PART 3 NOVEMBER 1970

High frequency transistors

Switching transistors

Accessories

SEMICONDUCTORS AND INTEGRATED CIRCUITS

Part 3 **November 1970**

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 (5 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 pusblished 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.

January 1970

ELECTRON TUBES (BLUE SERIES)

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

Part 1 **January 1970**

Transmitting tubes (Tetrodes, Pentodes)
Associated accessories

Part 2 **February 1970**

Tubes for microwave equipment

Part 3 **March 1970**

Special Quality tubes
Miscellaneous devices

Part 4 **April 1970**

Receiving tubes

Part 5 **May 1970**

Cathode-ray tubes
Photo tubes
Camera tubes
Photoconductive devices
Associated accessories

Part 6 **June 1970**

Photomultiplier tubes
Scintillators
Photoscintillators
Radiation counter tubes
Semiconductor radiation detectors
Neutron generator tubes
Associated accessories

Part 7 **July 1970**

Voltage stabilizing and reference tubes
Counter, selector, and indicator tubes
Trigger tubes
Switching diodes
Thyratrons
Ignitrons
Industrial rectifying tubes
High-voltage rectifying tubes

Part 8 **August 1970**

T.V. Picture tubes

Part 9 **December 1969**

Transmitting tubes (Triodes)
Tubes for R.F. heating (Triodes)
Associated accessories

August 1970

SEMICONDUCTORS AND INTEGRATED CIRCUITS (RED SERIES)

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

Part 1 Diodes and Thyristors — September 1970

General
Signal diodes
Tunnel diodes
Variable capacitance diodes
Voltage regulator diodes
Rectifier diodes
Thyristors, diacs, triacs
Rectifier stacks
Accessories
Heatsinks

Part 2 Low frequency; Deflection — October 1970

General
Low frequency transistors (low power)
Low frequency power transistors
Deflection transistors
Accessories

Part 3 High frequency; Switching — November 1970

General
High frequency transistors
Switching transistors
Accessories

Part 4 Special types — December 1969

General
Transmitting transistors
Field effect transistors
Dual transistors
Diodes and transistors for thick- and thin-film circuits
Photo devices
Accessories

Part 5 Integrated Circuits — February 1970

General
Digital integrated circuits
  FC family; standard temperature range
  FC family; extended temperature range
  FD family
  FJ family; standard temperature range
Linear integrated circuits

COMPONENTS AND MATERIALS (GREEN SERIES)

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

Part 1 Circuit Blocks, Input/Output Devices — September 1970

Circuit blocks 100kHz Series
Circuit blocks 1-Series
Circuit blocks 10-Series
Circuit blocks 20-Series
Circuit blocks 40-Series
Counter modules 50-Series
Norbits 60-Series, 61-Series
Circuit blocks 90-Series
Circuit blocks for ferrite core memory drive
Input/output devices

Part 2 Resistors, Capacitors — November 1969

Fixed resistors
Variable resistors
Non-linear resistors
Ceramic capacitors
Polycarbonate, paper, mica, polystyrene capacitors
Electrolytic capacitors
Variable capacitors

Part 3 Radio, Audio, Television — January 1970

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

Part 4 Magnetic Materials, White Ceramics — March 1970

Ferrites for radio, audio and television
Ferroxcube potcores and square cores
Microchokes
Ferroxcube transformer cores
Piezoxide
Permanent magnet materials

Part 5 Memory Products, Magnetic Heads, Quartz Crystals, Microwave Devices, Variable Transformers, Electro-mechanical Components — June 1970

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

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 ($R_{th\ j\text{-}mb} > 15\ ^{o}C/W$)
D	Power transistor for a.f. applications ($R_{th\ j\text{-}mb} \leq 15\ ^{o}C/W$)
E	Tunnel diode
F	Transistor for h.f. applications ($R_{th\ j\text{-}mb} > 15\ ^{o}C/W$)
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 ($R_{th\ j\text{-}mb} \leq 15\ ^{o}C/W$)
M	Hall generator in a closed electrically energised magnetic circuit, e.g. Hall modulator or multiplier
P	Radiation sensitive device 1)
Q	Radiation generating device
R	Electrically triggered controlling and switching device having a breakdown characteristic ($R_{th\ j\text{-}mb} > 15\ ^{o}C/W$)
S	Transistor for switching applications ($R_{th\ j\text{-}mb} > 15\ ^{o}C/W$)
T	Electrically, or by means of light, triggered controlling and switching power device having a breakdown characteristic ($R_{th\ j\text{-}mb} \leq 15\ ^{o}C/W$) 1)
U	Power transistor for switching applications ($R_{th\ j\text{-}mb} \leq 15\ ^{o}C/W$)
X	Multiplier diode, e.g. varactor, step recovery diode
Y	Rectifying diode, booster diode, efficiency diode 1)
Z	Voltage reference or voltage regulator diode 1)

---

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 V ± 5%
BYX13-1200	The particular normal polarity type out of the BYX13series with a maximum repetitive peak reverse voltage of 1200 V
BTX64-200R	The particular reverse polarity type out of the BTX64 thyristor range of which the lower maximum repetitive peak voltage is 200 V

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.

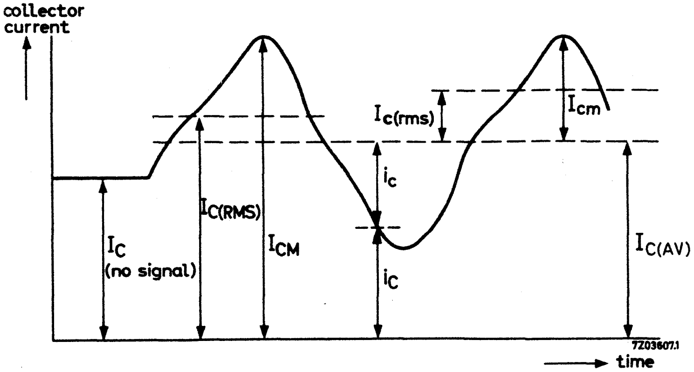


Fig. 1

CONVENTIONS FOR SUBSCRIPT SEQUENCE

1. Currents

For transistors	the first subscript indicates the terminal carrying the current (conventional current flow from the external circuit into the terminal is positive)
For diodes	a forward current (conventional current flow into the anode terminal) is represented by the subscript F or f; a reverse current (conventional current flow out of the anode terminal) is represented by the subscript R or r.

2. Voltages

For transistors	normally, two subscripts are used to indicate the points between which the voltage is measured. The first subscript indicates one terminal point and the second the reference terminal. Where there is no possibility of confusion, the second subscript may be omitted.
For diodes	a forward voltage (anode positive with respect to cathode) is represented by the subscript F or f and a reverse voltage (anode negative with respect to cathode) by the subscript R or r.

3. Supply voltages

Supply voltages may be indicated by repeating the terminal subscript.

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

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

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

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

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

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

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

ELECTRICAL PARAMETER SYMBOLS

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

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

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

   Examples: H_i, Z_o, H_F, Y_R

SUBSCRIPTS FOR PARAMETER SYMBOLS

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

   Examples: h_{IB}, h_{FE}

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

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

   Examples: h_{ib}, z_{ob}

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

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

   Examples:
   $$V_1 = h_i I_1 + h_r V_2$$
   $$I_2 = h_f I_1 + h_o V_2$$

Notes 1) The voltage and current symbols in matrix notation are indicated by a single digit subscript.
The subscript 1 = input; the subscript 2 = output

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

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.

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

$Im(h_{ib})$ 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 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
$R_{th\ j\text{-}a}$	Thermal resistance from junction to ambient
$R_{th\ j\text{-}mb}$	Thermal resistance from junction to mounting base
$R_{th\ j\text{-}c}$	Thermal resistance from junction to case
$R_{th\ mb\text{-}h}$	Thermal resistance from mounting base to heatsink (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 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	Output short circuited to a.c.
b_{ib}, b_{ie}, b_{is}		
g_{ib}, g_{ie}, g_{is}	Input conductance	
C_{ib}, C_{ie}, C_{is}	Input capacitance	
φ_{ib}, φ_{ie}, φ_{is}	Phase angle of input admittance	
y_{fb}, y_{fe}, y_{fs}	Transfer admittance	Output short circuited to a.c.
b_{fb}, b_{fe}, b_{fs}		
g_{fb}, g_{fe}, g_{fs}	Transfer conductance	
C_{fb}, C_{fe}, C_{fs}	Transfer capacitance	
φ_{fb}, φ_{fe}, φ_{fs}	Phase angle of transfer admittance	
y_{ob}, y_{oe}, y_{os}	Output admittance	Input short circuited to a.c.
b_{ob}, b_{oe}, b_{os}		
g_{ob}, g_{oe}, g_{os}	Output conductance	
C_{ob}, C_{oe}, C_{os}	Output capacitance	
φ_{ob}, φ_{oe}, φ_{os}	Phase angle of output admittance	
y_{rb}, y_{re}, y_{rs}	Feedback admittance	Input short circuited to a.c.
b_{rb}, b_{re}, b_{rs}		
g_{rb}, g_{re}, g_{rs}	Feedback conductance	
C_{rb}, C_{re}, C_{rs}	Feedback capacitance	
φ_{rb}, φ_{re}, φ_{rs}	Phase angle of feedback admittance	
Z_{th}	Transient thermal **impedance**	

LETTER SYMBOLS
FOR RECTIFIER DIODES AND THYRISTORS

This system is based on the Recommendations of the INTERNATIONAL ELECTROTECHNICAL COMMISSION.

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 or crest), 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.
2. Values of varying components are indicated by lower case subscripts.
3. For power rectifier diodes and thyristors the **terminals** are <u>not</u> indicated in the subscripts, except for the gate-terminal of thyristors.
4. List of subscripts:

G, g = Gate terminal
F, f = Forward 1)
D, d = Forward off-state 1); non trigger (gate voltage or current)
T, t = Forward on-state 1); trigger (gate voltage or current)
R, r = As first subscript; Reverse
As second subscript: Repetitive
(AV), (av) = Average value
M, m = Maximum (peak or crest) value
(RMS), (rms) = R.M.S. value
(BR) = Breakdown
(BO) = Breakover
H = Holding
L = Latching
Q, q = Turn-off
S, s = As a second subscript: Non-repetitive
W = Working

---

1) For the anode-cathode voltage of thyristors F is replaced either by D or by T, to distinguish between "off-state" (non triggered) and "on-state" (triggered).

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

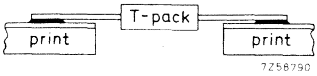


Fig. 1. Flat-lead mounting

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

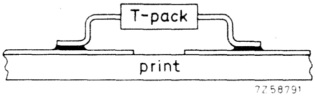


Fig. 2. Bent-lead mounting

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 heatsink. 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).

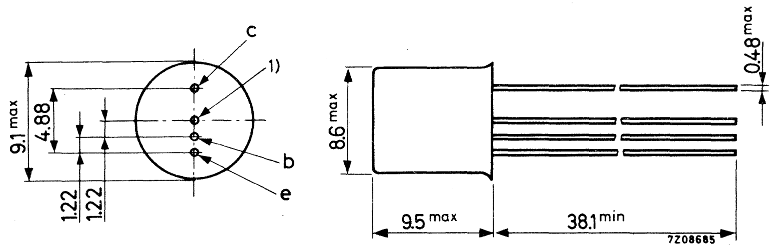
Total power dissipation up to T_{amb} = 45 °C	P_{tot}	max.	75	mW

THERMAL RESISTANCE

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

MECHANICAL DATA Dimensions in mm

TO-7



1) = 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 $T_{amb} = 45$ °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

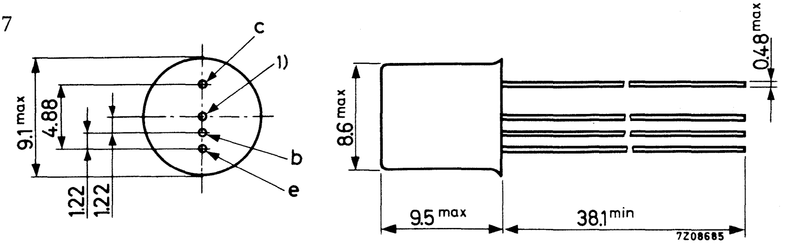
THERMAL RESISTANCE

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

MECHANICAL DATA

Dimensions in mm

TO-7



1) = shield lead (connected to case)

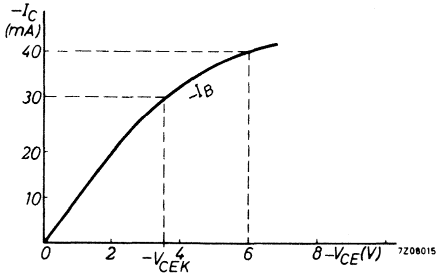
Accessory available: 56207

FOR NEW DESIGN THE SUCCESSOR TYPES BF177 to 179
(N-P-N) ARE RECOMMENDED

CHARACTERISTICS

T_{amb} 25 °C unless otherwise specified

Collector cut-off current				
$I_E = 0$; $-V_{CB} = 70$ V	$-I_{CBO}$	<	60	μA
$I_E = 0$; $-V_{CB} = 70$ V; $T_j = 90$ °C	$-I_{CBO}$	<	1.6	mA
Base current				
$-I_C = 10$ mA; $-V_{CE} = 2$ V	$-I_B$	typ. <	55 275	μA μA
Base-emitter voltage				
$-I_C = 10$ mA; $-V_{CE} = 2$ V	$-V_{BE}$	<	375	mV
Knee voltage				
$-I_C = 30$ mA; $-I_B$ = value for which $-I_C = 40$ mA at $-V_{CE} = 6$ V	$-V_{CEK}$	typ. <	3.5 5	V V



Feedback capacitance at f = 10.7 MHz				
$-I_C = 10$ mA; $-V_{CE} = 6$ V	$-C_{re}$	typ. <	1.8 2.3	pF pF
Frequency at which $\|h_{fe}\| = 1$				
$I_E = 10$ mA; $-V_{CB} = 6$ V	f_1	> typ.	125 175	MHz MHz
Feedback impedance at f = 2 MHz				
$I_E = 10$ mA; $-V_{CB} = 6$ V	$\|z_{rb}\|$	typ.	30	Ω
Transfer admittance at f = 10.7 MHz				
$-I_C = 10$ mA; $-V_{CE} = 6$ V	$\|y_{fe}\|$	> typ.	100 130	$m\Omega^{-1}$ $m\Omega^{-1}$

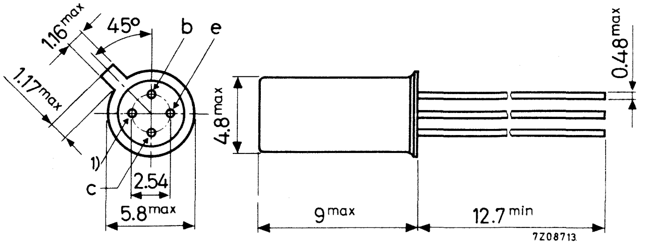
R.F. GERMANIUM ALLOY-DIFFUSED TRANSISTOR

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 $T_{amb} = 45\ ^{o}C$	P_{tot}	max.	140	mW
Junction temperature, incidentally	T_j	max.	90	^{o}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	$\lvert y_{fe}\rvert$	typ.	80	$m\Omega^{-1}$

MECHANICAL DATA Dimensions in mm



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 $R_B/R_E < 100$; $R_E > 200\ \Omega$	$-V_{CER}$	max.	25	V

Currents

Collector current (d.c.)	$-I_C$	max.	10	mA
Collector current (peak value)	$-I_{CM}$	max.	15	mA
Reverse emitter current	$-I_E$	max.	1	mA

Power dissipation

Total power dissipation up to T_{amb} = 45 °C with cooling clip 56263	P_{tot}	max.	140	mW

Temperatures

Storage temperature	T_{stg}	−55 to +75		°C
Junction temperature: continuous	T_j	max.	75	°C
incidentally	T_j	max.	90	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	= 0.45	°C/mW
From junction to case	$R_{th\ j-c}$	= 0.22	°C/mW
From junction to ambient with cooling clip 56263	$R_{th\ j-a}$	= 0.32	°C/mW

---

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

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

Collector cut-off current				
$I_E = 0$; $-V_{CB} = 10$ V	$-I_{CBO}$	typ. <	1.2 8	μA μA
$I_E = 0$; $-V_{CB} = 10$ V; $T_j = 75$ °C	$-I_{CBO}$	<	150	μA
Base current				
$-I_C = 3$ mA; $-V_{CE} = 10$ V	$-I_B$	typ. <	40 100	μA μA
Base-emitter voltage				
$-I_C = 3$ mA; $-V_{CE} = 10$ V	$-V_{BE}$	typ.	320 280 to 380	mV mV
Feedback capacitance at f = 0.45 MHz				
$-I_C = 1$ mA; $-V_{CE} = 10$ V	$-C_{re}$	typ.	450 250 to 650	fF [1] fF [1]
Transition frequency				
$-I_C = 3$ mA; $-V_{CE} = 10$ V	f_T	typ.	270	MHz
Noise figure at f = 100 MHz [2]				
$I_E = 2$ mA; $-V_{CB} = 5$ V	F	typ. <	4.5 6	dB dB
y parameters at f = 0.45 MHz (common emitter) [3]				
$-I_C = 2$ mA; $-V_{CE} = 5$ V				
Input conductance	g_{ie}	typ.	0.8	$m\Omega^{-1}$
Input capacitance	C_{ie}	typ.	45	pF
Feedback admittance	$\|y_{re}\|$	typ.	1.7	$\mu\Omega^{-1}$
Phase angle of feedback admittance	φ_{re}	typ.	270°	
Transfer admittance	$\|y_{fe}\|$	typ.	73	$m\Omega^{-1}$
Phase angle of transfer admittance	φ_{fe}	typ.	0	
Output conductance	g_{oe}	typ.	0.8	$\mu\Omega^{-1}$
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 $Y_S = (11 - 6j)\ m\Omega^{-1}$

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

CHARACTERISTICS (continued) $T_{amb} = 25\ ^{o}C$

y parameters at f = 5.5 MHz (common emitter) [1]

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

Input conductance	g_{ie}	typ.	1.0	$m\Omega^{-1}$
Input capacitance	C_{ie}	typ.	45	pF
Feedback admittance	$\|y_{re}\|$	typ.	21	$\mu\Omega^{-1}$
Phase angle of feedback admittance	φ_{re}	typ.	270^{o}	
Transfer admittance	$\|y_{fe}\|$	typ.	71	$m\Omega^{-1}$
Phase angle of transfer admittance	φ_{fe}	typ.	350^{o}	
Output conductance	g_{oe}	typ.	5	$\mu\Omega^{-1}$
Output capacitance	C_{oe}	typ.	2.6	pF

y parameters at f = 10.7 MHz (common emitter) [1]

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

Input conductance	g_{ie}	typ.	1.3	$m\Omega^{-1}$
Input capacitance	C_{ie}	typ.	45	pF
Feedback admittance	$\|y_{re}\|$	typ.	40	$\mu\Omega^{-1}$
Phase angle of feedback admittance	φ_{re}	typ.	270^{o}	
Transfer admittance	$\|y_{fe}\|$	typ.	70	$m\Omega^{-1}$
Phase angle of transfer admittance	φ_{fe}	typ.	347^{o}	
Output conductance	g_{oe}	typ.	13	$\mu\Omega^{-1}$
Output capacitance	C_{oe}	typ.	2.5	pF

y parameters at f = 35 MHz (common emitter) [1]

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

Input conductance	g_{ie}	typ.	6.5	$m\Omega^{-1}$
Input capacitance	C_{ie}	typ.	35	pF
Feedback admittance	$\|y_{re}\|$	typ.	100	$\mu\Omega^{-1}$
Phase angle of feedback admittance	φ_{re}	typ.	260^{o}	
Transfer admittance	$\|y_{fe}\|$	typ.	80	$m\Omega^{-1}$
Phase angle of transfer admittance	φ_{fe}	typ.	322^{o}	
Output conductance	g_{oe}	typ.	100	$\mu\Omega^{-1}$
Output capacitance	C_{oe}	typ.	1.8	pF

---

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

CHARACTERISTICS (continued) $T_{amb} = 25\ ^{o}C$

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

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

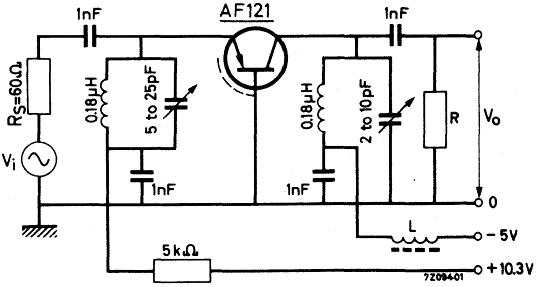
Input conductance	g_{ib}	typ.	32	$m\Omega^{-1}$
Input capacitance	$-C_{ib}$	typ.	35	pF
Feedback admittance	$\lvert y_{rb}\rvert$	typ.	320	$\mu\Omega^{-1}$
Phase angle of feedback admittance	φ_{rb}	typ.	240^o	
Transfer admittance	$\lvert y_{fb}\rvert$	typ.	34	$m\Omega^{-1}$
Phase angle of transfer admittance	φ_{fb}	typ.	110^o	
Output conductance	g_{ob}	typ.	250	$\mu\Omega^{-1}$
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}	>	17	dB
		typ.	19	dB

Basic circuit for measuring the transducer gain



The resistor R is choosen 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

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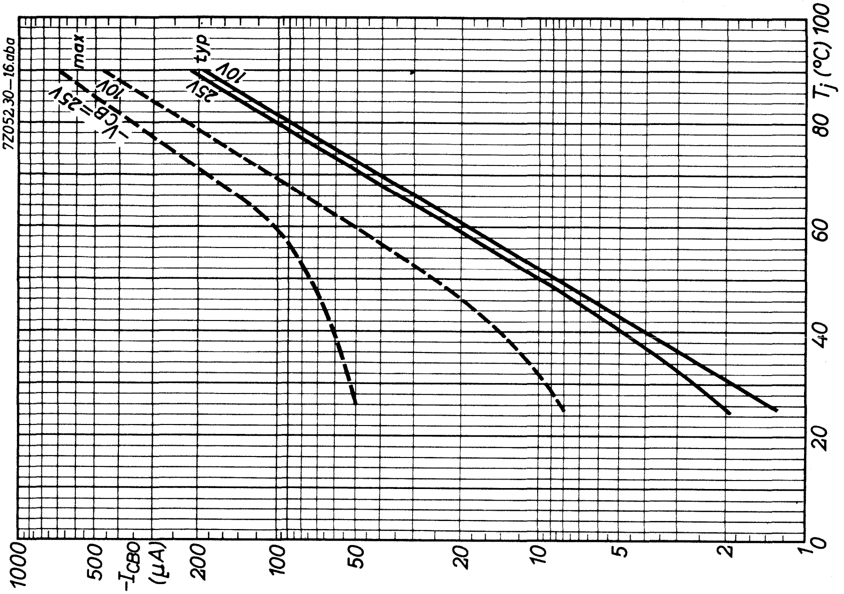
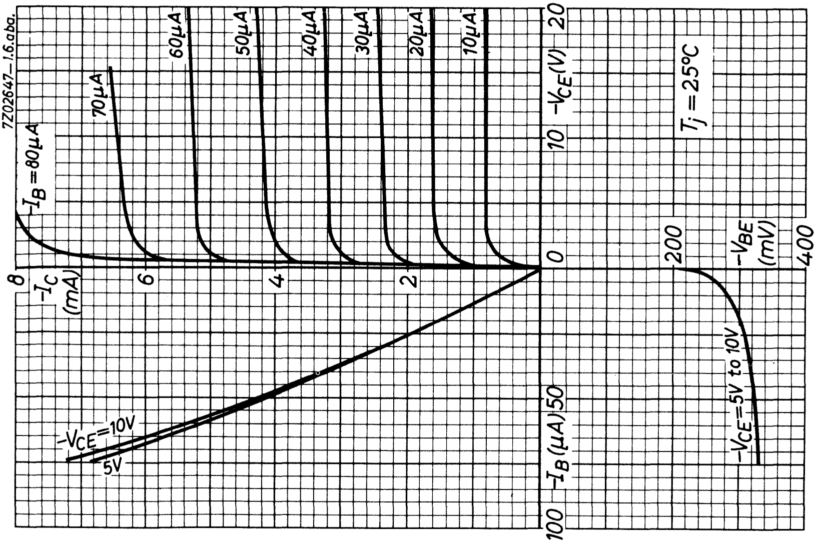
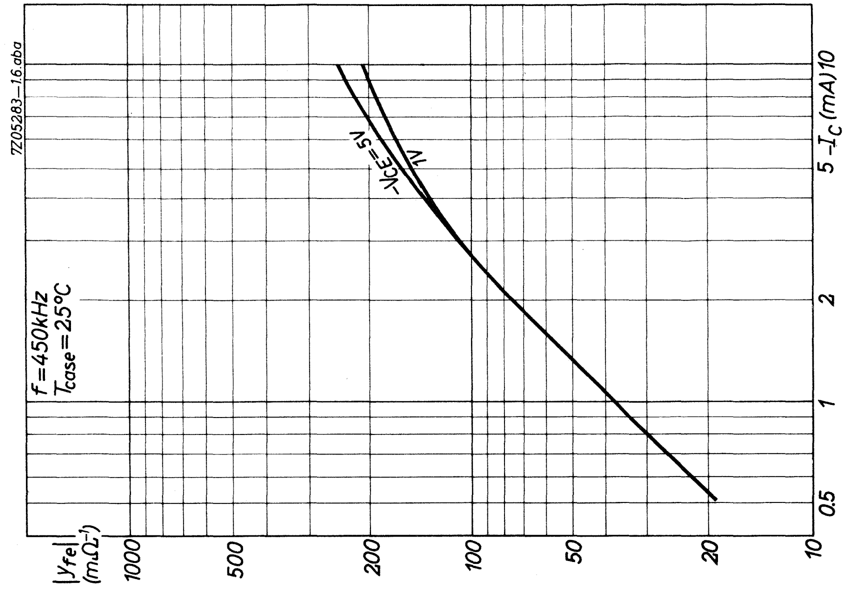
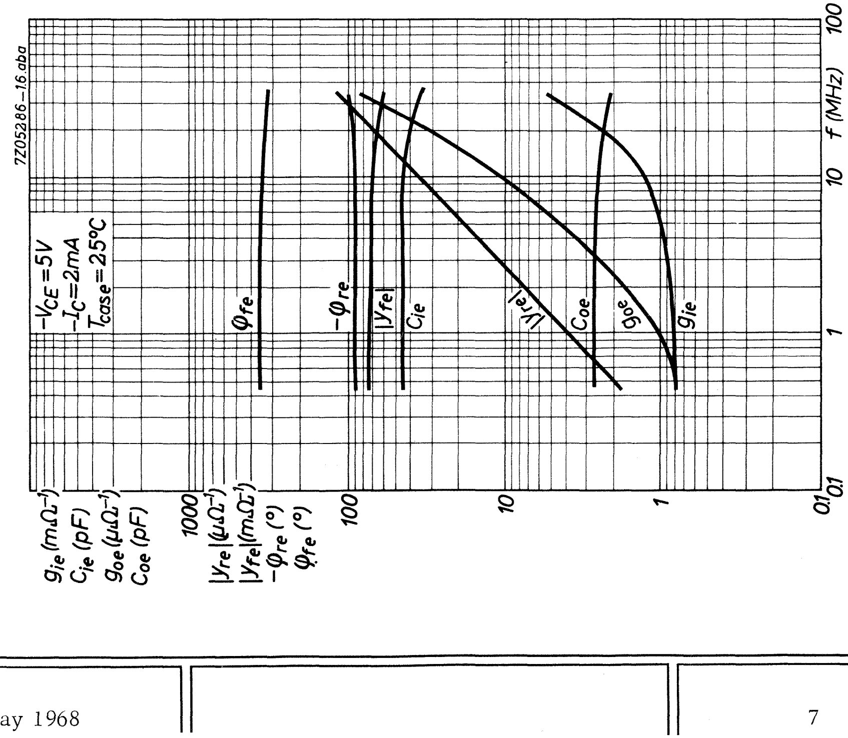
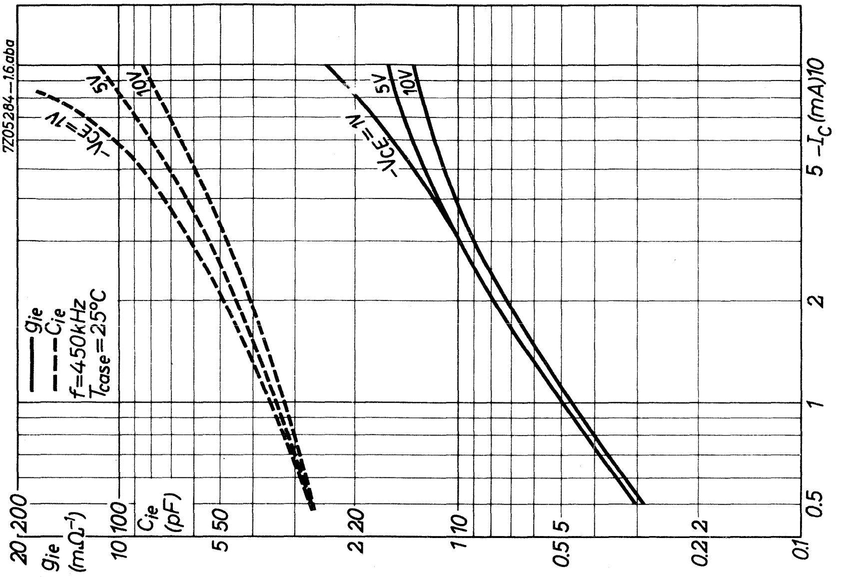
[1]) Length of leads between bottom of transistor and measuring jig is 5 mm.


7Z05230-16.aba
max
typ
$-V_{CB}=25V$
10V
25V
10V
$-I_{CBO}$ (μA)
1000
500
200
100
50
20
10
5
2
1
T_j (°C)
0
20
40
60
80
100

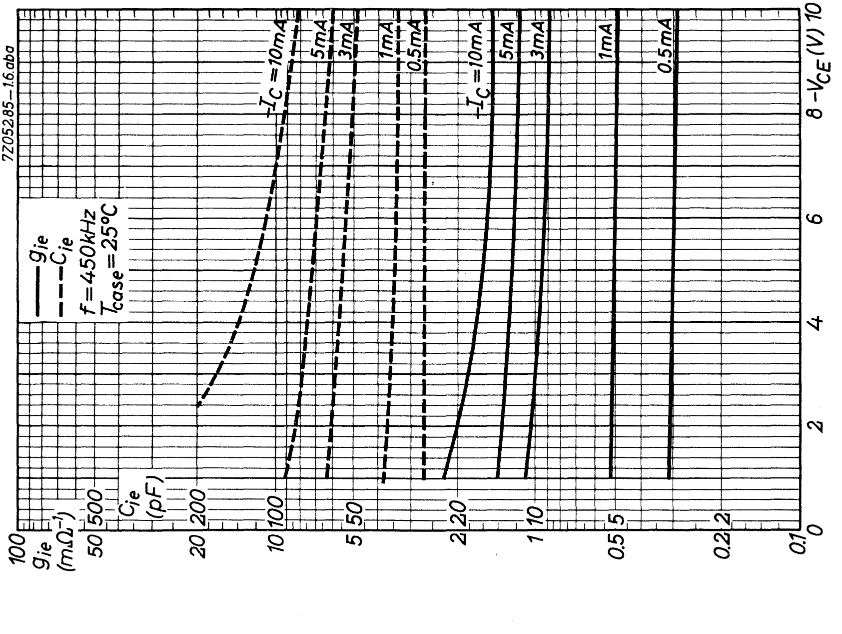

7Z02647-1.6.aba.
$-I_B=80\mu A$
70μA
60μA
50μA
40μA
30μA
20μA
10μA
$-V_{CE}(V)$
0
10
20
$T_j=25°C$
$-I_C$ (mA)
8
6
4
2
$-V_{CE}=10V$
5V
$-I_B$ (μA)
50
100
200
400
$-V_{BE}$ (mV)
$-V_{CE}=5V$ to 10V


7Z05283–1.6.aba
f = 450kHz
T_case = 25°C
|y_fe| (mΩ⁻¹)
1000
500
200
100
50
20
10
0.5
1
2
5
10
-I_C (mA)
-V_CE = 5V
1V

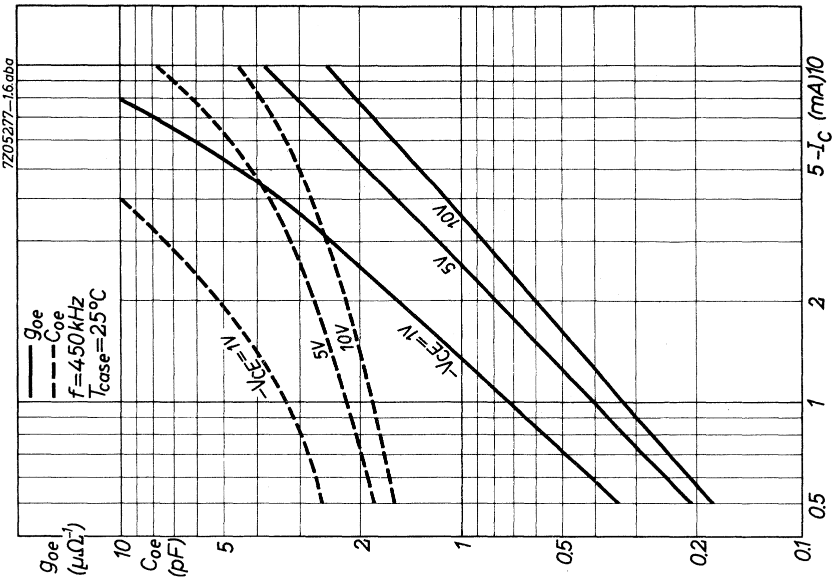

7Z05286–1.6.aba
-V_CE = 5V
-I_C = 2mA
T_case = 25°C
g_ie (mΩ⁻¹)
C_ie (pF)
g_oe (μΩ⁻¹)
C_oe (pF)
|y_re| (μΩ⁻¹)
|y_fe| (mΩ⁻¹)
-φ_re (°)
φ_fe (°)
1000
100
10
1
0.1
0.1
1
10
100
f (MHz)
φ_fe
-φ_re
|y_fe|
C_ie
|y_re|
C_oe
g_oe
g_ie

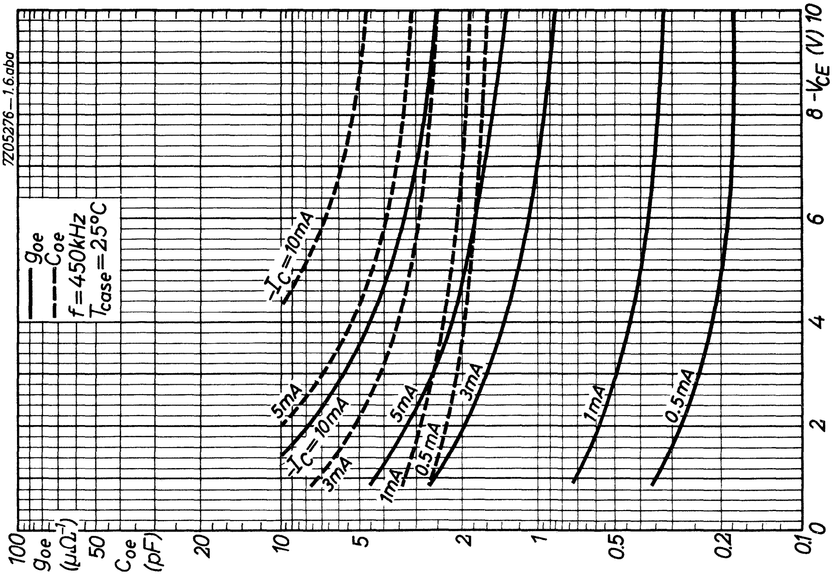


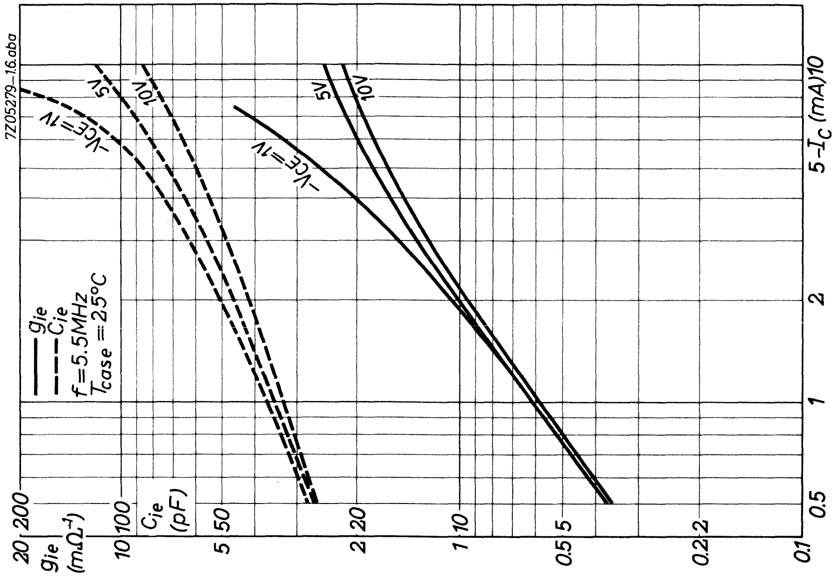
7Z05284-1.6.aba
g_{ie}
C_{ie}
f = 450 kHz
T_{case} = 25°C
$-V_{CE}$ = 1V
5V
10V
5V
10V
$-V_{CE}$ = 1V
g_{ie} ($m\Omega^{-1}$)
20
10
5
2
1
0.5
0.2
0.1
C_{ie} (pF)
200
100
50
20
10
5
2
$-I_C$ (mA)
0.5
1
2
5
10

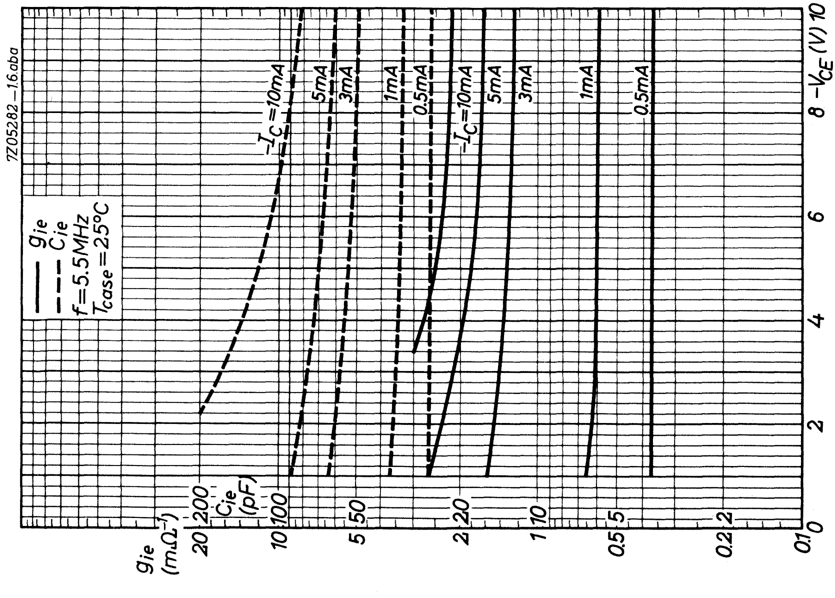


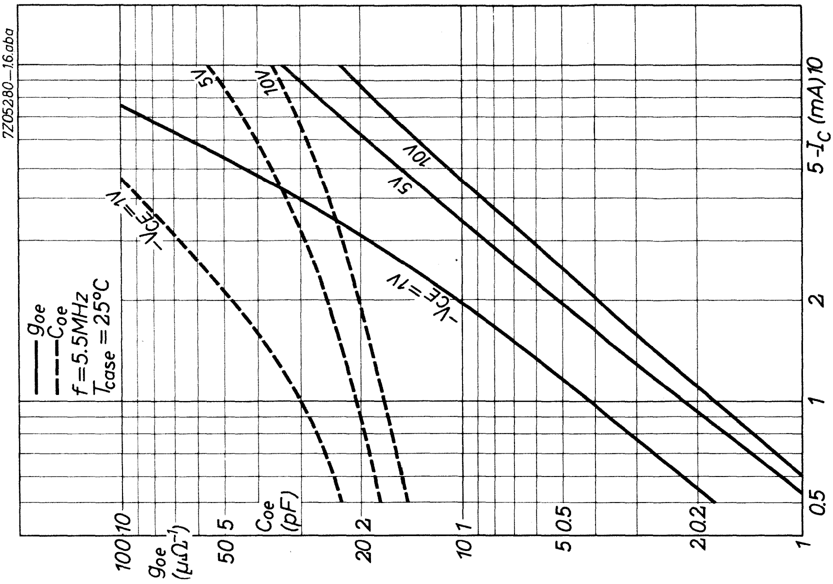
7Z05285-1.6.aba
g_{ie}
C_{ie}
f = 450 kHz
T_{case} = 25°C
$-I_C$ = 10mA
5mA
3mA
1mA
0.5mA
$-I_C$ = 10mA
5mA
3mA
1mA
0.5mA
g_{ie} ($m\Omega^{-1}$)
100
50
20
10
5
2
1
0.5
0.2
0.1
C_{ie} (pF)
500
200
100
50
20
10
5
2
$-V_{CE}$ (V)
0
2
4
6
8
10

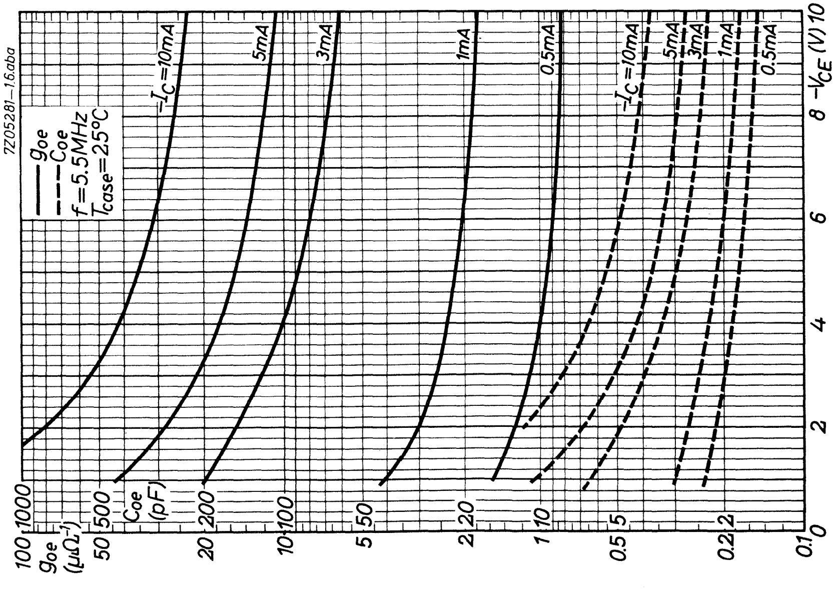

7Z05277–1.6.aba
g_oe
C_oe
f=450kHz
T_case=25°C
-V_CE=1V
5V
10V
-V_CE=1V
5V
10V
g_oe (μΩ⁻¹)
C_oe (pF)
10
5
2
1
0.5
0.2
0.1
-I_C (mA)
0.5
1
2
5
10

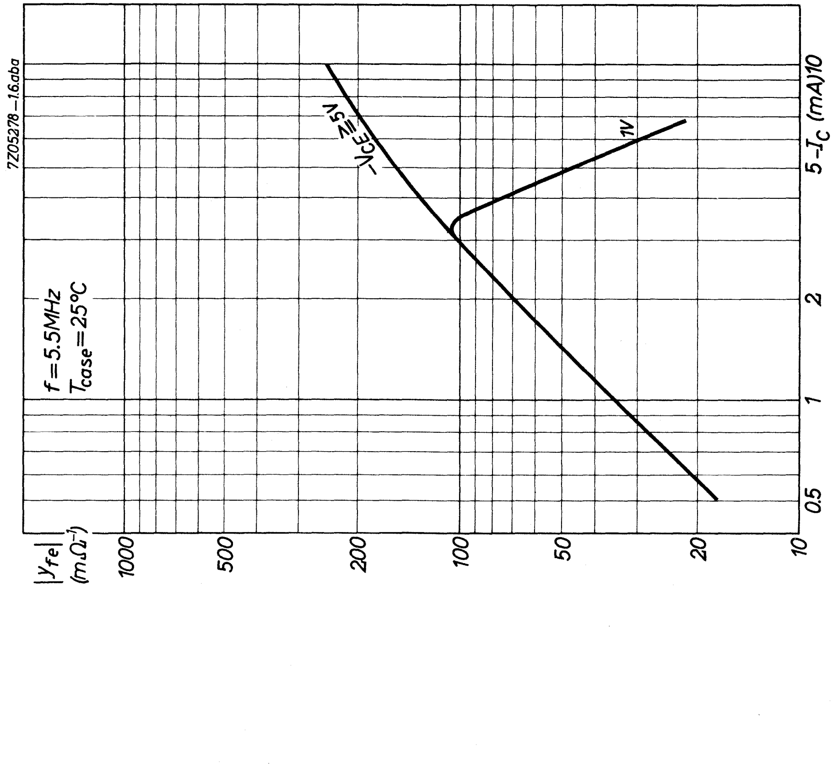

7Z05276–1.6.aba
g_oe
C_oe
f=450kHz
T_case=25°C
-I_C=10mA
5mA
3mA
1mA
0.5mA
-I_C=10mA
5mA
3mA
1mA
0.5mA
g_oe (μΩ⁻¹)
C_oe (pF)
100
50
20
10
5
2
1
0.5
0.2
0.1
-V_CE (V)
0
2
4
6
8
10

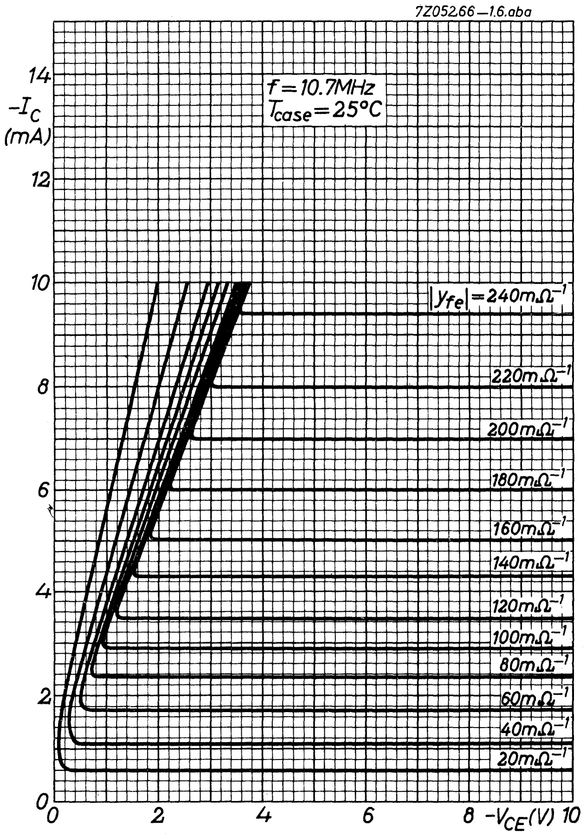

7Z05279-1.6.aba
g_ie
C_ie
f=5.5MHz
T_case=25°C
-V_CE=1V
5V
10V
-I_C (mA)
0.5
1
2
5
10
g_ie (mΩ^-1)
20
10
5
2
1
0.5
0.2
0.1
C_ie (pF)
200
100
50
20
10
5
2

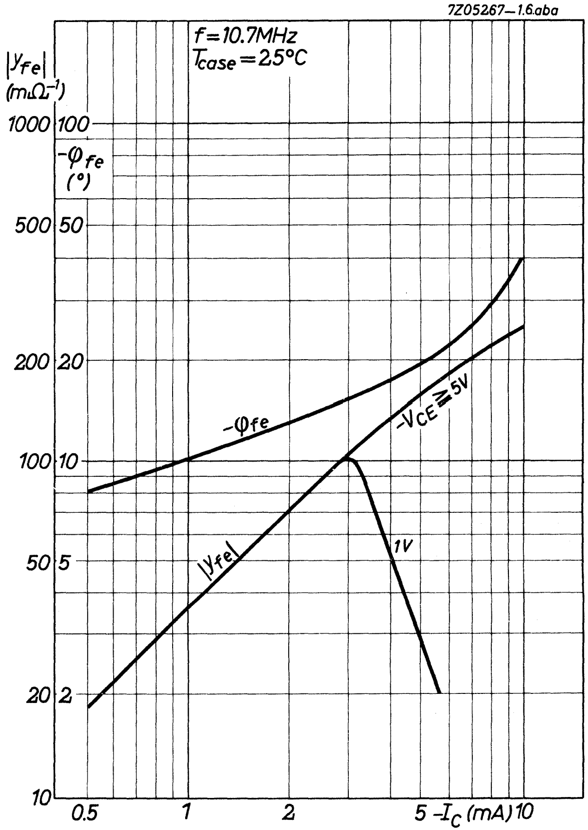

7Z05282-1.6.aba
g_ie
C_ie
f=5.5MHz
T_case=25°C
-I_C=10mA
5mA
3mA
1mA
0.5mA
-V_CE (V)
0
2
4
6
8
10
g_ie (mΩ^-1)
20
10
5
2
1
0.5
0.2
0.1
C_ie (pF)
200
100
50
20
10
5
2

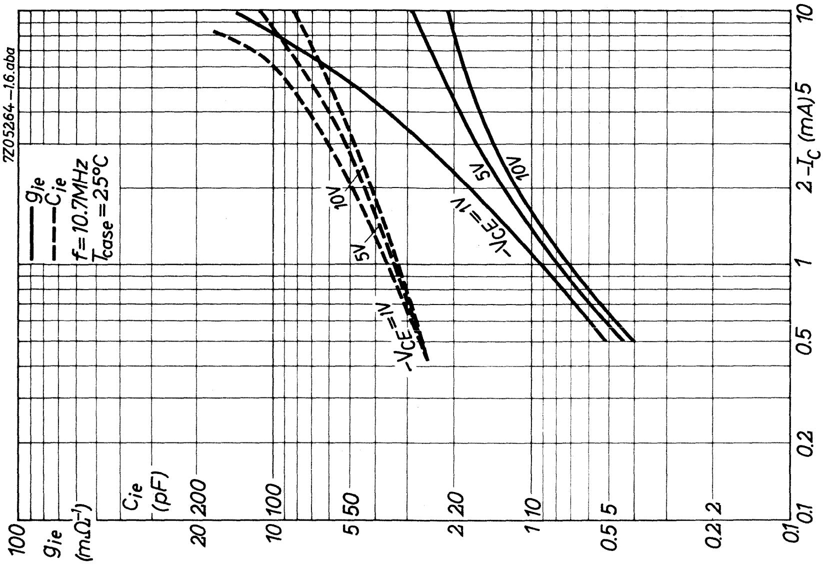

7Z05280—1.6.aba
g_oe
C_oe
f = 5.5MHz
T_case = 25°C
-V_CE = 1V
5V
10V
-V_CE = 1V
5V
10V
g_oe (μΩ⁻¹)
100
50
20
10
5
2
1
C_oe (pF)
10
5
2
1
0.5
0.2
-I_C (mA)
0.5
1
2
5
10

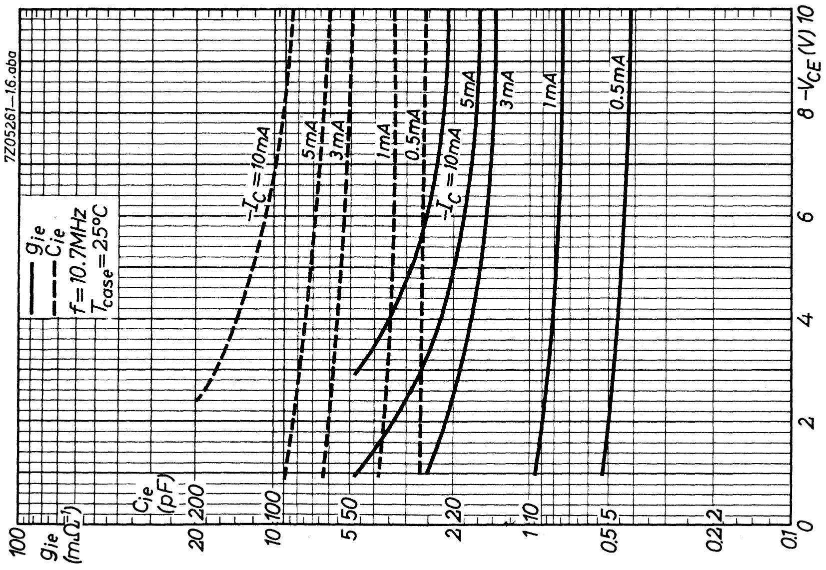

7Z05281-1.6.aba
g_oe
C_oe
f = 5.5MHz
T_case = 25°C
-I_C = 10mA
5mA
3mA
1mA
0.5mA
-I_C = 10mA
5mA
3mA
1mA
0.5mA
g_oe (μΩ⁻¹)
100
50
20
10
5
2
1
0.5
0.2
0.1
C_oe (pF)
1000
500
200
100
50
20
10
5
2
-V_CE (V)
0
2
4
6
8
10

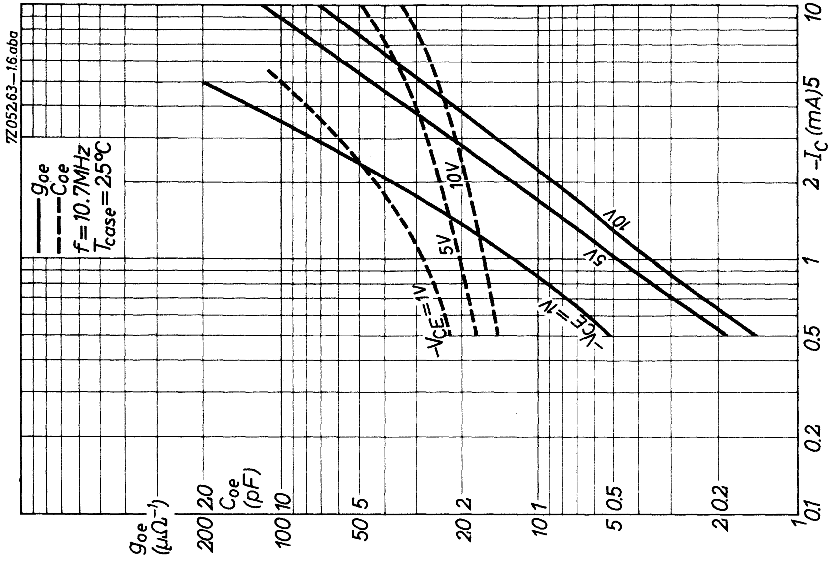

7Z05278-1.6.aba
f = 5.5MHz
T_{case} = 25°C
$|y_{fe}|$ (mΩ^{-1})
1000
500
200
100
50
20
10
$-V_{CE}$ = 5V
1V
0.5
1
2
5
10
$-I_C$ (mA)

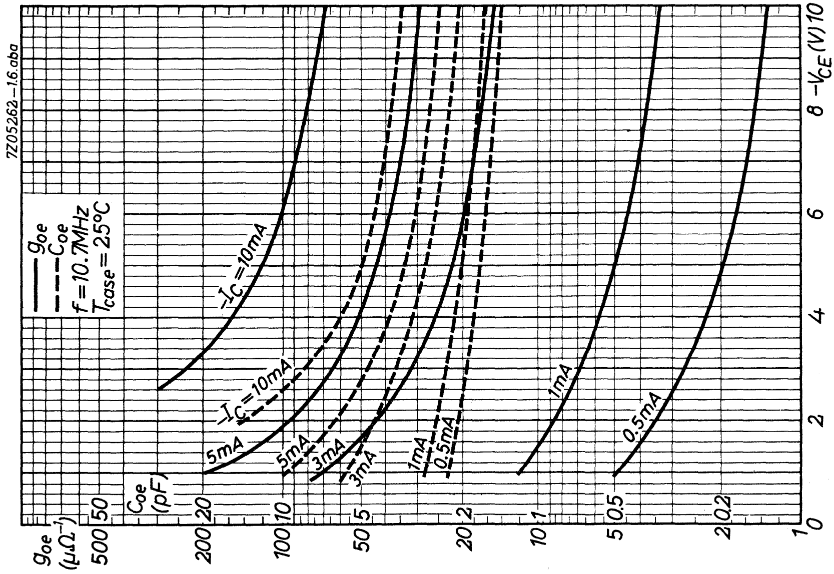

7Z05266—1.6.aba
f = 10.7MHz
Tcase = 25°C
−IC (mA)
14
12
10
8
6
4
2
0
0
2
4
6
8
−VCE (V)
10
|yfe| = 240mΩ⁻¹
220mΩ⁻¹
200mΩ⁻¹
180mΩ⁻¹
160mΩ⁻¹
140mΩ⁻¹
120mΩ⁻¹
100mΩ⁻¹
80mΩ⁻¹
60mΩ⁻¹
40mΩ⁻¹
20mΩ⁻¹

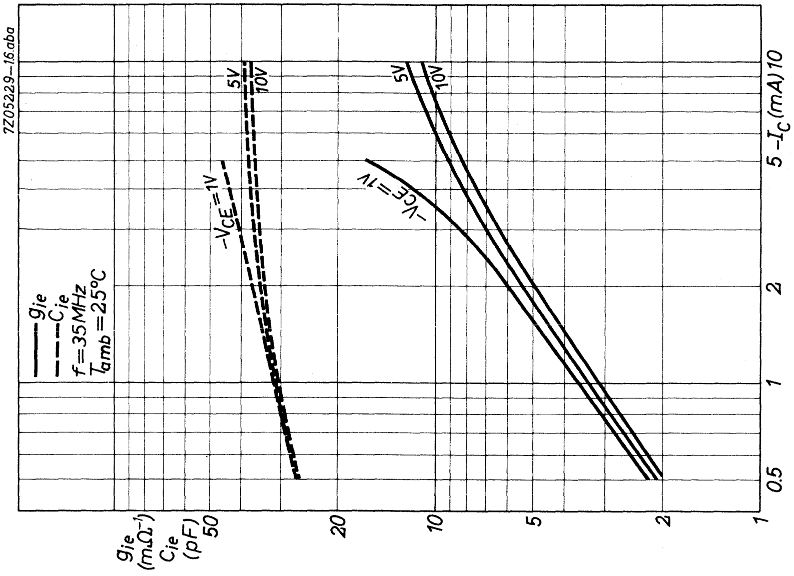

7Z05267—1.6.aba
f = 10.7MHz
Tcase = 25°C
|yfe| (mΩ⁻¹)
−φfe (°)
1000 100
500 50
200 20
100 10
50 5
20 2
10
−φfe
−VCE ≧ 5V
1V
|yfe|
0.5
1
2
5
−IC (mA)
10

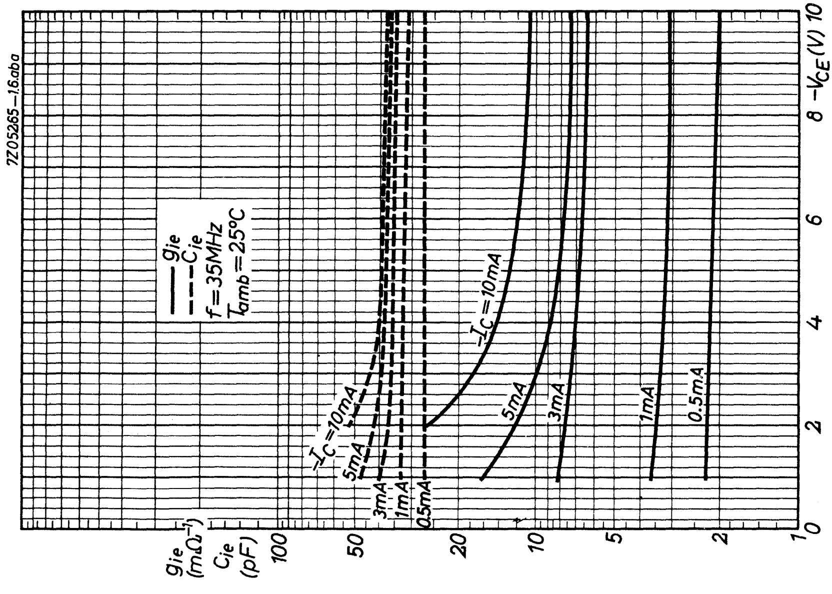

7Z05264-1.6.aba
— g_{ie}
- - - C_{ie}
f = 10.7MHz
T_{case} = 25°C
g_{ie} (mΩ⁻¹)
C_{ie} (pF)
100
20 200
10 100
5 50
2 20
1 10
0.5 5
0.2 2
0.1
0.1
0.2
0.5
1
2
5
10
$-I_C$ (mA)
$-V_{CE}$ = 1V
5V
10V
$-V_{CE}$ = 1V
5V
10V

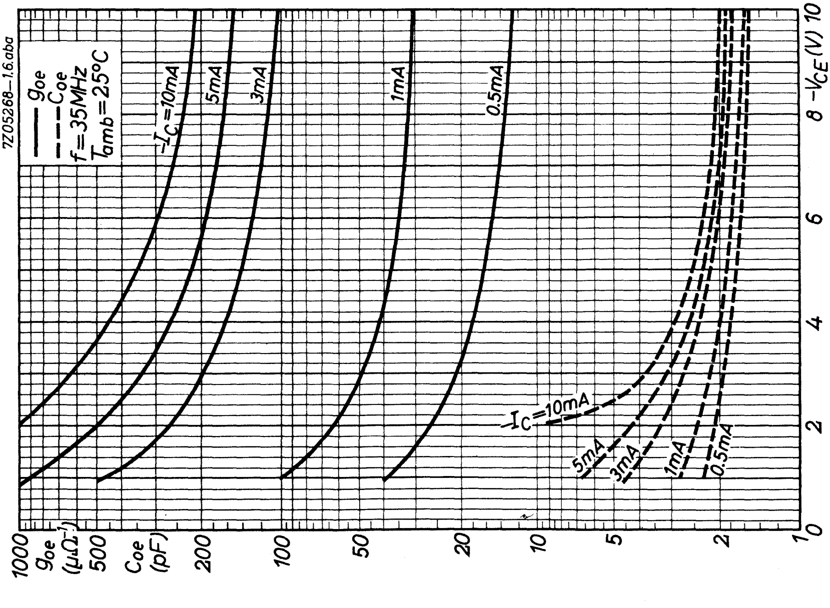

7Z05261-1.6.aba
— g_{ie}
- - - C_{ie}
f = 10.7MHz
T_{case} = 25°C
g_{ie} (mΩ⁻¹)
C_{ie} (pF)
100
20 200
10 100
5 50
2 20
1 10
0.5 5
0.2 2
0.1
0
2
4
6
8
10
$-V_{CE}$ (V)
$-I_C$ = 10mA
5mA
3mA
1mA
0.5mA
$-I_C$ = 10mA
5mA
3mA
1mA
0.5mA

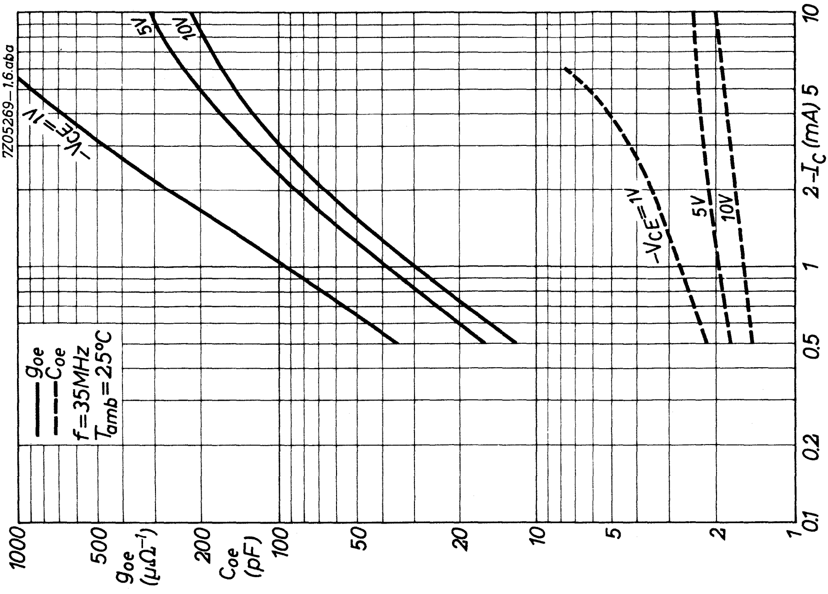

7Z05263-1.6.aba
g_oe
C_oe
f=10.7MHz
T_case=25°C
-I_C (mA)
10
5
2
1
0.5
0.2
0.1
g_oe (μΩ^-1)
200
100
50
20
10
5
2
1
C_oe (pF)
20
10
5
2
1
0.5
0.2
0.1
-V_CE=1V
5V
10V
-V_CE=1V
5V
10V

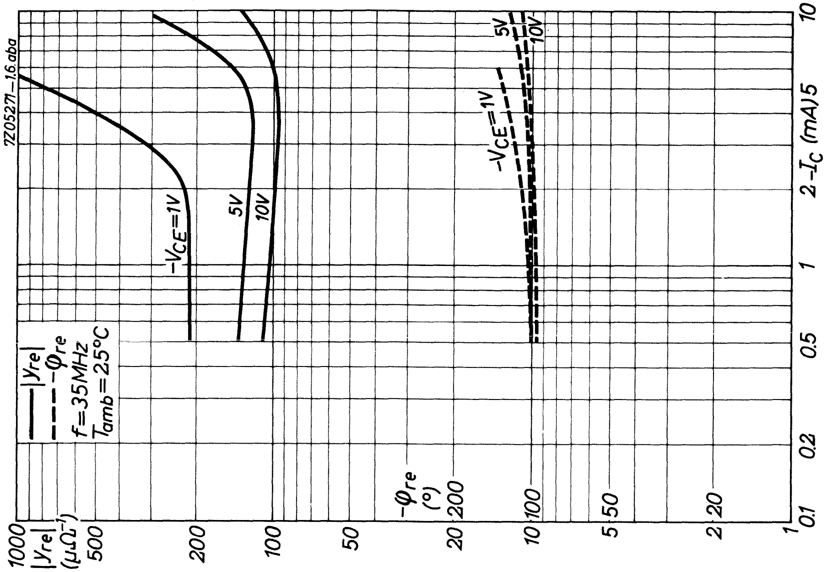

7Z05262-1.6.aba
g_oe
C_oe
f=10.7MHz
T_case=25°C
-V_CE (V)
0
2
4
6
8
10
g_oe (μΩ^-1)
500
200
100
50
20
10
5
2
1
C_oe (pF)
50
20
10
5
2
1
0.5
0.2
-I_C=10mA
5mA
3mA
1mA
0.5mA
-I_C=10mA
5mA
3mA
3mA
1mA
0.5mA

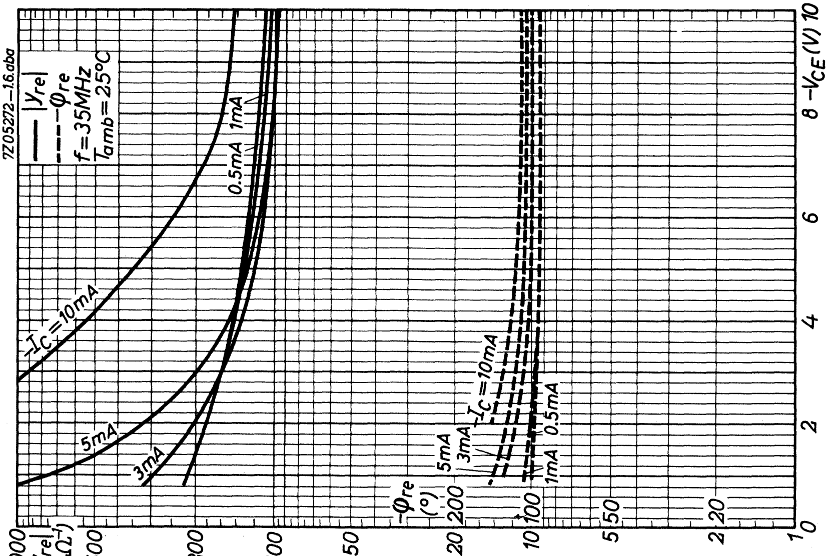

7Z05229-1.6.aba
g_ie
C_ie
f = 35MHz
T_amb = 25°C
-V_CE = 1V
5V
10V
-V_CE = 1V
5V
10V
-I_C (mA)
0.5
1
2
5
10
g_ie (mΩ⁻¹)
C_ie (pF)
50
20
10
5
2
1

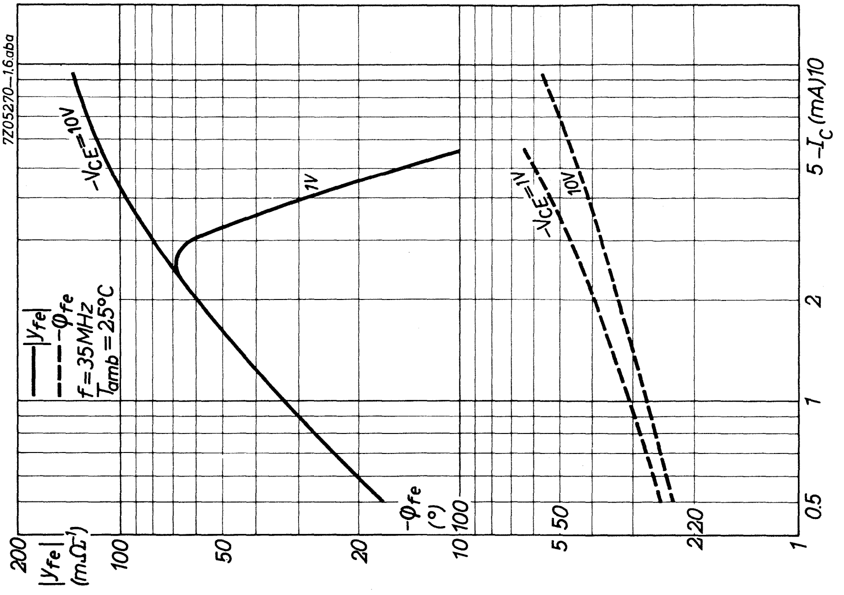

7Z05265-1.6.aba
g_ie
C_ie
f = 35MHz
T_amb = 25°C
-I_C = 10mA
5mA
3mA
1mA
0.5mA
-I_C = 10mA
5mA
3mA
1mA
0.5mA
-V_CE (V)
0
2
4
6
8
10
g_ie (mΩ⁻¹)
C_ie (pF)
100
50
20
10
5
2
1

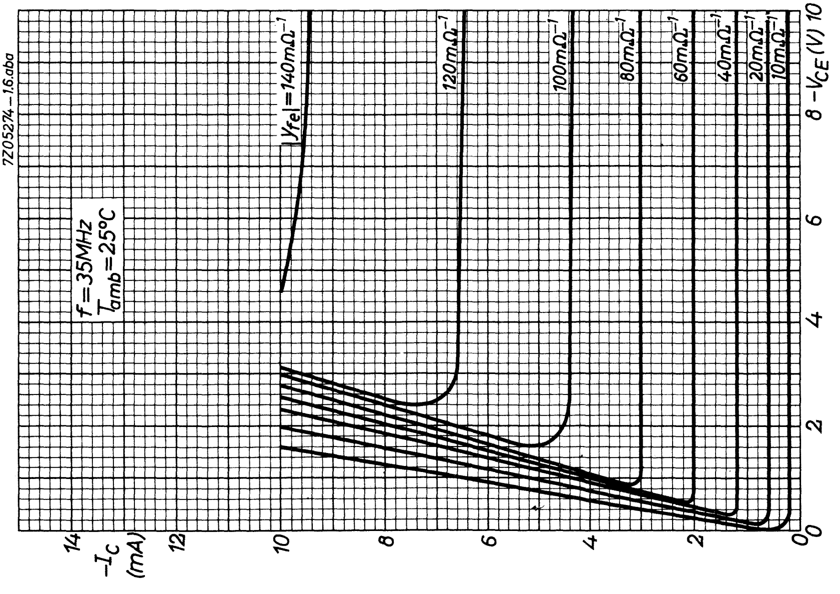

7Z05268–1.6.aba
g_oe
C_oe
f=35MHz
T_amb=25°C
-I_C=10mA
5mA
3mA
1mA
0.5mA
-I_C=10mA
5mA
3mA
1mA
0.5mA
g_oe (μΩ^-1)
C_oe (pF)
1000
500
200
100
50
20
10
5
2
1
0
2
4
6
8
10
-V_CE (V)

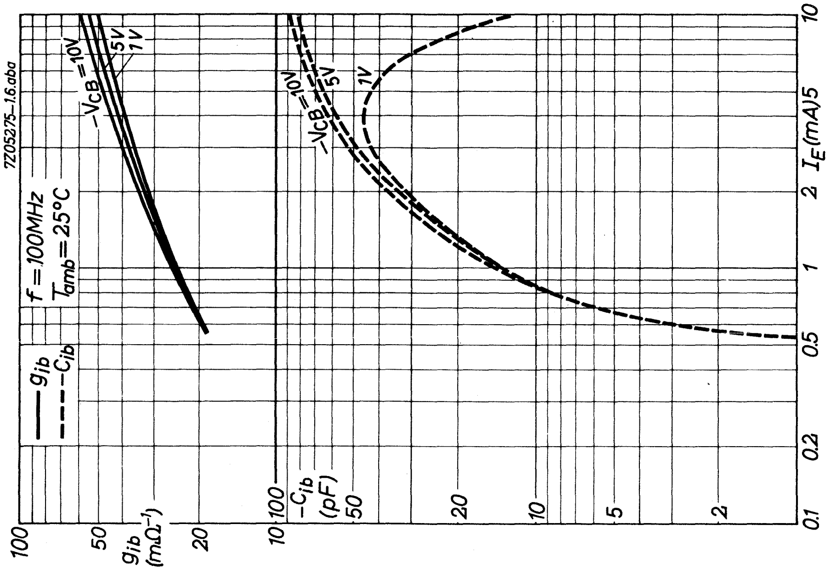

7Z05269–1.6.aba
g_oe
C_oe
f=35MHz
T_amb=25°C
-V_CE=1V
5V
10V
-V_CE=1V
5V
10V
g_oe (μΩ^-1)
C_oe (pF)
1000
500
200
100
50
20
10
5
2
1
0.1
0.2
0.5
1
2
5
10
-I_C (mA)

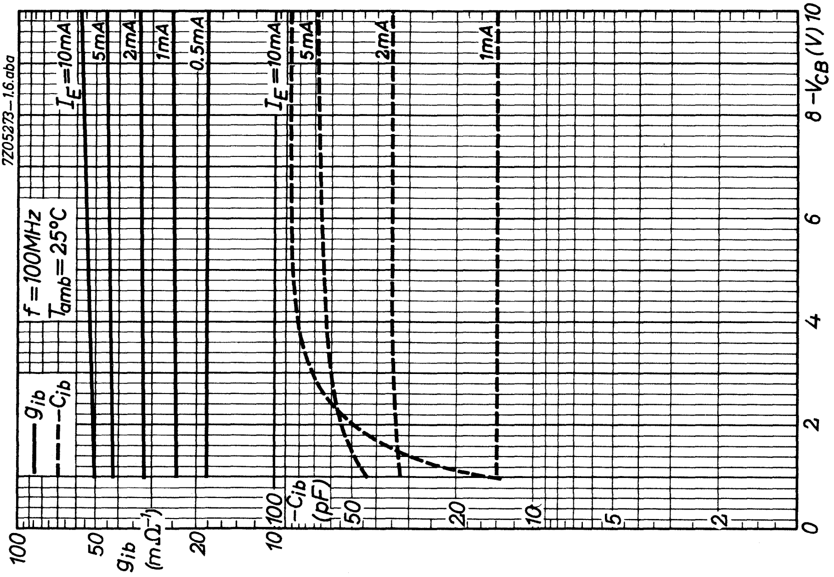

7Z05271—1.6.aba
|yre|
−φre
f=35MHz
Tamb=25°C
−VCE=1V
5V
10V
−VCE=1V
5V
10V
|yre| (µΩ⁻¹)
1000
500
200
100
50
20
10
5
2
1
−φre (°)
200
100
50
20
0.1
0.2
0.5
1
2
5
10
−IC (mA)

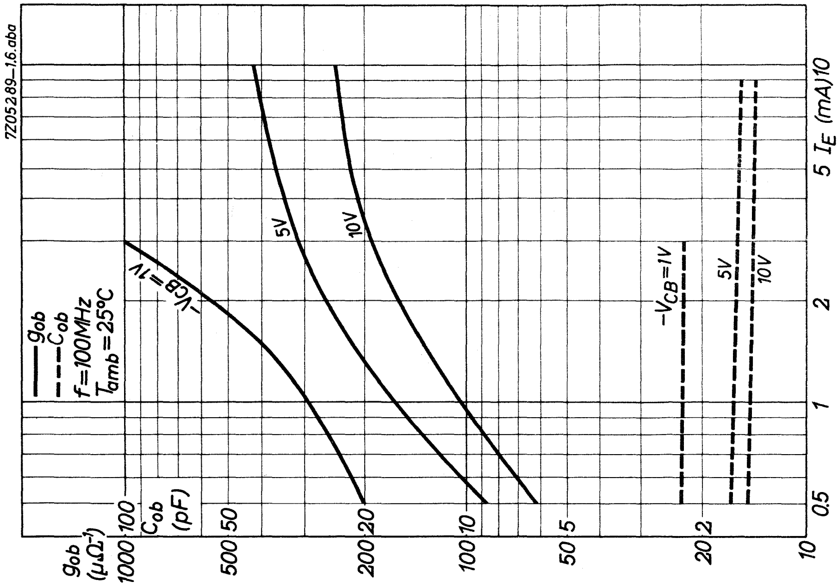

7Z05272—1.6.aba
|yre|
−φre
f=35MHz
Tamb=25°C
−IC=10mA
5mA
3mA
1mA
0.5mA
−IC=10mA
5mA
3mA
1mA
0.5mA
|yre| (µΩ⁻¹)
1000
500
200
100
50
20
10
5
2
1
−φre (°)
200
100
50
20
0
2
4
6
8
10
−VCE (V)

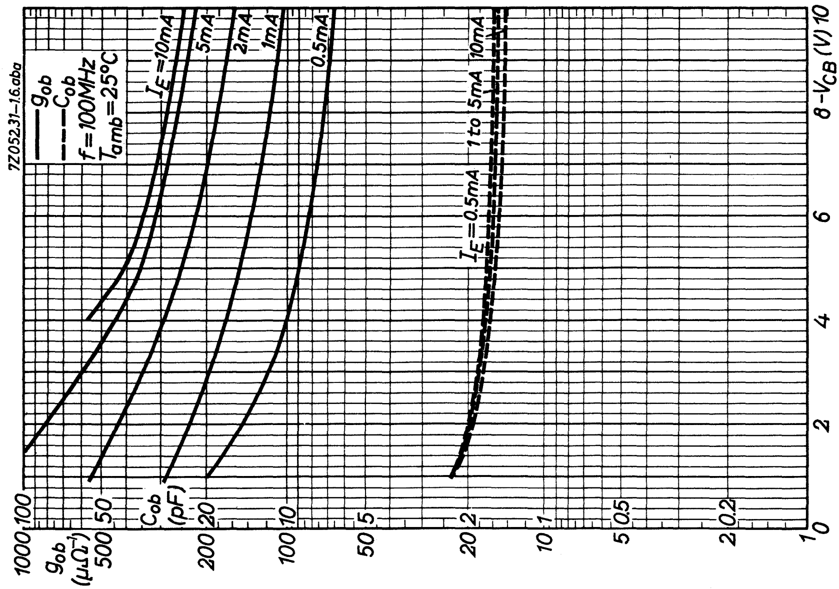

7Z05270–1.6.aba
$|y_{fe}|$
$-\varphi_{fe}$
f = 35 MHz
T_{amb} = 25°C
$-V_{CE}$ = 10V
1V
$-V_{CE}$ = 1V
10V
$|y_{fe}|$ (mΩ^{-1})
200
100
50
20
10
5
2
1
$-\varphi_{fe}$ (°)
100
50
20
$-I_C$ (mA)
0.5
1
2
5
10

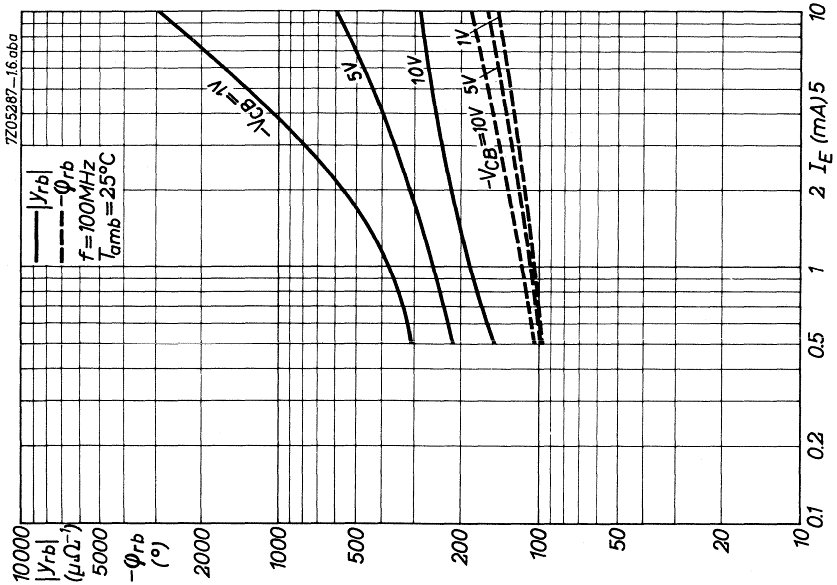

7Z05274–1.6.aba
f = 35MHz
T_{amb} = 25°C
$|y_{fe}|$ = 140 mΩ^{-1}
120 mΩ^{-1}
100 mΩ^{-1}
80 mΩ^{-1}
60 mΩ^{-1}
40 mΩ^{-1}
20 mΩ^{-1}
10 mΩ^{-1}
$-I_C$ (mA)
14
12
10
8
6
4
2
0
$-V_{CE}$ (V)
0
2
4
6
8
10

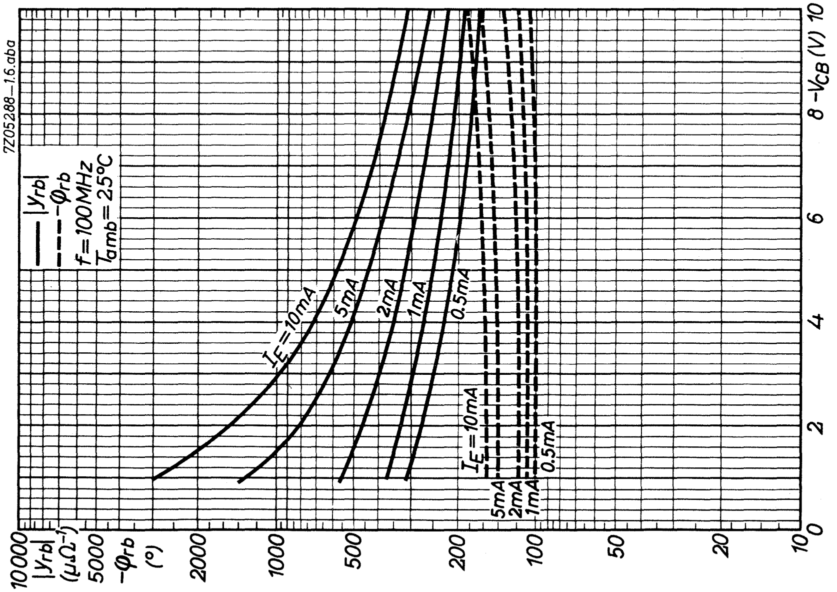

7Z05275-1.6.aba
f = 100MHz
T_{amb} = 25°C
g_{ib}
$-C_{ib}$
$-V_{CB}$ = 10V
5V
1V
$-V_{CB}$ = 10V
5V
1V
g_{ib} ($m\Omega^{-1}$)
100
50
20
10
$-C_{ib}$ (pF)
100
50
20
10
5
2
I_E (mA)
0.1
0.2
0.5
1
2
5
10

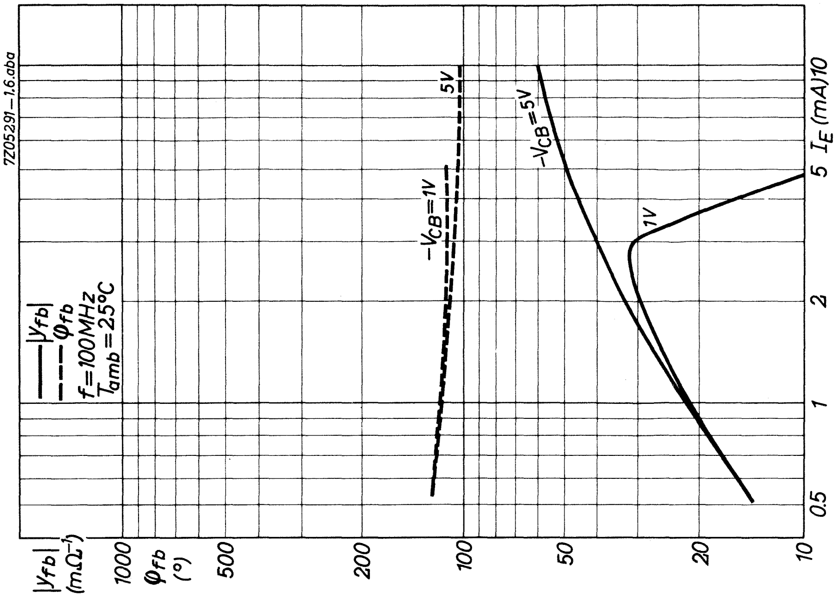

7Z05273-1.6.aba
f = 100MHz
T_{amb} = 25°C
g_{ib}
$-C_{ib}$
I_E = 10mA
5mA
2mA
1mA
0.5mA
I_E = 10mA
5mA
2mA
1mA
g_{ib} ($m\Omega^{-1}$)
100
50
20
10
$-C_{ib}$ (pF)
100
50
20
10
5
2
$-V_{CB}$ (V)
0
2
4
6
8
10

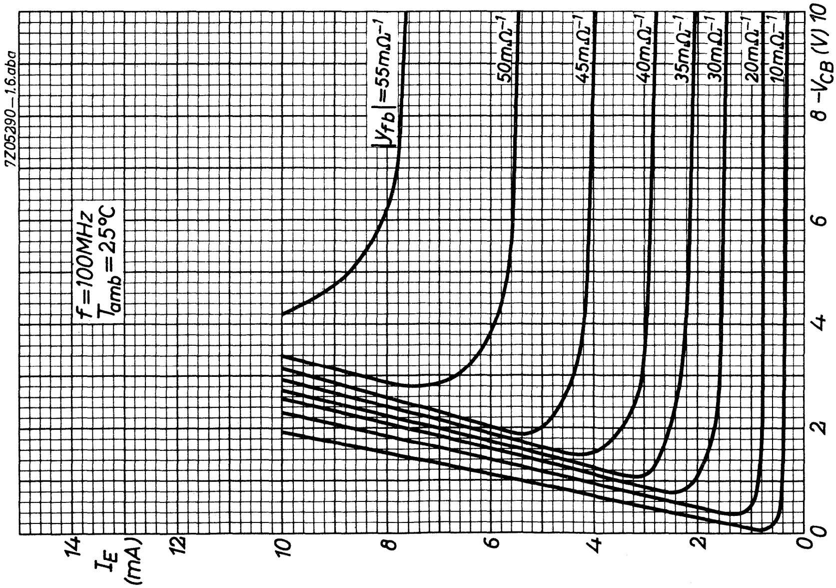

7Z05289-1.6.aba
g_ob
C_ob
f=100MHz
T_amb=25°C
-V_CB=1V
5V
10V
-V_CB=1V
5V
10V
g_ob (μΩ^-1)
1000
500
200
100
50
20
10
C_ob (pF)
100
50
20
10
5
2
0.5
1
2
5
I_E (mA)
10


7Z05231-1.6.aba
g_ob
C_ob
f=100MHz
T_amb=25°C
I_E=10mA
5mA
2mA
1mA
0.5mA
I_E=0.5mA
1 to 5mA
10mA
g_ob (μΩ^-1)
1000
500
200
100
50
20
10
5
2
1
C_ob (pF)
100
50
20
10
5
2
1
0.5
0.2
0
2
4
6
8
-V_CB (V)
10


7Z05287-1.6.aba
|y_{rb}|
-φ_{rb}
f=100MHz
T_{amb}=25°C
-V_{CB}=1V
5V
10V
1V
5V
-V_{CB}=10V
10000
|y_{rb}|
(µΩ^{-1})
5000
-φ_{rb}
(°)
2000
1000
500
200
100
50
20
10
0.1
0.2
0.5
1
2
5
10
I_E (mA)


7Z05288-1.6.aba
|y_{rb}|
-φ_{rb}
f=100MHz
T_{amb}=25°C
I_E=10mA
5mA
2mA
1mA
0.5mA
I_E=10mA
5mA
2mA
1mA
0.5mA
10000
|y_{rb}|
(µΩ^{-1})
5000
-φ_{rb}
(°)
2000
1000
500
200
100
50
20
10
0
2
4
6
8
10
-V_{CB} (V)


7Z05291−1.6.aba
—— |y_fb|
- - - φ_fb
f=100MHz
T_amb=25°C
−V_CB=1V
5V
−V_CB=5V
1V
I_E (mA)
10
5
2
1
0.5
|y_fb| (mΩ⁻¹)
φ_fb (°)
1000
500
200
100
50
20
10


7Z05290−1.6.aba
f=100MHz
T_amb=25°C
|y_fb|=55mΩ⁻¹
50mΩ⁻¹
45mΩ⁻¹
40mΩ⁻¹
35mΩ⁻¹
30mΩ⁻¹
20mΩ⁻¹
10mΩ⁻¹
−V_CB (V)
10
8
6
4
2
0
I_E (mA)
14
12
10
8
6
4
2
0

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.)	$\lvert I_B \rvert$	max.	1	mA
Reverse emitter current	$-I_E$	max.	1	mA
Total power dissipation up to T_{amb} = 45 °C	P_{tot}	max.	60	mW
Storage temperature	T_{stg}		-55 to +75	°C
Junction temperature: continuous	T_j	max.	75	°C
incidentally	T_j	max.	90	°C

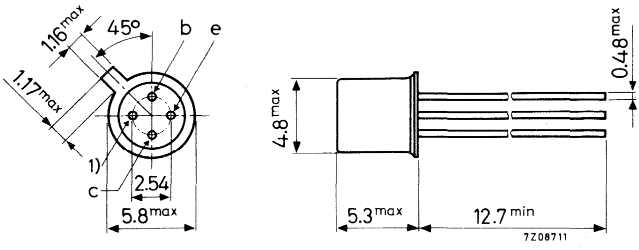
THERMAL RESISTANCE

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

MECHANICAL DATA

Dimensions in mm

TO-72



1) = shield lead (connected to case)

Accessories available: 56246, 56263

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

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

Collector cut-off current				
$I_E = 0$; $-V_{CB} = 6$ V	$-I_{CBO}$	typ. <	1.2 8	μA μA
$I_E = 0$; $-V_{CB} = 6$ V; $T_j = 75$ °C	$-I_{CBO}$	typ. <	90 180	μA μA
Base current				
$I_E = 1$ mA; $-V_{CB} = 6$ V	$-I_B$	typ. <	7 25	μA μA
Base-emitter voltage				
$-I_C = 1$ mA; $-V_{CE} = 6$ V	$-V_{BE}$	typ. 210 to	270 330	mV mV
Small signal current gain at f = 1 kHz				
$-I_C = 1$ mA; $-V_{CE} = 6$ V	h_{fe}	typ.	150	
Feedback capacitance at f = 450 kHz				
$-I_C = 1$ mA; $-V_{CE} = 6$ V	$-C_{re}$	typ.	1.5	pF
y parameters at f = 100 MHz (common base)				
$I_E = 1$ mA; $-V_{CB} = 6$ V [1]				
Input conductance	g_{ib}	typ.	15	$m\Omega^{-1}$
Input capacitance	$-C_{ib}$	typ.	5	pF
Feedback admittance	$\lvert y_{rb} \rvert$	typ.	0.45	$m\Omega^{-1}$
Phase angle of feedback admittance	φ_{rb}	typ.	250°	
Transfer admittance	$\lvert y_{fb} \rvert$	typ.	16	$m\Omega^{-1}$
Phase angle of transfer admittance	φ_{fb}	typ.	95°	
Output conductance	g_{ob}	typ.	0.3	$m\Omega^{-1}$
Output capacitance	C_{ob}	typ.	2.5	pF
Feedback impedance at f = 2 MHz				
$I_E = 1$ mA; $-V_{CB} = 6$ V	$\lvert z_{rb} \rvert$	typ.	20	Ω

---

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

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

Transition frequency

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

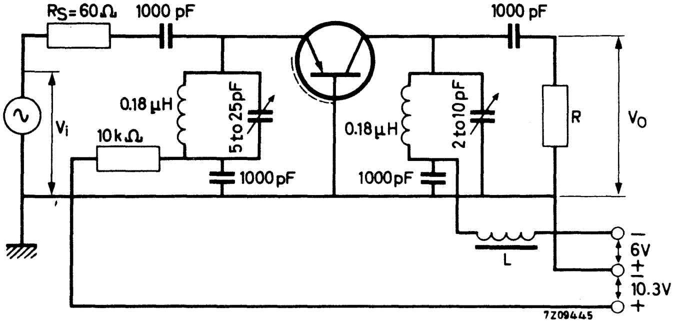
Noise figure at f = 100 MHz

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

Power gain at f = 100 MHz

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

Test circuit

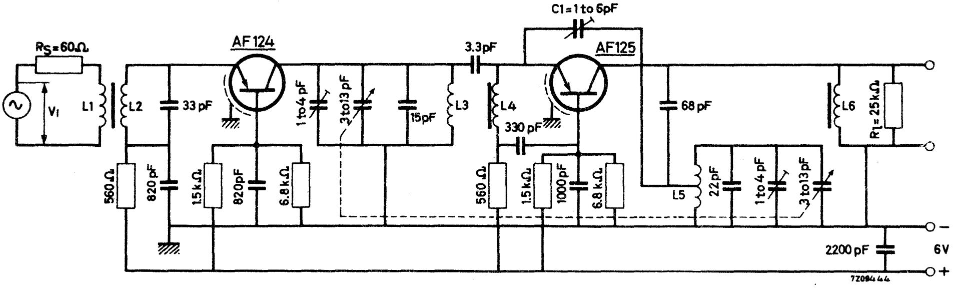


R is chosen such that the total load impedance R_l consisting of R and the tuned circuit in parallel is 3.3 kΩ.

L = ferrite bead

APPLICATION INFORMATION

Front-end unit of a f.m. tuner

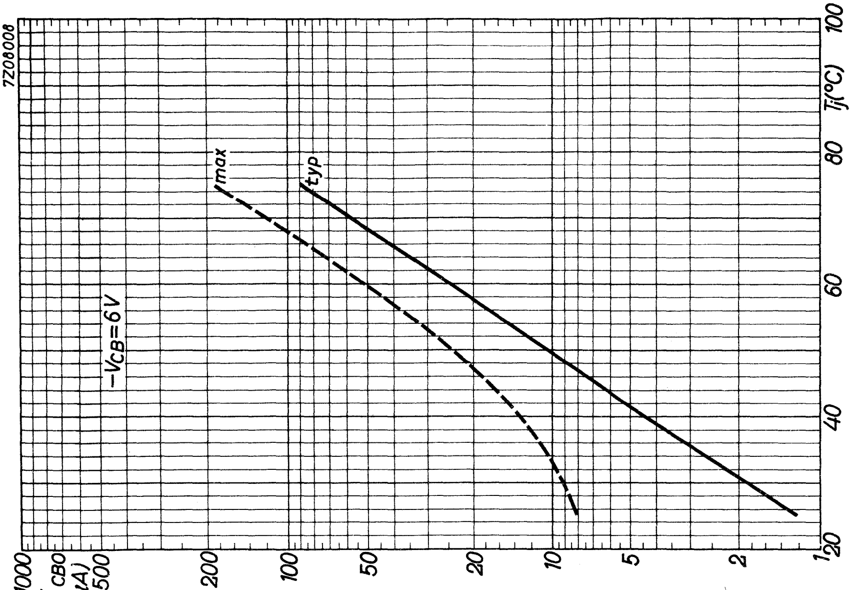


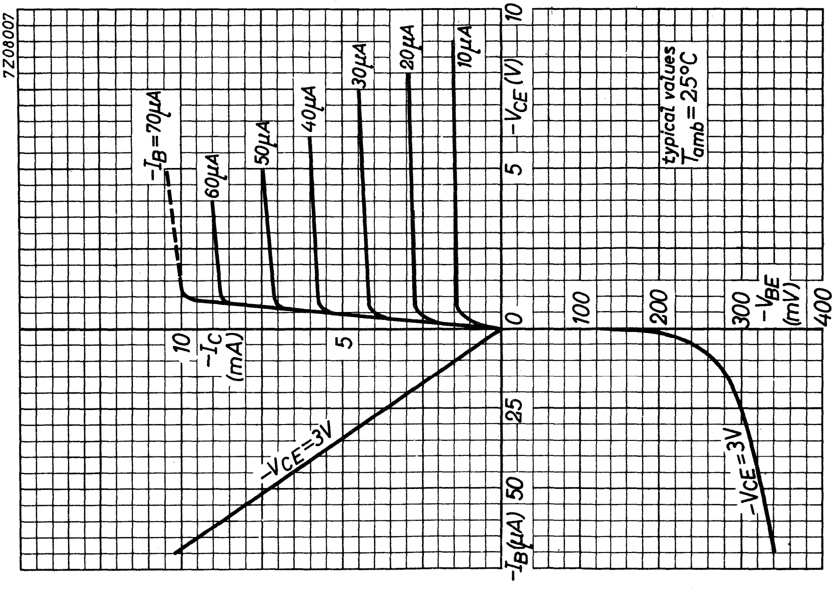
The oscillator voltage at the emitter of the AF 125 should be adjusted to 80 mV by means of C1 at a battery voltage V_S = 4 V

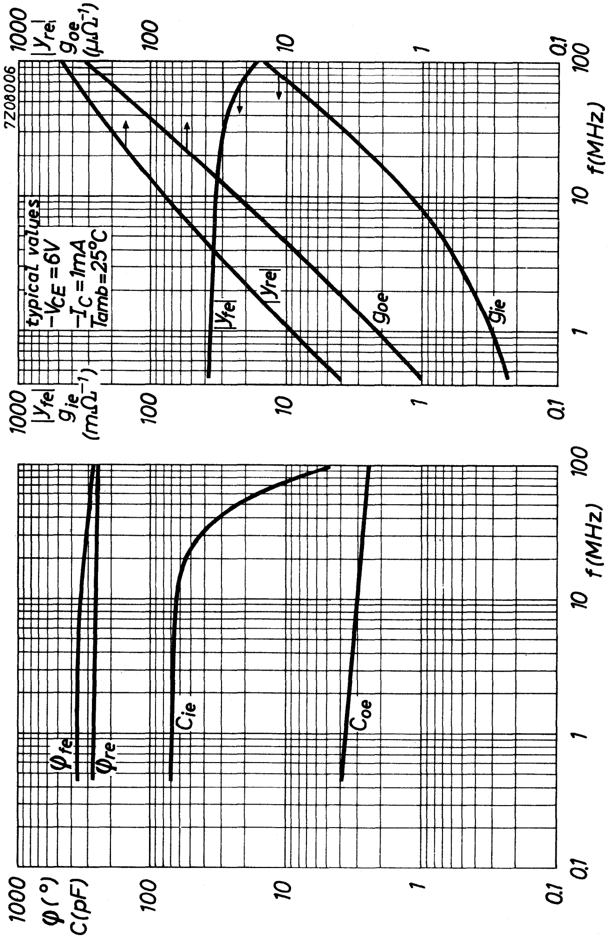
L1 = 4.5 turns enamelled Cu wire (0.3 mm), wound between L_2.
L2 = 4 turns enamelled Cu wire (1 mm), winding pitch 2 mm, inductance 0.18 μH, unloaded Q-factor 60 to 80.
L3 = 3.25 turns silvered Cu wire (1 mm), winding pitch 2 mm, inductance 0.086 μH, unloaded Q-factor 200.
L4 = 6 turns enamelled Cu wire (0.5 mm), closely wound, inductance 0.65 μH.
L5 = 2.5 turns silvered Cu wire (1 mm), winding pitch 2 mm, inductance 0.062 μH, 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 μH; unloaded Q-factor 120; loaded Q-factor with 25 kΩ : 60.

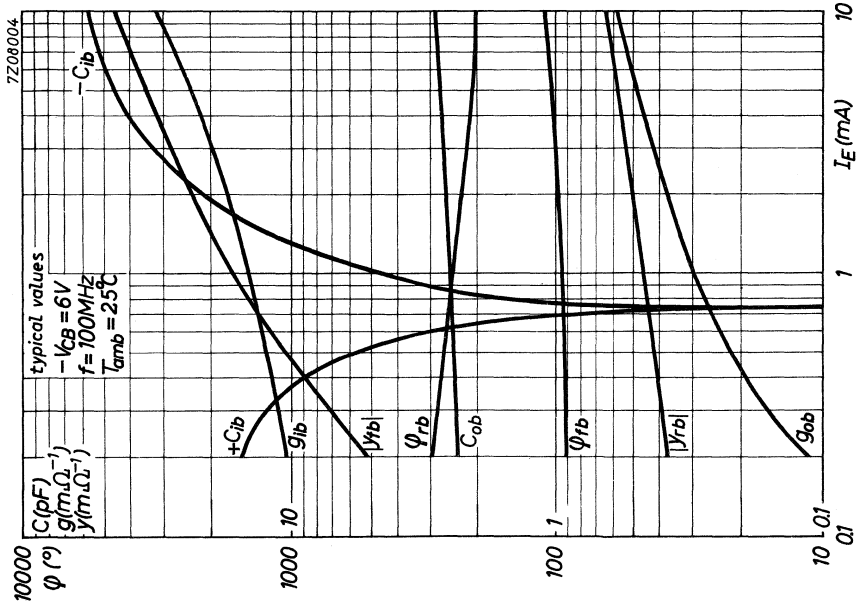
Frequency range	f		87 to 101	MHz
Collector current AF124	$-I_C$		1.4	mA
AF125	$-I_C$		1.5	mA
Total power gain	G_p	>	24	dB
		typ.	28	dB
Noise figure	F	typ.	8	dB
		<	9.5	dB
Oscillator voltage at aerial terminals		typ.	1.5	mV
Image rejection		typ.	27	dB

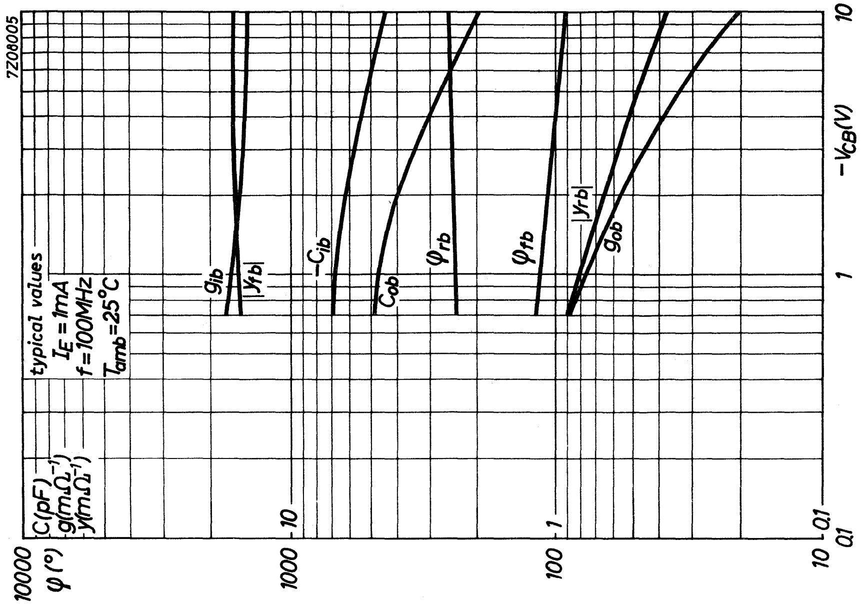
The shift of the oscillator frequency as a function of the battery voltage is about 50 kHz from 6 to 5 V and about 100 kHz from 5 to 4 V.

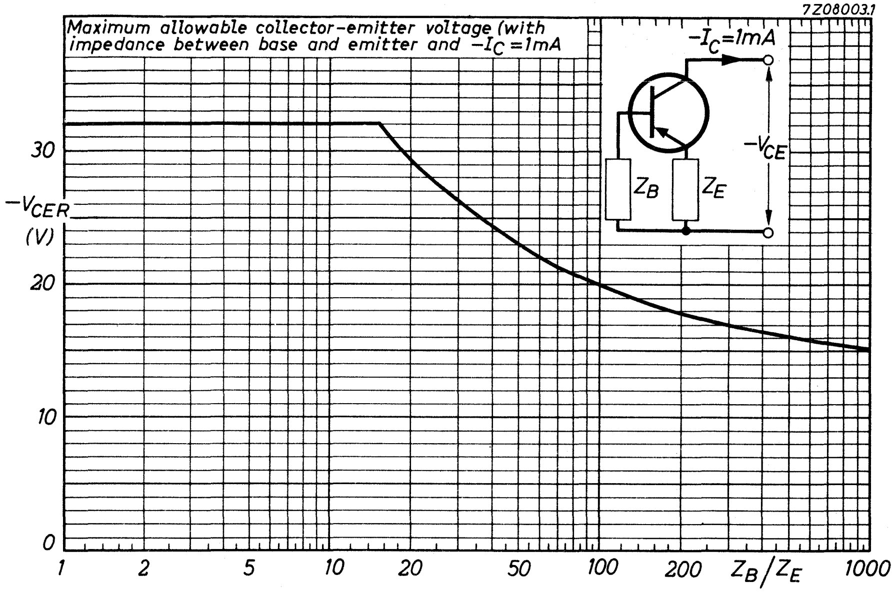

7Z08008
$-V_{CB}=6V$
max
typ
T_j(°C)
20
40
60
80
100
$-I_{CBO}$ (μA)
1000
500
200
100
50
20
10
5
2
1


7Z08007
$-I_B=70\mu A$
60μA
50μA
40μA
30μA
20μA
10μA
$-V_{CE}$(V)
0
5
10
typical values
$T_{amb}=25°C$
$-I_C$ (mA)
10
5
$-V_{CE}=3V$
25
50
$-I_B$(μA)
100
200
300
400
$-V_{BE}$ (mV)
$-V_{CE}=3V$


7Z08006
typical values
$-V_{CE}=6V$
$-I_C=1mA$
$T_{amb}=25^{\circ}C$
$|y_{re}|$
g_{oe}
$(\mu\Omega^{-1})$
$|y_{fe}|$
g_{ie}
$(m\Omega^{-1})$
1000
100
10
1
0.1
$|y_{fe}|$
$|y_{re}|$
g_{oe}
g_{ie}
0.1
1
10
100
f(MHz)
$\varphi(^{\circ})$
C(pF)
φ_{fe}
φ_{re}
C_{ie}
C_{oe}


7Z08004
typical values
$-V_{CB} = 6V$
$f = 100MHz$
$T_{amb} = 25°C$
C(pF)
$g(m\Omega^{-1})$
$y(m\Omega^{-1})$
φ (°)
10000
1000
100
10
10
1
0.1
0.1
1
10
I_E (mA)
$-C_{ib}$
$+C_{ib}$
g_{ib}
$|y_{fb}|$
φ_{rb}
C_{ob}
φ_{fb}
$|y_{rb}|$
g_{ob}


7Z08005
typical values
$I_E = 1mA$
$f = 100MHz$
$T_{amb} = 25°C$
C(pF)
$g(m\Omega^{-1})$
$y(m\Omega^{-1})$
φ (°)
10000
1000
100
10
10
1
0.1
0.1
1
10
$-V_{CB}$(V)
g_{ib}
$|y_{fb}|$
$-C_{ib}$
C_{ob}
φ_{rb}
φ_{fb}
$|y_{rb}|$
g_{ob}


7Z08003.1
Maximum allowable collector-emitter voltage (with impedance between base and emitter and $-I_C = 1mA$
$-I_C = 1mA$
$-V_{CE}$
Z_B
Z_E
$-V_{CER}$
(V)
30
20
10
0
1
2
5
10
20
50
100
200
Z_B/Z_E
1000

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.)	$\lvert I_B \rvert$	max.	1	mA
Reverse emitter current	$-I_E$	max.	1	mA
Total power dissipation up to $T_{amb} = 45\,^{o}C$	P_{tot}	max.	60	mW
Storage temperature	T_{stg}		-55 to +75	^{o}C
Junction temperature: continuous	T_j	max.	75	^{o}C
incidentally	T_j	max.	90	^{o}C

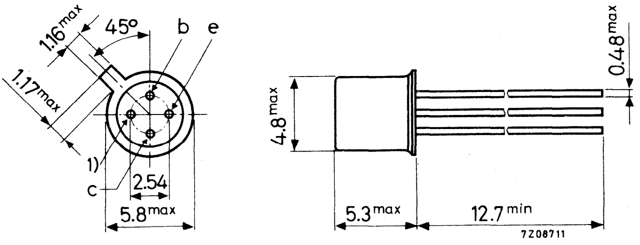
THERMAL RESISTANCE

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

MECHANICAL DATA

Dimensions in mm

TO-72



1) = shield lead (connected to case)

Accessories available: 56246, 56263

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

CHARACTERISTICS

T_{amb} = 25 °C unless otherwise specified

Collector cut-off current				
$I_E = 0$; $-V_{CB} = 6$ V	$-I_{CBO}$	typ.	1.2	μA
		<	8	μA
$I_E = 0$; $-V_{CB} = 6$ V; $T_j = 75$ °C	$-I_{CBO}$	typ.	90	μA
		<	180	μA
Base current				
$I_E = 1$ mA; $-V_{CB} = 6$ V	$-I_B$	typ.	7	μA
		<	25	μA
Base-emitter voltage				
$-I_C = 1$ mA; $-V_{CE} = 6$ V	$-V_{BE}$	typ.	270	mV
			210 to 330	mV
Small signal current gain at f = 1 kHz				
$-I_C = 1$ mA; $-V_{CE} = 6$ V	h_{fe}	typ.	150	
Feedback capacitance at f = 450 kHz				
$-I_C = 1$ mA; $-V_{CE} = 6$ V	$-C_{re}$	typ.	1.5	pF

y parameters 1)

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

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

$-I_C = 1$ mA; $-V_{CE} = 6$ V		f =	10.7	0.45	MHz
Input conductance	g_{ie}	typ.	1.3	0.25	$m\Omega^{-1}$
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	$m\Omega^{-1}$
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

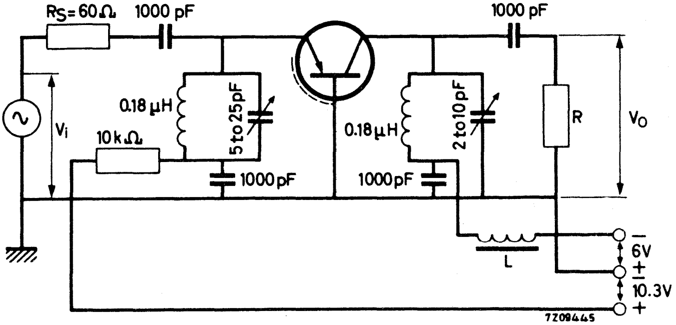
---

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

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

Feedback impedance at f = 2 MHz				
I_E = 1 mA; $-V_{CB}$ = 6 V	$\lvert z_{rb}\rvert$	typ.	25	Ω
Transition frequency				
I_E = 1 mA; $-V_{CB}$ = 6 V	f_T	typ.	75	MHz
Noise figure at I_E = 1 mA; $-V_{CB}$ = 6 V				
R_S = 60 Ω; f = 100 MHz	F	typ.	9.5	dB
R_S = 200 Ω; f = 10.7 MHz	F	typ.	3.0	dB
R_S = 500 Ω; f = 1 MHz	F	typ. <	1.5 3	dB dB
Conversion noise figure at I_E = 1 mA; $-V_{CB}$ = 6 V				
R_S = 500 Ω; f = 1 MHz	F_c	typ. <	3 5	dB dB
R_S = 2 kΩ; f = 200 kHz	F_c	typ. <	4 7	dB dB
Power gain at f = 100 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	> typ.	10 13	dB dB

Test circuit:



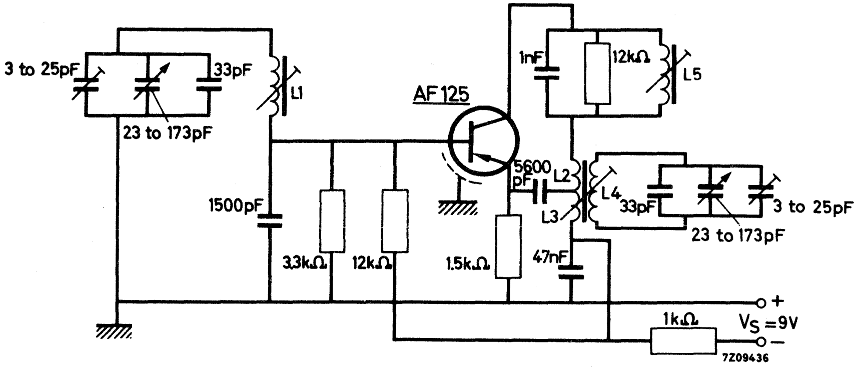
R is chosen such that the total load impedance R_ℓ consisting of R and the tuned circuit in parallel is 3.3 kΩ.

L = ferrite bead

APPLICATION INFORMATION

1. Front-end unit of a f.m. tuner see AF124

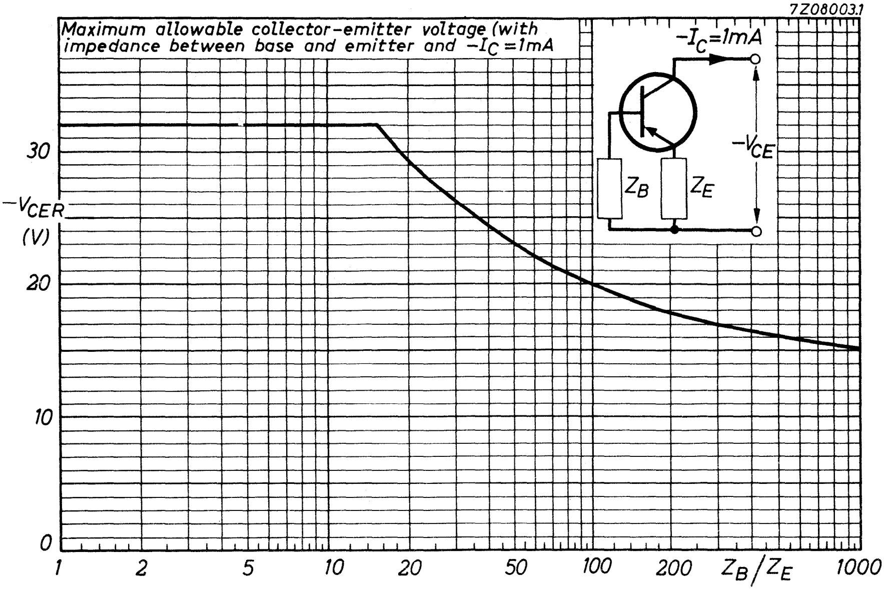
2. Self-oscillating mixer stage (15.1 to 26.1 MHz)

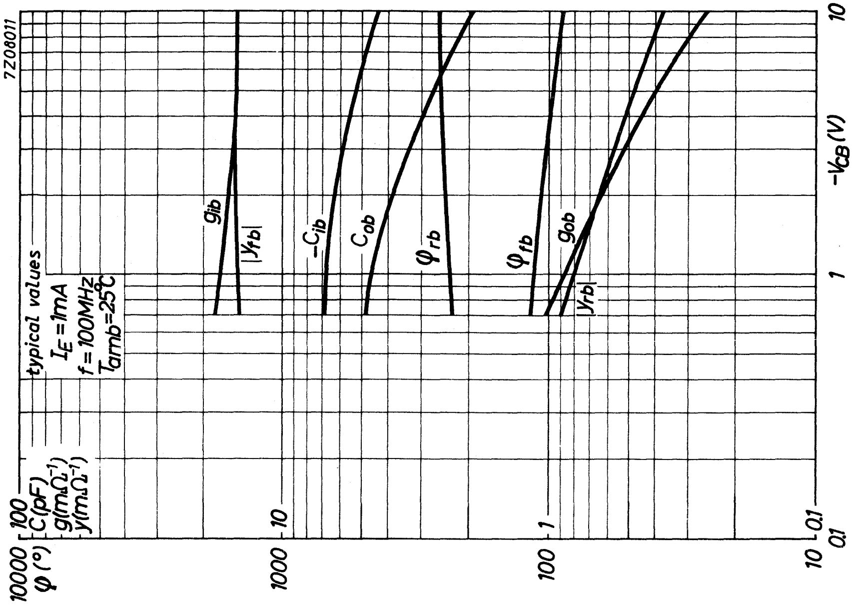


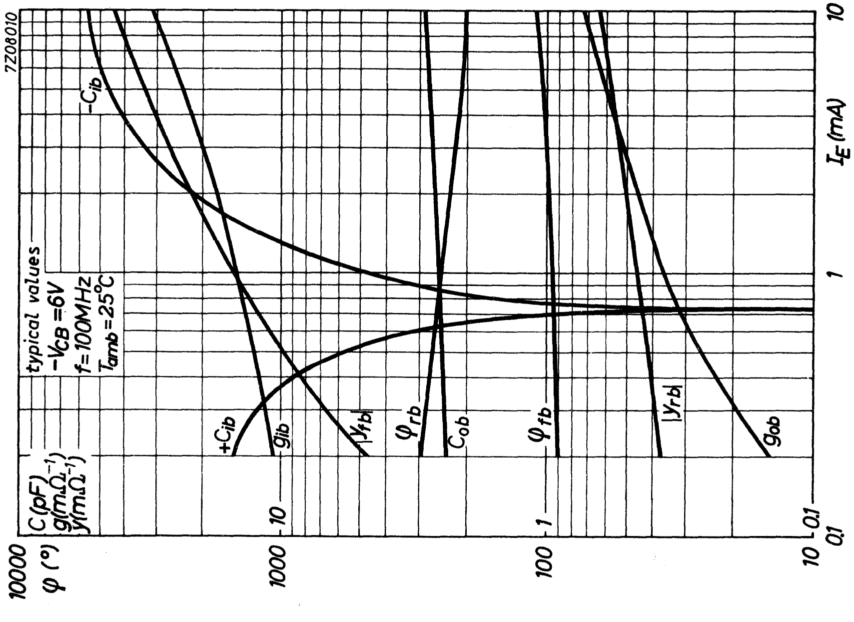
L_1 = 5.5 turns enamelled Cu wire (0.25 mm), closely wound on coil former with diameter of 7 mm; inductance 0.59 μH; unloaded Q-factor 100 at f = 15 MHz and 115 at f = 26 MHz.
L_2 = 1.25 turns enamelled Cu wire (0.25 mm), wound in L_4 at earth side.
L_3 = 1 turn enamelled Cu wire (0.25 mm), wound in 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 μH; unloaded Q-factor 110 at f = 15 MHz and f = 26 MHz
L_5 = Inductance 125 μH; unloaded Q-factor 140.

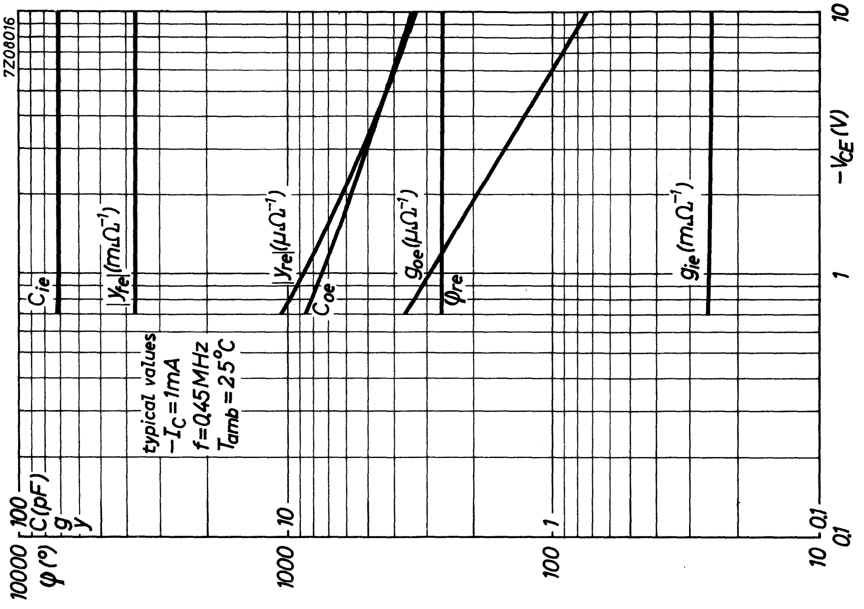
Battery voltage	V_S	=	9	V
Collector-emitter voltage	$-V_{CE}$	=	6	V
Emitter current	I_E	=	1	mA

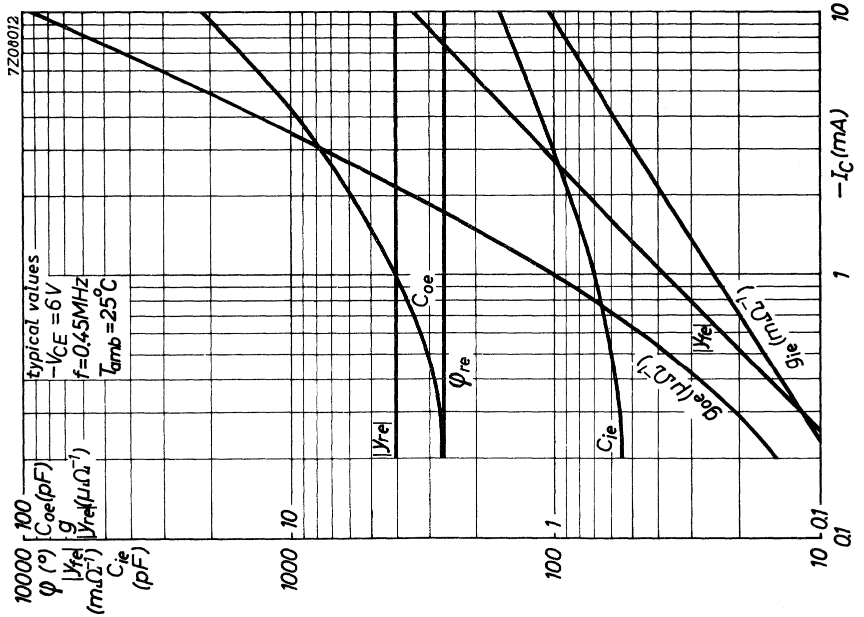
			f = 15	20	26	MHz
Oscillator voltage between emitter and earth	V_{osc}	typ.	0.11	0.14	0.15	V
Frequency shift by a battery voltage variation from 9 to 6 V	Δf_{osc}	typ.	3	2	10	kHz
Conversion gain, defined as the ratio between the i.f. power in a 10 kΩ load (the total i.f. impedance in the collector circuit) and the available r.f. power in the aerial circuit	$\frac{P_o}{P_i}$	typ.	26	23	20	dB

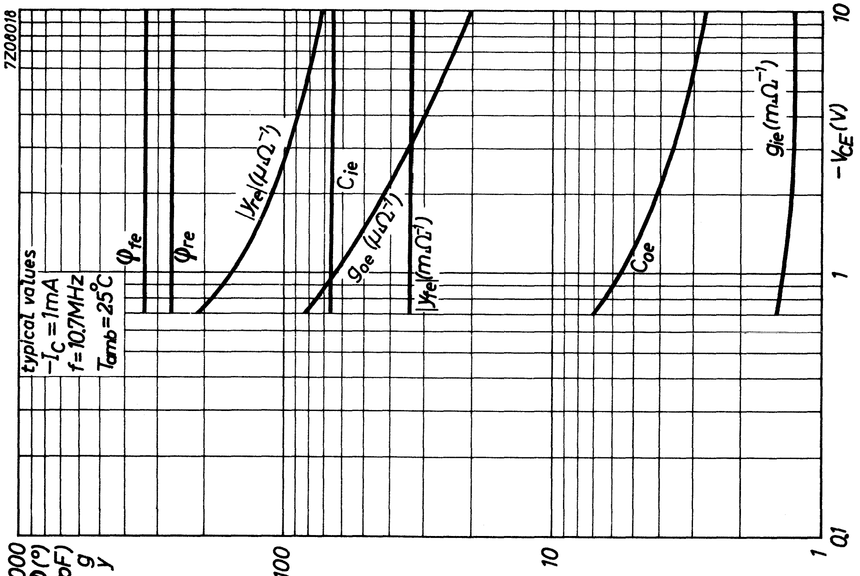

7Z08003.1
Maximum allowable collector-emitter voltage (with impedance between base and emitter and $-I_C = 1mA$
$-I_C=1mA$
$-V_{CE}$
Z_B
Z_E
$-V_{CER}$ (V)
30
20
10
0
1
2
5
10
20
50
100
200
Z_B/Z_E
1000

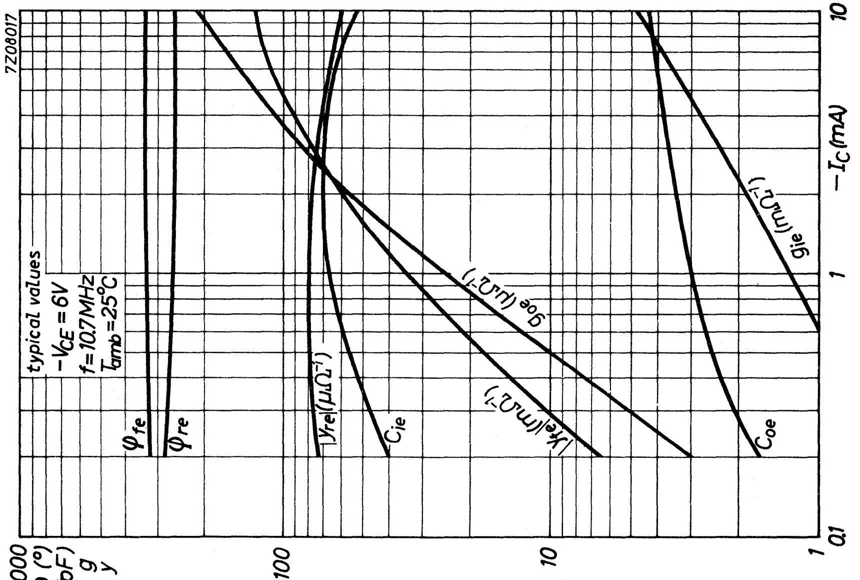

7Z08011
typical values
I_E = 1mA
f = 100MHz
T_amb = 25°C
10000
φ (°)
100
C (pF)
g (mΩ⁻¹)
y (mΩ⁻¹)
1000
10
100
1
10
0.1
0.1
1
10
-V_CB (V)
g_ib
|y_fb|
-C_ib
C_ob
φ_rb
φ_fb
g_ob
|y_rb|

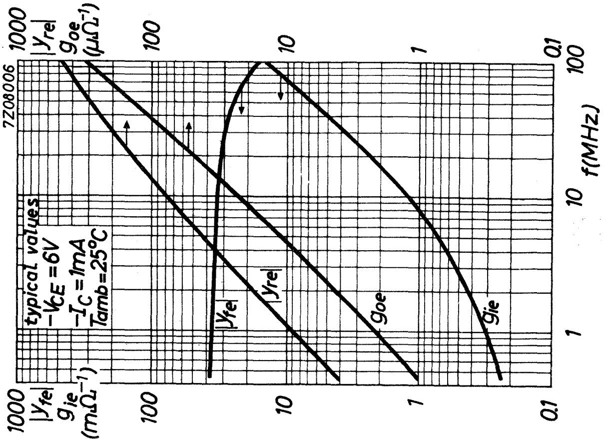

7Z08010
typical values
-V_CB = 6V
f = 100MHz
T_amb = 25°C
10000
φ (°)
C (pF)
g (mΩ⁻¹)
y (mΩ⁻¹)
1000
10
100
1
10
0.1
0.1
1
10
I_E (mA)
-C_ib
+C_ib
g_ib
|y_fb|
φ_rb
C_ob
φ_fb
|y_rb|
g_ob

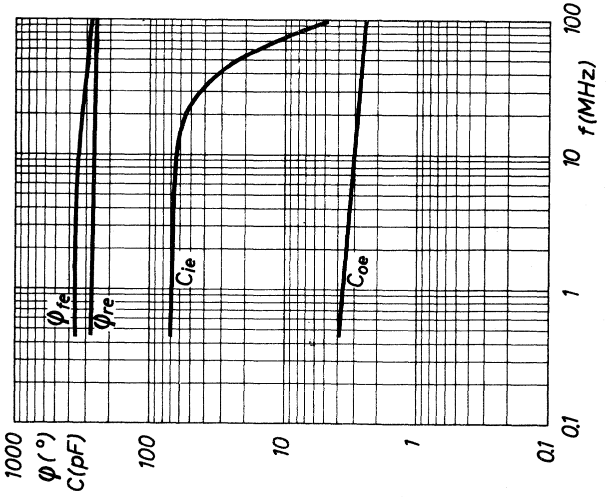

7Z08016
C_ie
|y_fe| (mΩ⁻¹)
typical values
−I_C = 1mA
f = 0.45MHz
T_amb = 25°C
|y_re| (μΩ⁻¹)
C_oe
g_oe (μΩ⁻¹)
φ_re
g_ie (mΩ⁻¹)
10000
φ (°)
100
C (pF)
g
y
1000
10
100
1
10
0.1
0.1
1
10
−V_CE (V)

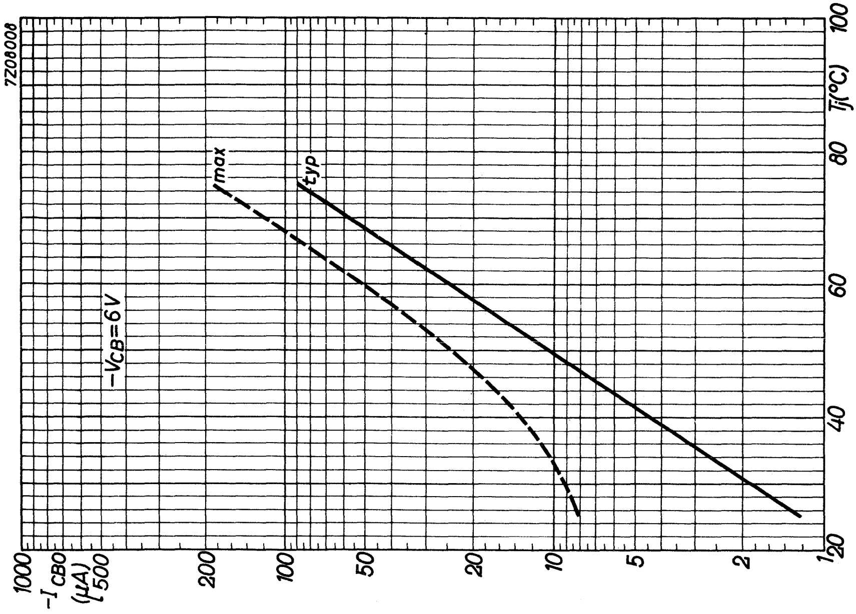

7Z08012
typical values
−V_CE = 6V
f = 0.45MHz
T_amb = 25°C
C_oe
φ_re
|y_re|
C_ie
g_oe (μΩ⁻¹)
|y_fe|
g_ie (mΩ⁻¹)
10000
φ (°)
|y_fe| (mΩ⁻¹)
C_ie (pF)
100
C_oe (pF)
g
|y_re| (μΩ⁻¹)
1000
10
100
1
10
0.1
0.1
1
10
−I_C (mA)

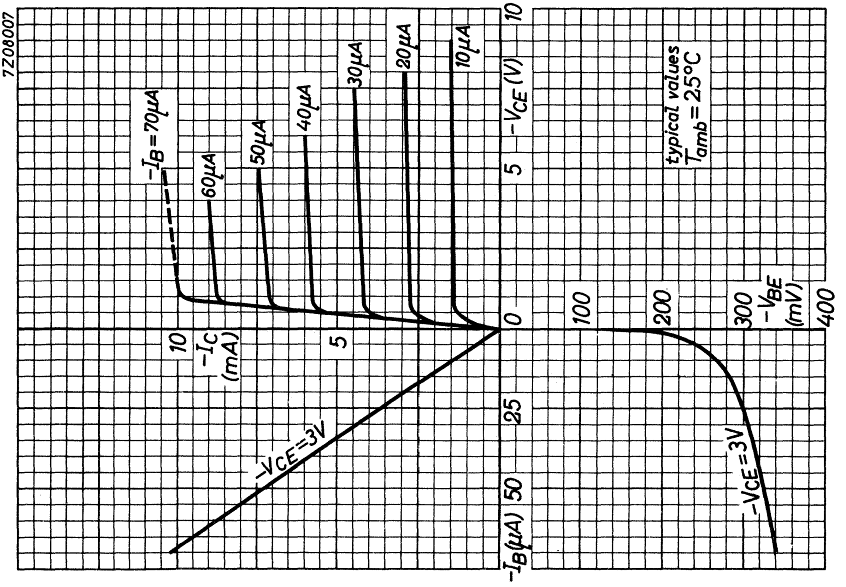

7Z08018
typical values
−I_C = 1mA
f = 10.7MHz
T_amb = 25°C
φ_fe
φ_re
|y_re| (μΩ⁻¹)
C_ie
g_oe (μΩ⁻¹)
|y_fe| (mΩ⁻¹)
C_oe
g_ie (mΩ⁻¹)
1000
φ (°)
C (pF)
g
y
100
10
1
0.1
1
10
−V_CE (V)


7Z08017
typical values
−V_CE = 6V
f = 10.7MHz
T_amb = 25°C
φ_fe
φ_re
|y_re| (μΩ⁻¹)
C_ie
|y_fe| (mΩ⁻¹)
g_oe (μΩ⁻¹)
C_oe
g_ie (mΩ⁻¹)
1000
φ (°)
C (pF)
g
y
100
10
1
0.1
1
10
−I_C (mA)


7Z08006
1000
|y_re|
g_oe
(μΩ⁻¹)
100
10
1
0.1
1000
|y_fe|
g_ie
(mΩ⁻¹)
100
10
1
0.1
typical values
−V_CE = 6V
−I_C = 1mA
T_amb = 25°C
|y_fe|
|y_re|
g_oe
g_ie
1
10
100
f(MHz)


1000
φ(°)
C(pF)
100
10
1
0.1
φ_fe
φ_re
C_ie
C_oe
0.1
1
10
100
f(MHz)


7Z08008
-V_CB=6V
max
typ
-I_CBO (μA)
1000
500
200
100
50
20
10
5
2
1
T_j(°C)
20
40
60
80
100


7Z08007
-I_B=70μA
60μA
50μA
40μA
30μA
20μA
10μA
-V_CE (V)
10
5
0
-I_C (mA)
10
5
typical values
T_amb=25°C
-V_CE=3V
-I_B(μA)
25
50
100
200
300
400
-V_BE (mV)
-V_CE=3V

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.)	$\lvert I_B \rvert$	max.	1	mA
Reverse emitter current	$-I_E$	max.	1	mA
Total power dissipation up to T_{amb} = 45 °C	P_{tot}	max.	60	mW
Storage temperature	T_{stg}		−55 to +75	°C
Junction temperature : continuous	T_j	max.	75	°C
incidentally	T_j	max.	90	°C

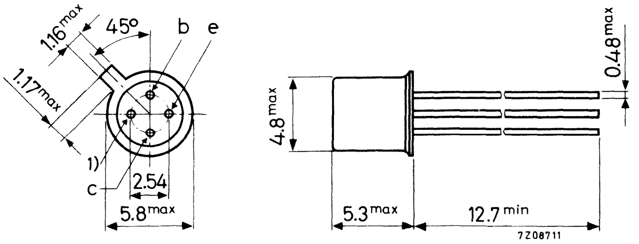
THERMAL RESISTANCE

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

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

Collector cut-off current				
$I_E = 0;\ -V_{CB} = 6$ V	$-I_{CBO}$	typ.	1.2	µA
		<	8	µA
$I_E = 0;\ -V_{CB} = 6$ V; $T_j = 75\ ^{o}C$	$-I_{CBO}$	typ.	90	µA
		<	180	µA
Base current				
$I_E = 1$ mA; $-V_{CB} = 6$ V	$-I_B$	typ.	7	µA
		<	25	µA
Base-emitter voltage				
$-I_C = 1$ mA; $-V_{CE} = 6$ V	$-V_{BE}$	typ.	270	mV
			210 to 330	mV
Small signal current gain at f = 1 kHz				
$- -I_C = 1$ mA; $-V_{CE} = 6$ V	h_{fe}	typ.	150	
Feedback capacitance at f = 450 kHz				
$-I_C = 1$ mA; $-V_{CE} = 6$ V	$-C_{re}$	typ.	1.5	pF

y parameters (common emitter)

$-I_C = 1$ mA; $-V_{CE} = 6$ V [1]

			f = 10.7	0.45	MHz
Input conductance	g_{ie}	typ.	1.7	0.25	$m\Omega^{-1}$
Input capacitance	C_{ie}	typ.	60	70	pF
Feedback admittance	$\lvert y_{re} \rvert$	typ.	100	4.0	$\mu\Omega^{-1}$
Phase angle of feedback admittance	φ_{re}	typ.	260^o	270^o	
Transfer admittance	$\lvert y_{fe} \rvert$	typ.	32	37	$m\Omega^{-1}$
Phase angle of transfer admittance	φ_{fe}	typ.	335^o	0	
Output conductance	g_{oe}	typ.	40	1.0	$\mu\Omega^{-1}$
Output capacitance	C_{oe}	typ.	3.5	4.0	pF

Feedback impedance at f = 2 MHz				
$I_E = 1$ mA; $-V_{CB} = 6$ V	$\lvert z_{rb} \rvert$	typ.	27	Ω

---

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

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

Transition frequency

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

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

R_S = 60 Ω; f = 10.7 MHz	F	typ. <	3.0 4.5	dB dB
R_S = 500 Ω; f = 1 MHz	F	typ. <	1.5 3.0	dB dB

Conversion noise figure

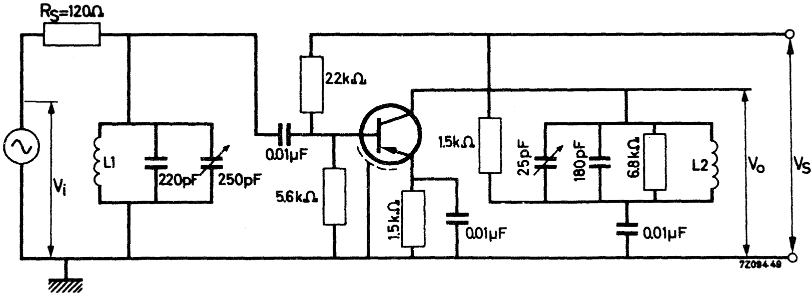
I_E = 1 mA; $-V_{CB}$ = 6 V

R_S = 500 Ω; f = 1 MHz	F_c	typ. <	3 5	dB dB
R_S = 2 kΩ; f = 200 kHz	F_c	typ. <	4 7	dB dB

Power gain at f = 10.7 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	> typ.	19 25	dB dB

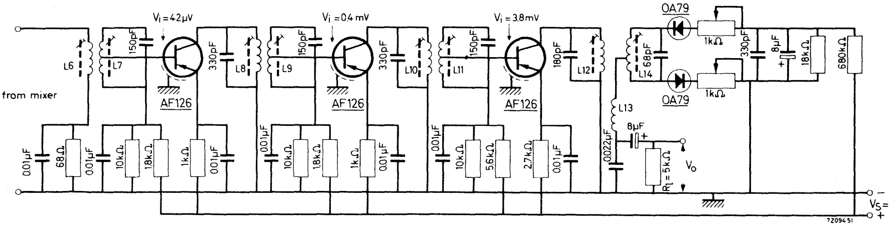
Test circuit:



Total collector resistance R_1 = 4.8 kΩ
L1 = 0.5 µH; unloaded Q-factor 100
L2 = 2.47 µH; unloaded Q-factor 100

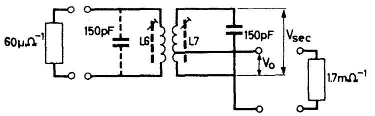
APPLICATION INFORMATION

I.F. amplifier for 10.7 MHz



Emitter current of each transistor $I_E = 1.0$ mA

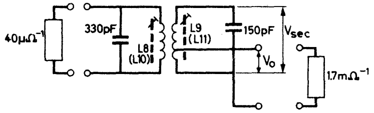
Coil data :



L6 = 1.4 µH; $Q_0 \geq 120$; $Q_L = 70$

L7 = 1.4 µH; $Q_0 \geq 110$; $Q_L = 92$

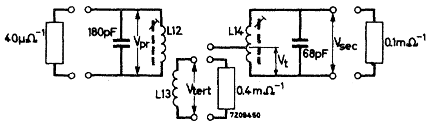
$kQ_L = 1.25$ $\frac{V_o}{V_{sec}} = 0.1$



L8 = L10 = 0.67 µH; $Q_0 \geq 110$; $Q_L = 92$

L9 = L11 = 1.4 µH; $Q_0 \geq 110$; $Q_L = 92$

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

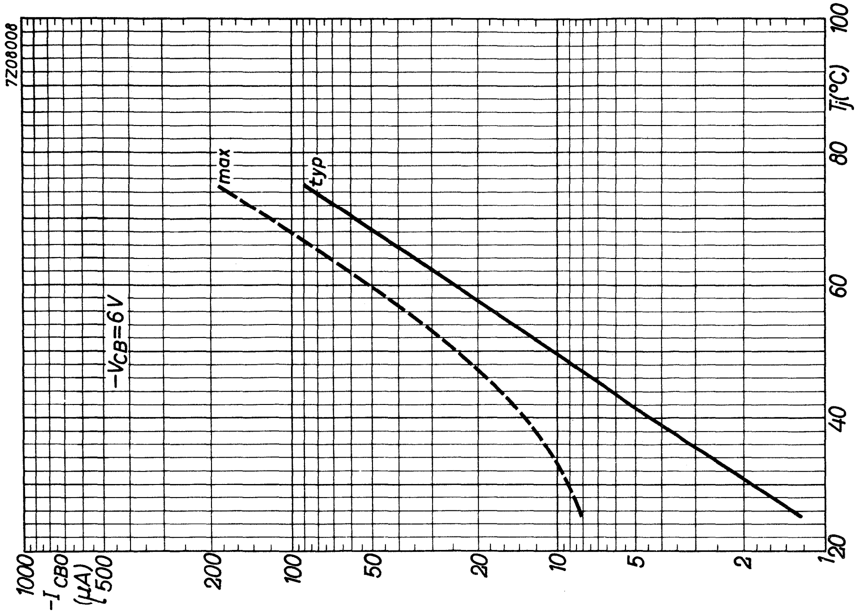


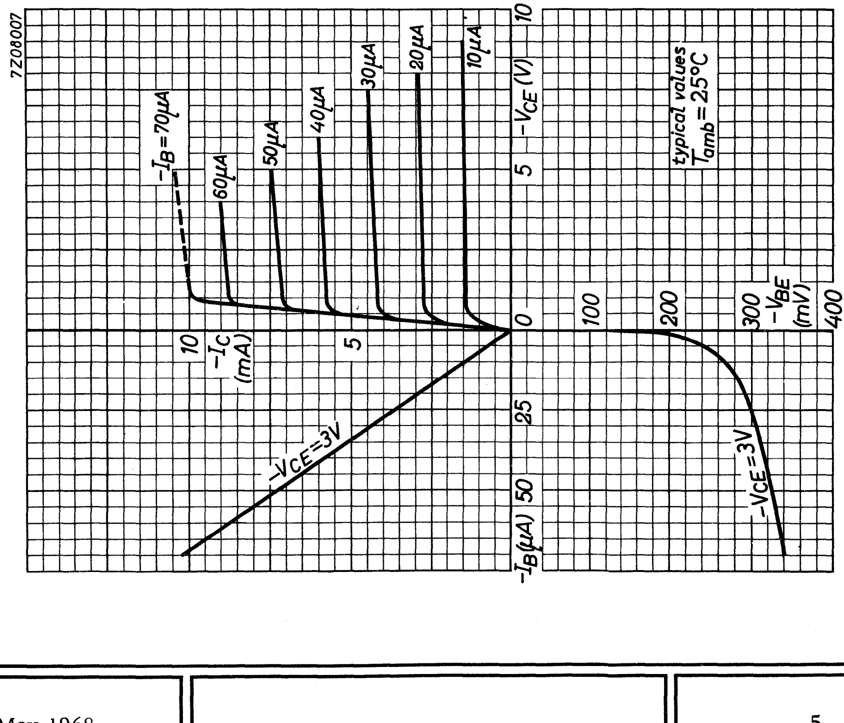
L12 = 1.2 µH; $Q_0 = 90$

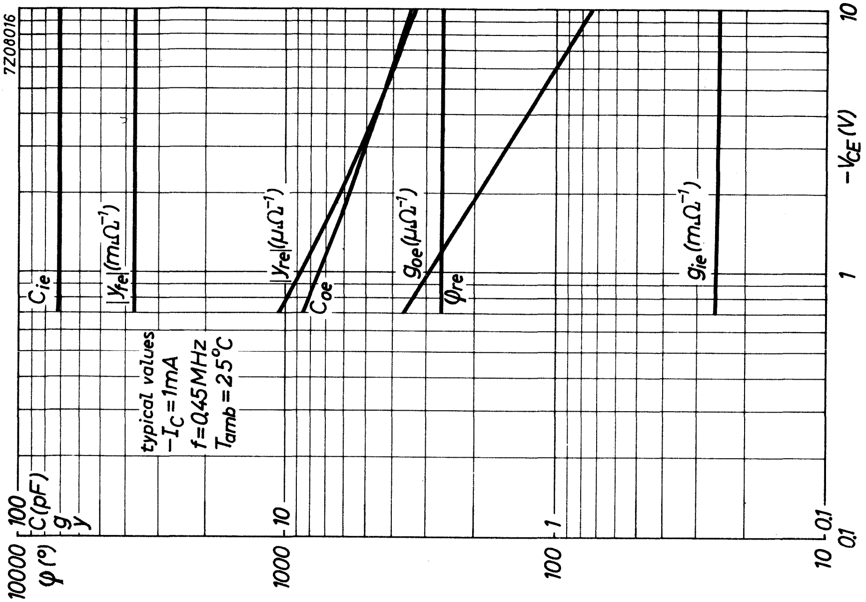
L14 = 3.05 µH; $Q_0 = 90$ (bifilarly wound)

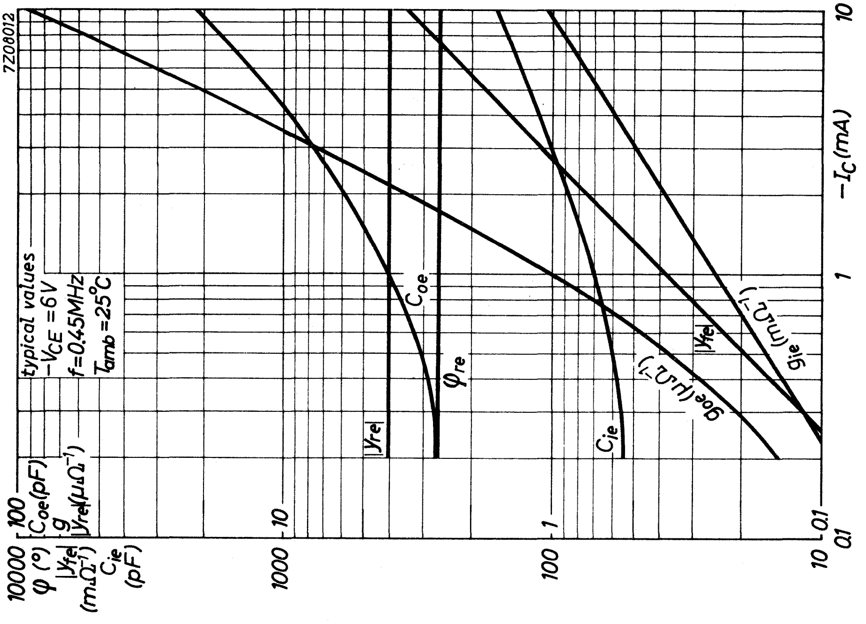
$kQ_L = 0.7$

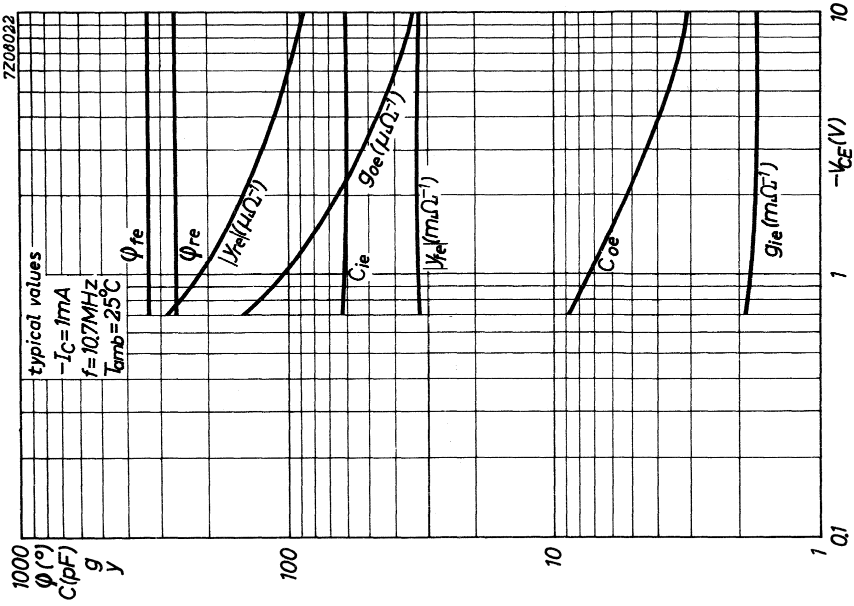
$\frac{V_{tert}}{V_{pr}} = 0.45$; $\frac{V_t}{V_{sec}} = 0.5$

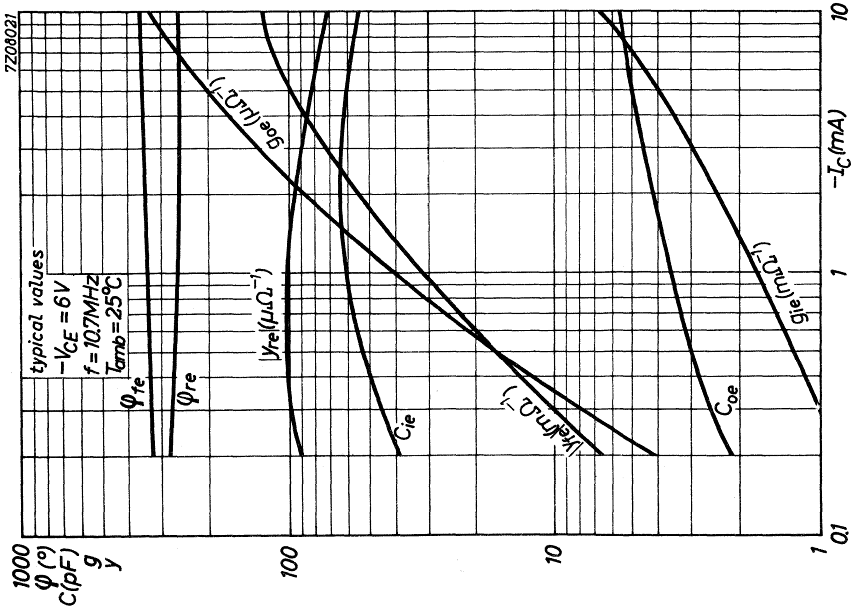

7Z08008
-I_CBO (µA)
1000
500
200
100
50
20
10
5
2
1
Tj(°C)
20
40
60
80
100
-V_CB=6V
max
typ

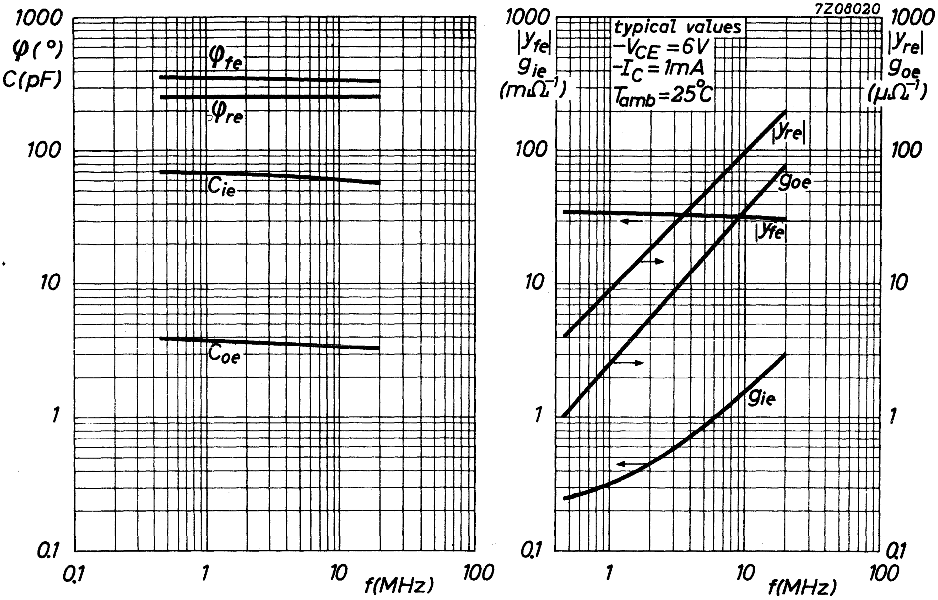

7Z08007
-I_B=70µA
60µA
50µA
40µA
30µA
20µA
10µA
-V_CE (V)
0
5
10
-I_C (mA)
10
5
typical values
T_amb=25°C
100
200
300
400
-V_BE (mV)
-I_B(µA)
25
50
-V_CE=3V
-V_CE=3V

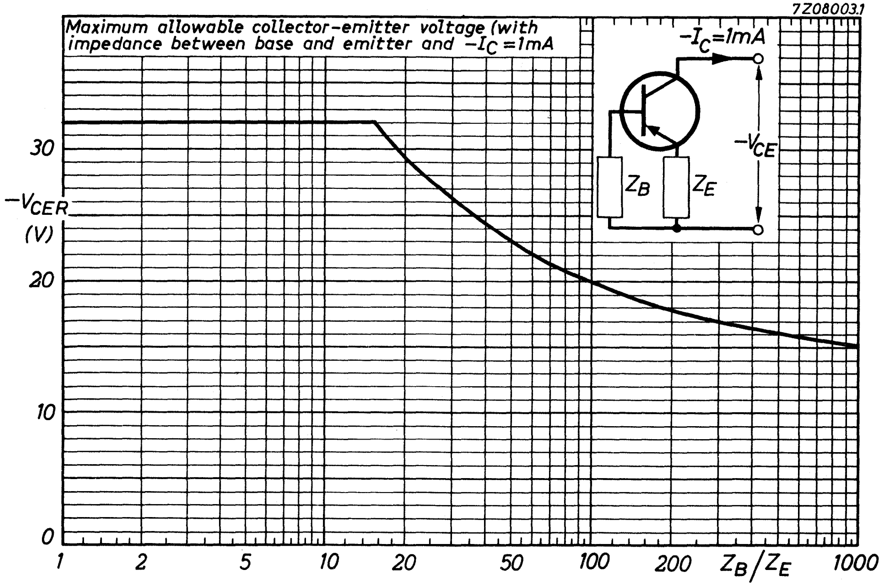

7Z08016
typical values
−I_C = 1mA
f = 0.45MHz
T_amb = 25°C
C_ie
|y_fe| (mΩ⁻¹)
|y_re| (μΩ⁻¹)
C_oe
g_oe (μΩ⁻¹)
φ_re
g_ie (mΩ⁻¹)
10000 φ (°)
100 C (pF) g y
1000
10
100
1
10
0.1
0.1
1
10
−V_CE (V)


7Z08012
typical values
−V_CE = 6V
f = 0.45MHz
T_amb = 25°C
C_oe
φ_re
|y_re|
C_ie
g_oe (μΩ⁻¹)
|y_fe|
g_ie (mΩ⁻¹)
10000 φ (°) |y_fe| (mΩ⁻¹) C_ie (pF)
100 C_oe (pF) g |y_re| (μΩ⁻¹)
1000
10
100
1
10
0.1
0.1
1
10
−I_C (mA)


7Z08022
typical values
−I_C = 1mA
f = 10.7MHz
T_amb = 25°C
φ_fe
φ_re
|y_re| (μΩ⁻¹)
g_oe (μΩ⁻¹)
C_ie
|y_fe| (mΩ⁻¹)
C_oe
g_ie (mΩ⁻¹)
1000
φ (°)
C (pF)
g
y
100
10
1
0.1
1
10
−V_CE (V)


7Z08021
typical values
−V_CE = 6V
f = 10.7MHz
T_amb = 25°C
φ_fe
φ_re
|y_re| (μΩ⁻¹)
g_oe (μΩ⁻¹)
C_ie
|y_fe| (mΩ⁻¹)
C_oe
g_ie (mΩ⁻¹)
1000
φ (°)
C (pF)
g
y
100
10
1
0.1
1
10
−I_C (mA)


7Z08020
1000
φ(°)
C(pF)
φfe
φre
Cie
Coe
100
10
1
0.1
0.1
1
10
100
f(MHz)
1000
|yfe|
gie
(mΩ⁻¹)
typical values
−VCE = 6V
−IC = 1mA
Tamb = 25°C
|yre|
goe
|yfe|
gie
1000
|yre|
goe
(μΩ⁻¹)
100
10
1
0.1
1
10
100
f(MHz)


7Z08003.1
Maximum allowable collector-emitter voltage (with impedance between base and emitter and −IC = 1mA
−IC = 1mA
−VCE
ZB
ZE
30
−VCER
(V)
20
10
0
1
2
5
10
20
50
100
200
ZB/ZE
1000

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 low collector capacitance, low noise and good a.g.c. performance and is intended for use as i.f. amplifier, r.f. amplifier and mixer-oscillator in a.m. receivers up to 6 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.)	$\lvert I_B \rvert$	max.	1	mA
Reverse emitter current	$-I_E$	max.	1	mA
Total power dissipation up to T_{amb} = 45 °C	P_{tot}	max.	60	mW
Storage temperature	T_{stg}		-55 to +75	°C
Junction temperature : continuous	T_j	max.	75	°C
incidentally	T_j	max.	90	°C

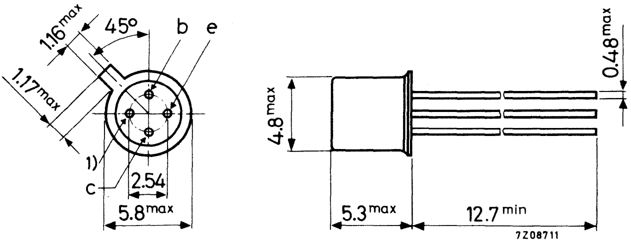
THERMAL RESISTANCE

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

MECHANICAL DATA

Dimensions in mm

TO-72



1) = shield lead (connected to case)

Accessories available: 56246, 56263

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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

Collector cut-off current

$I_E = 0;\ -V_{CB} = 6\ V$	$-I_{CBO}$	typ. <	1.2 8	μA μA
$I_E = 0;\ -V_{CB} = 6\ V;\ T_j = 75\ ^{\circ}C$	$-I_{CBO}$	typ. <	90 180	μA μA

Base current

$I_E = 1\ mA;\ -V_{CB} = 6\ V$	$-I_B$	typ. <	7 25	μA μA

Base-emitter voltage

$-I_C = 1\ mA;\ -V_{CE} = 6\ V$	$-V_{BE}$	typ. 210 to	270 330	mV mV

Small signal current gain at f = 1 kHz

$-I_C = 1\ mA;\ -V_{CE} = 6\ V$	h_{fe}	typ.	150	

Feedback capacitance at f = 450 kHz

$-I_C = 1\ mA;\ -V_{CE} = 6\ V$	$-C_{re}$	typ.	1.5	pF

y parameters at f = 0.45 MHz (common emitter)

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

Input conductance	g_{ie}	typ.	0.25	$m\Omega^{-1}$
Input capacitance	C_{ie}	typ.	70	pF
Feedback admittance	$\lvert y_{re} \rvert$	typ.	4.0	$\mu\Omega^{-1}$
Phase angle of feedback admittance	φ_{re}	typ.	270°	
Transfer admittance	$\lvert y_{fe} \rvert$	typ.	37	$m\Omega^{-1}$
Phase angle of transfer admittance	φ_{fe}	typ.	0	
Output conductance	g_{oe}	typ.	1.0	$\mu\Omega^{-1}$
Output capacitance	C_{oe}	typ.	4.0	pF

Feedback impedance at f = 2 MHz

$I_E = 1\ mA;\ -V_{CB} = 6\ V$	$\lvert z_{rb} \rvert$	typ.	35	Ω

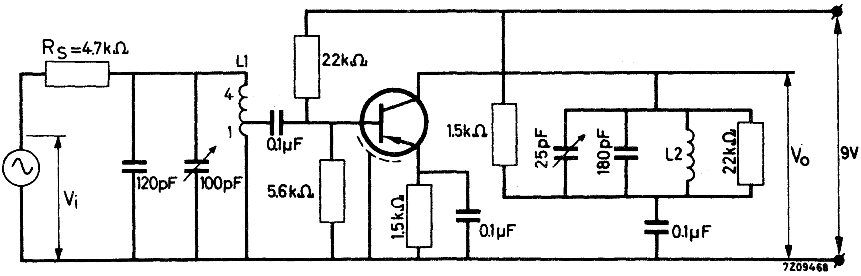
---

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

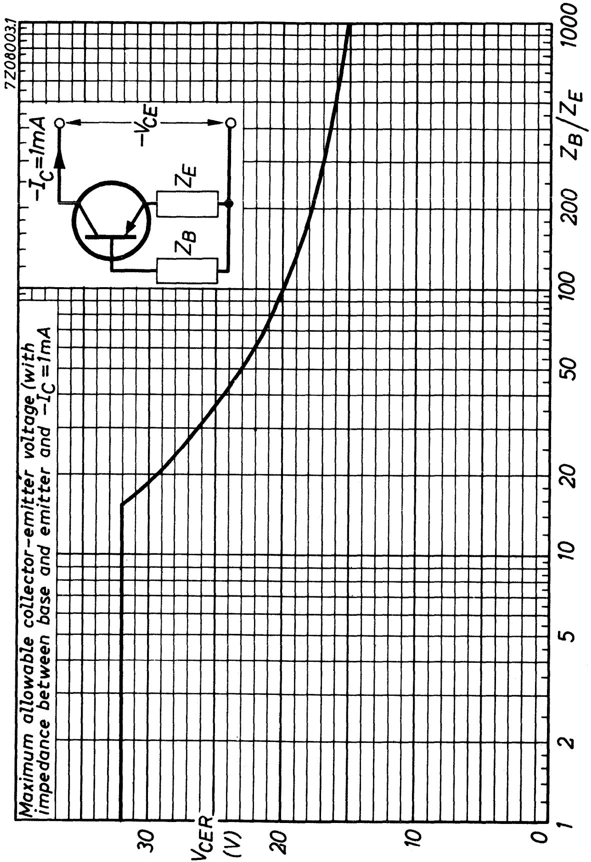
CHARACTERISTICS (continued) T_{amb} = 25 °C unless otherwise specified

Transition frequency				
$I_E = 1$ mA; $-V_{CB} = 6$ V	f_T	typ.	75	MHz
Noise figure at f = 1.0 MHz				
$I_E = 1$ mA; $-V_{CB} = 6$ V; $R_S = 500\ \Omega$	F	typ. <	1.5 3	dB dB
Conversion noise figure				
$I_E = 1$ mA; $-V_{CB} = 6$ V				
$R_S = 500\ \Omega$; f = 1 MHz	F_c	typ. <	3 5	dB dB
$R_S = 2$ kΩ; f = 200 kHz	F_c	typ. <	4 7	dB dB
Power gain at f = 0.45 MHz				
$G_p = \frac{V_o^2}{V_i^2} \cdot \frac{4 R_S}{R_l} = 0.94 \frac{V_o^2}{V_i^2}$	G_p	> typ.	40 42	dB dB

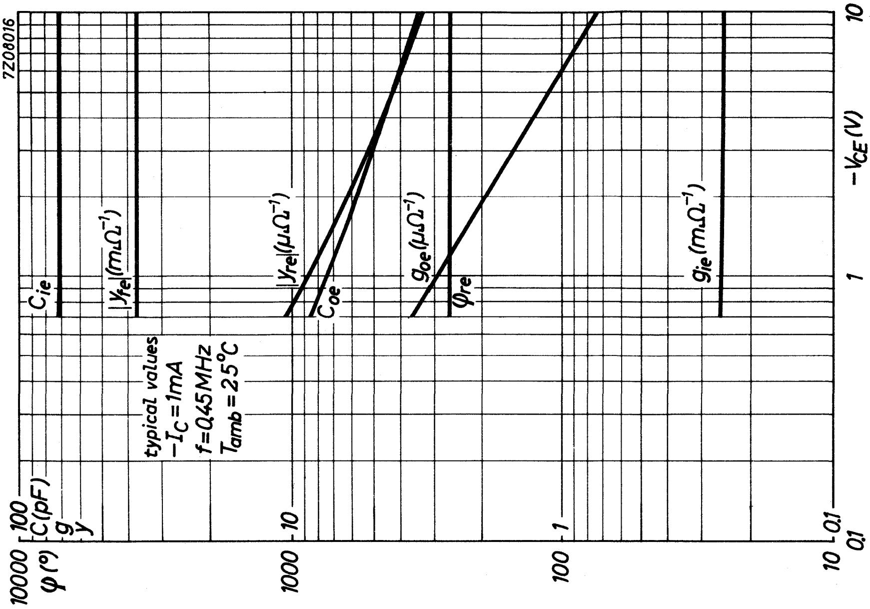
Test circuit :

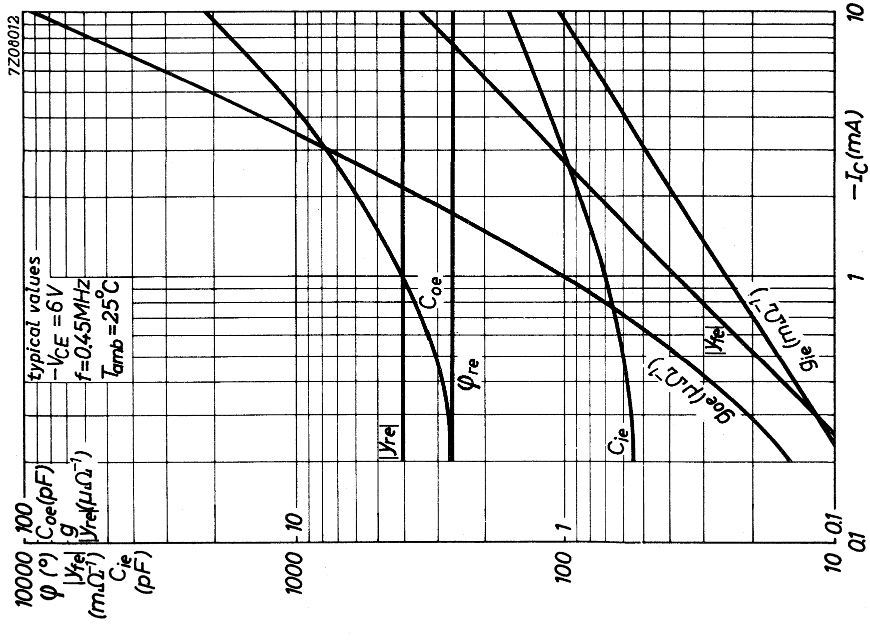


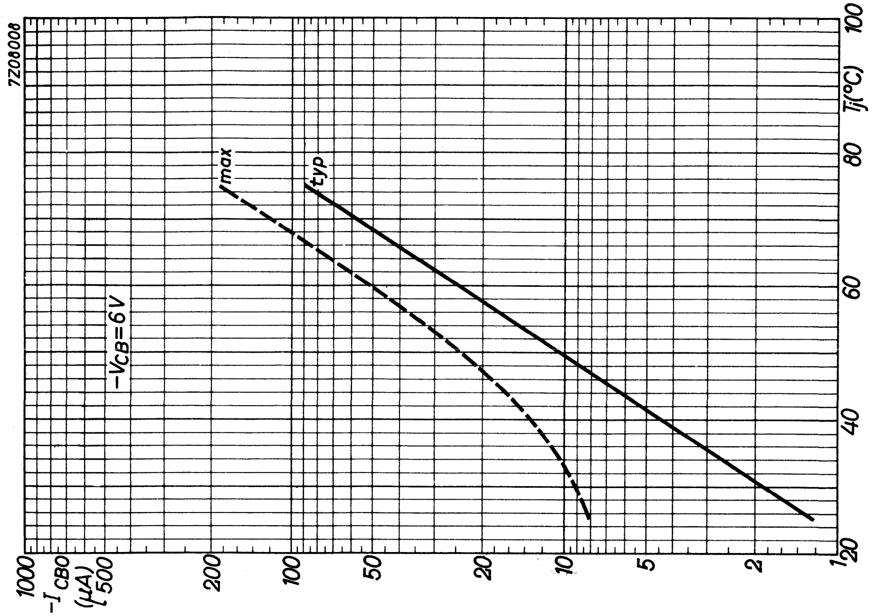
Total collector resistance R_l = 20 kΩ
L1 = 625 µH; unloaded Q-factor 140; tap at 0.2
L2 = 625 µH; unloaded Q-factor 140

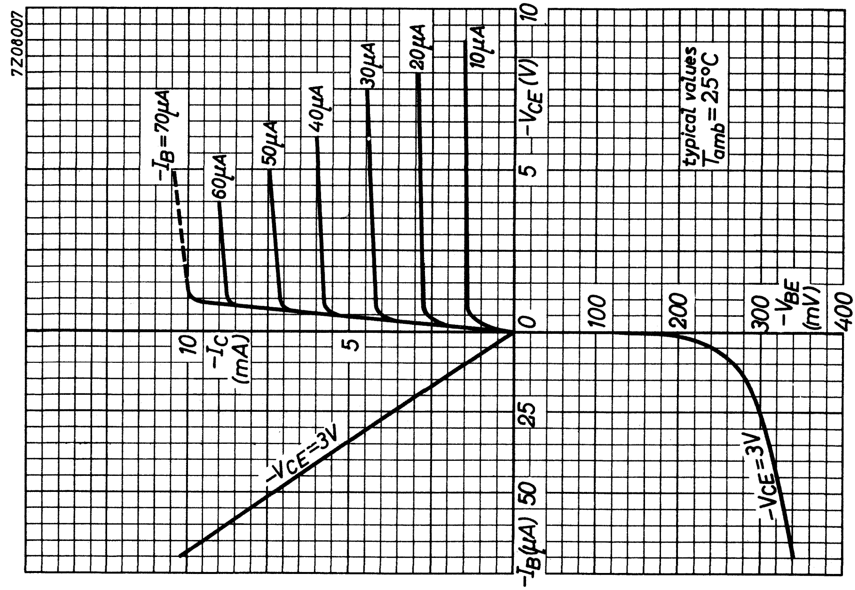


Maximum allowable collector-emitter voltage (with impedance between base and emitter and $-I_C = 1mA$


7Z08016
10000
φ (°)
100
C (pF)
g
y
1000
10
100
1
10
0.1
0.1
1
10
−V_CE (V)
C_ie
|y_fe| (mΩ⁻¹)
|y_re| (μΩ⁻¹)
C_oe
g_oe (μΩ⁻¹)
φ_re
g_ie (mΩ⁻¹)
typical values
−I_C = 1mA
f = 0.45MHz
T_amb = 25°C


7Z08012
10000
φ (°)
|y_fe| (mΩ⁻¹)
C_ie (pF)
100
C_oe (pF)
g
|y_re| (μΩ⁻¹)
1000
10
100
1
10
0.1
0.1
1
10
−I_C (mA)
typical values
−V_CE = 6V
f = 0.45MHz
T_amb = 25°C
C_oe
φ_re
|y_re|
C_ie
g_oe (μΩ⁻¹)
|y_fe|
g_ie (mΩ⁻¹)


7Z08008
$-I_{CBO}$ (μA)
1000
500
200
100
50
20
10
5
2
1
20
40
60
80
100
T_j (°C)
max
typ
$-V_{CB}=6V$


7Z08007
$-I_B=70μA$
60μA
50μA
40μA
30μA
20μA
10μA
$-V_{CE}$ (V)
0
5
10
10
5
$-I_C$ (mA)
100
200
300
400
$-V_{BE}$ (mV)
typical values
$T_{amb}=25°C$
$-V_{CE}=3V$
25
50
$-I_B$ (μA)
$-V_{CE}=3V$

U.H.F. GERMANIUM MESA TRANSISTOR

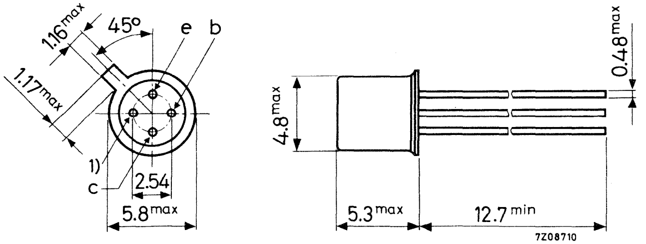
P-N-P transistor in a TO-72 metal envelope, primarily intended for use in pre-amplifier, mixer or oscillator circuits up to frequencies of 860 MHz.

