PHILIPS

Data handbook

Electronic
components
and materials

Semiconductors and integrated circuits

Part 4a March 1973

Transmitting transistors

Microwave devices

Field-effect transistors

Dual transistors

Microminiature devices

SEMICONDUCTORS AND INTEGRATED CIRCUITS

Part 4 a

March 1973

Index and maintenance type list at the back

Argentina
FAPESA I.y.C.
Av. Crovara 2550
Tel. 652-7438/7478
BUENOS AIRES

Australia
Philips Industries Ltd.
Elcoma Division
95-99 York Street
Tel. 20223
SYDNEY, N.S.W. 2000

Austria
Osterreichische Philips
Bauelemente Industrie G.m.b.H.
Zieglergasse 6
Tel. 93 26 22
A1072 VIENNA

Belgium
M.B.L.E.
80, rue des Deux Gares
Tel. 23 00 00
1070 BRUSSELS

Brazil
IBRAPE S.A.
Av. Paulista 2073-S/Loja
Tel. 278-1111
SAO PAULO, SP.

Canada
Philips Electron Devices
116, Vanderhoof Ave.
Tel. 425-5161
TORONTO 17, Ontario

Chile
Philips Chilena S.A.
Av. Santa Maria 0760
Tel. 39-40 01
SANTIAGO

Colombia
SADAPE S.A.
Calle 19, No. 5-51
Tel. 422-175
BOGOTA D.E. 1

Denmark
Miniwatt A/S
Emdrupvej 115A
Tel. (01) 69 16 22
DK-2400 KØBENHAVN NV

Finland
Oy Philips Ab
Elcoma Division
Kaivokatu 8
Tel. 65 80 33
SF-00100 HELSINKI 10

France
R.T.C.
La Radiotechnique-Compelec
130 Avenue Ledru Rollin
Tel. 357-69-30
PARIS 11

Germany
Valvo G.m.b.H.
Valvo Haus
Burchardstrasse 19
Tel. (0411) 3296-1
2 HAMBURG 1

Greece
Philips S.A. Hellénique
Elcoma Division
52, Av. Syngrou
Tel. 915 311
ATHENS

Hong Kong
Philips Hong Kong Ltd.
Components Dept. (Kowloon Branch)
7/F. Wai Yip Industrial Building
41 Tsun Yip St. Kwuntong
Tel. K-42 82 05-8
HONG KONG

India
INBELEC Div. of
Philips India Ltd.
Band Box House
254-D, Dr. Annie Besant Road
Tel. 457 311 to 15
Prabhadevi, BOMBAY -25- DD

Indonesia
P.T. Philips-Ralin Electronics
Elcoma Division
Djalan Gadjah Mada 18
Tel. 44 163
DJAKARTA

Ireland
Philips Electrical (Ireland) Ltd.
Newstead, Clonskeagh
Tel. 69 33 55
DUBLIN 14

Italy
Philips S.p.A.
Sezione Elcoma
Piazza IV Novembre 3
Tel. 69 94
MILANO

Japan
NIHON PHILIPS
32nd Fl. World Trade Center Bldg.
5, 3-chome, Shiba Hamamatsu-cho
Minato-ku
Tel. (435) 5204-5
TOKYO

Mexico
Electrónica S.A. de C.V.
Varsovia No. 36
Tel. 5-33-11-80
MEXICO 6, D.F.

Netherlands
Philips Nederland B.V.
Afd. Elonco
Boschdijk, VB
Tel. (040) 79 33 33
EINDHOVEN

New Zealand
EDAC Ltd.
70-72 Kingsford Smith Street
Tel. 873 159
WELLINGTON

Norway
Electronica A.S
Middelthunsgate 27
Tel. 46 39 70
OSLO 3

Peru
CADESA
Jr. Ilo, No. 216
Appartado 10132
Tel. 27 7317
LIMA

Philippines
EDAC
Philips Industrial Dev. Inc.
2246 Pasong Tamo
Tel. 88-94-53 (to 56)
MAKATI-RIZAL

Portugal
Philips Portuguesa S.A.R.L.
Av. Eng. Duharte Pacheco 6
Tel. 68 31 21
LISBOA 1

Singapore
Philips Singapore Private Ltd.
8th Floor, International Building
360 Orchard Road
Tel. 37 22 11 (10 lines)
SINGAPORE-9

South Africa
EDAC (Pty.) Ltd.
South Park Lane
New Doornfontein
Tel. 24/6701-2
JOHANNESBURG

Spain
COPRESA S.A.
Balmes 22
Tel. 232 66 80
BARCELONA 7

Sweden
ELCOMA A.B.
Lidingövägen 50
Tel. 08/67 97 80
10250 STOCKHOLM 27

Switzerland
Philips A.G.
Edenstrasse 20
Tel. 01/44 22 11
CH-8027 ZUERICH

Taiwan
Philips Taiwan Ltd.
San Min Building, 3rd Fl.
57-1, Chung Shan N. Road
Section 2
Tel. 553101-5
TAIPEI

Turkey
Turk Philips Ticaret A.S.
EMET Department
Gümüssuyu Cad. 78-80
Tel. 45.32.50
Beyoglü, ISTANBUL

United Kingdom
Mullard Ltd.
Mullard House
Torrington Place
Tel. 01-580 6633
LONDON WC1E 7HD

United States
North American Philips
Electronic Component Corp.
230, Duffy Avenue
Tel. (516) 931-6200
HICKSVILLE, N.Y. 11802

Uruguay
Luzilectron S.A.
Rondeau 1567, piso 5
Tel. 9 43 21
MONTEVIDEO

Venezuela
C.A. Philips Venezolana
Elcoma Department
Colinas de Bello Monte
Tel. 72.01.51
CARACAS

DATA HANDBOOK SYSTEM

Our Data Handbook System is a comprehensive source of information on electronic components, subassemblies and materials; it is made up of three series of handbooks each comprising several parts.

ELECTRON TUBES	**BLUE**
SEMICONDUCTORS AND INTEGRATED CIRCUITS	**RED**
COMPONENTS AND MATERIALS	**GREEN**

The several parts contain all pertinent data available at the time of publication, and each is revised and reissued periodically.

Where ratings or specifications differ from those published in the preceding edition they are pointed out by arrows. Where application information is given it is advisory and does not form part of the product specification.

If you need confirmation that the published data about any of our products are the latest available, please contact our representative. He is at your service and will be glad to answer your inquiries.

December 1972

ELECTRON TUBES (BLUE SERIES)

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

Part 1	**Transmitting tubes (Tetrodes, Pentodes);** **Amplifier circuit assemblies**	**January 1972**
Part 2	**Tubes for microwave equipment**	**February 1972**
Part 3	**Special Quality tubes;** **Miscellaneous devices**	**March 1972**
Part 4	**Receiving tubes**	**June 1972**
Part 5	**Cathode-ray tubes; Photo tubes; Camera tubes**	**July 1972**
Part 6	**Devices for nuclear equipment** Photomultiplier tubes Channel electron multipliers Scintillators Photoscintillators Radiation counter tubes Semicinductor radiation detectors Neutron generator tubes Photo diodes	**September 1972**
Part 7	**Gas-filled tubes** Voltage stabilizing and reference tubes Counter, selector, and indicator tubes Trigger tubes Switching diodes Thyratrons Ignitrons Industrial rectifying tubes High-voltage rectifying tubes	**October 1972**
Part 8	**T.V.Picture tubes**	**November 1972**
Part 9	**Transmitting tubes (Triodes) ;** **Tubes for r.f. heating (Triodes)**	**December 1971**

SEMICONDUCTORS AND INTEGRATED CIRCUITS (RED SERIES)

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

Part 1a Rectifier diodes and thyristors — December 1972

- Rectifier diodes
- Voltage regulator diodes
- Transient suppressor diodes
- Thyristors, diacs, triacs
- Ignistors
- Rectifier stacks

Part 1b Diodes — December 1972

- Small signal germanium diodes
- Small signal silicon diodes
- Special diodes
- Voltage regulator diodes
- Voltage reference diodes
- Tuner diodes

Part 2 Low frequency and deflection transistors — January 1973

Part 3 High frequency and switching transistors — February 1973

Part 4a Special semiconductors — March 1973

- Transmitting transistors
- Microwave devices
- Field effect transistors
- Dual transistors
- Microminiature devices for thick- and thin-film circuits

Part 4b Devices for opto-electronics — March 1973

- Photosensitive diodes and transistors
- Light emitting diodes
- Infra-red sensitive devices
- Photoconductive devices

Part 5 Linear integrated circuits — February 1972

Part 6 Digital integrated circuits — March 1972

DTL (FC family)
DTL/HNIL (FZ family)
TTL (FJ family)
TTL (GJ family)
CML (GH family)
MOS (FD family)

COMPONENTS AND MATERIALS (GREEN SERIES)

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

Part 1 Circuit Blocks, Input/Output Devices, Electro-mechanical Components, Peripheral Devices — **January 1973**

- Circuit blocks 40-Series and CSA70
- Counter modules 50-Series
- Norbits 60-Series, 61- Series
- Circuit blocks 90-Series
- Input/output devices
- Electro-mechanical components
- Peripheral devices

Part 2 Resistors, Capacitors — **April 1973**

- Electrolytic capacitors
- Paper capacitors and film capacitors
- Ceramic capacitors
- Variable capacitors
- Fixed resistors
- Variable resistors
- Non-linear resistors (VDR, LDR, NTC, PTC)

Part 3 Radio, Audio, Television — **February 1972**

- FM tuners
- Coil assemblies
- Piezoelectric ceramic resonators and filters
- Loudspeakers
- Audio and mains transformers
- Television tuners, aerial input assemblies
- Components for black and white television
- Components for colour television
- Deflection assemblies for camera tubes

Part 4 Magnetic Materials, Piezoelectric Ceramics, Ni Cd cells — **May 1972**

- Ferrites for radio, audio and television
- Small coils and assembling parts
- Ferroxcube potcores and square cores
- Ferroxcube transformer cores
- Piezoelectric ceramics
- Permanent magnet materials
- Cylindrical nickel cadmium cells *)

Part 5 Memory Products, Magnetic Heads, Quartz Crystals, Microwave Devices, Variable Transformers — **August 1972**

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

Part 6 Electric Motors and Accessories, Timing and Control Devices — **October 1972**

- Small synchronous motors
- Stepper motors
- D.C. motors
- D.C. tachogenerators
- Asynchronous motors
- Indicators for built-in test equipment
- Time indicators, timers, timing motors
- Aircraft electronic clock system

Part 7 Circuit Blocks — **September 1971**

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

*) These items have been discontinued

April 1973

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 ($R_{th\ j\text{-}mb} > 15\ ^{\circ}C/W$)
D	Power transistor for a.f. applications ($R_{th\ j\text{-}mb} \leq 15\ ^{\circ}C/W$)
E	Tunnel diode
F	Transistor for h.f. applications ($R_{th\ j\text{-}mb} > 15\ ^{\circ}C/W$)
G	Multiple of dissimilar devices (see note on page 1); Miscellaneous
H	Magnetic sensitive diode; Field probe
K	Hall generator in an open magnetic circuit, e.g. magnetogram or signal probe
L	Power transistor for h.f. applications ($R_{th\ j\text{-}mb} \leq 15\ ^{\circ}C/W$)
M	Hall generator in a closed electrically energised magnetic circuit, e.g. Hall modulator or multiplier
→ N	Photocoupler
P	Radiation sensitive device 1)
Q	Radiation generating device
R	Electrically triggered controlling and switching device having a break-down characteristic ($R_{th\ j\text{-}mb} > 15\ ^{\circ}C/W$)
S	Transistor for switching applications ($R_{th\ j\text{-}mb} > 15\ ^{\circ}C/W$)
T	Electrically, or by means of light, triggered controlling and switching power device having a breakdown characteristic ($R_{th\ j\text{-}mb} \leq 15\ ^{\circ}C/W$) 1)
U	Power transistor for switching applications ($R_{th\ j\text{-}mb} \leq 15\ ^{\circ}C/W$)
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.

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

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.

---

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

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.

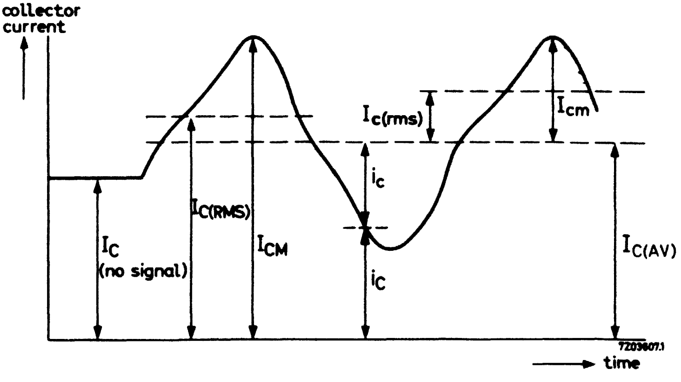


Fig.1

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},	See y parameters
b_{fe}, b_{fs}, b_{ob}, b_{oe},	
b_{os}, b_{rb}, b_{re}, b_{rs}	
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}	See y parameters
C_{fe}, C_{fs}, C_{ob}, C_{oe}	
C_{os}, C_{rb}, C_{re}, C_{rs}	
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

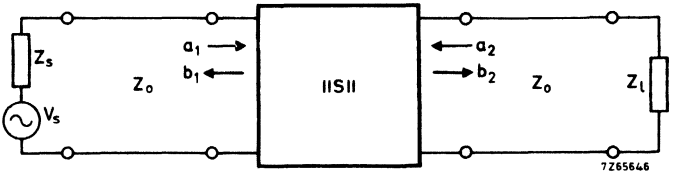
Letter symbol	Definition
r_D	Diode (internal) series resistance
r_{DS}	Drain-source resistance
r_{GS}	Gate-source resistance
R_L	Load resistance
R_S	Source resistance
R_{th}	Thermal resistance
$R_{th\ j\text{-}a}$	Thermal resistance from junction to ambient
$R_{th\ j\text{-}mb}$	Thermal resistance from 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}	Input susceptance	
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}	Transfer susceptance	
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}	Output susceptance	
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}	Feedback susceptance	
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	

SCATTERING PARAMETERS

In distinction to the conventional h, y and z parameters, s-parameters relate to travelling wave conditions. The figure below shows a two-port network with the incident and reflected travelling wave quantities a_1, b_1, a_2 and b_2, which are square roots of power.



a_1^2 = the power incident at the input $\left(= \frac{V_{i1}^2}{Z_o} \right)$

a_2^2 = the power incident at the output $\left(= \frac{V_{i2}^2}{Z_o} \right)$

b_1^2 = the power reflected from (or generated at) the input $\left(= \frac{V_{r1}^2}{Z_o} \right)$

b_2^2 = the power reflected from (or generated at) the output $\left(= \frac{V_{r2}^2}{Z_o} \right)$

Z_o = the characteristic impedance of the transmission line in which the two-port is connected

V_i = incident voltage

V_r = reflected (generated) voltage

The four-pole equations for s-parameters are:

$$b_1 = s_{11}a_1 + s_{12}a_2$$

$$b_2 = s_{21}a_1 + s_{22}a_2$$

Using the subscripts i. for 11, o for 22, f for 21 and r for 12, it follows that

$$s_i = s_{11} = \left. \frac{b_1}{a_1} \right| a_2 = 0$$

$$s_f = s_{21} = \left. \frac{b_2}{a_1} \right| a_2 = 0$$

$$s_o = s_{22} = \left. \frac{b_2}{a_2} \right| a_1 = 0$$

$$s_r = s_{12} = \left. \frac{b_1}{a_2} \right| a_1 = 0$$

a_1 can be made zero by terminating the input side with $Z_s = Z_o$ (no input power and no reflection from the source).

a_2 can be made zero by terminating the output side with $Z_l = Z_o$ (no reflection from the load).

Because $\frac{b_1}{a_1} = \frac{V_{r1}}{V_{i1}}$ it can be seen that s_i is the input reflection coefficient; in the same way s_o is the output reflection coefficient.

The s-parameters can be named and expressed as follows:

$s_i = s_{11}$ = Input reflection coefficient (for the given characteristic impedance) - Ratio between the square root of the power reflected from the input and the square root of the power incident at the input, output terminated with the characteristic impedance.

$s_f = s_{21}$ = Forward transmission coefficient (for the given characteristic impedance) - Ratio between the square root of the power generated at the output and the square root of the power incident at the input, output terminated with the characteristic impedance.

$s_o = s_{22}$ = Output reflection coefficient (for the given characteristic impedance) - Ratio between the square root of the power reflected from the output and the square root of the power incident at the output, input terminated with the characteristic impedance.

$s_r = s_{12}$ = Reverse transmission coefficient (for the given characteristic impedance) - Ratio between the square root of the power generated at the input and the square root of the power incident at the output, input terminated with the characteristic impedance.

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 (+0.05, - 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.

Transmitting transistors

V.H.F. POWER TRANSISTOR

N-P-N epitaxial planar transistor intended for use in class A, B and C operated mobile, industrial and military transmitters with a supply voltage of 13.5 V. The transistor is resistance stabilized. Every transistor is tested under severe load mismatch conditions with a supply overvoltage to 16.5 V. It has a TO-39 envelope with the collector connected to the case.

QUICK REFERENCE DATA

R.F. performance up to T_{mb} = 25 °C in an unneutralised common-emitter class B circuit.

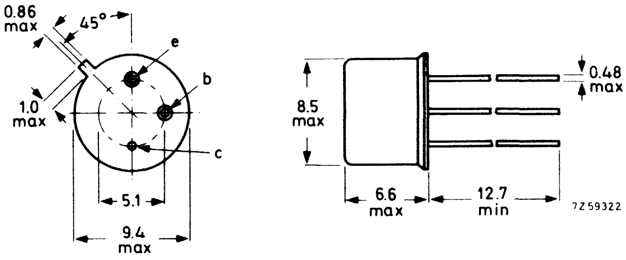
Mode of operation	V_{CC} (V)	f (MHz)	P_S (W)	P_L (W)	I_C (A)	G_p (dB)	η (%)	$\bar{z}_i$ (Ω)	$\bar{Y}_L$ (mA/V)
c.w.	13.5	175	$<$ 0.63	4	$<$ 0.49	$>$ 8	$>$ 60	3.8+j2.2	36-j22
c.w.	12.5	175	typ. 0.63	4	typ. 0.53	typ. 8	typ. 60		

MECHANICAL DATA

Dimensions in mm

TO-39

Collector connected to case



Accessories available on request: 56218; 56245; 56265

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

Voltages

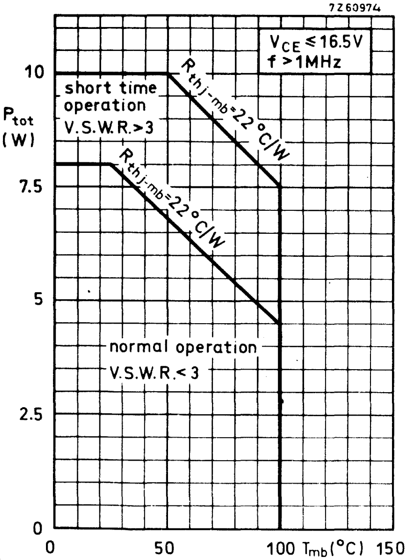
Collector-base voltage (open emitter) peak value	V_{CBOM}	max.	36	V
Collector-emitter voltage (open base)	V_{CEO}	max.	18	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4	V

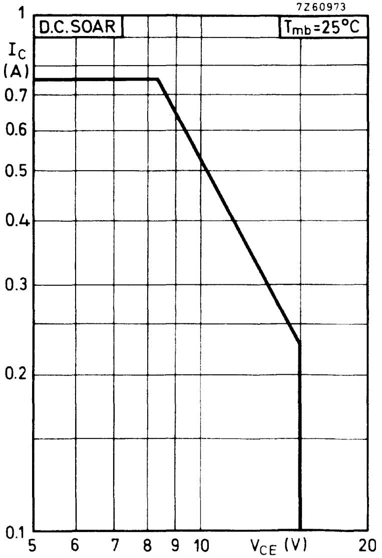
Currents

Collector current (average)	$I_{C(AV)}$	max.	0.75	A
Collector current (peak value) f > 1 MHz	I_{CM}	max.	2.25	A

Power dissipation

Total power dissipation up to T_{mb} = 25 °C f > 1 MHz	P_{tot}	max.	8	W





Temperature

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

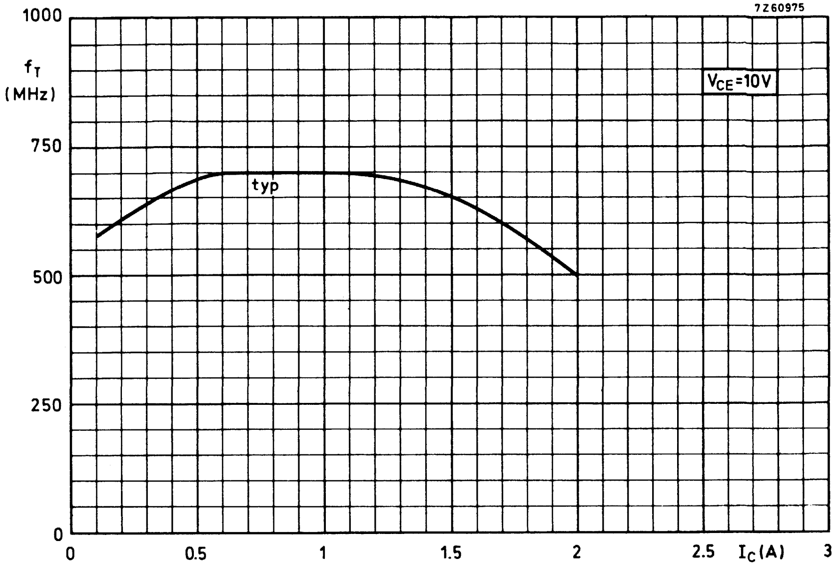
THERMAL RESISTANCE

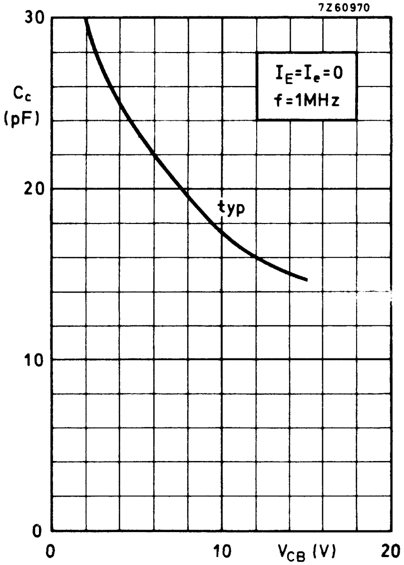
From junction to mounting base	$R_{th\,j\text{-}mb}$	=	22	°C/W
From mounting base to heatsink with a boron nitride washer for electrical insulation	$R_{th\,mb\text{-}h}$	=	2.5	°C/W

CHARACTERISTICS

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

Collector cut-off current				
$I_B = 0$; $V_{CE} = 14\ V$	I_{CEO}	<	5	mA
Breakdown voltages				
Collector-base voltage open emitter, $I_C = 1\ mA$	$V_{(BR)CBO}$	>	36	V
Collector-emitter voltage open base, $I_C = 10\ mA$	$V_{(BR)CEO}$	>	18	V
Emitter-base voltage open collector, $I_E = 1\ mA$	$V_{(BR)EBO}$	>	4	V
Transient energy				
$L = 25\ mH$; $f = 50\ Hz$				
open base	E	>	0.5	mWs
$-V_{BE} = 1.5\ V$; $R_{BE} = 33\ \Omega$	E	>	0.5	mWs
D.C. current gain				
$I_C = 500\ mA$; $V_{CE} = 5\ V$	h_{FE}	>	5	
Transition frequency				
$I_C = 350\ mA$; $V_{CE} = 10\ V$	f_T	typ.	700	MHz
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; $V_{CB} = 15\ V$	C_c	typ. <	15 20	pF pF
Feedback capacitance at f = 1 MHz				
$I_C = 50\ mA$; $V_{CE} = 15\ V$	$-C_{re}$	typ.	11	pF


7Z60975
1000
f_T
(MHz)
750
500
250
0
V_{CE}=10V
typ
0
0.5
1
1.5
2
2.5
I_C (A)
3


7Z60970
30
C_c
(pF)
20
10
0
I_E=I_e=0
f=1MHz
typ
0
10
V_{CB} (V)
20

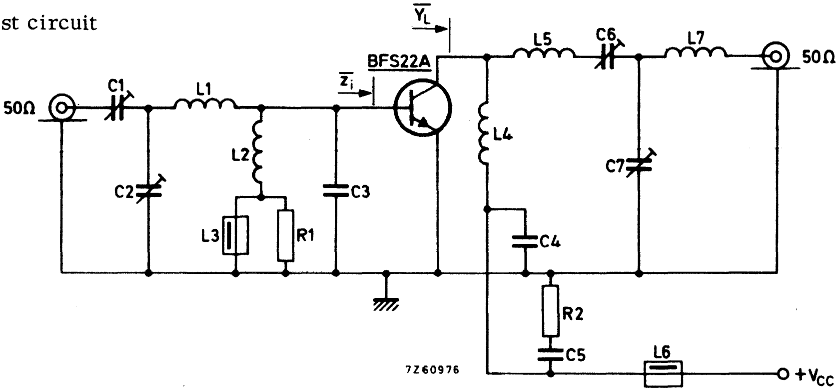
APPLICATION INFORMATION

R.F. performance in c.w. operation (unneutralised common-emitter class-B circuit)

f = 175 MHz; T_{mb} up to 25 °C

V_{CC}(V)	P_S(W)	P_L(W)	I_C(A)	G_p(dB)	η(%)	$\overline{z}_i$ (Ω)	$\overline{Y}_L$(mA/V)
13.5	< 0.63	4	< 0.49	> 8	> 60	3.8+j2.2	36-j22
12.5	typ. 0.63	4	typ. 0.53	typ. 8	typ. 60		

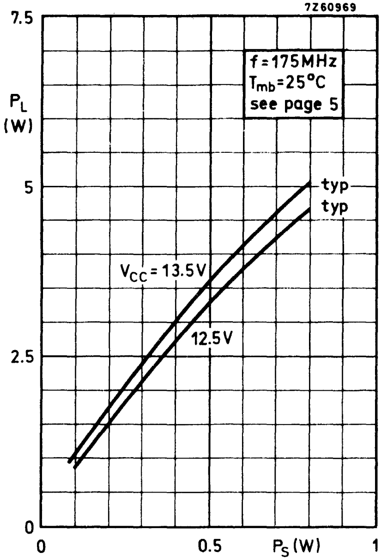
Test circuit

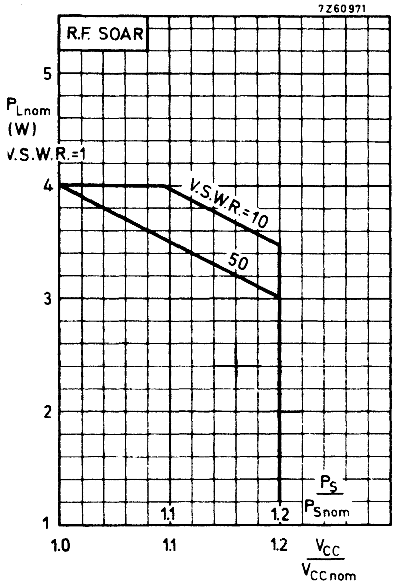


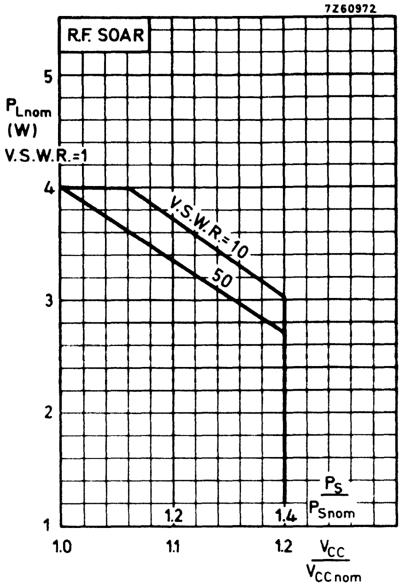
C1 = C6 = 4 to 29 pF air trimmer with insulated rotor
C2 = C7 = 4 to 29 pF air trimmer with non-insulated rotor
C3 = 39 pF ceramic
C4 = 100 pF ceramic
C5 = 15 nF polyester

L1 = 1 turn enamelled Cu wire (1.0 mm); int. diam. 10 mm; leads 2 x 10 mm
L2 = 6 turns enamelled Cu wire (0.7 mm); int. diam. 4 mm; leads 2 x 10 mm
L3 = L6 = ferroxcube choke (code number 4312 020 36640)
L4 = 8 turns enamelled Cu wire (0.7 mm); int. diam. 4 mm; leads 2 x 10 mm
L5 = 5 turns enamelled Cu wire (1.0 mm); winding pitch 1.0 mm; int. diam. 8 mm; leads 2 x 10 mm
L7 = 7 turns enamelled Cu wire (1.0 mm); winding pitch 1.0 mm; int. diam. 6 mm; leads 2 x 5 mm

R1 = R2 = 10 Ω carbon


7Z60969
7.5
5
2.5
0
P_L (W)
0
0.5
P_S (W)
1
f = 175MHz
T_{mb} = 25°C
see page 5
typ
typ
V_{CC} = 13.5V
12.5V





Conditions for R.F. SOAR:

f = 175 MHz $P_{Snom} = P_S$ at $V_{CC} = V_{CCnom}$ and V.S.W.R. = 1
T_{mb} = 70 °C see also page 5
V_{CCnom} = 12.5 or 13.5 V

The transistor has been developed for use with unstabilized supply voltages. As the output power and drive power increase with the supply voltage, the nominal output power must be derated in accordance with the graphs above for safe operation at supply voltages other than the nominal. The graphs show the allowable output power under nominal conditions, as a function of the supply overvoltage ratio, with V.S.W.R. as parameter.
The left hand graph applies to the situation in which the drive (P_S/P_{Snom}) increases linearly with supply overvoltage ratio.
The right hand graph shows the derating factor to be applied when the drive (P_S/P_{Snom}) increases as the square of the supply overvoltage ratio (V_{CC}/V_{CCnom}).
Depending on the operating conditions, the appropriate derating factor may lie in the region between the linear and the square-law functions.

V.H.F. POWER TRANSISTOR

N-P-N epitaxial planar transistor intended for use in class A, B and C operated mobile, industrial and military transmitters with a supply voltage of 28 V. The transistor is resistance stabilized. Every transistor is tested under severe load mismatch conditions. It has a TO-39 envelope with the collector connected to the case.

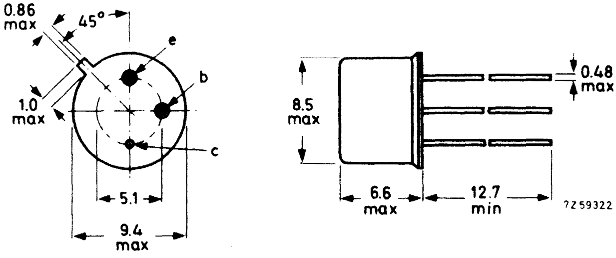
QUICK REFERENCE DATA

R.F. performance up to T_{mb} = 25 °C in an unneutralised common-emitter class B circuit.

Mode of operation	V_{CC} (V)	f (MHz)	P_S (W)	P_L (W)	I_C (A)	G_p (dB)	η (%)	$\overline{z_i}$ (Ω)	$\overline{Y_L}$ (mA/V)
c.w.	28	175	< 0.40	4	< 0.22	> 10	> 65	2.3+j1.6	8.6-j18

MECHANICAL DATA Dimensions in mm

TO-39
Collector connected
to case



Accessories available on request: 56218; 56245; 56265.

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

Voltages

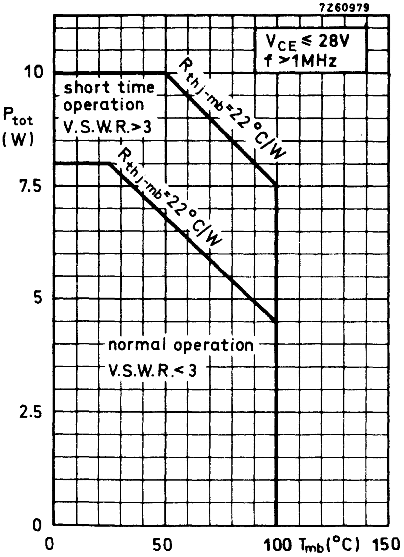
Collector-base voltage (open emitter) peak value	V_{CBOM}	max.	65	V
Collector-emitter voltage (open base)	V_{CEO}	max.	36	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4	V

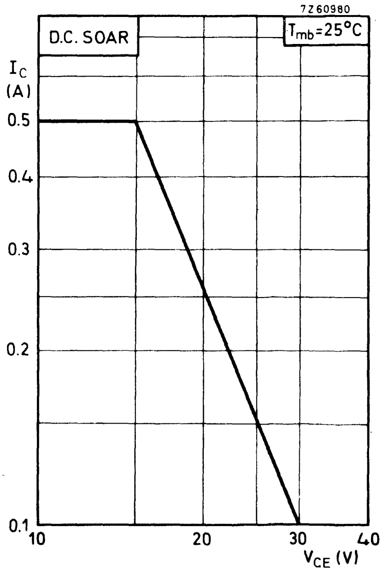
Currents

Collector current (average)	$I_{C(AV)}$	max.	0.5	A
Collector current (peak value) f > 1 MHz	I_{CM}	max.	1.5	A

Power dissipation

Total power dissipation up to T_{mb} = 25 °C f > 1 MHz	P_{tot}	max.	8	W





Temperature

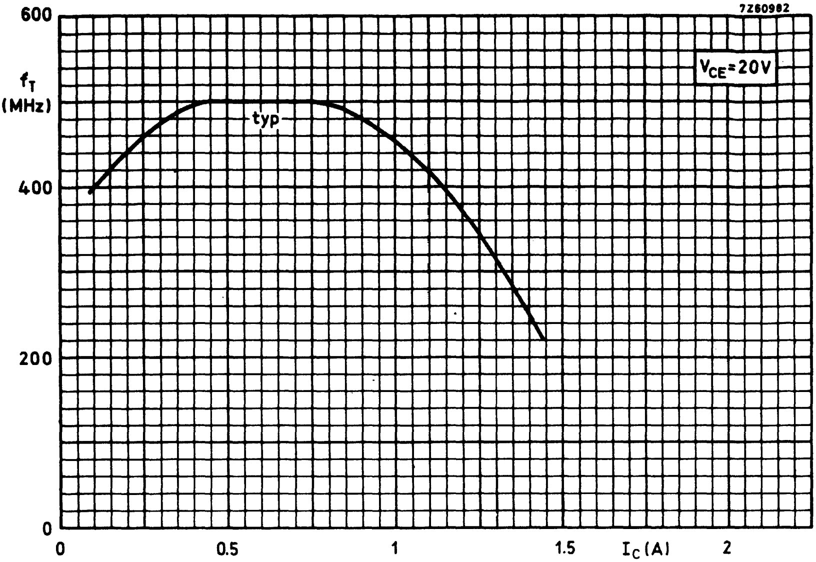
Storage temperature	T_{stg}	−65 to	+200	°C
Operating junction temperature	T_j	max.	200	°C

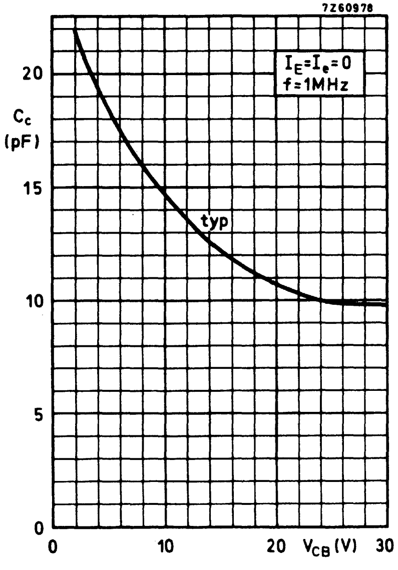
THERMAL RESISTANCE

From junction to mounting base	$R_{th\,j\text{-}mb}$	=	22	°C/W
From mounting base to heatsink with a boron nitride washer for electrical insulation	$R_{th\,mb\text{-}h}$	=	2.5	°C/W

CHARACTERISTICS T_j = 25 °C unless otherwise specified

Collector cut-off current				
$I_B = 0$; $V_{CE} = 28$ V	I_{CEO}	<	5	mA
Breakdown voltages				
Collector-base voltage open emitter, $I_C = 1$ mA	$V_{(BR)CBO}$	>	65	V
Collector-emitter voltage open base, $I_C = 10$ mA	$V_{(BR)CEO}$	>	36	V
Emitter-base voltage open collector; $I_E = 1$ mA	$V_{(BR)EBO}$	>	4	V
Transient energy				
L = 25 mH; f = 50 Hz				
open base	E	>	0.5	mWs
$-V_{BE} = 1.5$ V; $R_{BE} = 33\ \Omega$	E	>	0.5	mWs
D.C. current gain				
$I_C = 500$ mA; $V_{CE} = 5$ V	h_{FE}	>	5	
Transition frequency				
$I_C = 400$ mA; $V_{CE} = 20$ V	f_T	typ.	500	MHz
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; $V_{CB} = 30$ V	C_c	typ. <	10 15	pF pF
Feedback capacitance at f = 1 MHz				
$I_C = 25$ mA; $V_{CE} = 30$ V	$-C_{re}$	typ.	7.5	pF


7Z60982
600
400
200
0
f_T (MHz)
$V_{CE}=20V$
typ
0
0.5
1
1.5
I_C (A)
2


7Z60978
20
15
10
5
0
C_c (pF)
$I_E=I_e=0$
f=1MHz
typ
0
10
20
V_{CB} (V)
30

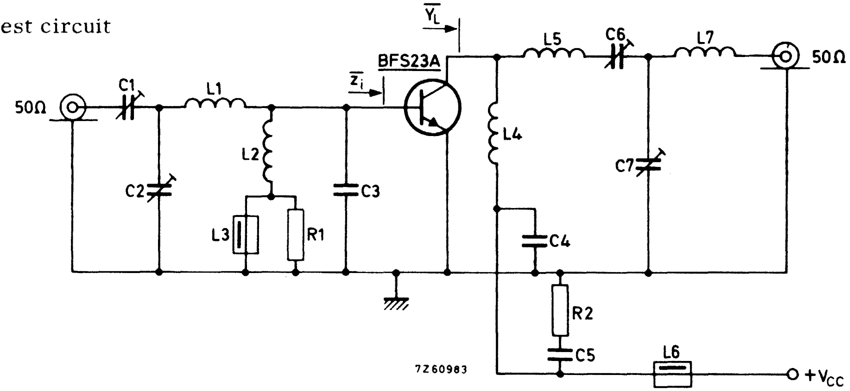
APPLICATION INFORMATION

R.F. performance in c.w. operation (unneutralised common-emitter class B circuit)

V_{CC} = 28 V; T_{mb} up to 25 °C

f(MHz)	P_S (W)	P_L (W)	I_C (A)	G_p (dB)	η (%)	$\overline{z_i}$ (Ω)	$\overline{Y_L}$ (mA/V)
175	< 0.40	4	< 0.22	> 10	> 65	2.3+j1.6	8.6-j18

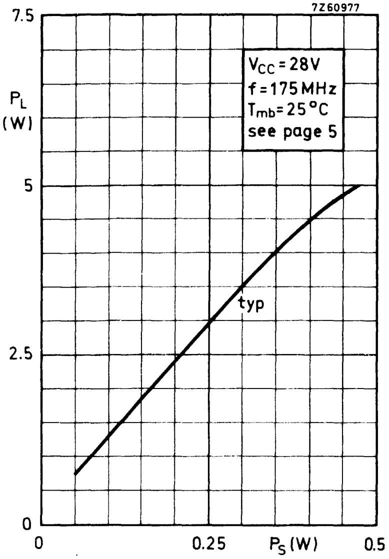
Test circuit

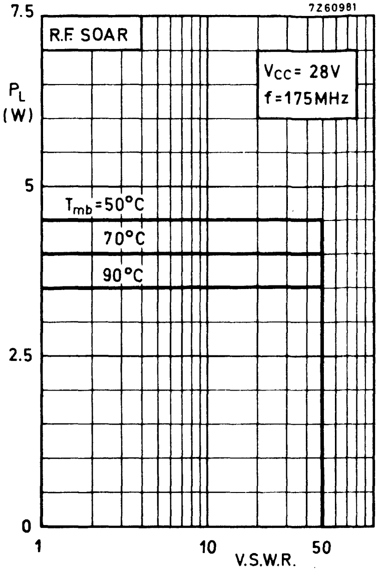


C1 = C6 = 4 to 29 pF air trimmer with insulated rotor
C2 = C7 = 4 to 29 pF air trimmer with non-insulated rotor
C3 = 39 pF ceramic
C4 = 100 pF ceramic
C5 = 15 nF polyester

L1 = 1 turn enamelled Cu wire (1.0 mm); int. diam. 10 mm; leads 2 x 10 mm
L2 = 6 turns enamelled Cu wire (0.7 mm); int. diam. 4 mm; leads 2 x 10 mm
L3 = L6 = ferroxcube choke (code number 4312 020 36640)
L4 = 8 turns enamelled Cu wire (0.7 mm); int. diam. 4 mm; leads 2 x 10 mm
L5 = 5 turns enamelled Cu wire (1.0 mm); winding pitch 1.0 mm; int. diam. 8 mm; leads 2 x 10 mm
L7 = 4 turns enamelled Cu wire (1.0 mm); winding pitch 1.0 mm; int. diam. 6 mm; leads 2 x 5 mm

R1 = R2 = 10 Ω carbon





For high voltage operation, a stabilized power supply is generally used.
The graph shows the allowable output power under nominal conditions as a function of the V.S.W.R., with heat-sink temperature as parameter.

SILICON PLANAR EPITAXIAL TRANSISTORS

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

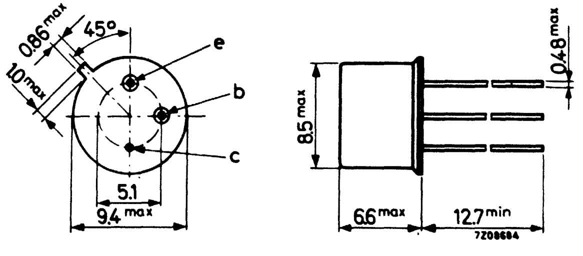
QUICK REFERENCE DATA

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

MECHANICAL DATA

Dimensions in mm

Collector connected to case
TO-39



Accessories available: 56218, 56245, 56265

TRANSMITTING TRANSISTOR

N-P-N epitaxial planar transistor intended for s.s.b. in class A and AB and in f.m. transmitting applications in class C with a supply voltage up to 28 V. The transistor is resistance stabilized and tested under severe load mismatch conditions. It has a $\frac{1}{4}$" capstan envelope with a moulded cap. All leads are isolated from the stud.

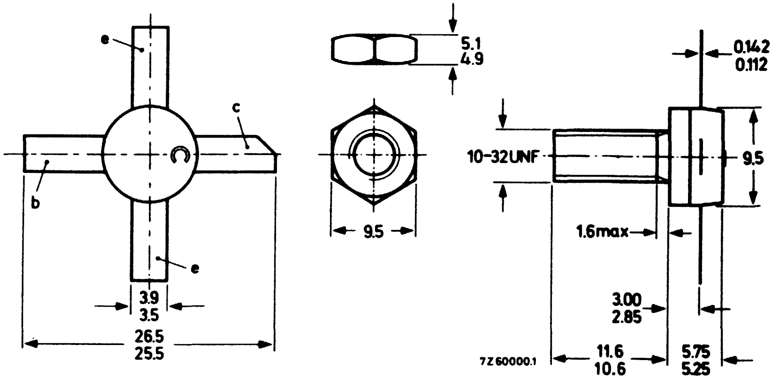
QUICK REFERENCE DATA

Operation	Class	V_{CE} (V)	f_1 (MHz)	f_2 (MHz)	P_L (W)	G_p (dB)	d_3 (dB)	I_C (A)	η_{dt} (%)
s.s.b.	A	26	28.000	28.001	0-8(PEP)	>18	< -40	1.2	-
s.s.b.	AB	28	28.000	28.001	25(PEP)	>18	typ. -35	typ. 1.28	typ. 35

Operation	Class	V_{CC} (V)	f (MHz)	P_S (W)	P_L (W)	G_p (dB)	I_C (A)	η (%)	$\overline{z_i}$ (Ω)	$\overline{Y_L}$ (mA/V)
c.w.	B	28	70	typ. 0.5	25	typ. 17	typ. 1.49	typ. 60	0.53-j1.4	42.5-j54

MECHANICAL DATA

Dimensions in mm



Torque on nut: min. 15 kg cm
(1.5 Newton metres)
max. 17 kg cm
(1.7 Newton metres)

Diameter of clearance hole in heatsink: max. 5.0 mm.
Mounting hole to have no burrs at either end. De-burring must leave surface flat; do not chamfer or countersink either end of hole.

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

Voltages

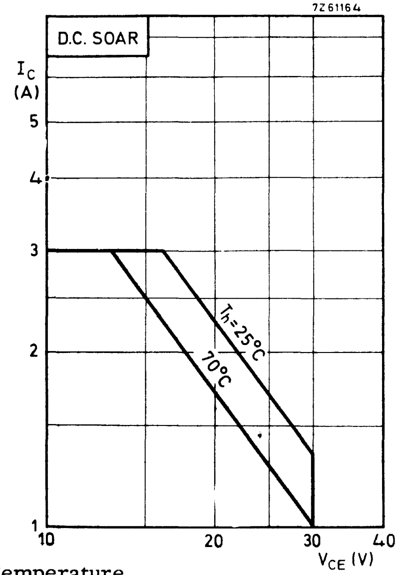
Collector-base voltage (open emitter) peak value	V_{CBOM}	max.	65	V
Collector-emitter voltage (open base)	V_{CEO}	max.	36	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4.0	V

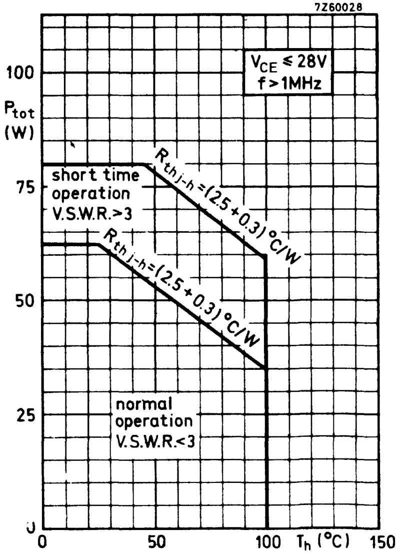
Currents

Collector current (average)	$I_{C(AV)}$	max.	3.0	A
Collector current (peak value) f > 1 MHz	I_{CM}	max.	6	A

Power dissipation

Total power dissipation up to T_h = 25 °C f > 1 MHz	P_{tot}	max.	**62.5**	W





Temperature

Storage temperature	T_{stg}	−30 to +200		°C
Operating junction temperature	T_j	max.	200	°C

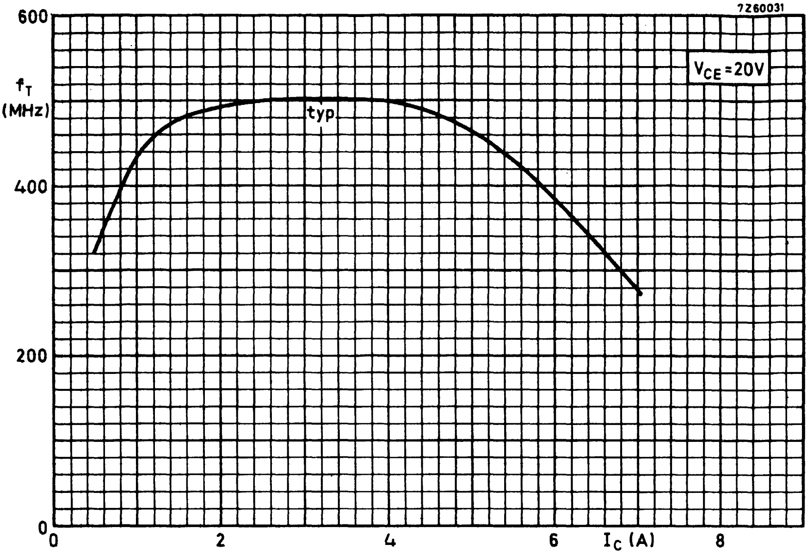
THERMAL RESISTANCE

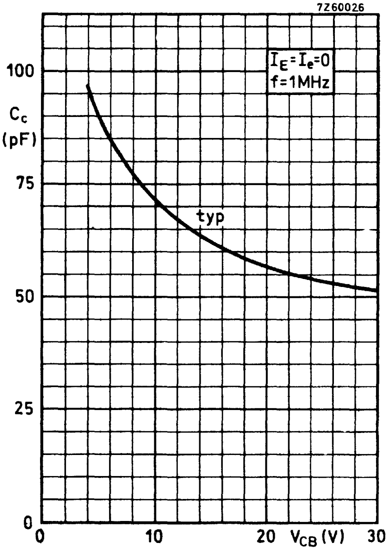
From junction to mounting base	$R_{th\ j\text{-}mb}$	=	2.5	°C/W
From mounting base to heatsink	$R_{th\ mb\text{-}h}$	=	0.3	°C/W

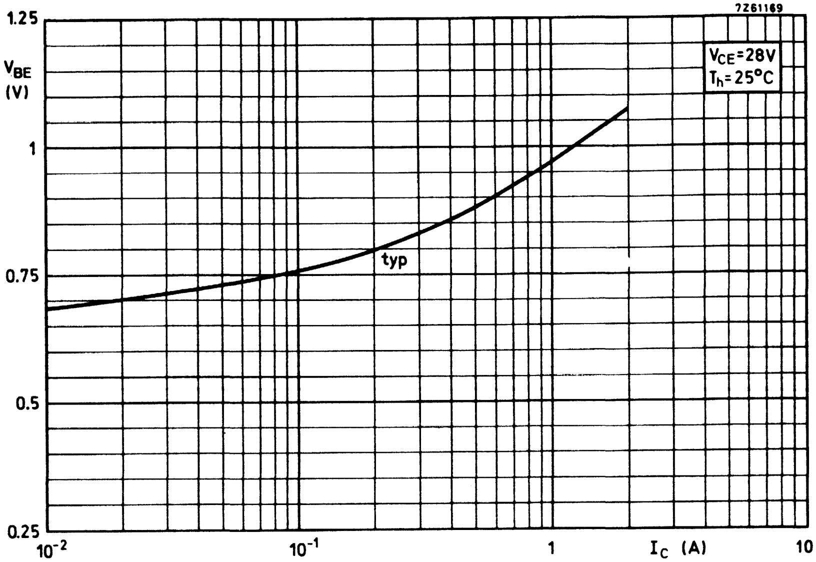
CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Breakdown voltages				
Collector-base voltage open emitter; I_C = 50 mA	$V_{(BR)CBO}$	>	65	V
Collector-emitter voltage open base; I_C = 50 mA	$V_{(BR)CEO}$	>	36	V
Emitter-base voltage open collector; I_E = 10 mA	$V_{(BR)EBO}$	>	4.0	V
Transient energy				
L = 25 mH; f = 50 Hz				
open base	E	>	8	mWs
$-V_{BE}$ = 1.5 V; R_{BE} = 33 Ω	E	>	8	mWs
D.C. current gain				
I_C = 1.0 A; V_{CE} = 5 V	h_{FE}	typ.	50	
			10 to 100	
Transition frequency				
I_C = 3.0 A; V_{CE} = 20 V	f_T	typ.	500	MHz
Collector capacitance at f = 1 MHz				
$I_E = I_e$ = 0; V_{CB} = 30 V	C_c	typ.	50	pF
		<	65	pF
Feedback capacitance				
I_C = 100 mA; V_{CE} = 30 V	$-C_{re}$	typ.	31	pF
Collector-stud capacitance	C_{cs}	typ.	2	pF


7Z60031
600
f_T
(MHz)
400
200
0
0
2
4
6
8
I_C (A)
V_{CE} = 20V
typ


7Z60026
100
C_c
(pF)
75
50
25
0
0
10
20
30
V_{CB} (V)
$I_E = I_e = 0$
f = 1MHz
typ


7Z61169
1.25
V_{BE}
(V)
1
0.75
0.5
0.25
10^{-2}
10^{-1}
1
I_C (A)
10
V_{CE}=28V
T_h=25°C
typ

APPLICATION INFORMATION

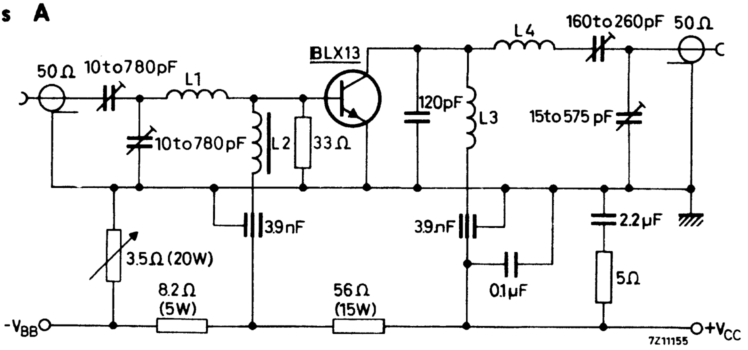
R.F. performance in S.S.B. operation (linear power amplifier)

V_{CE} = 26 V; T_h up to 25 °C
f_1 = 28.000 MHz; f_2 = 28.001 MHz

output power (W)	G_p (dB)	d_3 (dB) 1)	I_C (A)	Class
0-8 (PEP)	> 18	< −40	1.2	A

Test circuit:

S.S.B.
class A



L1 = 3 turns enamelled Cu wire (1.5 mm); winding pitch 2.5 mm; int. diam. 7 mm leads 50 mm totally
L2 = 7 turns enamelled Cu wire (0.7 mm) on 3H1 toroid; 60 μH (code number of 3H1: 4322 020 36620)
L3 = 4 turns enamelled Cu wire (1.5 mm); winding pitch 2.5 mm; int. diam. 10 mm
L4 = 7 turns enamelled Cu wire (1.5 mm); winding pitch 2.5 mm; int. diam. 12 mm

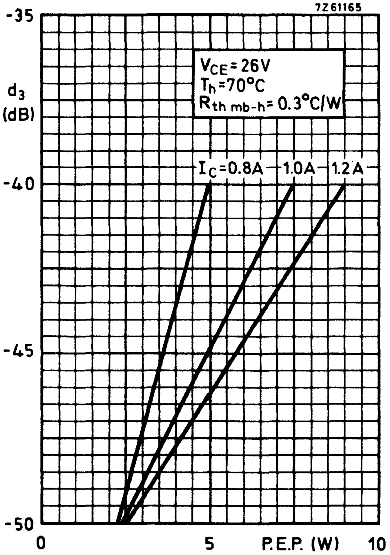
- - - - - - - - - - - - - - - - - - - -

Detailed information for a wide band application
1.6 to 28 MHz available on request

- - - - - - - - - - - - - - - - - - - -

---

1) Stated figures are maxima encountered at any driving level between the specified values of PEP and are referred to the according level of either of the equal ampl. tones. Relative to the according peak envelope power these figures should be increased by 6 dB.


7Z61165
V_{CE} = 26V
T_h = 70°C
$R_{th\ mb-h}$ = 0.3°C/W
I_C = 0.8A
1.0A
1.2A
d_3 (dB)
-35
-40
-45
-50
0
5
P.E.P. (W)
10

APPLICATION INFORMATION

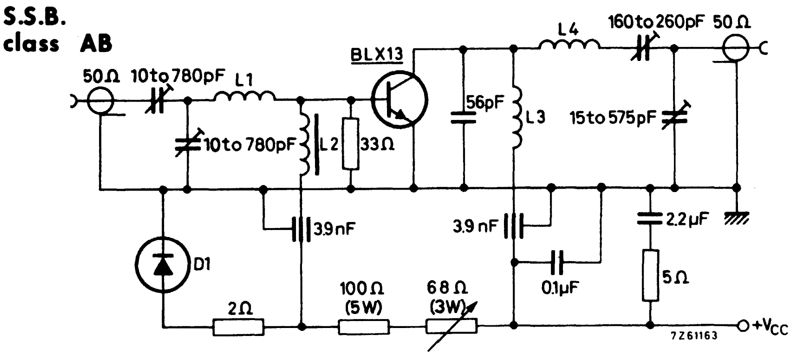
R.F. performance in S.S.B. operation (linear power amplifier)

V_{CC} = 28 V; T_h up to 25 °C

f_1 = 28.000 MHz; f_2 = 28.001 MHz

output power (W)	G_p (dB)	dt (%)	d_3 (dB) ¹)	I_{CZS} (mA)	I_C (A)	Class
25 PEP	> 18	typ. 35	typ. −35	25	typ. 1.28	AB

Test circuit:



D1 = AYY10/120

L1 = 3 turns enamelled Cu wire (1.5 mm); winding pitch 2.5 mm; int. diam. 7 mm
leads 50 mm totally

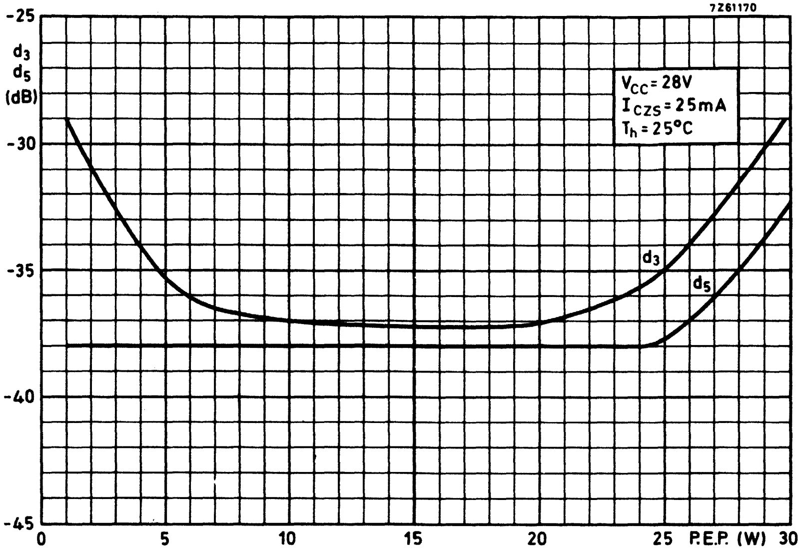
L2 = 7 turns enamelled Cu wire (0.7 mm) on 3H1 toroid; 60 μH
(code number of 3H1: 4322 020 36620)

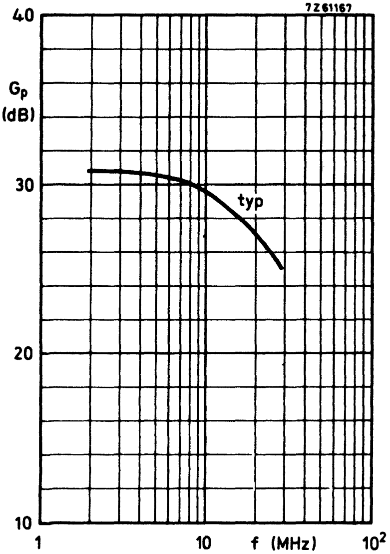
L3 = 4 turns enamelled Cu wire (1.5 mm); winding pitch 2.5 mm; int. diam. 10 mm

L4 = 7 turns enamelled Cu wire (1.5 mm); winding pitch 2.5 mm; int. diam. 12 mm

---

[1] Stated intermodulation distortion figures are referred to the according level of either of the equal amplified tones. Relative to the according peak envelope powers these figures should be increased by 6 dB.





Conditions:

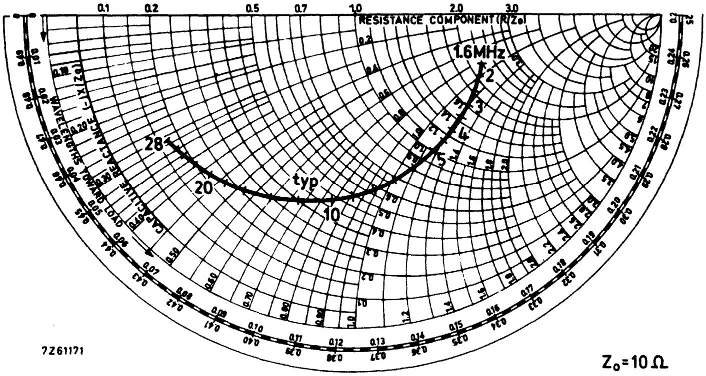
P_L = 25 W PEP

V_{CC} = 28 V

I_{CZS} = 25 mA

Z_L = 12.5 Ω

T_h = 25 °C



Conditions:

P_L = 25 W PEP

V_{CC} = 28 V

I_{CZS} = 25 mA

Z_L = 12.5 Ω

T_h = 25 °C

APPLICATION INFORMATION

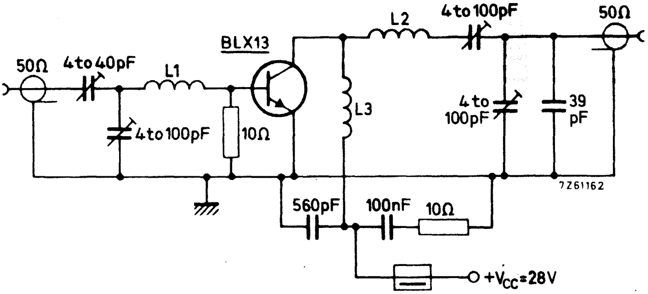
R.F. performance in c.w. operation (class B)

V_{CC} = 28 V; T_h up to 25 °C

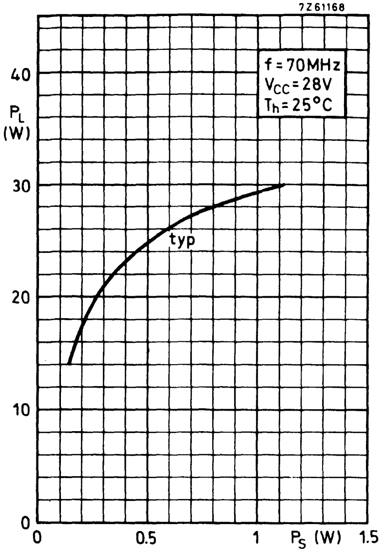
f (MHz)	P_S (W)	P_L (W)	I_C (A)	G_p (dB)	η (%)	$\bar{z}_i$ (Ω)	$\bar{Y}_L$ (mA/V)
70	typ. 0.5	25	typ. 1.49	typ. 17	typ. 60	0.53-j1.4	42.5-j54

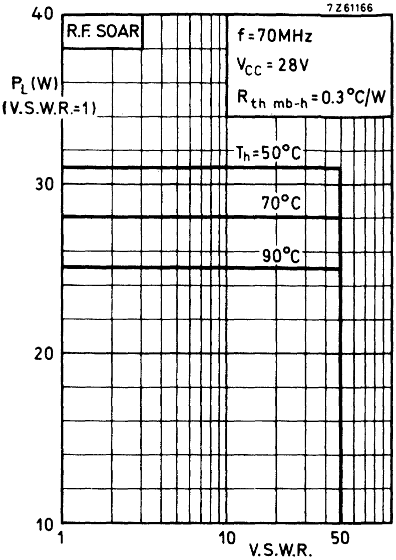
Test circuit:

C.W. class B



L1 = 93 nH; 3 turns enamelled Cu wire (1.5 mm); int. diam. 10 mm; length 8 mm; leads 2 x 5 mm
L2 = 147 nH; 5 turns enamelled Cu wire (1.5 mm); int. diam. 9 mm; length 14 mm; leads 2 x 5 mm
L3 = 118 nH; 4 turns enamelled Cu wire (1.5 mm); int. diam. 9 mm; length 10.5 mm; leads 2 x 5 mm
L4 = FXC choke (code number 4312 020 36640)





For high voltage operation, a stabilized power supply is generally used.
The graph shows the allowable output power under nominal conditions as a function of the V.S.W.R., with heat-sink temperature as parameter.

TRANSMITTING TRANSISTOR

Silicon n-p-n power transistor for use in industrial and military s.s.b. and c.w. equipment operating in the h.f. and v.h.f. band;

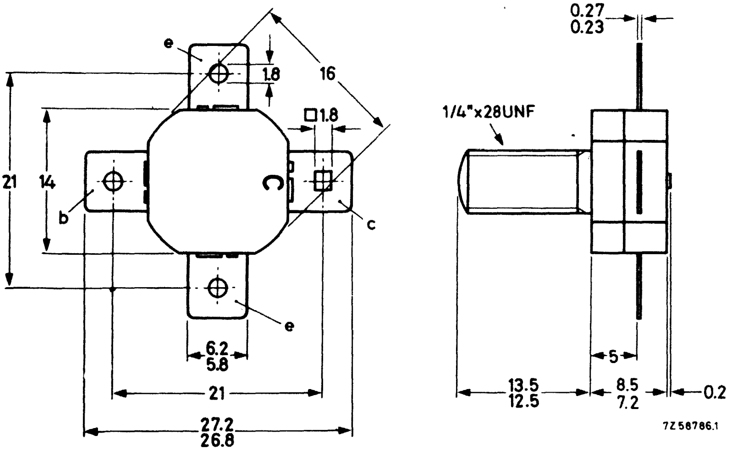
- rated for 50 W PEP at 1.6 MHz to 28 MHz
  (intermodulation distortion better than 30 dB down);
  full load mismatch permissible at stud temperatures up to 70 °C
- rated at 50 W for frequencies up to 70 MHz in c.w. operation
- supply voltage 28 V
- plastic stripline package

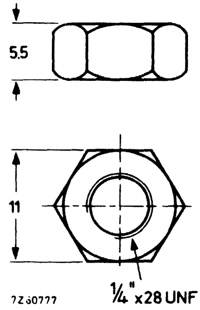
QUICK REFERENCE DATA

Operation	Class	V_{CC} (V)	f (MHz)	P_L (W)	G_p (dB)	d3 (dB)	I_{CZS} (A)
s.s.b.	A	28	1.6 to 28	15 (PEP)	> 13	typ. -40	2.0
s.s.b.	AB	28	1.6 to 28	7.5-50 (PEP)	> 13	< -30	0.1
c.w.	B	28	70	50	> 7.5		
c.w.	B	28	30	50	typ. 16		

MECHANICAL DATA

Dimensions in mm





Torque on nut: min. 23 kg cm
(2.3 Newton metres)
max. 27 kg cm
(2.7 Newton metres)

Diameter of clearance hole in heatsink: max. 6.5 mm.
Mounting hole to have no burrs at either end. De-burring must leave surface flat; do not chamfer or countersink either end of hole.

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

Voltages

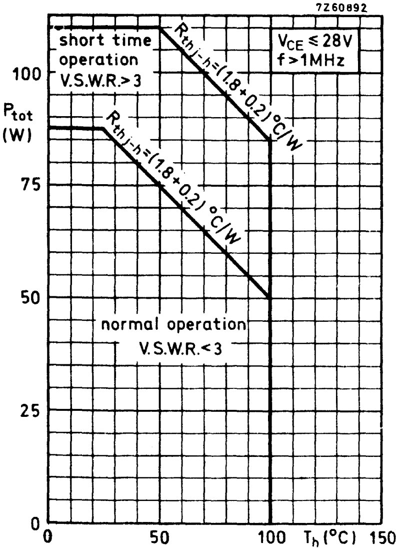
Collector-base voltage (open emitter) peak value	V_{CBOM}	max.	85	V
Collector-emitter voltage (R_{BE} = 10 Ω) peak value	V_{CERM}	max.	85	V
Collector-emitter voltage (open base)	V_{CEO}	max.	36	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4.0	V

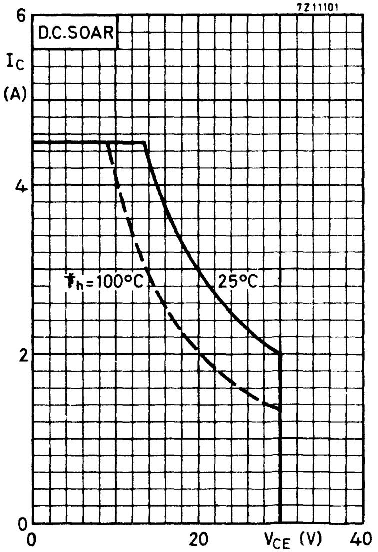
Currents

Collector current (average)	I_{CAV}	max.	4.0	A
Collector current (peak value) f > 1 MHz	I_{CM}	max.	12	A

Power dissipation

Total power dissipation up to T_h = 25 °C f > 1 MHz	P_{tot}	max.	88	W





Temperature

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

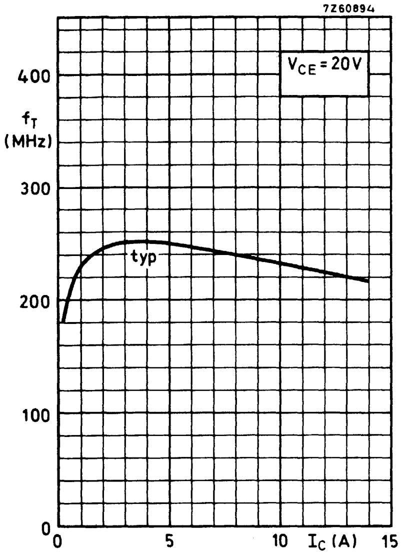
THERMAL RESISTANCE

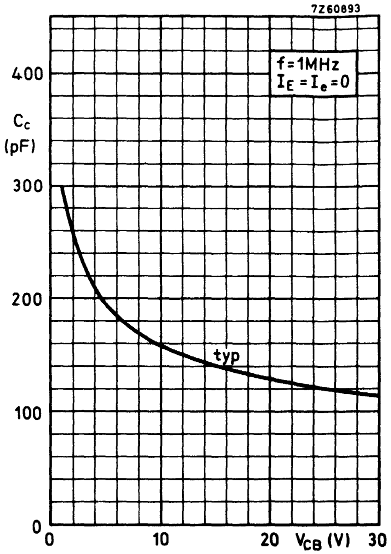
From junction to mounting base	$R_{th\ j-mb}$	=	1.8	°C/W
From mounting base to heatsink	$R_{th\ mb-h}$	=	0.2	°C/W

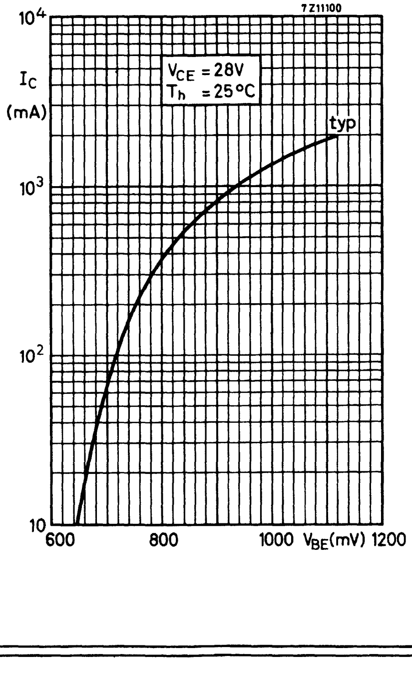
CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Breakdown voltages				
Collector-base voltage open emitter; I_C = 25 mA	$V_{(BR)CBO}$	>	85	V
Collector-emitter voltage R_{BE} = 10 Ω; I_C = 25 mA	$V_{(BR)CER}$	>	85	V
Collector-emitter voltage open base; I_C = 50 mA	$V_{(BR)CEO}$	>	36	V
Emitter-base voltage open collector; I_E = 10 mA	$V_{(BR)EBO}$	>	4.0	V
Collector-emitter saturation voltage				
I_C = 0.7 A; I_B = 0.14 A	V_{CEsat}	<	1.0	V
Transient energy				
L = 25 mH; f = 50 Hz				
open base	E	>	8	mWs
$-V_{BE}$ = 1.5 V; R_{BE} = 33 Ω	E	>	8	mWs
D.C. current gain				
I_C = 1.4 A; V_{CE} = 6 V	h_{FE}	15 to 100		
Transition frequency				
I_C = 3.0 A; V_{CE} = 10 V	f_T	typ.	250	MHz
Collector capacitance at f = 1 MHz				
$I_E = I_e$ = 0; V_{CB} = 30 V	C_c	typ. <	115 125	pF pF
Feedback capacitance at f = 1 MHz				
I_C = 100 mA; V_{CE} = 30 V	$-C_{re}$	typ.	90	pF
Collector-stud capacitance	C_{cs}	typ.	3.5	pF


7Z60894
$V_{CE} = 20V$
400
f_T
(MHz)
300
typ
200
100
0
0
5
10
I_C (A)
15


7Z60893
f = 1MHz
$I_E = I_e = 0$
400
C_c
(pF)
300
200
typ
100
0
0
10
20
V_{CB} (V)
30


7Z11100
10^4
I_C
(mA)
$V_{CE} = 28V$
$T_h = 25°C$
typ
10^3
10^2
10
600
800
1000
V_{BE}(mV)
1200

APPLICATION INFORMATION

R.F. performance in S.S.B. operation (linear power amplifier)

V_{CC} = 28 V; T_h up to 25 °C

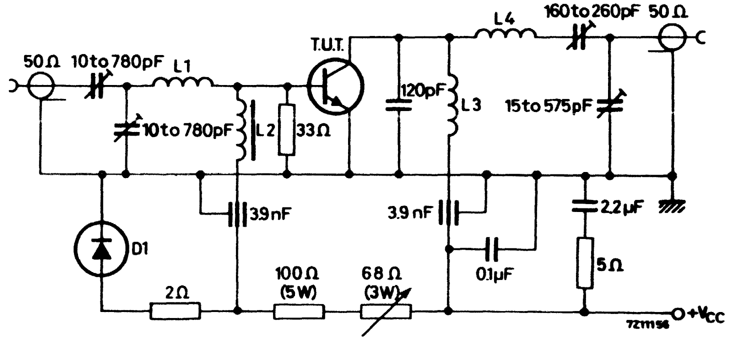
f_1 = 28.000 MHz; f_2 = 28.001 MHz

output power (W)	G_p (dB)	η_{dt} (%)	d_3 (dB) [1]	d_5 (dB) [1]	I_{CZS} (A)	I_C (A)	Class
7.5 to 50 (PEP)	>13	>35	< −30	< −30	0.1	<2.55	AB

At temperatures up to 90 °C the output power relative to that at 25 °C is diminished by a factor −40 mW/°C

The transistor is designed to withstand a full load mismatch operating under 50 W PEP at V_{CC} = 28 V and T_h = 70 °C

Test circuit:
S.S.B.
class A-B



D1 = AYY10/120

L1 = 3 turns enamelled Cu wire (1.5 mm); winding pitch 2.5 mm; int. diam. 7 mm leads 50 mm totally

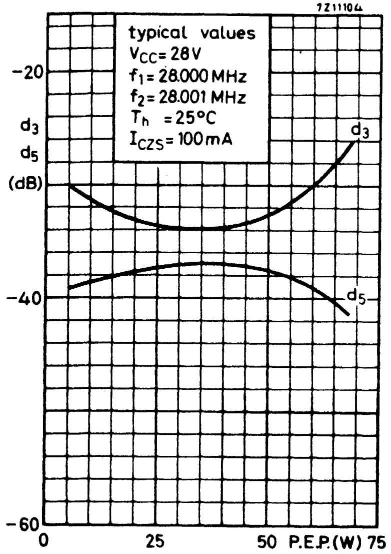
L2 = 7 turns enamelled Cu wire (0.7 mm) on 3H1 toroid; 60 μH (code number of 3H1: 4322 020 36620)

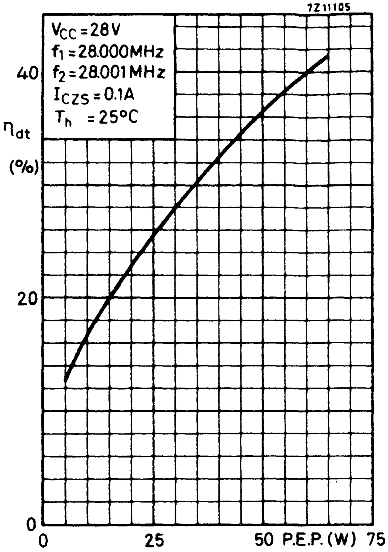
L3 = 4 turns enamelled Cu wire (1.5 mm); winding pitch 2.5 mm; int. diam. 10mm

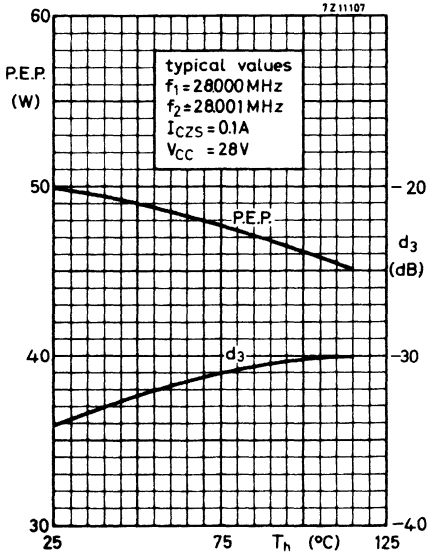
L4 = 7 turns enamelled Cu wire (1.5 mm); winding pitch 2.5 mm; int. diam. 12mm

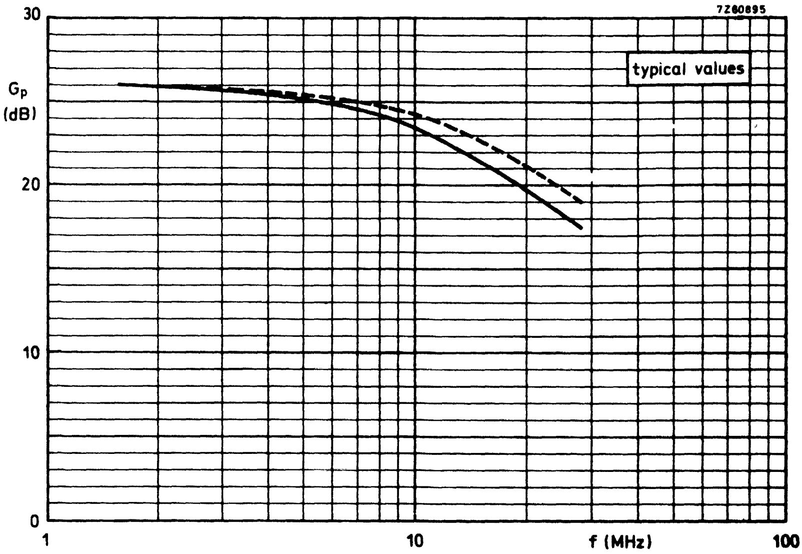
---

[1] Stated figures are maxima encountered at any driving level between the specified values of PEP and are referred to the according level of either of the equal ampl. tones. Relative to the according peak envelope power these figures should be increased by 6 dB.


7Z11104
typical values
V_{CC} = 28 V
f_1 = 28.000 MHz
f_2 = 28.001 MHz
T_h = 25°C
I_{CZS} = 100 mA
d_3
d_5
(dB)
−20
−40
−60
d_3
d_5
0
25
50
P.E.P. (W)
75


7Z11105
V_{CC} = 28 V
f_1 = 28.000 MHz
f_2 = 28.001 MHz
I_{CZS} = 0.1 A
T_h = 25°C
η_{dt}
(%)
40
20
0
0
25
50
P.E.P. (W)
75


7Z11107
typical values
f_1 = 28.000 MHz
f_2 = 28.001 MHz
I_{CZS} = 0.1 A
V_{CC} = 28 V
P.E.P.
(W)
60
50
40
30
P.E.P.
d_3
d_3
(dB)
−20
−30
−40
25
75
T_h (°C)
125

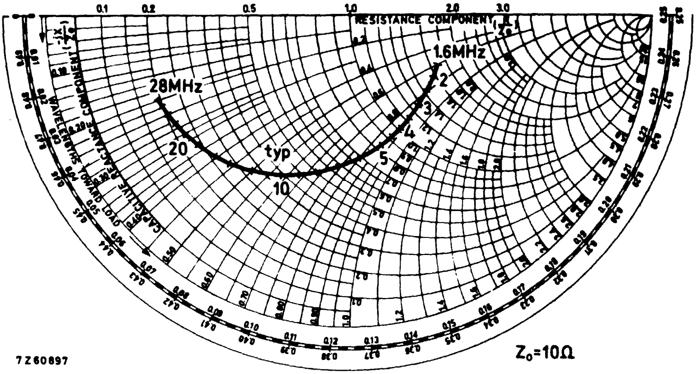


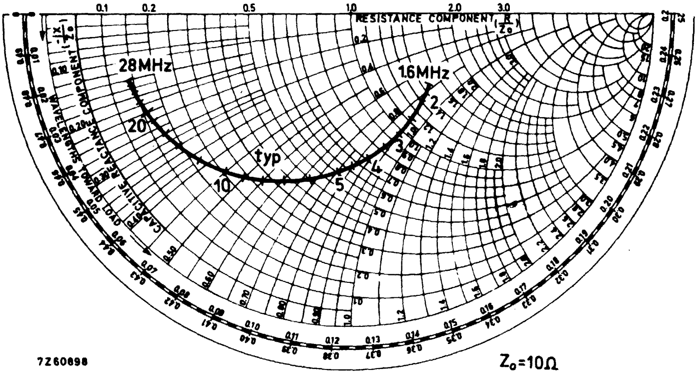
S.S.B. class AB operation

P_L = 50 W PEP
V_{CC} = 28 V
I_C = 100 mA
Z_L = 6.25 Ω
T_h = 25 °C

The drawn curve holds for an unneutralized amplifier.

The dashed curve holds for a push-pull amplifier with cross neutralization.
Collector-base neutralizing capacitor: 82 pF





S.S.B. class AB operation

P_L = 50 W PEP
V_{CC} = 28 V
I_C = 100 mA
Z_L = 6.25 Ω
T_h = 25 °C

The upper graph holds for a push-pull amplifier with cross neutralization.
Collector-base neutralizing capacitor: 82 pF

The lower graph holds for an unneutralized amplifier.

APPLICATION INFORMATION (continued)

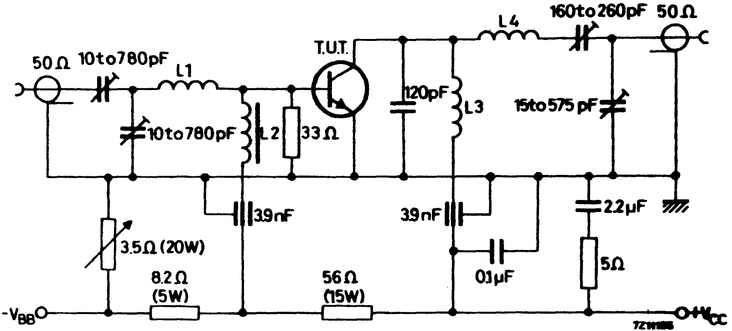
R.F. performance in S.S.B. operation (linear power amplifier)

V_{CC} = 28 V; T_h up to 25 °C
f_1 = 28.000 MHz; f_2 = 28.001 MHz

output power (W)	G_p (dB)	d_3 (dB) 1)	d_5 (dB) 1)	I_C (A)	Class
15 PEP	> 13	typ. −40	typ. −45	2.0	A

Test circuit:

S.S.B. class A

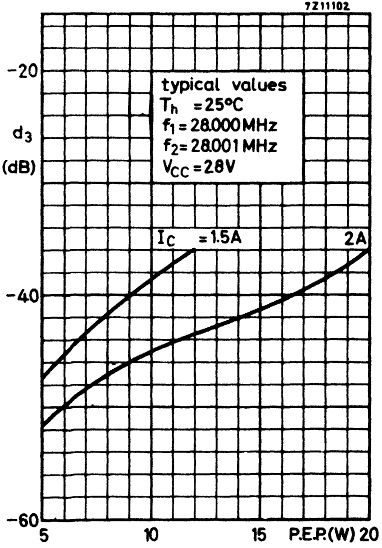


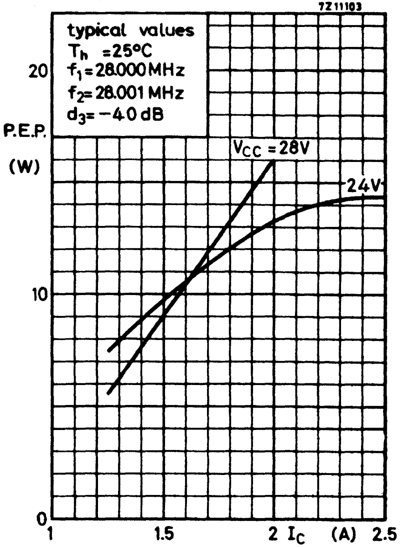
L1 = 3 turns enamelled Cu wire (1.5 mm); winding pitch 2.5 mm; int. diam. 7 mm
leads 50 mm totally

L2 = 7 turns enamelled Cu wire (0.7 mm) on 3H1 toroid; 60 µH
(code number of 3H1: 4322 020 36620)

L3 = 4 turns enamelled Cu wire (1.5 mm); winding pitch 2.5 mm; int. diam. 10 mm

L4 = 7 turns enamelled Cu wire (1.5 mm); winding pitch 2.5 mm; int. diam. 12 mm





APPLICATION INFORMATION

R.F. performance in c.w. operation (class B)

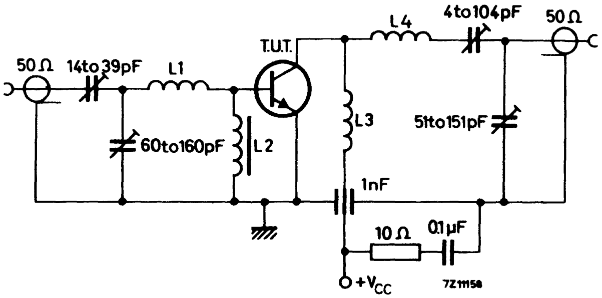
V_{CC} = 28 V; T_h up to 25 °C

f (MHz)	P_S (W)	P_L (W)	I_C (A)	G_p (dB)	η (%)	$\bar{z}_i$ (Ω)	$\bar{Y}_L$ (mA/V)
70	< 8.9	50	< 3.25	> 7.5	> 55	1.0+j0.2	115-j77
50	typ. 4	50	typ. 3.25	typ. 11	typ. 55	0.9-j0.5	104-j85
30	typ. 1.2	50	typ. 3.25	typ. 16	typ. 55	0.75-j1.6	89-j101

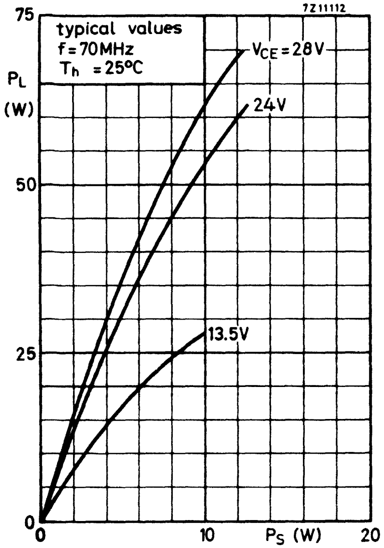
At temperatures up to 90 °C the output power relative to that at 25 °C is diminished by a factor −40 mW/°C.

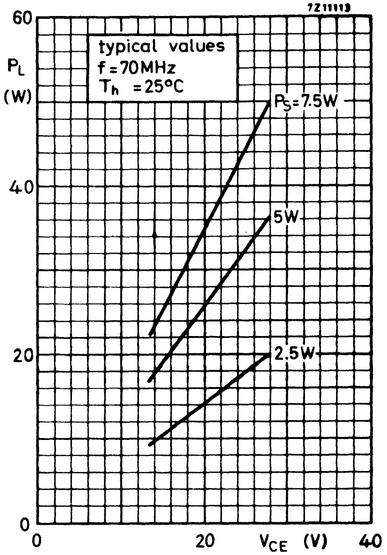
Test circuit:

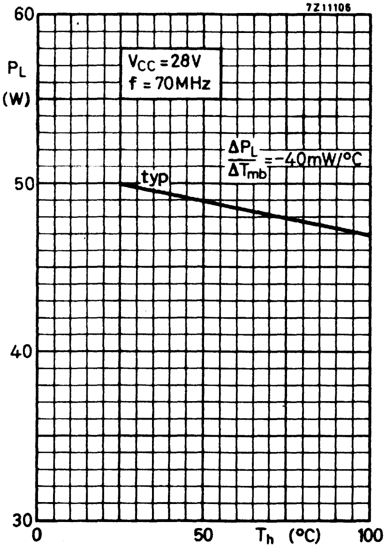
C.W.
70 MHz



L1 = 60 mm straight enamelled Cu wire (1.5 mm); 9 mm above chassis
L2 = FXC choke coil (code number 4322 020 36640)
L3 = 2 turns enamelled Cu wire (1.5 mm); winding pitch 2 mm; int. diam. 10 mm
leads 55 mm totally
L4 = 3 turns enamelled Cu wire (1.5 mm); winding pitch 2.5 mm; int. diam. 10 mm
leads 50 mm totally


7Z11112
typical values
f = 70MHz
T_h = 25°C
P_L
(W)
V_{CE} = 28V
24V
13.5V
75
50
25
0
0
10
P_S (W)
20

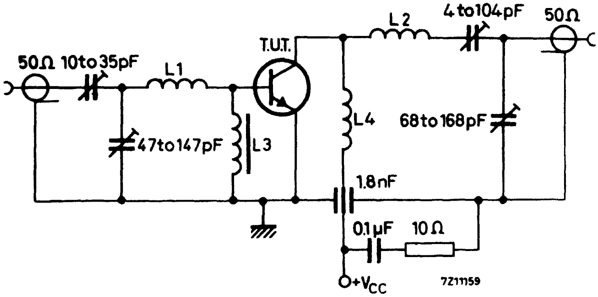

7Z11113
typical values
f = 70MHz
T_h = 25°C
P_L
(W)
P_S = 7.5W
5W
2.5W
60
40
20
0
0
20
V_{CE} (V)
40


7Z11106
V_{CC} = 28V
f = 70MHz
P_L
(W)
$\frac{\Delta P_L}{\Delta T_{mb}} = -40$mW/°C
typ
60
50
40
30
0
50
T_h (°C)
100

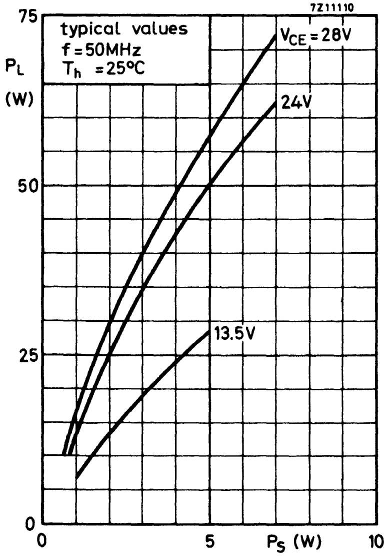
APPLICATION INFORMATION (continued)

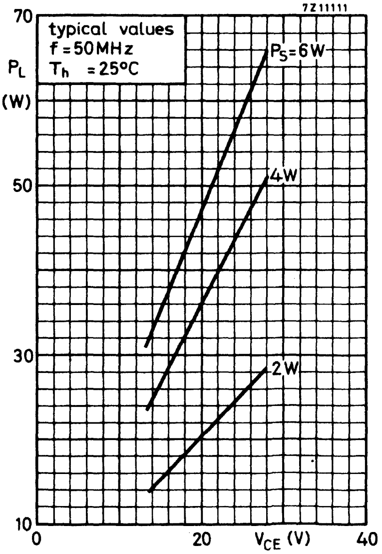
Test circuit:

C.W.
50 MHz



L1 = 1 turn enamelled Cu wire (1.5 mm); int. diam. 10 mm; leads 40 mm totally
L2 = 4 turns enamelled Cu wire (1.5 mm); int. diam. 12 mm; leads 40 mm totally
winding pitch 2 mm
L3 = FXC choke coil (code number 4322 020 36640)
L4 = 3 turns enamelled Cu wire (1.5 mm); int. diam. 10 mm; leads 40 mm totally
winding pitch 2 mm

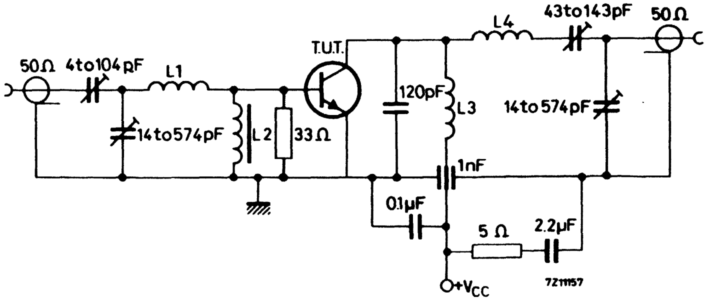




APPLICATION INFORMATION (continued)

Test circuit :

C.W.
30 MHz

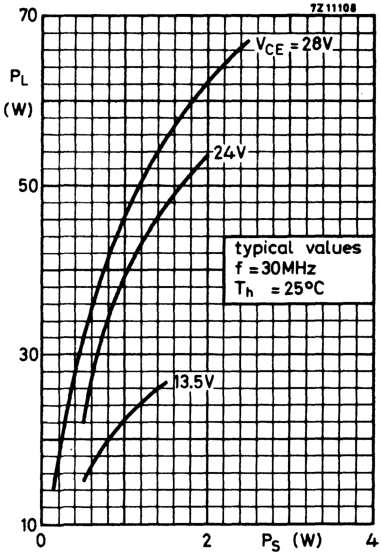


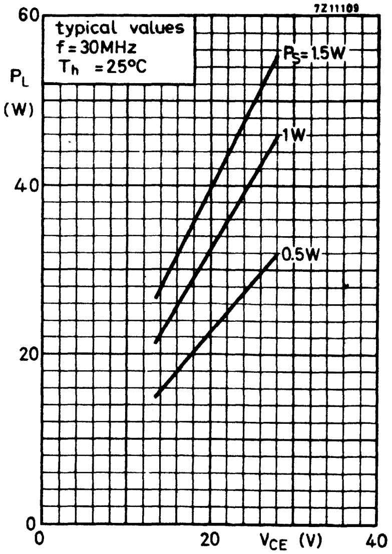
L1 = 2 turns enamelled Cu wire (1.5 mm); winding pitch 2 mm; int. diam. 10 mm leads 60 mm totally

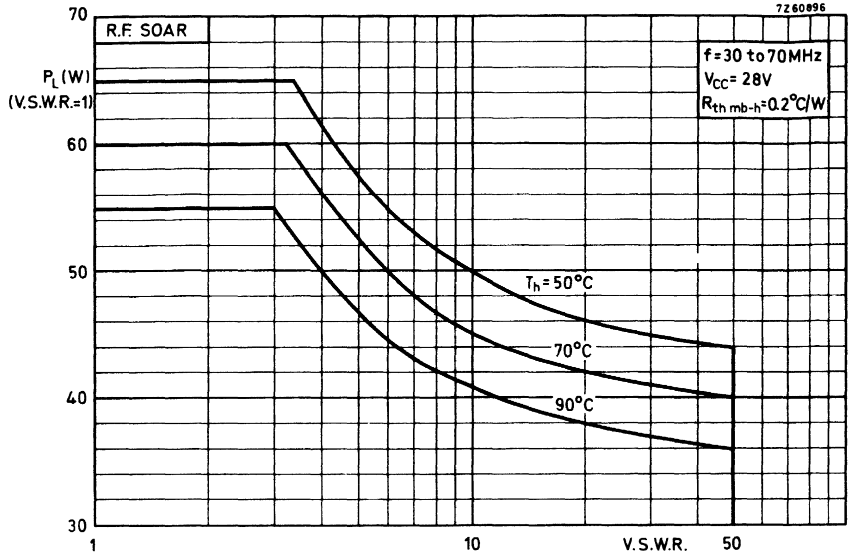
L2 = 7 turns enamelled Cu wire (0.7 mm) on 3H1 toroid; 60 μH (code number of 3H1: 4322 020 36620)

L3 = 4 turns enamelled Cu wire (1.5 mm); winding pitch 2 mm; int. diam. 10 mm leads 50 mm totally

L4 = 6 turns enamelled Cu wire (1.5 mm); winding pitch 2 mm; int. diam. 12 mm leads 50 mm totally







For high voltage operation, a stabilized power supply is generally used.
The graph shows the allowable output power under nominal conditions as a function of the V.S.W.R., with heatsink temperature as parameter.

U.H.F./V.H.F. TRANSMITTING TRANSISTOR

N-P-N transistor intended for use in class B and C operated mobile, industrial and military transmitters with a supply voltage of 13.8 V. It has a TO-39 metal envelope with the collector connected to the case.

QUICK REFERENCE DATA

R.F. performance up to T_{case} = 25 °C in an unneutralized common-emitter class B circuit.

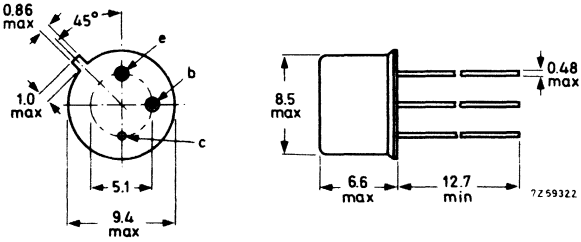
Mode of operation	V_{CC} (V)	f (MHz)	P_S (W)	P_L (W)	I_C (A)	G_p (dB)	η (%)	$\bar{z}_i$ (Ω)	$\bar{Y}_L$ (mA/V)
c.w.	13.8	470	typ. 0.4	2.0	typ. 0.22	typ. 7	typ. 66	5 + j10	16 − j50
c.w.	12.5	470	< 0.5	2.0	< 0.25	> 6	> 65	−	−
c.w.	12.5	175	typ. 0.12	2.0	typ. 0.21	typ. 12	typ. 75	−	−

MECHANICAL DATA

Dimensions in mm

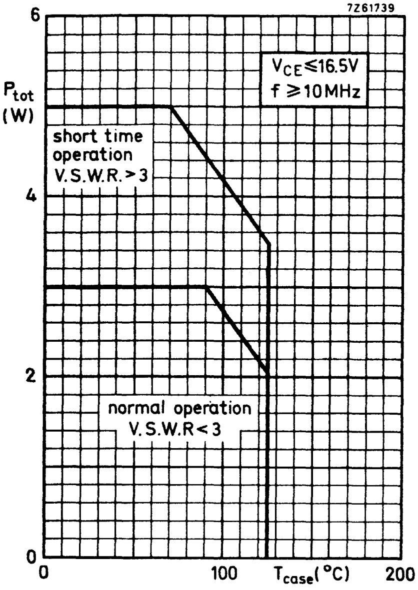
TO-39

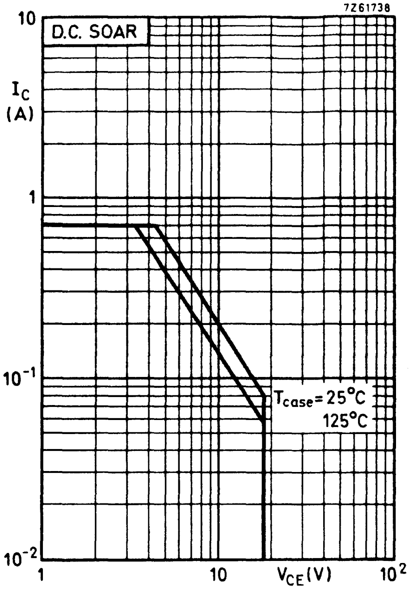
Collector connected to case



Max. lead diameter guaranteed only for 12.7 mm

Accessories supplied on request: 56218, 56245, 56265.


7Z61739
Ptot
(W)
6
4
2
0
0
100
Tcase(°C)
200
VCE≤16.5V
f≥10MHz
short time
operation
V.S.W.R.>3
normal operation
V.S.W.R<3


7Z61738
D.C. SOAR
IC
(A)
10
1
10⁻¹
10⁻²
1
10
VCE(V)
10²
Tcase=25°C
125°C

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

Voltages

Collector-base voltage (open emitter) peak value	V_{CBOM}	max.	36	V
Collector-emitter voltage ($V_{BE} = 0$) peak value	V_{CESM}	max.	36	V
Collector-emitter voltage (open base)	V_{CEO}	max.	18	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4	V

Currents

Collector current (average)	$I_{C(AV)}$	max.	0.7	A
Collector current (peak value) f > 1 MHz	I_{CM}	max.	2.0	A

Power dissipation

Total power dissipation up to $T_{case} = 90$ °C f > 10 MHz	P_{tot}	max.	3.0	W

Temperatures

Storage temperature	T_{stg}	-65 to +150		°C
Operating junction temperature	T_j	max	165	°C

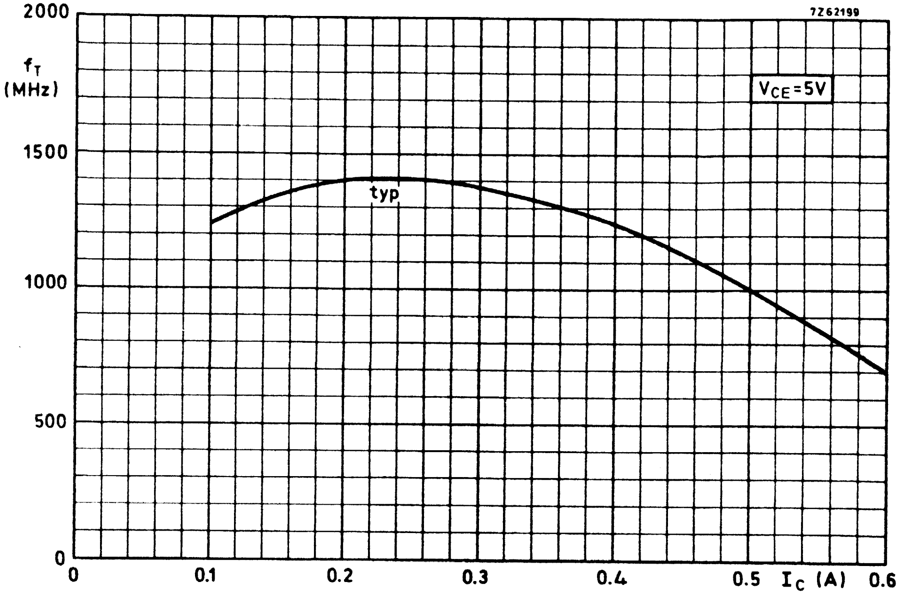
THERMAL RESISTANCE

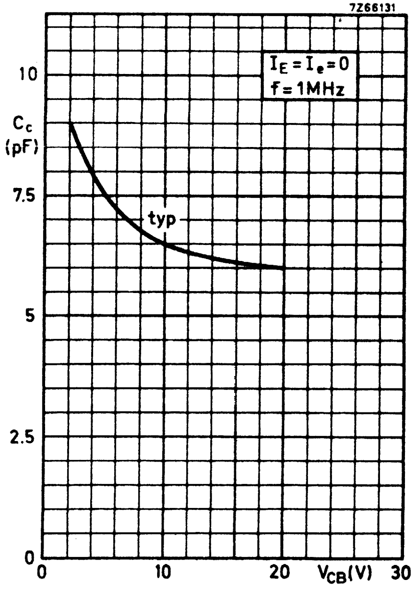
From junction to case	$R_{th\ j-c}$	=	25	°C/W
From mounting base to heatsink with a boron nitride washer for electrical insulation	$R_{th\ mb-h}$	=	2.5	°C/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Breakdown voltages				
Collector-base voltage open emitter, I_C = 10 mA	$V_{(BR)CBO}$	>	36	V
Collector-emitter voltage V_{BE} = 0; I_C = 10 mA	$V_{(BR)CES}$	>	36	V
Collector-emitter voltage open base, I_C = 25 mA	$V_{(BR)CEO}$	>	18	V
Emitter-base voltage open collector, I_E = 1.0 mA	$V_{(BR)EBO}$	>	4	V
Collector-emitter saturation voltage				
I_C = 100 mA; I_B = 20 mA	V_{CEsat}	typ.	0.1	V
D.C. current gain				
I_C = 100 mA; V_{CE} = 5 V	h_{FE}	> typ.	10 40	
Transition frequency				
I_C = 200 mA; V_{CE} = 5 V; f = 500 MHz	f_T	typ.	1400	MHz
Collector capacitance at f = 1 MHz				
$I_E = I_e$ = 0; V_{CB} = 10 V	C_c	typ. <	6.5 9.0	pF pF
Feedback capacitance at f = 1 MHz				
I_C = 20 mA; V_{CE} = 10 V	$-C_{re}$	typ.	4.8	pF


7Z62199
2000
f_T
(MHz)
1500
1000
500
0
0
0.1
0.2
0.3
0.4
0.5
I_C (A)
0.6
$V_{CE} = 5V$
typ


7Z66131
10
C_c
(pF)
7.5
5
2.5
0
0
10
20
V_{CB}(V)
30
$I_E = I_e = 0$
f = 1MHz
typ

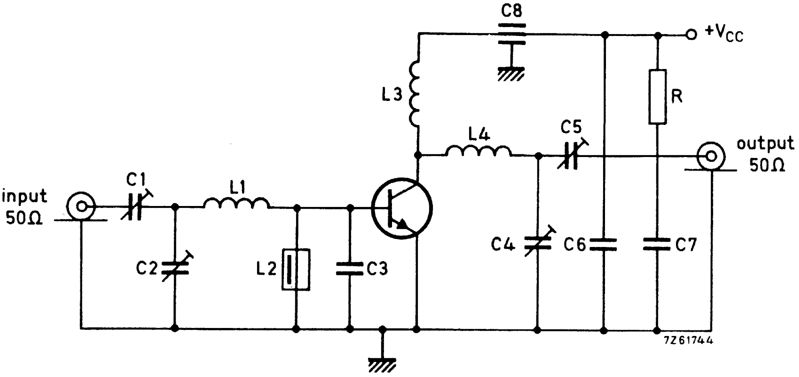
APPLICATION INFORMATION

R.F. performance in c.w. operation (unneutralized common-emitter class B circuit)

T_{case} up to 25 °C

f (MHz)	V_{CC} (V)	P_S (W)	P_L (W)	I_C (A)	G_p (dB)	η (%)	$\overline{z}_i$ (Ω)	$\overline{Y}_L$ (mA/V)
470	13.8	typ. 0.4	2.0	typ. 0.22	typ. 7	typ. 66	5 + j10	16 − j50
470	12.5	< 0.5	2.0	< 0.25	< 6	> 65	–	–
→ 175	12.5	typ. 0.12	2.0	typ. 0.21	typ. 12	typ. 75	–	–

Test circuit:



To obtain optimum gain performance the emitter lead length should not exceed 1.6 mm

C1 = C2 = C4 = C5 =	1.8 to 18 pF film dielectric trimmer
C3 =	22 pF disc ceramic capacitor
C6 =	10 nF ceramic capacitor
C7 =	0.1 μF polyester capacitor
C8 =	4 nF feed-through capacitor

L1 = 1 turn Cu wire (1 mm); int. diam. 5 mm, max. lead length 1 mm
L2 = 0.22 μH choke
L3 = 1 turn Cu wire (1 mm); int. diam. 7 mm; lead length 2 mm
L4 = 1 turn Cu wire (1 mm); int. diam. 5 mm; lead length 2 mm

R = 10 Ω carbon

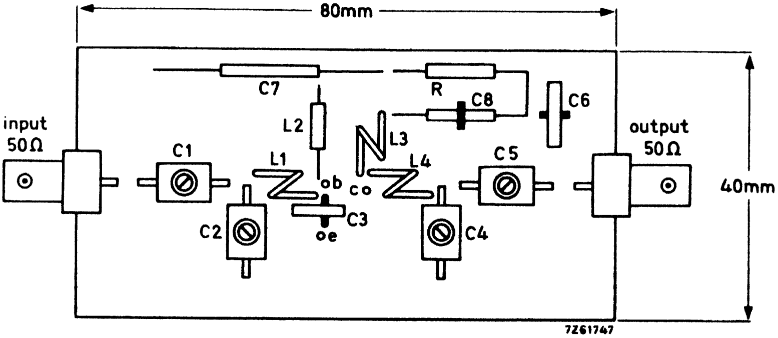
At P_L = 2.0 W and V_{CC} = 12.5 V the output power at case temperatures between 25 °C and 90 °C relative to that at 25 °C is diminished by typ. 5 mW/°C.

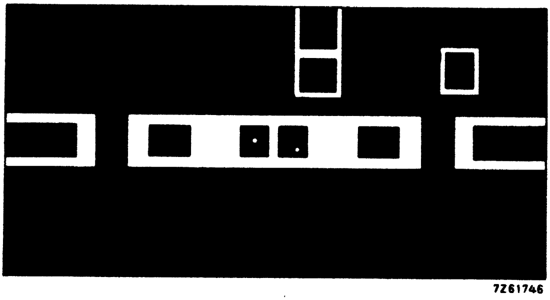
The transistor is designed to withstand full load mismatch in the test circuit under the following conditions: V_{CC} = 16.5 V; f = 470 MHz; T_{case} = 70 °C
V.S.W.R. = 50 : 1 through all phases; $P_S = P_{Snom} + 20\ \%$
where $P_{Snom} = P_S$ for 1.4 W transistor output into 50 Ω load at V_{CC} = 13.8 V.

Component lay-out for 470 MHz see page 7.

APPLICATION INFORMATION (continued)

Component lay-out and printed circuit board for 470 MHz test circuit.

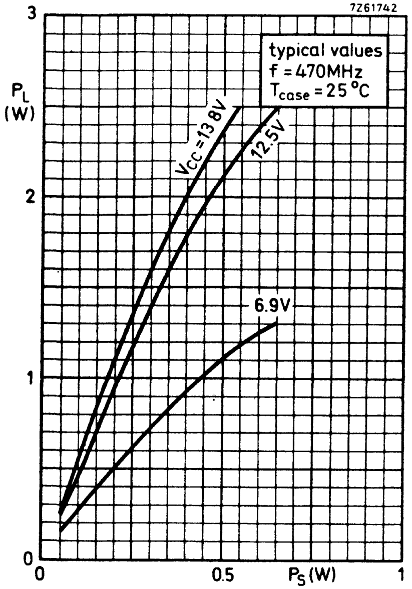


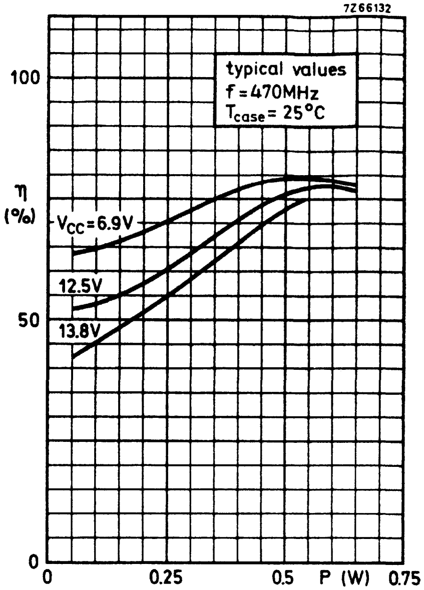


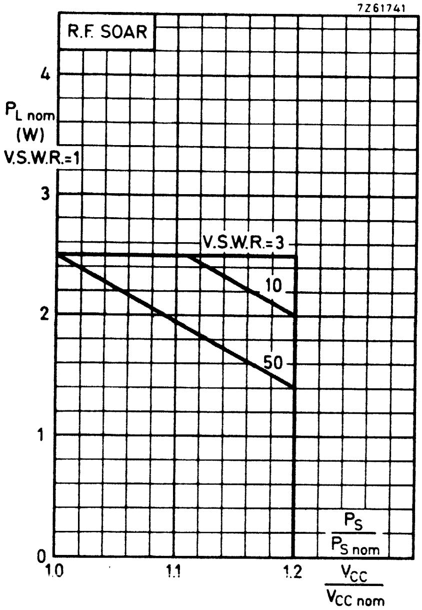
Shaded area copper

Back area not metalized

Material of printed circuit board: 1.5 mm epoxy fibre-glass


7Z61742
typical values
f = 470MHz
T_{case} = 25 °C
P_L (W)
3
2
1
0
V_{CC} = 13.8V
12.5V
6.9V
0
0.5
P_S (W)
1


7Z66132
typical values
f = 470MHz
T_{case} = 25°C
η (%)
100
50
0
V_{CC} = 6.9V
12.5V
13.8V
0
0.25
0.5
P (W)
0.75



Conditions for R.F. SOAR

f = 470 MHz

T_{case} = 70 °C

V_{CCnom} = 13.8 V

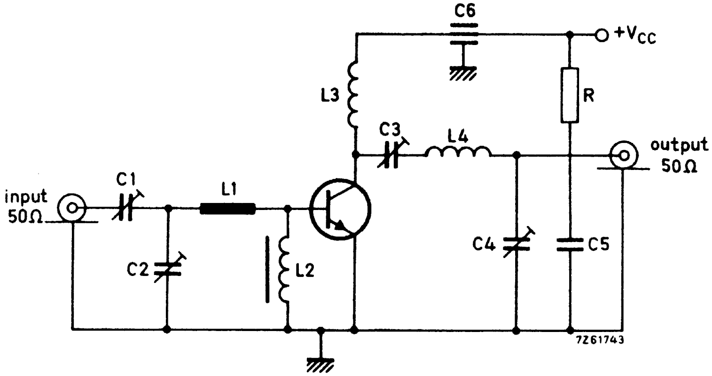
$P_{Snom} = P_S$ at $V_{CC} = V_{CCnom}$ and V.S.W.R. = 1

see also page 6

The transistor was developed for use with unstabilized supply voltage V_{CC}. The above graph is based on its measured performance in the circuit given on page 6. Supply voltage was varied from V_{CCnom} to 1.2 V_{CCnom}, and V.S.W.R. from 1 to 50. It shows the maximum allowable output power under nominal conditions in order not to exceed the maximum allowable power dissipation under conditions of supply overvoltage ($V_{CC} > V_{CCnom}$) and load mismatch (V.S.W.R. > 1). It is assumed that the drive power increases linearly with the supply voltage; i.e. $P_S/P_{Snom} = V_{CC}/V_{CCnom}$.

APPLICATION INFORMATION (continued)

Test circuit for 175 MHz



To obtain optimum gain performance the emitter lead length should not exceed 1.6 mm

C1 = C4 = 60 pF concentric air trimmer
C2 = C3 = 30 pF concentric air trimmer
C5 = 0.25 μF polyester capacitor
C6 = 4 nF feed-through capacitor

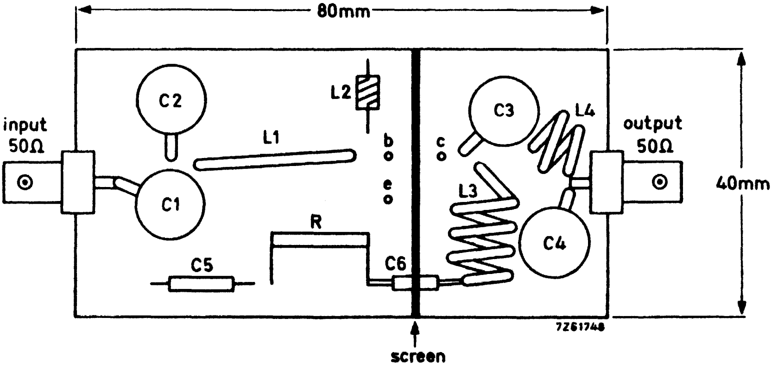
L1 = 25 mm straight Cu wire (1.2 mm); height above print 3 mm
L2 = 3 turns Cu wire (0.5 mm) on ferrite FX1115, d = 2 mm, D = 4 mm, 1 = 5 mm, material 3B (code number 3113 991 16740)
L3 = 5 turns closely wound Cu wire (1.2 mm); int. diam. 10 mm; lead length 5 mm
L4 = 3 turns closely wound Cu wire (1.2 mm); int. diam. 10 mm; lead length 5 mm

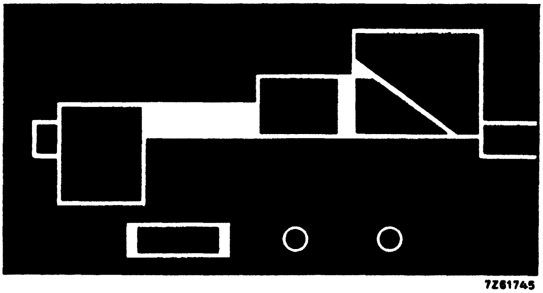
R = 10 Ω carbon

Component lay-out for 175 MHz see page 11.

APPLICATION INFORMATION (continued)

Component lay-out and printed cicuit board for 175 MHz test circuit:

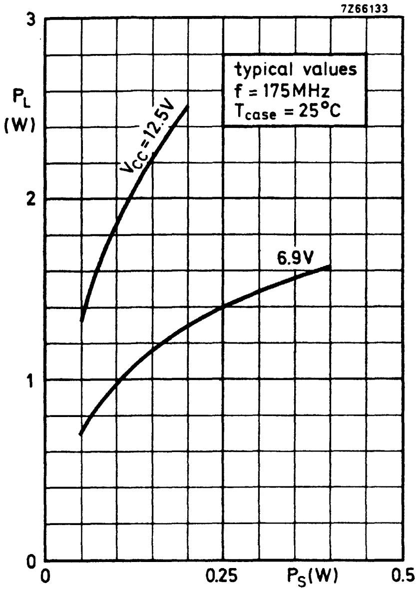


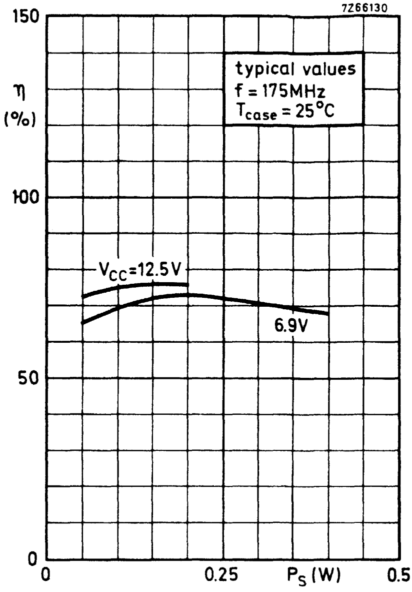


Shaded area copper

Back area not metallized

Material of printed circuit board: 1.5 mm epoxy fibre-glass


7Z66133
typical values
f = 175MHz
Tcase = 25°C
PL
(W)
VCC=12.5V
6.9V
0
1
2
3
0
0.25
PS(W)
0.5


7Z66130
typical values
f = 175MHz
Tcase = 25°C
η
(%)
VCC=12.5V
6.9V
0
50
100
150
0
0.25
PS (W)
0.5

U.H.F./V.H.F. TRANSMITTING TRANSISTOR

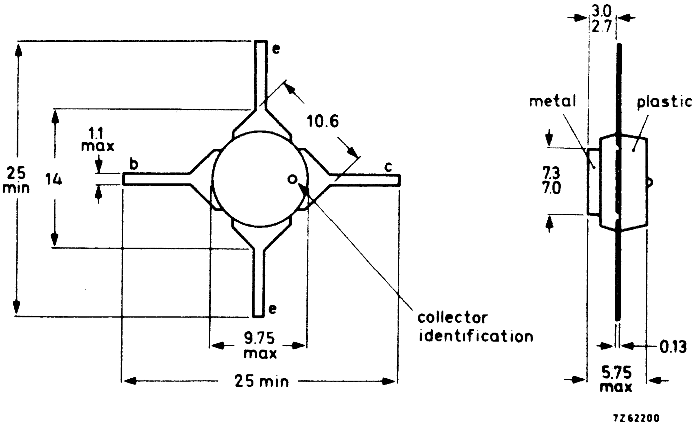
N-P-N transistor intended for use in class B and C operated mobile, industrial and military transmitters with a supply voltage of 13.8 V. It has a capstan envelope with a moulded cap. All leads are isolated from the stud.

