} = 20\text{ V}$

f_T > 80 MHz
 typ. 130 MHz



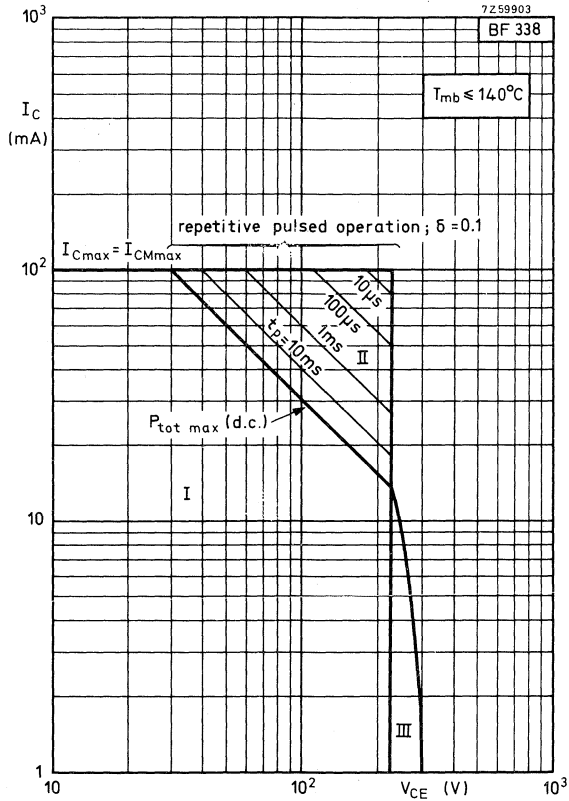
Safe Operating Area with the transistor forward biased

- I Region of permissible d. c. operation
- II Permissible extension for repetitive pulsed operation



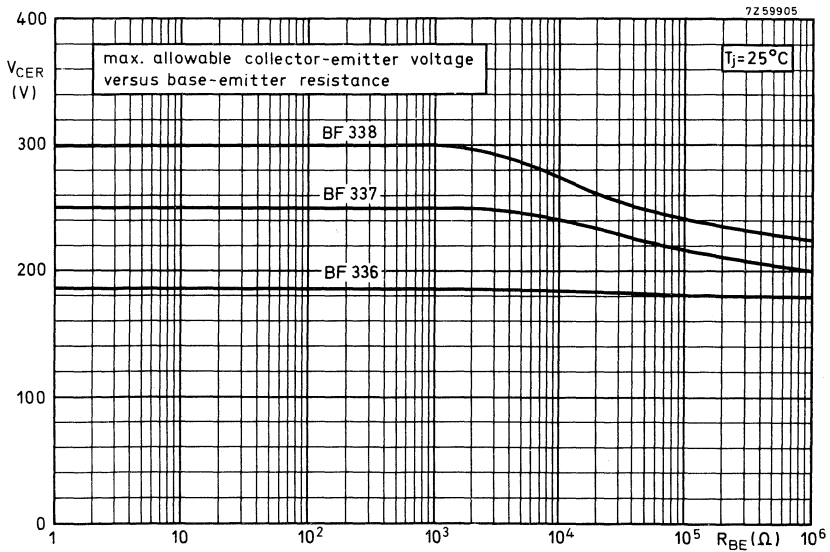
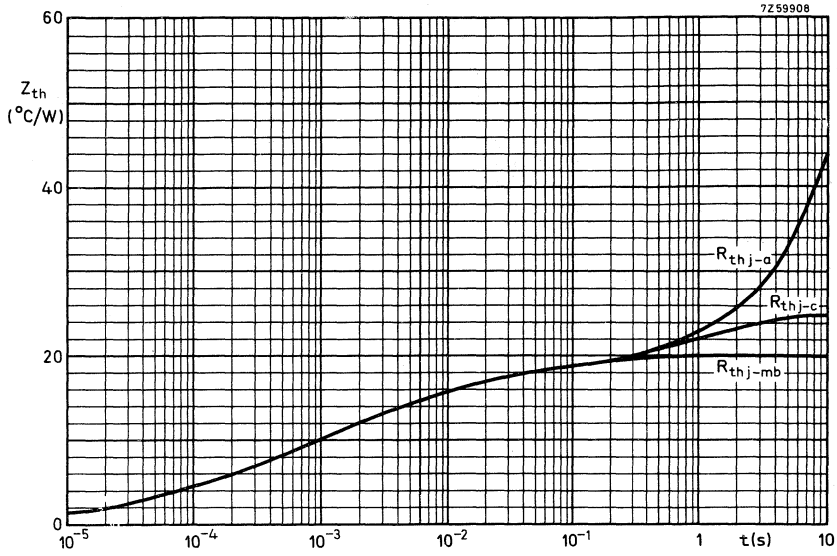
Safe Operating Area with the transistor forward biased

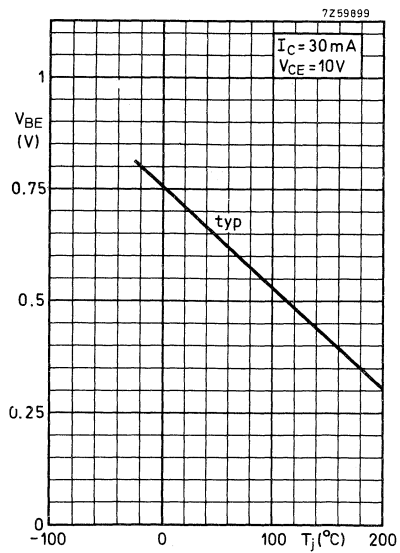
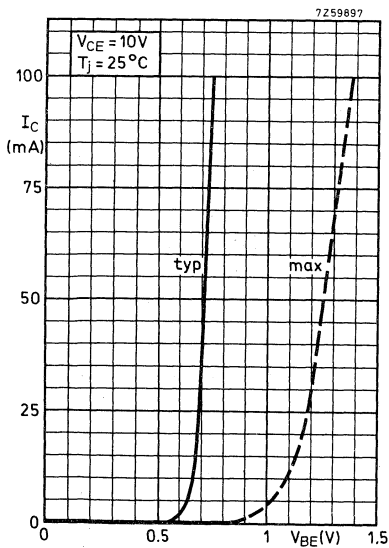
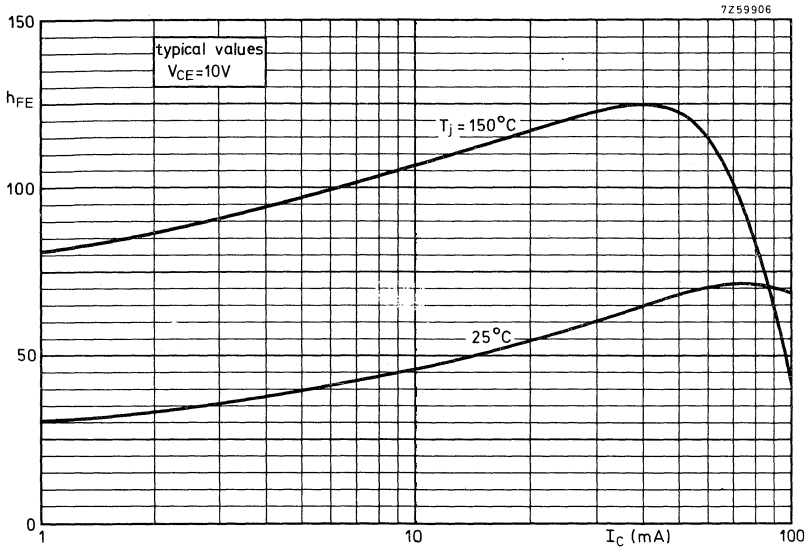
- I Region of permissible d.c. operation
- II Permissible extension for repetitive pulsed operation
- III Repetitive pulsed operation in this region is allowable, provided $R_{BE} \leq 1\ k\Omega$

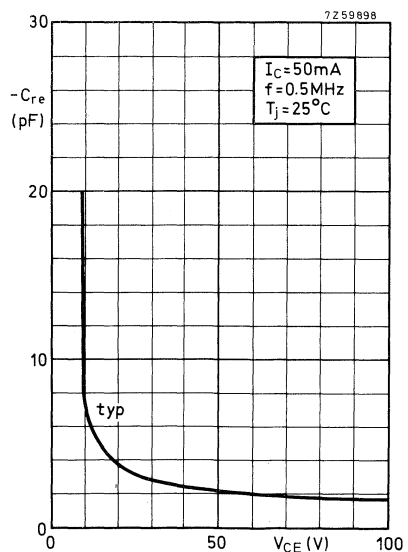
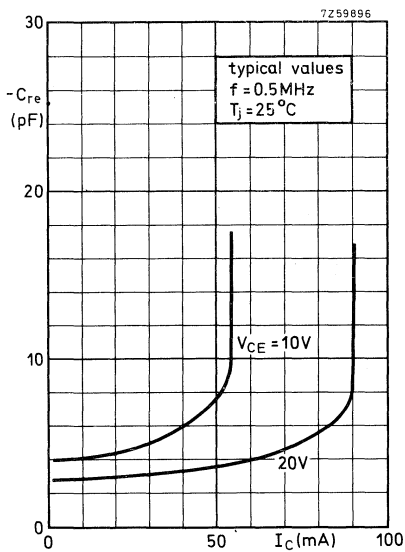
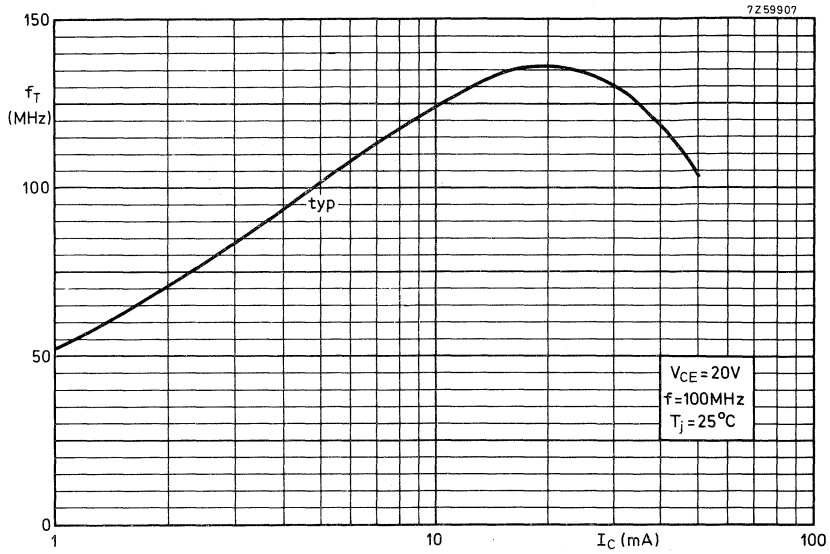


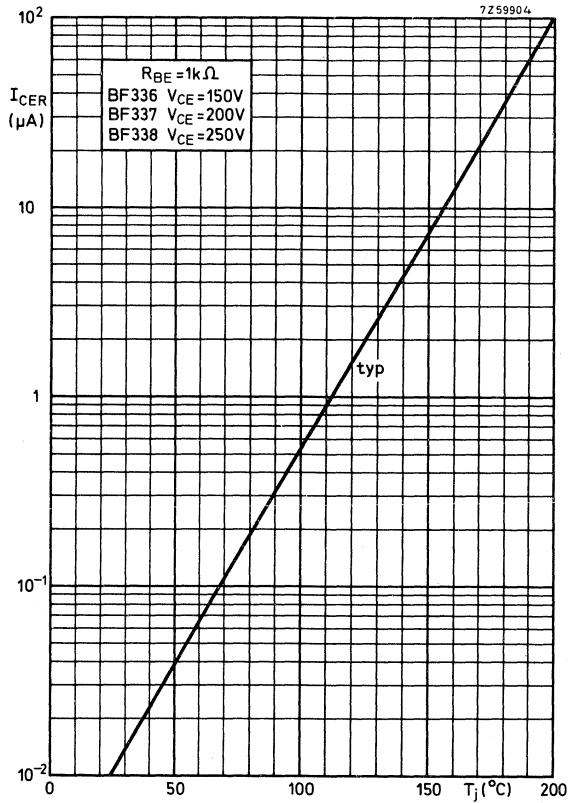
Safe Operating Area with the transistor forward biased

- I Region of permissible d. c. operation
- II Permissible extension for repetitive pulsed operation
- III Repetitive pulsed operation in this region is allowable, provided $R_{BE} \leq 1 \text{ k}\Omega$









SILICON PLANAR EPITAXIAL TRANSISTORS

N-P-N multi-emitter silicon transistors in a capstan envelope. The transistors have extremely good intermodulation properties and high power gain.

The device is primarily intended for:

- a- Final and driver stages of channel and band aerial amplifiers with high output power for band I, II, III and IV/V (40-860 MHz).
- b- Final and driver stages of wide band amplifiers (40-230 MHz).
- c- Final stages of the wide band vertical amplifier in high speed oscilloscopes.
- d- Frequency multiplier and oscillator circuits.

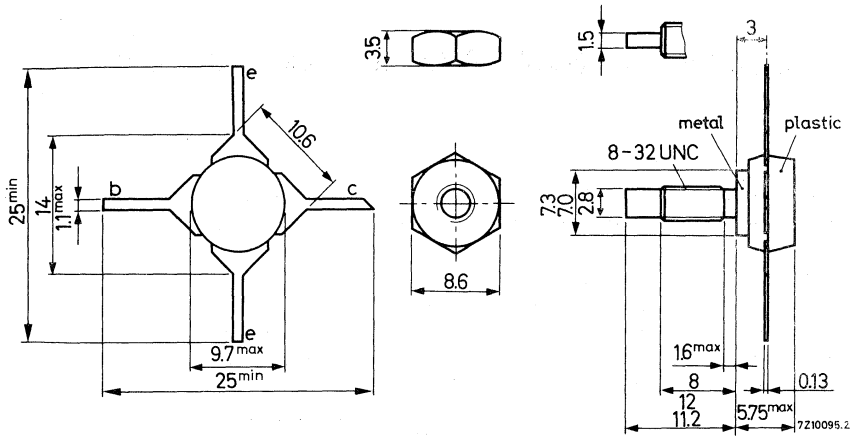


QUICK REFERENCE DATA			
Collector-base voltage (open emitter; peak value)	V_{CBOM}	max.	40 V
Collector-emitter voltage (open base)	V_{CEO}	max.	25 V
Collector current (peak value)	I_{CM}	max.	500 mA
Total power dissipation up to $T_{mb} = 60^{\circ}C$; $f \geq 1$ MHz	P_{tot}	max.	3.5 W
Junction temperature	T_j	max.	150 $^{\circ}C$
Transition frequency at $f = 500$ MHz			
$I_C = 75$ mA; $V_{CE} = 20$ V	f_T	> 1000	<u>BFR63</u> <u>BFR64</u> 1200 MHz
Output power at $f = 200$ MHz			
$I_C = 70$ mA; $V_{CE} = 20$ V; $d_{im} = -30$ dB	P_o	typ. 150	150 mW
Power gain at $f = 200$ MHz			
$I_C = 70$ mA; $V_{CE} = 20$ V	G_p	typ. 16	16 dB

MECHANICAL DATA See page 2

MECHANICAL DATA

Dimensions in mm



Diameter of hole in heatsink: max. 4.17 mm

Torque on nut: min. 7.5 cm kg

max. 8.5 cm kg

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

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

Voltages

Collector-base voltage (open emitter; peak value)	V_{CBOM}	max. 40 V ¹⁾
Collector-emitter voltage ($R_{BE} = 10 \Omega$; peak value)	V_{CERM}	max. 40 V ²⁾
Collector-emitter voltage (open base)	V_{CEO}	max. 25 V ²⁾
Emitter-base voltage (open collector)	V_{EBO}	max. 3.5 V ³⁾

Currents

Collector current (d.c.)	I_C	max. 200 mA
Collector current (peak value) $f > 1$ MHz	I_{CM}	max. 500 mA

Power dissipation ($f \geq 1$ MHz; see SOAR)

Total power dissipation up to $T_{mb} = 60$ °C	P_{tot}	max. 3.5 W
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Temperatures

Storage temperature	T_{stg}	-40 to +150 °C
Junction temperature	T_j	max. 150 °C

THERMAL RESISTANCE

From junction to mounting base	$R_{th j-mb}$	= 25 °C/W
From mounting base to heatsink	$R_{th mb-h}$	= 0.5 °C/W

¹⁾ at $I_C = 100 \mu A$ ²⁾ at $I_C = 10$ mA ³⁾ at $I_E = 100 \mu A$

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

CHARACTERISTICS

Collector cut-off current

$I_E = 0; V_{CB} = 20\text{ V}$ $I_{CBO} < 10\ \mu\text{A}$

Saturation voltage

$I_C = 100\text{ mA}; I_B = 10\text{ mA}$ $V_{CEsat} < 0.75\text{ V}$

D.C. current gain

$I_C = 50\text{ mA}; V_{CE} = 5\text{ V}$ $h_{FE} > 25$
 $I_C = 150\text{ mA}; V_{CE} = 5\text{ V}$ $h_{FE} > 25$

Collector capacitance at $f = 1\text{ MHz}$

$I_E = I_e = 0; V_{CB} = 20\text{ V}$ $C_c < 4.5\text{ pF}$

Feedback capacitance at $f = 1\text{ MHz}$

$I_C = 10\text{ mA}; V_{CE} = 20\text{ V}; T_{mb} = 25^\circ\text{C}$ $-C_{re}$ typ. 1.7 pF

Noise figure at $f = 200\text{ MHz}$

$I_C = 40\text{ mA}; V_{CE} = 20\text{ V}; R_S = 75\ \Omega; T_{mb} = 25^\circ\text{C}$ F typ. 6 dB

Transition frequency at $f = 500\text{ MHz}$

		BFR63		BFR64	
$I_C = 15\text{ mA}; V_{CE} = 20\text{ V}$	f_T	typ.	-	1000	MHz
$I_C = 75\text{ mA}; V_{CE} = 20\text{ V}$	f_T	>	1000	1200	MHz
$I_C = 150\text{ mA}; V_{CE} = 20\text{ V}$	f_T	typ.	1100	1200	MHz

Output power at $f = 200\text{ MHz}; T_{mb} = 25^\circ\text{C}$

$I_C = 70\text{ mA}; V_{CE} = 20\text{ V}; \text{V.S.W.R. at output} < 2$
 $f_p = 202\text{ MHz}; f_q = 205\text{ MHz}; d_{im} = -30\text{ dB}$
 measured at $f_{(2q-p)} = 208\text{ MHz}$ (channel 9) P_o $> -$ 130 mW
 typ. 150 150 mW

Output power at $f = 800\text{ MHz}; T_{mb} = 25^\circ\text{C}$

$I_C = 70\text{ mA}; V_{CE} = 20\text{ V}; \text{V.S.W.R. at output} < 2$
 $f_p = 798\text{ MHz}; f_q = 802\text{ MHz}; d_{im} = -30\text{ dB}$
 measured at $f_{(2q-p)} = 806\text{ MHz}$ (channel 62) P_o $> -$ 70 mW
 typ. $-$ 90 mW

Power gain (not neutralized) $T_{mb} = 25^\circ\text{C}$

$I_C = 70\text{ mA}; V_{CE} = 20\text{ V}; f = 200\text{ MHz}$ G_p $> -$ 15 dB
 typ. 16 16 dB

$I_C = 70\text{ mA}; V_{CE} = 20\text{ V}; f = 800\text{ MHz}$ G_p typ. $-$ 6.5 dB

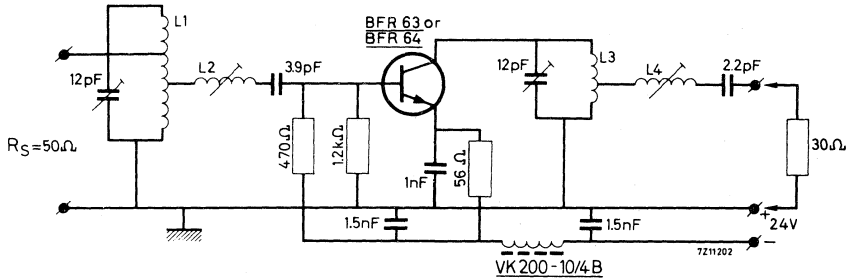
CHARACTERISTICS (continued)

Intermodulation characteristics

1. Output power at $f = 200 \text{ MHz}$; $T_{mb} = 25 \text{ }^\circ\text{C}$

$I_C = 70 \text{ mA}$; $V_{CE} = 20 \text{ V}$; V.S.W.R. at output < 2
 $f_p = 202 \text{ MHz}$; $f_q = 205 \text{ MHz}$; $d_{im} = -30 \text{ dB}$
 measured at $f(2q-p) = 208 \text{ MHz}$ (channel 9)

Test circuit:



Coil data:

- L1 = 3 turns silver plated Cu wire (1.4 mm); winding pitch 2.7 mm; int. diam. 8 mm; taps at 0.5 turn and 1.5 turns earth.
- L2 = 5.5 turns silver plated Cu wire (1.4 mm); winding pitch 2.2 mm; int. diam. 8 mm
- L3 = 3 turns silver plated Cu wire (1.4 mm); winding pitch 3.3 mm; int. diam. 8 mm
- L4 = 5.5 turns silver plated Cu wire (1.4 mm); winding pitch 2.2 mm; int. diam. 1.1 mm

CHARACTERISTICS (continued)

Basis of adjustment

The intermodulation at an intermodulation distortion of -30 dB is caused by h.f. output current - voltage clipping.

The maximum undistorted output power is realised, if

- a. Current and voltage clipping take place concurrently.

This occurs if

$$R_L = \frac{V_{CE} - V_{CEK}}{I_C},$$

in which V_{CEK} is the high frequency knee voltage.

- b. The h.f. collector current is as small as possible.

This is so if $-C_L = +C_{oe}$,

in which C_{oe} is the output capacitance of the transistor at short circuited input.

For maximum output power at an intermodulation distortion of -30 dB, the (experimentally found) values of R_L and C_L are:

$R_L = 220 \Omega$; $C_L = -4 \text{ pF}$.

Adjustment procedure

1. Remove the transistor and connect a dummy consisting of a 220Ω resistor in parallel with a 4 pF capacitor between the collector and emitter connections of the output circuit.
2. Tune and match the output circuit for zero reflection at 205 MHz ($V.S.W.R. = 1$). After this adjustment, no further change may be made in the output circuit.
3. Replace the dummy by the transistor. Tune and match the input circuit for maximum power gain and good band pass curve.
The $V.S.W.R.$ of the output will then, in most cases, be ≤ 2 over the whole channel.
Corrections can be made by tuning L2; this will not disturb the band pass curve.

CHARACTERISTICS (continued)

Intermodulation characteristics

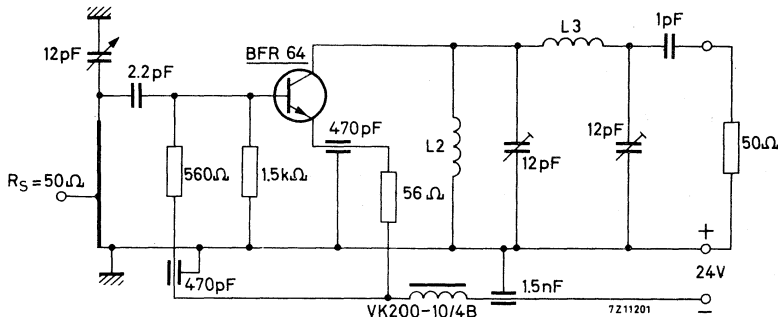
2. Output power at $f = 800$ MHz; $T_{mb} = 25^\circ\text{C}$

$I_C = 70$ mA; $V_{CE} = 20$ V; V.S.W.R. at output < 2

$f_p = 798$ MHz; $f_q = 802$ MHz; $d_{im} = -30$ dB

measured at $f(2q-p) = 806$ MHz (Channel 62)

Test circuit:



Coil data:

L1 = 25 mm x 7 mm x 0.85 mm silver plated Cu strip

Tap of the input at 5 mm from earth.

L2 = 13 turns enamelled Cu wire (0.6 mm); int. diam. 8 mm

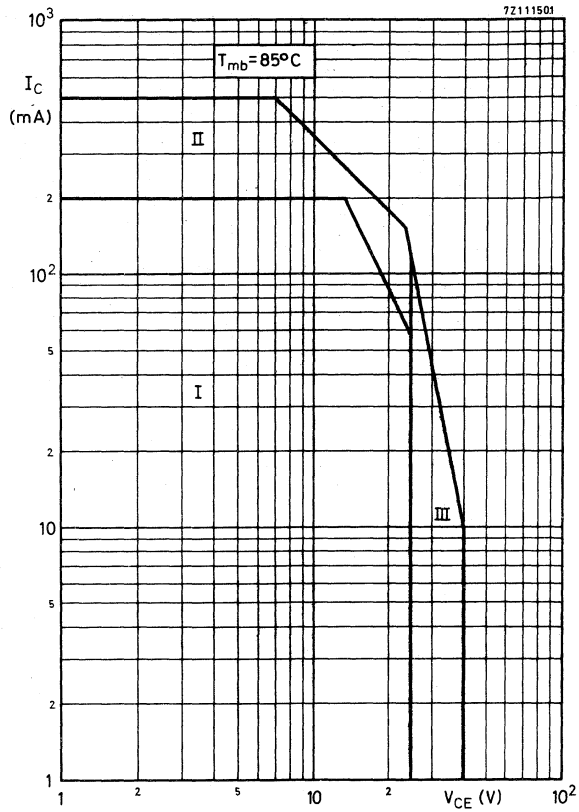
L3 = 1.5 turns Cu wire (1.3 mm); int. diam. 8 mm

Basis of adjustment

At 800 MHz no dummy can be used to adjust for optimum collector load because at these frequencies the impedance transformations of a dummy are too high. A small signal at the mid-channel frequency of 802 MHz is fed to the input and increased until clipping occurs; that is, until the output power no longer increases linearly with the input signal. This clipping can be eliminated by tuning the output circuit, thereby making the output power equal to

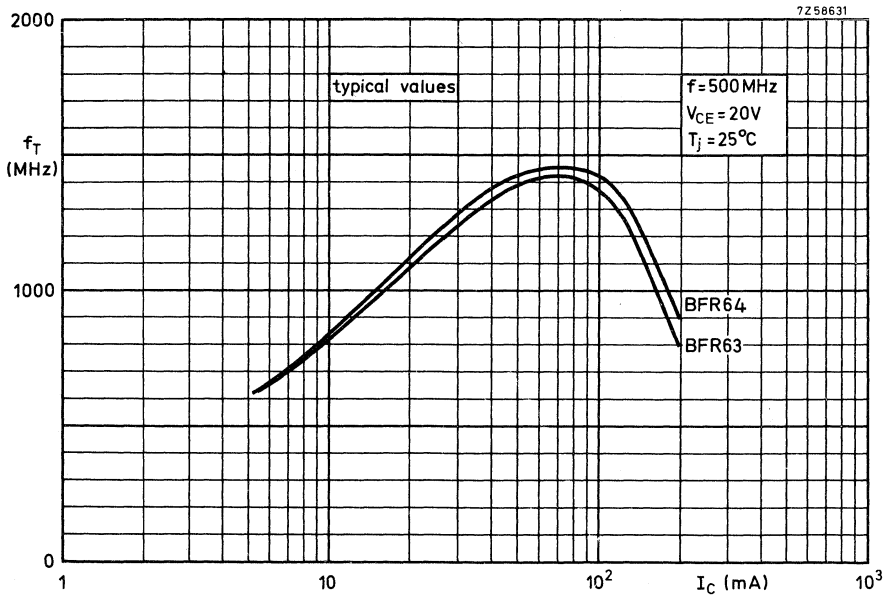
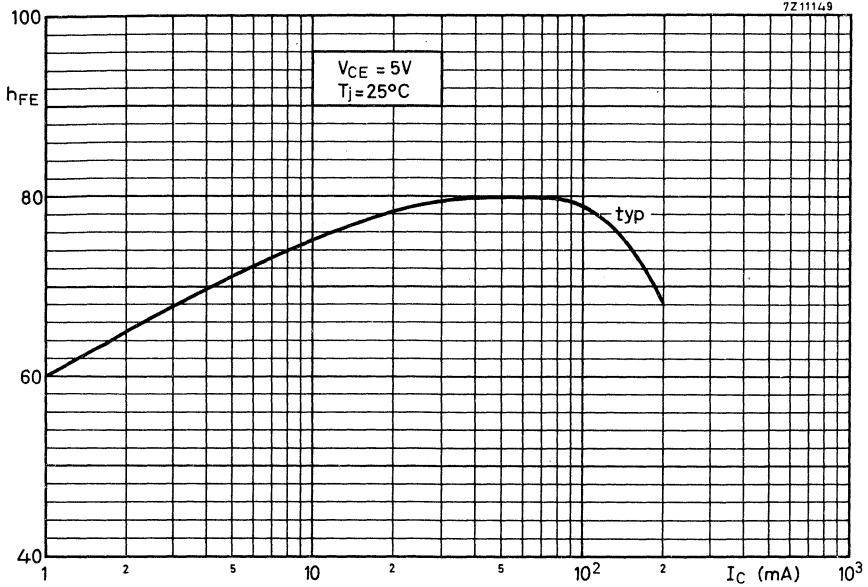
$$P_o = \frac{I_C(V_{CE} - V_{CEK})}{2} = 480 \text{ mW.}$$

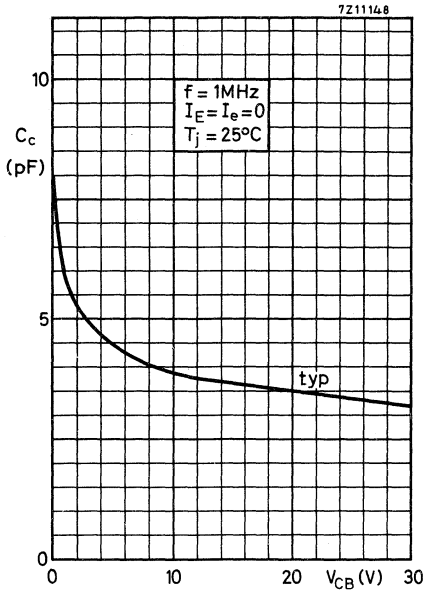
The output circuit is adjusted for minimum intermodulation if the input signal is as small as possible at $P_o = 480$ mW. With this adjusting method care must be taken, that the transistor is not destructed by second breakdown (the voltage swing may not exceed the rated V_{CER} value). Therefore as soon as clipping occurs, the increase of the input signal should be stopped until the clipping has been eliminated. After this adjustment has been made no further change may be made in the output circuit. Adjust the input circuit for maximum power gain and good band pass curve. The V.S.W.R. of the output is then ≤ 2 over the whole channel.



Safe Operating Area with the transistor forward biased

- I Region of permissible d.c. operation
- II Permissible extension for repetitive pulsed operation; $f > 1$ MHz
- III Repetitive pulsed operation in this region is allowable, provided $R_{BE} < 10 \Omega$ and $f > 1$ MHz





SILICON PLANAR EPITAXIAL TRANSISTORS

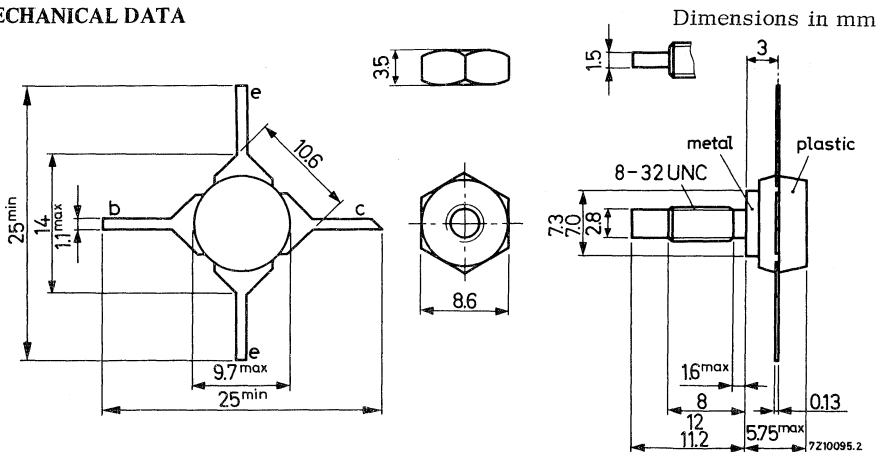
N-P-N multi-emitter silicon transistor in a capstan envelope. The transistor has extremely good intermodulation properties and high power gain.

The device is primarily intended for channel amplifiers in aerial amplifier systems as well as other applications where an excellent f_T linearity and higher signal handling capabilities than available in existing devices are required.

QUICK REFERENCE DATA

Collector-base voltage (open emitter; peak value)	V_{CBOM}	max.	40 V
Collector-emitter voltage (open base)	V_{CEO}	max.	25 V
Collector current (peak value)	I_{CM}	max.	1000 mA
Junction temperature	T_j	max.	200 °C
Thermal resistance from junction to mounting base	$R_{th\ j-mb}$	=	15 degC/W
Transition frequency at $f = 500$ MHz $I_C = 200$ mA; $V_{CE} = 20$ V	f_T	>	1200 MHz
Output power at $f = 200$ MHz $I_C = 200$ mA; $V_{CE} = 20$ V; $d_{im} = -30$ dB	P_o	typ.	450 mW
Power gain at $f = 200$ MHz $I_C = 200$ mA; $V_{CE} = 20$ V	G_p	typ.	19 dB

MECHANICAL DATA



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

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

Diameter of clearance hole in heatsink: max.
4.17 mm.

Mounting hole to have no burrs at either end
De-burring must leave surface flat; do not
chamfer or countersink either end of hole.

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

Voltages

Collector-base voltage (open emitter; peak value)	V_{CBOM}	max.	40	V
Collector-emitter voltage ($R_{BE} = 10 \Omega$; peak value)	V_{CERM}	max.	40	V
Collector-emitter voltage (open base)	V_{CEO}	max.	25	V
Emitter-base voltage (open collector)	V_{EBO}	max.	3.5	V

Currents

Collector current (d.c.)	I_C	max.	400	mA
Collector current (peak value) $f > 1$ MHz	I_{CM}	max.	1000	mA

Power dissipation

Total power dissipation up to $T_{mb} = 125^\circ\text{C}$

See also page 6

P_{tot}	max.	5	W
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Temperatures

Storage temperature	T_{stg}	-65 to +200	$^\circ\text{C}$
Junction temperature	T_j	max. 200	$^\circ\text{C}$

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j-mb}$	=	15	degC/W
From mounting base to heatsink	$R_{th\ mb-h}$	=	0.5	degC/W

CHARACTERISTICS

 $T_j = 25^\circ\text{C}$ unless otherwise specifiedBreakdown voltages

Collector-base voltage open emitter, $I_C = 1\text{ mA}$	$V_{(BR)CBO}$	>	40	V
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Collector-emitter voltage $R_{BE} = 10\ \Omega$, $I_C = 5\text{ mA}$	$V_{(BR)CER}$	>	40	V
open base, $I_C = 5\text{ mA}$	$V_{(BR)CEO}$	>	25	V

Emitter-base voltage open collector; $I_E = 1\text{ mA}$	$V_{(BR)EBO}$	>	3.5	V
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Collector cut-off current

$I_E = 0$; $V_{CB} = 20\text{ V}$	I_{CBO}	<	100	μA
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Saturation voltage

$I_C = 200\text{ mA}$; $I_B = 20\text{ mA}$	V_{CEsat}	<	0.75	V
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D.C. current gain

$I_C = 200\text{ mA}$; $V_{CE} = 20\text{ V}$	h_{FE}	>	30
$I_C = 400\text{ mA}$; $V_{CE} = 20\text{ V}$	h_{FE}	>	20

Collector capacitance at $f = 1\text{ MHz}$

$I_E = I_e = 0$; $V_{CB} = 20\text{ V}$	C_c	<	10	pF
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Feedback capacitance at $f = 1\text{ MHz}$

$I_C = 10\text{ mA}$; $V_{CE} = 20\text{ V}$; $T_{mb} = 25^\circ\text{C}$	C_{re}	typ.	3.5	pF
---	----------	------	-----	----

Collector-stud capacitance

	C_{cs}	typ.	2	pF
--	----------	------	---	----

Transition frequency at $f = 500\text{ MHz}$

$I_C = 200\text{ mA}$; $V_{CE} = 20\text{ V}$	f_T	>	1200	MHz
$I_C = 400\text{ mA}$; $V_{CE} = 20\text{ V}$	f_T	>	1000	MHz

Output power at $f = 200\text{ MHz}$; $T_{mb} = 25^\circ\text{C}$

$I_C = 200\text{ mA}$; $V_{CE} = 20\text{ V}$; V.S.W.R. at output < 2 $f_p = 202\text{ MHz}$; $f_q = 205\text{ MHz}$; $d_{im} = -30\text{ dB}$ measured at $f(2q-p) = 208\text{ MHz}$ (channel 9)	P_o	typ.	450	mW
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Power gain (not neutralized) $T_{mb} = 25^\circ\text{C}$

$I_C = 200\text{ mA}$; $V_{CE} = 20\text{ V}$; $f = 200\text{ MHz}$	G_p	>	15	dB
		typ.	19	dB
$I_C = 200\text{ mA}$; $V_{CE} = 20\text{ V}$; $f = 800\text{ MHz}$	G_p	typ.	4.5	dB

CHARACTERISTICS (continued)

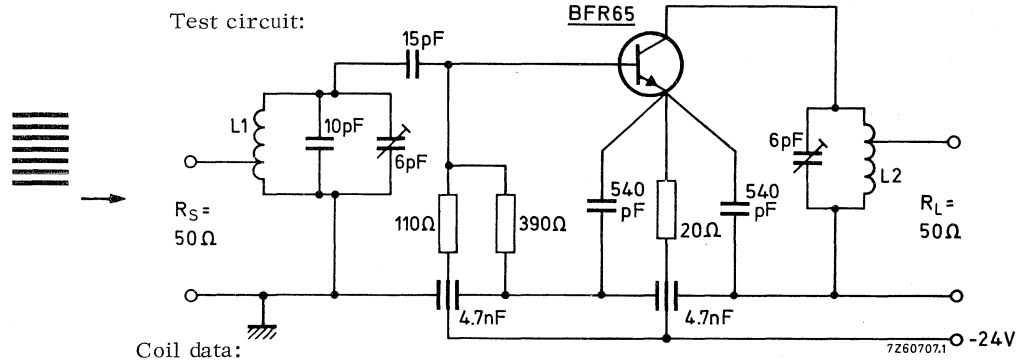
Intermodulation characteristics

1. Output power at $f = 200$ MHz; $T_{mb} = 25$ °C

$I_C = 200$ mA; $V_{CE} = 20$ V; V.S.W.R. at output < 2

$f_p = 202$ MHz; $f_q = 205$ MHz; $d_{im} = -30$ dB
measured at $f(2q-p) = 208$ MHz (channel 9)

Test circuit:



- L1 = 1 turn silver plated Cu wire (1.4 mm); int. diam. 8 mm; tap at 0.75 turn from earth.
- L2 = 3 turns silver plated Cu wire (1.4 mm); int. diam. 8 mm; winding pitch 2.7 mm; tap at 2.5 turns from earth.

CHARACTERISTICS (continued)

Basis of adjustment

The intermodulation at an intermodulation distortion of -30 dB is caused by h.f. output current - voltage clipping.

The maximum undistorted output power is realised, if

- a. Current and voltage clipping take place concurrently.

This occurs if

$$R_L = \frac{V_{CE} - V_{CEK}}{I_C},$$

in which V_{CEK} is the high frequency knee voltage.

- b. The h.f. collector current is as small as possible.

This is so if $-C_L = +C_{oe}$,

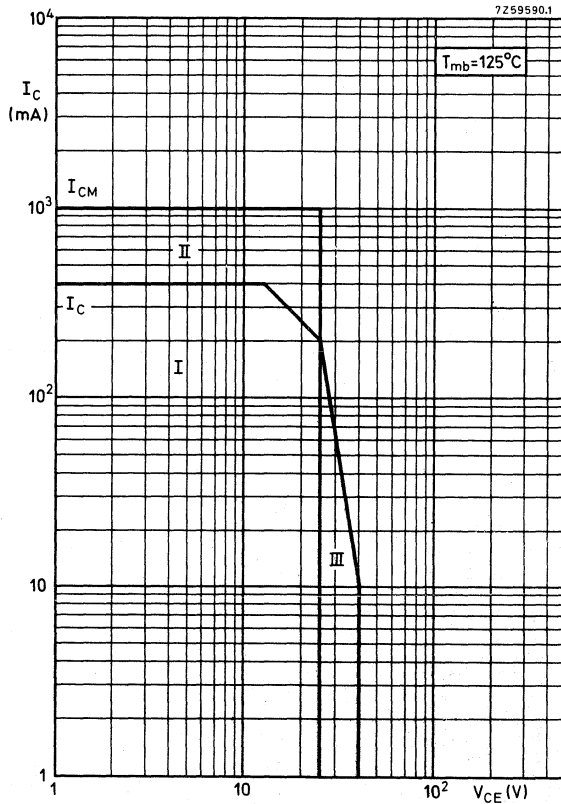
in which C_{oe} is the output capacitance of the transistor at short circuited input.

For maximum output power at an intermodulation distortion of -30 dB, the (experimentally found) values of R_L and C_L are:

$R_L = 91 \Omega$; $C_L = -6.8 \text{ pF}$.

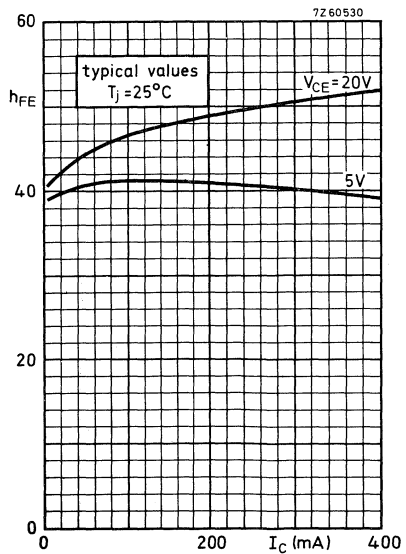
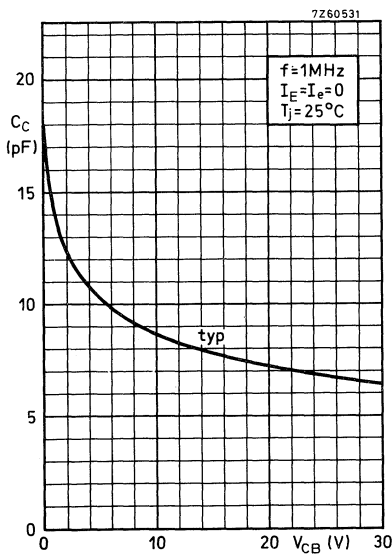
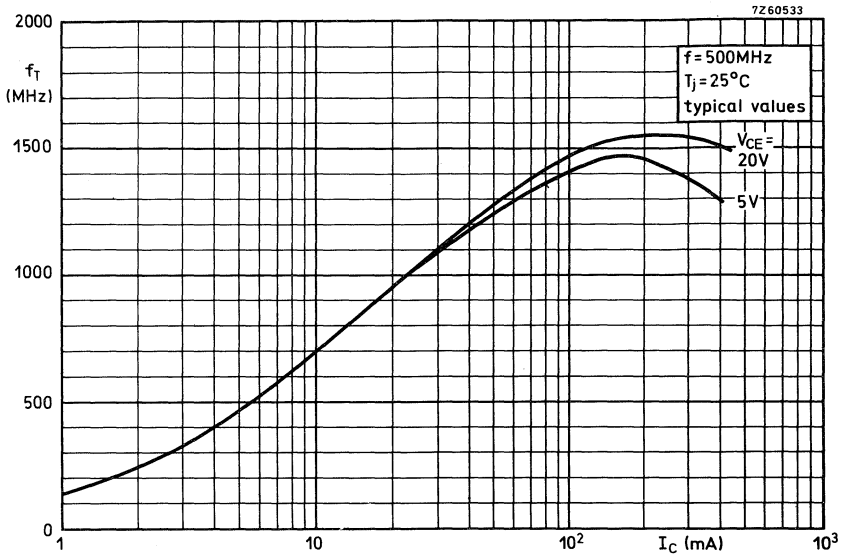
Adjustment procedure

1. Remove the transistor and connect a dummy consisting of a 91Ω resistor in parallel with a 6.8 pF capacitor between the collector and emitter connections of the output circuit.
2. Tune and match the output circuit for zero reflection at 205 MHz (V.S.W.R. = 1) After this adjustment, no further change may be made in the output circuit.
3. Replace the dummy by the transistor. Tune and match the input circuit for maximum power gain and good band pass curve. The V.S.W.R. of the output will then, in most cases, be ≤ 2 over the whole channel.



Safe Operating Area with the transistor forward biased

- I Region of permissible d.c. operation
- II Permissible extension for repetitive pulsed operation; $f > 1\text{ MHz}$
- III Repetitive pulsed operation in this region is allowable, provided $f > 1\text{ MHz}$; $R_{BE} < 10\ \Omega$



SILICON EPITAXIAL PLANAR TRANSISTORS

P-N-P transistors in a TO-39 metal envelope with the collector connected to the case. These transistors are intended for general industrial applications.

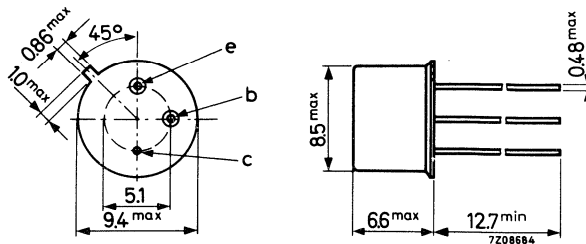
QUICK REFERENCE DATA

		BFS 92	BFS 93	BFS 94	BFS 95
Collector-base voltage (open emitter) $-V_{CBO}$ max.		100	100	80	40 V
Collector-emitter voltage (open base) $-V_{CEO}$ max.		60	60	40	35 V
Collector current (d. c.) $-I_C$ max.		1.0	1.0	1.0	1.0 A
Total power dissipation up to $T_{mb} = 50^\circ\text{C}$	P_{tot} max.	5	5	5	5 W
Junction temperature	T_j max.	200	200	200	200 $^\circ\text{C}$
Collector-emitter saturation voltage $-I_C = 500\text{ mA}; -I_B = 50\text{ mA}$	$-V_{CEsat}$ <	1.0	1.0	0.7	0.7 V
D. C. current gain $-I_C = 150\text{ mA}; -V_{CE} = 10\text{ V}$	h_{FE} >	30	70	40	70
Transition frequency at $f = 35\text{ MHz}$ $-I_C = 50\text{ mA}; -V_{CE} = 10\text{ V}$	f_T typ.	70	70	70	70 MHz

MECHANICAL DATA

Dimensions in mm

TO-39
Collector connected
to case



max. lead diameter is guaranteed only for 12.7 mm.

Accessories supplied on request: 56218, 56245, 56265.

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

Voltages

		BFS	BFS	BFS	BFS
		92	93	94	95
Collector-base voltage (open emitter)	$-V_{CBO}$	max. 100	100	80	40 V
Collector-emitter voltage (open base)	$-V_{CEO}$	max. 60	60	40	35 V
Emitter-base voltage (open collector)	$-V_{EBO}$	max. 6	6	6	6 V

Currents

Collector current (d. c.)	$-I_C$	max.	1.0 A
Collector current (peak value)	$-I_{CM}$	max.	1.0 A
Emitter current (d. c.)	I_E	max.	1.0 A
Emitter current (peak value)	I_{EM}	max.	1.0 A
Reverse base current (peak value)	$+I_{BM}$	max.	100 mA

Power dissipation

Total power dissipation up to $T_{mb} = 50\text{ }^\circ\text{C}$ See page 6	P_{tot}	max.	5 W
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Temperatures

Storage temperature	T_{stg}	-65 to +200	$^\circ\text{C}$
Junction temperature	T_j	max. 200	$^\circ\text{C}$

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	220 $^\circ\text{C/W}$
From junction to case	$R_{th\ j-c}$	=	35 $^\circ\text{C/W}$
From junction to mounting base	$R_{th\ j-mb}$	=	30 $^\circ\text{C/W}$

CHARACTERISTICS

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

Collector cut-off current

$I_E = 0; -V_{CB} = 80\text{ V}; T_j = 25\text{ }^\circ\text{C}$	<u>BFS92; BFS93</u>	$-I_{CBO} < 50\text{ nA}$
		$-I_{CBO} < 2.5\text{ }\mu\text{A}$
$I_E = 0; -V_{CB} = 60\text{ V}; T_j = 25\text{ }^\circ\text{C}$	<u>BFS94</u>	$-I_{CBO} < 50\text{ nA}$
		$-I_{CBO} < 2.5\text{ }\mu\text{A}$
$I_E = 0; -V_{CB} = 30\text{ V}; T_j = 25\text{ }^\circ\text{C}$	<u>BFS95</u>	$-I_{CBO} < 50\text{ nA}$
		$-I_{CBO} < 2.5\text{ }\mu\text{A}$

Emitter cut-off current

$I_C = 0; -V_{EB} = 5\text{ V}; T_j = 25\text{ }^\circ\text{C}$	$-I_{EBO} < 50\text{ nA}$
	$-I_{EBO} < 2.5\text{ }\mu\text{A}$

Saturation voltages

	<u>BFS92</u>	<u>BFS93</u>	<u>BFS94</u>	<u>BFS95</u>	
$-I_C = 10\text{ mA}; -I_B = 1\text{ mA}$	$-V_{CEsat} < 0.15$	0.15	0.10	0.10	V
	$-V_{BEsat} < 1.2$	1.2	1.2	1.2	V
$-I_C = 150\text{ mA}; -I_B = 15\text{ mA}$	$-V_{CEsat} < 0.35$	0.35	0.20	0.20	V
	$-V_{BEsat} < 1.3$	1.3	1.3	1.3	V
$-I_C = 500\text{ mA}; -I_B = 50\text{ mA}$	$-V_{CEsat} < 1.00$	1.00	0.70	0.70	V
	$-V_{BEsat} < 1.5$	1.5	1.5	1.5	V
$-I_C = 1\text{ A}; -I_B = 100\text{ mA}$	$-V_{CEsat} < 2.00$	1.60	1.00	1.00	V
	$-V_{BEsat} < 2.0$	2.0	2.0	2.0	V

D.C. current gain

$-I_C = 10\text{ mA}; -V_{CE} = 10\text{ V}$	$h_{FE} > 20$	50	30	50
$-I_C = 150\text{ mA}; -V_{CE} = 10\text{ V}$	$h_{FE} > 30$	70	40	70
$-I_C = 500\text{ mA}; -V_{CE} = 10\text{ V}$	$h_{FE} > 20$	30	25	30
$-I_C = 1\text{ A}; -V_{CE} = 10\text{ V}$	$h_{FE} > 15$	15	15	15

Collector capacitance at $f = 1\text{ MHz}$

$I_E = I_e = 0; -V_{CB} = 10\text{ V}$	$C_c < 20\text{ pF}$
--	----------------------

Transition frequency at $f = 35\text{ MHz}$

$-I_C = 50\text{ mA}; -V_{CE} = 10\text{ V}$	$f_T > 40\text{ MHz}$
	typ. 70 MHz

CHARACTERISTICS (continued)

h parameters at f = 1 kHz

$-I_C = 10 \text{ mA}; -V_{CE} = 5 \text{ V}$

Input impedance	h_{ie}	typ.	300	Ω
Reverse voltage transfer ratio	h_{re}	typ.	70	10^{-6}
Small signal current gain	h_{fe}	typ.	100	
Output admittance	h_{oe}	typ.	60	$\mu\Omega^{-1}$

$-I_C = 1 \text{ mA}; -V_{CE} = 5 \text{ V}$

Small signal current gain	h_{fe}	typ.	90	
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Switching times (see also page 5)

Turn on time

$-I_C = 150 \text{ mA}; -I_B = +I_{BM} = 15 \text{ mA}$
 delay time
 rise time

t_d	typ.	20	ns
t_r	typ.	35	ns

Turn off time

$-I_C = 150 \text{ mA}; -I_B = +I_{BM} = 15 \text{ mA}$
 storage time
 fall time

t_s	typ.	500	ns
t_f	typ.	65	ns

MEASUREMENT OF SWITCHING TIMES

Fig. 1: Circuit diagram

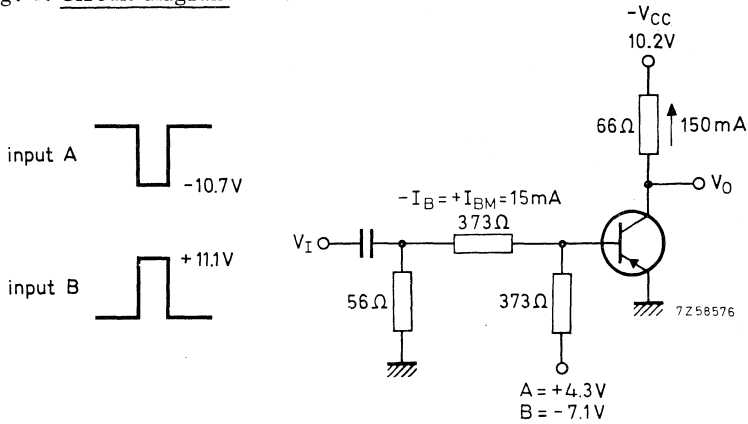
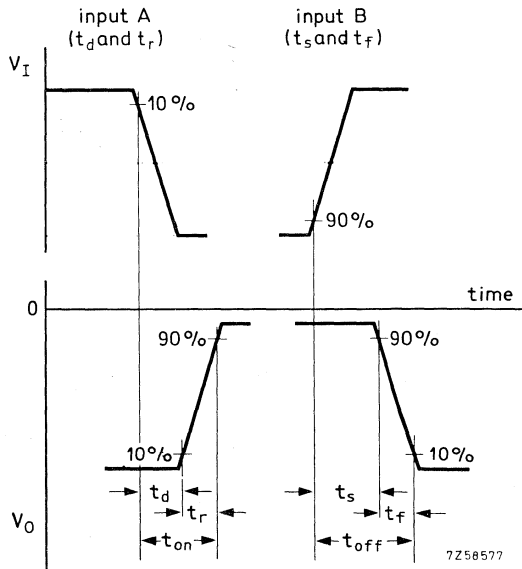
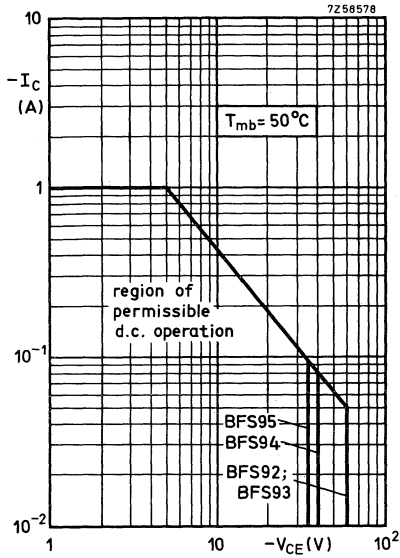


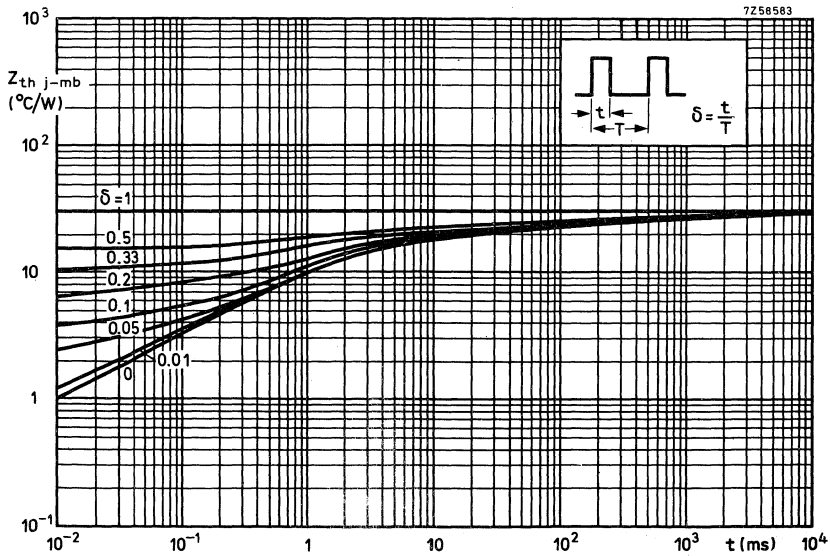
Fig. 2: Waveforms

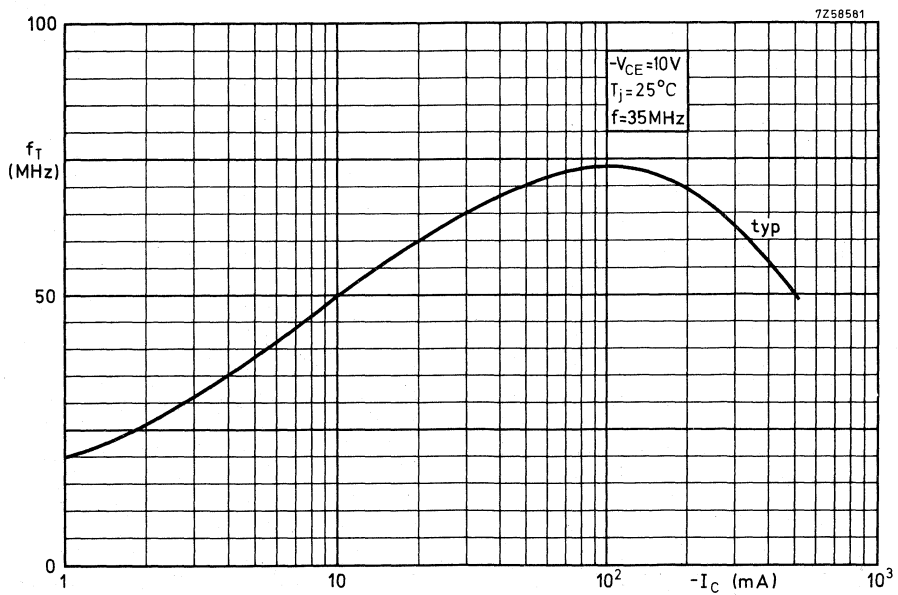
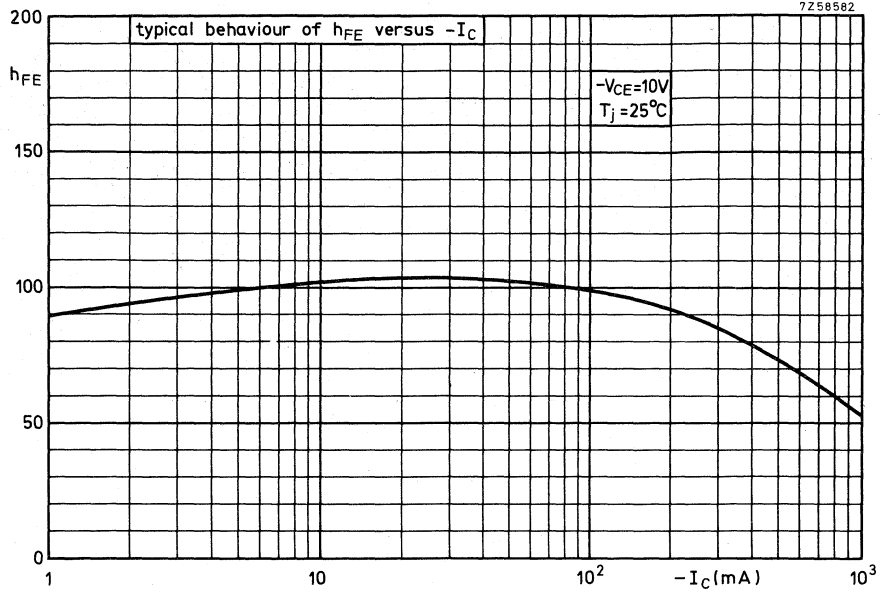


Equipment: Pulse generator (rise time = 1 ns)
Double beam or dual trace oscilloscope (rise time < 5 ns)

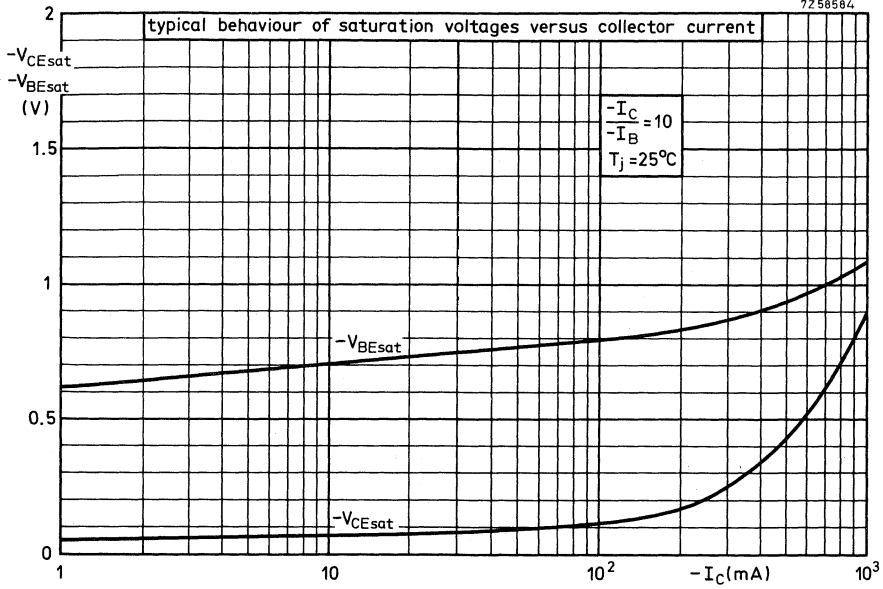


Safe Operating Area
with the transistor forward biased

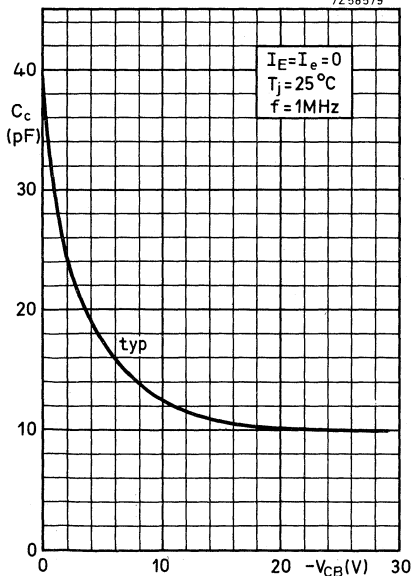




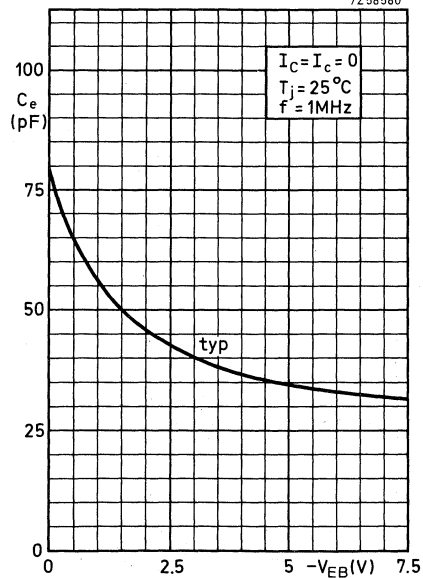
7258584



7258579



7258580



SILICON PLANAR EPITAXIAL TRANSISTOR

N-P-N multi-emitter transistor in a TO-39 metal envelope, with the collector connected to the case. The transistor has extreme good intermodulation properties and a high power gain. It is a ruggedized version of the BFW16, which it succeeds. It is primarily intended for:

- Final and driver stages of channel- and band aerial amplifiers with high output power for band I, II, III and IV/V (40-860 MHz).
- Final stage of the wide band vertical amplifier in high speed oscilloscopes.

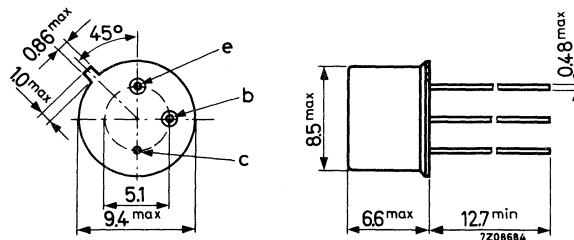
QUICK REFERENCE DATA			
Collector-base voltage (open emitter; peak value)	V_{CBOM}	max.	40 V
Collector-emitter voltage (open base)	V_{CEO}	max.	25 V
Collector current (peak value; $f > 1$ MHz)	I_{CM}	max.	300 mA
Total power dissipation up to $T_{mb} = 125$ °C	P_{tot}	max.	1.5 W
Junction temperature	T_j	max.	200 °C
Feedback capacitance at $f = 1$ MHz $I_C = 10$ mA; $V_{CE} = 15$ V	$-C_{re}$	typ.	1.7 pF
Transition frequency $I_C = 150$ mA; $V_{CE} = 15$ V; $f = 500$ MHz	f_T	typ.	1.2 GHz
Power gain (not neutralized) $I_C = 70$ mA; $V_{CE} = 18$ V	G_p	f = 200 800 MHz	
		typ.	16 6.5 dB
Output power $d_{im} = -30$ dB; V.S.W.R. at output <2 $I_C = 70$ mA; $V_{CE} = 18$ V	P_o	typ.	
		150 90	mW

MECHANICAL DATA

Dimensions in mm

Collector connected to case

TO-39



Accessories available: 56218; 56245; 56265

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

Collector-base voltage (open emitter; peak value)	V_{CBOM}	max.	40 V
Collector-emitter voltage ($R_{BE} \leq 50 \Omega$) peak value	V_{CERM}	max.	40 V 1)
Collector-emitter voltage (open base)	V_{CEO}	max.	25 V 1)
Emitter-base voltage (open collector)	V_{EBO}	max.	2 V

Currents

Collector current (d.c.)	I_C	max.	150 mA
Collector current (peak value; $f > 1$ MHz)	I_{CM}	max.	300 mA

Power dissipation

Total power dissipation up to $T_{mb} = 125$ °C	P_{tot}	max.	1.5 W
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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	$R_{th j-a}$	=	250 °C/W
From junction to mounting base	$R_{th j-mb}$	=	50 °C/W
From mounting base to heatsink mounted with top clamping washer of 56218 and a boron nitride washer for electrical insulation	$R_{th mb-h}$	=	1.2 °C/W

1) $I_C = 10$ mA.

CHARACTERISTICS

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

Collector cut-off current

$I_E = 0; V_{CB} = 20\text{ V}; T_j = 150\text{ }^\circ\text{C}$

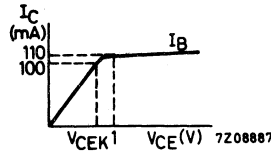
$I_{CBO} < 20\text{ }\mu\text{A}$

Knee voltage

$I_C = 100\text{ mA}; I_B = \text{value for which}$

$I_C = 110\text{ mA at } V_{CE} = 1\text{ V}$

$V_{CEK} < 0.75\text{ V}$



D.C. current gain

$I_C = 50\text{ mA}; V_{CE} = 5\text{ V}$

$h_{FE} > 25$

$I_C = 150\text{ mA}; V_{CE} = 5\text{ V}$

$h_{FE} > 25$

Transition frequency

$I_C = 150\text{ mA}; V_{CE} = 15\text{ V}; f = 500\text{ MHz}$

$f_T \text{ typ. } 1.2\text{ GHz}$

Collector capacitance at $f = 1\text{ MHz}$

$I_E = I_e = 0; V_{CB} = 15\text{ V}$

$C_c < 4\text{ pF}$

Feedback capacitance at $f = 1\text{ MHz}$

$I_C = 10\text{ mA}; V_{CE} = 15\text{ V}; T_{amb} = 25\text{ }^\circ\text{C}$

$-C_{re} \text{ typ. } 1.7\text{ pF}$

Noise figure at $f = 200\text{ MHz}$

$I_C = 30\text{ mA}; V_{CE} = 15\text{ V}; R_S = 75\text{ }\Omega; T_{amb} = 25\text{ }^\circ\text{C}$

$F < 6\text{ dB}$

Power gain (not neutralized)

$I_C = 70\text{ mA}; V_{CE} = 18\text{ V}; T_{amb} = 25\text{ }^\circ\text{C}$

	$f = 200$	800 MHz
$G_p \text{ typ. } 16$	6.5 dB	

CHARACTERISTICS (continued)

Intermodulation characteristics

1. Output power at $f = 200$ MHz; $T_{amb} = 25$ °C

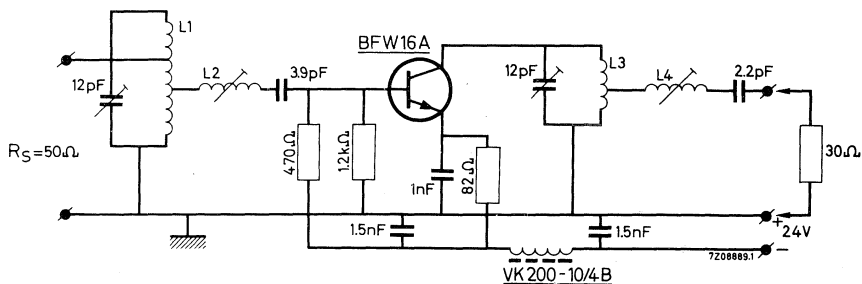
$I_C = 70$ mA; $V_{CE} = 18$ V; V.S.W.R. at output < 2

$f_p = 202$ MHz; $f_q = 205$ MHz; $d_{im} = -30$ dB

measured at $f(2q-p) = 208$ MHz (Channel 9)

$P_o > 130$ mW
typ. 150 mW

Test circuit:



Coil data:

L1 = 3 turns silver plated Cu wire (1.4 mm); winding pitch 2.7 mm;
int. diam. 8 mm; taps at 0.5 turn and 1.5 turns from earth.

L2 = 5.5 turns silver plated Cu wire (1.4 mm); winding pitch 2.2 mm;
int. diam. 8 mm.

L3 = 3 turns silver plated Cu wire (1.4 mm); winding pitch 3.3 mm;
int. diam. 8 mm.

L4 = 5.5 turns silver plated Cu wire (1.4 mm); winding pitch 2.2 mm;
int. diam. 11 mm.

CHARACTERISTICS (continued)

Basis of adjustment

The intermodulation at an intermodulation distortion of -30 dB is caused by h.f. output current - voltage clipping.

The maximum undistorted output power is realised, if

- a. Current and voltage clipping take place concurrently.

This occurs if

$$R_L = \frac{V_{CE} - V_{CEK}}{I_C},$$

in which V_{CEK} is the high frequency knee voltage.

- b. The h.f. collector current is as small as possible.

This is so if $-C_L = +C_{Oe}$,

in which C_{Oe} is the output capacitance of the transistor at short circuited input.

For maximum output power at an intermodulation distortion of -30 dB, the (experimentally found) values of R_L and C_L are:

$$R_L = 220 \Omega; C_L = -5.6 \text{ pF}.$$

C_{Oe} is found by 4 pF of the transistor and 1.6 pF by the mounting system concerning of a borium nitride washer between the envelope of the transistor and the chassis.

See also page 10, note 1.

Adjustment procedure

1. Remove the transistor and connect a dummy consisting of a 220- Ω resistor in parallel with a 5.6 pF capacitor between the collector and emitter connections of the output circuit.
2. Tune and match the output circuit for zero reflection at 205 MHz (V.S.W.R. = 1). After this adjustment, no further change may be made in the output circuit.
3. Replace the dummy by the transistor. Tune and match the input circuit for maximum power gain and good band pass curve.
The V.S.W.R. of the output will then, in most cases, be ≤ 2 over the whole channel.
Corrections can be made by tuning L2; this will not disturb the band pass curve.

CHARACTERISTICS (continued)

Intermodulation characteristics

2. Output power at $f = 800 \text{ MHz}$; $T_{\text{amb}} = 25 \text{ }^\circ\text{C}$

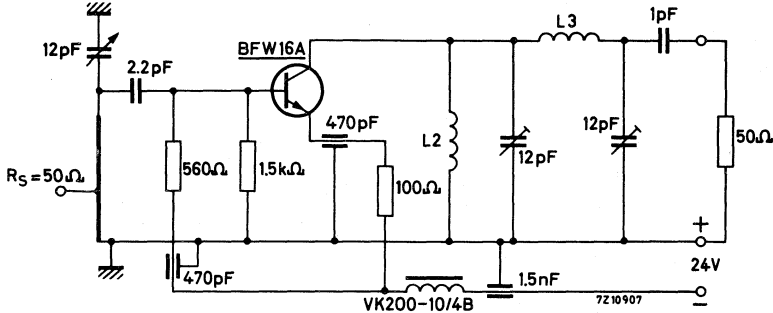
$I_C = 70 \text{ mA}$; $V_{CE} = 18 \text{ V}$; V.S.W.R. at output < 2

$f_p = 798 \text{ MHz}$; $f_q = 802 \text{ MHz}$; $d_{\text{im}} = -30 \text{ dB}$

measured at $f(2q-p) = 806 \text{ MHz}$ (Channel 62)

$P_o > 70 \text{ mW}$
typ. 90 mW

Test circuit:



Coil data:

L1 = 25 mm x 7 mm x 0.85 mm silver plated Cu strip

Tap of the input at 5 mm from earth.

L2 = 13 turns enamelled Cu wire (0.6 mm); int. diam. 8 mm

L3 = 1.5 turns Cu wire (1.3 mm); int. diam. 8 mm

Basis of adjustment

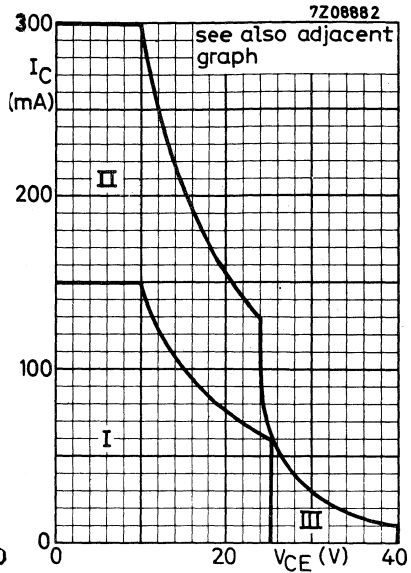
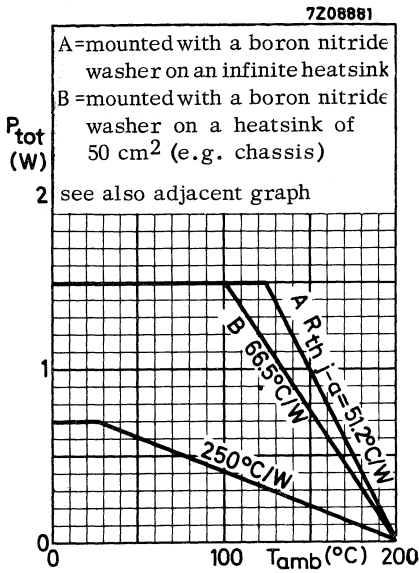
At 800 MHz no dummy can be used to adjust for optimum collector load because at these frequencies the impedance transformations of a dummy are too high. A small signal at the mid-channel frequency of 802 MHz is fed to the input and increased until clipping occurs; that is, until the output power no longer increases linearly with the input signal. This clipping can be eliminated by tuning the output circuit, thereby making the output power equal to

$$P_o = \frac{I_C(V_{CE} - V_{CEK})}{2} = 480 \text{ mW.}$$

The output circuit is adjusted for minimum intermodulation if the input signal is as small as possible at $P_o = 480 \text{ mW}$.

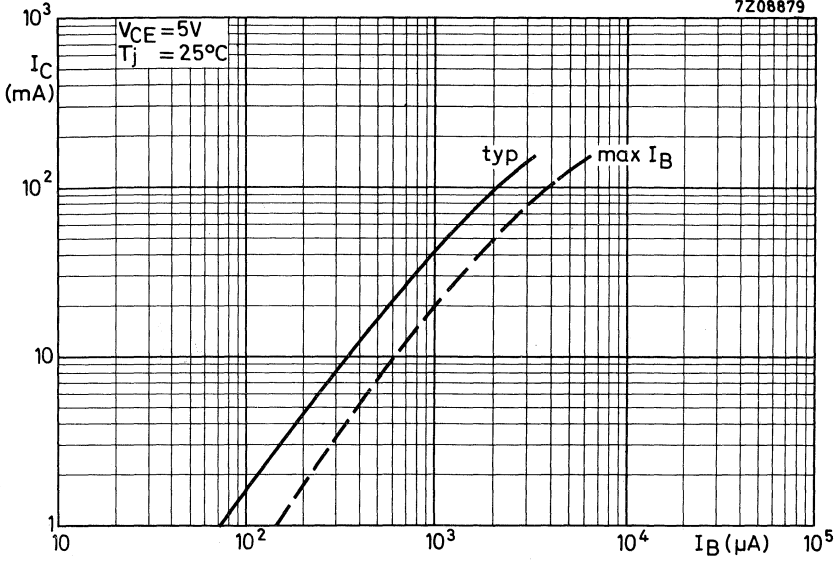
With this adjusting method care must be taken, that the transistor is not destructed by second breakdown (the voltage swing may not exceed the rated V_{CEK} value). Therefore as soon as clipping occurs, the increase of the input signal should be stopped until the clipping has been eliminated. After this adjustment has been made no further change may be made in the output circuit.

Adjust the input circuit for maximum power gain and good band pass curve. The V.S.W.R. of the output is then ≤ 2 over the whole-channel.

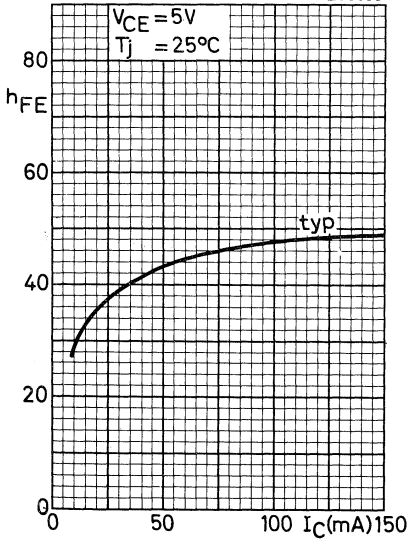


- I = Region of permissible operation under all base-emitter conditions and at all frequencies, including d.c.
- II = Additional region of operation at $f \geq 1$ MHz.
- III = Operating under pulsed conditions is allowed, provided the transistor is cut-off with $R_{BE} \leq 50 \Omega$ and $f \geq 1$ MHz.

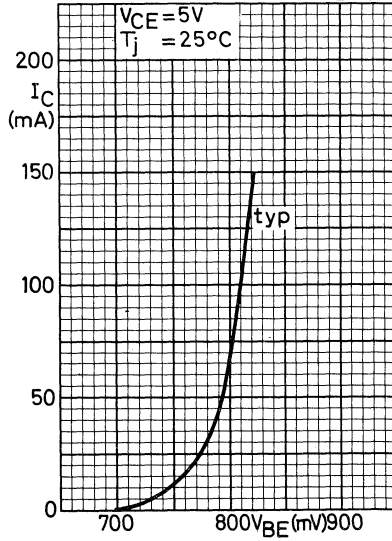
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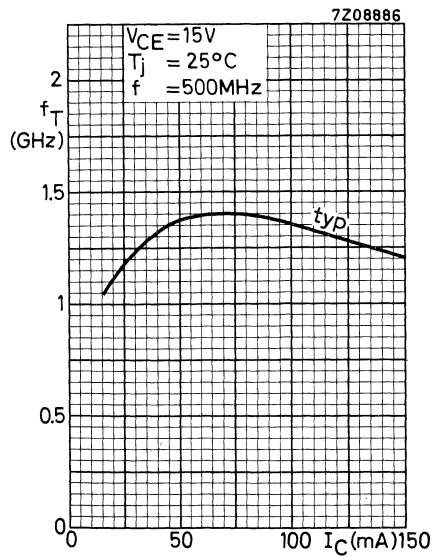
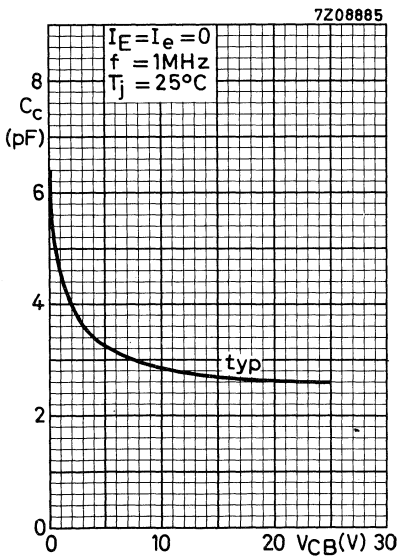
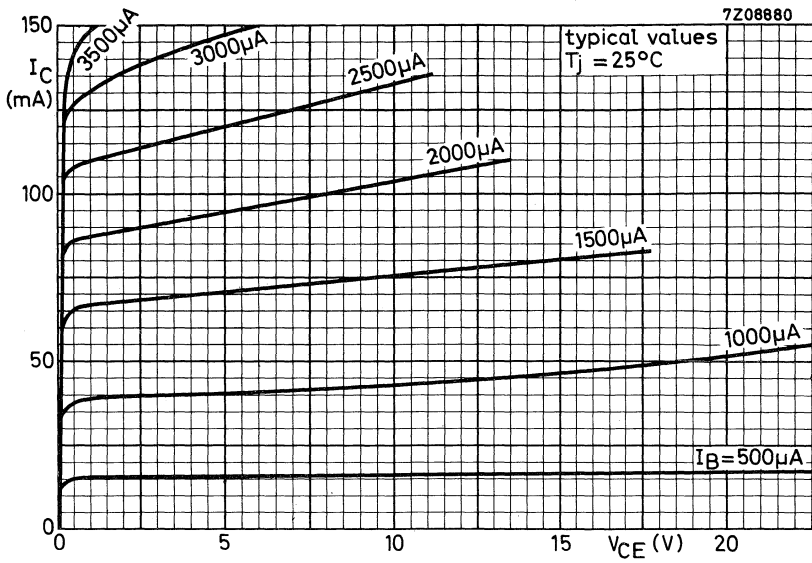


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APPLICATION INFORMATION

Performance of channel- and band amplifiers ¹⁾

Frequency range	channel 4 61-68	channel 9 202-209	channel 55 742-750	band I 47-68	band II 87.5-108	band III 174-230	MHz
Transistor used in final stage	BFW16A	BFW16A	BFW16A	BFW16A	BFW16A	BFW16A	
driver stage		BFW16A	BFW16A			BFW16A	
second stage			BFY90				
first stage	BFY90	BFY90	BFY90	BFY90	BFY90	BFY90	
Output power at $d_{im} = -30$ dB	150 ²⁾	150 ²⁾	100				mW
$d_{im} = -50$ dB					30		mW
$d_{im} = -60$ dB				10		10	mW
Power gain	50	44	26.5	51	43	39	dB
Noise figure	7	6	8	6.0-6.5	6.5	6.5	dB
V.S.W.R. over the whole channel or band							
for the input	< 2	< 2	< 2	< 2	< 2	< 2	
for the output	< 2	< 2	< 2	< 2	< 2	< 2	
Load impedance	30	30	50	30	30	30	Ω
Source impedance	60	60	50	60	60	60	Ω

¹⁾ Application information bulletins of all these amplifiers and a study of inter-modulation are available on request.

²⁾ $V_O = 2.2$ V over $R_L = 30 \Omega$ or
 $V_O = 3$ V over $R_L = 60 \Omega$.

SILICON PLANAR EPITAXIAL TRANSISTOR

N-P-N multi-emitter transistor in a TO-39 metal envelope, with the collector connected to the case. The transistor has extreme good intermodulation properties and a high power gain. It is a ruggedized version of the BFW17, which it succeeds. It is primarily intended for final and driver stages of channel- and band aerial amplifiers with high output power for band I; II and III (40-230 MHz).

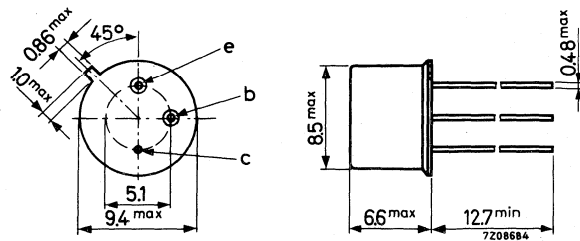
QUICK REFERENCE DATA		
Collector-base voltage (open emitter; peak value)	V_{CBOM}	max. 40 V
Collector-emitter voltage (open base)	V_{CEO}	max. 25 V
Collector current (peak value; $f > 1$ MHz)	I_{CM}	max. 300 mA
Total power dissipation up to $T_{mb} = 125$ °C	P_{tot}	max. 1.5 W
Junction temperature	T_j	max. 200 °C
Feedback capacitance at $f = 1$ MHz $I_C = 10$ mA; $V_{CE} = 15$ V	$-C_{re}$	typ. 1.7 pF
Transition frequency $I_C = 150$ mA; $V_{CE} = 15$ V; $f = 500$ MHz	f_T	typ. 1.1 GHz
Power gain (not neutralized) $I_C = 70$ mA; $V_{CE} = 18$ V; $f = 200$ MHz	G_p	typ. 16 dB
Output power $d_{im} = -30$ dB; V.S.W.R. at output < 2 $I_C = 70$ mA; $V_{CE} = 18$ V	P_o	typ. 150 mW

MECHANICAL DATA

Dimensions in mm

Collector connected to case

TO-39



Accessories available: 56218; 56245; 56265

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

Voltages

Collector-base voltage (open emitter; peak value)	V_{CBOM}	max.	40 V
Collector-emitter voltage ($R_{BE} \leq 50 \Omega$) peak value	V_{CERM}	max.	40 V 1)
Collector-emitter voltage (open base)	V_{CEO}	max.	25 V 1)
Emitter-base voltage (open collector)	V_{EBO}	max.	2 V

Currents

Collector current (d.c.)	I_C	max.	150 mA
Collector current (peak value; $f > 1 \text{ MHz}$)	I_{CM}	max.	300 mA

Power dissipation

Total power dissipation up to $T_{mb} = 125 \text{ }^\circ\text{C}$	P_{tot}	max.	1.5 W
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Temperatures

Storage temperature	T_{stg}	-65 to +200	$^\circ\text{C}$
Junction temperature	T_j	max.	200 $^\circ\text{C}$

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th \text{ j-a}}$	=	250 $^\circ\text{C/W}$
From junction to mounting base	$R_{th \text{ j-mb}}$	=	50 $^\circ\text{C/W}$
From mounting base to heatsink mounted with top clamping washer of 56218 and a boron nitride washer for electrical insulation	$R_{th \text{ mb-h}}$	=	1.2 $^\circ\text{C/W}$

1) $I_C = 10 \text{ mA}$.

CHARACTERISTICS

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

Collector cut-off current

$I_E = 0; V_{CB} = 20\text{ V}; T_j = 150\text{ }^\circ\text{C}$

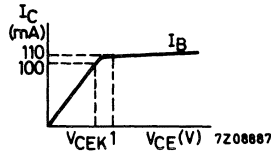
$I_{CBO} < 20\text{ }\mu\text{A}$

Knee voltage

$I_C = 100\text{ mA}; I_B = \text{value for which}$

$I_C = 110\text{ mA at } V_{CE} = 1\text{ V}$

$V_{CEK} < 0.75\text{ V}$



D.C. current gain

$I_C = 50\text{ mA}; V_{CE} = 5\text{ V}$

$h_{FE} > 25$

$I_C = 150\text{ mA}; V_{CE} = 5\text{ V}$

$h_{FE} > 25$

Transition frequency

$I_C = 150\text{ mA}; V_{CE} = 15\text{ V}; f = 500\text{ MHz}$

$f_T \text{ typ. } 1.1\text{ GHz}$

Collector capacitance at $f = 1\text{ MHz}$

$I_E = I_e = 0; V_{CB} = 15\text{ V}$

$C_c < 4\text{ pF}$

Feedback capacitance at $f = 1\text{ MHz}$

$I_C = 10\text{ mA}; V_{CE} = 15\text{ V}; T_{amb} = 25\text{ }^\circ\text{C}$

$-C_{re} \text{ typ. } 1.7\text{ pF}$

Power gain (not neutralized)

$I_C = 70\text{ mA}; V_{CE} = 18\text{ V}$

$f = 200\text{ MHz}; T_{amb} = 25\text{ }^\circ\text{C}$

$G_p \text{ typ. } 16\text{ dB}$

CHARACTERISTICS (continued)

Intermodulation characteristics

1. Output power at $f = 200$ MHz; $T_{amb} = 25$ °C

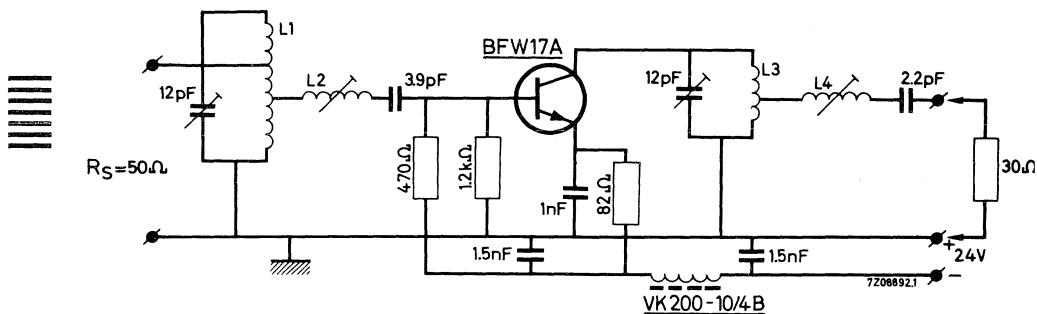
$I_C = 70$ mA; $V_{CE} = 18$ V; V.S.W.R. at output < 2

$f_p = 202$ MHz; $f_q = 205$ MHz; $d_{im} = -30$ dB

measured at $f(2q-p) = 208$ MHz (Channel 9)

P_o typ. 150 mW

Test circuit:



Coil data:

L1 = 3 turns silver plated Cu wire (1.4 mm); winding pitch 2.7 mm;

int. diam. 8 mm; taps at 0.5 turn and 1.5 turns from earth.

L2 = 5.5 turns silver plated Cu wire (1.4 mm); winding pitch 2.2 mm;

int. diam. 8 mm.

L3 = 3 turns silver plated Cu wire (1.4 mm); winding pitch 3.3 mm;

int. diam. 8 mm.

L4 = 5.5 turns silver plated Cu wire (1.4 mm); winding pitch 2.2 mm;

int. diam. 11 mm.

CHARACTERISTICS (continued)

Basis of adjustment

The intermodulation at an intermodulation distortion of -30 dB is caused by h.f. output current - voltage clipping.

The maximum undistorted output power is realised, if

- a. Current and voltage clipping take place concurrently.

This occurs if

$$R_L = \frac{V_{CE} - V_{CEK}}{I_C}$$

in which V_{CEK} is the high frequency knee voltage.

- b. The h.f. collector current is as small as possible.

This is so if $-C_L = +C_{Oe}$,

in which C_{Oe} is the output capacitance of the transistor at short circuited input.

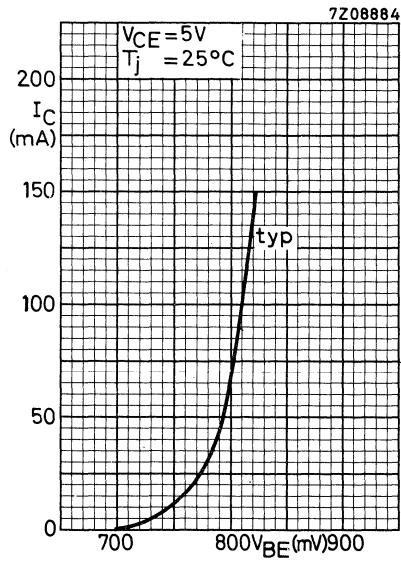
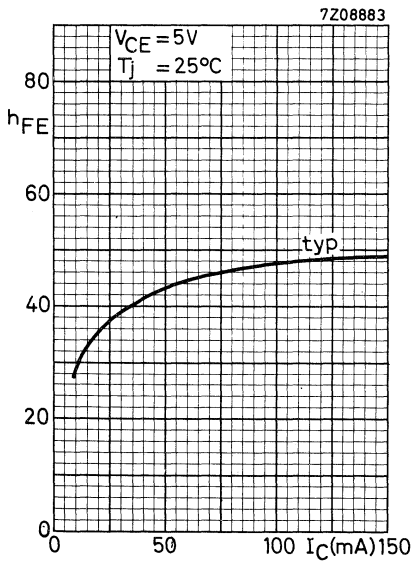
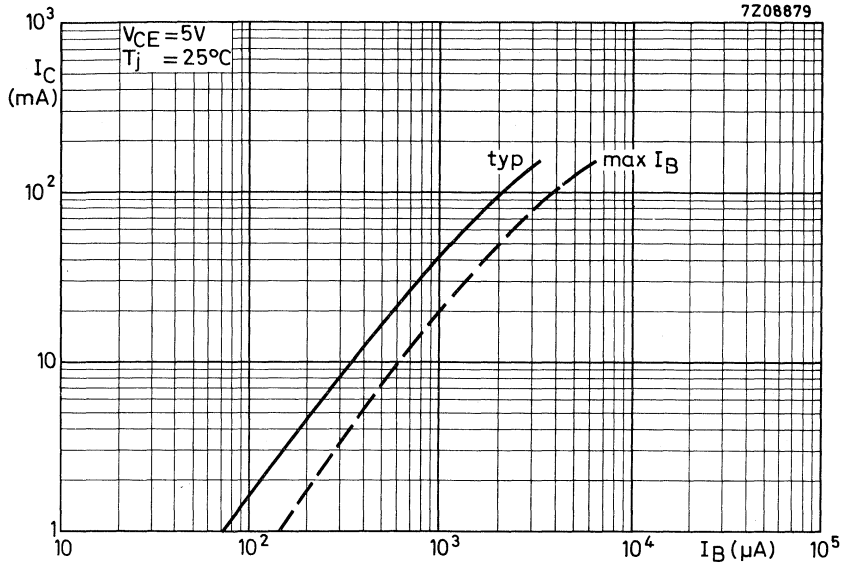
For maximum output power at an intermodulation distortion of -30 dB, the (experimentally found) values of R_L and C_L are:

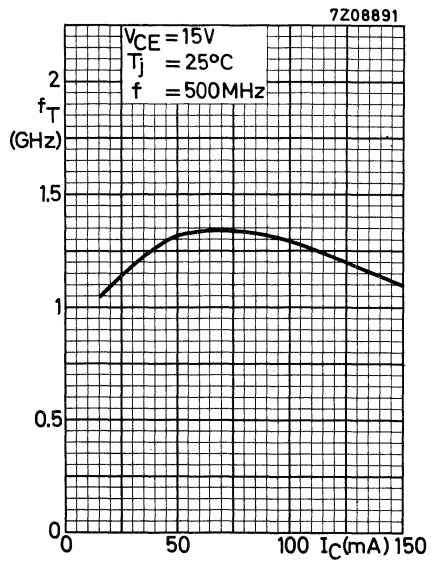
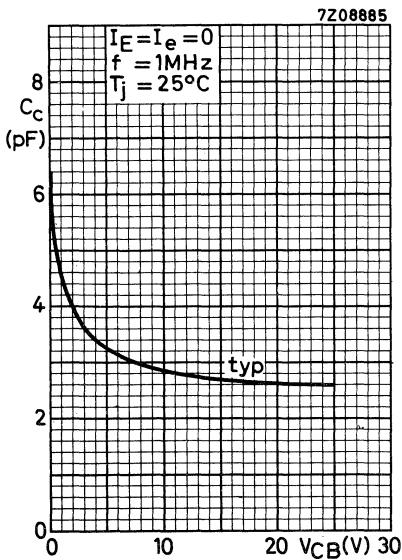
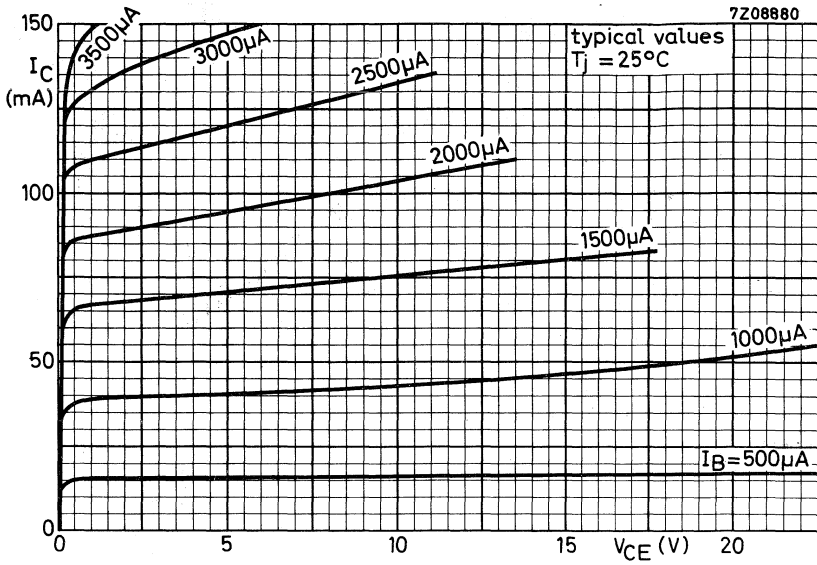
$R_L = 220 \Omega$; $C_L = -5.6 \text{ pF}$.

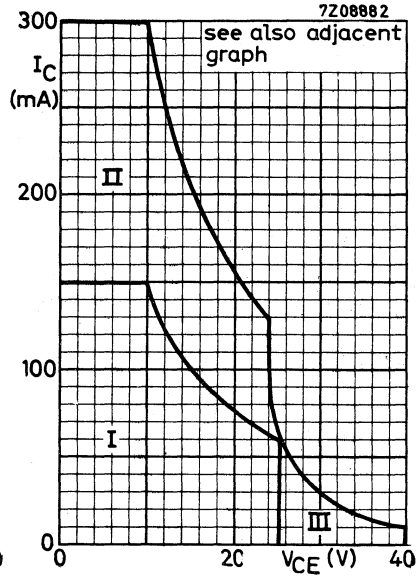
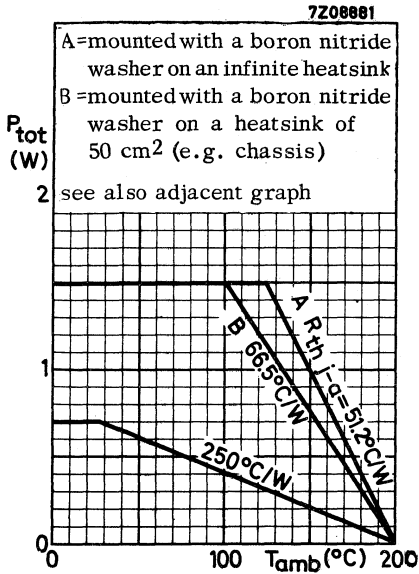
C_{Oe} is found by 4 pF of the transistor and 1.6 pF by the mounting system concerning of a borium nitride washer between the envelope of the transistor and the chassis.

Adjustment procedure

1. Remove the transistor and connect a dummy consisting of a 220Ω resistor in parallel with a 5.6 pF capacitor between the collector and emitter connections of the output circuit.
2. Tune and match the output circuit for zero reflection at 205 MHz ($V.S.W.R. = 1$). After this adjustment, no further change may be made in the output circuit.
3. Replace the dummy by the transistor. Tune and match the input circuit for maximum power gain and good band pass curve.
The $V.S.W.R.$ of the output will then, in most cases, be ≤ 2 over the whole channel.
Corrections can be made by tuning L2; this will not disturb the band pass curve.







- I = Region of permissible operation under all base-emitter conditions and at all frequencies, including d.c.
- II = Additional region of operation at $f \geq 1$ MHz
- III = Operating under pulsed conditions is allowed, provided the transistor is cut-off with $R_{BE} \leq 50 \Omega$ and $f \geq 1$ MHz.

SILICON PLANAR EPITAXIAL TRANSISTOR

N-P-N multi-emitter transistor in a TO-72 metal envelope, with insulated electrodes and a shield lead connected to the case. The transistor has very low intermodulation distortion and very high power gain.

It is primarily intended for:

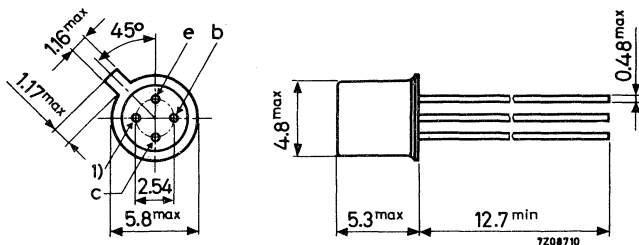
- Wideband vertical amplifiers in high speed oscilloscopes.
- Wideband aerial amplifiers (40-860 MHz)
- Television distribution amplifiers

QUICK REFERENCE DATA			
Collector-base voltage (open emitter; peak value)	V_{CBOM}	max.	20 V
Collector-emitter voltage (open base)	V_{CEO}	max.	10 V
Collector current (peak value; $f > 1$ MHz)	I_{CM}	max.	100 mA
Total power dissipation up to $T_{amb} = 25$ °C	P_{tot}	max.	250 mW
Junction temperature	T_j	max.	200 °C
Feedback capacitance at $f = 1$ MHz $I_C = 2$ mA; $V_{CE} = 5$ V	$-C_{re}$	typ.	0.8 pF
Transition frequency $I_C = 50$ mA; $V_{CE} = 5$ V; $f = 500$ MHz	f_T	typ.	1.6 GHz
Power gain (not neutralized) $I_C = 30$ mA; $V_{CE} = 5$ V	G_p	$f = 200$ MHz	typ. 21 dB
		$f = 800$ MHz	typ. 7.5 dB
Intermodulation distortion $I_C = 30$ 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.	-60 dB

MECHANICAL DATA

Dimensions in mm

TO-72
insulated electrodes



1) = shield lead (connected to case)

Accessories available: 56246; 56263

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

Collector-base voltage (open emitter; peak value)	V_{CBOM}	max.	20	V
Collector-emitter voltage (open base)				
$I_C = 10$ mA	V_{CEO}	max.	10	V 2)
Emitter-base voltage (open collector)	V_{EBO}	max.	2.5	V

Currents

Collector current (d. c.)	I_C	max.	50	mA
Collector current (peak value; $f > 1$ MHz)	I_{CM}	max.	100	mA

Power dissipation

Total power dissipation up to $T_{amb} = 25$ °C	P_{tot}	max.	250	mW
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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	$R_{th j-a}$	=	0.7	°C/mW
From junction to case	$R_{th j-c}$	=	0.5	°C/mW

CHARACTERISTICS

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

Collector cut-off current

$$I_E = 0; V_{CB} = 10\text{ V}$$

$$I_{CBO} < 50\text{ nA}$$

D.C. current gain

$$I_C = 25\text{ mA}; V_{CE} = 5\text{ V}$$

$$h_{FE} > 25$$

$$I_C = 50\text{ mA}; V_{CE} = 5\text{ V}$$

$$h_{FE} > 25$$

Transition frequency ¹⁾

$$I_C = 50\text{ mA}; V_{CE} = 5\text{ V}; f = 500\text{ MHz}$$

$$f_T \text{ typ. } 1.6\text{ GHz}$$

Collector capacitance at $f = 1\text{ MHz}$ ²⁾

$$I_E = I_e = 0; V_{CB} = 5\text{ V}$$

$$C_C < 1.5\text{ pF}$$

Feedback capacitance at $f = 1\text{ MHz}$ ¹⁾

$$I_C = 2\text{ mA}; V_{CE} = 5\text{ V}$$

$$-C_{re} \text{ typ. } 0.8\text{ pF}$$

Noise figure ¹⁾

$$I_C = 2\text{ mA}; V_{CE} = 5\text{ V}$$

$$f = 500\text{ MHz}; R_S = 50\text{ }\Omega$$

$$F < 5\text{ dB}$$

Power gain (not neutralized) ¹⁾

$$I_C = 30\text{ mA}; V_{CE} = 5\text{ V}; T_{amb} = 25\text{ }^\circ\text{C}$$

G_P	$f = 200$	800 MHz
	> 19	dB
	$\text{typ. } 21$	7.5 dB

Intermodulation distortion ¹⁾

$$I_C = 30\text{ mA}; V_{CE} = 6\text{ V}; R_L = 37.5\text{ }\Omega; T_{amb} = 25\text{ }^\circ\text{C}$$

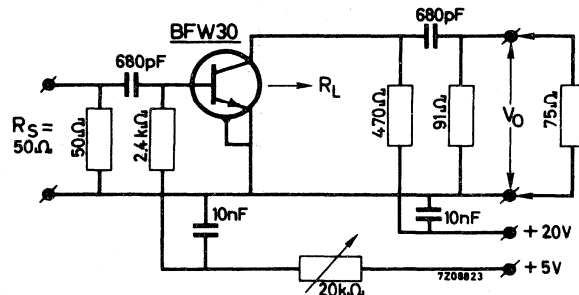
$$V_O = 100\text{ mV at } f_p = 183\text{ MHz}$$

$$V_O = 100\text{ mV at } f_q = 200\text{ MHz}$$

$$\text{measured at } f(2q-p) = 217\text{ MHz}$$

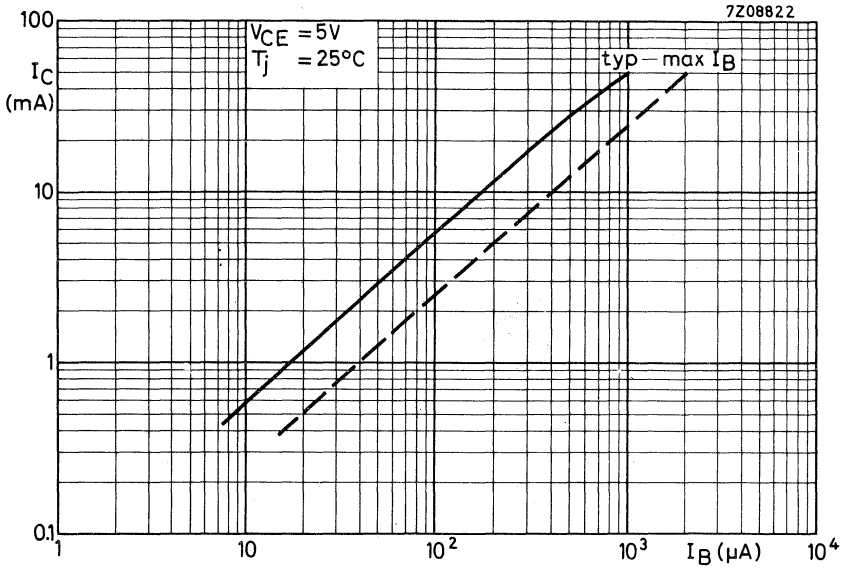
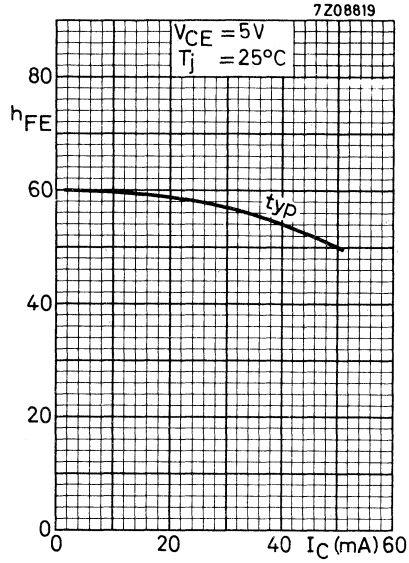
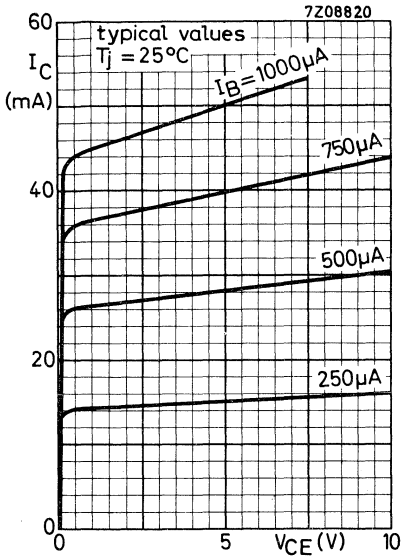
$$d_{im} \text{ typ. } -60\text{ dB}$$

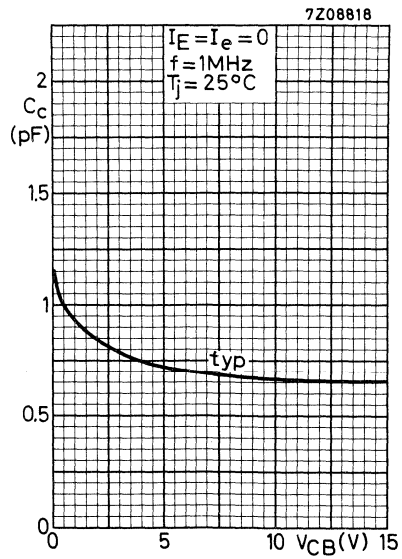
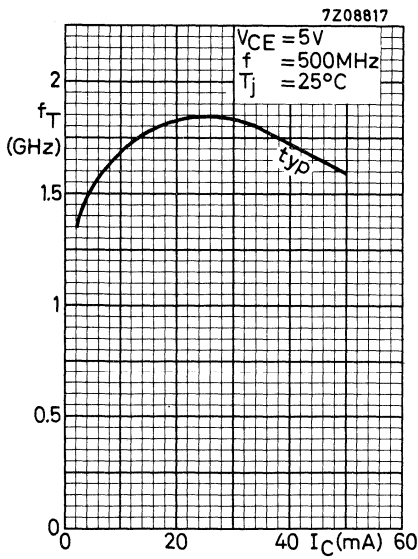
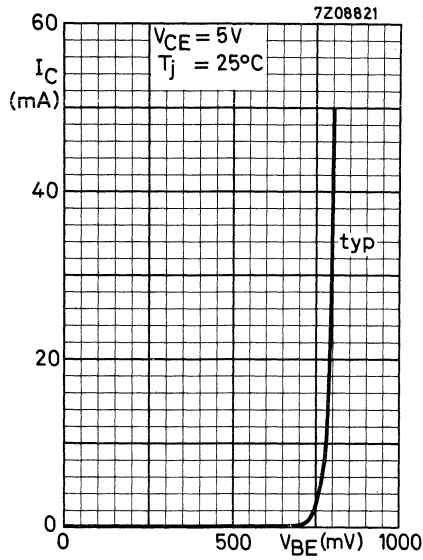
Test circuit



1) Shield lead grounded.

2) Shield lead not connected.





SILICON PLANAR EPITAXIAL TRANSISTOR

N-P-N transistor in a subminiature plastic T-package. It has a low noise over a wide current range, a very high power gain and good intermodulation properties. It is primarily intended for:

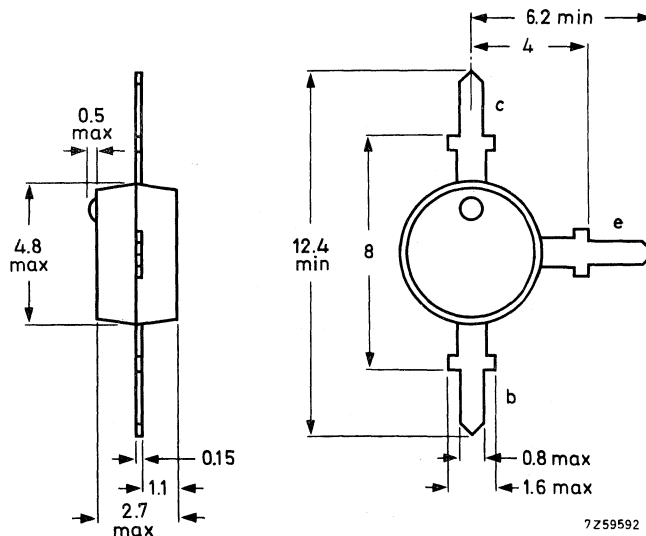
- Wide band aerial amplifiers (40-860 MHz)
- Channel- and band aerial amplifiers for band I, II, III and IV/V (40-860 MHz)
- Television distribution amplifiers
- Low noise wide band vertical amplifier in high speed oscilloscopes.