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

MECHANICAL DATA Dimensions in mm

TO-72



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 $T_{amb} = 45\ ^oC$	P_{tot}	max.	60	mW

Temperatures

Storage temperature	T_{stg}		-30 to +75	°C
Junction temperature	T_j	max.	90	°C

THERMAL RESISTANCE

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

---

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

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current

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

Emitter cut-off current

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

Base current

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

Emitter-base voltage

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

Transition frequency

$-I_C = 1.5$ mA; $-V_{CE} = 12$ V	f_T	typ.	550	MHz

Reverse transfer time constant

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

Feedback capacitance at f = 450 kHz

$-I_C = 1.5$ mA; $-V_{CE} = 12$ V	$-C_{re}$	typ.	250	fF 1)

Noise figure at $R_S = 60\ \Omega$

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

---

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

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

y parameters at f = 800 MHz [1]

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

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

y parameters at f = 200 MHz [1]

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

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

Maximum unilateralised power gain

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

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

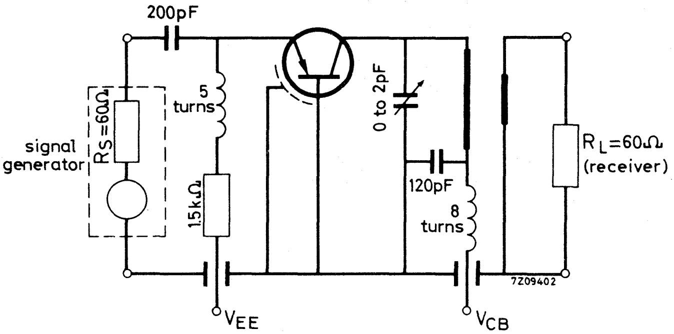
---

[1] Measured with a lead length of 5 mm.

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

Transducer gain

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



Total effective collector resistance R_c = 1.4 kΩ

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

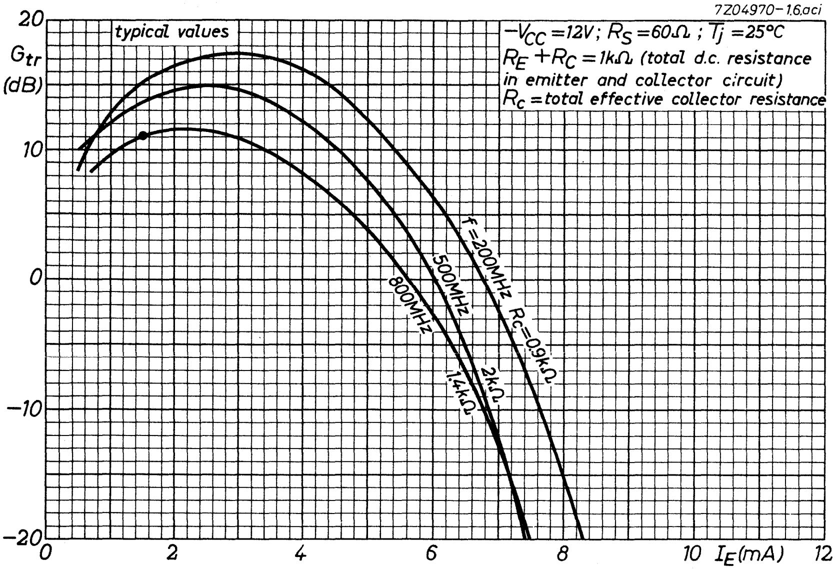
I_E = 1.5 mA; $-V_{CB}$ = 12 V

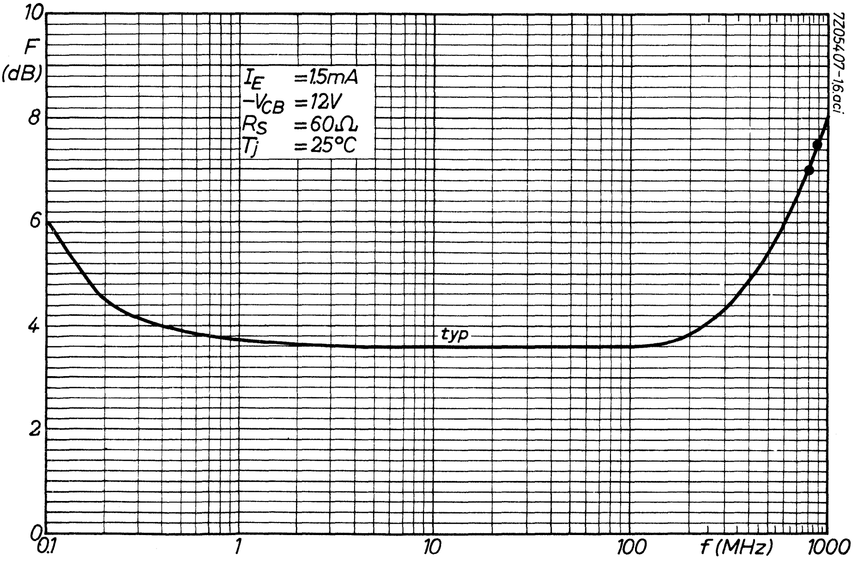
f = 800 MHz	G_{tr}	>	9	dB
		typ.	11	dB
f = 860 MHz	G_{tr}	>	7.5	dB
		typ.	10	dB

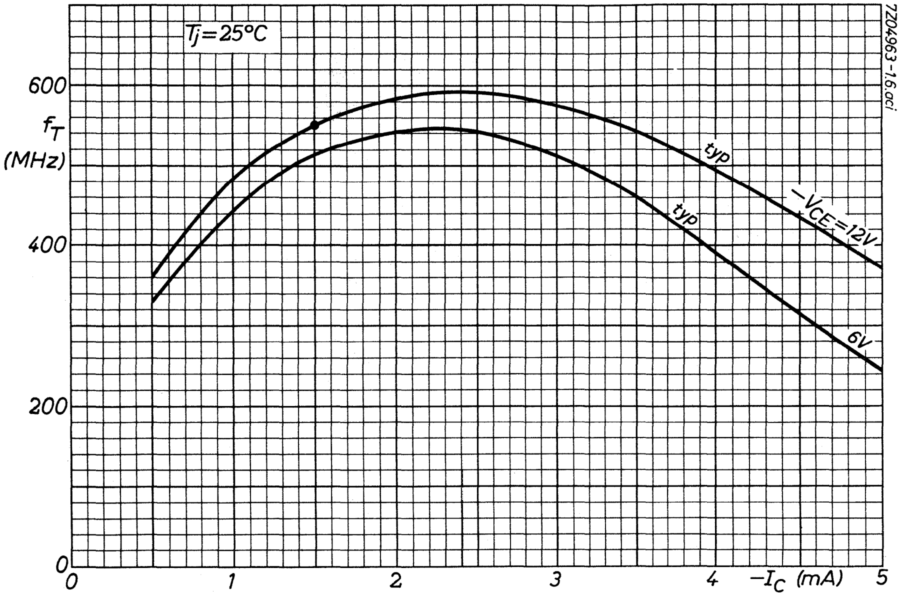
Reverse transducer gain

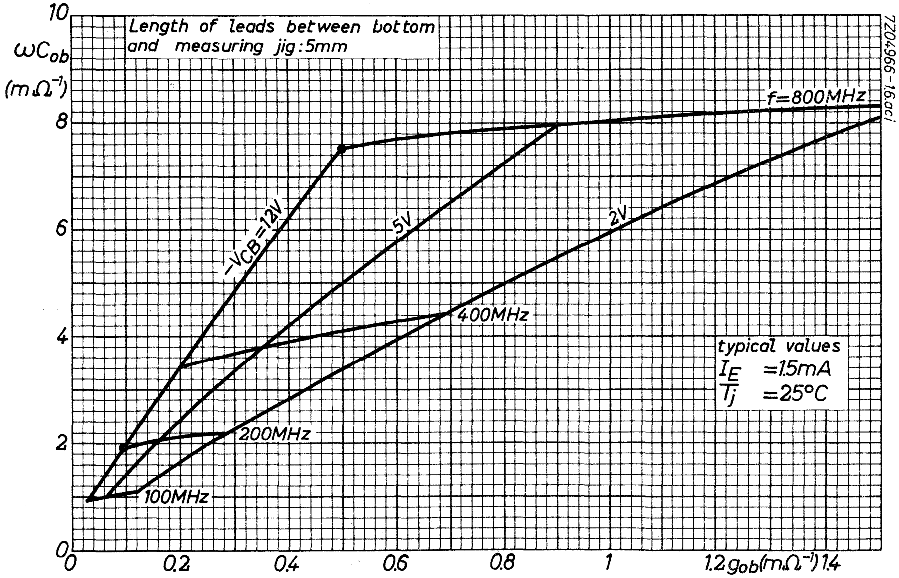
I_E = 1.5 mA; $-V_{CB}$ = 12 V; f = 800 MHz	$G_{tr\ rev}$	typ.	−23	dB

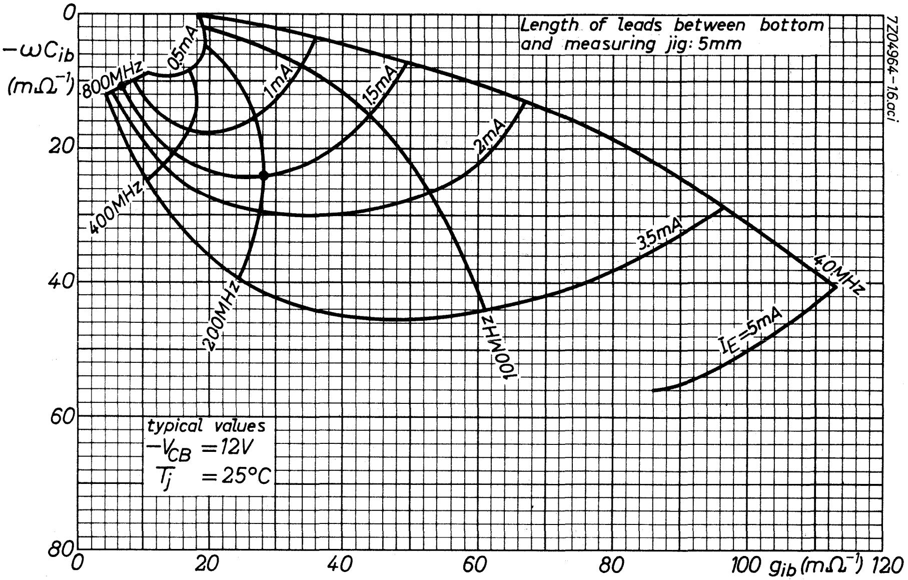
The reverse transducer gain is measured in the above circuit, with the signal generator and the load (receiver) interchanged.

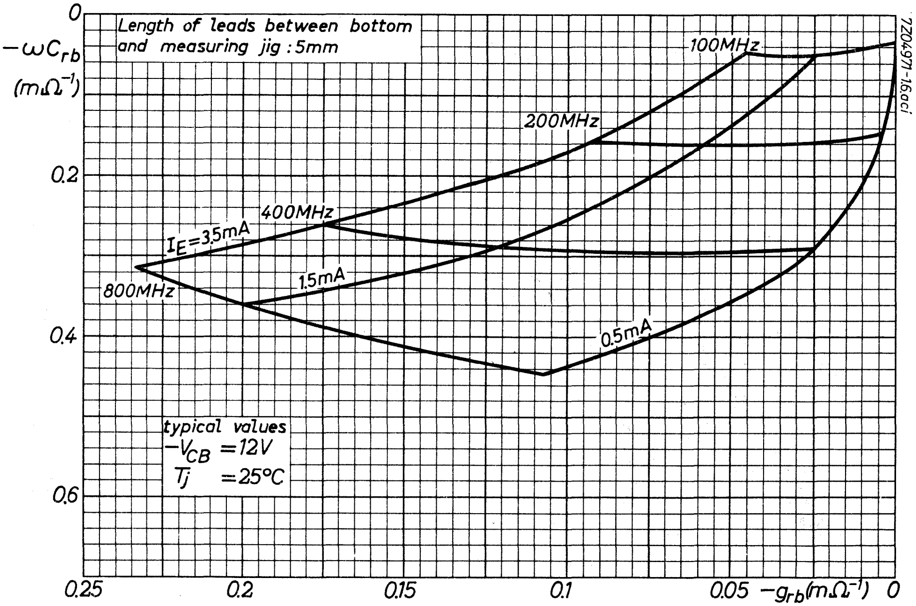

7Z04970-1.6.aci
typical values
$-V_{CC} = 12V$; $R_S = 60\Omega$; $T_j = 25°C$
$R_E + R_C = 1k\Omega$ (total d.c. resistance in emitter and collector circuit)
R_c = total effective collector resistance
G_{tr} (dB)
20
10
0
−10
−20
0
2
4
6
8
10
12
I_E(mA)
f = 200MHz
R_C=0.9kΩ
500MHz
2kΩ
800MHz
1.4kΩ

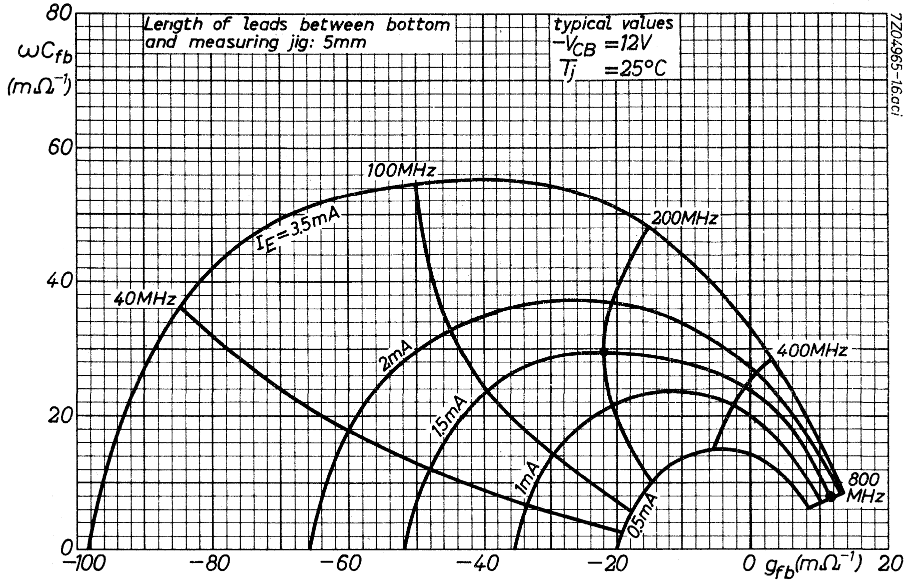

7Z05407-1.6.aci
I_E = 1.5mA
$-V_{CB}$ = 12V
R_S = 60Ω
T_j = 25°C
F (dB)
10
8
6
4
2
0
0.1
1
10
100
1000
f (MHz)
typ

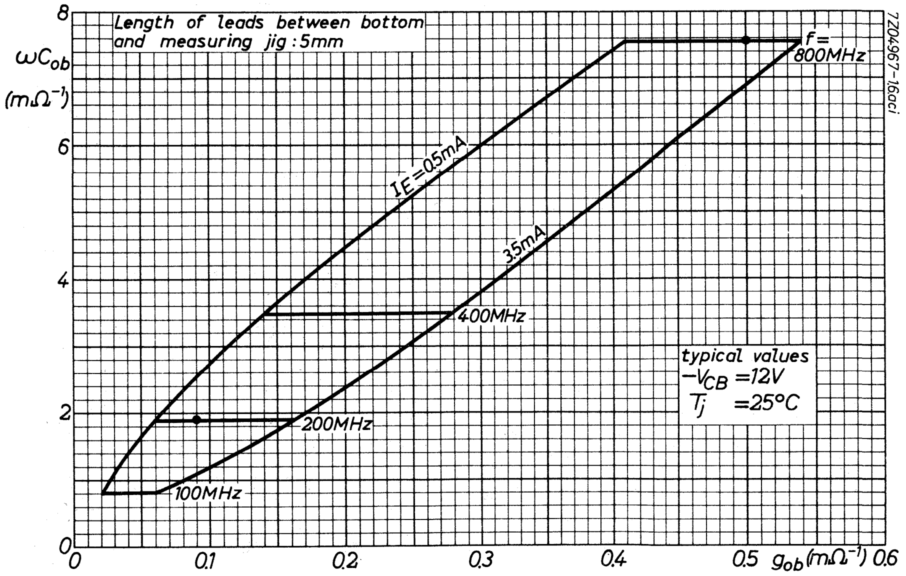

Tj=25°C
600
fT
(MHz)
400
200
0
0
1
2
3
4
5
−IC (mA)
typ
typ
−VCE=12V
6V
7Z04963-1.6.aci

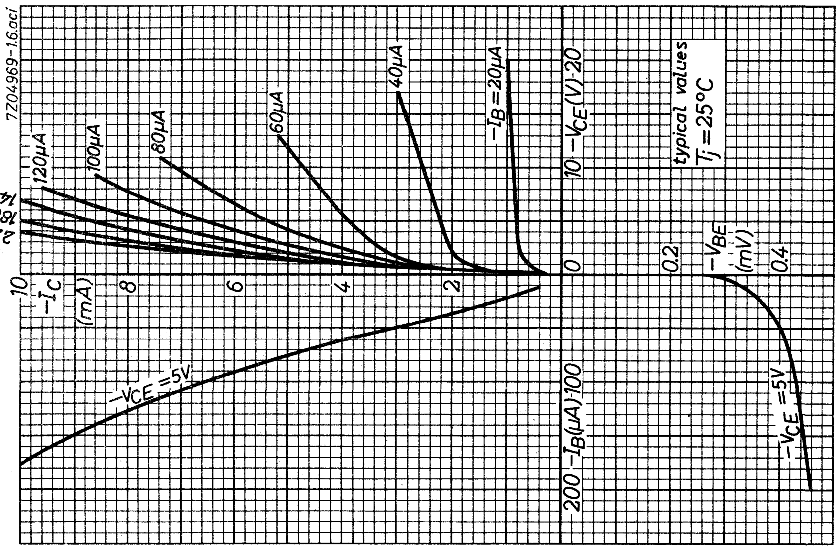

10
ωCob
(mΩ⁻¹)
8
6
4
2
0
0
0.2
0.4
0.6
0.8
1
1.2
gob(mΩ⁻¹)
1.4
Length of leads between bottom and measuring jig: 5mm
f=800MHz
−VCB=12V
5V
2V
400MHz
200MHz
100MHz
typical values
IE =1.5mA
Tj =25°C
7Z04966-1.6.aci

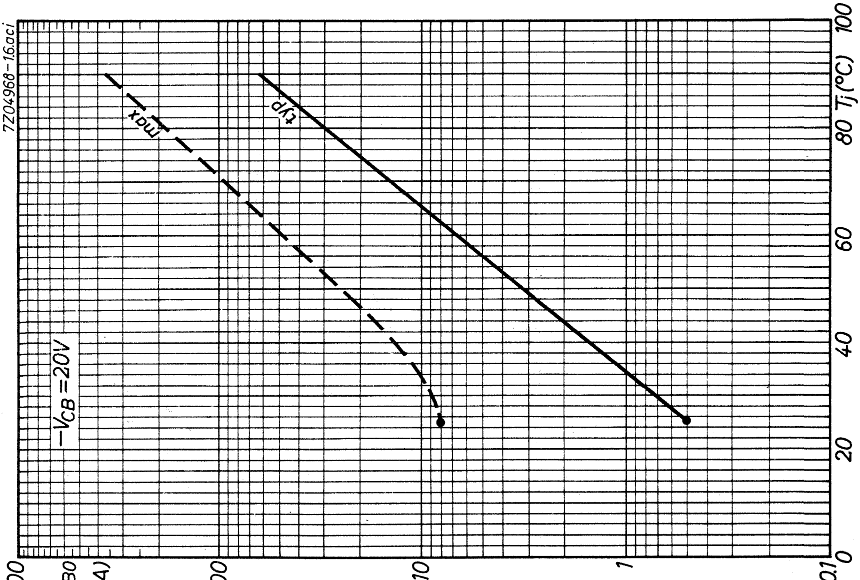

0
$-\omega C_{ib}$
$(m\Omega^{-1})$
20
40
60
80
0
20
40
60
80
100 g_{ib} $(m\Omega^{-1})$ 120
Length of leads between bottom and measuring jig: 5mm
7Z04964-1.6.aci
800MHz
0.5mA
1mA
1.5mA
2mA
3.5mA
I_E=5mA
400MHz
200MHz
100MHz
40MHz
typical values
$-V_{CB}$ = 12V
T_j = 25°C


0
$-\omega C_{rb}$
$(m\Omega^{-1})$
0.2
0.4
0.6
0.25
0.2
0.15
0.1
0.05 $-g_{rb}$ $(m\Omega^{-1})$ 0
Length of leads between bottom and measuring jig : 5mm
7Z04971-1.6.aci
100MHz
200MHz
400MHz
800MHz
I_E=3.5mA
1.5mA
0.5mA
typical values
$-V_{CB}$ = 12V
T_j = 25°C


Length of leads between bottom and measuring jig: 5mm
typical values
$-V_{CB}$ =12V
T_j =25°C
7Z04965-1.6aci
ωC_{fb} ($m\Omega^{-1}$)
g_{fb} ($m\Omega^{-1}$)
80
60
40
20
0
−100
−80
−60
−40
−20
0
20
100MHz
200MHz
40MHz
400MHz
800 MHz
I_E=3.5mA
2mA
1.5mA
1mA
0.5mA


Length of leads between bottom and measuring jig: 5mm
typical values
$-V_{CB}$ =12V
T_j =25°C
7Z04967-1.6aci
ωC_{ob} ($m\Omega^{-1}$)
g_{ob} ($m\Omega^{-1}$)
8
6
4
2
0
0
0.1
0.2
0.3
0.4
0.5
0.6
f= 800MHz
400MHz
200MHz
100MHz
I_E=0.5mA
3.5mA


7Z04969-1.6.aci
typical values
Tj = 25°C
−I_B = 20µA
40µA
60µA
80µA
100µA
120µA
140µA
180µA
220µA
10 −V_CE(V) 20
0
10
−I_C
(mA)
8
6
4
2
−V_CE = 5V
200 −I_B(µA) 100
−V_BE
(mV)
0.2
0.4
−V_CE = 5V


7Z04968-1.6.aci
max
typ
−V_CB = 20V
1000
−I_CBO
(µA)
100
10
1
0.1
0
20
40
60
80
100
Tj (°C)

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.

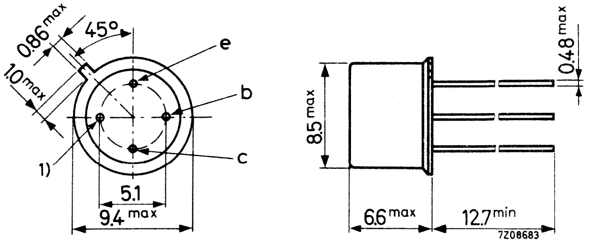
Collector-base voltage (open-emitter)	$-V_{CBO}$	max.	25	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	0.5	V
Collector current (d.c.)	$-I_C$	max.	10	mA
Base current (d.c.)	$-I_B$	max.	1	mA
Total power dissipation up to T_{amb} = 45 °C	P_{tot}	max.	75	mW
Storage temperature	T_{stg}		-55 to +75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

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	0.6	°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

CHARACTERISTICS

T_{amb} = 25 °C unless otherwise specified

Collector cut-off current				
$I_E = 0$; $-V_{CB} = 12$ V	$-I_{CBO}$	<	10	μA
$I_E = 0$; $-V_{CB} = 25$ V	$-I_{CBO}$	<	50	μA
Base current				
$-I_C = 1$ mA; $-V_{CE} = 12$ V	$-I_B$	<	50	μA
Base-emitter voltage				
$-I_C = 1$ mA; $-V_{CE} = 12$ V	$-V_{BE}$		220 to 360	mV
Feedback capacitance at f = 0.45 MHz				
$-I_C = 1$ mA; $-V_{CE} = 12$ V	$-C_{re}$	typ.	0.8	pF
Transition frequency				
$I_E = 1$ mA; $-V_{CB} = 12$ V	f_T	typ.	180	MHz
Feedback impedance at f = 2 MHz				
$I_E = 1$ mA; $-V_{CB} = 12$ V	$\|z_{rb}\|$	typ.	10	Ω
Small signal current gain at f = 1 kHz				
$-I_C = 1$ mA; $-V_{CE} = 12$ V	h_{fe}	>	20	
Noise figure at f = 200 MHz				
$-I_C = 1$ mA; $-V_{CE} = 12$ V; $R_S = 30$ Ω	F	typ. <	6 7.5	dB 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.

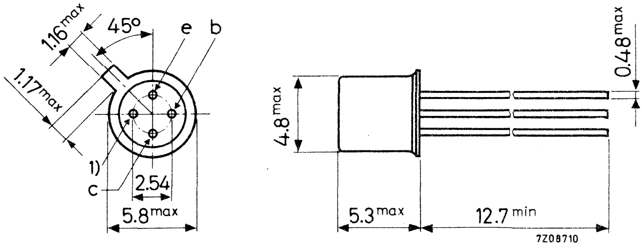
QUICK REFERENCE DATA

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 °C	P_{tot}	max.	60	mW
Junction temperature	T_j	max.	90	°C
Transition frequency				
$-I_C$ = 2 mA; $-V_{CE}$ = 10 V	f_T	typ.	650	MHz
Max. unilateralised power gain				
I_E = 2 mA; $-V_{CB}$ = 10 V; f = 800 MHz	G_{UM}	typ.	17	dB
Noise figure				
I_E = 2 mA; $-V_{CB}$ = 10 V G_S = 16.7 mΩ^{-1}; B_S = 0				
f = 200 MHz	F	typ.	3	dB
f = 800 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 $T_{amb} = 45\ ^oC$	P_{tot}	max.	60	mW

Temperatures

Storage temperature	T_{stg}		-30 to +75	^oC
Junction temperature	T_j	max.	90	^oC

THERMAL RESISTANCE

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

---

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

CHARACTERISTICS

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

Collector cut-off current				
$V_{EB} = 0$; $-V_{CB} = 20$ V	$-I_{CBS}$	typ. <	0.5 8	μA μA
$I_B = 0$; $-V_{CE} = 15$ V	$-I_{CEO}$	<	500	μA
Emitter cut-off current				
$I_C = 0$; $-V_{EB} = 0.3$ V	$-I_{EBO}$	<	100	μA
Base current				
$I_E = 2$ mA; $-V_{CB} = 10$ V	$-I_B$	typ. <	60 200	μA μA
$I_E = 5$ mA; $-V_{CB} = 5$ V	$-I_B$	typ.	167	μA
$I_E = 10$ mA; $-V_{CB} = 2$ V	$-I_B$	<	1	mA
Emitter-base voltage				
$I_E = 2$ mA; $-V_{CB} = 10$ V	V_{EB}	typ.	350	mV
$I_E = 5$ mA; $-V_{CB} = 5$ V	V_{EB}	typ.	400	mV
Transition frequency				
$-I_C = 2$ mA; $-V_{CE} = 10$ V	f_T	typ.	650	MHz
Feeback capacitance at f = 1 MHz				
$-I_C = 2$ mA; $-V_{CE} = 10$ V	$-C_{re}$	typ.	230	fF ¹)
Noise figure				
$I_E = 2$ mA; $-V_{CB} = 10$ V				
$G_S = 16.7\ m\Omega^{-1}$; $B_S = 0$				
f = 200 MHz	F	typ.	3	dB
f = 800 MHz	F	typ. <	5 6	dB dB
f = 900 MHz	F	typ. <	6 7	dB dB
Maximum unilateralised power gain				
$G_{UM} = \frac{\lvert y_{fb}\rvert^2}{4\,g_{ib}g_{ob}}$				
$I_E = 2$ mA; $-V_{CB} = 10$ V; f = 800 MHz	G_{UM}	typ.	17	dB

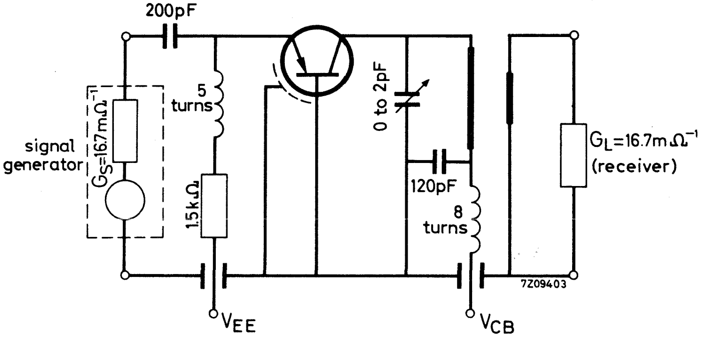
---

¹) 1 fF = 1 femtofarad = 10^{-15} F

CHARACTERISTICS (continued)

Transducer gain at T_{amb} = 25 °C

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

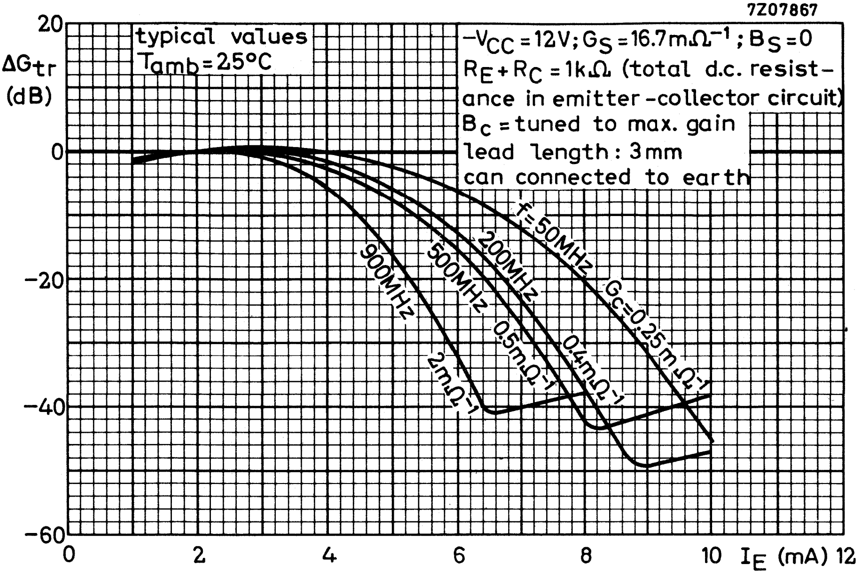


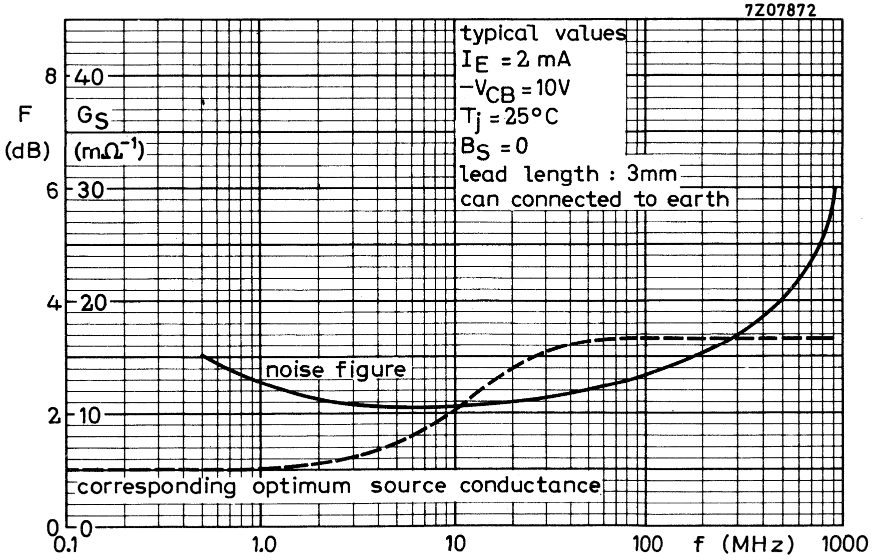
$$G_{tr} = \frac{\text{output power in load } G_L}{\text{available power from source } G_S}$$

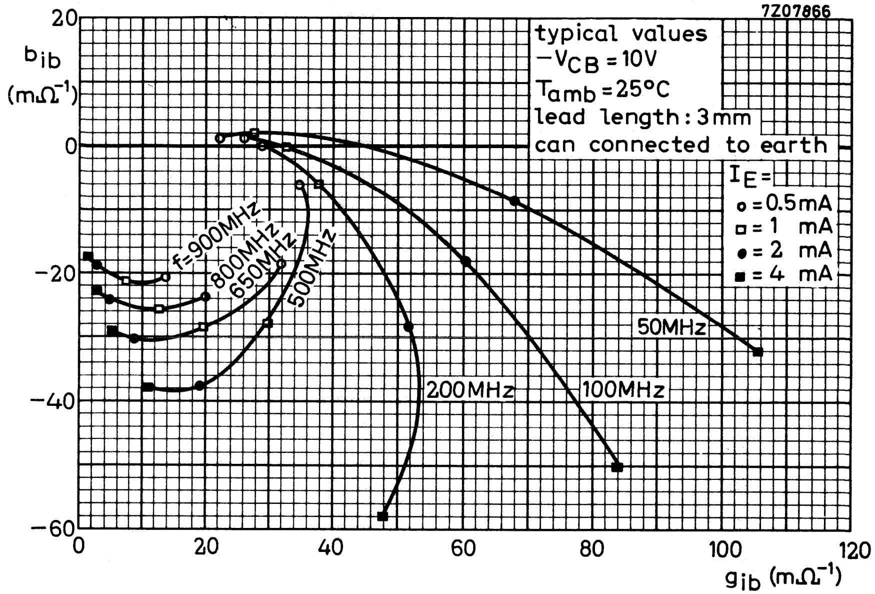
I_E = 2 mA; $-V_{CB}$ = 10 V; lead length: 3 mm; can connected to earth.

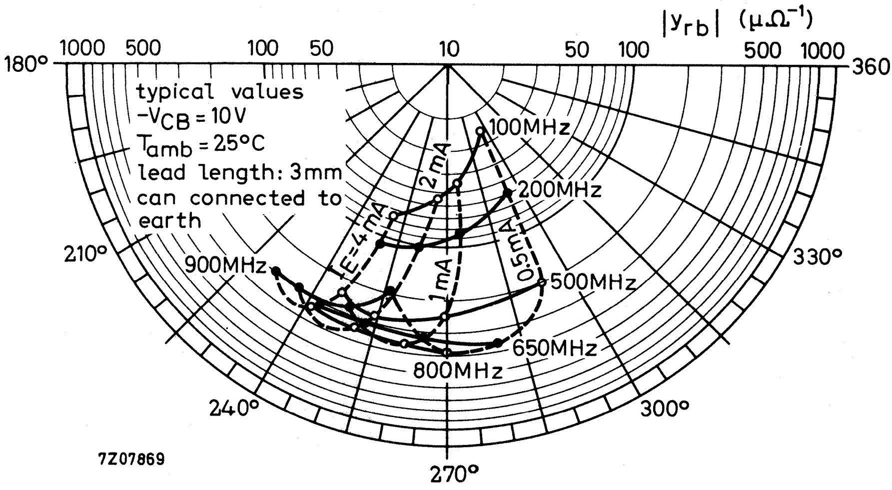
f = 50 MHz; G_c = 0.25 mΩ^{-1}	G_{tr}	typ.	22.5	dB
f = 200 MHz; G_c = 0.4 mΩ^{-1}	G_{tr}	typ.	21.5	dB
f = 500 MHz; G_c = 0.5 mΩ^{-1}	G_{tr}	typ.	18	dB
f = 800 MHz; G_c = 0.5 mΩ^{-1}	G_{tr}	> typ.	11.5 14	dB dB
G_c = 2 mΩ^{-1}	G_{tr}	> typ.	9 11.5	dB dB
f = 900 MHz; G_c = 0.5 mΩ^{-1}	G_{tr}	typ.	12.5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

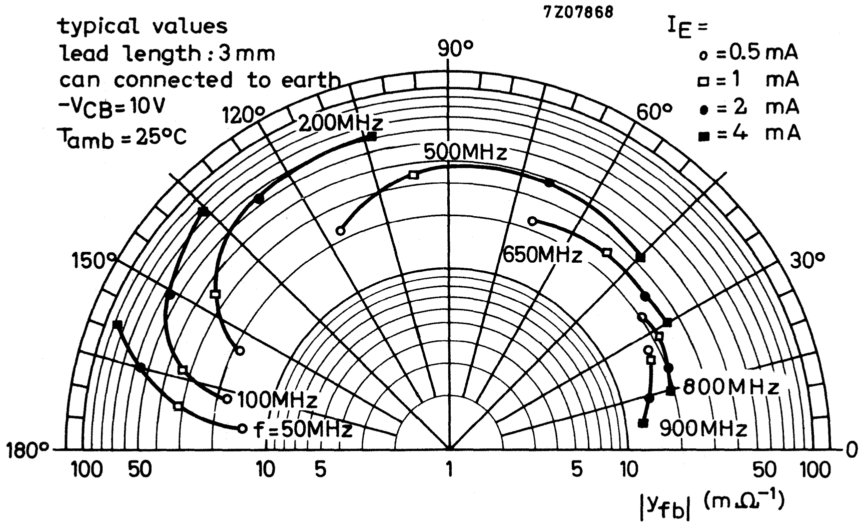
G_c = total effective collector conductance.

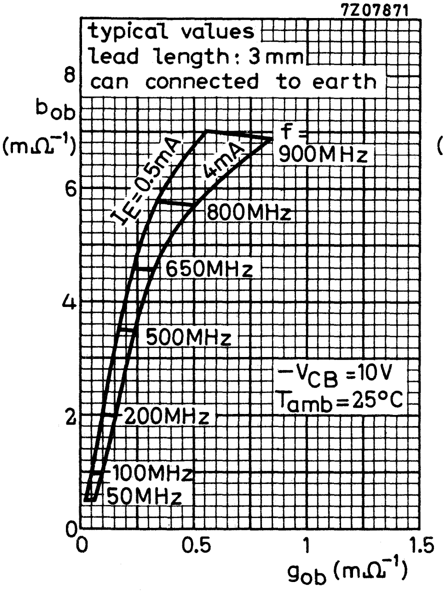

7Z07867
typical values
T_{amb} = 25°C
$-V_{CC}$ = 12V; G_S = 16.7mΩ^{-1}; B_S = 0
$R_E + R_C$ = 1kΩ (total d.c. resistance in emitter-collector circuit)
B_C = tuned to max. gain
lead length: 3mm
can connected to earth
ΔG_{tr} (dB)
20
0
−20
−40
−60
0
2
4
6
8
10
12
I_E (mA)
f = 50MHz
200MHz
500MHz
900MHz
G_C = 0.25 mΩ^{-1}
0.4mΩ^{-1}
0.5mΩ^{-1}
2mΩ^{-1}

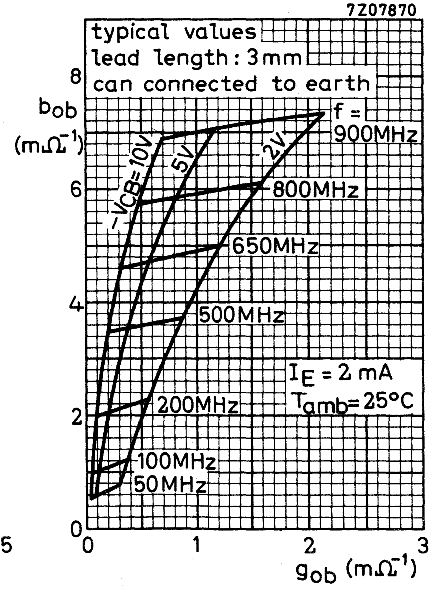

7Z07872
typical values
I_E = 2 mA
$-V_{CB}$ = 10V
T_j = 25°C
B_S = 0
lead length : 3mm
can connected to earth
F (dB)
G_S (mΩ^{-1})
0
2
4
6
8
0
10
20
30
40
0.1
1.0
10
100
1000
f (MHz)
noise figure
corresponding optimum source conductance

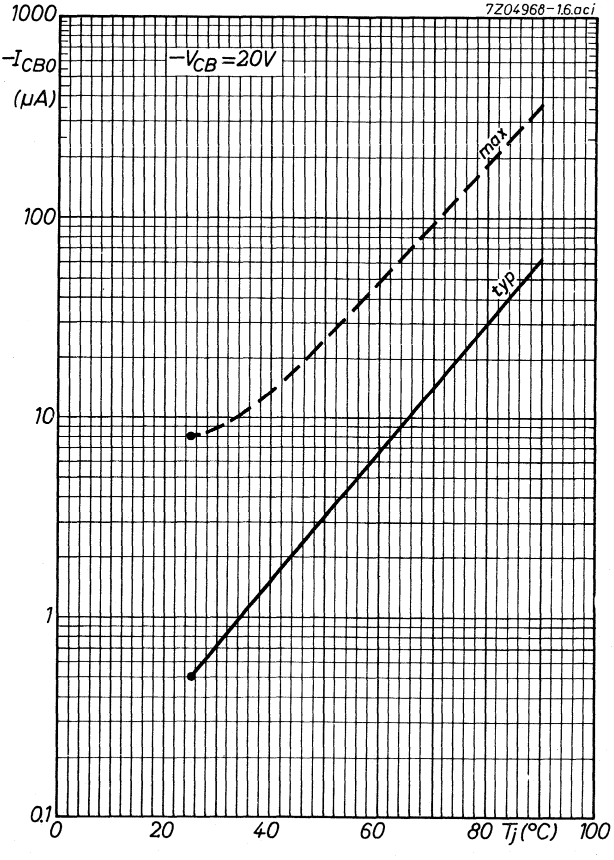

7Z07866
b_{ib}
(mΩ^{-1})
20
0
−20
−40
−60
0
20
40
60
80
100
120
g_{ib} (mΩ^{-1})
typical values
$-V_{CB}$ = 10V
T_{amb} = 25°C
lead length: 3mm
can connected to earth
I_E =
○ = 0.5mA
□ = 1 mA
● = 2 mA
■ = 4 mA
f=900MHz
800MHz
650MHz
500MHz
200MHz
100MHz
50MHz


|y_{rb}| (µΩ^{-1})
1000
500
100
50
10
50
100
500
1000
180°
360°
210°
330°
240°
300°
270°
typical values
$-V_{CB}$ = 10V
T_{amb} = 25°C
lead length: 3mm
can connected to earth
100MHz
200MHz
500MHz
650MHz
800MHz
900MHz
I_E=4mA
2 mA
1 mA
0.5mA
7Z07869


7Z07868
typical values
lead length: 3 mm
can connected to earth
$-V_{CB}$ = 10 V
T_{amb} = 25°C
I_E =
○ = 0.5 mA
□ = 1 mA
● = 2 mA
■ = 4 mA
90°
120°
60°
150°
30°
180°
0
200MHz
500MHz
650MHz
800MHz
900MHz
100MHz
f = 50MHz
100
50
10
5
1
5
10
50
100
$|y_{fb}|$ (mΩ^{-1})


7Z07871
typical values
lead length: 3 mm
can connected to earth
b_{ob} (mΩ^{-1})
8
6
4
2
0
I_E = 0.5 mA
4 mA
f = 900MHz
800MHz
650MHz
500MHz
200MHz
100MHz
50MHz
$-V_{CB}$ = 10V
T_{amb} = 25°C
0
0.5
1
1.5
g_{ob} (mΩ^{-1})


7Z07870
typical values
lead length: 3 mm
can connected to earth
b_{ob} (mΩ^{-1})
8
6
4
2
0
$-V_{CB}$ = 10V
5V
2V
f = 900MHz
800MHz
650MHz
500MHz
200MHz
100MHz
50MHz
I_E = 2 mA
T_{amb} = 25°C
0
1
2
3
g_{ob} (mΩ^{-1})


7Z04968-1.6.aci
1000
$-I_{CBO}$
(μA)
$-V_{CB}=20V$
100
10
1
0.1
max
typ
0
20
40
60
80
T_j (°C)
100

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.

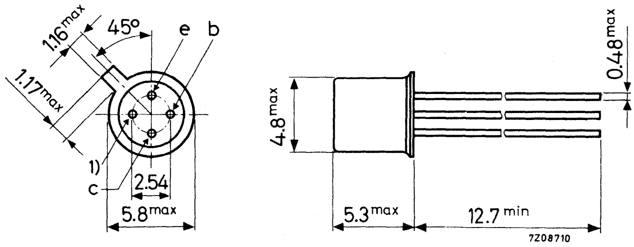
QUICK REFERENCE DATA

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 $T_{amb} = 45\ ^oC$	P_{tot}	max.	60	mW
Junction temperature	T_j	max.	90	^oC
Transition frequency $-I_C = 2$ mA; $-V_{CE} = 10$ V	f_T	typ.	780	MHz
Transducer gain at $I_E = 2$ mA; $-V_{CB} = 10$ V				
f = 800 MHz; $G_c = 0.5\ m\Omega^{-1}$	G_{tr}	typ.	15	dB
f = 900 MHz; $G_c = 2\ m\Omega^{-1}$	G_{tr}	typ.	12	dB
Noise figure $I_E = 2$ mA; $-V_{CB} = 10$ V $G_S = 16.7\ m\Omega^{-1}$; $B_S = 0$				
f = 800 MHz	F	<	5	dB
f = 900 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 °C	P_{tot}	max.	60	mW
Temperatures				
Storage temperature	T_{stg}		−30 to +75	°C
Junction temperature	T_j	max.	90	°C

THERMAL RESISTANCE

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

CHARACTERISTICS $T_j = 25$ °C unless otherwise specified

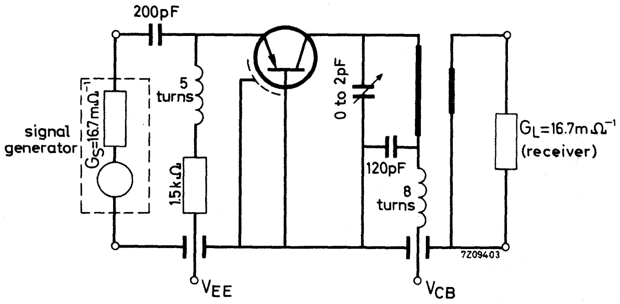
Collector cut-off current				
$V_{EB} = 0$; $-V_{CB} = 20$ V	$-I_{CBS}$	typ. <	0.5 8	μA μA
$I_B = 0$; $-V_{CE} = 15$ V	$-I_{CEO}$	<	500	μA
Emitter cut-off current				
$I_C = 0$; $-V_{EB} = 0.3$ V	$-I_{EBO}$	<	100	μA
Base current				
$I_E = 2$ mA; $-V_{CB} = 10$ V	$-I_B$	typ. <	60 200	μA μA
$I_E = 5$ mA; $-V_{CB} = 5$ V	$-I_B$	typ.	167	μA
$I_E = 10$ mA; $-V_{CB} = 2$ V	$-I_B$	<	1	mA

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

Emitter-base voltage					
I_E = 2 mA; $-V_{CB}$ = 10 V		V_{EB}	typ.	350	mV
I_E = 5 mA; $-V_{CB}$ = 5 V		V_{EB}	typ.	400	mV
Transition frequency					
$-I_C$ = 2 mA; $-V_{CE}$ = 10 V		f_T	typ.	780	MHz
Feedback capacitance at f = 1 MHz					
$-I_C$ = 2 mA; $-V_{CE}$ = 10 V		$-C_{re}$	typ.	200	fF
Noise figure					
I_E = 2 mA; $-V_{CB}$ = 10 V G_S = 16.7 mΩ^{-1}; B_S = 0	f = 800 MHz	F	<	5	dB
	f = 900 MHz	F	<	6	dB

Transducer gain at T_{amb} = 25 °C

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

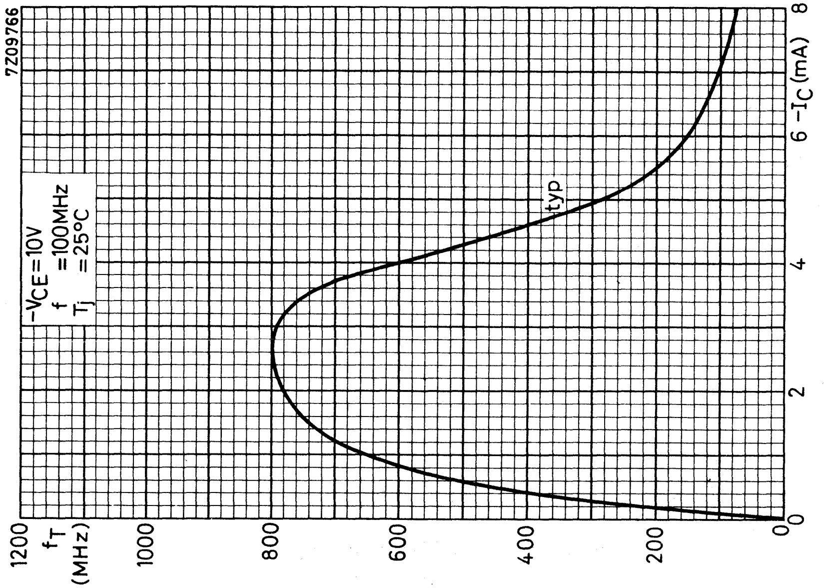


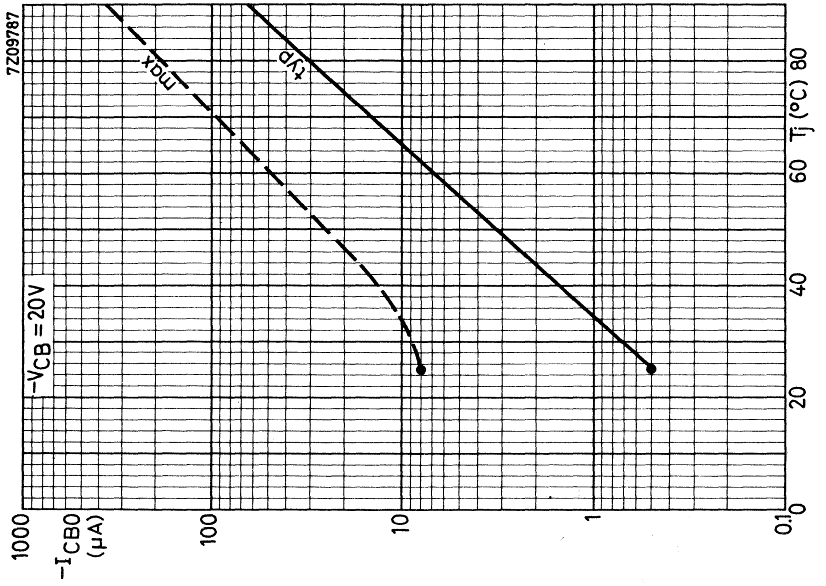
$$G_{tr} \text{ in dB} = 10 \log \frac{\text{output power in load } G_L}{\text{available power from source } G_S}$$

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

f = 800 MHz; G_c = 0.5 mΩ^{-1}	G_{tr}	typ.	15	dB
G_c = 2 mΩ^{-1}	G_{tr}	typ.	12.5	dB
f = 900 MHz; G_c = 2 mΩ^{-1}	G_{tr}	>	11	dB
		typ.	12	dB

G_c = total effective collector conductance.


7Z09766
$-V_{CE} = 10V$
f = 100MHz
T_j = 25°C
typ
f_T (MHz)
1200
1000
800
600
400
200
0
0
2
4
6
$-I_C$ (mA)
8


7Z09787
$-V_{CB} = 20V$
max
typ
$-I_{CBO}$ (µA)
1000
100
10
1
0.1
0
20
40
60
T_j (°C)
80

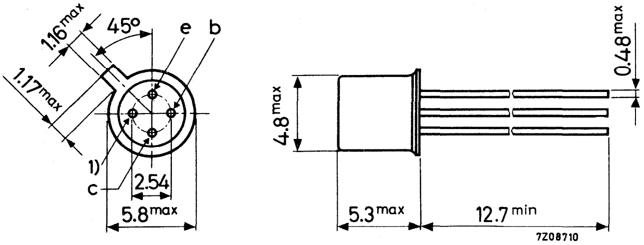
U.H.F. GERMANIUM MESA TRANSISTOR

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 °C	P_{tot}	max.	60	mW
Junction temperature	T_j	max.	90	°C
Transition frequency at f = 100 MHz $-I_C$ = 2 mA; $-V_{CE}$ = 10 V	f_T	typ.	650	MHz
Transducer gain at f = 800 MHz (common base) I_E = 2 mA; $-V_{CB}$ = 10 V G_S = 16.7 mΩ^{-1}; G_L = 0.5 mΩ^{-1}	G_{tr}	typ.	14	dB
Noise figure I_E = 2 mA; $-V_{CB}$ = 10 V G_S = 16.7 mΩ^{-1}; B_S = 0; f = 200 MHz	F	typ.	4.5	dB
f = 800 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) [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

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 °C	P_{tot}	max.	60	mW

Temperatures

Storage temperature	T_{stg}		−30 to +75	°C
Junction temperature	T_j	max.	90	°C

THERMAL RESISTANCE

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

Collector cut-off current

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

Emitter cut-off current

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

Base current

$-I_C = 2$ mA; $-V_{CE} = 10$ V	$-I_B$	typ. $<$	80 200	μA μA

Emitter-base voltage

$-I_C = 2$ mA; $-V_{CE} = 10$ V	$-V_{BE}$	typ.	370	mV

D.C. current gain

$-I_C = 2$ mA; $-V_{CE} = 10$ V	h_{FE}	$>$ typ.	10 25	

Transition frequency

$-I_C = 2$ mA; $-V_{CE} = 10$ V	f_T	typ.	650	MHz

Feedback capacitance at f = 1 MHz

$-I_C = 1$ mA; $-V_{CE} = 10$ V	$-C_{re}$	typ.	260	fF

Noise figure

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

$G_S = 16.7\ \mathrm{m\Omega^{-1}}$; $B_S = 0$; $f = 200$ MHz	F	typ.	4.5	dB
$f = 800$ MHz	F	typ.	5.5	dB

Transducer gain at f = 800 MHz (common base) [1]

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

$I_E = 2$ mA; $-V_{CB} = 10$ V; $G_S = 16.7\ \mathrm{m\Omega^{-1}}$

$G_L = 0.5\ \mathrm{m\Omega^{-1}}$	G_{tr}	typ.	14	dB
$G_L = 2\ \mathrm{m\Omega^{-1}}$	G_{tr}	typ.	12	dB

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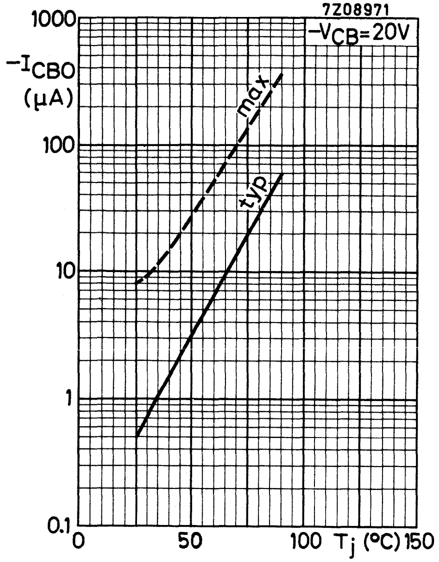
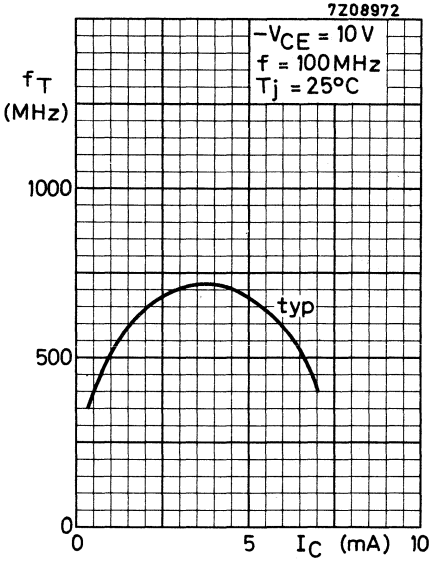
[1]) Length of leads is 3 mm from can to earth.


7Z08971
−V_CB=20V
−I_CBO (μA)
1000
100
10
1
0.1
max
typ
0
50
100
T_j (°C)
150


7Z08972
−V_CE = 10 V
f = 100 MHz
Tj = 25°C
f_T (MHz)
1000
500
0
typ
0
5
I_C (mA)
10

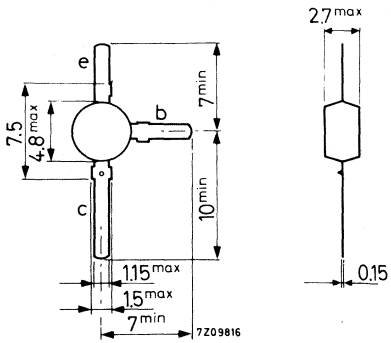
U.H.F. GERMANIUM SEMIPLANAR TRANSISTOR

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 °C	P_{tot}	max.	60	mW
Junction temperature	T_j	max.	90	°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 mΩ^{-1}	G_{tr}	typ.	12	dB
Noise figure I_E = 2 mA; $-V_{CB}$ = 10 V G_S = 16.7 mΩ^{-1}; 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

Power dissipation

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

Temperatures

Storage temperature	T_{stg}	−30 to +75		°C
Junction temperature	T_j	max.	90	°C

THERMAL RESISTANCE

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

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

Collector cut-off current

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

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

Base-emitter voltage

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

Transition frequency at f = 100 MHz

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

Feedback capacitance at f = 0.45 MHz

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

Output capacitance at f = 900 MHz

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

Noise figure

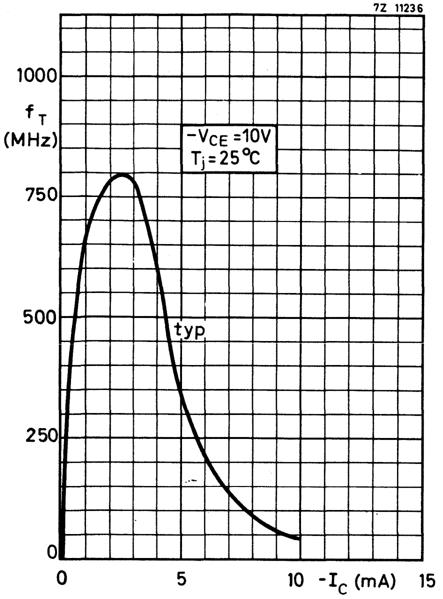
$-I_C = 2$ mA; $-V_{CE} = 10$ V $G_S = 16.7\ m\Omega^{-1}$; $B_S = 0$	f = 900 MHz	F	<	6	dB

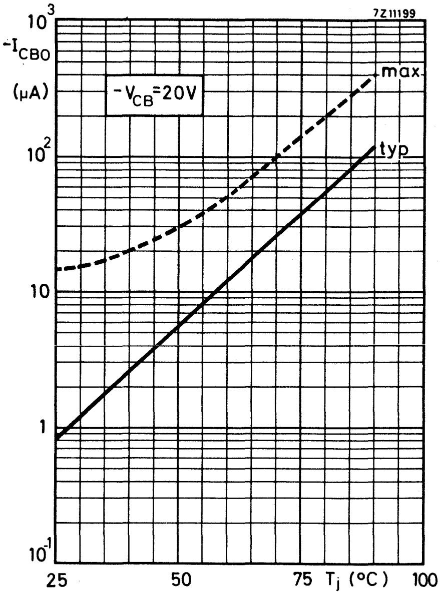
Transducer gain at $T_{amb} = 25\,^{\circ}C$

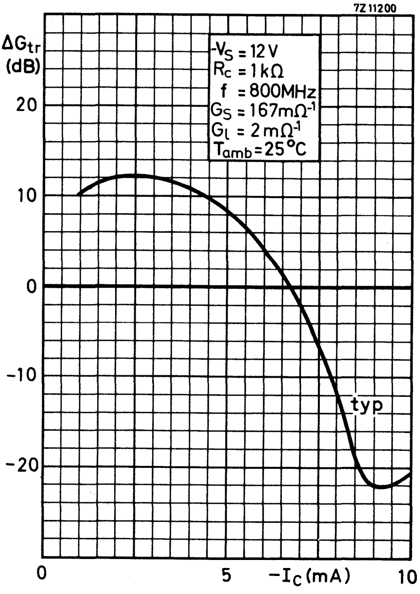
$$G_{tr} \text{ in dB} = 10 \log \frac{\text{output power in load } G_L}{\text{available power from source } G_S}$$

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

G_c = total effective collecor conductance.


7Z 11236
1000
f_T
(MHz)
750
500
250
0
−V_CE = 10V
T_j = 25 °C
typ
0
5
10
−I_C (mA)
15


7Z11199
10^3
−I_CBO
(μA)
10^2
10
1
10^-1
−V_CB = 20V
max
typ
25
50
75
T_j (°C)
100


7Z11200
ΔG_tr
(dB)
20
10
0
−10
−20
−V_S = 12 V
R_c = 1 kΩ
f = 800MHz
G_S = 167mΩ^-1
G_L = 2 mΩ^-1
T_amb = 25 °C
typ
0
5
−I_C (mA)
10

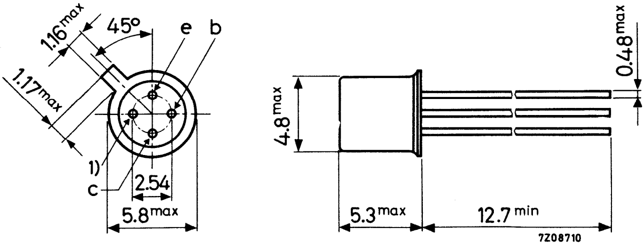
U.H.F. GERMANIUM MESA TRANSISTOR

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

QUICK REFERENCE DATA				
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	30	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	25	V
Collector current (d.c.)	$-I_C$	max.	8	mA
Total power dissipation up to T_{amb} = 45 °C	P_{tot}	max.	60	mW
Junction temperature	T_j	max.	90	°C
Transition frequency				
$-I_C$ = 1.5 mA; $-V_{CE}$ = 12 V	f_T	typ.	550	MHz
Max. unilateralised power gain				
I_E = 1.5 mA; $-V_{CB}$ = 12 V; f = 800 MHz	G_{UM}	typ.	11.5	dB
Noise figure				
I_E = 1.5 mA; $-V_{CB}$ = 12 V;				
f = 800 MHz; R_S = 60 Ω	F	typ.	7	dB

MECHANICAL DATA Dimensions in mm

TO-72



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 °C	P_{tot}	max.	60	mW

Temperatures

Storage temperature	T_{stg}		-30 to +75	°C
Junction temperature	T_j	max.	90	°C

THERMAL RESISTANCE

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

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

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

Collector cut-off current

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

Emitter cut-off current

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

Base current

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

Emitter-base voltage

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

Transition frequency

$-I_C = 1.5$ mA; $-V_{CE} = 12$ V	f_T	typ.	550	MHz

Reverse transfer time constant

$I_E = 1.5$ mA; $-V_{CB} = 12$ V; $f = 2.5$ MHz	$r_{bb'} . C_{b'c}$	typ.	3	ps

Feedback capacitance at $f = 450$ kHz

$-I_C = 1.5$ mA; $-V_{CE} = 12$ V	$-C_{re}$	typ.	250	fF 1)

---

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

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

y parameters at f = 800 MHz [1]

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

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

Maximum unilateralised power gain

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

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

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[1] Measured with a lead length of 5 mm.

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

Transducer gain

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

$I_E = 1.5$ mA; $-V_{CB} = 12$ V; f = 800 MHz	G_{tr}	>	10.2	dB
		typ.	11	dB

Reverse transducer gain

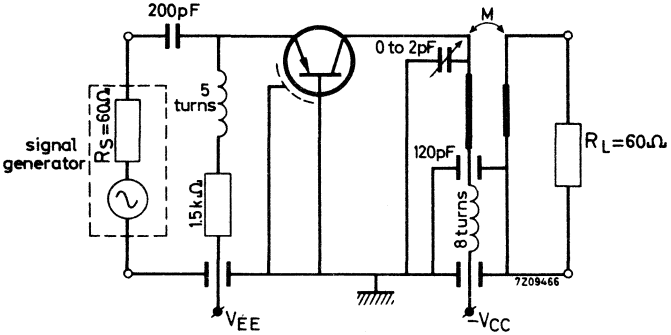
$I_E = 1.5$ mA; $-V_{CB} = 12$ V; f = 800 MHz	$G_{tr\ rev}$	typ.	−23	dB

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

Noise figure

$I_E = 1.5$ mA; $-V_{CB} = 12$ V; f = 800 MHz	F	typ.	7	dB
		<	8	dB

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



Total effective collector resistance $R_c = 1.4$ kΩ

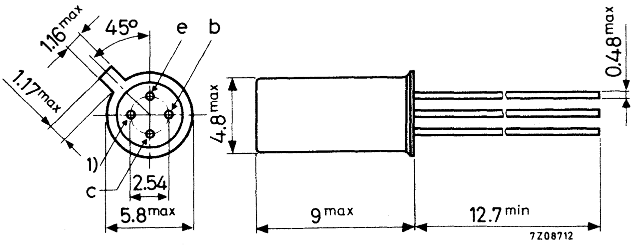
U.H.F. GERMANIUM EPITAXIAL MESA TRANSISTOR

P-N-P transistor in a metal envelope, with insulated electrodes and a shield lead connected to the case. It is primarily intended for use in output stages of aerial amplifiers up to frequencies of 860 MHz.

QUICK REFERENCE DATA

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	32	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	20	V
Collector current (d.c.)	$-I_C$	max.	20	mA
Total power dissipation up to T_{amb} = 30 °C	P_{tot}	max.	140	mW
Junction temperature	T_j	max.	90	°C
Transition frequency				
$-I_C$ = 6 mA; $-V_{CE}$ = 12 V	f_T	typ.	700	MHz
Transducer gain at T_j = 70 °C				
I_E = 4 mA; $-V_{CB}$ = 20 V; f = 800 MHz	G_{tr}	typ.	12	dB
Noise figure				
I_E = 1.5 mA; $-V_{CB}$ = 12 V;				
f = 800 MHz; R_S = 60 Ω	F	typ.	7	dB

MECHANICAL DATA Dimensions in mm



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 °C with cooling fin No. 56263	P_{tot}	max.	140	mW

Temperatures

Storage temperature	T_{stg}		−30 to +75	°C
Junction temperature	T_j	max.	90	°C

THERMAL RESISTANCE

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

CHARACTERISTICS T_j = 25 °C unless otherwise specified

Transition frequency

$-I_C$ = 6 mA; $-V_{CE}$ = 12 V	f_T	typ.	700	MHz

Noise figure at f = 800 MHz

I_E = 1.5 mA; $-V_{CB}$ = 12 V; R_S = 60 Ω	F	typ.	7	dB

Transducer gain

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

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

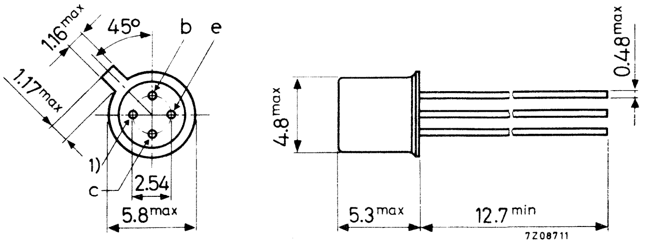
QUICK REFERENCE DATA

Collector-base voltage (open emitter)	$-V_{CBO}$	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 $T_{amb} = 25\ ^oC$	P_{tot}	max.	85	mW
Junction temperature	T_j	max.	75	^oC
Transition frequency $-I_C = 1$ mA; $-V_{CE} = 6$ V	f_T	typ.	180	MHz
Noise figure $-I_C = 1$ mA; $-V_{CE} = 12$ V f = 200 MHz; $R_S = 30\ \Omega$	F	typ.	6.0	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 ($+V_{BE}=0.5$ 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 $T_{amb}=25$ °C	P_{tot}	max.	85	mW
Temperatures				
Storage temperature	T_{stg}		-55 to +75	°C
Junction temperature, continuous	T_j	max.	75	°C
incidentally	T_j	max.	90	°C

THERMAL RESISTANCE

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

---

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

CHARACTERISTICS

T_{amb} = 25 °C unless otherwise specified

Collector cut-off current				
$I_E = 0$; $-V_{CB} = 6$ V	$-I_{CBO}$	typ. $<$	1.0 6.0	μA μA
$I_E = 0$; $-V_{CB} = 20$ V	$-I_{CBO}$	typ. $<$	2.6 50	μA μA
Emitter cut-off current				
$I_C = 0$; $-V_{EB} = 0.5$ V	$-I_{EBO}$	typ. $<$	2.0 27	μA μA
Base-emitter voltage				
$-I_C = 1$ mA; $-V_{CE} = 6$ V	$-V_{BE}$	typ. 220 to	310 380	mV mV
$-I_C = 10$ mA; $-V_{CE} = 2$ V	$-V_{BE}$	typ.	380	mV
D.C. current gain				
$-I_C = 1$ mA; $-V_{CE} = 6$ V	h_{FE}	$>$ typ.	20 60	
$-I_C = 10$ mA; $-V_{CE} = 2$ V	h_{FE}	$>$ typ.	25 60	
Transition frequency				
$-I_C = 1$ mA; $-V_{CE} = 6$ V	f_T	$>$ typ.	135 180	MHz MHz
Feedback impedance at f = 2 MHz				
$-I_C = 1$ mA; $-V_{CE} = 6$ V	$\lvert z_{rb} \rvert$	typ.	10	Ω
Small signal current gain at f = 1 kHz				
$-I_C = 1$ mA; $-V_{CE} = 6$ V	h_{fe}	$>$ typ.	20 70	
Feedback capacitance at f = 450 kHz				
$-I_C = 1$ mA; $-V_{CE} = 6$ V	$-C_{re}$	typ. $<$	1.0 1.5	pF pF
Noise figure				
$-I_C = 1$ mA; $-V_{CE} = 12$ V f = 200 MHz; $R_S = 30\ \Omega$	F	typ. $<$	6.0 7.5	dB dB

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

y parameters at f = 200 MHz (common emitter)
$-I_C$ = 1 mA; $-V_{CE}$ = 12 V [1]

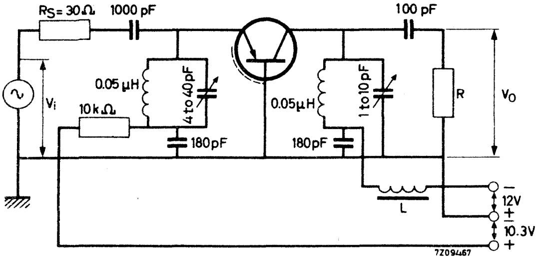
Input conductance	g_{ie}	typ.	28	$m\Omega^{-1}$
Input capacitance	C_{ie}	typ.	13	pF
Feedback admittance	$\lvert y_{re}\rvert$	typ.	500	$\mu\Omega^{-1}$
Phase angle of feedback admittance	φ_{re}	typ.	250°	
Transfer admittance	$\lvert y_{fe}\rvert$	typ.	34	$m\Omega^{-1}$
Phase angle of transfer admittance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

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

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

Power gain	G_p	$>$ typ.	10 13	dB dB

Test circuit:



R is chosen such that the total load impedance R_ℓ (R and the tuned circuit in parallel) is 2 kΩ.
L = ferrite bead

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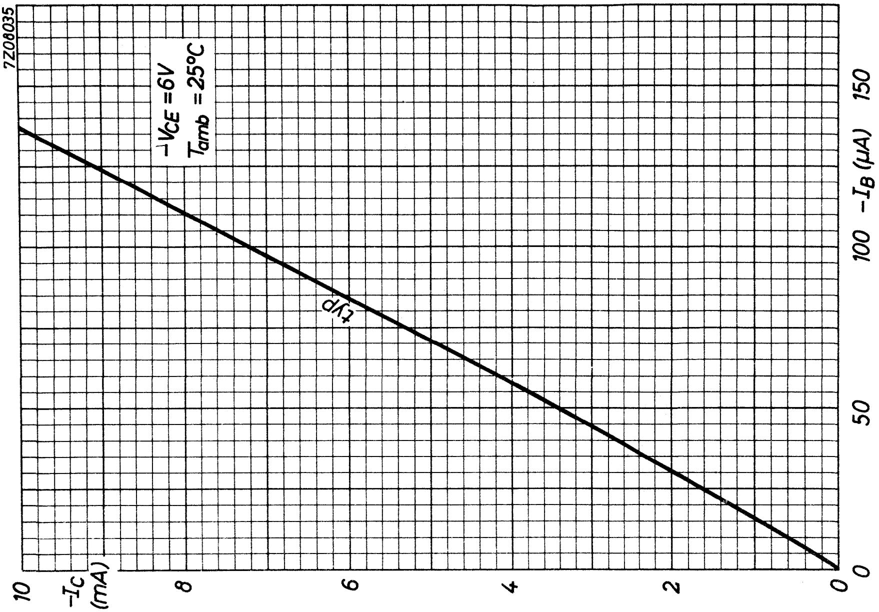
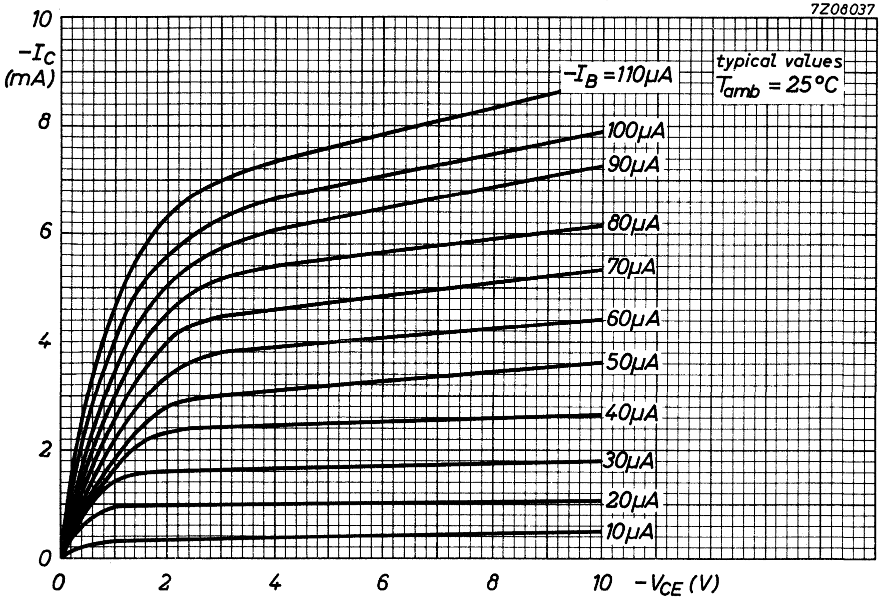
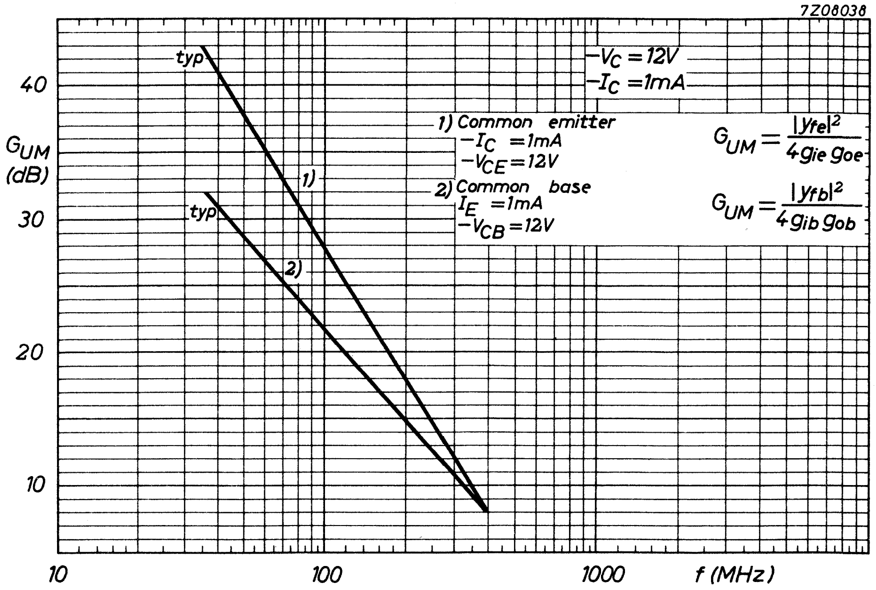
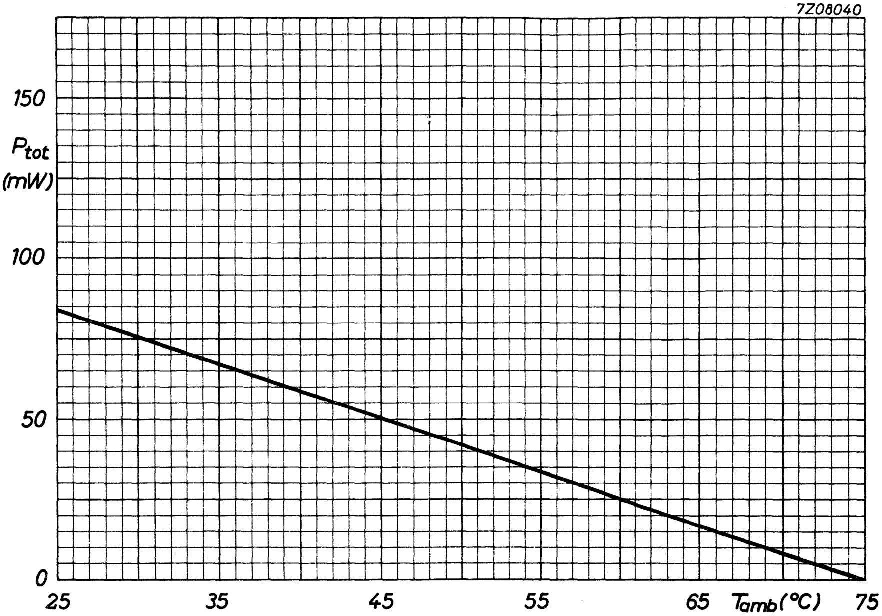
[1] Measured with a length of leads between transistor bottom and measuring jig of 5 mm.

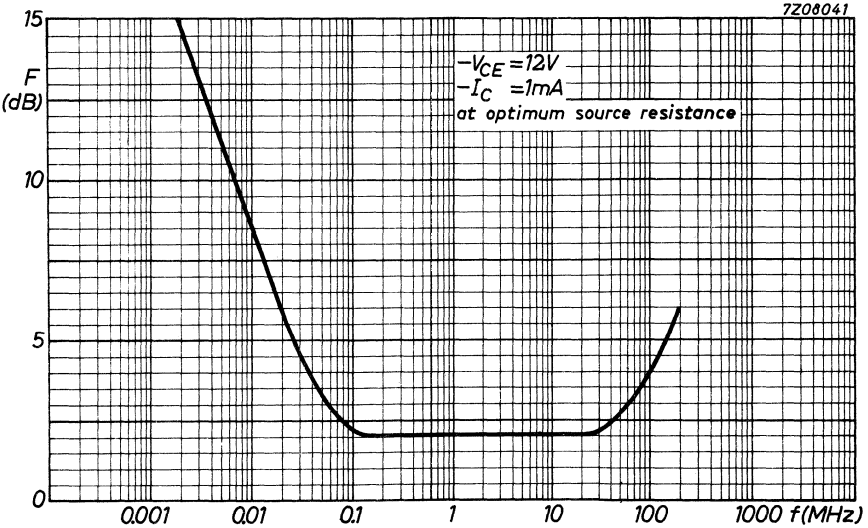

7Z08035
−V_CE = 6V
T_amb = 25°C
typ
−I_B (μA)
0
50
100
150
−I_C (mA)
10
8
6
4
2
0

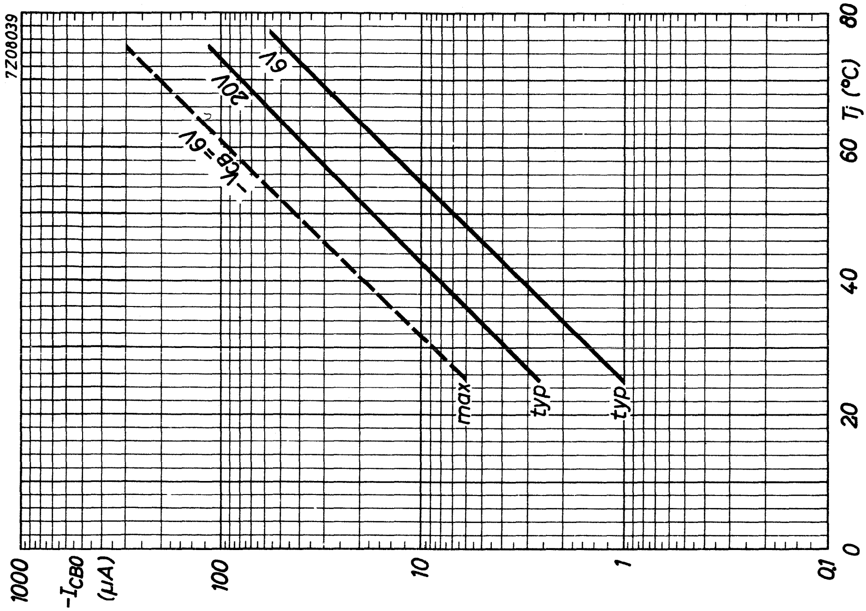

7Z08036
−V_CE = 6V
T_amb = 25°C
typ
−V_BE (mV)
0
200
400
600
−I_C (mA)
10
8
6
4
2
0

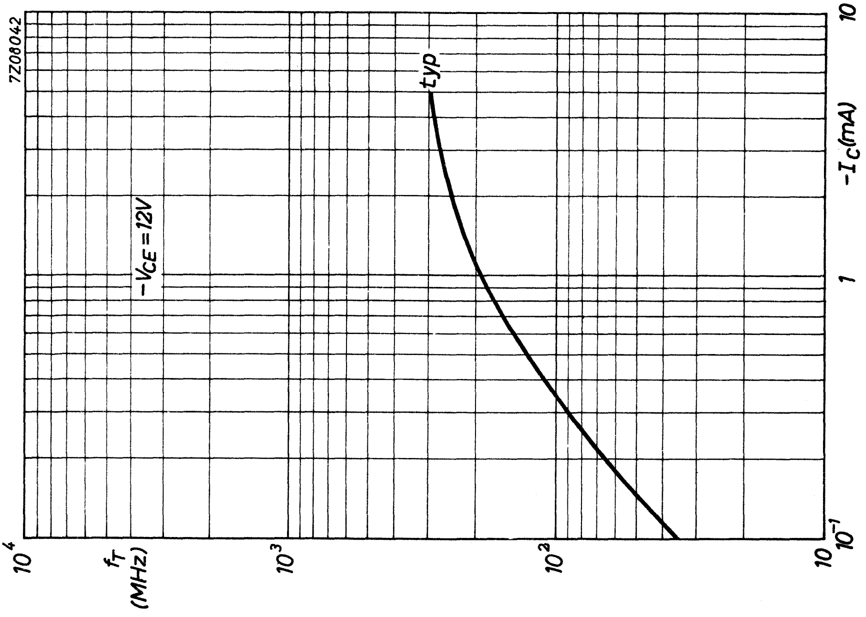

7Z08037
10
$-I_C$ (mA)
8
6
4
2
0
0
2
4
6
8
10
$-V_{CE}$ (V)
typical values
$T_{amb} = 25\,°C$
$-I_B = 110\mu A$
$100\mu A$
$90\mu A$
$80\mu A$
$70\mu A$
$60\mu A$
$50\mu A$
$40\mu A$
$30\mu A$
$20\mu A$
$10\mu A$

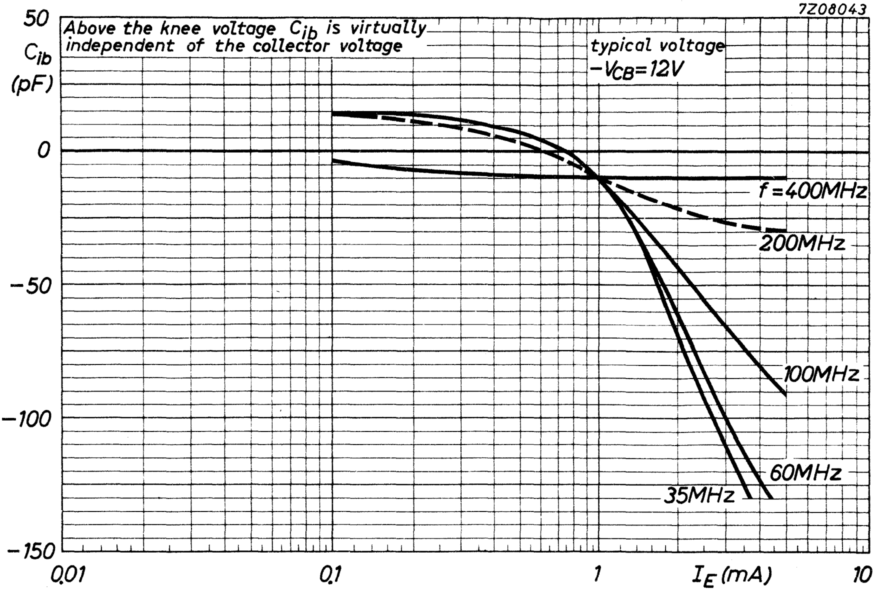

7Z08038
40
G_{UM} (dB)
30
20
10
10
100
1000
f (MHz)
typ
typ
1)
2)
$-V_C = 12V$
$-I_C = 1mA$
1) Common emitter
$-I_C = 1mA$
$-V_{CE} = 12V$
2) Common base
$I_E = 1mA$
$-V_{CB} = 12V$
$G_{UM} = \frac{|y_{fe}|^2}{4 g_{ie} g_{oe}}$
$G_{UM} = \frac{|y_{fb}|^2}{4 g_{ib} g_{ob}}$

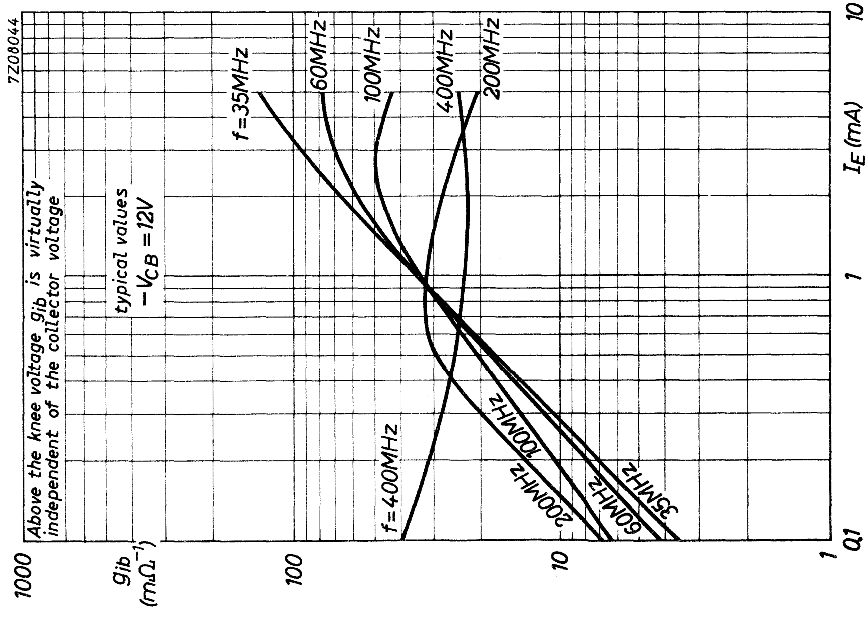

7Z08040
150
P_{tot}
(mW)
100
50
0
25
35
45
55
65
T_{amb} (°C)
75

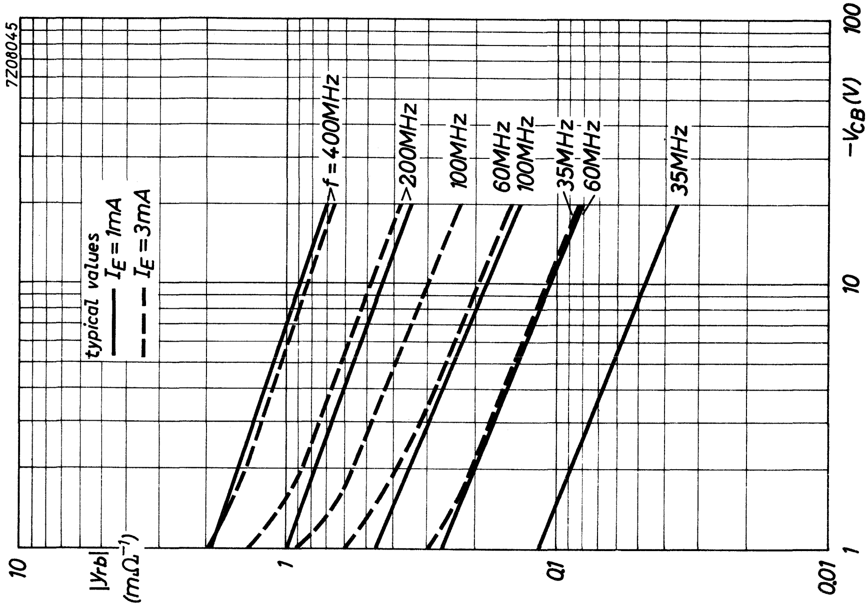

7Z08041
15
F
(dB)
10
5
0
$-V_{CE}$ = 12V
$-I_C$ = 1mA
at optimum source resistance
0.001
0.01
0.1
1
10
100
1000
f(MHz)

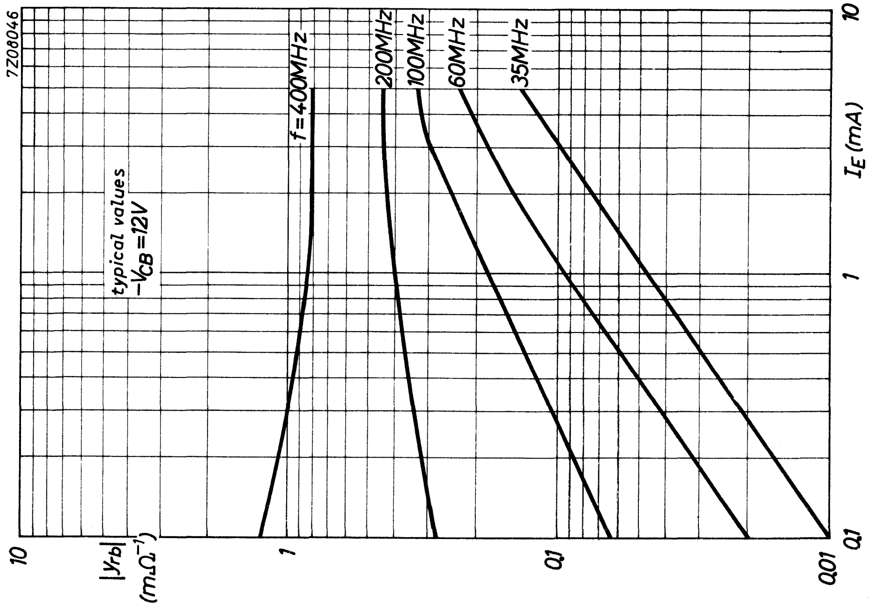

7Z08039
$-I_{CBO}$ (μA)
1000
100
10
1
0.1
T_j (°C)
0
20
40
60
80
$-V_{CB}=6V$
20V
6V
max
typ
typ

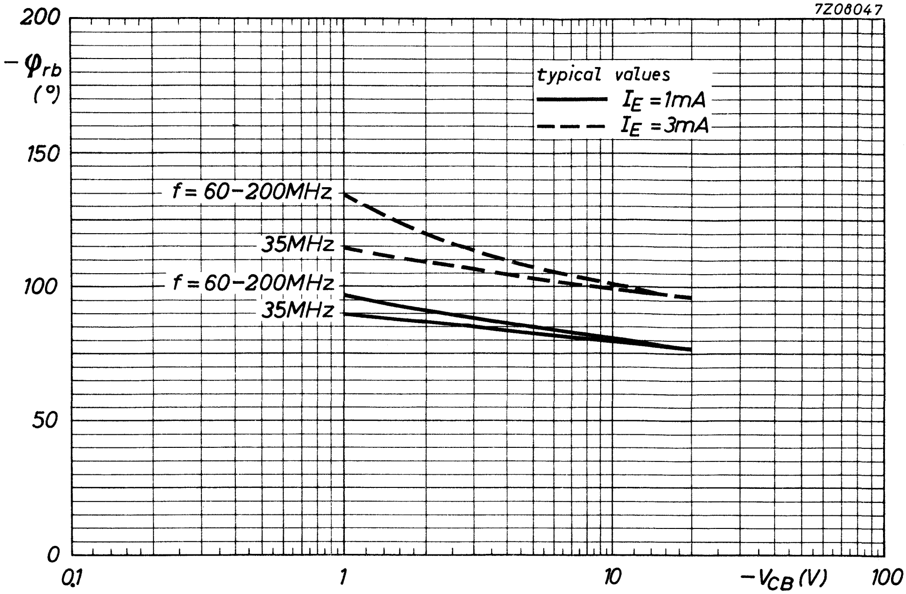

7Z08042
f_T (MHz)
10^4
10^3
10^2
10
$-I_C$ (mA)
10^{-1}
1
10
$-V_{CE}=12V$
typ

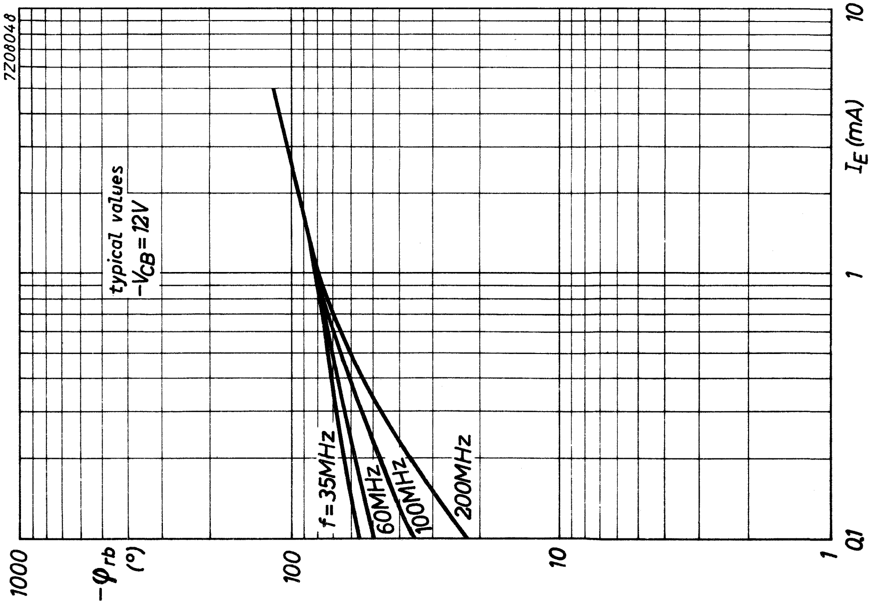

7Z08043
Above the knee voltage C_{ib} is virtually independent of the collector voltage
typical voltage
$-V_{CB}=12V$
50
C_{ib}
(pF)
0
−50
−100
−150
0.01
0.1
1
I_E (mA)
10
f = 400MHz
200MHz
100MHz
60MHz
35MHz

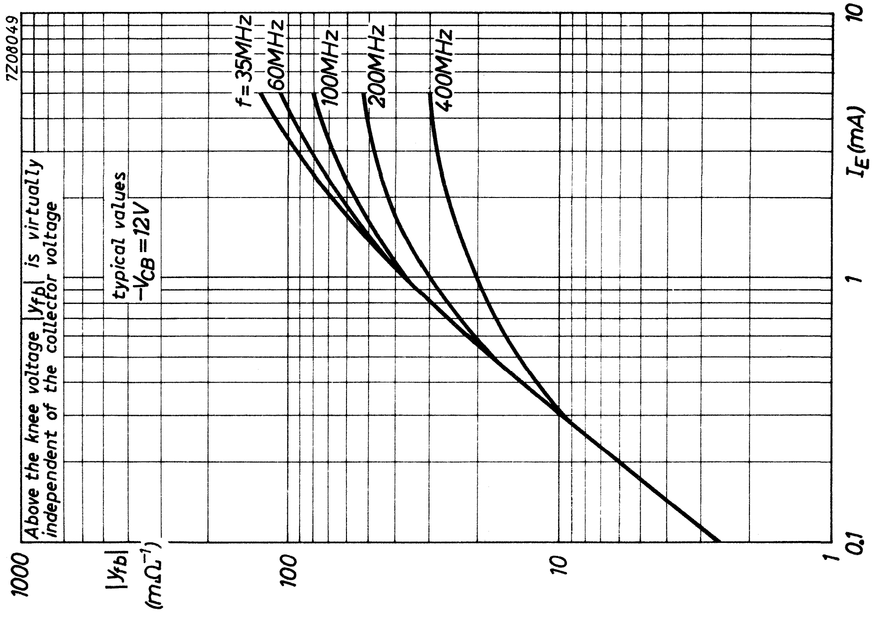

7Z08044
Above the knee voltage g_{ib} is virtually independent of the collector voltage
typical values
$-V_{CB}=12V$
f = 35MHz
60MHz
100MHz
400MHz
200MHz
f = 400MHz
100MHz
200MHz
60MHz
35MHz
1000
g_{ib}
($m\Omega^{-1}$)
100
10
1
0.1
1
I_E (mA)
10

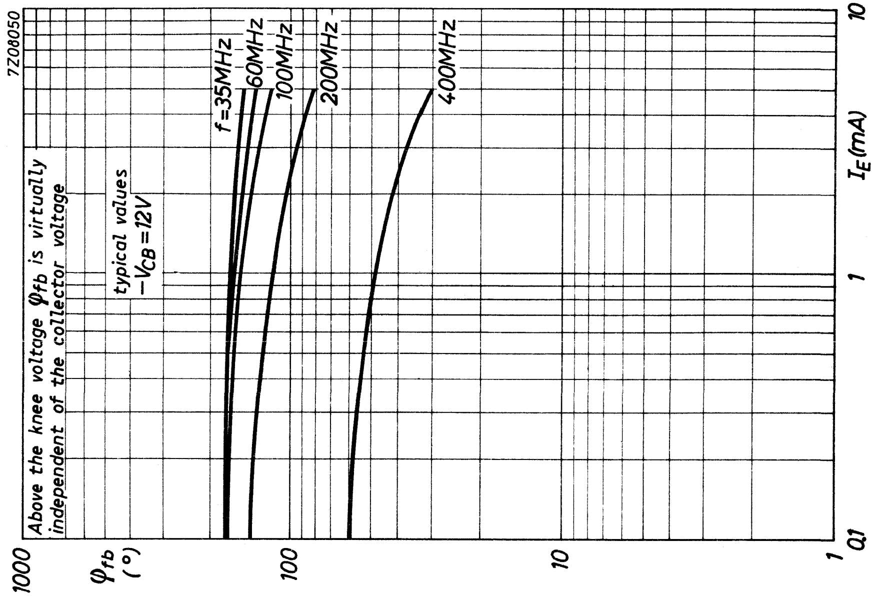

7Z08045
typical values
I_E = 1mA
I_E = 3mA
>f = 400MHz
>200MHz
100MHz
60MHz
100MHz
35MHz
60MHz
35MHz
|y_rb| (mΩ⁻¹)
10
1
0.1
0.01
−V_CB (V)
1
10
100

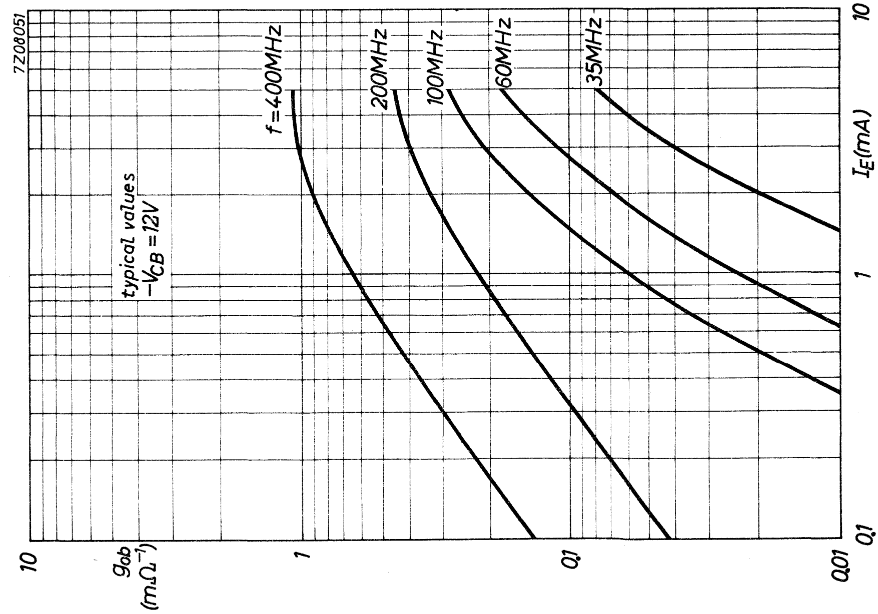

7Z08046
typical values
−V_CB = 12V
f = 400MHz
200MHz
100MHz
60MHz
35MHz
|y_rb| (mΩ⁻¹)
10
1
0.1
0.01
I_E (mA)
0.1
1
10

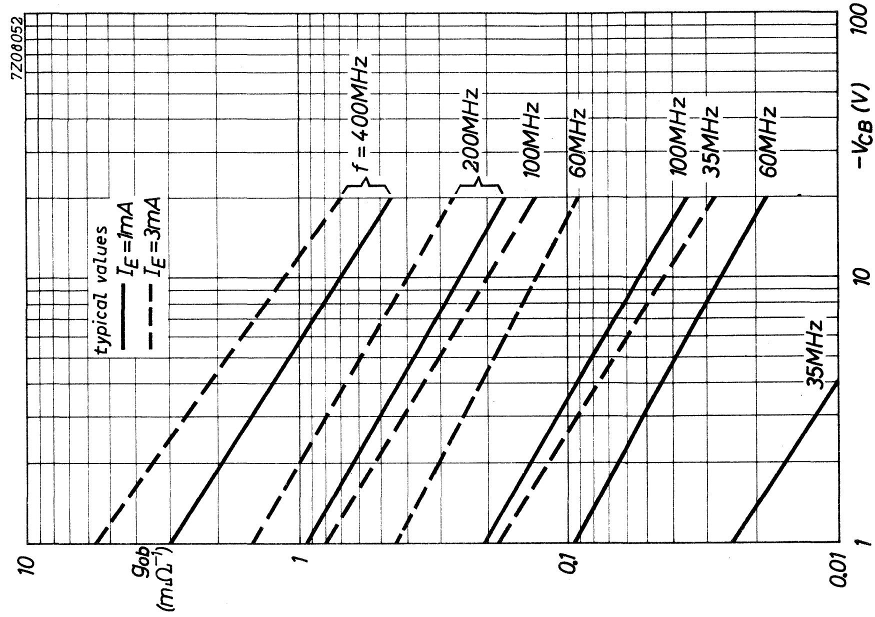

7Z08047
200
−φrb
(°)
150
100
50
0
0.1
1
10
−VCB (V)
100
typical values
IE = 1mA
IE = 3mA
f = 60−200MHz
35MHz
f = 60−200MHz
35MHz

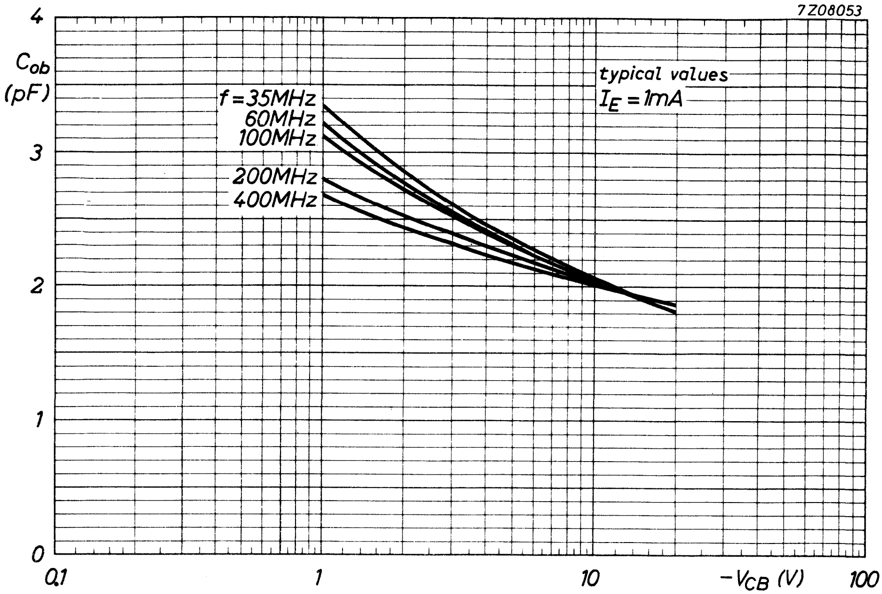

7Z08048
typical values
−VCB = 12V
IE (mA)
10
1
0.1
1000
−φrb
(°)
100
10
1
f = 35MHz
60MHz
100MHz
200MHz

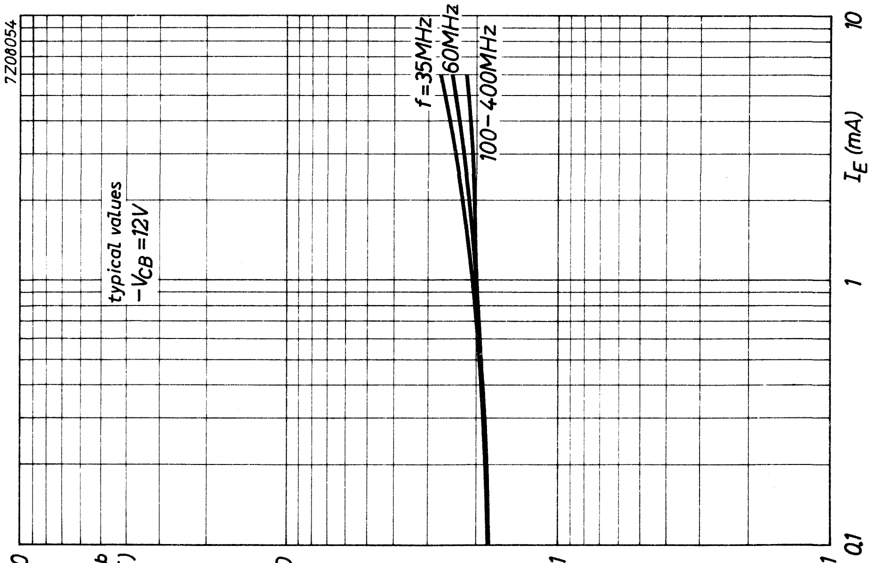

7Z08049
Above the knee voltage |yfb| is virtually independent of the collector voltage
typical values
−VCB=12V
f=35MHz
60MHz
100MHz
200MHz
400MHz
1000
|yfb|
(mΩ⁻¹)
100
10
1
0.1
1
10
IE (mA)

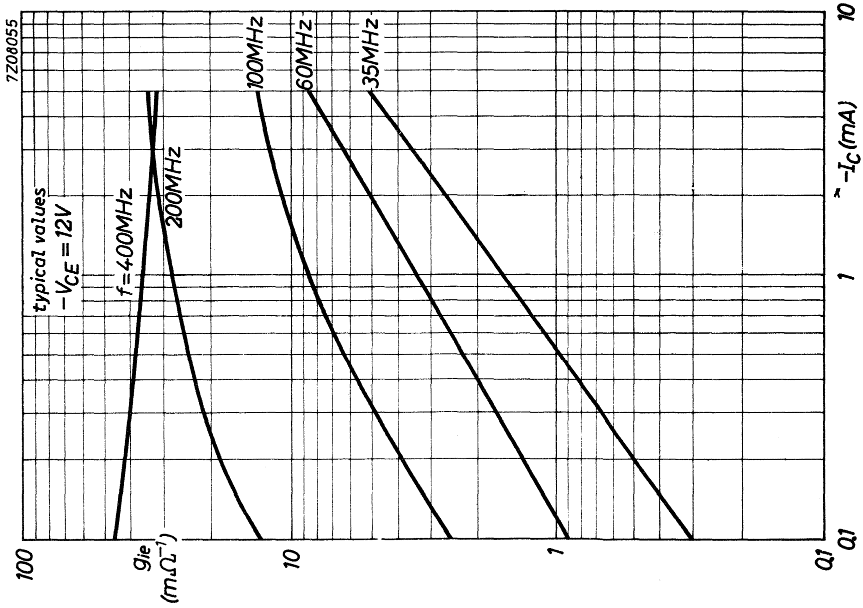

7Z08050
Above the knee voltage φfb is virtually independent of the collector voltage
typical values
−VCB=12V
f=35MHz
60MHz
100MHz
200MHz
400MHz
1000
φfb
(°)
100
10
1
0.1
1
10
IE (mA)

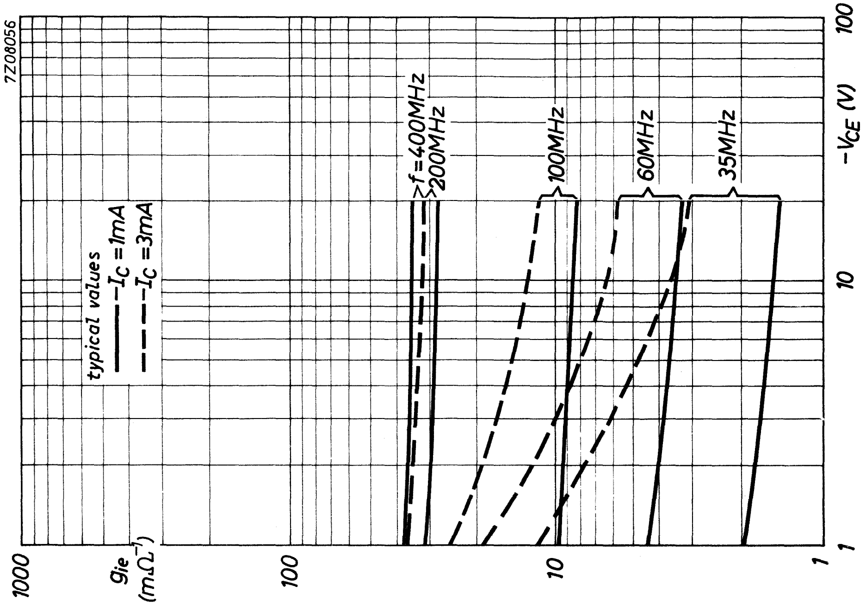

7Z08051
typical values
$-V_{CB} = 12V$
f = 400MHz
200MHz
100MHz
60MHz
35MHz
g_{ob} (mΩ^{-1})
10
1
0.1
0.01
I_E(mA)
0.1
1
10

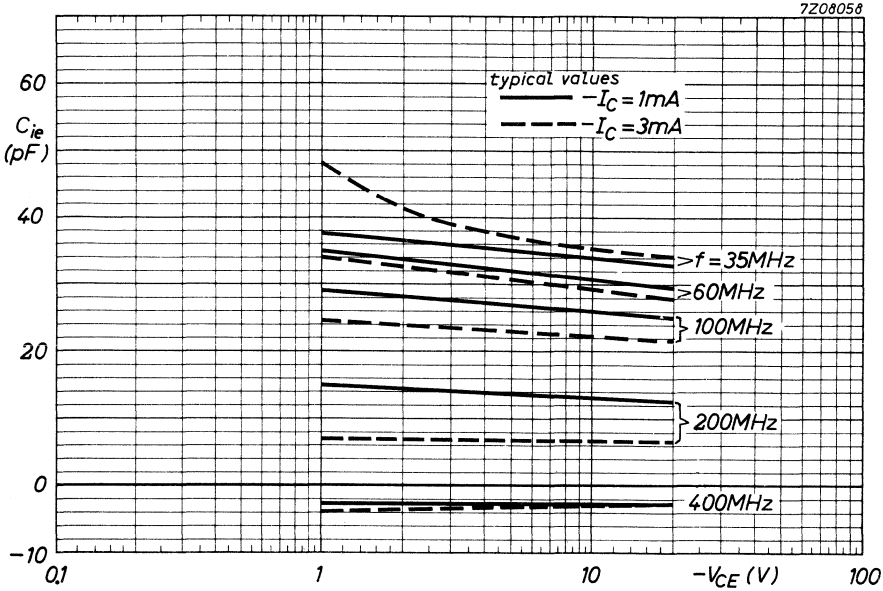

7Z08052
typical values
$I_E = 1mA$
$I_E = 3mA$
f = 400MHz
200MHz
100MHz
60MHz
100MHz
35MHz
60MHz
35MHz
g_{ob} (mΩ^{-1})
10
1
0.1
0.01
$-V_{CB}$ (V)
1
10
100

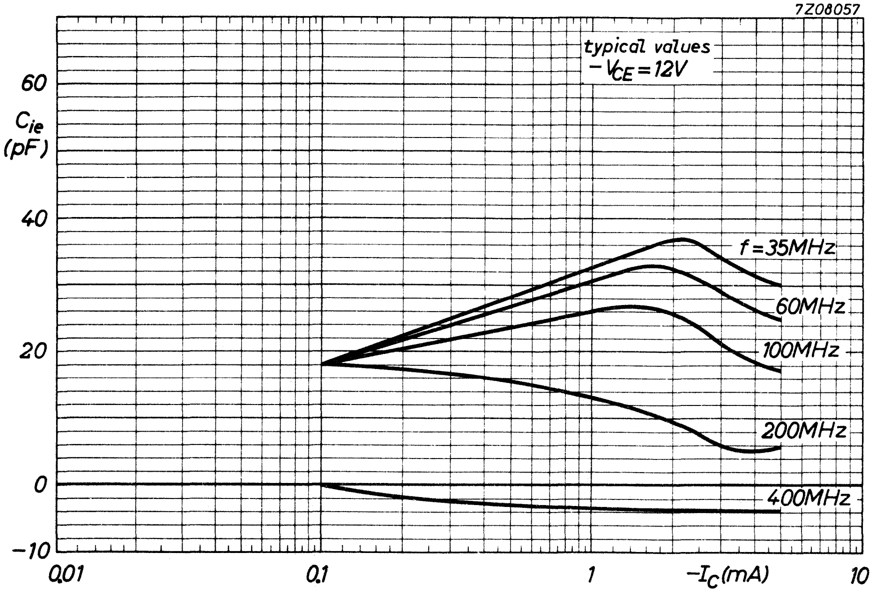

7Z08053
4
C_ob
(pF)
3
2
1
0
f = 35MHz
60MHz
100MHz
200MHz
400MHz
typical values
I_E = 1mA
0.1
1
10
−V_CB (V)
100

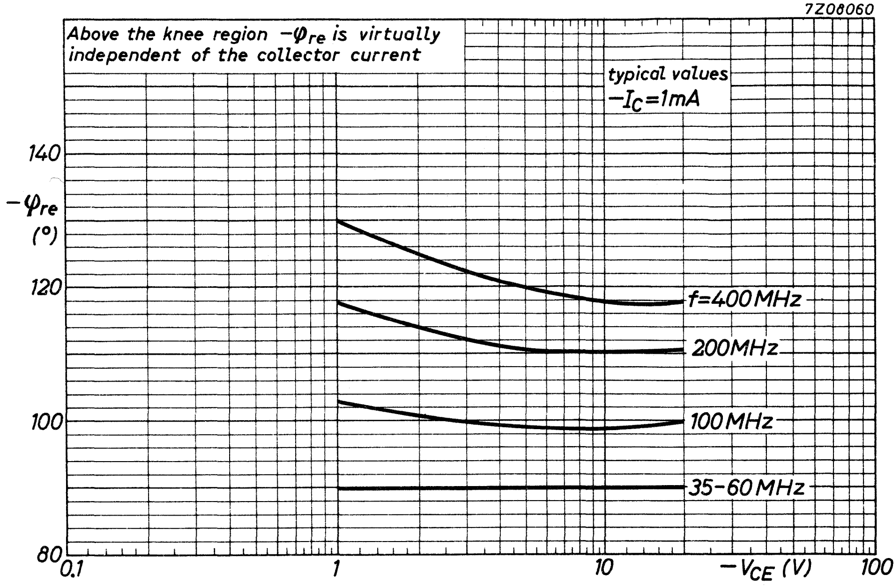

7Z08054
f = 35MHz
60MHz
100−400MHz
typical values
−V_CB = 12V
10
1
0.1
I_E (mA)
100
C_ob
(pF)
10
1
0.1

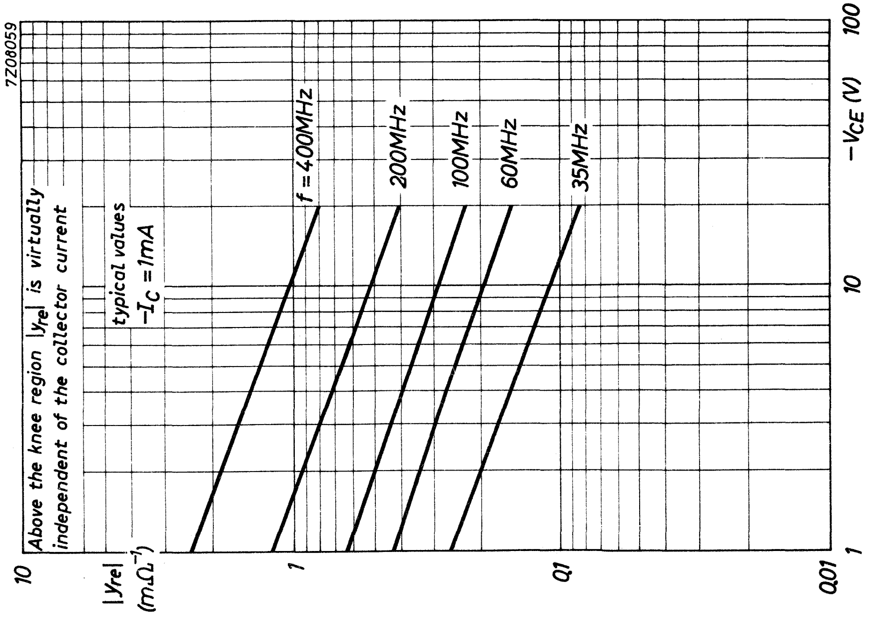

7Z08055
typical values
$-V_{CE} = 12V$
f = 400MHz
200MHz
100MHz
60MHz
35MHz
g_{ie} $(m\Omega^{-1})$
100
10
1
0.1
$-I_C$ (mA)
0.1
1
10

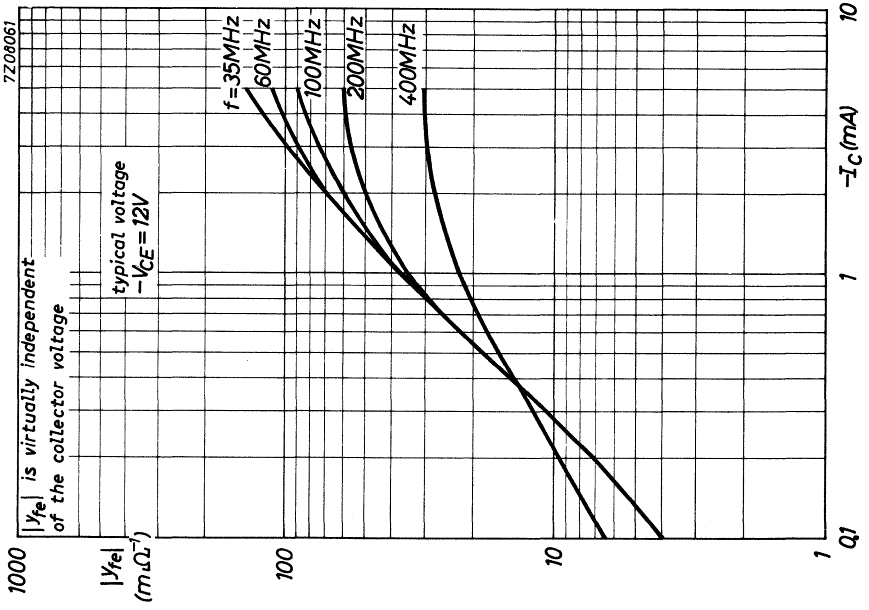

7Z08056
typical values
$-I_C = 1mA$
$-I_C = 3mA$
f = 400MHz
200MHz
100MHz
60MHz
35MHz
g_{ie} $(m\Omega^{-1})$
1000
100
10
1
$-V_{CE}$ (V)
1
10
100

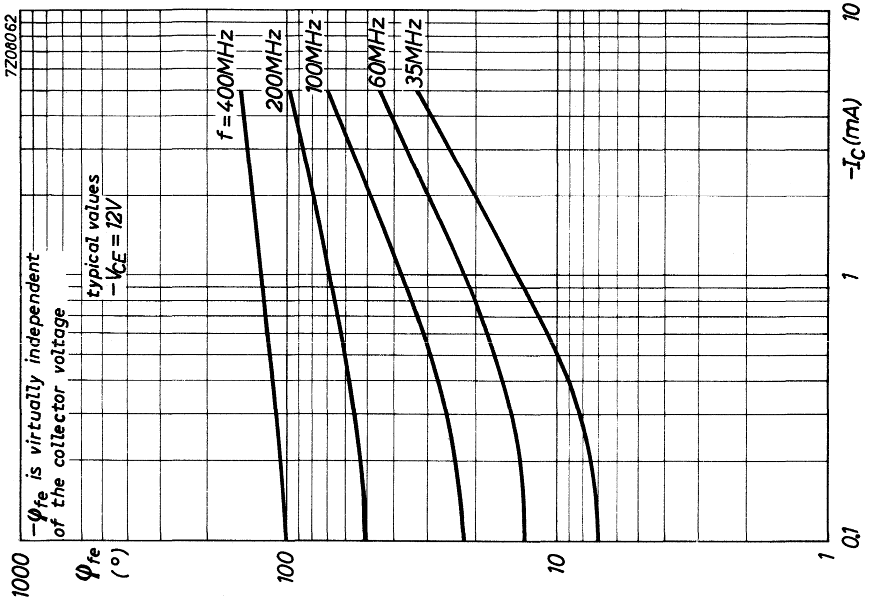

7Z08058
typical values
$-I_C = 1mA$
$-I_C = 3mA$
C_{ie} (pF)
60
40
20
0
−10
f = 35MHz
60MHz
100MHz
200MHz
400MHz
0.1
1
10
$-V_{CE}$ (V)
100


7Z08057
typical values
$-V_{CE} = 12V$
C_{ie} (pF)
60
40
20
0
−10
f = 35MHz
60MHz
100MHz
200MHz
400MHz
0.01
0.1
1
$-I_C$ (mA)
10


7Z08060
Above the knee region $-\varphi_{re}$ is virtually independent of the collector current
typical values
$-I_C = 1\,mA$
140
120
100
80
$-\varphi_{re}$
(°)
f=400 MHz
200MHz
100 MHz
35-60 MHz
0.1
1
10
100
$-V_{CE}$ (V)


7Z08059
Above the knee region $|y_{re}|$ is virtually independent of the collector current
typical values
$-I_C = 1\,mA$
f = 400MHz
200MHz
100MHz
60MHz
35MHz
10
$|y_{re}|$
(mΩ^{-1})
1
0.1
0.01
1
10
100
$-V_{CE}$ (V)


7Z08061
|y_fe| is virtually independent of the collector voltage
typical voltage
−V_CE = 12V
f = 35MHz
60MHz
100MHz
200MHz
400MHz
1000
|y_fe|
(mΩ⁻¹)
100
10
1
0.1
1
10
−I_C (mA)


7Z08062
−φ_fe is virtually independent of the collector voltage
typical values
−V_CE = 12V
f = 400MHz
200MHz
100MHz
60MHz
35MHz
1000
φ_fe
(°)
100
10
1
0.1
1
10
−I_C (mA)

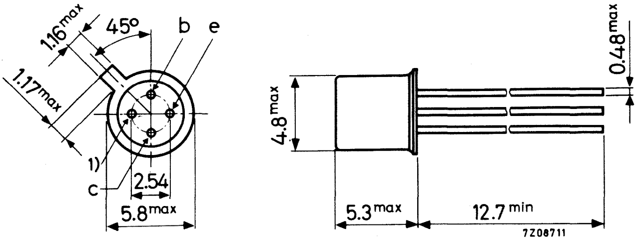
SILICON PLANAR EPITAXIAL TRANSISTOR

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

MECHANICAL DATA Dimensions in mm

TO-72



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 °C	P_{tot}	max.	145	mW
Temperatures				
Storage temperature	T_{stg}	-65 to +175		°C
Junction temperature	T_j	max.	175	°C

THERMAL RESISTANCE

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

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

CHARACTERISTICS T_j = 25 °C unless otherwise specified

Emitter-base voltage [1]				
$-I_E$ = 1 mA; V_{CB} = 10 V	$-V_{EB}$		0.65 to 0.74	V
$-I_E$ = 20 mA; V_{CB} = 2 V; T_{amb} = 25 °C	$-V_{EB}$	<	1.0	V
Feedback capacitance at f = 0.45 MHz				
I_C = 1 mA; V_{CE} = 10 V	$-C_{re}$	typ.	0.65	pF
D.C. current gain				
I_C = 1 mA; V_{CE} = 10 V	h_{FE}		45 to 165	
I_C = 20 mA; V_{CE} = 2 V	h_{FE}	>	40	
Transition frequency				
I_C = 1 mA; V_{CE} = 10 V	f_T	typ.	230	MHz
Noise figure at I_C = 1 mA; V_{CE} = 10 V				
f = 0.2 MHz; G_S = 3.3 mΩ^{-1}	F	typ.	1.5	dB
f = 1 MHz; G_S = 20 mΩ^{-1}	F	typ.	3.5	dB
f = 1 MHz; G_S = 3.3 mΩ^{-1}	F	typ.	1.2	dB
f = 100 MHz; G_S = 10 mΩ^{-1}	F	typ.	4	dB
Conversion noise figure at I_C = 1 mA; V_{CE} = 10 V				
f = 0.2 MHz; G_S = 1 mΩ^{-1}	F_c	typ.	3.5	dB
f = 1 MHz; G_S = 2 mΩ^{-1}	F_c	typ.	2.5	dB

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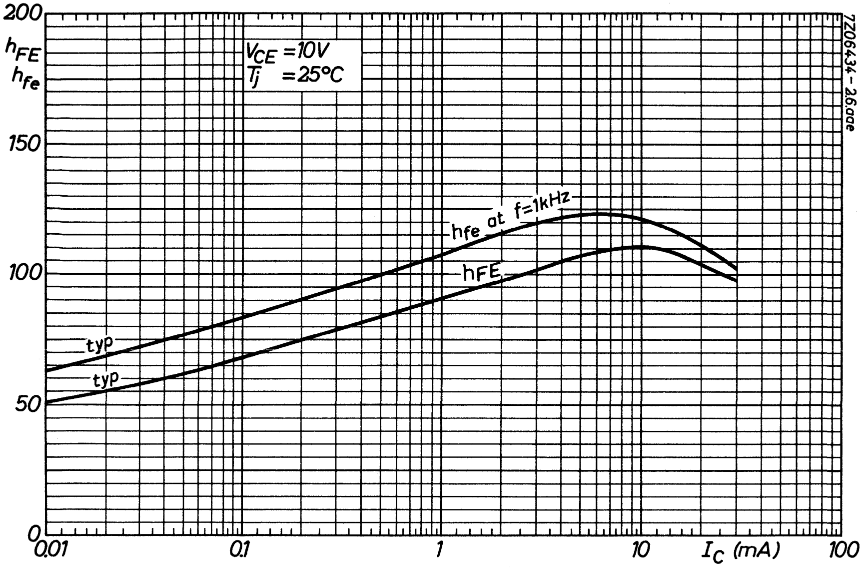
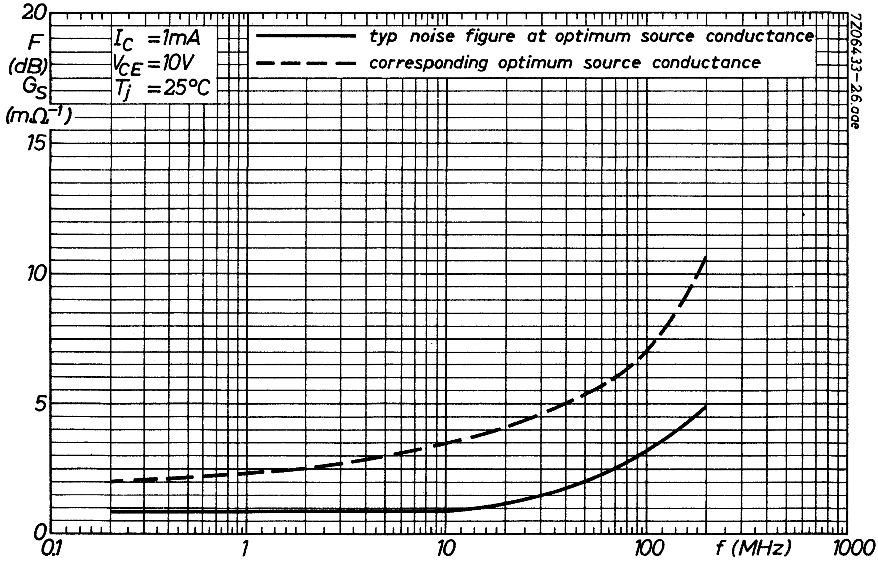
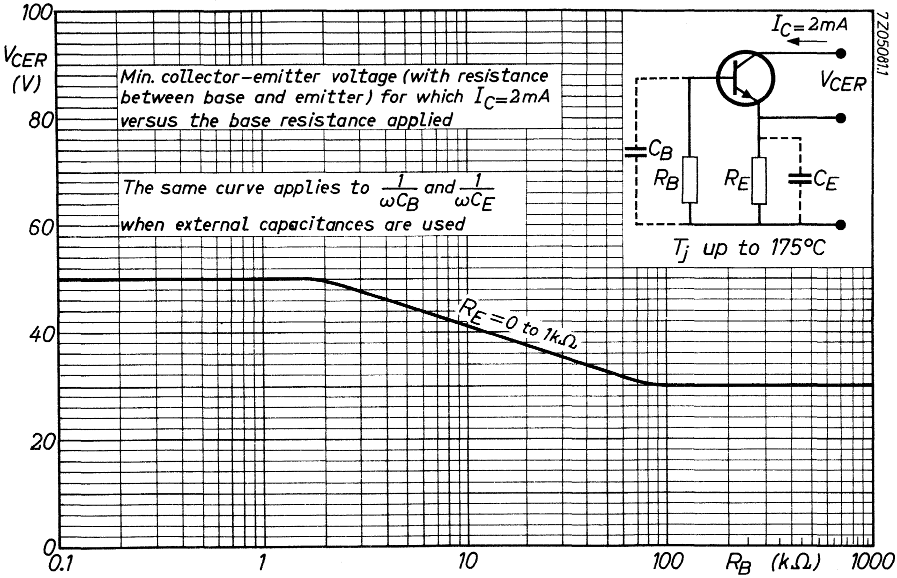
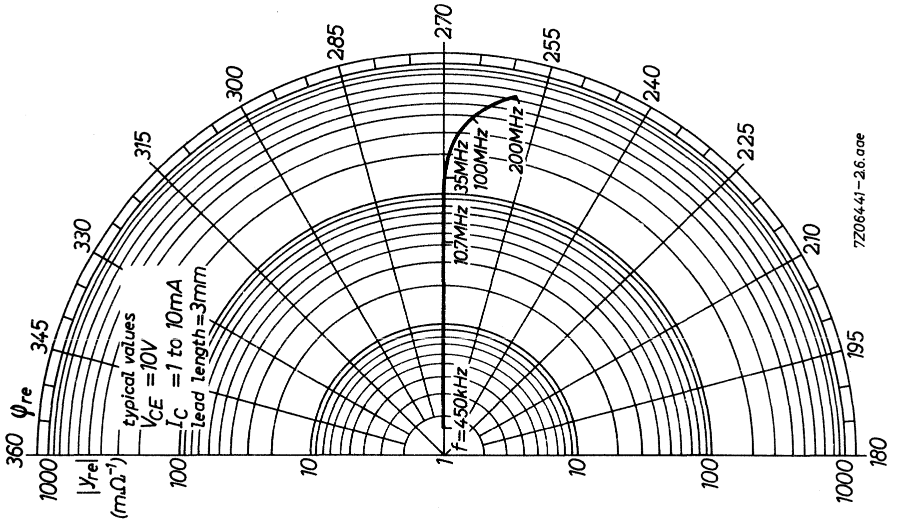
[1] $-V_{EB}$ decreases by about 1.7 mV/°C with increasing temperature.

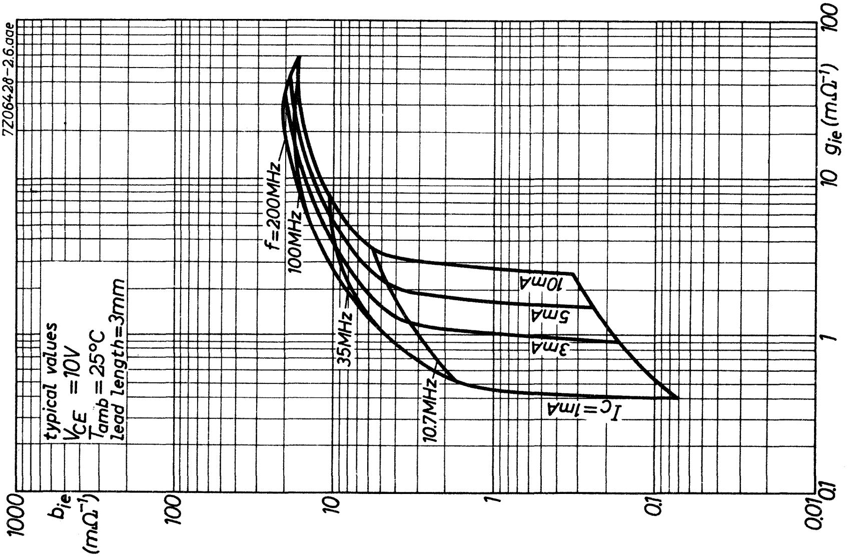

200
h_{FE}
h_{fe}
150
100
50
0
V_{CE} = 10V
T_j = 25°C
h_{fe} at f=1kHz
h_{FE}
typ
typ
0.01
0.1
1
10
I_C (mA)
100
7Z06434-26.aae

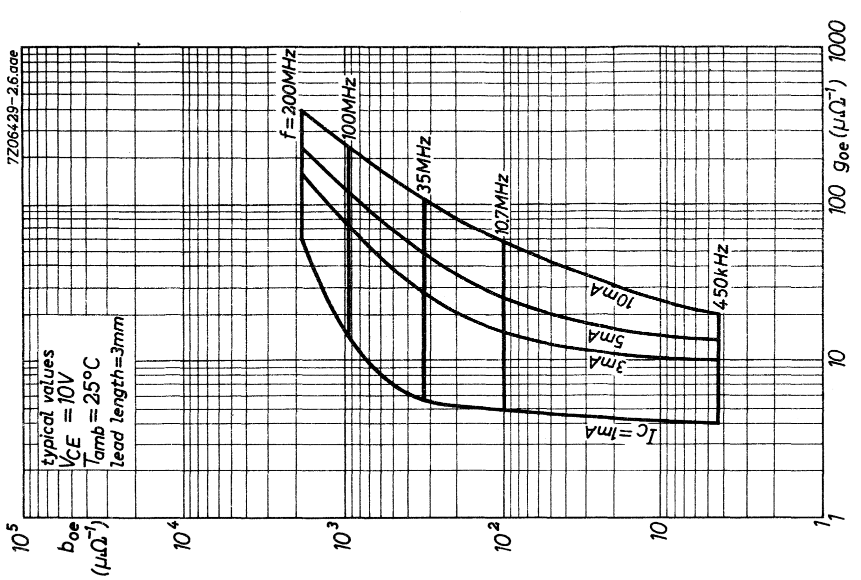

20
F
(dB)
G_S
(mΩ⁻¹)
15
10
5
0
I_C = 1mA
V_{CE} = 10V
T_j = 25°C
typ noise figure at optimum source conductance
corresponding optimum source conductance
0.1
1
10
100
f (MHz)
1000
7Z06433-26.aae

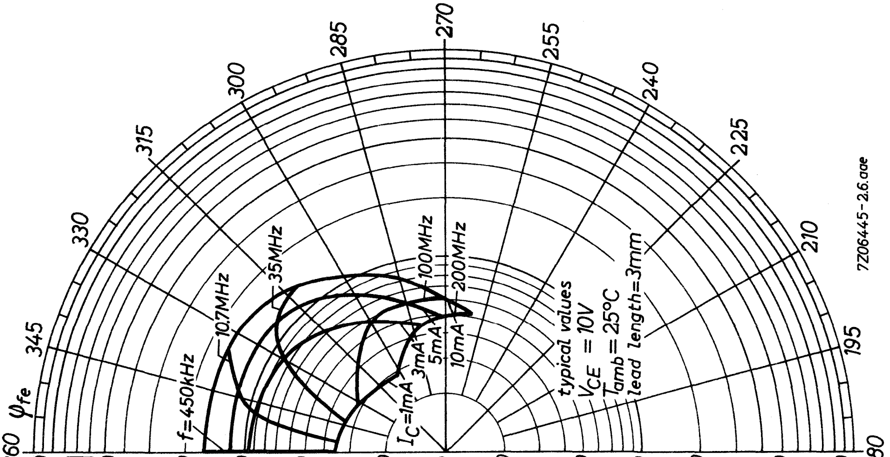


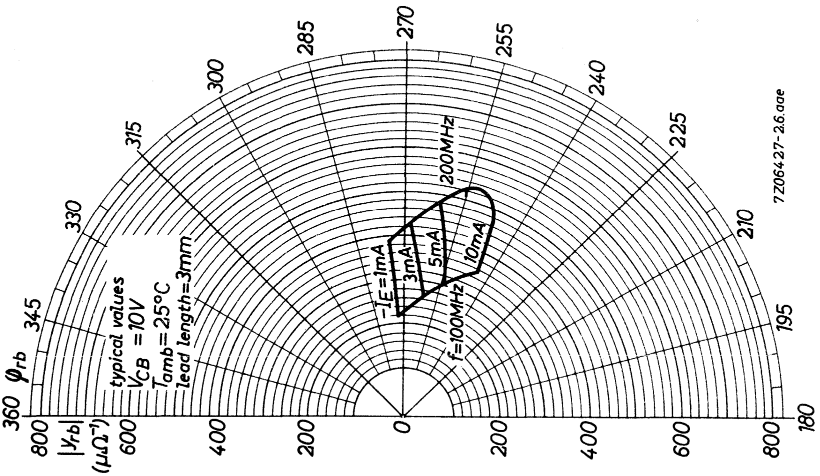
100
VCER (V)
80
60
40
20
0
0.1
1
10
100
RB (kΩ)
1000
7Z05081.1
Min. collector-emitter voltage (with resistance between base and emitter) for which IC=2mA versus the base resistance applied
The same curve applies to 1/ωCB and 1/ωCE when external capacitances are used
RE=0 to 1kΩ
IC=2mA
VCER
CB
RB
RE
CE
Tj up to 175°C

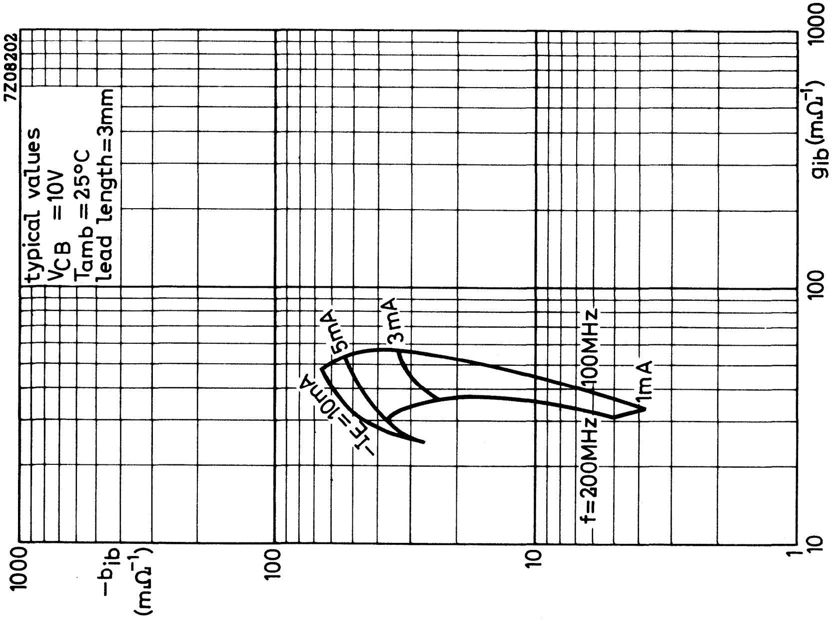

φre
360
345
330
315
300
285
270
255
240
225
210
195
180
\|yre\| (mΩ⁻¹)
1000
100
10
1
10
100
1000
typical values
VCE =10V
IC =1 to 10mA
lead length=3mm
f=450kHz
10.7MHz
35MHz
100MHz
200MHz
7Z06441–2.6.aae

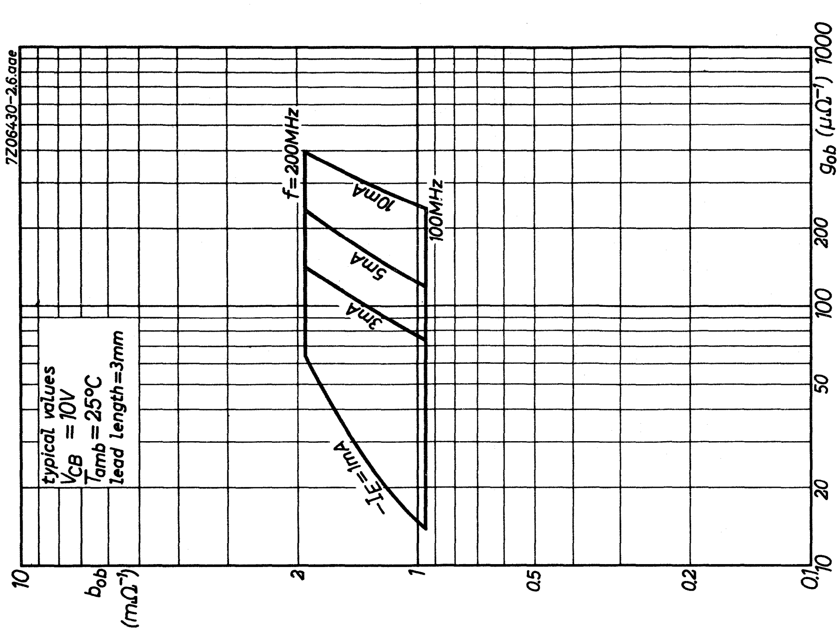

bie (mΩ⁻¹)
1000
100
10
1
0.1
0.01
0.1
1
10
100
gie (mΩ⁻¹)
typical values
VCE =10V
Tamb =25°C
lead length=3mm
f=200MHz
100MHz
35MHz
10.7MHz
IC=1mA
3mA
5mA
10mA
7Z06428–2.6.aae

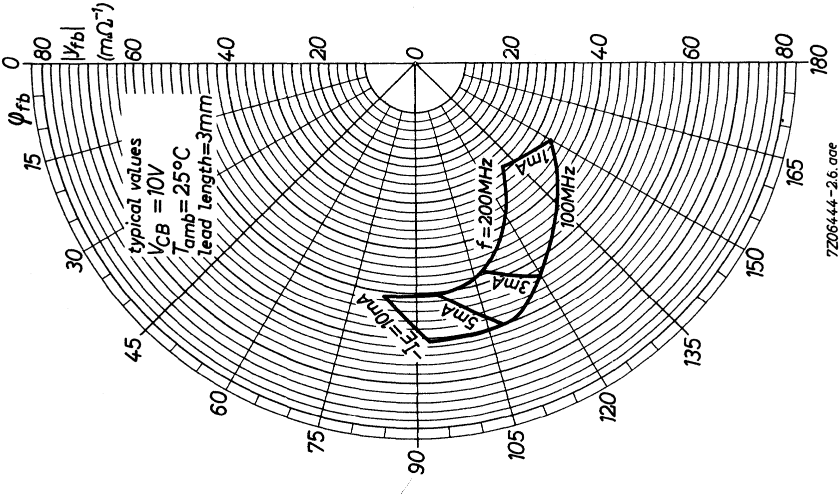

7Z06429-2.6.aae
typical values
VCE = 10V
Tamb = 25°C
lead length = 3mm
f=200MHz
100MHz
35MHz
10.7MHz
450kHz
10mA
5mA
3mA
IC=1mA
boe (μΩ⁻¹)
10⁵
10⁴
10³
10²
10
1
goe (μΩ⁻¹)
1
10
100
1000

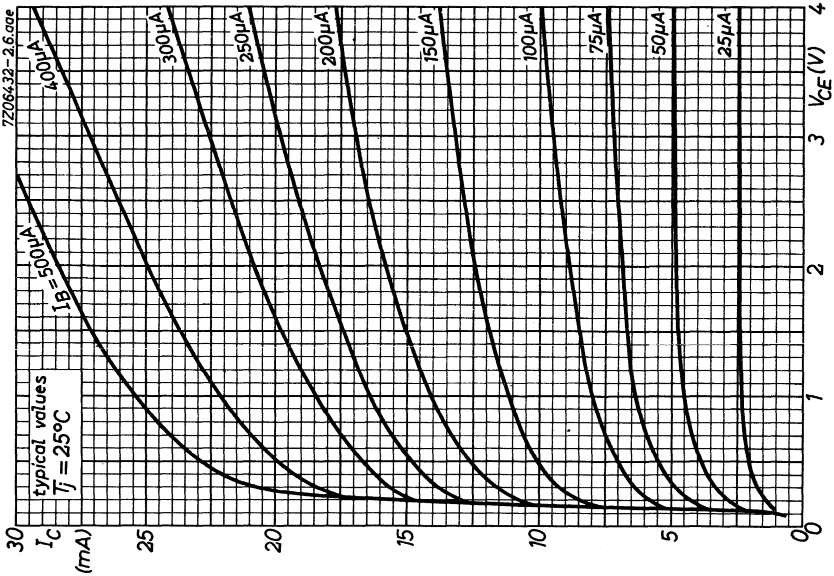

φfe
360
345
330
315
300
285
270
255
240
225
210
195
180
|yfe| (mΩ⁻¹)
1000
200
100
50
20
10
20
50
100
200
500
1000
f=450kHz
10.7MHz
35MHz
100MHz
200MHz
IC=1mA
3mA
5mA
10mA
typical values
VCE = 10V
Tamb = 25°C
lead length=3mm
7Z06445-2.6.aae

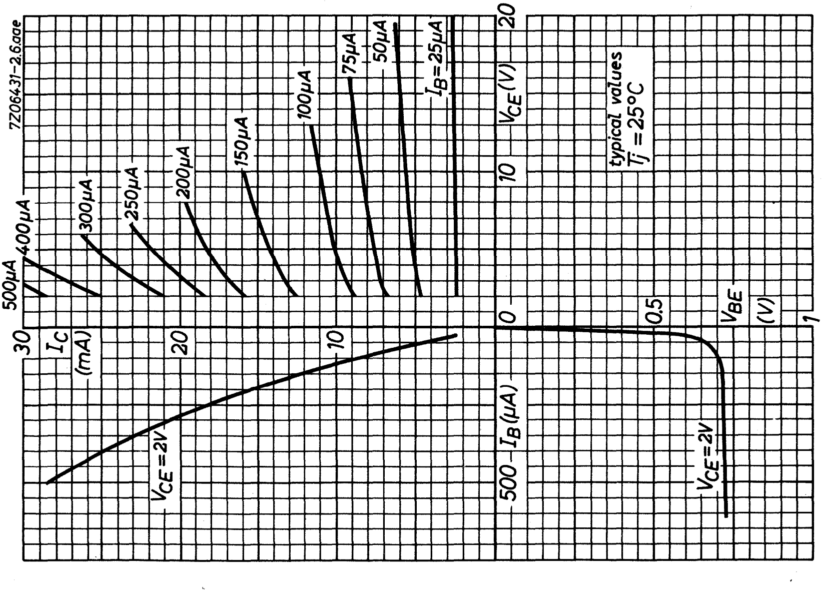

φ_{rb}
360
345
330
315
300
285
270
255
240
225
210
195
180
$|y_{rb}|$
($\mu\Omega^{-1}$)
800
600
400
200
0
200
400
600
800
typical values
V_{CB} =10V
T_{amb}=25°C
lead length=3mm
$-I_E$=1mA
3mA
5mA
10mA
f=100MHz
200MHz
7Z06427-2.6.aae


7Z08202
typical values
V_{CB} =10V
Tamb = 25°C
lead length=3mm
$-b_{ib}$
($m\Omega^{-1}$)
1000
100
10
1
g_{ib} ($m\Omega^{-1}$)
10
100
1000
$-I_E$=10mA
5mA
3mA
1mA
f=200MHz
100MHz


7Z06430-2.6.aae
typical values
V_{CB} = 10V
T_{amb} = 25°C
lead length = 3mm
f = 200MHz
100MHz
10mA
5mA
3mA
$-I_E$ = 1mA
b_{ob} (mΩ⁻¹)
10
2
1
0.5
0.2
0.1
g_{ob} (μΩ⁻¹)
10
20
50
100
200
1000

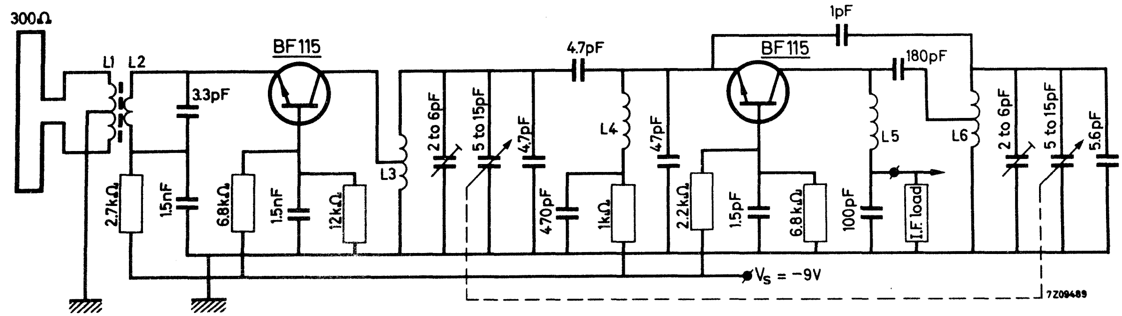

φ_{fb}
0
15
30
45
60
75
90
105
120
135
150
165
180
$|y_{fb}|$ (mΩ⁻¹)
80
60
40
20
0
20
40
60
80
typical values
V_{CB} = 10V
T_{amb} = 25°C
lead length = 3mm
f = 200MHz
100MHz
1mA
3mA
5mA
$-I_E$ = 10mA
7Z06444-2.6.aae


7Z06432-2.6.aae
typical values
$T_j = 25°C$
I_C (mA)
30
25
20
15
10
5
0
0
1
2
3
4
V_{CE} (V)
I_B=500μA
400μA
300μA
250μA
200μA
150μA
100μA
75μA
50μA
25μA


7Z06431-2.6.aae
500μA
400μA
300μA
250μA
200μA
150μA
100μA
75μA
50μA
I_B=25μA
0
10
20
V_{CE} (V)
30
I_C (mA)
20
10
V_{CE}=2V
500
I_B (μA)
0.5
1
V_{BE} (V)
V_{CE}=2V
typical values
$T_j = 25°C$

APPLICATION INFORMATION

F.M. Tuner with 2 x BF115



COIL DATA

L1 = 5 turns; L2 = 2 turns
L1 and L2 on twin bead K505006/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 wounded; d = 4 mm

L5 = 14 turns stranded wire (36 x 0.03) on coil former 3016/02 with ferroxcube core K512002 (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	G_{tr}	typ.	24	dB
Noise figure	F	typ.	4.5	dB
Spurious response				
repeat spot suppression		typ.	55	dB
double beat suppression		typ.	57	dB
Image response		typ.	35	dB
Frequency drift $\Delta V_S = 2$ V	Δf_{osc}	typ. <	10 15	kHz 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.

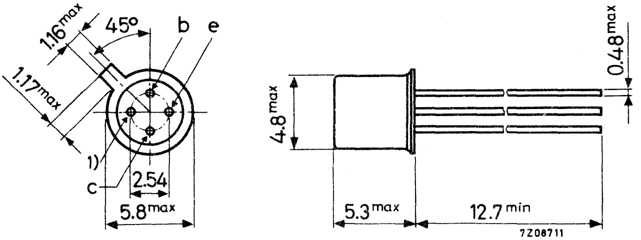
QUICK REFERENCE DATA

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 °C	P_{tot}	max.	130	mW
Junction temperature	T_j	max.	175	°C
Transition frequency				
I_C = 4 mA; V_{CE} = 10 V	f_T	typ.	350	MHz
Feedback capacitance at f = 10.7 MHz				
I_C = 1 mA; V_{CE} = 10 V	$-C_{re}$	typ.	0.15	pF
Max. unilateralised power gain				
I_C = 4 mA; V_{CE} = 10 V; f = 35 MHz	G_{UM}	typ.	42	dB
Gain control range	ΔG_{tr}	typ.	60	dB

MECHANICAL DATA

Dimensions in mm

TO-72



1) = 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 $T_{amb} = 45\ ^{o}C$	P_{tot}	max.	130	mW
Temperatures				
Storage temperature	T_{stg}	-65 to +175		°C
Junction temperature	T_j	max.	175	°C

THERMAL RESISTANCE

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

---

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

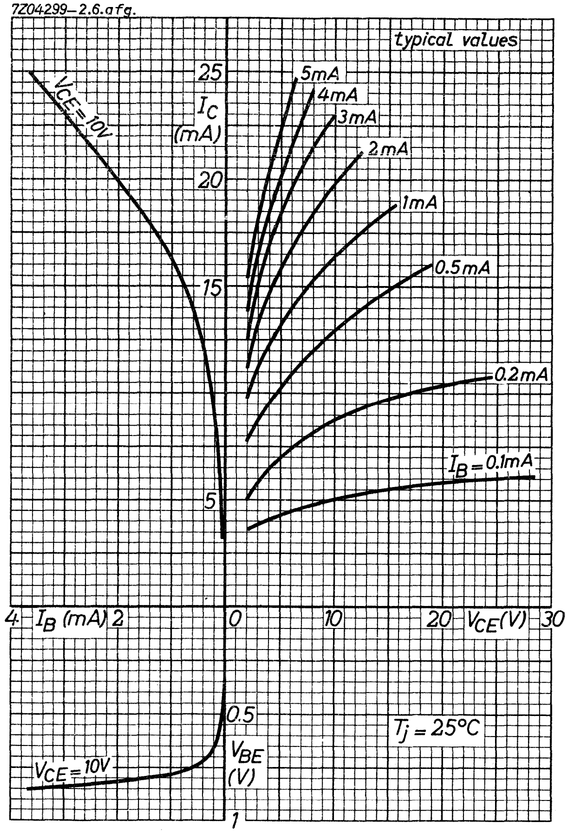
CHARACTERISTICS $T_{amb} = 25\ ^{o}C$ unless otherwise specified

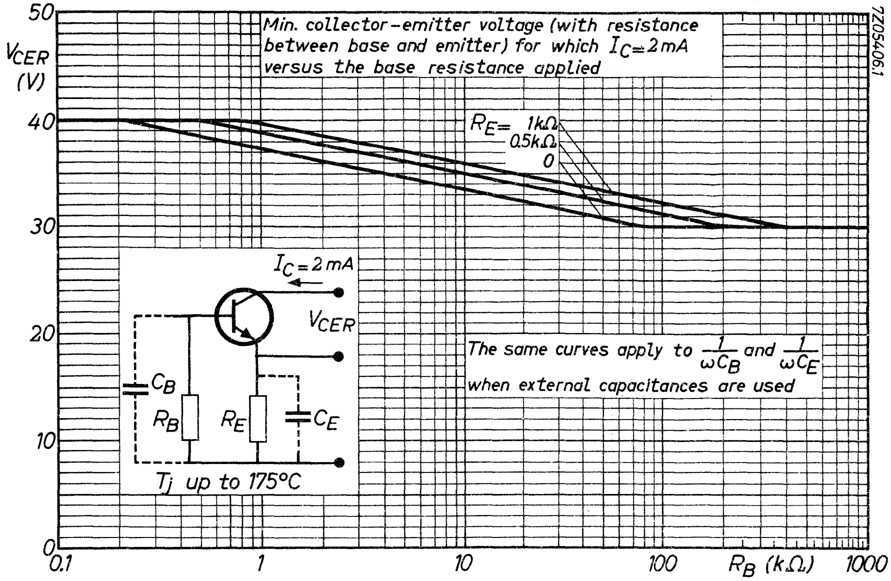
Base current				
$I_C = 4$ mA; $V_{CE} = 10$ V	I_B	typ. <	70 150	μA μA
Base-emitter voltage				
$I_C = 4$ mA; $V_{CE} = 10$ V	V_{BE}	typ.	700	mV 1)
Feedback capacitance at f = 10.7 MHz				
$I_C = 1$ mA; $V_{CE} = 10$ V	$-C_{re}$	typ.	150	fF 2)
Transition frequency				
$I_C = 4$ mA; $V_{CE} = 10$ V	f_T	typ.	350	MHz
Noise figure at f = 35 MHz				
$I_C = 4$ mA; $V_{CE} = 10$ V; $G_S = 10$ mΩ^{-1}; $B_S = 0$	F	typ.	3	dB
y parameters at f = 35 MHz				
$I_C = 4$ mA; $V_{CE} = 10$ V				
Input conductance	g_{ie}	typ.	4.8	mΩ^{-1}
Input capacitance	C_{ie}	typ.	45	pF
Feedback admittance	$\lvert y_{re}\rvert$	typ.	37	μΩ^{-1}
Phase angle of feedback admittance	φ_{re}	typ.	268^o	
Transfer admittance	$\lvert y_{fe}\rvert$	typ.	95	mΩ^{-1}
Phase angle of transfer admittance	φ_{fe}	typ.	337^o	
Output conductance	g_{oe}	typ.	30	μΩ^{-1}
Output capacitance	C_{oe}	typ.	1.2	pF
Maximum unilateralised power gain				
$G_{UM} = \frac{\lvert y_{fe}\rvert^2}{4\ g_{ie}\ g_{oe}}$				
$I_C = 4$ mA; $V_{CE} = 10$ V; f = 35 MHz	G_{UM}	typ.	42	dB

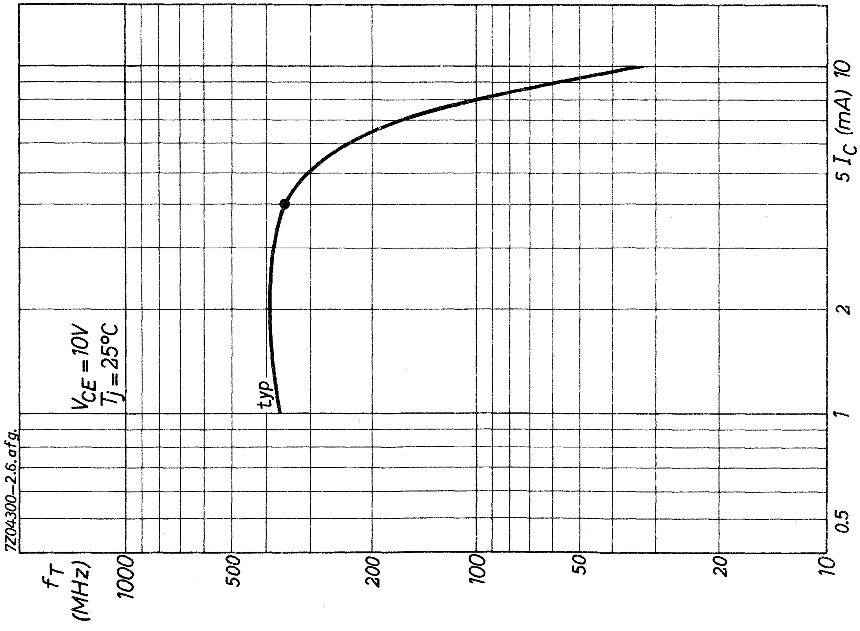
---

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

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


7Z04299-2.6.afg.
typical values
25
20
15
5
IC (mA)
5mA
4mA
3mA
2mA
1mA
0.5mA
0.2mA
IB = 0.1mA
VCE = 10V
4
IB (mA)
2
0
10
20
VCE(V)
30
0.5
VBE (V)
1
Tj = 25°C
VCE = 10V


Min. collector-emitter voltage (with resistance between base and emitter) for which $I_C = 2\,mA$ versus the base resistance applied
7Z54061
V_{CER} (V)
50
40
30
20
10
0
0.1
1
10
100
1000
R_B (kΩ)
R_E = 1kΩ
0.5kΩ
0
$I_C = 2\,mA$
V_{CER}
C_B
R_B
R_E
C_E
T_j up to 175°C
The same curves apply to $\frac{1}{\omega C_B}$ and $\frac{1}{\omega C_E}$ when external capacitances are used


$V_{CE} = 10V$
$T_j = 25°C$
typ
7Z04300—2.6.afg.
f_T (MHz)
1000
500
200
100
50
20
10
I_C (mA)
0.5
1
2
5
10

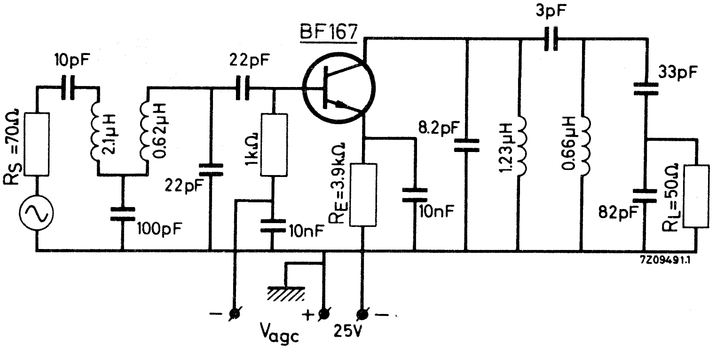
APPLICATION INFORMATION

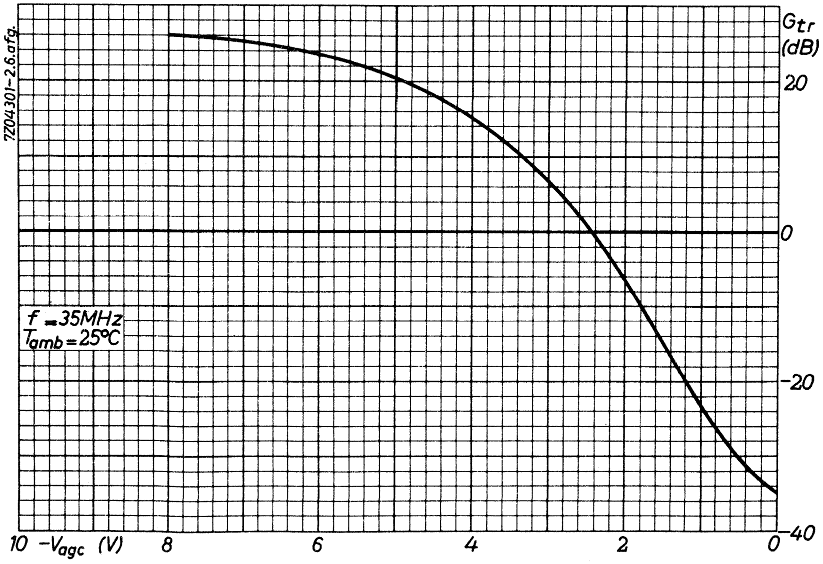
First stage of an intermediate frequency amplifier with a BF167 transistor. (Basic circuit with voltage gain control).