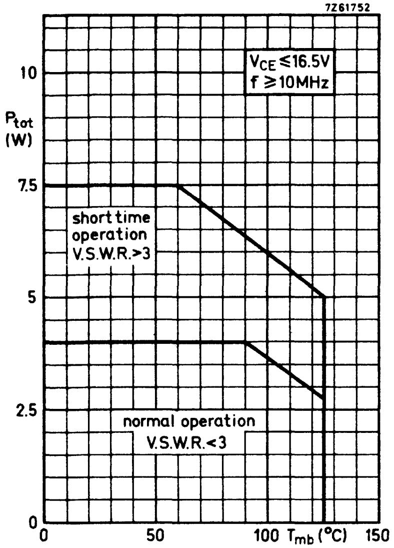
QUICK REFERENCE DATA

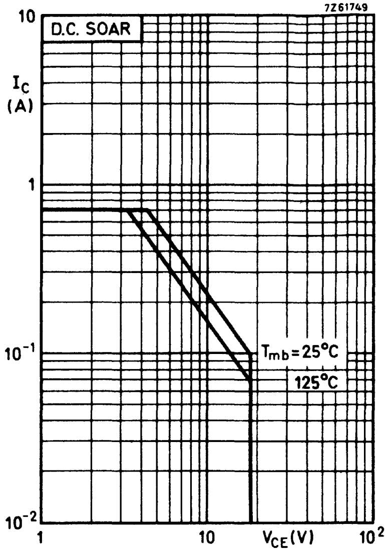
R.F. performance up to T_{mb} = 25 °C in an unneutralized common-emitter class B circuit.

Mode of operation	V_{CC} (V)	f (MHz)	P_S (W)	P_L (W)	I_C (A)	G_p (dB)	η (%)	$\bar{z}_i$ (Ω)	$\bar{Y}_L$ (mA/V)
c.w.	13.8	470	typ. 0.15	1.5	typ. 0.17	typ. 10	typ. 65	-	-
c.w.	13.8	470	typ. 0.28	2.5	typ. 0.24	typ. 9.5	typ. 75	2.5 + j4.5	23 - j35
c.w.	12.5	470	< 0.35	2.5	< 0.31	> 8.5	> 65	-	-
c.w.	12.5	175	typ. 0.03	3.0	typ. 0.29	typ. 20	typ. 84	2.4 - j3.8	35 - j40

MECHANICAL DATA Dimensions in mm




7Z61752
$V_{CE} \leq 16.5V$
$f \geq 10MHz$
P_{tot} (W)
10
7.5
5
2.5
0
short time operation V.S.W.R.>3
normal operation V.S.W.R.<3
0
50
100
T_{mb} (°C)
150


7Z61749
D.C. SOAR
I_C (A)
10
1
10^{-1}
10^{-2}
T_{mb} = 25°C
125°C
1
10
V_{CE} (V)
10^2

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

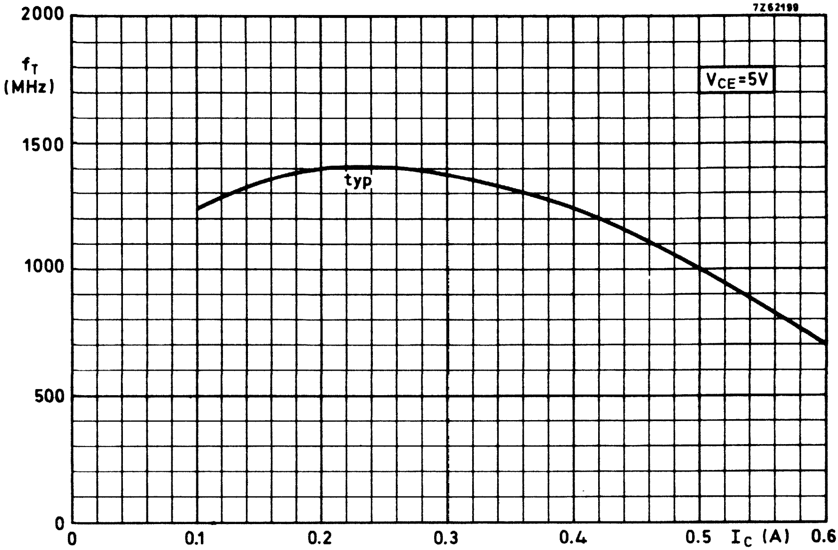
Voltages				
Collector-base voltage (open emitter) peak value	V_{CBOM}	max.	36	V
Collector-emitter voltage (R_{BE} = 0) peak value	V_{CESM}	max.	36	V
Collector-emitter voltage (open base)	V_{CEO}	max.	18	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4	V
Currents				
Collector current (average)	$I_{C(AV)}$	max.	0.7	A
Collector current (peak value) f > 1 MHz	I_{CM}	max.	2.0	A
Power dissipation				
Total power dissipation up to T_{mb} = 90 °C f > 10 MHz	P_{tot}	max.	4.0	W
Temperatures				
Storage temperature	T_{stg}		-65 to +150	°C
Junction temperature	T_j	max.	150	°C

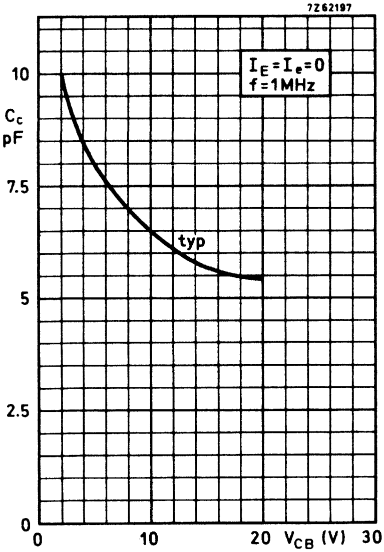
THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	12	°C/W

CHARACTERISTICS T_j = 25 °C unless otherwise specified

Breakdown voltages				
Collector-base voltage open emitter, I_C = 10 mA	$V_{(BR)CBO}$	>	36	V
Collector-emitter voltage V_{BE} = 0; I_C = 10 mA	$V_{(BR)CES}$	>	36	V
Collector-emitter voltage open base, I_C = 25 mA	$V_{(BR)CEO}$	>	18	V
Emitter-base voltage open collector, I_E = 1.0 mA	$V_{(BR)EBO}$	>	4	V
Collector-emitter saturation voltage				
I_C = 100 mA; I_B = 20 mA	V_{CEsat}	typ.	0.1	V
D.C. current gain				
I_C = 100 mA; V_{CE} = 5 V	h_{FE}	> typ.	10 40	
Transition frequency				
I_C = 200 mA; V_{CE} = 5 V; f = 500 MHz	f_T	typ.	1400	MHz
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; V_{CB} = 10 V	C_c	typ. <	6.5 9.0	pF pF
Feedback capacitance at f = 1MHz				
I_C = 20 mA; V_{CE} = 10 V	$-C_{re}$	typ.	4.8	pF
Collector-stud capacitance	C_{cs}	typ.	2	pF


7Z62199
2000
f_T
(MHz)
1500
1000
500
0
0
0.1
0.2
0.3
0.4
0.5
I_C (A)
0.6
V_{CE}=5V
typ


7Z62197
10
C_c
pF
7.5
5
2.5
0
0
10
20
V_{CB} (V)
30
I_E=I_e=0
f=1MHz
typ

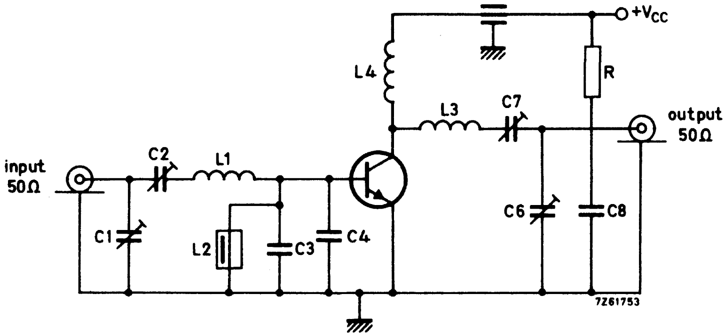
APPLICATION INFORMATION

R.F.performance in c.w. operation (unneutralized common-emitter class B circuit)

T_{mb} = 25 °C

f (MHz)	V_{CC} (V)	P_S (W)	P_L (W)	I_C (A)	G_p (dB)	η (%)	$\bar{z}_i$ (Ω)	$\bar{Y}_L$ (mA/V)
470	13.8	typ. 0.15	1.5	typ. 0.17	typ. 10	typ. 65	-	-
470	13.8	typ. 0.28	2.5	typ. 0.24	typ. 9.5	typ. 75	2.5 + j 4.5	23 - j35
470	12.5	< 0.35	2.5	< 0.31	> 8.5	> 65	-	-
175	12.5	typ. 0.03	3.0	typ. 0.29	typ. 20	typ. 84	2.4 - j 3.8	35 - j40

Test circuit for 470 MHz:



C1 = C2 = C6 = C7 = 1.8 to 18 pF film dielectric trimmer
C3 = C4 = 18 pF disc ceramic capacitor
C5 = 4 nF feed-through capacitor
C8 = 0.1 µF polyester capacitor

L1 = 1 turn Cu wire (1.2 mm); int. diam. 6 mm; max. lead length 1 mm.
L2 = 1 µH choke
L3 = 30 mm straight Cu wire (2 mm); height above print 2 mm.
L4 = 2 turns closely wound Cu wire (0.5 mm); int. diam. 3 mm; max. lead length 8 mm.

R = 10 Ω carbon

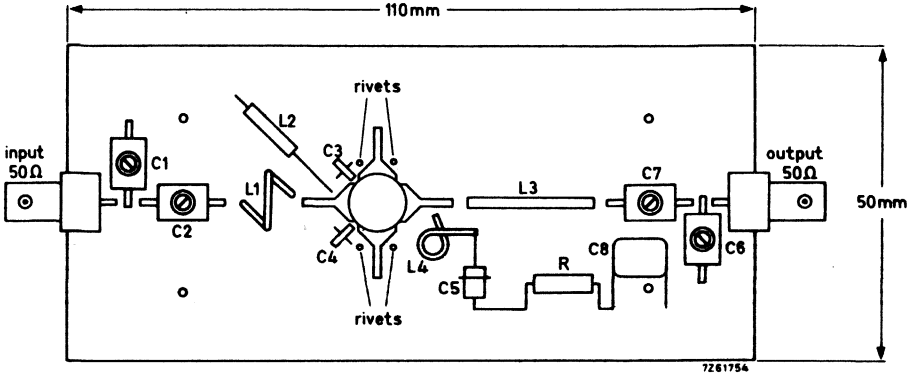
At P_L = 2.5 W and V_{CC} = 12.5 V the output power at mounting-base temperatures between 25 °C and 90 °C relative to that at 25 °C is diminished by typ. 5 mW/°C

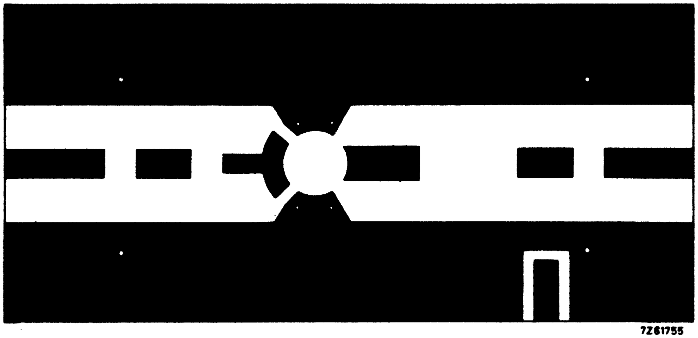
The transistor is designed to withstand full load mismatch in the test circuit under the following conditions: V_{CC} = 16.5 V; f = 470 MHz; T_{mb} = 70 °C;
V.S.W.R. = 50 : 1 through all phases; P_S = P_{Snom} + 20 %
where P_{Snom} = P_S for 2.5 W transistor output into 50 Ω load at V_{CC} = 13.8 V

Component lay-out for 470 MHz see page 7

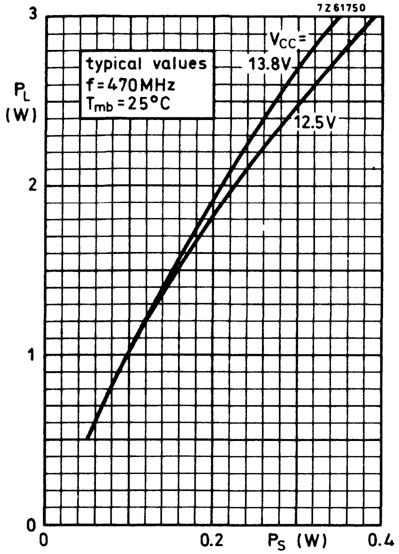
APPLICATION INFORMATION (continued)

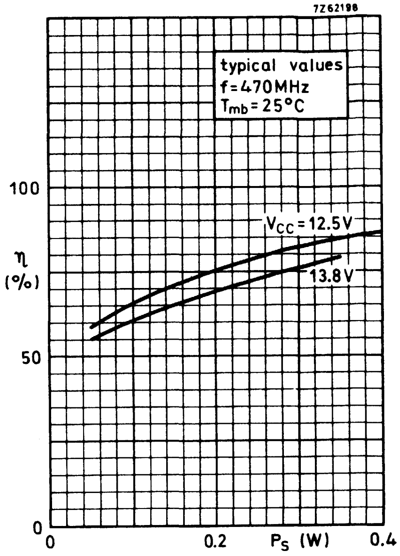
Component lay-out and printed circuit board for 470 MHz test circuit.

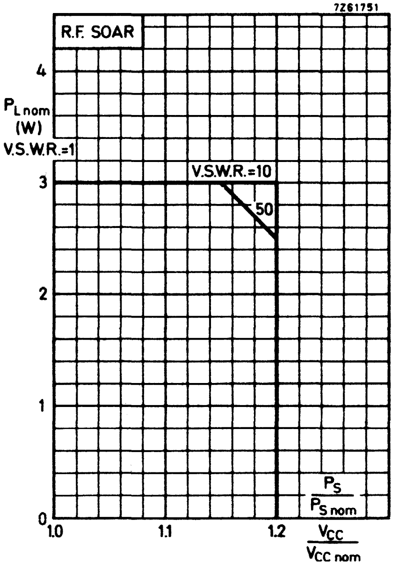




Shaded area copper
Back area completely copper clad
Material of printed circuit board: 1.5 mm epoxy fibre glass


7Z61750
typical values
f=470MHz
T_{mb}=25°C
V_{CC}=
13.8V
12.5V
P_L
(W)
3
2
1
0
0
0.2
P_S (W)
0.4


7Z62198
typical values
f=470MHz
T_{mb}=25°C
V_{CC}=12.5V
13.8V
η
(%)
100
50
0
0
0.2
P_S (W)
0.4



Conditions for R.F. SOAR

f = 470 MHz $P_{Snom} = P_S$ at $V_{CC} = V_{CCnom}$ and V.S.W.R. = 1

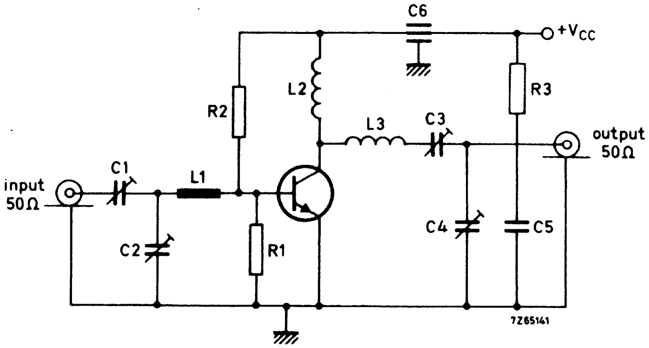
T_{mb} = 70 °C

V_{CCnom} = 13.8 V see also page 6

The transistor was developed for use with unstabilized supply voltage V_{CC}.
The above graph is based on its measured performance in the circuit given on page 6. Supply voltage was varied from V_{CCnom} to 1.2 V_{CCnom}, and V.S.W.R. from 1 to 50. It shows the max. allowable output power under nominal conditions in order not to exceed the max. allowable power dissipation under conditions of supply overvoltage ($V_{CC} > V_{CCnom}$) and load mismatch (V.S.W.R. > 1).
It is assumed that the drive power increases linearly with the supply voltage; i.e. $P_S/P_{Snom} = V_{CC}/V_{CCnom}$.

APPLICATION INFORMATION (continued)

Test circuit for 175 MHz:



C1 = C3 = C4 = 30 pF concentric air trimmer
C2 = 60 pF concentric air trimmer
C5 = 0.25 μF polyester capacitor
C6 = 4 nF feed-through capacitor

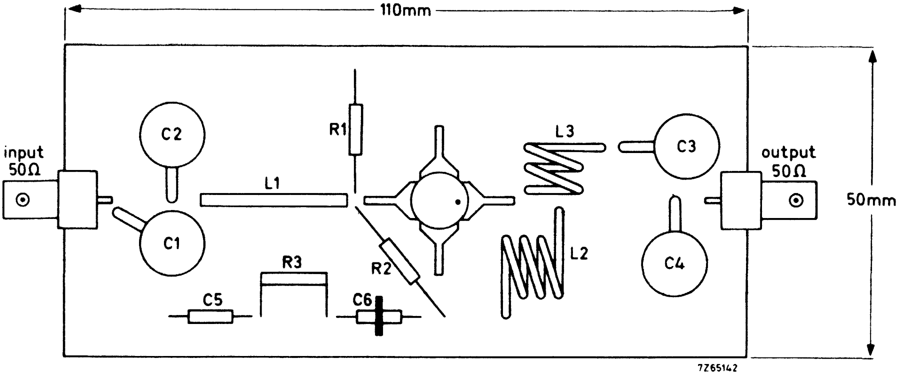
L1 = 25 mm straight Cu wire (1.2 mm); height above print max. 3 mm
L2 = 3 turns closely wound Cu wire (1.2 mm); int. diam. 10 mm; max. lead lenght 5 mm
L3 = 2 turns closely wound Cu wire (1.7 mm); int. diam. 12 mm; max. lead lenght 5 mm

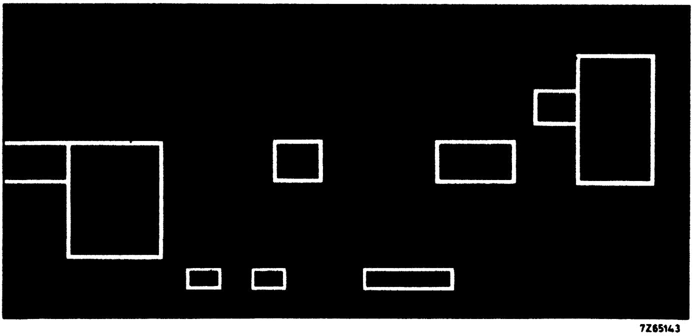
R1 = 50 Ω carbon
R2 = 1.2 kΩ carbon
R3 = 5 Ω carbon

Component lay-out for 175 MHz see page 11.

APPLICATION INFORMATION (continued)

Component lay-out and printed circuit board for 175 MHz test circuit.





Shaded area copper
Back area not metallized
Material of printed circuit board: 1.5 mm epoxy fibre glass

U.H.F./V.H.F. TRANSMITTING TRANSISTOR

N-P-N transistor intended for use in class B and C operated mobile, industrial and military transmitters with a supply voltage of 13.8 V. It has a capstan envelope with a moulded cap. All leads are isolated from the stud.

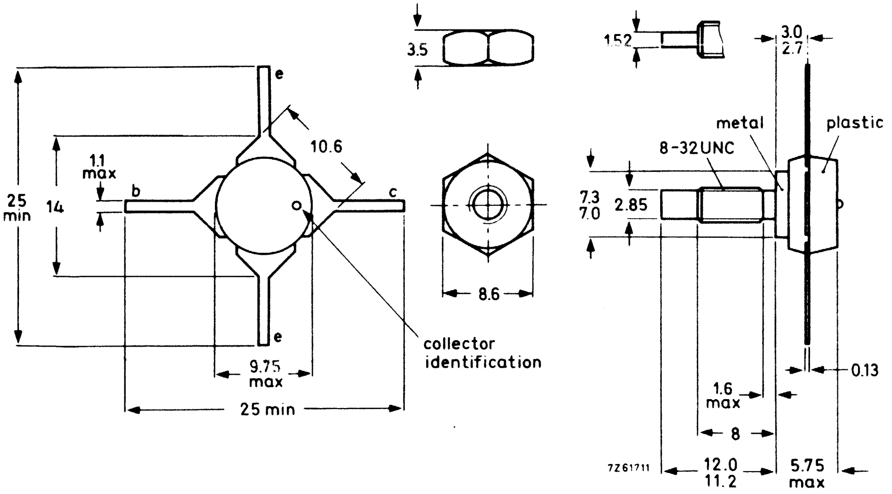
QUICK REFERENCE DATA

R.F. performance up to T_h = 25 °C in an unneutralized common-emitter class B circuit

Mode of operation	V_{CC} (V)	f (MHz)	P_S (W)	P_L (W)	I_C (A)	G_p (dB)	η (%)	$\bar{z}_i$ (Ω)	$\bar{Y}_L$ (mA/V)
c.w.	13.8	470	typ. 0.15	1.5	typ. 0.17	typ. 10	typ. 65	-	-
c.w.	13.8	470	typ. 0.35	3.0	typ. 0.28	typ. 9.3	typ. 79	3.0+j5.0	27 - j38
c.w.	12.5	470	< 0.35	2.5	< 0.31	> 8.5	> 65	-	-
c.w.	12.5	175	typ. 0.03	3.0	typ. 0.29	typ. 20	typ. 84	2.4 - j3.8	35 - j40

MECHANICAL DATA

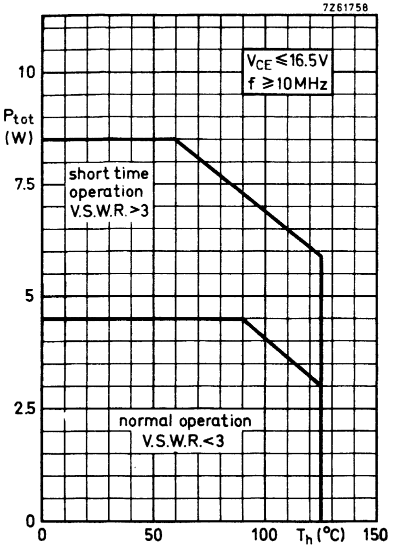
Dimensions in mm

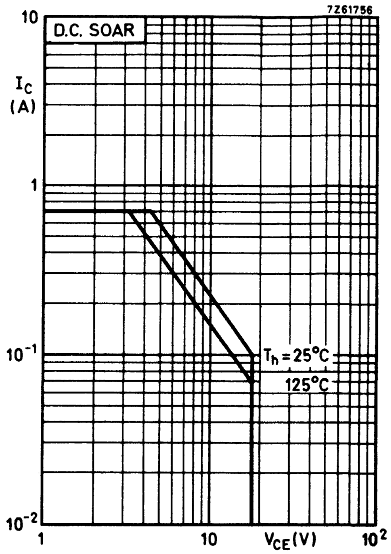


When locking is required an adhesive instead of a lock washer is preferred

Torque on nut: min. 7.5 kg cm
(0.75 Newton metres)
max. 8.5 kg cm
(0.85 Newton metres)

Diameter of clearance hole in heatsink: max. 4.17 mm.
Mounting hole to have no burrs at either end
De-burring must leave surface flat; do not chamfer or countersink either end of hole.


7Z61758
10
P_tot
(W)
7.5
5
2.5
0
0
50
100
T_h (°C)
150
V_CE ≤ 16.5 V
f ≥ 10 MHz
short time
operation
V.S.W.R. > 3
normal operation
V.S.W.R. < 3


7Z61756
D.C. SOAR
10
I_C
(A)
1
10⁻¹
10⁻²
1
10
V_CE (V)
10²
T_h = 25°C
125°C

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

Voltages

Collector-base voltage (open emitter) peak value	V_{CBOM}	max.	36	V
Collector-emitter voltage (R_{BE} = 0) peak value	V_{CESM}	max.	36	V
Collector-emitter voltage (open base)	V_{CEO}	max.	18	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4	V

Currents

Collector current (average)	$I_{C(AV)}$	max.	0.7	A
Collector current (peak value) f > 1 MHz	I_{CM}	max.	2.0	A

Power dissipation

Total power dissipation up to T_h = 90 °C f > 10 MHz	P_{tot}	max.	4.5	W

Temperature

Storage temperature	T_{stg}	−65 to	+150	°C
Junction temperature	T_j	max.	150	°C

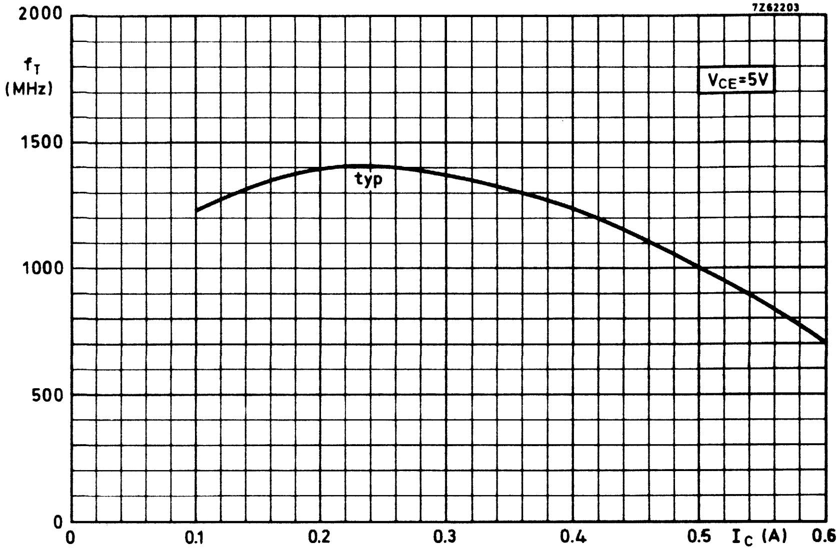
THERMAL RESISTANCE

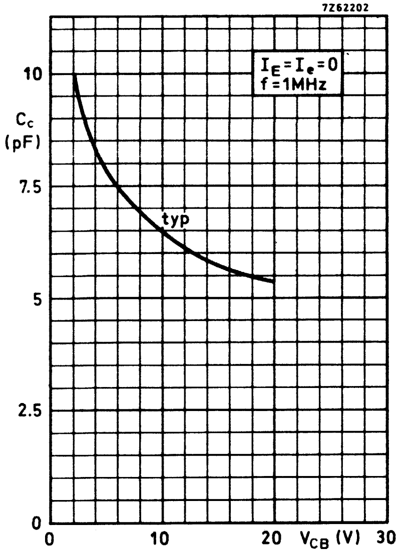
From junction to mounting base	$R_{th\ j\text{-}mb}$ =	12	°C/W
From mounting base to heatsink	$R_{th\ mb\text{-}h}$ =	0.6	°C/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Breakdown voltages				
Collector-base voltage open emitter, I_C = 10 mA	$V_{(BR)CBO}$	>	36	V
Collector-emitter voltage V_{BE} = 0; I_C = 10 mA	$V_{(BR)CES}$	>	36	V
Collector-emitter voltage open base, I_C = 25 mA	$V_{(BR)CEO}$	>	18	V
Emitter-base voltage open collector, I_E = 1.0 mA	$V_{(BR)EBO}$	>	4	V
Collector-emitter saturation voltage				
I_C = 100 mA; I_B = 20 mA	V_{CEsat}	typ.	0.1	V
D.C. current gain				
I_C = 100 mA; V_{CE} = 5 V	h_{FE}	> typ.	10 40	
Transition frequency				
I_C = 0.2 A; V_{CE} = 5 V; f = 500 MHz	f_T	typ.	1400	MHz
Collector capacitance at f = 1 MHz				
I_E = I_e = 0; V_{CB} = 10 V	C_c	typ. <	6.5 9.0	pF pF
Feedback capacitance at f = 1 MHz				
I_C = 20 mA; V_{CE} = 10 V	$-C_{re}$	typ.	4.8	pF
Collector-stud capacitance	C_{cs}	typ.	2	pF


7Z62203
2000
f_T
(MHz)
1500
1000
500
0
0
0.1
0.2
0.3
0.4
0.5
I_C (A)
0.6
V_{CE}=5V
typ


7Z62202
10
C_c
(pF)
7.5
5
2.5
0
0
10
20
V_{CB} (V)
30
$I_E = I_e = 0$
f = 1MHz
typ

APPLICATION INFORMATION

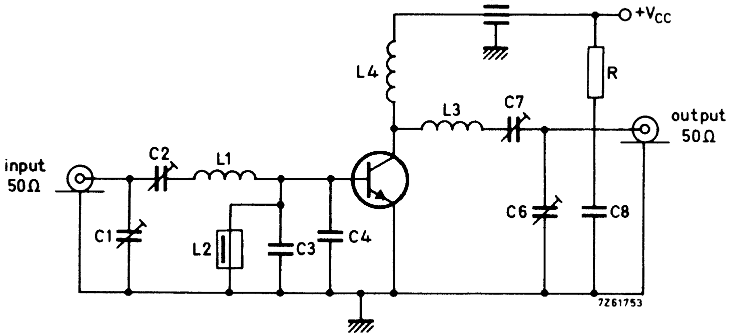
T_j = 25 °C unless otherwise specified

R.F. performance in c.w. operation (unneutralized common-emitter class B circuit)

T_h up to 25 °C

f (MHz)	V_{CC} (V)	P_S (W)	P_L (W)	I_C (A)	G_p (dB)	η (%)	$\bar{z}_i$ (Ω)	$\bar{Y}_L$ (mA/V)
470	13.8	typ. 0.15	1.5	typ. 0.17	typ. 10	typ. 65	-	-
470	13.8	typ. 0.35	3.0	typ. 0.28	typ. 9.3	typ. 79	3.0+j5.0	27-j38
470	12.5	< 0.35	2.5	< 0.31	> 8.5	> 65	-	-
175	12.5	typ. 0.03	3.0	typ. 0.29	typ. 20	typ. 84	2.4-j3.8	35-j40

Test circuit for 470 MHz:



C1 = C2 = C6 = C7 = 1.8 to 18 pF film dielectric trimmer
C3 = C4 = 18 pF disc ceramic capacitor
C5 = 4 nF feed-through capacitor
C8 = 0.1 μF polyester capacitor

L1 = 1 turn Cu wire (1.2 mm); int. diam. 6 mm; max. lead length 1 mm
L2 = 1 μH choke
L3 = 30 mm straight Cu wire (2 mm); height above print 2 mm
L4 = 2 turns closely wound Cu wire (0.5 mm); int. diam. 3 mm; max. lead length 8 mm

R = 10 Ω carbon

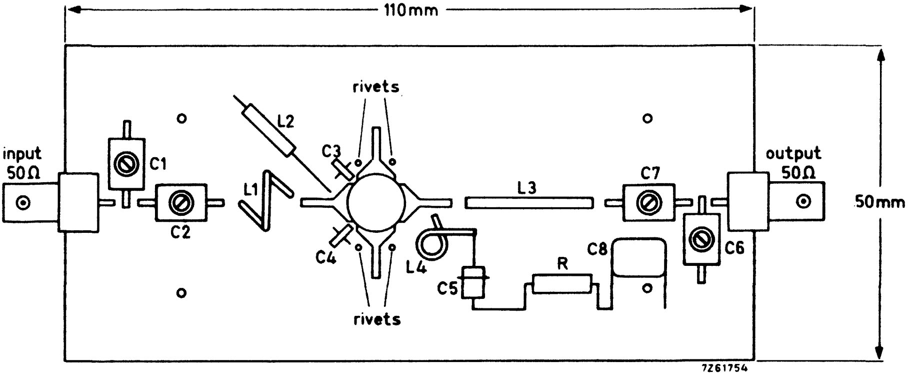
At P_L = 2.5 W and V_{CC} = 12.5 V, the output power at heatsink temperatures between 25 °C and 90 °C relative to that at 25 °C is diminished by typ. 5 mW/°C.

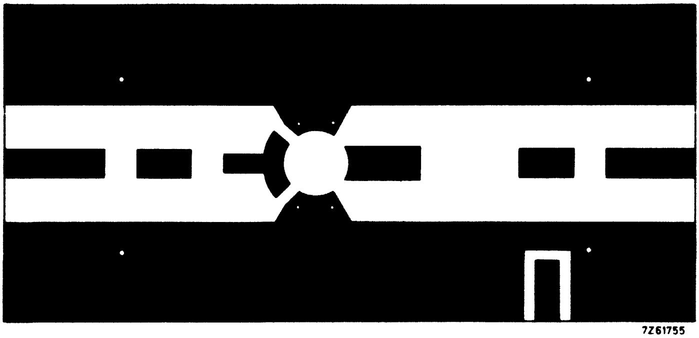
The transistor is designed to withstand full load mismatch in the test circuit under the following conditions: V_{CC} = 16.5 V; f = 470 MHz; T_h = 70 °C;
V.S.W.R. = 50 : 1 through all phases; $P_S = P_{Snom}$ + 20 %
where $P_{Snom} = P_S$ for 2.5 W transistor output into 50 Ω load and V_{CC} = 13.8 V

Component lay-out for 470 MHz see page 7

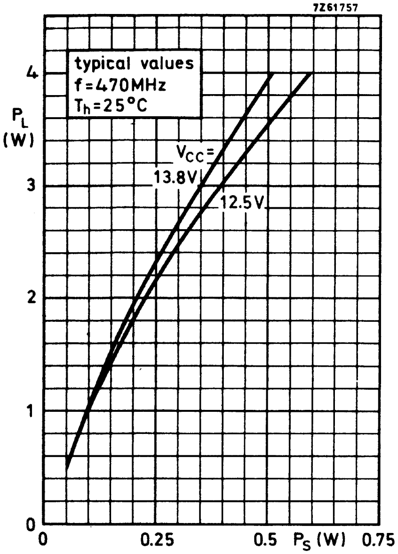
APPLICATION INFORMATION (continued)

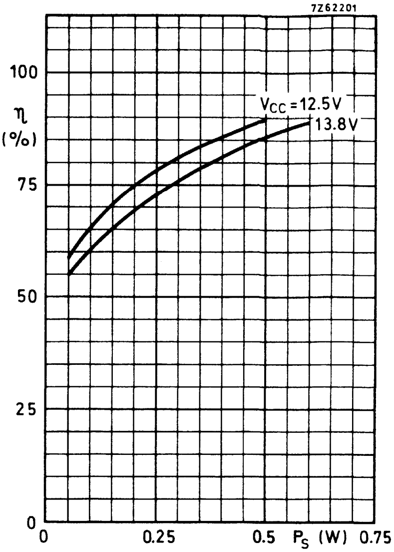
Component lay-out and printed circuit board for 470 MHz test circuit.

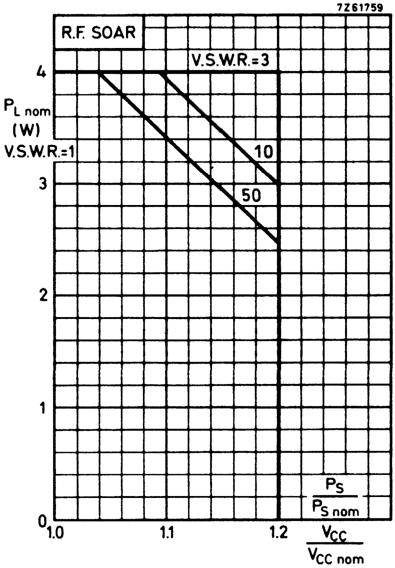




Shaded area copper
Back area completely copper clad.
Material of printed circuit board: 1.5 mm epoxy fibre glass.


7Z61757
typical values
f = 470MHz
T_h = 25°C
P_L (W)
0
1
2
3
4
V_{CC} =
13.8V
12.5V
0
0.25
0.5
P_S (W)
0.75


7Z62201
η (%)
0
25
50
75
100
V_{CC} = 12.5V
13.8V
0
0.25
0.5
P_S (W)
0.75



Conditions for R.F. SOAR

f = 470 MHz

T_h = 70 °C

V_{CCnom} = 13.8 V

$P_{Snom} = P_S$ at $V_{CC} = V_{CCnom}$ and V.S.W.R. = 1

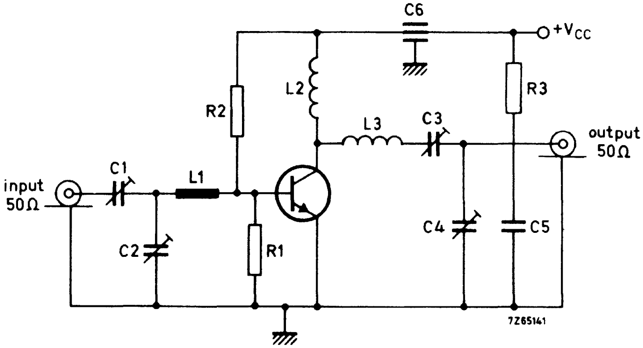
$R_{th\,mb\text{-}h}$ = 0.6 °C

see also page 6

The transistor was developed for use with unstabilized supply voltage V_{CC}.
The above graph is based on its measured performance in the circuit given on page 6. Supply voltage was varied from V_{CCnom} to 1.2 V_{CCnom}, and V.S.W.R. from 1 to 50. It shows the max. allowable output power under nominal conditions in order not to exceed the max. allowable power dissipation under conditions of supply overvoltage ($V_{CC} > V_{CCnom}$) and load mismatch (V.S.W.R. > 1).
It is assumed that the drive power increases linearly with the supply voltage; i.e. $P_S/P_{Snom} = V_{CC}/V_{CCnom}$.

APPLICATION INFORMATION (continued)

Test circuit for 175 MHz:



C1 = C3 = C4=	30 pF	concentric air trimmer
C2 =	60 pF	concentric air trimmer
C5 =	0.25 µF	ceramic capacitor
C6 =	4 nF	polyester capacitor

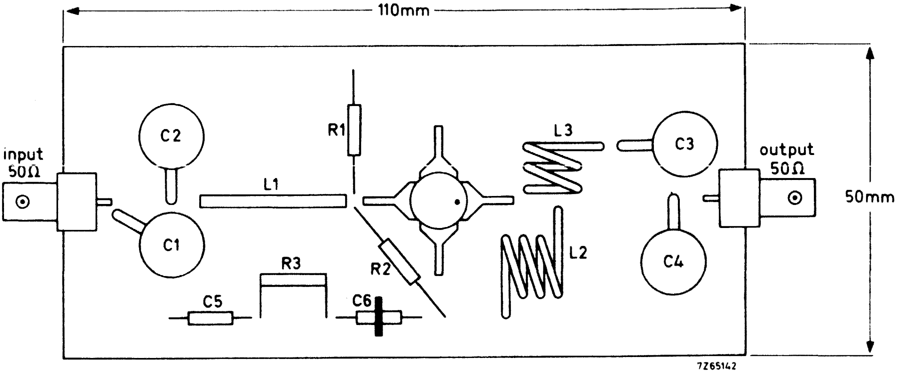
L1 = 25 mm straight Cu wire (1.2 mm); height above print max. 3 mm
L2 = 3 turns closely wound Cu wire (1.2 mm); int. diam. 10 mm; lead length 5 mm
L3 = 2 turns closely wound Cu wire (1.7 mm); int. diam. 12 mm; lead length 5 mm

R1 =	50 Ω	carbon
R2 =	1.2 kΩ	carbon
R3 =	5 Ω	carbon

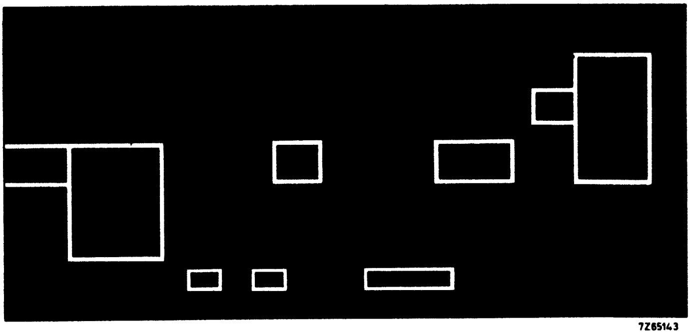
Component lay-out for 175 MHz see page 11.

APPLICATION INFORMATION (continued)

Component lay-out and printed circuit board for 175MHz test circuit.



Shaded area copper
Back area not metalized
Material of pcb : 1.5 mm epoxy fibre glass



U.H.F./ V.H.F. POWER TRANSISTOR

N-P-N- transistor intended for use in class B and C operated mobile, industrial and military transmitters with a supply voltage of 13.8 V. It has a capstan envelope with a moulded cap. All leads are isolated from the stud.

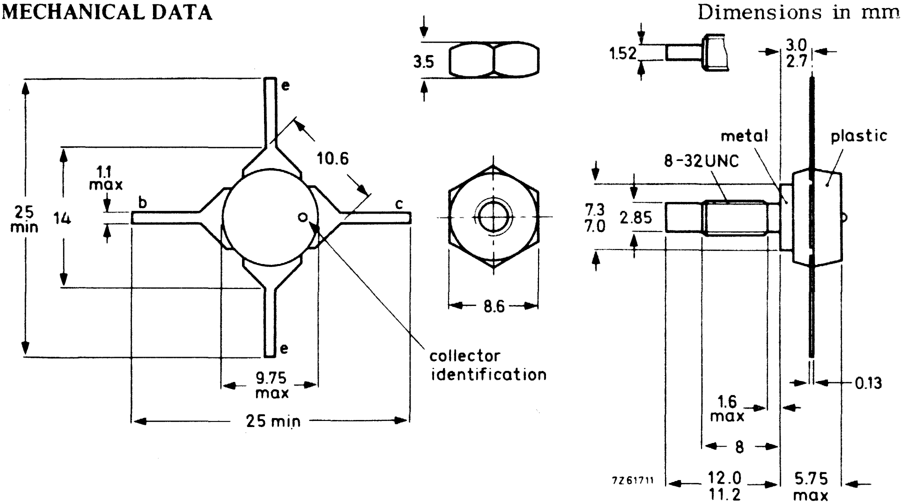
QUICK REFERENCE DATA

R.F. performance up to T_h = 25 °C in an unneutralised common-emitter class B circuit.

Mode of operation	V_{CC} (V)	f MHz	P_S (W)	P_L (W)	I_C (A)	G_p (dB)	η (%)	$\overline{z_i}$ (Ω)	$\overline{Y_L}$ (mA/V)
c.w	13.8	470	< 2.0	7.0	< 0.78	> 5.4	> 65	-	-
c.w	13.8	470	typ. 2.0	7.8	typ. 0.81	typ. 5.9	typ. 70	2.3+j6.3	50 - j36
c.w.	12.5	470	< 2.2	7.0	< 0.86	> 5.0	> 65	-	-
c.w.	12.5	175	typ. 0.4	7.2	typ. 0.87	typ. 12.6	typ. 66	3.0+j0.5	90 - j40

MECHANICAL DATA

Dimensions in mm



When locking is required an adhesive instead of a lock washer is preferred.

Torque on nut: min. 7.5 kg cm
(0.75 Newton metres)
max. 8.5 kg cm
(0.85 Newton metres)

Diameter of clearance hole in heatsink: max. 4.17 mm.

Mounting hole to have no burrs at either end. De-burring must leave surface flat; do not chamfer or countersink either end of hole.

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

Voltages

Collector-base voltage (open emitter) peak value	V_{CBOM}	max.	36	V
Collector-emitter voltage ($R_{BE} = 0$) peak value	V_{CESM}	max.	36	V
Collector-emitter voltage (open base)	V_{CEO}	max.	18	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4	V

Currents

Collector current (average)	$I_{C(AV)}$	max.	1.0	A
Collector current (peak value) f > 1 MHz	I_{CM}	max.	4.0	A

Power dissipation

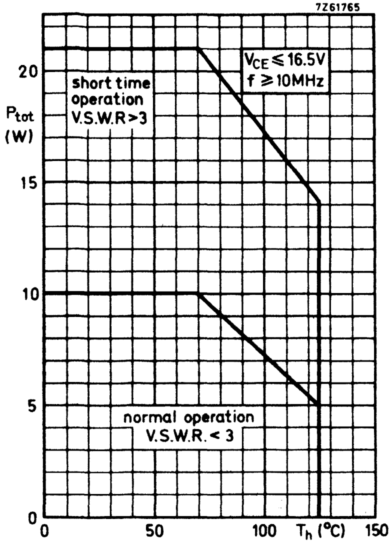
Total power dissipation up to T_h = 70 °C f > 10 MHz	P_{tot}	max.	10	W

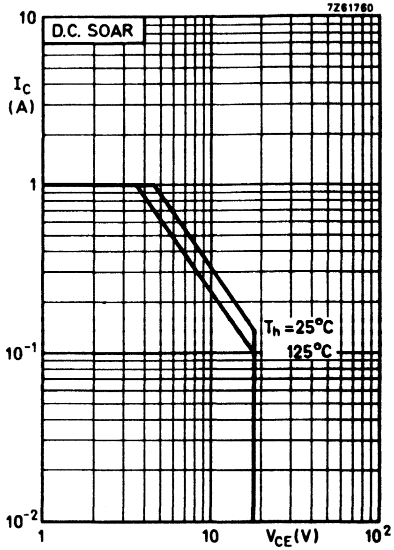
Temperatures

Storage temperature	T_{stg}		−65 to +150	°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	7.0	°C/W
From mounting base to heatsink	$R_{th\ mb\text{-}h}$	=	0.6	°C/W

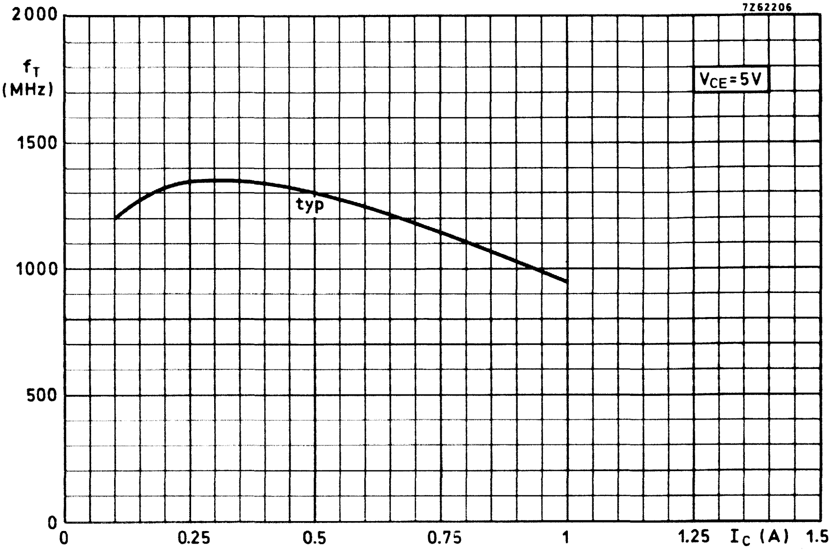

7Z61765
P_{tot} (W)
20
15
10
5
0
0
50
100
T_h (°C)
150
short time operation V.S.W.R>3
$V_{CE} \leq 16.5V$
$f \geq 10MHz$
normal operation V.S.W.R.< 3

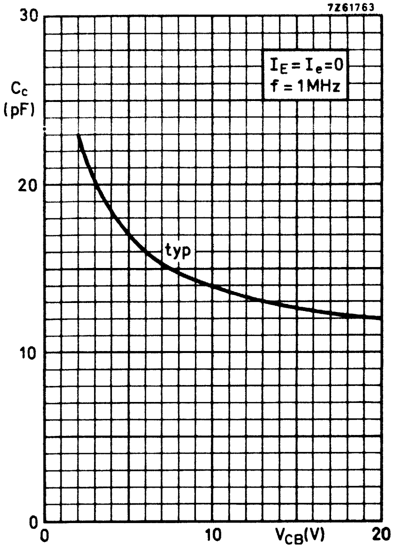

7Z61760
D.C. SOAR
I_C (A)
10
1
10^{-1}
10^{-2}
1
10
V_{CE}(V)
10^2
T_h =25°C
125°C

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Breakdown voltages				
Collector-base voltage open emitter, I_C = 10 mA	$V_{(BR)CBO}$	>	36	V
Collector-emitter voltage V_{BE} = 0; I_C = 10 mA	$V_{(BR)CES}$	>	36	V
Collector-emitter voltage open base, I_C = 25 mA	$V_{(BR)CEO}$	>	18	V
Emitter-base voltage open collector, I_E = 1.0 mA	$V_{(BR)EBO}$	>	4	V
Collector-emitter saturation voltage				
I_C = 500 mA; I_B = 100 mA	V_{CEsat}	typ.	0.2	V
D.C. current gain				
I_C = 500 mA; V_{CE} = 5 V	h_{FE}	> typ.	10 40	
Transition frequency				
I_C = 500 mA; V_{CE} = 5 V; f = 500 MHz	f_T	typ.	1300	MHz
Collector capacitance at f = 1 MHz				
I_E = I_e = 0; V_{CB} = 10 V	C_c	typ. <	14 20	pF pF
Emitter capacitance at f = 1 MHz				
I_C = I_c = 0; V_{EB} = 0	C_e	typ.	65	pF
Feedback capacitance at f = 1 MHz				
I_C = 50 mA; V_{CE} = 10 V	C_{re}	typ.	10.5	pF
Collector-stud capacitance	C_{cs}	typ.	2	pF


7Z62206
2000
f_T
(MHz)
1500
1000
500
0
0
0.25
0.5
0.75
1
1.25
I_C (A)
1.5
V_{CE} = 5 V
typ


7Z61763
30
C_c
(pF)
20
10
0
0
10
V_{CB}(V)
20
$I_E = I_e = 0$
f = 1 MHz
typ

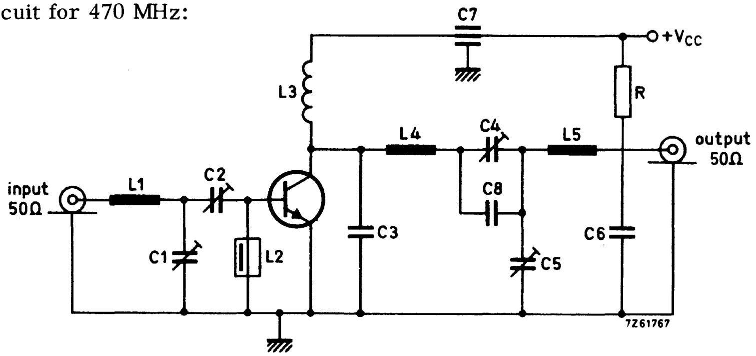
APPLICATION INFORMATION

R.F. performance in c.w. operation (unneutralized common-emitter class B circuit)

T_h up to 25 °C

f (MHz)	V_{CC} (V)	P_S (W)	P_L (W)	I_C (A)	G_p (dB)	η (%)	$\overline{z}_i$ (Ω)	$\overline{Y}_L$ (mA/V)
470	13.8	< 2.0	7.0	< 0.78	> 5.4	> 65	-	-
470	13.8	typ. 2.0	7.8	typ. 0.81	typ. 5.9	typ. 70	2.3+j6.3	50 - j36
470	12.5	< 2.2	7.0	< 0.86	> 5.0	> 65	-	-
175	12.5	typ. 0.4	7.2	typ. 0.87	typ. 12.6	typ. 66	3.0+j0.5	90 - j40

Test circuit for 470 MHz:



C1 = C2 = C4 = C5 = 1.8 to 18 pF film dielectric trimmer
C3 = 6.8 pF ceramic capacitor
C6 = 0.1 μF polyester capacitor
C7 = 4 nF feed-through capacitor
C8 = 10 pF ceramic capacitor

L1 = L4 = L5 = 20 mm straight Cu wire (1.2 mm); height above print 12 mm
L2 = 0.47 μH choke
L3 = 1 turn Cu wire (1.7 mm); int. diam. 10 mm; max. lead length 5 mm

R = 10 Ω carbon

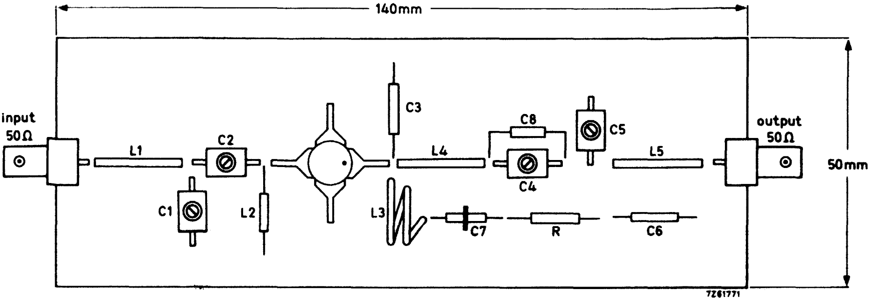
At P_L = 7.0 W and V_{CC} = 12.5 V the output power at heatsink temperatures between 25 °C and 90 °C relative to that at 25 °C is diminished by typ. 10 mW/°C

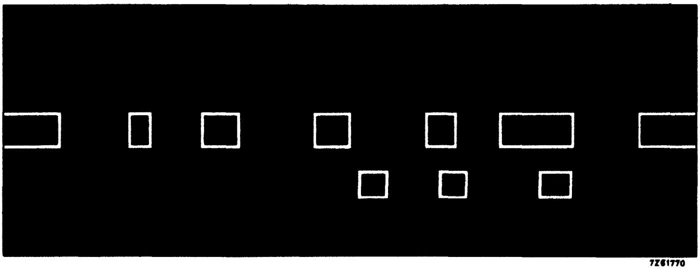
The transistor is designed to withstand full load mismatch in the test circuit under the following conditions: V_{CC} = 16.5 V; f = 470 MHz; T_h = 70 °C;
V.S.W.R. = 50 : 1 through all phases; $P_S = P_{Snom} + 20\ \%$
where $P_{Snom} = P_S$ for 7.0 W transistor output into 50 Ω load at V_{CC} = 13.8 V

Component lay-out for 470 MHz see page 7

APPLICATION INFORMATION (continued)

Component lay-out and printed circuit board for 470 MHz test circuit.

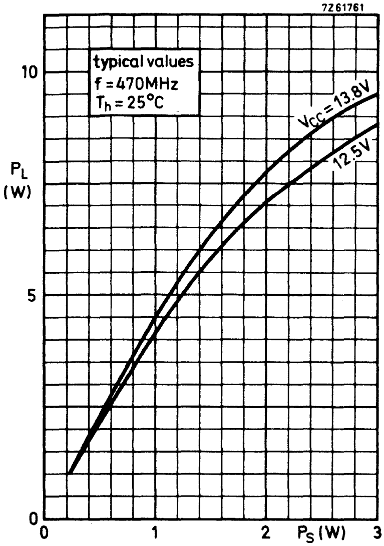


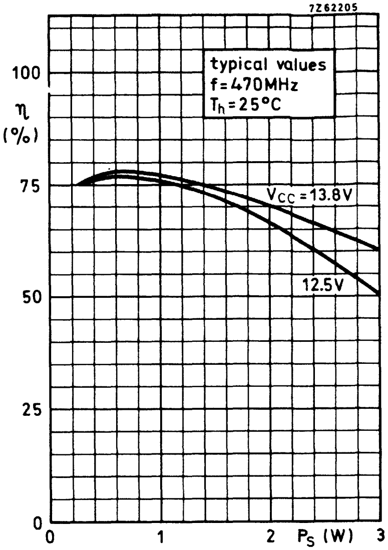


Shaded area copper

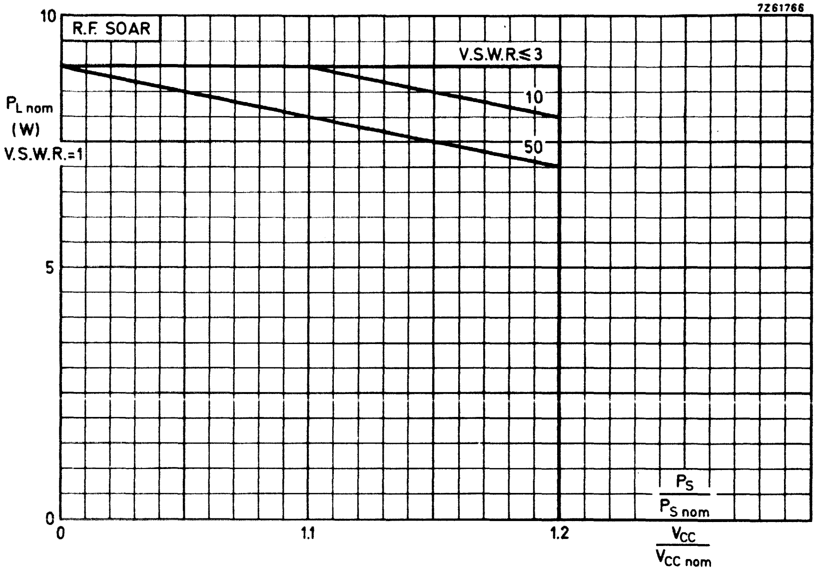
Back area completely copper clad

Material of printed circuit board: 1.5 mm epoxy fibre glass


7Z61761
typical values
f = 470MHz
T_h = 25°C
P_L
(W)
10
5
0
0
1
2
P_S (W)
3
V_{CC} = 13.8V
12.5V


7Z62205
typical values
f = 470MHz
T_h = 25°C
η
(%)
100
75
50
25
0
0
1
2
P_S (W)
3
V_{CC} = 13.8V
12.5V

The transistor was developed for use with unstabilized supply voltage V_{CC}. The graph below is based on its measured performance in the circuit given on page 6. Supply voltage was varied from V_{CCnom} to 1.2 V_{CCnom}, and V.S.W.R. from 1 to 50. It shows the max. allowable output power under nominal conditions in order not to exceed the max. allowable power dissipation under conditions of supply overvoltage ($V_{CC} > V_{CCnom}$) and load mismatch (V.S.W.R. > 1).
It is assumed that the drive power increases linearly with the supply voltage; i.e. $P_S/P_{Snom} = V_{CC}/V_{CCnom}$.



Conditions for R.F. SOAR:

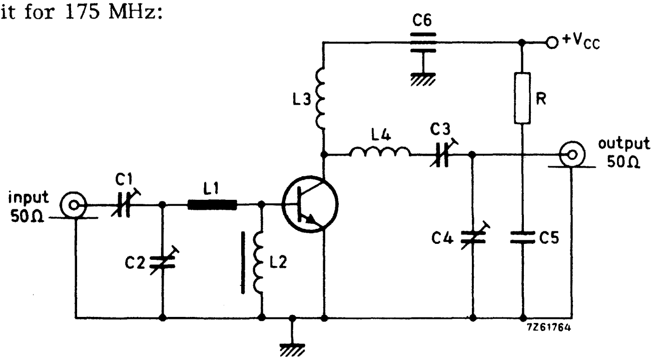
f = 470 MHz $P_{S\,nom} = P_S$ at $V_{CC} = V_{CC\,nom}$ and V.S.W.R. = 1

T_h = 70 °C

$V_{CC\,nom}$ = 13.8 V see also page 6.

APPLICATION INFORMATION (continued)

Test circuit for 175 MHz:



C1 = C3 = C4 = 30 pF concentric air trimmer
C2 = 60 pF concentric air trimmer
C5 = 0.25 μF polyester capacitor
C6 = 4.0 nF feed-through capacitor

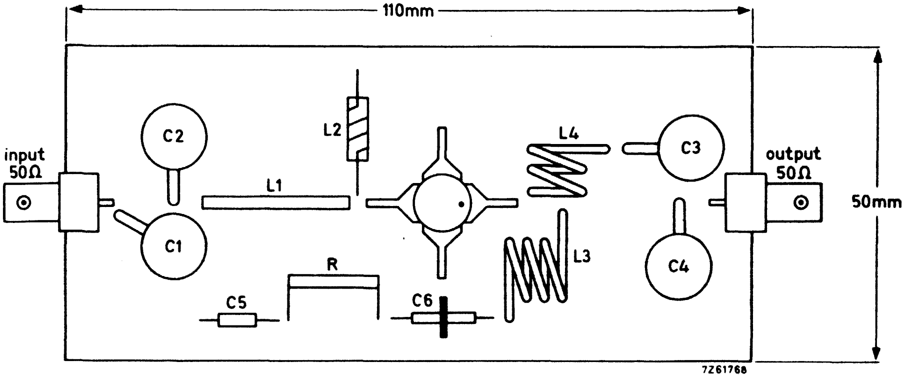
L1 = 25 mm straight Cu wire (1.2 mm); height above print 3 mm
L2 = 3 turns Cu wire (0.5 mm) on Ferrite FX1115, d = 2 mm, D = 4 mm, l = 5 mm material 3B (code number 3113 991 16740)
L3 = 5 turns closely wound Cu wire (1.2 mm); int. diam. 10 mm; lead length 5 mm
L4 = 3 turns closely wound Cu wire (1.2 mm); int. diam. 10 mm; lead length 5 mm

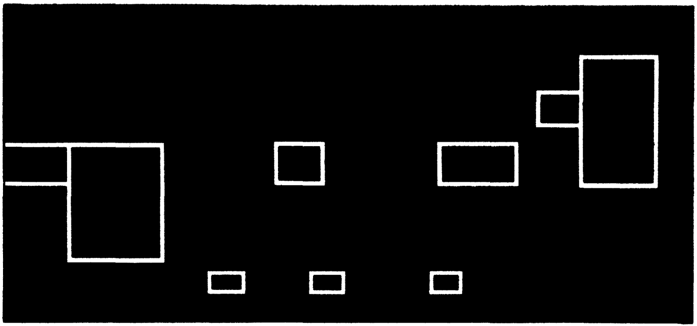
R = 10 Ω carbon

Component lay-out for 175 MHz see page 11.

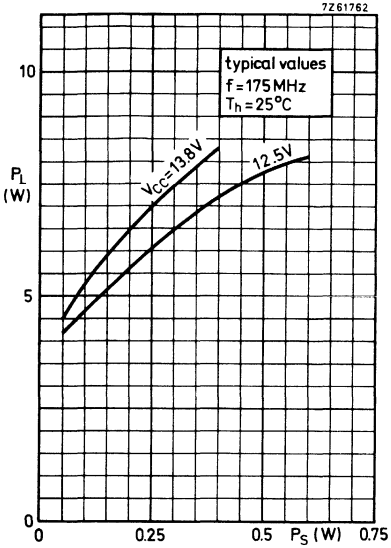
APPLICATION INFORMATION (continued)

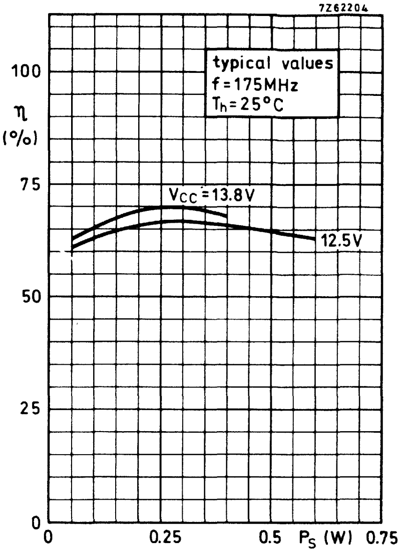
Component lay-out and printed circuit board for 175 MHz test circuit





Shaded area copper
Back area not metalized
Material of printed circuit board: 1.5 mm epoxy fibre glass


7Z61762
typical values
f = 175 MHz
T_h = 25°C
P_L (W)
10
5
0
V_{CC} = 13.8V
12.5V
0
0.25
0.5
P_S (W)
0.75


7Z62204
typical values
f = 175 MHz
T_h = 25°C
η (%)
100
75
50
25
0
V_{CC} = 13.8 V
12.5V
0
0.25
0.5
P_S (W)
0.75

U.H.F. POWER TRANSISTOR

N-P-N epitaxial planar transistor intended for use in class A, B and C operated mobile, industrial and military transmitters with a supply voltage of 13.5 V. The transistor is resistance stabilized. Every transistor is tested under severe load mismatch conditions with a supply overvoltage to 16.5 V. It has a capstan envelope with a moulded cap. All leads are isolated from the stud.

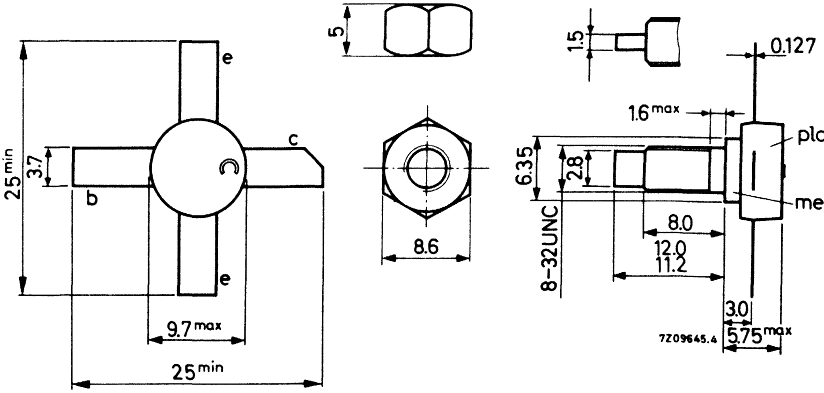
QUICK REFERENCE DATA

R.F. performance up to T_{mb} = 25 °C in an unneutralised common-emitter class B circuit.

Mode of operation	V_{CC} (V)	f (MHz)	P_S (W)	P_L (W)	I_C (A)	G_p (dB)	η (%)	$\overline{z_i}$ (Ω)	$\overline{Y_L}$ (mA/V)
c.w.	13.5	470	< 8	20	< 2.28	> 4	> 65	1.1 + j4.9	190-j45
c.w.	12.5	470	< 6.8	17	< 2.09	> 4	> 65		

MECHANICAL DATA

Dimensions in mm



Torque on nut: min. 7.5 kg cm
(0.75 Newton metres)
max. 8.5 kg cm
(0.85 Newton metres)

Diameter of clearance hole in heatsink: max. 4.17 mm.
Mounting hole to have no burrs at either end. De-burring must leave surface flat; do not chamfer or countersink either end of hole.

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

Voltages

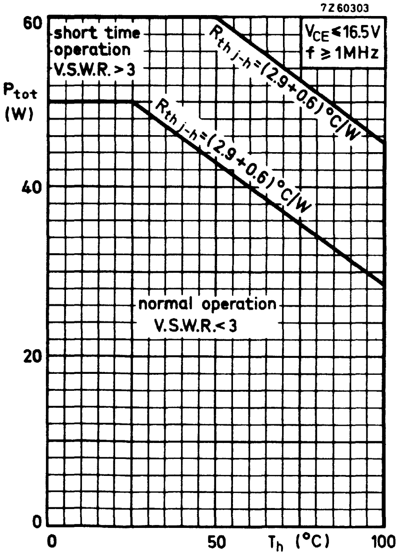
Collector-base voltage (open emitter) peak value	V_{CBOM}	max.	36	V
Collector-emitter voltage (open base)	V_{CEO}	max.	18	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4	V

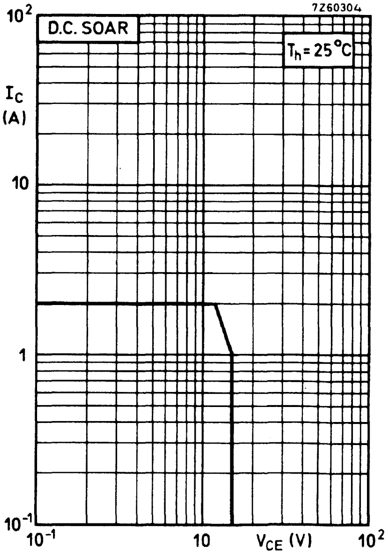
Currents

Collector current (average)	$I_{C(AV)}$	max.	3.5	A
Collector current (peak value) f > 1 MHz	I_{CM}	max.	10	A

Power dissipation

Total power dissipation up to T_h = 25 °C f > 1 MHz	P_{tot}	max.	50	W





Temperature

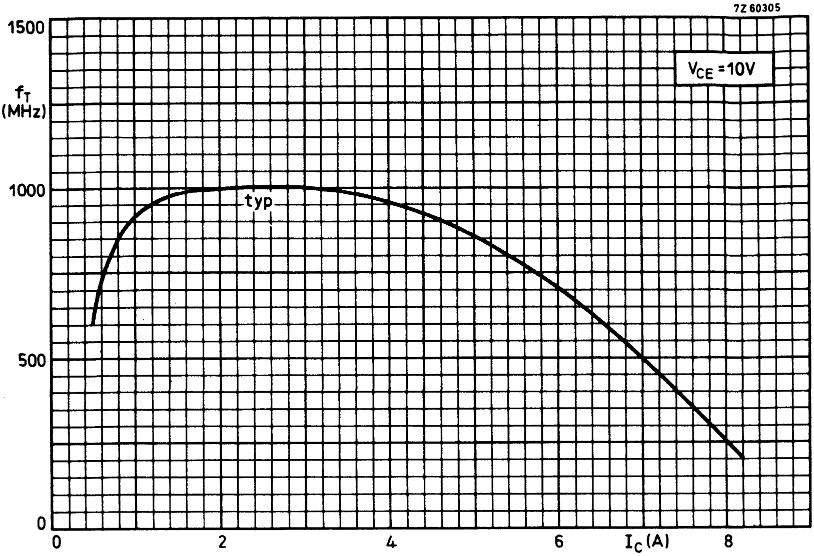
Storage temperature	T_{stg}		−30 to +200	°C
Operating junction temperature	T_j	max.	200	°C

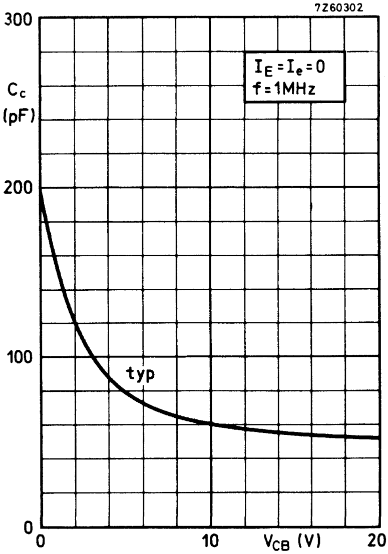
THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j-mb}$ =	2.9	°C/W
From mounting base to heatsink	$R_{th\ mb-h}$ =	0.6	°C/W

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

Breakdown voltages				
Collector-base voltage open emitter, $I_C = 25$ mA	$V_{(BR)CBO}$	>	36	V
Collector-emitter voltage open base, $I_C = 25$ mA	$V_{(BR)CEO}$	>	18	V
Emitter-base voltage open collector; $I_E = 10$ mA	$V_{(BR)EBO}$	>	4	V
Transient energy				
L = 25 mH; f = 50 Hz				
open base	E	>	3.1	mWs
$-V_{BE} = 1.5$ V; $R_{BE} = 33\ \Omega$	E	>	3.1	mWs
D.C. current gain				
$I_C = 1$ A; $V_{CE} = 5$ V	h_{FE}	> typ.	10 30	
Transition frequency				
$I_C = 2$ A; $V_{CE} = 10$ V	f_T	typ.	1.0	GHz
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; $V_{CB} = 15$ V	C_c	typ. <	55 70	pF pF
Feedback capacitance				
$I_C = 100$ mA; $V_{CE} = 15$ V	$-C_{re}$	typ.	32	pF
Collector-stud capacitance	C_{cs}	typ.	2	pF


7Z 60305
1500
f_T
(MHz)
1000
500
0
V_{CE} = 10V
typ
0
2
4
6
I_C (A)
8


7Z60302
300
C_c
(pF)
200
100
0
$I_E = I_e = 0$
f = 1MHz
typ
0
10
V_{CB} (V)
20

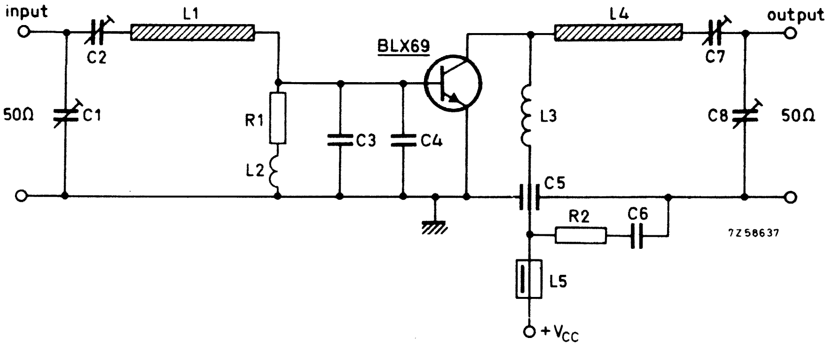
APPLICATION INFORMATION

R. F. performance in c. w. operation (unneutralised common-emitter class B ciruit)

T_{mb} up to 25 °C

f (MHz)	V_{CC} (V)	P_S (W)	P_L (W)	I_C (A)	G_p (dB)	η (%)	$\overline{z_i}$ (Ω)	$\overline{Y_L}$ (mA/V)
470	13.5	< 8	20	< 2.28	> 4	> 65	1.1 + j4.9	190-j45
470	12.5	< 6.8	17	< 2.09	> 4	> 65		
175	12.5	typ. 1.35	17	typ. 2.3	typ. 11	typ. 60	1.5 + j0.6	170-j57

Test circuit for 470 MHz:



List of components:

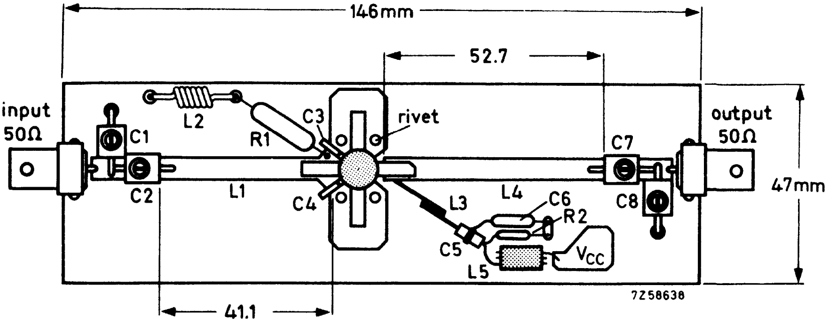
C1=C2=C7=C8=1.8 to 9.0 pF film dielectric trimmer (code number 2222 809 05002)
C3=C4= 15 pF chip capacitor
C5= 100 pF feed through capacitor
C6= 33 nF polyester capacitor
R1= 1 Ω
R2= 10 Ω
L1= strip-line (41.1 mm x 5.0 mm)
L2= 13 turns closely wound enamelled Cu wire (0.5 mm); int. diam. 4.0 mm (0.32 μH)
L3= 2 turns Cu wire (1 mm); winding pitch 1.5 mm; int. diam. 4 mm; leads 2x5 mm
L4= strip-line (52.7 mm x 5.0 mm)
L5= ferroxcube choke coil. Z (at f = 250 MHz) = 400 Ω ± 20 %
(code number 4312 020 36640)

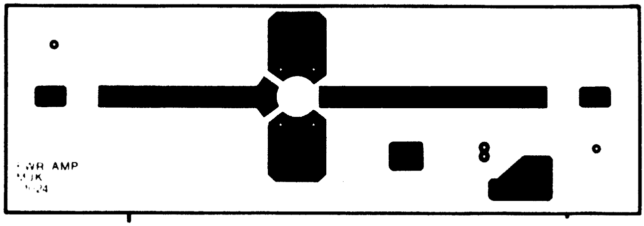
L1 and L4 are strip lines on a double Cu clad print plate with teflon fibre glass dielectric
(ϵ_r = 2.74); thickness 1.45 mm

Component lay-out for 470 MHz: see page 6

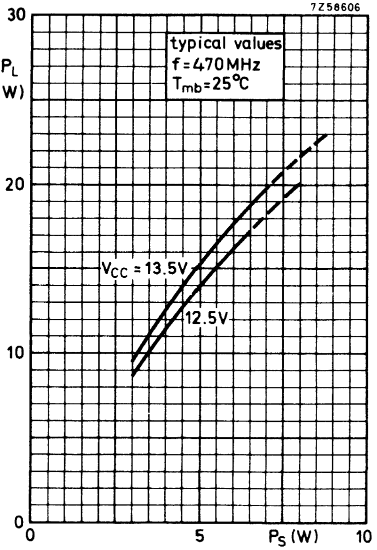
APPLICATION INFORMATION (continued)

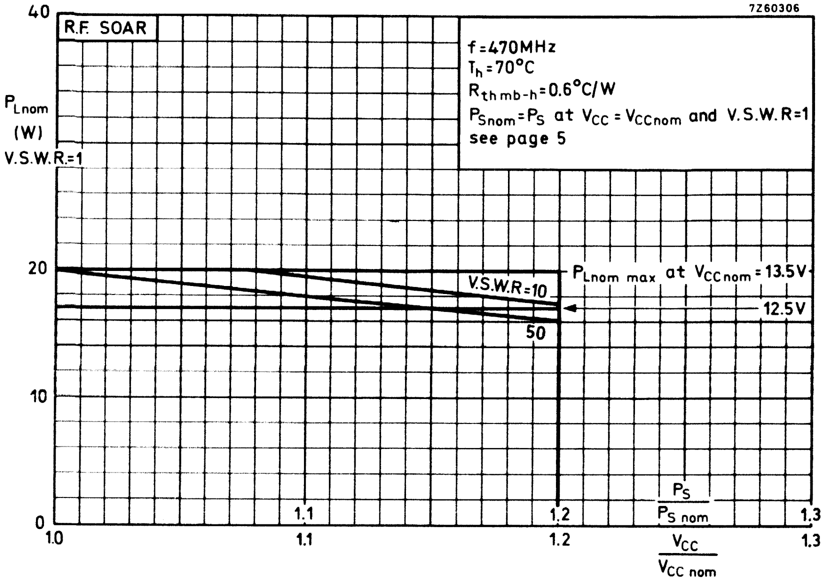
Component lay-out and printed circuit board for 470 MHz test circuit.

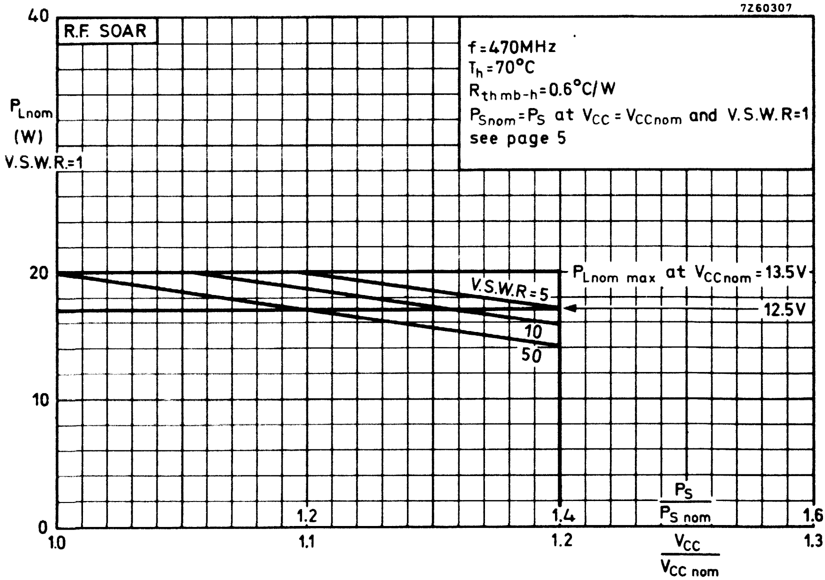




The circuit and the components are situated on one side of the epoxy fibre-glass board, the other side being fully metallised to serve as earth. Earth connections are made by means of hollow rivets.




7Z60306
R.F. SOAR
40
20
10
0
P_{Lnom} (W) V.S.W.R.=1
f = 470MHz
T_h = 70°C
$R_{th\,mb-h}$ = 0.6°C/W
$P_{Snom} = P_S$ at $V_{CC} = V_{CCnom}$ and V.S.W.R=1
see page 5
$P_{Lnom\,max}$ at V_{CCnom} = 13.5V
12.5V
V.S.W.R=10
50
1.1
1.2
1.3
$\frac{P_S}{P_{S\,nom}}$
1.0
1.1
1.2
1.3
$\frac{V_{CC}}{V_{CC\,nom}}$


7Z60307
R.F. SOAR
40
20
10
0
P_{Lnom} (W) V.S.W.R.=1
f = 470MHz
T_h = 70°C
$R_{th\,mb-h}$ = 0.6°C/W
$P_{Snom} = P_S$ at $V_{CC} = V_{CCnom}$ and V.S.W.R=1
see page 5
$P_{Lnom\,max}$ at V_{CCnom} = 13.5V
12.5V
V.S.W.R=5
10
50
1.2
1.4
1.6
$\frac{P_S}{P_{S\,nom}}$
1.0
1.1
1.2
1.3
$\frac{V_{CC}}{V_{CC\,nom}}$

The transistor has been developed for use with unstabilized supply voltages. As the output power and drive power increase with the supply voltage, the nominal output power must be derated in accordance with the graphs on page 7 for safe operation at supply voltages other than the nominal. The graphs show the allowable output power, under nominal conditions, as a function of the supply overvoltage ratio, with V.S.W.R. as parameter.
The upper graph applies to the situation in which the drive (P_S/P_{Snom}) increases linearly with the supply overvoltage ratio.
The lower graph shows the derating factor to be applied when the drive (P_S/P_{Snom}) increases as the square of the supply overvoltage ratio (V_{CC}/V_{CCnom}).

Depending on the operating conditions, the appropriate derating factor may lie in the region between the linear and the square-law functions.

The horizontal line at 20 W applies at V_{CCnom} = 13.5 V.
For V_{CCnom} = 12.5 V, P_L should be derated to 17 W.

U.H.F. TRANSMITTING TRANSISTOR

N-P-N silicon planar epitaxial transistor intended for transmitting applications in class A, B or C with a supply voltage up to 28 V.
The transistor is resistance stabilized and is tested under severe load mismatch conditions. It has a 1/4" capstan envelope with a moulded cap. All leads are isolated from the stud.

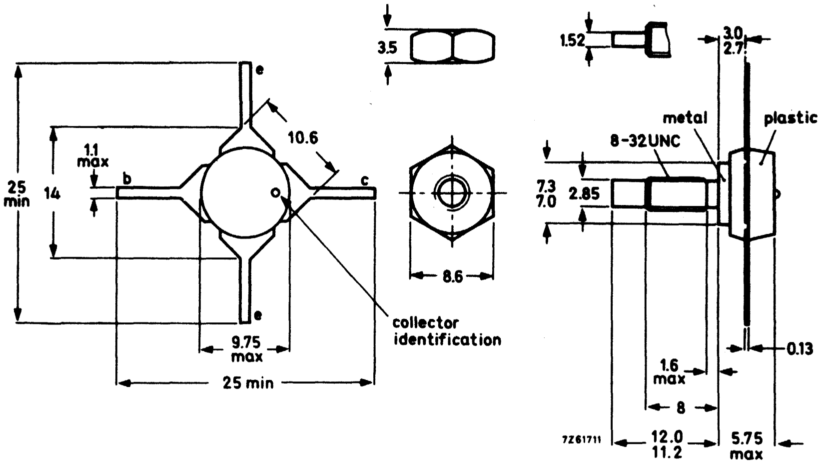
QUICK REFERENCE DATA

R.F. performance up to T_h = 25 °C in an unneutralized common-emitter clas B circuit.

Mode of operation	V_{CC} (V)	f (MHz)	P_S (mW)	P_L (W)	I_C (mA)	G_p (dB)	(%)	$\overline{z_i}$ (Ω)	$\overline{Y_L}$ (mA/V)
c.w.	24	470	typ. 50	0,85	typ. 67	typ. 12,3	typ. 53	–	–
c.w.	28	470	< 80	1,0	< 71	> 11,0	> 50	–	–
c.w.	28	470	typ. 80	1,45	typ. 86	typ. 12,6	typ. 60	1,4 + j1,6	3,7 – j22
c.w.	28	1000	typ. 400	1,4	typ. 100	typ. 5,4	typ. 50	–	–

MECHANICAL DATA

Dimensions in mm



When locking is required an adhesive instead of a lock washer is preferred.

Torque on nut: min. 0,75 Nm
(7,5 kg cm)
max. 0,85 Nm
(8,5 kg cm)

Diameter of clearance hole in heatsink: max. 4,17 mm
Mounting hole to have no burrs at either end
De-burring must leave surface flat; do not chamfer or countersink either end of hole.

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

Voltages

Collector-base voltage (open emitter) peak value	V_{CBOM}	max.	65	V
Collector-emitter voltage (V_{BE} = 0) peak value	V_{CESM}	max.	65	V
Collector-emitter voltage (open base)	V_{CEO}	max.	33	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4,0	V

Currents

Collector current (d.c.)	I_C	max.	400	mA
Collector current (peak value); f ≥ 10 MHz	I_{CM}	max.	800	mA

Power dissipation

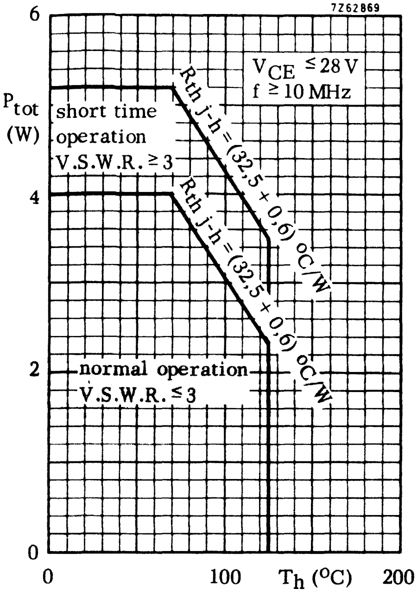
Total power dissipation up to T_h = 70 °C f ≥ 10 MHz (see also page 3)	P_{tot}	max.	4,0	W

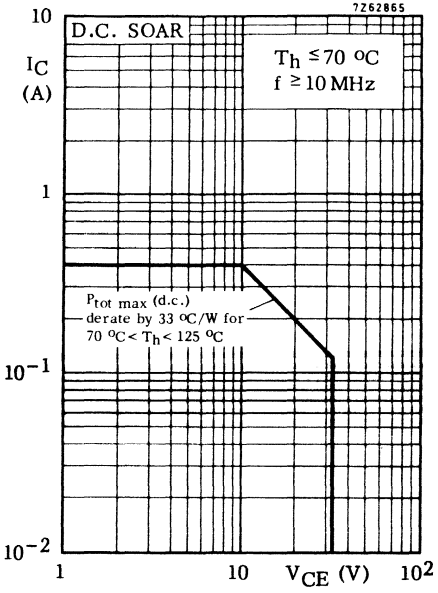
Temperatures

Storage temperature	T_{stg}	-65 to +150		°C
Operating junction temperature	T_j	max.	200	°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	32,5	°C/W
From mounting base to heatsink	$R_{th\ mb\text{-}h}$	=	0,6	°C/W

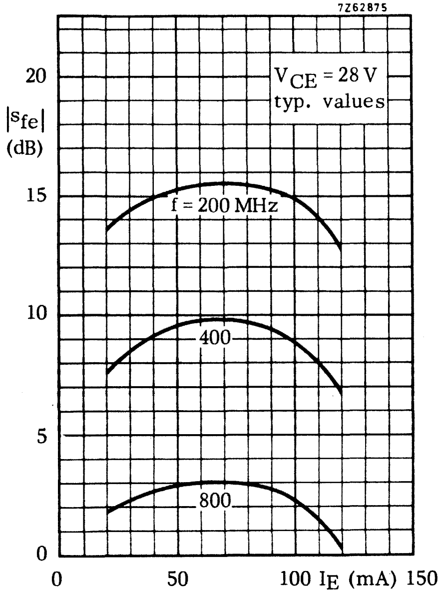

7Z62869
P_{tot}
(W)
6
4
2
0
0
100
200
T_h (°C)
$V_{CE} \leq 28$ V
f ≥ 10 MHz
short time
operation
V.S.W.R. ≥ 3
normal operation
V.S.W.R. ≤ 3
$R_{th\ j\text{-}h}$ = (32,5 + 0,6) °C/W
$R_{th\ j\text{-}h}$ = (32,5 + 0,6) °C/W

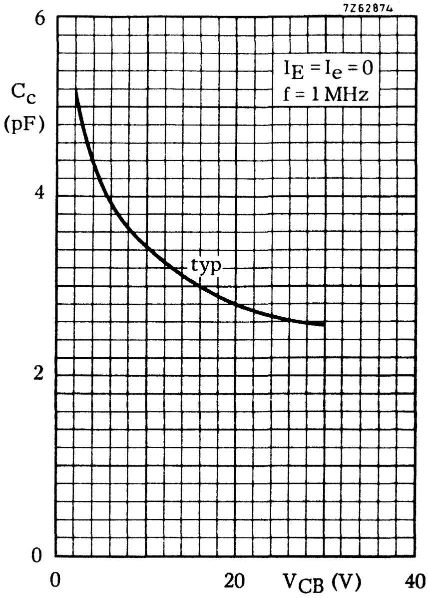

7Z62865
D.C. SOAR
$T_h \leq 70$ °C
f ≥ 10 MHz
I_C
(A)
10
1
10^{-1}
10^{-2}
1
10
10^2
V_{CE} (V)
$P_{tot\ max}$ (d.c.)
derate by 33 °C/W for
70 °C < T_h < 125 °C

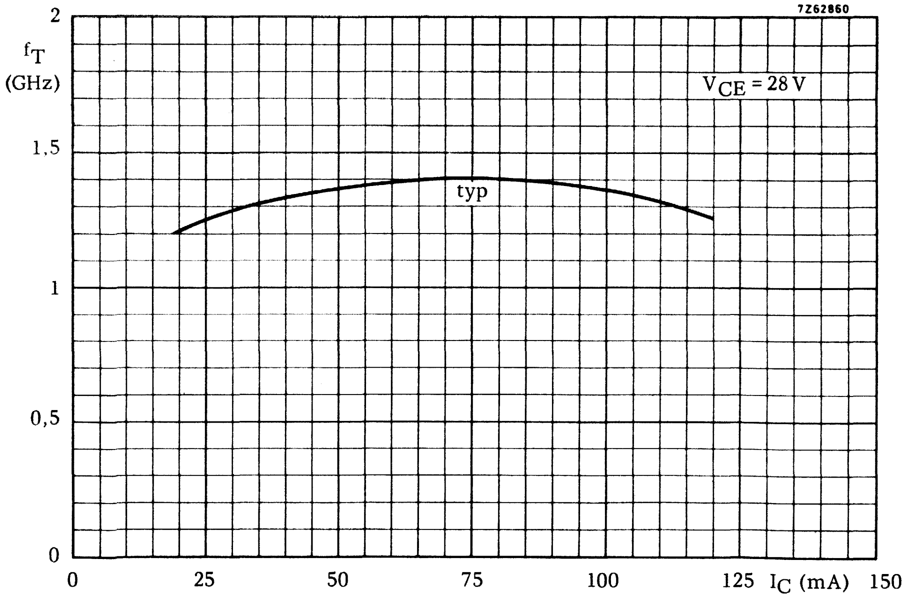
CHARACTERISTICS

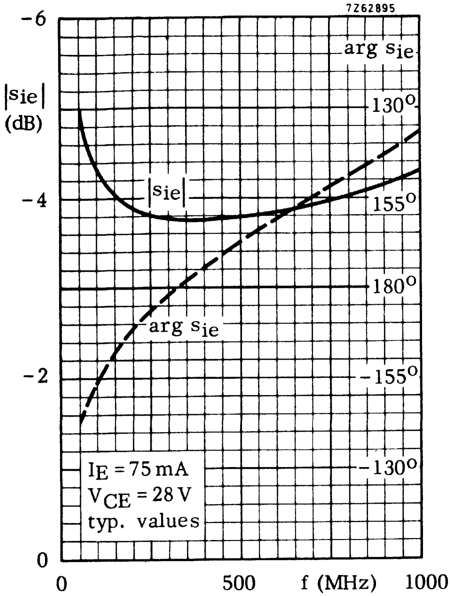
$T_j = 25\,^{\circ}C$ unless otherwise specified

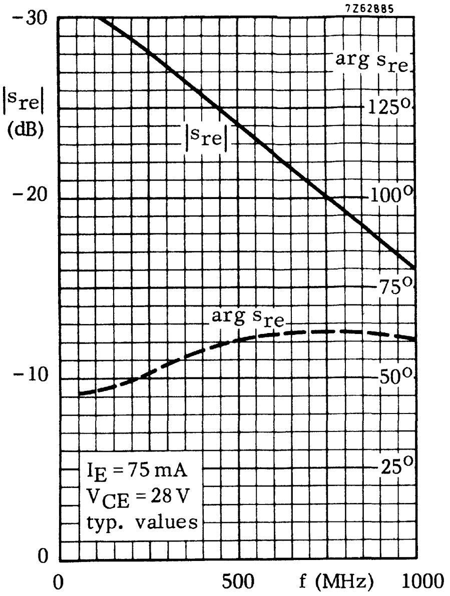
Breakdown voltages				
Collector-base voltage open emitter, $I_C = 10$ mA	$V_{(BR)CBO}$	>	65	V
Collector-emitter voltage $V_{BE} = 0$, $I_C = 10$ mA	$V_{(BR)CES}$	>	65	V
Collector-emitter voltage open base, $I_C = 25$ mA	$V_{(BR)CEO}$	>	33	V
Emitter-base voltage open collector, $I_E = 1{,}0$ mA	$V_{(BR)EBO}$	>	4,0	V
D.C. current gain				
$I_C = 100$ mA; $V_{CE} = 5{,}0$ V	h_{FE}	> typ.	10 35	
Transition frequency				
$I_C = 50$ mA; $V_{CE} = 5{,}0$ V	f_T	typ.	1,2	GHz
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; $V_{CB} = 10$ V	C_c	typ.	3,5	pF
Emitter capacitance at f = 1 MHz				
$I_C = I_c = 0$; $V_{EB} = 0$	C_e	typ.	11	pF
Feedback capacitance at f = 1 MHz				
$I_C = 5$ mA; $V_{CE} = 10$ V	C_{re}	typ.	2,5	pF
Collector-stud capacitance	C_{cs}	typ.	2,0	pF

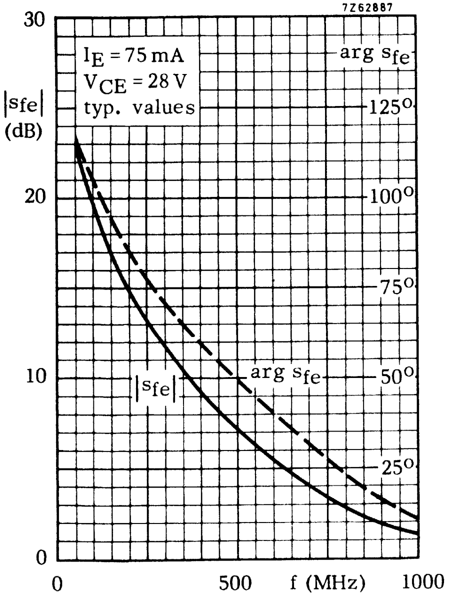

7Z62875
20
|s_fe|
(dB)
15
10
5
0
0
50
100 I_E (mA) 150
V_CE = 28 V
typ. values
f = 200 MHz
400
800

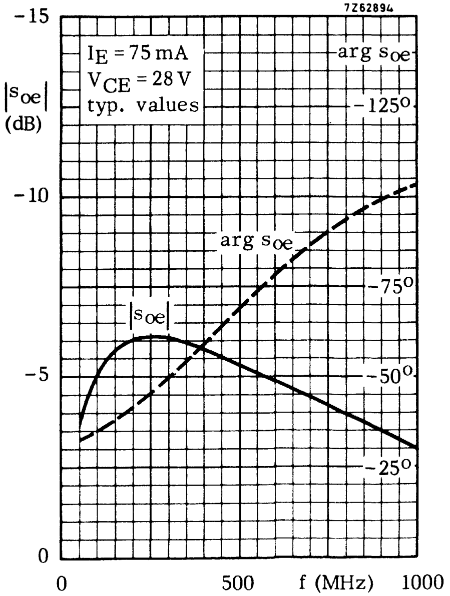

7Z62874
6
C_c
(pF)
4
2
0
0
20
V_CB (V)
40
I_E = I_e = 0
f = 1 MHz
typ


7Z62860
2
f_T
(GHz)
1,5
1
0,5
0
0
25
50
75
100
125 I_C (mA) 150
V_CE = 28 V
typ


7Z62895
-6
-4
-2
0
|sie|
(dB)
arg sie
130°
155°
180°
-155°
-130°
|sie|
arg sie
IE = 75 mA
VCE = 28 V
typ. values
0
500
f (MHz)
1000


7Z62885
-30
-20
-10
0
|sre|
(dB)
arg sre
125°
100°
75°
50°
25°
|sre|
arg sre
IE = 75 mA
VCE = 28 V
typ. values
0
500
f (MHz)
1000


7Z62887
30
20
10
0
|sfe|
(dB)
IE = 75 mA
VCE = 28 V
typ. values
arg sfe
125°
100°
75°
50°
25°
arg sfe
|sfe|
0
500
f (MHz)
1000


7Z62894
-15
-10
-5
0
|soe|
(dB)
IE = 75 mA
VCE = 28 V
typ. values
arg soe
-125°
arg soe
-75°
|soe|
-50°
-25°
0
500
f (MHz)
1000

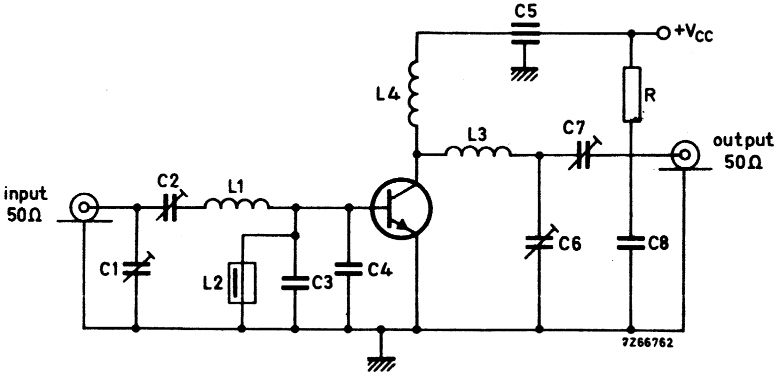
APPLICATION INFORMATION

R.F. performance in c.w. operation (Unneutralized common-emitter class B circuit)

T_h = 25 °C

V_{CC} (V)	f (MHz)	P_S (mW)	P_L (W)	I_C (mA)	G_p (dB)	(%)	$\overline{z_i}$ (Ω)	$\overline{Y_L}$ (mA/V)
24	470	typ. 50	0,85	typ. 67	typ. 12,3	typ. 53	–	–
28	470	< 80	1,0	< 71	> 11,0	> 50	–	–
28	470	typ. 80	1,45	typ. 86	typ. 12,6	typ. 60	1,4 + j1,6	3,7 – j22
28	1000	typ. 400	1,4	100	typ. 5,4	typ. 50	–	–

Test circuit for 470 MHz:



C1 = C2 = C7 = 1,8 to 18 pF film dielectric trimmer
C3 = C4 = 18 pF disc ceramic capacitor
C5 = 1 nF feed-through capacitor
C6 = 1,0 to 9,0 pF film dielectric trimmer
C8 = 0,1 μF polyester capacitor

L1 = 1 turn Cu wire (1,2 mm); int.diam.5 mm; lead length = 2 mm
L2 = 0,47 μH choke
L3 = 4 turns closely wound enamelled Cu wire (1,2 mm); int. diam. 6,5 mm; lead length = 4 mm
L4 = 5 turns closely wound enamelled Cu wire (0,5 mm); int. diam. 4 mm; lead length = 5 mm

R = 10 Ω carbon

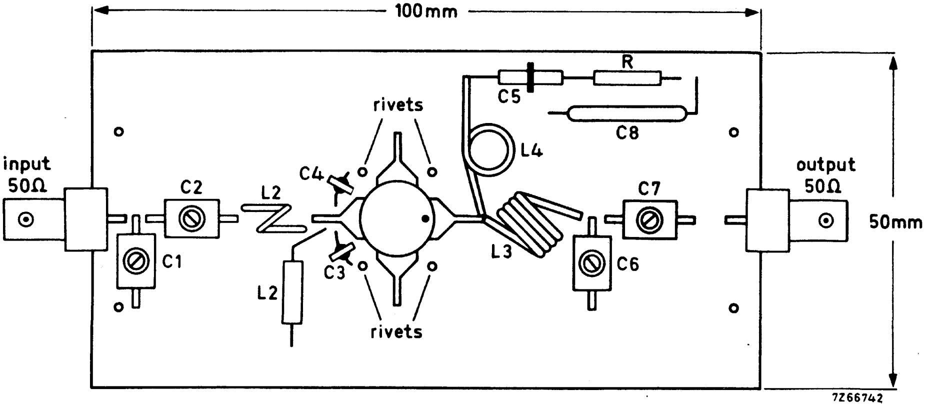
At P_L = 1,0 W and V_{CC} = 28 V, the output power at heatsink temperatures between 25 °C and 90 °C relative to that at 25 °C is diminished by typ. 2 mW/°C.

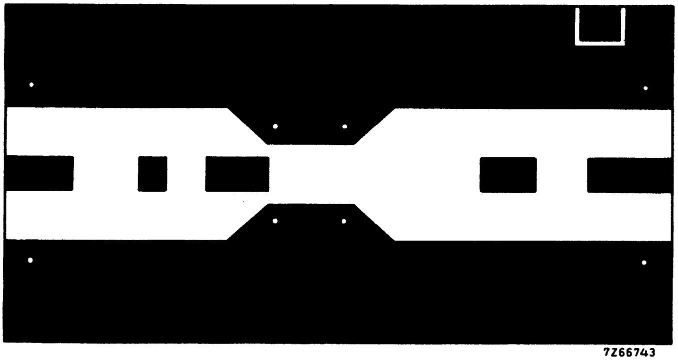
The transistor is designed to withstand full load mismatch in the test circuit under the following conditions: V_{CC} = 28 V; f = 470 MHz; T_h = 90 °C
V.S.W.R. = 50 : 1 through all phases; P_L = 1,2 W

Component lay-out for 470 MHz test circuit see page 8.

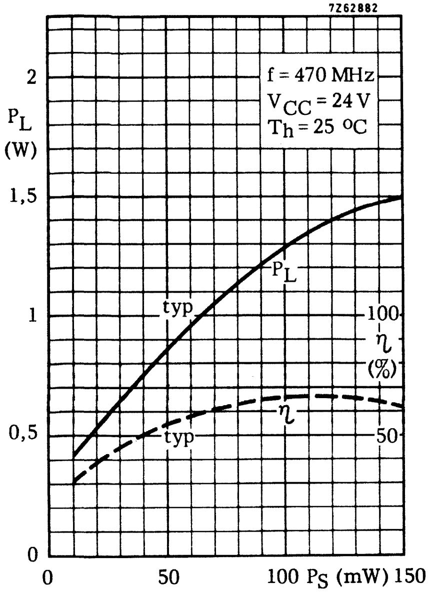
APPLICATION INFORMATION (continued)

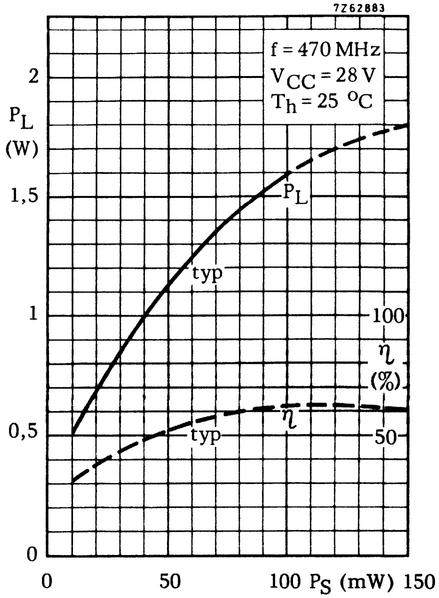
Component lay-out and printed circuit board for 470 MHz test circuit.

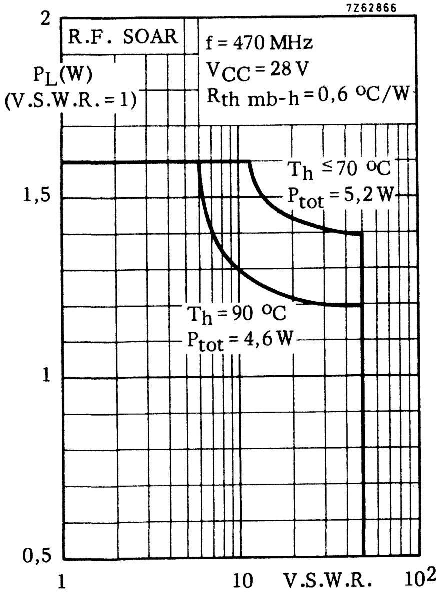




Shaded area copper
Back area completely copper clad
Material of printed circuit board: 1,5 mm epoxy fibre-glass







Indicated load power as a function of overload

The graph has been derived from an evaluation of the performance of transistors matched up to 1,6 W load power in the test amplifier on page 7 and subsequently subjected to various mismatch conditions at 28 V with V. S. W. R. up to 50 : 1 and elevated heatsink temperatures. This indicates a restriction to the load power matched under nominal conditions in the recommended test configuration.

U.H.F. TRANSMITTING TRANSISTOR

N-P-N silicon planar epitaxial transistor intended for transmitting applications in class A, B or C with a supply voltage up to 28 V.
The transistor is resistance stabilized and is tested under severe load mismatch conditions. It has a 1/4" capstan envelope with a moulded cap. All leads are isolated from the stud.

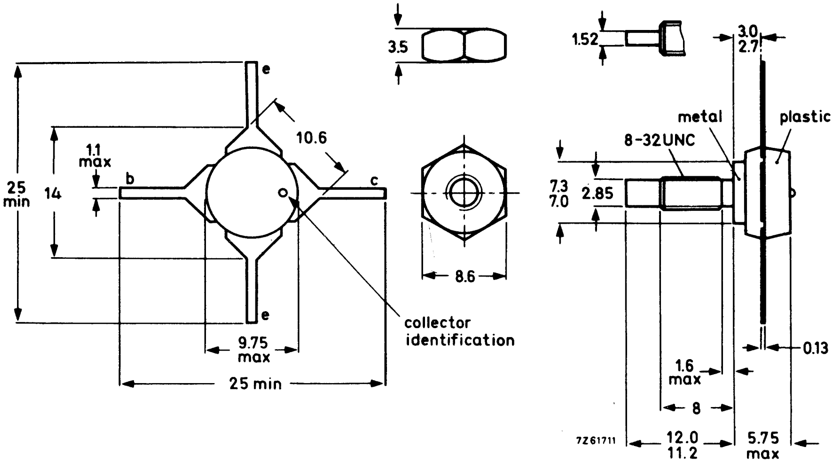
QUICK REFERENCE DATA

R.F. performance up to T_h = 25 °C in an unneutralized common-emitter class B circuit.

Mode of operation	V_{CC} (V)	f (MHz)	P_S (W)	P_L (W)	I_C (mA)	G_p (dB)	(%)	$\overline{z_i}$ (Ω)	$\overline{Y_L}$ (mA/V)
c.w.	24	470	typ. 0,2	2,4	typ. 143	typ. 10,8	typ. 70	–	–
c.w.	28	470	< 0,2	2,5	< 149	> 11,0	> 60	–	–
c.w.	28	470	typ. 0,2	3,0	typ. 162	typ. 11,7	typ. 66	1,6 + j3,4	7,7 – j31
c.w.	28	1000	typ. 0,7	2,5	typ. 179	typ. 5,5	typ. 50	–	–

MECHANICAL DATA

Dimensions in mm



When locking is required an adhesive instead of a lock washer is preferred.

Torque on nut: min. 0,75 Nm
(7,5 kg cm)
max. 0,85 Nm
(8,5 kg cm)

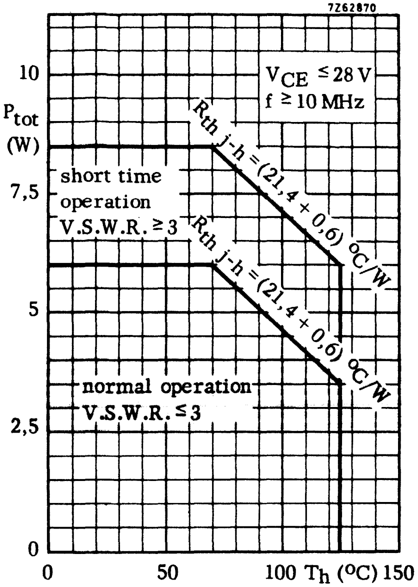
Diameter of clearance hole in heatsink: max. 4,17 mm.
Mounting hole to have no burrs at either end De-burring must leave surface flat; do not chamfer or countersink either end of hole.

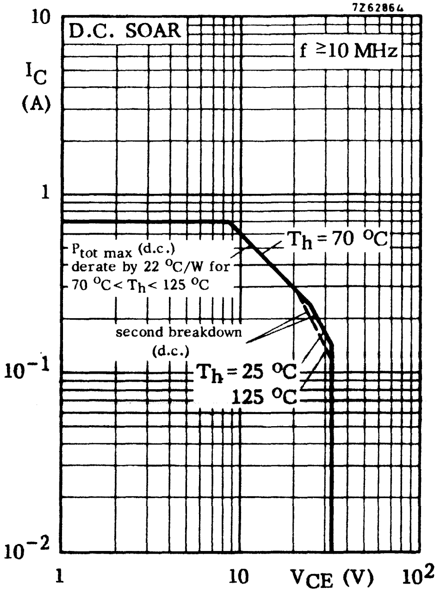
RATINGS Limiting values in accordance with the Absolute Maximum System (IEC134)

Voltages				
Collector-base voltage (open emitter) peak value	V_{CBOM}	max.	65	V
Collector-emitter voltage (V_{BE} = 0) peak value	V_{CESM}	max.	65	V
Collector-emitter voltage (open base)	V_{CEO}	max.	33	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4,0	V
Currents				
Collector current (d.c.)	I_C	max.	0,7	A
Collector current (peak value) f ≥ 10 MHz	I_{CM}	max.	2,0	A
Power dissipation				
Total power dissipation up to T_h = 70 °C f ≥ 10 MHz (see also page 3)	P_{tot}	max.	6,0	W
Temperatures				
Storage temperature	T_{stg}	-65 to +150		°C
Operating junction temperature	T_j	max.	200	°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j-mb}$	=	21,4	°C/W
From mounting base to heatsink	$R_{th\ mb-h}$	=	0,6	°C/W

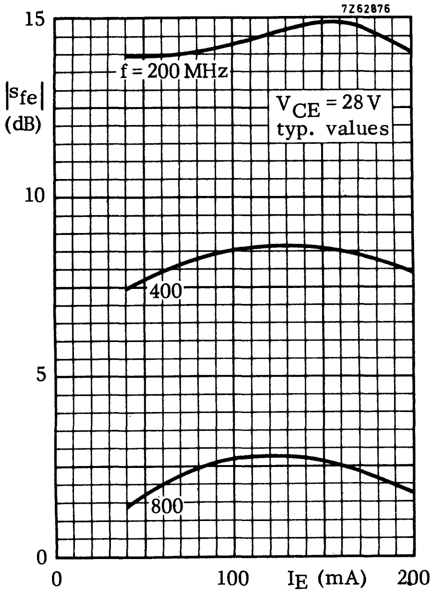

7Z62870
P_{tot} (W)
10
7,5
5
2,5
0
0
50
100 T_h (°C) 150
$V_{CE} \leq 28$ V
f ≥ 10 MHz
$R_{th\ j\text{-}h} = (21,4 + 0,6)$ °C/W
short time operation V.S.W.R. ≥ 3
$R_{th\ j\text{-}h} = (21,4 + 0,6)$ °C/W
normal operation V.S.W.R. ≤ 3

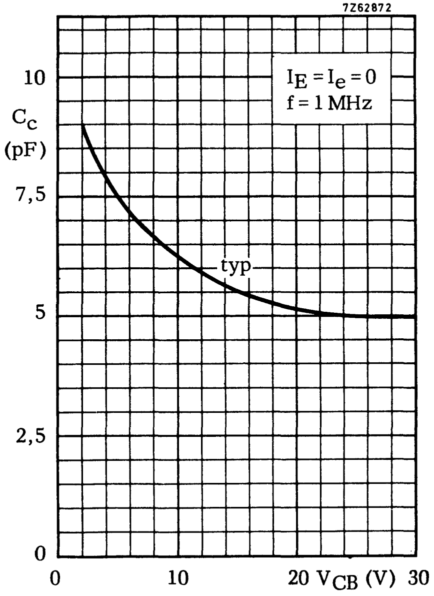

7Z62864
D.C. SOAR
f ≥ 10 MHz
I_C (A)
10
1
10^{-1}
10^{-2}
1
10
V_{CE} (V)
10^2
$T_h = 70$ °C
$P_{tot\ max}$ (d.c.) derate by 22 °C/W for 70 °C < T_h < 125 °C
second breakdown (d.c.)
$T_h = 25$ °C
125 °C

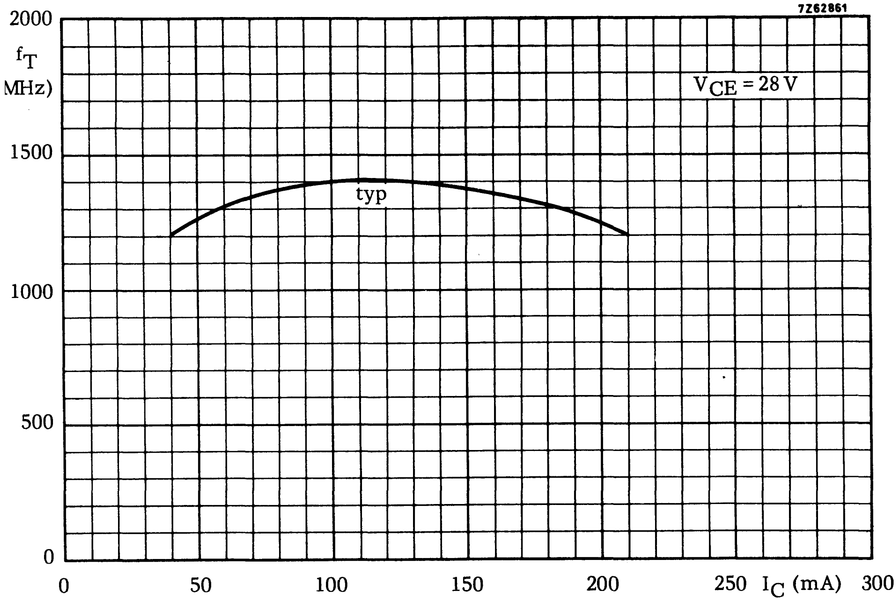
CHARACTERISTICS

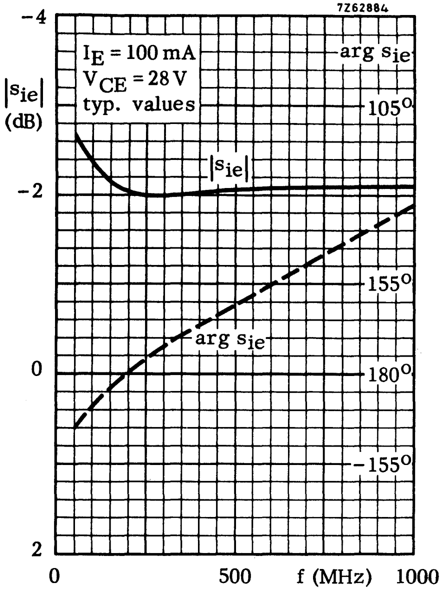
T_j = 25 °C unless otherwise specified

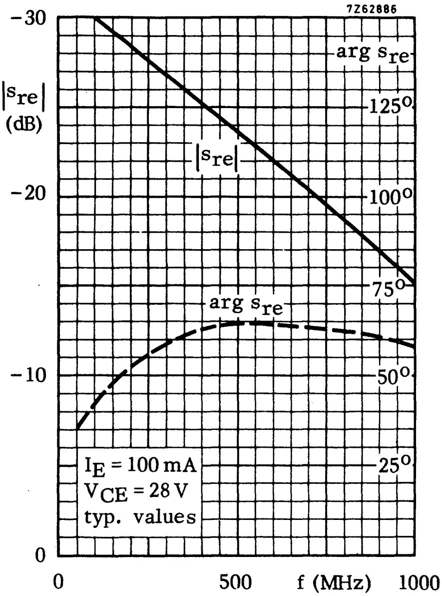
Breakdown voltages				
Collector-base voltage open emitter, I_C = 10 mA	$V_{(BR)CBO}$	>	65	V
Collector-emitter voltage V_{BE} = 0, I_C = 10 mA	$V_{(BR)CES}$	>	65	V
Collector-emitter voltage open base, I_C = 25 mA	$V_{(BR)CEO}$	>	33	V
Emitter-base voltage open collector, I_E = 1,0 mA	$V_{(BR)EBO}$	>	4,0	V
Collector-emitter saturation voltage				
I_C = 100 mA; I_B = 20 mA	V_{CEsat}	typ.	0,17	V
D.C. current gain				
I_C = 100 mA; V_{CE} = 5,0 V	h_{FE}	> typ.	10 40	
Transition frequency				
I_C = 100 mA; V_{CE} = 5,0 V	f_T	typ.	1,2	GHz
Collector capacitance at f = 1 MHz				
I_E = I_e = 0; V_{CB} = 10 V	C_c	typ.	6,5	pF
Emitter capacitance at f = 1 MHz				
I_C = I_c = 0; V_{EB} = 0	C_e	typ.	25	pF
Feedback capacitance at f = 1 MHz				
I_C = 10 mA; V_{CE} = 10 V	C_{re}	typ.	4,8	pF
Collector-stud capacitance	C_{cs}	typ.	2,0	pF

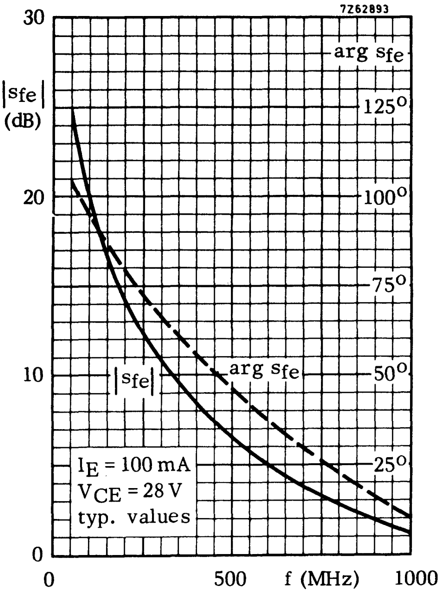

7Z62876
15
10
5
0
|s_fe|
(dB)
f = 200 MHz
400
800
V_CE = 28 V
typ. values
0
100
I_E (mA)
200

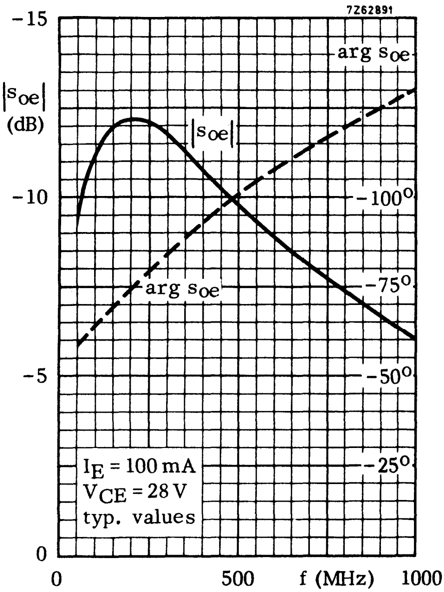

7Z62872
10
7,5
5
2,5
0
C_c
(pF)
I_E = I_e = 0
f = 1 MHz
typ
0
10
20 V_CB (V)
30


7Z62861
2000
1500
1000
500
0
f_T
MHz)
V_CE = 28 V
typ
0
50
100
150
200
250
I_C (mA)
300


7Z62884
-4
-2
0
2
|s_ie| (dB)
I_E = 100 mA
V_CE = 28 V
typ. values
arg s_ie
105°
155°
180°
-155°
|s_ie|
arg s_ie
0
500
f (MHz)
1000


7Z62886
-30
-20
-10
0
|s_re| (dB)
arg s_re
125°
100°
75°
50°
25°
|s_re|
arg s_re
I_E = 100 mA
V_CE = 28 V
typ. values
0
500
f (MHz)
1000


7Z62893
30
20
10
0
|s_fe| (dB)
arg s_fe
125°
100°
75°
50°
25°
|s_fe|
arg s_fe
I_E = 100 mA
V_CE = 28 V
typ. values
0
500
f (MHz)
1000


7Z62891
-15
-10
-5
0
|s_oe| (dB)
arg s_oe
-100°
-75°
-50°
-25°
|s_oe|
arg s_oe
I_E = 100 mA
V_CE = 28 V
typ. values
0
500
f (MHz)
1000

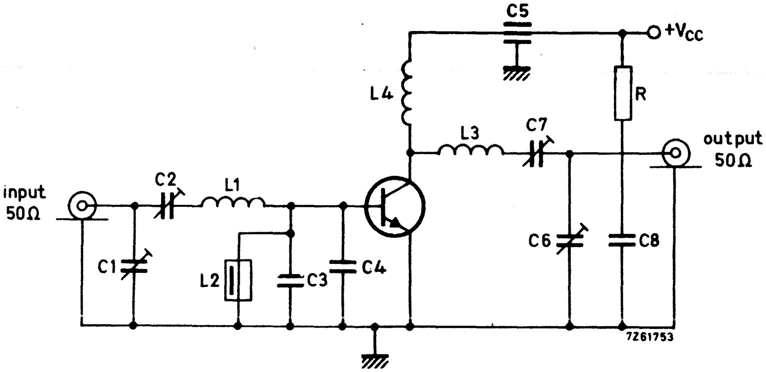
APPLICATION INFORMATION

R.F. performance in c.w. operation (Unneutralized common-emitter class B circuit)

T_h = 25 °C

V_{CC} (V)	f (MHz)	P_S (W)	P_L (W)	I_C (mA)	G_p (dB)	(%)	$\overline{z_i}$ (Ω)	$\overline{Y_L}$ (mA/V)
24	470	typ. 0,2	2,4	typ. 143	typ. 10,8	typ. 70	–	–
28	470	< 0,2	2,5	< 149	> 11,0	> 60	–	–
28	470	typ. 0,2	3,0	typ. 162	typ. 11,7	typ. 66	1,6 + j3,4	7,7 – j31
28	1000	typ. 0,7	2,5	typ. 179	typ. 5,5	typ. 50	–	–

Test circuit for 470 MHz:



C1 = C2 = 1,8 to 18 pF film dielectric trimmer
C3 = C4 = 18 pF disc ceramic capacitor
C5 = 1 nF feed-through capacitor
C6 = C7 = 1,0 to 9,0 pF film dielectric trimmer
C8 = 0,1 μF polyester capacitor

L1 = 1 turn Cu wire (1,2 mm); int. diam. 5 mm; lead length = 2 mm
L2 = 0,47 μH choke
L3 = 2 turns closely wound enamelled Cu wire (1,2 mm); int. diam. 6,5 mm; lead length = 4 mm
L4 = 3 turns closely wound enamelled Cu wire (0,5 mm); int. diam. 4,0 mm; lead length = 5 mm

R = 10 Ω carbon

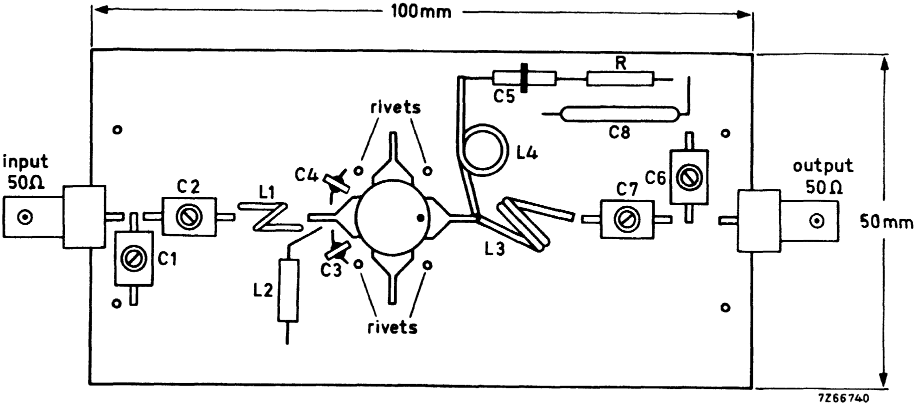
At P_L = 2,5 W and V_{CC} = 28 V, the output power at heatsink temperatures between 25 °C and 90 °C relative to that at 25 °C is diminished by typ. 5 mW/°C.