QUICK REFERENCE DATA

Collector-base voltage (open emitter; peak value)	V_{CBOM}	max.	25 V
Collector-emitter voltage (open base)	V_{CEO}	max.	15 V
Collector current (peak value; $f > 1$ MHz)	I_{CM}	max.	50 mA
Total power dissipation up to $T_{amb} = 73$ °C	P_{tot}	max.	130 mW
Junction temperature	T_j	max.	125 °C
Transition frequency at $f = 500$ MHz $I_C = 25$ mA; $V_{CE} = 5$ V	f_T	typ.	1.6 GHz
Feedback capacitance at $f = 1$ MHz $I_C = 2$ mA; $V_{CE} = 5$ V	$-C_{re}$	typ.	0.6 pF
Noise figure at $f = 500$ MHz $I_C = 2$ mA; $V_{CE} = 5$ V; $R_S = 50$ Ω	F	typ.	4 dB
Power gain (not neutralized) $I_C = 10$ mA; $V_{CE} = 10$ V; $T_{amb} = 25$ °C	G_p	$f = 200$ MHz	800 MHz
		typ. 23	11 dB
Output power at $d_{im} = -30$ dB V.S.W.R. at output < 2 ; $I_C = 10$ mA; $V_{CE} = 10$ V	P_o	typ. 8	8 mW

MECHANICAL DATA

Dimensions in mm



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

Voltages

Collector-base voltage (open emitter; peak value)	V_{CBOM}	max.	25 V
Collector-emitter voltage (open base)	V_{CEO}	max.	15 V ¹⁾
Emitter-base voltage (open collector)	V_{EBO}	max.	2.5 V

Currents

Collector current (d. c.)	I_C	max.	25 mA
Collector current (peak value; $f > 1$ MHz)	I_{CM}	max.	50 mA

Power dissipation

Total power dissipation up to $T_{amb} = 73$ °C	P_{tot}	max.	130 mW
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Temperatures

Storage temperature	T_{stg}	-40 to +125 °C
Junction temperature	T_j	max. 125 °C

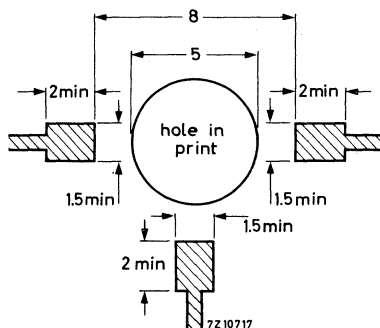
THERMAL RESISTANCE

From junction to ambient in free air
mounted on a glass-fibre print *)
of 40 mm x 25 mm x 1 mm

$$R_{th\ j-a} = 0.4 \text{ °C/mW}$$

*) Requirements for glass-fibre print

(dimensions in mm)



¹⁾ At $I_C = 10$ mA

CHARACTERISTICS

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

Collector cut-off current

$I_E = 0; V_{CB} = 10\text{ V}$

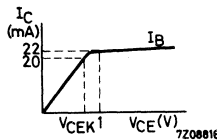
$I_{CBO} < 50\text{ nA}$

Knee voltage ¹⁾

$I_C = 20\text{ mA}; I_B = \text{value for which}$

$I_C = 22\text{ mA at } V_{CE} = 1\text{ V}$

$V_{CEK} < 0.75\text{ V}$



D.C. current gain

$I_C = 2\text{ mA}; V_{CE} = 1\text{ V}$

$h_{FE} > 20$
 $h_{FE} < 150$

$I_C = 25\text{ mA}; V_{CE} = 1\text{ V}^1)$

$h_{FE} > 20$

Transition frequency at $f = 500\text{ MHz}$

$I_C = 2\text{ mA}; V_{CE} = 5\text{ V}$

$f_T \text{ typ. } 1.0\text{ GHz}$

$I_C = 25\text{ mA}; V_{CE} = 5\text{ V}^1)$

$f_T \text{ typ. } 1.6\text{ GHz}$

Collector capacitance at $f = 1\text{ MHz}$

$I_E = I_e = 0; V_{CB} = 10\text{ V}$

$C_c \text{ typ. } 0.7\text{ pF}$

Emitter capacitance at $f = 1\text{ MHz}$

$I_C = I_c = 0; V_{EB} = 0.5\text{ V}$

$C_e \text{ typ. } 1.5\text{ pF}$

Feedback capacitance at $f = 1\text{ MHz}$

$I_C = 2\text{ mA}; V_{CE} = 5\text{ V}; T_{amb} = 25\text{ }^\circ\text{C}$

$-C_{re} \text{ typ. } 0.6\text{ pF}$

Noise figure at $f = 500\text{ MHz}$

$I_C = 2\text{ mA}; V_{CE} = 5\text{ V}; R_S = 50\text{ }^\Omega; T_{amb} = 25\text{ }^\circ\text{C}$

$F \text{ typ. } 4.0\text{ dB}$

Power gain (not neutralized)

$I_C = 10\text{ mA}; V_{CE} = 10\text{ V}; T_{amb} = 25\text{ }^\circ\text{C}$

	$f = 200$	800	MHz
G_p	typ. 23	.11	dB

¹⁾ Measured under pulsed conditions.

CHARACTERISTICS (continued)

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

Intermodulation characteristics

1. Output power at $f = 200\text{ MHz}$; $T_{\text{amb}} = 25\text{ }^\circ\text{C}$

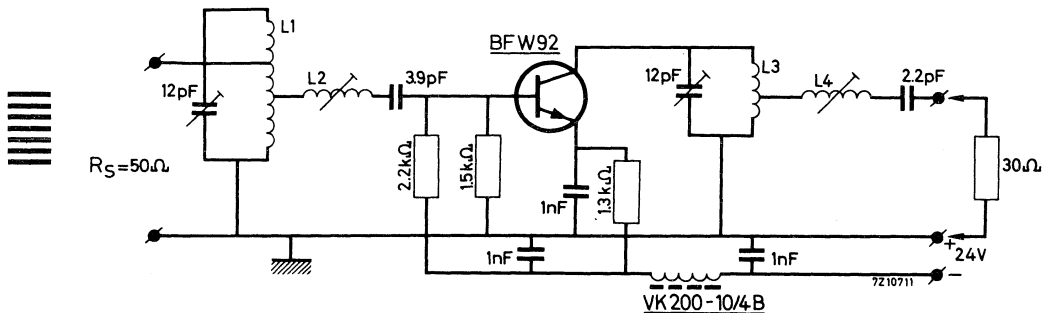
$I_C = 10\text{ mA}$; $V_{CE} = 10\text{ V}$; V.S.W.R. at output < 2

$f_p = 202\text{ MHz}$; $f_q = 205\text{ MHz}$; $d_{\text{im}} = -30\text{ dB}$

measured at $f_{(2q-p)} = 208\text{ MHz}$ (Channel 9)

P_o typ. 8 mW

Test circuit:



Coil data:

L1 = 3 turns silver plated Cu wire (1.4 mm); winding pitch 2.7 mm;
int. diam. 8 mm; taps at 0.5 turn and 1.5 turns from earth.

L2 = 5.5 turns silver plated Cu wire (1.4 mm); winding pitch 2.2 mm;
int. diam. 8 mm.

L3 = 3 turns silver plated Cu wire (1.4 mm); winding pitch 3.3 mm;
int. diam. 8 mm.

L4 = 5.5 turns silver plated Cu wire (1.4 mm); winding pitch 2.2 mm;
int. diam. 11 mm.

CHARACTERISTICS (continued)

Basis of adjustment

The intermodulation at an intermodulation distortion of -30 dB is caused by h.f. output current - voltage clipping.

The maximum undistorted output power is realised, if

- a. Current and voltage clipping take place concurrently.
This occurs if

$$R_L = \frac{V_{CE} - V_{CEK}}{I_C},$$

in which V_{CEK} is the high frequency knee voltage.

- b. The h.f. collector current is as small as possible.

This is so if $-C_L = +C_{oe}$,

in which C_{oe} is the output capacitance of the transistor at short circuited input.

For maximum output power at an intermodulation distortion of -30 dB, the (experimentally found) values of R_L and C_L are:

$$R_L = 820 \Omega; C_L = -1.0 \text{ pF}$$

Adjustment procedure

1. Remove the transistor and connect a dummy consisting of a 820 Ω resistor in parallel with a 1.0 pF capacitor between the collector and emitter connections of the output circuit.
2. Tune and match the output circuit for zero reflection at 205 MHz (V.S.W.R. = 1). After this adjustment, no further change may be made in the output circuit.
3. Replace the dummy by the transistor. Tune and match the input circuit for maximum power gain and good band pass curve.
The V.S.W.R. of the output will then, in most cases, be ≤ 2 over the whole channel.
Corrections can be made by tuning L2; this will not disturb the band pass curve.



CHARACTERISTICS (continued)

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

Intermodulation characteristics

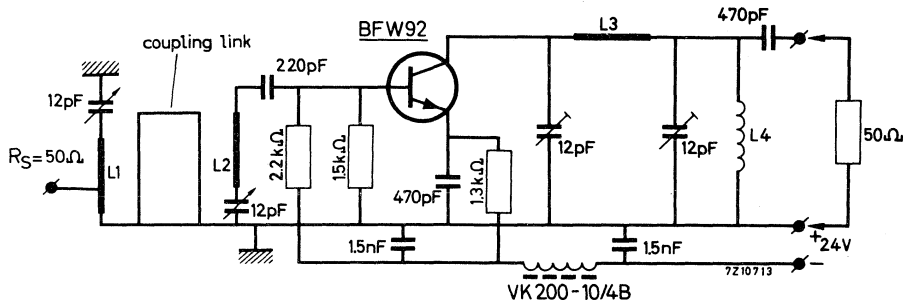
2. Output power at $f = 800\text{ MHz}$; $T_{\text{amb}} = 25\text{ }^\circ\text{C}$

$I_C = 10\text{ mA}$; $V_{CE} = 10\text{ V}$; V. S. W. R. at output < 2

$f_p = 798\text{ MHz}$; $f_q = 802\text{ MHz}$; $d_{\text{im}} = -30\text{ dB}$

measured at $f_{(2q-p)} = 806\text{ MHz}$ (Channel 62)

P_O typ. 8 mW



Coil data:

L1 = 24 mm x 6 mm x 0.5 mm silver plated Cu strip.

Tap of the input at 5 mm from earth.

L2 = 15 mm x 6 mm x 0.5 mm silver plated Cu strip.

L3 = 20 mm x 8 mm x 0.5 mm silver plated Cu strip.

L4 = 4 turns enamelled Cu wire (0.5 mm); winding pitch 1.5 mm; int. diam. 4 mm

Coupling link: 42 mm silver plated Cu wire (1 mm).

Basis of adjustment.

At 800 MHz no dummy can be used to adjust for optimum collector load because at these frequencies the impedance transformations of a dummy are too high. A small signal at the mid-channel frequency of 802 MHz is fed to the input and increased until clipping occurs; that is, until the output power no longer increases linearly with the input signal. This clipping can be eliminated by tuning the output circuit, thereby making the output power equal to

$$P_O = \frac{I_C (V_{CE} - V_{CEK})}{2} = 40\text{ mW}$$

The output circuit is adjusted for minimum intermodulation if the input signal is as small as possible at $P_O = 40\text{ mW}$.

After this adjustment has been made no further change may be made in the output circuit.

Adjust the input circuit for maximum power gain and good band pass curve.

The V. S. W. R. of the output is then ≤ 2 over the whole channel.

CHARACTERISTICS (continued)

Intermodulation characteristics

3. Intermodulation distortion

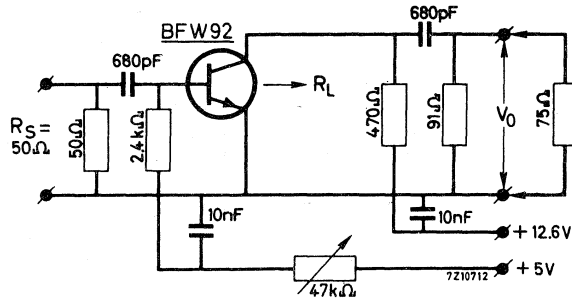
$I_C = 10 \text{ mA}$; $V_{CE} = 6 \text{ V}$; $R_L = 37.5 \Omega$; $T_{amb} = 25^\circ\text{C}$

$V_0 = 100 \text{ mV}$ at $f_p = 183 \text{ MHz}$

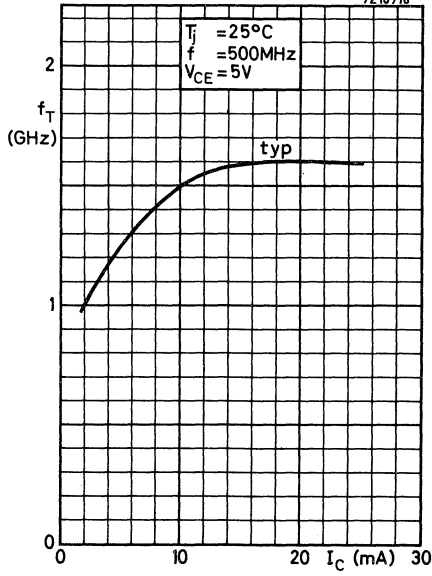
$V_0 = 100 \text{ mV}$ at $f_q = 200 \text{ MHz}$
 measured at $f_{(2q-p)} = 217 \text{ MHz}$

d_{im} typ. -45 dB

Test circuit:



7210716



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)

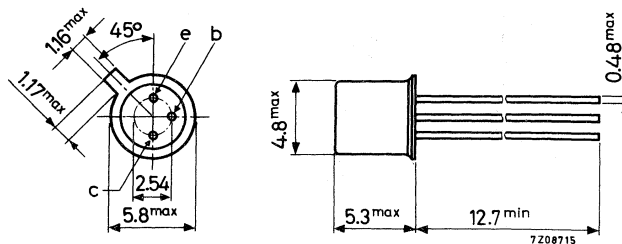
QUICK REFERENCE DATA			
Collector-base voltage (open emitter)	V_{CBO}	max.	40 V
Collector-emitter voltage ($R_{BE} = 10 \Omega$)	V_{CER}	max.	23 V
Collector current (peak value)	I_{CM}	max.	250 mA
Total power dissipation up to $T_{amb} = 25 \text{ }^\circ\text{C}$	P_{tot}	max.	360 mW
Junction temperature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

MECHANICAL DATA

Dimensions in mm

Collector connected to case

TO-18



Accessories available: 56246, 56263

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 ²⁾
Collector-emitter voltage with $R_{BE} = 10 \Omega$	V_{CER}	max.	23 V ²⁾
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 $T_{amb} = 25^\circ C$	P_{tot}	max.	360 mW
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Temperatures

Storage temperature	T_{stg}	-65 to +200	$^\circ C$
Junction temperature	T_j	max.	200 $^\circ C$

THERMAL RESISTANCE

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

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

²⁾ $I_C = 10 \text{ mA}$.

CHARACTERISTICS

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

Collector cut-off current

$I_E = 0; V_{CB} = 20\text{ V}$	I_{CBO}	max. 100 nA
$I_E = 0; V_{CB} = 20\text{ V}; T_j = 150\text{ }^\circ\text{C}$	I_{CBO}	max. 20 μA

Emitter cut-off current

$I_C = 0; V_{EB} = 2\text{ V}$	I_{EBO}	max. 50 nA
$I_C = 0; V_{EB} = 2\text{ V}; T_j = 150\text{ }^\circ\text{C}$	I_{EBO}	max. 20 μA

Saturation voltages

$I_C = 100\text{ mA}; I_B = 10\text{ mA}$	V_{CEsat}	< 0.6 V
	V_{BEsat}	< 1.5 V

D.C. current gain

$I_C = 10\text{ mA}; V_{CE} = 1\text{ V}$	h_{FE}	40 to 120
$I_C = 100\text{ mA}; V_{CE} = 1\text{ V}$	h_{FE}	> 20

Collector capacitance at $f = 1\text{ MHz}$

$I_E = I_e = 0; V_{CE} = 5\text{ V}$	C_c	< 4 pF
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Emitter capacitance at $f = 1\text{ MHz}$

$I_C = I_c = 0; V_{EB} = 0.5\text{ V}$	C_e	< 4.5 pF
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Transition frequency

$I_C = 10\text{ mA}; V_{CE} = 10\text{ V}$	f_T	> 500 MHz
$I_C = 100\text{ mA}; V_{CE} = 3\text{ V}$	f_T	> 300 MHz

Feedback time constant

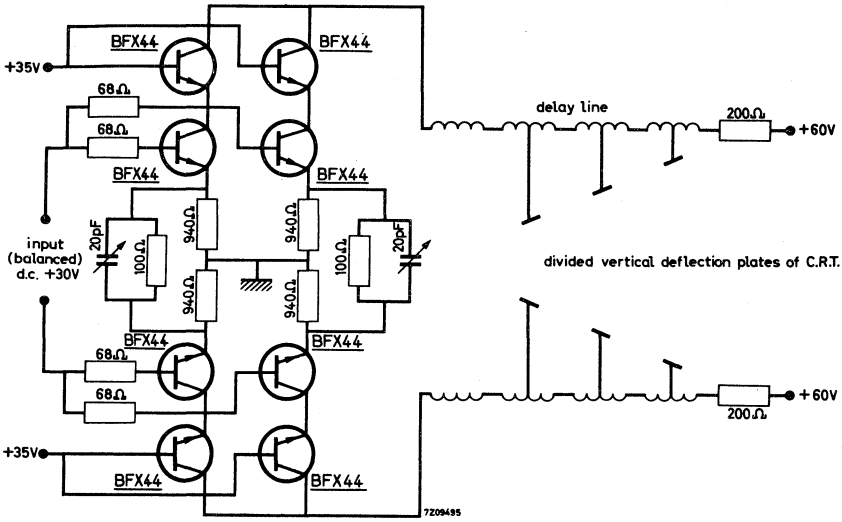
$-I_E = 1\text{ mA}; V_{CB} = 5\text{ V}; f = 10.7\text{ MHz}$	$r_{bb}'C_{b'c}$	< 40 ps
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Storage time

$I_C = I_B = -I_{BM} = 10\text{ mA}$	t_s	< 30 ns
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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.

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.

The transistor has a low noise, a very high power gain and good intermodulation properties.

It is primarily intended for:

- Channel aerial amplifiers for band I, II, III and IV/V (40-860 MHz)
- Wide band aerial amplifiers (40-860 MHz).

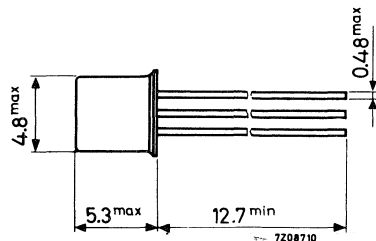
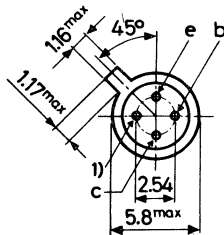
QUICK REFERENCE DATA

Collector-base voltage (open emitter; peak value)	V_{CBOM}	max.	30 V
Collector-emitter voltage (open base)	V_{CEO}	max.	15 V
Collector current (peak value; $f > 1$ MHz)	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
Transition frequency $I_C = 25$ mA; $V_{CE} = 5$ V; $f = 500$ MHz	f_T	typ.	1.2 GHz
Feedback capacitance $I_C = 2$ mA; $V_{CE} = 5$ V; $f = 1$ MHz	$-C_{re}$	typ.	0.6 pF
Noise figure at optimum source impedance $I_C = 2$ mA; $V_{CE} = 5$ V	F	typ.	3.3
		f = 200 MHz	7 dB
Power gain (not neutralized) $I_C = 8$ mA; $V_{CE} = 10$ V	G_p	typ.	22
		f = 800 MHz	7 dB
Output power $d_{im} = -30$ dB; V.S.W.R. at output < 2 $I_C = 8$ mA; $V_{CE} = 10$ V	P_o	typ.	6
			6 mW

MECHANICAL DATA

Dimensions in mm

TO-72
insulated electrodes



Accessories available: 56246, 56263

1) = shield lead (connected to case)

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

Voltages

Collector-base voltage (open emitter; peak value)	V_{CBOM}	max.	30 V
Collector-emitter voltage (peak value) $R_{BE} \leq 50 \Omega$	V_{CERM}	max.	30 V ¹⁾
Collector-emitter voltage (open base)	V_{CEO}	max.	15 V ¹⁾
Emitter-base voltage (open collector)	V_{EBO}	max.	2.5 V

Currents

Collector current (d.c.)	I_C	max.	25 mA
Collector current (peak value; $f > 1$ MHz)	I_{CM}	max.	50 mA

Power dissipation

Total power dissipation up to $T_{amb} = 25 \text{ }^\circ\text{C}$	P_{tot}	max.	200 mW
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Temperatures

Storage temperature	T_{stg}	-65 to +200	$^\circ\text{C}$
Junction temperature	T_j	max.	200 $^\circ\text{C}$

THERMAL RESISTANCE

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

¹⁾ $I_C = 10$ mA.

CHARACTERISTICS

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

Collector cut-off current

$I_E = 0; V_{CB} = 15\text{ V}$

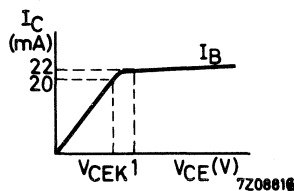
$I_{CBO} < 10\text{ nA}$

Knee voltage

$I_C = 20\text{ mA}; I_B = \text{value for which}$

$I_C = 22\text{ mA at } V_{CE} = 1\text{ V}$

$V_{CEK} < 0.75\text{ V}$



D.C. current gain

$I_C = 2\text{ mA}; V_{CE} = 1\text{ V}$

$h_{FE} \quad 20\text{ to }150$

$I_C = 25\text{ mA}; V_{CE} = 1\text{ V}$

$h_{FE} \quad 20\text{ to }125$

Transition frequency ¹⁾

$I_C = 2\text{ mA}; V_{CE} = 5\text{ V}; f = 500\text{ MHz}$

$f_T \quad \text{typ. } 1.0\text{ GHz}$

$I_C = 25\text{ mA}; V_{CE} = 5\text{ V}; f = 500\text{ MHz}$

$f_T \quad \text{typ. } 1.2\text{ GHz}$

Collector capacitance at $f = 1\text{ MHz}$ ²⁾

$I_E = I_e = 0; V_{CB} = 10\text{ V}$

$C_C < 1.7\text{ pF}$

Feedback capacitance at $f = 1\text{ MHz}$ ¹⁾

$I_C = 2\text{ mA}; V_{CE} = 5\text{ V}$

$-C_{re} \quad \text{typ. } 0.6\text{ pF}$

Noise figure ¹⁾

$I_C = 2\text{ mA}; V_{CE} = 5\text{ V}$

$f = 200\text{ MHz}; \text{ optimum source impedance}$

$F < 4\text{ dB}$

$f = 500\text{ MHz}; R_S = 50\text{ } \Omega$

$F < 6.5\text{ dB}$

$f = 800\text{ MHz}; \text{ optimum source impedance}$

$F \quad \text{typ. } 7.0\text{ dB}$

Power gain (not neutralized) ¹⁾

$I_C = 8\text{ mA}; V_{CE} = 10\text{ V}; T_{amb} = 25\text{ }^\circ\text{C}$

	$f = 200$	800 MHz
G_P	> 19	$-$
	typ. 22	7 dB

¹⁾ Shield lead grounded.

²⁾ Shield lead not connected.

CHARACTERISTICS (continued)

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

Intermodulation characteristics 1)

1. Output power at $f = 200\text{ MHz}$; $T_{\text{amb}} = 25\text{ }^\circ\text{C}$

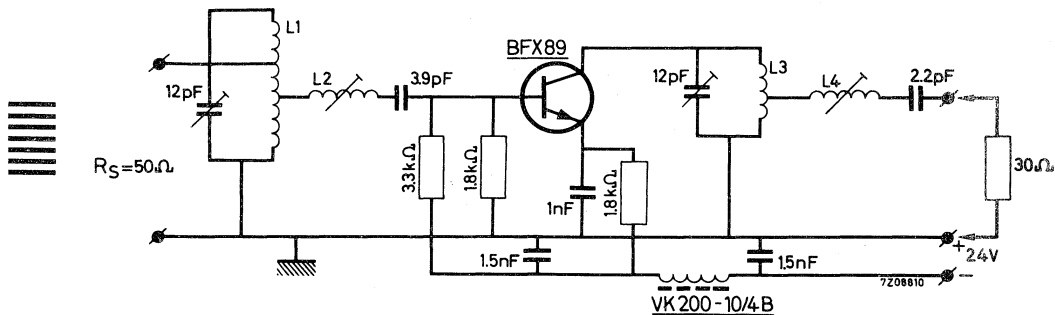
$I_C = 8\text{ mA}$; $V_{CE} = 10\text{ V}$; V.S.W.R. at output < 2

$f_p = 202\text{ MHz}$; $f_q = 205\text{ MHz}$; $d_{\text{im}} = -30\text{ dB}$

measured at $f(2q-p) = 208\text{ MHz}$ (Channel 9)

P_O typ. 6 mW

Test circuit:



Coil data:

L1 = 3 turns silver plated Cu wire (1.4 mm); winding pitch 2.7 mm;
int. diam. 8 mm; taps at 0.5 turn and 1.5 turns from earth.

L2 = 5.5 turns silver plated Cu wire (1.4 mm); winding pitch 2.2 mm;
int. diam. 8 mm.

L3 = 3 turns silver plated Cu wire (1.4 mm) winding pitch 3.3 mm;
int. diam. 8 mm.

L4 = 5.5 turns silver plated Cu wire (1.4 mm) winding pitch 2.2 mm;
int. diam. 11 mm.

1) Shield lead grounded.

CHARACTERISTICS (continued)

Basis of adjustment

The intermodulation at an intermodulation distortion of -30 dB is caused by h.f. output current - voltage clipping.

The maximum undistorted output power is realised, if

- a. Current and voltage clipping take place concurrently.

This occurs if

$$R_L = \frac{V_{CE} - V_{CEK}}{I_C},$$

in which V_{CEK} is the high frequency knee voltage.

- b. The h.f. collector current is as small as possible.

This is so if $-C_L = +C_{Oe}$,

in which C_{Oe} is the output capacitance of the transistor at short circuited input.

For maximum output power at an intermodulation distortion of -30 dB, the (experimentally found) values of R_L and C_L are:

$R_L = 1 \text{ k}\Omega$; $C_L = -1.8 \text{ pF}$

Adjustment procedure

1. Remove the transistor and connect a dummy consisting of a $1 \text{ k}\Omega$ resistor in parallel with a 1.8 pF capacitor between the collector and emitter connections of the output circuit.
2. Tune and match the output circuit for zero reflection at 205 MHz (V.S.W.R. = 1). After this adjustment, no further change may be made in the output circuit.
3. Replace the dummy by the transistor. Tune and match the input circuit for maximum power gain and good band pass curve.
The V.S.W.R. of the output will then, in most cases, be ≤ 2 over the whole channel.
Corrections can be made by tuning L2; this will not disturb the band pass curve.



CHARACTERISTICS (continued)

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

Intermodulation characteristics ¹⁾

2. Output power at $f = 800\text{ MHz}$; $T_{\text{amb}} = 25\text{ }^\circ\text{C}$

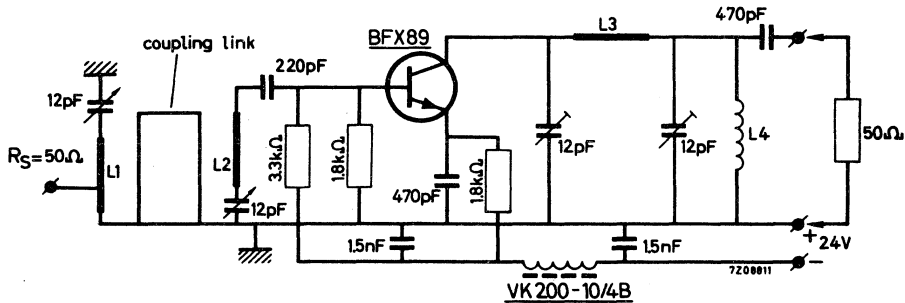
$I_C = 8\text{ mA}$; $V_{CE} = 10\text{ V}$; V.S.W.R. at output < 2

$f_p = 798\text{ MHz}$; $f_q = 802\text{ MHz}$; $d_{\text{im}} = -30\text{ dB}$

measured at $f(2q-p) = 806\text{ MHz}$ (Channel 62)

P_o typ. 6 mW

Test circuit:



Coil data:

L1 = 24 mm x 6 mm x 0.5 mm silver plated Cu strip.

Tap of the input at 5 mm from earth.

L2 = 15 mm x 6 mm x 0.5 mm silver plated Cu strip.

L3 = 20 mm x 8 mm x 0.5 mm silver plated Cu strip.

L4 = 4 turns enamelled Cu wire (0.5 mm); winding pitch 1.5 mm;
int. diam. 4 mm.

Coupling link: 42 mm silver plated Cu wire (1 mm).

Basis of adjustment

At 800 MHz no dummy can be used to adjust for optimum collector load because at these frequencies the impedance transformations of a dummy are too high. A small signal at the mid-channel frequency of 802 MHz is fed to the input and increased until clipping occurs; that is, until the output power no longer increases linearly with the input signal. This clipping can be eliminated by tuning the output circuit, thereby making the output power equal to

$$P_o = \frac{I_C (V_{CE} - V_{CEK})}{2} = 35\text{ mW}$$

The output circuit is adjusted for minimum intermodulation if the input signal is as small as possible at $P_o = 35\text{ mW}$.

After this adjustment has been made no further change may be made in the output circuit.

Adjust the input circuit for maximum power gain and good band pass curve.

The V.S.W.R. of the output is then ≤ 2 over the whole channel.

¹⁾ Shield lead grounded

CHARACTERISTICS (continued)

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

Intermodulation characteristics ¹⁾

3. Intermodulation distortion

$I_C = 8\text{ mA}$; $V_{CE} = 6\text{ V}$; $R_L = 37.5\text{ }\Omega$; $T_{amb} = 25\text{ }^\circ\text{C}$

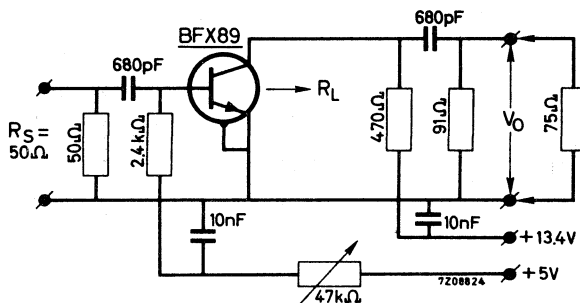
$V_o = 100\text{ mV}$ at $f_p = 183\text{ MHz}$

$V_o = 100\text{ mV}$ at $f_q = 200\text{ MHz}$

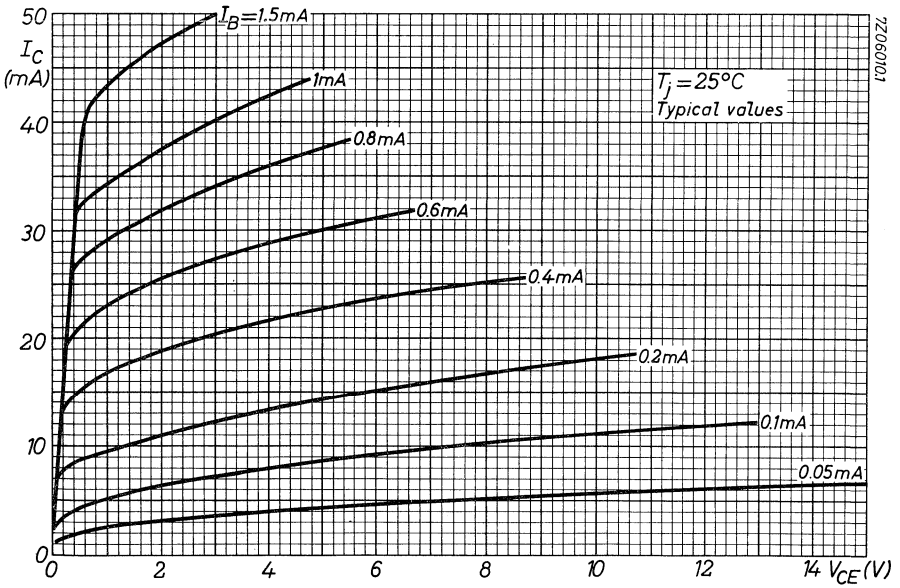
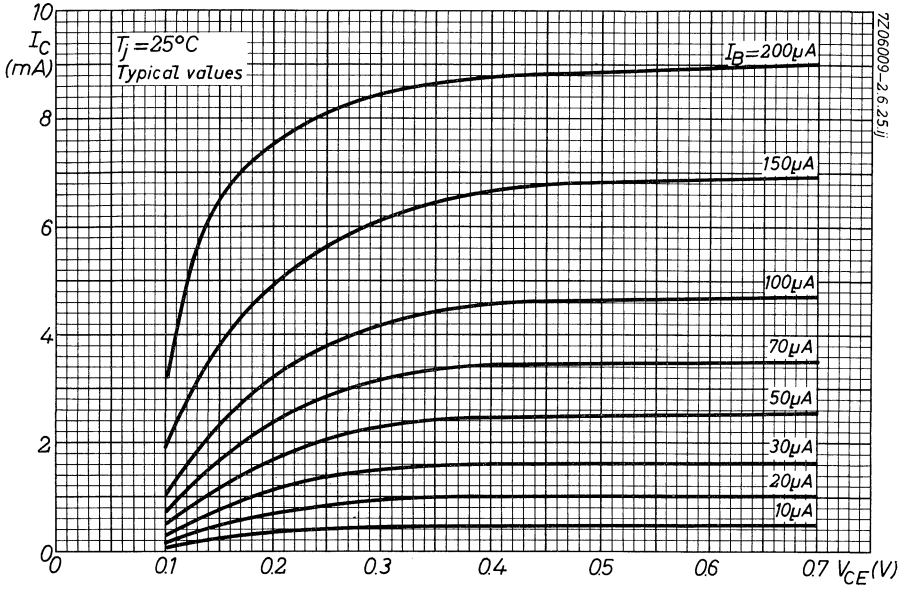
measured at $f(2q-p) = 217\text{ MHz}$

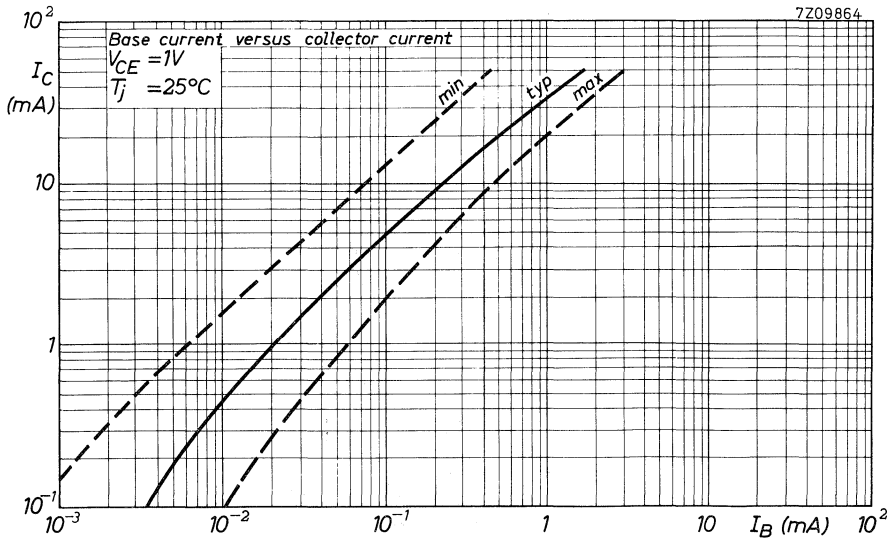
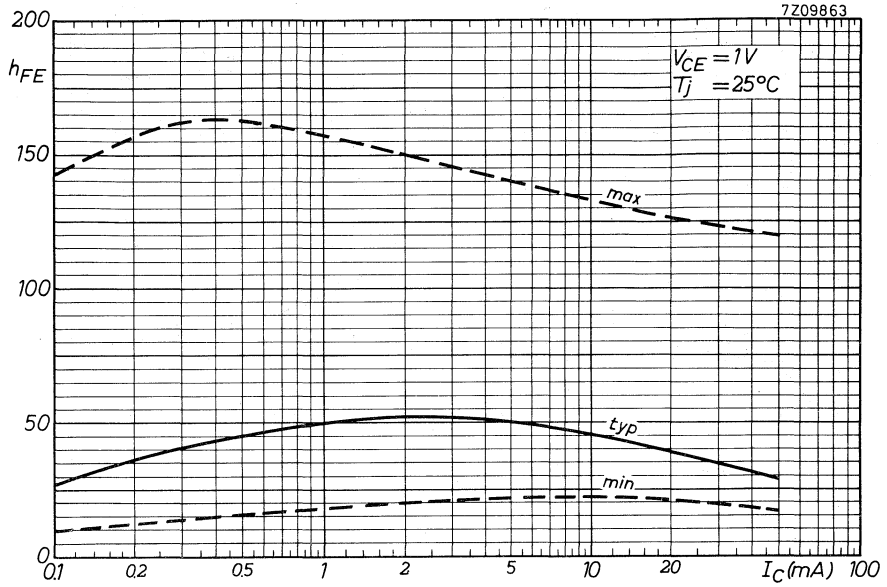
d_{im} typ. -40 dB

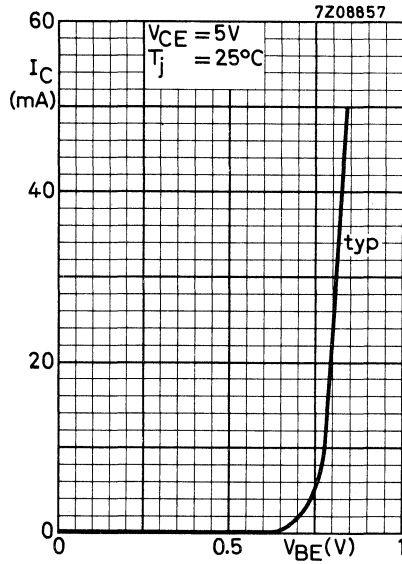
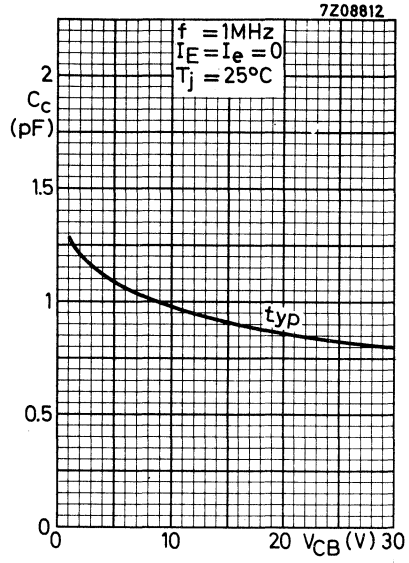
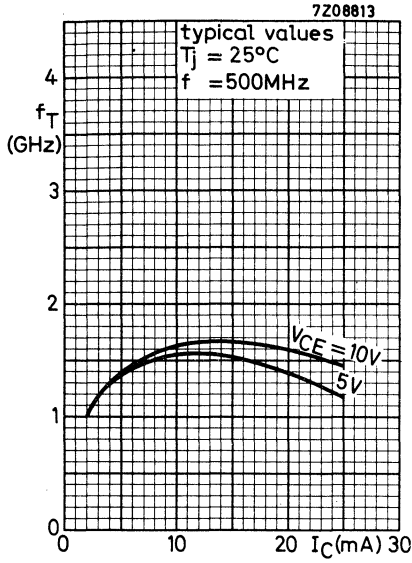
Test circuit:

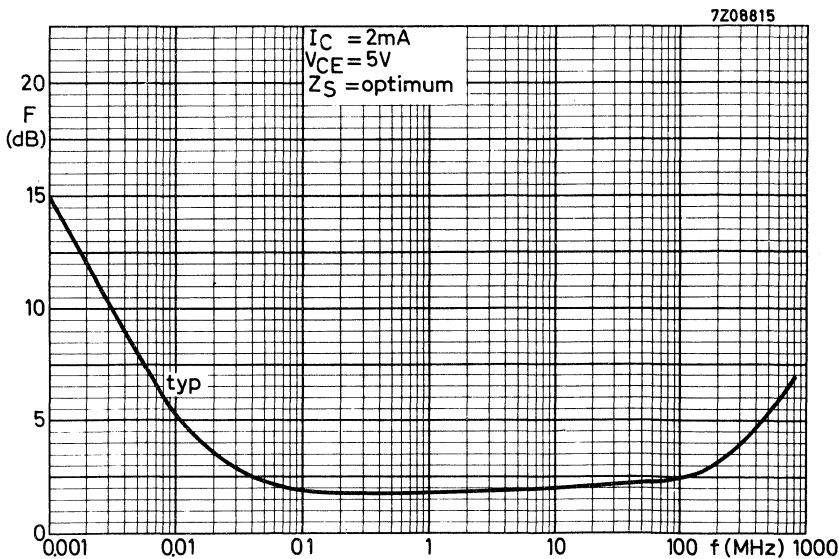
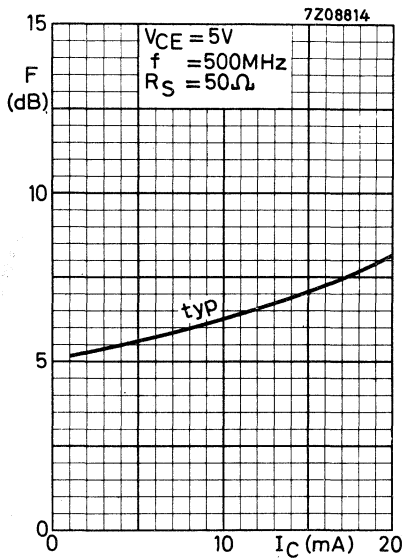


1) Shield lead grounded.









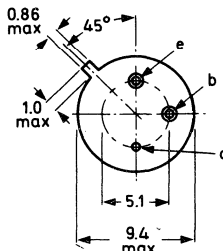
SILICON EPITAXIAL PLANAR TRANSISTORS

N-P-N transistors in a TO-39 metal envelope with the collector connected to the case. These transistors are intended for general purpose industrial applications.

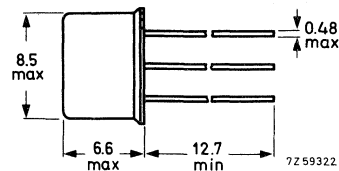
QUICK REFERENCE DATA							
				BFY50	BFY51	BFY52	
Collector-base voltage (open emitter)	V_{CBO}	max.	80	60	40	V	
Collector-emitter voltage (open base)	V_{CEO}	max.	35	30	20	V	
Collector current (peak value)	I_{CM}	max.	1	1	1	A	
Total dissipation up to $T_{mb} = 50\text{ }^{\circ}\text{C}$	P_{tot}	max.	5	5	5	W	
Junction temperature	T_j	max.	200	200	200	$^{\circ}\text{C}$	
D.C. current gain at $T_j = 25\text{ }^{\circ}\text{C}$	h_{FE}	typ.	112	123	142		
$I_C = 150\text{ mA}; V_{CE} = 10\text{ V}$							
Transition frequency	f_T	typ.	140	160	185	MHz	
$I_C = 50\text{ mA}; V_{CE} = 10\text{ V}$							
Saturation voltage	V_{CEsat}	<	0.7	1.0	1.0	V	
$I_C = 500\text{ mA}; I_B = 50\text{ mA}$							

MECHANICAL DATA

TO-39
Collector
connected
to case



Dimensions in mm



max. lead diameter is guaranteed only for 12.7 mm.
Accessories supplied on request: 56218, 56245, 56265.

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

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
Reverse base current (peak value)	$-I_{BM}$	max.			0.1	A

Power dissipation (See also page 8)

Total power dissipation up to $T_{mb} = 50^\circ C$	P_{tot}	max.			5	W
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Temperatures

Storage temperature	T_{stg}			- 65 to +200	$^\circ C$
Junction temperature	T_j	max.		200	$^\circ C$

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th j-a}$	=		220	$^\circ C/W$
From junction to case	$R_{th j-c}$	=		35	$^\circ C/W$
From junction to mounting base	$R_{th j-mb}$	=		30	$^\circ C/W$

CHARACTERISTICS

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

<u>Collector cut-off current</u>		BFY50	BFY51	BFY52	
$I_E = 0; V_{CB} = 60\text{ V}$	I_{CBO}	typ.	2		nA
		<	50		nA
$I_E = 0; V_{CB} = 40\text{ V}$	I_{CBO}	typ.		2	nA
		<		50	nA
$I_E = 0; V_{CB} = 30\text{ V}$	I_{CBO}	typ.			2 nA
		<			50 nA
$I_E = 0; V_{CB} = 60\text{ V}; T_j = 100\text{ }^\circ\text{C}$	I_{CBO}	typ.	100		nA
		<	2.5		μA
$I_E = 0; V_{CB} = 40\text{ V}; T_j = 100\text{ }^\circ\text{C}$	I_{CBO}	typ.		100	nA
		<		2.5	μA
$I_E = 0; V_{CB} = 30\text{ V}; T_j = 100\text{ }^\circ\text{C}$	I_{CBO}	typ.			100 nA
		<			2.5 μA
<u>Emitter cut-off current</u>					
$I_C = 0; V_{EB} = 5\text{ V}$	I_{EBO}	typ.	2	2	2 nA
		<	50	50	50 nA
$I_C = 0; V_{EB} = 5\text{ V}; T_j = 100\text{ }^\circ\text{C}$	I_{EBO}	typ.	0.1	0.1	0.1 μA
		<	2.5	2.5	2.5 μA
<u>Saturation voltages</u>					
$I_C = 10\text{ mA}; I_B = 1.0\text{ mA}$	V_{CEsat}	typ.	0.06	0.06	0.06 V
		<	0.10	0.15	0.15 V
	V_{BEsat}	typ.	0.69	0.69	0.69 V
		<	1.2	1.2	1.2 V
$I_C = 150\text{ mA}; I_B = 15\text{ mA}$	V_{CEsat}	typ.	0.15	0.15	0.15 V
		<	0.20	0.35	0.35 V
	V_{BEsat}	typ.	0.92	0.92	0.92 V
		<	1.3	1.3	1.3 V
$I_C = 500\text{ mA}; I_B = 50\text{ mA } 1)$	V_{CEsat}	typ.	0.35	0.35	0.35 V
		<	0.70	1.00	1.00 V
	V_{BEsat}	typ.	1.15	1.15	1.15 V
		<	1.5	1.5	1.5 V
$I_C = 1\text{ A}; I_B = 100\text{ mA } 1)$	V_{CEsat}	typ.	0.66	0.66	0.66 V
		<	1.00	1.60	1.60 V
	V_{BEsat}	typ.	1.40	1.40	1.40 V
		<	2.0	2.0	2.0 V

1) Measured under pulsed conditions to avoid excessive dissipation.

CHARACTERISTICS (continued)

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

D. C. current gain

		BFY50	BFY51	BFY52
$I_C = 10\text{ mA}; V_{CE} = 10\text{ V}$	h_{FE}	> 20	30	30
	typ.	80	85	90
$I_C = 150\text{ mA}; V_{CE} = 10\text{ V}^1)$	h_{FE}	> 30	40	60
	typ.	112	123	142
$I_C = 500\text{ mA}; V_{CE} = 10\text{ V}^1)$	h_{FE}	> 20	25	30
	typ.	70	79	90
$I_C = 1\text{ A}; V_{CE} = 10\text{ V}^1)$	h_{FE}	> 15	15	15
	typ.	35	40	50

Switching times (See also page 5)

$I_C = 150\text{ mA}; +I_B = -I_{BM} = 15\text{ mA}$				
delay time	t_d	typ. 15	15	15 ns
rise time	t_r	typ. 40	40	40 ns
storage time	t_s	typ. 300	300	300 ns
fall time	t_f	typ. 60	60	60 ns

Collector capacitance at $f = 1\text{ MHz}$

$I_E = I_e = 0; V_{CB} = 10\text{ V}$	C_c	< 12	12	12 pF
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Transition frequency at $f = 35\text{ MHz}$

$I_C = 50\text{ mA}; V_{CE} = 10\text{ V}$	f_T	> 60	50	50 MHz
	typ.	140	160	185 MHz

h parameters at $f = 1\text{ kHz}$

$I_C = 10\text{ mA}; V_{CE} = 5\text{ V}$				
Input impedance	h_{ie}	< 750	750	750 Ω
Reverse voltage transfer ratio	h_{re}	< 5.0	5.0	5.0 10^{-4}
Small signal current gain	h_{fe}	> 15	45	45
	typ.	90	100	110
Output admittance	h_{oe}	< 80	80	80 $\mu\Omega^{-1}$
$I_C = 1\text{ mA}; V_{CE} = 5\text{ V}$				
Small signal current gain	h_{fe}	> 10	30	30
	typ.	60	65	70

¹⁾ Measured under pulsed conditions to avoid excessive dissipation.

MEASUREMENT OF SWITCHING TIMES

Fig. 1 : Circuit diagram

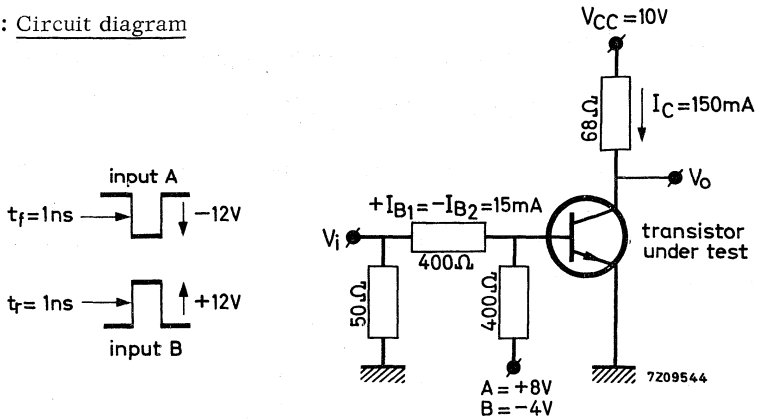
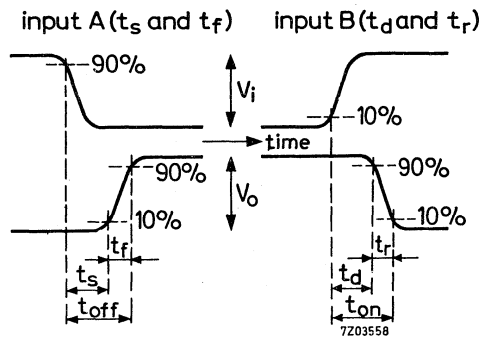


Fig. 2 : Waveforms



Equipment Pulse generator: rise time $t_r = 1 \text{ ns}$
 pulse duration $t_p = 1 \mu\text{s}$
 Double beam or dual trace oscilloscope: rise time $t_r < 5 \text{ ns}$

OPERATING NOTES (Dissipation and heatsink considerations)

1. Steady-state conditions

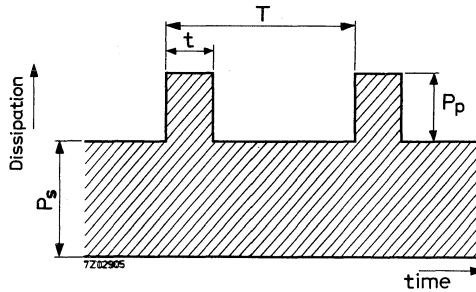
The max. allowable steady-state dissipation P_S is given by the relationship

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

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

$R_{\text{th j-a}}$ 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

$$P_P = \frac{(T_{j \text{ max.}} - T_{\text{amb}}) - (P_S \cdot R_{\text{th j-a}})}{Z_{\text{th}} + \delta \cdot R_{\text{th mb-a}}}$$

where Z_{th} is the thermal impedance of the device between junction and mounting base and is a function of the pulse duration t and duty cycle δ (see page 9),

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

$R_{\text{th mb-a}}$ is the total thermal resistance between mounting base 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 °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 thermal impedance $Z_{\text{th}} = 13 \text{ }^\circ\text{C/W}$ (from page 9)

OPERATING NOTES (continued)

$$P_{pmax} = \frac{(200-65) - (0.35 \times 220)}{13 + 0.2 (220-30)}$$

$$= \frac{135 - 77}{13 + 38} = 1.14 \text{ W}$$

The peak pulse dissipation of 1.14 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

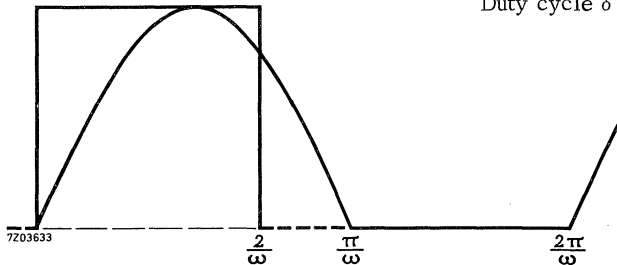
The following example illustrates how to find the maximum permissible peak dissipation of a BFY52 operating in a class "B" circuit at 1 kHz. The device is mounted on a heatsink of thermal resistance equal to 50 °C/W and at an ambient temperature not exceeding 100 °C. Assuming that the waveform is sinusoidal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

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

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

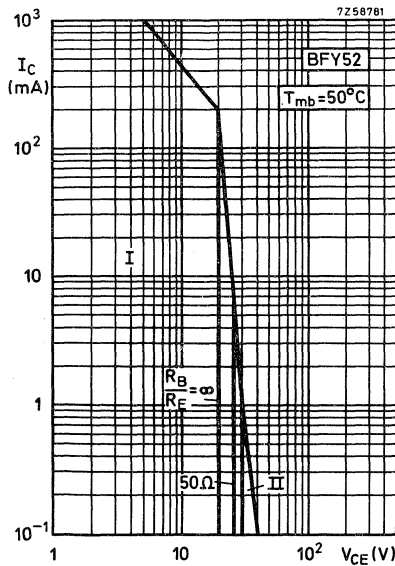
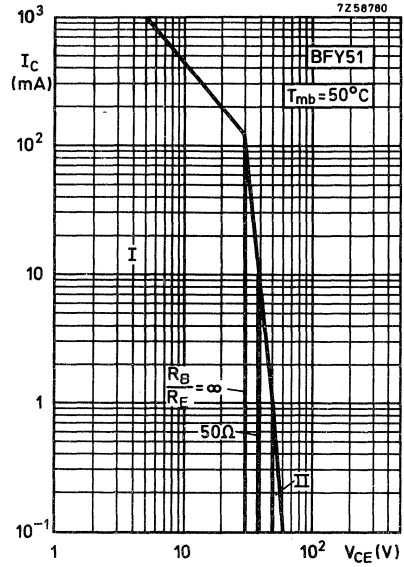
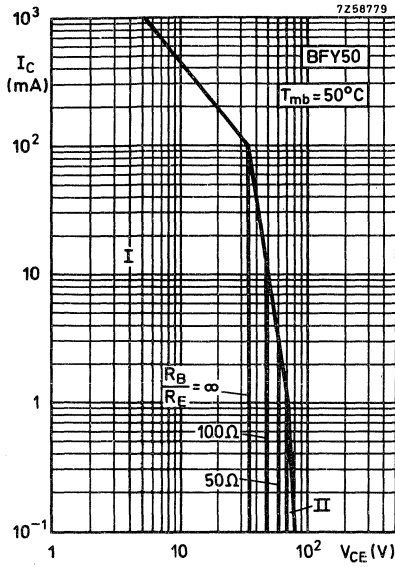


From page 9: $Z_{th 0} = 6.0 \text{ °C/W}$ $R_{th j-mb} = 30 \text{ °C/W}$

$$Z_{th} (\text{at } \delta = 0.318) = 6.0 + 0.318 (30-6.0) = 13.6 \text{ °C/W}$$

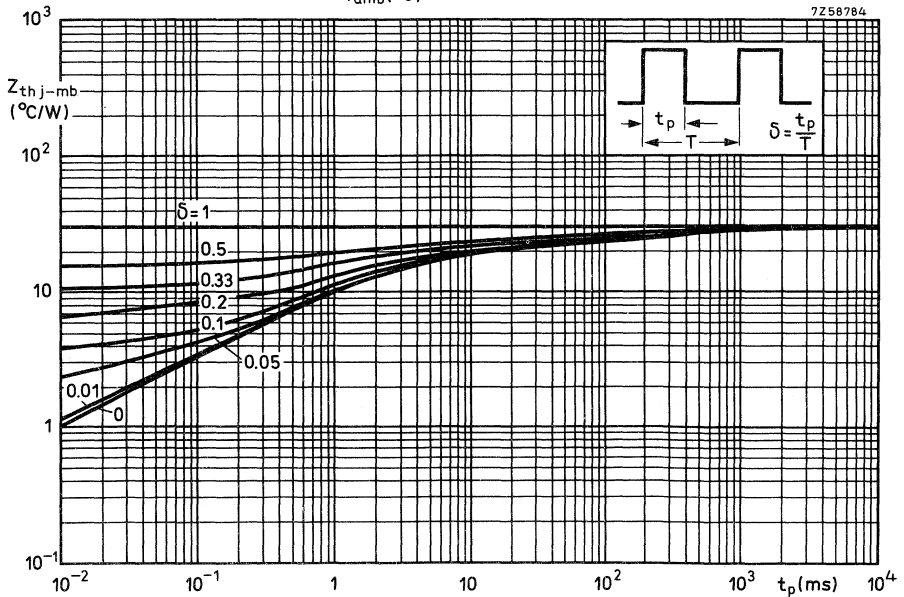
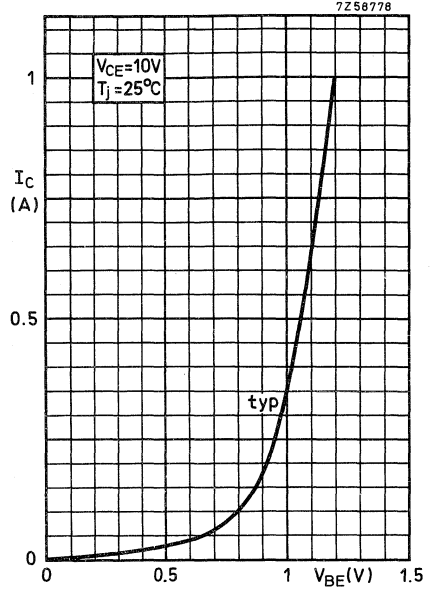
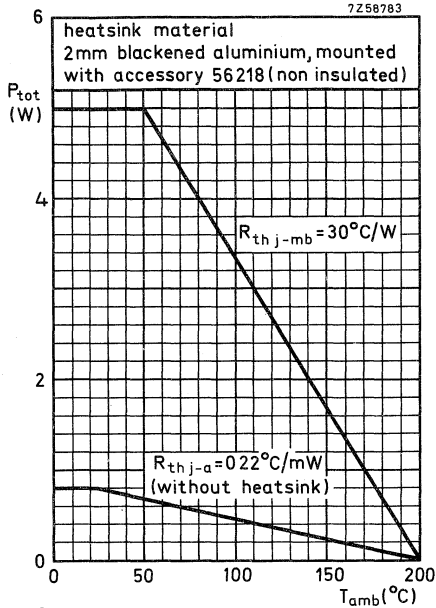
$$P_{pmax} = \frac{(200-100) - 0}{13.6 + 0.318 \times 50} = 3.39 \text{ W}$$

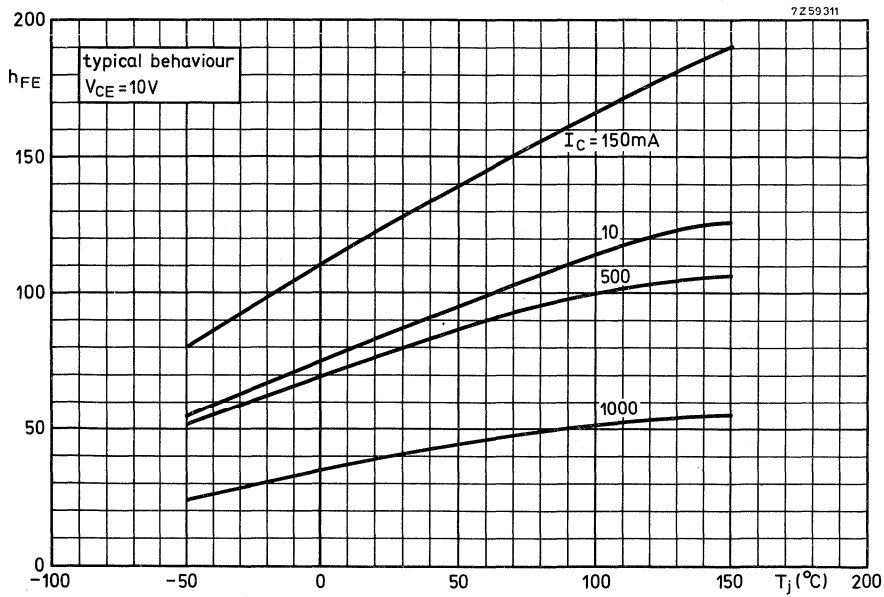
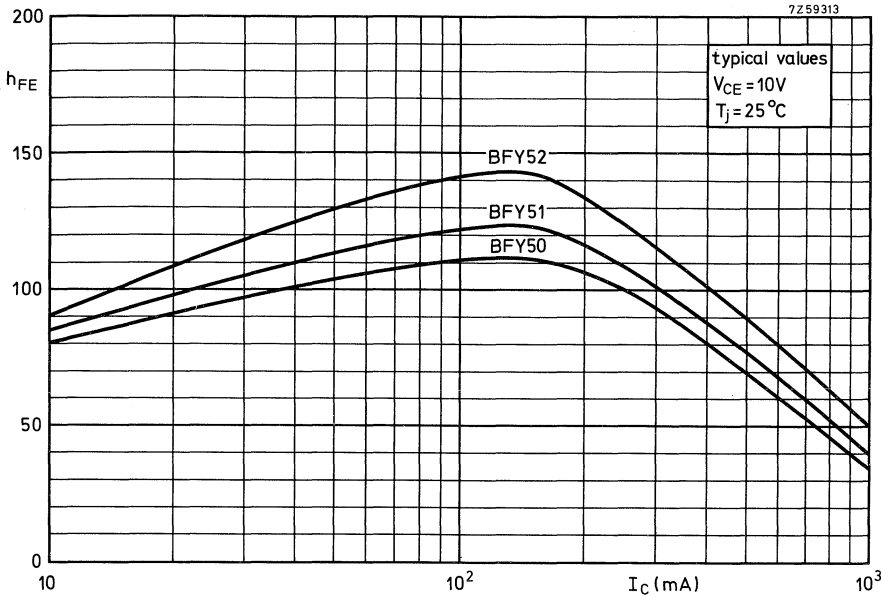
A peak power of 3.39 W is therefore permissible provided that the voltage and current ratings of the device are not exceeded.

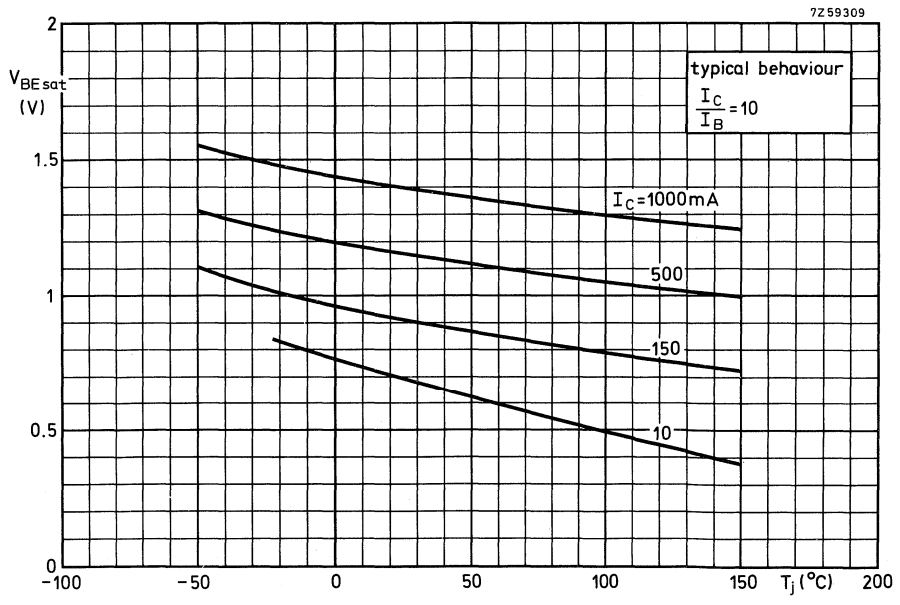
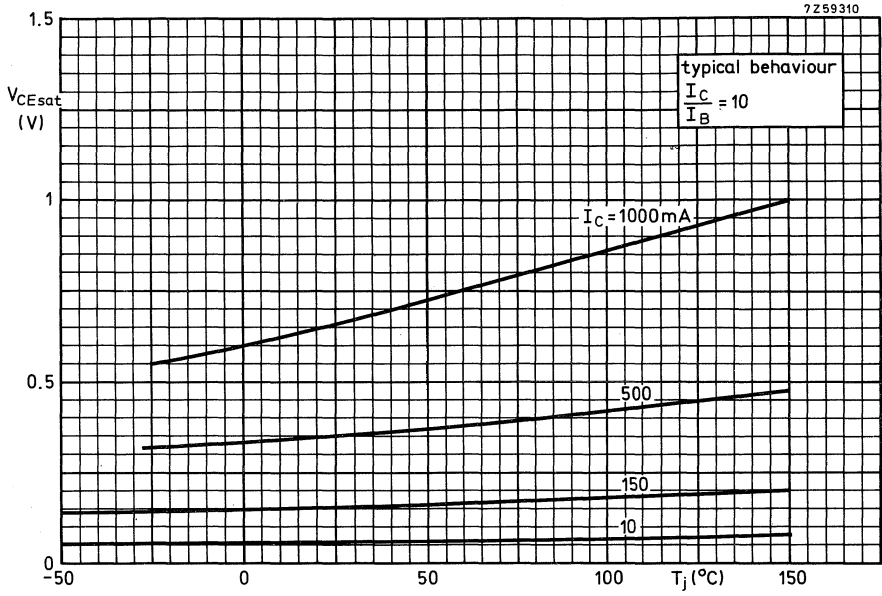


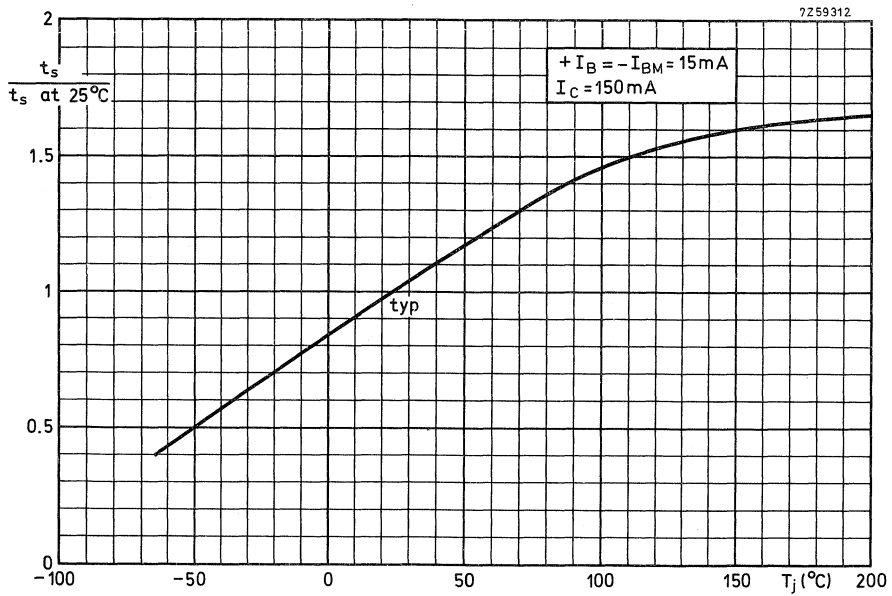
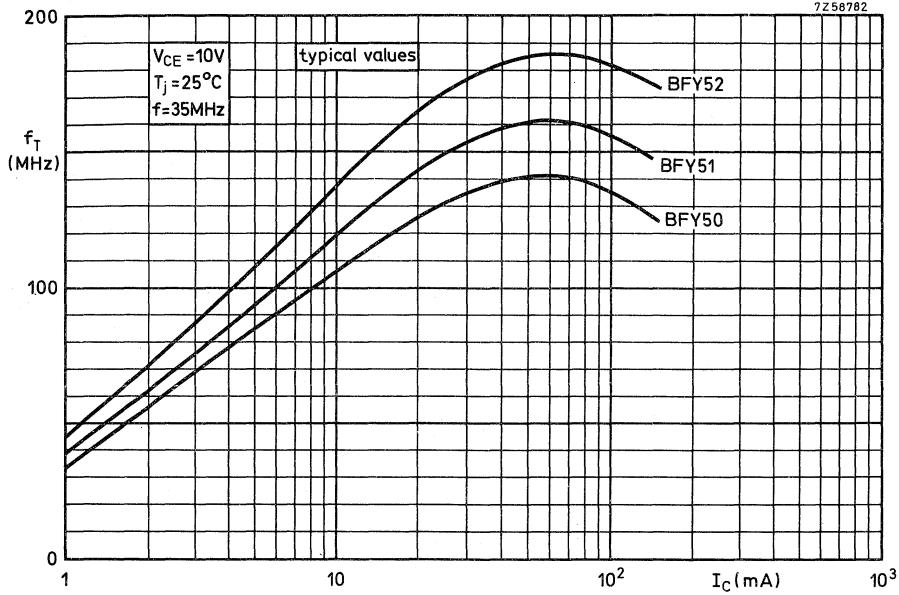
Safe Operating Area with the transistor forward biased

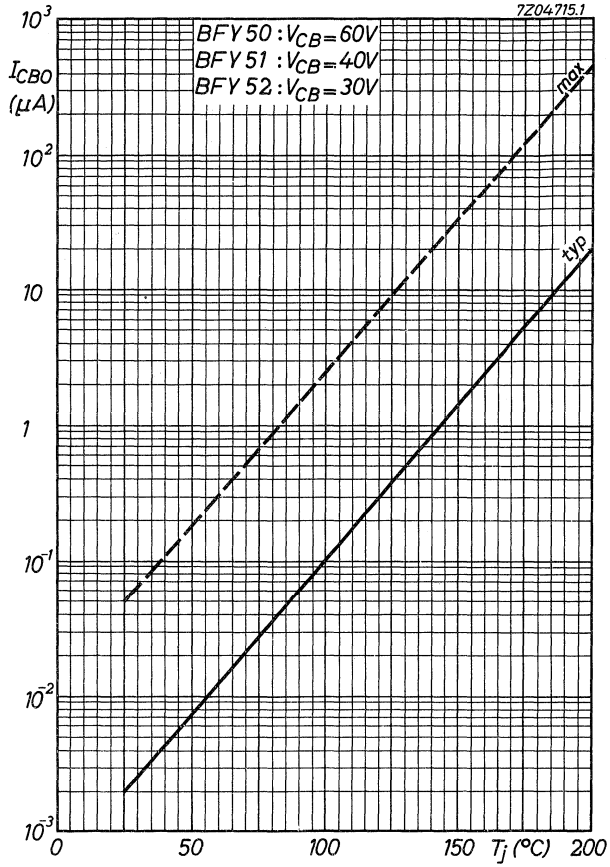
- I. Region of permissible d.c. operation
- II. Additional area for d.c. operation when $R_B / R_E < 10 \Omega$

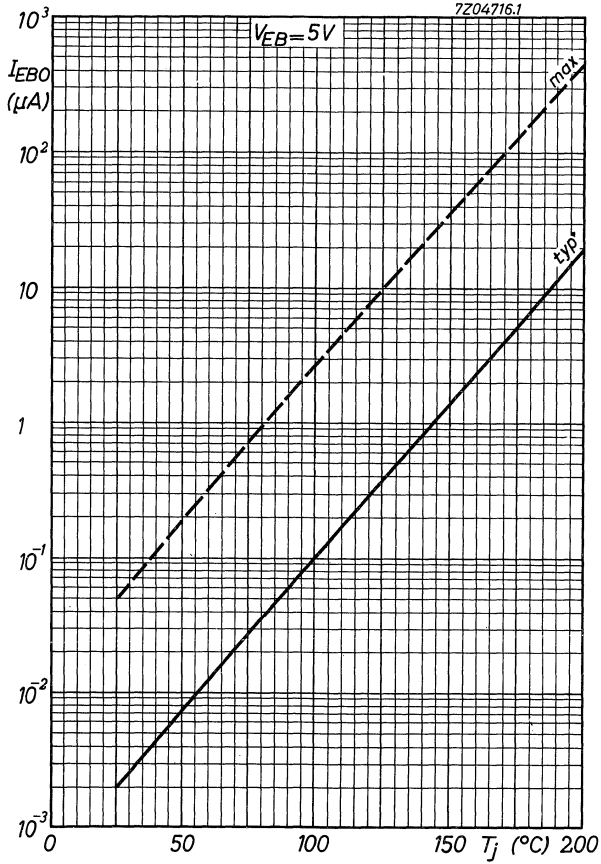












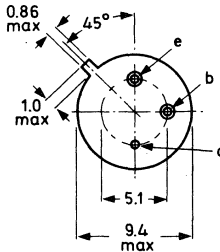
SILICON PLANAR EPITAXIAL TRANSISTOR

N-P-N transistor in TO-39 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.

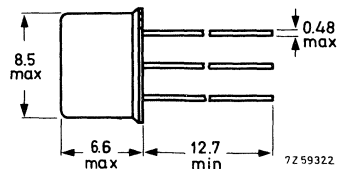
QUICK REFERENCE DATA		
Collector-base voltage (open emitter)	V_{CBO}	max. 80 V
Collector-emitter voltage (open base)	V_{CEO}	max. 35 V
Collector current (d. c.)	I_C	max. 1 A
Total power dissipation up to $T_{amb} = 25\text{ }^\circ\text{C}$	P_{tot}	max. 800 mW
Junction temperature	T_j	max. 200 $^\circ\text{C}$
D. C. current gain at $T_j = 25\text{ }^\circ\text{C}$		
$I_C = 150\text{ mA}; V_{CE} = 10\text{ V}$	h_{FE}	> 40
Transition frequency		
$I_C = 50\text{ mA}; V_{CE} = 10\text{ V}$	f_T	> 60 MHz
Collector-emitter saturation voltage		
$I_C = 1\text{ A}; I_B = 100\text{ mA}$	V_{CEsat}	< 1 V

MECHANICAL DATA

Collector connected
to case
TO-39



Dimensions in mm



max. lead diameter is guaranteed only for 12.7 mm

Accessories available: 56218, 56245, 56265

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 4)

Total power dissipation up to $T_{amb} = 40\text{ }^\circ\text{C}$	P_{tot}	max.	4 W
Total power dissipation without cooling fin up to $T_{amb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	0.8 W

Temperatures

Storage temperature	T_{stg}	-65 to +200	$^\circ\text{C}$
Junction temperature	T_j	max.	200 $^\circ\text{C}$

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	0.22 $^\circ\text{C}/\text{mW}$
From junction to case	$R_{th\ j-c}$	=	0.035 $^\circ\text{C}/\text{mW}$

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

CHARACTERISTICS

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

Collector cut-off current

$I_E = 0; V_{CB} = 60\text{ V}$ $I_{CBO} < 10\text{ nA}$

$I_E = 0; V_{CB} = 60\text{ V}; T_j = 150\text{ }^\circ\text{C}$ $I_{CBO} < 10\text{ }\mu\text{A}$

Emitter cut-off current

$I_C = 0; V_{EB} = 5\text{ V}$ $I_{EBO} < 10\text{ nA}$

Saturation voltages

$I_C = 150\text{ mA}; I_B = 15\text{ mA}$ $V_{CEsat} < 0.2\text{ V}$

$I_C = 1\text{ A}; I_B = 100\text{ mA}$ ¹⁾²⁾ $V_{CEsat} < 1.0\text{ V}$
 $V_{BEsat} < 1.6\text{ V}$

Sustaining voltage

$I_C = 30\text{ mA}; I_B = 0$ ²⁾ $V_{CEOsust} > 35\text{ V}$

D.C. current gain ²⁾

$I_C = 10\text{ mA}; V_{CE} = 10\text{ V}$ $h_{FE} > 30$

$I_C = 150\text{ mA}; V_{CE} = 10\text{ V}$ $h_{FE} 40\text{ to }120$

$I_C = 1\text{ A}; V_{CE} = 10\text{ V}$ $h_{FE} > 15$

Feedback time constant

$I_C = 10\text{ mA}; V_{CB} = 10\text{ V}; f = 4\text{ MHz}$ $r_b \cdot C_c < 800\text{ ps}$

Collector capacitance at $f = 500\text{ kHz}$

$I_E = I_e = 0; V_{CB} = 10\text{ V}$ $C_c < 12\text{ pF}$

Emitter capacitance at $f = 500\text{ kHz}$

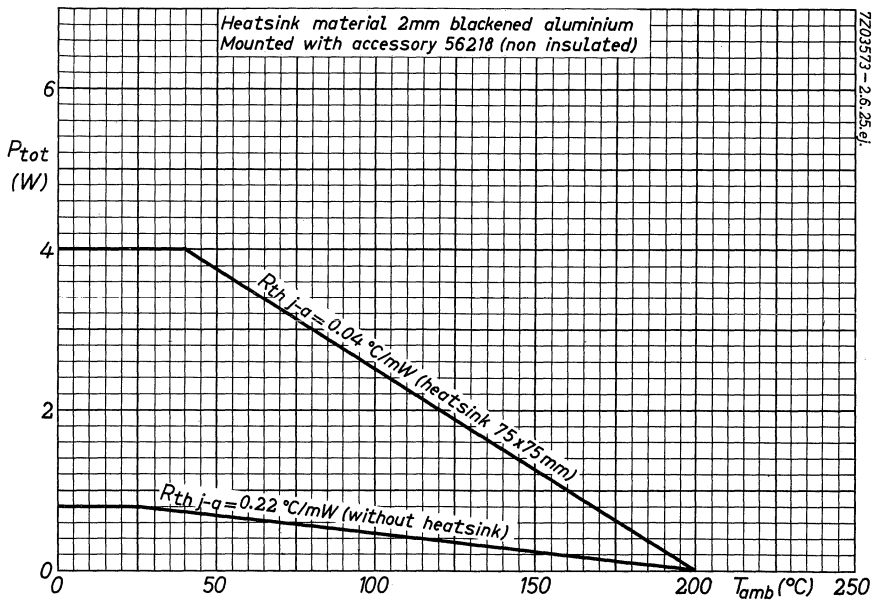
$I_C = I_c = 0; V_{EB} = 0.5\text{ V}$ $C_e < 80\text{ pF}$

Transition frequency

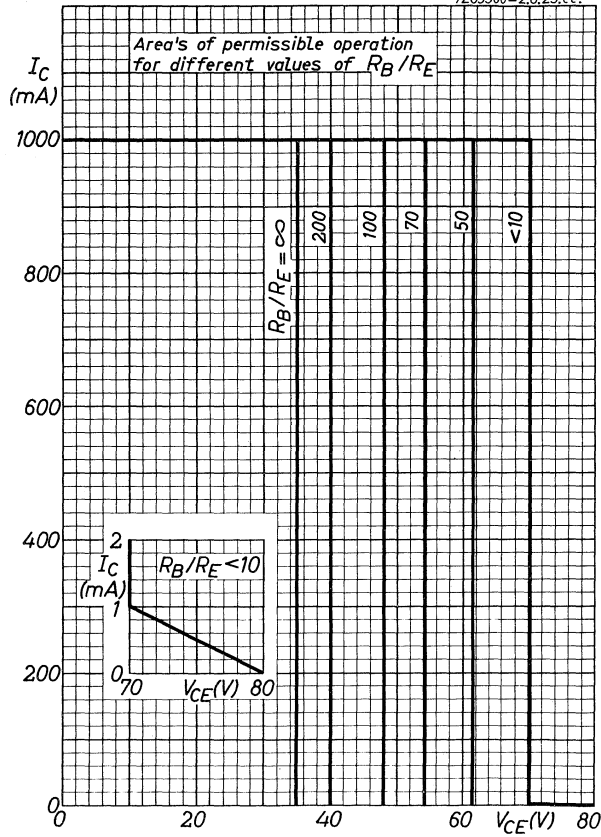
$I_C = 50\text{ mA}; V_{CE} = 10\text{ V}$ $f_T > 60\text{ MHz}$

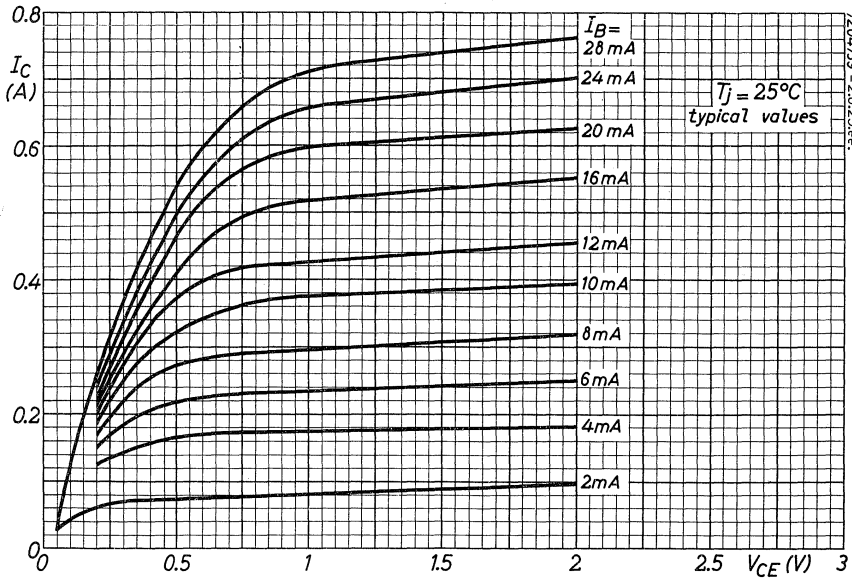
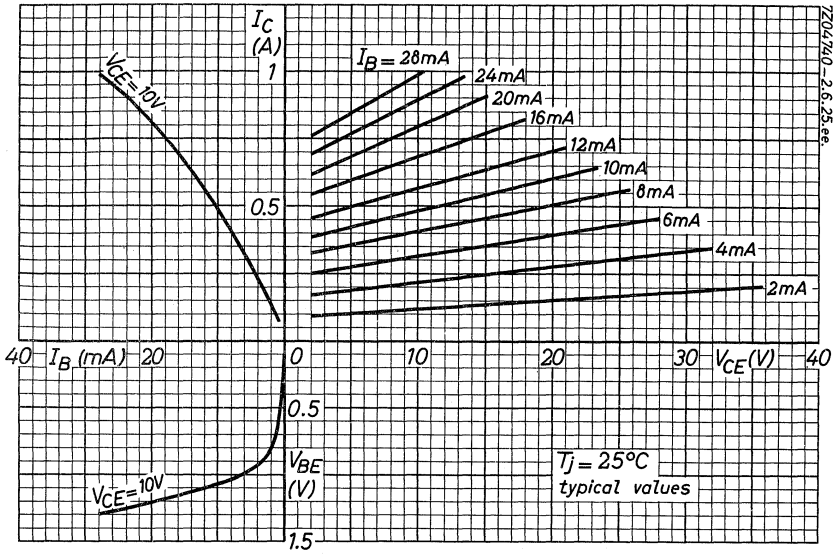
¹⁾ Measured with a lead length of 1 cm.

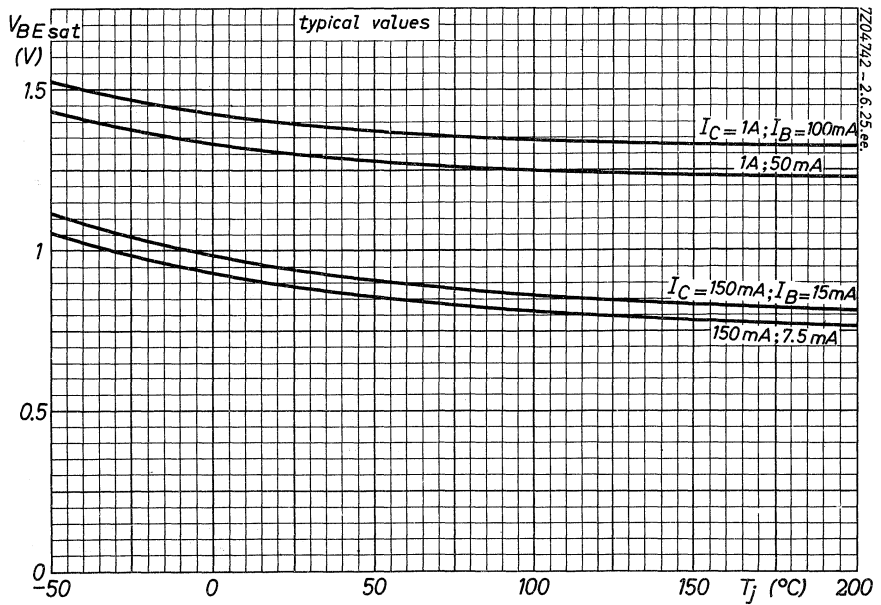
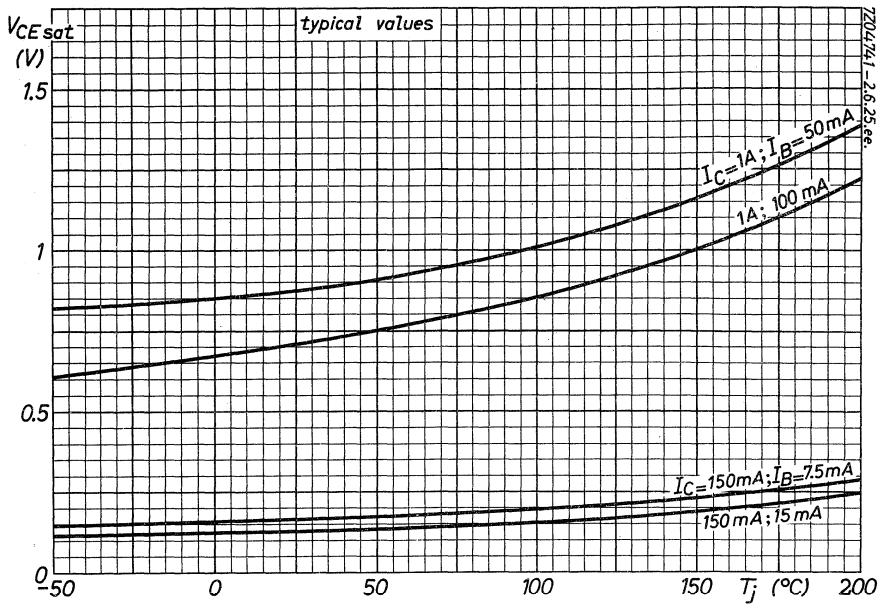
²⁾ Measured under pulsed conditions to avoid excessive dissipation.
 Pulse duration = 300 μs ; duty cycle $\delta < 0.01$

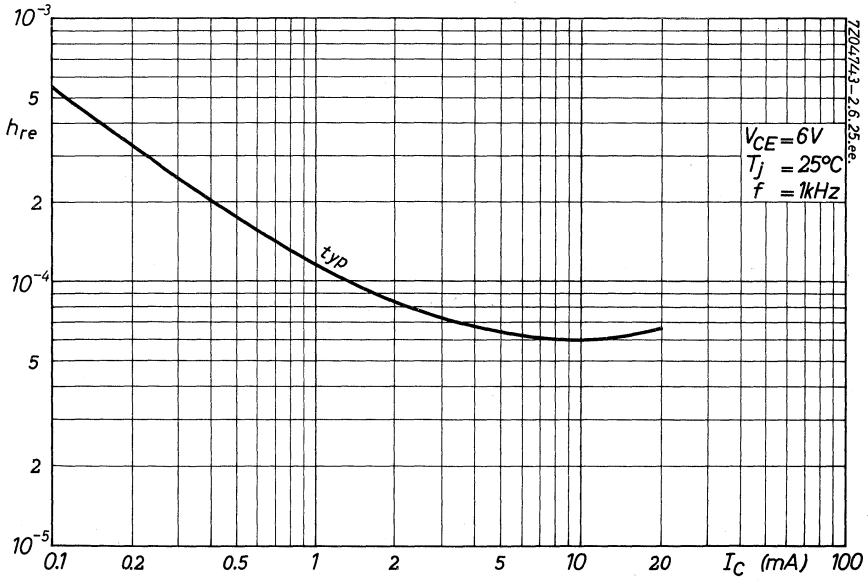
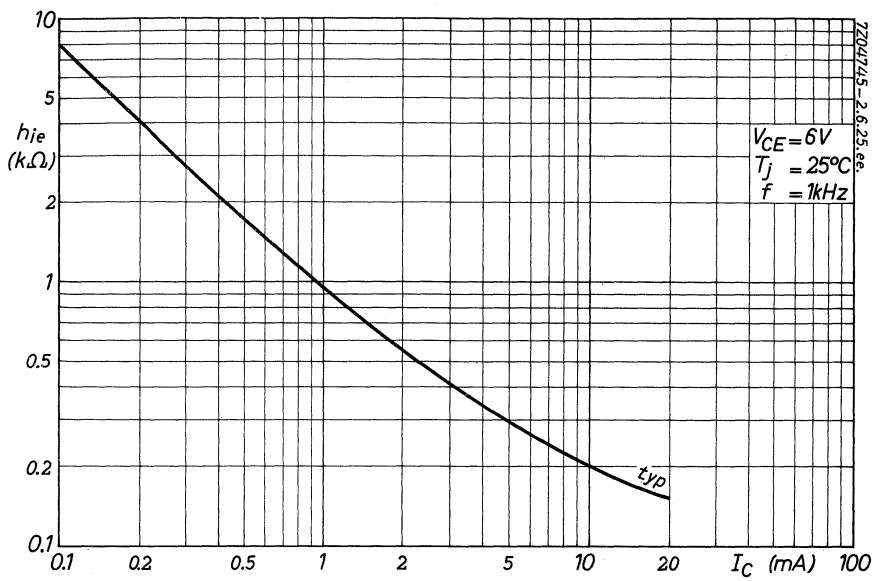


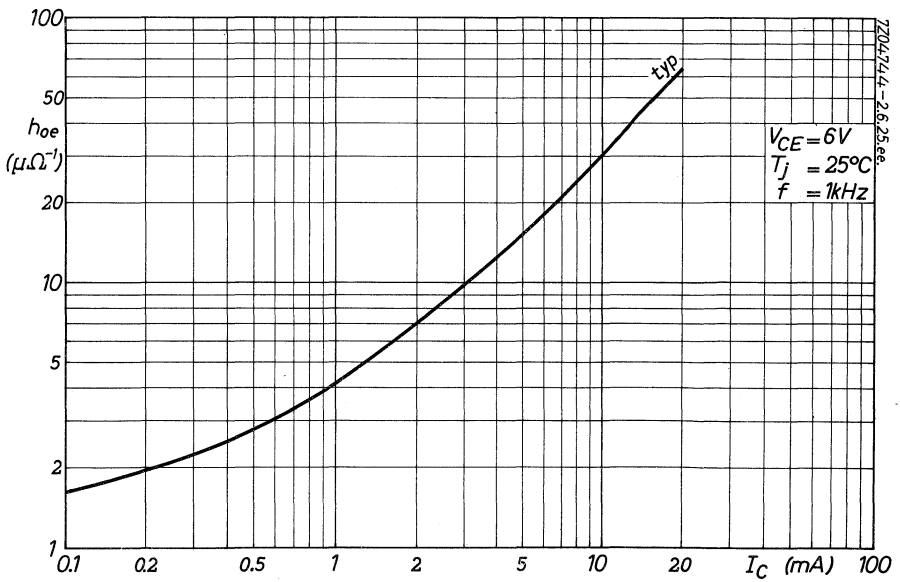
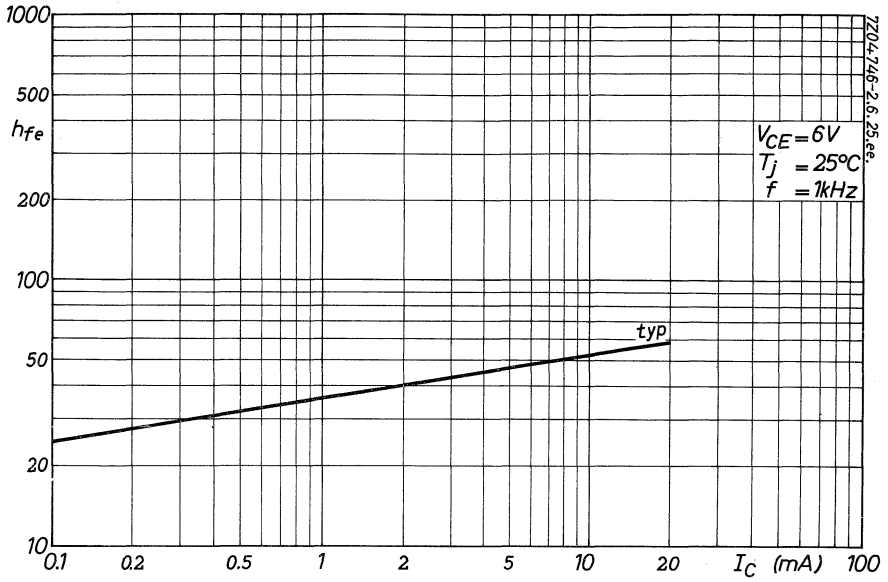
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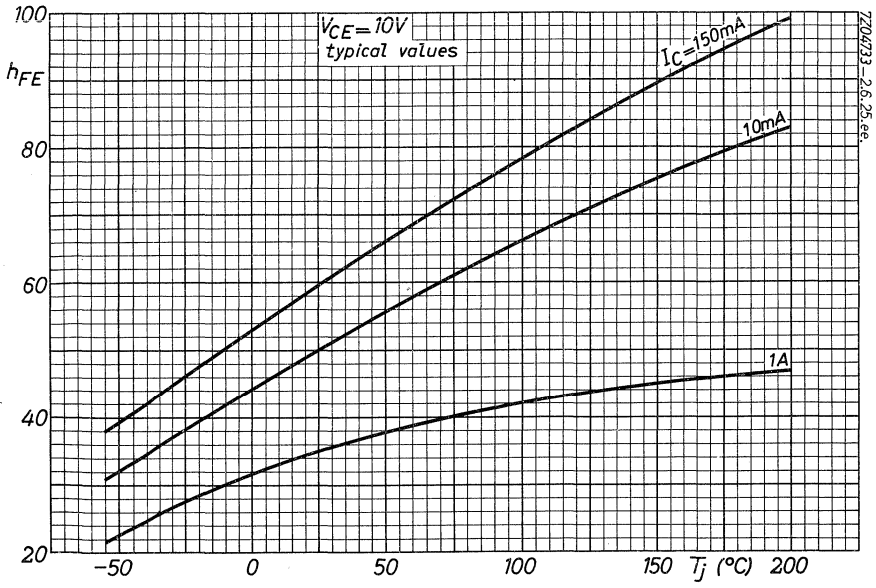
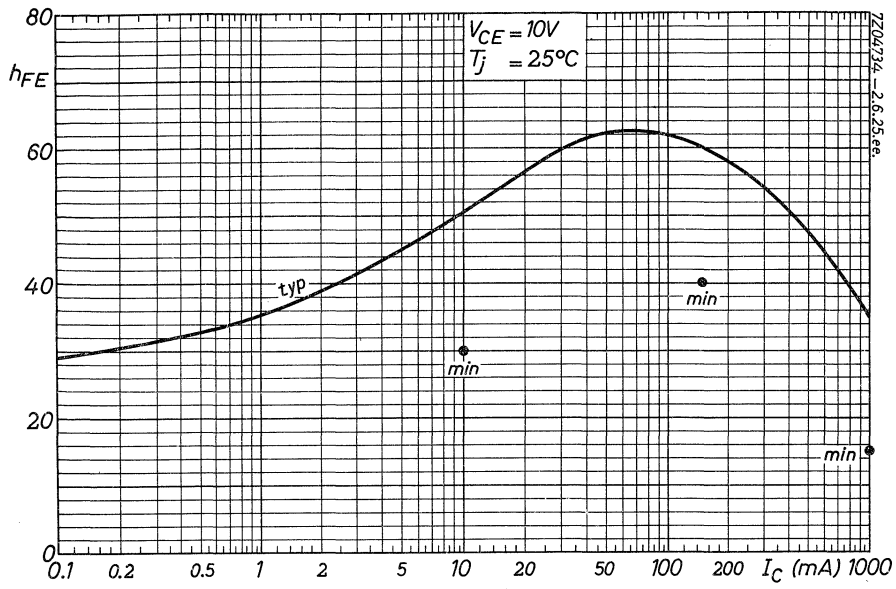


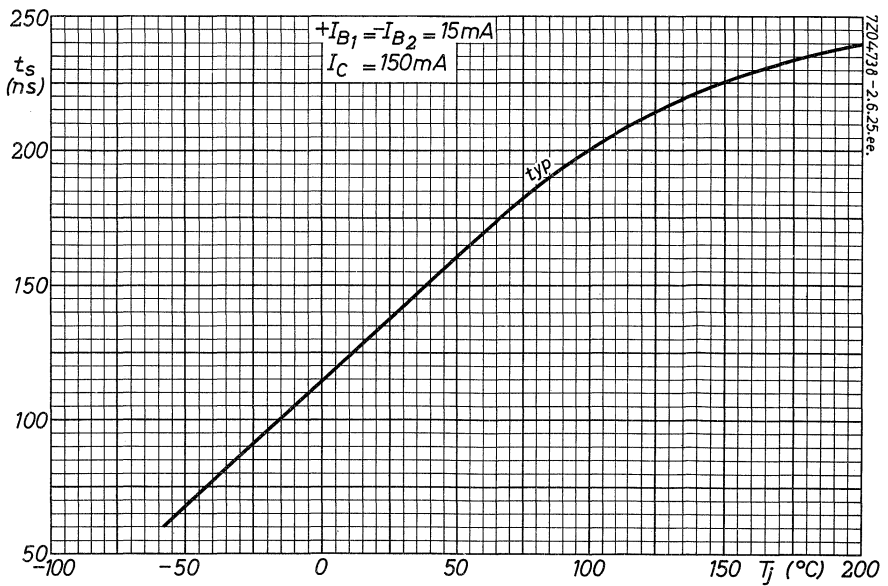
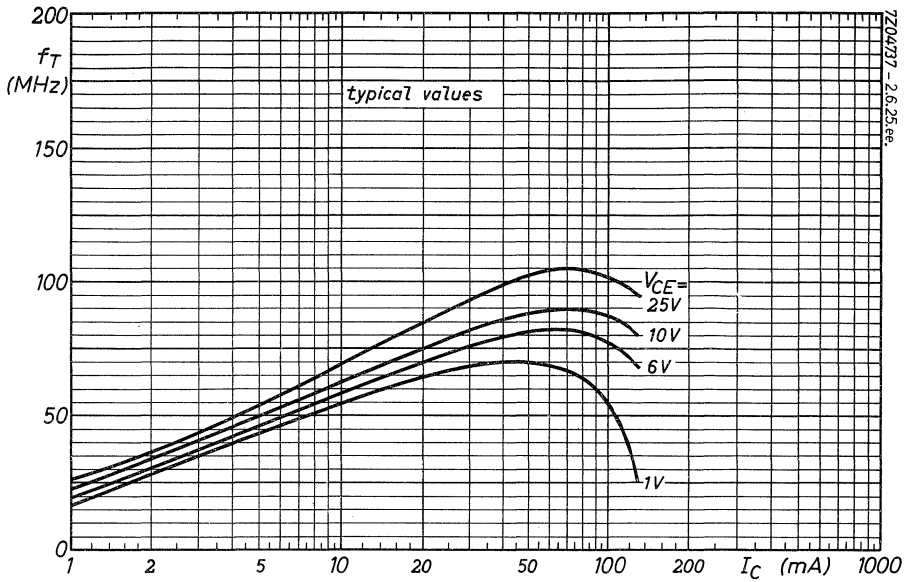


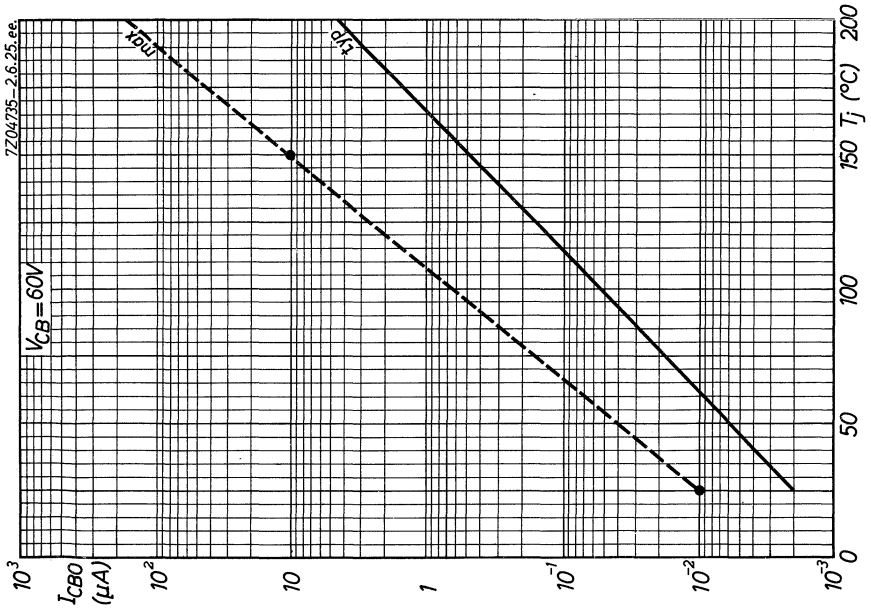
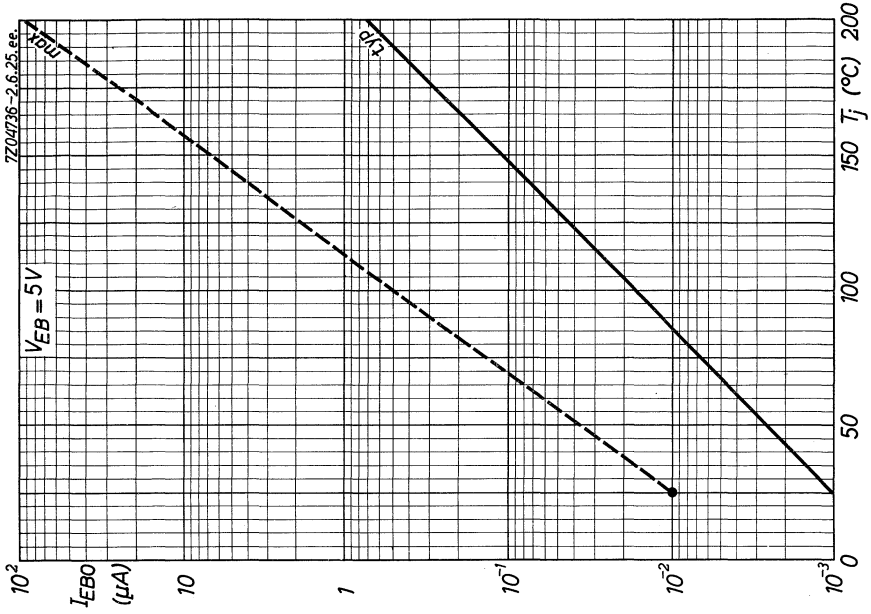












SILICON PLANAR EPITAXIAL TRANSISTOR

N-P-N transistor in a TO-72 metal envelope with insulated electrodes and a shield lead connected to the case.

The transistor has very low noise over a wide current range, a very high power gain and excellent intermodulation properties.

It is primarily intended for:

- Channel- and band aerial amplifiers for band I, II, III and IV/V (40-860 MHz)
 - Wide band aerial amplifiers (40-860 MHz)
 - Television distribution amplifiers
 - Low noise wide band vertical amplifier in high speed oscilloscopes
- It is also suitable for military- and industrial applications, such as:
- R.F. amplifiers and mixers for communication equipment
 - Microwave telephony link systems, wide band i.f. amplifiers
 - Large bandwidth radar i.f. amplifiers

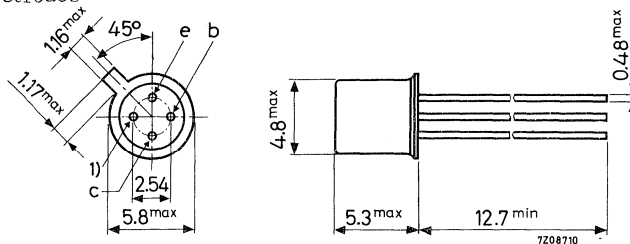
QUICK REFERENCE DATA

Collector-base voltage (open emitter; peak value)	V_{CBOM}	max.	30	V
Collector-emitter voltage (open base)	V_{CEO}	max.	15	V
Collector current (peak value; $f > 1$ MHz)	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
Transition frequency $I_C = 25$ mA; $V_{CE} = 5$ V; $f = 500$ MHz	f_T	typ.	1.4	GHz
Feedback capacitance at $f = 1$ MHz $I_C = 2$ mA; $V_{CE} = 5$ V	$-C_{re}$	typ.	0.6	pF
Noise figure at optimum source impedance $I_C = 2$ mA; $V_{CE} = 5$ V	F	f = 200 typ. 2.5	800	5.5 dB
Power gain (not neutralized) $I_C = 14$ mA; $V_{CE} = 10$ V	G_p	typ. 23	8	dB
Output power $d_{im} = -30$ dB; V.S.W.R. at output < 2 $I_C = 14$ mA; $V_{CE} = 10$ V	P_o	typ. 12	12	mW

MECHANICAL DATA

Dimensions in mm

TO-72
insulated electrodes



1) = shield lead (connected to case)

Accessories available: 56246; 56263

RATINGS (Limiting values) ¹⁾

Voltages

Collector-base voltage (open emitter; peak value)	V_{CBOM}	max.	30 V	
Collector-emitter voltage (peak value) $R_{BE} \leq 50 \Omega$	V_{CERM}	max.	30 V	2)
Collector-emitter voltage (open base)	V_{CEO}	max.	15 V	2)
Emitter-base voltage (open collector)	V_{EBO}	max.	2.5 V	

Currents

Collector current (d.c.)	I_C	max.	25 mA
Collector current (peak value; $f > 1$ MHz)	I_{CM}	max.	50 mA

Power dissipation

Total power dissipation up to $T_{amb} = 25^\circ C$	P_{tot}	max.	200 mW
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Temperatures

Storage temperature	T_{stg}	-65 to +200	$^\circ C$
Junction temperature	T_j	max.	200 $^\circ C$

THERMAL RESISTANCE

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

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

²⁾ $I_C = 10$ mA

CHARACTERISTICS

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

Collector cut-off current

$I_E = 0; V_{CB} = 15\text{ V}$

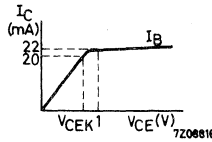
$I_{CBO} < 10\text{ nA}$

Knee voltage

$I_C = 20\text{ mA}; I_B = \text{value for which}$

$I_C = 22\text{ mA at } V_{CE} = 1\text{ V}$

$V_{CEK} < 0.75\text{ V}$



D.C. current gain

$I_C = 2\text{ mA}; V_{CE} = 1\text{ V}$

$h_{FE} \quad 25\text{ to }150$

$I_C = 25\text{ mA}; V_{CE} = 1\text{ V}$

$h_{FE} \quad 20\text{ to }125$

Transition frequency 1)

$I_C = 2\text{ mA}; V_{CE} = 5\text{ V}; f = 500\text{ MHz}$

$f_T > 1.0\text{ GHz}$
typ. 1.1 GHz

$I_C = 25\text{ mA}; V_{CE} = 5\text{ V}; f = 500\text{ MHz}$

$f_T > 1.3\text{ GHz}$
typ. 1.4 GHz

Collector capacitance at $f = 1\text{ MHz}$ 2)

$I_E = I_e = 0; V_{CB} = 10\text{ V}$

$C_C < 1.5\text{ pF}$

Feedback capacitance at $f = 1\text{ MHz}$ 1)

$I_C = 2\text{ mA}; V_{CE} = 5\text{ V}$

$-C_{re}$ typ. 0.6 pF
< 0.8 pF

Noise figure 1)

$I_C = 2\text{ mA}; V_{CE} = 5\text{ V}$

$f = 100\text{ kHz}; \text{ optimum source resistance}$

$F < 4\text{ dB}$

$f = 200\text{ MHz}; \text{ optimum source impedance}$

$F < 3.5\text{ dB}$

$f = 500\text{ MHz}; R_S = 50\text{ }\Omega$

$F < 5\text{ dB}$

$f = 800\text{ MHz}; \text{ optimum source impedance}$

$F \text{ typ. } 5.5\text{ dB}$

Power gain (not neutralized) 1)

$I_C = 14\text{ mA}; V_{CE} = 10\text{ V}; T_{amb} = 25\text{ }^\circ\text{C}$

		$f = 200$	800	MHz
G_p	>	21		dB
	typ.	23	8	dB

1) Shield lead grounded.

2) Shield lead not connected.

CHARACTERISTICS (continued)

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

Intermodulation characteristics ¹⁾

1. Output power at $f = 200\text{ MHz}$; $T_{amb} = 25\text{ }^\circ\text{C}$

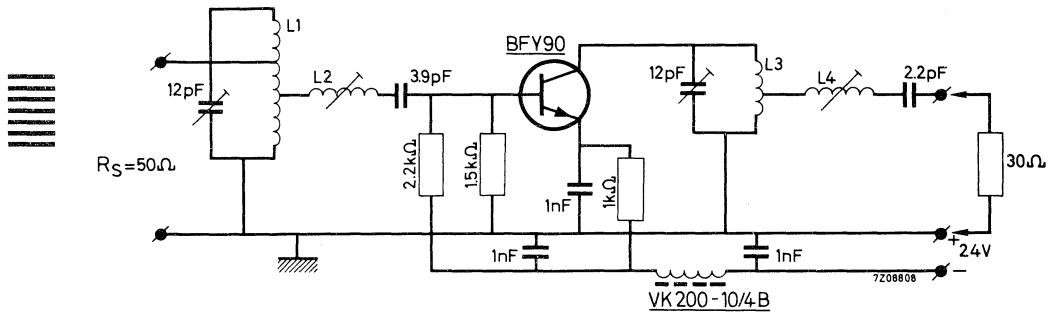
$I_C = 14\text{ mA}$; $V_{CE} = 10\text{ V}$; V.S.W.R. at output < 2

$f_p = 202\text{ MHz}$; $f_q = 205\text{ MHz}$; $d_{im} = -30\text{ dB}$

measured at $f(2q-p) = 208\text{ MHz}$ (Channel 9)

$P_o > 10\text{ mW}$
typ. 12 mW

Test circuit:



Coil data:

L1 = 3 turns silver plated Cu wire (1.4 mm); winding pitch 2.7 mm;
int. diam. 8 mm; taps at 0.5 turn and 1.5 turns from earth.

L2 = 5.5 turns silver plated Cu wire (1.4 mm); winding pitch 2.2 mm;
int. diam. 8 mm.

L3 = 3 turns silver plated Cu wire (1.4 mm); winding pitch 3.3 mm;
int. diam. 8 mm.

L4 = 5.5 turns silver plated Cu wire (1.4 mm); winding pitch 2.2 mm;
int. diam. 11 mm.

¹⁾ Shield lead grounded

CHARACTERISTICS (continued)

Basis of adjustment

The intermodulation at an intermodulation distortion of -30 dB is caused by h.f. output current - voltage clipping.

The maximum undistorted output power is realised, if

- a. Current and voltage clipping take place concurrently.

This occurs if

$$R_L = \frac{V_{CE} - V_{CEK}}{I_C},$$

in which V_{CEK} is the high frequency knee voltage.

- b. The h.f. collector current is as small as possible.

This is so if $-C_L = +C_{oe}$,

in which C_{oe} is the output capacitance of the transistor at short circuited input.

For maximum output power at an intermodulation distortion of -30 dB, the (experimentally found) values of R_L and C_L are:

$$R_L = 560 \Omega; C_L = -1.8 \text{ pF}$$

Adjustment procedure

1. Remove the transistor and connect a dummy consisting of a 560Ω resistor in parallel with a 1.8 pF capacitor between the collector and emitter connections of the output circuit.
2. Tune and match the output circuit for zero reflection at 205 MHz (V.S.W.R. = 1). After this adjustment, no further change may be made in the output circuit.
3. Replace the dummy by the transistor. Tune and match the input circuit for maximum power gain and good band pass curve.
The V.S.W.R. of the output will then, in most cases, be ≤ 2 over the whole channel.
Corrections can be made by tuning L_2 ; this will not disturb the band pass curve.

CHARACTERISTICS (continued)

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

Intermodulation characteristics ¹⁾

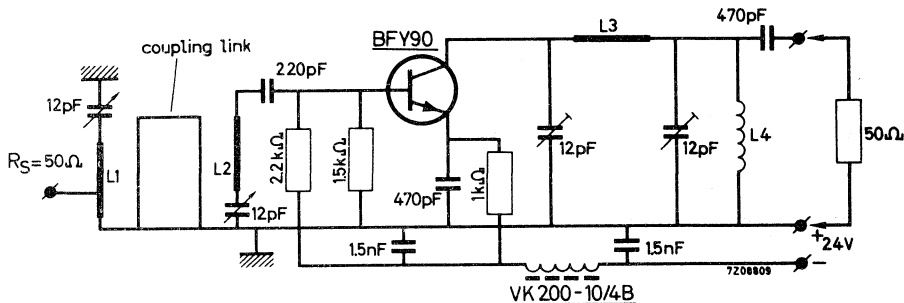
2. Output power at $f = 800\text{ MHz}$; $T_{amb} = 25\text{ }^\circ\text{C}$

$I_C = 14\text{ mA}$; $V_{CE} = 10\text{ V}$; V.S.W.R. at output < 2

$f_p = 798\text{ MHz}$; $f_q = 802\text{ MHz}$; $d_{im} = -30\text{ dB}$
 measured at $f(2q-p) = 806\text{ MHz}$ (Channel 62)

P_o typ. 12 mW

Test circuit:



Coil data:

L1 = 24 mm x 6 mm x 0.5 mm silver plated Cu strip.

Tap of the input at 5 mm from earth.

L2 = 15 mm x 6 mm x 0.5 mm silver plated Cu strip.

L3 = 20 mm x 8 mm x 0.5 mm silver plated Cu strip.

L4 = 4 turns enamelled Cu wire (0.5 mm); winding pitch 1.5 mm; int. diam. 4 mm

Coupling link: 42 mm silver plated Cu wire (1 mm).

Basis of adjustment.

At 800 MHz no dummy can be used to adjust for optimum collector load because at these frequencies the impedance transformations of a dummy are too high. A small signal at the mid-channel frequency of 802 MHz is fed to the input and increased until clipping occurs; that is, until the output power no longer increases linearly with the input signal. This clipping can be eliminated by tuning the output circuit, thereby making the output power equal to

$$P_o = \frac{I_C (V_{CE} - V_{CEK})}{2} = 60\text{ mW}$$

The output circuit is adjusted for minimum intermodulation if the input signal is as small as possible at $P_o = 60\text{ mW}$.

After this adjustment has been made no further change may be made in the output circuit.

Adjust the input circuit for maximum power gain and good band pass curve.

The V.S.W.R. of the output is then ≤ 2 over the whole channel.