Transducer gain

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

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





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.

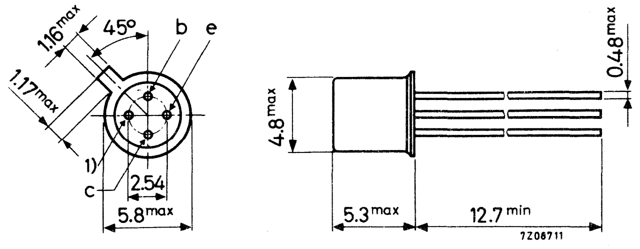
QUICK REFERENCE DATA

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 °C	P_{tot}	max.	260	mW
Junction temperature	T_j	max.	175	°C
Transition frequency				
I_C = 5 mA; V_{CE} = 10 V	f_T	typ.	550	MHz
Feedback capacitance at f = 10.7 MHz				
I_C = 1 mA; V_{CE} = 10 V	$-C_{re}$	typ.	0.23	pF
Max. unilateralised power gain				
I_C = 7 mA; V_{CE} = 10 V; f = 35 MHz	G_{UM}	typ.	42.5	dB
Output voltage in the circuit of page 4	V_O	typ.	7.7	V

MECHANICAL DATA

Dimensions in mm

TO-72



1) = 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 °C with cooling fin No. 56263 [2]	P_{tot}	max.	260	mW

Temperatures

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

THERMAL RESISTANCE

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

---

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

[2] Peak power dissipation see page 5.

CHARACTERISTICS

T_{amb} = 25 °C unless otherwise specified

Base current				
I_C = 7 mA; V_{CE} = 10 V	I_B	typ. <	80 185	μA μA
Base-emitter voltage				
I_C = 7 mA; V_{CE} = 10 V	V_{BE}	typ. <	740 900	mV (1) mV
Feedback capacitance at f = 10.7 MHz				
I_C = 1 mA; V_{CE} = 10 V	$-C_{re}$	typ.	230	fF (2)
Transition frequency				
I_C = 5 mA; V_{CE} = 10 V	f_T	typ.	550	MHz
y parameters at f = 35 MHz				
I_C = 7 mA; V_{CE} = 10 V				
Input conductance	g_{ie}	typ.	4.5	$m\Omega^{-1}$
Input capacitance	C_{ie}	typ.	45	pF
Feedback admittance	$\lvert y_{re} \rvert$	typ.	55	$\mu\Omega^{-1}$
Phase angle of feedback admittance	φ_{re}	typ.	266°	
Transfer admittance	$\lvert y_{fe} \rvert$	typ.	145	$m\Omega^{-1}$
Phase angle of transfer admittance	φ_{fe}	typ.	338°	
Output conductance	g_{oe}	typ.	65	$\mu\Omega^{-1}$
Output capacitance	C_{oe}	typ.	2.1	pF
Maximum unilateralised power gain				
$G_{UM} = \frac{\lvert y_{fe} \rvert^2}{4\, g_{ie}\, g_{oe}}$				
I_C = 7 mA; V_{CE} = 10 V; f = 35 MHz	G_{UM}	typ.	42.5	dB

---

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

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

APPLICATION INFORMATION

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

Output voltage of the i.f. output stage

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

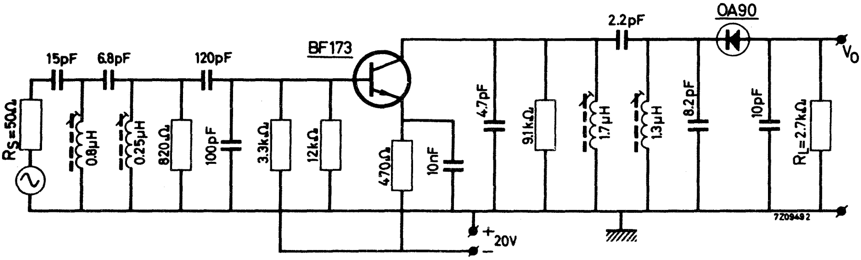
f = 38.9 MHz; I_C = 7.2 mA; V_{CE} = 16.6 V	V_O	>	6	V
		typ.	7.7	V

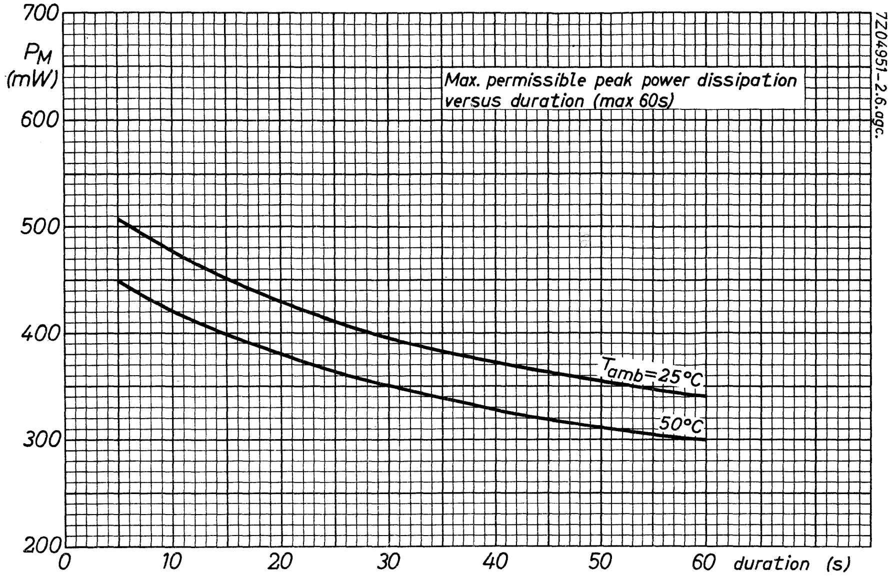
Transducer gain

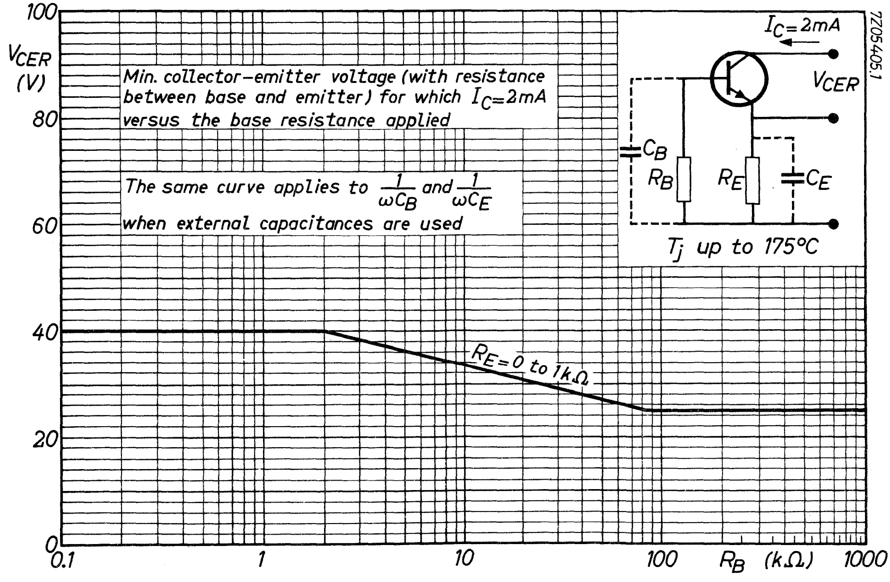
$$G_{tr} = \frac{\text{output power in load } R_L}{\text{available power from source with } R_S}$$

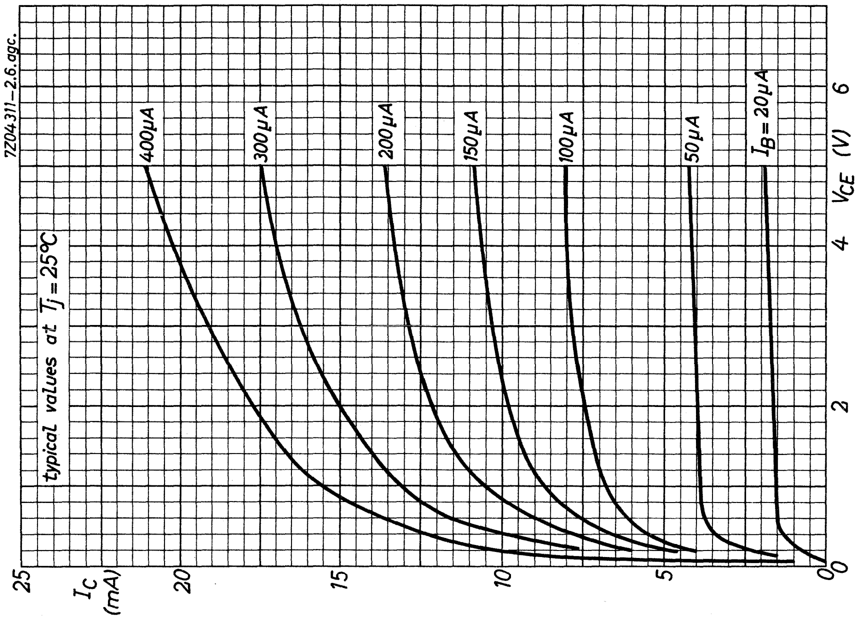
f = 36.4 MHz; I_C = 7.2 mA; V_{CE} = 16.6 V	G_{tr}	typ.	26	dB

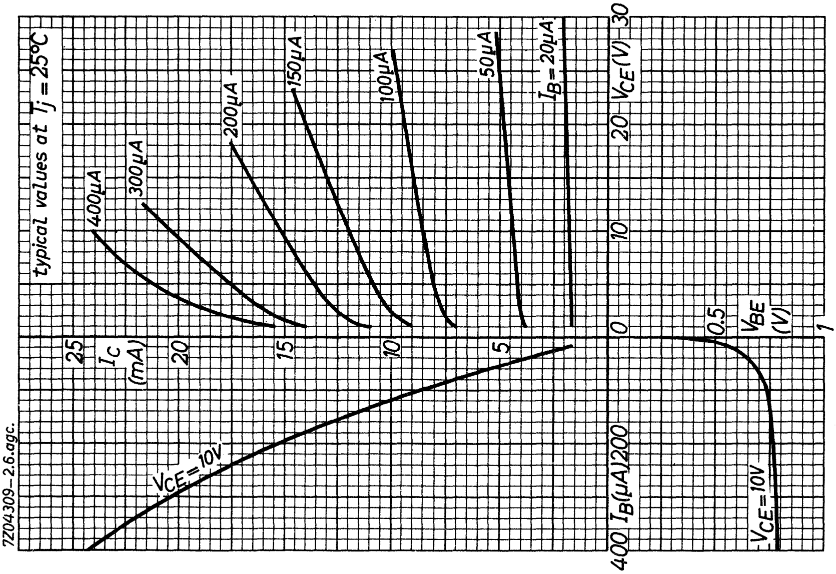
Tuning frequency for all tuned circuits is 37 MHz




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


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


7Z04311–2.6.agc.
typical values at $T_j = 25°C$
400μA
300μA
200μA
150μA
100μA
50μA
$I_B = 20μA$
I_C (mA)
25
20
15
10
5
0
0
2
4
6
V_{CE} (V)


7Z04309–2.6.agc.
typical values at $T_j = 25°C$
400μA
300μA
200μA
150μA
100μA
50μA
$I_B = 20μA$
V_{CE}(V)
0
10
20
30
I_C (mA)
25
20
15
10
5
$V_{CE} = 10V$
I_B(μA)
400
200
0.5
1
V_{BE} (V)
$V_{CE} = 10V$

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 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

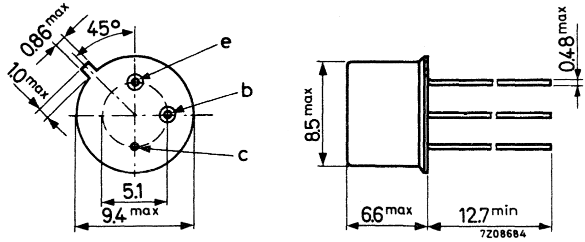
			BF177	BF178	BF179	
Collector-base voltage (open emitter)	V_{CBO}	max.	100	185	250	V
Collector-emitter voltage (open base)	V_{CEO}	max.	60	115	115	V
Collector current (peak value)	I_{CM}	max.	50	50	50	mA
Total power dissipation						
up to T_{amb} = 65 °C	P_{tot}	max.	0.6	0.6	0.6	W
up to T_{mb} = 130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

MECHANICAL DATA

Dimensions in mm

TO-39

Collector connected to case



Accessories available: 56218; 56245; 56265

MOUNTING METHOD see page 4

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

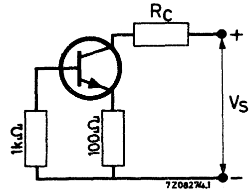
Voltages			BF177	BF178	BF179	
Collector-base voltage (open emitter)	V_{CBO}	max.	100	185	250	V [1]
Collector-emitter voltage ($R_B \leq 1$ kΩ)	V_{CER}	max.	100	185	250	V [1]
Collector-emitter voltage (open base) I_C = 4 mA	V_{CEO}	max.	60	115	115	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	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 °C in free air	P_{tot}	max.	0.6	0.6	0.6	W
up to T_{mb} = 130 °C	P_{tot}	max.		1.7	1.7	W
Temperatures						
Storage temperature	T_{stg}		−55 to +175			°C
Junction temperature	T_j	max.	200			°C

THERMAL RESISTANCE (see page 4)

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

CHARACTERISTICS

			BF177	BF178	BF179	
Collector cut-off current at T_j = 200 °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 °C I_{CER} < 1 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 8).

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

Base current

Conditions	Type	Symbol		Value	Unit
I_C = 15 mA; V_{CE} = 10 V	BF177	I_B	typ. <	0.36 0.75	mA mA
I_C = 20 mA; V_{CE} = 15 V	BF179	I_B	typ. <	0.45 1.0	mA mA
I_C = 30 mA; V_{CE} = 20 V	BF178	I_B	typ. <	0.72 1.5	mA mA

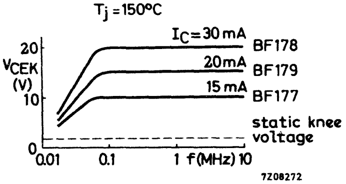
Base-emitter voltage [1]

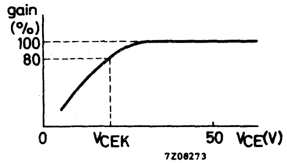
Conditions	Symbol		Value	Unit
I_C = 15 mA; V_{CE} = 10 V for BF177 I_C = 20 mA; V_{CE} = 15 V for BF179 I_C = 30 mA; V_{CE} = 20 V for BF178	V_{BE}	typ. <	0.75 1.2	V V

High frequency knee voltage at T_j = 150 °C

Conditions	Symbol		Value	Unit
BF177: I_C = 15 mA	V_{CEK}	typ.	10	V
BF179: I_C = 20 mA	V_{CEK}	typ.	15	V
BF178: I_C = 30 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 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 MHz

Conditions	Symbol		Value	Unit
I_C = 10 mA; V_{CE} = 20 V	$-C_{re}$	typ. <	1.8 3.5	pF pF

Feedback time constant at f = 10 MHz

Conditions	Symbol		Value	Unit
$-I_E$ = 10 mA; V_{CB} = 10 V	$r_{bb'} \cdot C_{b'c}$	typ. <	25 100	ps ps

Transition frequency

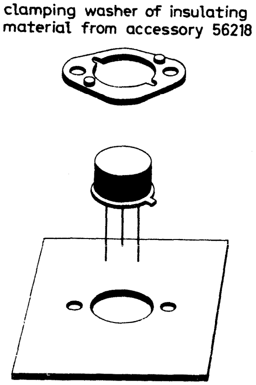
Conditions	Symbol		Value	Unit
I_C = 10 mA; V_{CE} = 10 V	f_T	typ.	120	MHz

---

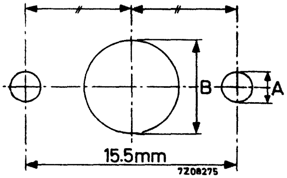
[1] V_{BE} decreases by about 1.6 mV/°C with increasing temperature.

MOUNTING METHOD

Transistor mounted directly on a heatsink ($R_{th\ j\text{-}mb} = 40\ ^{o}C/W$)
$R_{th\ mb\text{-}h} \approx 3\ ^{o}C/W$



Fasten with M2.6 bolts



Diameter A: 2.8 mm

Diameter B: min. 7.0 mm
max. 7.7 mm

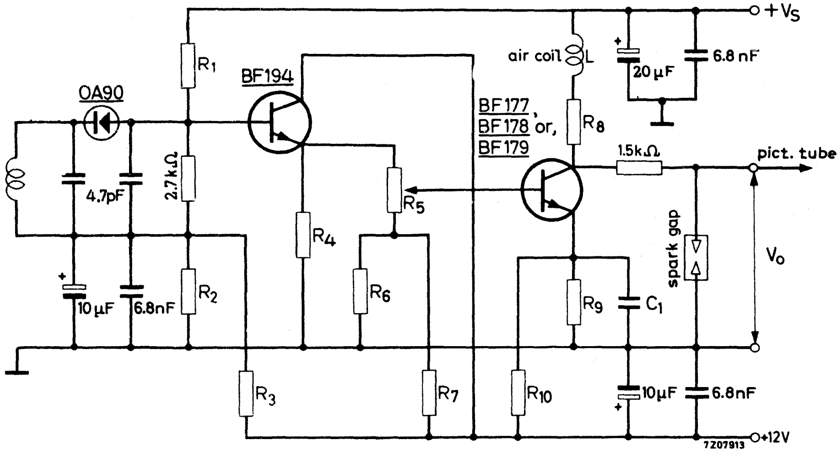
Recommended bore plan

COMPONENTS of circuit on page 5

		BF177	BF178	BF179	
V_S	=	85	145	170	V.
R_1	=	390	560	820	kΩ
R_2	=	1.2	2.2	1.8	kΩ
R_3	=	1	1	1.5	kΩ
R_4	=	470	680	560	Ω
R_5	=	300	300	300	Ω
R_6	=	47	56	56	Ω
R_7	=	120	100	120	Ω
R_8	=	4.7	3.9	5.6	kΩ
R_9	=	180	150	120	Ω
R_{10}	=	820	560	470	Ω
C_1	=	180	220	330	pF
L	=	120	120	250	μH

APPLICATION INFORMATION

BF177 in the video output stage of a tiny-vision black and white television receiver. BF178 or BF179 in the video output stage of large screen black and white television receivers.

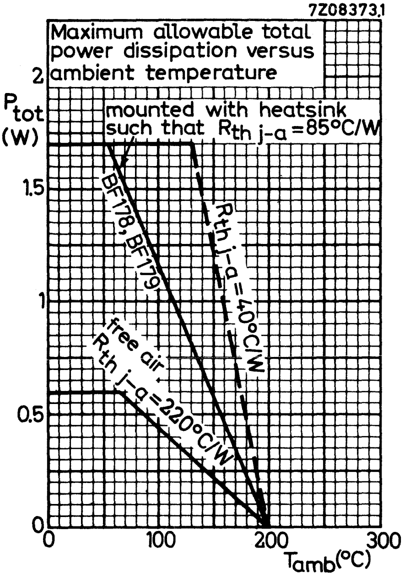


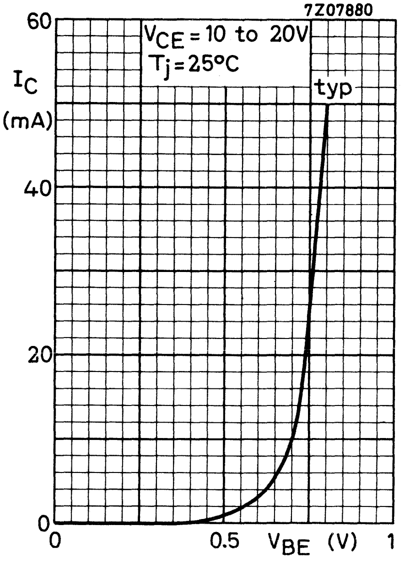
Performance			BF177	BF178	BF179	
Voltage gain	G_v	typ.	30	30	50	
Output voltage (black-white)	V_o	typ.	50	80	110	V
Output voltage (peak-peak)	V_{om}	typ.	75	110	140	V
Bandwidth (3 dB)	B	>	4	4	3	MHz
Rise time	t_r	<	80	80	120	ns
Overshoot		<	5	5	3	%
Contrast control ratio			1 : 8	1 : 8	1 : 8	

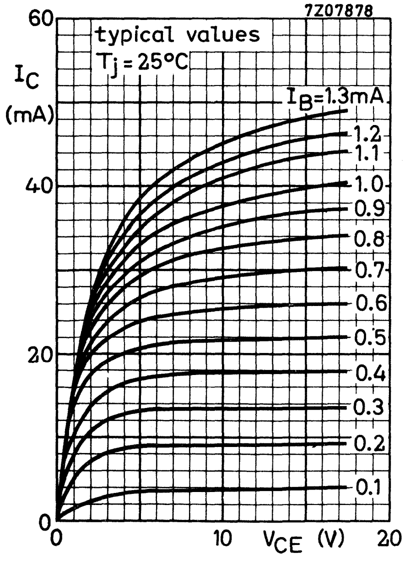
NOTES

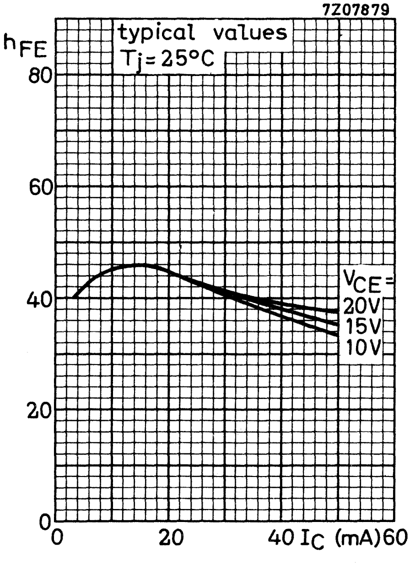
1. For the BF177 up to T_{amb} = 55 °C no heatsink is needed.
2. In order to keep T_j below the maximum value for the BF178 and BF179 and to allow the maximum dissipation of 1.7 W the thermal resistance from junction to ambient should be: $R_{th\,j\text{-}a} \leq 85$ °C/W.
3. To ensure the above mentioned performance for bandwidth and transient response, the contribution to the total output capacitance of the device by the heatsink should not exceed 4 pF.

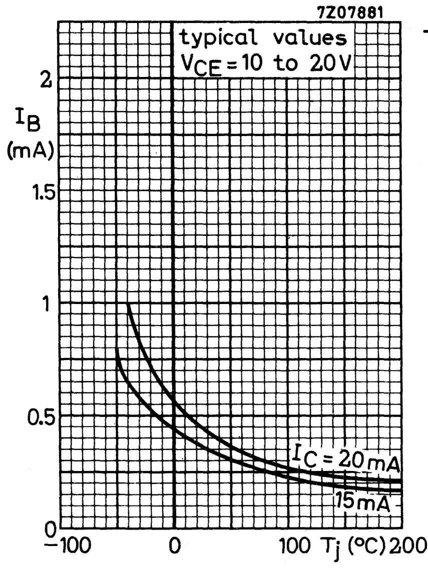
APPLICATION INFORMATION bulletins available on request

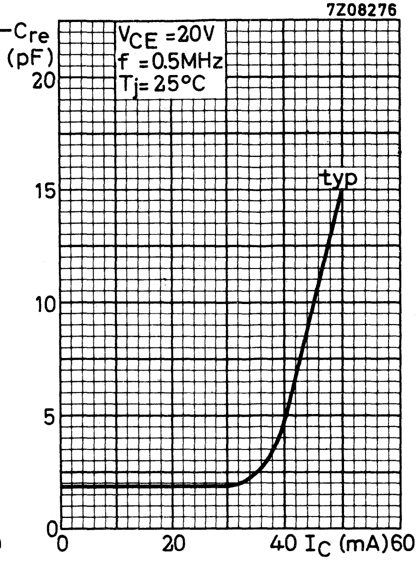

7Z08373.1
Maximum allowable total power dissipation versus ambient temperature
P_{tot} (W)
2
1.5
1
0.5
0
mounted with heatsink such that $R_{th\ j-a} = 85°C/W$
BF178, BF179
$R_{th\ j-a} = 40°C/W$
free air $R_{th\ j-a} = 220°C/W$
0
100
200
300
T_{amb} (°C)

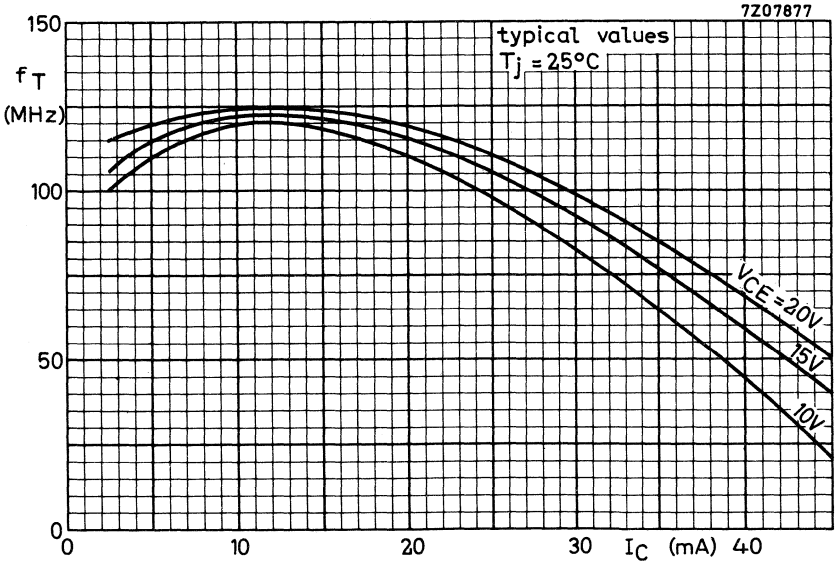

7Z07880
$V_{CE} = 10$ to 20V
$T_j = 25°C$
I_C (mA)
60
40
20
0
typ
0
0.5
V_{BE} (V)
1


7Z07878
typical values
$T_j = 25°C$
I_C (mA)
60
40
20
0
$I_B = 1.3mA$
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
10
V_{CE} (V)
20

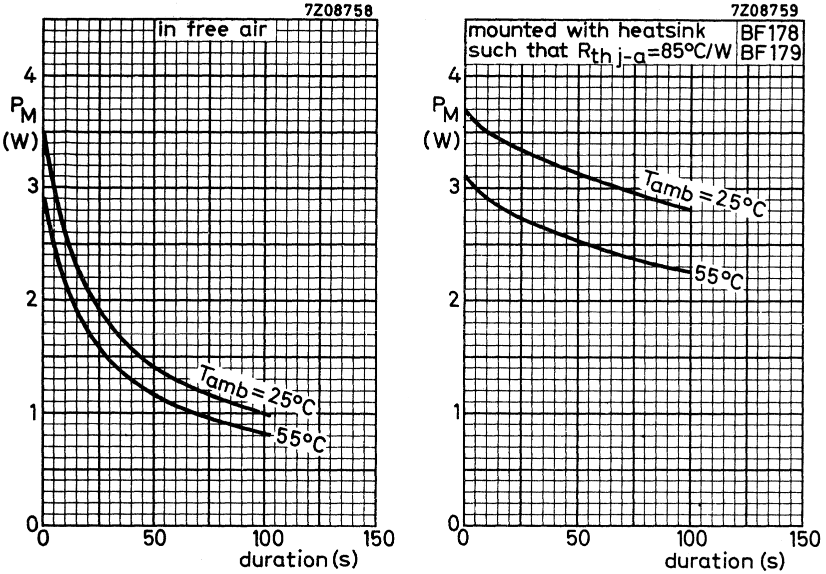

7Z07879
typical values
$T_j = 25°C$
h_{FE}
80
60
40
20
0
V_{CE} =
20V
15V
10V
0
20
40
I_C (mA)
60


7Z07881
typical values
V_{CE} = 10 to 20V
I_B (mA)
2
1.5
1
0.5
0
I_C = 20mA
15mA
−100
0
100
T_j (°C)
200


7Z08276
$-C_{re}$ (pF)
V_{CE} = 20V
f = 0.5MHz
T_j = 25°C
20
15
10
5
0
typ
0
20
40
I_C (mA)
60


7Z07877
typical values
T_j = 25°C
f_T (MHz)
150
100
50
0
V_{CE} = 20V
15V
10V
0
10
20
30
I_C (mA)
40

maximum allowable peak power dissipation versus duration



SILICON PLANAR TRANSISTOR

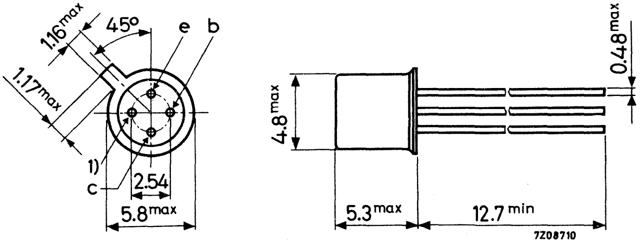
N-P-N transistor in a TO-72 metal envelope with insulated electrodes and a shield lead connected to the case. The BF180 is primarily intended for application in a forward gain controlled pre-amplifier in u.h.f. and integrated television tuners.

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 °C	P_{tot}	max.	150	mW
Junction temperature	T_j	max.	175	°C
Transition frequency				
I_C = 2 mA; V_{CE} = 10 V	f_T	typ.	675	MHz
Feedback capacitance at f = 10.7 MHz				
I_C = 1 mA; V_{CE} = 10 V	$-C_{re}$	typ.	280	fF
Max. unilateralised power gain				
$-I_E$ = 2 mA; V_{CB} = 10 V; f = 200 MHz	G_{UM}	typ.	24	dB
$-I_E$ = 2 mA; V_{CB} = 10 V; f = 900 MHz	G_{UM}	typ.	12	dB
Noise figure at optimum source admittance				
$-I_E$ = 2 mA; V_{CB} = 10 V; f = 200 MHz	F	typ.	2.5	dB
$-I_E$ = 2 mA; V_{CB} = 10 V; f = 800 MHz	F	typ.	5.7	dB

MECHANICAL DATA Dimensions in mm

TO-72



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
Emitter-base voltage (open collector)	V_{EBO}	max.	3	V

Currents

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

Power dissipation

Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	150	mW

Temperatures

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

THERMAL RESISTANCE

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

---

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

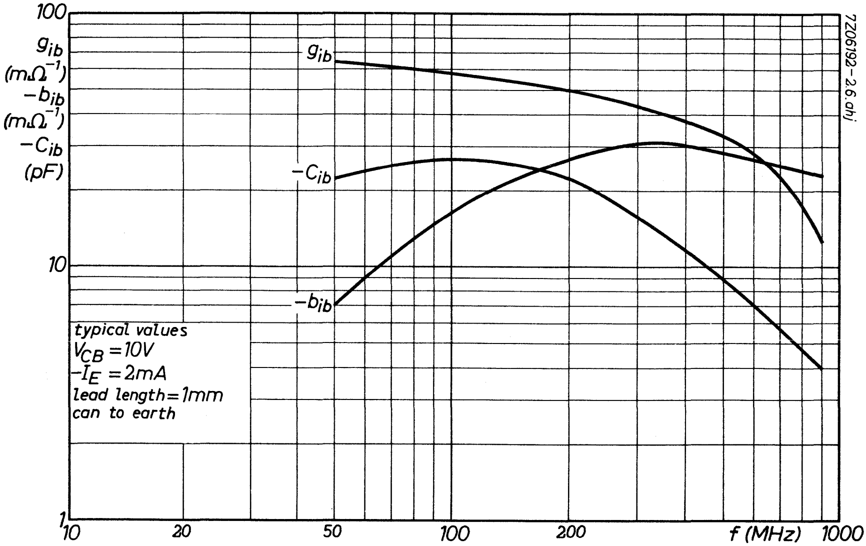
CHARACTERISTICS T_{amb} = 25 °C unless otherwise specified

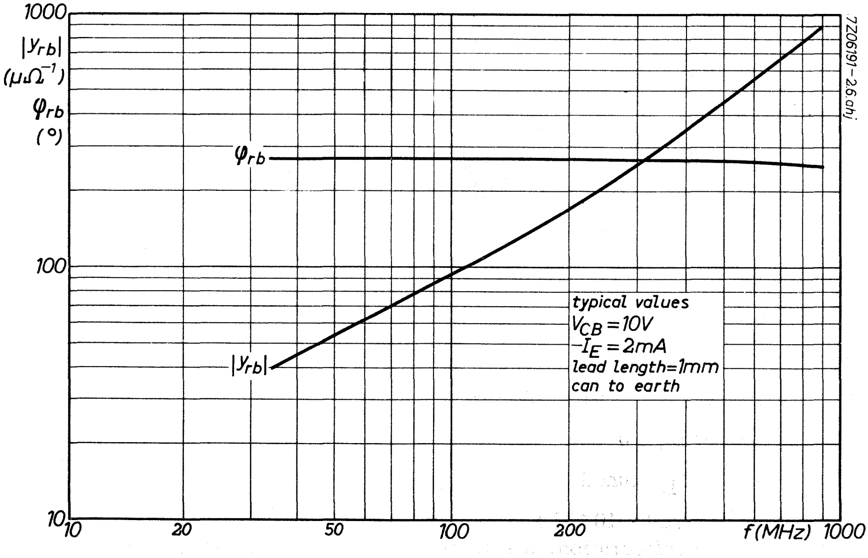
Base current				
$-I_E$ = 2 mA; V_{CB} = 10 V	I_B	typ. <	45 150	μA μA
$-I_E$ = 12 mA; V_{CB} = 7 V	I_B	<	2.2	mA
Emitter-base voltage				
$-I_E$ = 2 mA; V_{CB} = 10 V	$-V_{EB}$	typ.	0.75	V
Feedback capacitance at f = 10.7 MHz				
I_C = 1 mA; V_{CE} = 10 V	$-C_{re}$	typ.	280	fF 1)
Transition frequency				
I_C = 2 mA; V_{CE} = 10 V	f_T	typ.	675	MHz
Noise figure 2)				
$-I_E$ = 2 mA; V_{CB} = 10 V; G_S = 40 mΩ^{-1}; B_S = 0; f = 200 MHz	F	typ.	4.5	dB
$-I_E$ = 2 mA; V_{CB} = 10 V; G_S = 10 mΩ^{-1}; B_S = 0; f = 800 MHz	F	typ. <	7.0 9.5	dB dB
Maximum unilaterised power gain 2)				
$G_{UM} = \dfrac{\lvert y_{fb}\rvert^2}{4\, g_{ib}\, g_{ob}}$				
$-I_E$ = 2 mA; V_{CB} = 10 V; f = 50 MHz	G_{UM}	>	32	dB
$-I_E$ = 2 mA; V_{CB} = 10 V; f = 200 MHz	G_{UM}	typ.	24	dB
$-I_E$ = 2 mA; V_{CB} = 10 V; f = 500 MHz	G_{UM}	typ.	14	dB
$-I_E$ = 2 mA; V_{CB} = 10 V; f = 900 MHz	G_{UM}	typ.	12	dB
Transducer gain 2)				
$-I_E$ = 2 mA; V_{CB} = 10 V; f = 200 MHz; G_S = 40 mΩ^{-1}; B_S = 0; G_L = 1 mΩ^{-1}; B_L : tuned	G_{tr}	typ.	16.5	dB
$-I_E$ = 2 mA; V_{CB} = 10 V; f = 900 MHz; G_S = 20 mΩ^{-1}; B_S = 0; G_L = 2 mΩ^{-1}; B_L : tuned	G_{tr}	> typ.	7.5 9	dB dB

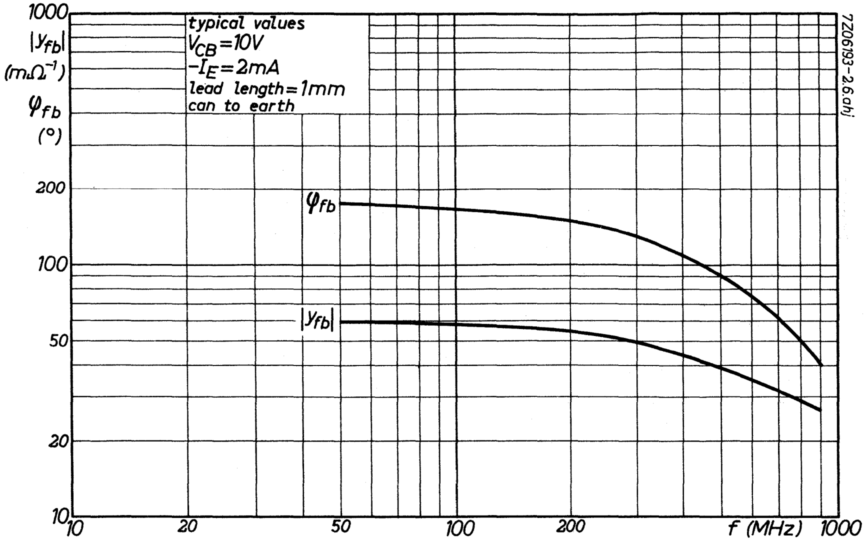
---

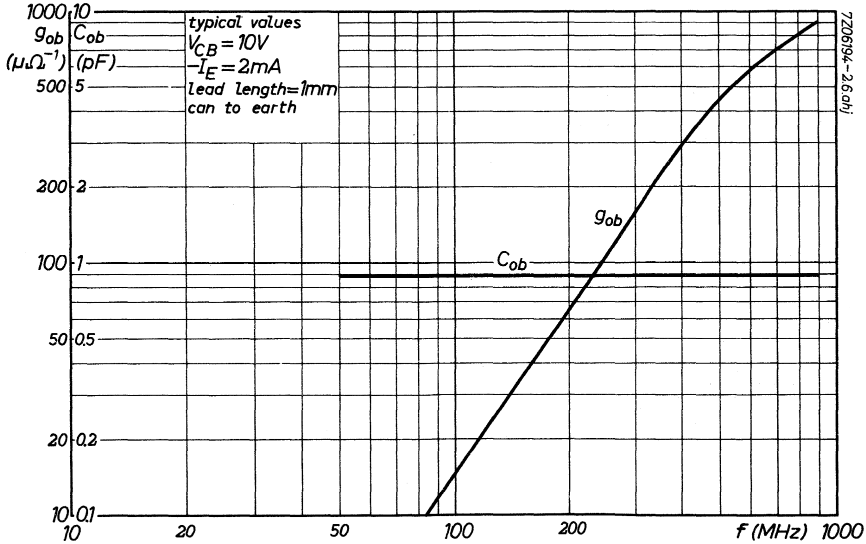
1) 1 fF = 1 femtofarad = 10^{-15} F

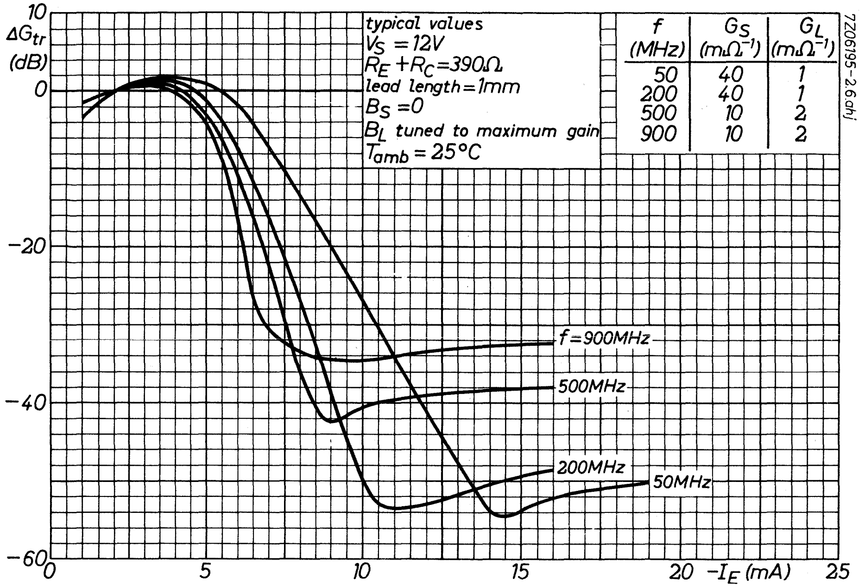
2) Common base configuration, metal envelope contacted to earth directly, external lead length: 1 mm.


100
g_{ib}
($m\Omega^{-1}$)
$-b_{ib}$
($m\Omega^{-1}$)
$-C_{ib}$
(pF)
10
1
g_{ib}
$-C_{ib}$
$-b_{ib}$
typical values
$V_{CB}=10V$
$-I_E=2mA$
lead length=1mm
can to earth
10
20
50
100
200
f (MHz)
1000
7Z06192-2.6.ahj


1000
$|y_{rb}|$
($\mu\Omega^{-1}$)
φ_{rb}
(°)
100
10
φ_{rb}
$|y_{rb}|$
typical values
$V_{CB}=10V$
$-I_E=2mA$
lead length=1mm
can to earth
10
20
50
100
200
f (MHz)
1000
7Z06191-2.6.ahj

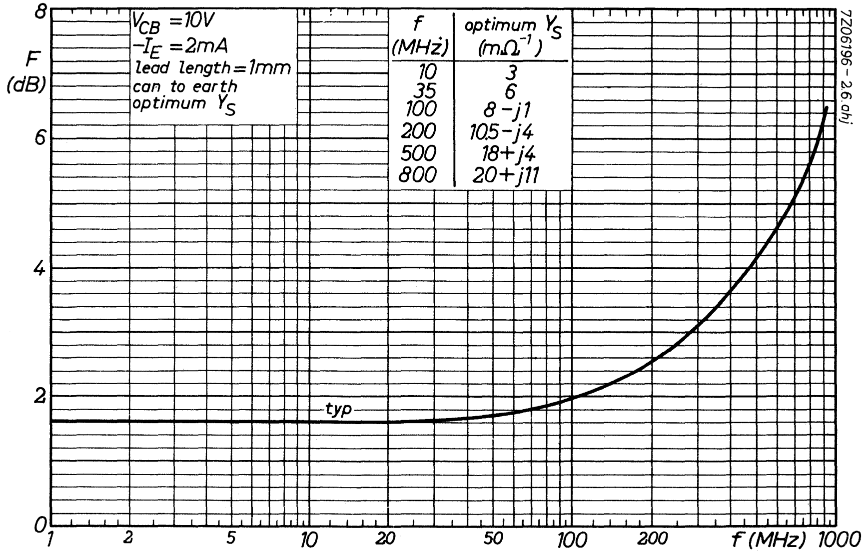

1000
$|y_{fb}|$
($m\Omega^{-1}$)
φ_{fb}
(°)
200
100
50
20
10
typical values
V_{CB}=10V
$-I_E$=2mA
lead length=1mm
can to earth
φ_{fb}
$|y_{fb}|$
10
20
50
100
200
f (MHz)
1000
7Z06193-2.6.ahj


1000
10
g_{ob}
C_{ob}
($\mu\Omega^{-1}$)
(pF)
500
5
200
2
100
1
50
0.5
20
0.2
10
0.1
typical values
V_{CB}=10V
$-I_E$=2mA
lead length=1mm
can to earth
g_{ob}
C_{ob}
10
20
50
100
200
f (MHz)
1000
7Z06194-2.6.ahj



typical values
$V_S = 12V$
$R_E + R_C = 390\Omega$
lead length = 1mm
$B_S = 0$
B_L tuned to maximum gain
$T_{amb} = 25°C$

f (MHz)	G_S ($m\Omega^{-1}$)	G_L ($m\Omega^{-1}$)
50	40	1
200	40	1
500	10	2
900	10	2



$V_{CB} = 10V$
$-I_E = 2mA$
lead length = 1mm
can to earth
optimum Y_S

f (MHz)	optimum Y_S ($m\Omega^{-1}$)
10	3
35	6
100	8 − j1
200	10.5 − j4
500	18 + j4
800	20 + j11

SILICON PLANAR TRANSISTOR

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

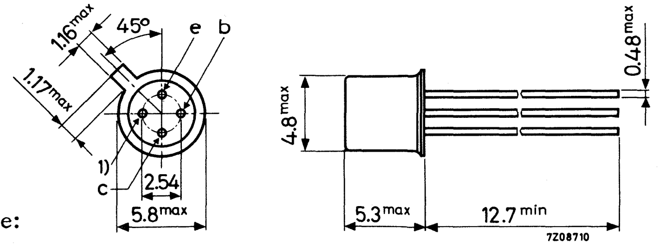
QUICK REFERENCE DATA

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

MECHANICAL DATA

Dimensions in mm

TO-72



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 $T_{amb} = 25\ ^oC$	P_{tot}	max.	150	mW

Temperatures

Storage temperature	T_{stg}		-65 to +175	^oC
Junction temperature	T_j	max.	175	^oC

THERMAL RESISTANCE

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

---

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

CHARACTERISTICS

T_{amb} = 25 °C unless otherwise specified

Base current				
$-I_E$ = 2 mA; V_{CB} = 10 V	I_B	typ. <	70 150	μA μA
Emitter-base voltage				
$-I_E$ = 2 mA; V_{CB} = 10 V	$-V_{EB}$	typ.	0.75	V
Feedback capacitance at f = 10.7 MHz				
I_C = 1 mA; V_{CE} = 10 V	$-C_{re}$	typ.	280	fF [1]
Transition frequency				
I_C = 2 mA; V_{CE} = 10 V	f_T	typ.	600	MHz
y parameters at f = 35 MHz [2]				
$-I_E$ = 2 mA; V_{CB} = 10 V				
Output conductance	g_{ob}	typ.	10	$\mu\Omega^{-1}$
Output capacitance	C_{ob}	typ.	0.9	pF

Maximum unilateralised power gain [2]

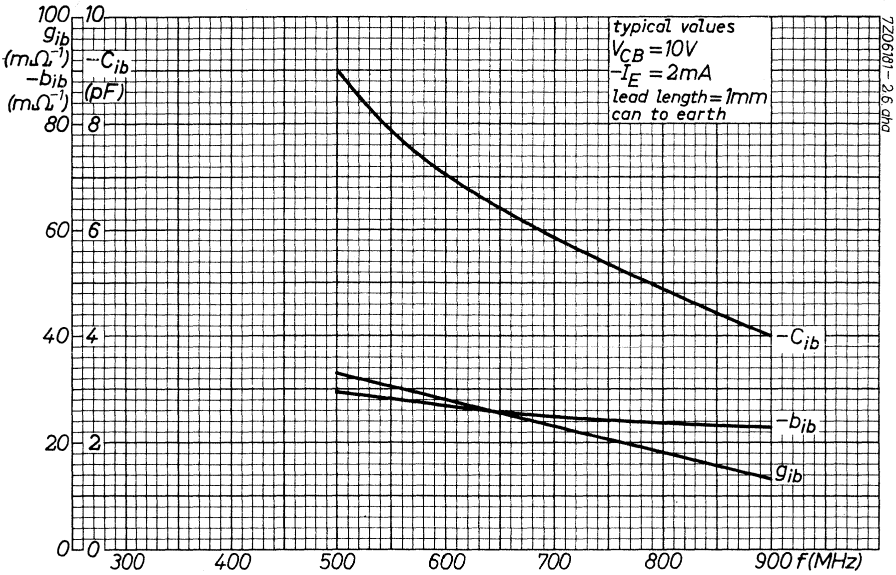
$$G_{UM} = \frac{|\grave{y}_{fb}|^2}{4\, g_{ib}\, g_{ob}}$$

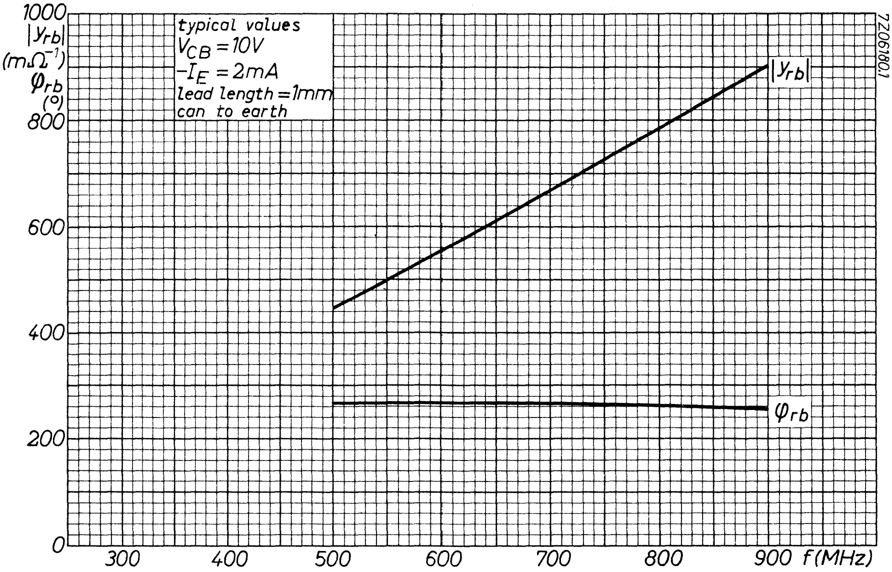
$-I_E$ = 2 mA; V_{CB} = 10 V; f = 500 MHz	G_{UM}	typ.	13.5	dB
$-I_E$ = 2 mA; V_{CB} = 10 V; f = 900 MHz	G_{UM}	typ.	11	dB
Transducer gain [2]				
$-I_E$ = 2 mA; V_{CB} = 10 V; f = 900 MHz; G_S = 20 mΩ^{-1}; B_S = 0 G_L = 2 mΩ^{-1}; B_L : tuned	G_{tr}	typ.	8	dB

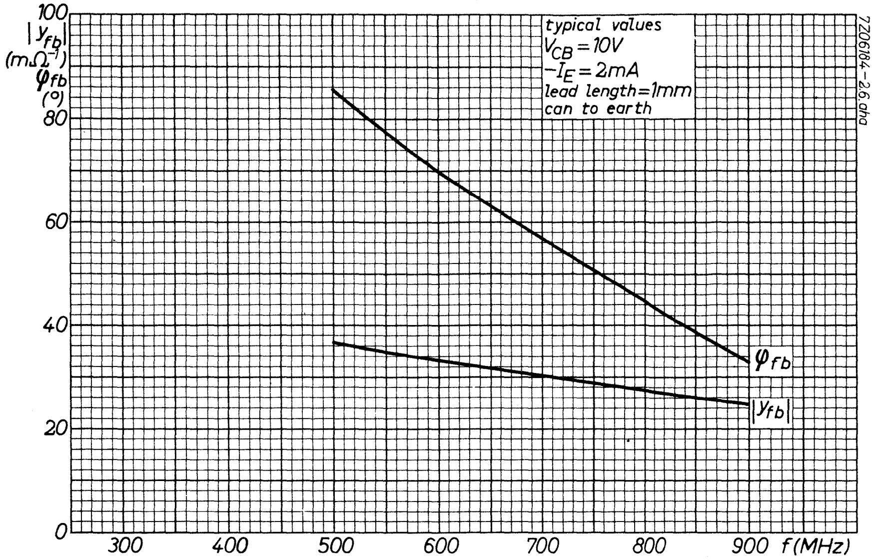
---

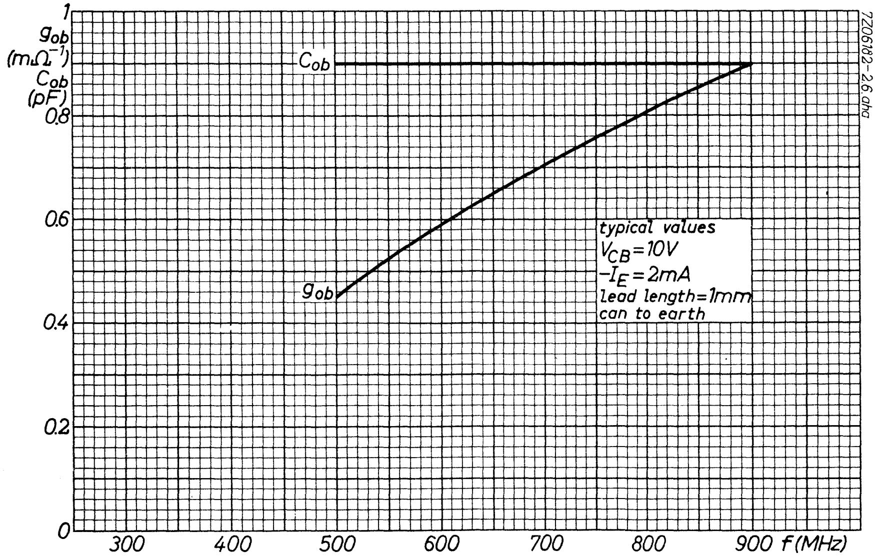
[1] 1 fF = 1 femtofarad = 10^{-15} F.

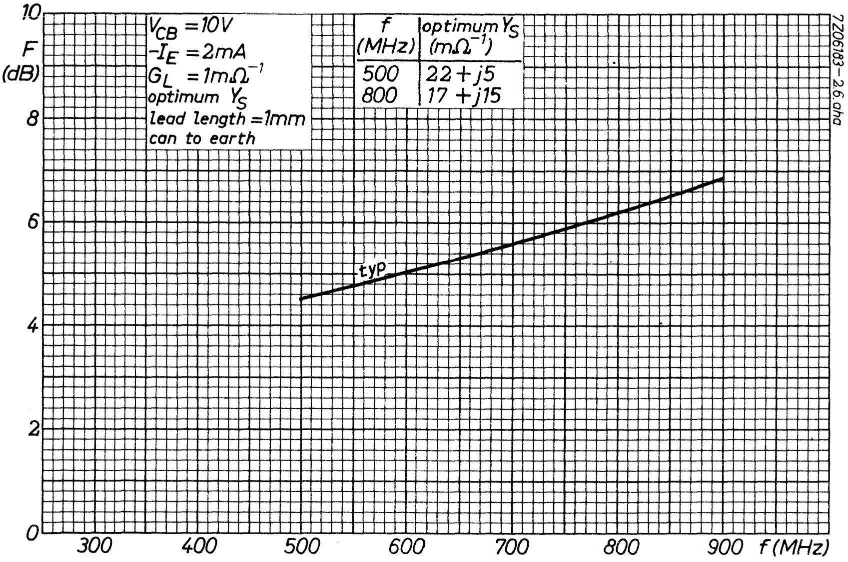
[2] Common base configuration, metal envelope contacted to earth directly, external lead length: 1 mm.


100
g_{ib}
$(m\Omega^{-1})$
$-b_{ib}$
$(m\Omega^{-1})$
80
60
40
20
0
10
$-C_{ib}$
(pF)
8
6
4
2
0
typical values
$V_{CB} = 10V$
$-I_E = 2mA$
lead length = 1mm
can to earth
$-C_{ib}$
$-b_{ib}$
g_{ib}
300
400
500
600
700
800
900 f(MHz)
7Z06181 - 2.6 dha


1000
$|y_{rb}|$
$(m\Omega^{-1})$
φ_{rb}
(°)
800
600
400
200
0
typical values
$V_{CB} = 10V$
$-I_E = 2mA$
lead length = 1mm
can to earth
$|y_{rb}|$
φ_{rb}
300
400
500
600
700
800
900 f(MHz)
7Z06180.1


100
$|y_{fb}|$
$(m\Omega^{-1})$
φ_{fb}
(°)
80
60
40
20
0
300
400
500
600
700
800
900
f (MHz)
typical values
$V_{CB} = 10V$
$-I_E = 2mA$
lead length = 1mm
can to earth
φ_{fb}
$|y_{fb}|$
7Z06184-2.6.aha


1
g_{ob}
$(m\Omega^{-1})$
C_{ob}
(pF)
0.8
0.6
0.4
0.2
0
300
400
500
600
700
800
900
f (MHz)
C_{ob}
g_{ob}
typical values
$V_{CB} = 10V$
$-I_E = 2mA$
lead length = 1mm
can to earth
7Z06182-2.6.aha


10
F
(dB)
8
6
4
2
0
V_{CB} = 10 V
$-I_E$ = 2 mA
G_L = 1 mΩ^{-1}
optimum Y_S
lead length = 1 mm
can to earth
f (MHz)
optimum Y_S (mΩ^{-1})
500
22 + j5
800
17 + j15
typ
300
400
500
600
700
800
900
f (MHz)
7Z06183 – 2.6.aha

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.

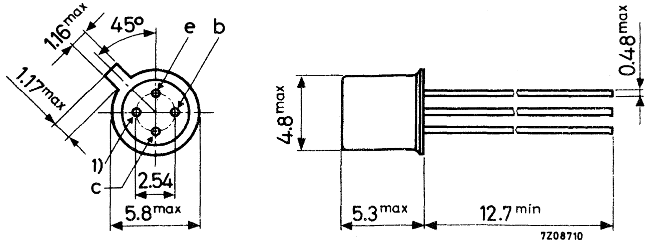
QUICK REFERENCE DATA

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 $T_{amb} = 25\ ^oC$	P_{tot}	max.	150	mW
Junction temperature	T_j	max.	175	^oC
Transition frequency				
$I_C = 2$ mA; $V_{CE} = 10$ V	f_T	typ.	650	MHz
Max. unilaterised power gain				
$-I_E = 2$ mA; $V_{CB} = 10$ V; f = 900 MHz	G_{UM}	typ.	11	dB
Noise figure at optimum source admittance				
$-I_E = 2$ mA; $V_{CB} = 10$ V; f = 800 MHz	F	typ.	7.4	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.	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 °C	P_{tot}	max.	150	mW

Temperatures

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

THERMAL RESISTANCE

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

CHARACTERISTICS

T_{amb} = 25 °C unless otherwise specified

Base current				
$-I_E = 2$ mA; $V_{CB} = 10$ V	I_B	typ. <	100 200	μA μA
Emitter-base voltage [2]				
$-I_E = 2$ mA; $V_{CB} = 10$ V	$-V_{EB}$	typ.	770	mV
Transition frequency				
$I_C = 2$ mA; $V_{CE} = 10$ V	f_T	typ.	650	MHz
Feedback capacitance at f = 10.7 MHz				
$I_C = 1$ mA; $V_{CE} = 10$ V	$-C_{re}$	typ.	330	fF

---

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

[2] $-V_{EB}$ decreases by about 1.6 mV/°C with increasing temperature.

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

Output conductance at f = 35 MHz

$-I_E$ = 2 mA; V_{CB} = 10 V	g_{ob}	typ.	8	$\mu\Omega^{-1}$

Transducer gain at f = 900 MHz (common base) [1]

$-I_E$ = 2 mA; V_{CB} = 10 V G_S = 20 mΩ^{-1}; G_L = 2 mΩ^{-1}	G_{tr}	> typ.	8 10	dB dB

Max. unilateralised power gain

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

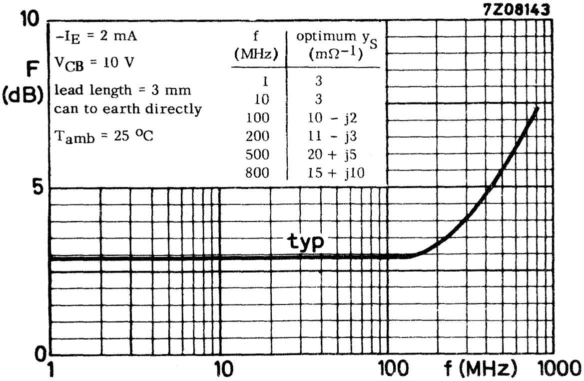
$-I_E$ = 2 mA; V_{CB} = 10 V; f = 500 MHz	G_{UM}	typ.	15	dB
$-I_E$ = 2 mA; V_{CB} = 10 V; f = 900 MHz	G_{UM}	typ.	11	dB

Noise figure at optimum source admittance

$-I_E$ = 2 mA; V_{CB} = 10 V; f = 200 MHz	F	typ.	3.3	dB
$-I_E$ = 2 mA; V_{CB} = 10 V; f = 800 MHz	F	typ.	7.4	dB

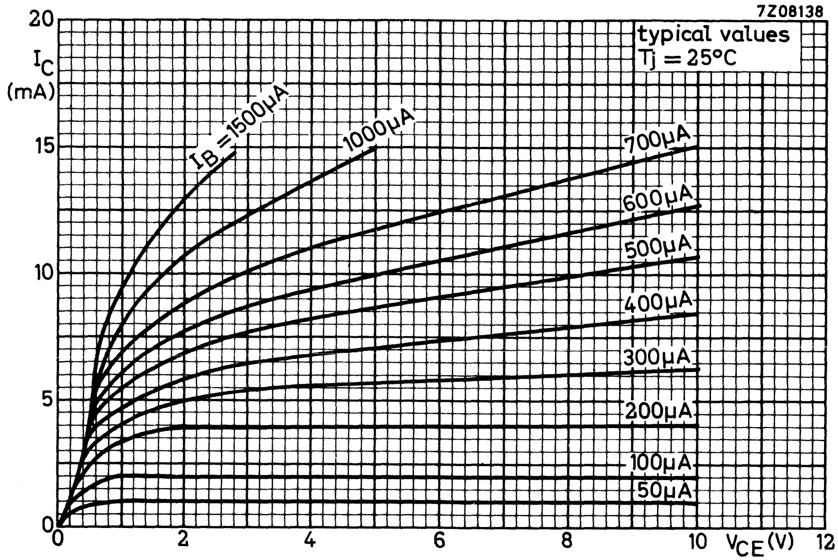
---

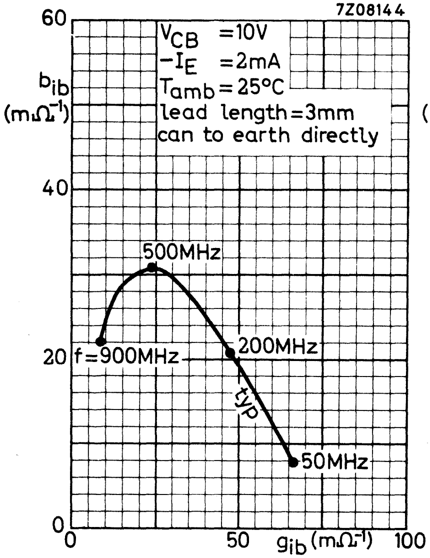
[1] Envelope connected to earth directly, lead length = 3 mm.

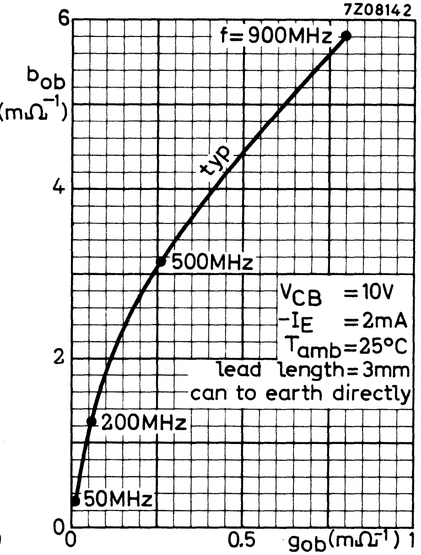


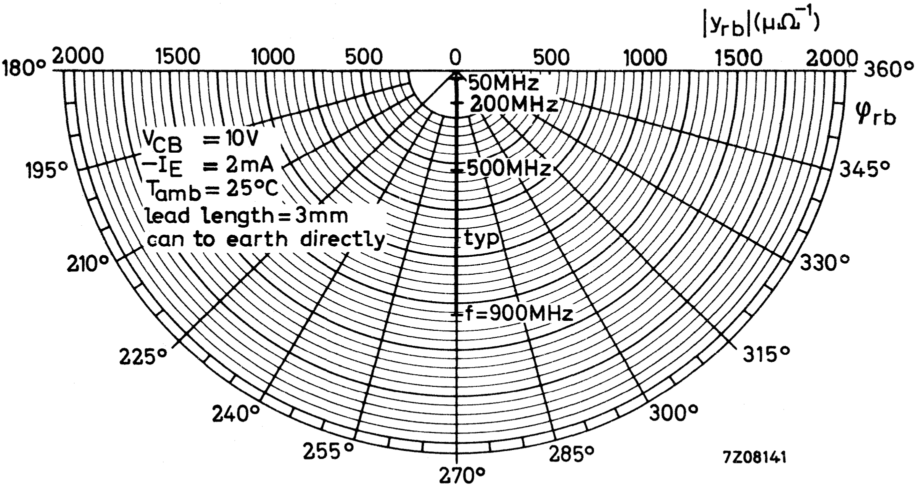
$-I_E$ = 2 mA
V_{CB} = 10 V
lead length = 3 mm
can to earth directly
T_{amb} = 25 °C

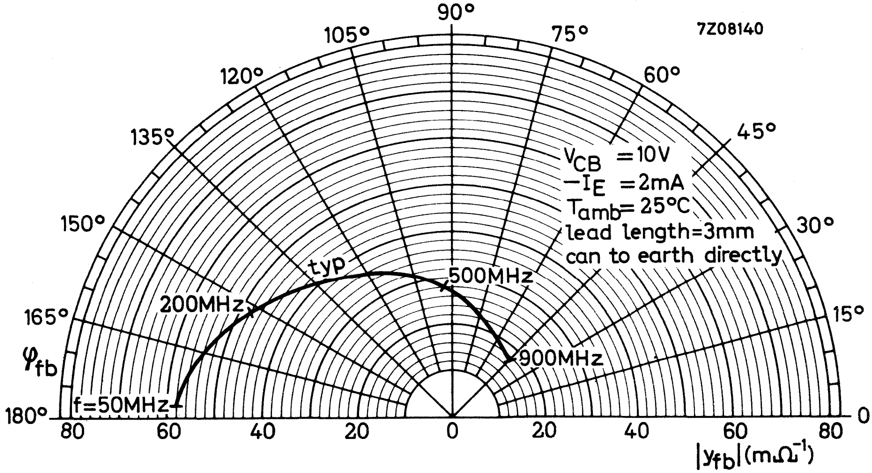
f (MHz)	optimum y_S (mΩ^{-1})
1	3
10	3
100	10 - j2
200	11 - j3
500	20 + j5
800	15 + j10

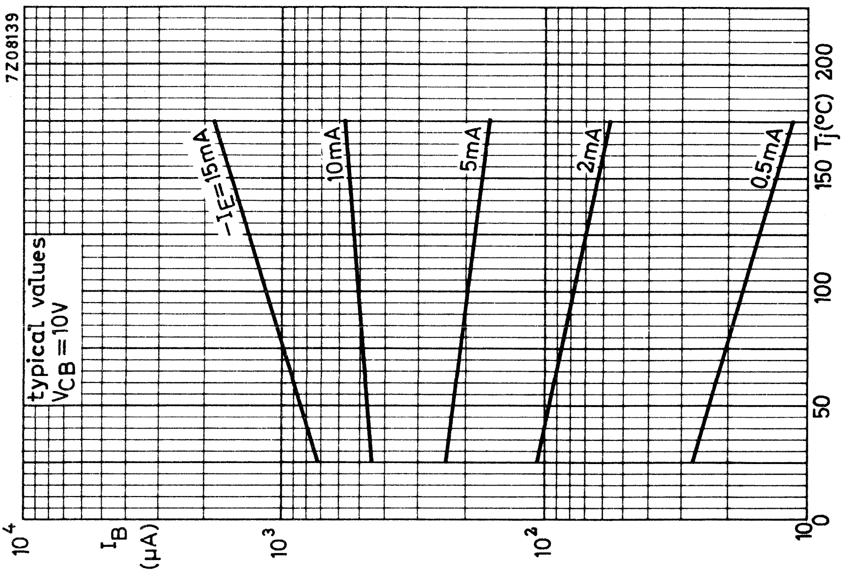

7Z08138
typical values
Tj = 25°C
I_C
(mA)
20
15
10
5
0
I_B = 1500μA
1000μA
700μA
600μA
500μA
400μA
300μA
200μA
100μA
50μA
0
2
4
6
8
10
V_CE (V)
12

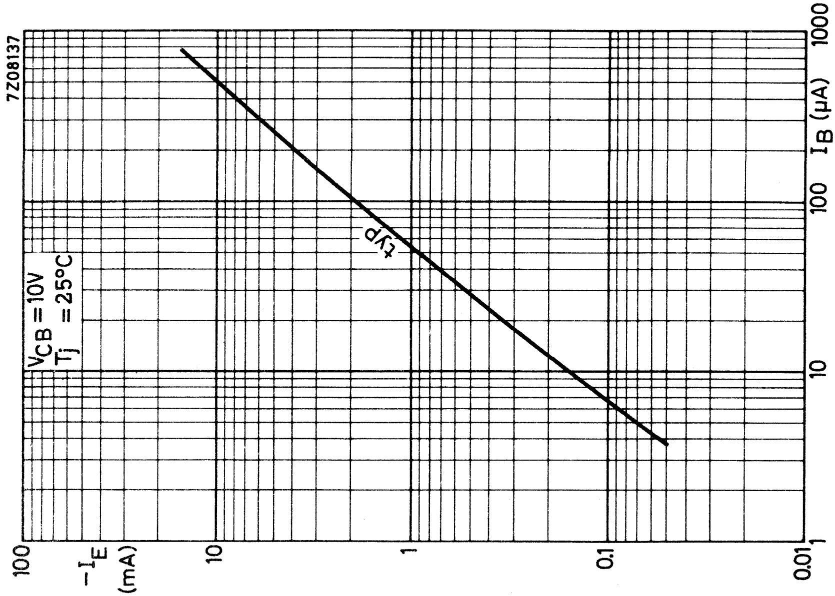

7Z08144
V_CB = 10V
-I_E = 2mA
T_amb = 25°C
lead length = 3mm
can to earth directly
b_ib
(mΩ^-1)
60
40
20
0
500MHz
f = 900MHz
200MHz
typ
50MHz
0
50
g_ib (mΩ^-1)
100


7Z08142
f = 900MHz
b_ob
(mΩ^-1)
6
4
2
0
typ
500MHz
V_CB = 10V
-I_E = 2mA
T_amb = 25°C
lead length = 3mm
can to earth directly
200MHz
50MHz
0
0.5
g_ob (mΩ^-1)
1


|y_rb| (μΩ⁻¹)
2000
1500
1000
500
0
500
1000
1500
2000
180°
195°
210°
225°
240°
255°
270°
285°
300°
315°
330°
345°
360°
φrb
50MHz
200MHz
500MHz
typ
f=900MHz
VCB = 10V
−IE = 2mA
Tamb = 25°C
lead length = 3mm
can to earth directly
7Z08141


90°
105°
75°
120°
60°
135°
45°
150°
30°
165°
15°
180°
0
φfb
7Z08140
VCB = 10V
−IE = 2mA
Tamb = 25°C
lead length = 3mm
can to earth directly
typ
200MHz
500MHz
900MHz
f=50MHz
80
60
40
20
0
20
40
60
80
|yfb| (mΩ⁻¹)


7Z08139
typical values
V_CB = 10V
−I_E = 15mA
10mA
5mA
2mA
0.5mA
I_B (µA)
10^4
10^3
10^2
10
0
50
100
150
200
T_j (°C)


7Z08137
V_CB = 10V
T_j = 25°C
typ
−I_E (mA)
100
10
1
0.1
0.01
1
10
100
1000
I_B (µA)

U.H.F. SILICON PLANAR TRANSISTOR

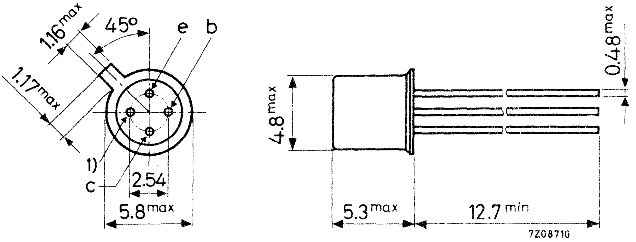
N-P-N transistor in a TO-72 metal envelope with insulated electrodes and a shield lead connected to the case. The BF183 is primarily intended for application in integrated television tuners as local oscillator with excellent frequency stability.

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 °C	P_{tot}	max.	150	mW
Junction temperature	T_j	max.	175	°C
Transition frequency				
I_C = 3 mA; V_{CE} = 10 V	f_T	typ.	800	MHz
Max. unlilateralised power gain				
$-I_E$ = 3 mA; V_{CB} = 10 V; f = 900 MHz	G_{UM}	typ.	13	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.	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 °C	P_{tot}	max.	150	mW

Temperatures

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

THERMAL RESISTANCE

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

---

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

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

Base-current				
$-I_E$ = 3 mA; V_{CB} = 10 V	I_B	typ. <	125 300	μA μA
Emitter-base voltage [1]				
$-I_E$ = 3 mA; V_{CB} = 10 V	$-V_{EB}$	typ.	770	mV
Transition frequency				
I_C = 3 mA; V_{CE} = 10 V	f_T	typ.	800	MHz
Feedback capacitance at f = 10.7 MHz				
I_C = 1 mA; V_{CE} = 10 V	$-C_{re}$	typ.	330	fF
Transducer gain at f = 900 MHz (common base) [2]				
$-I_E$ = 3 mA; V_{CB} = 10 V G_S = 20 $m\Omega^{-1}$; G_L = 2 $m\Omega^{-1}$	G_{tr}	> typ.	8.5 12	dB dB
Max. unilateralised power gain				
$G_{UM} = \frac{\lvert y_{fb} \rvert^2}{4 g_{ib} g_{ob}}$				
$-I_E$ = 3 mA; V_{CB} = 10 V; f = 500 MHz	G_{UM}	typ.	16	dB
$-I_E$ = 3 mA; V_{CB} = 10 V; f = 900 MHz	G_{UM}	typ.	13	dB

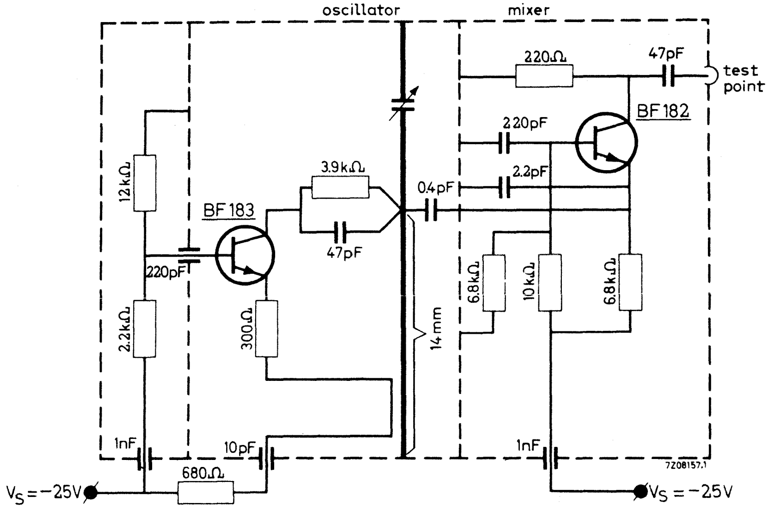
---

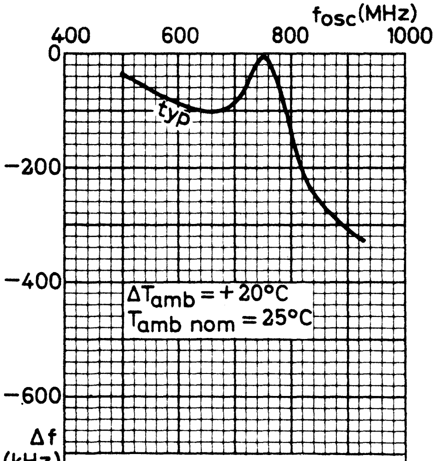
[1] $-V_{EB}$ decreases by about 1.6 mV/°C with increasing temperature.

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

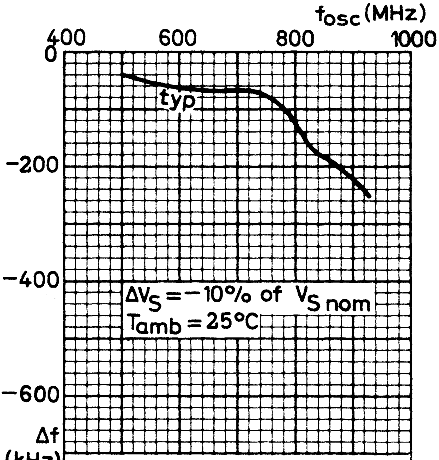
APPLICATION INFORMATION

Oscillator circuit with simplified mixer stage



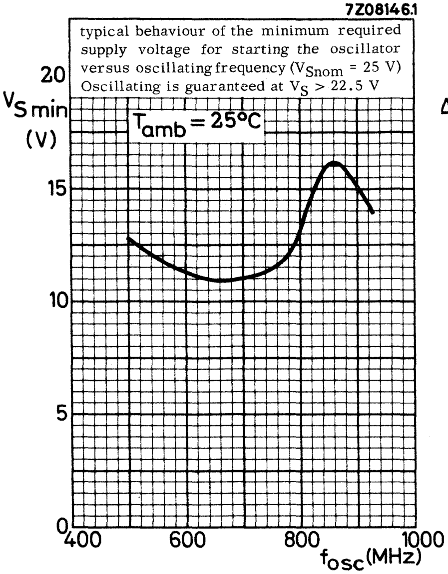


frequency change due to increase of the ambient temperature versus oscillator frequency

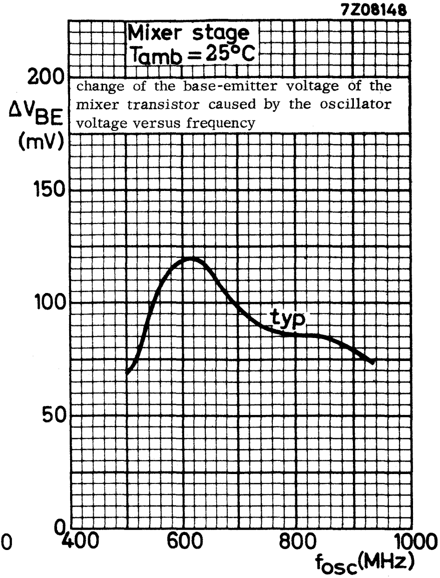


frequency change due to decrease of supply voltage versus oscillator frequency

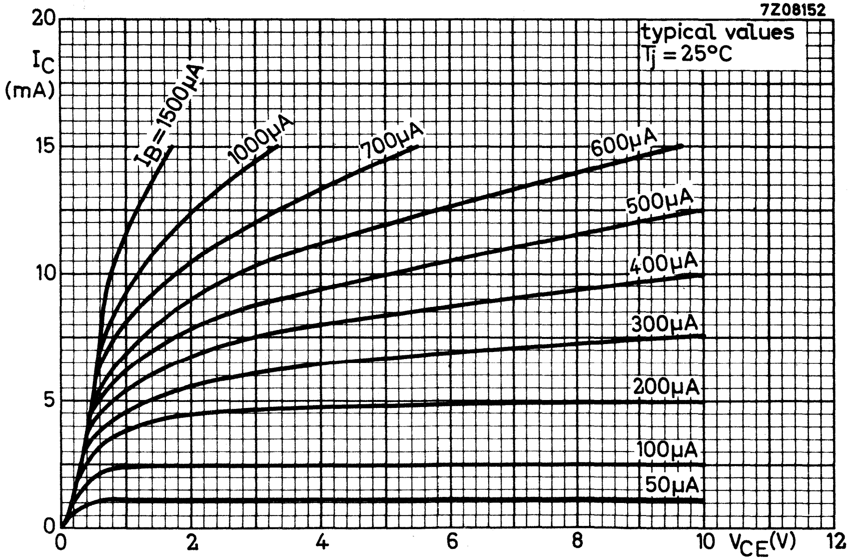
APPLICATION INFORMATION bulletin available on request

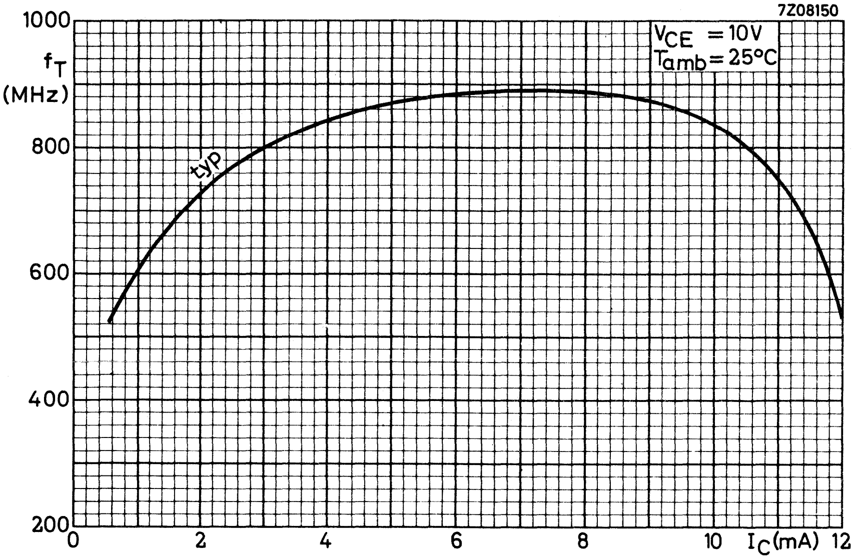


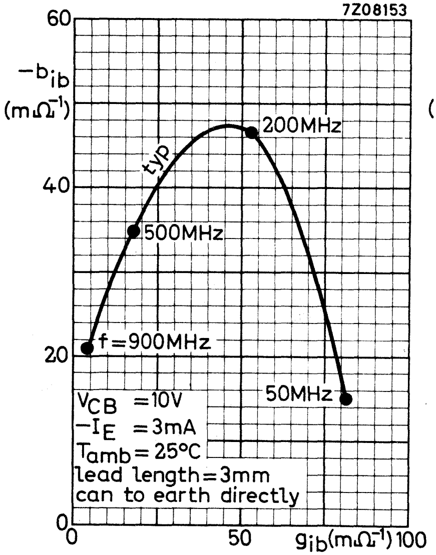
typical behaviour of the minimum required supply voltage for starting the oscillator versus oscillating frequency (V_{Snom} = 25 V)
Oscillating is guaranteed at $V_S > 22.5$ V

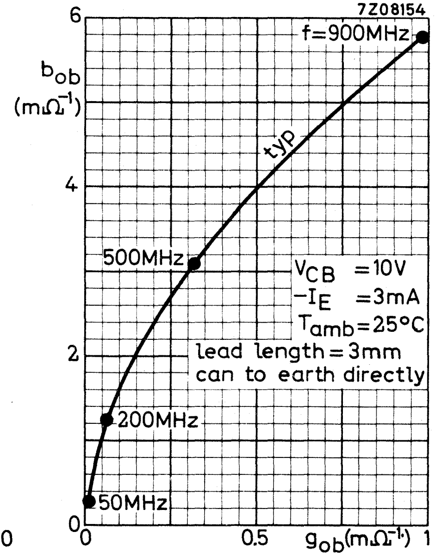


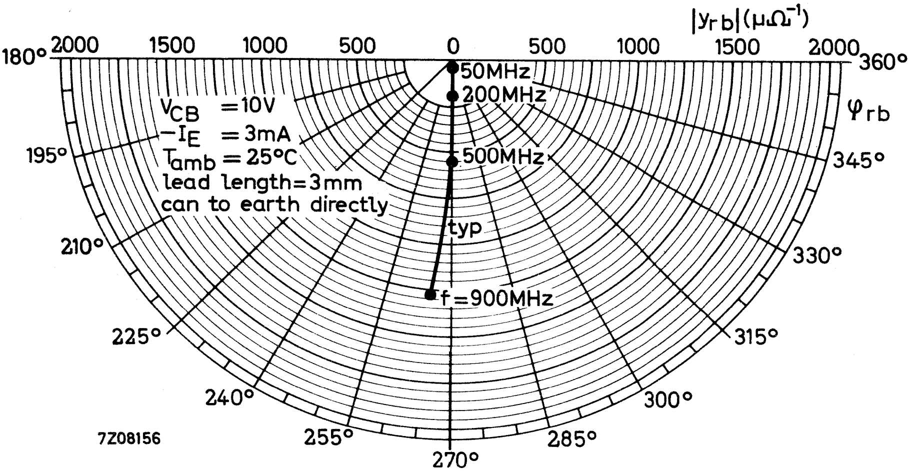
change of the base-emitter voltage of the mixer transistor caused by the oscillator voltage versus frequency

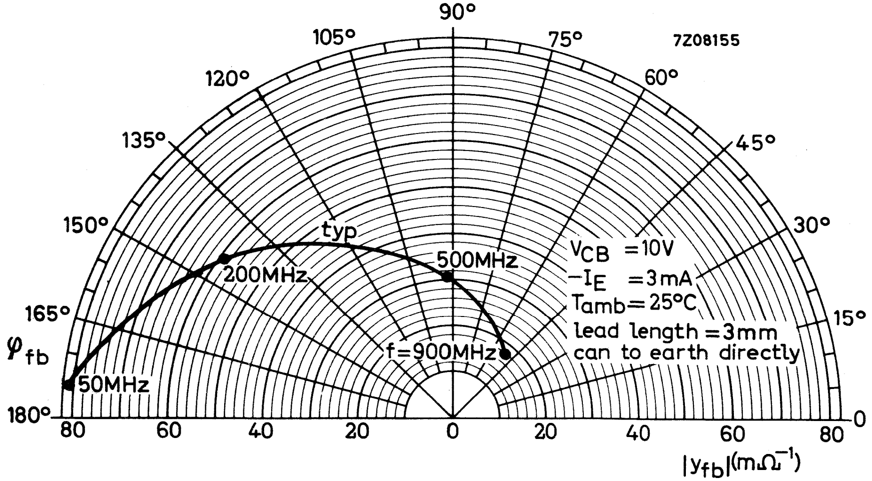


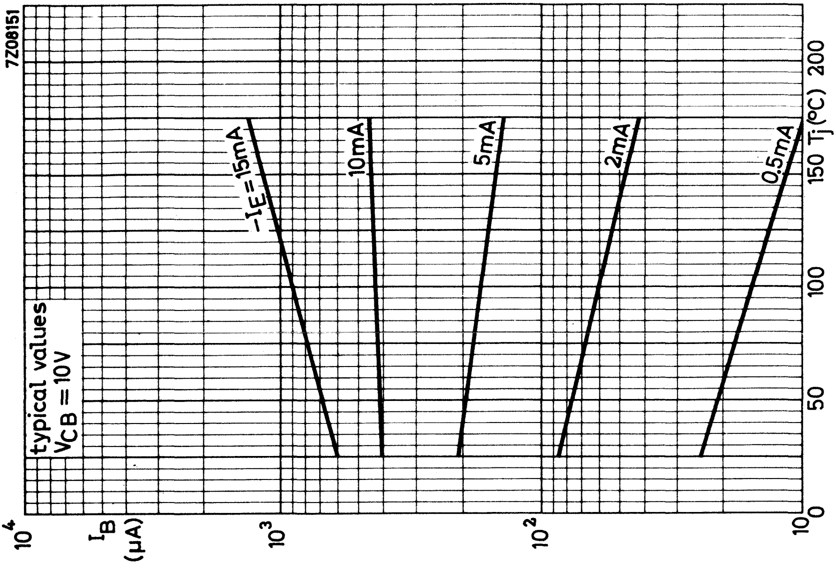

7Z08150
1000
f_T
(MHz)
800
600
400
200
0
2
4
6
8
10
I_C(mA)
12
V_{CE} = 10V
T_{amb} = 25°C
typ

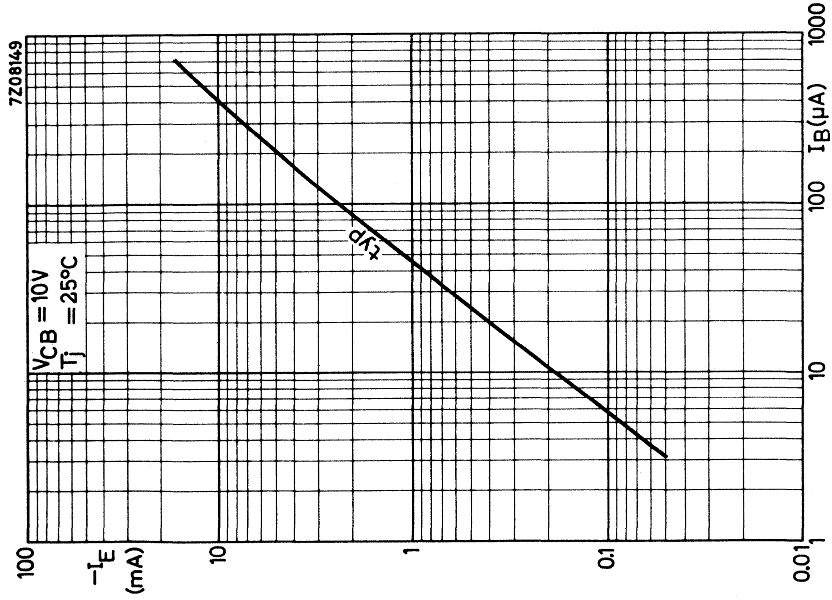

7Z08153
60
$-b_{ib}$
(mΩ^{-1})
40
20
0
0
50
g_{ib}(mΩ^{-1})
100
typ
200MHz
500MHz
f = 900MHz
50MHz
V_{CB} = 10V
$-I_E$ = 3mA
T_{amb} = 25°C
lead length = 3mm
can to earth directly


7Z08154
6
b_{ob}
(mΩ^{-1})
4
2
0
0
0.5
g_{ob}(mΩ^{-1})
1
f = 900MHz
typ
500MHz
200MHz
50MHz
V_{CB} = 10V
$-I_E$ = 3mA
T_{amb} = 25°C
lead length = 3mm
can to earth directly


|y_rb| (μΩ⁻¹)
2000
1500
1000
500
0
500
1000
1500
2000
180°
195°
210°
225°
240°
255°
270°
285°
300°
315°
330°
345°
360°
φrb
50MHz
200MHz
500MHz
typ
f=900MHz
VCB =10V
−IE =3mA
Tamb =25°C
lead length=3mm
can to earth directly
7Z08156


90°
105°
120°
135°
150°
165°
180°
75°
60°
45°
30°
15°
0
7Z08155
φfb
typ
200MHz
500MHz
f=900MHz
50MHz
VCB =10V
−IE =3mA
Tamb= 25°C
lead length =3mm
can to earth directly
80
60
40
20
0
20
40
60
80
|yfb| (mΩ⁻¹)


7Z08151
typical values
V_{CB} = 10V
$-I_E$ = 15mA
10mA
5mA
2mA
0.5mA
I_B (μA)
10^4
10^3
10^2
10
0
50
100
150
200
T_j (°C)


7Z08149
V_{CB} = 10V
T_j = 25°C
typ
$-I_E$ (mA)
100
10
1
0.1
0.01
1
10
100
1000
I_B (μA)

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.

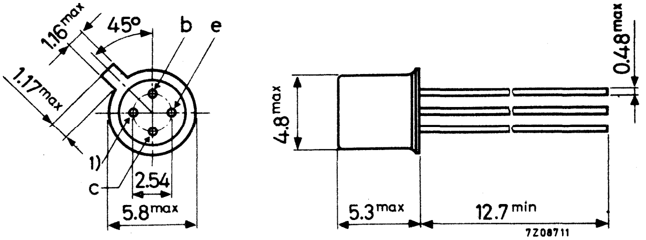
QUICK REFERENCE DATA

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 °C	P_{tot}	max.	145	mW
Junction temperature	T_j	max.	175	°C
D.C. current gain at T_j = 25 °C				
I_C = 1 mA; V_{CE} = 10 V	h_{FE}	typ.	115	
Transition frequency				
I_C = 1 mA; V_{CE} = 10 V	f_T	typ.	300	MHz

MECHANICAL DATA

Dimensions in mm

TO-72
Insulated electrodes



1) = shield lead (connected to case)

Accessories available: 56246, 56263.

FOR NEW DESIGN THE SUCCESSOR TYPE BF194 IS RECOMMENDED

RATINGS (Limiting values) [1]

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 °C	P_{tot}	max.	145	mW
Temperatures				
Storage temperature	T_{stg}	−65 to +175		°C
Junction temperature	T_j	max.	175	°C

THERMAL RESISTANCE

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

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Base-emitter voltage [2]				
I_C = 1 mA; V_{CE} = 10 V	V_{BE}	0.65 to 0.74		V
I_C = 20 mA; V_{CE} = 2 V	V_{BE}	<	1.0	V
Feedback capacitance at f = 0.45 MHz				
I_C = 1 mA; V_{CE} = 10 V	$-C_{re}$	typ.	0.65	pF
D.C. current gain				
I_C = 1 mA; V_{CE} = 10 V	h_{FE}	75 to	750	
		typ.	115	
Transition frequency				
I_C = 1 mA; V_{CE} = 10 V	f_T	typ.	300	MHz
Conversion noise figure				
I_C = 1 mA; V_{CE} = 10 V				
G_S = 0.6 mΩ^{-1}; f = 0.2 MHz	F_c	typ.	3	dB
G_S = 1.2 mΩ^{-1}; f = 1.0 MHz	F_c	typ.	2	dB

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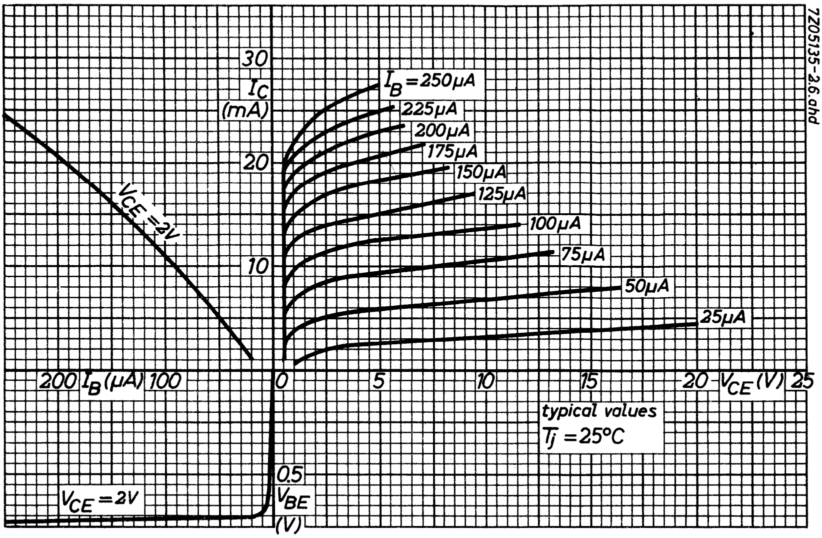
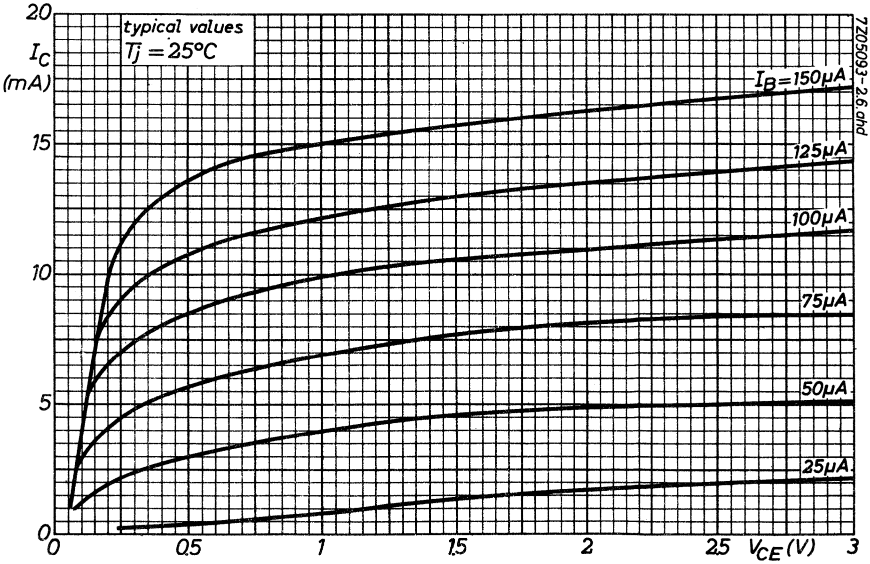
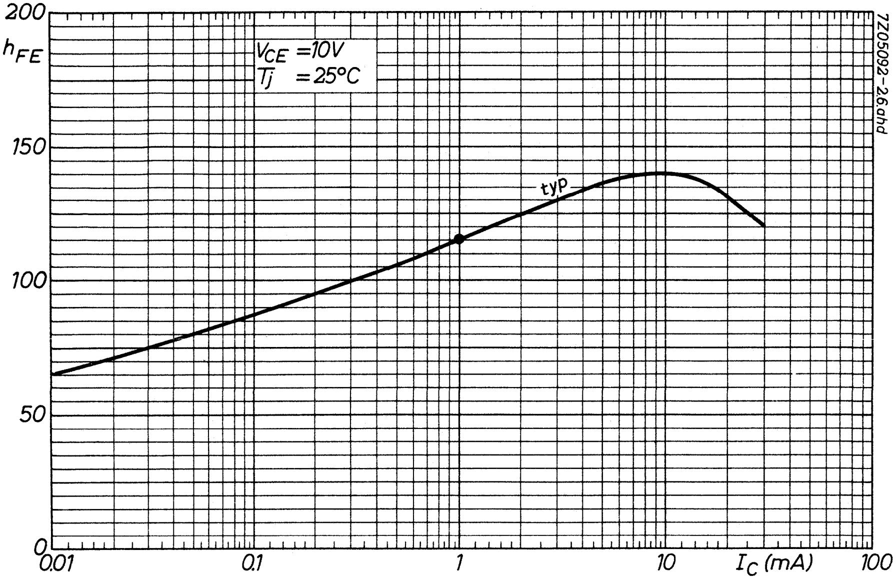
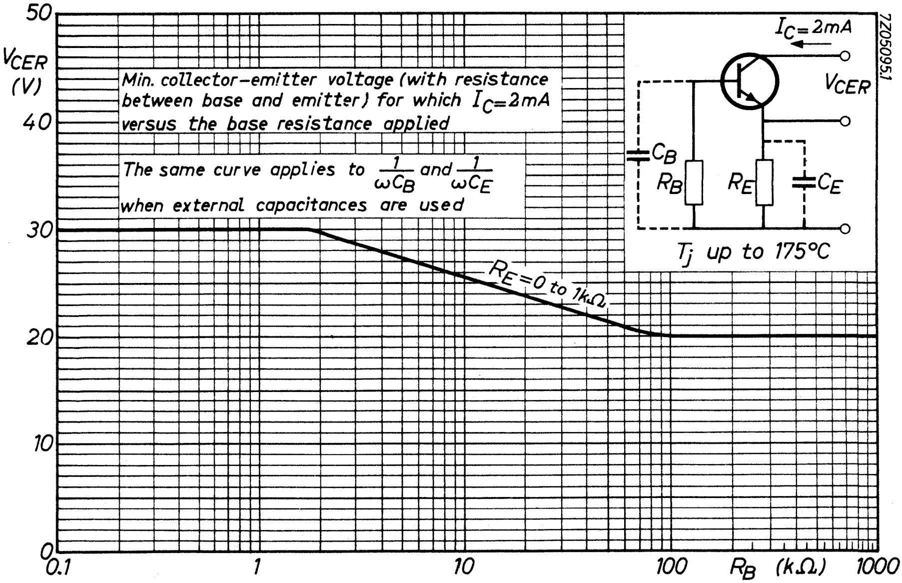
[1] Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

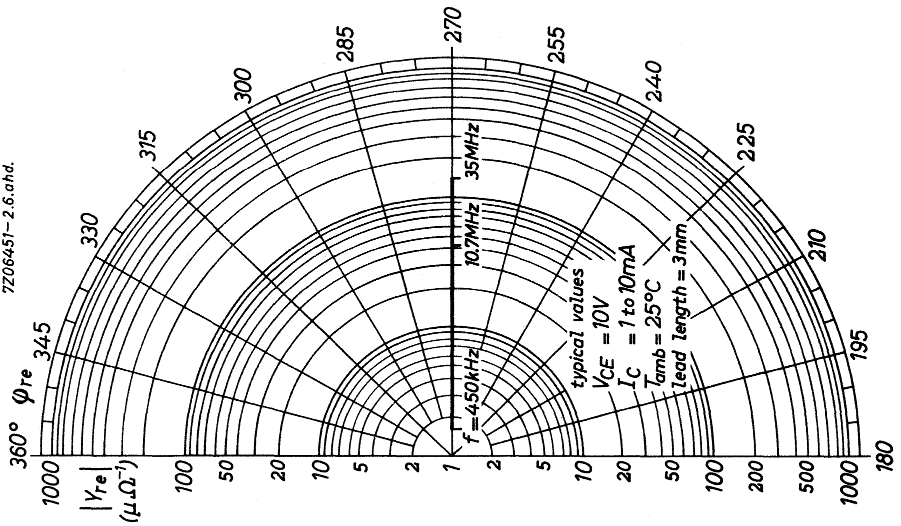
[2] V_{BE} decreases with about 1.7 mV/°C at increasing temperature.

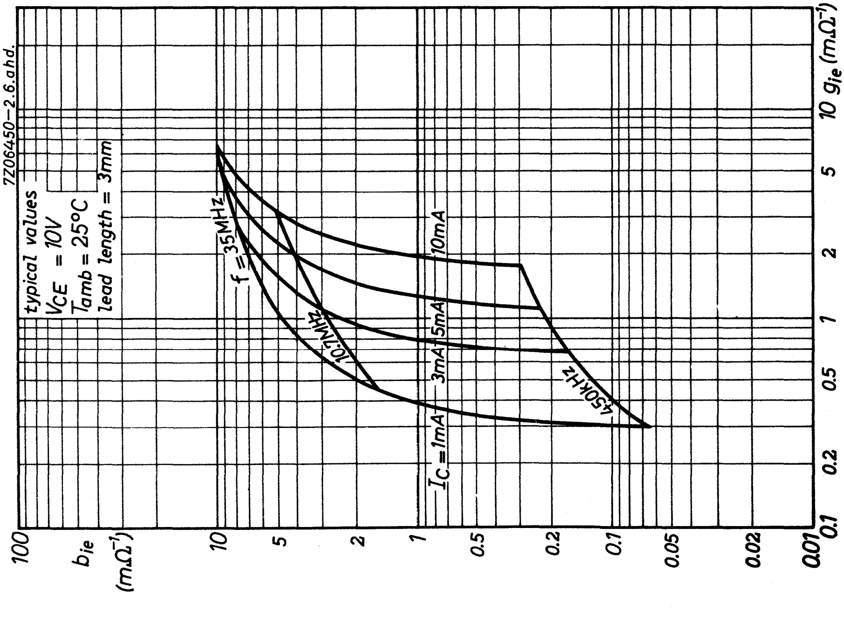

7Z05135-2.6.ahd
30
I_C
(mA)
20
10
$I_B = 250 \mu A$
225µA
200µA
175µA
150µA
125µA
100µA
75µA
50µA
25µA
$V_{CE} = 2V$
200 I_B (µA) 100
0
5
10
15
20 V_{CE} (V) 25
typical values
$T_j = 25°C$
0.5
V_{BE}
(V)
$V_{CE} = 2V$

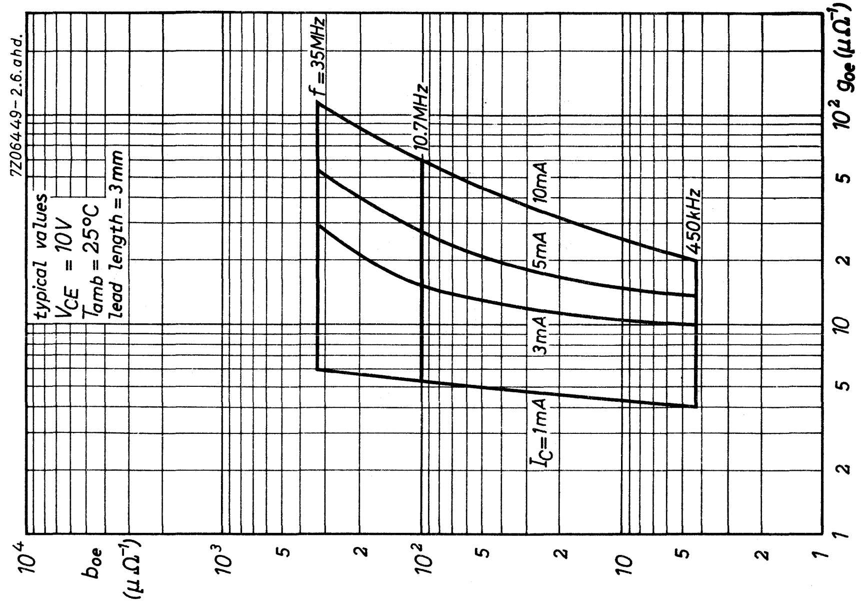

20
I_C
(mA)
15
10
5
0
typical values
$T_j = 25°C$
7Z05093-2.6.ahd
$I_B = 150 \mu A$
125µA
100µA
75µA
50µA
25µA
0
0.5
1
1.5
2
2.5 V_{CE} (V) 3

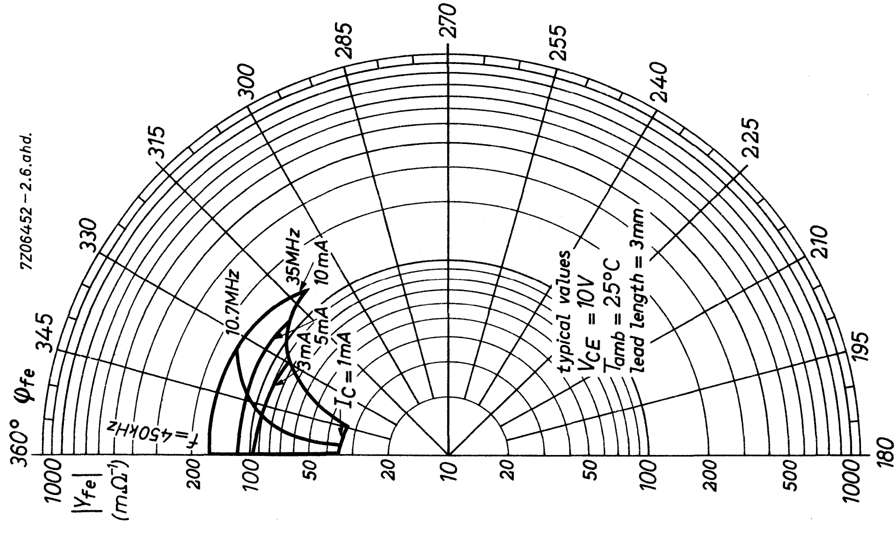

200
h_{FE}
150
100
50
0
0.01
0.1
1
10
I_C (mA)
100
V_{CE} =10V
T_j =25°C
typ
7Z05092-2.6ahd


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


7Z06451–2.6.ahd.
360°
φ_{re}
345
330
315
300
285
270
255
240
225
210
195
180
$|y_{re}|$
($\mu\Omega^{-1}$)
1000
100
50
20
10
5
2
1
2
5
10
20
50
100
200
500
1000
f = 450kHz
10.7MHz
35MHz
typical values
V_{CE} = 10V
I_C = 1 to 10mA
T_{amb} = 25°C
lead length = 3mm


7Z06450–2.6.ahd.
typical values
V_{CE} = 10V
T_{amb} = 25°C
lead length = 3mm
b_{ie}
($m\Omega^{-1}$)
100
10
5
2
1
0.5
0.2
0.1
0.05
0.02
0.01
0.1
0.2
0.5
1
2
5
10
g_{ie} ($m\Omega^{-1}$)
f = 35MHz
10.7MHz
450kHz
I_C = 1mA
3mA
5mA
10mA


7Z06449-2.6.ahd.
typical values
V_{CE} = 10V
T_{amb} = 25°C
lead length = 3mm
f = 35MHz
10.7MHz
450kHz
I_C=1mA
3mA
5mA
10mA
b_{oe} ($\mu\Omega^{-1}$)
10^4
10^3
5
2
10^2
5
2
10
5
2
1
g_{oe} ($\mu\Omega^{-1}$)
10^2
5
2
10
5
2
1


7Z06452-2.6.ahd.
φ_{fe}
360°
345
330
315
300
285
270
255
240
225
210
195
180
$|Y_{fe}|$ ($m\Omega^{-1}$)
1000
200
100
50
20
10
20
50
100
200
500
1000
f=450kHz
10.7MHz
35MHz
10mA
5mA
3mA
I_C=1mA
typical values
V_{CE} = 10V
T_{amb} = 25°C
lead length = 3mm

SILICON PLANAR EPITAXIAL TRANSISTOR

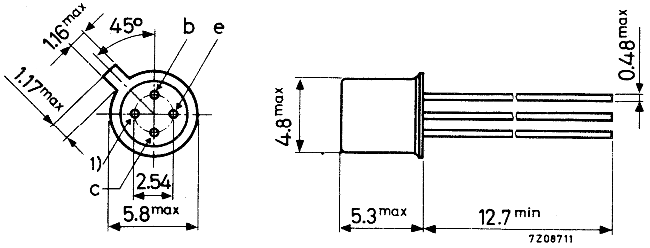
N-P-N transistor in a TO-72 metal case with insulated electrodes and a shield lead connected to the case; the same transistor is available in lock-fit encapsulation under the type number BF195.
The BF185 is intended for h.f. applications in radio and television receivers; it is especially recommended 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 $T_{amb} = 45\ ^oC$	P_{tot}	max.	145	mW
Junction temperature	T_j	max.	175	^oC
D.C. current gain at $T_j = 25\ ^oC$				
$I_C = 1$ mA; $V_{CE} = 10$ V	h_{FE}	typ.	67	
Transition frequency				
$I_C = 1$ mA; $V_{CE} = 10$ V	f_T	typ.	220	MHz
Noise figure at f = 100 MHz				
$I_C = 1$ mA; $V_{CE} = 10$ V; $G_S = 10\ m\Omega^{-1}$	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 TYPE BF195 IS RECOMMENDED

RATINGS (Limiting values) [1]

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 $T_{amb} = 45\ ^{o}C$	P_{tot}	max.	145	mW
Temperatures				
Storage temperature	T_{stg}	−65 to +175		°C
Junction temperature	T_j	max.	175	°C

THERMAL RESISTANCE

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

CHARACTERISTICS

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

Base-emitter voltage [2]				
$I_C = 1$ mA; $V_{CE} = 10$ V	V_{BE}	0.65 to 0.74		V
$I_C = 20$ mA; $V_{CE} = 2$ V	V_{BE}	<	1.0	V
Feedback capacitance at f = 0.45 MHz				
$I_C = 1$ mA; $V_{CE} = 10$ V	$-C_{re}$	typ.	0.65	pF
D.C. current gain				
$I_C = 1$ mA; $V_{CE} = 10$ V	h_{FE}	34 to typ.	140 67	
Transition frequency				
$I_C = 1$ mA; $V_{CE} = 10$ V	f_T	typ.	220	MHz

---

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

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

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

Noise figure

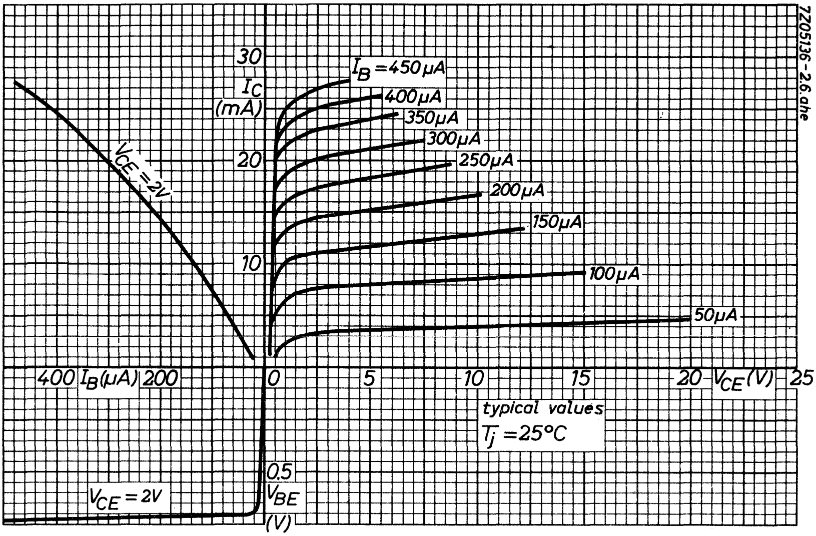
I_C = 1 mA; V_{CE} = 10 V				
f = 0.2 MHz; G_S = 5 mΩ^{-1}	F	typ.	2	dB
f = 1 MHz; G_S = 20 mΩ^{-1}	F	typ.	3.5	dB
f = 100 MHz; G_S = 10 mΩ^{-1}	F	typ.	4	dB

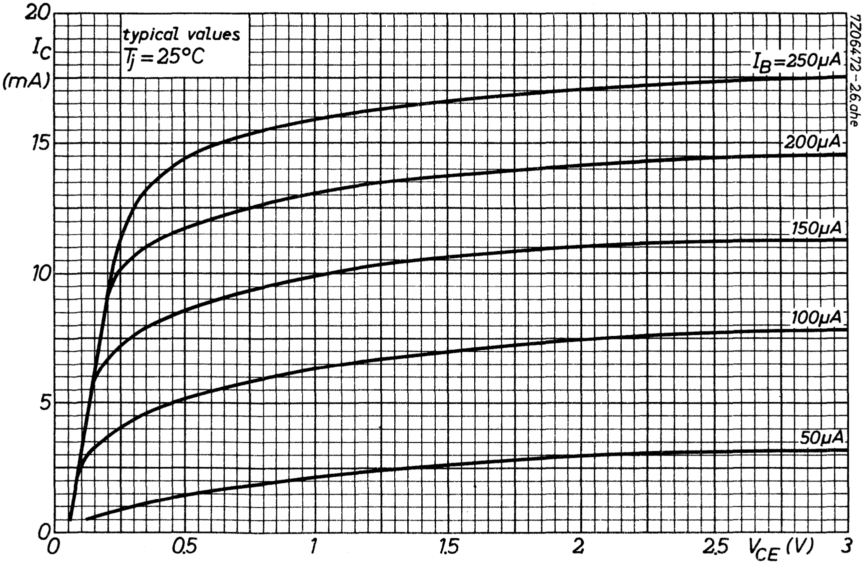
y parameters at f = 100 MHz (common base)

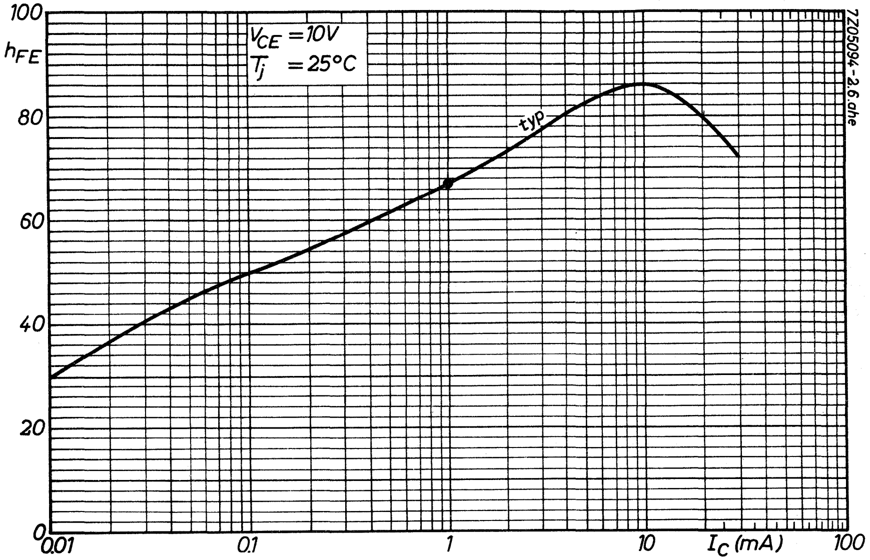
$-I_E$ = 1 mA; V_{CB} = 10 V				
Input conductance	g_{ib}	typ.	33	mΩ^{-1}
Input capacitance	$-C_{ib}$	typ.	5.5	pF
Feedback admittance	$\lvert y_{rb}\rvert$	typ.	220	$\mu\Omega^{-1}$
Phase angle of feedback admittance	φ_{rb}	typ.	273°	
Transfer admittance	$\lvert y_{fb}\rvert$	typ.	33	mΩ^{-1}
Phase angle of transfer admittance	φ_{fb}	typ.	150°	
Output conductance	g_{ob}	typ.	12	$\mu\Omega^{-1}$
Output capacitance	C_{ob}	typ.	1.5	pF

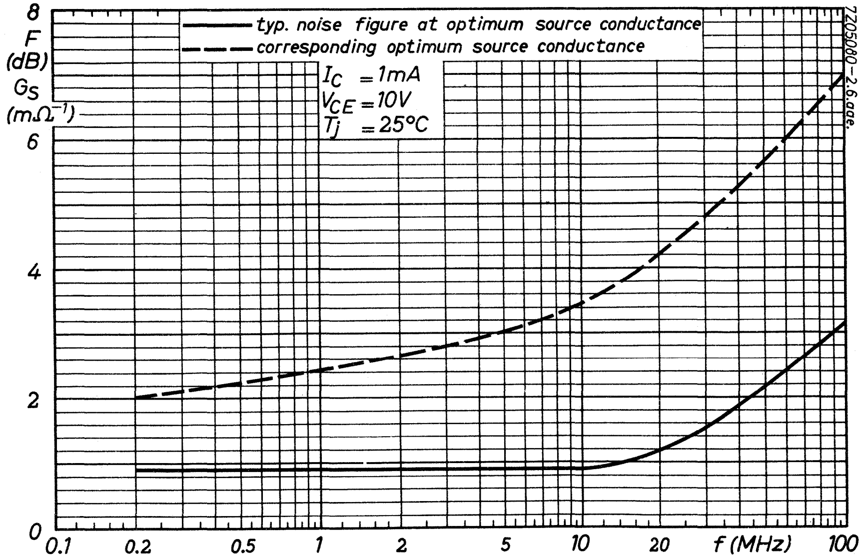
NOTE

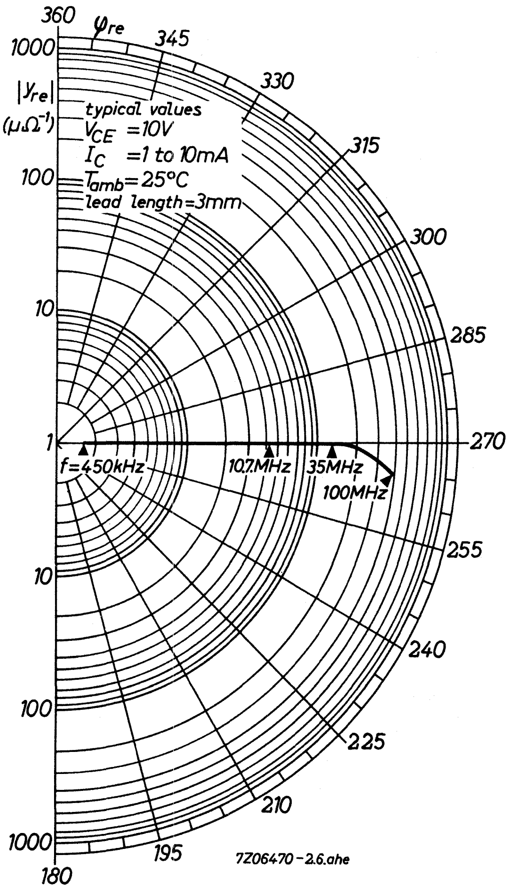
All small signal quantities have been measured with a length of leads between the bottom of the transistor and measuring jig of 3 mm.

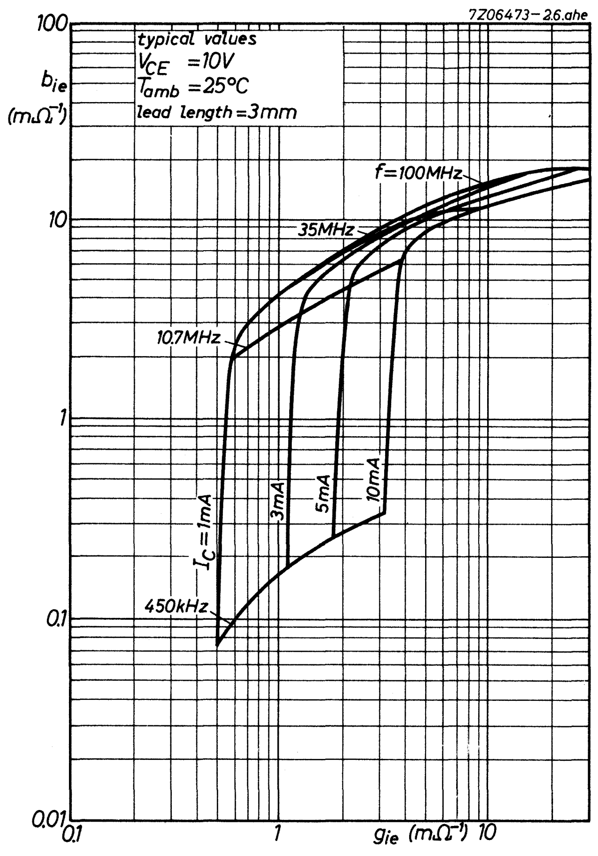

7Z05136-2.6.ahe
30
I_C
(mA)
20
10
I_B = 450 µA
400 µA
350 µA
300 µA
250 µA
200 µA
150 µA
100 µA
50 µA
V_{CE} = 2V
400
I_B(µA)
200
0
5
10
15
20
V_{CE}(V)
25
typical values
T_j = 25°C
0.5
V_{BE}
(V)
V_{CE} = 2V

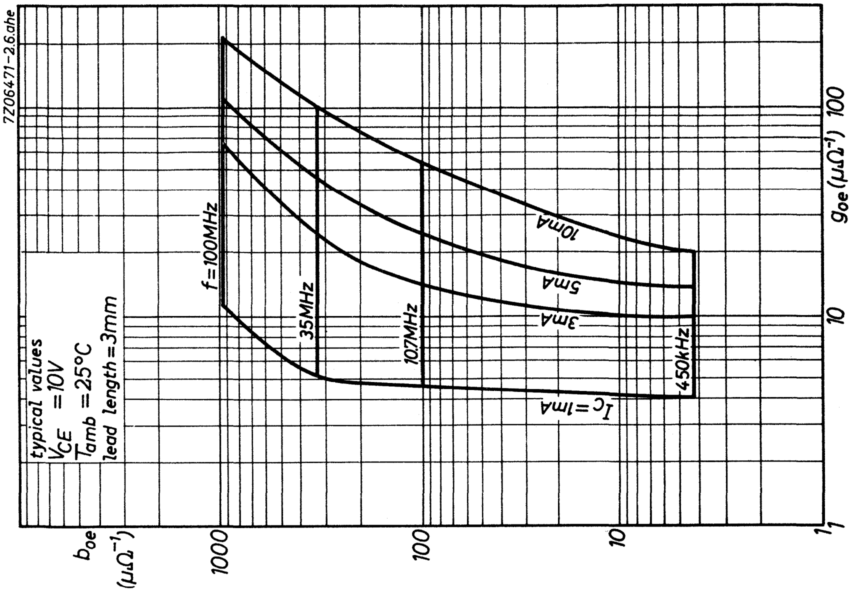

7Z06472-2.6.ahe
20
I_C
(mA)
15
10
5
0
typical values
T_j = 25°C
I_B = 250 µA
200 µA
150 µA
100 µA
50 µA
0
0.5
1
1.5
2
2.5
V_{CE} (V)
3

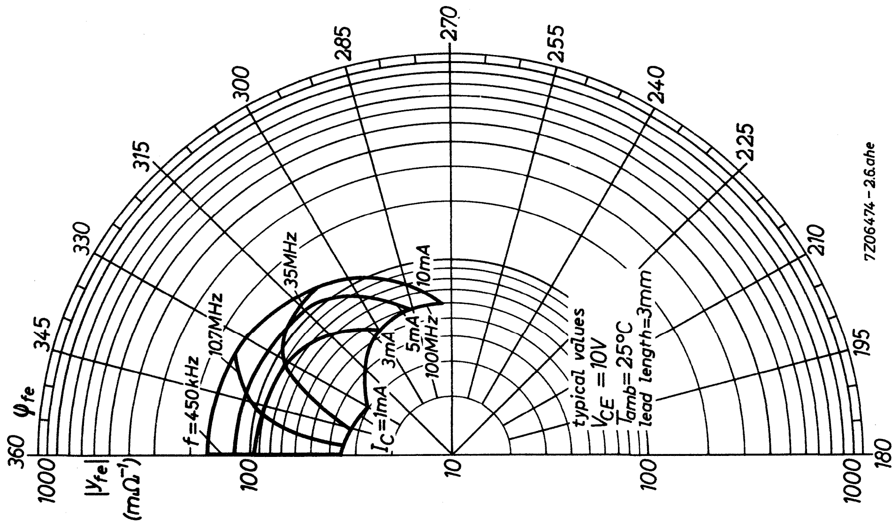

100
h_{FE}
80
60
40
20
0
V_{CE} = 10V
T_j = 25°C
typ
7Z05094-2.6.ahe
0.01
0.1
1
10
I_C (mA)
100

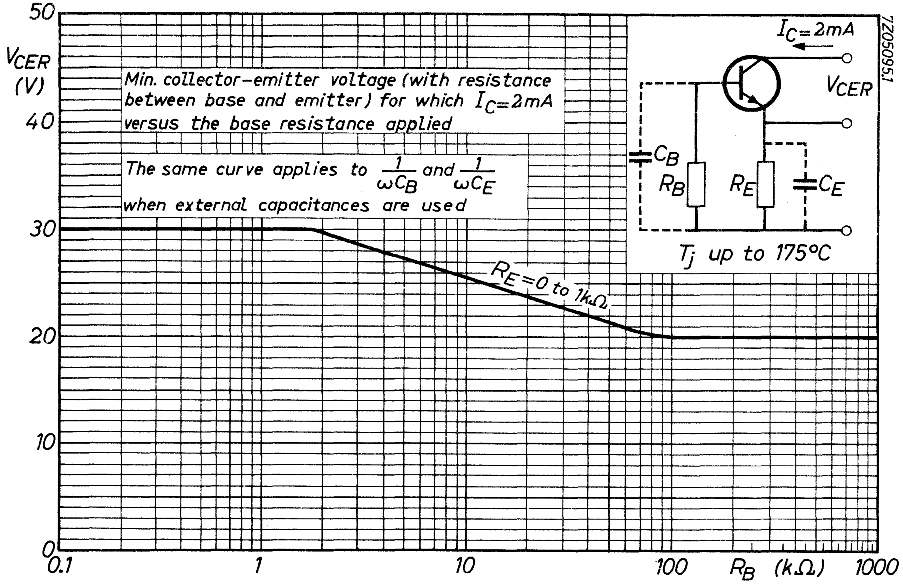

8
F
(dB)
G_S
(mΩ^{-1})
6
4
2
0
typ. noise figure at optimum source conductance
corresponding optimum source conductance
I_C = 1mA
V_{CE} = 10V
T_j = 25°C
7Z05080-2.6.aae.
0.1
0.2
0.5
1
2
5
10
20
f (MHz)
100


360
φ_{re}
345
330
315
300
285
270
255
240
225
210
195
180
1000
$|y_{re}|$
$(\mu\Omega^{-1})$
100
10
1
10
100
1000
typical values
V_{CE} = 10V
I_C = 1 to 10mA
T_{amb} = 25°C
lead length = 3mm
f = 450kHz
10.7MHz
35MHz
100MHz
7Z06470-2.6.ahe


100
b_{ie}
$(m\Omega^{-1})$
10
1
0.1
0.01
0.1
1
g_{ie} $(m\Omega^{-1})$
10
typical values
V_{CE} = 10V
T_{amb} = 25°C
lead length = 3mm
f = 100MHz
35MHz
10.7MHz
450kHz
I_C = 1mA
3mA
5mA
10mA
7Z06473-2.6.ahe


7Z06471-2.6.ahe
typical values
V_{CE} = 10V
T_{amb} = 25°C
lead length = 3mm
f=100MHz
35MHz
10.7MHz
450kHz
I_C=1mA
3mA
5mA
10mA
b_{oe} ($\mu\Omega^{-1}$)
1000
100
10
1
g_{oe} ($\mu\Omega^{-1}$)
100
10
1


7Z06474-2.6.ahe
φ_{fe}
360
345
330
315
300
285
270
255
240
225
210
195
180
$|y_{fe}|$ ($m\Omega^{-1}$)
1000
100
10
100
1000
f=450kHz
10.7MHz
35MHz
100MHz
I_C=1mA
3mA
5mA
10mA
typical values
V_{CE} = 10V
T_{amb} = 25°C
lead length = 3mm


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

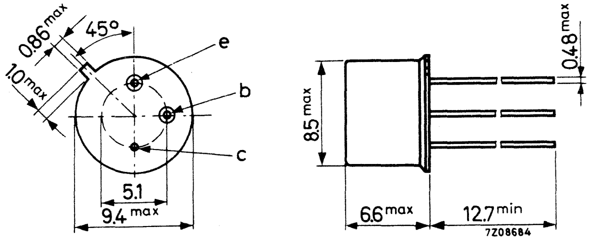
SILICON PLANAR TRANSISTOR FOR LUMINANCE AMPLIFIERS

N-P-N transistor in a TO-39 metal envelope with the collector connected to the case. The BF186 is intended for use in the output stage of the luminance amplifier in colour television receivers.

QUICK REFERENCE DATA				
Collector-base voltage (open emitter)	V_{CBO}	max.	190	V
Collector-emitter voltage ($R_B \leq 1$ kΩ)	V_{CER}	max.	190	V
Collector current (peak value)	I_{CM}	max.	60	mA
Total power dissipation up to $T_{amb} = 55$ °C	P_{tot}	max.	0.725	W
up to $T_{mb} = 145$ °C	P_{tot}	max.	2.75	W
Junction temperature	T_j	max.	200	°C
D.C. current gain at $T_j = 25$ °C				
$I_C = 40$ mA; $V_{CE} = 20$ V	h_{FE}	>	20	
Transition frequency				
$I_C = 10$ mA; $V_{CE} = 10$ V	f_T	typ.	120	MHz
Feedback capacitance				
$I_C = 10$ mA; $V_{CE} = 20$ V	$-C_{re}$	typ.	1.8	pF

MECHANICAL DATA

Collector connected to case
TO-39



Accessories available: 56218; 56245; 56265

FOR NEW DESIGN THE SUCCESSOR TYPE BD115 IS RECOMMENDED

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

Voltages				
Collector-base voltage (open emitter)	V_{CBO}	max.	190	V
Collector-emitter voltage ($R_B \leq 1$ kΩ)	V_{CER}	max.	190	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	V
Currents				
Collector current (d.c.)	I_C	max.	60	mA
Collector current (peak value)	I_{CM}	max.	60	mA
Power dissipation				
Total power dissipation up to T_{amb} = 55 °C (in free air)	P_{tot}	max.	0.725	W
T_{mb} = 145 °C	P_{tot}	max.	2.75	W
Temperatures				
Storage temperature	T_{stg}		-55 to +175	°C
Junction temperature	T_j	max.	200	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	200	°C/W
From junction to mounting base	$R_{th\ j\text{-}mb}$	=	20	°C/W

CHARACTERISTICS T_j = 25 °C unless otherwise specified

D.C. current gain				
I_C = 40 mA; V_{CE} = 20 V	h_{FE}	>	**20**	
Feedback capacitance at f = 0.5 MHz				
I_C = 10 mA; V_{CE} = 20 V	$-C_{re}$	typ. <	1.8 3.5	pF pF
Transition frequency				
I_C = 10 mA; V_{CE} = 10 V	f_T	typ.	120	MHz

SILICON PLANAR EPITAXIAL TRANSISTOR

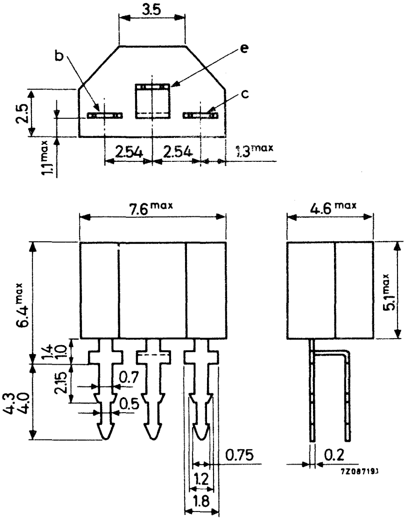
N-P-N transistor in a plastic envelope with stiff, self-locking pins suitable for use with standard printed boards.
The BF194 is intended for h.f. applications in radio and television receivers; it is especially recommended for f.m. tuners, low noise a.m. mixer-oscillators with high source impedance 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 $T_{amb} = 25\,^{\circ}C$	P_{tot}	max.	250	mW
Junction temperature	T_j	max.	125	°C
D.C. current gain at $T_j = 25\,^{\circ}C$				
$I_C = 1$ mA; $V_{CE} = 10$ V	h_{FE}	typ.	115	
Transition frequency				
$I_C = 1$ mA; $V_{CE} = 10$ V	f_T	typ.	260	MHz
Noise figure at f = 100 MHz				
$I_C = 1$ mA; $V_{CE} = 10$ V; $G_S = 10\,m\Omega^{-1}$	F	typ.	4	dB
Conversion noise figure at f = 1 MHz				
$I_C = 1$ mA; $V_{CE} = 10$ V; $G_S = 1.2\,m\Omega^{-1}$	F_c	typ.	2	dB

MECHANICAL DATA

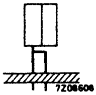
Dimensions in mm



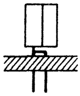
The envelope fulfils the accelerated damp heat test described in IEC publication 68-2 (test D, severity IV, 6 cycles).

MOUNTING INSTRUCTIONS

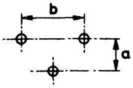
1. Thickness of printed board: max. 1.1 mm
   Hole diameter 0.77 to 0.83 mm



2. Thickness of printed board: max. 1.7 mm
   Hole diameter 1.25 to 1.35 mm



Bore plan



a = 2.49 to 2.59 mm
b = 5.03 to 5.13 mm

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 °C	P_{tot}	max.	250	mW

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	$R_{th\ j\text{-}a}$	=	0.4	°C/mW

CHARACTERISTICS

T_j = 25 °C

Base-emitter voltage [1]

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

Base current

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

Feedback capacitance at f = 0.45 MHz

I_C = 1 mA; V_{CE} = 10 V	$-C_{re}$	typ.	0.95	pF

Transition frequency

I_C = 1 mA; V_{CE} = 10 V	f_T	typ.	260	MHz

Noise figure

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

G_S = 2 $m\Omega^{-1}$; f = 0.2 MHz	F	typ.	1.5	dB
G_S = 1.5 $m\Omega^{-1}$; f = 1.0 MHz	F	typ.	1.2	dB
G_S = 10 $m\Omega^{-1}$; f = 100 MHz	F	typ.	4	dB

Conversion noise figure

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

G_S = 0.6 $m\Omega^{-1}$; f = 0.2 MHz	F_c	typ.	3	dB
G_S = 1.2 $m\Omega^{-1}$; f = 1.0 MHz	F_c	typ.	2	dB

y parameters at f = 100 MHz (common base)

I_C = 1 mA; V_{CE} = 10 V (lead length = 3 mm)

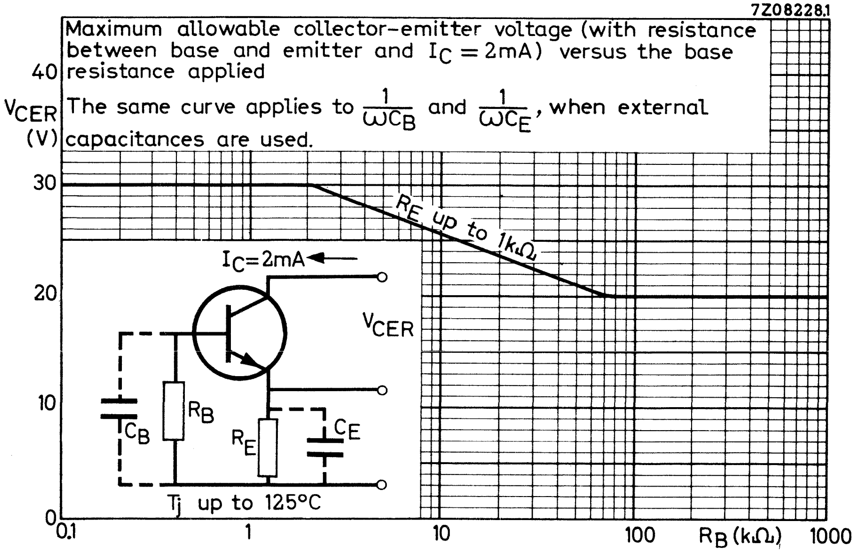
Input conductance	g_{ib}	typ.	36	$m\Omega^{-1}$
Input susceptance	$-b_{ib}$	typ.	3	$m\Omega^{-1}$
Feedback admittance	$\lvert y_{rb} \rvert$	typ.	450	$\mu\Omega^{-1}$
Phase angle of feedback admittance	φ_{rb}	typ.	272°	
Tranfer admittance	$\lvert y_{fb} \rvert$	typ.	33	$m\Omega^{-1}$
Phase angle of transfer admittance	φ_{fb}	typ.	146°	
Output conductance	g_{ob}	typ.	22	$\mu\Omega^{-1}$
Output susceptance	b_{ob}	typ.	1.1	$m\Omega^{-1}$

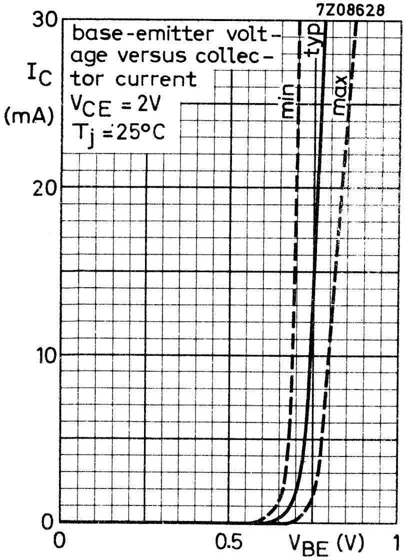
y parameters (common emitter)

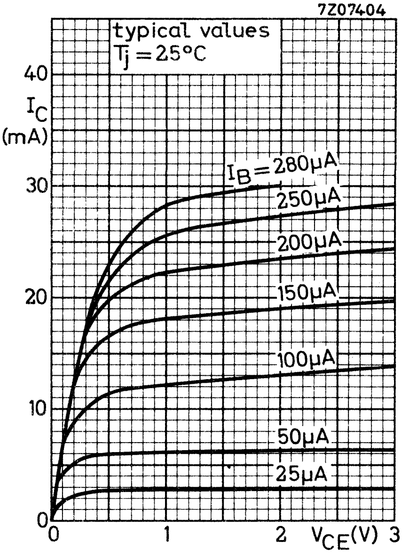
I_C = 1 mA; V_{CE} = 10 V (lead length = 3 mm)			f = 10.7 MHz	f = 0.45 MHz	
Input conductance	g_{ie}	<	0.64	0.54	$m\Omega^{-1}$
Output conductance	g_{oe}	<	13.5	11.5	$\mu\Omega^{-1}$

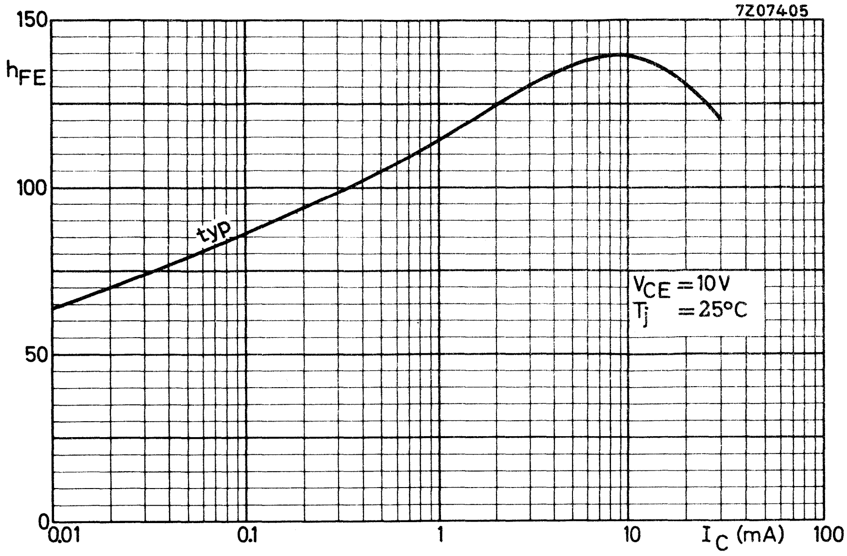
---

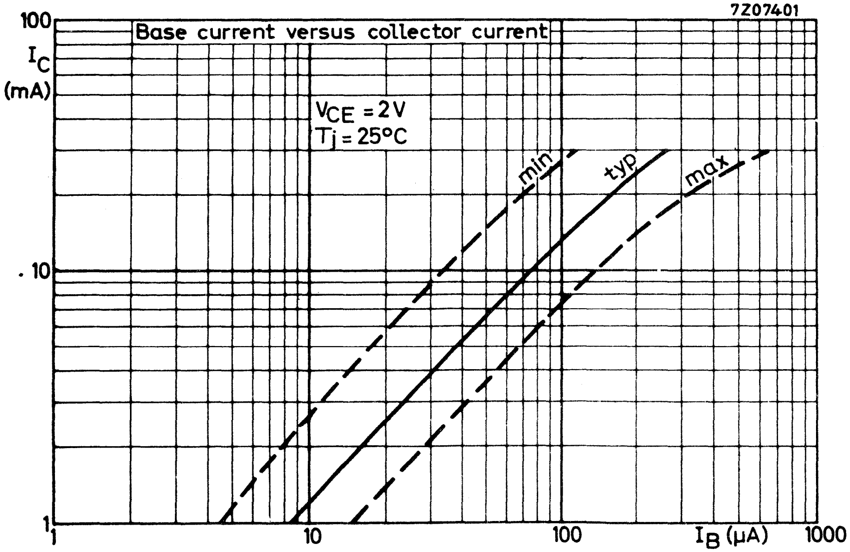
[1] V_{BE} decreases by about 1.7 mV/°C with increasing temperature.

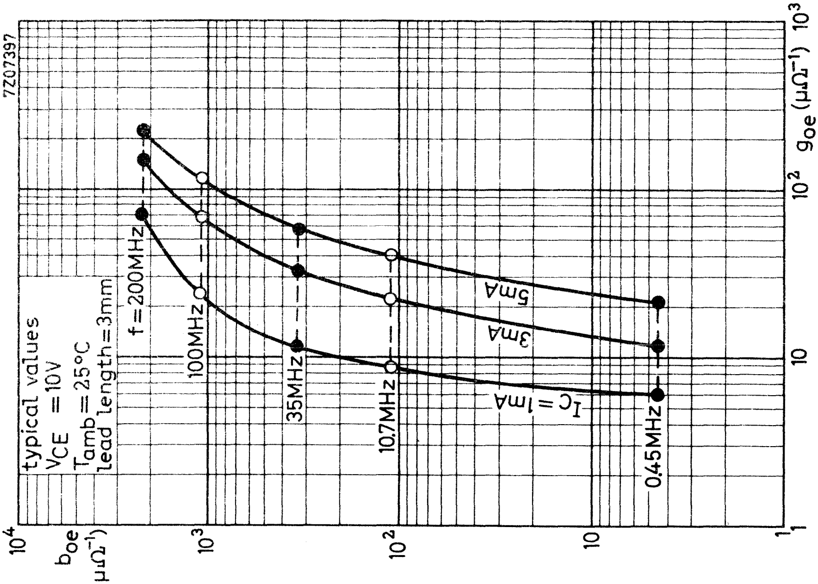

7Z08228.1
Maximum allowable collector-emitter voltage (with resistance between base and emitter and $I_C = 2mA$) versus the base resistance applied
The same curve applies to $\frac{1}{\omega C_B}$ and $\frac{1}{\omega C_E}$, when external capacitances are used.
V_{CER} (V)
40
30
20
10
0
0.1
1
10
100
R_B (kΩ)
1000
RE up to 1kΩ
I_C=2mA
V_{CER}
R_B
C_B
R_E
C_E
T_j up to 125°C

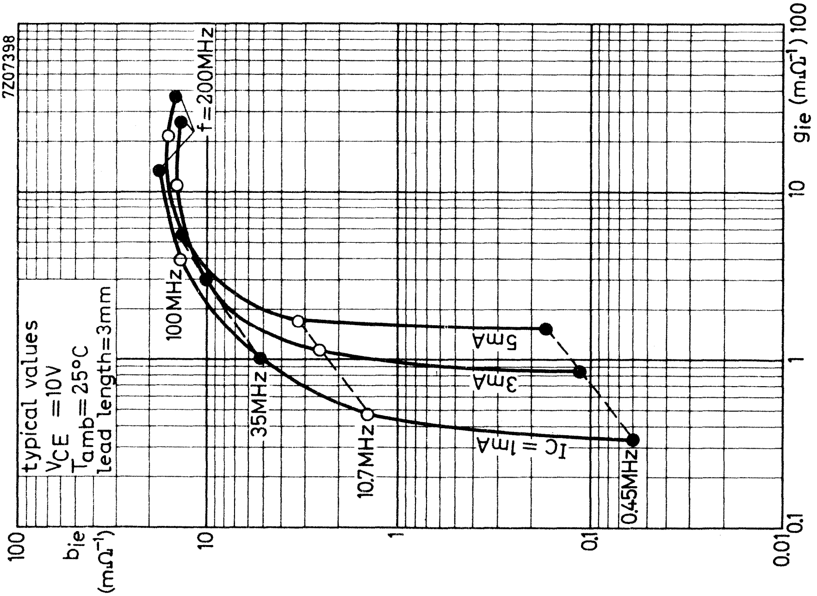

7Z08628
base-emitter voltage versus collector current
V_{CE} = 2V
T_j = 25°C
I_C (mA)
30
20
10
0
min
typ
max
0
0.5
V_{BE} (V)
1

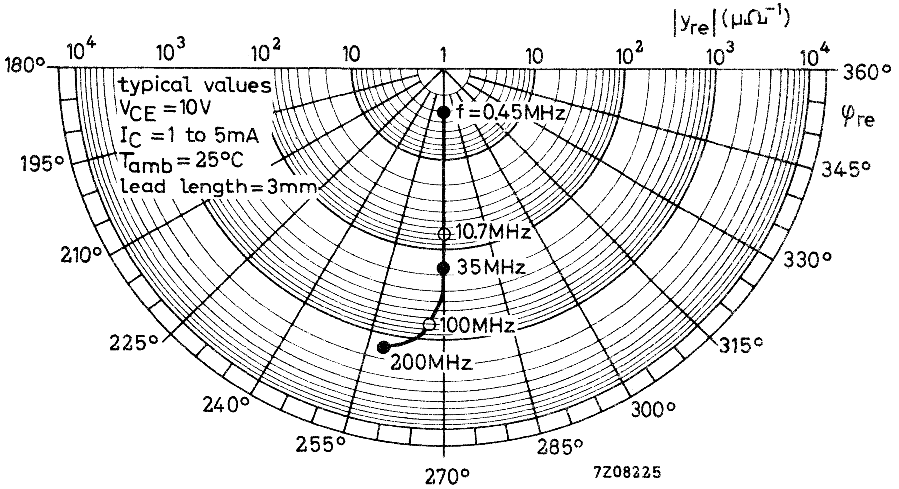

7Z07404
typical values
T_j = 25°C
I_C (mA)
40
30
20
10
0
I_B = 280μA
250μA
200μA
150μA
100μA
50μA
25μA
0
1
2
V_{CE}(V)
3

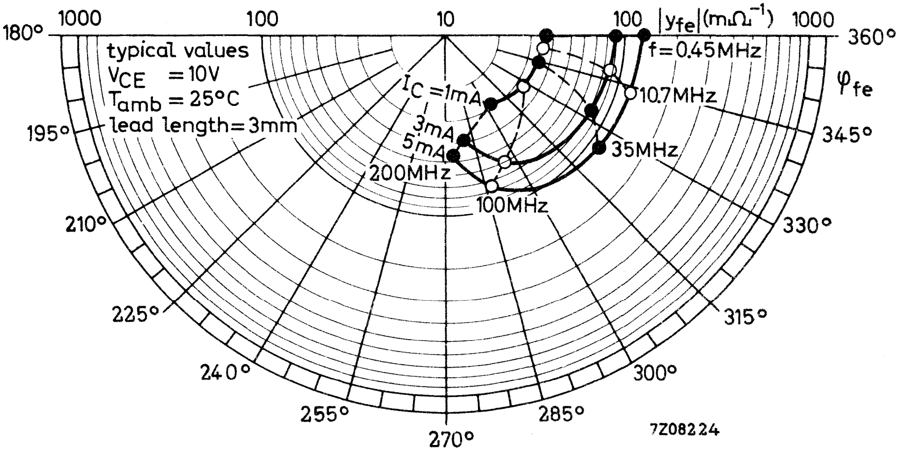

7Z07405
150
hFE
100
50
0
0.01
0.1
1
10
IC (mA)
100
typ
VCE = 10 V
Tj = 25°C

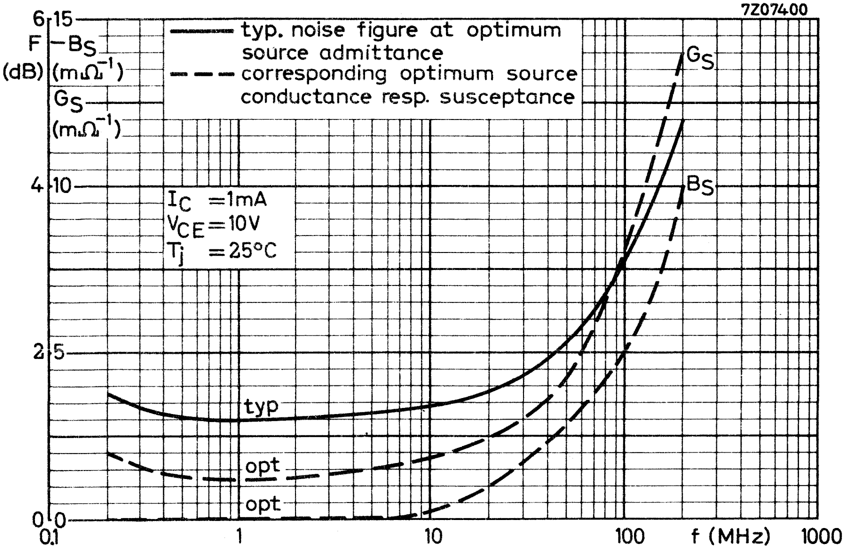

7Z07401
Base current versus collector current
100
IC
(mA)
10
1
1
10
100
IB (µA)
1000
VCE = 2 V
Tj = 25°C
min
typ
max

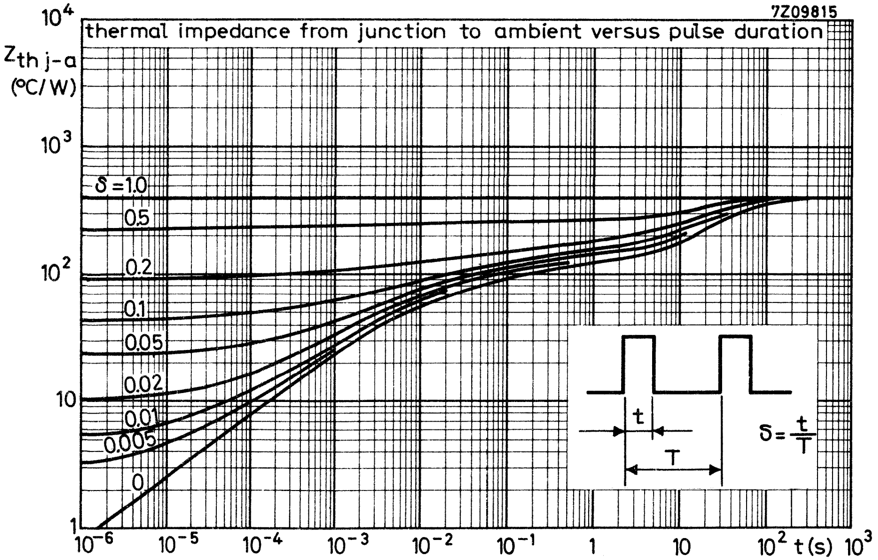

7Z07397
typical values
V_{CE} = 10V
T_{amb} = 25°C
lead length = 3mm
f = 200MHz
100MHz
35MHz
10.7MHz
0.45MHz
I_C = 1mA
3mA
5mA
b_{oe} ($\mu\Omega^{-1}$)
10^4
10^3
10^2
10
1
g_{oe} ($\mu\Omega^{-1}$)
1
10
10^2
10^3


7Z07398
typical values
V_{CE} = 10V
T_{amb} = 25°C
lead length = 3mm
f = 200MHz
100MHz
35MHz
10.7MHz
0.45MHz
I_C = 1mA
3mA
5mA
b_{ie} ($m\Omega^{-1}$)
100
10
1
0.1
0.01
g_{ie} ($m\Omega^{-1}$)
0.1
1
10
100


|y_re| (μΩ⁻¹)
10⁴
10³
10²
10
1
10
10²
10³
10⁴
180°
195°
210°
225°
240°
255°
270°
285°
300°
315°
330°
345°
360°
φ_re
typical values
V_CE = 10V
I_C = 1 to 5mA
T_amb = 25°C
lead length = 3mm
f = 0.45MHz
10.7MHz
35MHz
100MHz
200MHz
7Z08225


1000
100
10
100
|y_fe| (mΩ⁻¹)
1000
180°
195°
210°
225°
240°
255°
270°
285°
300°
315°
330°
345°
360°
φ_fe
typical values
V_CE = 10V
T_amb = 25°C
lead length = 3mm
I_C = 1mA
3mA
5mA
f = 0.45MHz
10.7MHz
35MHz
100MHz
200MHz
7Z08224


7Z07400
F (dB)
−B_S (mΩ⁻¹)
G_S (mΩ⁻¹)
typ. noise figure at optimum source admittance
corresponding optimum source conductance resp. susceptance
I_C = 1mA
V_CE = 10V
T_j = 25°C
G_S
B_S
typ
opt
opt
6 15
4 10
2 5
0 0
0.1
1
10
100
f (MHz)
1000


7Z09815
thermal impedance from junction to ambient versus pulse duration
Z_th j-a (°C/W)
10^4
10^3
10^2
10
1
δ = 1.0
0.5
0.2
0.1
0.05
0.02
0.01
0.005
0
t
T
δ = t/T
10^-6
10^-5
10^-4
10^-3
10^-2
10^-1
1
10
10^2
t (s)
10^3

SILICON PLANAR EPITAXIAL TRANSISTOR

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

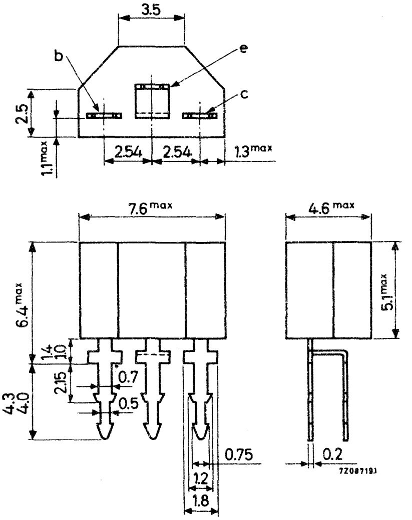
The BF195 is intended for h.f. applications in radio and television receivers; it is especially recommended for f.m. tuners, i.f. amplifiers in a.m./f.m. receivers where a low transistor output conductance is of importance, a.m. input stages of carradios where a low noise figure at low source impedance 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 $T_{amb} = 25\,^oC$	P_{tot}	max.	250	mW
Junction temperature	T_j	max.	125	^oC
D.C. current gain at $T_j = 25\,^oC$				
$I_C = 1$ mA; $V_{CE} = 10$ V	h_{FE}	typ.	67	
Transition frequency				
$I_C = 1$ mA; $V_{CE} = 10$ V	f_T	typ.	200	MHz
Noise figure				
$I_C = 1$ mA; $V_{CE} = 10$ V				
$G_S = 20\ m\Omega^{-1}$; f = 1 MHz	F	typ.	3.5	dB
$G_S = 10\ m\Omega^{-1}$; f = 100 MHz	F	typ.	4	dB

MECHANICAL DATA

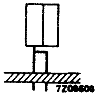
Dimensions in mm



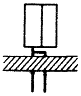
The envelope fulfils the accelerated damp heat test described in IEC publication 68-2 (test D, severity IV, 6 cycles).

MOUNTING INSTRUCTIONS

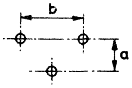
1. Thickness of printed board: max. 1.1 mm
   Hole diameter 0.77 to 0.83 mm



2. Thickness of printed board: max. 1.7 mm
   Hole diameter 1.25 to 1.35 mm



Bore plan



a = 2.49 to 2.59 mm
b = 5.03 to 5.13 mm

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 °C	P_{tot}	max.	250	mW
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	$R_{th\ j\text{-}a}$	=	0.4	°C/mW

CHARACTERISTICS

T_j = 25 °C

Base-emitter voltage [1]

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

Base current

I_C = 1 mA; V_{CE} = 10 V	I_B	8 to	28	μA
		typ.	15	μA

Feedback capacitance at f = 0.45 MHz

I_C = 1 mA; V_{CE} = 10 V	$-C_{re}$	typ.	0.95	pF

Transition frequency

I_C = 1 mA; V_{CE} = 10 V	f_T	typ.	200	MHz

Noise figure

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

G_S = 20 mΩ^{-1}; f = 1 MHz	F	typ.	3.5	dB
G_S = 10 mΩ^{-1}; f = 100 MHz	F	typ.	4	dB

Conversion noise figure

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

G_S = 1.2 mΩ^{-1}; f = 0.2 MHz	F_c	typ.	4	dB
G_S = 1.5 mΩ^{-1}; f = 1 MHz	F_c	typ.	2.5	dB

y parameters at f = 100 MHz (common base)

I_C = 1 mA; V_{CE} = 10 V (lead length = 3 mm)

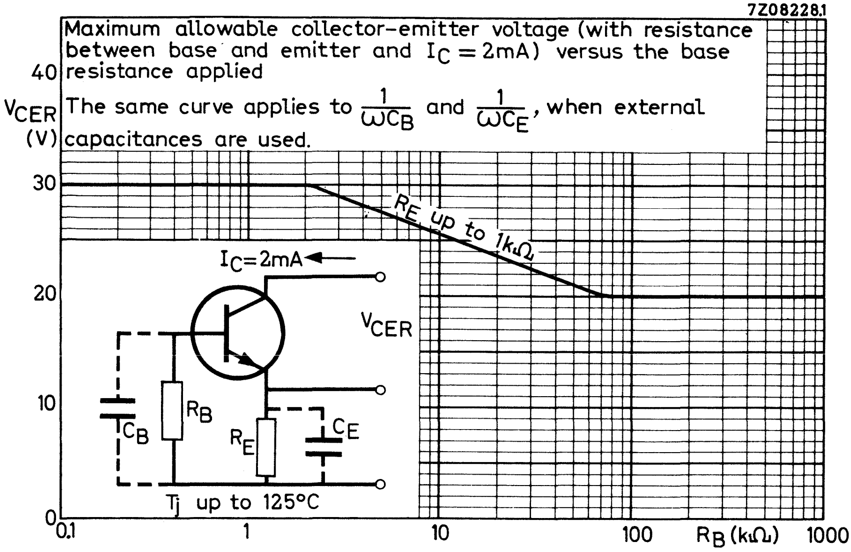
Input conductance	g_{ib}	typ.	38	mΩ^{-1}
Input susceptance	$-b_{ib}$	typ.	1	mΩ^{-1}
Feedback admittance	$\|y_{rb}\|$	typ.	440	μΩ^{-1}
Phase angle of feedback admittance	φ_{rb}	typ.	275°	
Transfer admittance	$\|y_{fb}\|$	typ.	34	mΩ^{-1}
Phase angle of transfer admittance	φ_{fb}	typ.	140°	
Output conductance	g_{ob}	typ.	12	μΩ^{-1}
Output susceptance	b_{ob}	typ.	1.1	mΩ^{-1}

y parameters (common emitter)

I_C = 1 mA; V_{CE} = 10 V (lead length = 3 mm)			f = 10.7 MHz	f = 0.45 MHz	
Input conductance	g_{ie}	<	0.96	0.86	mΩ^{-1}
Output conductance	g_{oe}	<	9.5	7.0	μΩ^{-1}

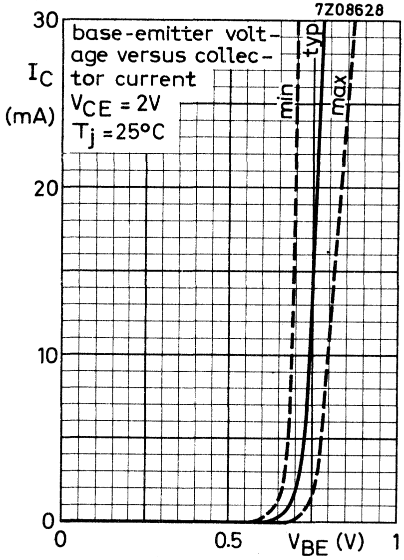
---

1) V_{BE} decreases by about 1.7 mV/°C with increasing temperature.