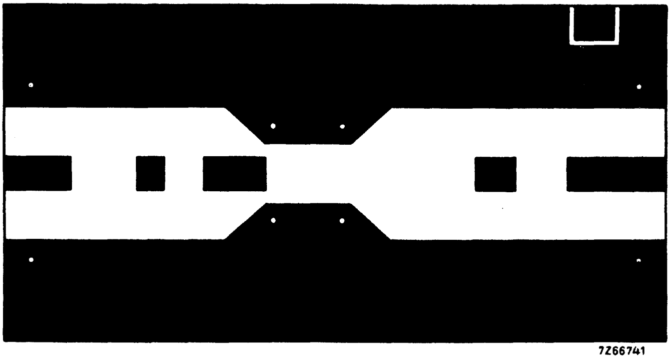
The transistor is designed to withstand full load mismatch in the test circuit under the following conditions: V_{CC} = 28 V; f = 470 MHz; T_h = 90 °C
V.S.W.R. = 50 : 1 through all phases; P_L = 2,5 W

Component lay-out for 470 MHz test circuit see page 8.

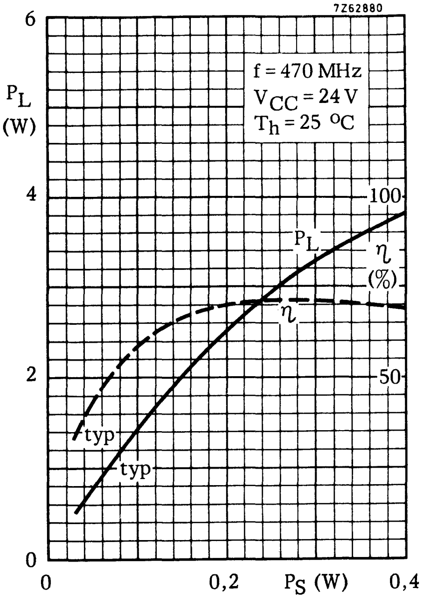
APPLICATION INFORMATION (continued)

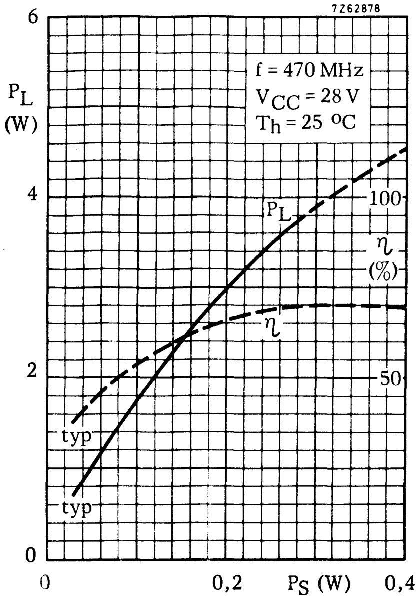
Component lay-out and printed circuit board for 470 MHz test circuit.

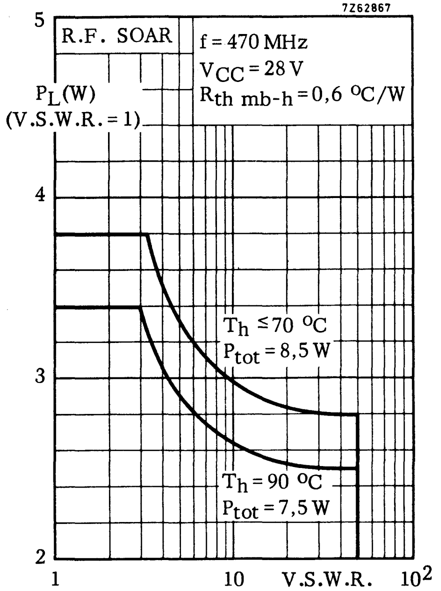




Shade area copper
Back area completely copper clad
Material of printed circuit board: 1,5 mm epoxy fibre-glass







Indicated load power as a function of overload

The graph has been derived from an evaluation of the performance of transistors matched up to 3,8 W load power in the test amplifier on page 7 and subsequently subjected to various mismatch conditions at 28 V with V.S.W.R. up to 50 : 1 and elevated heatsink temperatures. This indicates a restriction to the load power matched under nominal conditions in the recommended test configuration.

U.H.F. TRANSMITTING TRANSISTOR

N-P-N silicon planar epitaxial transistor intended for transmitting applications in class A, B or C with a supply voltage up to 28 V.
The transistor is resistance stabilized and is tested under severe load mismatch conditions.
It has a 1/4" capstan envelope with a moulded cap. All leads are isolated from the stud.

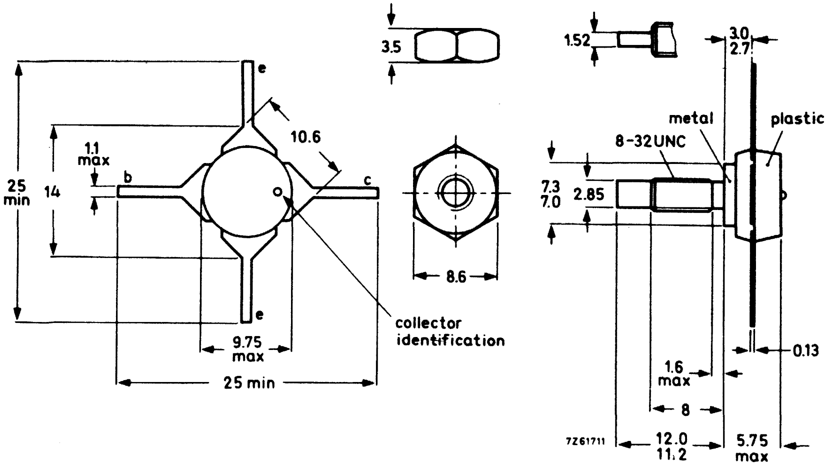
QUICK REFERENCE DATA

R.F. performance up to T_h = 25 °C in an unneutralized common-emitter class B circuit.

Mode of operation	V_{CC} (V)	f (MHz)	P_S (W)	P_L (W)	I_C (A)	G_p (dB)	(%)	$\overline{z_i}$ (Ω)	$\overline{Y_L}$ (mA/V)
c.w.	24	470	typ. 1,0	7,0	typ. 0,42	typ. 8,5	typ. 70	–	–
c.w.	28	470	< 1,0	7,0	< 0,42	> 8,5	> 60	–	–
c.w.	28	470	typ. 1,0	8,0	typ. 0,38	typ. 9,0	typ. 75	1,6 + j5,5	20 – j40
c.w.	28	1000	typ. 1,5	5,0	typ. 0,40	typ. 5,2	typ. 45	–	–

MECHANICAL DATA

Dimensions in mm



When locking is required an adhesive instead of a lock washer is preferred.

Torque on nut: min. 0,75 Nm
(7,5 kg cm)
max. 0,85 Nm
(8,5 kg cm)

Diameter of clearance hole in heatsink:max. 4,17 mm.
Mounting hole to have no burrs at either end
De-burring must leave surface flat; do not chamfer or countersink either end of hole.

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

Voltages

Collector-base voltage (open emitter) peak value	V_{CBOM}	max.	65	V
Collector-emitter voltage (V_{BE} = 0) peak value	V_{CESM}	max.	65	V
Collector-emitter voltage (open base)	V_{CEO}	max.	33	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4,0	V

Currents

Collector current (d.c.)	I_C	max.	1,0	A
Collector current (peak value) f ≥ 10 MHz	I_{CM}	max.	3,0	A

Power dissipation

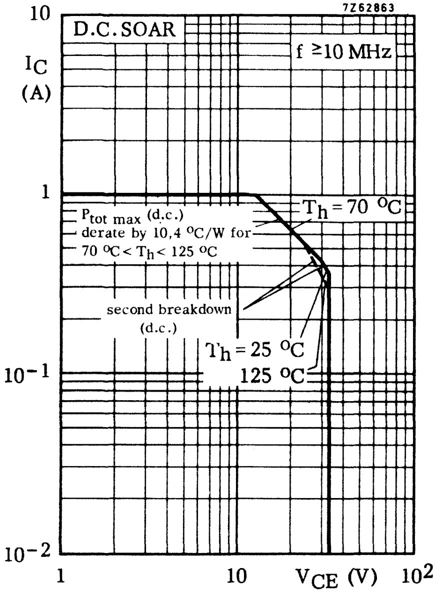
Total power dissipation up to T_h = 70 °C f ≥ 10 MHz (see also page 3)	P_{tot}	max.	12,5	W

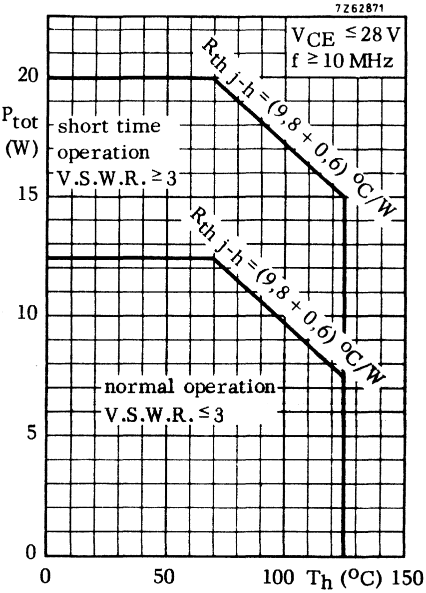
Temperatures

Storage temperature	T_{stg}	-65 to +150		°C
Operating junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j-mb}$	=	9,8	°C/W
From mounting base to heatsink	$R_{th\ mb-h}$	=	0,6	°C/W

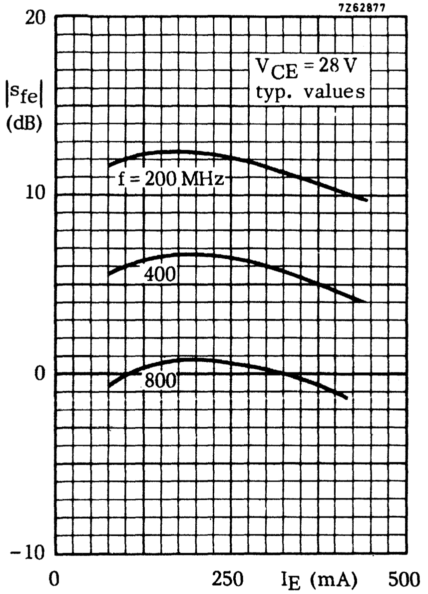

7Z62863
D.C. SOAR
f ≥10 MHz
I_C (A)
10
1
10^-1
10^-2
P_tot max (d.c.) derate by 10,4 °C/W for 70 °C < T_h < 125 °C
T_h = 70 °C
second breakdown (d.c.)
T_h = 25 °C
125 °C
1
10
V_CE (V)
10^2

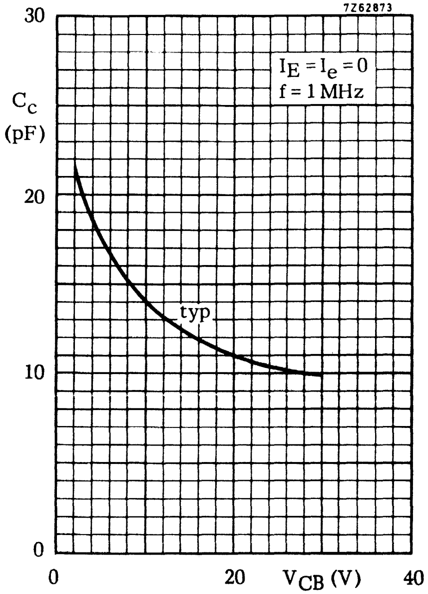

7Z62871
V_CE ≤ 28 V
f ≥ 10 MHz
P_tot (W)
20
15
10
5
0
short time operation V.S.W.R. ≥ 3
R_th j-h = (9,8 + 0,6) °C/W
R_th j-h = (9,8 + 0,6) °C/W
normal operation V.S.W.R. ≤ 3
0
50
100
T_h (°C)
150

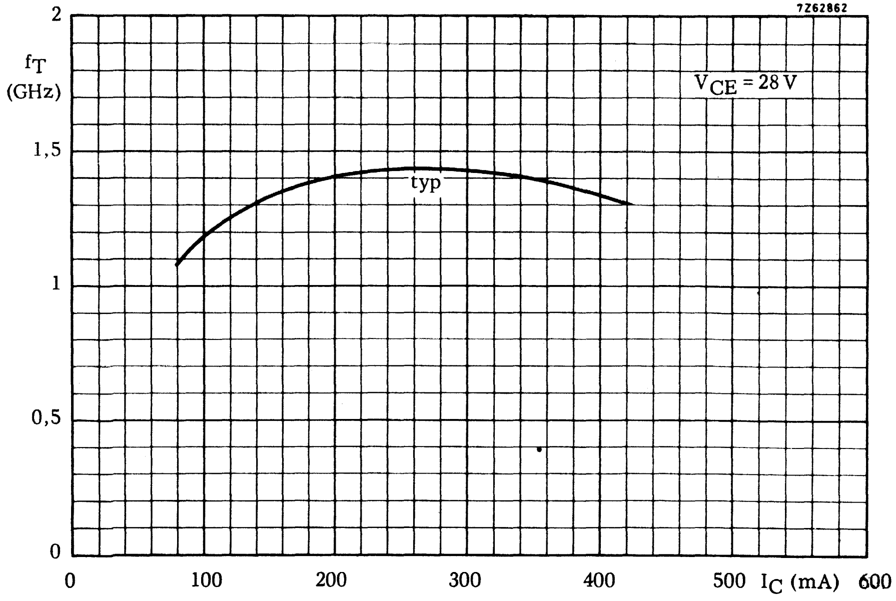
CHARACTERISTICS

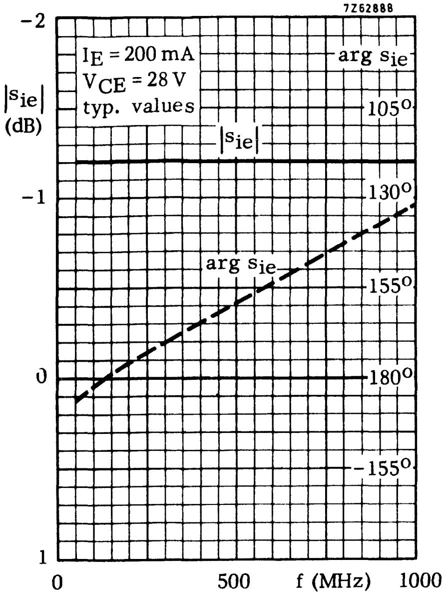
T_j = 25 °C unless otherwise specified

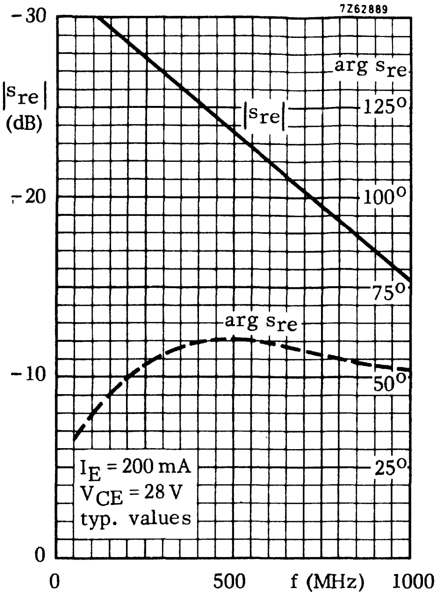
Breakdown voltages				
Collector-base voltage open emitter, I_C = 10 mA	$V_{(BR)CBO}$	>	65	V
Collector-emitter voltage open base, I_C = 10 mA	$V_{(BR)CES}$	>	65	V
Collector-emitter voltage open base, I_C = 25 mA	$V_{(BR)CEO}$	>	33	V
Emitter-base voltage open collector, I_E = 1,0 mA	$V_{(BR)EBO}$	>	4,0	V
D.C. current gain				
I_C = 100 mA; V_{CE} = 5,0 V	h_{FE}	>	10	
		typ.	35	
Transition frequency				
I_C = 200 mA; V_{CE} = 5,0 V	f_T	typ.	1,2	GHz
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; V_{CB} = 10 V	C_c	typ.	14	pF
Emitter capacitance at f = 1 MHz				
$I_C = I_c = 0$; $V_{EB} = 0$	C_e	typ.	60	pF
Feedback capacitance at f = 1 MHz				
I_C = 20 mA; V_{CE} = 10 V	C_{re}	typ.	10	pF
Collector-stud capacitance	C_{cs}	typ.	2,0	pF

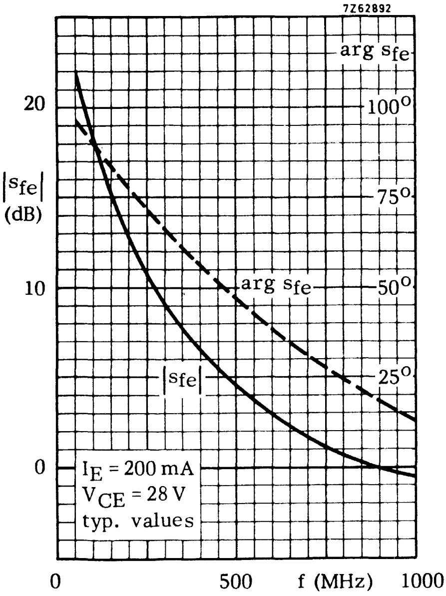

7Z62877
|s$_{fe}$|
(dB)
20
10
0
−10
V$_{CE}$ = 28 V
typ. values
f = 200 MHz
400
800
0
250
I$_E$ (mA)
500

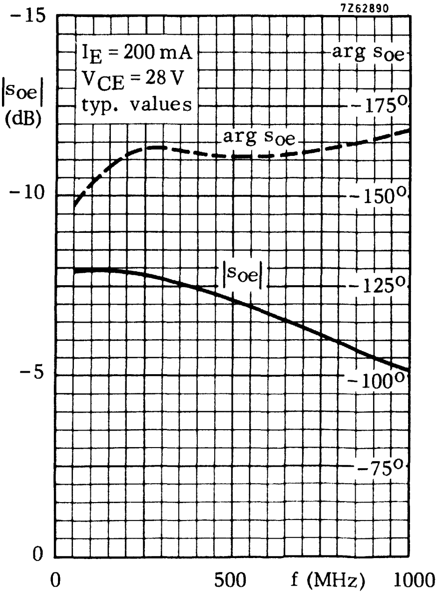

7Z62873
C$_c$
(pF)
30
20
10
0
I$_E$ = I$_e$ = 0
f = 1 MHz
typ
0
20
V$_{CB}$ (V)
40


7Z62862
f$_T$
(GHz)
2
1,5
1
0,5
0
V$_{CE}$ = 28 V
typ
0
100
200
300
400
500
I$_C$ (mA)
600


7Z62888
−2
−1
0
1
$|s_{ie}|$ (dB)
$I_E = 200$ mA
$V_{CE} = 28$ V
typ. values
arg s_{ie}
105°
$|s_{ie}|$
130°
arg s_{ie}
155°
180°
−155°
0
500
f (MHz)
1000


7Z62889
−30
−20
−10
0
$|s_{re}|$ (dB)
arg s_{re}
$|s_{re}|$
125°
100°
75°
arg s_{re}
50°
25°
$I_E = 200$ mA
$V_{CE} = 28$ V
typ. values
0
500
f (MHz)
1000


7Z62892
20
10
0
$|s_{fe}|$ (dB)
arg s_{fe}
100°
75°
arg s_{fe}
50°
$|s_{fe}|$
25°
$I_E = 200$ mA
$V_{CE} = 28$ V
typ. values
0
500
f (MHz)
1000


7Z62890
−15
−10
−5
0
$|s_{oe}|$ (dB)
$I_E = 200$ mA
$V_{CE} = 28$ V
typ. values
arg s_{oe}
−175°
arg s_{oe}
−150°
$|s_{oe}|$
−125°
−100°
−75°
0
500
f (MHz)
1000

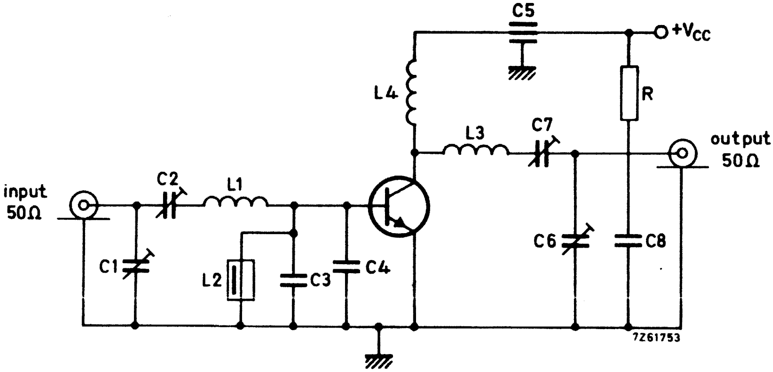
APPLICATION INFORMATION

R.F. performance in c.w. operation (Unneutralized common-emitter class B circuit)

T_h = 25 °C

V_{CC} (V)	f (MHz)	P_S (W)	P_L (W)	I_C (A)	G_p (dB)	(%)	$\overline{z_i}$ (Ω)	$\overline{Y_L}$ (mA/V)
24	470	typ. 1,0	7,0	typ. 0,42	typ. 8,5	typ. 70	–	–
28	470	< 1,0	7,0	< 0,42	> 8,5	> 60	–	–
28	470	typ. 1,0	8,0	typ. 0,38	typ. 9,0	typ. 75	1,6 + j5,5	20 – j40
28	1000	typ. 1,5	5,0	typ. 0,40	typ. 5,2	typ. 45	–	–

Test circuit for 470 MHz:



C1 = C2 = 1,8 to 18 pF film dielectric trimmer
C3 = C4 = 18 pF disc ceramic capacitor
C5 = 1 nF feed-through capacitor
C6 = C7 = 1,0 to 9,0 pF film dielectric trimmer
C8 = 0,1 μF polyester capacitor

L1 = 1 turn Cu wire (1,2 mm); int. diam. 5 mm; lead length = 2 mm
L2 = 0,47 μH choke
L3 = 2 turns closely wound enamelled Cu wire (1,2 mm); int. diam. 6,5 mm; lead length = 4 mm
L4 = 3 turns closely wound enamelled Cu wire (0,5 mm); int. diam. 4,0 mm; lead length = 5 mm

R = 10 Ω carbon

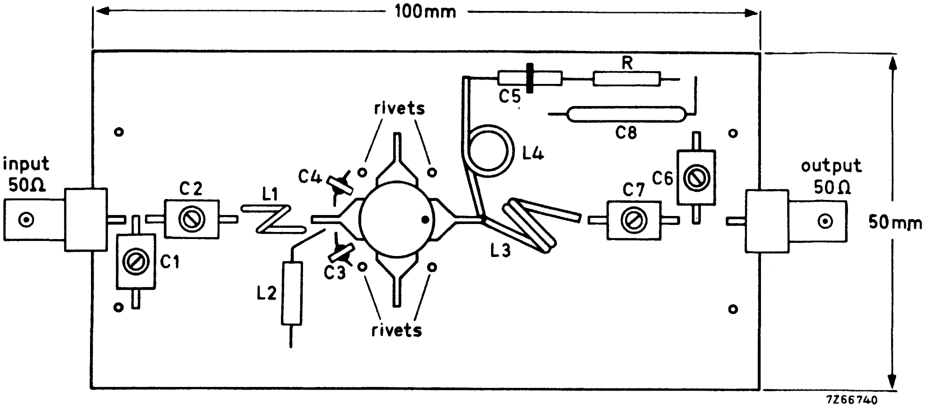
At P_L = 7,0 W and V_{CC} = 28 V, the output power at heatsink temperatures between 25 °C and 90 °C relative to that at 25 °C is diminished by typ. 10 mW/°C.

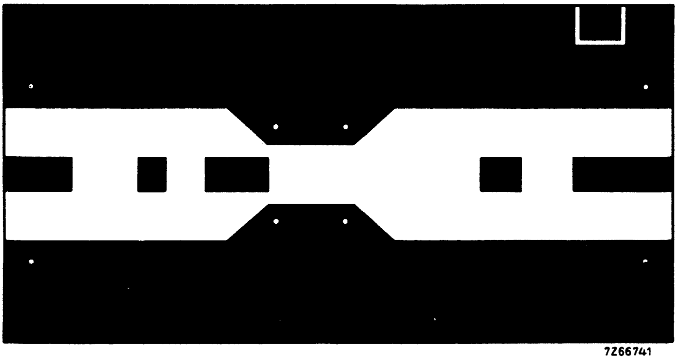
The transistor is designed to withstand full load mismatch in the test circuit under the following conditions: V_{CC} = 28 V; f = 470 MHz; T_h = 90 °C.
V.S.W.R. = 50 : 1 through all phases; P_L = 7,0 W

Component lay-out for 470 MHz test circuit see page 8.

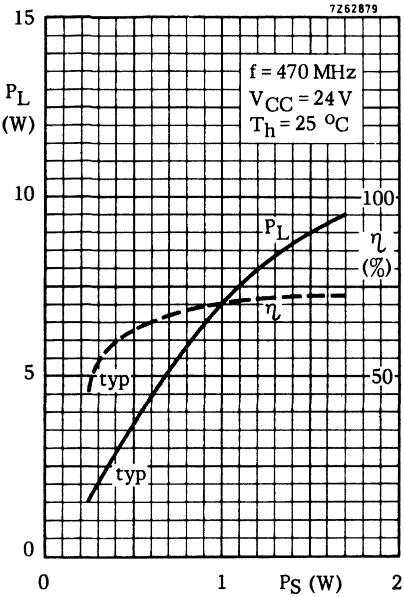
APPLICATION INFORMATION (continued)

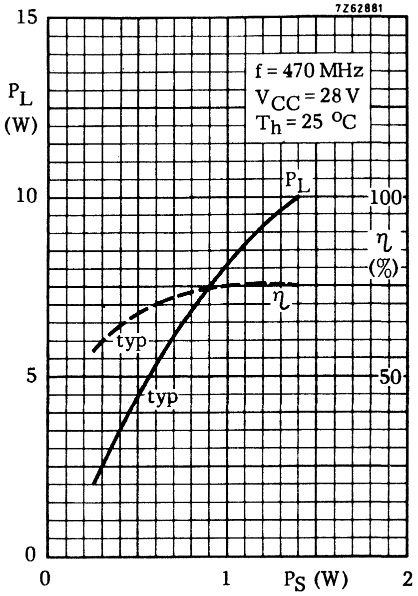
Component lay-out and printed circuit board for 470 MHz test circuit.

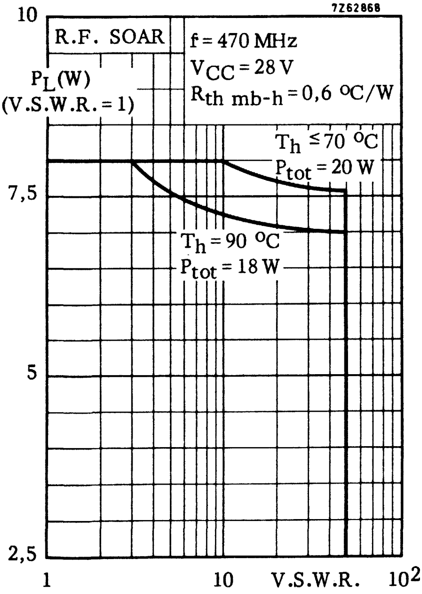




Shaded area copper
Back area completely copper clad
Material of printed circuit board: 1,5 mm epoxy fibre-glass







Indicated load power as a function of overload

The graph has been derived from an evaluation of the performance of transistors matched up to 8 W load power in the test amplifier on page 7 and subsequently subjected to various mismatch conditions at 28 V with V.S.W.R. up to 50 : 1 and elevated heatsink temperatures. This indicates a restriction to the load power matched under nominal conditions in the recommended test configuration.

U.H.F. POWER TRANSISTOR

N-P-N silicon planar epitaxial transistor intended for transmitting applications in class A, B or C with a supply voltage up to 28 V.
The transistor is resistance stabilized and is tested under severe load mismatch conditions.
It has a 1/4" capstan envelope with a moulded cap. All leads are isolated from the stud.

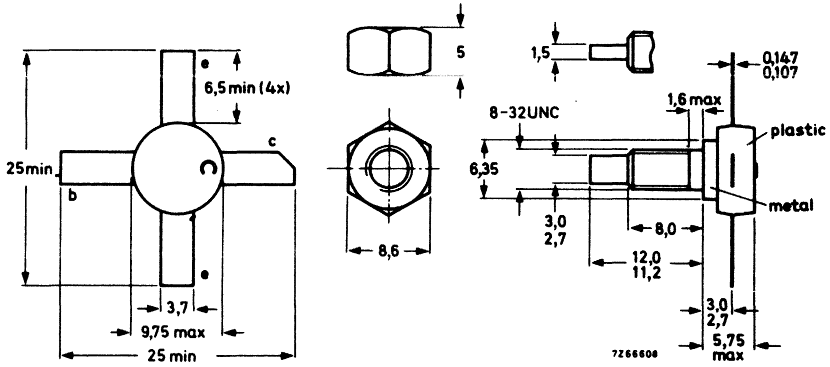
QUICK REFERENCE DATA

R.F. performance up to T_{mb} = 25 °C in an unneutralized common-emitter class B circuit.

Mode of operation	V_{CC} (V)	f (MHz)	P_S (W)	P_L (W)	I_C (A)	G_p (dB)	η (%)	$\overline{z_i}$ (Ω)	$\overline{Y_L}$ (mA/V)
c.w.	28	470	< 5	20	< 1.3	> 6	> 55	0.65+j3.9	62 − j97

MECHANICAL DATA

Dimensions in mm



Torque on nut: min. 7.5 kgcm
(0.75 Nm)
max. 8.5 kgcm
(0.85 Nm)

Diameter of clearance hole in heatsink: max. 4.17 mm
Mounting hole to have no burrs at either end. De-burring must leave surface flat; do not chamfer or countersink either end of hole.

When locking is required, an adhesive instead of a lock washer is preferred.

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

Voltages

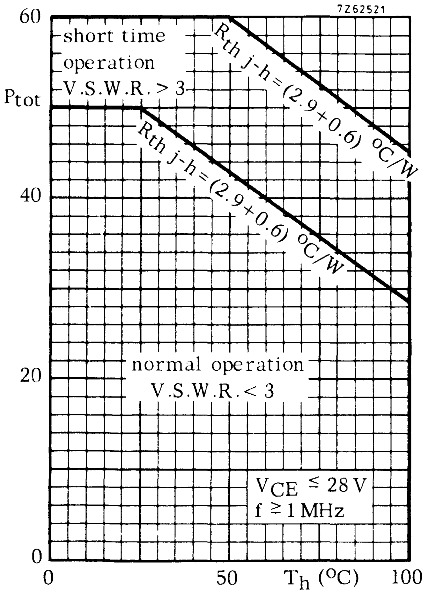
Collector-base voltage (open emitter) peak value	V_{CBOM}	max.	65	V
Collector-emitter voltage (open base)	V_{CEO}	max.	33	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4	V

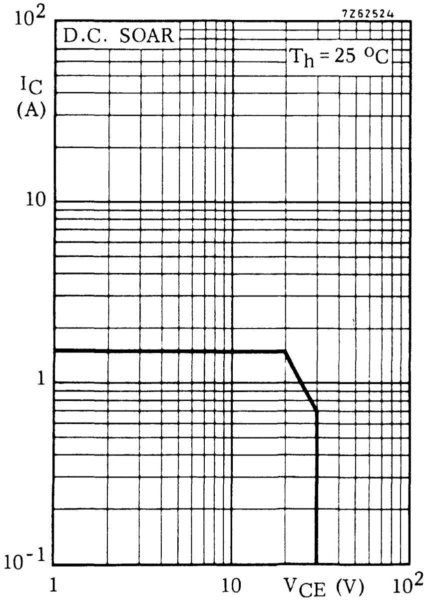
Currents

Collector current (average)	$I_{C(AV)}$	max.	2.0	A
Collector current (peak value) f > 1 MHz	I_{CM}	max.	6.0	A

Power dissipation

Total power dissipation up to T_h = 25 °C f > 1 MHz	P_{tot}	max.	50	W





Temperatures

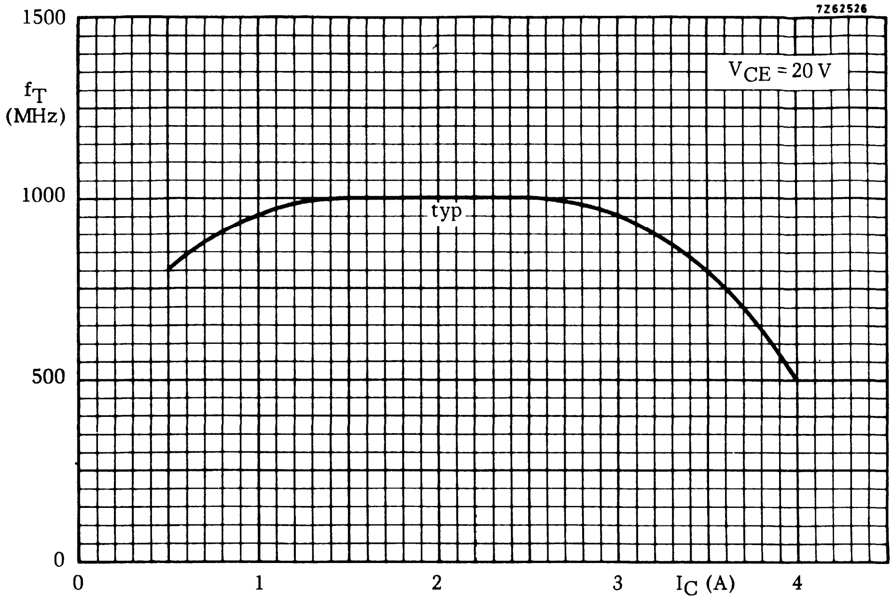
Storage temperature	T_{stg}	−30 to +200		°C
Junction temperature	T_j	max.	200	°C

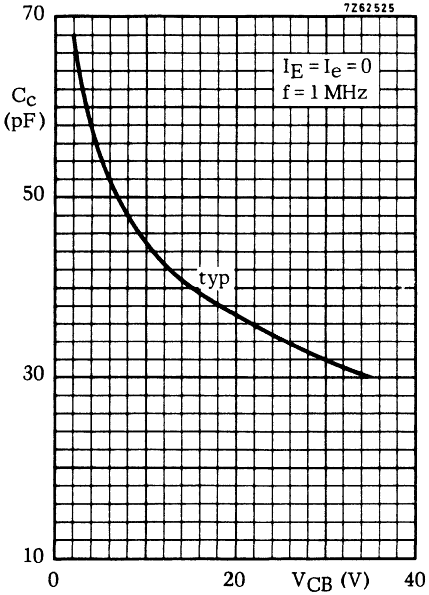
THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j-mb}$	=	2.9	°C/W
From mounting base to heatsink	$R_{th\ mb-h}$	=	0.6	°C/W

CHARACTERISTICS T_j = 25 °C unless otherwise specified

Collector cut-off current				
$I_B = 0$; $V_{CE} = 28$ V	I_{CEO}	<	10	mA
Breakdown voltages				
Collector-base voltage open emitter, $I_C = 25$ mA	$V_{(BR)CBO}$	>	65	V
Collector-emitter voltage open base, $I_C = 25$ mA	$V_{(BR)CEO}$	>	33	V
Emitter-base voltage open collector, $I_E = 10$ mA	$V_{(BR)EBO}$	>	4	V
Transient energy				
$L = 25$ mH; $f = 50$ Hz				
open base	E	>	3	mWs
$-V_{BE} = 1.5$ V; $R_{BE} = 33\ \Omega$	E	>	3	mWs
D.C. current gain				
$I_C = 1$ A; $V_{CE} = 5$ V	h_{FE}	min. typ.	15 50	
Transition frequency				
$I_C = 2$ A; $V_{CE} = 20$ V	f_T	typ.	1.0	GHz
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; $V_{CB} = 30$ V	C_c	typ. <	32 50	pF pF
Feedback capacitance at f = 1 MHz				
$I_C = 100$ mA; $V_{CE} = 30$ V	$-C_{re}$	typ.	18	pF
Collector-stud capacitance	C_{cs}	typ.	2	pF


7Z62526
1500
fT
(MHz)
1000
500
0
VCE = 20 V
typ
0
1
2
3
IC (A)
4


7Z62525
70
Cc
(pF)
50
30
10
IE = Ie = 0
f = 1 MHz
typ
0
20
VCB (V)
40

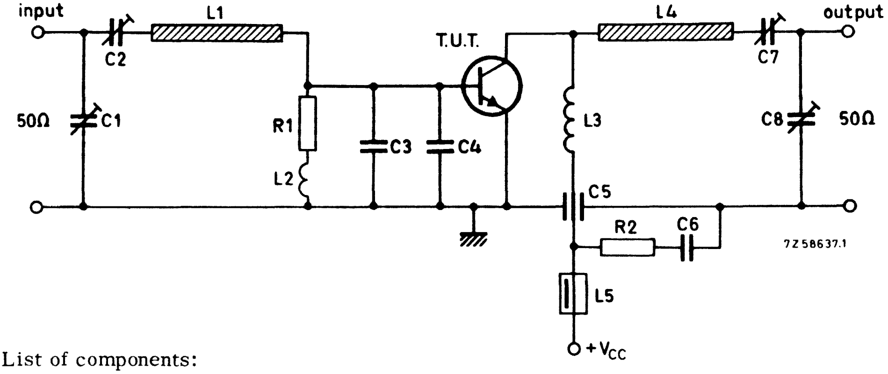
APPLICATION INFORMATION

R.F. performance in c.w. operation (Unneutralized common-emitter class B circuit)

f = 470 MHz; T_{mb} = 25 °C

V_{CC} (V)	P_S (W)	P_L (W)	I_C (A)	G_p (dB)	η (%)	$\overline{z_i}$ (Ω)	$\overline{Y_L}$ (mA/V)
28	< 5	20	< 1.3	> 6	> 55	0.65 + j3.9	62 − j97

Test circuit:



List of components:

C1 = C2 = C8 = 2 to 9 pF film dielectric trimmer (code number 2222 809 09002)
C3 = C4 = 15 pF chip capacitor
C5 = 100 pF feed through capacitor
C6 = 33 nF polyester capacitor
C7 = 2 to 18 pF film dielectric trimmer (code number 2222 809 09003)

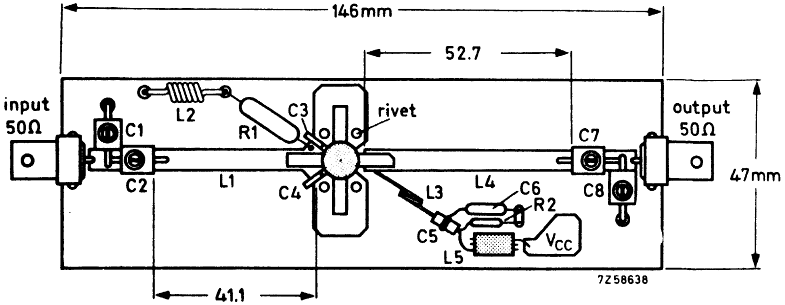
R1 = 1 Ω carbon resistor
R2 = 10 Ω carbon resistor

L1 = strip line (40.8 mm x 5.0 mm)
L2 = 13 turns closely wound enamelled Cu wire (0.5 mm); int. diam. 4.0 mm
L3 = 2 turns Cu wire (1 mm); winding pitch 1.5 mm; int. diam. 4 mm; leads 2 x 5 mm
L4 = strip line (52.4 x 5.0 mm)
L5 = ferroxcube choke coil. Z (at f = 50 MHz) = 750 Ω ±20% (code number 4312 020 36640)

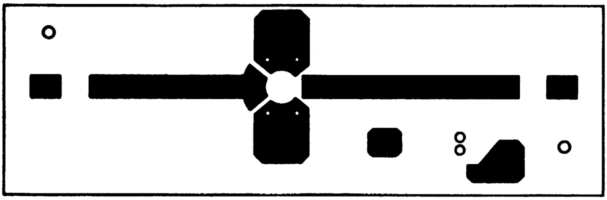
L1 and L4 are strip lines on a double Cu clad print plate with teflon fibre-glass dielectric. (ϵ_r = 2.74); thickness 1.45 mm

APPLICATION INFORMATION (continued)

Component lay-out and printed circuit board for 470 MHz test circuit.

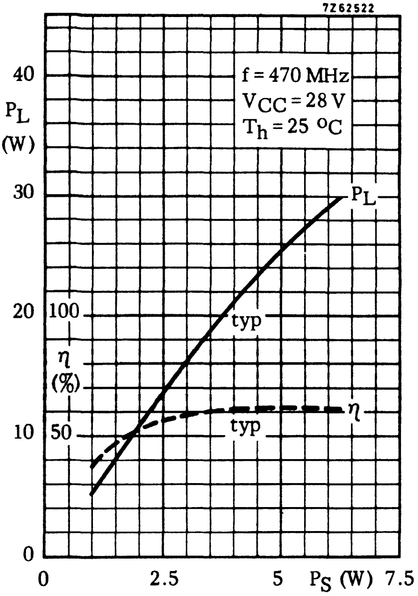


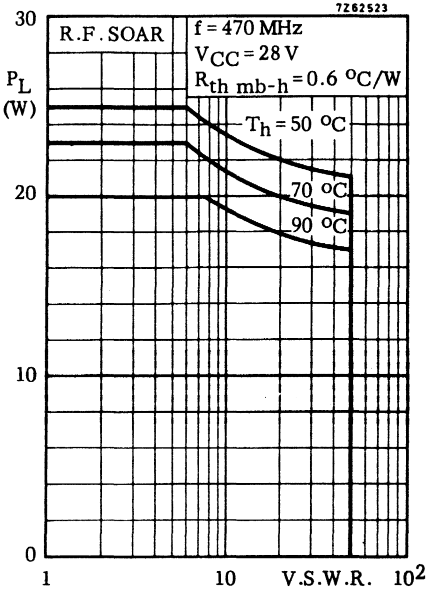
7Z58638



7Z66443

The circuit and the components are situated on one side of the teflon fibre-glass board, the other side being fully metallised to serve as earth. Earth connections are made by means of hollow rivets.





For high voltage operation, a stabilized power supply is generally used.
The graph shows the allowable output power under nominal conditions as a function of the V.S.W.R., with heat-sink temperature as parameter.

N-P-N SILICON V.H.F. POWER TRANSISTORS

Silicon high frequency power transistors in a capstan envelope, designed for mobile operation in class B.

The BLY83 is primarily intended for a.m. operation at 13.8 V but is also suitable for f.m. operation at 24 V.

The BLY84 is primarily intended for f.m. operation at 13.8 V.

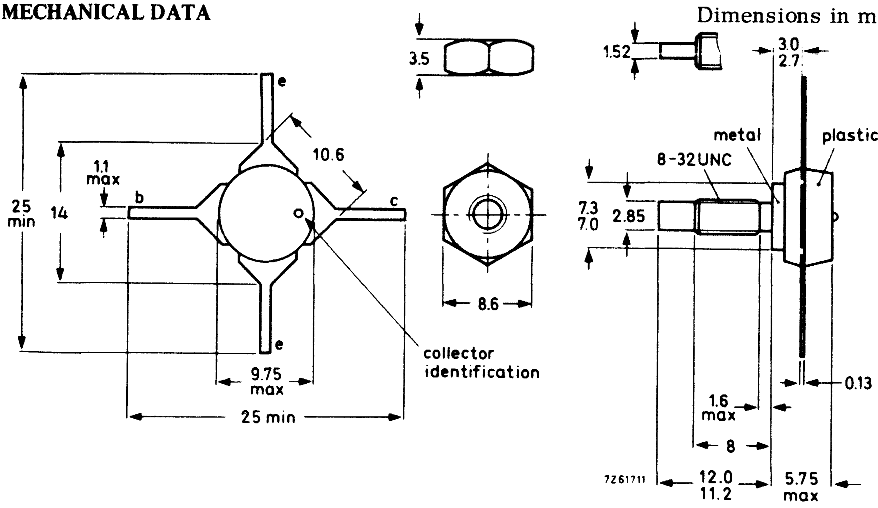
QUICK REFERENCE DATA

R.F. performance up to T_h = 40 °C

Type No.	Mode of operation	V_{CC} (V)	f (MHz)	f_{mod} (kHz)	P_S (W)	P_L (W)	$P_{L(car)}$ (W)	I_C (A)	G_p (dB)	η (%)	d_{tot} (%)	m (%)
BLY83	c.w.	24	175	-	1.35	13	-	0.84	9.8	65	-	-
BLY84	c.w.	13.8	175	-	3.4	13	-	1.2	5.8	79	-	-
BLY84	c.w.	13.8	80	-	0.5	13.25	-	1.2	14.2	80	-	-
BLY83	a.m.	13.8	175	1	0.35	-	7	0.66	13	77	< 5	80
BLY83	a.m.	13.8	80	1	0.06	-	7.5	0.7	21	77	< 5	80

MECHANICAL DATA

Dimensions in mm



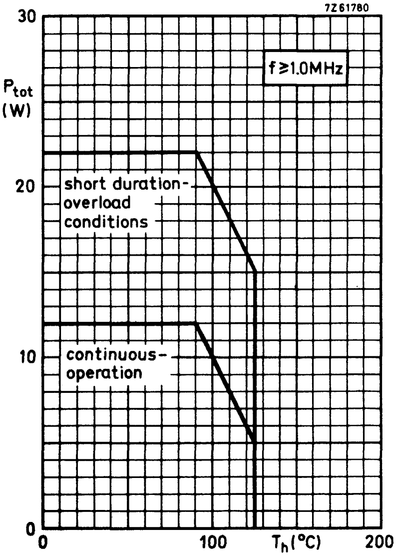
Diameter of clearance hole in heatsink: max. 4.17 mm.
Mounting hole to have no burrs at either end. De-burring must leave surface flat; do not chamfer or coutersink either end of hole.

Torque on nut: min. 7.5 kg cm
(0.75 Newton-metres)
max. 8.5 kg cm
(0.85 Newton-metres)

When locking is required, an adhesive instead of a lock washer is required.

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

Voltages			BLY83	BLY84	
Collector-base voltage (open emitter) peak value	V_{CBOM}	max.	66	40	V
Collector-emitter voltage (open base)	V_{CEO}	max.	33	20	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4		V
Currents					
Collector-current (peak value) f < 1.0 MHz	I_{CM}	max.	2.5		A
Collector-current (peak value) f > 1.0 MHz	I_{CM}	max.	7.5		A
Power dissipation					
Total power dissipation up to $T_h = 90\ ^oC$	P_{tot}	max.	12		W



Temperature

Storage temperature	T_{stg}	−65 to +150		^oC

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			BLY83	BLY84	
Breakdown voltages					
Collector-base voltage open emitter; I_C = 10 mA	$V_{(BR)CBO}$	>	66	40	V
Collector-emitter voltage V_{BE} = 0; I_C = 10 mA	$V_{(BR)CES}$	>	66	40	V
Collector-emitter voltage open base; I_C = 50 mA	$V_{(BR)CEO}$	>	33	20	V
Emitter-base voltage open collector; I_E = 1 mA	$V_{(BR)EBO}$	>	4	4	V
D.C. current gain		>	10	10	
I_C = 1.0 A; V_{CE} = 5.0 V	h_{FE}	typ.	60	60	
		<	220	-	
Transition frequency					
I_C = 1.0 A; V_{CE} = 5.0 V; f = 100 MHz	f_T	>	250	250	MHz
		typ.	450	450	MHz
Collector capacitance at f = 1 MHz					
I_E = I_e = 0; V_{CB} = 10 V	C_c	typ.	34	37	pF
		<	45	45	pF
Emitter capacitance at f = 1 MHz					
I_C = I_c = 0; V_{EB} = 0	C_e	>	100	100	pF
		typ.	155	155	pF

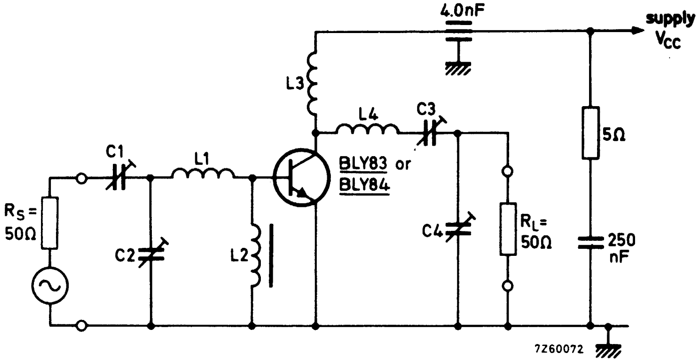
APPLICATION INFORMATION

R.F. performance in c.w. operation at f = 175 MHz

T_h up to 40 °C

Type No.	V_{CC} (V)	P_S (W)	P_L (W)	I_C (A)	G_p (dB)	η (%)
BLY84	13.8	1.20	7.0	0.66	7.6	77
BLY84	13.8	3.40	13.0	1.20	5.8	79
BLY83	24.0	1.35	13.0	0.84	9.8	65

Test circuit



List of components:

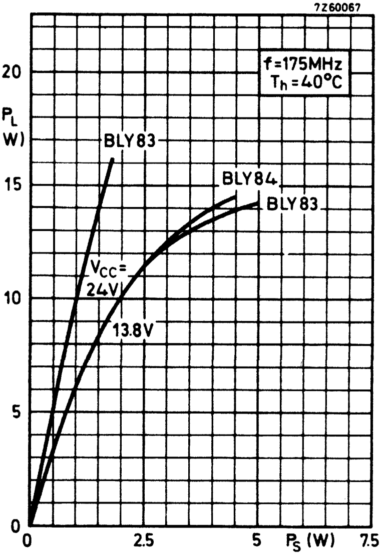
C1 = C3 = C4 = 30 pFmax } air trimmers
C2 = 60 pF max }

L1 = 25.4 mm of straight Cu wire (1 mm)

L2 = 3 turns of Cu wire (0.5 mm) on Ferrite FX1115

L3 = 3 turns of Cu wire (1.3 mm), int. diam. 9.5 mm, 1 = 9.5 mm

L4 = 2 turns of Cu wire (1.6 mm), int. diam. 12.7 mm, 1 = 9.5 mm


7Z60067
f = 175 MHz
T_h = 40 °C
P_L (W)
20
15
10
5
0
BLY83
BLY84
BLY83
V_{CC} = 24 V
13.8 V
0
2.5
5
P_S (W)
7.5

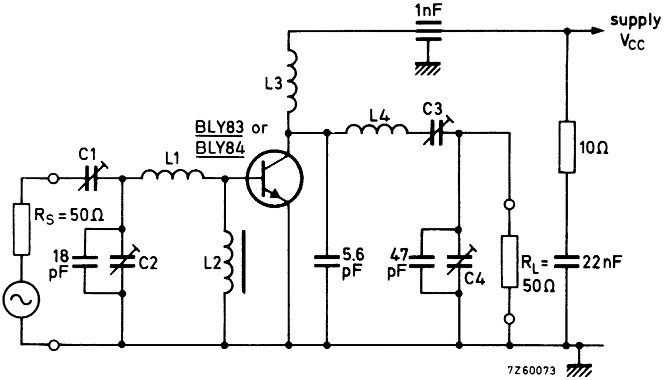
APPLICATION INFORMATION

R.F. performance in c.w. operation at 80 MHz

T_h up to 40 °C

Type No.	V_{CC} (V)	P_S (W)	P_L (W)	I_C (A)	G_P (dB)	η (%)
BLY84	6.9	0.5	5.3	0.96	10.3	80
BLY84	13.8	0.5	13.25	1.2	14.2	80

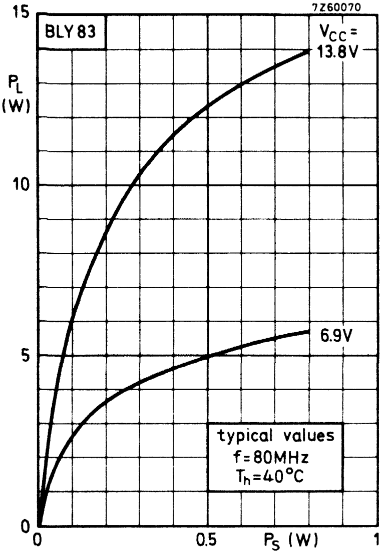
Test circuit

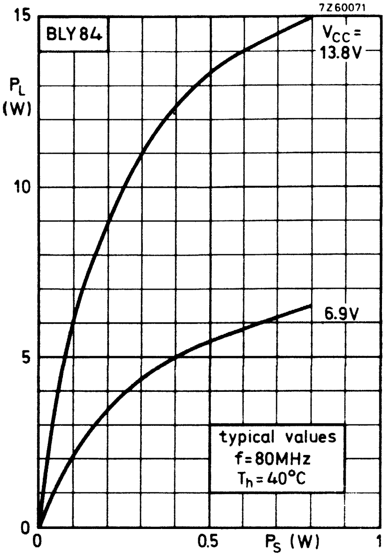


List of components:

C1 = C2 = C3 = C4 = 4 to 29 pF air trimmers

L1 = 4 turns Cu wire (1 mm); int. diam. 6.3 mm; l = 8.0 mm
L2 = 2 turns Cu wire (0.35 mm) on Ferrite bead FX1115
L3 = 5 turns closely wound Cu wire (1 mm); int. diam. 6.3 mm
L4 = 5 turns Cu wire (1.3 mm); int. diam. 9.5 mm; l = 12 mm


7Z60070
BLY83
P_L (W)
15
10
5
0
V_{CC} = 13.8V
6.9V
typical values
f = 80MHz
T_h = 40°C
0
0.5
P_S (W)
1

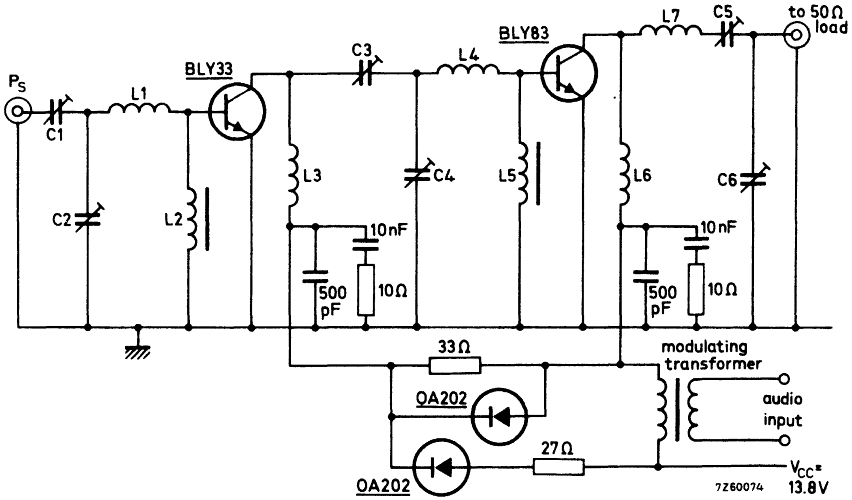

7Z60071
BLY84
P_L (W)
15
10
5
0
V_{CC} = 13.8V
6.9V
typical values
f = 80MHz
T_h = 40°C
0
0.5
P_S (W)
1

APPLICATION INFORMATION

R.F. performance in a 7 W a.m. transmitter at 175 MHz

V_{CC} = 13.8 V; f_{mod} = 1 kHz

Type No.	f (MHz)	P_S (W)	P_L (car) (W)	I_C dr. (A)	I_C ampl. (A)	G_p (dB)	η (%)	m (%)	d_{tot} (%)
BLY83	175	0.35	7.0	0.22	0.66	13	77	80	< 5



List of components

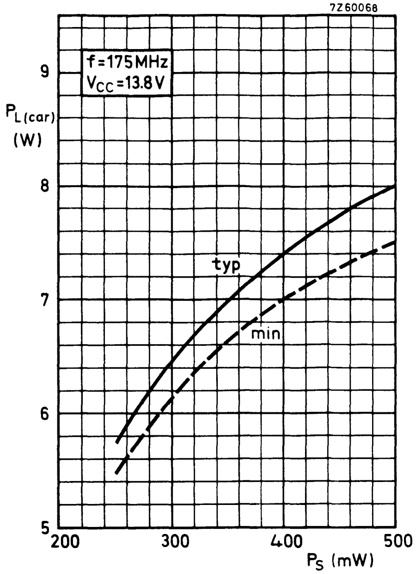
C1 = C2 = C3 = C4 = C5 = C6 = 4 to 29 pF air trimmers

L1 = L4 = 3 turns of 18 s.w.g. en.cu. d = 6.4 mm, l = 5.0 mm

L3 = L6 = 5 turns of 18 s.w.g. en.cu. d = 6.4 mm, l = 10 mm

L7 = 3 turns of 16 s.w.g. en.cu. d = 10 mm, l = 10 mm

L2 = L5 = 2 turns of 26 s.w.g. en.cu. wound on ferrite bead FX1115



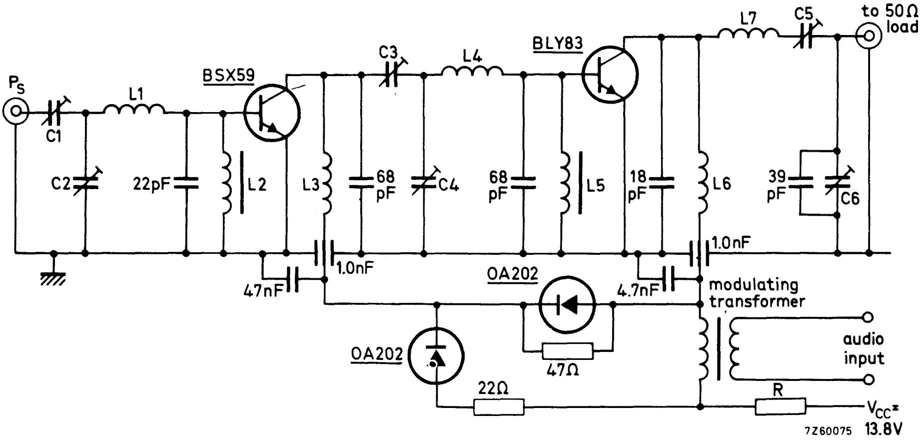
Aerial carrier power versus c.w. drive power

APPLICATION INFORMATION

R.F. performance in a 7 W a.m. transmitter at 80 MHz

V_{CC} = 13.8 V; f_{mod} = 1 kHz

Type No.	f (MHz)	P_S (W)	P_L (car) (W)	I_C dr. (A)	I_C ampl. (A)	G_P (dB)	η (%)	m (%)	d_{tot} (%)
BLY83	80	0.06	7.5	0.06	0.7	21	77	80	< 5



List of components:

C1 = C2 = C3 = C4 = C5 = C6 = 4 to 29 pF air trimmers

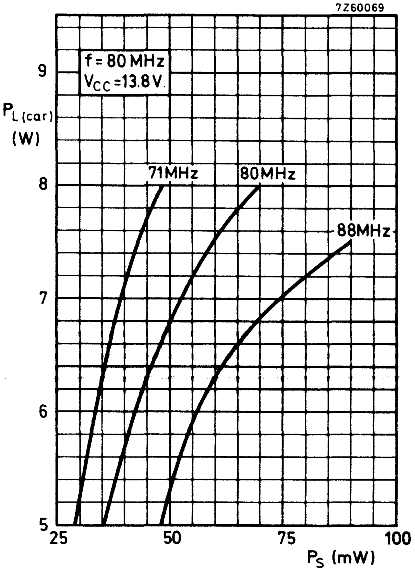
L1 = L4 = 5 turns of 18 s.w.g. en.cu. d = 6.3 mm, l = 9.0 mm

L3 = L6 = 3 turns of 18 s.w.g. en.cu. d = 7.0 mm, l = 6.0 mm

L7 = 6 turns of 14 s.w.g. cu. d = 10 mm, l = 13 mm

L2 = L5 = 1 turn of 26 s.w.g. en.cu. wound on ferrite bead FX1115

R This resistor is incorporated in the equipment to reduce the carrier level to 8 W or below.



Aerial carrier power versus c.w. drive power

V.H.F. POWER TRANSISTOR

N-P-N epitaxial planar transistor intended for use in class A, B and C operated mobile, industrial and military transmitters with a supply voltage of 13.5 V. The transistor is resistance stabilized. Every transistor is tested under severe load mismatch conditions with a supply overvoltage to 16.5 V. It has a $\frac{1}{4}$" capstan envelope with a moulded cap. All leads are isolated from the stud.

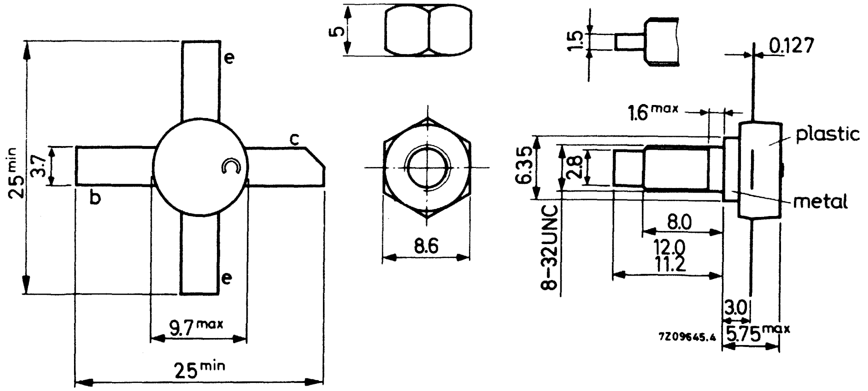
QUICK REFERENCE DATA

R.F. performance up to T_{mb} = 25 °C in an unneutralised common-emitter class B circuit.

Mode of operation	V_{CC} (V)	f (MHz)	P_S (W)	P_L (W)	I_C (A)	G_p (dB)	η (%)	$\bar{z}_i$ (Ω)	$\bar{Y}_L$ (mA/V)
c.w.	13.5	175	< 1.0	8	< 0.85	> 9	> 70	2.75+j1.5	74-j18
c.w.	12.5	175	typ. 1.0	8	typ. 0.91	typ. 9	typ. 70		

MECHANICAL DATA

Dimensions in mm



Torque on nut: min. 7.5 kg cm
(0.75 Newton metres)
max. 8.5 kg cm
(0.85 Newton metres)

Diameter of clearance hole in heatsink: max. 4.17 mm.
Mounting hole to have no burrs at either end. De-burring must leave surface flat; do not chamfer or countersink either end of hole.

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

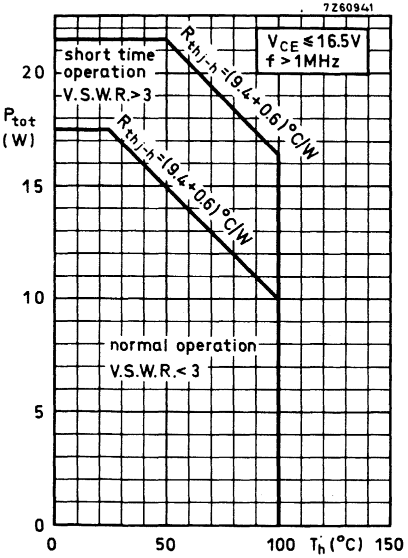
Collector-base voltage (open emitter) peak value	V_{CBOM}	max.	36	V
Collector-emitter voltage (open base)	V_{CEO}	max.	18	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4	V

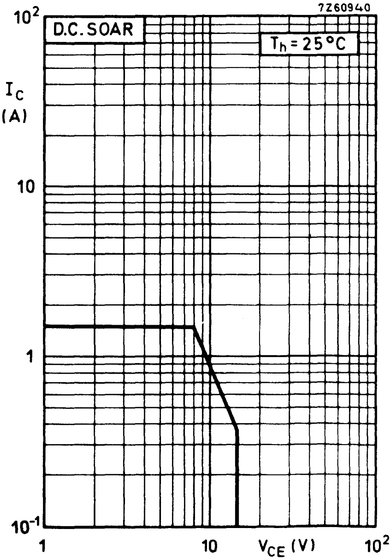
Currents

Collector current (average)	$I_{C(AV)}$	max.	1.25	A
Collector current (peak value) f > 1 MHz	I_{CM}	max.	3.75	A

Power dissipation

Total power dissipation up to T_h = 25 °C f > 1 MHz	P_{tot}	max.	17.5	W





Temperature

Storage temperature	T_{stg}		−30 to +200	°C
Operating junction temperature	T_j	max.	200	°C

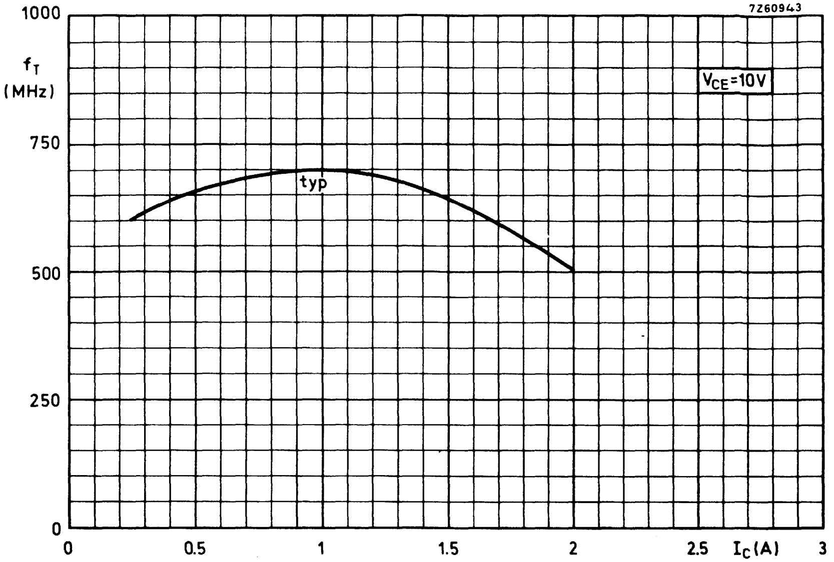
THERMAL RESISTANCE

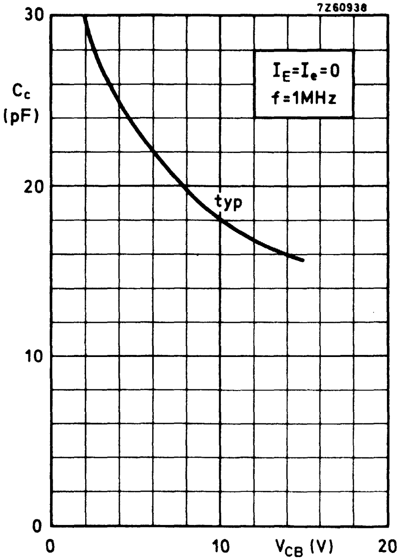
From junction to mounting base	$R_{th\ j-mb}$	=	9.4	°C/W
From mounting base to heatsink	$R_{th\ mb-h}$	=	0.6	°C/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current				
$I_B = 0$; $V_{CE} = 14$ V	I_{CEO}	<	5	mA
Breakdown voltages				
Collector-base voltage open emitter, $I_C = 1$ mA	$V_{(BR)CBO}$	>	36	V
Collector-emitter voltage open base, $I_C = 10$ mA	$V_{(BR)CEO}$	>	18	V
Emitter-base voltage open collector, $I_E = 1$ mA	$V_{(BR)EBO}$	>	4	V
Transient energy				
$L = 25$ mH; $f = 50$ Hz				
open base	E	>	0.5	mWs
$-V_{BE} = 1.5$ V; $R_{BE} = 33\,\Omega$	E	>	0.5	mWs
D.C. current gain				
$I_C = 500$ mA; $V_{CE} = 5$ V	h_{FE}	>	5	
Transition frequency				
$I_C = 500$ mA; $V_{CE} = 10$ V	f_T	typ.	700	MHz
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; $V_{CB} = 15$ V	C_c	typ. <


7Z60943
1000
f_T (MHz)
750
500
250
0
$V_{CE}=10V$
typ
0
0.5
1
1.5
2
2.5
I_C (A)
3


7Z60938
30
C_c (pF)
20
10
0
$I_E=I_e=0$
$f=1MHz$
typ
0
10
V_{CB} (V)
20

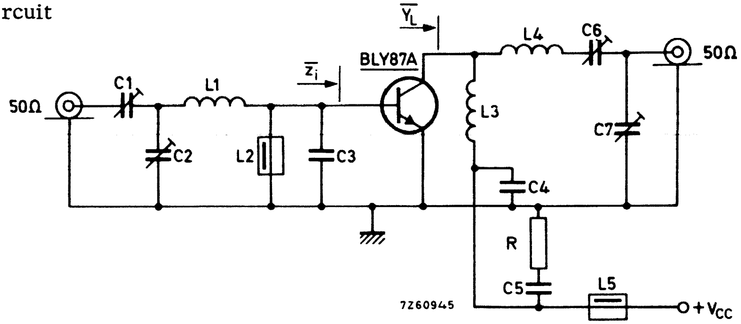
APPLICATION INFORMATION

R.F. performance in c.w. operation (unneutralised common-emitter class B circuit)

f = 175 MHz; T_{mb} up to 25 °C

V_{CC}(V)	P_S(W)	P_L(W)	I_C (A)	G_p(dB)	η(%)	$\bar{z}_i$ (Ω)	$\bar{Y}_L$(mA/V)
13.5	< 1.0	8	< 0.85	> 9	> 70	2.75+j1.5	74-j18
12.5	typ. 1.0	8	typ. 0.91	typ. 9	typ. 70		

Test circuit



C1 = 2.5 to 20 pF film dielectric trimmer (code number 2222 809 07004)
C2 = C6 = C7 = 4 to 40 pF film dielectric trimmer (code number 2222 809 07008)
C3 = 47 pF ceramic
C4 = 100 pF ceramic
C5 = 150 nF polyester

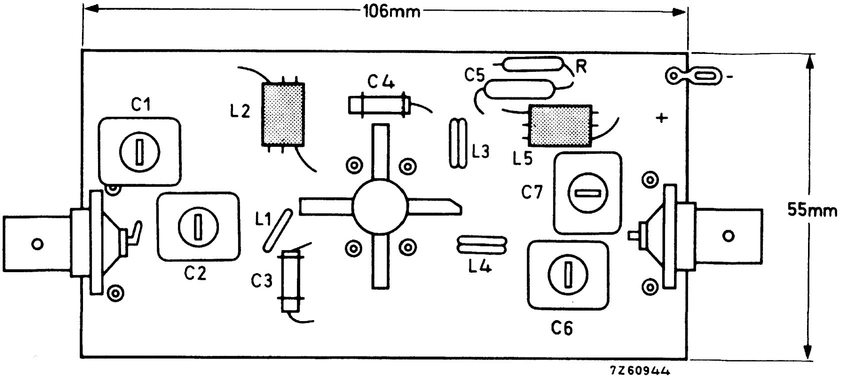
L1 = 0.5 turn enamelled Cu wire (1.5 mm); int. diam. 6 mm; leads 2 x 10 mm
L2 = L5 = ferroxcube choke (code number 4312 020 36640)
L3 = 2.5 turns closely wound enamelled Cu wire (1.5 mm); int. diam. 6 mm; leads 2 x 10 mm
L4 = 4.5 turns enamelled Cu wire (1.5 mm); int. diam. 6 mm; leads 2 x 10 mm

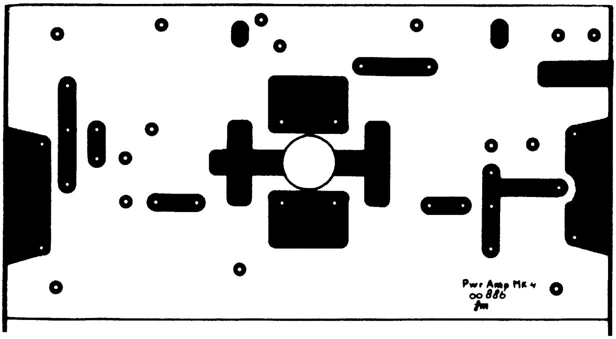
R = 10 Ω carbon

Component lay-out for 175 MHz test circuit see page 6

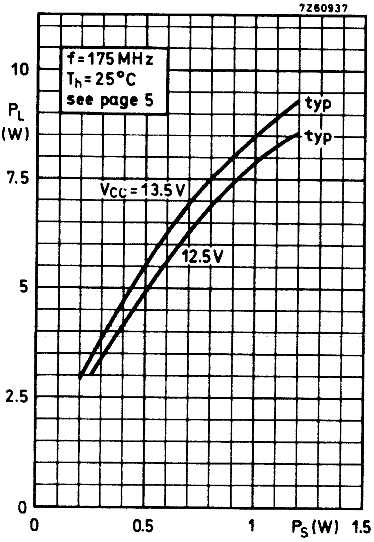
APPLICATION INFORMATION (continued)

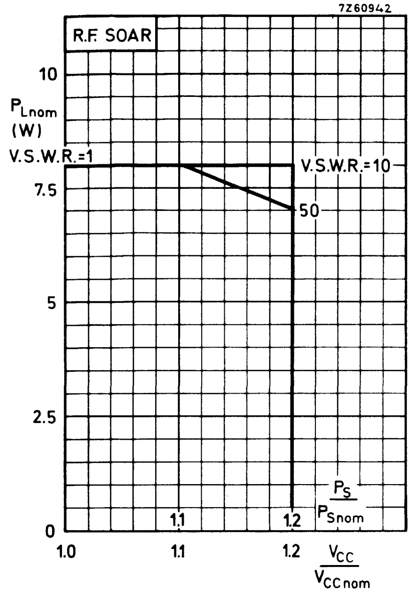
Component lay-out and printed circuit board for 175 MHz test circuit.

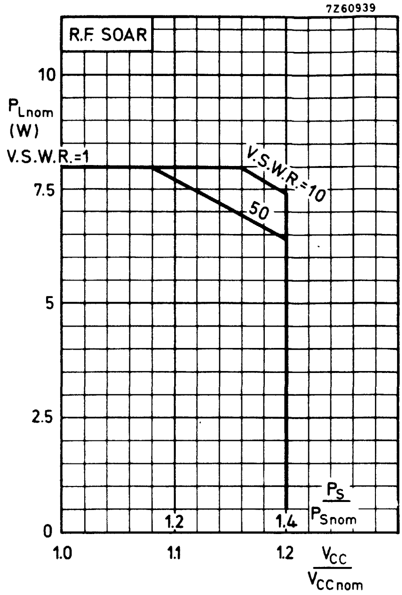




The circuit and the components are situated on one side of the epoxy fibre-glass board, the other side being fully metallised to serve as earth. Earth connections are made by means of hollow rivets.


7Z60937
f = 175 MHz
T_h = 25°C
see page 5
P_L (W)
10
7.5
5
2.5
0
V_{CC} = 13.5 V
12.5 V
typ
typ
0
0.5
1
P_S (W)
1.5





Conditions for R.F. SOAR:

f = 175 MHz $P_{Snom} = P_S$ at $V_{CC} = V_{CCnom}$ and V.S.W.R. = 1
T_h = 70 °C $R_{th\ mb\text{-}h} \leqq 0.6$ °C/W
V_{CCnom} = 12.5 or 13.5 V see also page 5

The transistor has been developed for use with unstabilized supply voltages. As the output power and drive power increase with the supply voltage, the nominal output power must be derated in accordance with the graphs above for safe operation at supply voltages other than the nominal. The graphs show the allowable output power under nominal conditions, as a function of the supply overvoltage ratio, with V.S.W.R. as parameter.
The left hand graph applies to the situation in which the drive (P_S/P_{Snom}) increases linearly with supply overvoltage ratio.
The right hand graph shows the derating factor to be applied when the drive (P_S/P_{Snom}) increases as the square of the supply overvoltage ratio (V_{CC}/V_{CCnom}).
Depending on the operating conditions, the appropriate derating factor may lie in the region between the linear and the square-law functions.

V.H.F. POWER TRANSISTOR

N-P-N epitaxial planar transistor intended for use in class A, B and C operated mobile, industrial and military transmitters with a supply voltage of 13.5 V. The transistor is resistance stabilized. Every transistor is tested under severe load mismatch conditions with a supply overvoltage to 16.5 V. It has a ¼" capstan envelope with a moulded cap. All leads are isolated from the stud.

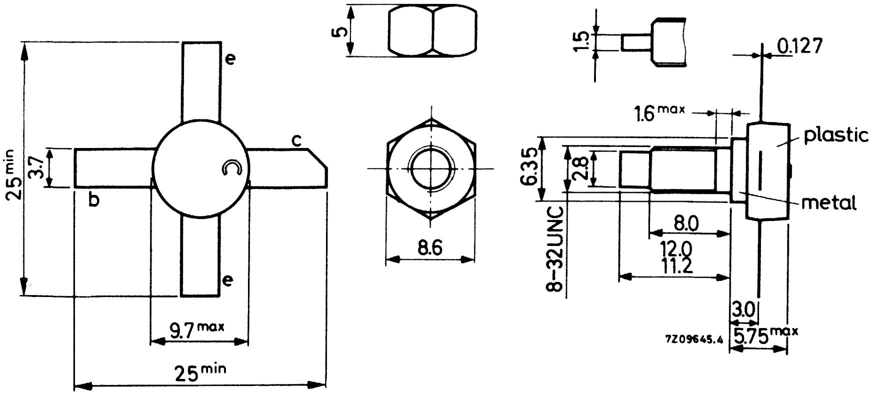
QUICK REFERENCE DATA

R.F. performance up to T_{mb} = 25 °C in an unneutralised common-emitter class B circuit.

Mode of operation	V_{CC} (V)	f (MHz)	P_S (W)	P_L (W)	I_C (A)	G_p (dB)	η (%)	$\bar{z}_i$ (Ω)	$\bar{Y}_L$ (mA/V)
c.w.	13.5	175	< 2.65	15	< 1.71	> 7.5	> 65	2.3+j2.5	120-j7.8
c.w.	12.5	175	typ. 2.65	15	typ. 1.85	typ. 7.5	typ. 65		

MECHANICAL DATA

Dimensions in mm



Torque on nut: min. 7.5 kg cm
(0.75 Newton metres)
max. 8.5 kg cm
(0.85 Newton metres)

Diameter of clearance hole in heatsink: max. 4.17 mm.
Mounting hole to have no burrs at either end. De-burring must leave surface flat; do not chamfer or countersink either end of hole.

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

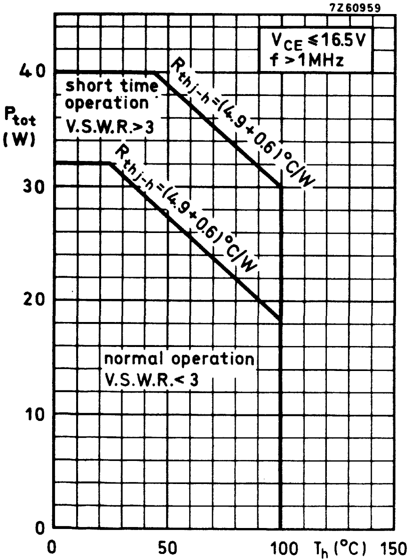
Collector-base voltage (open emitter) peak value	V_{CBOM}	max.	36	V
Collector-emitter voltage (open base)	V_{CEO}	max.	18	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4	V

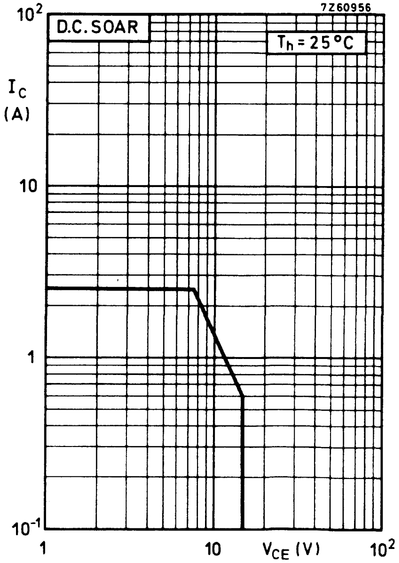
Currents

Collector current (average)	$I_{C(AV)}$	max.	2.5	A
Collector (peak value) f > 1 MHz	I_{CM}	max.	7.5	A

Power dissipation

Total power dissipation up to T_h = 25 °C f > 1 MHz	P_{tot}	max.	32	W





Temperature

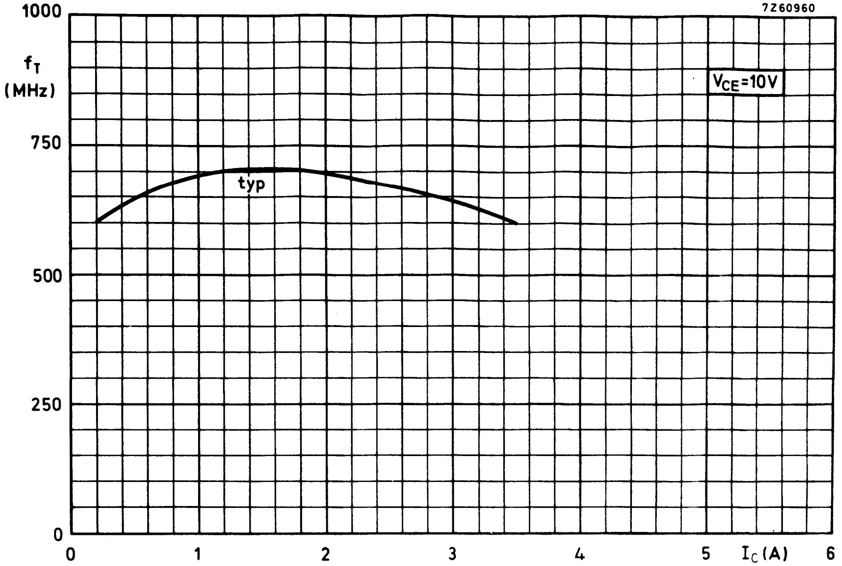
Storage temperature	T_{stg}		−30 to +200	°C
Operating junction temperature	T_j	max.	200	°C

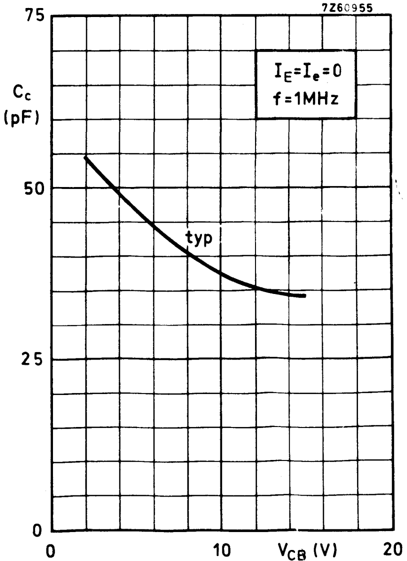
THERMAL RESISTANCE

From junction to mounting base	$R_{th\,j-mb}$	=	4.9	°C/W
From mounting base to heatsink	R_{mb-h}	=	0.6	°C/W

CHARACTERISTICS T_j = 25 °C unless otherwise specified

Collector cut-off current				
$I_B = 0$; $V_{CE} = 14$ V	I_{CEO}	<	10	mA
Breakdown voltages				
Collector-base voltage open emitter, $I_C = 3$ mA	$V_{(BR)CBO}$	>	36	V
Collector-emitter voltage open base, $I_C = 25$ mA	$V_{(BR)CEO}$	>	18	V
Emitter-base voltage open collector; $I_E = 3$ mA	$V_{(BR)EBO}$	>	4	V
Transient energy				
$L = 25$ mH; $f = 50$ Hz				
open base	E	>	2.0	mWs
$-V_{BE} = 1.5$ V; $R_{BE} = 33\ \Omega$	E	>	4.5	mWs
D.C. current gain				
$I_C = 500$ mA; $V_{CE} = 5$ V	h_{FE}	>	5	
Transition frequency				
$I_C = 1$ A; $V_{CE} = 10$ V	f_T	typ.	700	MHz
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; $V_{CB} = 15$ V	C_c	typ. <	34 40	pF pF
Feedback capacitance at f = 1 MHz				
$I_C = 100$ mA; $V_{CE} = 15$ V	$-C_{re}$	typ.	25	pF
Collector-stud capacitance	C_{cs}	typ.	2	pF


7Z60960
1000
f_T (MHz)
750
500
250
0
0
1
2
3
4
5
I_C (A)
6
V_{CE}=10V
typ


7Z60955
75
C_c (pF)
50
25
0
0
10
V_{CB} (V)
20
$I_E = I_e = 0$
f = 1MHz
typ

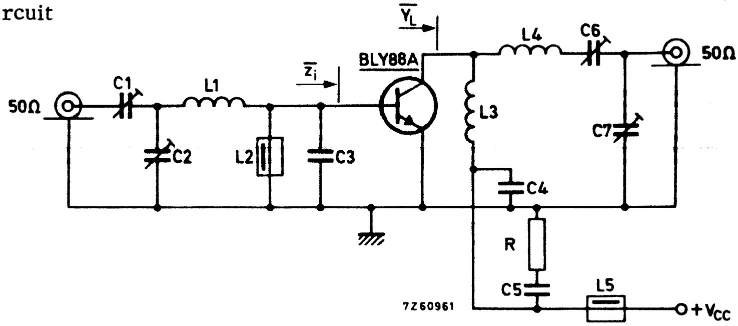
APPLICATION INFORMATION

R. F. performance in c. w. operation (unneutralised common-emitter class B circuit)

f = 175 MHz; T_{mb} up to 25 °C

V_{CC}(V)	P_S(W)	P_L(W)	I_C(A)	G_p(dB)	η(%)	$\bar{z}_i$(Ω)	$\bar{Y}_L$(mA/V)
13.5	< 2.65	15	< 1.71	> 7.5	> 65	2.3+j2.5	120-j7.8
12.5	typ. 2.65	15	typ. 1.85	typ. 7.5	typ. 65		

Test circuit



C1=	2.5 to 20 pF	film dielectric trimmer (code number 2222 809 07004)
C2=C6=C7=	4 to 40 pF	film dielectric trimmer (code number 2222 809 07008)
C3=	47 pF	ceramic
C4=	100 pF	ceramic
C5=	150 nF	polyester

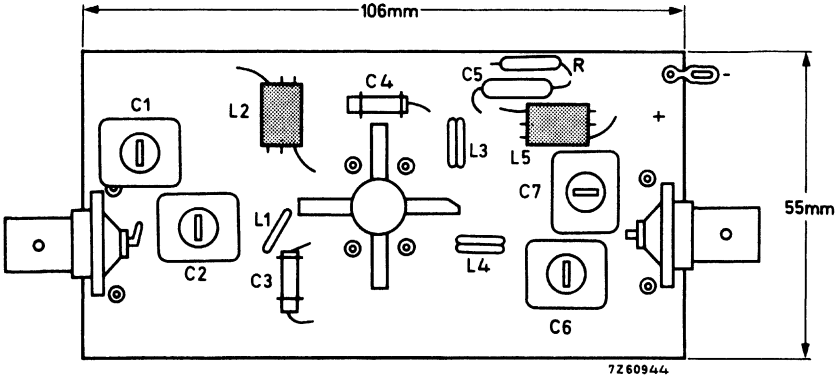
L1=	0.5 turn enamelled Cu wire (1.5 mm); int. diam. 6 mm; leads 2 x 10 mm
L2=L5=	ferroxcube choke (code number 4312 020 36640)
L3=	2.5 turns closely wound enamelled Cu wire (1.5 mm); int. diam. 6 mm; leads 2 x 10 mm
L4=	2.5 turns enamelled Cu wire (1.5 mm); int. diam. 6 mm; leads 2 x 10 mm

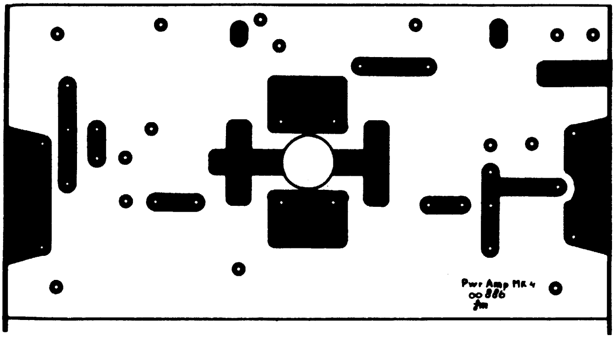
R = 10 Ω carbon

Component lay-out for 175 MHz test circuit see page 6.

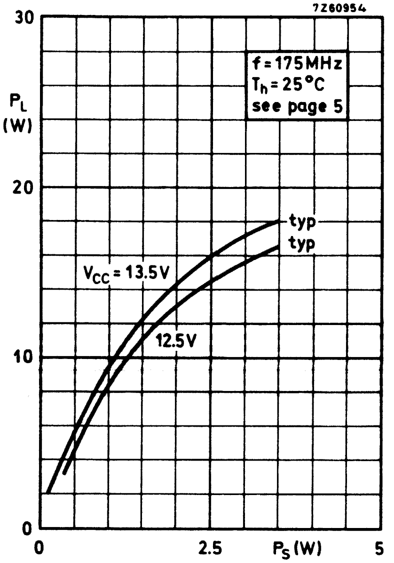
APPLICATION INFORMATION (continued)

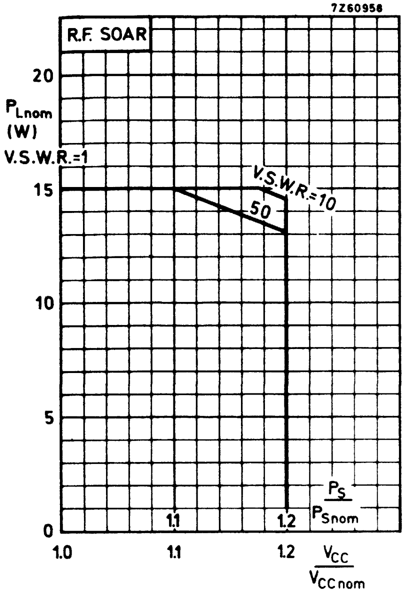
Component lay-out and printed circuit board for 175 MHz test circuit.

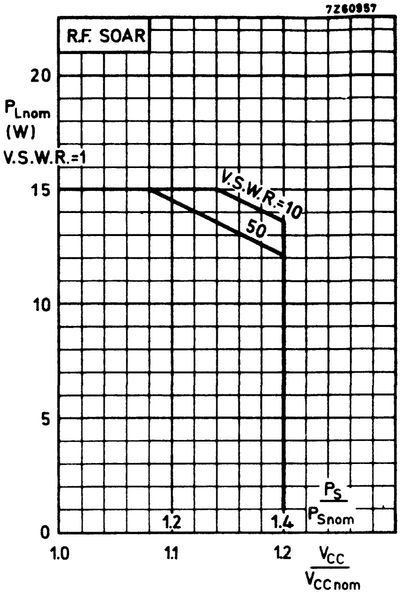




The circuit and the components are situated on one side of the epoxy fibre-glass board, the other side being fully metallised to serve as earth. Earth connections are made by means of hollow rivets.


7Z60954
30
20
10
0
P_L (W)
f = 175 MHz
T_h = 25 °C
see page 5
typ
typ
V_{CC} = 13.5 V
12.5 V
0
2.5
P_S (W)
5





Conditions for R.F. SOAR:

f = 175 MHz $P_{Snom} = P_S$ at $V_{CC} = V_{CCnom}$ and V.S.W.R. = 1
T_h = 70 °C $R_{th\ mb\text{-}h} = 0.6$ °C/W
V_{CCnom} = 12.5 or 13.5 V   see also page 5

The transistor has been developed for use with unstabilized supply voltages. As the output power and drive power increase with the supply voltage, the nominal output power must be derated in accordance with the graphs above for safe operation at supply voltages other than the nominal. The graphs show the allowable output power under nominal conditions, as a function of the supply overvoltage ratio, with V. S. W. R. as parameter.
The left hand graph applies to the situation in which the drive (P_S/P_{Snom}) increases linearly with supply overvoltage ratio.
The right hand graph shows the derating factor to be applied when the drive (P_S/P_{Snom}) increases as the square of the supply overvoltage ratio (V_{CC}/V_{CCnom}).
Depending on the operating conditions, the appropriate derating factor may lie in the region between the linear and the square-law functions.

V.H.F. POWER TRANSISTOR

N-P-N epitaxial planar transistor intended for use in class A, B and C operated mobile, industrial and military transmitters with a supply voltage of 13.5 V. The transistor is resistance stabilized. Every transistor is tested under severe load mismatch conditions with a supply overvoltage to 16.5 V. It has a $\frac{1}{4}$" capstan envelope with a moulded cap. All leads are isolated from the stud.

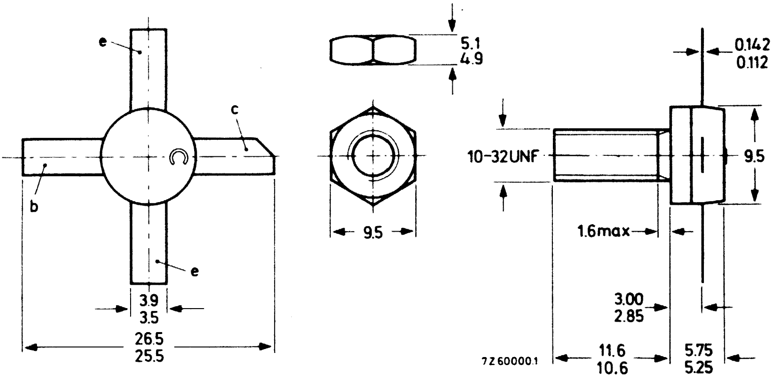
QUICK REFERENCE DATA

R.F. performance up to T_{mb} = 25 °C in an unneutralised common-emitter class B circuit.

Mode of operation	V_{CC} (V)	f (MHz)	P_S (W)	P_L (W)	I_C (A)	G_p (dB)	η (%)	$\bar{z}_i$ (Ω)	$\bar{Y}_L$ (mA/V)
c.w.	13.5	175	< 6.25	25	<2.64	> 6	>70	1.7+j1.4	209+j13.7

MECHANICAL DATA

Dimensions in mm



Torque on nut: min. 15 kg cm
(1.5 Newton metres)
max. 17 kg cm
(1.7 Newton metres)

Diameter of clearance hole in heatsink: max. 5.0 mm.
Mounting hole to have no burrs at either end.
De-burring must leave surface flat; do not chamfer or countersink either end of hole.

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

Voltages

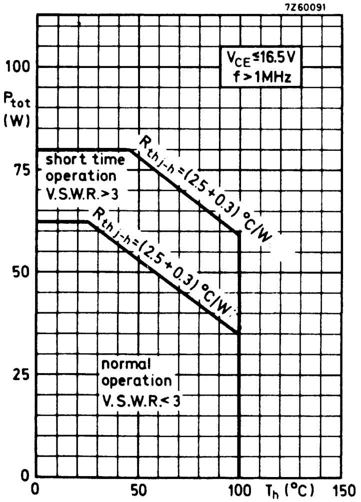
Collector-base voltage (open emitter) peak value	V_{CBOM}	max.	36	V
Collector-emitter voltage (open base)	V_{CEO}	max.	18	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4	V

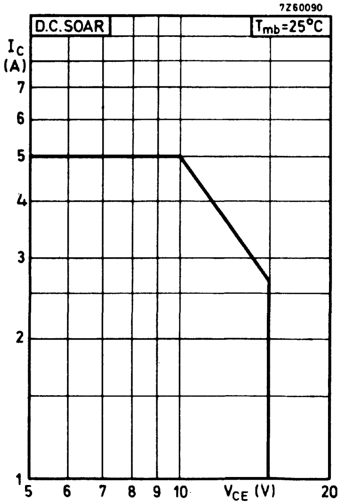
Currents

Collector current (average)	$I_{C(AV)}$	max.	5	A
Collector current (peak value) f > 1 MHz	I_{CM}	max.	10	A

Power dissipation

Total power dissipation up to T_{mb} = 25 °C f > 1 MHz	P_{tot}	max.	70	W





Temperature

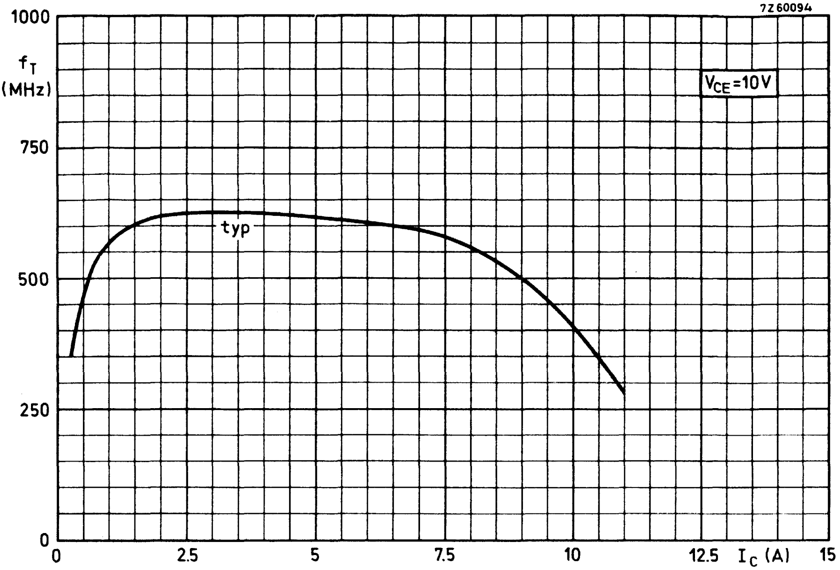
Storage temperature	T_{stg}		−30 to +200	°C
Operating junction temperature	T_j	max.	200	°C

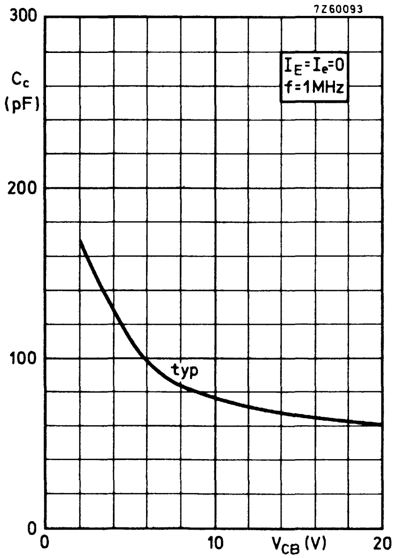
THERMAL RESISTANCE

From junction to mounting base	$R_{th\,j-mb}$	=	2.5	°C/W
From mounting base to heatsink	$R_{th\,mb-h}$	=	0.3	°C/W

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

Breakdown voltages				
Collector-base voltage open emitter, $I_C = 50$ mA	$V_{(BR)CBO}$	>	36	V
Collector-emitter voltage open base, $I_C = 50$ mA	$V_{(BR)CEO}$	>	18	V
Emitter-base voltage open collector; $I_E = 10$ mA	$V_{(BR)EBO}$	>	4	V
Transient energy				
$L = 25$ mH; $f = 50$ Hz				
open base	E	>	8	mWs
$-V_{BE} = 1.5$ V; $R_{BE} = 33\,\Omega$	E	>	8	mWs
D.C. current gain				
$I_C = 1$ A; $V_{CE} = 5$ V	h_{FE}	typ. 10 to	50 120	
Transition frequency				
$I_C = 4$ A; $V_{CE} = 10$ V	f_T	typ.	650	MHz
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; $V_{CB} = 15$ V	C_c	typ. <	65 90	pF pF
Feedback capacitance at f = 1 MHz				
$I_C = 100$ mA; $V_{CE} = 15$ V	$-C_{re}$	typ.	41	pF
Collector-stud capacitance	C_{cs}	typ.	2	pF


7Z60094
f_T (MHz)
1000
750
500
250
0
V_{CE} = 10 V
typ
0
2.5
5
7.5
10
12.5
I_C (A)
15


7Z60093
C_c (pF)
300
200
100
0
$I_E = I_e = 0$
f = 1 MHz
typ
0
10
V_{CB} (V)
20

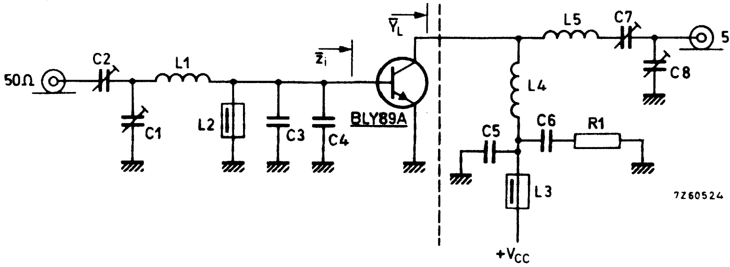
APPLICATION INFORMATION

R. F. performance in c. w. operation (unneutralised common-emitter class B circuit)

V_{CC} = 13.5 V; T_{mb} up to 25 °C

f(MHz)	P_S (W)	P_L (W)	I_C (A)	G_p (dB)	η(%)	$\bar{z}_i$ (Ω)	$\bar{Y}_L$ (mA/V)
175	< 6.25	25	< 2.64	> 6	> 70	1.7+j1.4	209+j13.7

Test circuit



C1 = 4 to 44 pF film dielectric trimmer (code number 2222 809 07008)
C2 = 2 to 22 pF film dielectric trimmer (code number 2222 809 07004)
C3 = C4 = 47 pF ceramic
C5 = 100 pF ceramic
C6 = 150 nF polyester
C7 = 4 to 104 pF film dielectric trimmer (code number 2222 809 07015)
C8 = 4 to 64 pF film dielectric trimmer (code number 2222 809 07011)

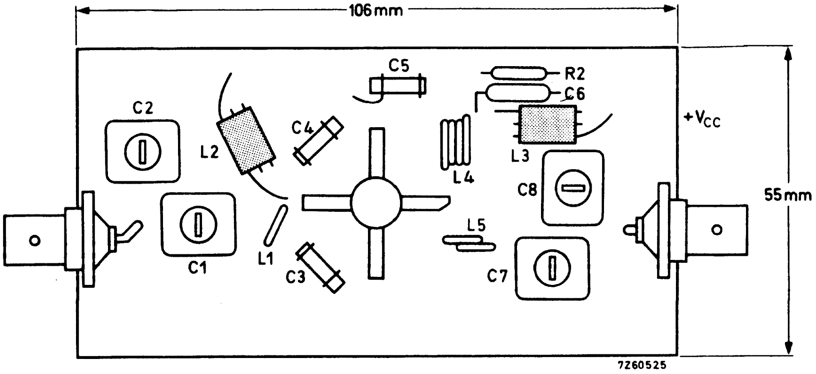
L1 = 0.5 turn enamelled Cu wire (1.5 mm); int.diam. 6 mm; leads 2x6 mm
L2 = L3 = ferroxcube choke (code number 4312 020 36640)
L4 = 3.5 turns closely wound enamelled Cu wire (1.5 mm); int.diam. 6 mm; leads 2x6 mm
L5 = 1 turn enamelled Cu wire (1.5 mm); int.diam. 6 mm; leads 2x6 mm

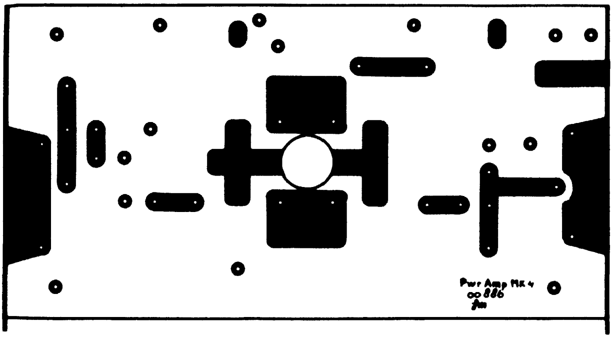
R1 = 10 Ω carbon

Component lay-out for 175 MHz see page 6.

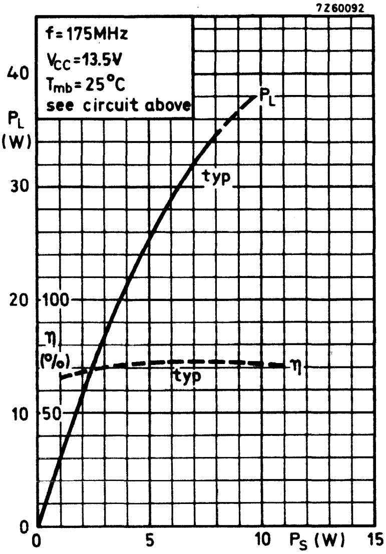
APPLICATION INFORMATION (continued)

Component lay-out and printed circuit board for 175 MHz test circuit.





The circuit and the components are situated on one side of the epoxy fibre-glass board, the other side being fully metallised to serve as earth. Earth connections are made by means of hollow rivets.

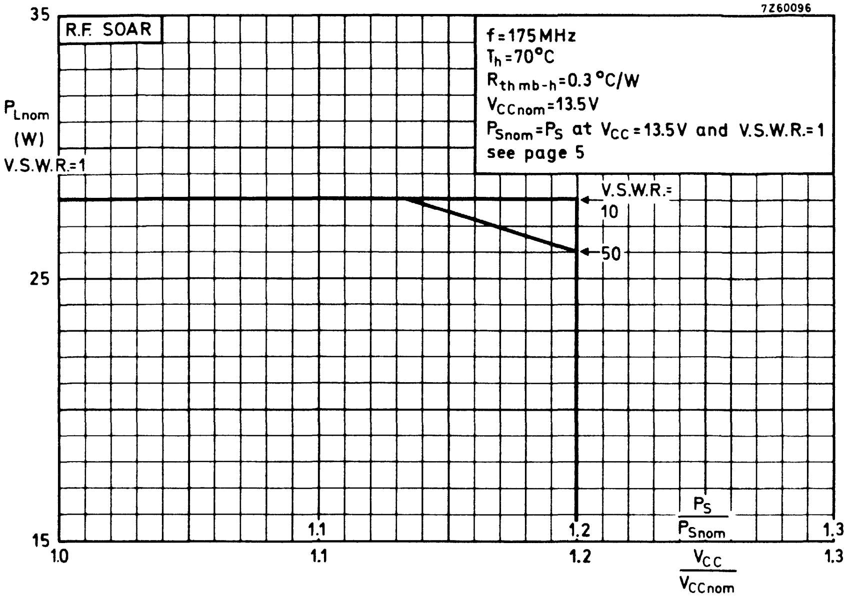


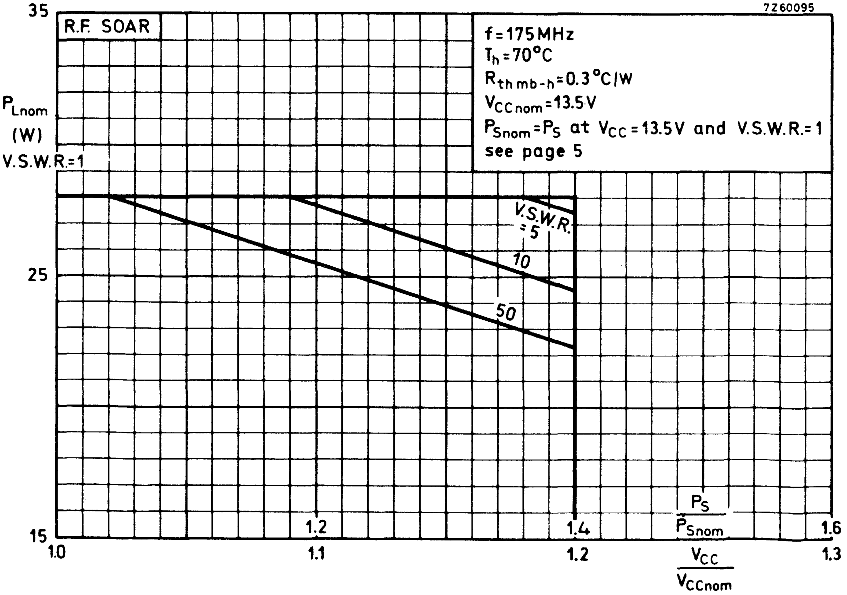
The transistor has been developed for use with unstabilized supply voltages. As the output power and drive power increase with the supply voltage, the nominal output power must be derated in accordance with the graphs on page 8 for safe operation at supply voltages other than the nominal. The graphs show the allowable output power under nominal conditions, as a function of the supply overvoltage ratio, with V.S.W.R. as parameter

The upper graph applies to the situation in which the drive (P_S/P_{Snom}) increases linearly with supply overvoltage ratio.

The lower graph shows the derating factor to be applied when the drive (P_S/P_{Snom}) increases as the square of the supply overvoltage ratio (V_{CC}/V_{CCnom}).

Depending on the operating conditions, the appropriate derating factor may lie in the region between the linear and the square-law functions.


7Z60096
R.F. SOAR
f = 175 MHz
T_h = 70 °C
$R_{th\,mb\text{-}h}$ = 0.3 °C/W
V_{CCnom} = 13.5 V
$P_{Snom} = P_S$ at V_{CC} = 13.5 V and V.S.W.R. = 1
see page 5
P_{Lnom}
(W)
V.S.W.R. = 1
35
25
15
V.S.W.R. =
10
50
1.1
1.2
1.3
$\frac{P_S}{P_{Snom}}$
1.0
1.1
1.2
1.3
$\frac{V_{CC}}{V_{CCnom}}$


7Z60095
R.F. SOAR
f = 175 MHz
T_h = 70 °C
$R_{th\,mb\text{-}h}$ = 0.3 °C/W
V_{CCnom} = 13.5 V
$P_{Snom} = P_S$ at V_{CC} = 13.5 V and V.S.W.R. = 1
see page 5
P_{Lnom}
(W)
V.S.W.R. = 1
35
25
15
V.S.W.R. = 5
10
50
1.2
1.4
1.6
$\frac{P_S}{P_{Snom}}$
1.0
1.1
1.2
1.3
$\frac{V_{CC}}{V_{CCnom}}$

V.H.F. POWER TRANSISTOR

N-P-N epitaxial planar transistor intended for use in class A, B and C operated mobile, industrial and military transmitters with a supply voltage of 12.5 V. The transistor is resistance stabilized. Every transistor is tested under severe load mismatch conditions with a supply overvoltage to 15 V. It has a plastic encapsulated stripline package. All leads are isolated from the stud.

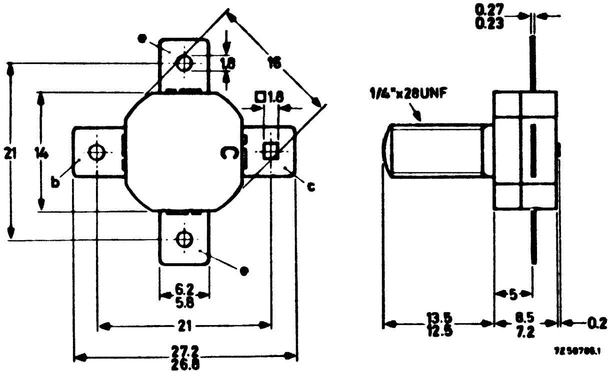
QUICK REFERENCE DATA

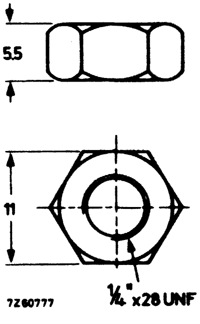
R.F. performance up to T_h = 25 °C in an unneutralised common-emitter class B circuit.

Mode of operation	V_{CC} (V)	f (MHz)	P_S (W)	P_L (W)	I_C (A)	G_p (dB)	η (%)	$\overline{z_i}$ (Ω)	$\overline{Y_L}$ (mA/V)
c.w.	12.5	175	< 15.8	50	< 5.33	> 5.0	> 75	1.3+j1.6	270+j160

MECHANICAL DATA

Dimensions in mm





Torque on nut: min. 23 kg cm
(2.3 Newton metres)
max. 27 kg cm
(2.7 Newton metres)

Diameter of clearance hole in heatsink: max. 6.5 mm.
Mounting hole to have no burrs at either end.
De-burring must leave surface flat; do not chamfer or countersink either end of hole.

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

Voltages

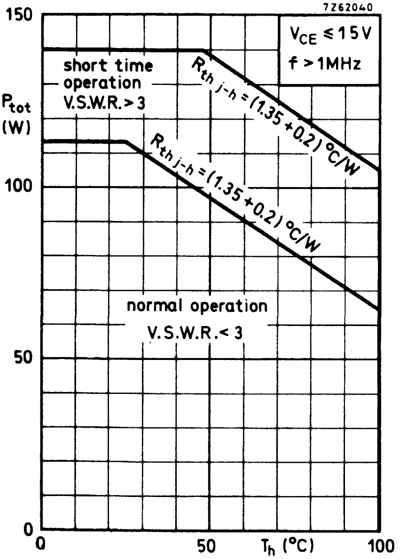
Collector-base voltage (open emitter) peak value	V_{CBOM}	max.	36	V
Collector-emitter voltage (open base)	V_{CEO}	max.	18	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4	V

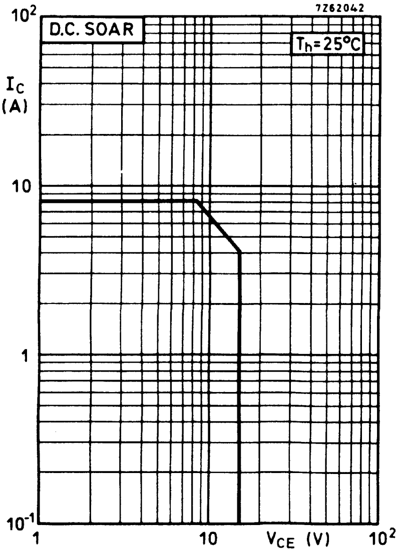
Currents

Collector current (average)	$I_{C(AV)}$	max.	8	A
Collector current (peak value) f > 1 MHz	I_{CM}	max.	20	A

Power dissipation

Total power dissipation up to T_{mb} = 25 °C f > 1 MHz	P_{tot}	max.	130	W





Temperature

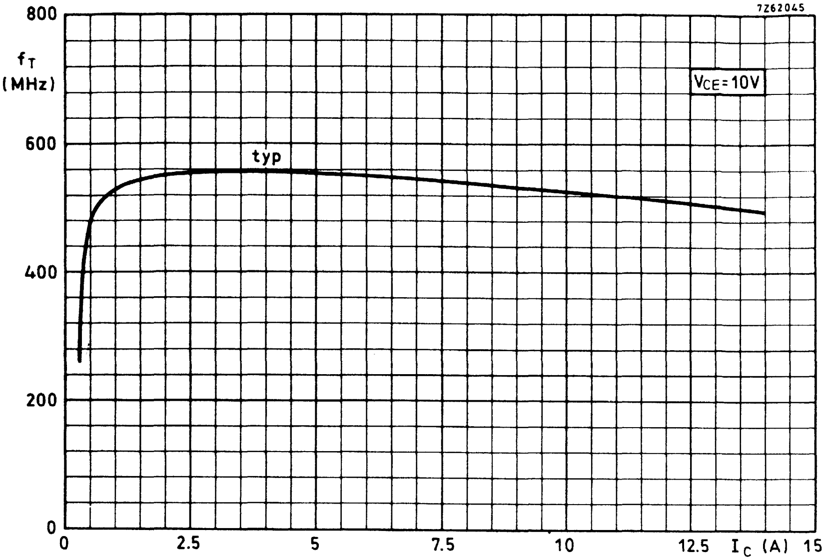
Storage temperature	T_{stg}		−65 to +200	°C
Operating junction temperature	T_j	max.	200	°C

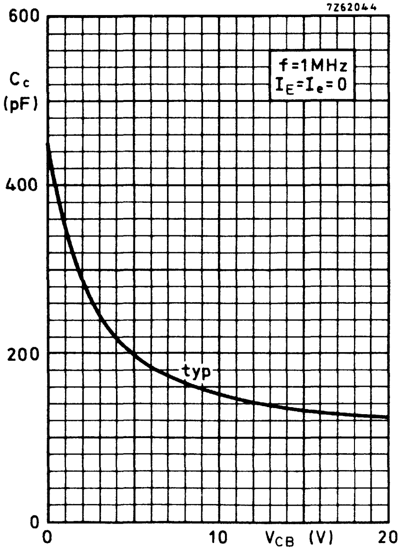
THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	1.35	°C/W
From mounting base to heatsink	$R_{th\ mb\text{-}h}$	=	0.2	°C/W

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

Breakdown voltages				
Collector-base voltage open emitter, $I_C = 100$ mA	$V_{(BR)CBO}$	>	36	V
Collector-emitter voltage open base, $I_C = 100$ mA	$V_{(BR)CEO}$	>	18	V
Emitter-base voltage open collector, $I_E = 25$ mA	$V_{(BR)EBO}$	>	4	V
Transient energy				
$L = 25$ mH; $f = 50$ Hz				
open base	E	>	8	mWs
$-V_{BE} = 1.5$ V; $R_{BE} = 33\,\Omega$	E	>	8	mWs
D.C. current gain				
$I_C = 1$ A; $V_{CE} = 5$ V	h_{FE}	> typ.	10 50	
Transition frequency				
$I_C = 6$ A; $V_{CE} = 10$ V	f_T	typ.	550	MHz
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; $V_{CB} = 15$ V	C_c	typ. <	130 160	pF pF
Feedback capacitance				
$I_C = 200$ mA; $V_{CE} = 15$ V	$-C_{re}$	typ.	82	pF
Collector-stud capacitance	C_{cs}	typ.	3.5	pF


7Z62045
800
f_T
(MHz)
600
400
200
0
$V_{CE} = 10V$
typ
0
2.5
5
7.5
10
12.5
I_C (A)
15


7Z62044
600
C_c
(pF)
400
200
0
$f = 1 MHz$
$I_E = I_e = 0$
typ
0
10
V_{CB} (V)
20

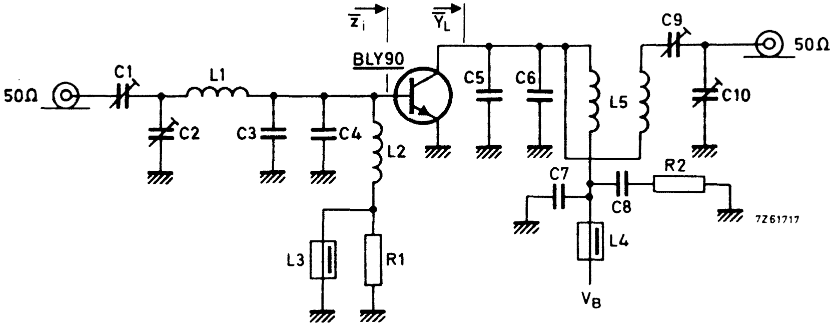
APPLICATION INFORMATION

R.F. performance in c.w. operation (unneutralised common-emitter class B circuit)

f = 175 MHz; T_h up to 25 °C

V_{CC} (V)	P_S (W)	P_L (W)	I_C (A)	G_p (dB)	η (%)	$\overline{z_i}$ (Ω)	$\overline{Y_L}$ (mA/V)
12.5	< 15.8	50	< 5.33	> 5.0	> 75	1.3+j1.6	270+j160

Test circuit for 175 MHz:



C1 = 2 to 20 pF film dielectric trimmer
C2 = 4 to 40 pF film dielectric trimmer
C3 = C4 = C5 = C6 = 56 pF ceramic
C7 = 100 pF ceramic
C8 = 100 nF polyester
C9 = 4 to 80 pF film dielectric trimmer
C10 = 4 to 60 pF film dielectric trimmer

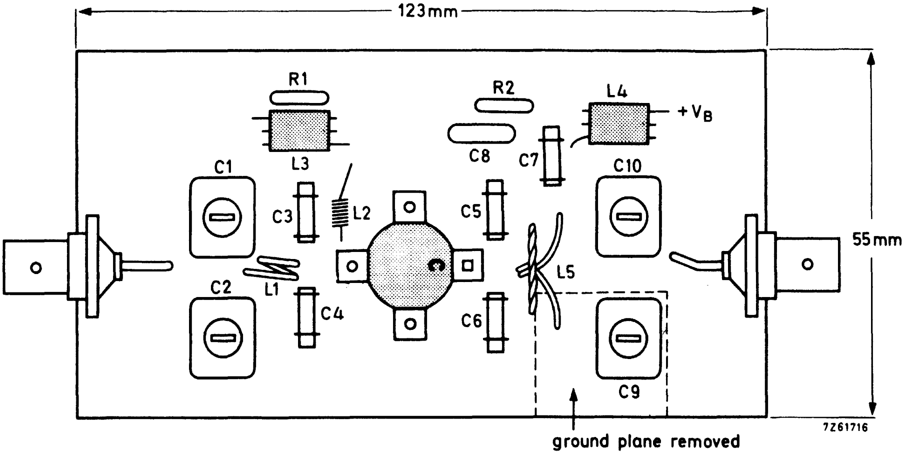
L1 = 1.5 turns enamelled Cu wire (1.5 mm); int. diam. 6 mm; length 4 mm; leads 2 x 5 mm
L2 = 7 turns closely wound enamelled Cu wire (0.5 mm); int. diam. 3 mm; leads 2 x 5 mm
L3 = L4 = ferroxcube choke (code number 4312 020 36640)
L5 = bifilar wound enamelled Cu wire (1.0 mm); see figure on page 6

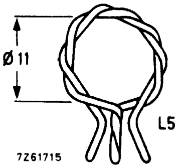
R1 = 10 Ω carbon
R2 = 4.7 Ω carbon

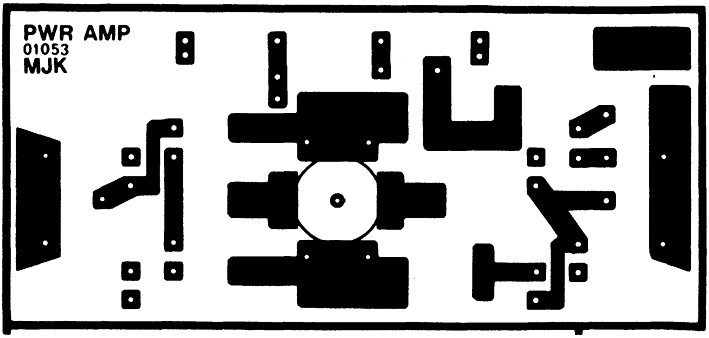
Component lay-out for 175 MHz see page 6.