¹⁾ Shield lead grounded

CHARACTERISTICS (continued)

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

Intermodulation characteristics ¹⁾

3. Intermodulation distortion

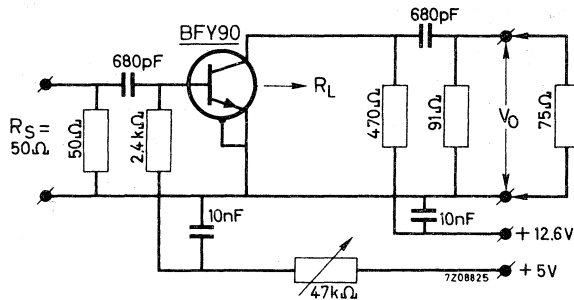
$I_C = 14\text{ mA}$; $V_{CE} = 6\text{ V}$; $R_L = 37.5\text{ }\Omega$; $T_{amb} = 25\text{ }^\circ\text{C}$

$V_O = 100\text{ mV}$ at $f_p = 183\text{ MHz}$

$V_O = 100\text{ mV}$ at $f_q = 200\text{ MHz}$
measured at $f(2q-p) = 217\text{ MHz}$

d_{im} typ. -50 dB

Test circuit:



y parameters at $f = 500\text{ MHz}$ (common emitter) ¹⁾

$I_C = 2\text{ mA}$; $V_{CE} = 5\text{ V}$

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

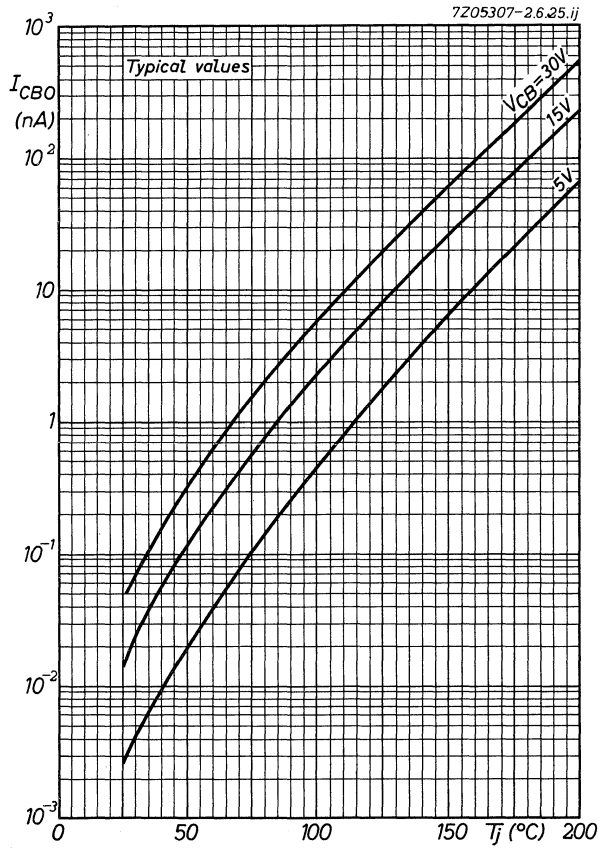
Maximum unilateralised power gain

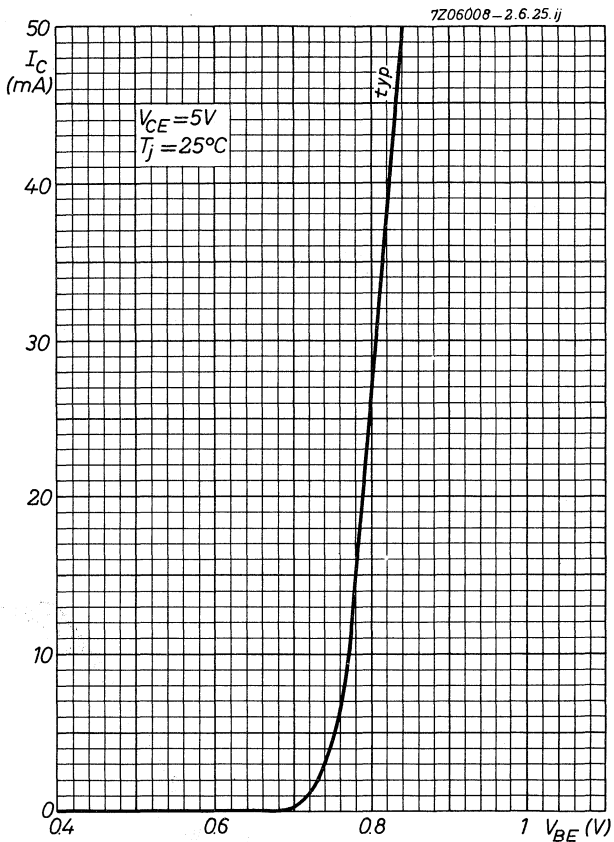
$$G_{UM} = \frac{|y_{fe}|^2}{4g_{ie}g_{oe}}$$

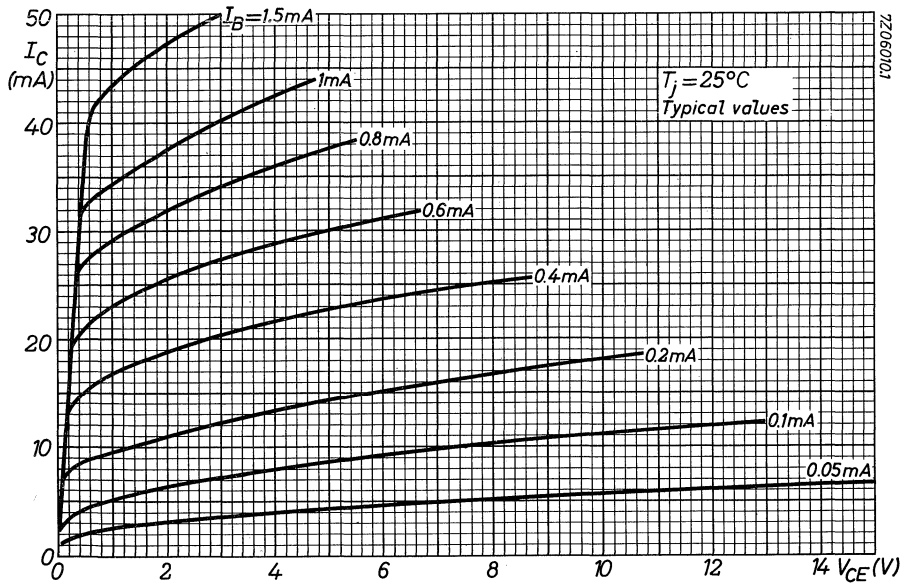
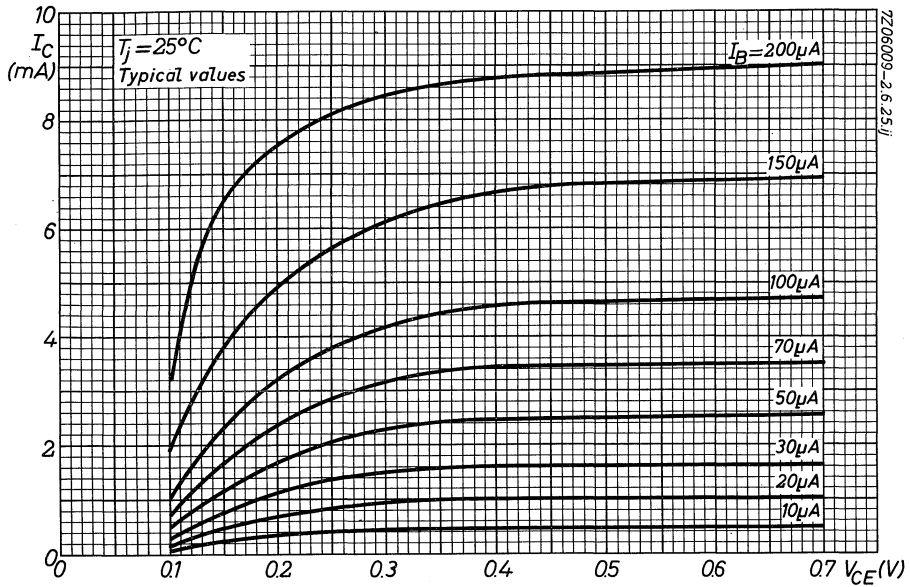
$I_C = 2\text{ mA}$; $V_{CE} = 5\text{ V}$; $f = 500\text{ MHz}$

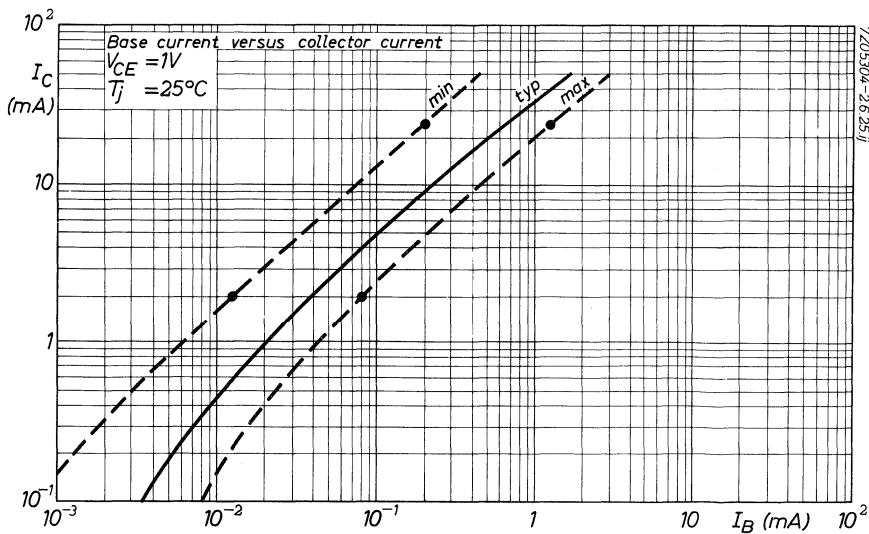
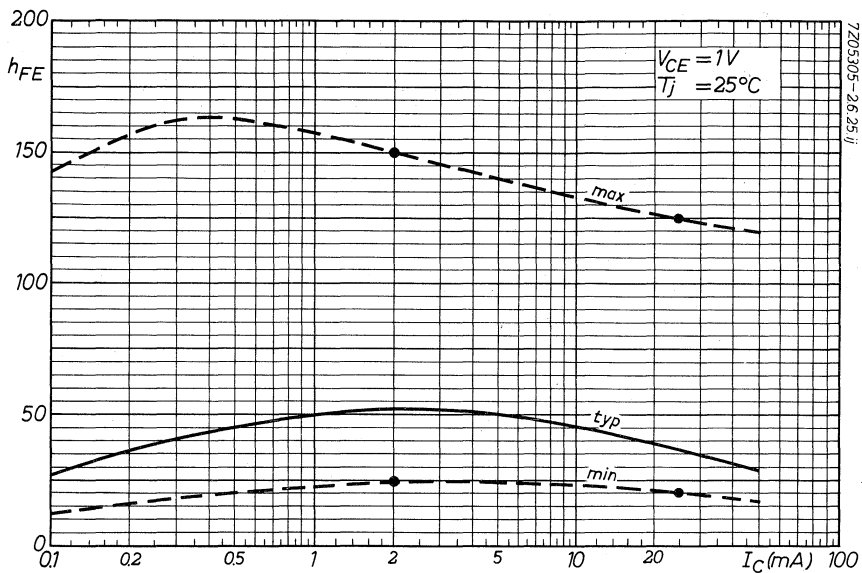
G_{UM} typ. 22 dB

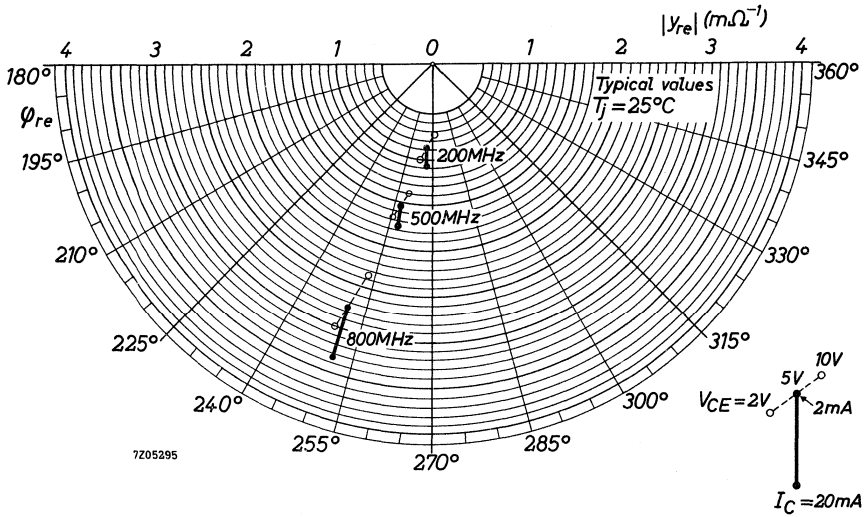
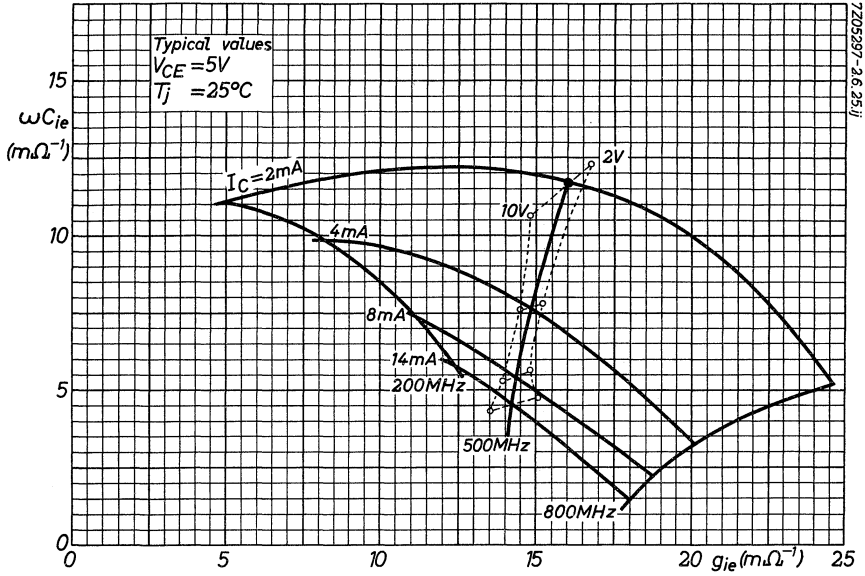
¹⁾ Shield lead grounded

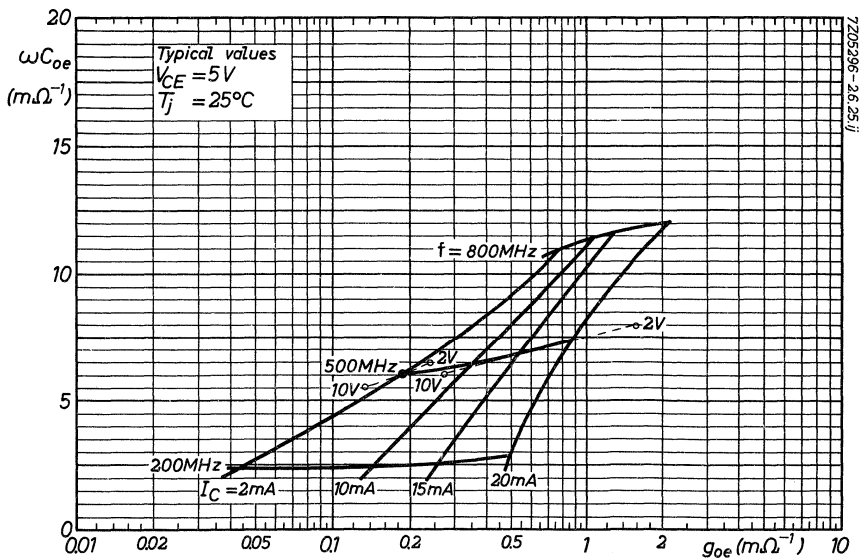
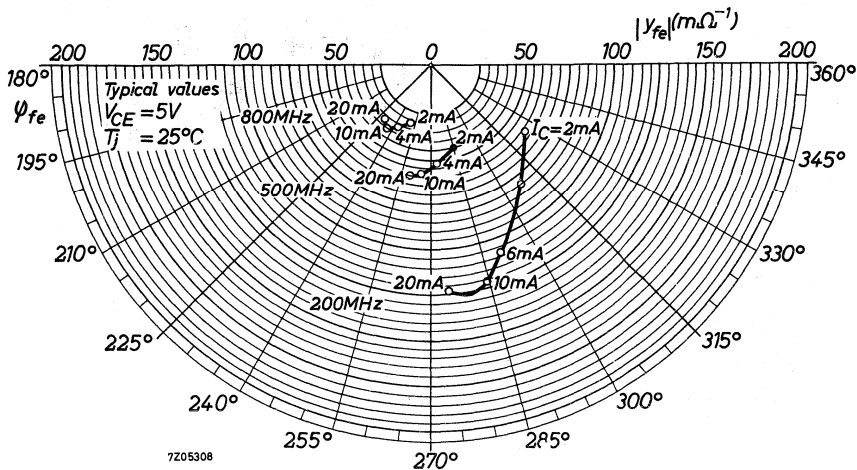


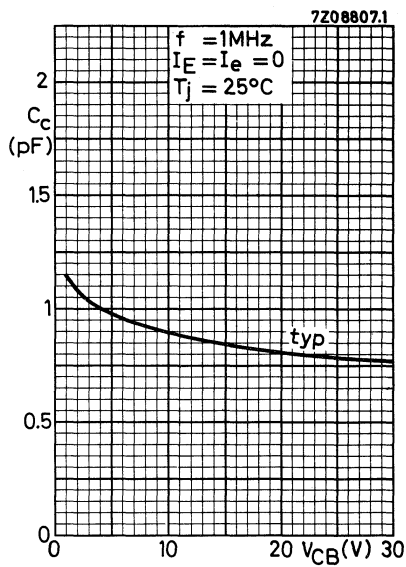
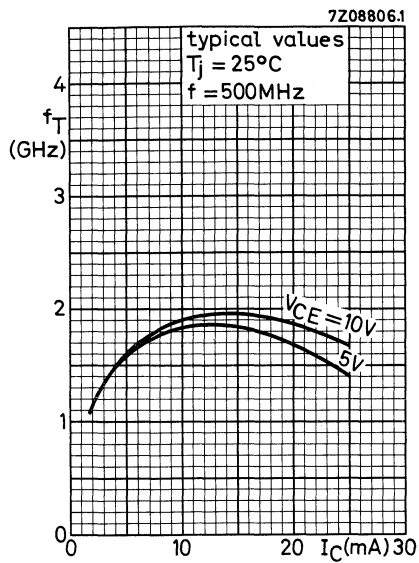


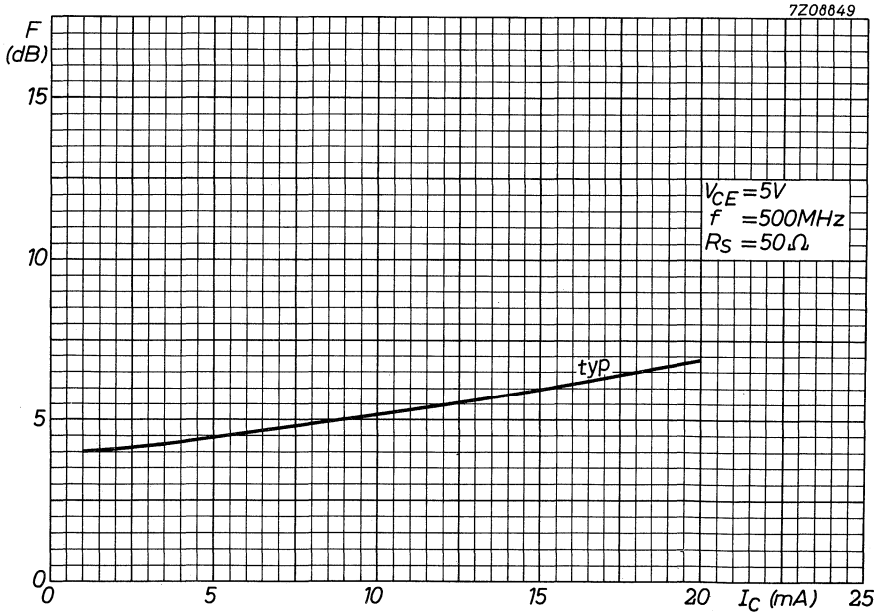
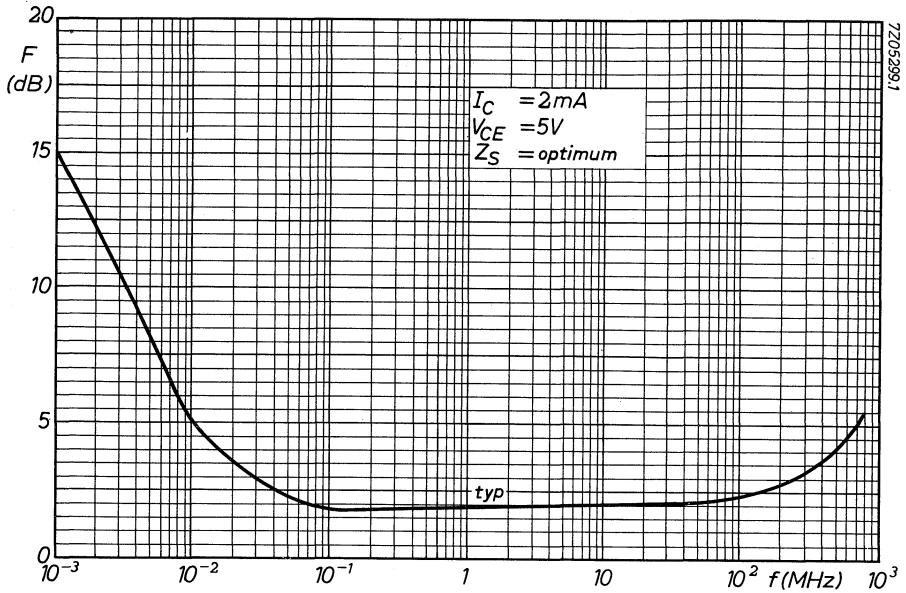












APPLICATION INFORMATION

Performance of channel- and band amplifiers 1)

Frequency range	Channel 9 202-209			Channel 55 742-750	Band II 87.5-108	Band III 174-230	MHz
Transistor used in final stage	BFW16	BFW16	BFY90	BFW16	BFW16	BFW16	
driver stage	BFW16	BFY90	BF183	BFW16		BFW16	
second stage				BFY90			
first stage	BFY90	BF200	BF200	BFY90	BFY90	BFY90	
<u>Output power at</u>							
$d_{im} = -30$ dB	150 ²⁾	60	10	80			mW
$d_{im} = -50$ dB					25		mW
$d_{im} = -60$ dB						10	mW
<u>Power gain</u>	44	48	49	30	42.5	39	dB
<u>Noise figure</u>	6.3	5.7	5.5	7	6.0-6.5	6.2-6.7	dB
<u>V.S.W.R.</u> over the whole channel or band							
for the input	< 2	< 2	< 2	< 2	< 2	< 2	
for the output	< 2	< 2	< 2	< 2	< 2	< 2	
<u>Load impedance</u>	30	30	30	50	30	30	Ω
<u>Source impedance</u>	60	60	60	50	60	60	Ω

1) Application information bulletins with detailed informations of all these amplifiers and a study of intermodulation are available on request.

2) $V_o = 2.2$ V over $R_L = 30 \Omega$ or
 $V_o = 3$ V over $R_L = 60 \Omega$.

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.

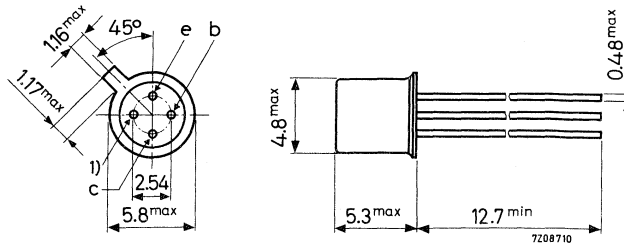
QUICK REFERENCE DATA			
Collector-base voltage (open emitter)	V_{CBO}	max.	30 V
Collector-emitter voltage (open base)	V_{CEO}	max.	15 V
Collector current (d. c.)	I_C	max.	50 mA
Total power dissipation up to $T_{amb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	200 mW
Junction temperature	T_j	max.	200 $^\circ\text{C}$
Transition frequency $I_C = 6\text{ mA}; V_{CE} = 10\text{ V}$	f_T	>	900 MHz
Maximum unilaterised power gain $I_C = 6\text{ mA}; V_{CE} = 12\text{ V}; f = 200\text{ MHz}$	G_{UM}	typ.	36 dB
Noise figure at $f = 60\text{ MHz}$ $I_C = 1\text{ mA}; V_{CE} = 6\text{ V}; R_S = 400\text{ }\Omega$	F	<	6 dB

MECHANICAL DATA

Dimensions in mm

TO-72

Insulated electrodes



1) = shield lead (connected to case)

Accessories available: 56246, 56263

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

Voltages

Collector-base voltage (open emitter)	V_{CBO}	max.	30 V
Collector-emitter voltage (open base) $I_C = 3 \text{ mA}$	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
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Power dissipation

Total power dissipation up to $T_{amb} = 25 \text{ }^\circ\text{C}$	P_{tot}	max.	200 mW
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Temperatures

Storage temperature	T_{stg}	-65 to +200	$^\circ\text{C}$
Junction temperature	T_j	max.	200 $^\circ\text{C}$

THERMAL RESISTANCE

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

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

All measurements taken with ungrounded shield lead

Collector cut-off current

$I_E = 0; V_{CB} = 15\text{ V}$	I_{CBO}	< 10 nA
$I_E = 0; V_{CB} = 15\text{ V}; T_j = 150\text{ }^\circ\text{C}$	I_{CBO}	< 1 μA

Saturation voltages

$I_C = 10\text{ mA}; I_B = 1\text{ mA}$	V_{CEsat}	< 0.4 V
	V_{BEsat}	< 1 V

D.C. current gain

$I_C = 3\text{ mA}; V_{CE} = 1\text{ V}$	h_{FE}	> 20
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Collector capacitance at $f = 140\text{ kHz}$

$I_E = I_e = 0; V_{CB} = 10\text{ V}$	C_c	< 1.7 pF
$I_E = I_e = 0; V_{CB} = 0$	C_c	< 3.0 pF

Emitter capacitance at $f = 140\text{ kHz}$

$I_C = I_c = 0; V_{EB} = 0.5\text{ V}$	C_e	< 2.0 pF
--	-------	----------

Transition frequency

$I_C = 6\text{ mA}; V_{CE} = 10\text{ V}^1)$	f_T	> 900 MHz
--	-------	-----------

Noise figure at $f = 60\text{ MHz}$

$I_C = 1\text{ mA}; V_{CE} = 6\text{ V}; R_S = 400\ \Omega$	F	< 6 dB
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Oscillator power output at $f = 500\text{ MHz}$

$-I_E = 8\text{ mA}; V_{CB} = 15\text{ V}$	P_o	> 30 mW
--	-------	---------

Maximum unilateralised power gain

$G_{UM} = \frac{ y_{fe} ^2}{4g_{ie}g_{oe}}$		
$I_C = 6\text{ mA}; V_{CE} = 12\text{ V}; f = 200\text{ MHz}$	G_{UM}	typ. 36 dB

¹⁾ JEDEC registration: $I_C = 4\text{ mA}; V_{CE} = 10\text{ V}, f_T > 600\text{ MHz}$.

CHARACTERISTICS (continued)

$T_j = 25\text{ }^\circ\text{C}$

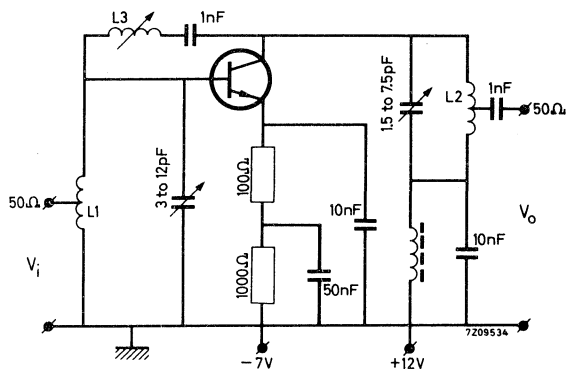
Available power gain at $f = 200\text{ MHz}$

$I_C = 6\text{ mA}$

$G_p > 15\text{ dB}$

Basic circuit for measuring the available neutralised power gain

Grounded shield lead



$L1 = 3.5$ turns tinned Cu wire, 1.3 mm
 $d = 8$ mm; length = 11 mm

Tap at ≈ 2 turns from earth side

$L2 = 8$ turns tinned Cu wire, 1.3 mm
 $d = 3$ mm; length = 22 mm

Tap at 1 turn from earth side

$L3 = 0.4$ to $0.65\text{ }\mu\text{H}$

SILICON PLANAR TRANSISTOR

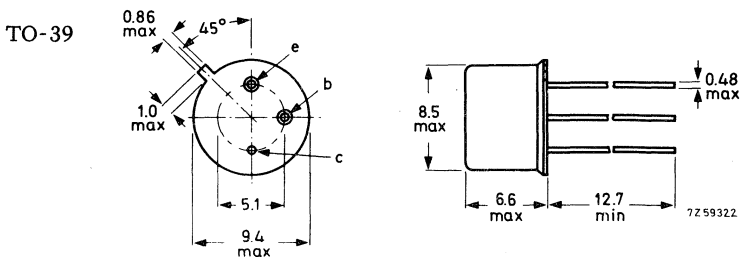
N-P-N double diffused transistor in a TO-39 metal envelope with the collector connected to the case. The 2N1613 is intended for use in a wide variety of applications, such as d.c. and high frequency amplifiers and switching applications.

QUICK REFERENCE DATA		
Collector-base voltage (open emitter)	V_{CB0}	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 $T_{amb} = 25^\circ\text{C}$	P_{tot}	max. 0.8 W
Junction temperature	T_j	max. 200 $^\circ\text{C}$
D.C. current gain		
$I_C = 0.1 \text{ mA}; V_{CE} = 10 \text{ V}$	h_{FE}	> 20
$I_C = 10 \text{ mA}; V_{CE} = 10 \text{ V}$	h_{FE}	> 35
$I_C = 150 \text{ mA}; V_{CE} = 10 \text{ V}$	h_{FE}	40 to 120
Transition frequency		
$I_C = 50 \text{ mA}; V_{CE} = 10 \text{ V}$	f_T	> 60 MHz

MECHANICAL DATA

Dimensions in mm

Collector connected to case



max. lead diameter is guaranteed only for 12.7 mm

Accessories available: 56218, 56245, 56265.

RATINGS (Limiting values) ¹⁾Voltages

Collector-base voltage (open emitter)	V _{CBO}	max.	75 V
Collector-emitter voltage (R _{BE} < 10 Ω)	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
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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.

CHARACTERISTICS $T_{amb} = 25\text{ }^{\circ}\text{C}$ unless otherwise specifiedCollector cut-off current $I_E = 0; V_{CB} = 60\text{ V}$ $I_{CBO} < 10\text{ nA}$ $I_E = 0; V_{CB} = 60\text{ V}; T_{amb} = 150\text{ }^{\circ}\text{C}$ $I_{CBO} < 10\text{ }\mu\text{A}$ Emitter cut-off current $I_C = 0; V_{EB} = 5\text{ V}$ $I_{EBO} < 10\text{ nA}$ Collector-emitter sustaining voltage $I_C = 100\text{ mA}; R_{BE} < 10\text{ }\Omega$ $V_{CERsust} > 50\text{ V}^1)$ Saturation voltages $I_C = 150\text{ mA}; I_B = 15\text{ mA}$ $V_{CEsat} < 1.5\text{ V}^1)$ $V_{BEsat} < 1.3\text{ V}^1)$ D.C. current gain $I_C = 0.1\text{ mA}; V_{CE} = 10\text{ V}$ $h_{FE} > 20$ $I_C = 10\text{ mA}; V_{CE} = 10\text{ V}$ $h_{FE} > 35\text{ }^1)$ $I_C = 150\text{ mA}; V_{CE} = 10\text{ V}$ $h_{FE} 40\text{ to }120\text{ }^1)$ $I_C = 500\text{ mA}; V_{CE} = 10\text{ V}$ $h_{FE} > 20\text{ }^1)$ $I_C = 10\text{ mA}; V_{CE} = 10\text{ V}; T_{amb} = -55\text{ }^{\circ}\text{C}$ $h_{FE} > 20$ h parameters at $f = 1\text{ kHz}$ $-I_E = 1\text{ mA}; V_{CB} = 5\text{ V}$ Input impedance $h_{ib} 24\text{ to }34\text{ }\Omega$ Reverse voltage transfer $h_{rb} < 3\text{ }10^{-4}$ Output admittance $h_{ob} 0.1\text{ to }0.5\text{ }\mu\Omega^{-1}$ $-I_E = 5\text{ mA}; V_{CB} = 10\text{ V}$ Input impedance $h_{ib} 4\text{ to }8\text{ }\Omega$ Reverse voltage transfer $h_{rb} < 3\text{ }10^{-4}$ Output admittance $h_{ob} 0.1\text{ to }1.0\text{ }\mu\Omega^{-1}$ Small signal current gain $I_C = 1\text{ mA}; V_{CE} = 5\text{ V}$ $h_{fe} 30\text{ to }100$ $I_C = 5\text{ mA}; V_{CE} = 10\text{ V}$ $h_{fe} 35\text{ to }150$ ¹⁾ Measured under pulse conditions to avoid excessive dissipation.Pulse duration $t < 300\text{ }\mu\text{s}$, duty cycle $\delta < 0.01$

CHARACTERISTICS (continued)

$T_{amb} = 25\text{ }^{\circ}\text{C}$ unless otherwise specified

Transition frequency

$I_C = 50\text{ mA}; V_{CE} = 10\text{ V}$

$f_T > 60\text{ MHz}$

Collector capacitance at $f = 1\text{ MHz}$

$I_E = I_e = 0; V_{CB} = 10\text{ V}$

$C_c < 25\text{ pF}$

Emitter capacitance at $f = 1\text{ MHz}$

$I_C = I_c = 0; V_{EB} = 0.5\text{ V}$

$C_e < 80\text{ pF}$

Noise figure at $f = 1\text{ kHz}$

$I_C = 0.3\text{ mA}; V_{CE} = 10\text{ V}$

$R_S = 510\text{ }\Omega; \text{Bandwidth: } 200\text{ Hz}$

$F < 12\text{ dB}$

SILICON PLANAR TRANSISTOR

N-P-N double diffused transistor in a TO-39 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.

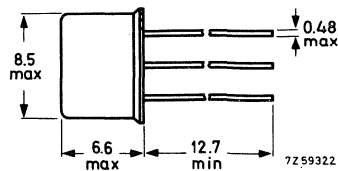
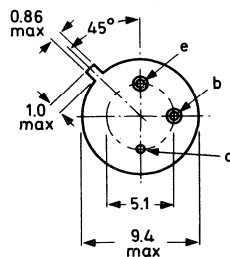
QUICK REFERENCE DATA			
Collector-base voltage (open emitter)	V_{CBO}	max.	75 V
Collector-emitter voltage ($R_{BE} < 10 \Omega$)	V_{CER}	max.	50 V
Collector current (peak value)	I_{CM}	max.	1 A
Total power dissipation up to $T_{amb} = 25^\circ C$	P_{tot}	max.	0.8 W
Junction temperature	T_j	max.	200 $^\circ C$
D.C. current gain			
$I_C = 0.1 \text{ mA}; V_{CE} = 10 \text{ V}$	h_{FE}	>	35
$I_C = 10 \text{ mA}; V_{CE} = 10 \text{ V}$	h_{FE}	>	75
$I_C = 150 \text{ mA}; V_{CE} = 10 \text{ V}$	h_{FE}		100 to 300
Transition frequency			
$I_C = 50 \text{ mA}; V_{CE} = 10 \text{ V}$	f_T	>	70 MHz

MECHANICAL DATA

Dimensions in mm

Collector connected to case

TO-39



max. lead diameter is guaranteed only for 12.7 mm

Accessories available: 56218, 56245, 56265.

CHARACTERISTICS $T_{amb} = 25\text{ }^{\circ}\text{C}$ unless otherwise specifiedCollector cut-off current $I_E = 0; V_{CB} = 60\text{ V}$ $I_{CBO} < 10\text{ nA}$ $I_E = 0; V_{CB} = 60\text{ V}; T_{amb} = 150\text{ }^{\circ}\text{C}$ $I_{CBO} < 10\text{ }\mu\text{A}$ Emitter cut-off current $I_C = 0; V_{EB} = 5\text{ V}$ $I_{EBO} < 5\text{ nA}$ Collector-emitter sustaining voltage $I_C = 100\text{ mA}; R_{BE} < 10\text{ }\Omega$ $V_{CERsust} > 50\text{ V }^1)$ Saturation voltages $I_C = 150\text{ mA}; I_B = 15\text{ mA}$ $V_{CEsat} < 1.5\text{ V }^1)$ $V_{BEsat} < 1.3\text{ V }^1)$ D.C. current gain $I_C = 10\text{ }\mu\text{A}; V_{CE} = 10\text{ V}$ $h_{FE} > 20$ $I_C = 0.1\text{ mA}; V_{CE} = 10\text{ V}$ $h_{FE} > 35$ $I_C = 10\text{ mA}; V_{CE} = 10\text{ V}$ $h_{FE} > 75\text{ }^1)$ $I_C = 150\text{ mA}; V_{CE} = 10\text{ V}$ $h_{FE} 100\text{ to }300\text{ }^1)$ $I_C = 500\text{ mA}; V_{CE} = 10\text{ V}$ $h_{FE} > 40\text{ }^1)$ $I_C = 10\text{ mA}; V_{CE} = 10\text{ V}; T_{amb} = -55\text{ }^{\circ}\text{C}$ $h_{FE} > 35$ h parameters at $f = 1\text{ kHz}$ $-I_E = 1\text{ mA}; V_{CB} = 5\text{ V}$ Input impedance $h_{ib} 24\text{ to }34\text{ }\Omega$ Reverse voltage transfer $h_{rb} < 5\text{ }10^{-4}$ Output admittance $h_{ob} 0.1\text{ to }0.5\text{ }\mu\Omega^{-1}$ $-I_E = 5\text{ mA}; V_{CB} = 10\text{ V}$ Input impedance $h_{ib} 4\text{ to }8\text{ }\Omega$ Reverse voltage transfer $h_{rb} < 5\text{ }10^{-4}$ Output admittance $h_{ob} 0.1\text{ to }1.0\text{ }\mu\Omega^{-1}$ Small signal current gain $I_C = 1\text{ mA}; V_{CE} = 5\text{ V}$ $h_{fe} 50\text{ to }200$ $I_C = 5\text{ mA}; V_{CE} = 10\text{ V}$ $h_{fe} 70\text{ to }300$ ¹⁾ Measured under pulse conditions to avoid excessive dissipation.Pulse duration $t < 300\text{ }\mu\text{s}$, duty cycle $\delta < 0.01$

CHARACTERISTICS (continued)

$T_{amb} = 25\text{ }^{\circ}\text{C}$ unless otherwise specified

Transition frequency

$I_C = 50\text{ mA}; V_{CE} = 10\text{ V}$

$f_T > 70\text{ MHz}$

Collector capacitance at $f = 1\text{ MHz}$

$I_E = I_e = 0; V_{CB} = 10\text{ V}$

$C_c < 25\text{ pF}$

Emitter capacitance at $f = 1\text{ MHz}$

$I_C = I_c = 0; V_{EB} = 0.5\text{ V}$

$C_e < 80\text{ pF}$

Noise figure at $f = 1\text{ kHz}$

$I_C = 0.3\text{ mA}; V_{CE} = 10\text{ V}$
 $R_S = 510\text{ }\Omega; \text{Bandwidth: } 200\text{ Hz}$

$F < 8\text{ dB}$



SILICON TRANSISTOR

High voltage n-p-n transistor in a TO-5 metal envelope with the collector connected to the case.

It is intended for use in high performance amplifier, oscillator and switching applications.

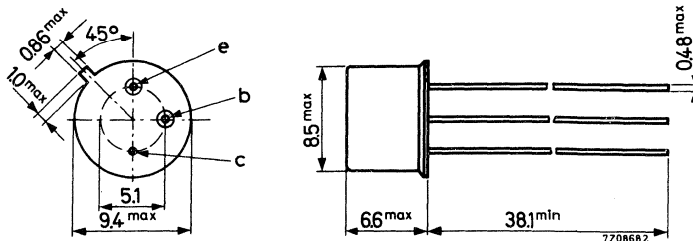
QUICK REFERENCE DATA		
Collector-base voltage (open emitter)	V_{CBO}	max. 120 V
Collector-emitter voltage ($R_{BE} \leq 10 \Omega$)	V_{CER}	max. 100 V
Collector current (d.c.)	I_C	max. 500 mA
Total power dissipation up to $T_{case} = 25^\circ C$	P_{tot}	max. 3.0 W
Junction temperature	T_j	max. 200 $^\circ C$
D.C. current gain		
$I_C = 0.1 \text{ mA}; V_{CE} = 10 \text{ V}$	h_{FE}	> 20
$I_C = 10 \text{ mA}; V_{CE} = 10 \text{ V}; T = -55^\circ C$	h_{FE}	> 20
$I_C = 10 \text{ mA}; V_{CE} = 10 \text{ V}$	h_{FE}	> 35
$I_C = 150 \text{ mA}; V_{CE} = 10 \text{ V}$	h_{FE}	40 to 120

MECHANICAL DATA

Dimensions in mm

Collector connected to case

TO-5



Accessories available: 56218, 56245, 56265.

RATINGS (Limiting values) ¹⁾Voltages

Collector-base voltage (open emitter)	V_{CBO}	max. 120 V
Collector-emitter voltage (open base)	V_{CEO}	max. 80 V
Collector-emitter voltage ($R_{BE} \leq 10 \Omega$)	V_{CER}	max. 100 V
Emitter-base voltage (open collector)	V_{EBO}	max. 7.0 V

Current

Collector current (d.c.)	I_C	max. 500 mA
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Power dissipation

Total power dissipation up to $T_{amb} = 25 \text{ }^\circ\text{C}$	P_{tot}	max. 0.8 W
up to $T_{case} = 100 \text{ }^\circ\text{C}$	P_{tot}	max. 1.7 W
up to $T_{case} = 25 \text{ }^\circ\text{C}$	P_{tot}	max. 3.0 W

Temperatures

Storage temperature	T_{stg}	-65 to +200 $^\circ\text{C}$
Junction temperature	T_j	max. 200 $^\circ\text{C}$

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th j-a}$	= 219 $^\circ\text{C/W}$
From junction to case	$R_{th j-c}$	= 58.3 $^\circ\text{C/W}$

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

CHARACTERISTICS $T_{amb} = 25\text{ }^{\circ}\text{C}$ unless otherwise specifiedCollector cut-off current

$I_E = 0; V_{CB} = 90\text{ V}$

$I_{CBO} < 10\text{ nA}$

$I_E = 0; V_{CB} = 90\text{ V}; T_{amb} = 150\text{ }^{\circ}\text{C}$

$I_{CBO} < 15\text{ }\mu\text{A}$

Emitter cut-off current

$I_C = 0; V_{EB} = 5\text{ V}$

$I_{EBO} < 10\text{ nA}$

Collector-emitter sustaining voltage ¹⁾

$I_C = 100\text{ mA}; R_{BE} \geq 10\text{ }\Omega$

$V_{CER\text{ sust}} > 100\text{ V}$

$I_C = 30\text{ mA}; I_B = 0$

$V_{CEO\text{ sust}} > 80\text{ V}$

Saturation voltages ¹⁾

$I_C = 150\text{ mA}; I_B = 15\text{ mA}$

$V_{CE\text{ sat}} < 5.0\text{ V}$

$V_{BE\text{ sat}} < 1.3\text{ V}$

$I_C = 50\text{ mA}; I_B = 5\text{ mA}$

$V_{CE\text{ sat}} < 1.2\text{ V}$

$V_{BE\text{ sat}} < 0.9\text{ V}$

Breakdown voltages

$I_E = 0; I_C = 100\text{ }\mu\text{A}$

$V_{(BR)\text{ CBO}} > 120\text{ V}$

$I_C = 0; I_E = 100\text{ }\mu\text{A}$

$V_{(BR)\text{ EBO}} > 7.0\text{ V}$

D.C. current gain

$I_C = 0.1\text{ mA}; V_{CE} = 10\text{ V}$

$h_{FE} > 20$

$I_C = 10\text{ mA}; V_{CE} = 10\text{ V}; T = -55\text{ }^{\circ}\text{C}$

$h_{FE} > 20$

$I_C = 10\text{ mA}; V_{CE} = 10\text{ V} ¹⁾$

$h_{FE} > 35$

$I_C = 150\text{ mA}; V_{CE} = 10\text{ V} ¹⁾$

$h_{FE} \text{ 40 to 120}$

¹⁾ Measured under pulsed conditions to avoid excessive dissipation.
Pulse duration $t \leq 300\text{ }\mu\text{s}$, duty cycle $\delta < 0.02$

CHARACTERISTICS (continued)

$T_{amb} = 25\text{ }^{\circ}\text{C}$ unless otherwise specified

h parameters at $f = 1\text{ kHz}$ (common base)

$I_C = 1\text{ mA}; V_{CE} = 5\text{ V}$

Input impedance	h_{ib}	20 to 30	Ω
Reverse voltage transfer ratio	h_{rb}	1.25	10^{-4}
Output conductance	h_{ob}	0.5	$\mu\Omega^{-1}$

$I_C = 5\text{ mA}; V_{CE} = 10\text{ V}$

Input impedance	h_{ib}	4 to 8	Ω
Reverse voltage transfer ratio	h_{rb}	1.50	10^{-4}
Output conductance	h_{ob}	0.5	$\mu\Omega^{-1}$

Small signal current gain (common emitter)

$I_C = 1\text{ mA}; V_{CE} = 5\text{ V}; f = 1\text{ kHz}$

h_{fe} 30 to 100

$I_C = 5\text{ mA}; V_{CE} = 10\text{ V}; f = 1\text{ kHz}$

$h_{fe} > 45$

$I_C = 50\text{ mA}; V_{CE} = 10\text{ V}; f = 20\text{ MHz}$

$h_{fe} > 2.5$

Collector capacitance

$I_E = I_e = 0; V_{CB} = 10\text{ V}$

$C_c < 15\text{ pF}$

Emitter capacitance

$I_C = I_c = 0; V_{EB} = 0.5\text{ V}$

$C_e < 85\text{ pF}$

$T_{amb} = 25\text{ }^{\circ}\text{C}$ unless otherwise specified**CHARACTERISTICS**Collector cut-off current

$I_E = 0; V_{CB} = 60\text{ V}$	I_{CBO}	<	10 nA
$I_E = 0; V_{CB} = 60\text{ V}; T_{amb} = 150\text{ }^{\circ}\text{C}$	I_{CBO}	<	10 μA

Emitter cut-off current

$I_C = 0; V_{EB} = 5\text{ V}$	I_{EBO}	<	10 nA
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Sustaining voltage

$I_C = 30\text{ mA}; I_B = 0\text{ }^2)$	$V_{CEOsust}$	>	35 V
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Saturation voltages

$I_C = 150\text{ mA}; I_B = 15\text{ mA}$	V_{CEsat}	<	0.2 V
$I_C = 1\text{ A}; I_B = 100\text{ mA }^1)^2)$	V_{CEsat}	<	1.0 V
	V_{BEsat}	<	1.6 V

D.C. current gain ²⁾

$I_C = 10\text{ mA}; V_{CE} = 10\text{ V}$	h_{FE}	>	30
$I_C = 150\text{ mA}; V_{CE} = 10\text{ V}$	h_{FE}		40 to 120
$I_C = 1\text{ A}; V_{CE} = 10\text{ V}$	h_{FE}	>	15

Feedback time constant

$I_C = 10\text{ mA}; V_{CB} = 10\text{ V}; f = 4\text{ MHz}$	$r_b'C_c$	<	800 ps
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Collector capacitance at $f = 500\text{ kHz}$

$I_E = I_e = 0; V_{CB} = 10\text{ V}$	C_c	<	12 pF
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Emitter capacitance at $f = 500\text{ kHz}$

$I_C = I_c = 0; V_{EB} = 0.5\text{ V}$	C_e	<	80 pF
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Transition frequency

$I_C = 50\text{ mA}; V_{CE} = 10\text{ V}$	f_T	>	60 MHz
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¹⁾ Measured with a lead length of 1 cm.

²⁾ Measured under pulsed conditions to avoid excessive dissipation.
Pulse duration $t = 300\text{ }\mu\text{s}$; duty cycle $\delta < 0.01$

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.

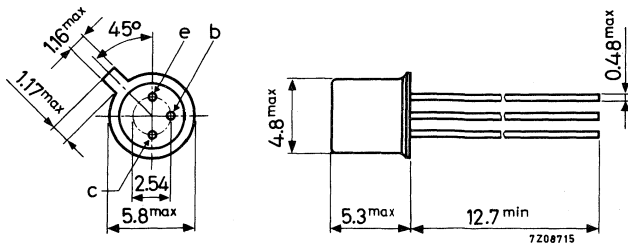
QUICK REFERENCE DATA

		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 $T_{amb} = 25\text{ }^{\circ}\text{C}$	P_{tot} max.	360	360 mW
Junction temperature	T_j max.	200	200 $^{\circ}\text{C}$
D.C. current gain at $T_j = 25\text{ }^{\circ}\text{C}$			
$I_C = 10\text{ }\mu\text{A}$; $V_{CE} = 5\text{ V}$	h_{FE}	40 to 120	100 to 500
$I_C = 1\text{ mA}$; $V_{CE} = 5\text{ V}$	h_{FE}	> 175	250
$I_C = 10\text{ mA}$; $V_{CE} = 5\text{ V}$	h_{FE}	< 500	800
Transition frequency			
$I_C = 0.5\text{ mA}$; $V_{CE} = 5\text{ V}$	f_T typ.	80	80 MHz
Noise figure			
$I_C = 10\text{ }\mu\text{A}$; $V_{CE} = 5\text{ V}$; $R_S = 10\text{ k}\Omega$			
Bandwidth: 15.7 kHz	F	< 4	3 dB

MECHANICAL DATA

Dimensions in mm

Collector connected
to case
TO-18



Accessories available: 56246, 56263

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 _{EB0}	max.	6 V

Currents

Collector current (peak value)	I _{CM}	max.	50 mA
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Power dissipation

Total power dissipation up to T _{amb} = 25 °C	P _{tot}	max.	360 mW
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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.

CHARACTERISTICS

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

Collector cut-off current

$I_E = 0; V_{CB} = 45\text{ V}$ $I_{CBO} < 10\text{ nA}$

$I_E = 0; V_{CB} = 45\text{ V}; T_j = 150\text{ }^\circ\text{C}$ $I_{CBO} < 10\text{ }\mu\text{A}$

Emitter cut-off current

$I_C = 0; V_{EB} = 5\text{ V}$ $I_{EBO} < 10\text{ nA}$

Base-emitter voltage

$I_C = 0.1\text{ mA}; V_{CE} = 5\text{ V}$ $V_{BE} = 0.5\text{ to }0.7\text{ V}$

Collector-emitter saturation voltage

$I_C = 1\text{ mA}; I_B = 0.1\text{ mA}$ $V_{CEsat} < 350\text{ mV}$

D.C. current gain

	2N2483	2N2484
$I_C = 1\text{ }\mu\text{A}; V_{CE} = 5\text{ V}$	$h_{FE} >$	30
$I_C = 10\text{ }\mu\text{A}; V_{CE} = 5\text{ V}$	$h_{FE} = 40\text{ to }120$	100 to 500
$I_C = 10\text{ }\mu\text{A}; V_{CE} = 5\text{ V}; T_j = 55\text{ }^\circ\text{C}$	$h_{FE} > 10$	20
$I_C = 100\text{ }\mu\text{A}; V_{CE} = 5\text{ V}$	$h_{FE} > 75$	175
$I_C = 500\text{ }\mu\text{A}; V_{CE} = 5\text{ V}$	$h_{FE} > 100$	200
$I_C = 1\text{ mA}; V_{CE} = 5\text{ V}$	$h_{FE} > 175$	250
$I_C = 10\text{ mA}; V_{CE} = 5\text{ V}^1)$	$h_{FE} < 500$	800

Collector capacitance at $f = 1\text{ MHz}$

$I_E = I_e = 0; V_{CB} = 5\text{ V}$ $C_c < 6\text{ pF}$

Emitter capacitance at $f = 1\text{ MHz}$

$I_C = I_c = 0; V_{EB} = 0.5\text{ V}$ $C_e < 6\text{ pF}$

Transition frequency

$I_C = 50\text{ }\mu\text{A}; V_{CE} = 5\text{ V}$ $f_T > 12\text{ MHz}$

$I_C = 500\text{ }\mu\text{A}; V_{CE} = 5\text{ V}$ $f_T > 60\text{ MHz}$
 $f_T \text{ typ. } 80\text{ MHz}$

¹⁾ Measured under pulsed conditions to prevent excessive dissipation.
Pulse duration $t < 300\text{ }\mu\text{s}$; duty cycle $\delta < 0.01$

CHARACTERISTICS (continued)

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

Noise figure

$I_C = 10\text{ }\mu\text{A}$; $V_{CE} = 5\text{ V}$; $R_S = 10\text{ k}\Omega$

$f = 100\text{ Hz}$; bandwidth 20 Hz

$f = 1\text{ kHz}$; bandwidth 200 Hz

$f = 10\text{ kHz}$; bandwidth 2 kHz

Wide band: bandwidth 15.7 kHz

	2N2483	2N2484
F	< 15	10 dB
F	< 4	3 dB
F	< 3	2 dB
F	< 4	3 dB

h parameters at $f = 1\text{ kHz}$

$I_C = 1\text{ mA}$; $V_{CE} = 5\text{ V}$

Input impedance

Reverse voltage transfer

Small signal current gain

Output admittance

h_{ie}	1.5 to 13	3.5 to 24 $\text{k}\Omega$
h_{re}	< 8	8 10^{-4}
h_{fe}	80 to 450	150 to 900
h_{oe}	< 30	40 $\mu\Omega^{-1}$

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.

RATINGS (Limiting values)

Voltages

Collector-base voltage (open emitter)

	2N3570	2N3571	2N3572	
V_{CBO}	max. 30	25	25	V

Collector-emitter voltage (open base)

V_{CEO}	max. 15	15	13	V
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$I_C = 15$ mA

Emitter-base voltage (open collector)

V_{EBO}	max. 3	3	3	V
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Current

Collector current (d.c.)

I_C	max. 50	mA
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Power dissipation

Total power dissipation up to $T_{amb} = 25$ °C

P_{tot}	max. 200	mW
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Temperatures

Storage temperature

T_{stg}	-65 to +200	°C
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Junction temperature

T_j	max. 200	°C
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THERMAL RESISTANCE

From junction to ambient in free air

$R_{th\ j-a}$	0.88	°C/mW
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From junction to case

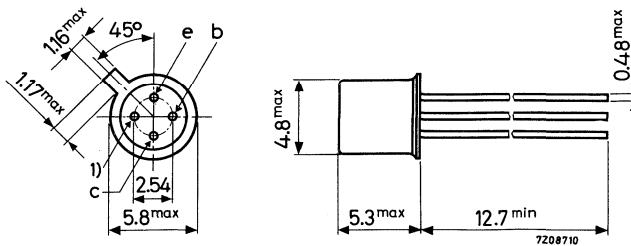
$R_{th\ j-c}$	0.50	°C/mW
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MECHANICAL DATA

Dimensions in mm

Insulated electrodes

TO-72



1) = shield lead (connected to case)

Accessories available: 56246, 56263

CHARACTERISTICS

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

The shield lead is grounded for all measurements except for C_{re}

		2N3570	2N3571	2N3572
<u>Collector cut-off current</u>				
$I_E = 0; V_{CB} = 6\text{ V}$	I_{CBO}	< 10	10	10 nA
$I_E = 0; V_{CB} = 6\text{ V}; T_j = 150\text{ }^\circ\text{C}$	I_{CBO}	< 1	1	1 μA
<u>D.C. current gain</u>				
$I_C = 5\text{ mA}; V_{CE} = 6\text{ V}$	h_{FE}	> 20 < 150	20 200	20 300
<u>Small signal current gain</u>				
$I_C = 5\text{ mA}; V_{CE} = 6\text{ V}; f = 1\text{ kHz}$	h_{fe}	> 20 < 200	20 250	20 350
<u>Collector-base time constant</u>				
$-I_E = 5\text{ mA}; V_{CB} = 6\text{ V}; f = 10.7\text{ MHz}$	$r_{bb'}C_b'c$	> 1 < 8	1 10	1 ps 13 ps
<u>Feedback capacitance</u>				
$I_E = 0; V_{CB} = 6\text{ V}; f = 1\text{ MHz}$	$-C_{re}$	< 0.75	0.85	0.85 pF
<u>Transition frequency</u>				
$I_C = 5\text{ mA}; V_{CE} = 6\text{ V}$	f_T	> 1.5 < 2.4	1.2 2.4	1.0 GHz 2.4 GHz
<u>Noise figure</u>				
$-I_E = 2\text{ mA}; V_{CB} = 6\text{ V}$				
$f = 1\text{ GHz}; R_S = 50\text{ }\Omega$	F	< 7		dB
$f = 450\text{ MHz}; R_S = 100\text{ }\Omega$	F	<	4	6 dB

HIGH FREQUENCY PACKAGE

The high frequency package 40820 contains three silicon transistors selected from the BF194 and BF195 products.

The BF194B is intended for use as mixer-oscillator transistor, the BF195C for controlled first i.f. transistor, the BF195D for second i.f. transistor.

The low h_{FE} spread of the transistors makes it possible to apply current biasing (one base resistor) and achieve a gain with small spread and low dependence on supply voltage, even at low battery voltages.

The transistors have a plastic envelope with stiff, self-locking pins suitable for use with standard printed wiring-boards.

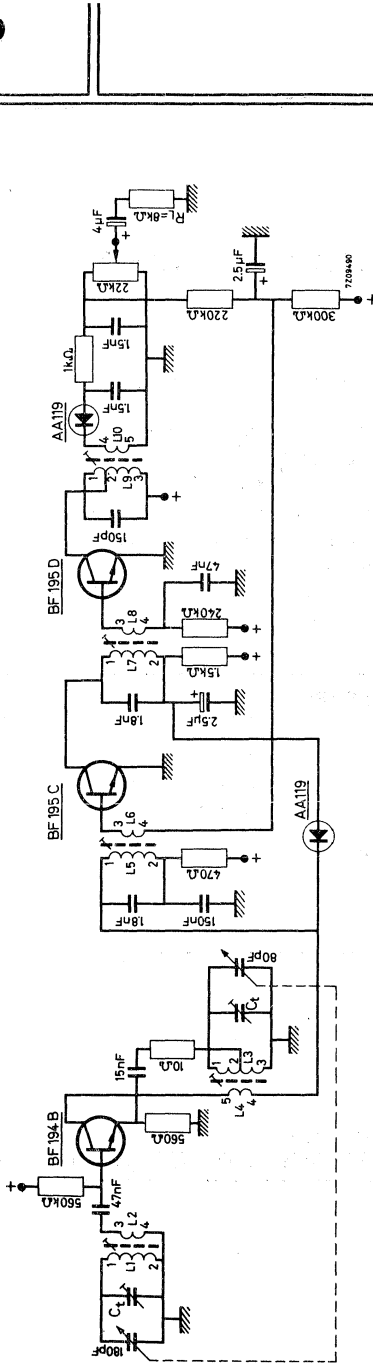
QUICK REFERENCE DATA

Base current $I_C = 1 \text{ mA}; V_{CE} = 10 \text{ V}$	BF194B	I_B	5 to 9 μA
	BF195C	I_B	9 to 14 μA
	BF195D	I_B	14 to 26 μA
Conversion noise figure of mixer BF194B			
$I_C = 1 \text{ mA}; V_{CE} = 10 \text{ V}$			
$G_S = 1.0 \text{ m}\Omega^{-1}; f = 1 \text{ MHz}$	F_C typ.		2 dB

FOR THE DATA OF THE INDIVIDUAL TRANSISTORS PLEASE
REFER TO THE DATA SHEETS OF THE BF194 AND THE BF195

APPLICATION INFORMATION

H.F. section of a 6 V medium wave portable radio receiver



COIL DATA

L1 = 450 μH; Q0 at f = 1 MHz : 120

Voltage ratio $\frac{n3-4}{n1-2}$: 5.7x10⁻²

L3 = 260 μH; Q0 at f = 1.2 MHz : 120

Voltage ratio $\frac{n2-3}{n1-3}$: 3x10⁻²

Voltage ratio $\frac{n4-5}{n1-3}$: 5.4x10⁻²

L5 = L7 = 69 μH; Q0 at f = 0.45 MHz : 80

Voltage ratio $\frac{n3-4}{n1-2}$: 7.35x10⁻²

L9 = 800 μH; Q0 at f = 0.45 MHz : 110

Voltage ratio $\frac{n2-3}{n1-3}$: 41.5x10⁻²

Voltage ratio $\frac{n4-5}{n1-3}$: 59.2x10⁻²

PERFORMANCE at $f = 1 \text{ MHz}$; $T_{amb} = 25 \text{ }^\circ\text{C}$

Supply voltage (from 6 V, via a RC-smoothing filter)

$$V_S = 5.25 \text{ V}$$

Sensitivity

Signal to obtain $V_O = 10 \text{ mV}$ across $R_L = 8 \text{ k}\Omega$ 25 $\mu\text{V}/\text{m}$

Total current drain

$$I_{tot} = 3 \text{ mA}$$

Gain spread of the h.f. part

$$\Delta G = \pm 3.6 \text{ dB}$$

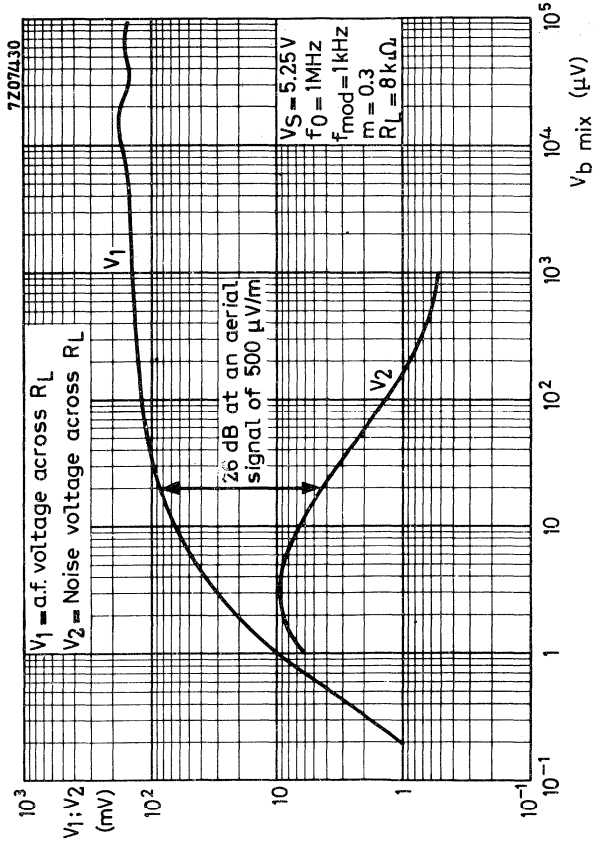
Signal to obtain 26 dB signal/noise ratio 500 $\mu\text{V}/\text{m}$

Signal handling capability

$$\geq 2 \text{ V}/\text{m}$$

Decrease of sensitivity at $V_S \approx 3.2 \text{ V}$ 15 dB

$d_{tot} = 10\%$; $m = 0.8$



CHARACTERISTICS

y parameters (common emitter) $I_C = 1 \text{ mA}; V_{CE} = 10 \text{ V}$ (lead length = 3 mm)

		f = 10.7 MHz		f = 0.45 MHz	
Input conductance	<u>BF194B</u> :	g_{ie}	< 0.5	0.4	$\text{m}\Omega^{-1}$
	<u>BF195C</u> :	g_{ie}	< 0.64	0.54	$\text{m}\Omega^{-1}$
	<u>BF195D</u> :	g_{ie}	< 0.95	0.85	$\text{m}\Omega^{-1}$
Output conductance	<u>BF194B</u> :	g_{oe}	typ. 10	6.5	$\mu\Omega^{-1}$
			< 13.5	11.5	$\mu\Omega^{-1}$
	<u>BF195C</u> :	g_{oe}	typ. 6.5	4	$\mu\Omega^{-1}$
			< 9.5	7	$\mu\Omega^{-1}$
	<u>BF195D</u> :	g_{oe}	typ. 4	2	$\mu\Omega^{-1}$
			< 9.5	7	$\mu\Omega^{-1}$

PACKAGE FOR COLOUR DIFFERENCE AMPLIFIERS

The package 40822 consists of three n-p-n silicon planar transistors BF179A; BF179B and BF179C, intended for application in colour difference amplifiers of television receivers.

The BF179A is meant for the G-Y amplifier,
 the BF179B for the R-Y amplifier and
 the BF179C for the B-Y amplifier.

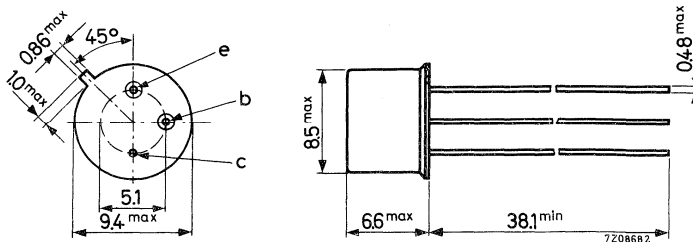
QUICK REFERENCE DATA				
	G-Y amplifier	R-Y amplifier	B-Y amplifier	
Peak-peak output voltage	100	170	200	V
Bandwidth (3 dB)	1	1	1	MHz
Transient response				
rise time		300 ns		
fall time		300 ns		
overshoot		< 5 %		

MECHANICAL DATA

Dimensions in mm

TO-5

Collector connected to case

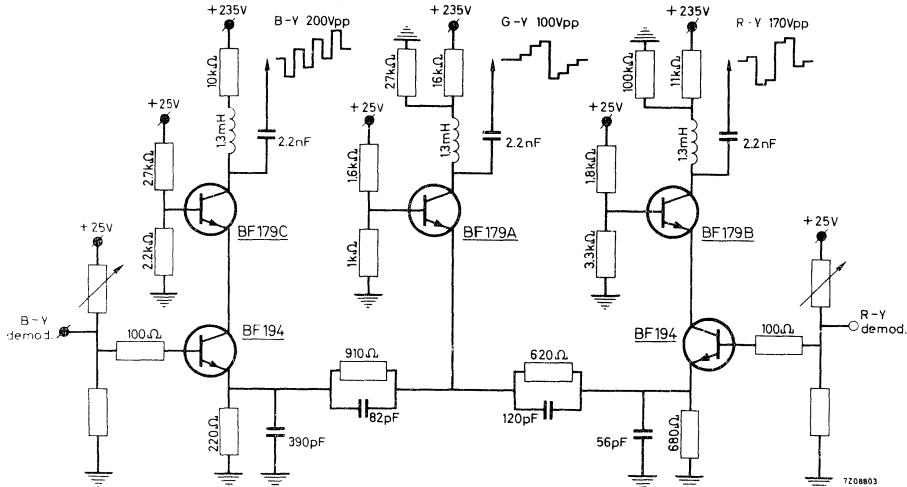


Accessories available: 56218; 56245; 56265

APPLICATION INFORMATION

Application as colour difference amplifier

The circuit below is able to drive shadow mask colour picture tubes with screen sizes up to 25".



Performance up to $T_{amb} = 55\text{ }^{\circ}\text{C}$

Gain

Peak-peak output voltage

Bandwidth (3 dB)

Transient response ¹⁾

rise time

fall time

overshoot

	G-Y amplifier	R-Y amplifier	B-Y amplifier	
Gain		30	50	
Peak-peak output voltage	100	170	200	V
Bandwidth (3 dB)	1	1	1	MHz ¹⁾

300 ns

300 ns

< 5 %

NOTE

In order not to exceed the junction temperature rating, the thermal resistance from junction to ambient should have the following values:

G-Y output stage: $R_{th\ j-a} \rightarrow 220\text{ }^{\circ}\text{C/W}$

R-Y output stage: $R_{th\ j-a} \rightarrow 110\text{ }^{\circ}\text{C/W}$ ²⁾

B-Y output stage: $R_{th\ j-a} \rightarrow 85\text{ }^{\circ}\text{C/W}$ ²⁾

¹⁾ With a total load capacitance < 30 pF, including the capacitance due to the heatsink.

²⁾ To ensure the above mentioned performance for bandwidth and transient response, the contribution of the heatsink to the total output capacitance of the device should not exceed 4 pF.

DATA OF THE INDIVIDUAL TRANSISTORS

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

<u>Voltages</u>	BF179A	BF179B	BF179C
Collector-base voltage (open emitter) V_{CBO} max.	160	220	250 V ¹⁾
Collector-emitter voltage ($R_{BE} \leq 1 \text{ k}\Omega$) V_{CER} max.	160	220	250 V ¹⁾
Emitter-base voltage (open collector) V_{EBO} max.	5	5	5 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 $T_{mb} = 130 \text{ }^\circ\text{C}$	P_{tot}	max.	1.7 W
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Temperatures

Storage temperature	T_{stg}	-55 to +175	$^\circ\text{C}$
Junction temperature	T_j	max.	200 $^\circ\text{C}$

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th \text{ j-a}}$	=	220 $^\circ\text{C/W}$
From junction to mounting base	$R_{th \text{ j-mb}}$	=	40 $^\circ\text{C/W}$
From junction to case	$R_{th \text{ j-c}}$	=	45 $^\circ\text{C/W}$

¹⁾ During switching on, a supply voltage of 1.2 times the rated V_{CER} value is permitted.

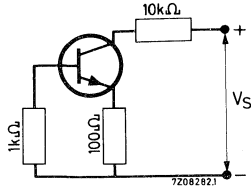
The current must be limited so that maximum dissipation and maximum junction temperature are not exceeded. (See page 5)

DATA OF THE INDIVIDUAL TRANSISTORS

CHARACTERISTICS

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

Collector cut-off current



$T_j = 200\text{ }^\circ\text{C}$

BF179A; $V_{CE} = 160\text{ V}$	$I_{CER} < 1\text{ mA}$
BF179B; $V_{CE} = 220\text{ V}$	$I_{CER} < 1\text{ mA}$
BF179C; $V_{CE} = 250\text{ V}$	$I_{CER} < 1\text{ mA}$
BF179A; $V_S = 160\text{ V}$	$I_{CER} < 2\text{ mA}$
BF179B; $V_S = 225\text{ V}$	$I_{CER} < 3\text{ mA}$
BF179C; $V_S = 260\text{ V}$	$I_{CER} < 4\text{ mA}$

Base current

$I_C = 20\text{ mA}$; $V_{CE} = 15\text{ V}$

I_B	typ. 0.45 mA
	$< 1.0\text{ mA}$

Base-emitter voltage ¹⁾

$I_C = 20\text{ mA}$; $V_{CE} = 15\text{ V}$

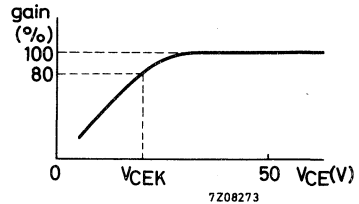
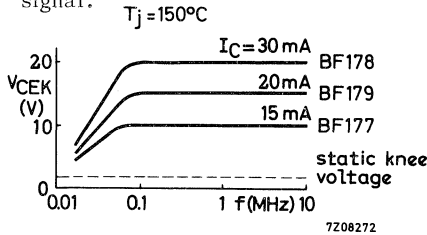
V_{BE}	typ. 0.75 V
	$< 1.2\text{ V}$

High frequency knee voltage at $T_j = 150\text{ }^\circ\text{C}$

$I_C = 20\text{ mA}$

V_{CEK}	typ. 15 V
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The high frequency knee voltage of a transistor is that value of the collector-emitter voltage at which the small signal gain, measured in a practical circuit, has dropped to 80% of the gain at $V_{CE} = 50\text{ V}$. A further decrease of the collector-emitter voltage results in a rapid increase of the distortion of the signal.



Feedback capacitance

$I_C = 10\text{ mA}$; $V_{CE} = 20\text{ V}$; $f = 0.5\text{ MHz}$

$-C_{re}$	typ. 1.8 pF
	$< 3.5\text{ pF}$

Feedback time constant

$-I_E = 10\text{ mA}$; $V_{CB} = 15\text{ V}$; $f = 10\text{ MHz}$

$r_{bb}'C_{b'c}$	typ. 20 ps
	$< 100\text{ ps}$

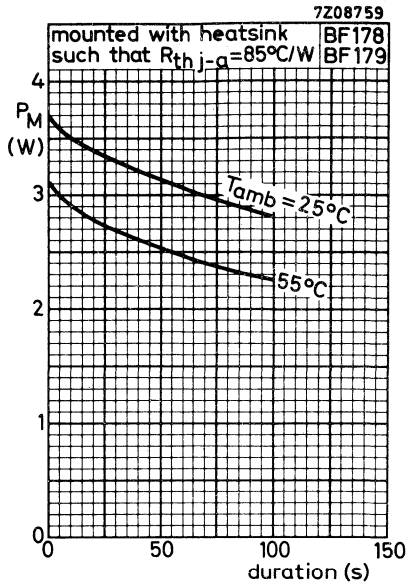
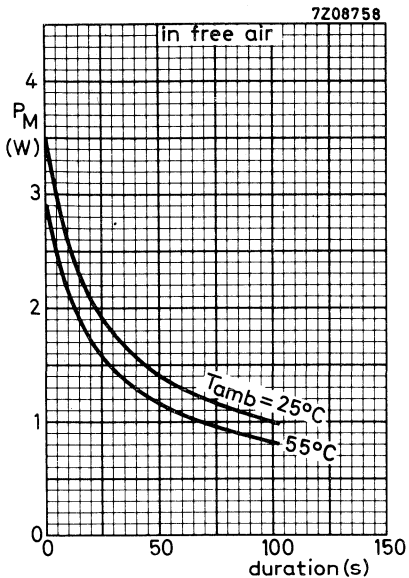
Transition frequency

$I_C = 10\text{ mA}$; $V_{CE} = 15\text{ V}$

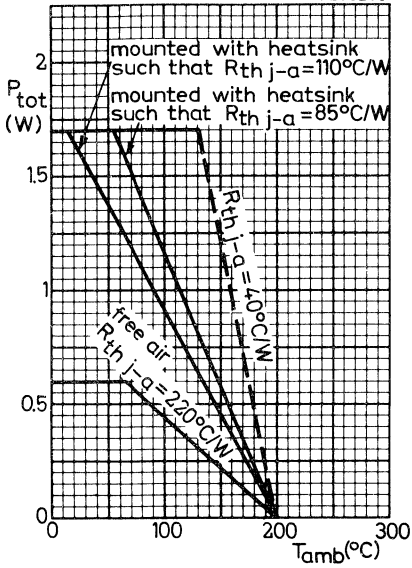
f_T	typ. 120 MHz
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¹⁾ V_{BE} decreases by about $1.6\text{ mV}/^\circ\text{C}$ with increasing temperature.

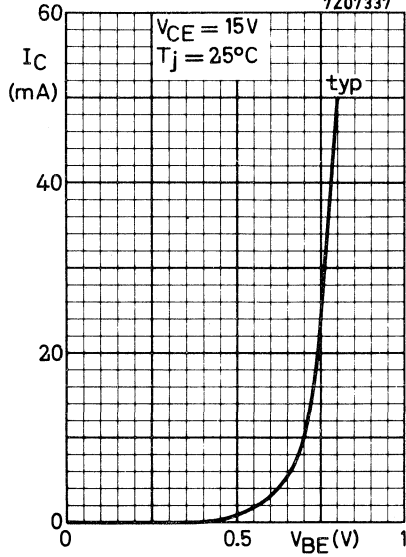
maximum allowable peak power dissipation versus duration



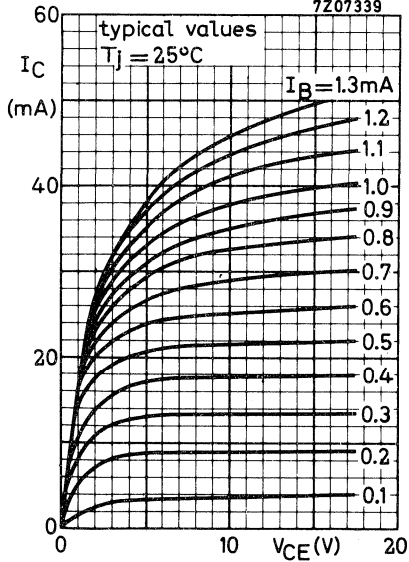
7Z08283



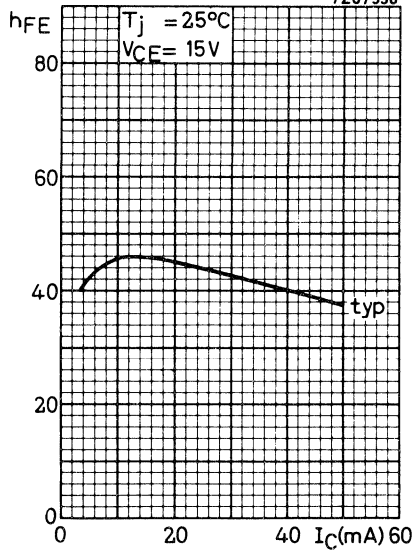
7Z07337

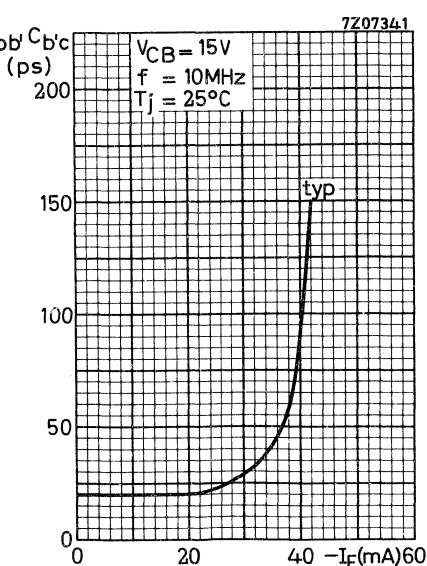
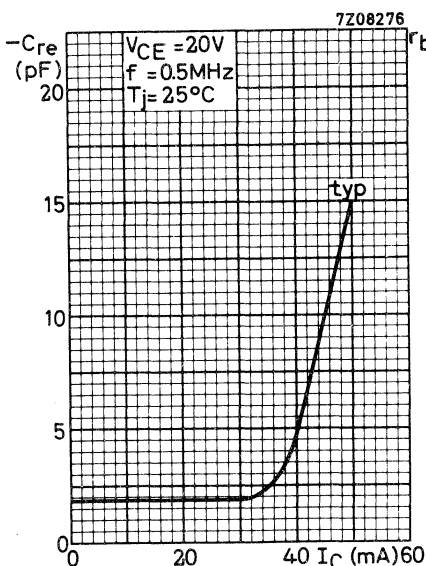
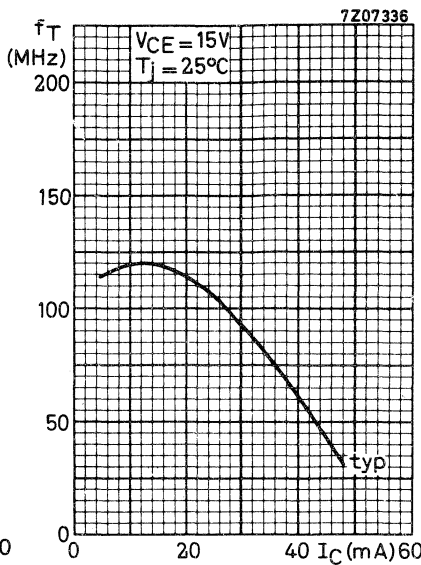
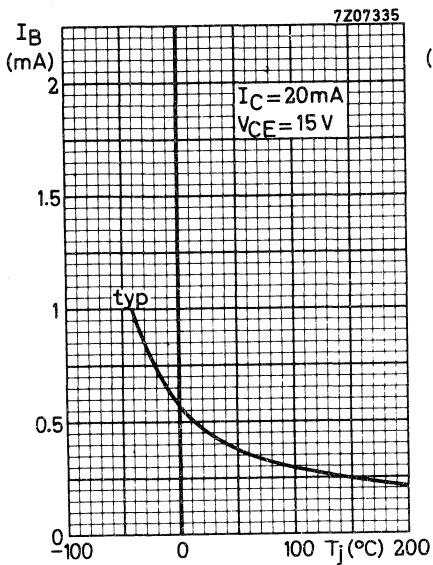


7Z07339



7Z07338





HIGH FREQUENCY PACKAGE

The high frequency package 40829 contains three silicon transistors selected from the BF254 and BF255 products.

The BF254B is intended for use as mixer-oscillator transistor,
the BF255C for controlled first i.f. transistor,
the BF255D for second i.f. transistor.

The low h_{FE} spread of the transistors makes it possible to apply current biasing (one base resistor) and achieve a gain with small spread and low dependence on supply voltage, even at low battery voltages.

The transistors have a plastic envelope.

QUICK REFERENCE DATA

Base current

$$I_C = 1 \text{ mA}; V_{CE} = 10 \text{ V}$$

BF254B I_B 5 to 9 μA

BF255C I_B 9 to 14 μA

BF255D I_B 14 to 26 μA

Conversion noise figure of mixer BF254B

$$I_C = 1 \text{ mA}; V_{CE} = 10 \text{ V}$$

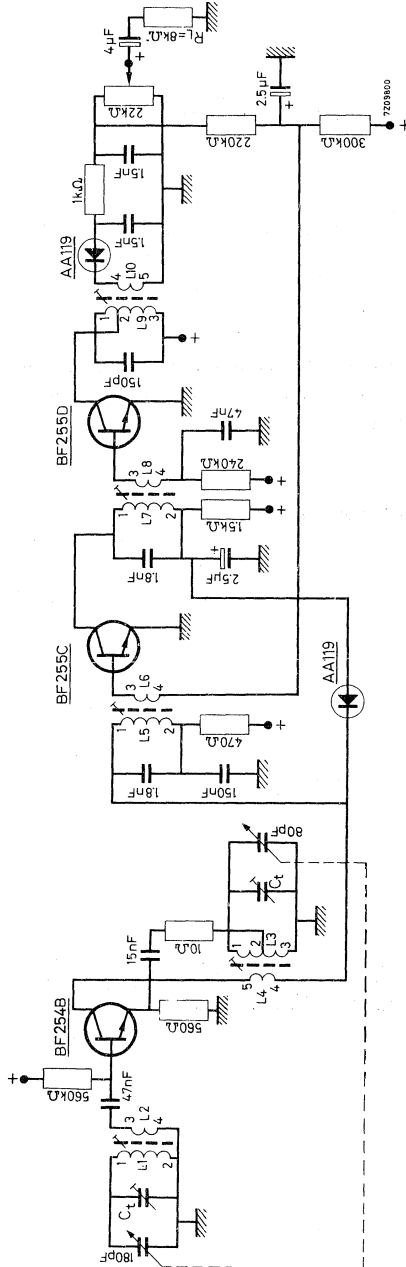
$$G_S = 1.0 \text{ m}\Omega^{-1}; f = 1 \text{ MHz}$$

F_c typ. 2 dB

FOR THE DATA OF THE INDIVIDUAL TRANSISTORS PLEASE
REFER TO THE DATA SHEETS OF THE BF254 AND THE BF255

APPLICATION INFORMATION

H.F. section of a 6 V medium wave portable radio receiver.



COIL DATA

L1 = 450 μH; Q0 at f = 1 MHz : 120

Voltage ratio $\frac{n3-4}{n1-2}$: 5.7 x 10⁻²

L3 = 260 μH; Q0 at f = 1.2 MHz : 120

Voltage ratio $\frac{n2-3}{n1-3}$: 3 x 10⁻²

Voltage ratio $\frac{n4-5}{n1-3}$: 5.4 x 10⁻²

L5 = L7 = 69 μH; Q0 at f = 0.45 MHz : 80

Voltage ratio $\frac{n3-4}{n1-2}$: 7.35 x 10⁻²

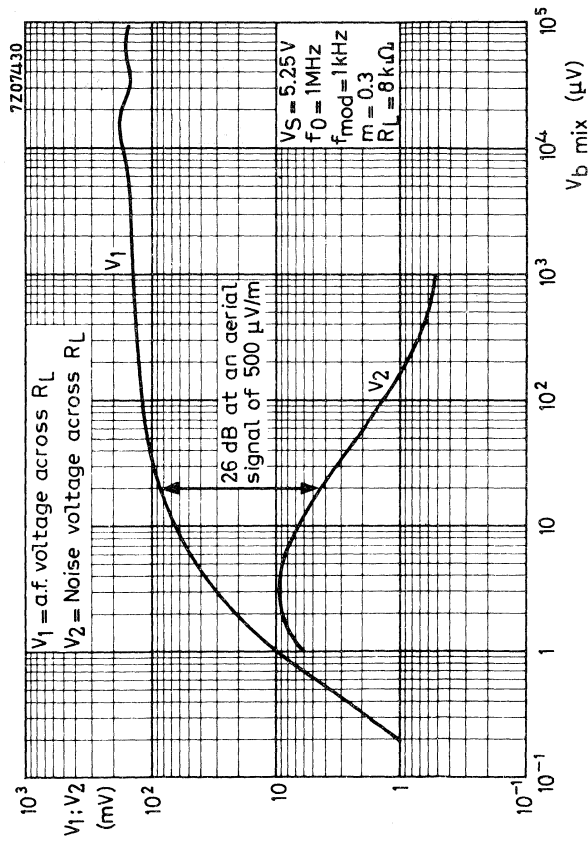
L9 = 800 μH; Q0 at f = 0.45 MHz : 110

Voltage ratio $\frac{n2-3}{n1-3}$: 41.5 x 10⁻²

Voltage ratio $\frac{n4-5}{n1-3}$: 59.2 x 10⁻²

PERFORMANCE at $f = 1 \text{ MHz}$; $T_{\text{amb}} = 25 \text{ }^\circ\text{C}$

Supply voltage (from 6 V, via a RC-smoothing filter)	$V_S = 5.25 \text{ V}$	Sensitivity	Signal to obtain $V_o = 10 \text{ mV}$ across $R_L = 8 \text{ k}\Omega$	25 $\mu\text{V}/\text{m}$
Total current drain	$I_{\text{tot}} = 3 \text{ mA}$		Signal to obtain 26 dB signal/noise ratio	500 $\mu\text{V}/\text{m}$
Gain spread of the h.f. part	$\Delta G = \pm 3.6 \text{ dB}$		Decrease of sensitivity at $V_S \approx 3.2 \text{ V}$	15 dB
Signal handling capability	$\geq 2 \text{ V}/\text{m}$			
$d_{\text{tot}} = 10\%$; $m = 0.8$				



CHARACTERISTICS

y parameters (common emitter)

 $I_C = 1 \text{ mA}$; $V_{CE} = 10 \text{ V}$ (lead length = 3 mm)

		$f = 10.7 \text{ MHz}$		$f = 0.45 \text{ MHz}$	
Input conductance	<u>BF254B</u> :	g_{ie}	< 0.5	0.4	$\text{m}\Omega^{-1}$
	<u>BF255C</u> :	g_{ie}	< 0.64	0.54	$\text{m}\Omega^{-1}$
	<u>BF255D</u> :	g_{ie}	< 0.95	0.85	$\text{m}\Omega^{-1}$
Output conductance	<u>BF254B</u> :	g_{oe}	typ. 10	6.5	$\mu\Omega^{-1}$
			< 13.5	11.5	$\mu\Omega^{-1}$
	<u>BF255C</u> :	g_{oe}	typ. 6.5	4	$\mu\Omega^{-1}$
			< 9.5	7	$\mu\Omega^{-1}$
	<u>BF255D</u> :	g_{oe}	typ. 4	2	$\mu\Omega^{-1}$
			< 9.5	7	$\mu\Omega^{-1}$

Switching transistors



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.

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

Voltages

		ASY26	ASY27
Collector-base voltage (open emitter)	$-V_{CBO}$	max. 30	25 V
Collector-emitter voltage (open base)	$-V_{CEO}$	max. 15	15 V
Collector-emitter voltage at $+V_{BE} = 0.2 V$	$-V_{CEX}$	max. 25	20 V
Emitter-base voltage (open collector)	$-V_{EBO}$	max. 20	20 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 $T_{amb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	150 mW
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Temperatures

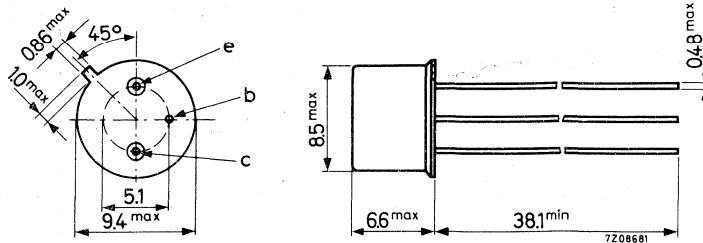
Storage temperature	T_{stg}	-65 to +100	$^\circ\text{C}$
Junction temperature	T_j	max.	85 $^\circ\text{C}$

MECHANICAL DATA

Dimensions in mm

TO-5

Base connected to case



Accessories available: 56218, 56245, 56265

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a} = 0.4\ ^\circ\text{C}/\text{mW}$
From junction to case	$R_{th\ j-c} = 0.2\ ^\circ\text{C}/\text{mW}$

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

<u>Collector cut-off current</u>		ASY26	ASY27
$I_E = 0; -V_{CB} = 30\ \text{V}$	$-I_{CBO} <$	7	μA
$I_E = 0; -V_{CB} = 25\ \text{V}$	$-I_{CBO} <$		7 μA
$I_E = 0; -V_{CB} = 30\ \text{V}; T_j = 60\ ^\circ\text{C}$	$-I_{CBO} <$	35	μA
$I_E = 0; -V_{CB} = 25\ \text{V}; T_j = 60\ ^\circ\text{C}$	$-I_{CBO} <$		35 μA
<u>Emitter cut-off current</u>			
$I_C = 0; -V_{EB} = 5\ \text{V}$	$-I_{EBO} <$	3	3 μA
<u>Currents at reverse biased emitter junction</u>			
$-V_{CE} = 25\ \text{V}; +V_{BE} = 0.2\ \text{V}; T_j = 60\ ^\circ\text{C}$	$-I_{CEX} <$	35	μA
$-V_{CE} = 20\ \text{V}; +V_{BE} = 0.2\ \text{V}; T_j = 60\ ^\circ\text{C}$	$-I_{CEX} <$		35 μA
$-V_{CE} = 20\ \text{V}; +V_{BE} = 5\ \text{V}; T_j = 60\ ^\circ\text{C}$	$+I_{BEX} <$	35	35 μA
<u>Base-emitter voltage</u>			
$-I_C = 100\ \text{mA}; -V_{CE} = 1\ \text{V}$	$-V_{BE} <$	0.65	0.55 V
$-I_C = 300\ \text{mA}; -V_{CE} = 1\ \text{V}$	$-V_{BE} <$	1.5	1.4 V
<u>Collector-emitter saturation voltage</u>			
$-I_C = 10\ \text{mA}; -I_B = 0.33\ \text{mA}$	$-V_{CE\ sat} <$	0.20	V
$-I_C = 10\ \text{mA}; -I_B = 0.2\ \text{mA}$	$-V_{CE\ sat} <$		0.20 V
$-I_C = 50\ \text{mA}; -I_B = 2\ \text{mA}$	$-V_{CE\ sat} <$	0.25	V
$-I_C = 50\ \text{mA}; -I_B = 1.25\ \text{mA}$	$-V_{CE\ sat} <$		0.25 V
<u>Base-emitter saturation voltage</u>			
$-I_C = 10\ \text{mA}; -I_B = 0.4\ \text{mA}$	$-V_{BE\ sat} >$	0.20	V
	$-V_{BE\ sat} <$	0.37	V
$-I_C = 10\ \text{mA}; -I_B = 0.25\ \text{mA}$	$-V_{BE\ sat} >$		0.15 V
	$-V_{BE\ sat} <$		0.32 V
$-I_C = 50\ \text{mA}; -I_B = 2.4\ \text{mA}$	$-V_{BE\ sat} <$	0.55	V
$-I_C = 50\ \text{mA}; -I_B = 1.55\ \text{mA}$	$-V_{BE\ sat} <$		0.45 V

CHARACTERISTICS (continued) $T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified

		ASY26	ASY27
<u>Collector-emitter sustaining voltage</u>			
$-I_C = 5\text{ mA}; I_B = 0$	$-V_{CEO\text{ sust}}$	> 15	15 V
<u>Punch through voltage</u>			
	V_{pt}	> 25	20 V
<u>Base-emitter floating voltage</u>			
$I_B = 0; -V_{CE} = 25\text{ V}; T_j = 60\text{ }^\circ\text{C}$	$-V_{BE\text{ fl}}$	< 0.20	V
$I_B = 0; -V_{CE} = 20\text{ V}; T_j = 60\text{ }^\circ\text{C}$	$-V_{BE\text{ fl}}$	<	0.20 V
<u>D.C. current gain</u>			
$-I_C = 10\text{ mA}; -V_{CE} = 1\text{ V}$	h_{FE}	> 30 typ. 45	50 80
$-I_C = 20\text{ mA}; -V_{CE} = 1\text{ V}$	h_{FE}	> 30 typ. 47 < 80	50 78 150
$-I_C = 100\text{ mA}; -V_{CE} = 1\text{ V}$	h_{FE}	> 20 typ. 39	30 58
$-I_C = 200\text{ mA}; -V_{CE} = 1\text{ V}$	h_{FE}	> 15 typ. 27	20 40
<u>Collector capacitance at $f = 1\text{ MHz}$</u>			
$I_E = I_e = 0; -V_{CB} = 5\text{ V}$	C_c	typ. 11 < 16	11 pF 16 pF
<u>Emitter capacitance at $f = 1\text{ MHz}$</u>			
$I_C = I_c = 0; -V_{EB} = 5\text{ V}$	C_e	typ. 7 < 13	6 pF 13 pF
<u>Transition frequency</u>			
$-I_C = 3\text{ mA}; -V_{CE} = 5\text{ V}$	f_T	> 4 typ. 8	6 MHz 14 MHz
<u>h parameters at $f = 1\text{ kHz}$</u>			
$-I_C = 2\text{ mA}; -V_{CE} = 5\text{ V}$			
Input impedance	h_{ie}	typ. 0.75	1.4 k Ω
Reverse voltage transfer ratio	h_{re}	typ. 5.0	7.5 10^{-4}
Small signal current gain	h_{fe}	typ. 50	90
Output admittance	h_{oe}	typ. 65	100 $\mu\Omega^{-1}$

ASY26 ASY27

CHARACTERISTICS (continued) $T_j = 25^\circ\text{C}$ unless otherwise specified

Switching characteristics

Desaturation time constant

$I_C = 0; -I_B = 1 \text{ mA}$

		ASY26	ASY27
τ_s	<	1.25	1.25 μs

Current feed time constant

$-I_{CM} = 50 \text{ mA}; -V_{CE} = 0.75 \text{ V}$

τ_c	<	2.2	2.2 μs
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Voltage feed time constant

$-I_{CM} = 1 \text{ mA}; -V_{CE} = 0.75 \text{ V}$

τ_v	<	0.2	0.2 μs
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Switching times (See test circuit)

delay time

t_d	typ.	65	50 ns
	<	90	75 ns

rise time

t_r	typ.	275	200 ns
	<	490	350 ns

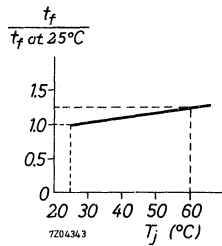
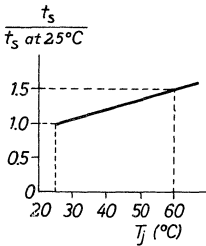
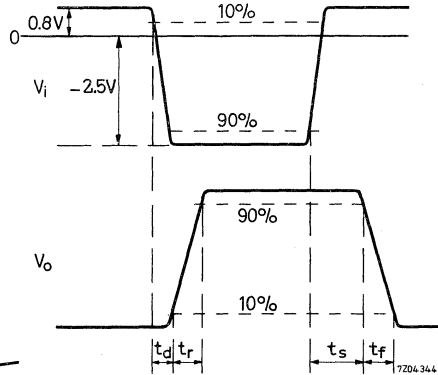
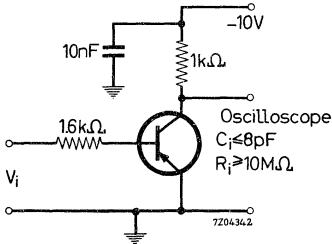
storage time

t_s	typ.	500	600 ns
	<	1350	1500 ns

fall time

t_f	typ.	475	400 ns
	<	730	620 ns

Test circuit:



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.

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

Voltages

		ASY28	ASY29
Collector-base voltage (open emitter)	V_{CBO}	max. 30	25 V
Collector-emitter voltage (open base)	V_{CEO}	max. 15	15 V
Collector-emitter voltage at $-V_{BE} = 0.2$ V	V_{CEX}	max. 25	20 V
Emitter-base voltage (open collector)	V_{EBO}	max. 20	20 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
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Temperatures

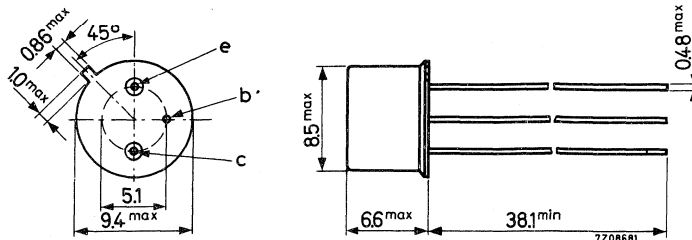
Storage temperature	T_{stg}	-65 to +100	°C
Junction temperature	T_j	max.	85 °C

MECHANICAL DATA

Dimensions in mm

TO-5

Base connected to case



Accessories available: 56218, 56245, 56263.

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

CHARACTERISTICS $T_j = 25\text{ °C}$ unless otherwise specified

Collector cut-off current		ASY28	ASY29
$I_E = 0; V_{CB} = 30\text{ V}$	$I_{CBO} <$	7	μA
$I_E = 0; V_{CB} = 25\text{ V}$	$I_{CBO} <$		7 μA
$I_E = 0; V_{CB} = 30\text{ V}; T_j = 60\text{ °C}$	$I_{CBO} <$	35	μA
$I_E = 0; V_{CB} = 25\text{ V}; T_j = 60\text{ °C}$	$I_{CBO} <$		35 μA
<u>Emitter cut-off current</u>			
$I_C = 0; V_{EB} = 5\text{ V}$	$I_{EBO} <$	3	3 μA
<u>Currents at reverse biased emitter junction</u>			
$V_{CE} = 25\text{ V}; -V_{BE} = 0.2\text{ V}; T_j = 60\text{ °C}$	$I_{CEX} <$	35	μA
$V_{CE} = 20\text{ V}; -V_{BE} = 0.2\text{ V}; T_j = 60\text{ °C}$	$I_{CEX} <$		35 μA
$V_{CE} = 20\text{ V}; -V_{BE} = 5\text{ V}; T_j = 60\text{ °C}$	$-I_{BEX} <$	35	35 μA
<u>Base-emitter voltage</u>			
$I_C = 100\text{ mA}; V_{CE} = 1\text{ V}$	$V_{BE} <$	0.65	0.55 V
$I_C = 300\text{ mA}; V_{CE} = 1\text{ V}$	$V_{BE} <$	1.5	1.4 V
<u>Collector-emitter saturation voltage</u>			
$I_C = 10\text{ mA}; I_B = 0.33\text{ mA}$	$V_{CE\ sat} <$	0.20	V
$I_C = 10\text{ mA}; I_B = 0.2\text{ mA}$	$V_{CE\ sat} <$		0.20 V
$I_C = 50\text{ mA}; I_B = 2\text{ mA}$	$V_{CE\ sat} <$	0.25	V
$I_C = 50\text{ mA}; I_B = 1.25\text{ mA}$	$V_{CE\ sat} <$		0.25 V
<u>Base-emitter saturation voltage</u>			
$I_C = 10\text{ mA}; I_B = 0.4\text{ mA}$	$V_{BE\ sat} >$	0.20	V
	$V_{BE\ sat} <$	0.37	V
$I_C = 10\text{ mA}; I_B = 0.25\text{ mA}$	$V_{BE\ sat} >$		0.15 V
	$V_{BE\ sat} <$		0.32 V
$I_C = 50\text{ mA}; I_B = 2.4\text{ mA}$	$V_{BE\ sat} <$	0.55	V
$I_C = 50\text{ mA}; I_B = 1.55\text{ mA}$	$V_{BE\ sat} <$		0.45 V

CHARACTERISTICS (continued) $T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified

		ASY28	ASY29
<u>Collector-emitter sustaining voltage</u>			
$I_C = 5\text{ mA}; I_B = 0$	$V_{CEO\text{ sust}}$	> 15	15 V
<u>Punch through voltage</u>			
	V_{pt}	> 25	20 V
<u>Base-emitter floating voltage</u>			
$I_B = 0; V_{CE} = 25\text{ V}; T_j = 60\text{ }^\circ\text{C}$	$V_{BE\text{ fl}}$	< 0.20	V
$I_B = 0; V_{CE} = 20\text{ V}; T_j = 60\text{ }^\circ\text{C}$	$V_{BE\text{ fl}}$	<	0.20 V
<u>D.C. current gain</u>			
$I_C = 10\text{ mA}; V_{CE} = 1\text{ V}$	h_{FE}	>	30
		typ.	43
$I_C = 20\text{ mA}; V_{CE} = 1\text{ V}$	h_{FE}	>	30
		typ.	46
		<	80
$I_C = 100\text{ mA}; V_{CE} = 1\text{ V}$	h_{FE}	>	20
		typ.	43
$I_C = 200\text{ mA}; V_{CE} = 1\text{ V}$	h_{FE}	>	15
		typ.	32
<u>Collector capacitance at $f = 1\text{ MHz}$</u>			
$I_E = I_e = 0; V_{EB} = 5\text{ V}$	C_c	typ.	11
		<	16
<u>Emitter capacitance at $f = 1\text{ MHz}$</u>			
$I_C = I_c = 0; V_{EB} = 5\text{ V}$	C_e	typ.	7
		<	13
<u>Transition frequency</u>			
$I_C = 3\text{ mA}; V_{CE} = 5\text{ V}$	f_T	>	4
		typ.	14
<u>h parameters at $f = 1\text{ kHz}$</u>			
$I_C = 2\text{ mA}; V_{CE} = 5\text{ V}$			
Input impedance	h_{ie}	typ. 0.75	1.4 $k\Omega$
Reverse voltage transfer ratio	h_{re}	typ. 3.5	5.0 10^{-4}
Small signal current gain	h_{fe}	typ. 50	90
Output admittance	h_{oe}	typ. 45	70 $\mu\Omega^{-1}$

CHARACTERISTICS (continued) $T_j = 25^\circ\text{C}$ unless otherwise specified

Switching characteristics

Desaturation time constant

$I_C = 0; I_B = 1 \text{ mA}$

	ASY28	ASY29
τ_s	< 1.4	1.4 μs

Current feed time constant

$I_{CM} = 50 \text{ mA}; V_{CE} = 0.75 \text{ V}$

τ_c	< 2.2	2.2 μs
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Voltage feed time constant

$I_{CM} = 1 \text{ mA}; V_{CE} = 5 \text{ V}$

τ_v	< 0.2	0.2 μs
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Switching times (See test circuit)

delay time

t_d	typ. 50	45 ns
	< 90	75 ns

rise time

t_r	typ. 175	140 ns
	< 400	300 ns

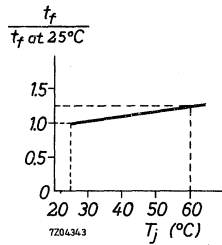
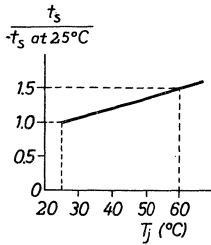
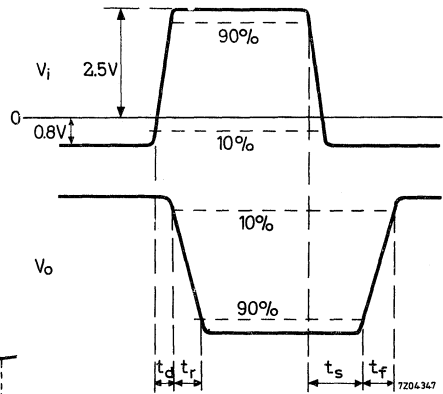
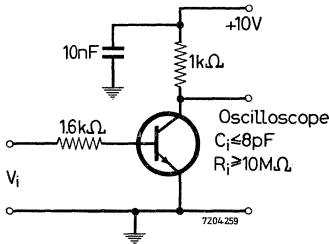
storage time

t_s	typ. 450	500 ns
	< 700	800 ns

fall time

t_f	typ. 325	300 ns
	< 620	520 ns

Test circuit:



SYMMETRICAL N-P-N SWITCHING TRANSISTORS

Symmetrical N-P-N germanium alloy transistors in a TO-5 metal envelope with the base connected to the case intended for high current medium speed switching applications.

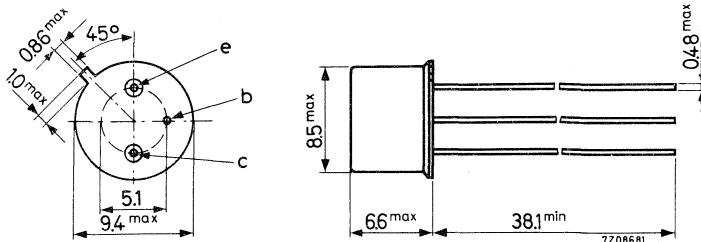
QUICK REFERENCE DATA					
		ASY73	ASY74	ASY75	
Collector-base voltage (open emitter)	V_{CB0}	max. 30	30	30	V
Collector-emitter voltage (open base)	V_{CEO}	max. 15	15	15	V
Collector-current (d.c. or average)	I_C	max. 400	400	400	mA
Total power dissipation up to $T_{amb} = 25^\circ\text{C}$	P_{tot}	max. 140	140	140	mW
Junction temperature	T_j	max. 75	75	75	$^\circ\text{C}$
D.C. current gain at $T_j = 25^\circ\text{C}$					
$-I_E = 200\text{ mA}; V_{CB} = 0$	h_{FE}	> 20	35	50	
$-I_C = 200\text{ mA}; V_{EB} = 0$	h_{FC}	> 12	20	20	
Transition frequency					
$-I_E = 3\text{ mA}; V_{CB} = 5\text{ V}$	f_T	> 4	6	10	MHz
Desaturation time constant $I_B = 1\text{ mA}; I_C = 0$	τ_s	< 1.75	1.75	1.75	μs

MECHANICAL DATA

Dimensions in mm

TO-5

Base connected to case



Accessories available: 56218, 56245, 56265.

RATINGS (Limiting values) ¹⁾

Voltages

Collector-base voltage (open-emitter)	V_{CBO}	max.	30 V
Collector-emitter voltage (open base)	V_{CEO}	max.	15 V ²⁾
Collector-emitter voltage with - $V_{BE} = 0.2$ V	V_{CEX}	max.	20 V ²⁾
Emitter-base voltage (open collector)	V_{EBO}	max.	30 V

Currents

Collector current (d.c. 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 steady state power dissipation up to $T_{amb} = 25$ °C	P_{tot}	max.	140 mW
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Temperatures

Storage temperature	T_{stg}	-55 to 85 °C
Operating junction temperature	T_j	max. 75 °C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	0.35 °C/mW
From junction to case	$R_{th\ j-c}$	=	0.2 °C/mW

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

²⁾ For switch-off transients with inductive load see page 12

CHARACTERISTICS

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

Collector cut-off current

$$I_E = 0; V_{CB} = 5\text{ V}$$

$$I_{CBO} < 3\text{ }\mu\text{A}$$

$$V_{CB} = 30\text{ V}; T_j = 55\text{ }^\circ\text{C}$$

$$I_{CBO} < 100\text{ }\mu\text{A}$$

Emitter cut-off current

$$I_C = 0; V_{EB} = 5\text{ V}$$

$$I_{EBO} < 3\text{ }\mu\text{A}$$

$$V_{EB} = 30\text{ V}; T_j = 55\text{ }^\circ\text{C}$$

$$I_{EBO} < 100\text{ }\mu\text{A}$$

Currents at reverse biased emitter junction

$$V_{CE} = 20\text{ V}; -V_{BE} = 0.2\text{ V}; T_j = 55\text{ }^\circ\text{C}$$

$$I_{CEX} < 50\text{ }\mu\text{A}$$

$$-V_{BE} = 20\text{ V}; V_{CB} = 20\text{ V}; T_j = 55\text{ }^\circ\text{C}$$

$$-I_{BEX} < 50\text{ }\mu\text{A}$$

Saturation voltages

ASY73. $I_C = 50\text{ mA}; I_B = 2.5\text{ mA}$

$$V_{CEsat} < 0.22\text{ V}$$

$$I_C = 200\text{ mA}; I_B = 10\text{ mA}$$

$$V_{CEsat} < 0.30\text{ V}$$

$$I_E = 200\text{ mA}; I_B = 16.5\text{ mA}$$

$$V_{ECsat} < 0.30\text{ V}$$

$$I_C = 50\text{ mA}; I_B = 3\text{ mA}$$

$$V_{BEsat} < 0.50\text{ V}$$

$$I_C = 200\text{ mA}; I_B = 12\text{ mA}$$

$$V_{BEsat} < 0.90\text{ V}$$

ASY74. $I_C = 50\text{ mA}; I_B = 1.25\text{ mA}$

$$V_{CEsat} < 0.22\text{ V}$$

$$I_C = 200\text{ mA}; I_B = 5.7\text{ mA}$$

$$V_{CEsat} < 0.30\text{ V}$$

$$I_C = 400\text{ mA}; I_B = 20\text{ mA}$$

$$V_{CEsat} < 0.37\text{ V}$$

$$I_E = 200\text{ mA}; I_B = 10\text{ mA}$$

$$V_{ECsat} < 0.30\text{ V}$$

$$I_C = 50\text{ mA}; I_B = 1.5\text{ mA}$$

$$V_{BEsat} < 0.38\text{ V}$$

$$I_C = 200\text{ mA}; I_B = 7\text{ mA}$$

$$V_{BEsat} < 0.70\text{ V}$$

$$I_C = 400\text{ mA}; V_{CB} = 0$$

$$V_{BEsat} < 0.90\text{ V}$$

ASY75. $I_C = 50\text{ mA}; I_B = 0.75\text{ mA}$

$$V_{CEsat} < 0.22\text{ V}$$

$$I_C = 200\text{ mA}; I_B = 4\text{ mA}$$

$$V_{CEsat} < 0.30\text{ V}$$

$$I_C = 400\text{ mA}; I_B = 13.5\text{ mA}$$

$$V_{CEsat} < 0.37\text{ V}$$

$$I_E = 200\text{ mA}; I_B = 10\text{ mA}$$

$$V_{ECsat} < 0.30\text{ V}$$

$$I_C = 50\text{ mA}; I_B = 0.95\text{ mA}$$

$$V_{BEsat} < 0.34\text{ V}$$

$$I_C = 200\text{ mA}; I_B = 5\text{ mA}$$

$$V_{BEsat} < 0.60\text{ V}$$

$$I_C = 400\text{ mA}; V_{CB} = 0$$

$$V_{BEsat} < 0.70\text{ V}$$

Sustaining voltage

$$I_C = 10\text{ mA}; I_B = 0$$

$$V_{CEO\text{sust}} > 15\text{ V}$$

CHARACTERISTICS (continued)

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

Punch-through voltage

$$V_{pt} > 20\text{ V}$$

Floating potential

$$I_E = 0; V_{CB} = 20\text{ V}; T_j = 55\text{ }^\circ\text{C}$$

$$V_{EBfl} < 180\text{ mV}$$

$$I_C = 0; V_{CB} = 20\text{ V}; T_j = 55\text{ }^\circ\text{C}$$

$$V_{CBfl} < 180\text{ mV}$$

D.C. current gain

ASY73 $V_{CB} = 0; -I_E = 50\text{ mA}$
 $V_{CB} = 0; -I_E = 200\text{ mA}$
 $V_{EB} = 0; -I_C = 200\text{ mA}$

$$h_{FE} > 25$$

$$h_{FE} > 20$$

$$h_{FC} > 12$$

ASY74 $V_{CB} = 0; -I_E = 50\text{ mA}$
 $V_{CB} = 0; -I_E = 200\text{ mA}$
 $V_{CB} = 0; -I_E = 400\text{ mA}$
 $V_{EB} = 0; -I_C = 200\text{ mA}$

$$h_{FE} > 40$$

$$h_{FE} > 35$$

$$h_{FE} > 20$$

$$h_{FC} > 20$$

ASY75 $V_{CB} = 0; -I_E = 50\text{ mA}$
 $V_{CB} = 0; -I_E = 200\text{ mA}$
 $V_{CB} = 0; -I_E = 400\text{ mA}$
 $V_{EB} = 0; -I_C = 200\text{ mA}$

$$h_{FE} > 65$$

$$h_{FE} > 50$$

$$h_{FE} > 30$$

$$h_{FC} > 20$$

Switching parameters

Desaturation time constant $I_B = 1\text{ mA}; I_C = 0$

$$\tau_s < 1.75\text{ }\mu\text{s}$$

Current-feed time constant $I_{CM} = 200\text{ mA};$
 $V_{CE} = 0.75\text{ V}$

$$\tau_c < 1.75\text{ }\mu\text{s}$$

Voltage-feed time constant $I_{CM} = 1\text{ mA};$
 $V_{CE} = 5\text{ V}$

$$\tau_v < 0.20\text{ }\mu\text{s}$$

Collector capacitance at $f = 1\text{ MHz}$

$$I_E = I_e = 0; V_{CB} = 5\text{ V}$$

$$C_c < 30\text{ pF}$$

Emitter capacitance at $f = 1\text{ MHz}$

$$I_C = I_c = 0; V_{EB} = 5\text{ V}$$

$$C_e < 30\text{ pF}$$

Transition frequency

$$-I_E = 3\text{ mA}; V_{CB} = 5\text{ V} \left\{ \begin{array}{l} \text{ASY73} \\ \text{ASY74} \\ \text{ASY75} \end{array} \right.$$

$$f_T > 4\text{ MHz}$$

$$f_T > 6\text{ MHz}$$

$$f_T > 10\text{ MHz}$$

P-N-P SWITCHING TRANSISTORS

Germanium p-n-p transistors in a TO-5 metal envelope with the base connected to the case. The ASY76, ASY77 and ASY80 are primarily intended for amplifying, switching and pulse oscillating applications.