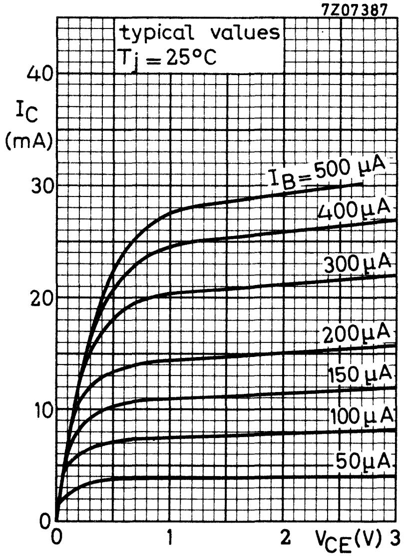


Maximum allowable collector-emitter voltage (with resistance between base and emitter and $I_C = 2mA$) versus the base resistance applied

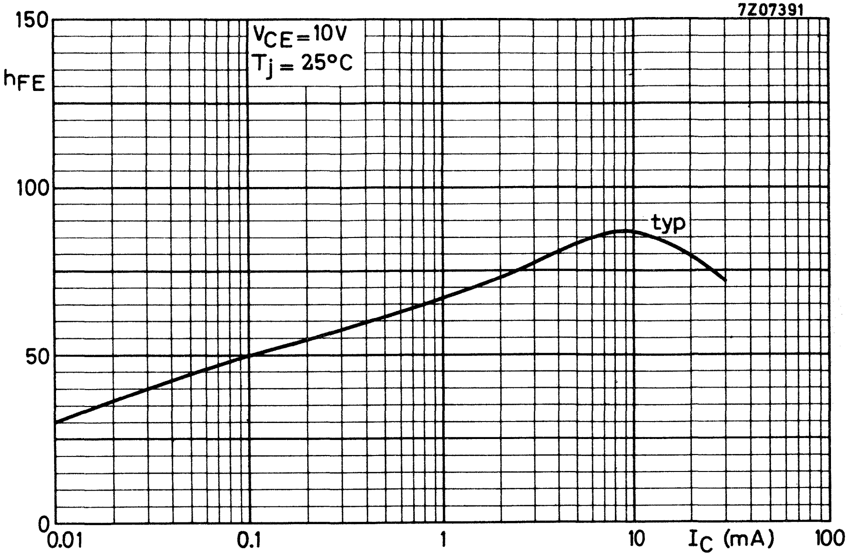
The same curve applies to $\frac{1}{\omega C_B}$ and $\frac{1}{\omega C_E}$, when external capacitances are used.

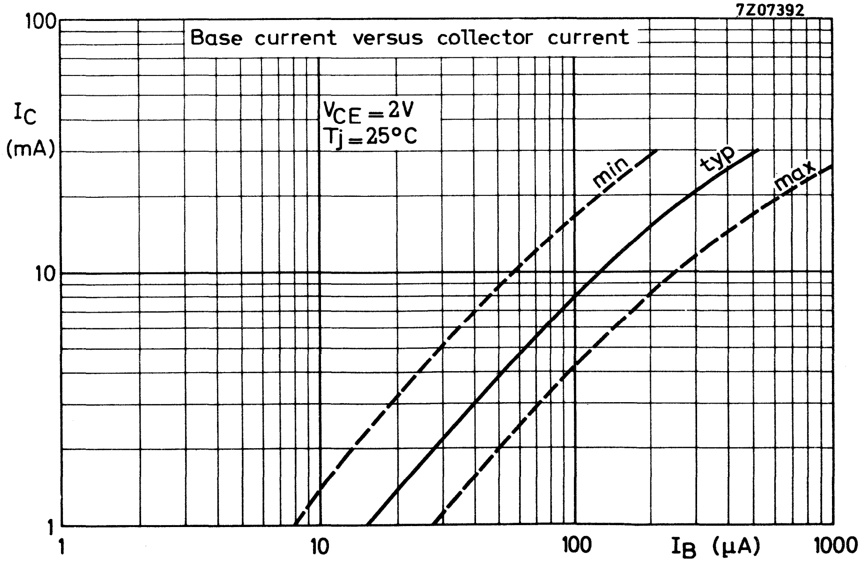


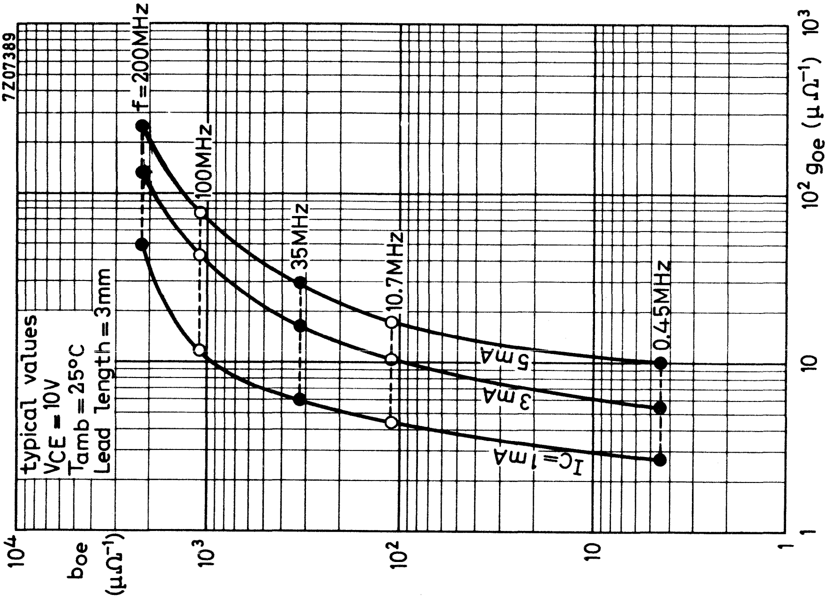
base-emitter voltage versus collector current
V_{CE} = 2V
T_j = 25°C

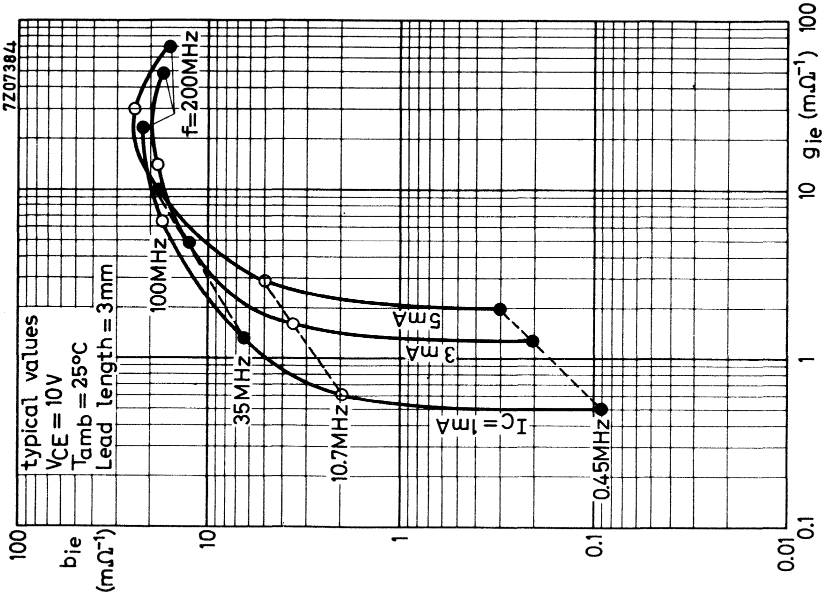


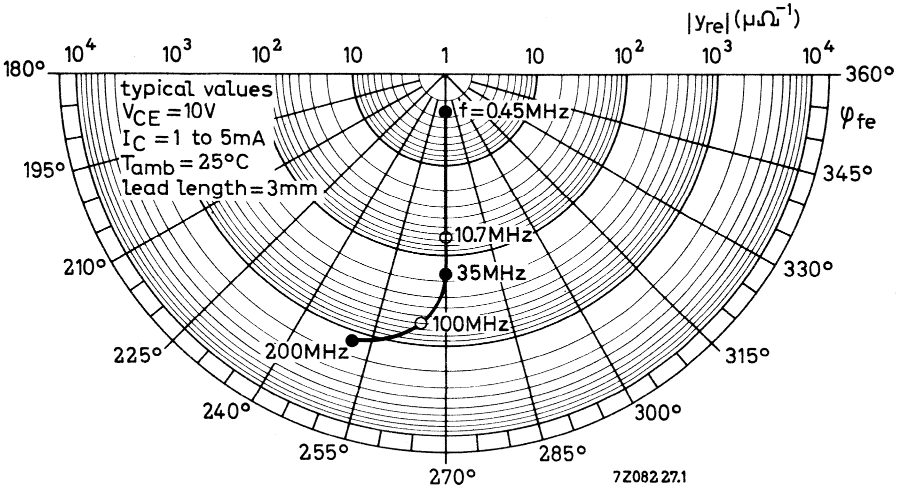
typical values
T_j = 25°C

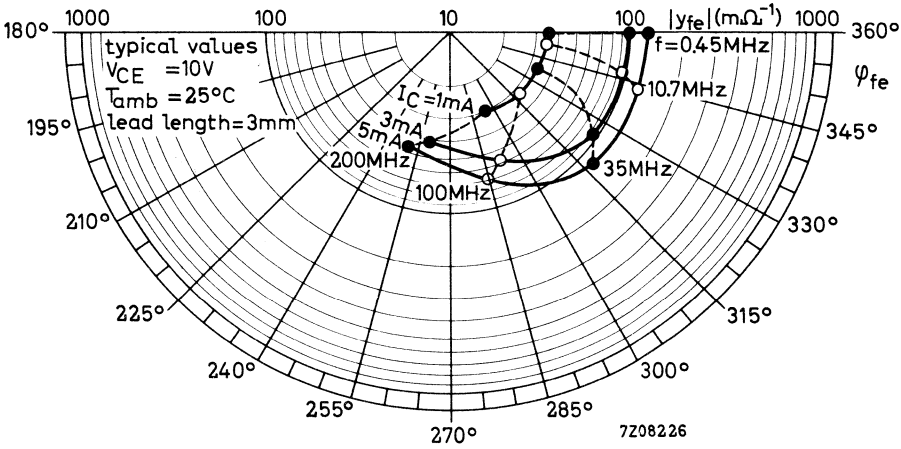

7Z07391
150
hFE
100
50
0
0.01
0.1
1
10
100
IC (mA)
$V_{CE} = 10V$
$T_j = 25°C$
typ

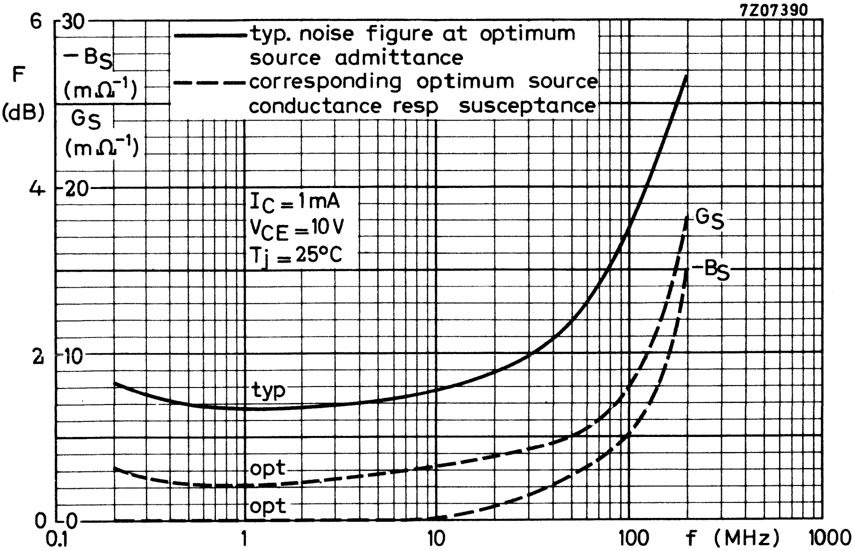

7Z07392
Base current versus collector current
100
IC
(mA)
10
1
1
10
100
1000
IB (μA)
$V_{CE} = 2V$
$T_j = 25°C$
min
typ
max

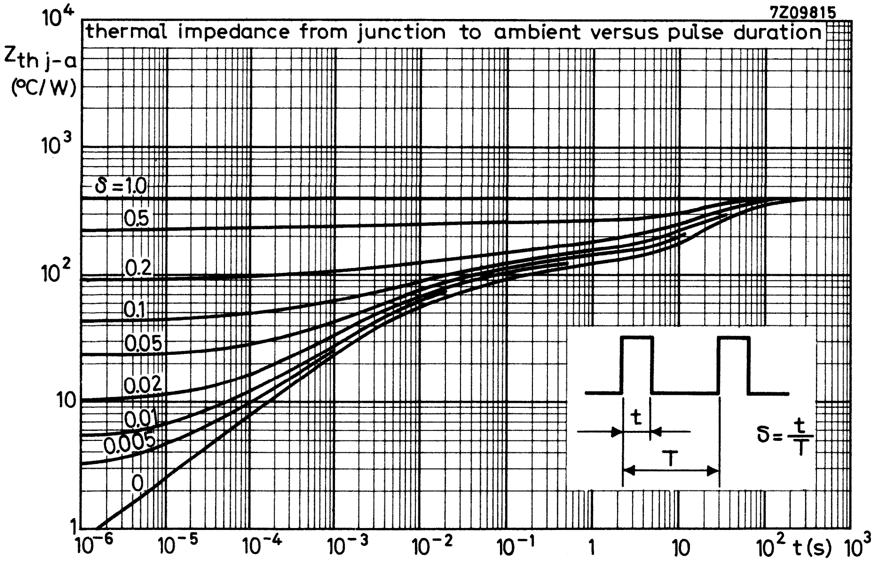

7Z07389
typical values
$V_{CE} = 10V$
$T_{amb} = 25°C$
Lead length = 3mm
f = 200MHz
100MHz
35MHz
10.7MHz
0.45MHz
$I_C = 1mA$
3 mA
5 mA
b_{oe}
$(\mu\Omega^{-1})$
10^4
10^3
10^2
10
1
1
10
10^2 g_{oe} $(\mu\Omega^{-1})$
10^3


7Z07384
typical values
$V_{CE} = 10V$
$T_{amb} = 25°C$
Lead length = 3mm
f=200MHz
100MHz
35MHz
10.7MHz
0.45MHz
$I_C = 1mA$
3 mA
5 mA
b_{ie}
$(m\Omega^{-1})$
100
10
1
0.1
0.01
0.1
1
10 g_{ie} $(m\Omega^{-1})$
100


|y_re| (μΩ⁻¹)
10⁴
10³
10²
10
1
10
10²
10³
10⁴
180°
195°
210°
225°
240°
255°
270°
285°
300°
315°
330°
345°
360°
φ_fe
typical values
V_CE = 10V
I_C = 1 to 5mA
T_amb = 25°C
lead length = 3mm
f = 0.45MHz
10.7MHz
35MHz
100MHz
200MHz
7Z08227.1


1000
100
10
100
|y_fe| (mΩ⁻¹)
1000
180°
195°
210°
225°
240°
255°
270°
285°
300°
315°
330°
345°
360°
φ_fe
typical values
V_CE = 10V
T_amb = 25°C
lead length = 3mm
I_C = 1mA
3mA
5mA
f = 0.45MHz
10.7MHz
35MHz
100MHz
200MHz
7Z08226


7Z07390
typ. noise figure at optimum source admittance
corresponding optimum source conductance resp susceptance
F (dB)
$-B_S$ ($m\Omega^{-1}$)
G_S ($m\Omega^{-1}$)
$I_C = 1\,mA$
$V_{CE} = 10\,V$
$T_j = 25\,°C$
typ
opt
opt
G_S
$-B_S$
6
4
2
0
30
20
10
0
0.1
1
10
100
f (MHz)
1000


7Z09815
thermal impedance from junction to ambient versus pulse duration
$Z_{th\,j-a}$ (°C/W)
10^4
10^3
10^2
10
1
$\delta = 1.0$
0.5
0.2
0.1
0.05
0.02
0.01
0.005
0
10^{-6}
10^{-5}
10^{-4}
10^{-3}
10^{-2}
10^{-1}
1
10
10^2
t (s)
10^3
t
T
$\delta = \frac{t}{T}$

SILICON PLANAR TRANSISTOR

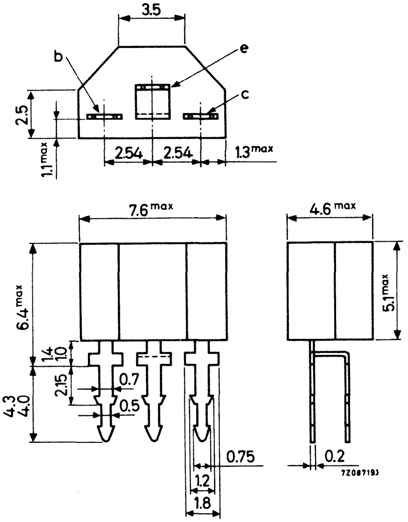
N-P-N transistor in a plastic envelope with stiff self-locking pins suitable for use with standard printed boards. The transistor has a very low feedback capacitance and is intended for use in the forward gain control stage of the television i.f. amplifier.

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 °C	P_{tot}	max.	250	mW
Junction temperature	T_j	max.	125	°C
Transition frequency at f = 100 MHz I_C = 4 mA; V_{CE} = 10 V	f_T	typ.	400	MHz
Feedback capacitance at f = 10.7 MHz I_C = 1 mA; V_{CE} = 10 V	$-C_{re}$	typ.	200	fF
Max. unilateralised power gain I_C = 4 mA; V_{CE} = 10 V; f = 35 MHz	G_{UM}	typ.	42	dB
f = 45 MHz	G_{UM}	typ.	39	dB
Gain control range	ΔG_{tr}	typ.	60	dB

MECHANICAL DATA

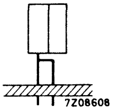
Dimensions in mm



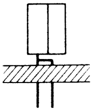
The envelope fulfils the accelerated damp heat test described in IEC publication 68-2 (test D, severity IV, 6 cycles).

MOUNTING INSTRUCTIONS

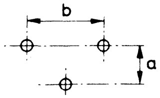
1. Thickness of printed board: max. 1.1 mm
   Hole diameter 0.77 to 0.83 mm



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 °C	P_{tot}	max.	250	mW

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	$R_{th\ j\text{-}a}$	=	0.4	°C/mW

---

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

[2] See also page 6 .

CHARACTERISTICS

T_{amb} = 25 °C unless otherwise specified

Base current at about 50 dB gain control

I_C = 6 mA; V_{CE} = 2 V	I_B	<	270	μA
I_C = 15 mA; V_{CE} = 5 V	I_B	<	1.5	mA

Base current

I_C = 4 mA; V_{CE} = 10 V	I_B	typ. <	60 150	μA μA

Base-emitter voltage (1)

I_C = 4 mA; V_{CE} = 10 V	V_{BE}	typ. <	750 840	mV mV

Feedback capacitance at f = 10.7 MHz

I_C = 1 mA; V_{CE} = 10 V	$-C_{re}$	typ.	200	fF

Transition frequency at f = 100 MHz

I_C = 4 mA; V_{CE} = 10 V	f_T	typ.	400	MHz

Noise figure

I_C = 4 mA; V_{CE} = 10 V G_S = 10 mΩ^{-1}; f = 35 MHz; B_S = 0	F	typ.	3	dB

y parameters (common emitter)

I_C = 4 mA; V_{CE} = 10 V (mounted according to instruction 2, see page 2)

			f = 35	45	MHz
Input conductance	g_{ie}	typ.	3.2	4.8	mΩ^{-1}
Input capacitance	C_{ie}	typ.	37	35	pF
Feedback admittance	$\lvert y_{re}\rvert$	typ.	47	60	μΩ^{-1}
Phase angle of feedback admittance	φ_{re}	typ.	268°	268°	
Transfer admittance	$\lvert y_{fe}\rvert$	typ.	105	100	mΩ^{-1}
Phase angle of transfer admittance	φ_{fe}	typ.	340°	340°	
Output conductance	g_{oe}	typ.	50	60	μΩ^{-1}
Output capacitance	C_{oe}	typ.	1.3	1.3	pF

Maximum unilateralised power gain

$$G_{UM} \text{ (in dB)} = 10 \log \frac{|y_{fe}|^2}{4 g_{ie} g_{oe}}$$

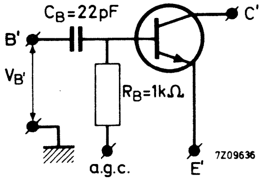
I_C = 4 mA; V_{CE} = 10 V	G_{UM}	typ.	42	39	dB

---

1) V_{BE} decreases by about 1.7 mV/°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.



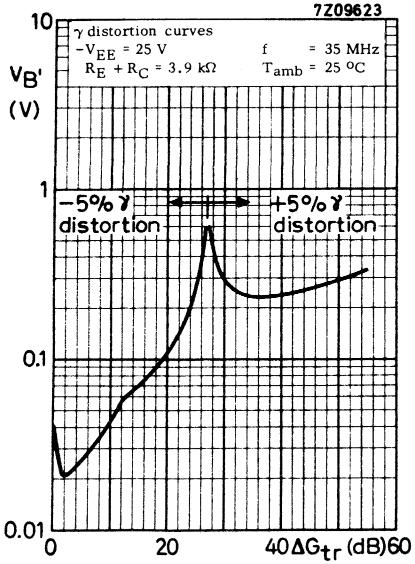
The transistor with these additional components is effectively an "equivalent transistor" for gain control purposes, the signal handling capability of which may be expressed in terms of voltage. (Without these components the varying input admittance means that the signal handling capability can only be expressed in terms of power).

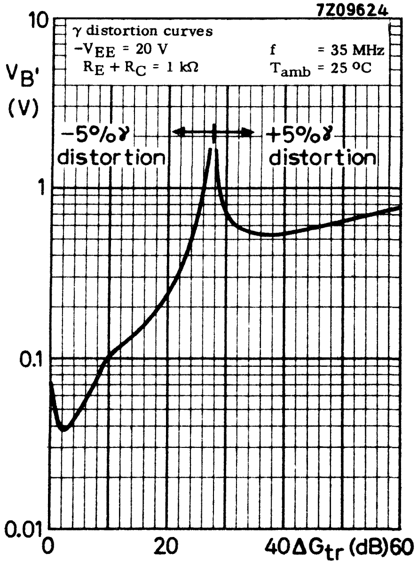
The signal handling capability of the equivalent transistor as a function of ΔG_{tr} (the reduction in transducer gain with gain control) will be found on pages 4 and 5.

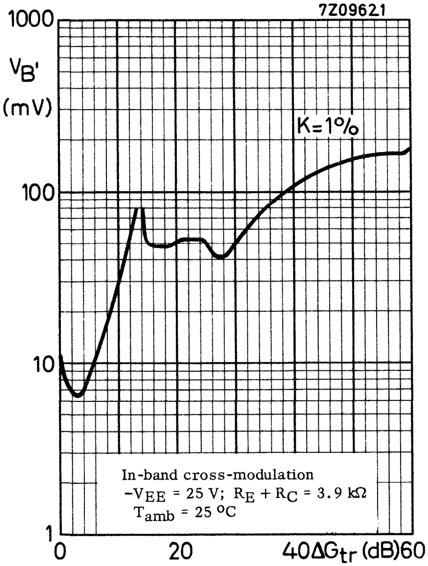
a. Voltage versus ΔG_{tr} curves for a γ distortion of 5% are below.

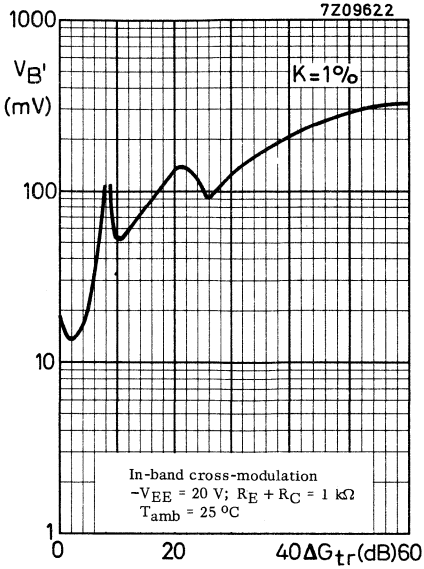
b. Voltage versus ΔG_{tr} curves for an in-band cross modulation factor of 1% are on page 5.

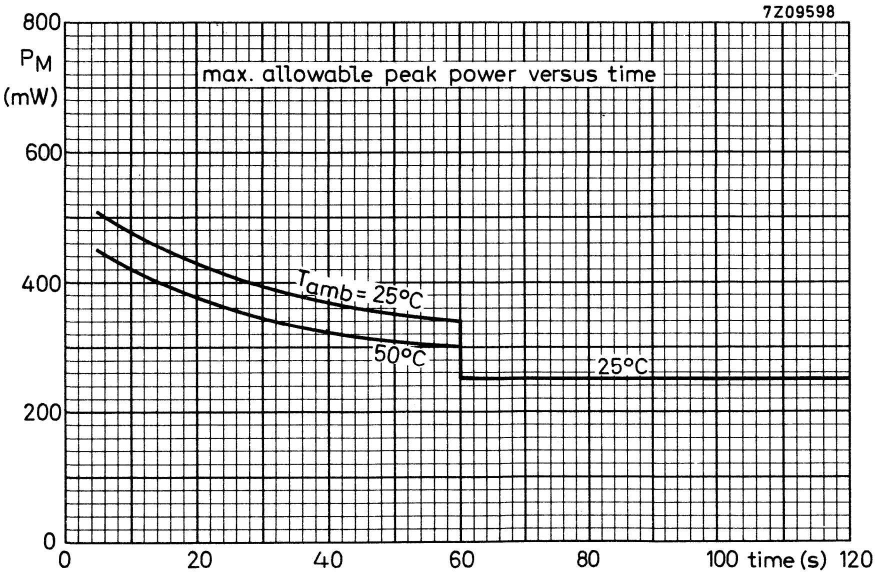
Graphs of the y-parameters are on pages 8 to 11.

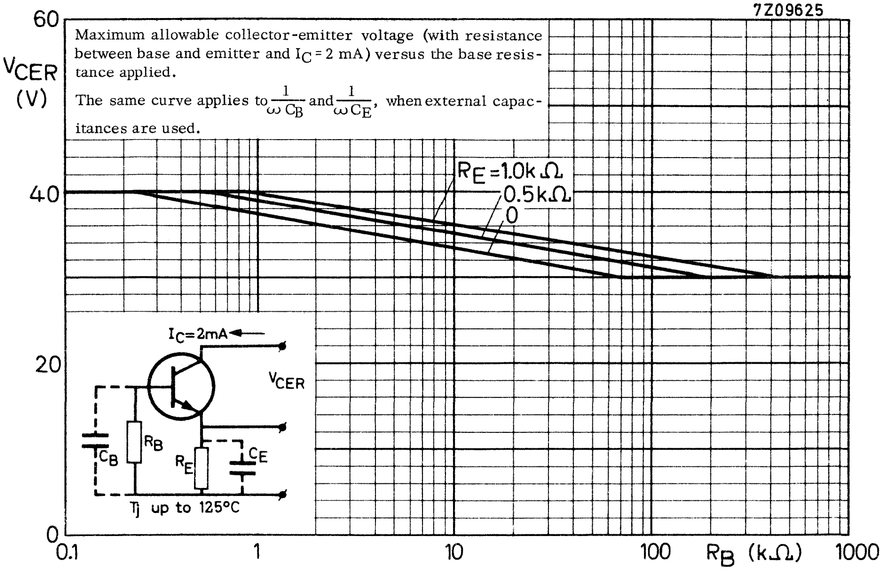





7Z09621
1000
$V_{B'}$
(mV)
K=1%
100
10
1
In-band cross-modulation
$-V_{EE}$ = 25 V; $R_E + R_C$ = 3.9 kΩ
T_{amb} = 25 °C
0
20
40 ΔG_{tr} (dB) 60

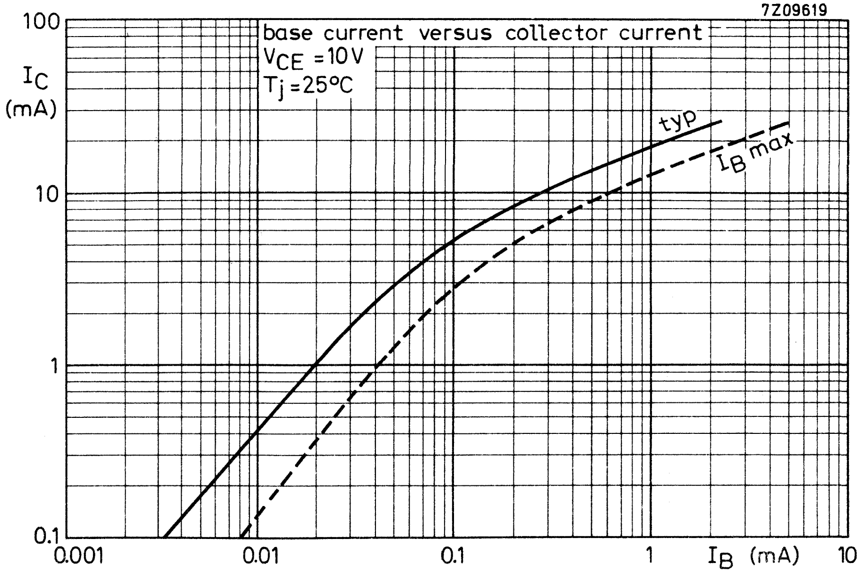

7Z09622
1000
$V_{B'}$
(mV)
K=1%
100
10
1
In-band cross-modulation
$-V_{EE}$ = 20 V; $R_E + R_C$ = 1 kΩ
T_{amb} = 25 °C
0
20
40 ΔG_{tr} (dB) 60


7Z09598
800
P_M
(mW)
max. allowable peak power versus time
600
400
T_{amb} = 25 °C
50 °C
25 °C
200
0
0
20
40
60
80
100 time (s) 120

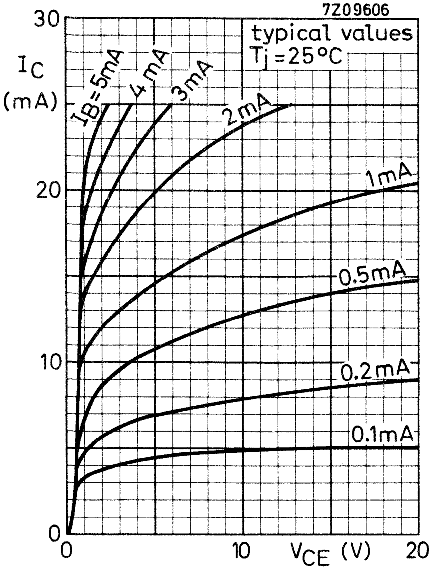


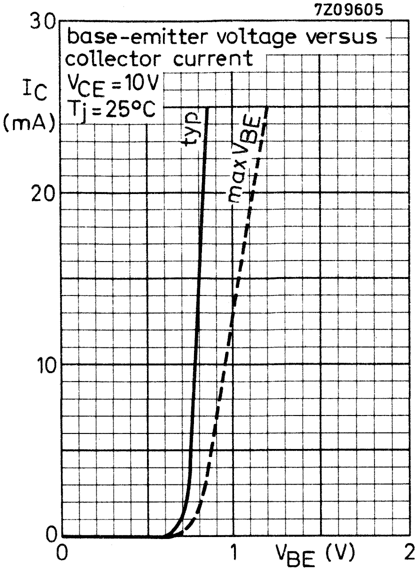
Maximum allowable collector-emitter voltage (with resistance between base and emitter and $I_C = 2$ mA) versus the base resistance applied.

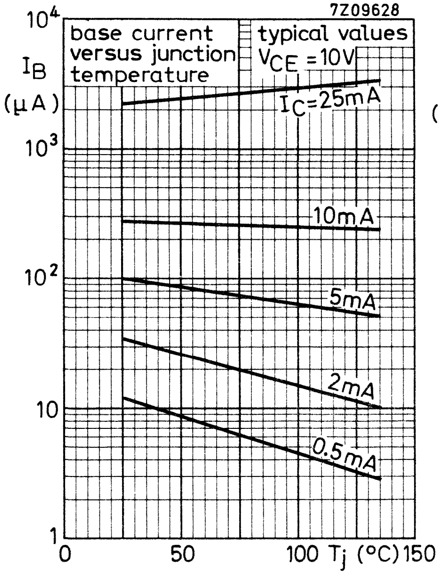
The same curve applies to $\frac{1}{\omega C_B}$ and $\frac{1}{\omega C_E}$, when external capacitances are used.

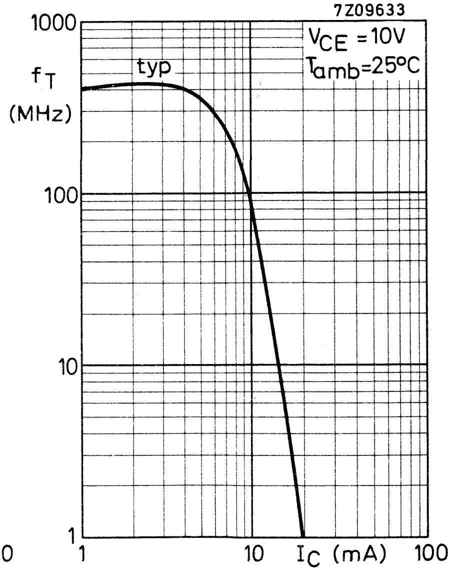


base current versus collector current
V_{CE} = 10 V
T_j = 25°C

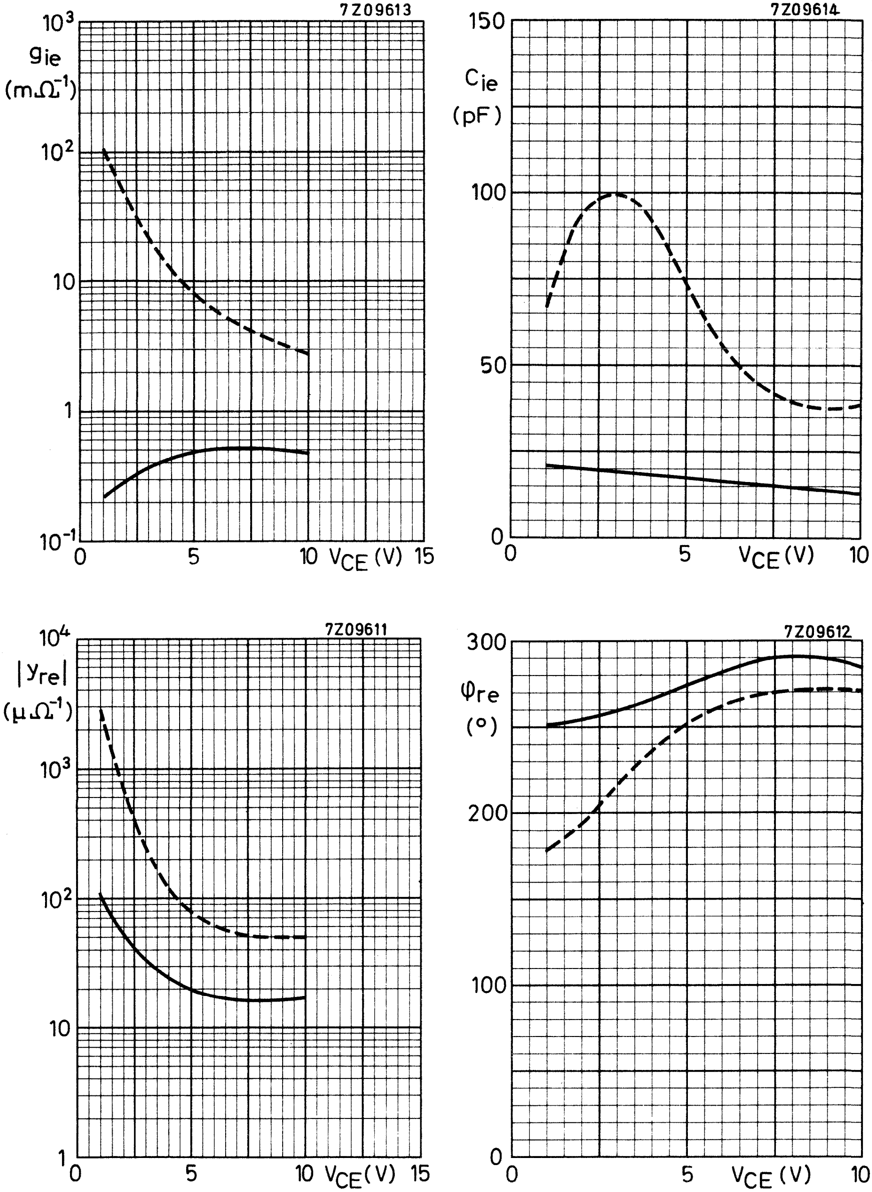

7Z09606
typical values
Tj = 25 °C
I_C (mA)
30
20
10
0
I_B = 5mA
4 mA
3mA
2mA
1mA
0.5mA
0.2mA
0.1mA
0
10
V_{CE} (V)
20


7Z09605
base-emitter voltage versus collector current
V_{CE} = 10 V
Tj = 25 °C
I_C (mA)
30
20
10
0
typ
max V_{BE}
0
1
V_{BE} (V)
2


7Z09628
base current versus junction temperature
typical values
V_{CE} = 10V
I_B (µA)
10^4
10^3
10^2
10
1
I_C=25mA
10mA
5mA
2mA
0.5mA
0
50
100
T_j (°C)
150

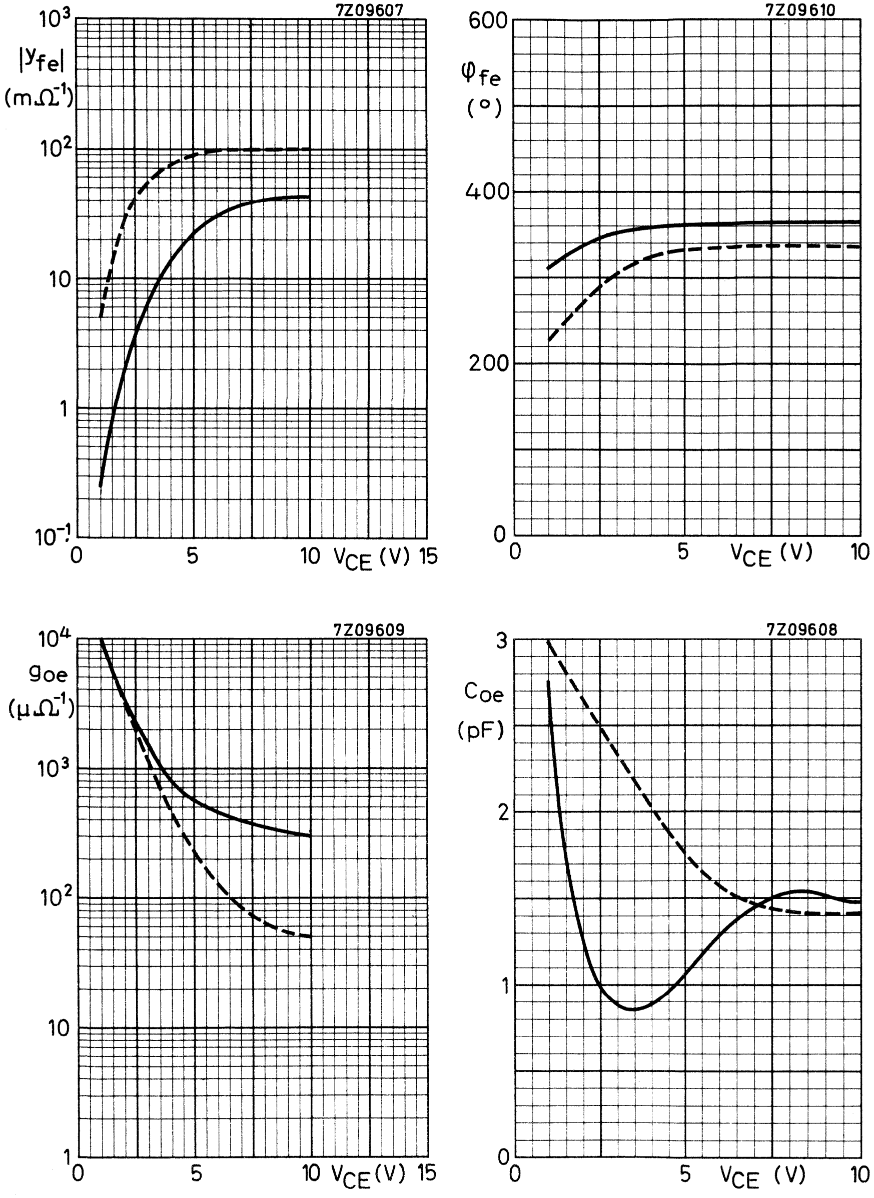

7Z09633
V_{CE} = 10V
T_{amb}=25°C
f_T (MHz)
1000
100
10
1
typ
1
10
I_C (mA)
100

Voltage control; $-V_{EE} = 25$ V; $R_E + R_C = 3.9$ kΩ; f = 35 MHz



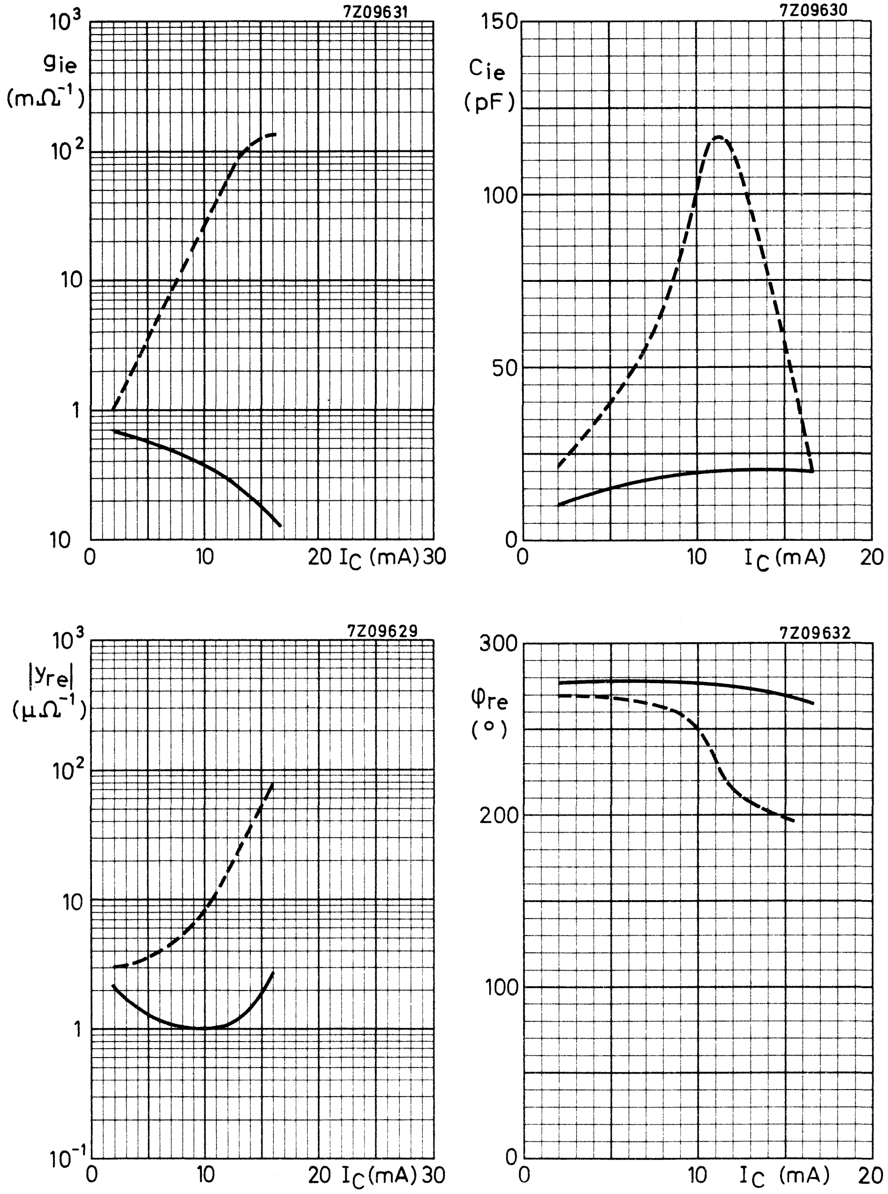
y-parameters of the equivalent gain control transistor, including base capacitor and base resistor as shown on page 4 (dashed curves apply to the transistor only).

Voltage control; $-V_{EE}$ = 25 V; $R_E + R_C$ = 3.9 kΩ; f = 35 MHz



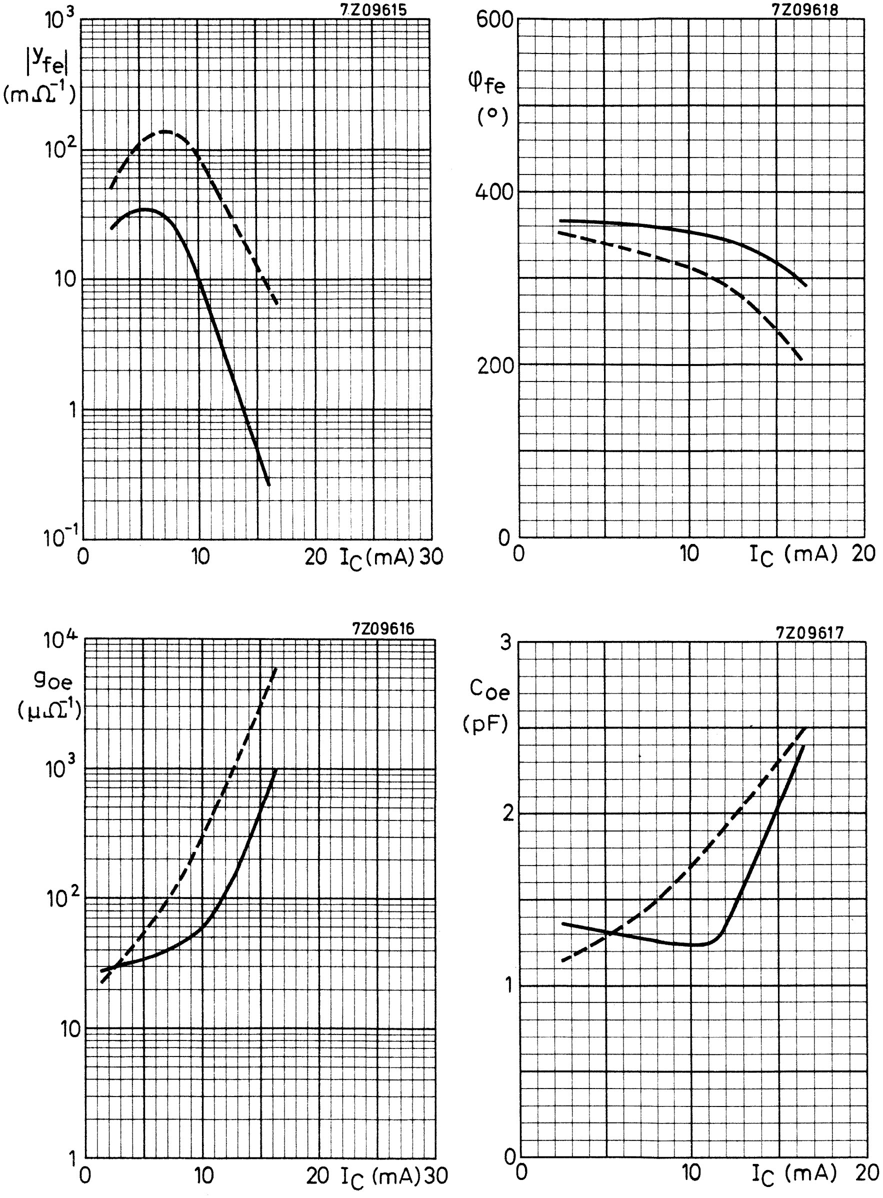
y-parameters of the equivalent gain control transistor, including base capacitor and base resistor as shown on page 4 (dashed curves apply to the transistor only).

Current control; $-V_{EE}$ = 20 V; $R_E + R_C$ = 1 kΩ; f = 35 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; $-V_{EE} = 20$ V; $R_E + R_C = 1$ kΩ; f = 35 MHz

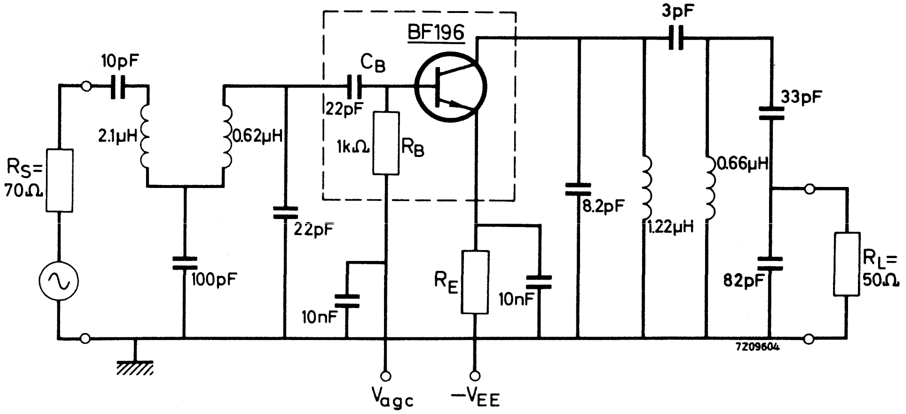


y-parameters of the equivalent gain control transistor, including base capacitor and base resistor as shown on page 4 (dashed curves apply to the transistor only).

APPLICATION INFORMATION

First stage of an i.f. amplifier ¹)

Basic circuit with voltage gain control: $R_E + R_C = 3.9\ k\Omega$; $-V_{EE} = 25\ V$
current gain control: $R_E + R_C = 1\ k\Omega$; $-V_{EE} = 20\ V$



Transducer gain

$$G_{tr}\ (\text{in dB}) = 10 \log \frac{\text{output power in load } R_L}{\text{available power from source } R_S}$$

$f = 36.4$ MHz; $I_C = 4$ mA; $R_E + R_C = 3.9\ k\Omega$; $-V_{EE} = 25$ V	G_{tr}	typ.	25.5	dB
Gain control range (see also upper graphs next page)	ΔG_{tr}	typ.	60	dB

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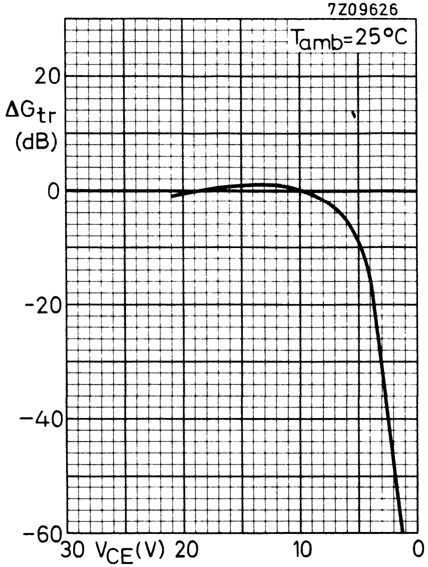
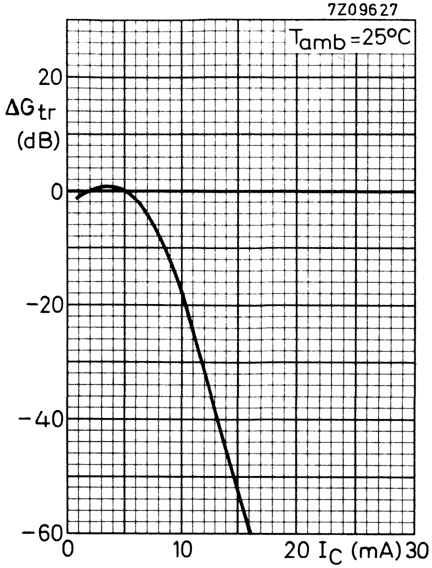
¹) Application information bulletins are available on request.

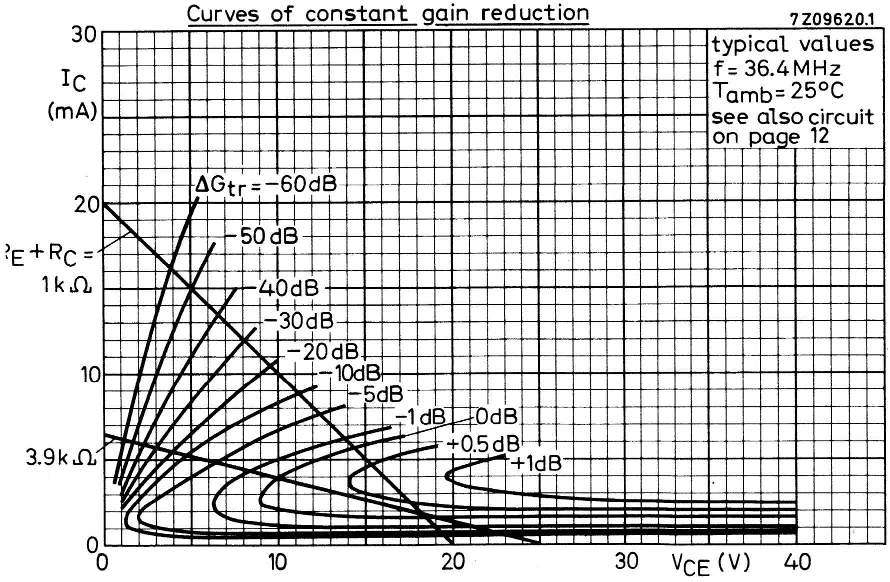
voltage gain control



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.

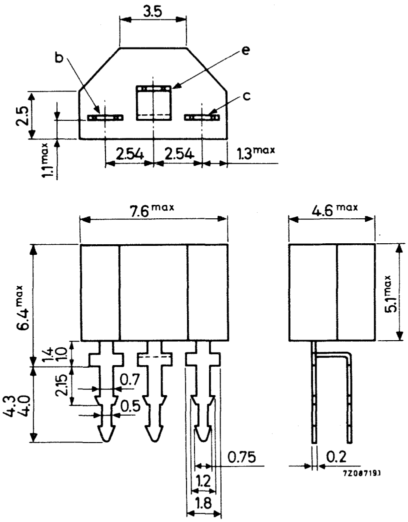
The BF197 has a very low feedback capacitance and is intended for use in the output stage of a television video i.f. amplifier.

QUICK REFERENCE DATA

Collector-base voltage (open emitter)	V_{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 °C	P_{tot}	max.	250	mW
Junction temperature	T_j	max.	125	°C
Transition frequency at f = 100 MHz I_C = 5 mA; V_{CE} = 10 V	f_T	typ.	550	MHz
Feedback capacitance at f = 10.7 MHz I_C = 1 mA; V_{CE} = 10 V	$-C_{re}$	typ.	300	fF
Max. unilateralised power gain I_C = 7 mA; V_{CE} = 10 V; f = 35 MHz	G_{UM}	typ.	43	dB
f = 45 MHz	G_{UM}	typ.	41	dB
Video detector output voltage	V_O	typ.	7.7	V

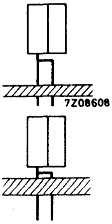
MECHANICAL DATA

Dimensions in mm



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

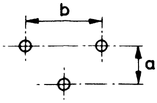
MOUNTING INSTRUCTIONS



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



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.	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 °C	P_{tot}	max.	250	mW

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	$R_{th\ j\text{-}a}$	=	0.4	°C/mW

---

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

[2] See also page 4.

CHARACTERISTICS

T_{amb} = 25 °C unless otherwise specified

Base current				
I_C = 7 mA; V_{CE} = 10 V	I_B	typ. <	60 185	μA μA
Base-emitter voltage 1)				
I_C = 7 mA; V_{CE} = 10 V	V_{BE}	typ. <	750 900	mV mV
Feedback capacitance at f = 10.7 MHz				
I_C = 1 mA; V_{CE} = 10 V	$-C_{re}$	typ.	300	fF
Transition frequency at f = 100 MHz				
I_C = 5 mA; V_{CE} = 10 V	f_T	typ.	550	MHz

y parameters (common emitter)

I_C = 7 mA; V_{CE} = 10 V (mounted according to instruction 2, see page 2)

			f = 35	45	MHz
Input conductance	g_{ie}	typ.	4.5	5.5	$m\Omega^{-1}$
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	$m\Omega^{-1}$
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} (in dB) = 10 log $\frac{\|y_{fe}\|^2}{4 g_{ie} g_{oe}}$					
I_C = 7 mA; V_{CE} = 10 V	G_{UM}	typ.	43	41	dB

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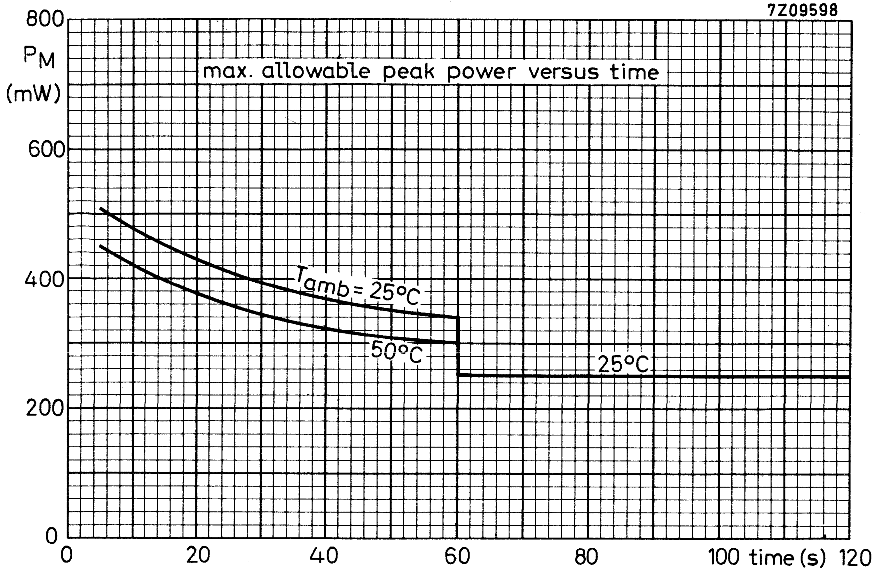
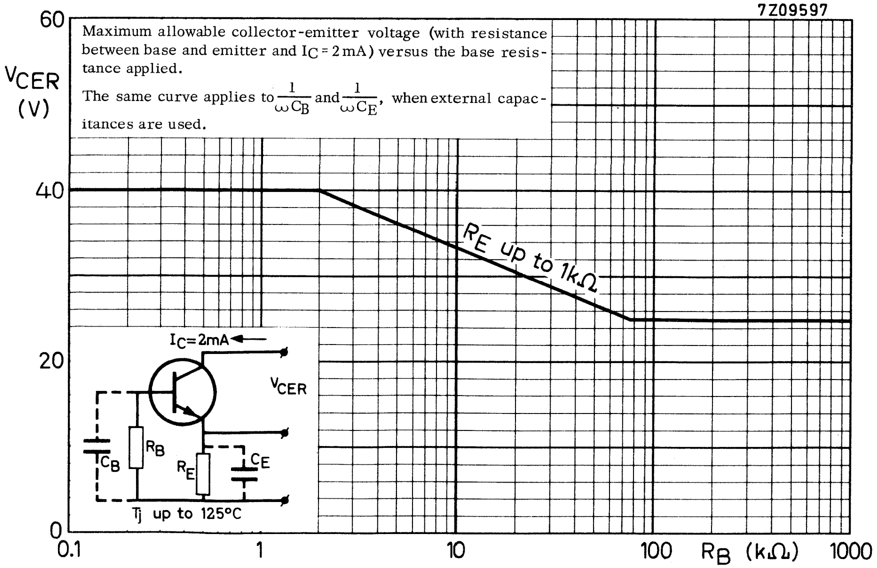
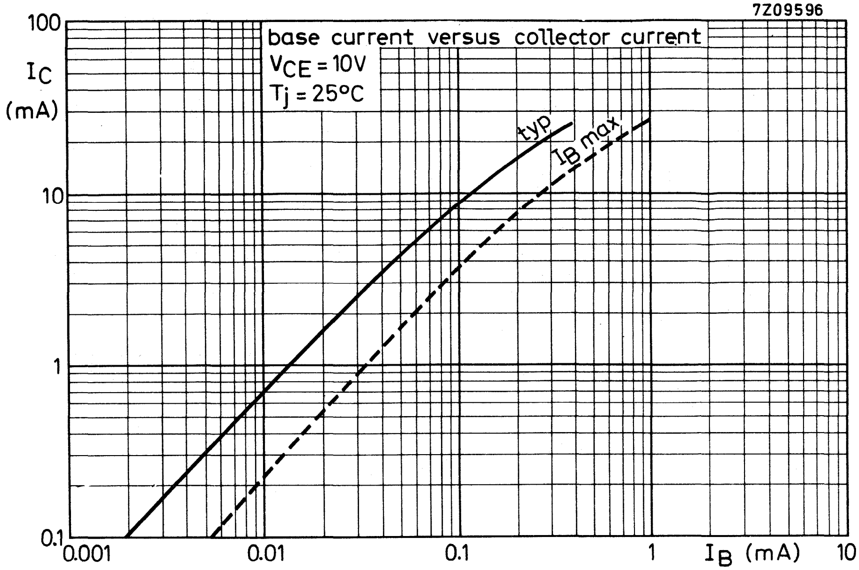
1) V_{BE} decreases by about 1.7 mV/°C with increasing temperature.

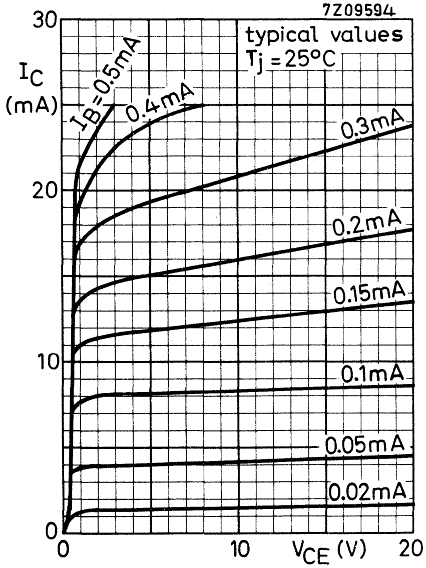


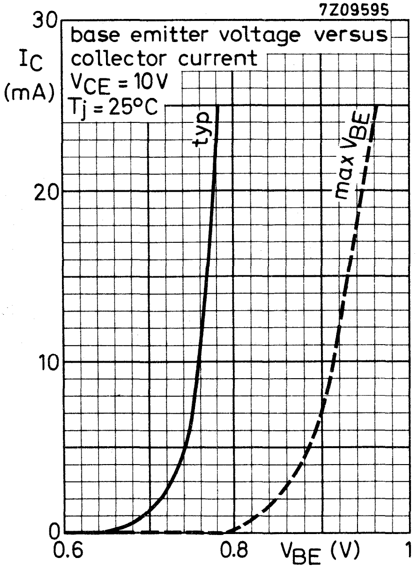


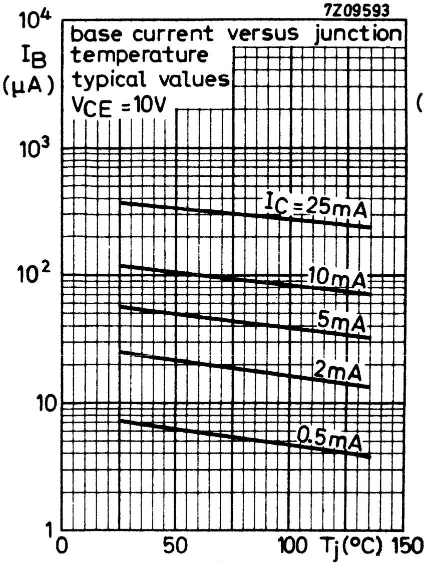
Maximum allowable collector-emitter voltage (with resistance between base and emitter and $I_C = 2$ mA) versus the base resistance applied.

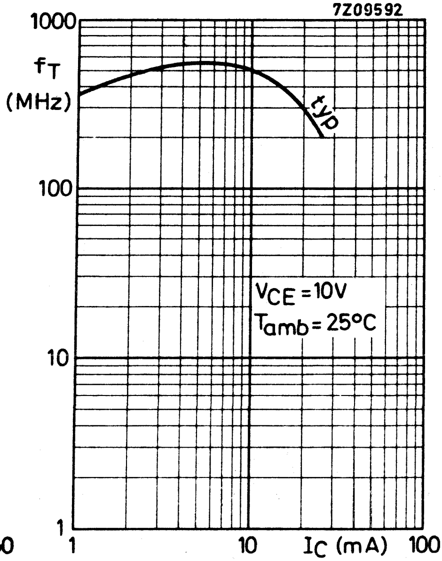
The same curve applies to $\frac{1}{\omega C_B}$ and $\frac{1}{\omega C_E}$, when external capacitances are used.


7Z09596
base current versus collector current
V_{CE} = 10V
T_j = 25°C
I_C (mA)
100
10
1
0.1
0.001
0.01
0.1
1
I_B (mA)
10
typ
I_B max


7Z09594
typical values
T_j = 25°C
I_C (mA)
30
20
10
0
I_B = 0.5mA
0.4mA
0.3mA
0.2mA
0.15mA
0.1mA
0.05mA
0.02mA
0
10
V_{CE} (V)
20

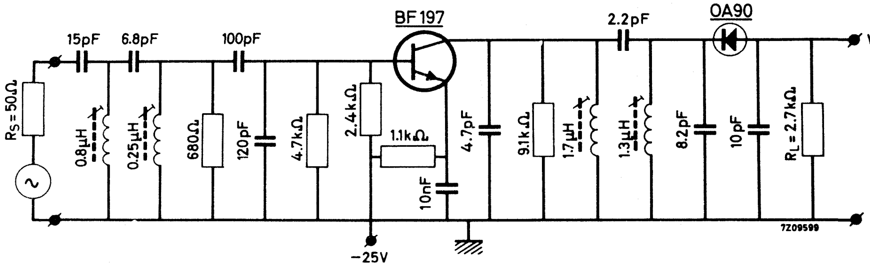

7Z09595
base emitter voltage versus collector current
V_{CE} = 10V
T_j = 25°C
I_C (mA)
30
20
10
0
typ
max V_{BE}
0.6
0.8
V_{BE} (V)
1





APPLICATION INFORMATION

Output stage of a television video i.f. amplifier with the BF197 transistor, followed by a video detector circuit. [1]



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[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

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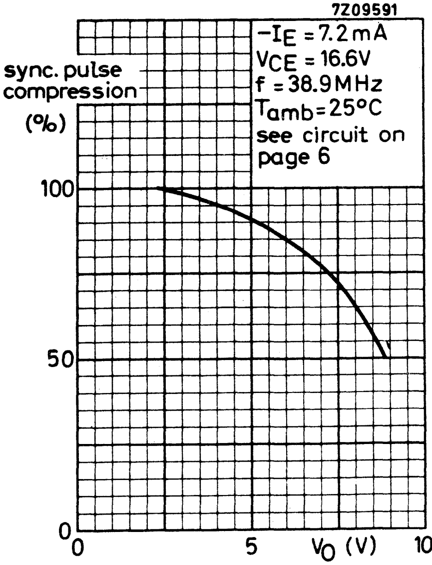
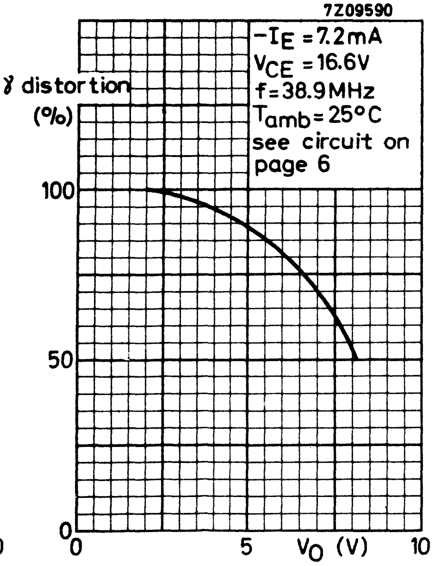
[1] The output voltage V_O is defined as the voltage across the 2.7 kΩ detector load R_L for 30% synchronisation pulse compression.





SILICON PLANAR TRANSISTOR

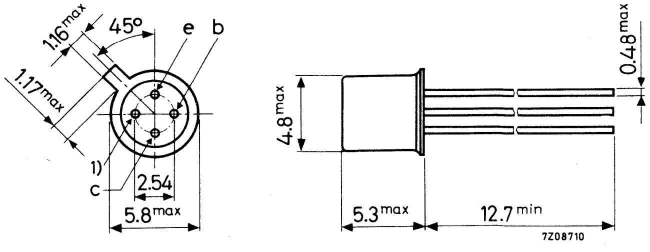
N-P-N transistor in a TO-72 metal envelope with insulated electrodes and a shield lead connected to the case. The BF200 is primarily intended for application in a forward gain controlled pre-amplifier in v.h.f. television tuners and f.m. tuners.

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 °C	P_{tot}	max.	150	mW
Junction temperature	T_j	max.	175	°C
Transition frequency				
$-I_E$ = 3 mA; V_{CB} = 10 V	f_T	typ.	650	MHz
Max. unilateralised power gain				
$-I_E$ = 3 mA; V_{CB} = 10 V; f = 50 MHz	G_{UM}	typ.	30	dB
f = 200 MHz	G_{UM}	typ.	22	dB
Noise figure at optimum source admittance				
$-I_E$ = 2 mA; V_{CB} = 10 V; f = 100 MHz	F	typ.	2	dB
$-I_E$ = 3 mA; V_{CB} = 10 V; f = 200 MHz	F	typ.	2.7	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.	20	V
Collector-emitter voltage ($R_{BE} \leq 1$ kΩ)	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 $T_{amb} = 25$ °C	P_{tot}	max.	150	mW

Temperatures

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

THERMAL RESISTANCE

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

---

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

CHARACTERISTICS

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

Base current

$-I_E = 3$ mA; $V_{CB} = 10$ V	I_B	typ. <	100 200	μA μA
$-I_E = 12$ mA; $V_{CB} = 7$ V	I_B	<	2.2	mA

Emitter-base voltage

$-I_E = 3$ mA; $V_{CB} = 10$ V	$-V_{EB}$	typ.	0.75	V
$-I_E = 12$ mA; $V_{CB} = 7$ V	$-V_{EB}$	<	1.0	V

Transition frequency

$-I_E = 3$ mA; $V_{CB} = 10$ V	f_T	typ.	650	MHz

Feedback capacitance at f = 10.7 MHz

$I_C = 1$ mA; $V_{CE} = 10$ V	$-C_{re}$	typ.	280	fF [1]

Noise figure at optimum source admittance

$-I_E = 3$ mA; $V_{CB} = 10$ V; f = 50 MHz	F	typ.	1.9	dB
f = 200 MHz	F	typ.	2.7	dB
$-I_E = 2$ mA; $V_{CB} = 10$ V; f = 100 MHz	F	typ.	2.0	dB

Maximum unilateralised power gain [2]

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

$-I_E = 3$ mA; $V_{CB} = 10$ V; f = 50 MHz	G_{UM}	typ.	30	dB
f = 200 MHz	G_{UM}	typ.	22	dB
$-I_E = 2$ mA; $V_{CB} = 10$ V; f = 100 MHz	G_{UM}	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 °C unless otherwise specified

y parameters at f = 100 MHz (common emitter)

I_C = 2 mA; V_{CE} = 10 V

Input conductance	g_{ie}	typ.	5	$m\Omega^{-1}$
Input capacitance	C_{ie}	typ.	16	pF
Feedback admittance	$\|y_{re}\|$	typ.	0.16	$m\Omega^{-1}$
Phase angle of feedback admittance	φ_{re}	typ.	270°	
Transfer admittance	$\|y_{fe}\|$	typ.	56	$m\Omega^{-1}$
Phase angle of transfer admittance	φ_{fe}	typ.	340°	
Output conductance	g_{oe}	typ.	15	$\mu\Omega^{-1}$
Output capacitance	C_{oe}	typ.	0.9	pF

y parameters at f = 50 MHz (common base)

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

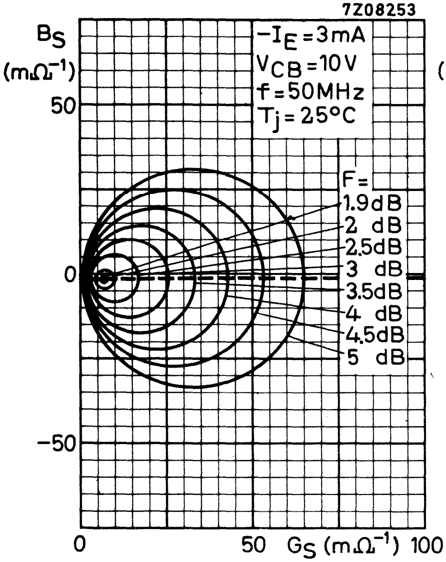
Input conductance	g_{ib}	typ.	85	$m\Omega^{-1}$
Input susceptance	$-b_{ib}$	typ.	15	$m\Omega^{-1}$
Feedback admittance	$\|y_{rb}\|$	typ.	55	$\mu\Omega^{-1}$
Phase angle of feedback admittance	φ_{rb}	typ.	270°	
Transfer admittance	$\|y_{fb}\|$	typ.	85	$m\Omega^{-1}$
Phase angle of transfer admittance	φ_{fb}	typ.	165°	
Output conductance	g_{ob}	typ.	15	$\mu\Omega^{-1}$
Output susceptance	b_{ob}	typ.	280	$\mu\Omega^{-1}$

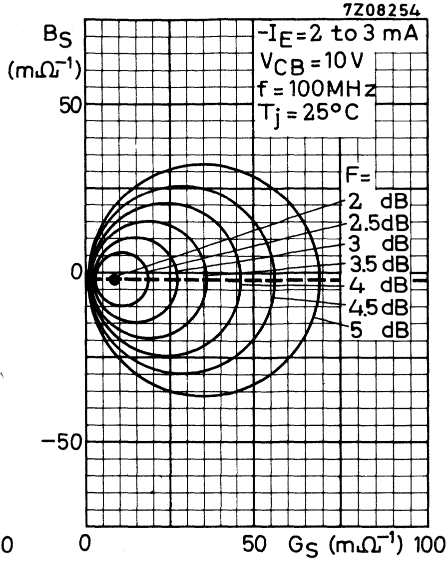
y parameters at f = 200 MHz (common base)

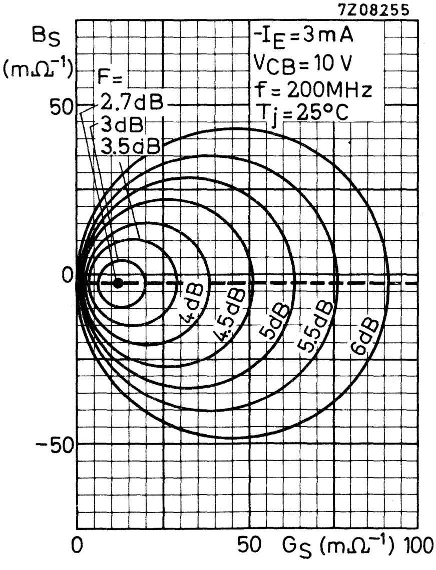
$-I_E$ = 3 mA; V_{CB} = 10 V

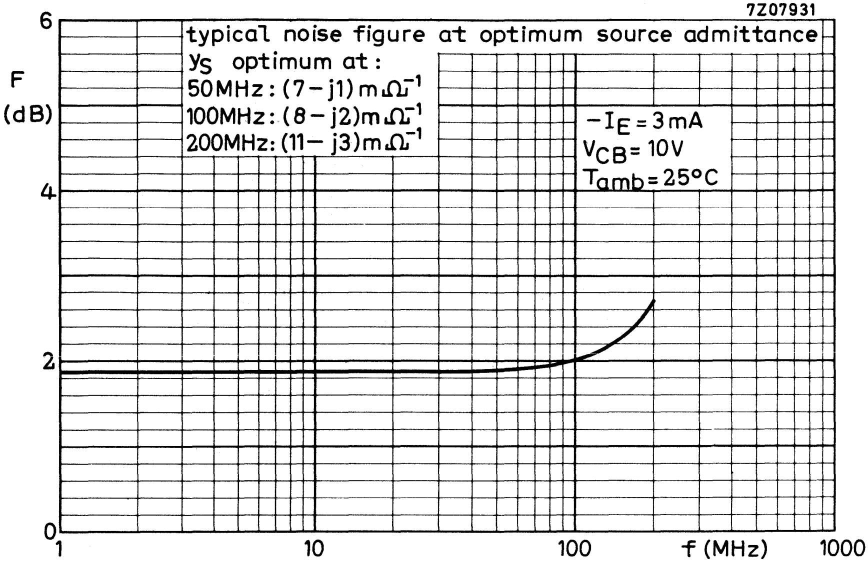
Input conductance	g_{ib}	typ.	62	$m\Omega^{-1}$
Input susceptance	$-b_{ib}$	typ.	38	$m\Omega^{-1}$
Feedback admittance	$\|y_{rb}\|$	typ.	180	$\mu\Omega^{-1}$
Phase angle of feedback admittance	φ_{rb}	typ.	270°	
Transfer admittance	$\|y_{fb}\|$	typ.	70	$m\Omega^{-1}$
Phase angle of transfer admittance	φ_{fb}	typ.	145°	
Output conductance	g_{ob}	typ.	150	$\mu\Omega^{-1}$
Output susceptance	b_{ob}	typ.	1.1	$m\Omega^{-1}$

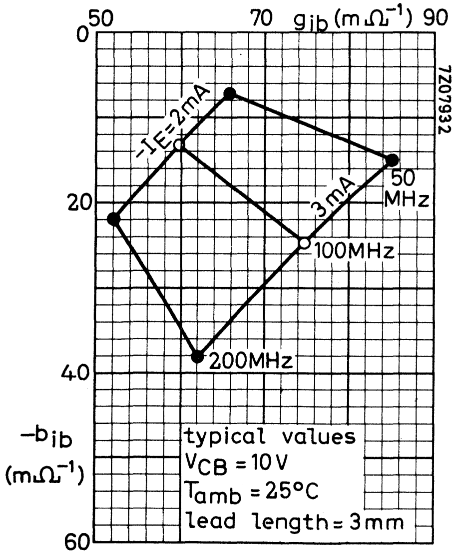
circles of constant noise figure

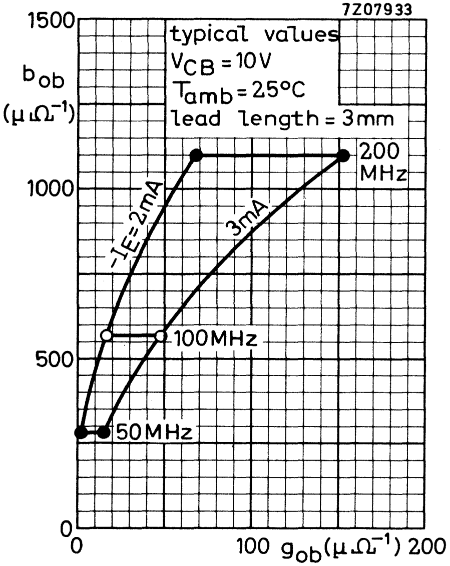


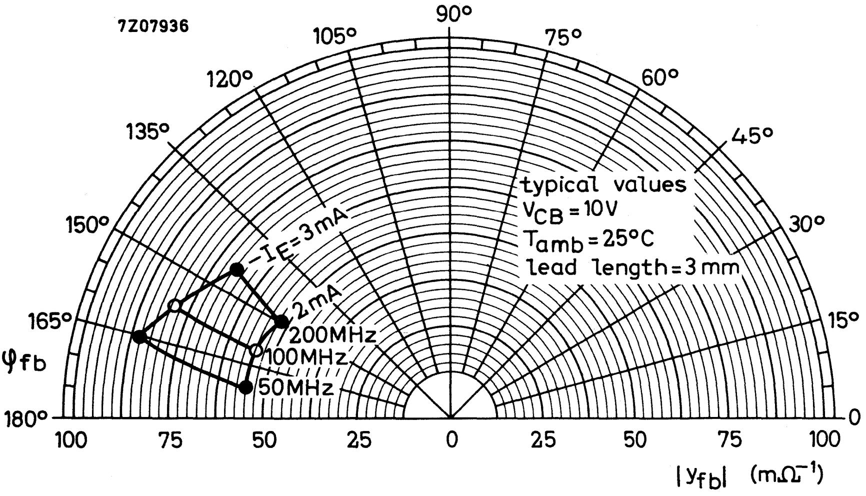


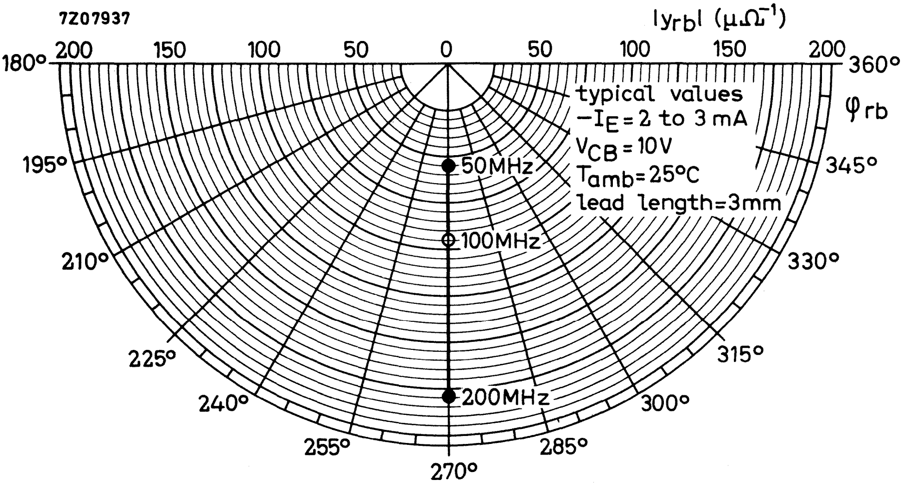


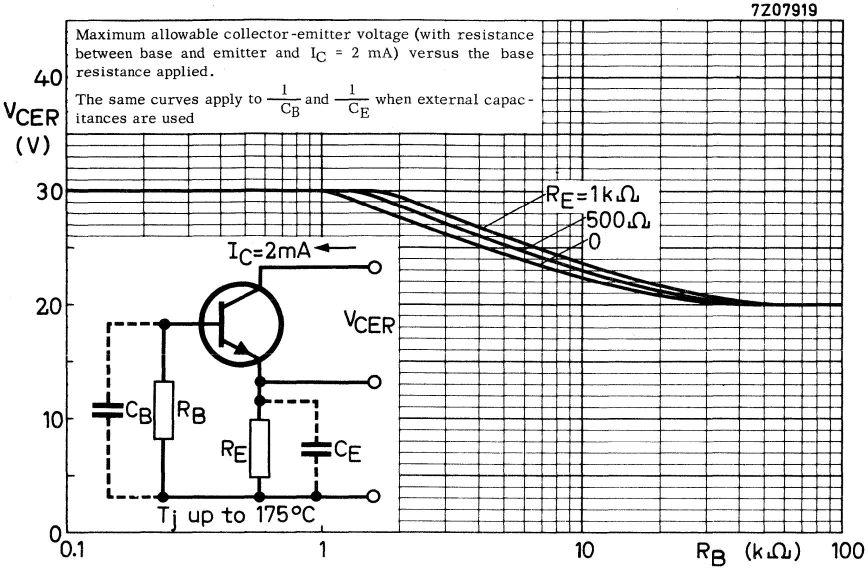

7Z07931
typical noise figure at optimum source admittance
y_S optimum at:
50MHz: (7 − j1) mΩ⁻¹
100MHz: (8 − j2) mΩ⁻¹
200MHz: (11 − j3) mΩ⁻¹
−I_E = 3 mA
V_CB = 10 V
T_amb = 25°C
F
(dB)
6
4
2
0
1
10
100
f (MHz)
1000


7Z07932
50
70
g_ib (mΩ⁻¹)
90
0
20
40
60
−b_ib
(mΩ⁻¹)
−I_E = 2mA
3mA
50
MHz
100MHz
200MHz
typical values
V_CB = 10 V
T_amb = 25°C
lead length = 3mm


7Z07933
typical values
V_CB = 10V
T_amb = 25°C
lead length = 3mm
b_ob
(μΩ⁻¹)
1500
1000
500
0
0
100
g_ob (μΩ⁻¹)
200
200
MHz
−I_E = 2mA
3mA
100MHz
50MHz


7Z07936
90°
105°
75°
120°
60°
135°
45°
150°
30°
165°
15°
φ_{fb}
180°
0
typical values
$V_{CB} = 10V$
$T_{amb} = 25°C$
lead length = 3 mm
$-I_E = 3mA$
2 mA
200MHz
100MHz
50MHz
100
75
50
25
0
25
50
75
100
$|y_{fb}|$ ($m\Omega^{-1}$)


7Z07937
$|y_{rb}|$ ($\mu\Omega^{-1}$)
200
150
100
50
0
50
100
150
200
180°
360°
φ_{rb}
typical values
$-I_E = 2$ to 3 mA
$V_{CB} = 10V$
$T_{amb} = 25°C$
lead length = 3mm
50MHz
100MHz
200MHz
195°
345°
210°
330°
225°
315°
240°
300°
255°
285°
270°

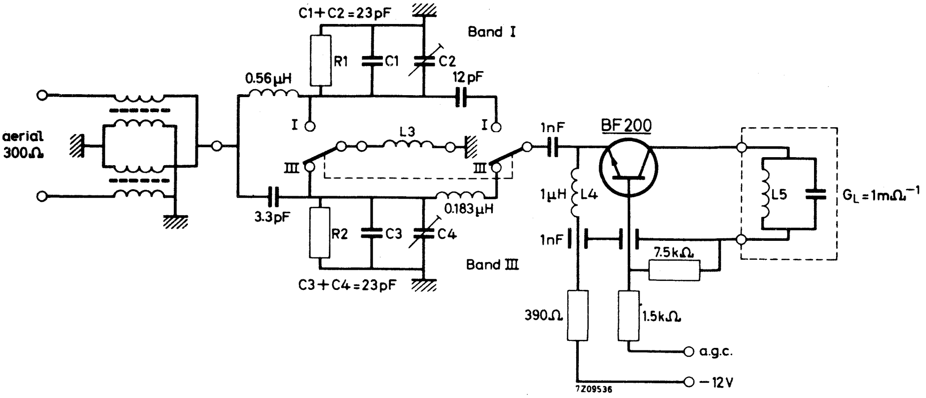


Maximum allowable collector-emitter voltage (with resistance between base and emitter and I_C = 2 mA) versus the base resistance applied.

The same curves apply to $\frac{1}{C_B}$ and $\frac{1}{C_E}$ when external capacitances are used

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 °C (see circuit above)

Transducer gain

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

$-I_E$ = 3 mA; f = 50 MHz	G_{tr}	typ.	13	dB
$-I_E$ = 3 mA; f = 200 MHz	G_{tr}	typ.	13	dB

Noise figure

f = 50 MHz	F	typ.	4.9	dB
f = 200 MHz	F	typ.	5.2	dB

Voltage standing wave ratio over the entired 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

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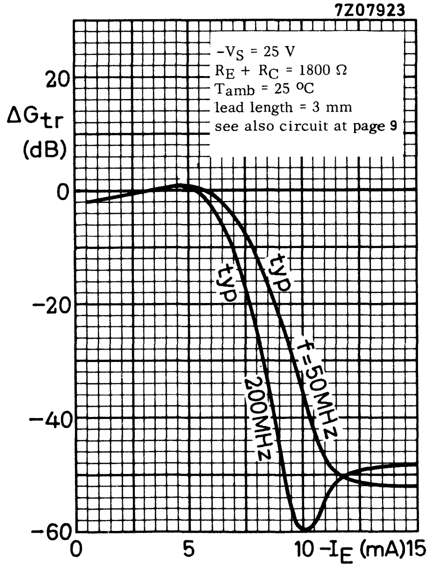
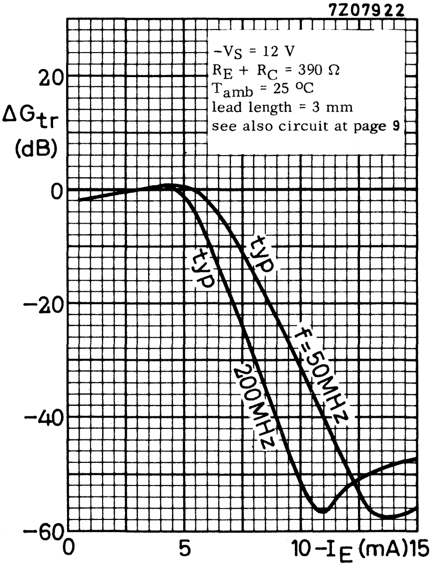
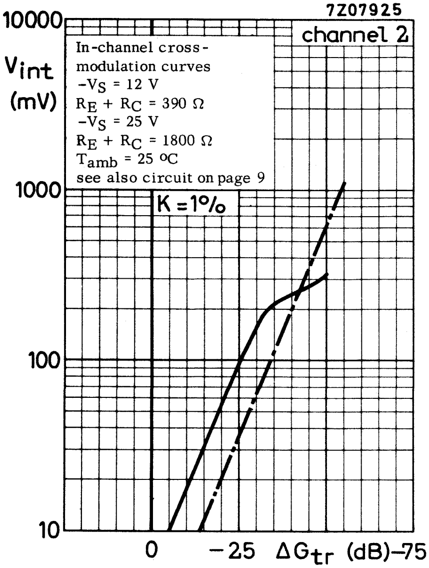
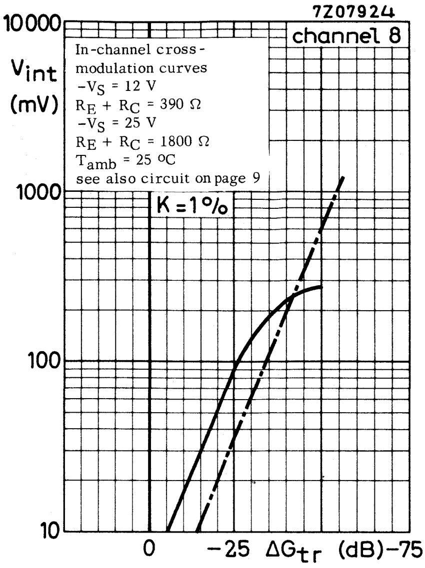
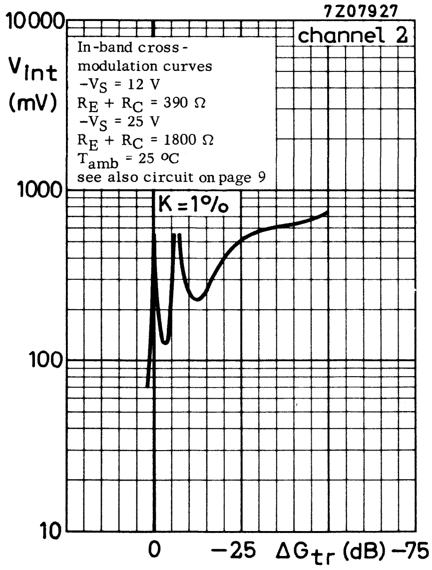


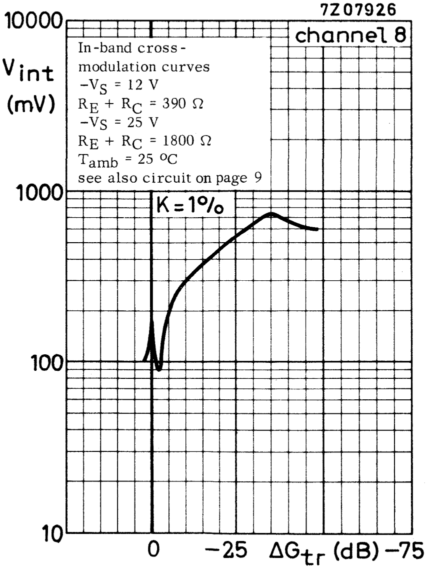


APPLICATION INFORMATION (continued)



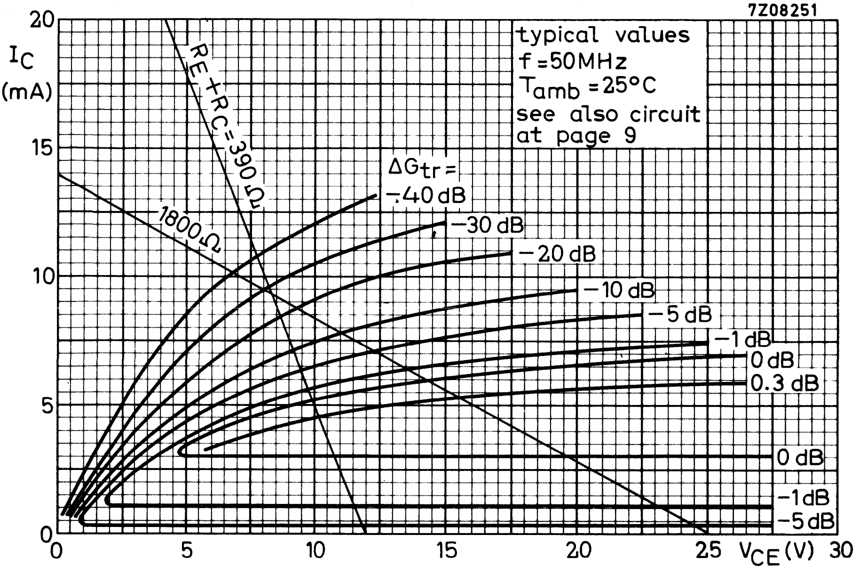


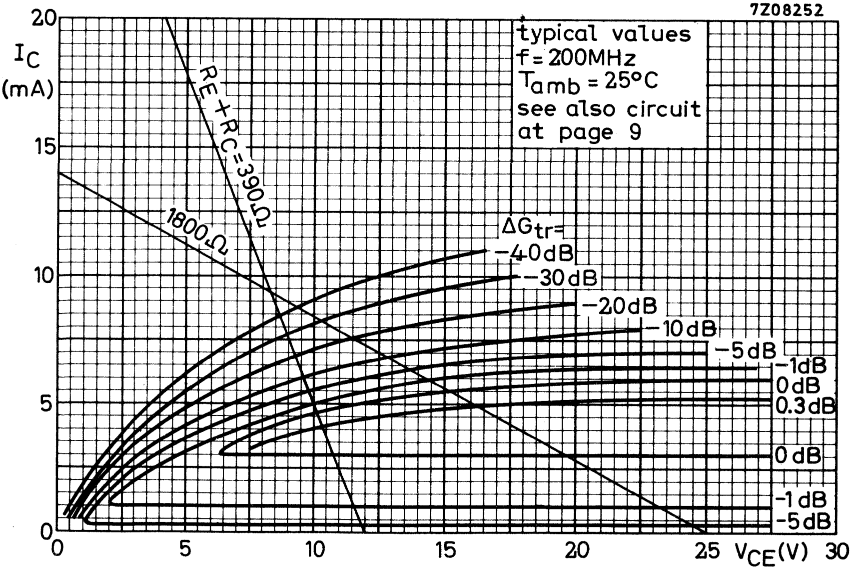




APPLICATION INFORMATION (continued)

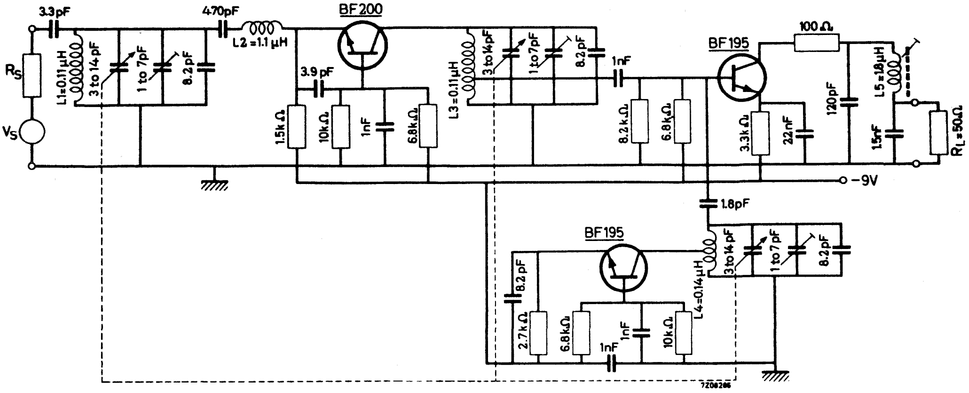
curves of constant gain reduction





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

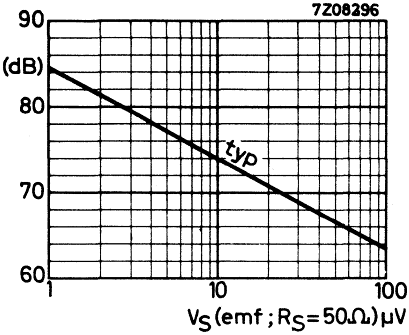
Coil former	AP3016/02	Ferroxcube core	3122 104 93041
Can	AP3015/02	Ferroxcube frame	AP3014/02

APPLICATION INFORMATION (continued)

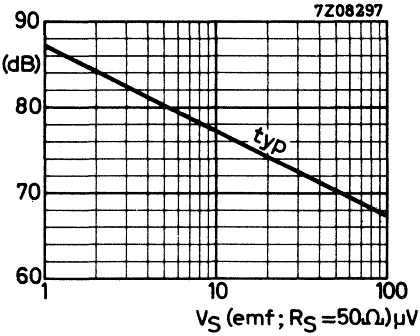
Typical performance of the f.m. tuner at T_{amb} = 25 °C; f = 98 MHz (oscillator frequency lower than tuning frequency)

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 μV; emf; R_S = 50 Ω)		85	dB
Repeat spot suppression (V_S = 1 μV; emf; R_S = 50 Ω)		87	dB
Oscillator frequency variation at ΔV_B = 2 V	Δf_{osc}	< 20	kHz
Signal handling for Δf_{osc} = 20 kHz (emf; R_S = 50 Ω)		> 1	V

Double beat suppression

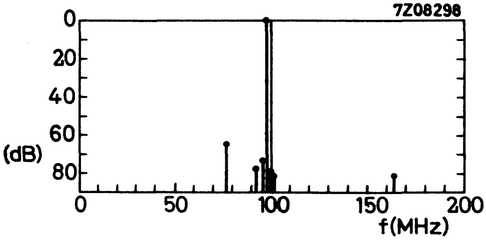


Repeat spot suppression



Spurious response suppression

Tuner adjusted to f = 98 MHz.
Reference level of wanted source signal: 8 μV (emf; R_S = 50 Ω) = 0 dB.



SILICON PLANAR EPITAXIAL TRANSISTOR

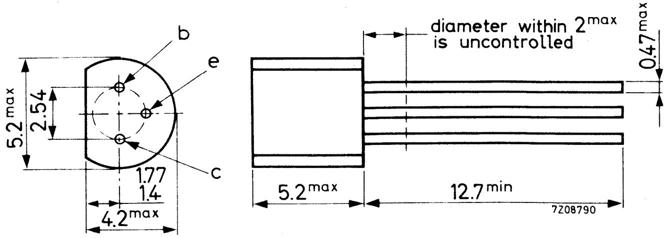
N-P-N transistor in a plastic envelope.
The BF254 is intended for h.f. applications in radio and television receivers; it is especially recommended for f.m. tuners, low noise a.m. mixer-oscillators with high source impedance and i.f. amplifiers in a.m./f.m. receivers where a high current gain is of importance.

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 $T_{amb} = 25\ ^oC$	P_{tot}	max.	300	mW
Junction temperature	T_j	max.	125	^oC
D.C. current gain at $T_j = 25\ ^oC$ $I_C = 1$ mA; $V_{CE} = 10$ V	h_{FE}	typ.	115	
Transition frequency at f = 35 MHz $I_C = 1$ mA; $V_{CE} = 10$ V	f_T	typ.	260	MHz
Noise figure at f = 100 MHz $I_C = 1$ mA; $V_{CE} = 10$ V; $G_S = 10\ m\Omega^{-1}$	F	typ.	4	dB
Conversion noise figure at f = 1 MHz $I_C = 1$ mA; $V_{CE} = 10$ V; $G_S = 1.2\ m\Omega^{-1}$	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 $T_{amb} = 25\ ^oC$	P_{tot}	max.	300	mW
Temperatures				
Storage temperature	T_{stg}	-65 to +125		^oC
Junction temperature	T_j	max.	125	^oC

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	0.33	$^oC/mW$

CHARACTERISTICS

T_j = 25 °C

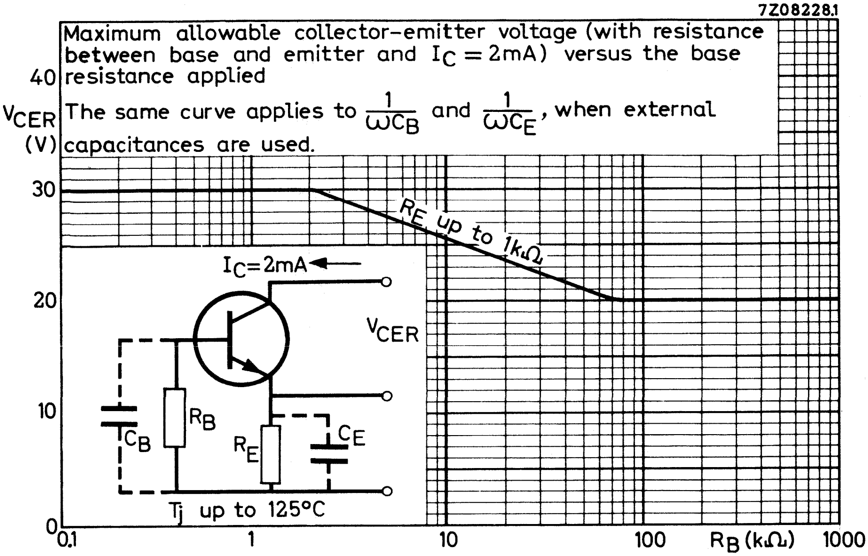
Base-emitter voltage [1]				
I_C = 1 mA; V_{CE} = 10 V	V_{BE}	0.65 to	0.74	V
Base current				
I_C = 1 mA; V_{CE} = 10 V	I_B	typ. 4.5 to	8.7 15	μA μA
Feedback capacitance at f = 0.45 MHz				
I_C = 1 mA; V_{CE} = 10 V	$-C_{re}$	typ.	0.85	pF
Transition frequency at f = 35 MHz				
I_C = 1 mA; V_{CE} = 10 V	f_T	typ.	260	MHz
Noise figure				
I_C = 1 mA; V_{CE} = 10 V				
G_S = 2 $m\Omega^{-1}$; f = 0.2 MHz	F	typ.	1.5	dB
G_S = 1.5 $m\Omega^{-1}$; f = 1.0 MHz	F	typ.	1.2	dB
G_S = 10 $m\Omega^{-1}$; f = 100 MHz	F	typ.	4	dB
Conversion noise figure				
I_C = 1 mA; V_{CE} = 10 V				
G_S = 0.6 $m\Omega^{-1}$; f = 0.2 MHz	F_c	typ.	3	dB
G_S = 1.2 $m\Omega^{-1}$; f = 1.0 MHz	F_c	typ.	2	dB
y parameters at f = 100 MHz (common base)				
I_C = 1 mA; V_{CE} = 10 V (lead length = 3 mm)				
Input conductance	g_{ib}	typ.	36	$m\Omega^{-1}$
Input susceptance	$-b_{ib}$	typ.	3	$m\Omega^{-1}$
Feedback admittance	$\|y_{rb}\|$	typ.	410	$\mu\Omega^{-1}$
Phase angle of feedback admittance	φ_{rb}	typ.	272°	
Transfer admittance	$\|y_{fb}\|$	typ.	33	$m\Omega^{-1}$
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	$m\Omega^{-1}$

y parameters (common emitter)

I_C = 1 mA; V_{CE} = 10 V (lead length = 3 mm)			f = 10.7 MHz	f = 0.45 MHz	
Input conductance	g_{ie}	<	0.64	0.54	$m\Omega^{-1}$
Output conductance	g_{oe}	<	13.5	11.5	$\mu\Omega^{-1}$

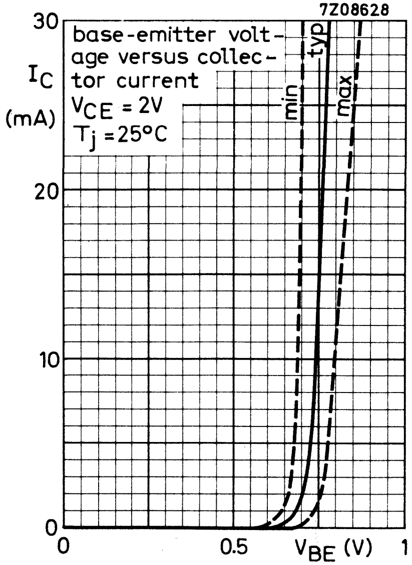
---

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

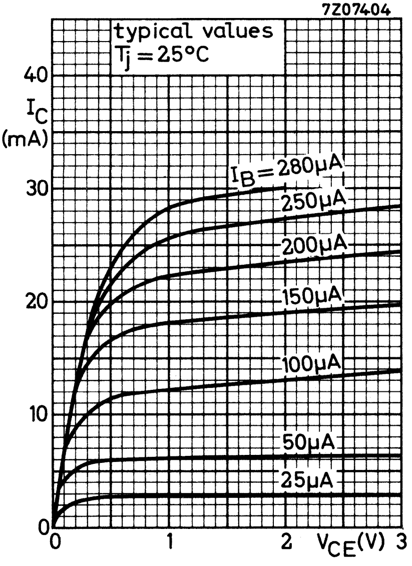


Maximum allowable collector-emitter voltage (with resistance between base and emitter and $I_C = 2mA$) versus the base resistance applied

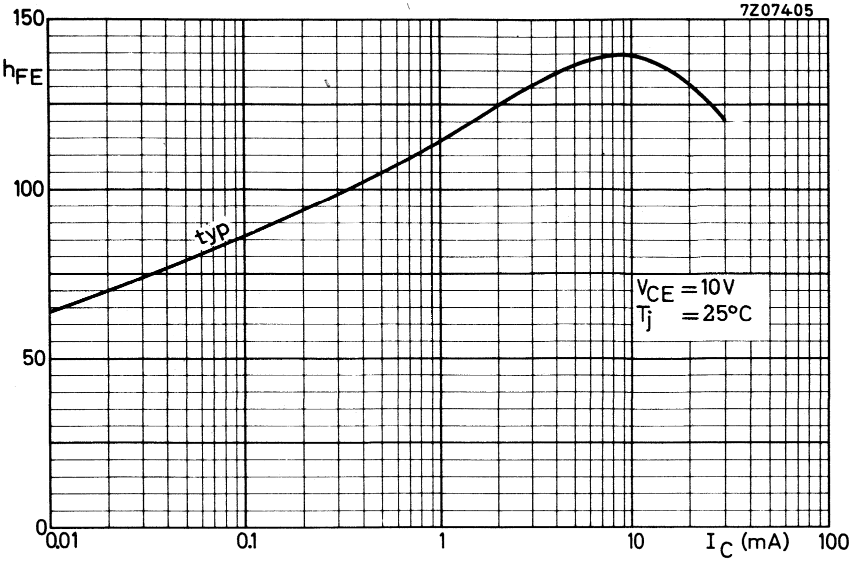
The same curve applies to $\frac{1}{\omega C_B}$ and $\frac{1}{\omega C_E}$, when external capacitances are used.

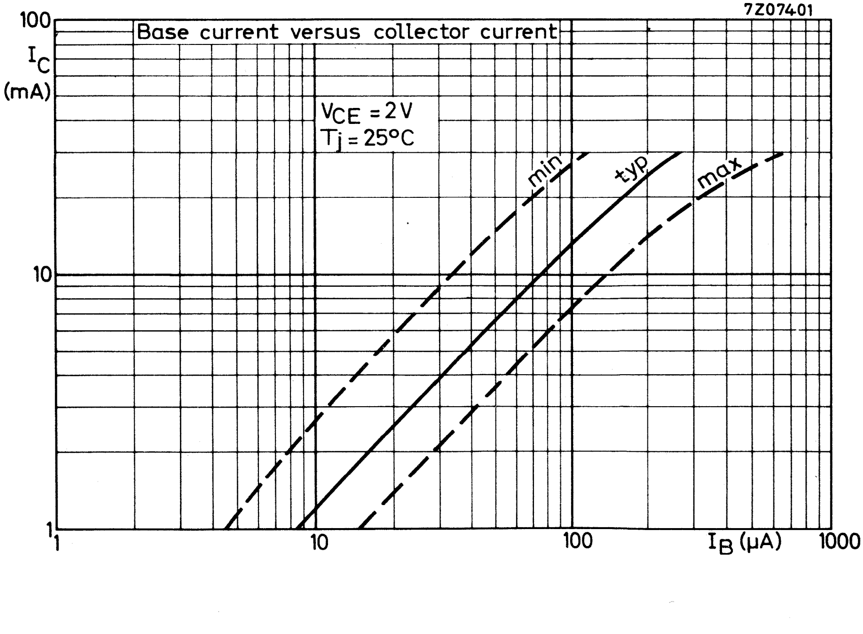


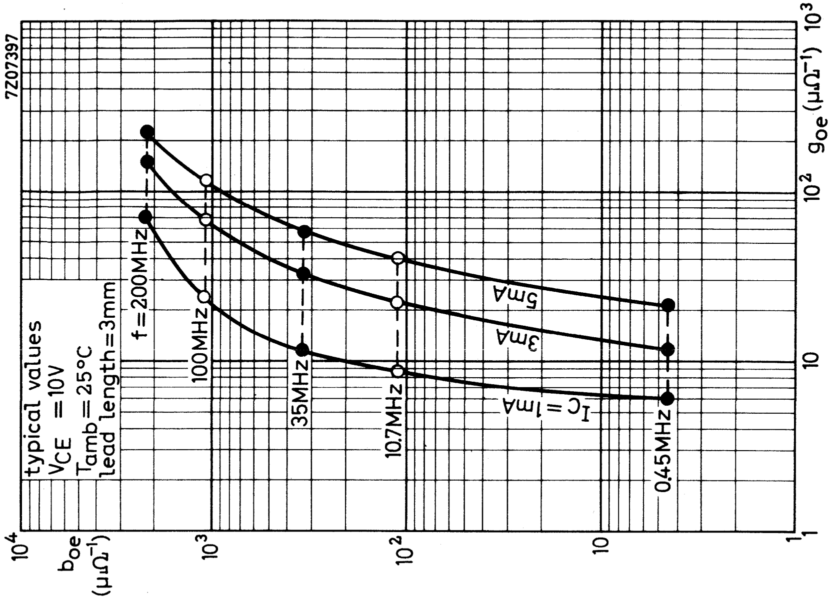
base-emitter voltage versus collector current
V_{CE} = 2V
T_j = 25°C

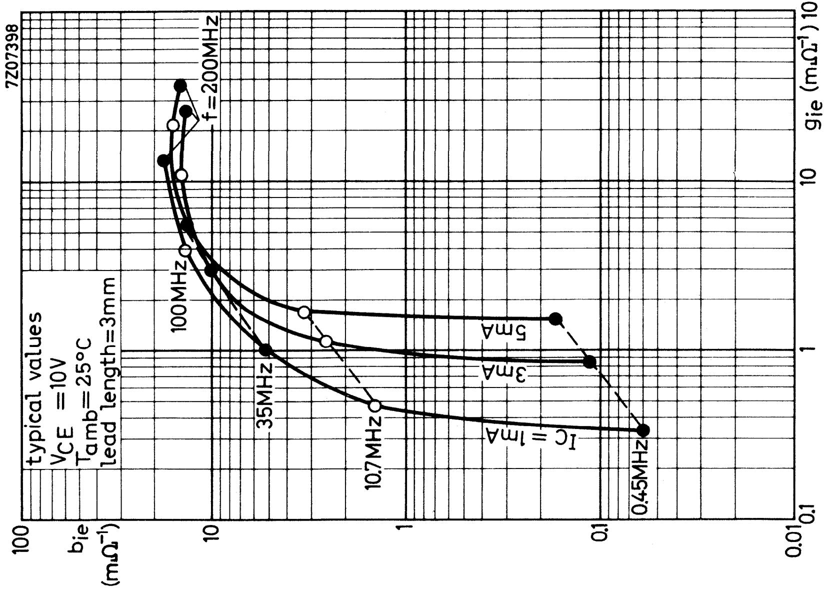


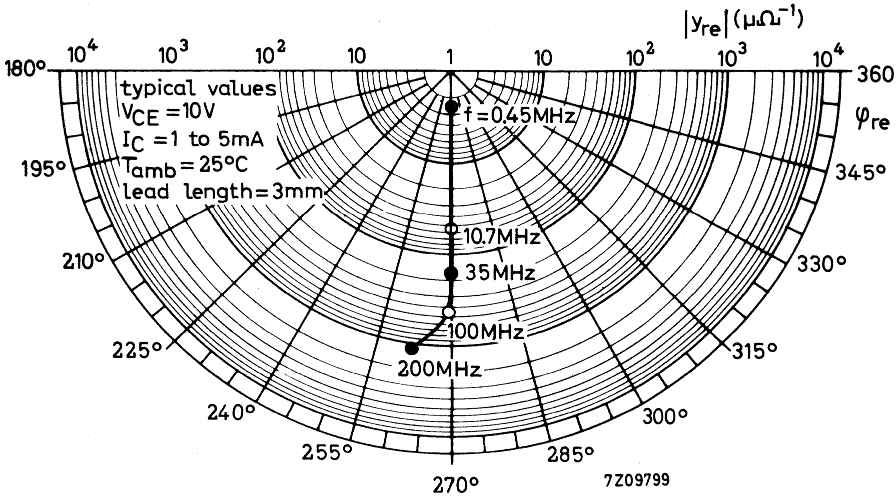
typical values
T_j = 25°C

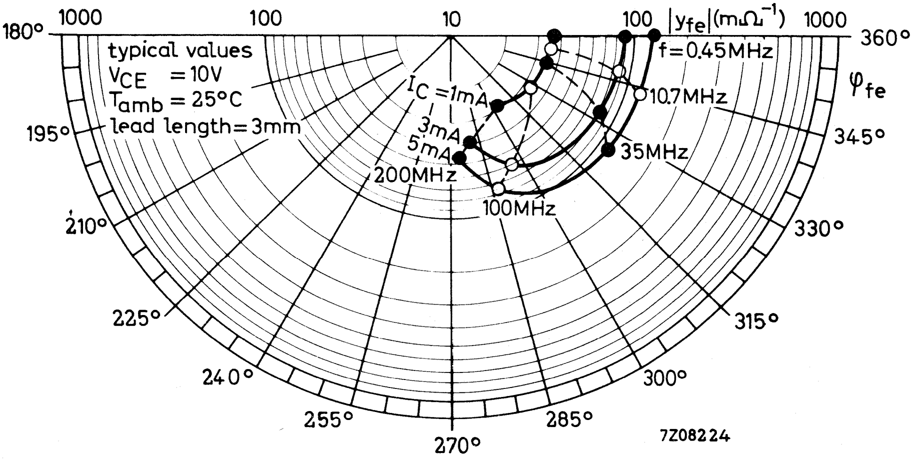

7Z07405
150
h_{FE}
100
50
0
typ
V_{CE} = 10 V
T_j = 25°C
0.01
0.1
1
10
I_C (mA)
100

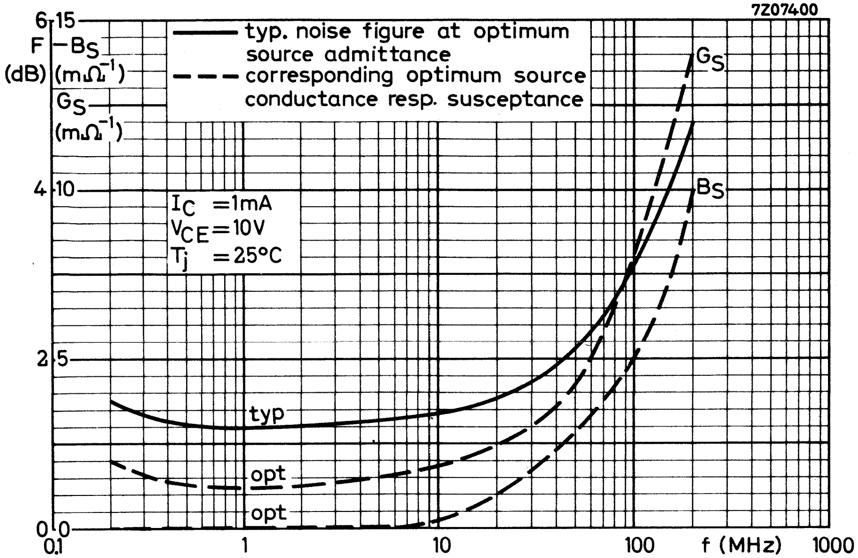

7Z07401
Base current versus collector current
100
I_C
(mA)
10
1
V_{CE} = 2 V
T_j = 25°C
min
typ
max
1
10
100
I_B (μA)
1000

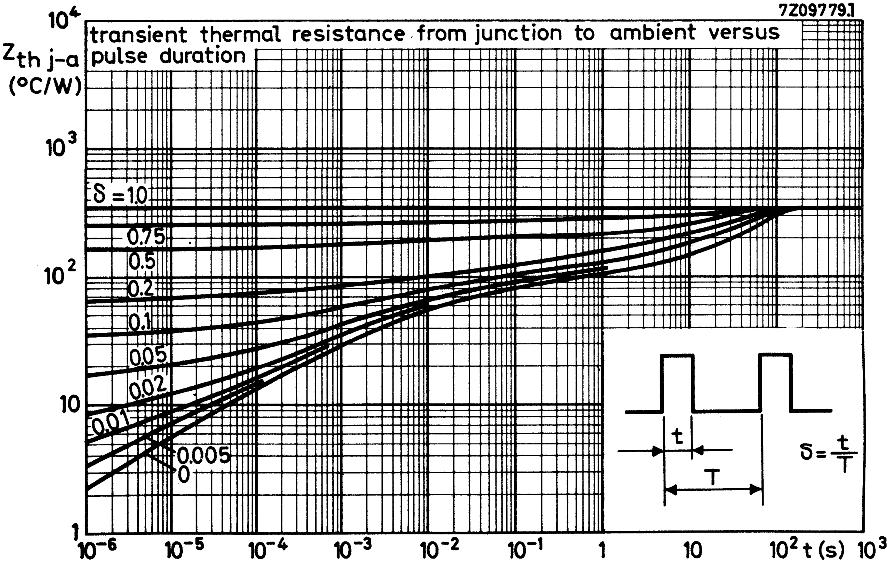

7Z07397
typical values
VCE = 10V
Tamb = 25°C
lead length = 3mm
f = 200MHz
100MHz
35MHz
10.7MHz
0.45MHz
IC = 1mA
3mA
5mA
boe
(μΩ⁻¹)
10⁴
10³
10²
10
1
goe (μΩ⁻¹)
1
10
10²
10³


7Z07398
typical values
VCE = 10V
Tamb = 25°C
lead length = 3mm
f = 200MHz
100MHz
35MHz
10.7MHz
0.45MHz
IC = 1mA
3mA
5mA
bie
(mΩ⁻¹)
100
10
1
0.1
0.01
gie (mΩ⁻¹)
0.1
1
10
100


|y_{re}| (μΩ^{-1})
10^4
10^3
10^2
10
1
10
10^2
10^3
10^4
180°
360°
φ_{re}
195°
345°
210°
330°
225°
315°
240°
300°
255°
285°
270°
typical values
V_{CE} = 10V
I_C = 1 to 5mA
T_{amb} = 25°C
lead length = 3mm
f = 0.45MHz
10.7MHz
35MHz
100MHz
200MHz
7Z09799


1000
100
10
100
|y_{fe}| (mΩ^{-1})
1000
180°
360°
φ_{fe}
195°
345°
210°
330°
225°
315°
240°
300°
255°
285°
270°
typical values
V_{CE} = 10V
T_{amb} = 25°C
lead length = 3mm
I_C = 1mA
3mA
5mA
f = 0.45MHz
10.7MHz
35MHz
100MHz
200MHz
7Z08224


7Z07400
6
F
(dB)
4
2
0
15
−Bs
(mΩ⁻¹)
Gs
(mΩ⁻¹)
10
5
0
typ. noise figure at optimum source admittance
corresponding optimum source conductance resp. susceptance
Ic =1mA
VCE =10V
Tj =25°C
typ
opt
opt
Gs
Bs
0.1
1
10
100
f (MHz)
1000


7Z09779.1
10⁴
Zth j-a
(°C/W)
10³
10²
10
1
transient thermal resistance from junction to ambient versus pulse duration
δ = 1.0
0.75
0.5
0.2
0.1
0.05
0.02
0.01
0.005
0
t
T
δ = t/T
10⁻⁶
10⁻⁵
10⁻⁴
10⁻³
10⁻²
10⁻¹
1
10
10²
t (s)
10³

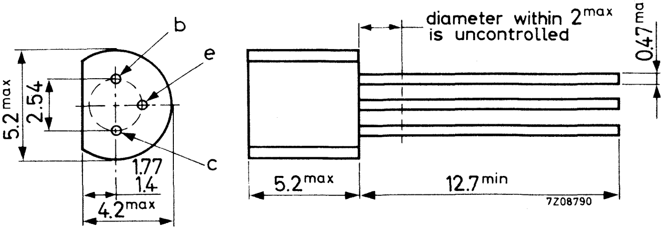
SILICON PLANAR EPITAXIAL TRANSISTOR

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 $T_{amb} = 25\ ^oC$	P_{tot}	max.	300	mW
Junction temperature	T_j	max.	125	^oC
D.C. current gain at $T_j = 25\ ^oC$				
$I_C = 1$ mA; $V_{CE} = 10$ V	h_{FE}	typ.	67	
Transition frequency at f = 35 MHz				
$I_C = 1$ mA; $V_{CE} = 10$ V	f_T	typ.	200	MHz
Noise figure				
$I_C = 1$ mA; $V_{CE} = 10$ V				
$G_S = 20\ m\Omega^{-1}$; f = 1 MHz	F	typ.	3.5	dB
$G_S = 10\ m\Omega^{-1}$; f = 100 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 $T_{amb} = 25\ ^{o}C$	P_{tot}	max.	300	mW

Temperatures

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

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	0.33	$^{o}C/mW$

CHARACTERISTICS $T_j = 25\ ^oC$

Base-emitter voltage [1]

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

Base current

$I_C = 1$ mA; $V_{CE} = 10$ V	I_B	typ.	15	μA
		8 to	28	μA

Feedback capacitance at f = 0.45 MHz

$I_C = 1$ mA; $V_{CE} = 10$ V	$-C_{re}$	typ.	0.85	pF

Transition frequency at f = 35 MHz

$I_C = 1$ mA; $V_{CE} = 10$ V	f_T	typ.	200	MHz

Noise figure

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

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

Conversion noise figure

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

$G_S = 1.2\ m\Omega^{-1}$; f = 0.2 MHz	F_c	typ.	4	dB
$G_S = 1.5\ m\Omega^{-1}$; f = 1 MHz	F_c	typ.	2.5	dB

y parameters at f = 100 MHz (common base)

$I_C = 1$ mA; $V_{CE} = 10$ V (lead length = 3 mm)

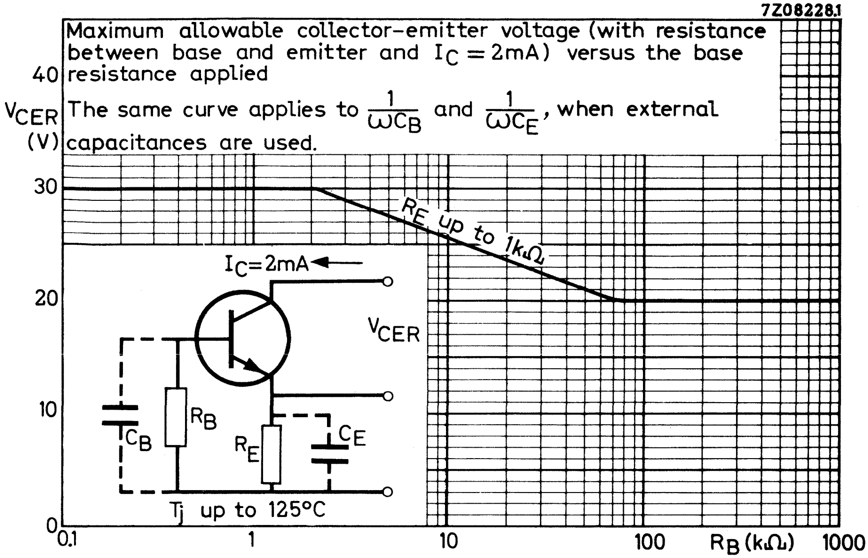
Input conductance	g_{ib}	typ.	38	$m\Omega^{-1}$
Input susceptance	$-b_{ib}$	typ.	1	$m\Omega^{-1}$
Feedback admittance	$\lvert y_{rb}\rvert$	typ.	400	$\mu\Omega^{-1}$
Phase angle of feedback admittance	φ_{rb}	typ.	275^o	
Transfer admittance	$\lvert y_{fb}\rvert$	typ.	34	$m\Omega^{-1}$
Phase angle of transfer admittance	φ_{fb}	typ.	140^o	
Output conductance	g_{ob}	typ.	12	$\mu\Omega^{-1}$
Output susceptance	b_{ob}	typ.	1.1	$m\Omega^{-1}$

y parameters (common emitter)

$I_C = 1$ mA; $V_{CE} = 10$ V (lead length = 3 mm)			f = 10.7 MHz	f = 0.45 MHz	
Input conductance	g_{ie}	<	0.96	0.86	$m\Omega^{-1}$
Output conductance	g_{oe}	<	9.5	7.0	$\mu\Omega^{-1}$

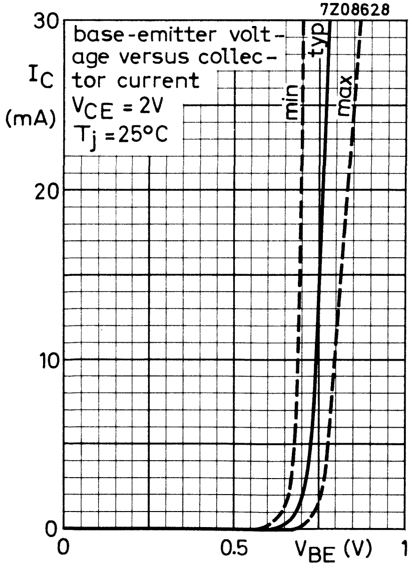
---

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



Maximum allowable collector-emitter voltage (with resistance between base and emitter and $I_C = 2mA$) versus the base resistance applied

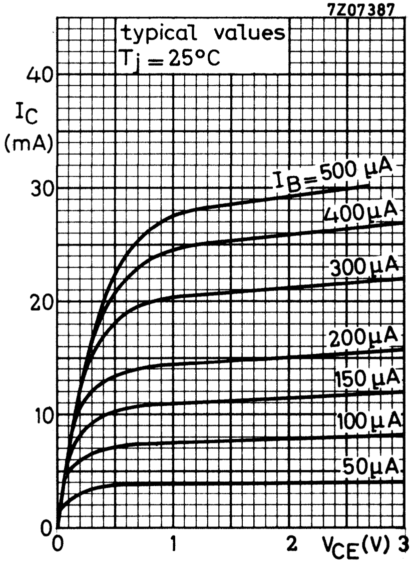
The same curve applies to $\frac{1}{\omega C_B}$ and $\frac{1}{\omega C_E}$, when external capacitances are used.



base-emitter voltage versus collector current

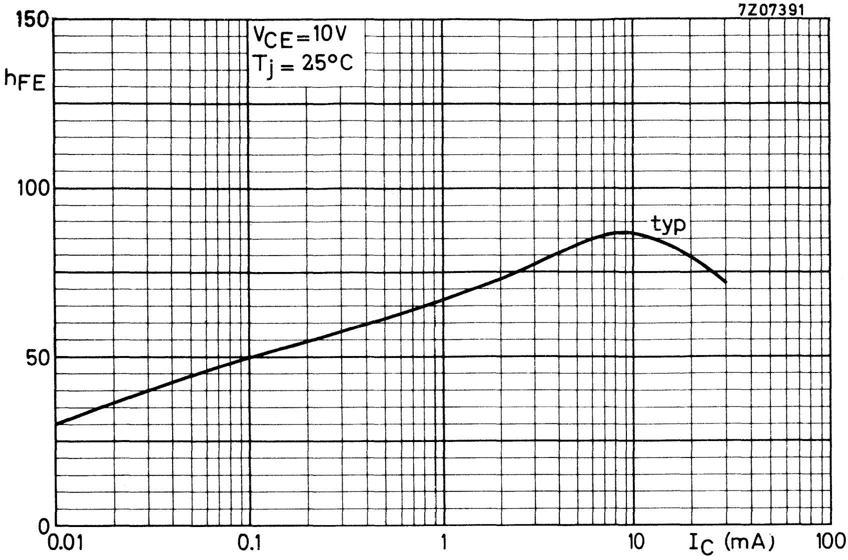
V_{CE} = 2V

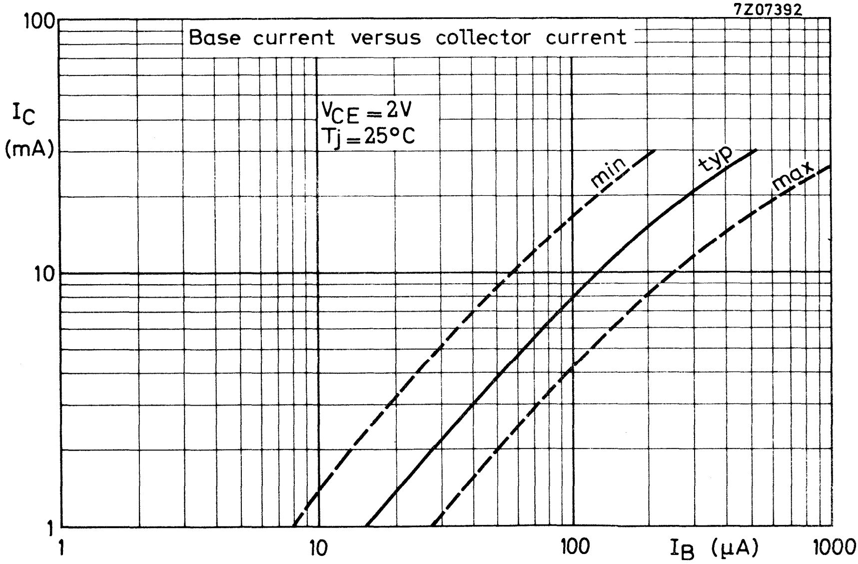
T_j =25°C

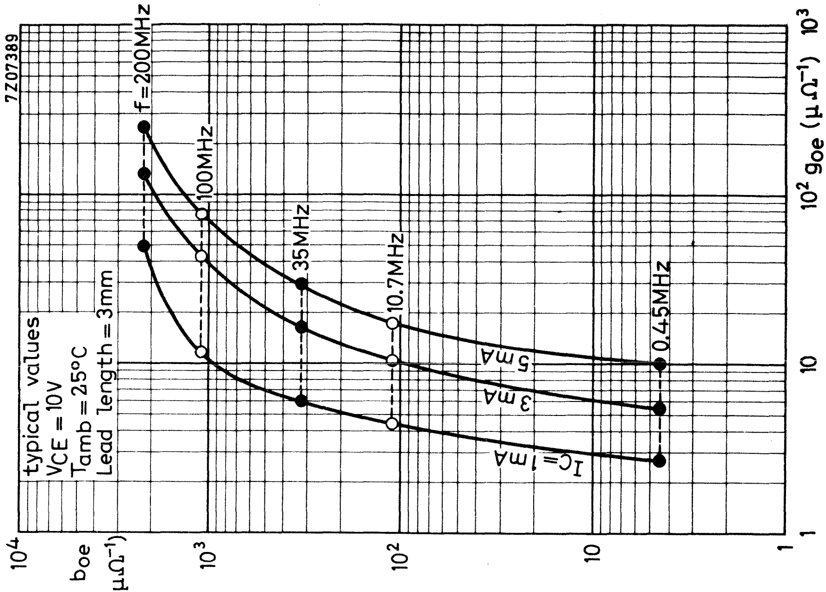


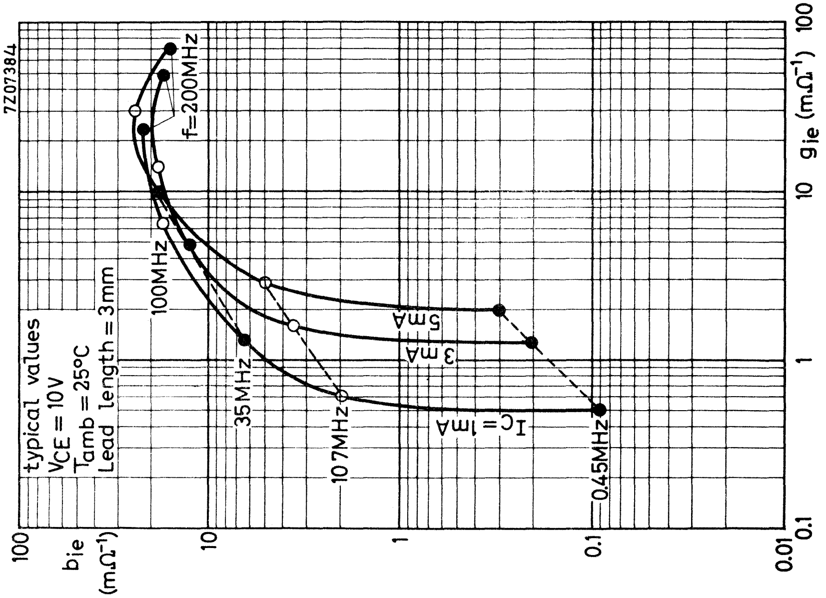
typical values

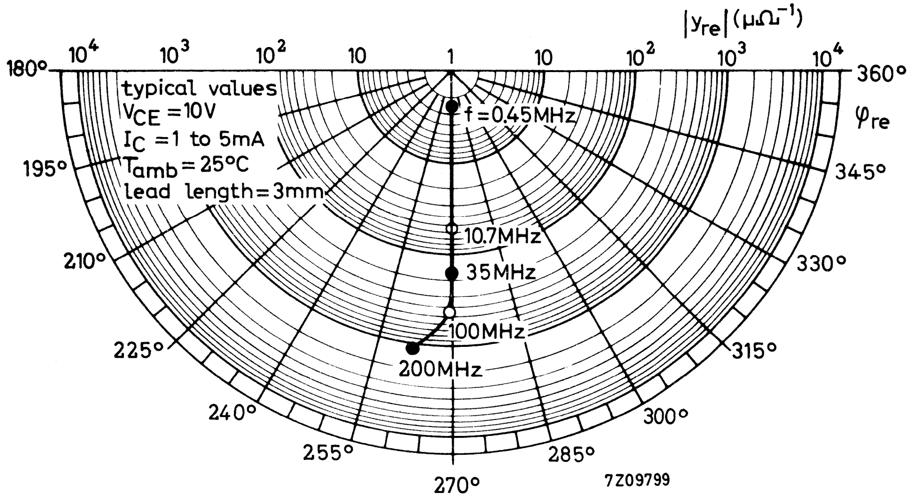
$T_j = 25°C$

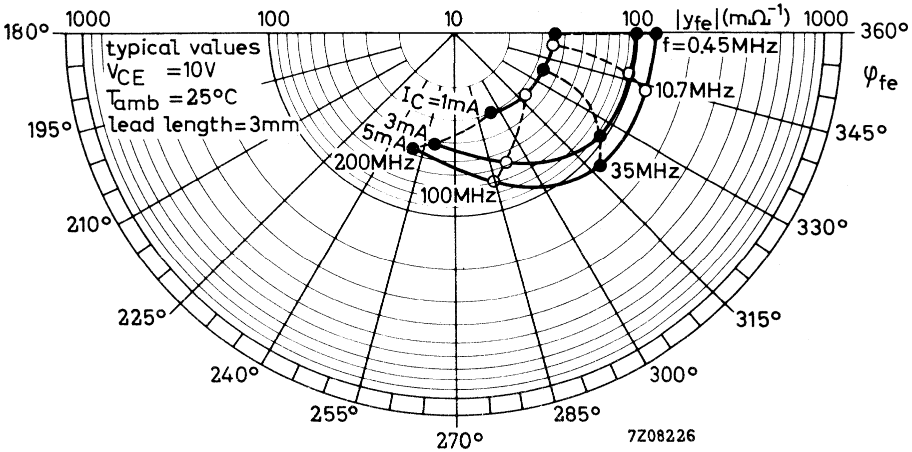

7Z07391
150
hFE
100
50
0
0.01
0.1
1
10
IC (mA)
100
VCE = 10 V
Tj = 25°C
typ

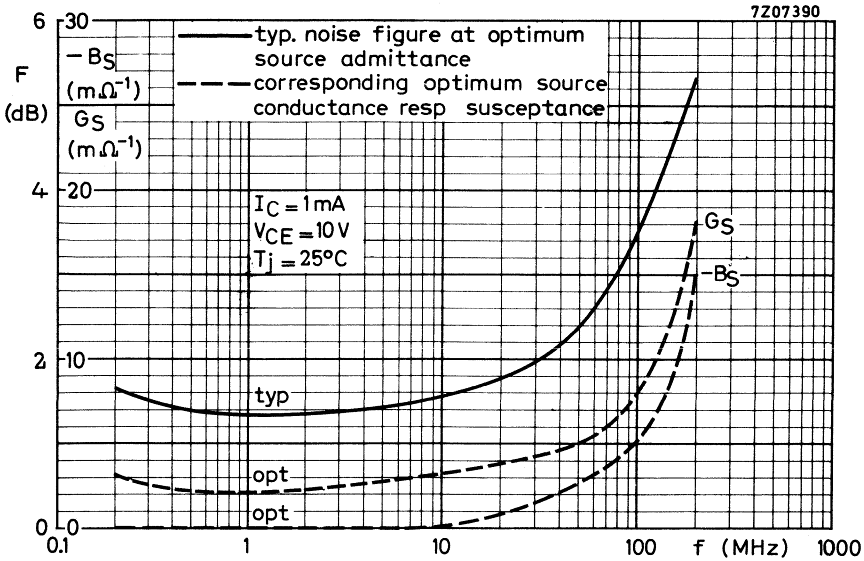

7Z07392
Base current versus collector current
100
IC
(mA)
10
1
1
10
100
IB (µA)
1000
VCE = 2 V
Tj = 25°C
min
typ
max

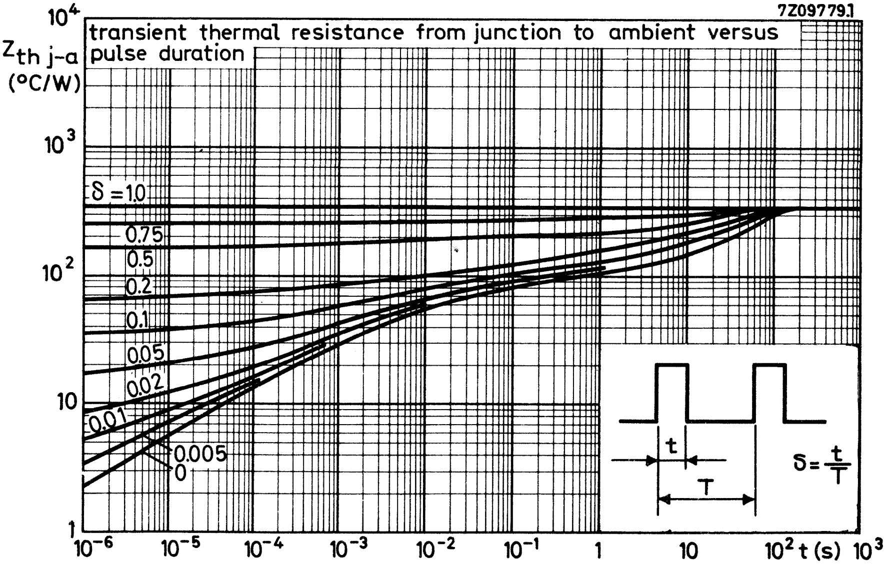

7Z07389
typical values
$V_{CE} = 10V$
$T_{amb} = 25°C$
Lead length = 3mm
f = 200MHz
100MHz
35MHz
10.7MHz
0.45MHz
I_C = 1mA
3 mA
5 mA
b_{oe} ($\mu\Omega^{-1}$)
10^4
10^3
10^2
10
1
g_{oe} ($\mu\Omega^{-1}$)
1
10
10^2
10^3


7Z07384
typical values
$V_{CE} = 10V$
$T_{amb} = 25°C$
Lead length = 3mm
f=200MHz
100MHz
35MHz
10.7MHz
0.45MHz
I_C = 1mA
3 mA
5 mA
b_{ie} ($m\Omega^{-1}$)
100
10
1
0.1
0.01
g_{ie} ($m\Omega^{-1}$)
0.1
1
10
100


|y_re| (μΩ⁻¹)
10⁴
10³
10²
10
1
10
10²
10³
10⁴
180°
360°
φ_re
typical values
V_CE = 10V
I_C = 1 to 5mA
T_amb = 25°C
lead length = 3mm
f = 0.45MHz
10.7MHz
35MHz
100MHz
200MHz
195°
345°
210°
330°
225°
315°
240°
300°
255°
285°
270°
7Z09799


1000
100
10
100
|y_fe| (mΩ⁻¹)
1000
180°
360°
φ_fe
typical values
V_CE = 10V
T_amb = 25°C
lead length = 3mm
f = 0.45MHz
10.7MHz
I_C = 1mA
3mA
5mA
200MHz
35MHz
100MHz
195°
345°
210°
330°
225°
315°
240°
300°
255°
285°
270°
7Z08226


7Z07390
typ. noise figure at optimum source admittance
corresponding optimum source conductance resp susceptance
F (dB)
$-B_S$ ($m\Omega^{-1}$)
G_S ($m\Omega^{-1}$)
6
4
2
0
30
20
10
0
$I_C = 1\,mA$
$V_{CE} = 10\,V$
$T_j = 25°C$
typ
opt
opt
G_S
$-B_S$
0.1
1
10
100
f (MHz)
1000


7Z09779.1
transient thermal resistance from junction to ambient versus pulse duration
$Z_{th\ j-a}$ (°C/W)
10^4
10^3
10^2
10
1
$\delta = 1.0$
0.75
0.5
0.2
0.1
0.05
0.02
0.01
0.005
0
t
T
$\delta = \frac{t}{T}$
10^{-6}
10^{-5}
10^{-4}
10^{-3}
10^{-2}
10^{-1}
1
10
10^2
t (s)
10^3

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.

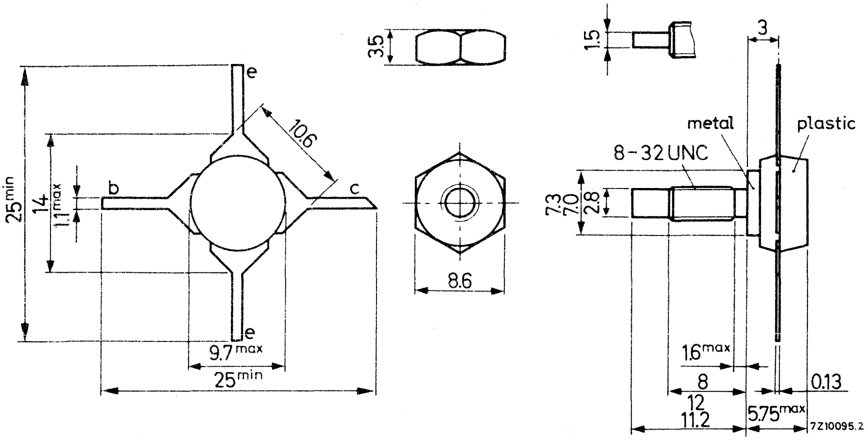
QUICK REFERENCE DATA

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 $T_{mb} = 60\,^{o}C$; $f \geq 1\,MHz$	P_{tot}	max.	3.5		W
Junction temperature	T_j	max.	150		^{o}C
Transition frequency at f = 500 MHz			BFR63	BFR64	
$I_C = 75$ mA; $V_{CE} = 20$ V	f_T	>	1000	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 Ω; 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 ≥ 1 MHz; see SOAR)				
Total power dissipation up to T_{mb} = 60 °C	P_{tot}	max.	3.5	W
Temperatures				
Storage temperature	T_{stg}		-40 to +150	°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	25	°C/W
From mounting base to heatsink	$R_{th\ mb\text{-}h}$	=	0.5	°C/W

1) at I_C = 100 μA   2) at I_C = 10 mA   3) at I_E = 100 μA

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

Collector cut-off current				
$I_E = 0$; $V_{CB} = 20$ V	I_{CBO}	<	10	μA
Saturation voltage				
$I_C = 100$ mA; $I_B = 10$ mA	V_{CEsat}	<	0.75	V
D.C. current gain				
$I_C = 50$ mA; $V_{CE} = 5$ V	h_{FE}	>	25	
$I_C = 150$ mA; $V_{CE} = 5$ V	h_{FE}	>	25	
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; $V_{CB} = 20$ V	C_c	<	4.5	pF
Feedback capacitance at f = 1 MHz				
$I_C = 10$ mA; $V_{CE} = 20$ V; $T_{mb} = 25\,^{\circ}C$	$-C_{re}$	typ.	1.7	pF
Noise figure at f = 200 MHz				
$I_C = 40$ mA; $V_{CE} = 20$ V; $R_S = 75\ \Omega$; $T_{mb} = 25\,^{\circ}C$	F	typ.	6	dB

			BFR63	BFR64	
Transition frequency at f = 500 MHz					
$I_C = 15$ mA; $V_{CE} = 20$ V	f_T	typ.	–	1000	MHz
$I_C = 75$ mA; $V_{CE} = 20$ V	f_T	>	1000	1200	MHz
$I_C = 150$ mA; $V_{CE} = 20$ V	f_T	typ.	1100	1200	MHz
Output power at f = 200 MHz; $T_{mb} = 25\,^{\circ}C$					
$I_C = 70$ 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)	P_o	>	–	130	mW
		typ.	150	150	mW
Output power at f = 800 MHz; $T_{mb} = 25\,^{\circ}C$					
$I_C = 70$ 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)	P_o	>	–	70	mW
		typ.	–	90	mW
Power gain (not neutralized) $T_{mb} = 25\,^{\circ}C$					
$I_C = 70$ mA; $V_{CE} = 20$ V; f = 200 MHz	G_p	>	–	15	dB
		typ.	16	16	dB
$I_C = 70$ mA; $V_{CE} = 20$ V; f = 800 MHz	G_p	typ.	–	6.5	dB

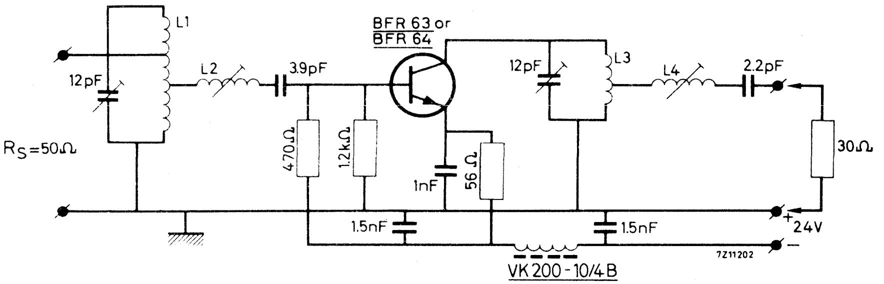
CHARACTERISTICS (continued)

Intermodulation characteristics

1. Output power at f = 200 MHz; T_{mb} = 25 °C

   I_C = 70 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:



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. 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:
$R_L = 220\ \Omega$; $C_L = -4$ pF.

Adjustment procedure

1. Remove the transistor and connect a dummy consisting of a 220 Ω 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.

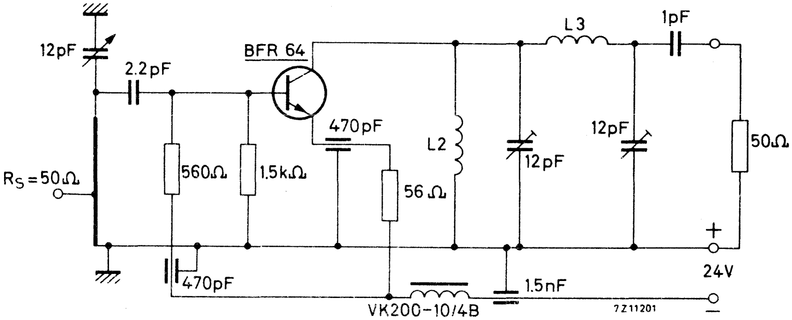
CHARACTERISTICS (continued)

Intermodulation characteristics

2. Output power at f = 800 MHz; $T_{mb} = 25\,^{\circ}C$

$I_C = 70$ 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:

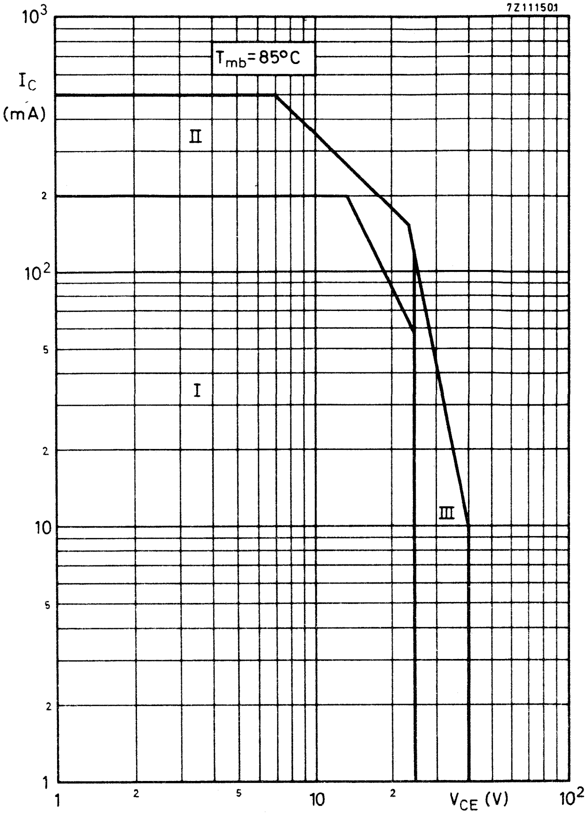
L1 = 25 mm x 7 mm x 0.85 mm silver plated Cu strip
Tap of the input at 5 mm from earth.
L2 = 13 turns enamelled Cu wire (0.6 mm); int. diam. 8 mm
L3 = 1.5 turns Cu wire (1.3 mm); int. diam. 8 mm

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 linearily with the input signal. This clipping can be eliminated by tuning the output circuit, thereby making the output power equal to

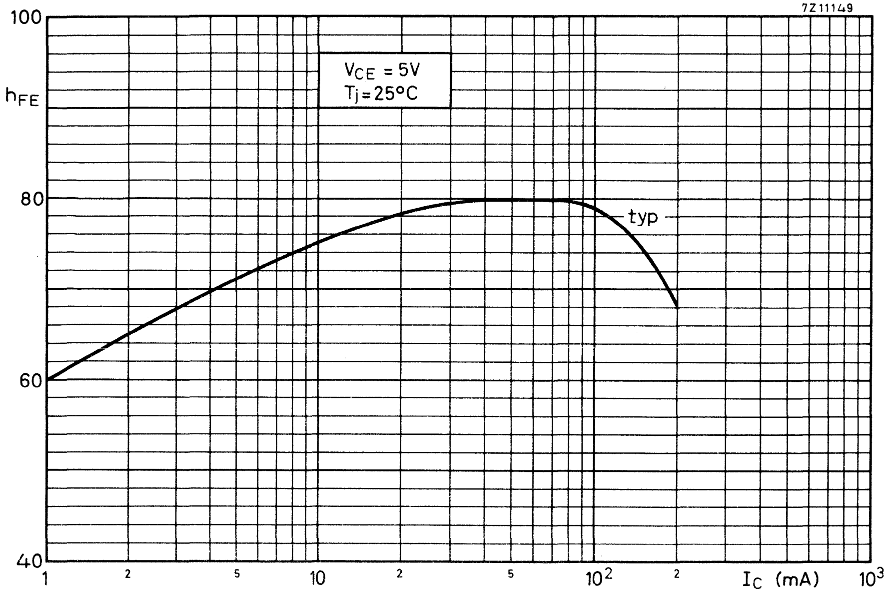
$$P_o = \frac{I_C(V_{CE}-V_{CEK})}{2} = 480 \text{ mW}.$$

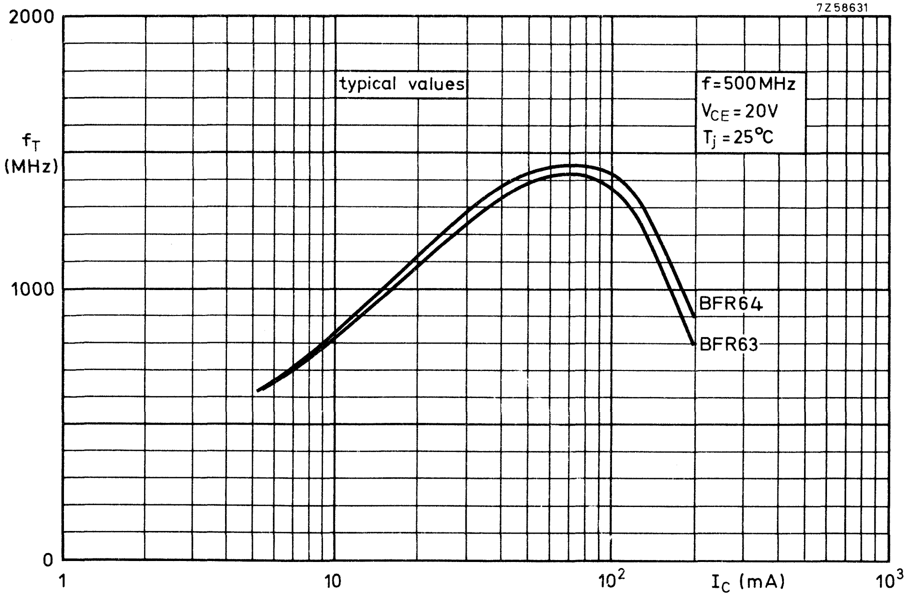
The output circuit is adjusted for minimum intermodulation if the input signal is as small as possible at $P_o = 480$ mW. With this adjusting method care must be taken, that the transistor is not destructed by second breakdown (the voltage swing may not exceed the rated V_{CER} value). Therefore as soon 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.

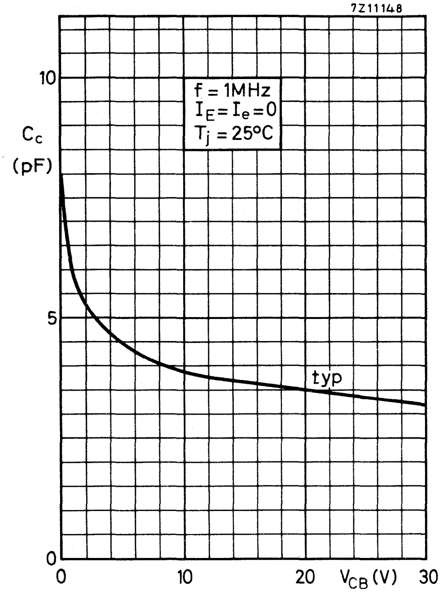


Safe Operating Area with the transistor forward biased

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


7Z11149
100
80
60
40
h_{FE}
V_{CE} = 5V
T_j = 25°C
typ
1
2
5
10
2
5
10^2
2
I_C (mA)
10^3


7Z58631
2000
1000
0
f_T (MHz)
typical values
f = 500 MHz
V_{CE} = 20V
T_j = 25°C
BFR64
BFR63
1
10
10^2
I_C (mA)
10^3


7Z11148
f = 1MHz
$I_E = I_e = 0$
$T_j = 25°C$
C_c
(pF)
10
5
0
typ
0
10
20
V_{CB} (V)
30

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.

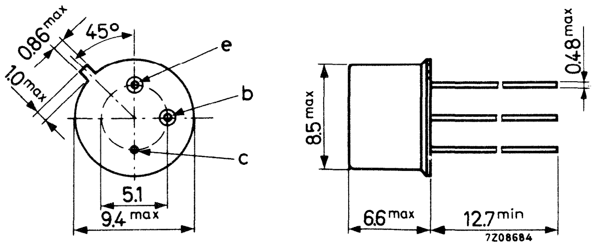
QUICK REFERENCE DATA

			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 °C	P_{tot}	max.	5	5	5	5	W
Junction temperature	T_j	max.	200	200	200	200	°C
Collector-emitter saturation voltage $-I_C$ = 500 mA; $-I_B$ = 50 mA	$-V_{CEsat}$	<	1.0	1.0	0.7	0.7	V
D. C. current gain $-I_C$ = 150 mA; $-V_{CE}$ = 10 V	h_{FE}	>	30	70	40	70	
Transition frequency at f = 35 MHz $-I_C$ = 50 mA; $-V_{CE}$ = 10 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 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
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 °C See page 6	P_{tot}	max.	5	W

Temperatures

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

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	220	°C/W
From junction to case	$R_{th\ j\text{-}c}$	=	35	°C/W
From junction to mounting base	$R_{th\ j\text{-}mb}$	=	30	°C/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current

$I_E = 0$; $-V_{CB} = 80$ V; $T_j = 25$ °C	BFS92; BFS93	$-I_{CBO}$	<	50	nA
$T_j = 100$ °C		$-I_{CBO}$	<	2.5	μA
$I_E = 0$; $-V_{CB} = 60$ V; $T_j = 25$ °C	BFS94	$-I_{CBO}$	<	50	nA
$T_j = 100$ °C		$-I_{CBO}$	<	2.5	μA
$I_E = 0$; $-V_{CB} = 30$ V; $T_j = 25$ °C	BFS95	$-I_{CBO}$	<	50	nA
$T_j = 100$ °C		$-I_{CBO}$	<	2.5	μA

Emitter cut-off current

$I_C = 0$; $-V_{EB} = 5$ V; $T_j = 25$ °C	$-I_{EBO}$	<	50	nA
$T_j = 100$ °C	$-I_{EBO}$	<	2.5	μA

Saturation voltages			BFS92	BFS93	BFS94	BFS95	
$-I_C = 10$ mA; $-I_B = 1$ mA	$-V_{CEsat}$	<	0.15	0.15	0.10	0.10	V
	$-V_{BEsat}$	<	1.2	1.2	1.2	1.2	V
$-I_C = 150$ mA; $-I_B = 15$ mA	$-V_{CEsat}$	<	0.35	0.35	0.20	0.20	V
	$-V_{BEsat}$	<	1.3	1.3	1.3	1.3	V
$-I_C = 500$ mA; $-I_B = 50$ mA	$-V_{CEsat}$	<	1.00	1.00	0.70	0.70	V
	$-V_{BEsat}$	<	1.5	1.5	1.5	1.5	V
$-I_C = 1$ A; $-I_B = 100$ 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							
$-I_C = 10$ mA; $-V_{CE} = 10$ V	h_{FE}	>	20	50	30	50	
$-I_C = 150$ mA; $-V_{CE} = 10$ V	h_{FE}	>	30	70	40	70	
$-I_C = 500$ mA; $-V_{CE} = 10$ V	h_{FE}	>	20	30	25	30	
$-I_C = 1$ A; $-V_{CE} = 10$ V	h_{FE}	>	15	15	15	15	

Collector capacitance at f = 1 MHz

$I_E = I_e = 0$; $-V_{CB} = 10$ V	C_c	<	20	pF

Transition frequency at f = 35 MHz

$-I_C = 50$ mA; $-V_{CE} = 10$ V	f_T	>	40	MHz
		typ.	70	MHz

CHARACTERISTICS (continued)

h parameters at f = 1 kHz

$-I_C$ = 10 mA; $-V_{CE}$ = 5 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 mA; $-V_{CE}$ = 5 V				
Small signal current gain	h_{fe}	typ.	90	

Switching times (see also page 5)

Turn on time				
$-I_C$ = 150 mA; $-I_B$ = + I_{BM} = 15 mA				
delay time	t_d	typ.	20	ns
rise time	t_r	typ.	35	ns
Turn off time				
$-I_C$ = 150 mA; $-I_B$ = + I_{BM} = 15 mA				
storage time	t_s	typ.	500	ns
fall time	t_f	typ.	65	ns

MEASUREMENT OF SWITCHING TIMES

Fig. 1: Circuit diagram

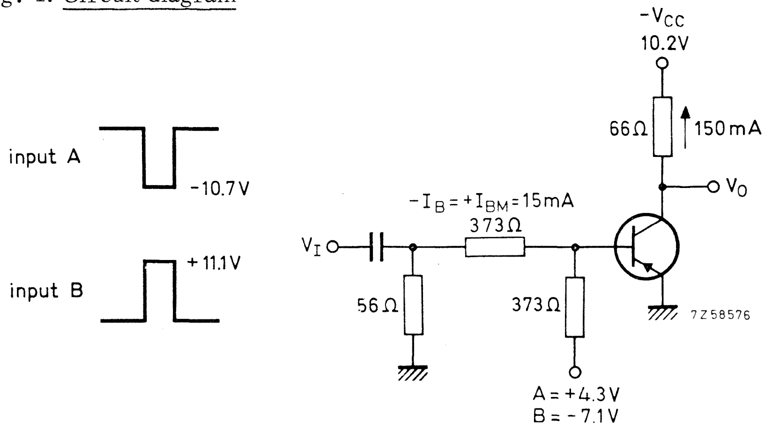
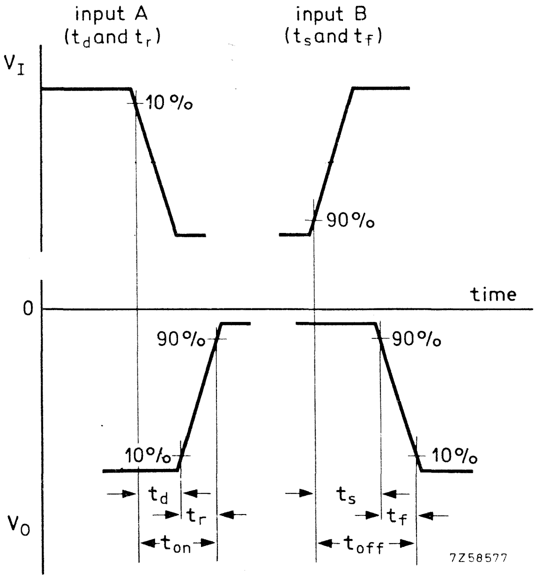
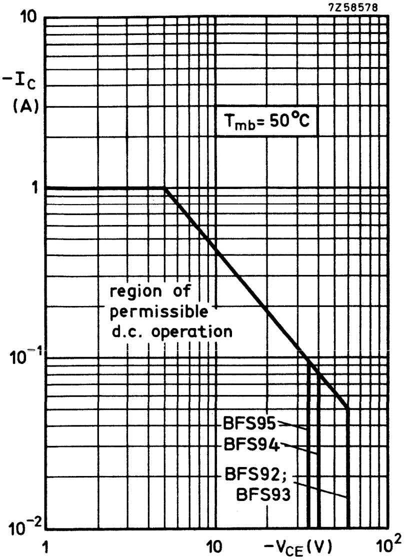


Fig. 2: Waveforms

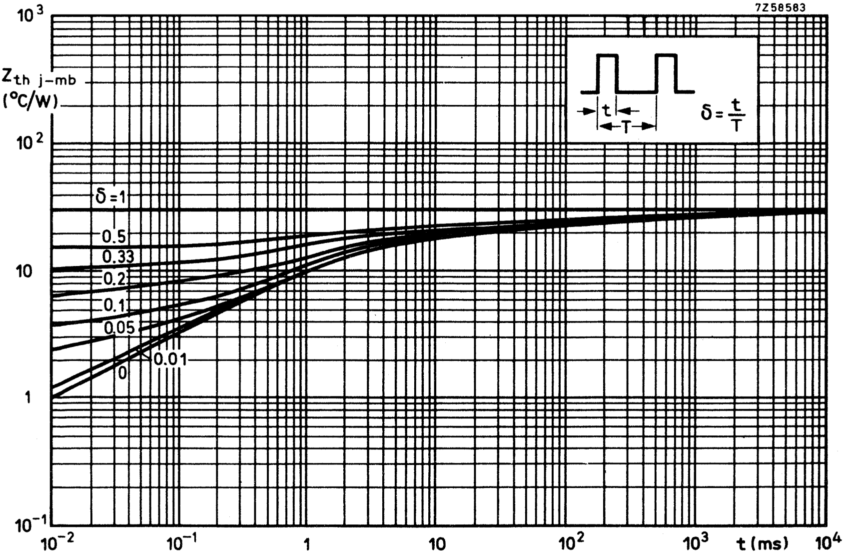


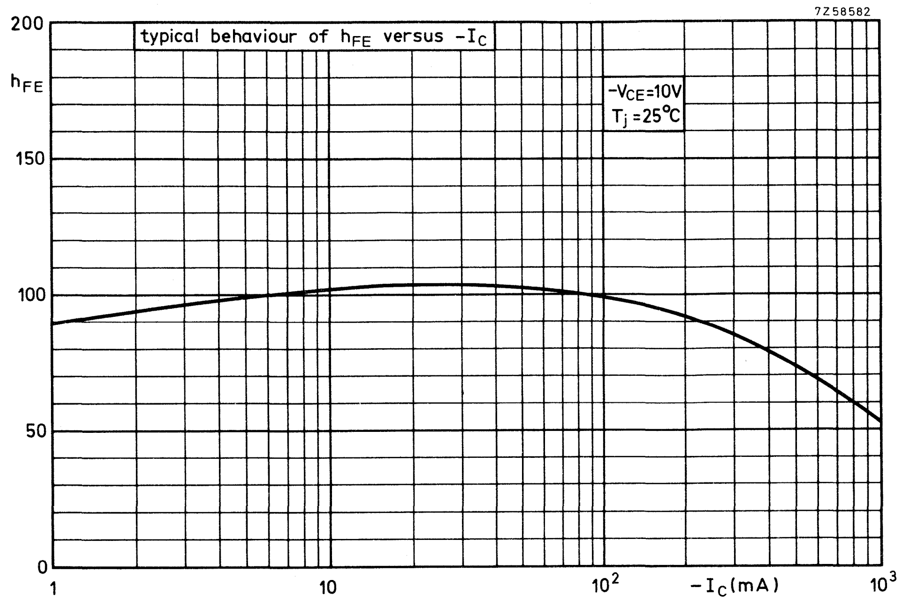
Equipment: Pulse generator (rise time = 1 ns)
Double beam or dual trace oscilloscope (rise time < 5 ns)

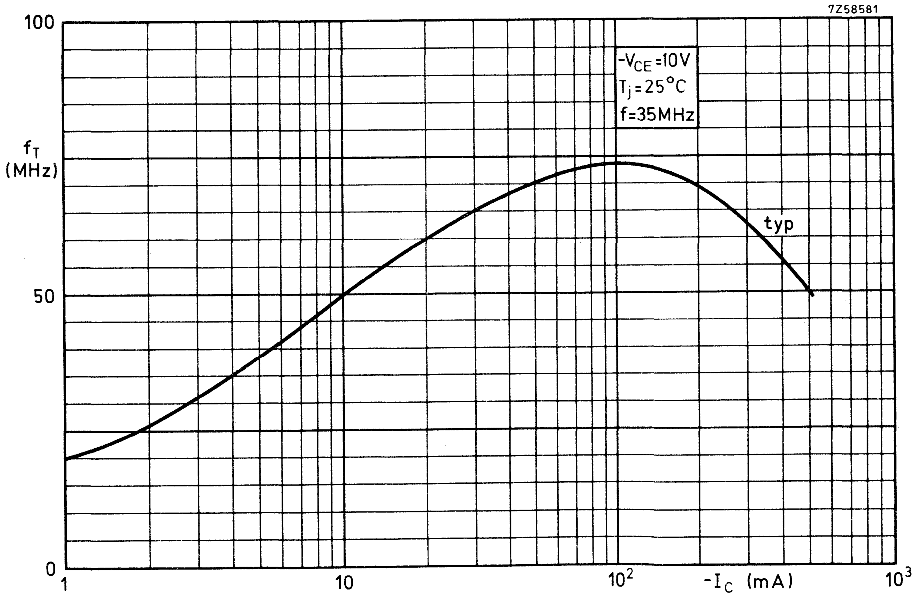


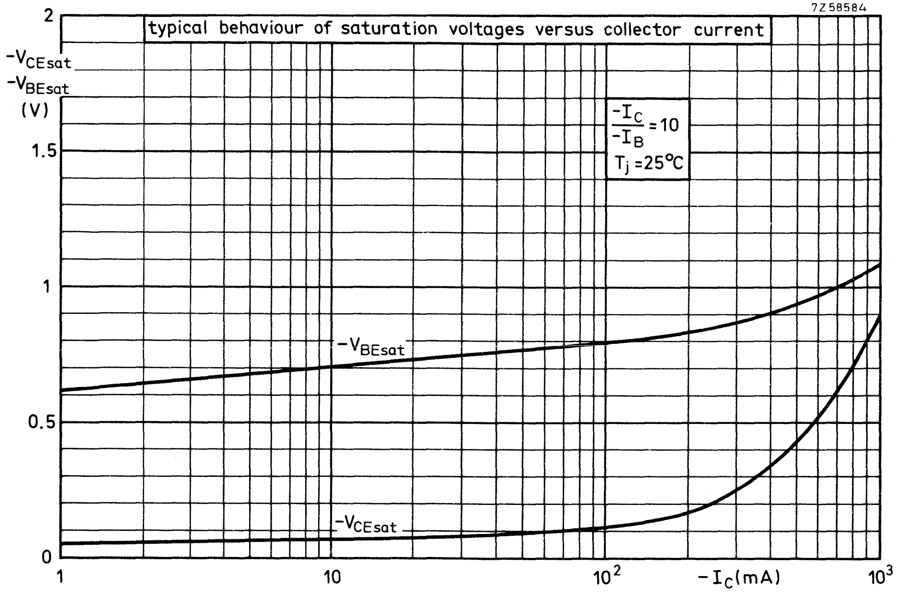
Safe Operating Area

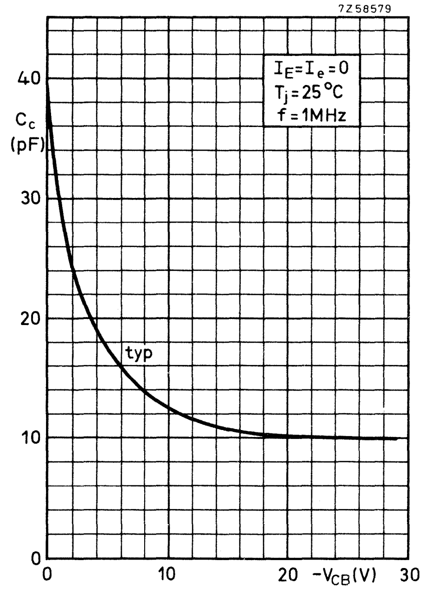
with the transistor forward biased

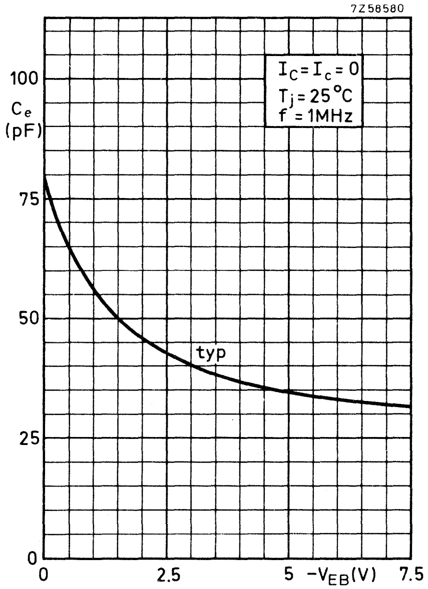



7Z58582
typical behaviour of h_{FE} versus $-I_C$
$-V_{CE}=10V$
$T_j=25°C$
h_{FE}
200
150
100
50
0
1
10
10^2
$-I_C$(mA)
10^3


7Z58581
$-V_{CE}=10V$
$T_j=25°C$
f=35MHz
f_T (MHz)
typ
100
50
0
1
10
10^2
$-I_C$ (mA)
10^3


7Z58584
typical behaviour of saturation voltages versus collector current
$-V_{CEsat}$
$-V_{BEsat}$
(V)
2
1.5
1
0.5
0
$\frac{-I_C}{-I_B} = 10$
$T_j = 25\,^{\circ}C$
$-V_{BEsat}$
$-V_{CEsat}$
1
10
10^2
$-I_C$(mA)
10^3


7Z58579
$I_E = I_e = 0$
$T_j = 25\,^{\circ}C$
f = 1MHz
C_c
(pF)
40
30
20
10
0
typ
0
10
20
$-V_{CB}$(V)
30


7Z58580
$I_C = I_c = 0$
$T_j = 25\,^{\circ}C$
f = 1MHz
C_e
(pF)
100
75
50
25
0
typ
0
2.5
5
$-V_{EB}$(V)
7.5

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.