APPLICATION INFORMATION (continued)

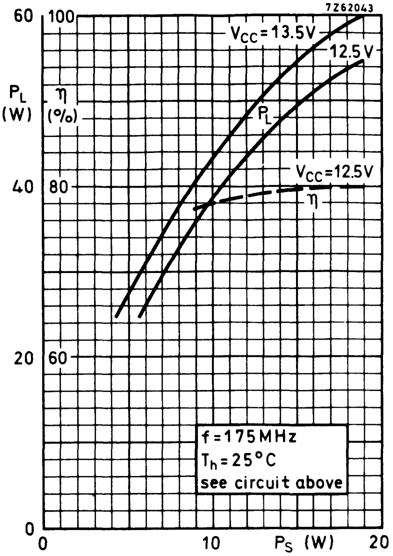
Component lay-out and printed circuit board for 175 MHz test circuit.

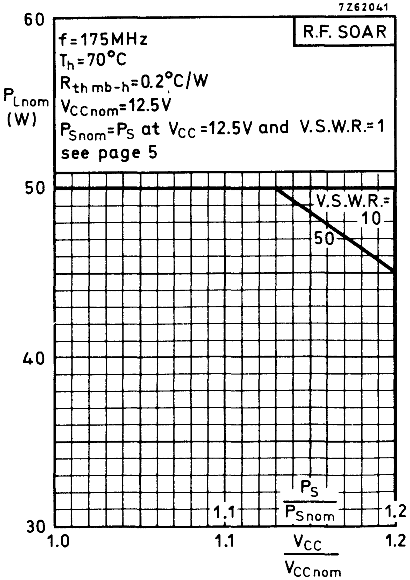






The circuit and the components are situated on one side of the epoxy fibre-glass board, the other side being fully metallized to serve as earth. Earth connections are made by means of hollow rivets.





The transistor has been developed for use with unstabilized supply voltages. As the output power and drive power increase with the supply voltage, the nominal output power (P_{Lnom}) must be derated in accordance with the adjacent graph for safe operation at supply voltage other than the nominal. The graph shows the allowable output power under nominal conditions, as a function of the supply overvoltage ratio with V.S.W.R. as parameter. The graph applies to the situation in which the drive (P_S/P_{Snom}) increases linearly with supply overvoltage ratio (V_{CC} = V_{CCnom}).

V.H.F. POWER TRANSISTOR

N-P-N epitaxial planar transistor intended for use in class A, B and C operated mobile, industrial and military transmitters with a supply voltage of 28 V. The transistor is resistance stabilized. Every transistor is tested under severe load mismatch conditions. It has a $\frac{1}{4}$" capstan envelope with a moulded cap. All leads are isolated from the stud.

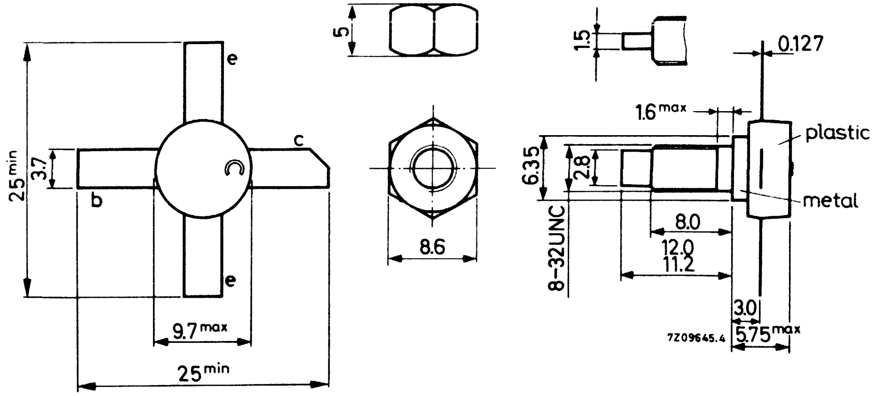
QUICK REFERENCE DATA

R.F. performance up to T_{mb} = 25 °C in an unneutralised common-emitter class B circuit

Mode of operation	V_{CC} (V)	f (MHz)	P_S (W)	P_L (W)	I_C (A)	G_p (dB)	η (%)	$\overline{z_i}$ (Ω)	$\overline{Y_L}$ (mA/V)
c.w.	28	175	< 0.50	8	< 0.44	> 12	> 65	1.8+j1.0	17-j20

MECHANICAL DATA

Dimensions in mm



Torque on nut: min. 7.5 kg cm
(0.75 Newton metres)
max. 8.5 kg cm
(0.85 Newton metres)

Diameter of clearance hole in heatsink: max. 4.17 mm
Mounting hole to have no burrs at either end
De-burring must leave surface flat; do not chamfer or countersink either end of hole.

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

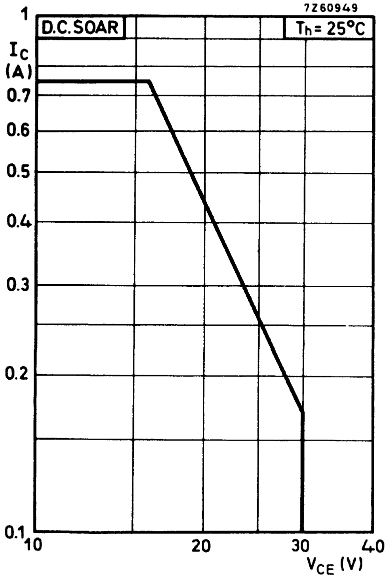
Collector-base voltage (open emitter) peak value	V_{CBOM}	max.	65	V
Collector-emitter voltage (open base)	V_{CEO}	max.	36	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4	V

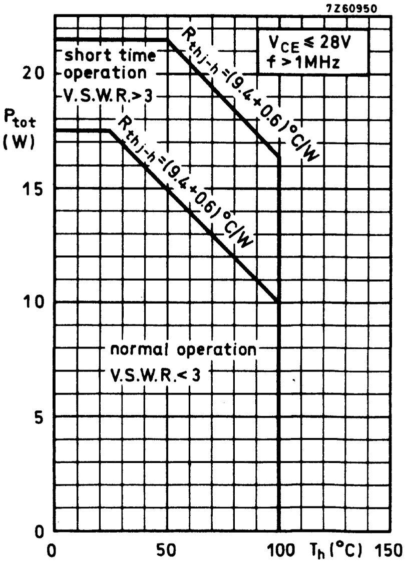
Currents

Collector current (average)	$I_{C(AV)}$	max.	0.75	A
Collector current (peak value) f > 1 MHz	I_{CM}	max.	2.25	A

Power dissipation

Total power dissipation up to T_h = 25 °C f > 1 MHz	P_{tot}	max.	17.5	W





Temperatures

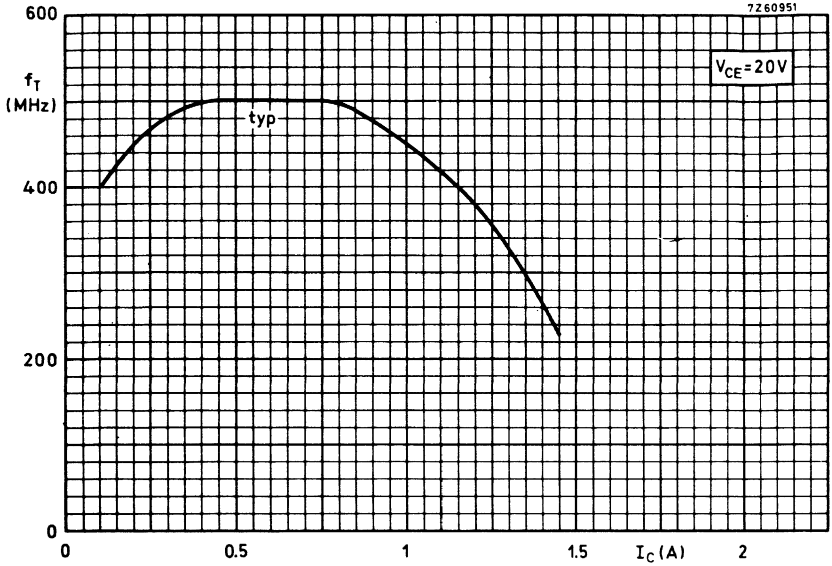
Storage temperature	T_{stg}	−30 to +200		°C
Operating junction temperature	T_j	max.	200	°C

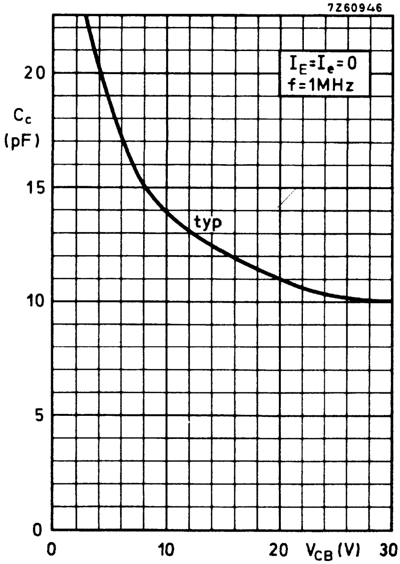
THERMAL RESISTANCE

From junction to mounting base	$R_{th\,j-mb}$	=	9.4	°C/W
From mounting base to heatsink	$R_{th\,mb-h}$	=	0.6	°C/W

CHARACTERISTICS T_j = 25 °C unless otherwise specified

Collector cut-off current				
$I_B = 0$; $V_{CE} = 28$ V	I_{CEO}	<	5	mA
Breakdown voltages				
Collector-base voltage open emitter; $I_C = 1$ mA	$V_{(BR)CBO}$	>	65	V
Collector-emitter voltage open base, $I_C = 10$ mA	$V_{(BR)CEO}$	>	36	V
Emitter-base voltage open collector; $I_E = 1$ mA	$V_{(BR)EBO}$	>	4	V
Transient energy				
L = 25 mH; f = 50 Hz				
open base	E	>	0.5	mWs
$-V_{BE} = 1.5$ V; $R_{BE} = 33\,\Omega$	E	>	0.5	mWs
D.C. current gain				
$I_C = 500$ mA; $V_{CE} = 5$ V	h_{FE}	>	5	
Transition frequency				
$I_C = 400$ mA; $V_{CE} = 20$ V	f_T	typ.	500	MHz
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; $V_{CB} = 30$ V	C_c	typ. <	10 15	pF pF
Feedback capacitance at f = 1 MHz				
$I_C = 50$ mA; $V_{CE} = 30$ V	$-C_{re}$	typ.	7.5	pF
Collector-stud capacitance	C_{cs}	typ.	2	pF


7Z60951
600
400
200
0
f_T
(MHz)
typ
$V_{CE} = 20V$
0
0.5
1
1.5
I_C (A)
2


7Z60946
20
15
10
5
0
C_c
(pF)
typ
$I_E = I_e = 0$
f = 1MHz
0
10
20
V_{CB} (V)
30

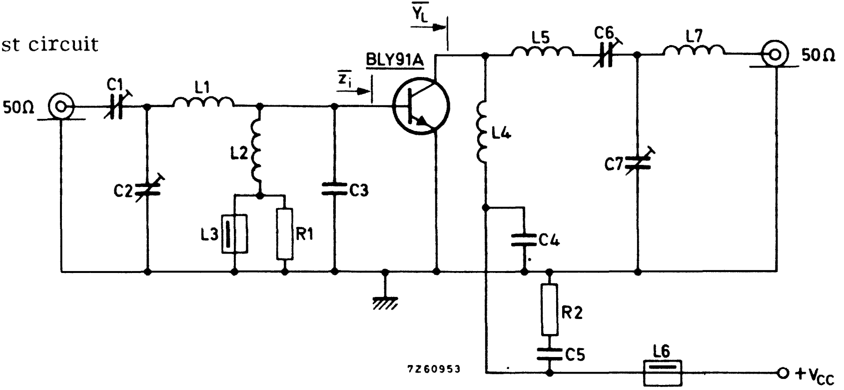
APPLICATION INFORMATION

R.F. performance in c.w. operation (unneutralised common-emitter class B circuit)

V_{CC} = 28 V; T_{mb} up to 25 °C

f(MHz)	P_S (W)	P_L (W)	I_C (A)	G_p (dB)	η (%)	$\overline{z_i}$ (Ω)	$\overline{Y_L}$ (mA/V)
175	< 0.50	8	< 0.44	≥ 12	> 65	1.8+j1.0	17-j20

Test circuit



C1 = 2.5 to 20 pF film dielectric trimmer (code number 2222 809 07004)
C2 = C6 = C7 = 4 to 40 pF film dielectric trimmer (code number 2222 809 07008)
C3 = 47 pF ceramic
C4 = 100 pF ceramic
C5 = 150 nF polyester

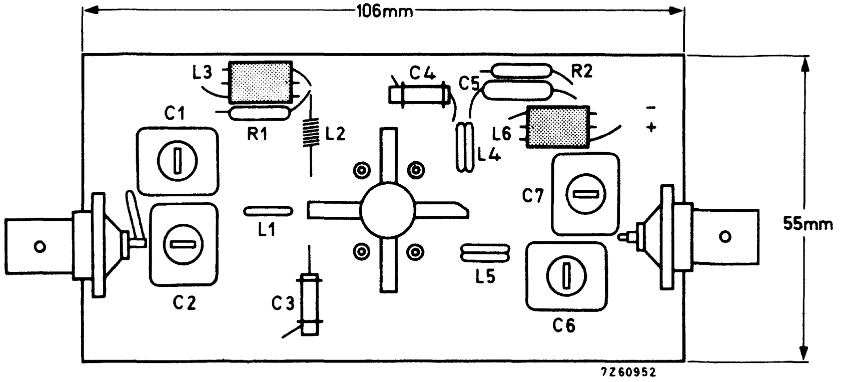
L1 = 0.5 turn enamelled Cu wire (1.5 mm); int. diam. 6 mm; leads 2 x 10 mm
L2 = 6.5 turns closely wound enamelled Cu wire (0.7 mm); int. diam. 4 mm; leads 2 x 5 mm
L3 = L6 = ferroxcube choke (code number 4312 020 36640)
L4 = 7.5 turns enamelled Cu wire (0.7 mm); int. diam. 4 mm; leads 2 x 5 mm
L5 = 4.5 turns enamelled Cu wire (0.7 mm); int. diam. 6 mm; leads 2 x 7 mm
L7 = 3.5 turns enamelled Cu wire (0.7 mm); int. diam. 6 mm; leads 2 x 7 mm

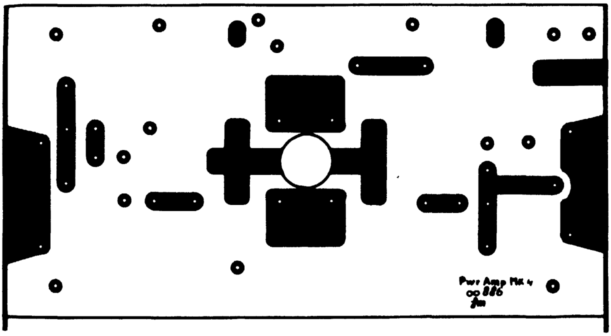
R1 = R2 = 10 Ω carbon

Component lay-out for 175 MHz test circuit see page 6.

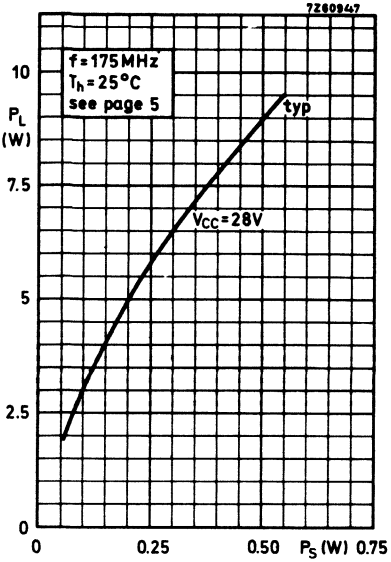
APPLICATION INFORMATION (continued)

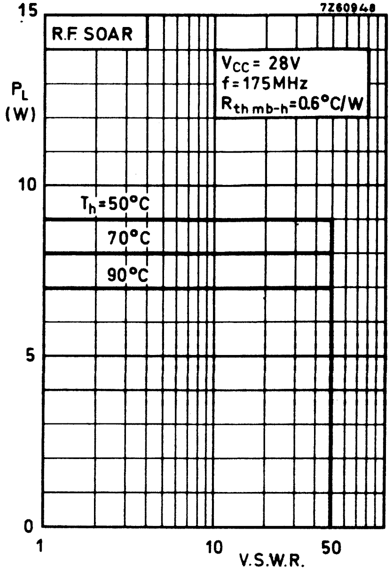
Component lay-out and printed circuit board for 175 MHz test circuit.





The circuit and the components are situated on one side of the epoxy fibre-glass board, the other side being fully metallised to serve as earth. Earth connections are made by means of hollow rivets.





For high voltage operation, a stabilized power supply is generally used.
The graph shows the allowable output power under nominal conditions as a function of the V.S.W.R., with heat-sink temperature as parameter.

V.H.F. POWER TRANSISTOR

N-P-N epitaxial planar transistor intended for use in class A, B and C operated mobile, industrial and military transmitters with a supply voltage of 28 V. The transistor is resistance stabilized. Every transistor is tested under severe load mismatch conditions. It has a $\frac{1}{4}$" capstan envelope with a moulded cap. All leads are isolated from the stud.

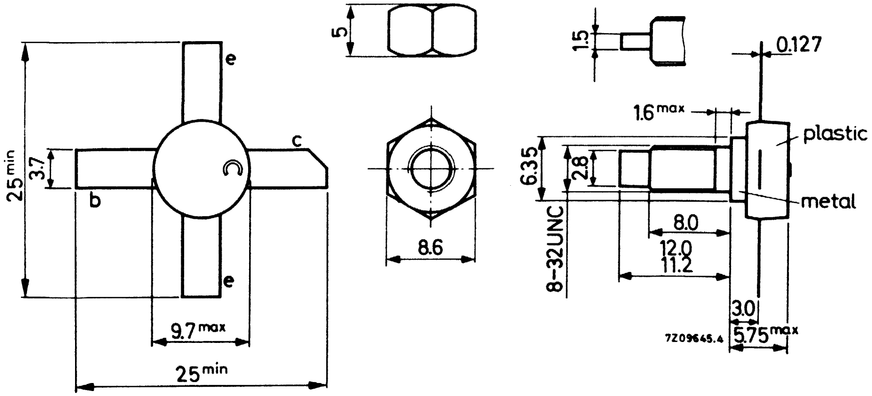
QUICK REFERENCE DATA

R.F. performance up to T_{mb} = 25 °C in an unneutralised common-emitter class B circuit

Mode of operation	V_{CC} (V)	f (MHz)	P_S (W)	P_L (W)	I_C (A)	G_p (dB)	η (%)	$\bar{z}_i$ (Ω)	$\bar{Y}_L$ (mA/V)
c.w.	28	175	< 1.5	15	< 0.83	> 10	> 65	1.4+j2.15	32-j28

MECHANICAL DATA

Dimensions in mm



Torque on nut: min. 7.5 kg cm
(0.75 Newton metres)
max. 8.5 kg cm
(0.85 Newton metres)

Diameter of clearance hole in heatsink: max. 4.17 mm
Mounting hole to have no burrs at either end
De-burring must leave surface flat; do not chamfer or countersink either end of hole.

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

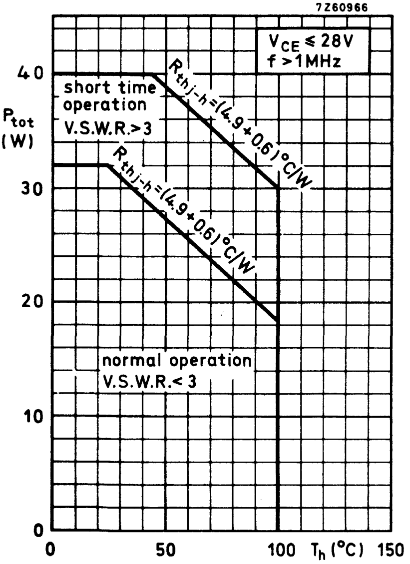
Collector-base voltage (open emitter) peak value	V_{CBOM}	max.	65	V
Collector-emitter voltage (open base)	V_{CEO}	max.	36	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4	V

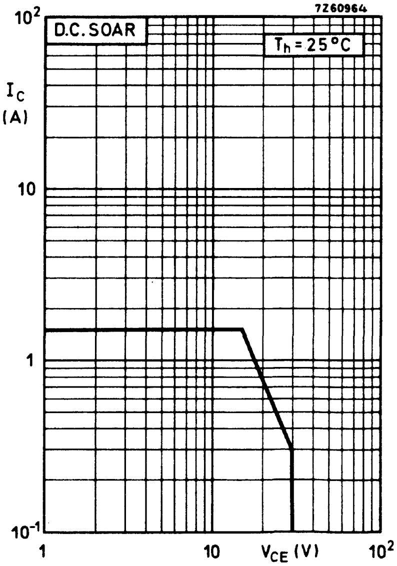
Currents

Collector current (average)	$I_{C(AV)}$	max.	1.5	A
Collector current (peak value) f > 1 MHz	I_{CM}	max.	4.5	A

Power dissipation

Total power dissipation up to T_h = 25 °C f > 1 MHz	P_{tot}	max.	32	W





Temperatures

Storage temperature	T_{stg}	-30 to	+200	°C
Operating junction temperature	T_j	max.	200	°C

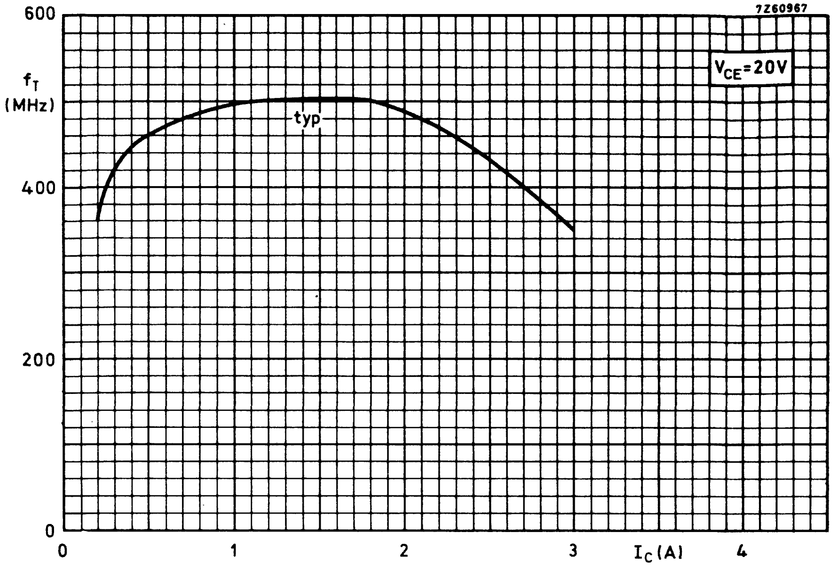
THERMAL RESISTANCE

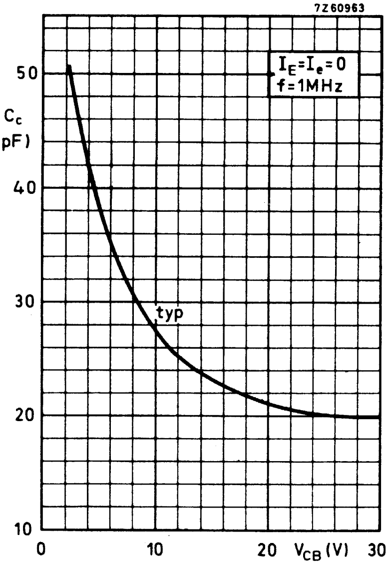
From junction to mounting base	$R_{th\ j-mb}$	=	4.9	°C/W
From mounting base to heatsink	$R_{th\ mb-h}$	=	0.6	°C/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current				
$I_B = 0$; $V_{CE} = 28$ V	I_{CEO}	<	10	mA
Breakdown voltages				
Collector-base voltage open emitter, $I_C = 3$ mA	$V_{(BR)CBO}$	>	65	V
Collector-emitter voltage open base, $I_C = 25$ mA	$V_{(BR)CEO}$	>	36	V
Emitter-base voltage open collector; $I_E = 3$ mA	$V_{(BR)EBO}$	>	4	V
Transient energy				
L = 25 mH; f = 50 Hz				
open base	E	>	2.0	mWs
$-V_{BE} = 1.5$ V; $R_{BE} = 33\,\Omega$	E	>	4.5	mWs
D.C. current gain				
$I_C = 500$ mA; $V_{CE} = 5$ V	h_{FE}	>	5	
Transition frequency				
$I_C = 600$ mA; $V_{CE} = 20$ V	f_T	typ.	500	MHz
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; $V_{CB} = 30$ V	C_c	typ. <	20 30	pF pF
Feedback capacitance at f = 1 MHz				
$I_C = 100$ mA; $V_{CE} = 30$ V	$-C_{re}$	typ.	15	pF
Collector-stud capacitance	C_{cs}	typ.	2	pF


7Z60967
600
400
200
0
f_T
(MHz)
typ
$V_{CE} = 20V$
0
1
2
3
I_C (A)
4


7Z60963
50
40
30
20
10
C_c
(pF)
$I_E = I_e = 0$
f = 1MHz
typ
0
10
20
V_{CB} (V)
30

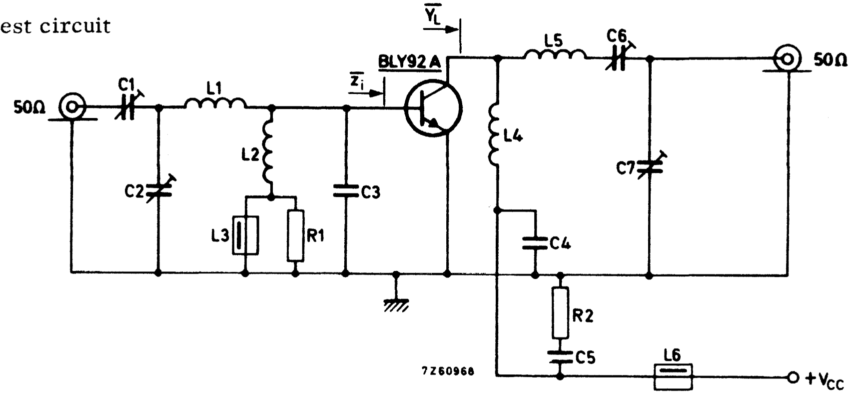
APPLICATION INFORMATION

R.F. performance in c.w. operation (unneutralised common-emitter class B circuit)

V_{CC} = 28 V; T_{mb} up to 25 °C

f(MHz)	P_S (W)	P_L (W)	I_C (A)	G_p (dB)	η(%)	$\overline{z_i}$ (Ω)	$\overline{Y_L}$ (mA/V)
175	< 1.5	15	< 0.83	> 10	> 65	1.4+j2.15	32-j28

Test circuit



C1 = 2.5 to 20 pF film dielectric trimmer (code number 2222 809 07004)
C2 = C6 = C7 = 4 to 40 pF film dielectric trimmer (code number 2222 809 07008)
C3 = 47 pF ceramic
C4 = 100 pF ceramic
C5 = 150 nF polyester

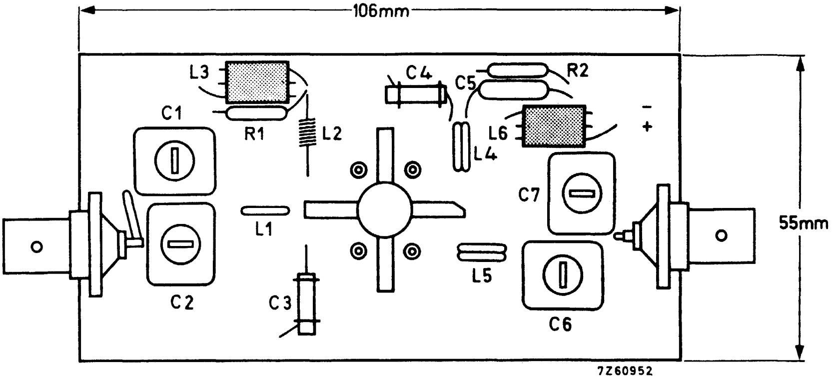
L1 = 0.5 turn enamelled Cu wire (1.5 mm); int. diam. 6 mm; leads 2 x 10 mm
L2 = 6.5 turns closely wound enamelled Cu wire (0.7 mm); int. diam. 4 mm; leads 2 x 5 mm
L3 = L5 = ferroxcube choke (code number 4312 020 36640)
L4 = 2.5 turns enamelled Cu wire (0.7 mm); int. diam. 6 mm; leads 2 x 7 mm
L6 = 4.5 turns enamelled Cu wire (0.7 mm); int. diam. 6 mm; leads 2 x 7 mm

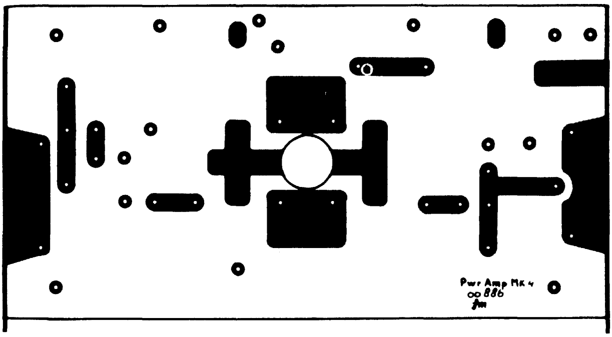
R1 = R2 = 10 Ω carbon

Component lay-out for 175 MHz test circuit see page 6.

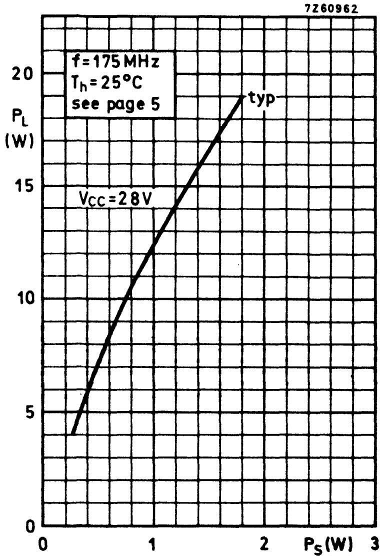
APPLICATION INFORMATION (continued)

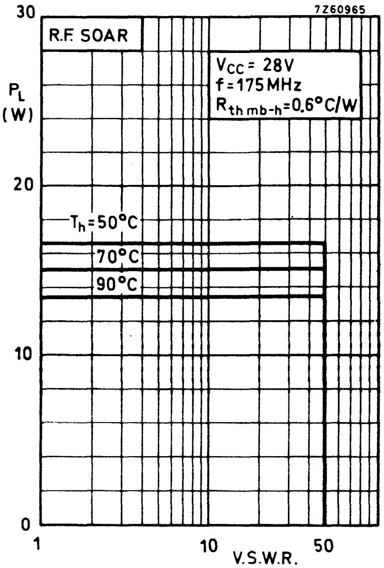
Component lay-out and printed circuit board for 175 MHz test circuit.





The circuit and the components are situated on one side of the epoxy fibre-glass board, the other side being fully metallised to serve as earth. Earth connections are made by means of hollow rivets.





For high voltage operation, a stabilized power supply is generally used.
The graph shows the allowable output power under nominal conditions as a function of the V.S.W.R., with heat-sink temperature as parameter.

V.H.F. POWER TRANSISTOR

N-P-N epitaxial planar transistor intended for use in class A, B and C operated mobile, industrial and military transmitters with a supply voltage of 28 V. The transistor is resistance stabilized. Every transistor is tested under severe load mismatch conditions. It has a $\frac{1}{4}$" capstan envelope with a moulded cap. All leads are isolated from the stud.

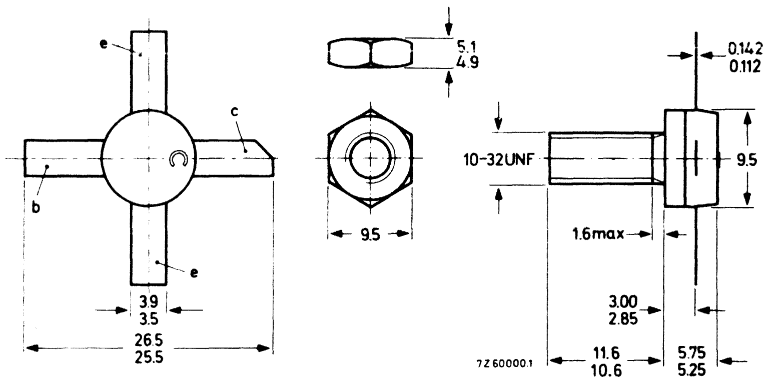
QUICK REFERENCE DATA

R.F. performance up to T_{mb} = 25 °C in an unneutralised common-emitter class B circuit.

Mode of operation	V_{CC} (V)	f (MHz)	P_S (W)	P_L (W)	I_C (A)	G_p (dB)	η (%)	$\bar{z}_i$ (Ω)	$\bar{Y}_L$ (mA/V)
c.w.	28	175	< 3.1	25	< 1.5	> 9	> 60	1.0+j1.2	57.7-j52.7

MECHANICAL DATA

Dimensions in mm



Torque on nut: min. 15 kg cm
(1.5 Newton metres)
max. 17 kg cm
(1.7 Newton metres)

Diameter of clearance hole in heatsink: max. 5.0 mm.
Mounting hole to have no burrs at either end. De-burring must leave surface flat; do not chamfer or countersink either end of hole.

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

Voltages

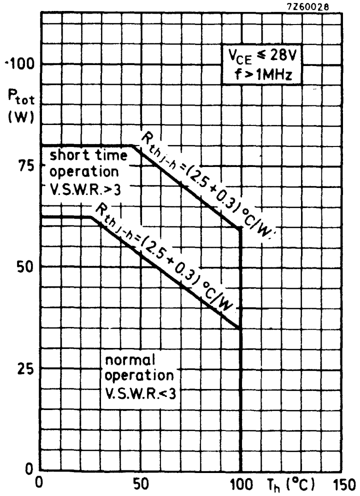
Collector-base voltage (open emitter) peak value	V_{CBOM}	max.	65	V
Collector-emitter voltage (open base)	V_{CEO}	max.	36	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4	V

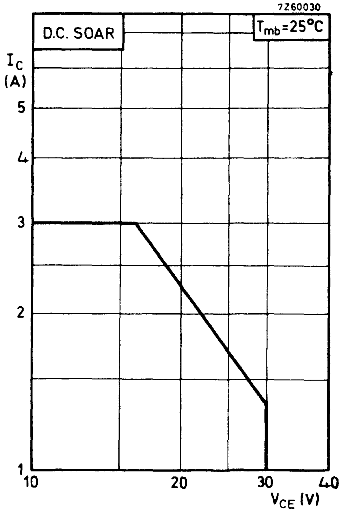
Currents

Collector current (average)	$I_{C(AV)}$	max.	3	A
Collector current (peak value) f > 1 MHz	I_{CM}	max.	9	A

Power dissipation

Total power dissipation up to T_{mb} = 25 °C f > 1 MHz	P_{tot}	max.	70	W





Temperature

Storage temperature	T_{stg}		−30 to +200	°C
Operating junction temperature	T_j	max.	200	°C

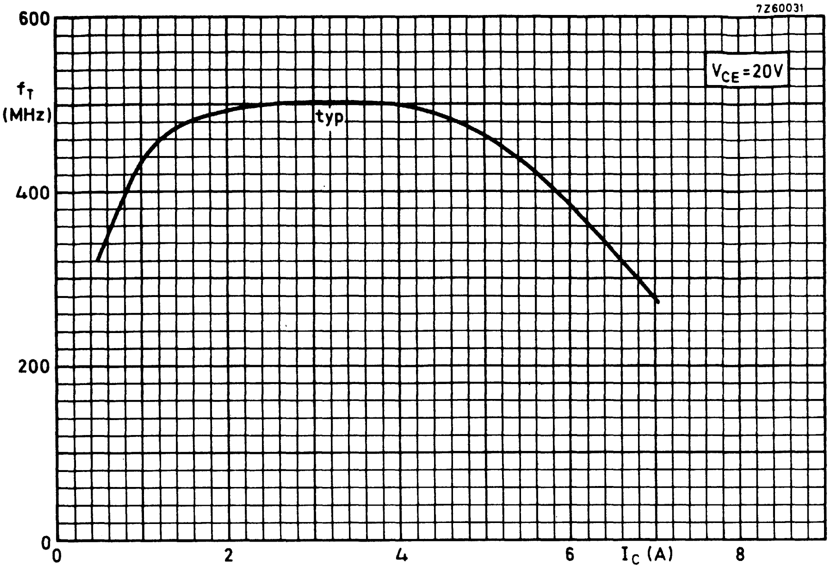
THERMAL RESISTANCE

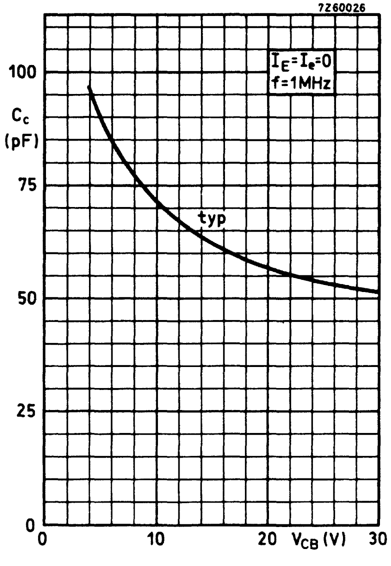
From junction to mounting base	$R_{th\ j-mb}$	=	2.5	°C/W
From mounting base to heatsink	$R_{th\ mb-h}$	=	0.3	°C/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Breakdown voltages				
Collector-base voltage open emitter, I_C = 50 mA	$V_{(BR)CBO}$	>	65	V
Collector-emitter voltage open base, I_C = 50 mA	$V_{(BR)CEO}$	>	36	V
Emitter-base voltage open collector; I_E = 10 mA	$V_{(BR)EBO}$	>	4	V
Transient energy				
L = 25 mH; f = 50 Hz				
open base	E	>	8	mWs
$-V_{BE}$ = 1.5 V; R_{BE} = 33 Ω	E	>	8	mWs
D.C. current gain				
I_C = 1 A; V_{CE} = 5 V	h_{FE}	typ.	50	
			10 to 120	
Transition frequency				
I_C = 3 A; V_{CE} = 20 V	f_T	typ.	500	MHz
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; V_{CB} = 30 V	C_c	typ.	50	pF
		<	65	pF
Feedback capacitance at f = 1 MHz				
I_C = 100 mA; V_{CE} = 30 V	$-C_{re}$	typ.	31	pF
Collector-stud capacitance	C_{cs}	typ.	2	pF


7Z60031
600
400
200
0
f_T
(MHz)
V_{CE}=20V
typ
0
2
4
6
I_C (A)
8


7Z60026
100
C_c
(pF)
75
50
25
0
I_E=I_e=0
f=1MHz
typ
0
10
20
V_{CB} (V)
30

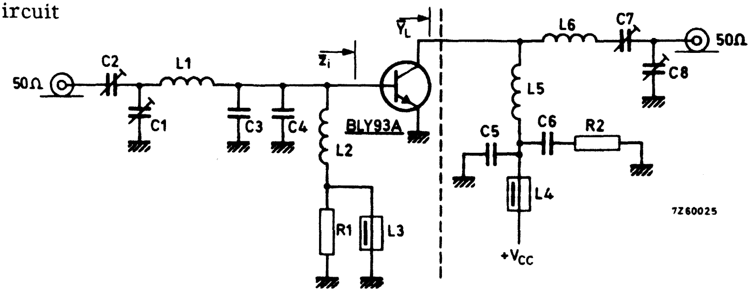
APPLICATION INFORMATION

R.F. performance in c.w. operation (unneutralised common-emitter class B circuit)

$V_{CC} = 28$ V; $T_{mb} = 25\,^{o}$C

f(MHz)	P_S (W)	P_L (W)	I_C (A)	G_p (dB)	η (%)	$\bar{z}_i$ (Ω)	$\bar{Y}_L$ (mA/V)
175	< 3.1	25	< 1.5	> 9	> 60	1.0+j1.2	57.7-j52.7

Test circuit



C1 = 4 to 44 pF film dielectric trimmer (code number 2222 809 07008)
C2 = 2 to 22 pF film dielectric trimmer (code number 2222 809 07004)
C3 = C4 = 47 pF ceramic
C5 = 100 pF ceramic
C6 = 150 nF polyester
C7 = 4 to 104 pF film dielectric trimmer (code number 2222 809 07015)
C8 = 4 to 64 pF film dielectric trimmer (code number 2222 809 07011)

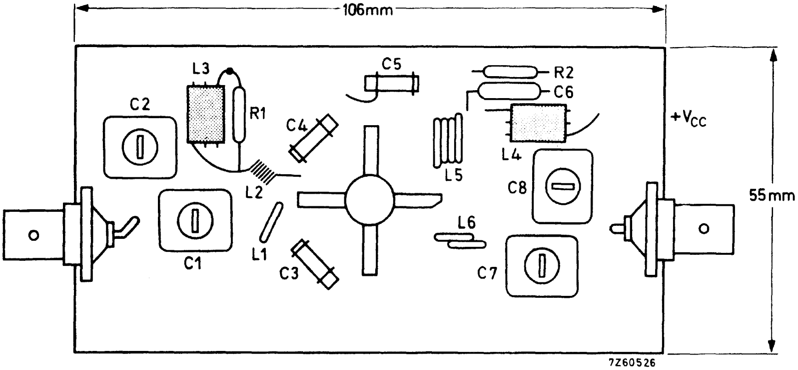
L1 = 0.5 turn enamelled Cu wire (1.5 mm); int.diam.6 mm; leads 2x6 mm
L2 = 6 turns closely wound enamelled Cu wire (0.7 mm); int.diam.4 mm; leads 2x4 mm
L3 = L4 = ferroxcube choke (code number 4312 020 36640)
L5 = 3.5 turns enamelled Cu wire (1.5 mm); int.diam. 6 mm; leads 2x6 mm
L6 = 1.5 turns enamelled Cu wire (1.5 mm); int.diam. 6 mm; leads 2x6 mm

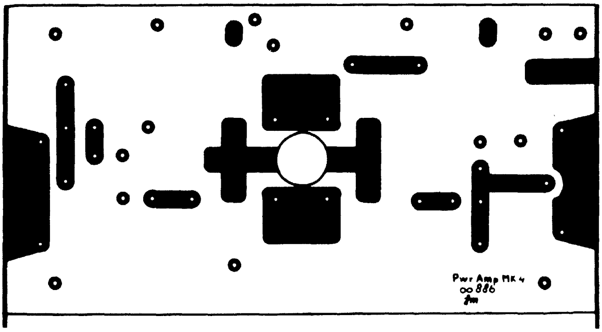
R1 = R2 = 10 Ω carbon

Component lay-out for 175 MHz see page 6.

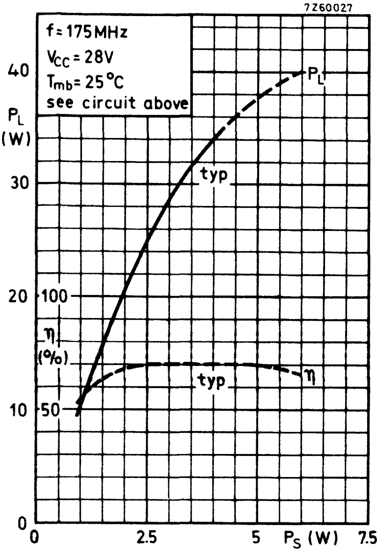
APPLICATION INFORMATION (continued)

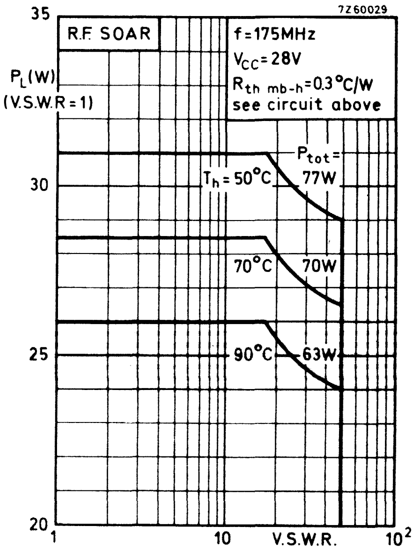
Component lay-out and printed circuit board for 175 MHz test circuit.





The circuit and the components are situated on one side of the epoxy fibre-glass board, the other side being fully metallised to serve as earth. Earth connections are made by means of hollow rivets.





For high voltage operation, a stabilized power supply is generally used.
The graph shows the allowable output power under nominal conditions as a function of the V.S.W.R., with heat-sink temperature as parameter.

V.H.F. POWER TRANSISTOR

N-P-N epitaxial planar transistor intended for use in class A, B and C operated mobile, industrial and military transmitters with a supply voltage of 28 V. The transistor is resistance stabilized. Every transistor is tested under severe load mismatch conditions. It has a plastic encapsulated stripline package. All leads are isolated from the stud.

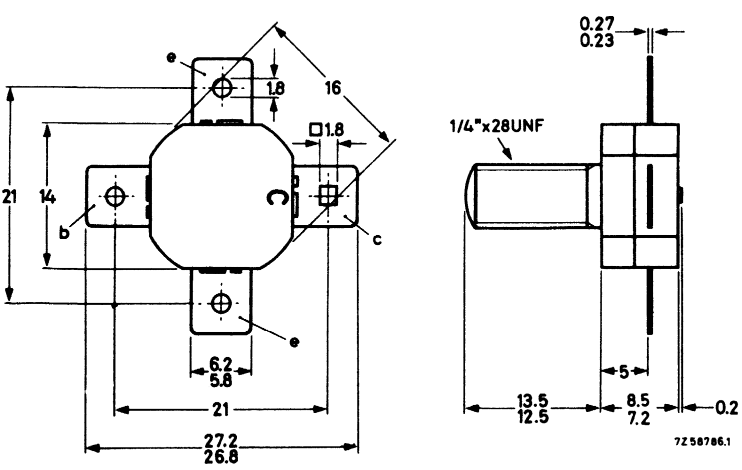
QUICK REFERENCE DATA

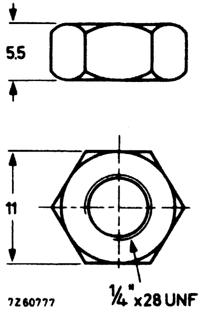
R. F. performance up to T_{mb} = 25 °C in an unneutralised common-emitter class B circuit.

Mode of operation	V_{CC} (V)	f (MHz)	P_S (W)	P_L (W)	I_C (A)	G_p (dB)	η (%)	$\overline{z_i}$ (Ω)	$\overline{Y_L}$ (mA/V)
c.w.	28	175	< 10	50	< 2.75	> 7	> 65	0.7+j1.45	120-j70

MECHANICAL DATA

Dimensions in mm





Torque on nut: min. 23 kg cm
(2.3 Newton metres)
max. 27 kg cm
(2.7 Newton metres)

Diameter of clearance hole in heatsink: max. 6.5 mm.
Mounting hole to have no burrs at either end.
De-burring must leave surface flat; do not chamfer or countersink either end of hole.

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

Voltages

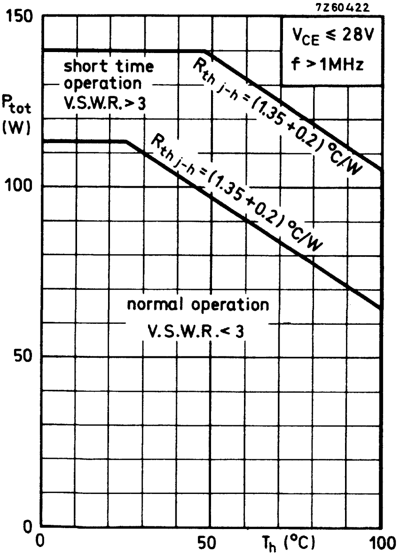
Collector-base voltage (open emitter) peak value	V_{CBOM}	max.	65	V
Collector-emitter voltage (open base)	V_{CEO}	max.	36	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4	V

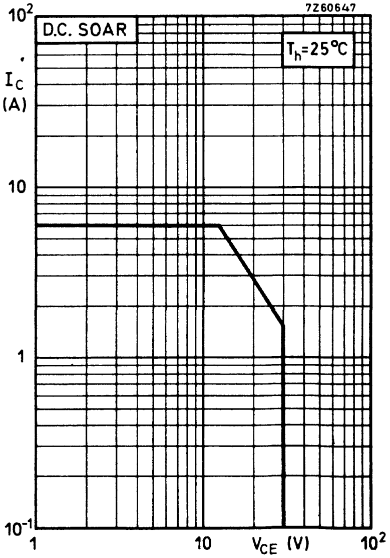
Currents

Collector current (average)	$I_{C(AV)}$	max.	6	A
Collector current (peak value) f > 1 MHz	I_{CM}	max.	12	A

Power dissipation

Total power dissipation up to $T_{mb} = 25\ ^oC$ f > 1 MHz	P_{tot}	max.	130	W





Temperature

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

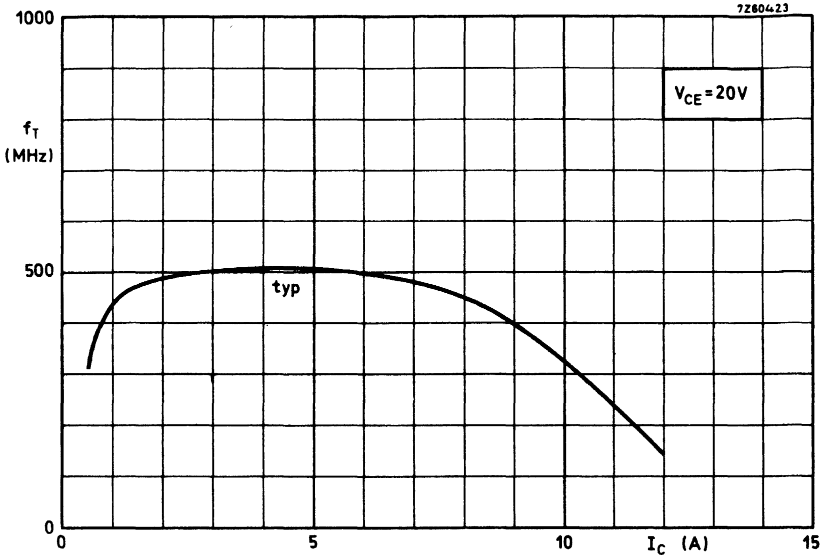
THERMAL RESISTANCE

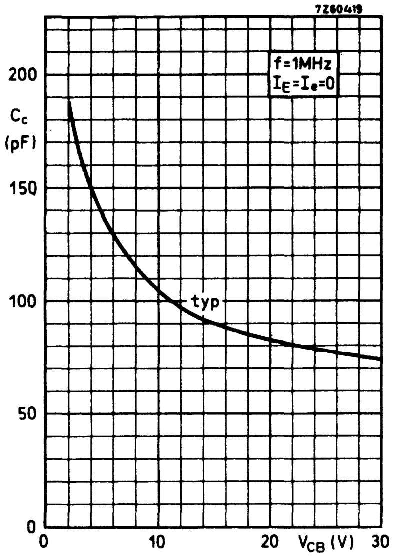
From junction to mounting base	$R_{th\ j\text{-}mb}$	=	1.35	°C/W
From mounting base to heatsink	$R_{th\ mb\text{-}h}$	=	0.2	°C/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Breakdown voltages				
Collector-base voltage open emitter, I_C = 100 mA	$V_{(BR)CBO}$	>	65	V
Collector-emitter voltage open base, I_C = 100 mA	$V_{(BR)CEO}$	>	36	V
Emitter-base voltage open collector; I_E = 25 mA	$V_{(BR)EBO}$	>	4	V
Transient energy				
L = 25 mH; f = 50 Hz				
open base	E	>	8	mWs
$-V_{BE}$ = 1.5 V; R_{BE} = 33 Ω	E	>	8	mWs
D.C. current gain				
I_C = 1 A; V_{CE} = 5 V	h_{FE}	10 to 120		
Transition frequency				
I_C = 6 A; V_{CE} = 20 V	f_T	typ.	500	MHz
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; V_{CB} = 30 V	C_c	typ. <	75 130	pF pF
Feedback capacitance				
I_C = 100 mA; V_{CE} = 30 V	$-C_{re}$	typ.	47	pF
Collector-stud capacitance	C_{cs}	typ.	3.5	pF


7Z60423
1000
f_T (MHz)
500
0
0
5
10
I_C (A)
15
$V_{CE} = 20V$
typ


7Z60419
200
C_c (pF)
150
100
50
0
0
10
20
V_{CB} (V)
30
f = 1MHz
$I_E = I_e = 0$
typ

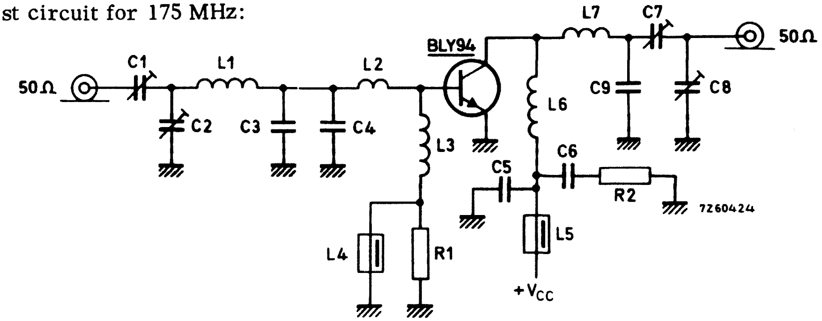
APPLICATION INFORMATION

R.F. performance in c.w. operation (unneutralised common-emitter class B circuit)

f = 175 MHz; T_{mb} up to 25 °C

V_{CC} (V)	P_S (W)	P_L (W)	I_C (A)	G_p (dB)	η (%)	$\overline{z_i}$ (Ω)	$\overline{Y_L}$ (mA/V)
28	< 10	50	< 2.75	> 7	> 65	0.7+j1.45	120-j70

Test circuit for 175 MHz:



List of components:

C1 = 2 to 20 pF film dielectric trimmer (code number 2222 809 07004)
C2 = 4 to 40 pF film dielectric trimmer (code number 2222 809 07008)
C3 = C4 = 56 pF ceramic
C5 = 100 pF ceramic
C6 = 100 nF polyester
C7 = 4 to 60 pF film dielectric trimmer (code number 2222 809 07011)
C8 = 4 to 100 pF film dielectric trimmer (code number 2222 809 07015)
C9 = 6.8 pF ceramic

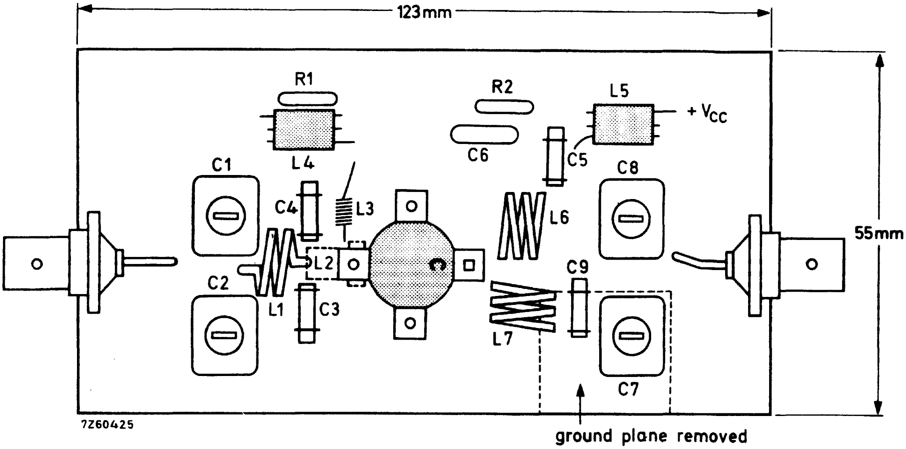
L1 = 36 nH; 2 turns enamelled Cu wire (1.5 mm); int. diam. 7 mm; length 5 mm; lead length 2 x 5 mm
L2 = formed by the metallization on the p.c. board; see component lay-out
L3 = 100 nH; 7 turns closely wound enamelled Cu wire (0.5 mm); int. diam 3 mm; lead length 2 x 5 mm
L4 = L5 = ferroxcube choke (code number 4312 020 36640)
L6 53 nH; 2 turns enamelled Cu wire (1.5 mm); int. diam. 10 mm; length 5.2 mm; lead length 2 x 5 mm
L7 = 46 nH; 2 turns enamelled Cu wire (1.5 mm); int. diam. 9 mm; length 5.4 mm; lead length 2 x 5 mm

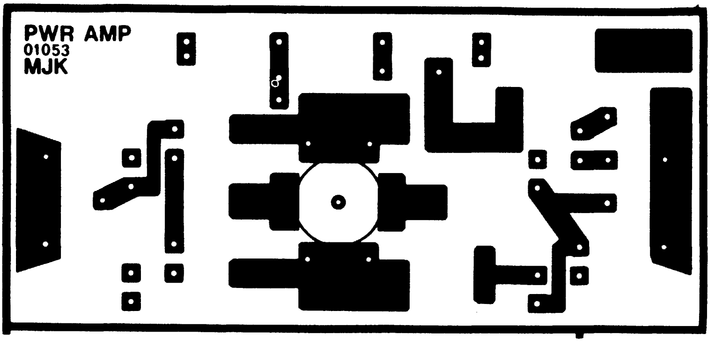
R1 = R2 = 10 Ω carbon

Component lay-out see page 6

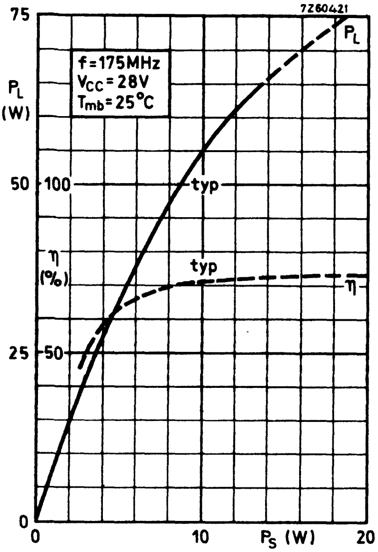
APPLICATION INFORMATION (continued)

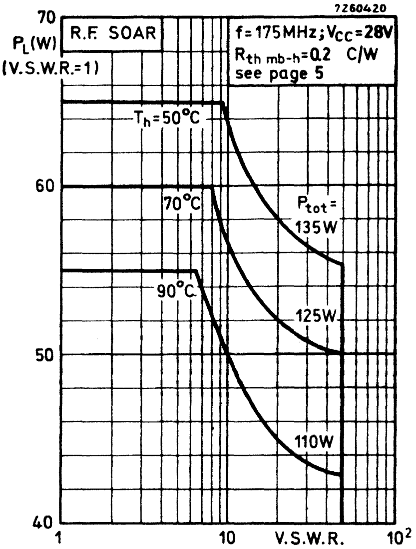
Component lay-out and printed circuit board for 175 MHz test circuit.





The circuit and the components are situated on one side of the epoxy fibre-glass board, the other side being fully metallised to serve as earth. Earth connections are made by means of hollow rivets.





For high voltage operation, a stabilized power supply is generally used.
The graph shows the allowable output power under nominal conditions as a function of the V.S.W.R., with heat-sink temperature as parameter.

SILICON EPITAXIAL PLANAR OVERLAY TRANSISTORS

The 2N3553 is a n-p-n overlay transistor in a TO-39 metal envelope with the collector connected to the case.
The 2N3375 and the 2N3632 are n-p-n overlay transistors in TO-60 metal envelopes with the electrodes insulated from the studs.
The 2N3553 and the 2N3375 are intended for v.h.f./u.h.f. and the 2N3632 for v.h.f. transmitting applications.

QUICK REFERENCE DATA

			2N3553	2N3375	2N3632	
Collector-emitter voltage $-V_{BE} = 1.5$ V	V_{CEX}	max.	65	65	65	V
Collector-emitter voltage (open base)	V_{CEO}	max.	40	40	40	V
Collector current (peak value)	I_{CM}	max.	1.0	1.5	3.0	A
Total power dissipation up to $T_{mb} = 25$ °C	P_{tot}	max.	7	11.6	23	W
Junction temperature	T_j	max.	200	200	200	°C
Transition frequency $I_C = 125$ mA; $V_{CE} = 28$ V	f_T	typ.	500	500		MHz
$I_C = 250$ mA; $V_{CE} = 28$ V	f_T	typ.			400	MHz

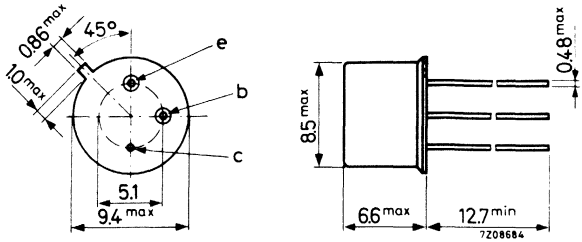
R.F. performance at $V_{CE} = 28$ V

	f (MHz)	P_o (W)	P_i (W)	η (%)
2N3553	175	2.5	< 0.25	> 50
2N3375	100	7.5	< 1	> 65
2N3375	400	> 3	1	> 40
2N3632	175	> 13.5	3.5	> 70

MECHANICAL DATA

Dimensions in mm

2N3553
Collector connected to case
TO-39



Accessories available: 56218, 56245, 56265.

MECHANICAL DATA (continued)

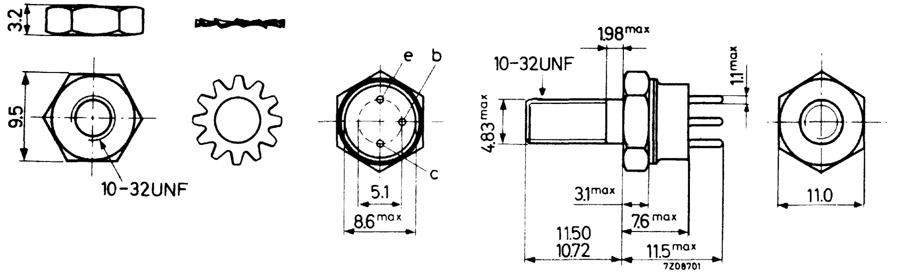
2N3375
2N3632

Dimensions in mm

TO-60
The top pins should not be bent

Torque on nut: min. 8 cm kg
max. 17 cm kg

Diameter of hole in heatsink: 4.8 to 5.2 mm



RATINGS (Limiting values) [1]

Voltages [2]

Collector-base voltage (open emitter)	V_{CBO}	max.	65	V
Collector-emitter voltage I_C up to 200 mA; $-V_{BE}$ = 1.5 V	V_{CEX}	max.	65	V
Collector-emitter voltage (open base) I_C up to 200 mA	V_{CEO}	max.	40	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4	V

Currents [2]

			2N3553	2N3375	2N3632	
Collector current (d.c.)	I_C	max.	0.35	0.5	1	A
Collector current (peak value)	I_{CM}	max.	1.0	1.5	3	A

Power dissipation [2]

Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	7	11.6	23	W

Temperatures

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

---

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

[2] See also areas of permissible operation at pages 10 and 11.

THERMAL RESISTANCE

			2N3553	2N3375	2N3632	
From junction to mounting base	$R_{th\ j\text{-}mb}$	=	25	15	7.5	°C/W
From mounting base to heatsink	$R_{th\ mb\text{-}h}$	=		0.6	0.6	°C/W
From mounting base to heatsink mounted with top clamping washer of 56218	$R_{th\ mb\text{-}h}$	=	1.0			°C/W
top clamping washer of 56218 and a boron nitride washer for electrical insulation	$R_{th\ mb\text{-}h}$	=	**2.5**			°C/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			2N3553	2N3375	2N3632	
Collector cut-off current						
$I_B = 0$; $V_{CE} = 30$ V	I_{CEO}	<	100	100	250	μA
Breakdown voltages						
$I_E = 0$; $I_C = 250\ \mu A$	$V_{(BR)CBO}$	>	65	65	65	V
I_C up to 200 mA						
$-V_{BE} = 1.5$ V; $R_B = 33\ \Omega$ [1]	$V_{(BR)CEX}$	>	65	65	65	V
$I_B = 0$ [1]	$V_{(BR)CEO}$	>	40	40	40	V
$I_C = 0$; $I_E = 250\ \mu A$	$V_{(BR)EBO}$	>	4	4	4	V
Base-emitter voltage						
$I_C = 250$ mA; $V_{CE} = 5$ V	V_{BE}	<	1.5			V
$I_C = 500$ mA; $V_{CE} = 5$ V	V_{BE}	<		1.5		V
$I_C = 1000$ mA; $V_{CE} = 5$ V	V_{BE}	<			1.5	V
Saturation voltage						
$I_C = 250$ mA; $I_B = 50$ mA	V_{CEsat}	<	1.0			V
$I_C = 500$ mA; $I_B = 100$ mA	V_{CEsat}	<		1.0		V
$I_C = 1000$ mA; $I_B = 200$ mA	V_{CEsat}	<			1.0	V

---

[1] Pulsed through an inductor of 25 mH; $\delta = 0.5$; f = 50 Hz

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

			2N3553	2N3375	2N3632	
D.C. current gain						
I_C = 125 mA; V_{CE} = 5 V	h_{FE}	> <	15 200	15 200		
I_C = 250 mA; V_{CE} = 5 V	h_{FE}	> <	10 100	10 100	10 150	
I_C = 1000 mA; V_{CE} = 5 V	h_{FE}	> <			5 110	
Collector capacitance at f = 1 MHz						
$I_E = I_e = 0$; V_{CB} = 28 V	C_c	<	10	10	20	pF
Collector-case capacitance		<		6	6	pF
Transition frequency						
I_C = 125 mA; V_{CE} = 28 V	f_T	typ.	500	500		MHz
I_C = 250 mA; V_{CE} = 28 V	f_T	typ.			400	MHz
Real part of input impedance at f = 200 MHz						
I_C = 125 mA; V_{CE} = 28 V	$Re(h_{ie})$	<	20	20		Ω
I_C = 250 mA; V_{CE} = 28 V	$Re(h_{ie})$	<			20	Ω

R.F. performance at V_{CE} = 28 V

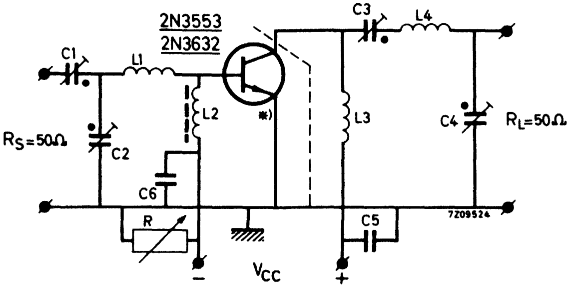
	f (MHz)	P_o (W)	P_i (W)	I_C (mA)	η %	Test circuit at page
2N3553	175	2.5	< 0.25	< 180	> 50	5
2N3375	100	7.5	< 1	< 410	> 65	6
2N3375	400	> 3	1	270	> 40	7
2N3632	175	> 13.5	3.5	690	> 70	5

NOTE

The transistors can withstand an output V.S.W.R. of 3:1 varied through all phases under conditions mentioned in the table above.

CHARACTERISTICS (continued)

Test circuit with the 2N3553 or the 2N3632 at f = 175 MHz



*) The length of the external emitter wire of the 2N3553 is 1.6 mm.
The emitter of the 2N3632 should be connected to the case as short as possible.

Components

C1 = C2 = C3 = C4 = 4 to 29 pF air trimmer

C5 = 10 nF polyester

C6 = 100 pF ceramic

L1 = 1 turn Cu wire (1.0 mm); int. diam. 10 mm; leads 2 x 10 mm

L2 = Ferroxcube choke coil. Z (at f = 175 MHz) = 550 Ω ± 20%
(code number 4312 020 **36640**)

L3 = 15 turns closely wound enamelled Cu wire (0.7 mm); int. diam. 4 mm

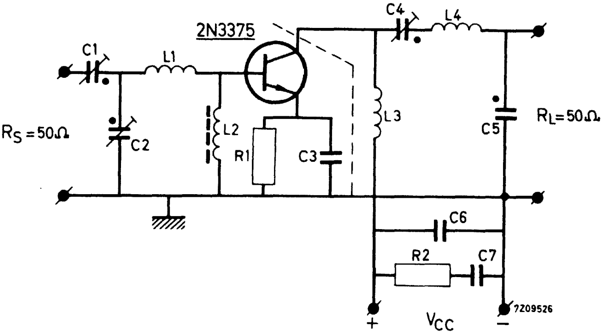
L4 = 3 turns closely wound enamelled Cu wire (1.5 mm); int. diam. 12 mm; leads 2 x 20 mm

R = 0 for the 2N3553

R = 0 to 2 Ω for the 2N3632

CHARACTERISTICS (continued)

Test circuit with the 2N3375 at f = 100 MHz



Components

C1 = C2 = 3.5 to 61.5 pF air trimmer

C3 = 10 nF polyester

C4 = C5 = 4 to 29 pF air trimmer

C6 = 330 pF ceramic

C7 = 10 nF polyester

L1 = 2 turns closely wound enamelled Cu wire (1.5 mm); int. diam. 10 mm; leads 2 x 10 mm

L2 = Ferroxcube choke coil. Z (at f = 100 MHz) = 700 Ω ± 20% (code number 4312 020 36640)

L3 = 23 turns closely wound enamelled Cu wire (0.7 mm); int. diam. 6 mm

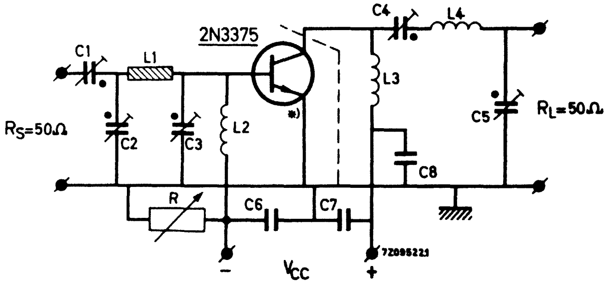
L4 = 5 turns closely wound enamelled Cu wire (1.5 mm); int. diam. 12 mm; leads 2 x 10 mm

R1 = 1.35 Ω carbon

R2 = 10 Ω carbon

CHARACTERISTICS (continued)

Test circuit with the 2N3375 at f = 400 MHz



*) The emitter should be connected to the case as short as possible.

Components

C1 = C2 = 0.7 to 6.7 pF ceramic trimmer

C3 = 0.5 to 3.5 pF ceramic trimmer

C4 = C5 = 3 to 19 pF air trimmer

C6 = C7 = 15 pF ceramic

C8 = 4700 pF ceramic

L1 = 20 mm straight Cu wire; diam. 1.5 mm; spaced 8 mm from chassis

L2 = 17 turns closely wound enamelled Cu wire (0.5 mm); int. diam. 3 mm

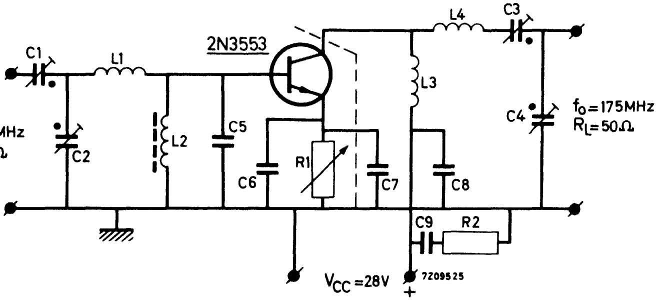
L3 = 7 turns closely wound enamelled Cu wire (0.5 mm); int. diam. 3 mm

L4 = 1 turn Cu wire (1.5 mm); int. diam. 10 mm; leads 2 x 5 mm

R = 0 to 5 Ω

APPLICATION INFORMATION

The 2N3553 used in a frequency doubler circuit 87.5 - 175 MHz

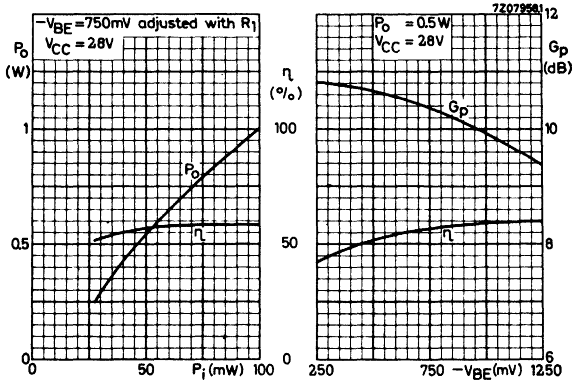


Components

C1 = C2 = C3 = 4 to 29 pF air trimmer
C4 = 3.5 to 61.5 pF air trimmer
C5 = 56 pF ceramic
C6 = 680 pF ceramic
C7 = 150 pF ceramic
C8 = 100 pF ceramic
C9 = 10 nF polyester

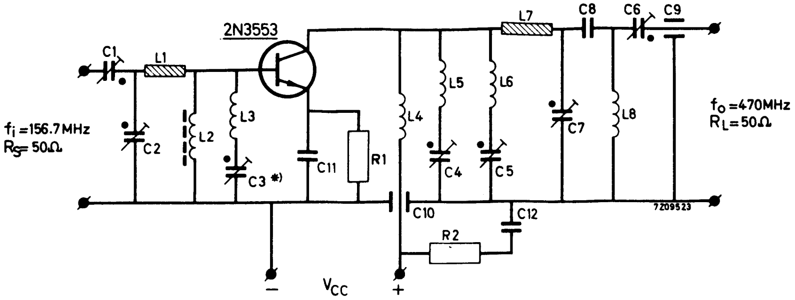
R_1 = 0 to 50 Ω
R_2 = 10 Ω carbon

L1 = 5 turns Cu wire (1 mm); winding pitch 1.5 mm; int. diam. 6 mm; leads 2 x 12 mm
L2 = Ferroxcube choke coil; Z (at f = 87.5 MHz) = 750 Ω ± 20% (code number 4312 020 **36640**)
L3 = 15 turns closely wound enamelled Cu wire (0.7 mm); int. diam. 4 mm
L4 = 6 turns Cu wire (1 mm); winding pitch 1.5 mm; int. diam. 6 mm; leads 2 x 12 mm



APPLICATION INFORMATION (continued)

The 2N3553 used in a parametric frequency tripler 156.7 - 470 MHz



*) C3 tuned to second harmonic frequency

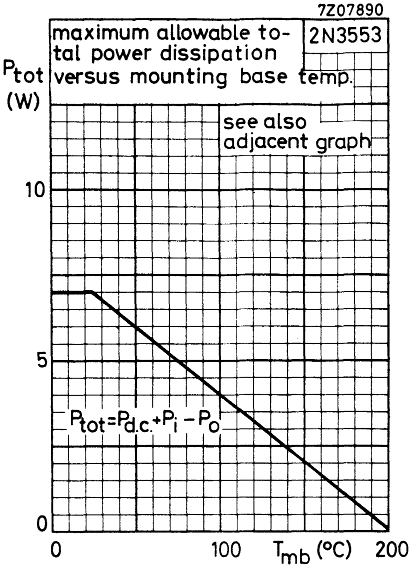
Components

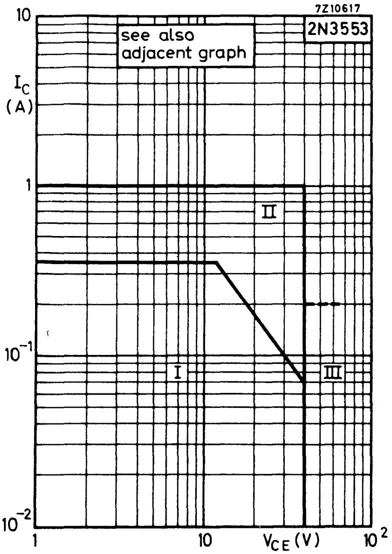
C1 = C2 = C3 = C4 =	4 to 29 pF	air trimmer	R_1 = 2.2 Ω	carbon
C5 = C6 = C7 =	4 to 10.4 pF	air trimmer	R_2 = 10 Ω	carbon
C8 =	1.0 pF	ceramic		
C9 =	12 pF	ceramic; feed through		
C10 =	100 pF	ceramic; feed through		
C11 =	1000 pF	ceramic		
C12 =	15 nF	polyester		

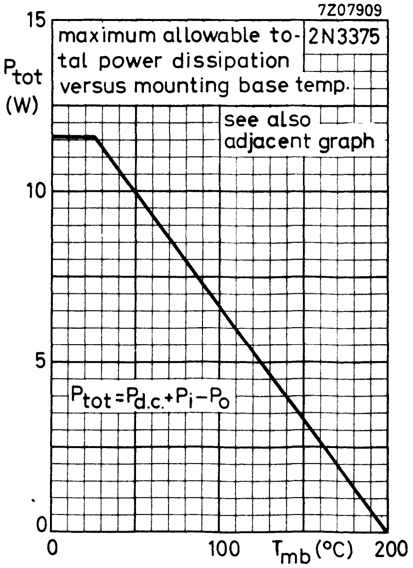
L1 = 35 mm straight Cu wire; diam. 1 mm; spaced 5.5 mm from chassis
L2 = Ferroxcube choke coil; Z (at f = 156.7 MHz) = 600 Ω ± 20% (code number 4312 020 36640)
L3 = 18 mm straight Cu wire; diam. 1 mm; spaced 5.5. mm from chassis
L4 = 7 turns closely wound enamelled Cu wire (0.5 mm); int. diam. 3.5 mm
L5 = 3 turns Cu wire (1 mm); winding pitch 1.7 mm; int. diam. 8.5 mm; leads 2 x 10 mm
L6 = 2 turns Cu wire (1 mm); winding pitch 1.7 mm; int. diam. 7 mm; leads 2 x 10 mm
L7 = 40 mm straight Cu wire; diam. 1.5 mm; spaced 5.5 mm from chassis
L8 = 1 turn Cu wire; int. diam. 7 mm; leads 2 x 5 mm

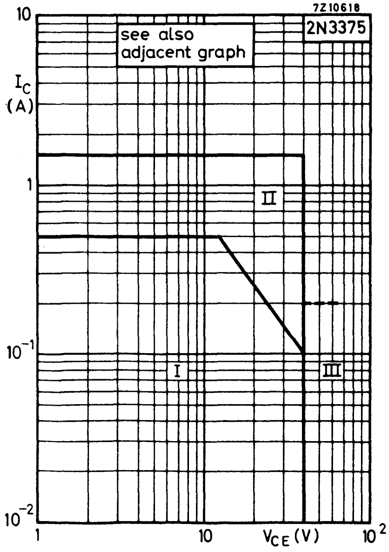
Typical performance at V_{CC} = 28 V

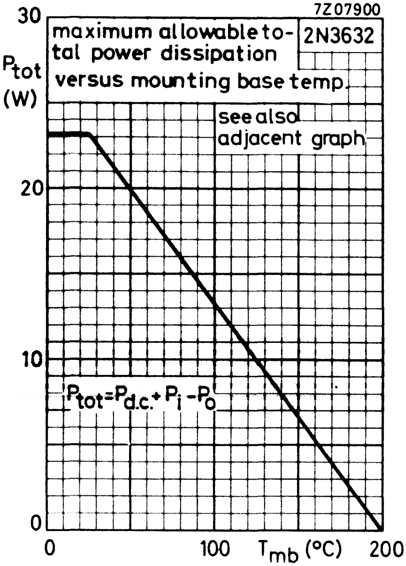
P_o (W)	P_i (W)	G_p (dB)	I_C (mA)	η %
1.5	0.27	7.5	125	43
2.0	0.39	7.1	156	46

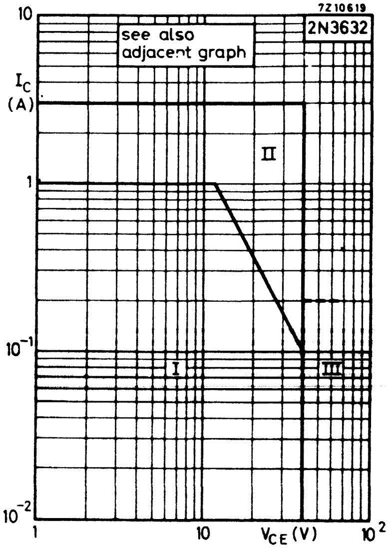

7Z07890
maximum allowable total power dissipation versus mounting base temp.
2N3553
P_{tot}
(W)
see also adjacent graph
10
5
0
$P_{tot} = P_{d.c.} + P_i - P_o$
0
100
T_{mb} (°C)
200


7Z10617
2N3553
10
see also adjacent graph
I_C
(A)
1
II
10^{-1}
I
III
10^{-2}
1
10
V_{CE} (V)
10^2


7Z07909
15
maximum allowable total power dissipation versus mounting base temp.
2N3375
P_{tot}
(W)
see also adjacent graph
10
5
$P_{tot} = P_{d.c.} + P_i - P_o$
0
0
100
T_{mb} (°C)
200


7Z10618
10
see also adjacent graph
2N3375
I_C
(A)
1
II
10^{-1}
I
III
10^{-2}
1
10
V_{CE} (V)
10^2

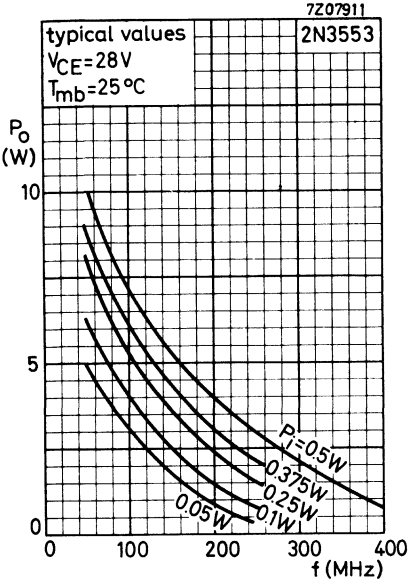


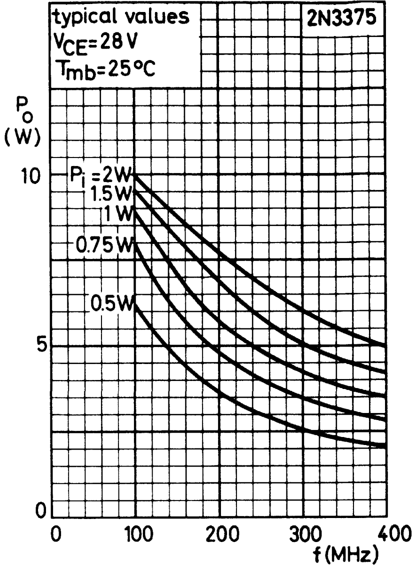


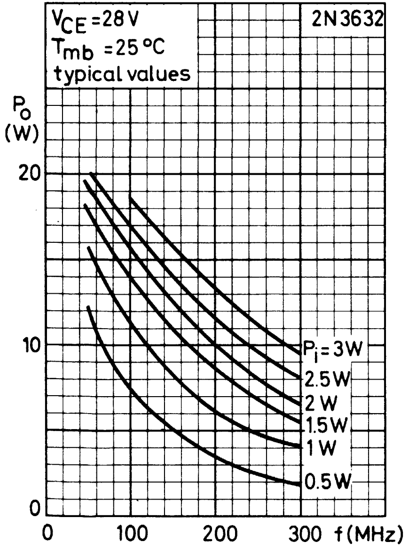
I Region of permissible operation under all base-emitter conditions and at all frequencies, including d.c.

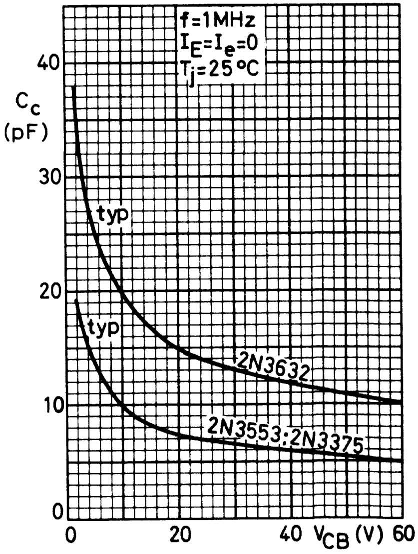
II Additional region of operation at f ≥ 1 MHz.
Care must be taken to reduce the d.c. adjustment to region I before removing the a.c. signal. This may be achieved by an appropriate bias in class A, B or C.

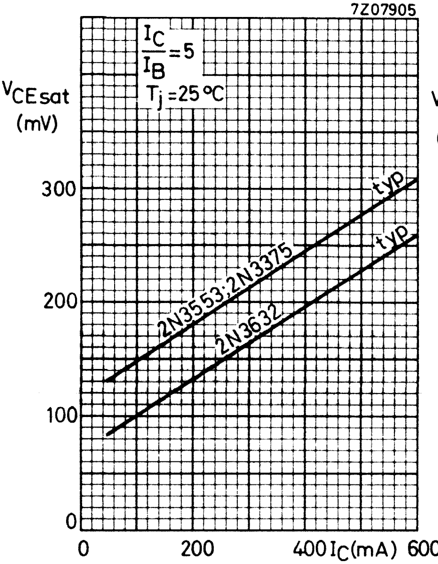
III Operating during switching off in this region is allowed, provided the transistor is cut-off with $-V_{BB} \leq 1.5$ V and $R_{BE} \geq 33\ \Omega$, $I_C \leq 200$ mA and the transient energy does not exceed 0.5 mWs.

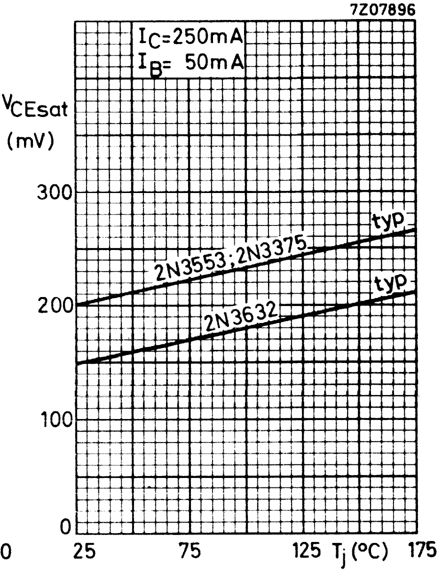

7Z07911

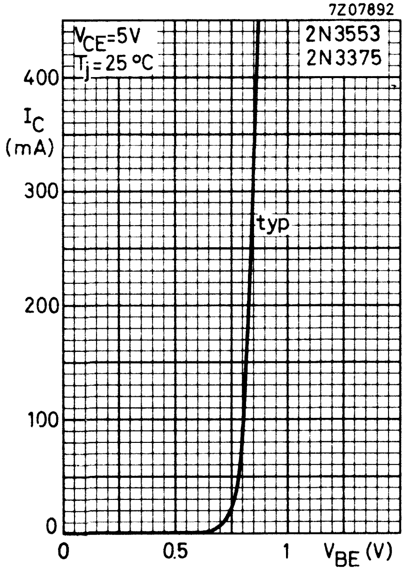

7Z07908

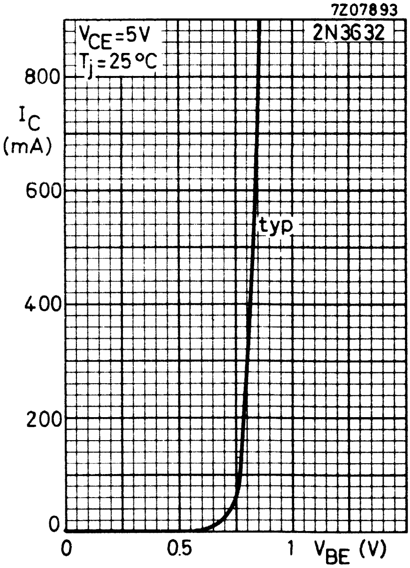

7Z07894

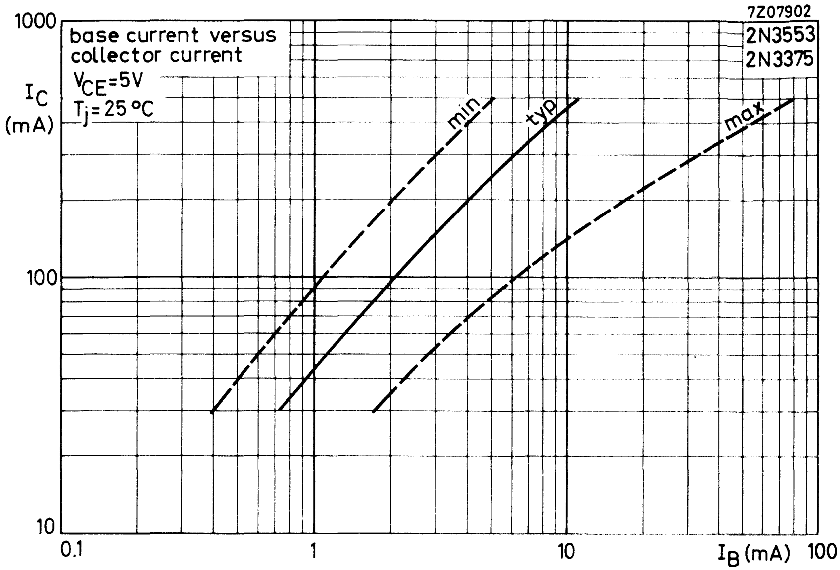

7Z07898

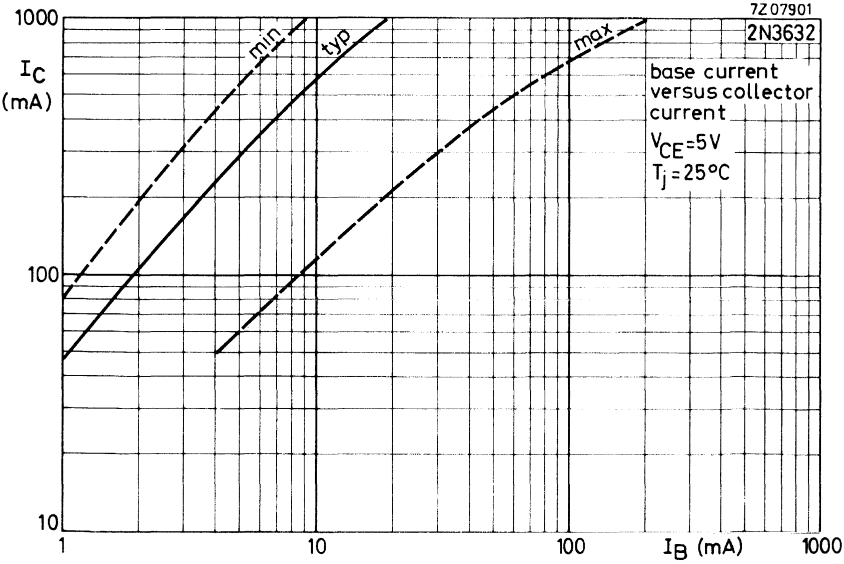

7Z07905
$\frac{I_C}{I_B} = 5$
$T_j = 25$ °C
V_{CEsat} (mV)
300
200
100
0
0
200
400
I_C (mA)
600
2N3553;2N3375
2N3632
typ
typ

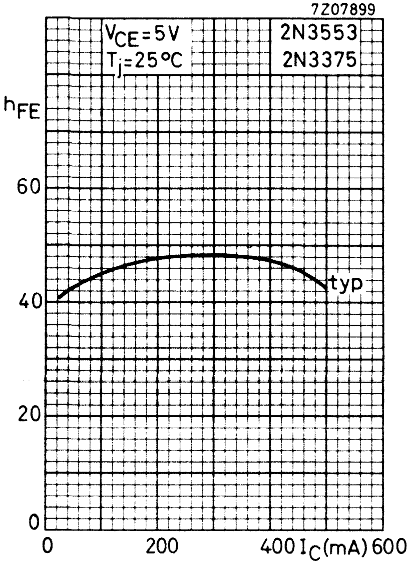

7Z07896
$I_C = 250$ mA
$I_B = 50$ mA
V_{CEsat} (mV)
300
200
100
0
25
75
125
T_j (°C)
175
2N3553;2N3375
2N3632
typ
typ

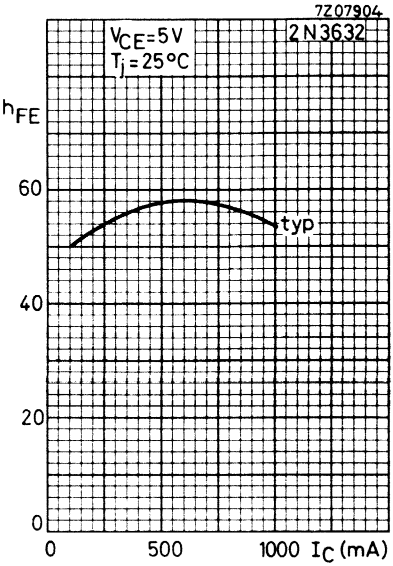

7Z07892
$V_{CE} = 5$ V
$T_j = 25$ °C
2N3553
2N3375
I_C (mA)
400
300
200
100
0
0
0.5
1
V_{BE} (V)
typ

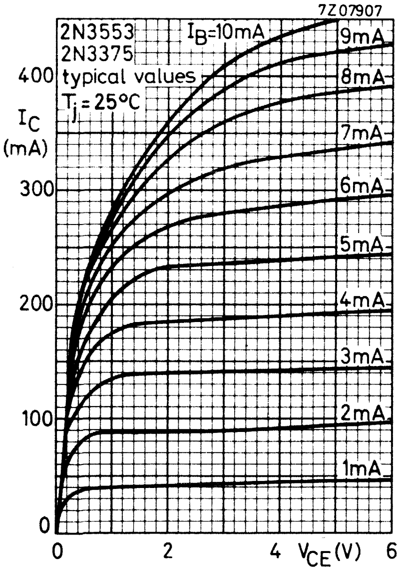

7Z07893
$V_{CE} = 5$ V
$T_j = 25$ °C
2N3632
I_C (mA)
800
600
400
200
0
0
0.5
1
V_{BE} (V)
typ

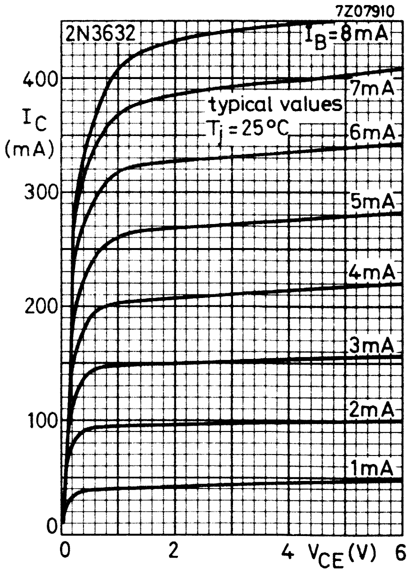

7Z07902
2N3553
2N3375
base current versus
collector current
V_{CE}=5V
T_j=25 °C
I_C
(mA)
1000
100
10
0.1
1
10
100
I_B (mA)
min
typ
max

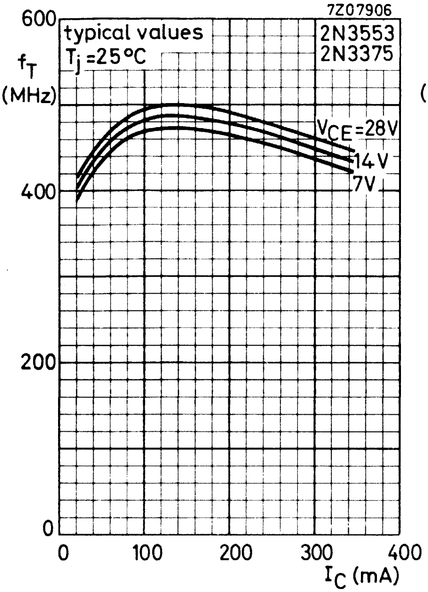

7Z07901
2N3632
base current
versus collector
current
V_{CE}=5V
T_j=25°C
I_C
(mA)
1000
100
10
1
10
100
1000
I_B (mA)
min
typ
max

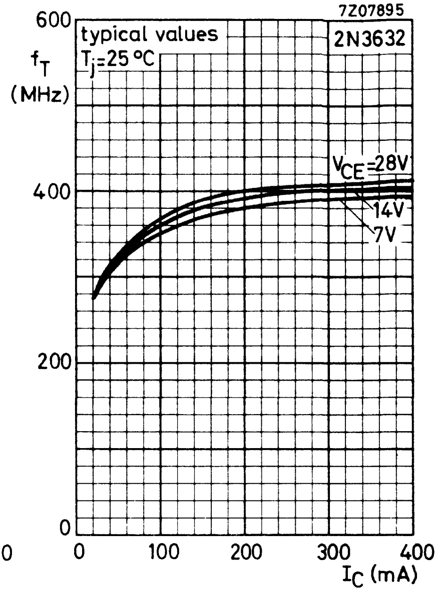

7Z07899
V_{CE} = 5 V
T_j = 25 °C
2N3553
2N3375
h_{FE}
60
40
20
0
typ
0
200
400
I_C (mA)
600

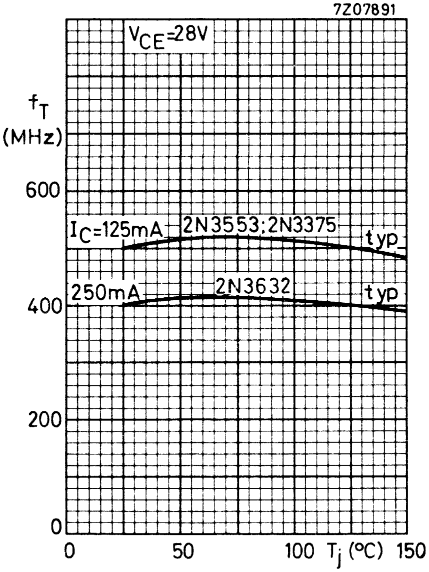

7Z07904
V_{CE} = 5 V
T_j = 25 °C
2N3632
h_{FE}
60
40
20
0
typ
0
500
1000
I_C (mA)

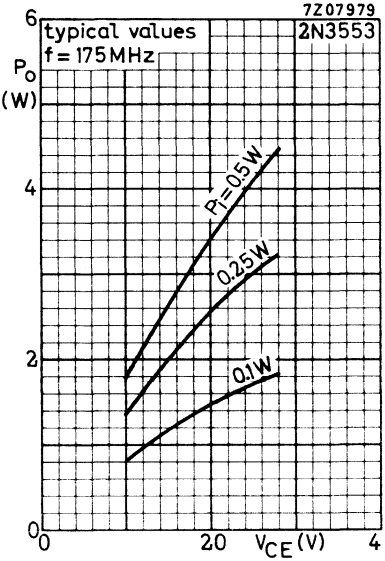

7Z07907
2N3553
2N3375
typical values
T_j = 25 °C
I_B = 10 mA
9mA
8mA
7mA
6mA
5mA
4mA
3mA
2mA
1mA
I_C (mA)
400
300
200
100
0
0
2
4
V_{CE} (V)
6

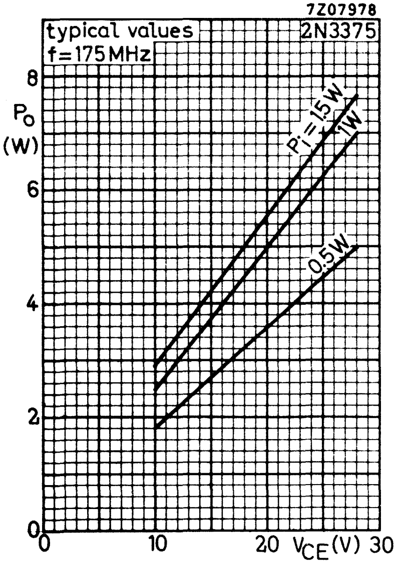

7Z07910
2N3632
I_B = 8 mA
typical values
T_j = 25 °C
7mA
6mA
5mA
4mA
3mA
2mA
1mA
I_C (mA)
400
300
200
100
0
0
2
4
V_{CE} (V)
6

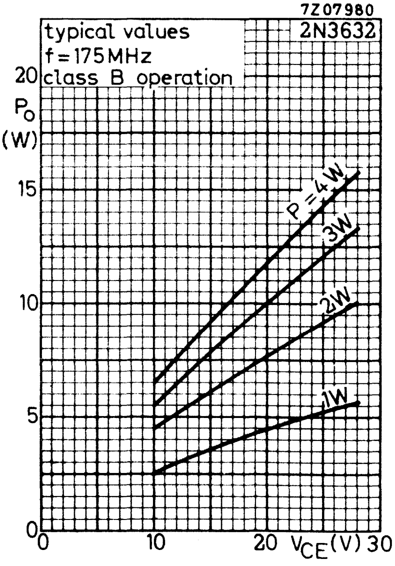

7Z07906
typical values
T_j =25 °C
2N3553
2N3375
f_T (MHz)
600
400
200
0
V_{CE}=28V
14 V
7V
0
100
200
300
400
I_C (mA)


7Z07895
typical values
T_j=25 °C
2N3632
f_T (MHz)
600
400
200
0
V_{CE}=28V
14V
7V
0
100
200
300
400
I_C (mA)


7Z07891
V_{CE}=28V
f_T (MHz)
600
400
200
0
I_C=125mA
2N3553;2N3375
typ
250mA
2N3632
typ
0
50
100
T_j (°C)
150


7Z07979
typical values
f = 175 MHz
2N3553
P_o
(W)
6
4
2
0
0
20
V_{CE} (V)
4
P_i = 0.5W
0.25W
0.1W


7Z07978
typical values
f = 175 MHz
2N3375
P_o
(W)
8
6
4
2
0
0
10
20
V_{CE} (V)
30
P_i = 1.5W
1W
0.5W


7Z07980
typical values
f = 175 MHz
class B operation
2N3632
P_o
(W)
20
15
10
5
0
0
10
20
V_{CE} (V)
30
P_i = 4W
3W
2W
1W

SILICON EPITAXIAL PLANAR OVERLAY TRANSISTORS

N-P-N overlay transistors in a TO-39 metal envelope with the collector connected to the case. The devices are primarily intended for class A, B or C amplifiers, frequency multiplier- and oscillator circuits.
The transistors are suitable in output, driver or pre-driver stages in v.h.f. and u.h.f. equipment.

QUICK REFERENCE DATA

			2N3866	2N4427	
Collector-emitter voltage R_{BE} = 10 Ω	V_{CER}	max.	55	40	V
Collector-emitter voltage (open base)	V_{CEO}	max.	30	20	V
Collector current (d.c. or averaged over any 20 ms period)	I_C	max.	0.4	0.4	A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	5	3.5	W
Junction temperature	T_j	max.	200	200	°C
Transition frequency					
I_C = 25 mA; V_{CE} = 15 V; f = 100 MHz	f_T	typ.	700		MHz
I_C = 25 mA; V_{CE} = 10 V; f = 100 MHz	f_T	typ.		700	MHz

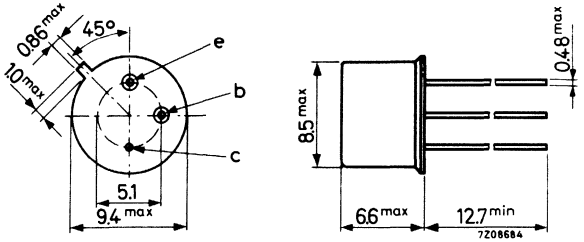
R.F. performance

Type	f (MHz)	V_{CE} (V)	P_o (W)	P_i (W)	η (%)
2N3866	400	28	1	< 0.1	> 45
2N4427	175	12	1	< 0.1	> 50

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)

			2N3866	2N4427	
Voltages [1]					
Collector-base voltage (open emitter)	V_{CBO}	max.	55	40	V
Collector-emitter voltage R_{BE} = 10 Ω	V_{CER}	max.	55	40	V
Collector-emitter voltage (open base)	V_{CEO}	max.	30	20	V
Emitter-base voltage (open collector)	V_{EBO}	max.	3.5	2.0	V
Currents [1]					
Collector current (d.c. or averaged over any 20 ms period)	I_C	max.	0.4	0.4	A
Collector current (peak value)	I_{CM}	max.	0.4	0.4	A
Power dissipation [1]					
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	5	3.5	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	$R_{th\ j\text{-}a}$	=	200	°C/W
From junction to mounting base	$R_{th\ j\text{-}mb}$	=	35	°C/W
From mounting base to heatsink mounted with top clamping washer of 56218	$R_{th\ mb\text{-}h}$	=	1.0	°C/W
top clamping washer of 56218 and a boron nitride washer for electrical insulation	$R_{th\ mb\text{-}h}$	=	**2.5**	°C/W

---

[1] See also areas of permissible operation on page 6 .

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			2N3866	2N4427	
Collector cut-off current					
$I_B = 0$; $V_{CE} = 28$ V	I_{CEO}	<	20		μA
$I_B = 0$; $V_{CE} = 12$ V	I_{CEO}	<		20	μA
Breakdown voltages					
$I_E = 0$; $I_C = 100$ μA	$V_{(BR)CBO}$	>	55	40	V
$I_C = 5$ mA; $R_{BE} = 10$ Ω	$V_{(BR)CER}$	>	55	40	V
$I_B = 0$; $I_C = 5$ mA	$V_{(BR)CEO}$	>	30	20	V
$I_C = 0$; $I_E = 100$ μA	$V_{(BR)EBO}$	>	3.5	2	V
Collector-emitter saturation voltage					
$I_C = 100$ mA; $I_B = 20$ mA	V_{CEsat}	<	1.0	0.5	V
D.C. current gain					
$I_C = 50$ mA; $V_{CE} = 5$ V	h_{FE}		10 to 200		
$I_C = 100$ mA; $V_{CE} = 5$ V	h_{FE}			10 to 200	
$I_C = 360$ mA; $V_{CE} = 5$ V	h_{FE}	>	5	5	
Transition frequency					
$I_C = 25$ mA; $V_{CE} = 15$ V; f = 100 MHz	f_T	typ.	700		MHz
$I_C = 25$ mA; $V_{CE} = 10$ V; f = 100 MHz	f_T	typ.		700	MHz
Collector capacitance					
$V_{CB} = 28$ V; $I_E = I_e = 0$; f = 1 MHz	C_c	<	3		pF
$V_{CB} = 12$ V; $I_E = I_e = 0$; f = 1 MHz	C_c	<		4	pF

R.F. performance at T_{mb} = 25 °C

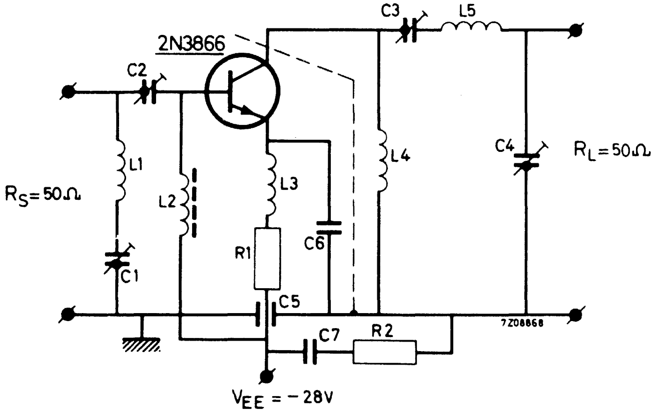
	f (MHz)	V_{CE} (V)	P_o (W)	P_i (W)	I_C (mA)	η (%)	Test circuit on page
2N3866	100	28	1.8	0.05	< 107	> 60	
2N3866	250	28	1.5	0.1	< 107	> 50	
2N3866	400	28	1.0	< 0.1	< 79	> 45	4 *
2N4427	175	12	1.0	< 0.1	< 167	> 50	5 *
2N4427	470	12	0.4	0.1	67	50	

---

*) The transistor can withstand an output V.S.W.R. of 3 : 1 varied through all phases for conditions, mentioned in the table above.

CHARACTERISTICS (continued)

Test circuit with the 2N3866 at f = 400 MHz



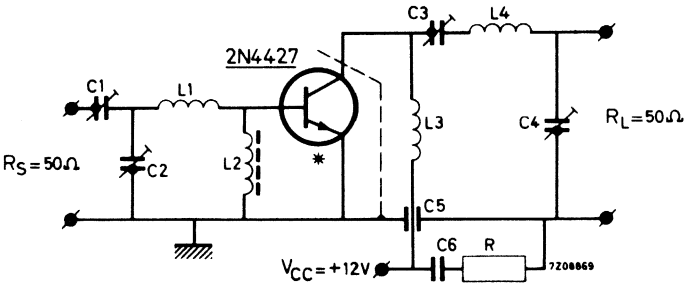
C1 = C2 = C3 = 4 to 29 pF air trimmer
C4 = 4 to 14 pF air trimmer
C5 = 1 nF feed through
C6 = 12 pF
C7 = 12 nF

R1 = 5.6 Ω
R2 = 10 Ω

L1 = 2 turns Cu wire (1 mm); int. diam. 6 mm; winding pitch 3 mm
L2 = Ferroxcube choke coil; Z (at f = 250 MHz) = 450 Ω (code number 4312 020 36690)
L3 = L4 = 6 turns enamelled Cu wire (0.5 mm); int. diam. 3.5 mm (100 nH)
L5 = 2 turns Cu wire (1 mm); int. diam. 7 mm; winding pitch 2.5 mm; leads 2x15 mm.

CHARACTERISTICS (continued)

Test circuit with the 2N4427 at f = 175 MHz

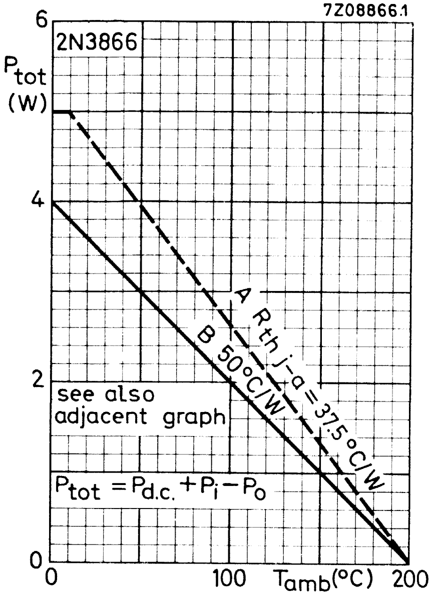


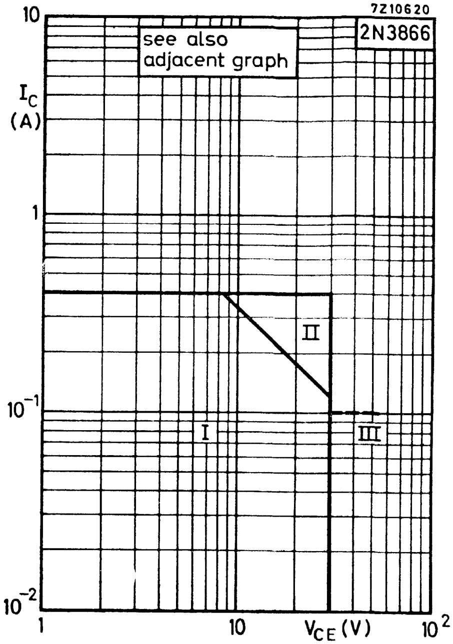
*) The length of the external emitter wire is 1.6 mm

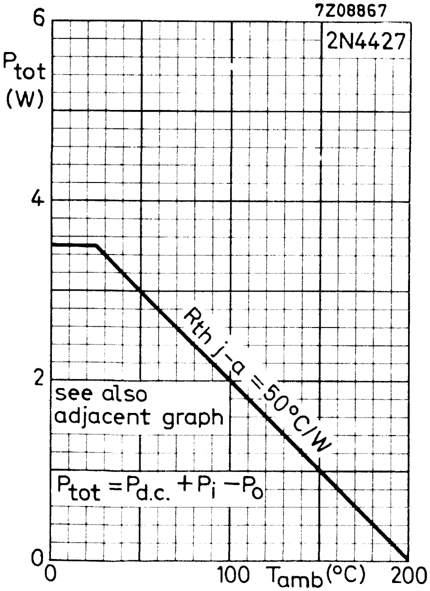
C1 = C2 = C3 = C4 = 4 to 29 pF air trimmer
C5 = 1 nF feed through
C6 = 12 nF

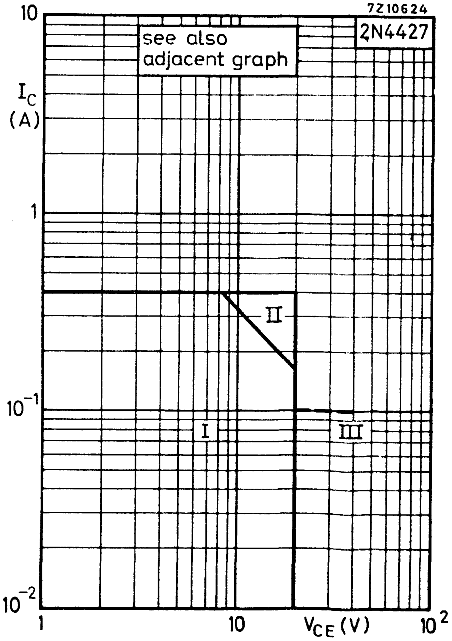
R = 10 Ω

L1 = 2 turns Cu wire (1 mm); int. diam. 6 mm; winding pitch 2 mm; leads 2x10 mm
L2 = Ferroxcube choke coil; Z (at f = 175 MHz) = 550 Ω (code number 4312 020 36640)
L3 = 2 turns Cu wire (1 mm); int. diam. 5 mm; winding pitch 2 mm; leads 2x10 mm
L4 = 3 turns Cu wire (1.5 mm); int. diam. 10 mm; winding pitch 2 mm; leads 2x15 mm


7Z08866.1
2N3866
P_{tot} (W)
6
4
2
0
0
100
T_{amb} (°C)
200
A $R_{th\ j-a}$ = 37.5 °C/W
B 50 °C/W
see also adjacent graph
$P_{tot} = P_{d.c.} + P_i - P_o$


7Z10620
2N3866
see also adjacent graph
I_C (A)
10
1
10^{-1}
10^{-2}
1
10
V_{CE} (V)
10^2
I
II
III

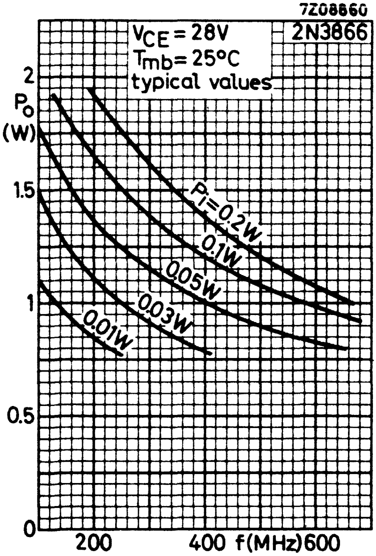

7Z08867
2N4427
P_{tot} (W)
6
4
2
0
0
100
T_{amb} (°C)
200
$R_{th\ j-a}$ = 50 °C/W
see also adjacent graph
$P_{tot} = P_{d.c.} + P_i - P_o$

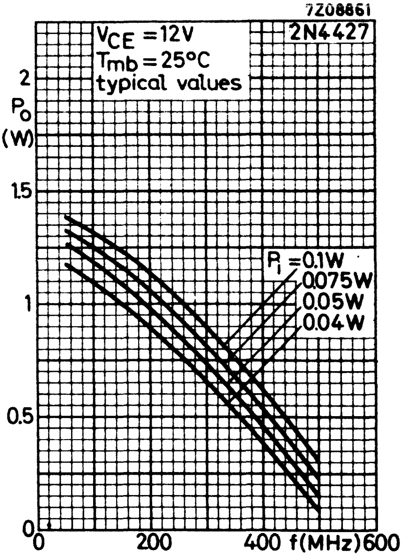

7Z10624
2N4427
see also adjacent graph
I_C (A)
10
1
10^{-1}
10^{-2}
1
10
V_{CE} (V)
10^2
I
II
III

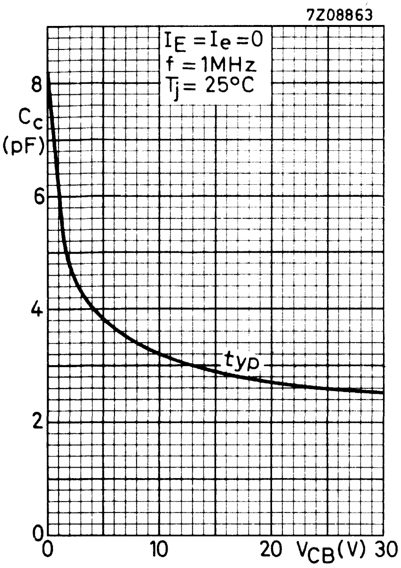
I Region of permissible operation under all base-emitter conditions and at all frequencies, including d.c.