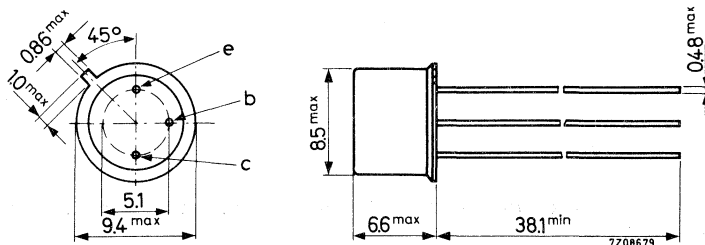
QUICK REFERENCE DATA				
		ASY76	ASY77	ASY80
Collector-base voltage (open emitter)	$-V_{CBO}$	max. 40	60	40 V
Collector-emitter voltage (+ $V_{BE} = 0.6$ V)	$-V_{CEX}$	max. 32	60	40 V
Collector current (peak value)	$-I_{CM}$	max. 1000	mA	
Total power dissipation up to $T_{amb} = 25$ °C	P_{tot}	max. 500	mW	
Junction temperature	T_j	max. 85	°C	
Thermal resistance from junction to case	$R_{th\ j-c}$	=	75	°C/W
D.C. current gain at $T_j = 25$ °C				
$-I_C = 600$ mA; $-V_{CE} = 1$ V	<u>ASY76, ASY77</u>	h_{FE}	>	20
	<u>ASY80</u>	h_{FE}	>	40
Transition frequency				
$-I_C = 1$ mA; $-V_{CE} = 10$ V	f_T	typ.	0.9	MHz

MECHANICAL DATA

Dimensions in mm

TO-5

Base connected to case



Accessories available: 56218, 56245, 56265

RATINGS (Limiting values) ¹⁾

Voltages

		ASY76	ASY77	ASY80
Collector-base voltage (open emitter)	$-V_{CBO}$	max. 40	60	40 V
Collector-emitter voltage with + $V_{BE} = 0.6$ V	$-V_{CEX}$	max. 32	60	40 V
Emitter-base voltage (open collector)	$-V_{EBO}$	max. 10	10	20 V

Currents

Collector current (d.c. or average over any 20 ms period)	$-I_C$	max. 500	mA
Collector current (peak value)	$-I_{CM}$	max. 1000	mA
Base current (d.c. or average over any 20 ms period)	$-I_B$	max. 40	mA
Base current (peak value)	$-I_{BM}$	max. 200	mA

Power dissipation

Total power dissipation up to $T_{amb} = 25$ °C	P_{tot}	max. 500	mW
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Temperatures

Storage temperature	T_{stg}	-65 to +85	°C
Junction temperature	T_j	max. 85	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th j-a}$	=	250	°C/W
From junction to case	$R_{th j-c}$	=	75	°C/W
From junction to ambient with cooling fin 56265 on a heatsink of 12.5 cm ²	$R_{th j-a}$	=	120	°C/W

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

CHARACTERISTICS

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

<u>Collector cut-off current</u>		ASY76	ASY77	ASY80
$I_E = 0; -V_{CB} = 10\text{ V}$	$-I_{CBO}$	typ. 4.5	4.5	4.5 μA
		< 10	10	10 μA
$I_E = 0; -V_{CB} = 40\text{ V}$	$-I_{CBO}$	< 40	-	40 μA
		< -	40	- μA
$I_E = 0; -V_{CB} = 60\text{ V}$	$-I_{CBO}$	< -	40	- μA
<u>Emitter cut-off current</u>				
$I_C = 0; -V_{EB} = 10\text{ V}$	$-I_{EBO}$	< 20	20	20 μA
<u>Currents at reverse biased emitter junction</u>				
$-V_{CE} = 30\text{ V}; +V_{BE} = 0.5\text{ V}$	$-I_{CEX}$	< 30	-	30 μA
$-V_{CE} = 60\text{ V}; +V_{BE} = 0.5\text{ V}$	$-I_{CEX}$	< -	30	- μA
$-V_{CE} = 30\text{ V}; +V_{BE} = 0.5\text{ V}$ $T_j = 60\text{ }^\circ\text{C}$	$-I_{CEX}$	< 200	-	200 μA
$-V_{CE} = 60\text{ V}; +V_{BE} = 0.5\text{ V}$ $T_j = 60\text{ }^\circ\text{C}$	$-I_{CEX}$	< -	200	- μA
<u>Sustaining voltage</u>				
$-I_C = 600\text{ mA}; +V_{BE} = 0.6\text{ V}$	$-V_{CEXsust}$	> -	-	32 V
<u>Base-emitter voltage</u>				
$I_E = 300\text{ mA}; V_{CB} = 0$	$-V_{BE}$	typ. 420	420	420 mV
		< 750	750	750 mV
<u>Saturation voltages</u>				
$-I_C = 300\text{ mA}; -I_B = 12\text{ mA}$	$-V_{CEsat}$	< 300	300	- mV
$-I_C = 300\text{ mA}; -I_B = 6\text{ mA}$	$-V_{CEsat}$	< -	-	400 mV
<u>Emitter-base floating voltage</u>				
$I_E = 0; -V_{CB} = 40\text{ V}$	$-V_{EBfl}$	< 300	-	300 mV
$I_E = 0; -V_{CB} = 60\text{ V}$	$-V_{EBfl}$	< -	300	- mV
<u>D.C. current gain</u>				
$-I_C = 10\text{ mA}; -V_{CE} = 6\text{ V}$	h_{FE}	> 45	45	-
$-I_C = 50\text{ mA}; -V_{CB} = 0$	h_{FE}	-	-	60 to 165
$-I_C = 300\text{ mA}; V_{CB} = 0$	h_{FE}	25 to 130	25 to 130	> 50



CHARACTERISTICS (continued)

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

Collector capacitance at $f = 1\text{ MHz}$

$I_E = I_e = 0; -V_{CB} = 5\text{ V}$

C_c	typ.	40	pF
	<	60	pF

Emitter capacitance at $f = 1\text{ MHz}$

$I_C = I_c = 0; -V_{EB} = 5\text{ V}$

C_e	typ.	30	pF
	<	50	pF

Transition frequency

$-I_C = 10\text{ mA}; -V_{CE} = 5\text{ V}$

<u>ASY76, ASY77</u>	f_T	>	500	kHz
<u>ASY80</u>	f_T	>	700	kHz

Noise figure at $f = 1\text{ kHz}$

$I_E = 0.5\text{ mA}; -V_{CB} = 2\text{ V}$

Bandwidth $200\text{ Hz}; R_S = 500\text{ }\Omega$

F	<	15	dB
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Feedback impedance at $f = 0.5\text{ MHz}$

$I_E = 1\text{ mA}; -V_{CB} = 5\text{ V}$

$ z_{rb} $	typ.	75	Ω
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CHARACTERISTICS

$T_{amb} = 25^{\circ}C$ unless otherwise specified

Collector cut-off current

$I_E = 0; -V_{CB} = 6 V$ $-I_{CBO} < 4.5 \mu A$

$I_E = 0; -V_{CB} = 40 V$ $-I_{CBO} < 50 \mu A$

Emitter cut-off current

$I_C = 0; -V_{EB} = 1 V$ $-I_{EBO} < 50 \mu A$

Base current

$I_E = 1 mA; -V_{CB} = 6 V$ $-I_B < 25 \mu A$

$I_E = 10 mA; -V_{CB} = 2 V$ $-I_B > 20 \mu A$

Base-emitter voltage

$I_E = 1 mA; -V_{CB} = 6 V$ $-V_{BE} \text{ 210 to 330 mV}$

$I_E = 10 mA; -V_{CB} = 2 V$ $-V_{BE} \text{ 260 to 400 mV}$

Frequency at which $|h_{fe}| = 1$

$I_E = 1 mA; -V_{CB} = 6 V$ $f_1 > 40 \text{ MHz}$
typ. 75 MHz

$I_E = 10 mA; -V_{CB} = 2 V$ $f_1 > 100 \text{ MHz}$

Collector capacitance at $f = 0.45 \text{ MHz}$

$I_E = I_e = 0; -V_{CB} = 6 V$ $C_c < 2.5 \text{ pF}$

Feedback impedance at $f = 2 \text{ MHz}$

$I_E = 1 mA; -V_{CB} = 6 V$ $|z_{rb}| < 120 \Omega$

h parameters

$I_E \leq 10 mA; -V_{CB} \leq 6 V; T_{amb} = 60^{\circ}C$ $-h_{fb} < 1.01$

$-I_C = 1 mA; -V_{CE} = 6 V; f = 1 \text{ kHz}$ $h_{fe} > 45$

Noise figure at $R_S = 500 \Omega$

$-I_C = 1 mA; -V_{CE} = 6 V; f = 1 \text{ kHz}$ $F \text{ typ. } 15 \text{ dB}$
 $< 20 \text{ dB}$

$f = 450 \text{ kHz}$ $F < 6 \text{ dB}$

GERMANIUM ALLOY DIFFUSED TRANSISTOR

P-N-P transistor in a TO-18 metal envelope. It is intended for use in high-speed saturated logic applications.

QUICK REFERENCE DATA

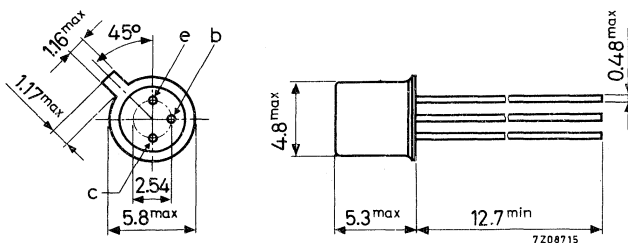
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	20 V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	15 V
Collector current (peak value)	$-I_{CM}$	max.	50 mA
Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}$	P_{tot}	max.	120 mW
Junction temperature	T_j	max.	85 $^{\circ}\text{C}$
D.C. current gain at $T_{amb} = 25\text{ }^{\circ}\text{C}$ $-I_C = 10\text{ mA}; -V_{CE} = 0.5\text{ V}$	h_{FE}	>	30
Transition frequency $I_E = 10\text{ mA}; -V_{CB} = 2\text{ V}$	f_T	>	300 MHz

MECHANICAL DATA

Dimensions in mm

TO-18

Collector connected to case



Accessories available: 56246, 56263

RATINGS (Limiting values) ¹⁾Voltages

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	20 V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	15 V

Currents

Collector current (d.c. or average over any 20 ms period)	$-I_C$	max.	30 mA
Collector current (peak value)	$-I_{CM}$	max.	50 mA
Emitter current (d.c. or average over any 20 ms period)	I_E	max.	5 mA
Emitter current (peak value)	I_{EM}	max.	10 mA

Power dissipation

Total power dissipation up to $T_{amb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	120 mW
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Temperatures

Storage temperature	T_{stg}	-55 to +75	$^\circ\text{C}$
Junction temperature	T_j	max.	85 $^\circ\text{C}$

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	0.50 $^\circ\text{C}/\text{mW}$
From junction to case	$R_{th\ j-c}$	=	0.18 $^\circ\text{C}/\text{mW}$

CHARACTERISTICS $T_{amb} = 25\text{ }^\circ\text{C}$ unless otherwise specifiedEmitter cut-off current

$I_C = 0$; $-V_{EB} = 0.5\text{ V}$	$-I_{EBO}$	<	2 μA
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Currents at reverse biased emitter junction

$-V_{CE} = 15\text{ V}$; $-V_{EB} = 0.2\text{ V}$; $T_{amb} = 60\text{ }^\circ\text{C}$	$-I_{CEX}$	<	60 μA
	$+I_{BEX}$	<	60 μA

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

CHARACTERISTICS (continued)

$T_{amb} = 25\text{ }^{\circ}\text{C}$ unless otherwise specified

Breakdown voltages at $T_{amb} = 60\text{ }^{\circ}\text{C}$

$I_E = 0; -I_C = 100\text{ }\mu\text{A}$	$-V_{(BR)\text{ CBO}}$	$> 20\text{ V}$
$I_C = 0; -I_E = 100\text{ }\mu\text{A}$	$-V_{(BR)\text{ EBO}}$	$> 2.5\text{ V}$

Sustaining voltage

$I_B = 0; -I_C = 5\text{ mA}$	$-V_{CEO\text{ sust}}$	$> 9\text{ V}$
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Saturation voltage

$-I_C = 10\text{ mA}; -I_B = 1\text{ mA}$	$-V_{CE\text{ sat}}$	$< 0.35\text{ V}$
$-I_C = 50\text{ mA}; -I_B = 3\text{ mA}$	$-V_{CE\text{ sat}}$	$< 1.10\text{ V}$

Base-emitter voltage

$-I_C = 10\text{ mA}; -I_B = 0.44\text{ mA}$	$-V_{BE}$	0.25 to 0.5 V
$-I_C = 30\text{ mA}; -I_B = 0.9\text{ mA}$	$-V_{BE}$	0.35 to 0.75 V

D.C. current gain

$-I_C = 10\text{ mA}; -V_{CE} = 0.5\text{ V}$	h_{FE}	> 30
$-I_C = 30\text{ mA}; -V_{CE} = 1.0\text{ V}$	h_{FE}	> 50

Collector capacitance

$I_E = I_e = 0; -V_{CB} = 6\text{ V}$	C_c	$< 5\text{ pF}$
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Emitter capacitance

$I_C = I_c = 0; -V_{EB} = 1\text{ V}$	C_e	$< 12\text{ pF}$
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Transition frequency

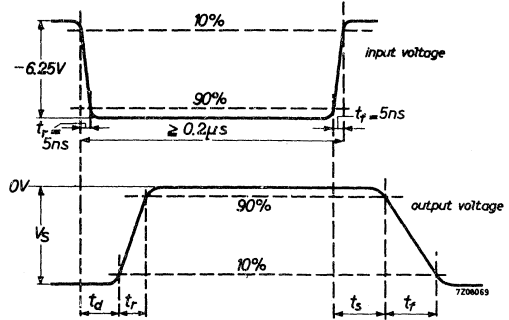
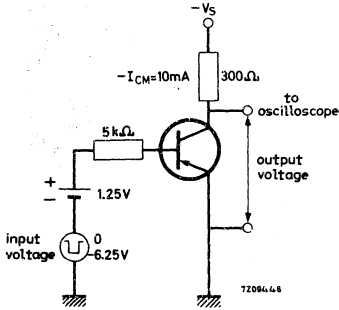
$I_E = 10\text{ mA}; -V_{CB} = 2\text{ V}$	f_T	$> 300\text{ MHz}$
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CHARACTERISTICS (continued)

$T_{amb} = 25^\circ C$ unless otherwise specified

Switching characteristics

Test circuit:



Delay time

t_d typ. 30 ns
15 to 40 ns

Rise time

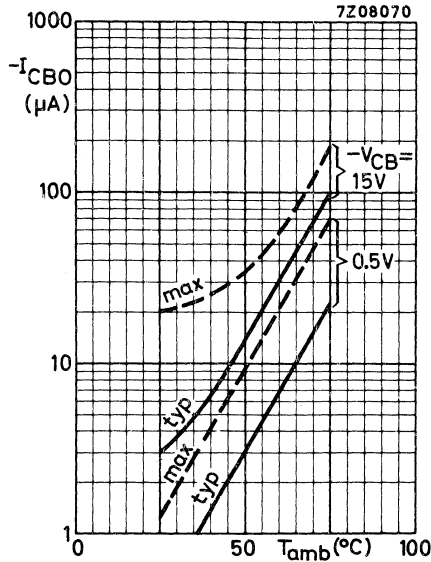
t_r typ. 20 ns
10 to 35 ns

Storage time

t_s typ. 40 ns
25 to 60 ns

Fall time

t_f typ. 40 ns
25 to 55 ns



SILICON PLANAR EPITAXIAL TRANSISTOR

N-P-N transistor in a TO-39 metal envelope primarily intended for use as high current switching device, e.g. inverters and switching regulators.

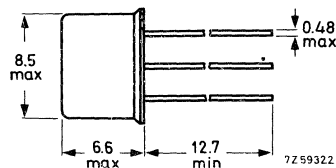
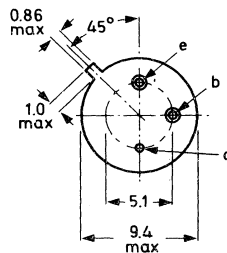
QUICK REFERENCE DATA			
Collector-base voltage (open emitter)	V_{CBO}	max.	120 V
Collector-emitter voltage (open base)	V_{CEO}	max.	60 V
Collector-current (peak value)	I_{CM}	max.	5.0 A
Total power dissipation up to $T_{case} = 25^{\circ}C$	P_{tot}	max.	5.0 W
Junction temperature	T_j	max.	200 $^{\circ}C$
D.C. current gain $I_C = 2 A; V_{CE} = 2 V$	h_{FE}		40 to 150
Transition frequency at $f = 35 MHz$ $I_C = 0.5 A; V_{CE} = 5 V$	f_T	>	70 MHz
Turn off time when switched from $I_C = 5 A; I_B = 0.5 A$ to cut-off with $-I_{BM} = 0.5 A$	t_{off}	<	1.2 μs

MECHANICAL DATA

Dimensions in mm

Collector connected to case

TO-39



max. lead diameter is guaranteed only for 12.7 mm

Accessories supplied on request: 56218, 56254, 56265

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

Collector-base voltage (open emitter)	V_{CB0}	max.	120	V
Collector-emitter voltage (open base)	V_{CE0}	max.	60	V
Emitter-base voltage (open collector)	V_{EB0}	max.	6	V

Currents

Collector current (d. c.)	I_C	max.	2.0	A
Collector current (peak value)	I_{CM}	max.	5.0	A
Base current (d. c.)	I_B	max.	1.0	A

Power dissipation

Total power dissipation up to $T_{case} = 25\text{ }^{\circ}\text{C}$	P_{tot}	max.	5.0	W
up to $T_{amb} = 25\text{ }^{\circ}\text{C}$	P_{tot}	max.	0.87	W

Temperatures

Storage temperature	T_{stg}	-55 to +200	$^{\circ}\text{C}$
Junction temperature	T_j	max. 200	$^{\circ}\text{C}$

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	200	$^{\circ}\text{C}/\text{W}$
From junction to case	$R_{th\ j-c}$	=	35	$^{\circ}\text{C}/\text{W}$

CHARACTERISTICS

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

Collector cut-off current

$V_{EB} = 0; V_{CE} = 60\text{ V}$

$I_{CES} < 10\ \mu\text{A}$

Emitter cut-off current

$I_C = 0; V_{EB} = 4\text{ V}$

I_{EBO} typ. 0.01 μA
< 10 μA

Saturation voltages

$I_C = 5\text{ A}; I_B = 0.5\text{ A}$

V_{CEsat} typ. 0.77 V
< 1.0 V

V_{BEsat} typ. 1.43 V
< 1.8 V

D. C. current gain

$I_C = 1.0\text{ A}; V_{CE} = 2.0\text{ V}$

h_{FE} typ. 130

$I_C = 1.5\text{ A}; V_{CE} = 0.6\text{ V}$

h_{FE} typ. 60

$I_C = 2.0\text{ A}; V_{CE} = 2.0\text{ V}$

h_{FE} typ. 110
40 to 150

Collector capacitance at $f = 1\text{ MHz}$

$I_E = I_e = 0; V_{CB} = 10\text{ V}$

C_c typ. 36 pF
< 100 pF

Emitter-capacitance at $f = 1\text{ MHz}$

$I_C = I_c = 0; V_{EB} = 0.5\text{ V}$

C_e typ. 345 pF

Transition frequency at $f = 35\text{ MHz}$

$I_C = 0.5\text{ A}; V_{CE} = 5\text{ V}$

f_T > 70 MHz
typ. 100 MHz

Turn on time when switched from

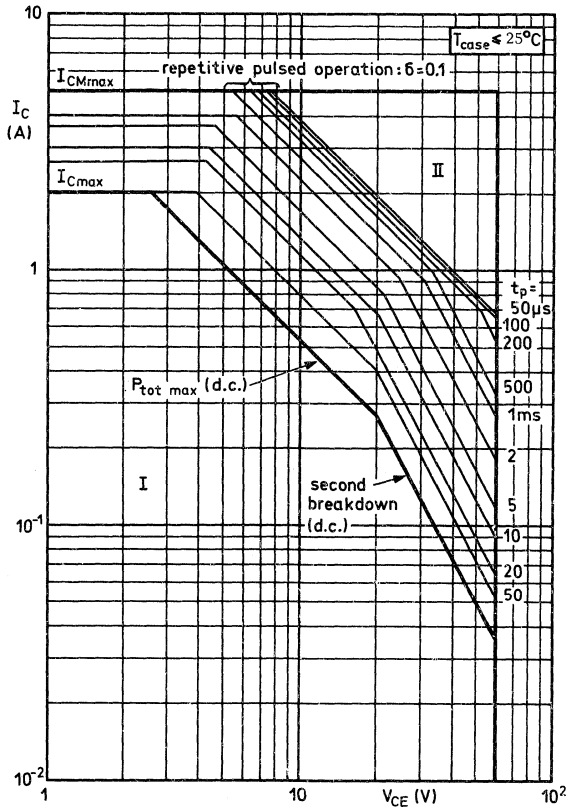
$-V_{BE} = 2.0\text{ V}$ to $I_C = 5\text{ A}; I_B = 0.5\text{ A}$
with $I_{BM} = 0.5\text{ A}$

t_{on} typ. 0.2 μs
< 0.6 μs

Turn off time when switched from

$I_C = 5\text{ A}; I_B = 0.5\text{ A}$ to $-V_{BE} = 2.0\text{ V}$
with $-I_{BM} = 0.5\text{ A}$

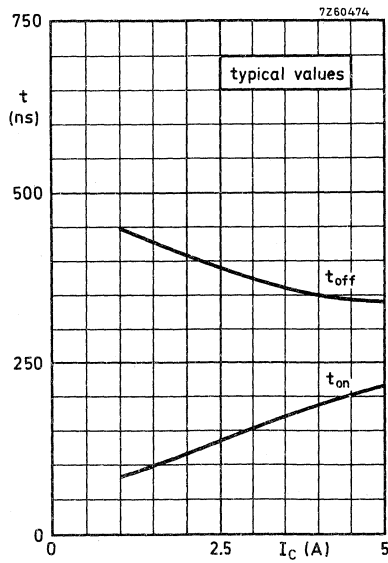
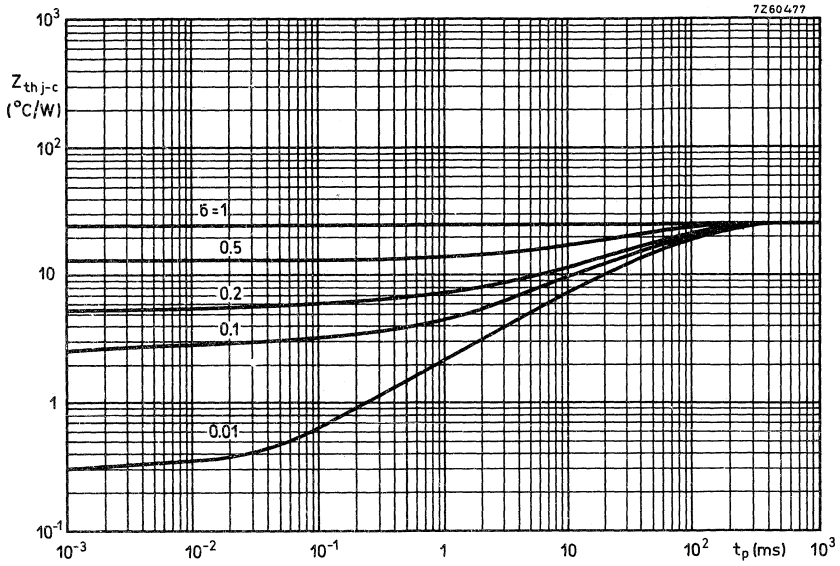
t_{off} typ. 0.34 μs
< 1.2 μs

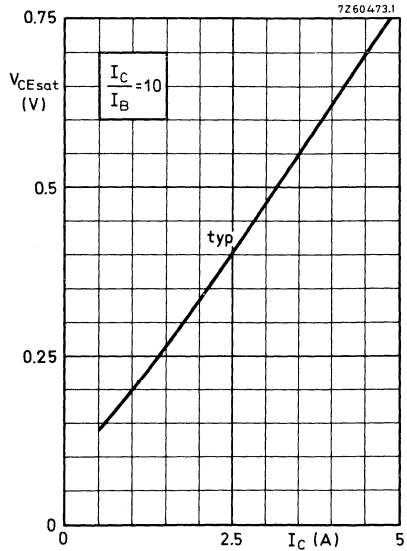
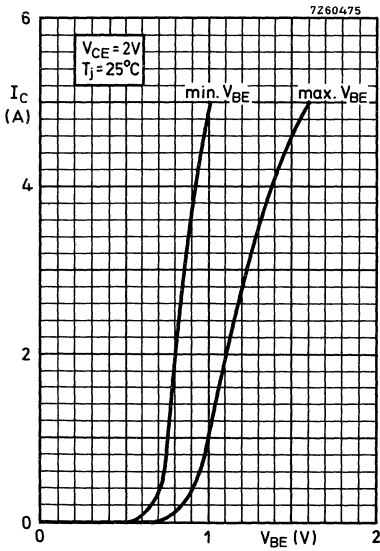
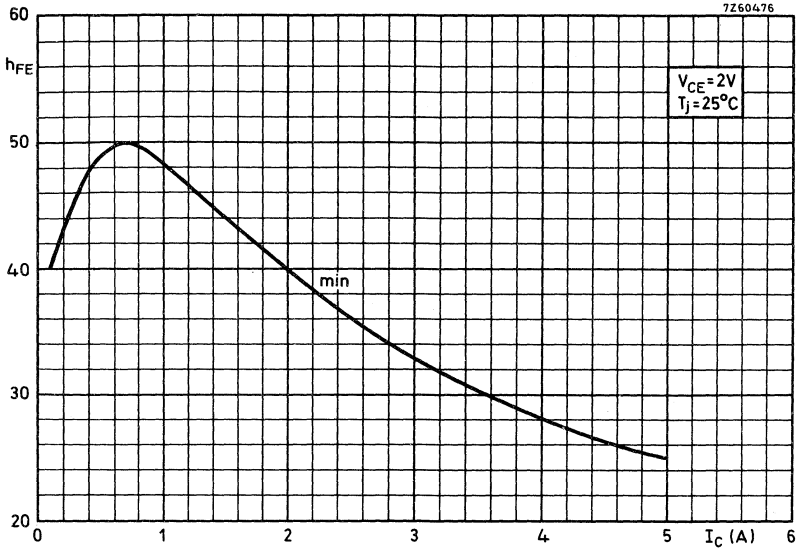


Safe Operation Area with the transistor forward biased

I Region of permissible d. c. operation

II Permissible extension for repetitive pulsed operation





SILICON CONTROLLED SWITCH

The BRY39 is a planar p-n-p-n switch in a TO-72 metal envelope, intended as driver for numerical indicator tubes and other switching applications.

It is an integrated pnp-npn transistor pair of which all electrodes are accessible. The collector of the n-p-n transistor is connected to the case.

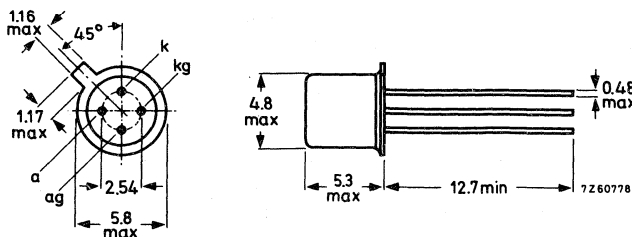
For the applications of the BRY39 as THYRISTOR see Handbook Part 1, section THYRISTORS and as PROGRAMMABLE UNIJUNCTION TRANSISTOR see Handbook Part 3, section SWITCHING TRANSISTORS.

QUICK REFERENCE DATA			
P-N-P transistor			
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	70 V
N-P-N transistor			
Collector-base voltage (open emitter)	V_{CBO}	max.	70 V
Repetitive peak emitter current (peak value)	$-I_{ERM}$	max.	2.5 A
Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}$	P_{tot}	max.	275 mW
Junction temperature	T_j	max.	150 $^{\circ}\text{C}$
Forward on-state voltage $I_A = 50\text{ mA}; I_C = 0; R_{BE} = 10\text{ k}\Omega$	V_{AE}	<	1.4 V
Holding current $I_C = 10\text{ mA}; -V_{BB} = 2\text{ V}; R_{BE} = 10\text{ k}\Omega$	I_H	<	1.0 mA
Turn on time	t_{on}	<	0.25 μs
Turn off time	t_q	<	5.0 μs

MECHANICAL DATA

Dimensions in mm

Collector connected to case
TO-72



Accessories available: 56246; 56263.

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

<u>Voltages</u>			p-n-p	n-p-n
Collector-base voltage (open emitter)	V_{CBO}	max.	-70	70 ¹⁾ V
Collector-emitter voltage ($R_{BE} = 10 \text{ k}\Omega$)	V_{CER}	max.		70 ¹⁾ V
Collector-emitter voltage (open base)	V_{CEO}	max.	-70	V
Emitter-base voltage (open collector)	V_{EBO}	max.	-70 ¹⁾	5 ²⁾ V
<u>Currents</u>				
→ Emitter current (d.c.)	I_E	max.	175	-175 mA
→ Repetitive peak emitter current (peak value) $t_p = 10 \text{ }\mu\text{s}; \delta = 0.01$	I_{ERM}	max.	2.5	-2.5 A
Collector current (d.c.)	I_C	max.		50 mA
Collector current (peak value)	I_{CM}	max.		100 ³⁾ mA

Power dissipation

→ Total power dissipation up to $T_{amb} = 25 \text{ }^\circ\text{C}$ P_{tot} max. 275 mW

Temperatures

Storage temperature T_{stg} -65 to +200 $^\circ\text{C}$

Junction temperature T_j max. 150 $^\circ\text{C}$

THERMAL RESISTANCE

→ From junction to ambient $R_{th \text{ j-a}}$ = 0.45 $^\circ\text{C}/\text{mW}$

1) In numerical indicator tube driver circuits higher voltages are allowed, provided the collector current does not exceed a d.c. current of 1 mA.

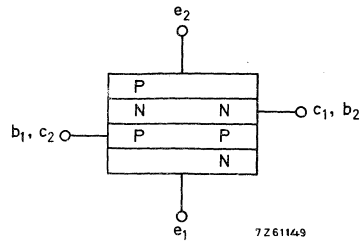
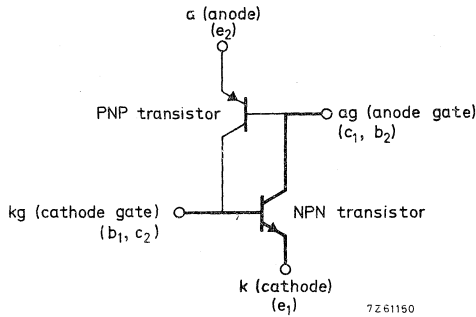
2) In numerical indicator tube driver circuits higher voltages are allowed during the discharge of a capacitor of max. 390 pF, provided the charge does not exceed 50 nC and the current is limited to 150 mA.

3) During switching-on, the device can withstand a discharge of a capacitor of max. 500 pF. This capacitor is charged, when the transistor is in cut-off condition, with a collector supply voltage of 160 V with a series resistance of 100 k Ω .

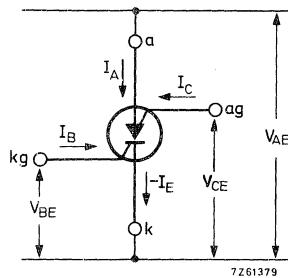
MEANING OF SYMBOLS, used in the schematic presentation of the S.C.S.

2 transistors equivalent circuit
 n-p-n transistor + p-n-p transistor

p-n-p-n S.C.S. equivalent circuit



S.C.S. symbol



CHARACTERISTICS

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

INDIVIDUAL N-P-N TRANSISTOR

Collector cut-off current

$V_{CE} = 70\text{ V}; R_{BE} = 10\text{ k}\Omega$

$I_{CER} < 100\text{ nA}$

$V_{CE} = 70\text{ V}; R_{BE} = 10\text{ k}\Omega; T_j = 150\text{ }^\circ\text{C}$

$I_{CER} < 10\text{ }\mu\text{A}$

Emitter cut-off current

$I_C = 0; V_{EB} = 5\text{ V}; T_j = 150\text{ }^\circ\text{C}$

$I_{EBO} < 10\text{ }\mu\text{A}$

CHARACTERISTICS (continued)

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

INDIVIDUAL N-P-N TRANSISTOR

Saturation voltages

$I_C = 10\text{ mA}; I_B = 1\text{ mA}$

$V_{CEsat} < 500\text{ mV}$
 $V_{BEsat} < 900\text{ mV}$

D. C. current gain

$I_C = 10\text{ mA}; V_{CE} = 2\text{ V}$

$h_{FE} > 50$

Transition frequency

$I_C = 10\text{ mA}; V_{CE} = 2\text{ V}$

f_T typ. 300 MHz

Collector capacitance

$I_E = I_e = 0; V_{CB} = 20\text{ V}$

$C_c < 5\text{ pF}$

Emitter capacitance

$I_C = I_c = 0; V_{EB} = 1\text{ V}$

$C_e < 25\text{ pF}$

INDIVIDUAL P-N-P TRANSISTOR

Collector cut-off current

$I_B = 0; -V_{CE} = 70\text{ V}; T_j = 150\text{ }^\circ\text{C}$

$-I_{CEO} < 10\text{ }\mu\text{A}$

Emitter cut-off current

$I_C = 0; -V_{EB} = 70\text{ V}; T_j = 150\text{ }^\circ\text{C}$

$-I_{EBO} < 10\text{ }\mu\text{A}$

D. C. current gain

$I_E = 1\text{ mA}; V_{CB} = 0$

$h_{FB} 0.25\text{ to }2.5$

COMBINED DEVICE

Forward voltage at $R_{BE} = 10\text{ k}\Omega$

$I_A = 50\text{ mA}; I_C = 0$

$V_{AE} < 1.4\text{ V}$

$I_A = 50\text{ mA}; I_C = 0; T_j = -55\text{ }^\circ\text{C}$

$V_{AE} < 1.9\text{ V}$

$I_A = 1\text{ mA}; I_C = 10\text{ mA}$

$V_{AE} < 1.2\text{ V}$

Holding current at $R_{BE} = 10\text{ k}\Omega$

$I_C = 10\text{ mA}; -V_{BB} = 2\text{ V}$

$I_H 0.1\text{ to }1.0\text{ mA}$

CHARACTERISTICS (continued)

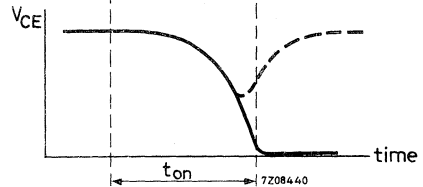
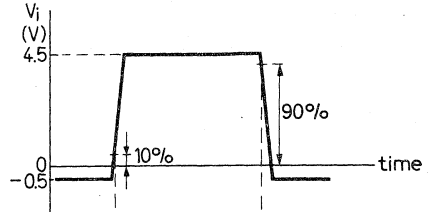
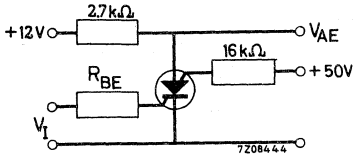
SWITCHING TIMES see also page 6

Turn on time when switched from

$-V_{BE} = 0.5 \text{ V}$ to $+V_{BE} = 4.5 \text{ V}$; $R_{BE} = 1 \text{ k}\Omega$
 $R_{BE} = 10 \text{ k}\Omega$

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

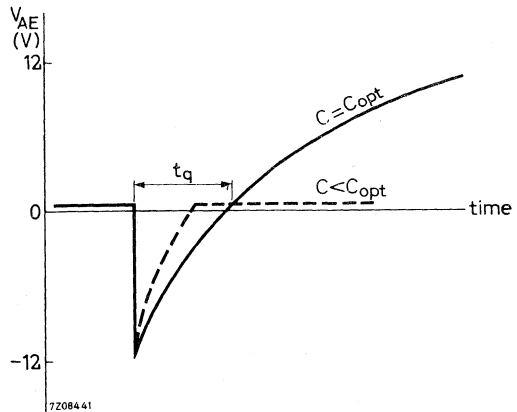
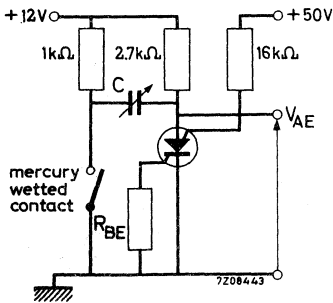
$t_{on} < 0.25 \text{ }\mu\text{s}$
 $t_{on} < 1.5 \text{ }\mu\text{s}$



Pulse duration increased until dashed curve disappears

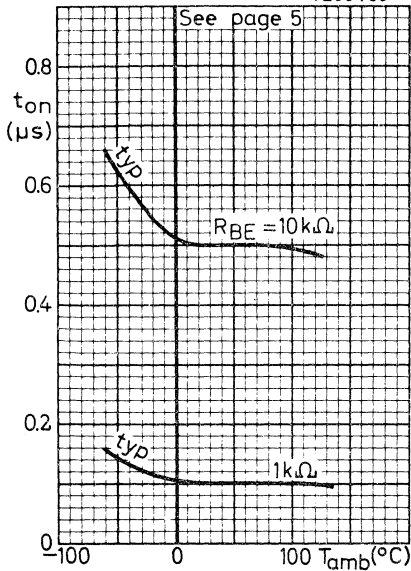
Turn off time

$T_j = 125 \text{ }^\circ\text{C}$; $R_{BE} = 1 \text{ k}\Omega$ $t_q < 5 \text{ }\mu\text{s}$
 $R_{BE} = 10 \text{ k}\Omega$ $t_q < 8 \text{ }\mu\text{s}$
 $R_{BE} = 10 \text{ k}\Omega$ $t_q < 15 \text{ }\mu\text{s}$

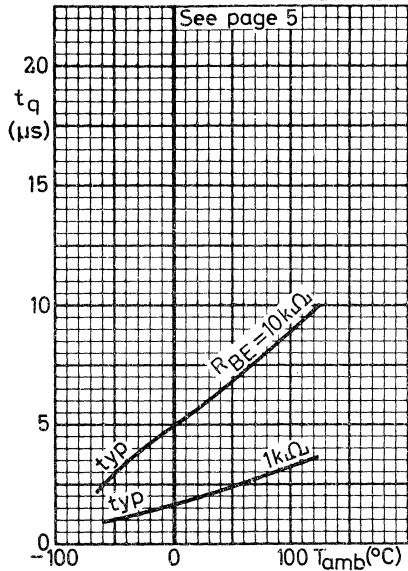


Capacitance increased until dashed curve disappears at $C = C_{opt}$

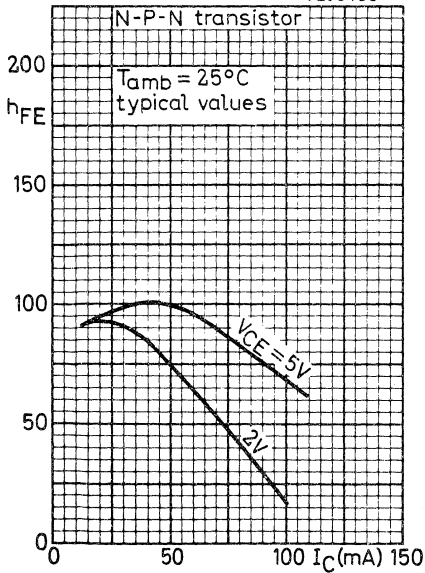
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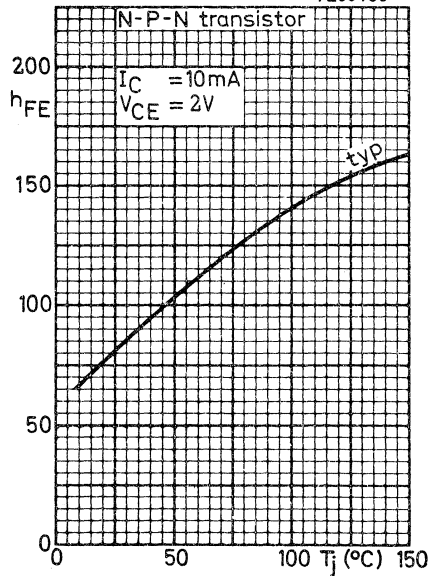
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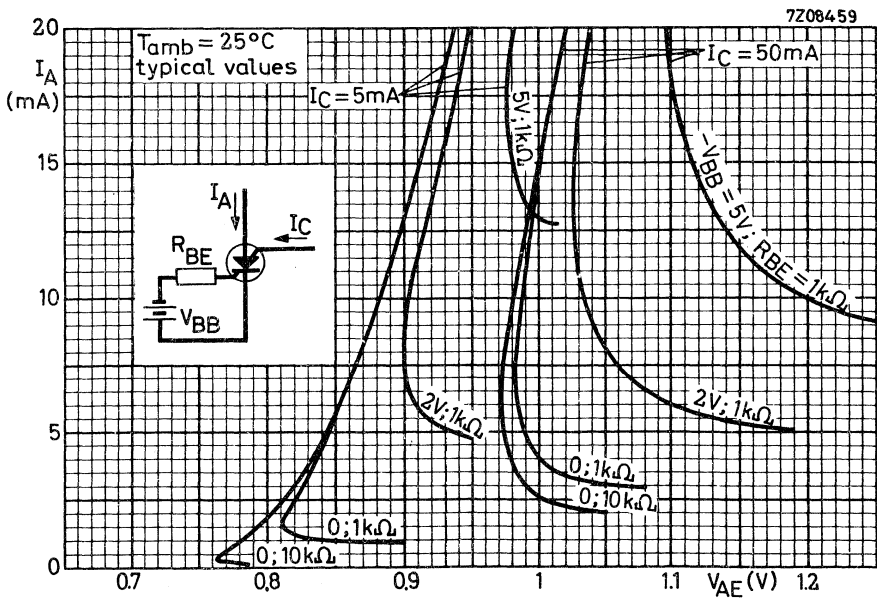
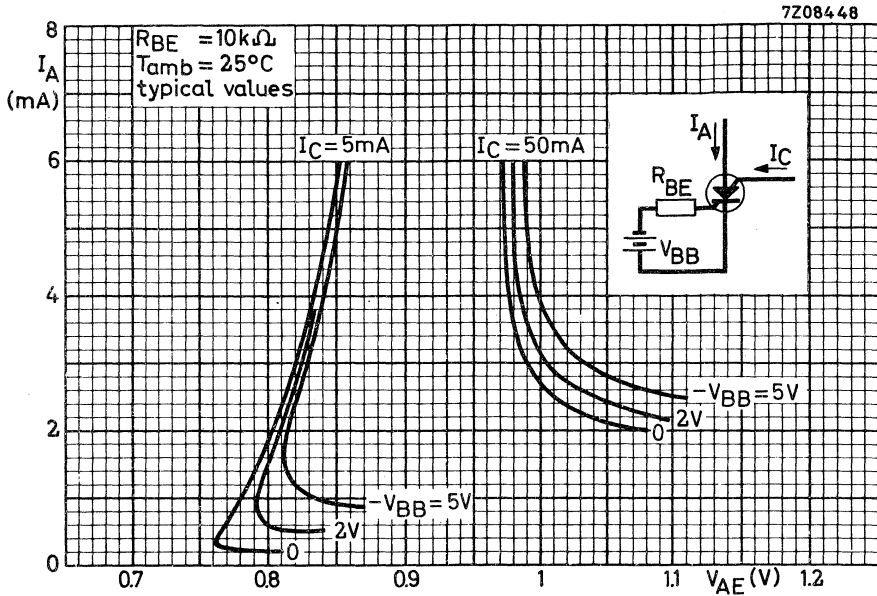


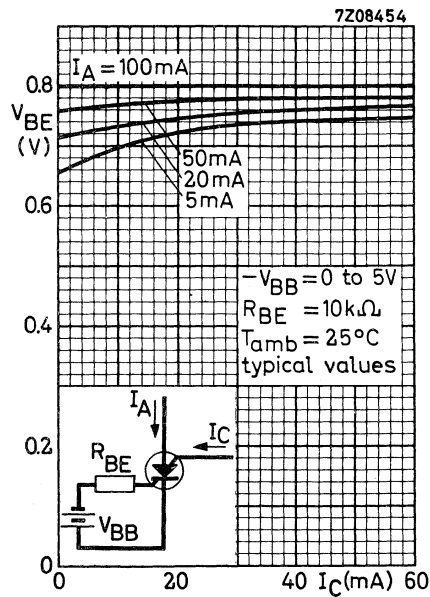
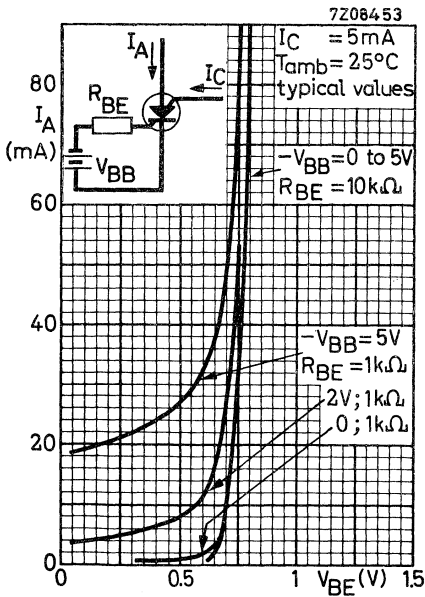
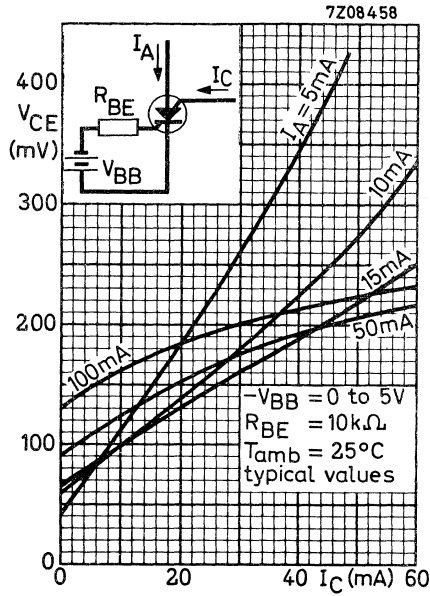
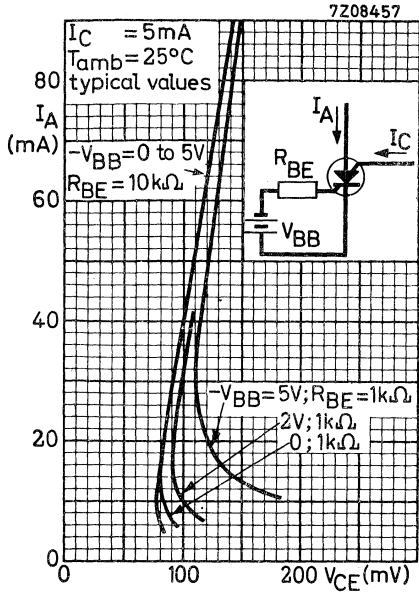
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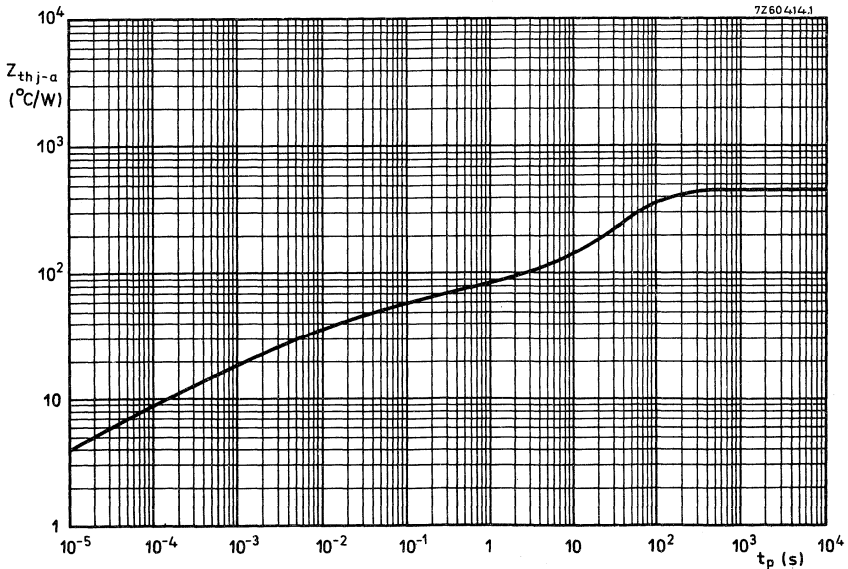
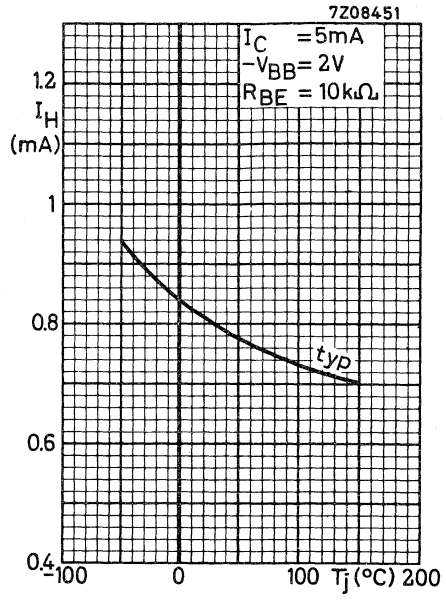
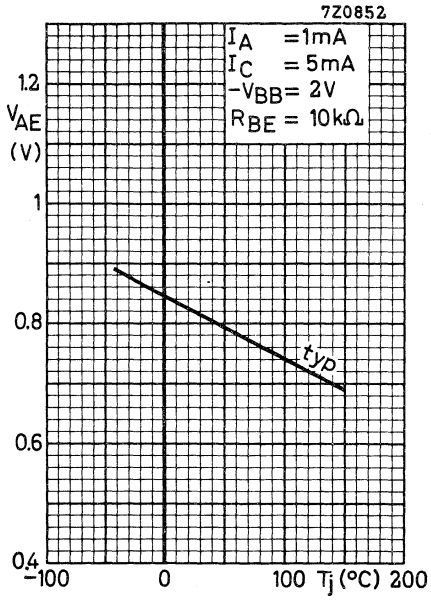


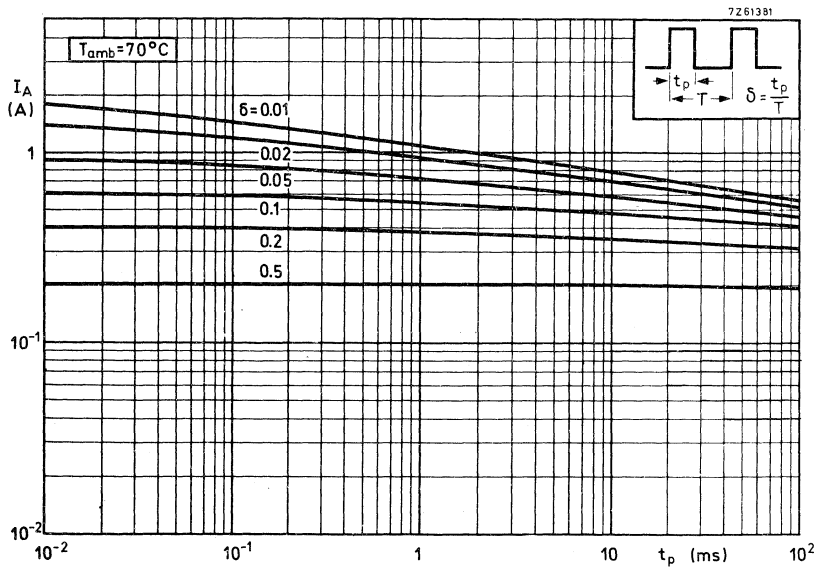
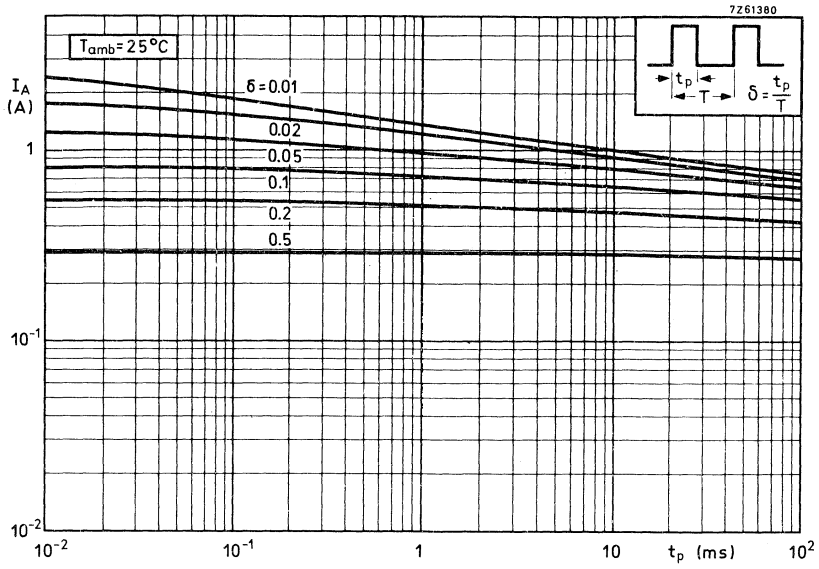
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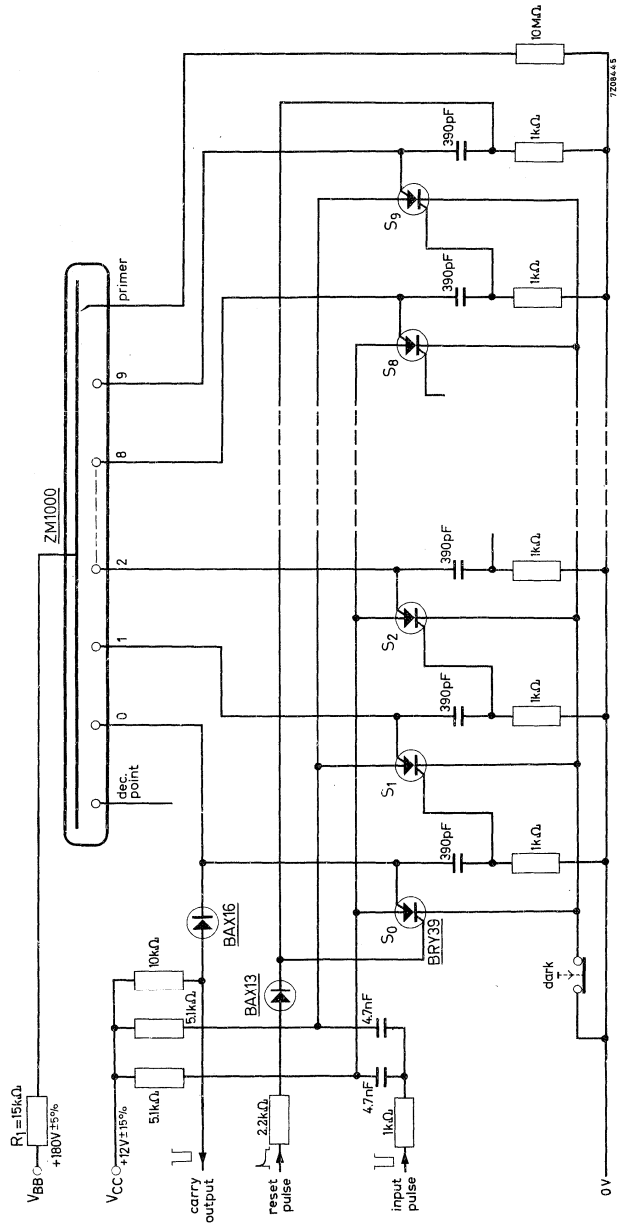




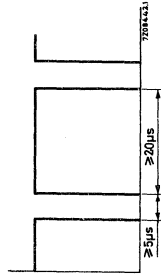
APPLICATION INFORMATION

Decade ring-counter circuit with display ($f \leq 40$ kHz)

Operating ambient temperature T_{amb} 0 to 70 °C



Input pulse:



All resistors 1/8 W; ± 5%, except R_1 ± 3%



PROGRAMMABLE UNIJUNCTION TRANSISTOR

The BRY39 is a planar p-n-p-n trigger device in a TO-72 metal envelope, intended for use in switching applications such as motor control, oscillators, relay replacement, timers, pulse shaper, trigger device etc.

For the applications of the BRY39 as SCS see Handbook Part 3, section SWITCHING TRANSISTORS and as THYRISTOR TETRODE see Handbook Part 1, section THYRISTORS, DIACS, TRIACS. (For explanation of symbols see page 2)

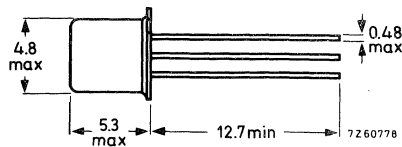
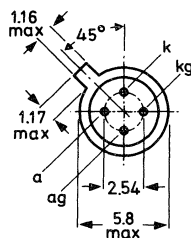
QUICK REFERENCE DATA				
Gate-cathode voltage	V_{GK}	max.	70	V
Gate-anode voltage	V_{GA}	max.	70	V
Anode current (d. c.) up to $T_{case} = 85\text{ }^{\circ}\text{C}$	I_A	max.	250	mA
Junction temperature	T_j	max.	150	$^{\circ}\text{C}$
Peak point current				
$V_S = 10\text{ V}; R_G = 10\text{ k}\Omega$	I_p	<	5	μA
Valley point current				
$V_S = 10\text{ V}; R_G = 10\text{ k}\Omega$	I_V	>	50	μA

MECHANICAL DATA

Dimensions in mm

Anode gate connected to case

TO-72



Accessories supplied on request: 56246; 56263

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

→ Voltages

Gate-cathode voltage	V_{GK}	max.	70	V
Gate-anode voltage	V_{GA}	max.	70	V

Currents

Anode current (d. c.) up to $T_{amb} = 25\text{ }^{\circ}\text{C}$ I_A max. 175 mA

Anode current (d. c.) up to $T_{case} = 85\text{ }^{\circ}\text{C}$ I_A max. 250 mA

Repetitive peak anode current
 $t = 10\text{ }\mu\text{s}; \delta = 0.01$ I_{ARM} max. 2.5 A

Non-repetitive peak anode current
 $t = 10\text{ }\mu\text{s}; T_j = 150\text{ }^{\circ}\text{C}$ I_{ASM} max. 3 A

Rate of rise of anode current
 up to $I_A = 2.5\text{ A}$ $\frac{dI_A}{dt}$ max. 20 A/ μs

Temperatures

Storage temperature T_{stg} -65 to +200 $^{\circ}\text{C}$

Junction temperature T_j max. 150 $^{\circ}\text{C}$

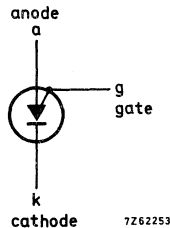
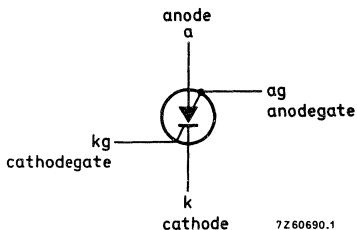
THERMAL RESISTANCE

From junction to ambient in free air $R_{th\ j-a} = 0.45\text{ }^{\circ}\text{C/mW}$

From junction to case $R_{th\ j-c} = 0.15\text{ }^{\circ}\text{C/mW}$

→ EXPLANATION OF SYMBOLS

For applications of the BRY39 as programmable unijunction transistor only the anode gate is used. To simplify the symbols the term gate instead of anode gate will be applied.



CHARACTERISTICS

$T_{amb} = 25\text{ }^{\circ}\text{C}$ unless otherwise specified

Peak point current

$V_S = 10\text{ V}; R_G = 10\text{ k}\Omega$

$I_P < 5\text{ }\mu\text{A}$

$V_S = 10\text{ V}; R_G = 1\text{ M}\Omega$

$I_P < 1\text{ }\mu\text{A}$

Valley point current

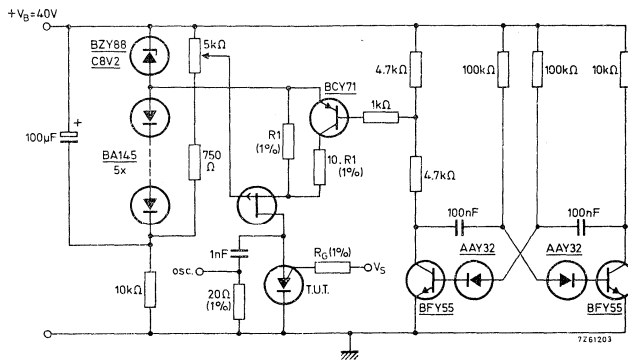
$V_S = 10\text{ V}; R_G = 10\text{ k}\Omega$

$I_V > 50\text{ }\mu\text{A}$ ←

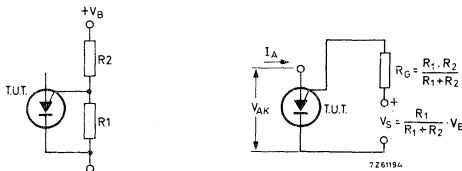
$V_S = 10\text{ V}; R_G = 1\text{ M}\Omega$

$I_V < 50\text{ }\mu\text{A}$

Practical test circuit: 1 Remove BCY71 during measurement of I_P
2 Value of R_1 depends on the voltage range of voltmeter



Equivalent test circuit

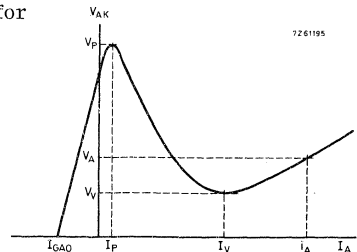


BRY39 with "program" resistors R_1 and R_2

Equivalent test circuit for characteristics testing

Offset voltage $V_{offset} = V_P - V_S (I_A = 0)$

See graph on page 6.



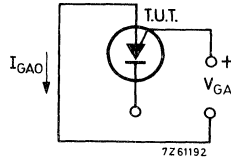
CHARACTERISTICS (continued)

$T_{amb} = 25\text{ }^{\circ}\text{C}$ unless otherwise specified

Gate-anode leakage current

$I_K = 0; V_{GA} = 70\text{ V}$

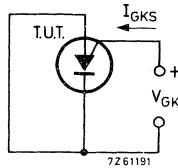
$I_{GAO} < 10\text{ nA}$



Gate-cathode leakage current

$V_{AK} = 0; V_{GK} = 70\text{ V}$

$I_{GKS} < 100\text{ nA}$



Anode voltage at $I_A = 100\text{ mA}$

$V_A < 1.4\text{ V}$

Peak output voltage

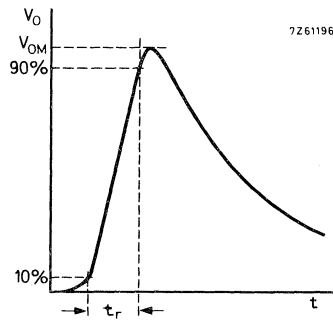
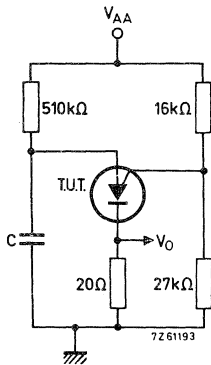
$V_{AA} = 20\text{ V}; C = 0.2\text{ }\mu\text{F}$

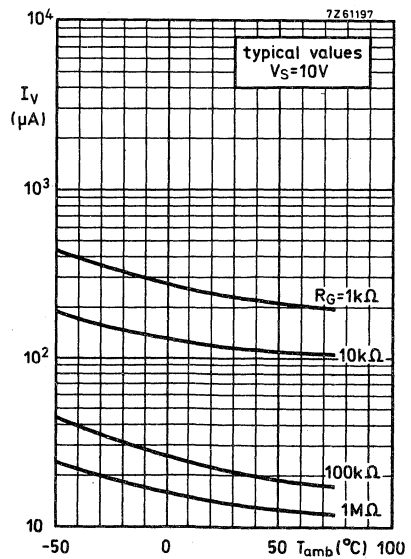
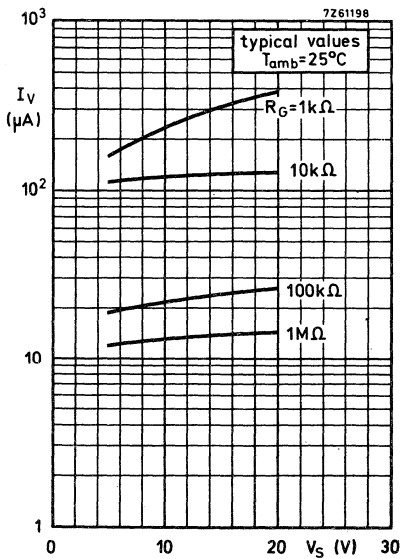
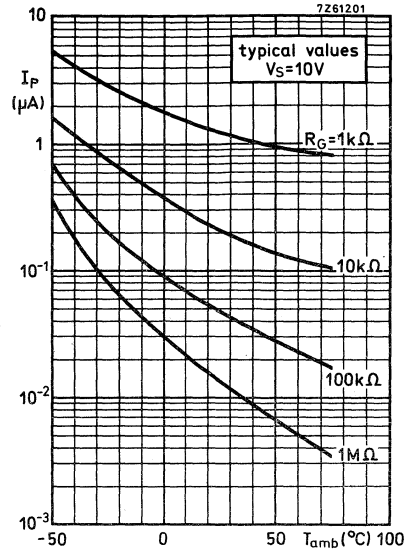
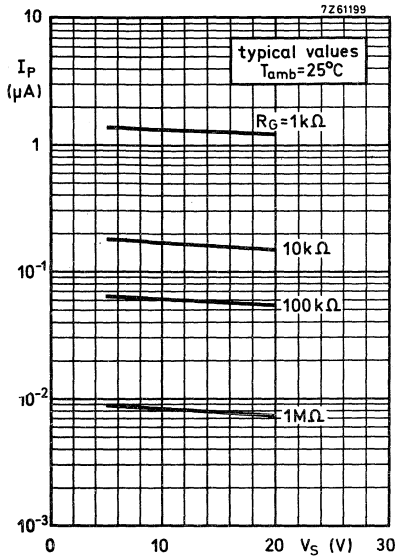
$V_{OM} > 6\text{ V}$

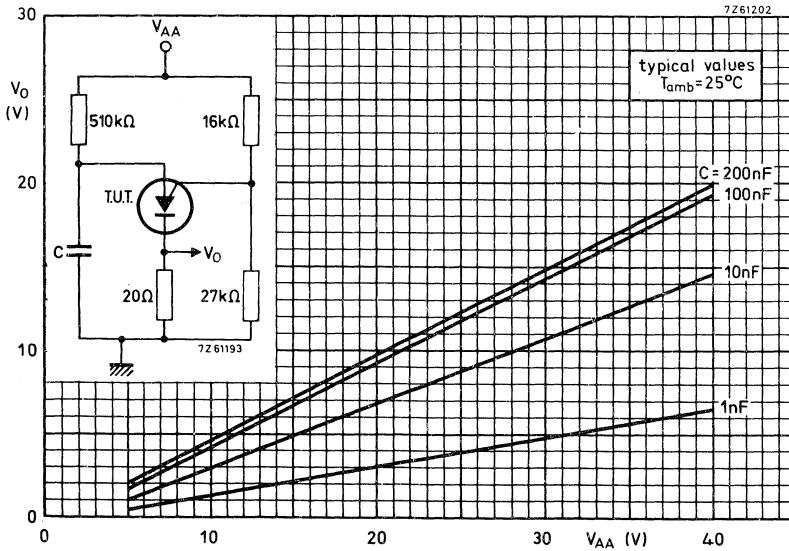
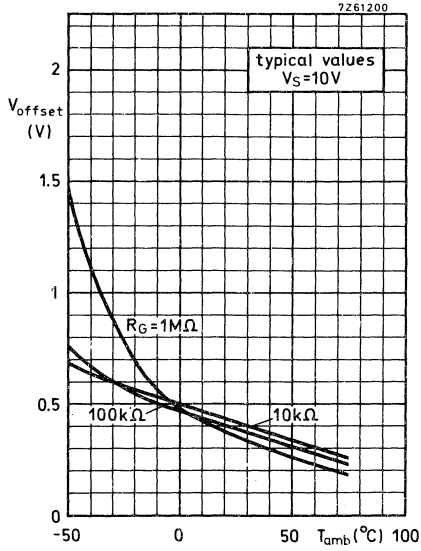
Rise time

$V_{AA} = 20\text{ V}; C = 10\text{ nF}$

$t_r < 80\text{ ns}$







SWITCHING TRANSISTORS

N-P-N transistor in a TO-39 metal envelope with the collector connected to the case. It is primarily intended for core-driving in the 0.3 μ s stores range.

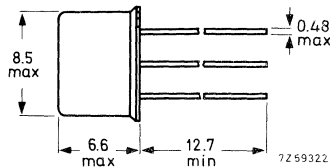
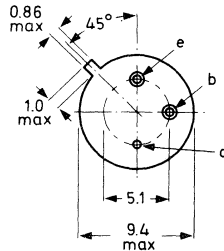
QUICK REFERENCE DATA						
		BSS27		BSS28	BSS29	
Collector-emitter voltage (open base)	V_{CEO}	max.	45	30	30	V
Collector current (peak value)	I_{CM}	max.	1	1	1	A
Total power dissipation up to $T_{amb} = 25^{\circ}C$	P_{tot}	max.	800	800	800	mW
D.C. current gain $I_C = 500$ mA; $V_{CE} = 1$ V	h_{FE}	>	25	30	20	
Saturation voltage $I_C = 500$ mA; $I_B = 35$ mA	V_{CEsat}	<	0.4	0.4	0.5	V
Turn off time $I_C = 500$ mA; $I_B = 50$ mA; $-I_{BM} = 50$ mA	t_{off}	<	40	45	50	ns

MECHANICAL DATA

Dimensions in mm

Collector connected to case

TO-39



Accessories available: 56218; 56245; 56265

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

Voltages

		BSS27	BSS28	BSS29	
Collector-base voltage (open emitter)	V _{CB0}	max. 70	50	50	V
Collector-emitter voltage (open base)	V _{CE0}	max. 45	30	30	V
Emitter-base voltage (open collector)	V _{EB0}	max. 5	5	5	V

Currents

Collector current (d.c.)	I _C	max.	1	A
Collector current (peak value)	I _{CM}	max.	1	A
Reverse base current (peak value)	-I _{BM}	max.	0.2	A

Power dissipation

Total power dissipation up to T _{amb} = 25 °C	P _{tot}	max.	800	mW
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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} =	225	°C/W
From junction to case	R _{th j-c} =	35	°C/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current

		BSS27	BSS28	BSS29
V _{CE} = 40 V; R _{BE} = 50 Ω	I _{CER}	< 1	-	- μA
V _{CE} = 40 V; R _{BE} = 50 Ω; T _j = 150 °C	I _{CER}	< 1000	-	- μA
V _{CE} = 25 V; R _{BE} = 50 Ω	I _{CER}	< -	1	1 μA
V _{CE} = 25 V; R _{BE} = 50 Ω; T _j = 150 °C	I _{CER}	< -	1000	1000 μA

Currents at reverse biased emitter junction

-V _{BE} = 4 V; V _{CE} = 40 V	-I _{BEX}	< 1	-	- μA
-V _{BE} = 4 V; V _{CE} = 25 V	-I _{BEX}	< -	1	1 μA

CHARACTERISTICS (continued)

		BSS27	BSS28	BSS29
<u>Breakdown voltages</u>				
Collector-base voltage; $I_E = 0$; $I_C = 10 \mu A$	$V_{(BR)CBO} >$	70	50	50 V
Collector-emitter voltage; $I_C = 1 \text{ mA}$; $R_{BE} = 50 \Omega$	$V_{(BR)CER} >$	70	50	50 V
Collector-emitter voltage; $I_B = 0$; $I_C = 10 \text{ mA}$	$V_{(BR)CEO} >$	45	30	30 V
Emitter-base voltage; $I_C = 0$; $I_E = 10 \mu A$	$V_{(BR)EBO} >$	5	5	5 V
<u>Saturation voltages</u> ¹⁾				
$I_C = 150 \text{ mA}$; $I_B = 10 \text{ mA}$	$V_{CEsat} <$	0.3	0.3	0.4 V
	$V_{BEsat} <$	1.0	1.0	1.0 V
$I_C = 500 \text{ mA}$; $I_B = 35 \text{ mA}$	$V_{CEsat} <$	0.4	0.4	0.5 V
	$V_{BEsat} \left\{ \begin{array}{l} > \\ < \end{array} \right.$	0.8	0.8	0.78 V
		1.2	1.2	1.2 V
$I_C = 800 \text{ mA}$; $I_B = 60 \text{ mA}$	$V_{CEsat} <$	0.75	-	- V
	V_{BEsat}	0.82 to 1.3	-	- V
$I_C = 1000 \text{ mA}$; $I_B = 100 \text{ mA}$	$V_{CEsat} <$	0.8	-	- V
	$V_{BEsat} <$	1.5	-	- V
<u>D. C. current gain</u>				
$I_C = 150 \text{ mA}$; $V_{CE} = 1 \text{ V}$	$h_{FE} >$	30	40	25
$I_C = 500 \text{ mA}$; $V_{CE} = 1 \text{ V}$	$h_{FE} >$	25	30	20
$I_C = 800 \text{ mA}$; $V_{CE} = 1 \text{ V}$	h_{FE}	18 to 60	-	-
$I_C = 1000 \text{ mA}$; $V_{CE} = 5 \text{ V}$	$h_{FE} >$	15	-	-
<u>Transition frequency at $f = 100 \text{ MHz}$</u> ¹⁾				
$I_C = 50 \text{ mA}$; $V_{CE} = 10 \text{ V}$	f_T	typ. 400	400	400 MHz
$I_C = 500 \text{ mA}$; $V_{CE} = 10 \text{ V}$	f_T	typ. 300	300	300 MHz
<u>Collector capacitance at $f = 1 \text{ MHz}$</u>				
$I_E = I_e = 0$; $V_{CB} = 10 \text{ V}$	$C_c <$		8	pF
<u>Emitter capacitance at $f = 1 \text{ MHz}$</u>				
$I_C = I_c = 0$; $V_{EB} = 0.5 \text{ V}$	C_e	typ.	30	pF
		$<$	45	pF

¹⁾ Measured under pulsed conditions: $t_p = 300 \mu s$; $\delta = 0.01$

CHARACTERISTICS (continued)

Switching times

Turn on time when switched from

$-V_{BE} = 2 \text{ V to } I_C = 500 \text{ mA; } I_B = 50 \text{ mA}$

$t_{on} >$	5	-	- ns
$t_{on} <$	25	25	30 ns

$-V_{BE} = 2 \text{ V to } I_C = 1000 \text{ mA; } I_B = 100 \text{ mA}$

t_{on}	5 to 20	-	- ns
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Turn off time when switched from

$I_C = 500 \text{ mA; } I_B = 50 \text{ mA to cut-off with } -I_{BM} = 1 \text{ mA}$

$t_{off} <$	-	45	50 ns
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$I_C = 500 \text{ mA; } I_B = 50 \text{ mA to cut-off with } -I_{BM} = 50 \text{ mA}$

$t_{off} >$	15	-	- ns
$t_{off} <$	40	45	50 ns

$I_C = 1000 \text{ mA; } I_B = 100 \text{ mA to cut-off with } -I_{BM} = 100 \text{ mA}$

t_{off}	10 to 40	-	- ns
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Storage time when switched from

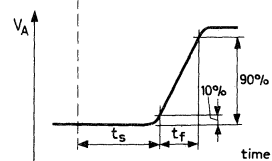
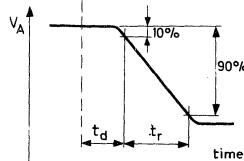
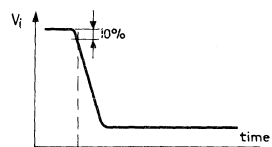
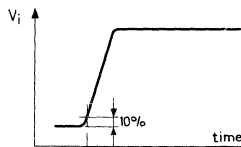
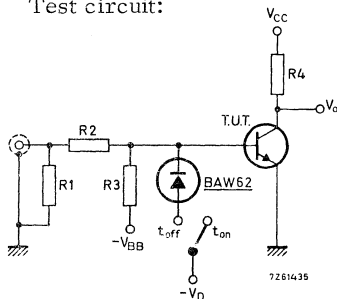
$I_C = 500 \text{ mA; } I_B = 50 \text{ mA to cut-off with } -I_{BM} = 50 \text{ mA}$

$t_s >$	12	10	10 ns
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$I_C = 1000 \text{ mA; } I_B = 100 \text{ mA to cut-off with } -I_{BM} = 100 \text{ mA}$

$t_s >$	8	-	- ns
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Test circuit:



Pulse generator:

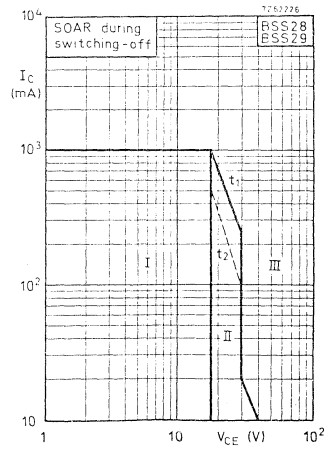
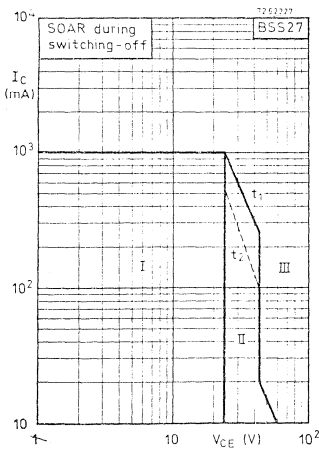
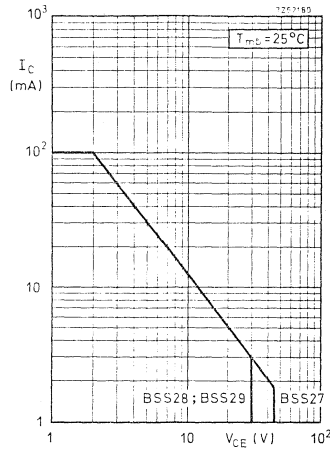
Pulse duration $t_p \geq 500 \text{ ns}$

Rise time $t_r \leq 5 \text{ ns}$

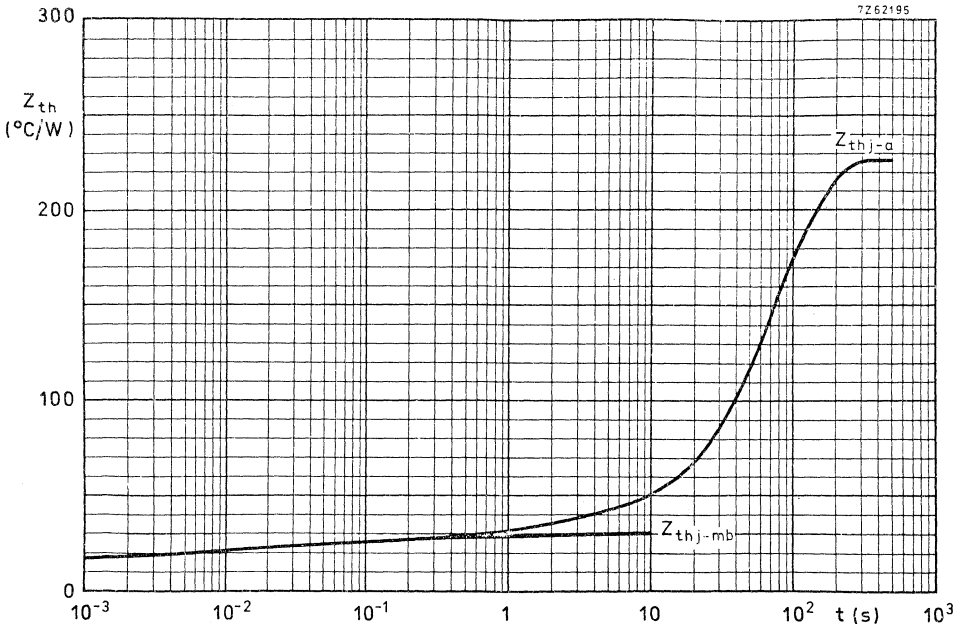
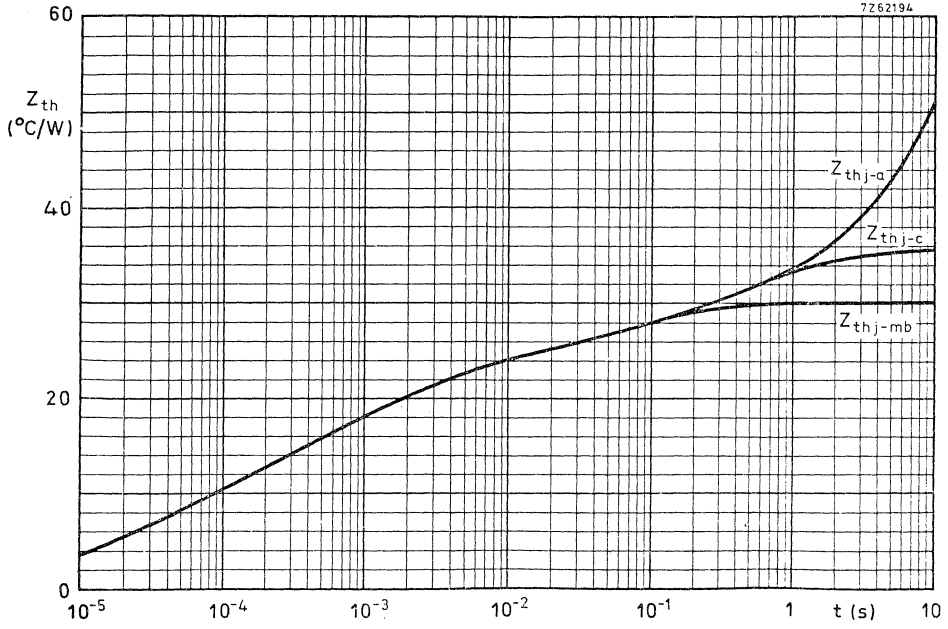
Fall time $t_f \leq 5 \text{ ns}$

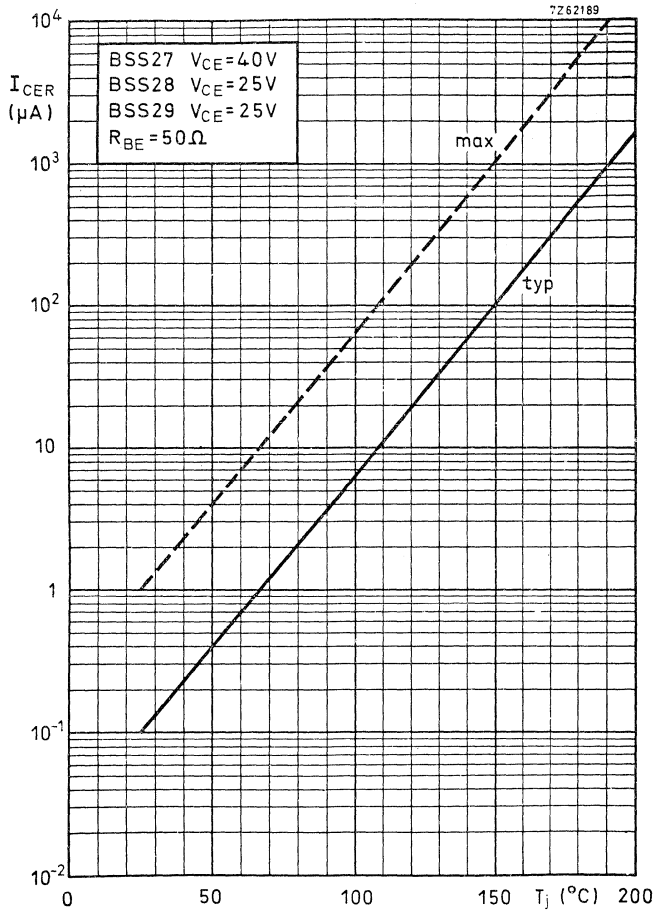
Source impedance $R_S = 50 \Omega$

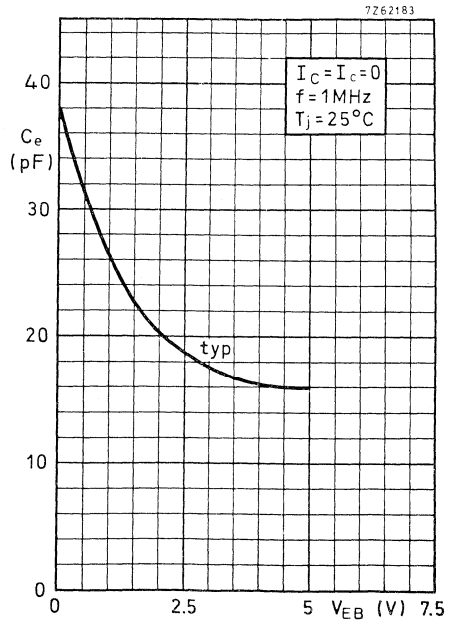
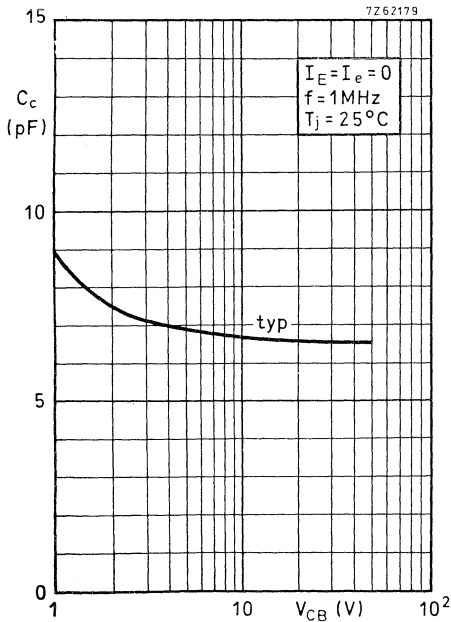
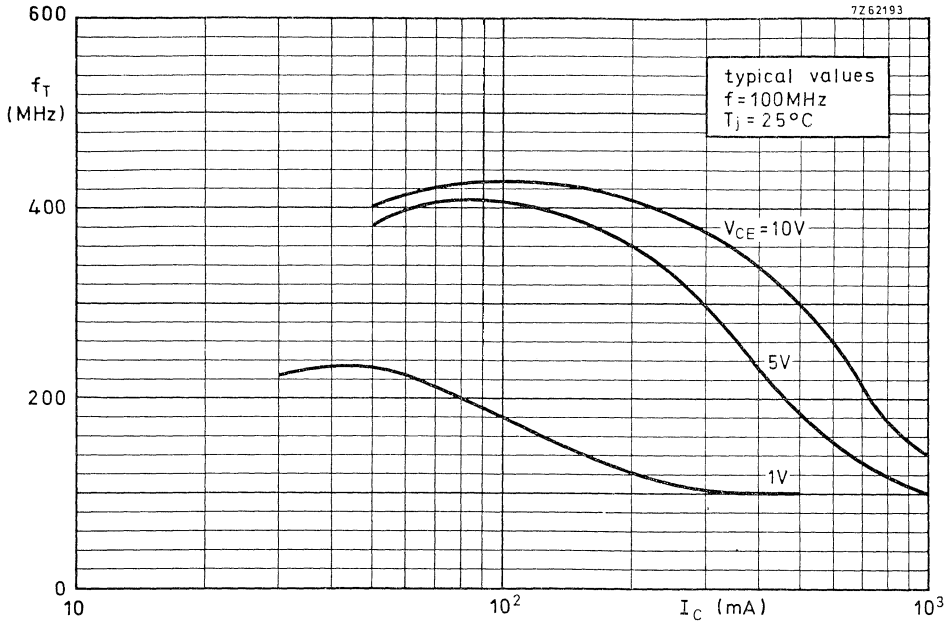
	I_C (mA)	I_B (mA)	$-I_{BM}$ (mA)	V_{CC} (V)	R_1 (Ω)	R_2 (Ω)	R_3 (Ω)	R_4 (Ω)	turn-on time		turn-off time		
									$-V_{BB}$ (V)	V_i (V)	V_{BB} (V)	V_I (V)	$-V_D$ (V)
BSS27	500	50	50	45	375	400	56	90	4.0	24.75	16.7	37.5	3
BSS27	1000	100	100	45	200	200	56	45	4.0	24.75	16.7	37.5	3
BSS27	500	50	1	45	270	300	68	90	-	-	27.6	40.6-0.46	4
BSS28; BSS29	500	50	50	30	375	400	56	60	4.0	24.75	16.7	-	3
BSS28; BSS29	500	50	1	30	275	300	68	60	-	-	27.6	-	4

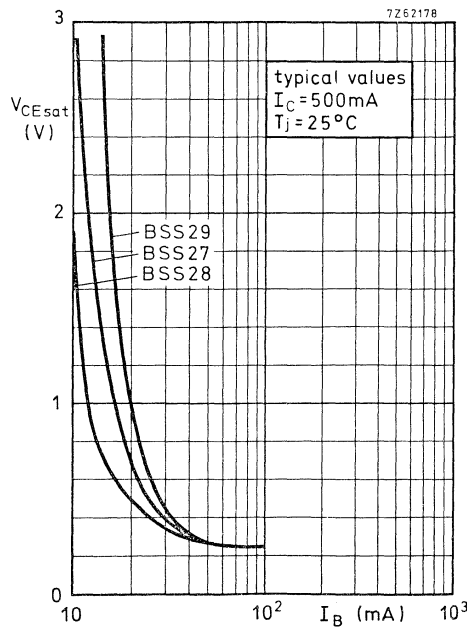
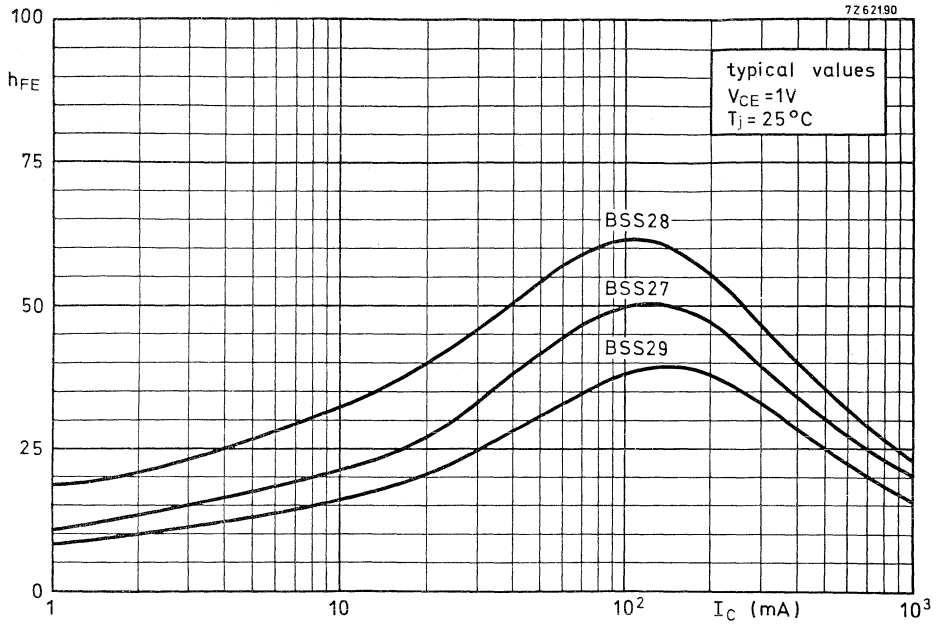


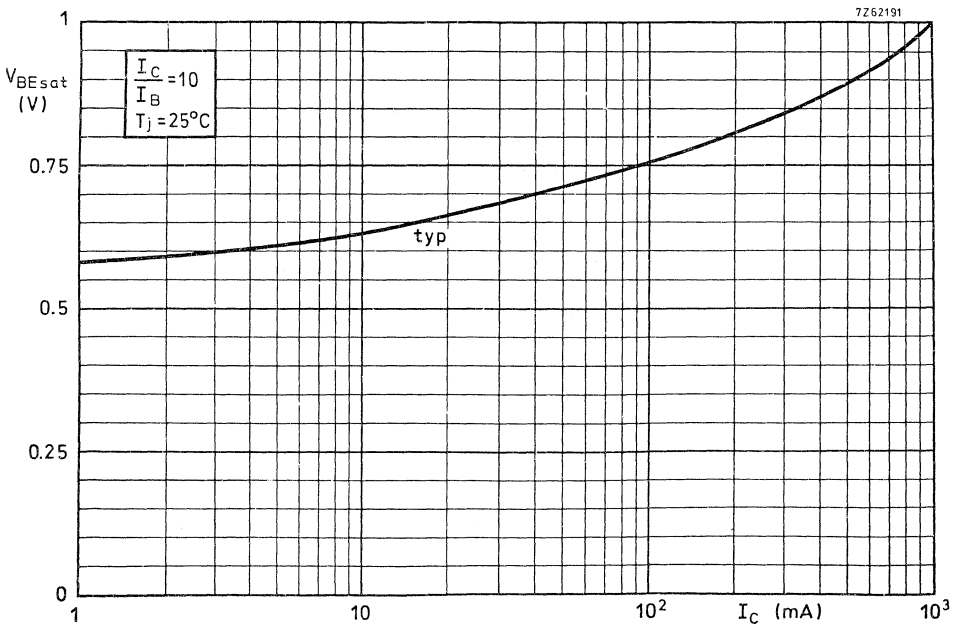
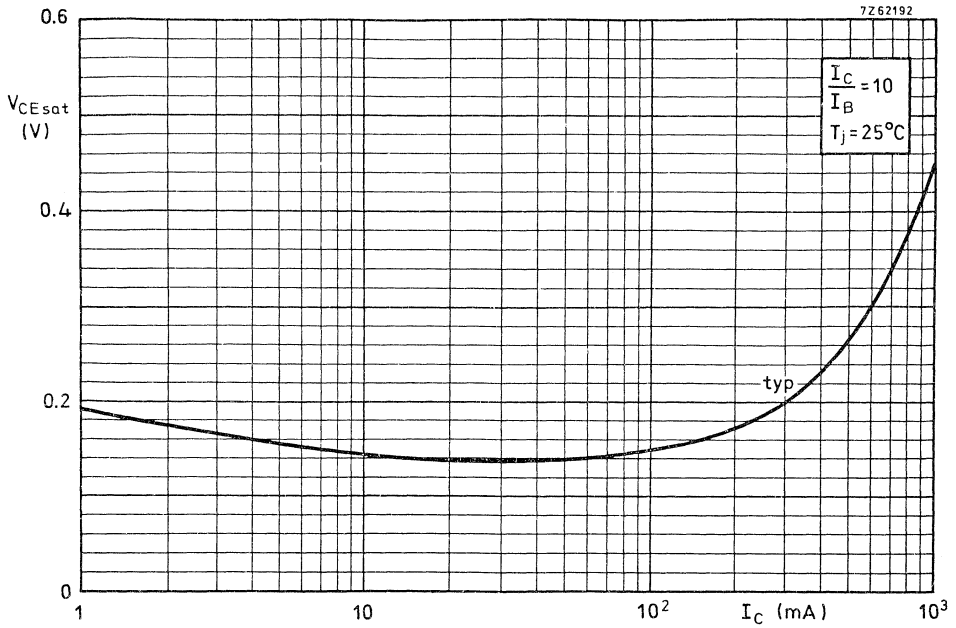
- I Region of permissible operation during switching off with $-V_{BB} = 4\text{ V}$; $R_{BE} = 39\ \Omega$
- II Permissible extension for repetitive pulsed operation
 - t_1 limits operations with $t_p \leq 0.1\ \mu\text{s}$; $\delta = 0.25$
 - t_2 limits operations with $t_p \leq 1\ \mu\text{s}$; $\delta = 0.25$
- III Operation in this area is not allowed.

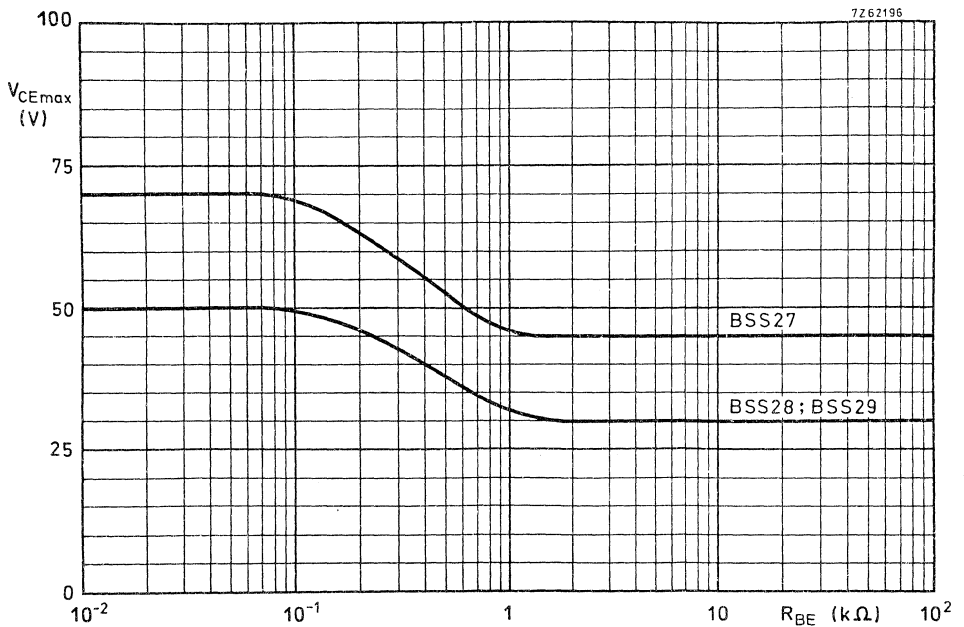
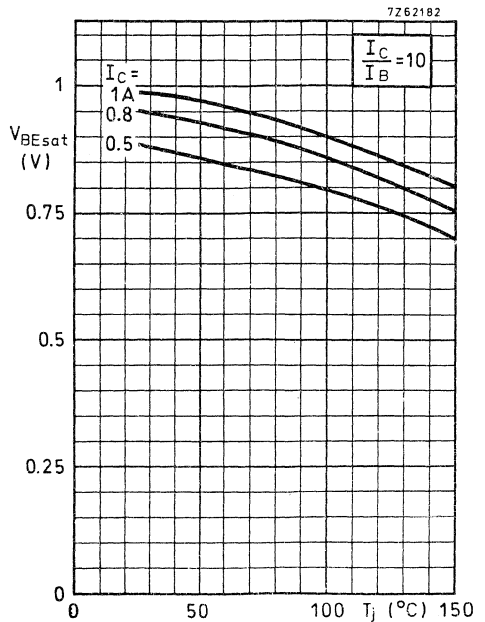
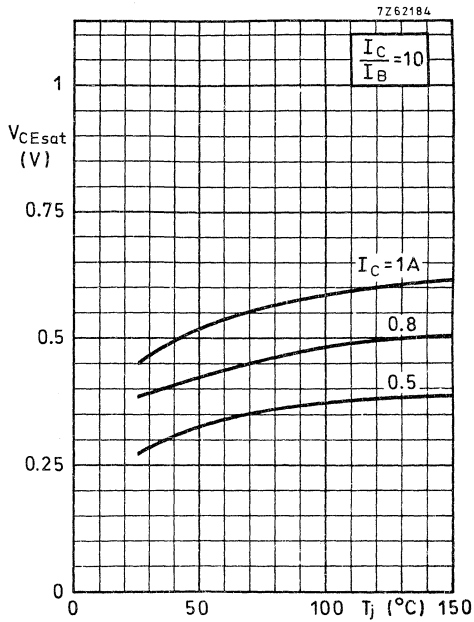


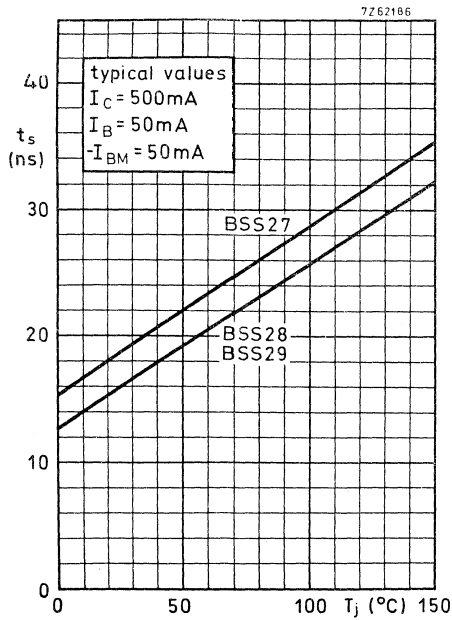
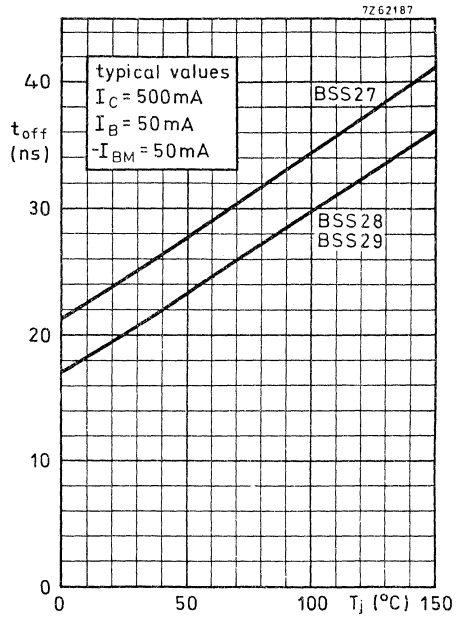
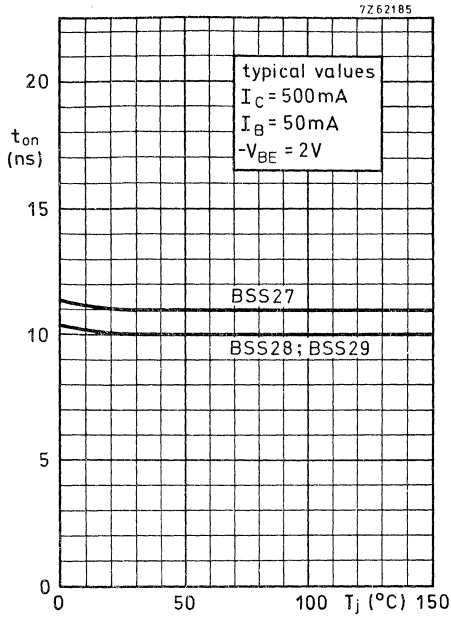


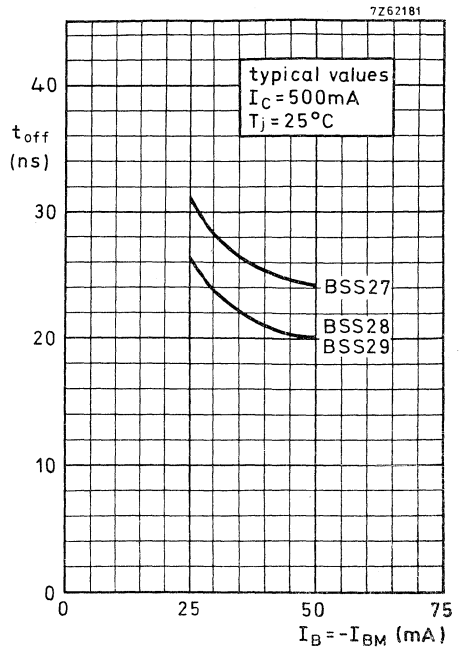
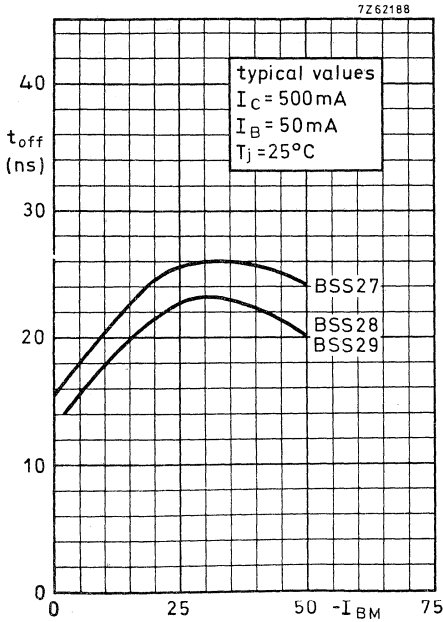












SILICON PLANAR EPITAXIAL TRANSISTOR

N-P-N transistor in a TO-39 metal envelope primarily intended for use as a print hammer drive. It has good high current saturation characteristics.

QUICK REFERENCE DATA

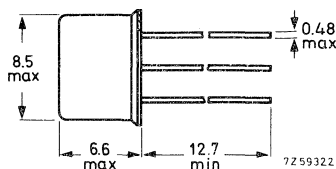
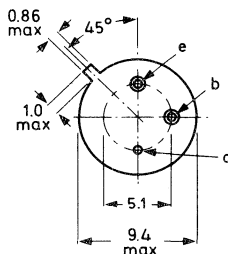
Collector-base voltage (open emitter)	V_{CBO}	max. 100 V
Collector-emitter voltage (open base)	V_{CEO}	max. 60 V
Collector current (peak value)	I_{CM}	max. 5.0 A
Total power dissipation up to $T_{case} = 50\text{ }^{\circ}\text{C}$	P_{tot}	max. 5.0 W
Junction temperature	T_j	max. 175 $^{\circ}\text{C}$
D.C. current gain	h_{FE}	> 40
$I_C = 2\text{ A}; V_{CE} = 2\text{ V}$		
Transition frequency at $f = 35\text{ MHz}$	f_T	typ. 100 MHz
$I_C = 0.5\text{ A}; V_{CE} = 5\text{ V}$		
Turn off time when switched from $I_C = 5\text{ A}; I_B = 0.5\text{ A}$ to cut-off with $-I_{BM} = 0.5\text{ A}$	t_{off}	< 1.2 μs

MECHANICAL DATA

Dimensions in mm

Collector connected to case

TO-39



max. lead diameter is guaranteed only for 12.7 mm

Accessories supplied on request: 56218; 56245, 56265

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

Collector-base voltage (open emitter)	V_{CBO}	max.	100 V
Collector-emitter voltage $R_{BE} \leq 50 \Omega$	V_{CER}	max.	80 V
Collector-emitter voltage (open base)	V_{CEO}	max.	60 V
Emitter-base voltage (open collector)	V_{EBO}	max.	5 V

Currents

Collector current (d.c.)	I_C	max.	2.0 A
Collector current (peak value)	I_{CM}	max.	5.0 A
Base current (d.c.)	I_C	max.	1.0 A

Power dissipation

Total power dissipation up to $T_{case} = 50 \text{ }^\circ\text{C}$	P_{tot}	max.	5.0 W
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Temperatures

Storage temperature	T_{stg}	-55 to +175	$^\circ\text{C}$
Junction temperature	T_j	max.	175 $^\circ\text{C}$

THERMAL RESISTANCE

From junction to case	$R_{th \text{ j-c}}$	=	25 $^\circ\text{C/W}$
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CHARACTERISTICS $T_j = 25\text{ }^\circ\text{C}$ unless otherwise specifiedCollector cut-off current

$I_E = 0; V_{CB} = 60\text{ V}$

$I_{CBO} < 10\text{ }\mu\text{A}$

Emitter cut-off current

$I_C = 0; V_{EB} = 4\text{ V}$

$I_{EBO} < 10\text{ }\mu\text{A}$

Saturation voltages

$I_C = 5\text{ A}; I_B = 0.5\text{ A}$

$V_{CEsat} < 1.0\text{ V}$

$V_{BEsat} < 1.8\text{ V}$

D.C. current gain

$I_C = 2\text{ A}; V_{CE} = 2\text{ V}$

$h_{FE} > 40$

Collector capacitance at $f = 1\text{ MHz}$

$I_E = I_e = 0; V_{CB} = 10\text{ V}$

$C_C < 80\text{ pF}$

Transition frequency at $f = 35\text{ MHz}$

$I_C = 0.5\text{ A}; V_{CE} = 5\text{ V}$

$f_T \text{ typ. } 100\text{ MHz}$

Turn on time when switched from

$-V_{BE} = 2.0\text{ V to } I_C = 5\text{ A}; I_B = 0.5\text{ A}$

with $I_{BM} = 0.5\text{ A}$

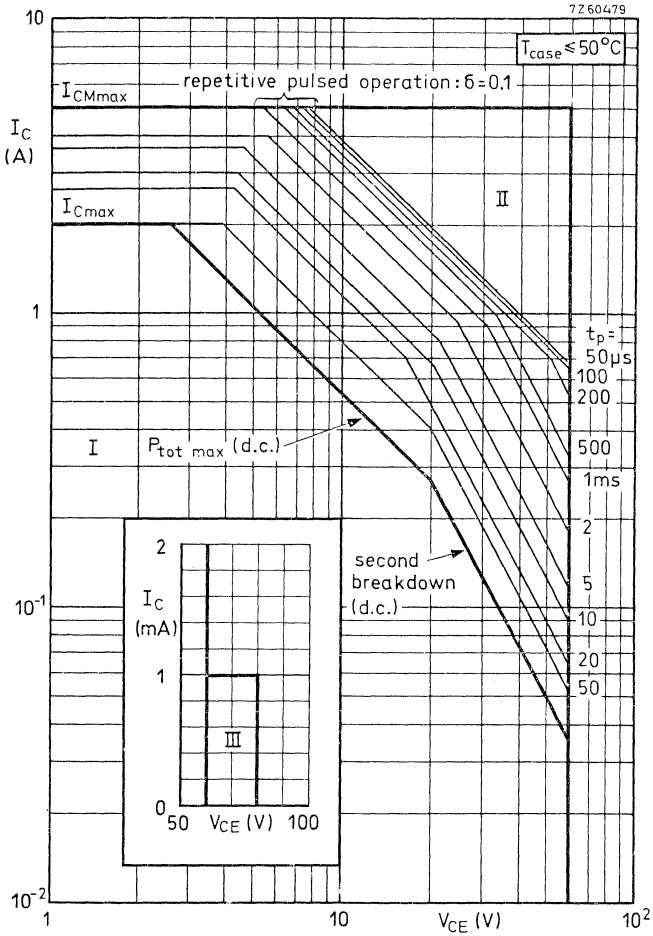
$t_{on} < 0.6\text{ }\mu\text{s}$

Turn off time when switched from

$I_C = 5\text{ A}; I_B = 0.5\text{ A to } -V_{BE} = 2.0\text{ V}$

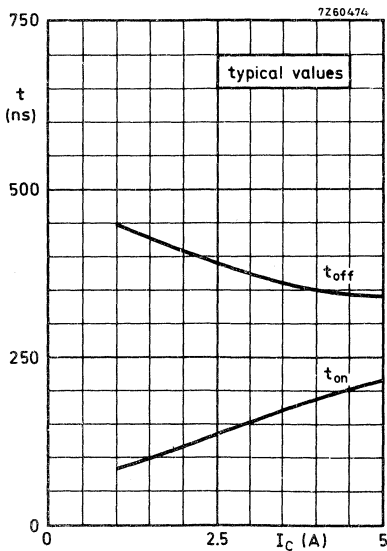
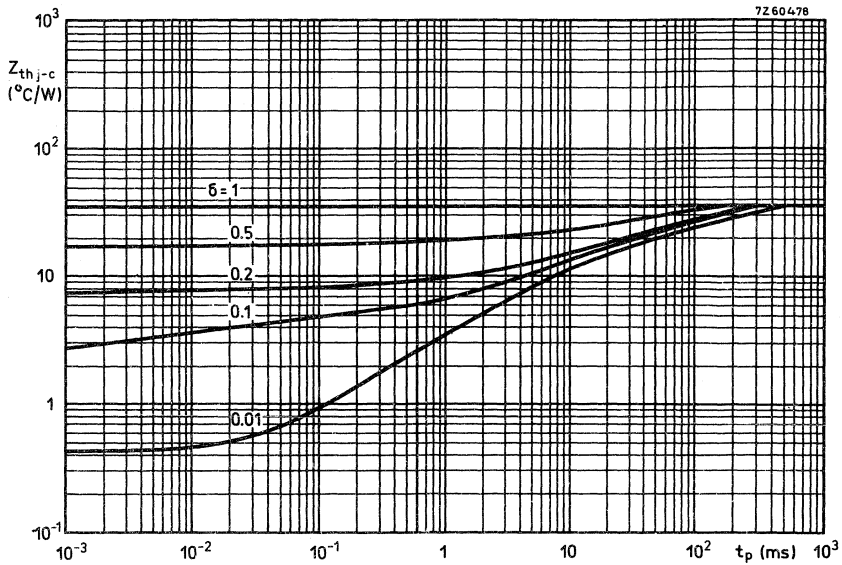
with $-I_{BM} = 0.5\text{ A}$

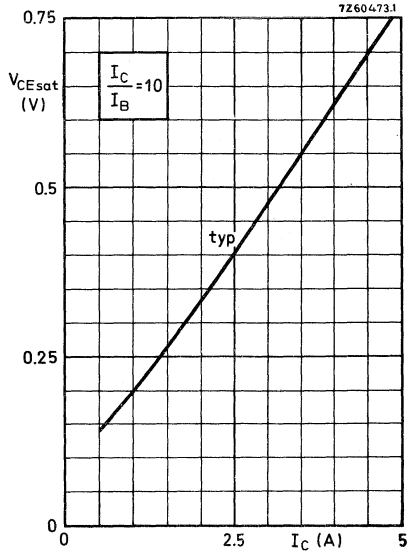
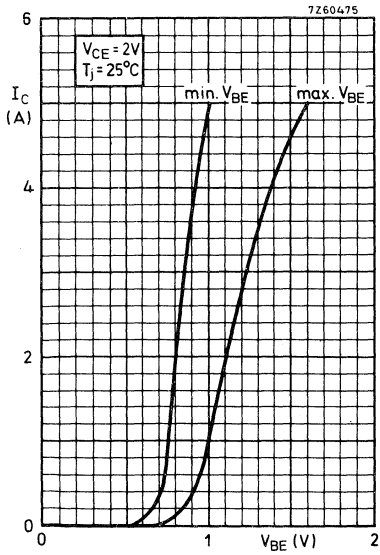
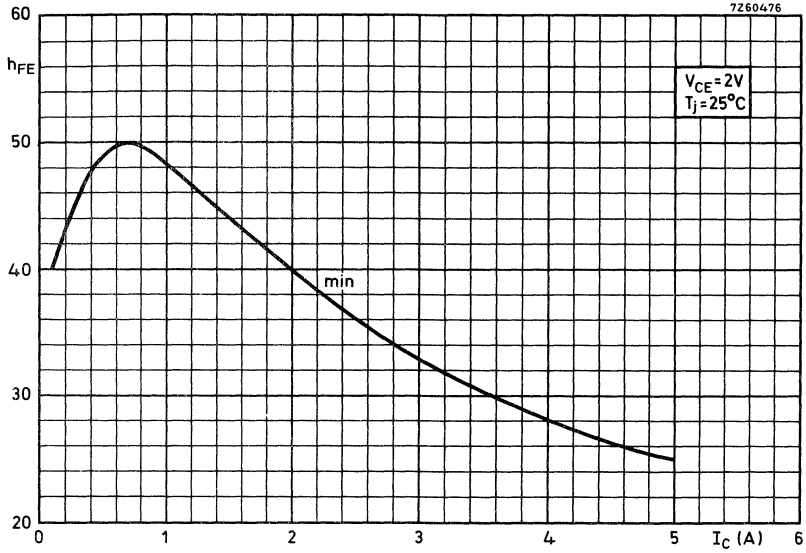
$t_{off} < 1.2\text{ }\mu\text{s}$



Safe Operating Area

- I Region of permissible d.c. operation
- II Permissible extension for repetitive pulsed operation
- III D.C. operation in this region is allowable, provided $R_{BE} \leq 50 \Omega$





HIGH VOLTAGE P-N-P TRANSISTOR

Silicon planar epitaxial transistor in a TO-18 metal envelope with the collector connected to the case. It is intended for anode switching in dynamically driven numerical indicator tubes.