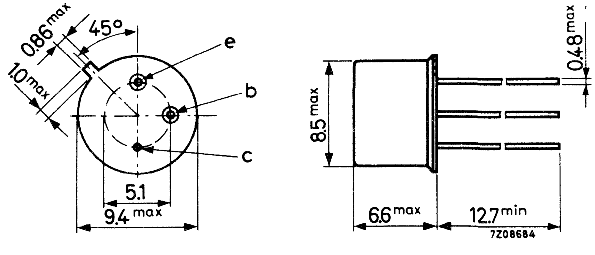
QUICK REFERENCE DATA

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
		f =	200	800	MHz
Power gain (not neutralized) I_C = 70 mA; V_{CE} = 18 V	G_p	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 $T_{mb} = 125\ ^oC$	P_{tot}	max.	1.5	W

Temperatures

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

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	250	°C/W
From junction to mounting base	$R_{th\ j\text{-}mb}$	=	50	°C/W
From mounting base to heatsink mounted with top clamping washer of 56218 and a boron nitride washer for electrical insulation	$R_{th\ mb\text{-}h}$	=	1.2	°C/W

---

[1] $I_C = 10$ mA.

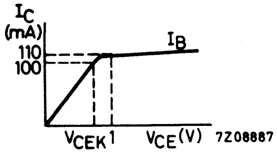
CHARACTERISTICS $T_j = 25\ ^{o}C$ unless otherwise specified

Collector cut-off current

$I_E = 0$; $V_{CB} = 20$ V; $T_j = 150\ ^{o}C$	I_{CBO}	<	20	μA

Knee voltage

$I_C = 100$ mA; I_B = value for which $I_C = 110$ mA at $V_{CE} = 1$ V	V_{CEK}	<	0.75	V



D.C. current gain

$I_C = 50$ mA; $V_{CE} = 5$ V	h_{FE}	>	25
$I_C = 150$ mA; $V_{CE} = 5$ V	h_{FE}	>	25

Transition frequency

$I_C = 150$ mA; $V_{CE} = 15$ V; f = 500 MHz	f_T	typ.	1.2	GHz

Collector capacitance at f = 1 MHz

$I_E = I_e = 0$; $V_{CB} = 15$ V	C_c	<	4	pF

Feedback capacitance at f = 1 MHz

$I_C = 10$ mA; $V_{CE} = 15$ V; $T_{amb} = 25\ ^{o}C$	$-C_{re}$	typ.	1.7	pF

Noise figure at f = 200 MHz

$I_C = 30$ mA; $V_{CE} = 15$ V; $R_S = 75\ \Omega$; $T_{amb} = 25\ ^{o}C$	F	<	6	dB

Power gain (not neutralized)

		f = 200	800	MHz
$I_C = 70$ mA; $V_{CE} = 18$ V; $T_{amb} = 25\ ^{o}C$	G_p	typ. 16	6.5	dB

CHARACTERISTICS (continued)

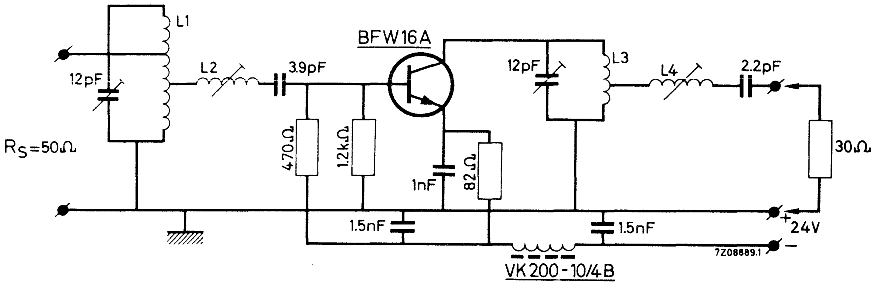
Intermodulation characteristics

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:
$R_L = 220\ \Omega$; $C_L = -5.6$ 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.

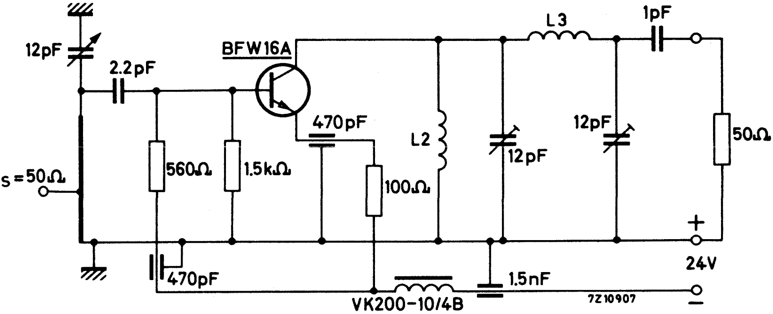
CHARACTERISTICS (continued)

Intermodulation characteristics

2. Output power at f = 800 MHz; T_{amb} = 25 °C
I_C = 70 mA; V_{CE} = 18 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)

P_o	>	70 mW
	typ.	90 mW

Test circuit:



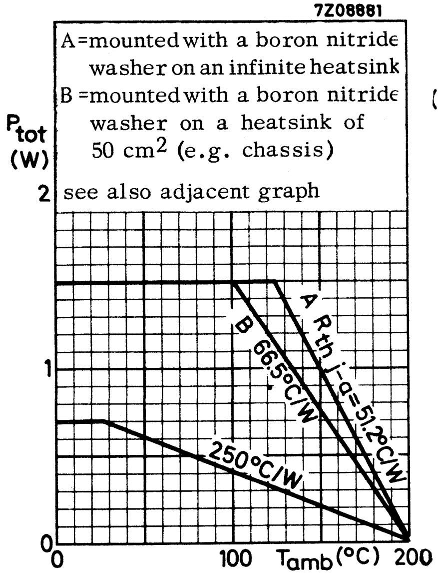
Coil data:
L1 = 25 mm x 7 mm x 0.85 mm silver plated Cu strip
Tap of the input at 5 mm from earth.
L2 = 13 turns enamelled Cu wire (0.6 mm); int. diam. 8 mm
L3 = 1.5 turns Cu wire (1.3 mm); int. diam. 8 mm

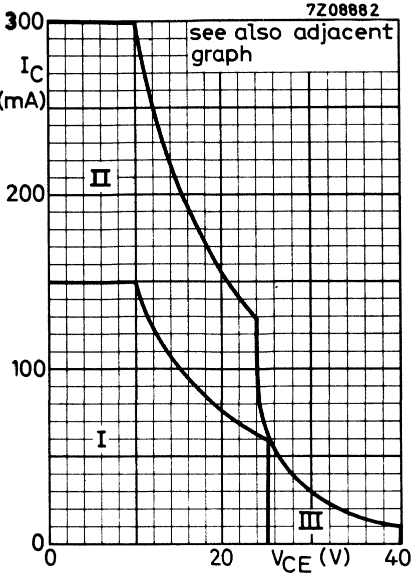
Basis of adjustment

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 linearily 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.

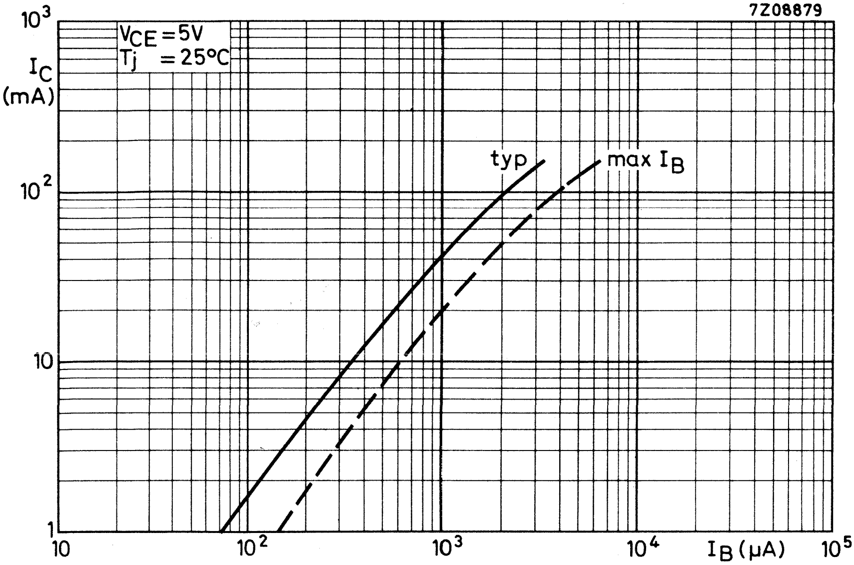


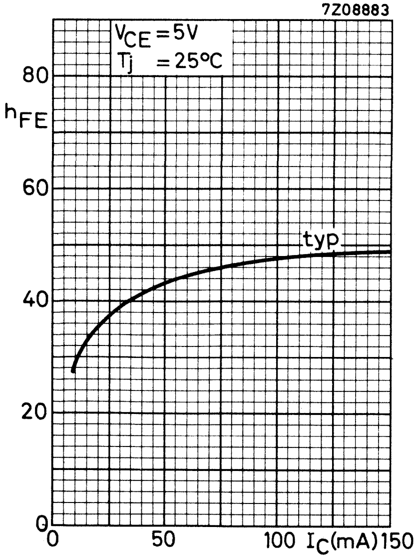


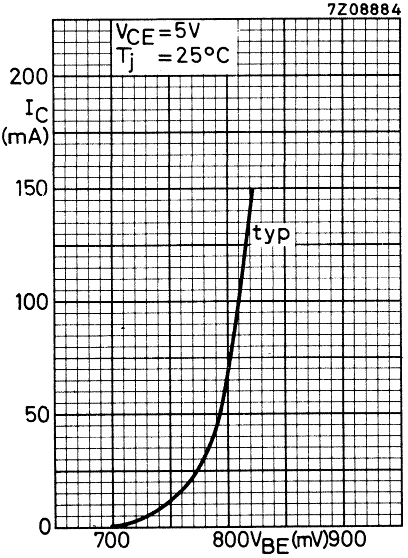
I = Region of permissible operation under all base-emitter conditions and at all frequencies, including d.c.

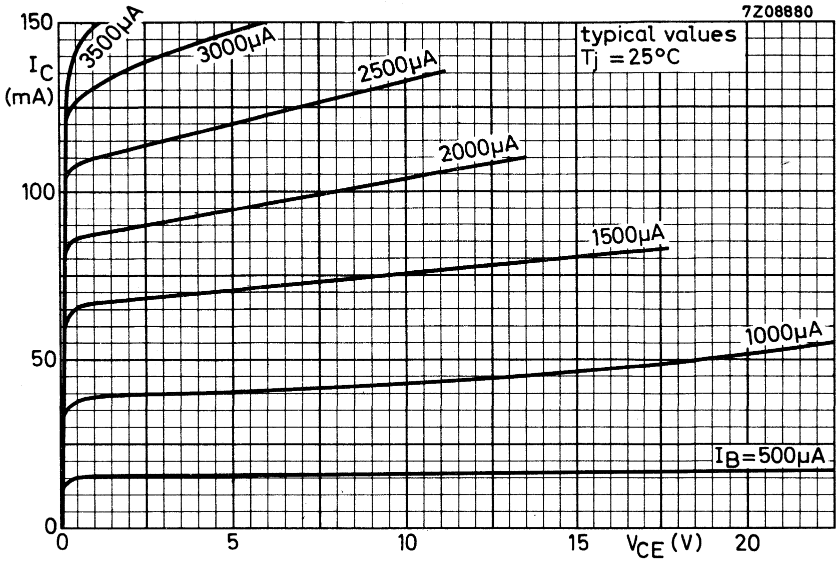
II = Additional region of operation at f ≥ 1 MHz.

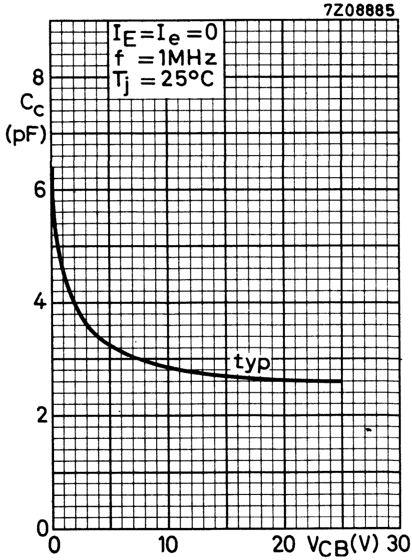
III = Operating under pulsed conditions is allowed, provided the transistor is cut-off with $R_{BE} \leq 50\ \Omega$ and f ≥ 1 MHz.

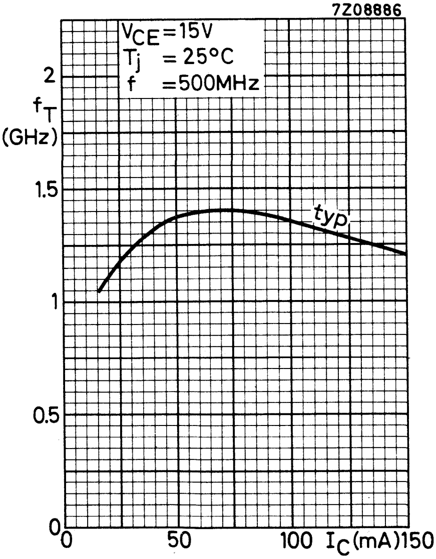

7Z08879
V_{CE} = 5V
T_j = 25°C
I_C (mA)
10^3
10^2
10
1
10
10^2
10^3
10^4
I_B (μA)
10^5
typ
max I_B


7Z08883
V_{CE} = 5V
T_j = 25°C
h_{FE}
80
60
40
20
0
0
50
100
I_C (mA)
150
typ


7Z08884
V_{CE} = 5V
T_j = 25°C
I_C (mA)
200
150
100
50
0
700
800
V_{BE} (mV)
900
typ


7Z08880
typical values
Tj = 25°C
IC (mA)
150
100
50
0
3500µA
3000µA
2500µA
2000µA
1500µA
1000µA
IB = 500µA
0
5
10
15
VCE (V)
20


7Z08885
IE = Ie = 0
f = 1MHz
Tj = 25°C
Cc (pF)
8
6
4
2
0
typ
0
10
20
VCB (V)
30


7Z08886
VCE = 15V
Tj = 25°C
f = 500MHz
fT (GHz)
2
1.5
1
0.5
0
typ
0
50
100
IC (mA)
150

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 intermodulation are available on request.

[2] V_o = 2.2 V over R_L = 30 Ω or
V_o = 3 V over R_L = 60 Ω.

SILICON PLANAR EPITAXIAL TRANSISTOR

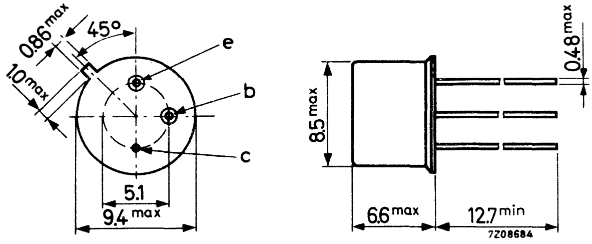
N-P-N multi-emitter transistor in a TO-39 metal envelope, with the collector connected to the case. The transistor has extreme good intermodulation properties and a high power gain. It is a ruggedized version of the BFW17, which it succeeds.
It is primarily intended for final and driver stages of channel- 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 $T_{mb} = 125\ ^{o}C$	P_{tot}	max.	1.5	W
Junction temperature	T_j	max.	200	^{o}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 MHz)	I_{CM}	max.	300	mA

Power dissipation

Total power dissipation up to T_{mb} = 125 °C	P_{tot}	max.	1.5	W

Temperatures

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

THERMAL RESISTANCE

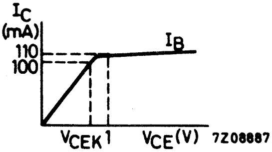
From junction to ambient in free air	$R_{th\ j-a}$	=	250	°C/W
From junction to mounting base	$R_{th\ j-mb}$	=	50	°C/W
From mounting base to heatsink mounted with top clamping washer of 56218 and a boron nitride washer for electrical insulation	$R_{th\ mb-h}$	=	1.2	°C/W

---

1) I_C = 10 mA.

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

Collector cut-off current				
$I_E = 0$; $V_{CB} = 20$ V; $T_j = 150\ ^oC$	I_{CBO}	<	20	μA
Knee voltage				
$I_C = 100$ mA; I_B = value for which $I_C = 110$ mA at $V_{CE} = 1$ V	V_{CEK}	<	0.75	V



D.C. current gain				
$I_C = 50$ mA; $V_{CE} = 5$ V	h_{FE}	>	25	
$I_C = 150$ mA; $V_{CE} = 5$ V	h_{FE}	>	25	
Transition frequency				
$I_C = 150$ mA; $V_{CE} = 15$ V; f = 500 MHz	f_T	typ.	1.1	GHz
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; $V_{CB} = 15$ V	C_c	<	4	pF
Feedback capacitance at f = 1 MHz				
$I_C = 10$ mA; $V_{CE} = 15$ V; $T_{amb} = 25\ ^oC$	$-C_{re}$	typ.	1.7	pF
Power gain (not neutralized)				
$I_C = 70$ mA; $V_{CE} = 18$ V f = 200 MHz; $T_{amb} = 25\ ^oC$	G_p	typ.	16	dB

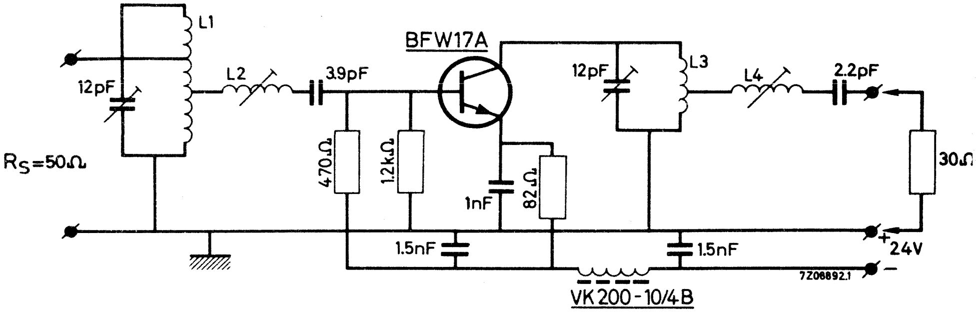
CHARACTERISTICS (continued)

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

$$R_L = \frac{V_{CE} - V_{CEK}}{I_C}$$

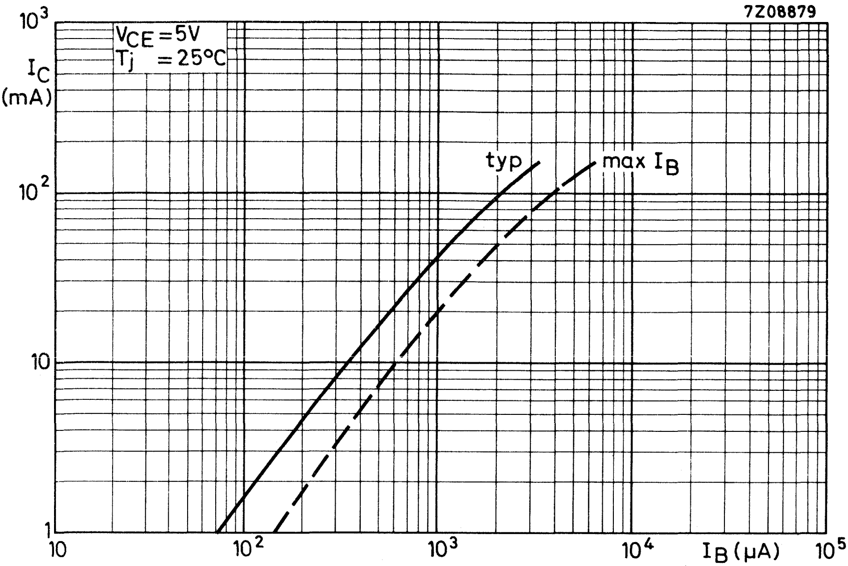
in which V_{CEK} is the high frequency knee voltage.

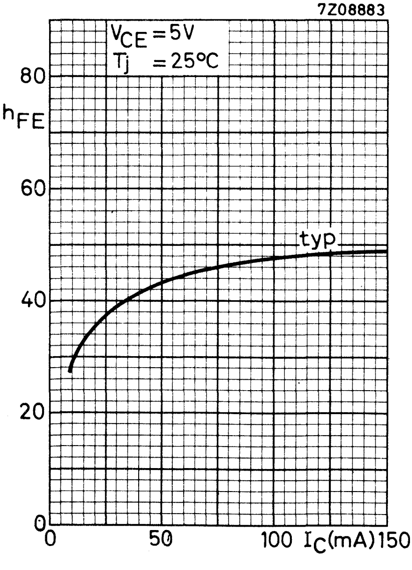
b. The h.f. collector current is as small as possible.
This is so if $-C_L = +C_{oe}$,
in which C_{oe} is the output capacitance of the transistor at short circuited input.

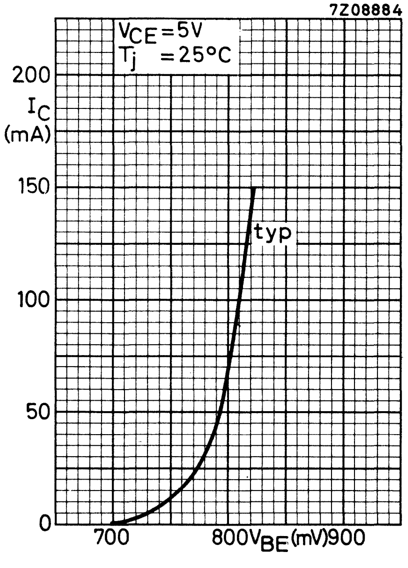
For maximum output power at an intermodulation distortion of −30 dB, the (experimentally found) values of R_L and C_L are:
$R_L = 220\ \Omega$; $C_L = -5.6$ pF.
C_{oe} is found by 4 pF of the transistor and 1.6 pF by the mounting system concerning of a borium nitride washer between the envelope of the transistor and the chassis.

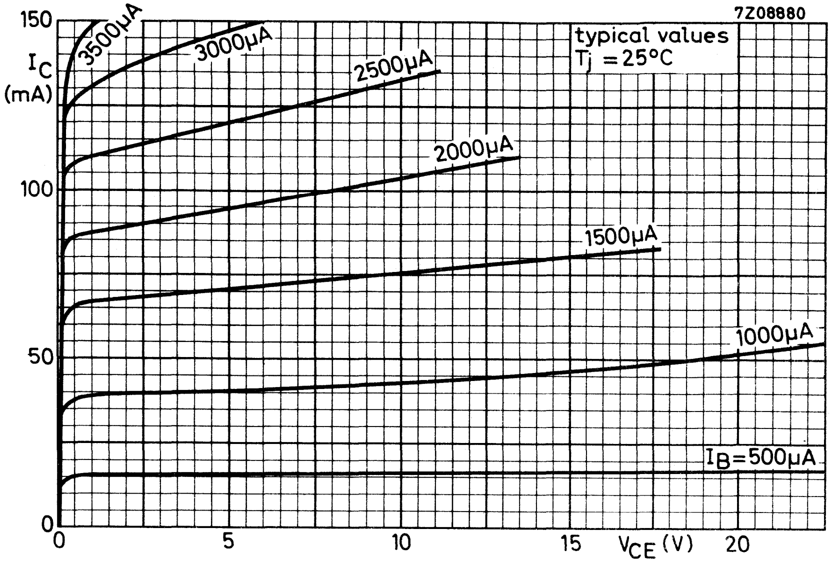
Adjustment procedure

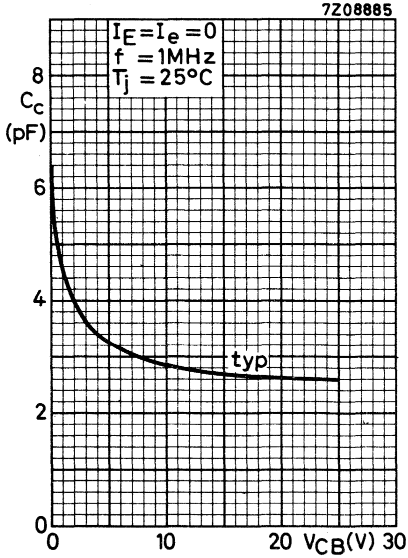
1. Remove the transistor and connect a dummy consisting of a 220 Ω resistor in parallel with a 5.6 pF capacitor between the collector and emitter connections of the output circuit.
2. Tune and match the output circuit for zero reflection at 205 MHz (V.S.W.R. = 1). After this adjustment, no further change 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.

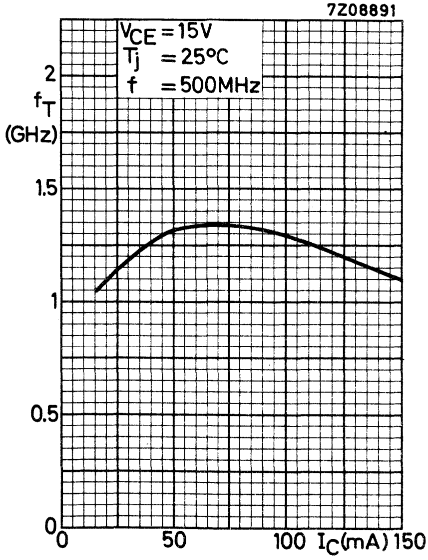

7Z08879
$V_{CE} = 5V$
$T_j = 25°C$
I_C (mA)
10^3
10^2
10
1
typ
max I_B
10
10^2
10^3
10^4
I_B (μA)
10^5

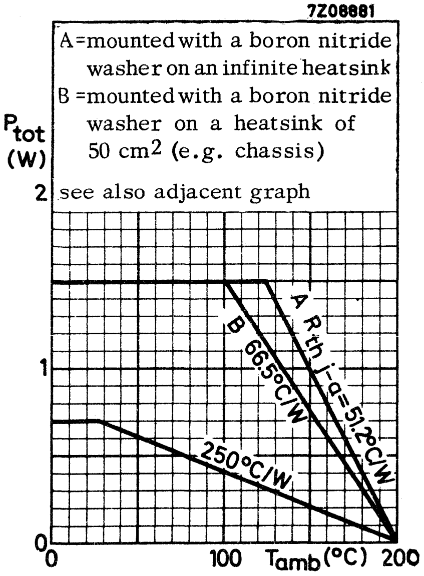

7Z08883
$V_{CE} = 5V$
$T_j = 25°C$
h_{FE}
80
60
40
20
0
typ
0
50
100
I_C (mA)
150

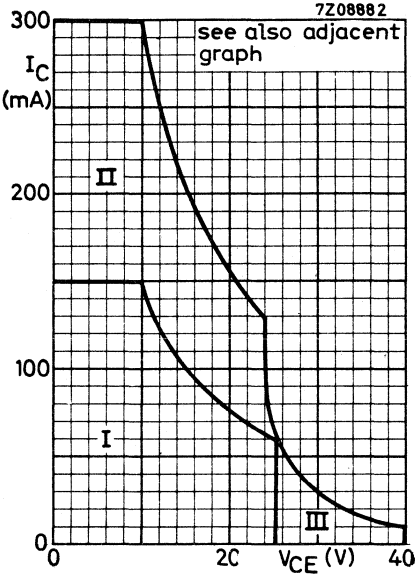

7Z08884
$V_{CE} = 5V$
$T_j = 25°C$
I_C (mA)
200
150
100
50
0
typ
700
800
V_{BE} (mV)
900


7Z08880
typical values
T_j = 25°C
I_C (mA)
150
100
50
0
3500µA
3000µA
2500µA
2000µA
1500µA
1000µA
I_B=500µA
0
5
10
15
20
V_{CE} (V)


7Z08885
$I_E = I_e = 0$
f = 1MHz
T_j = 25°C
C_c (pF)
8
6
4
2
0
typ
0
10
20
30
V_{CB} (V)


7Z08891
V_{CE} = 15V
T_j = 25°C
f = 500MHz
f_T (GHz)
2
1.5
1
0.5
0
0
50
100
150
I_C (mA)





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.

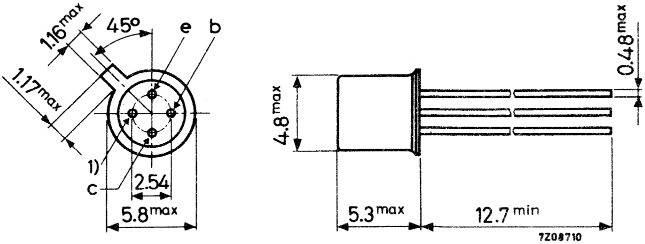
SILICON PLANAR EPITAXIAL TRANSISTOR

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
		f =	200	800	MHz
Power gain (not neutralized) I_C = 30 mA; V_{CE} = 5 V	G_p	typ.	21	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

Temperatures

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

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	0.7	°C/mW
From junction to case	$R_{th\ j\text{-}c}$	=	0.5	°C/mW

CHARACTERISTICS

$T_j = 25$ °C unless otherwise specified

Collector cut-off current				
$I_E = 0$; $V_{CB} = 10$ V	I_{CBO}	<	50	nA
D.C. current gain				
$I_C = 25$ mA; $V_{CE} = 5$ V	h_{FE}	>	25	
$I_C = 50$ mA; $V_{CE} = 5$ V	h_{FE}	>	25	
Transition frequency [1]				
$I_C = 50$ mA; $V_{CE} = 5$ V; f = 500 MHz	f_T	typ.	1.6	GHz
Collector capacitance at f = 1 MHz [2]				
$I_E = I_e = 0$; $V_{CB} = 5$ V	C_c	<	1.5	pF
Feedback capacitance at f = 1 MHz [1]				
$I_C = 2$ mA; $V_{CE} = 5$ V	$-C_{re}$	typ.	0.8	pF
Noise figure [1]				
$I_C = 2$ mA; $V_{CE} = 5$ V f = 500 MHz; $R_S = 50\ \Omega$	F	<	5	dB

Power gain (not neutralized) [1]

$I_C = 30$ mA; $V_{CE} = 5$ V; $T_{amb} = 25$ °C

	f =	200	800	MHz
G_p	>	19		dB
	typ.	21	7.5	dB

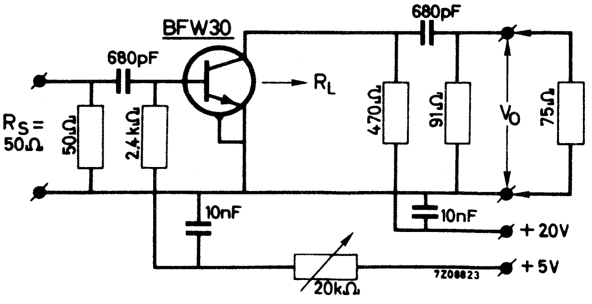
Intermodulation distortion [1]

$I_C = 30$ mA; $V_{CE} = 6$ V; $R_L = 37.5\ \Omega$; $T_{amb} = 25$ °C

$V_o = 100$ 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

Test circuit



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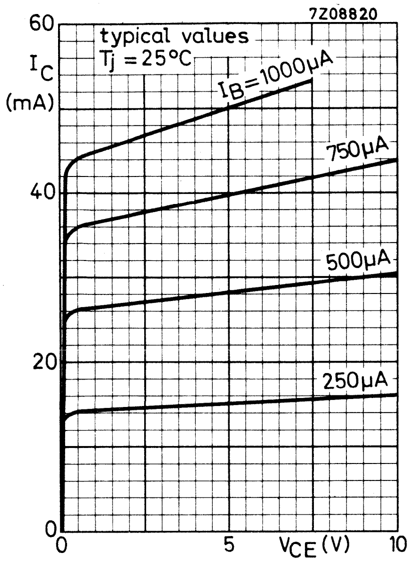
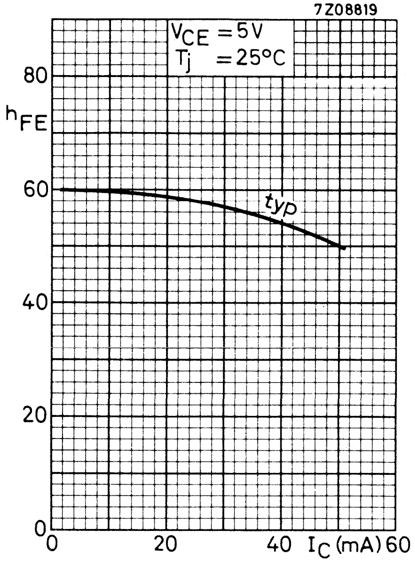
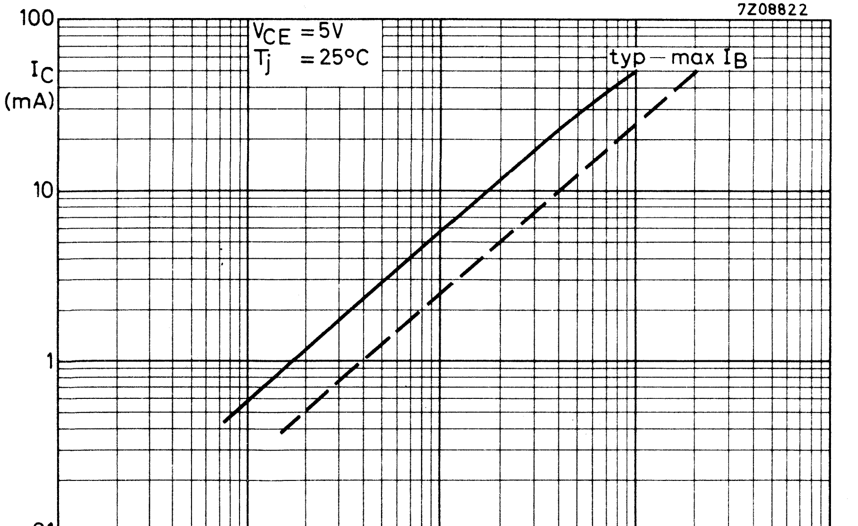
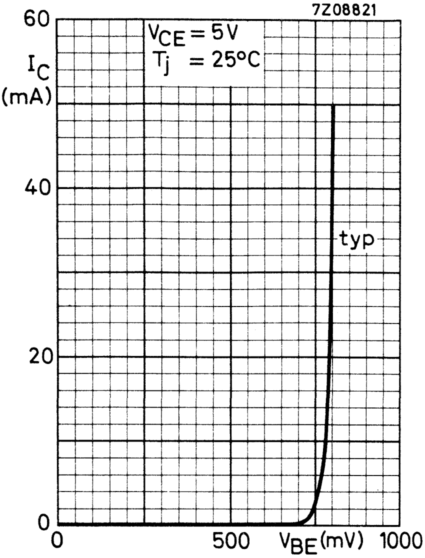
[1] Shield lead grounded.

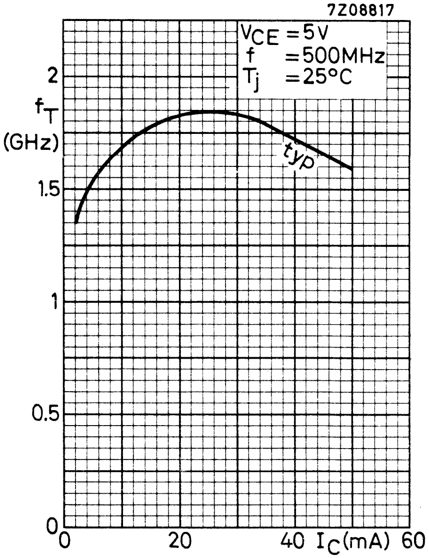
[2] Shield lead not connected.

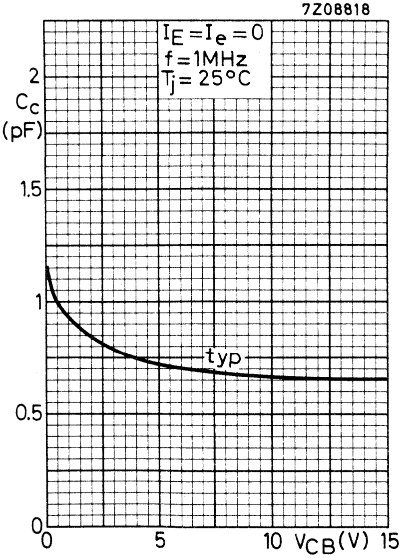

7Z08820
typical values
Tj = 25°C
IC
(mA)
IB=1000µA
750µA
500µA
250µA
60
40
20
0
0
5
VCE (V)
10


7Z08819
VCE = 5 V
Tj = 25°C
hFE
typ
80
60
40
20
0
0
20
40
IC (mA)
60


7Z08822
VCE = 5 V
Tj = 25°C
IC
(mA)
typ — max IB
100
10
1
0.1
1
10
10²
10³
IB (µA)
10⁴


7Z08821
V_{CE} = 5 V
T_j = 25°C
I_C (mA)
60
40
20
0
0
500
V_{BE} (mV)
1000
typ


7Z08817
V_{CE} = 5 V
f = 500 MHz
T_j = 25°C
f_T (GHz)
2
1.5
1
0.5
0
0
20
40
I_C (mA)
60
typ


7Z08818
$I_E = I_e = 0$
f = 1 MHz
T_j = 25°C
C_c (pF)
2
1.5
1
0.5
0
0
5
10
V_{CB} (V)
15
typ

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:

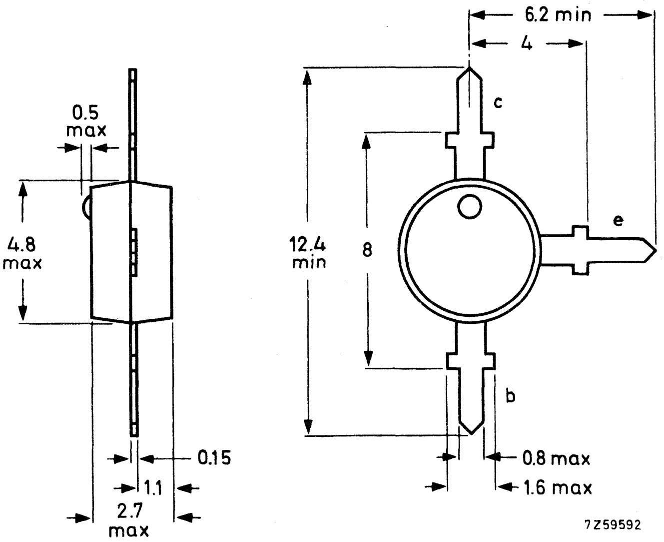
- Wide band aerial amplifiers (40-860 MHz)
- Channel- and band aerial amplifiers for band I, II, III and IV/V (40-860 MHz)
- Television distribution amplifiers
- Low noise wide band vertical amplifier in high speed oscilloscopes.

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; $R_S = 50\ \Omega$	F	typ.	4		dB
		f =	200	800	MHz
Power gain (not neutralized)					
$I_C = 10$ mA; $V_{CE} = 10$ V; $T_{amb} = 25$ °C	G_p	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)

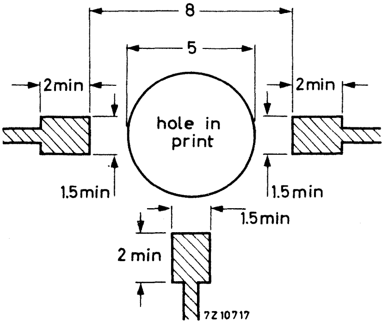
Voltages				
Collector-base voltage (open emitter; peak value)	V_{CBOM}	max.	25	V
Collector-emitter voltage (open base)	V_{CEO}	max.	15	V [1]
Emitter-base voltage (open collector)	V_{EBO}	max.	2.5	V
Currents				
Collector current (d.c.)	I_C	max.	25	mA
Collector current (peak value; f > 1 MHz)	I_{CM}	max.	50	mA
Power dissipation				
Total power dissipation up to $T_{amb} = 73\ ^oC$	P_{tot}	max.	130	mW
Temperatures				
Storage temperature	T_{stg}	-40 to +125		^oC
Junction temperature	T_j	max.	125	^oC

THERMAL RESISTANCE

From junction to ambient in free air mounted on a glass-fibre print *) of 40 mm x 25 mm x 1 mm $R_{th\ j\text{-}a}$ = 0.4 $^oC/mW$

*) Requirements for glass-fibre print

(dimensions in mm)



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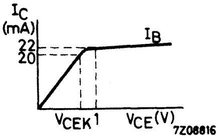
[1] At I_C = 10 mA

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

Collector cut-off current				
$I_E = 0$; $V_{CB} = 10$ V	I_{CBO}	<	50	nA
Knee voltage [1]				
$I_C = 20$ mA; I_B = value for which $I_C = 22$ mA at $V_{CE} = 1$ V	V_{CEK}	<	0.75	V



D.C. current gain				
$I_C = 2$ mA; $V_{CE} = 1$ V	h_{FE}	> <	20 150	
$I_C = 25$ mA; $V_{CE} = 1$ V [1]	h_{FE}	>	20	
Transition frequency at f = 500 MHz				
$I_C = 2$ mA; $V_{CE} = 5$ V	f_T	typ.	1.0	GHz
$I_C = 25$ mA; $V_{CE} = 5$ V [1]	f_T	typ.	1.6	GHz
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; $V_{CB} = 10$ V	C_c	typ.	0.7	pF
Emitter capacitance at f = 1 MHz				
$I_C = I_c = 0$; $V_{EB} = 0.5$ V	C_e	typ.	1.5	pF
Feedback capacitance at f = 1 MHz				
$I_C = 2$ mA; $V_{CE} = 5$ V; $T_{amb} = 25\ ^oC$	$-C_{re}$	typ.	0.6	pF
Noise figure at f = 500 MHz				
$I_C = 2$ mA; $V_{CE} = 5$ V; $R_S = 50\ \Omega$; $T_{amb} = 25\ ^oC$	F	typ.	4.0	dB

			f = 200	800	MHz
Power gain (not neutralized)					
$I_C = 10$ mA; $V_{CE} = 10$ V; $T_{amb} = 25\ ^oC$	G_p	typ.	23	11	dB

---

[1] Measured under pulsed conditions.

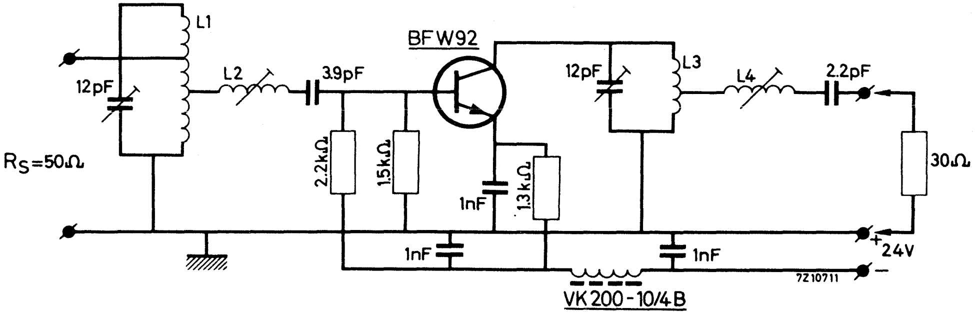
CHARACTERISTICS (continued) T_j = 25 °C unless otherwise specified

Intermodulation characteristics

1. Output power at f = 200 MHz; T_{amb} = 25 °C

   I_C = 10 mA; V_{CE} = 10 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. 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:
$R_L = 820\ \Omega$; $C_L = -1.0$ pF

Adjustment procedure

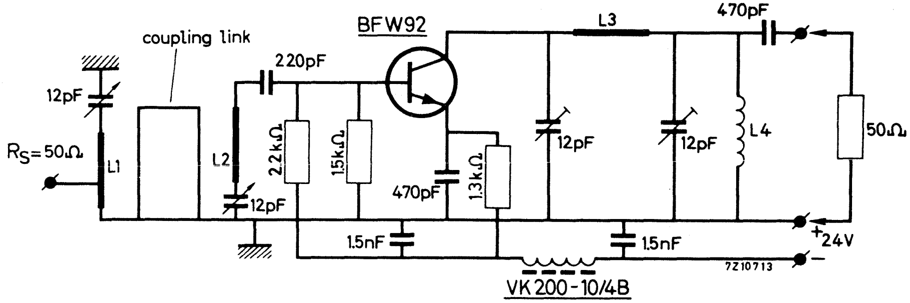
1. Remove the transistor and connect a dummy consisting of a 820 Ω resistor in parallel with a 1.0 pF capacitor between the collector and emitter connections of the output circuit.
2. Tune and match the output circuit for zero reflection at 205 MHz (V.S.W.R. = 1). After this adjustment, no further change 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 °C unless otherwise specified

Intermodulation characteristics

2. Output power at f = 800 MHz; T_{amb} = 25 °C

I_C = 10 mA; V_{CE} = 10 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) 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 (0.5mm); winding pitch 1.5mm; int. diam. 4mm
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 linearily 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 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

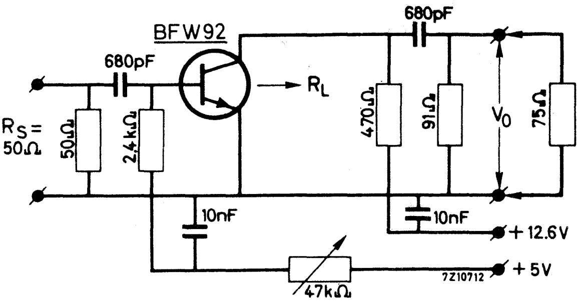
3. Intermodulation distortion

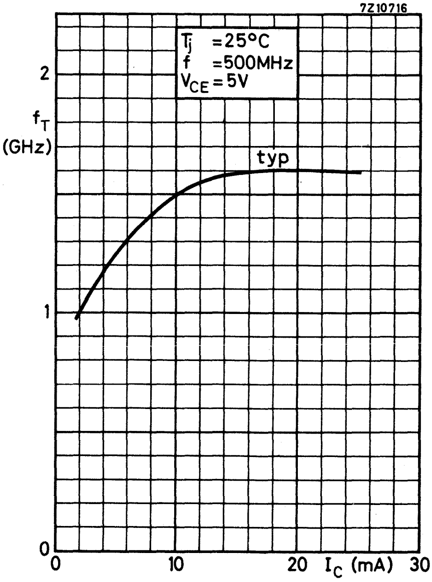
I_C = 10 mA; V_{CE} = 6 V; R_L = 37.5 Ω; T_{amb} = 25 °C

V_0 = 100 mV at f_p = 183 MHz

V_0 = 100 mV at f_q = 200 MHz
measured at $f_{(2q-p)}$ = 217 MHz d_{im} typ. −45 dB

Test circuit:




7Z10716
T_j = 25°C
f = 500MHz
V_{CE} = 5V
f_T
(GHz)
2
1
0
typ
0
10
20
I_C (mA)
30

SILICON PLANAR EPITAXIAL TRANSISTOR

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

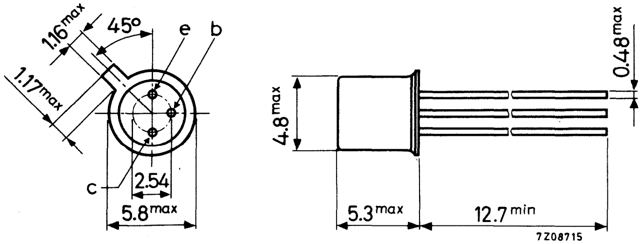
QUICK REFERENCE DATA

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

MECHANICAL DATA Dimensions in mm

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 $T_{amb} = 25\ ^{o}C$	P_{tot}	max.	360	mW

Temperatures

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

THERMAL RESISTANCE

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

---

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

[2] $I_C = 10$ mA.

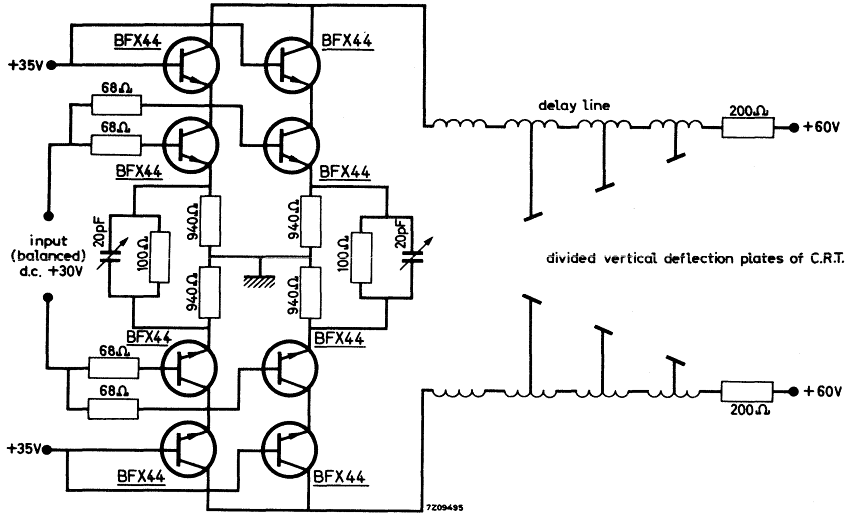
CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current				
$I_E = 0$; $V_{CB} = 20$ V	I_{CBO}	max.	100	nA
$I_E = 0$; $V_{CB} = 20$ V; $T_j = 150$ °C	I_{CBO}	max.	20	µA
Emitter cut-off current				
$I_C = 0$; $V_{EB} = 2$ V	I_{EBO}	max.	50	nA
$I_C = 0$; $V_{EB} = 2$ V; $T_j = 150$ °C	I_{EBO}	max.	20	µA
Saturation voltages				
$I_C = 100$ mA; $I_B = 10$ mA	V_{CEsat} V_{BEsat}	$<$ $<$	0.6 1.5	V V
D.C. current gain				
$I_C = 10$ mA; $V_{CE} = 1$ V	h_{FE}		40 to 120	
$I_C = 100$ mA; $V_{CE} = 1$ V	h_{FE}	$>$	20	
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; $V_{CE} = 5$ V	C_c	$<$	4	pF
Emitter capacitance at f = 1 MHz				
$I_C = I_c = 0$; $V_{EB} = 0.5$ V	C_e	$<$	4.5	pF
Transition frequency				
$I_C = 10$ mA; $V_{CE} = 10$ V	f_T	$>$	500	MHz
$I_C = 100$ mA; $V_{CE} = 3$ V	f_T	$>$	300	MHz
Feedback time constant				
$-I_E = 1$ mA; $V_{CB} = 5$ V; f = 10.7 MHz	$r_{bb'}C_{b'c}$	$<$	40	ps
Storage time				
$I_C = I_B = -I_{BM} = 10$ mA	t_s	$<$	30	ns

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).

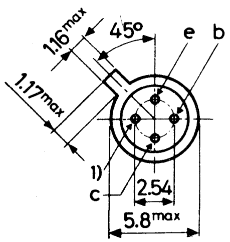
QUICK REFERENCE DATA

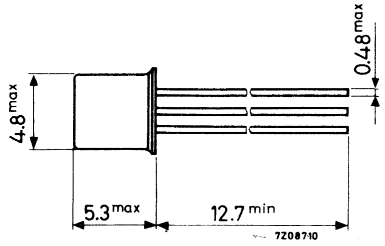
Collector-base voltage (open emitter; peak value)	V_{CBOM}	max.	30		V
Collector-emitter voltage (open base)	V_{CEO}	max.	15		V
Collector current (peak value; f > 1 MHz)	I_{CM}	max.	50		mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	200		mW
Junction temperature	T_j	max.	200		°C
Transition 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
			f = 200	800	MHz
Noise figure at optimum source impedance I_C = 2 mA; V_{CE} = 5 V	F	typ.	3.3	7	dB
Power gain (not neutralized) I_C = 8 mA; V_{CE} = 10 V	G_p	typ.	22	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 °C	P_{tot}	max.	200	mW

Temperatures

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

THERMAL RESISTANCE

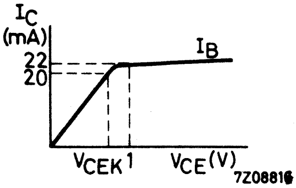
From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	0.88	°C/mW
From junction to case	$R_{th\ j\text{-}c}$	=	0.58	°C/mW

---

[1]) I_C = 10 mA.

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

Collector cut-off current				
$I_E = 0$; $V_{CB} = 15$ V	I_{CBO}	<	10	nA
Knee voltage				
$I_C = 20$ mA; I_B = value for which $I_C = 22$ mA at $V_{CE} = 1$ V	V_{CEK}	<	0.75	V



D.C. current gain				
$I_C = 2$ mA; $V_{CE} = 1$ V	h_{FE}		20 to 150	
$I_C = 25$ mA; $V_{CE} = 1$ V	h_{FE}		20 to 125	
Transition frequency [1]				
$I_C = 2$ mA; $V_{CE} = 5$ V; f = 500 MHz	f_T	typ.	1.0	GHz
$I_C = 25$ mA; $V_{CE} = 5$ V; f = 500 MHz	f_T	typ.	1.2	GHz
Collector capacitance at f = 1 MHz [2]				
$I_E = I_e = 0$; $V_{CB} = 10$ V	C_c	<	1.7	pF
Feedback capacitance at f = 1 MHz [1]				
$I_C = 2$ mA; $V_{CE} = 5$ V	$-C_{re}$	typ.	0.6	pF
Noise figure [1]				
$I_C = 2$ mA; $V_{CE} = 5$ V				
f = 200 MHz; optimum source impedance	F	<	4	dB
f = 500 MHz; $R_S = 50\ \Omega$	F	<	6.5	dB
f = 800 MHz; optimum source impedance	F	typ.	7.0	dB

Power gain (not neutralized) [1]			f = 200	800	MHz
$I_C = 8$ mA; $V_{CE} = 10$ V; $T_{amb} = 25\ ^{o}C$	G_p	>	19	-	dB
		typ.	22	7	dB

---

[1] Shield lead grounded.
[2] Shield lead not connected.

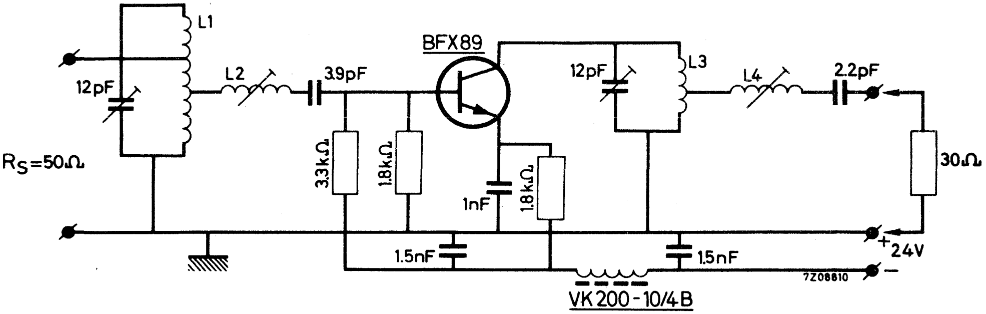
CHARACTERISTICS (continued) T_j = 25 °C unless otherwise specified

Intermodulation characteristics (1)

1. Output power at f = 200 MHz; T_{amb} = 25 °C

I_C = 8 mA; V_{CE} = 10 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. 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 kΩ 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.

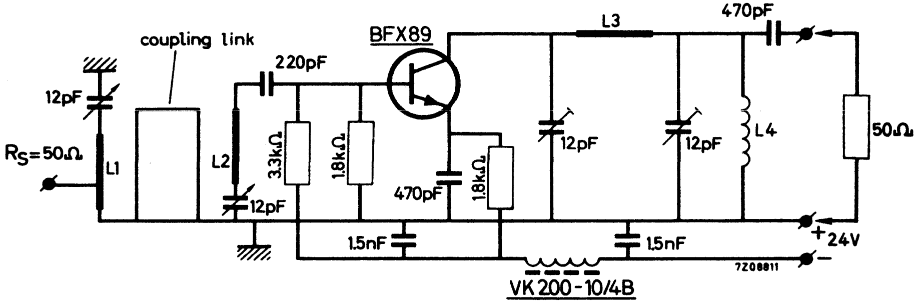
CHARACTERISTICS (continued) T_j = 25 °C unless otherwise specified

Intermodulation characteristics [1]

2. Output power at f = 800 MHz; T_{amb} = 25 °C

I_C = 8 mA; V_{CE} = 10 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) 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

$$P_o = \frac{I_C\,(V_{CE} - V_{CEK})}{2} = 35\ \mathrm{mW}$$

The output circuit is adjusted for minimum intermodulation if the input signal is as small as possible at P_o = 35 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

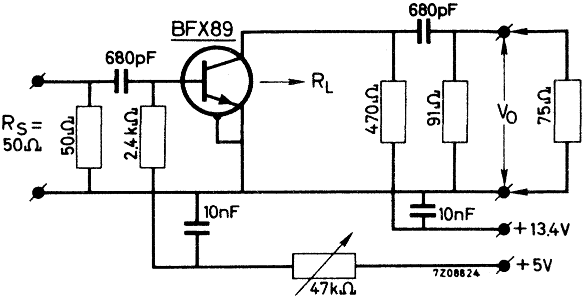
CHARACTERISTICS (continued) T_j = 25 °C unless otherwise specified

Intermodulation characteristics [1]

3. Intermodulation distortion

I_C = 8 mA; V_{CE} = 6 V; R_L = 37.5 Ω; T_{amb} = 25 °C
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. −40 dB

Test circuit:



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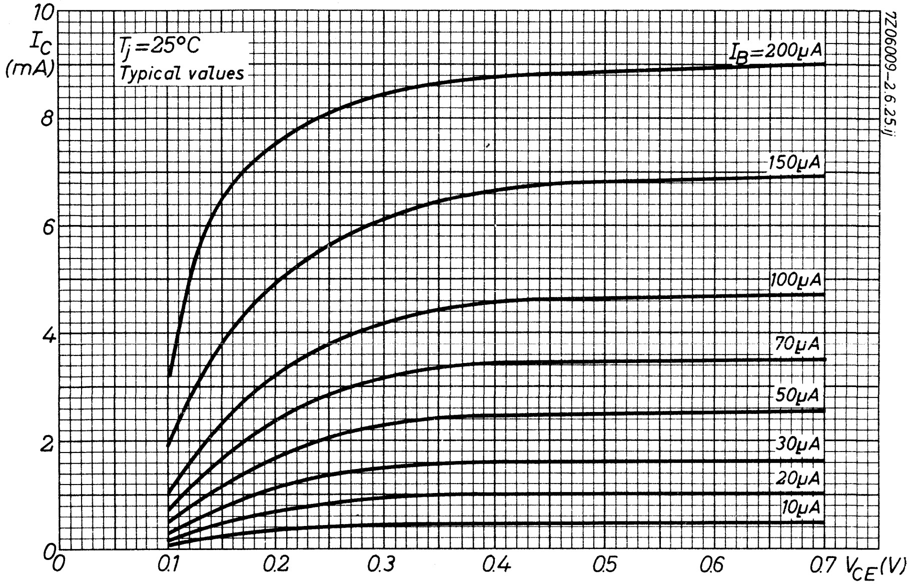
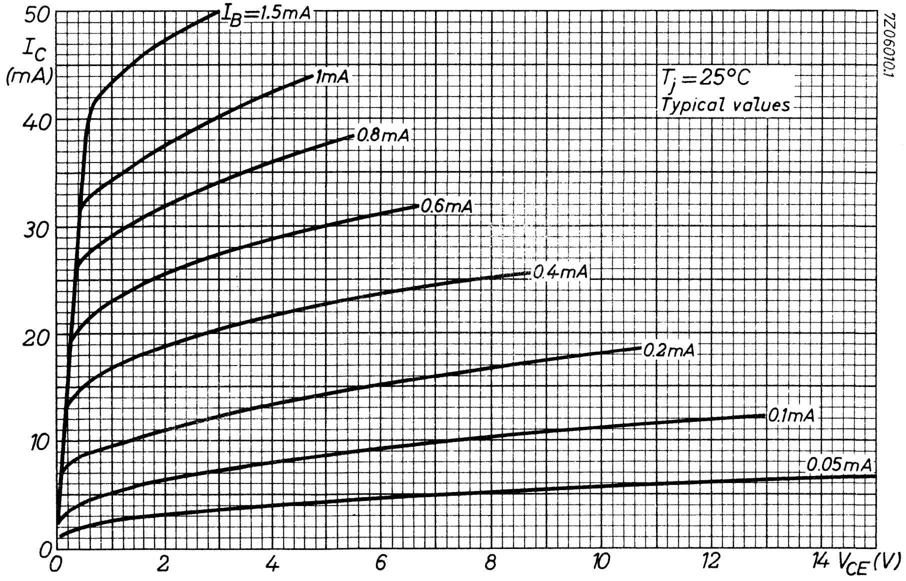
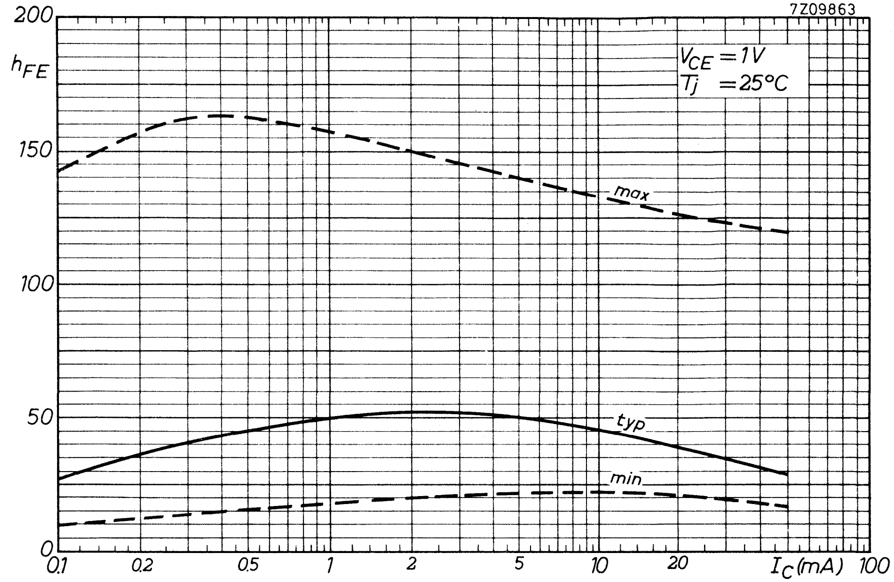
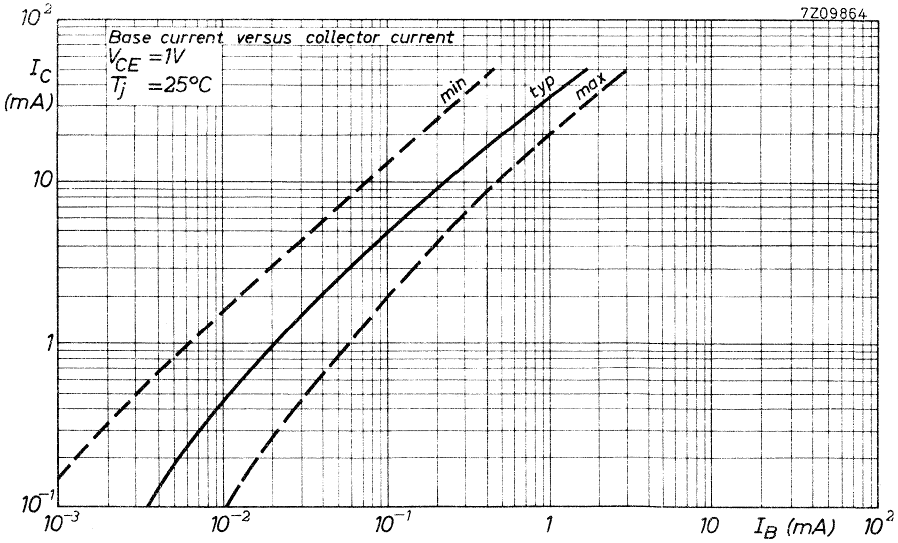
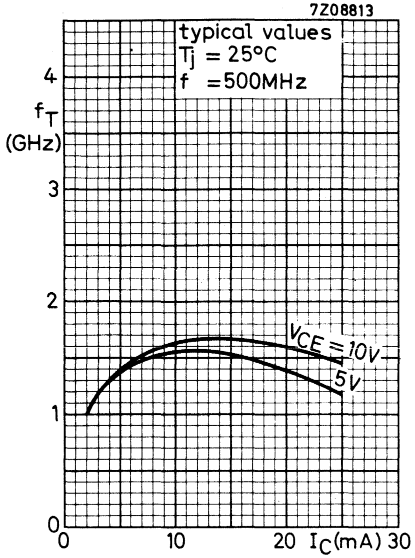
[1] Shield lead grounded.

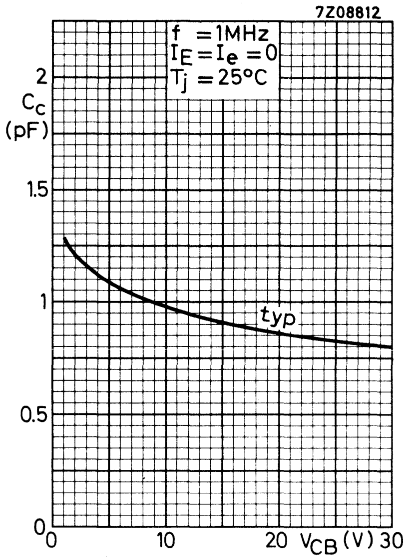

10
I_C
(mA)
8
6
4
2
0
$T_j = 25°C$
Typical values
$I_B = 200 \mu A$
150μA
100μA
70μA
50μA
30μA
20μA
10μA
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
V_{CE} (V)
7Z06009-2.6.25.ij

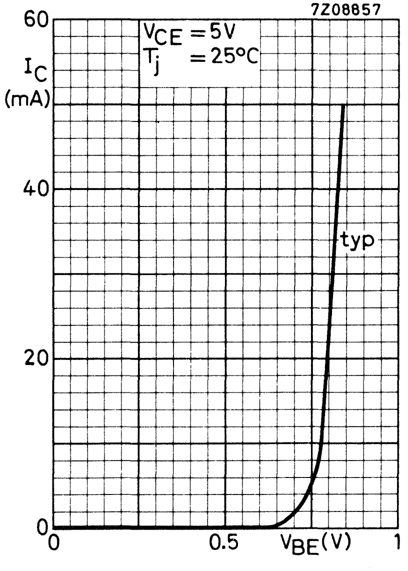

50
I_C
(mA)
40
30
20
10
0
$I_B = 1.5 mA$
1mA
0.8mA
0.6mA
0.4mA
0.2mA
0.1mA
0.05mA
$T_j = 25°C$
Typical values
0
2
4
6
8
10
12
14
V_{CE} (V)
7Z06010.1

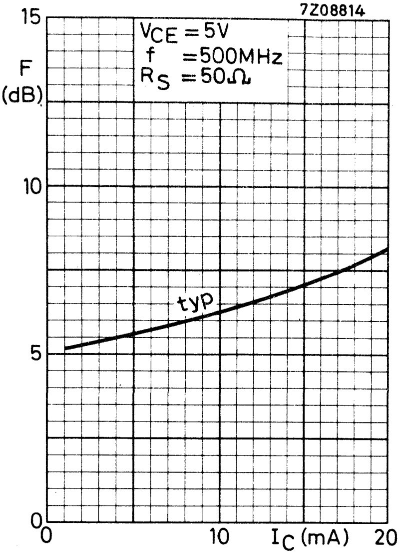

7Z09863
200
h_{FE}
150
100
50
0
$V_{CE} = 1V$
$T_j = 25°C$
max
typ
min
0.1
0.2
0.5
1
2
5
10
20
I_C (mA)
100

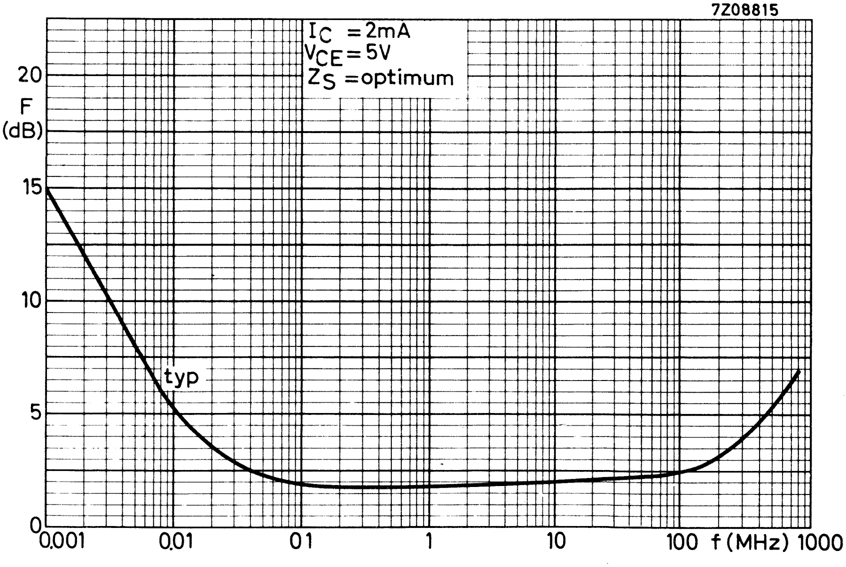

7Z09864
10^2
I_C
(mA)
Base current versus collector current
$V_{CE} = 1V$
$T_j = 25°C$
min
typ
max
10
1
10^{-1}
10^{-3}
10^{-2}
10^{-1}
1
10
I_B (mA)
10^2


7Z08813
typical values
T_j = 25°C
f = 500MHz
f_T (GHz)
0
1
2
3
4
V_{CE} = 10V
5V
0
10
20
I_C (mA)
30


7Z08812
f = 1MHz
$I_E = I_e = 0$
T_j = 25°C
C_c (pF)
0
0.5
1
1.5
2
typ
0
10
20
V_{CB} (V)
30


7Z08857
V_{CE} = 5V
T_j = 25°C
I_C (mA)
0
20
40
60
typ
0
0.5
V_{BE} (V)
1


7Z08814
F
(dB)
15
10
5
0
0
10
20
I_C (mA)
V_{CE} = 5V
f = 500MHz
R_S = 50Ω
typ


7Z08815
F
(dB)
20
15
10
5
0
0,001
0,01
0,1
1
10
100
f (MHz)
1000
I_C = 2mA
V_{CE} = 5V
Z_S = optimum
typ

N-P-N MESA TRANSISTORS

H.F. silicon mesa transistors in a TO-5 metal envelope intended for amplifying applications.

QUICK REFERENCE DATA

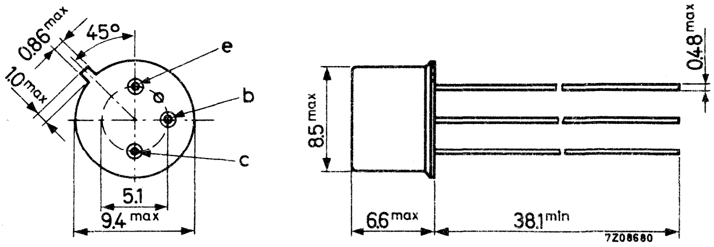
Collector-base voltage (open emitter)	V_{CBO}	max.	45	V
Collector-emitter voltage ($-V_{BE} = 1$ V)	V_{CEX}	max.	45	V
Collector current (peak value)	I_{CM}	max.	75	mA
Total power dissipation up to $T_{amb} = 25$ °C	P_{tot}	max.	300	mW
Junction temperature	T_j	max.	175	°C
Transition frequency $-I_E = 5$ mA; $V_{CB} = 10$ V	f_T	> typ.	60 120	MHz MHz
Collector-emitter saturation voltage $I_C = 10$ mA; $I_B = 1$ mA	V_{CEsat}	<	1.5	V

MECHANICAL DATA

Dimensions in mm

Insulated electrodes

TO-5



Accessories available: 56218; 56245; 56265

RATINGS (Limiting values) [1]

Voltages

Collector-base voltage (open emitter)	V_{CBO}	max.	45	V
Collector-emitter voltage ($-V_{BE} = 1$ V)	V_{CEX}	max.	45	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.	50	mA
Collector current (peak value)	I_{CM}	max.	75	mA
Base current (d.c. or average over any 20 ms period)	I_B	max.	5	mA
Base current (peak value)	I_{BM}	max.	7.5	mA

Power dissipation

Total power dissipation up to $T_{amb} = 25\,^oC$	P_{tot}	max.	300	mW

Temperatures

Storage temperature	T_{stg}		-55 to +175	^oC
Junction temperature	T_j	max.	175	^oC

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	0.5	$^oC/mW$
From junction to case	$R_{th\ j\text{-}c}$	=	0.35	$^oC/mW$

---

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

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

Collector cut-off current					
$I_E = 0$; $V_{CB} = 20$ V	I_{CBO}	<	2		μA
$I_E = 0$; $V_{CB} = 20$ V; $T_{amb} = 125$ °C	I_{CBO}	<	15		μA
Emitter cut-off current					
$I_C = 0$; $V_{EB} = 5$ V	I_{EBO}	<	50		μA
			BFY10	BFY11	
Base current					
$-I_E = 10$ mA; $V_{CB} = 5$ V	I_B	>	200	80	μA
		<	400	250	μA
Breakdown voltages					
$I_B = 0$; $I_C = 100$ μA	$V_{(BR)CEO}$	>	25		V
$I_C = 50$ μA; $-V_{BE} = 1$ V	$V_{(BR)CEX}$	>	45		V
$I_E = 0$; $I_C = 50$ μA	$V_{(BR)CBO}$	>	45		V
Base-emitter voltage					
$-I_E = 10$ mA; $V_{CB} = 5$ V	V_{BE}	<	1.5		V
Saturation voltage					
$I_C = 10$ mA; $I_B = 1$ mA	V_{CEsat}	<	1.5		V
Collector capacitance					
$I_E = I_e = 0$; $V_{CB} = 10$ V	C_c	<	3		V
Transition frequency					
$-I_E = 5$ mA; $V_{CB} = 10$ V	f_T	>	60		MHz
		typ.	120		MHz
Noise figure at f = 0.45 MHz					
$-I_E = 5$ mA; $V_{CB} = 10$ V	F	typ.	20		dB
		<	40		dB
Small signal current gain at f = 1 kHz			BFY10	BFY11	
$I_C = 5$ mA; $V_{CE} = 5$ V	h_{fe}	>	20	35	

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

y parameters at f = 35 MHz (common base)

$-I_E$ = 5 mA; V_{CB} = 10 V

Input conductance	g_{ib}	typ.	17	$m\Omega^{-1}$
Input capacitance	$-C_{ib}$	typ.	85	pF
Feedback admittance	$\|y_{rb}\|$	typ.	0.8	$m\Omega^{-1}$
Phase angle of feedback admittance	φ_{rb}	typ.	210°	
Transfer admittance	$\|y_{fb}\|$	typ.	22	$m\Omega^{-1}$
Phase angle of transfer admittance	φ_{fb}	typ.	122°	
Output conductance	g_{ob}	typ.	1.0	$m\Omega^{-1}$
Output capacitance	C_{ob}	typ.	3.6	pF

y parameters at f = 35 MHz (common emitter)

I_C = 5 mA; V_{CE} = 10 V

Input conductance	g_{ie}	typ.	5	$m\Omega^{-1}$
Input capacitance	C_{ie}	typ.	16	pF
Feedback admittance	$\|y_{re}\|$	typ.	0.3	$m\Omega^{-1}$
Phase angle of feedback admittance	φ_{re}	typ.	265°	
Transfer admittance	$\|y_{fe}\|$	typ.	22	$m\Omega^{-1}$
Phase angle of transfer admittance	φ_{fe}	typ.	282°	
Output conductance	g_{oe}	typ.	1.0	$m\Omega^{-1}$
Output capacitance	C_{oe}	typ.	3.6	pF

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.

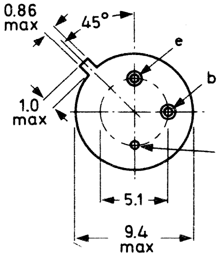
QUICK REFERENCE DATA

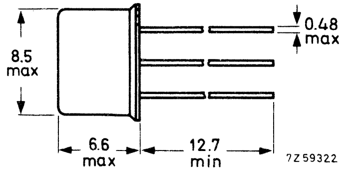
			BFY50	BFY51	BFY52	
Collector-base voltage (open emitter)	V_{CBO}	max.	80	60	40	V
Collector-emitter voltage (open base)	V_{CEO}	max.	35	30	20	V
Collector current (peak value)	I_{CM}	max.	1	1	1	A
Total dissipation up to T_{mb} = 50 °C	P_{tot}	max.	5	5	5	W
Junction temperature	T_j	max.	200	200	200	°C
D.C. current gain at T_j = 25 °C						
I_C = 150 mA; V_{CE} = 10 V	h_{FE}	typ.	112	123	142	
Transition frequency						
I_C = 50 mA; V_{CE} = 10 V	f_T	typ.	140	160	185	MHz
Saturation voltage						
I_C = 500 mA; I_B = 50 mA	V_{CEsat}	<	0.7	1.0	1.0	V

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

			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 $T_{mb} = 50\ ^{o}C$	P_{tot}	max.	5	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	$R_{th\ j-c}$	=	35	°C/W
→ From junction to mounting base	$R_{th\ j-mb}$	=	30	°C/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			BFY50	BFY51	BFY52	
Collector cut-off current						
$I_E = 0$; $V_{CB} = 60$ V	I_{CBO}	typ.	2			nA
		<	50			nA
$I_E = 0$; $V_{CB} = 40$ V	I_{CBO}	typ.		2		nA
		<		50		nA
$I_E = 0$; $V_{CB} = 30$ V	I_{CBO}	typ.			2	nA
		<			50	nA
$I_E = 0$; $V_{CB} = 60$ V; $T_j = 100$ °C	I_{CBO}	typ.	100			nA
		<	2.5			μA
$I_E = 0$; $V_{CB} = 40$ V; $T_j = 100$ °C	I_{CBO}	typ.		100		nA
		<		2.5		μA
$I_E = 0$; $V_{CB} = 30$ V; $T_j = 100$ °C	I_{CBO}	typ.			100	nA
		<			2.5	μA
Emitter cut-off current						
$I_C = 0$; $V_{EB} = 5$ V	I_{EBO}	typ.	2	2	2	nA
		<	50	50	50	nA
$I_C = 0$; $V_{EB} = 5$ V; $T_j = 100$ °C	I_{EBO}	typ.	0.1	0.1	0.1	μA
		<	2.5	2.5	2.5	μA
Saturation voltages						
$I_C = 10$ mA; $I_B = 1.0$ 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
$I_C = 150$ mA; $I_B = 15$ 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
$I_C = 500$ mA; $I_B = 50$ 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
$I_C = 1$ A; $I_B = 100$ 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 °C unless otherwise specified

			BFY50	BFY51	BFY52	
→ D.C. current gain						
I_C = 10 mA; V_{CE} = 10 V	h_{FE}	>	20	30	30	
		typ.	80	85	90	
I_C = 150 mA; V_{CE} = 10 V 1)	h_{FE}	>	30	40	60	
		typ.	112	123	142	
I_C = 500 mA; V_{CE} = 10 V 1)	h_{FE}	>	20	25	30	
		typ.	70	79	90	
I_C = 1 A ; V_{CE} = 10 V 1)	h_{FE}	>	15	15	15	
		typ.	35	40	50	
→ Switching times (See also page 5)						
I_C = 150 mA; $+I_B = -I_{BM}$ = 15 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 MHz						
$I_E = I_e = 0$; V_{CB} = 10 V	C_c	<	12	12	12	pF
Transition frequency at f = 35 MHz						
→ I_C = 50 mA; V_{CE} = 10 V	f_T	>	60	50	50	MHz
		typ.	140	160	185	MHz
→ h parameters at f = 1 kHz						
I_C = 10 mA; V_{CE} = 5 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 mA; V_{CE} = 5 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

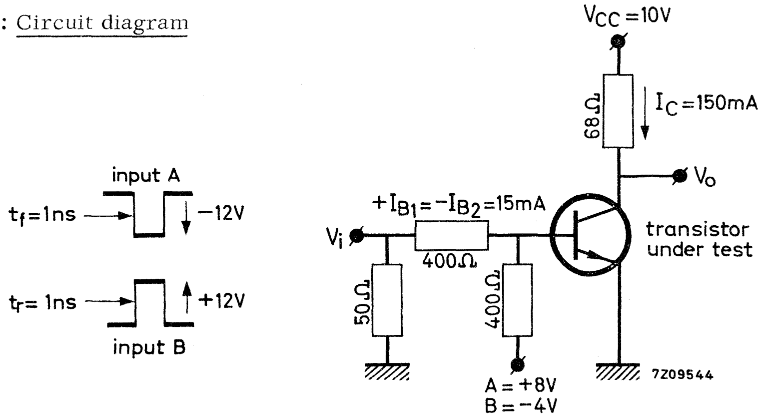
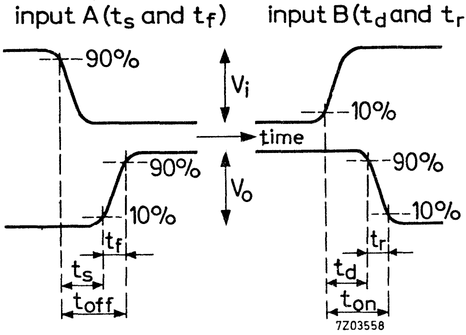


Fig. 2 : Waveforms



Equipment	Pulse generator:	rise time	$t_r = 1$ ns
		pulse duration	$t_p = 1$ μs
	Double beam or dual trace oscilloscope:	rise time	$t_r < 5$ ns

OPERATING NOTES (Dissipation and heatsink considerations)

1. Steady-state conditions

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

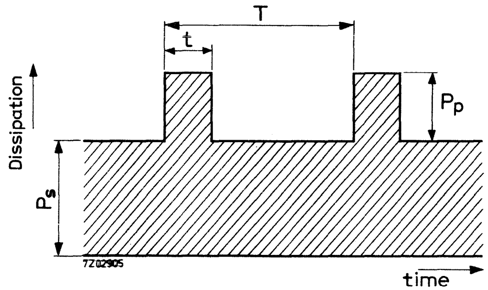
$$P_{s\,max.} = \frac{T_{j\,max.} - T_{amb}}{R_{th\,j\text{-}a}}$$

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

T_{amb} is the ambient temperature,

$R_{th\,j\text{-}a}$ is the total thermal resistance between junction and ambient.

2. Pulse conditions (rectangular pulses)



The maximum allowable pulse power P_p is given by the formula

$$P_p = \frac{(T_{j\,max.} - T_{amb}) - (P_s \,.\, R_{th\,j\text{-}a})}{Z_{th} + \delta . R_{th\,mb\text{-}a}}$$

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,

$R_{th\,mb\text{-}a}$ 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_{th} = 13 °C/W (from page 9)

OPERATING NOTES (continued)

$$P_{p\,max} = \frac{(200-65) - (0.35 \times 220)}{13 + 0.2\,(220-30)}$$

$$= \frac{135 - 77}{13 + 38} = 1.14\,W$$

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

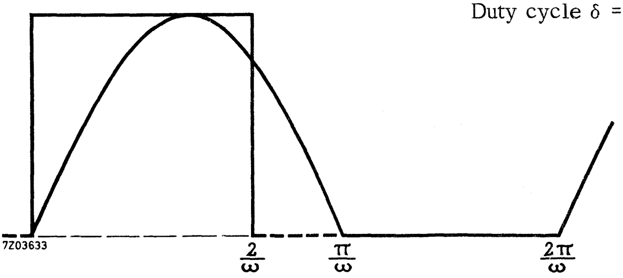
The following example illustrates how to find the maximum permissible peak dissipation of a BFY52 operating in a class "B" circuit at 1 kHz. The device is mounted on a heatsink of thermal resistance equal to 50 °C/W and at an ambient temperature not exceeding 100 °C. Assuming that the waveform is sinusoidal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

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

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

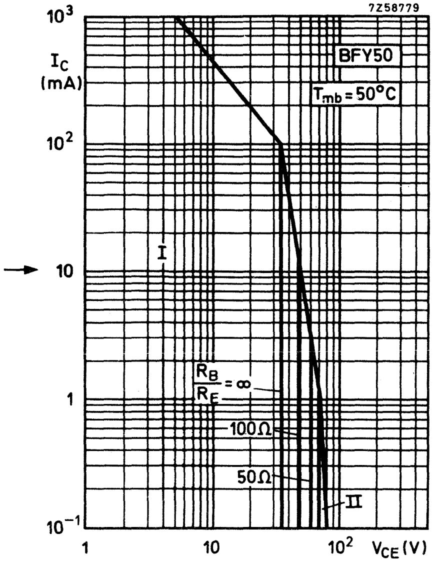


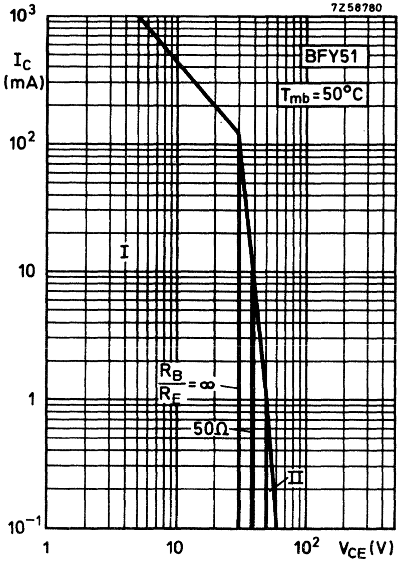
From page 9: $Z_{th\,0} = 6.0\ ^{\circ}C/W$ $R_{th\,j\text{-}mb} = 30\ ^{\circ}C/W$

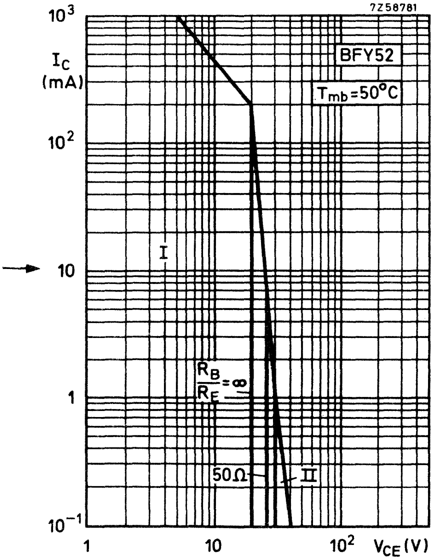
$$Z_{th}\ (\text{at } \delta = 0.318) = 6.0 + 0.318\,(30-6.0) = 13.6\ ^{\circ}C/W$$

$$P_{p\,max} = \frac{(200-100) - 0}{13.6 + 0.318 \times 50} = 3.39\ W$$

A peak power of 3.39 W is therefore permissible provided that the voltage and current ratings of the device are not exceeded.



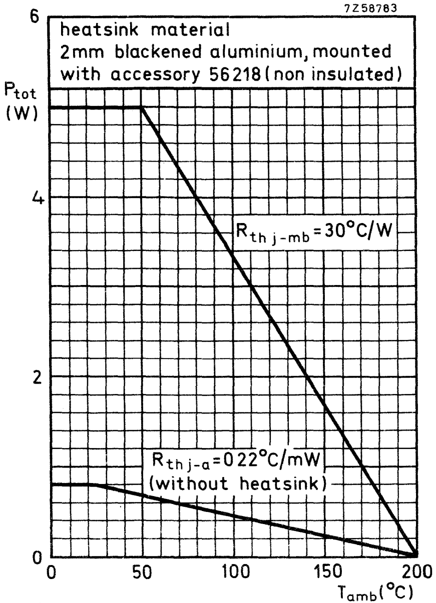


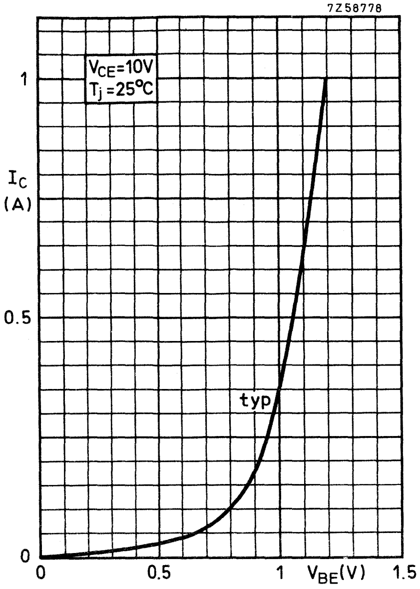


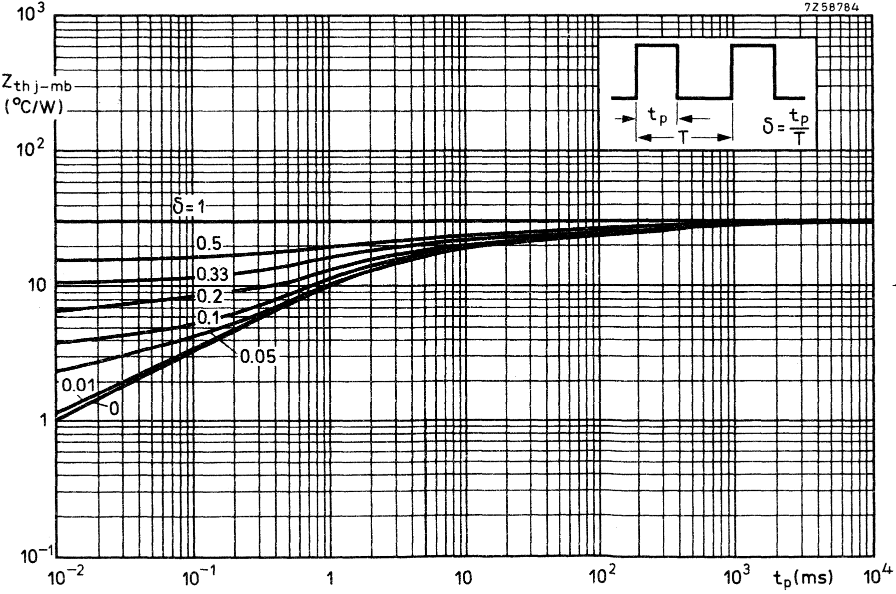
Safe Operating Area with the transistor forward biased

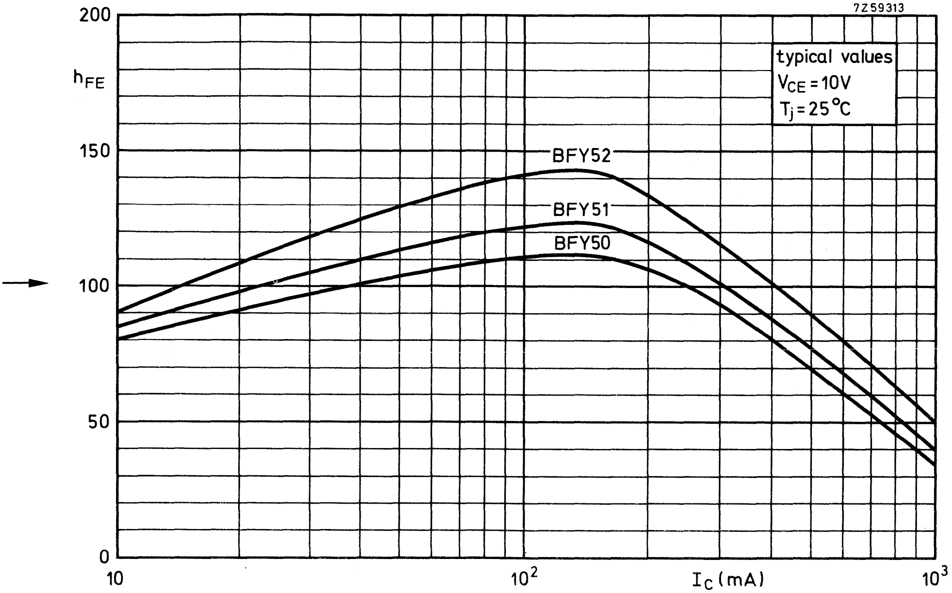
I. Region of permissible d.c. operation

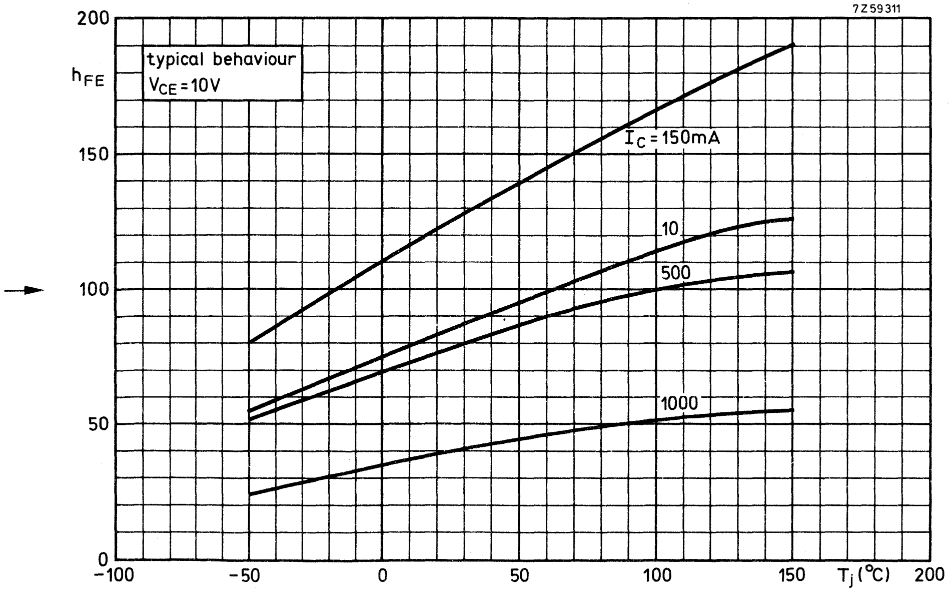
II. Additional area for d.c. operation when $R_B / R_E < 10\ \Omega$

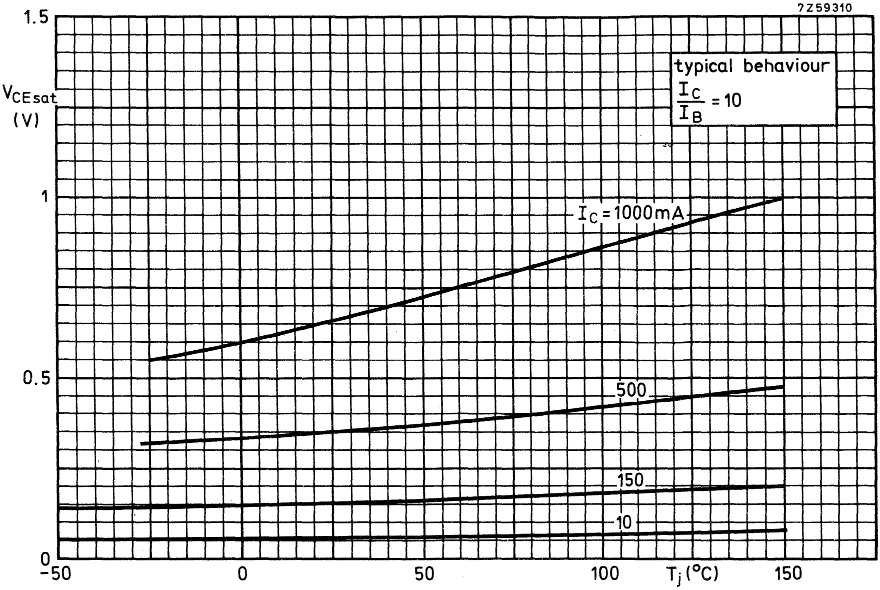

7Z58783
heatsink material
2mm blackened aluminium, mounted
with accessory 56218 (non insulated)
Ptot
(W)
6
4
2
0
Rth j-mb = 30°C/W
Rth j-a = 0.22°C/mW
(without heatsink)
0
50
100
150
200
Tamb (°C)

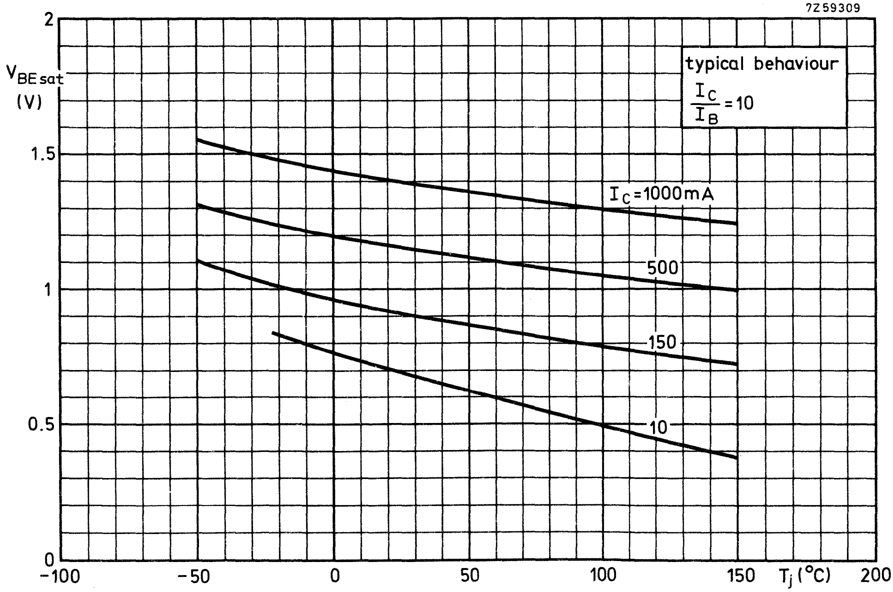

7Z58778
VCE = 10V
Tj = 25°C
IC
(A)
1
0.5
0
typ
0
0.5
1
VBE (V)
1.5

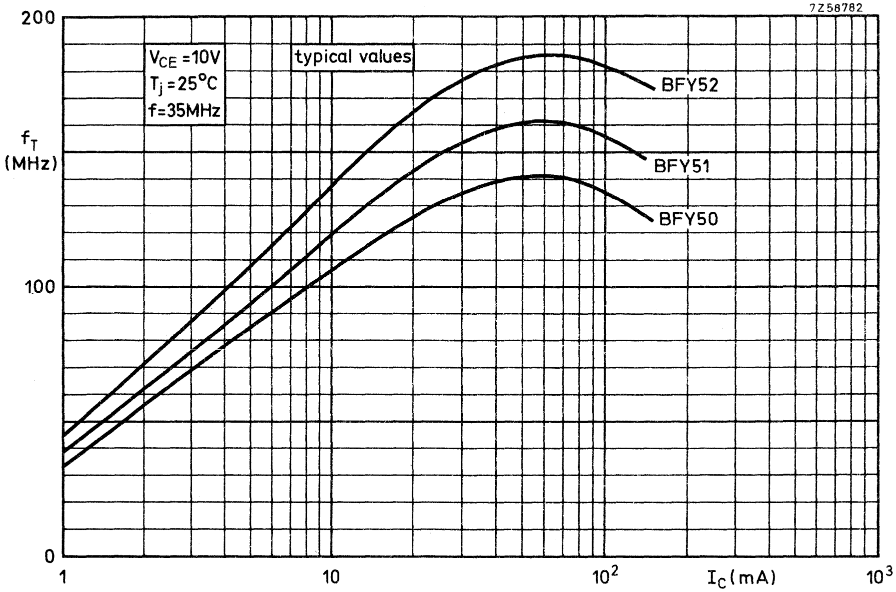

7Z58784
Zth j-mb
(°C/W)
10³
10²
10
1
10⁻¹
tp
T
δ = tp/T
δ = 1
0.5
0.33
0.2
0.1
0.05
0.01
0
10⁻²
10⁻¹
1
10
10²
10³
tp (ms)
10⁴

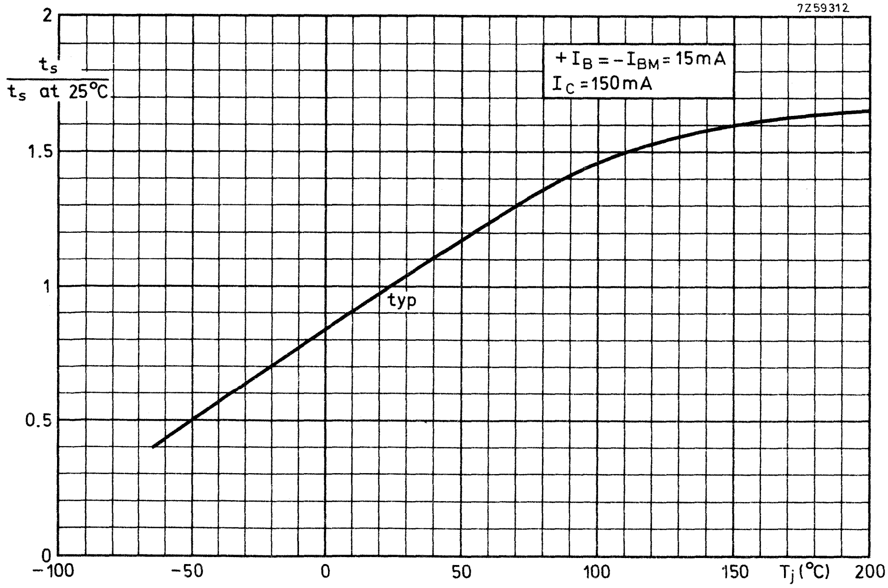

7Z59313
typical values
V_{CE} = 10V
T_j = 25 °C
h_{FE}
200
150
100
50
0
BFY52
BFY51
BFY50
10
10^2
I_C (mA)
10^3

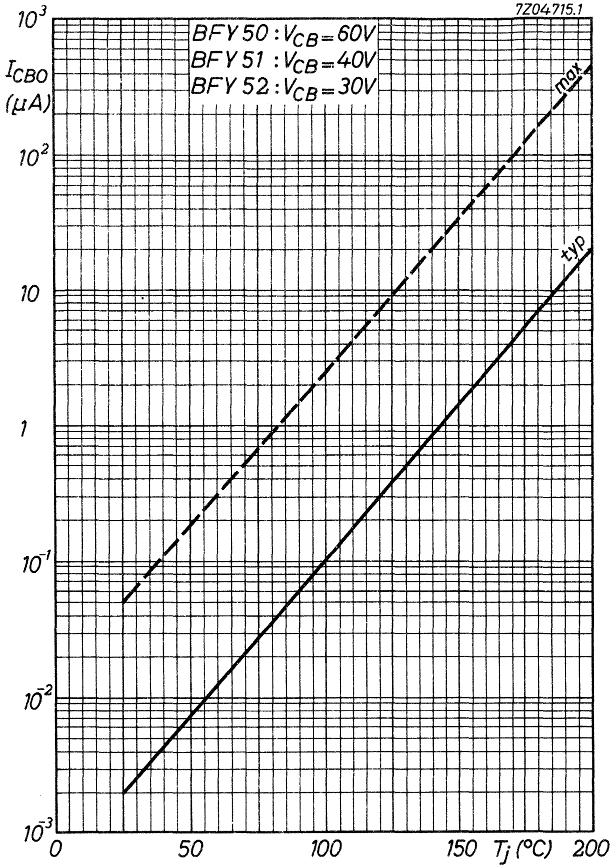

7Z59311
typical behaviour
V_{CE} = 10V
h_{FE}
200
150
100
50
0
I_C = 150mA
10
500
1000
−100
−50
0
50
100
150
T_j (°C)
200

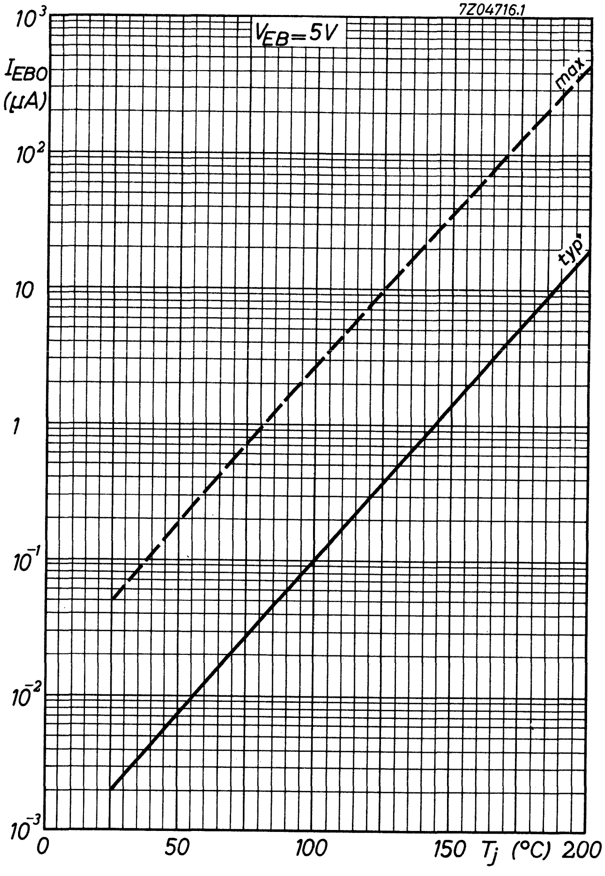

7Z59310
typical behaviour
$\frac{I_C}{I_B} = 10$
V_{CEsat} (V)
1.5
1
0.5
0
$I_C = 1000 mA$
500
150
10
−50
0
50
100
T_j (°C)
150


7Z59309
typical behaviour
$\frac{I_C}{I_B} = 10$
V_{BEsat} (V)
2
1.5
1
0.5
0
$I_C = 1000 mA$
500
150
10
−100
−50
0
50
100
150
T_j (°C)
200


7Z58782
200
100
0
f_T (MHz)
V_CE = 10V
T_j = 25°C
f = 35MHz
typical values
BFY52
BFY51
BFY50
1
10
10^2
I_C (mA)
10^3


7Z59312
2
t_s / t_s at 25°C
1.5
1
0.5
0
+I_B = −I_BM = 15mA
I_C = 150mA
typ
−100
−50
0
50
100
150
T_j (°C)
200


7Z04715.1
BFY 50 : V_{CB} = 60V
BFY 51 : V_{CB} = 40V
BFY 52 : V_{CB} = 30V
I_{CBO} (μA)
10^3
10^2
10
1
10^{-1}
10^{-2}
10^{-3}
max.
typ
0
50
100
150
T_j (°C)
200


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

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.

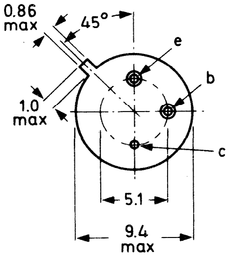
QUICK REFERENCE DATA

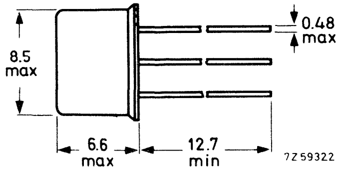
Collector-base voltage (open emitter)	V_{CBO}	max.	80	V
Collector-emitter voltage (open base)	V_{CEO}	max.	35	V
Collector current (d.c.)	I_C	max.	1	A
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	800	mW
Junction temperature	T_j	max.	200	°C
D.C. current gain at T_j = 25 °C				
I_C = 150 mA; V_{CE} = 10 V	h_{FE}	>	40	
Transition frequency				
I_C = 50 mA; V_{CE} = 10 V	f_T	>	60	MHz
Collector-emitter saturation voltage				
I_C = 1 A; I_B = 100 mA	V_{CEsat}	<	1	V

MECHANICAL DATA

Dimensions in mm

Collecter 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.	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 °C	P_{tot}	max.	4	W
Total power dissipation without cooling fin up to T_{amb} = 25 °C	P_{tot}	max.	0.8	W

Temperatures

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

THERMAL RESISTANCE

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

---

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

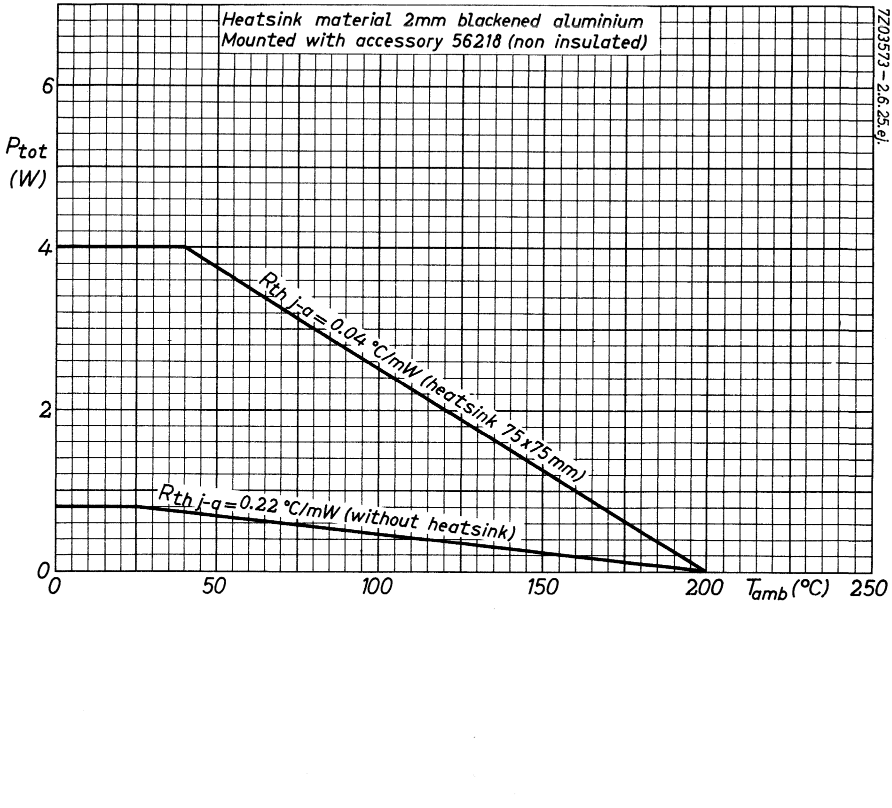
CHARACTERISTICS T_j = 25 °C unless otherwise specified

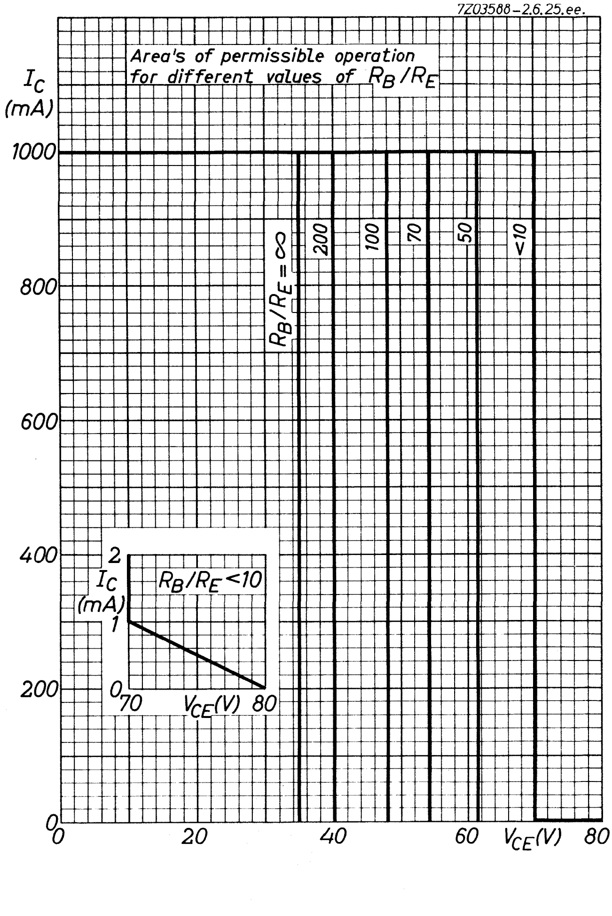
Collector cut-off current				
$I_E = 0$; $V_{CB} = 60$ V	I_{CBO}	$<$	10	nA
$I_E = 0$; $V_{CB} = 60$ V; $T_j = 150$ °C	I_{CBO}	$<$	10	μA
Emitter cut-off current				
$I_C = 0$; $V_{EB} = 5$ V	I_{EBO}	$<$	10	nA
Saturation voltages				
$I_C = 150$ mA; $I_B = 15$ mA	V_{CEsat}	$<$	0.2	V
$I_C = 1$ A; $I_B = 100$ mA [1][2]	V_{CEsat}	$<$	1.0	V
	V_{BEsat}	$<$	1.6	V
Sustaining voltage				
$I_C = 30$ mA; $I_B = 0$ [2]	$V_{CEOsust}$	$>$	35	V
D.C. current gain [2]				
$I_C = 10$ mA; $V_{CE} = 10$ V	h_{FE}	$>$	30	
$I_C = 150$ mA; $V_{CE} = 10$ V	h_{FE}		40 to 120	
$I_C = 1$ A; $V_{CE} = 10$ V	h_{FE}	$>$	15	
Feedback time constant				
$I_C = 10$ mA; $V_{CB} = 10$ V; f = 4 MHz	$r_{b'}C_c$	$<$	800	ps
Collector capacitance at f = 500 kHz				
$I_E = I_e = 0$; $V_{CB} = 10$ V	C_c	$<$	12	pF
Emitter capacitance at f = 500 kHz				
$I_C = I_c = 0$; $V_{EB} = 0.5$ V	C_e	$<$	80	pF
Transition frequency				
$I_C = 50$ mA; $V_{CE} = 10$ V	f_T	$>$	60	MHz

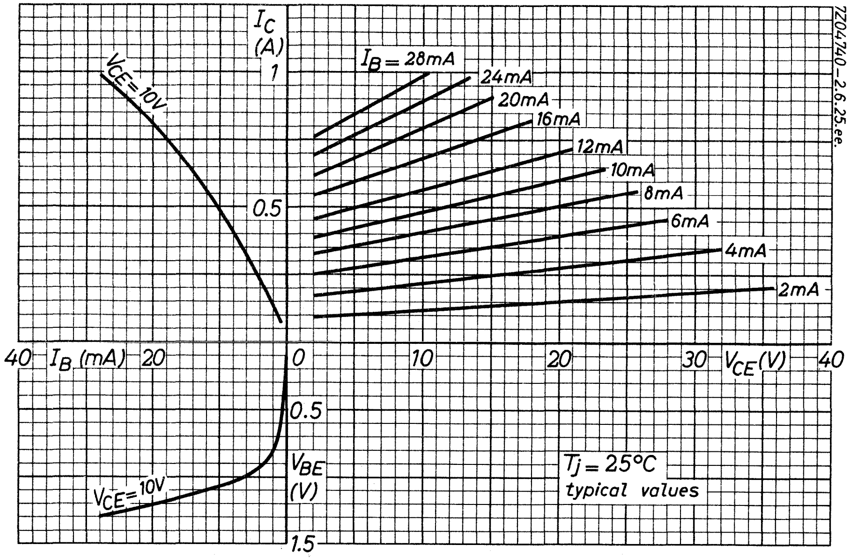
---

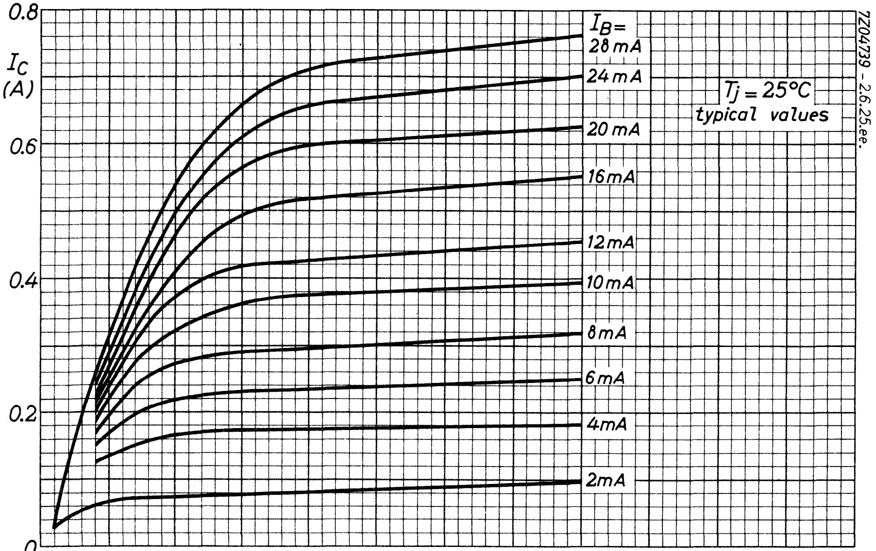
[1] Measured with a lead length of 1 cm.

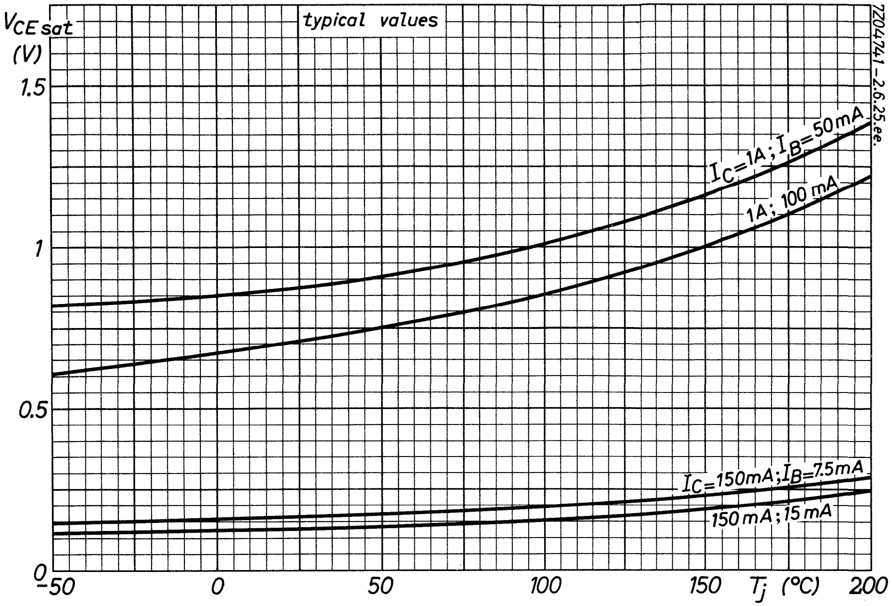
[2] Measured under pulsed conditions to avoid excessive dissipation.
Pulse duration = 300 μs; duty cycle $\delta < 0.01$

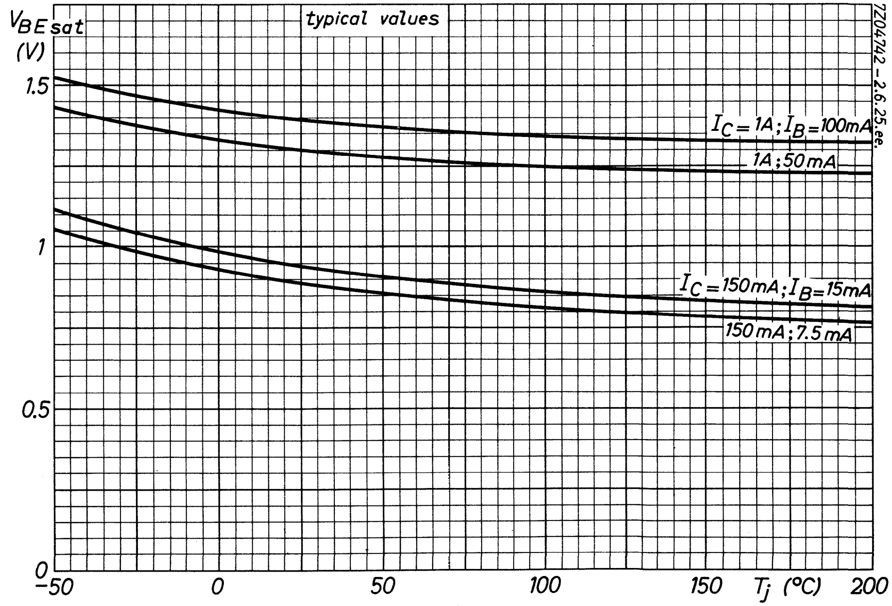

Heatsink material 2mm blackened aluminium
Mounted with accessory 56218 (non insulated)
7Z03573 – 2.6.25.ej.
P_{tot} (W)
6
4
2
0
0
50
100
150
200
T_{amb} (°C)
250
$R_{th\,j-a}$ = 0.04 °C/mW (heatsink 75 x 75 mm)
$R_{th\,j-a}$ = 0.22 °C/mW (without heatsink)

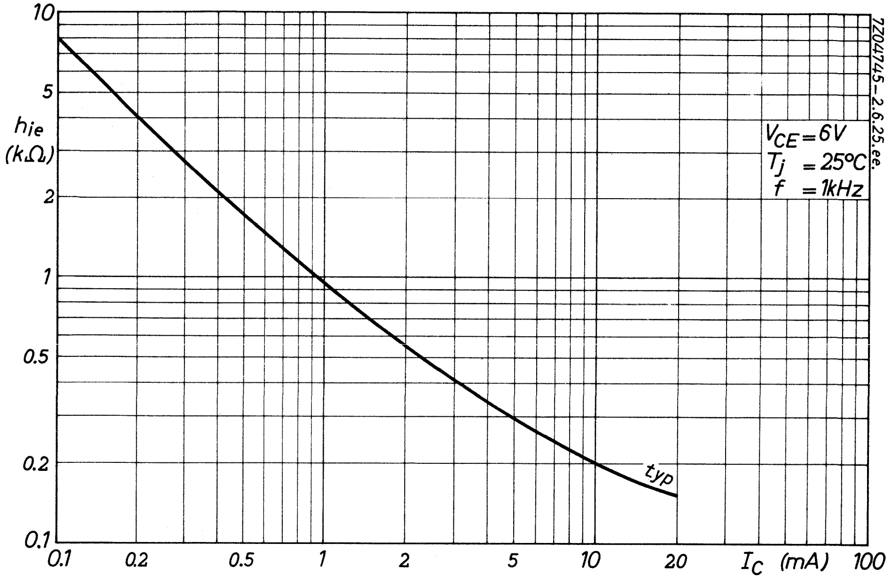

7Z03588-2.6.25.ee.
Area's of permissible operation for different values of R_B/R_E
I_C (mA)
1000
800
600
400
200
0
$R_B/R_E=\infty$
200
100
70
50
<10
0
20
40
60
V_{CE}(V)
80
2
I_C (mA)
1
0
$R_B/R_E<10$
70
V_{CE}(V)
80

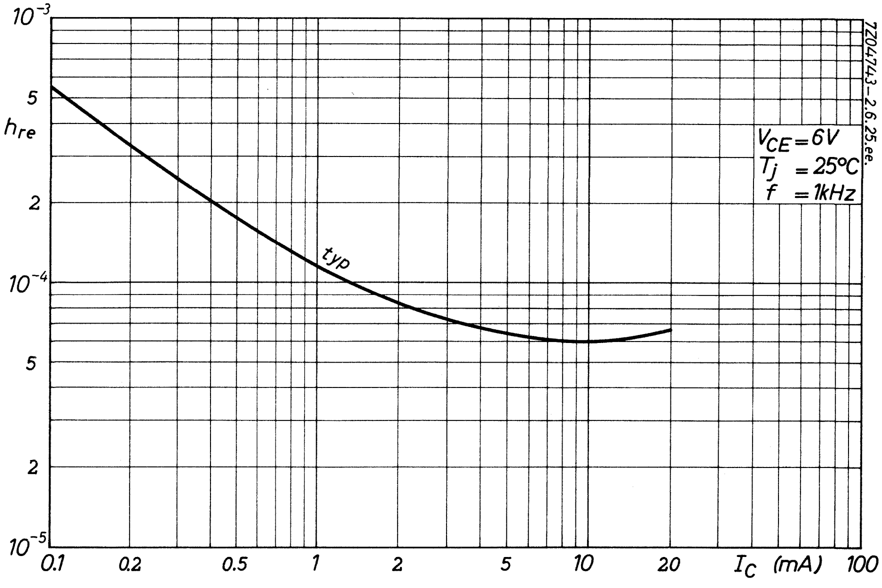

I_C
(A)
1
0.5
V_CE = 10V
I_B = 28mA
24mA
20mA
16mA
12mA
10mA
8mA
6mA
4mA
2mA
40
I_B (mA)
20
0
10
20
30
V_CE (V)
40
0.5
V_BE
(V)
1.5
V_CE = 10V
T_j = 25°C
typical values
7Z04740 – 2.6.25.ee.

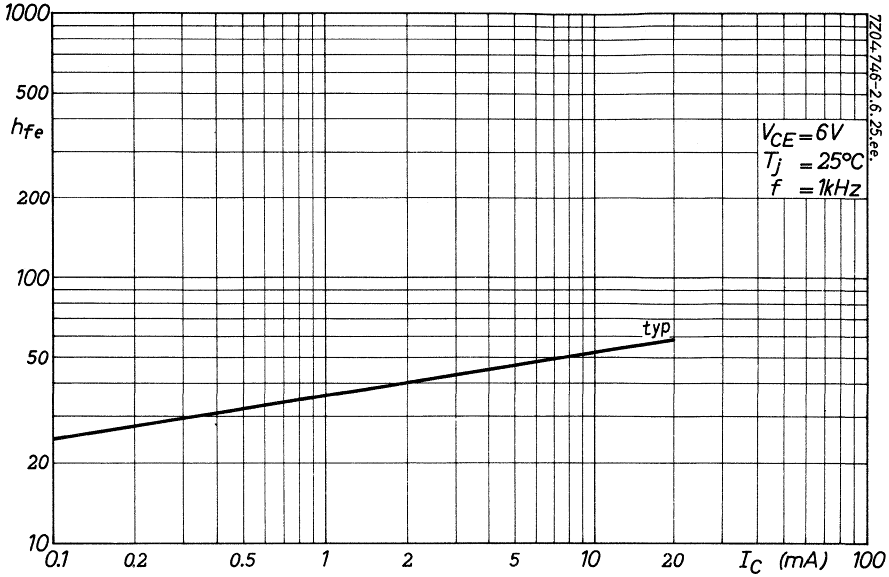

0.8
I_C
(A)
0.6
0.4
0.2
0
0
0.5
1
1.5
2
2.5
V_CE (V)
3
I_B =
28 mA
24 mA
20 mA
16mA
12mA
10mA
8mA
6mA
4mA
2mA
T_j = 25°C
typical values
7Z04739 – 2.6.25.ee.

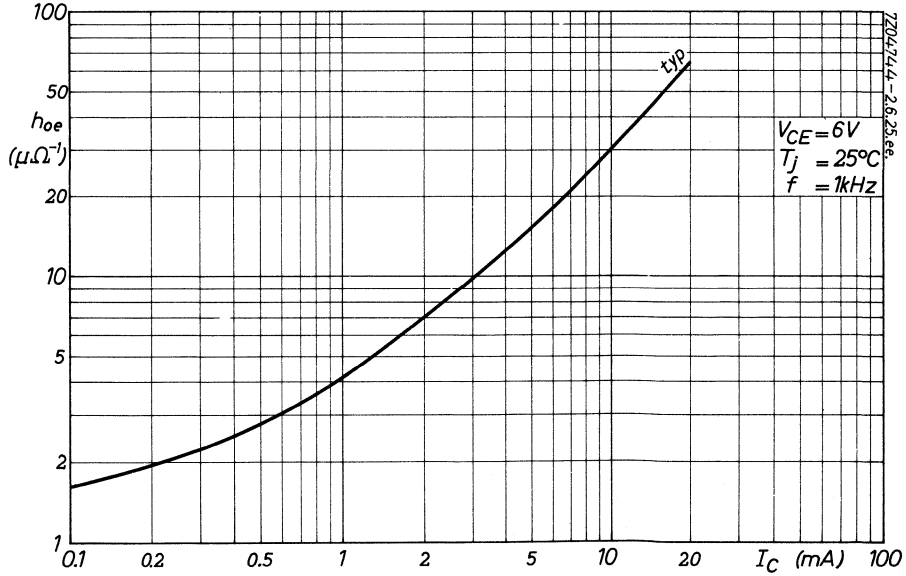

VCEsat (V)
typical values
7Z04741 – 2.6.25.ee.
1.5
1
0.5
0
I_C=1A; I_B=50mA
1A; 100 mA
I_C=150mA; I_B=7.5mA
150 mA; 15 mA
−50
0
50
100
150
T_j (°C)
200

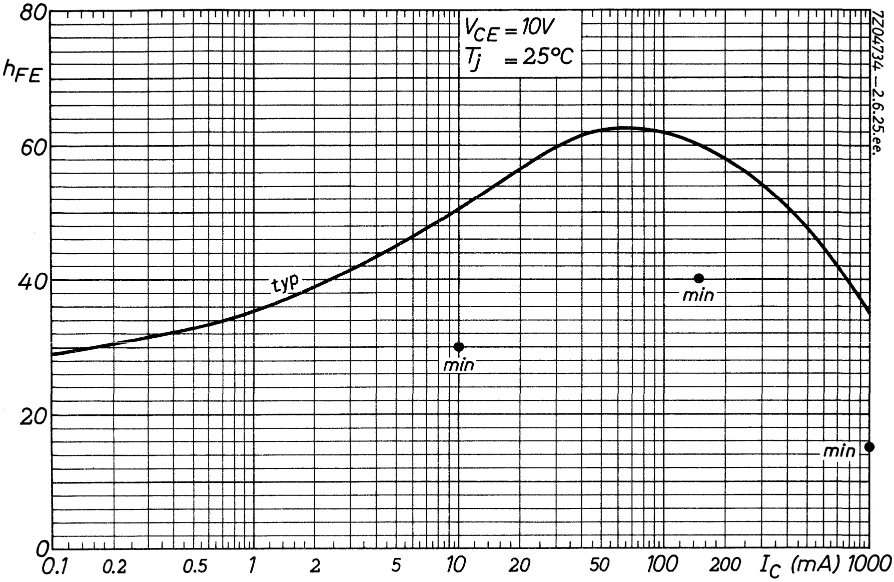

VBEsat (V)
typical values
7Z04742 – 2.6.25.ee.
1.5
1
0.5
0
I_C = 1A; I_B = 100mA
1A; 50mA
I_C = 150mA; I_B = 15mA
150 mA; 7.5 mA
−50
0
50
100
150
T_j (°C)
200


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

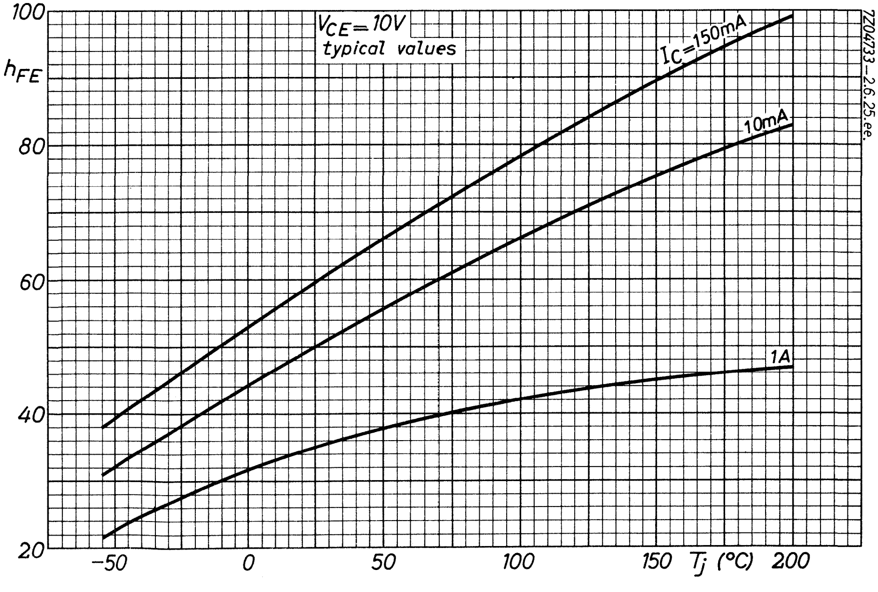

10^{-3}
5
h_{re}
2
10^{-4}
5
2
10^{-5}
0.1
0.2
0.5
1
2
5
10
20
I_C (mA)
100
typ
$V_{CE} = 6V$
$T_j = 25°C$
f = 1kHz
7Z04743–2.6.25.ee.


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

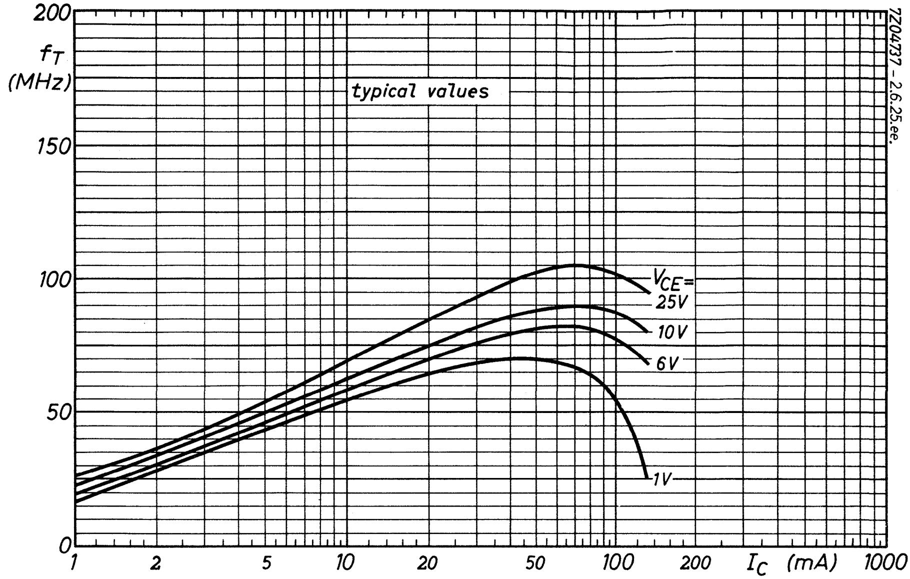

100
50
h_{oe}
($\mu\Omega^{-1}$)
20
10
5
2
1
0.1
0.2
0.5
1
2
5
10
20
I_C (mA)
100
typ
$V_{CE} = 6V$
$T_j = 25°C$
$f = 1kHz$
7Z04744-2.6.25.ee.

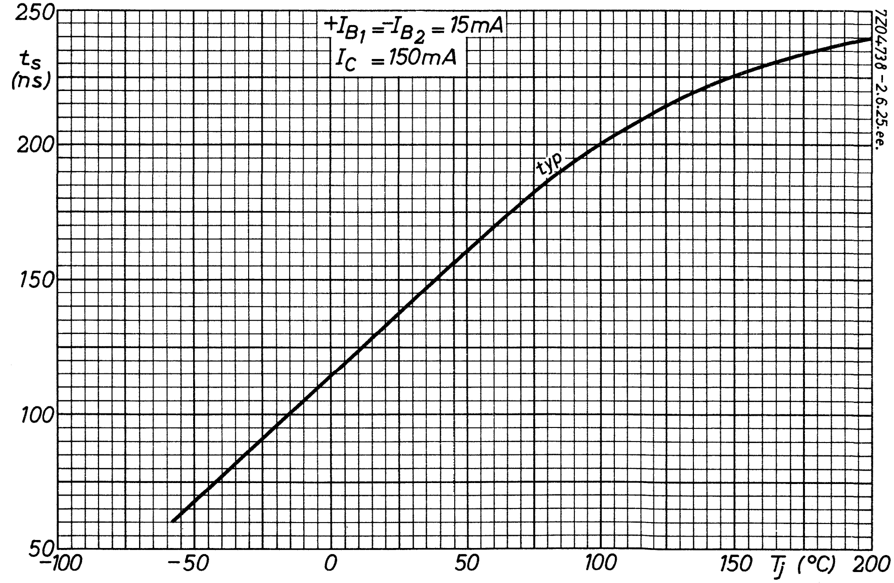


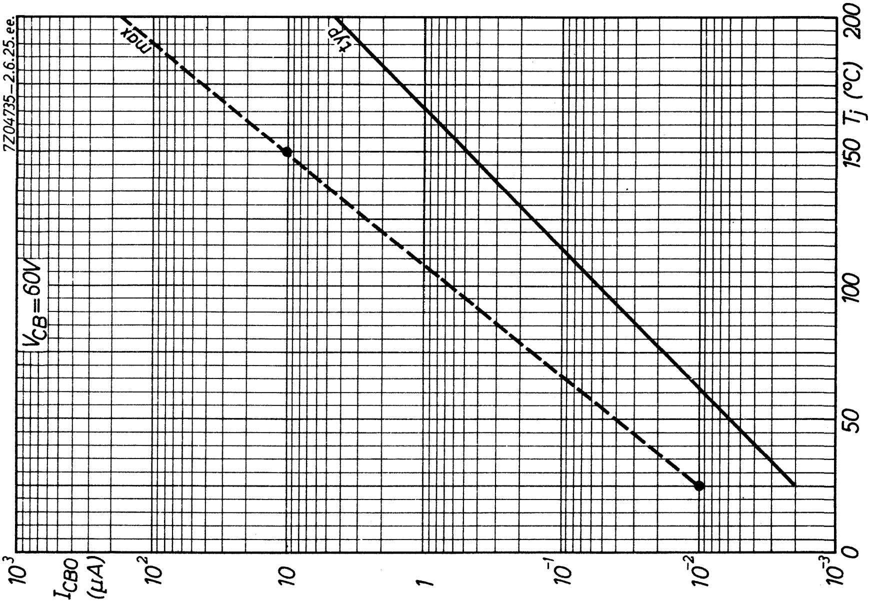
$V_{CE} = 10V$
$T_j = 25°C$
h_{FE}
80
60
40
20
0
typ
min
min
min
0.1
0.2
0.5
1
2
5
10
20
50
100
200
I_C (mA) 1000
7Z04734−2.6.25.ee.

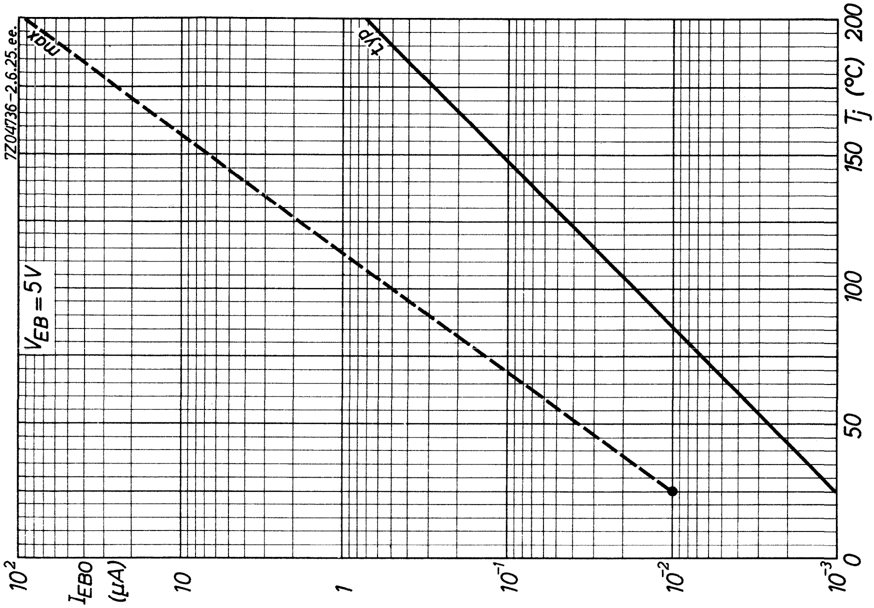


$V_{CE} = 10V$
typical values
h_{FE}
100
80
60
40
20
$I_C = 150mA$
10mA
1A
−50
0
50
100
150
T_j (°C)
200
7Z04733−2.6.25.ee.


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


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


7Z04735-2.6.25.ee.
$V_{CB} = 60V$
max
typ
10^3
I_{CBO} (μA)
10^2
10
1
10^{-1}
10^{-2}
10^{-3}
0
50
100
150
200
T_j (°C)


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

BFY67
BFY68

SILICON PLANAR TRANSISTORS

N-P-N double diffused transistors in a TO-39 metal envelope with the collector connected to the case. They are intended for use in a wide variety of applications, such as d.c. and high frequency amplifiers and switching applications.

QUICK REFERENCE DATA

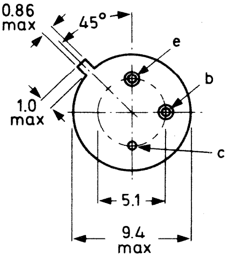
			BFY67	BFY68	
Collector-base voltage (open emitter)	V_{CBO}	max.	75	75	V
Collector-emitter voltage ($R_{BE} < 10\,\Omega$)	V_{CER}	max.	50	50	V
Collector current (peak value)	I_{CM}	max.	1	1	A
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	0.8	0.8	W
Junction temperature	T_j	max.	200	200	°C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

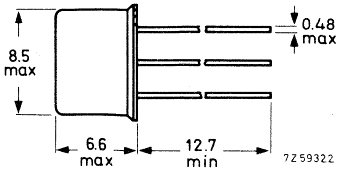
MECHANICAL DATA

Dimensions in mm

Collecter 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.	75	V
Collector-emitter voltage (open base)	V_{CEO}	max.	30	V [2]
Collector-emitter voltage ($R_{BE} < 10\ \Omega$)	V_{CER}	max.	50	V [2][3]
Emitter-base voltage (open collector)	V_{EBO}	max.	7	V

Currents

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

Power dissipation

Total power dissipation up to $T_{amb} = 25\ ^oC$	P_{tot}	max.	0.8	W

Temperatures

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

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	220	$^oC/W$
From junction to case	$R_{th\ j\text{-}c}$	=	58	$^oC/W$

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

[2] See page 13.

[3] $I_C = 100$ mA.

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

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

---

1) Measured under pulse conditions to avoid excessive dissipation. Pulse duration $t < 300$ μs, duty cycle $\delta < 0.01$

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

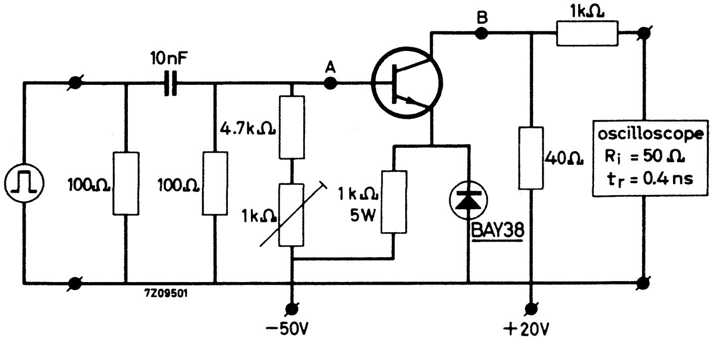
			BFY67	BFY68	
h parameters at f = 1 kHz					
$-I_E$ = 1 mA; V_{CB} = 5 V					
Input impedance	h_{ib}	>	24	24	Ω
		<	34	34	Ω
Reverse voltage transfer	h_{rb}	<	3	5	10^{-4}
Output admittance	h_{ob}	>	0.1	0.1	$\mu\Omega^{-1}$
		<	0.5	0.5	$\mu\Omega^{-1}$
$-I_E$ = 5 mA; V_{CB} = 10 V					
Input impedance	h_{ib}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

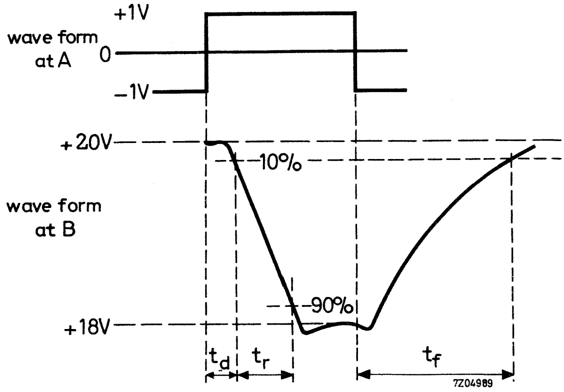
CHARACTERISTICS (continued) T_j = 25 °C unless otherwise specified

Total switching time

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

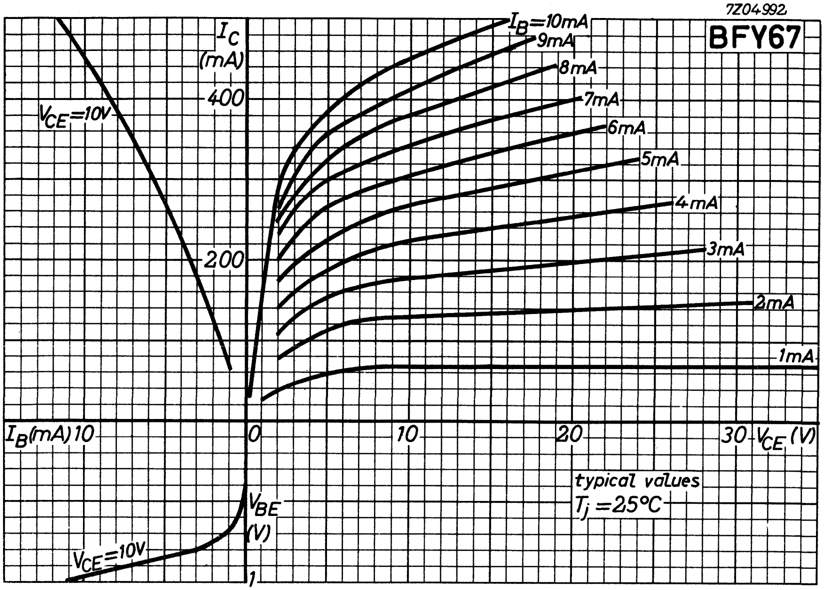
Measuring circuit:

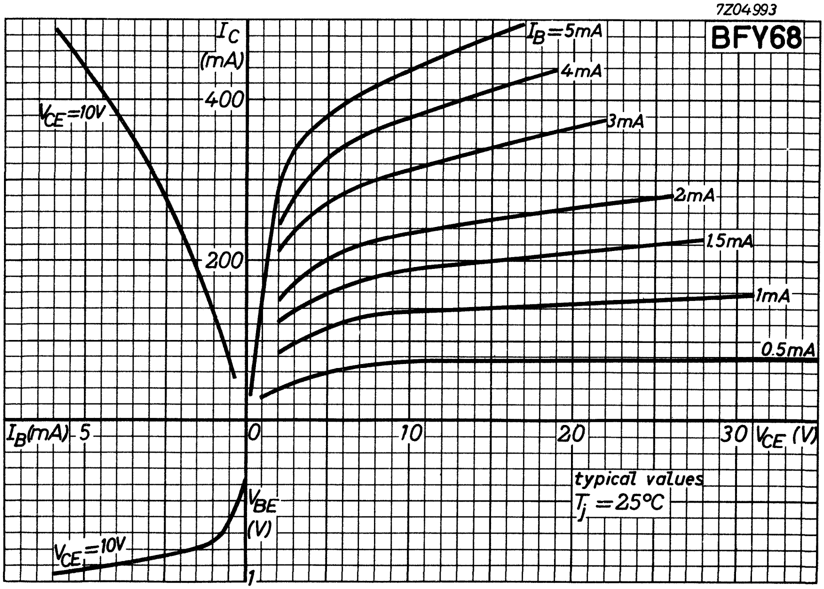


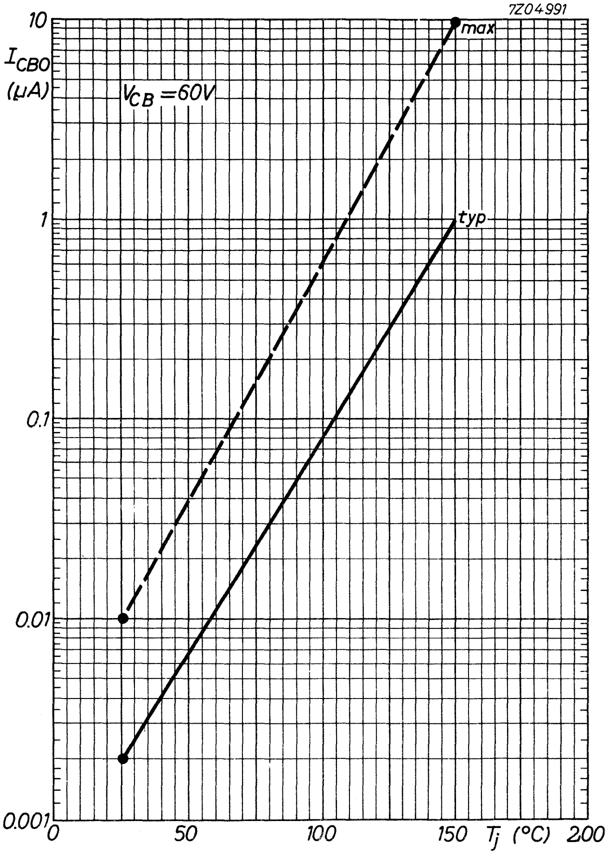


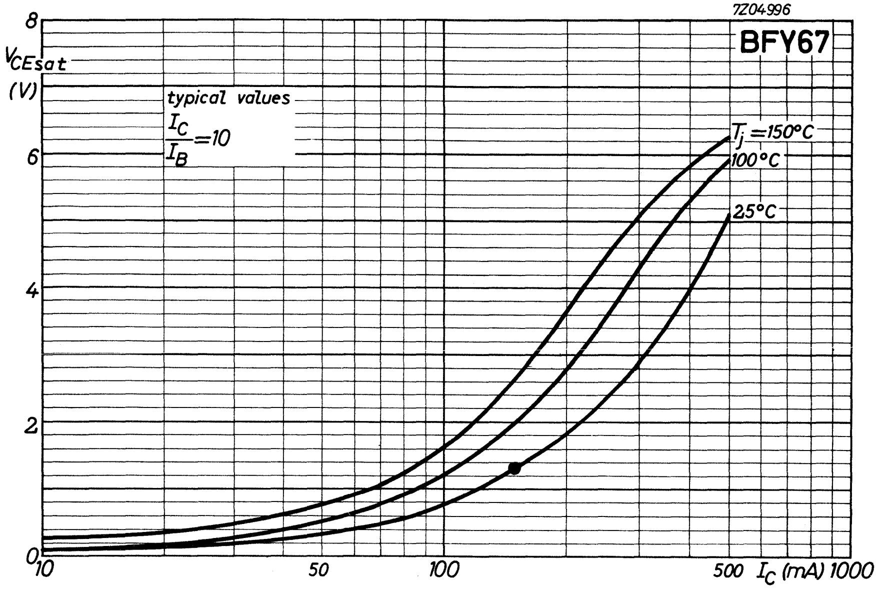
Input pulse:

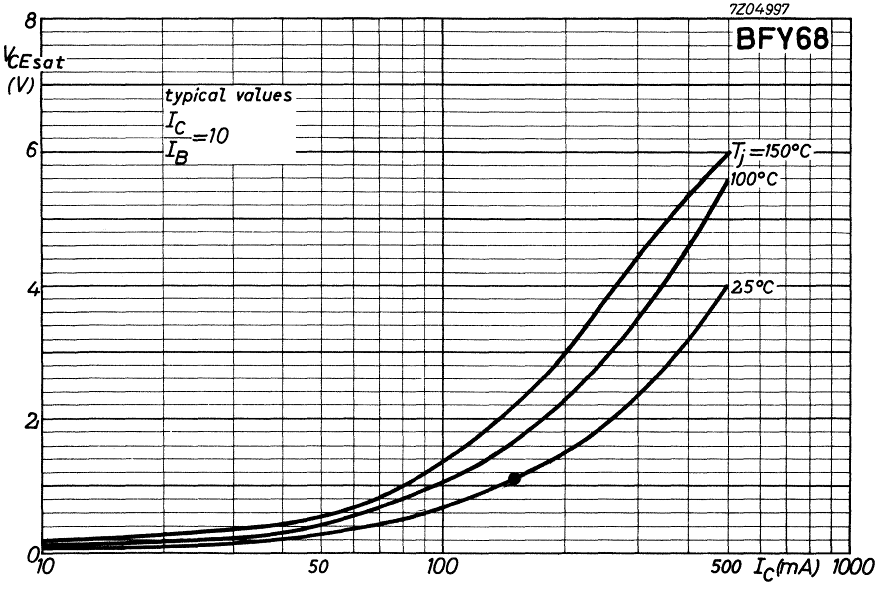
Pulse duration	t_p	=	15 ns
Rise time	t_r	<	1 ns
Duty cycle	δ	<	0.02

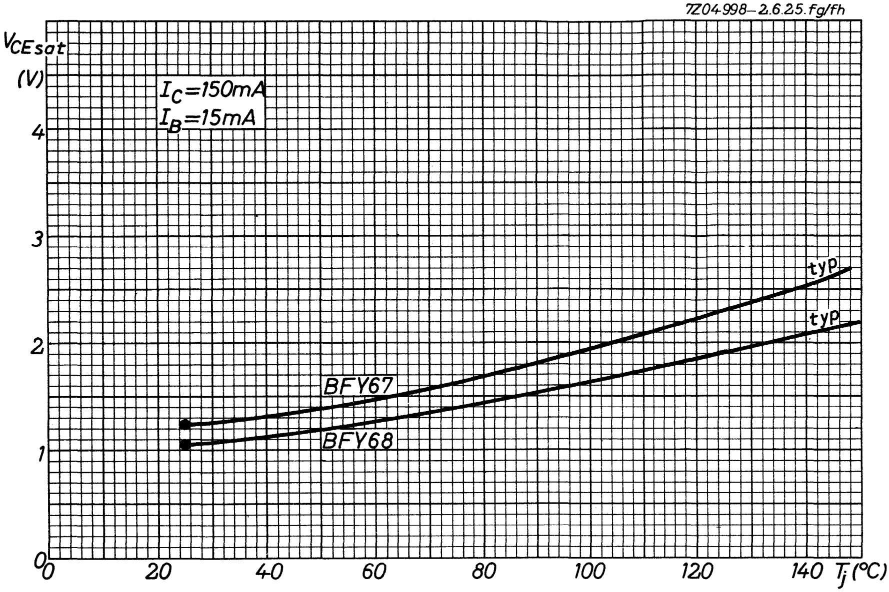

7Z04992
BFY67
I_C (mA)
400
200
I_B=10mA
9mA
8mA
7mA
6mA
5mA
4mA
3mA
2mA
1mA
V_{CE}=10V
I_B(mA) 10
0
10
20
30
V_{CE} (V)
typical values
T_j = 25°C
V_{BE} (V)
1
V_{CE}=10V

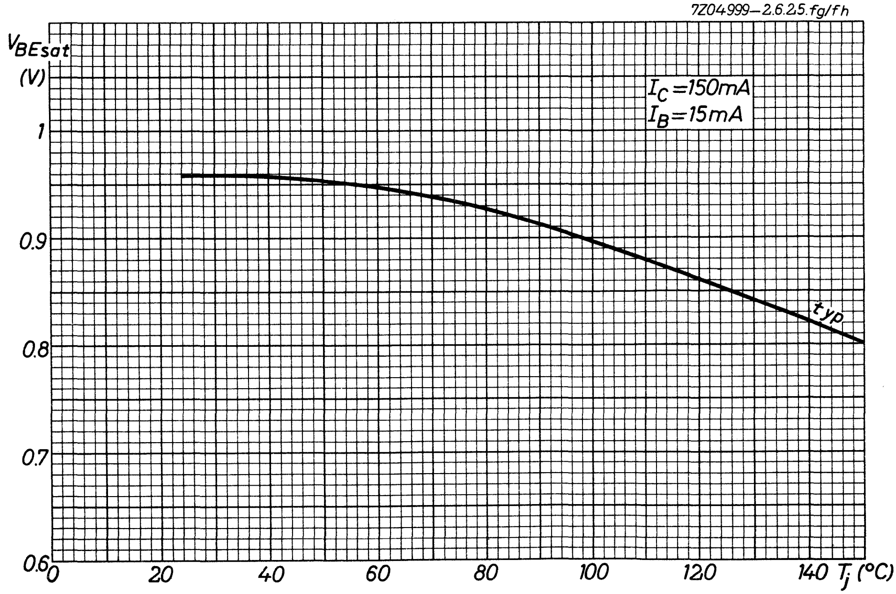

7Z04993
BFY68
I_C (mA)
400
200
I_B=5mA
4mA
3mA
2mA
1.5mA
1mA
0.5mA
V_{CE}=10V
I_B(mA) 5
0
10
20
30
V_{CE} (V)
typical values
T_j = 25°C
V_{BE} (V)
1
V_{CE}=10V

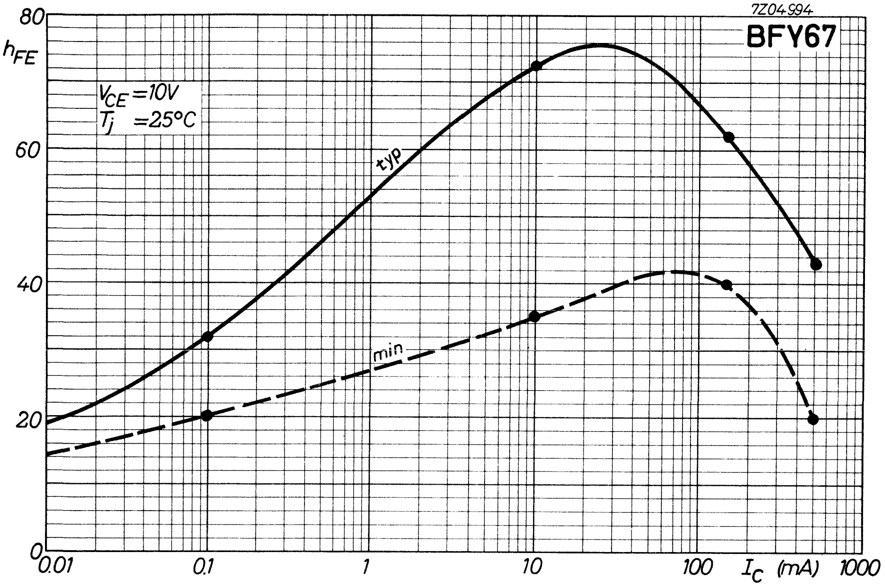

7Z04991
10
I_{CBO}
(μA)
V_{CB} = 60V
max
1
typ
0.1
0.01
0.001
0
50
100
150
T_j (°C)
200

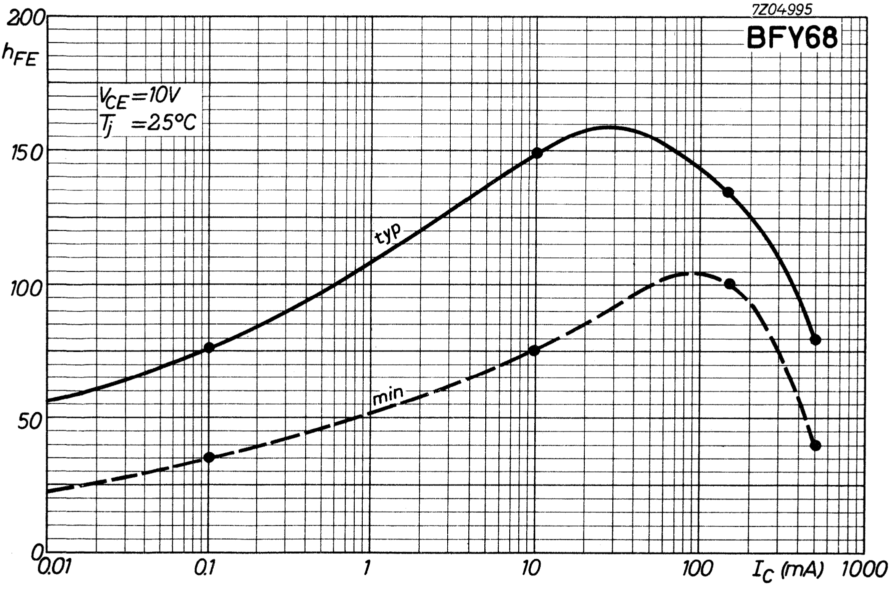

7Z04996
BFY67
V_{CEsat} (V)
typical values
$\frac{I_C}{I_B}=10$
$T_j = 150°C$
100°C
25°C
0
2
4
6
8
10
50
100
500
I_C (mA)
1000

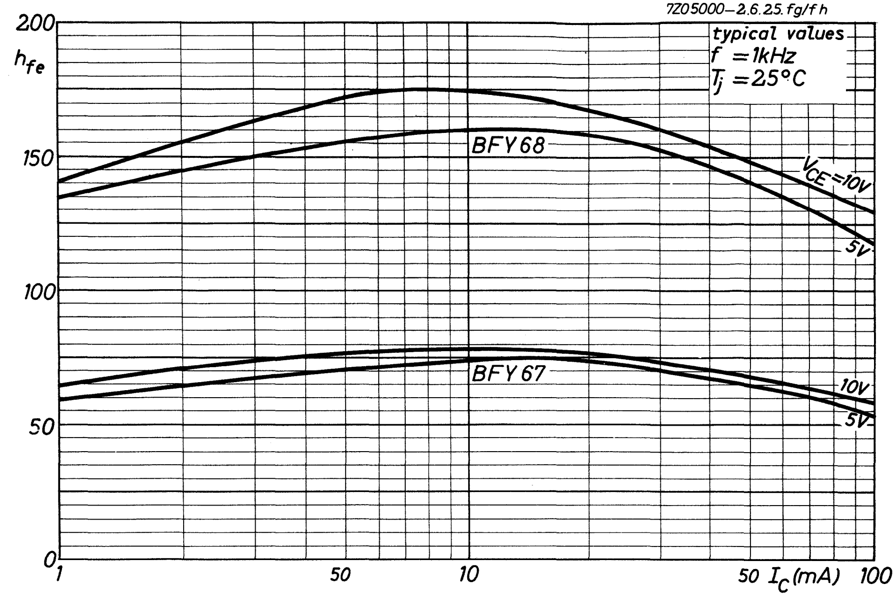

7Z04997
BFY68
V_{CEsat} (V)
typical values
$\frac{I_C}{I_B}=10$
$T_j = 150°C$
100°C
25°C
0
2
4
6
8
10
50
100
500
I_C (mA)
1000

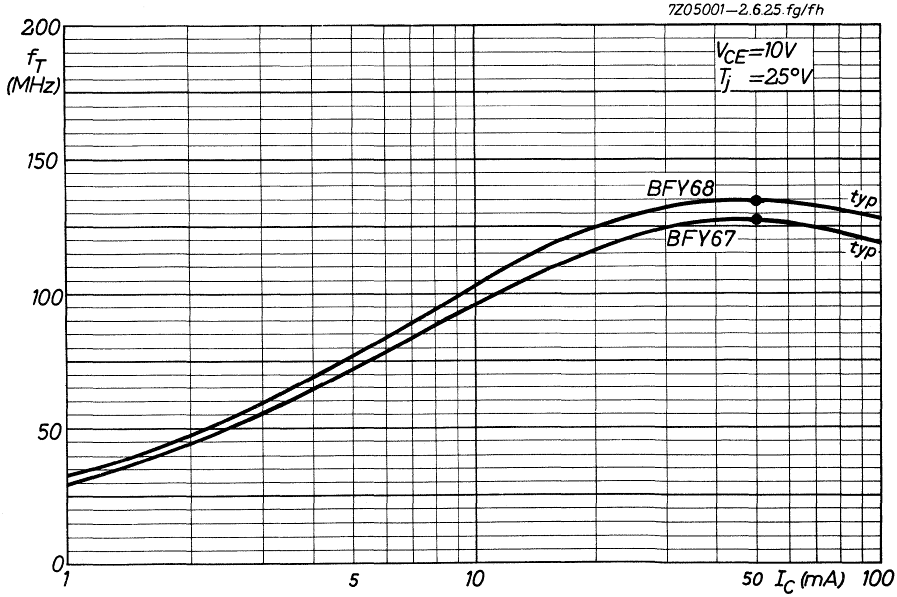

7Z04998–2.6.2.5.fg/fh
V_{CEsat} (V)
I_C=150mA
I_B=15mA
4
3
2
1
0
0
20
40
60
80
100
120
140
T_j (°C)
typ
typ
BFY67
BFY68

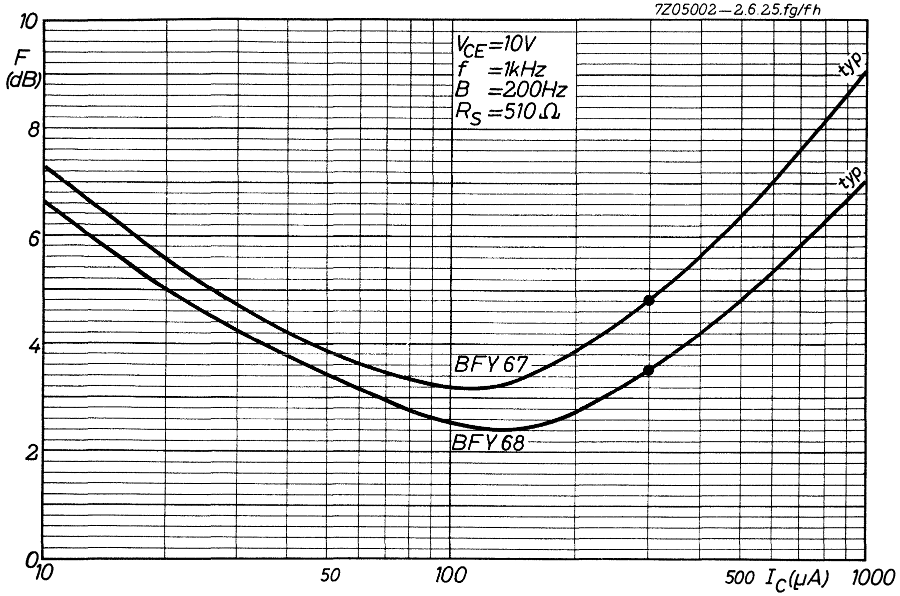

7Z04999–2.6.2.5.fg/fh
V_{BEsat} (V)
I_C=150mA
I_B=15mA
1
0.9
0.8
0.7
0.6
0
20
40
60
80
100
120
140
T_j (°C)
typ

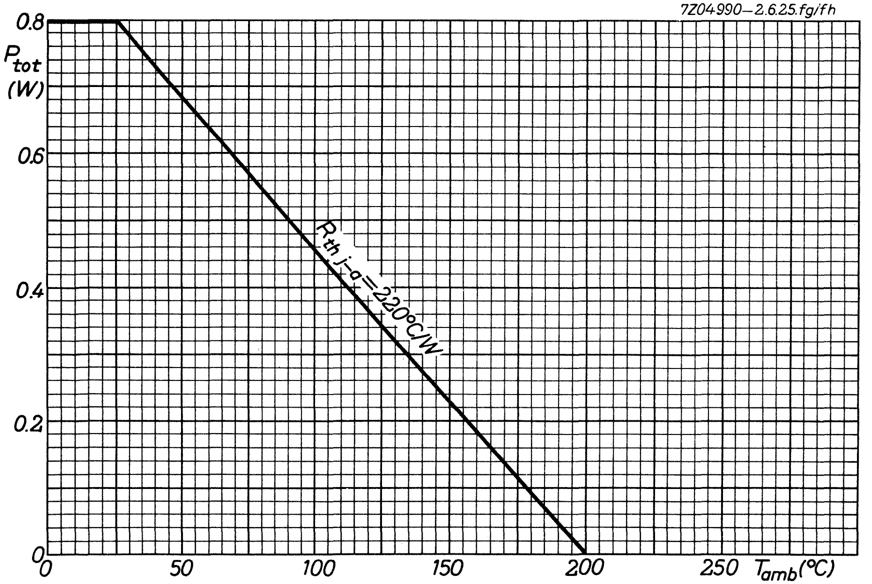

7Z04994
BFY67
h_{FE}
80
60
40
20
0
V_{CE}=10V
T_j =25°C
typ
min
0.01
0.1
1
10
100
I_C (mA)
1000

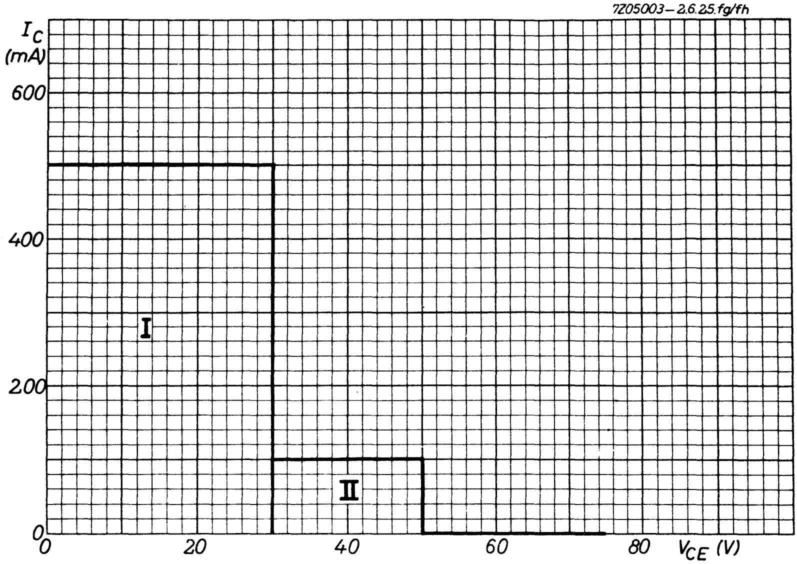

7Z04995
BFY68
h_{FE}
200
150
100
50
0
V_{CE}=10V
T_j =25°C
typ
min
0.01
0.1
1
10
100
I_C (mA)
1000


7Z05000–2.6.25.fg/fh
200
h_fe
150
100
50
0
1
50
10
50
I_C (mA)
100
typical values
f = 1kHz
T_j = 25°C
BFY 68
V_CE=10V
5V
BFY 67
10V
5V


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


7Z05002—2.6.2.5.fg/fh
F
(dB)
10
8
6
4
2
0
VCE = 10V
f = 1kHz
B = 200Hz
RS = 510 Ω
typ
typ
BFY 67
BFY 68
10
50
100
500
IC (μA)
1000


7Z04990—2.6.2.5.fg/fh
Ptot
(W)
0.8
0.6
0.4
0.2
0
Rth j-a = 220°C/W
0
50
100
150
200
250
Tamb (°C)



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

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

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

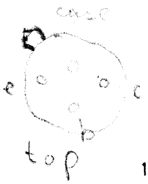
QUICK REFERENCE DATA

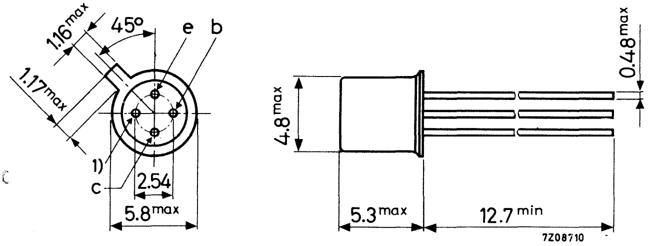
Collector-base voltage (open emitter; peak value)	V_{CBOM}	max.	30		V
Collector-emitter voltage (open base)	V_{CEO}	max.	15		V
Collector current (peak value; f > 1 MHz)	I_{CM}	max.	50		mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	200		mW
Junction temperature	T_j	max.	200		°C
Transition 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		f =	200	800	MHz
I_C = 2 mA; V_{CE} = 5 V	F	typ.	2.5	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 °C	P_{tot}	max.	200	mW

Temperatures

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

THERMAL RESISTANCE

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

---

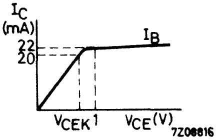
[1] Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

2) I_C = 10 mA

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current				
$I_E = 0$; $V_{CB} = 15$ V	I_{CBO}	<	10	nA
Knee voltage				
$I_C = 20$ mA; I_B = value for which $I_C = 22$ mA at $V_{CE} = 1$ V	V_{CEK}	<	0.75	V



D.C. current gain				
$I_C = 2$ mA; $V_{CE} = 1$ V	h_{FE}		25 to 150	
$I_C = 25$ mA; $V_{CE} = 1$ V	h_{FE}		20 to 125	
Transition frequency 1)				
$I_C = 2$ mA; $V_{CE} = 5$ V; f = 500 MHz	f_T	>	1.0	GHz
		typ.	1.1	GHz
$I_C = 25$ mA; $V_{CE} = 5$ V; f = 500 MHz	f_T	>	1.3	GHz
		typ.	1.4	GHz
Collector capacitance at f = 1 MHz 2)				
$I_E = I_e = 0$; $V_{CB} = 10$ V	C_c	<	1.5	pF
Feedback capacitance at f = 1 MHz 1)				
$I_C = 2$ mA; $V_{CE} = 5$ V	$-C_{re}$	typ.	0.6	pF
		<	0.8	pF
Noise figure 1)				
$I_C = 2$ mA; $V_{CE} = 5$ V				
f = 100 kHz; optimum source resistance	F	<	4	dB
f = 200 MHz; optimum source impedance	F	<	3.5	dB
f = 500 MHz; $R_S = 50\ \Omega$	F	<	5	dB
f = 800 MHz; optimum source impedance	F	typ.	5.5	dB

			f = 200	800	MHz
Power gain (not neutralized) 1) $I_C = 14$ mA; $V_{CE} = 10$ V; $T_{amb} = 25$ °C	G_p	>	21		dB
		typ.	23	8	dB

---

1) Shield lead grounded.