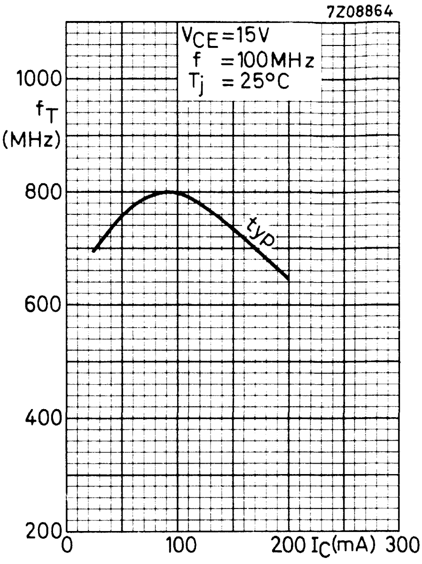
II Additional region of operation at f ≥ 1 MHz.
Care must be taken to reduce the d.c. adjustment to region I before removing the a.c. signal. This may be achieved by an appropriate bias in class A, B' or C.

III Operating during switching off in this region is allowed, provided the transistor is cut-off with $-V_{BB} \leq 1.5$ V and $R_{BE} \geq 33\ \Omega$, $I_C \leq 100$ mA and the transient energy does not exceed 0.125 mWs.






7Z08863
$I_E = I_e = 0$
f = 1MHz
T_j = 25°C
C_c (pF)
8
6
4
2
0
typ
0
10
20
V_{CB}(V)
30


7Z08864
V_{CE}=15V
f = 100MHz
T_j = 25°C
f_T (MHz)
1000
800
600
400
200
typ
0
100
200
I_C(mA)
300

SILICON EPITAXIAL PLANAR OVERLAY TRANSISTORS

The 2N3924 is a n-p-n overlay transistor in a TO-39 metal envelope with the collector connected to the case.
The 2N3926 and the 2N3927 are n-p-n overlay transistors in TO-60 metal envelopes with the emitter connected to the case.
The transistors are intended for v.h.f. transmitting applications.

QUICK REFERENCE DATA

			2N3924	2N3926	2N3927	
Collector-emitter voltage $-V_{BE} = 1.5$ V	V_{CEX}	max.	36	36	36	V
Collector-emitter voltage (open base)	V_{CEO}	max.	18	18	18	V
Collector current (peak value)	I_{CM}	max.	1.5	3.0	4.5	A
Total power dissipation up to $T_{mb} = 25$ °C	P_{tot}	max.	7	11.6	23	W
Junction temperature	T_j	max.	200	200	200	°C
Transition frequency						
$I_C = 100$ mA; $V_{CE} = 13.5$ V	f_T	>	250	250		MHz
$I_C = 200$ mA; $V_{CE} = 13.5$ V	f_T	>			200	MHz

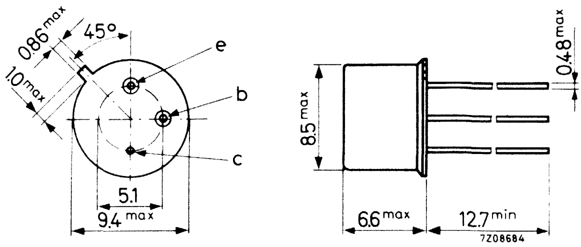
R.F. performance at $V_{CE} = 13.5$ V; f = 175 MHz

	P_o (W)	P_i (W)	η (%)
2N3924	4	< 1	> 70
2N3926	7	< 2	> 70
2N3927	12	< 4	> 80

MECHANICAL DATA

Dimensions in mm

2N3924
Collector connected
to case
TO-39



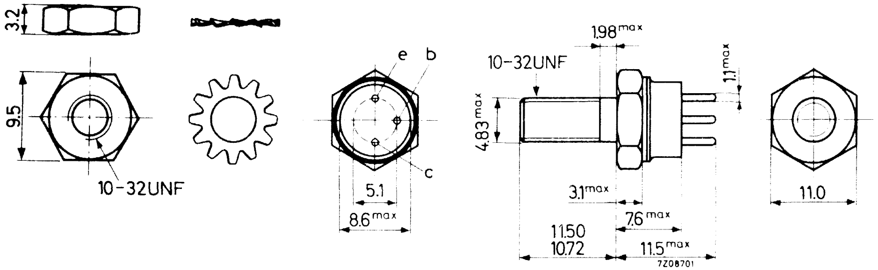
Accessories available: 56218, 56245, 56265.

MECHANICAL DATA (continued)

Dimensions in mm

2N3926
2N3927
TO-60
The emitter connected to the case
The top pins should not be bent

Diameter of hole in heatsink: 4.8 to 5.2 mm
The device is supplied with nut and lock washer
Torque on nut: min. 8 cm kg
max. 17 cm kg



RATINGS (Limiting values) [1]

Voltages [2]

Collector-base voltage (open emitter)	V_{CBO}	max.	36	V
Collector-emitter voltage I_C up to 400 mA; $-V_{BE}$ = 1.5 V	V_{CEX}	max.	36	V
Collector-emitter voltage (open base) I_C up to 400 mA	V_{CEO}	max.	18	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4	V

Currents [2]

			2N3924	2N3926	2N3927	
Collector current (d.c.)	I_C	max.	0.5	1.0	1.5	A
Collector current (peak value)	I_{CM}	max.	1.5	3.0	4.5	A

Power dissipation [2]

			2N3924	2N3926	2N3927	
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	7	11.6	23	W

Temperatures

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

---

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

[2] See also areas of permissible operation at pages 8 and 9.

THERMAL RESISTANCE			2N3924	2N3926	2N3927	
From junction to mounting base	$R_{th\ j\text{-}mb}$	=	25	15	7.5	°C/W
From mounting base to heatsink	$R_{th\ mb\text{-}h}$	=		0.6	0.6	°C/W
From mounting base to heatsink mounted with top clamping washer of 56218	$R_{th\ mb\text{-}h}$	=	1.0			°C/W
top clamping washer of 56218 and a boron nitride washer for electrical insulation	$R_{th\ mb\text{-}h}$	=	**2.5**			°C/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			2N3924	2N3926	2N3927	
Collector cut-off current						
$I_E = 0$; $V_{CB} = 15$ V	I_{CBO}	<	100	100	**250**	μA
$I_E = 0$; $V_{CB} = 15$ V; $T_j = 150$ °C	I_{CBO}	<	5	5	**10**	mA
Breakdown voltages						
$I_E = 0$; $I_C = 250$ μA	$V_{(BR)CBO}$	>	36	36	36	V
I_C up to 400 mA $-V_{BE} = 1.5$ V; $R_B = 33\ \Omega$ 1)	$V_{(BR)CEX}$	>	36	36	36	V
$I_B = 0$ 1)	$V_{(BR)CEO}$	>	18	18	18	V
$I_C = 0$; $I_E = 250$ μA	$V_{(BR)EBO}$	>	4	4	4	V
Base-emitter voltage						
$I_C = 250$ mA; $V_{CE} = 5$ V	V_{BE}	<	1.5			V
$I_C = 500$ mA; $V_{CE} = 5$ V	V_{BE}	<		1.5		V
$I_C = 1000$ mA; $V_{CE} = 5$ V	V_{BE}	<			1.5	V
Saturation voltage						
$I_C = 250$ mA; $I_B = 50$ mA	V_{CEsat}	<	0.75			V
$I_C = 500$ mA; $I_B = 100$ mA	V_{CEsat}	<		0.75		V
$I_C = 1000$ mA; $I_B = 200$ mA	V_{CEsat}	<			1.0	V

---

1) Pulsed through an inductor of 25 mH; $\delta = 0.5$; f = 50 Hz

CHARACTERISTICS (continued)

T_j = 25 °C unless otherwise specified

			2N3924	2N3926	2N3927	
D.C. current gain						
I_C = 250 mA; V_{CE} = 5 V	h_{FE}	> <	10 150			
I_C = 500 mA; V_{CE} = 5 V	h_{FE}	> <		5 150		
I_C = 1000 mA; V_{CE} = 5 V	h_{FE}	> <			5 150	
Collector capacitance at f = 1 MHz						
$I_E = I_e$ = 0; V_{CB} = 13.5 V	C_c	<	20	20	45	pF
Transition frequency						
I_C = 100 mA; V_{CE} = 13.5 V	f_T	>	250	250		MHz
I_C = 200 mA; V_{CE} = 13.5 V	f_T	>			200	MHz
Real part of input impedance at f = 200 MHz						
I_C = 100 mA; V_{CE} = 13.5 V	Re(h_{ie})	<	20	20		Ω
I_C = 200 mA; V_{CE} = 13.5 V	Re(h_{ie})	<			20	Ω

R.F. performance at V_{CE} = 13.5 V; f = 175 MHz

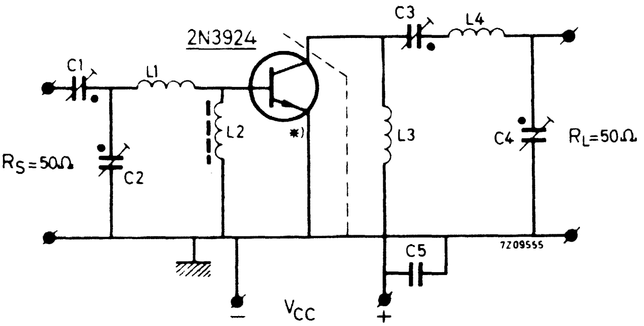
	P_o (W)	P_i (W)	I_C (mA)	η %	Test circuit at page
2N3924	4	< 1	< 420	> 70	5
2N3926	7	< 2	< 740	> 70	6
2N3927	12	< 4	< 1100	> 80	6

NOTE

The transistors can withstand an output V.S.W.R. of 3:1 varied through all phases under conditions mentioned in the table above.

CHARACTERISTICS (continued)

Test circuit with the 2N3924 at f = 175 MHz



*) The length of the external emitter wire of the 2N3924 is 1.6 mm.

Components

C1 = C2 = C3 = C4 =	4 to 29 pF	air trimmer
C5 =	10 nF	polyester

L1 = 1 turn Cu wire (1.0 mm); int. diam. 10 mm; leads 2 x 10 mm

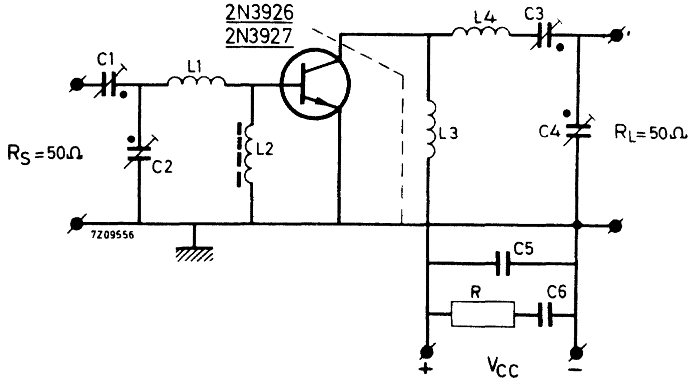
L2 = Ferroxcube choke coil. Z (at f = 175 MHz) = 550 Ω ± 20% (code number 4312 020 **36640**)

L3 = 15 turns closely wound enamelled Cu wire (0.7 mm); int. diam. 4 mm

L4 = 3 turns closely wound enamelled Cu wire (1.5 mm); int. diam. 12 mm; leads 2 x 20 mm

CHARACTERISTICS (continued)

Test circuit with the 2N3926 or 2N3927 at f = 175 MHz



Components

C1 = C2 = C3 = C4 =	4 to 29 pF	air trimmer
C5 =	100 pF	ceramic
C6 =	10 nF	polyester

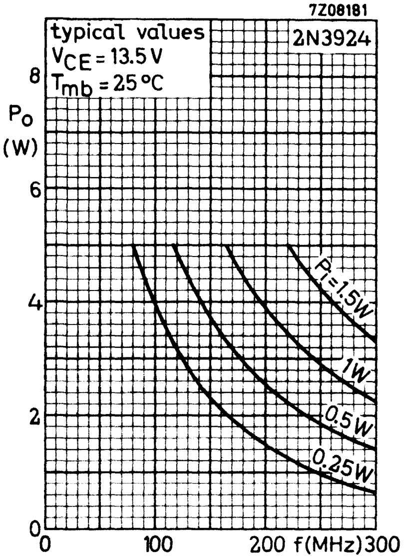
L1 = 1 turn Cu wire (1.0 mm); int. diam. 10 mm; leads 2 x 10 mm

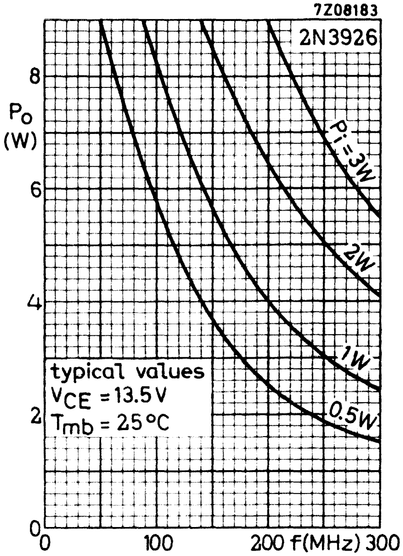
L2 = Ferroxcube choke coil. Z (at f = 175 MHz) = 550 Ω ± 20%
(code number 4312 020 **36640**)

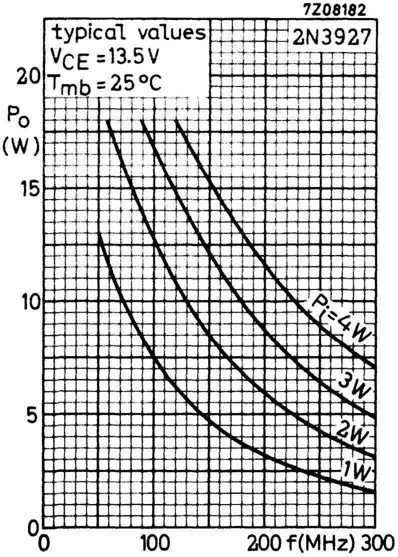
L3 = 15 turns closely wound enamelled Cu wire (0.7 mm); int. diam. 4 mm

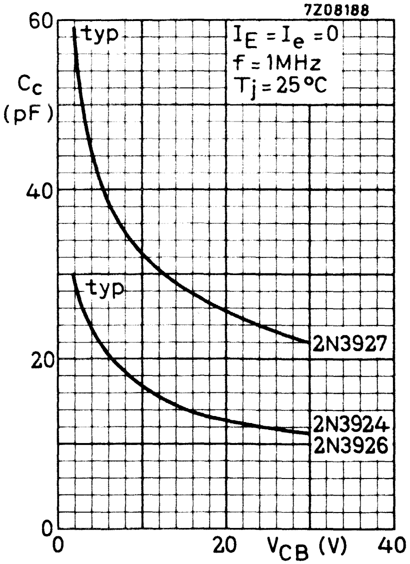
L4 = 2 turns closely wound enamelled Cu wire (1.5 mm); int. diam. 8.5 mm; leads 2 x 20 mm

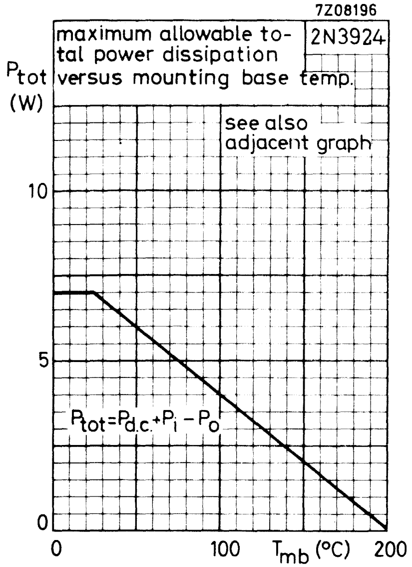
R = 10 Ω carbon

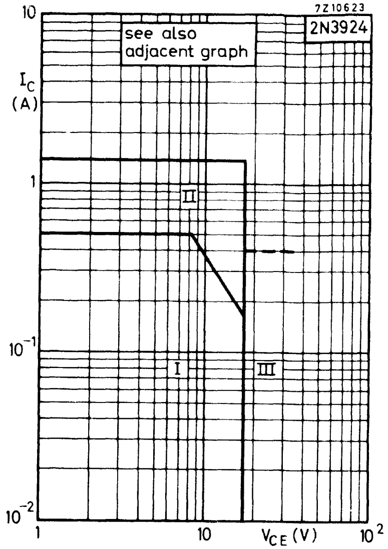

7Z08181
typical values
V_{CE} = 13.5 V
T_{mb} = 25 °C
2N3924
P_o (W)
0
2
4
6
8
P_i = 1.5W
1W
0.5W
0.25W
0
100
200
f(MHz)
300

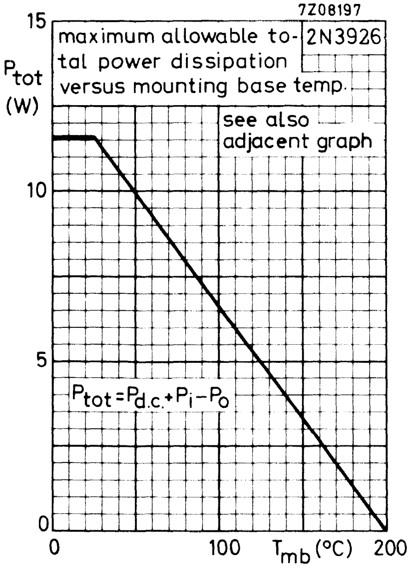

7Z08183
2N3926
P_o (W)
0
2
4
6
8
P_i = 3W
2W
1W
0.5W
typical values
V_{CE} = 13.5 V
T_{mb} = 25 °C
0
100
200
f(MHz)
300

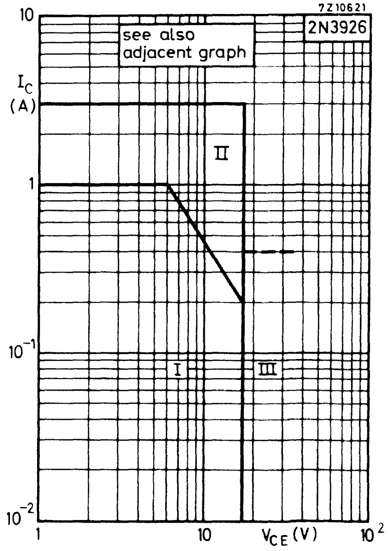

7Z08182
typical values
V_{CE} = 13.5 V
T_{mb} = 25 °C
2N3927
P_o (W)
0
5
10
15
20
P_i = 4W
3W
2W
1W
0
100
200
f(MHz)
300

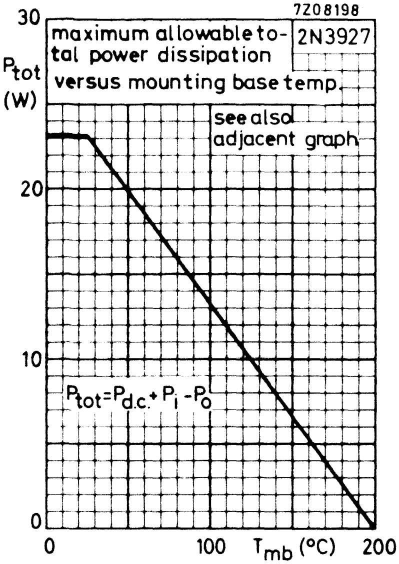

7Z08188
C_c (pF)
0
20
40
60
typ
typ
$I_E = I_e = 0$
f = 1MHz
T_j = 25 °C
2N3927
2N3924
2N3926
0
20
V_{CB} (V)
40

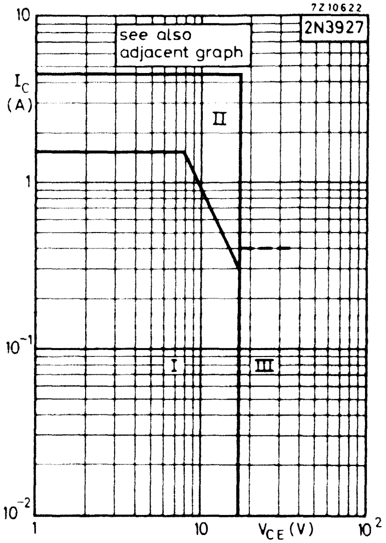

7Z08196
maximum allowable total power dissipation versus mounting base temp.
2N3924
P_{tot} (W)
see also adjacent graph
$P_{tot}=P_{d.c.}+P_i-P_o$
10
5
0
0
100
T_{mb} (°C)
200


7Z10623
2N3924
see also adjacent graph
I_C (A)
10
1
10^{-1}
10^{-2}
II
I
III
1
10
V_{CE} (V)
10^2


7Z08197
maximum allowable total power dissipation versus mounting base temp.
2N3926
P_{tot} (W)
see also adjacent graph
$P_{tot}=P_{d.c.}+P_i-P_o$
15
10
5
0
0
100
T_{mb} (°C)
200


7Z10621
2N3926
see also adjacent graph
I_C (A)
10
1
10^{-1}
10^{-2}
II
I
III
1
10
V_{CE} (V)
10^2

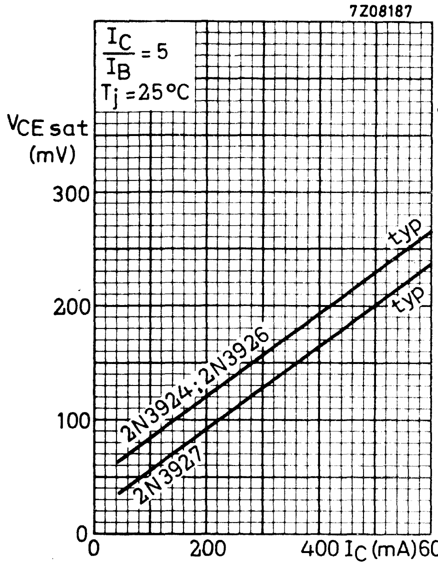


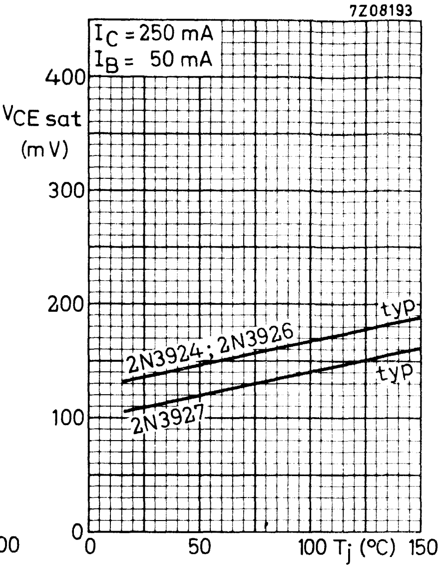


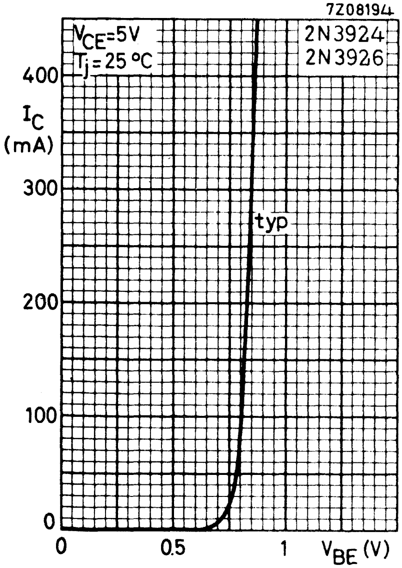
I Region of permissible operation under all base-emitter conditions and at all frequencies, including d.c.

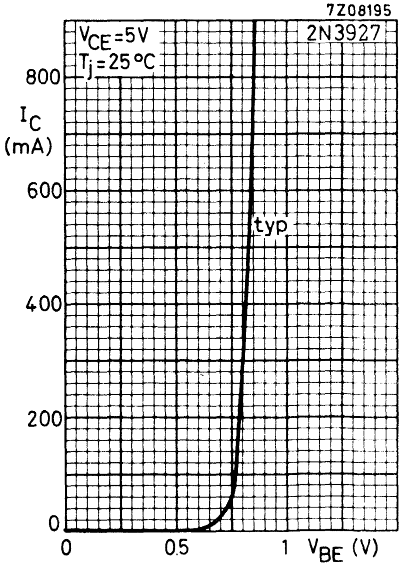
II Additional region of operation at f ≥ 1 MHz.
Care must be taken to reduce the d.c. adjustment to region I before removing the a.c. signal. This may be achieved by an appropriate bias in class A, B or C.

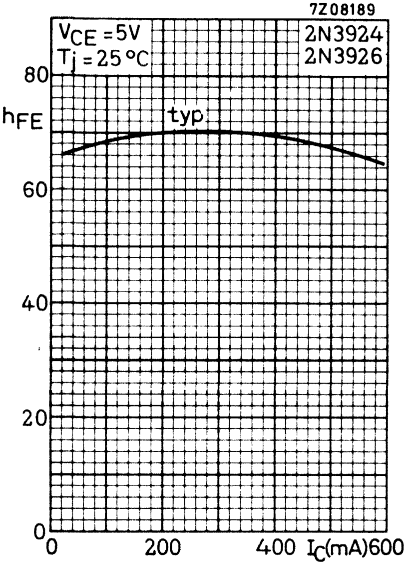
III Operating during switching off in this region is allowed, provided the transistor is cut-off with $-V_{BB} \leq 1.5$ V and $R_{BE} \geq 33\ \Omega$, $I_C \leq 400$ mA and the transient energy does not exceed 2 mWs.

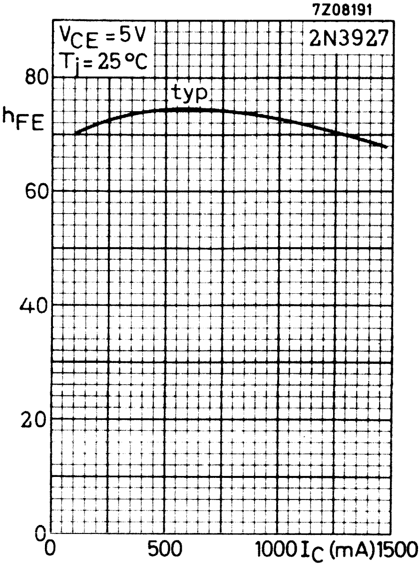

7Z08187
$\frac{I_C}{I_B} = 5$
$T_j = 25\,°C$
$V_{CE\,sat}$ (mV)
0
100
200
300
0
200
400
I_C (mA)
600
2N3924; 2N3926
typ
2N3927
typ

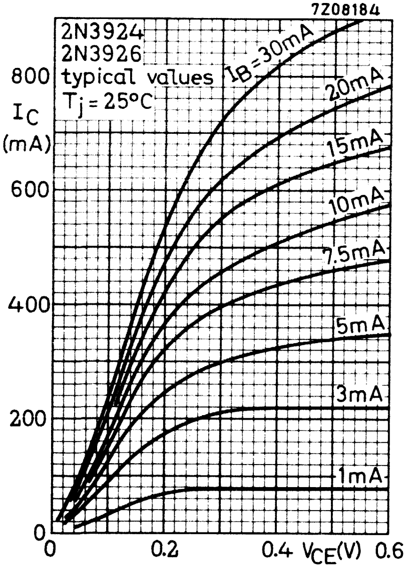

7Z08193
$I_C = 250$ mA
$I_B = 50$ mA
$V_{CE\,sat}$ (mV)
0
100
200
300
400
0
50
100
T_j (°C)
150
2N3924; 2N3926
typ
2N3927
typ

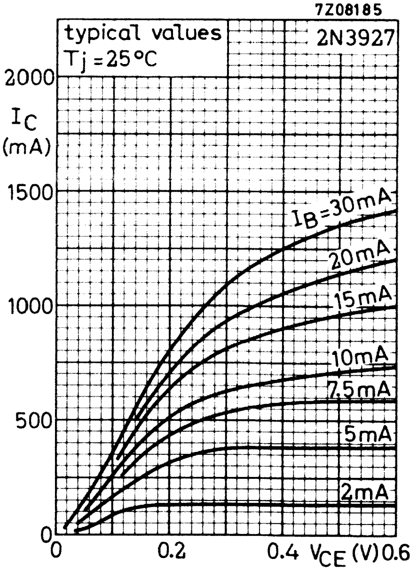

7Z08194
$V_{CE} = 5$V
$T_j = 25\,°C$
2N3924
2N3926
I_C (mA)
0
100
200
300
400
0
0.5
1
V_{BE} (V)
typ

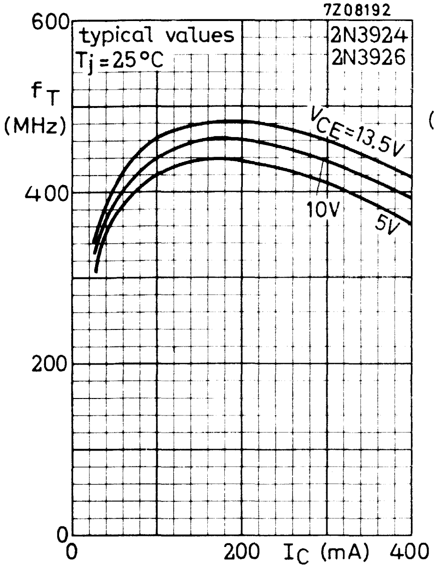

7Z08195
$V_{CE} = 5$V
$T_j = 25\,°C$
2N3927
I_C (mA)
0
200
400
600
800
0
0.5
1
V_{BE} (V)
typ

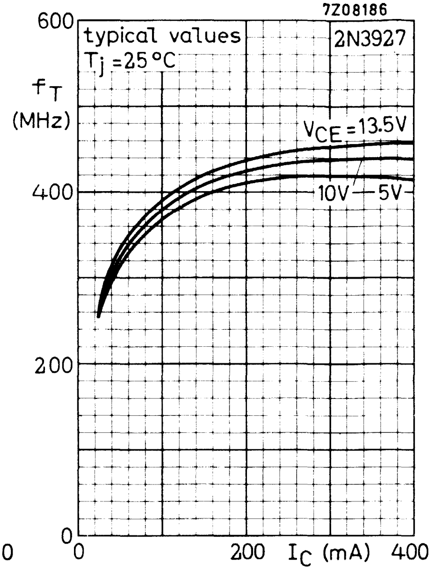

7Z08189
VCE = 5V
Tj = 25 °C
2N3924
2N3926
hFE
typ
80
60
40
20
0
0
200
400
IC(mA)600

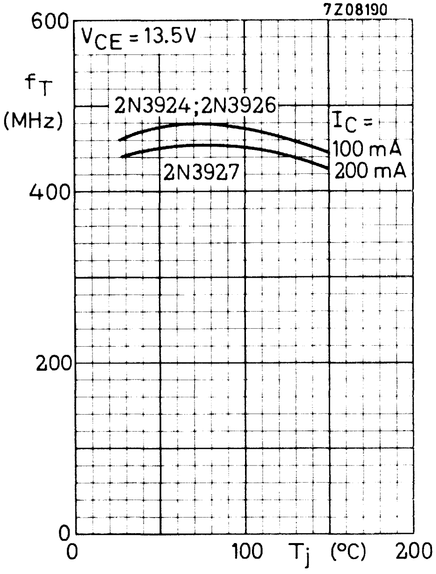

7Z08191
VCE = 5V
Tj = 25 °C
2N3927
hFE
typ
80
60
40
20
0
0
500
1000
IC (mA)1500


7Z08184
2N3924
2N3926
typical values
Tj = 25°C
IC
(mA)
800
600
400
200
0
IB = 30mA
20mA
15mA
10mA
7.5mA
5mA
3mA
1mA
0
0.2
0.4
VCE(V)
0.6


7Z08185
typical values
Tj = 25°C
2N3927
IC
(mA)
2000
1500
1000
500
0
IB = 30mA
20mA
15mA
10mA
7.5mA
5mA
2mA
0
0.2
0.4
VCE (V)0.6


7Z08192
typical values
Tj = 25 °C
2N3924
2N3926
fT (MHz)
VCE = 13.5V
10V
5V
600
400
200
0
0
200
IC (mA)
400


7Z08186
typical values
Tj = 25 °C
2N3927
fT (MHz)
VCE = 13.5V
10V
5V
600
400
200
0
0
200
IC (mA)
400


7Z08190
VCE = 13.5V
fT (MHz)
2N3924;2N3926
2N3927
IC =
100 mA
200 mA
600
400
200
0
0
100
Tj (°C)
200

SILICON EPITAXIAL PLANAR OVERLAY TRANSISTOR

For data of this transistor please refer to type 2N3866

Microwave devices

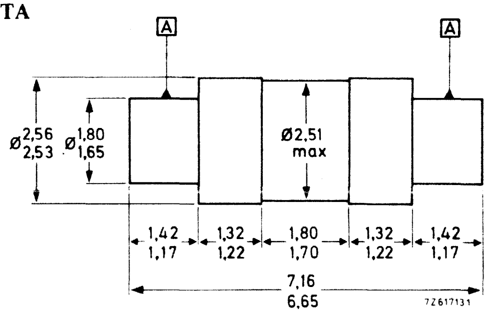
MICROWAVE MIXER DIODES

Subminiature germanium point-contact mixer diodes primarily intended for low noise mixer applications at X-band.

QUICK REFERENCE DATA					
Frequency range		f		1.0 to 18	GHz
Noise figure	AAY39	F	typ.	6.0	dB
	AAY39A	F	typ.	7.0	dB

MECHANICAL DATA

Dimensions in mm



A = concentricity tolerance = ± 0,15

The cathode indicates the electrode which becomes positive in an a.c. rectifier circuit.

The cathode is marked red

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

Burn-out				
D.C. spike		max.	0.1	erg
R.F. spike		max.	0.05	erg
Pulse peak power (t_p = 0.5 μs)		max.	0.5	W
Temperatures				
Storage temperature	T_{stg}		-55 to +100	°C
Operating ambient temperature	T_{amb}		-55 to +100	°C

CHARACTERISTICS T_{amb} = 25 °C

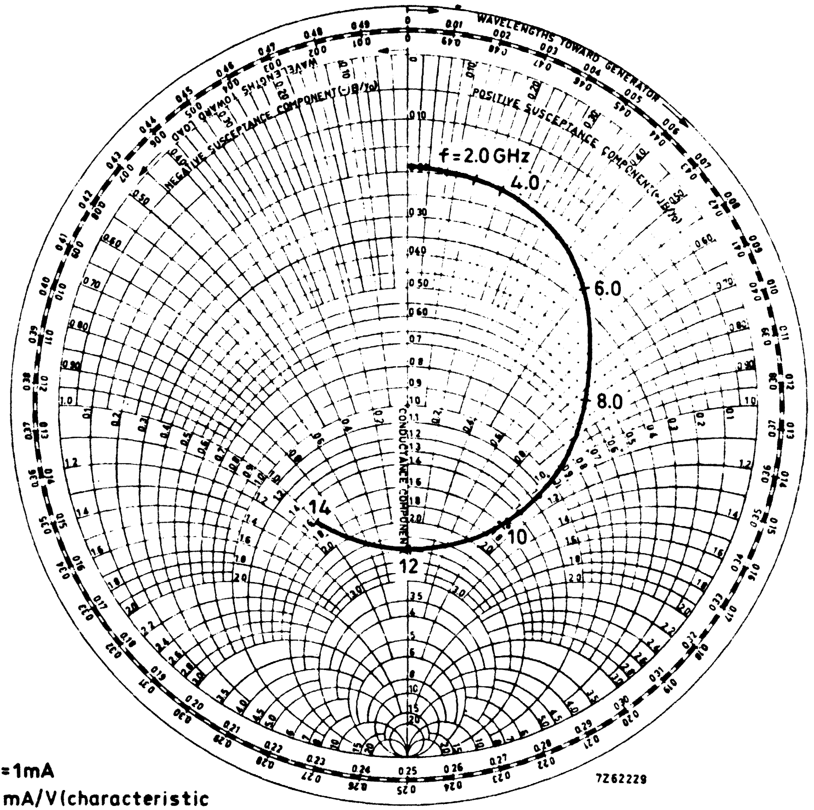
Reverse current at V_R = 0.5 V		I_R	typ.	3.0	μA
Forward current at V_F = 0.5 V		I_F	typ.	5.0	mA
Overall noise figure [1]	AAY39	F	typ.	6.0	dB
				5.5 to 6.5	dB
	AAY39A	F	typ.	7.0	dB
			<	7.5	dB
Conversion loss	AAY39		typ.	4.2	dB
	AAY39A		typ.	5.0	dB
Noise temperature ratio					
i.f. = 45 MHz	AAY39		typ.	1.1 : 1	
	AAY39A		typ.	1.2 : 1	
Voltage standing wave ratio		V.S.W.R.	<	1.43 : 1	
Intermediate frequency impedance		Z_{if}		250 to 450	Ω
Operating frequency range		f		1.0 to 18	GHz

NOTE

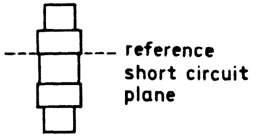
Optimum performance is obtained when the oscillator drive is adjusted to give a diode rectified current of 1.0 mA and the load resistance is restricted to max. 100 Ω

---

[1] Measured at 9.375 GHz, 1.0 mA diode rectified current, R_L = 15 Ω, this value includes i.f. noise of 1.5 dB.



$I_{F(AV)} = 1\text{mA}$
$y_0 = 20\text{mA/V}$ (characteristic admittance)



APPLICATION INFORMATION

1. Mixer performance

Measured overall noise figure

$f = 16.5$ GHz; $F_{if} = 1.5$ dB; i.f. $= 45$ MHz	F	typ.	7.0	dB
$f = 3.0$ GHz; $F_{if} = 1.5$ dB; i.f. $= 45$ MHz	F	typ.	5.5	dB
$f = 9.5$ GHz; i.f. $= 3.0$ kHz	F	typ.	29	dB

2. Signal/Flicker noise ratio at 9.5 GHz

measured at 2.0 kHz from carrier in a 70 Hz bandwidth			131	dB

3. Detector performance

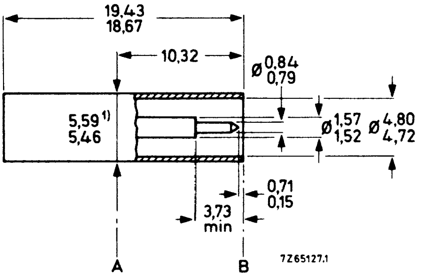
Tangential sensitivity $f = 9.375$ GHz; $B = 1.0$ MHz; $I_F = 50$ μA		typ.	−52	dBm
Video impedance; $I_F = 50$ μA	Z_{iv}	typ.	800	Ω

MICROWAVE MIXER DIODES

The AAY51 and AAY51R as well as the AAY52 and AAY52R (for terminal identification see mechanical data on this page) form a pair of normal and reverse polarity mixer diodes for use in balanced mixer circuits at J-band (Ku-band). The diodes give a good impedance match over the whole band. These types are packaged in the standard coaxial outline for the frequency, similar to 1N78 types.
The encapsulation is hermetically sealed.

QUICK REFERENCE DATA					
Frequency range		f		12 to 18	GHz
Noise figure	AAY51; AAY51R	F	typ.	7.0	dB
	AAY52; AAY52R	F	typ.	8.0	dB

MECHANICAL DATA Dimensions in mm



1) Body diameter values are guaranteed only from A to B

The body is cadmium plated in order to be compatible with an aluminium holder.

TERMINAL IDENTIFICATION

AAY51 AAY52	Pin	cathode
	Body (red)	anode
AAY51R AAY52R	Pin	anode
	Body (blue)	cathode

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

Burn-out			
Multiple d.c. spike		max. 0.1	erg
Temperatures			
Storage temperature	T_{stg}	−55 to +100	°C
Ambient temperature	T_{amb}	−55 to +100	°C

CHARACTERISTICS T_{amb} = 25 °C

Reverse current at V_R = 0.5 V		I_R	typ. 3.0	μA
Forward current at V_F = 0.5 V		I_F	typ. 9.0	mA
Overall noise figure [1]				
	AAY51; AAY51R	F	typ. 7.0 < 7.5	dB dB
	AAY52; AAY52R	F	typ. 8.0 < 8.5	dB dB
Conversion loss	AAY51; AAY51R		typ. 5.2	dB
Noise temperature ratio; i.f. = 45 MHz				
	AAY51; AAY51R		1.1 : 1	
Voltage standing wave ratio; i.f. = 45 MHz				
Measured at 13.5 GHz		V.S.W.R.	< 1.5 : 1	
Measured in band 13 - 18 GHz		V.S.W.R.	< 2.5 : 1	
Intermediate frequency impedance		Z_{if}	typ. 270 220 to 320	Ω Ω
Operating frequency range		f	12 to 18	GHz

---

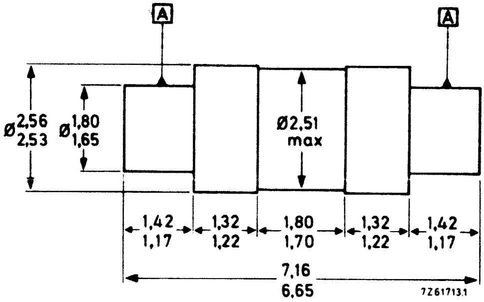
[1] Measured at 13.5 GHz in JAN201 holder, this value includes i.f. noise of 1.5 dB.

MICROWAVE MIXER DIODE

Subminiature germanium point-contact mixer diode for use at Q-band (Ka-band)

QUICK REFERENCE DATA			
Frequency range		26 to 40	GHz
Noise figure	typ.	8.5	dB

MECHANICAL DATA Dimensions in mm



A = concentricity tolerance = ±0,15

The cathode is marked red
The cathode indicates the electrode which becomes positive in an a.c. rectifier circuit.

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

Burn-out

R.F. spike		max.	0.03 erg
Pulse peak power (t_p = 0.2 μs)		max.	0.5 W

Temperatures

Storage temperature	T_{stg}		-55 to +100 °C
Operating ambient temperature	T_{amb}		-55 to +100 °C

CHARACTERISTICS T_{amb} = 25 °C

Reverse current at V_R = 0.5 V	I_R	typ.	2.0 μA
Forward current at V_F = 0.5 V	I_F	typ.	2.0 mA
Overall noise figure [1]	F	typ. <	8.5 dB 10 dB
Conversion loss		typ.	5.5 dB
Noise temperature ratio; i.f. = 45 MHz			1.6 : 1
Voltage standing wave ratio [2]	V.S.W.R.	typ. <	1.4 : 1 1.8 : 1
Intermediate frequency impedance	Z_{if}	typ.	1000 Ω 700 to 1400 Ω
Operating frequency range			26 to 40 GHz

MATCHED PAIRS

The diodes can be supplied in matched pairs under the typenumber 2-AAY59M.
The diodes are matched to ±10% on rectified current and within 150 Ω i.f. impedance

---

[1] Measured at 34.86 GHz, 0.5 mA diode rectified current, this value includes i.f. noise of 1.5 dB

[2] With respect to standard test holder

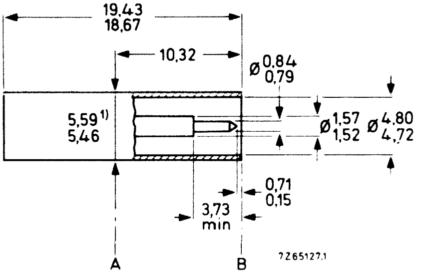
MICROWAVE DETECTOR DIODES

Germanium bonded backward diodes primarily intended for low level detector applications at J-band (Ku-band). The AEY29 and AEY29R are packaged in the standard coaxial outline for this frequency band, similar to 1N78 types.
The encapsulation is hermetically sealed.

QUICK REFERENCE DATA						
Frequency range	f	12	to	18	GHz
Zero bias tangential sensitivity at J-band		typ.		−43	dBm

MECHANICAL DATA

Dimensions in mm



Body diameter values are guaranteed only from A to B

TERMINAL IDENTIFICATION

AEY29	Pin	cathode
	Body (red)	anode
AEY29R	Pin	anode
	Body (green)	cathode

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

Temperatures

Storage temperature	T_{stg}	−55 to +100	°C
Ambient temperature	T_{amb}	−55 to +100	°C

CHARACTERISTICS

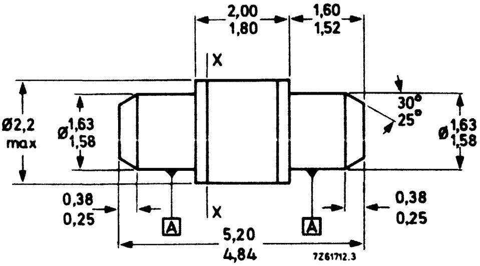
			T_{amb} = 25	°C
Reverse current at $V_R = 0.3$ V	I_R	typ.	100	μA
Forward current at $V_F = 0.3$ V	I_F	typ.	12	mA
→ Tangential sensitivity				
measured at 16.5 GHz, zero bias, video bandwidth 1.0 MHz (in JAN201 holder)		typ.	−43	dBm
Figure of merit				
measured at 16.5 GHz, M is taken as the product of current sensitivity, expressed in μA/μW and the root of video impedance in Ω (in JAN201 holder)	M	>	50	
Video impedance				
zero bias, $V_i < 1.0$ mV (d.c. or a.c. r.m.s.)	Z_{iv}	typ.	300	Ω
Voltage standing wave ratio				
w.r.t. JAN201 holder, measured at f = 16.5 GHz, zero bias and c.w. input power < 1.0 μW	V.S.W.R.	<	5 : 1	

MICROWAVE DETECTOR DIODES

Subminiature germanium bonded backward diodes primarily intended for broad band low level detector applications at X-band.

QUICK REFERENCE DATA				
Frequency range			1 to 18	GHz
Zero bias tangential sensitivity at X-band	AEY31 :	typ.	-53	dBm
	AEY31A:	typ.	-50	dBm

MECHANICAL DATA Dimensions in mm



A = concentricity tolerance = ± 0. 15

The cathode is marked red.
The cathode indicates the electrode which becomes positive in an a.c. rectifier circuit.

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

Temperatures

Storage temperature	T_{stg}	-55 to +150	°C
Operating ambient temperature	T_{amb}	-55 to +150	°C

CHARACTERISTICS $T_{amb} = 25\,°C$

Reverse current at $V_R = 0.3$ V		I_R	typ.	100	µA
Forward current at $V_F = 0.3$ V		I_F	typ.	12	mA
Tangential sensitivity					
measured at 9.375 GHz, zero bias, video bandwidth 1.0 MHz	AEY31		typ.	-53	dBm
	AEY31A		typ.	-50	dBm
Figure of merit					
measured at 9.375 GHz, M is taken as the product of current sensitivity expressed in µA/µW, and the root of video impedance in Ω	AEY31	M	>	120	
	AEY31A	M	>	50	
Video impedance					
Zero bias, $V_i < 1.0$ mV (d.c. or a.c. r.m.s.)		Z_{iv}	typ.	300	Ω
Voltage standing wave ratio					
w.r.t. 50 Ω, measured at f = 9.375 GHz, zero bias and c.w. input power < 1.0µW. The nominal rectifier admittance at a reference plane X-X taken at the end faces of the ceramic insulator (see drawing page 1) = $\frac{1-j}{25}$ A/V		V.S.W.R.	<	5 : 1	

APPLICATION INFORMATION

1. Detector performance

Tangential sensitivity $f = 1.0$ to 18 GHz; $B = 1.0$ MHz	AEY31 :		typ.	−53	dBm
	AEY31A:		typ.	−50	dBm
Voltage standing wave ratio $f = 1.0$ to 18 GHz; $Z_0 = 50\ \Omega$		V.S.W.R.	<	5 : 1	

2. Mixer performance i.f. = 45 MHz

Measured overall noise figure $f = 9.375$ GHz; $F_{if} = 1.5$ dB $P_{L.O.} = 200\ \mu W$; $I_0 = 1.0$ mA	F_0	typ.	9.0	dB
$f = 16.5$ GHz; $F_{if} = 1.5$ dB $P_{L.O.} = 200\ \mu W$; $I_0 = 1.0$ mA	F_0	typ.	9.5	dB
Intermediate frequency impedance $I_0 = 1.0$ mA	Z_{if}	typ.	130	Ω
Voltage standing wave ratio $f = 1$ to 18 GHz; $Z_0 = 50\ \Omega$ $I_0 = 1.0$ mA	V.S.W.R.	<	2.5 : 1	

3. Doppler mixer performance

Measured overall noise figure $f = 9.375$ GHz; i.f. = 3 kHz $F_{if} = 2.0$ dB	F_0	typ.	18	dB

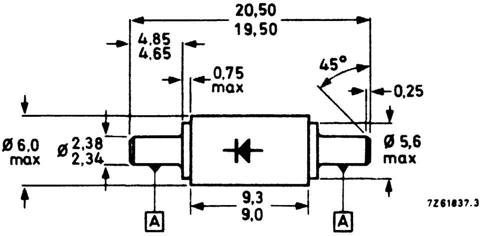
MICROWAVE DETECTOR DIODE

Silicon Schottky barrier diode in DO-23 (1N23) outline intended for use in doppler radar systems and intruder alarms where low 1/f noise and high detector sensitivity is required.

QUICK REFERENCE DATA				
Current sensitivity at X-band		typ.	1.0	μA/μW
1/f noise at 1 kHz	F	typ.	10	dB

MECHANICAL DATA Dimensions in mm

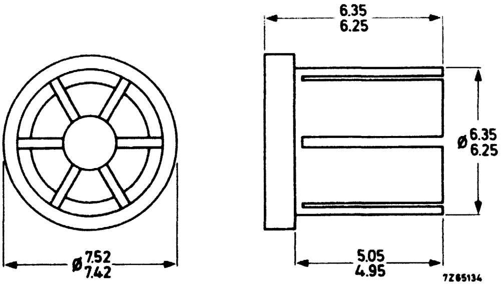
DO-23



A = concentricity tolerance = ± 0,20

Accessory 56321 Dimensions in mm

Converts the BAV46 to DO-22 outline



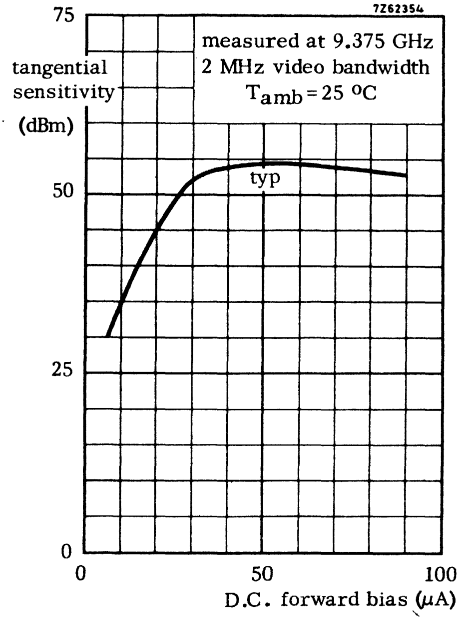
RATINGS Limiting values in accordance with the Absolute Maximum System (IEC134)

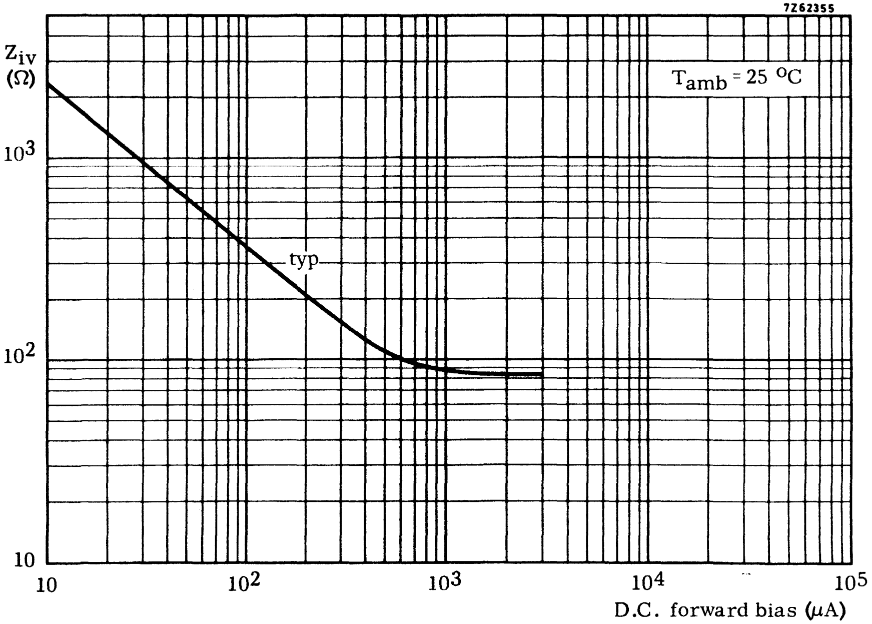
Burn-out				
Multiple R.F. spike		max. max.	20 0.2	nJ erg
Pulse power (peak value)				
$f = 9.375$ GHz; $t_p = 0.5$ µs		max.	1.0	W
Temperatures				
Storage temperature	T_{stg}		−55 to +150	°C
Ambient temperature	T_{amb}		−55 to +150	°C

CHARACTERISTICS

$T_{amb} = 25$ °C

Current sensitivity at f = 9.375 GHz				
D.C. forward bias = 30 µA Local oscillator drive = 1 µW Socket: JAN106 holder		> typ.	0.8 1.0	µA µA
Tangential sensitivity				
Video bandwidth = 2 MHz		typ.	52	dBm
1/f noise figure				
$f_{if} = 1$ kHz; B = 50 Hz D.C. forward bias = 30 µA	F	typ. <	10 15	dB dB
Voltage standing wave ratio at f = 9.375 GHz				
D.C. forward bias = 30 µA Local oscillator drive = 1 µW $R_L = 15$ Ω; JAN106 holder	V.S.W.R.	typ. <	3 : 1 5 : 1	
Video impedance				
D.C. forward bias = 30 µA	Z_{iv}	typ.	850	Ω


7Z62354
75
50
25
0
tangential sensitivity (dBm)
measured at 9.375 GHz
2 MHz video bandwidth
T_{amb} = 25 °C
typ
0
50
100
D.C. forward bias (μA)


7Z62355
Z_{iv} (Ω)
10^3
10^2
10
T_{amb} = 25 °C
typ
10
10^2
10^3
10^4
10^5
D.C. forward bias (μA)

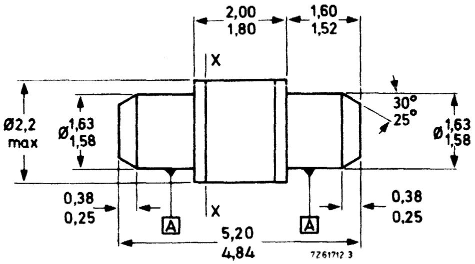
MICROWAVE MIXER DIODES

A series of sub-miniature reversible outline Schottky barrier mixer diodes. The planar technology employed imparts a high degree of reliability and reproducability.
The metal ceramic case is hermetically sealed.

QUICK REFERENCE DATA					
Noise figure at X-band	BAV96A	F	<	7,5	dB
	BAV96B	F	<	7,0	dB
	BAV96C	F	<	6,5	dB
	BAV96D	F	<	6,0	dB

MECHANICAL DATA

Dimensions in mm



A = concentricity tolerance = ± 0,15

The cathode is marked red.
The cathode indicates the electrode which becomes positive in an a.c. rectifier circuit.

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

Burn-out 1)		max.	0,18	erg
Temperatures				
Storage temperature	T_{stg}	−55 to +150		°C
Ambient temperature	T_{amb}	−55 to +150		°C

CHARACTERISTICS

$T_{amb} = 25$ °C

Noise figure at f = 9,375 GHz 2)	BAV96A	F	<	7,5	dB
	BAV96B	F	<	7,0	dB
	BAV96C	F	<	6,5	dB
	BAV96D	F	<	6,0	dB
Voltage standing wave ratio 3)		V.S.W.R.	typ. 	1,33 1,43	
Intermediate frequency impedance 4)		Z_{if}	200 to	400	Ω
Local oscillator power 2)		P_{lo}	typ. <	0,8 1,5	mW mW

MATCHED PAIRS

Matched pairs may be supplied. Matching is normally: Rectified current ±10%; Intermediate frequency impedance ±25 Ω.
Type numbering follows the pattern 2-BAV96AM etc.

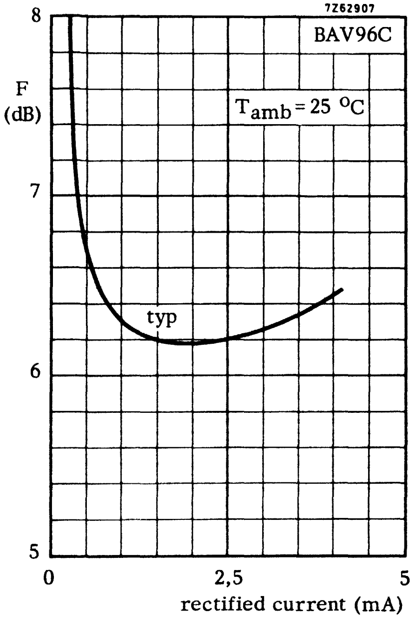
---

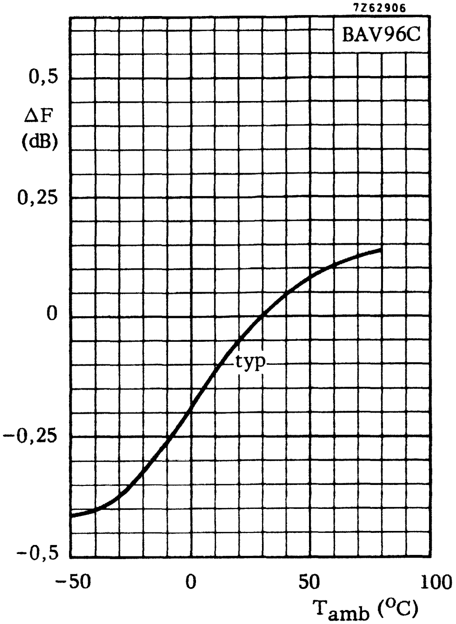
1) Burn-out is defined as the r.f. pulse energy necessary to cause 1 dB degradation in noise figure when the diode is subjected to 2×10^8 pulses of 2 ns width.

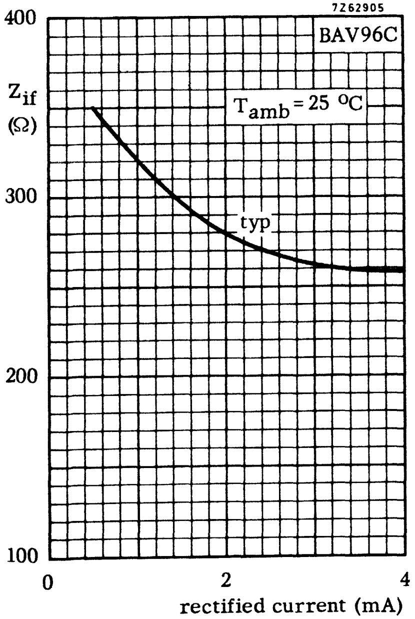
2) Measured at 9,375 GHz ±0,1 GHz and includes i.f. amplifier contribution of 1,5 dB; i.f. amplifier 45 MHz, d.c. return for diode less than 15 Ω. Rectified current 1 mA. Test method BS9321/1406.

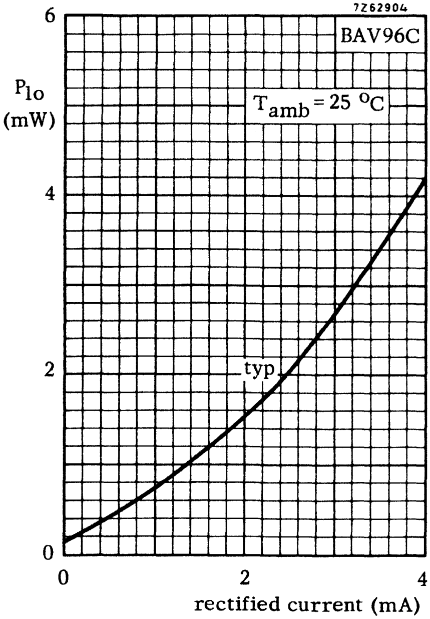
3) Measured in a reduced height waveguide mount under the same test conditions as note 2. Test method BS9321/1409.

4) Test method BS9321/1405. Same test conditions as note 3).


7Z62907
BAV96C
F
(dB)
8
7
6
5
Tamb = 25 °C
typ
0
2,5
5
rectified current (mA)


7Z62906
BAV96C
ΔF
(dB)
0,5
0,25
0
−0,25
−0,5
typ
−50
0
50
100
Tamb (°C)


7Z62905
BAV96C
Zif
(Ω)
400
300
200
100
Tamb = 25 °C
typ
0
2
4
rectified current (mA)


7Z62904
BAV96C
Plo
(mW)
6
4
2
0
Tamb = 25 °C
typ
0
2
4
rectified current (mA)

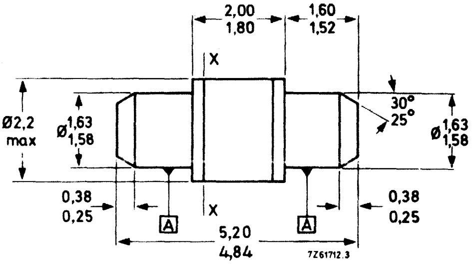
MICROWAVE DETECTOR DIODE

A silicon Schottky barrier diode especially designed to give high sensitivity when used as a microwave detector over the frequency range 1 to 18 GHz. The diode exhibits low 1/f noise making it suitable for use in doppler radar systems as well as detector applications. The BAV97 is supplied in a subminiature reversible encapsulation equally suited to waveguide, coaxial and strip line circuits.

QUICK REFERENCE DATA				
Tangential sensitivity		typ.	54	dBm
1/f noise at 1 kHz	F	typ.	10	dB

MECHANICAL DATA

Dimensions in mm



A = concentricity tolerance = ± 0,15

The cathode is marked red.
The cathode indicates the electrode which becomes positive in an a.c. rectifier circuit.

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

Peak R.F. power 1)		max.	0,75	W
Temperatures				
Storage temperature	T_{stg}	−55 to +150		°C
Junction temperature	T_j	−55 to +150		°C

CHARACTERISTICS

Tangential sensitivity 2)		>	52	-dBm
		typ.	54	-dBm
1/f noise figure 3)	F	typ.	10	dB
		<	15	dB
Video impedance 4)	Z_{iv}	typ.	500	Ω

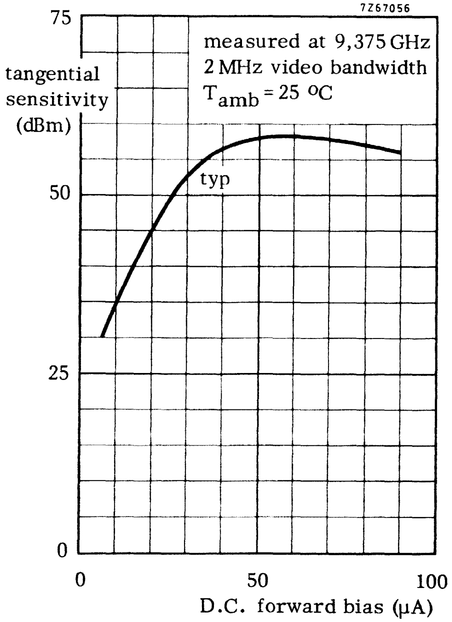
---

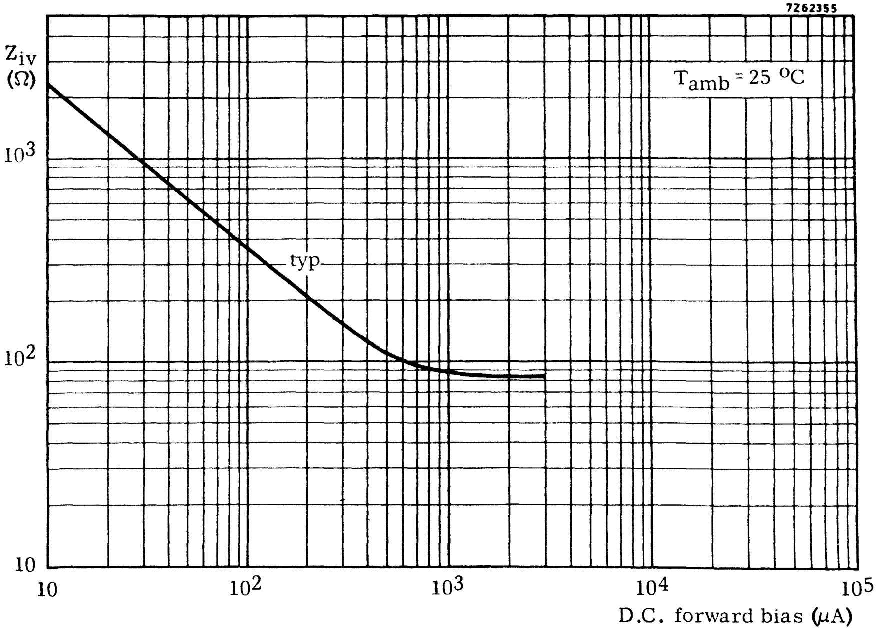
1) Measured at 9,375 GHz with 0,5 μs pulse width and pulse repetition frequency of 2 kHz. Rating defined as the power level which will give no greater than 5 dB deterioration in tangential sensitivity.

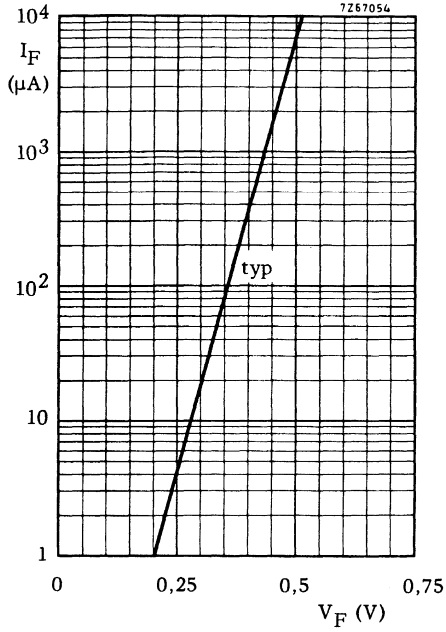
2) Measured with 0 - 2 MHz video bandwidth and 50 μA forward bias. Microwave test frequency 9,375 GHz. There will be a 2 dB improvement in sensitivity with a video bandwidth 1 kHz - 2 MHz.

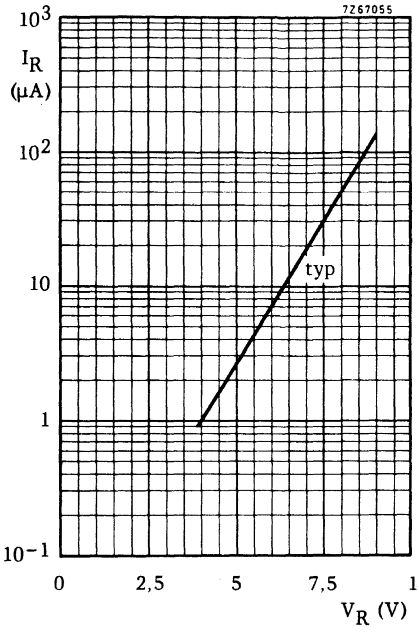
3) Measured at 30 μA forward bias and a frequency of 1 kHz with a bandwidth of 250 Hz. The 1/f noise is unchanged up to 150 μA bias.

4) Measured with forward bias of 50 μA.


7Z67056
75
50
25
0
tangential sensitivity (dBm)
measured at 9,375 GHz
2 MHz video bandwidth
T_{amb} = 25 °C
typ
0
50
100
D.C. forward bias (μA)


7Z62355
Z_{iv} (Ω)
10^3
10^2
10
T_{amb} = 25 °C
typ
10
10^2
10^3
10^4
10^5
D.C. forward bias (μA)


7Z67054
10^4
I_F
(μA)
10^3
10^2
10
1
typ
0
0,25
0,5
0,75
V_F (V)


7Z67055
10^3
I_R
(μA)
10^2
10
1
10^{-1}
typ
0
2,5
5
7,5
1
V_R (V)

MICROWAVE MIXER DIODES

Silicon Schottky barrier mixer diodes in a DO-22 envelope. The diodes are equivalent to 1N23 and 1N415 series.

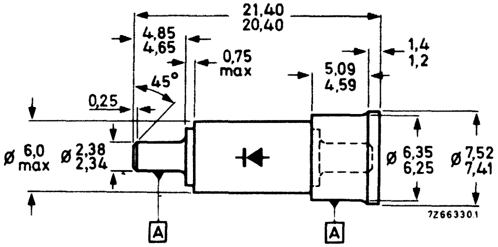
QUICK REFERENCE DATA

Noise figure in X-band	BAW95D	F	<	8.2	dB
	BAW95E	F	<	7.5	dB
	BAW95F	F	<	7.0	dB
	BAW95G	F	<	6.5	dB

MECHANICAL DATA

Dimensions in mm

DO-22



A = concentricity tolerance = ± 0,20

Symbol indicates polarity

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

Total power dissipation (peak value)				
$f = 9.375$ GHz; $t_p = 0.5$ μs	P_{tot}	max.	1.0	W
Burn-out				
Multiple r.f. spike; $\Delta F = 1$ dB		max.	20	nJ
		max.	0.2	erg
Temperatures				
Storage temperature	T_{stg}		−55 to +150	°C
Ambient temperature	T_{amb}		−55 to +150	°C

CHARACTERISTICS $T_{amb} = 25$ °C

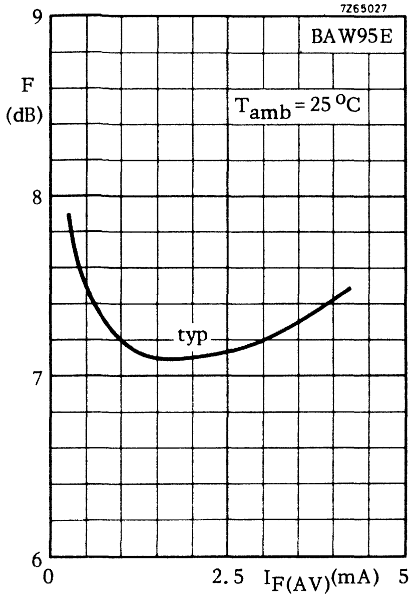
Overall noise figure at $f = 9.375$ GHz

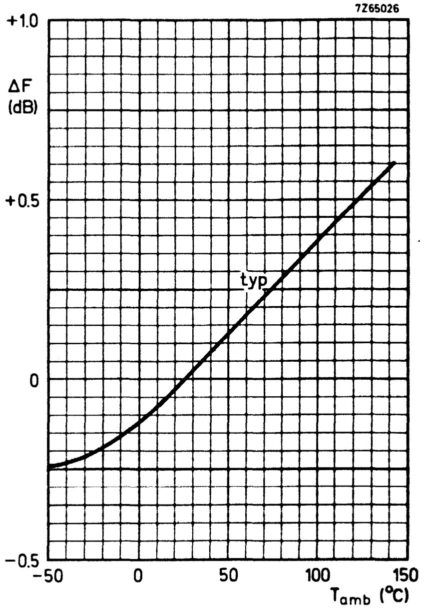
$I_{F(AV)} = 1$ mA; $R_L = 15\,\Omega$

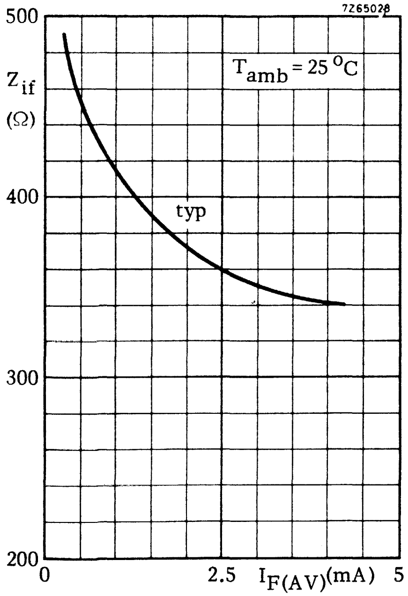
F includes $F_{if} = 1.5$ dB with 45 MHz i.f.

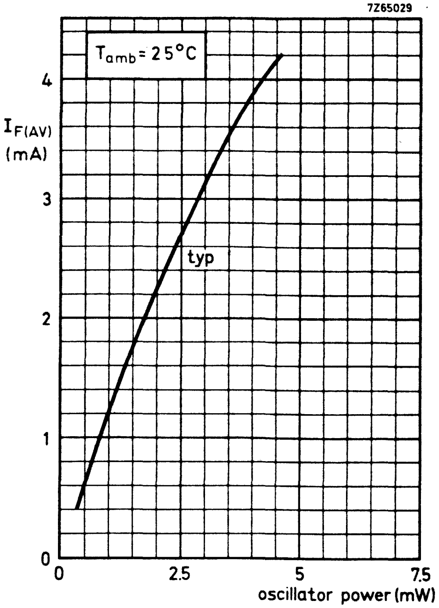
BAW95D	F	typ.	7.8	dB
		<	8.2	dB
BAW95E	F	typ.	7.2	dB
		<	7.5	dB
BAW95F	F	typ.	6.8	dB
		<	7.0	dB
→ BAW95G	F	typ.	6.3	dB
		<	6.5	dB

Voltage standing wave ratio at $f = 9.375$ GHz				
$I_{F(AV)} = 1$ mA; $R_L = 15\,\Omega$; socket: JAN-106	V.S.W.R.	<	1.3	
Intermediate frequency impedance at $f = 9.375$ GHz				
→ $I_{F(AV)} = 1$ mA; $R_L = 15\,\Omega$ with 45 MHz i.f.	Z_{if}	typ.	415	Ω
			250 to 500	Ω


7Z65027
BAW95E
F
(dB)
$T_{amb} = 25\,^{o}C$
typ
9
8
7
6
0
2.5
$I_{F(AV)}$(mA)
5


7Z65026
ΔF
(dB)
+1.0
+0.5
0
−0.5
typ
−50
0
50
100
150
T_{amb} (°C)


7Z65028
Z_{if}
(Ω)
$T_{amb} = 25\,^{o}C$
typ
500
400
300
200
0
2.5
$I_{F(AV)}$(mA)
5


7Z65029
$T_{amb} = 25\,°C$
$I_{F(AV)}$
(mA)
typ
4
3
2
1
0
0
2.5
5
7.5
oscillator power (mW)

SILICON PLANAR EPITAXIAL VARACTOR DIODE

Varactor diode with a very low series resistance, in a low inductance, hermetically sealed, welded ceramic-metal DO-4 envelope.
The BAY96 is a high efficiency frequency multiplier designed for use in the v.h.f. and u.h.f. regions.
With the reverse voltage rating of 120 V, it can handle an input power up to 40 W.

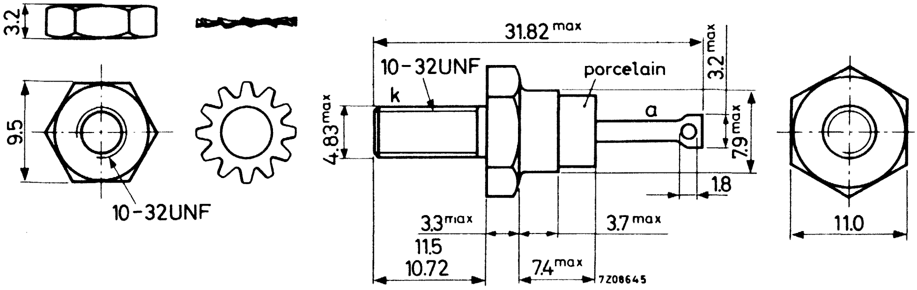
QUICK REFERENCE DATA

Continuous reverse voltage	V_R	max.	120	V
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	20	W
Junction temperature	T_j	max.	175	°C
Total capacitance at f = 1 MHz				
V_R = 6 V	C_d		28 to 39	pF
Diode series resistance at f = 400 MHz				
V_R = 6 V	r_D	max.	1.2	Ω
Cut-off frequency $\frac{1}{2\pi r_D C_d}$ at V_R = 120 V	f_{co}	typ.	25	GHz

MECHANICAL DATA

Dimensions in mm

DO-4



Diameter of hole in heatsink: max. 5.2 mm
Accessories available: 56295 (56262A)

Torque on nut: min. 8 cm kg
max. 17 cm kg

RATINGS (Limiting values) [1]

Voltage

Continuous reverse voltage	V_R	max.	120	V

Power dissipation

Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	20	W

Temperatures

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

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	7.5	°C/W

CHARACTERISTICS

Total capacitance at f = 1 MHz				
V_R = 6 V	C_d	28 to	39	pF
Diode series resistance at f = 400 MHz				
V_R = 6 V	r_D	typ. <	0.9 1.2	Ω Ω
Cut-off frequency $\frac{1}{2\pi r_D C_d}$ at V_R = 120 V	f_{co}	typ.	25	GHz

APPLICATION INFORMATION

Frequency tripler 150 to 450 MHz

The tripler circuit at page 3 consists of a parallel connection of the varactor, the input and output circuits, and the idler circuits. This shunt configuration has two outstanding advantages for high power harmonic generation.

1. The varactor can be grounded on one side, thus utilizing the chassis as a heatsink.
2. The varactor, being a low impedance device, operates best in a circuit that requires a low impedance coupling element between input and output circuits.

The function of the input and output networks is to provide impedance matching, and at the same time eliminate undesired r.f. current components, minimizing losses. A single tuned circuit is insufficient for the reduction of spurious response and therefore, a suitable output filter should follow the multiplier.

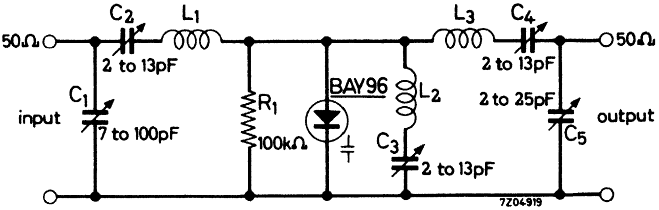
---

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

APPLICATION INFORMATION (continued)

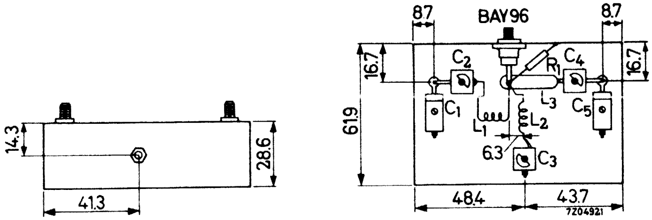
140 to 450 MHz tripler circuit

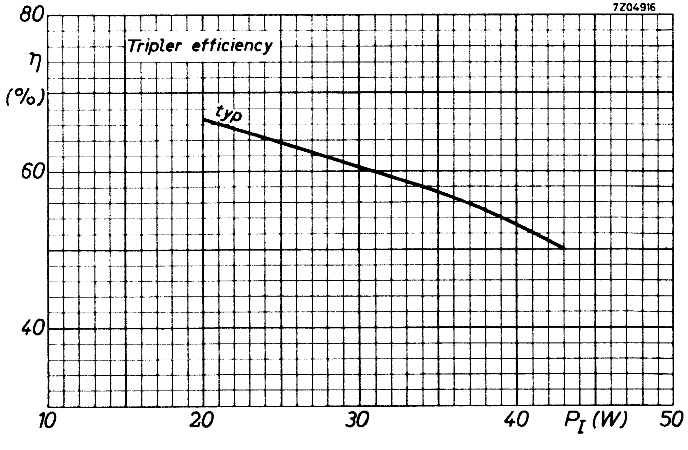
Efficiency at P_I = 25 W	η	>	60	%
		typ.	64	%

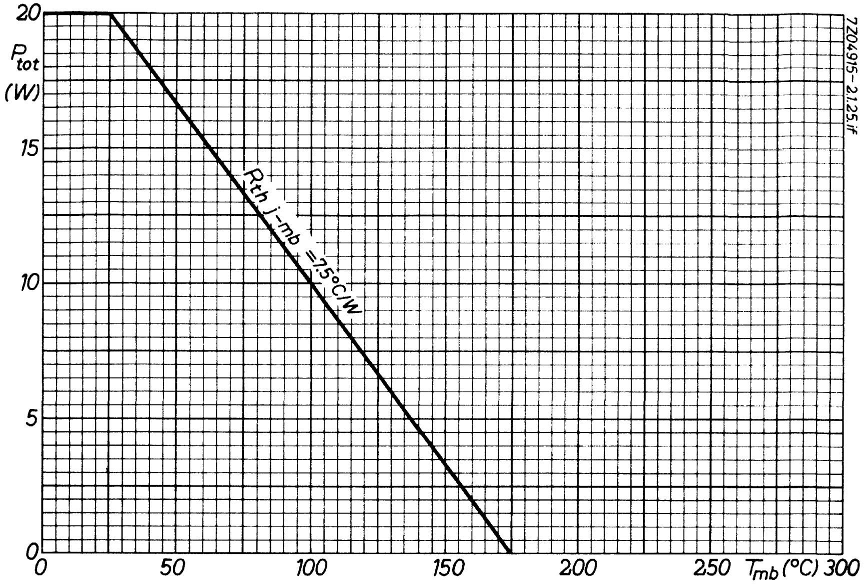


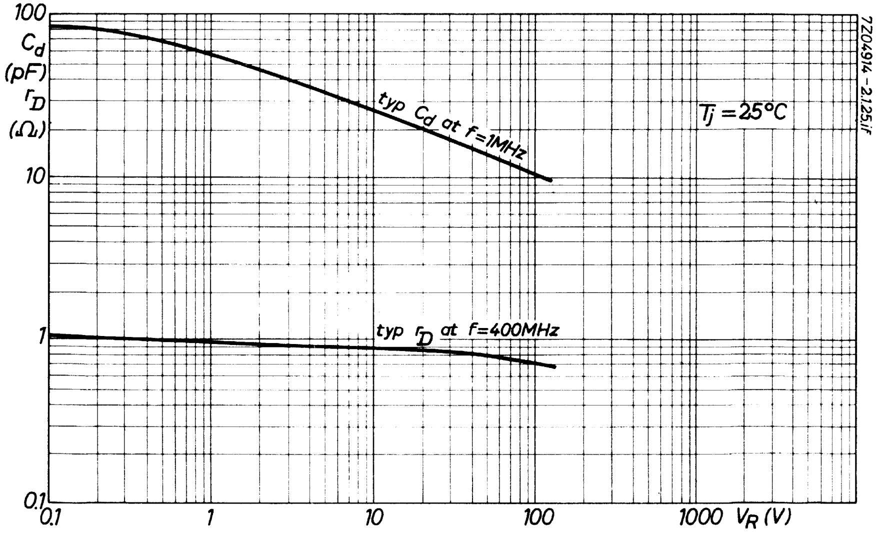
L_1 = 6.5 turns; d = 1.3 mm. Length of coil: 14.3 mm, inner diameter: 7.5 mm.
L_2 = 2 turns; d = 2 mm. Length of coil: 7.9 mm, inner diameter: 6.7 mm.
L_3 = copper strip, cross section 6.3 x 0.5 mm^2, length: 25.4 mm, height above chassis: 14.3 mm.

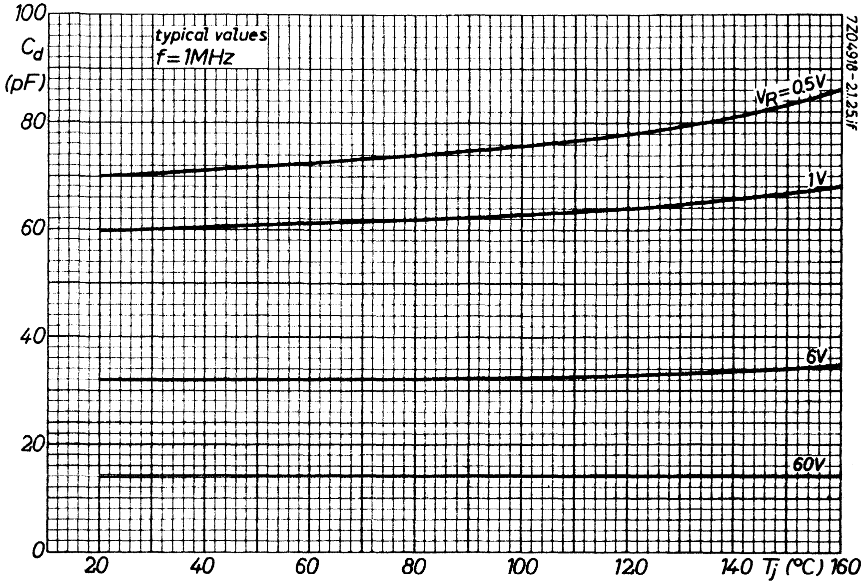
Component lay-out of tripler circuit: Dimensions in mm

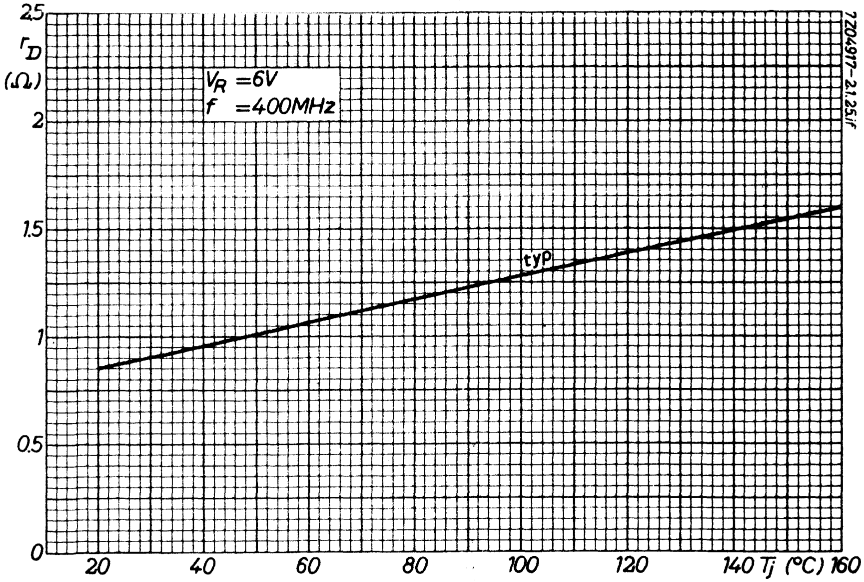





20
P_{tot}
(W)
15
10
5
0
0
50
100
150
200
250
T_{mb} (°C)
300
$R_{th\ j-mb}$ = 7.5°C/W
7Z04915-2.1.25.if


100
C_d
(pF)
r_D
(Ω)
10
1
0.1
0.1
1
10
100
1000
V_R (V)
typ C_d at f=1MHz
typ r_D at f=400MHz
T_j = 25°C
7Z04914-2.1.25.if


100
C_d
(pF)
80
60
40
20
0
typical values
f = 1MHz
V_R = 0.5V
1V
6V
60V
20
40
60
80
100
120
140 T_j (°C) 160
7Z04918-2.1.25.if


2.5
r_D
(Ω)
2
1.5
1
0.5
0
V_R = 6V
f = 400MHz
typ
20
40
60
80
100
120
140 T_j (°C) 160
7Z04917-2.1.25.if

SILICON VARACTOR DIODE

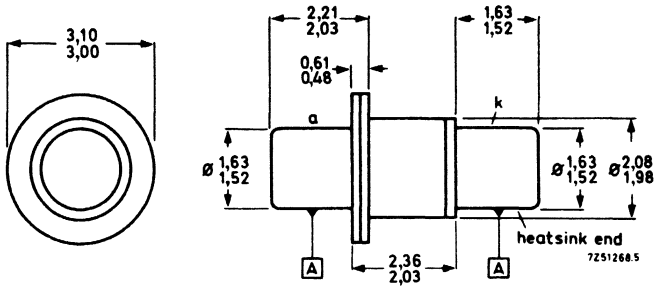
The BXY27 is a silicon planar epitaxial varactor diode exhibiting step recovery characteristics, especially suitable for use in frequency multiplier circuits up to S-band output frequency and 10 W input power.
The device is mounted in a small double ended ceramic-metal case with hermetic seal. The diode is packed in a container.

QUICK REFERENCE DATA

Input power (doubler 1 to 2 GHz)	P_i	<	10	W
Output power (doubler 1 to 2 GHz)	P_o	>	5	W
Junction temperature	T_j	max.	175	°C
Cut-off frequency	f_c	typ.	100	GHz
Diode capacitance	C_d	typ.	4.5	pF

MECHANICAL DATA

Dimensions in mm



A = concentricity tolerance = ±0,13
Type marking on the container

The heat should be transferred via the cathode pin.

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

Reverse voltage	V_R	max.	55	V
Total power dissipation up to $T_{pin} = 95\,^oC$	P_{tot}	max.	4	W
Storage temperature	T_{stg}	-65 to +175		^oC
Junction temperature	T_j	max.	175	^oC

THERMAL RESISTANCE

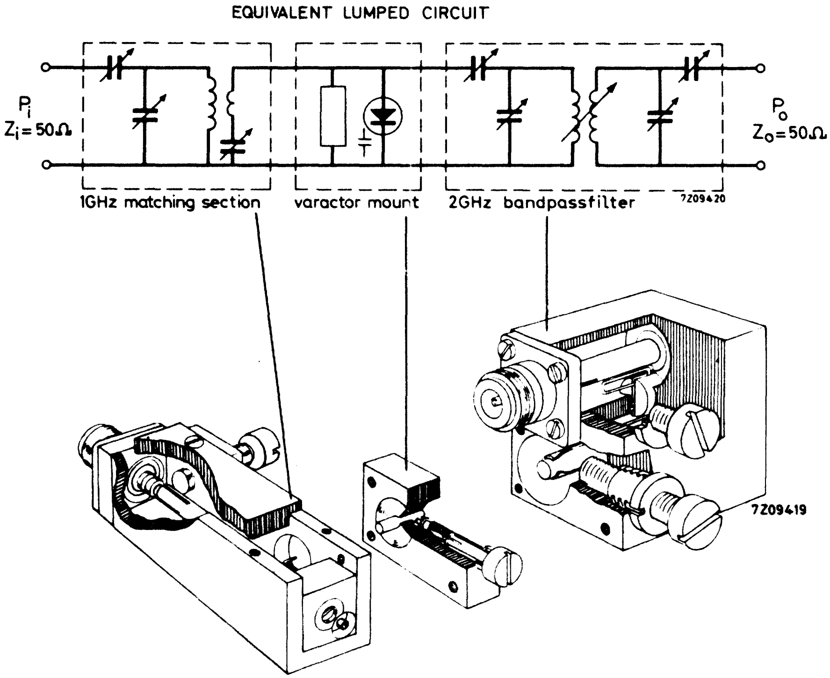
From junction to pin	$R_{th\ j\text{-}pin}$	=	20	$^oC/W$

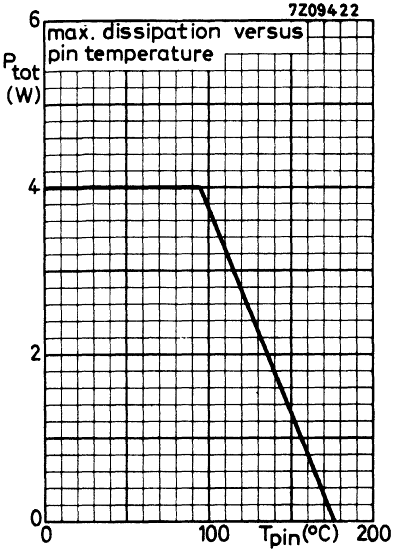
CHARACTERISTICS $T_{amb} = 25\,^oC$ unless otherwise specified

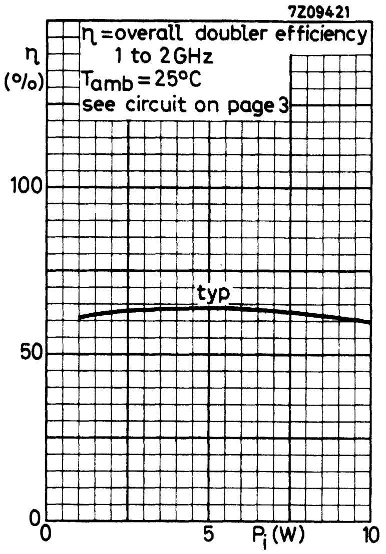
Reverse current at $V_R = 6$ V	I_R	typ. <	1 1	nA μA
Cut-off frequency at $V_R = 6$ V $f_c = \frac{1}{2\pi r_d(C_d - C_{str})}$	f_c	> typ.	50 100	GHz GHz
Diode capacitance at f = 1 MHz $V_R = 6$ V (C_d includes C_{str})	C_d	typ. 3.0 to	4.5 6.5	pF pF
Stray capacitance	C_{str}	typ.	0.25	pF
Diode series inductance	L_d	typ.	650	pH
Diode series resistance at f = 2 GHz $V_R = 6$ V	r_d	typ.	0.4	Ω
Overall efficiency in frequency doubler circuit on page 3. $P_i = 10$ W: $f_i = 1$ GHz	η	> typ.	50 60	% %
Overall efficiency in frequency tripler circuit $P_i = 10$ W: $f_i = 1$ GHz	η	typ.	40	%

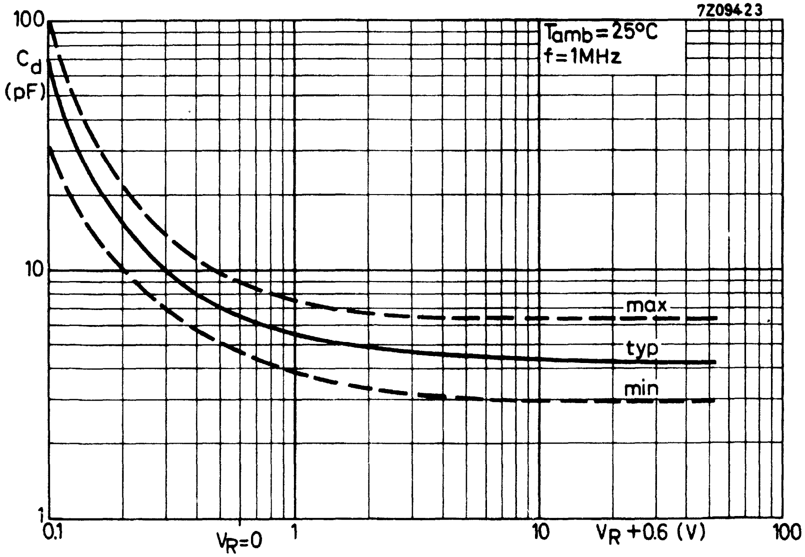
CHARACTERISTICS

Test circuit




7Z09422
max. dissipation versus pin temperature
P_{tot} (W)
6
4
2
0
0
100
T_{pin} (°C)
200


7Z09421
η = overall doubler efficiency 1 to 2 GHz
T_{amb} = 25°C
see circuit on page 3
η (%)
100
50
0
typ
0
5
P_i (W)
10

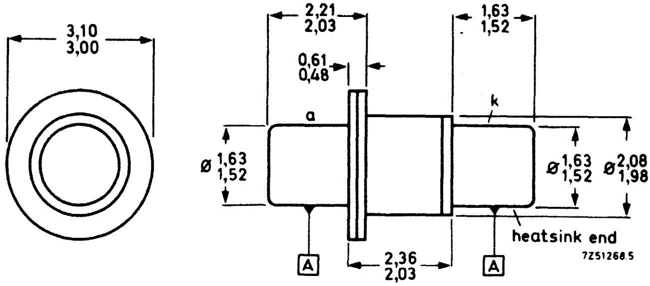

7Z09423
T_{amb} = 25°C
f = 1 MHz
C_d (pF)
100
10
1
max
typ
min
0.1
V_R=0
1
10
V_R +0.6 (V)
100

SILICON VARACTOR DIODE

The BXY28 is a silicon planar epitaxial varactor diode exhibiting step recovery characteristics, especially suitable for use in frequency multiplier circuits up to C-band output frequency and 7 W input power.
The device is mounted in a small double ended ceramic-metal case with hermetic seal. The diode is packed in a container.

QUICK REFERENCE DATA				
Input power (doubler 2 to 4 GHz)	P_i	<	7	W
Output power (doubler 2 to 4 GHz)	P_o	>	3.5	W
Junction temperature	T_j	max.	175	°C
Cut-off frequency	f_c	typ.	100	GHz
Diode capacitance	C_d	typ.	1.5	pF

MECHANICAL DATA Dimensions in mm



A = concentricity tolerance = ±0,13
Type marking on the container

The heat should be transferred via the cathode pin.

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

Reverse voltage	V_R	max.	45	V
Total power dissipation up to T_{pin} = 70 °C	P_{tot}	max.	3.5	W
Storage temperature	T_{stg}		−65 to +175	°C
Junction temperature	T_j	max.	175	°C

THERMAL RESISTANCE

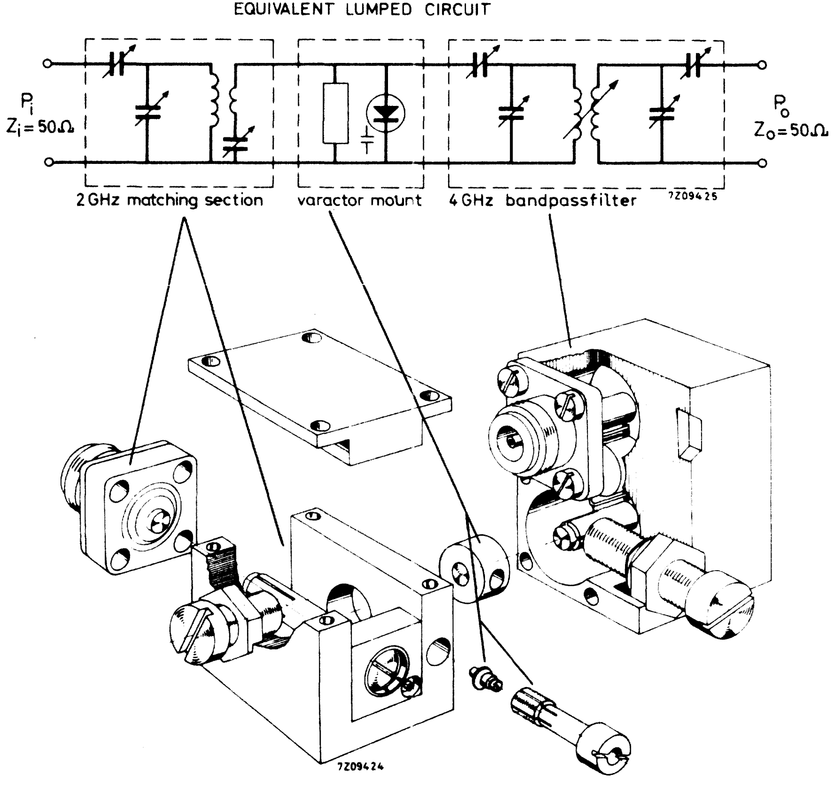
From junction to pin	$R_{th\ j\text{-}pin}$	=	30	°C/W

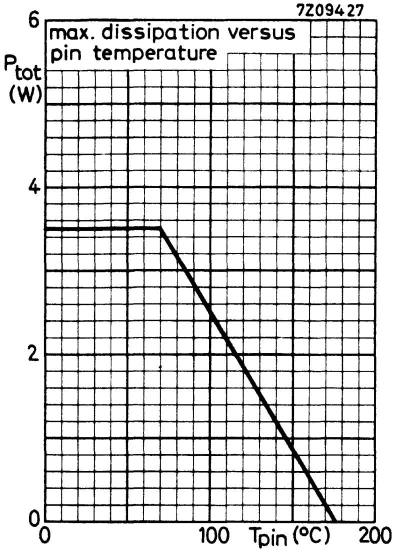
CHARACTERISTICS T_{amb} = 25 °C unless otherwise specified

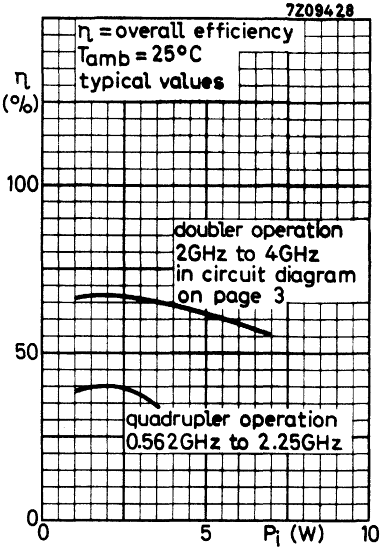
Reverse current at V_R = 6 V	I_R	typ. <	1 1	nA μA
Cut-off frequency at V_R = 6 V $f_c = \frac{1}{2\pi r_d(C_d - C_{str})}$	f_c	> typ.	80 100	GHz GHz
Diode capacitance at f = 1 MHz V_R = 6 V (C_d includes C_{str})	C_d	typ. 1.0 to	1.5 2.5	pF pF
Stray capacitance	C_{str}	typ.	0.25	pF
Diode series inductance	L_d	typ.	650	pH
Diode series resistance at f = 2 GHz V_R = 6 V	r_d	typ.	0.9	Ω
Overall efficiency in frequency doubler circuit of page 3 P_i = 7 W; f_i = 2 GHz	η	> typ.	50 55	% %
Overall efficiency in frequency quadrupler circuit P_i = 2 W; f_i = 0.56 GHz	η	typ.	40	%

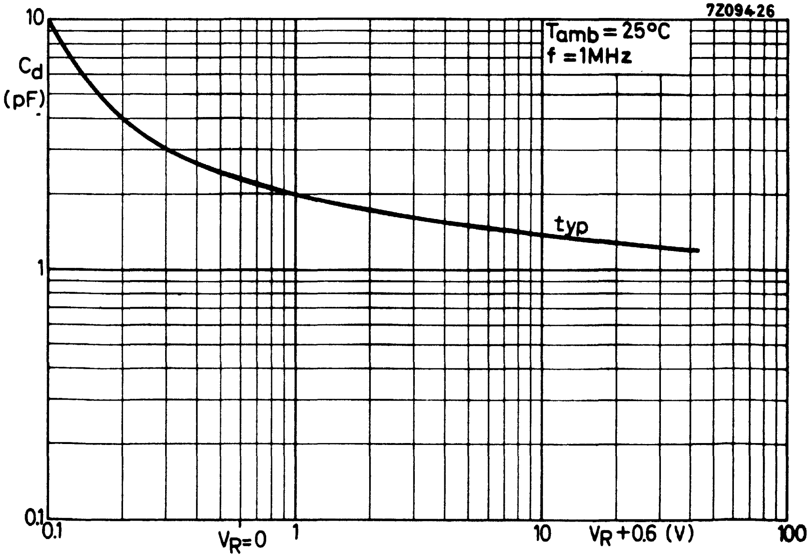
CHARACTERISTICS

Test circuit




7Z09427
max. dissipation versus pin temperature
P_{tot} (W)
6
4
2
0
0
100
200
T_{pin} (°C)


7Z09428
η = overall efficiency
T_{amb} = 25°C
typical values
η (%)
100
50
0
0
5
10
P_i (W)
doubler operation 2GHz to 4GHz in circuit diagram on page 3
quadrupler operation 0.562GHz to 2.25GHz


7Z09426
T_{amb} = 25°C
f = 1MHz
C_d (pF)
10
1
0.1
0.1
1
10
100
V_R=0
V_R + 0.6 (V)
typ

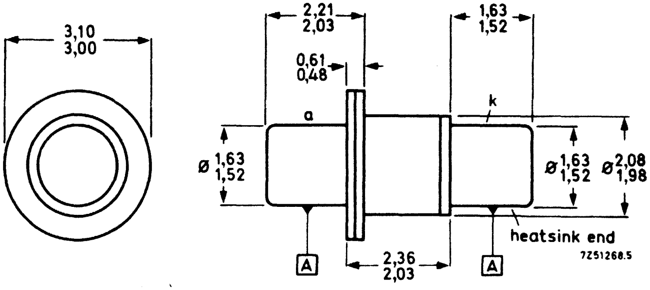
SILICON VARACTOR DIODE

Silicon planar epitaxial varactor diode exhibiting step recovery characteristics, especially suitable for use in frequency multiplier circuits up to X-band output frequency.
The device is mounted in a small double ended ceramic-metal case with hermetic seal.

QUICK REFERENCE DATA				
Output power (quadrupler 2.25 to 9.0 GHz)				
at P_i = 1.0 W	P_o	>	0.3	W
Resistive cut-off frequency at V_R = 6 V	f_c	typ.	120	GHz
Diode capacitance at V_R = 6 V	C_d	typ.	1.0	pF
Junction temperature	T_j	max.	150	°C

MECHANICAL DATA

Dimensions in mm



A = concentricity tolerance = ±0,13
Type marking on container
The heat should be transferred via the cathode pin

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

Reverse voltage	V_R	max.	25	V
Total power dissipation up to T_{pin} = 70 °C	P_{tot}	max.	1	W
Storage temperature	T_{stg}	−55 to +150		°C
Junction temperature	T_j	max.	150	°C

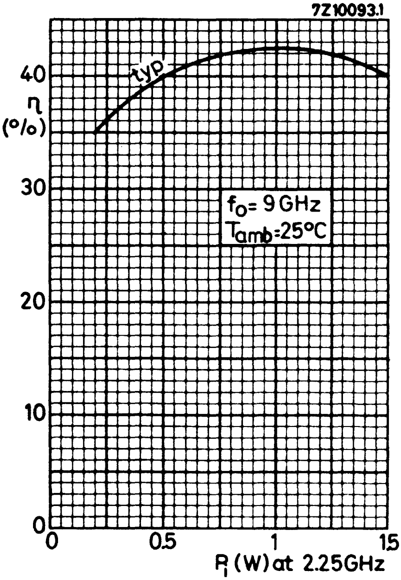
THERMAL RESISTANCE

From junction to pin	$R_{th\ j\text{-}pin}$	=	50	°C/W

CHARACTERISTICS

T_{amb} = 25 °C

Reverse current at V_R = 6 V	I_R	typ.	1.0	nA
		<	1.0	μA
Cut-off frequency at V_R = 6 V $f_c = \frac{1}{2\pi r_D(C_d - C_{str})}$	f_c	>	90	GHz
		typ.	120	GHz
Diode capacitance at V_R = 6 V; f = 1 MHz	C_d	typ.	1.0	pF
		0.8 to	1.5	pF
Stray capacitance	C_{str}	typ.	0.25	pF
Diode series inductance	L_d	typ.	650	pH
Overall efficiency in quadrupler circuit P_i = 1.0 W; f_i = 2.25 GHz	η	>	30	%

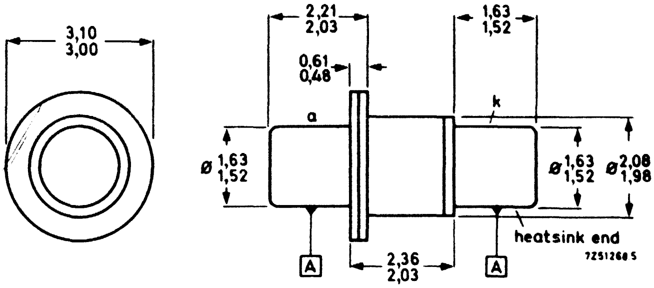


SILICON VARACTOR DIODE

Silicon planar epitaxial varactor diode exhibiting step recovery characteristics, especially suitable for use in high order frequency multiplier circuits up to X-band output frequency.
The device is mounted in a small double ended ceramic-metal case with hermetic seal.

QUICK REFERENCE DATA				
Output power (frequency multiplier 1 to 10 GHz)				
at P_i = 500 mW	P_o	typ.	20	mW
Resistive cut-off frequency at V_R = 6 V	f_c	typ.	150	GHz
Diode capacitance at V_R = 6 V	C_d	typ.	0.75	pF
Junction temperature	T_j	max.	150	°C

MECHANICAL DATA Dimensions in mm



A = concentricity tolerance = ±0,13
Type marking on container.
The heat should be transferred via the cathode pin.

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

Reverse voltage	V_R	max.	20	V
Total power dissipation up to T_{pin} = 70 °C	P_{tot}	max.	1	W
Storage temperature	T_{stg}	−55 to +150		°C
Junction temperature	T_j	max.	150	°C

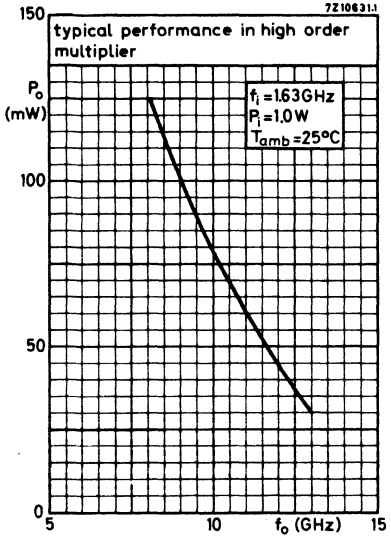
THERMAL RESISTANCE

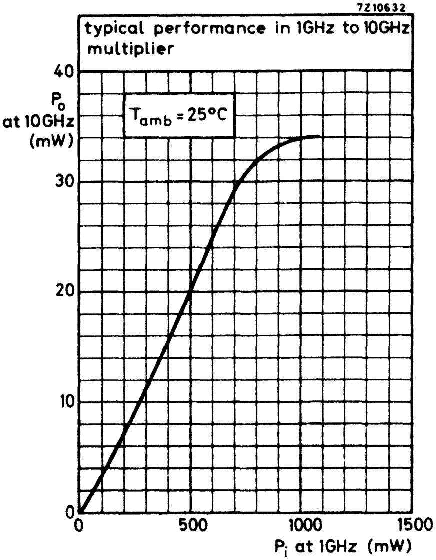
From junction to pin	$R_{th\ j\text{-}pin}$	=	50	°C/W

CHARACTERISTICS

T_{amb} = 25 °C

Reverse current at V_R = 6 V	I_R	typ. <	1 1	nA μA
Cut-off frequency at V_R = 6 V $f_c = \frac{1}{2\pi r_D(C_d - C_{str})}$	f_c	> typ.	100 150	GHz GHz
Diode capacitance at V_R = 6 V; f = 1 MHz	C_d	typ. 0.5 to	0.75 1	pF pF
Stray capacitance	C_{str}	typ.	0.25	pF
Diode series inductance	L_d	typ.	650	pH
Transition time	t_t	<	150	ps
Storage time	t_s	typ.	50	ns
Multiplier performance Output power at P_i = 500 mW (frequency multiplier 1 to 10 GHz)	P_o	> typ.	15 20	mW mW


7Z10631.1
typical performance in high order multiplier
P_o (mW)
150
100
50
0
f_i = 1.63 GHz
P_i = 1.0 W
T_{amb} = 25 °C
5
10
15
f_o (GHz)


7Z10632
typical performance in 1GHz to 10GHz multiplier
P_o at 10GHz (mW)
40
30
20
10
0
T_{amb} = 25 °C
0
500
1000
1500
P_i at 1GHz (mW)

GALLIUM ARSENIDE VARACTOR DIODE

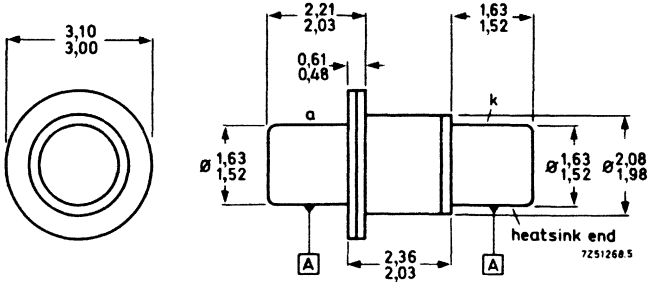
Diffused mesa varactor diode with a high cut-off frequency for use in parametric amplifiers, frequency multipliers and switches.
The device is mounted in a small double ended ceramic-metal case with hermetic seal.

QUICK REFERENCE DATA

Reverse voltage	V_R	max.	6.0	V
Average forward current	$I_{F(AV)}$	max.	70	mA
Total power dissipation up to T_{pin} = 107 °C	P_{tot}	max.	50	mW
Operating ambient temperature	T_{amb}	−196 to +150		°C
Cut-off frequency; V_R = 6 V	f_c	typ.	240	GHz

MECHANICAL DATA

Dimensions in mm



A = concentricity tolerance = ±0,13
Type marking on the container
The heat should be transferred via the flangeless pin

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

Voltage				
Continuous reverse voltage	V_R	max.	6.0	V
Current				
Average forward current	$I_{F(AV)}$	max.	70	mA
Power dissipation				
Total power dissipation up to T_{pin} = 107 °C	P_{tot}	max.	50	mW
Temperatures				
Storage temperature	T_{stg}		−196 to +150	°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

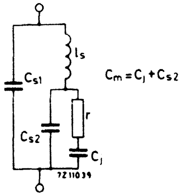
From junction to pin	$R_{th\ j\text{-}pin}$	=	0.9	°C/mW

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

Reverse current				
$V_R = 6.0$ V	I_R	typ.	0.1	μA
		<	1.0	μA
Forward voltage				
$I_F = 1.0$ μA	V_F	typ.	0.9	V
Effective diode capacitance 1) $C_m = \frac{1}{4\pi^2 f_{res}^2 l_s}$				
$V_R = 0$	C_m	typ.	0.4	pF
		0.3 to	0.5	pF
Stray capacitance 1)	C_{s1}	typ.	0.10	pF
	C_{s2}	typ.	0.15	pF
Series inductance 1)	l_s	typ.	625	pH
Cut-off frequency 2) at $V_R = 0$	f_{co}	>	125	GHz
		typ.	150	GHz
$V_R = 6$ V	f_{co}	typ.	240	GHz
Capacitance variation coefficient 3)	γ	>	0.12	
		typ.	0.15	
Series resonant frequency at $V_R = 0$ 2)	f_{res}	typ.	10	GHz
		8.9 to	11.6	GHz

---

1) A suitable lumped circuit equivalent may be drawn as follows:



2) Measurements at and about f_{res}, in a suitable waveguide holder, enable the values of f_{res} and the diode Q factor to be determined. The effective diode capacitance and the cut-off frequency can be calculated taking l_s to be the typical value. $f_{co} = Q_o\, f_{res}$ where Q_o is the Q factor at zero bias.

3) $$\gamma = \frac{C_{m\,max} - C_{m\,min}}{2\,(C_{m\,max} + C_{m\,min})} = \frac{(1-V)^{-1/3} - 2^{-1/3}}{2\left\{(1-V)^{-1/3} + 2^{-1/3}\right\} + \frac{4\,C_{s2}}{C_j}}$$

where $C_{m\,max}$ = effective capacitance at $I_F = 1.0\ \mu A$
$C_{m\,min}$ = effective capacitance at V_R 1.0 V
$V = V_F$ at $1.0\ \mu A$
$C_j = C_m - C_{s2}$

GALLIUM ARSENIDE DIFFUSED MESA VARACTOR DIODE

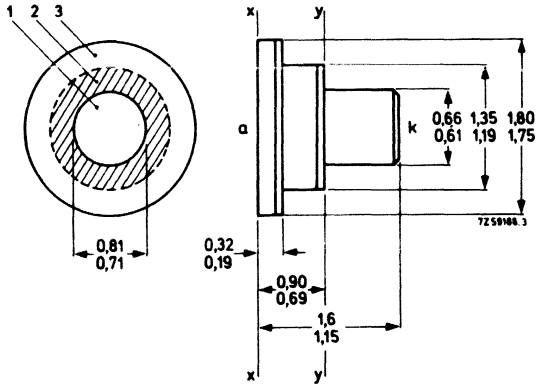
Varactor diode with a high cut-off frequency, primarily intended for use in microwave parametric amplifiers. The device is mounted in a small ceramic-metal case with hermetic welded seal.

QUICK REFERENCE DATA

Continuous reverse voltage	V_R	max.	6	V
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	50	mW
Junction temperature	T_j	−196 to +135		°C
Cut-off frequency ; V_R = 0	f_{co}	typ.	350	GHz

MECHANICAL DATA

Dimensions in mm



Compression force on mounting surfaces x-x and y-y: max. 2.45 N

1. Do not press on this area.
2. Preferred area of pressure.
3. Take care not to flex the flange

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

Voltage

Continuous reverse voltage	V_R	max.	6.0	V

Power dissipation

Total power dissipation up to $T_{mb} = 25\ ^oC$	P_{tot}	max.	50	mW

Temperatures

Storage temperature	T_{stg}		-196 to +175	oC
Junction temperature	T_j	max.	135	oC

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	0.9	oC/mW

CHARACTERISTICS

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

Reverse current				
$V_R = 6.0$ V	I_R	typ.	0.1	µA
		<	1.0	µA
Capacitance $\frac{1}{2\pi r_D f_{co}}$				
$V_R = 0$	C_d	typ.	0.2	pF
Stray capacitance	C_s	typ.	0.3	pF
Diode series resistance				
$V_R = 0$	r_D	typ.	2.25	Ω
		1 to	3.0	Ω
Series inductance $\frac{1}{4\pi^2 f_{res}{}^2 C_d}$	l_s	typ.	140	pH
Cut-off frequency; $V_R = 0$	f_{co}	>	200	GHz
		typ.	350	GHz
Product of capacitance variation coefficient and cut-off frequency; $V_R = 0$ 1)	γf_{co}	>	35	GHz
		typ.	40	GHz
Series resonant frequency; $V_R = 0$	f_{res}	typ.	30	GHz
		27 to	34	GHz

---

1)
$$\gamma = \frac{C_{d\,max} - C_{d\,min}}{2(C_{d\,max} + C_{d\,min})} = \frac{\frac{1}{f_{res\,min}{}^2} - \frac{1}{f_{res\,max}{}^2}}{2\left(\frac{1}{f_{res\,min}{}^2} + \frac{1}{f_{res\,max}{}^2}\right)}$$

where $C_{d\,max}$ = capacitance at $I_F = 1.0\ \mu A$
$C_{d\,min}$ = capacitance at $V_R = 1.0$ V
$f_{res\,min}$ and $f_{res\,max}$ are the corresponding resonant frequencies assuming a constant inductance. Hence it is directly measurable in the transmission loss system.

Remark

The dynamic parameters are quoted using a holder which takes the form of a double four-section, wide band, low v.s.w.r. Q-band 26 to 40 GHz waveguide transformer to a reduced height of 0.25 mm. The transformer is step down followed by step up in order to use standard Q-band components on either side. A d.c. isolated choke system allows the diode to be inserted across the 0.25 mm reduced height section and to be biased.

Using a swept frequency transmission loss measuring system the f_{co}, the Q and γ of the diode-holder system can be measured ($f_{co} = Q \times f_{res}$).

Separately, by measuring the transmission loss past the diode at resonance, r_D can be found.

OPERATING NOTES

The CXY10 varactor diode will give excellent noise performance in a parametric amplifier of suitable design.

For instance, at a signal frequency of 8.5GHz in an amplifier having an over-coupled ratio of 4dB to 5dB with a pump frequency at 35GHz and an idler frequency of 26.5GHz, the effective input noise temperature of the amplifier less the contribution due to the circulator would be typically 200°K and a maximum of 250°K with the amplifier at room temperature. In cooled paramps, due to its low temperature working capability, the device would give appropriately lower effective input noise temperatures.