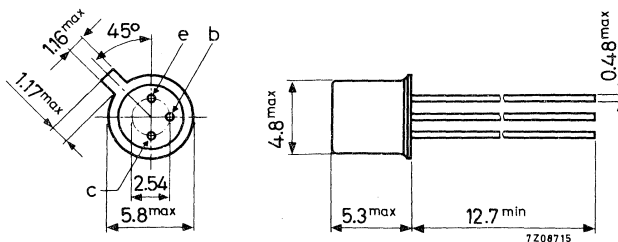
QUICK REFERENCE DATA			
Collector-emitter voltage ($R_{BE} = 10\text{ k}\Omega$)	$-V_{CER}$	max.	110 V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	100 V
Collector current (peak value)	$-I_{CM}$	max.	100 mA
Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}$	P_{tot}	max.	250 mW
Junction temperature	T_j	max.	150 $^{\circ}\text{C}$
D.C. current gain at $T_j = 25\text{ }^{\circ}\text{C}$			
$-I_C = 25\text{ mA}; -V_{CE} = 5\text{ V}$	h_{FE}	>	30
Transition frequency at $f = 35\text{ MHz}$			
$-I_C = 25\text{ mA}; -V_{CE} = 5\text{ V}$	f_T	typ.	95 MHz

MECHANICAL DATA

Dimensions in mm

TO-18

Collector connected to case



max. lead diameter is guaranteed only for 12.7 mm

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

Collector-base voltage (open emitter) -I _C = 10 μA	-V _{CBO}	max.	110 V
Collector-emitter voltage (R _{BE} = 10 kΩ) -I _C = 10 μA	-V _{CER}	max.	110 V ^{1) 2)}
Collector-emitter voltage (open base) -I _C = 100 μA	-V _{CEO}	max.	100 V
Emitter-base voltage (open collector) -I _E = 10 μA	-V _{EBO}	max.	6 V

Currents

Collector current (d. c.)	-I _C	max.	100 mA
Collector current (peak value)	-I _{CM}	max.	100 mA ³⁾
Base current (peak value)	-I _{BM}	max.	100 mA

Power dissipation

Total power dissipation up to T _{amb} = 25 °C	P _{tot}	max.	250 mW
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Temperatures

Storage temperature	T _{stg}	-65 to +150 °C
Junction temperature	T _j	max. 150 °C

THERMAL RESISTANCE

From junction to ambient in free air	R _{th j-a}	=	0.5 °C/mW
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- 1) The transistor may be operated in the breakdown region, provided the collector current does not exceed 10 μA at T_{amb} = 70 °C
- 2) The transistor can withstand an inductive load of 4 mH in series with a resistance of 4 kΩ, combined with a collector current of 25 mA before switching-off
- 3) The transistor can withstand a capacitive load of 100 pF, combined with a collector voltage equal to -V_{CER} before switching-on

CHARACTERISTICS

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

Collector cut-off current

$I_E = 0; -V_{CB} = 100\text{ V}; T_j = 70\text{ }^\circ\text{C}$	$-I_{CBO}$	<	10 μA
$-V_{CE} = 110\text{V}; R_{BE} = 10\text{ k}\Omega$	$-I_{CER}$	<	10 μA

Emitter cut-off current

$I_C = 0; -V_{EB} = 6\text{ V}$	$-I_{EBO}$	<	10 μA
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Saturation voltages

$-I_C = 25\text{ mA}; -I_B = 2.5\text{ mA}$	$-V_{CEsat}$	<	250 mV
	$-V_{BEsat}$	<	900 mV

D.C. current gain

$-I_C = 10\text{ mA}; -V_{CE} = 5\text{ V}$	h_{FE}	>	30
$-I_C = 25\text{ mA}; -V_{CE} = 5\text{ V}$	h_{FE}	>	30

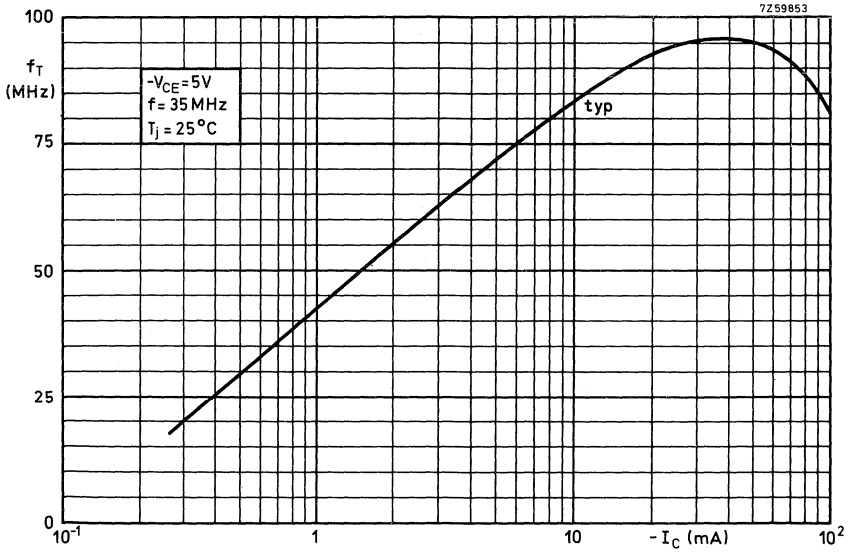
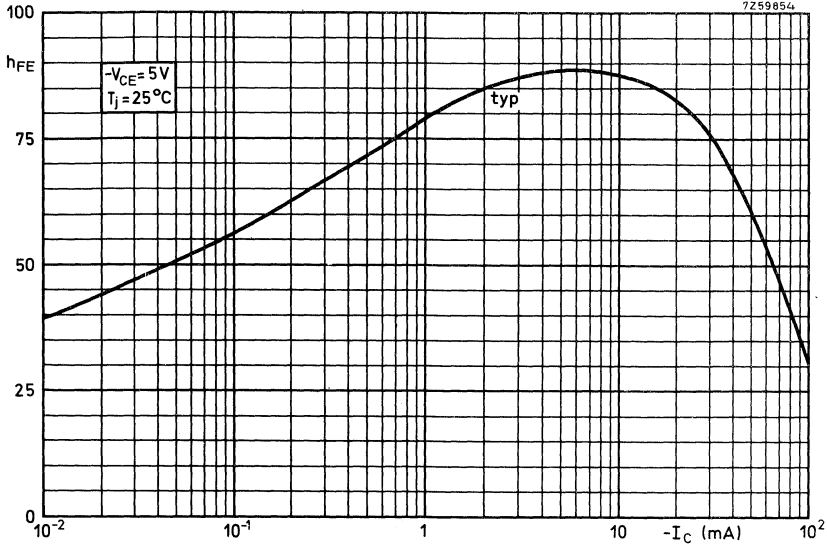
Collector capacitance at $f = 1\text{ MHz}$

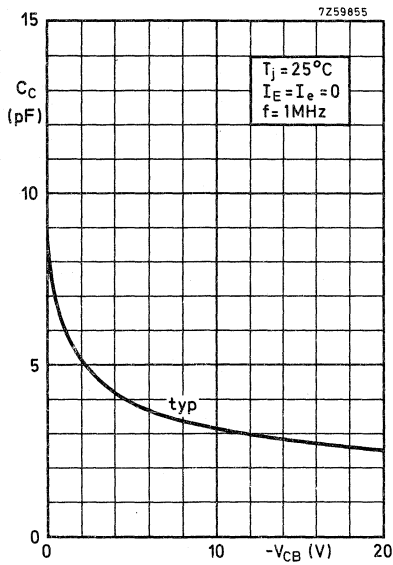
$I_E = I_e = 0; -V_{CB} = 10\text{ V}$	C_c	<	5 pF
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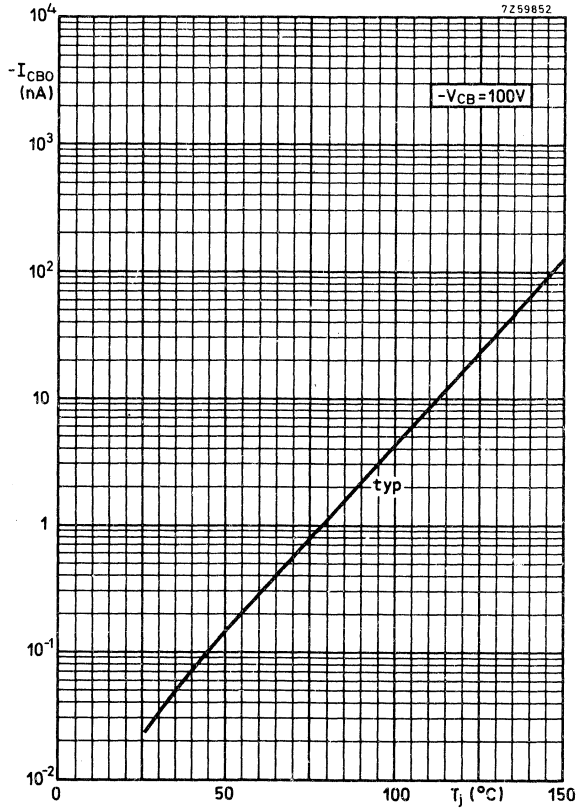
Transition frequency at $f = 35\text{ MHz}$

$-I_C = 25\text{ mA}; -V_{CE} = 5\text{ V}$	f_T	>	50 MHz
		typ.	95 MHz









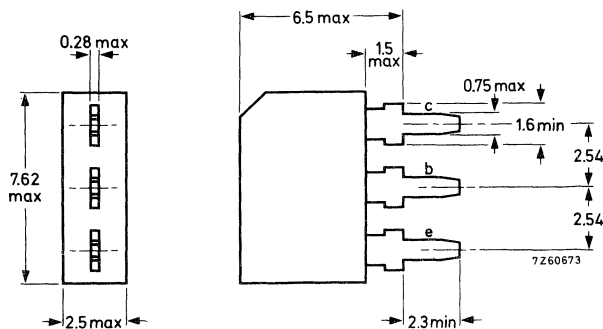
SWITCHING TRANSISTORS

Planar epitaxial transistors for switching applications.

		QUICK REFERENCE DATA		
		BSV86	BSV87	BSV88
Collector-base voltage (open emitter)	V_{CBO} max.	75	75	60 V
Collector-emitter voltage (open base)	V_{CEO} max.	30	30	25 V
Collector current (peak value)	I_{CM} max.	1.0	1.0	1.0 A
Total power dissipation up to $T_{amb} = 50^{\circ}C$	P_{tot} max.	220	220	220 mW
D. C. current gain	$I_C = 150 \text{ mA}; V_{CE} = 10 \text{ V}$	$h_{FE} >$	100	40
		$h_{FE} <$	300	120
Transition frequency at $f = 100 \text{ MHz}$	$I_C = 50 \text{ mA}; V_{CE} = 10 \text{ V}$	$f_T >$	100	100

MECHANICAL DATA

Dimensions in mm



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

<u>Voltages</u>		BSV86		BSV88
		BSV87		
Collector-base voltage (open emitter)	V_{CBO}	max. 75		60 V
Collector-emitter voltage ($R_{BE} = 10 \Omega$)	V_{CER}	max. 50		35 V
Collector-emitter voltage (open base)	V_{CEO}	max. 30		25 V
Emitter-base voltage (open collector)	V_{EBO}	max. 7		5 V

Currents

Collector current (d. c.)	I_C	max.	0.4	A
Collector current (peak value)	I_{CM}	max.	1.0	A
Emitter current (peak value)	$-I_{EM}$	max.	1.12	A
Base current (peak value)	I_{BM}	max.	0.12	A

Power dissipation

Total power dissipation up to $T_{amb} = 50 \text{ }^\circ\text{C}$	P_{tot}	max.	220	mW
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Temperatures

Storage temperature	T_{stg}	-65 to	+150	$^\circ\text{C}$
Junction temperature	T_j	max.	150	$^\circ\text{C}$

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th j-a}$	=	450	$^\circ\text{C}/\text{W}$
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CHARACTERISTICS

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

Collector cut-off current

		BSV86	BSV87	BSV88
$I_E = 0; V_{CB} = 60\text{ V}$	$I_{CBO} <$	100	100	nA
$I_E = 0; V_{CB} = 30\text{ V}$	$I_{CBO} <$			100 nA
$I_E = 0; V_{CB} = 60\text{ V}; T_j = 100\text{ }^\circ\text{C}$	$I_{CBO} <$	10	10	μA
$I_E = 0; V_{CB} = 30\text{ V}; T_j = 100\text{ }^\circ\text{C}$	$I_{CBO} <$			10 μA

Emitter cut-off current

$I_C = 0; V_{EB} = 5\text{ V}$	$I_{EBO} <$	100	100	nA
$I_C = 0; V_{EB} = 3\text{ V}$	$I_{EBO} <$			100 nA

Base-emitter voltage

$I_C = 1\text{ mA}; V_{CE} = 5\text{ V}$	$V_{BE} <$	0.9	0.9	0.9 V
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Saturation voltages

$I_C = 10\text{ mA}; I_B = 1\text{ mA}$	$V_{CEsat} <$	80	80	80 mV
$I_C = 50\text{ mA}; I_B = 5\text{ mA}$	$V_{CEsat} <$	120	120	120 mV
$I_C = 150\text{ mA}; I_B = 15\text{ mA}$	$V_{CEsat} <$	200	200	200 mV
	$V_{BEsat} <$	1300	1300	1300 mV
$I_C = 400\text{ mA}; I_B = 40\text{ mA}$	$V_{CEsat} <$	425	425	425 mV
	$V_{BEsat} <$	1300	1300	1300 mV

D.C. current gain

$I_C = 10\text{ mA}; V_{CE} = 10\text{ V}$	$h_{FE} >$	75	35	35
$I_C = 150\text{ mA}; V_{CE} = 10\text{ V}$	$h_{FE} >$	100	40	35
	$h_{FE} <$	300	120	-
$I_C = 500\text{ mA}; V_{CE} = 10\text{ V}$	$h_{FE} >$	40	20	20

Small signal current gain at $f = 1\text{ kHz}$

$I_C = 1\text{ mA}; V_{CE} = 5\text{ V}$	$h_{fe} >$	50	40	-
	$h_{fe} <$	200	120	-
$I_C = 5\text{ mA}; V_{CE} = 10\text{ V}$	$h_{fe} >$	70	35	-
	$h_{fe} <$	300	150	-

CHARACTERISTICS (continued)

Collector capacitance at $f = 1$ MHz

$$I_E = I_e = 0; V_{CB} = 10 \text{ V}$$

$$C_c < 25 \text{ pF}$$

Emitter capacitance at $f = 1$ MHz

$$I_C = I_c = 0; V_{EB} = 0.5 \text{ V}$$

$$C_e < 80 \text{ pF}$$

Transition frequency at $f = 100$ MHz

$$I_C = 50 \text{ mA}; V_{CE} = 10 \text{ V}$$

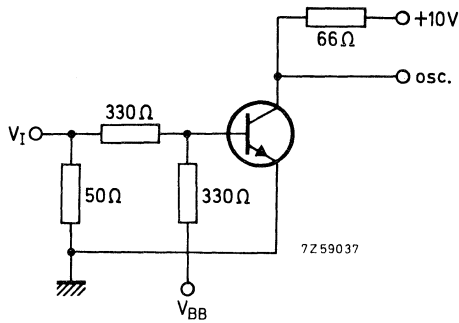
$$f_T > 100 \text{ MHz}$$

Switching times

$$I_C = 150 \text{ mA}; I_{B1} = -I_{B2} = 15 \text{ mA}$$

		BSV86 BSV87	BSV88	
Delay time	t_d typ.	20	20	ns
Rise time	t_r typ.	30	30	ns
Storage time	t_s typ.	190	190	ns
	t_s <	250	-	ns
Fall time	t_f typ.	20	20	ns

Test circuit:



measuring t_d and t_r : $V_{BB} = -5 \text{ V}; V_I = +12 \text{ V}$ with $t_r = 20 \text{ ns}$
 measuring t_s and t_f : $V_{BB} = +6 \text{ V}; V_I = -11 \text{ V}$ with $t_f = 20 \text{ ns}$

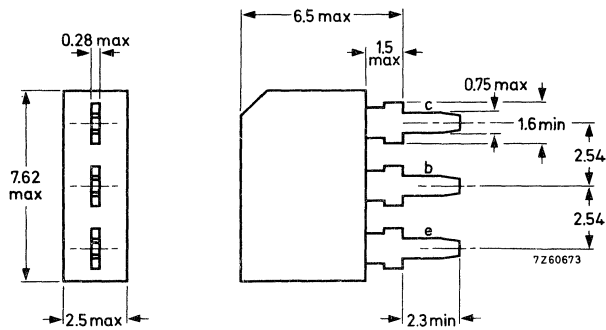
SWITCHING TRANSISTORS

Planar epitaxial transistors for switching applications.

		BSV96	BSV97	BSV98
Collector-base voltage (open emitter)	$-V_{CBO}$ max.	30	30	30 V
Collector-emitter voltage (open base)	$-V_{CEO}$ max.	30	30	30 V
Collector current (peak value)	$-I_{CM}$ max.	800	800	800 mA
Total power dissipation up to $T_{amb}=50^{\circ}C$	P_{tot} max.	220	220	220 mW
D.C. current gain				
$-I_C = 150$ mA; $-V_{CE} = 2$ V	$h_{FE} >$	100	40	30
	$h_{FE} <$	250	120	-
Transition frequency at $f = 35$ MHz				
$-I_C = 50$ mA; $-V_{CE} = 5$ V	f_T typ.	75	75	75 MHz

MECHANICAL DATA

Dimensions in mm



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

Voltages

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	30	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	30	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5	V

Currents

Collector current (d.c. or average over any 20 ms period)	$-I_{C(AV)}$	max.	300	mA
Collector current (peak value)	$-I_{CM}$	max.	800	mA

Power dissipation

Total power dissipation up to $T_{amb} = 50\text{ }^{\circ}\text{C}$	P_{tot}	max.	220	mW
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Temperatures

Storage temperature	T_{stg}	-65 to +150	$^{\circ}\text{C}$
Junction temperature	T_j	max. 150	$^{\circ}\text{C}$

THERMLA RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	450	$^{\circ}\text{C}/\text{W}$
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CHARACTERISTICS

 $T_j = 25\text{ }^\circ\text{C}$ unless otherwise specifiedCollector cut-off current

		BSV96	BSV97	BSV98
$V_{BE} = 0; -V_{CE} = 20\text{ V}$	$-I_{CES} <$	100	100	100 nA
$V_{BE} = 0; -V_{CE} = 20\text{ V}; T_j = 100\text{ }^\circ\text{C}$	$-I_{CES} <$	10	10	10 μA

Saturation voltages

$-I_C = 300\text{ mA}; -I_B = 30\text{ mA}$	$-V_{CEsat} <$	0.5	0.5	0.5 V
	$-V_{BEsat} <$	1.3	1.3	1.3 V
$-I_C = 800\text{ mA}; -I_B = 30\text{ mA}$	$-V_{CEsat} <$	6	6	6 V

D.C. current gain

$-I_C = 10\text{ mA}; -V_{CE} = 2\text{ V}$	$h_{FE} >$	25	25	25
$-I_C = 150\text{ mA}; -V_{CE} = 2\text{ V}$	$h_{FE} >$	100	40	30
	$h_{FE} <$	250	120	-
$-I_C = 500\text{ mA}; -V_{CE} = 2\text{ V}$	$h_{FE} >$	25	25	25

Transition frequency at $f = 35\text{ MHz}$

$-I_C = 50\text{ mA}; -V_{CE} = 5\text{ V}$	f_T typ.	75	75	75 MHz
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Collector capacitance at $f = 1\text{ MHz}$

$I_E = I_e = 0; -V_{CB} = 10\text{ V}$	C_c typ.	10	10	10 pF
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SILICON PLANAR EPITAXIAL TRANSISTOR

N-P-N transistor in a TO-18 metal envelope intended for core driver applications in small memories.

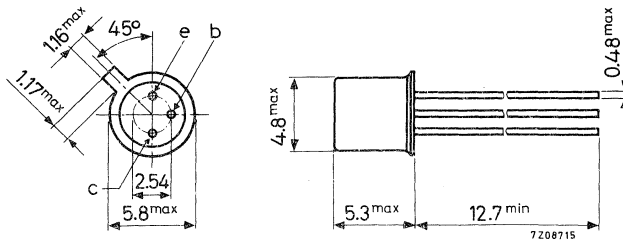
QUICK REFERENCE DATA		
Collector-base voltage (open emitter)	V_{CBO}	max. 40 V
Collector-emitter voltage (open base)	V_{CEO}	max. 25 V
Collector current (peak value)	I_{CM}	max. 500 mA
Total power dissipation up to $T_{case} = 25\text{ }^{\circ}\text{C}$	P_{tot}	max. 1.0 W
Junction temperature	T_j	max. 200 $^{\circ}\text{C}$
D.C. current gain $I_C = 50\text{ mA}; V_{CE} = 10\text{ V}$	h_{FE}	> 20
Transition frequency $I_C = 50\text{ mA}; V_{CE} = 10\text{ V}; f = 100\text{ MHz}$	f_T	> 250 MHz
Turn off time when switched from $I_C = 300\text{ mA}; I_B = 40\text{ mA}$ to cut-off with $-I_{BM} = 20\text{ mA}$	t_{off}	< 100 ns

MECHANICAL DATA

Dimensions in mm

Collector connected to case

TO-18



Accessories available: 56246; 56263

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

Collector-base voltage (open emitter) $I_C = 0.1 \text{ mA}$	V_{CBO}	max.	40 V
Collector-emitter voltage (open base) $I_C = 30 \text{ mA}$	V_{CEO}	max.	25 V
Emitter-base voltage (open collector) $I_E = 0.1 \text{ mA}$	V_{EBO}	max.	5 V

Currents

Collector current (d.c.)	I_C	max.	300 mA
Collector current (peak value)	I_{CM}	max.	500 mA

Power dissipation

Total power dissipation up to $T_{case} = 25 \text{ }^\circ\text{C}$	P_{tot}	max.	1.0 W
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Temperatures

Storage temperature	T_{stg}	-65 to +200	$^\circ\text{C}$
Junction temperature	T_j	max.	200 $^\circ\text{C}$

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th \text{ j-a}}$	=	0.50 $^\circ\text{C/mW}$
From junction to case	$R_{th \text{ j-c}}$	=	0.175 $^\circ\text{C/mW}$

CHARACTERISTICS

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

Collector cut-off current

$I_E = 0; V_{CB} = 30\text{ V}$	I_{CBO}	<	0.5 μA
$I_E = 0; V_{CB} = 30\text{ V}; T_j = 100\text{ }^\circ\text{C}$	I_{CBO}	<	50 μA

Saturation voltages

$I_C = 150\text{ mA}; I_B = 15\text{ mA}$	V_{CEsat}	<	0.5 V
	V_{BEsat}	<	1.3 V
$I_C = 500\text{ mA}; I_B = 35\text{ mA}$	V_{CEsat}	<	0.7 V
$I_C = 500\text{ mA}; I_B = 50\text{ mA}$	V_{BEsat}	<	1.8 V

D. C. current gain

$I_C = 10\text{ mA}; V_{CE} = 10\text{ V}$	h_{FE}	>	30
$I_C = 500\text{ mA}; V_{CE} = 10\text{ V}$	h_{FE}	>	20

Collector capacitance

$I_E = I_c = 0; V_{CB} = 10\text{ V}; f = 1\text{ MHz}$	C_c	<	8.0 pF
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Transition frequency at $f = 100\text{ MHz}$

$I_C = 50\text{ mA}; V_{CE} = 10\text{ V}$	f_T	>	250 MHz
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Turn on time when switched to

a) $I_C = 150\text{ mA}; I_B = 15\text{ mA}$ (fig. 1 on page 4)	t_{on}	<	60 ns
b) $I_C = 300\text{ mA}; I_B = 40\text{ mA}$ (fig. 1 on page 4)	t_{on}	<	50 ns

Turn off time when switched from

c) $I_C = 150\text{ mA}; I_B = 15\text{ mA}$ to cut-off with $-I_{BM} = 15\text{ mA}$ (fig. 2 on page 4)	t_{off}	<	60 ns
d) $I_C = 300\text{ mA}; I_B = 40\text{ mA}$ to cut-off with $-I_{BM} = 20\text{ mA}$ (fig. 1 on page 4)	t_{off}	<	100 ns
e) $I_C = 400\text{ mA}; I_B = 50\text{ mA}$ to cut-off with $-I_{BM} = 1\text{ mA}$ (fig. 1 on page 4)	t_{off}	<	300 ns

CHARACTERISTICS (continued)

	I_C (mA)	I_B (mA)	I_{BM} (mA)	V_{CC} (V)	R_1 (k Ω)	R_2 (k Ω)	R_3 (Ω)	R_4 (Ω)	V_{BB} (V)	V_{BE} (V)	V_i (V)
a	150	15	-	10	1	∞	50	62	-	-	0 to +16
b	300	40	-	15.5	0.33	0.33	56	50	-4.5	-2.25	0 to +20
c	150	15	-15	10	1	1	50	62	+16	-	0 to -30
d	300	40	-20	15.5	0.33	0.33	56	50	+15.3	-	0 to -20
e	400	50	-1	12.5	1	∞	50	30	-	-	+51 to 0

Test circuits

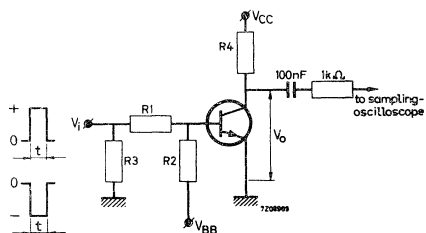


Fig. 1

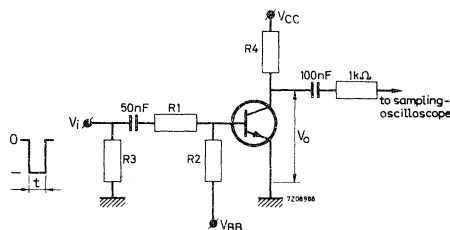


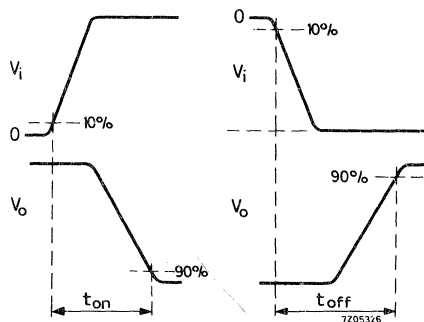
Fig. 2

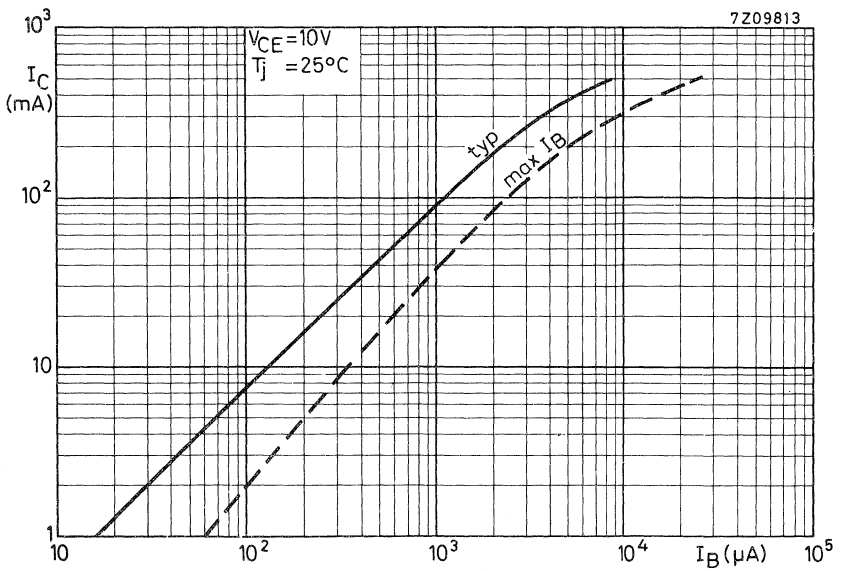
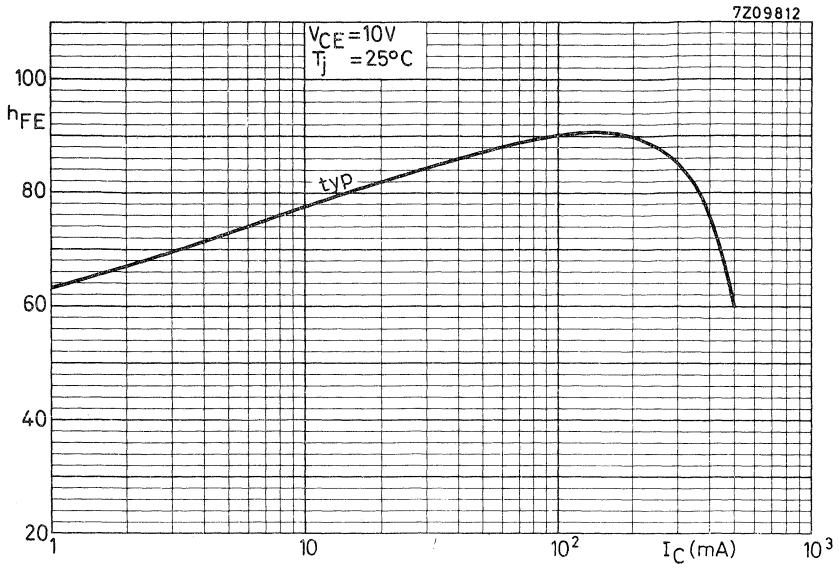
Pulse generator:

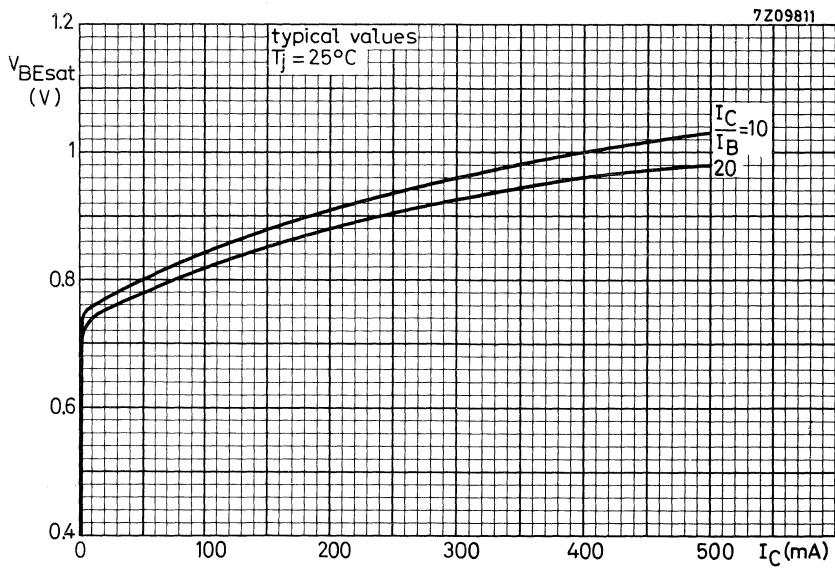
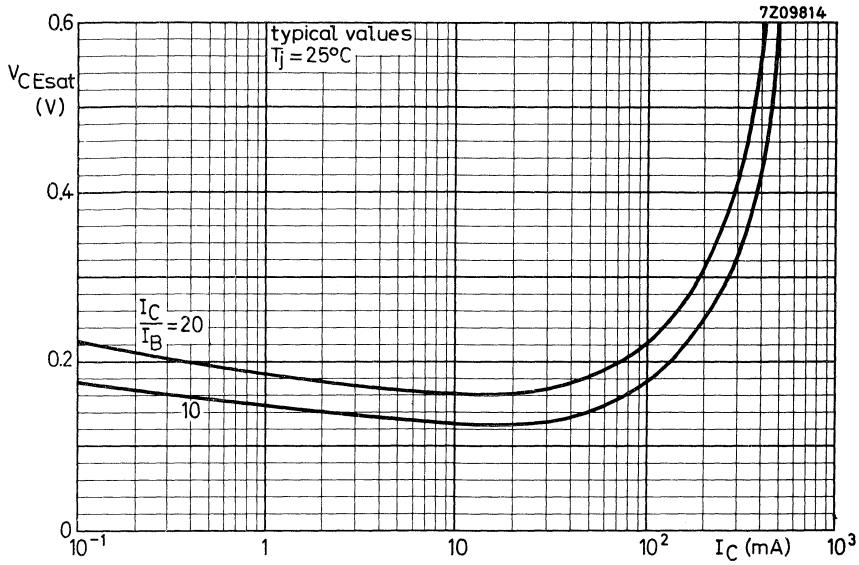
Rise time	$t_R \leq 2$ ns
Pulse duration	$t = 200$ ns
Fall time	$t_f \leq 2$ ns
Output resistance	$R_O = 50$ Ω

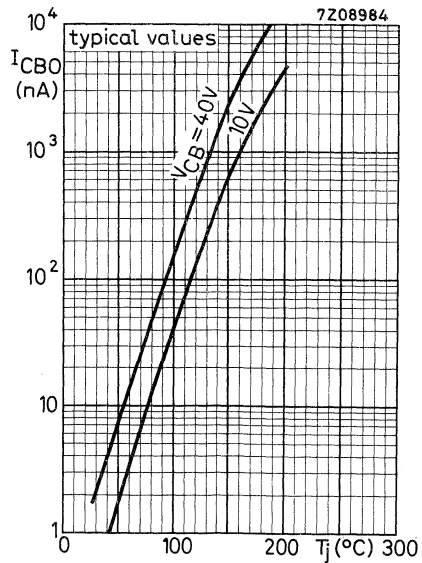
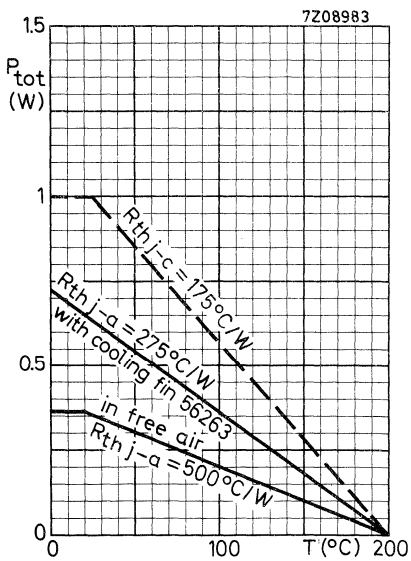
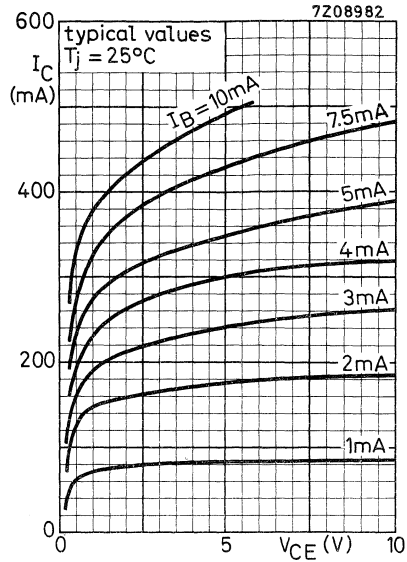
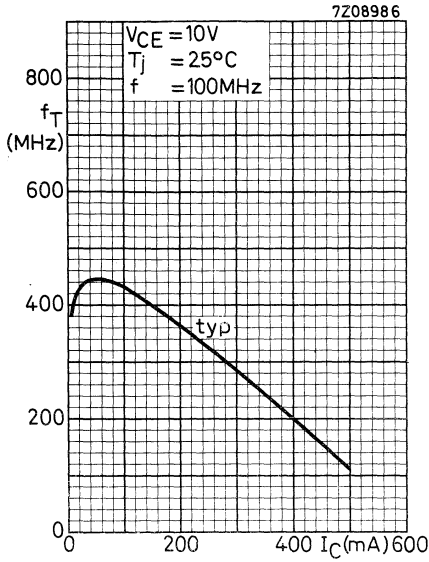
Oscilloscope:

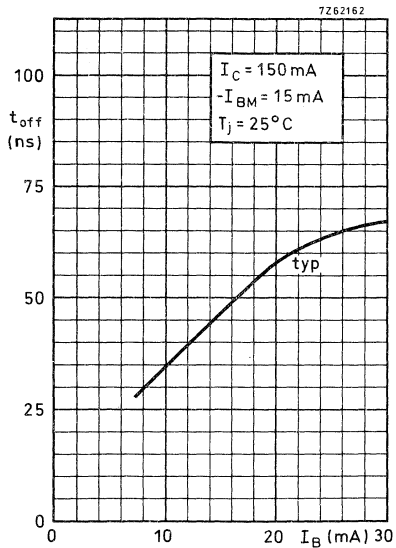
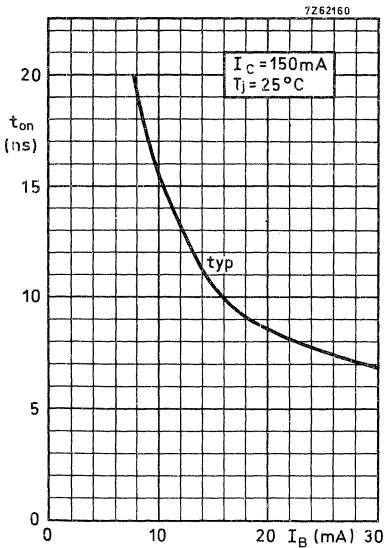
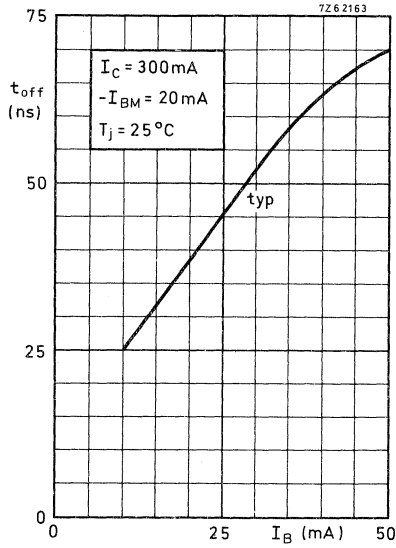
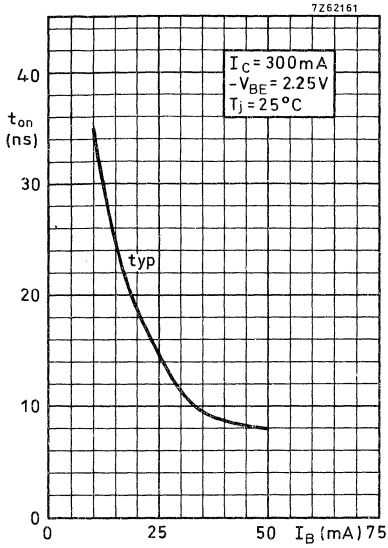
Input resistance $R_i = 50$ Ω











$P_D = 800\text{mW}$

$V_{CE} = 120\text{V}$

$V_{CE} = 100\text{V}$

$V_{CE(SAT)} @ I_C$

$5.0\text{V} \rightarrow 150\text{mA}$

$h_{FE} = 30$

$h_{FE} \text{ by } @ I_C$

MIN MAX 150mA
40 120

freq. 50MHz

2B81N2

BSW 67

BSW 68

SILICON PLANAR EPITAXIAL TRANSISTORS

N-P-N transistors in a TO-39 metal envelope with the collector connected to the case. The transistors are intended for general purposes, especially for switching with inductive load.

QUICK REFERENCE DATA

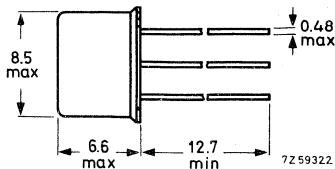
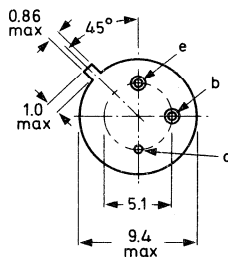
		BSW66	BSW67	BSW68
Collector-base voltage (open emitter)	V_{CBO}	max. 100	120	150 V
Collector-emitter voltage (open base)	V_{CEO}	max. 100	120	150 V
Emitter-base voltage (open collector)	V_{EBO}	max. 6	6	6 V
Collector current (peak value)	I_{CM}	max. 2 A		
Total power dissipation up to $T_{case} = 25\text{ }^{\circ}\text{C}$	P_{tot}	max. 5.0 W		
Junction temperature	T_j	max. 200 $^{\circ}\text{C}$		
Transition frequency at $f = 35\text{ MHz}$				
$I_C = 100\text{ mA}; V_{CE} = 20\text{ V}$	f_T	typ. 80 MHz		
D. C. current gain				
$I_C = 10\text{ mA}; V_{CE} = 5\text{ V}$	h_{FE}	> 30		
$I_C = 500\text{ mA}; V_{CE} = 5\text{ V}$	h_{FE}	> 30		

MECHANICAL DATA

Dimensions in mm

Collector connected to case

TO-39



Accessories available: 56218, 56245, 56265

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

Voltages

		BSW66	BSW67	BSW68
Collector-base voltage (open emitter)	V_{CBO}	max. 100	120	150 V
Collector-emitter voltage (open base) ¹⁾	V_{CEO}	max. 100	120	150 V
Emitter-base voltage (open collector)	V_{EBO}	max. 6	6	6 V

Currents

Collector current (d.c. or average over any 20 ms period)	I_C	max.	1 A
Collector current (peak value)	I_{CM}	max.	2 A
Emitter current (peak value)	$-I_{EM}$	max.	2 A

Power dissipation

Total power dissipation up to $T_{amb} = 25\text{ }^\circ\text{C}$ $T_{case} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	0.8 W
	P_{tot}	max.	5.0 W

Switch off energy with inductive load

$I_C \leq 500\text{ mA}$	E	max.	5 mWs
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Temperatures

Storage temperature	T_{stg}	-65 to +200	$^\circ\text{C}$
Junction temperature	T_j	max. 200	$^\circ\text{C}$

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	220 $^\circ\text{C/W}$
From junction to case	$R_{th\ j-c}$	=	35 $^\circ\text{C/W}$

CHARACTERISTICS

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

Collector cut-off current

$I_E = 0; V_{CB} = V_{CBOmax}$	I_{CBO}	<	100 μA
$I_E = 0; V_{CB} = \frac{1}{2} V_{CBOmax}$	I_{CBO}	<	100 nA
$I_E = 0; V_{CB} = \frac{1}{2} V_{CBOmax}; T_j = 150\text{ }^\circ\text{C}$	I_{CBO}	<	50 μA

Emitter cut-off current

$I_C = 0; V_{EB} = 6\text{ V}$	I_{EBO}	<	100 μA
$I_C = 0; V_{EB} = 3\text{ V}$	I_{EBO}	<	100 nA

¹⁾ $I_C = 100\text{ mA}$

CHARACTERISTICS (continued)

Saturation voltages

$I_C = 100 \text{ mA}; I_B = 10 \text{ mA}$

V_{CEsat}	<	150 mV
V_{BEsat}	<	900 mV

$I_C = 500 \text{ mA}; I_B = 50 \text{ mA}$ BSW66; BSW67
BSW68

V_{CEsat}	<	400 mV
V_{CEsat}	<	500 mV
V_{BEsat}	<	1.1 V

$I_C = 1 \text{ A}; I_B = 150 \text{ mA}$

V_{CEsat}	<	1 V
V_{BEsat}	<	1.4 V

D.C. current gain

$I_C = 10 \text{ mA}; V_{CE} = 5 \text{ V}$

h_{FE}	>	30
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$I_C = 100 \text{ mA}; V_{CE} = 5 \text{ V}$

h_{FE}	>	40
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$I_C = 500 \text{ mA}; V_{CE} = 5 \text{ V}$

h_{FE}	>	30
----------	---	----

$I_C = 1 \text{ A}; V_{CE} = 5 \text{ V}$

h_{FE}	>	15
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Collector capacitance at f = 1 MHz

$I_E = I_e = 0; V_{CB} = 10 \text{ V}$

C_c	<	35 pF
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Emitter capacitance at f = 1 MHz

$I_C = I_c = 0; V_{EB} = 0$

C_e	<	650 pF
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Transition frequency at f = 35 MHz

$I_C = 100 \text{ mA}; V_{CE} = 20 \text{ V}$

f_T	typ.	80 MHz
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Turn on time when switched from

$-V_{BE} = 4 \text{ V}$ to $I_C = 500 \text{ mA}; I_B = 50 \text{ mA}$

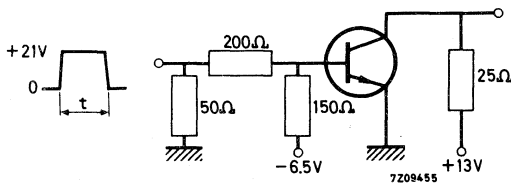
t_{on}	typ.	0.5 μs
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Turn off time when switched from

$I_C = 500 \text{ mA}; I_B = 50 \text{ mA}$ to $-V_{BB} = 6.5 \text{ V}$
($-I_{BM} = 50 \text{ mA}$)

t_{off}	typ.	1 μs
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Test circuit:



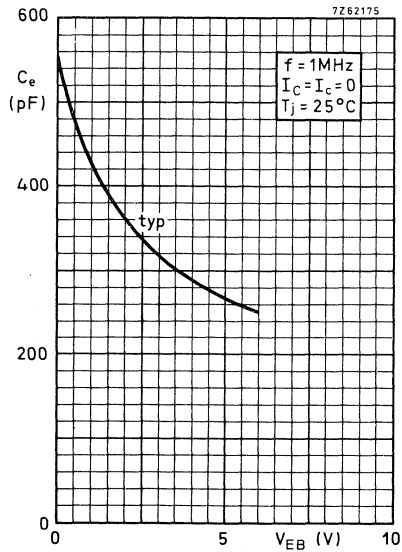
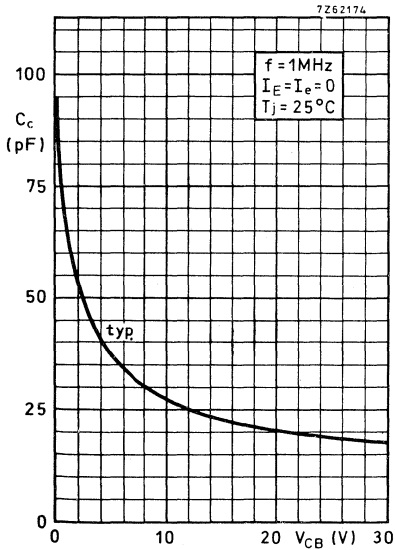
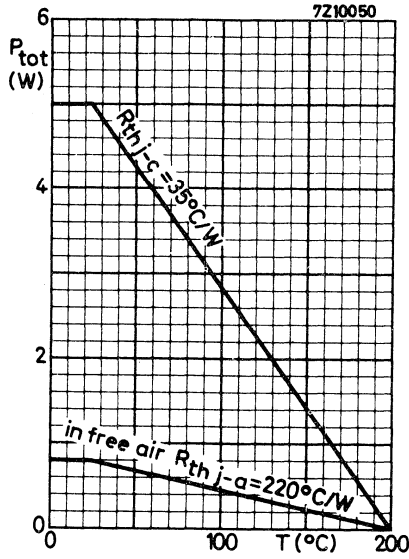
Pulse generator:

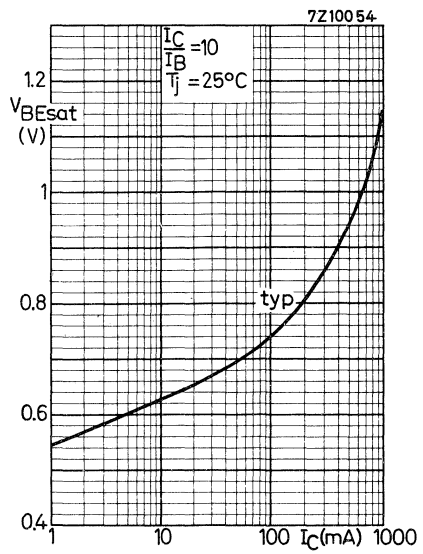
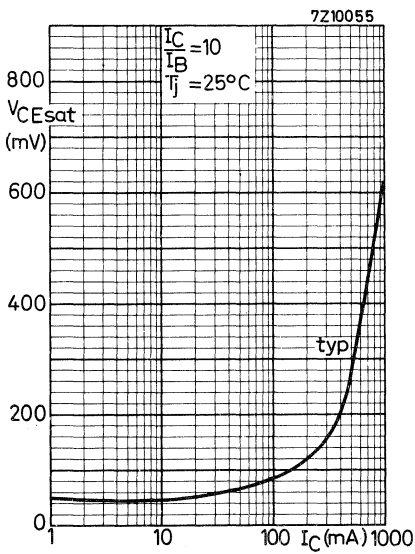
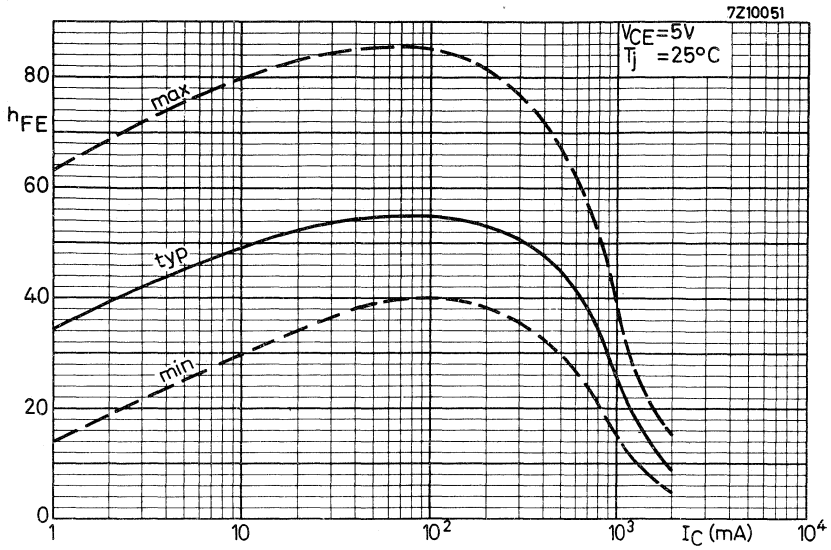
Pulse duration	$t > 5 \mu\text{s}$
Rise time	$t_r < 10 \text{ ns}$
Fall time	$t_f < 10 \text{ ns}$

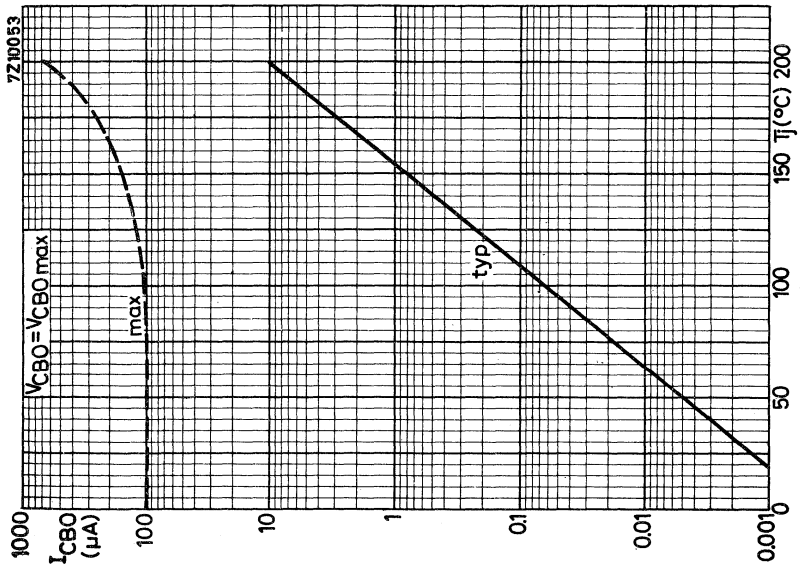
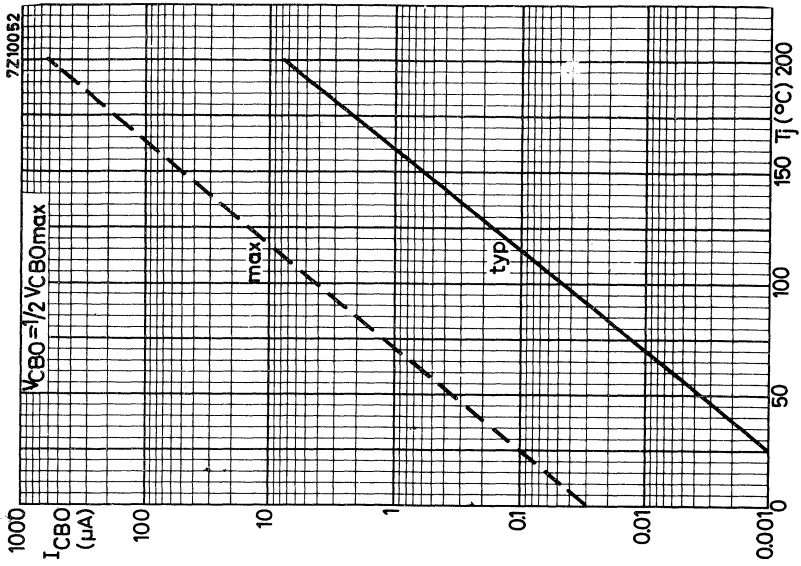
Note

$-I_{BM}$ 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.

CHARACTERISTICS (continued)







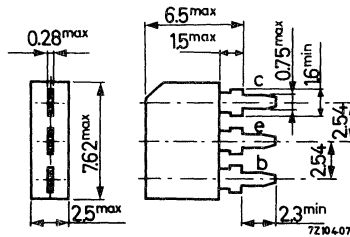
SILICON PLANAR SWITCHING TRANSISTOR

N-P-N transistor in a plastic envelope intended for driving numerical indicator tubes

QUICK REFERENCE DATA			
Collector-base voltage (open emitter)	V_{CBO}	max.	150 V
Collector-emitter voltage with $R_{BE} = 10\text{ k}\Omega$	V_{CER}	max.	150 V
Collector current (d. c.)	I_C	max.	50 mA
Total power dissipation up to $T_{amb} = 50\text{ }^\circ\text{C}$	P_{tot}	max.	125 mW
D. C. current gain at $T_i = 25\text{ }^\circ\text{C}$ $I_C = 4\text{ mA}; V_{CE} = 2\text{ V}$	h_{FE}	>	30
Transition frequency at $f = 100\text{ MHz}$ $I_C = 10\text{ mA}; V_{CE} = 5\text{ V}$	f_T	typ.	130 MHz

MECHANICAL DATA

Dimensions in mm



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

Voltages

Collector-base voltage (open emitter)	V_{CBO}	max.	150	V
Collector-emitter voltage with $R_{BE} = 10\text{ k}\Omega$	V_{CER}	max.	150	V
Emitter-base voltage (open collector)	V_{EBO}	max.	6	V

Currents

Collector current (d.c.)	I_C	max.	50	mA
Emitter current (d.c.)	$-I_E$	max.	50	mA

Power dissipation

Total power dissipation up to $T_{amb} = 50\text{ }^\circ\text{C}$	P_{tot}	max.	125	mW
--	-----------	------	-----	----

Temperatures

Storage temperature	T_{stg}	-30 to +125	$^\circ\text{C}$
Junction temperature	T_j	max.	125 $^\circ\text{C}$

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	0.6	$^\circ\text{C}/\text{mW}$
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CHARACTERISTICS

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

Collector cut-off current

$I_E = 0; V_{CB} = 100\text{ V}$	I_{CBO}	<	100	nA
$I_E = 0; V_{CB} = 150\text{ V}$	I_{CBO}	<	10	μA
$V_{BE} = 150\text{ V}; R_{BE} = 10\text{ k}\Omega$	I_{CER}	<	100	μA
$V_{CE} = 100\text{ V}; V_{BE} = 0.4\text{ V}; T_j = 75\text{ }^\circ\text{C}$	I_{CEX}	<	100	μA

Emitter cut-off current

$I_C = 0; V_{EB} = 4\text{ V}$	I_{EBO}	<	100	nA
$I_C = 0; V_{EB} = 6\text{ V}$	I_{EBO}	<	10	μA

CHARACTERISTICS (continued)

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

Base-emitter voltage

$I_C = 4\text{ mA}; V_{CE} = 2\text{ V}$

$V_{BE} < 0.75\text{ V}$

Saturation voltage

$I_C = 20\text{ mA}; I_B = 1\text{ mA}$

$V_{CEsat} < 4\text{ V}$

D.C. current gain

$I_C = 4\text{ mA}; V_{CE} = 2\text{ V}$

$h_{FE} > 30$

Collector capacitance at $f = 1\text{ MHz}$

$I_E = I_e = 0; V_{CB} = 10\text{ V}$

C_c typ. 2 pF

Emitter capacitance at $f = 1\text{ MHz}$

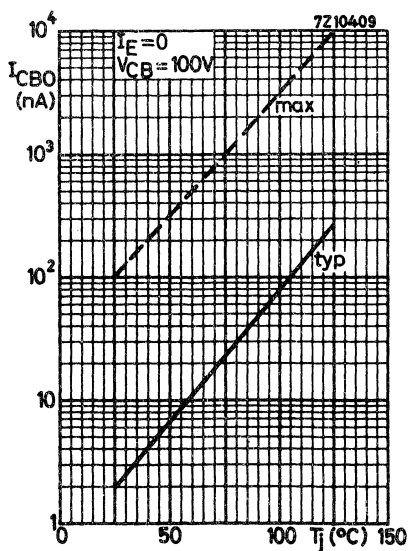
$I_C = I_c = 0; V_{EB} = 0.5\text{ V}$

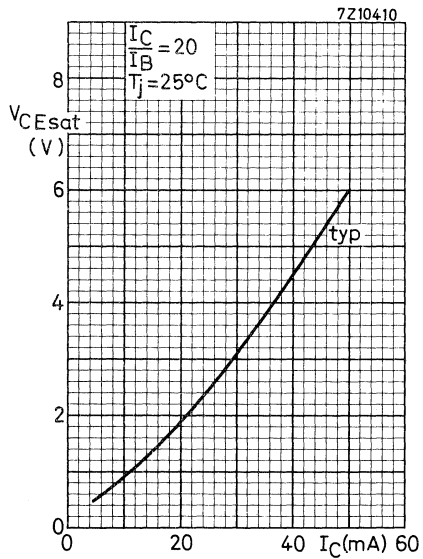
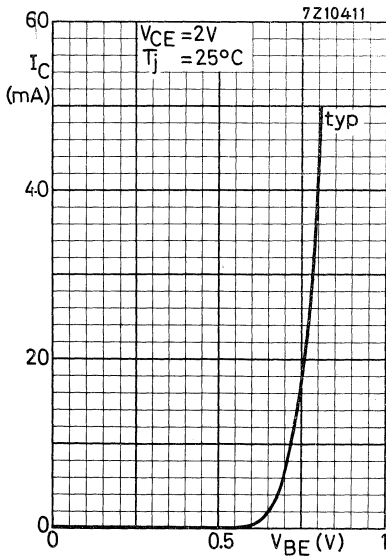
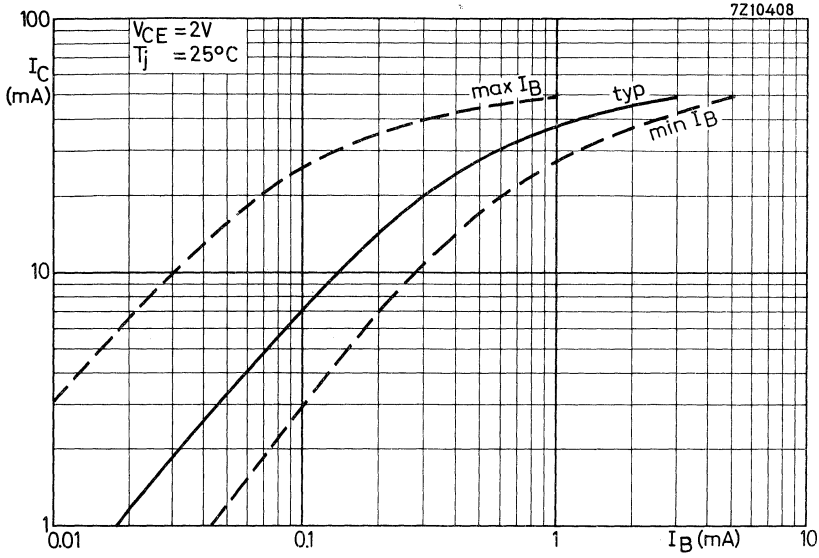
C_e typ. 17 pF

Transition frequency at $f = 100\text{ MHz}$

$I_C = 10\text{ mA}; V_{CE} = 5\text{ V}$

f_T typ. 130 MHz





SILICON PLANAR EPITAXIAL TRANSISTORS

N-P-N transistors in a TO-39 (reduced height) metal envelope with the collector connected to the case. They are intended for very high speed switching capability in high current applications.

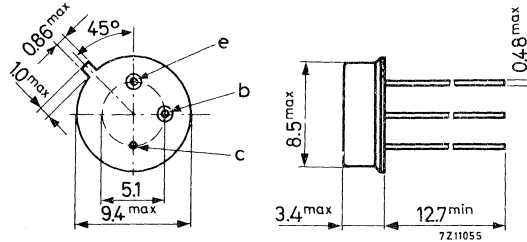
QUICK REFERENCE DATA					
			BSX12	BSX12A	
Collector-base voltage (open emitter)	V_{CBO}	max.	25	25	V
Collector-emitter voltage (open base)	V_{CEO}	max.	12	15	V
Collector current (d. c.)	I_C	max.	1		A
Total power dissipation up to $T_{mb} = 95^\circ\text{C}$	P_{tot}	max.	3		W
Junction temperature	T_j	max.	200		$^\circ\text{C}$
Collector-emitter saturation voltage $I_C = 100 \text{ mA}; I_B = 10 \text{ mA}$	V_{CEsat}	<	230		mV
D. C. current gain at $T_j = 25^\circ\text{C}$ $I_C = 300 \text{ mA}; V_{CE} = 0.5 \text{ V}$	h_{FE}	typ.	60		
		30 to	120		
Transition frequency $I_C = 100 \text{ mA}; V_{CE} = 5 \text{ V}; f = 100 \text{ MHz}$	f_T	typ.	620		MHz
Storage time when switched from $I_C = 1 \text{ A}; I_B = 100 \text{ mA}$ to cut-off with $-I_{BM} = 100 \text{ mA}$	t_s	<	18		ns

MECHANICAL DATA see page 2

MECHANICAL DATA

Dimensions in mm

TO-39 (reduced height)
Collector connected to case



max. lead diameter is guaranteed only for 12.7 mm

Accessories supplied on request: 56218

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

Voltages

			BSX12	BSX12A	
Collector-base voltage (open emitter)	V_{CBO}	max.	25	25	V
Collector-emitter voltage ($V_{BE} = 0$)	V_{CES}	max.	25	25	V
Collector-emitter voltage (open base)	V_{CEO}	max.	12	15	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4	4	V

Currents

Collector current (d. c.)	I_C	max.	1	A
Collector current (peak value)	I_{CM}	max.	1	A
Base current (peak value)	I_{BM}	max.	0.2	A

Power dissipation

Total power dissipation up to $T_{mb} = 95^{\circ}\text{C}$	P_{tot}	max.	3	W
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Temperatures

Storage temperature	T_{stg}	-65 to +200	$^{\circ}\text{C}$
Junction temperature	T_j	max. 200	$^{\circ}\text{C}$

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	300	$^{\circ}\text{C}/\text{W}$
From junction to mounting base	$R_{th\ j-mb}$	=	35	$^{\circ}\text{C}/\text{W}$

CHARACTERISTICS

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

Collector cut-off currents

$I_E = 0; V_{CB} = 25\text{ V}$	I_{CBO}	typ. <	10 500	nA μA
$I_E = 0; V_{CB} = 25\text{ V}; T_j = 150\text{ }^\circ\text{C}$	I_{CBO}	typ. <	7 1	μA mA
$V_{BE} = 0; V_{CE} = 15\text{ V}$	I_{CES}	typ. <	10 100	nA μA
$V_{BE} = 0; V_{CE} = 15\text{ V}; T_j = 125\text{ }^\circ\text{C}$	I_{CES}	typ. <	5 500	μA μA

Emitter cut-off current

$I_C = 0; V_{EB} = 4\text{ V}; T_j = 150\text{ }^\circ\text{C}$	I_{EBO}	typ. <	100 500	nA μA
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Current at reverse biased emitter junction

$V_{CE} = 15\text{ V}; -V_{BE} = 2\text{ V}$	$-I_{BEX}$	typ. <	100 100	nA μA
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Saturation voltages

$I_C = 10\text{ mA}; I_B = 1\text{ mA}$	V_{CEsat}	<	0.25	V
	V_{BEsat}	typ. <	0.72 0.78	V V
$I_C = 100\text{ mA}; I_B = 10\text{ mA}$	V_{CEsat}	<	0.23	V
	V_{BEsat}	typ. <	0.8 1.1	V V
$I_C = 300\text{ mA}; I_B = 30\text{ mA}$	V_{CEsat}	<	0.33	V
	V_{BEsat}	typ. <	0.9 1.2	V V
$I_C = 300\text{ mA}; I_B = 30\text{ mA}; T_j = 85\text{ }^\circ\text{C}$	V_{CEsat}	<	0.5	V
$I_C = 1\text{ A}; I_B = 0.1\text{ A}$	V_{CEsat}	<	0.7	V
	V_{BEsat}	typ. 0.9 to	1.1 1.7	V V



CHARACTERISTICS (continued)

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

D. C. current gain

$I_C = 10\text{ mA}; V_{CE} = 0.5\text{ V}$

h_{FE} > 20
typ. 45

$I_C = 100\text{ mA}; V_{CE} = 0.5\text{ V}$

h_{FE} > 30
typ. 65

$I_C = 300\text{ mA}; V_{CE} = 0.5\text{ V}$

h_{FE} typ. 60
30 to 120

$I_C = 1\text{ A}; V_{CE} = 1\text{ V}$

h_{FE} > 15
typ. 35

Collector capacitance at $f = 1\text{ MHz}$

$I_E = I_e = 0; V_{CB} = 0$

C_c typ. 10 pF
< 25 pF

$I_E = I_e = 0; V_{CB} = 5\text{ V}$

C_c typ. 8 pF
< 12 pF

Emitter capacitance at $f = 1\text{ MHz}$

$I_C = I_c = 0; V_{EB} = 0.5\text{ V}$

C_e typ. 16.5 pF
< 25 pF

Transition frequency at $f = 100\text{ MHz}$

$I_C = 100\text{ mA}; V_{CE} = 5\text{ V}$

f_T > 450 MHz
typ. 620 MHz

$I_C = 500\text{ mA}; V_{CB} = 0$

f_T > 200 MHz
typ. 400 MHz

CHARACTERISTICS (continued)

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

Switching times (see page 6)

Turn on time when switched from

$-V_{BE} = 4\text{ V}$ to $I_C = 1\text{ A}$; $I_B = 100\text{ mA}$

t_{on}	typ.	11 ns
	<	15 ns

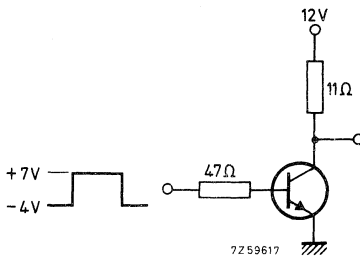
Turn off time when switched from

$I_C = 1\text{ A}$; $I_B = 0.1\text{ A}$ to cut off with $-I_{BM} = 0.1\text{ A}$

t_s	typ.	13 ns
	<	18 ns

t_{off}	typ.	19 ns
	<	25 ns

Test circuit:



Pulse generator:

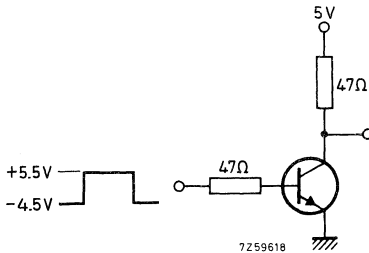
Pulse duration	t_p	=	100 ns
Rise time	t_r	<	1 ns
Duty cycle	δ	=	0.01

Storage time

$I_C = I_{B1} = -I_{B2} = 0.1\text{ A}$

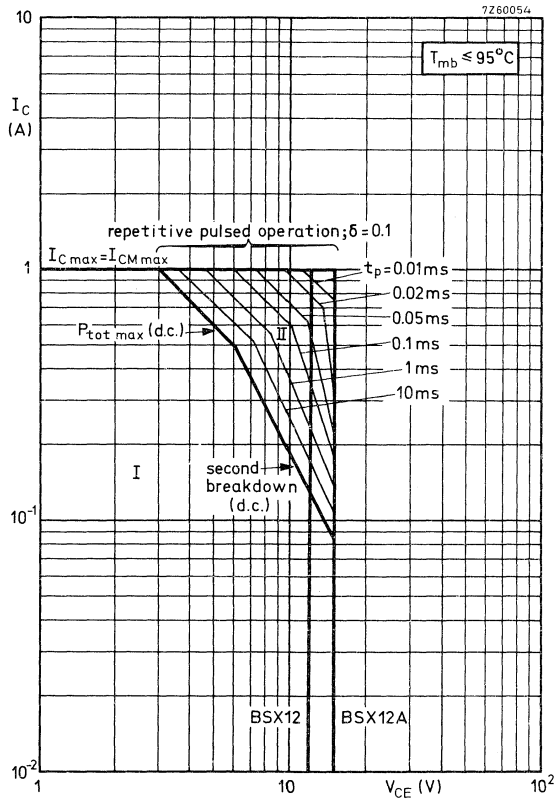
τ_s	typ.	11 ns
	<	15 ns

Test circuit:



Pulse generator:

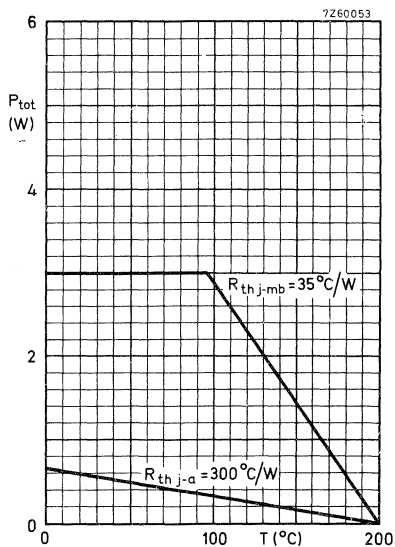
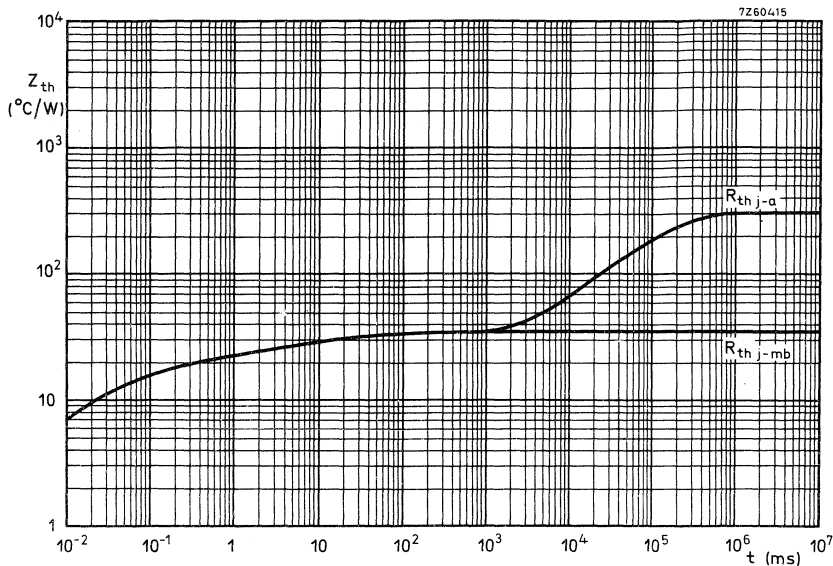
Pulse duration	t_p	=	100 ns
Rise time	t_r	<	1 ns
Duty cycle	δ	=	0.01



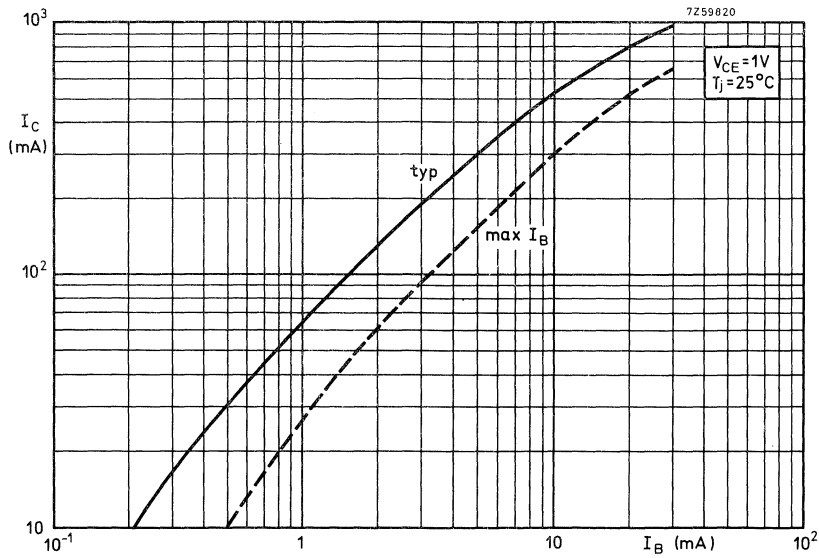
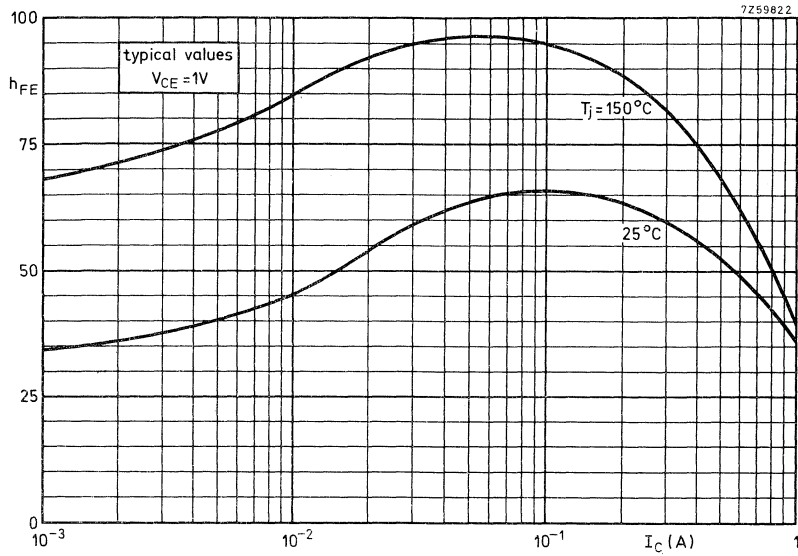
Safe Operating Area with the transistor forward biased

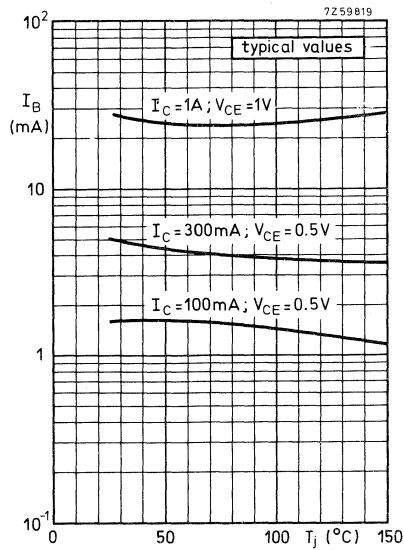
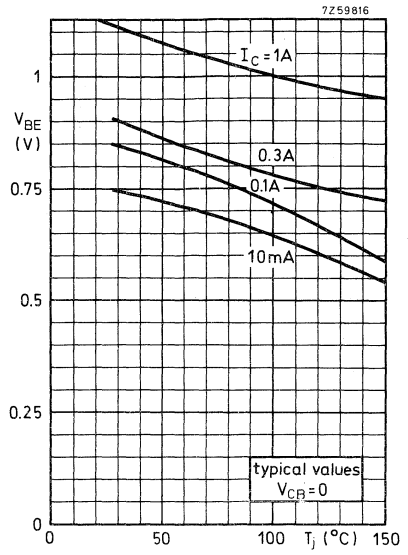
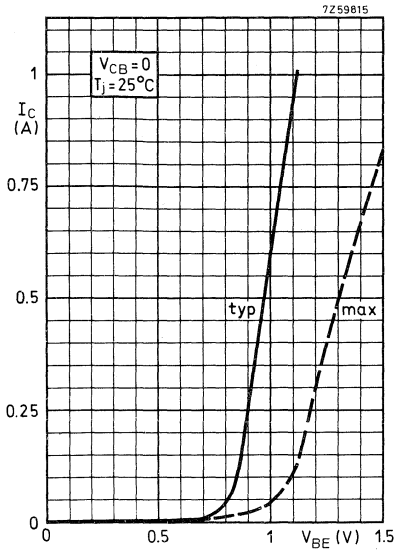
I Region of permissible d. c. operation

II Permissible extension for repetitive pulsed operation

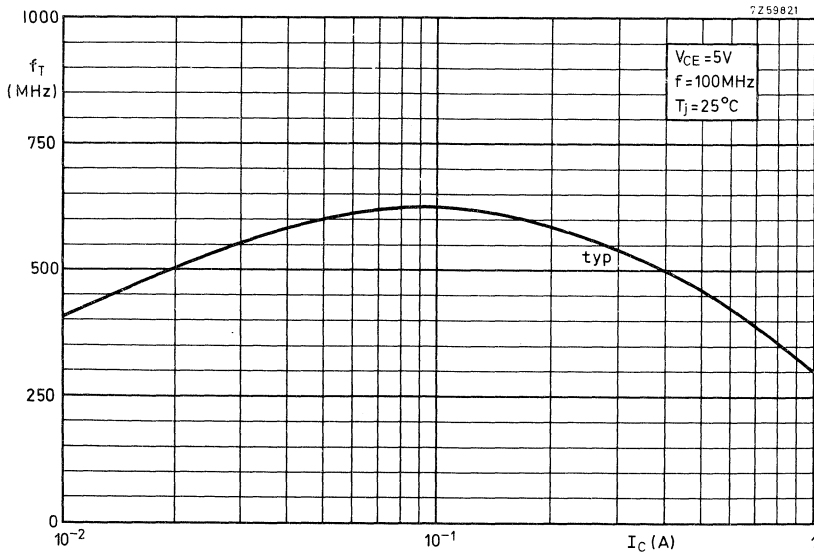
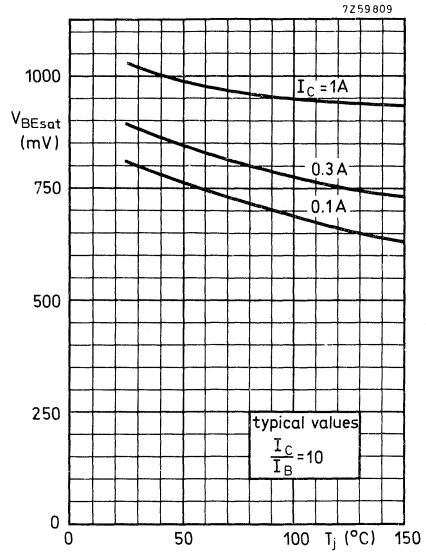
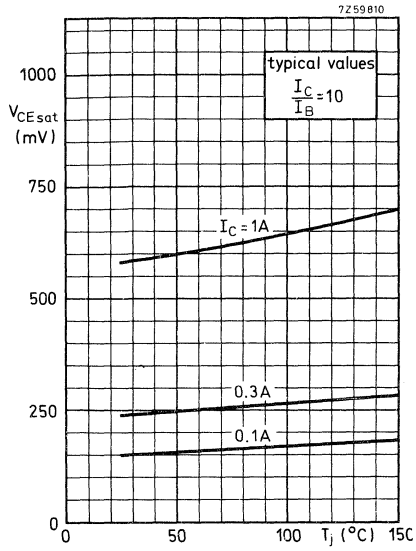


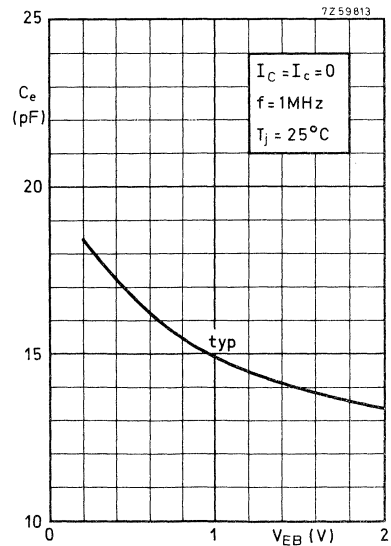
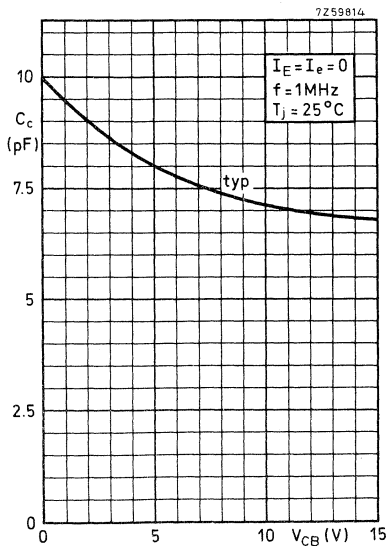
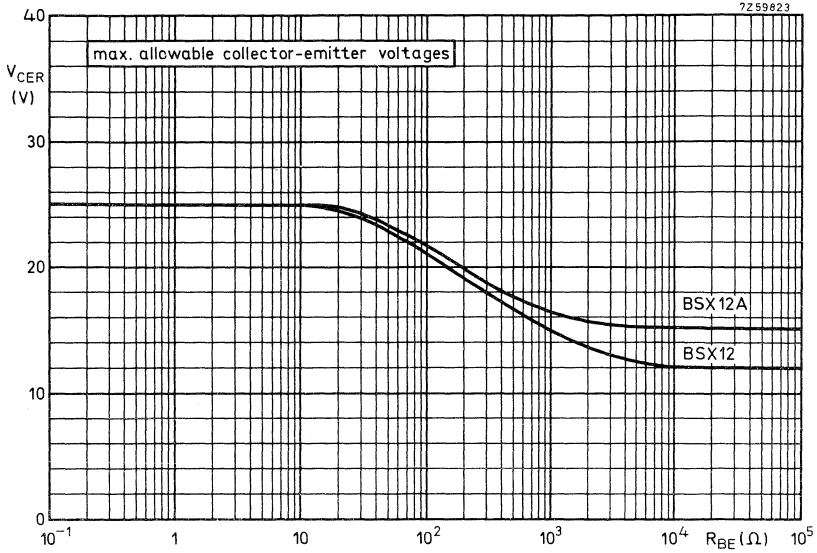
BSX12 BSX12A

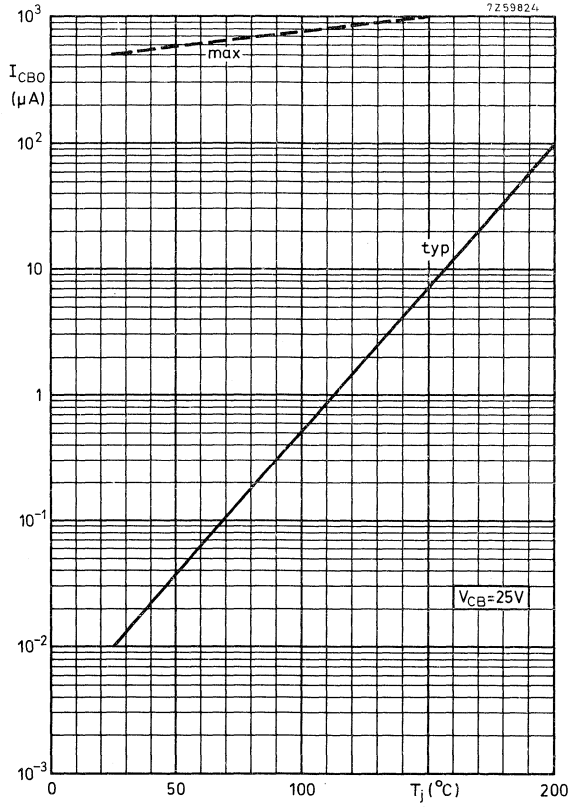


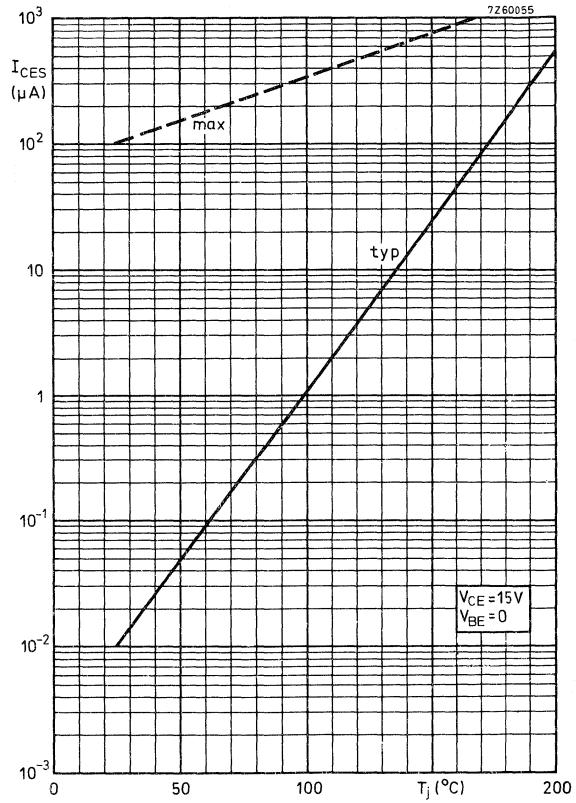


BSX12 BSX12A

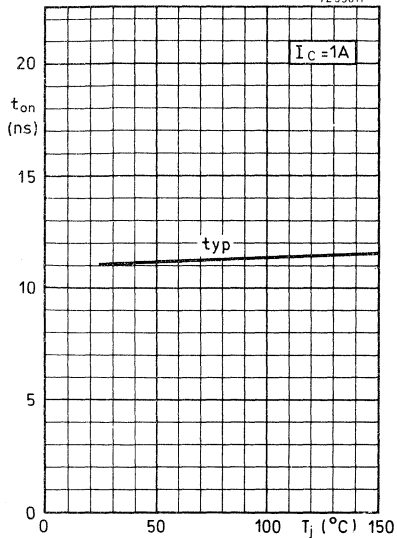




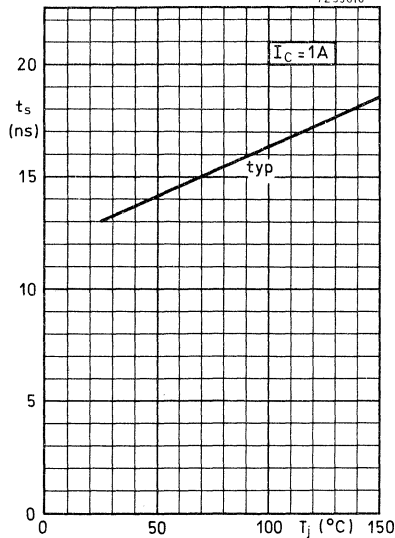




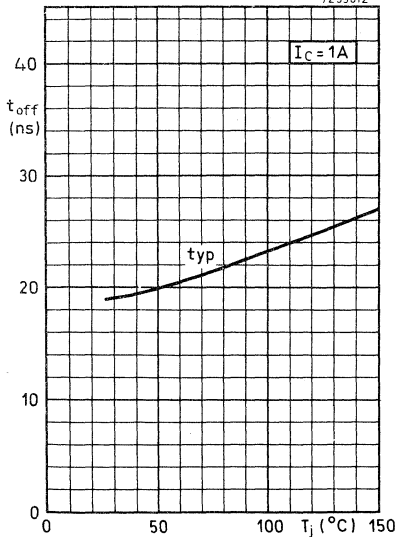
7Z59811



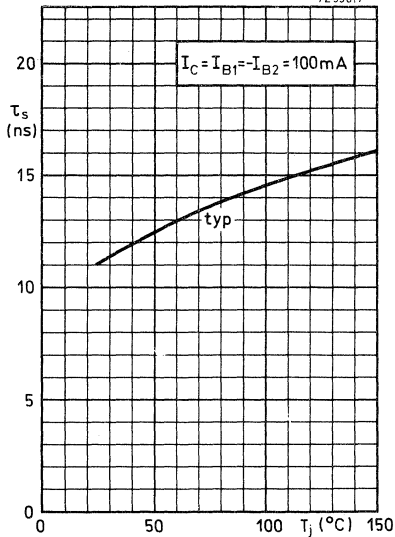
7Z59818



7Z59812



7Z59817



VERY HIGH SPEED SWITCHING TRANSISTORS

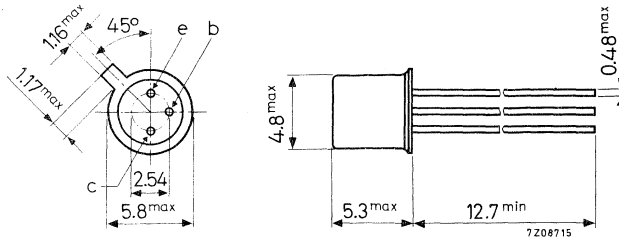
N-P-N silicon planar epitaxial transistors in a TO-18 metal envelope with the collector connected to the case. The BSX19 and BSX20 are primarily intended for very high speed saturated switching.

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 $T_{amb} = 25\text{ }^{\circ}\text{C}$	P_{tot}	max. 360	360 mW
D.C. current gain at $T_j = 25\text{ }^{\circ}\text{C}$			
$I_C = 10\text{ mA}; V_{CE} = 1\text{ V}$	h_{FE}	20 to 60	40 to 120
$I_C = 100\text{ mA}; V_{CE} = 2\text{ V}$	h_{FE}	> 10	20
Transition frequency			
$I_C = 10\text{ mA}; V_{CE} = 10\text{ V}$	f_T	> 400	500 MHz
Storage time			
$I_C = I_B = -I_{BM} = 10\text{ mA}$	t_s	< 10	13 ns

MECHANICAL DATA

Dimensions in mm

Collector connected to case
TO-18



Accessories available: 56246, 56263

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
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Power dissipation

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

Storage temperature	T_{stg}	-65 to +200	$^\circ\text{C}$
Junction temperature	T_j	max. 200	$^\circ\text{C}$

THERMAL RESISTANCE

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

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

CHARACTERISTICS

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

Collector cut-off current

$I_E = 0; V_{CB} = 20\text{ V}$	I_{CBO}	<	400 nA
$I_E = 0; V_{CB} = 20\text{ V}; T_j = 150^\circ\text{C}$	I_{CBO}	<	30 μA
$V_{BE} = 0; V_{CE} = 15\text{ V}; T_j = 55^\circ\text{C}$	I_{CES}	<	0.40 μA
$V_{BE} = 0; V_{CE} = 40\text{ V}$	I_{CES}	<	1.0 μA

Emitter cut-off current

$I_C = 0; V_{EB} = 4.5\text{ V}$	I_{EBO}	<	10 μA
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Currents at reverse biased emitter junction

$V_{CE} = 15\text{ V}; -V_{BE} = 3\text{ V}; T_j = 55^\circ\text{C}$	I_{CEX}	<	0.60 μA
	$-I_{BEX}$	<	0.60 μA

Sustaining voltages

$I_C = 10\text{ mA}; I_B = 0$	$V_{CEO\text{sust}}$	>	15 V
$I_C = 10\text{ mA}; R_{BE} = 10\ \Omega$	$V_{CER\text{sust}}$	>	20 V

Base-emitter voltage (see also page 8)

$I_C = 30\ \mu\text{A}; V_{CE} = 20\text{ V}; T_j = 100^\circ\text{C}$	V_{BE}	>	0.35 V
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Saturation voltages

$I_C = 10\text{ mA};$ BSX19: $I_B = 0.6\text{ mA}$ BSX20: $I_B = 0.3\text{ mA}$	$V_{CE\text{sat}}$	<	0.3 V
$I_C = 10\text{ mA}; I_B = 1\text{ mA}$	$V_{CE\text{sat}}$	<	0.25 V
	$V_{BE\text{sat}}$	0.70 to	0.85 V
$I_C = 100\text{ mA}; I_B = 10\text{ mA}$	$V_{CE\text{sat}}$	<	0.60 V
	$V_{BE\text{sat}}$	<	1.50 V

Collector capacitance at $f = 1\text{ MHz}$

$I_E = I_e = 0; V_{CB} = 5\text{ V}$	C_c	<	4 pF
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Emitter capacitance at $f = 1\text{ MHz}$

$I_C = I_c = 0; V_{EB} = 1\text{ V}$	C_e	<	4.5 pF
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CHARACTERISTICS (continued)

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

D.C. current gain

$I_C = 10\text{ mA}; V_{CE} = 1\text{ V}$

$I_C = 10\text{ mA}; V_{CE} = 1\text{ V}; T_j = -55\text{ }^\circ\text{C}$

$I_C = 100\text{ mA}; V_{CE} = 2\text{ V}$

	BSX19	BSX20
h_{FE}	20 to 60	40 to 120
h_{FE}	> 10	20
h_{FE}	> 10	20
f_T	> 400 typ. 500	500 MHz 600 MHz

Transition frequency

$I_C = 10\text{ mA}; V_{CE} = 10\text{ V}$

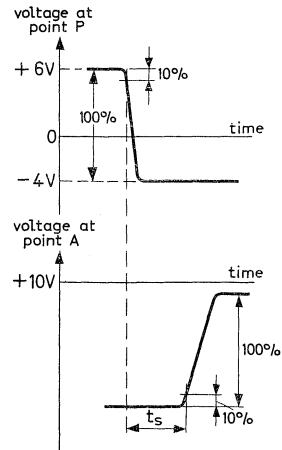
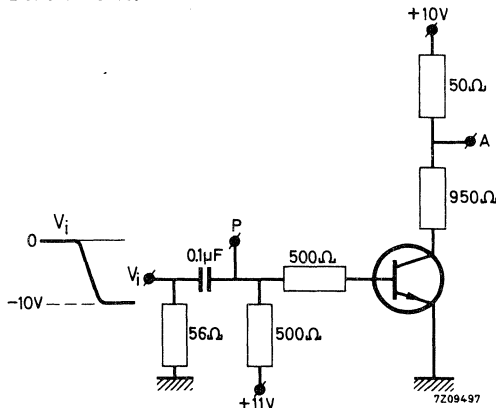
Switching times

Storage time (see also pages 20 and 21)

$I_C = I_B = -I_{BM} = 10\text{ mA}$

t_s	typ. 5	6 ns
	< 10	13 ns

Test circuit:



Pulse generator:

Rise time	$t_R < 1\text{ ns}$
Pulse duration	$t > 300\text{ ns}$
Duty cycle	$\delta < 0.02$
Source impedance	$R_S = 50\text{ }\Omega$

Oscilloscope:

Input impedance	$R_i = 50\text{ }\Omega$
Rise time	$t_R < 1\text{ ns}$

CHARACTERISTICS (continued)

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

Switching times

Turn on time (see also pages 14 and 15)

from $-V_{BE} = 1.5\text{ V}$ to $I_C = 10\text{ mA}$; $I_B = 3\text{ mA}$

$t_{on} < 12\text{ ns}$

from $-V_{BE} = 2.25\text{ V}$ to $I_C = 100\text{ mA}$; $I_B = 40\text{ mA}$

$t_{on} < 7\text{ ns}$

Turn off time (see also pages 16 to 19)

from $I_C = 10\text{ mA}$; $I_B = 3\text{ mA}$

BSX19

$t_{off} < 15\text{ ns}$

to cut-off with $-I_{BM} = 1.5\text{ mA}$

BSX20

$t_{off} < 18\text{ ns}$

from $I_C = 100\text{ mA}$; $I_B = 40\text{ mA}$ to cut-off

BSX19

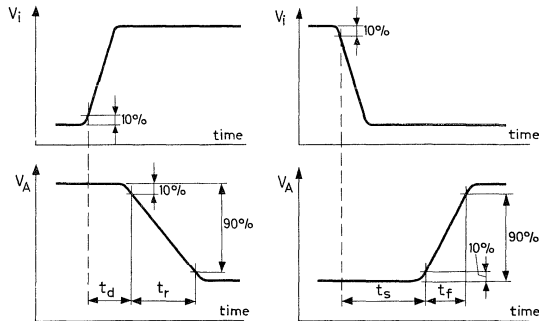
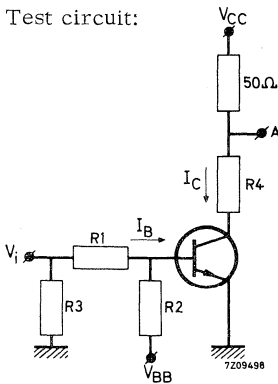
$t_{off} < 18\text{ ns}$

with $-I_{BM} = 20\text{ mA}$

BSX20

$t_{off} < 21\text{ ns}$

Test circuit:



Pulse generator:

Rise time $t_r < 1\text{ ns}$

Pulse duration $t > 300\text{ ns}$

Duty cycle $\delta < 0.02$

Source impedance $R_S = 50\text{ }\Omega$

Oscilloscope:

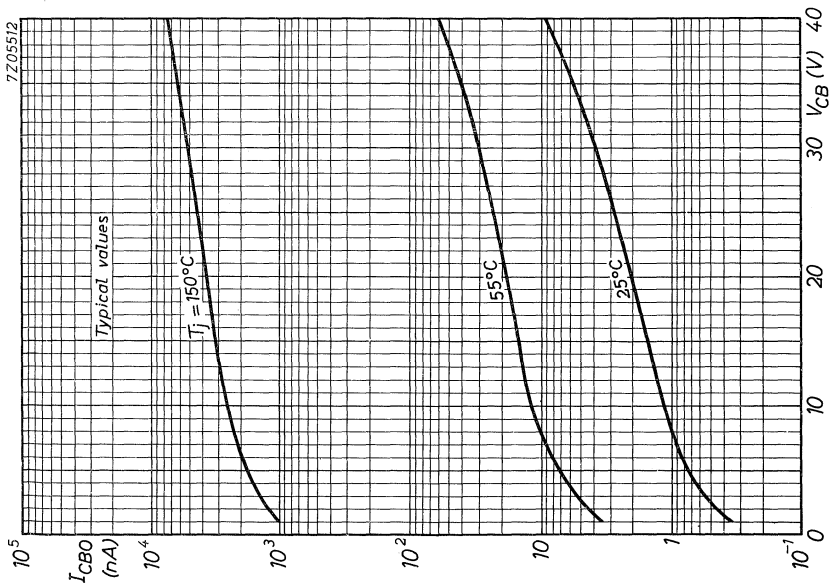
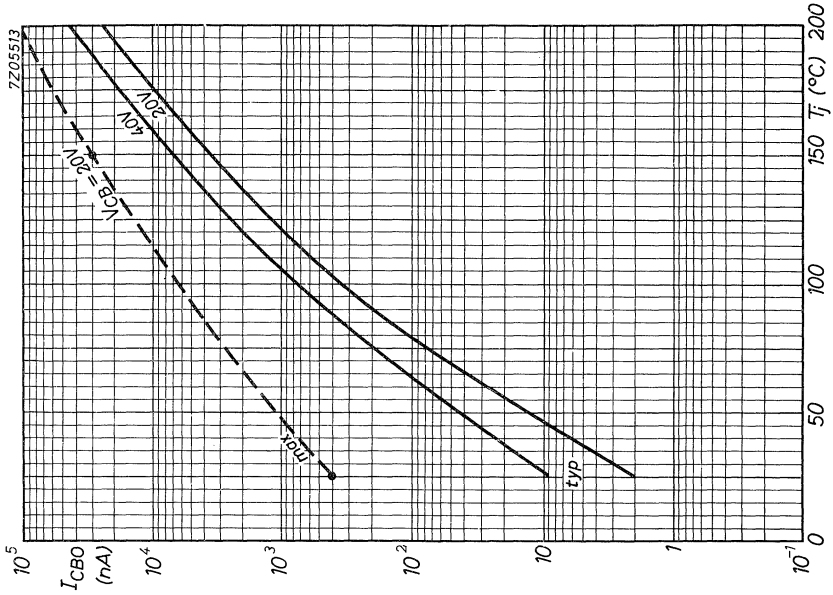
Input impedance $R_i = 50\text{ }\Omega$

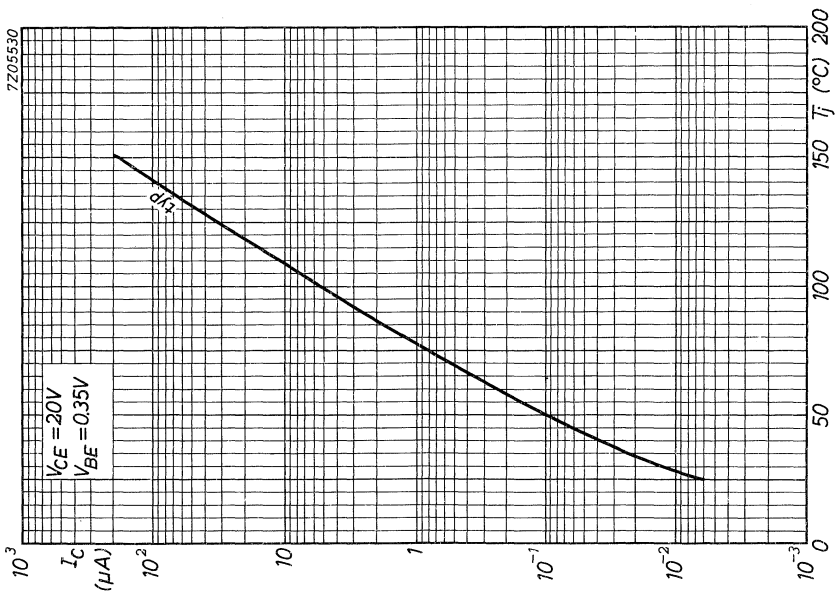
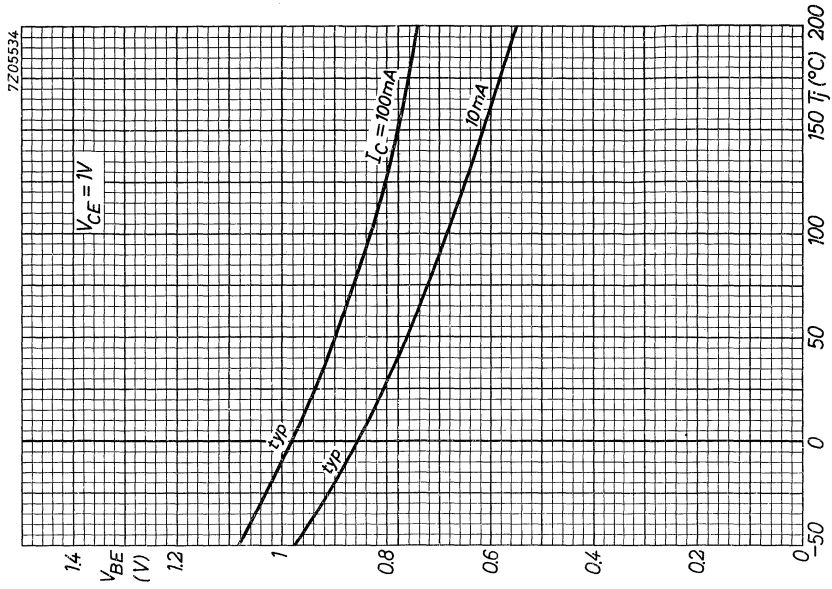
Rise time $t_r < 1\text{ ns}$

I_C (mA)	I_B (mA)	$-I_{BM}$ (mA)	V_{CC} (V)	$R1;R2$ (k Ω)	$R3$ (Ω)	$R4$ (Ω)	turn on time			turn off time	
							$-V_{BB}$ (V)	$-V_{BE}$ (V)	V_i (V)	V_{BB} (V)	$-V_i$ (V)
10	3	1.5	3	3.3	50	220	3.0	1.5	15	12.0	15
100	40	20	6	0.33	56	0	4.5	2.25	20	15.3	20

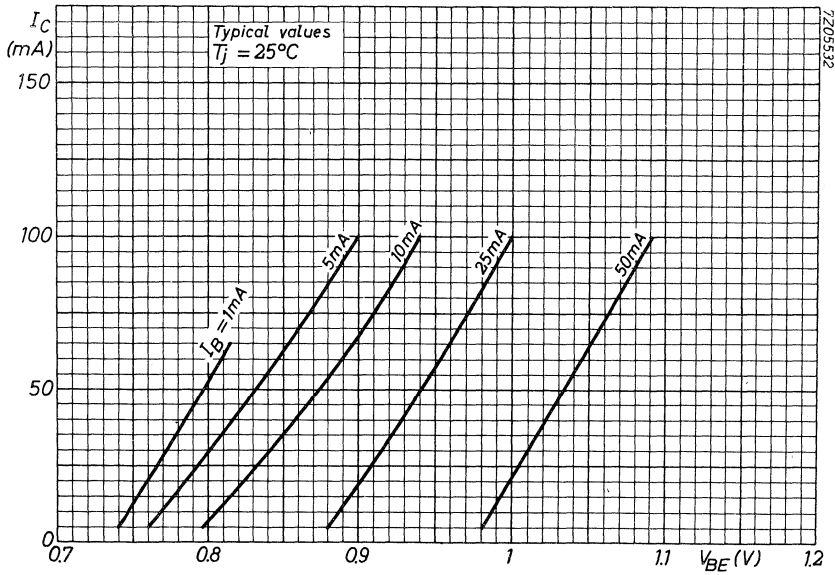
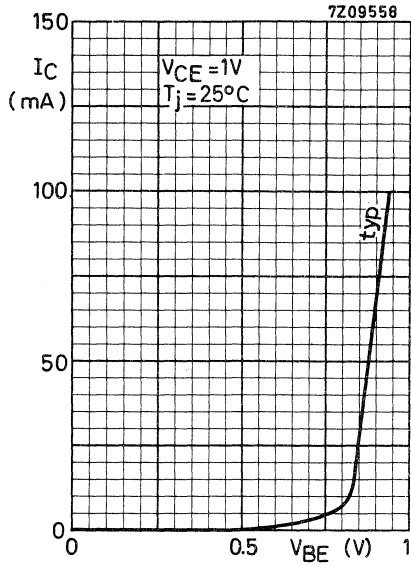
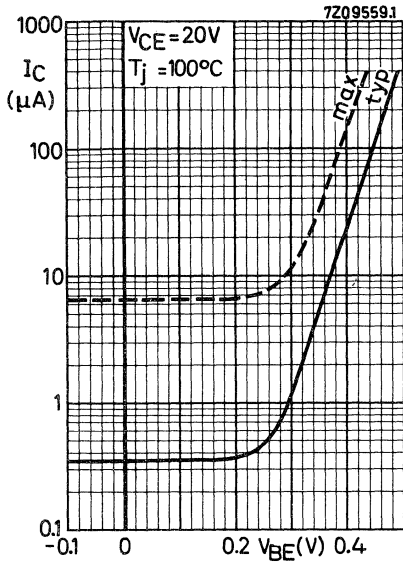
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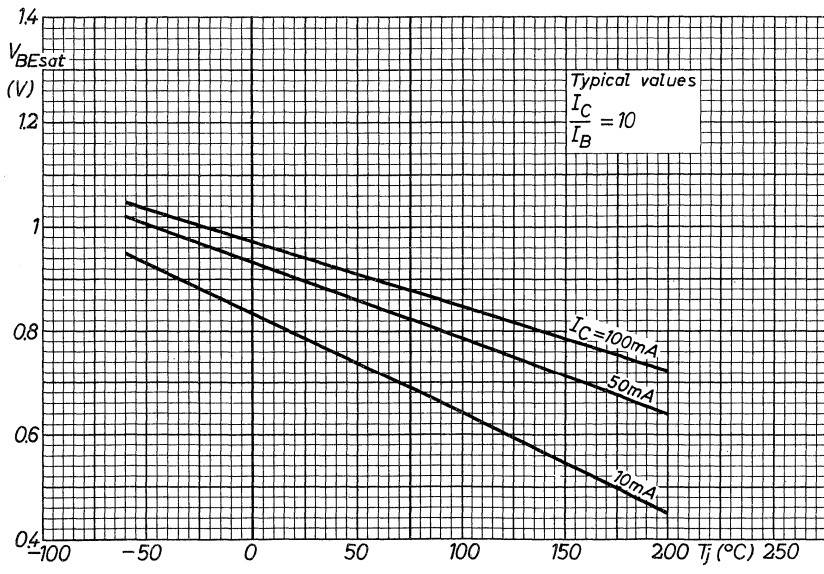
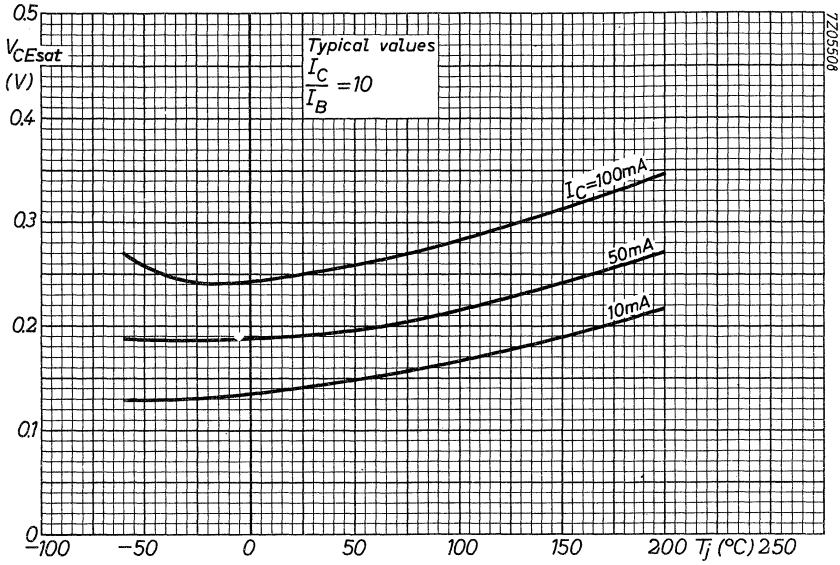
$-I_{BM}$ is the reverse current that can flow during switching off. The indicated $-I_{BM}$ is determined and limited by the applied cut-off voltage and series resistance.