2) Shield lead not connected.

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

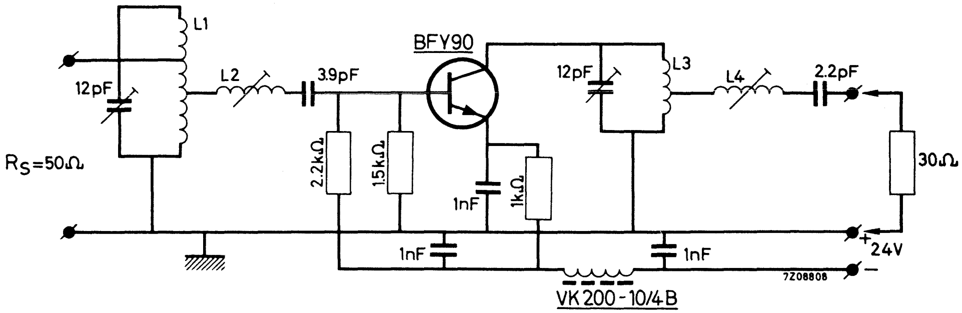
Intermodulation characteristics [1]

1. Output power at f = 200 MHz; T_{amb} = 25 °C

I_C = 14 mA; V_{CE} = 10 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	>	10	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:
$R_L = 560\ \Omega$; $C_L = -1.8$ pF

Adjustment procedure

1. Remove the transistor and connect a dummy consisting of a 560 Ω 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.

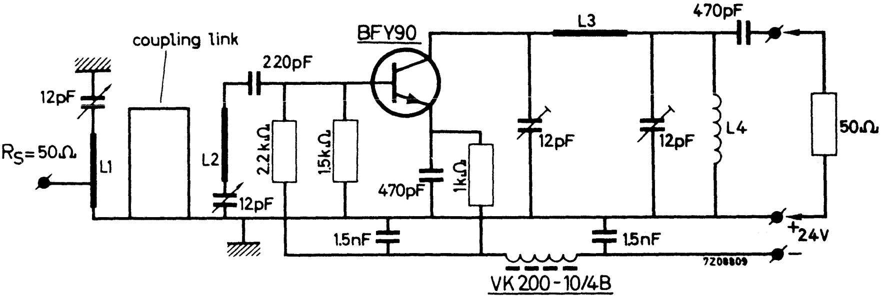
CHARACTERISTICS (continued) T_j = 25 °C unless otherwise specified

Intermodulation characteristics [1]

2. Output power at f = 800 MHz; T_{amb} = 25 °C

   I_C = 14 mA; V_{CE} = 10 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) 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 linearily 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 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 $\leq$ 2 over the whole channel.

---

[1] Shield lead grounded

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

Intermodulation characteristics [1]

3. Intermodulation distortion

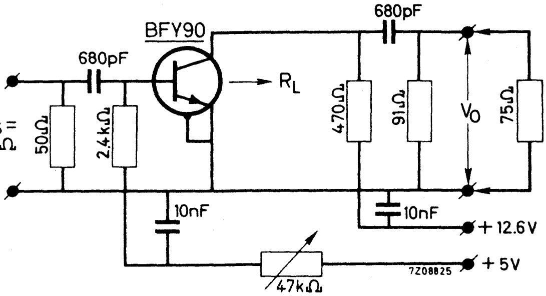
$I_C = 14$ mA; $V_{CE} = 6$ V; $R_L = 37.5\ \Omega$; $T_{amb} = 25\ ^{o}C$

$V_o = 100$ 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.	-50	dB

Test circuit:



y parameters at f = 500 MHz (common emitter) [1]

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

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

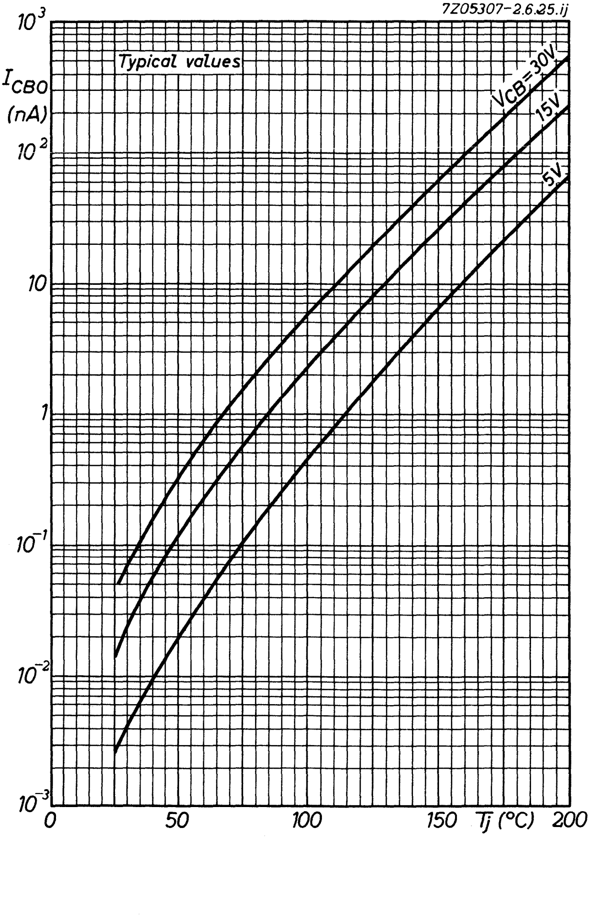
Maximum unilateralised power gain

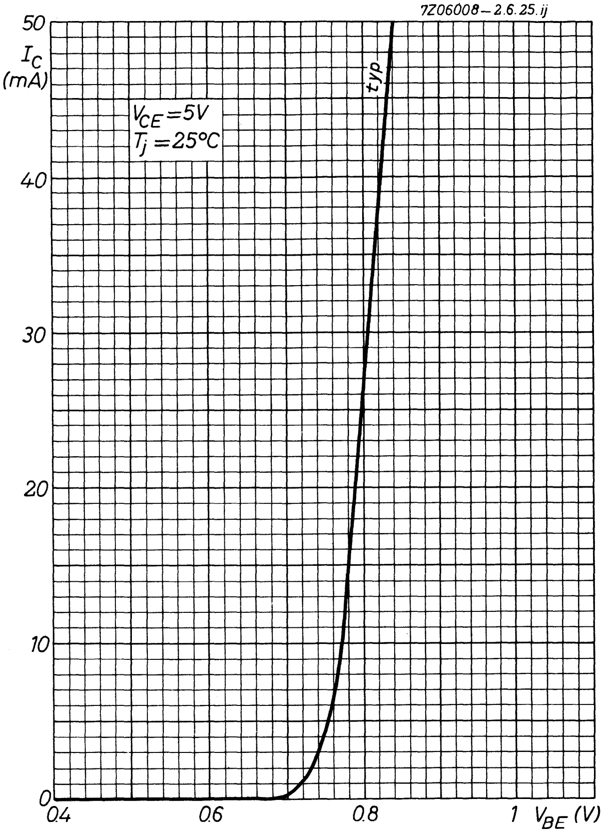
$$G_{UM} = \frac{|y_{fe}|^2}{4 g_{ie} g_{oe}}$$

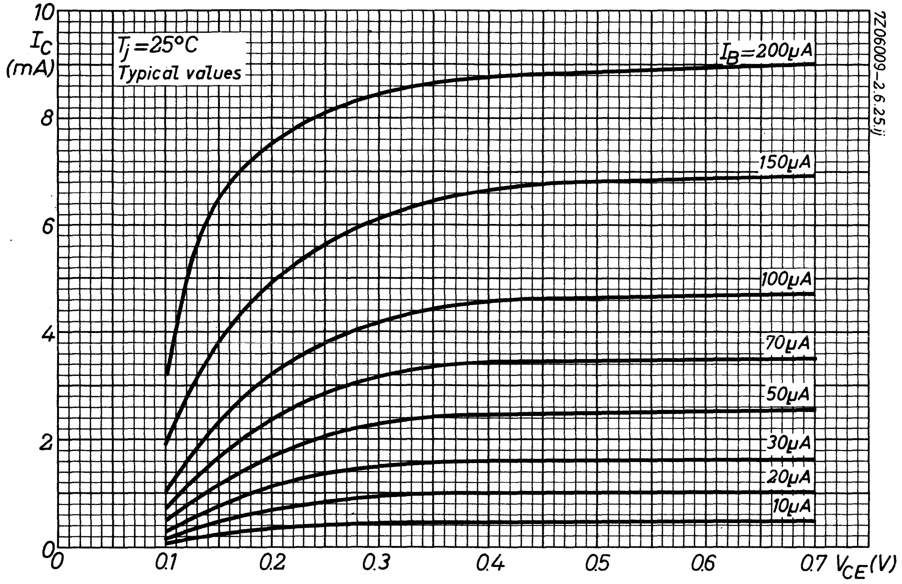
$I_C = 2$ mA; $V_{CE} = 5$ V; f = 500 MHz	G_{UM}	typ.	22	dB

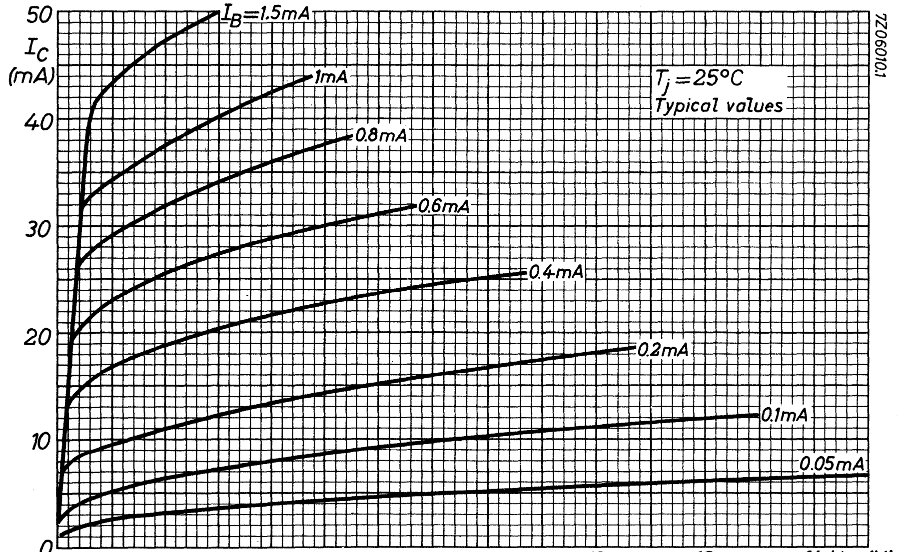
---

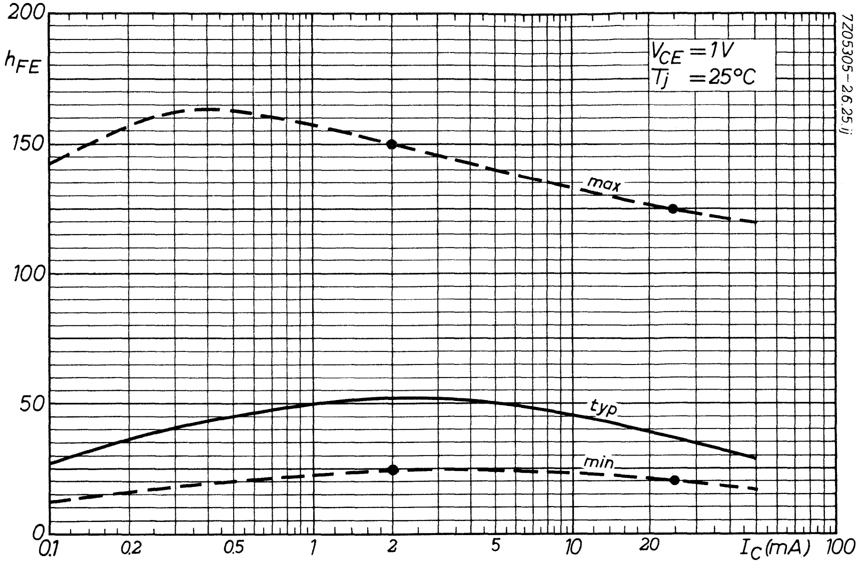
[1] Shield lead grounded

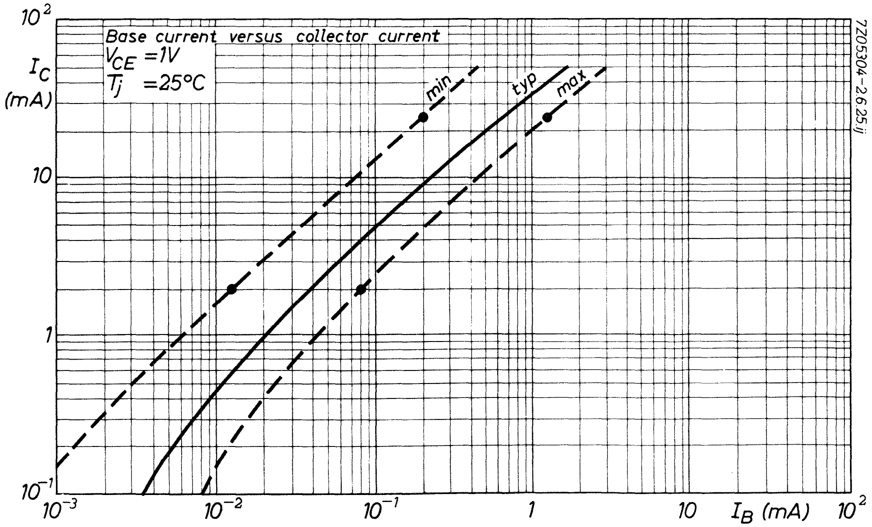

7Z05307-2.6.25.ij
Typical values
I_{CBO} (nA)
10^3
10^2
10
1
10^{-1}
10^{-2}
10^{-3}
V_{CB}=30V
15V
5V
0
50
100
150
T_j (°C)
200

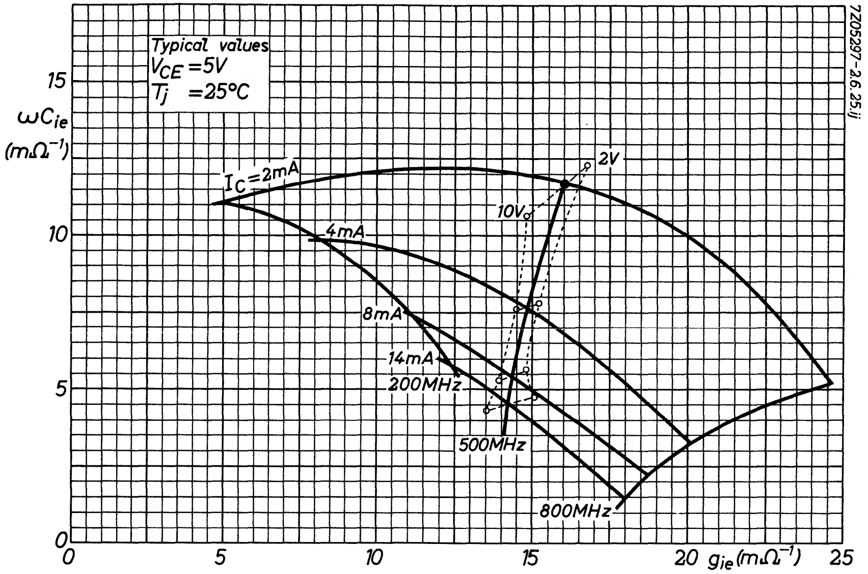

7Z06008 – 2.6.25.ij
50
I_C
(mA)
40
30
20
10
0
V_{CE} = 5V
T_j = 25°C
typ
0.4
0.6
0.8
1
V_{BE} (V)


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

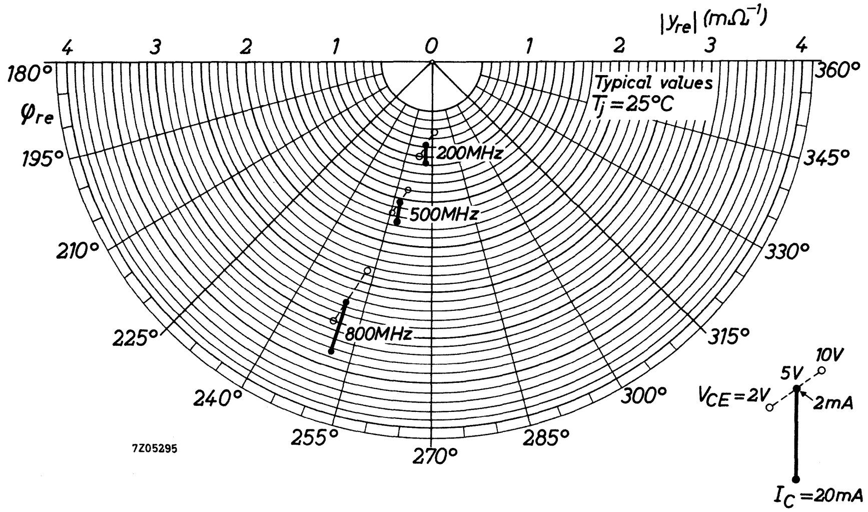

50
I_C
(mA)
40
30
20
10
0
$I_B = 1.5mA$
1mA
0.8mA
0.6mA
0.4mA
0.2mA
0.1mA
0.05mA
$T_j = 25°C$
Typical values
0
2
4
6
8
10
12
14 V_{CE} (V)
7Z06010.1


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

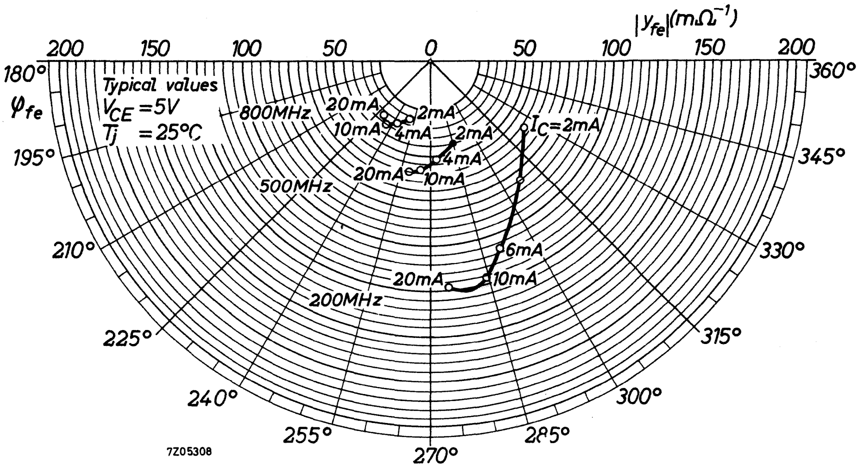

Base current versus collector current
V_{CE} = 1V
T_j = 25°C
10^2
I_C
(mA)
10
1
10^{-1}
10^{-3}
10^{-2}
10^{-1}
1
10
I_B (mA)
10^2
min
typ
max
7Z05304−2.6.25.ij

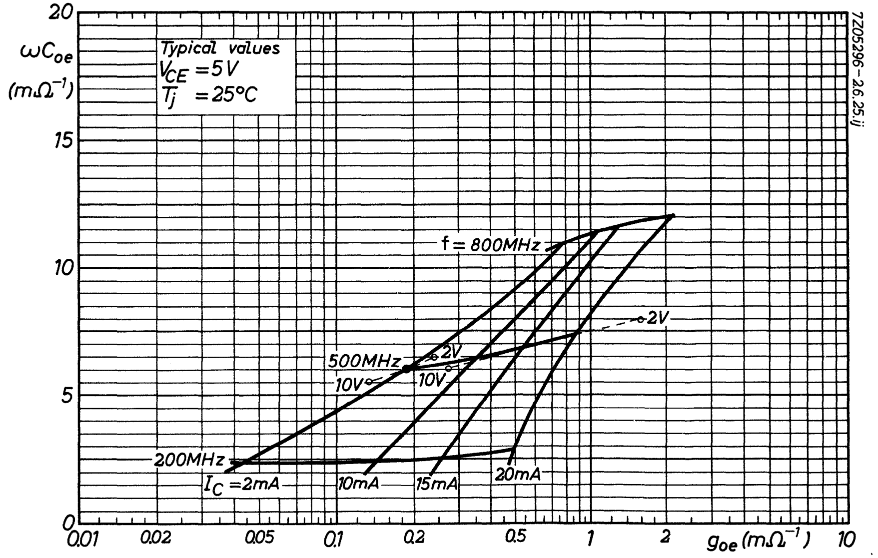


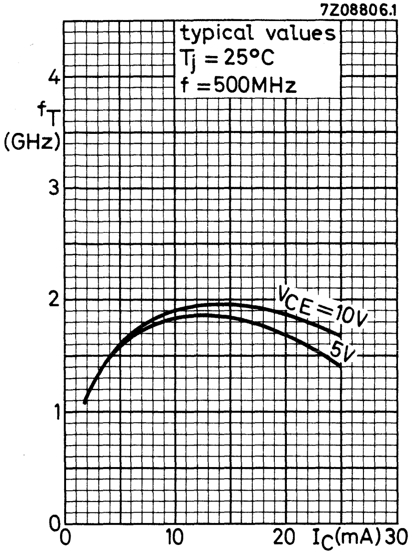
Typical values
V_CE = 5V
T_j = 25°C
15
10
5
0
ωC_ie (mΩ⁻¹)
0
5
10
15
20
25
g_ie (mΩ⁻¹)
I_C = 2mA
4mA
8mA
14mA
200MHz
500MHz
800MHz
10V
2V
7Z05297-2.6.25.ij

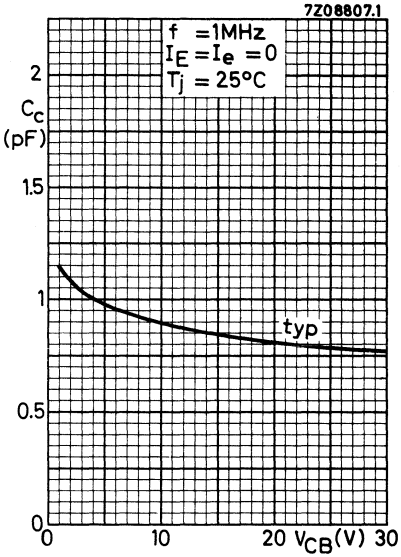


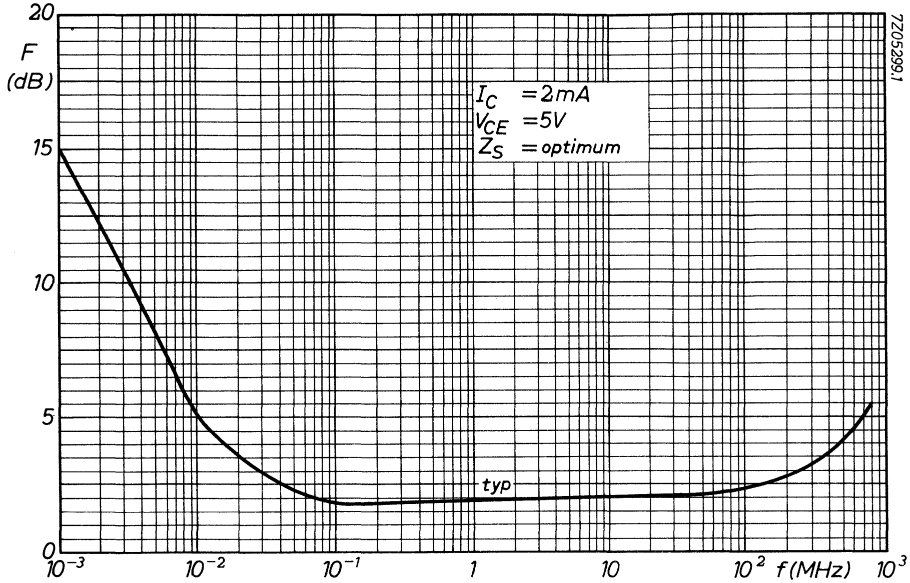
|y_re| (mΩ⁻¹)
4
3
2
1
0
1
2
3
4
180°
φ_re
195°
210°
225°
240°
255°
270°
285°
300°
315°
330°
345°
360°
Typical values
T_j = 25°C
200MHz
500MHz
800MHz
10V
5V
V_CE = 2V
2mA
I_C = 20mA
7Z05295

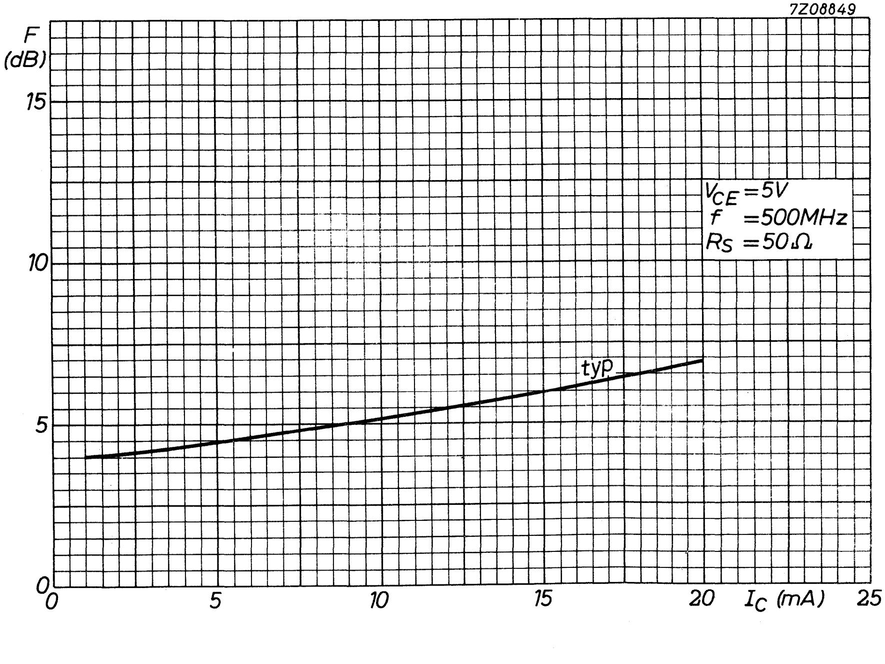

|y_fe| (mΩ⁻¹)
200
150
100
50
0
50
100
150
200
180°
195°
210°
225°
240°
255°
270°
285°
300°
315°
330°
345°
360°
φ_fe
Typical values
V_CE = 5V
T_j = 25°C
800MHz
20mA
10mA
4mA
2mA
500MHz
20mA
10mA
4mA
2mA
200MHz
20mA
10mA
6mA
I_C = 2mA
7Z05308


ωC_oe (mΩ⁻¹)
20
15
10
5
0
Typical values
V_CE = 5V
T_j = 25°C
f = 800MHz
500MHz
200MHz
2V
10V
2V
10V
2V
I_C = 2mA
10mA
15mA
20mA
0.01
0.02
0.05
0.1
0.2
0.5
1
2
10
g_oe (mΩ⁻¹)
7Z05296 - 2.6.25.ij


7Z08806.1
typical values
$T_j = 25°C$
f = 500MHz
f_T (GHz)
4
3
2
1
0
0
10
20
I_C(mA)
30
V_{CE} = 10V
5V


7Z08807.1
f = 1MHz
$I_E = I_e = 0$
$T_j = 25°C$
C_c (pF)
2
1.5
1
0.5
0
0
10
20
V_{CB}(V)
30
typ


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


7Z08849
F
(dB)
15
10
5
0
V_{CE} = 5V
f = 500MHz
R_S = 50Ω
typ
0
5
10
15
20
I_C (mA)
25

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	
Output power at							
$d_{im} = -30$ dB	150 2)	60	10	80			mW
$d_{im} = -50$ dB					25		mW
$d_{im} = -60$ dB						10	mW
Power gain	44	48	49	30	42.5	39	dB
Noise figure	6.3	5.7	5.5	7	6.0-6.5	6.2-6.7	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	30	50	30	30	Ω
Source impedance	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 $R_L = 60\ \Omega$.

GERMANIUM H.F. TRANSISTORS

P-N-P germanium transistor in all-glass construction. It is intended primarily for converter and mixer-oscillator applications.

RATINGS (Limiting values)

Voltages

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	15	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	5	V
Collector-emitter voltage with $R_{BE} < 1.5$ kΩ	$-V_{CER}$	max.	15	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	12	V

Currents

Collector current (d.c. or average over any 20 ms period)	$-I_C$	max.	5	mA
Collector current (peak value)	$-I_{CM}$	max.	10	mA

Power dissipation

Total power dissipation up to $T_{amb} = 25$ °C	P_{tot}	max.	85	mW

Temperatures

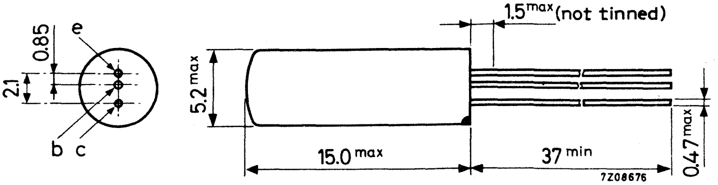
Storage temperature	T_{stg}		−55 to +75	°C
Junction temperature: continuous	T_j	max.	75	°C
incidentally	T_j	max.	90	°C

THERMAL RESISTANCE

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

MECHANICAL DATA

Dimensions in mm



The coloured dot indicates the collector

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

			OC44	OC45	
Collector cut-off currents					
$I_E = 0$; $-V_{CB} = 2$ V	$-I_{CBO}$	typ. <	0.5 2.0	0.5 2.0	µA µA
$I_E = 0$; $-V_{CB} = 15$ V	$-I_{CBO}$	<	10	10	µA
$I_B = 0$; $-V_{CE} = 2$ V	$-I_{CEO}$	typ. <	25 75	12 40	µA µA
Emitter cut-off current					
$I_C = 0$; $-V_{EB} = 2$ V	$-I_{EBO}$	typ. <	0.4 2.0	0.4 2.0	µA µA
$I_C = 0$; $-V_{EB} = 12$ V	$-I_{EBO}$	<	40	40	µA
Base-emitter voltage					
$-I_C = 1$ mA; $-V_{CE} = 6$ V	$-V_{BE}$	typ.	150 125 to 185	170 145 to 195	mV mV
Collector-base capacitance at f = 450 kHz					
$-I_C = 1$ mA; $-V_{CE} = 6$ V	$C_{b'c}$	typ.	10.5 7 to 14	10.5 7 to 14	pF pF
Small signal current gain at f = 1 kHz					
$-I_C = 1$ mA; $-V_{CE} = 6$ V	h_{fe}	typ.	100 45 to 225	50 25 to 125	
Cut-off frequency					
$I_E = 1$ mA; $-V_{CB} = 6$ V	f_{hfb}	> typ.	7.5 15	3 12	MHz MHz
Base-resistance at f = 450 kHz					
$-I_C = 1$ mA; $-V_{CE} = 6$ V	$r_{bb'}$	typ. <	110 250	75 200	Ω Ω
y parameters at f = 450 kHz (common emitter)					
$-I_C = 1$ mA; $-V_{CE} = 6$ V					
Input conductance	g_{ie}	typ.	0.6	1	$m\Omega^{-1}$
Input capacitance	C_{ie}	typ.	500	800	pF
Feedback admittance	$\lvert y_{re} \rvert$	typ.	20	20	$\mu\Omega^{-1}$
Transfer admittance	$\lvert y_{fe} \rvert$	typ.	30	28	$m\Omega^{-1}$
Output conductance	g_{oe}	typ.	25	20	$\mu\Omega^{-1}$
Output capacitance	C_{oe}	typ.	40	40	pF

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.

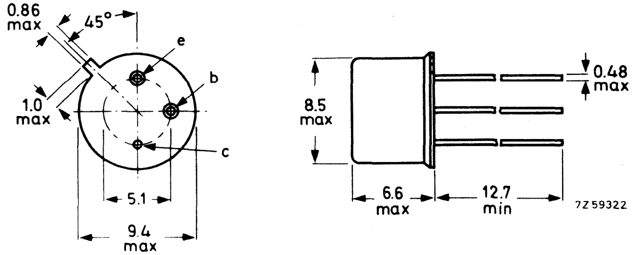
QUICK REFERENCE DATA

Collector-base voltage (open emitter)	V_{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 $T_{amb} = 25\,^{o}C$	P_{tot}	max.	0.8	W
Junction temperature	T_j	max.	200	^{o}C
D.C. current gain				
$I_C = 0.1$ mA; $V_{CE} = 10$ V	h_{FE}	>	20	
$I_C = 10$ mA; $V_{CE} = 10$ V	h_{FE}	>	35	
$I_C = 150$ mA; $V_{CE} = 10$ V	h_{FE}		40 to 120	
Transition frequency				
$I_C = 50$ mA; $V_{CE} = 10$ V	f_T	>	60	MHz

MECHANICAL DATA Dimensions in mm

Collector connected to case

TO-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.	75	V
Collector-emitter voltage ($R_{BE} < 10\,\Omega$)	V_{CER}	max.	50	V
Emitter-base voltage (open collector)	V_{EBO}	max.	7	V

Current

Collector current (peak value)	I_{CM}	max.	1	A

Power dissipation

Total power dissipation up to $T_{amb} = 25\ ^{o}C$	P_{tot}	max.	0.8	W
up to $T_{case} = 100\ ^{o}C$	P_{tot}	max.	1.7	W
up to $T_{case} = 25\ ^{o}C$	P_{tot}	max.	3.0	W

Temperatures

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

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\,j\text{-}a}$	=	220	$^{o}C/W$
From junction to case	$R_{th\,j\text{-}c}$	=	58	$^{o}C/W$

---

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

CHARACTERISTICS

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

Collector cut-off current

$I_E = 0$; $V_{CB} = 60$ V	I_{CBO}	<	10	nA
$I_E = 0$; $V_{CB} = 60$ V; $T_{amb} = 150$ °C	I_{CBO}	<	10	μA

Emitter cut-off current

$I_C = 0$; $V_{EB} = 5$ V	I_{EBO}	<	10	nA

Collector-emitter sustaining voltage

$I_C = 100$ mA; $R_{BE} < 10\ \Omega$	$V_{CERsust}$	>	50	V [1]

Saturation voltages

$I_C = 150$ mA; $I_B = 15$ mA	V_{CEsat}	<	1.5	V [1]
	V_{BEsat}	<	1.3	V [1]

D.C. current gain

$I_C = 0.1$ mA; $V_{CE} = 10$ V	h_{FE}	>	20	
$I_C = 10$ mA; $V_{CE} = 10$ V	h_{FE}	>	35	[1]
$I_C = 150$ mA; $V_{CE} = 10$ V	h_{FE}		40 to 120	[1]
$I_C = 500$ mA; $V_{CE} = 10$ V	h_{FE}	>	20	[1]
$I_C = 10$ mA; $V_{CE} = 10$ V; $T_{amb} = -55$ °C	h_{FE}	>	20	

h parameters at f = 1 kHz

$-I_E = 1$ mA; $V_{CB} = 5$ V				
Input impedance	h_{ib}		24 to 34	Ω
Reverse voltage transfer	h_{rb}	<	3	10^{-4}
Output admittance	h_{ob}		0.1 to 0.5	$\mu\Omega^{-1}$
$-I_E = 5$ mA; $V_{CB} = 10$ V				
Input impedance	h_{ib}		4 to 8	Ω
Reverse voltage transfer	h_{rb}	<	3	10^{-4}
Output admittance	h_{ob}		0.1 to 1.0	$\mu\Omega^{-1}$
Small signal current gain				
$I_C = 1$ mA; $V_{CE} = 5$ V	h_{fe}		30 to 100	
$I_C = 5$ mA; $V_{CE} = 10$ V	h_{fe}		35 to 150	

---

[1] Measured under pulse conditions to avoid excessive dissipation. Pulse duration $t < 300\ \mu$s, duty cycle $\delta < 0.01$

CHARACTERISTICS (continued) $T_{amb} = 25\ ^{o}C$ unless otherwise specified

Transition frequency				
$I_C = 50$ mA; $V_{CE} = 10$ V	f_T	>	60	MHz
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; $V_{CB} = 10$ V	C_c	<	25	pF
Emitter capacitance at f = 1 MHz				
$I_C = I_c = 0$; $V_{EB} = 0.5$ V	C_e	<	80	pF
Noise figure at f = 1 kHz				
$I_C = 0.3$ mA; $V_{CE} = 10$ V $R_S = 510\ \Omega$; Bandwidth: 200 Hz	F	<	12	dB

SILICON PLANAR TRANSISTOR

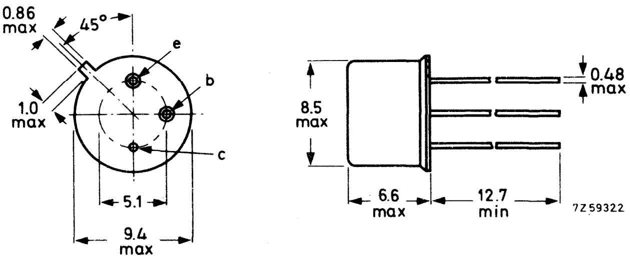
N-P-N double diffused transistor in a TO-39 metal envelope with the collector connected to the case. The 2N1711 is intended for use in a wide variety of applications, such as d.c. and high frequency amplifiers and switching applications.

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 $T_{amb} = 25\,^{o}C$	P_{tot}	max.	0.8	W
Junction temperature	T_j	max.	200	^{o}C
D.C. current gain				
$I_C = 0.1$ mA; $V_{CE} = 10$ V	h_{FE}	>	35	
$I_C = 10$ mA; $V_{CE} = 10$ V	h_{FE}	>	75	
$I_C = 150$ mA; $V_{CE} = 10$ V	h_{FE}	100 to 300		
Transition frequency				
$I_C = 50$ mA; $V_{CE} = 10$ V	f_T	>	70	MHz

MECHANICAL DATA Dimensions in mm

Collector connected to case

TO-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.	75	V
Collector-emitter voltage ($R_{BE} < 10\,\Omega$)	V_{CER}	max.	50	V
Emitter-base voltage (open collector)	V_{EBO}	max.	7	V

Current

Collector current (peak value)	I_{CM}	max.	1	A

Power dissipation

Total power dissipation up to $T_{amb} = 25\,^{o}C$	P_{tot}	max.	0.8	W
up to $T_{case} = 100\,^{o}C$	P_{tot}	max.	1.7	W
up to $T_{case} = 25\,^{o}C$	P_{tot}	max.	3.0	W

Temperatures

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

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\,j\text{-}a}$	=	220	$^{o}C/W$
From junction to case	$R_{th\,j\text{-}c}$	=	58	$^{o}C/W$

---

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

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

Collector cut-off current				
$I_E = 0$; $V_{CB} = 60$ V	I_{CBO}	$<$	10	nA
$I_E = 0$; $V_{CB} = 60$ V; $T_{amb} = 150$ °C	I_{CBO}	$<$	10	μA
Emitter cut-off current				
$I_C = 0$; $V_{EB} = 5$ V	I_{EBO}	$<$	5	nA
Collector-emitter sustaining voltage				
$I_C = 100$ mA; $R_{BE} < 10\ \Omega$	$V_{CERsust}$	$>$	50	V [1]
Saturation voltages				
$I_C = 150$ mA; $I_B = 15$ mA	V_{CEsat}	$<$	1.5	V [1]
	V_{BEsat}	$<$	1.3	V [1]
D.C. current gain				
$I_C = 10\ \mu$A; $V_{CE} = 10$ V	h_{FE}	$>$	20	
$I_C = 0.1$ mA; $V_{CE} = 10$ V	h_{FE}	$>$	35	
$I_C = 10$ mA; $V_{CE} = 10$ V	h_{FE}	$>$	75	[1]
$I_C = 150$ mA; $V_{CE} = 10$ V	h_{FE}		100 to 300	[1]
$I_C = 500$ mA; $V_{CE} = 10$ V	h_{FE}	$>$	40	[1]
$I_C = 10$ mA; $V_{CE} = 10$ V; $T_{amb} = -55$ °C	h_{FE}	$>$	35	
h parameters at f = 1 kHz				
$-I_E = 1$ mA; $V_{CB} = 5$ V				
Input impedance	h_{ib}		24 to 34	Ω
Reverse voltage transfer	h_{rb}	$<$	5	10^{-4}
Output admittance	h_{ob}		0.1 to 0.5	$\mu\Omega^{-1}$
$-I_E = 5$ mA; $V_{CB} = 10$ V				
Input impedance	h_{ib}		4 to 8	Ω
Reverse voltage transfer	h_{rb}	$<$	5	10^{-4}
Output admittance	h_{ob}		0.1 to 1.0	$\mu\Omega^{-1}$
Small signal current gain				
$I_C = 1$ mA; $V_{CE} = 5$ V	h_{fe}		50 to 200	
$I_C = 5$ mA; $V_{CE} = 10$ V	h_{fe}		70 to 300	

---

1) Measured under pulse conditions to avoid excessive dissipation. Pulse duration $t < 300\ \mu$s, duty cycle $\delta < 0.01$

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

Transition frequency				
I_C = 50 mA; V_{CE} = 10 V	f_T	>	70	MHz
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; V_{CB} = 10 V	C_c	<	25	pF
Emitter capacitance at f = 1 MHz				
$I_C = I_c = 0$; V_{EB} = 0.5 V	C_e	<	80	pF
Noise figure at f = 1 kHz				
I_C = 0.3 mA; V_{CE} = 10 V R_S = 510 Ω; Bandwidth: 200 Hz	F	<	8	dB

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

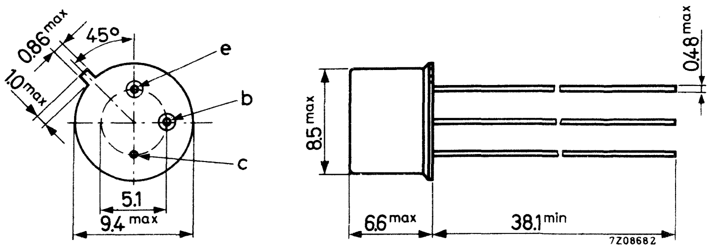
Collector-base voltage (open emitter)	V_{CBO}	max.	120	V
Collector-emitter voltage ($R_{BE} \leq 10\ \Omega$)	V_{CER}	max.	100	V
Collector current (d.c.)	I_C	max.	500	mA
Total power dissipation up to T_{case} = 25 °C	P_{tot}	max.	3.0	W
Junction temperature	T_j	max.	200	°C
D.C. current gain				
I_C = 0.1 mA; V_{CE} = 10 V	h_{FE}	>	20	
I_C = 10 mA; V_{CE} = 10 V; T = −55 °C	h_{FE}	>	20	
I_C = 10 mA; V_{CE} = 10 V	h_{FE}	>	35	
I_C = 150 mA; V_{CE} = 10 V	h_{FE}	40 to	120	

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

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	$R_{th\ j-a}$	=	219	°C/W
From junction to case	$R_{th\ j-c}$	=	58.3	°C/W

---

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

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

Collector cut-off current

$I_E = 0$; $V_{CB} = 90$ V	I_{CBO}	<	10	nA
$I_E = 0$; $V_{CB} = 90$ V; $T_{amb} = 150$ °C	I_{CBO}	<	15	μA

Emitter cut-off current

$I_C = 0$; $V_{EB} = 5$ V	I_{EBO}	<	10	nA

Collector-emitter sustaining voltage ¹)

$I_C = 100$ mA; $R_{BE} \geq 10\ \Omega$	$V_{CER\ sust}$	>	100	V
$I_C = 30$ mA; $I_B = 0$	$V_{CEO\ sust}$	>	80	V

Saturation voltages ¹)

$I_C = 150$ mA; $I_B = 15$ mA	$V_{CE\ sat}$	<	5.0	V
	$V_{BE\ sat}$	<	1.3	V
$I_C = 50$ mA; $I_B = 5$ mA	$V_{CE\ sat}$	<	1.2	V
	$V_{BE\ sat}$	<	0.9	V

Breakdown voltages

$I_E = 0$; $I_C = 100\ \mu$A	$V_{(BR)\ CBO}$	>	120	V
$I_C = 0$; $I_E = 100\ \mu$A	$V_{(BR)\ EBO}$	>	7.0	V

D.C. current gain

$I_C = 0.1$ mA; $V_{CE} = 10$ V	h_{FE}	>	20
$I_C = 10$ mA; $V_{CE} = 10$ V; $T = -55$ °C	h_{FE}	>	20
$I_C = 10$ mA; $V_{CE} = 10$ V ¹)	h_{FE}	>	35
$I_C = 150$ mA; $V_{CE} = 10$ V ¹)	h_{FE}	40 to	120

---

¹) Measured under pulsed conditions to avoid excessive dissipation.
Pulse duration $t \leq 300\ \mu$s, duty cycle $\delta < 0.02$

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

h parameters at f = 1 kHz (common base)			
I_C = 1 mA; V_{CE} = 5 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 mA; V_{CE} = 10 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 mA; V_{CE} = 5 V; f = 1 kHz	h_{fe}	30 to 100	
I_C = 5 mA; V_{CE} = 10 V; f = 1 kHz	h_{fe}	> 45	
I_C = 50 mA; V_{CE} = 10 V; f = 20 MHz	h_{fe}	> 2.5	
Collector capacitance			
$I_E = I_e = 0$; V_{CB} = 10 V	C_c	< 15	pF
Emitter capacitance			
$I_C = I_c = 0$; V_{EB} = 0.5 V	C_e	< 85	pF

SILICON PLANAR EPITAXIAL TRANSISTOR

N-P-N transistor in a TO-39 metal envelope with the collector connected to the case. It is primarily intended for use in high frequency and very high frequency oscillators and amplifiers as well as for output stages of servo amplifiers.

RATINGS (Limiting values)

Voltages

Collector-base voltage (open emitter)	V_{CBO}	max.	80	V
Collector-emitter voltage (open base)	V_{CEO}	max.	35	V
Emitter-base voltage (open collector)	V_{EBO}	max.	7	V

Current

Collector current (d.c. or average over any 20 ms period)	I_C	max.	1	A

Power dissipation

Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	0.8	W
up to T_{case} = 100 °C	P_{tot}	max.	2.8	W
up to T_{case} = 25 °C	P_{tot}	max.	5.0	W

Temperatures

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

THERMAL RESISTANCE

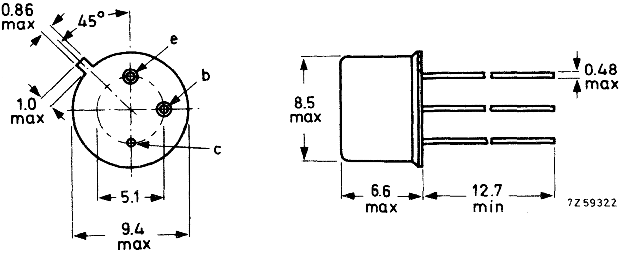
From junction to ambient in free air	$R_{th\,j\text{-}a}$	=	0.22	°C/mW
From junction to case	$R_{th\,j\text{-}c}$	=	0.035	°C/mW

MECHANICAL DATA

Dimensions in mm

Collecter connected to case

TO-39



max. lead diameter is guaranteed only for 12.7 mm

Accessories available: 56218, 56245, 56265

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

Collector cut-off current				
$I_E = 0$; $V_{CB} = 60$ V	I_{CBO}	<	10	nA
$I_E = 0$; $V_{CB} = 60$ V; $T_{amb} = 150$ °C	I_{CBO}	<	10	µA
Emitter cut-off current				
$I_C = 0$; $V_{EB} = 5$ V	I_{EBO}	<	10	nA
Sustaining voltage				
$I_C = 30$ mA; $I_B = 0$ 2)	$V_{CEOsust}$	>	35	V
Saturation voltages				
$I_C = 150$ mA; $I_B = 15$ mA	V_{CEsat}	<	0.2	V
$I_C = 1$ A; $I_B = 100$ mA 1)2)	V_{CEsat} V_{BEsat}	< <	1.0 1.6	V V
D.C. current gain 2)				
$I_C = 10$ mA; $V_{CE} = 10$ V	h_{FE}	>	30	
$I_C = 150$ mA; $V_{CE} = 10$ V	h_{FE}	40 to	120	
$I_C = 1$ A; $V_{CE} = 10$ V	h_{FE}	>	15	
Feedback time constant				
$I_C = 10$ mA; $V_{CB} = 10$ V; f = 4 MHz	$r_{b'}C_c$	<	800	ps
Collector capacitance at f = 500 kHz				
$I_E = I_e = 0$; $V_{CB} = 10$ V	C_c	<	12	pF
Emitter capacitance at f = 500 kHz				
$I_C = I_c = 0$; $V_{EB} = 0.5$ V	C_e	<	80	pF
Transition frequency				
$I_C = 50$ mA; $V_{CE} = 10$ V	f_T	>	60	MHz

---

1) Measured with a lead length of 1 cm.

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

SILICON PLANAR TRANSISTORS

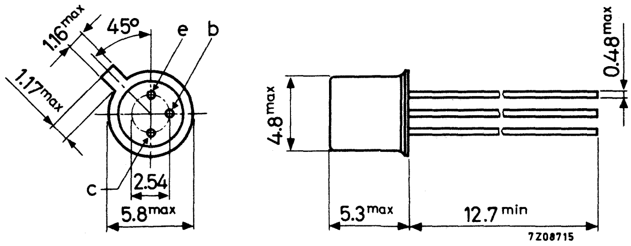
N-P-N transistors in a TO-18 metal envelope with the collector connected to the case.
These transistors are primarily intended for use in high performance, low level, low noise amplifier applications both for d.c. and frequencies up to 100 MHz.

QUICK REFERENCE DATA

			2N2483	2N2484	
Collector-base voltage (open emitter)	V_{CBO}	max.	60	60	V
Collector-emitter voltage (open base)	V_{CEO}	max.	60	60	V
Collector current (peak value)	I_{CM}	max.	50	50	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	360	360	mW
Junction temperature	T_j	max.	200	200	°C
D.C. current gain at T_j = 25 °C					
I_C = 10 μA ; V_{CE} = 5 V	h_{FE}		40 to 120	100 to 500	
I_C = 1 mA; V_{CE} = 5 V	h_{FE}	>	175	250	
I_C = 10 mA; V_{CE} = 5 V	h_{FE}	<	500	800	
Transition frequency					
I_C = 0.5 mA; V_{CE} = 5 V	f_T	typ.	80	80	MHz
Noise figure					
I_C = 10 μA; V_{CE} = 5 V; R_S = 10 kΩ					
Bandwidth: 15.7 kHz	F	<	4	3	dB

MECHANICAL DATA Dimensions in mm

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_{EBO}	max.	6	V

Currents

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

Power dissipation

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

Temperatures

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

THERMAL RESISTANCE

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

---

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

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current				
$I_E = 0$; $V_{CB} = 45$ V	I_{CBO}	<	10	nA
$I_E = 0$; $V_{CB} = 45$ V; $T_j = 150$ °C	I_{CBO}	<	10	μA
Emitter cut-off current				
$I_C = 0$; $V_{EB} = 5$ V	I_{EBO}	<	10	nA
Base-emitter voltage				
$I_C = 0.1$ mA; $V_{CE} = 5$ V	V_{BE}		0.5 to 0.7	V
Collector-emitter saturation voltage				
$I_C = 1$ mA; $I_B = 0.1$ mA	V_{CEsat}	<	350	mV

			2N2483	2N2484	
D.C. current gain					
$I_C = 1$ μA; $V_{CE} = 5$ V	h_{FE}	>		30	
$I_C = 10$ μA; $V_{CE} = 5$ V	h_{FE}		40 to 120	100 to 500	
$I_C = 10$ μA; $V_{CE} = 5$ V; $T_j = 55$ °C	h_{FE}	>	10	20	
$I_C = 100$ μA; $V_{CE} = 5$ V	h_{FE}	>	75	175	
$I_C = 500$ μA; $V_{CE} = 5$ V	h_{FE}	>	100	200	
$I_C = 1$ mA; $V_{CE} = 5$ V	h_{FE}	>	175	250	
$I_C = 10$ mA; $V_{CE} = 5$ V [1]	h_{FE}	<	500	800	
Collector capacitance at f = 1 MHz					
$I_E = I_e = 0$; $V_{CB} = 5$ V	C_c	<	6	6	pF
Emitter capacitance at f = 1 MHz					
$I_C = I_c = 0$; $V_{EB} = 0.5$ V	C_e	<	6	6	pF
Transition frequency					
$I_C = 50$ μA; $V_{CE} = 5$ V	f_T	>	12	15	MHz
$I_C = 500$ μA; $V_{CE} = 5$ V	f_T	>	60	60	MHz
		typ.	80	80	MHz

---

[1] Measured under pulsed conditions to prevent excessive dissipation. Pulse duration t < 300 μs; duty cycle $\delta < 0.01$

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

			2N2483	2N2484	
Noise figure					
I_C = 10 μA; V_{CE} = 5 V; R_S = 10 kΩ					
f = 100 Hz; bandwidth 20 Hz	F	<	15	10	dB
f = 1 kHz; bandwidth 200 Hz	F	<	4	3	dB
f = 10 kHz; bandwidth 2 kHz	F	<	3	2	dB
Wide band: bandwidth 15.7 kHz	F	<	4	3	dB
h parameters at f = 1 kHz					
I_C = 1 mA; V_{CE} = 5 V					
Input impedance	h_{ie}		1.5 to 13	3.5 to 24	kΩ
Reverse voltage transfer	h_{re}	<	8	8	10^{-4}
Small signal current gain	h_{fe}		80 to 450	150 to 900	
Output admittance	h_{oe}	<	30	40	$\mu\Omega^{-1}$

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			2N3570	2N3571	2N3572	
Collector-base voltage (open emitter)	V_{CBO}	max.	30	25	25	V
Collector-emitter voltage (open base) I_C = 15 mA	V_{CEO}	max.	15	15	13	V
Emitter-base voltage (open collector)	V_{EBO}	max.	3	3	3	V

Current

Collector current (d.c.)	I_C	max.	50	mA

Power dissipation

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

Temperatures

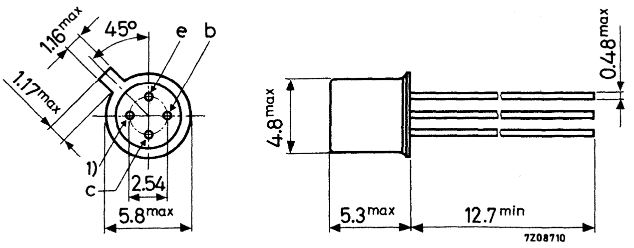
Storage temperature	T_{stg}		−65 to +200	°C
Junction temperature	T_j	max.	200	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$ =	0.88	°C/mW
From junction to case	$R_{th\ j-c}$ =	0.50	°C/mW

MECHANICAL DATA Dimensions in mm

Insulated electrodes
TO-72



1) = shield lead (connected to case)

Accessories available: 56246, 56263

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

The shield lead is grounded for all measurements except for C_{re}

			2N3570	2N3571	2N3572	
Collector cut-off current						
$I_E = 0$; $V_{CB} = 6$ V	I_{CBO}	<	10	10	10	nA
$I_E = 0$; $V_{CB} = 6$ V; $T_j = 150$ °C	I_{CBO}	<	1	1	1	μA
D.C. current gain						
$I_C = 5$ mA; $V_{CE} = 6$ V	h_{FE}	>	20	20	20	
		<	150	200	300	
Small signal current gain						
$I_C = 5$ mA; $V_{CE} = 6$ V; f = 1 kHz	h_{fe}	>	20	20	20	
		<	200	250	350	
Collector-base time constant						
$-I_E = 5$ mA; $V_{CB} = 6$ V; f = 10.7 MHz	$r_{bb'}C_{b'c}$	>	1	1	1	ps
		<	8	10	13	ps
Feedback capacitance						
$I_E = 0$; $V_{CB} = 6$ V; f = 1 MHz	$-C_{re}$	<	0.75	0.85	0.85	pF
Transition frequency						
$I_C = 5$ mA; $V_{CE} = 6$ V	f_T	>	1.5	1.2	1.0	GHz
		<	2.4	2.4	2.4	GHz
Noise figure						
$-I_E = 2$ mA; $V_{CB} = 6$ V						
f = 1 GHz; $R_S = 50\ \Omega$	F	<	7			dB
f = 450 MHz; $R_S = 100\ \Omega$	F	<		4	6	dB

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.

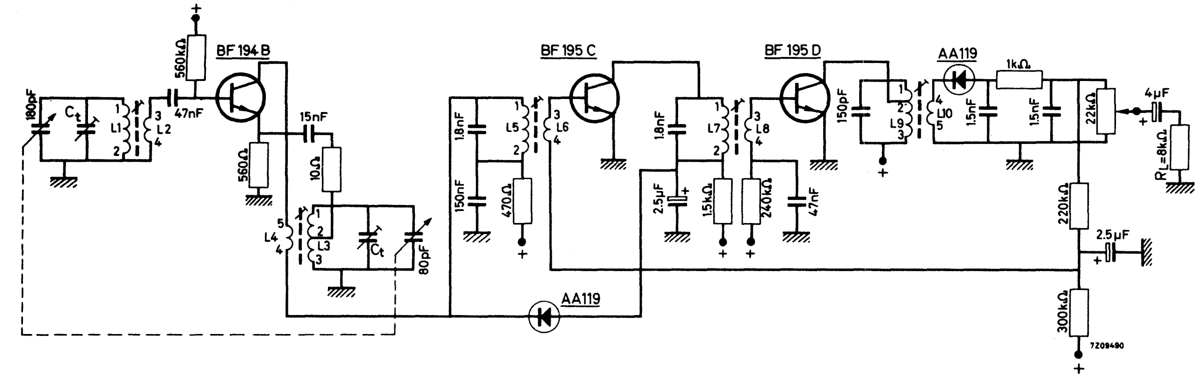
QUICK REFERENCE DATA

Base current				
I_C = 1 mA; V_{CE} = 10 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 mA; V_{CE} = 10 V				
G_S = 1.0 mΩ^{-1}; f = 1 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; Q_0 at f = 1 MHz : 120

Voltage ratio $\frac{n_{3-4}}{n_{1-2}}$: $5.7x10^{-2}$

L3 = 260 µH; Q_0 at f = 1.2 MHz : 120

Voltage ratio $\frac{n_{2-3}}{n_{1-3}}$: $3x10^{-2}$

Voltage ratio $\frac{n_{4-5}}{n_{1-3}}$: $5.4x10^{-2}$

L5 = L7 = 69 µH; Q_0 at f = 0.45 MHz : 80

Voltage ratio $\frac{n_{3-4}}{n_{1-2}}$: $7.35x10^{-2}$

L9 = 800 µH; Q_0 at f = 0.45 MHz : 110

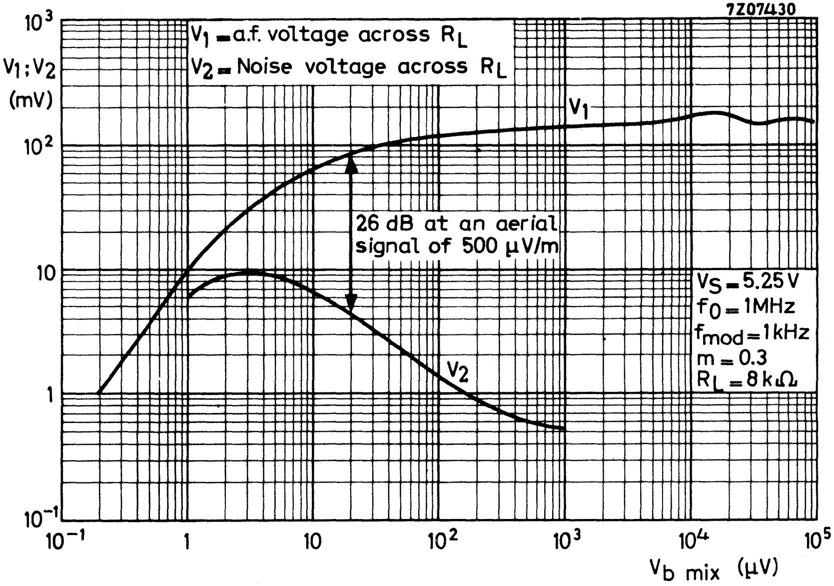
Voltage ratio $\frac{n_{2-3}}{n_{1-3}}$: $41.5x10^{-2}$

Voltage ratio $\frac{n_{4-5}}{n_{1-3}}$: $59.2x10^{-2}$

PERFORMANCE at f = 1 MHz; T_{amb} = 25 °C

Supply voltage (from 6 V, via a RC-smoothing filter)	V_S	=	5.25	V
Total current drain	I_{tot}	=	3	mA
Gain spread of the h.f. part	Δ_G	=	±3.6	dB
Signal handling capability d_{tot} = 10%; m = 0.8		≥	2	V/m

Sensitivity		
Signal to obtain V_o = 10 mV across R_L = 8 kΩ	25	μV/m
Signal to obtain 26 dB signal/noise ratio	500	μV/m
Decrease of sensitivity at $V_S \approx 3.2$ V	15	dB



CHARACTERISTICS

y parameters (common emitter)

I_C = 1 mA; V_{CE} = 10 V (lead length = 3 mm)

				f = 10.7 MHz	f = 0.45 MHz	
Input conductance	BF194B :	g_{ie}	$<$	0.5	0.4	$m\Omega^{-1}$
	BF195C :	g_{ie}	$<$	0.64	0.54	$m\Omega^{-1}$
	BF195D :	g_{ie}	$<$	0.95	0.85	$m\Omega^{-1}$
Output conductance	BF194B :	g_{oe}	typ.	10	6.5	$\mu\Omega^{-1}$
			$<$	13.5	11.5	$\mu\Omega^{-1}$
	BF195C :	g_{oe}	typ.	6.5	4	$\mu\Omega^{-1}$
			$<$	9.5	7	$\mu\Omega^{-1}$
	BF195D :	g_{oe}	typ.	4	2	$\mu\Omega^{-1}$
			$<$	9.5	7	$\mu\Omega^{-1}$

PACKAGE FOR COLOUR DIFFERENCE AMPLIFIERS

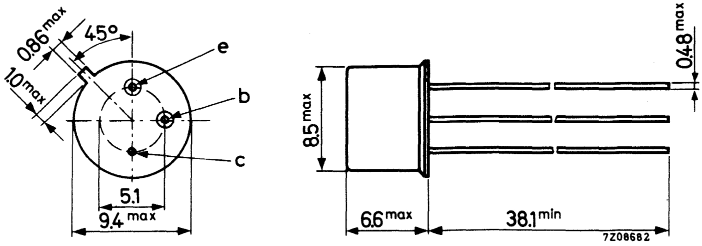
The package 40822 consists of three n-p-n silicon planar transistors BF179A; BF179B and BF179C, intended for application in colour difference amplifiers of television receivers.
The BF179A is meant for the G-Y amplifier,
the BF179B for the R-Y amplifier and
the BF179C for the B-Y amplifier.

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

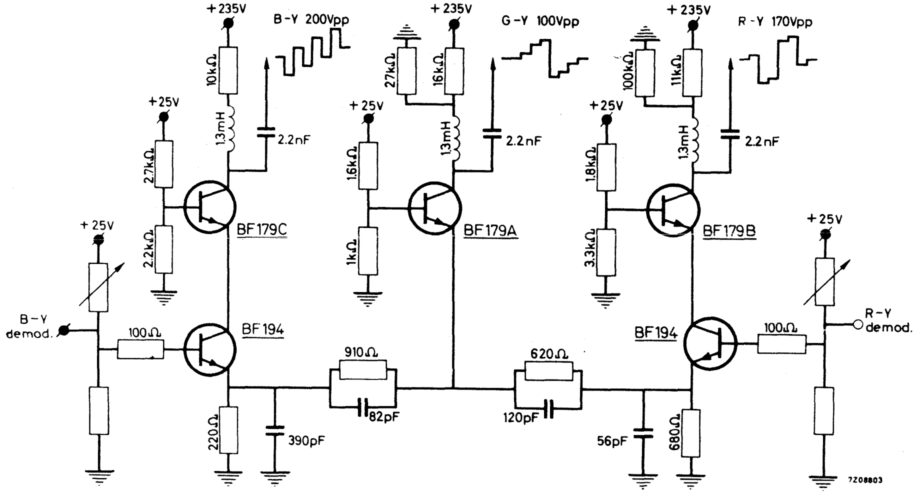


Accessories available: 56218; 56245; 56265
MOUNTING METHODS see page 5

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 °C	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]

Transient response [1]		
rise time	300	ns
fall time	300	ns
overshoot	< 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: $R_{th\ j-a}$ → 220 °C/W

R-Y output stage: $R_{th\ j-a}$ → 110 °C/W [2]

B-Y output stage: $R_{th\ j-a}$ → 85 °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) [1]

Voltages			BF179A	BF179B	BF179C	
Collector-base voltage (open emitter)	V_{CBO}	max.	160	220	250	V [2]
Collector-emitter voltage ($R_{BE} \leq 1\ k\Omega$)	V_{CER}	max.	160	220	250	V [2]
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 °C	P_{tot}	max.	1.7	W
Temperatures				
Storage temperature	T_{stg}		-55 to +175	°C
Junction temperature	T_j	max.	200	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	220	°C/W
From junction to mounting base	$R_{th\ j\text{-}mb}$	=	40	°C/W [3]
From junction to case	$R_{th\ j\text{-}c}$	=	45	°C/W [3]

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

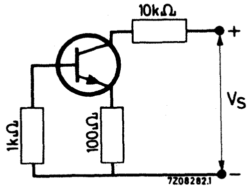
[2] During switching on, a supply voltage of 1.2 times the rated V_{CER} value is permitted.
The current must be limited so that maximum dissipation and maximum junction temperature are not exceeded. (see page 6)

[3] See also pages 5 and 6.

DATA OF THE INDIVIDUAL TRANSISTORS

CHARACTERISTICS T_j = 25 °C unless otherwise specified

Collector cut-off current



	BF179A; V_{CE} = 160 V	I_{CER}	< 1	mA
	BF179B; V_{CE} = 220 V	I_{CER}	< 1	mA
	BF179C; V_{CE} = 250 V	I_{CER}	< 1	mA
T_j = 200 °C	BF179A; V_S = 160 V	I_{CER}	< 2	mA
	BF179B; V_S = 225 V	I_{CER}	< 3	mA
	BF179C; V_S = 260 V	I_{CER}	< 4	mA

Base current

I_C = 20 mA; V_{CE} = 15 V	I_B	typ.	0.45	mA
		<	1.0	mA

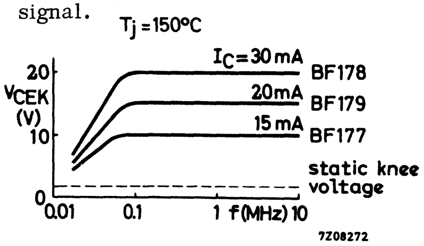
Base-emitter voltage [1]

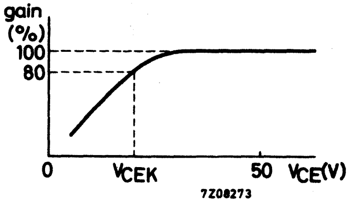
I_C = 20 mA; V_{CE} = 15 V	V_{BE}	typ.	0.75	V
		<	1.2	V

High frequency knee voltage at T_j = 150 °C

I_C = 20 mA	V_{CEK}	typ.	15	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 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 mA; V_{CE} = 20 V; f = 0.5 MHz	$-C_{re}$	typ.	1.8	pF
		<	3.5	pF

Feedback time constant

$-I_E$ = 10 mA; V_{CB} = 15 V; f = 10 MHz	$r_{bb'}C_{b'c}$	typ.	20	ps
		<	100	ps

Transition frequency

I_C = 10 mA; V_{CE} = 15 V	f_T	typ.	120	MHz

---

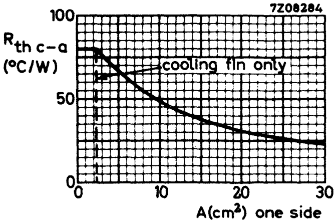
[1] V_{BE} decreases by about 1.6 mV/°C with increasing temperature.

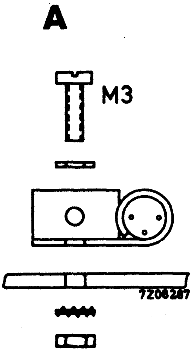
DATA OF THE INDIVIDUAL TRANSISTORS

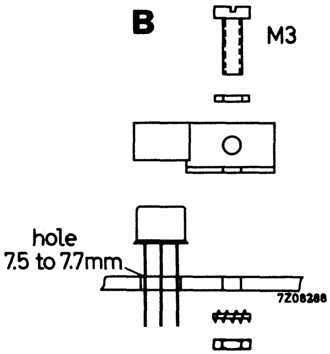
MOUNTING METHODS

1. Transistor mounted with cooling fin 56265 on a heatsink ($R_{th\ j\text{-}c} = 45\ ^{o}C/W$)
   $R_{th\ j\text{-}a} = R_{th\ j\text{-}c} + R_{th\ c\text{-}a}$. $R_{th\ c\text{-}a}$ includes the contact thermal resistance

   Heatsink material:
   1.5 mm aluminium, blackened





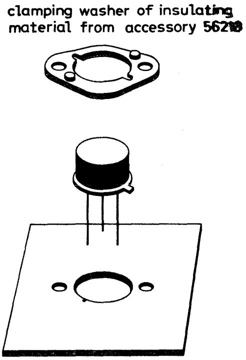


Torque on nut (for good heat transfer): 5 cm kg

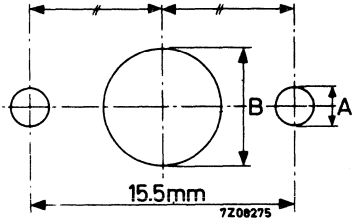
DATA OF THE INDIVIDUAL TRANSISTORS

MOUNTING METHODS (continued)

2. Transistor mounted directly on a heatsink ($R_{th\ j\text{-}mb} = 40\ ^{o}C/W$)
   $R_{th\ mb\text{-}h} \approx 3\ ^{o}C/W$



Fasten with M2.6 bolts

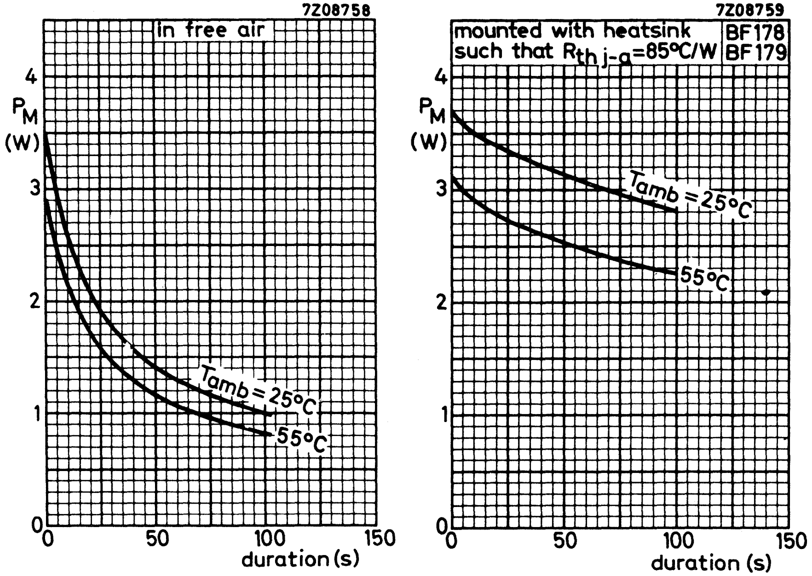


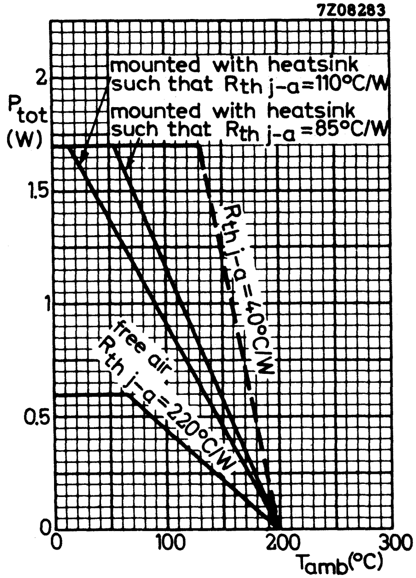
Diameter A: 2.8 mm

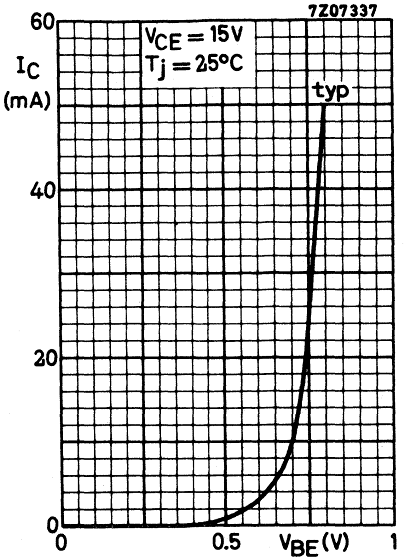
Diameter B: min. 7.0 mm
max. 7.7 mm

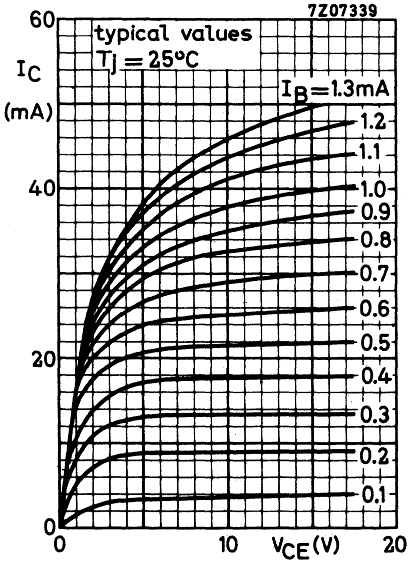
Recommended bore plan

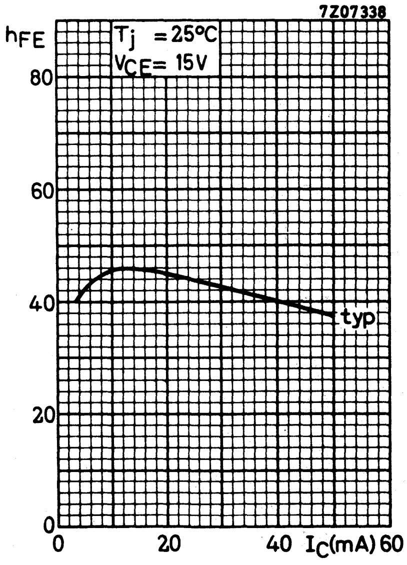
maximum allowable peak power dissipation versus duration

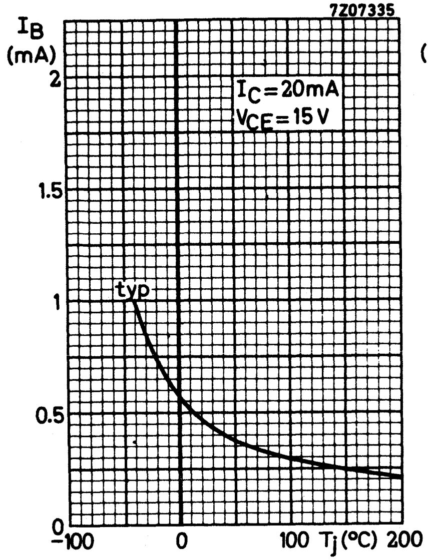


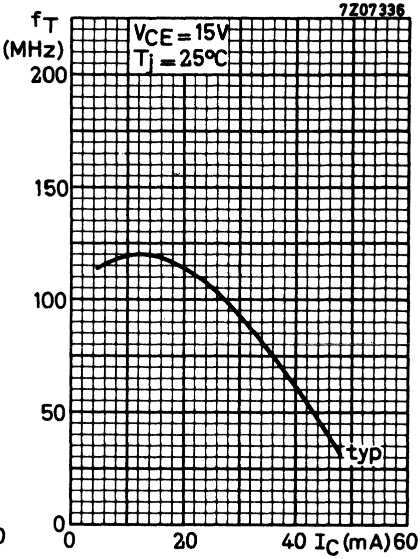

7Z08283
Ptot (W)
Tamb (°C)
mounted with heatsink such that Rth j-a = 110°C/W
mounted with heatsink such that Rth j-a = 85°C/W
Rth j-a = 40°C/W
free air Rth j-a = 220°C/W
0
0.5
1
1.5
2
0
100
200
300

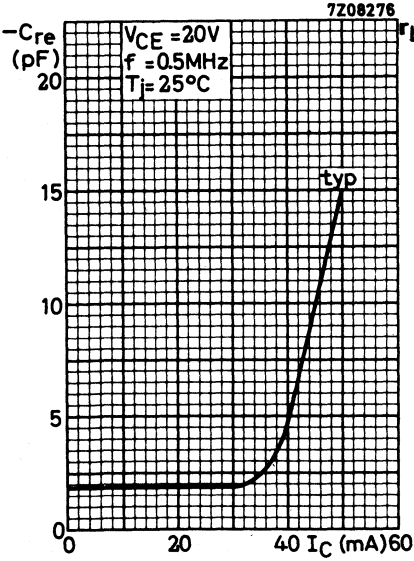

7Z07337
IC (mA)
VBE (V)
VCE = 15 V
Tj = 25°C
typ
0
20
40
60
0
0.5
1

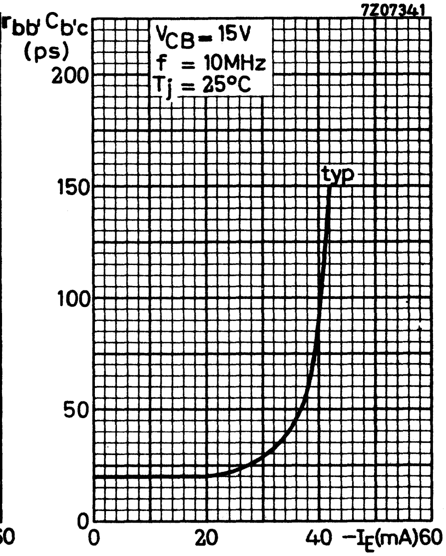

7Z07339
IC (mA)
VCE (V)
typical values
Tj = 25°C
IB = 1.3 mA
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
20
40
60
0
10
20


7Z07338
hFE
IC (mA)
Tj = 25°C
VCE = 15 V
typ
0
20
40
60
80
0
20
40
60


7Z07335
I$_B$
(mA)
2
1.5
1
0.5
0
I$_C$ = 20mA
V$_{CE}$ = 15 V
typ
−100
0
100
T$_j$ (°C)
200


7Z07336
f$_T$
(MHz)
200
150
100
50
0
V$_{CE}$ = 15V
T$_j$ = 25°C
typ
0
20
40
I$_C$ (mA)
60


7Z08276
−C$_{re}$
(pF)
20
15
10
5
0
V$_{CE}$ = 20V
f = 0.5MHz
T$_j$ = 25°C
typ
0
20
40
I$_C$ (mA)
60


7Z07341
r$_{bb'}$ C$_{b'c}$
(ps)
200
150
100
50
0
V$_{CB}$ = 15V
f = 10MHz
T$_j$ = 25°C
typ
0
20
40
−I$_E$(mA)
60

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.

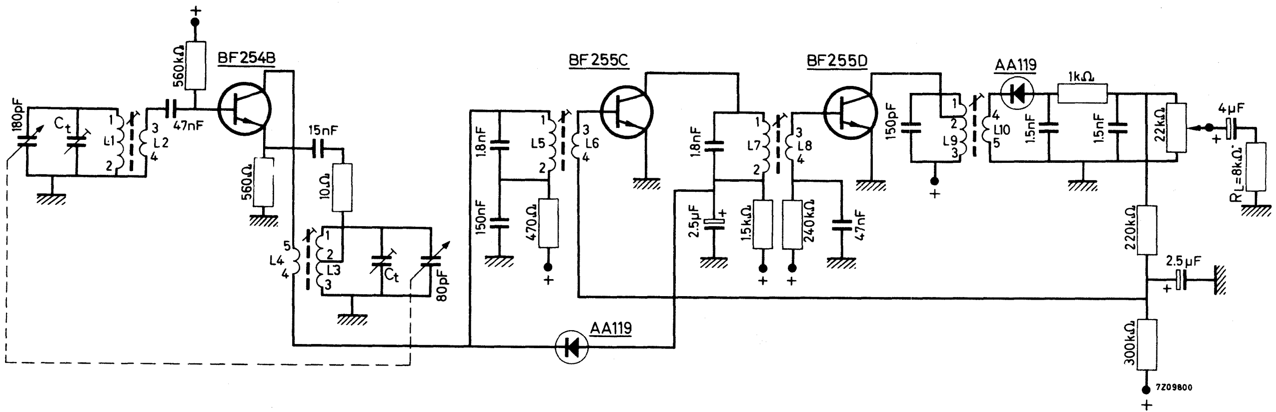
QUICK REFERENCE DATA

Base current				
I_C = 1 mA; V_{CE} = 10 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 mA; V_{CE} = 10 V				
G_S = 1.0 mΩ^{-1}; f = 1 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; Q_0 at f = 1 MHz : 120

Voltage ratio $\frac{n_{3-4}}{n_{1-2}}$: 5.7×10^{-2}

L3 = 260 µH; Q_0 at f = 1.2 MHz : 120

Voltage ratio $\frac{n_{2-3}}{n_{1-3}}$: 3×10^{-2}

Voltage ratio $\frac{n_{4-5}}{n_{1-3}}$: 5.4×10^{-2}

L5 = L7 = 69 µH; Q_0 at f = 0.45 MHz : 80

Voltage ratio $\frac{n_{3-4}}{n_{1-2}}$: 7.35×10^{-2}

L9 = 800 µH; Q_0 at f = 0.45 MHz : 110

Voltage ratio $\frac{n_{2-3}}{n_{1-3}}$: 41.5×10^{-2}

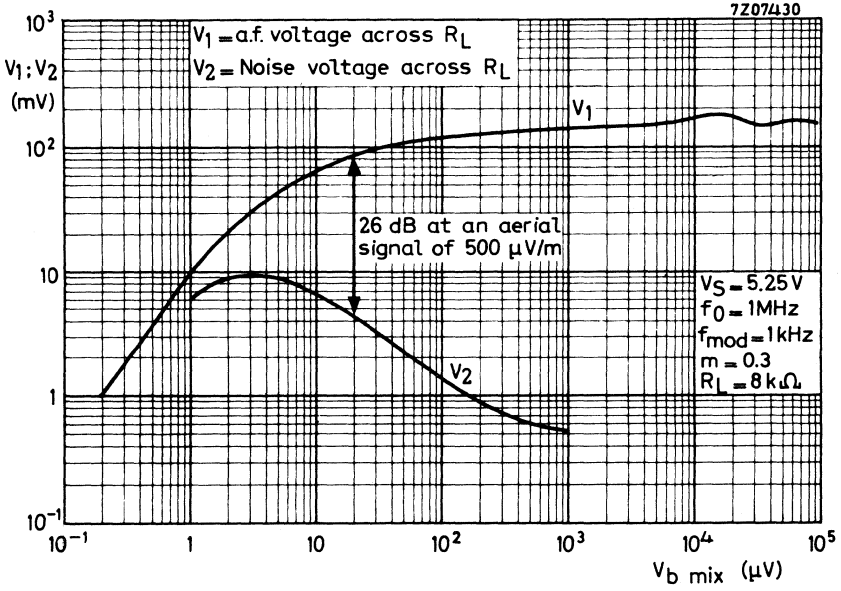
Voltage ratio $\frac{n_{4-5}}{n_{1-3}}$: 59.2×10^{-2}

PERFORMANCE at f = 1 MHz; T_{amb} = 25 °C

Supply voltage (from 6 V, via a RC-smoothing filter)	V_S	=	5.25	V
Total current drain	I_{tot}	=	3	mA
Gain spread of the h.f. part	ΔG	=	± 3.6	dB
Signal handling capability d_{tot} = 10 %; m = 0.8		$\geq$	2	V/m

Sensitivity

Signal to obtain V_o = 10 mV across R_L = 8 kΩ	25	μV/m
Signal to obtain 26 dB signal/noise ratio	500	μV/m
Decrease of sensitivity at $V_S \approx 3.2$ V	15	dB



CHARACTERISTICS

y parameters (common emitter)

I_C = 1 mA; V_{CE} = 10 V (lead length = 3 mm)			f = 10.7 MHz		f = 0.45 MHz	
Input conductance	BF254B :	g_{ie}	$<$	0.5	0.4	$m\Omega^{-1}$
	BF255C :	g_{ie}	$<$	0.64	0.54	$m\Omega^{-1}$
	BF255D :	g_{ie}	$<$	0.95	0.85	$m\Omega^{-1}$
Output conductance	BF254B :	g_{oe}	typ.	10	6.5	$\mu\Omega^{-1}$
			$<$	13.5	11.5	$\mu\Omega^{-1}$
	BF255C :	g_{oe}	typ.	6.5	4	$\mu\Omega^{-1}$
			$<$	9.5	7	$\mu\Omega^{-1}$
	BF255D :	g_{oe}	typ.	4	2	$\mu\Omega^{-1}$
			$<$	9.5	7	$\mu\Omega^{-1}$

Switching transistors

GERMANIUM ALLOYED TRANSISTORS

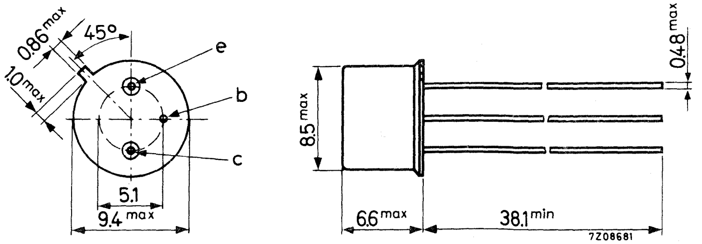
P-N-P transistors in a TO-5 metal envelope with the base connected to the case. These general purpose transistors are primarily intended for medium current medium speed computer logic applications.

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

		ASY26	ASY27	
Voltages				
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 $T_{amb} = 25\,^{o}C$	P_{tot}	max.	150	mW
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, 56265

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	0.4	°C/mW
From junction to case	$R_{th\ j\text{-}c}$	=	0.2	°C/mW

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

			ASY26	ASY27	
Collector cut-off current					
$I_E = 0;\ -V_{CB} = 30\ V$	$-I_{CBO}$	<	7		μA
$I_E = 0;\ -V_{CB} = 25\ V$	$-I_{CBO}$	<		7	μA
$I_E = 0;\ -V_{CB} = 30\ V;\ T_j = 60\ ^{\circ}C$	$-I_{CBO}$	<	35		μA
$I_E = 0;\ -V_{CB} = 25\ V;\ T_j = 60\ ^{\circ}C$	$-I_{CBO}$	<		35	μA
Emitter cut-off current					
$I_C = 0;\ -V_{EB} = 5\ V$	$-I_{EBO}$	<	3	3	μA
Currents at reverse biased emitter junction					
$-V_{CE} = 25\ V;\ +V_{BE} = 0.2\ V;\ T_j = 60\ ^{\circ}C$	$-I_{CEX}$	<	35		μA
$-V_{CE} = 20\ V;\ +V_{BE} = 0.2\ V;\ T_j = 60\ ^{\circ}C$	$-I_{CEX}$	<		35	μA
$-V_{CE} = 20\ V;\ +V_{BE} = 5\ V;\ T_j = 60\ ^{\circ}C$	$+I_{BEX}$	<	35	35	μA
Base-emitter voltage					
$-I_C = 100\ mA;\ -V_{CE} = 1\ V$	$-V_{BE}$	<	0.65	0.55	V
$-I_C = 300\ mA;\ -V_{CE} = 1\ V$	$-V_{BE}$	<	1.5	1.4	V
Collector-emitter saturation voltage					
$-I_C = 10\ mA;\ -I_B = 0.33\ mA$	$-V_{CE\,sat}$	<	0.20		V
$-I_C = 10\ mA;\ -I_B = 0.2\ mA$	$-V_{CE\,sat}$	<		0.20	V
$-I_C = 50\ mA;\ -I_B = 2\ mA$	$-V_{CE\,sat}$	<	0.25		V
$-I_C = 50\ mA;\ -I_B = 1.25\ mA$	$-V_{CE\,sat}$	<		0.25	V
Base-emitter saturation voltage					
$-I_C = 10\ mA;\ -I_B = 0.4\ mA$	$-V_{BE\,sat}$	> <	0.20 0.37		V V
$-I_C = 10\ mA;\ -I_B = 0.25\ mA$	$-V_{BE\,sat}$	> <		0.15 0.32	V V
$-I_C = 50\ mA;\ -I_B = 2.4\ mA$	$-V_{BE\,sat}$	<	0.55		V
$-I_C = 50\ mA;\ -I_B = 1.55\ mA$	$-V_{BE\,sat}$	<		0.45	V

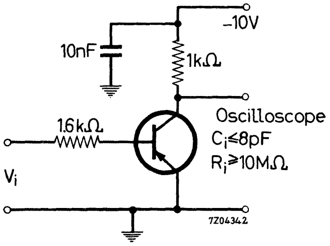
CHARACTERISTICS (continued) T_j = 25 °C unless otherwise specified

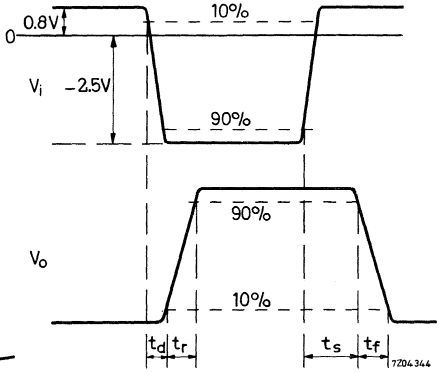
			ASY26	ASY27	
Collector-emitter sustaining voltage					
$-I_C$ = 5 mA; I_B = 0	$-V_{CEO\,sust}$	>	15	15	V
Punch through voltage	V_{pt}	>	25	20	V
Base-emitter floating voltage					
I_B = 0; $-V_{CE}$ = 25 V; T_j = 60 °C	$-V_{BE\,fl}$	<	0.20		V
I_B = 0; $-V_{CE}$ = 20 V; T_j = 60 °C	$-V_{BE\,fl}$	<		0.20	V
D.C. current gain					
$-I_C$ = 10 mA; $-V_{CE}$ = 1 V	h_{FE}	>	30	50	
		typ.	45	80	
$-I_C$ = 20 mA; $-V_{CE}$ = 1 V	h_{FE}	>	30	50	
		typ.	47	78	
		<	80	150	
$-I_C$ = 100 mA; $-V_{CE}$ = 1 V	h_{FE}	>	20	30	
		typ.	39	58	
$-I_C$ = 200 mA; $-V_{CE}$ = 1 V	h_{FE}	>	15	20	
		typ.	27	40	
Collector capacitance at f = 1 MHz					
$I_E = I_e$ = 0; $-V_{CB}$ = 5 V	C_c	typ.	11	11	pF
		<	16	16	pF
Emitter capacitance at f = 1 MHz					
$I_C = I_c$ = 0; $-V_{EB}$ = 5 V	C_e	typ.	7	6	pF
		<	13	13	pF
Transition frequency					
$-I_C$ = 3 mA; $-V_{CE}$ = 5 V	f_T	>	4	6	MHz
		typ.	8	14	MHz
h parameters at f = 1 kHz					
$-I_C$ = 2 mA; $-V_{CE}$ = 5 V					
Input impedance	h_{ie}	typ.	0.75	1.4	kΩ
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	$\mu\Omega^{-1}$

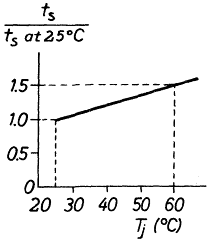
CHARACTERISTICS (continued) T_j = 25 °C unless otherwise specified

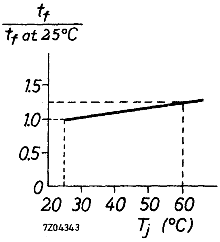
Switching characteristics			ASY26	ASY27	
Desaturation time constant $I_C = 0$; $-I_B = 1$ mA	τ_s	<	1.25	1.25	μs
Current feed time constant $-I_{CM} = 50$ mA; $-V_{CE} = 0.75$ V	τ_c	<	2.2	2.2	μs
Voltage feed time constant $-I_{CM} = 1$ mA; $-V_{CE} = 0.75$ V	τ_v	<	0.2	0.2	μs
Switching times (See test 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 computor 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

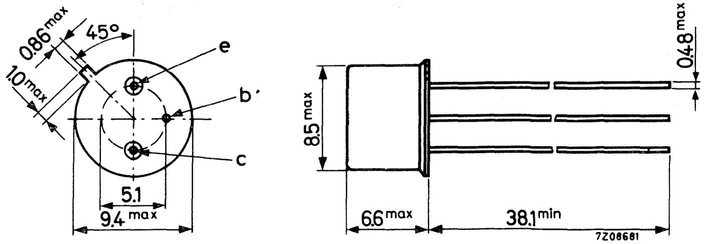
Currents				
Collector current (d.c. or average over any 20 ms period)	I_C	max.	200	mA
Collector current (peak value)	I_{CM}	max.	300	mA

Power dissipation				
Total power dissipation up to $T_{amb} = 25\ ^oC$	P_{tot}	max.	150	mW

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 $R_{th\ j\text{-}a}$ = 0.4 °C/mW
From junction to case $R_{th\ j\text{-}c}$ = 0.2 °C/mW

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

			ASY28	ASY29	
Collector cut-off current					
$I_E = 0;\ V_{CB} = 30\ V$	I_{CBO}	<	7		μA
$I_E = 0;\ V_{CB} = 25\ V$	I_{CBO}	<		7	μA
$I_E = 0;\ V_{CB} = 30\ V;\ T_j = 60\ ^{\circ}C$	I_{CBO}	<	35		μA
$I_E = 0;\ V_{CB} = 25\ V;\ T_j = 60\ ^{\circ}C$	I_{CBO}	<		35	μA
Emitter cut-off current					
$I_C = 0;\ V_{EB} = 5\ V$	I_{EBO}	<	3	3	μA
Currents at reverse biased emitter junction					
$V_{CE} = 25\ V;\ -V_{BE} = 0.2\ V;\ T_j = 60\ ^{\circ}C$	I_{CEX}	<	35		μA
$V_{CE} = 20\ V;\ -V_{BE} = 0.2\ V;\ T_j = 60\ ^{\circ}C$	I_{CEX}	<		35	μA
$V_{CE} = 20\ V;\ -V_{BE} = 5\ V;\ T_j = 60\ ^{\circ}C$	$-I_{BEX}$	<	35	35	μA
Base-emitter voltage					
$I_C = 100\ mA;\ V_{CE} = 1\ V$	V_{BE}	<	0.65	0.55	V
$I_C = 300\ mA;\ V_{CE} = 1\ V$	V_{BE}	<	1.5	1.4	V
Collector-emitter saturation voltage					
$I_C = 10\ mA;\ I_B = 0.33\ mA$	$V_{CE\,sat}$	<	0.20		V
$I_C = 10\ mA;\ I_B = 0.2\ mA$	$V_{CE\,sat}$	<		0.20	V
$I_C = 50\ mA;\ I_B = 2\ mA$	$V_{CE\,sat}$	<	0.25		V
$I_C = 50\ mA;\ I_B = 1.25\ mA$	$V_{CE\,sat}$	<		0.25	V
Base-emitter saturation voltage					
$I_C = 10\ mA;\ I_B = 0.4\ mA$	$V_{BE\,sat}$	> <	0.20 0.37		V V
$I_C = 10\ mA;\ I_B = 0.25\ mA$	$V_{BE\,sat}$	> <		0.15 0.32	V V
$I_C = 50\ mA;\ I_B = 2.4\ mA$	$V_{BE\,sat}$	<	0.55		V
$I_C = 50\ mA;\ I_B = 1.55\ mA$	$V_{BE\,sat}$	<		0.45	V

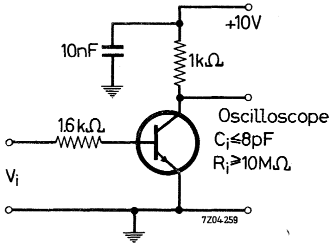
CHARACTERISTICS (continued) T_j = 25 °C unless otherwise specified

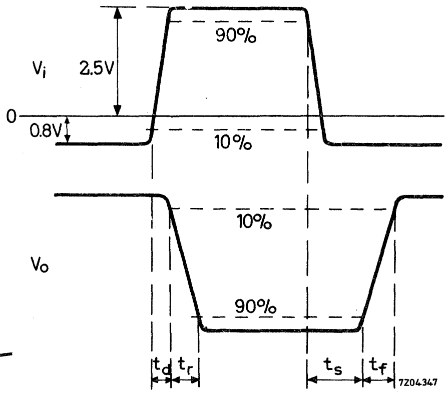
			ASY28	ASY29	
Collector-emitter sustaining voltage					
I_C = 5 mA; I_B = 0	$V_{CEO\,sust}$	>	15	15	V
Punch through voltage	V_{pt}	>	25	20	V
Base-emitter floating voltage					
I_B = 0; V_{CE} = 25 V; T_j = 60 °C	$V_{BE\,fl}$	<	0.20		V
I_B = 0; V_{CE} = 20 V; T_j = 60 °C	$V_{BE\,fl}$	<		0.20	V
D.C. current gain					
I_C = 10 mA; V_{CE} = 1 V	h_{FE}	>	30	50	
		typ.	43	113	
I_C = 20 mA; V_{CE} = 1 V	h_{FE}	>	30	50	
		typ.	46	113	
		<	80	150	
I_C = 100 mA; V_{CE} = 1 V	h_{FE}	>	20	30	
		typ.	43	102	
I_C = 200 mA; V_{CE} = 1 V	h_{FE}	>	15	20	
		typ.	32	84	
Collector capacitance at f = 1 MHz					
$I_E = I_e$ = 0; V_{EB} = 5 V	C_c	typ.	11	11	pF
		<	16	16	pF
Emitter capacitance at f = 1 MHz					
$I_C = I_c$ = 0; V_{EB} = 5 V	C_e	typ.	7	6	pF
		<	13	13	pF
Transition frequency					
I_C = 3 mA; V_{CE} = 5 V	f_T	>	4	10	MHz
		typ.	14	20	MHz
h parameters at f = 1 kHz					
I_C = 2 mA; V_{CE} = 5 V					
Input impedance	h_{ie}	typ.	0.75	1.4	kΩ
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	$\mu\Omega^{-1}$

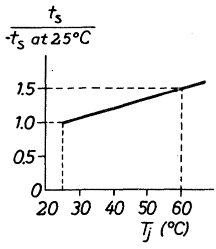
CHARACTERISTICS (continued) T_j = 25 °C unless otherwise specified

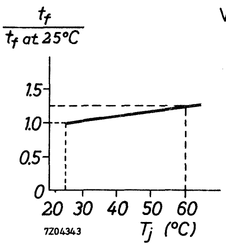
Switching characteristics			ASY28	ASY29	
Desaturation time constant I_C = 0; I_B = 1 mA	τ_s	<	1.4	1.4	μs
Current feed time constant I_{CM} = 50 mA; V_{CE} = 0.75 V	τ_c	<	2.2	2.2	μs
Voltage feed time constant I_{CM} = 1 mA; V_{CE} = 5 V	τ_v	<	0.2	0.2	μs
Switching times (See test circuit)					
delay time	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:









GERMANIUM ALLOYED TRANSISTORS

P-N-P transistors in all-glass construction for medium current, medium speed computer logic applications.

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 ($+V_{BE} = 0.2$ V)	$-V_{CEX}$	max.	20	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	20	V

Currents

Collector current (d.c. or average over any 20 ms period)	$-I_C$	max.	100	mA
Collector current (peak value)	$-I_{CM}$	max.	200	mA

Power dissipation

Total power dissipation up to $T_{amb} = 25$ °C	P_{tot}	max.	125	mW

Temperatures

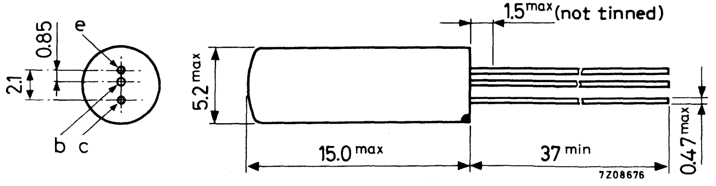
Storage temperature	T_{stg}		-55 to +75	°C
Junction temperature	T_j	max.	75	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	0.4	°C/mW
From junction to case	$R_{th\ j\text{-}c}$	=	0.2	°C/mW

MECHANICAL DATA

Dimensions in mm



The coloured dot indicates the collector

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

CHARACTERISTICS T_j = 25 °C unless otherwise specified

Collector cut-off current				
$I_E = 0$; $-V_{CB} = 5$ V	$-I_{CBO}$	<	3	μA
Emitter cut-off current				
$I_C = 0$; $-V_{EB} = 5$ V	$-I_{EBO}$	<	3	μA
Currents at reverse biased emitter junction				
$-V_{CE} = 20$ V; $+V_{BE} = 0.2$ V; $T_j = 60$ °C	$-I_{CEX}$	<	35	μA
$-V_{CE} = 20$ V; $+V_{BE} = 5$ V; $T_j = 60$ °C	$+I_{BEX}$	<	35	μA
Collector-emitter sustaining voltage				
$-I_C = 5$ mA; $I_B = 0$	$-V_{CEOsust}$	>	15	V
Punch-through voltage	V_{pt}	>	20	V
Base-emitter floating voltage				
$I_B = 0$; $-V_{CE} = 20$ V; $T_j = 60$ °C	$-V_{BEfl}$	<	0.20	V
Collector capacitance				
$I_E = I_e = 0$; $-V_{CB} = 5$ V	C_c	<	16	pF
Emitter capacitance				
$I_C = I_c = 0$; $-V_{EB} = 5$ V	C_e	<	13	pF
Switching characteristics				
Desaturation time constant $I_C = 0$; $-I_B = 1$ mA	τ_s	<	1.4	μs
Current feed time constant $-I_{CM} = 50$ mA; $-V_{CE} = 0.75$ V	τ_c	<	2.2	μs
Voltage feed time constant $-I_{CM} = 1$ mA; $-V_{CE} = 0.75$ V	τ_v	<	0.2	μs

CHARACTERISTICS (continued) T_j = 25 °C

			ASY31	ASY32	
Base-emitter voltage					
$-I_C$ = 50 mA; $-I_B$ = 1.55 mA	$-V_{BE}$	<	–	0.45	V
$-I_C$ = 50 mA; $-I_B$ = 2.4 mA	$-V_{BE}$	<	0.55	–	V
$-I_C$ = 100 mA; V_{CB} = 0	$-V_{BE}$	<	0.65	0.55	V
Saturation voltages					
$-I_C$ = 10 mA; $-I_B$ = 0.20 mA	$-V_{CEsat}$	<	–	0.20	V
$-I_C$ = 10 mA; $-I_B$ = 0.33 mA	$-V_{CEsat}$	<	0.20	–	V
$-I_C$ = 50 mA; $-I_B$ = 1.25 mA	$-V_{CEsat}$	<	–	0.25	V
$-I_C$ = 50 mA; $-I_B$ = 2 mA	$-V_{CEsat}$	<	0.25	–	V
$-I_C$ = 10 mA; $-I_B$ = 0.25 mA	$-V_{BEsat}$		–	0.15 to 0.32	V
$-I_C$ = 10 mA; $-I_B$ = 0.4 mA	$-V_{BEsat}$		0.20 to 0.37	–	V
D.C. current gain					
$-I_C$ = 10 mA; V_{CB} = 0	h_{FE}	>	30	50	
$-I_C$ = 20 mA; V_{CB} = 0	h_{FE}		30 to 80	50 to 150	
$-I_C$ = 100 mA; V_{CB} = 0	h_{FE}	>	20	30	
Transition frequency					
$-I_C$ = 3 mA; $-V_{CE}$ = 5 V	f_T	>	4	6	MHz

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

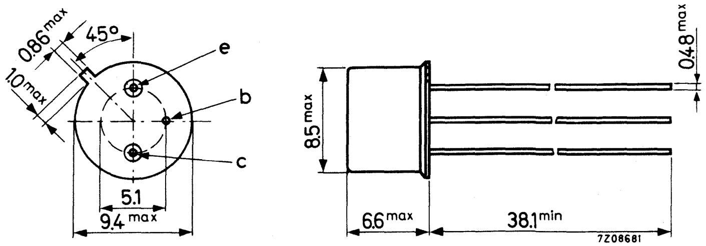
			ASY73	ASY74	ASY75	
Collector-base voltage (open emitter)	V_{CBO}	max.	30	30	30	V
Collector-emitter voltage (open base)	V_{CEO}	max.	15	15	15	V
Collector-current (d.c. or average)	I_C	max.	400	400	400	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	140	140	140	mW
Junction temperature	T_j	max.	75	75	75	°C
D.C. current gain at T_j = 25 °C						
$-I_E$ = 200 mA; V_{CB} = 0	h_{FE}	>	20	35	50	
$-I_C$ = 200 mA; V_{EB} = 0	h_{FC}	>	12	20	20	
Transition frequency						
$-I_E$ = 3 mA; V_{CB} = 5 V	f_T	>	4	6	10	MHz
Desaturation time constant						
I_B = 1 mA; I_C = 0	τ_s		<1.75	1.75	1.75	µs

MECHANICAL DATA

Dimensions in mm

TO-5

Base connected to case



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

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	$R_{th\ j\text{-}a}$	=	0.35	°C/mW
From junction to case	$R_{th\ j\text{-}c}$	=	0.2	°C/mW

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[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

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

Collector cut-off current

$I_E = 0;\ V_{CB} = 5\ V$	I_{CBO}	<	3	µA
$V_{CB} = 30\ V;\ T_j = 55\ ^{\circ}C$	I_{CBO}	<	100	µA

Emitter cut-off current

$I_C = 0;\ V_{EB} = 5\ V$	I_{EBO}	<	3	µA
$V_{EB} = 30\ V;\ T_j = 55\ ^{\circ}C$	I_{EBO}	<	100	µA

Currents at reverse biased emitter junction

$V_{CE} = 20\ V;\ -V_{BE} = 0.2\ V;\ T_j = 55\ ^{\circ}C$	I_{CEX}	<	50	µA
$-V_{BE} = 20\ V;\ V_{CB} = 20\ V;\ T_j = 55\ ^{\circ}C$	$-I_{BEX}$	<	50	µA

Saturation voltages

ASY73.	$I_C = 50\ mA;\ I_B = 2.5\ mA$	V_{CEsat}	<	0.22	V
	$I_C = 200\ mA;\ I_B = 10\ mA$	V_{CEsat}	<	0.30	V
	$I_E = 200\ mA;\ I_B = 16.5\ mA$	V_{ECsat}	<	0.30	V
	$I_C = 50\ mA;\ I_B = 3\ mA$	$V_{BE\,sat}$	<	0.50	V
	$I_C = 200\ mA;\ I_B = 12\ mA$	$V_{BE\,sat}$	<	0.90	V
ASY74.	$I_C = 50\ mA;\ I_B = 1.25\ mA$	V_{CEsat}	<	0.22	V
	$I_C = 200\ mA;\ I_B = 5.7\ mA$	V_{CEsat}	<	0.30	V
	$I_C = 400\ mA;\ I_B = 20\ mA$	V_{CEsat}	<	0.37	V
	$I_E = 200\ mA;\ I_B = 10\ mA$	V_{ECsat}	<	0.30	V
	$I_C = 50\ mA;\ I_B = 1.5\ mA$	$V_{BE\,sat}$	<	0.38	V
	$I_C = 200\ mA;\ I_B = 7\ mA$	$V_{BE\,sat}$	<	0.70	V
	$I_C = 400\ mA;\ V_{CB} = 0$	$V_{BE\,sat}$	<	0.90	V
ASY75.	$I_C = 50\ mA;\ I_B = 0.75\ mA$	V_{CEsat}	<	0.22	V
	$I_C = 200\ mA;\ I_B = 4\ mA$	V_{CEsat}	<	0.30	V
	$I_C = 400\ mA;\ I_B = 13.5\ mA$	V_{CEsat}	<	0.37	V
	$I_E = 200\ mA;\ I_B = 10\ mA$	V_{ECsat}	<	0.30	V
	$I_C = 50\ mA;\ I_B = 0.95\ mA$	$V_{BE\,sat}$	<	0.34	V
	$I_C = 200\ mA;\ I_B = 5\ mA$	$V_{BE\,sat}$	<	0.60	V
	$I_C = 400\ mA;\ V_{CB} = 0$	$V_{BE\,sat}$	<	0.70	V

Sustaining voltage

$I_C = 10\ mA;\ I_B = 0$	$V_{CEOsust}$	>	15	V

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

Punch-through voltage

	V_{pt}	>	20	V

Floating potential

$I_E = 0$; $V_{CB} = 20$ V; $T_j = 55$ °C	V_{EBfl}	<	180	mV
$I_C = 0$; $V_{CB} = 20$ V; $T_j = 55$ °C	V_{CBfl}	<	180	mV

D.C. current gain

ASY73	$V_{CB} = 0$; $-I_E = 50$ mA	h_{FE}	>	25
	$V_{CB} = 0$; $-I_E = 200$ mA	h_{FE}	>	20
	$V_{EB} = 0$; $-I_C = 200$ mA	h_{FC}	>	12
ASY74	$V_{CB} = 0$; $-I_E = 50$ mA	h_{FE}	>	40
	$V_{CB} = 0$; $-I_E = 200$ mA	h_{FE}	>	35
	$V_{CB} = 0$; $-I_E = 400$ mA	h_{FE}	>	20
	$V_{EB} = 0$; $-I_C = 200$ mA	h_{FC}	>	20
ASY75	$V_{CB} = 0$; $-I_E = 50$ mA	h_{FE}	>	65
	$V_{CB} = 0$; $-I_E = 200$ mA	h_{FE}	>	50
	$V_{CB} = 0$; $-I_E = 400$ mA	h_{FE}	>	30
	$V_{EB} = 0$; $-I_C = 200$ mA	h_{FC}	>	20

Switching parameters

Desaturation time constant $I_B = 1$ mA; $I_C = 0$	τ_s	<	1.75	µs
Current-feed time constant $I_{CM} = 200$ mA; $V_{CE} = 0.75$ V	τ_c	<	1.75	µs
Voltage-feed time constant $I_{CM} = 1$ mA; $V_{CE} = 5$ V	τ_v	<	0.20	µs

Collector capacitance at f = 1 MHz

$I_E = I_e = 0$; $V_{CB} = 5$ V	C_c	<	30	pF

Emitter capacitance at f = 1 MHz

$I_C = I_c = 0$; $V_{EB} = 5$ V	C_e	<	30	pF

Transition frequency

$-I_E = 3$ mA; $V_{CB} = 5$ V	ASY73	f_T	>	4	MHz
	ASY74	f_T	>	6	MHz
	ASY75	f_T	>	10	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

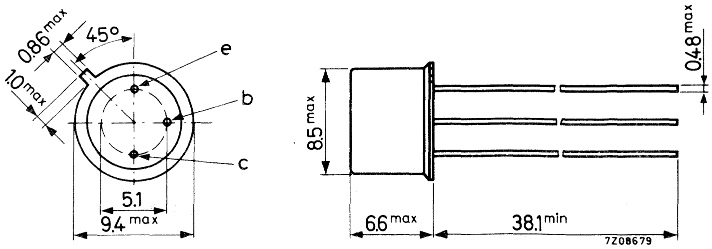
			ASY76	ASY77	ASY80	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	40	60	40	V
Collector-emitter voltage ($+V_{BE} = 0.6$ V)	$-V_{CEX}$	max.	32	60	40	V

Collector current (peak value)	$-I_{CM}$	max.	1000	mA
Total power dissipation up to $T_{amb} = 25\ ^{o}C$	P_{tot}	max.	500	mW
Junction temperature	T_j	max.	85	^{o}C
Thermal resistance from junction to case	$R_{th\ j\text{-}c}$	=	75	$^{o}C/W$
D.C. current gain at $T_j = 25\ ^{o}C$				
$-I_C = 600$ mA; $-V_{CE} = 1$ V ASY76, ASY77	h_{FE}	>	20	
$-I_C = 600$ mA; $-V_{CE} = 1$ V ASY80	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

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	$R_{th\ j\text{-}a}$	=	250	°C/W
From junction to case	$R_{th\ j\text{-}c}$	=	75	°C/W
From junction to ambient with cooling fin 56265 on a heatsink of 12.5 cm^2	$R_{th\ j\text{-}a}$	=	120	°C/W

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

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			ASY76	ASY77	ASY80	
Collector cut-off current						
$I_E = 0$; $-V_{CB} = 10$ V	$-I_{CBO}$	typ.	4.5	4.5	4.5	μA
		<	10	10	10	μA
$I_E = 0$; $-V_{CB} = 40$ V	$-I_{CBO}$	<	40	–	40	μA
$I_E = 0$; $-V_{CB} = 60$ V	$-I_{CBO}$	<	–	40	–	μA
Emitter cut-off current						
$I_C = 0$; $-V_{EB} = 10$ V	$-I_{EBO}$	<	20	20	20	μA
Currents at reverse biased emitter junction						
$-V_{CE} = 30$ V; $+V_{BE} = 0.5$ V	$-I_{CEX}$	<	30	–	30	μA
$-V_{CE} = 60$ V; $+V_{BE} = 0.5$ V	$-I_{CEX}$	<	–	30	–	μA
$-V_{CE} = 30$ V; $+V_{BE} = 0.5$ V $T_j = 60$ °C	$-I_{CEX}$	<	200	–	200	μA
$-V_{CE} = 60$ V; $+V_{BE} = 0.5$ V $T_j = 60$ °C	$-I_{CEX}$	<	–	200	–	μA
Sustaining voltage						
$-I_C = 600$ mA; $+V_{BE} = 0.6$ V	$-V_{CEXsust}$	>	–	–	32	V
Base-emitter voltage						
$I_E = 300$ mA; $V_{CB} = 0$	$-V_{BE}$	typ.	420	420	420	mV
		<	750	750	750	mV
Saturation voltages						
$-I_C = 300$ mA; $-I_B = 12$ mA	$-V_{CEsat}$	<	300	300	–	mV
$-I_C = 300$ mA; $-I_B = 6$ mA	$-V_{CEsat}$	<	–	–	400	mV
Emitter-base floating voltage						
$I_E = 0$; $-V_{CB} = 40$ V	$-V_{EBfl}$	<	300	–	300	mV
$I_E = 0$; $-V_{CB} = 60$ V	$-V_{EBfl}$	<	–	300	–	mV
D.C. current gain						
$-I_C = 10$ mA; $-V_{CE} = 6$ V	h_{FE}	>	45	45	–	
$-I_C = 50$ mA; $-V_{CB} = 0$	h_{FE}		–	–	60 to 165	
$-I_C = 300$ mA; $V_{CB} = 0$	h_{FE}		25 to 130	25 to 130	> 50	

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

Collector capacitance at f = 1 MHz					
$I_E = I_e = 0$; $-V_{CB} = 5$ V		C_c	typ. <	40 60	pF pF
Emitter capacitance at f = 1 MHz					
$I_C = I_c = 0$; $-V_{EB} = 5$ V		C_e	typ. <	30 50	pF pF
Transition frequency					
$-I_C = 10$ mA; $-V_{CE} = 5$ V	ASY76, ASY77	f_T	>	500	kHz
	ASY80	f_T	>	700	kHz
Noise figure at f = 1 kHz					
$I_E = 0.5$ mA; $-V_{CB} = 2$ V					
Bandwidth 200 Hz; $R_S = 500\ \Omega$		F	<	15	dB
Feedback impedance at f = 0.5 MHz					
$I_E = 1$ mA; $-V_{CB} = 5$ V		$\lvert z_{rb} \rvert$	typ.	75	Ω

P-N-P ALLOY DIFFUSED TRANSISTOR

P-N-P alloy diffused germanium transistor in a TO-7 metal envelope. It is intended for use in wide band amplifier applications and current mode switching.

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 ($R_B/R_E < 6$)	$-V_{CER}$	max.	40	V
Currents				
Collector current (d.c.)	$-I_C$	max.	25	mA
Base current (d.c.)	$-I_B$	max.	25	mA
Reverse base current (d.c.)	I_B	max.	1	mA
Reverse base current (peak value)	I_{BM}	max.	10	mA
Power dissipation				
Total power dissipation up to $T_{amb} = 25\ ^oC$	P_{tot}	max.	110	mW
Temperatures				
Storage temperature	T_{stg}		-55 to +75	^oC
Junction temperature : continuous	T_j	max.	75	^oC
incidentally	T_j	max.	90	^oC

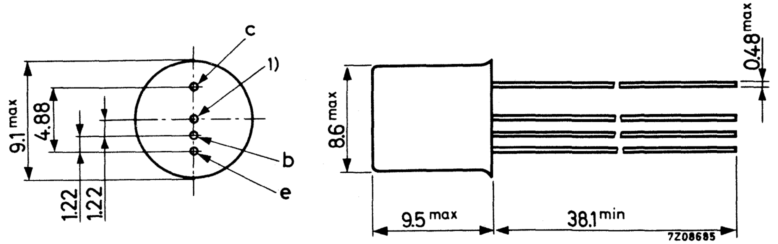
THERMAL RESISTANCE

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

MECHANICAL DATA

Dimensions in mm

TO-7



1) = shield lead (connected to case)

Accessories available: 56207

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

Collector cut-off current				
$I_E = 0$; $-V_{CB} = 6$ V	$-I_{CBO}$	$<$	4.5	μA
$I_E = 0$; $-V_{CB} = 40$ V	$-I_{CBO}$	$<$	50	μA
Emitter cut-off current				
$I_C = 0$; $-V_{EB} = 1$ V	$-I_{EBO}$	$<$	50	μA
Base current				
$I_E = 1$ mA; $-V_{CB} = 6$ V	$-I_B$	$<$	25	μA
$I_E = 10$ mA; $-V_{CB} = 2$ V	$-I_B$	$>$	20	μA
Base-emitter voltage				
$I_E = 1$ mA; $-V_{CB} = 6$ V	$-V_{BE}$		210 to 330	mV
$I_E = 10$ mA; $-V_{CB} = 2$ V	$-V_{BE}$		260 to 400	mV
Frequency at which $\lvert h_{fe} \rvert = 1$				
$I_E = 1$ mA; $-V_{CB} = 6$ V	f_1	$>$ typ.	40 75	MHz MHz
$I_E = 10$ mA; $-V_{CB} = 2$ V	f_1	$>$	100	MHz
Collector capacitance at f = 0.45 MHz				
$I_E = I_e = 0$; $-V_{CB} = 6$ V	C_c	$<$	2.5	pF
Feedback impedance at f = 2 MHz				
$I_E = 1$ mA; $-V_{CB} = 6$ V	$\lvert z_{rb} \rvert$	$<$	120	Ω
h parameters				
$I_E \leq 10$ mA; $-V_{CB} \leq 6$ V; $T_{amb} = 60$ °C	$-h_{fb}$	$<$	1.01	
$-I_C = 1$ mA; $-V_{CE} = 6$ V; f = 1 kHz	h_{fe}	$>$	45	
Noise figure at $R_S = 500\ \Omega$				
$-I_C = 1$ mA; $-V_{CE} = 6$ V; f = 1 kHz	F	typ. $<$	15 20	dB dB
f = 450 kHz	F	$<$	6	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

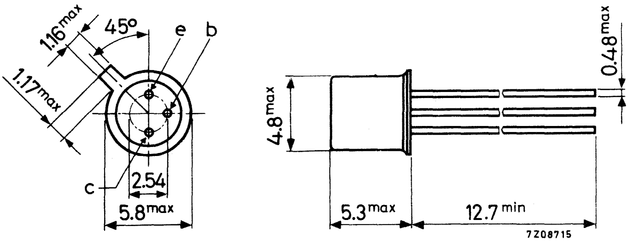
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	20	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	15	V
Collector current (peak value)	$-I_{CM}$	max.	50	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	120	mW
Junction temperature	T_j	max.	85	°C
D.C. current gain at T_{amb} = 25 °C				
$-I_C$ = 10 mA; $-V_{CE}$ = 0.5 V	h_{FE}	>	30	
Transition frequency				
I_E = 10 mA; $-V_{CB}$ = 2 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 $T_{amb} = 25\ ^{o}C$	P_{tot}	max.	120	mW

Temperatures

Storage temperature	T_{stg}		-55 to +75	°C
Junction temperature	T_j	max.	85	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	0.50	°C/mW
From junction to case	$R_{th\ j-c}$	=	0.18	°C/mW

CHARACTERISTICS

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

Emitter cut-off current

$I_C = 0$; $-V_{EB} = 0.5$ V	$-I_{EBO}$	<	2	μA

Currents at reverse biased emitter junction

$-V_{CE} = 15$ V; $-V_{EB} = 0.2$ V; $T_{amb} = 60\ ^{o}C$	$-I_{CEX}$	<	60	μA
	$+I_{BEX}$	<	60	μA

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

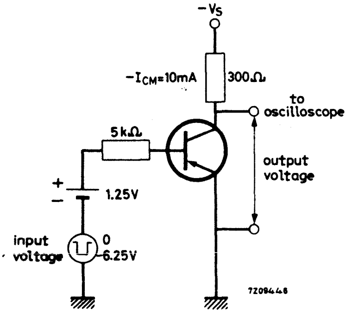
CHARACTERISTICS (continued) T_{amb} = 25 °C unless otherwise specified

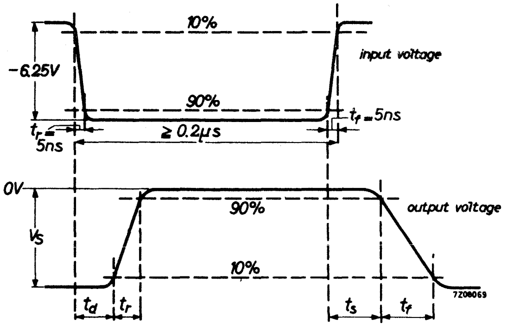
Breakdown voltages at T_{amb} = 60 °C				
$I_E = 0$; $-I_C = 100\ \mu A$	$-V_{(BR)\,CBO}$	>	20	V
$I_C = 0$; $-I_E = 100\ \mu A$	$-V_{(BR)\,EBO}$	>	2.5	V
Sustaining voltage				
$I_B = 0$; $-I_C = 5$ mA	$-V_{CEO\,sust}$	>	9	V
Saturation voltage				
$-I_C = 10$ mA; $-I_B = 1$ mA	$-V_{CE\,sat}$	<	0.35	V
$-I_C = 50$ mA; $-I_B = 3$ mA	$-V_{CE\,sat}$	<	1.10	V
Base-emitter voltage				
$-I_C = 10$ mA; $-I_B = 0.44$ mA	$-V_{BE}$	0.25 to	0.5	V
$-I_C = 30$ mA; $-I_B = 0.9$ mA	$-V_{BE}$	0.35 to	0.75	V
D.C. current gain				
$-I_C = 10$ mA; $-V_{CE} = 0.5$ V	h_{FE}	>	30	
$-I_C = 30$ mA; $-V_{CE} = 1.0$ V	h_{FE}	>	50	
Collector capacitance				
$I_E = I_e = 0$; $-V_{CB} = 6$ V	C_c	<	5	pF
Emitter capacitance				
$I_C = I_c = 0$; $-V_{EB} = 1$ V	C_e	<	12	pF
Transition frequency				
$I_E = 10$ mA; $-V_{CB} = 2$ V	f_T	>	300	MHz

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

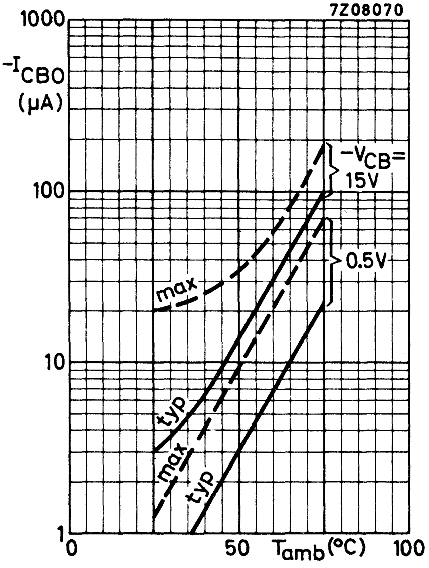
Switching characteristics

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 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.

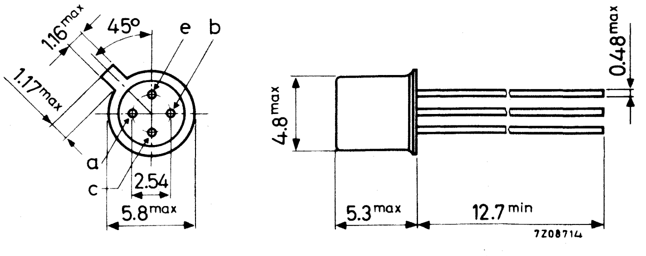
QUICK REFERENCE DATA

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
Emitter current (peak value)	$-I_{EM}$	max.	500	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	250	mW
Junction temperature	T_j	max.	150	°C
Forward on-state voltage I_A = 50 mA; I_C = 0; R_{BE} = 10 kΩ	V_{AE}	<	1.4	V
Holding current I_C = 10 mA; $-V_{BB}$ = 2 V; R_{BE} = 10 kΩ	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) [1]

			p-n-p	n-p-n	
Voltages					
Collector-base voltage (open emitter)	V_{CBO}	max.	−70	70[2]	V
Collector-emitter voltage (R_{BE} = 10 kΩ)	V_{CER}	max.		70[2]	V
Collector-emitter voltage (open base)	V_{CEO}	max.	−70		V
Emitter-base voltage (open collector)	V_{EBO}	max.	−70[2]	5[3]	V
Currents					
Emitter current (d.c.)	I_E	max.	100	−100	mA
Emitter current (peak value) $t_p \leq 1$ ms; $\delta \leq 0.05$	I_{EM}	max.	500	−500	mA
Collector current (d.c.)	I_C	max.		50	mA
Collector current (peak value)	I_{CM}	max.		100[4]	mA

Power dissipation				
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	250	mW
Temperatures				
Storage temperature	T_{stg}		−65 to + 200	°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

From junction to ambient	$R_{th\ j\text{-}a}$	=	0.5	°C/mW

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

[2] In numerical indicator tube driver circuits higher voltages are allowed, provided the collector current does not exceed a d.c. current of 1 mA.

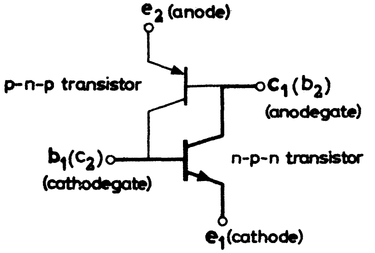
[3] In numerical indicator tube driver circuits higher voltages are allowed during the discharge of a capacitor of max. 390 pF, provided the charge does not exceed 50 nC and the current is limited to 150 mA.

[4] 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 kΩ.

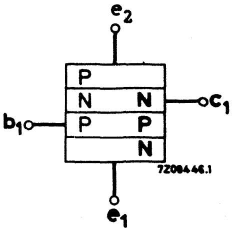
MEANING OF SYMBOLS, used in the schematic presentation of the S.C.S.

2 transistors equivalent circuit

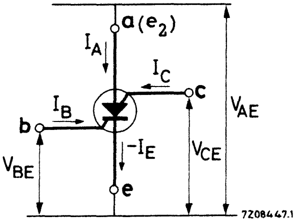
n-p-n transistor + p-n-p transistor



p-n-p-n S.C.S. equivalent circuit



S.C.S. symbol



a = anode(emitter of p-n-p transistor)

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

INDIVIDUAL N-P-N TRANSISTOR

Collector cut-off current

V_{CE} = 70 V; R_{BE} = 10 kΩ	I_{CER}	<	100 nA
V_{CE} = 70 V; R_{BE} = 10 kΩ; T_j = 150 °C	I_{CER}	<	10 μA

Emitter cut-off current

I_C = 0; V_{EB} = 5 V; T_j = 150 °C	I_{EBO}	<	10 μA

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

INDIVIDUAL N-P-N TRANSISTOR				
Saturation voltages				
I_C = 10 mA; I_B = 1 mA	V_{CEsat} V_{BEsat}	$<$ $<$	500 900	mV mV
D.C. current gain				
I_C = 10 mA; V_{CE} = 2 V	h_{FE}	$>$	50	
Transition frequency				
I_C = 10 mA; V_{CE} = 2 V	f_T	typ.	300	MHz
Collector capacitance				
$I_E = I_e$ = 0; V_{CB} = 20 V	C_c	$<$	5	pF
Emitter capacitance				
$I_C = I_c$ = 0; V_{EB} = 1 V	C_e	$<$	25	pF
INDIVIDUAL P-N-P TRANSISTOR				
Collector cut-off current				
I_B = 0; $-V_{CE}$ = 70 V; T_j = 150 °C	$-I_{CEO}$	$<$	10	μA
Emitter cut-off current				
I_C = 0; $-V_{EB}$ = 70 V; T_j = 150 °C	$-I_{EBO}$	$<$	10	μA
D.C. current gain				
I_E = 1 mA; V_{CB} = 0	h_{FE}	0.25 to 2.5		
COMBINED DEVICE				
Forward voltage at R_{BE} = 10 kΩ				
I_A = 50 mA; I_C = 0	V_{AE}	$<$	1.4	V
I_A = 50 mA; I_C = 0; T_j = −55 °C	V_{AE}	$<$	1.9	V
I_A = 1 mA; I_C = 10 mA	V_{AE}	$<$	1.2	V
Holding current at R_{BE} = 10 kΩ				
I_C = 10 mA; $-V_{BB}$ = 2 V	I_H	0.1 to 1.0		mA

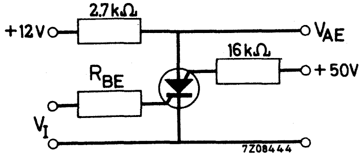
CHARACTERISTICS (continued) $T_j = 25\ ^{\circ}C$ unless otherwise specified

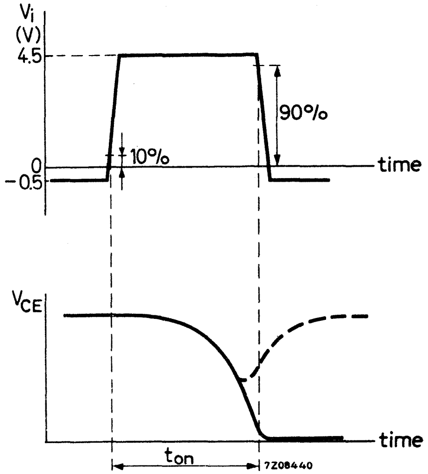
SWITCHING TIMES see also page 6

Turn on time when switched from

$-V_{BE} = 0.5$ V to $+V_{BE} = 4.5$ V; $R_{BE} = 1$ kΩ $t_{on} < 0.25$ μs

$R_{BE} = 10$ kΩ $t_{on} < 1.5$ μs





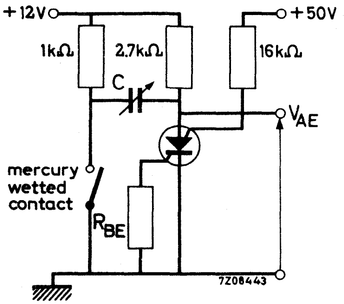
Pulse duration increased until dashed curve disappears

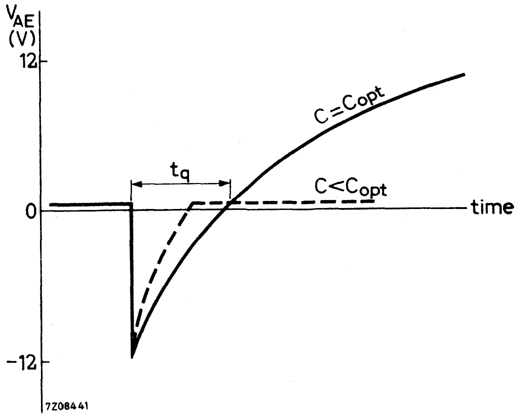
Turn off time

$R_{BE} = 1$ kΩ $t_q < 5$ μs

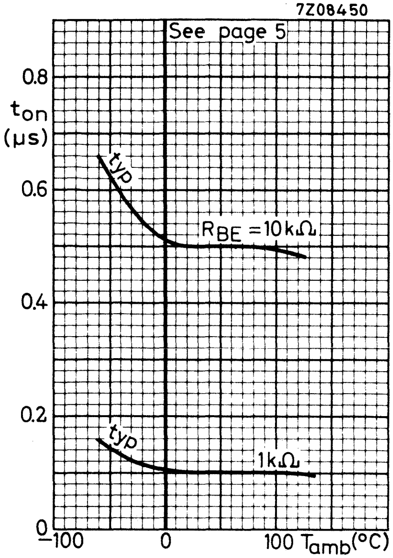
$R_{BE} = 10$ kΩ $t_q < 8$ μs

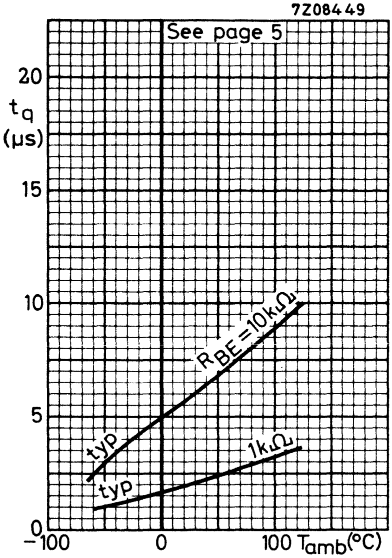
$T_j = 125\ ^{\circ}C$; $R_{BE} = 10$ kΩ $t_q < 15$ μs

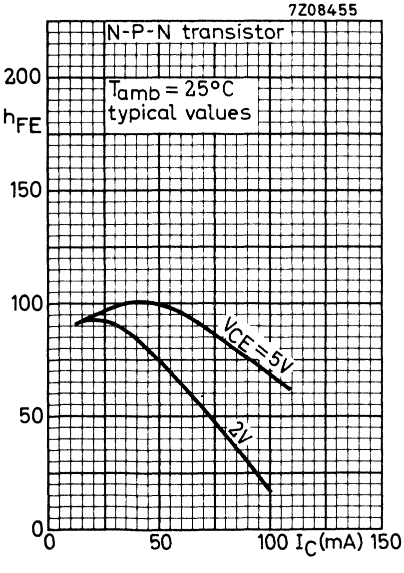


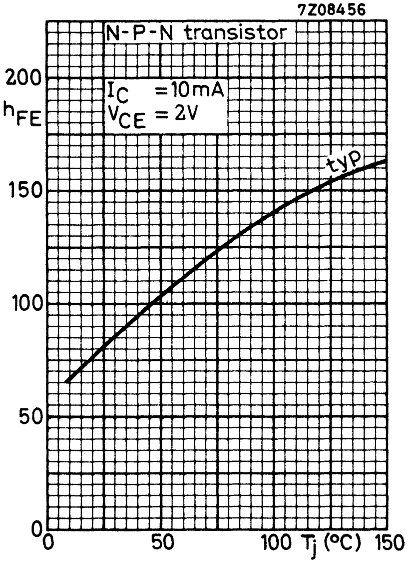


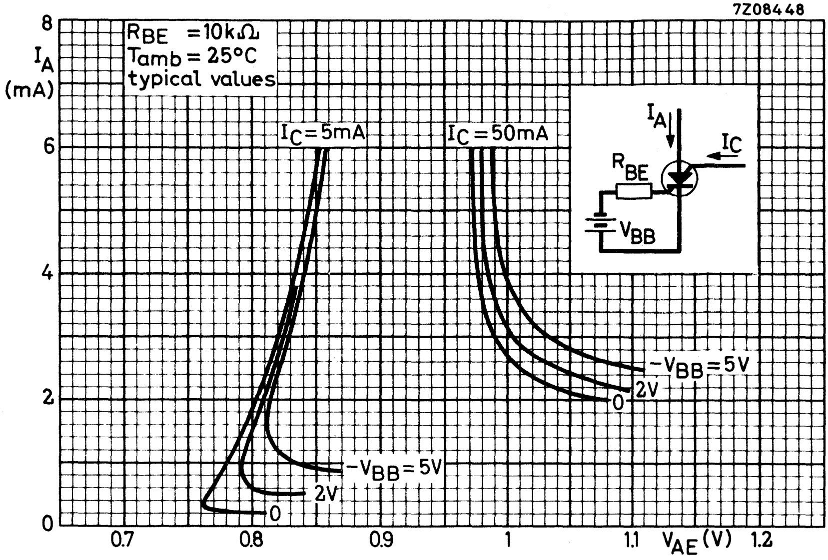
Capacitance increased until dashed curve disappears at $C = C_{opt}$

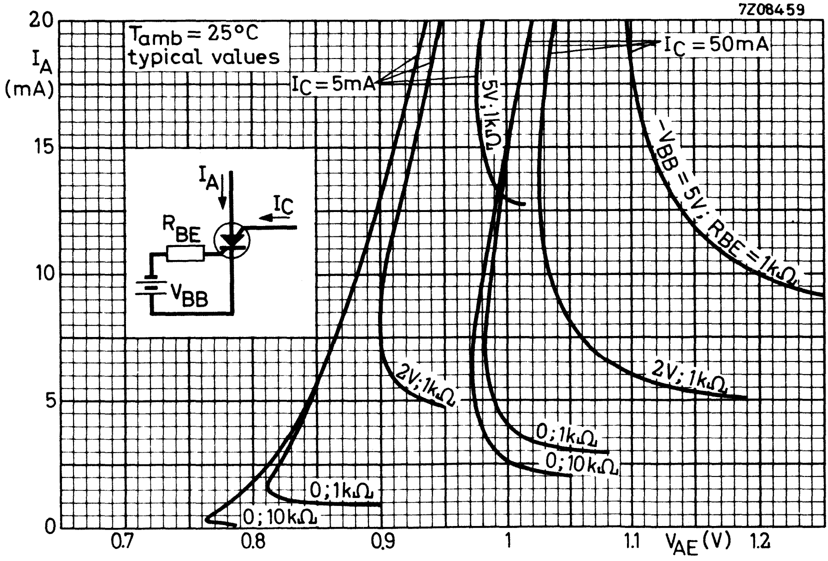

7Z08450
See page 5
t_{on} (μs)
0.8
0.6
0.4
0.2
0
typ
R_{BE} = 10 kΩ
typ
1 kΩ
−100
0
100 T_{amb} (°C)

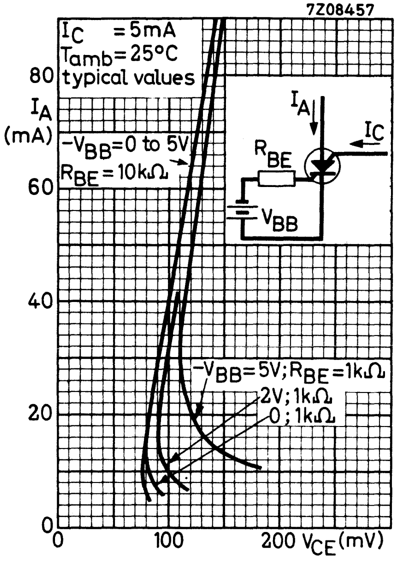

7Z08449
See page 5
t_q (μs)
20
15
10
5
0
typ
R_{BE} = 10 kΩ
typ
1 kΩ
−100
0
100 T_{amb} (°C)

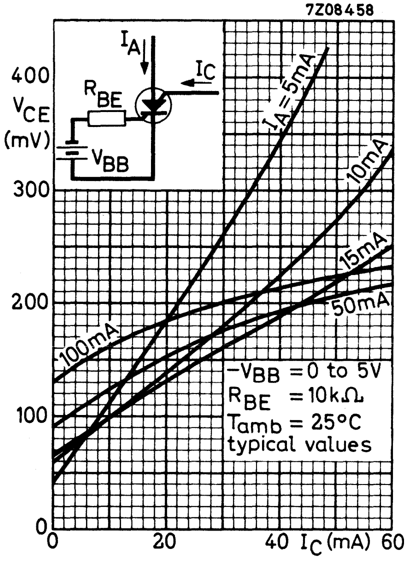

7Z08455
N-P-N transistor
T_{amb} = 25°C
typical values
h_{FE}
200
150
100
50
0
V_{CE} = 5V
2V
0
50
100 I_C (mA) 150

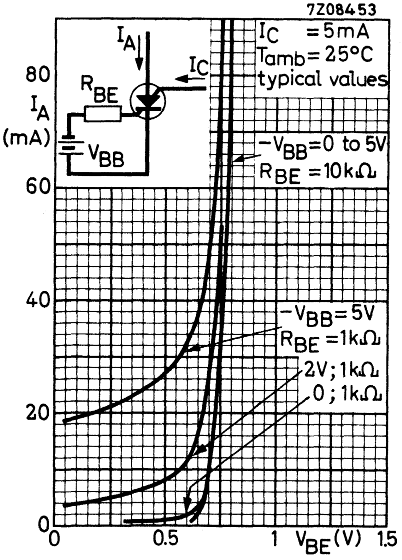

7Z08456
N-P-N transistor
I_C = 10 mA
V_{CE} = 2V
h_{FE}
200
150
100
50
0
typ
0
50
100 T_j (°C) 150

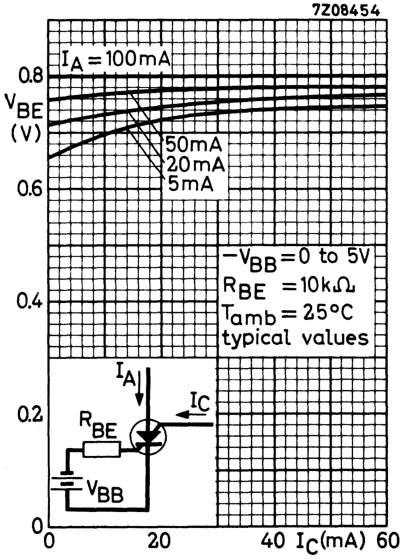

7Z08448
R_BE = 10 kΩ
T_amb = 25°C
typical values
I_A (mA)
8
6
4
2
0
I_C = 5mA
I_C = 50mA
−V_BB = 5V
2V
0
−V_BB = 5V
2V
0
I_A
I_C
R_BE
V_BB
0.7
0.8
0.9
1
1.1
V_AE (V)
1.2

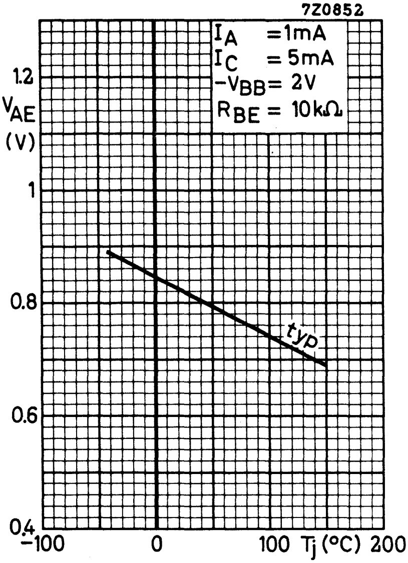

7Z08459
T_amb = 25°C
typical values
I_A (mA)
20
15
10
5
0
I_C = 5mA
I_C = 50mA
5V; 1kΩ
−V_BB = 5V; R_BE = 1kΩ
2V; 1kΩ
2V; 1kΩ
0; 1kΩ
0; 10kΩ
0; 1kΩ
0; 10kΩ
I_A
I_C
R_BE
V_BB
0.7
0.8
0.9
1
1.1
V_AE (V)
1.2

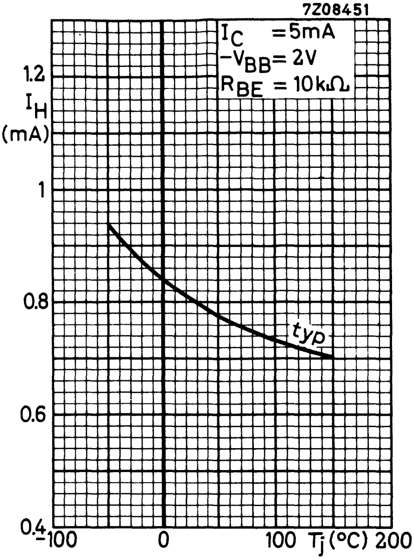

7Z08457
I_C = 5mA
T_{amb} = 25°C
typical values
$-V_{BB}$ = 0 to 5V
R_{BE} = 10kΩ
$-V_{BB}$ = 5V; R_{BE} = 1kΩ
2V; 1kΩ
0; 1kΩ
I_A
I_C
R_{BE}
V_{BB}
I_A (mA)
0
20
40
60
80
0
100
200
V_{CE} (mV)


7Z08458
I_A = 5mA
10mA
15mA
50mA
100mA
$-V_{BB}$ = 0 to 5V
R_{BE} = 10kΩ
T_{amb} = 25°C
typical values
I_A
I_C
R_{BE}
V_{BB}
V_{CE} (mV)
0
100
200
300
400
0
20
40
60
I_C (mA)


7Z08453
I_C = 5mA
T_{amb} = 25°C
typical values
$-V_{BB}$ = 0 to 5V
R_{BE} = 10kΩ
$-V_{BB}$ = 5V
R_{BE} = 1kΩ
2V; 1kΩ
0; 1kΩ
I_A
I_C
R_{BE}
V_{BB}
I_A (mA)
0
20
40
60
80
0
0.5
1
1.5
V_{BE} (V)


7Z08454
I_A = 100mA
50mA
20mA
5mA
$-V_{BB}$ = 0 to 5V
R_{BE} = 10kΩ
T_{amb} = 25°C
typical values
I_A
I_C
R_{BE}
V_{BB}
V_{BE} (V)
0
0.2
0.4
0.6
0.8
0
20
40
60
I_C (mA)

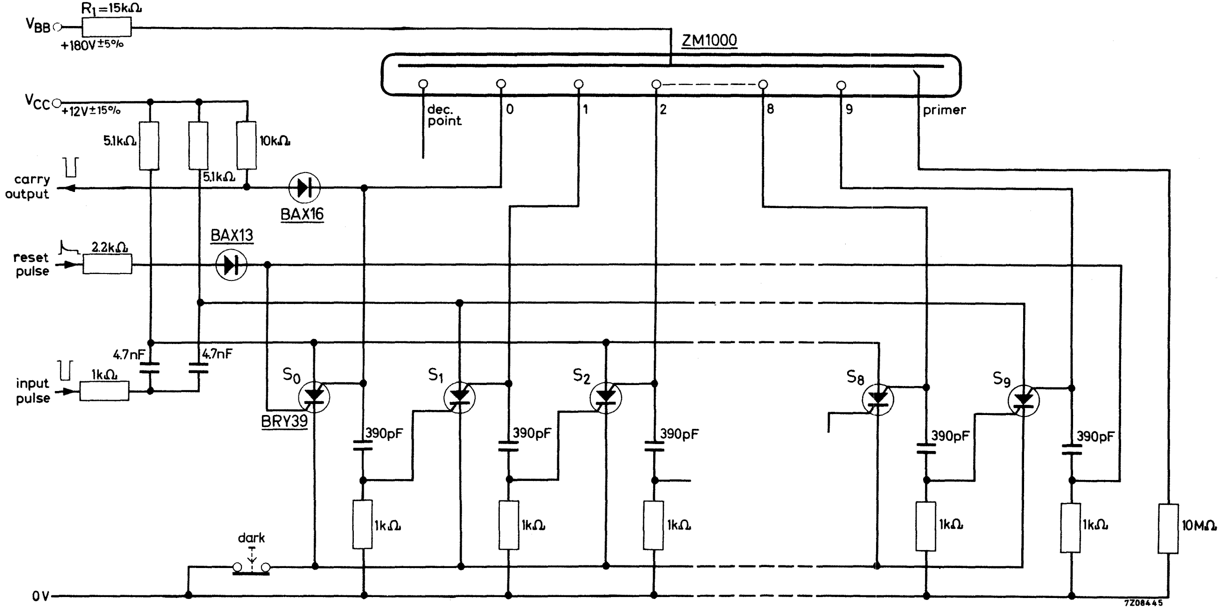

7Z0852
I_A = 1mA
I_C = 5mA
$-V_{BB}$ = 2V
R_{BE} = 10kΩ
V_{AE} (V)
1.2
1
0.8
0.6
0.4
−100
0
100
200
T_j (°C)
typ


7Z08451
I_C = 5mA
$-V_{BB}$ = 2V
R_{BE} = 10kΩ
I_H (mA)
1.2
1
0.8
0.6
0.4
−100
0
100
200
T_j (°C)
typ

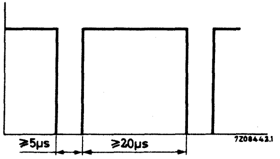
APPLICATION INFORMATION

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%

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

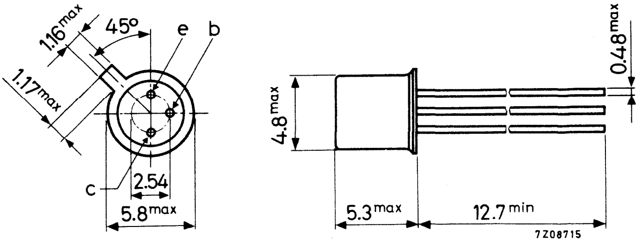
Collector-base voltage (open emitter)	V_{CBO}	max.	40	V
Collector-emitter voltage (open base)	V_{CEO}	max.	25	V
Collector current (peak value)	I_{CM}	max.	500	mA
Total power dissipation up to T_{case} = 25 °C	P_{tot}	max.	1.0	W
Junction temperature	T_j	max.	200	°C
D.C. current gain I_C = 500 mA; V_{CE} = 10 V	h_{FE}	>	20	
Transition frequency I_C = 50 mA; V_{CE} = 10 V; f = 100 MHz	f_T	>	250	MHz
Turn off time when switched from I_C = 300 mA; I_B = 40 mA to cut-off with $-I_{BM}$ = 20 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) $I_C = 0.1$ mA	V_{CBO}	max.	40	V
Collector-emitter voltage (open base) $I_C = 30$ mA	V_{CEO}	max.	25	V
Emitter-base voltage (open collector) $I_E = 0.1$ 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 $T_{case} = 25$ °C	P_{tot}	max.	1.0	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	$R_{th\ j-a}$	=	0.50	°C/mW
From junction to case	$R_{th\ j-c}$	=	0.175	°C/mW

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

Collector cut-off current

$I_E = 0$; $V_{CB} = 30$ V	I_{CBO}	<	0.5	μA
$I_E = 0$; $V_{CB} = 30$ V; $T_j = 100\ ^oC$	I_{CBO}	<	50	μA

Saturation voltages

$I_C = 150$ mA; $I_B = 15$ mA	V_{CEsat} V_{BEsat}	< <	0.5 1.3	V V
$I_C = 500$ mA; $I_B = 35$ mA	V_{CEsat}	<	0.7	V
$I_C = 500$ mA; $I_B = 50$ mA	V_{BEsat}	<	1.8	V

D.C. current gain

$I_C = 10$ mA; $V_{CE} = 10$ V	h_{FE}	>	30	
$I_C = 500$ mA; $V_{CE} = 10$ V	h_{FE}	>	20	

Collector capacitance

$I_E = I_e = 0$; $V_{CB} = 10$ V; f = 1 MHz	C_c	<	8.0	pF

Transition frequency at f = 100 MHz

$I_C = 50$ mA; $V_{CE} = 10$ V	f_T	>	250	MHz

Turn on time when switched to

a) $I_C = 150$ mA; $I_B = 15$ mA (fig. 1 on page 4)	t_{on}	<	60	ns
b) $I_C = 300$ mA; $I_B = 40$ mA (fig. 1 on page 4)	t_{on}	<	50	ns

Turn off time when switched from

c) $I_C = 150$ mA; $I_B = 15$ mA to cut-off with $-I_{BM} = 15$ mA (fig. 2 on page 4)	t_{off}	<	60	ns
d) $I_C = 300$ mA; $I_B = 40$ mA to cut-off with $-I_{BM} = 20$ mA (fig. 1 on page 4)	t_{off}	<	100	ns
e) $I_C = 400$ mA; $I_B = 50$ mA to cut-off with $-I_{BM} = 1$ mA (fig. 1 on page 4)	t_{off}	<	300	ns

CHARACTERISTICS (continued)

	I_C (mA)	I_B (mA)	I_{BM} (mA)	V_{CC} (V)	R1 (kΩ)	R2 (kΩ)	R3 (Ω)	R4 (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

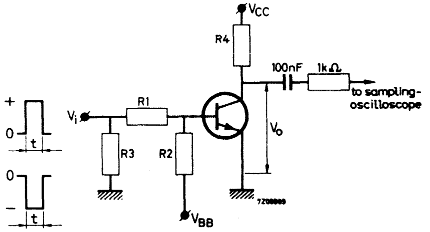


Fig. 1

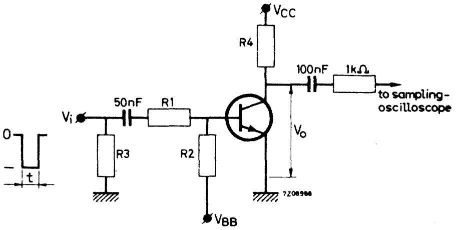


Fig. 2

Pulse generator:

Rise time $t_r \leq 2$ ns

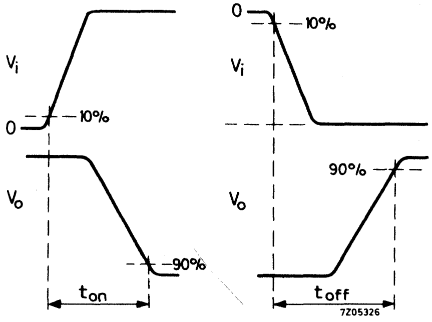
Pulse duration $t = 200$ ns

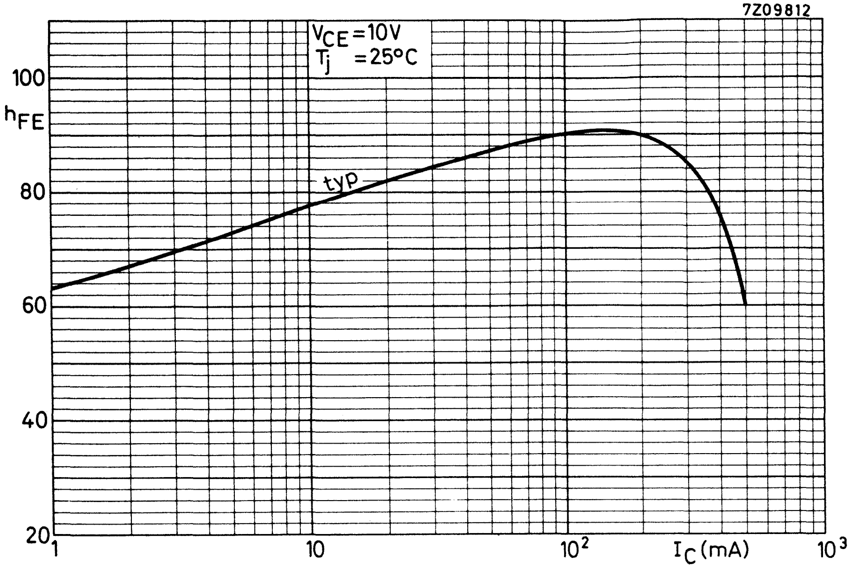
Fall time $t_f \leq 2$ ns

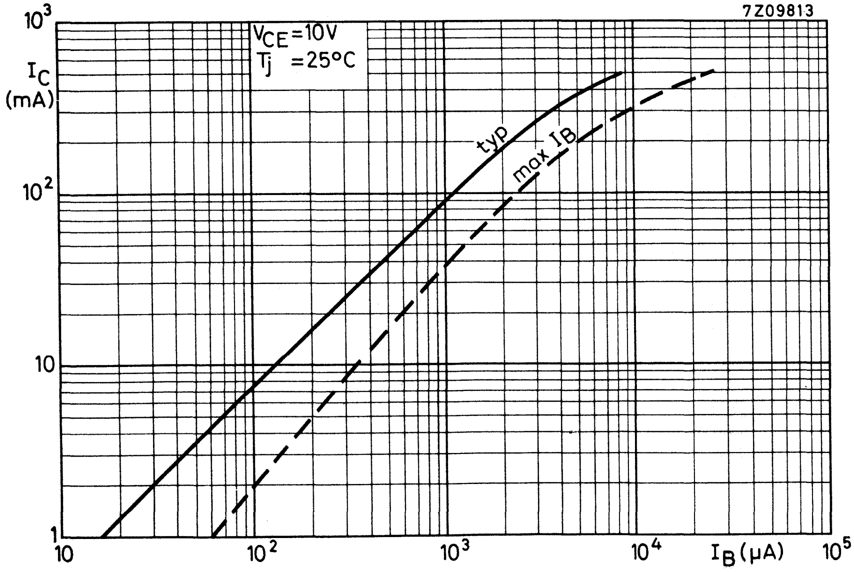
Output resistance $R_o = 50$ Ω

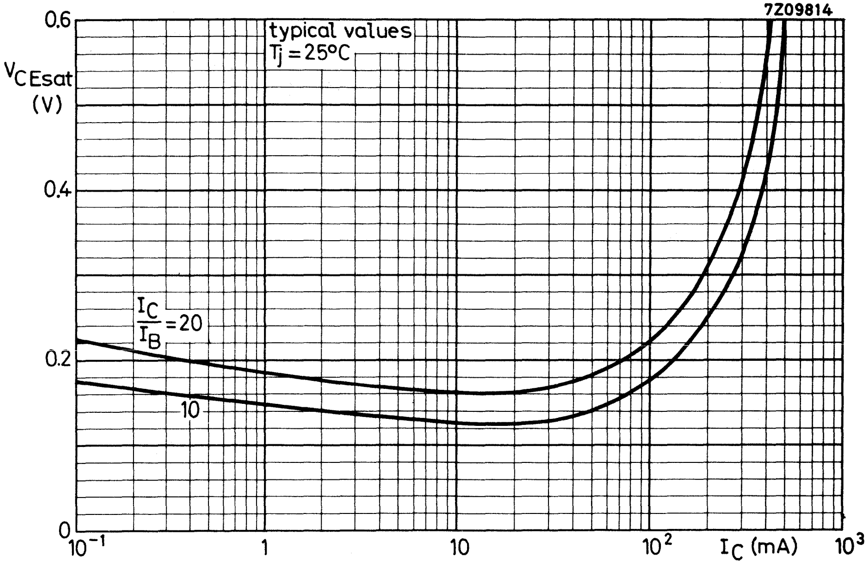
Oscilloscope:

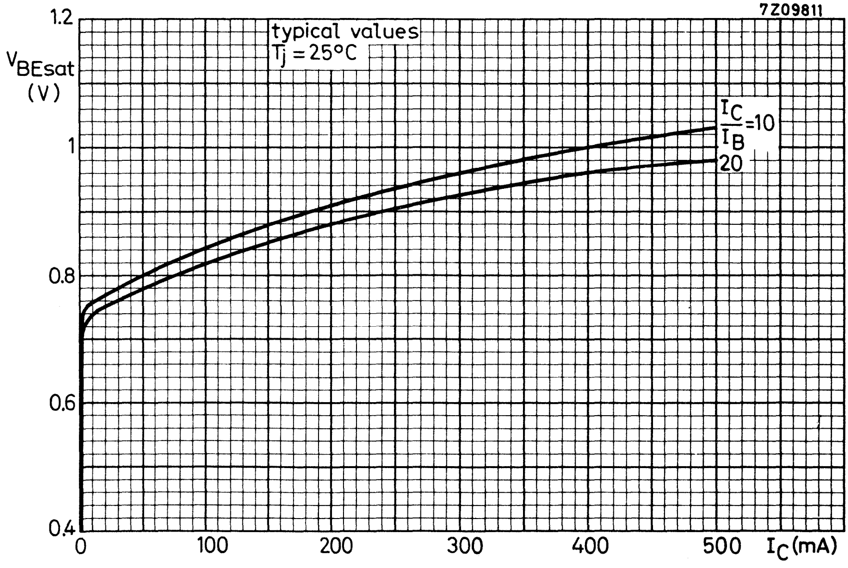
Input resistance $R_i = 50$ Ω

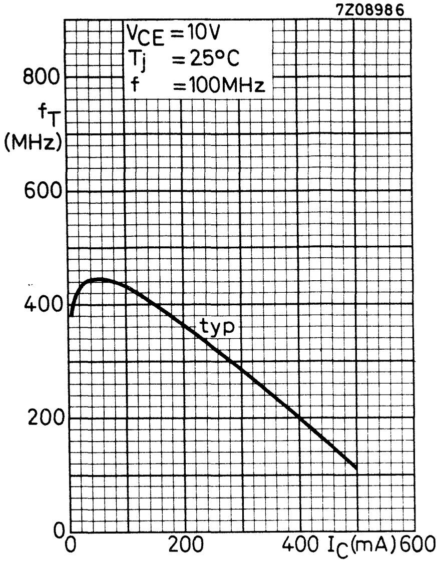


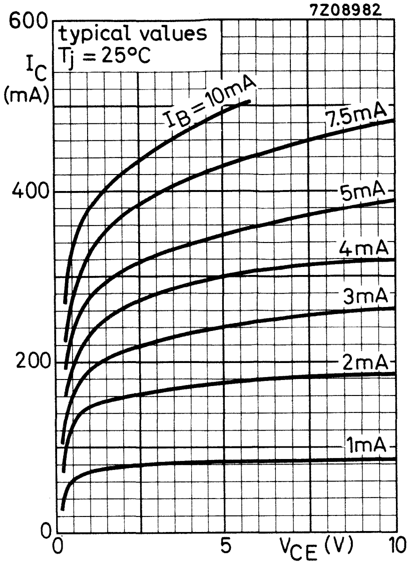

7Z09812
V_{CE} = 10 V
T_j = 25°C
h_{FE}
100
80
60
40
20
typ
1
10
10^2
I_C (mA)
10^3

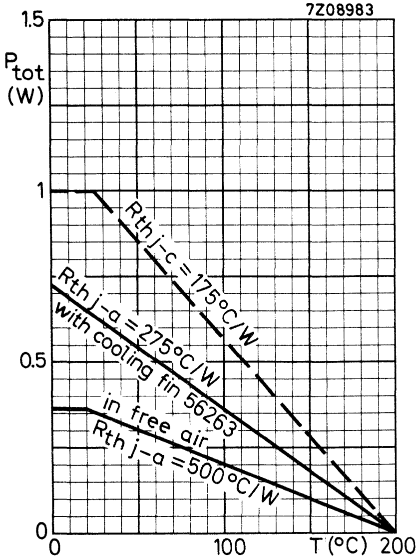

7Z09813
V_{CE} = 10 V
T_j = 25°C
I_C (mA)
10^3
10^2
10
1
typ
max I_B
10
10^2
10^3
10^4
I_B (μA)
10^5

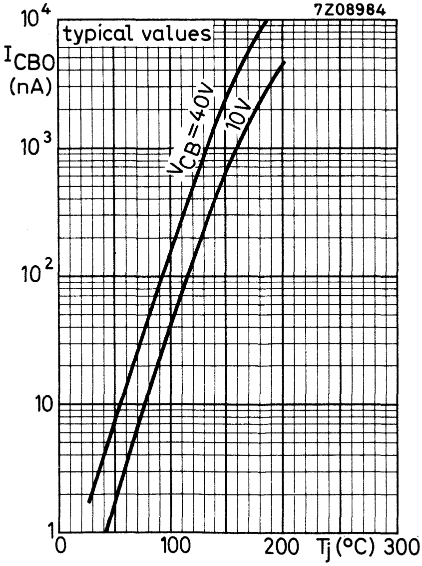

7Z09814
typical values
$T_j = 25°C$
V_{CEsat} (V)
0.6
0.4
0.2
0
$\frac{I_C}{I_B} = 20$
10
10^{-1}
1
10
10^2
I_C (mA)
10^3


7Z09811
typical values
$T_j = 25°C$
V_{BEsat} (V)
1.2
1
0.8
0.6
0.4
$\frac{I_C}{I_B} = 10$
20
0
100
200
300
400
500
I_C (mA)


7Z08986
V_{CE} = 10V
T_j = 25°C
f = 100MHz
f_T (MHz)
800
600
400
200
0
typ
0
200
400
600
I_C (mA)


7Z08982
typical values
T_j = 25°C
I_C (mA)
600
400
200
0
I_B = 10mA
7.5mA
5mA
4mA
3mA
2mA
1mA
0
5
10
V_{CE} (V)


7Z08983
P_{tot} (W)
1.5
1
0.5
0
Rth j-c = 175°C/W
Rth j-a = 275°C/W with cooling fin 56263
in free air Rth j-a = 500°C/W
0
100
200
T (°C)


7Z08984
typical values
I_{CBO} (nA)
10^4
10^3
10^2
10
1
V_{CB} = 40V
10V
0
100
200
300
T_j (°C)

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

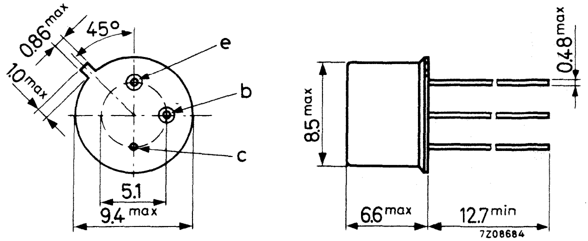
			BSW66	BSW67	BSW68	
Collector-base voltage (open emitter)	V_{CBO}	max.	100	120	150	V
Collector-emitter voltage (open base)	V_{CEO}	max.	100	120	150	V
Emitter-base voltage (open collector)	V_{EBO}	max.	6	6	6	V
Collector current (peak value)	I_{CM}	max.	2			A
Total power dissipation up to T_{case} = 25 °C	P_{tot}	max.	5.0			W
Junction temperature	T_j	max.	200			°C
Transition frequency at f = 35 MHz I_C = 100 mA; V_{CE} = 20 V	f_T	typ.	80			MHz
D.C. current gain I_C = 10 mA; V_{CE} = 5 V	h_{FE}	>	30			
I_C = 500 mA; V_{CE} = 5 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 $T_{amb} = 25\ ^oC$	P_{tot}	max.	0.8	W
$T_{case} = 25\ ^oC$	P_{tot}	max.	5.0	W

Switch off energy with inductive load (see page 4)

$L \leq 150$ mH	E	max.	5	mWs

Temperatures

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

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	220	$^oC/W$
From junction to case	$R_{th\ j\text{-}c}$	=	35	$^oC/W$

CHARACTERISTICS $T_j = 25\ ^oC$ 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
$I_E = 0$; $V_{CB} = \frac{1}{2} V_{CBOmax}$; $T_j = 150\ ^oC$	I_{CBO}	<	50	μA

Emitter cut-off current

$I_C = 0$; $V_{EB} = 6$ V	I_{EBO}	<	100	μA
$I_C = 0$; $V_{EB} = 3$ V	I_{EBO}	<	100	nA

---

[1] $I_C = 100$ mA

CHARACTERISTICS (continued)

Saturation voltages

I_C = 100 mA; I_B = 10 mA		V_{CEsat}	<	150	mV
		V_{BEsat}	<	900	mV
I_C = 500 mA; I_B = 50 mA	BSW66; BSW67	V_{CEsat}	<	400	mV
	BSW68	V_{CEsat}	<	500	mV
		V_{BEsat}	<	1.1	V
I_C = 1 A; I_B = 150 mA		V_{CEsat}	<	1	V
		V_{BEsat}	<	1.4	V

D.C. current gain

I_C = 10 mA; V_{CE} = 5 V	h_{FE}	>	30	
I_C = 100 mA; V_{CE} = 5 V	h_{FE}	>	40	
I_C = 500 mA; V_{CE} = 5 V	h_{FE}	>	30	
I_C = 1 A; V_{CE} = 5 V	h_{FE}	>	15	

Collector capacitance at f = 1 MHz

$I_E = I_e = 0$; V_{CB} = 10 V	C_c	<	35	pF

Emitter capacitance at f = 1 MHz

$I_C = I_c = 0$; $V_{EB} = 0$	C_e	<	650	pF

Transition frequency at f = 35 MHz

I_C = 100 mA; V_{CE} = 20 V	f_T	typ.	80	MHz

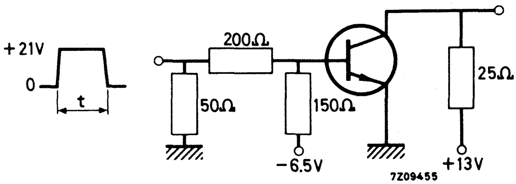
Turn on time when switched from

$-V_{BE}$ = 4 V to I_C = 500 mA; I_B = 50 mA	t_{on}	typ.	0.5	μs

Turn off time when switched from

I_C = 500 mA; I_B = 50 mA to $-V_{BB}$ = 6.5 V ($-I_{BM}$ = 50 mA)	t_{off}	typ.	1	μs

Test circuit:



Pulse generator:

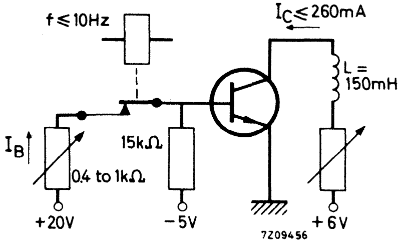
Pulse duration	t > 5 μs
Rise time	t_r < 10 ns
Fall time	t_f < 10 ns

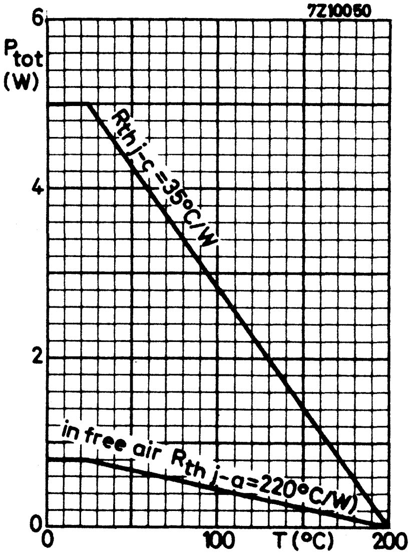
Note

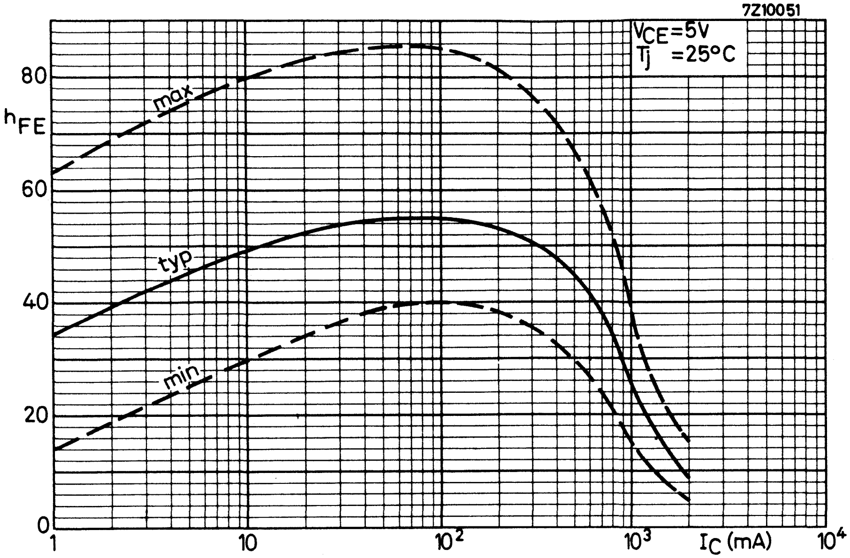
$-I_{BM}$ is the reverse current that can flow during switching off. The indicated $-I_{BM}$ is determined and limited by the applied cut-off voltage and series resistance.