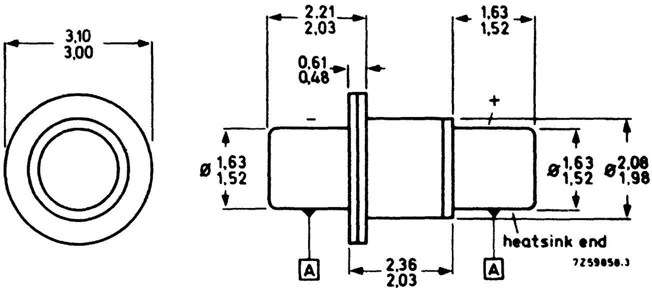
GUNN EFFECT DIODES

Gallium arsenide Gunn effect diodes for c.w. oscillators at to X-band frequencies. The devices are mounted in a small double ended ceramic-metal case with hermetic seal suitable for mounting in various types of cavity.
The main types CXY11A to C will oscillate throughout X-band, the actual frequency depending on the cavity used. The sub-types 8.5, 10.5 and 11.5 are only specified in a 1 GHz band centred on 8.5, 10.5 and 11.5 GHz respectively (see table 1 on page 2)

QUICK REFERENCE DATA					
Operating voltage		V	typ.	7	V
Total power dissipation up to T_{pin} = 35 °C		P_{tot}	max.	1.0	W
Operating frequency			X-band		
Output power at f = 9.5 GHz	CXY11A	P_o	>	5	mW
	CXY11B	P_o	>	10	mW
	CXY11C	P_o	>	15	mW

MECHANICAL DATA

Dimensions in mm



A = concentricity tolerance = ±0,13
Type marking on the container
The heat should be transferred via the flangeless pin

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

Voltage 1)	V	max.	7.0	V
Total power dissipation up to T_{pin} = 35 °C	P_{tot}	max.	1.0	W
Storage temperature	T_{stg}	max.	175	°C

CHARACTERISTICS T_{pin} = 35 °C

Current at V = 7.0 V	I	typ.	140	mA
Operating frequency 2)	f		8.0 to 12	GHz
Output power 3)				
CXY11A	P_o	>	5	mW
		typ.	8	mW
CXY11B	P_o	>	10	mW
		typ.	12	mW
CXY11C	P_o	>	15	mW
		typ.	20	mW

---

1) Bias must always be applied in such a way that the flanged end of the device is negative. Reversing polarity or exceeding maximum rating may cause permanent damage. Care should be taken not to exceed voltage transients of 8 V.

2) The frequency is governed by the choise of cavity to which the device is coupled. For frequency coverage see table 1.

3) P_o is measured in a coaxial cavity at the test frequency given in table 1.

Table 1.	Test frequency and frequency coverage in GHz			
	8.5 8 to 9	9.5 8 to 12	10.5 10 to 11	11.5 11 to 12
P_o > 5 mW typ. 8 mW	CXY11A$_{8.5}$	CXY11A	CXY11A$_{10.5}$	CXY11A$_{11.5}$
P_o > 10 mW typ. 12 mW	CXY11B$_{8.5}$	CXY11B	CXY11B$_{10.5}$	CXY11B$_{11.5}$
P_o > 15 mW typ. 20 mW	CXY11C$_{8.5}$	CXY11C	CXY11C$_{10.5}$	CXY11C$_{11.5}$

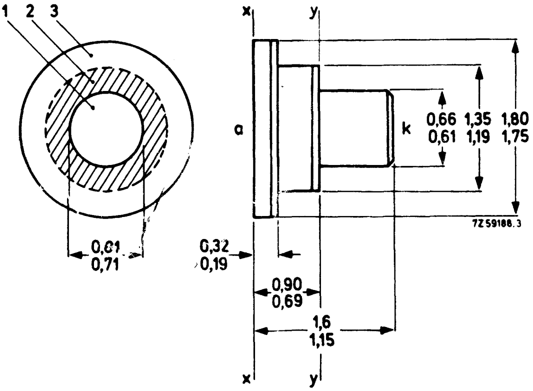
GALLIUM ARSENIDE DIFFUSED MESA VARACTOR DIODE

Diffused mesa varactor diode suitable for use in frequency multiplier circuits up to Q-band output frequency. The device is mounted in a small ceramic-metal case with hermetic welded seal.

QUICK REFERENCE DATA				
Output power (quadrupler 9.0 to 36 GHz) at P_i = 500 mW	P_o	>	50	mW
Resistive cut-off frequency at V_R = 6 V	f_c	typ.	500	GHz
Junction temperature	T_j	max.	175	°C

MECHANICAL DATA

Dimensions in mm



Compression force on mounting surfaces x-x and y-y: max. 2.45 N

1. Do not press on this area.
2. Preferred area of pressure.
3. Take care not to flex the flange.

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

Voltage

Continuous reverse voltage	V_R	max.	10	V

Power dissipation

Total power dissipation up to $T_{mb} = 25\ ^{o}C$	P_{tot}	max.	300	mW
R.F. input power	P_i	max.	500	mW

Temperatures

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

THERMAL RESISTANCE

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

CHARACTERISTICS

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

Reverse current				
$V_R = 6.0$ V	I_R	typ. <	0.001 1.0	μA μA
Capacitance $\frac{1}{2\pi r_D f_{co}}$				
$V_R = 6.0$ V	C_d	typ.	0.25	pF
Stray capacitance	C_s	typ.	0.3	pF
Diode series resistance				
$V_R = 6.0$ V	r_D	typ.	1.3	Ω
Series inductance $\frac{1}{4\pi^2 f_{res}^2 C_d}$	l_s	typ.	120	pH
Cut-off frequency ; $V_R = 6.0$ V	f_{co}	> typ.	300 500	GHz GHz
Series resonant frequency ; $V_R = 6.0$ V	f_{res}	typ. 27 to	29 35	GHz GHz

Remark

The dynamic parameters are quoted using a holder which takes the form of a double four-section, wide band, low v.s.w.r. Q-band 26 to 40 GHz waveguide transformer to a reduced height of 0.25 mm. The transformer is step down followed by step up in order to use standard Q-band components on either side. A d.c. isolated choke system allows the diode to be inserted across the 0.25 mm reduced height section and to be biased.

Using a swept frequency transmission loss measuring system the f_{co}, the Q of the diode-holder system can be measured ($f_{co} = Q \times f_{res}$).

Separately, by measuring the transmission loss past the diode at resonance, r_D can be found.

SILICON VARACTOR DIODES

Silicon planar epitaxial varactor diodes exhibiting step recovery characteristics, especially suitable for use in frequency multiplier circuits up to S-band output frequency.

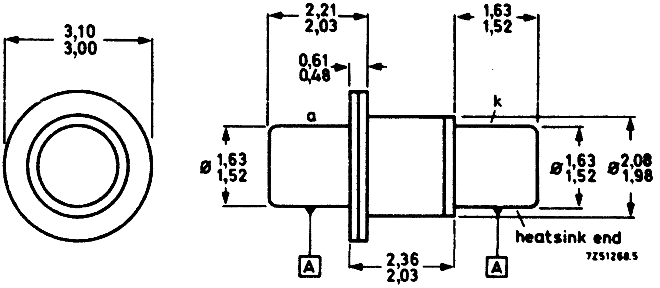
QUICK REFERENCE DATA

Ouput power (doubler 1.0 to 2.0 GHz) at P_i = 12 W	P_o	>	6.0	W
Resistive cut-off frequency at V_R = 6 V	f_c	typ.	100	GHz
Diode capacitance at V_R = 6 V	C_d	typ.	6.0	pF

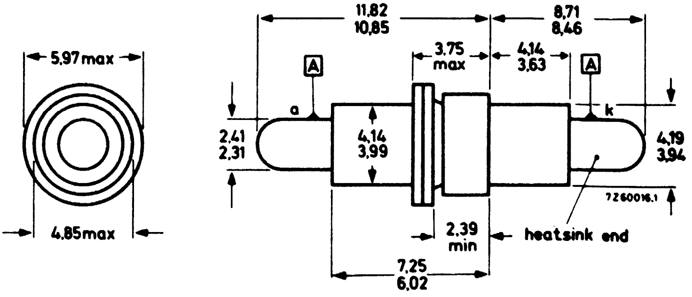
MECHANICAL DATA

Dimensions in mm

1N5152



1N5153



A = concentricity tolerance = ±0,13
Type marking on container
The heat should be transferred via the cathode pin

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

Reverse voltage	V_R	max.	75	V
Total power dissipation up to T_{pin} = 70 °C	P_{tot}	max.	5	W
Storage temperature	T_{stg}		−55 to +175	°C
Junction temperature	T_j	max.	175	°C

THERMAL RESISTANCE

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

CHARACTERISTICS at T_{amb} = 25 °C

Reverse breakdown voltage I_R = 10 μA	$V_{(BR)R}$	>	75	V
Forward voltage I_F = 10 mA	V_F	<	1.0	V
Reverse current at V_R = 60 V	I_R	typ. <	1.0 1.0	nA μA
Resistive cut-off frequency at V_R = 6 V; f = 2.0 GHz	f_c	> typ.	55 100	GHz GHz
Diode capacitance at V_R = 6 V; f = 1 MHz	C_d		5.0 to 7.5	pF
Overall efficiency in doubler circuit P_i = 12 W; f_i = 1.0 GHz	η	> typ.	50 60	% %

SILICON VARACTOR DIODE

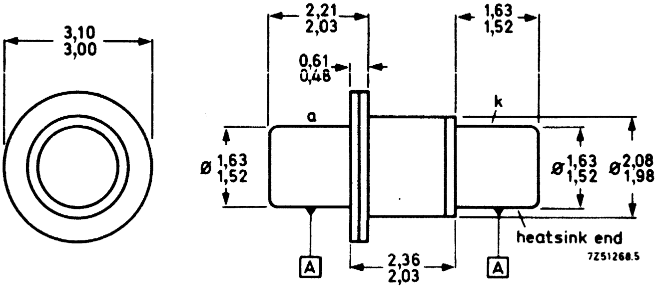
Silicon planar epitaxial varactor diode exhibiting step recovery characteristics; especially suitable for use in frequency multiplier circuits up to C-band output frequency.

QUICK REFERENCE DATA

Output power (tripler 2.0 to 6.0 GHz) at P_i = 5 W	P_o	>	2.0	W
Resistive cut-off frequency at V_R = 6 V	f_c	typ.	120	GHz
Diode capacitance at V_R = 6 V	C_d	typ.	2.0	pF

MECHANICAL DATA

Dimensions in mm



A = concentricity tolerance = ±0,13

Type marking on container

The heat should be transferred via the cathode pin

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

Reverse voltage	V_R	max.	35	V
Total power dissipation up to T_{pin} = 70 °C	P_{tot}	max.	3	W
Storage temperature	T_{stg}	−55 to +175		°C
Junction temperature	T_j	max.	175	°C

THERMAL RESISTANCE

From junction to pin	$R_{th\ j\text{-}pin}$	=	35	°C/W

CHARACTERISTICS at T_{amb} = 25 °C

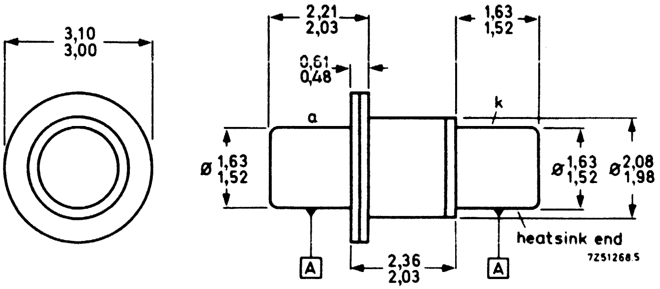
Reverse breakdown voltage I_R = 10 μA	$V_{(BR)R}$	>	35	V
Forward voltage I_F = 10 mA	V_F	<	1.0	V
Reverse current at V_R = 26 V	I_R	typ. <	1.0 1.0	nA μA
Resistive cut-off frequency at V_R = 6 V; f = 2.0 GHz	f_c	> typ.	100 120	GHz GHz
Diode capacitance at V_R = 6 V; f = 1 MHz	C_d	1.0 to	3.0	pF
Overall efficiency in tripler circuit P_i = 5 W; f_i = 2.0 GHz	η	>	40	%

SILICON VARACTOR DIODE

Silicon planar epitaxial varactor diode exhibiting step recovery characteristics, especially suitable for use in frequency multiplier circuits up to X-band output frequency.

QUICK REFERENCE DATA				
Output power (doubler 5.0 to 10 GHz) at P_i = 2.6 W	P_o	>	1.0	W
Resistive cut-off frequency at V_R = 6 V	f_c	typ.	200	GHz
Diode capacitance at V_R = 6 V	C_d	typ.	0.8	pF

MECHANICAL DATA Dimensions in mm



A = concentricity tolerance = ±0,13
Type marking on container
The heat should be transferred via the cathode pin

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

Reverse voltage	V_R	max.	20	V
Total power dissipation up to T_{pin} = 70 °C	P_{tot}	max.	2.5	W
Storage temperature	T_{stg}		−55 to +175	°C
Junction temperature	T_j	max.	175	°C

THERMAL RESISTANCE

From junction to pin	$R_{th\ j\text{-}pin}$	=	38.5	°C/W

CHARACTERISTICS at T_{amb} = 25 °C

Reverse breakdown voltage I_R = 10 μA	$V_{(BR)R}$	>	20	V
Forward voltage I_F = 10 mA	V_F	<	1.0	V
Reverse current at V_R = 16 V	I_R	<	0.1	μA
Resistive cut-off frequency at V_R = 6 V; f = 8 GHz	f_c	> typ.	180 200	GHz GHz
Diode capacitance at V_R = 6 V; f = 1 MHz	C_d	0.6 to	1.0	pF
Overall efficiency in doubler circuit P_i = 2.6 W; f_i = 5.0 GHz	η	>	38	%

Field-effect transistors

N-CHANNEL SILICON FIELD-EFFECT TRANSISTORS

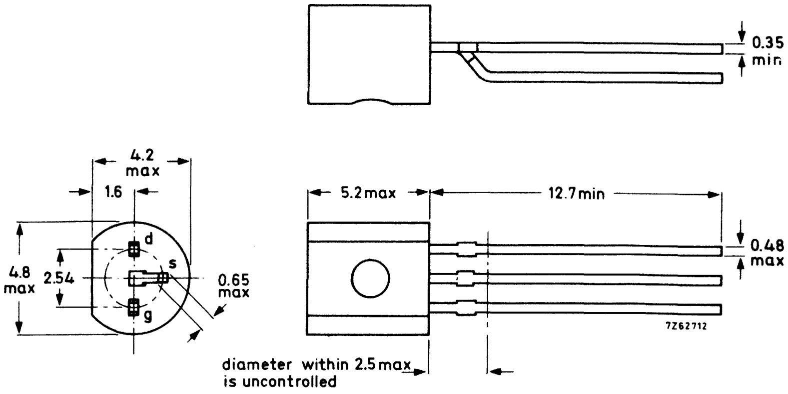
N-channel silicon epitaxial planar junction field-effect transistors in a plastic TO-92 variant; intended for low input noise stages in tape recorders, hi-fi amplifiers and other audio frequency equipment.

QUICK REFERENCE DATA

Drain-source voltage	$\pm V_{DS}$	max.	30	V
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	300	mW
Junction temperature	T_j	max.	150	°C
Drain current V_{DS} = 15 V; V_{GS} = 0	I_{DSS}		2 to 12	mA
Transfer admittance (common source) V_{DS} = 15 V; V_{GS} = 0; f = 1 kHz	$\lvert y_{fs} \rvert$	typ.	3,5	mA/V
Noise figure at V_{DS} = 15 V; V_{GS} = 0 f = 1 kHz; R_G = 1 MΩ	F	<	2	dB

MECHANICAL DATA Dimensions in mm

TO-92 variant



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

Voltages				
Drain-source voltage	$\pm V_{DS}$	max.	30	V
Drain-gate voltage (open source)	V_{DGO}	max.	30	V
Gate-source voltage (open drain)	$-V_{GSO}$	max.	30	V
Current				
Gate current	I_G	max.	10	mA
Power dissipation				
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	300	mW
Temperatures				
Storage temperature	T_{stg}		-65 to +150	°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	0, 42	°C/mW

CHARACTERISTICS

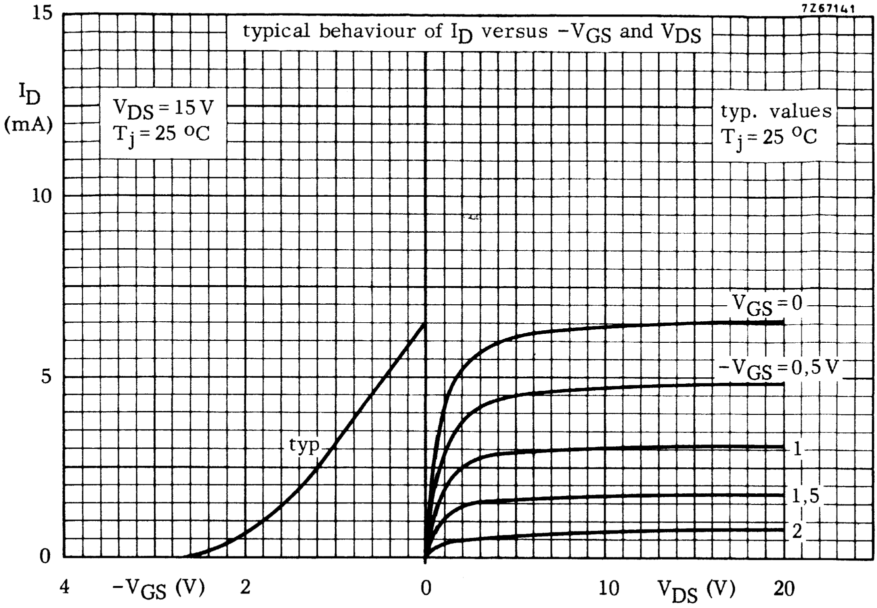
T_j = 25 °C unless otherwise specified

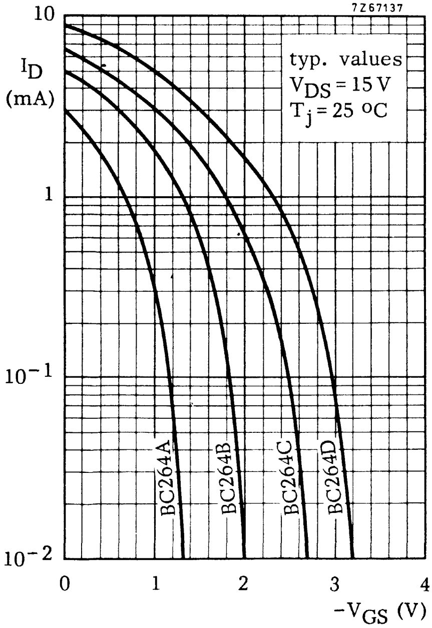
			BC264A	B	C	D	
Gate cut-off current							
$-V_{GS}$ = 20 V; V_{DS} = 0	$-I_{GSS}$	<	10	10	10	10	nA
Drain current [1]							
V_{DS} = 15 V; V_{GS} = 0	I_{DSS}	>	2,0	3,5	5,0	7,0	mA
		<	4,5	6,5	8,0	12,0	mA
Gate-source breakdown voltage							
$-I_G$ = 1 µA; V_{DS} = 0	$-V_{(BR)GSS}$	>	30	30	30	30	V
Gate-source voltage							
I_D = 200 µA ; V_{DS} = 15 V	$-V_{GS}$	>	0,4	0,4	0,4	0,4	V
I_D = 1,0 mA; V_{DS} = 15 V	$-V_{GS}$	>	0,2	–	–	–	V
		<	1,2	–	–	–	V
I_D = 1,5 mA; V_{DS} = 15 V	$-V_{GS}$	>	–	0,4	–	–	V
		<	–	1,4	–	–	V
I_D = 2,5 mA; V_{DS} = 15 V	$-V_{GS}$	>	–	–	0,5	–	V
		<	–	–	1,5	–	V
I_D = 3,5 mA; V_{DS} = 15 V	$-V_{GS}$	>	–	–	–	0,6	V
		<	–	–	–	1,6	V
Gate-source cut-off voltage							
I_D = 10 nA ; V_{DS} = 15 V	$-V_{(P)GS}$	>	0,5	0,5	0,5	0,5	V
y-parameters at T_{amb} = 25 °C							
V_{DS} = 15 V; V_{GS} = 0; f = 1 kHz							
Transfer admittance	$\|y_{fs}\|$	>	2,5	3,0	3,5	4,0	mA/V

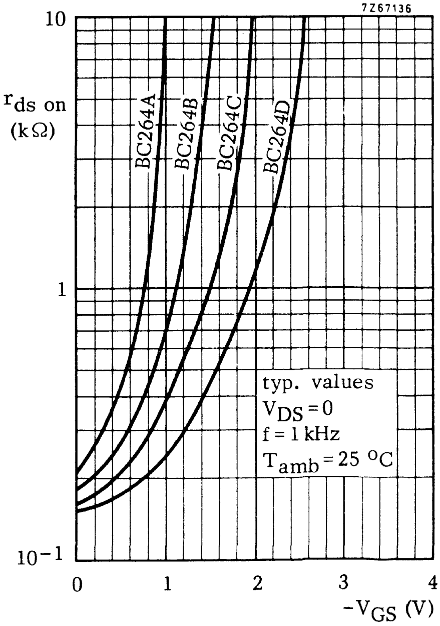
V_{DS} = 15 V; $-V_{GS}$ = 1 V; f = 1 MHz				
Input capacitance	C_{is}	typ.	4,0	pF
Feedback capacitance	C_{rs}	typ.	1,2	pF
Output capacitance	C_{os}	typ.	1,6	pF
Noise figure at f = 1 kHz; R_G = 1 MΩ				
V_{DS} = 15 V; V_{GS} = 0; T_{amb} = 25 °C	F	typ.	0,5	dB
		<	2	dB
Equivalent noise voltage at T_{amb} = 25 °C				
V_{DS} = 15 V; V_{GS} = 0; f = 10 Hz	$V_n/\sqrt{B}$	typ.	40	nV/$\sqrt{\text{Hz}}$

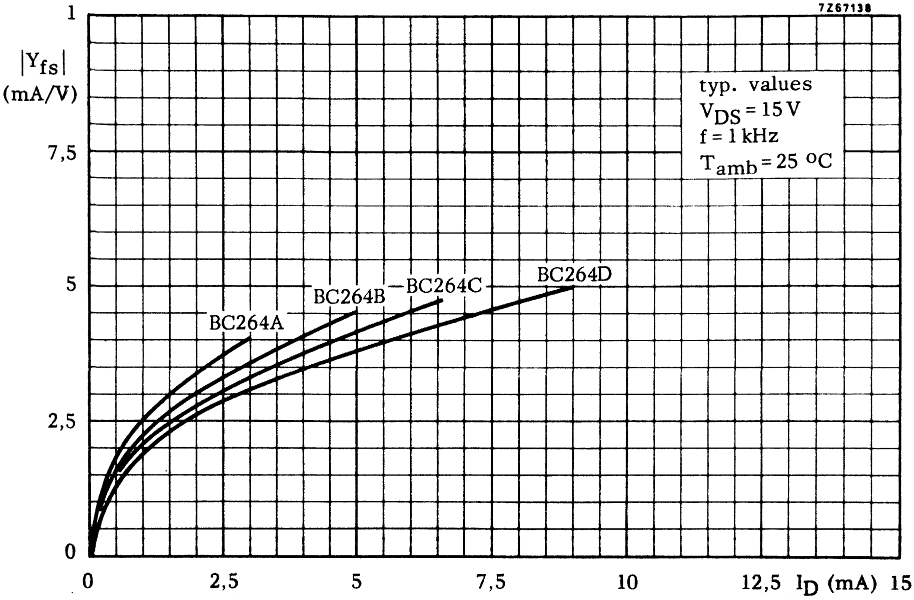
---

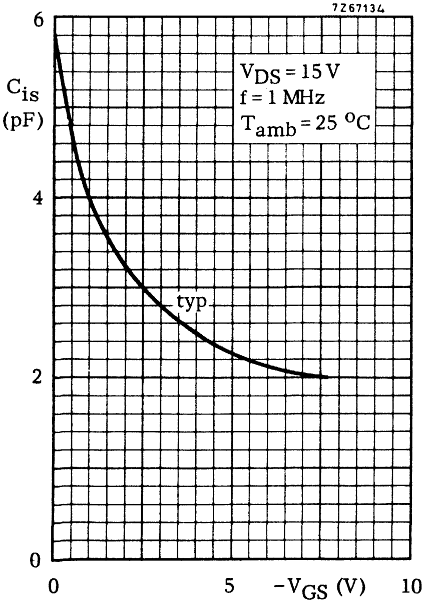
[1] Measured under pulse conditions.

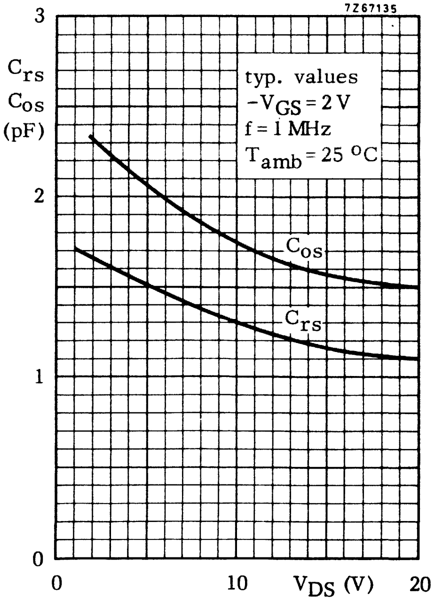

7Z67141
typical behaviour of I_D versus $-V_{GS}$ and V_{DS}
I_D (mA)
15
10
5
0
$V_{DS} = 15$ V
$T_j = 25$ °C
typ
typ. values
$T_j = 25$ °C
$V_{GS} = 0$
$-V_{GS} = 0,5$ V
1
1,5
2
4
$-V_{GS}$ (V)
2
0
10
V_{DS} (V)
20

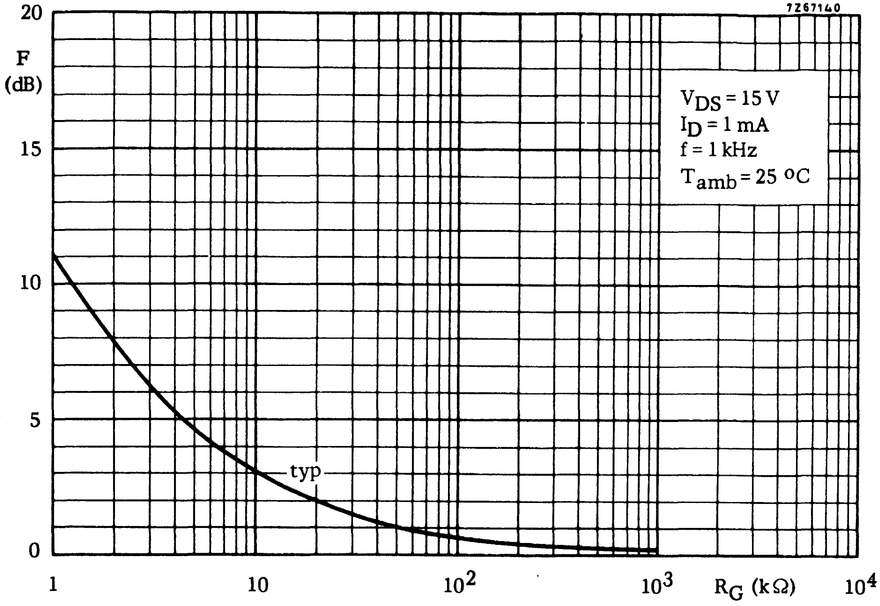

7Z67137
I_D (mA)
10
1
10^{-1}
10^{-2}
typ. values
$V_{DS} = 15$ V
$T_j = 25$ °C
BC264A
BC264B
BC264C
BC264D
0
1
2
3
4
$-V_{GS}$ (V)


7Z67136
$r_{ds\ on}$ (kΩ)
10
1
10^{-1}
BC264A
BC264B
BC264C
BC264D
typ. values
$V_{DS} = 0$
f = 1 kHz
$T_{amb} = 25$ °C
0
1
2
3
4
$-V_{GS}$ (V)


7Z67138
|Y_fs|
(mA/V)
1
7,5
5
2,5
0
0
2,5
5
7,5
10
12,5
I_D (mA)
15
typ. values
V_DS = 15 V
f = 1 kHz
T_amb = 25 °C
BC264A
BC264B
BC264C
BC264D


7Z67134
C_is
(pF)
6
4
2
0
0
5
−V_GS (V)
10
V_DS = 15 V
f = 1 MHz
T_amb = 25 °C
typ


7Z67135
C_rs
C_os
(pF)
3
2
1
0
0
10
V_DS (V)
20
typ. values
−V_GS = 2 V
f = 1 MHz
T_amb = 25 °C
C_os
C_rs


7Z67140
F
(dB)
20
15
10
5
0
1
10
10^2
10^3
10^4
R_G (kΩ)
V_{DS} = 15 V
I_D = 1 mA
f = 1 kHz
T_{amb} = 25 °C
typ

N-CHANNEL SILICON FIELD-EFFECT TRANSISTORS

General purpose symmetrical N-channel planar epitaxial junction field-effect transistors in a plastic TO-92; intended for applications in l.f. and d.c. amplifiers, and in h.f. amplifiers.

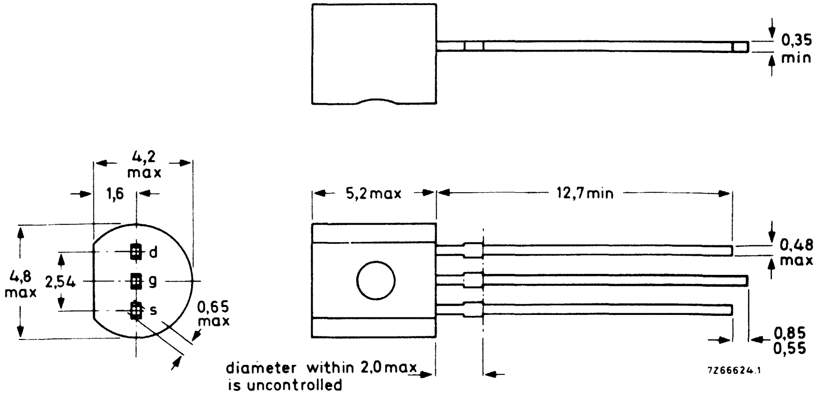
QUICK REFERENCE DATA

			BF244A	B	C	
Drain-source voltage	$\pm V_{DS}$	max.			30	V
Gate-source voltage (open drain)	$-V_{GSO}$	max.			30	V
Total power dissipation up to T_{amb} = 75 °C	P_{tot}	max.			300	mW
Drain current V_{DS} = 15 V; V_{GS} = 0	I_{DSS}	>	2	6,0	12	mA
		<	6,5	15,0	25	mA
Gate-source cut-off voltage I_D = 10 nA; V_{DS} = 15 V	$-V_{(P)GS}$				0,5 to 8,0	V
Feedback capacitance at f = 1 kHz V_{DS} = 20 V; $-V_{GS}$ = 1 V; T_{amb} = 25 °C	C_{rs}	typ.			1,1	pF
Transfer admittance (common source) V_{DS} = 15 V; V_{GS} = 0; f = 1 kHz; T_{amb} = 25 °C	$\lvert y_{fs}\rvert$				3,0 to 6,5	mA/V

MECHANICAL DATA

Dimensions in mm

TO-92



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

Voltages					
Drain-source voltage	$\pm V_{DS}$	max.	30	V	
Drain-gate voltage (open source)	V_{DGO}	max.	30	V	
Gate-source voltage (open drain)	$-V_{GSO}$	max.	30	V	
Currents					
Drain current	I_D	max.	25	mA	
Gate current	I_G	max.	10	mA	
Power dissipation					
Power dissipation up to T_{amb} = 75 °C	P_{tot}	max.	300	mW	
up to T_{amb} = 90 °C	P_{tot}	max.	300	mW	1)
Temperatures					
Storage temperature	T_{stg}		−65 to +150	°C	
Junction temperature	T_j	max.	150	°C	

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	0,25	°C/mW	
From junction to ambient	$R_{th\ j-a}$	=	0,20	°C/mW	1)

---

1) Transistor mounted on printed circuit board, max. lead length 3 mm, mounting pad for drain lead minimum 10 mm x 10 mm.

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

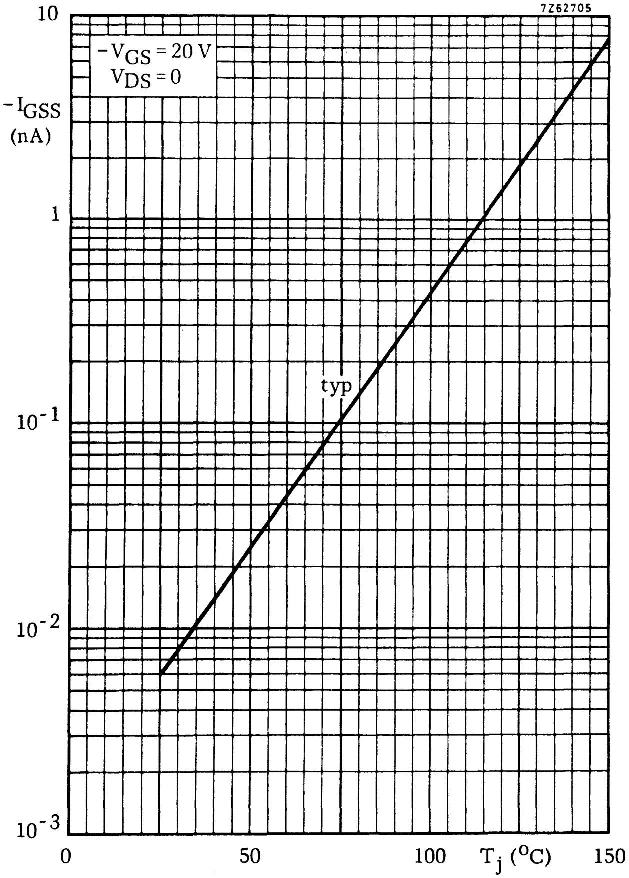
		BF244A	B	C	
Gate cut-off current					
$-V_{GS}$ = 20 V; V_{DS} = 0	$-I_{GSS}$	< 5	5	5	nA
$-V_{GS}$ = 20 V; V_{DS} = 0; T_j = 125 °C	$-I_{GSS}$	< 0,5	0,5	0,5	μA
Drain current [1]					
V_{DS} = 15 V; V_{GS} = 0	I_{DSS}	> 2	6,0	12	mA
		< 6,5	15,0	25	mA
Gate-source breakdown voltage					
$-I_G$ = 1 μA; V_{DS} = 0	$-V_{(BR)GSS}$	> 30	30	30	V
Gate-source voltage					
I_D = 200 μA; V_{DS} = 15 V	$-V_{GS}$	> 0,4	1,6	3,2	V
		< 2,2	3,8	7,5	V

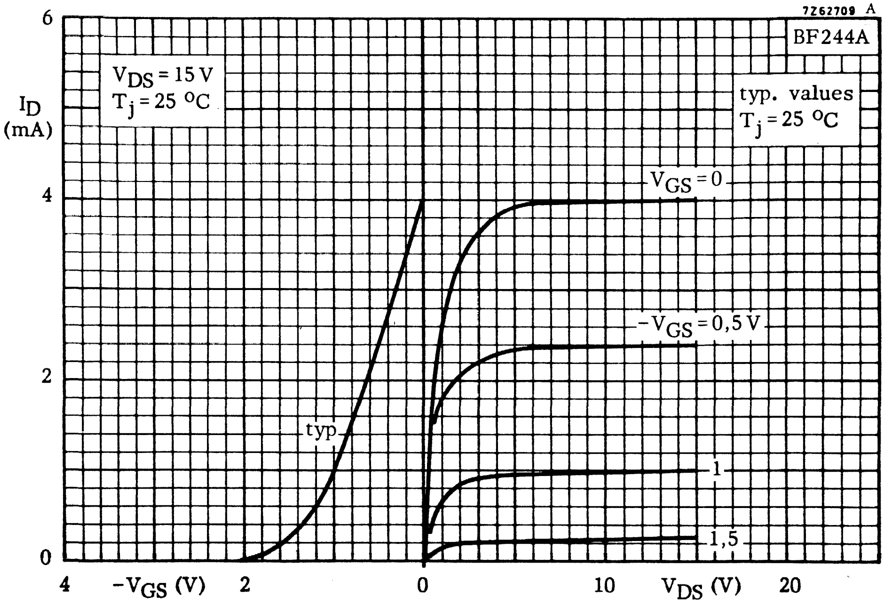
Gate-source cut-off voltage					
I_D = 10 nA; V_{DS} = 15 V		$-V_{(P)GS}$	0,5 to 8,0		V
y-parameters at T_{amb} = 25 °C (common source)					
V_{DS} = 15 V; V_{GS} = 0					
f = 1 kHz	Transfer admittance	$\lvert y_{fs} \rvert$	3,0 to 6,5		mA/V
	Output admittance	$\lvert y_{os} \rvert$	typ.	25	μA/V
f = 200 MHz	Input conductance	g_{is}	typ.	250	μA/V
	Reverse transfer admittance	$\lvert y_{rs} \rvert$	typ.	1,4	mA/V
	Transfer admittance	$\lvert y_{fs} \rvert$	typ.	6	mA/V
	Output conductance	g_{os}	typ.	40	μA/V
V_{DS} = 20 V; $-V_{GS}$ = 1 V					
f = 1 MHz	Input capacitance	C_{is}	typ.	4,0	pF
	Feedback capacitance	C_{rs}	typ.	1,1	pF
	Output capacitance	C_{os}	typ.	1,6	pF
Cut-off frequency [2]					
V_{DS} = 15 V; V_{GS} = 0		f_{gfs}	typ.	700	MHz
Noise figure at f = 100 MHz; R_G = 1 kΩ (common source)					
V_{DS} = 15 V; V_{GS} = 0; T_{amb} = 25 °C input tuned to minimum noise		F	typ.	1,5	dB

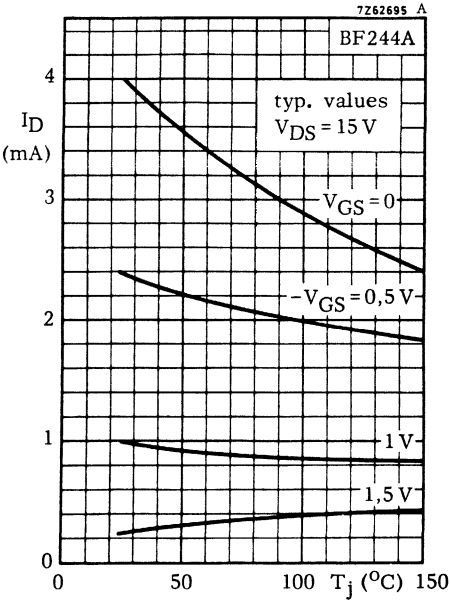
---

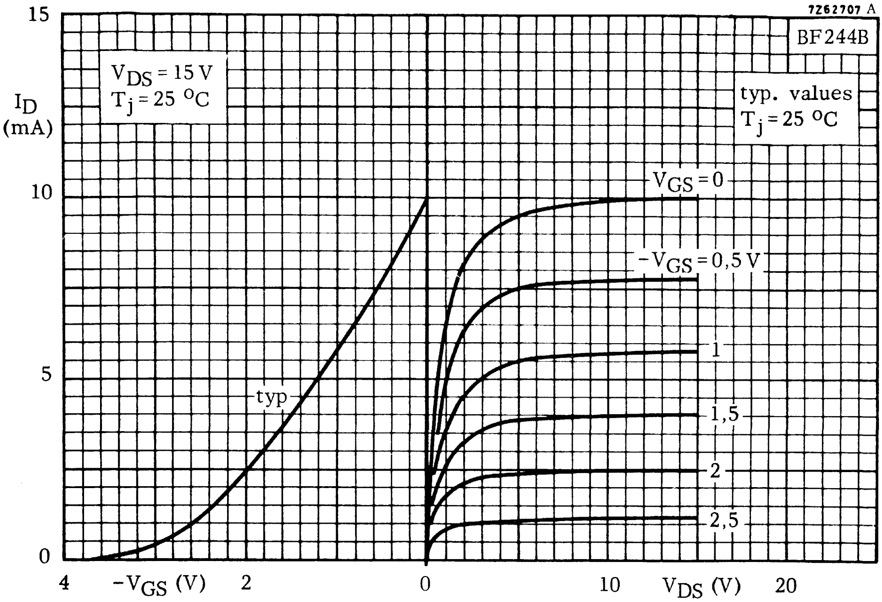
[1] Measured under pulse condition: t_p = 300 μs; $\delta \le 0,02$

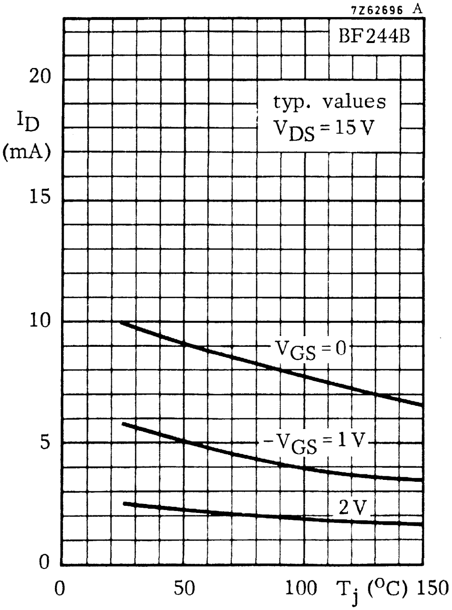
[2] The frequency at which g_{fs} is 0,7 of its value at 1 kHz.

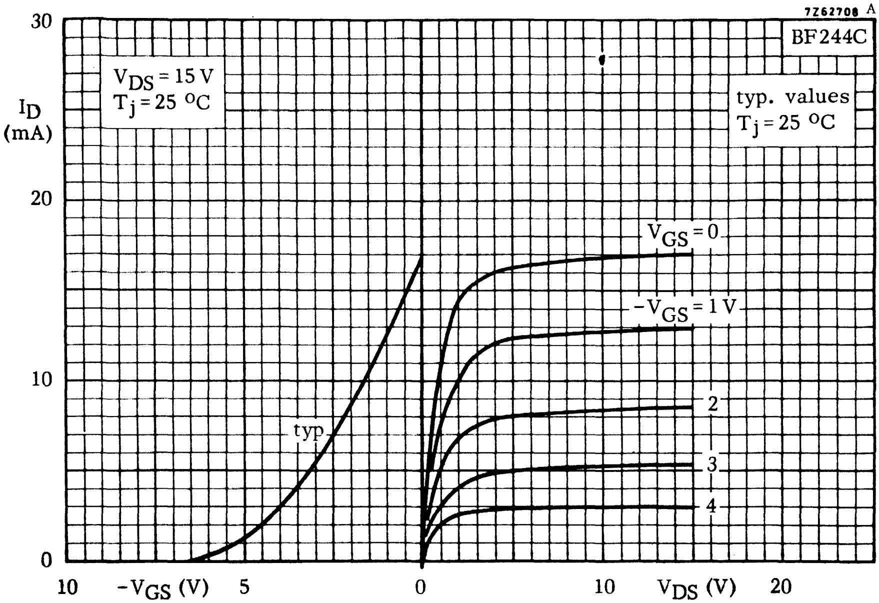

7Z62705
10
1
10^{-1}
10^{-2}
10^{-3}
$-I_{GSS}$ (nA)
$-V_{GS} = 20$ V
$V_{DS} = 0$
typ
0
50
100
150
T_j (°C)

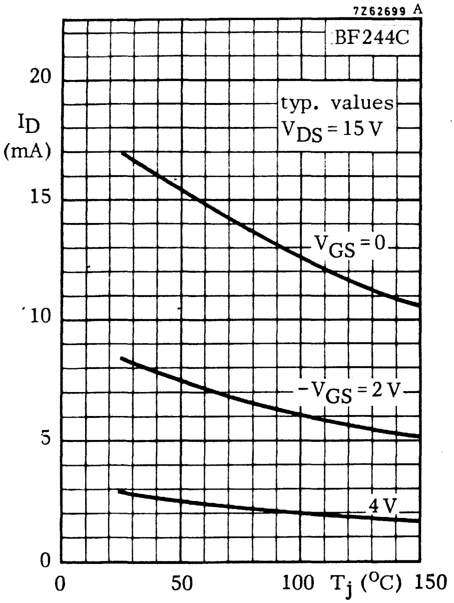

7Z62709 A
BF244A
V_{DS} = 15 V
T_j = 25 °C
I_D (mA)
typ. values
T_j = 25 °C
V_{GS} = 0
$-V_{GS}$ = 0,5 V
1
1,5
typ
6
4
2
0
4
$-V_{GS}$ (V)
2
0
10
V_{DS} (V)
20

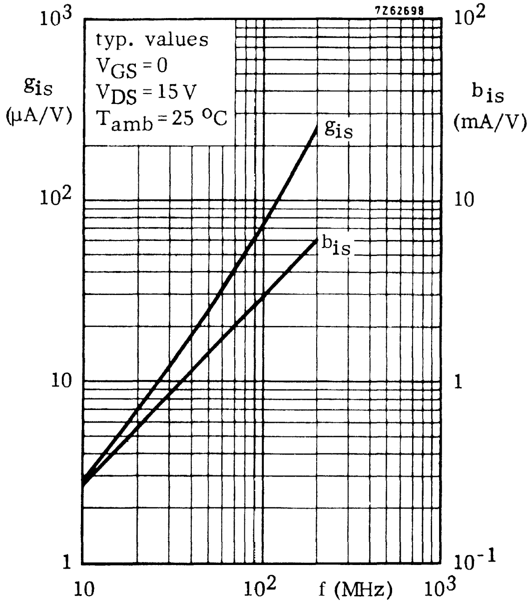

7Z62695 A
BF244A
typ. values
V_{DS} = 15 V
I_D (mA)
V_{GS} = 0
$-V_{GS}$ = 0,5 V
1 V
1,5 V
4
3
2
1
0
0
50
100
T_j (°C)
150

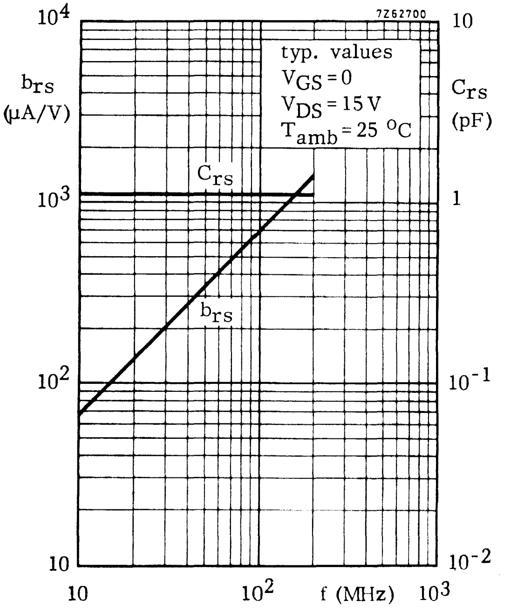

7Z62707 A
BF244B
V_{DS} = 15 V
T_j = 25 °C
typ. values
T_j = 25 °C
I_D (mA)
15
10
5
0
typ
V_{GS} = 0
$-V_{GS}$ = 0,5 V
1
1,5
2
2,5
4
$-V_{GS}$ (V)
2
0
10
V_{DS} (V)
20

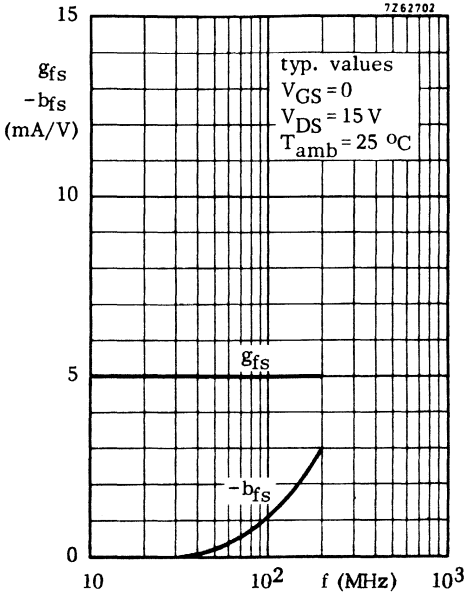

7Z62696 A
BF244B
typ. values
V_{DS} = 15 V
I_D (mA)
20
15
10
5
0
V_{GS} = 0
$-V_{GS}$ = 1 V
2 V
0
50
100
T_j (°C)
150

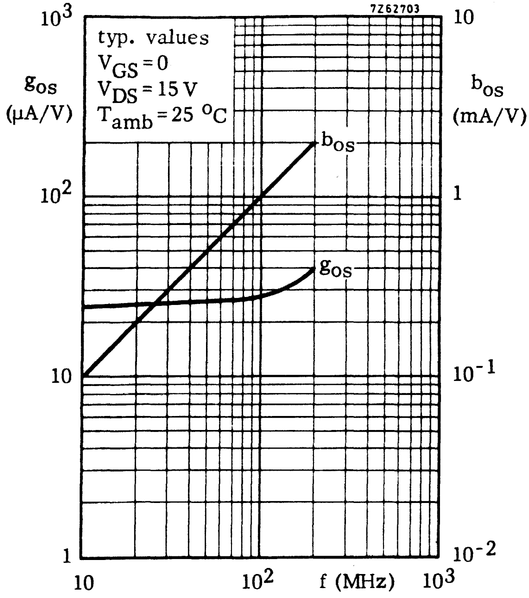

7Z62708 A
BF244C
I_D (mA)
30
20
10
0
V_{DS} = 15 V
T_j = 25 °C
typ. values
T_j = 25 °C
typ
V_{GS} = 0
$-V_{GS}$ = 1 V
2
3
4
10
$-V_{GS}$ (V)
5
0
10
V_{DS} (V)
20

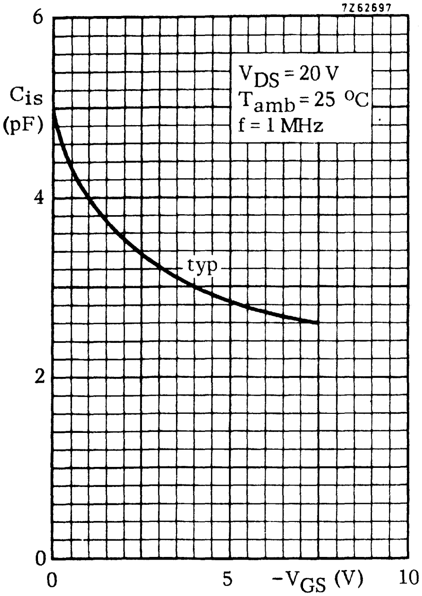

7Z62699 A
BF244C
typ. values
V_{DS} = 15 V
I_D (mA)
20
15
10
5
0
V_{GS} = 0
$-V_{GS}$ = 2 V
4 V
0
50
100
T_j (°C)
150

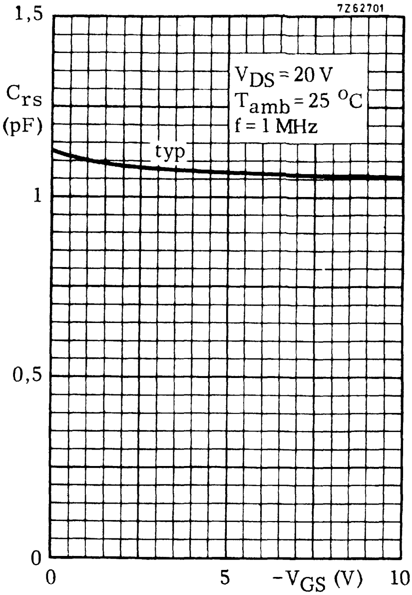

7Z62698
typ. values
$V_{GS} = 0$
$V_{DS} = 15\,V$
$T_{amb} = 25\ ^oC$
g_{is} (μA/V)
b_{is} (mA/V)
g_{is}
b_{is}
10^3
10^2
10
1
10^2
10
1
10^{-1}
10
10^2
f (MHz)
10^3

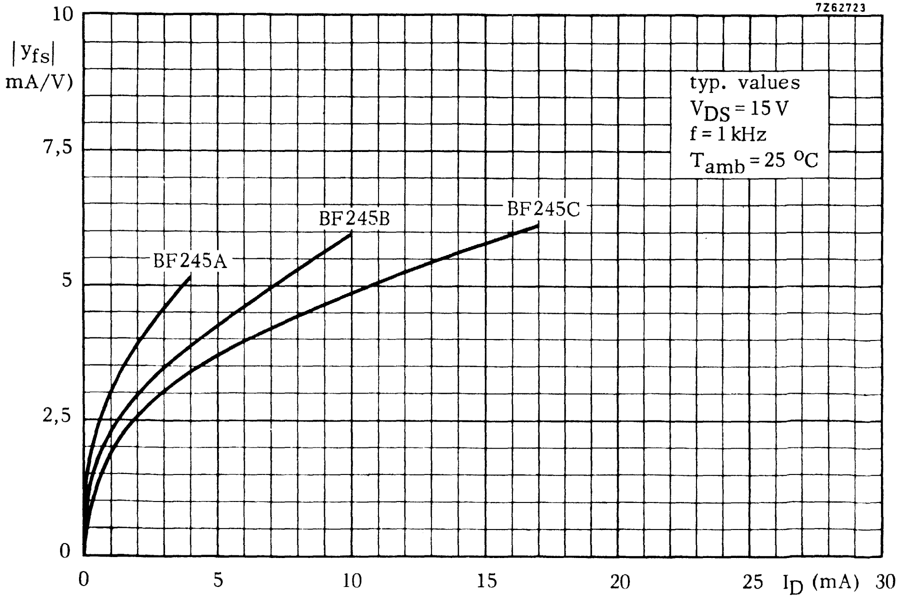

7Z62700
typ. values
$V_{GS} = 0$
$V_{DS} = 15\,V$
$T_{amb} = 25\ ^oC$
b_{rs} (μA/V)
C_{rs} (pF)
C_{rs}
b_{rs}
10^4
10^3
10^2
10
10
1
10^{-1}
10^{-2}
10
10^2
f (MHz)
10^3

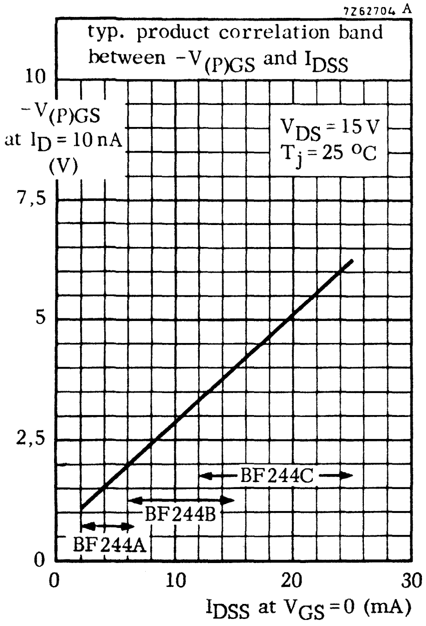

7Z62702
15
10
5
0
g_{fs}
$-b_{fs}$
(mA/V)
typ. values
$V_{GS} = 0$
$V_{DS} = 15$ V
$T_{amb} = 25$ °C
g_{fs}
$-b_{fs}$
10
10^2
f (MHz)
10^3

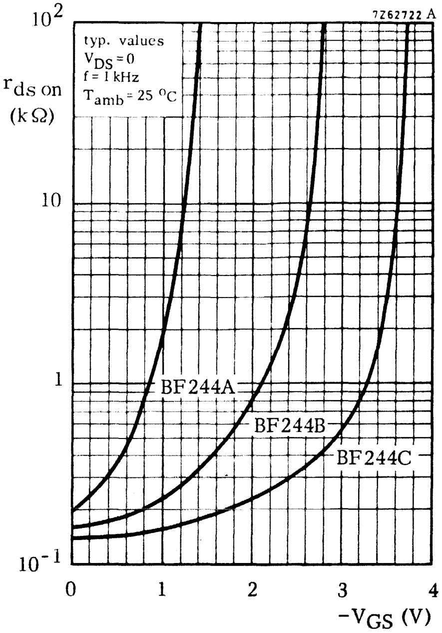

7Z62703
10^3
10^2
10
1
g_{os}
(μA/V)
typ. values
$V_{GS} = 0$
$V_{DS} = 15$ V
$T_{amb} = 25$ °C
b_{os}
g_{os}
10
1
10^{-1}
10^{-2}
b_{os}
(mA/V)
10
10^2
f (MHz)
10^3

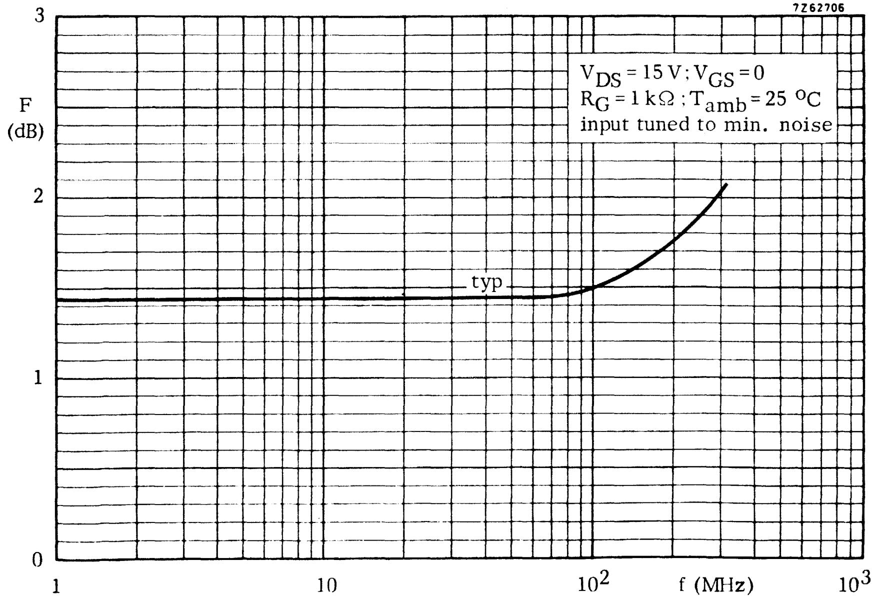

7Z62697
6
4
2
0
C_{is}
(pF)
$V_{DS} = 20$ V
$T_{amb} = 25$ °C
f = 1 MHz
typ
0
5
$-V_{GS}$ (V)
10


7Z62701
1,5
1
0,5
0
C_{rs}
(pF)
$V_{DS} = 20$ V
$T_{amb} = 25$ °C
f = 1 MHz
typ
0
5
$-V_{GS}$ (V)
10


7Z62723
10
$|y_{fs}|$
mA/V)
7,5
5
2,5
0
typ. values
$V_{DS} = 15$ V
f = 1 kHz
$T_{amb} = 25$ °C
BF245A
BF245B
BF245C
0
5
10
15
20
25
I_D (mA)
30


7Z62704 A
typ. product correlation band between $-V_{(P)GS}$ and I_{DSS}
$-V_{(P)GS}$ at $I_D = 10$ nA (V)
$V_{DS} = 15$ V
$T_j = 25$ °C
10
7,5
5
2,5
0
BF244C
BF244B
BF244A
0
10
20
30
I_{DSS} at $V_{GS} = 0$ (mA)


7Z62722 A
10^2
typ. values
$V_{DS} = 0$
f = 1 kHz
$T_{amb} = 25$ °C
$r_{ds\,on}$ (kΩ)
10
1
10^{-1}
BF244A
BF244B
BF244C
0
1
2
3
4
$-V_{GS}$ (V)


7Z62706
3
2
1
0
F (dB)
$V_{DS} = 15$ V; $V_{GS} = 0$
$R_G = 1$ kΩ ; $T_{amb} = 25$ °C
input tuned to min. noise
typ
1
10
10^2
f (MHz)
10^3

N-CHANNEL SILICON FIELD-EFFECT TRANSISTORS

General purpose symmetrical N-channel planar epitaxial junction field-effect transistors in a plastic TO-92 variant; intended for applications in l.f. and d.c. amplifiers, and in h.f. amplifiers.

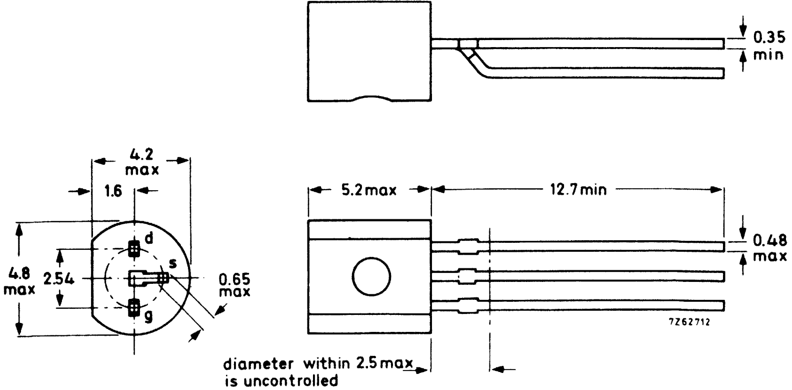
QUICK REFERENCE DATA

Drain-source voltage	$\pm V_{DS}$	max.			30	V
Gate-source voltage (open drain)	$-V_{GSO}$	max.			30	V
Total power dissipation up to T_{amb} = 75 °C	P_{tot}	max.			300	mW
			BF245A	B	C	
Drain current V_{DS} = 15 V; V_{GS} = 0	I_{DSS}	>	2	6,0	12	mA
		<	6,5	15,0	25	mA
Gate-source cut-off voltage I_D = 10 nA; V_{DS} = 15 V	$-V_{(P)GS}$				0,5 to 8,0	V
Feedback capacitance at f = 1 kHz V_{DS} = 20 V; $-V_{GS}$ = 1 V; T_{amb} = 25 °C	C_{rs}	typ.			1,1	pF
Transfer admittance (common source) V_{DS} = 15 V; V_{GS} = 0; f = 1 kHz; T_{amb} = 25 °C	$\lvert y_{fs}\rvert$				3,0 to 6,5	mA/V

MECHANICAL DATA

Dimensions in mm

TO-92 variant



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

Voltages

Drain-source voltage	$\pm V_{DS}$	max.	30	V	
Drain-gate voltage (open source)	V_{DGO}	max.	30	V	
Gate-source voltage (open drain)	$-V_{GSO}$	max.	30	V	

Currents

Drain current	I_D	max.	25	mA	
Gate current	I_G	max.	10	mA	

Power dissipation

Power dissipation up to T_{amb} = 75 °C	P_{tot}	max.	300	mW	
up to T_{amb} = 90 °C	P_{tot}	max.	300	mW	1)

Temperatures

Storage temperature	T_{stg}		−65 to +150	°C	
Junction temperature	T_j	max.	150	°C	

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	0, 25	°C/mW	
From junction to ambient	$R_{th\ j\text{-}a}$	=	0, 20	°C/mW	1)

---

1) Transistor mounted on printed circuit board, max. lead length 3 mm, mounting pad for drain lead minimum 10 mm x 10 mm.

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

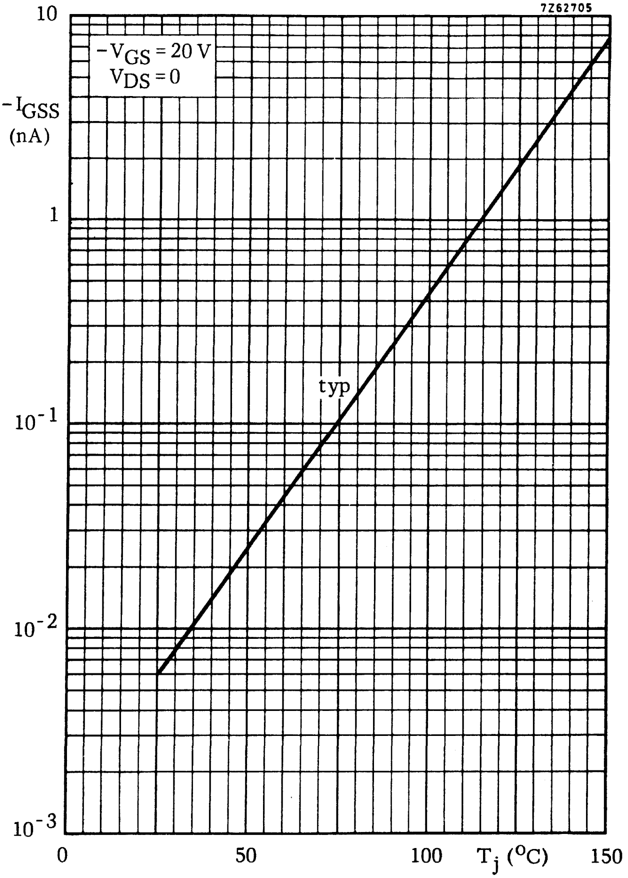
		BF245A	B	C	
Gate cut-off current					
$-V_{GS}$ = 20 V; V_{DS} = 0	$-I_{GSS}$	< 5	5	5	nA
$-V_{GS}$ = 20 V; V_{DS} = 0; T_j = 125 °C	$-I_{GSS}$	< 0,5	0,5	0,5	μA
Drain current [1]					
V_{DS} = 15 V; V_{GS} = 0	I_{DSS}	> 2	6,0	12	mA
		< 6,5	15,0	25	mA
Gate-source breakdown voltage					
$-I_G$ = 1 μA; V_{DS} = 0	$-V_{(BR)GSS}$	> 30	30	30	V
Gate-source voltage					
I_D = 200 μA; V_{DS} = 15 V	$-V_{GS}$	> 0,4	1,6	3,2	V
		< 2,2	3,8	7,5	V

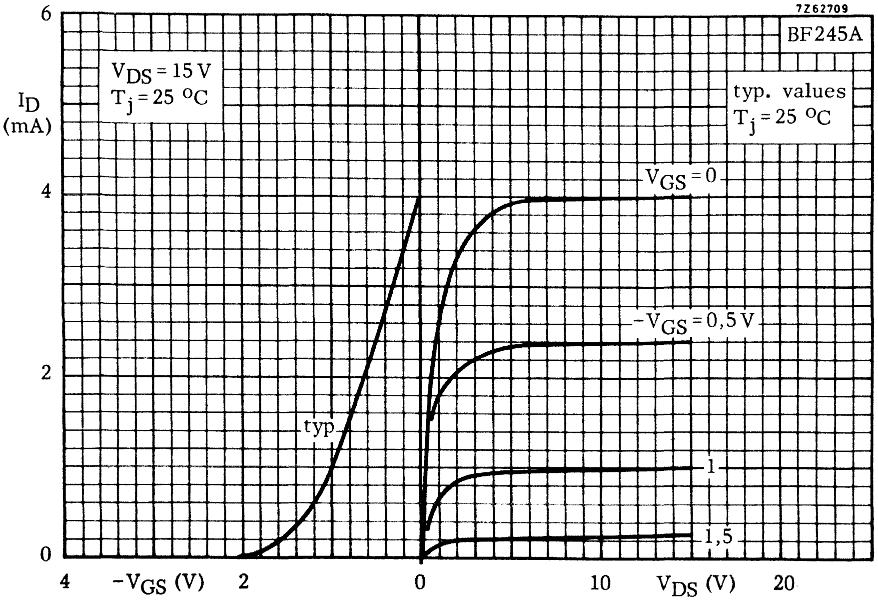
Gate-source cut-off voltage					
I_D = 10 nA; V_{DS} = 15 V		$-V_{(P)GS}$		0,5 to 8,0	V
y-parameters at T_{amb} = 25 °C (common source)					
V_{DS} = 15 V; V_{GS} = 0					
f = 1 kHz	Transfer admittance	$\lvert y_{fs}\rvert$		3,0 to 6,5	mA/V
	Output admittance	$\lvert y_{os}\rvert$	typ.	25	μA/V
f = 200 MHz	Input conductance	g_{is}	typ.	250	μA/V
	Reverse transfer admittance	$\lvert y_{rs}\rvert$	typ.	1,4	mA/V
	Transfer admittance	$\lvert y_{fs}\rvert$	typ.	6	mA/V
	Output conductance	g_{os}	typ.	40	μA/V
V_{DS} = 20 V; $-V_{GS}$ = 1 V					
f = 1 MHz	Input capacitance	C_{is}	typ.	4,0	pF
	Feedback capacitance	C_{rs}	typ.	1,1	pF
	Output capacitance	C_{os}	typ.	1,6	pF
Cut-off frequency [2]					
V_{DS} = 15 V; V_{GS} = 0		f_{gfs}	typ.	700	MHz
Noise figure at f = 100 MHz; R_G = 1 kΩ (common source)					
V_{DS} = 15 V; V_{GS} = 0; T_{amb} = 25 °C input tuned to minimum noise		F	typ.	1,5	dB

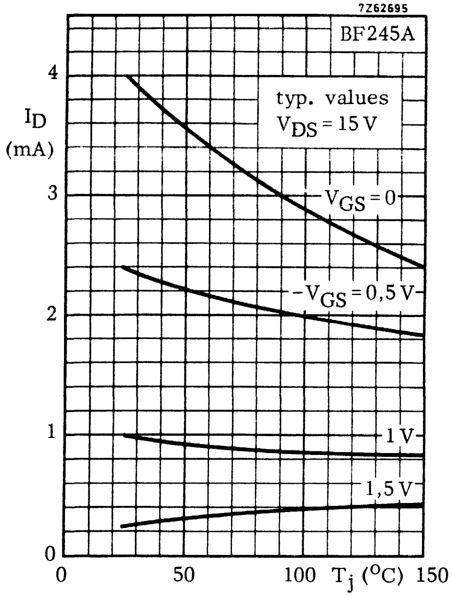
---

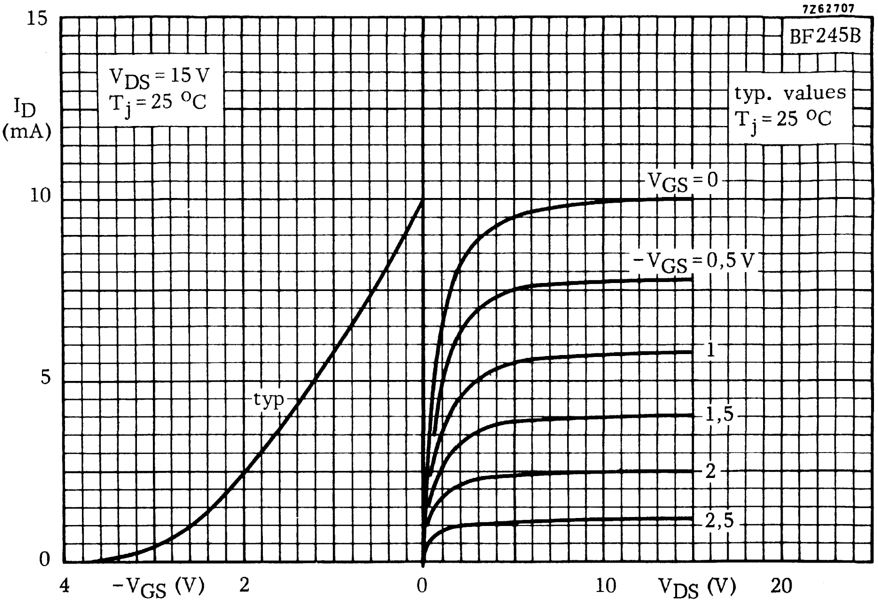
1) Measured under pulse condition: t_p = 300 μs; $\delta \leq 0,02$

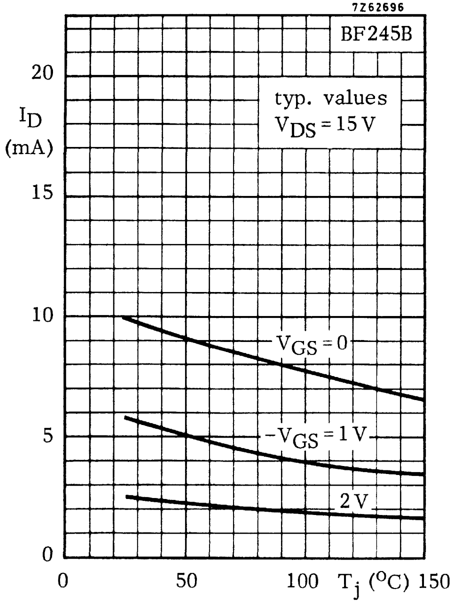
2) The frequency at which g_{fs} is 0,7 of its value at 1 kHz.

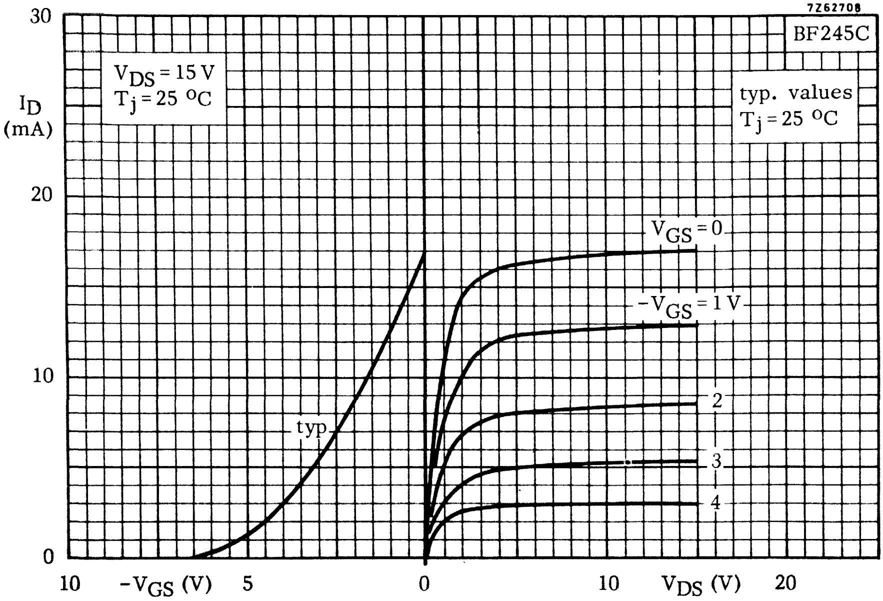

7Z62705
$-V_{GS} = 20$ V
$V_{DS} = 0$
$-I_{GSS}$ (nA)
10
1
10^{-1}
10^{-2}
10^{-3}
typ
0
50
100
T_j (°C)
150

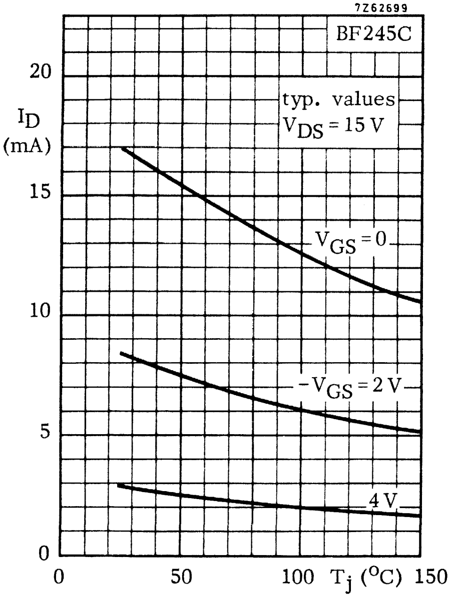

7Z62709
BF245A
V_{DS} = 15 V
T_j = 25 °C
I_D (mA)
typ. values
T_j = 25 °C
V_{GS} = 0
$-V_{GS}$ = 0,5 V
1
1,5
typ
0
2
4
6
4
$-V_{GS}$ (V)
2
0
10
V_{DS} (V)
20

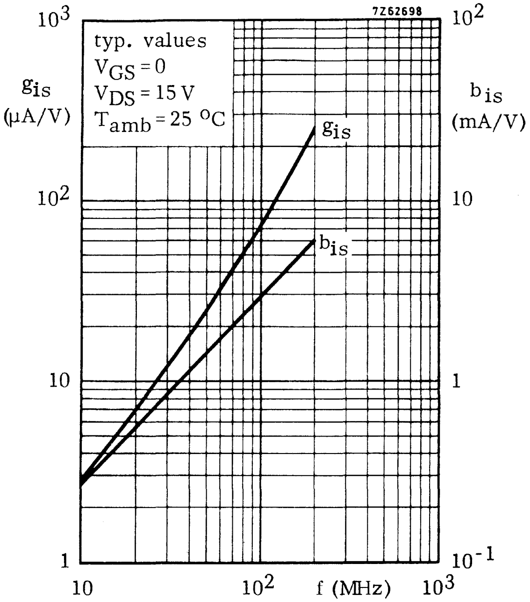

7Z62695
BF245A
typ. values
V_{DS} = 15 V
I_D (mA)
V_{GS} = 0
$-V_{GS}$ = 0,5 V
1 V
1,5 V
0
1
2
3
4
0
50
100
T_j (°C)
150

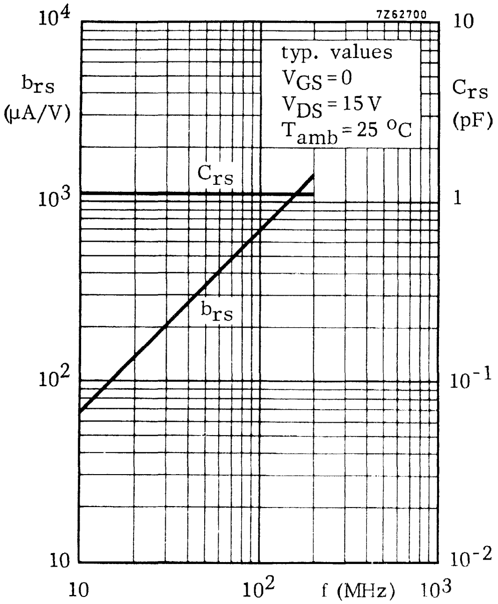

7Z62707
BF245B
V_{DS} = 15 V
T_j = 25 °C
typ. values
T_j = 25 °C
I_D (mA)
15
10
5
0
typ
V_{GS} = 0
$-V_{GS}$ = 0,5 V
1
1,5
2
2,5
4
$-V_{GS}$ (V)
2
0
10
V_{DS} (V)
20

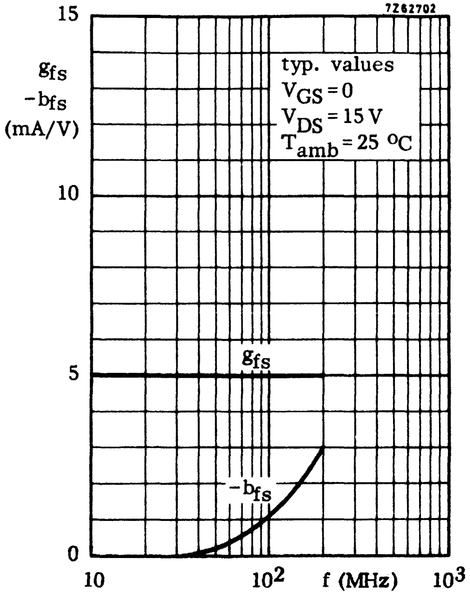

7Z62696
BF245B
typ. values
V_{DS} = 15 V
I_D (mA)
20
15
10
5
0
V_{GS} = 0
$-V_{GS}$ = 1 V
2 V
0
50
100
T_j (°C)
150

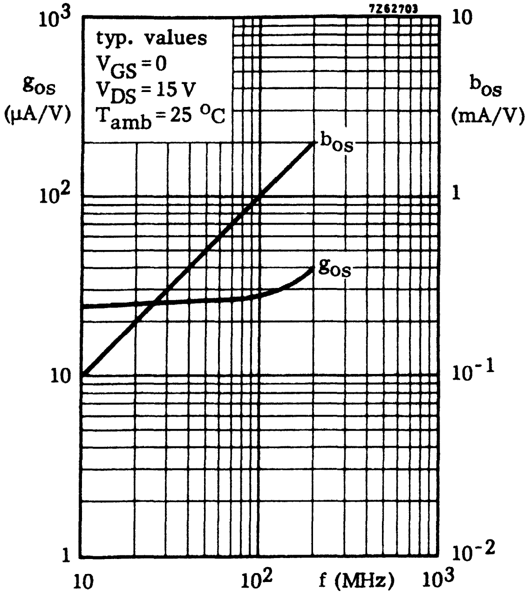

7Z62708
BF245C
V_{DS} = 15 V
T_j = 25 °C
typ. values
T_j = 25 °C
I_D (mA)
30
20
10
0
typ
V_{GS} = 0
$-V_{GS}$ = 1 V
2
3
4
10
$-V_{GS}$ (V)
5
0
10
V_{DS} (V)
20

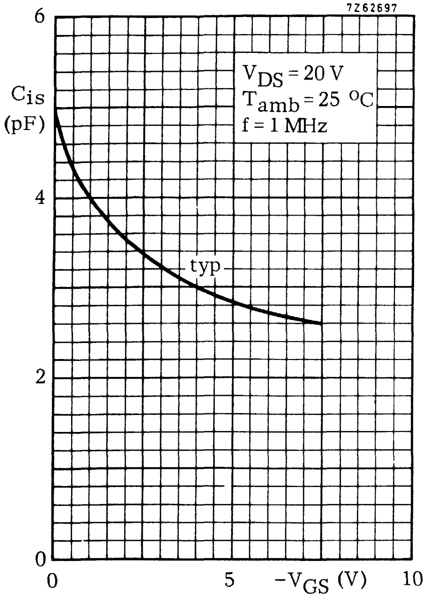

7Z62699
BF245C
typ. values
V_{DS} = 15 V
I_D (mA)
20
15
10
5
0
V_{GS} = 0
$-V_{GS}$ = 2 V
4 V
0
50
100
T_j (°C)
150

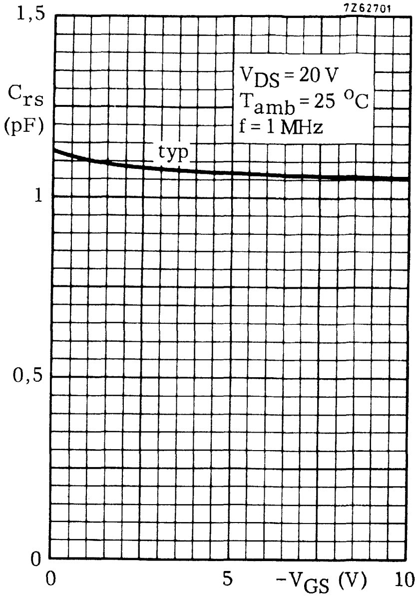

7Z62698
typ. values
$V_{GS} = 0$
$V_{DS} = 15$ V
$T_{amb} = 25$ °C
g_{is} (μA/V)
b_{is} (mA/V)
g_{is}
b_{is}
10^3
10^2
10
1
10^2
10
1
10^{-1}
10
10^2
f (MHz)
10^3

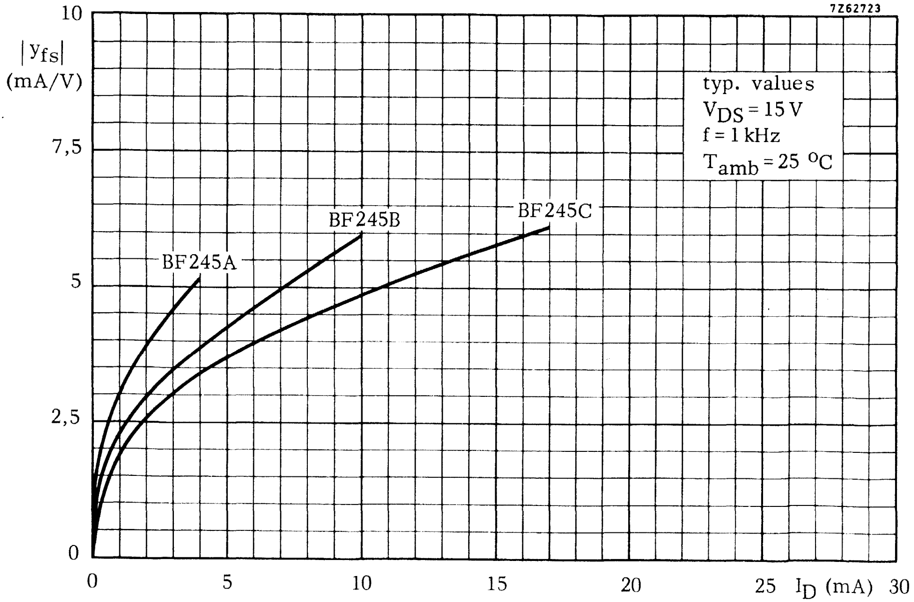

7Z62700
typ. values
$V_{GS} = 0$
$V_{DS} = 15$ V
$T_{amb} = 25$ °C
b_{rs} (μA/V)
C_{rs} (pF)
C_{rs}
b_{rs}
10^4
10^3
10^2
10
10
1
10^{-1}
10^{-2}
10
10^2
f (MHz)
10^3

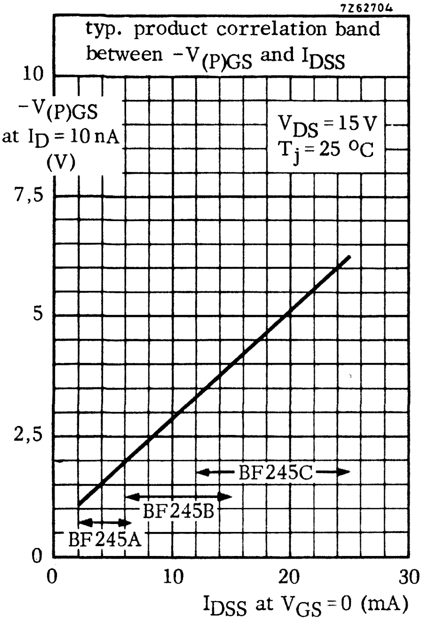

7Z62702
15
g_{fs}
$-b_{fs}$
(mA/V)
10
5
0
typ. values
$V_{GS} = 0$
$V_{DS} = 15$ V
$T_{amb} = 25$ °C
g_{fs}
$-b_{fs}$
10
10^2
f (MHz)
10^3

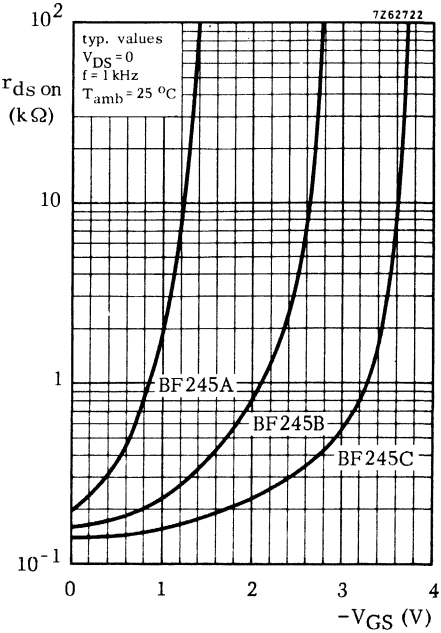

7Z62703
10^3
g_{os}
(μA/V)
10^2
10
1
10
b_{os}
(mA/V)
1
10^{-1}
10^{-2}
typ. values
$V_{GS} = 0$
$V_{DS} = 15$ V
$T_{amb} = 25$ °C
b_{os}
g_{os}
10
10^2
f (MHz)
10^3

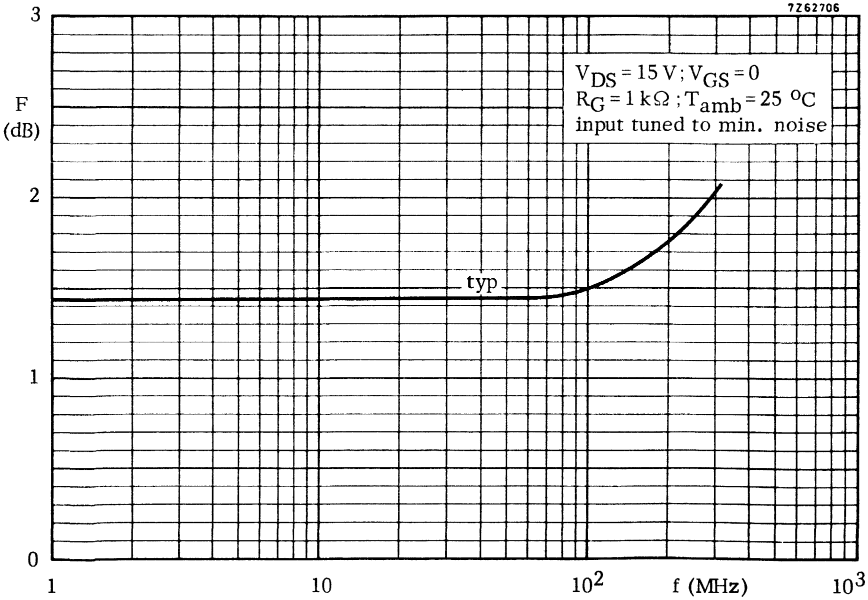

7Z62697
6
4
2
0
Cis
(pF)
V_{DS} = 20 V
T_{amb} = 25 °C
f = 1 MHz
typ
0
5
$-V_{GS}$ (V)
10


7Z62701
1,5
1
0,5
0
Crs
(pF)
V_{DS} = 20 V
T_{amb} = 25 °C
f = 1 MHz
typ
0
5
$-V_{GS}$ (V)
10


7Z62723
10
7,5
5
2,5
0
|yfs|
(mA/V)
typ. values
V_{DS} = 15 V
f = 1 kHz
T_{amb} = 25 °C
BF245A
BF245B
BF245C
0
5
10
15
20
25
I_D (mA)
30


7Z62704
typ. product correlation band between $-V_{(P)GS}$ and I_{DSS}
$-V_{(P)GS}$ at $I_D = 10$ nA (V)
$V_{DS} = 15$ V
$T_j = 25$ °C
10
7,5
5
2,5
0
BF245C
BF245B
BF245A
0
10
20
30
I_{DSS} at $V_{GS} = 0$ (mA)


7Z62722
typ. values
$V_{DS} = 0$
f = 1 kHz
$T_{amb} = 25$ °C
$r_{ds\ on}$ (kΩ)
10^2
10
1
10^{-1}
BF245A
BF245B
BF245C
0
1
2
3
4
$-V_{GS}$ (V)


7Z62706
$V_{DS} = 15$ V; $V_{GS} = 0$
$R_G = 1$ kΩ; $T_{amb} = 25$ °C
input tuned to min. noise
F (dB)
3
2
1
0
typ
1
10
10^2
f (MHz)
10^3

N-CHANNEL SILICON FIELD-EFFECT TRANSISTORS

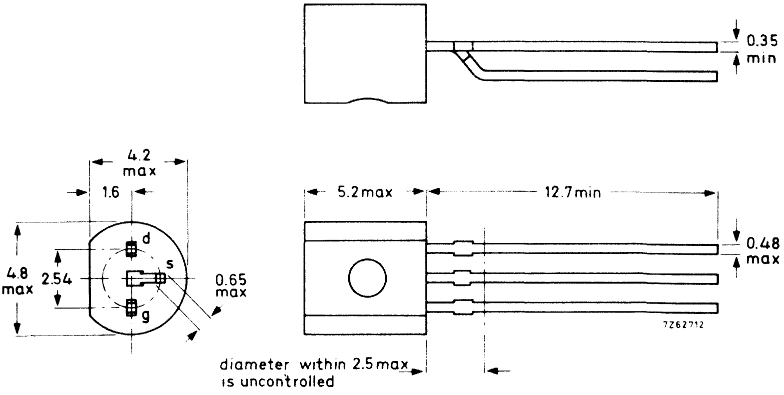
Symmetrical N-channel planar epitaxial junction field-effect transistors in a plastic TO-92 variant; intended for v.h.f. and u.h.f. applications.

QUICK REFERENCE DATA

<table>
<tr><td>Drain-source voltage</td><td>±V_{DS}</td><td>max.</td><td colspan="3">30</td><td>V</td></tr>
<tr><td>Gate-source voltage (open drain)</td><td>$-V_{GSO}$</td><td>max.</td><td colspan="3">30</td><td>V</td></tr>
<tr><td>Total power dissipation up to T_{amb} = 75 °C</td><td>P_{tot}</td><td>max.</td><td colspan="3">300</td><td>mW</td></tr>
<tr><td></td><td></td><td></td><td>BF256A</td><td>B</td><td>C</td><td></td></tr>
<tr><td>Drain current
V_{DS} = 15 V; V_{GS} = 0</td><td>I_{DSS}</td><td>></td><td>3</td><td>6</td><td>11</td><td>mA</td></tr>
<tr><td></td><td></td><td><</td><td>7</td><td>13</td><td>18</td><td>mA</td></tr>
<tr><td>Feedback capacitance at f = 1 MHz
V_{DS} = 20 V; $-V_{GS}$ = 1 V; T_{amb} = 25 °C</td><td>C_{rs}</td><td>typ.</td><td colspan="3">0,7</td><td>pF</td></tr>
<tr><td>Transfer admittance (common source)
V_{DS} = 15 V; V_{GS} = 0; f = 1 kHz; T_{amb} = 25 °C</td><td>$|y_{fs}|$</td><td>></td><td colspan="3">4,5</td><td>mA/V</td></tr>
<tr><td>Power gain at f = 800 MHz
V_{DS} = 15 V; R_S = 47 Ω</td><td>G_p</td><td>typ.</td><td colspan="3">11</td><td>dB</td></tr>
</table>

MECHANICAL DATA Dimensions in mm

TO-92 variant



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

Voltages

Drain-source voltage	$\pm V_{DS}$	max.	30	V	
Drain-gate voltage (open source)	V_{DGO}	max.	30	V	
Gate-source voltage (open drain)	$-V_{GSO}$	max.	30	V	

Current

Gate current	I_G	max.	10	mA	

Power dissipation

Total power dissipation up to T_{amb} = 75 °C	P_{tot}	max.	300	mW	
up to T_{amb} = 90 °C	P_{tot}	max.	300	mW	1)

Temperatures

Storage temperature	T_{stg}	-65 to +150		°C	
Junction temperature	T_j	max.	150	°C	

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	0,25	°C/mW	
From junction to ambient	$R_{th\ j\text{-}a}$	=	0,20	°C/mW	1)

---

1) Transistor mounted on printed circuit board, max. lead length 3 mm, mounting pad for drain lead minimum 10 mm x 10 mm.

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

Gate cut-off current					
$-V_{GS}$ = 20 V; V_{DS} = 0	$-I_{GSS}$	<	5	nA	

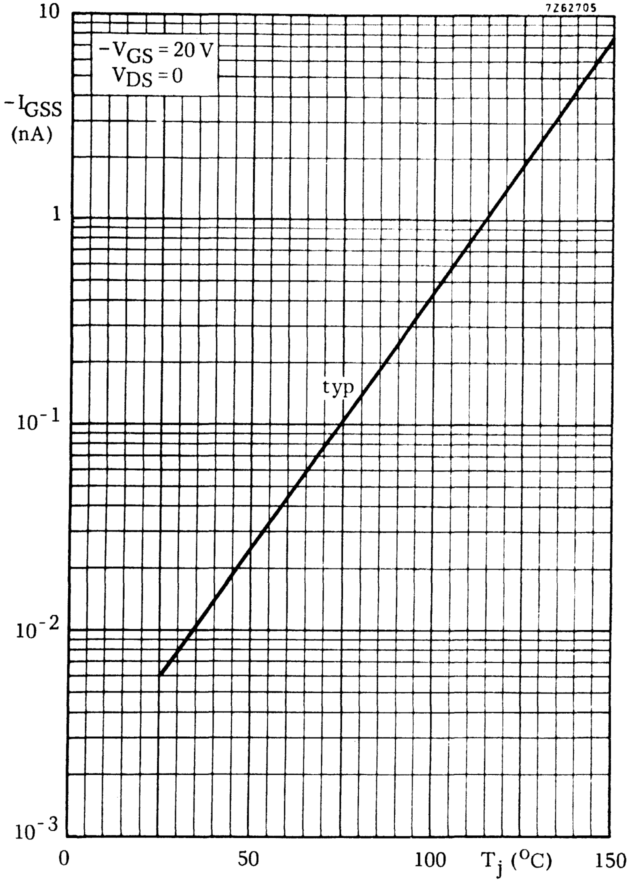
			BF256A	B	C		
Drain current							
V_{DS} = 15 V; V_{GS} = 0	I_{DSS}	>	3	6	11	mA	1)
		<	7	13	18	mA	1)

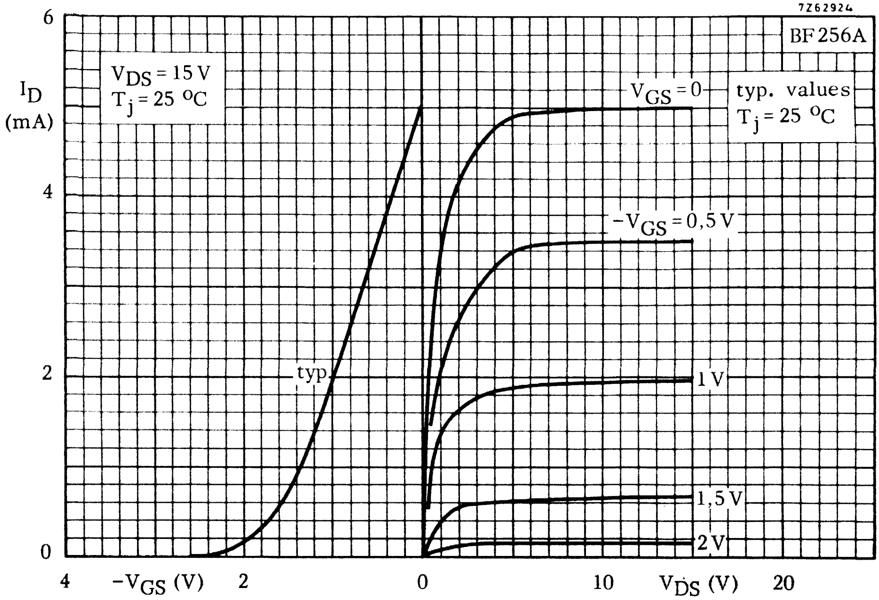
Gate-source breakdown voltage					
$-I_G$ = 1 µA; V_{DS} = 0	$-V_{(BR)GSS}$	>	30	V	
Gate-source voltage					
I_D = 200 µA; V_{DS} = 15 V	$-V_{GS}$		0,5 to 7,5	V	
y-parameters (common source)					
Transfer admittance at f = 1 kHz V_{DS} = 15 V; V_{GS} = 0	$\lvert y_{fs} \rvert$	> typ.	4,5 5	mA/V mA/V	1) 1)
Output capacitance at f = 1 MHz V_{DS} = 20 V; V_{GS} = 0	C_{os}	typ.	1,2	pF	
Feedback capacitance at f = 1 MHz V_{DS} = 20 V; $-V_{GS}$ = 1 V	C_{rs}	typ.	0,7	pF	
Cut-off frequency					
V_{DS} = 15 V; V_{GS} = 0	f_{gfs}	typ.	1	GHz	2)
Noise figure at f = 800 MHz					
V_{DS} = 10 V; R_S = 47 Ω	F	typ.	7,5	dB	
Power gain at f = 800 MHz					
V_{DS} = 15 V; R_S = 47 Ω	G_p	typ.	11	dB	

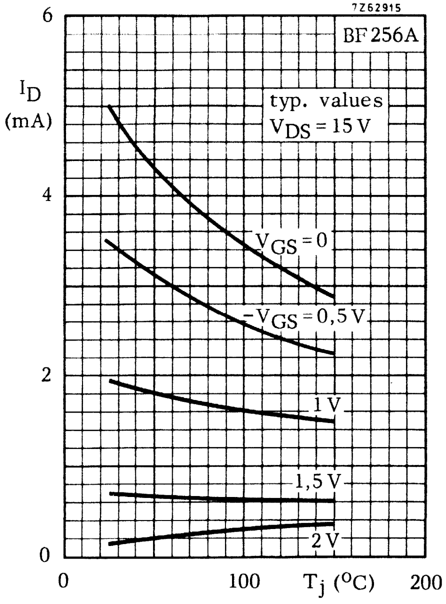
---

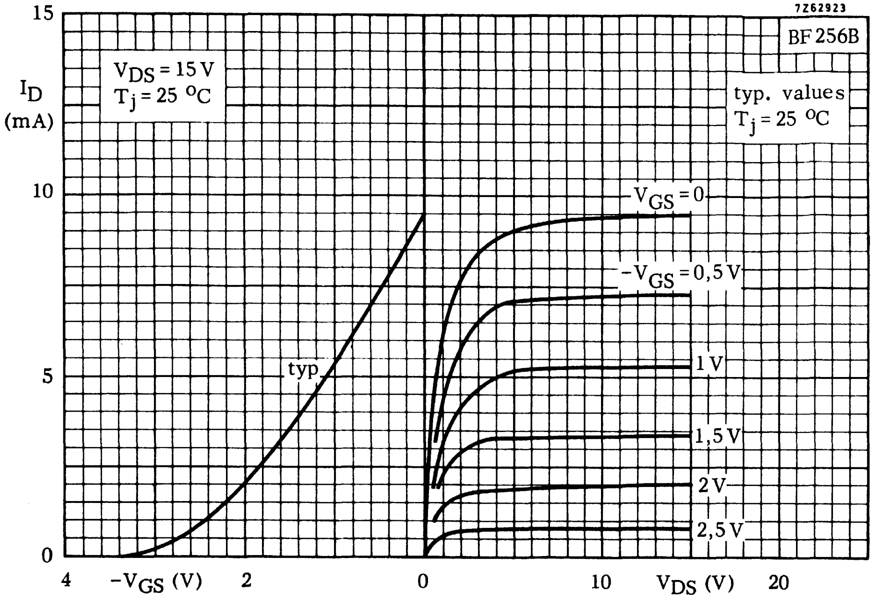
1) Measured under pulse conditions: t_p = 300 µs; $\delta \leq 0{,}02$

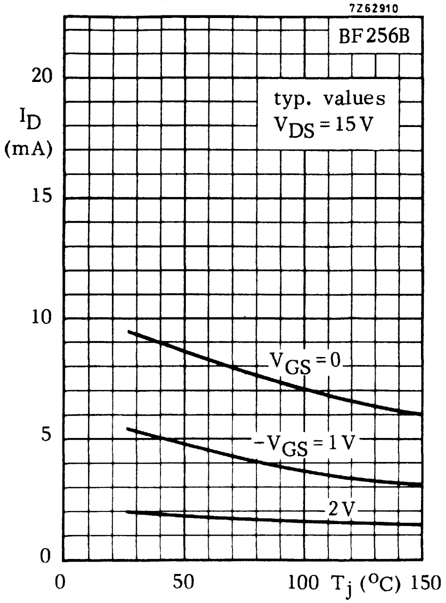
2) The frequency at which g_{fs} is 0,7 of its value at 1 kHz.

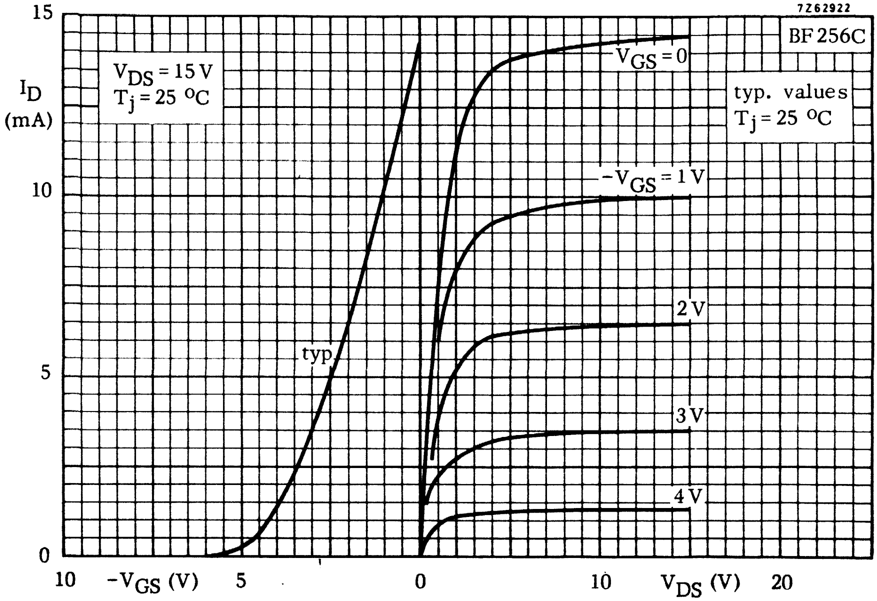

7Z62705
$-V_{GS} = 20$ V
$V_{DS} = 0$
$-I_{GSS}$ (nA)
10
1
10^{-1}
10^{-2}
10^{-3}
typ
0
50
100
T_j (°C)
150

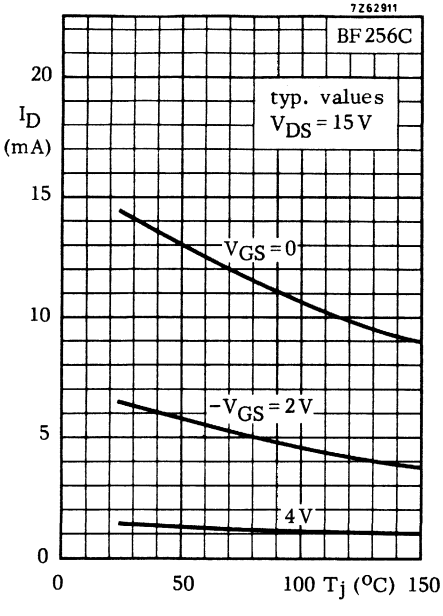

7Z62924
BF256A
6
4
2
0
I_D (mA)
V_{DS} = 15 V
T_j = 25 °C
typ.
V_{GS} = 0
$-V_{GS}$ = 0,5 V
1 V
1,5 V
2 V
typ. values
T_j = 25 °C
4
$-V_{GS}$ (V)
2
0
10
V_{DS} (V)
20

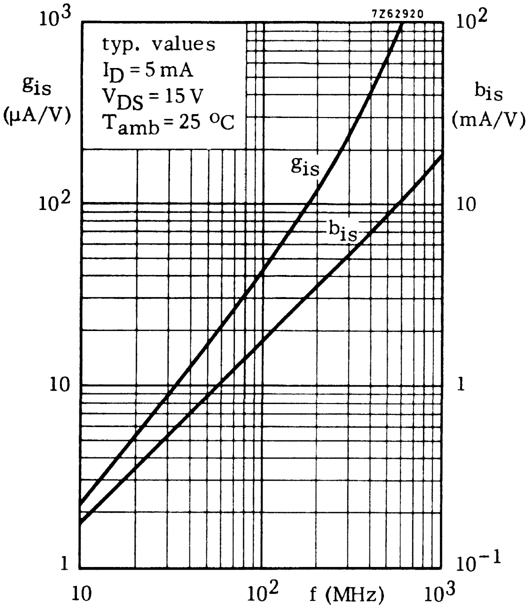

7Z62915
BF256A
6
4
2
0
I_D (mA)
typ. values
V_{DS} = 15 V
V_{GS} = 0
$-V_{GS}$ = 0,5 V
1 V
1,5 V
2 V
0
100
T_j (°C)
200

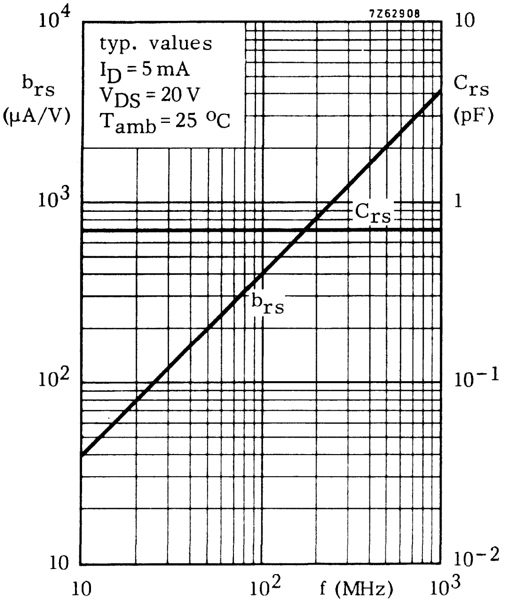

7Z62923
BF256B
V_{DS} = 15 V
T_j = 25 °C
I_D (mA)
15
10
5
0
typ
typ. values
T_j = 25 °C
V_{GS} = 0
$-V_{GS}$ = 0,5 V
1 V
1,5 V
2 V
2,5 V
4
$-V_{GS}$ (V)
2
0
10
V_{DS} (V)
20

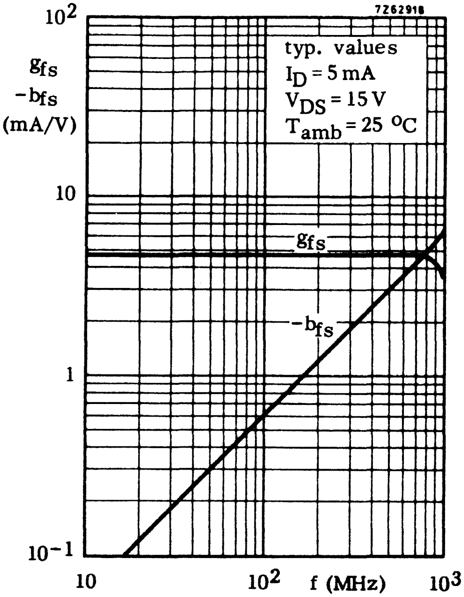

7Z62910
BF256B
typ. values
V_{DS} = 15 V
I_D (mA)
20
15
10
5
0
V_{GS} = 0
$-V_{GS}$ = 1 V
2 V
0
50
100
T_j (°C)
150

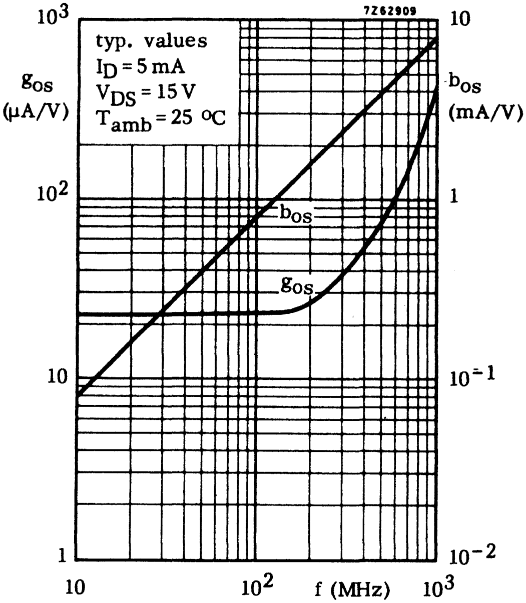

7Z62922
BF256C
V_{DS} = 15 V
T_j = 25 °C
typ. values
T_j = 25 °C
I_D (mA)
15
10
5
0
typ
V_{GS} = 0
$-V_{GS}$ = 1 V
2 V
3 V
4 V
10
$-V_{GS}$ (V)
5
0
10
V_{DS} (V)
20

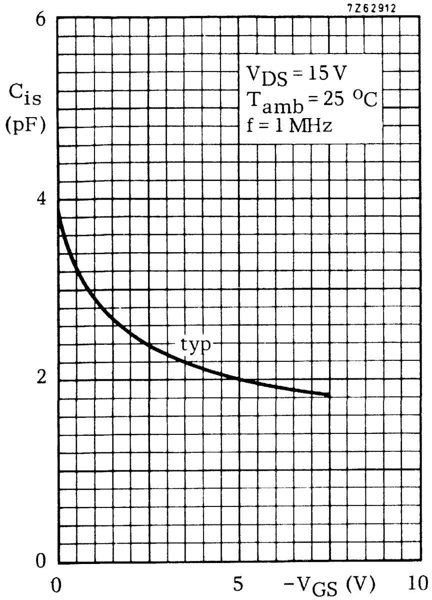

7Z62911
BF256C
typ. values
V_{DS} = 15 V
I_D (mA)
20
15
10
5
0
V_{GS} = 0
$-V_{GS}$ = 2 V
4 V
0
50
100 T_j (°C) 150

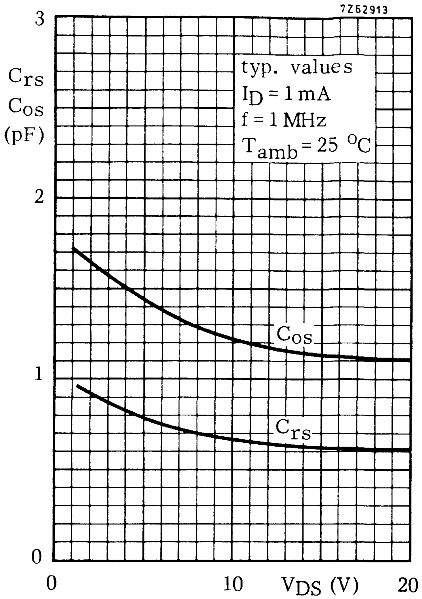

7Z62920
typ. values
$I_D = 5$ mA
$V_{DS} = 15$ V
$T_{amb} = 25$ °C
g_{is} (μA/V)
b_{is} (mA/V)
g_{is}
b_{is}
10^3
10^2
10
1
10^2
10
1
10^{-1}
10
10^2
f (MHz)
10^3

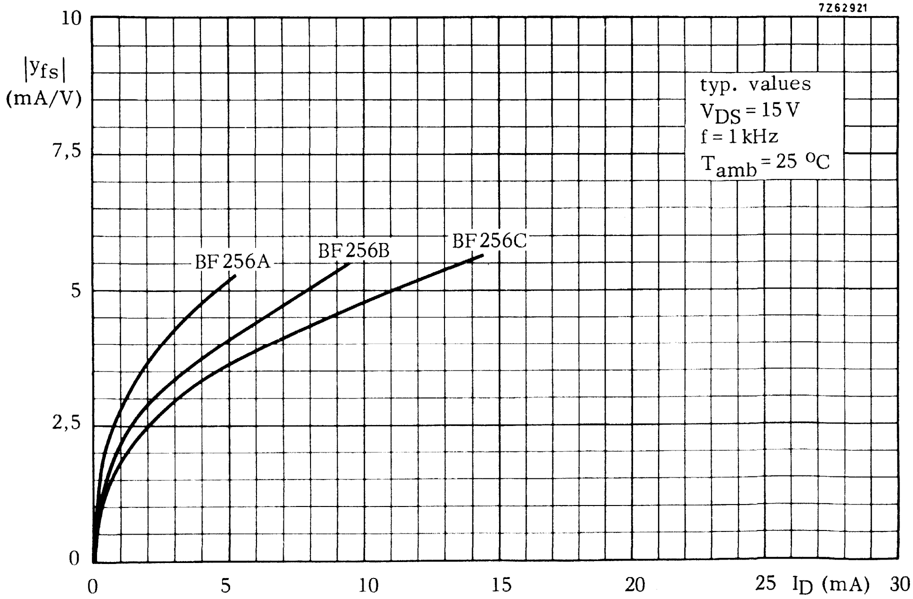

7Z62908
typ. values
$I_D = 5$ mA
$V_{DS} = 20$ V
$T_{amb} = 25$ °C
b_{rs} (μA/V)
C_{rs} (pF)
C_{rs}
b_{rs}
10^4
10^3
10^2
10
10
1
10^{-1}
10^{-2}
10
10^2
f (MHz)
10^3

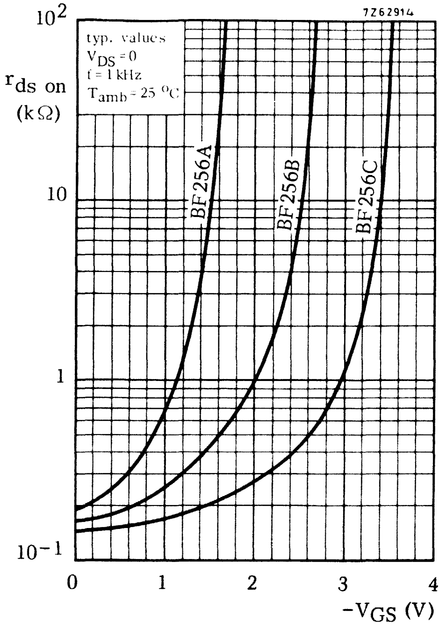

7Z62918
typ. values
$I_D = 5$ mA
$V_{DS} = 15$ V
$T_{amb} = 25$ °C
g_{fs}
$-b_{fs}$
(mA/V)
10^2
10
1
10^{-1}
g_{fs}
$-b_{fs}$
10
10^2
f (MHz)
10^3

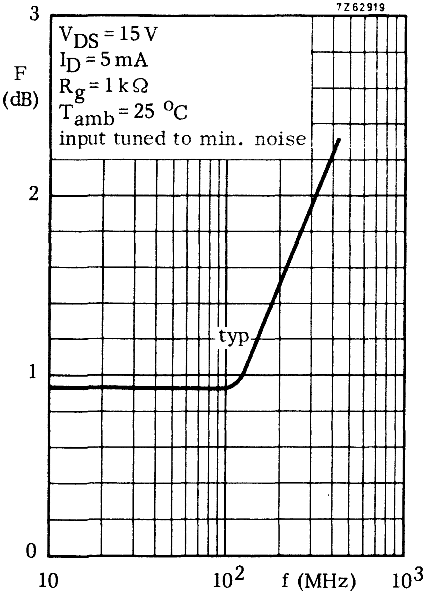

7Z62909
typ. values
$I_D = 5$ mA
$V_{DS} = 15$ V
$T_{amb} = 25$ °C
g_{os}
(µA/V)
10^3
10^2
10
1
b_{os}
(mA/V)
10
1
10^{-1}
10^{-2}
b_{os}
g_{os}
10
10^2
f (MHz)
10^3

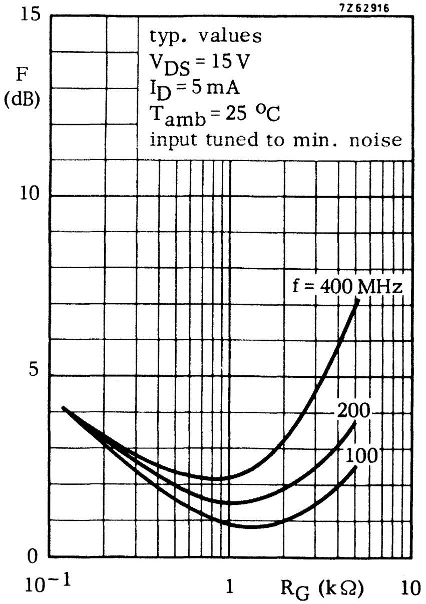

7Z62912
C_{is} (pF)
V_{DS} = 15 V
T_{amb} = 25 °C
f = 1 MHz
typ
6
4
2
0
0
5
$-V_{GS}$ (V)
10


7Z62913
C_{rs} C_{os} (pF)
typ. values
I_D = 1 mA
f = 1 MHz
T_{amb} = 25 °C
C_{os}
C_{rs}
3
2
1
0
0
10
V_{DS} (V)
20


7Z62921
$|y_{fs}|$ (mA/V)
typ. values
V_{DS} = 15 V
f = 1 kHz
T_{amb} = 25 °C
BF256A
BF256B
BF256C
10
7,5
5
2,5
0
0
5
10
15
20
25
I_D (mA)
30


7Z62914
typ. values
$V_{DS} = 0$
$f = 1$ kHz
$T_{amb} = 25$ °C
$r_{ds\ on}$ (kΩ)
10^2
10
1
10^{-1}
BF256A
BF256B
BF256C
0
1
2
3
4
$-V_{GS}$ (V)


7Z62919
$V_{DS} = 15$ V
$I_D = 5$ mA
$R_g = 1$ kΩ
$T_{amb} = 25$ °C
input tuned to min. noise
F (dB)
3
2
1
0
typ
10
10^2
f (MHz)
10^3


7Z62916
typ. values
$V_{DS} = 15$ V
$I_D = 5$ mA
$T_{amb} = 25$ °C
input tuned to min. noise
F (dB)
15
10
5
0
f = 400 MHz
200
100
10^{-1}
1
R_G (kΩ)
10

DUAL N-CHANNEL FETs

Dual n-channel silicon planar epitaxial junction field-effect transistors in TO-71 metal envelope, with electrically insulated gates and a common substrate connected to the envelope; intended for high performance low level differential amplifiers.

QUICK REFERENCE DATA

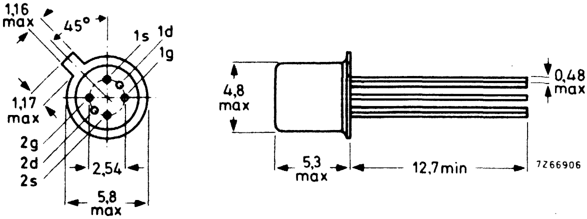
Characteristics measured at T_{amb} = 25 °C; I_D = 200 µA; V_{DG} = 15 V

			BFQ10	11	12	13	14	15	16	
Difference in gate current	$\lvert\Delta I_G\rvert$	<	10	10	10	10	10	10	10	pA
Gate-source voltage difference	$\lvert\Delta V_{GS}\rvert$	<	5	10	10	10	15	20	50	mV
Thermal drift of gate-source voltage difference	$\left\lvert\frac{d\,\Delta V_{GS}}{dT}\right\rvert$	<	5	5	10	20	20	40	50	µV/°C
Transfer conductance ratio	$\frac{g_{1fs}}{g_{2fs}}$	> <	0,98 1,02	0,98 1,02	0,98 1,02	0,98 1,02	0,98 1,02	0,95 1,05	0,95 1,05	
Difference in transfer impedance	$\left\lvert\Delta\frac{1}{g_{fs}}\right\rvert$	<	6	6	12	12	12	20	30	Ω
Difference in penetration factor	$\left\lvert\Delta\frac{g_{os}}{g_{fs}}\right\rvert$	<	10	30	30	30	30	30	100	µV/V
Common mode rejection ratio	CMRR	>	100	90	90	90	90	90	80	dB

MECHANICAL DATA

Dimensions in mm

TO-71
All leads insulated
from the case



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

Voltages

Drain-source voltage	$\pm V_{DS}$	max.	30	V
Drain-gate voltage (open source)	V_{DGO}	max.	30	V
Gate-source voltage (open drain)	$-V_{GSO}$	max.	30	V
Voltage between gate 1 and gate 2	$\pm V_{1G-2G}$	max.	40	V

Currents

Drain current	I_D	max.	30	mA
Gate current	I_G	max.	10	mA

Power dissipation

Total power dissipation up to T_{amb} = 75 °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	$R_{th\ j-a}$	=	0,5	°C/mW

CHARACTERISTICS (total device) $T_{amb} = 25\ ^{o}C$ unless otherwise specified

Measured at: $I_D = 200\ \mu A$; $V_{DG} = 15\ V$ except for drain current ratio.