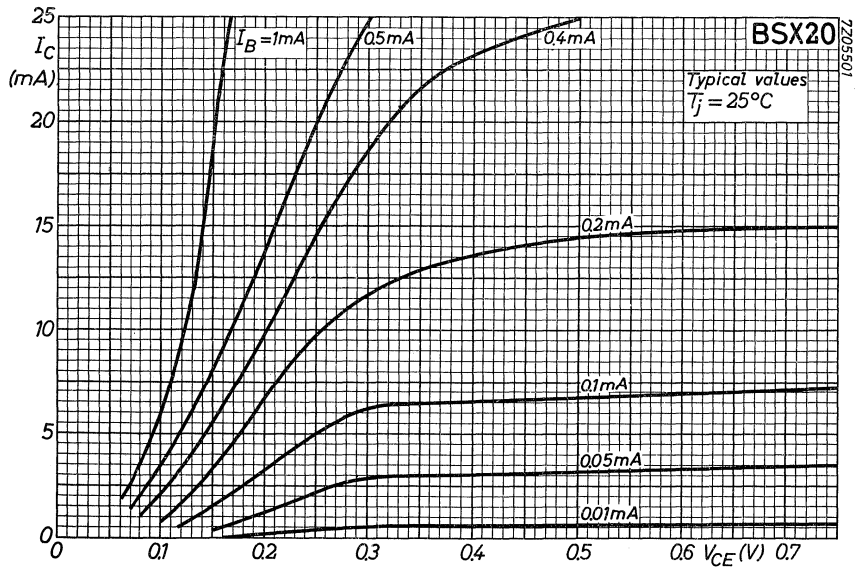
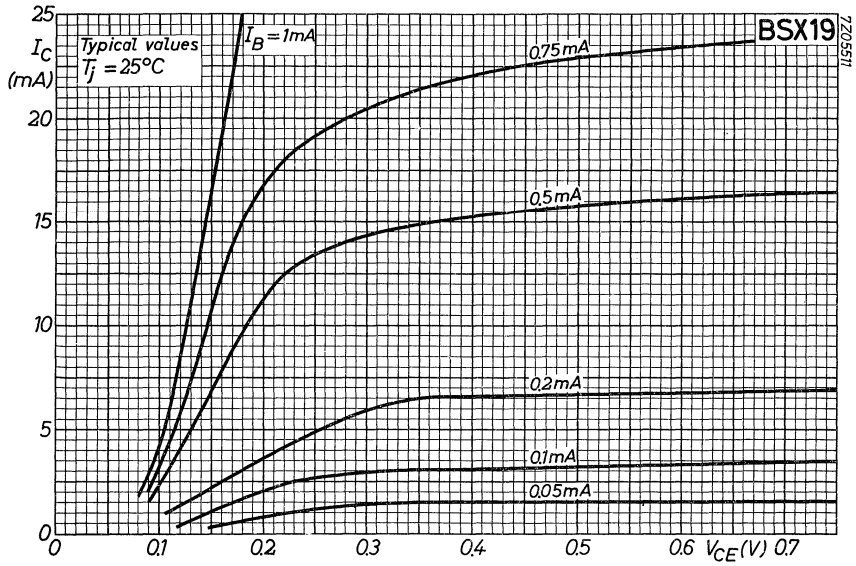


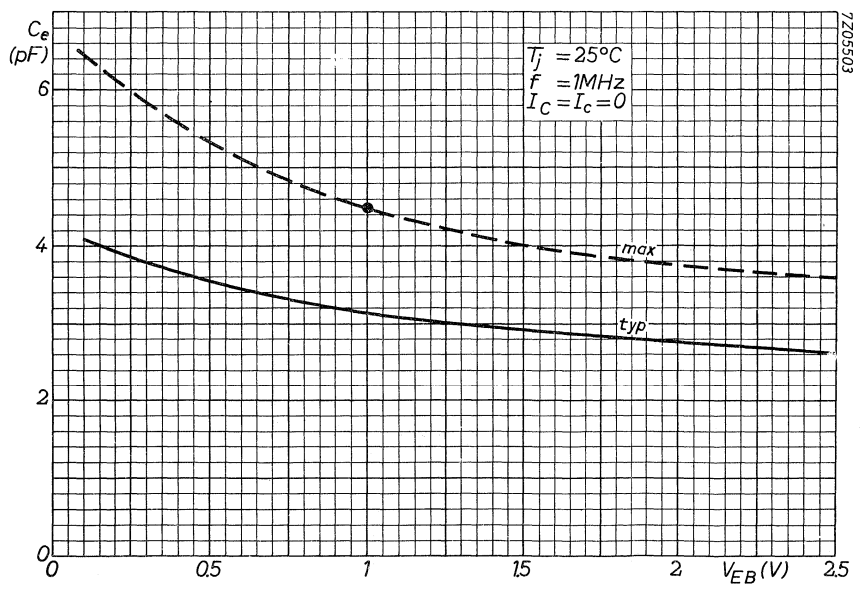
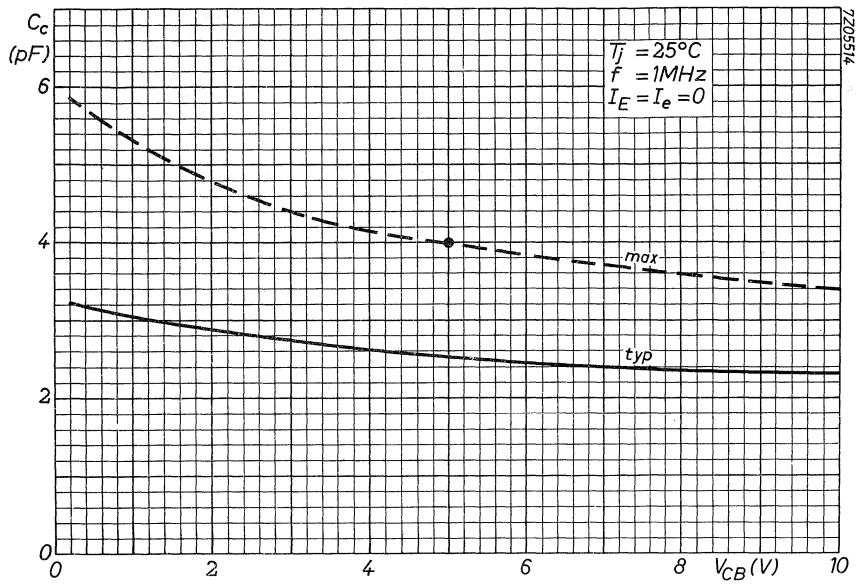
BSX19
BSX20



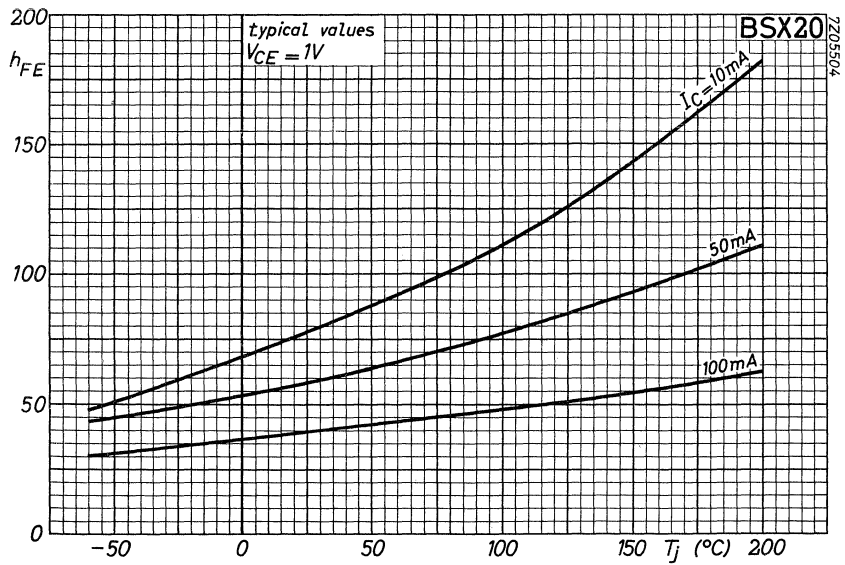
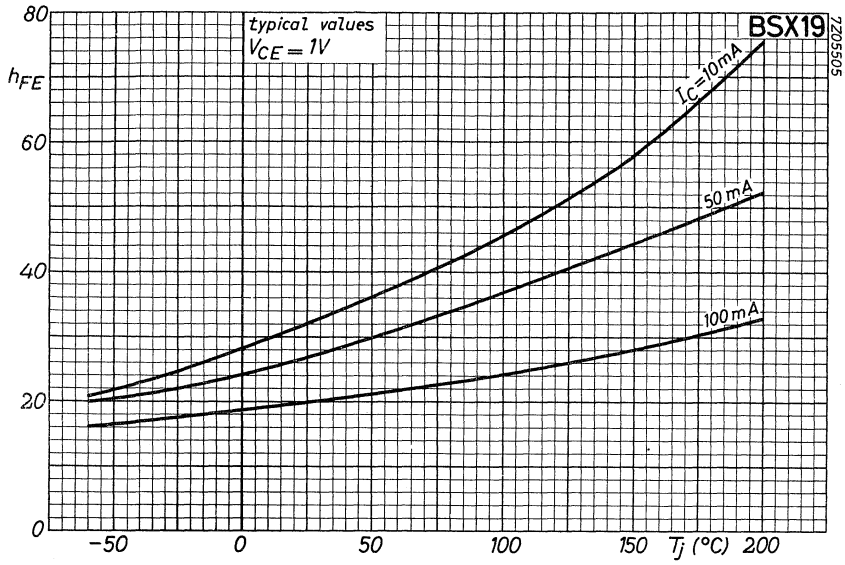


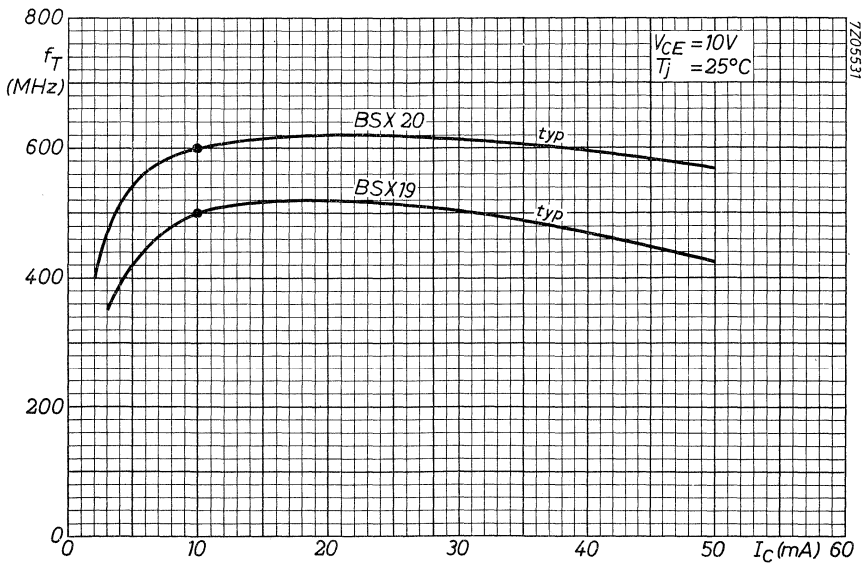
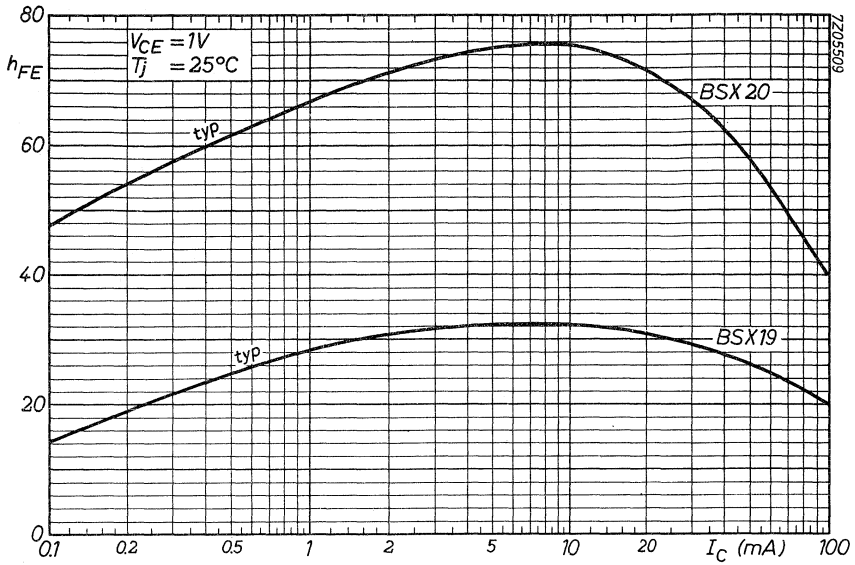
BSX19 BSX20

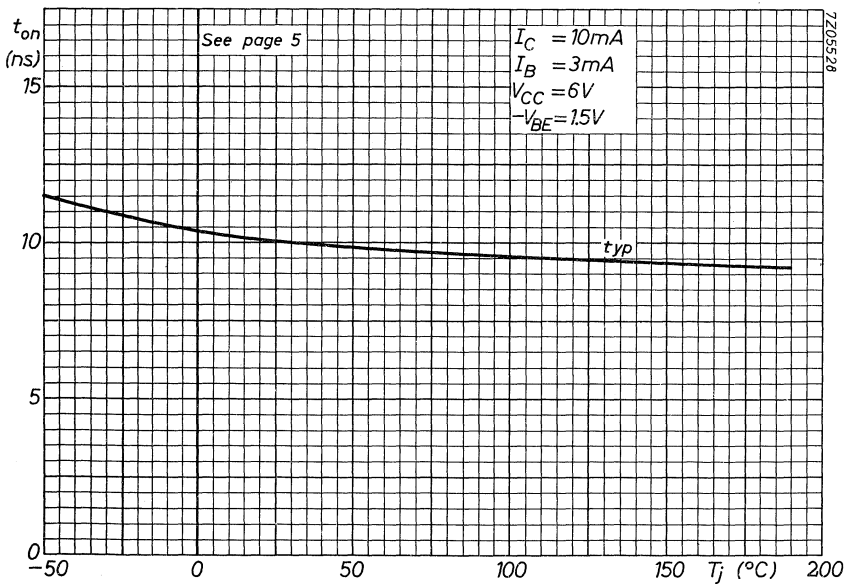
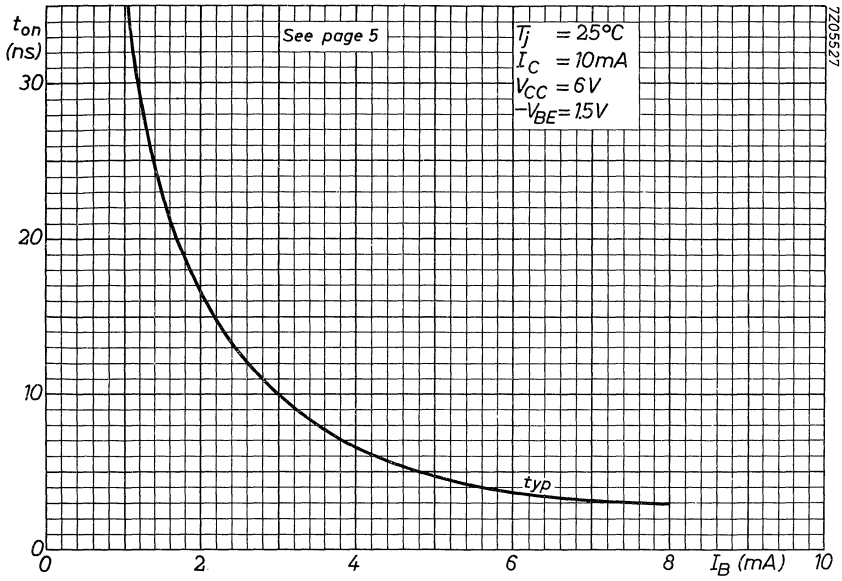


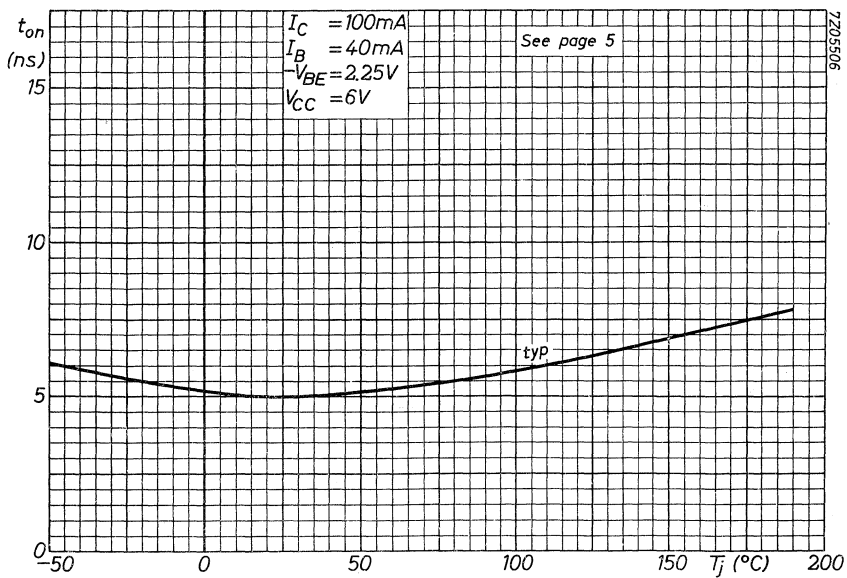
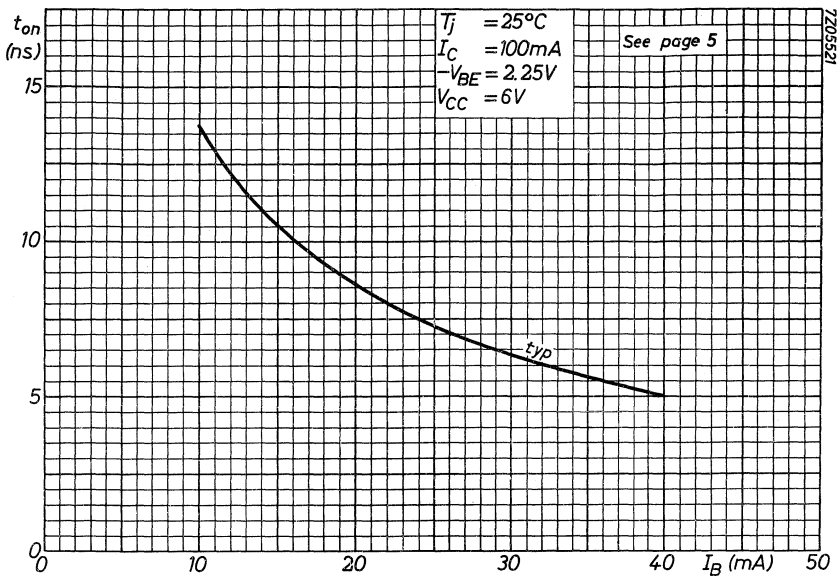


BSX 19
BSX 20

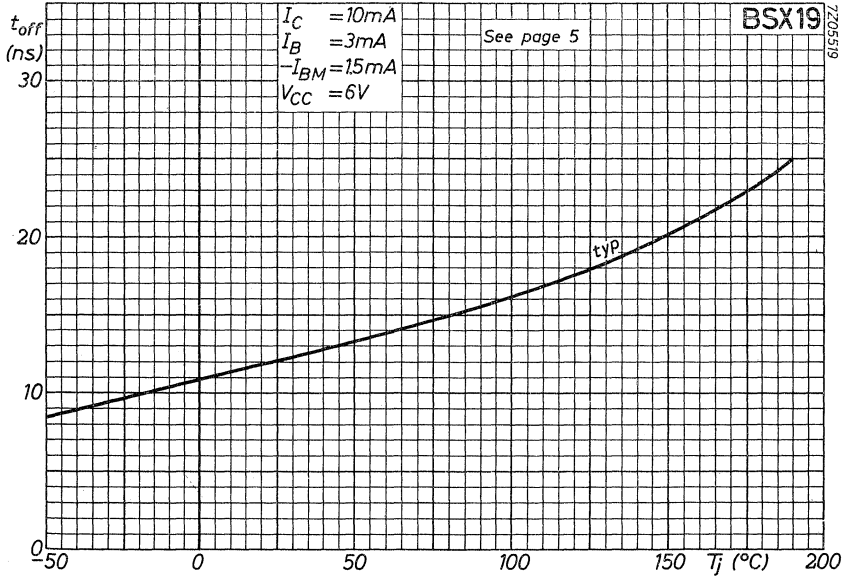
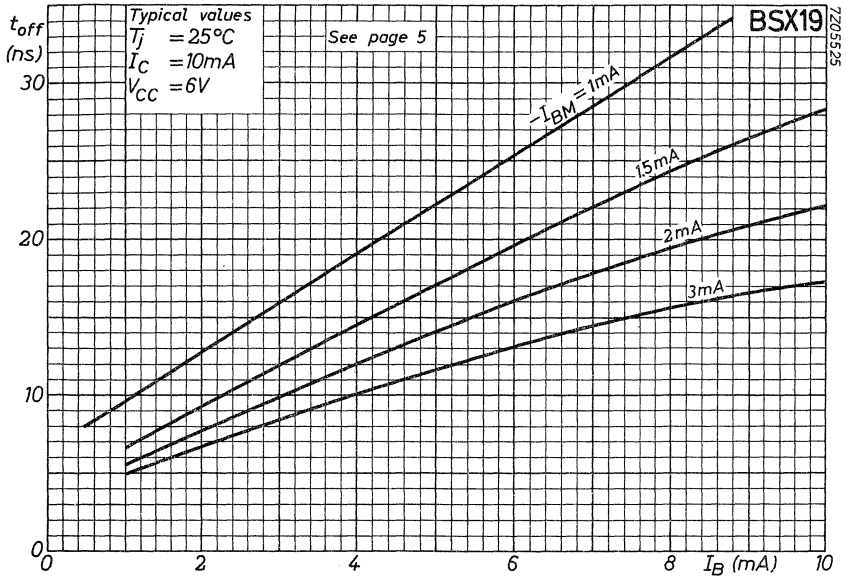


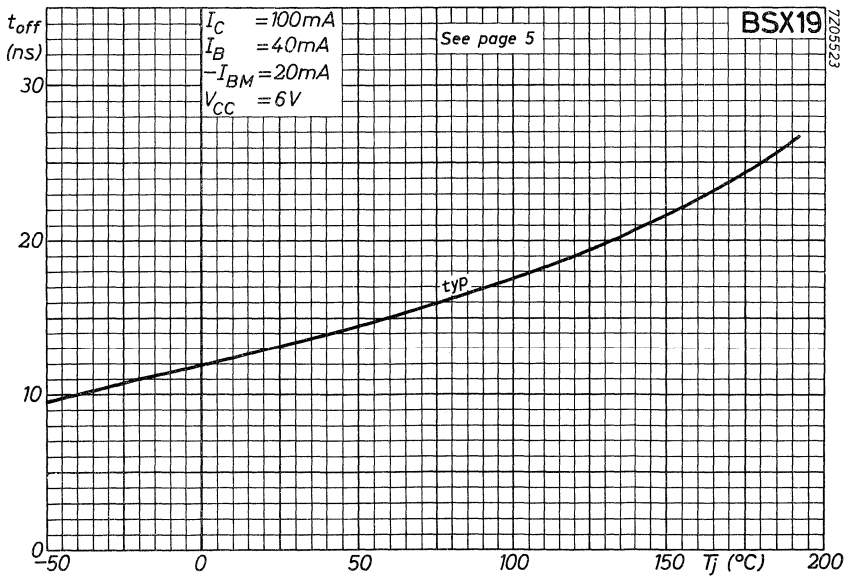
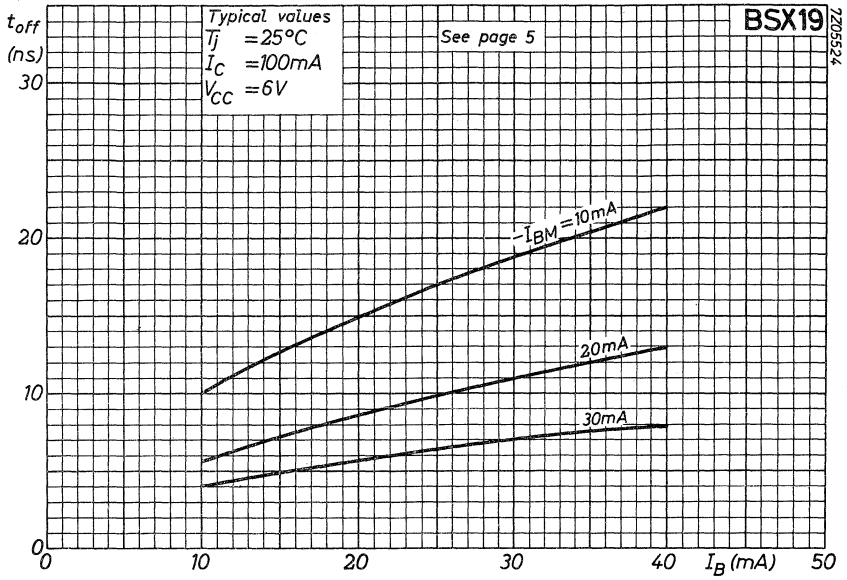


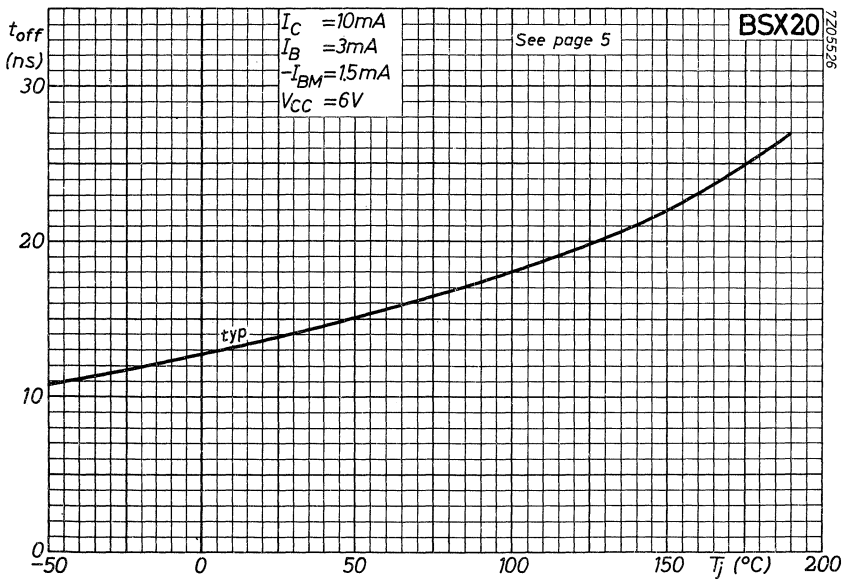
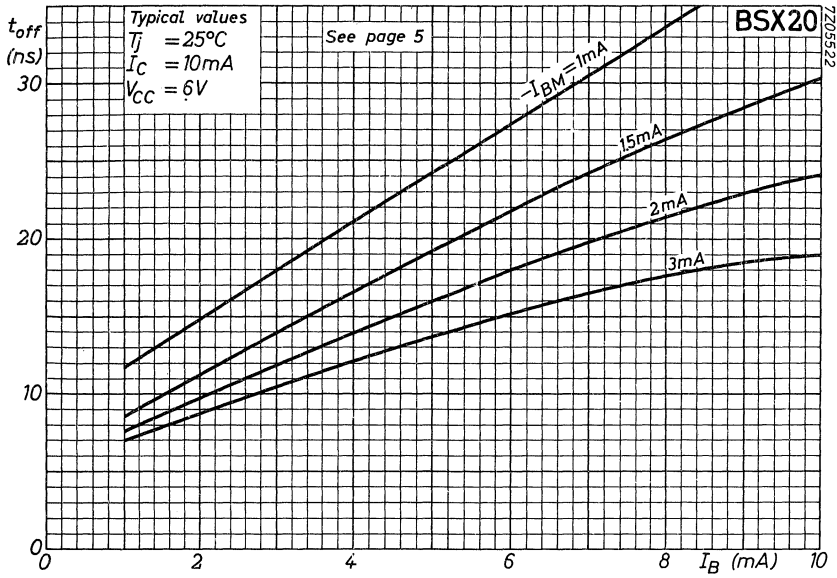


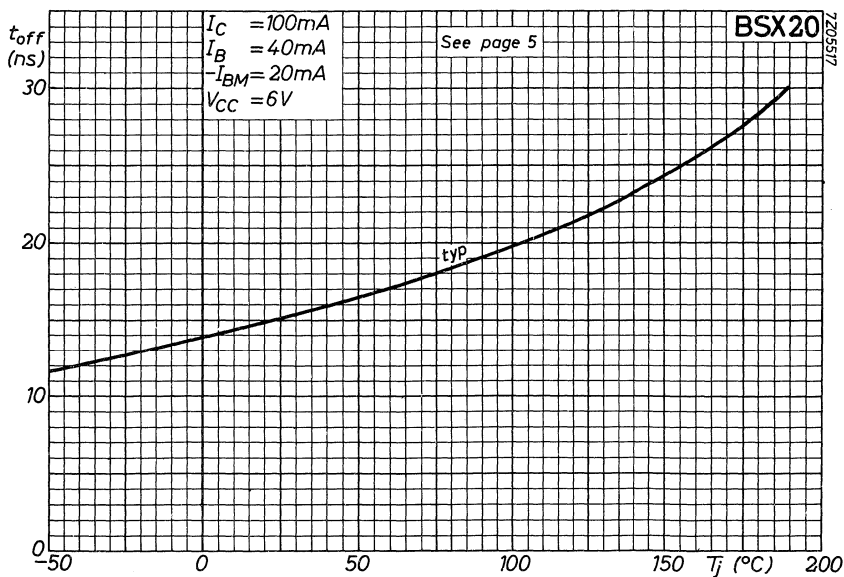
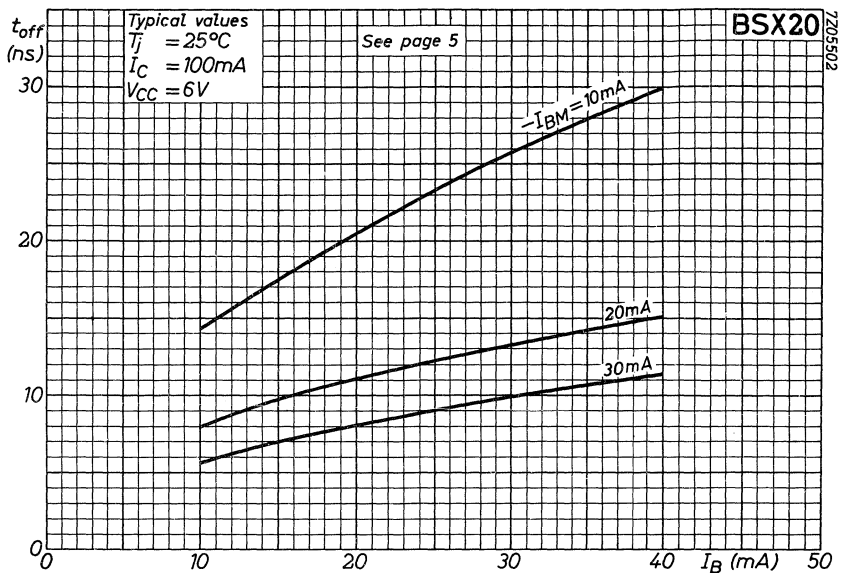


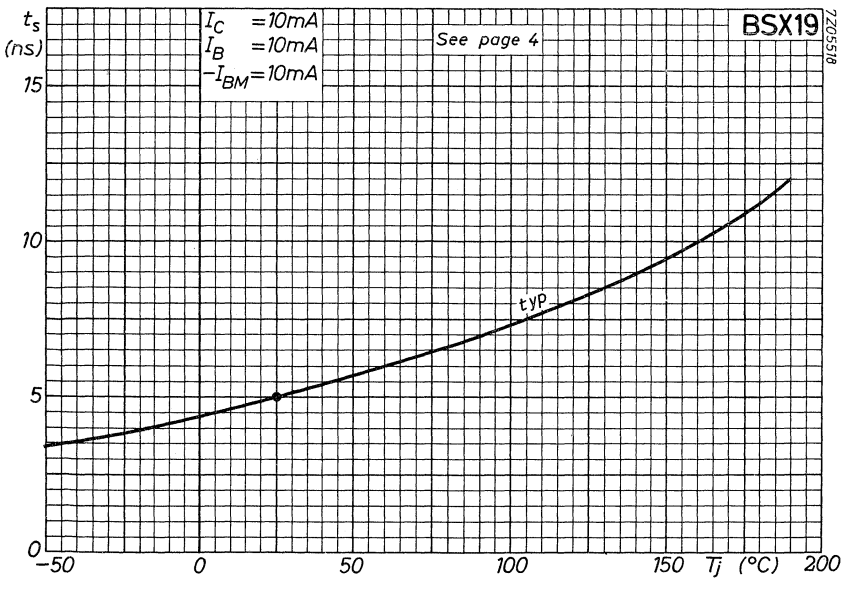
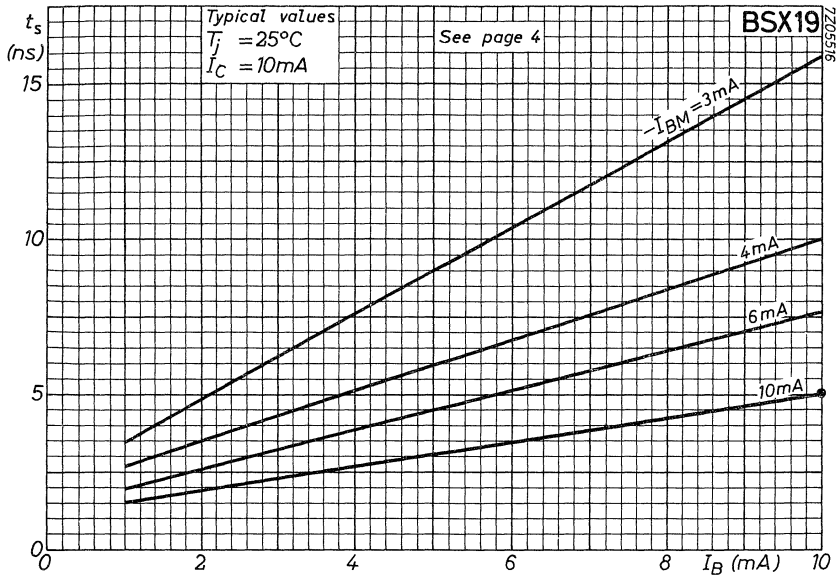
BSX 19
BSX 20

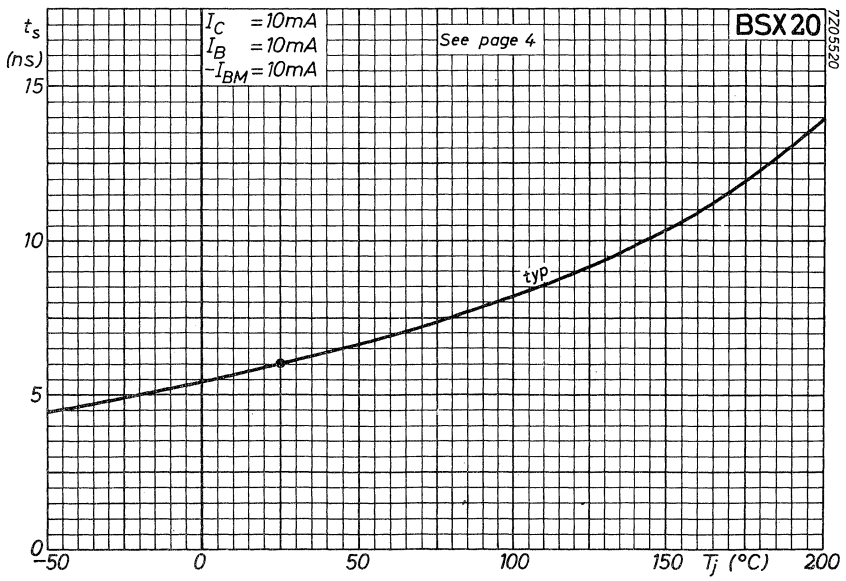
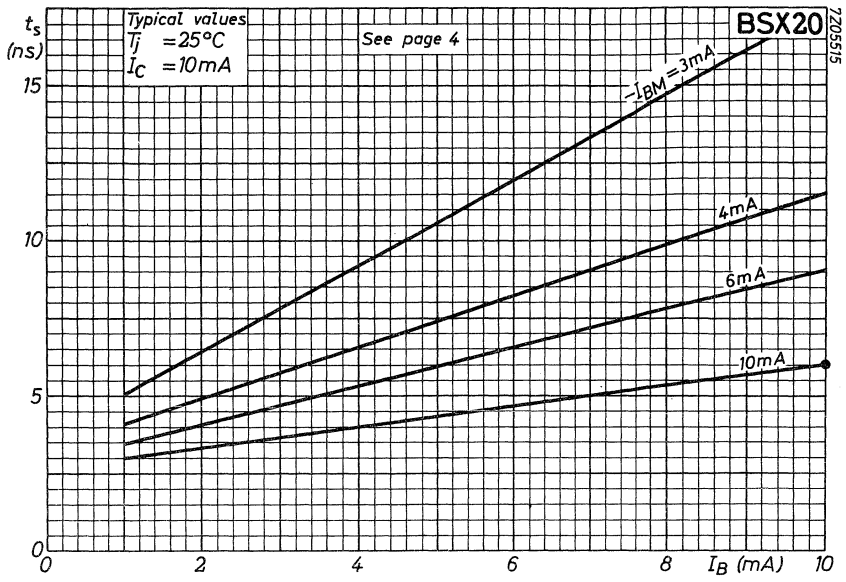






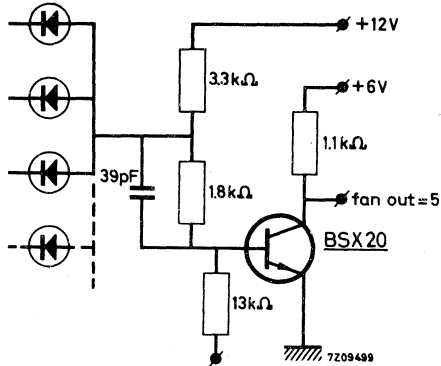






APPLICATION INFORMATION

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.

SILICON PLANAR EPITAXIAL 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.

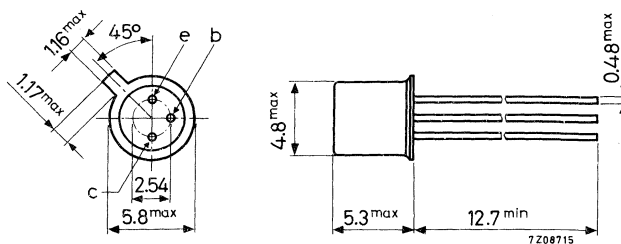
QUICK REFERENCE DATA		
Collector-base voltage (open emitter)	V_{CBO}	max. 120 V
Collector-emitter voltage (open base)	V_{CEO}	max. 80 V
Collector current (peak value)	I_{CM}	max. 250 mA
Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}$	P_{tot}	max. 300 mW
Junction temperature	T_j	max. 175 $^{\circ}\text{C}$
D.C. current gain at $T_j = 25\text{ }^{\circ}\text{C}$		
$I_C = 4\text{ mA}; V_{CE} = 1\text{ V}$	h_{FE}	> 20 typ. 80
Transition frequency at $f = 35\text{ MHz}$		
$I_C = 4\text{ mA}; V_{CE} = 10\text{ V}$	f_T	> 60 MHz
NOTE: The BSX21 may be operated in the breakdown region up to $V_{CE} = 160\text{ V}$, provided P_{tot} at $T_{amb} = 85\text{ }^{\circ}\text{C}$ does not exceed 100 mW.		

MECHANICAL DATA

Dimensions in mm

Collector connected to case

TO-18



Accessories available: 56246, 56263

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

Collector-base voltage (open emitter) $I_C = 100 \mu\text{A}$	V_{CBO}	max.	120 V ¹⁾
Collector-emitter voltage (open base) $I_C = 4 \text{ mA}$	V_{CEO}	max.	80 V ¹⁾
Emitter-base voltage (open collector) $I_E = 100 \mu\text{A}$	V_{EBO}	max.	5 V

Currents

Collector current (d.c. or average over any 20 ms period)	I_C	max.	100 mA
Collector current (peak value)	I_{CM}	max.	250 mA ²⁾
Emitter current (d.c. or average over any 20 ms period)	$-I_E$	max.	100 mA
Emitter current (peak value)	$-I_{EM}$	max.	250 mA

Power dissipation

Total power dissipation up to $T_{amb} = 25 \text{ }^\circ\text{C}$	P_{tot}	max.	300 mW
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Temperatures

Storage temperature	T_{stg}	-65 to +175 $^\circ\text{C}$
Junction temperature	T_j	max. 175 $^\circ\text{C}$

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th \text{ j-a}}$	=	0.5 $^\circ\text{C}/\text{mW}$
From junction to case	$R_{th \text{ j-c}}$	=	0.15 $^\circ\text{C}/\text{mW}$

1) The BSX21 may be operated in the breakdown region up to $V_{CE} = 160 \text{ V}$, provided P_{tot} at $T_{amb} = 85 \text{ }^\circ\text{C}$ does not exceed 100 mW.

2) The transistor can withstand a capacitive load of 500 pF, combined with a collector-base voltage of max. 150 V before switching on.

CHARACTERISTICS

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

Collector cut-off current

$I_E = 0; V_{CB} = 90\text{ V}$	I_{CBO}	typ. 1 nA < 200 nA
$I_E = 0; V_{CB} = 90\text{ V}; T_j = 150\text{ }^\circ\text{C}$	I_{CBO}	typ. 0.25 μA < 50 μA
$V_{BE} = 0; V_{CE} = 80\text{ V}; T_j = 85\text{ }^\circ\text{C}$	I_{CES}	typ. 0.01 μA < 20 μA

Emitter cut-off current

$I_C = 0; V_{EB} = 4\text{ V}$	I_{EBO}	typ. 0.5 nA < 200 nA
$I_C = 0; V_{EB} = 4\text{ V}; T_j = 150\text{ }^\circ\text{C}$	I_{EBO}	typ. 0.05 μA < 50 μA

Saturation voltages

$I_C = 4\text{ mA}; I_B = 400\text{ } \mu\text{A}$	V_{CEsat}	< 0.7 V
	V_{BEsat}	< 1.2 V

D.C. current gain

$I_C = 1\text{ mA}; V_{CE} = 1\text{ V}$	h_{FE}	typ. 60
$I_C = 4\text{ mA}; V_{CE} = 1\text{ V}$	h_{FE}	> 20 typ. 80
$I_C = 10\text{ mA}; V_{CE} = 1\text{ V}$	h_{FE}	typ. 82
$I_C = 20\text{ mA}; V_{CE} = 1\text{ V}$	h_{FE}	typ. 55

Collector capacitance at $f = 1\text{ MHz}$

$I_E = I_e = 0; V_{CB} = 10\text{ V}$	C_c	typ. 3.4 pF < 4.5 pF
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Emitter capacitance at $f = 1\text{ MHz}$

$I_C = I_c = 0; V_{EB} = 0.5\text{ V}$	C_e	typ. 12 pF < 17 pF
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Transition frequency at $f = 35\text{ MHz}$

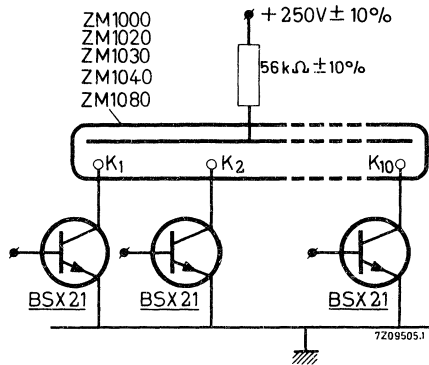
$I_C = 4\text{ mA}; V_{CE} = 10\text{ V}$	f_T	> 60 MHz typ. 160 MHz
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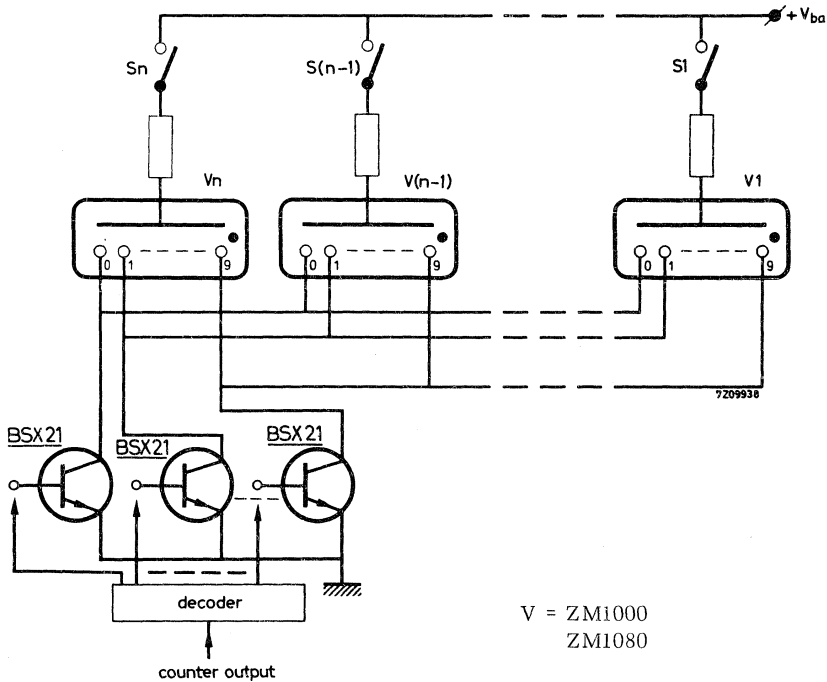
CHARACTERISTICS (continued)

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

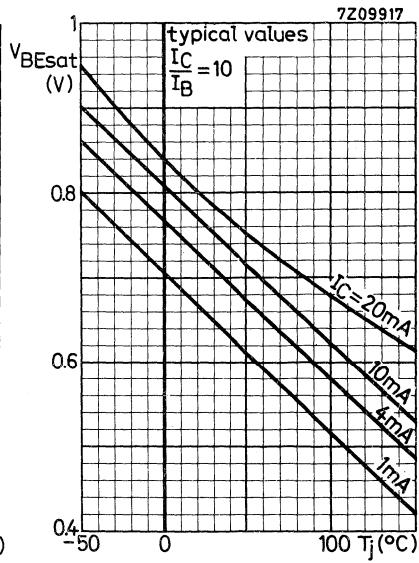
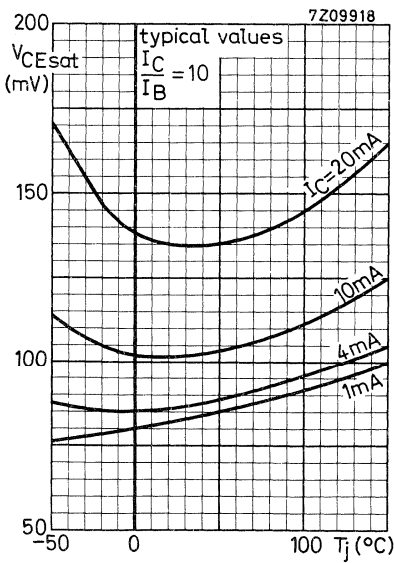
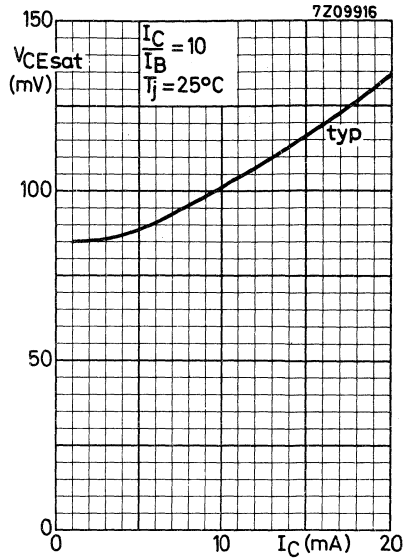
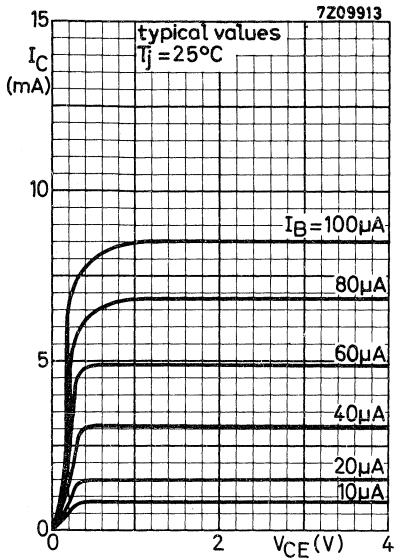
Practical circuit for static operation



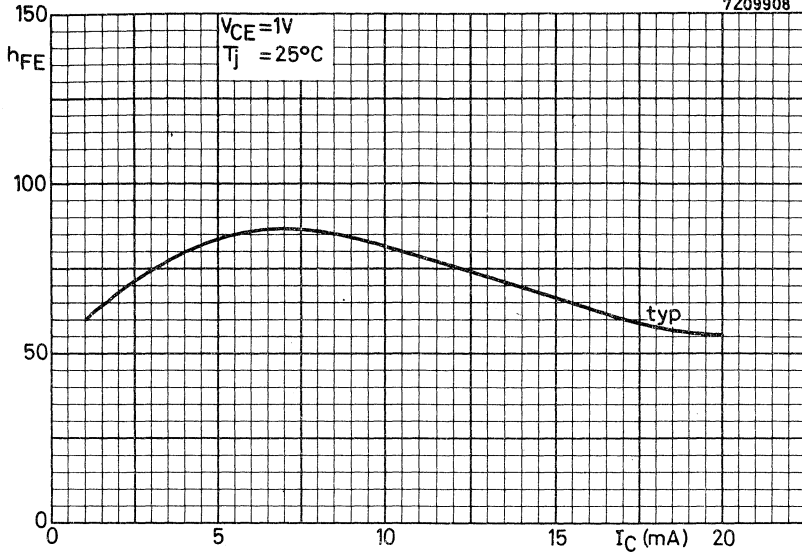
Practical circuit for dynamic operation



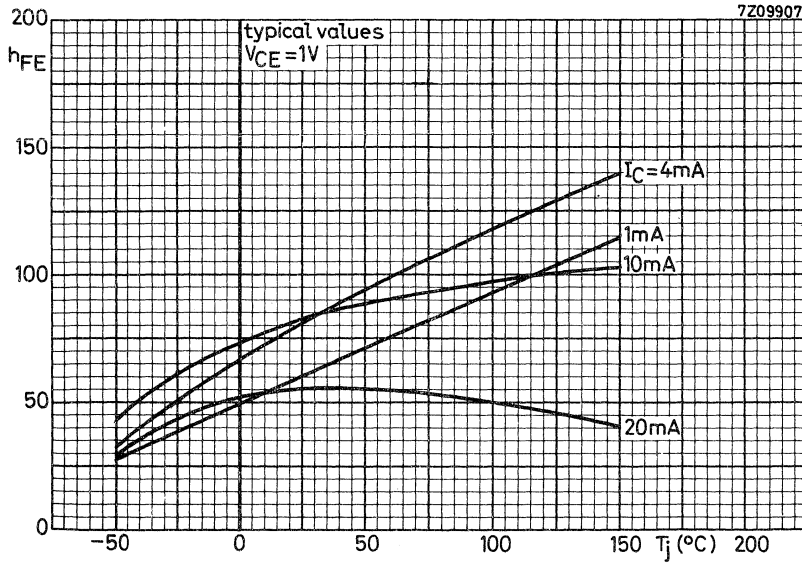
APPLICATION INFORMATION bulletins available on request

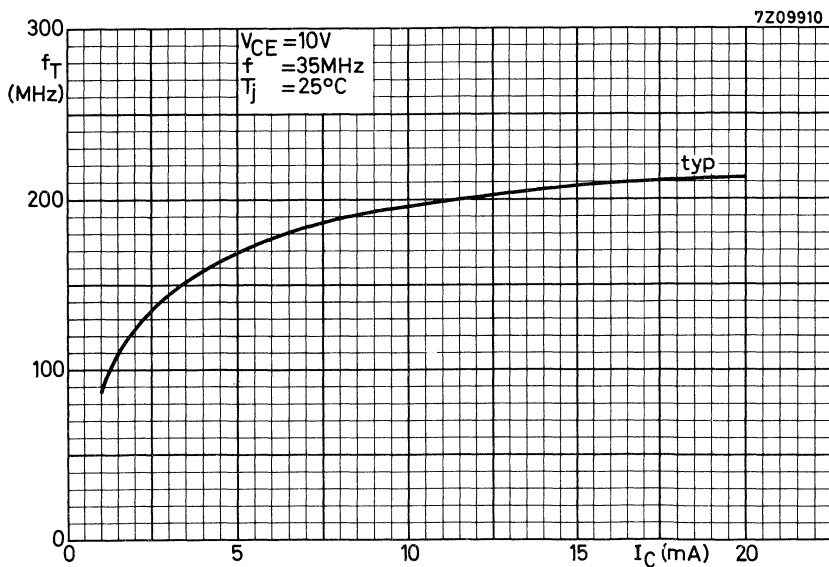
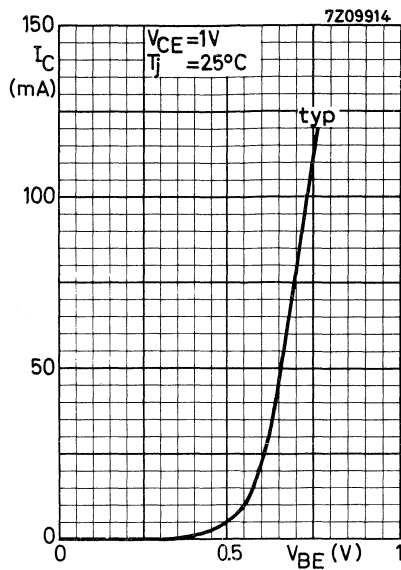
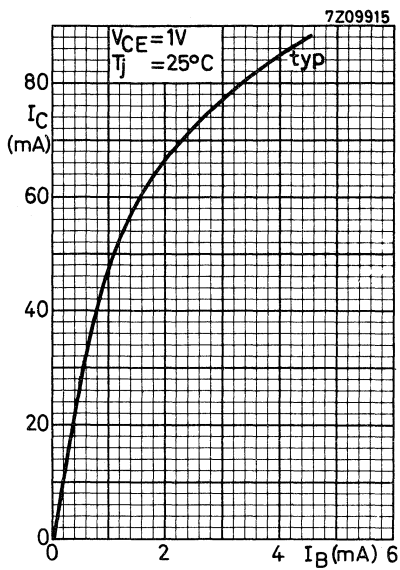


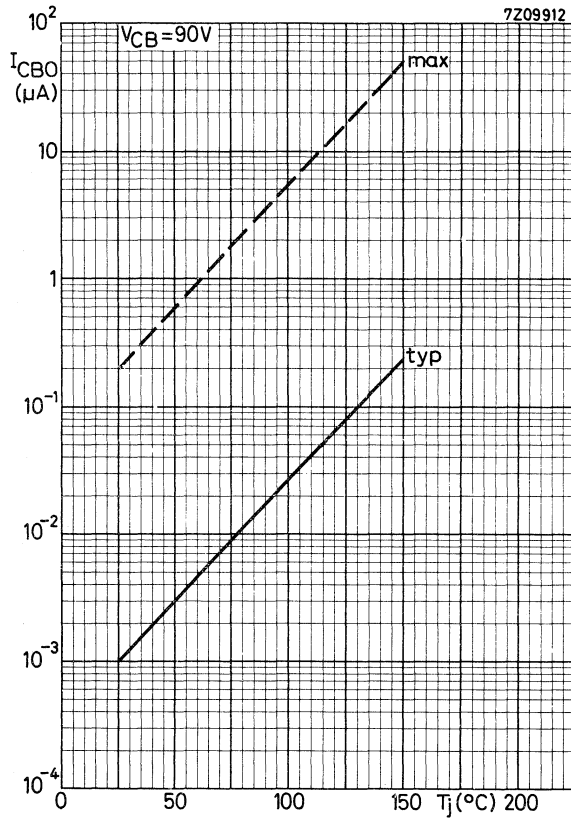
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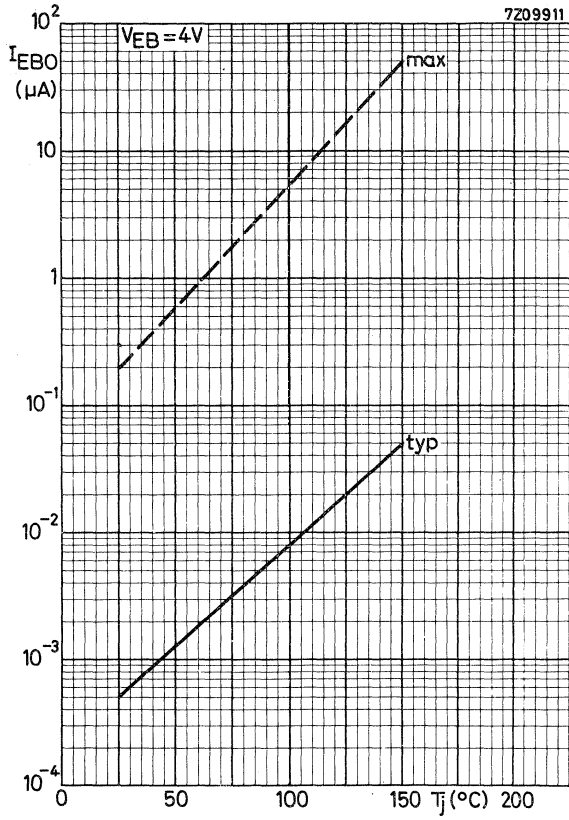


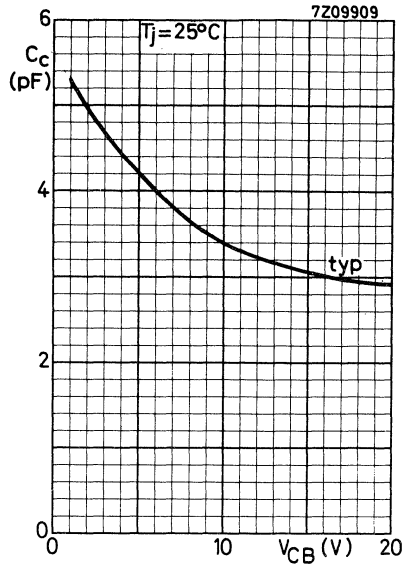
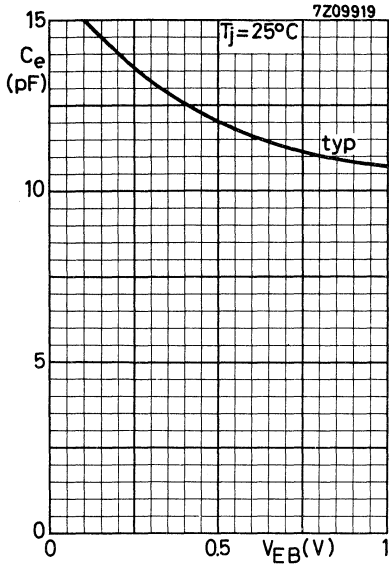
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SILICON PLANAR EPITAXIAL TRANSISTORS

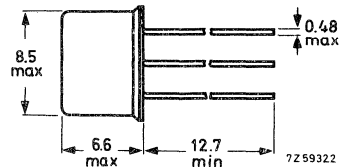
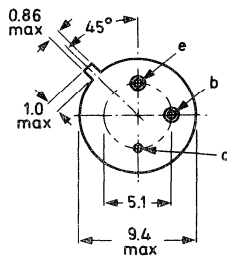
N-P-N transistors in a TO-39 metal envelope with the collector connected to the case. The BSX59, BSX60 and BSX61 are primarily intended for very high speed core-driving purposes.

QUICK REFERENCE DATA		BSX59	BSX60	BSX61
Collector-base voltage (open emitter)	V_{CBO} max.	70	70	70 V
Collector-emitter voltage (open base)	V_{CEO} max.	45	30	45 V
Collector current (peak value)	I_{CM} max.	1	1	1 A
Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}$	P_{tot} max.	0.8	0.8	0.8 W
Junction temperature	T_j max.	200	200	200 $^{\circ}\text{C}$
D.C. current gain $I_C = 500\text{ mA}; V_{CE} = 1\text{ V}$	$h_{FE} >$	30	30	30
Saturation voltage $I_C = 500\text{ mA}; I_B = 50\text{ mA}$	$V_{CEsat} <$	0.5	0.5	0.7 V
Transition frequency $I_C = 50\text{ mA}; V_{CE} = 10\text{ V}$	f_T typ.	450	475	475 MHz
Turn off time $I_C = 500\text{ mA}; I_B = 50\text{ mA}$	$t_{off} <$	60	70	100 ns

MECHANICAL DATA

Dimensions in mm

Collector connected to case.
TO-39



max. lead diameter is guaranteed only for 12.7 mm

Accessories available: 56218; 56245; 56265.

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

Voltages

		BSX59	BSX60	BSX61	
Collector-base voltage (open emitter)	V_{CBO}	max. 70	70	70	V
Collector-emitter voltage (open base) $I_C = 10 \text{ mA}$	V_{CEO}	max. 45	30	45	V
Emitter-base voltage (open collector)	V_{EBO}	max. 5	5	5	V

Currents

Collector current (d.c.)	I_C	max.	1	A
Collector current (peak value)	I_{CM}	max.	1	A
Emitter current (peak value)	$-I_{EM}$	max.	1	A

Power dissipation

Total power dissipation up to $T_{amb} = 25 \text{ }^\circ\text{C}$	P_{tot}	max.	0.8	W
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Temperatures

Storage temperature	T_{stg}	-65 to +200	$^\circ\text{C}$
Junction temperature	T_j	max. 200	$^\circ\text{C}$

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th j-a}$	=	220	$^\circ\text{C}/\text{W}$
From junction to case	$R_{th j-c}$	=	43	$^\circ\text{C}/\text{W}$
From junction to mounting base	$R_{th j-mb}$	=	35	$^\circ\text{C}/\text{W}$

CHARACTERISTICS

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

		BSX59	BSX60	BSX61
<u>Collector cut-off current</u>				
$I_E = 0; V_{CB} = 40\text{ V}$	$I_{CBO} <$	500	500	500 nA
$I_E = 0; V_{CB} = 40\text{ V}; T_j = 150\text{ }^\circ\text{C}$	$I_{CBO} <$	300	300	300 μA
<u>Emitter cut-off current</u>				
$I_C = 0; V_{EB} = 4\text{ V}$	$I_{EBO} <$	300	300	500 nA
$I_C = 0; V_{EB} = 4\text{ V}; T_j = 150\text{ }^\circ\text{C}$	$I_{EBO} <$	50	50	50 μA
<u>Currents at reverse biased emitter junction</u>				
$-V_{BE} = 4\text{ V}; V_{CE} = 40\text{ V}$	$+I_{CEX} <$	500	500	1000 nA
	$-I_{BEX} <$	500	500	1000 nA
$-V_{BE} = 4\text{ V}; V_{CE} = 40\text{ V}; T_j = 150\text{ }^\circ\text{C}$	$+I_{CEX} <$	300	300	500 μA
	$-I_{BEX} <$	300	300	500 μA
<u>Saturation voltages</u>				
$I_C = 150\text{ mA}; I_B = 15\text{ mA}$	$V_{CEsat} <$	0.3	0.3	0.5 V
	$V_{BEsat} <$	1.0	1.0	1.0 V
$I_C = 500\text{ mA}; I_B = 50\text{ mA}$	$V_{CEsat} <$	0.5	0.5	0.7 V
	$V_{BEsat} >$	0.85	0.7	0.7 V
$I_C = 1\text{ A}; I_B = 100\text{ mA}$	$V_{CEsat} <$	1.2	1.3	1.3 V
	$V_{BEsat} <$	1.8	1.8	1.8 V
<u>D.C. current gain</u>				
$I_C = 150\text{ mA}; V_{CE} = 1\text{ V}$	$h_{FE} >$	30	30	30
	typ.	70	90	105
$I_C = 500\text{ mA}; V_{CE} = 1\text{ V}$	$h_{FE} >$	30	30	30
	<	90	90	90
$I_C = 1\text{ A}; V_{CE} = 5\text{ V}$	$h_{FE} >$	20	25	20
	typ.	40	50	55
<u>Transition frequency</u>				
$I_C = 50\text{ mA}; V_{CE} = 10\text{ V}$	$f_T >$	250	250	250 MHz
	typ.	450	475	475 MHz
<u>Collector capacitance at $f = 1\text{ MHz}$</u>				
$I_E = I_e = 0; V_{CB} = 10\text{ V}$	C_c typ.	6	6	6 pF
	<	10	10	10 pF
<u>Emitter capacitance at $f = 1\text{ MHz}$</u>				
$I_C = I_c = 0; V_{EB} = 0.5\text{ V}$	C_e typ.	36	36	36 pF
	<	50	50	50 pF



CHARACTERISTICS (continued)

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

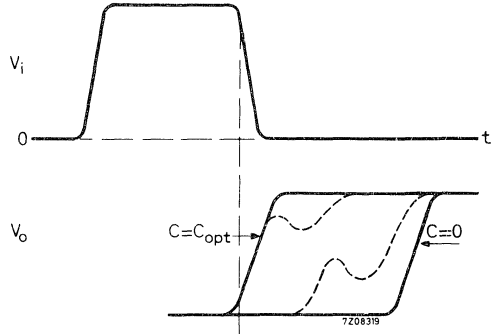
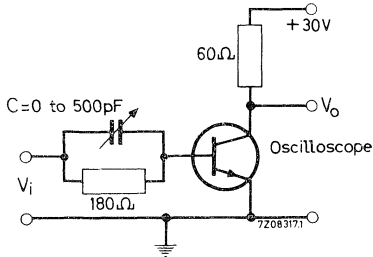
Recovered charge

$I_C = 500\text{ mA}; I_B = 50\text{ mA}$

BSX60

$Q_S < 5\text{ nC}$

Test circuit:



Adjust C from zero to C_{opt}

$$Q_S = C_{opt} \cdot V_i$$

Pulse generator:

Pulse duration $t_p = 10\ \mu\text{s}$

Duty cycle $\delta = 0.02$

CHARACTERISTICS (continued)

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

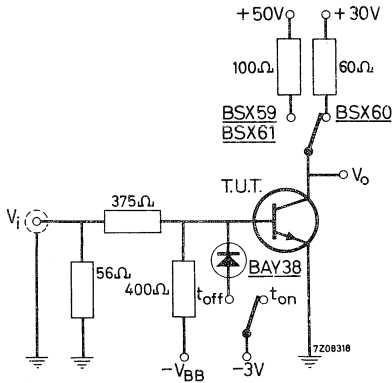
Switching times (see also page 10)

Turn on time when switched from $-V_{BE} = 2\text{ V}$ to $I_C = 500\text{ mA}$; $I_B = 50\text{ mA}$

Turn off time when switched from $I_C = 500\text{ mA}$; $I_B = 50\text{ mA}$ to cut-off with $-I_{BM} = 50\text{ mA}$ ¹⁾

		BSX59	BSX60	BSX61
t_{on}	typ.	17	17	18 ns
	<	35	40	50 ns
t_{off}	typ.	45	58	70 ns
	<	60	70	100 ns

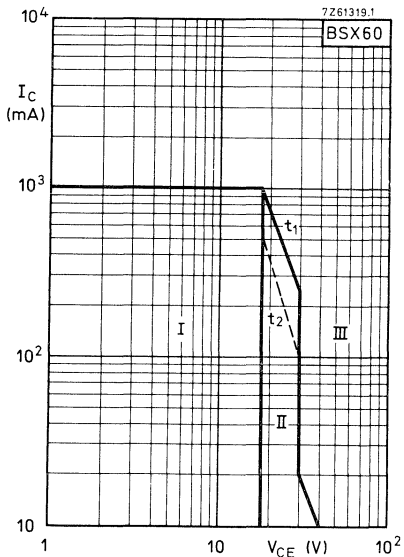
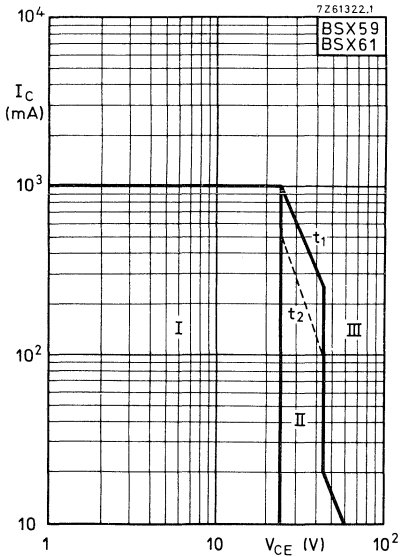
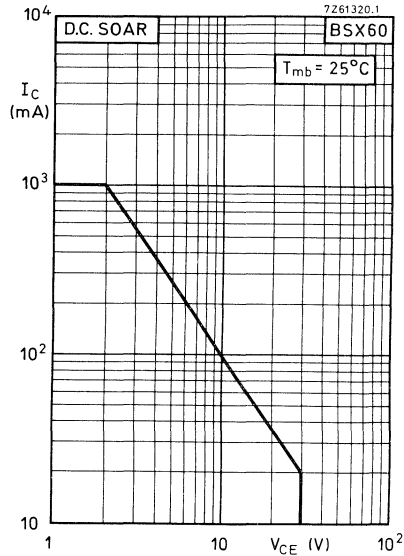
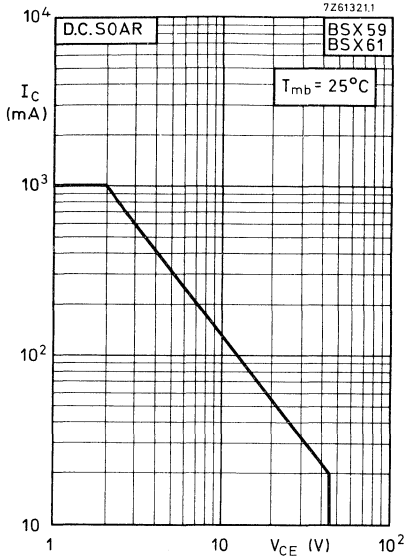
Test circuit:



	t_{on}	t_{off}
V_{BB}	4	16.7 V
V_i	24.75	37.5 V

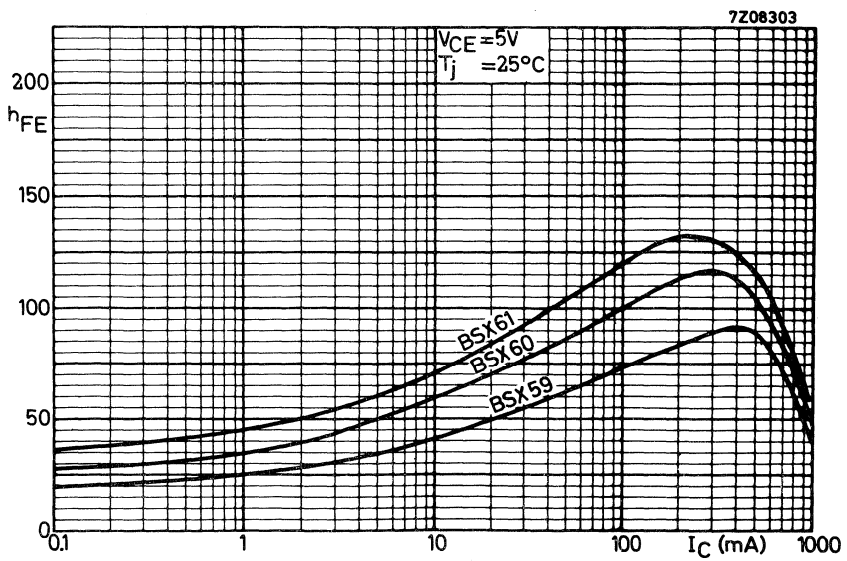
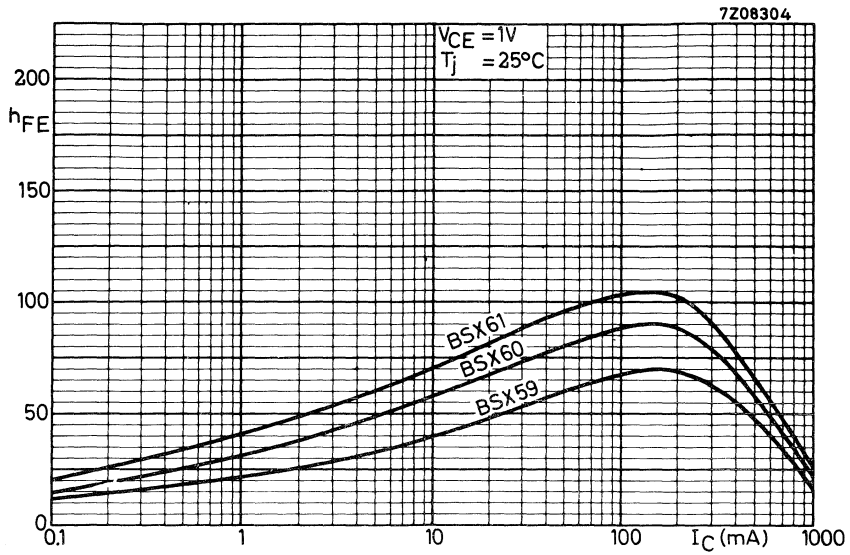
- Pulse generator: Pulse duration $t_p \geq 500\text{ ns}$
 Rise time $t_r \leq 5\text{ ns}$
 Fall time $t_f \leq 5\text{ ns}$
 Output resistance $R_o = 50\text{ }\Omega$ (during pulse, otherwise infinite)

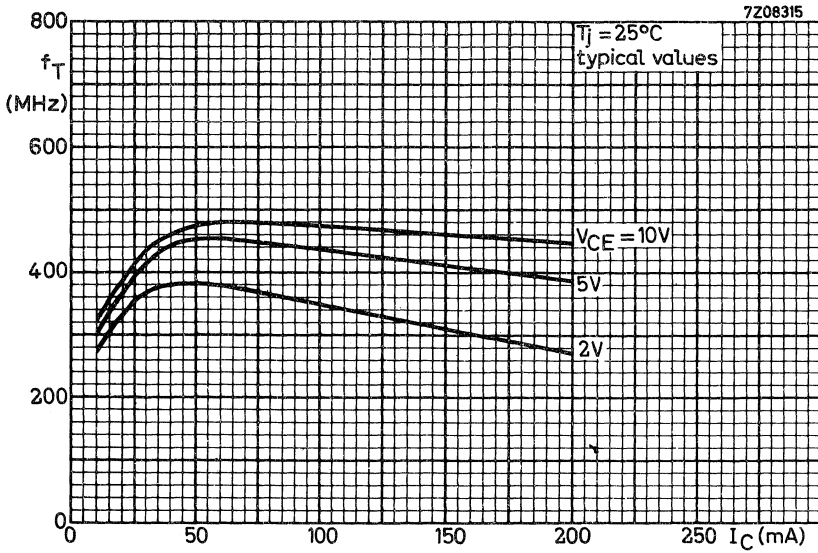
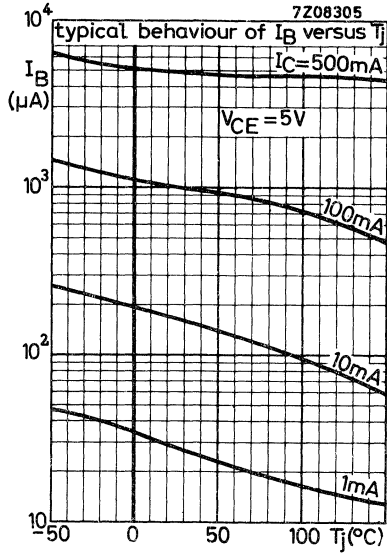
¹⁾ $-I_{BM}$ is the reverse current that can flow during switching off. The indicated $-I_{BM}$ is determined and limited by the applied cut-off voltage and the series resistance.



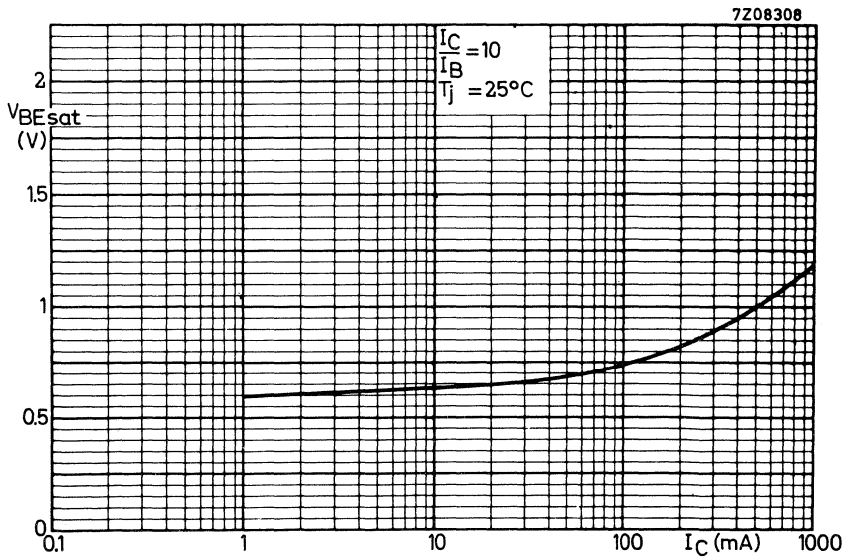
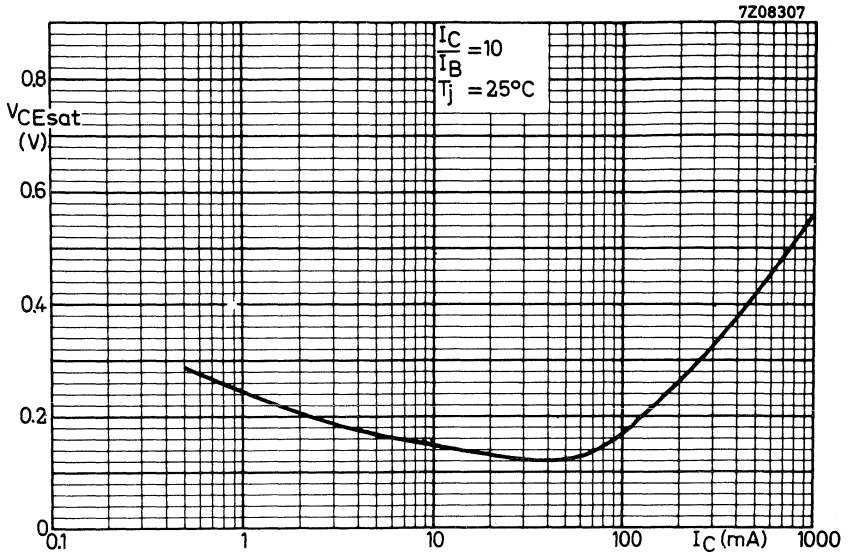
- I Region of permissible operation during switching off with $-V_{BB} = 4 \text{ V}$; $R_{BE} = 39 \Omega$
- II Permissible extension for repetitive pulsed operation.
- t_1 limits operations with $t_p \leq 0.1 \mu\text{s}$; $\delta = 0.25$
- t_2 limits operations with $t_p \leq 1 \mu\text{s}$; $\delta = 0.25$
- III Operation in this area is not allowed.

Typical behaviour of d.c. current gain versus I_C

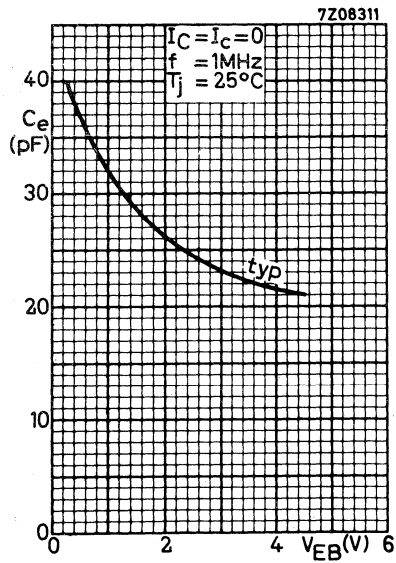
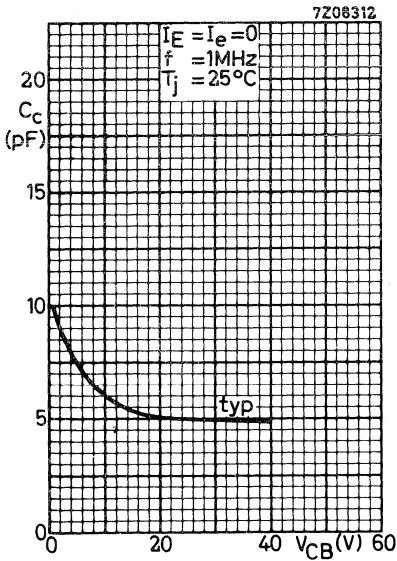
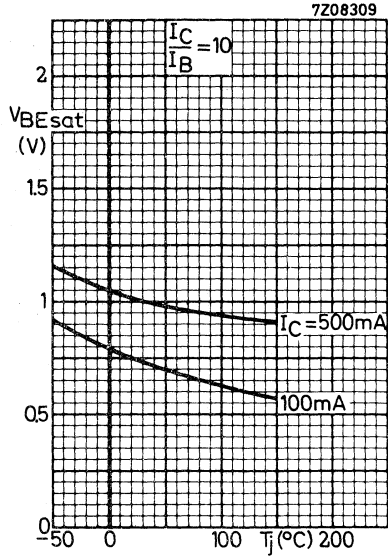
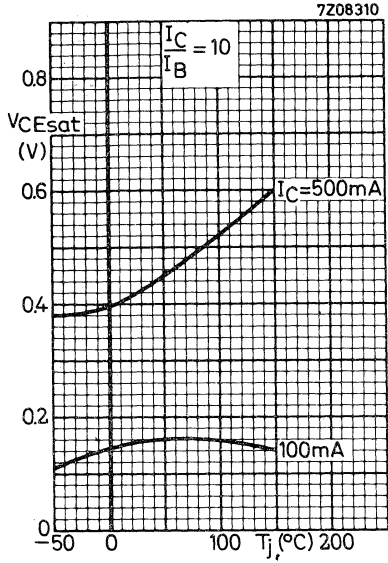


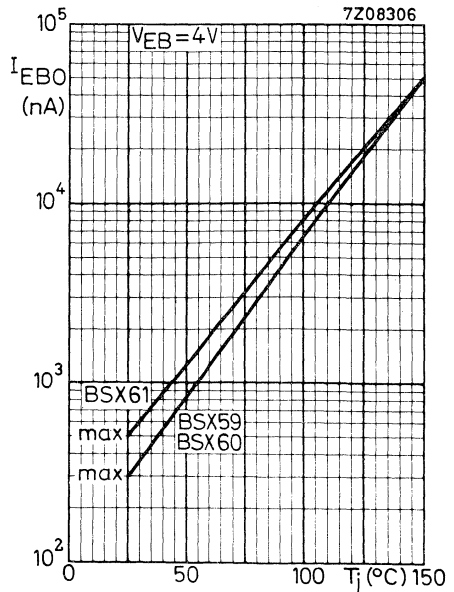
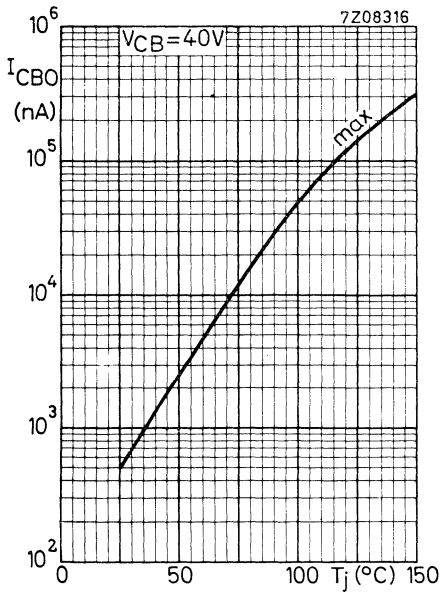
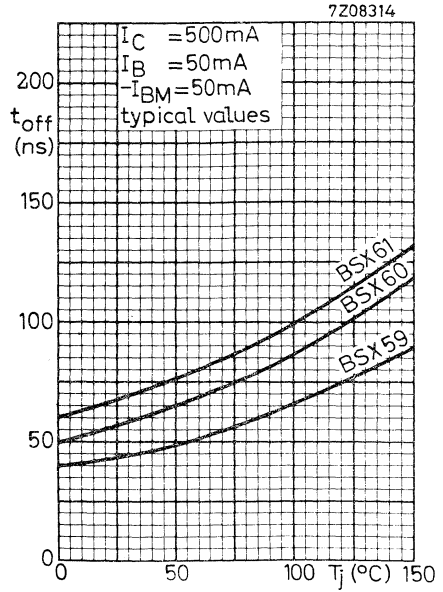
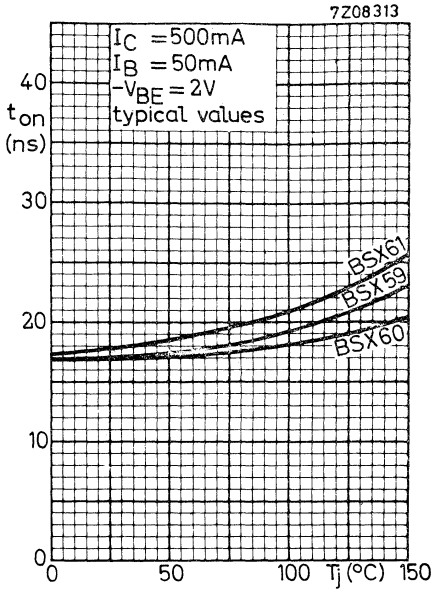


Typical behaviour of saturation voltages versus I_C



Typical behaviour of saturation voltages versus T_j





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 BSY38 and BSY39 are primarily intended for very high speed saturated switching and general purposes.

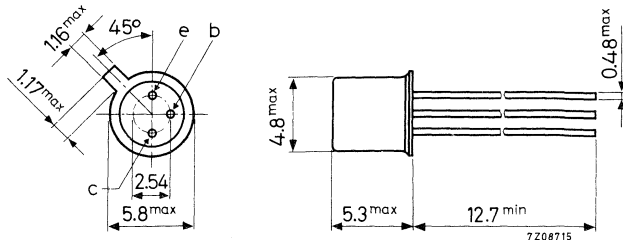
QUICK REFERENCE DATA			
		BSY38	BSY39
Collector-base voltage (open emitter)	V_{CBO}	max. 20	20 V
Collector-emitter voltage ($V_{BE} \leq 0$)	V_{CEX}	max. 15	15 V
Collector current (peak value)	I_{CM}	max. 200	200 mA
Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}$	P_{tot}	max. 300	300 mW
D. C. current gain at $T_j = 25\text{ }^{\circ}\text{C}$			
$I_C = 10\text{ mA}; V_{CE} = 0.35\text{ V}$	h_{FE}	30 to 60	40 to 120
$I_C = 100\text{ mA}; V_{CE} = 1\text{ V}$	h_{FE}	15 to 45	20 to 70
Transition frequency			
$I_C = 10\text{ mA}; V_{CE} = 2\text{ V}$	f_T	typ. 350	350 MHz
Storage time			
$I_C = I_B = -I_{BM} = 10\text{ mA}$	t_s	typ. 8	8 ns

MECHANICAL DATA

Dimensions in mm

Collector connected to case

TO-18



Accessories available: 56246, 56263.

RATINGS (Limiting values) ¹⁾

Voltages

Collector-base voltage (open emitter)	V_{CBO}	max.	20 V
Collector-emitter voltage ($V_{BE} \leq 0$)	V_{CEX}	max.	15 V
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.	100 mA
Collector current (peak value)	I_{CM}	max.	200 mA

Power dissipation

Total power dissipation up to $T_{amb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	300 mW
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Temperatures

Storage temperature	T_{stg}	-65 to +175	$^\circ\text{C}$
Junction temperature	T_j	max.	175 $^\circ\text{C}$

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	0.50 $^\circ\text{C}/\text{mW}$
From junction to case	$R_{th\ j-c}$	=	0.15 $^\circ\text{C}/\text{mW}$

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

CHARACTERISTICS

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

Collector cut-off current

$I_E = 0; V_{CB} = 20\text{ V}$	I_{CBO}	<	100 nA
$I_E = 0; V_{CB} = 20\text{ V}; T_j = 150\text{ }^\circ\text{C}$	I_{CBO}	<	10 μA
$V_{BE} = 0; V_{CE} = 15\text{ V}; T_j = 55\text{ }^\circ\text{C}$	I_{CES}	<	0.40 μA

Emitter cut-off current

$I_C = 0; V_{EB} = 5\text{ V}$	I_{EBO}	<	500 nA
$I_C = 0; V_{EB} = 5\text{ V}; T_j = 150\text{ }^\circ\text{C}$	I_{EBO}	<	10 μA

Currents at reverse biased emitter junction

$V_{CE} = 15\text{ V}; -V_{BE} = 3\text{ V}; T_j = 55\text{ }^\circ\text{C}$	$-I_{BEX}$	<	0.60 μA
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Sustaining voltages

$I_C = 10\text{ mA}; I_B = 0$	$V_{CEO\text{sust}}$	>	12 V
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Base-emitter voltage (see also page 9)

$I_C = 30\text{ }\mu\text{A}; V_{CE} = 10\text{ V}; T_j = 100\text{ }^\circ\text{C}$	V_{BE}	>	0.35 V
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Saturation voltages

$I_C = 10\text{ mA}; I_B = 1\text{ mA}$	$V_{CE\text{sat}}$	<	0.25 V
	$V_{BE\text{sat}}$		0.70 to 0.85 V
$I_C = 100\text{ mA}; I_B = 10\text{ mA}$	$V_{CE\text{sat}}$	<	0.60 V
	$V_{BE\text{sat}}$	<	1.50 V

Collector capacitance at $f = 1\text{ MHz}$

$I_E = I_e = 0; V_{CB} = 5\text{ V}$	C_c	<	5 pF
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Emitter capacitance at $f = 1\text{ MHz}$

$I_C = I_c = 0; V_{EB} = 1\text{ V}$	C_e	<	6 pF
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CHARACTERISTICS (continued)

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

D.C. current gain

$I_C = 10\text{ mA}; V_{CE} = 0.35\text{ V}$

$I_C = 100\text{ mA}; V_{CE} = 1\text{ V}$

	BSY38	BSY39
h_{FE}	30 to 60	40 to 120
h_{FE}	15 to 45	20 to 70

Transition frequency

$I_C = 10\text{ mA}; V_{CE} = 2\text{ V}$

f_T	> 200	MHz
	typ. 350	MHz

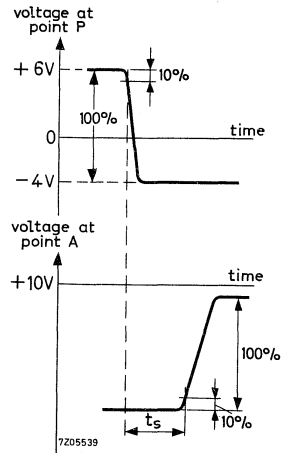
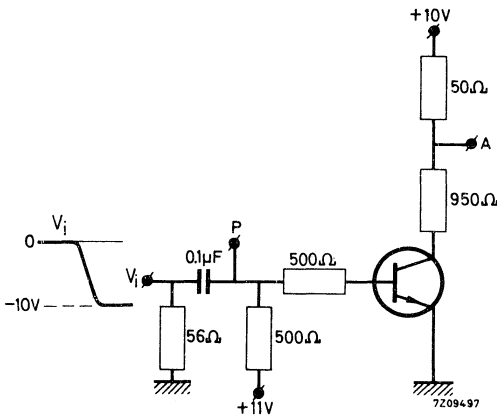
Switching times

Storage time (see also page 12)

$I_C = I_B = -I_{BM} = 10\text{ mA}$

t_s	typ. 8	ns
	< 16	ns

Test circuit:



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.

CHARACTERISTICS (continued)

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

Switching times

Turn on time (see also page 13)

when switched from $-V_{BE} = 2.25\text{ V}$ to

$I_C = 100\text{ mA}$; $I_B = 40\text{ mA}$ with $-I_{BM} = 20\text{ mA}$

$-V_{BB} = 4.5\text{ V}$; $V_{CC} = 6\text{ V}$; $V_i = 20\text{ V}$

t_{on} typ. 9 ns
 < 14 ns

Turn off time (see also page 13)

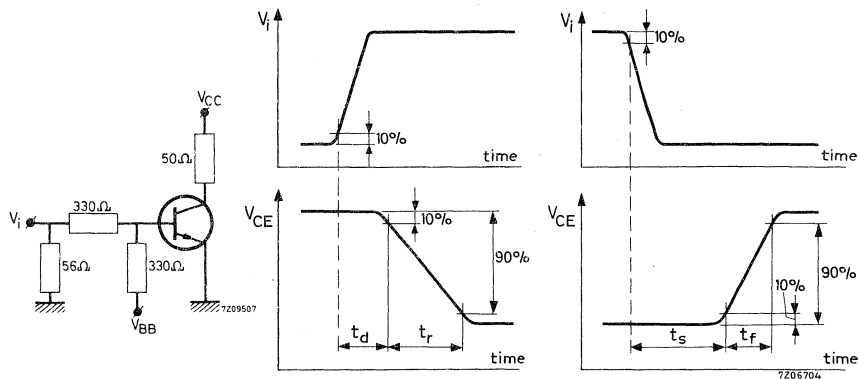
when switched from $I_C = 100\text{ mA}$; $I_B = 40\text{ mA}$

to cut-off with $-I_{BM} = 20\text{ mA}$

$V_{BB} = 15.3\text{ V}$; $V_{CC} = 6\text{ V}$; $-V_i = 20\text{ V}$

t_{off} typ. 25 ns
 < 45 ns

Test circuit:



Pulse generator:

Rise time $t_r < 1\text{ ns}$

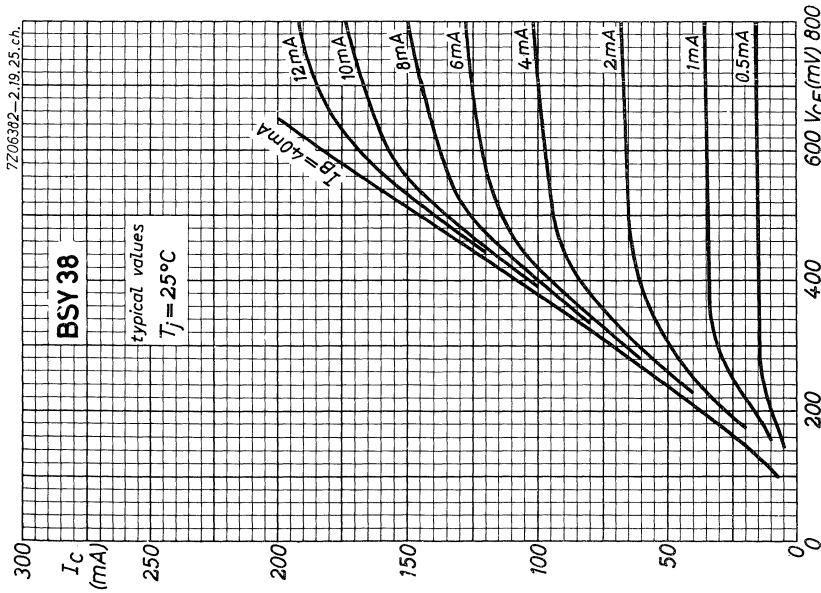
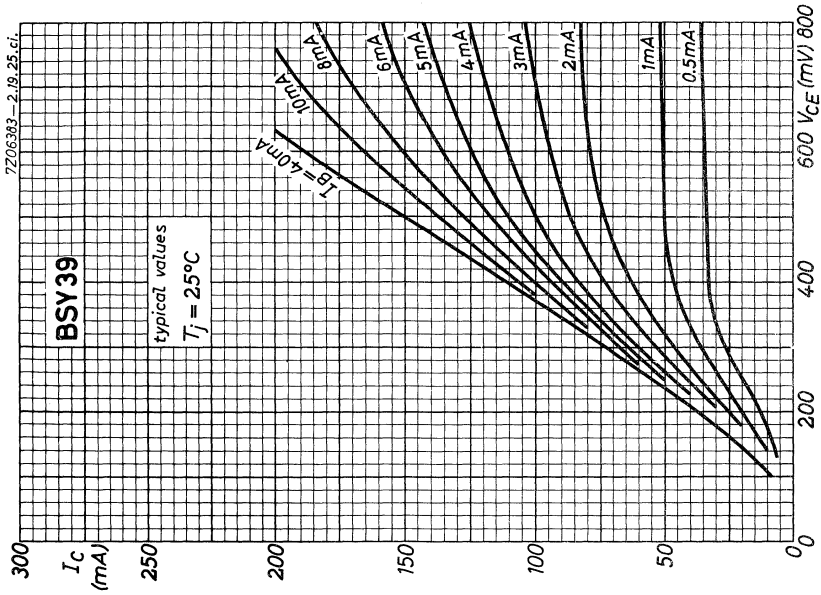
Pulse duration $t > 60\text{ ns}$

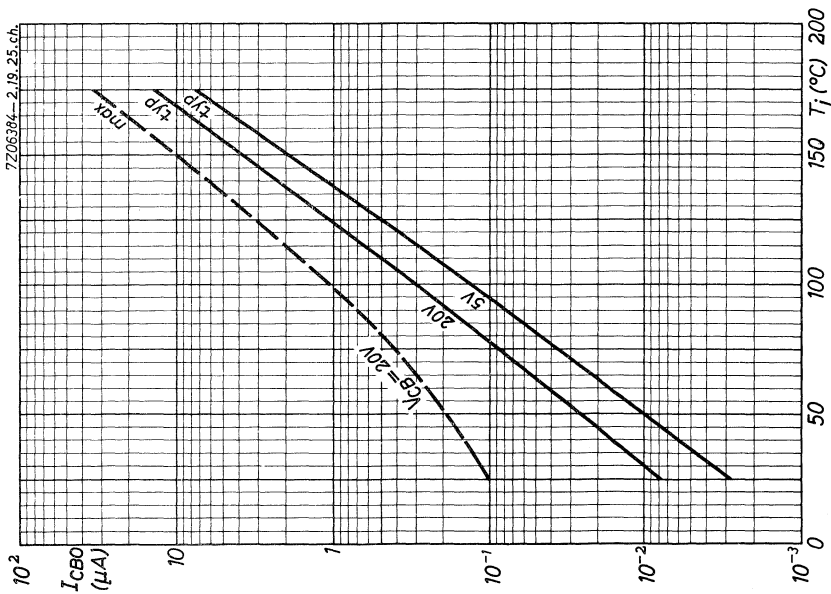
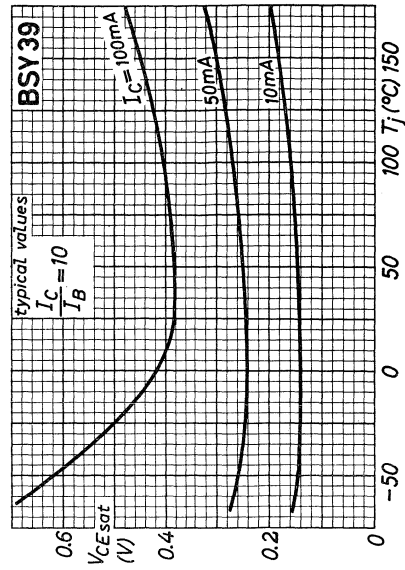
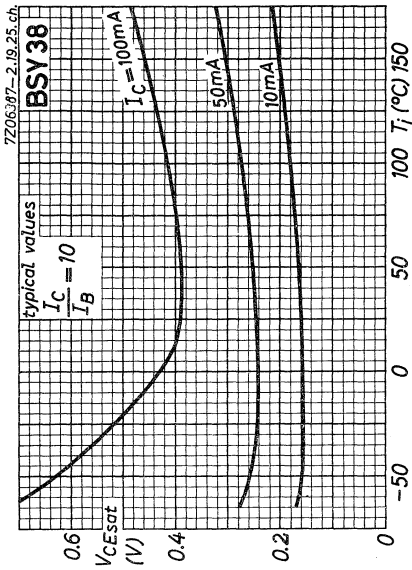
Duty cycle $\delta < 0.02$

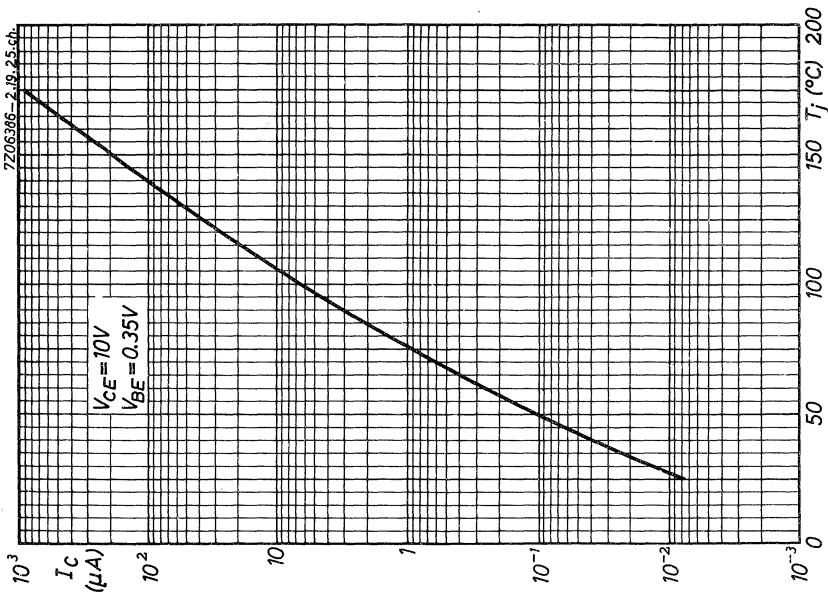
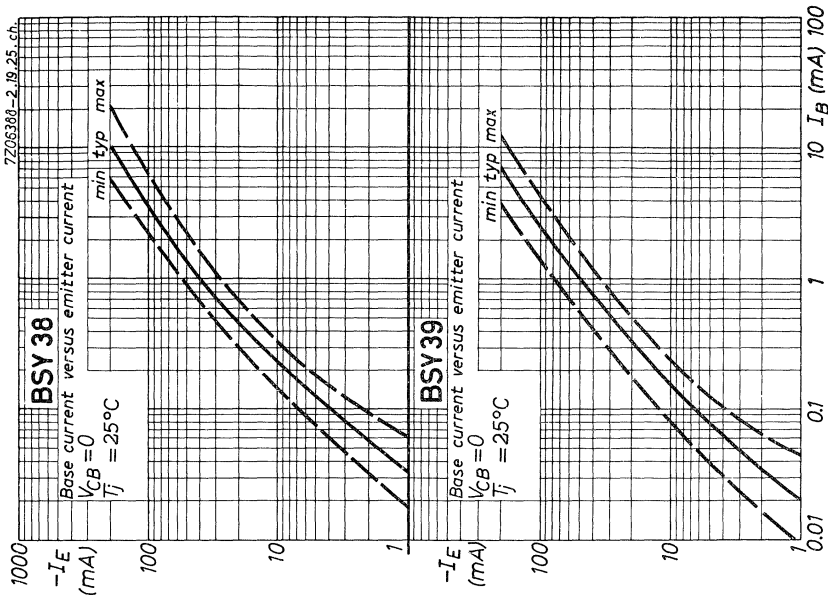
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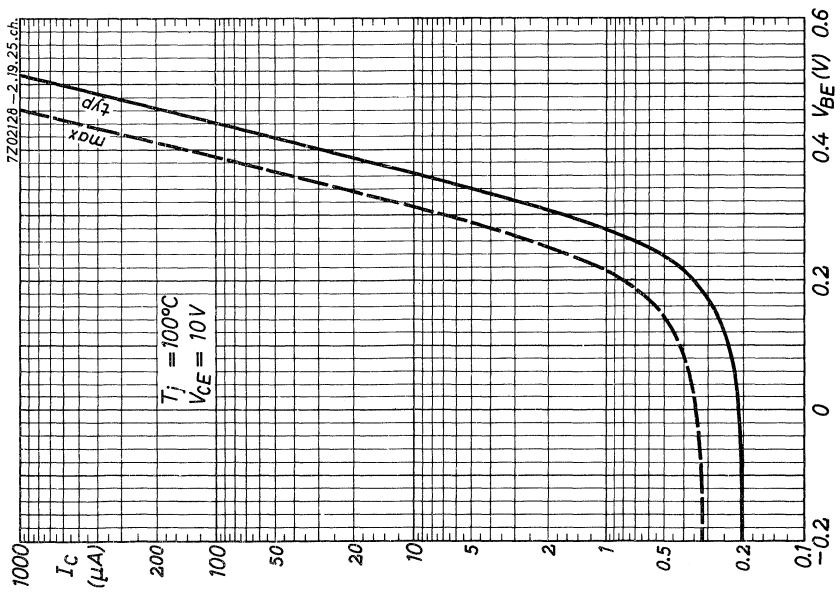
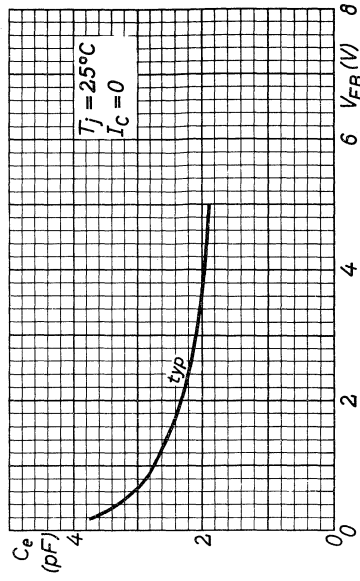
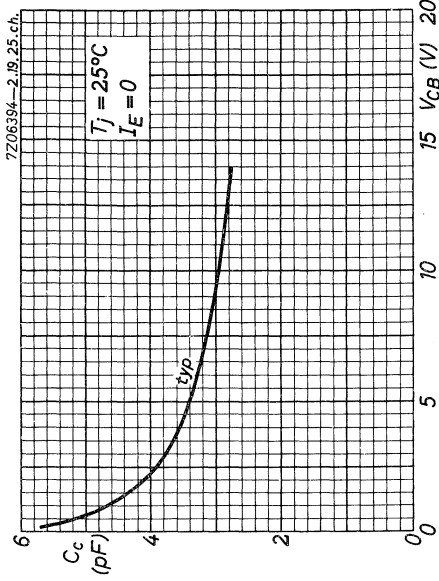
$-I_{BM}$ is the reverse current that can flow during switching off. The indicated $-I_{BM}$ is determined and limited by the applied cut-off voltage and series resistance.

BSY38
BSY39

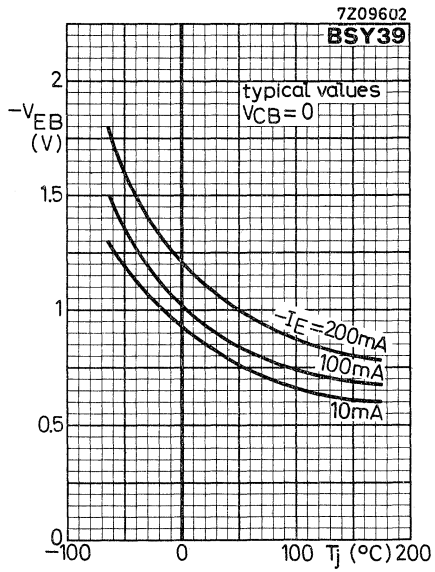
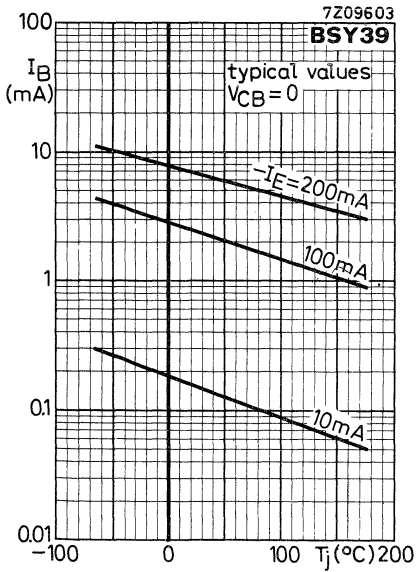
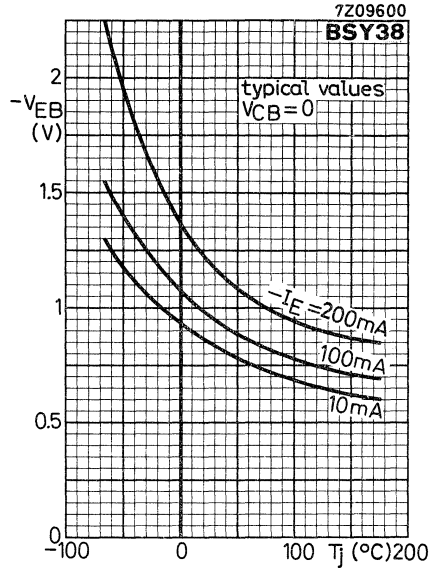
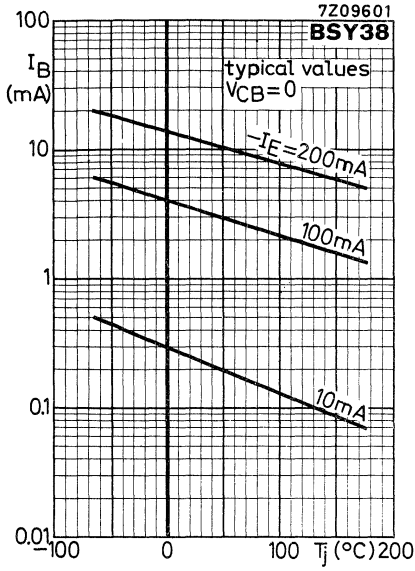


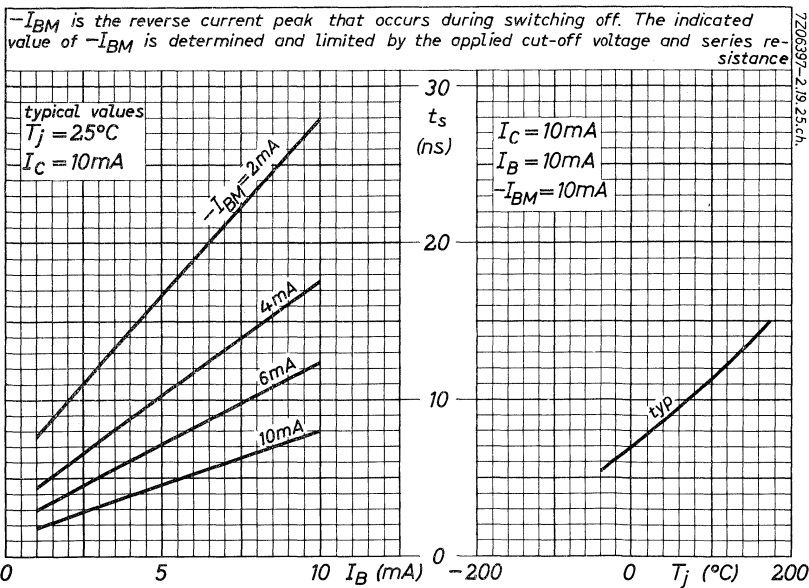
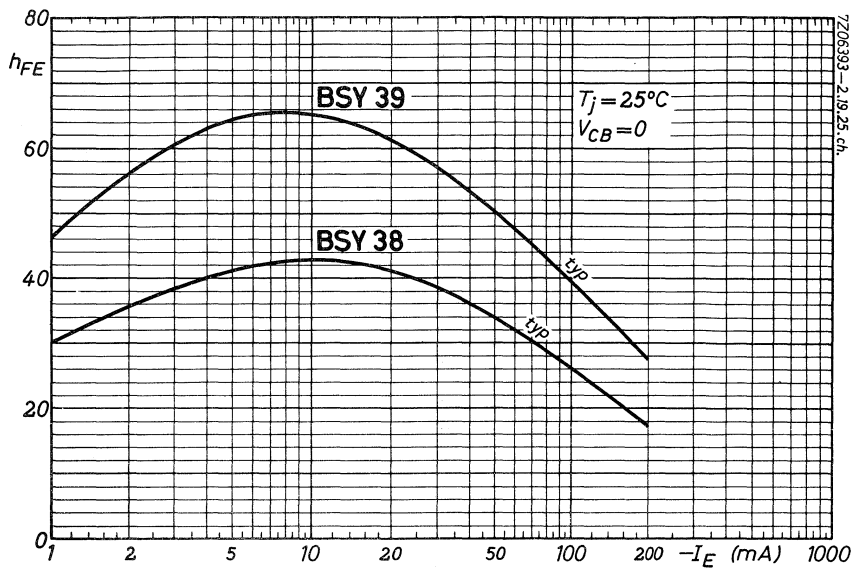


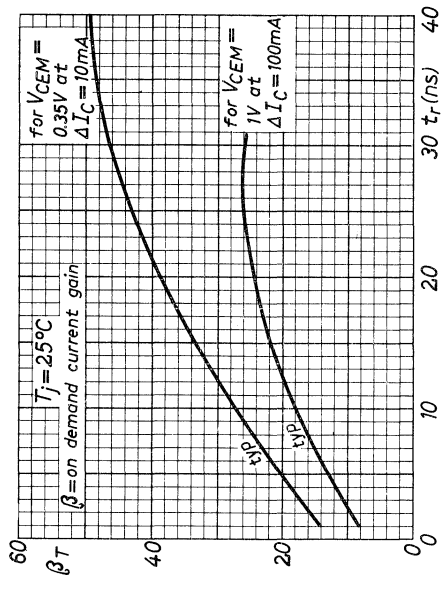
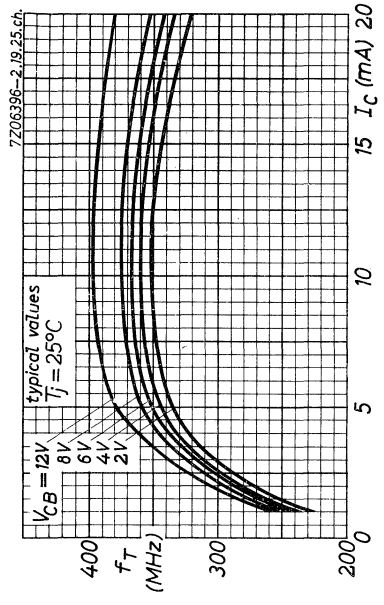


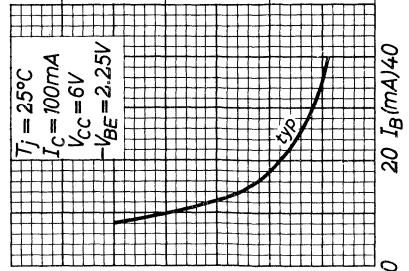
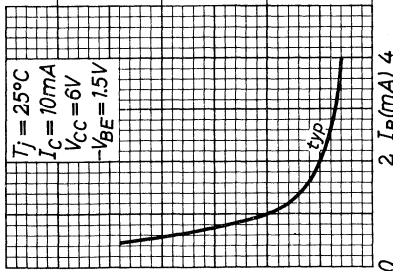
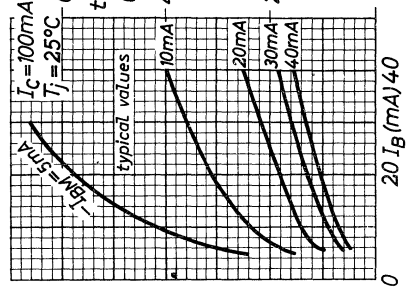
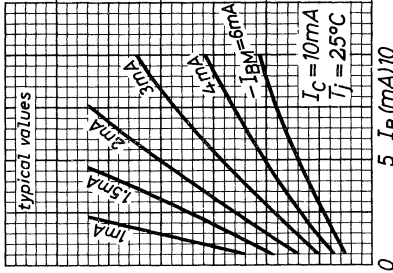
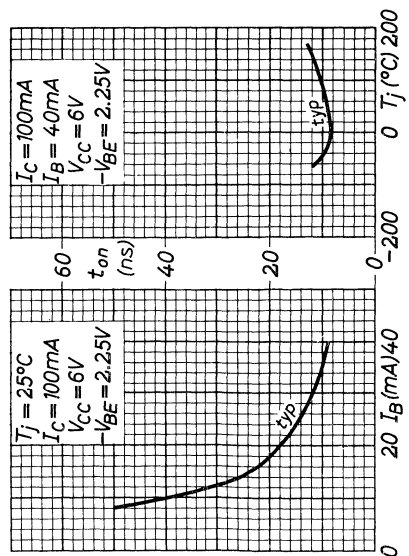
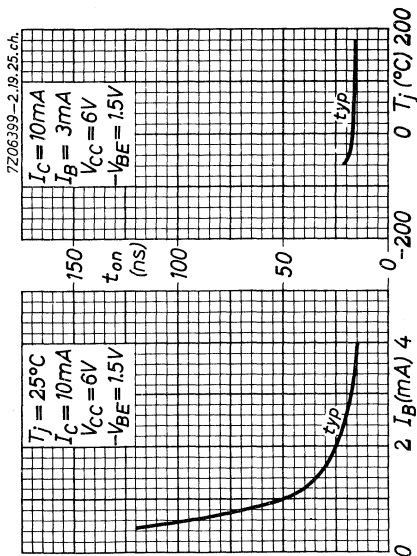
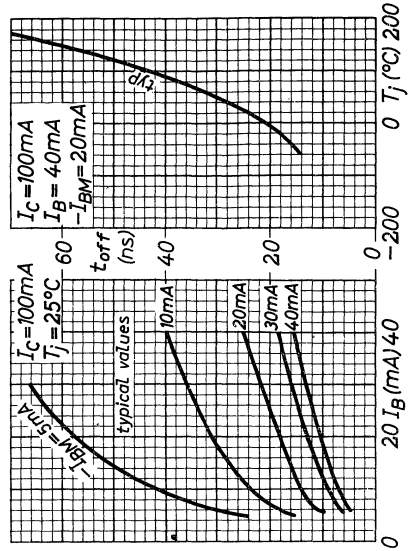
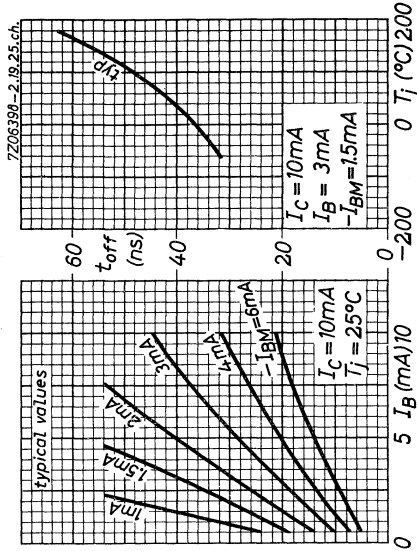


BSY38
BSY39



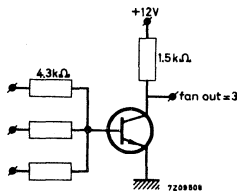






APPLICATION INFORMATION

NOR gate circuit (Resistor Transistor Logic)



Delay time per stage

fan in = 3

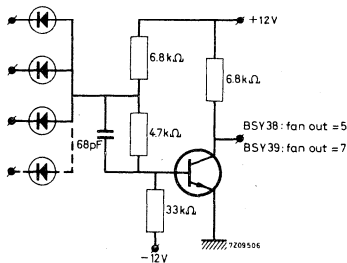
t_d typ. 60 ns

Note

Fan out = 3 means: The circuit may be loaded by maximum 3 circuits, each presenting a load identical to that of one input branch of the circuit itself.