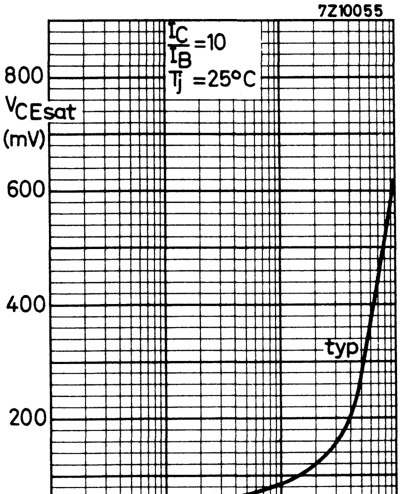
CHARACTERISTICS (continued)

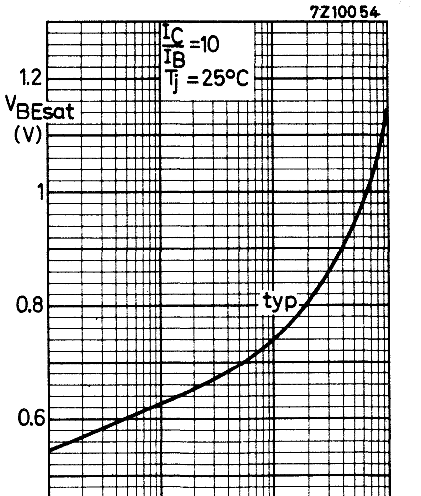
Test circuit for switching off inductive loads.

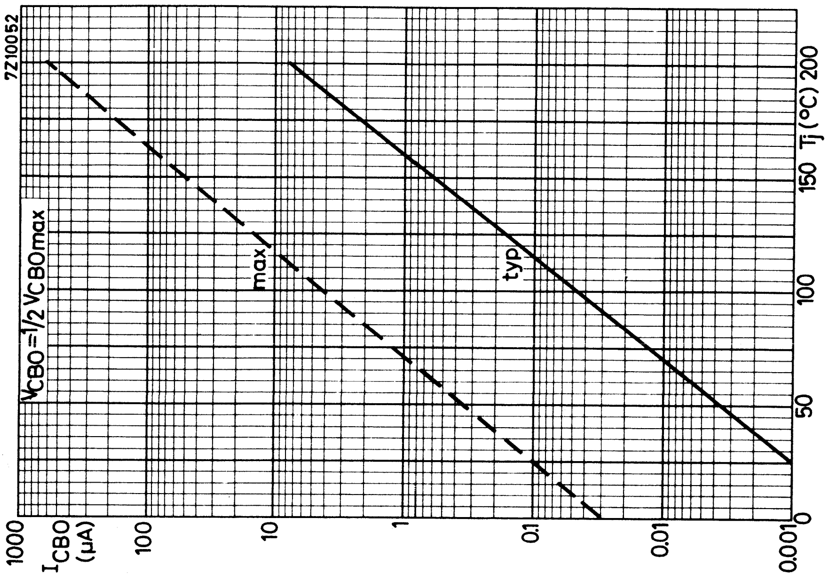


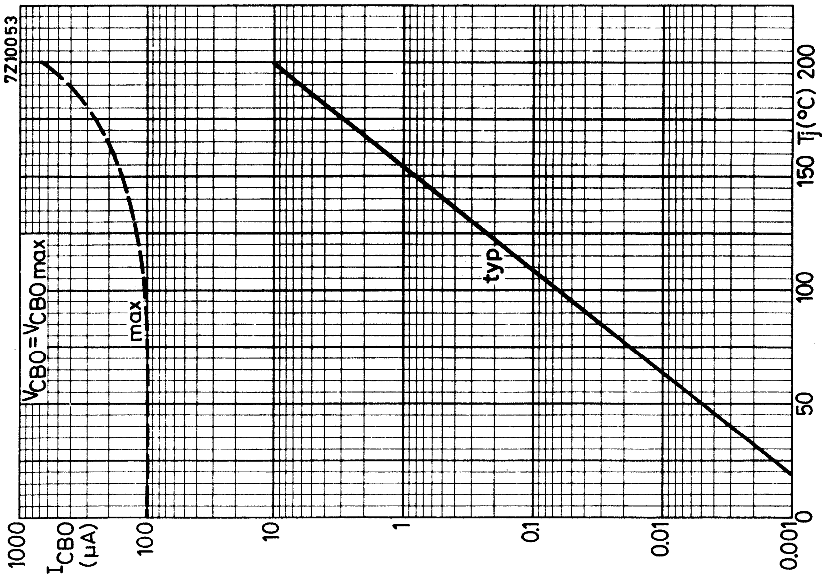



7Z10051
V_{CE}=5V
T_j =25°C
h_{FE}
80
60
40
20
0
max
typ
min
1
10
10^2
10^3
I_C (mA)
10^4


7Z10055
$\frac{I_C}{I_B}$=10
T_j =25°C
800
V_{CEsat}
(mV)
600
400
200
0
typ
1
10
100
I_C(mA)
1000


7Z10054
$\frac{I_C}{I_B}$=10
T_j =25°C
1.2
V_{BEsat}
(V)
1
0.8
0.6
0.4
typ
1
10
100
I_C(mA)
1000


7Z10052
VCBO = 1/2 VCBOmax
max
typ
ICBO (μA)
1000
100
10
1
0.1
0.01
0.001
0
50
100
150
200
Tj (°C)


7Z10053
VCBO = VCBOmax
max
typ
ICBO (μA)
1000
100
10
1
0.1
0.01
0.001
0
50
100
150
200
Tj (°C)

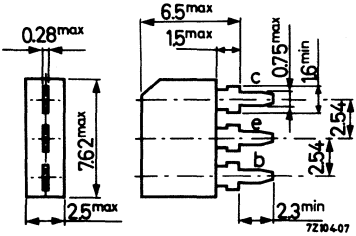
SILICON PLANAR SWITCHING TRANSISTOR

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 kΩ	V_{CER}	max.	150	V
Collector current (d.c.)	I_C	max.	50	mA
Total power dissipation up to T_{amb} = 50 °C	P_{tot}	max.	125	mW
D.C. current gain at T_j = 25 °C I_C = 4 mA; V_{CE} = 2 V	h_{FE}	>	30	
Transition frequency at f = 100 MHz I_C = 10 mA; V_{CE} = 5 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 kΩ	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 °C	P_{tot}	max.	125	mW
Temperatures				
Storage temperature	T_{stg}		−30 to +125	°C
Junction temperature	T_j	max.	125	°C

THERMAL RESISTANCE

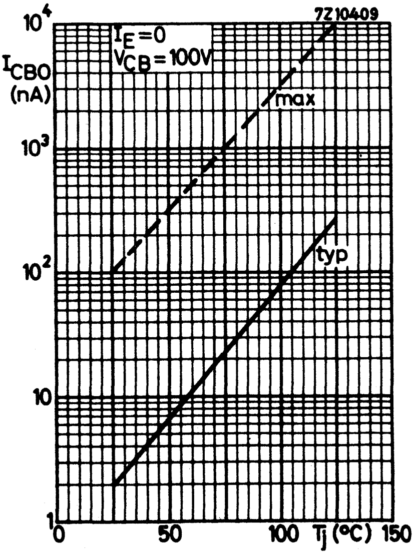
From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	0.6	°C/mW

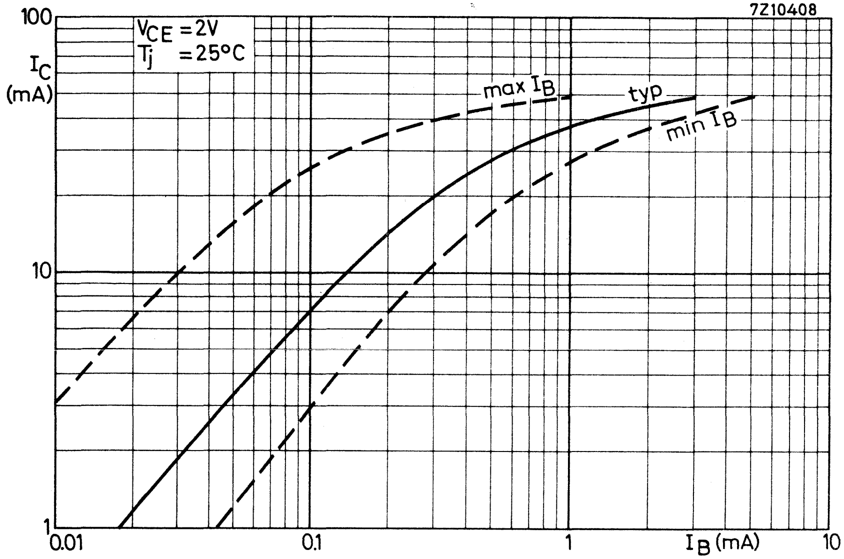
CHARACTERISTICS T_j = 25 °C unless otherwise specified

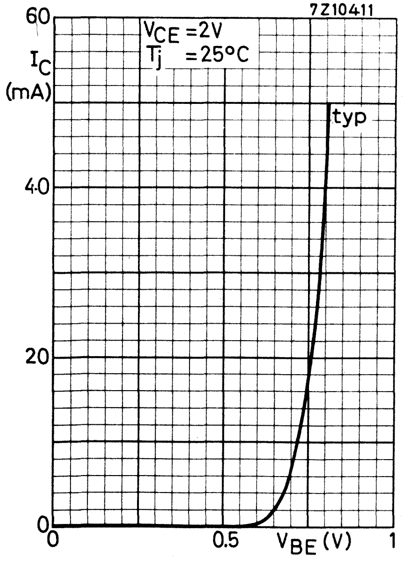
Collector cut-off current				
$I_E = 0$; V_{CB} = 100 V	I_{CBO}	<	100	nA
$I_E = 0$; V_{CB} = 150 V	I_{CBO}	<	10	μA
V_{BE} = 150 V; R_{BE} = 10 kΩ	I_{CER}	<	100	μA
V_{CE} = 100 V; V_{BE} = 0.4 V; T_j = 75 °C	I_{CEX}	<	100	μA
Emitter cut-off current				
$I_C = 0$; V_{EB} = 4 V	I_{EBO}	<	100	nA
$I_C = 0$; V_{EB} = 6 V	I_{EBO}	<	10	μA

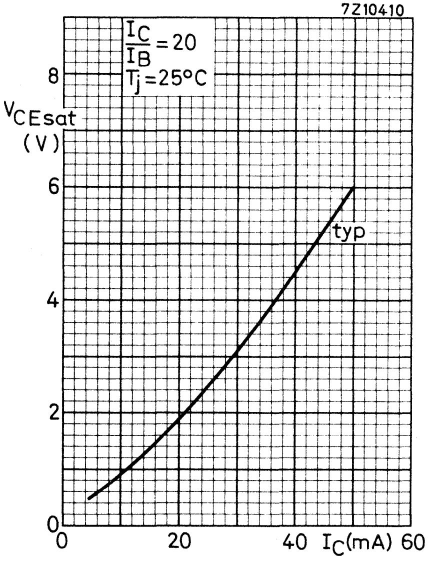
CHARACTERISTICS (continued) $T_j = 25\ ^{o}C$ unless otherwise specified

Base-emitter voltage				
$I_C = 4$ mA; $V_{CE} = 2$ V	V_{BE}	<	0.75	V
Saturation voltage				
$I_C = 20$ mA; $I_B = 1$ mA	V_{CEsat}	<	4	V
D.C. current gain				
$I_C = 4$ mA; $V_{CE} = 2$ V	h_{FE}	>	30	
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; $V_{CB} = 10$ V	C_c	typ.	2	pF
Emitter capacitance at f = 1 MHz				
$I_C = I_c = 0$; $V_{EB} = 0.5$ V	C_e	typ.	17	pF
Transition frequency at f = 100 MHz				
$I_C = 10$ mA; $V_{CE} = 5$ V	f_T	typ.	130	MHz




7Z10408
100
I_C
(mA)
10
1
0.01
0.1
1
I_B (mA)
10
V_CE = 2V
T_j = 25°C
max I_B
typ
min I_B


7Z10411
60
I_C
(mA)
40
20
0
0
0.5
V_BE (V)
1
V_CE = 2V
T_j = 25°C
typ


7Z10410
I_C/I_B = 20
T_j = 25°C
8
V_CEsat
(V)
6
4
2
0
0
20
40
I_C(mA)
60
typ

VERY HIGH SPEED SWITCHING TRANSISTORS

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

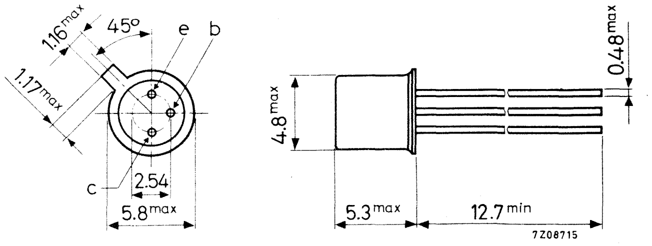
QUICK REFERENCE DATA

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

MECHANICAL DATA Dimensions in mm

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

Power dissipation

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

Temperatures

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

THERMAL RESISTANCE

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

---

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

CHARACTERISTICS

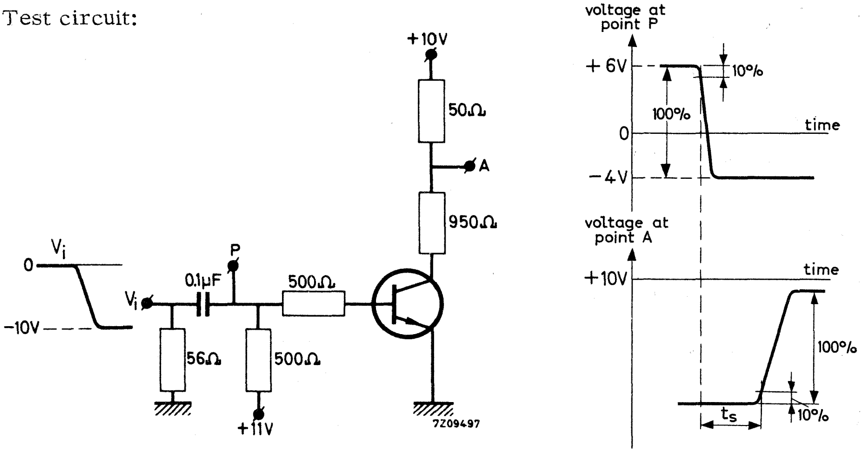
T_j = 25 °C unless otherwise specified

Collector cut-off current				
$I_E = 0$; $V_{CB} = 20$ V	I_{CBO}	<	400	nA
$I_E = 0$; $V_{CB} = 20$ V; $T_j = 150$ °C	I_{CBO}	<	30	μA
$V_{BE} = 0$; $V_{CE} = 15$ V; $T_j = 55$ °C	I_{CES}	<	0.40	μA
$V_{BE} = 0$; $V_{CE} = 40$ V	I_{CES}	<	1.0	μA
Emitter cut-off current				
$I_C = 0$; $V_{EB} = 4.5$ V	I_{EBO}	<	10	μA
Currents at reverse biased emitter junction				
$V_{CE} = 15$ V; $-V_{BE} = 3$ V; $T_j = 55$ °C	I_{CEX} $-I_{BEX}$	< <	0.60 0.60	μA μA
Sustaining voltages				
$I_C = 10$ mA; $I_B = 0$	$V_{CEOsust}$	>	15	V
$I_C = 10$ mA; $R_{BE} = 10\ \Omega$	$V_{CERsust}$	>	20	V
Base-emitter voltage (see also page 8)				
$I_C = 30\ \mu$A; $V_{CE} = 20$ V; $T_j = 100$ °C	V_{BE}	>	0.35	V
Saturation voltages				
$I_C = 10$ mA; BSX19: $I_B = 0.6$ mA BSX20: $I_B = 0.3$ mA	V_{CEsat}	<	0.3	V
$I_C = 10$ mA; $I_B = 1$ mA	V_{CEsat} V_{BEsat}	< 0.70 to	0.25 0.85	V V
$I_C = 100$ mA; $I_B = 10$ mA	V_{CEsat} V_{BEsat}	< <	0.60 1.50	V V
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; $V_{CB} = 5$ V	C_c	<	4	pF
Emitter capacitance at f = 1 MHz				
$I_C = I_c = 0$; $V_{EB} = 1$ V	C_e	<	4.5	pF

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

		BSX19	BSX20	
D.C. current gain				
I_C = 10 mA; V_{CE} = 1 V	h_{FE}	20 to 60	40 to 120	
I_C = 10 mA; V_{CE} = 1 V; T_j = −55 °C	h_{FE}	> 10	20	
I_C = 100 mA; V_{CE} = 2 V	h_{FE}	> 10	20	
Transition frequency				
I_C = 10 mA; V_{CE} = 10 V	f_T	> 400 typ. 500	500 600	MHz MHz
Switching times				
Storage time (see also pages 20 and 21)				
$I_C = I_B = -I_{BM}$ = 10 mA	t_s	typ. 5 < 10	6 13	ns ns

Test circuit:



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

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

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

Switching times

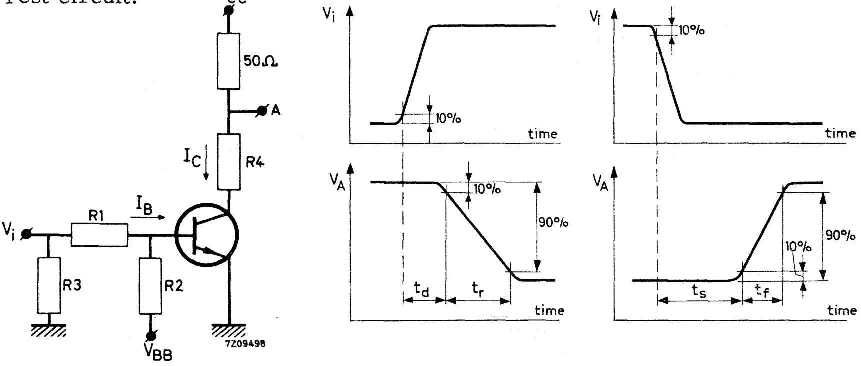
Turn on time (see also pages 14 and 15)

from $-V_{BE}$ = 1.5 V to I_C = 10 mA; I_B = 3 mA		t_{on}	<	12	ns
from $-V_{BE}$ = 2.25 V to I_C = 100 mA; I_B = 40 mA		t_{on}	<	7	ns

Turn off time (see also pages 16 to 19)

from I_C = 10 mA; I_B = 3 mA	BSX19	t_{off}	<	15	ns
to cut-off with $-I_{BM}$ = 1.5 mA	BSX20	t_{off}	<	18	ns
from I_C = 100 mA; I_B = 40 mA to cut-off	BSX19	t_{off}	<	18	ns
with $-I_{BM}$ = 20 mA	BSX20	t_{off}	<	21	ns

Test circuit:



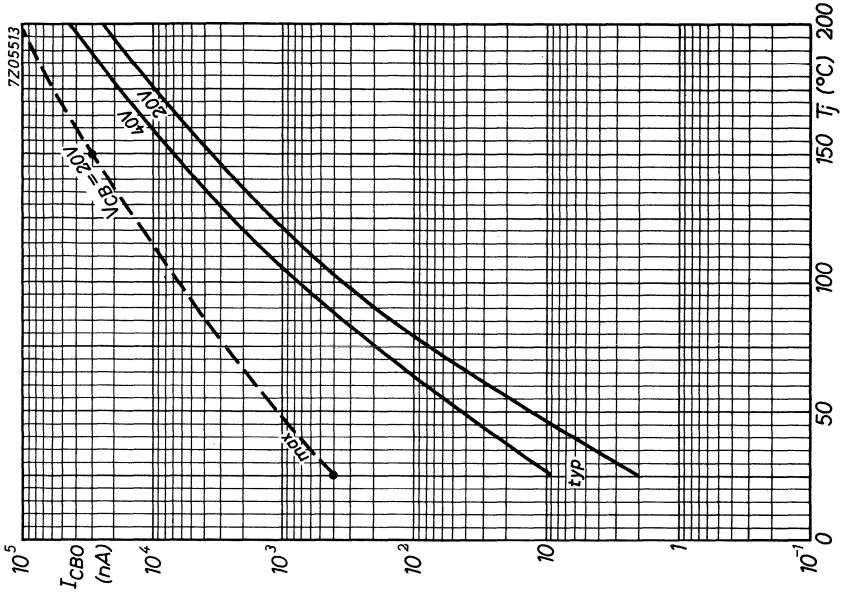
Pulse generator:				
Rise time	t_r	<	1	ns
Pulse duration	t	>	300	ns
Duty cycle	δ	<	0.02	
Source impedance	R_S	=	50	Ω

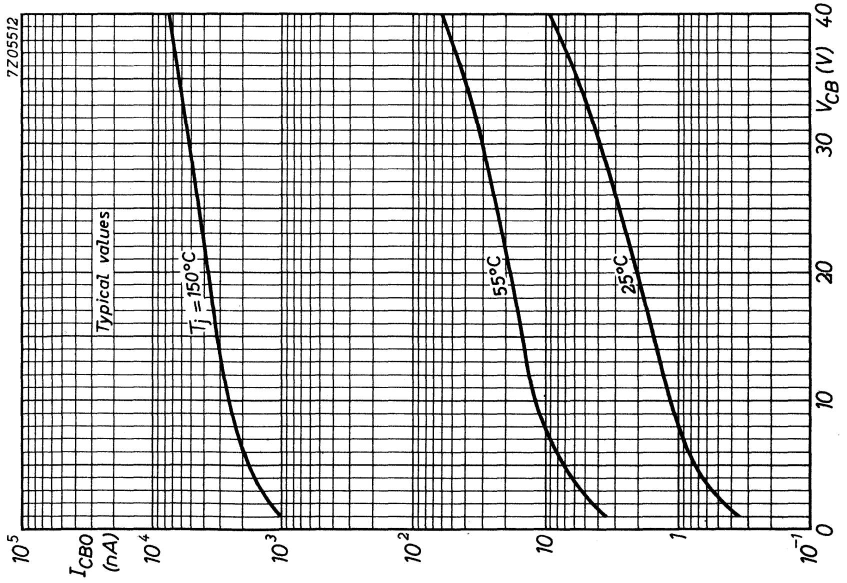
Oscilloscope:				
Input impedance	R_i	=	50	Ω
Rise time	t_r	<	1	ns

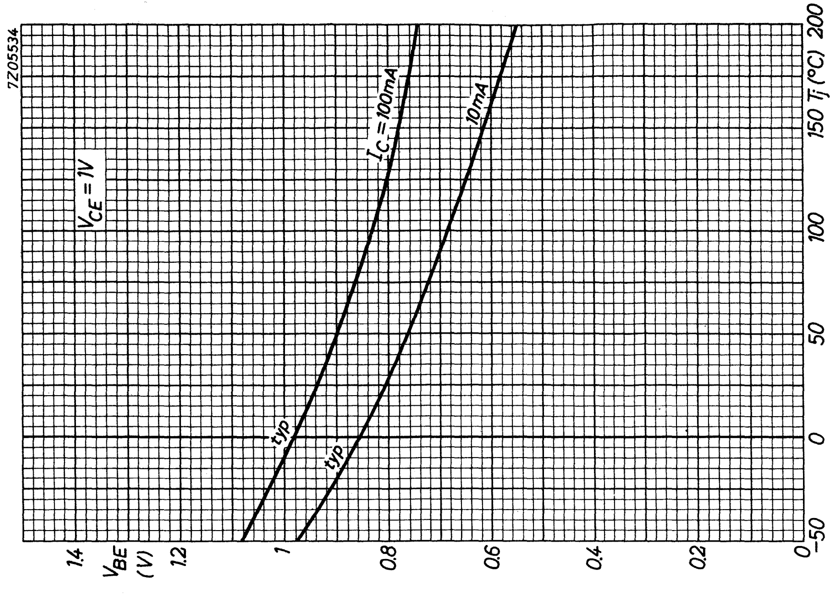
							turn on time			turn off time	
I_C (mA)	I_B (mA)	$-I_{BM}$ (mA)	V_{CC} (V)	R1;R2 (kΩ)	R3 (Ω)	R4 (Ω)	$-V_{BB}$ (V)	$-V_{BE}$ (V)	V_i (V)	V_{BB} (V)	$-V_i$ (V)
10	3	1.5	3	3.3	50	220	3.0	1.5	15	12.0	15
100	40	20	6	0.33	56	0	4.5	2.25	20	15.3	20

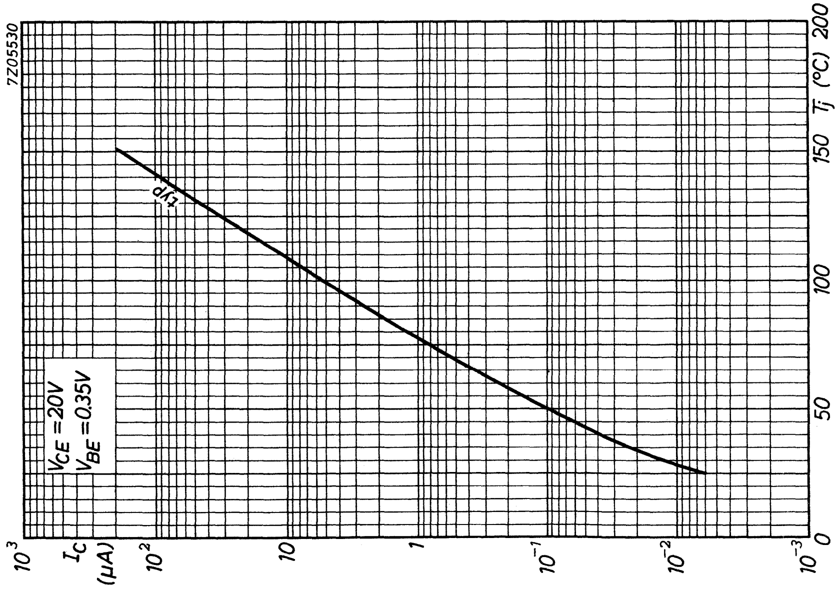
Note

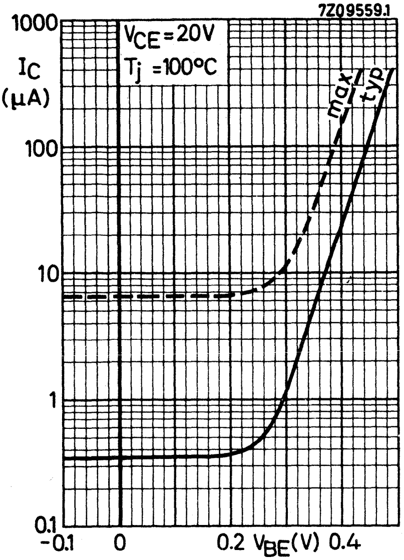
$-I_{BM}$ is the reverse current that can flow during switching off. The indicated $-I_{BM}$ is determined and limited by the applied cut-off voltage and series resistance.

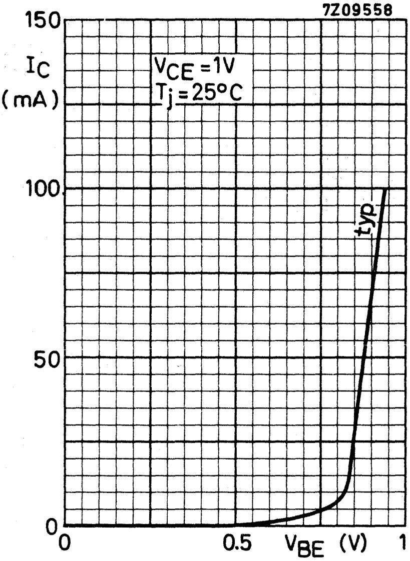

7Z05513
I_{CBO} (nA)
10^5
10^4
10^3
10^2
10
1
10^{-1}
T_j (°C)
0
50
100
150
200
V_{CB} = 20V
40V
20V
max
typ

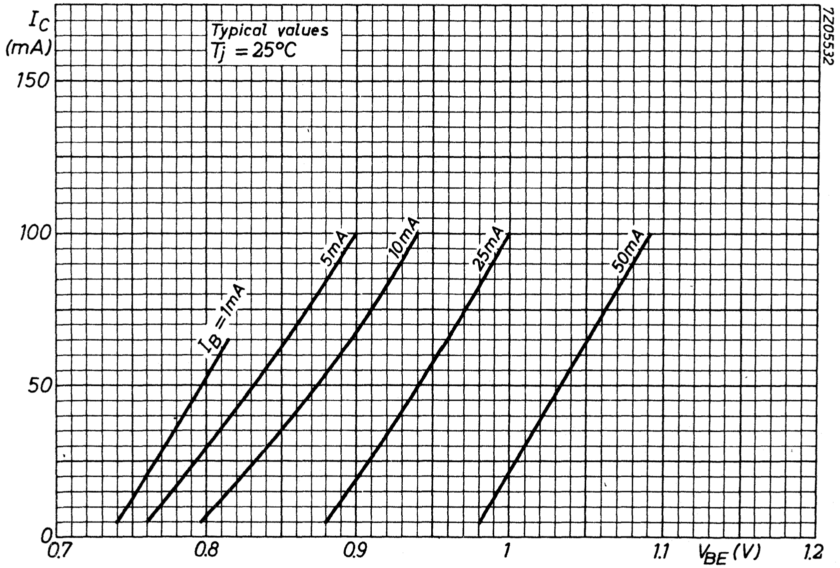

7Z05512
Typical values
I_{CBO} (nA)
10^5
10^4
10^3
10^2
10
1
10^{-1}
T_j = 150°C
55°C
25°C
V_{CB} (V)
0
10
20
30
40

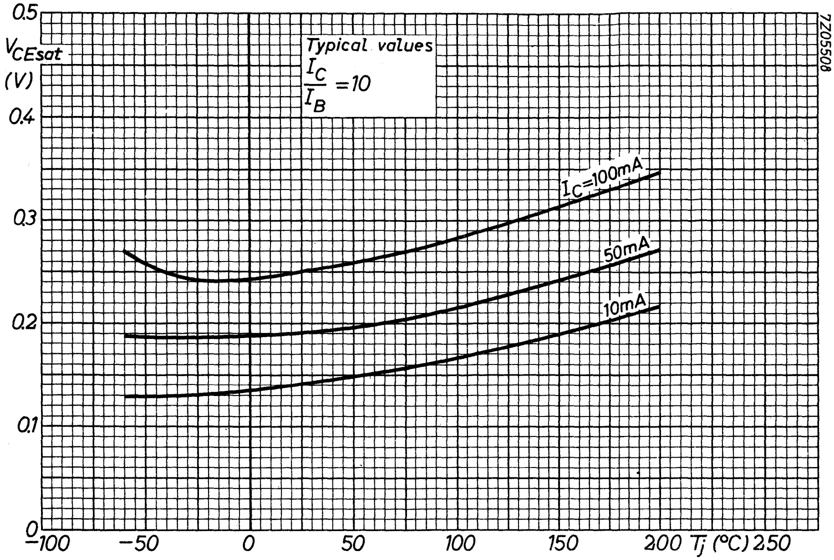

7Z05534
$V_{CE} = 1V$
$I_C = 100mA$
10mA
typ
typ
V_{BE} (V)
1.4
1.2
1
0.8
0.6
0.4
0.2
0
−50
0
50
100
150
200
T_j (°C)

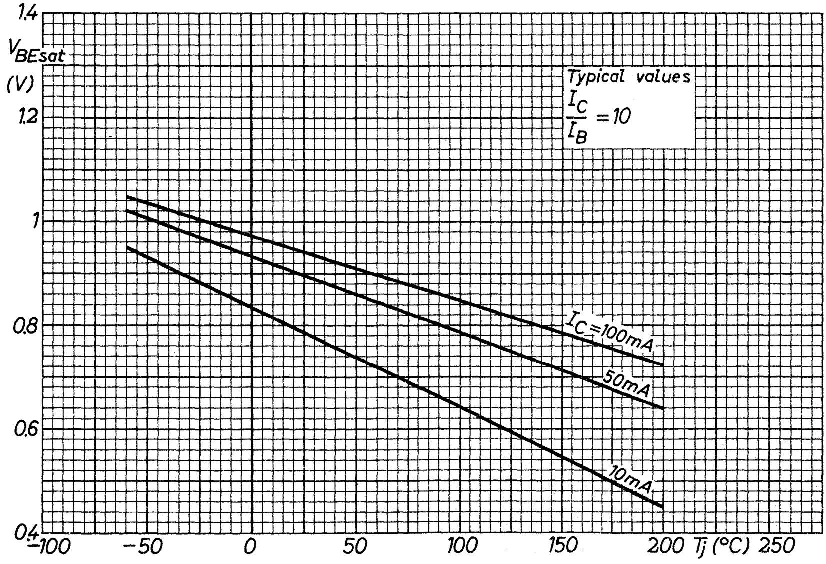

7Z05530
$V_{CE} = 20V$
$V_{BE} = 0.35V$
typ
I_C (μA)
10^3
10^2
10
1
10^{-1}
10^{-2}
10^{-3}
0
50
100
150
200
T_j (°C)

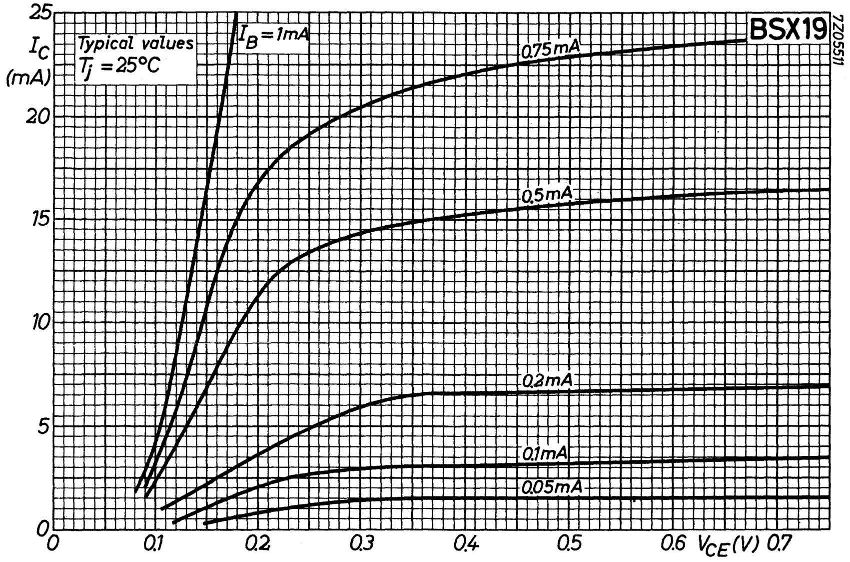

7Z09559.1
1000
100
10
1
0.1
I_C
(μA)
$V_{CE} = 20V$
$T_j = 100°C$
max
typ
−0.1
0
0.2
V_{BE}(V)
0.4

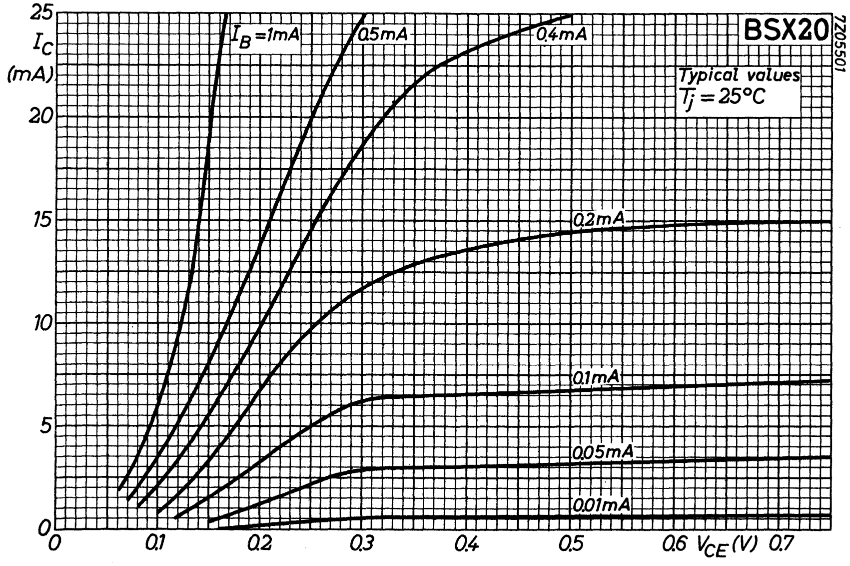

7Z09558
150
100
50
0
I_C
(mA)
$V_{CE} = 1V$
$T_j = 25°C$
typ
0
0.5
V_{BE} (V)
1

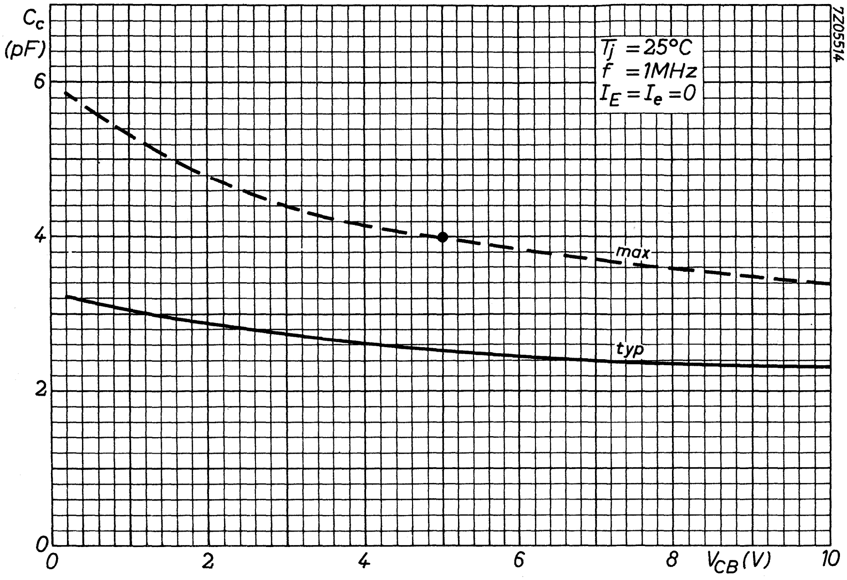

7Z05532
I_C
(mA)
150
100
50
0
Typical values
$T_j = 25°C$
$I_B = 1mA$
5mA
10mA
25mA
50mA
0.7
0.8
0.9
1
1.1
V_{BE} (V)
1.2

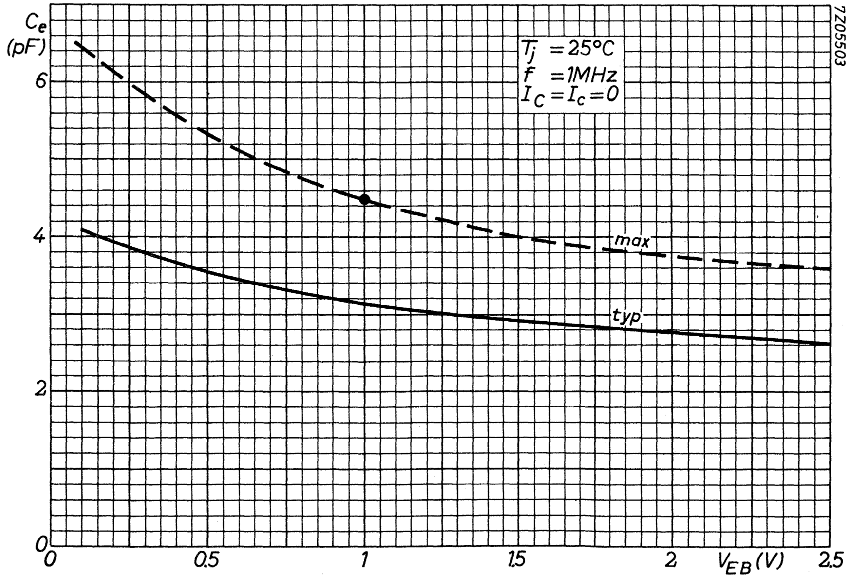

0.5
V_{CEsat}
(V)
0.4
0.3
0.2
0.1
0
−100
−50
0
50
100
150
200
T_j (°C)
250
Typical values
$\frac{I_C}{I_B}=10$
I_C=100mA
50mA
10mA
7Z05508

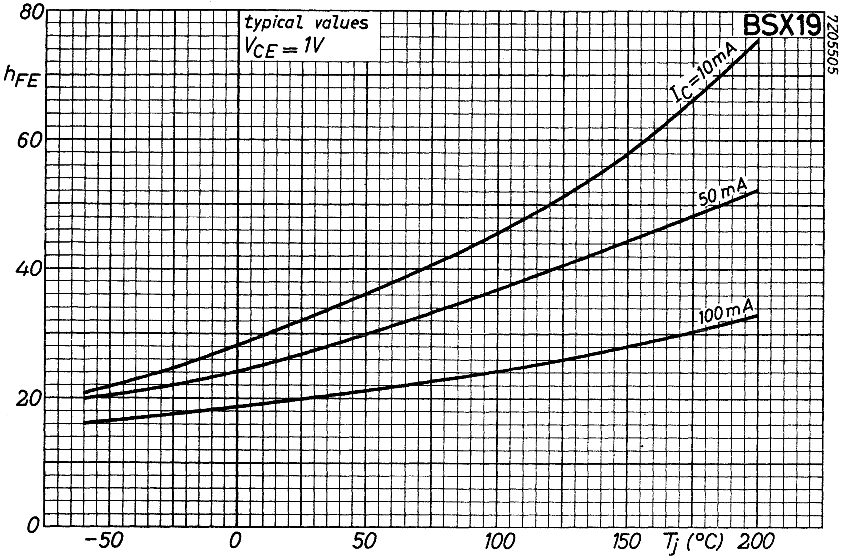

1.4
V_{BEsat}
(V)
1.2
1
0.8
0.6
0.4
−100
−50
0
50
100
150
200
T_j (°C)
250
Typical values
$\frac{I_C}{I_B}=10$
I_C=100mA
50mA
10mA

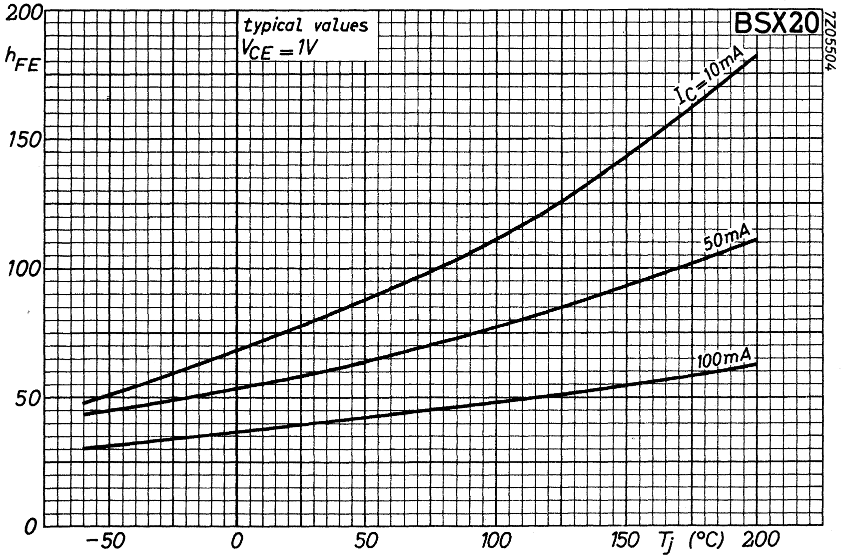

BSX19
7205511
Typical values
$T_j = 25°C$
I_C
(mA)
$I_B = 1mA$
0.75mA
0.5mA
0.2mA
0.1mA
0.05mA
25
20
15
10
5
0
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
V_{CE}(V)

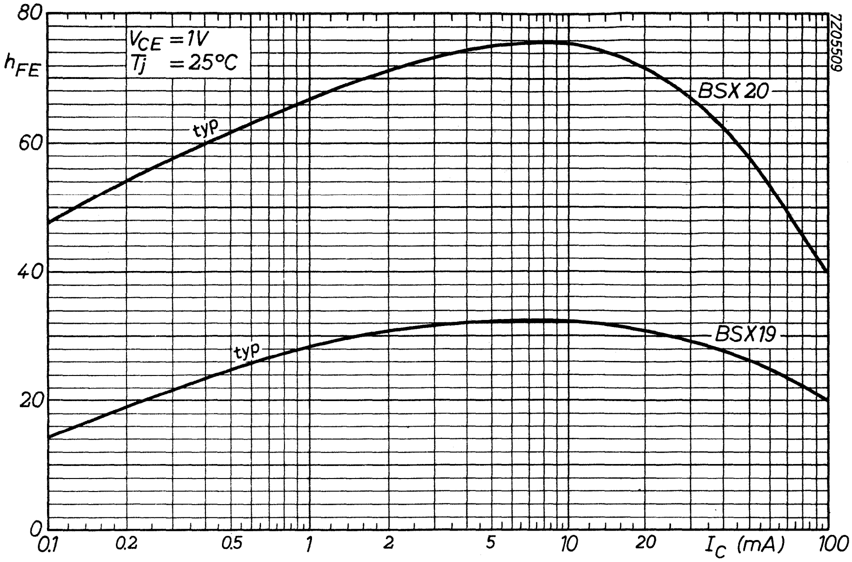

BSX20
7205501
Typical values
$T_j = 25°C$
I_C
(mA)
$I_B = 1mA$
0.5mA
0.4mA
0.2mA
0.1mA
0.05mA
0.01mA
25
20
15
10
5
0
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
V_{CE}(V)

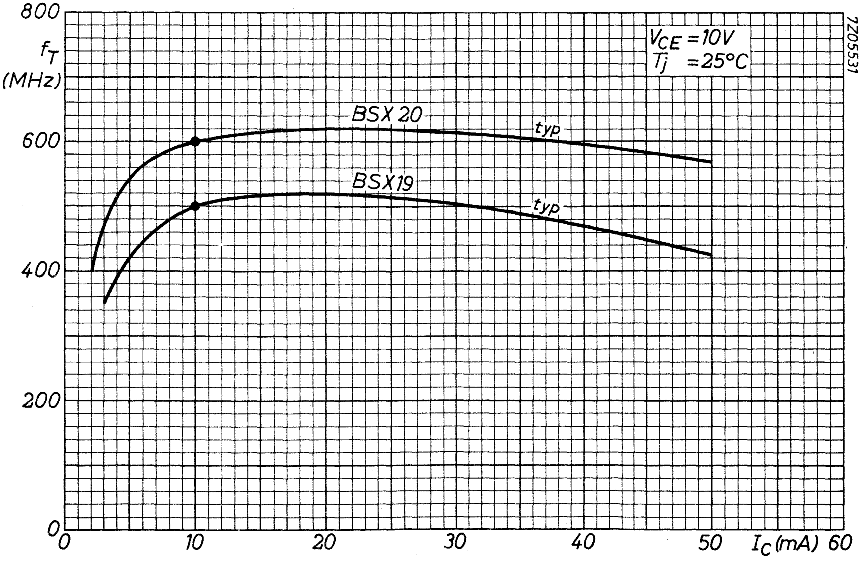

C_c (pF)
6
4
2
0
0
2
4
6
8
V_{CB} (V)
10
T_j = 25°C
f = 1MHz
$I_E = I_e = 0$
max
typ
7Z05514

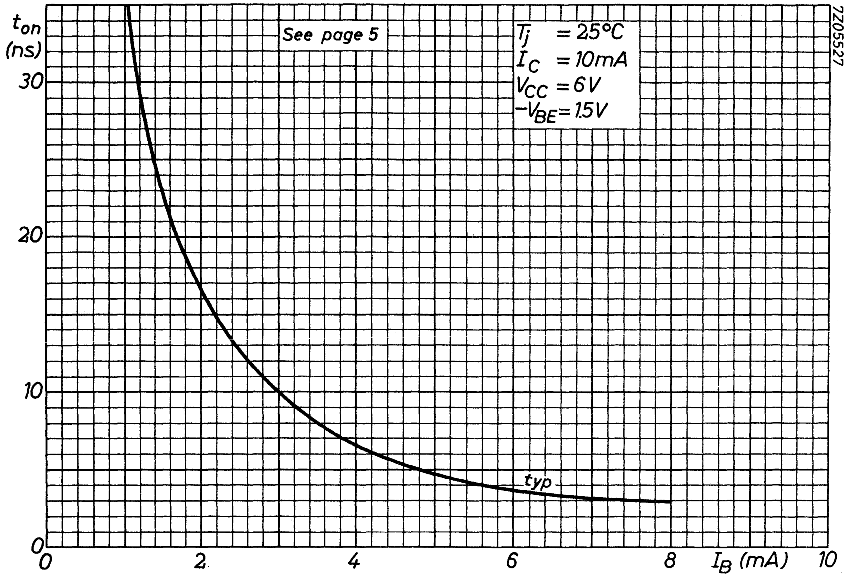

C_e (pF)
6
4
2
0
0
0.5
1
1.5
2
V_{EB} (V)
2.5
T_j = 25°C
f = 1MHz
$I_C = I_c = 0$
max
typ
7Z05503

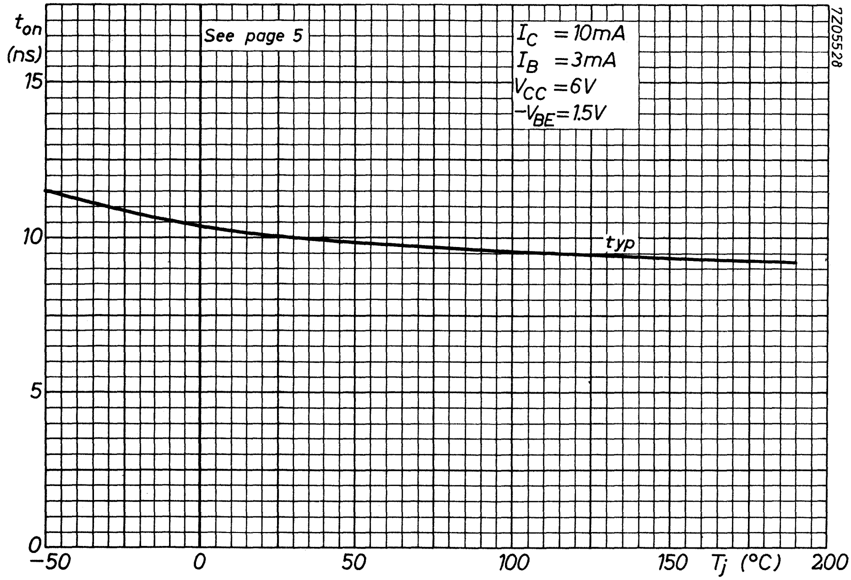

80
60
40
20
0
h_{FE}
typical values
$V_{CE} = 1V$
BSX19
7Z05505
$I_C = 10mA$
50 mA
100 mA
−50
0
50
100
150
T_j (°C)
200

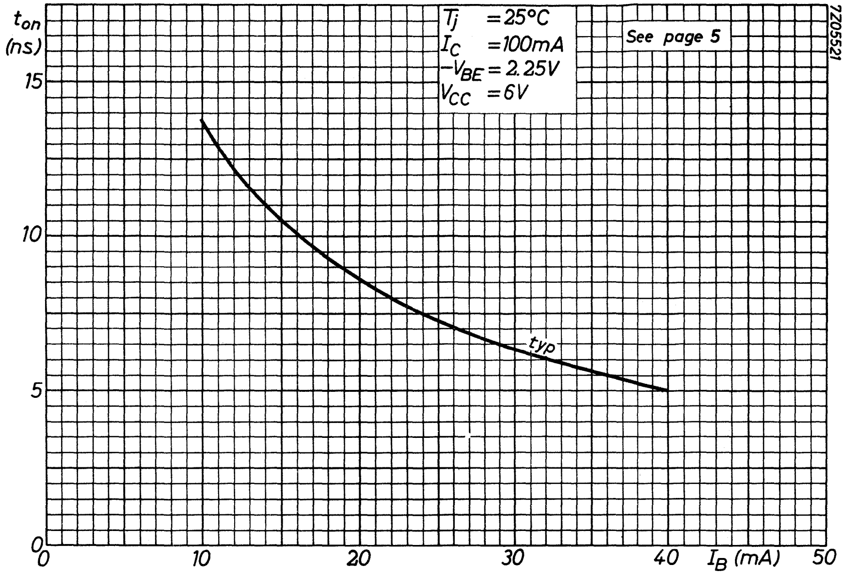

200
150
100
50
0
h_{FE}
typical values
$V_{CE} = 1V$
BSX20
7Z05504
$I_C = 10mA$
50mA
100mA
−50
0
50
100
150
T_j (°C)
200

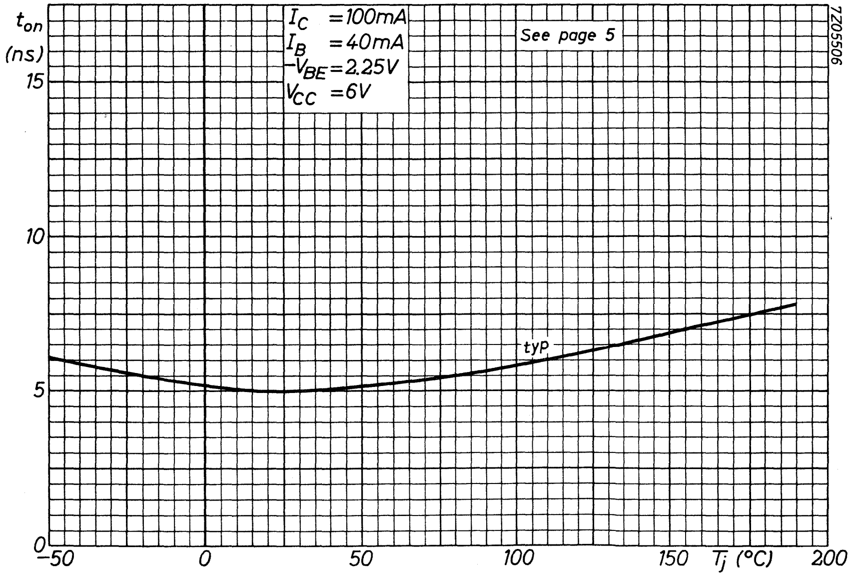

80
60
40
20
0
h_{FE}
$V_{CE} = 1V$
$T_j = 25°C$
typ
typ
BSX 20
BSX19
0.1
0.2
0.5
1
2
5
10
20
I_C (mA)
100
7Z05509

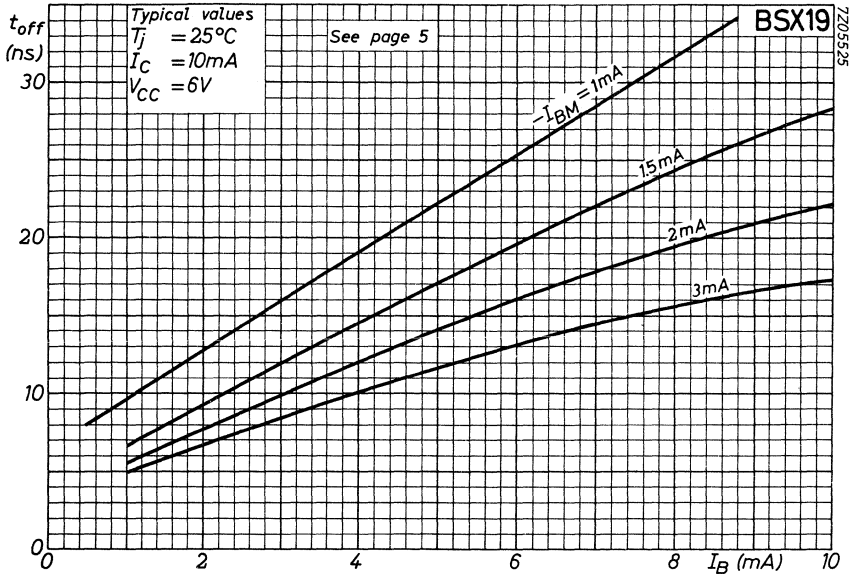

800
f_T
(MHz)
600
400
200
0
$V_{CE} = 10V$
$T_j = 25°C$
BSX 20
typ
BSX19
typ
0
10
20
30
40
50
I_C (mA)
60
7Z05531

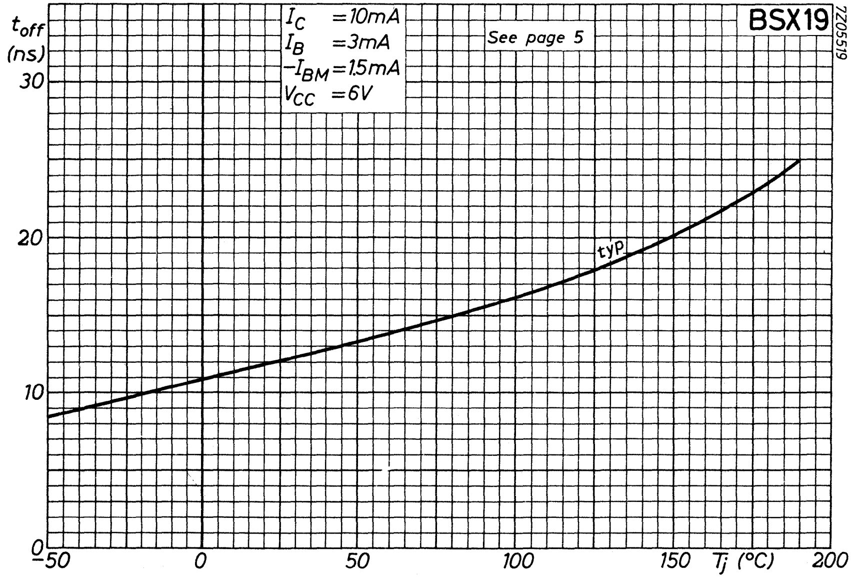

t_{on} (ns)
30
20
10
0
0
2
4
6
8
I_B (mA)
10
See page 5
T_j = 25°C
I_C = 10mA
V_{CC} = 6V
$-V_{BE}$ = 1.5V
typ
7Z05527

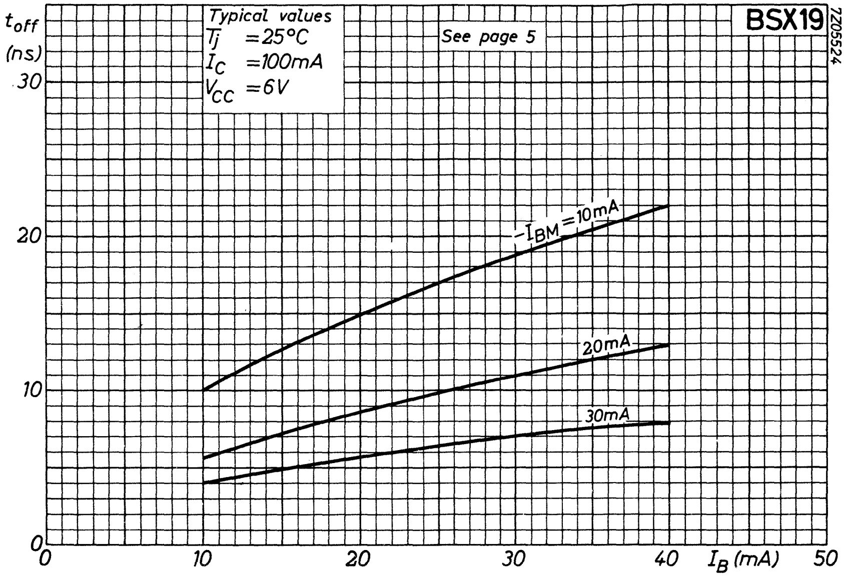

t_{on} (ns)
15
10
5
0
−50
0
50
100
150
T_j (°C)
200
See page 5
I_C = 10mA
I_B = 3mA
V_{CC} = 6V
$-V_{BE}$ = 1.5V
typ
7Z05528

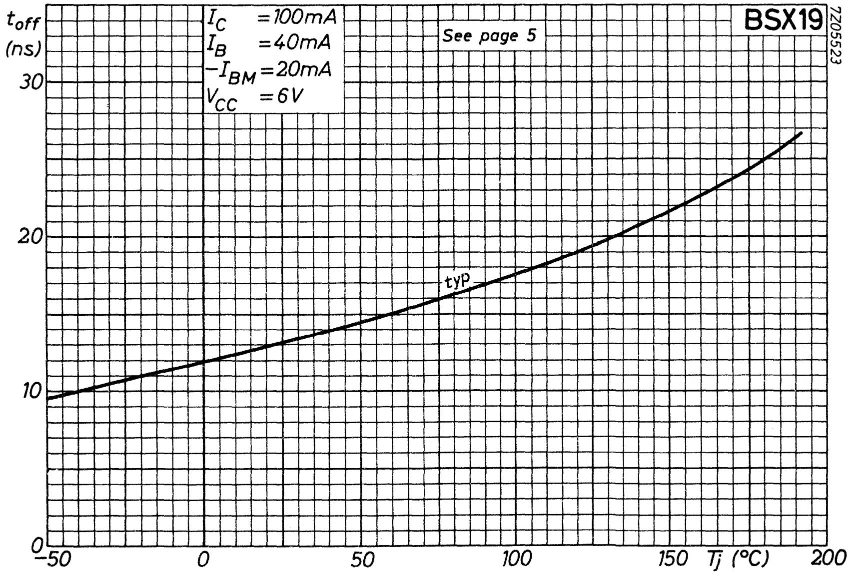

t_{on} (ns)
15
10
5
0
T_j = 25°C
I_C = 100mA
$-V_{BE}$ = 2.25V
V_{CC} = 6V
See page 5
7Z05521
typ
0
10
20
30
40
I_B (mA)
50

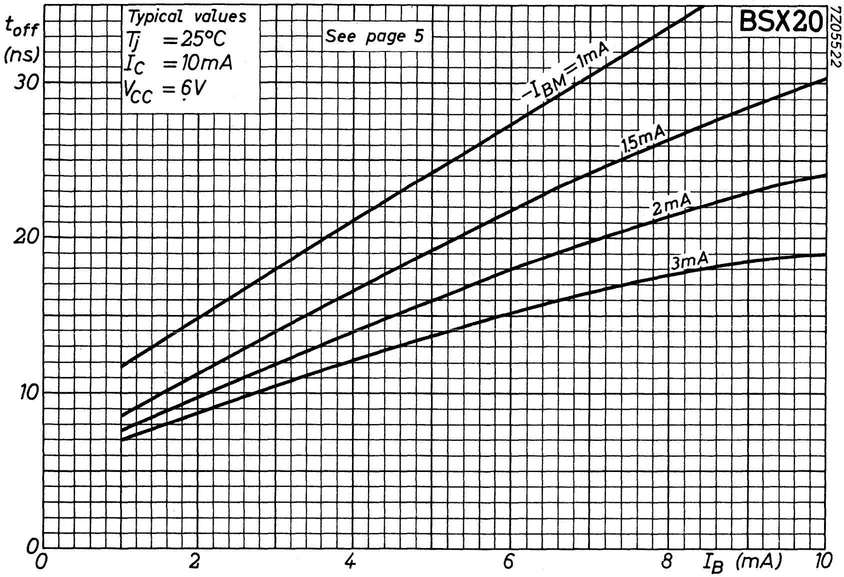

t_{on} (ns)
15
10
5
0
I_C = 100mA
I_B = 40mA
$-V_{BE}$ = 2.25V
V_{CC} = 6V
See page 5
7Z05506
typ
−50
0
50
100
150
T_j (°C)
200

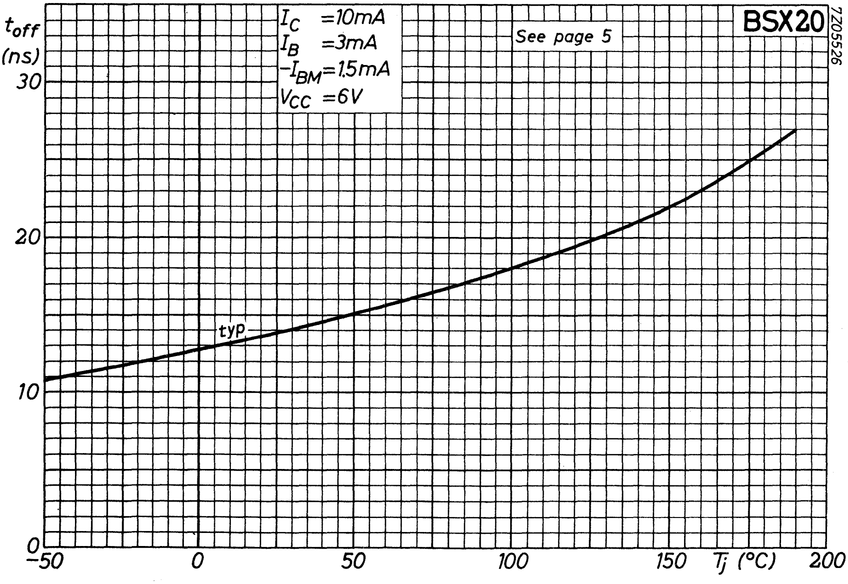

Typical values
T_j = 25°C
I_C = 10mA
V_{CC} = 6V
See page 5
BSX19
7Z05525
t_{off} (ns)
0
10
20
30
0
2
4
6
8
10
I_B (mA)
$-I_{BM}$ = 1mA
1.5mA
2mA
3mA

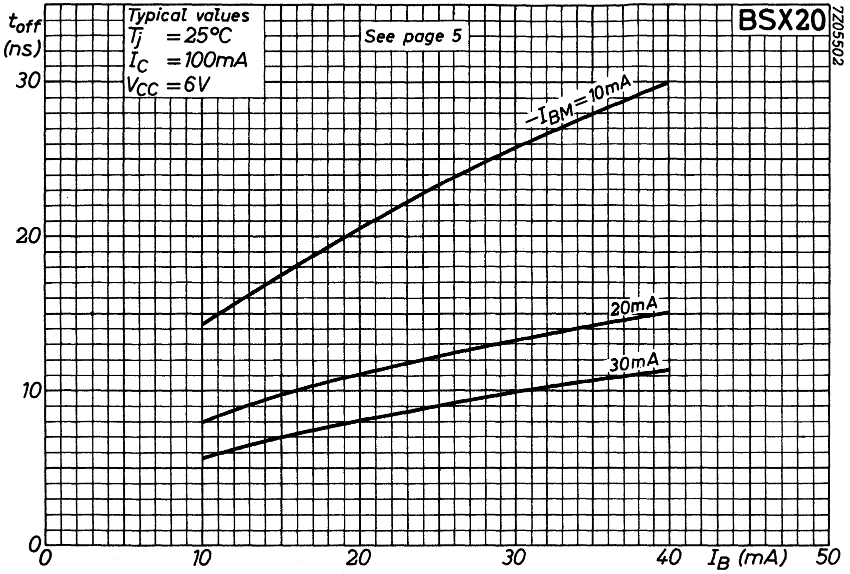

I_C = 10mA
I_B = 3mA
$-I_{BM}$ = 1.5mA
V_{CC} = 6V
See page 5
BSX19
7Z05519
t_{off} (ns)
0
10
20
30
−50
0
50
100
150
200
T_j (°C)
typ

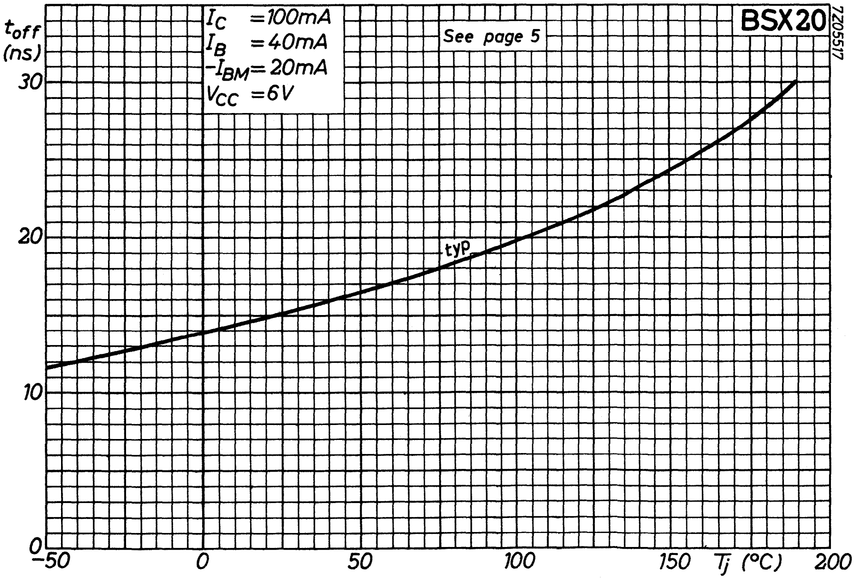

t_{off}
(ns)
Typical values
T_j = 25°C
I_C = 100mA
V_{CC} = 6V
See page 5
BSX19
7Z05524
$-I_{BM}$ = 10mA
20mA
30mA
0
10
20
30
0
10
20
30
40
I_B (mA)
50

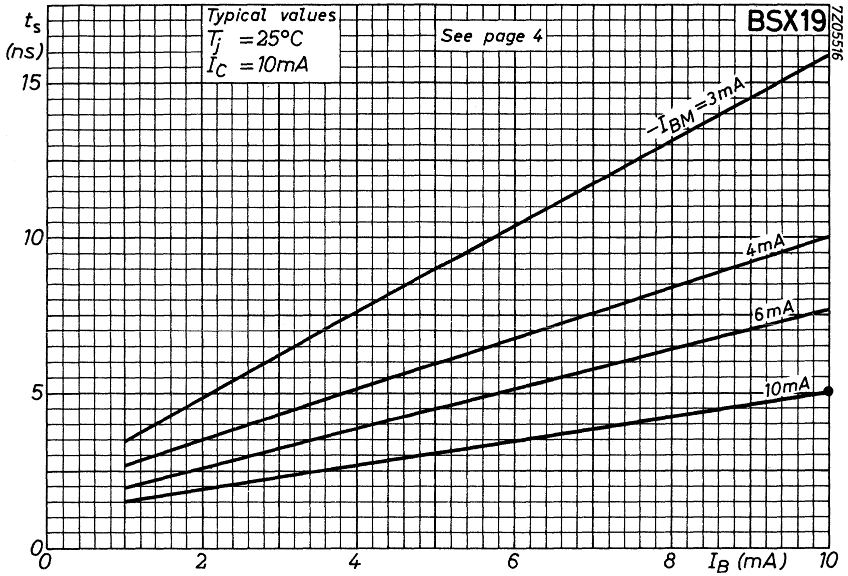

t_{off}
(ns)
I_C = 100mA
I_B = 40mA
$-I_{BM}$ = 20mA
V_{CC} = 6V
See page 5
BSX19
7Z05523
typ
0
10
20
30
−50
0
50
100
150
T_j (°C)
200

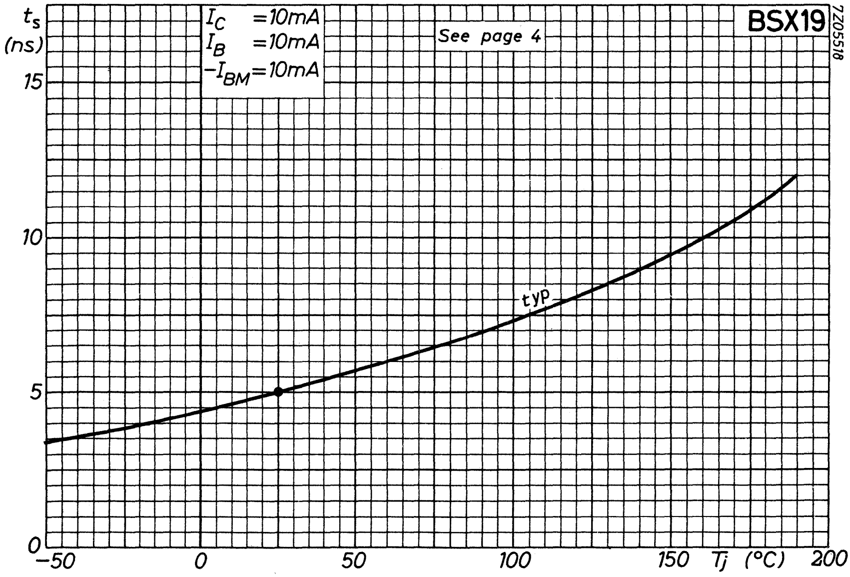

t_{off} (ns)
Typical values
T_j = 25°C
I_C = 10mA
V_{CC} = 6V
See page 5
BSX20
7Z05522
$-I_{BM}$=1mA
1.5mA
2mA
3mA
0
10
20
30
0
2
4
6
8
I_B (mA)
10

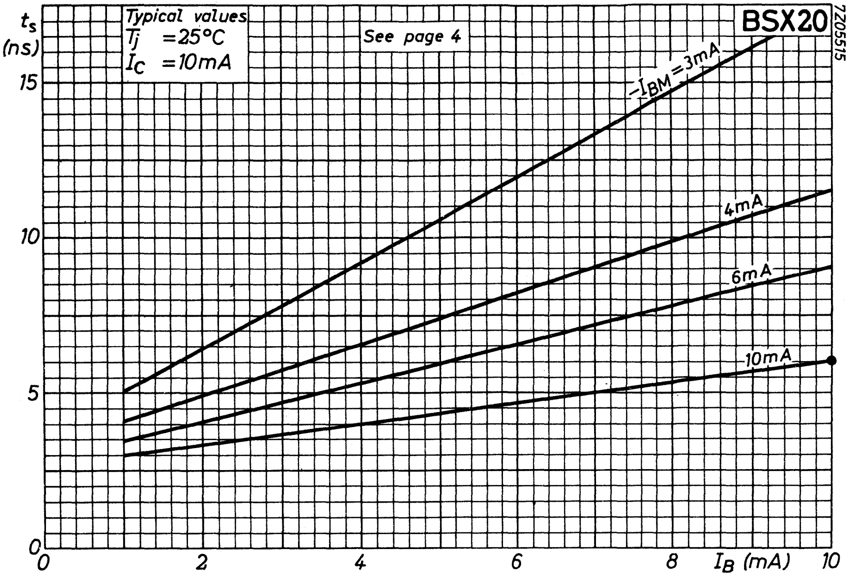

t_{off} (ns)
I_C = 10mA
I_B = 3mA
$-I_{BM}$=1.5mA
V_{CC} = 6V
See page 5
BSX20
7Z05526
typ
0
10
20
30
−50
0
50
100
150
T_j (°C)
200

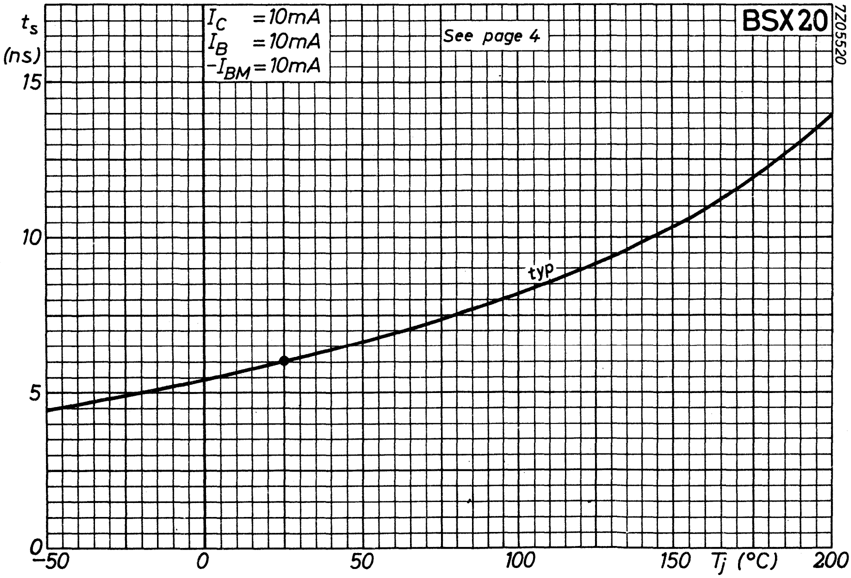

t_{off} (ns)
30
20
10
0
Typical values
T_j = 25°C
I_C = 100mA
V_{CC} = 6V
See page 5
BSX20
7Z05502
$-I_{BM}$=10mA
20mA
30mA
0
10
20
30
40
I_B (mA)
50


t_{off} (ns)
30
20
10
0
I_C = 100mA
I_B = 40mA
$-I_{BM}$= 20mA
V_{CC} = 6V
See page 5
BSX20
7Z05517
typ
−50
0
50
100
150
T_j (°C)
200


t_s (ns)
Typical values
T_j = 25°C
I_C = 10mA
See page 4
BSX19
7Z05516
$-I_{BM}$=3mA
4mA
6mA
10mA
0
5
10
15
0
2
4
6
8
10
I_B (mA)

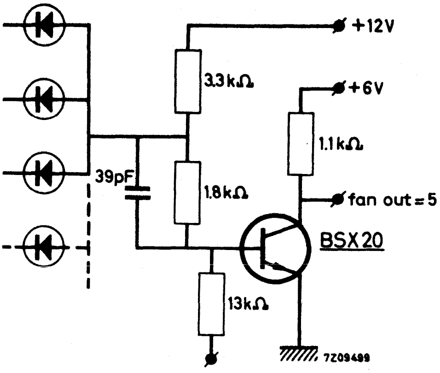

t_s (ns)
I_C = 10mA
I_B = 10mA
$-I_{BM}$ = 10mA
See page 4
BSX19
7Z05518
typ
0
5
10
15
−50
0
50
100
150
200
T_j (°C)


t_s (ns)
Typical values
T_j = 25°C
I_C = 10mA
See page 4
BSX20
7205515
$-I_{BM}$ = 3mA
4mA
6mA
10mA
0
5
10
15
0
2
4
6
8
10
I_B (mA)


t_s (ns)
I_C = 10mA
I_B = 10mA
$-I_{BM}$ = 10mA
See page 4
BSX20
7205520
typ
0
5
10
15
−50
0
50
100
150
200
T_j (°C)

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

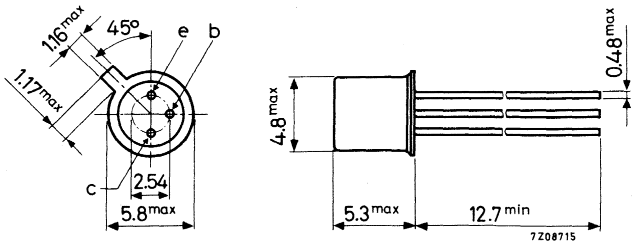
Collector-base voltage (open emitter)	V_{CBO}	max.	120	V
Collector-emitter voltage (open base)	V_{CEO}	max.	80	V
Collector current (peak value)	I_{CM}	max.	250	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	300	mW
Junction temperature	T_j	max.	175	°C
D.C. current gain at T_j = 25 °C				
I_C = 4 mA; V_{CE} = 1 V	h_{FE}	> typ.	20 80	
Transition frequency at f = 35 MHz				
I_C = 4 mA; V_{CE} = 10 V	f_T	>	60	MHz

NOTE: The BSX21 may be operated in the breakdown region up to V_{CE} = 160 V, provided P_{tot} at T_{amb} = 85 °C does not exceed 100 mW.

MECHANICAL DATA Dimensions in mm

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 μA	V_{CBO}	max.	120	V 1)
Collector-emitter voltage (open base) I_C = 4 mA	V_{CEO}	max.	80	V 1)
Emitter-base boltage (open collector) I_E = 100 μA	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 °C	P_{tot}	max.	300	mW

Temperatures

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

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	0.5	°C/mW
From junction to case	$R_{th\ j\text{-}c}$	=	0.15	°C/mW

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1) The BSX21 may be operated in the breakdown region up to V_{CE} = 160 V, provided P_{tot} at T_{amb} = 85 °C does not exceed 100 mW.

2) The transistor can withstand a capacitive load of 500 pF, combined with a collector-base voltage of max. 150 V before switching on.

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current

$I_E = 0$; $V_{CB} = 90$ V	I_{CBO}	typ. <	1 200	nA nA
$I_E = 0$; $V_{CB} = 90$ V; $T_j = 150$ °C	I_{CBO}	typ. <	0.25 50	μA μA
$V_{BE} = 0$; $V_{CE} = 80$ V; $T_j = 85$ °C	I_{CES}	typ. <	0.01 20	μA μA

Emitter cut-off current

$I_C = 0$; $V_{EB} = 4$ V	I_{EBO}	typ. <	0.5 200	nA nA
$I_C = 0$; $V_{EB} = 4$ V; $T_j = 150$ °C	I_{EBO}	typ. <	0.05 50	μA μA

Saturation voltages

$I_C = 4$ mA; $I_B = 400$ μA	V_{CEsat}	<	0.7	V
	V_{BEsat}	<	1.2	V

D.C. current gain

$I_C = 1$ mA; $V_{CE} = 1$ V	h_{FE}	typ.	60
$I_C = 4$ mA; $V_{CE} = 1$ V	h_{FE}	> typ.	20 80
$I_C = 10$ mA; $V_{CE} = 1$ V	h_{FE}	typ.	82
$I_C = 20$ mA; $V_{CE} = 1$ V	h_{FE}	typ.	55

Collector capacitance at f = 1 MHz

$I_E = I_e = 0$; $V_{CB} = 10$ V	C_c	typ. <	3.4 4.5	pF pF

Emitter capacitance at f = 1 MHz

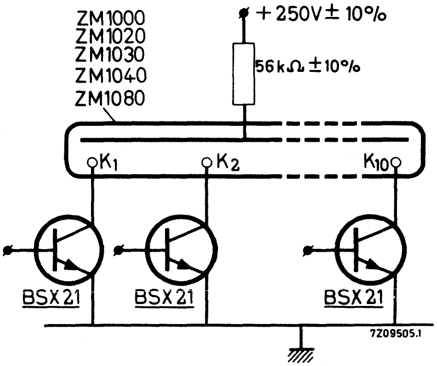
$I_C = I_c = 0$; $V_{EB} = 0.5$ V	C_e	typ. <	12 17	pF pF

Transition frequency at f = 35 MHz

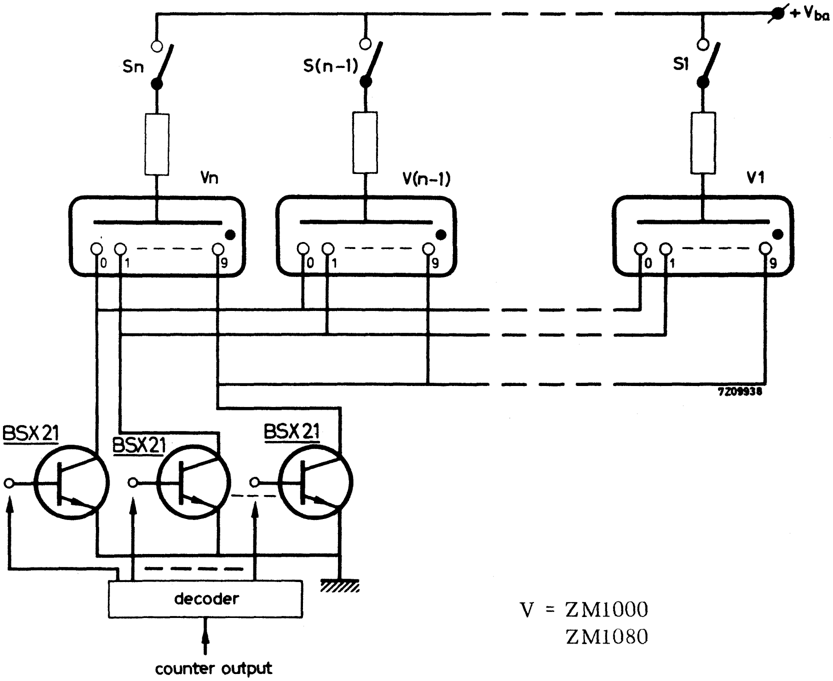
$I_C = 4$ mA; $V_{CE} = 10$ V	f_T	> typ.	60 160	MHz MHz

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

Practical circuit for static operation

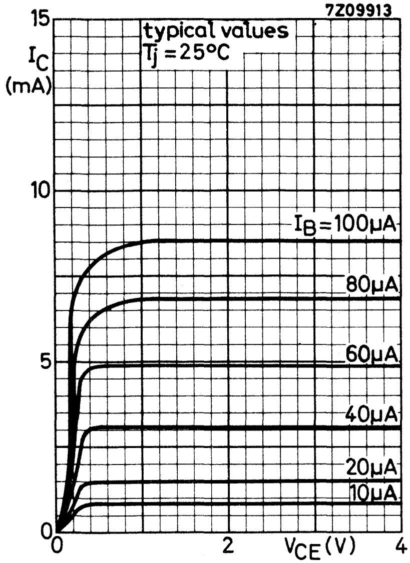


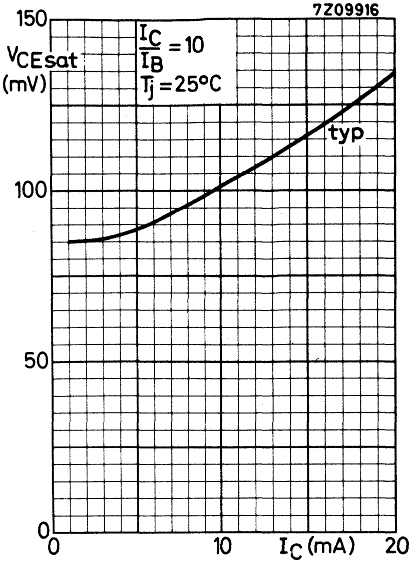
Practical circuit for dynamic operation

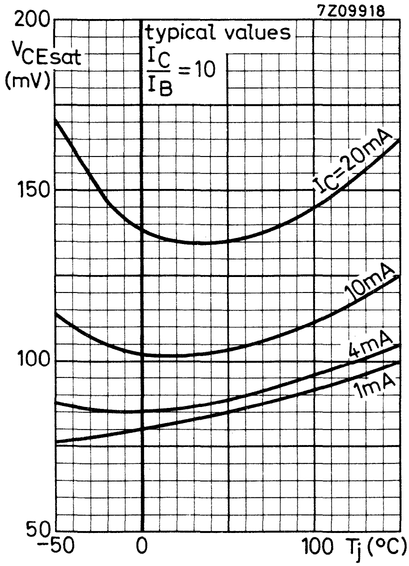


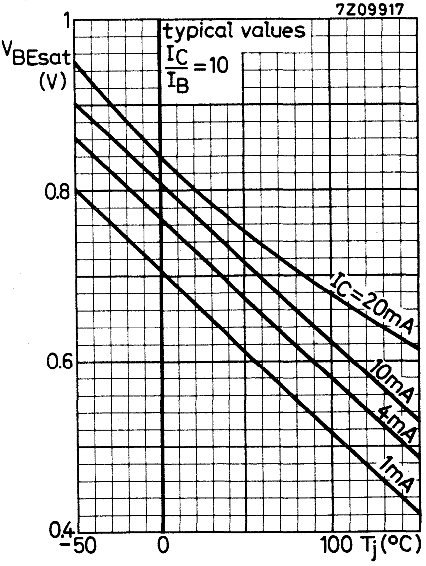
V = ZM1000
ZM1080

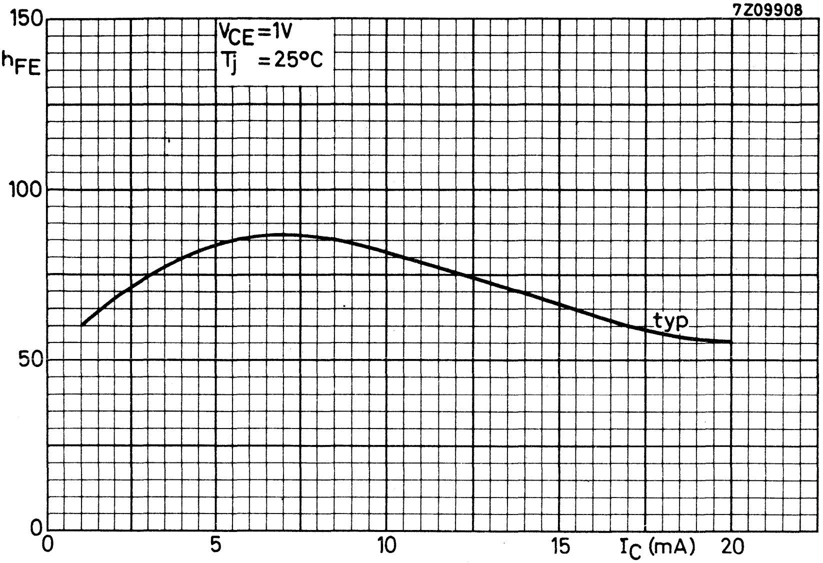
APPLICATION INFORMATION bulletins available on request

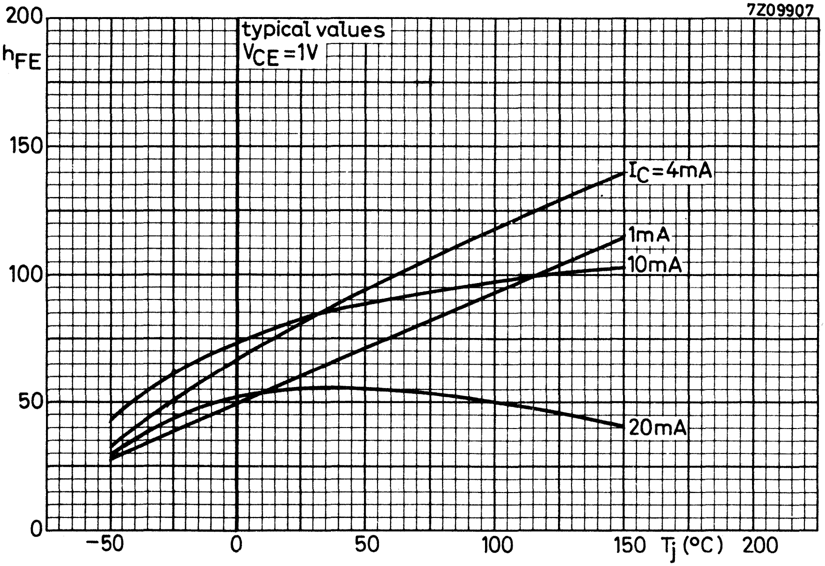

7Z09913
typical values
Tj = 25°C
I_C (mA)
15
10
5
0
I_B = 100µA
80µA
60µA
40µA
20µA
10µA
0
2
V_{CE} (V)
4

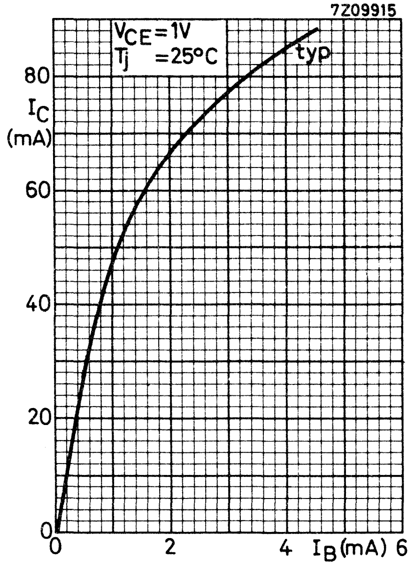

7Z09916
$\frac{I_C}{I_B}$ = 10
Tj = 25°C
V_{CEsat} (mV)
150
100
50
0
typ
0
10
I_C (mA)
20

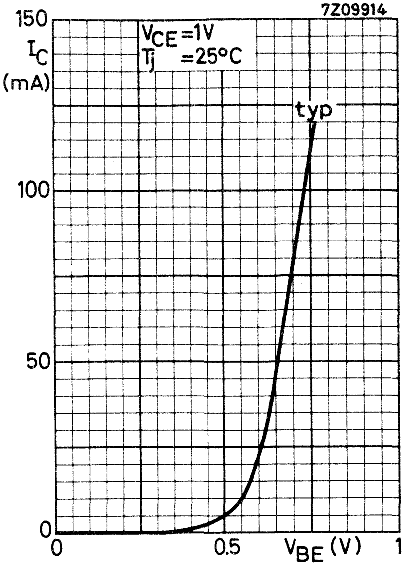

7Z09918
typical values
$\frac{I_C}{I_B}$ = 10
V_{CEsat} (mV)
200
150
100
50
I_C=20mA
10mA
4mA
1mA
−50
0
100
T_j (°C)

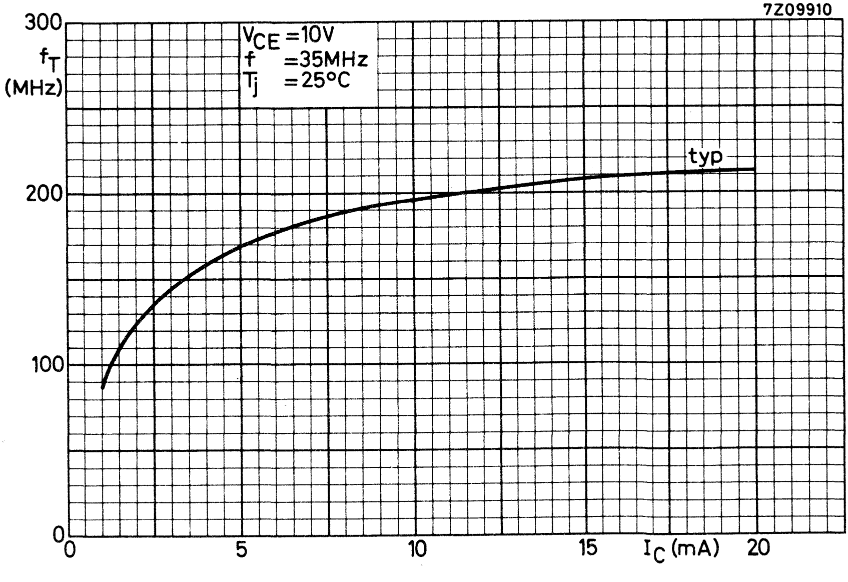

7Z09917
typical values
$\frac{I_C}{I_B}$ = 10
V_{BEsat} (V)
1
0.8
0.6
0.4
I_C=20mA
10mA
4mA
1mA
−50
0
100
T_j (°C)

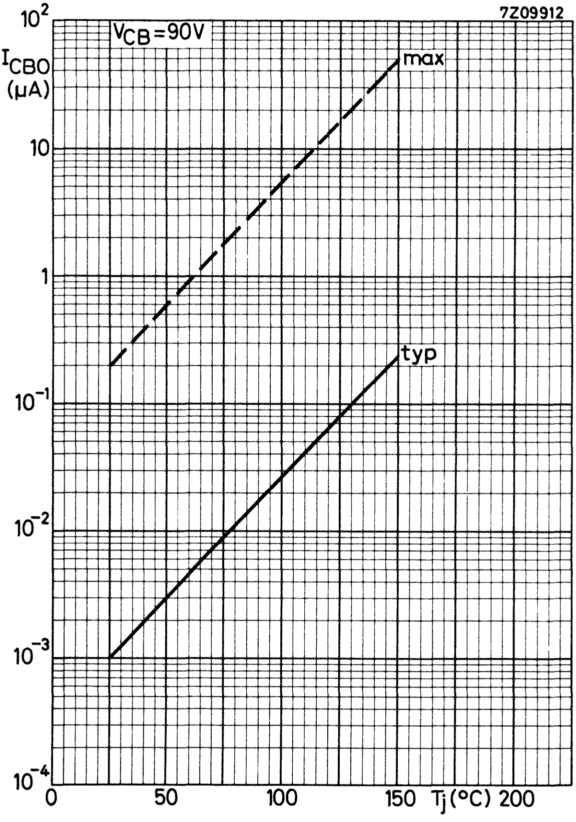

7Z09908
150
h_{FE}
100
50
0
V_{CE} = 1V
T_j = 25°C
typ
0
5
10
15
I_C (mA)
20

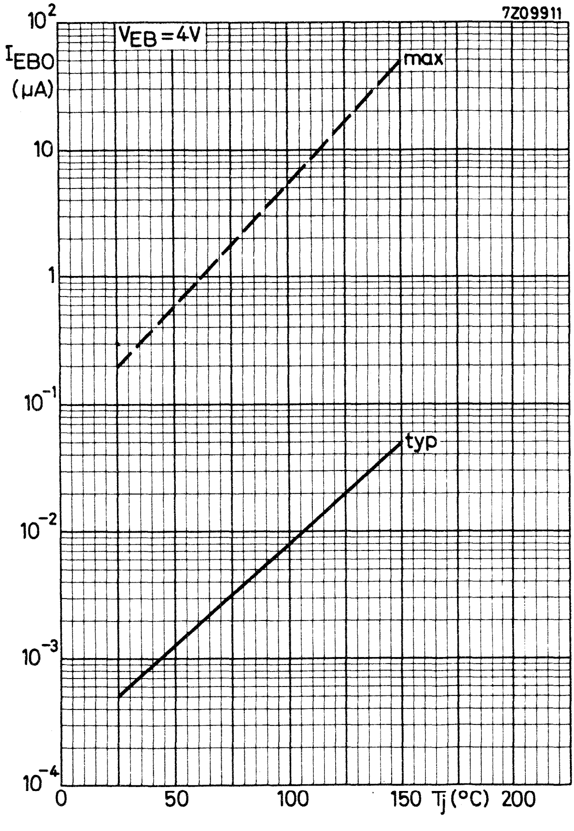

7Z09907
200
h_{FE}
150
100
50
0
typical values
V_{CE} = 1V
I_C = 4mA
1mA
10mA
20mA
−50
0
50
100
150
T_j (°C)
200

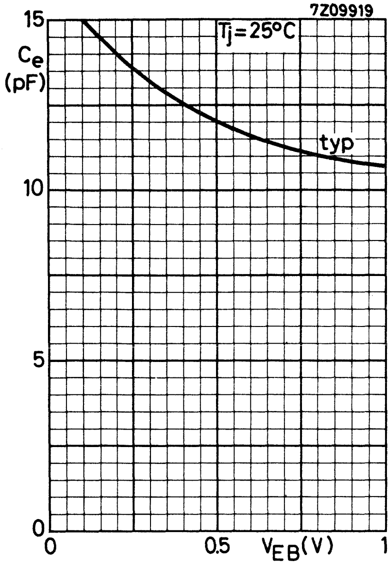

7Z09915
V_{CE} = 1V
T_j = 25°C
typ
I_C (mA)
0
20
40
60
80
0
2
4
I_B (mA)
6

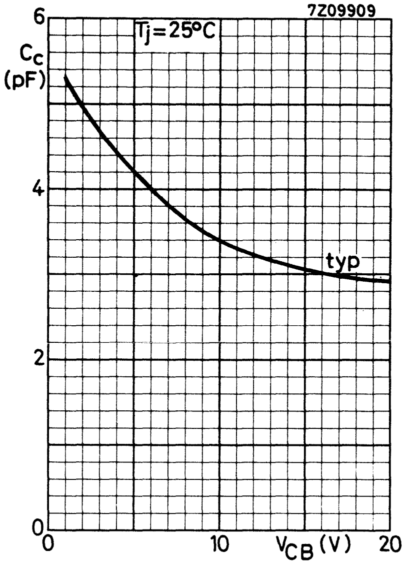

7Z09914
V_{CE} = 1V
T_j = 25°C
typ
150
I_C (mA)
100
50
0
0
0.5
V_{BE} (V)
1


7Z09910
V_{CE} = 10V
f = 35MHz
T_j = 25°C
typ
300
f_T (MHz)
200
100
0
0
5
10
15
I_C (mA)
20


7Z09912
$V_{CB} = 90V$
I_{CBO}
(μA)
10^2
10
1
10^{-1}
10^{-2}
10^{-3}
10^{-4}
max
typ
0
50
100
150
T_j (°C)
200


7Z09911
10^2
I_{EBO}
(µA)
10
1
10^{-1}
10^{-2}
10^{-3}
10^{-4}
$V_{EB} = 4V$
max
typ
0
50
100
150
T_j (°C)
200


7Z09919
15
C_e
(pF)
10
5
0
$T_j = 25°C$
typ
0
0.5
V_{EB} (V)
1


7Z09909
6
C_c
(pF)
4
2
0
$T_j = 25°C$
typ
0
10
V_{CB} (V)
20

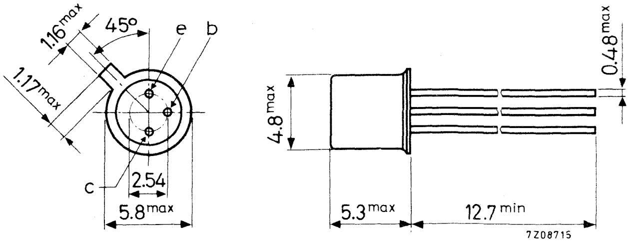
SILICON PLANAR EPITAXIAL TRANSISTOR

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

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

MECHANICAL DATA Dimensions in mm

Collector connected to case
TO-18



Accessories available: 56246, 56263

RATINGS (Limiting values) [1]

Voltages

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

Current

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

Power dissipation

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

Temperatures

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

THERMAL RESISTANCE

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

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

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off currents

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

Emitter cut-off currents

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

Sustaining voltages

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

Saturation voltages

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

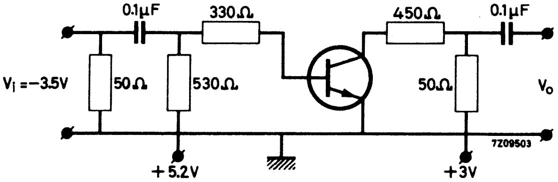
D.C. current gain

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

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

Collector capacitance at f = 1 MHz				
$I_E = I_e = 0;\ V_{CB} = 5\ V$	C_c	typ. <	2 3	pF pF
Emitter capacitance at f = 1 MHz				
$I_C = I_c = 0;\ V_{EB} = 0.5\ V$	C_e	typ. <	1.75 2.5	pF pF
Transition frequency				
$I_C = 20\ mA;\ V_{CE} = 2\ V$	f_T	> typ.	600 740	MHz MHz
Switching times				
Storage time (See page 10)				
$I_C = I_B = -I_{BM} = 5\ mA$	t_s	typ. <	3.8 6	ns ns

Test circuit:



Pulse generator:

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

Oscilloscope:

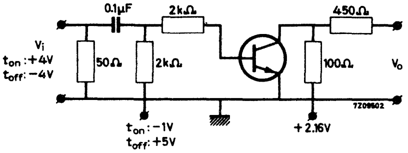
Input impedance	R_i	=	50	Ω
Rise time	t_r	<	1	ns

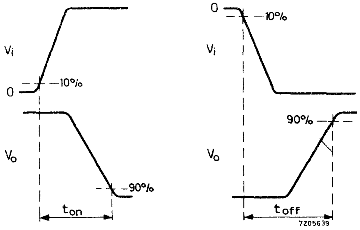
CHARACTERISTICS (continued) $T_j = 25\ ^{\circ}C$ unless otherwise specified

Switching times

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

Test circuit:

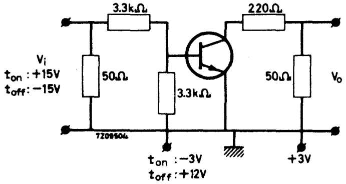


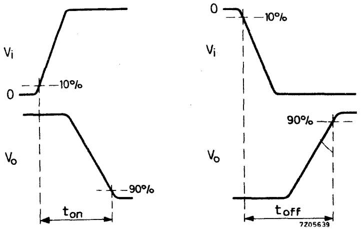


Pulse generator:					Oscilloscope:				
Pulse duration	t	>	300	ns	Input impedance	R_i	=	50	Ω
Rise time	t_r	<	1	ns	Rise time	t_r	<	1	ns
Duty cycle	δ	<	0.02						
Output impedance	R_o	=	50	Ω					

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

Test circuit:





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

---

[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.

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.

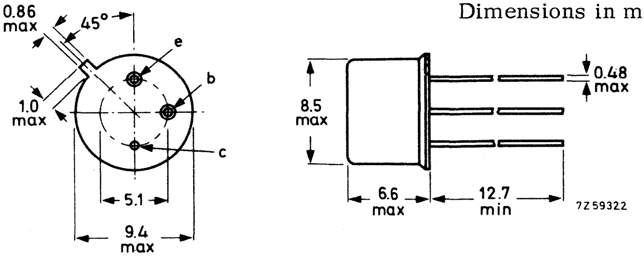
QUICK REFERENCE DATA

			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 °C	P_{tot}	max.	0.8	0.8	0.8	W
Junction temperature	T_j	max.	200	200	200	°C
D.C. current gain I_C = 500 mA; V_{CE} = 1 V	h_{FE}	>	30	30	30	
Saturation voltage I_C = 500 mA; I_B = 50 mA	V_{CEsat}	<	0.5	0.5	0.7	V
Transition frequency I_C = 50 mA; V_{CE} = 10 V	f_T	typ.	450	475	475	MHz
Turn off time I_C = 500 mA; I_B = 50 mA	t_{off}	<	60	70	100	ns

MECHANICAL DATA

Dimensions in mm

Collecter 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

			BSX59	BSX60	BSX61	
Collector-base voltage (open emitter)	V_{CBO}	max.	70	70	70	V
Collector-emitter voltage (open base) I_C = 10 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 °C	P_{tot}	max.	0.8	W

Temperatures

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

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\,j-a}$	=	220	°C/W
From junction to case	$R_{th\,j-c}$	=	43	°C/W
From junction to mounting base	$R_{th\,j-mb}$	=	35	°C/W

---

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

CHARACTERISTICS

$T_j = 25$ °C unless otherwise specified

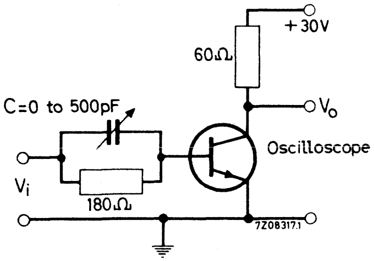
			BSX59	BSX60	BSX61	
Collector cut-off current						
$I_E = 0$; $V_{CB} = 40$ V	I_{CBO}	<	500	500	500	nA
$I_E = 0$; $V_{CB} = 40$ V; $T_j = 150$ °C	I_{CBO}	<	300	300	300	µA
Emitter cut-off current						
$I_C = 0$; $V_{EB} = 4$ V	I_{EBO}	<	300	300	500	nA
$I_C = 0$; $V_{EB} = 4$ V; $T_j = 150$ °C	I_{EBO}	<	50	50	50	µA
Currents at reverse biased emitter junction						
$-V_{BE} = 4$ V; $V_{CE} = 40$ V	$+I_{CEX}$	<	500	500	1000	nA
	$-I_{BEX}$	<	500	500	1000	nA
$-V_{BE} = 4$ V; $V_{CE} = 40$ V; $T_j = 150$ °C	$+I_{CEX}$	<	300	300	500	µA
	$-I_{BEX}$	<	300	300	500	µA
Saturation voltages						
$I_C = 150$ mA; $I_B = 15$ mA	V_{CEsat}	<	0.3	0.3	0.5	V
	V_{BEsat}	<	1.0	1.0	1.0	V
$I_C = 500$ mA; $I_B = 50$ mA	V_{CEsat}	<	0.5	0.5	0.7	V
	V_{BEsat}	>	0.85	0.7	0.7	V
		<	1.2	1.3	1.3	V
$I_C = 1$ A; $I_B = 100$ mA	V_{CEsat}	<	1.0	1.0	1.3	V
	V_{BEsat}	<	1.8	1.8	1.8	V
D.C. current gain						
$I_C = 150$ mA; $V_{CE} = 1$ V	h_{FE}	>	30	30	30	
		typ.	70	90	105	
$I_C = 500$ mA; $V_{CE} = 1$ V	h_{FE}	>	30	30	30	
		<	90	90	90	
$I_C = 1$ A; $V_{CE} = 5$ V	h_{FE}	>	20	25	20	
		typ.	40	50	55	
Transition frequency						
$I_C = 50$ mA; $V_{CE} = 10$ V	f_T	>	250	250	250	MHz
		typ.	450	475	475	MHz
Collector capacitance at f = 1 MHz						
$I_E = I_e = 0$; $V_{CB} = 10$ V	C_c	typ.	6	6	6	pF
		<	10	10	10	pF
Emitter capacitance at f = 1 MHz						
$I_C = I_c = 0$; $V_{EB} = 0.5$ V	C_e	typ.	36	36	36	pF
		<	50	50	50	pF

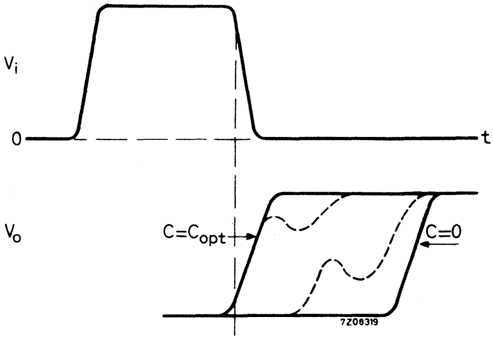
CHARACTERISTICS (continued) $T_j = 25\ ^{\circ}C$ unless otherwise specified

Recovered charge

$I_C = 500$ mA; $I_B = 50$ mA BSX60 Q_s < 5 nC

Test circuit:





Adjust C from zero to C_{opt}
$Q_s = C_{opt} \cdot V_i$

Pulse generator:

Pulse duration $t_p = 10\ \mu s$

Duty cycle $\delta = 0.02$

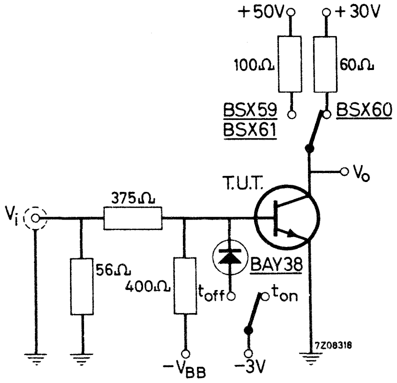
CHARACTERISTICS (continued)

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

Switching times (see also page 10)

			BSX59	BSX60	BSX61	
Turn on time when switched from $-V_{BE} = 2$ V to $I_C = 500$ mA; $I_B = 50$ mA	t_{on}	typ.	17	17	18	ns
		<	35	40	50	ns
Turn off time when switched from $I_C = 500$ mA; $I_B = 50$ mA to cut-off with $-I_{BM} = 50$ mA [1]	t_{off}	typ.	45	58	70	ns
		<	60	70	100	ns

Test circuit:



	t_{on}	toff	
V_{BB}	4	16.7	V
V_i	24.75	37.5	V

Pulse generator: Pulse duration $t_p \geq 500$ ns

Rise time $t_r \leq 5$ ns

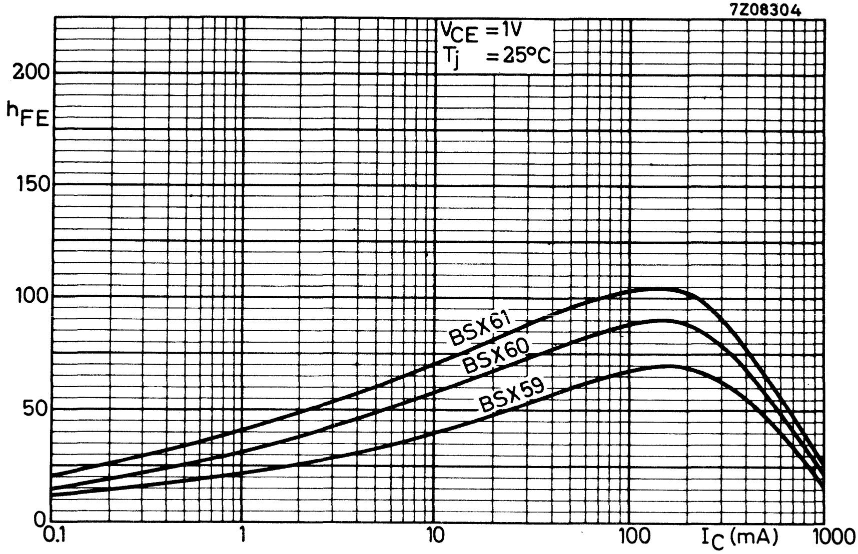
Fall time $t_f \leq 5$ ns

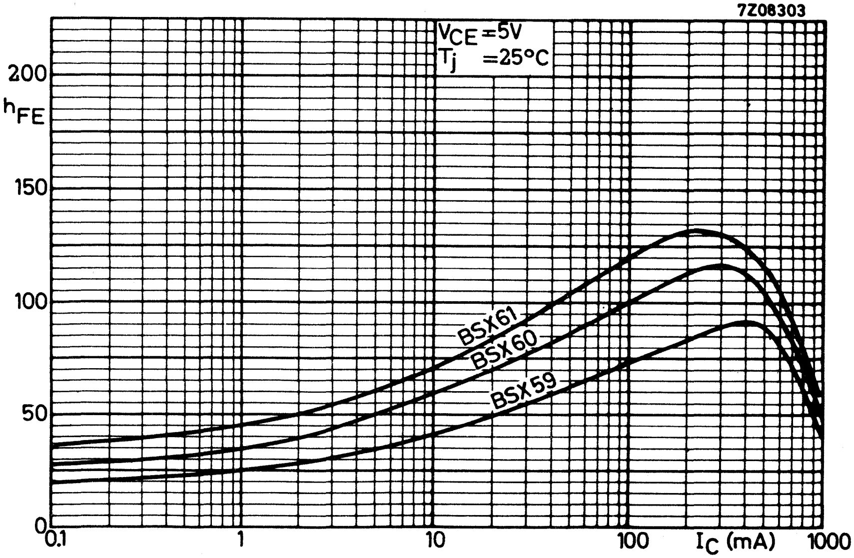
Output resistance $R_o = 50\ \Omega$ (during pulse, otherwise infinite)

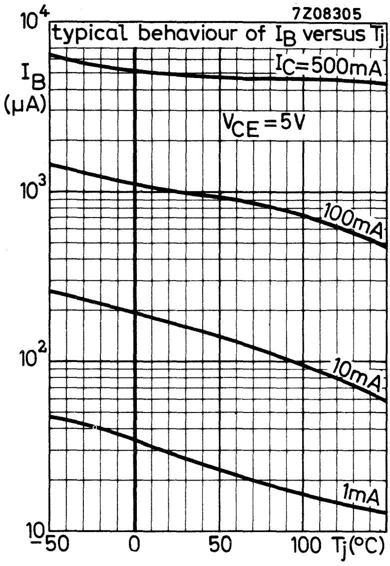
---

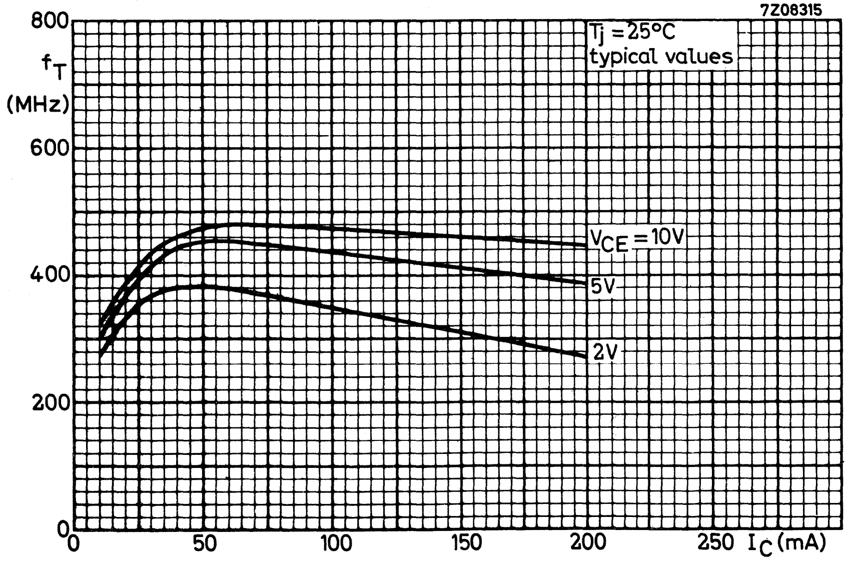
[1] $-I_{BM}$ is the reverse current that can flow during switching off. The indicated $-I_{BM}$ is determined and limited by the applied cut-off voltage and the series resistance.

Typical behaviour of d.c. current gain versus I_C

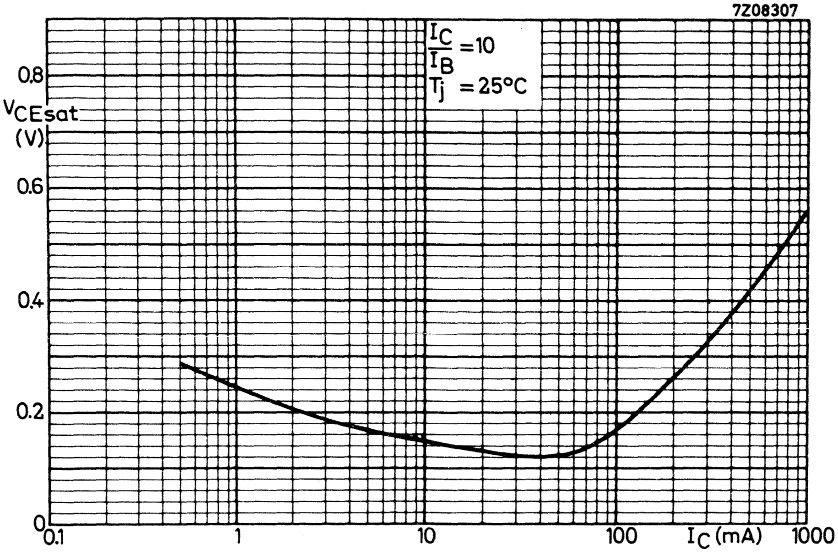


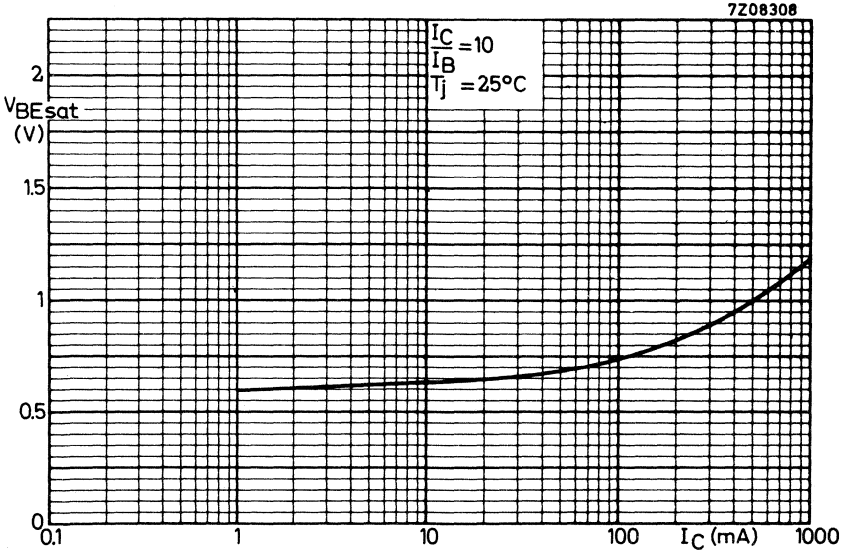



7Z08305
typical behaviour of I_B versus T_j
I_B (μA)
10^4
10^3
10^2
10
I_C=500mA
V_{CE}=5V
100mA
10mA
1mA
−50
0
50
100
T_j(°C)

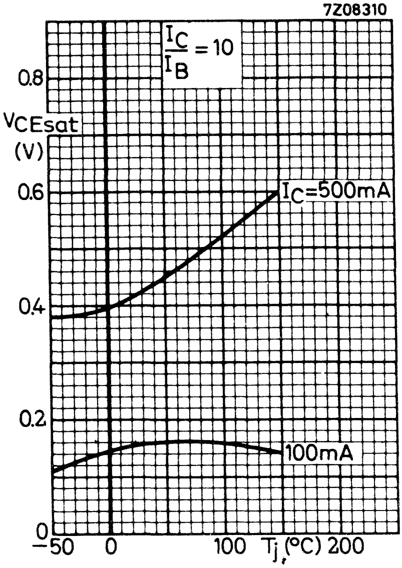

7Z08315
T_j = 25°C
typical values
f_T (MHz)
800
600
400
200
0
V_{CE} = 10V
5V
2V
0
50
100
150
200
250
I_C (mA)

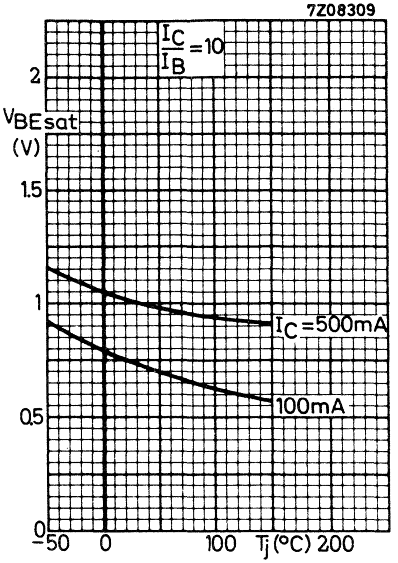
Typical behaviour of saturation voltages versus I_C

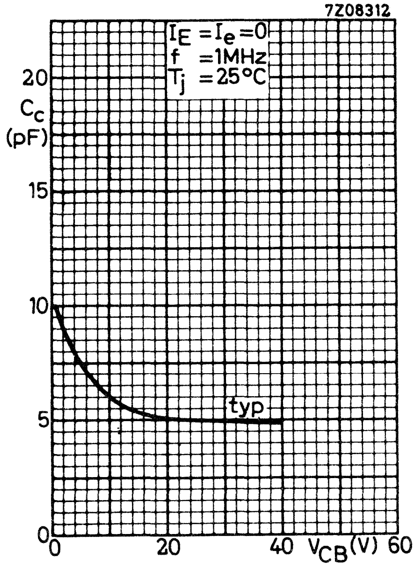


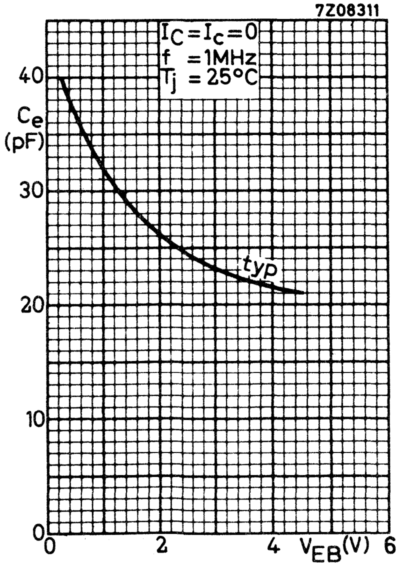


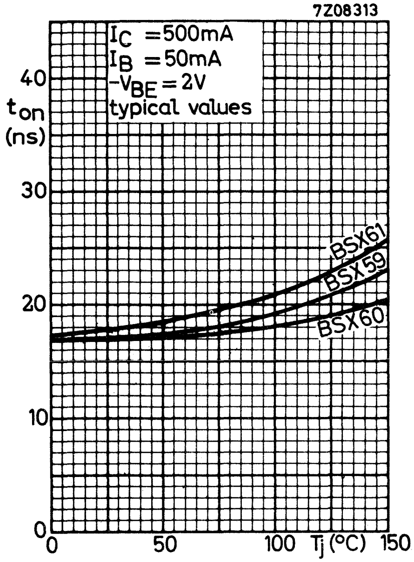
Typical behaviour of saturation voltages versus T_j

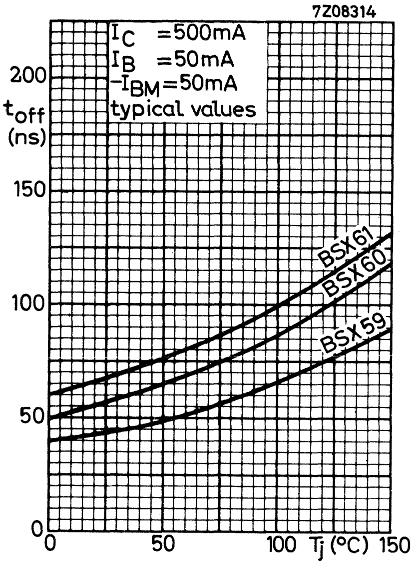


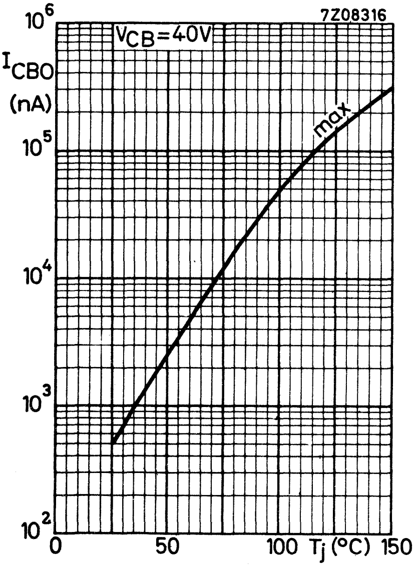


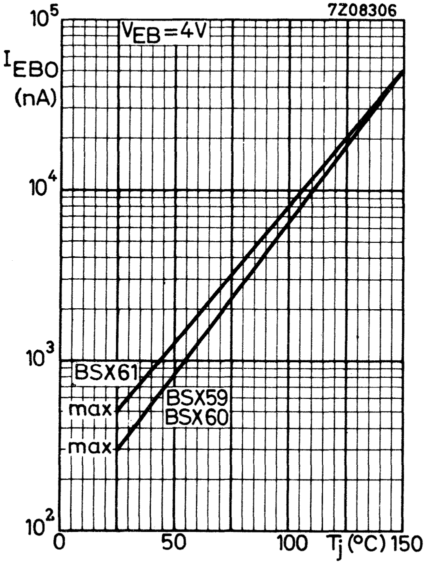





7Z08313
I_C = 500mA
I_B = 50mA
$-V_{BE}$ = 2V
typical values
t_{on} (ns)
0
10
20
30
40
BSX61
BSX59
BSX60
0
50
100
T_j (°C)
150


7Z08314
I_C = 500mA
I_B = 50mA
$-I_{BM}$ = 50mA
typical values
t_{off} (ns)
0
50
100
150
200
BSX61
BSX60
BSX59
0
50
100
T_j (°C)
150


7Z08316
V_{CB} = 40V
I_{CBO} (nA)
10^2
10^3
10^4
10^5
10^6
max
0
50
100
T_j (°C)
150


7Z08306
V_{EB} = 4V
I_{EBO} (nA)
10^2
10^3
10^4
10^5
BSX61
max
BSX59
BSX60
max
0
50
100
T_j (°C)
150

N-P-N SILICON MESA SWITCHING TRANSISTORS

N-P-N silicon mesa transistors in a TO-5 metal envelope. The BSY10 and BSY11 are primarily intended for high speed switching applications.

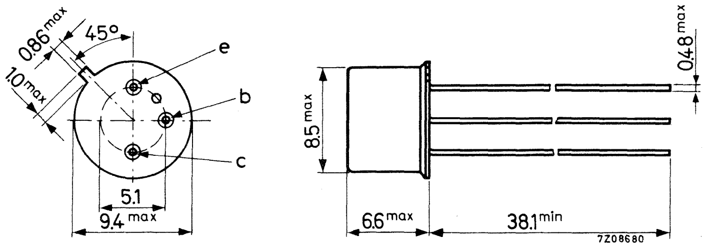
QUICK REFERENCE DATA

			BSY10	BSY11	
Collector-base voltage (open emitter)	V_{CBO}	max.	60	45	V
Collector-emitter voltage ($-V_{BE} = 1$ V)	V_{CEX}	max.	60	45	V
Collector current (peak value)	I_{CM}	max.	75		mA
Transition frequency $-I_E = 5$ mA; $V_{CB} = 10$ V	f_T	>	60		MHz
		typ.	180		MHz

MECHANICAL DATA

Dimensions in mm

Insulated electrodes.
TO-5



Accessories available: 56218; 56245; 56265

RATINGS (Limiting values) [1]

Voltages

			BSY10	BSY11	
Collector-base voltage (open emitter)	V_{CBO}	max.	60	45	V
Collector-emitter voltage ($-V_{BE} = 1$ V)	V_{CEX}	max.	60	45	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	5	V

Currents

Collector current (d.c. or average over any 20 ms period)	I_C	max.	50	mA
Collector current (peak value)	I_{CM}	max.	75	mA
Base current (d.c. or average over any 20 ms period)	I_B	max.	5	mA
Base current (peak value)	I_{BM}	max.	7.5	mA

Power dissipation

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

Temperatures

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

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	0.5	°C/mW
From junction to case	$R_{th\ j\text{-}c}$	=	0.35	°C/mW

---

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

CHARACTERISTICS

T_{amb} = 25 °C unless otherwise specified

Collector cut-off current

$I_E = 0$; $V_{CB} = 20$ V	I_{CBO}	<	2	μA
$I_E = 0$; $V_{CB} = 20$ V; $T_{amb} = 125$ °C	I_{CBO}	<	15	μA

Emitter cut-off current

$I_C = 0$; $V_{EB} = 5$ V	I_{EBO}	<	50	μA

Base current

			BSY10	BSY11	
$-I_E = 10$ mA; $V_{CB} = 5$ V	I_B	<	125	80	μA
		>	225	165	μA

Base-emitter voltage

$-I_E = 10$ mA; $V_{CB} = 5$ V	V_{BE}	<	1.5	V

Saturation voltage

$I_C = 10$ mA; $I_B = 1$ mA	V_{CEsat}	<	1	V

Breakdown voltages

			BSY10	BSY11	
$I_B = 0$; $I_C = 100$ μA	$V_{(BR)CEO}$	>	30	25	V
$I_E = 0$; $I_C = 50$ μA	$V_{(BR)CBO}$	>	60	45	V

Small signal current gain at f = 1 kHz

			BSY10	BSY11
$I_C = 5$ mA; $V_{CE} = 5$ V	h_{fe}	>	40	55

Collector capacitance

$I_E = I_e = 0$; $V_{CB} = 20$ V	C_c	<	5	pF
$I_E = I_e = 0$; $V_{CB} = 5$ V	C_c	typ.	5	pF

Emitter capacitance

$I_C = I_c = 0$; $V_{EB} = 2$ V	C_e	typ.	9	pF

Transition frequency

$-I_E = 5$ mA; $V_{CB} = 10$ V	f_T	>	60	MHz
		typ.	180	MHz

Noise figure

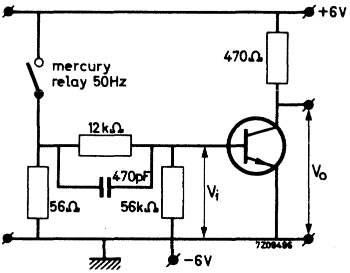
$-I_E = 5$ mA; $V_{CB} = 10$ V	F	typ.	20	dB
		<	40	dB

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

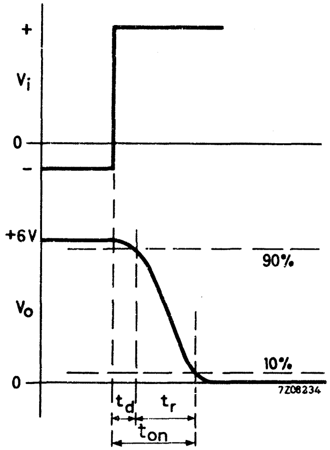
Switching characteristics

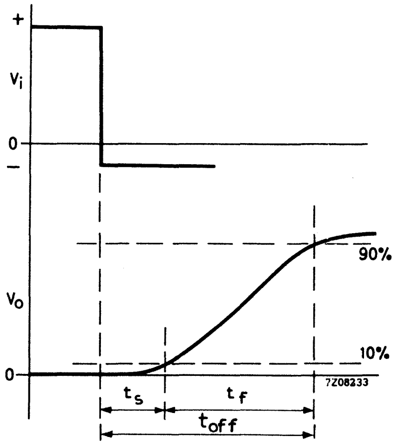
Delay time	t_d	typ.	4.7	ns
Rise time	t_r	typ.	13	ns
Storage time	t_s	typ.	35	ns
Fall time	t_f	typ.	75	ns

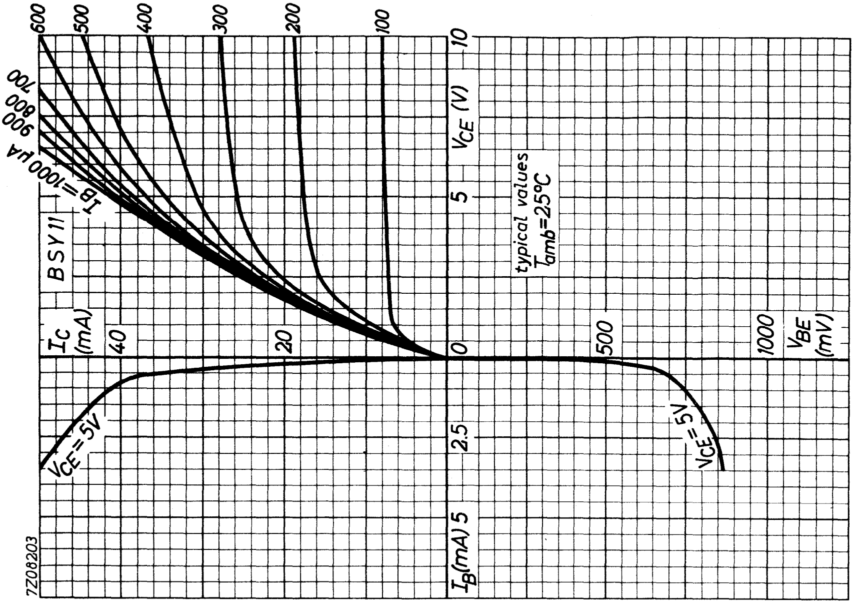
Test circuit:

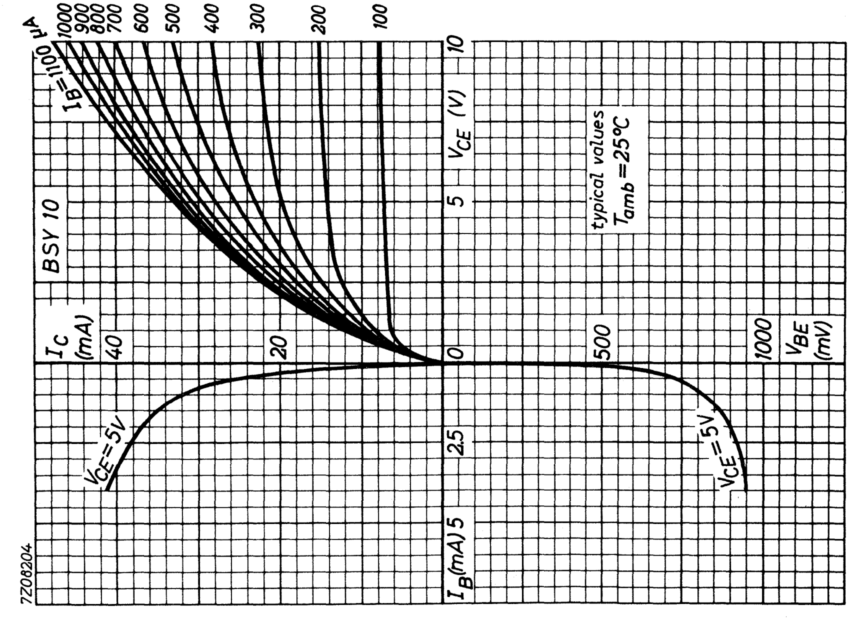


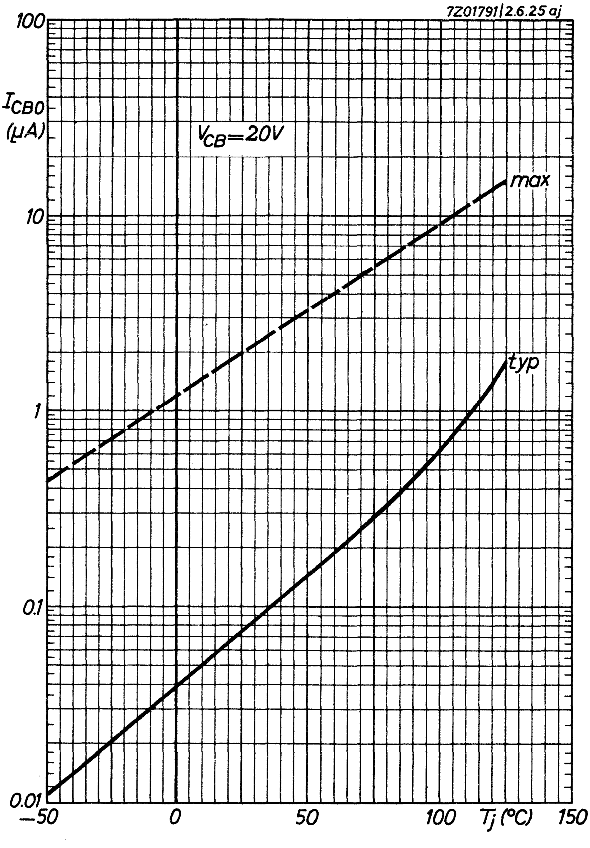
Oscilloscope: $C_i \leq 20$ pF; $R_i \geq 1$ MΩ






BSY 11
I_B = 1000 µA
900
800
700
600
500
400
300
200
100
V_{CE} (V)
10
5
0
typical values
T_{amb} = 25°C
I_C (mA)
40
20
500
1000
V_{BE} (mV)
V_{CE} = 5V
V_{CE} = 5V
2.5
I_B (mA) 5
7Z08203


BSY 10
I_B = 1100 µA
1000
900
800
700
600
500
400
300
200
100
V_{CE} (V)
10
5
0
typical values
T_{amb} = 25°C
I_C (mA)
40
20
500
1000
V_{BE} (mV)
V_{CE} = 5V
V_{CE} = 5V
2.5
I_B (mA) 5
7Z08204


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

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.

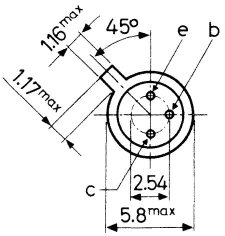
QUICK REFERENCE DATA

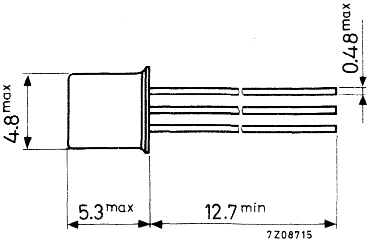
			BSY38	BSY39	
Collector-base voltage (open emitter)	V_{CBO}	max.	20	20	V
Collector-emitter voltage ($V_{BE} \leq 0$)	V_{CEX}	max.	15	15	V
Collector current (peak value)	I_{CM}	max.	200	200	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	300	300	mW
D.C. current gain at T_j = 25 °C					
I_C = 10 mA; V_{CE} = 0.35 V	h_{FE}		30 to 60	40 to 120	
I_C = 100 mA; V_{CE} = 1 V	h_{FE}		15 to 45	20 to 70	
Transition frequency					
I_C = 10 mA; V_{CE} = 2 V	f_T	typ.	350	350	MHz
Storage time					
$I_C = I_B = -I_{BM}$ = 10 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 °C	P_{tot}	max.	300	mW

Temperatures

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

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	0.50	°C/mW
From junction to case	$R_{th\ j\text{-}c}$	=	0.15	°C/mW

---

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

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current				
$I_E = 0$; $V_{CB} = 20$ V	I_{CBO}	$<$	100	nA
$I_E = 0$; $V_{CB} = 20$ V; $T_j = 150$ °C	I_{CBO}	$<$	10	μA
$V_{BE} = 0$; $V_{CE} = 15$ V; $T_j = 55$ °C	I_{CES}	$<$	0.40	μA
Emitter cut-off current				
$I_C = 0$; $V_{EB} = 5$ V	I_{EBO}	$<$	500	nA
$I_C = 0$; $V_{EB} = 5$ V; $T_j = 150$ °C	I_{EBO}	$<$	10	μA
Currents at reverse biased emitter junction				
$V_{CE} = 15$ V; $-V_{BE} = 3$ V; $T_j = 55$ °C	$-I_{BEX}$	$<$	0.60	μA
Sustaining voltages				
$I_C = 10$ mA; $I_B = 0$	$V_{CEOsust}$	$>$	12	V
Base-emitter voltage (see also page 9)				
$I_C = 30$ μA; $V_{CE} = 10$ V; $T_j = 100$ °C	V_{BE}	$>$	0.35	V
Saturation voltages				
$I_C = 10$ mA; $I_B = 1$ mA	V_{CEsat}	$<$	0.25	V
	V_{BEsat}		0.70 to 0.85	V
$I_C = 100$ mA; $I_B = 10$ mA	V_{CEsat}	$<$	0.60	V
	V_{BEsat}	$<$	1.50	V
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; $V_{CB} = 5$ V	C_c	$<$	5	pF
Emitter capacitance at f = 1 MHz				
$I_C = I_c = 0$; $V_{EB} = 1$ V	C_e	$<$	6	pF

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

D.C. current gain

		BSY38	BSY39
I_C = 10 mA; V_{CE} = 0.35 V	h_{FE}	30 to 60	40 to 120
I_C = 100 mA; V_{CE} = 1 V	h_{FE}	15 to 45	20 to 70

Transition frequency

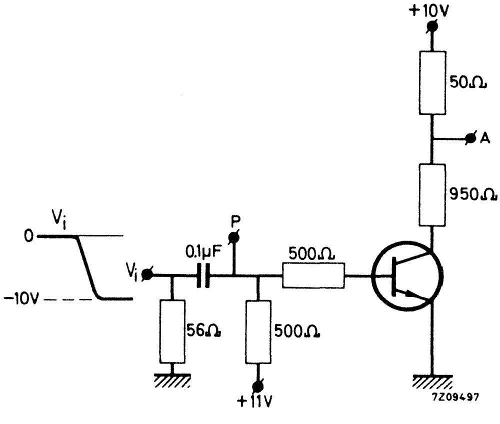
I_C 10 mA; V_{CE} = 2 V	f_T	> 200 typ. 350	MHz MHz

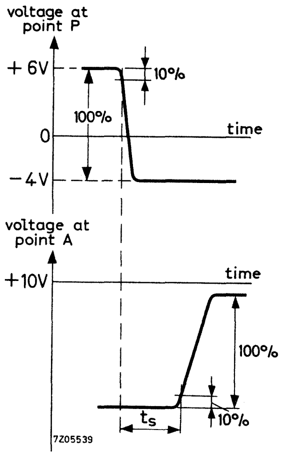
Switching times

Storage time (see also page 12)

I_C = I_B = $-I_{BM}$ = 10 mA	t_s	typ. 8 < 16	ns ns

Test circuit:





Note

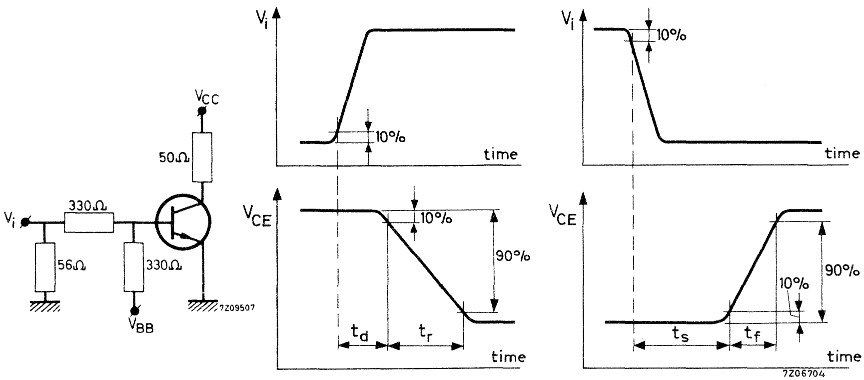
$-I_{BM}$ is the reverse current that can flow during switching off. The indicated $-I_{BM}$ is determined and limited by the applied cut-off voltage and series resistance.

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

Switching times

Turn on time (see also page 13) when switched from $-V_{BE}$ = 2.25 V to I_C = 100 mA; I_B = 40 mA with $-I_{BM}$ = 20 mA $-V_{BB}$ = 4.5 V; V_{CC} = 6 V; V_i = 20 V	t_{on}	typ. <	9 14	ns ns
Turn off time (see also page 13) when switched from I_C = 100 mA; I_B = 40 mA to cut-off with $-I_{BM}$ = 20 mA V_{BB} = 15.3 V; V_{CC} = 6 V; $-V_i$ = 20 V	t_{off}	typ. <	25 45	ns ns

Test circuit:

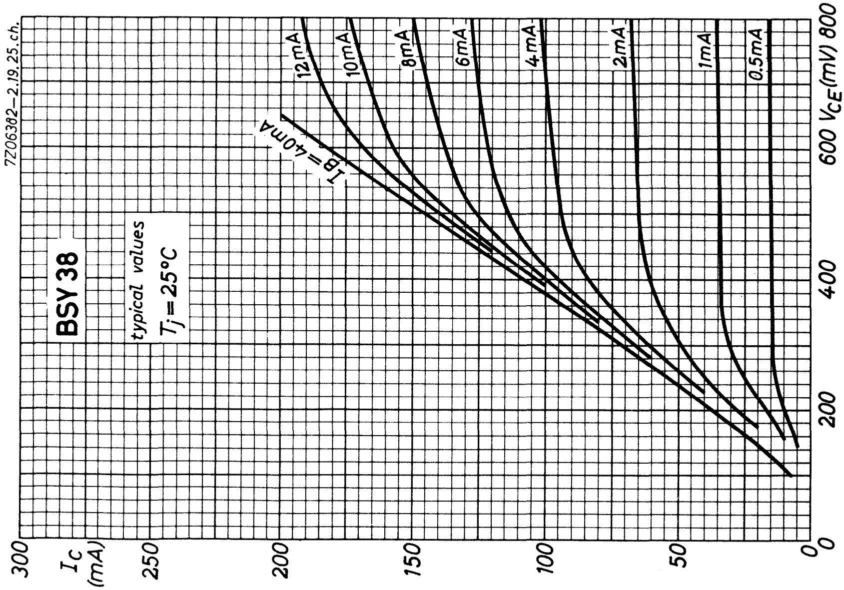


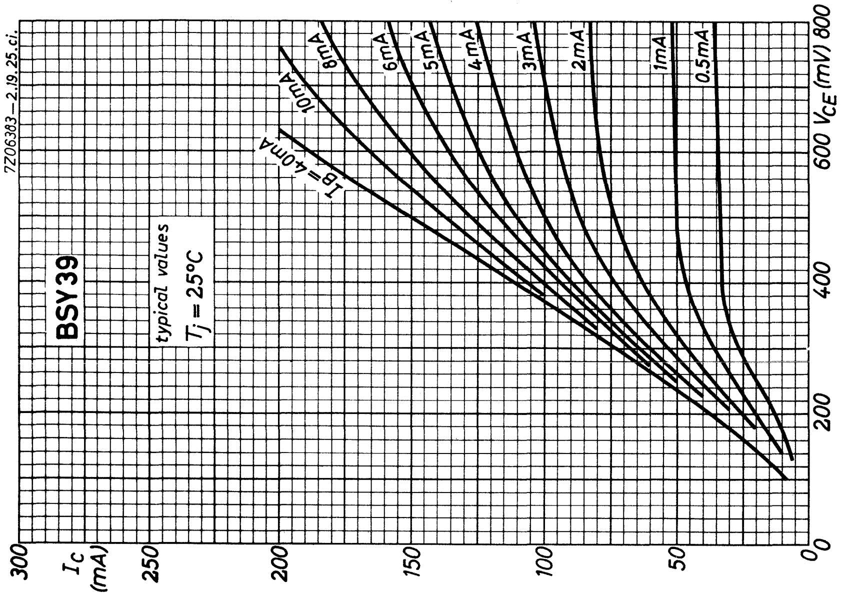
Pulse generator:

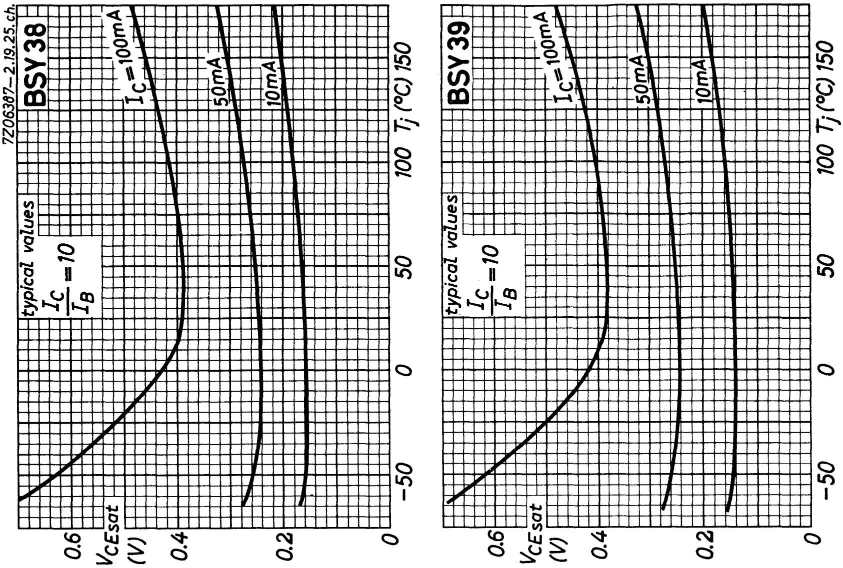
Rise time	t_r	<	1	ns
Pulse duration	t	>	60	ns
Duty cycle	δ	<	0.02	

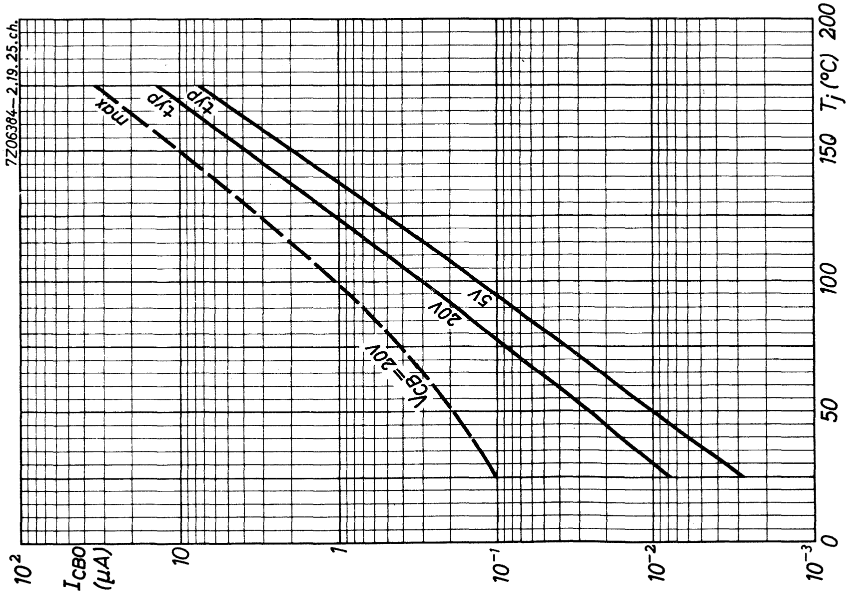
Note

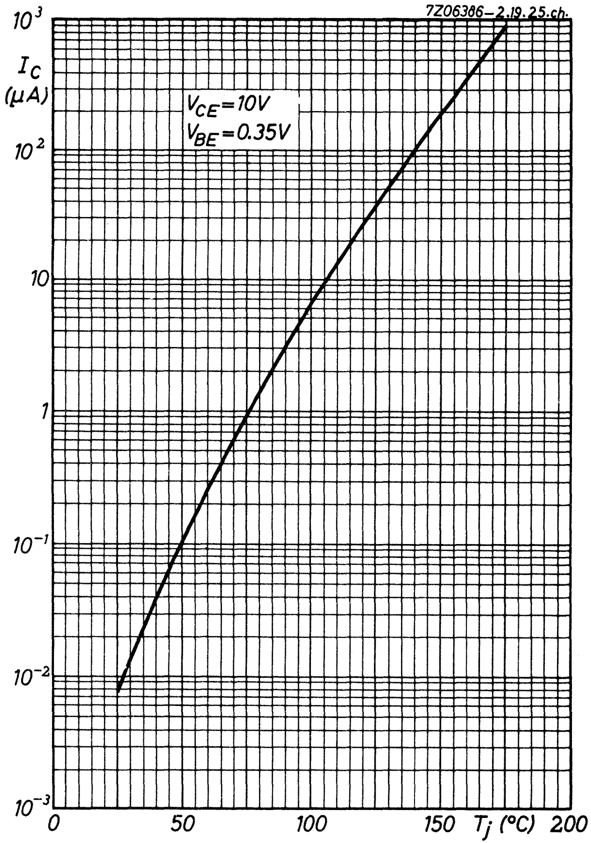
$-I_{BM}$ is the reverse current that can flow during switching off. The indicated $-I_{BM}$ is determined and limited by the applied cut-off voltage and series resistance.