			BFQ10	11	12	13	14	15	16	
Drain current ratio 1) $V_{DG} = 15\ V$; $V_{GS} = 0$	$\frac{I_{1D-1SS}}{I_{2D-2SS}}$	>	0,97	0,95	0,95	0,95	0,92	0,90	0,80	
		<	1,03	1,05	1,05	1,05	1,08	1,10	1,20	
Difference in gate current	$\lvert \Delta I_G \rvert$	<	10	10	10	10	10	10	10	pA
Gate-source voltage difference	$\lvert \Delta V_{GS} \rvert$	<	5	10	10	10	15	20	50	mV
Thermal drift of gate-source voltage difference	$\left\lvert \frac{d\ \Delta V_{GS}}{dT} \right\rvert$	<	5	5	10	20	20	40	50	$\mu V/^{o}C$
Transfer conductance ratio	$\frac{g_{1fs}}{g_{2fs}}$	>	0,98	0,98	0,98	0,98	0,98	0,95	0,95	
		<	1,02	1,02	1,02	1,02	1,02	1,05	1,05	
Difference in transfer impedance 2)	$\left\lvert \Delta \frac{1}{g_{fs}} \right\rvert$	<	6	6	12	12	12	20	30	Ω
Difference in penetration factor 3)	$\left\lvert \Delta \frac{g_{os}}{g_{fs}} \right\rvert$	<	10	30	30	30	30	30	100	$\mu V/V$
Common mode rejection ratio 4)	CMRR	>	100	90	90	90	90	90	80	dB

---

1) Measured under pulse conditions.

2) The difference in transfer impedance is equal to the ratio of the change of the gate-source voltage difference to the change of drain current, at constant drain-gate voltage.

$$\left(\Delta \frac{1}{g_{fs}} = \frac{d\ \Delta V_{GS}}{d\ I_D} \text{ at } V_{DG} = \text{constant}\right)$$

3) The difference in penetration factor is equal to the ratio of the change of the gate-source voltage difference to the change of drain-gate voltage, at constant drain current.

$$\left(\Delta \frac{g_{os}}{g_{fs}} = \frac{d\ \Delta V_{GS}}{d\ V_{DG}} \text{ at } I_D = \text{constant}\right)$$

4) Common mode rejection ratio

$$\text{CMRR (in dB)} = -20 \log \left\lvert \Delta \frac{g_{os}}{g_{fs}} \right\rvert$$

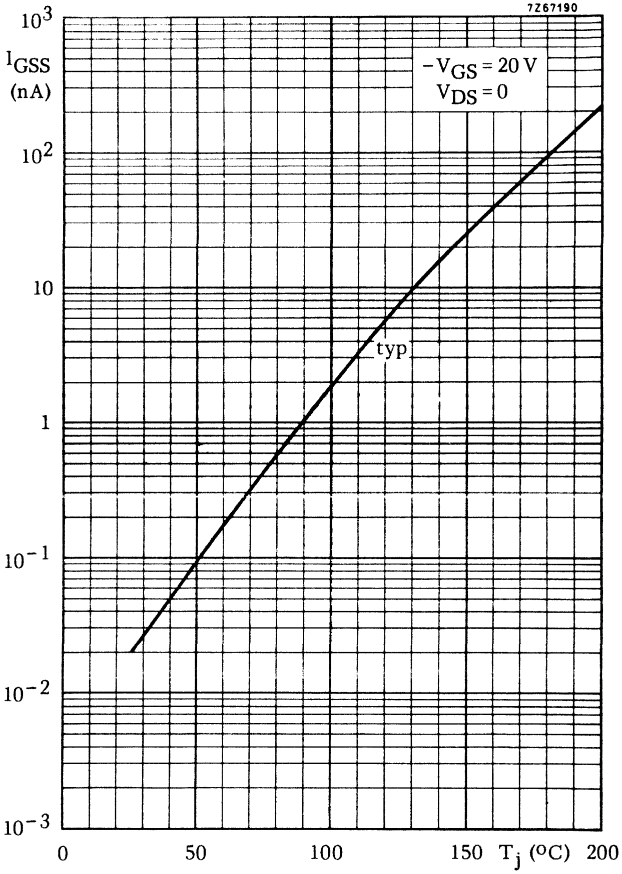
CHARACTERISTICS (Individual transistor) T_{amb} = 25 °C unless otherwise specified

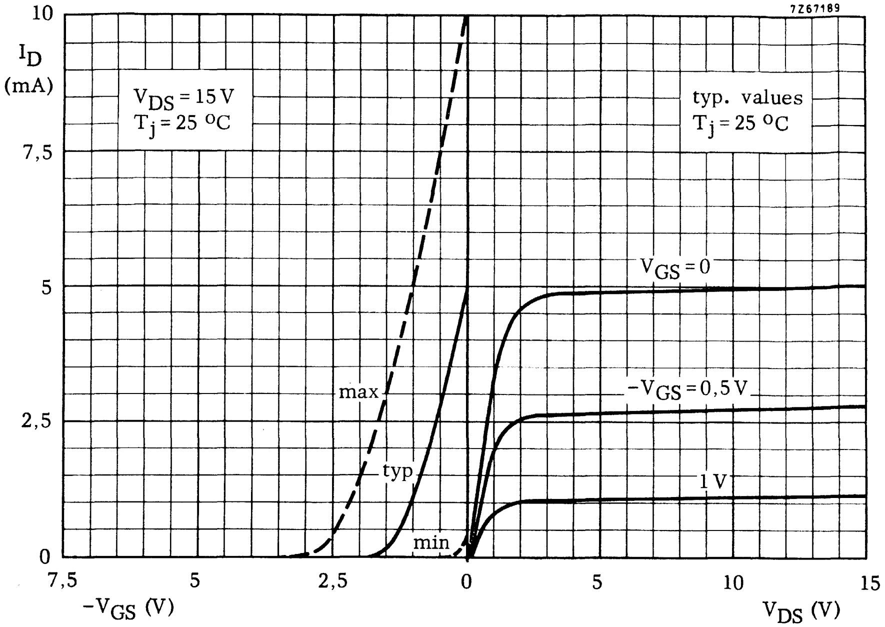
Gate cut-off current				
$-V_{GS}$ = 20 V; V_{DS} = 0	$-I_{GSS}$	<	100	pA
$-V_{GS}$ = 20 V; V_{DS} = 0; T_{amb} = 125 °C	$-I_{GSS}$	<	20	nA
Gate current				
I_D = 200 μA; V_{DG} = 15 V; T_{amb} = 125 °C	I_G	<	10	nA
Drain current				
V_{DS} = 15 V; V_{GS} = 0	I_{DSS}		0,5 to 10	mA [1]
Gate-source voltage				
I_D = 200 μA; V_{DG} = 15 V	$-V_{GS}$	<	2,7	V
Gate-source cut-off voltage				
I_D = 1 nA; V_{DG} = 15 V	$-V_{(P)GS}$		0,5 to 3,5	V
Transfer conductance at f = 1 kHz				
I_D = 200 μA; V_{DG} = 15 V	g_{fs}	>	1,0	mA/V
Output conductance at f = 1 kHz				
I_D = 200 μA; V_{DG} = 15 V	g_{os}	<	5	μA/V
Input capacitance at f = 1 MHz				
I_D = 200 μA; V_{DG} = 15 V	C_{is}	<	8	pF [2]
Feedback capacitance at f = 1 MHz				
I_D = 200 μA; V_{DG} = 15 V	C_{rs}	<	1,0	pF [2]
Equivalent noise voltage				
I_D = 200 μA; V_{DS} = 15 V B = 0,6 to 100 Hz	V_n	<	0,5	μV

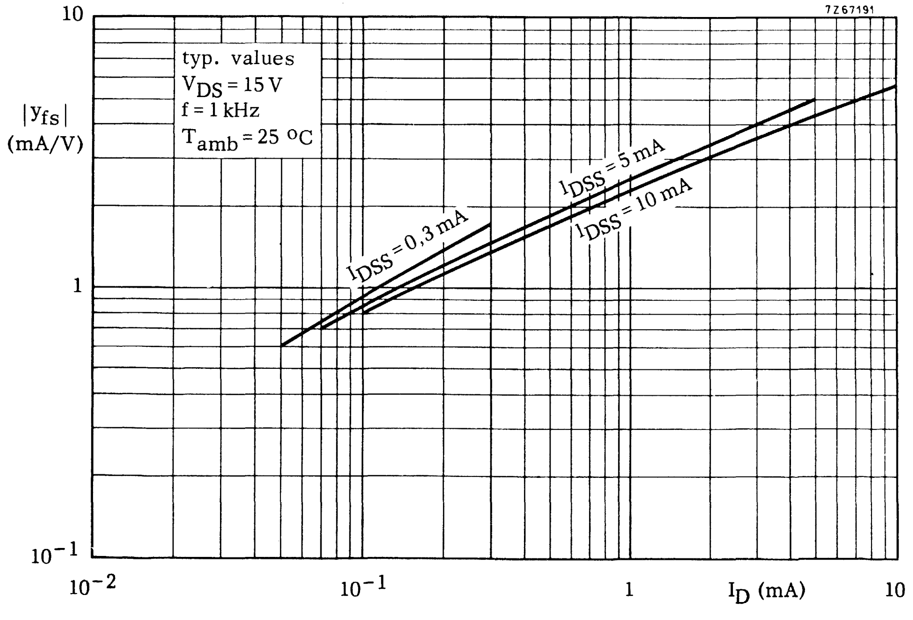
---

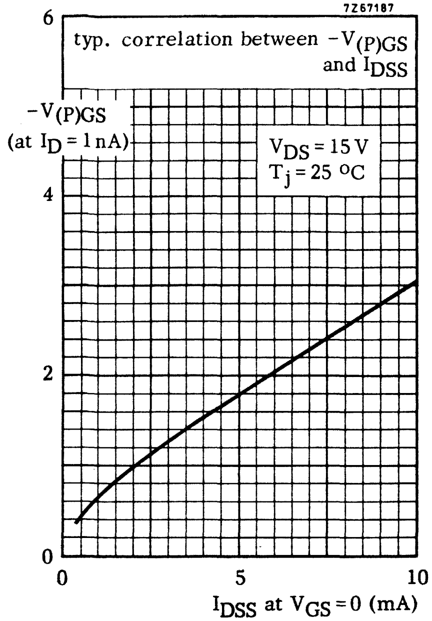
[1] Measured under pulse conditions.

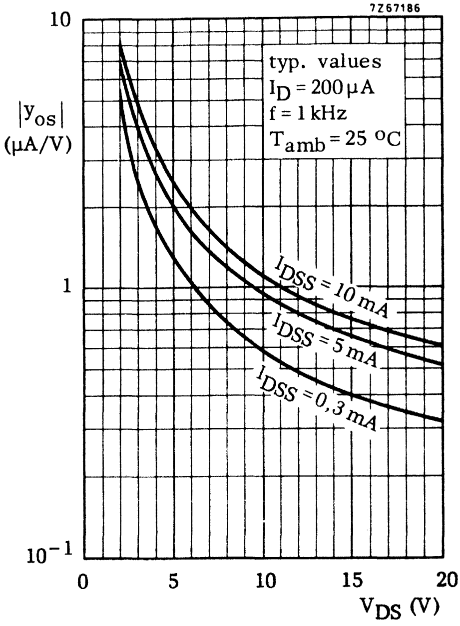
[2] Measured with case grounded.

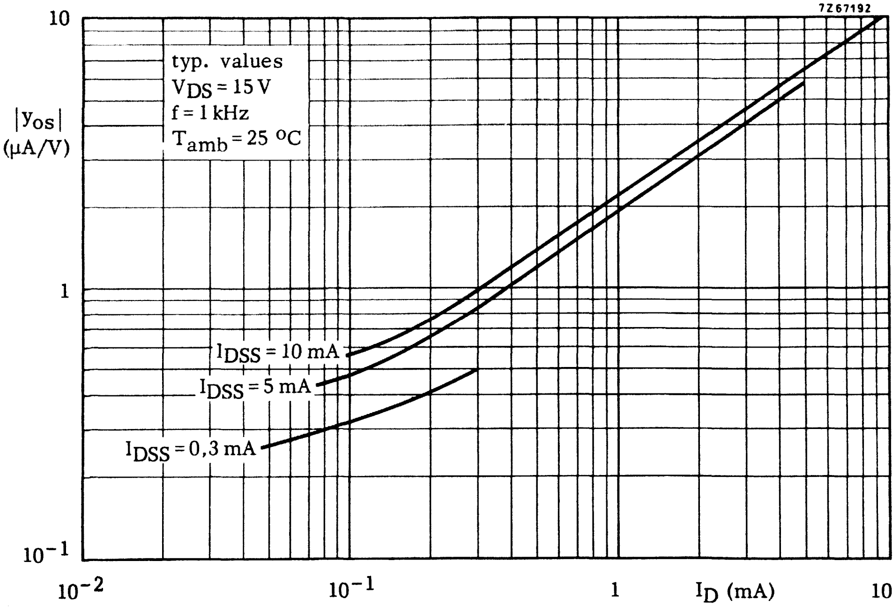

7Z67190
10^3
I_{GSS}
(nA)
10^2
10
1
10^{-1}
10^{-2}
10^{-3}
$-V_{GS} = 20$ V
$V_{DS} = 0$
typ
0
50
100
150
T_j (°C)
200

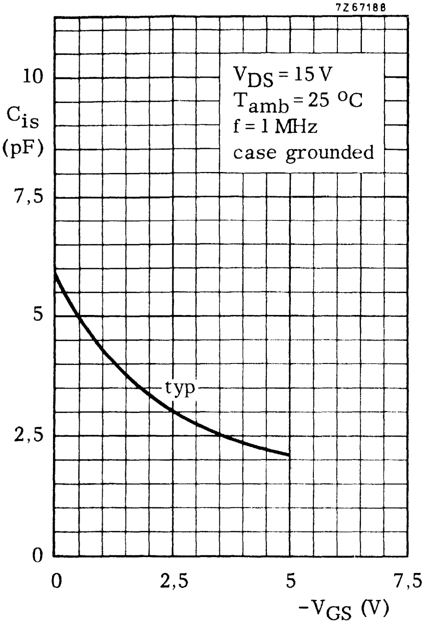

7Z67189
10
I_D
(mA)
7,5
5
2,5
0
$V_{DS} = 15$ V
$T_j = 25$ °C
typ. values
$T_j = 25$ °C
$V_{GS} = 0$
$-V_{GS} = 0{,}5$ V
1 V
max
typ
min
7,5
5
2,5
0
5
10
15
$-V_{GS}$ (V)
V_{DS} (V)

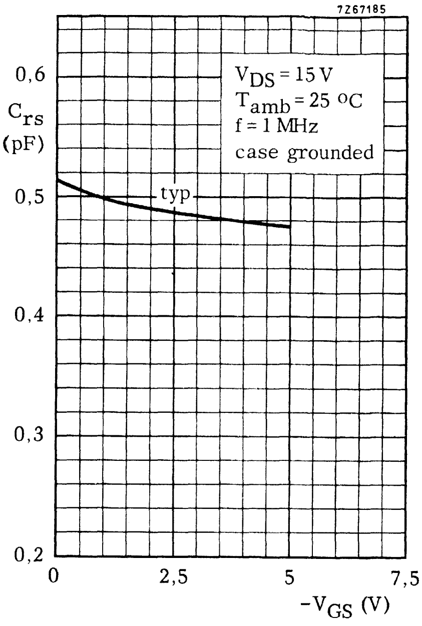

7Z67191
10
1
10^{-1}
$|y_{fs}|$
(mA/V)
typ. values
$V_{DS} = 15$ V
f = 1 kHz
$T_{amb} = 25$ °C
$I_{DSS} = 0{,}3$ mA
$I_{DSS} = 5$ mA
$I_{DSS} = 10$ mA
10^{-2}
10^{-1}
1
I_D (mA)
10

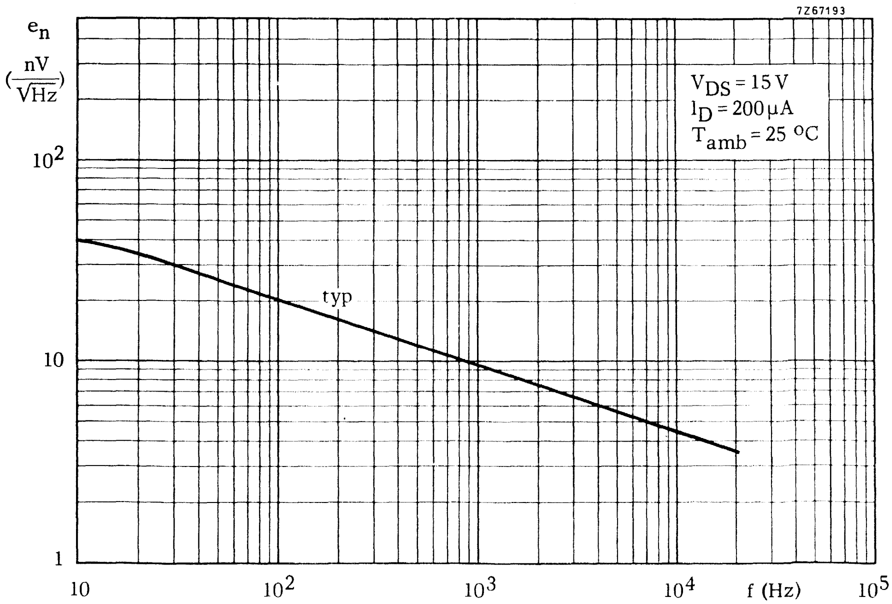

7Z67187
typ. correlation between $-V_{(P)GS}$ and I_{DSS}
$-V_{(P)GS}$ (at I_D = 1 nA)
V_{DS} = 15 V
T_j = 25 °C
6
4
2
0
0
5
10
I_{DSS} at V_{GS} = 0 (mA)


7Z67186
typ. values
I_D = 200 μA
f = 1 kHz
T_{amb} = 25 °C
$|y_{os}|$ (μA/V)
10
1
10^{-1}
I_{DSS} = 10 mA
I_{DSS} = 5 mA
I_{DSS} = 0,3 mA
0
5
10
15
20
V_{DS} (V)


7Z67192
typ. values
V_{DS} = 15 V
f = 1 kHz
T_{amb} = 25 °C
$|y_{os}|$ (μA/V)
10
1
10^{-1}
I_{DSS} = 10 mA
I_{DSS} = 5 mA
I_{DSS} = 0,3 mA
10^{-2}
10^{-1}
1
I_D (mA)
10


7Z67188
10
7,5
5
2,5
0
C_{is}
(pF)
V_{DS} = 15 V
T_{amb} = 25 °C
f = 1 MHz
case grounded
typ
0
2,5
5
7,5
$-V_{GS}$ (V)


7Z67185
0,6
0,5
0,4
0,3
0,2
C_{rs}
(pF)
V_{DS} = 15 V
T_{amb} = 25 °C
f = 1 MHz
case grounded
typ
0
2,5
5
7,5
$-V_{GS}$ (V)


7Z67193
e_n
$(\frac{nV}{\sqrt{Hz}})$
10^2
10
1
V_{DS} = 15 V
I_D = 200 µA
T_{amb} = 25 °C
typ
10
10^2
10^3
10^4
f (Hz)
10^5

N-CHANNEL INSULATED GATE FIELD EFFECT TRANSISTOR

Depletion type insulated gate field effect transistor in a TO-72 metal envelope with the substrate connected to the case.

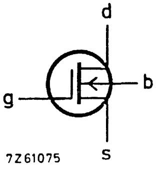
It is intended for linear applications in the audio as well as the i.f. and v.h.f. frequency region, and in cases where high input impedance, low gate leakage currents and low noise figures are of importance.

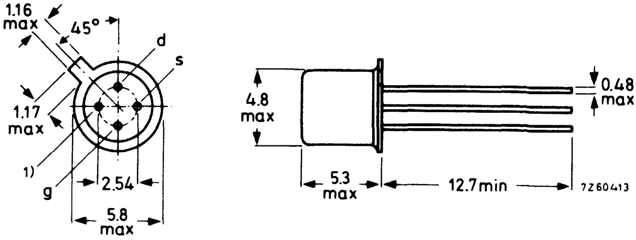
QUICK REFERENCE DATA				
Drain-substrate voltage	V_{DB}	max.	30	V
Gate-substrate voltage	V_{GB}	max. min.	10 −10	V V
Drain current V_{DS} = 15 V; V_{GS} = 0	I_{DSS}	10 to	40	mA
Transfer admittance I_D = 5 mA; V_{DS} = 15 V; f = 1 kHz	$\|y_{fs}\|$	>	6	mA/V
Feedback capacitance I_D = 5 mA; V_{DS} = 15 V; f = 1 MHz	C_{rs}	<	0.7	pF
Noise figure at f = 200 MHz ; T_{amb} = 25 °C I_D = 5 mA; V_{DS} = 15 V G_S = 1 mΩ^{-1}; B_S = B_{Sopt}	F	<	5	dB
Equivalent noise voltage ; T_{amb} = 25 °C I_D = 5 mA; V_{DS} = 15 V; f = 1 kHz	$V_n/\sqrt{B}$	typ.	100	nV/$\sqrt{\text{Hz}}$

MECHANICAL DATA see page 2

MECHANICAL DATA

TO-72





Note: To safeguard the gates against damage due to accumulation of static charge during transport or handling, the leads are encircled by a ring of conductive rubber which should be removed just after the transistor is soldered into the circuit.

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

Voltages

Drain-substrate voltage	V_{DB}	max.	30	V
Source-substrate voltage	V_{SB}	max.	30	V
Gate-substrate voltage (continuous)	V_{GB}	max. min.	10 −10	V V
Repetitive peak gate to all other terminals voltage $V_{SB} = V_{DB} = 0$; $f > 100$ Hz	$V_{G\text{-}N}$	max. min.	15 −15	V V

Currents

Drain current (d.c.)	I_D	max.	20	mA
Drain current (peak value) $t_r = 20$ ms; $\delta = 0.1$	I_{DM}	max.	50	mA

Power dissipation

Total power dissipation up to $T_{amb} = 25\,^{o}C$	P_{tot}	max.	200	mW

Temperatures

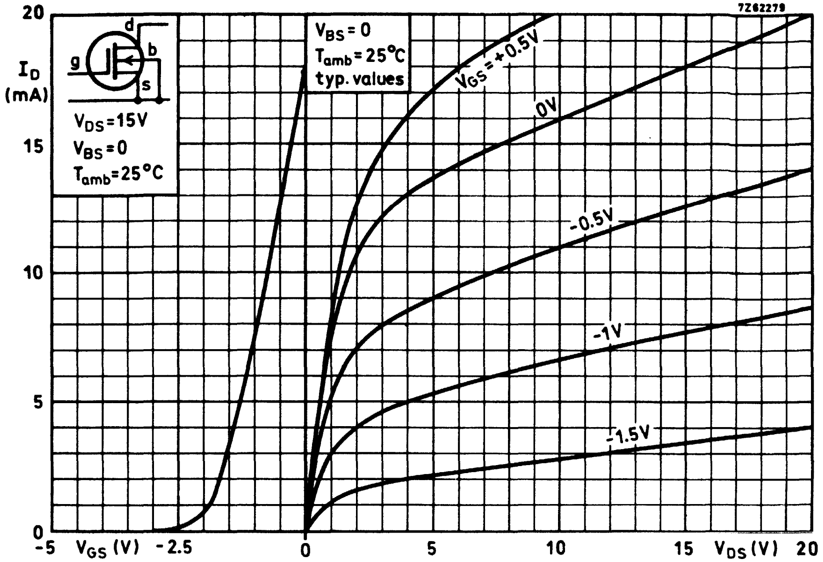
Storage temperature	T_{stg}		−65 to +125	^{o}C
Junction temperature	T_j	max.	125	^{o}C

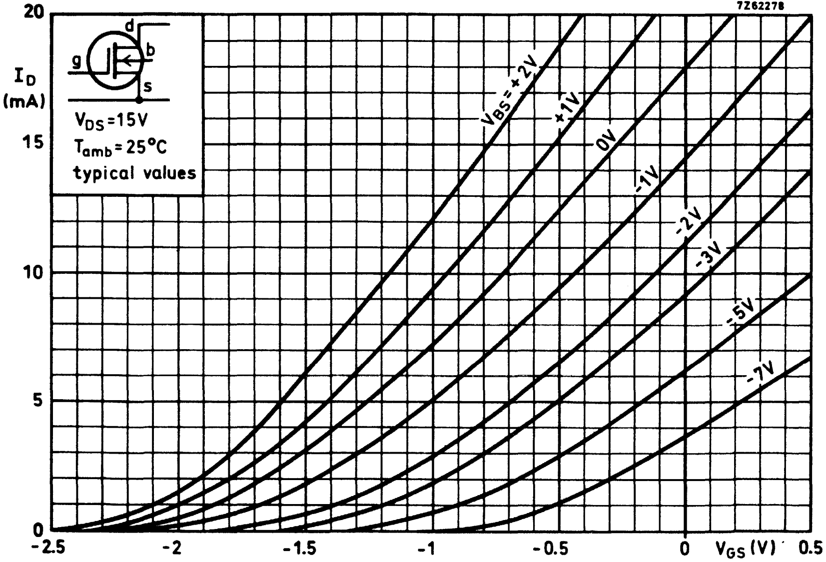
THERMAL RESISTANCE

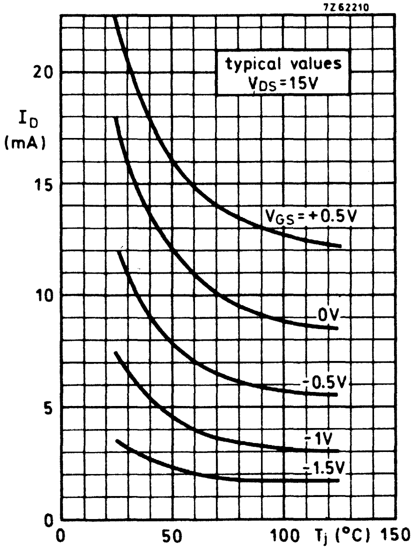
From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	0.5	$^{o}C/mW$

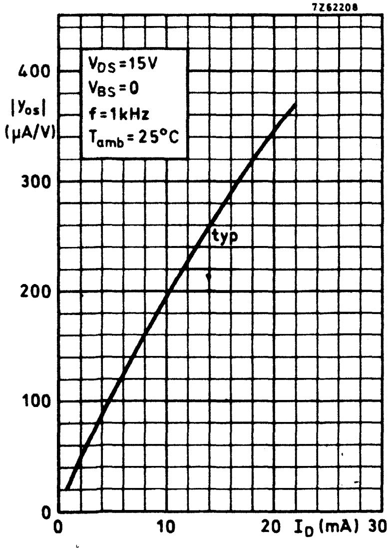
CHARACTERISTICS T_j = 25 °C unless otherwise specified

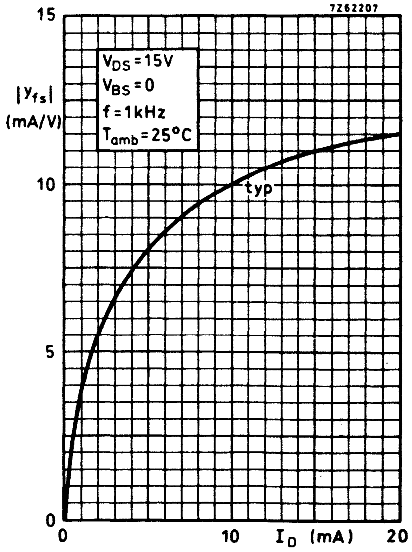
Gate currents; $V_{BS} = 0$				
$-V_{GS} = 10$ V; $V_{DS} = 0$	$-I_{GSS}$	<	10	pA
$V_{GS} = 10$ V; $V_{DS} = 0$	I_{GSS}	<	10	pA
$-V_{GS} = 10$ V; $V_{DS} = 0$; $T_j = 125$ °C	$-I_{GSS}$	<	200	pA
$V_{GS} = 10$ V; $V_{DS} = 0$; $T_j = 125$ °C	I_{GSS}	<	200	pA
Bulk currents; $V_{GB} = 0$				
$-V_{BD} = 30$ V; $I_S = 0$	$-I_{BDO}$	<	10	μA
$-V_{BS} = 30$ V; $I_D = 0$	$-I_{BSO}$	<	10	μA
Drain current				
$V_{DS} = 15$ V; $V_{GS} = 0$	I_{DSS}		10 to 40	mA
Gate-source voltage				
$I_D = 100$ nA; $V_{DS} = 15$ V	$-V_{GS}$		0.5 to 3.5	V
Gate-source cut-off voltage				
$I_D = 100$ nA ; $V_{DS} = 15$ V	$-V_{(P)GS}$	<	4	V
y parameters $T_{amb} = 25$ °C				
$I_D = 5$ mA; $V_{DS} = 15$ V				
Transfer admittance at f = 1 kHz	$\lvert y_{fs} \rvert$	>	6	mA/V
Output admittance at f = 1 kHz	$\lvert y_{os} \rvert$	<	0.4	mA/V
Input capacitance at f = 1 MHz	C_{is}	<	5	pF
Feedback capacitance at f = 1 MHz	C_{rs}	<	0.7	pF
Output capacitance at f = 1 MHz	C_{os}	<	3	pF
Noise figure at f = 200 MHz $T_{amb} = 25$ °C				
$I_D = 5$ mA; $V_{DS} = 15$ V				
$G_S = 1$ mΩ^{-1}; $B_S = B_{Sopt}$	F	<	5	dB
Equivalent noise voltage $T_{amb} = 25$ °C				
$I_D = 5$ mA; $V_{DS} = 15$ V; f = 120 Hz	$V_n/\sqrt{B}$	typ.	300	nV/$\sqrt{\text{Hz}}$
f = 1 kHz	$V_n/\sqrt{B}$	typ.	100	nV/$\sqrt{\text{Hz}}$
f = 10 kHz	$V_n/\sqrt{B}$	typ.	35	nV/$\sqrt{\text{Hz}}$

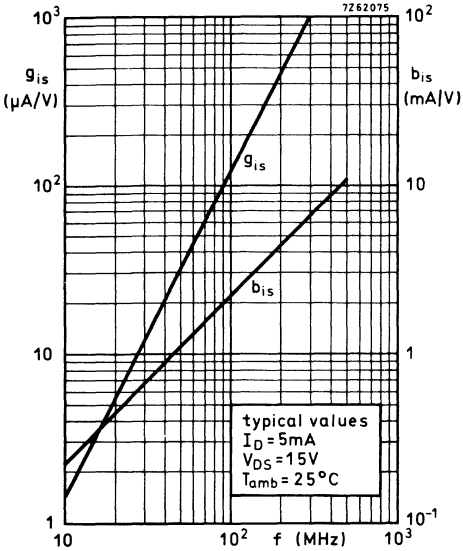

7Z62279
20
15
10
5
0
I_D (mA)
d
g
b
s
V_{DS}=15V
V_{BS}=0
T_{amb}=25°C
V_{BS}=0
T_{amb}=25°C
typ. values
V_{GS}=+0.5V
0V
-0.5V
-1V
-1.5V
-5
V_{GS} (V)
-2.5
0
5
10
15
V_{DS} (V)
20

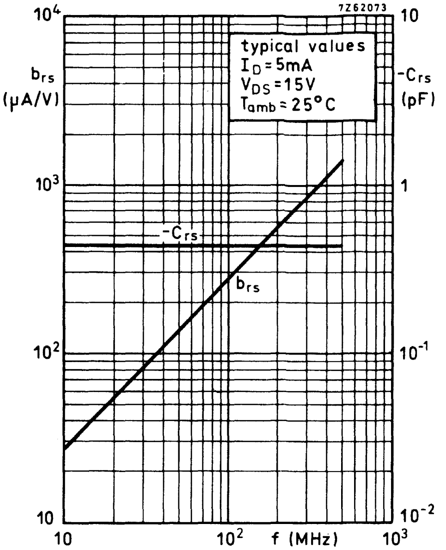

7Z62278
20
15
10
5
0
I_D (mA)
d
g
b
s
V_{DS}=15V
T_{amb}=25°C
typical values
V_{BS}=+2V
+1V
0V
-1V
-2V
-3V
-5V
-7V
-2.5
-2
-1.5
-1
-0.5
0
V_{GS} (V)
0.5

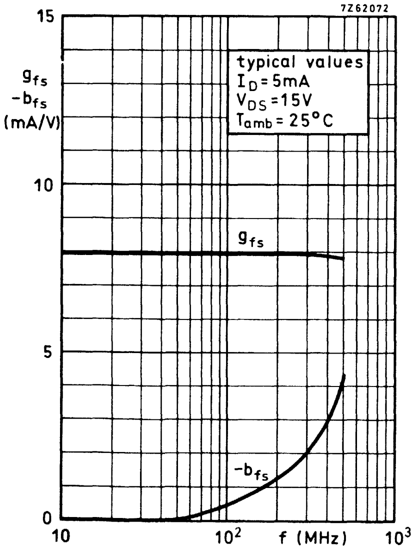

7Z62210
typical values
V_{DS} = 15V
I_D (mA)
0
5
10
15
20
V_{GS} = +0.5V
0V
-0.5V
-1V
-1.5V
0
50
100
T_j (°C)
150

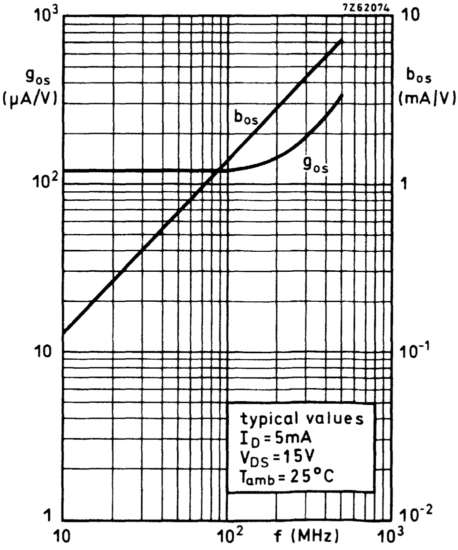

7Z62208
V_{DS} = 15V
V_{BS} = 0
f = 1kHz
T_{amb} = 25°C
$|y_{os}|$ (μA/V)
0
100
200
300
400
typ
0
10
20
I_D (mA)
30

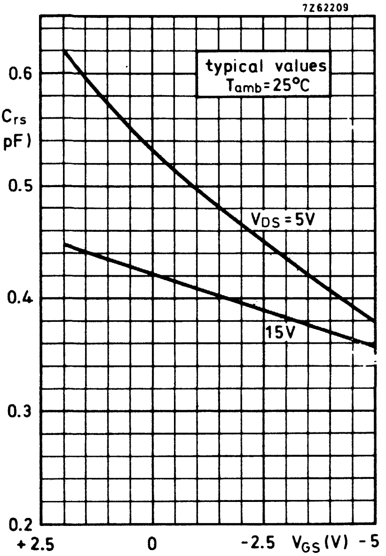

7Z62207
V_{DS} = 15V
V_{BS} = 0
f = 1kHz
T_{amb} = 25°C
$|y_{fs}|$ (mA/V)
0
5
10
15
typ
0
10
I_D (mA)
20

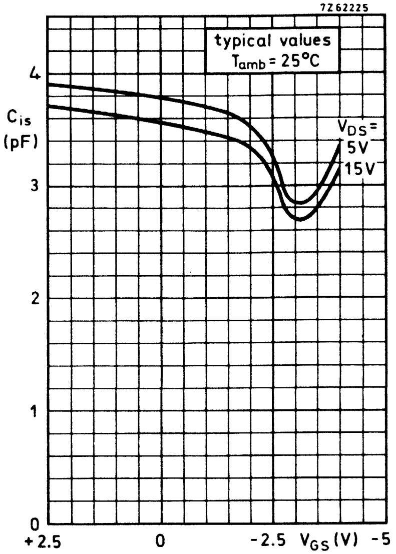

7Z62075
g_{is} (μA/V)
b_{is} (mA/V)
10^3
10^2
10
1
10^2
10
1
10^{-1}
g_{is}
b_{is}
typical values
$I_D = 5mA$
$V_{DS} = 15V$
$T_{amb} = 25°C$
10
10^2
f (MHz)
10^3


7Z62073
b_{rs} (μA/V)
$-C_{rs}$ (pF)
10^4
10^3
10^2
10
10
1
10^{-1}
10^{-2}
typical values
$I_D = 5mA$
$V_{DS} = 15V$
$T_{amb} = 25°C$
$-C_{rs}$
b_{rs}
10
10^2
f (MHz)
10^3


7Z62072
g_{fs}
$-b_{fs}$
(mA/V)
15
10
5
0
typical values
$I_D = 5mA$
$V_{DS} = 15V$
$T_{amb} = 25°C$
g_{fs}
$-b_{fs}$
10
10^2
f (MHz)
10^3


7Z62074
g_{os} (μA/V)
b_{os} (mA/V)
10^3
10^2
10
1
10
1
10^{-1}
10^{-2}
b_{os}
g_{os}
typical values
$I_D = 5mA$
$V_{DS} = 15V$
$T_{amb} = 25°C$
10
10^2
f (MHz)
10^3


7Z62209
typical values
T_{amb} = 25°C
$-C_{rs}$ (pF)
0.6
0.5
0.4
0.3
0.2
+2.5
0
-2.5
V_{GS} (V)
-5
V_{DS} = 5V
15V


7Z62225
typical values
T_{amb} = 25°C
C_{is} (pF)
4
3
2
1
0
+2.5
0
-2.5
V_{GS} (V)
-5
V_{DS} =
5V
15V

For data and curves of these types please refer to section Microminiature devices for thick- and thin-film circuits

MATCHED N-CHANNEL FET's

Matched pair of n-channel silicon epitaxial planar junction field effect transistors in TO-72 metal envelopes held together by a metal S-clip.
It is intended for low level differential amplifiers.

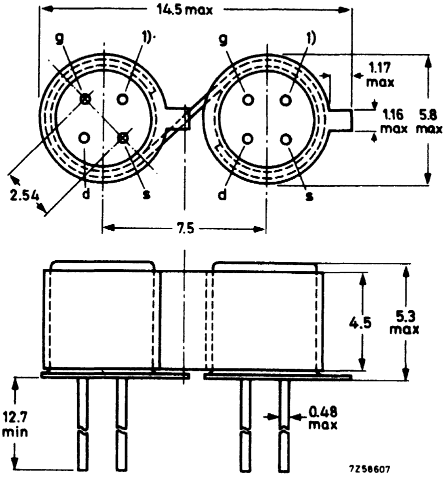
QUICK REFERENCE DATA

Characteristics $T_{amb} = 25\ ^{o}C$; $V_{DG} = 15$ V; $I_D = 0.5$ mA			BFS21	BFS21A	
Gate cut-off current	I_G	<	0.5	0.5	nA
Gate-source voltage difference	$\lvert \Delta V_{GS} \rvert$	<	20	10	mV
Thermal drift of gate-source voltage difference	$\left\lvert \frac{d\ \Delta V_{GS}}{dT} \right\rvert$	<	75	40	$\mu V/^{o}C$
Difference of penetration factor	$\left\lvert \Delta \frac{g_{os}}{g_{fs}} \right\rvert$	<	1	0.5	10^{-3}
Difference of transfer impedance	$\left\lvert \Delta \frac{1}{g_{fs}} \right\rvert$	<	15	7.5	Ω
Common mode rejection ratio	CMRR	>	60	66	dB

TOTAL DEVICE

Dimensions in mm

MECHANICAL DATA



1) = shield lead (connected to case)

max. lead diameter is guaranteed only for 12.7 mm

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

Voltage				
Voltage between any 2 terminals	V	max.	30	V
Currents				
Drain current	I_D	max.	4	mA
Gate current	I_G	max.	0.5	mA
Power dissipation				
Total power dissipation up to T_{amb} = 100 °C	P_{tot}	max.	30	mW
Temperature				
Operating ambient temperature	Tamb	-20 to + 100		°C

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

			BFS21	BFS21A	
Drain current ratio					
V_{DG} = 15 V; V_{GS} = 0; T_j = 25 °C	$\frac{I_{D1-S1S}}{I_{D2-S2S}}$	> <	0.95 1.05	0.95 1.05	
Gate-source voltage difference					
I_D = 500 μA; V_{DG} = 15 V	$\lvert \Delta V_{GS} \rvert$	<	20	10	mV
I_D = 100 μA; V_{DG} = 15 V	$\lvert \Delta V_{GS} \rvert$	<	20	10	mV
Thermal drift of gate-source voltage difference					
I_D = 500 μA; V_{DG} = 15 V	$\left\lvert \frac{d\ \Delta V_{GS}}{dT} \right\rvert$	<	75	40	μV/°C
I_D = 100 μA; V_{DG} = 15 V	$\left\lvert \frac{d\ \Delta V_{GS}}{dT} \right\rvert$	<	75	40	μV/°C
Change of gate-source voltage difference with ambient temperature					
T_{amb} = 25 to 100 °C					
I_D = 500 μA; V_{DG} = 15 V	$\lvert \Delta V_{GS}(T_{amb2}) - \Delta V_{GS}(T_{amb1}) \rvert$	<	6	3	mV
I_D = 100 μA; V_{DG} = 15 V	$\lvert \Delta V_{GS}(T_{amb2}) - \Delta V_{GS}(T_{amb1}) \rvert$	<	6	3	mV
Difference of penetration factors ¹)					
I_D = 500 μA; V_{DG} = 15 V	$\left\lvert \Delta \frac{g_{os}}{g_{fs}} \right\rvert$	<	1	0.5	10^{-3}
I_D = 100 μA; V_{DG} = 15 V	$\left\lvert \Delta \frac{g_{os}}{g_{fs}} \right\rvert$	<	1	0.5	10^{-3}
Difference of transfer impedances ²)					
I_D = 500 μA; V_{DG} = 15 V	$\left\lvert \Delta \frac{1}{g_{fs}} \right\rvert$	<	15	7.5	Ω
I_D = 100 μA; V_{DG} = 15 V	$\left\lvert \Delta \frac{1}{g_{fs}} \right\rvert$	<	75	37.5	Ω

---

1) The difference between the penetration factors is equal to the ratio of the change of the gate-source voltage difference to the change of drain-gate voltage, at constant drain current.

$$\left(\Delta \frac{g_{os}}{g_{fs}} = \frac{d\ \Delta V_{GS}}{d\ V_{DG}} \text{ at } I_D = \text{constant}\right)$$

2) The difference between the transfer impedances is equal to the ratio of the change of the gate-source voltage difference to the change of drain current, at constant drain-gate voltage.

$$\left(\Delta \frac{1}{g_{fs}} = \frac{d\ \Delta V_{GS}}{d\ I_D} \text{ at } V_{DG} = \text{constant}\right)$$

CHARACTERISTICS (continued) (total device)

Common mode rejection ratio [1]			BFS21	BFS21A	
I_D = 500 μA; V_{DG} = 15 V	CMRR	>	60	66	dB
I_D = 100 μA; V_{DG} = 15 V	CMRR	>	60	66	dB

INDIVIDUAL TRANSISTOR

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

Voltages				
Drain-source voltage	$\pm V_{DS}$	max.	30	V
Drain-gate voltage (open source)	V_{DGO}	max.	30	V
Gate-source voltage (open drain)	$-V_{GSO}$	max.	30	V
Currents				
Drain current	I_D	max.	20	mA
Gate current	I_G	max.	10	mA
Power dissipation				
Total power dissipation up to T_{amb} = 25°	P_{tot}	max.	300	mW
Temperatures				
Storage temperature	T_{stg}		-65 to +200	°C
Junction temperature	T_j	max.	200	°C

THERMAL RESISTANCE

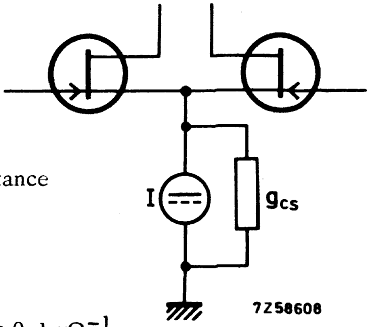
From junction to ambient in free air (for individual transistor without S-clip)	$R_{th\ j\text{-}a}$	=	0.59	°C/mW

---

[1] Common mode rejection ratio

$$(\mathrm{CMRR})^{-1} = \Delta \frac{g_{os}}{g_{fs}} + \tfrac{1}{2} g_{cs}\, \Delta \frac{1}{g_{fs}}$$

where g_{cs} in this formula is the output conductance of the summing current source.



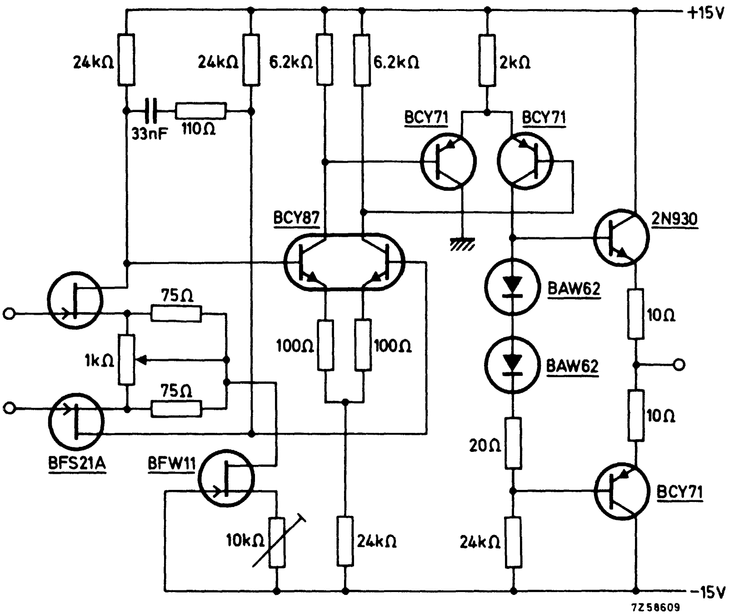
The guaranteed values of CMRR apply at g_{cs} = 0.1 $\mu\Omega^{-1}$

CHARACTERISTICS (individual transistor) $T_{amb} = 25\,^{o}C$ unless otherwise specified

Gate cut-off current				
$I_D = 500\ \mu A$; $V_{DS} = 15\ V$	I_G	<	0.5	nA
$I_D = 500\ \mu A$; $V_{DS} = 15\ V$; $T_{amb} = 100\ ^{o}C$	I_G	<	25	nA
Drain current				
$V_{DS} = 15\ V$, $V_{GS} = 0$, $T_j = 25\ ^{o}C$	I_{DSS}	>	1	mA
Gate-source cut-off voltage				
$I_D = 0.5\ nA$, $V_{DS} = 15\ V$	$-V_{(P)GS}$	<	6	V
Transfer conductance at f = 1 kHz				
$I_D = 500\ \mu A$; $V_{DS} = 15\ V$	g_{fs}	>	1.0	$m\Omega^{-1}$
Output conductance at f = 1 kHz				
$I_D = 500\ \mu A$; $V_{DS} = 15\ V$	g_{os}	<	15	$\mu\Omega^{-1}$
Input capacitance at f = 1 MHz				
$I_D = 500\ \mu A$; $V_{DS} = 15\ V$	C_{is}	<	5	pF
Feedback capacitance at f = 1 MHz				
$I_D = 500\ \mu A$; $V_{DS} = 15\ V$	C_{rs}	<	0.75	pF
Equivalent noise voltage				
f = 10 Hz				
$I_D = 500\ \mu A$; $V_{DS} = 15\ V$	$V_n/\sqrt{B}$	<	200	$nV/\sqrt{Hz}$
$V_{DS} = 15\ V$, $V_{GS} = 0$	$V_n/\sqrt{B}$	<	75	$nV/\sqrt{Hz}$

APPLICATION INFORMATION

Operational amplifier



APPLICATION INFORMATION (continued)

Input voltages

Initial off-set voltage	<	10	mV
Differential off-set voltage change with temperature	<	40	µV/°C
Differential off-set voltage change with time	<	40	µV/day
Noise voltage (B = 100 kHz)	<	2	µV
Common mode rejection ratio	>	65	dB
Supply rejection ratio	<	500	10^{-6}
Input voltage range	±	10	V

Input currents

Input bias current; $T_{amb} = 25\,^{o}C$	typ.	50	pA
; $T_{amb} = 100\,^{o}C$	<	25	nA
Off-set current ; $T_{amb} = 25\,^{o}C$	typ.	20	pA
; $T_{amb} = 100\,^{o}C$	<	25	nA

Input impedance

Input resistance	typ.	100	GΩ
Input resistance (common mode)	typ.	100	GΩ
Input capacitance	typ.	3	pF
Input capacitance (common mode)	typ.	3	pF

Frequency response

Bandwidth ($G_V = 1$)	typ.	10	MHz
Slewing rate	typ.	10	V/µs

Output voltage range	±	10	V
Output current range	±	10	mA
Output resistance	typ.	300	Ω

SILICON N-CHANNEL DUAL INSULATED GATE FIELD EFFECT TRANSISTOR

Depletion type field effect transistor in a TO-72 metal envelope with source and substrate connected to the case.
This M.O.S.-tetrode is intended for a wide range of applications in communication, instrumentation and control.
The tetrode configuration, a series arrangement of two gate controlled channels offers:

a. very low feedback capacitance providing the possibility of more than 40 dB gain control in r.f. amplifiers requiring negligible a.g.c. power.
b. excellent signal handling capability over the entire gain control range.
c. low noise figure combined with high gain.

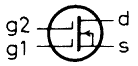
QUICK REFERENCE DATA				
Drain-source voltage	V_{DSX}	max.	20	V
Gate 1-source voltage	$\pm V_{G1-S}$	max.	8	V
Gate 2-source voltage	$\pm V_{G2-S}$	max.	8	V
Drain current	I_D	max.	20	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	200	mW
Junction temperature	T_j	max.	135	°C
Transfer admittance at f = 1 kHz I_D = 10 mA; V_{DS} = 13 V; $+V_{G2-S}$ = 4 V	$\|y_{fs}\|$	> typ.	8 13	mA/V mA/V
Feedback capacitance at f = 10 MHz I_D = 10 mA; V_{DS} = 13 V; $+V_{G2-S}$ = 4 V	$-C_{rs}$	typ.	25	fF
Transducer gain at f = 200 MHz I_D = 10 mA; V_{DS} = 13 V; $+V_{G2-S}$ = 4 V B_S and B_L tuned for maximum gain	G_{tr}	typ.	18	dB
Noise figure at optimum source admittance I_D = 10 mA; V_{DS} = 13 V; $+V_{G2-S}$ = 4 V; f = 200 MHz	F_{min}	typ. <	3 4	dB dB

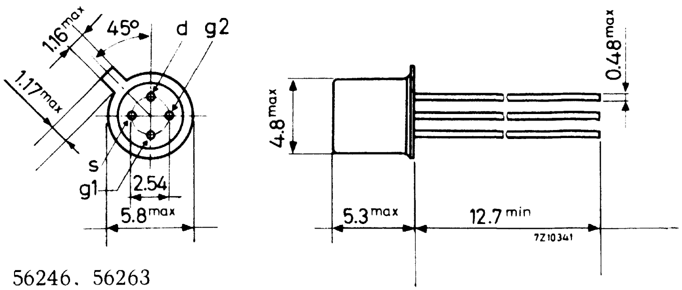
MECHANICAL DATA see page 2.

MECHANICAL DATA

Dimensions in mm

TO-72
Source and substrate
connected to the case





Accessories available: 56246, 56263

Note: To safeguard the gates against damage due to accumulation of static charge during transport or handling, the leads are encircled by a ring of conductive rubber which should be removed just after the transistor is soldered into the circuit.

RATINGS

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

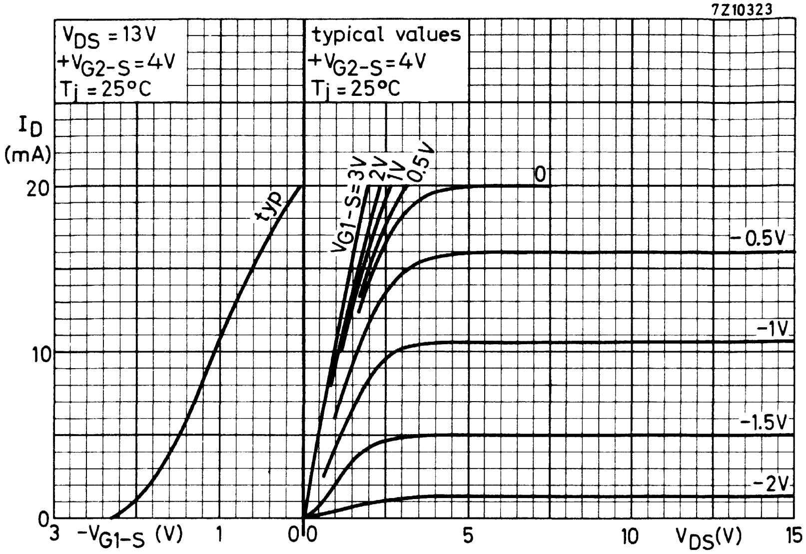
Voltages				
Drain-source voltage	V_{DSX}	max.	20	V
Gate 1-source voltage	$\pm V_{G1-S}$	max.	8	V
Gate 2-source voltage	$\pm V_{G2-S}$	max.	8	V
Non repetitive peak voltage ($t \leq 10$ ms)				
gate 1-source voltage	$\pm V_{G1-SM}$	max.	50	V
gate 2-source voltage	$\pm V_{G2-SM}$	max.	50	V
Current				
Drain current	I_D	max.	20	mA
Power dissipation				
Total power dissipation up to $T_{amb} = 25\,^{\circ}C$	P_{tot}	max.	200	mW
Temperatures				
Storage temperature	T_{stg}		-65 to +135	°C
Junction temperature	T_j	max.	135	°C

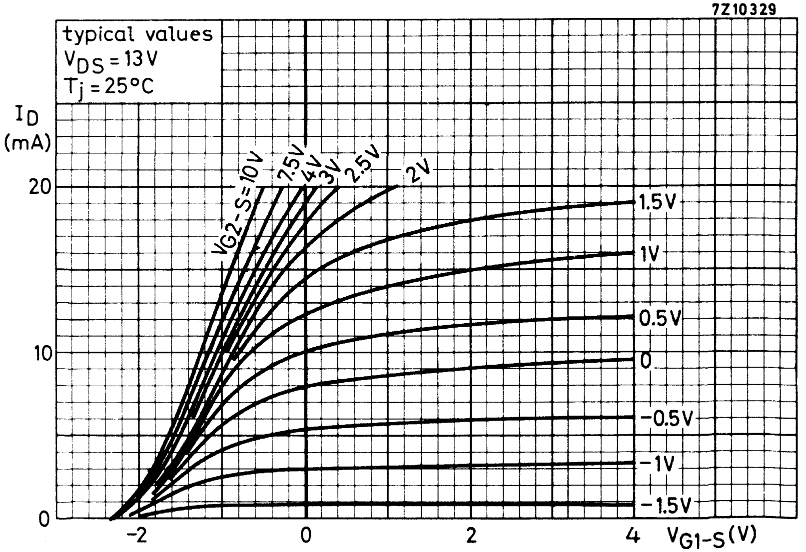
THERMAL RESISTANCE

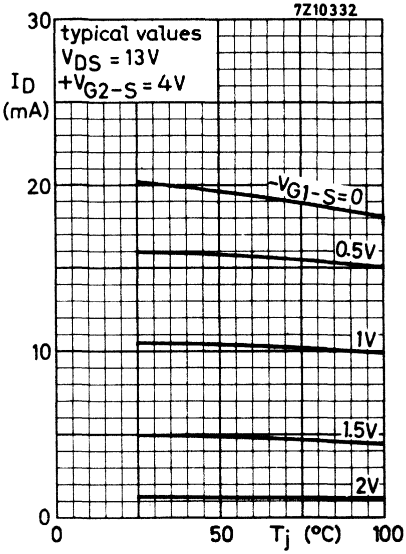
From junction to ambient in free air	$R_{th\ j-a}$	=	0.55	°C/mW

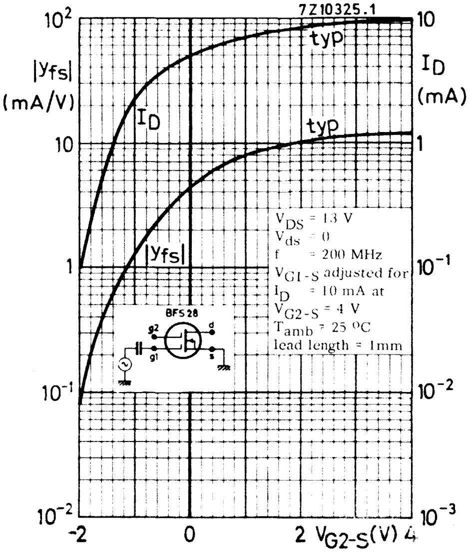
CHARACTERISTICS T_j = 25 °C unless otherwise specified

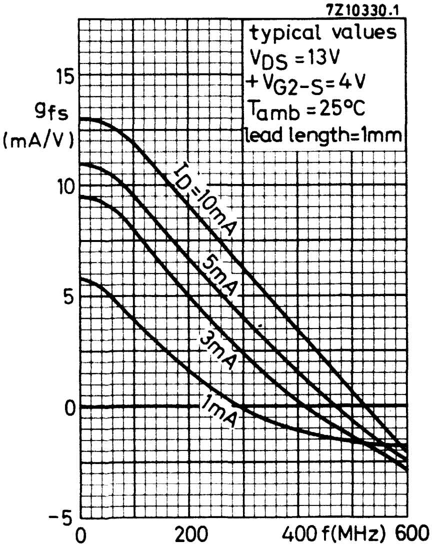
Gate 1 cut-off current				
$\pm V_{G1-S}$ = 8 V; V_{G2-S} = 0; V_{DS} = 0; T_j = 135 °C	$\pm I_{G1-SS}$	<	1	nA
Gate 2 cut-off current				
$\pm V_{G2-S}$ = 8 V; V_{G1-S} = 0; V_{DS} = 0; T_j = 135 °C	$\pm I_{G2-SS}$	<	1	nA
Gate 1-source voltage				
I_D = 10 mA; V_{DS} = 13 V; $+V_{G2-S}$ = 4 V	$-V_{G1-S}$	0.6 to 2.8		V
Gate 1-source cut-off voltage				
I_D = 100 μA; V_{DS} = 20 V; $+V_{G2-S}$ = 4 V	$-V_{G1-S}$	<	5	V
Gate 2-source cut-off voltage				
I_D = 50 μA; V_{DS} = 20 V; V_{G1-S} = 0	$-V_{G2-S}$	<	4	V
y parameters (common source)				
I_D = 10 mA; V_{DS} = 13 V; $+V_{G2-S}$ = 4 V; T_{amb} = 25 °C				
Transfer admittance f = 1 kHz	$\|y_{fs}\|$	> typ.	8 13	mA/V mA/V
f = 200 MHz	$\|y_{fs}\|$	typ.	12.1	mA/V
f = 500 MHz	$\|y_{fs}\|$	typ.	11.2	mA/V
Feedback capacitance f = 10 MHz	$-C_{rs}$	typ.	25	fF
Transducer gain at f = 200 MHz				
I_D = 10 mA; V_{DS} = 13 V; $+V_{G2-S}$ = 4 V G_S = 1.3 mA/V; G_L = 1 mA/V; T_{amb} = 25 °C B_S and B_L tuned for maximum gain	G_{tr}	typ.	18	dB
Maximum unilateralised power gain at T_{amb} = 25 °C				
G_{UM} in dB = $10 \log \frac{\|y_{fs}\|^2}{4 g_{is} g_{os}}$				
I_D = 10 mA; V_{DS} = 13 V; $+V_{G2-S}$ = 4 V; f = 200 MHz	G_{UM}	typ.	21.3	dB
f = 500 MHz	G_{UM}	typ.	7.3	dB
Noise figure at optimum source admittance at f = 200 MHz				
I_D = 10 mA; V_{DS} = 13 V; $+V_{G2-S}$ = 4 V				
G_{Sopt} = 1.4 mA/V; B_{Sopt} = 5.5 mA/V; T_{amb} = 25 °C	F_{min}	typ. <	3 4	dB dB

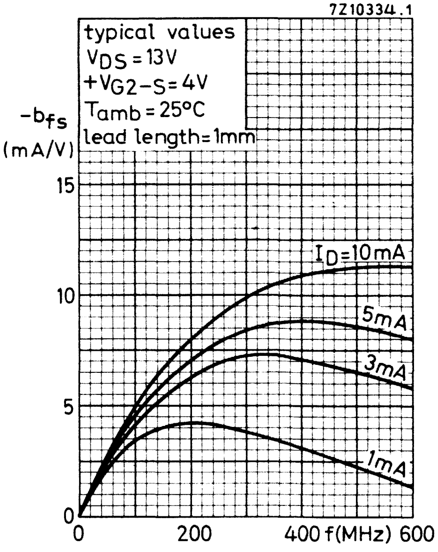

7Z10323
V_{DS} = 13 V
$+V_{G2-S}$ = 4 V
T_j = 25 °C
typical values
$+V_{G2-S}$ = 4 V
T_j = 25 °C
I_D (mA)
20
10
0
typ
V_{G1-S} = 3 V
2 V
1 V
0.5 V
0
−0.5 V
−1 V
−1.5 V
−2 V
3
$-V_{G1-S}$ (V)
1
0
0
5
10
V_{DS}(V)
15

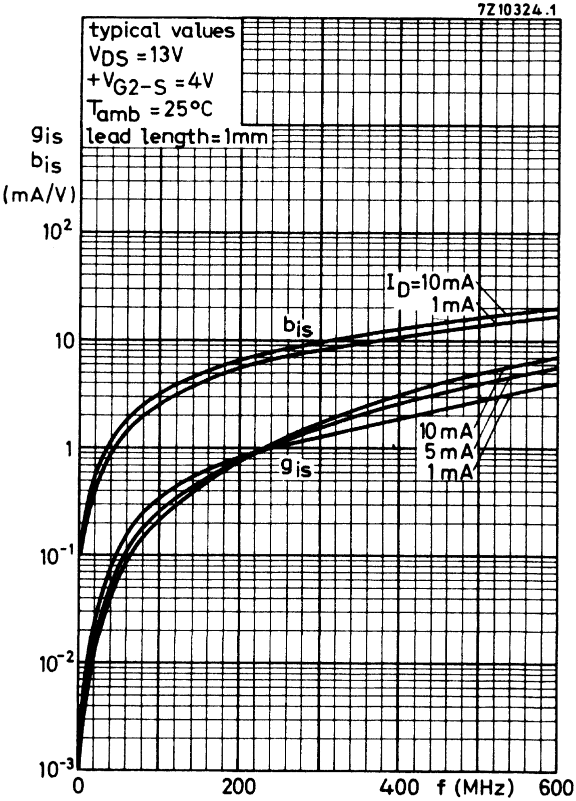

7Z10329
typical values
V_{DS} = 13 V
T_j = 25 °C
I_D (mA)
20
10
0
V_{G2-S} = 10 V
7.5 V
4 V
3 V
2.5 V
2 V
1.5 V
1 V
0.5 V
0
−0.5 V
−1 V
−1.5 V
−2
0
2
4
V_{G1-S} (V)

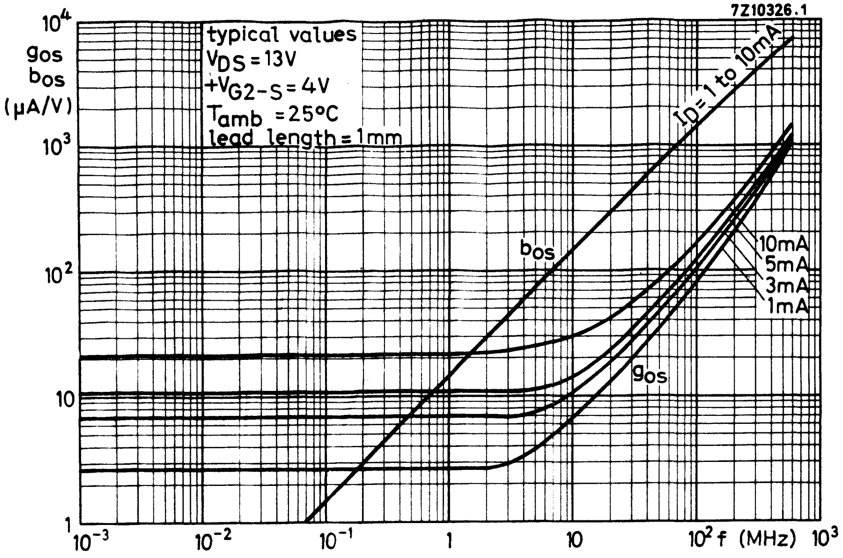

7Z10332
typical values
V_{DS} = 13 V
$+V_{G2-S}$ = 4 V
I_D (mA)
30
20
10
0
$-V_{G1-S}$ = 0
0.5 V
1 V
1.5 V
2 V
0
50
T_j (°C)
100

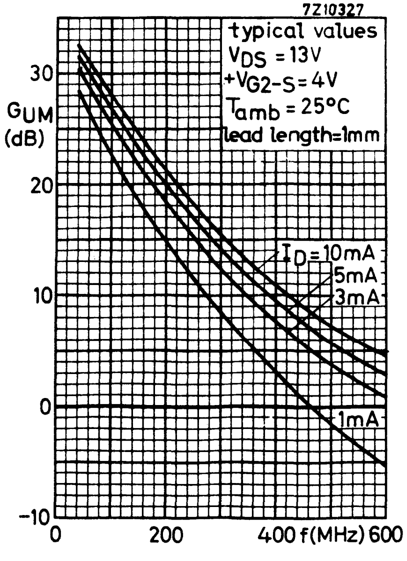

7Z10325.1
10^2
$|y_{fs}|$ (mA/V)
10
1
10^{-1}
10^{-2}
10
I_D (mA)
1
10^{-1}
10^{-2}
10^{-3}
typ
typ
I_D
$|y_{fs}|$
V_{DS} = 13 V
V_{ds} = 0
f = 200 MHz
V_{G1-S} adjusted for
I_D = 10 mA at
V_{G2-S} = 4 V
T_{amb} = 25 °C
lead length = 1 mm
BFS28
g2
d
g1
s
-2
0
2
V_{G2-S} (V)
4

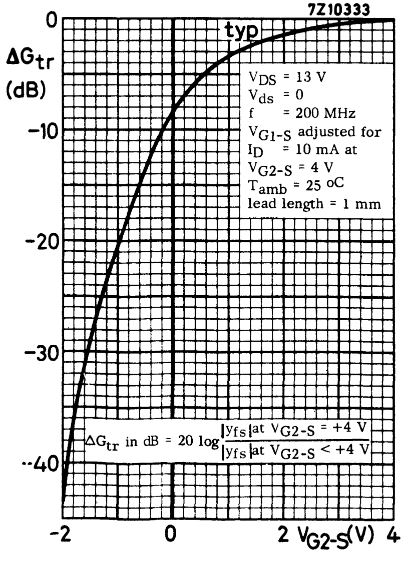

7Z10330.1
typical values
V_{DS} = 13 V
$+V_{G2-S}$ = 4 V
T_{amb} = 25 °C
lead length = 1 mm
g_{fs} (mA/V)
15
10
5
0
-5
I_D = 10 mA
5 mA
3 mA
1 mA
0
200
400
f (MHz)
600

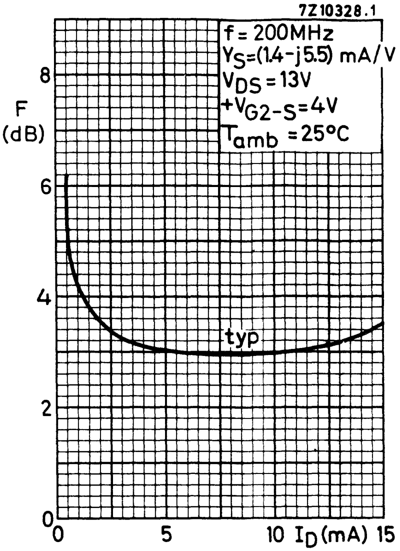

7Z10334.1
typical values
V_{DS} = 13 V
$+V_{G2-S}$ = 4 V
T_{amb} = 25 °C
lead length = 1 mm
$-b_{fs}$ (mA/V)
15
10
5
0
I_D = 10 mA
5 mA
3 mA
1 mA
0
200
400
f (MHz)
600

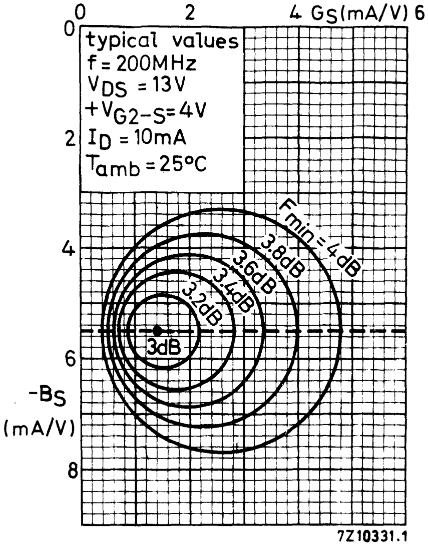

7Z10324.1
typical values
V_{DS} = 13V
$+V_{G2-S}$ = 4V
T_{amb} = 25°C
lead length = 1mm
g_{is}
b_{is}
(mA/V)
10^2
10
1
10^{-1}
10^{-2}
10^{-3}
0
200
400
f (MHz)
600
b_{is}
I_D=10mA
1mA
g_{is}
10 mA
5 mA
1 mA


7Z10326.1
10^4
g_{os}
b_{os}
(μA/V)
10^3
10^2
10
1
typical values
V_{DS} = 13V
$+V_{G2-S}$ = 4V
T_{amb} = 25°C
lead length = 1mm
I_D = 1 to 10mA
b_{os}
10mA
5mA
3mA
1mA
g_{os}
10^{-3}
10^{-2}
10^{-1}
1
10
10^2
f (MHz)
10^3


7Z10327
30
G_{UM}
(dB)
20
10
0
-10
typical values
V_{DS} = 13V
$+V_{G2-S}$ = 4V
T_{amb} = 25°C
lead length=1mm
I_D = 10mA
5mA
3mA
1mA
0
200
400 f(MHz) 600


7Z10333
0
ΔG_{tr}
(dB)
-10
-20
-30
-40
typ
V_{DS} = 13 V
V_{ds} = 0
f = 200 MHz
V_{G1-S} adjusted for
I_D = 10 mA at
V_{G2-S} = 4 V
T_{amb} = 25 oC
lead length = 1 mm
ΔG_{tr} in dB = $20 \log \frac{|y_{fs}| \text{at } V_{G2-S} = +4\text{ V}}{|y_{fs}| \text{at } V_{G2-S} < +4\text{ V}}$
-2
0
2 V_{G2-S}(V) 4


7Z10328.1
f = 200MHz
YS=(1.4-j5.5) mA/V
VDS = 13V
+VG2-S=4V
Tamb = 25°C
F
(dB)
8
6
4
2
0
typ
0
5
10 ID(mA) 15


0
2
4 GS(mA/V) 6
typical values
f = 200MHz
VDS = 13V
+VG2-S= 4V
ID = 10mA
Tamb = 25°C
Fmin = 4dB
3.8dB
3.6dB
3.4dB
3.2dB
3dB
0
2
4
6
8
-BS
(mA/V)
7Z10331.1

N-CHANNEL SILICON FIELD EFFECT TRANSISTORS

N-channel silicon epitaxial planar junction field effect transistors in a TO-72 metal envelope with the shield lead connected to the case.
The transistors are designed for broad band amplifiers (0 to 300 MHz).
Their very low noise at low frequencies makes these devices very suitable for differential amplifiers, electro-medical and nuclear detector pre-amplifiers.

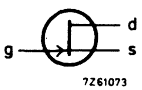
QUICK REFERENCE DATA

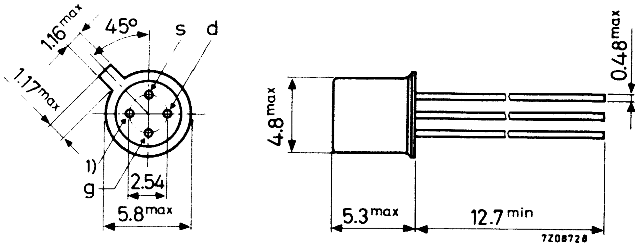
Drain-source voltage	$\pm V_{DS}$	max.	30		V
Gate-source voltage (open drain)	$-V_{GSO}$	max.	30		V
Total power dissipation up to $T_{amb} = 25\,^{o}C$	P_{tot}	max.	300		mW
			BFW10	BFW11	
Drain current $V_{DS} = 15$ V; $V_{GS} = 0$	I_{DSS}	>	8	4	mA
		<	20	10	mA
Gate-source cut-off voltage $I_D = 0.5$ nA; $V_{DS} = 15$ V	$-V_{(P)GS}$	<	8	6	V
Feedback capacitance at f = 1 MHz $V_{DS} = 15$ V; $V_{GS} = 0$	$-C_{rs}$	<	0.80	0.80	pF
Transfer admittance (common source) $V_{DS} = 15$ V; $V_{GS} = 0$; f = 200 MHz	$\lvert y_{fs} \rvert$	>	3.2	3.2	mA/V
Noise figure at $V_{DS} = 15$ V; $V_{GS} = 0$ f = 100 MHz; $R_G = 1$ kΩ	F	<	2.5	2.5	dB
Equivalent noise voltage f = 10 Hz	$V_n/\sqrt{B}$	<	75	75	nV/$\sqrt{Hz}$

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				
Drain-source voltage	$\pm V_{DS}$	max.	30	V
Drain-gate voltage (open source)	V_{DGO}	max.	30	V
Gate-source voltage (open drain)	$-V_{GSO}$	max.	30	V
Currents				
Drain current	I_D	max.	20	mA
Gate current	I_G	max.	10	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	$R_{th\ j\text{-}a}$	=	0.59	°C/mW

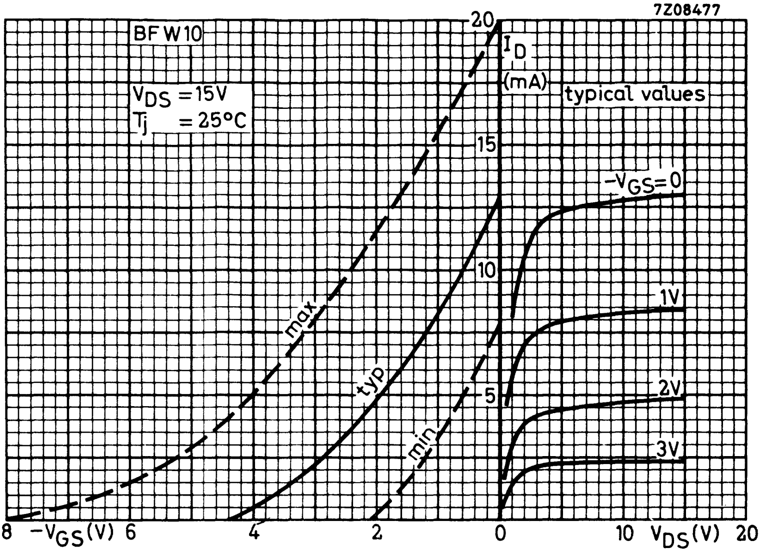
CHARACTERISTICS

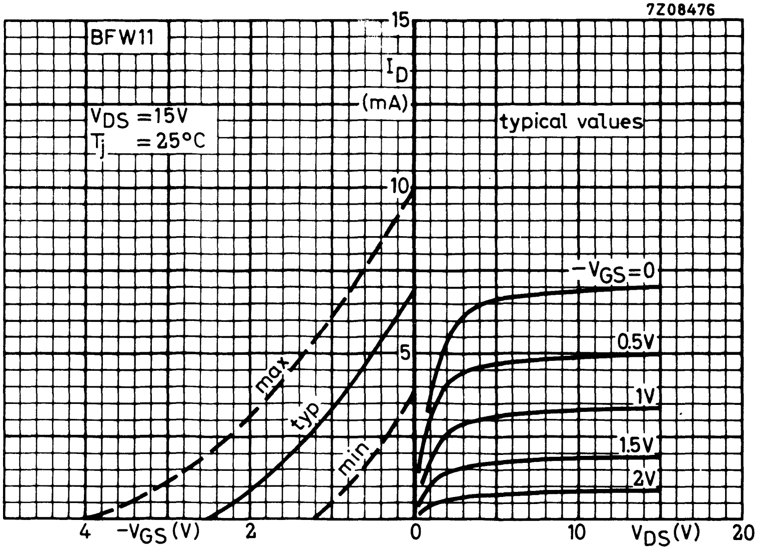
T_j = 25 °C unless otherwise specified

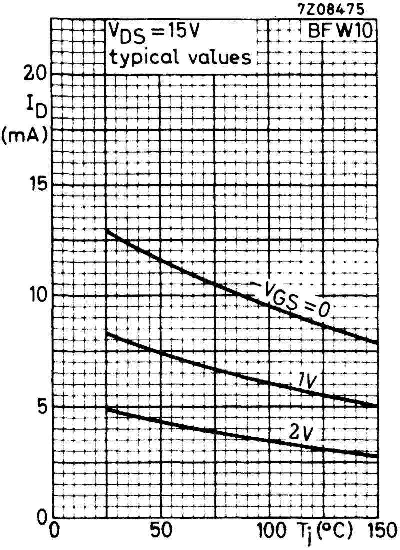
			BFW10	BFW11	
Gate cut-off current					
$-V_{GS}$ = 20 V; V_{DS} = 0	$-I_{GSS}$	<	0.1	0.1	nA
$-V_{GS}$ = 20 V; V_{DS} = 0; T_j = 150 °C	$-I_{GSS}$	<	0.5	0.5	µA
Drain current [1]					
V_{DS} = 15 V; V_{GS} = 0	I_{DSS}	>	8	4	mA
		<	20	10	mA
Gate-source voltage					
I_D = 400 µA; V_{DS} = 15 V	$-V_{GS}$	>	2.0		V
		<	7.5		V
I_D = 50 µA; V_{DS} = 15 V	$-V_{GS}$	>		1.25	V
		<		4.0	V
Gate-source cut-off voltage					
I_D = 0.5 nA; V_{DS} = 15 V	$-V_{(P)GS}$	<	8	6	V
y parameters					
V_{DS} = 15 V; V_{GS} = 0; T_{amb} = 25 °C					
f = 1 kHz Transfer admittance	$\vert y_{fs} \vert$	>	3.5	3.0	mA/V
		<	6.5	6.5	mA/V
Output admittance	$\vert y_{os} \vert$	<	85	50	µA/V
f = 1 MHz Input capacitance	C_{is}	typ.	4	4	pF
		<	5	5	pF
Feedback capacitance	$-C_{rs}$	typ.	0.6	0.6	pF
		<	0.80	0.80	pF
f = 200 MHz Transfer admittance	$\vert y_{fs} \vert$	>	3.2	3.2	mA/V
Input conductance	g_{is}	<	800	800	µA/V
Output conductance	g_{os}	<	200	100	µA/V
Noise figure at f = 100 MHz; R_G = 1 kΩ					
V_{DS} = 15 V; V_{GS} = 0; T_{amb} = 25 °C input tuned to minimum noise	F	<	2.5	2.5	dB
Equivalent noise voltage					
V_{DS} = 15 V; V_{GS} = 0; T_{amb} = 25 °C					
f = 10 Hz	$V_n/\sqrt{B}$	<	75	75	nV/$\sqrt{\text{Hz}}$

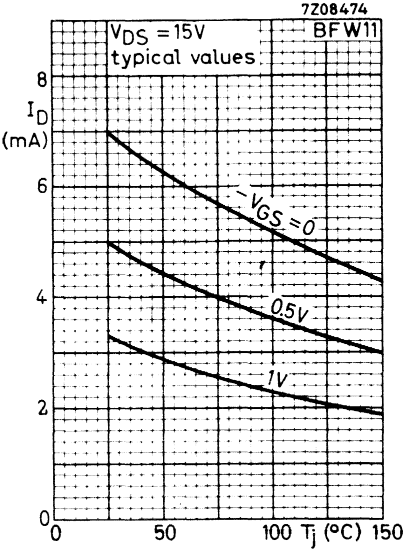
---

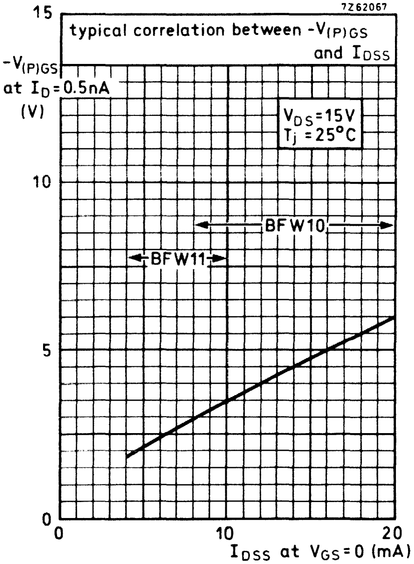
[1] Measured under pulsed conditions.

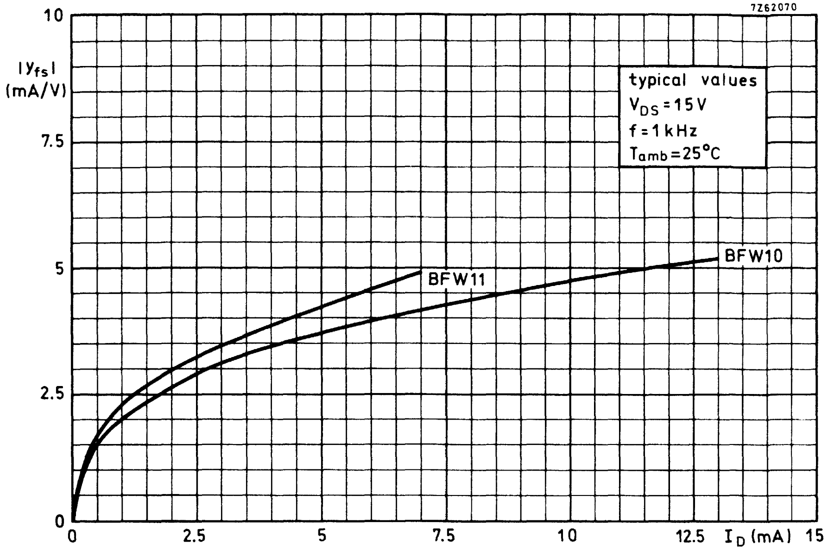

7Z08477
BFW10
V_{DS} = 15V
T_j = 25°C
I_D (mA)
typical values
20
15
10
5
max
typ
min
$-V_{GS}$ = 0
1V
2V
3V
8
$-V_{GS}$ (V)
6
4
2
0
10
V_{DS} (V)
20

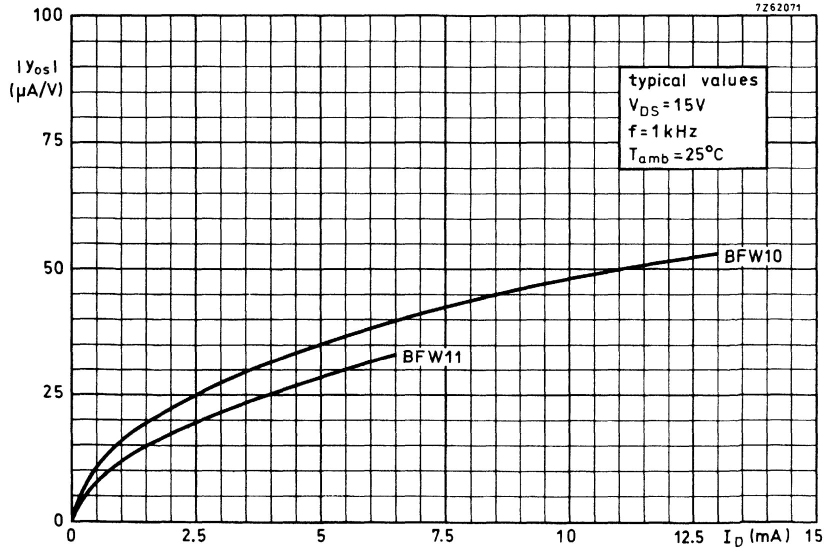

7Z08476
BFW11
V_{DS} = 15V
T_j = 25°C
I_D (mA)
typical values
15
10
5
max
typ
min
$-V_{GS}$ = 0
0.5V
1V
1.5V
2V
4
$-V_{GS}$ (V)
2
0
10
V_{DS} (V)
20

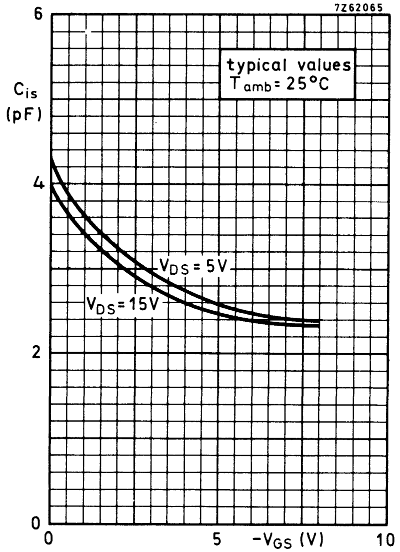

7Z08475
VDS = 15V
typical values
BFW10
ID (mA)
20
15
10
5
0
0
50
100
150
Tj (°C)
−VGS = 0
1V
2V

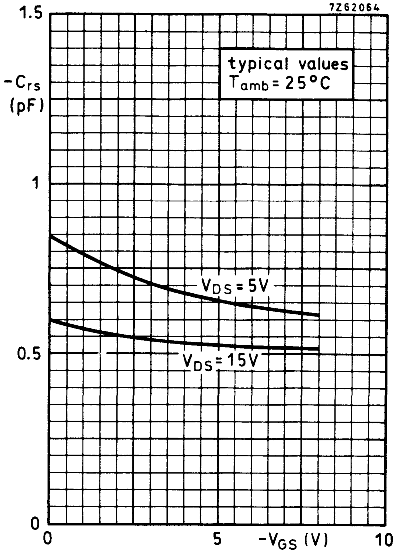

7Z08474
VDS = 15V
typical values
BFW11
ID (mA)
8
6
4
2
0
0
50
100
150
Tj (°C)
−VGS = 0
0.5V
1V

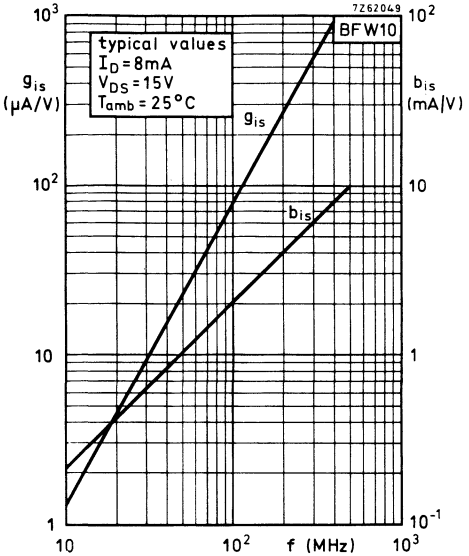

7Z62067
typical correlation between -V(P)GS and IDSS
-V(P)GS at ID = 0.5nA (V)
15
10
5
0
VDS = 15V
Tj = 25°C
BFW10
BFW11
0
10
20
IDSS at VGS = 0 (mA)

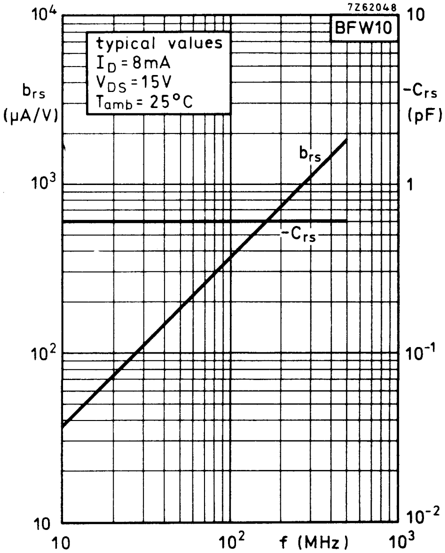

7Z62070
10
|y_fs|
(mA/V)
7.5
5
2.5
0
0
2.5
5
7.5
10
12.5
I_D (mA)
15
typical values
V_DS = 15 V
f = 1 kHz
T_amb = 25°C
BFW11
BFW10

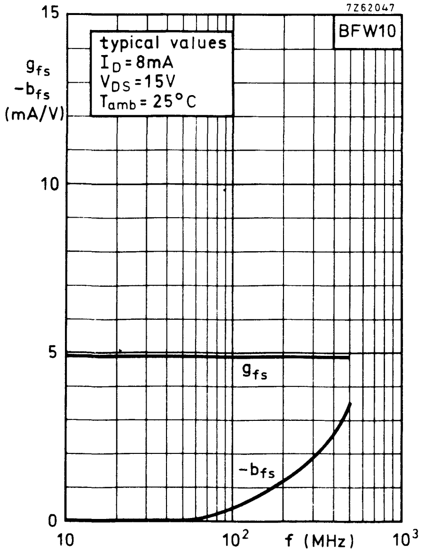

7Z62071
100
|y_os|
(μA/V)
75
50
25
0
0
2.5
5
7.5
10
12.5
I_D (mA)
15
typical values
V_DS = 15 V
f = 1 kHz
T_amb = 25°C
BFW10
BFW11

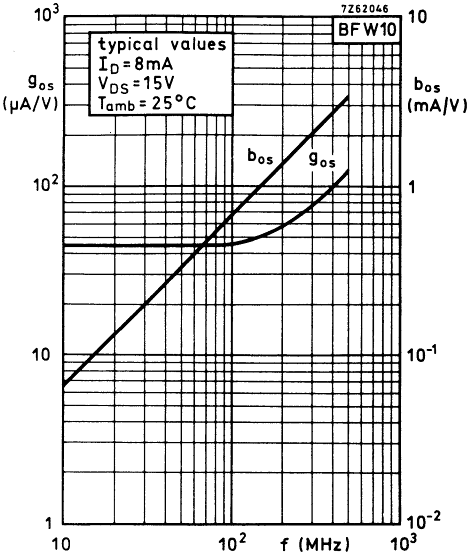

7Z62065
typical values
$T_{amb} = 25\,^{\circ}C$
C_{is} (pF)
6
4
2
0
$V_{DS} = 5V$
$V_{DS} = 15V$
0
5
$-V_{GS}$ (V)
10

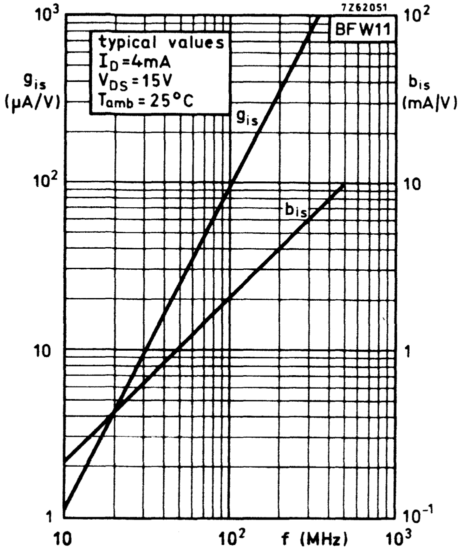

7Z62064
typical values
$T_{amb} = 25\,^{\circ}C$
$-C_{rs}$ (pF)
1.5
1
0.5
0
$V_{DS} = 5V$
$V_{DS} = 15V$
0
5
$-V_{GS}$ (V)
10

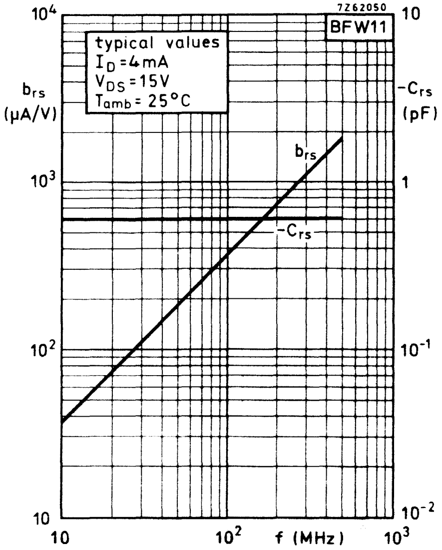

7Z62049
BFW10
typical values
$I_D = 8mA$
$V_{DS} = 15V$
$T_{amb} = 25°C$
g_{is} (μA/V)
b_{is} (mA/V)
g_{is}
b_{is}
10^3
10^2
10
1
10^2
10
1
10^{-1}
10
10^2
f (MHz)
10^3

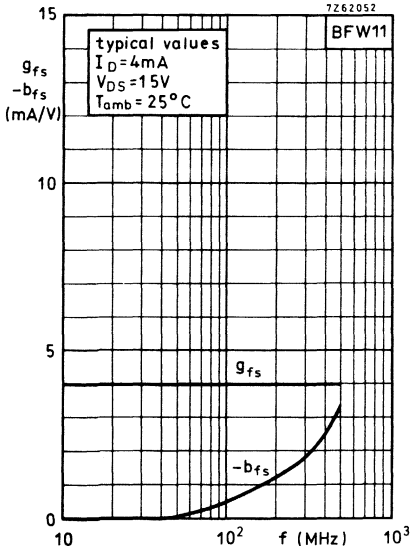

7Z62048
BFW10
typical values
$I_D = 8mA$
$V_{DS} = 15V$
$T_{amb} = 25°C$
b_{rs} (μA/V)
$-C_{rs}$ (pF)
b_{rs}
$-C_{rs}$
10^4
10^3
10^2
10
10
1
10^{-1}
10^{-2}
10
10^2
f (MHz)
10^3

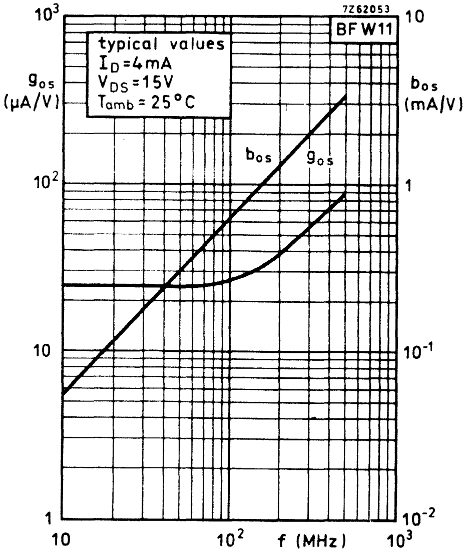

7Z62047
BFW10
typical values
$I_D = 8mA$
$V_{DS} = 15V$
$T_{amb} = 25°C$
g_{fs} $-b_{fs}$ (mA/V)
g_{fs}
$-b_{fs}$
15
10
5
0
10
10^2
f (MHz)
10^3

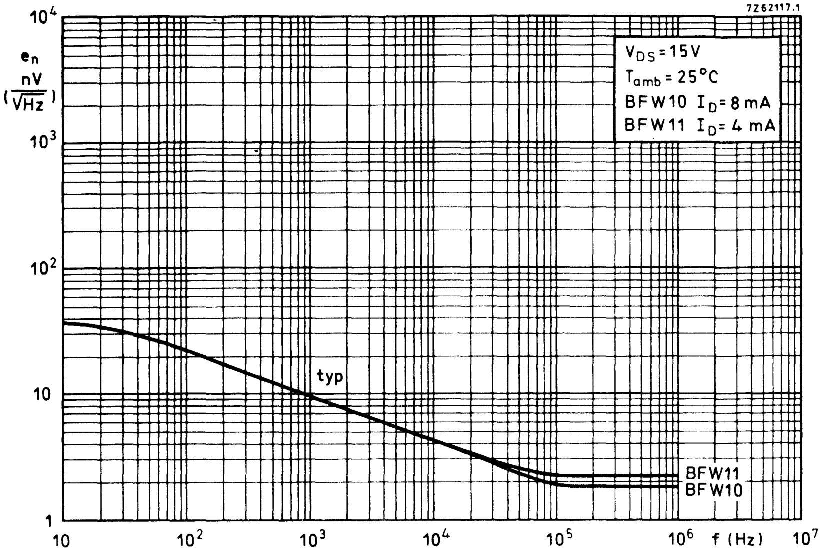

7Z62046
BFW10
typical values
$I_D = 8mA$
$V_{DS} = 15V$
$T_{amb} = 25°C$
g_{os} (μA/V)
b_{os} (mA/V)
b_{os}
g_{os}
10^3
10^2
10
1
10
1
10^{-1}
10^{-2}
10
10^2
f (MHz)
10^3

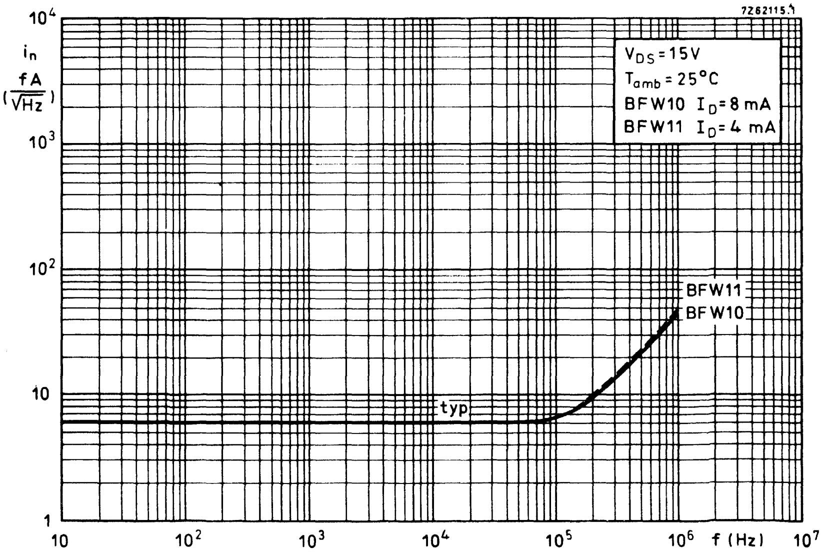

7Z62051
BFW11
typical values
$I_D = 4mA$
$V_{DS} = 15V$
$T_{amb} = 25°C$
g_{is} (µA/V)
b_{is} (mA/V)
g_{is}
b_{is}
10^3
10^2
10
1
10^2
10
1
10^{-1}
10
10^2
f (MHz)
10^3

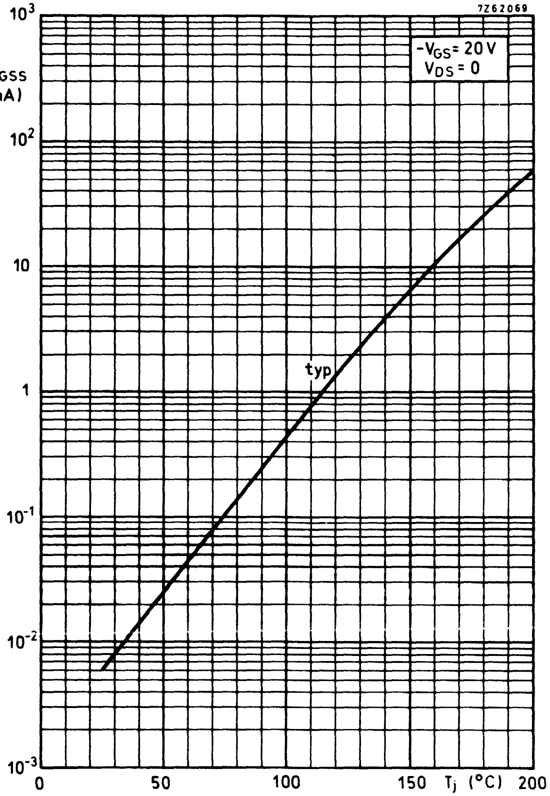

7Z62050
BFW11
typical values
$I_D = 4mA$
$V_{DS} = 15V$
$T_{amb} = 25°C$
b_{rs} (µA/V)
$-C_{rs}$ (pF)
b_{rs}
$-C_{rs}$
10^4
10^3
10^2
10
10
1
10^{-1}
10^{-2}
10
10^2
f (MHz)
10^3


7Z62052
BFW11
typical values
$I_D = 4mA$
$V_{DS} = 15V$
$T_{amb} = 25°C$
g_{fs}
$-b_{fs}$
(mA/V)
g_{fs}
$-b_{fs}$
15
10
5
0
10
10^2
f (MHz)
10^3


7Z62053
BFW11
typical values
$I_D = 4mA$
$V_{DS} = 15V$
$T_{amb} = 25°C$
g_{os} (µA/V)
b_{os} (mA/V)
b_{os}
g_{os}
10^3
10^2
10
1
10
1
10^{-1}
10^{-2}
10
10^2
f (MHz)
10^3

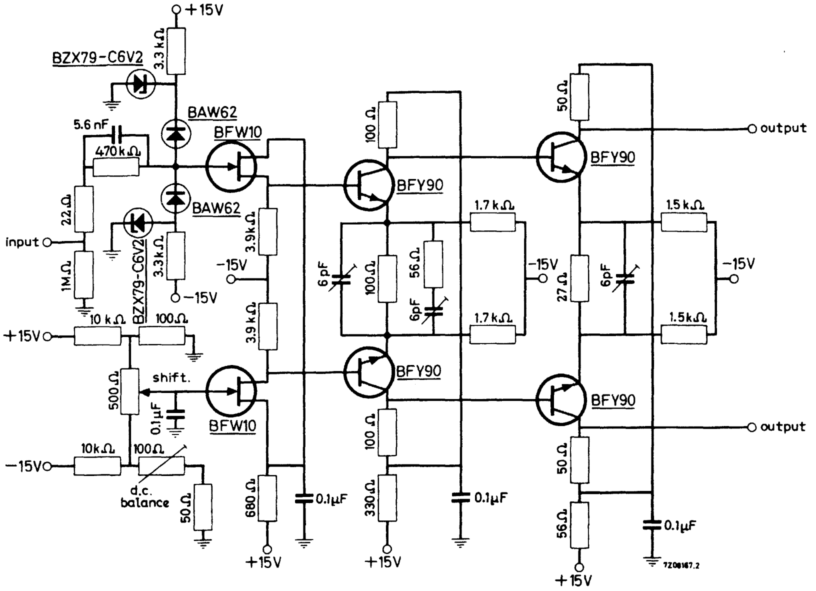

7Z62117.1
e_n
($\frac{nV}{\sqrt{Hz}}$)
10^4
10^3
10^2
10
1
V_{DS} = 15 V
T_{amb} = 25 °C
BFW10 I_D = 8 mA
BFW11 I_D = 4 mA
typ
BFW11
BFW10
10
10^2
10^3
10^4
10^5
10^6
f (Hz)
10^7


7Z62115.1
i_n
($\frac{fA}{\sqrt{Hz}}$)
10^4
10^3
10^2
10
1
V_{DS} = 15 V
T_{amb} = 25 °C
BFW10 I_D = 8 mA
BFW11 I_D = 4 mA
typ
BFW11
BFW10
10
10^2
10^3
10^4
10^5
10^6
f (Hz)
10^7


7Z62069
10^3
I_{GSS}
(nA)
10^2
10
1
10^{-1}
10^{-2}
10^{-3}
$-V_{GS}$ = 20 V
V_{DS} = 0
typ
0
50
100
150
T_j (°C)
200

APPLICATION INFORMATION

Input amplifier circuit for an oscilloscope.

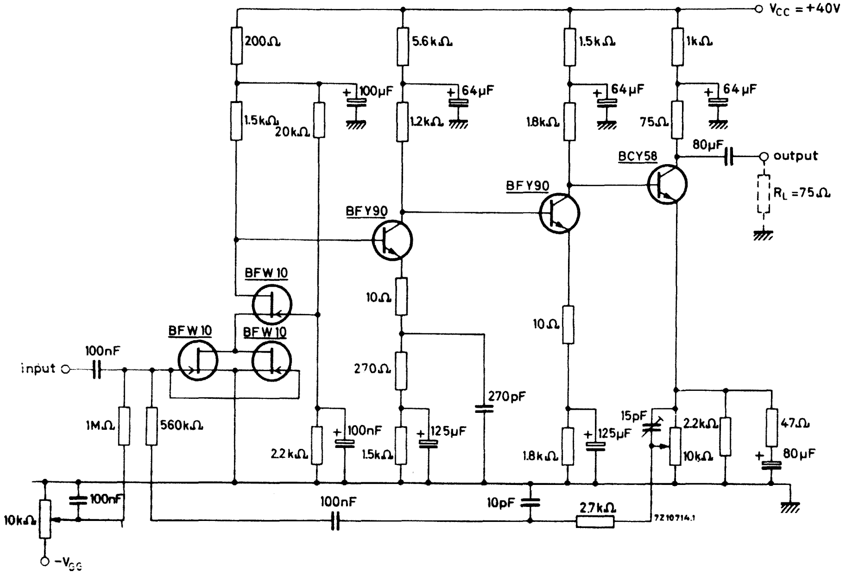


Performance:

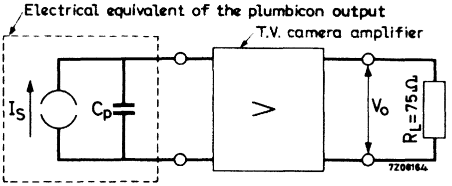
Input resistance	1 MΩ
Input capacitance	7.5 pF
Bandwidth	From d.c. to 300 MHz
Rise time	< 1 ns
Voltage gain	3.6
R.M.S. noise voltage (B = 300 MHz)	≤ 0.2 mV (input short-circuited)
Input sensitivity	This input amplifier is intended for an oscilloscope with a maximum input sensitivity of 5 or 10 mV/cm and a total bandwidth of 150 MHz
Input voltage	Max. permissible input voltage: peak to peak 600 V d.c. 300 V

APPLICATION INFORMATION (continued)

Television camera amplifier with BFW10



The circuit is designed for the Plumbicon Television Camera tube No. 55876. The electrical behaviour of this tube can be described as consisting of a current source I_S, shunted by a capacitance C_p ($C_p \approx 12$ pF).



Performance:

Transfer impedance (40 Hz to 5 MHz)	$\frac{V_O}{I_S}$	=	10^6 V/A
Output resistance	R_o	=	75 Ω
Output voltage (peak to peak) (d $\leq$ 5%)	V_O	<	1.3 V
Signal-noise ratio			
Ratio of V_O p-p (at I_S p-p = 0.3 µA) and the effective output noise voltage V_n (f from 40 Hz to 5 MHz)	$\frac{V_{O\,p\text{-}p}}{V_n}$	=	46 dB

N-CHANNEL SILICON FIELD EFFECT TRANSISTORS

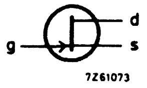
N-channel silicon epitaxial planar junction field effect transistors in a TO-72 metal envelope with the shield lead connected to the case.
The transistors are intended for battery powered equipment and other low current/ low voltage applications.

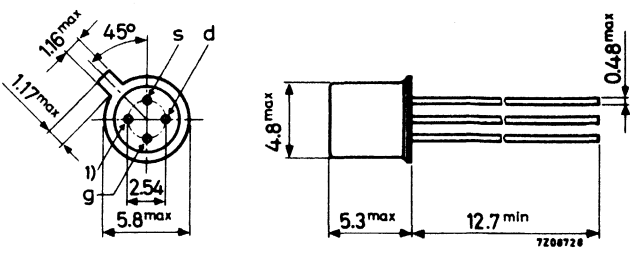
QUICK REFERENCE DATA

Drain-source voltage	$\pm V_{DS}$	max.	30		V
Gate-source voltage (open drain)	$-V_{GSO}$	max.	30		V
Total power dissipation up to $T_{amb} = 110\,^{\circ}C$	P_{tot}	max.	150		mW
			BFW12	BFW13	
Drain current $V_{DS} = 15$ V; $V_{GS} = 0$	I_{DSS}	>	1	0.2	mA
		<	5	1.5	mA
Gate-source cut-off voltage $I_D = 0.5$ nA; $V_{DS} = 15$ V	$-V_{(P)GS}$	<	2.5	1.2	V
Feedback capacitance at f = 1 MHz $V_{DS} = 15$ V; $V_{GS} = 0$	$-C_{rs}$	<	0.80	0.80	pF
Transfer admittance (common source) $V_{DS} = 15$ V; $I_D = 200\ \mu A$; f = 1 kHz	$\lvert y_{fs} \rvert$	>	0.5	0.5	mA/V
Equivalent noise voltage $V_{DS} = 15$ V; $I_D = 200\ \mu A$ B = 0.6 to 100 Hz	V_n	<	0.5	0.5	µV

MECHANICAL DATA Dimensions in mm

TO-72
Insulated electrodes





1) = shield lead (connected to case)

Accessories supplied on request: 56246, 56263

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

Voltages				
Drain-source voltage	$\pm V_{DS}$	max.	30	V
Drain-gate voltage (open source)	V_{DGO}	max.	30	V
Gate-source voltage (open drain)	$-V_{GSO}$	max.	30	V
Currents				
Drain current	I_D	max.	10	mA
Gate current	I_G	max.	5	mA
Power dissipation				
Total power dissipation up to T_{amb} = 110 °C	P_{tot}	max.	150	mW
Temperatures				
Storage temperature	T_{stg}	-65 to	+200	°C
Junction temperature	T_j	max.	200	°C

THERMAL RESISTANCE

From junction to ambient	$R_{th\ j\text{-}a}$	=	0.59	°C/mW

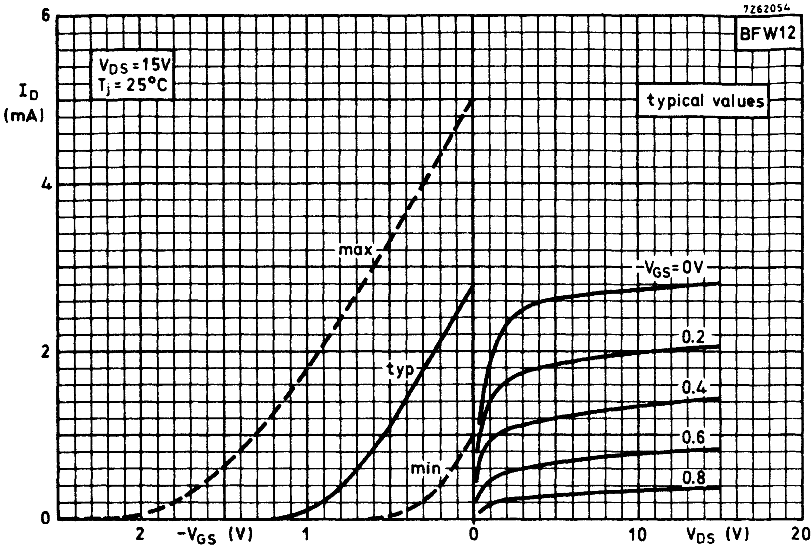
CHARACTERISTICS

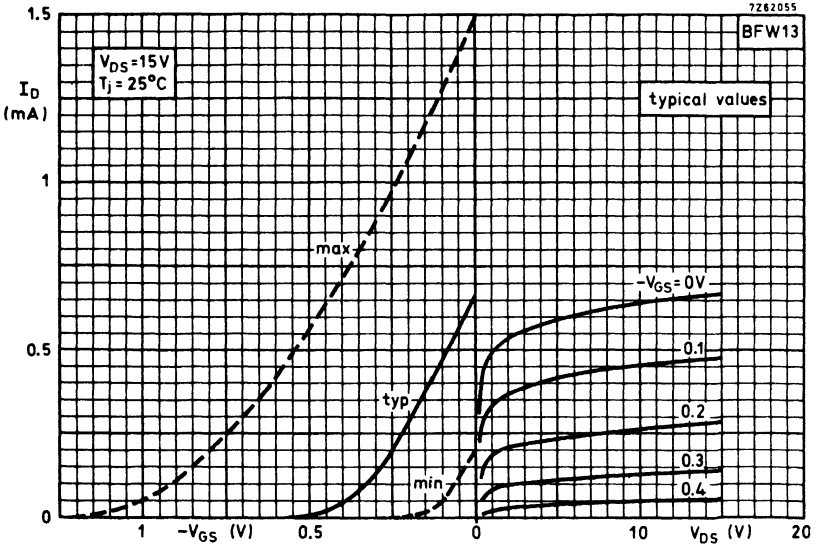
T_j = 25 °C unless otherwise specified

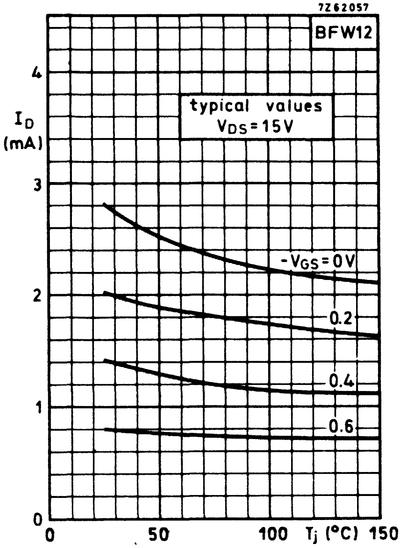
			BFW12	BFW13	
Gate cut-off current					
$-V_{GS}$ = 10 V; V_{DS} = 0	$-I_{GSS}$	<	0.1	0.1	nA
$-V_{GS}$ = 10 V; V_{DS} = 0; T_j = 150 °C	$-I_{GSS}$	<	0.1	0.1	μA
Drain current 1)					
V_{DS} = 15 V; V_{GS} = 0	I_{DSS}	>	1	0.2	mA
		<	5	1.5	mA
Gate-source voltage					
I_D = 50 μA; V_{DS} = 15 V	$-V_{GS}$	>	0.5	0.1	V
		<	2.0	1.0	V
Gate-source cut-off voltage					
I_D = 0.5 nA; V_{DS} = 15 V	$-V_{(P)GS}$	<	2.5	1.2	V
y parameters at f = 1 kHz; T_{amb} = 25 °C					
V_{DS} = 15 V; V_{GS} = 0					
Transfer admittance	$\|y_{fs}\|$	>	2.0	1.0	mA/V
Output admittance	$\|y_{os}\|$	<	30	10	μA/V
V_{DS} = 15 V; I_D = 500 μA					
Transfer admittance	$\|y_{fs}\|$	>	1.5	-	mA/V
Output admittance	$\|y_{os}\|$	<	10	-	μA/V
V_{DS} = 15 V; I_D = 200 μA					
Transfer admittance	$\|y_{fs}\|$	>	0.5	0.5	mA/V
Output admittance	$\|y_{os}\|$	<	5	5	μA/V
f = 1 MHz; T_{amb} = 25 °C					
V_{DS} = 15 V; V_{GS} = 0					
Input capacitance	C_{iss}	<	5	5	pF
Feedback capacitance	$-C_{rs}$	<	0.80	0.80	pF
Equivalent noise voltage					
V_{DS} = 15 V; I_D = 200 μA; T_{amb} = 25 °C B = 0.6 to 100 Hz	V_n	<	0.5	0.5	μV

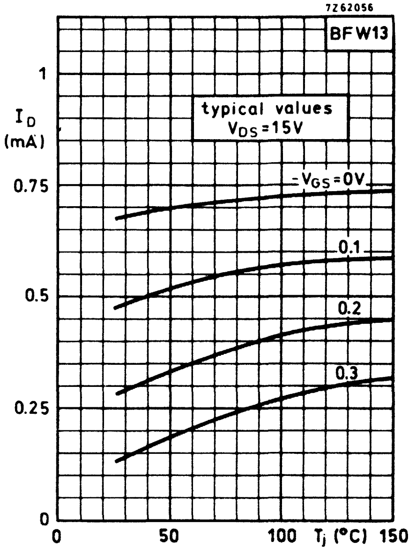
---

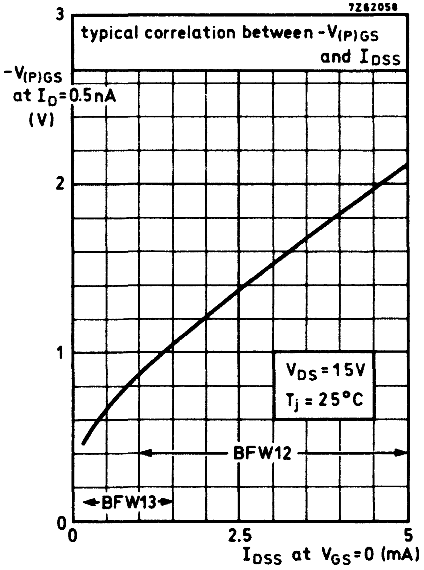
1) Measured under pulsed conditions.