The fan in and fan out figures have been calculated for worst case conditions.

NAND gate circuit (Diode Transistor Logic)



Delay time per stage

fan in = 10 (fast silicon epitaxial diodes)

t_d typ. 30 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.

The fan in and fan out figures have been calculated for worst case conditions.

GERMANIUM TRANSISTORS

P-N-P alloy transistors in TO-7 metal envelopes with the shield leads connected to the cases. They are intended for industrial switching applications.

RATINGS (Limiting values) ¹⁾

Voltages

		OC122	OC123
Collector-base voltage (open emitter)	$-V_{CBO}$	max. 32	50 V
Collector-emitter voltage ($+V_{BE} > 0.5$ V)	$-V_{CEX}$	max. 32	50 V
Emitter-base voltage (open collector)	$-V_{EBO}$	max. 12	15 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. 2.0	A

Power dissipation

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

Storage temperature	T_{stg}	-55 to +75	°C
Junction temperature	T_j	max. 90	°C

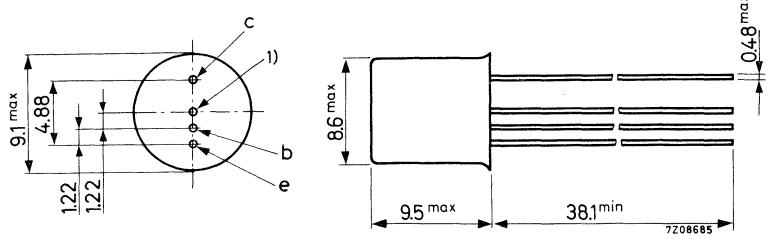
THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	0.22	°C/mW
From junction to case	$R_{th\ j-c}$	=	0.06	°C/mW

MECHANICAL DATA

Dimensions in mm

TO-7



1) = shield lead (connected to case)

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

CHARACTERISTICS

		OC122	OC123
<u>Collector cut-off current</u>			
$I_E = 0; -V_{CB} = 24 \text{ V}$	$-I_{CBO}$	typ. 40 < 150	μA μA
$I_E = 0; -V_{CB} = 10 \text{ V}$	$-I_{CBO}$	typ. <	20 μA 100 μA
<u>Base-emitter voltage</u>			
$-I_C = 100 \text{ mA}; -V_{CE} = 2 \text{ V}$	$-V_{BE}$	typ. 0.27 < 0.35	0.27 V 0.35 V
<u>D.C. current gain</u>			
$-I_C = 100 \text{ mA}; -V_{CE} = 6 \text{ V}$	h_{FE}	> 50 typ. 180	50 160
<u>Collector capacitance</u>			
$I_E = I_e = 0; -V_{CE} = 6 \text{ V}$	C_c	typ. 170	170 pF
<u>Transition frequency</u>			
$-I_C = 100 \text{ mA}; -V_{CE} = 2 \text{ V}$	f_T	typ. 1.3	1.5 MHz

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.

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

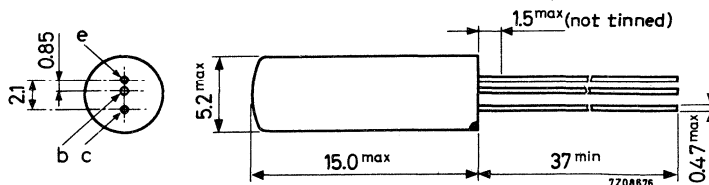
Collector-base voltage (open emitter)	V_{CBO}	max.	20 V
Collector-emitter voltage with $-V_{BE} > 2$ V	V_{CEX}	max.	20 V
Emitter-base voltage (open collector)	V_{EBO}	max.	20 V
Collector current (d.c. or average over any 20 ms period)	I_C	max.	250 mA
Emitter current (d.c. or average over any 20 ms period)	$-I_E$	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
Total power dissipation up to $T_{amb} = 25$ °C	P_{tot}	max.	145 mW
Storage temperature	T_{stg}	-55 to +75	°C
Junction temperature	T_j	max.	75 °C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th j-a}$	=	0.35 °C/mW
From junction to case	$R_{th j-c}$	=	0.20 °C/mW

MECHANICAL DATA

Dimensions in mm



The coloured dot indicates the collector
The collector is not necessarily related to pin configuration.

FOR REPLACEMENT THE SUCCESSOR TYPE ASY73
IS RECOMMENDED

$T_{amb} = 25\text{ }^{\circ}\text{C}$ unless otherwise specified

CHARACTERISTICS

Collector cut-off current

$I_E = 0; V_{CB} = 5\text{ V}$	I_{CBO}	typ. 0.3 μA < 3 μA
$I_E = 0; V_{CB} = 5\text{ V}; T_j = 60\text{ }^{\circ}\text{C}$	I_{CBO}	typ. 6 μA < 35 μA
$I_E = 0; V_{CB} = 20\text{ V}; T_j = 60\text{ }^{\circ}\text{C}$	I_{CBO}	< 100 μA

Emitter cut-off current

$I_C = 0; V_{EB} = 5\text{ V}$	I_{EBO}	typ. 0.3 μA < 3 μA
$I_C = 0; V_{EB} = 5\text{ V}; T_j = 60\text{ }^{\circ}\text{C}$	I_{EBO}	typ. 6 μA < 35 μA
$I_C = 0; V_{EB} = 20\text{ V}; T_j = 60\text{ }^{\circ}\text{C}$	I_{EBO}	< 100 μA

Sustaining voltage

$I_C = 250\text{ mA}; -V_{BE} = 2\text{ V}$	$V_{CEXsust}$	> 15 V
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Base-emitter voltage

$I_C = 200\text{ mA}; V_{CB} = 0$	V_{BE}	< 750 mV
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Saturation voltages

$I_C = 8.5\text{ mA}; I_B = 0.38\text{ mA}$	V_{CEsat}	< 175 mV
$I_C = 50\text{ mA}; I_B = 3.1\text{ mA}$	V_{CEsat}	typ. 60 mV < 220 mV
	V_{BEsat}	typ. 300 mV < 500 mV
	V_{pt}	> 20 V

Punch-through voltage

D. C. current gain

$I_C = 15\text{ mA}; V_{CB} = 0$	h_{FE}	20 to 84
$I_C = 200\text{ mA}; V_{CB} = 0$	h_{FE}	> 15

Transition frequency

$I_C = 3\text{ mA}; V_{CE} = 5\text{ V}$	f_T	typ. 6 MHz > 3.5 MHz
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Switching parameters

Current-drive time constant

$I_{CM} = 200\text{ mA}; V_{CE} = 0.75\text{ V}$	τ_C	< 1.75 μs
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Voltage-drive time constant

$I_{CM} = 1\text{ mA}; V_{CE} = 5\text{ V}$	τ_V	< 0.15 μs
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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.

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

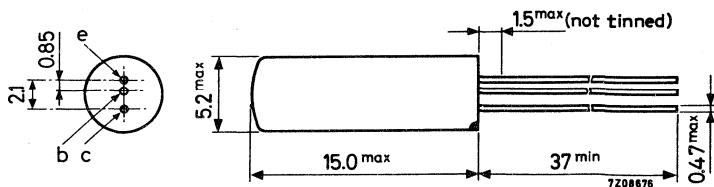
Collector-base voltage (open emitter)	V_{CBO}	max.	20 V
Collector-emitter voltage with $-V_{BE} > 2$ V	V_{CEX}	max.	20 V
Emitter-base voltage (open collector)	V_{EBO}	max.	20 V
Collector current (d.c. or average over any 20 ms period)	I_C	max.	400 mA
Emitter current (d.c. or average over any 20 ms period)	$-I_E$	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
Total power dissipation up to $T_{amb} = 25$ °C	P_{tot}	max.	145 mW
Storage temperature	T_{stg}	-55 to +75	°C
Junction temperature	T_j	max.	75 °C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th j-a}$	=	0.35 °C/mW
From junction to case	$R_{th j-c}$	=	0.20 °C/mW

MECHANICAL DATA

Dimensions in mm



The coloured dot indicates the collector

The collector is not necessarily related to pin configuration.

FOR REPLACEMENT THE SUCCESSOR TYPE ASY74
IS RECOMMENDED

$T_{amb} = 25\text{ }^{\circ}\text{C}$ unless otherwise specified

CHARACTERISTICS

Collector cut-off current

$I_E = 0; V_{CB} = 5\text{ V}$	I_{CBO}	typ. 0.3 μA < 3 μA
$I_E = 0; V_{CB} = 5\text{ V}; T_j = 60\text{ }^{\circ}\text{C}$	I_{CBO}	typ. 6 μA < 35 μA
$I_E = 0; V_{CB} = 20\text{ V}; T_j = 60\text{ }^{\circ}\text{C}$	I_{CBO}	< 100 μA

Emitter cut-off current

$I_C = 0; V_{EB} = 5\text{ V}$	I_{EBO}	typ. 0.3 μA < 3 μA
$I_C = 0; V_{EB} = 5\text{ V}; T_j = 60\text{ }^{\circ}\text{C}$	I_{EBO}	typ. 6 μA < 35 μA
$I_C = 0; V_{EB} = 20\text{ V}; T_j = 60\text{ }^{\circ}\text{C}$	I_{EBO}	< 100 μA

Sustaining voltage

$I_C = 400\text{ mA}; -V_{BE} = 2\text{ V}$	$V_{CEXsust}$	> 15 V
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Base-emitter voltage

$I_C = 200\text{ mA}; V_{CB} = 0$	V_{BE}	< 600 mV
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Saturation voltages

$I_C = 7.5\text{ mA}; I_B = 0.165\text{ mA}$	V_{CEsat}	< 175 mV
	V_{BEsat}	< 250 mV
$I_C = 50\text{ mA}; I_B = 1.25\text{ mA}$	V_{CEsat}	< 220 mV
	V_{BEsat}	< 380 mV
$I_C = 400\text{ mA}; I_B = 20\text{ mA}$	V_{CEsat}	< 370 mV
	V_{BEsat}	< 900 mV

Punch-through voltage

V_{pt}	> 20 V
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D.C. current gain

$I_C = 15\text{ mA}; V_{CB} = 0$	h_{FE}	50 to 150
$I_C = 200\text{ mA}; V_{CB} = 0$	h_{FE}	36 to 67
$I_E = 200\text{ mA}; V_{EB} = 0$	h_{FC}	> 21

Transition frequency

$I_C = 3\text{ mA}; V_{CE} = 5\text{ V}$	f_T	typ. 12 MHz > 4.5 MHz
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Switching parameters

Current-drive time constant

$I_{CM} = 200\text{ mA}; V_{CE} = 0.75\text{ V}$	τ_C	< 1.75 μs
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Voltage-drive time constant

$I_{CM} = 1\text{ mA}; V_{CE} = 5\text{ V}$	τ_V	< 0.15 μs
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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.

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

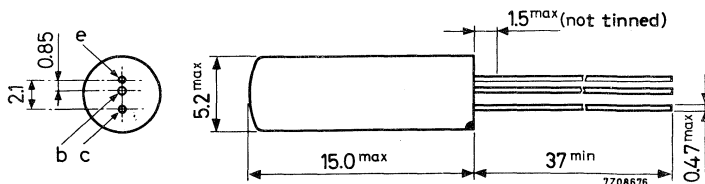
Collector-base voltage (open emitter)	V_{CBO}	max.	20 V
Collector-emitter voltage with $-V_{BE} > 2$ V	V_{CEX}	max.	20 V
Emitter-base voltage (open collector)	V_{EBO}	max.	20 V
Collector current (d.c. or average over any 20 ms period)	I_C	max.	400 mA
Emitter current (d.c. or average over any 20 ms period)	$-I_E$	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
Total power dissipation up to $T_{amb} = 25$ °C	P_{tot}	max.	145 mW
Storage temperature	T_{stg}		-55 to +75 °C
Junction temperature	T_j	max.	75 °C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th j-a}$	=	0.35 °C/mW
From junction to case	$R_{th j-c}$	=	0.20 °C/mW

MECHANICAL DATA

Dimensions in mm



The coloured dot indicates the collector

The collector is not necessarily related to pin configuration.

FOR REPLACEMENT THE SUCCESSOR TYPE ASY75
IS RECOMMENDED

$T_{amb} = 25\text{ }^{\circ}\text{C}$ unless otherwise specified

CHARACTERISTICS

Collector cut-off current

$I_E = 0; V_{CB} = 5\text{ V}$	I_{CBO}	typ. 0.3 μA < 3 μA
$I_E = 0; V_{CB} = 5\text{ V}; T_j = 60\text{ }^{\circ}\text{C}$	I_{CBO}	typ. 6 μA < 35 μA
$I_E = 0; V_{CB} = 20\text{ V}; T_j = 60\text{ }^{\circ}\text{C}$	I_{CBO}	< 100 μA

Emitter cut-off current

$I_C = 0; V_{EB} = 5\text{ V}$	I_{EBO}	typ. 0.3 μA < 3 μA
$I_C = 0; V_{EB} = 5\text{ V}; T_j = 60\text{ }^{\circ}\text{C}$	I_{EBO}	typ. 6 μA < 35 μA
$I_C = 0; V_{EB} = 20\text{ V}; T_j = 60\text{ }^{\circ}\text{C}$	I_{EBO}	typ. 100 μA

Sustaining voltage

$I_C = 400\text{ mA}; -V_{BE} = 2\text{ V}$	$V_{CEXsust}$	> 15 V
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Base-emitter voltage

$I_C = 200\text{ mA}; V_{CB} = 0$	V_{BE}	< 450 mV
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Saturation voltages

$I_C = 7.5\text{ mA}; I_B = 0.094\text{ mA}$	V_{CEsat}	< 175 mV
	V_{BEsat}	< 250 mV
$I_C = 50\text{ mA}; I_B = 0.75\text{ mA}$	V_{CEsat}	< 220 mV
	V_{BEsat}	< 340 mV
$I_C = 400\text{ mA}; I_B = 13.3\text{ mA}$	V_{CEsat}	< 370 mV
$I_C = 400\text{ mA}; I_B = 20\text{ mA}$	V_{BEsat}	< 700 mV

Punch-through voltage

	V_{pt}	> 20 V
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D.C. current gain

$I_C = 15\text{ mA}; V_{CB} = 0$	h_{FE}	80 to 200
$I_C = 200\text{ mA}; V_{CB} = 0$	h_{FE}	50 to 134
$I_E = 200\text{ mA}; V_{EB} = 0$	h_{FC}	> 21

Transition frequency

$I_C = 3\text{ mA}; V_{CE} = 5\text{ V}$	f_T	typ. 20 MHz < 9 MHz
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Switching parameters

Current-drive time constant

$I_{CM} = 200\text{ mA}; V_{CE} = 0.75\text{ V}$	T_C	< 1.75 μs
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Voltage-drive time constant

$I_{CM} = 1\text{ mA}; V_{CE} = 5\text{ V}$	T_V	< 0.15 μs
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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.

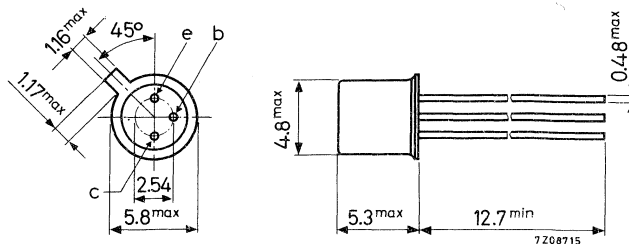
QUICK REFERENCE DATA			
Collector-base voltage (open emitter)	V_{CBO}	max.	25 V
Collector-emitter voltage (open base)	V_{CEO}	max.	15 V
Collector current (d.c.)	I_C	max.	50 mA
Total power dissipation up to $T_{amb} = 25^\circ\text{C}$	P_{tot}	max.	300 mW
Junction temperature	T_j	max.	175 $^\circ\text{C}$
D.C. current gain at $T_j = 25^\circ\text{C}$			
$I_C = 10\text{ mA}; V_{CE} = 1\text{ V}$	<u>2N706A</u>	h_{FE}	20 to 60
	<u>2N753</u>	h_{FE}	40 to 120
Transition frequency			
$I_C = 10\text{ mA}; V_{CE} = 10\text{ V}$		f_T	> 200 MHz
Storage time			
$I_C = I_B = -I_{BM} = 10\text{ mA}$	<u>2N706A</u>	t_s	< 25 ns
	<u>2N753</u>	t_s	< 35 ns

MECHANICAL DATA

Dimensions in mm

Collector connected to case

TO-18



Accessories available: 56246, 56263

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
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Power dissipation

Total power dissipation up to $T_{amb} = 25^\circ C$	P_{tot}	max.	300 mW
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Temperatures

Storage temperature	T_{stg}	-65 to +175	$^\circ C$
Junction temperature	T_j	max.	175 $^\circ C$

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th j-a}$	=	0.5 $^\circ C/mW$
From junction to case	$R_{th j-c}$	=	0.15 $^\circ C/mW$

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

CHARACTERISTICS

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

Collector cut-off current

$I_E = 0; V_{CB} = 15\text{ V}$	I_{CBO}	<	$0.5\ \mu\text{A}$
$I_E = 0; V_{CB} = 25\text{ V}$	I_{CBO}	<	$10\ \mu\text{A}$
$I_E = 0; V_{CB} = 15\text{ V}; T_j = 150\text{ }^\circ\text{C}$	I_{CBO}	<	$30\ \mu\text{A}$
$V_{CE} = 20\text{ V}; R_{BE} = 100\text{ k}\Omega$	I_{CER}	<	$10\ \mu\text{A}$

Emitter cut-off current

$I_C = 0; V_{EB} = 5\text{ V}$	I_{EBO}	<	$10\ \mu\text{A}$
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Sustaining voltages ¹⁾

$I_C = 10\text{ mA}; I_B = 0$	$V_{CEOsust}$	>	15 V
$I_C = 10\text{ mA}; R_{BE} = 10\ \Omega$	$V_{CERsust}$	>	20 V

Saturation voltages

$I_C = 10\text{ mA}; I_B = 1\text{ mA}$	V_{CEsat}	<	0.6 V
	V_{BEsat}		$0.7\text{ to }0.9\text{ V}$

D.C. current gain

$I_C = 10\text{ mA}; V_{CE} = 1\text{ V}$	<u>2N706A</u>	h_{FE}	$20\text{ to }60$
	<u>2N753</u>	h_{FE}	$40\text{ to }120$

Collector capacitance at $f = 1\text{ MHz}$

$I_E = I_c = 0; V_{CB} = 5\text{ V}$	C_c	<	5 pF
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Transition frequency

$I_C = 10\text{ mA}; V_{CE} = 10\text{ V}$	f_T	>	200 MHz
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¹⁾ Measured under pulsed conditions to avoid excessive dissipation
Pulse duration $t = 300\ \mu\text{s}$; duty cycle $\delta \leq 0.02$

CHARACTERISTICS (continued)

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

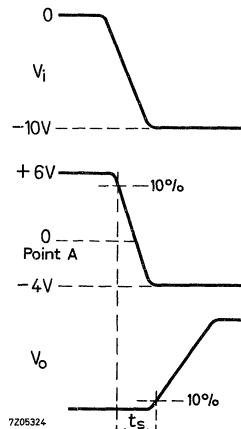
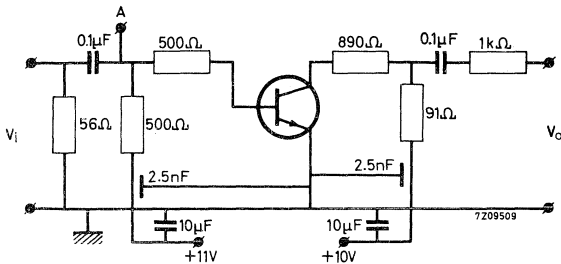
Storage time

$I_C = I_B = -I_{BM} = 10\text{ mA}$

Test circuit: 1)

2N706A
2N753

$t_s < 25\text{ ns}$
 $t_s < 35\text{ ns}$



Turn on time

$I_C = 10\text{ mA}; I_B = 3\text{ mA}; -V_{BE} = 2\text{ V}$

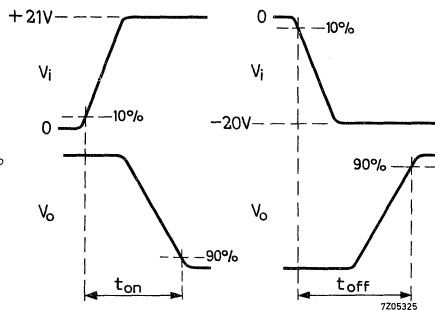
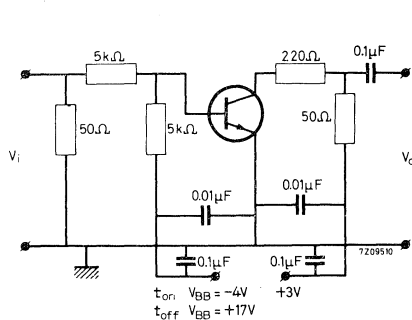
$t_{on} < 40\text{ ns}$

Turn off time

$I_C = 10\text{ mA}; I_B = 3\text{ mA}; -I_{BM} = 1\text{ mA}$

$t_{off} < 75\text{ ns}$

Test circuit: 1)



1) Pulse generator:

Pulse duration $t > 400\text{ ns}$
Duty cycle $\delta < 0.02$
Rise time $t_r < 1\text{ ns}$
Source impedance $R_S = 50\text{ }\Omega$

Oscilloscope:

Rise time $t_r < 1\text{ ns}$
Probe impedance $= 2\text{ k}\Omega$

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.

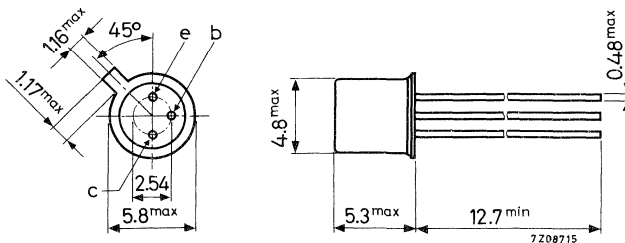
QUICK REFERENCE DATA		
Collector-base voltage (open emitter)	V_{CBO}	max. 40 V
Collector-emitter voltage (open base)	V_{CEO}	max. 15 V
Collector current (peak value)	I_{CM}	max. 500 mA
Total power dissipation up to $T_{amb} = 25^\circ\text{C}$	P_{tot}	max. 360 mW
Junction temperature	T_j	max. 200 $^\circ\text{C}$
D.C. current gain at $T_j = 25^\circ\text{C}$ $I_C = 10\text{ mA}; V_{CE} = 1\text{ V}$	h_{FE}	30 to 120
Transition frequency $I_C = 10\text{ mA}; V_{CE} = 10\text{ V}$	f_T	> 300 MHz
Storage time $I_C = I_B = -I_{BM} = 10\text{ mA}$	t_s	< 25 ns

MECHANICAL DATA

Dimensions in mm

Collector connected to case

TO-18



Accessories available: 56246, 56263

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; $t = 10 \mu s$)	I_{CM}	max.	500 mA
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Power dissipation

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

Storage temperature	T_{stg}	-65 to +200	$^\circ\text{C}$
Junction temperature	T_j	max.	200 $^\circ\text{C}$

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th j-a}$	=	0.48 $^\circ\text{C}/\text{mW}$
From junction to case	$R_{th j-c}$	=	0.145 $^\circ\text{C}/\text{mW}$

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

CHARACTERISTICS $T_j = 25\text{ }^\circ\text{C}$ unless otherwise specifiedCollector cut-off current

$I_E = 0; V_{CB} = 20\text{ V}$	I_{CBO}	<	25 nA
$I_E = 0; V_{CB} = 20\text{ V}; T_j = 150\text{ }^\circ\text{C}$	I_{CBO}	<	15 μA
$V_{CE} = 20\text{ V}; V_{BE} = 0.25\text{ V}; T_j = 125\text{ }^\circ\text{C}$	I_{CEX}	<	10 μA

Emitter cut-off current

$I_C = 0; V_{EB} = 4\text{ V}$	I_{EBO}	<	0.1 μA
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Sustaining voltages ¹⁾

$I_C = 30\text{ mA}; I_B = 0$	$V_{CEOsust}$	>	15 V
$I_C = 30\text{ mA}; R_B \leq 10\text{ }\Omega$	$V_{CERsust}$	>	20 V

Saturation voltages

$I_C = 10\text{ mA}; I_B = 1\text{ mA}$	V_{CEsat}	<	0.4 V
	V_{BEsat}		0.72 to 0.80 V
$I_C = 7\text{ mA}; I_B = 0.7\text{ mA};$ $T_j = -55\text{ to }+125\text{ }^\circ\text{C}$	V_{CEsat}	<	0.4 V
$I_C = 7\text{ mA}; I_B = 0.7\text{ mA}; T_j = -55\text{ }^\circ\text{C}$	V_{BEsat}	<	0.9 V

D.C. current gain

$I_C = 0.5\text{ mA}; V_{CE} = 1\text{ V}$	h_{FE}	>	15
$I_C = 10\text{ mA}; V_{CE} = 1\text{ V}$	h_{FE}		30 to 120
$I_C = 10\text{ mA}; V_{CE} = 1\text{ V}; T_j = -55\text{ }^\circ\text{C}$	h_{FE}	>	15

Collector capacitance at $f = 1\text{ MHz}$

$I_E = I_e = 0; V_{CB} = 10\text{ V}$	C_c	<	6 pF
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Transition frequency

$I_C = 10\text{ mA}; V_{CE} = 10\text{ V}$	f_T	>	300 MHz
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Real part of
small signal input impedance

$I_C = 10\text{ mA}; V_{CE} = 10\text{ V}; f = 300\text{ MHz}$	$R_e(h_{ie})$	<	50 Ω
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¹⁾ Measured under pulsed conditions to avoid excessive dissipation.
Pulse duration $t = 300\text{ }\mu\text{s}$; duty cycle $\delta < 0.01$

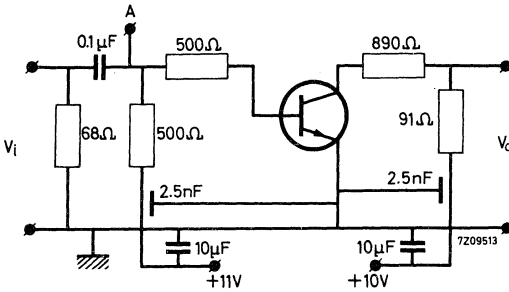
CHARACTERISTICS (continued)

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

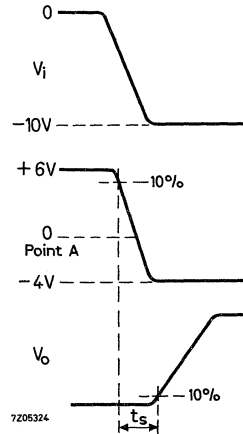
Storage time

$I_C = I_B = -I_{BM} = 10\text{ mA}$

Test circuit:



$t_s < 25\text{ ns}$



Pulse generator:

Pulse duration	$t \geq 400\text{ ns}$
Duty cycle	$\delta \leq 0.02$
Rise time	$t_r \leq 1\text{ ns}$
Source impedance	$R_S = 50\ \Omega$

Oscilloscope:

Rise time $t_r < 1\text{ ns}$
High impedance probe

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

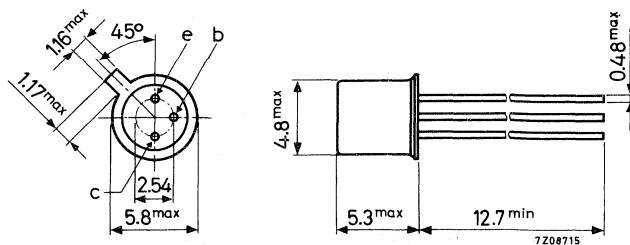
Collector-base voltage (open emitter)	V_{CBO}	max.	20	V
Collector-emitter voltage (open base)	V_{CEO}	max.	12	V
Collector current (d.c.)	I_C	max.	200	mA
Total power dissipation up to $T_{amb} = 25^\circ\text{C}$	P_{tot}	max.	300	mW
Junction temperature	T_j	max.	175	$^\circ\text{C}$
D.C. current gain at $T_j = 25^\circ\text{C}$				
$I_C = 10\text{ mA}; V_{CE} = 0.35\text{ V}$	<u>2N743</u>	h_{FE}	20 to	60
	<u>2N744</u>	h_{FE}	40 to	120
Transition frequency				
$I_C = 10\text{ mA}; V_{CE} = 10\text{ V}$	f_T	>	300	MHz
Storage time				
$I_C = I_B = -I_{BM} = 10\text{ mA}$	<u>2N743</u>	t_S	<	14
	<u>2N744</u>	t_S	<	18

MECHANICAL DATA

Dimensions in mm

Collector connected to case

TO-18



Accessories available: 56246, 56263

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
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Power dissipation

Total power dissipation up to $T_{amb} = 25^\circ C$	P_{tot}	max.	300 mW
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Temperatures

Storage temperature	T_{stg}	-65 to +175	$^\circ C$
Junction temperature	T_j	max.	175 $^\circ C$

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th j-a}$	=	0.5 $^\circ C/mW$
From junction to case	$R_{th j-c}$	=	0.15 $^\circ C/mW$

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

CHARACTERISTICS

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

Collector cut-off current

$I_E = 0; V_{CB} = 20\text{ V}$	I_{CBO}	<	1 μA
$V_{BE} = 0; V_{CE} = 20\text{ V}$	I_{CES}	<	1 μA
$V_{BE} = 0; V_{CE} = 20\text{ V}; T_j = 170\text{ }^\circ\text{C}$	I_{CES}	<	100 μA
$V_{BE} = 0.35\text{ V}; V_{CE} = 10\text{ V}; T_j = 100\text{ }^\circ\text{C}$	I_{CEX}	<	30 μA

Emitter cut-off current

$I_C = 0; V_{EB} = 5\text{ V}$	I_{EBO}	<	10 μA
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Sustaining voltage

$I_C = 10\text{ mA}; I_B = 0$	$V_{CEOsust}$	>	12 V ¹⁾
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Saturation voltages

$I_C = 10\text{ mA}; I_B = 1\text{ mA}; T_j = 170\text{ }^\circ\text{C}$	V_{CEsat}	<	0.35 V
$I_C = 100\text{ mA}; I_B = 10\text{ mA}; T_j = 170\text{ }^\circ\text{C}$	V_{CEsat}	<	1 V ¹⁾
$I_C = 10\text{ mA}; I_B = 1\text{ mA}$	V_{BEsat}		0.65 to 0.85 V
$I_C = 10\text{ mA}; I_B = 1\text{ mA}; T_j = -55\text{ }^\circ\text{C}$	V_{BEsat}	<	1.1 V
$I_C = 100\text{ mA}; I_B = 10\text{ mA}$	V_{BEsat}	<	1.5 V ¹⁾
$I_C = 100\text{ mA}; I_B = 10\text{ mA}; T_j = -55\text{ }^\circ\text{C}$	V_{BEsat}	<	1.6 V ¹⁾

Collector capacitance at $f = 1\text{ MHz}$

$I_E = I_e = 0; V_{CB} = 5\text{ V}$	C_c	<	5 pF
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Transition frequency

$I_C = 10\text{ mA}; V_{CE} = 10\text{ V}$	f_T	>	300 MHz
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D.C. current gain

		2N743	2N744
$I_C = 1\text{ mA}; V_{CE} = 0.25\text{ V}$	h_{FE}	> 10	20
$I_C = 10\text{ mA}; V_{CE} = 0.35\text{ V}$	h_{FE}	20 to 60	40 to 120
$I_C = 10\text{ mA}; V_{CE} = 0.35\text{ V}; T_j = -55\text{ }^\circ\text{C}$	h_{FE}	> 10	20
$I_C = 100\text{ mA}; V_{CE} = 1\text{ V}$	h_{FE}	> 10	20 ¹⁾

¹⁾ Measured under pulsed conditions to avoid excessive dissipation
Pulse duration $t = 300\text{ }\mu\text{s}$; duty cycle $\delta \leq 0.02$

CHARACTERISTICS (continued)

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

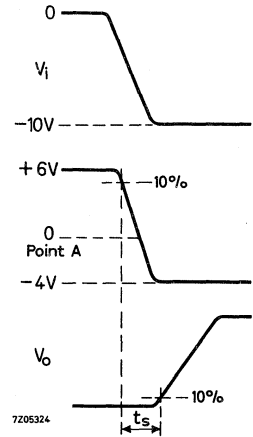
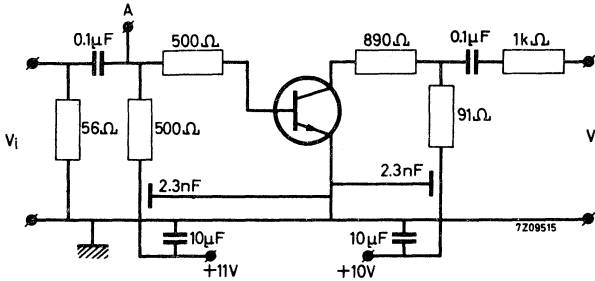
Storage time

$I_C = I_B = -I_{BM} = 10\text{ mA}$

2N743
2N744

$t_s < 14\text{ ns}$
 $t_s < 18\text{ ns}$

Test circuit:



Pulse generator:

- Pulse duration $t \geq 300\text{ ns}$
- Duty cycle $\delta \leq 0.02$
- Rise time $t_r \leq 1\text{ ns}$
- Source impedance $R_S = 50\text{ }\Omega$

Oscilloscope:

- Rise time $t_r \leq 1\text{ ns}$
- Input impedance $R_i = 50\text{ }\Omega$

CHARACTERISTICS (continued)

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

Turn on time

$I_C = 10\text{ mA}; I_B = 3\text{ mA}; -V_{BE} = 1.5\text{ V}$

$t_{on} < 16\text{ ns}$

$I_C = 100\text{ mA}; I_B = 40\text{ mA}; -V_{BE} = 2.4\text{ V}$

$t_{on} < 12\text{ ns}$

Turn off time

$I_C = 10\text{ mA}; I_B = 3\text{ mA}; -I_{BM} = 1.5\text{ mA}$

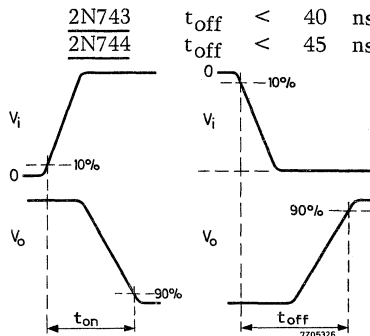
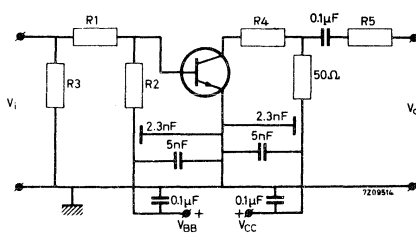
$t_{off} < 24\text{ ns}$

$I_C = 100\text{ mA}; I_B = 40\text{ mA}; -I_{BM} = 20\text{ mA}$

$t_{off} < 40\text{ ns}$

$t_{off} < 45\text{ ns}$

Test circuit:



I_C (mA)	I_B (mA)	V_{CC} (V)	R_1 (k Ω)	R_2 (k Ω)	R_3 (Ω)	R_4 (Ω)	R_5 (k Ω)	turn on			turn off		
								$-V_{BB}$ (V)	$-V_{BE}$ (V)	V_i (V)	V_{BB} (V)	$-I_{BM}$ (mA)	$-V_i$ (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	$t \geq 400\text{ ns}$
Duty cycle	$\delta \leq 0.02$
Rise time	$t_r \leq 1\text{ ns}$
Source impedance	$R_s = 50\text{ }\Omega$

Oscilloscope:

Rise time	$t_r \leq 1\text{ ns}$
Input impedance	$R_i = 50\text{ }\Omega$

SILICON PLANAR EPITAXIAL TRANSISTOR

For data of this transistor please refer to the 2N706A.



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.

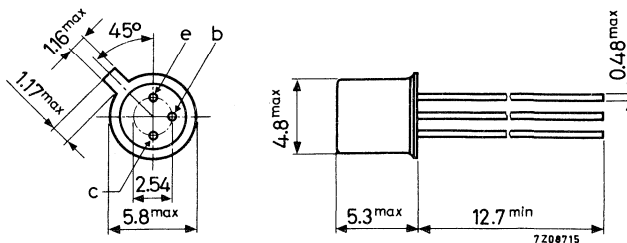
QUICK REFERENCE DATA		
Collector-base voltage (open emitter)	V_{CBO}	max. 40 V
Collector-emitter voltage (open base)	V_{CEO}	max. 15 V
Collector current (peak value)	I_{CM}	max. 500 mA
Total power dissipation up to $T_{amb} = 25^\circ\text{C}$	P_{tot}	max. 360 mW
Junction temperature	T_j	max. 200 $^\circ\text{C}$
D.C. current gain at $T_j = 25^\circ\text{C}$ $I_C = 10\text{ mA}; V_{CE} = 1\text{ V}$	h_{FE}	30 to 120
Transition frequency $I_C = 20\text{ mA}; V_{CE} = 10\text{ V}$	f_T	> 300 MHz
Storage time $I_C = I_B = -I_{BM} = 20\text{ mA}$	t_s	< 20 ns

MECHANICAL DATA

Dimensions in mm

Collector connected to case

TO-18



Accessories available: 56246, 56263

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; $t = 10 \mu s$)	I_{CM}	max.	500 mA
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Power dissipation

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

Storage temperature	T_{stg}	-65 to +200	$^\circ C$
Junction temperature	T_j	max.	200 $^\circ C$

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th j-a}$	=	0.48 $^\circ C/mW$
From junction to case	$R_{th j-c}$	=	0.145 $^\circ C/mW$

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

CHARACTERISTICS $T_j = 25\text{ }^\circ\text{C}$ unless otherwise specifiedCollector cut-off current

$I_E = 0; V_{CB} = 20\text{ V}$	I_{CBO}	<	25 nA
$I_E = 0; V_{CB} = 20\text{ V}; T_j = 150\text{ }^\circ\text{C}$	I_{CBO}	<	15 μA
$V_{CE} = 20\text{ V}; V_{BE} = 0.25\text{ V}; T_j = 125\text{ }^\circ\text{C}$	I_{CEX}	<	10 μA

Emitter cut-off current

$I_C = 0; V_{EB} = 4\text{ V}$	I_{EBO}	<	0.1 μA
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Sustaining voltages ¹⁾

$I_C = 30\text{ mA}; I_B = 0$	$V_{CEOsust}$	>	15 V
$I_C = 30\text{ mA}; R_B \leq 10\ \Omega$	$V_{CERsust}$	>	20 V

Saturation voltages

$I_C = 200\text{ mA}; I_B = 20\text{ mA}$	V_{CEsat}	<	0.7 V
$I_C = 10\text{ mA}; I_B = 0.1\text{ to }2\text{ mA}$ $T_j = -55\text{ to }+125\text{ }^\circ\text{C}$	V_{CEsat}	<	0.25 V
$I_C = 10\text{ mA}; I_B = 1\text{ mA}$	V_{BEsat}		0.7 to 0.8 V

D.C. current gain ¹⁾

$I_C = 500\text{ mA}; V_{CE} = 5\text{ V}$	h_{FE}	>	10
$I_C = 10\text{ mA}; V_{CE} = 1\text{ V}$	h_{FE}		30 to 120
$I_C = 10\text{ mA}; V_{CE} = 1\text{ V}; T_j = -55\text{ }^\circ\text{C}$	h_{FE}	>	12

Collector capacitance at $f = 1\text{ MHz}$

$I_E = I_e = 0; V_{CB} = 10\text{ V}$	C_c	<	6 pF
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Emitter capacitance at $f = 1\text{ MHz}$

$I_C = I_c = 0; V_{EB} = 0.5\text{ V}$	C_e	<	9 pF
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Transition frequency

$I_C = 20\text{ mA}; V_{CE} = 10\text{ V}$	f_T	>	300 MHz
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¹⁾ Measured under pulsed conditions to avoid excessive dissipation
Pulse duration $t = 300\ \mu\text{s}$; duty cycle $\delta \leq 0.01$

CHARACTERISTICS (continued)

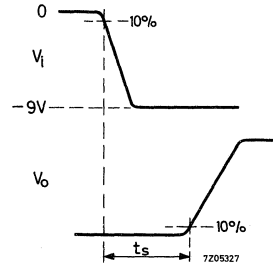
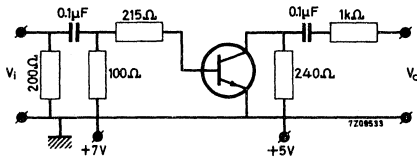
$T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified

Storage time

$I_C = I_B = -I_{BM} = 20\text{ mA}$

$t_s < 20\text{ ns}$

Test circuit: 1)



Turn on time

$I_C = 200\text{ mA}; I_B = 35\text{ mA}; -V_{BE} = 4\text{ V}$

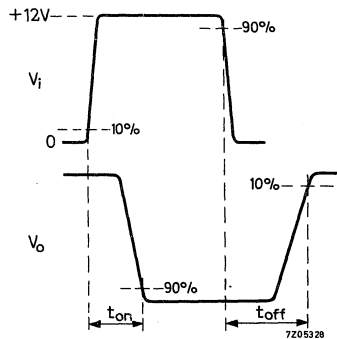
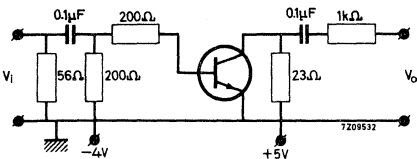
$t_{on} < 40\text{ ns}$

Turn off time

$I_C = 200\text{ mA}; I_B = 35\text{ mA}; -I_{BM} = 25\text{ mA}$

$t_{off} < 40\text{ ns}$

Test circuit: 1)



1) Pulse generator:

- Pulse duration $t = 100\text{ ns}$
- Duty cycle $\delta \leq 0.02$
- Source impedance $R_S = 50\ \Omega$

Oscilloscope:

- Rise time $t_r < 1\text{ ns}$
- Input impedance $R_i = 50\ \Omega$

Rise and fall time sufficiently fast so that doubling their values does not affect the measured results within the required accuracy.

P-N-P MEDIUM POWER GENERAL PURPOSE TRANSISTORS

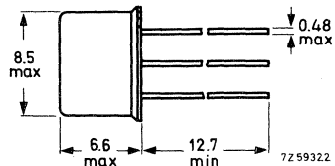
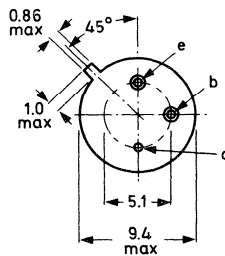
P-N-P silicon planar epitaxial transistors in a TO-39 metal envelope with the collector connected to the case. These transistors are primarily intended for high speed saturated switching applications for industrial service.

QUICK REFERENCE DATA			
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	50 V
Collector-emitter voltage (open base) ($R_{BE} \leq 10 \Omega$)	$-V_{CER}$	max.	50 V
Collector current (d. c.)	$-I_C$	max.	0.6 A
Total power dissipation up to $T_{amb} = 25^\circ C$	P_{tot}	max.	0.6 W
Junction temperature	T_j	max.	175 $^\circ C$
Transition frequency	f_T	>	200 MHz
$-I_C = 50 \text{ mA}; -V_{CE} = 20 \text{ V}$			
D. C. current gain at $T_j = 25^\circ C$			
		<u>2N1131</u>	<u>2N1132</u>
$-I_C = 5 \text{ mA}; -V_{CE} = 10 \text{ V}$	h_{FE}	> 15	> 25
$-I_C = 150 \text{ mA}; -V_{CE} = 10 \text{ V}$	h_{FE}	20 to 45	30 to 90

MECHANICAL DATA

Dimensions in mm

Collector connected to case
TO-39



max. lead diameter is guaranteed only for 12.7 mm

Accessories available: 56218, 56245, 56265.

RATINGS (Limiting values) ¹⁾

Voltages

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	50 V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	35 V
Collector-emitter voltage ($R_{BE} \leq 10 \Omega$)	$-V_{CER}$	max.	50 V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5 V

Current

Collector current (d.c.)	$-I_C$	max.	0.6 A
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Power dissipation

Total power dissipation up to $T_{amb} = 25 \text{ }^\circ\text{C}$	P_{tot}	max.	0.6 W
up to $T_{case} = 25 \text{ }^\circ\text{C}$	P_{tot}	max.	2 W
up to $T_{case} = 100 \text{ }^\circ\text{C}$	P_{tot}	max.	1 W

Temperatures

Storage temperature	T_{stg}	-65 to +200	$^\circ\text{C}$
Junction temperature	T_j	max.	175 $^\circ\text{C}$

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th j-a}$	=	250 $^\circ\text{C}/\text{W}$
From junction to case	$R_{th j-c}$	=	75 $^\circ\text{C}/\text{W}$

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

CHARACTERISTICS

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

Collector cut-off current

$I_E = 0; -V_{CB} = 30\text{ V}$	$-I_{CBO}$	<	1 μA
$I_E = 0; -V_{CB} = 50\text{ V}; T_{\text{amb}} = 25\text{ }^\circ\text{C}$	$-I_{CBO}$	<	100 μA
$I_E = 0; -V_{CB} = 30\text{ V}; T_{\text{amb}} = 150\text{ }^\circ\text{C}$	$-I_{CBO}$	<	100 μA

Emitter cut-off current

$I_C = 0; -V_{EB} = 2\text{ V}$	$-I_{EBO}$	<	100 μA
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Collector-emitter sustaining voltage ¹⁾

$-I_C = 100\text{ mA}; R_B \leq 10\ \Omega$	$-V_{CER(\text{sust})}$	>	50 V
$-I_C = 100\text{ mA}; I_B = 0$	$-V_{CEO(\text{sust})}$	>	35 V

Saturation voltages

$-I_C = 150\text{ mA}; -I_B = 15\text{ mA}$	$-V_{CE\text{sat}}$	<	1.5 V
	$-V_{BE\text{sat}}$	<	1.3 V

D. C. current gain

	2N1131	2N1132	
$-I_C = 5\text{ mA}; -V_{CE} = 10\text{ V}$	h_{FE}	> 15	> 25
$-I_C = 150\text{ mA}; -V_{CE} = 10\text{ V}$	h_{FE}	20 to 45	30 to 90

Collector capacitance

$f = 100\text{ kHz to } 1\text{ MHz}$			
$I_E = I_e = 0; -V_{CB} = 10\text{ V}$	C_C	<	45 pF

Emitter capacitance

$f = 100\text{ kHz to } 1\text{ MHz}$			
$I_C = I_c = 0; -V_{EB} = 0.5\text{ V}$	C_e	<	80 pF

¹⁾ Measured under pulsed conditions to avoid excessive dissipation.

CHARACTERISTICS (continued)

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

<u>Transition frequency</u>		2N1131	2N1132
$-I_C = 50\text{ mA}; -V_{CE} = 10\text{ V}$	f_T	> 50	60 MHz
<u>h parameters at $f = 1\text{ kHz}$ (common base)</u>			
$-I_C = 1\text{ mA}; -V_{CE} = 5\text{ V}$			
Input impedance	h_{ib}	25 to 35	25 to 35 Ω
Reverse voltage transfer ratio	h_{rb}	0 to 8×10^{-4}	0 to 8×10^{-4}
Small signal current gain	h_{fe}	15 to 50	25 to 100
Output conductance	h_{ob}	0 to 1	0 to 1 $\mu\Omega^{-1}$
$-I_C = 5\text{ mA}; -V_{CE} = 10\text{ V}$			
Input impedance	h_{ib}	< 10	10 Ω
Reverse voltage transfer ratio	h_{rb}	0 to 8×10^{-4}	0 to 8×10^{-4}
Small signal current gain	h_{fe}	> 20	30
Output conductance	h_{ob}	0 to 5	0 to 5 $\mu\Omega^{-1}$



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.

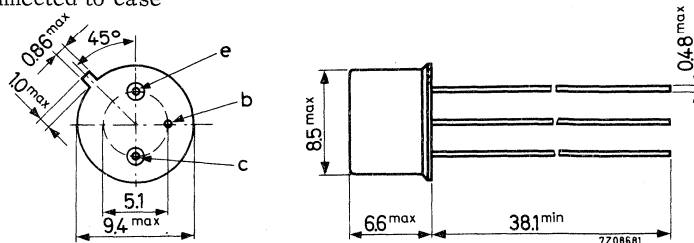
		QUICK REFERENCE DATA			
		2N1302	1304	1306	1308
Collector-base voltage (open emitter)	V_{CBO}	max. 25	25	25	25 V
Collector-emitter voltage (open base)	V_{CEO}	max. 25	20	15	15 V
Collector current (peak value)	I_{CM}	max. 300	300	300	300 mA
Total power dissipation up to $T_{amb} = 25^\circ\text{C}$	P_{tot}	max. 150	150	150	150 mW
Junction temperature	T_j	max. 85	85	85	85 $^\circ\text{C}$
D. C. current gain at $T_j = 25^\circ\text{C}$ $I_C = 10\text{ mA}; V_{CE} = 1\text{ V}$	h_{FE}	> 20	40	60	80
Saturation voltage $I_C = 10\text{ mA}; I_B = \frac{I_C}{h_{FEmin}}$	V_{CEsat}	< 0.2	0.2	0.2	0.2 V
Transition frequency $I_C = 1\text{ mA}; V_{CE} = 5\text{ V}$	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



Accessories available: 56218, 56245, 56265

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 $T_{amb} = 25\text{ }^\circ\text{C}$ P_{tot} max. 150 mW

Temperatures

Storage temperature T_{stg} -65 to +100 $^\circ\text{C}$

Junction temperature T_j max. 85 $^\circ\text{C}$

THERMAL RESISTANCE

From junction to ambient in free air $R_{th\ j-a} = 0.4\text{ }^\circ\text{C/mW}$

From junction to case $R_{th\ j-c} = 0.2\text{ }^\circ\text{C/mW}$

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

CHARACTERISTICS

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

		2N1302	1304	1306	1308	
<u>Collector cut-off current</u>						
$I_E = 0; V_{CB} = 25\text{ V}$	I_{CBO}	typ. 3	3	3	3	μA
		< 6	6	6	6	μA
<u>Emitter cut-off current</u>						
$I_C = 0; V_{EB} = 25\text{ V}$	I_{EBO}	typ. 2.2	2.2	2.2	2.2	μA
		< 6	6	6	6	μA
<u>Collector current at reverse biased emitter junction</u>						
$-V_{BE} = 0.2\text{ V}; T_j = 55\text{ }^\circ\text{C}$						
$V_{CE} = 20\text{ V}$	I_{CEX}	< 50	50			μA
$V_{CE} = 15\text{ V}$	I_{CEX}	<		50	50	μA
<u>Saturation voltages</u>						
$I_C = 10\text{ mA}; I_B = 0.5\text{ mA}$	V_{BEsat}	> 0.15	0.15	0.15	0.15	V
		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
$I_C = 10\text{ mA}; I_B = 0.25\text{ mA}$	V_{CEsat}	typ. <	0.1			V
			0.2			V
$I_C = 10\text{ mA}; I_B = 0.17\text{ mA}$	V_{CEsat}	typ. <		0.1		V
				0.2		V
$I_C = 10\text{ mA}; I_B = 0.13\text{ mA}$	V_{CEsat}	typ. <			0.1	V
					0.2	V
<u>Punch through voltage</u>						
	V_{pt}	> 25	20	15	15	V
<u>D.C. current gain</u>						
$I_C = 10\text{ mA}; V_{CE} = 1\text{ V}$	h_{FE}	> 20	40	60	80	
		typ. 50	70	100	150	
		<	100	200	300	
$I_C = 200\text{ mA}; V_{CE} = 0.35\text{ V}$	h_{FE}	> 10	15	20	20	
		typ. 48	65	95	145	
<u>Collector capacitance at $f = 1\text{ MHz}$</u>						
$I_E = I_e = 0; V_{CB} = 5\text{ V}$	C_c	typ. 12	12	12	12	pF
		< 20	20	20	20	pF
<u>Emitter capacitance at $f = 1\text{ MHz}$</u>						
$I_C = I_c = 0; V_{EB} = 5\text{ V}$	C_e	typ. 8	8	8	8	pF
<u>Transition frequency</u>						
$I_C = 1\text{ mA}; V_{CE} = 5\text{ V}$	f_T	> 3	5	10	15	MHz
		typ. 10	15	20	30	MHz



CHARACTERISTICS (continued)

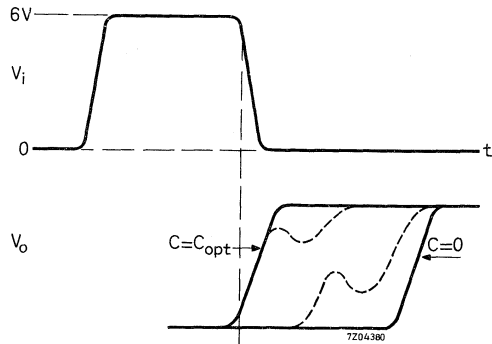
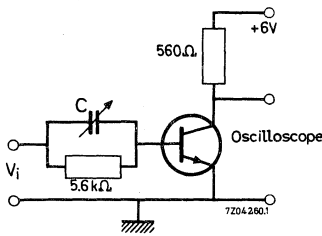
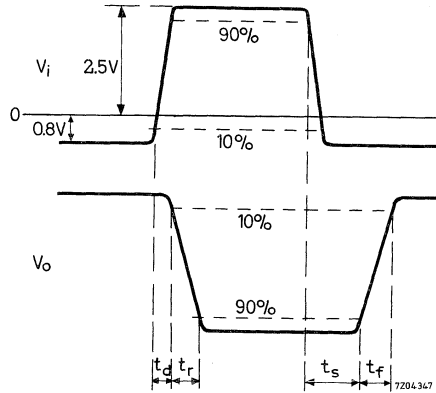
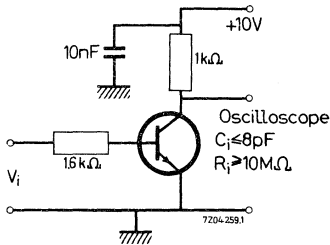
$T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified

Switching times

- delay time
- rise time
- storage time
- fall time

Recovered charge

	2N1302	1304	1306	1308	
t_d	typ. 65	60	55	55	ns
t_r	typ. 220	210	170	165	ns
t_s	typ. 500	500	500	500	ns
t_f	typ. 365	350	315	290	ns
Q_s	typ. 800	700	650	600	pC



Adjust C from zero to C_{opt}
 $Q_s = C_{opt} \cdot V_i$

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.

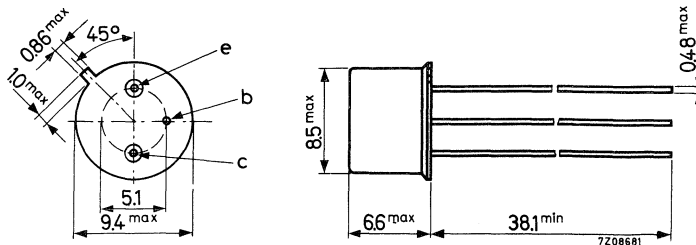
		QUICK REFERENCE DATA			
		2N1303	1305	1307	1309
Collector-base voltage (open emitter) $-V_{CBO}$ max.		30	30	30	30 V
Collector-emitter voltage (open base) $-V_{CEO}$ max.		25	20	15	15 V
Collector current (peak value) $-I_{CM}$ max.		300	300	300	300 mA
Total power dissipation up to $T_{amb} = 25^\circ\text{C}$ P_{tot} max.		150	150	150	150 mW
Junction temperature T_j max.		85	85	85	85 $^\circ\text{C}$
D. C. current gain at $T_j = 25^\circ\text{C}$ $-I_C = 10\text{ mA}; -V_{CE} = 1\text{ V}$ h_{FE}	>	20	40	60	80
Saturation voltage $-I_C = 10\text{ mA}; -I_B = \frac{-I_C}{h_{FEmin}}$ $-V_{CEsat}$	<	0.2	0.2	0.2	0.2 V
Transition frequency $-I_C = 1\text{ mA}; -V_{CE} = 5\text{ V}$ 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



Accessories available: 56218, 56245, 56265

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 $T_{amb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	150	mW
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Temperatures

Storage temperature	T_{stg}	-65 to +100	$^\circ\text{C}$
Junction temperature	T_j	max. 85	$^\circ\text{C}$

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	0.4	$^\circ\text{C}/\text{mW}$
From junction to case	$R_{th\ j-c}$	=	0.2	$^\circ\text{C}/\text{mW}$

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

CHARACTERISTICS

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

		2N1303	1305	1307	1309
<u>Collector cut-off current</u> $I_E = 0; -V_{CB} = 25\text{ V}$	$-I_{CBO}$	typ. 3 < 6	3 6	3 6	3 6 μA
<u>Emitter cut-off current</u> $I_C = 0; -V_{EB} = 25\text{ V}$	$-I_{EBO}$	typ. 1.7 < 6	1.7 6	1.7 6	1.7 6 μA
<u>Collector current at reverse biased emitter junction</u> $-V_{CE} = 15\text{ V}; +V_{BE} = 0.2\text{ V}$ $T_j = 55\text{ }^\circ\text{C}$	$-I_{CEX}$	< 50	50	50	50 μA
<u>Saturation voltages</u> $-I_C = 10\text{ mA}; -I_B = 0.5\text{ mA}$	$-V_{BEsat}$	> 0.15 typ. 0.30 < 0.40	0.15 0.25 0.35	0.15 0.24 0.35	0.15 0.23 0.35 V
	$-V_{CEsat}$	typ. 0.1 < 0.2			V V
$-I_C = 10\text{ mA}; -I_B = 0.25\text{ mA}$	$-V_{CEsat}$	typ. <	0.1 0.2		V V
$-I_C = 10\text{ mA}; -I_B = 0.17\text{ mA}$	$-V_{CEsat}$	typ. <		0.1 0.2	V V
$-I_C = 10\text{ mA}; -I_B = 0.13\text{ mA}$	$-V_{CEsat}$	typ. <			0.1 V 0.2 V
<u>Punch through voltage</u>	V_{pt}	> 25	20	15	15 V
<u>D.C. current gain</u> $-I_C = 10\text{ mA}; -V_{CE} = 1\text{ V}$	h_{FE}	> 20 typ. 50 <	40 70 100	60 100 200	80 150 300
$-I_C = 200\text{ mA}; -V_{CE} = 0.35\text{ V}$	h_{FE}	> 10 typ. 35	15 55	20 90	20 130
<u>Collector capacitance at $f = 1\text{ MHz}$</u> $I_E = I_c = 0; -V_{CB} = 5\text{ V}$	C_c	typ. 10 < 20	10 20	10 20	10 20 pF
<u>Emitter capacitance at $f = 1\text{ MHz}$</u> $I_C = I_c = 0; -V_{EB} = 5\text{ V}$	C_e	typ. 7	7	7	7 pF
<u>Transition frequency</u> $-I_C = 1\text{ mA}; -V_{CE} = 5\text{ V}$	f_T	> 3 typ. 5	5 10	10 15	15 20 MHz

CHARACTERISTICS (continued)

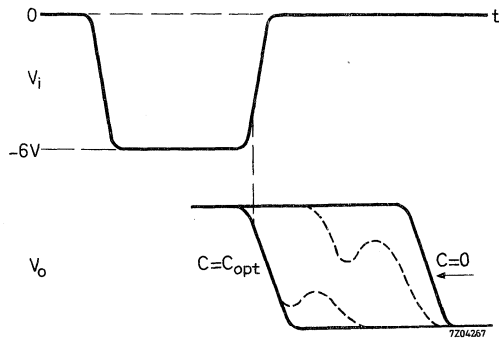
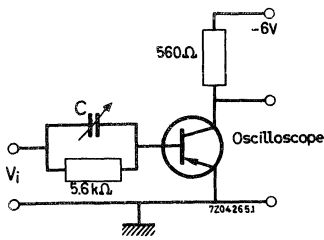
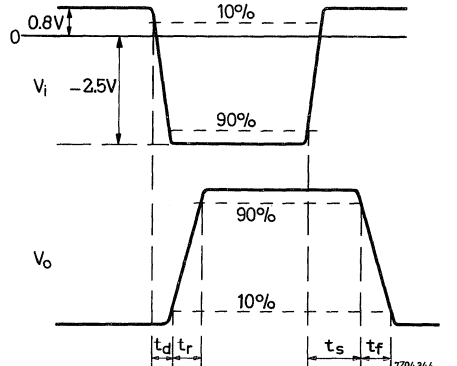
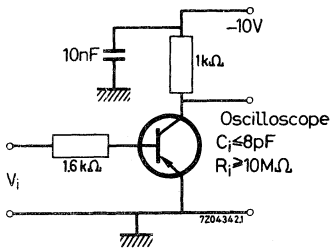
$T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified

Switching times

- delay time
- rise time
- storage time
- fall time

	2N1303	1305	1307	1309	
t_d	typ. 60	55	50	45	ns
t_r	typ. 300	200	180	155	ns
t_s	typ. 700	700	700	700	ns
t_f	typ. 600	450	350	350	ns
Q_s	typ. 1000	1000	1000	1000	pC

Recovered charge



Adjust C from zero to C_{opt}
 $Q_s = C_{opt} \cdot V_i$

SILICON PLANAR EPITAXIAL TRANSISTORS

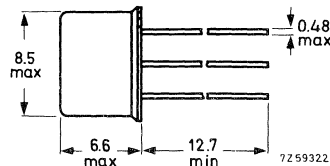
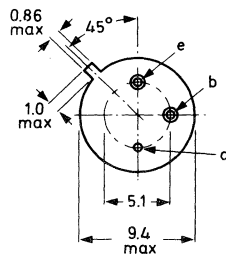
N-P-N transistors in a TO-39 metal envelope with the collector connected to the case. They are primarily intended for high speed switching. The 2N2218 is also suitable for d.c. and v.h.f. -u.h.f. amplifiers.

QUICK REFERENCE DATA			
		2N2218	2N2218A
Collector-base voltage (open emitter)	V_{CBO}	max. 60	75 V
Collector-emitter voltage (open base)	V_{CEO}	max. 30	40 V
Collector current (d.c.)	I_C	max. 800	800 mA
Total power dissipation up to $T_{amb} = 25^\circ\text{C}$	P_{tot}	max. 0.8	0.8 W
Junction temperature	T_j	max. 175	175 $^\circ\text{C}$
D.C. current gain at $T_j = 25^\circ\text{C}$ $I_C = 10\text{ mA}; V_{CE} = 10\text{ V}$	h_{FE}	> 35	35
Transition frequency at $f = 100\text{ MHz}$ $I_C = 20\text{ mA}; V_{CE} = 20\text{ V}$	f_T	> 250	250 MHz
Storage time $I_C = 150\text{ mA}; I_B = -I_{BM} = 15\text{ mA}$	t_s	< -	225 ns

MECHANICAL DATA

Dimensions in mm

Collector connected to case
TO-39



max. lead diameter is guaranteed only for 12.7 mm

Accessories available: 56218; 56245; 56265.

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

		2N2218	2N2218A
<u>Voltages</u>			
Collector-base voltage (open emitter)	V_{CBO}	max. 60	75 V
Collector-emitter voltage (open base)	V_{CEO}	max. 30	40 ¹⁾ V
Emitter-base voltage (open collector)	V_{EBO}	max. 5	6 V

Current

Collector current (d.c.)	I_C	max. 800	mA
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Power dissipation

Total power dissipation up to $T_{amb} = 25\text{ }^\circ\text{C}$	P_{tot}	max. 0.8	W
up to $T_{case} = 25\text{ }^\circ\text{C}$	P_{tot}	max. 3	W

Temperatures

Storage temperature	T_{stg}	-65 to +200	$^\circ\text{C}$
Junction temperature	T_j	max. 175	$^\circ\text{C}$

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	190 $^\circ\text{C/W}$
From junction to case	$R_{th\ j-c}$	=	50 $^\circ\text{C/W}$

CHARACTERISTICS

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

<u>Collector-cut-off current</u>		2N2218	2N2218A
$I_E = 0; V_{CB} = 50\text{ V}$	I_{CBO}	< 10	- nA
$I_E = 0; V_{CB} = 50\text{ V}; T_{amb} = 150\text{ }^\circ\text{C}$	I_{CBO}	< 10	- μA
$I_E = 0; V_{CB} = 60\text{ V}$	I_{CBO}	< -	10 nA
$I_E = 0; V_{CB} = 60\text{ V}; T_{amb} = 150\text{ }^\circ\text{C}$	I_{CBO}	< -	10 μA
<u>Emitter cut-off current</u>			
$I_C = 0; V_{EB} = 3\text{ V}$	I_{EBO}	< 10	10 nA
<u>Currents at reverse biased emitter junction</u>			
$V_{CE} = 60\text{ V}; -V_{BE} = 3\text{ V}$	I_{CEX}	< -	10 nA
	$-I_{BEX}$	< -	20 nA

1) Applicable up to $I_C = 500\text{ mA}$

CHARACTERISTICS (continued)

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

		2N2218	2N2218A
<u>Breakdown voltages</u>			
$I_E = 0; I_C = 10\ \mu\text{A}$	$V_{(BR)CBO} >$	60	75 V
$I_B = 0; I_C = 10\ \text{mA}$	$V_{(BR)CEO} >$	30	40 V
$I_C = 0; I_E = 10\ \mu\text{A}$	$V_{(BR)EBO} >$	5	6 V
<u>Saturation voltages ¹⁾</u>			
$I_C = 150\ \text{mA}; I_B = 15\ \text{mA}$	$V_{CEsat} <$	0.4	0.3 V
	$V_{BEsat} >$	-	0.6 V
$I_C = 500\ \text{mA}; I_B = 50\ \text{mA}$	$V_{BEsat} <$	1.3	1.2 V
	$V_{CEsat} <$	1.6	1.0 V
	$V_{BEsat} <$	2.6	2.0 V
<u>D.C. current gain</u>			
$I_C = 0.1\ \text{mA}; V_{CE} = 10\ \text{V}$	$h_{FE} >$	20	20
$I_C = 1\ \text{mA}; V_{CE} = 10\ \text{V}$	$h_{FE} >$	25	25
$I_C = 10\ \text{mA}; V_{CE} = 10\ \text{V}$	$h_{FE} >$	35	35
$I_C = 10\ \text{mA}; V_{CE} = 10\ \text{V}; T_{amb} = -55\text{ }^\circ\text{C}$	$h_{FE} >$	-	15
$I_C = 150\ \text{mA}; V_{CE} = 1\ \text{V}^1)$	$h_{FE} >$	20	20
$I_C = 150\ \text{mA}; V_{CE} = 10\ \text{V}^1)$	$h_{FE} >$	40 to 120	40 to 120
$I_C = 500\ \text{mA}; V_{CE} = 10\ \text{V}^1)$	$h_{FE} >$	20	25
<u>Transition frequency at $f = 100\ \text{MHz}$</u>			
$I_C = 20\ \text{mA}; V_{CE} = 20\ \text{V}$	$f_T >$	250	250 MHz
<u>Collector capacitance at $f = 100\ \text{kHz}$</u>			
$I_E = I_e = 0; V_{CB} = 10\ \text{V}$	$C_c <$	8	8 pF
<u>Emitter capacitance at $f = 100\ \text{kHz}$</u>			
$I_C = I_c = 0; V_{EB} = 0.5\ \text{V}$	$C_e <$	-	25 pF
<u>Feedback time constant at $f = 31.8\ \text{MHz}$</u>			
$I_C = 20\ \text{mA}; V_{CE} = 20\ \text{V}$	$r_b C_c <$	-	150 ps

¹⁾ Pulse duration $\leq 300\ \mu\text{s}$; duty cycle $\leq 2\%$.

2N2218 2N2218A

CHARACTERISTICS (continued)

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

h parameters (common emitter)

$I_C = 1\text{ mA}; V_{CE} = 10\text{ V}; f = 1\text{ kHz}$

2N2218A

Input impedance	h_{ie}	1 to 3.5	$k\Omega$
Reverse voltage transfer ratio	h_{re}	< 5	10^{-4}
Small signal current gain	h_{fe}	30 to 150	
Output admittance	h_{oe}	3 to 15	$\mu\Omega^{-1}$

$I_C = 10\text{ mA}; V_{CE} = 10\text{ V}; f = 1\text{ kHz}$

Input impedance	h_{ie}	0.2 to 1.0	$k\Omega$
Reverse voltage transfer ratio	h_{re}	< 2.5	10^{-4}
Small signal current gain	h_{fe}	50 to 300	
Output admittance	h_{oe}	10 to 100	$\mu\Omega^{-1}$

$I_C = 20\text{ mA}; V_{CE} = 20\text{ V}; f = 100\text{ MHz}$

2N2218 | 2N2218A

Small signal current gain	h_{fe}	> 2.5	2.5
Real part of input impedance	$Re(h_{ie})$	< 60	60 Ω

Switching times for 2N2218A

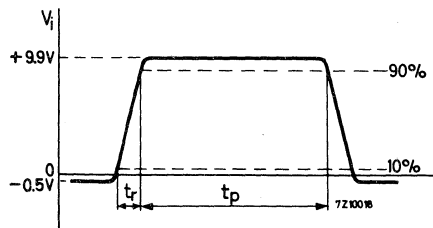
Turn on time when switched from
 $-V_{BE} = 0.5\text{ V}$ to $I_C = 150\text{ mA}; I_B = 15\text{ mA}$

Delay time

Rise time

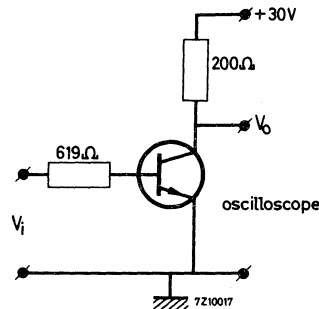
t_d	<	10	ns
t_r	<	25	ns

Test circuit:



Pulse generator:

pulse duration	$t_p \leq 200\text{ ns}$
rise time	$t_r \leq 2\text{ ns}$



Oscilloscope:

input resistance	$R_i > 100\text{ k}\Omega$
input capacitance	$C_i < 12\text{ pF}$
rise time	$t_r < 5\text{ ns}$

CHARACTERISTICS (continued)

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

Switching times for 2N2218A

Turn off time

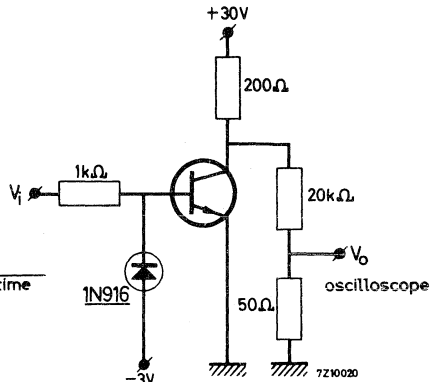
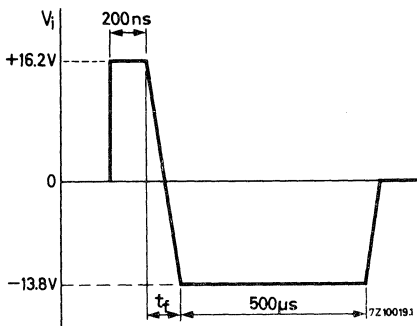
$I_C = 150\text{ mA}$; $I_B = -I_{BM} = 15\text{ mA}$

Storage time

Fall time

Test circuit:

$t_s < 225\text{ ns}$
 $t_f < 60\text{ ns}$



Pulse generator:

fall time $t_f < 5\text{ ns}$

Oscilloscope:

input impedance $R_i > 100\text{ k}\Omega$
input capacitance $C_i < 12\text{ pF}$
rise time $t_r < 5\text{ ns}$

SILICON PLANAR EPITAXIAL TRANSISTORS

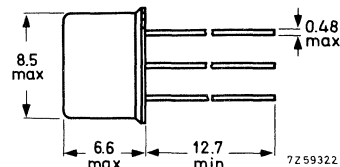
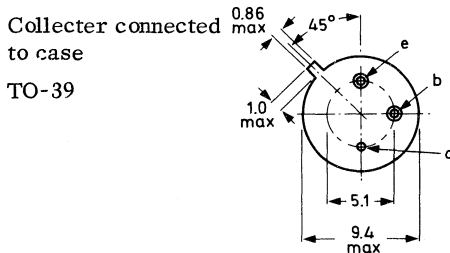
N-P-N transistors in a TO-39 metal envelope with the collector connected to the case. They are primarily intended for high speed switching. The 2N2219 is also suitable for d. c. and v. h. f. -u. h. f. amplifiers.

QUICK REFERENCE DATA

		2N2219	2N2219A
Collector-base voltage (open emitter)	V_{CBO}	max. 60	75 V
Collector-emitter voltage (open base)	V_{CEO}	max. 30	40 V
Collector current (d. c.)	I_C	max. 800	800 mA
Total power dissipation up to $T_{amb} = 25^\circ\text{C}$	P_{tot}	max. 0.8	0.8 W
Junction temperature	T_j	max. 175	175 $^\circ\text{C}$
D. C. current gain at $T_j = 25^\circ\text{C}$ $I_C = 10\text{ mA}; V_{CE} = 10\text{ V}$	h_{FE}	> 75	75
Transition frequency at $f = 100\text{ MHz}$ $I_C = 20\text{ mA}; V_{CE} = 20\text{ V}$	f_T	> 250	300 MHz
Storage time $I_C = 150\text{ mA}; I_B = -I_{BM} = 15\text{ mA}$	t_s	> -	225 ns

MECHANICAL DATA

Dimensions in mm



max. lead diameter is guaranteed only for 12.7 mm

Accessories available: 56218, 56245, 56265

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

<u>Voltages</u>		2N2219	2N2219A
Collector-base voltage (open emitter)	V_{CBO}	max. 60	75 V
Collector-emitter voltage (open base)	V_{CEO}	max. 30	40 ¹⁾ V
Emitter-base voltage (open collector)	V_{EBO}	max. 5	6 V

Current

Collector current (d.c.)	I_C	max.	800 mA
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Power dissipation

Total power dissipation up to $T_{amb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	0.8 W
up to $T_{case} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	3 W

Temperatures

Storage temperature	T_{stg}	-65 to +200	$^\circ\text{C}$
Junction temperature	T_j	max.	175 $^\circ\text{C}$

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	190 $^\circ\text{C}/\text{W}$
From junction to case	$R_{th\ j-c}$	=	50 $^\circ\text{C}/\text{W}$

CHARACTERISTICS

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

Collector cut-off current

		2N2219	2N2219A
$I_E = 0; V_{CB} = 50\text{ V}$	I_{CBO}	< 10	- nA
$I_E = 0; V_{CB} = 50\text{ V}; T_{amb} = 150\text{ }^\circ\text{C}$	I_{CBO}	< 10	- μA
$I_E = 0; V_{CB} = 60\text{ V}$	I_{CBO}	< -	10 nA
$I_E = 0; V_{CB} = 60\text{ V}; T_{amb} = 150\text{ }^\circ\text{C}$	I_{CBO}	< -	10 μA

Emitter cut-off current

$I_C = 0; V_{EB} = 3\text{ V}$	I_{EBO}	< 10	10 nA
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Currents at reverse biased emitter junction

$V_{CE} = 60\text{ V}; -V_{BE} = 3\text{ V}$	I_{CEX}	< -	10 nA
	$-I_{BEX}$	< -	20 nA

1) Applicable up to $I_C = 500\text{ mA}$

CHARACTERISTICS (continued)

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

<u>Breakdown voltages</u>	2N2219		2N2219A	
	$I_E = 0; I_C = 10 \mu\text{A}$	$V_{(BR)CBO} >$	60	75
$I_B = 0; I_C = 10 \text{ mA}$	$V_{(BR)CEO} >$	30	40	V
$I_C = 0; I_E = 10 \mu\text{A}$	$V_{(BR)EBO} >$	5	6	V
<u>Saturation voltages</u> ¹⁾				
$I_C = 150 \text{ mA}; I_B = 15 \text{ mA}$	$V_{CEsat} <$	0.4	0.3	V
	$V_{BEsat} >$	-	0.6	V
$I_C = 500 \text{ mA}; I_B = 50 \text{ mA}$	$V_{BEsat} <$	1.3	1.2	V
	$V_{CEsat} <$	1.6	1.0	V
	$V_{BEsat} <$	2.6	2.0	V
<u>D. C. current gain</u>				
$I_C = 0.1 \text{ mA}; V_{CE} = 10 \text{ V}$	$h_{FE} >$	35	35	
$I_C = 1 \text{ mA}; V_{CE} = 10 \text{ V}$	$h_{FE} >$	50	50	
$I_C = 10 \text{ mA}; V_{CE} = 10 \text{ V}$	$h_{FE} >$	75	75	
$I_C = 10 \text{ mA}; V_{CE} = 10 \text{ V}; T_{amb} = -55^\circ\text{C}$	$h_{FE} >$	-	35	
$I_C = 150 \text{ mA}; V_{CE} = 1 \text{ V}$ ¹⁾	$h_{FE} >$	50	50	
$I_C = 150 \text{ mA}; V_{CE} = 10 \text{ V}$ ¹⁾	$h_{FE} >$	100 to 300	100 to 300	
$I_C = 500 \text{ mA}; V_{CE} = 10 \text{ V}$ ¹⁾	$h_{FE} >$	30	40	
<u>Transition frequency at $f = 100 \text{ MHz}$</u>				
$I_C = 20 \text{ mA}; V_{CE} = 20 \text{ V}$	$f_T >$	250	300	MHz
<u>Collector capacitance at $f = 100 \text{ kHz}$</u>				
$I_E = I_e = 0; V_{CB} = 10 \text{ V}$	$C_c <$	8	8	pF
<u>Emitter capacitance at $f = 100 \text{ kHz}$</u>				
$I_C = I_c = 0; V_{EB} = 0.5 \text{ V}$	$C_e <$	-	25	pF
<u>Feedback time constant at $f = 31.8 \text{ MHz}$</u>				
$I_C = 20 \text{ mA}; V_{CE} = 20 \text{ V}$	$r_b' C_c <$	-	150	ps

¹⁾ Pulse duration $\leq 300 \mu\text{s}$; duty cycle $\leq 2\%$.

CHARACTERISTICS (continued)
h parameters (common emitter)

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

$I_C = 1\text{ mA}; V_{CE} = 10\text{ V}; f = 1\text{ kHz}$

Input impedance
Reverse voltage transfer ratio
Small signal current gain
Output admittance

2N2219A	
h_{ie}	2 to 8 $\text{k}\Omega$
h_{re}	< 8 10^{-4}
h_{fe}	50 to 300
h_{oe}	5 to 35 $\mu\Omega^{-1}$

$I_C = 10\text{ mA}; V_{CE} = 10\text{ V}; f = 1\text{ kHz}$

Input impedance
Reverse voltage transfer ratio
Small signal current gain
Output admittance

h_{ie}	0.25 to 1.25 $\text{k}\Omega$
h_{re}	< 4 10^{-4}
h_{fe}	75 to 375
h_{oe}	25 to 200 $\mu\Omega^{-1}$

$I_C = 20\text{ mA}; V_{CE} = 20\text{ V}; f = 100\text{ MHz}$

Small signal current gain

2N2219	2N2219A
h_{fe}	> 2.5
	3.0

$I_C = 20\text{ mA}; V_{CE} = 20\text{ V}; f = 300\text{ MHz}$

Real part of input impedance

$\text{Re}(h_{ie})$	< 60	60 Ω
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Noise figure at $f = 1\text{ kHz}$

$I_C = 0.1\text{ mA}; V_{CE} = 10\text{ V}$

$R_G = 1\text{ k}\Omega; B = 1\text{ Hz}$

F	< -	4 dB
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Switching times for 2N2219A

Turn on time when switched from
 $-V_{BE} = 0.5\text{ V}$ to $I_C = 150\text{ mA}; I_B = 15\text{ mA}$

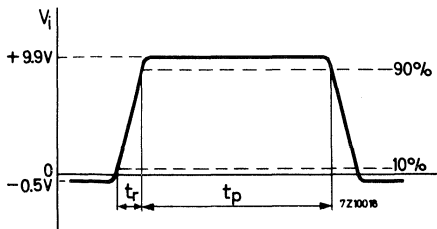
Delay time

t_d	<	10 ns
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Rise time

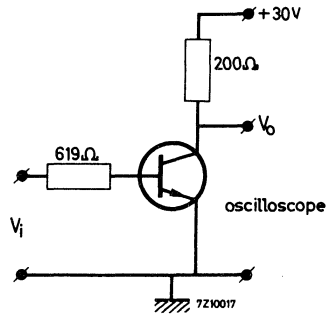
t_r	<	25 ns
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Test circuit:



Pulse generator:

pulse duration $t_p \leq 200\text{ ns}$
rise time $t_r \leq 2\text{ ns}$



Oscilloscope:

input resistance $R_i > 100\text{ k}\Omega$
input capacitance $C_i < 12\text{ pF}$
rise time $t_r < 5\text{ ns}$

CHARACTERISTICS (continued)

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

Switching times for 2N2219A

Turn off time

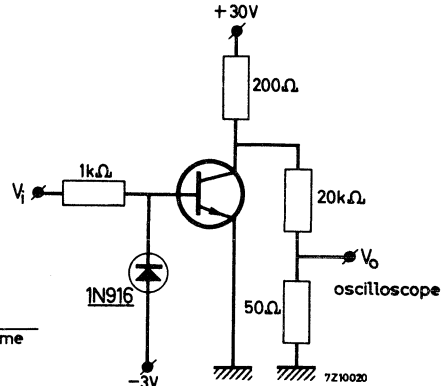
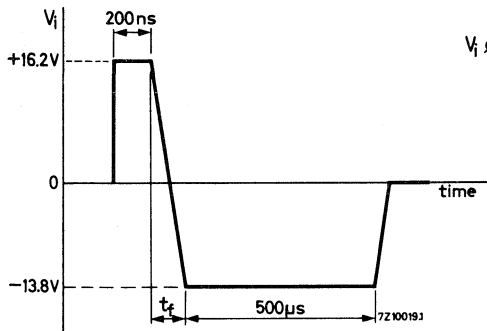
$I_C = 150\text{ mA}$; $I_B = -I_{BM} = 15\text{ mA}$

Storage time

Fall time

Test circuit:

$t_s < 225\text{ ns}$
 $t_f < 60\text{ ns}$



Pulse generator:

fall time $t_f < 5\text{ ns}$

Oscilloscope:

input impedance $R_i > 100\text{ k}\Omega$

input capacitance $C_i < 12\text{ pF}$

rise time $t_r < 5\text{ ns}$

SILICON PLANAR EPITAXIAL TRANSISTORS

N-P-N transistors in a TO-18 metal envelope with the collector connected to the case. They are primarily intended for high speed switching. The 2N2221 is also suitable for d. c. and v. h. f. -u. h. f. amplifiers.

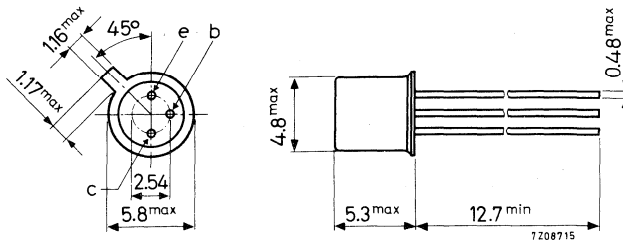
QUICK REFERENCE DATA

		2N2221	2N2221A
Collector-base voltage (open emitter)	V_{CBO}	max. 60	75 V
Collector-emitter voltage (open base)	V_{CEO}	max. 30	40 V
Collector current (d. c.)	I_C	max. 800	800 mA
Total power dissipation up to $T_{amb} = 25^\circ C$	P_{tot}	max. 0.5	0.5 W
Junction temperature	T_j	max. 175	175 $^\circ C$
D. C. current gain at $T_j = 25^\circ C$ $I_C = 10 \text{ mA}; V_{CE} = 10 \text{ V}$	h_{FE}	> 35	35
Transition frequency at $f = 100 \text{ MHz}$ $I_C = 20 \text{ mA}; V_{CE} = 20 \text{ V}$	f_T	> 250	250 MHz
Storage time $I_C = 150 \text{ mA}; I_B = -I_{BM} = 15 \text{ mA}$	t_s	< -	225 ns

MECHANICAL DATA

Dimensions in mm

Collector connected to case
TO-18



Accessories available: 56246, 56263

2N2221
2N2221A

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

<u>Voltages</u>		2N2221	2N2221A
Collector-base voltage (open emitter)	V_{CB0}	max. 60	75 V
Collector-emitter voltage (open base)	V_{CEO}	max. 30	40 ¹⁾ V
Emitter-base voltage (open collector)	V_{EBO}	max. 5	6 V

Current

Collector current (d. c.)	I_C	max.	800 mA
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Power dissipation

Total power dissipation up to $T_{amb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	0.5 W
up to $T_{case} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	1.8 W

Temperatures

Storage temperature	T_{stg}	-65 to +200	$^\circ\text{C}$
Junction temperature	T_j	max.	175 $^\circ\text{C}$

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	300 $^\circ\text{C/W}$
From junction to case	$R_{th\ j-c}$	=	83 $^\circ\text{C/W}$

CHARACTERISTICS

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

Collector cut-off current

		2N2221	2N2221A
$I_E = 0; V_{CB} = 50\text{ V}$	I_{CBO}	< 10	- nA
$I_E = 0; V_{CB} = 50\text{ V}; T_{amb} = 150\text{ }^\circ\text{C}$	I_{CBO}	< 10	- μA
$I_E = 0; V_{CB} = 60\text{ V}$	I_{CBO}	< -	10 nA
$I_E = 0; V_{CB} = 60\text{ V}; T_{amb} = 150\text{ }^\circ\text{C}$	I_{CBO}	< -	10 μA

Emitter cut-off current

$I_C = 0; V_{EB} = 3\text{ V}$	I_{EBO}	< 10	10 nA
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Currents at reverse biased emitter junction

$V_{CE} = 60\text{ V}; -V_{BE} = 3\text{ V}$	I_{CEX}	< -	10 nA
	$-I_{BEX}$	< -	20 nA

¹⁾ Applicable up to $I_C = 500\text{ mA}$

CHARACTERISTICS (continued)

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

Breakdown voltages

		2N2221	2N2221A
$I_E = 0; I_C = 10\ \mu\text{A}$	$V_{(BR)CBO} >$	60	75 V
$I_B = 0; I_C = 10\ \text{mA}$	$V_{(BR)CEO} >$	30	40 V
$I_C = 0; I_E = 10\ \mu\text{A}$	$V_{(BR)EBO} >$	5	6 V

Saturation voltages ¹⁾

$I_C = 150\ \text{mA}; I_B = 15\ \text{mA}$	$V_{CEsat} <$	0.4	0.3 V
	$V_{BEsat} >$	-	0.6 V
$I_C = 500\ \text{mA}; I_B = 50\ \text{mA}$	$V_{BEsat} <$	1.3	1.2 V
	$V_{CEsat} <$	1.6	1.0 V
	$V_{BEsat} <$	2.6	2.0 V

D. C. current gain

$I_C = 0.1\ \text{mA}; V_{CE} = 10\ \text{V}$	$h_{FE} >$	20	20
$I_C = 1\ \text{mA}; V_{CE} = 10\ \text{V}$	$h_{FE} >$	25	25
$I_C = 10\ \text{mA}; V_{CE} = 10\ \text{V}$	$h_{FE} >$	35	35
$I_C = 10\ \text{mA}; V_{CE} = 10\ \text{V}; T_{amb} = -55^\circ\text{C}$	$h_{FE} >$	-	15
$I_C = 150\ \text{mA}; V_{CE} = 1\ \text{V}$ ¹⁾	$h_{FE} >$	20	20
$I_C = 150\ \text{mA}; V_{CE} = 10\ \text{V}$ ¹⁾	h_{FE}	40 to 120	40 to 120
$I_C = 500\ \text{mA}; V_{CE} = 10\ \text{V}$ ¹⁾	$h_{FE} >$	20	25

Transition frequency at $f = 100\ \text{MHz}$

$I_C = 20\ \text{mA}; V_{CE} = 20\ \text{V}$	$f_T >$	250	250 MHz
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Collector capacitance at $f = 100\ \text{kHz}$

$I_E = I_e = 0; V_{CB} = 10\ \text{V}$	$C_c <$	8	8 pF
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Emitter capacitance at $f = 100\ \text{kHz}$

$I_C = I_c = 0; V_{EB} = 0.5\ \text{V}$	$C_e <$	-	25 pF
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Feedback time constant at $f = 31.8\ \text{MHz}$

$I_C = 20\ \text{mA}; V_{CE} = 20\ \text{V}$	$r_b' C_c <$	-	150 ps
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¹⁾ Pulse duration $\leq 300\ \mu\text{s}$; duty cycle $\leq 2\%$.

CHARACTERISTICS (continued)

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

h parameters (common emitter)

$I_C = 1\text{ mA}; V_{CE} = 10\text{ V}; f = 1\text{ kHz}$

Input impedance
Reverse voltage transfer ratio
Small signal current gain
Output admittance

2N2221A	
h_{ie}	1 to 3.5 $k\Omega$
h_{re}	< 5 10^{-4}
h_{fe}	30 to 150
h_{oe}	3 to 15 $\mu\Omega^{-1}$

$I_C = 10\text{ mA}; V_{CE} = 10\text{ V}; f = 1\text{ kHz}$

Input impedance
Reverse voltage transfer ratio
Small signal current gain
Output admittance

h_{ie}	0.2 to 1.0 $k\Omega$
h_{re}	< 2.5 10^{-4}
h_{fe}	50 to 300
h_{oe}	10 to 100 $\mu\Omega^{-1}$

$I_C = 20\text{ mA}; V_{CE} = 20\text{ V}; f = 100\text{ MHz}$

Small signal current gain

2N2221	2N2221A
h_{fe}	> 2.5

$I_C = 20\text{ mA}; V_{CE} = 20\text{ V}; f = 300\text{ MHz}$

Real part of input impedance

$Re(h_{ie})$	< 60	60 Ω
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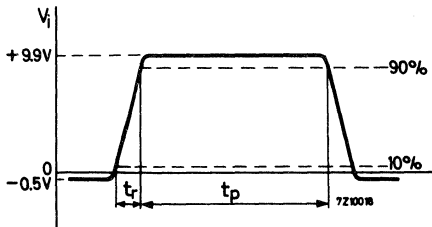
Switching times for 2N2221A

Turn on time when switched from
 $-V_{BE} = 0.5\text{ V}$ to $I_C = 150\text{ mA}; I_B = 15\text{ mA}$

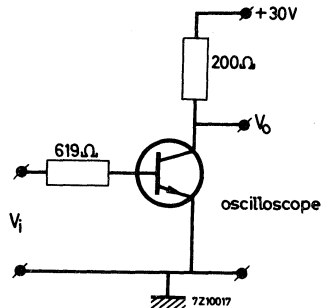
Delay time
Rise time

t_d	< 10 ns
t_r	< 25 ns

Test circuit:



Pulse generator:
pulse duration $t_p \leq 200\text{ ns}$
rise time $t_r \leq 2\text{ ns}$



Oscilloscope:
input resistance $R_i > 100\text{ k}\Omega$
input capacitance $C_i < 12\text{ pF}$
rise time $t_r < 5\text{ ns}$

CHARACTERISTICS (continued)

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

Switching times for 2N2221A

Turn off time

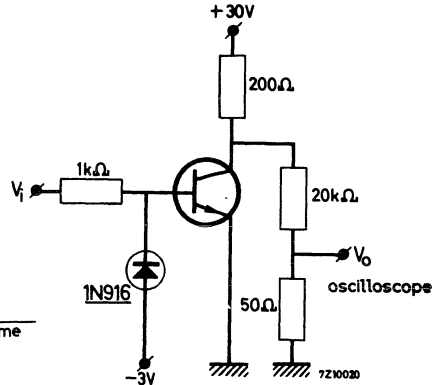
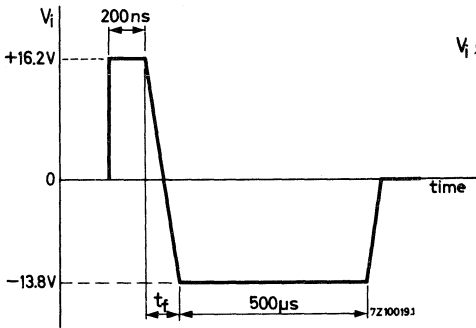
$I_C = 150\text{ mA}; I_B = -I_{BM} = 15\text{ mA}$

Storage time

Fall time

Test circuit:

$t_S < 225\text{ ns}$
 $t_f < 60\text{ ns}$



Pulse generator:

fall time $t_f < 5\text{ ns}$

Oscilloscope:

input impedance
input capacitance
rise time

$R_i > 100\text{ k}\Omega$
 $C_i < 12\text{ pF}$
 $t_r < 5\text{ ns}$

SILICON PLANAR EPITAXIAL TRANSISTORS

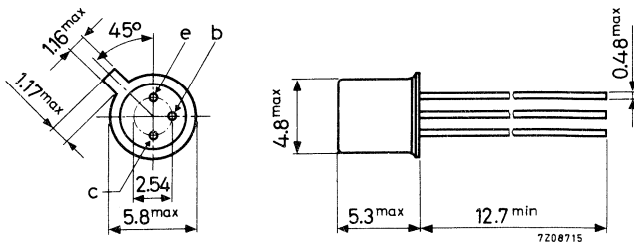
N-P-N transistors in a TO-18 metal envelope with the collector connected to the case. They are primarily intended for high speed switching. The 2N2222 is also suitable for d.c. and v.h.f. -u.h.f. amplifiers.

QUICK REFERENCE DATA			
		2N2222	2N2222A
Collector-base voltage (open emitter)	V_{CBO}	max. 60	75 V
Collector-emitter voltage (open base)	V_{CEO}	max. 30	40 V
Collector current (d.c.)	I_C	max. 800	800 mA
Total power dissipation up to $T_{amb} = 25^\circ C$	P_{tot}	max. 0.5	0.5 W
Junction temperature	T_j	max. 175	175 $^\circ C$
D.C. current gain at $T_j = 25^\circ C$ $I_C = 10$ mA; $V_{CE} = 10$ V	h_{FE}	> 75	75
Transition frequency at $f = 100$ MHz $I_C = 20$ mA; $V_{CE} = 20$ V	f_T	> 250	300 MHz
Storage time $I_C = 150$ mA; $I_B = -I_{BM} = 15$ mA	t_s	< -	225 ns

MECHANICAL DATA

Dimensions in mm

Collector connected to case
TO-18



Accessories available: 56246, 56263

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

		2N2222	2N2222A
<u>Voltages</u>			
Collector-base voltage (open emitter)	V_{CBO}	max. 60	75 V
Collector-emitter voltage (open base)	V_{CEO}	max. 30	40 ¹⁾ V
Emitter-base voltage (open collector)	V_{EBO}	max. 5	6 V

Current

Collector current (d.c.)	I_C	max. 800	mA
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Power dissipation

Total power dissipation up to $T_{amb} = 25\text{ }^\circ\text{C}$	P_{tot}	max. 0.5	W
up to $T_{case} = 25\text{ }^\circ\text{C}$	P_{tot}	max. 1.8	W

Temperatures

Storage temperature	T_{stg}	-65 to +200	$^\circ\text{C}$
Junction temperature	T_j	max. 175	$^\circ\text{C}$

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	= 300	$^\circ\text{C}/\text{W}$
From junction to case	$R_{th\ j-c}$	= 83	$^\circ\text{C}/\text{W}$

CHARACTERISTICS

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

<u>Collector cut-off current</u>		2N2222	2N2222A
$I_E = 0; V_{CB} = 50\text{ V}$	I_{CBO}	< 10	- nA
$I_E = 0; V_{CB} = 50\text{ V}; T_{amb} = 150\text{ }^\circ\text{C}$	I_{CBO}	< 10	- μA
$I_E = 0; V_{CB} = 60\text{ V}$	I_{CBO}	< -	10 nA
$I_E = 0; V_{CB} = 60\text{ V}; T_{amb} = 150\text{ }^\circ\text{C}$	I_{CBO}	< -	10 μA
<u>Emitter cut-off current</u>			
$I_C = 0; V_{EB} = 3\text{ V}$	I_{EBO}	< 10	10 nA
<u>Currents at reverse biased emitter junction</u>			
$V_{CE} = 60\text{ V}; -V_{BE} = 3\text{ V}$	I_{CEX}	< -	10 nA
	$-I_{BEX}$	< -	20 nA

¹⁾ Applicable up to $I_C = 500\text{ mA}$

CHARACTERISTICS (continued)

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

		2N2222	2N2222A
<u>Breakdown voltages</u>			
$I_E = 0; I_C = 10\text{ }\mu\text{A}$	$V_{(BR)CBO} >$	60	75 V
$I_B = 0; I_C = 10\text{ mA}$	$V_{(BR)CEO} >$	30	40 V
$I_C = 0; I_E = 10\text{ }\mu\text{A}$	$V_{(BR)EBO} >$	5	6 V
<u>Saturation voltages</u> ¹⁾			
$I_C = 150\text{ mA}; I_B = 15\text{ mA}$	$V_{CEsat} <$	0.4	0.3 V
	$V_{BEsat} >$	-	0.6 V
	$V_{BEsat} <$	1.3	1.2 V
$I_C = 500\text{ mA}; I_B = 50\text{ mA}$	$V_{CEsat} <$	1.6	1.0 V
	$V_{BEsat} <$	2.6	2.0 V
<u>D.C. current gain</u>			
$I_C = 0.1\text{ mA}; V_{CE} = 10\text{ V}$	$h_{FE} >$	35	35
$I_C = 1\text{ mA}; V_{CE} = 10\text{ V}$	$h_{FE} >$	50	50
$I_C = 10\text{ mA}; V_{CE} = 10\text{ V}$	$h_{FE} >$	75	75
$I_C = 10\text{ mA}; V_{CE} = 10\text{ V}; T_{amb} = -55\text{ }^\circ\text{C}$	$h_{FE} >$	-	35
$I_C = 150\text{ mA}; V_{CE} = 1\text{ V}$ ¹⁾	$h_{FE} >$	50	50
$I_C = 150\text{ mA}; V_{CE} = 10\text{ V}$ ¹⁾	h_{FE}	100 to 300	100 to 300
$I_C = 500\text{ mA}; V_{CE} = 10\text{ V}$ ¹⁾	$h_{FE} >$	30	40
<u>Transition frequency at $f = 100\text{ MHz}$</u>			
$I_C = 20\text{ mA}; V_{CE} = 20\text{ V}$	$f_T >$	250	300 MHz
<u>Collector capacitance at $f = 100\text{ kHz}$</u>			
$I_E = I_e = 0; V_{CB} = 10\text{ V}$	$C_c <$	8	8 pF
<u>Emitter capacitance at $f = 100\text{ kHz}$</u>			
$I_C = I_c = 0; V_{EB} = 0.5\text{ V}$	$C_e <$	-	25 pF
<u>Feedback time constant at $f = 31.8\text{ MHz}$</u>			
$I_C = 20\text{ mA}; V_{CE} = 20\text{ V}$	$r_b C_c <$	-	150 ps

¹⁾ Pulse duration $\leq 300\text{ }\mu\text{s}$; duty cycle $\leq 2\%$.

CHARACTERISTICS (continued)

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

h parameters (common emitter)

$I_C = 1\text{ mA}; V_{CE} = 10\text{ V}; f = 1\text{ kHz}$

Input impedance
Reverse voltage transfer ratio
Small signal current
Output admittance

2N2222A	
h_{ie}	2 to 8 $k\Omega$
h_{re}	< 8 10^{-4}
h_{fe}	50 to 300
h_{oe}	5 to 35 $\mu\Omega^{-1}$

$I_C = 10\text{ mA}; V_{CE} = 10\text{ V}; f = 1\text{ kHz}$

Input impedance
Reverse voltage transfer ratio
Small signal current gain
Output admittance

h_{ie}	0.25 to 1.25 $k\Omega$
h_{re}	< 4 10^{-4}
h_{fe}	75 to 375
h_{oe}	25 to 200 $\mu\Omega^{-1}$

$I_C = 20\text{ mA}; V_{CE} = 20\text{ V}; f = 100\text{ MHz}$

Small signal current gain

2N2222	2N2222A
h_{fe}	> 2.5
	3.0

$I_C = 20\text{ mA}; V_{CE} = 20\text{ V}; f = 300\text{ MHz}$

Real part of input impedance

$Re(h_{ie})$	< 60	60 Ω
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Noise figure at $f = 1\text{ kHz}$

$I_C = 0.1\text{ mA}; V_{CE} = 10\text{ V}$
 $R_G = 1\text{ k}\Omega; B = 1\text{ Hz}$

F	< -	4 dB
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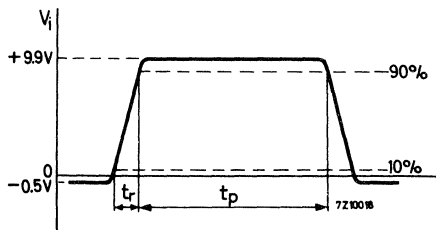
Switching times for 2N2222A

Turn on time when switched from
 $-V_{BE} = 0.5\text{ V}$ to $I_C = 150\text{ mA}; I_B = 15\text{ mA}$

Delay time
Rise time

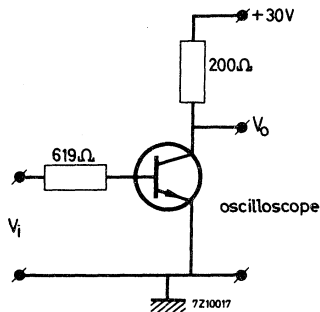
t_d	< 10 ns
t_r	< 25 ns

Test circuit:



Pulse generator:

pulse duration $t_p \leq 200\text{ ns}$
rise time $t_r \leq 2\text{ ns}$



Oscilloscope:

input resistance $R_i > 100\text{ k}\Omega$
input capacitance $C_i < 12\text{ pF}$
rise time $t_r < 5\text{ ns}$

CHARACTERISTICS (continued)

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

Switching times for 2N2222A

Turn off time

$I_C = 150\text{ mA}; I_B = -I_{BM} = 15\text{ mA}$

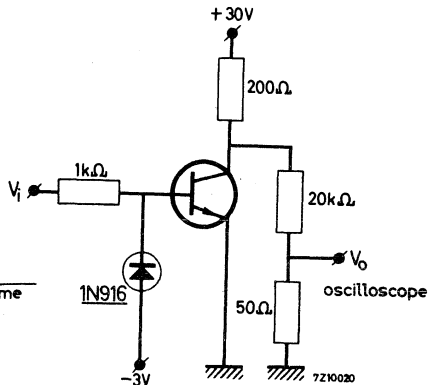
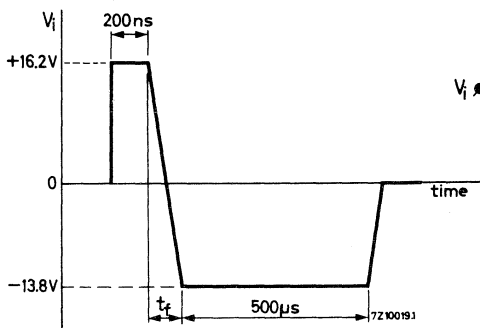
Storage time

$t_s < 225\text{ ns}$

Fall time

$t_f < 60\text{ ns}$

Test circuit:



Pulse generator:

fall time $t_f < 5\text{ ns}$

Oscilloscope:

input impedance $R_i > 100\text{ k}\Omega$

input capacitance $C_i < 12\text{ pF}$

rise time $t_r < 5\text{ ns}$

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.

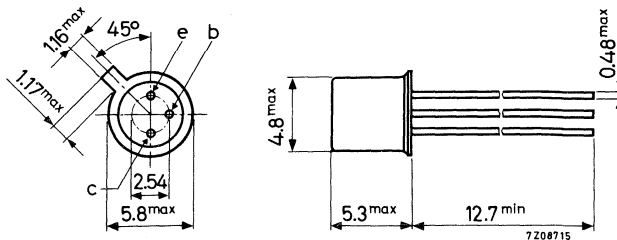
QUICK REFERENCE DATA			
Collector-base voltage (open emitter)	V_{CBO}	max.	40 V
Collector-emitter voltage (open base)	V_{CEO}	max.	15 V
Collector current (peak value)	I_{CM}	max.	500 mA
Total power dissipation up to $T_{amb} = 25^{\circ}C$	P_{tot}	max.	360 mW
Junction temperature	T_j	max.	200 $^{\circ}C$
D.C. current gain at $T_j = 25^{\circ}C$			
$I_C = 10 \text{ mA}; V_{CE} = 1 \text{ V}$	<u>2N2368</u>	h_{FE}	20 to 60
	<u>2N2369</u>	h_{FE}	40 to 120
Transition frequency			
$I_C = 10 \text{ mA}; V_{CE} = 10 \text{ V}$	<u>2N2368</u>	f_T	> 400 MHz
	<u>2N2369</u>	f_T	> 500 MHz
Storage time			
$I_C = I_B = -I_{BM} = 10 \text{ mA}$	<u>2N2368</u>	t_s	< 10 ns
	<u>2N2369</u>	t_s	< 13 ns

MECHANICAL DATA

Dimensions in mm

Collector connected to case

TO-18



Accessories available: 56246, 56263

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
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Power dissipation

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

Storage temperature	T_{stg}	-65 to +200	$^\circ C$
Junction temperature	T_j	max.	200 $^\circ C$

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th j-a}$	=	0.48 $^\circ C/mW$
From junction to case	$R_{th j-c}$	=	0.145 $^\circ C/mW$

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

CHARACTERISTICS

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

Collector cut-off current

$I_E = 0; V_{CB} = 20\text{ V}$

$I_{CBO} < 0.4\text{ }\mu\text{A}$

$I_E = 0; V_{CB} = 20\text{ V}; T_j = 150\text{ }^\circ\text{C}$

$I_{CBO} < 30\text{ }\mu\text{A}$

Sustaining voltage ¹⁾

$I_C = 10\text{ mA}; I_B = 0$

$V_{CEOsust} > 15\text{ V}$ ¹⁾

Saturation voltages

$I_C = 10\text{ mA}; I_B = 1\text{ mA}$

$V_{CEsat} < 0.25\text{ V}$

$V_{BEsat} 0.7\text{ to }0.85\text{ V}$

Collector capacitance at $f = 140\text{ kHz}$

$I_E = I_e = 0; V_{CB} = 5\text{ V}$

$C_c < 4\text{ pF}$

D.C. current gain ¹⁾

$I_C = 10\text{ mA}; V_{CE} = 1\text{ V}$

	2N2368	2N2369
h_{FE}	20 to 60	40 to 120

$I_C = 10\text{ mA}; V_{CE} = 1\text{ V}; T_j = -55\text{ }^\circ\text{C}$

$h_{FE} > 10$

$I_C = 100\text{ mA}; V_{CE} = 2\text{ V}$

$h_{FE} > 10$

Transition frequency

$I_C = 10\text{ mA}; V_{CE} = 10\text{ V}$

$f_T > 400$ | 500 MHz

¹⁾ Measured under pulsed conditions to avoid excessive dissipation
Pulse duration $t = 300\text{ }\mu\text{s}$; duty cycle $\delta = 0.01$

CHARACTERISTICS (continued)

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

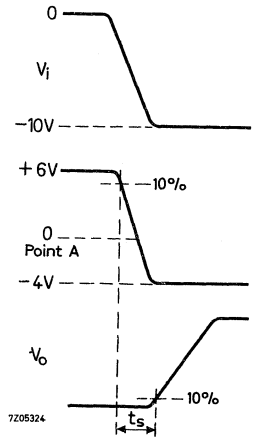
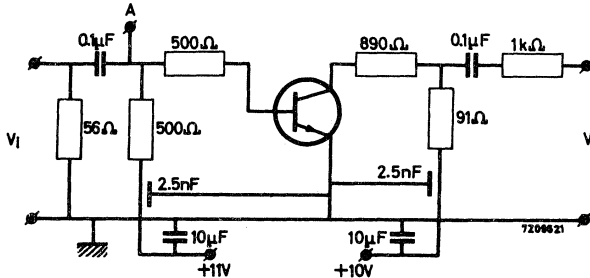
Storage time

$I_C = I_B = -I_{BM} = 10\text{ mA}$

Test circuit: 1)

2N2368
2N2369

$t_s < 10\text{ ns}$
 $t_s < 13\text{ ns}$



Turn on time

$I_C = 10\text{ mA}; I_B = 3\text{ mA}; -V_{BE} = 1.5\text{ V}$

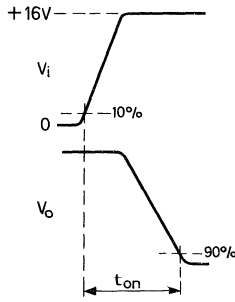
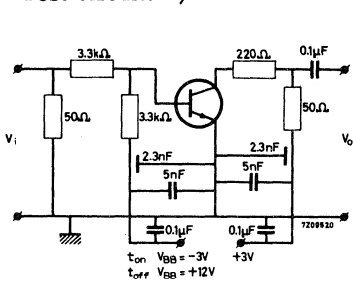
Turn off time

$I_C = 10\text{ mA}; I_B = 3\text{ mA}; -I_{BM} = 1.5\text{ mA}$

2N2368
2N2369

$t_{on} < 12\text{ ns}$
 $t_{off} < 15\text{ ns}$
 $t_{off} < 18\text{ ns}$

Test circuit: 1)



1) Pulse generator:

Pulse duration	$t \geq 300\text{ ns}$
Duty cycle	$\delta \leq 0.02$
Rise time	$t_r \leq 1\text{ ns}$
Source impedance	$R_S = 50\ \Omega$

Oscilloscope:

Rise time	$t_r \leq 1\text{ ns}$
Input impedance	$R_i = 50\ \Omega$

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.