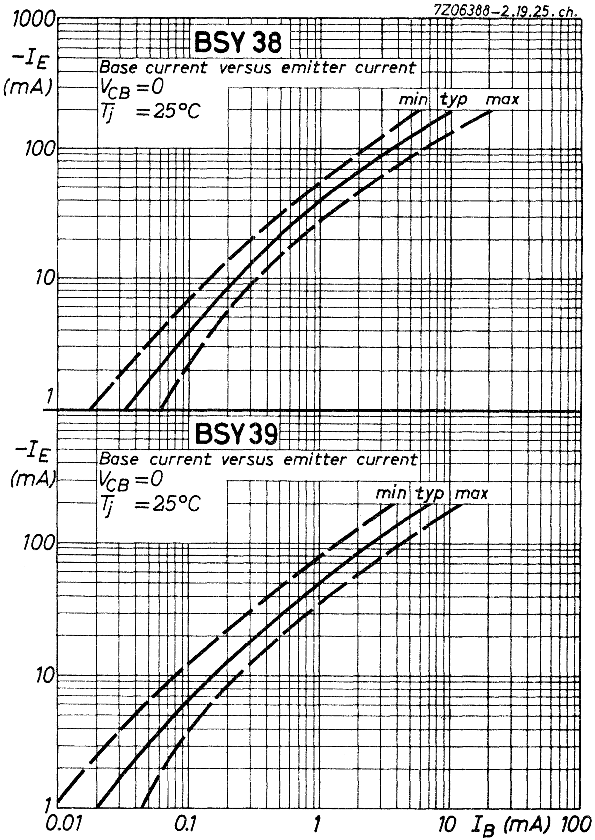

7Z06382–2.19.25.ch.
BSY 38
typical values
$T_j = 25°C$
$I_B = 40mA$
12mA
10mA
8mA
6mA
4mA
2mA
1mA
0.5mA
I_C (mA)
300
250
200
150
100
50
0
0
200
400
600
800
V_{CE} (mV)

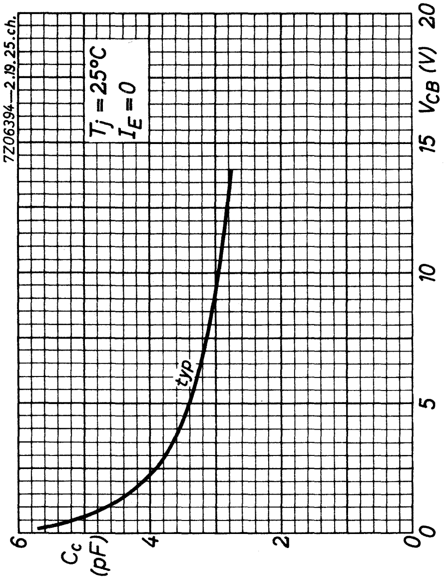

7Z06383–2.19.25.ci.
BSY39
typical values
$T_j = 25°C$
$I_B = 40mA$
10mA
8mA
6mA
5mA
4mA
3mA
2mA
1mA
0.5mA
I_C (mA)
300
250
200
150
100
50
0
0
200
400
600
800
V_{CE} (mV)

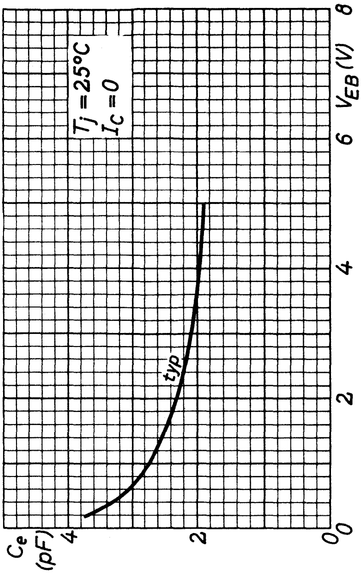

7Z06387–2.19.25.ch.
BSY38
typical values
$\frac{I_C}{I_B} = 10$
I_C=100mA
50mA
10mA
BSY39
typical values
$\frac{I_C}{I_B} = 10$
I_C=100mA
50mA
10mA
V_{CEsat} (V)
0.6
0.4
0.2
0
−50
0
50
100
150
T_j (°C)

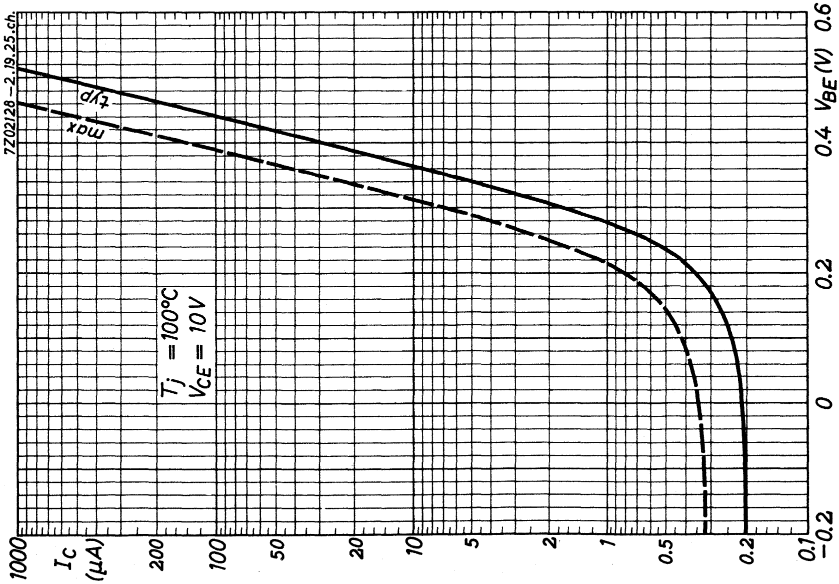

7Z06384–2.19.25.ch.
I_{CBO} (μA)
10^2
10
1
10^{-1}
10^{-2}
10^{-3}
0
50
100
150
200
T_j (°C)
max
typ
typ
V_{CB}=20V
20V
5V

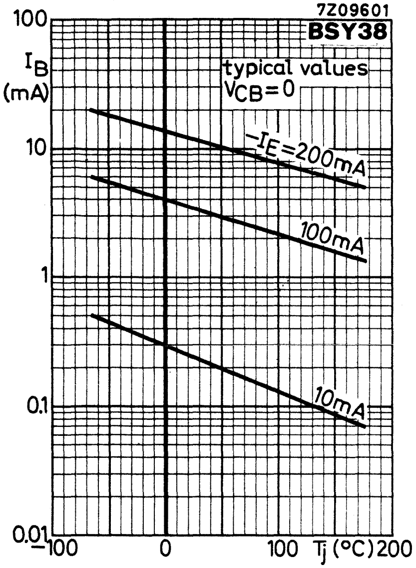

7Z06386–2.19.25.ch.
I_C (μA)
10^3
10^2
10
1
10^{-1}
10^{-2}
10^{-3}
V_{CE}=10V
V_{BE}=0.35V
0
50
100
150
200
T_j (°C)

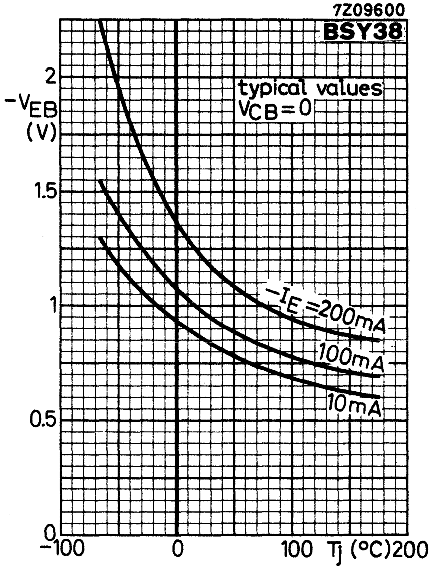

7Z06388–2.19.25.ch.
BSY 38
Base current versus emitter current
V_{CB}=0
T_j =25°C
$-I_E$ (mA)
1000
100
10
1
min
typ
max
BSY 39
Base current versus emitter current
V_{CB}=0
T_j =25°C
$-I_E$ (mA)
100
10
1
min
typ
max
0.01
0.1
1
10
100
I_B (mA)

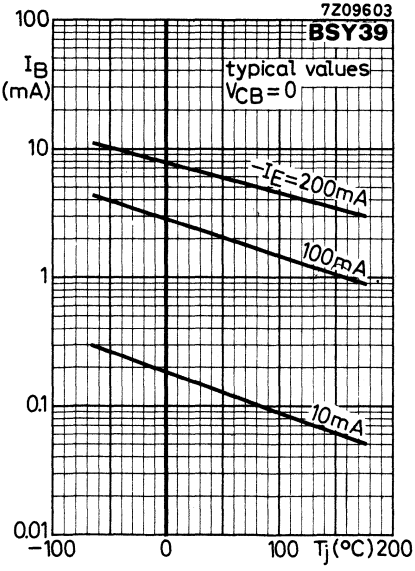

7Z06394—2.19.25.ch.
$T_j = 25°C$
$I_E = 0$
typ
C_c (pF)
6
4
2
0
V_{CB} (V)
0
5
10
15
20

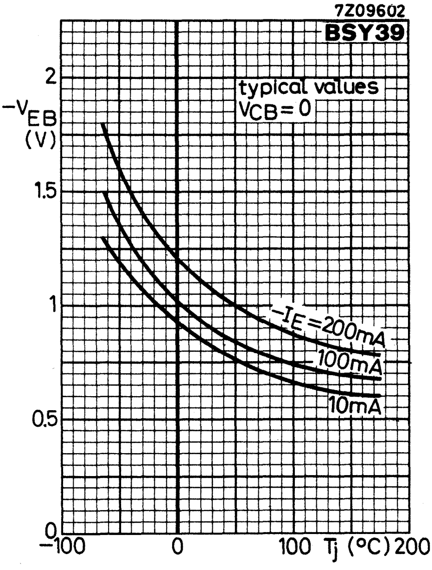

$T_j = 25°C$
$I_C = 0$
typ
C_e (pF)
4
2
0
V_{EB} (V)
0
2
4
6
8

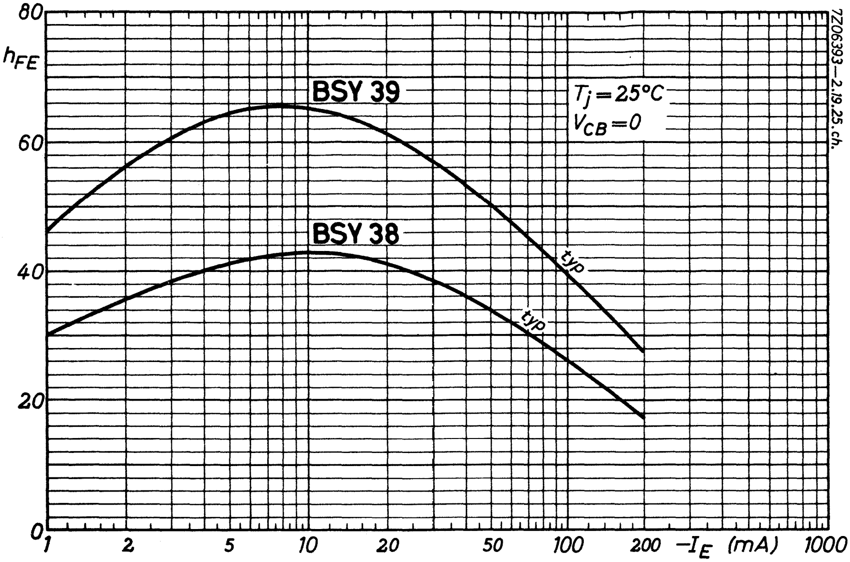

7Z02128—2.19.25.ch.
$T_j = 100°C$
$V_{CE} = 10$ V
typ
max
I_C (µA)
1000
200
100
50
20
10
5
2
1
0.5
0.2
0.1
V_{BE} (V)
−0.2
0
0.2
0.4
0.6

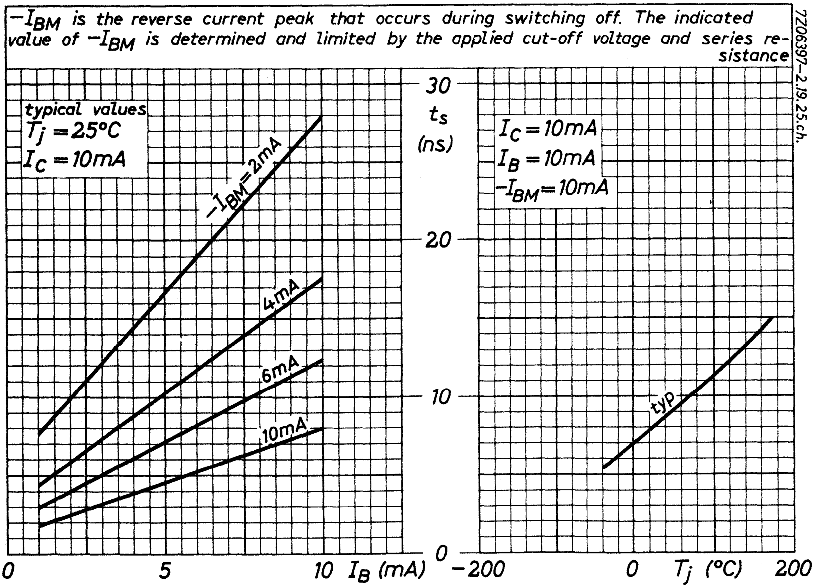

7Z09601
BSY38
typical values
$V_{CB}=0$
I_B (mA)
100
10
1
0.1
0.01
$-I_E=200mA$
100mA
10mA
−100
0
100
T_j (°C)
200


7Z09600
BSY38
typical values
$V_{CB}=0$
$-V_{EB}$ (V)
2
1.5
1
0.5
0
$-I_E=200mA$
100mA
10mA
−100
0
100
T_j (°C)
200

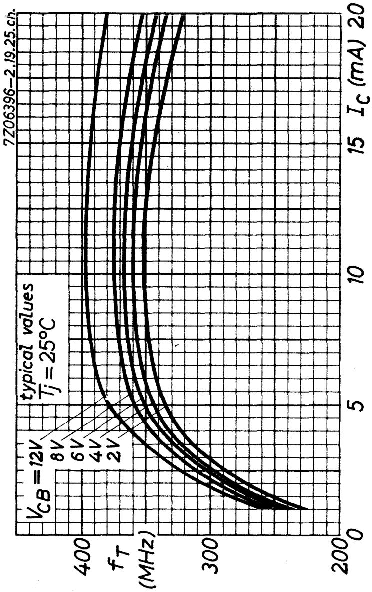

7Z09603
BSY39
typical values
$V_{CB}=0$
I_B (mA)
100
10
1
0.1
0.01
$-I_E=200mA$
100mA
10mA
−100
0
100
T_j (°C)
200

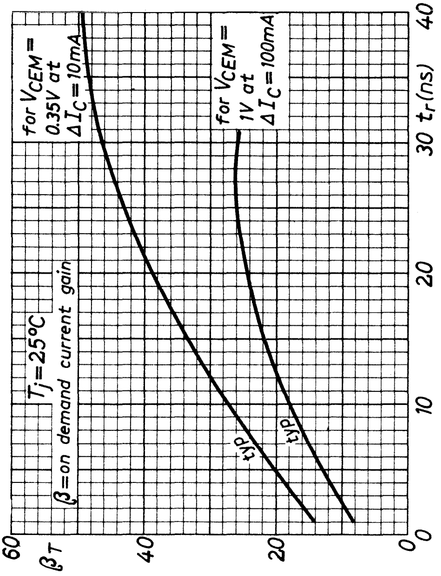

7Z09602
BSY39
typical values
$V_{CB}=0$
$-V_{EB}$ (V)
2
1.5
1
0.5
0
$-I_E=200mA$
100mA
10mA
−100
0
100
T_j (°C)
200

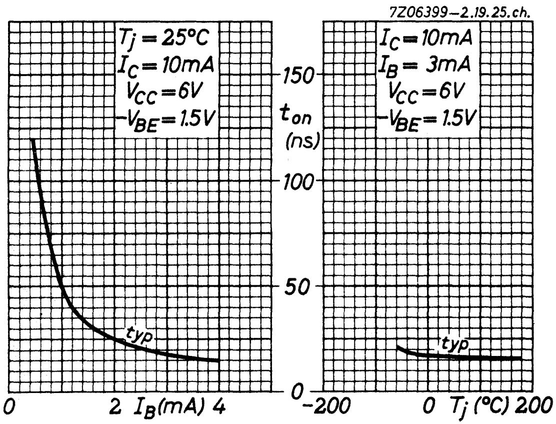


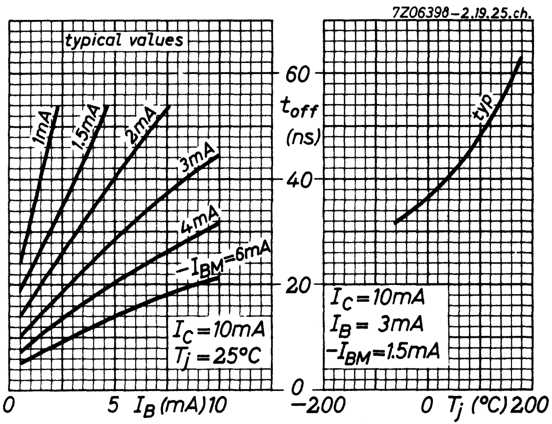


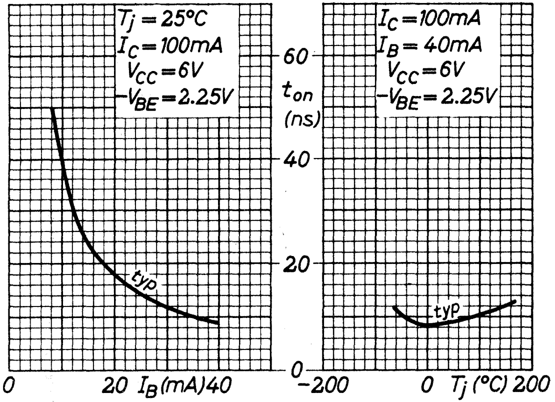
$-I_{BM}$ is the reverse current peak that occurs during switching off. The indicated value of $-I_{BM}$ is determined and limited by the applied cut-off voltage and series resistance

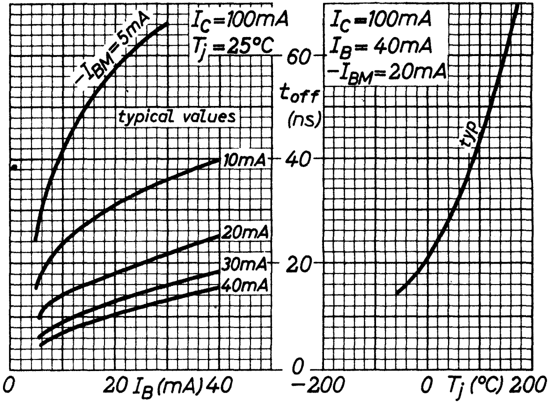

7206396-2.19.25.ch.
typical values
$T_j = 25°C$
$V_{CB} = 12V$
8V
6V
4V
2V
f_T (MHz)
200
300
400
0
5
10
15
20
I_C (mA)


for $V_{CEM} =$ 0.35V at $\Delta I_C = 10mA$
for $V_{CEM} =$ 1V at $\Delta I_C = 100mA$
$T_j = 25°C$
$\beta =$ on demand current gain
typ
typ
β_T
0
20
40
60
0
10
20
30
40
t_r (ns)


7Z06399−2.19.25.ch.
$T_j = 25°C$
$I_C = 10mA$
$V_{CC} = 6V$
$-V_{BE} = 1.5V$
typ
0
2
I_B (mA)
4
150
100
50
0
t_{on}
(ns)
$I_C = 10mA$
$I_B = 3mA$
$V_{CC} = 6V$
$-V_{BE} = 1.5V$
typ
−200
0
T_j (°C)
200

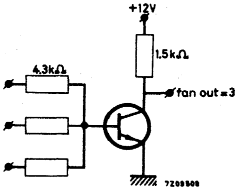

7Z06398−2.19.25.ch.
typical values
1mA
1.5mA
2mA
3mA
4mA
$-I_{BM}$=6mA
$I_C = 10mA$
$T_j = 25°C$
0
5
I_B (mA)
10
60
40
20
0
t_{off}
(ns)
typ
$I_C = 10mA$
$I_B = 3mA$
$-I_{BM} = 1.5mA$
−200
0
T_j (°C)
200


$T_j = 25°C$
$I_C = 100mA$
$V_{CC} = 6V$
$-V_{BE} = 2.25V$
typ
0
20
I_B (mA)
40
60
40
20
0
t_{on}
(ns)
$I_C = 100mA$
$I_B = 40mA$
$V_{CC} = 6V$
$-V_{BE} = 2.25V$
typ
−200
0
T_j (°C)
200


$-I_{BM}$=5mA
$I_C = 100mA$
$T_j = 25°C$
typical values
10mA
20mA
30mA
40mA
0
20
I_B (mA)
40
60
40
20
0
t_{off}
(ns)
$I_C = 100mA$
$I_B = 40mA$
$-I_{BM} = 20mA$
typ
−200
0
T_j (°C)
200

APPLICATION INFORMATION

NOR gate circuit (Resistor Transistor Logic)



Delay time per stage

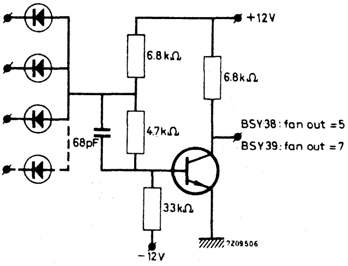
fan in = 3	t_d	typ.	60	ns

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 SWITCHING TRANSISTORS

Germanium p-n-p transistors in all glass construction for medium current, high speed, computer switching applications.

(IEC 134)

RATINGS Limiting values in accordance with the Absolute Maximum System

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	20	V
Collector-emitter voltage with $+V_{BE} > 0.2$ V	$-V_{CEX}$	max.	20	V
Collector current (d.c. and average)	$-I_C$	max.	100	mA
Collector current (peak value)	$-I_{CM}$	max.	125	mA
Base current (d.c. and average)	$-I_B$	max.	15	mA
Total power dissipation up to $T_{amb} = 25$ °C	P_{tot}	max.	80	mW
Junction temperature: continuous	T_j	max.	75	°C
incidentally	T_j	max.	90	°C

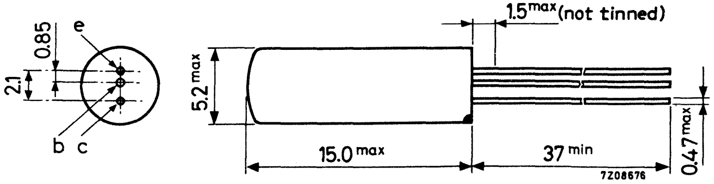
THERMAL RESISTANCE

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

CHARACTERISTICS at $T_j = 25$ °C

		OC46	OC47
D.C. current gain			
$-I_C = 15$ mA; $-V_{CB} = 0$	h_{FE}	20 to 80	50 to 200
Cut-off frequency			
$I_E = 3$ mA; $-V_{CB} = 5$ V	f_{hfb}	> 3 MHz	> 4.5 MHz

MECHANICAL DATA Dimensions in mm



The coloured dot in indicates the collector

FOR REPLACEMENT THE SUCCESSOR TYPES
ASY26 AND ASY27 ARE RECOMMENDED

GERMANIUM SWITCHING TRANSISTOR

P-N-P transistor in all glass envelope with metal cover. It is primarily intended for switching and pulse-oscillating circuits such as d.c. converters.

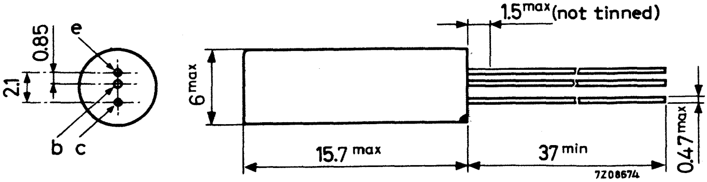
RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	32	V
Collector-emitter voltage ($R_{BE} < 1$ kΩ)	$-V_{CER}$	max.	32	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	16	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	10	V
Collector current (d.c.)	$-I_C$	max.	125	mA
Collector current (peak value)	$-I_{CM}$	max.	250	mA
Base current (d.c.)	$-I_B$	max.	20	mA
Base current (peak value)	$-I_{BM}$	max.	125	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	125	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	$R_{th\ j\text{-}a}$	=	0.4	°C/mW

MECHANICAL DATA Dimensions in mm



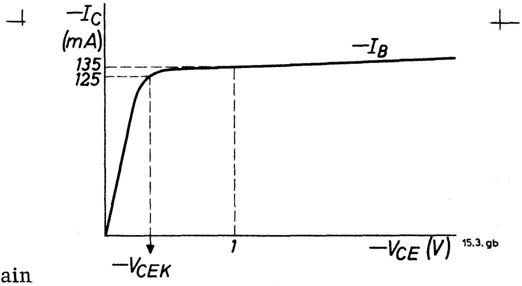
The coloured dot indicates the collector

FOR REPLACEMENT THE SUCCESSOR TYPE ASY76
IS RECOMMENDED

CHARACTERISTICS

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

Collector cut-off current		
$I_E = 0; -V_{CB} = 10\ V$	$-I_{CBO}$	typ. 4.5 μA < 10 μA
$I_B = 0; -V_{CE} = 6\ V$	$-I_{CEO}$	typ. 200 μA < 600 μA
$+V_{BE} = 0.5\ V; -V_{CE} = 30\ V$	$-I_{CEX}$	typ. 7.5 μA < 15 μA
Emitter cut-off current		
$I_C = 0; -V_{EB} = 10\ V$	$-I_{EBO}$	typ. 4.5 μA < 8 μA
Base-emitter voltage		
$I_E = 80\ mA; -V_{CE} = 0.7\ V$	$-V_{BE}$	< 0.45 V
$I_E = 125\ mA; -V_{CE} = 0.7\ V$	$-V_{BE}$	< 0.70 V
Knee voltage		
$-I_C = 125\ mA; -I_B$ = value for which $-I_C = 135\ mA$ at $-V_{CE} = 1\ V$	$-V_{CEK}$	typ. 0.3 V < 0.4 V



D.C. current gain		
$-I_C = 10\ mA; -V_{CE} = 5.4\ V$	h_{FE}	45 to 330
$-I_C = 80\ mA; -V_{CE} = 0.7\ V$	h_{FE}	30 to 230
$-I_C = 125\ mA; -V_{CE} = 0.7\ V$	h_{FE}	25 to 170
$-I_C = 250\ mA; -V_{CE} = 1\ V$	h_{FE}	15 to 125
Cut-off frequency		
$I_E = 10\ mA; -V_{CB} = 6\ V$	f_{hfb}	> 350 kHz typ. 900 kHz
Noise figure at f = 1 kHz		
$I_E = 0.5\ mA; -V_{CE} = 2\ V; R_S = 500\ \Omega$	F	typ. 8 dB < 15 dB

GERMANIUM SWITCHING TRANSISTOR

P-N-P transistor in all glass envelope with metal cover. It is primarily intended for switching and pulse-oscillating circuits such as d.c. converters.

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

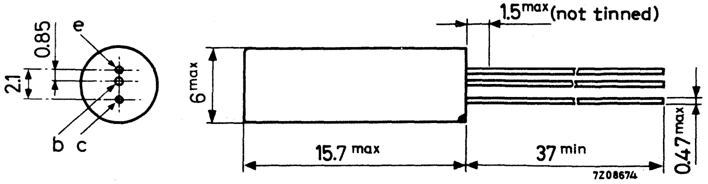
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60	V
Collector-emitter voltage ($R_{BE} < 400\ \Omega$)	$-V_{CER}$	max.	60	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	15	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	10	V
Collector current (d.c.)	$-I_C$	max.	125	mA
Collector current (peak value)	$-I_{CM}$	max.	250	mA
Base current (d.c.)	$-I_B$	max.	20	mA
Base current (peak value)	$-I_{BM}$	max.	125	mA
Total power dissipation up to $T_{amb} = 25\ ^oC$	P_{tot}	max.	125	mW
Storage temperature	T_{stg}		-55 to +75	^oC
Junction temperature: continuous	T_j	max.	75	^oC
incidentally	T_j	max.	90	^oC

THERMAL RESISTANCE

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

MECHANICAL DATA

Dimensions in mm



The coloured dot indicates the collector

FOR REPLACEMENT THE SUCCESSOR TYPE ASY77
IS RECOMMENDED

CHARACTERISTICS

T_{amb} = 25 °C unless otherwise specified

Collector cut-off current

$I_E = 0$; $-V_{CB} = 10$ V	$-I_{CBO}$	typ. <	4.5 10	μA μA
$I_B = 0$; $-V_{CE} = 6$ V	$-I_{CEO}$	typ. <	200 600	μA μA
$+V_{BE} = 0.5$ V; $-V_{CE} = 60$ V	$-I_{CEX}$	typ. <	15 30	μA μA

Emitter cut-off current

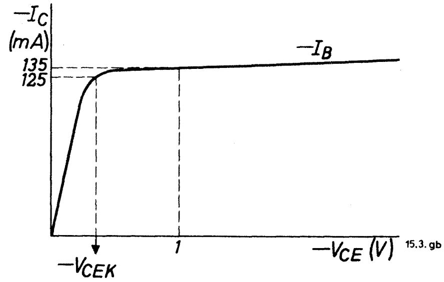
$I_C = 0$; $-V_{EB} = 10$ V	$-I_{EBO}$	typ. <	4.5 10	μA μA

Base-emitter voltage

$I_E = 80$ mA; $-V_{CE} = 0.7$ V	$-V_{BE}$	<	0.45	V
$I_E = 125$ mA; $-V_{CE} = 0.7$ V	$-V_{BE}$	<	0.70	V

Knee voltage

$-I_C = 125$ mA; $-I_B$ = value for which $-I_C = 135$ mA at $-V_{CE} = 1$ V	$-V_{CEK}$	<	0.4	V



D.C. current gain

$-I_C = 10$ mA; $-V_{CE} = 5.4$ V	h_{FE}	>	45
$-I_C = 80$ mA; $-V_{CE} = 0.7$ V	h_{FE}	>	30
$-I_C = 125$ mA; $-V_{CE} = 0.7$ V	h_{FE}	>	25
$-I_C = 250$ mA; $-V_{CE} = 1$ V	h_{FE}	>	15

Cut-off frequency

$I_E = 10$ mA; $-V_{CB} = 6$ V	f_{hfb}	>	350	kHz

Noise figure at f = 1 kHz

$I_E = 0.5$ mA; $-V_{CE} = 2$ V; $R_S = 500\ \Omega$	F	<	15	dB

GERMANIUM SWITCHING TRANSISTOR

P-N-P transistor in all glass envelope with metal cover, primarily intended for switching and pulse-oscillating circuits.

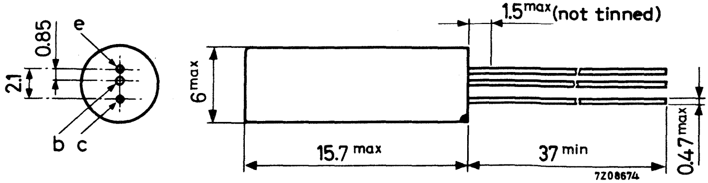
RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	32	V
Collector-emitter voltage (V_{BE} = 0)	$-V_{CES}$	max.	32	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	20	V
Collector current (d.c. or average over any 50 ms period)	$-I_C$	max.	300	mA
Collector current (peak value)	$-I_{CM}$	max.	600	mA
Base current (d.c. or average over any 50 ms period)	$-I_B$	max.	40	mA
Base current (peak value)	$-I_{BM}$	max.	200	mA
Total power dissipation up to T_{amb} = 40 °C	P_{tot}	max.	550	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	$R_{th\ j\text{-}a}$	=	0.22	°C/mW

MECHANICAL DATA Dimensions in mm



The coloured dot indicates the collector

FOR REPLACEMENT THE SUCCESSOR TYPE ASY80
IS RECOMMENDED

CHARACTERISTICS

T_{amb} = 25 °C unless otherwise specified

Collector cut-off current

$I_E = 0$; $-V_{CB} = 12$ V	$-I_{CBO}$	typ. <	10 20	μA μA
$I_E = 0$; $-V_{CB} = 12$ V; $T_{amb} = 60$ °C	$-I_{CBO}$	<	330	μA

Emitter cut-off current

$I_C = 0$; $-V_{EB} = 6$ V	$-I_{EBO}$	typ. <	6 20	μA μA

Sustaining voltage

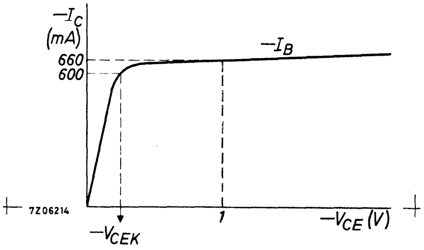
$-I_C = 600$ mA; $V_{BE} = 0$	$-V_{CESsust}$	>	32	V

Base-emitter voltage

$-I_C = 600$ mA; $V_{CB} = 0$	$-V_{BE}$	typ.	0.6	V

Knee voltage

$-I_C = 600$ mA; $-I_B$ = value for which $-I_C = 660$ mA at $-V_{CE} = 1$ V	$-V_{CEK}$	typ. <	0.4 0.9	V V



Emitter-base floating voltage

$I_E = 0$; $-V_{CB} = 32$ V	V_{EBfl}	<	0.55	V

D.C. current gain

$-I_C = 50$ mA; $-V_{CE} = 6$ V	h_{FE}	typ.	180
$-I_C = 600$ mA; $-V_{CB} = 0$	h_{FE}	typ.	85

Cut-off frequency

$I_E = 50$ mA; $-V_{CB} = 6$ V	f_{hfb}	typ.	2	MHz

Feedback impedance at f = 0.5 MHz

$I_E = 1$ mA; $-V_{CE} = 6$ V	$\lvert z_{rb} \rvert$	typ.	60	Ω

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

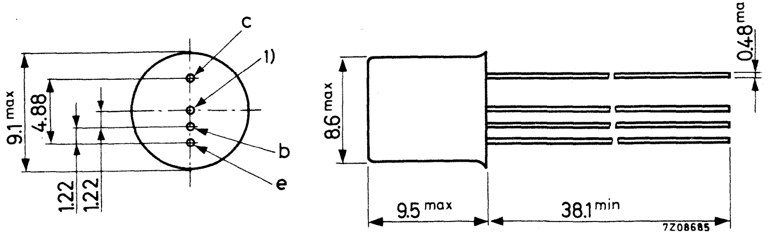
Currents				
Collector current (d.c. or average over any 20 ms period)	$-I_C$	max.	0.5	A
Collector current (peak value)	$-I_{CM}$	max.	2.0	A
Power dissipation				
Total power dissipation up to $T_{amb} = 25\ ^oC$	P_{tot}	max.	300	mW
Temperatures				
Storage temperature	T_{stg}		−55 to +75	^oC
Junction temperature	T_j	max.	90	^oC

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	0.22	$^oC/mW$
From junction to case	$R_{th\ j\text{-}c}$	=	0.06	$^oC/mW$

MECHANICAL DATA Dimensions in mm

TO-7



1) = shield lead (connected to case)

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

CHARACTERISTICS

			OC122	OC123	
Collector cut-off current					
$I_E = 0$; $-V_{CB} = 24$ V	$-I_{CBO}$	typ. <	40 150		μA μA
$I_E = 0$; $-V_{CB} = 10$ V	$-I_{CBO}$	typ. <		20 100	μA μA
Base-emitter voltage					
$-I_C = 100$ mA; $-V_{CE} = 2$ V	$-V_{BE}$	typ. <	0.27 0.35	0.27 0.35	V V
D.C. current gain					
$-I_C = 100$ mA; $-V_{CE} = 6$ V	h_{FE}	> typ.	50 180	50 160	
Collector capacitance					
$I_E = I_e = 0$; $-V_{CE} = 6$ V	C_c	typ.	170	170	pF
Transition frequency					
$-I_C = 100$ mA; $-V_{CE} = 2$ 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.

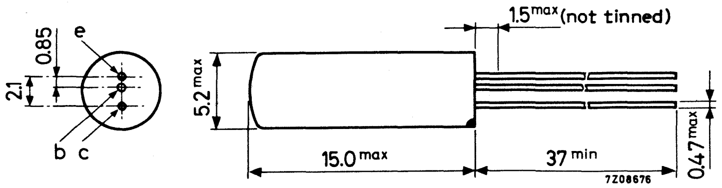
RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

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	$R_{th\ j\text{-}a}$	=	0.35	°C/mW
From junction to case	$R_{th\ j\text{-}c}$	=	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

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

Collector cut-off current				
$I_E = 0$; $V_{CB} = 5$ V	I_{CBO}	typ. $<$	0.3 3	μA μA
$I_E = 0$; $V_{CB} = 5$ V; $T_j = 60$ °C	I_{CBO}	typ. $<$	6 35	μA μA
$I_E = 0$; $V_{CB} = 20$ V; $T_j = 60$ °C	I_{CBO}	$<$	100	μA
Emitter cut-off current				
$I_C = 0$; $V_{EB} = 5$ V	I_{EBO}	typ. $<$	0.3 3	μA μA
$I_C = 0$; $V_{EB} = 5$ V; $T_j = 60$ °C	I_{EBO}	typ. $<$	6 35	μA μA
$I_C = 0$; $V_{EB} = 20$ V; $T_j = 60$ °C	I_{EBO}	$<$	100	μA
Sustaining voltage				
I_C 250 mA; $-V_{BE} = 2$ V	$V_{CEXsust}$	$>$	15	V
Base-emitter voltage				
$I_C = 200$ mA; $V_{CB} = 0$	V_{BE}	$<$	750	mV
Saturation voltages				
$I_C = 8.5$ mA; $I_B = 0.38$ mA	V_{CEsat}	$<$	175	mV
$I_C = 50$ mA; $I_B = 3.1$ mA	V_{CEsat}	typ. $<$	60 220	mV mV
	V_{BEsat}	typ. $<$	300 500	mV mV
Punch-through voltage	V_{pt}	$>$	20	V
D.C. current gain				
$I_C = 15$ mA; $V_{CB} = 0$	h_{FE}		20 to 84	
$I_C = 200$ mA; $V_{CB} = 0$	h_{FE}	$>$	15	
Transition frequency				
$I_C = 3$ mA; $V_{CE} = 5$ V	f_T	typ. $>$	6 3.5	MHz MHz
Switching parameters				
Current-drive time constant $I_{CM} = 200$ mA; $V_{CE} = 0.75$ V	τ_c	$<$	1.75	μs
Voltage-drive time constant $I_{CM} = 1$ mA; $V_{CE} = 5$ V	τ_v	$<$	0.15	μs

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.

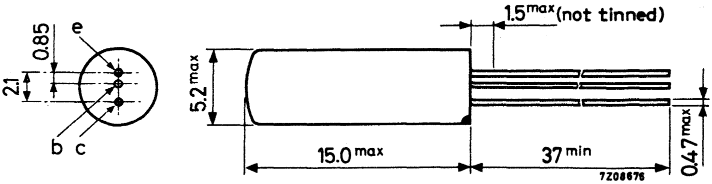
RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

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

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

Collector cut-off current				
$I_E = 0$; $V_{CB} = 5$ V	I_{CBO}	typ. <	0.3 3	μA μA
$I_E = 0$; $V_{CB} = 5$ V; $T_j = 60$ °C	I_{CBO}	typ. <	6 35	μA μA
$I_E = 0$; $V_{CB} = 20$ V; $T_j = 60$ °C	I_{CBO}	<	100	μA
Emitter cut-off current				
$I_C = 0$; $V_{EB} = 5$ V	I_{EBO}	typ. <	0.3 3	μA μA
$I_C = 0$; $V_{EB} = 5$ V; $T_j = 60$ °C	I_{EBO}	typ. <	6 35	μA μA
$I_C = 0$; $V_{EB} = 20$ V; $T_j = 60$ °C	I_{EBO}	<	100	μA
Sustaining voltage				
$I_C = 400$ mA; $-V_{BE} = 2$ V	$V_{CEXsust}$	>	15	V
Base-emitter voltage				
$I_C = 200$ mA; $V_{CB} = 0$	V_{BE}	<	600	mV
Saturation voltages				
$I_C = 7.5$ mA; $I_B = 0.165$ mA	V_{CEsat} V_{BEsat}	< <	175 250	mV mV
$I_C = 50$ mA; $I_B = 1.25$ mA	V_{CEsat} V_{BEsat}	< <	220 380	mV mV
$I_C = 400$ mA; $I_B = 20$ mA	V_{CEsat} V_{BEsat}	< <	370 900	mV mV
Punch-through voltage	V_{pt}	>	20	V
D.C. current gain				
$I_C = 15$ mA; $V_{CB} = 0$	h_{FE}	50 to 150		
$I_C = 200$ mA; $V_{CB} = 0$	h_{FE}	36 to 67		
$I_E = 200$ mA; $V_{EB} = 0$	h_{FC}	>	21	
Transition frequency				
$I_C = 3$ mA; $V_{CE} = 5$ V	f_T	typ. >	12 4.5	MHz MHz
Switching parameters				
Current-drive time constant $I_{CM} = 200$ mA; $V_{CE} = 0.75$ V	τ_c	<	1.75	μs
Voltage-drive time constant $I_{CM} = 1$ mA; $V_{CE} = 5$ V	τ_v	<	0.15	μs

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.

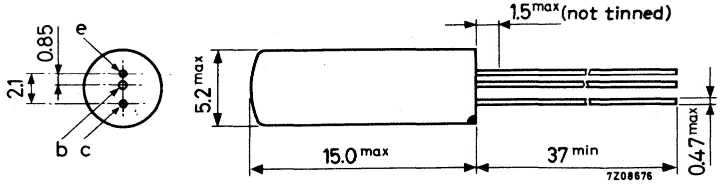
RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

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	$R_{th\ j\text{-}a}$	=	0.35	°C/mW
From junction to case	$R_{th\ j\text{-}c}$	=	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

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

Collector cut-off current				
$I_E = 0$; $V_{CB} = 5$ V	I_{CBO}	typ. <	0.3 3	μA μA
$I_E = 0$; $V_{CB} = 5$ V; $T_j = 60$ °C	I_{CBO}	typ. <	6 35	μA μA
$I_E = 0$; $V_{CB} = 20$ V; $T_j = 60$ °C	I_{CBO}	<	100	μA
Emitter cut-off current				
$I_C = 0$; $V_{EB} = 5$ V	I_{EBO}	typ. <	0.3 3	μA μA
$I_C = 0$; $V_{EB} = 5$ V; $T_j = 60$ °C	I_{EBO}	typ. <	6 35	μA μA
$I_C = 0$; $V_{EB} = 20$ V; $T_j = 60$ °C	I_{EBO}	typ.	100	μA
Sustaining voltage				
$I_C = 400$ mA; $-V_{BE} = 2$ V	$V_{CEXsust}$	>	15	V
Base-emitter voltage				
$I_C = 200$ mA; $V_{CB} = 0$	V_{BE}	<	450	mV
Saturation voltages				
$I_C = 7.5$ mA; $I_B = 0.094$ mA	V_{CEsat} V_{BEsat}	< <	175 250	mV mV
$I_C = 50$ mA; $I_B = 0.75$ mA	V_{CEsat} V_{BEsat}	< <	220 340	mV mV
$I_C = 400$ mA; $I_B = 13.3$ mA	V_{CEsat}	<	370	mV
$I_C = 400$ mA; $I_B = 20$ mA	V_{BEsat}	<	700	mV
Punch-through voltage	V_{pt}	>	20	V
D.C. current gain				
$I_C = 15$ mA; $V_{CB} = 0$	h_{FE}	80 to 200		
$I_C = 200$ mA; $V_{CB} = 0$	h_{FE}	50 to 134		
$I_E = 200$ mA; $V_{EB} = 0$	h_{FC}	>	21	
Transition frequency				
$I_C = 3$ mA; $V_{CE} = 5$ V	f_T	typ. <	20 9	MHz MHz
Switching parameters				
Current-drive time constant $I_{CM} = 200$ mA; $V_{CE} = 0.75$ V	τ_c	<	1.75	μs
Voltage-drive time constant $I_{CM} = 1$ mA; $V_{CE} = 5$ V	τ_v	<	0.15	μs

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

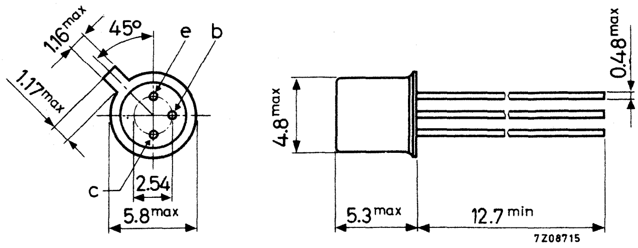
Collector-base voltage (open emitter)		V_{CBO}	max.	25	V
Collector-emitter voltage (open base)		V_{CEO}	max.	15	V
Collector current (d.c.)		I_C	max.	50	mA
Total power dissipation up to $T_{amb} = 25\ ^oC$		P_{tot}	max.	300	mW
Junction temperature		T_j	max.	175	^oC
D.C. current gain at $T_j = 25\ ^oC$					
$I_C = 10$ mA; $V_{CE} = 1$ V	2N706A	h_{FE}		20 to 60	
	2N753	h_{FE}		40 to 120	
Transition frequency					
$I_C = 10$ mA; $V_{CE} = 10$ V		f_T	>	200	MHz
Storage time					
$I_C = I_B = -I_{BM} = 10$ mA	2N706A	t_s	<	25	ns
	2N753	t_s	<	35	ns

MECHANICAL DATA

Dimensions in mm

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 $R_{BE} \leqq 10\,\Omega$	V_{CER}	max.	20	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	V

Current

Collector current (d.c. or average over any 20 ms period)	I_C	max.	50	mA

Power dissipation

Total power dissipation up to $T_{amb} = 25\,^{\circ}C$	P_{tot}	max.	300	mW

Temperatures

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

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	0.5	°C/mW
From junction to case	$R_{th\ j\text{-}c}$	=	0.15	°C/mW

---

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

CHARACTERISTICS T_j = 25 °C unless otherwise specified

Collector cut-off current					
$I_E = 0$; $V_{CB} = 15$ V		I_{CBO}	<	0.5	μA
$I_E = 0$; $V_{CB} = 25$ V		I_{CBO}	<	10	μA
$I_E = 0$; $V_{CB} = 15$ V; $T_j = 150$ °C		I_{CBO}	<	30	μA
$V_{CE} = 20$ V; $R_{BE} = 100$ kΩ		I_{CER}	<	10	μA
Emitter cut-off current					
$I_C = 0$; $V_{EB} = 5$ V		I_{EBO}	<	10	μA
Sustaining voltages [1]					
$I_C = 10$ mA; $I_B = 0$		$V_{CEOsust}$	>	15	V
$I_C = 10$ mA; $R_{BE} = 10$ Ω		$V_{CERsust}$	>	20	V
Saturation voltages					
$I_C = 10$ mA; $I_B = 1$ mA		V_{CEsat}	<	0.6	V
		V_{BEsat}		0.7 to 0.9	V
D.C. current gain					
$I_C = 10$ mA; $V_{CE} = 1$ V	2N706A	h_{FE}		20 to 60	
	2N753	h_{FE}		40 to 120	
Collector capacitance at f = 1 MHz					
$I_E = I_e = 0$; $V_{CB} = 5$ V		C_c	<	5	pF
Transition frequency					
$I_C = 10$ mA; $V_{CE} = 10$ V		f_T	>	200	MHz

---

[1] Measured under pulsed conditions to avoid excessive dissipation
Pulse duration t = 300 μs; duty cycle $\delta \leq 0.02$

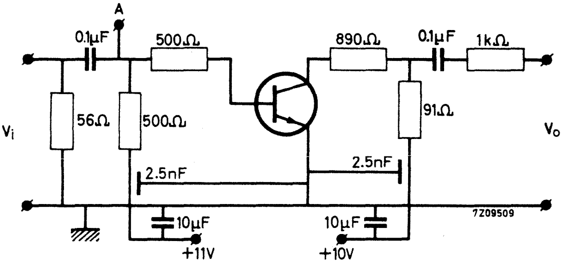
CHARACTERISTICS (continued) $T_j = 25\ ^{\circ}C$ unless otherwise specified

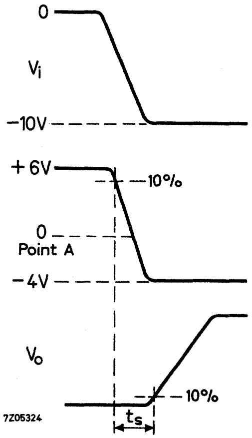
Storage time

$I_C = I_B = -I_{BM} = 10$ mA

Test circuit: 1)

2N706A	t_s	<	25	ns
2N753	t_s	<	35	ns





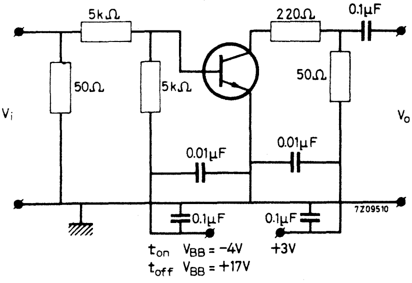
Turn on time

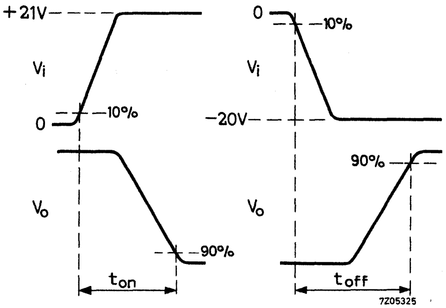
$I_C = 10$ mA; $I_B = 3$ mA; $-V_{BE} = 2$ V t_{on} < 40 ns

Turn off time

$I_C = 10$ mA; $I_B = 3$ mA; $-I_{BM} = 1$ mA t_{off} < 75 ns

Test circuit: 1)





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1) Pulse generator:

Pulse duration	t	>	400	ns
Duty cycle	δ	<	0.02	
Rise time	t_r	<	1	ns
Source impedance	R_S	=	50	Ω

Oscilloscope:

Rise time	t_r	<	1	ns
Probe impedance		=	2	kΩ

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.

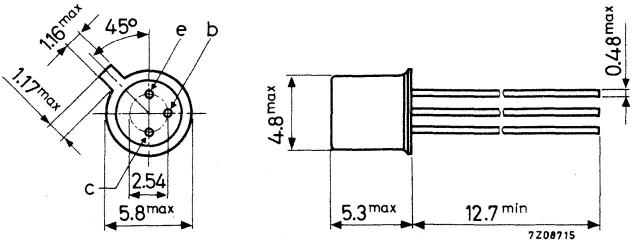
QUICK REFERENCE DATA

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 $T_{amb} = 25\ ^oC$	P_{tot}	max.	360	mW
Junction temperature	T_j	max.	200	^oC
D.C. current gain at $T_j = 25\ ^oC$				
$I_C = 10$ mA; $V_{CE} = 1$ V	h_{FE}	30 to 120		
Transition frequency				
$I_C = 10$ mA; $V_{CE} = 10$ V	f_T	>	300	MHz
Storage time				
$I_C = I_B = -I_{BM} = 10$ mA	t_s	<	25	ns

MECHANICAL DATA Dimensions in mm

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 μs)	I_{CM}	max.	500	mA
Power dissipation				
Total power dissipation up to $T_{amb} = 25\ ^oC$	P_{tot}	max.	360	mW
Temperatures				
Storage temperature	T_{stg}	-65 to +200		^oC
Junction temperature	T_j	max.	200	^oC

THERMAL RESISTANCE

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

---

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

CHARACTERISTICS T_j = 25 °C unless otherwise specified

Collector cut-off current				
$I_E = 0$; $V_{CB} = 20$ V	I_{CBO}	$<$	25	nA
$I_E = 0$; $V_{CB} = 20$ V; $T_j = 150$ °C	I_{CBO}	$<$	15	µA
$V_{CE} = 20$ V; $V_{BE} = 0.25$ V; $T_j = 125$ °C	I_{CEX}	$<$	10	µA
Emitter cut-off current				
$I_C = 0$; $V_{EB} = 4$ V	I_{EBO}	$<$	0.1	µA
Sustaining voltages [1]				
$I_C = 30$ mA; $I_B = 0$	$V_{CEOsust}$	$>$	15	V
$I_C = 30$ mA; $R_B \leq 10\ \Omega$	$V_{CERsust}$	$>$	20	V
Saturation voltages				
$I_C = 10$ mA; $I_B = 1$ mA	V_{CEsat}	$<$	0.4	V
	V_{BEsat}		0.72 to 0.80	V
$I_C = 7$ mA; $I_B = 0.7$ mA; $T_j = -55$ to $+125$ °C	V_{CEsat}	$<$	0.4	V
$I_C = 7$ mA; $I_B = 0.7$ mA; $T_j = -55$ °C	V_{BEsat}	$<$	0.9	V
D.C. current gain				
$I_C = 0.5$ mA; $V_{CE} = 1$ V	h_{FE}	$>$	15	
$I_C = 10$ mA; $V_{CE} = 1$ V	h_{FE}		30 to 120	
$I_C = 10$ mA; $V_{CE} = 1$ V; $T_j = -55$ °C	h_{FE}	$>$	15	
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; $V_{CB} = 10$ V	C_c	$<$	6	pF
Transition frequency				
$I_C = 10$ mA; $V_{CE} = 10$ V	f_T	$>$	300	MHz
Real part of small signal input impedance				
$I_C = 10$ mA; $V_{CE} = 10$ V; f = 300 MHz	$R_e(h_{ie})$	$<$	50	Ω

---

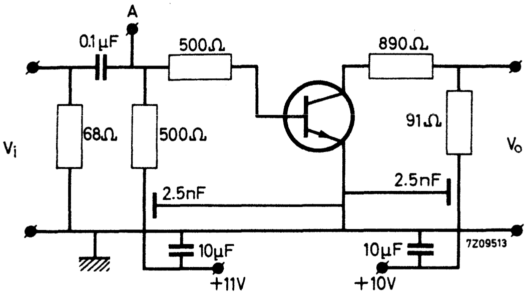
[1] Measured under pulsed conditions to avoid excessive dissipation. Pulse duration $t = 300\ \mu s$; duty cycle $\delta < 0.01$

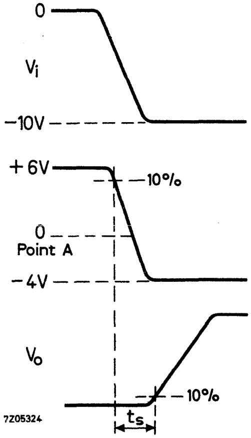
CHARACTERISTICS (continued) T_j = 25 °C unless otherwise specified

Storage time

$I_C = I_B = -I_{BM} = 10$ mA $t_s < 25$ ns

Test circuit:





Pulse generator:

Pulse duration	t	≥	400	ns
Duty cycle	δ	≤	0.02	
Rise time	t_r	≤	1	ns
Source impedance	R_S	=	50	Ω

Oscilloscope:

Rise time $t_r < 1$ ns

High impedance probe

SILICON PLANAR EPITAXIAL TRANSISTORS

N-P-N transistor in a TO-18 metal envelope with the collector connected to the case.
The 2N709 is primarily intended for use in ultra-high speed saturated logic applications.

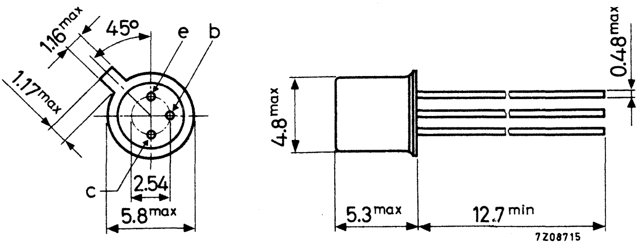
QUICK REFERENCE DATA

Collector-base voltage (open emitter)	V_{CBO}	max.	15	V
Collector-emitter voltage (open base)	V_{CEO}	max.	6	V
Collector current (peak value)	I_{CM}	max.	200	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	0.3	W
Junction temperature	T_j	max.	200	°C
D.C. current gain at T_j = 25 °C I_C = 10 mA; V_{CE} = 0.5 V	h_{FE}		20 to 120	
Transition frequency I_C = 5 mA; V_{CE} = 4 V; f = 100 MHz	f_T	>	600	MHz
Storage time $I_C = I_B = -I_{BM}$ = 5 mA	t_s	<	6	ns

MECHANICAL DATA Dimensions in mm

Collector connected to case

TO-18



Accessories available: 56246, 56263

RATINGS (Limiting values) [1]

Voltages

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

Current

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

Power dissipation

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

Temperatures

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

THERMAL RESISTANCE

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

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

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

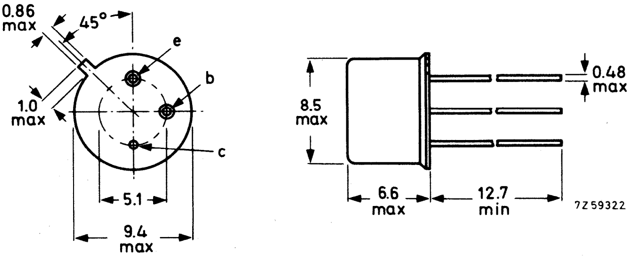
			2N2219	2N2219A	
Collector-base voltage (open emitter)	V_{CBO}	max.	60	75	V
Collector-emitter voltage (open base)	V_{CEO}	max.	30	40	V
Collector current (d.c.)	I_C	max.	800	800	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	0.8	0.8	W
Junction temperature	T_j	max.	175	175	°C
D.C. current gain at T_j = 25 °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

Collecter 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			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

Power dissipation				
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	0.8	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.	175	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	190	°C/W
From junction to case	$R_{th\ j-c}$	=	50	°C/W

CHARACTERISTICS T_j = 25 °C unless otherwise specified

Collector cut-off current			2N2219	2N2219A	
$I_E = 0$; $V_{CB} = 50$ V	I_{CBO}	<	10	–	nA
$I_E = 0$; $V_{CB} = 50$ V; $T_{amb} = 150$ °C	I_{CBO}	<	10	–	μA
$I_E = 0$; $V_{CB} = 60$ V	I_{CBO}	<	–	10	nA
$I_E = 0$; $V_{CB} = 60$ V; $T_{amb} = 150$ °C	I_{CBO}	<	–	10	μA
Emitter cut-off current					
$I_C = 0$; $V_{EB} = 3$ V	I_{EBO}	<	10	10	nA
Currents at reverse biased emitter junction					
$V_{CE} = 60$ V; $-V_{BE} = 3$ V	I_{CEX}	<	–	10	nA
	$-I_{BEX}$	<	–	20	nA

---

1) Applicable up to I_C = 500 mA

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

			2N2219	2N2219A	
Breakdown voltages					
$I_E = 0$; $I_C = 10\ \mu A$	$V_{(BR)CBO}$	>	60	75	V
$I_B = 0$; $I_C = 10$ mA	$V_{(BR)CEO}$	>	30	40	V
$I_C = 0$; $I_E = 10\ \mu A$	$V_{(BR)EBO}$	>	5	6	V
Saturation voltages [1]					
$I_C = 150$ mA; $I_B = 15$ mA	V_{CEsat}	<	0.4	0.3	V
	V_{BEsat}	>	–	0.6	V
		<	1.3	1.2	V
$I_C = 500$ mA; $I_B = 50$ mA	V_{CEsat}	<	1.6	1.0	V
	V_{BEsat}	<	2.6	2.0	V
D.C. current gain					
$I_C = 0.1$ mA; $V_{CE} = 10$ V	h_{FE}	>	35	35	
$I_C = 1$ mA; $V_{CE} = 10$ V	h_{FE}	>	50	50	
$I_C = 10$ mA; $V_{CE} = 10$ V	h_{FE}	>	75	75	
$I_C = 10$ mA; $V_{CE} = 10$ V; $T_{amb} = -55\,^oC$	h_{FE}	>	–	35	
$I_C = 150$ mA; $V_{CE} = 1$ V [1]	h_{FE}	>	50	50	
$I_C = 150$ mA; $V_{CE} = 10$ V [1]	h_{FE}		100 to 300	100 to 300	
$I_C = 500$ mA; $V_{CE} = 10$ V [1]	h_{FE}	>	30	40	
Transition frequency at f = 100 MHz					
$I_C = 20$ mA; $V_{CE} = 20$ V	f_T	>	250	300	MHz
Collector capacitance at f = 100 kHz					
$I_E = I_e = 0$; $V_{CB} = 10$ V	C_c	<	8	8	pF
Emitter capacitance at f = 100 kHz					
$I_C = I_c = 0$; $V_{EB} = 0.5$ V	C_e	<	–	25	pF
Feedback time constant at f = 31.8 MHz					
$I_C = 20$ mA; $V_{CE} = 20$ V	$r_{b'} C_c$	<	–	150	ps

---

[1] Pulse duration ≤ 300 μs; duty cycle ≤ 2%.

CHARACTERISTICS (continued)

T_J = 25 °C unless otherwise specified

h parameters (common emitter)

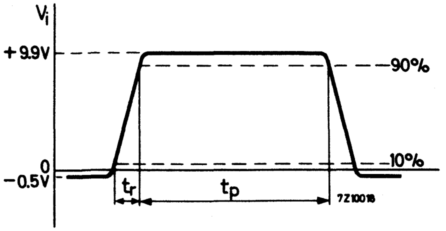
		2N2219	2N2219A	
I_C = 1 mA; V_{CE} = 10 V; f = 1 kHz				
Input impedance	h_{ie}		2 to 8	kΩ
Reverse voltage transfer ratio	h_{re}		< 8	10^{-4}
Small signal current gain	h_{fe}		50 to 300	
Output admittance	h_{oe}		5 to 35	$\mu\Omega^{-1}$
I_C = 10 mA; V_{CE} = 10 V; f = 1 kHz				
Input impedance	h_{ie}		0.25 to 1.25	kΩ
Reverse voltage transfer ratio	h_{re}		< 4	10^{-4}
Small signal current gain	h_{fe}		75 to 375	
Output admittance	h_{oe}		25 to 200	$\mu\Omega^{-1}$
I_C = 20 mA; V_{CE} = 20 V; f = 100 MHz				
Small signal current gain	h_{fe}	> 2.5	3.0	
I_C = 20 mA; V_{CE} = 20 V; f = 300 MHz				
Real part of input impedance	Re(h_{ie})	< 60	60	Ω
Noise figure at f = 1 kHz				
I_C = 0.1 mA; V_{CE} = 10 V R_G = 1 kΩ; B = 1 Hz	F	< –	4	dB

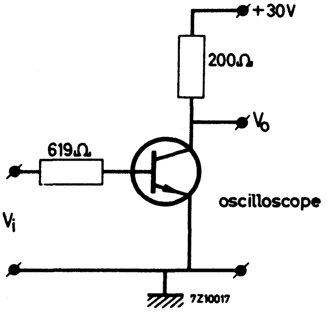
Switching times for 2N2219A

Turn on time when switched from
$-V_{BE}$ = 0.5 V to I_C = 150 mA; I_B = 15mA

Delay time	t_d	<	10	ns
Rise time	t_r	<	25	ns

Test circuit:





Pulse generator:

pulse duration	t_p	≤ 200 ns
rise time	t_r	≤ 2 ns

Oscilloscope:

input resistance	R_i	> 100 kΩ
input capacitance	C_i	< 12 pF
rise time	t_r	< 5 ns

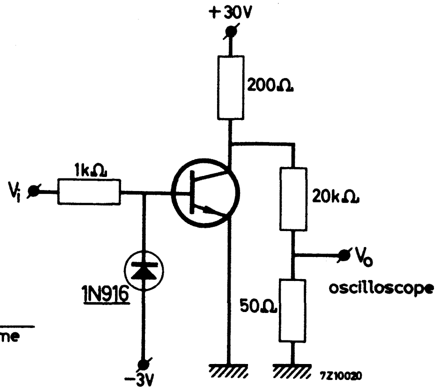
CHARACTERISTICS (continued) T_j = 25 °C unless otherwise specified

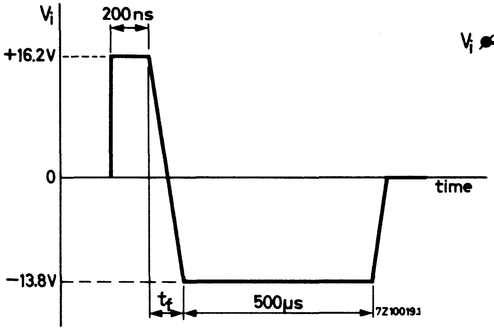
Switching times for 2N2219A

Turn off time
I_C = 150 mA; $I_B = -I_{BM}$ = 15 mA

Storage time	t_s	<	225	ns
Fall time	t_f	<	60	ns

Test circuit:





Pulse generator:
fall time t_f < 5 ns

Oscilloscope:

input impedance	R_i	>	100 kΩ
input capacitance	C_i	<	12 pF
rise time	t_r	<	5 ns

SILICON PLANAR EPITAXIAL TRANSISTORS

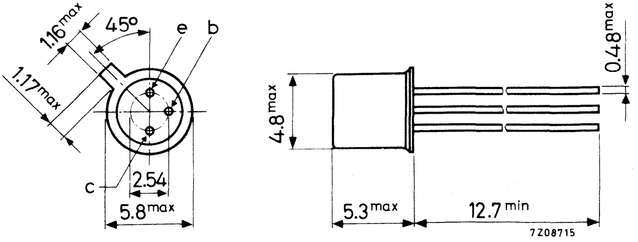
N-P-N transistors in a TO-18 metal envelope with the collector connected to the case. They are primarily intended for high speed switching.
The 2N2221 is also suitable for d.c. and v.h.f.-u.h.f. amplifiers.

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 $T_{amb} = 25\,^oC$	P_{tot}	max.	0.5	0.5	W
Junction temperature	T_j	max.	175	175	^oC
D.C. current gain at $T_j = 25\,^oC$ $I_C = 10$ mA; $V_{CE} = 10$ V	h_{FE}	>	35	35	
Transition frequency at f = 100 MHz $I_C = 20$ mA; $V_{CE} = 20$ V	f_T	>	250	250	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 (IEC 134)

Voltages

			2N2221	2N2221A	
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

Power dissipation

Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	0.5	W
up to T_{case} = 25 °C	P_{tot}	max.	1.8	W

Temperatures

Storage temperature	T_{stg}		−65 to +200	°C
Junction temperature	T_j	max.	175	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	300	°C/W
From junction to case	$R_{th\ j\text{-}c}$	=	83	°C/W

CHARACTERISTICS T_j = 25 °C unless otherwise specified

			2N2221	2N2221A	
Collector cut-off current					
$I_E = 0$; $V_{CB} = 50$ V	I_{CBO}	<	10	–	nA
$I_E = 0$; $V_{CB} = 50$ V; $T_{amb} = 150$ °C	I_{CBO}	<	10	–	μA
$I_E = 0$; $V_{CB} = 60$ V	I_{CBO}	<	–	10	nA
$I_E = 0$; $V_{CB} = 60$ V; $T_{amb} = 150$ °C	I_{CBO}	<	–	10	μA
Emitter cut-off current					
$I_C = 0$; $V_{EB} = 3$ V	I_{EBO}	<	10	10	nA
Currents at reverse biased emitter junction					
$V_{CE} = 60$ V; $-V_{BE} = 3$ V	I_{CEX}	<	–	10	nA
	$-I_{BEX}$	<	–	20	nA

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[1] Applicable up to I_C = 500 mA

CHARACTERISTICS (continued)

T_j = 25 °C unless otherwise specified

			2N2221	2N2221A	
Breakdown voltages					
$I_E = 0$; $I_C = 10\ \mu A$	$V_{(BR)CBO}$	>	60	75	V
$I_B = 0$; $I_C = 10$ mA	$V_{(BR)CEO}$	>	30	40	V
$I_C = 0$; $I_E = 10\ \mu A$	$V_{(BR)EBO}$	>	5	6	V
Saturation voltages 1)					
$I_C = 150$ mA; $I_B = 15$ mA	V_{CEsat}	<	0.4	0.3	V
	V_{BEsat}	>	-	0.6	V
		<	1.3	1.2	V
$I_C = 500$ mA; $I_B = 50$ mA	V_{CEsat}	<	1.6	1.0	V
	V_{BEsat}	<	2.6	2.0	V
D.C. current gain					
$I_C = 0.1$ mA; $V_{CE} = 10$ V	h_{FE}	>	20	20	
$I_C = 1$ mA; $V_{CE} = 10$ V	h_{FE}	>	25	25	
$I_C = 10$ mA; $V_{CE} = 10$ V	h_{FE}	>	35	35	
$I_C = 10$ mA; $V_{CE} = 10$ V; $T_{amb} = -55\,^{\circ}C$	h_{FE}	>	-	15	
$I_C = 150$ mA; $V_{CE} = 1$ V 1)	h_{FE}	>	20	20	
$I_C = 150$ mA; $V_{CE} = 10$ V 1)	h_{FE}		40 to 120	40 to 120	
$I_C = 500$ mA; $V_{CE} = 10$ V 1)	h_{FE}	>	20	25	
Transition frequency at f = 100 MHz					
$I_C = 20$ mA; $V_{CE} = 20$ V	f_T	>	250	250	MHz
Collector capacitance at f = 100 kHz					
$I_E = I_e = 0$; $V_{CB} = 10$ V	C_c	<	8	8	pF
Emitter capacitance at f = 100 kHz					
$I_C = I_c = 0$; $V_{EB} = 0.5$ V	C_e	<	-	25	pF
Feedback time constant at f = 31.8 MHz					
$I_C = 20$ mA; $V_{CE} = 20$ V	$r_{b'}C_c$	<	-	150	ps

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1) Pulse duration ≤ 300 μs; duty cycle ≤ 2%.

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

h parameters (common emitter)

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

			2N2221A	
Input impedance	h_{ie}		1 to 3.5	kΩ
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 mA; V_{CE} = 10 V; f = 1 kHz

Input impedance	h_{ie}		0.2 to 1.0	kΩ
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	$\mu\Omega^{-1}$

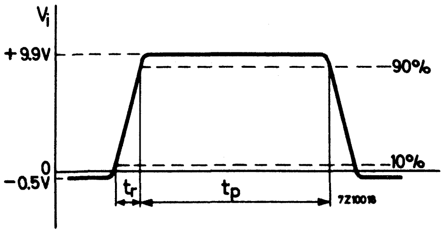
		2N2221	2N2221A	
I_C = 20 mA; V_{CE} = 20 V; f = 100 MHz				
Small signal current gain	h_{fe}	> 2.5	2.5	
I_C = 20 mA; V_{CE} = 20 V; f = 300 MHz				
Real part of input impedance	$Re(h_{ie})$	< 60	60	Ω

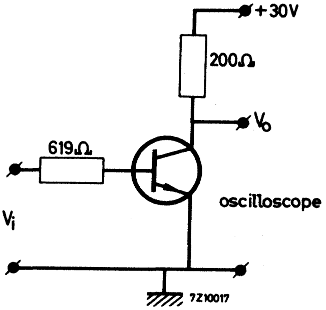
Switching times for 2N2221A

Turn on time when switched from
$-V_{BE}$ = 0.5 V to I_C = 150 mA; I_B = 15 mA

Delay time	t_d	<	10	ns
Rise time	t_r	<	25	ns

Test circuit:





Pulse generator:

pulse duration	t_p	≤ 200 ns
rise time	t_r	≤ 2 ns

Oscilloscope:

input resistance	R_i	> 100 kΩ
input capacitance	C_i	< 12 pF
rise time	t_r	< 5 ns

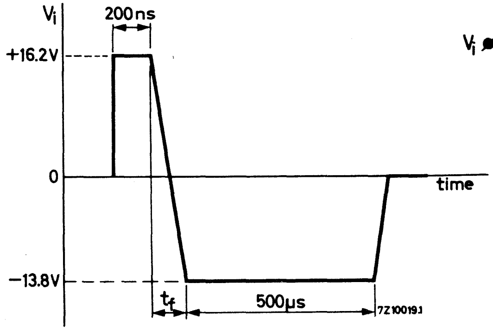
CHARACTERISTICS (continued) T_j = 25 °C unless otherwise specified

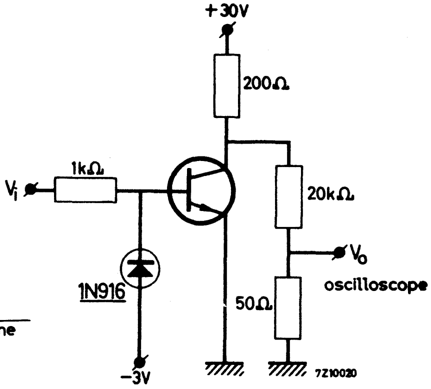
Switching times for 2N2221A

Turn off time
I_C = 150 mA; $I_B = -I_{BM}$ = 15 mA

Storage time	t_s	<	225	ns
Fall time	t_f	<	60	ns

Test circuit:





Pulse generator:
fall time $t_f < 5$ ns

Oscilloscope:

input impedance	R_i	>	100 kΩ
input capacitance	C_i	<	12 pF
rise time	t_r	<	5 ns

SILICON PLANAR EPITAXIAL TRANSISTORS

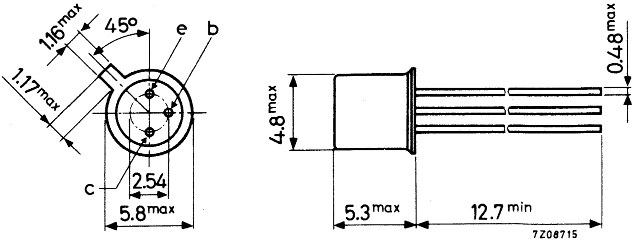
N-P-N transistors in a TO-18 metal envelope with the collector connected to the case. They are primarily intended for high speed switching.
The 2N2222 is also suitable for d.c. and v.h.f.-u.h.f. amplifiers.

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 $T_{amb} = 25\ ^oC$	P_{tot}	max.	0.5	0.5	W
Junction temperature	T_j	max.	175	175	^oC
D.C. current gain at $T_j = 25\ ^oC$ $I_C = 10$ 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)

Voltages

			2N2222	2N2222A	
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

Power dissipation

Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	0.5	W
up to T_{case} = 25 °C	P_{tot}	max.	1.8	W

Temperatures

Storage temperature	T_{stg}		−65 to + 200	°C
Junction temperature	T_j	max.	175	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	300	°C/W
From junction to case	$R_{th\ j\text{-}c}$	=	83	°C/W

CHARACTERISTICS T_j = 25 °C unless otherwise specified

			2N2222	2N2222A	
Collector cut-off current					
$I_E = 0$; $V_{CB} = 50$ V	I_{CBO}	<	10	−	nA
$I_E = 0$; $V_{CB} = 50$ V; $T_{amb} = 150$ °C	I_{CBO}	<	10	−	μA
$I_E = 0$; $V_{CB} = 60$ V	I_{CBO}	<	−	10	nA
$I_E = 0$; $V_{CB} = 60$ V; $T_{amb} = 150$ °C	I_{CBO}	<	−	10	μA
Emitter cut-off current					
$I_C = 0$; $V_{EB} = 3$ V	I_{EBO}	<	10	10	nA
Currents at reverse biased emitter junction					
$V_{CE} = 60$ V; $-V_{BE} = 3$ V	I_{CEX}	<	−	10	nA
	$-I_{BEX}$	<	−	20	nA

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[1] Applicable up to I_C = 500 mA

CHARACTERISTICS (continued)

T_j = 25 °C unless otherwise specified

			2N2222	2N2222A	
Breakdown voltages					
$I_E = 0$; $I_C = 10\ \mu A$	$V_{(BR)CBO}$	>	60	75	V
$I_B = 0$; $I_C = 10$ mA	$V_{(BR)CEO}$	>	30	40	V
$I_C = 0$; $I_E = 10\ \mu A$	$V_{(BR)EBO}$	>	5	6	V
Saturation voltages [1]					
$I_C = 150$ mA; $I_B = 15$ mA	V_{CEsat}	<	0.4	0.3	V
	V_{BEsat}	>	–	0.6	V
		<	1.3	1.2	V
$I_C = 500$ mA; $I_B = 50$ mA	V_{CEsat}	<	1.6	1.0	V
	V_{BEsat}	<	2.6	2.0	V
D.C. current gain					
$I_C = 0.1$ mA; $V_{CE} = 10$ V	h_{FE}	>	35	35	
$I_C = 1$ mA; $V_{CE} = 10$ V	h_{FE}	>	50	50	
$I_C = 10$ mA; $V_{CE} = 10$ V	h_{FE}	>	75	75	
$I_C = 10$ mA; $V_{CE} = 10$ V; $T_{amb} = -55$ °C	h_{FE}	>	–	35	
$I_C = 150$ mA; $V_{CE} = 1$ V [1]	h_{FE}	>	50	50	
$I_C = 150$ mA; $V_{CE} = 10$ V [1]	h_{FE}		100 to 300	100 to 300	
$I_C = 500$ mA; $V_{CE} = 10$ V [1]	h_{FE}	>	30	40	
Transition frequency at f = 100 MHz					
$I_C = 20$ mA; $V_{CE} = 20$ V	f_T	>	250	300	MHz
Collector capacitance at f = 100 kHz					
$I_E = I_e = 0$; $V_{CB} = 10$ V	C_c	<	8	8	pF
Emitter capacitance at f = 100 kHz					
$I_C = I_c = 0$; $V_{EB} = 0.5$ V	C_e	<	–	25	pF
Feedback time constant at f = 31.8 MHz					
$I_C = 20$ mA; $V_{CE} = 20$ V	$r_b\ C_c$	<	–	150	ps

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[1] Pulse duration ≤ 300 μs; duty cycle ≤ 2%.

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

h parameters (common emitter)

			2N2222A	
I_C = 1 mA; V_{CE} = 10 V; f = 1 kHz				
Input impedance	h_{ie}		2 to 8	kΩ
Reverse voltage transfer ratio	h_{re}	<	8	10^{-4}
Small signal current	h_{fe}		50 to 300	
Output admittance	h_{oe}		5 to 35	$\mu\Omega^{-1}$
I_C = 10 mA; V_{CE} = 10 V; f = 1 kHz				
Input impedance	h_{ie}		0.25 to 1.25	kΩ
Reverse voltage transfer ratio	h_{re}	<	4	10^{-4}
Small signal current gain	h_{fe}		75 to 375	
Output admittance	h_{oe}		25 to 200	$\mu\Omega^{-1}$

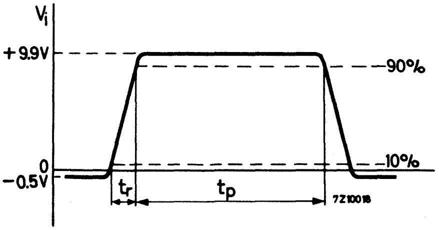
			2N2222	2N2222A	
I_C = 20 mA; V_{CE} = 20 V; f = 100 MHz					
Small signal current gain	h_{fe}	>	2.5	3.0	
I_C = 20 mA; V_{CE} = 20 V; f = 300 MHz					
Real part of input impedance	Re(h_{ie})	<	60	60	Ω
Noise figure at f = 1 kHz					
I_C = 0.1 mA; V_{CE} = 10 V R_G = 1 kΩ; B = 1 Hz	F	<	–	4	dB

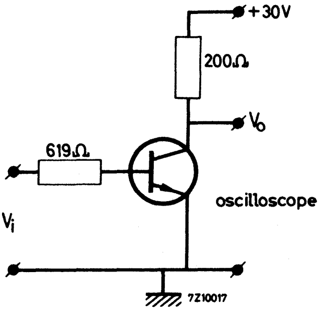
Switching times for 2N2222A

Turn on time when switched from
$-V_{BE}$ = 0.5 V to I_C = 150 mA; I_B = 15 mA

Delay time	t_d	<	10	ns
Rise time	t_r	<	25	ns

Test circuit:





Pulse generator:

pulse duration	t_p	≤	200 ns
rise time	t_r	≤	2 ns

Oscilloscope:

input resistance	R_i	>	100 kΩ
input capacitance	C_i	<	12 pF
rise time	t_r	<	5 ns

CHARACTERISTICS (continued)

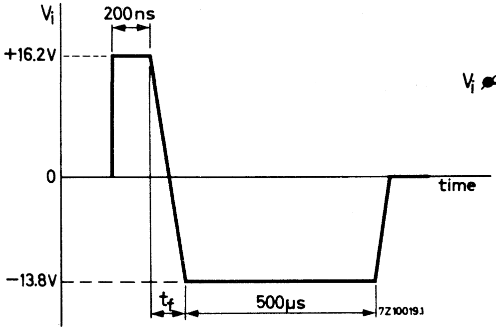
T_j = 25 °C unless otherwise specified

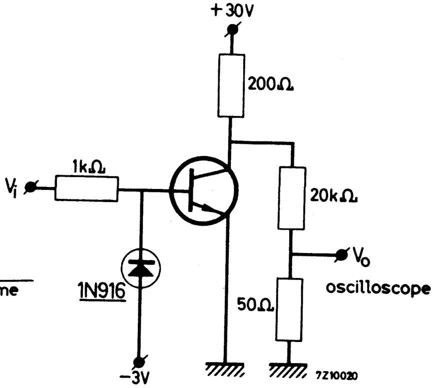
Switching times for 2N2222A

Turn off time
$I_C = 150$ mA; $I_B = -I_{BM} = 15$ mA

Storage time	t_s	<	225	ns
Fall time	t_f	<	60	ns

Test circuit:





Pulse generator:

fall time	t_f	<	5 ns

Oscilloscope:

input impedance	R_i	>	100 kΩ
input capacitance	C_i	<	12 pF
rise time	t_r	<	5 ns

2N2368
2N2369

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.

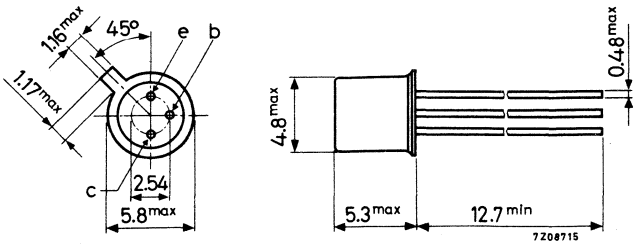
QUICK REFERENCE DATA

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 $T_{amb} = 25\,^{o}C$		P_{tot}	max.	360	mW
Junction temperature		T_j	max.	200	^{o}C
D.C. current gain at $T_j = 25\,^{o}C$					
$I_C = 10$ mA; $V_{CE} = 1$ V	2N2368	h_{FE}	20 to	60	
	2N2369	h_{FE}	40 to	120	
Transition frequency					
$I_C = 10$ mA; $V_{CE} = 10$ V	2N2368	f_T	>	400	MHz
	2N2369	f_T	>	500	MHz
Storage time					
$I_C = I_B = -I_{BM} = 10$ mA	2N2368	t_s	<	10	ns
	2N2369	t_s	<	13	ns

MECHANICAL DATA Dimensions in mm

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

Power dissipation

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

Temperatures

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

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	0.48	$^{o}C/mW$
From junction to case	$R_{th\ j-c}$	=	0.145	$^{o}C/mW$

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

CHARACTERISTICS

$T_j = 25\ ^oC$ unless otherwise specified

Collector cut-off current				
$I_E = 0$; $V_{CB} = 20$ V	I_{CBO}	<	0.4	µA
$I_E = 0$; $V_{CB} = 20$ V; $T_j = 150\ ^oC$	I_{CBO}	<	30	µA
Sustaining voltage 1)				
$I_C = 10$ mA; $I_B = 0$	$V_{CEOsust}$	>	15	V 1)
Saturation voltages				
$I_C = 10$ mA; $I_B = 1$ mA	V_{CEsat}	<	0.25	V
	V_{BEsat}		0.7 to 0.85	V
Collector capacitance at f = 140 kHz				
$I_E = I_e = 0$; $V_{CB} = 5$ V	C_c	<	4	pF

			2N2368	2N2369	
D.C. current gain 1)					
$I_C = 10$ mA; $V_{CE} = 1$ V	h_{FE}		20 to 60	40 to 120	
$I_C = 10$ mA; $V_{CE} = 1$ V; $T_j = -55\ ^oC$	h_{FE}	>	10	20	
$I_C = 100$ mA; $V_{CE} = 2$ V	h_{FE}	>	10	20	
Transition frequency					
$I_C = 10$ mA; $V_{CE} = 10$ V	f_T	>	400	500	MHz

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1) Measured under pulsed conditions to avoid excessive dissipation
Pulse duration t = 300 µs; duty cycle $\delta = 0.01$

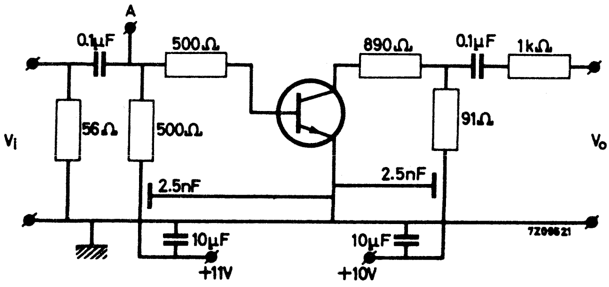
CHARACTERISTICS (continued) $T_j = 25\ ^{\circ}C$ unless otherwise specified

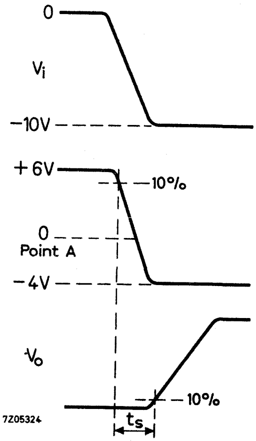
Storage time

$I_C = I_B = -I_{BM} = 10$ mA

2N2368	t_s	<	10	ns
2N2369	t_s	<	13	ns

Test circuit: 1)





Turn on time

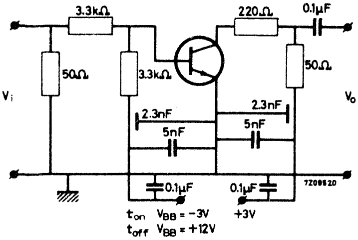
$I_C = 10$ mA; $I_B = 3$ mA; $-V_{BE} = 1.5$ V t_{on} < 12 ns

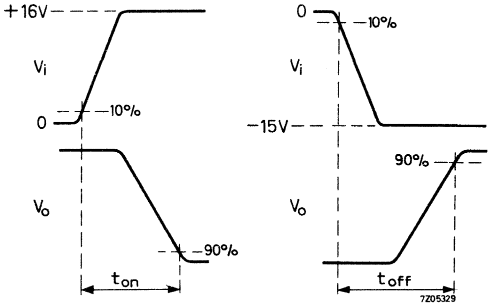
Turn off time

$I_C = 10$ mA; $I_B = 3$ mA; $-I_{BM} = 1.5$ mA

2N2368	t_{off}	<	15	ns
2N2369	t_{off}	<	18	ns

Test circuit: 1)





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1) Pulse generator:

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

Oscilloscope:

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

SILICON PLANAR EPITAXIAL TRANSISTOR

N-P-N transistor in a TO-18 metal envelope with the collector connected to the case. The 2N2369A is primarily intended for low-power very high-speed saturated switching applications in industrial service.

QUICK REFERENCE DATA

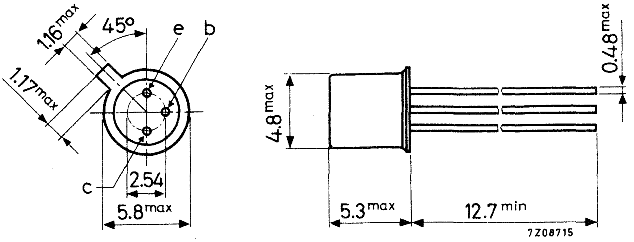
Collector-base voltage (open emitter)	V_{CBO}	max.	40	V
Collector-emitter voltage (open base)	V_{CEO}	max.	15	V
Collector current (peak value)	I_{CM}	max.	500	mA
Total power dissipation up to $T_{amb} = 25\ ^oC$	P_{tot}	max.	360	mW
Junction temperature	T_j	max.	200	^oC
D.C. current gain at $T_j = 25\ ^oC$				
$I_C = 10$ mA; $V_{CE} = 1$ V	h_{FE}		40 to 120	
Transition frequency				
$I_C = 10$ mA; $V_{CE} = 10$ V	f_T	>	500	MHz
Storage time				
$I_C = I_B = -I_{BM} = 10$ mA	t_s	<	13	ns

MECHANICAL DATA

Dimensions in mm

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 μs)	I_{CM}	max.	500	mA

Power dissipation

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

Temperatures

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

THERMAL RESISTANCE

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

---

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

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

Collector cut-off current

$V_{BE} = 0$; $V_{CE} = 20$ V	I_{CES}	$<$	0.4	μA
$I_E = 0$; $V_{CB} = 20$ V; $T_j = 150\ ^{\circ}C$	I_{CBO}	$<$	30	μA

Base current

$V_{BE} = 0$; $V_{CE} = 20$ V	$-I_{BEX}$	$<$	0.4	μA

Sustaining voltage [1]

$I_C = 10$ mA; $I_B = 0$	$V_{CEOsust}$	$>$	15	V

Saturation voltages

$I_C = 10$ mA; $I_B = 1$ mA	V_{CEsat}	$<$	0.2	V
	V_{BEsat}	0.7 to	0.85	V
$I_C = 30$ mA; $I_B = 3$ mA	V_{CEsat}	$<$	0.25	V
	V_{BEsat}	$<$	1.15	V
$I_C = 100$ mA; $I_B = 10$ mA	V_{CEsat}	$<$	0.5	V
	V_{BEsat}	$<$	1.6	V
$I_C = 10$ mA; $I_B = 1$ mA; $T_j = 125\ ^{\circ}C$	V_{CEsat}	$<$	0.3	V
	V_{BEsat}	$>$	0.59	V
$I_C = 10$ mA; $I_B = 1$ mA; $T_j = -55\ ^{\circ}C$	V_{BEsat}	$<$	1.02	V

D.C. current gain [1]

$I_C = 10$ mA; $V_{CE} = 1$ V	h_{FE}	40 to	120
$I_C = 30$ mA; $V_{CE} = 0.4$ V	h_{FE}	$>$	30
$I_C = 100$ mA; $V_{CE} = 1$ V	h_{FE}	$>$	20
$I_C = 10$ mA; $V_{CE} = 1$ V; $T_j = -55\ ^{\circ}C$	h_{FE}	$>$	20

Collector capacitance at $f = 140$ kHz

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

Transition frequency

$I_C = 10$ mA; $V_{CE} = 10$ V	f_T	$>$	500	MHz

---

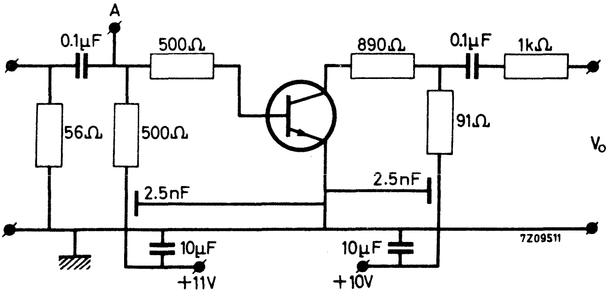
[1] Measured under pulsed conditions to avoid excessive dissipation
Pulse duration $t = 300\ \mu s$; duty cycle $\delta < 0.01$

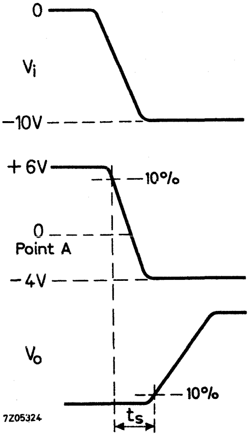
CHARACTERISTICS (continued) T_j = 25 °C unless otherwise specified

Storage time

$I_C = I_B = -I_{BM} = 10$ mA t_s < 13 ns

Test circuit: [1]





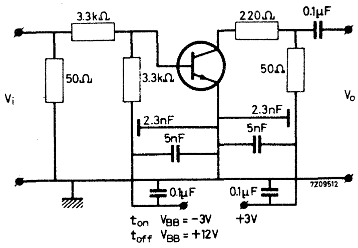
Turn on time

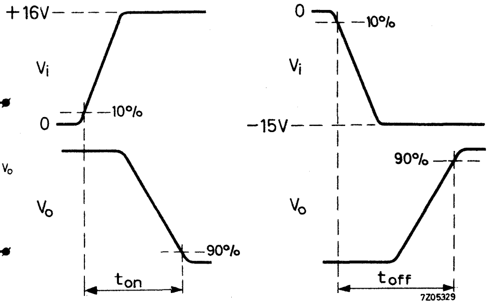
$I_C = 10$ mA; $I_B = 3$ mA; $-V_{BE} = 1.5$ V t_{on} < 12 ns

Turn off time

$I_C = 10$ mA; $I_B = 3$ mA; $-I_{BM} = 1.5$ mA t_{off} < 18 ns

Test circuit: [1]





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[1] Pulse generator:

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

Oscilloscope:

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

SILICON PLANAR EPITAXIAL TRANSISTOR

N-P-N transistor in a TO-18 metal envelope with the collector connected to the case.
The 2N2475 is primarily intended for high speed, low power saturated switching applications.

QUICK REFERENCE DATA

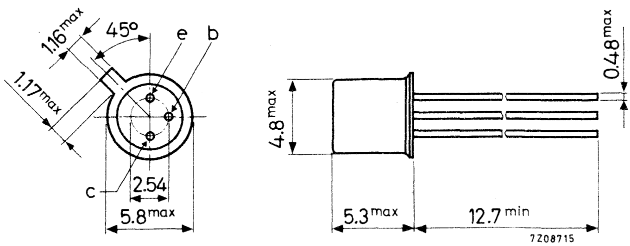
Collector-base voltage (open emitter)	V_{CBO}	max.	15	V
Collector-emitter voltage (open base)	V_{CEO}	max.	6	V
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	300	mW
Junction temperature	T_j	max.	200	°C
D.C. current gain at T_j = 25 °C				
I_C = 20 mA; V_{CE} = 0.4 V	h_{FE}		30 to 150	
Transition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

MECHANICAL DATA

Dimensions in mm

Collector connected to case

TO-18



Accessories available: 56246, 56263

RATINGS (Limiting values) [1]

Voltages

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

Power dissipation

Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	300	mW
Total power dissipation up to T_{case} = 100 °C	P_{tot}	max.	500	mW

Temperatures

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

THERMAL RESISTANCE

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

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

Collector cut-off current

$I_E = 0$; $V_{CB} = 5$ V	I_{CBO}	<	50	nA
$I_E = 0$; $V_{CB} = 5$ V; $T_{amb} = 150$ °C	I_{CBO}	<	5	μA

Emitter cut-off current

$I_C = 0$; $V_{EB} = 4$ V	I_{EBO}	<	10	μA

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

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

Sustaining voltages [1]				
I_C = 10 mA; I_B = 0	$V_{CEOsust}$	>	6	V
Saturation voltages				
I_C = 20 mA; I_B = 0.66 mA	V_{CEsat} V_{BEsat}	< 0.80 to	400 1.00	mV V
D.C. current gain				
I_C = 1 mA; V_{CE} = 300 mV	h_{FE}	>	20	
I_C = 20 mA; V_{CE} = 400 mV	h_{FE}	30 to	150	
I_C = 50 mA; V_{CE} = 500 mV	h_{FE}	>	20	
I_C = 20 mA; V_{CE} = 400 mV; T_{amb} = −55 °C	h_{FE}	>	15	
Collector capacitance at f = 120 to 140 kHz				
$I_E = I_e = 0$; V_{CB} = 5 V	C_c	<	3	pF
Emitter capacitance at f = 120 to 140 kHz				
$I_C = I_c = 0$; V_{EB} = 0.5 V	C_e	<	2.5	pF
Transition frequency				
I_C = 20 mA; V_{CE} = 2 V	f_T	>	600	MHz

---

[1] Measured under pulsed conditions.
Pulse duration t ≤ 6 ms; duty cycle $\delta \leq 0.3$

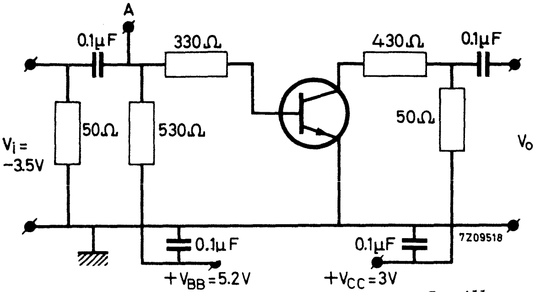
CHARACTERISTICS (continued) T_{amb} = 25 °C unless otherwise specified

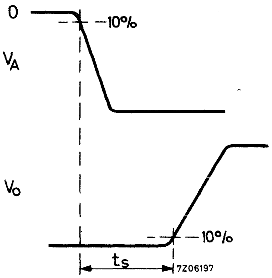
Switching times

Storage time

$I_C = I_B = -I_{BM} = 5$ mA $t_s < 6$ ns

Test circuit:





Pulse generator:

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

Oscilloscope:

Rise time	t_r	<	1	ns
Input capacitance				
(with shunt resistance		>	1	kΩ)
	C_i	<	2.5	pF

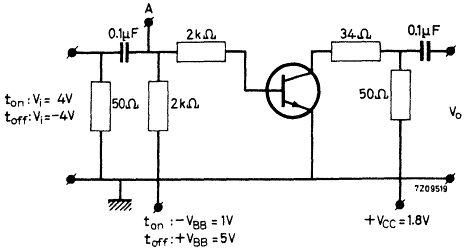
Turn on time when switched to

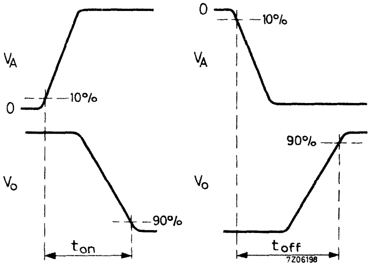
$I_C = 20$ mA; $I_{B1} = -I_{B2} = 1$ mA $t_{on} < 20$ ns

Turn off time when switched from

$I_C = 20$ mA; $I_{B1} = -I_{B2} = 1$ mA $t_{off} < 15$ ns

Test circuit:





Pulse generator:

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

Oscilloscope:

Rise time	t_r	<	0.5	ns
Input capacitance				
(with shunt resistance		>	1	kΩ)
	C_i	<	2.5	pF

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.

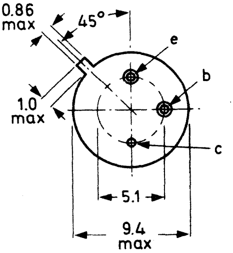
QUICK REFERENCE DATA

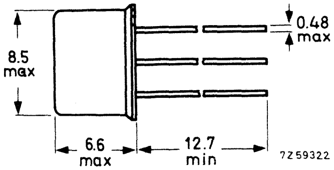
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60		V
Collector-emitter voltage (open base)					
2N2904	$-V_{CEO}$	max.	40		V
2N2904A	$-V_{CEO}$	max.	60		V
Collector current (d.c.)	$-I_C$	max.	0.6		A
Total power dissipation up to $T_{amb} = 25\ ^{o}C$	P_{tot}	max.	0.6		W
Junction temperature	T_j	max.	200		^{o}C
Transition frequency					
$-I_C = 50$ mA; $-V_{CE} = 20$ V	f_T	>	200		MHz
D.C. current gain at $T_j = 25\ ^{o}C$			2N2904	2N2904A	
$-I_C = 0.1$ mA; $-V_{CE} = 10$ V	h_{FE}	>	20	40	
$-I_C = 10$ mA; $-V_{CE} = 10$ V	h_{FE}	>	35	40	
$-I_C = 500$ mA; $-V_{CE} = 10$ V	h_{FE}	>	20	40	

MECHANICAL DATA

Dimensions in mm

Collecter 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.	60	V
Collector-emitter voltage (open base) $-I_C < 100$ mA 2N2904	$-V_{CEO}$	max.	40	V
2N2904A	$-V_{CEO}$	max.	60	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5	V

Current

Collector current (d.c.)	$-I_C$	max.	0.6	A

Power dissipation

Total power dissipation up to $T_{amb} = 25\ ^{o}C$	P_{tot}	max.	0.6	W
up to $T_{case} = 25\ ^{o}C$	P_{tot}	max.	3	W

Temperatures

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

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	290	$^{o}C/W$
From junction to case	$R_{th\ j\text{-}c}$	=	58	$^{o}C/W$

---

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

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

Collector cut-off current

			2N2904	2N2904A	
$I_E = 0;\ -V_{CB} = 50\ V$	$-I_{CBO}$	<	20	10	nA
$I_E = 0;\ -V_{CB} = 50\ V;\ T_j = 150\ ^{o}C$	$-I_{CBO}$	<	20	10	μA
$+V_{BE} = 0.5\ V;\ -V_{CE} = 30\ V$	$-I_{CEX}$	<	50		nA

Breakdown voltages

$I_E = 0;\ -I_C = 10\ \mu A$		$-V_{(BR)CBO}$	>	60	V
$I_B = 0;\ -I_C = 10\ mA$	2N2904	$-V_{(BR)CEO}$	>	40	V
	2N2904A	$-V_{(BR)CEO}$	>	60	V
$I_C = 0;\ -I_E = 10\ \mu A$		$-V_{(BR)EBO}$	>	5	V

Saturation voltages 1)

$-I_C = 150\ mA;\ -I_B = 15\ mA$	$-V_{CEsat}$	<	0.4	V
	$-V_{BEsat}$	<	1.3	V
$-I_C = 500\ mA;\ -I_B = 50\ mA$	$-V_{CEsat}$	<	1.6	V
	$-V_{BEsat}$	<	2.6	V

D.C. current gain

			2N2904	2N2904A
$-I_C = 0.1\ mA;\ -V_{CE} = 10\ V$	h_{FE}	>	20	40
$-I_C = 1\ mA;\ -V_{CE} = 10\ V$	h_{FE}	>	25	40
$-I_C = 10\ mA;\ -V_{CE} = 10\ V$	h_{FE}	>	35	40
$-I_C = 150\ mA;\ -V_{CE} = 10\ V$ 1)	h_{FE}	>	40	40
		<	120	120
$-I_C = 500\ mA;\ -V_{CE} = 10\ V$ 1)	h_{FE}	>	20	40

Collector capacitance at $f = 100$ kHz

$I_E = I_e = 0;\ -V_{CB} = 10\ V$	C_c	<	8	pF

Emitter capacitance at $f = 100$ kHz

$I_C = I_c = 0;\ -V_{EB} = 2\ V$	C_e	<	30	pF

Transition frequency

$-I_C = 50\ mA;\ -V_{CE} = 20\ V$	f_T	>	200	MHz

---

1) Measured under pulsed conditions to avoid excessive dissipation.
Pulse duration $t \leq 300\ \mu s$; duty cycle $\delta \leq 0.02$.

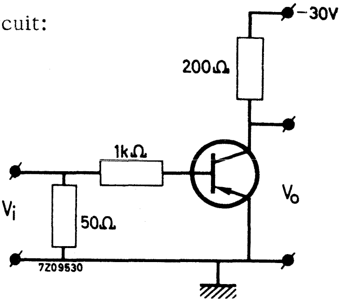
CHARACTERISTICS (continued) T_j = 25 °C unless otherwise specified

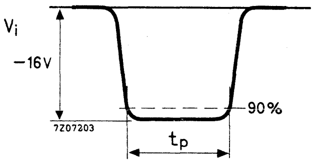
Switching times

Turn on time when switched to $-I_C = 150$ mA; $-I_B = 15$ mA

delay time	t_d	$<$	10	ns
rise time	t_r	$<$	40	ns
turn on time	t_{on}	$<$	45	ns

Test circuit:





Oscilloscope:

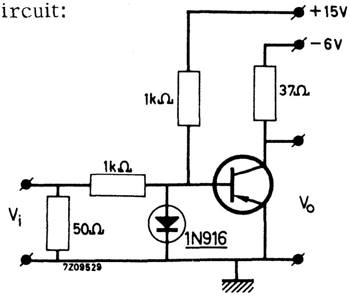
Rise time	t_r	$\leq$	5 ns
Input impedance	Z_i	=	10 MΩ

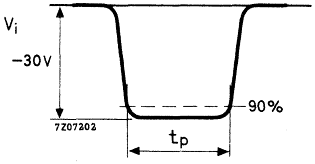
Pulse generator:	Frequency	f	=	150 Hz
	Pulse duration	t_p	=	200 ns
	Rise time	t_r	$\leq$	2 ns
	Output impedance	Z_o	=	50 Ω

Turn off time when switched from
$-I_C$ = 150 mA; $-I_B$ = 15 mA to cut-off with $+I_{BM}$ = 15 mA

storage time	t_s	$<$	80	ns
fall time	t_f	$<$	30	ns
turn off time	t_{off}	$<$	100	ns

Test circuit:





Oscilloscope:

Rise time	t_r	$\leq$	5 ns
Input impedance	Z_i	=	10 MΩ

Pulse generator:	Frequency	f	=	150 Hz
	Pulse duration	t_p	=	200 ns
	Rise time	t_r	$\leq$	2 ns
	Output impedance	Z_o	=	50 Ω

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.

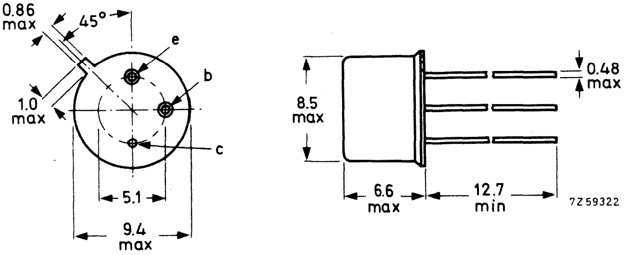
QUICK REFERENCE DATA

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60		V
Collector-emitter voltage (open base)					
2N2905	$-V_{CEO}$	max.	40		V
2N2905A	$-V_{CEO}$	max.	60		V
Collector current (d.c.)	$-I_C$	max.	0.6		A
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	0.6		W
Junction temperature	T_j	max.	200		°C
Transition frequency					
$-I_C$ = 50 mA; $-V_{CE}$ = 20 V	f_T	>	200		MHz
D.C. current gain at T_j = 25 °C			2N2905	2N2905A	
$-I_C$ = 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

Dimensions in mm

Collecter 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.	60	V
Collector-emitter voltage (open base) $-I_C < 100$ mA 2N2905	$-V_{CEO}$	max.	40	V
2N2905A	$-V_{CEO}$	max.	60	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5	V

Current

Collector current (d.c.)	$-I_C$	max.	0.6	A

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	$R_{th\ j\text{-}a}$	=	290	°C/W
From junction to case	$R_{th\ j\text{-}c}$	=	58	°C/W

---

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

CHARACTERISTICS

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

Collector cut-off current

			2N2905	2N2905A	
$I_E = 0;\ -V_{CB} = 50\ V$	$-I_{CBO}$	<	20	10	nA
$I_E = 0;\ -V_{CB} = 50\ V;\ T_j = 150\ ^{o}C$	$-I_{CBO}$	<	20	10	μA
$+V_{BE} = 0.5\ V;\ -V_{CE} = 30\ V$	$-I_{CEX}$	<	50		nA

Breakdown voltages

$I_E = 0;\ -I_C = 10\ \mu A$		$-V_{(BR)CBO}$	>	60	V
$I_B = 0;\ -I_C = 10\ mA$	2N2905	$-V_{(BR)CEO}$	>	40	V
	2N2905A	$-V_{(BR)CEO}$	>	60	V
$I_C = 0;\ -I_E = 10\ \mu A$		$-V_{(BR)EBO}$	>	5	V

Saturation voltages [1]

$-I_C = 150\ mA;\ -I_B = 15\ mA$	$-V_{CEsat}$	<	0.4	V
	$-V_{BEsat}$	<	1.3	V
$-I_C = 500\ mA;\ -I_B = 50\ mA$	$-V_{CEsat}$	<	1.6	V
	$-V_{BEsat}$	<	2.6	V

D.C. current gain

			2N2905	2N2905A
$-I_C = 0.1\ mA;\ -V_{CE} = 10\ V$	h_{FE}	>	35	75
$-I_C = 1\ mA;\ -V_{CE} = 10\ V$	h_{FE}	>	50	100
$-I_C = 10\ mA;\ -V_{CE} = 10\ V$	h_{FE}	>	75	100
$-I_C = 150\ mA;\ -V_{CE} = 10\ V$ [1]	h_{FE}	> <	100 300	100 300
$-I_C = 500\ mA;\ -V_{CE} = 10\ V$ [1]	h_{FE}	>	30	50

Collector capacitance at f = 100 kHz

$I_E = I_e = 0;\ -V_{CB} = 10\ V$	C_c	<	8	pF

Emitter capacitance at f = 100 kHz

$I_C = I_c = 0;\ -V_{EB} = 2\ V$	C_e	<	30	pF

Transition frequency

$-I_C = 50\ mA;\ -V_{CE} = 20\ V$	f_T	>	200	MHz

---

[1] Measured under pulsed conditions to avoid excessive dissipation. Pulse duration $t \leq 300\ \mu s$; duty cycle $\delta \leq 0.02$.

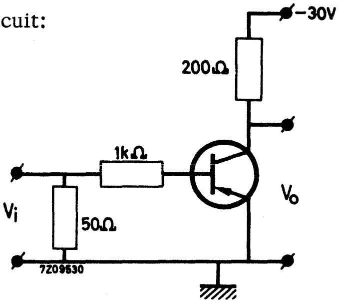
CHARACTERISTICS (continued) T_j = 25 °C unless otherwise specified

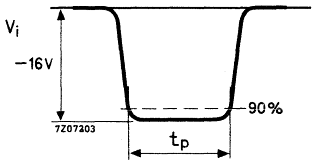
Switching times

Turn on time when switched to $-I_C$ = 150 mA; $-I_B$ = 15 mA

delay time	t_d	<	10	ns
rise time	t_r	<	40	ns
turn on time	t_{on}	<	45	ns

Test circuit:





Oscilloscope:

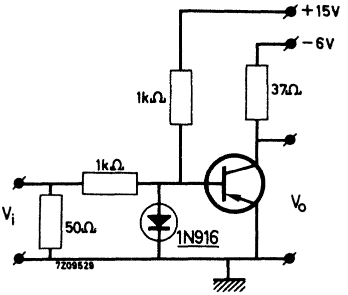
Rise time	t_r	≤	5	ns
Input impedance	Z_i	=	10	MΩ

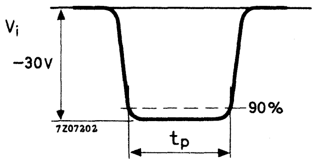
Pulse generator: Frequency	f	=	150	Hz
Pulse duration	t_p	=	200	ns
Rise time	t_r	≤	2	ns
Output impedance	Z_o	=	50	Ω

Turn off time when switched from
$-I_C$ = 150 mA; $-I_B$ = 15 mA to cut-off with $+I_{BM}$ = 15 mA

storage time	t_s	<	80	ns
fall time	t_f	<	30	ns
turn off time	t_{off}	<	100	ns

Test circuit:





Oscilloscope:

Rise time	t_r	≤	5	ns
Input impedance	Z_i	=	10	MΩ

Pulse generator: Frequency	f	=	150	Hz
Pulse duration	t_p	=	200	ns
Rise time	t_r	≤	2	ns
Output impedance	Z_o	=	50	Ω

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

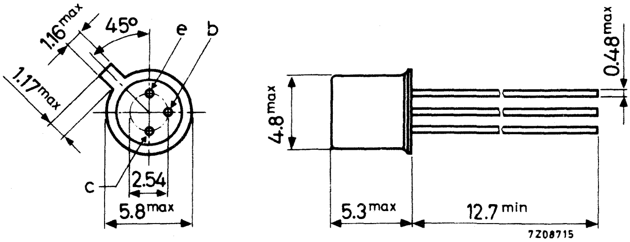
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60	V
Collector-emitter voltage (open base)				
2N2906	$-V_{CEO}$	max.	40	V
2N2906A	$-V_{CEO}$	max.	60	V
Collector current (d.c.)	$-I_C$	max.	0.6	A
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	0.4	W
Junction temperature	T_j	max.	200	°C
Transition frequency at f = 100 MHz				
$-I_C$ = 50 mA; $-V_{CE}$ = 20 V; T_{amb} = 25 °C	f_T	>	200	MHz
D.C. current gain at T_j = 25 °C		2N2906	2N2906A	
$-I_C$ = 0.1 mA; $-V_{CE}$ = 10 V	h_{FE}	> 20	40	
$-I_C$ = 10 mA; $-V_{CE}$ = 10 V	h_{FE}	> 35	40	
$-I_C$ = 500 mA; $-V_{CE}$ = 10 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)				
$-I_C < 100$ mA 2N2906	$-V_{CEO}$	max.	40	V
2N2906A	$-V_{CEO}$	max.	60	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5	V

Current

Collector current (d.c.)	$-I_C$	max.	0.6	A

Power dissipation

Total power dissipation up to $T_{amb} = 25\ ^oC$	P_{tot}	max.	0.4	W
up to $T_{case} = 25\ ^oC$	P_{tot}	max.	1.8	W

Temperatures

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

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	438	$^oC/W$
From junction to case	$R_{th\ j-a}$	=	97	$^oC/W$

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current

Conditions	Symbol		2N2906	2N2906A	Unit
$I_E = 0; -V_{CB} = 50$ V	$-I_{CBO}$	<	20	10	nA
$I_E = 0; -V_{CB} = 50$ V; $T_j = 150$ °C	$-I_{CBO}$	<	20	10	μA
$+V_{BE} = 0.5$ V; $-V_{CE} = 30$ V	$-I_{CEX}$	<	50	50	nA

Breakdown voltages

Conditions	Type	Symbol		Value	Unit
$I_E = 0; -I_C = 10$ μA		$-V_{(BR)CBO}$	>	60	V
$I_B = 0; -I_C = 10$ mA	2N2906	$-V_{(BR)CEO}$	>	40	V
	2N2906A	$-V_{(BR)CEO}$	>	60	V
$I_C = 0; -I_E = 10$ μA		$-V_{(BR)EBO}$	>	5	V

Saturation voltages [1]

Conditions	Symbol		Value	Unit
$-I_C = 150$ mA; $-I_B = 15$ mA	$-V_{CEsat}$	<	0.4	V
	$-V_{BEsat}$	<	1.3	V
$-I_C = 500$ mA; $-I_B = 50$ mA	$-V_{CEsat}$	<	1.6	V
	$-V_{BEsat}$	<	2.6	V

D.C. current gain

Conditions	Symbol		2N2906	2N2906A
$-I_C = 0.1$ mA; $-V_{CE} = 10$ V	h_{FE}	>	20	40
$-I_C = 1$ mA; $-V_{CE} = 10$ V	h_{FE}	>	25	40
$-I_C = 10$ mA; $-V_{CE} = 10$ V	h_{FE}	>	35	40
$-I_C = 150$ mA; $-V_{CE} = 10$ V [1]	h_{FE}	>	40	40
		<	120	120
$-I_C = 500$ mA; $-V_{CE} = 10$ V [1]	h_{FE}	>	20	40

Collector capacitance at f = 100 kHz

Conditions	Symbol		Value	Unit
$I_E = I_e = 0; -V_{CB} = 10$ V	C_c	<	8	pF

Emitter capacitance at f = 100 kHz

Conditions	Symbol		Value	Unit
$I_C = I_c = 0; -V_{EB} = 2$ V	C_e	<	30	pF

Transition frequency at f = 100 MHz

Conditions	Symbol		Value	Unit
$-I_C = 50$ mA; $-V_{CE} = 20$ V; $T_{amb} = 25$ °C	f_T	>	200	MHz

---

[1] Measured under pulsed conditions to avoid excessive dissipation.
Pulse duration $t \leq 300$ μs; duty cycle $\delta \leq 0.02$.

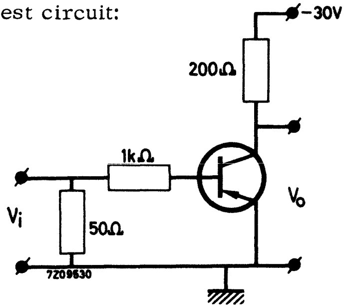
CHARACTERISTICS (continued) T_j = 25 °C unless otherwise specified

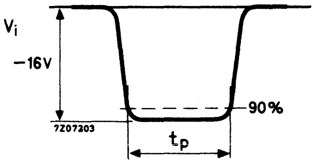
Switching times

Turn on time when switched to $-I_C$ = 150 mA; $-I_B$ = 15 mA

delay time	t_d	<	10	ns
rise time	t_r	<	40	ns
turn on time	t_{on}	<	45	ns

Test circuit:





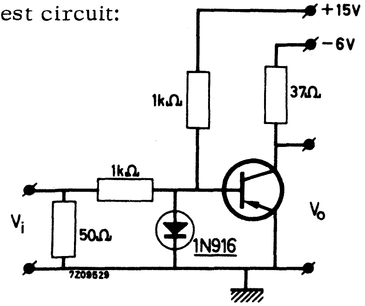
Oscilloscope:				
Rise time	t_r	≤	5	ns
Input impedance	Z_i	=	10	MΩ

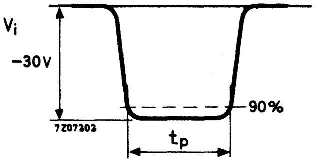
Pulse generator:				
Frequency	f	=	150	Hz
Pulse duration	t_p	=	200	ns
Rise time	t_r	≤	2	ns
Output impedance	Z_o	=	50	Ω

Turn off time when switched from
$-I_C$ = 150 mA; $-I_B$ = 15 mA to cut-off with $+I_{BM}$ = 15 mA

storage time	t_s	<	80	ns
fall time	t_f	<	30	ns
turn off time	t_{off}	<	100	ns

Test circuit:





Oscilloscope:				
Rise time	t_r	≤	5	ns
Input impedance	Z_i	=	10	MΩ

Pulse generator:				
Frequency	f	=	150	Hz
Pulse duration	t_p	=	200	ns
Rise time	t_r	≤	2	ns
Output impedance	Z_o	=	50	Ω

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.

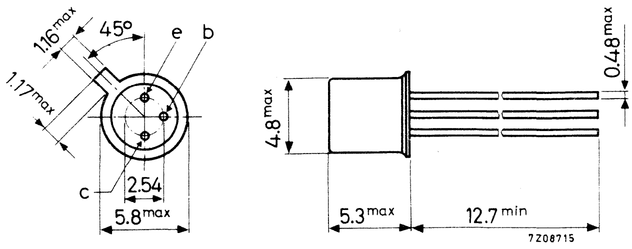
QUICK REFERENCE DATA

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60	V
Collector-emitter voltage (open base)				
2N2907	$-V_{CEO}$	max.	40	V
2N2907A	$-V_{CEO}$	max.	60	V
Collector current (d.c.)	$-I_C$	max.	0.6	A
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	0.4	W
Junction temperature	$-T_j$	max.	200	°C
Transition frequency at f = 100 MHz				
$-I_C$ = 50 mA; $-V_{CE}$ = 20 V; T_{amb} = 25 °C	f_T	>	200	MHz
D.C. current gain at T_j = 25 °C			2N2907	2N2907A
$-I_C$ = 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

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) $-I_C < 100$ mA 2N2907	$-V_{CEO}$	max.	40	V
2N2907A	$-V_{CEO}$	max.	60	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5	V
Current				
Collector current (d.c.)	$-I_C$	max.	0.6	A
Power dissipation				
Total power dissipation up to $T_{amb} = 25\ ^oC$	P_{tot}	max.	0.4	W
up to $T_{case} = 25\ ^oC$	P_{tot}	max.	1.8	W
Temperatures				
Storage temperature	T_{stg}		-65 to +200	^oC
Junction temperature	T_j	max.	200	^oC

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	438	$^oC/W$
From junction to case	$R_{th\ j\text{-}c}$	=	97	$^oC/W$

CHARACTERISTICS

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

Collector cut-off current

			2N2907	2N2907A	
$I_E = 0;\ -V_{CB} = 50\ V$	$-I_{CBO}$	<	20	10	nA
$I_E = 0;\ -V_{CB} = 50\ V;\ T_j = 150\ ^{\circ}C$	$-I_{CBO}$	<	20	10	µA
$+V_{BE} = 0.5\ V;\ -V_{CE} = 30\ V$	$-I_{CEX}$	<	50		nA

Breakdown voltages

$I_E = 0;\ -I_C = 10\ \mu A$		$-V_{(BR)CBO}$	>	60	V
$I_B = 0;\ -I_C = 10\ mA$	2N2907	$-V_{(BR)CEO}$	>	40	V
	2N2907A	$-V_{(BR)CEO}$	>	60	V
$I_C = 0;\ -I_E = 10\ \mu A$		$-V_{(BR)EBO}$	>	5	V

Saturation voltages [1]

$-I_C = 150\ mA;\ -I_B = 15\ mA$	$-V_{CEsat}$	<	0.4	V
	$-V_{BEsat}$	<	1.3	V
$-I_C = 500\ mA;\ -I_B = 50\ mA$	$-V_{CEsat}$	<	1.6	V
	$-V_{BEsat}$	<	2.6	V

D.C. current gain

			2N2907	2N2907A
$-I_C = 0.1\ mA;\ -V_{CE} = 10\ V$	h_{FE}	>	35	75
$-I_C = 1\ mA;\ -V_{CE} = 10\ V$	h_{FE}	>	50	100
$-I_C = 10\ mA;\ -V_{CE} = 10\ V$	h_{FE}	>	75	100
$-I_C = 150\ mA;\ -V_{CE} = 10\ V$ [1]	h_{FE}	>	100	100
		<	300	300
$-I_C = 500\ mA;\ -V_{CE} = 10\ V$ [1]	h_{FE}	>	30	50

Collector capacitance at f = 100 kHz

$I_E = I_e = 0;\ -V_{CB} = 10\ V$	C_c	<	8	pF

Emitter capacitance at f = 100 kHz

$I_C = I_c = 0;\ -V_{EB} = 2\ V$	C_e	<	30	pF

Transition frequency at f = 100 MHz

$-I_C = 50\ mA;\ -V_{CE} = 20\ V;\ T_{amb} = 25\ ^{\circ}C$	f_T	>	200	MHz

---

[1] Measured under pulsed conditions to avoid excessive dissipation. Pulsed duration $t \leq 300\ \mu s$; duty cycle $\delta \leq 0.02$.

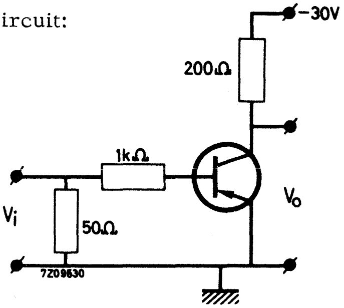
CHARACTERISTICS (continued) T_j = 25 °C unless otherwise specified

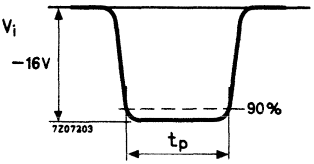
Switching times

Turn on time when switched to $-I_C$ = 150 mA; $-I_B$ = 15 mA

delay time	t_d	<	10	ns
rise time	t_r	<	40	ns
turn on time	t_{on}	<	45	ns

Test circuit:





Oscilloscope:

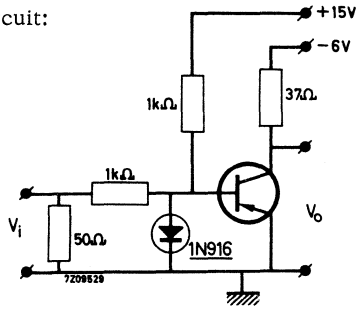
Rise time	t_r	≤	5	ns
Input impedance	Z_i	=	10	MΩ

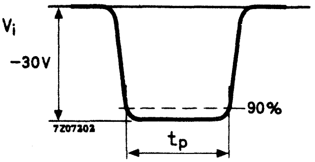
Pulse generator:			
Frequency	f	=	150 Hz
Pulse duration	t_p	=	200 ns
Rise time	t_r	≤	2 ns
Output impedance	Z_o	=	50 Ω

Turn off time when switched from
$-I_C$ = 150 mA; $-I_B$ = 15 mA to cut-off with $+I_{BM}$ = 15 mA

storage time	t_s	<	80	ns
fall time	t_f	<	30	ns
turn off time	t_{off}	<	100	ns

Test circuit:





Oscilloscope:

Rise time	t_r	≤	5	ns
Input impedance	Z_i	=	10	MΩ

Pulse generator:			
Frequency	f	=	150 Hz
Pulse duration	t_p	=	200 ns
Rise time	t_r	≤	2 ns
Output impedance	Z_o	=	50 Ω

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 $T_{amb} = 25\ ^{o}C$	P_{tot}	max.	0.6	W
Junction temperature	T_j	max.	200	^{o}C
Transition frequency				
$-I_C = 50$ mA; $-V_{CE} = 20$ V	f_T	>	200	MHz

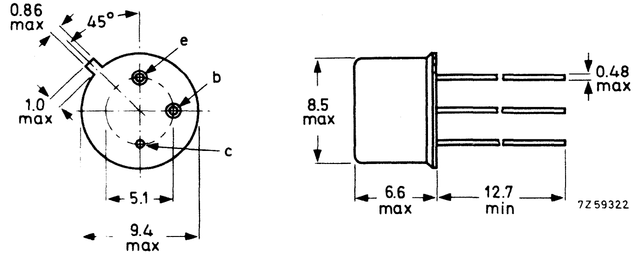
D.C. current gain at $T_j = 25\ ^{o}C$			2N3133	2N3134
$-I_C = 1$ mA; $-V_{CE} = 10$ V	h_{FE}	>	25	50
$-I_C = 150$ mA; $-V_{CE} = 1$ V	h_{FE}	>	10	25
$-I_C = 150$ mA; $-V_{CE} = 10$ V	h_{FE}		40 to 120	100 to 300

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) $-I_C < 600$ 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

Power dissipation

Total power dissipation up to $T_{amb} = 25\ ^{o}C$	P_{tot}	max.	0.6	W
up to $T_{case} = 25\ ^{o}C$	P_{tot}	max.	3	W

Temperatures

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

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	290	$^{o}C/W$
From junction to case	$R_{th\ j-c}$	=	58	$^{o}C/W$

---

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

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current

$I_E = 0$; $-V_{CB} = 30$ V	$-I_{CBO}$	$<$	50	nA
$I_E = 0$; $-V_{CB} = 30$ V; $T_j = 150$ °C	$-I_{CBO}$	$<$	30	μA

Currents at reverse biased emitter junction

$+V_{BE} = 0.5$ V; $-V_{CE} = 30$ V	$-I_{CEX}$	$<$	0.1	μA
$+V_{BE} = 0.5$ V; $-V_{CE} = 30$ V	$+I_{BEX}$	$<$	0.1	μA

Breakdown voltages

$I_E = 0$; $-I_C = 10$ μA	$-V_{(BR)CBO}$	$>$	50	V
$I_B = 0$; $-I_C = 10$ mA	$-V_{(BR)CEO}$	$>$	35	V
$I_C = 0$; $-I_E = 10$ μA	$-V_{(BR)EBO}$	$>$	4	V

Saturation voltages [1]

$-I_C = 150$ mA; $-I_B = 15$ mA	$-V_{CEsat}$	$<$	0.6	V
	$-V_{BEsat}$	$<$	1.5	V

D.C. current gain

			2N3133	2N3134
$-I_C = 1$ mA; $-V_{CE} = 10$ V	h_{FE}	$>$	25	50
$-I_C = 150$ mA; $-V_{CE} = 1$ V	h_{FE}	$>$	10	25
$-I_C = 150$ mA; $-V_{CE} = 10$ V	h_{FE}		40 to 120	100 to 300

Transition frequency

$-I_C = 50$ mA; $-V_{CE} = 20$ V	f_T	$>$	200	MHz

Collector capacitance at f = 100 kHz

$I_E = I_e = 0$; $-V_{CB} = 10$ V	C_c	$<$	10	pF

Emitter capacitance at f = 100 kHz

$I_C = I_c = 0$; $-V_{EB} = 2$ V	C_e	$<$	40	pF

---

1) Measured under pulsed conditions to avoid excessive dissipation. Pulse duration $t \leq 300$ μs; duty cycle $\delta \leq 0.02$.

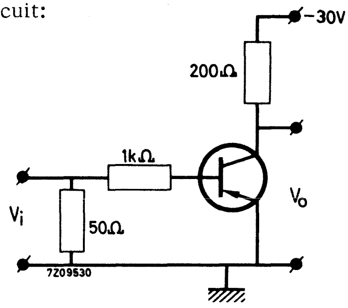
CHARACTERISTICS (continued) T_j = 25 °C unless otherwise specified

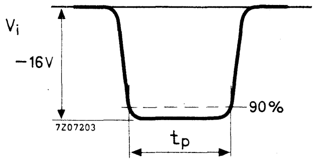
Switching times

Turn on time when switched to $-I_C$ = 150 mA; $-I_B$ = 15 mA

turn on time t_{on} < 75 ns

Test circuit:





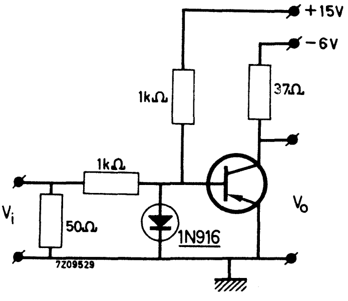
Oscilloscope:
Rise time $t_r \leq$ 5 ns
Input impedance Z_i = 10 MΩ

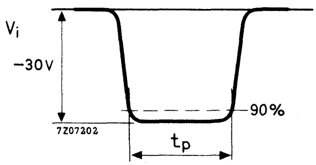
Pulse generator: Frequency f = 150 Hz
Pulse duration t_p = 200 ns
Rise time $t_r \leq$ 2 ns
Output impedance Z_o = 50 Ω

Turn off time when switched from
$-I_C$ = 150 mA; $-I_B$ = 15 mA to cut-off with $+I_{BM}$ = 15 mA

turn off time t_{off} < 150 ns

Test circuit:





Oscilloscope:
Rise time $t_r \leq$ 5 ns
Input impedance Z_i = 10 MΩ

Pulse generator: Frequency f = 150 Hz
Pulse duration t_p = 200 ns
Rise time $t_r \leq$ 2 ns
Output impedance Z_o = 50 Ω

Accessories

Introduction

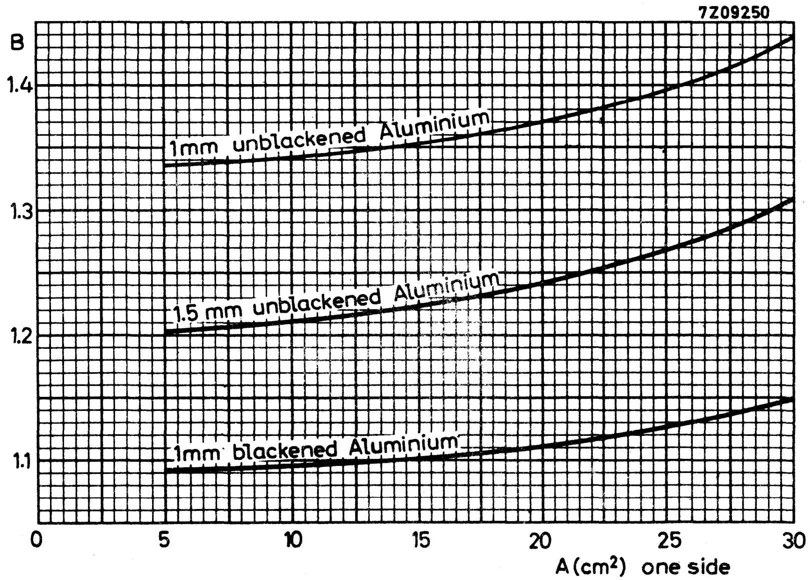
All information on thermal resistances of the accessories combined with flat heatsinks is valid for square heatsinks of 1.5 mm blackened aluminium.
For a few variations the thermal resistance may be derived as follows:

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 thicker heatsinks

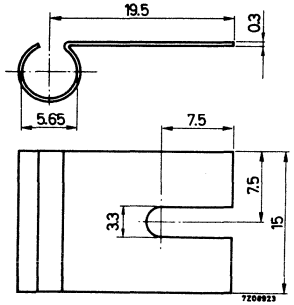
Multiply by the factor B given below as a function of the heatsink size A.



COOLING FIN

MECHANICAL DATA

Dimensions in mm

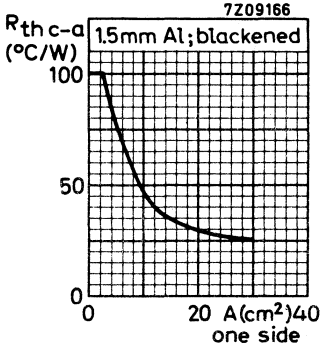


Fin material: brass, nickel plated

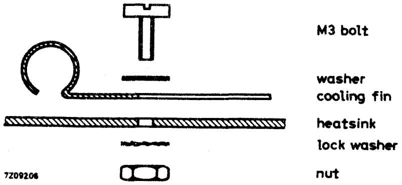
THERMAL RESISTANCE

From case to ambient with cooling fin only $R_{th\ c\text{-}a}$ = 100 °C/W

with heatsink see graph



MOUNTING INSTRUCTIONS

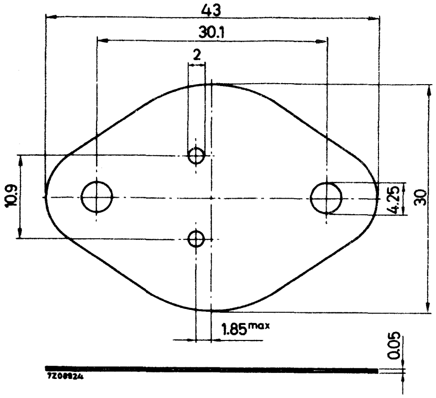


Torque on nut for good heat transfer: 5 cm kg

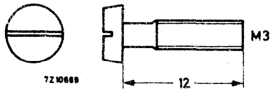
MOUNTING ACCESSORIES

MECHANICAL DATA

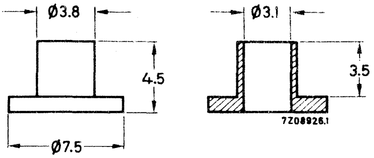
Dimensions in mm



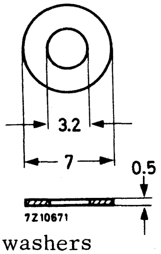
mica washer



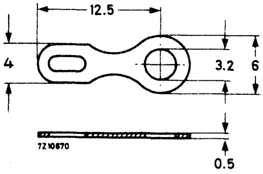
2 cheese head screws, slotted
material: brass, nickel plated



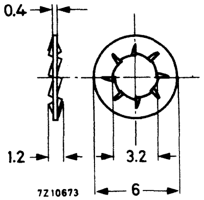
2 insulating bushes



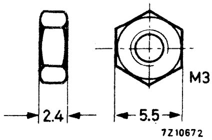
3 plain washers
material: brass, nickel plated



soldering tag



2 lock washers, internal teeth
material: steel, nickel plated



2 hexagon nuts
material: brass, nickel plated

THERMAL RESISTANCE

From mounting base to heatsink with mica washer $R_{th\,mb-h}$ = 1.0 °C/W

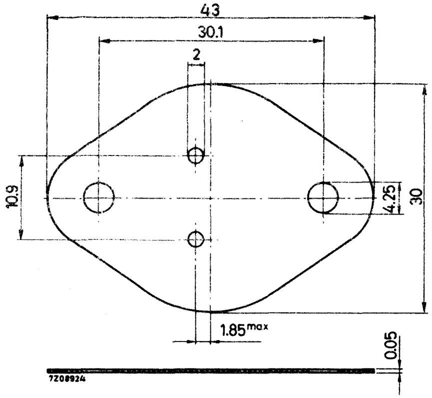
TEMPERATURES

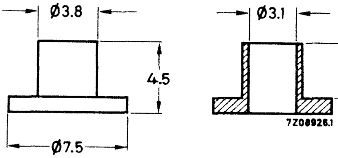
Maximum allowable temperature T_{max} = 150 °C

56201a MICA WASHER AND 2 INSULATING BUSHES

MECHANICAL DATA

Dimensions in mm





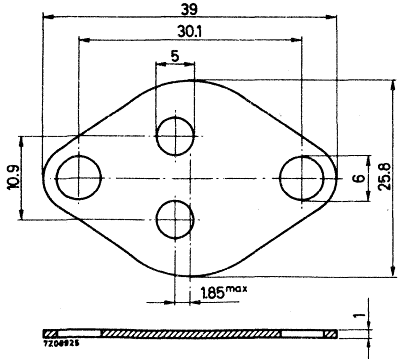
THERMAL RESISTANCE

From mounting base to heatsink $R_{th\,mb-h}$ = 1.0 °C/W

56201b LEAD WASHER

MECHANICAL DATA

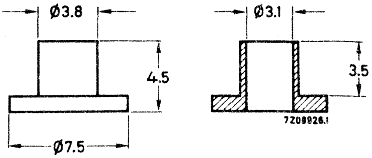
Dimensions in mm



56201c INSULATING BUSH

MECHANICAL DATA

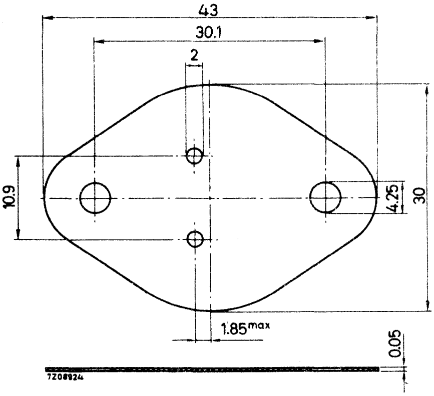
Dimensions in mm



56201d MICA WASHER

MECHANICAL DATA

Dimensions in mm



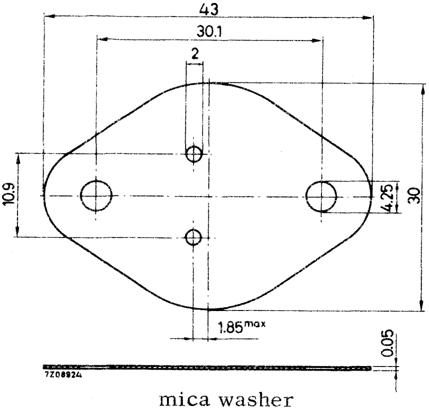
THERMAL RESISTANCE

From mounting base to heatsink $R_{th\ mb\text{-}h} = 1.0\ ^{\circ}C/W$

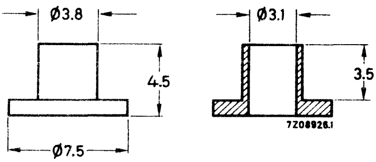
MOUNTING ACCESSORIES

MECHANICAL DATA

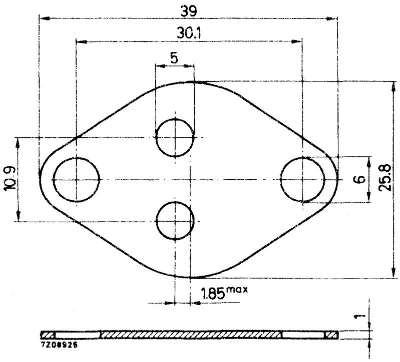
Dimensions in mm



mica washer



2 insulating bushes



lead washer

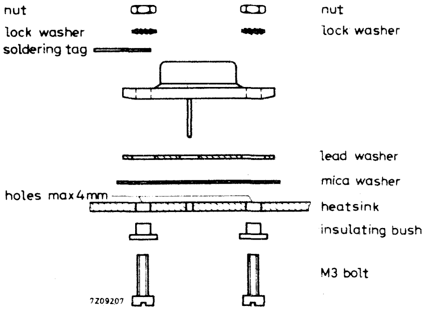
THERMAL RESISTANCE

From mounting base to heatsink
with mica washer only $R_{th\ mb\text{-}h}$ = 1.0 °C/W
with mica washer and lead washer $R_{th\ mb\text{-}h}$ = 0.75 °C/W

TEMPERATURE

Maximum allowable temperature T_{max} = 150 °C

MOUNTING INSTRUCTIONS

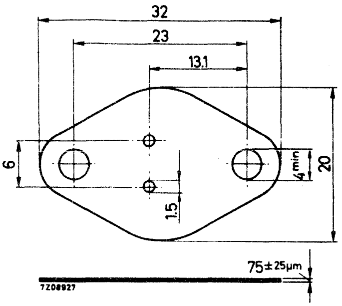


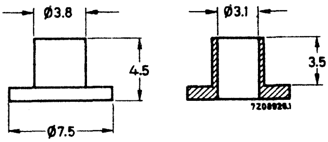
Torque on nut for good heat transfer : 5 cm kg

MICA WASHER AND 2 INSULATING BUSHES

MECHANICAL DATA

Dimensions in mm





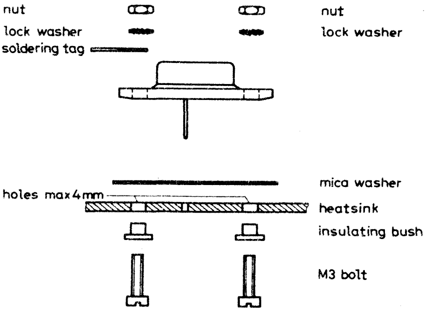
THERMAL RESISTANCE

From mounting base to heatsink $R_{th\ mb-h} = 1.5\ ^oC/W$

TEMPERATURE

Maximum allowable temperature $T_{max} = 150\ ^oC$

MOUNTING INSTRUCTIONS

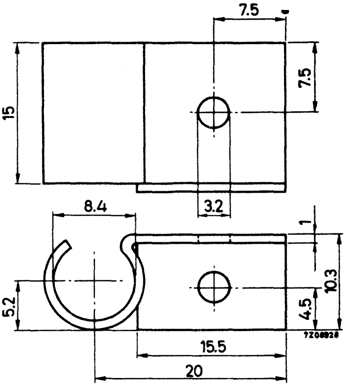


Torque on nut for good heat transfer: 5 cm kg

COOLING FIN

MECHANICAL DATA

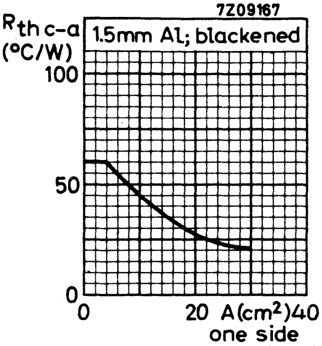
Dimensions in mm



Fin material: aluminium, blackened

THERMAL RESISTANCE

From case to ambient with cooling fin only	$R_{th\ c-a}$	= 60 °C/W
with heatsink		see graph



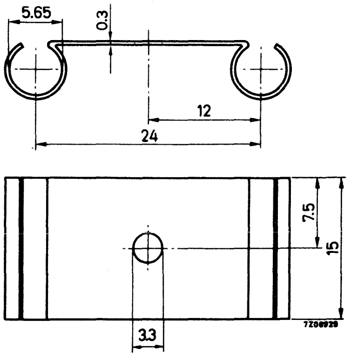
MOUNTING INSTRUCTIONS

Torque on M3 bolts for good heat transfer: 5 cmkg

COOLING FIN

MECHANICAL DATA

Dimensions in mm

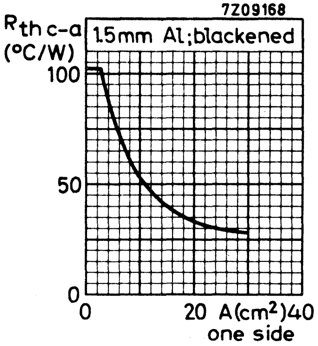


Fin material: brass, nickel plated

THERMAL RESISTANCE

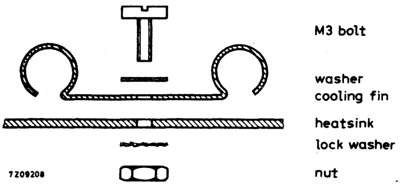
From case to ambient with cooling fin only $R_{th\ c\text{-}a}$ = 102 °C/W

with heatsink 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

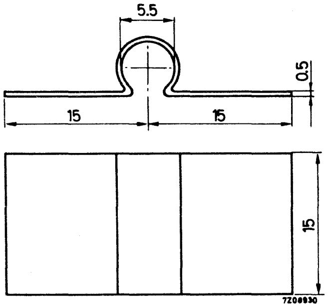


Torque on nut for good heat transfer: 5 cmkg

COOLING FIN

MECHANICAL DATA

Dimensions in mm



Fin material: brass, nickel plated

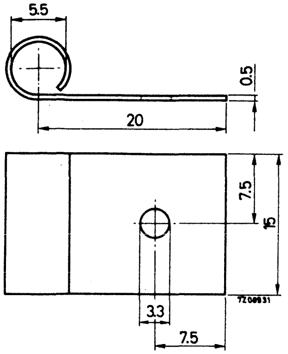
THERMAL RESISTANCE

From case to ambient with cooling fin only $R_{th\ c\text{-}a} = 75\ ^{o}C/W$

COOLING FIN

MECHANICAL DATA

Dimensions in mm

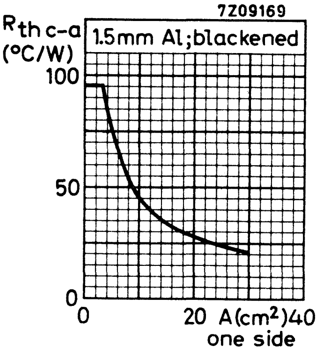


Fin material: brass, nickel plated

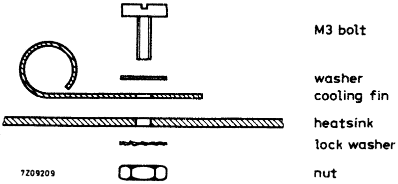
THERMAL RESISTANCE

From case to ambient with cooling fin only $R_{th\ c\text{-}a}$ = 95 °C/W

with heatsink see graph



MOUNTING INSTRUCTIONS

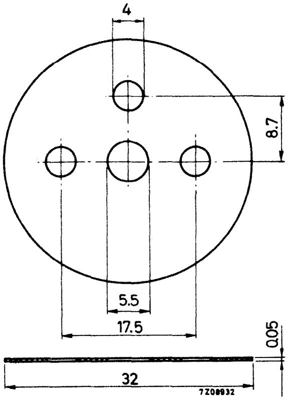


Torque on nut for good heat transfer: 5 cm kg

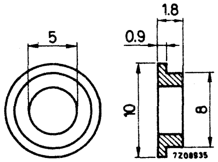
MOUNTING ACCESSORIES

MECHANICAL DATA

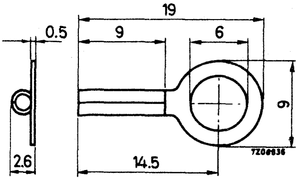
Dimensions in mm



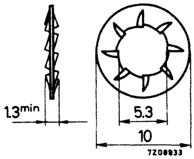
mica washer



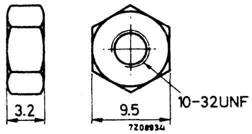
insulating ring



cable lug
material: brass, nickel plated



lock washer internal teeth
material: steel, nickel plated



hexagon nut
material: brass, nickel plated

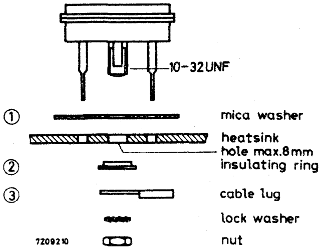
THERMAL RESISTANCE

From mounting base to heatsink $R_{th\ mb-h}$ = 1 °C/W

TEMPERATURE

Maximum allowable temperature T_{max} = 125 °C

MOUNTING INSTRUCTIONS



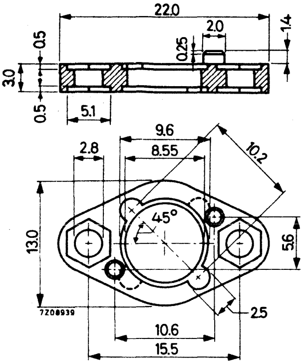
Torque on nut for good heat transfer: 20 cm

Non insulated mounting; without items 1, 2 and 3. (3 if necessary)

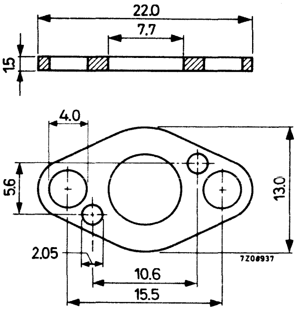
MOUNTING ACCESSORIES

MECHANICAL DATA

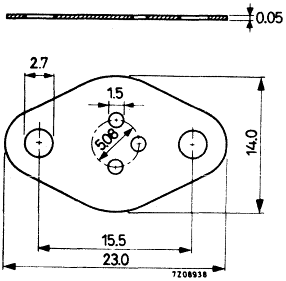
Dimensions in mm



top clamping washer
of insulating material



bottom clamping washer
material: brass, tin
plated



mylar washer

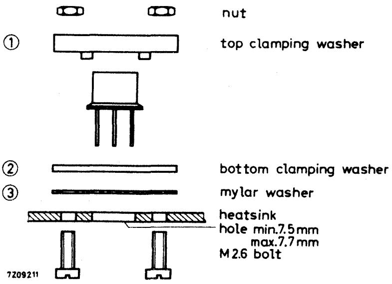
THERMAL RESISTANCE

From mounting base to heatsink non insulated mounting $R_{th\ mb\text{-}h}$ = 3 °C/W
insulated mounting $R_{th\ mb\text{-}h}$ = 6 °C/W

TEMPERATURE

Maximum allowable temperature T_{max} = 100 °C

MOUNTING INSTRUCTIONS

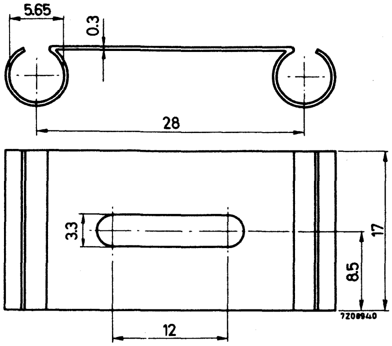


Non insulated mounting; without items 2 and 3. (Note: item 1 must than be mounted up-side down)

COOLING FIN

MECHANICAL DATA

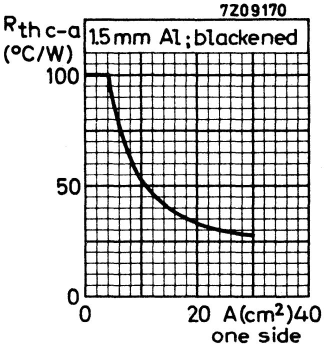
Dimensions in mm



Fin material: brass, nickel plated

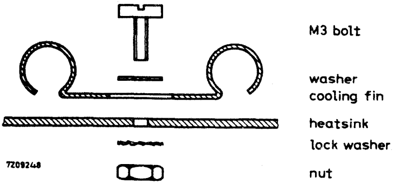
THERMAL RESISTANCE

From case to ambient with cooling fin only $R_{th\,c\text{-}a}$ = 100 °C/W
with heatsink 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

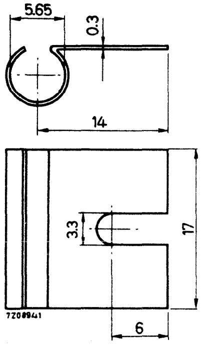


Torque on nut for good heat transfer: 5 cmkg

COOLING FIN

MECHANICAL DATA

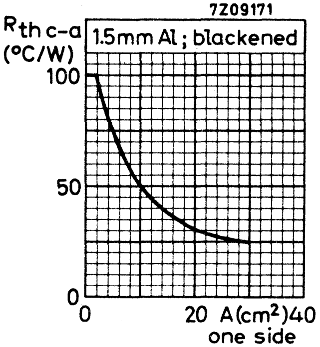
Dimensions in mm



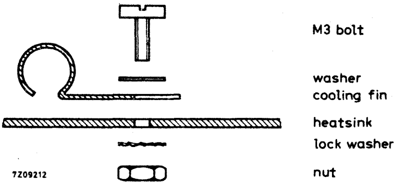
Fin material: brass, nickel plated

THERMAL RESISTANCE

From case to ambient with cooling fin only $R_{th\ c\text{-}a}$ = 100 °C/W
with heatsink see graph



MOUNTING INSTRUCTIONS



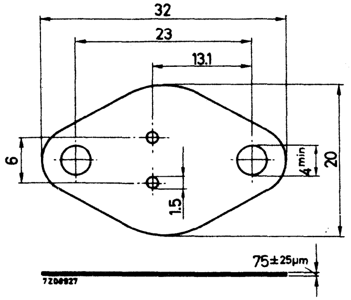
Torque on nut for good heat transfer: 5 cm kg

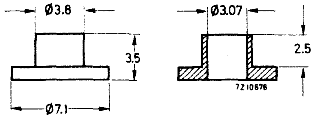
MICA WASHER AND 2 INSULATING BUSHES

56239

MECHANICAL DATA

Dimensions in mm





THERMAL RESISTANCE

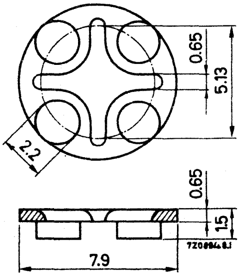
From mounting base to heatsink $R_{th\,mb-h}$ = 1.5 °C/W

TEMPERATURE

Maximum allowable temperature T_{max} = 150 °C

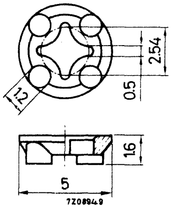
DISTANCE DISCS

56245



Insulating
material

56246



Insulating
material

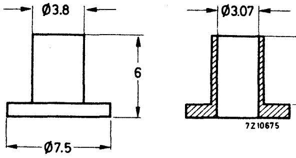
TEMPERATURE

Maximum allowable temperature T_{max} = 100 °C

2 INSULATING BUSHES

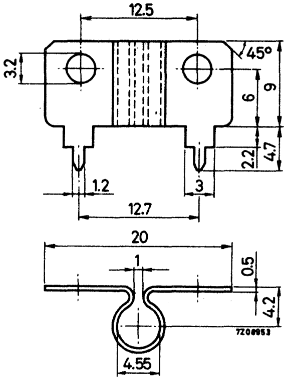
56261

MECHANICAL DATA Dimensions in mm



56263 COOLING FIN

MECHANICAL DATA Dimensions in mm



Fin material: copper, tin plated

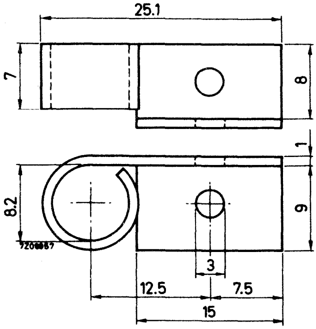
THERMAL RESISTANCE

From case to ambient $R_{th\ c\text{-}a}$ = 100 °C/W

COOLING FIN

MECHANICAL DATA

Dimensions in mm

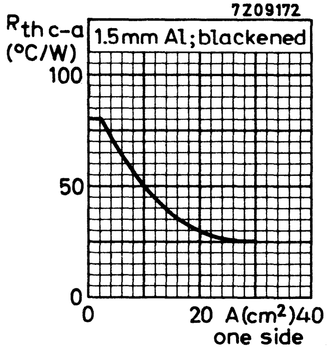


Fin material: aluminium, blackened

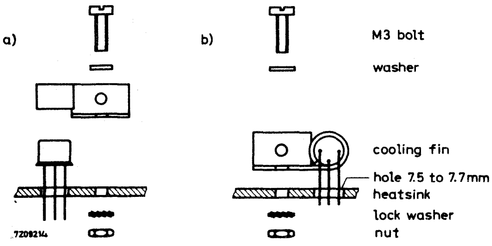
THERMAL RESISTANCE

From case to ambient with cooling fin only $R_{th\,c-a}$ = 80 °C/W

with heatsink see graph



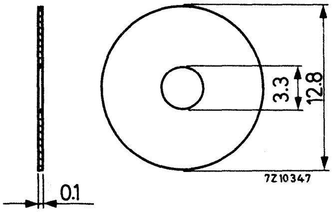
MOUNTING INSTRUCTIONS



Torque on nut for good heat transfer: 5 cm kg

56302 MICA WASHER

MECHANICAL DATA Dimensions in mm

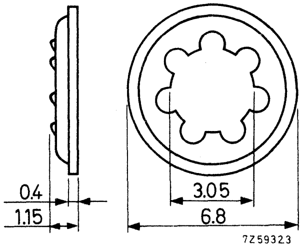


THERMAL RESISTANCE

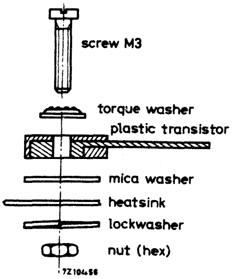
From mounting base to heatsink $R_{th\ mb\text{-}h}$ = 6 °C/W

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
AC107	2	LF	AF127	3	HF	BAW56	4	Mm
AC125	2	LF	AF139	3	HF	BAW99	4	B
AC126	2	LF	AF178	3	HF	BAY66	4	Mw
AC127	2	LF	AF239	3	HF	BAY96	4	Mw
AC127/01	2	LF	AF239S	3	HF	BC107	2	LF
AC128	2	LF	AF240	3	HF	BC108	2	LF
AC128/01	2	LF	AF267	3	HF	BC109	2	LF
AC132	2	LF	AFY16	3	HF	BC146	2	LF
AC132/01	2	LF	AFY19	4	Tr	BC147	2	LF
AC172	2	LF	AFY40	3	HF	BC148	2	LF
AC187	2	LF	AFZ12	3	HF	BC149	2	LF
AC187/01	2	LF	ASY26	3	Sw	BC157	2	LF
AC188	2	LF	ASY27	3	Sw	BC158	2	LF
AC188/01	2	LF	ASY28	3	Sw	BC159	2	LF
AD139	2	P	ASY29	3	Sw	BC177	2	LF
AD149	2	P	ASY31	3	Sw	BC178	2	LF
AD161	2	P	ASY32	3	Sw	BC179	2	LF
AD162	2	P	ASY73	3	Sw	BC200	2	LF
ADY26	2	P	ASY74	3	Sw	BC237	2	LF
ADZ11	2	P	ASY75	3	Sw	BC238	2	LF
ADZ12	2	P	ASY76	3	Sw	BC239	2	LF
AF114	3	HF	ASY77	3	Sw	BCW29	4	Mm
AF115	3	HF	ASY80	3	Sw	BCW30	4	Mm
AF116	3	HF	ASZ15	2	P	BCW31	4	Mm
AF117	3	HF	ASZ16	2	P	BCW32	4	Mm
AF118	3	HF	ASZ17	2	P	BCW33	4	Mm
AF121	3	HF	ASZ18	2	P	BCY10	2	LF
AF124	3	HF	ASZ20	3	Sw	BCY11	2	LF
AF125	3	HF	ASZ21	3	Sw	BCY12	2	LF
AF126	3	HF	AUY10	2	P	BCY30	2	LF

B = Beam lead devices for thick- and thin-film circuits
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
Sw = Switching transistors
Tr = Transmitting transistors

Type No.	Part	Section	Type No.	Part	Section	Type No.	Part	Section
BCY31	2	LF	BD139	2	P	BFS18	4	Mm
BCY32	2	LF	BD140	2	P	BFS19	4	Mm
BCY33	2	LF	BD144	2	Defl	BFS20	4	Mm
BCY34	2	LF	BDY10	2	P	BFS21	4	FET
BCY38	2	LF	BDY11	2	P	BFS21	4	Dual
BCY39	2	LF	BDY20	2	P	BFS21A	4	FET
BCY40	2	LF	BDY38	2	P	BFS21A	4	Dual
BCY54	2	LF	BF115	3	HF	BFS22	4	Tr
BCY55	2	LF	BF167	3	HF	BFS23	4	Tr
BCY55	4	Dual	BF173	3	HF	BFS28	4	FET
BCY56	2	LF	BF177	3	HF	BFS92	3	HF
BCY57	2	LF	BF178	3	HF	BFS93	3	HF
BCY70	2	LF	BF179	3	HF	BFS94	3	HF
BCY71	2	LF	BF180	3	HF	BFS95	3	HF
BCY72	2	LF	BF181	3	HF	BFW10	4	FET
BCY87	2	LF	BF182	3	HF	BFW11	4	FET
BCY87	4	Dual	BF183	3	HF	BFW16A	3	HF
BCY88	2	LF	BF184	3	HF	BFW17A	3	HF
BCY88	4	Dual	BF185	3	HF	BFW30	3	HF
BCY89	2	LF	BF186	3	HF	BFW45	2	Defl
BCY89	4	Dual	BF194	3	HF	BFW61	4	FET
BCZ10	2	LF	BF195	3	HF	BFW92	3	HF
BCZ11	2	LF	BF196	3	HF	BFX44	3	HF
BCZ12	2	LF	BF197	3	HF	BFX75	4	B
BD115	2	P	BF200	3	HF	BFX76	4	B
BD124	2	P	BF254	3	HF	BFX89	3	HF
BD135	2	P	BF255	3	HF	BFY10	3	HF
BD136	2	P	BFR63	3	HF	BFY11	3	HF
BD137	2	P	BFR64	3	HF	BFY44	4	Tr
BD138	2	P	BFS17	4	Mm	BFY50	3	HF

B = Beam lead devices for thick- and thin-film circuits
Defl = Deflection transistors
Dual = Dual transistors
FET = Field effect transistors
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Type No.	Part	Section
56200	2.3.4	A
56201	2.3.4	A
56201a	2.3.4	A
56201b	2.3.4	A
56201c	2.3.4	A
56201d	2.3.4	A
56201e	2.3.4	A
56203	2.3.4	A
56207	2.3.4	A
56208	2.3.4	A
56209	2.3.4	A
56210	2.3.4	A
56213	2.3.4	A
56218	2.3.4	A
56226	2.3.4	A
56227	2.3.4	A
56239	2.3.4	A
56245	2.3.4	A
56246	2.3.4	A
56261	2.3.4	A
56263	2.3.4	A
56265	2.3.4	A
56302	2.3.4	A
56303	2.3.4	A

A = Accessories

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