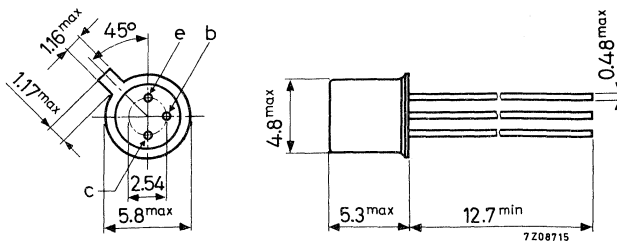
QUICK REFERENCE DATA		
Collector-base voltage (open emitter)	V_{CBO}	max. 40 V
Collector-emitter voltage (open base)	V_{CEO}	max. 15 V
Collector current (peak value)	I_{CM}	max. 500 mA
Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}$	P_{tot}	max. 360 mW
Junction temperature	T_j	max. 200 $^{\circ}\text{C}$
D.C. current gain at $T_j = 25\text{ }^{\circ}\text{C}$ $I_C = 10\text{ mA}; V_{CE} = 1\text{ V}$	h_{FE}	40 to 120
Transition frequency $I_C = 10\text{ mA}; V_{CE} = 10\text{ V}$	f_T	> 500 MHz
Storage time $I_C = I_B = -I_{BM} = 10\text{ mA}$	t_s	< 13 ns

MECHANICAL DATA

Dimensions in mm

Collector connected to the case

TO-18



Accessories available: 56246, 56263

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; $t = 10$ μ s)	I_{CM}	max.	500	mA

Power dissipation

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

CHARACTERISTICS

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

Collector cut-off current

$V_{BE} = 0; V_{CE} = 20\text{ V}$	I_{CES}	<	$0.4\text{ }\mu\text{A}$
$I_E = 0; V_{CB} = 20\text{ V}; T_j = 150\text{ }^\circ\text{C}$	I_{CBO}	<	$30\text{ }\mu\text{A}$

Base current

$V_{BE} = 0; V_{CE} = 20\text{ V}$	$-I_{BEX}$	<	$0.4\text{ }\mu\text{A}$
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Sustaining voltage 1)

$I_C = 10\text{ mA}; I_B = 0$	$V_{CEO\text{sust}}$	>	15 V
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Saturation voltages

$I_C = 10\text{ mA}; I_B = 1\text{ mA}$	$V_{CE\text{sat}}$	<	0.2 V
	$V_{BE\text{sat}}$		$0.7\text{ to }0.85\text{ V}$

$I_C = 30\text{ mA}; I_B = 3\text{ mA}$	$V_{CE\text{sat}}$	<	0.25 V
	$V_{BE\text{sat}}$	<	1.15 V

$I_C = 100\text{ mA}; I_B = 10\text{ mA}$	$V_{CE\text{sat}}$	<	0.5 V
	$V_{BE\text{sat}}$	<	1.6 V

$I_C = 10\text{ mA}; I_B = 1\text{ mA}; T_j = 125\text{ }^\circ\text{C}$	$V_{CE\text{sat}}$	<	0.3 V
	$V_{BE\text{sat}}$	>	0.59 V

$I_C = 10\text{ mA}; I_B = 1\text{ mA}; T_j = -55\text{ }^\circ\text{C}$	$V_{BE\text{sat}}$	<	1.02 V
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D.C. current gain 1)

$I_C = 10\text{ mA}; V_{CE} = 1\text{ V}$	h_{FE}		$40\text{ to }120$
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$I_C = 30\text{ mA}; V_{CE} = 0.4\text{ V}$	h_{FE}	>	30
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$I_C = 100\text{ mA}; V_{CE} = 1\text{ V}$	h_{FE}	>	20
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$I_C = 10\text{ mA}; V_{CE} = 1\text{ V}; T_j = -55\text{ }^\circ\text{C}$	h_{FE}	>	20
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Collector capacitance at $f = 140\text{ kHz}$

$I_E = I_e = 0; V_{CB} = 5\text{ V}$	C_c	<	4 pF
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Transition frequency

$I_C = 10\text{ mA}; V_{CE} = 10\text{ V}$	f_T	>	500 MHz
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1) Measured under pulsed conditions to avoid excessive dissipation
Pulse duration $t = 300\text{ }\mu\text{s}$; duty cycle $\delta < 0.01$

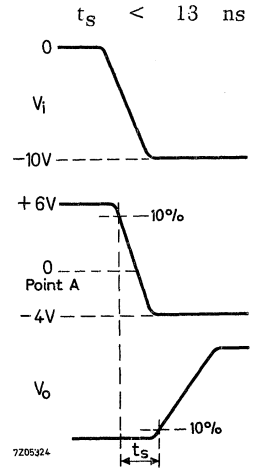
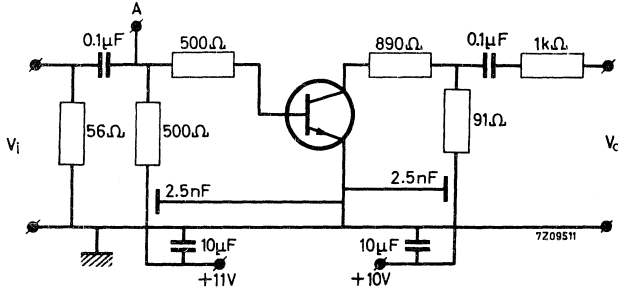
CHARACTERISTICS (continued)

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

Storage time

$I_C = I_B = -I_{BM} = 10\text{ mA}$

Test circuit: 1)



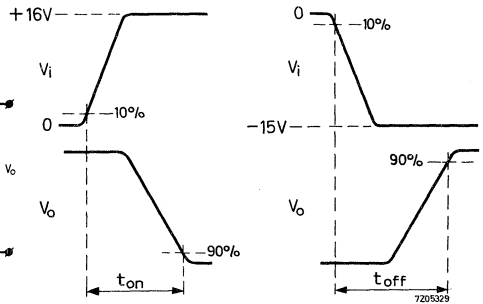
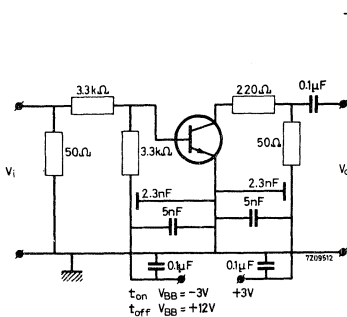
Turn on time

$I_C = 10\text{ mA}; I_B = 3\text{ mA}; -V_{BE} = 1.5\text{ V}$

Turn off time

$I_C = 10\text{ mA}; I_B = 3\text{ mA}; -I_{BM} = 1.5\text{ mA}$

Test circuit: 1)



1) Pulse generator:

Pulse duration	$t \geq 300\text{ ns}$
Duty cycle	$\delta \leq 0.02$
Rise time	$t_r \leq 1\text{ ns}$
Source impedance	$R_S = 50\ \Omega$

Oscilloscope:

Rise time	$t_r \leq 1\text{ ns}$
Input impedance	$R_i = 50\ \Omega$

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

Voltages

			2N2894	2N2894A
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	12	12 V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	12	12 V ¹⁾
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	4.0	4.5 V

Current

Collector current (d. c.)	$-I_C$	max.	200	mA
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Power dissipation

Total power dissipation up to $T_{amb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	0.36	W
up to $T_{case} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	1.2	W

Temperatures

Storage temperature	T_{stg}	-65 to +200	$^\circ\text{C}$
Junction temperature	T_j	max.	200 $^\circ\text{C}$

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	486	$^\circ\text{C/W}$
From junction to case	$R_{th\ j-c}$	=	146	$^\circ\text{C/W}$

CHARACTERISTICS

$T_{amb} = 25\text{ }^\circ\text{C}$ unless otherwise specified

Collector cut-off current

			2N2894	2N2894A
$I_E = 0; -V_{CB} = 6.0\text{ V}; T_{amb} = 125\text{ }^\circ\text{C}$	$-I_{CBO}$	<	10	- μA
$I_E = 0; -V_{CB} = 10\text{ V}; T_{amb} = 125\text{ }^\circ\text{C}$	$-I_{CBO}$	<	-	10 μA
$V_{BE} = 0; -V_{CE} = 6.0\text{ V}$	$-I_{CES}$	<	80	- nA
$V_{BE} = 0; -V_{CE} = 10\text{ V}$	$-I_{CES}$	<	-	50 nA

Breakdown voltages

$I_E = 0; -I_C = 10\text{ }\mu\text{A}$	$-V_{(BR)CBO}$	>	12	12 V
$V_{BE} = 0; -I_C = 10\text{ }\mu\text{A}$	$-V_{(BR)CES}$	>	12	12 V
$I_C = 0; -I_E = 100\text{ }\mu\text{A}$	$-V_{(BR)EBO}$	>	4.0	4.5 V

¹⁾ Applicable up to $-I_C = 10\text{ mA}$

CHARACTERISTICS (continued)

$T_{amb} = 25\text{ }^{\circ}\text{C}$ unless otherwise specified

Sustaining voltage ¹⁾

$I_B = 0; -I_C = 10\text{ mA}$

	2N2894	2N2894A
$-V_{CEOsust} >$	12	12 V

Saturation voltages ¹⁾

$-I_C = 10\text{ mA}; -I_B = 1.0\text{ mA}$

$-V_{CEsat} <$	0.15	0.13 V
$-V_{BEsat}$	0.78 to 0.98	0.78 to 0.92 V

$-I_C = 30\text{ mA}; -I_B = 3.0\text{ mA}$

$-V_{CEsat} <$	0.2	0.19 V
$-V_{BEsat}$	0.85 to 1.2	0.85 to 1.15 V

$-I_C = 100\text{ mA}; -I_B = 10\text{ mA}$

$-V_{CEsat} <$	0.5	0.45 V
$-V_{BEsat} >$	-	1.0 V
$-V_{BEsat} <$	1.7	1.5 V

D.C. current gain ¹⁾

$-I_C = 1.0\text{ mA}; -V_{CE} = 0.5\text{ V}$

$h_{FE} >$	-	20
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$-I_C = 10\text{ mA}; -V_{CE} = 0.3\text{ V}$

$h_{FE} >$	30	30
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$-I_C = 30\text{ mA}; -V_{CE} = 0.5\text{ V}$

h_{FE}	40 to 150	40 to 120
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$-I_C = 30\text{ mA}; -V_{CE} = 0.5\text{ V}; T_{amb} = -55^{\circ}\text{C}$

$h_{FE} >$	17	20
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$-I_C = 100\text{ mA}; -V_{CE} = 1.0\text{ V}$

$h_{FE} >$	25	30
------------	----	----

Collector capacitance at $f = 140\text{ kHz}$

$I_E = I_e = 0; -V_{CB} = 5.0\text{ V}$

$C_c <$	6.0	4.5 pF
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Emitter capacitance at $f = 140\text{ kHz}$

$I_C = I_c = 0; -V_{EB} = 0.5\text{ V}$

$C_e <$	6.0	6.0 pF
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h parameter at $f = 100\text{ MHz}$ (common emitter)

$-I_C = 30\text{ mA}; -V_{CE} = 10\text{ V}$

$h_{fe} >$	4.0	8.0
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¹⁾ Pulse duration = 300 μs ; duty cycle = 0.01

2N2894 2N2894A

Switching times

$$-I_C = 30 \text{ mA}; -I_{B1} = +I_{B2} = 1.5 \text{ mA}$$

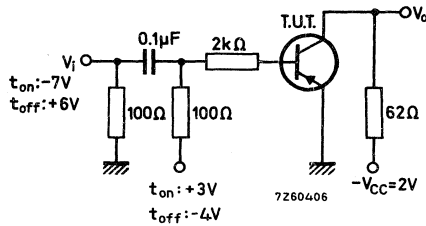
Turn-on time

Turn-off time

$T_{\text{amb}} = 25 \text{ }^\circ\text{C}$ unless otherwise specified

	2N2894	2N2894A	
$t_{\text{on}} <$	60	60	ns
$t_{\text{off}} <$	90	35	ns

Test circuit:



Pulse generator:

Pulse duration	t_p	$>$	200 ns
Rise time	t_r	$<$	1 ns
Output impedance	Z_o	$=$	50 Ω

Sampling scope:

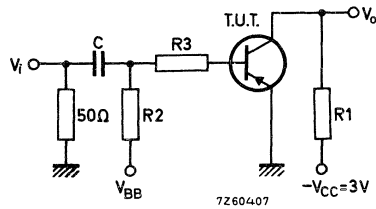
Rise time	t_r	$<$	1 ns
Input impedance	Z_i	$=$	100 k Ω

Switching times (continued)

$T_{amb} = 25\text{ }^{\circ}\text{C}$ unless otherwise specified

Turn-on time	2N2894A	t_{on}	<	20	ns
Turn-off time	2N2894A	t_{off}	<	25	ns
Storage time	2N2894A	τ_s	<	20	ns

Test circuit:



Pulse generator:

Pulse duration = 400 ns
Rise time < 1 ns
Output impedance = 50 Ω

Sampling scope:

Rise time < 1 ns
Input impedance = 100 k Ω

	V_i (V)	V_{BB} (V)	R_1 (Ω)	R_2 (k Ω)	R_3 (k Ω)	$-I_C$ (mA)	$-I_{B1}$ (mA)	I_{B2} (mA)	C (μF)
t_{on}	-6.85	0	94	1.0	2.0	30	3.0	-	0.1
t_{off}	11.7	-9.85	94	1.0	2.0	30	3.0	3.0	0.1
τ_s	10	-11	270	0.5	0.5	10	10	10	0.33

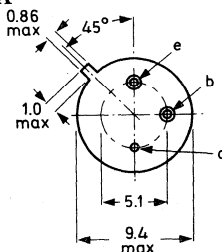
P-N-P MEDIUM POWER GENERAL PURPOSE TRANSISTORS

P-N-P silicon planar epitaxial transistors in a TO-39 metal envelope with the collector connected to the case. These transistors are primarily intended for saturated switching and driver applications for industrial service.

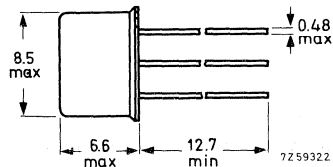
QUICK REFERENCE DATA			
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60 V
Collector-emitter voltage (open base)			
	<u>2N2904</u>	$-V_{CEO}$	max. 40 V
	<u>2N2904A</u>	$-V_{CEO}$	max. 60 V
Collector current (d.c.)	$-I_C$	max.	0.6 A
Total power dissipation up to $T_{amb} = 25^\circ\text{C}$	P_{tot}	max.	0.6 W
Junction temperature	T_j	max.	200 $^\circ\text{C}$
Transition frequency			
$-I_C = 50\text{ mA}; -V_{CE} = 20\text{ V}$	f_T	>	200 MHz
D.C. current gain at $T_j = 25^\circ\text{C}$			
			<u>2N2904</u> <u>2N2904A</u>
$-I_C = 0.1\text{ mA}; -V_{CE} = 10\text{ V}$	h_{FE}	> 20	40
$-I_C = 10\text{ mA}; -V_{CE} = 10\text{ V}$	h_{FE}	> 35	40
$-I_C = 500\text{ mA}; -V_{CE} = 10\text{ V}$	h_{FE}	> 20	40

MECHANICAL DATA

Collector connected
to case
TO-39



Dimensions in mm



max. lead diameter is guaranteed only for 12.7 mm

Accessories available: 56218, 56245, 56265

RATINGS (Limiting values) ¹⁾

Voltages

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60 V
Collector-emitter voltage (open base)			
$-I_C < 100$ mA	<u>2N2904</u>	$-V_{CEO}$	max. 40 V
	<u>2N2904A</u>	$-V_{CEO}$	max. 60 V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5 V

Current

Collector current (d. c.)	$-I_C$	max.	0.6 A
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Power dissipation

Total power dissipation up to $T_{amb} = 25$ °C	P_{tot}	max.	0.6 W
up to $T_{case} = 25$ °C	P_{tot}	max.	3 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	$R_{th j-a}$	=	290 °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.

CHARACTERISTICS

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

Collector cut-off current

	2N2904	2N2904A
$I_E = 0; -V_{CB} = 50\text{ V}$	$-I_{CBO} < 20$	10 nA
$I_E = 0; -V_{CB} = 50\text{ V}; T_j = 150\text{ }^\circ\text{C}$	$-I_{CBO} < 20$	10 μA
$+V_{BE} = 0.5\text{ V}; -V_{CE} = 30\text{ V}$	$-I_{CEX} < 50$	nA

Breakdown voltages

$I_E = 0; -I_C = 10\text{ }\mu\text{A}$	$-V_{(BR)CBO} > 60$	V
$I_B = 0; -I_C = 10\text{ mA}$	<u>2N2904</u> $-V_{(BR)CEO} > 40$	V
	<u>2N2904A</u> $-V_{(BR)CEO} > 60$	V
$I_C = 0; -I_E = 10\text{ }\mu\text{A}$	$-V_{(BR)EBO} > 5$	V

Saturation voltages ¹⁾

$-I_C = 150\text{ mA}; -I_B = 15\text{ mA}$	$-V_{CEsat} < 0.4$	V
	$-V_{BEsat} < 1.3$	V
$-I_C = 500\text{ mA}; -I_B = 50\text{ mA}$	$-V_{CEsat} < 1.6$	V
	$-V_{BEsat} < 2.6$	V

D. C. current gain

	2N2904	2N2904A
$-I_C = 0.1\text{ mA}; -V_{CE} = 10\text{ V}$	$h_{FE} > 20$	40
$-I_C = 1\text{ mA}; -V_{CE} = 10\text{ V}$	$h_{FE} > 25$	40
$-I_C = 10\text{ mA}; -V_{CE} = 10\text{ V}$	$h_{FE} > 35$	40
$-I_C = 150\text{ mA}; -V_{CE} = 10\text{ V}$ ¹⁾	$h_{FE} > 40$	40
	$h_{FE} < 120$	120
$-I_C = 500\text{ mA}; -V_{CE} = 10\text{ V}$ ¹⁾	$h_{FE} > 20$	40

Collector capacitance at $f = 100\text{ kHz}$

$I_E = I_e = 0; -V_{CB} = 10\text{ V}$	$C_c < 8$	pF
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Emitter capacitance at $f = 100\text{ kHz}$

$I_C = I_c = 0; -V_{EB} = 2\text{ V}$	$C_e < 30$	pF
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Transition frequency

$-I_C = 50\text{ mA}; -V_{CE} = 20\text{ V}$	$f_T > 200$	MHz
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¹⁾ Measured under pulsed conditions to avoid excessive dissipation.
Pulse duration $t \leq 300\text{ }\mu\text{s}$; duty cycle $\delta \leq 0.02$.

CHARACTERISTICS (continued)

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

Switching times

Turn on time when switched to $-I_C = 150\text{ mA}$; $-I_B = 15\text{ mA}$

delay time

$$t_d < 10\text{ ns}$$

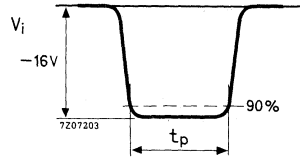
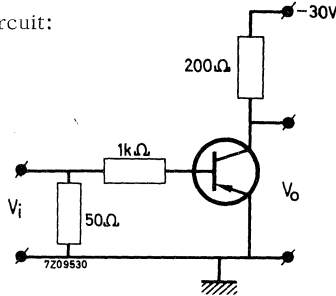
rise time

$$t_r < 40\text{ ns}$$

turn on time

$$t_{on} < 45\text{ ns}$$

Test circuit:



Oscilloscope:

Rise time $t_r \leq 5\text{ ns}$

Input impedance $Z_i = 10\text{ M}\Omega$

Pulse generator: Frequency

$$f = 150\text{ Hz}$$

Pulse duration

$$t_p = 200\text{ ns}$$

Rise time

$$t_r \leq 2\text{ ns}$$

Output impedance

$$Z_o = 50\text{ }\Omega$$

Turn off time when switched from

$-I_C = 150\text{ mA}$; $-I_B = 15\text{ mA}$ to cut-off with $+I_{BM} = 15\text{ mA}$

storage time

$$t_s < 80\text{ ns}$$

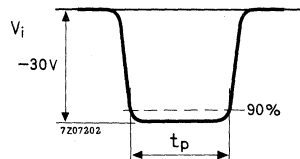
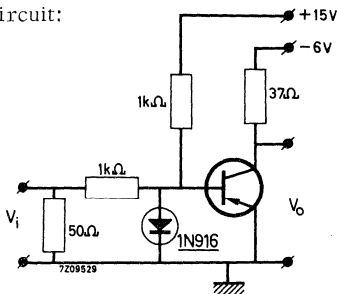
fall time

$$t_f < 30\text{ ns}$$

turn off time

$$t_{off} < 100\text{ ns}$$

Test circuit:



Oscilloscope:

Rise time $t_r \leq 5\text{ ns}$

Input impedance $Z_i = 10\text{ M}\Omega$

Pulse generator: Frequency

$$f = 150\text{ Hz}$$

Pulse duration

$$t_p = 200\text{ ns}$$

Rise time

$$t_r \leq 2\text{ ns}$$

Output impedance

$$Z_o = 50\text{ }\Omega$$

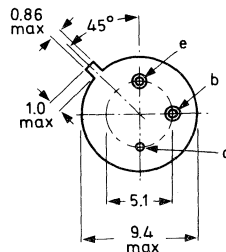
P-N-P MEDIUM POWER GENERAL PURPOSE TRANSISTORS

P-N-P silicon planar epitaxial transistors in a TO-39 metal envelope with the collector connected to the case. These transistors are primarily intended for saturated switching and driver applications for industrial service.

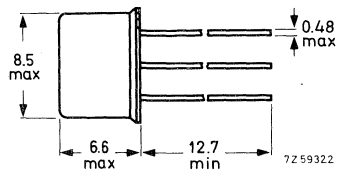
QUICK REFERENCE DATA			
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60 V
Collector-emitter voltage (open base)			
	<u>2N2905</u>	$-V_{CEO}$	max. 40 V
	<u>2N2905A</u>	$-V_{CEO}$	max. 60 V
Collector current (d. c.)	$-I_C$	max.	0.6 A
Total power dissipation up to $T_{amb} = 25^\circ C$	P_{tot}	max.	0.6 W
Junction temperature	T_j	max.	200 $^\circ C$
Transition frequency			
$-I_C = 50$ mA; $-V_{CE} = 20$ V	f_T	>	200 MHz
D. C. current gain at $T_j = 25^\circ C$			
$-I_C = 0.1$ mA; $-V_{CE} = 10$ V	h_{FE}	>	35 75
$-I_C = 10$ mA; $-V_{CE} = 10$ V	h_{FE}	>	75 100
$-I_C = 500$ mA; $-V_{CE} = 10$ V	h_{FE}	>	30 50

MECHANICAL DATA

Collector connected
to case
TO-39



Dimensions in mm



max. lead diameter is guaranteed only for 12.7 mm

Accessories available: 56218, 56245, 56265

RATINGS (Limiting values) ¹⁾

Voltages

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60 V
Collector-emitter voltage (open base)			
$-I_C < 100 \text{ mA}$	<u>2N2905</u>	$-V_{CEO}$	max. 40 V
	<u>2N2905A</u>	$-V_{CEO}$	max. 60 V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5 V

Current

Collector current (d.c.)	$-I_C$	max.	0.6 A
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Power dissipation

Total power dissipation up to $T_{amb} = 25 \text{ }^\circ\text{C}$	P_{tot}	max.	0.6 W
up to $T_{case} = 25 \text{ }^\circ\text{C}$	P_{tot}	max.	3 W

Temperatures

Storage temperature	T_{stg}	-65 to +200	$^\circ\text{C}$
Junction temperature	T_j	max. 200	$^\circ\text{C}$

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th \text{ j-a}}$	=	290 $^\circ\text{C/W}$
From junction to case	$R_{th \text{ j-c}}$	=	58 $^\circ\text{C/W}$

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

CHARACTERISTICS

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

<u>Collector cut-off current</u>		2N2905	2N2905A
$I_E = 0; -V_{CB} = 50\text{ V}$	$-I_{CBO}$	< 20	10 nA
$I_E = 0; -V_{CB} = 50\text{ V}; T_j = 150^\circ\text{C}$	$-I_{CBO}$	< 20	10 μA
$+V_{BE} = 0.5\text{ V}; -V_{CE} = 30\text{ V}$	$-I_{CEX}$	< 50	nA
<u>Breakdown voltages</u>			
$I_E = 0; -I_C = 10\ \mu\text{A}$	$-V_{(BR)CBO}$	> 60	V
$I_B = 0; -I_C = 10\text{ mA}$	$-V_{(BR)CEO}$	> 40	V
	<u>2N2905</u>		
	$-V_{(BR)CEO}$	> 60	V
	<u>2N2905A</u>		
$I_C = 0; -I_E = 10\ \mu\text{A}$	$-V_{(BR)EBO}$	> 5	V
<u>Saturation voltages</u> ¹⁾			
$-I_C = 150\text{ mA}; -I_B = 15\text{ mA}$	$-V_{CEsat}$	< 0.4	V
	$-V_{BEsat}$	< 1.3	V
$-I_C = 500\text{ mA}; -I_B = 50\text{ mA}$	$-V_{CEsat}$	< 1.6	V
	$-V_{BEsat}$	< 2.6	V
<u>D. C. current gain</u>		2N2905	2N2905A
$-I_C = 0.1\text{ mA}; -V_{CE} = 10\text{ V}$	h_{FE}	> 35	75
$-I_C = 1\text{ mA}; -V_{CE} = 10\text{ V}$	h_{FE}	> 50	100
$-I_C = 10\text{ mA}; -V_{CE} = 10\text{ V}$	h_{FE}	> 75	100
$-I_C = 150\text{ mA}; -V_{CE} = 10\text{ V}$ ¹⁾	h_{FE}	> 100	100
$-I_C = 500\text{ mA}; -V_{CE} = 10\text{ V}$ ¹⁾	h_{FE}	< 300	300
	h_{FE}	> 30	50
<u>Collector capacitance</u> at $f = 100\text{ kHz}$			
$I_E = I_e = 0; -V_{CB} = 10\text{ V}$	C_c	< 8	pF
<u>Emitter capacitance</u> at $f = 100\text{ kHz}$			
$I_C = I_c = 0; -V_{EB} = 2\text{ V}$	C_e	< 30	pF
<u>Transition frequency</u>			
$-I_C = 50\text{ mA}; -V_{CE} = 20\text{ V}$	f_T	> 200	MHz

¹⁾ Measured under pulsed conditions to avoid excessive dissipation.
Pulse duration $t \leq 300\ \mu\text{s}$; duty cycle $\delta \leq 0.02$.

CHARACTERISTICS (continued)

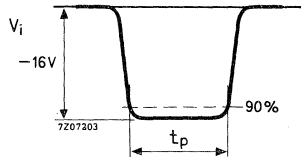
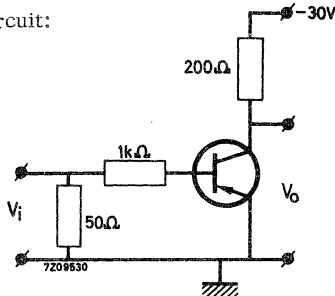
$T_j = 25^\circ\text{C}$ unless otherwise specified

Switching times

Turn on time when switched to $-I_C = 150\text{ mA}$; $-I_B = 15\text{ mA}$

delay time	$t_d < 10\text{ ns}$
rise time	$t_r < 40\text{ ns}$
turn on time	$t_{on} < 45\text{ ns}$

Test circuit:



Oscilloscope:

Rise time	$t_r \leq 5\text{ ns}$
Input impedance	$Z_i = 10\text{ M}\Omega$

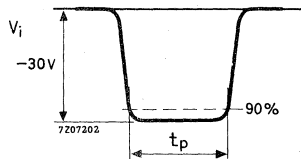
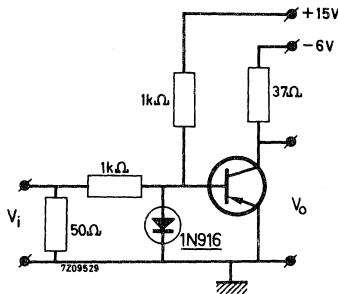
Pulse generator: Frequency	$f = 150\text{ Hz}$
Pulse duration	$t_p = 200\text{ ns}$
Rise time	$t_r \leq 2\text{ ns}$
Output impedance	$Z_o = 50\text{ }\Omega$

Turn off time when switched from

$-I_C = 150\text{ mA}$; $-I_B = 15\text{ mA}$ to cut-off with $+I_{BM} = 15\text{ mA}$

storage time	$t_s < 80\text{ ns}$
fall time	$t_f < 30\text{ ns}$
turn off time	$t_{off} < 100\text{ ns}$

Test circuit:



Oscilloscope:

Rise time	$t_r \leq 5\text{ ns}$
Input impedance	$Z_i = 10\text{ M}\Omega$

Pulse generator: Frequency	$f = 150\text{ Hz}$
Pulse duration	$t_p = 200\text{ ns}$
Rise time	$t_r \leq 2\text{ ns}$
Output impedance	$Z_o = 50\text{ }\Omega$

**P-N-P MEDIUM POWER
GENERAL PURPOSE TRANSISTORS**

P-N-P silicon planar epitaxial transistors in a TO-18 metal envelope with the collector connected to the case. These transistors are primarily intended for saturated switching and driver applications for industrial service.

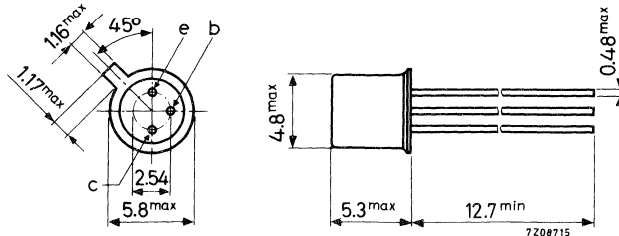
QUICK REFERENCE DATA			
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60 V
Collector-emitter voltage (open base)			
	<u>2N2906</u>	$-V_{CEO}$	max. 40 V
	<u>2N2906A</u>	$-V_{CEO}$	max. 60 V
Collector current (d.c.)	$-I_C$	max.	0.6 A
Total power dissipation up to $T_{amb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	0.4 W
Junction temperature	T_j	max.	200 $^\circ\text{C}$
Transition frequency at $f = 100\text{ MHz}$			
$-I_C = 50\text{ mA}; -V_{CE} = 20\text{ V}; T_{amb} = 25\text{ }^\circ\text{C}$	f_T	>	200 MHz
D.C. current gain at $T_j = 25\text{ }^\circ\text{C}$			
			<u>2N2906</u> <u>2N2906A</u>
$-I_C = 0.1\text{ mA}; -V_{CE} = 10\text{ V}$	h_{FE}	> 20	40
$-I_C = 10\text{ mA}; -V_{CE} = 10\text{ V}$	h_{FE}	> 35	40
$-I_C = 500\text{ mA}; -V_{CE} = 10\text{ V}$	h_{FE}	> 20	40

MECHANICAL DATA

Dimensions in mm

Collector connected to case

TO-18



Accessories available: 56246, 56263

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

Voltages

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60 V
Collector-emitter voltage (open base)			
$-I_C < 100 \text{ mA}$	<u>2N2906</u>	$-V_{CEO}$	max. 40 V
	<u>2N2906A</u>	$-V_{CEO}$	max. 60 V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5 V

Current

Collector current (d.c.)	$-I_C$	max.	0.6 A
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Power dissipation

Total power dissipation up to $T_{amb} = 25 \text{ }^\circ\text{C}$	P_{tot}	max.	0.4 W
up to $T_{case} = 25 \text{ }^\circ\text{C}$	P_{tot}	max.	1.8 W

Temperatures

Storage temperature	T_{stg}	-65 to +200	$^\circ\text{C}$
Junction temperature	T_j	max. 200	$^\circ\text{C}$

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th j-a}$	=	438 $^\circ\text{C/W}$
From junction to case	$R_{th j-a}$	=	97 $^\circ\text{C/W}$

CHARACTERISTICS

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

Collector cut-off current

		2N2906	2N2906A
$I_E = 0; -V_{CB} = 50\text{ V}$	$-I_{CBO}$	< 20	10 nA
$I_E = 0; -V_{CB} = 50\text{ V}; T_j = 150\text{ }^\circ\text{C}$	$-I_{CBO}$	< 20	10 μA
$+V_{BE} = 0.5\text{ V}; -V_{CE} = 30\text{ V}$	$-I_{CEX}$	< 50 nA	

Breakdown voltages

$I_E = 0; -I_C = 10\text{ }\mu\text{A}$		$-V_{(BR)CBO}$	> 60 V
$I_B = 0; -I_C = 10\text{ mA}$	<u>2N2906</u>	$-V_{(BR)CEO}$	> 40 V
	<u>2N2906A</u>	$-V_{(BR)CEO}$	> 60 V
$I_C = 0; -I_E = 10\text{ }\mu\text{A}$		$-V_{(BR)EBO}$	> 5 V

Saturation voltages ¹⁾

$-I_C = 150\text{ mA}; -I_B = 15\text{ mA}$	$-V_{CEsat}$	< 0.4 V
	$-V_{BEsat}$	< 1.3 V
$-I_C = 500\text{ mA}; -I_B = 50\text{ mA}$	$-V_{CEsat}$	< 1.6 V
	$-V_{BEsat}$	< 2.6 V

D.C. current gain

		2N2906	2N2906A
$-I_C = 0.1\text{ mA}; -V_{CE} = 10\text{ V}$	h_{FE}	> 20	40
$-I_C = 1\text{ mA}; -V_{CE} = 10\text{ V}$	h_{FE}	> 25	40
$-I_C = 10\text{ mA}; -V_{CE} = 10\text{ V}$	h_{FE}	> 35	40
$-I_C = 150\text{ mA}; -V_{CE} = 10\text{ V}$ ¹⁾	h_{FE}	> 40	40
$-I_C = 500\text{ mA}; -V_{CE} = 10\text{ V}$ ¹⁾	h_{FE}	< 120	120
	h_{FE}	> 20	40

Collector capacitance at $f = 100\text{ kHz}$

$I_E = I_e = 0; -V_{CB} = 10\text{ V}$	C_c	< 8 pF
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Emitter capacitance at $f = 100\text{ kHz}$

$I_C = I_c = 0; -V_{EB} = 2\text{ V}$	C_e	< 30 pF
---------------------------------------	-------	---------

Transition frequency at $f = 100\text{ MHz}$

$-I_C = 50\text{ mA}; -V_{CE} = 20\text{ V}; T_{amb} = 25\text{ }^\circ\text{C}$	f_T	> 200 MHz
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¹⁾ Measured under pulsed conditions to avoid excessive dissipation.
Pulse duration $t \leq 300\text{ }\mu\text{s}$; duty cycle $\delta \leq 0.02$.

CHARACTERISTICS (continued)

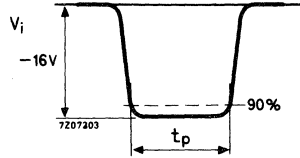
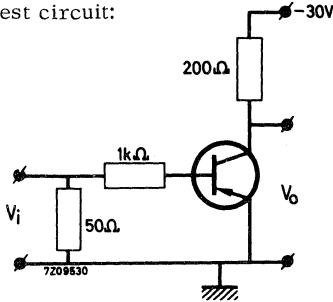
$T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified

Switching times

Turn on time when switched to $-I_C = 150\text{ mA}$; $-I_B = 15\text{ mA}$

delay time	$t_d < 10\text{ ns}$
rise time	$t_r < 40\text{ ns}$
turn on time	$t_{on} < 45\text{ ns}$

Test circuit:



Oscilloscope:

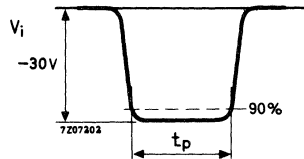
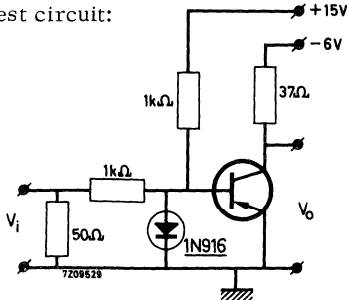
Rise time	$t_r \leq 5\text{ ns}$
Input impedance	$Z_i = 10\text{ M}\Omega$

Pulse generator: Frequency	$f = 150\text{ Hz}$
Pulse duration	$t_p = 200\text{ ns}$
Rise time	$t_r \leq 2\text{ ns}$
Output impedance	$Z_o = 50\text{ }\Omega$

Turn off time when switched from $-I_C = 150\text{ mA}$; $-I_B = 15\text{ mA}$ to cut-off with $+I_{BM} = 15\text{ mA}$

storage time	$t_s < 80\text{ ns}$
fall time	$t_f < 30\text{ ns}$
turn off time	$t_{off} < 100\text{ ns}$

Test circuit:



Oscilloscope:

Rise time	$t_r \leq 5\text{ ns}$
Input impedance	$Z_i = 10\text{ M}\Omega$

Pulse generator: Frequency	$f = 150\text{ Hz}$
Pulse duration	$t_p = 200\text{ ns}$
Rise time	$t_r \leq 2\text{ ns}$
Output impedance	$Z_o = 50\text{ }\Omega$

**P-N-P MEDIUM POWER
GENERAL PURPOSE TRANSISTORS**

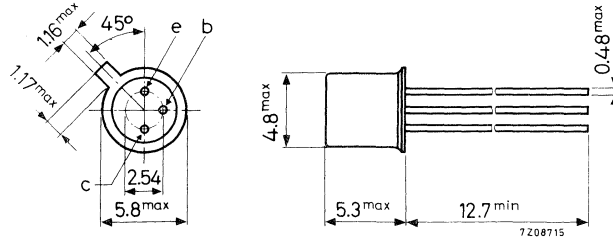
P-N-P silicon planar epitaxial transistors in a TO-18 metal envelope with the collector connected to the case. These transistors are primarily intended for saturated switching and driver applications for industrial service.

QUICK REFERENCE DATA			
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60 V
Collector-emitter voltage (open base)			
	<u>2N2907</u>	$-V_{CEO}$	max. 40 V
	<u>2N2907A</u>	$-V_{CEO}$	max. 60 V
Collector current (d.c.)	$-I_C$	max.	0.6 A
Total power dissipation up to $T_{amb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	0.4 W
Junction temperature	$-T_j$	max.	200 $^\circ\text{C}$
Transition frequency at $f = 100\text{ MHz}$			
$-I_C = 50\text{ mA}; -V_{CE} = 20\text{ V}; T_{amb} = 25\text{ }^\circ\text{C}$	f_T	>	200 MHz
D.C. current gain at $T_j = 25\text{ }^\circ\text{C}$			
			<u>2N2907</u> <u>2N2907A</u>
$-I_C = 0.1\text{ mA}; -V_{CE} = 10\text{ V}$	h_{FE}	> 35	75
$-I_C = 10\text{ mA}; -V_{CE} = 10\text{ V}$	h_{FE}	> 75	100
$-I_C = 500\text{ mA}; -V_{CE} = 10\text{ V}$	h_{FE}	> 30	50

MECHANICAL DATA

Dimensions in mm

Collector connected to case
TO-18



Accessories available: 56246, 56263

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

Voltages

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60 V
Collector-emitter voltage (open base)			
$-I_C < 100 \text{ mA}$	<u>2N2907</u>	$-V_{CEO}$	max. 40 V
	<u>2N2907A</u>	$-V_{CEO}$	max. 60 V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5 V

Current

Collector current (d.c.)	$-I_C$	max.	0.6 A
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Power dissipation

Total power dissipation up to $T_{amb} = 25 \text{ }^\circ\text{C}$	P_{tot}	max.	0.4 W
up to $T_{case} = 25 \text{ }^\circ\text{C}$	P_{tot}	max.	1.8 W

Temperatures

Storage temperature	T_{stg}	-65 to +200	$^\circ\text{C}$
Junction temperature	T_j	max. 200	$^\circ\text{C}$

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th j-a}$	=	438 $^\circ\text{C/W}$
From junction to case	$R_{th j-c}$	=	97 $^\circ\text{C/W}$

CHARACTERISTICS

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

Collector cut-off current

		2N2907	2N2907A
$I_E = 0; -V_{CB} = 50\text{ V}$	$-I_{CBO}$	< 20	10 nA
$I_E = 0; -V_{CB} = 50\text{ V}; T_j = 150\text{ }^\circ\text{C}$	$-I_{CBO}$	< 20	10 μA
$+V_{BE} = 0.5\text{ V}; -V_{CE} = 30\text{ V}$	$-I_{CEX}$	< 50 nA	

Breakdown voltages

$I_E = 0; -I_C = 10\text{ }\mu\text{A}$		$-V_{(BR)CBO}$	> 60 V
$I_B = 0; -I_C = 10\text{ mA}$	<u>2N2907</u>	$-V_{(BR)CEO}$	> 40 V
	<u>2N2907A</u>	$-V_{(BR)CEO}$	> 60 V
$I_C = 0; -I_E = 10\text{ }\mu\text{A}$		$-V_{(BR)EBO}$	> 5 V

Saturation voltages ¹⁾

$-I_C = 150\text{ mA}; -I_B = 15\text{ mA}$		$-V_{CEsat}$	< 0.4 V
		$-V_{BEsat}$	< 1.3 V
$-I_C = 500\text{ mA}; -I_B = 50\text{ mA}$		$-V_{CEsat}$	< 1.6 V
		$-V_{BEsat}$	< 2.6 V

D.C. current gain

		2N2907	2N2907A
$-I_C = 0.1\text{ mA}; -V_{CE} = 10\text{ V}$	h_{FE}	> 35	75
$-I_C = 1\text{ mA}; -V_{CE} = 10\text{ V}$	h_{FE}	> 50	100
$-I_C = 10\text{ mA}; -V_{CE} = 10\text{ V}$	h_{FE}	> 75	100
$-I_C = 150\text{ mA}; -V_{CE} = 10\text{ V}^1)$	h_{FE}	> 100	100
$-I_C = 500\text{ mA}; -V_{CE} = 10\text{ V}^1)$	h_{FE}	< 300	300
	h_{FE}	> 30	50

Collector capacitance at $f = 100\text{ kHz}$

$I_E = I_e = 0; -V_{CB} = 10\text{ V}$	C_c	< 8 pF
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Emitter capacitance at $f = 100\text{ kHz}$

$I_C = I_c = 0; -V_{EB} = 2\text{ V}$	C_e	< 30 pF
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Transition frequency at $f = 100\text{ MHz}$

$-I_C = 50\text{ mA}; -V_{CE} = 20\text{ V}; T_{amb} = 25\text{ }^\circ\text{C}$	f_T	> 200 MHz
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¹⁾ Measured under pulsed conditions to avoid excessive dissipation.
Pulsed duration $t \leq 300\text{ }\mu\text{s}$; duty cycle $\delta \leq 0.02$.

2N2907 2N2907A

CHARACTERISTICS (continued)

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

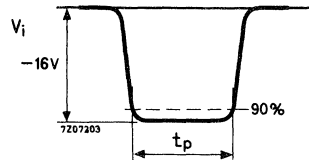
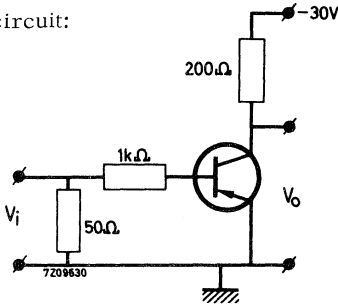
Switching times

Turn on time when switched to $-I_C = 150\text{ mA}$; $-I_B = 15\text{ mA}$

delay time
rise time
turn on time

$t_d < 10\text{ ns}$
 $t_r < 40\text{ ns}$
 $t_{on} < 45\text{ ns}$

Test circuit:



Oscilloscope:

Rise time $t_r \leq 5\text{ ns}$
Input impedance $Z_i = 10\text{ M}\Omega$

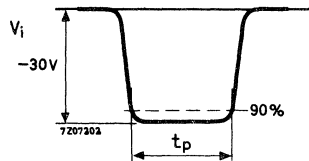
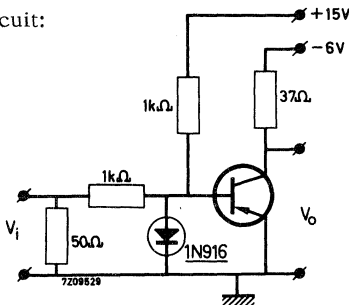
Pulse generator: Frequency $f = 150\text{ Hz}$
Pulse duration $t_p = 200\text{ ns}$
Rise time $t_r \leq 2\text{ ns}$
Output impedance $Z_o = 50\text{ }\Omega$

Turn off time when switched from $-I_C = 150\text{ mA}$; $-I_B = 15\text{ mA}$ to cut-off with $+I_{BM} = 15\text{ mA}$

storage time
fall time
turn off time

$t_s < 80\text{ ns}$
 $t_f < 30\text{ ns}$
 $t_{off} < 100\text{ ns}$

Test circuit:



Oscilloscope:

Rise time $t_r \leq 5\text{ ns}$
Input impedance $Z_i = 10\text{ M}\Omega$

Pulse generator: Frequency $f = 150\text{ Hz}$
Pulse duration $t_p = 200\text{ ns}$
Rise time $t_r \leq 2\text{ ns}$
Output impedance $Z_o = 50\text{ }\Omega$

P-N-P MEDIUM POWER GENERAL PURPOSE TRANSISTORS

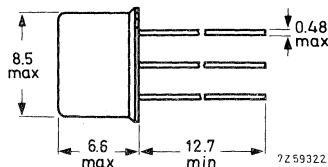
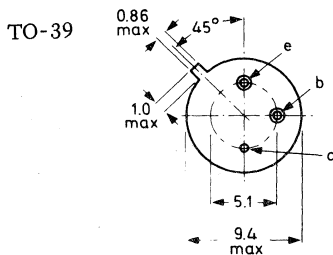
P-N-P silicon planar epitaxial transistors in a TO-39 metal envelope with the collector connected to the case. These transistors are primarily intended for high speed saturated switching applications for industrial service.

QUICK REFERENCE DATA			
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	50 V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	35 V
Collector current (d.c.)	$-I_C$	max.	0.6 A
Total power dissipation up to $T_{amb} = 25^\circ\text{C}$	P_{tot}	max.	0.6 W
Junction temperature	T_j	max.	200 $^\circ\text{C}$
Transition frequency	f_T	>	200 MHz
$-I_C = 50 \text{ mA}; -V_{CE} = 20 \text{ V}$			
D.C. current gain at $T_j = 25^\circ\text{C}$			
$-I_C = 1 \text{ mA}; -V_{CE} = 10 \text{ V}$	h_{FE}	>	25
$-I_C = 150 \text{ mA}; -V_{CE} = 1 \text{ V}$	h_{FE}	>	10
$-I_C = 150 \text{ mA}; -V_{CE} = 10 \text{ V}$	h_{FE}		40 to 120
			2N3133
			2N3134
			50
			25
			100 to 300

MECHANICAL DATA

Dimensions in mm

Collector connected to case



max. lead diameter is guaranteed only for 12.7 mm

Accessories available: 56218, 56245, 56265

RATINGS (Limiting values) ¹⁾

Voltages

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	50 V
Collector-emitter voltage (open base) $-I_C < 600 \text{ mA}$	$-V_{CEO}$	max.	35 V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	4 V

Current

Collector current (d.c.)	$-I_C$	max.	0.6 A
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Power dissipation

Total power dissipation up to $T_{amb} = 25 \text{ }^\circ\text{C}$	P_{tot}	max.	0.6 W
up to $T_{case} = 25 \text{ }^\circ\text{C}$	P_{tot}	max.	3 W

Temperatures

Storage temperature	T_{stg}	-65 to +200	$^\circ\text{C}$
Junction temperature	T_j	max.	200 $^\circ\text{C}$

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th \text{ j-a}}$	=	290 $^\circ\text{C/W}$
From junction to case	$R_{th \text{ j-c}}$	=	58 $^\circ\text{C/W}$

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

CHARACTERISTICS

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

Collector cut-off current

$I_E = 0; -V_{CB} = 30\text{ V}$	$-I_{CBO}$	<	50 nA
$I_E = 0; -V_{CB} = 30\text{ V}; T_j = 150\text{ }^\circ\text{C}$	$-I_{CBO}$	<	30 μA

Currents at reverse biased emitter junction

$+V_{BE} = 0.5\text{ V}; -V_{CE} = 30\text{ V}$	$-I_{CEX}$	<	0.1 μA
$+V_{BE} = 0.5\text{ V}; -V_{CE} = 30\text{ V}$	$+I_{BEX}$	<	0.1 μA

Breakdown voltages

$I_E = 0; -I_C = 10\text{ }\mu\text{A}$	$-V_{(BR)CBO}$	>	50 V
$I_B = 0; -I_C = 10\text{ mA}$	$-V_{(BR)CEO}$	>	35 V
$I_C = 0; -I_E = 10\text{ }\mu\text{A}$	$-V_{(BR)EBO}$	>	4 V

Saturation voltages ¹⁾

$-I_C = 150\text{ mA}; -I_B = 15\text{ mA}$	$-V_{CEsat}$	<	0.6 V
	$-V_{BEsat}$	<	1.5 V

D.C. current gain

	2N3133	2N3134
$-I_C = 1\text{ mA}; -V_{CE} = 10\text{ V}$	$h_{FE} > 25$	50
$-I_C = 150\text{ mA}; -V_{CE} = 1\text{ V}$	$h_{FE} > 10$	25
$-I_C = 150\text{ mA}; -V_{CE} = 10\text{ V}$	h_{FE} 40 to 120	100 to 300

Transition frequency

$-I_C = 50\text{ mA}; -V_{CE} = 20\text{ V}$	f_T	>	200 MHz
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Collector capacitance at $f = 100\text{ kHz}$

$I_E = I_e = 0; -V_{CB} = 10\text{ V}$	C_c	<	10 pF
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Emitter capacitance at $f = 100\text{ kHz}$

$I_C = I_c = 0; -V_{EB} = 2\text{ V}$	C_e	<	40 pF
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¹⁾ Measured under pulsed conditions to avoid excessive dissipation.
Pulse duration $t \leq 300\text{ }\mu\text{s}$; duty cycle $\delta \leq 0.02$.

CHARACTERISTICS (continued)

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

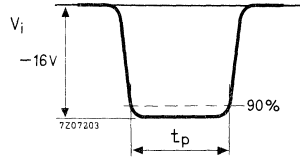
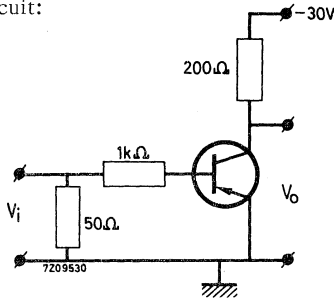
Switching times

Turn on time when switched to $-I_C = 150\text{ mA}$; $-I_B = 15\text{ mA}$

turn on time

$t_{on} < 75\text{ ns}$

Test circuit:



Oscilloscope:

Rise time $t_r \leq 5\text{ ns}$
Input impedance $Z_i = 10\text{ M}\Omega$

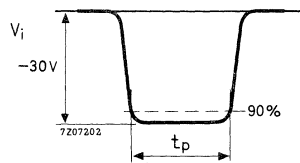
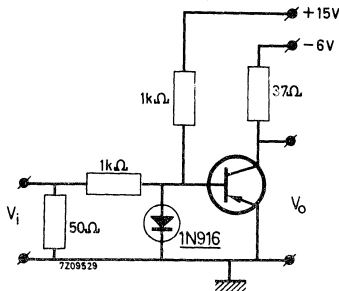
Pulse generator: Frequency $f = 150\text{ Hz}$
Pulse duration $t_p = 200\text{ ns}$
Rise time $t_r \leq 2\text{ ns}$
Output impedance $Z_o = 50\text{ }\Omega$

Turn off time when switched from $-I_C = 150\text{ mA}$; $-I_B = 15\text{ mA}$ to cut-off with $+I_{BM} = 15\text{ mA}$

turn off time

$t_{off} < 150\text{ ns}$

Test circuit:



Oscilloscope:

Rise time $t_r \leq 5\text{ ns}$
Input impedance $Z_i = 10\text{ M}\Omega$

Pulse generator: Frequency $f = 150\text{ Hz}$
Pulse duration $t_p = 200\text{ ns}$
Rise time $t_r \leq 2\text{ ns}$
Output impedance $Z_o = 50\text{ }\Omega$

SILICON PLANAR EPITAXIAL TRANSISTORS

N-P-N transistors in a TO-39 (reduced height) metal envelope with the collector connected to the case. They are intended for very high speed switching capability in high current applications.

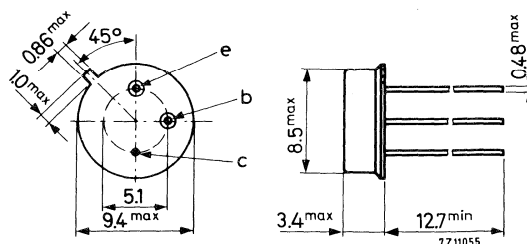
QUICK REFERENCE DATA			
Collector-base voltage (open emitter)	V_{CBO}	max.	25 V
Collector-emitter voltage (open base)	V_{CEO}	max.	12 V
Collector current (d. c.)	I_C	max.	1 A
Total power dissipation up to $T_{Case} = 25^\circ C$	P_{tot}	max.	3 W
Junction temperature	T_j	max.	200 $^\circ C$
Collector-emitter saturation voltage $I_C = 100 \text{ mA}; I_B = 10 \text{ mA}$	V_{CEsat}	<	230 mV
D. C. current gain at $T_j = 25^\circ C$ $I_C = 300 \text{ mA}; V_{CE} = 0.5 \text{ V}$	h_{FE}		30 to 120
Transition frequency $I_C = 100 \text{ mA}; V_{CE} = 5 \text{ V}; f = 100 \text{ MHz}$	f_T	>	450 MHz
Storage time when switched from $I_C = I_{B1} = -I_{B2} = 100 \text{ mA}$	τ_s	<	15 ns

MECHANICAL DATA

Dimensions in mm

TO-39 (reduced height)

Collector connected to case



max. lead diameter is guaranteed only for 12.7 mm

Accessories supplied on request: 56218

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

Voltages

Collector-base voltage (open emitter)	V_{CBO}	max.	25	V
Collector-emitter voltage (open base) $I_C = 0.1$ to 30 mA	V_{CEO}	max.	12	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4	V

Current

Collector current (d. c.)	I_C	max.	1	A
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Power dissipation

Total power dissipation up to $T_{amb} = 25$ °C up to $T_{case} = 25$ °C	P_{tot}	max.	0.6	W
	P_{tot}	max.	3	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	$R_{th\ j-a}$	=	290	°C/W
From junction to case	$R_{th\ j-c}$	=	58	°C/W



CHARACTERISTICS

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

Collector cut-off currents

$V_{BE} = 0; V_{CE} = 15\text{ V}$ $I_{CES} < 100\text{ }\mu\text{A}$

Base current

$V_{BE} = 0; V_{CE} = 15\text{ V}$ $-I_{BES} < 100\text{ }\mu\text{A}$

Breakdown voltages

$I_E = 0; I_C = 0.5\text{ mA}$ $V_{(BR)CBO} > 25\text{ V}$

$I_C = 0; I_E = 0.1\text{ mA}$ $V_{(BR)EBO} > 4\text{ V}$

Sustaining voltage ¹⁾

$I_B = 0; I_C = 30\text{ mA}$ $V_{CEO\text{sust}} > 12\text{ V}$

Saturation voltages

$I_C = 10\text{ mA}; I_B = 1\text{ mA}$ $V_{CE\text{sat}} < 0.25\text{ V}$

$V_{BE\text{sat}} < 0.78\text{ V}$

$I_C = 100\text{ mA}; I_B = 10\text{ mA}$ ¹⁾ $V_{CE\text{sat}} < 0.23\text{ V}$

$V_{BE\text{sat}} < 1.10\text{ V}$

$I_C = 300\text{ mA}; I_B = 30\text{ mA}$ ¹⁾ $V_{CE\text{sat}} < 0.33\text{ V}$

$V_{BE\text{sat}} < 1.30\text{ V}$

$I_C = 300\text{ mA}; I_B = 30\text{ mA}; T_{\text{amb}} = 125\text{ }^\circ\text{C}$ ¹⁾ $V_{CE\text{sat}} < 0.5\text{ V}$

$I_C = 300\text{ mA}; I_B = 30\text{ mA}; T_{\text{amb}} = 85\text{ }^\circ\text{C}$ ¹⁾ $V_{CE\text{sat}} < 0.5\text{ V}$

$I_C = 1000\text{ mA}; I_B = 100\text{ mA}$ ¹⁾ $V_{CE\text{sat}} < 0.7\text{ V}$

$V_{BE\text{sat}} < 2.1\text{ V}$

	2N3303	2N3426
$V_{CE\text{sat}}$	< 0.5	$-$
$V_{CE\text{sat}}$	$< -$	0.5
$V_{CE\text{sat}}$	< 0.7	0.7
$V_{BE\text{sat}}$	< 2.1	$0.9\text{ to }2.1$

D.C. current gain

$I_C = 10\text{ mA}; V_{CE} = 0.5\text{ V}$ $h_{FE} > 20$

$I_C = 100\text{ mA}; V_{CE} = 0.5\text{ V}$ ¹⁾ $h_{FE} > 30$

$I_C = 300\text{ mA}; V_{CE} = 0.5\text{ V}$ ¹⁾ $h_{FE} 30\text{ to }120$

$I_C = 300\text{ mA}; V_{CE} = 0.5\text{ V}$ ¹⁾ $T_{\text{amb}} = -55\text{ }^\circ\text{C}$ 2N3303 $h_{FE} > 10$

¹⁾ Measured under pulsed conditions to avoid excessive dissipation.

Pulse duration $t = 300\text{ }\mu\text{s}$; 2N3303: $\delta \leq 0.02$
2N3426: $\delta = 0.01$

CHARACTERISTICS (continued)

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

Collector capacitance at $f = 140\text{ kHz}$

$I_E = I_e = 0; V_{CB} = 0$

2N3426 $C_c < 25\text{ pF}$

$I_E = I_e = 0; V_{CB} = 5\text{ V}$

$C_c < 15\text{ pF}$

Emitter capacitance at $f = 140\text{ kHz}$

$I_C = I_c = 0; V_{EB} = 0.5\text{ V}$

$C_e < 25\text{ pF}$

Transition frequency at $f = 100\text{ MHz}$

$I_C = 100\text{ mA}; V_{CE} = 5\text{ V}$

$f_T > 450\text{ MHz}$

$I_C = 500\text{ mA}; V_{CB} = 0$

2N3426 $f_T > 200\text{ MHz}$

Switching times

Turn on time when switched from

$-V_{BE} = 4\text{ V to } I_C = 1\text{ A}; I_B = 100\text{ mA}$

turn on time $t_{on} < 15\text{ ns}$

2N3426 { delay time $t_d < 5\text{ ns}$
rise time $t_r < 15\text{ ns}$

Turn off time when switched from

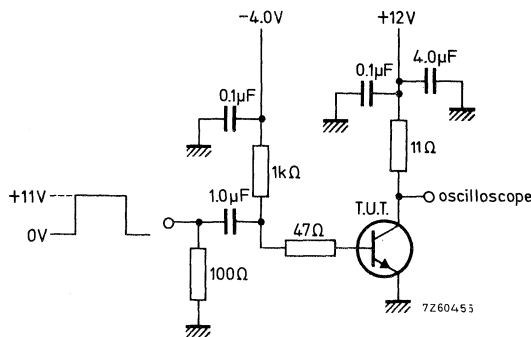
$I_C = 1\text{ A}; I_B = 0.1\text{ A}$

to cut off with $-I_{BM} = 0.1\text{ A}$

turn off time $t_{off} < 25\text{ ns}$

2N3426 { storage time $t_s < 20\text{ ns}$
fall time $t_f < 15\text{ ns}$

Test circuit:



Pulse generator:

$t_p = 100\text{ ns}$
 $t_r < 1\text{ ns}$
 $t_f < 1\text{ ns}$
 $Z_o = 50\text{ } \Omega$

Oscilloscope:

$Z_i = 100\text{ k}\Omega$
 $t_r < 1\text{ ns}$

CHARACTERISTICS (continued)

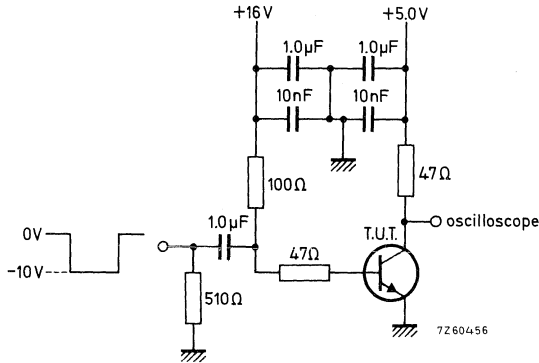
$T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified

Storage time

$$I_C = I_{B1} = -I_{B2} = 0.1\text{ A}$$

$$\tau_s < 15\text{ ns}$$

Test circuit:



Pulse generator:

$$t_p = 100\text{ ns}$$

$$t_r < 1\text{ ns}$$

$$Z_o = 50\ \Omega$$

Oscilloscope:

$$Z_i = 100\text{ k}\Omega$$

$$t_r < 1\text{ ns}$$



SILICON EPITAXIAL TRANSISTOR

P-N-P transistor in a TO-39 metal envelope with the collector connected to the case. The transistor is intended for general industrial applications.

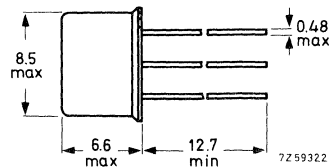
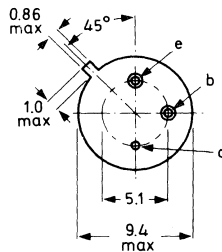
QUICK REFERENCE DATA			
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	90 V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	65 V
Collector current (d. c.)	$-I_C$	max.	1.0 A
Total power dissipation up to $T_{case} = 25\text{ }^{\circ}\text{C}$	P_{tot}	max.	5 W
Junction temperature	T_j	max.	200 $^{\circ}\text{C}$
Collector-emitter saturation voltage $-I_C = 150\text{ mA}; -I_B = 15\text{ mA}$	$-V_{CEsat}$	<	0.65 V
D. C. current gain $-I_C = 150\text{ mA}; -V_{CE} = 10\text{ V}$	h_{FE}		40 to 140
Transition frequency at $f = 20\text{ MHz}$ $-I_C = 50\text{ mA}; -V_{CE} = 10\text{ V}$	f_T	>	60 MHz

MECHANICAL DATA

Dimensions in mm

TO-39

Collector connected
to case



max. lead diameter is guaranteed only for 12.7 mm.

Accessories supplied on request: 56218, 56245, 56265.

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

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	90	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	65	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	7	V

Currents

Collector current (d. c.)	$-I_C$	max.	1.0	A
Base current (d. c.)	$-I_B$	max.	0.5	A

Power dissipation

Total power dissipation up to $T_{case} = 25^{\circ}C$	P_{tot}	max.	5	W
--	-----------	------	---	---

Temperatures

Storage temperature	T_{stg}	-65 to +200	$^{\circ}C$
Junction temperature	T_j	max. 200	$^{\circ}C$

THERMAL RESISTANCE

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

CHARACTERISTICS $T_j = 25^\circ\text{C}$ unless otherwise specifiedCollector cut-off current

$I_E = 0; -V_{CB} = 60\text{ V}$	$-I_{CBO}$	<	20	nA
$+V_{BE} = 1.5\text{ V}; V_{CE} = 30\text{ V}; T_{\text{case}} = 150^\circ\text{C}$	$-I_{CEX}$	<	100	μA

Breakdown voltages

Collector-base voltage

$I_E = 0; -I_C = 100\ \mu\text{A}$	$-V_{(BR)CBO}$	>	90	V
------------------------------------	----------------	---	----	---

Collector-emitter voltage

$+V_{BE} = 1.5\text{ V}; -I_C = 100\text{ mA}$	$-V_{(BR)CEX}$	>	85	V
--	----------------	---	----	---

Emitter-base voltage

$I_C = 0; I_E = 100\ \mu\text{A}$	$-V_{(BR)EBO}$	>	7	V
-----------------------------------	----------------	---	---	---

Collector-emitter sustaining voltage

$I_B = 0; -I_C = 100\text{ mA}$	$-V_{CEO\text{sust}}$	>	65	V
---------------------------------	-----------------------	---	----	---

Saturation voltage

$-I_C = 150\text{ mA}; -I_B = 15\text{ mA}$	$-V_{CE\text{sat}}$	<	0.65	V
	$-V_{BE\text{sat}}$	<	1.4	V

D.C. current gain

$-I_C = 0.1\text{ mA}; -V_{CE} = 10\text{ V}$	h_{FE}	>	20
$-I_C = 150\text{ mA}; -V_{CE} = 10\text{ V}$	h_{FE}		40 to 140
$-I_C = 150\text{ mA}; -V_{CE} = 2\text{ V}$	h_{FE}		20 to 200
$-I_C = 500\text{ mA}; -V_{CE} = 10\text{ V}$	h_{FE}	>	20

Transition frequency at $f = 20\text{ MHz}$

$-I_C = 50\text{ mA}; -V_{CE} = 10\text{ V}$	f_T	>	60	MHz
--	-------	---	----	-----

Collector-base capacitance at $f = 1\text{ MHz}$

$I_E = I_e = 0; -V_{CB} = 10\text{ V}$	C_c	<	30	pF
--	-------	---	----	----

Switching times

Turn on time

$-I_C = 150 \text{ mA}$; $-I_B = +I_{BM} = 15 \text{ mA}$
 rise time
 turn on time

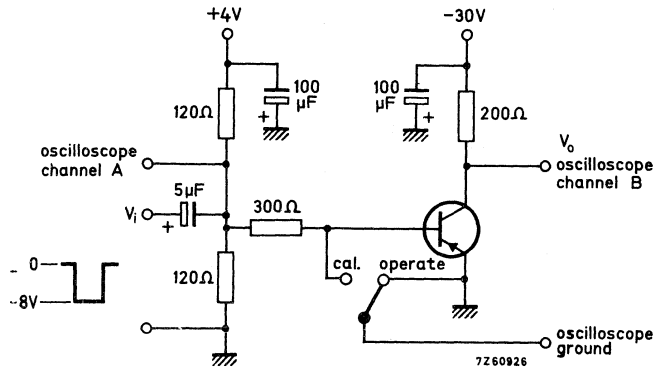
t_r	<	70	ns
t_{on}	<	110	ns

Turn off time

$-I_C = 150 \text{ mA}$; $-I_B = +I_{BM} = 15 \text{ mA}$
 storage time
 fall time
 turn off time

t_s	<	600	ns
t_f	<	100	ns
t_{off}	<	700	ns

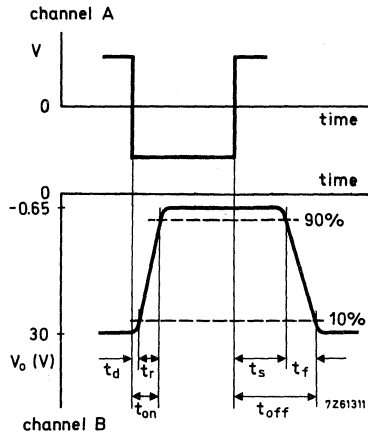
Test circuit:



Pulse generator: Oscilloscope:

$f = 10 \text{ kHz}$
 $t_r < 10 \text{ ns}$
 $t_p = 20 \mu\text{s}$

$Z_i = 10 \text{ M}\Omega$
 $C_i = 20 \text{ pF}$
 $t_r < 15 \text{ ns}$



Accessories



Introduction

All information on thermal resistances of the accessories combined with flat heat-sinks is valid for square heatsinks of 1.5 mm blackened aluminium.

For a few variations the thermal resistance may be derived as follows:

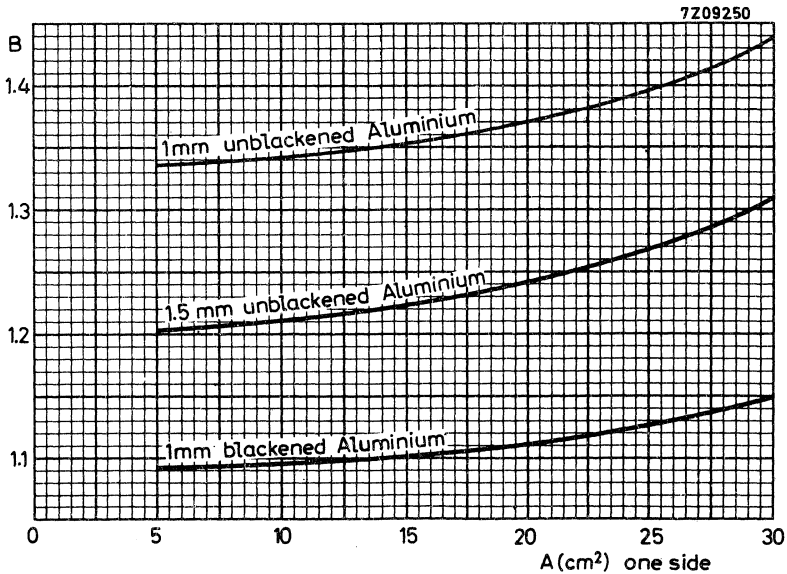
a. Rectangular heatsinks (sides a and 2a)

When mounted with long side horizontal, multiply by 0.95.

When mounted with short side horizontal, multiply by 1.10.

b. Unblackened or thinner heatsinks

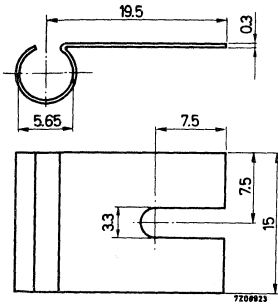
Multiply by the factor B given below as a function of the heatsink size A.



COOLING FIN

MECHANICAL DATA

Dimensions in mm



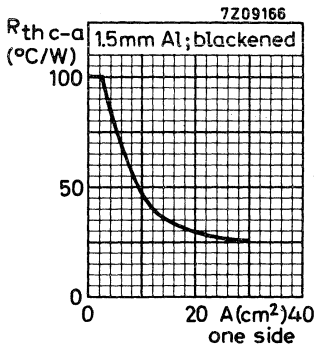
Fin material: brass, nickel plated

THERMAL RESISTANCE

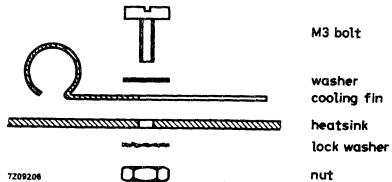
From case to ambient with cooling fin only
with heatsink

$$R_{th\ c-a} = 100\ ^\circ C/W$$

see graph



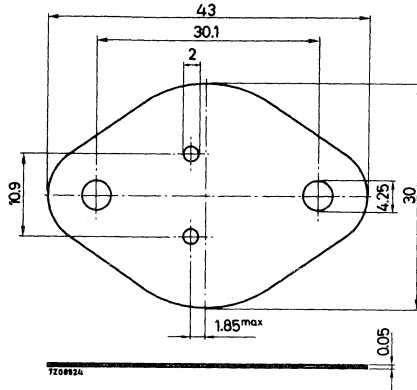
MOUNTING INSTRUCTIONS



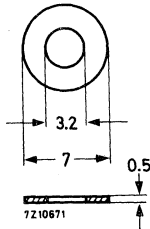
Torque on nut for good heat transfer: 5 cm kg

MOUNTING ACCESSORIES

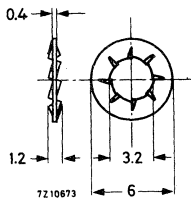
MECHANICAL DATA



mica washer



3 plain washers
material: brass, nickel plated



2 lock washers, internal teeth
material: steel, nickel plated

Thermal Resistance

From mounting base to heatsink with mica washer

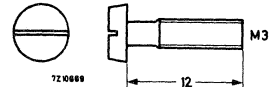
$$R_{th\ mb-h} = 1.0 \text{ } ^\circ\text{C/W}$$

TEMPERATURES

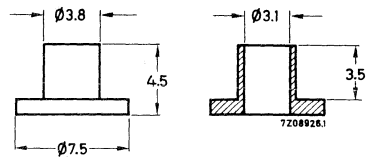
Maximum allowable temperature

$$T_{max} = 150 \text{ } ^\circ\text{C}$$

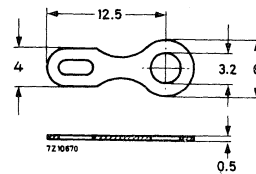
Dimensions in mm



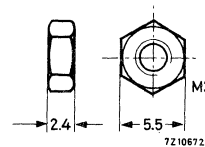
2 cheese head screws, slotted
material: brass, nickel plated



2 insulating bushes



soldering tag

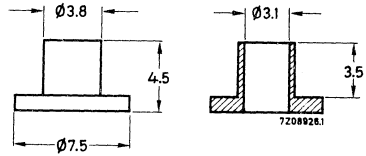
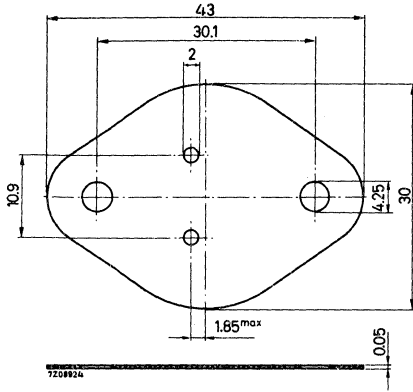


2 hexagon nuts
material: brass, nickel plated

56201a MICA WASHER AND 2 INSULATING BUSHES

MECHANICAL DATA

Dimensions in mm



THERMAL RESISTANCE

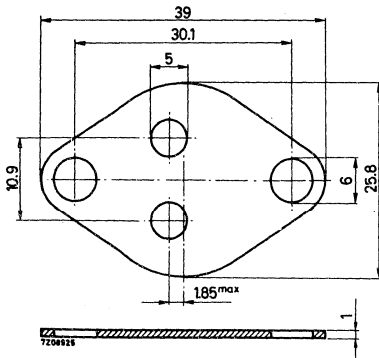
From mounting base to heatsink

$$R_{th\ mb-h} = 1.0\ \text{oC/W}$$

56201b LEAD WASHER

MECHANICAL DATA

Dimensions in mm

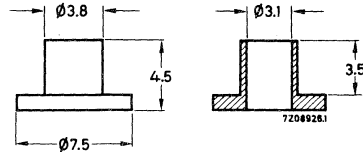


56201c

INSULATING BUSH

MECHANICAL DATA

Dimensions in mm

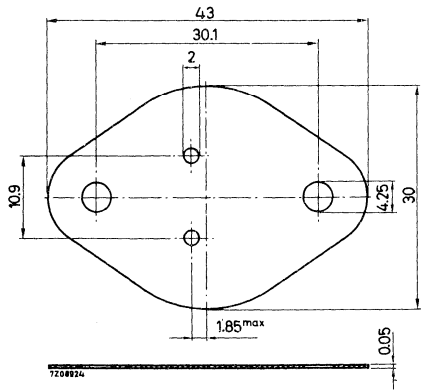


56201d

MICA WASHER

MECHANICAL DATA

Dimensions in mm



THERMAL RESISTANCE

From mounting base to heatsink

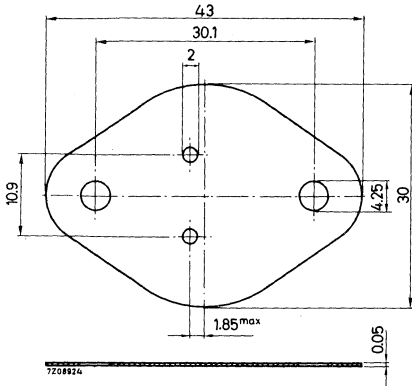
$$R_{th\ mb-h} = 1.0\ ^\circ C/W$$



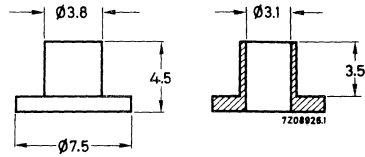
MOUNTING ACCESSORIES

MECHANICAL DATA

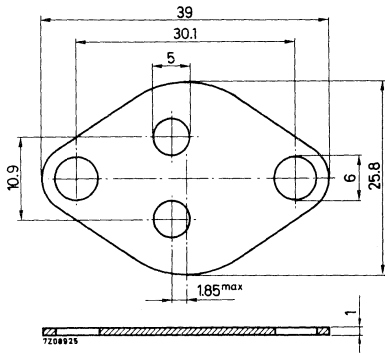
Dimensions in mm



mica washer



2 insulating bushes



lead washer

THERMAL RESISTANCE

From mounting base to heatsink
 with mica washer only
 with mica washer and lead washer

$$R_{th\ mb-h} = 1.0\ ^\circ C/W$$

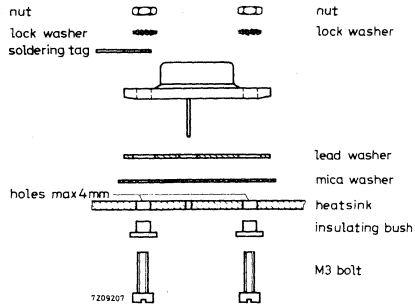
$$R_{th\ mb-h} = 0.75\ ^\circ C/W$$

TEMPERATURE

Maximum allowable temperature

$$T_{max} = 150\ ^\circ C$$

MOUNTING INSTRUCTIONS



Torque on nut for good heat transfer : 5 cm kg

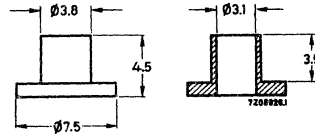
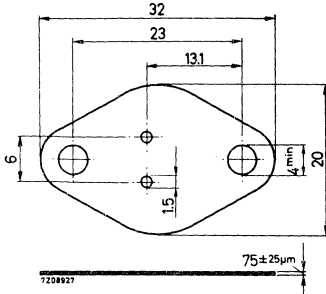
Warning: A plain washer shall be inserted between M3 bolt and insulating bush to prevent this insulating bush from being damaged.



MICA WASHER AND 2 INSULATING BUSHES

MECHANICAL DATA

Dimensions in mm



THERMAL RESISTANCE

From mounting base to heatsink

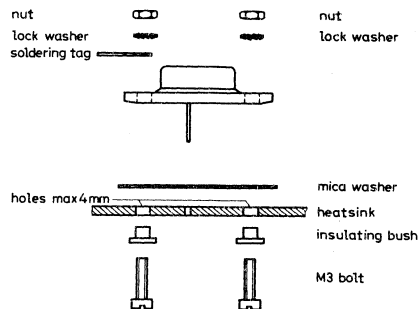
$$R_{th\ mb-h} = 1.5\ ^\circ C/W$$

TEMPERATURE

Maximum allowable temperature

$$T_{max} = 150\ ^\circ C$$

MOUNTING INSTRUCTIONS



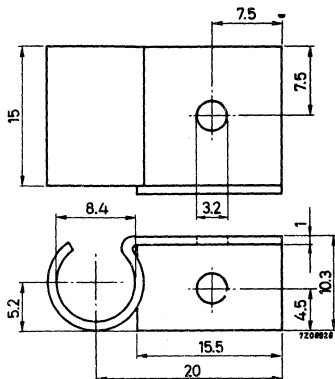
Torque on nut for good heat transfer: 5 cm kg

→ **Warning:** A plain washer shall be inserted between M3 bolt and insulating bush to prevent this insulating bush from being damaged.

COOLING FIN

MECHANICAL DATA

Dimensions in mm



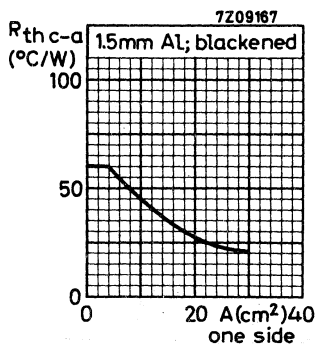
Fin material: aluminium, blackened

THERMAL RESISTANCE

From case to ambient with cooling fin only
with heatsink

$$R_{th\ c-a} = 60\ ^\circ C/W$$

see graph



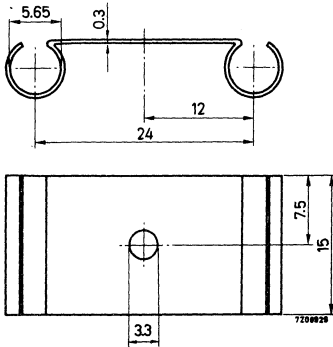
MOUNTING INSTRUCTIONS

Torque on M3 bolts for good heat transfer: 5 cm kg

COOLING FIN

MECHANICAL DATA

Dimensions in mm



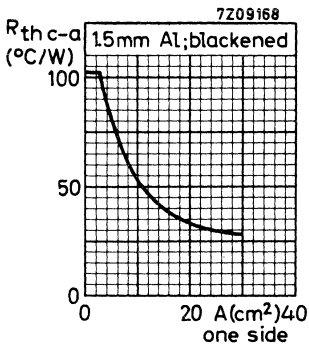
Fin material: brass, nickel plated

THERMAL RESISTANCE

From case to ambient with cooling fin only
with heatsink

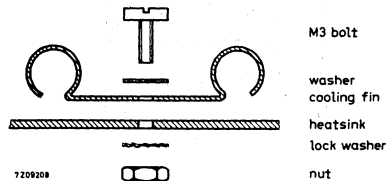
$$R_{th\ c-a} = 102\ ^\circ\text{C}/\text{W}$$

see graph



R_{th} values apply to each transistor, provided the two transistors have been mounted so that the heat flow from each is equal.

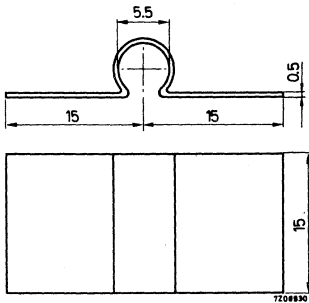
MOUNTING INSTRUCTIONS



Torque on nut for good heat transfer: 5 cm kg

COOLING FIN**MECHANICAL DATA**

Dimensions in mm



Fin material: brass, nickel plated

THERMAL RESISTANCE

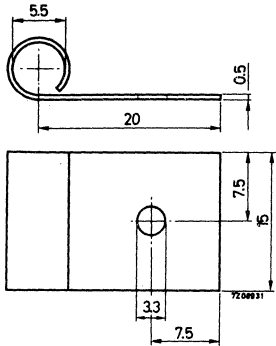
From case to ambient with cooling fin only

$$R_{th\ c-a} = 75\ ^\circ C/W$$

COOLING FIN

MECHANICAL DATA

Dimensions in mm



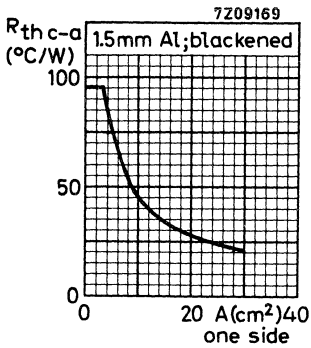
Fin material: brass, nickel plated

THERMAL RESISTANCE

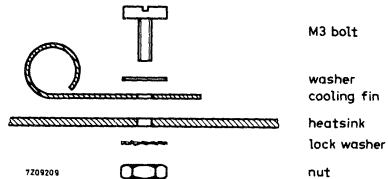
From case to ambient with cooling fin only
with heatsink

$$R_{th\ c-a} = 95\ ^\circ C/W$$

see graph



MOUNTING INSTRUCTIONS

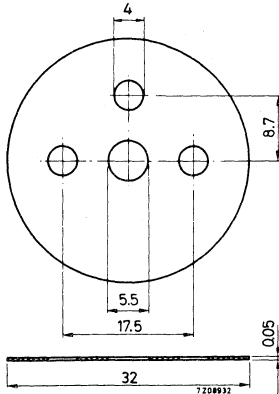


Torque on nut for good heat transfer: 5 cm kg

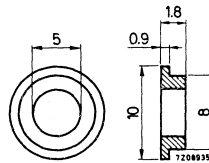
MOUNTING ACCESSORIES

MECHANICAL DATA

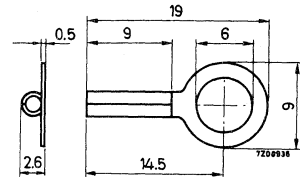
Dimensions in mm



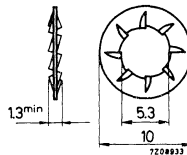
mica washer



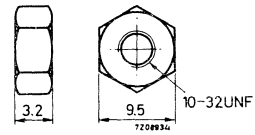
insulating ring



cable lug
material: brass, nickel plated



lock washer internal teeth
material: steel, nickel plated



hexagon nut
material: brass, nickel plated

THERMAL RESISTANCE

From mounting base to heatsink

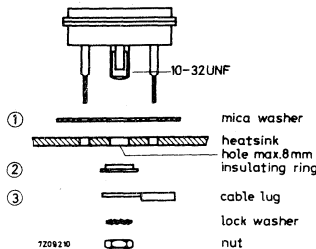
$$R_{th\ mb-h} = 1\ \text{°C/W}$$

TEMPERATURE

Maximum allowable temperature

$$T_{max} = 125\ \text{°C}$$

MOUNTING INSTRUCTIONS



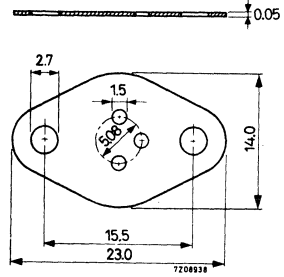
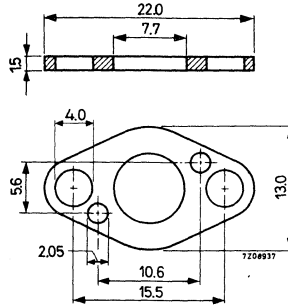
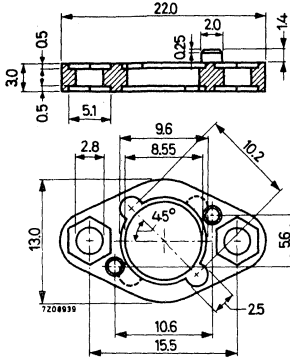
Torque on nut for good heat transfer: 17 cm kg

Non insulated mounting; without items 1, 2 and 3. (3 if necessary)

MOUNTING ACCESSORIES

MECHANICAL DATA

Dimensions in mm



top clamping washer
of insulating material

bottom clamping washer
material: brass, tin
plated

mylar washer

THERMAL RESISTANCE

From mounting base to heatsink non insulated mounting
insulated mounting

$$R_{th\ mb-h} = 3\ ^\circ C/W$$

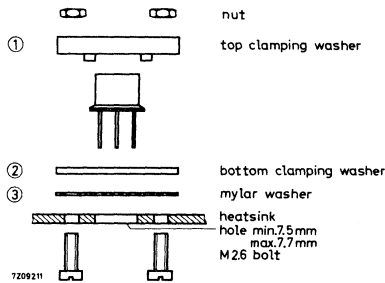
$$R_{th\ mb-h} = 6\ ^\circ C/W$$

TEMPERATURE

Maximum allowable temperature

$$T_{max} = 100\ ^\circ C$$

MOUNTING INSTRUCTIONS

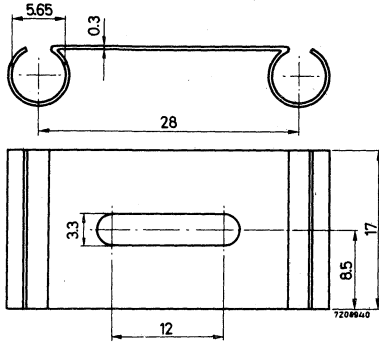


Non insulated mounting; without items 2 and 3. (Note: item 1 must than be mounted up-side down)

COOLING FIN

MECHANICAL DATA

Dimensions in mm

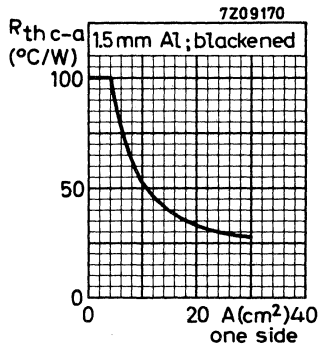


Fin material: brass, nickel plated

THERMAL RESISTANCE

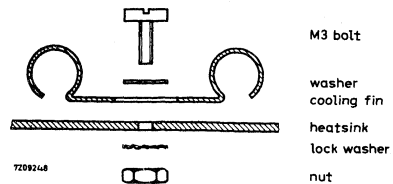
From case to ambient with cooling fin only
with heatsink

$R_{th\ c-a} = 100\ ^\circ C/W$
see graph



R_{th} values apply to each transistor, provided the two transistors have been mounted so that the heat flow from each is equal.

MOUNTING INSTRUCTIONS

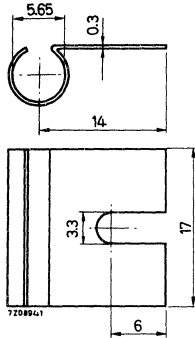


Torque on nut for good heat transfer: 5 cmkg

COOLING FIN

MECHANICAL DATA

Dimensions in mm



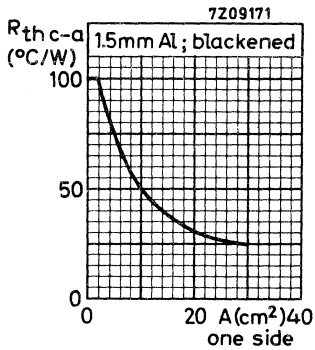
Fin material: brass, nickel plated

THERMAL RESISTANCE

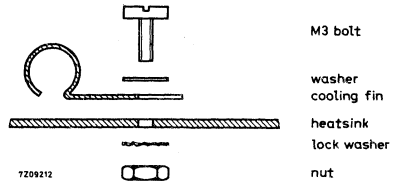
From case to ambient with cooling fin only
with heatsink

$$R_{th\ c-a} = 100\ ^\circ C/W$$

see graph



MOUNTING INSTRUCTIONS



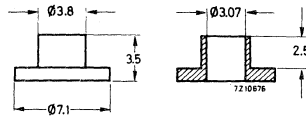
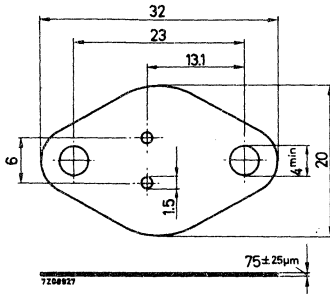
Torque on nut for good heat transfer: 5 cm kg

MICA WASHER AND 2 INSULATING BUSHES

56239

MECHANICAL DATA

Dimensions in mm



THERMAL RESISTANCE

From mounting base to heatsink

$$R_{th\ mb-h} = 1.5\ ^\circ C/W$$

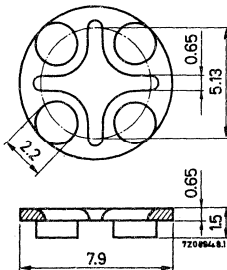
TEMPERATURE

Maximum allowable temperature

$$T_{max} = 150\ ^\circ C$$

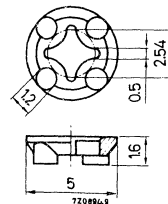
DISTANCE DISCS

56245



Insulating
material

56246



Insulating
material

TEMPERATURE

Maximum allowable temperature

$$T_{max} = 100\ ^\circ C$$

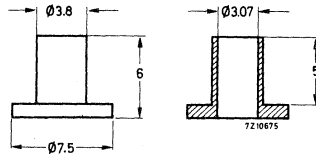
56261
56263

2 INSULATING BUSHES

56261

MECHANICAL DATA

Dimensions in mm

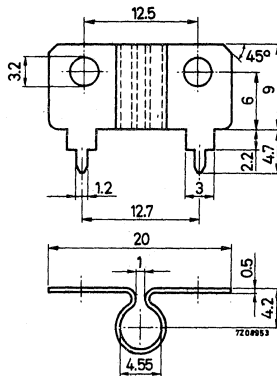


56263

COOLING FIN

MECHANICAL DATA

Dimensions in mm



Fin material: copper, tin plated

THERMAL RESISTANCE

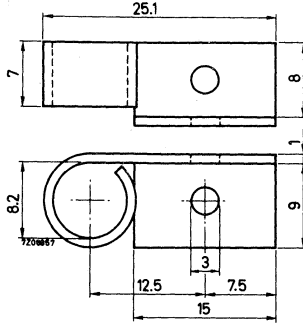
From case to ambient

$$R_{th\ c-a} = 100\ ^\circ\text{C}/\text{W}$$

COOLING FIN

MECHANICAL DATA

Dimensions in mm

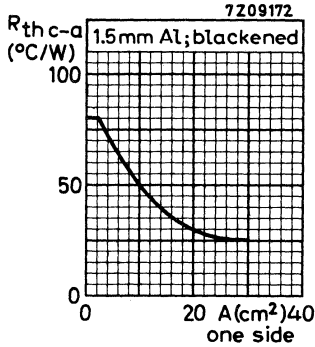


Fin material: aluminium, blackened

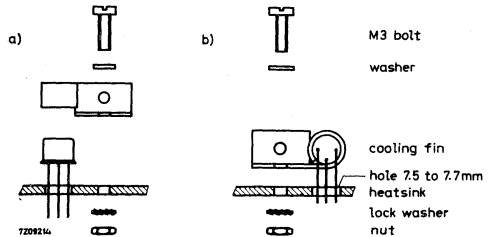
THERMAL RESISTANCE

From case to ambient with cooling fin only
with heatsink

$R_{th\ c-a} = 80\ ^\circ C/W$
see graph



MOUNTING INSTRUCTIONS



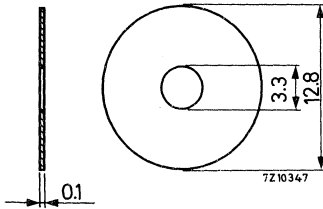
Torque on nut for good heat transfer: 5 cm kg

56302

MICA WASHER

MECHANICAL DATA

Dimensions in mm



THERMAL RESISTANCE

From mounting base to heatsink

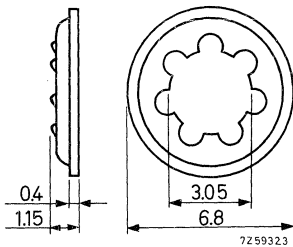
$$R_{th\ mb-h} = 6\ ^\circ C/W$$

56303

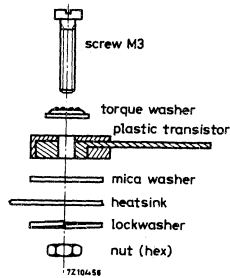
TORQUE WASHER

MECHANICAL DATA

Dimensions in mm



MOUNTING INSTRUCTIONS



Torque on nut: min. 8 cm kg
max. 9 cm kg

INDEX OF TYPE NUMBERS

The inclusion of a type number in this publication does not necessarily imply its availability.

Type No.	Part	Section	Type No.	Part	Section	Type No.	Part	Section
AA119	1	D	AEY16	4	Mw	ASY80	3	Sw
AA119	1	D	AF114	3	HF	ASZ15	2	P
AA119	1	D	AF115	3	HF	ASZ16	2	P
AA119	1	D	AF116	3	HF	ASZ17	2	P
AA119	1	D	AF117	3	HF	ASZ18	2	P
AA119	4	Mw	AF118	3	HF	ASZ20	3	Sw
AA119	4	Mw	AF121	3	HF	ASZ21	3	Sw
AA119	4	Mw	AF124	3	HF	AYY10-120	1	R
AA119	1	D	AF125	3	HF	BA100	1	D
AA119	1	D	AF126	3	HF	BA102	1	Var
AA119	1	D	AF127	3	HF	BA114	1	D
AA119	1	D	AF139	3	HF	BA145	1	D
AA119	2	LF	AF178	3	HF	BA148	1	D+R
AA119	2	LF	AF239	3	HF	BA182	1	D
AA119	2	LF	AF239S	3	HF	BA216	1	D
AA119	2	LF	AF240	3	HF	BA217	1	D
AA119	2	LF	AF267	3	HF	BA218	1	D
AA119	2	LF	AFY16	3	HF	BA219	1	D
AA119	2	LF	AFY19	4	Tr	BA220	1	D
AA119	2	LF	AFY40	3	HF	BA221	1	D
AA119	2	LF	AFZ12	3	HF	BA222	1	D
AA119	2	LF	ASY26	3	Sw	BAV10	1	D
AA119	2	LF	ASY27	3	Sw	BAV40	1	D
AA119	2	LF	ASY28	3	Sw	BAV41	1	D
AA119	2	LF	ASY29	3	Sw	BAV42	1	D
AA119	2	P	ASY73	3	Sw	BAV43	1	D
AA119	2	P	ASY74	3	Sw	BAV45	1	D
AA119	2	P	ASY75	3	Sw	BAW56	4	Mm
AA119	4	Mw	ASY76	3	Sw	BAW62	1	D
AA119	4	Mw	ASY77	3	Sw	BAW95D	4	Mw

D = Signal diodes

HF = High frequency transistors

LF = Low frequency transistors

Mm = Microminiature devices for thick- and thin-film circuits

Mw = Microwave devices

P = Low frequency power transistors

R = Rectifier diodes

Sw = Switching transistors

Tr = Transmitting transistors

Var = Variable capacitance diodes

INDEX

Type No.	Part	Section	Type No.	Part	Section	Type No.	Part	Section
BAW95E	4	Mw	BC308	2	LF	BCY55	4	Dual
BAW95F	4	Mw	BC309	2	LF	BCY56	2	LF
BAX12	1	D	BC327	2	LF	BCY57	2	LF
BAX13	1	D	BC328	2	LF	BCY58	2	LF
BAX15	1	D	BC337	2	LF	BCY59	2	LF
BAX16	1	D	BC338	2	LF	BCY70	2	LF
BAX17	1	D	BCW29	4	Mm	BCY71	2	LF
BAX18	1	D	BCW30	4	Mm	BCY72	2	LF
BAX78	1	D	BCW31	4	Mm	BCY87	4	Dual
BAY38	1	D	BCW32	4	Mm	BCY88	4	Dual
BAY66	4	Mw	BCW33	4	Mm	BCY89	4	Dual
BAY96	4	Mw	BCW46	2	LF	BCZ10	2	LF
BB104	1	Var	BCW47	2	LF	BCZ11	2	LF
12-BB105	1	Var	BCW48	2	LF	BCZ12	2	LF
12-BB106	1	Var	BCW49	2	LF	BD115	2	P
BB110	1	Var	BCW56	2	LF	BD124	2	P
BB117	1	Var	BCW57	2	LF	BD131	2	P
BC107	2	LF	BCW58	2	LF	BD132	2	P
BC108	2	LF	BCW59	2	LF	BD133	2	P
BC109	2	LF	BCW69	4	Mm	BD135	2	P
BC146	2	LF	BCW70	4	Mm	BD136	2	P
BC147	2	LF	BCW71	4	Mm	BD137	2	P
BC148	2	LF	BCW72	4	Mm	BD138	2	P
BC149	2	LF	BCY10	2	LF	BD139	2	P
BC157	2	LF	BCY11	2	LF	BD140	2	P
BC158	2	LF	BCY12	2	LF	BD181	2	P
BC159	2	LF	BCY30	2	LF	BD182	2	P
BC177	2	LF	BCY31	2	LF	BD183	2	P
BC178	2	LF	BCY32	2	LF	BDY20	2	P
BC179	2	LF	BCY33	2	LF	BDY38	2	P
BC200	2	LF	BCY34	2	LF	BDY60	2	P
BC237	2	LF	BCY38	2	LF	BDY61	2	P
BC238	2	LF	BCY39	2	LF	BDY90	2	P
BC239	2	LF	BCY40	2	LF	BDY91	2	P
BC307	2	LF	BCY54	2	LF	BDY92	2	P

D = Signal diodes

Dual = Dual transistors

LF = Low frequency transistors

Mm = Microminiature devices for
thick- and thin-film circuits

Mw = Microwave devices

P = Low frequency power devices

Var = Variable capacitance diodes

INDEX

Type No.	Part	Section	Type No.	Part	Section	Type No.	Part	Section
BF115	3	HF	BFS20	4	Mm	BLY83	4	Tr
BF167	3	HF	BFS21	4	FET	BLY84	4	Tr
BF173	3	HF	BFS21A	4	FET	BLY87A	4	Tr
BF177	3	HF	BFS22A	4	Tr	BLY88A	4	Tr
BF178	3	HF	BFS23A	4	Tr	BLY89A	4	Tr
BF179	3	HF	BFS28	4	FET	BLY90	4	Tr
BF180	3	HF	BFS92	3	HF	BLY91A	4	Tr
BF181	3	HF	BFS93	3	HF	BLY92A	4	Tr
BF182	3	HF	BFS94	3	HF	BLY93A	4	Tr
BF183	3	HF	BFS95	3	HF	BLY94	4	Tr
BF184	3	HF	BFW10	4	FET	BPX25	4	PhDT
BF185	3	HF	BFW11	4	FET	BPX29	4	PhDT
BF194	3	HF	BFW12	4	FET	BPX40	4	PhDT
BF195	3	HF	BFW13	4	FET	BPX41	4	PhDT
BF196	3	HF	BFW16A	3	HF	BPX42	4	PhDT
BF197	3	HF	BFW17A	3	HF	BPX71	4	PhDT
BF198	3	HF	BFW30	3	HF	BPY10	4	PhDT
BF199	3	HF	BFW45	2	Defl	BPY68	4	PhDT
BF200	3	HF	BFW61	4	FET	BPY69	4	PhDT
BF254	3	HF	BFW92	3	HF	BPY76	4	PhDT
BF255	3	HF	BFX34	3	Sw	BPY77	4	PhDT
BF334	3	HF	BFX44	3	HF	BR100	1	Thyr
BF335	3	HF	BFX89	3	HF	BRY39	1	Thyr
BF336	3	HF	BFY44	4	Tr	BRY39(SCS)	3	Sw
BF337	3	HF	BFY50	3	HF	BRY39(PUT)	3	Sw
BF338	3	HF	BFY51	3	HF	BSS27	3	Sw
BFR29	4	FET	BFY52	3	HF	BSS28	3	Sw
BFR30	4	Mm	BFY55	3	HF	BSS29	3	Sw
BFR31	4	Mm	BFY70	4	Tr	BSV52	4	Mm
BFR63	3	HF	BFY90	3	HF	BSV64	3	Sw
BFR64	3	HF	BLX13	4	Tr	BSV68	3	Sw
BFR65	3	HF	BLX14	4	Tr	BSV78	4	FET
BFS17	4	Mm	BLX69	4	Tr	BSV79	4	FET
BFS18	4	Mm	BLY14	4	Tr	BSV80	4	FET
BFS19	4	Mm	BLY17	4	Tr	BSV81	4	FET

Defl = Deflection transistors
 FET = Field effect transistors
 HF = High frequency transistors
 Mm = Microminiature devices for
 thick- and thin-film circuits

PhDT = Photodiodes and phototransistors
 Sw = Switching transistors
 Thyr = Thyristors, diacs, triacs
 Tr = Transmitting transistors

INDEX

Type No.	Part	Section	Type No.	Part	Section	Type No.	Part	Section
BSV86	3	Sw	BTX41series	1	Thyr	BYX13series	1	R
BSV87	3	Sw	BTX47series	1	Thyr	BYX22series	1	R
BSV88	3	Sw	BTX48series	1	Thyr	BYX23series	1	R
BSV96	3	Sw	BTX49series	1	Thyr	BYX25series	1	R
BSV97	3	Sw	BTX50series	1	Thyr	BYX27series	1	R
BSV98	3	Sw	BTX68series	1	Thyr	BYX29series	1	R
BSW41	3	Sw	BTX81series	1	Thyr	BYX30series	1	R
BSW66	3	Sw	BTX82series	1	Thyr	BYX32series	1	R
BSW67	3	Sw	BTX92series	1	Thyr	BYX33series	1	R
BSW68	3	Sw	BTX94series	1	Thyr	BYX34series	1	R
BSW69	3	Sw	BTX95series	1	Thyr	BYX35	1	R
BSX12	3	Sw	BTY79series	1	Thyr	BYX36series	1	R
BSX12A	3	Sw	BTY87series	1	Thyr	BYX38series	1	R
BSX19	3	Sw	BTY91series	1	Thyr	BYX39series	1	R
BSX20	3	Sw	BTY95series	1	Thyr	BYX40series	1	R
BSX21	3	Sw	BTY99series	1	Thyr	BYX42series	1	R
BSX59	3	Sw	BU105	2	Defl	BYX45series	1	R
BSX60	3	Sw	BU108	2	Defl	BYX46series	1	R
BSX61	3	Sw	BXY27	4	Mw	BYX48series	1	R
BSY38	3	Sw	BXY28	4	Mw	BYX50series	1	R
BSY39	3	Sw	BXY29	4	Mw	BYX51series	1	R
BT100Aseries	1	Thyr	BXY32	4	Mw	BYX52series	1	R
BT101series	1	Thyr	BY118	1	R	BYX56series	1	R
BT102series	1	Thyr	BY122	1	R	BYX59series	1	R
BTW23series	1	Thyr	BY123	1	R	BZX29series	1	Z
BTW24series	1	Thyr	BY126	1	R	BZX48	1	Z
BTW30series	1	Thyr	BY127	1	R	BZX49	1	Z
BTW31series	1	Thyr	BY140	1	R	BZX50	1	Z
BTW47series	1	Thyr	BY164	1	R	BZX61series	1	Z
BTW92series	1	Thyr	BY176	1	R	BZX70series	1	Z
BTX18series	1	Thyr	BY179	1	R	BZX75series	1	Z
BTX35series	1	Thyr	BY184	1	R	BZX79series	1	Z
BTX36series	1	Thyr	BY185	1	R	BZX84series	4	Mm
BTX37series	1	Thyr	BY187	1	R	BZY56	1	Z
BTX38series	1	Thyr	BYX10	1	R	BZY57	1	Z

Defl = Deflection transistors
Mm = Microminiature devices for
thick- and thin-film circuits
Mw = Microwave devices

R = Rectifier diodes
Sw = Switching transistors
Thyr = Thyristors, diacs, triacs
Z = Voltage regulator diodes

INDEX

Type No.	Part	Section	Type No.	Part	Section	Type No.	Part	Section
BZY58	1	Z	OA5	1	D	ORP52	4	PhC
BZY59	1	Z	OA7	1	D	ORP60	4	PhC
BZY60	1	Z	OA9	1	D	ORP61	4	PhC
BZY61	1	Z	OA47	1	D	ORP62	4	PhC
BZY62	1	Z	OA70	1	D	ORP63	4	PhC
BZY63	1	Z	OA72	1	D	ORP69	4	PhC
BZY78	1	Z	OA73	1	D	ORP90	4	PhC
BZY88series	1	Z	OA79	1	D	OSB9110	1	St
BZY91series	1	Z	OA81	1	D	OSB9210	1	St
BZY93series	1	Z	OA85	1	D	OSB9310	1	St
BZY95series	1	Z	OA90	1	D	OSB9410	1	St
BZY96series	1	Z	OA91	1	D	OSM9110	1	St
BZZ14	1	Z	OA92	1	D	OSM9210	1	St
BZZ15	1	Z	OA95	1	D	OSM9310	1	St
BZZ16	1	Z	OA200	1	D	OSM9410	1	St
BZZ17	1	Z	OA202	1	D	OSS9110	1	St
BZZ18	1	Z	OAP12	4	PhDT	OSS9210	1	St
BZZ19	1	Z	OAZ200	1	Z	OSS9310	1	St
BZZ20	1	Z	OAZ201	1	Z	OSS9410	1	St
BZZ21	1	Z	OAZ202	1	Z	RPY13	4	PhC
BZZ22	1	Z	OAZ203	1	Z	RPY18	4	PhC
BZZ23	1	Z	OAZ204	1	Z	RPY19	4	PhC
BZZ24	1	Z	OAZ205	1	Z	RPY20	4	PhC
BZZ25	1	Z	OAZ206	1	Z	RPY27	4	PhC
BZZ26	1	Z	OAZ207	1	Z	RPY33	4	PhC
BZZ27	1	Z	OC122	3	Sw	RPY41	4	PhC
BZZ28	1	Z	OC123	3	Sw	RPY43	4	PhC
BZZ29	1	Z	OC139	3	Sw	RPY55	4	PhC
CAY10	4	Mw	OC140	3	Sw	RPY58	4	PhC
CQY11B	4	L	OC141	3	Sw	RPY71	4	PhC
CXY10	4	Mw	OCP70	4	PhDT	RPY76A	4	I
CXY11A	4	Mw	ORP10	4	I	1N748A	1	Z
CXY11B	4	Mw	ORP13	4	I	1N749A	1	Z
CXY11C	4	Mw	ORP30N	4	PhC	1N750A	1	Z
CXY12	4	Mw	ORP50	4	PhC	1N751A	1	Z

D = Signal diodes
 I = Infrared devices
 L = Light emitting devices
 Mw = Microwave devices
 PhC = Photoconductive devices

PhDT = Photodiodes and phototransistors
 St = Rectifier stacks
 Sw = Switching transistors
 Z = Voltage regulator diodes

INDEX

Type No.	Part	Section	Type No.	Part	Section	Type No.	Part	Section
1N752A	1	Z	1N5739B	1	Z	2N1307	3	Sw
1N753A	1	Z	1N5740B	1	Z	2N1308	3	Sw
1N754A	1	Z	1N5741B	1	Z	2N1309	3	Sw
1N755A	1	Z	1N5742B	1	Z	2N1613	3	HF
1N756A	1	Z	1N5743B	1	Z	2N1711	3	HF
1N757A	1	Z	1N5744B	1	Z	2N1893	3	HF
1N758A	1	Z	1N5745B	1	Z	2N2218	3	Sw
1N759A	1	Z	1N5746B	1	Z	2N2218A	3	Sw
1N914	1	D	1N5747B	1	Z	2N2219	3	Sw
1N914A	1	D	1N5748B	1	Z	2N2219A	3	Sw
1N914B	1	D	1N5749B	1	Z	2N2221	3	Sw
1N916	1	D	1N5750B	1	Z	2N2221A	3	Sw
1N916A	1	D	1N5751B	1	Z	2N2222	3	Sw
1N916B	1	D	1N5752B	1	Z	2N2222A	3	Sw
1N4009	1	D	1N5753B	1	Z	2N2297	3	HF
1N4148	1	D	1N5754B	1	Z	2N2368	3	Sw
1N4150	1	D	1N5755B	1	Z	2N2369	3	Sw
1N4151	1	D	1N5756B	1	Z	2N2369A	3	Sw
1N4154	1	D	1N5757B	1	Z	2N2483	3	HF
1N4446	1	D	2N706A	3	Sw	2N2484	3	HF
1N4448	1	D	2N708	3	Sw	2N2894	3	Sw
1N5152	4	Mw	2N743	3	Sw	2N2894A	3	Sw
1N5153	4	Mw	2N744	3	Sw	2N2904	3	Sw
1N5155	4	Mw	2N753	3	Sw	2N2904A	3	Sw
1N5157	4	Mw	2N914	3	Sw	2N2905	3	Sw
1N5729B	1	Z	2N918	3	HF	2N2905A	3	Sw
1N5730B	1	Z	2N929	2	LF	2N2906	3	Sw
1N5731B	1	Z	2N930	2	LF	2N2906A	3	Sw
1N5732B	1	Z	2N1131	3	Sw	2N2907	3	Sw
1N5733B	1	Z	2N1132	3	Sw	2N2907A	3	Sw
1N5734B	1	Z	2N1302	3	Sw	2N3055	2	P
1N5735B	1	Z	2N1303	3	Sw	2N3133	3	Sw
1N5736B	1	Z	2N1304	3	Sw	2N3134	3	Sw
1N5737B	1	Z	2N1305	3	Sw	2N3303	3	Sw
1N5738B	1	Z	2N1306	3	Sw	2N3375	4	Tr

D = Signal diodes
 HF = High frequency transistors
 LF = Low frequency transistors
 Mw = Microwave devices

P = Low frequency power transistors
 Sw = Switching transistors
 Tr = Transmitting transistors
 Z = Voltage regulator diodes

INDEX

Type No.	Part	Section	Type No.	Part	Section	Type No.	Part	Section
2N3426	3	Sw	40829	3	HF	56265	2.3.4	A
2N3442	2	P	56200	2.3.4	A	56268	1	DH
2N3553	4	Tr	56201	2.3.4	A	56271	1	DH
2N3570	3	HF	56201a	2.3.4	A	56274	1	DH
2N3571	3	HF	56201b	2.3.4	A	56277	1	DH
2N3572	3	HF	56201c	2.3.4	A	56278	1	DH
2N3632	4	Tr	56201d	2.3.4	A	56279	1	DH
2N3771	2	P	56201e	2.3.4	A	56280	1	DH
2N3772	2	P	56203	2.3.4	A	56283	1	DH
2N3823	4	FET	56207	2.3.4	A	56284	1	DH
2N3866	4	Tr	56208	2.3.4	A	56286	1	DH
2N3924	4	Tr	56209	2.3.4	A	56290	1	HE
2N3926	4	Tr	56210	2.3.4	A	56293	1	HE
2N3927	4	Tr	56213	2.3.4	A	56295	1	A
2N3966	4	FET	56218	2.3.4	A	56296	1	A
2N4036	3	Sw	56226	2.3.4	A	56299	1	A
2N4091	4	FET	56227	2.3.4	A	56302	2.3.4	A
2N4092	4	FET	56230	1	HE	56303	2.3.4	A
2N4093	4	FET	56231	1	HE	56309B	1	A
2N4347	2	P	56233	1	A	56309R	1	A
2N4391	4	FET	56234	1	A	56311	1	WH
2N4392	4	FET	56239	2.3.4	A			
2N4393	4	FET	56243	1	A			
2N4427	4	Tr	56243A	1	A			
2N4856	4	FET	56244	1	A			
2N4857	4	FET	56245	2.3.4	A			
2N4858	4	FET	56246	1 to 4	A			
2N4859	4	FET	56247	1	A			
2N4860	4	FET	56250	1	DH			
2N4861	4	FET	56253	1	DH			
61SV	4	I	56256	1	DH			
40809	2	LF	56261	2.3.4	A			
40819	2	LF	56262A	1	A			
40820	3	HF	56263	1 to 4	A			
40822	3	HF	56264A	1	A			

A = Accessories

DH = Diecast heatsinks

FET = Field effect transistors

HE = Heatsink extrusions

HF = High frequency transistors

I = Infrared devices

LF = Low frequency transistors

P = Low frequency power transistors

Sw = Switching transistors

Tr = Transmitting transistors

WH = Water cooled heatsinks

General

High frequency transistors

Switching transistors

Accessories