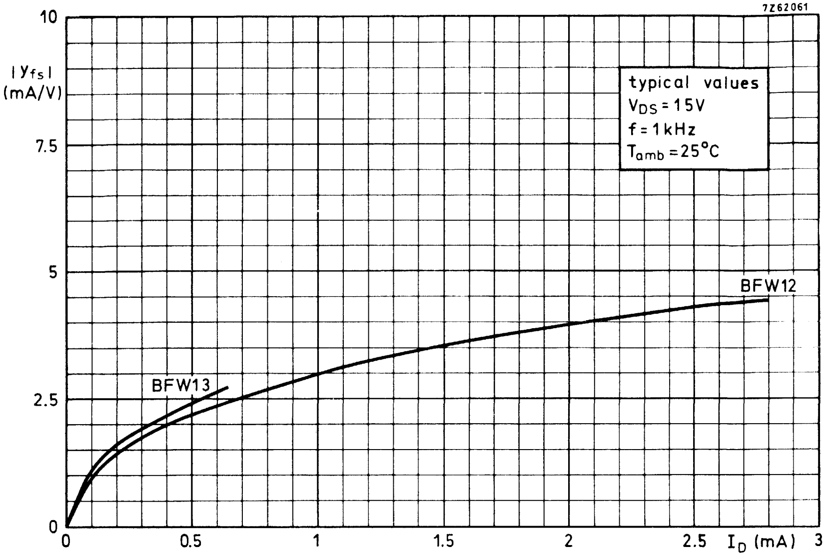

7Z62054
BFW12
V_{DS} = 15 V
T_j = 25 °C
I_D (mA)
typical values
max
typ
min
$-V_{GS}$ = 0 V
0.2
0.4
0.6
0.8
6
4
2
0
2
$-V_{GS}$ (V)
1
0
10
V_{DS} (V)
20

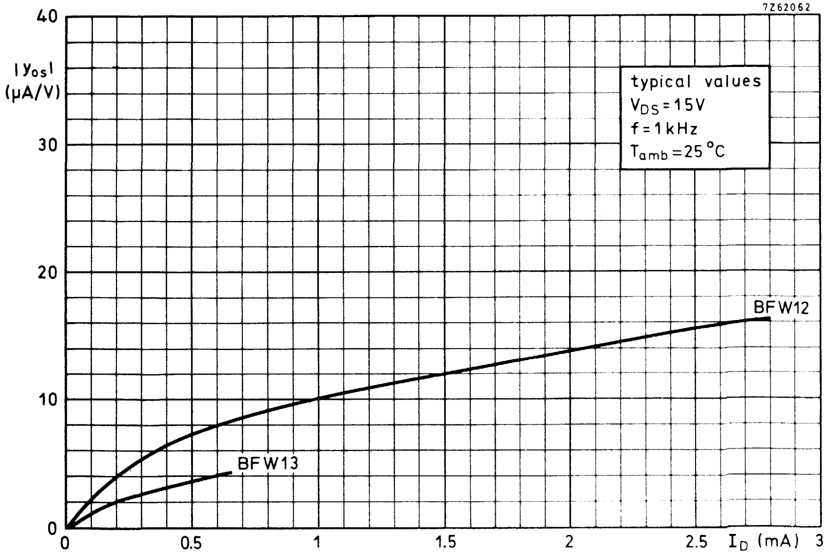

7Z62055
BFW13
V_{DS} = 15 V
T_j = 25 °C
I_D (mA)
typical values
max
typ
min
$-V_{GS}$ = 0 V
0.1
0.2
0.3
0.4
1.5
1
0.5
0
1
$-V_{GS}$ (V)
0.5
0
10
V_{DS} (V)
20

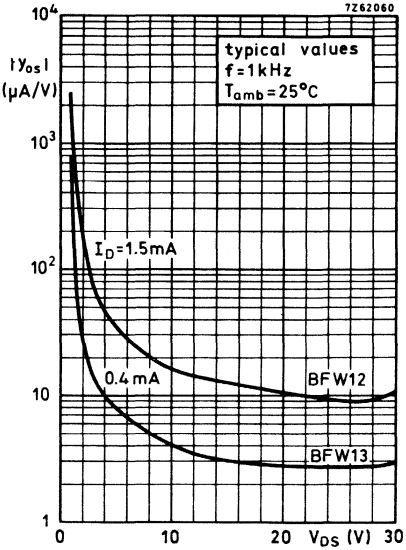

7Z62057
BFW12
typical values
V_{DS} = 15V
I_D (mA)
4
3
2
1
0
$-V_{GS}$ = 0V
0.2
0.4
0.6
0
50
100
T_j (°C)
150

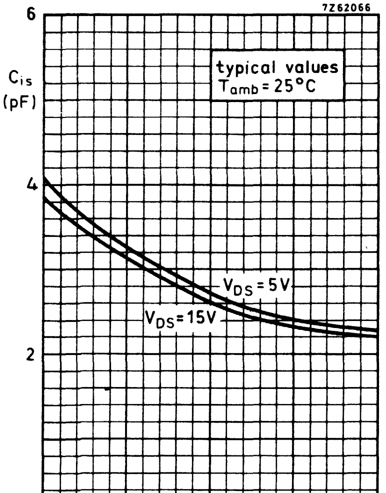

7Z62056
BFW13
typical values
V_{DS} = 15V
I_D (mA)
1
0.75
0.5
0.25
0
$-V_{GS}$ = 0V
0.1
0.2
0.3
0
50
100
T_j (°C)
150

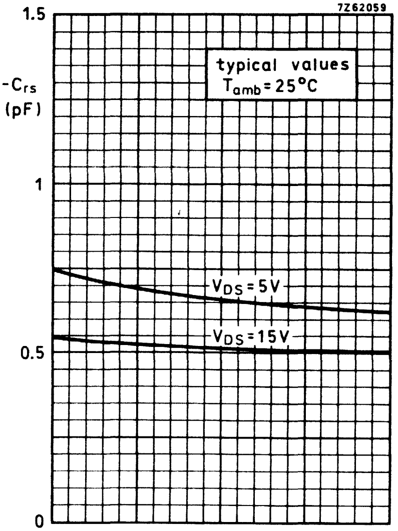

7Z62058
typical correlation between $-V_{(P)GS}$ and I_{DSS}
$-V_{(P)GS}$ at I_D = 0.5nA (V)
3
2
1
0
V_{DS} = 15V
T_j = 25°C
BFW12
BFW13
0
2.5
5
I_{DSS} at V_{GS} = 0 (mA)

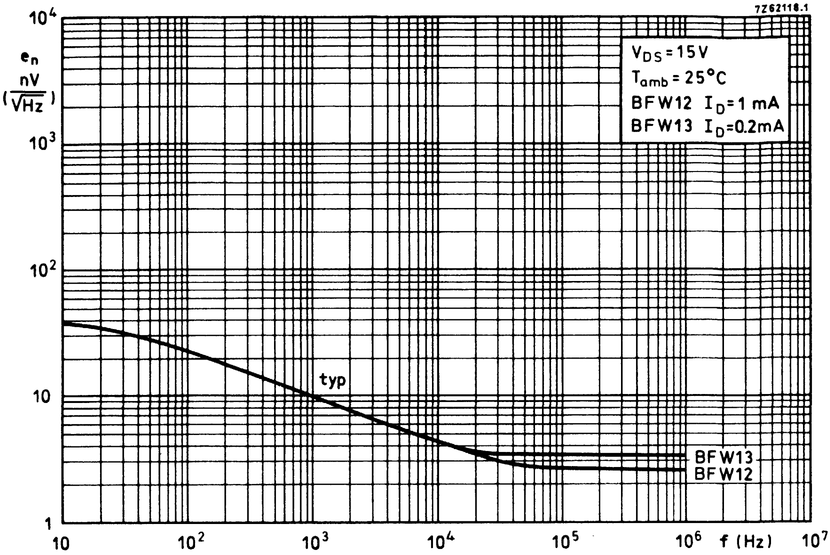

7Z62061
|yfs|
(mA/V)
10
7.5
5
2.5
0
0
0.5
1
1.5
2
2.5
I_D (mA)
3
typical values
V_{DS} = 15V
f = 1kHz
T_{amb} = 25°C
BFW12
BFW13

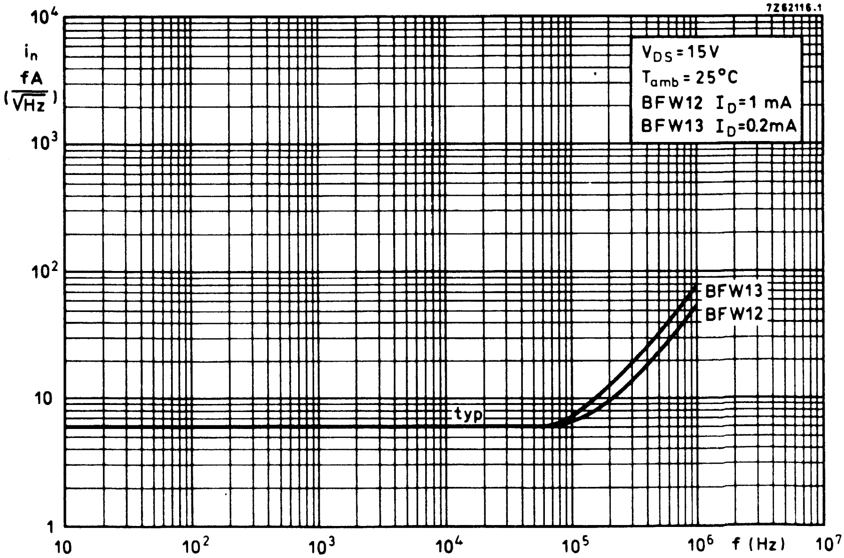

7Z62062
|yos|
(µA/V)
40
30
20
10
0
0
0.5
1
1.5
2
2.5
I_D (mA)
3
typical values
V_{DS} = 15V
f = 1kHz
T_{amb} = 25°C
BFW12
BFW13

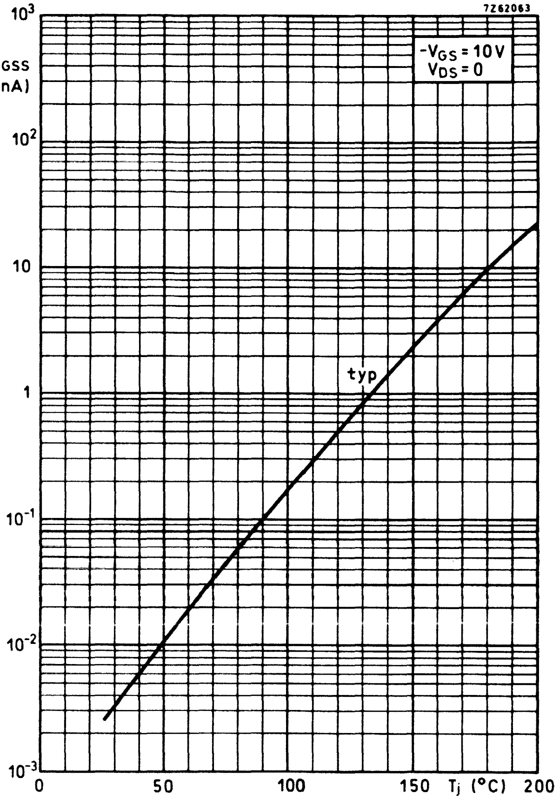

7Z62060
$|y_{os}|$
(μA/V)
10^4
10^3
10^2
10
1
typical values
f = 1 kHz
T_{amb} = 25°C
I_D = 1.5 mA
0.4 mA
BFW12
BFW13
0
10
20
V_{DS} (V)
30


7Z62066
C_{is}
(pF)
6
4
2
0
typical values
T_{amb} = 25°C
V_{DS} = 5V
V_{DS} = 15V
0
2
$-V_{GS}$ (V)
4


7Z62059
$-C_{rs}$
(pF)
1.5
1
0.5
0
typical values
T_{amb} = 25°C
V_{DS} = 5V
V_{DS} = 15V
0
2
$-V_{GS}$ (V)
4


7Z62118.1
e_n
$\frac{nV}{\sqrt{Hz}}$
10^4
10^3
10^2
10
1
$V_{DS} = 15 V$
$T_{amb} = 25°C$
BFW12 $I_D = 1$ mA
BFW13 $I_D = 0.2$ mA
typ
BFW13
BFW12
10
10^2
10^3
10^4
10^5
10^6
f (Hz)
10^7


7Z62116.1
i_n
$\frac{fA}{\sqrt{Hz}}$
10^4
10^3
10^2
10
1
$V_{DS} = 15 V$
$T_{amb} = 25°C$
BFW12 $I_D = 1$ mA
BFW13 $I_D = 0.2$ mA
typ
BFW13
BFW12
10
10^2
10^3
10^4
10^5
10^6
f (Hz)
10^7


7Z62063
I_{GSS} (nA)
10^3
10^2
10
1
10^{-1}
10^{-2}
10^{-3}
$-V_{GS} = 10\,V$
$V_{DS} = 0$
typ
0
50
100
150
T_j (°C)
200

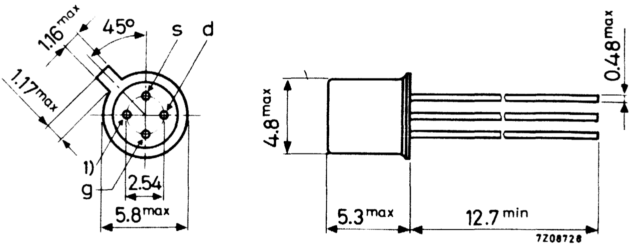
N-CHANNEL SILICON FIELD EFFECT TRANSISTOR

N-channel silicon epitaxial planar junction field effect transistor in a TO-72 metal envelope with the shield lead connected to the case.
The transistor is designed for general purpose amplifiers.

QUICK REFERENCE DATA				
Drain-source voltage	$\pm V_{DS}$	max.	25	V
Gate-source voltage (open drain)	$-V_{GSO}$	max.	25	V
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	300	mW
Drain current V_{DS} = 15 V; V_{GS} = 0	I_{DSS}		2 to 20	mA
Gate-source cut-off voltage I_D = 1.0 nA; V_{DS} = 15 V	$-V_{(P)GS}$	<	8	V
Feedback capacitance at f = 1 MHz V_{DS} = 15 V; V_{GS} = 0	$-C_{rs}$	<	2.0	pF
Transfer admittance (common source) V_{DS} = 15 V; V_{GS} = 0; f = 10 MHz	$\lvert y_{fs} \rvert$	>	1.6	$m\Omega^{-1}$

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 (IEC134)

Voltages

Drain-source voltage	$\pm V_{DS}$	max.	25	V
Drain-gate voltage (open source)	V_{DGO}	max.	25	V
Gate-source voltage (open drain)	$-V_{GSO}$	max.	25	V

Currents

Drain current	I_D	max.	20	mA
Gate current	I_G	max.	10	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	$R_{th\ j\text{-}a}$	=	0.59	°C/mW

CHARACTERISTICS T_j = 25 °C unless otherwise specified

Gate cut-off current				
$-V_{GS}$ = 20 V; V_{DS} = 0	$-I_{GSS}$	<	1.0	nA
$-V_{GS}$ = 20 V; V_{DS} = 0; T_j = 150 °C	$-I_{GSS}$	<	1.0	μA
Drain current [1]				
V_{DS} = 15 V; V_{GS} = 0	I_{DSS}	2 to	20	mA
Gate-source voltage				
I_D = 200 μA; V_{DS} = 15 V	$-V_{GS}$	0.5 to	7.5	V
Gate-source cut-off voltage				
I_D = 1.0 nA; V_{DS} = 15 V	$-V_{(P)GS}$	<	8	V
y parameters (common source)				
V_{DS} = 15 V; V_{GS} = 0				
f = 1 kHz Transfer admittance	$\lvert y_{fs} \rvert$	2.0 to	6.5	$m\Omega^{-1}$
Output admittance	$\lvert y_{os} \rvert$	<	85	$\mu\Omega^{-1}$
f = 1 MHz Input capacitance	C_{is}	<	6	pF
Feedback capacitance	$-C_{rs}$	<	2.0	pF
f = 10 MHz Transfer admittance	$\lvert y_{fs} \rvert$	>	1.6	$m\Omega^{-1}$

---

[1] Measured under pulsed conditions.

N-CHANNEL FIELD EFFECT TRANSISTORS

Silicon N-channel junction field effect transistors in a TO-18 metal envelope with the gate connected to the case. The transistors are intended for switching applications. The devices are symmetrical and have the feature: low "on" resistance at zero gate voltage.

QUICK REFERENCE DATA

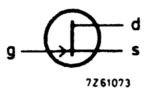
Drain-source voltage	V_{DS}	max.	40			V
Total power dissipation up to $T_{amb} = 25\,^{o}C$	P_{tot}	max.	350			mW
Drain current			BSV78	BSV79	BSV80	
$V_{DS} = 15\,V;\ V_{GS} = 0$	I_{DSS}	>	50	20	10	mA
Gate-source cut-off voltage $I_D = 1\,nA;\ V_{GS} = 15\,V$	$-V_{(P)GS}$	>	3.75	2.0	1.0	V
		<	11	7.0	5.0	V
Drain-source resistance (on) at f = 1 kHz $I_D = 0;\ V_{GS} = 0$	$r_{ds\ on}$	<	25	40	60	Ω
Feedback capacitance at f = 1 MHz $V_{DS} = 0;\ -V_{GS} = 10\,V$	$-C_{rs}$	<	5	5	5	pF
Turn on time	t_{on}	<	10	15	15	ns
Turn off time	t_{off}	<	10	15	25	ns

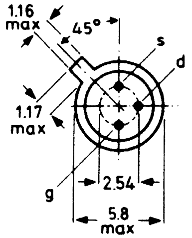
MECHANICAL DATA

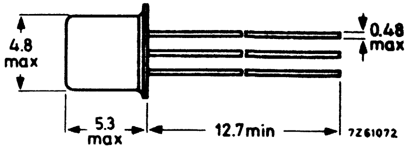
Dimensions in mm

Gate connected to case

TO-18







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

Voltages

Drain-source voltage	V_{DS}	max.	40	V
Drain-gate voltage (open source)	V_{DGO}	max.	40	V
Gate-source voltage (open drain)	$-V_{GSO}$	max.	40	V

Current

Forward gate current	I_G	max.	50	mA

Power dissipation

Total power dissipation up to $T_{amb} = 25\,^oC$	P_{tot}	max.	350	mW

Temperatures

Storage temperature	T_{stg}		-65 to +200	°C
Junction temperature	T_j	max.	175	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	0.43	°C/mW

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Gate cut-off current

$-V_{GS}$ = 20 V; V_{DS} = 0	$-I_{GSS}$	<	0.25	nA
$-V_{GS}$ = 20 V; V_{DS} = 0; T_j = 150 °C	$-I_{GSS}$	<	0.5	μA

Drain cut-off current

V_{DS} = 15 V; $-V_{GS}$ = 12 V	I_{DSX}	<	0.25	nA
V_{DS} = 15 V; $-V_{GS}$ = 12 V; T_j = 150 °C	I_{DSX}	<	0.5	μA

			BSV78	BSV79	BSV80	
Drain current						
V_{DS} = 15 V; V_{GS} = 0	I_{DSS}	>	50	20	10	mA
Gate-source cut-off voltage						
I_D = 1 nA; V_{DS} = 15 V	$-V_{(P)GS}$	>	3.75	2.0	1.0	V
		<	11	7.0	5.0	V
Gate-source voltage						
I_D = 1.5 μA; V_{DS} = 15 V	$-V_{GS}$	>	3.5	1.75	0.75	V
		<	10	6.0	4.0	V
Drain-source voltage (on)						
I_D = 20 mA; V_{GS} = 0	V_{DSon}	<	500			mV
I_D = 10 mA; V_{GS} = 0	V_{DSon}	<		400		mV
I_D = 5 mA; V_{GS} = 0	V_{DSon}	<			325	mV
Drain-source resistance (on) at f = 1 kHz						
I_D = 0; V_{GS} = 0	$r_{ds\ on}$	<	25	40	60	Ω
y parameters at f = 1 MHz (common source)						
$-V_{GS}$ = 10 V; V_{DS} = 0						
Input capacitance	C_{is}	<	10	10	10	pF
Feedback capacitance	$-C_{rs}$	<	5	5	5	pF

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

Turn on time when switched from

$-V_{GS} = 11$ V to $I_D = 20$ mA: BSV78
$-V_{GS} = 7$ V to $I_D = 10$ mA: BSV79
$-V_{GS} = 5$ V to $I_D = 5$ mA: BSV80
} at $V_{DD} = 10$ V

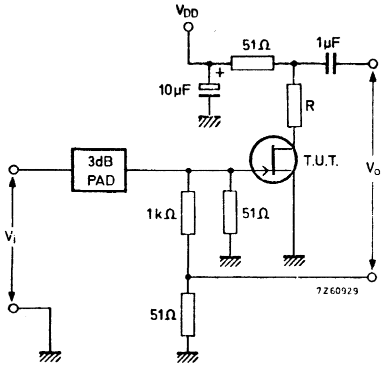
			BSV78	BSV79	BSV80	
delay time	t_d	<	5	10	8	ns
rise time	t_r	<	5	5	7	ns
turn on time	t_{on}	<	10	15	15	ns

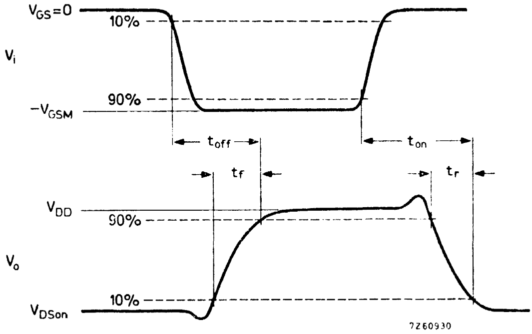
Turn off time when switched from

$I_D = 20$ mA to $-V_{GS} = 11$ V (BSV78)
$I_D = 10$ mA to $-V_{GS} = 7$ V (BSV79)
$I_D = 5$ mA to $-V_{GS} = 5$ V (BSV80)
} at $V_{DD} = 10$ V

			BSV78	BSV79	BSV80	
fall time	t_f	<	6	10	20	ns
storage time	t_s	<	4	5	5	ns
turn off time	t_{off}	<	10	15	25	ns

Test circuit:





$$R_L = \frac{10 - V_{DSon}}{I_{Don}} - 51\ \Omega$$

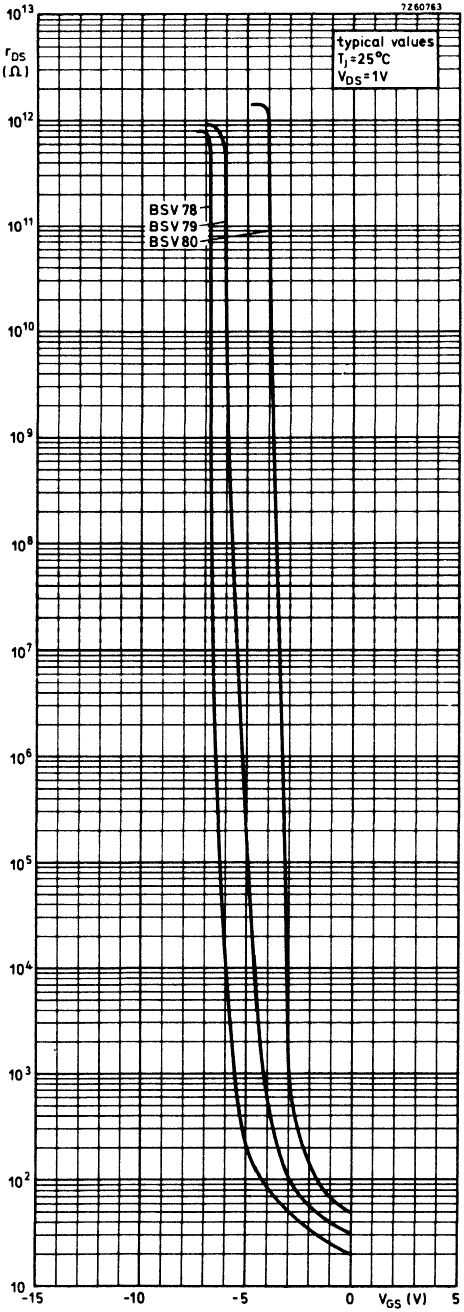
	BSV78	BSV79	BSV80	
R_L =	424	909	1885	Ω

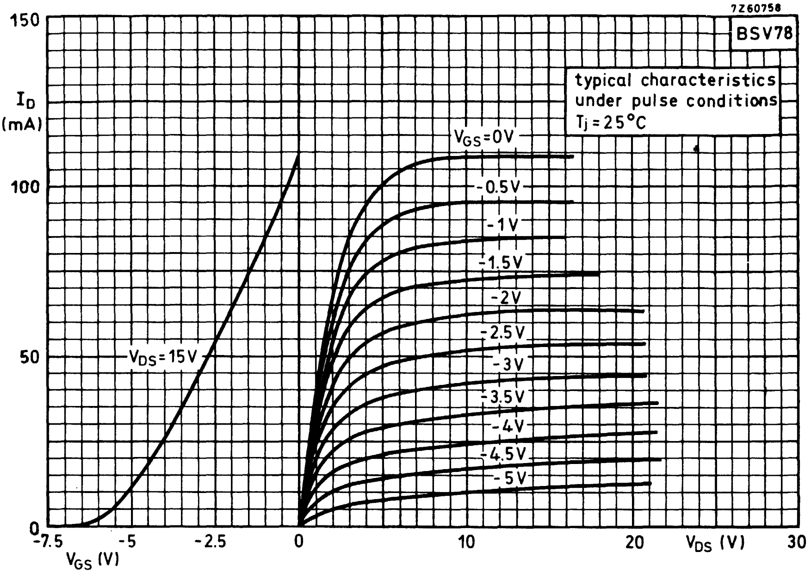
Pulse generator:

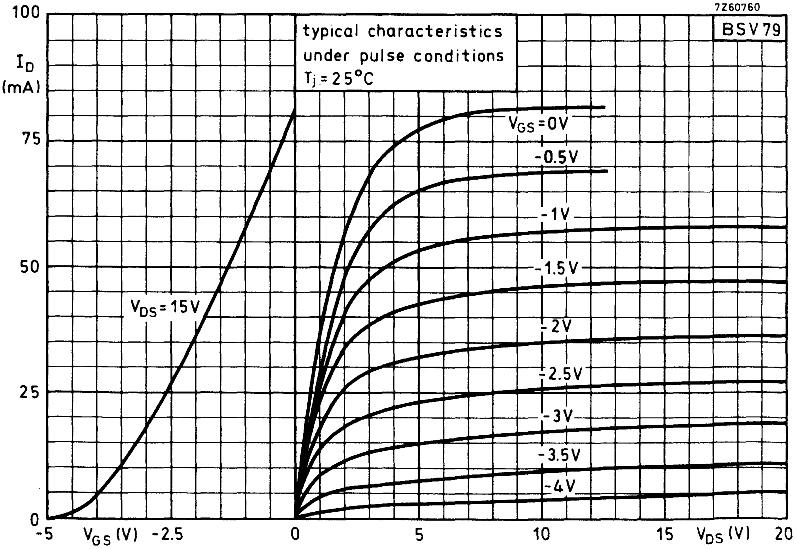
R_i = 50 Ω
t_r < 0.5 ns
t_f < 5 ns

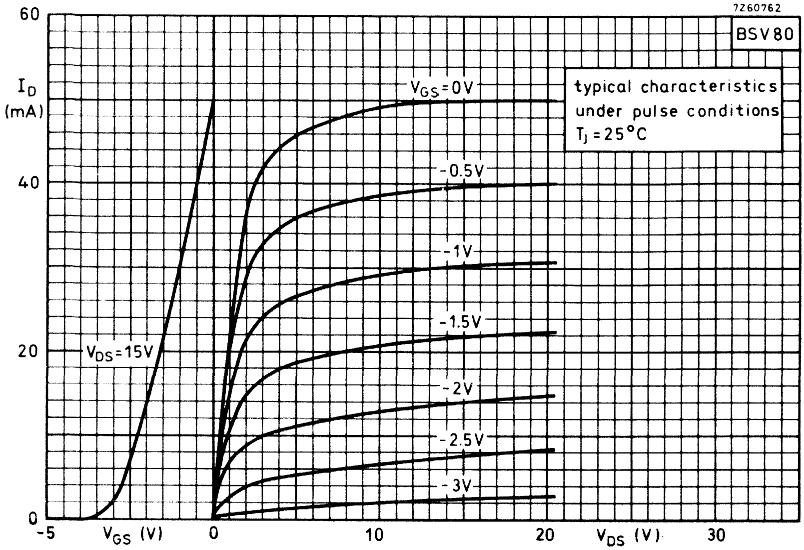
Oscilloscope:

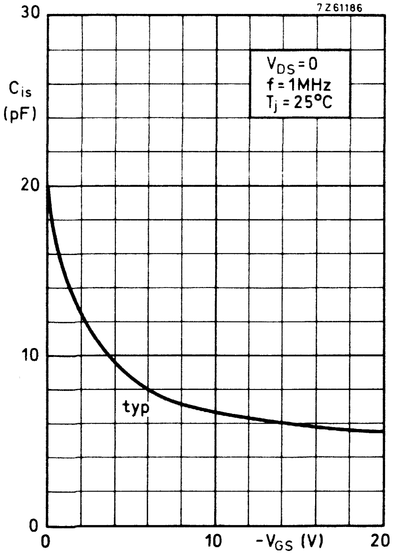
R_i = 50 Ω
t_r < 1 ns
t_f < 1 ns

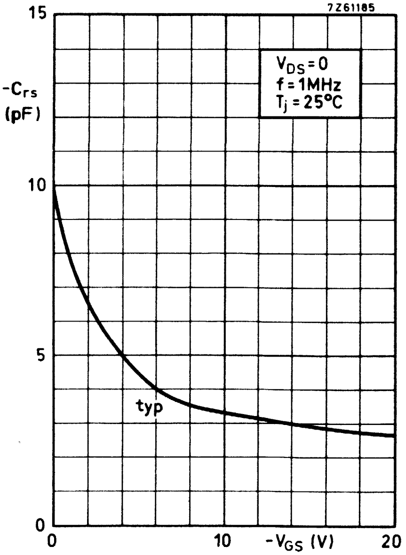

7Z60763
typical values
$T_j = 25\,°C$
$V_{DS} = 1\,V$
r_{DS} (Ω)
10^{13}
10^{12}
10^{11}
10^{10}
10^{9}
10^{8}
10^{7}
10^{6}
10^{5}
10^{4}
10^{3}
10^{2}
10
BSV 78
BSV 79
BSV 80
−15
−10
−5
0
V_{GS} (V)
5

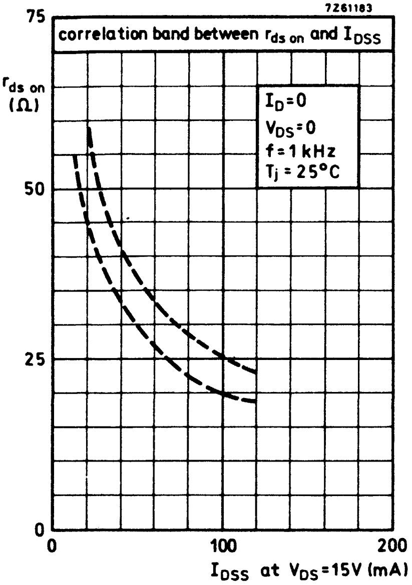

7Z60758
BSV78
typical characteristics
under pulse conditions
Tj = 25°C
150
100
50
0
ID
(mA)
VDS = 15 V
VGS = 0 V
-0.5 V
-1 V
-1.5 V
-2 V
-2.5 V
-3 V
-3.5 V
-4 V
-4.5 V
-5 V
-7.5
-5
-2.5
0
10
20
30
VGS (V)
VDS (V)

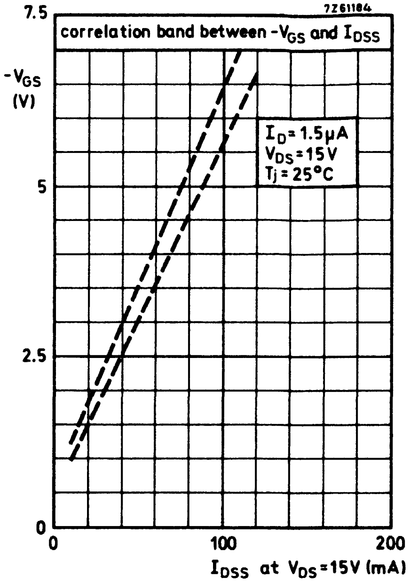

7Z60760
BSV79
typical characteristics
under pulse conditions
Tj = 25°C
100
75
50
25
0
ID
(mA)
VDS = 15 V
VGS = 0 V
-0.5 V
-1 V
-1.5 V
-2 V
-2.5 V
-3 V
-3.5 V
-4 V
-5
-2.5
0
5
10
15
20
VGS (V)
VDS (V)


7Z60762
BSV80
typical characteristics
under pulse conditions
$T_j = 25°C$
I_D
(mA)
60
40
20
0
-5
V_{GS} (V)
0
10
20
V_{DS} (V)
30
$V_{DS} = 15V$
$V_{GS} = 0V$
-0.5V
-1V
-1.5V
-2V
-2.5V
-3V


7Z61186
$V_{DS} = 0$
f = 1MHz
$T_j = 25°C$
C_{is}
(pF)
30
20
10
0
0
10
$-V_{GS}$ (V)
20
typ

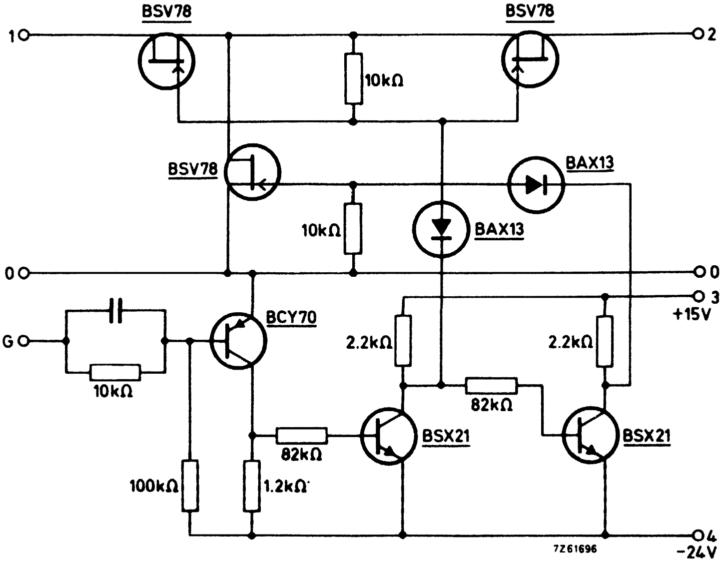

7Z61185
$V_{DS} = 0$
f = 1MHz
$T_j = 25°C$
$-C_{rs}$
(pF)
15
10
5
0
0
10
$-V_{GS}$ (V)
20
typ


7Z61183
correlation band between $r_{ds\,on}$ and I_{DSS}
$r_{ds\,on}$ (Ω)
75
50
25
0
$I_D = 0$
$V_{DS} = 0$
f = 1 kHz
$T_j = 25°C$
0
100
200
I_{DSS} at $V_{DS} = 15V$ (mA)


7Z61184
correlation band between $-V_{GS}$ and I_{DSS}
$-V_{GS}$ (V)
7.5
5
2.5
0
$I_D = 1.5\mu A$
$V_{DS} = 15V$
$T_j = 25°C$
0
100
200
I_{DSS} at $V_{DS} = 15V$ (mA)

APPLICATION INFORMATION

Floating bidirectional 50 mA switch with BSV78



Maximum allowable voltages:

V_{10}	max.	±	15	V
V_{20}	max.	±	15	V
V_{12}	max.	±	30	V

Maximum allowable current to be switched:

I_{12}	max.	±	50	mA

Supply currents:						
on-state	I_3 =	20 mA	off-state	I_3 =	20	mA
	I_4 =	20 mA		I_4 =	40	mA

Performance:

		on-state		off-state	
Gate voltage	typ.	6		0	V
Resistance between terminals 1 and 2	typ.	50		10^{10}	Ω
terminals 1 and 0	>	10^{10}		10^{10}	Ω
terminals 2 and 0	>	10^{10}		10^{10}	Ω

Switching times with R_L = 1 kΩ, when

switched to $V_{G\,on}$ = 6 V	t_{on}	< 50	ns
switched to $V_{G\,off}$ = 0	t_{off}	< 50	ns

N-CHANNEL INSULATED GATE FIELD EFFECT TRANSISTOR

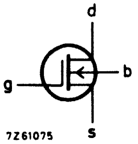
Depletion type insulated gate field effect transistor in a TO-72 metal envelope with the substrate connected to the case.
It is intended for chopper and other special switching applications, e.g. timing circuits, multiplex circuits, etc. The features are a very low drain-source 'on' resistance, a very high drain-source 'off' resistance and low feedback capacitances.

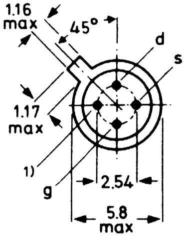
QUICK REFERENCE DATA

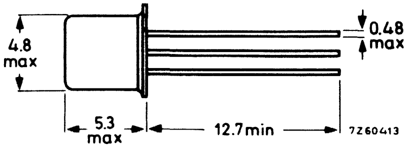
Drain-source resistance (on) at f = 1 kHz				
$V_{DS} = 0$; $V_{GS} = 5$ V; $V_{BS} = 0$	$r_{ds\,on}$	<	50	Ω
Drain-source resistance (off)				
$V_{DS} = 10$ V; $-V_{GS} = 5$ V; $V_{BS} = 0$	r_{DSoff}	>	10	GΩ
Feedback capacitances at f = 1 MHz				
$-V_{GS} = 5$ V; $V_{DS} = 0$; $I_B = 0$	$-C_{rs}$	<	0.5	pF
$-V_{GD} = 5$ V; $V_{SD} = 0$; $I_B = 0$	$-C_{rd}$	<	1.2	pF

MECHANICAL DATA Dimensions in mm

TO-72







[1] Substrate connected to case

Note: To safeguard the gates against damage duo to accumulation of static charge during transport or handling, the leads are encircled by a ring of conductive rubber which should be removed just after the transistor is soldered into the circuit.

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

Voltages

Drain-substrate voltage	V_{DB}	max.	30	V
Source-substrate voltage	V_{SB}	max.	30	V
Gate-substrate voltage (continuous)	V_{GB}	max.	10	V
		min.	−10	V
Repetitive peak gate to all other terminals voltage $V_{SB} = V_{DB} = 0$; $f > 100$ Hz	V_{G-N}	max.	15	V
		min.	−15	V
Non repetitive peak gate to all other terminals voltage $V_{SB} = V_{DB} = 0$; $t < 10$ ms	V_{G-N}	max.	50	V
		min.	−50	V

Currents

Drain current (peak value) $t_r = 20$ ms; $d = 0.1$	I_{DM}	max.	50	mA
Source current (peak value) $t_r = 20$ ms; $d = 0.1$	I_{SM}	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 +125	°C
Junction temperature	T_j	max.	125	°C

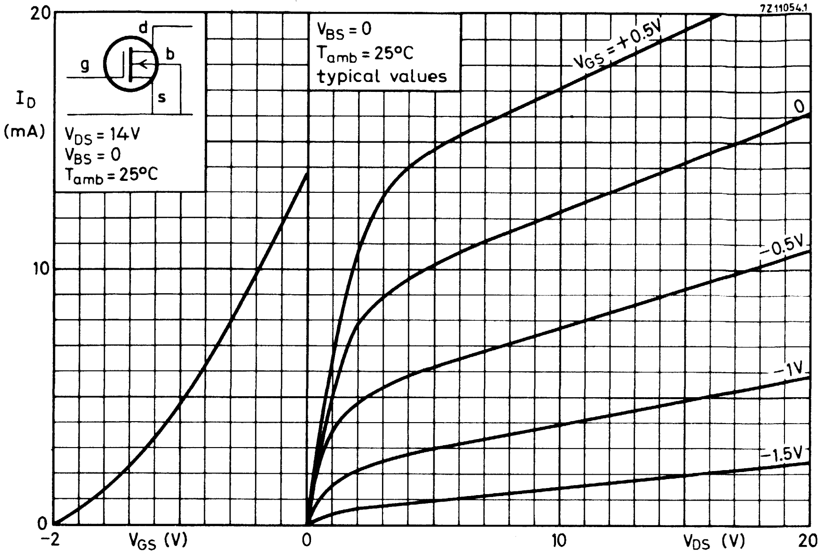
THERMAL RESISTANCE

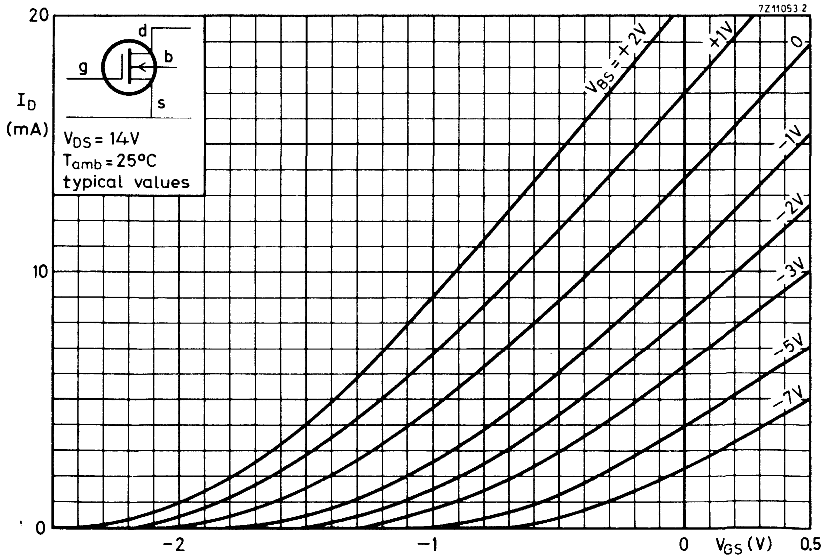
From junction to ambient in free air	$R_{th\ j-a}$	=	0.5	°C/mW

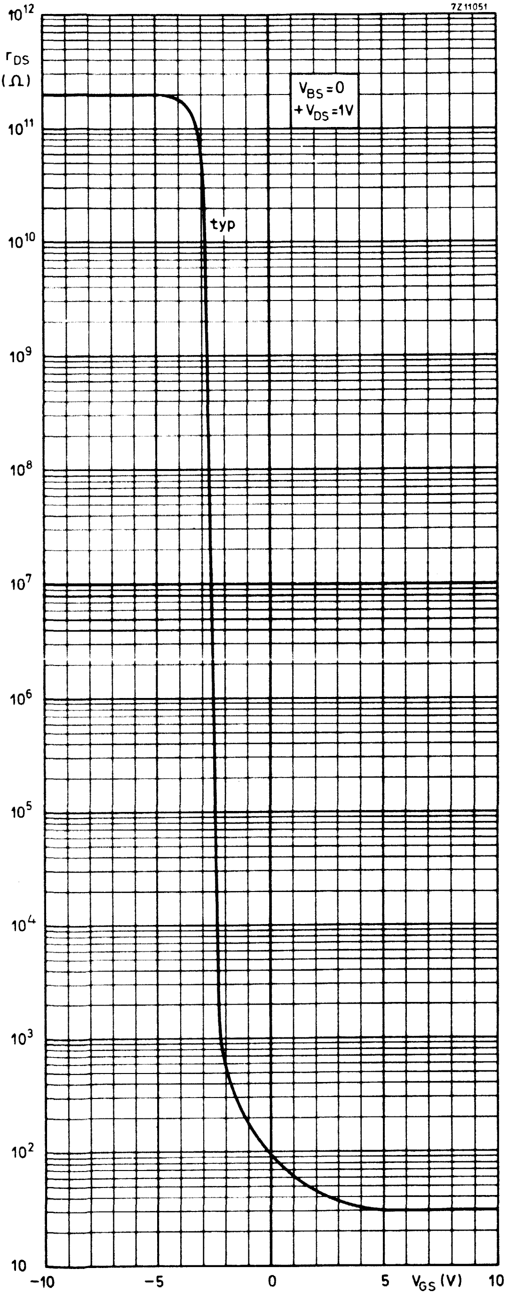
CHARACTERISTICS

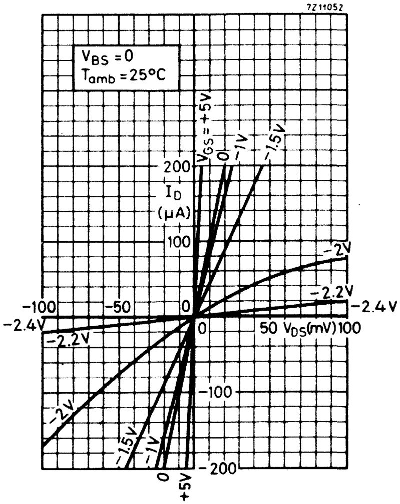
T_j = 25 °C unless otherwise specified

Drain cut-off currents; $V_{BS} = 0$				
$V_{DS} = 10$ V; $-V_{GS} = 5$ V	I_{DSX}	$<$	1	nA
$V_{DS} = 10$ V; $-V_{GS} = 5$ V; $T_j = 125$ °C	I_{DSX}	$<$	1	μA
Source cut-off currents; $V_{BD} = 0$				
$V_{SD} = 10$ V; $-V_{GD} = 5$ V	I_{SDX}	$<$	1	nA
$V_{SD} = 10$ V; $-V_{GD} = 5$ V; $T_j = 125$ °C	I_{SDX}	$<$	1	μA
Gate currents; $V_{BS} = 0$				
$-V_{GS} = 10$ V; $V_{DS} = 0$	$-I_{GSS}$	$<$	10	pA
$V_{GS} = 10$ V; $V_{DS} = 0$	I_{GSS}	$<$	10	pA
$-V_{GS} = 10$ V; $V_{DS} = 0$; $T_j = 125$ °C	$-I_{GSS}$	$<$	200	pA
$V_{GS} = 10$ V; $V_{DS} = 0$; $T_j = 125$ °C	I_{GSS}	$<$	200	pA
Bulk currents; $V_{GB} = 0$				
$-V_{BD} = 30$ V; $I_S = 0$	$-I_{BDO}$	$<$	10	μA
$-V_{BS} = 30$ V; $I_D = 0$	$-I_{BSO}$	$<$	10	μA
Drain-source resistance (on) at f = 1 kHz; $V_{BS} = 0$				
$V_{GS} = 0$; $V_{DS} = 0$	r_{dson}	$<$	100	Ω
$V_{GS} = 0$; $V_{DS} = 0$; $T_j = 125$ °C	r_{dson}	$<$	150	Ω
$+V_{GS} = 5$ V; $V_{DS} = 0$	r_{dson}	$<$	50	Ω
Drain-source resistance (off)				
$-V_{GS} = 5$ V; $V_{DS} = 10$ V; $V_{BS} = 0$	r_{DSoff}	$>$	10	GΩ
Feedback capacitances at f = 1 MHz				
$-V_{GS} = 5$ V; $V_{DS} = 0$; $I_B = 0$	C_{rs}	$<$	0.5	pF
$-V_{GD} = 5$ V; $V_{SD} = 0$; $I_B = 0$	C_{rd}	$<$	1.2	pF
Gate to all other terminals capacitance at f = 1 MHz				
$-V_{GB} = 5$ V; $V_{SB} = V_{DB} = 0$	C_{g-n}	$<$	5	pF


7Z11054.1
20
10
0
I_D
(mA)
d
g
b
s
V_DS = 14V
V_BS = 0
T_amb = 25°C
V_BS = 0
T_amb = 25°C
typical values
V_GS = +0.5V
0
−0.5V
−1V
−1.5V
−2
V_GS (V)
0
10
V_DS (V)
20


7Z11053.2
20
10
0
I_D
(mA)
d
g
b
s
V_DS = 14V
T_amb = 25°C
typical values
V_BS = +2V
+1V
0
−1V
−2V
−3V
−5V
−7V
−2
−1
0
V_GS (V)
0.5


7Z11051
10^{12}
r_{DS}
(Ω)
10^{11}
10^{10}
10^{9}
10^{8}
10^{7}
10^{6}
10^{5}
10^{4}
10^{3}
10^{2}
10
$V_{BS} = 0$
$+V_{DS} = 1V$
typ
−10
−5
0
5
V_{GS} (V)
10


7Z11052
$V_{BS} = 0$
$T_{amb} = 25°C$
$V_{GS} = +5V$
0
−1V
−1.5V
200
I_D
(μA)
100
−2V
−2.2V
−2.4V
−100
−50
0
0
50 V_{DS}(mV) 100
−2.4V
−2.2V
−100
−2V
−1.5V
−1V
0
+5V
−200

N-CHANNEL SILICON FIELD-EFFECT TRANSISTOR

Silicon N-channel depletion type junction-triode field-effect transistor in a plastic TO-92; intended for low-power audio amplifier applications in industrial service.

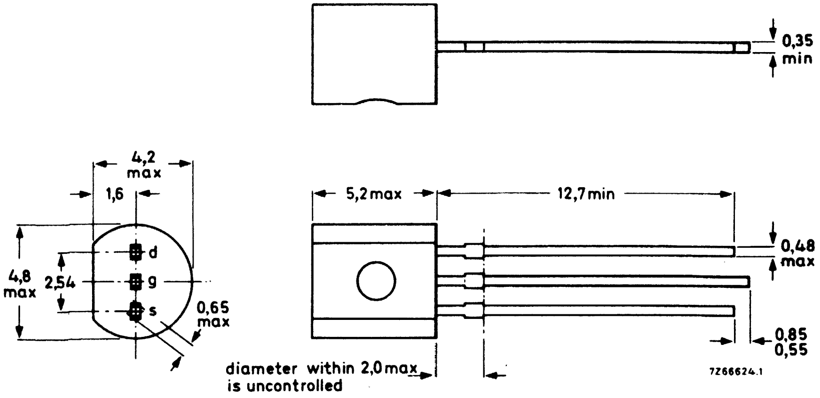
QUICK REFERENCE DATA

Drain-source voltage	$\pm V_{DS}$	max.	25	V
Gate-source voltage (open drain)	$-V_{GSO}$	max.	25	V
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	360	mW
Drain current V_{DS} = 15 V; V_{GS} = 0	I_{DSS}		2 to 20	mA
Gate-source cut-off voltage V_{DS} = 15 V; I_D = 2 nA	$-V_{(P)GS}$	<	8	V
Feedback capacitance at f = 1 MHz V_{DS} = 15 V; V_{GS} = 0; f = 1 kHz; T_{amb} = 25 °C	C_{rs}	<	4	pF
Transfer admittance (common source) V_{DS} = 15 V; V_{GS} = 0; T_{amb} = 25 °C	$\lvert y_{fs} \rvert$		2.0 to 6.5	mA/V

MECHANICAL DATA

Dimensions in mm

TO-92



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

Voltages

Drain-source voltage	$\pm V_{DS}$	max.	25	V
Drain-gate voltage (open source)	V_{DGO}	max.	25	V
Gate-source voltage (open drain)	$-V_{GSO}$	max.	25	V

Current

Gate current	I_G	max.	10	mA

Power dissipation

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

Temperatures

Storage temperature	T_{stg}	−65 to +150		°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	347	°C/W

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

Gate cut-off current					
$-V_{GS} = 20\ V;\ V_{DS} = 0$	$-I_{GSS}$	<	2	nA	
$-V_{GS} = 20\ V;\ V_{DS} = 0;\ T_{amb} = 100\ ^{o}C$	$-I_{GSS}$	<	2	μA	
Drain current					
$V_{DS} = 15\ V;\ V_{GS} = 0$	I_{DSS}		2 to 20	mA	1)
Gate-source breakdown voltage					
$-I_G = 1\ \mu A;\ V_{DS} = 0$	$-V_{(BR)GSS}$	>	25	V	
Gate-source voltage					
$I_D = 200\ \mu A;\ V_{DS} = 15\ V$	$-V_{GS}$		0,5 to 7,5	V	
Gate-source cut-off voltage					
$I_D = 2\ nA;\ V_{DS} = 15\ V$	$-V_{(P)GS}$	<	8	V	
y-parameters (common source)					
$V_{DS} = 15\ V;\ V_{GS} = 0$					
f = 1 kHz Transfer admittance	$\|y_{fs}\|$		2,0 to 6,5	mA/V	1)
Output admittance	$\|y_{os}\|$	typ.	50	μA/V	1)
f = 100 MHz Transfer admittance	$\|y_{fs}\|$	>	1,6	mA/V	
f = 1 MHz Input capacitance	C_{is}	<	8	pF	
Feedback capacitance	C_{rs}	<	4	pF	

---

1) Measured under pulse conditions: $t_p = 100\ ms;\ \delta \leq 0,1$

N-CHANNEL SILICON FIELD EFFECT TRANSISTOR

Silicon N-channel depletion type junction-triode field effect transistor in a TO-72 metal envelope, primarily intended for depletion mode operation in low power i.f.-r.f. amplifiers for industrial applications.

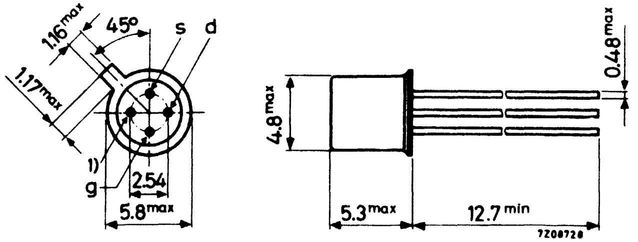
QUICK REFERENCE DATA

Drain-source voltage	V_{DS}	max.	30	V
Gate-source voltage	$-V_{GS}$	max.	30	V
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	300	mW
Gate cut-off current $-V_{GS}$ = 20 V; V_{DS} = 0	$-I_{GSS}$	<	0.5	nA
Feedback capacitance at f = 1 MHz V_{DS} = 15 V; V_{GS} = 0	$-C_{rs}$	<	2	pF
Transfer admittance (common source) V_{DS} = 15 V; V_{GS} = 0; f = 200 MHz T_{amb} = 25 °C	$\lvert y_{fs} \rvert$	>	3.2	$m\Omega^{-1}$

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				
Drain-source voltage	V_{DS}	max.	30	V
Drain-gate voltage	V_{DG}	max.	30	V
Gate-source voltage	$-V_{GS}$	max.	30	V
Current				
Gate current	I_G	max.	10	mA
Power dissipation				
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	300	mW
Linear derating factor			2	mW/°C
Temperatures				
Storage temperature	T_{stg}		-65 to +200	°C
Junction temperature	T_j	max.	200	°C

CHARACTERISTICS T_j = 25 °C unless otherwise specified

Gate cut-off current				
$-V_{GS}$ = 20 V; V_{DS} = 0	$-I_{GSS}$	<	0.5	nA
$-V_{GS}$ = 20 V; V_{DS} = 0; T_j = 150 °C	$-I_{GSS}$	<	0.5	µA
Drain current [1]				
V_{DS} = 15 V; V_{GS} = 0	I_{DSS}	4 to	20	mA
Gate-source voltage				
I_D = 400 µA; V_{DS} = 15 V	$-V_{GS}$	1 to	7.5	V
Gate-source cut-off voltage				
I_D = 0.5 nA; V_{DS} = 15 V	$-V_{(P)GS}$	<	8	V
Gate-source breakdown voltage				
$-I_G$ = 1 µA; V_{DS} = 0	$-V_{(BR)GSS}$	>	30	V

---

[1] Measured under pulsed conditions; pulse duration t = 100 ms; duty cycle $\delta \leq 0.1$.

CHARACTERISTICS (continued)

y parameters (common source)

$V_{DS} = 15$ V; $V_{GS} = 0$ $T_{amb} = 25$ °C

f = 1 kHz	Transfer admittance [1]	$\|y_{fs}\|$		3.5 to 6.5	$m\Omega^{-1}$
	Output admittance [1]	$\|y_{os}\|$	<	35	$\mu\Omega^{-1}$
f = 1 MHz	Input capacitance	C_{is}	<	6	pF
	Feedback capacitance	$-C_{rs}$	<	2	pF
f = 200 MHz	Transfer admittance	$\|y_{fs}\|$	>	3.2	$m\Omega^{-1}$
	Real part of input conductance	$R_e(y_{is})$	<	0.8	$m\Omega^{-1}$
	Real part of output conductance	$R_e(y_{os})$	<	0.2	$m\Omega^{-1}$

Noise figure at f = 100 MHz $T_{amb} = 25$ °C

$V_{DS} = 15$ V; $V_{GS} = 0$; $R_G = 1$ kΩ input tuned to minimum noise	F	<	2.5	dB

---

[1] Measured under pulsed conditions; Pulse duration t = 100 ms; duty cycle $\delta \leqslant 0.1$

N-CHANNEL SILICON FIELD EFFECT TRANSISTOR

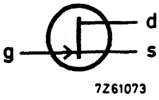
N-channel silicon epitaxial planar junction field effect transistor in a TO-72 metal envelope with the shield lead connected to the case.
The transistor is suitable in a variety of low power switching applications, e.g. in multiplexing systems.

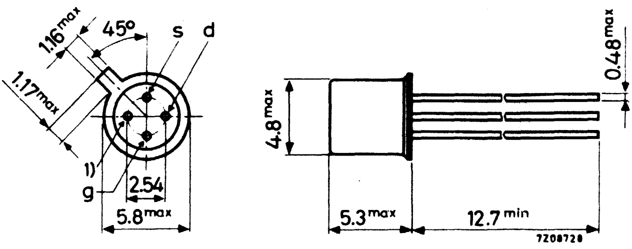
QUICK REFERENCE DATA

Drain-source voltage	$\pm V_{DS}$	max.	30	V
Gate-source voltage (open drain)	$-V_{GSO}$	max.	30	V
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	300	mW
Drain current V_{DS} = 20 V; V_{GS} = 0	I_{DSS}	>	2	mA
Gate-source cut-off voltage I_D = 10 nA; V_{DS} = 10 V	$-V_{(P)GS}$		4 to 6	V
Feedback capacitance at f = 1 MHz V_{DS} = 0; V_{GS} = 7 V	$-C_{rs}$	<	1.5	pF
Drain-source resistance (on) at f = 1 kHz V_{GS} = 0; I_D = 0	$r_{ds\ on}$	<	220	Ω

MECHANICAL DATA

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				
Drain-source voltage	$\pm V_{DS}$	max.	30	V
Drain-gate voltage (open source)	V_{DGO}	max.	30	V
Gate-source voltage (open drain)	$-V_{GSO}$	max.	30	V
Current				
Gate current	I_G	max.	10	mA
Power dissipation				
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	300	mW
Temperatures				
Storage temperature	T_{stg}		−55 to +200	°C
Junction temperature	T_j	max.	200	°C

THERMAL RESISTANCE

From junction to ambient $R_{th\ j\text{-}a}$ = 0.59 °C/mW

CHARACTERISTICS T_j = 25 °C unless otherwise specified

Gate cut-off current				
$-V_{GS}$ = 20 V; V_{DS} = 0	$-I_{GSS}$	<	0.1	nA
Drain current				
V_{DG} = 20 V; I_S = 0	I_{DGO}	<	0.1	nA
V_{DG} = 20 V; I_S = 0; T_{amb} = 150 °C	I_{DGO}	<	0.2	µA
Drain current [1])				
V_{DS} = 20 V; V_{GS} = 0	I_{DSS}	>	2	mA
Gate-source breakdown voltage				
$-I_G$ = 1.0 µA; V_{DS} = 0	$-V_{(BR)GS}$	>	30	V
Gate-source voltage				
I_D = 10 nA; V_{DS} = 10 V	$-V_{(P)GS}$		4 to 6	V
Drain-source voltage				
I_D = 1.0 mA; V_{GS} = 0	V_{DS}	<	0.25	V
Drain cut-off current				
V_{DS} = 10 V; $-V_{GS}$ = 7.0 V	I_D	<	1.0	nA
V_{DS} = 10 V; $-V_{GS}$ = 7.0 V; T_{amb} = 150 °C	I_D	<	2.0	µA
Drain-source resistance (on) at f = 1 kHz				
V_{GS} = 0; I_D = 0	$r_{ds\,on}$	<	220	Ω
Input capacitance at f = 1 MHz				
V_{DS} = 20 V; V_{GS} = 0	C_{is}	<	6	pF
Feedback capacitance at f = 1 MHz				
V_{DS} = 0; V_{GS} = 7 V	$-C_{rs}$	<	1.5	pF
Switching times				
V_{DD} = 1.5 V; $I_{D\,on}$ = 1.0 mA				
$V_{GS\,on}$ = 0; $-V_{GS\,off}$ = 6 V				
delay time	t_d	<	20	ns
rise time	t_r	<	100	ns
turn off time	t_{off}	<	100	ns

CHARACTERISTICS (continued)

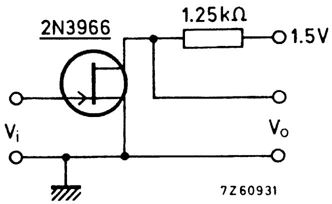
Switching times

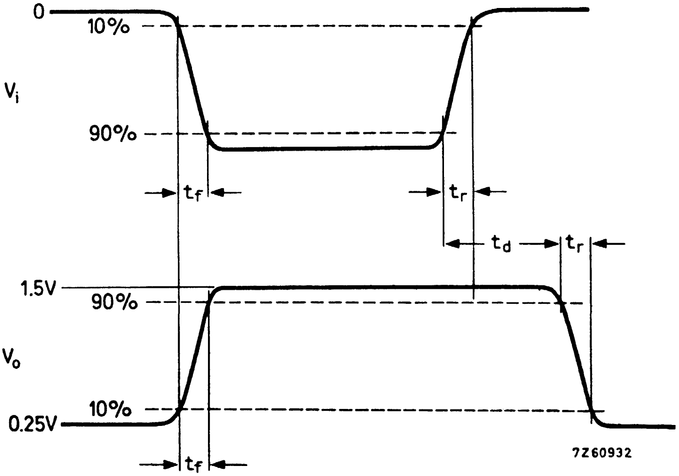
$V_{DD} = 1.5$ V; $I_{D\,on} = 1.0$ mA

$V_{GS\,on} = 0$; $-V_{GS\,off} = 6$ V

delay time	t_d	<	20	ns
rise time	t_r	<	100	ns
turn off time	t_{off}	<	100	ns

Test circuit:





Pulse generator:

$t_r < 1.0$ ns
$t_f < 1.0$ ns
$t_p = 1.0$ µs
$\delta < 0.5$
$R_S = 50\ \Omega$

Oscilloscope:

$t_r < 10$ ns
$R_i > 5$ MΩ
$C_i < 10$ pF

N-CHANNEL FIELD EFFECT TRANSISTORS

Silicon N-channel depletion type junction-triode field effect transistors in a TO-18 metal envelope with the gate connected to the case. The transistors are intended for low power switching applications in industrial service.

QUICK REFERENCE DATA

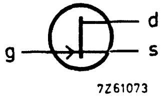
			2N4091	2N4092	2N4093	
Drain-source voltage	$\pm V_{DS}$	max.	40			V
Total power dissipation up to $T_{case} = 25\,^{o}C$	P_{tot}	max.	1.8			W
Drain current V_{DS} = 20 V; V_{GS} = 0	I_{DSS}	>	30	15	8	mA
Gate-source cut-off voltage I_D = 1 nA; V_{DS} = 20 V	$-V_{(P)GS}$	> <	5.0 10	2.0 7.0	1.0 5.0	V V
Drain-source resistance (on) at f = 1 kHz I_D = 0; V_{GS} = 0	$r_{ds\ on}$	<	30	50	80	Ω
Feedback capacitance at f = 1 MHz V_{DS} = 0; $-V_{GS}$ = 20 V	$-C_{rs}$	<		5.0		pF
Turn off time V_{DD} = 3.0 V; V_{GS} = 0						
I_D = 6.6 mA; $-V_{GSM}$ = 12 V 2N4091	t_{off}	<		40		ns
I_D = 4.0 mA; $-V_{GSM}$ = 8 V 2N4092	t_{off}	<		60		ns
I_D = 2.5 mA; $-V_{GSM}$ = 6 V 2N4093	t_{off}	<		80		ns

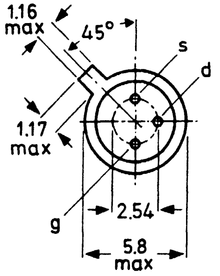
MECHANICAL DATA

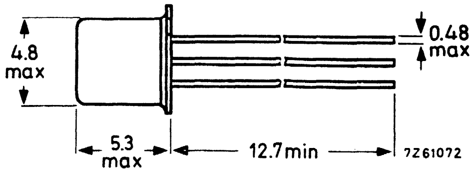
Dimensions in mm

Gate connected to case

TO-18







Accessories supplied on request: 56246, 56263.

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

Voltages

Drain-source voltage	$\pm V_{DS}$	max.	40	V
Drain-gate voltage (open source)	V_{DGO}	max.	40	V
Gate-source voltage (open drain)	$-V_{GSO}$	max.	40	V

Current

Forward gate current (d.c.)	I_G	max.	10	mA

Power dissipation

Total power dissipation up to $T_{case} = 25\ ^oC$	P_{tot}	max.	1.8	W

Temperatures

Storage temperature	T_{stg}	-55 to	+200	^oC
Junction temperature	T_j	max.	200	^oC

THERMAL RESISTANCE

From junction to case in free air	$R_{th\ j-c}$	=	0.1	$^oC/mW$

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

Drain current				
V_{DG} = 20 V; I_S = 0	I_{DGO}	<	0.2	nA
V_{DG} = 20 V; I_S = 0; T_{amb} = 150 °C	I_{DGO}	<	0.4	μA
Source current				
V_{SG} = 20 V; I_D = 0	I_{SGO}	<	0.2	nA

			2N4091	2N4092	2N4093	
Drain cut-off current						
V_{DS} = 20 V; $-V_{GS}$ = 12 V	I_{DSX}	<	0.2	–	–	nA
V_{DS} = 20 V; $-V_{GS}$ = 8 V	I_{DSX}	<	–	0.2	–	nA
V_{DS} = 20 V; $-V_{GS}$ = 6 V	I_{DSX}	<	–	–	0.2	nA
V_{DS} = 20 V; $-V_{GS}$ = 12 V; T_{amb} = 150 °C	I_{DSX}	<	0.4	–	–	μA
V_{DS} = 20 V; $-V_{GS}$ = 8 V; T_{amb} = 150 °C	I_{DSX}	<	–	0.4	–	μA
V_{DS} = 20 V; $-V_{GS}$ = 6 V; T_{amb} = 150 °C	I_{DSX}	<	–	–	0.4	μA
Gate-source breakdown voltage						
$-I_G$ = 1.0 μA; V_{DS} = 0	$-V_{(BR)GSS}$	>	40	40	40	V
Drain current [1]						
V_{DS} = 20 V; V_{GS} = 0	I_{DSS}	>	30	15	8	mA
Gate-source cut-off voltage						
I_D = 1 nA; V_{DS} = 20 V	$-V_{(P)GS}$	>	5.0	2.0	1.0	V ←
		<	10	7.0	5.0	V
Drain-source voltage (on)						
I_D = 6.6 mA; V_{GS} = 0	V_{DSon}	<	0.2	–	–	V
I_D = 4.0 mA; V_{GS} = 0	V_{DSon}	<	–	0.2	–	V
I_D = 2.5 mA; V_{GS} = 0	V_{DSon}	<	–	–	0.2	V
Drain- source resistance (on)						
I_D = 1.0 mA; V_{GS} = 0	r_{DSon}	<	30	50	80	Ω
Drain-source resistance (on) at f = 1 kHz						
I_D = 0; V_{GS} = 0	$r_{ds\ on}$	<	30	50	80	Ω

---

[1] Measured under pulsed conditions: $t_p \leq 300$ μs; $\delta \leq 0.03$

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

y-parameters at f = 1 MHz (common source)

V_{DS} = 20 V; V_{GS} = 0

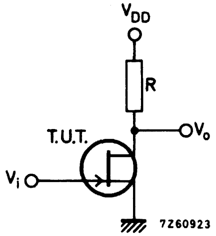
Input capacitance	C_{is}	<	16	pF
Feedback capacitance	$-C_{rs}$	<	5	pF

Switching times

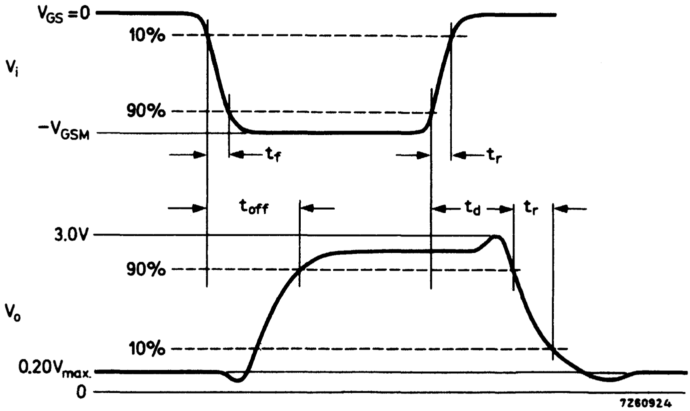
V_{DD} = 3.0 V; V_{GS} = 0

			2N4091	2N4092	2N4093	
	I_D	=	6.6	4.0	2.5	mA
	$-V_{GSM}$	=	12	8	6	V
Delay time	t_d	<	15	15	20	ns
Rise time	t_r	<	10	20	40	ns
Turn off time	t_{off}	<	40	60	80	ns

Test circuit:



$$R = \frac{2.8}{I_D}$$



Pulse generator:

t_r	<	1	ns
t_f	<	1	ns
t_p	=	1.0	µs
δ	=	0.1	
R_S	=	50	Ω

Oscilloscope:

t_r	<	0.4	ns
R_i	>	9.8	MΩ
Z_i	<	1.7	pF

N-CHANNEL FIELD EFFECT TRANSISTORS

Silicon N-channel depletion type junction-triode field effect transistors in a TO-18 metal envelope with the gate connected to the case. The transistors are intended for low power, chopper or switching, application in industrial service.

QUICK REFERENCE DATA

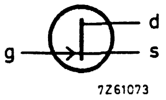
			2N4391	2N4392	2N4393	
Drain-source voltage	$\pm V_{DS}$	max.		40		V
Total power dissipation up to $T_{case} = 25\ ^{\circ}C$	P_{tot}	max.		1.8		W
Drain current $V_{DS} = 20\ V;\ V_{GS} = 0$	I_{DSS}	>	50	25	5	mA
Gate source cut-off voltage $I_D = 1\ nA;\ V_{DS} = 20\ V$	$-V_{(P)GS}$	>	4.0	2.0	0.5	V
		<	10	5.0	3.0	V
Drain-source resistance (on) at f = 1 kHz $I_D = 1\ mA;\ V_{GS} = 0$	r_{dson}	<	30	60	100	Ω
Feedback capacitance at f = 1 MHz $V_{DS} = 0;\ -V_{GS} = 12\ V$ (2N4391) $V_{DS} = 0;\ -V_{GS} = 7\ V$ (2N4392) $V_{DS} = 0;\ -V_{GS} = 5\ V$ (2N4393)	$-C_{rs}$	<	3.5	3.5	3.5	pF
Turn-off time $V_{DD} = 10\ V;\ V_{GS} = 0$ $I_D = 12\ mA;\ -V_{GSM} = 12\ V$ (2N4391)	t_{off}	<	20	-	-	ns
$I_D = 6.0\ mA;\ -V_{GSM} = 7\ V$ (2N4392)	t_{off}	<	-	35	-	ns
$I_D = 3.0\ mA;\ -V_{GSM} = 5\ V$ (2N4393)	t_{off}	<	-	-	50	ns

MECHANICAL DATA

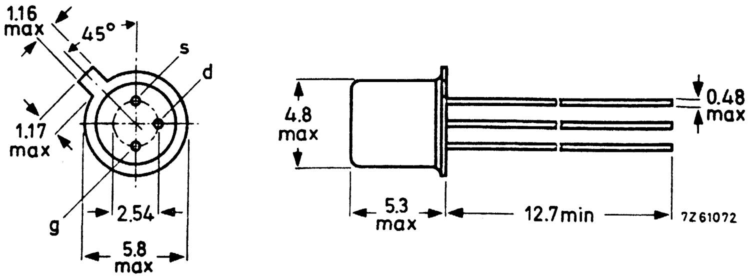
Dimensions in mm

Gate connected to case

TO-18



7Z61073



7Z61072

Accessories supplied on request: 56246, 56263

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

Voltages				
Drain-source voltage	$\pm V_{DS}$	max.	40	V
Drain-gate voltage (open source)	V_{DGO}	max.	40	V
Gate-source voltage	$-V_{GSO}$	max.	40	V
Current				
Gate current (d.c.)	I_G	max.	50	mA
Power dissipation				
Total power dissipation 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.	200	°C
Thermal resistance				
From junction to case in free air	$R_{th\ j\text{-}c}$	=	0.1	°C/mW

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

Gate cut-off current

$-V_{GS}$ = 20 V; V_{DS} = 0	$-I_{GSS}$ <	0.1	nA
$-V_{GS}$ = 20 V; V_{DS} = 0; T_{amb} = 150 °C	$-I_{GSS}$ <	0.2	µA

Drain cut-off current		2N4391	2N4392	2N4393	
V_{DS} = 20 V; $-V_{GS}$ = 12 V	I_{DSX} <	0.1	−	−	nA
V_{DS} = 20 V; $-V_{GS}$ = 7 V	I_{DSX} <	−	0.1	−	nA
V_{DS} = 20 V; $-V_{GS}$ = 5 V	I_{DSX} <	−	−	0.1	nA
V_{DS} = 20 V; $-V_{GS}$ = 12 V; T_{amb} = 150 °C	I_{DSX} <	0.2	−	−	µA
V_{DS} = 20 V; $-V_{GS}$ = 7 V; T_{amb} = 150 °C	I_{DSX} <	−	0.2	−	µA
V_{DS} = 20 V; $-V_{GS}$ = 5 V; T_{amb} = 150 °C	I_{DSX} <	−	−	0.2	µA

CHARACTERISTICS (continued)

T_{amb} = 25 °C unless otherwise specified

			2N4391	2N4392	2N4393	
Drain current [1]						
V_{DS} = 20 V; V_{GS} = 0	I_{DSS}	>	50	–	–	mA
		<	150	–	–	mA
V_{DS} = 20 V; V_{GS} = 0	I_{DSS}	>	–	25	–	mA
		<	–	75	–	mA
V_{DS} = 20 V; V_{GS} = 0	I_{DSS}	>	–	–	5	mA
		<	–	–	30	mA
Gate-source breakdown voltage						
$-I_G$ = 1 μA; V_{DS} = 0	$-V_{(BR)GSS}$	>	40	40	40	V
Gate-source voltage						
I_G = 1 mA; V_{DS} = 0	V_{GSon}	<	1.0	1.0	1.0	V
Gate-source cut-off voltage						
I_D = 1 nA; V_{DS} = 20 V	$-V_{(P)GS}$	>	4.0	2.0	0.5	V
		<	10	5.0	3.0	V
Drain-source voltage (on)						
I_D = 12 mA; V_{GS} = 0	V_{DSon}	<	0.4	–	–	V
I_D = 6.0 mA; V_{GS} = 0	V_{DSon}	<	–	0.4	–	V
I_D = 3.0 mA; V_{GS} = 0	V_{DSon}	<	–	–	0.4	V
Drain-source resistance (on)						
I_D = 1 mA; V_{GS} = 0	r_{DSon}	<	30	60	100	Ω
Drain-source resistance (on) at f = 1 kHz						
I_D = 0; V_{GS} = 0	r_{dson}	<	30	60	100	Ω
y parameters at f = 1 MHz (common source)						
Input capacitance						
V_{DS} = 20 V; V_{GS} = 0	C_{is}	<	14	14	14	pF
Feedback capacitance						
$-V_{GS}$ = 12 V; V_{DS} = 0	$-C_{rs}$	<	3.5	–	–	pF
$-V_{GS}$ = 7 V; V_{DS} = 0	$-C_{rs}$	<	–	3.5	–	pF
$-V_{GS}$ = 5 V; V_{DS} = 0	$-C_{rs}$	<	–	–	3.5	pF

---

[1] measured under pulsed conditions: t_p = 100 μs; δ = 0.01

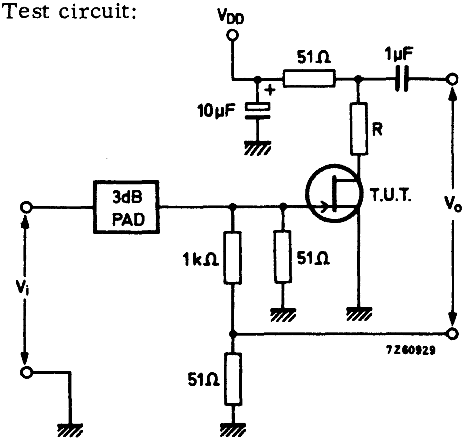
CHARACTERISTICS (continued) $T_{amb} = 25\,^{\circ}C$ unless otherwise specified

Switching times

$V_{DD} = 10\,V$; $V_{GS} = 0$

			2N4391	2N4392	2N4393	
	I_D	=	12	6.0	3.0	mA
	$-V_{GSM}$	=	12	7	5	V
Rise time	t_r	<	5	5	5	ns
Turn on time	t_{on}	<	15	15	15	ns
Fall time	t_f	<	15	20	30	ns
Turn off time	t_{off}	<	20	35	50	ns

Test circuit:



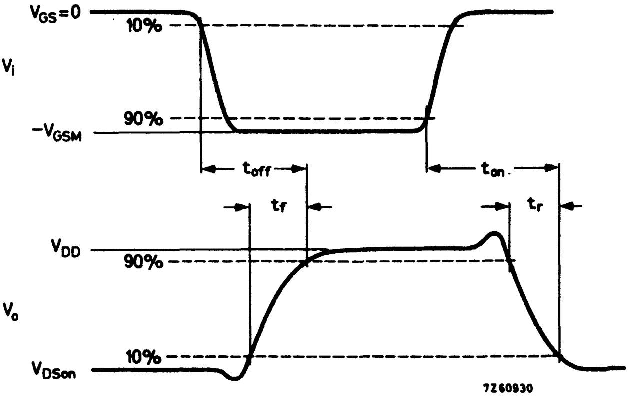
$$R = \frac{9.6}{I_D} - 51\,\Omega$$

Pulse generator:

t_r < 0.5 ns
t_f < 0.5 ns
t_p = 100 μs
δ = 0.01

Oscilloscope:

R_i = 50 Ω



N-CHANNEL FIELD EFFECT TRANSISTORS

Silicon N-channel depletion type junction-triode field effect transistors in a TO-18 metal envelope with the gate connected to the case. The transistors are intended for low power, chopper or switching, applications in industrial service.

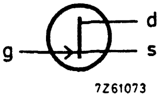
QUICK REFERENCE DATA

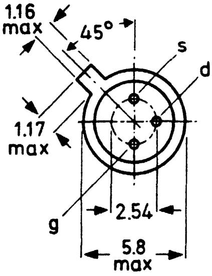
			2N4856 2N4859	2N4857 2N4860	2N4858 2N4861	
Drain-source voltage 2N4856 to 2N4858	$\pm V_{DS}$	max.	40			V
Drain-source voltage 2N4859 to 2N4861	$\pm V_{DS}$	max.	30			V
Total power dissipation up to $T_{amb} = 25\,^{\circ}C$	P_{tot}	max.	360			mW
Drain current $V_{DS} = 15\,V$; $V_{GS} = 0$	I_{DSS}	>	50	20	8	mA
Gate-source cut-off voltage $I_D = 0.5\,nA$; $V_{DS} = 15\,V$	$-V_{(P)GS}$	>	4	2	0.8	V
		<	10	6	4	V
Drain-source resistance (on) at f = 1 kHz $I_D = 0$; $V_{GS} = 0$	r_{dson}	<	25	40	60	Ω
Feedback capacitance at f = 1 MHz $V_{DS} = 0$; $-V_{GS} = 10\,V$	$-C_{rs}$	<		8		pF
Turn off time $V_{DD} = 10\,V$; $V_{GS} = 0$ $I_D = 20\,mA$; $-V_{GSM} = 10\,V$ — 2N4856; 2N4859	t_{off}	<	25			ns
$I_D = 10\,mA$; $-V_{GSM} = 6\,V$ — 2N4857; 2N4860	t_{off}	<		50		ns
$I_D = 5\,mA$; $-V_{GSM} = 4\,V$ — 2N4858; 2N4861	t_{off}	<			100	ns

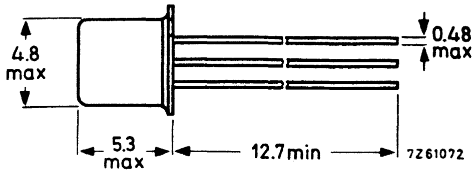
MECHANICAL DATA

Dimensions in mm

Gate connected to case
TO-18







Accessories supplied on request: 56246; 56263

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

			2N4856 2N4857 2N4858	2N4859 2N4860 2N4861	
Voltages					
Drain-source voltage	$\pm V_{DS}$	max.	40	30	V
Drain-gate voltage (open source)	V_{DGO}	max.	40	30	V
Gate-source voltage (open drain)	$-V_{GSO}$	max.	40	30	V
Current					
Gate current (d.c.)	I_G	max.	50		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	$R_{th\ j\text{-}a}$	=	0.49	$^oC/mW$

CHARACTERISTICS

T_{amb} = 25 °C unless otherwise specified

			2N4856 2N4857 2N4858	2N4859 2N4860 2N4861	
Gate cut-off current					
$-V_{GS} = 20\,V;\ V_{DS} = 0$	$-I_{GSS}$	<	0.25	-	nA
$-V_{GS} = 15\,V;\ V_{DS} = 0$	$-I_{GSS}$	<	-	0.25	nA
$-V_{GS} = 20\,V;\ V_{DS} = 0;\ T_{amb} = 150\,^{o}C$	$-I_{GSS}$	<	0.5	-	μA
$-V_{GS} = 15\,V;\ V_{DS} = 0;\ T_{amb} = 150\,^{o}C$	$-I_{GSS}$	<	-	0.5	μA
Drain cut-off current					
$V_{DS} = 15\,V;\ -V_{GS} = 10\,V$	I_{DSX}	<	0.25	0.25	nA
$V_{DS} = 15\,V;\ -V_{GS} = 10\,V;\ T_{amb} = 150\,^{o}C$	I_{DSX}	<	0.5	0.5	μA

			2N4856 2N4859	2N4857 2N4860	2N4858 2N4861	
Drain current [1]						
$V_{DS} = 15\,V;\ V_{GS} = 0$	I_{DSS}	>	50	20	8	mA
	I_{DSS}	<	-	100	80	mA

		2N4856 2N4857 2N4858	2N4859 2N4860 2N4861	
Gate-source breakdown voltage				
$-I_G = 1\,\mu A;\ V_{DS} = 0$	$-V_{(BR)GSS}$	40	30	V

			2N4856 2N4859	2N4857 2N4860	2N4858 2N4861	
Gate-source cut-off voltage						
$I_D = 0.5\,nA;\ V_{DS} = 15\,V$	$-V_{(P)GS}$	>	4	2	0.8	V
		<	10	6	4	V
Drain-source voltage (on)						
$I_D = 20\,mA;\ V_{GS} = 0$	V_{DSon}	<	0.75	-	-	V
$I_D = 10\,mA;\ V_{GS} = 0$	V_{DSon}	<	-	0.50	-	V
$I_D = 5\,mA;\ V_{GS} = 0$	V_{DSon}	<	-	-	0.50	V
Drain-source resistance (on) at f = 1 kHz						
$I_D = 0;\ V_{GS} = 0$	r_{dson}	<	25	40	60	Ω

---

[1] measured under pulsed conditions: t_p = 100 ms; $\delta \leq 0.1$

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

y-parameters at f = 1 MHz (common source)

$-V_{GS} = 10\,V;\ V_{DS} = 0$

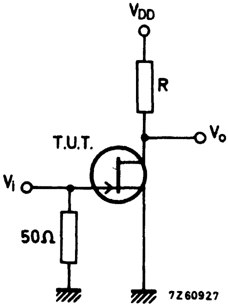
Input capacitance	C_{is}	<	18	pF
Feedback capacitance	$-C_{rs}$	<	8	pF

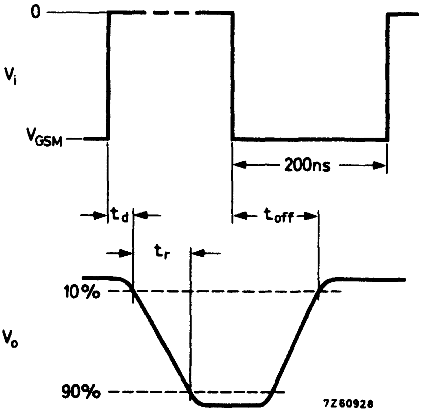
Switching times

$V_{DD} = 10\,V;\ V_{GS} = 0$

			2N4856 2N4859	2N4857 2N4860	2N4858 2N4861	
	I_D	=	20	10	5	mA
	$-V_{GSM}$	=	10	6	4	V
Delay time	t_d	<	6	6	10	ns
Rise time	t_r	<	3	4	10	ns
Turn off time	t_{off}	<	25	50	100	ns

Test circuit:





		2N4856 2N4859	2N4857 2N4860	2N4859 2N4861	
R	=	464	953	1910	Ω

Pulse generator:

$t_r \leq 1$ ns
$t_f \leq 1$ ns
$\delta = 0.02$
$Z_o = 50\ \Omega$

Oscilloscope:

$t_r \leq 0.75$ ns
$R_i \geq 1$ MΩ
$C_i \leq 2.5$ pF

Dual transistors

N-P-N SILICON PLANAR LOW-LEVEL DUAL TRANSISTORS FOR DIFFERENTIAL AMPLIFIERS

Two special matched transistors in a TO-18 metal envelope, housed together in an aluminium cube.
The BCY55 is intended for very low level, low noise and low drift differential amplifiers.

QUICK REFERENCE DATA

Equivalent differential voltage change referred to the input

$|I_{1E} + I_{2E}| \leq 200\ \mu A$

$V_{1C-1E} = V_{2C-2E} \leq 20\ V$

$|V_{1B-1E} - V_{2B-2E}| \leq 100\ \mu V$

T_{amb}: −20 to +90 °C

$\left\|\frac{\Delta V}{\Delta T}\right\|$	typ.	1	μV/°C
	<	3	μV/°C

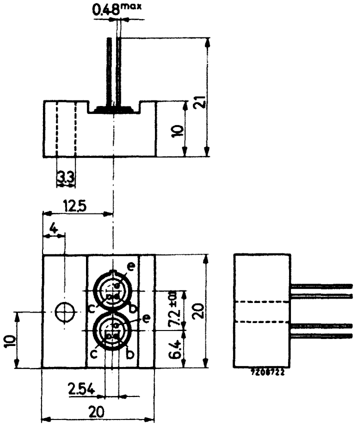
Equivalent differential current change referred to the input

$I_{1C} + I_{2C} = 100\ \mu A$

T_{amb}: −20 to +90 °C

$\left\|\frac{\Delta I}{\Delta T}\right\|$	typ.	0.5	nA/°C
	<	1.5	nA/°C

MECHANICAL DATA Dimensions in mm



CHARACTERISTICS of the individual transistors T_j = 25 °C unless otherwise specified

Collector cut-off current				
$I_E = 0$; $V_{CB} = 45$ V	I_{CBO}	<	10	nA
$I_E = 0$; $V_{CB} = 20$ V; $T_{amb} = 90$ °C	I_{CBO}	<	5	nA
Emitter cut-off current				
$I_C = 0$; $V_{EB} = 5$ V	I_{EBO}	<	10	nA
Emitter-base voltage				
$-I_E = 0.5$ mA; $V_{CB} = 5$ V	$-V_{EB}$		600 to 800	mV
Saturation voltages				
$I_C = 10$ mA; $I_B = 0.5$ mA	V_{CEsat}	<	1.0	V
	V_{BEsat}		0.6 to 1.0	V
D.C. current gain				
$I_C = 10$ μA; $V_{CE} = 5$ V	h_{FE}		100 to 300	
$I_C = 10$ mA; $V_{CE} = 5$ V	h_{FE}		200 to 600	
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; $V_{CB} = 5$ V	C_c	<	8	pF
Transition frequency				
$I_C = 0.5$ mA; $V_{CE} = 5$ V	f_T	>	50	MHz
		typ.	80	MHz
Cut-off frequency				
$I_C = 0.5$ mA; $V_{CE} = 5$ V	f_{hfe}	>	100	kHz
h parameters at f = 1 kHz				
$I_C = 1$ mA; $V_{CE} = 5$ V				
Input impedance	h_{ie}	typ.	10.0	kΩ
Reverse voltage transfer ratio	h_{re}	typ.	5.5	10^{-4}
Small signal current gain	h_{fe}	typ.	350	
			150 to 600	
Output admittance	h_{oe}	typ.	25	$\mu\Omega^{-1}$
Noise figure				
$I_C = 10$ μA; $V_{CE} = 5$ V $R_S = 10$ kΩ; B = 10 to 15000 Hz	F	typ.	2	dB
		<	3	dB

CHARACTERISTICS of the complete device

Ratio of collector currents

$V_{1B-1E} = V_{2B-2E}$
Emitter currents of each transistor up to 100 μA

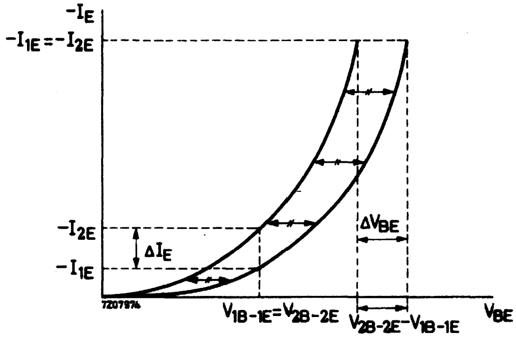
$\frac{I_{1C}}{I_{2C}}$ 0.85 to 1
typ. 0.93

Difference of base-emitter voltages

$-I_{1E} = -I_{2E}$ up to 100 μA
T_{amb}: −20 to +90 °C

$|V_{1B-1E} - V_{2B-2E}|$ typ. 2 mV
< 4 mV

Illustration of matching characteristics:



$$\frac{I_{2E}}{I_{1E}} = \exp.\ \frac{q}{kT} \cdot \Delta V_{BE}$$

$\frac{I_{2E}}{I_{1E}}$ measured at $\Delta V_{BE} = 0$

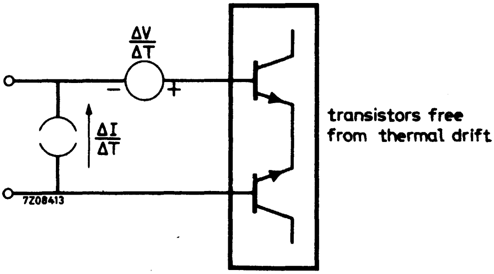
ΔV_{BE} measured at $\frac{I_{2E}}{I_{1E}} = 1$

CHARACTERISTICS of the complete device (continued)

Equivalent circuit for drift

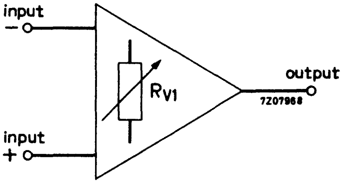
In the equivalent circuit the transistors are considered to be drift free. All temperature coefficients are concentrated in the voltage source $\frac{\Delta V}{\Delta T}$ and in the current source $\frac{\Delta I}{\Delta T}$.

It should be noted that the differential current change given is only valid when the source resistances are almost equal; the differential voltage change only when the base-emitter voltages are almost equal.



Block symbol of test amplifier

The test amplifier, used in the tests on page 5, is described on pages 6 and 7. It is represented by the following amplifier symbol:



CHARACTERISTICS of the complete device (continued)

Equivalent differential voltage change with temperature referred to the input.

$|I_{1E} + I_{2E}| \leq 200\ \mu A$; $V_{1C-1E} = V_{2C-2E} \leq 20$ V

$|V_{1B-1E} - V_{2B-2E}| \leq 100\ \mu V$; T_j: −20 to +90 °C

BCY55 unit (wires included) mounted in a small metal or plastic box for shielding against direct heat radiation.

$\left|\frac{\Delta V}{\Delta T}\right|$ typ. 1 µV/°C

< 3 µV/°C

Equivalent differential current change with temperature referred to the input.

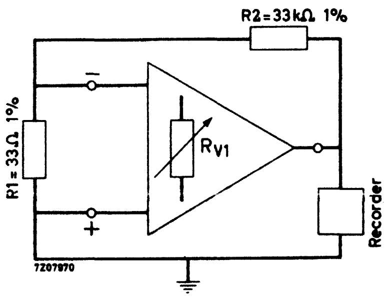
$I_{1C} + I_{2C} = 100\ \mu A$

$\frac{\Delta I}{\Delta T}$ typ. 0.5 nA/°C

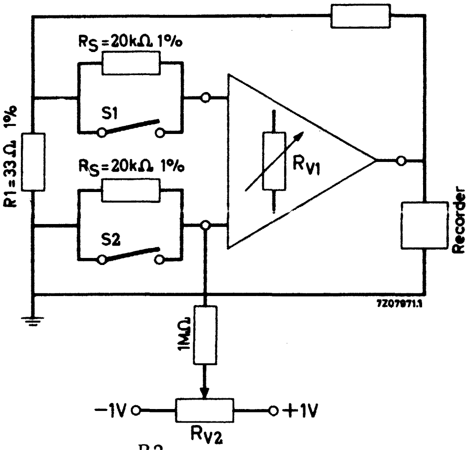
< 1.5 nA/°C

Test methods

$\boxed{\frac{\Delta V}{\Delta T}}$



$\boxed{\frac{\Delta I}{\Delta T}}$



NOTE

To prevent contact potentials, connections should be soldered.

Amplification factor determined by feedback circuit: $\frac{R2}{R1} = 1000$

Output voltage against time is recorded.

The temperature of the amplifier is adjusted to T_1 between −20 and +90 °C. When it has stabilized, the output voltage is brought to zero ($|V_{T1}| < 100$ mV)[1]. The amplifier temperature is then adjusted to T_2 between −20 and +90 °C. When it has stabilized the output voltage can be read off.

Then: $\frac{\Delta V}{\Delta T} = \frac{V_{T2} - V_{T1}}{T_2 - T_1} \cdot \frac{R1}{R2}$ or $\frac{\Delta I}{\Delta T} = \frac{V_{T2} - V_{T1}}{T_2 - T_1} \cdot \frac{R1}{R2} \cdot \frac{1}{2R_S}$

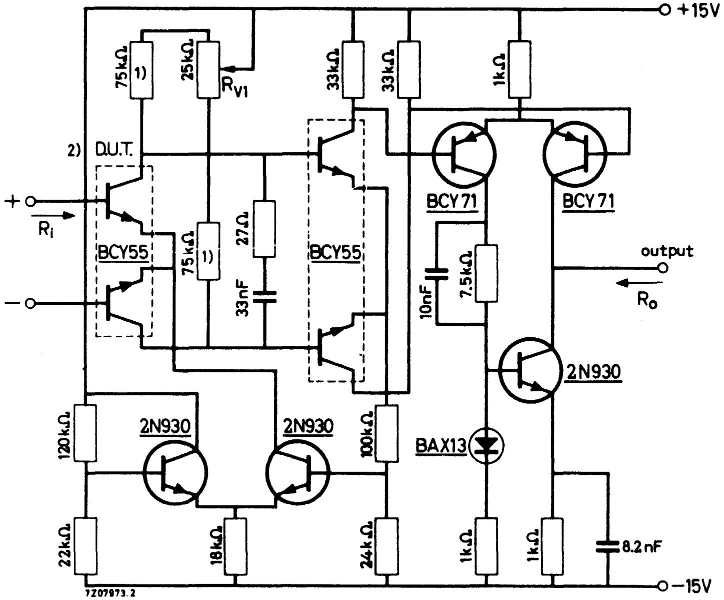
---

[1] For $\frac{\Delta V}{\Delta T}$: adjusted by R_{V1}

For $\frac{\Delta I}{\Delta T}$: first by R_{V1} with S1 and S2 closed, then by R_{V2} with the switches open.

Differential test-amplifier

The test amplifier (including feedback resistors, source-resistors and biasing-resistors) should be mounted in a small box to ensure a uniform temperature throughout.



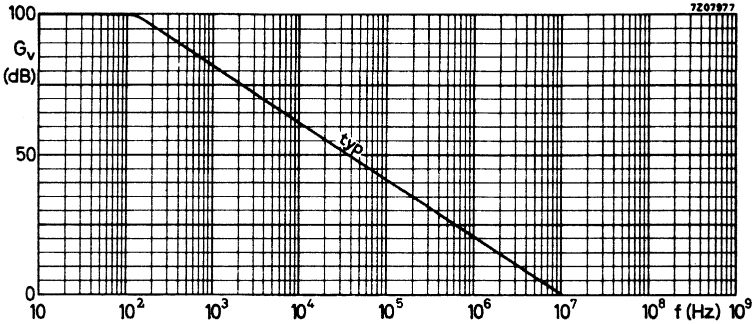
---

1) Relative temperature coefficient < $10^{-5}/^{\circ}C$

2) The device at the input is the device under test

Performance of the test amplifier

Open loop voltage gain (Z_L = 10 kΩ)	G_v	typ.	10^5	
Frequency at which G_v = 1	f_1	typ.	10	MHz
Max. common mode input voltage range			±10	V
Max. output current			±2.5	mA
Max. output voltage			±10	V
Input resistance	R_i	≥	100	kΩ
Output resistance	R_o	typ.	20	kΩ



RATINGS of the individual transistors (Limiting values) [1]

Voltages

Collector-base voltage (open emitter)	V_{CBO}	max.	45	V
Collector-emitter voltage (open base)	V_{CEO}	max.	45	V
Collector-emitter voltage with $V_{BE} = 0$	V_{CES}	max.	45	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	V

Currents

Collector currents (d.c. or average over any 50 ms period)	I_C	max.	30	mA
Collector current (peak value)	I_{CM}	max.	60	mA

Power dissipation

Total power dissipation up to $T_{amb} = 25\ ^{o}C$	P_{tot}	max.	300	mW

Temperatures

Storage temperature	T_{stg}	-50 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	$^{o}C/mW$

(This value applies to one transistor at equal dissipation or difference in dissipation < 20% in both transistors of the unit)

---

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

N-P-N SILICON PLANAR DUAL TRANSISTORS FOR DIFFERENTIAL AMPLIFIERS

Matched dual n-p-n transistors in a TO-71 metal envelope with all leads insulated from the case. They are primarily intended for differential amplifier applications in general industrial service; e.g. instrumentation and control.
The product is divided in three types according to their matching accuracy.
The BCY87 and BCY88 are intended for applications in prestages of differential amplifiers where low offset, drift and noise are of prime importance. The BCY89 is for second stages, long tail pairs and more general purposes.

QUICK REFERENCE DATA

Ratings

Collector-base voltage (open emitter)	V_{CBO}	max.	45	V
Collector-emitter voltage (open base)	V_{CEO}	max.	40	V
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	150	mW
Junction temperature	T_j	max.	175	°C

Characteristics of the complete device with collector-base voltage of 10 V and sum of emitter currents from 10 to 100 μA.

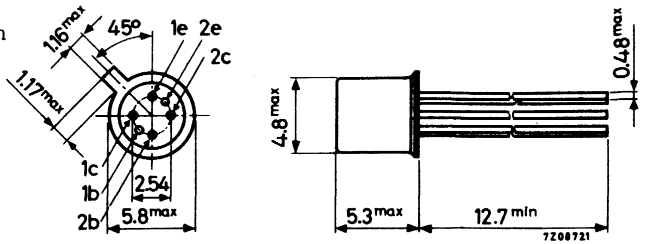
			BCY87	BCY88	BCY89	
Ratio of collector currents at $V_{1B-1E} = V_{2B-2E}$	I_{1C}/I_{2C}		0.9-1.11	0.8-1.25	0.67-1.5	
Base current difference at $V_{1B-1E} = V_{2B-2E}$	$\lvert I_{1B}-I_{2B}\rvert$	<	25	80	300	nA
Equivalent differential voltage change with temperature	$\left\lvert\frac{\Delta V}{\Delta T}\right\rvert$ 1)	<	3	6	10	μV/°C
Equivalent differential current change with temperature	$\left\lvert\frac{\Delta I}{\Delta T}\right\rvert$ 1)	<	0.5	2	10	nA/°C

MECHANICAL DATA

Dimensions in mm

TO-71
All leads insulated from the case

Accessories available:
56263



---

1) T_{amb} = −20 to +90 °C

RATINGS see page 7

CHARACTERISTICS of the individual transistors

T_{amb} = 25 °C unless otherwise specified

			BCY87	BCY88	BCY89	
Collector cut-off currents						
$I_E = 0$; $V_{CB} = 20$ V; $T_{amb} = 90$ °C	I_{CBO}	<	5	20	–	nA
$I_E = 0$; $V_{CB} = 20$ V	I_{CBO}	<	–	–	10	nA
D.C. current gain						
$I_C = 5\ \mu A$; $V_{CB} = 10$ V	h_{FE}	>	80	–	–	
$I_C = 50\ \mu A$; $V_{CB} = 10$ V	h_{FE}	> <	100 450	100 450	100 450	
$I_C = 500\ \mu A$; $V_{CB} = 10$ V	h_{FE}	> <	– –	120 600	– –	
$I_C = 10$ mA; $V_{CB} = 10$ V	h_{FE}	> <	– –	– –	100 600	
Transition frequency						
$-I_E = 50\ \mu A$; $V_{CB} = 10$ V	f_T	>	10	10	10	MHz
$-I_E = 500\ \mu A$; $V_{CB} = 10$ V	f_T	>	50	50	50	MHz
Collector capacitance at f = 1 MHz						
$I_E = I_e = 0$; $V_{CB} = 10$ V	C_c	<	3.5	3.5	3.5	pF
Noise figures						
$I_C = 50\ \mu A$; $V_{CE} = 5$ V; $R_S = 10$ kΩ Bandwidth 10 Hz to 15 kHz	F	<	3	4	4	dB
1 kHz spot noise figure $I_C = 50\ \mu A$; $V_{CE} = 5$ V; R_S = opt. Bandwidth = 200 Hz	F	<	4	5	5	dB

CHARACTERISTICS of the complete device.

These characteristics are valid under the following conditions:

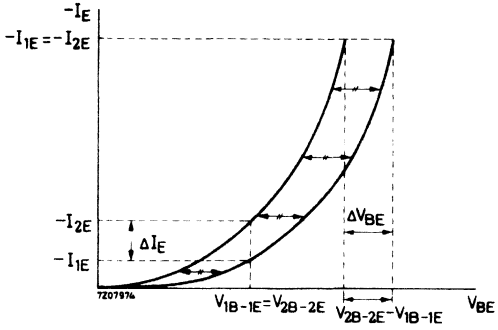
a. Collector-base voltage of both transistors not exceeding 10 V ($V_{1C-1B} = V_{2C-2B} \leq 10$ V)

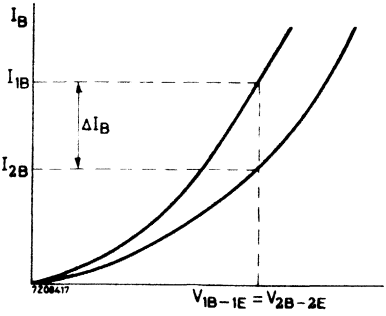
b. Sum of the emitter currents from 10 to 100 μA
$-(I_{1E} + I_{2E}) = 10$ to 100 μA

MATCHING CHARACTERISTICS

		BCY87	BCY88	BCY89	
Ratio of collector currents					
$V_{1B-1E} = V_{2B-2E}$	I_{1C}/I_{2C}	0.9-1.11	0.8-1.25	0.67-1.5	
Difference between base-emitter voltages					
$I_{1C} = I_{2C}$	$\lvert V_{1B-1E} - V_{2B-2E} \rvert$	< 3	6	10	mV
Difference between base currents					
$V_{1B-1E} = V_{2B-2E}$	$\lvert I_{1B} - I_{2B} \rvert$	< 25	80	300	nA
D.C. current gain ratio					
$I_{1C} = I_{2C}$	h_{1FE}/h_{2FE}	0.9-1.11	0.8-1.25	-	

Illustration of matching characteristics:





$$\frac{I_{2E}}{I_{1E}} = \exp . \frac{q}{KT} \cdot \Delta V_{BE}$$

$\frac{I_{2E}}{I_{1E}}$ measured at $\Delta V_{BE} = 0$

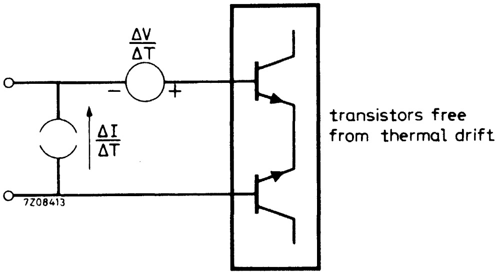
ΔV_{BE} measured at $\frac{I_{2E}}{I_{1E}} = 1$

CHARACTERISTICS of the complete device (continued)

Equivalent circuit for drift

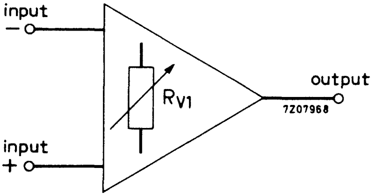
In the equivalent circuit the transistors are considered to be drift free. All temperature coefficients are concentrated in the voltage source $\frac{\Delta V}{\Delta T}$ and in the current source $\frac{\Delta I}{\Delta T}$.

It should be noted that the differential current change given is only valid when the source resistances are almost equal; the differential voltage change only when the base-emitter voltages are almost equal.



Block symbol of test amplifier

The test amplifier, used in the tests on page 5, is described on pages 6 and 7. It is represented by the following amplifier symbol:



CHARACTERISTICS of the complete device (continued)

Equivalent differential voltage change with temperature

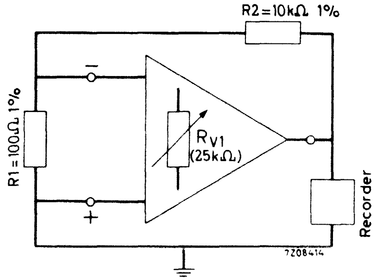
			BCY87	BCY88	BCY89	
$T_{amb} = -20$ to $+90$ °C	$\left\|\frac{\Delta V}{\Delta T}\right\|$	typ.	1	2	4	µV/°C
		<	3	6	10	µV/°C

Equivalent differential current change with temperature

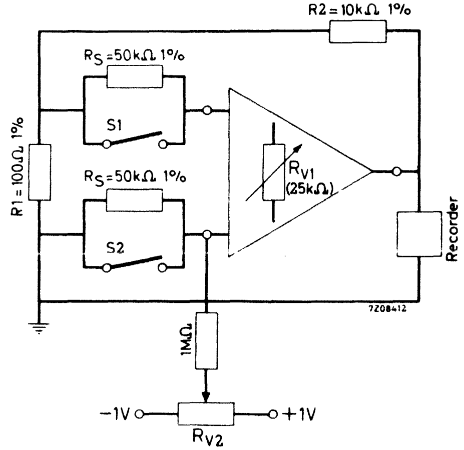
			BCY87	BCY88	BCY89	
$T_{amb} = -20$ to $+90$ °C	$\left\|\frac{\Delta I}{\Delta T}\right\|$	<	0.5	2	10	nA/°C

Test methods

$\boxed{\frac{\Delta V}{\Delta T}}$



$\boxed{\frac{\Delta I}{\Delta T}}$



NOTE

To prevent contact potentials, connections should be soldered.

Amplification factor determined by feedback circuit: $\frac{R2}{R1} = 100$

Output voltage against time is recorded.

The temperature of the amplifier is adjusted to T_1 between −20 and +90 °C. When it has stabilized, the output voltage is brought to zero ($|V_{T1}| < 1$ mV)[1]). The amplifier temperature is then adjusted to T_2 between −20 and +90 °C. When it has stabilized the output voltage can be read off.

$$\text{Then: } \frac{\Delta V}{\Delta T} = \frac{V_{T2} - V_{T1}}{T_2 - T_1} \cdot \frac{R1}{R2} \quad \text{or} \quad \frac{\Delta I}{\Delta T} = \frac{V_{T2} - V_{T1}}{T_2 - T_1} \cdot \frac{R1}{R2} \cdot \frac{1}{2R_S}$$

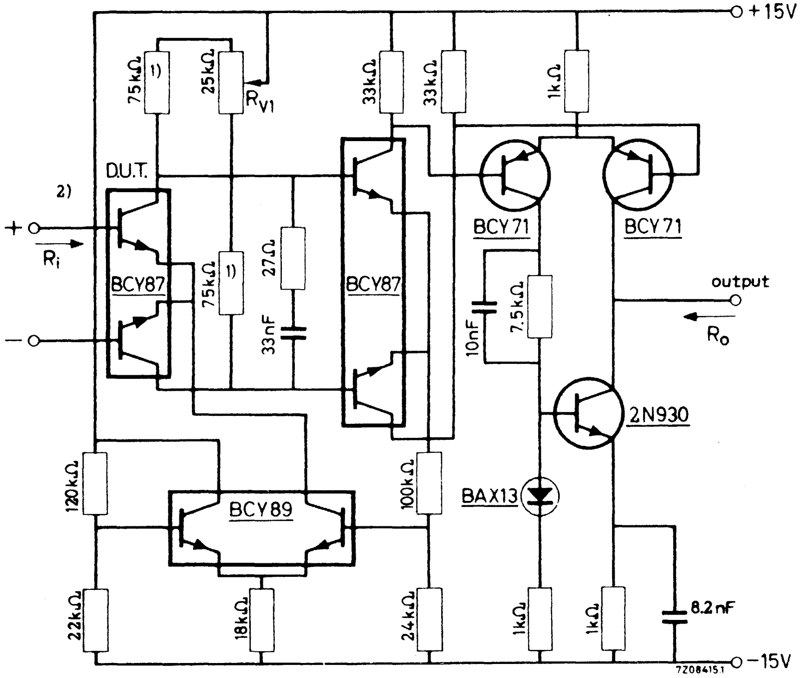
---

[1]) For $\frac{\Delta V}{\Delta T}$: adjusted by R_{V1}

For $\frac{\Delta I}{\Delta T}$: first by R_{V1} with S1 and S2 closed, then by R_{V2} with the switches open.

Differential test-amplifier

The test amplifier (including feedback resistors, source-resistors and biasing-resistors) should be mounted in a small box to ensure a uniform temperature throughout.



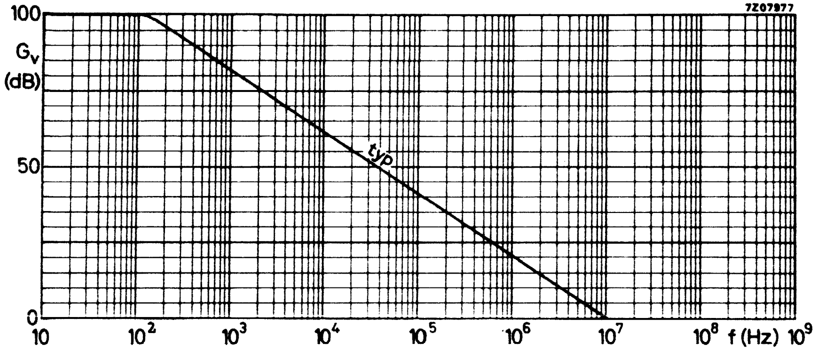
---

1) Relative temperature coefficient $< 10^{-5}/^{0}C$

2) The device at the input is the device under test

Performance of the test amplifier

Open loop voltage gain (Z_L = 10 kΩ)	G_V	typ.	10^5	
Frequency at which G_V = 1	f_1	typ.	10	MHz
Max. common mode input voltage range			±10	V
Max. output current			±2.5	mA
Max. output voltage			±10	V
Input resistance	R_i		100	kΩ
Output resistance	R_o	typ.	20	kΩ
Common mode rejection ratio			10^5	



RATINGS (Limiting values) [1]

Voltages (each transistor)				
Collector-base voltage (open emitter)	V_{CBO}	max.	45	V
Collector-emitter voltage (open base) I_C = 10 mA	V_{CEO}	max.	40	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	V
Currents (each transistor)				
Collector current (d.c.)	I_C	max.	30	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	150	mW
Temperatures				
Storage temperature	T_{stg}	max.	175	°C
Junction temperature	T_j	max.	175	°C

THERMAL RESISTANCE

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

---

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

For data and curves of these types please refer to section Field-effect transistors

For data and curves of these types please refer
to section Field effect transistors

Microminiature devices for thick- and thin-film circuits

SOLDERING RECOMMENDATIONS

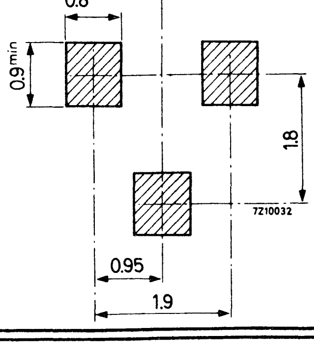
The preferred technique for mounting micro miniature components on hybrid thick- and thin-film circuits is reflow soldering. The fernico-tags of the SOT-23 envelope are pretinned with a solder that melts at about 185 °C. The best results are obtained when a similar solder is applied to the corresponding soldering areas on the substrate. This can be done by either dipping the substrate in a solder bath or by screen printing solder pastes. The component is put in place, a flux is added and the solder is reflowed by heating. For reliable connections the following should be kept in mind:

The maximum solder temperature and the proper flux are important. The flux must not affect the resistors and connectors, and its residue must be easy to remove. With the tags at the maximum permissible temperature (250 °C) soldering must be done within 10 seconds. The maximum permissible rate of temperature change is 25 °C/s.

The most economic procedure is a proces in which all the components (SOT-23, chip capacitors, etc.) are soldered simultaneously. First having been fluxed, all components are positioned on the substrate. The slight adhesive force of the flux is sufficient to keep the components in place. The solder paste contains a flux and has therefore good inherent adhesive properties, which eases positioning of the components.

With the components in position, the substrate is heated to a point where the solder begins to flow. This can be done on a heater plate or on a conveyor belt running through an infrared tunnel. Depending on the equipment used and the size of the substrate, a full soldering cycle takes between 10 and 15 seconds, all solder being liquid only during the last 1 or 2 seconds.
The surface tension of the liquid solder tends to draw the tags of the transistor towards the center of the soldering area, which has a correcting effect on slight mispositionings However, if the layout leaves something to be desired, the same effect can result in undesirable shifts, particularly if the soldering areas on substrate and component are not concentrically arranged. This problem is solved by using a standard contact pattern that leaves sufficient scope for the self-positioning effect:

Minimum required dimensions of metal connection pads on thick- and thin-film substrates.



The solder having set and cooled off, the connections are visually inspected and, where necessary, put right with a soldering iron. Finally the remnants of the flux must be carefully removed.

It is also possible to solder the SOT-23 components with a miniature hand-held soldering iron, but the procedure has the following drawbacks and should, therefore, be restricted to laboratory use and/or incidental repairs on production circuits:

It is expensive and time consuming.

The semiconductors cannot be positioned accurately, and therefore the connecting tags may come into contact with the substrate and damage it.

There is a great risk of breaking either the substrate or the connections inside the encapsulation; the encapsulation, too, may be damaged by the iron.

The transistors in this chapter are also available with the base and emitter connections interchanged. These types are indicated by the letter R following the type number: e.g. BCW29R

Type No.	Marking code	Type No.	Marking code
BAV70	A4		
BAV99	A7		
BAW56	A1		
BBY31	S1		
BCW29	C1	BCW29R	C4
BCW30	C2	BCW30R	C5
BCW31	D1	BCW31R	D4
BCW32	D2	BCW32R	D5
BCW33	D3	BCW33R	D6
BCW69	H1	BCW69R	H4
BCW70	H2	BCW70R	H5
BCW71	K1	BCW71R	K4
BCW72	K2	BCW72R	K5
BCX17	T1	BCX17R	T4
BCX18	T2	BCX18R	T5
BCX19	U1	BCX19R	U4
BCX20	U2	BCX20R	U5
BFR30	M1		
BFR31	M2		
BFR53	N1	BFR53R	N4
BFR92	P1	BFR92R	P4
BFR93	R1	BFR93R	R4
BFS17	E1	BFS17R	E4
BFS18	F1	BFS18R	F4
BFS19	F2	BFS19R	F5
BFS20	G1	BFS20R	G4
BSV52	B2	BSV52R	B4
BZX84-C4V7	Z1		
BZX84-C5V1	Z2		
BZX84-C5V6	Z3		
BZX84-C6V2	Z4		
BZX84-C6V8	Z5		
BZX84-C7V5	Z6		
BZX84-C8V2	Z7		
BZX84-C9V1	Z8		
BZX84-C10	Z9		
BZX84-C11	Y1		
BZX84-C12	Y2		

SILICON PLANAR EPITAXIAL HIGH SPEED DIODES

The device consists of two diodes in a microminiature plastic envelope. The cathodes are commoned and the unit is intended for high speed switching in thick and thin film circuits.

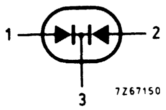
QUICK REFERENCE DATA (per diode)				
Continuous reverse voltage	V_R	max.	70	V
Repetitive peak reverse voltage	V_{RRM}	max.	70	V
Repetitive peak forward current	I_{FRM}	max.	200	mA
Junction temperature	T_j	−65 to +150		°C
Forward voltage at I_F = 50 mA	V_F	<	1.1	V
Reverse recovery time when switched from I_F = 10 mA to V_R = 1 V; R_L = 100 Ω measured at I_R = 1 mA	t_{rr}	<	6	ns
Recovered charge when switched from I_F = 10 mA to V_R = 5 V; R_L = 500 Ω	Q_s	<	45	pC

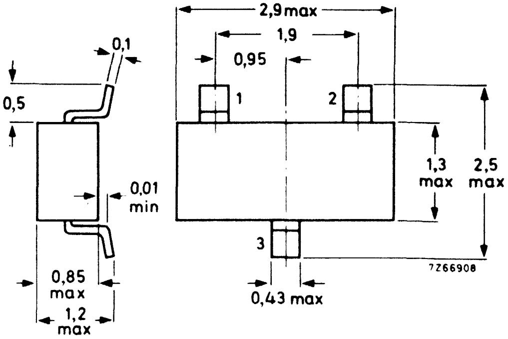
MECHANICAL DATA

Dimensions in mm

SOT-23

Code: A4





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

→ Voltages

Continuous reverse voltage	V_R	max.	70	V	
Repetitive peak reverse voltage	V_{RRM}	max.	70	V	

→ Currents

Averaged rectified forward current (averaged over any 20 ms period)	$I_{F(AV)}$	max.	100	mA	1)
Forward current (d.c.)	I_F	max.	100	mA	
Repetitive peak forward current	I_{FRM}	max.	200	mA	

→ Temperatures

Storage temperature	T_{stg}		−65 to +150	°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE (per diode)

From junction to ambient mounted on a ceramic substrate of 7 mm x 5 mm x 0.5 mm

both diodes loaded simultaneously	$R_{th\ j\text{-}a}$	=	1.1	°C/mW
one diode loaded	$R_{th\ j\text{-}a}$	=	0.60	°C/mW

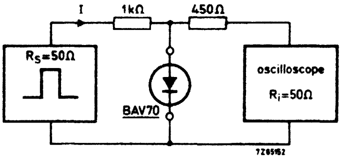
---

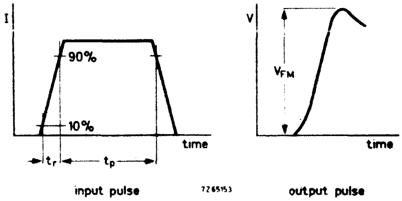
1) Measured under pulse conditions: pulse time $t_p \leq 0.5$ ms.
For sinusoidal operation $I_{F(AV)} = 65$ mA; averaging time $t_{(av)} \leq 1$ ms.

CHARACTERISTICS (per diode) $T_j = 25\ ^\circ C$ unless otherwise specified

Forward voltage				
$I_F = 1$ mA	V_F	<	715	mV
$I_F = 10$ mA	V_F	<	855	mV
$I_F = 50$ mA	V_F	<	1100	mV
$I_F = 100$ mA	V_F	<	1300	mV
Reverse current				
$V_R = 25$ V; $T_j = 150\ ^\circ C$	I_R	<	60	µA
$V_R = 70$ V	I_R	<	5	µA
$V_R = 70$ V; $T_j = 150\ ^\circ C$	I_R	<	100	µA
Diode capacitance at f = 1 MHz; $V_R = 0$	C_d	<	1.5	pF
Forward recovery voltage				
$I_F = 10$ mA; $t_r = 20$ ns	V_{FM}	<	1.75	V

Test circuit:





Current pulse: Rise time $t_r = 20$ ns Oscilloscope: Rise time $t_r = 0.35$ ns

Pulse duration $t_p = 120$ ns

Duty cycle $\delta = 0.01$

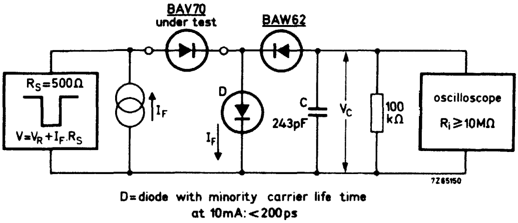
Circuit capacitance C < 1 pF (C = Oscilloscope + parasitical capacitance)

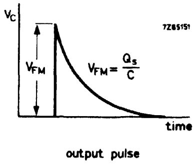
CHARACTERISTICS (continued) $T_j = 25\ ^oC$ unless otherwise specified

Recovered charge when switched from

$I_F = 10$ mA to $V_R = 5$ V; $R_L = 500\ \Omega$ Q_s < 45 pC

Test circuit:





Reverse pulse: Rise time t_r = 2 ns

Pulse duration t_p = 400 ns

Duty cycle δ = 0.02

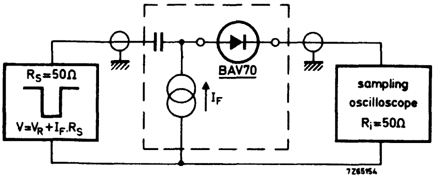
Circuit capacitance C < 7 pF (C = Oscilloscope + parasitical capacitance)

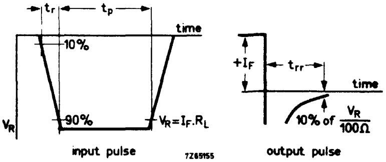
Reverse recovery time when switched from

$I_F = 10$ mA to $V_R = 1$ V; $R_L = 100\ \Omega$

measured at $I_R = 1$ mA t_{rr} < 6 ns

Test circuit:



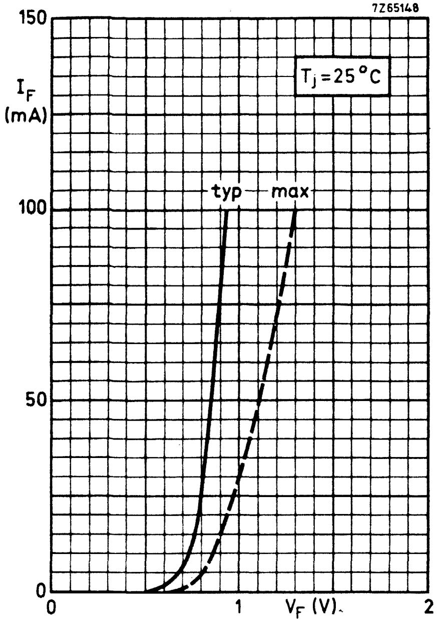


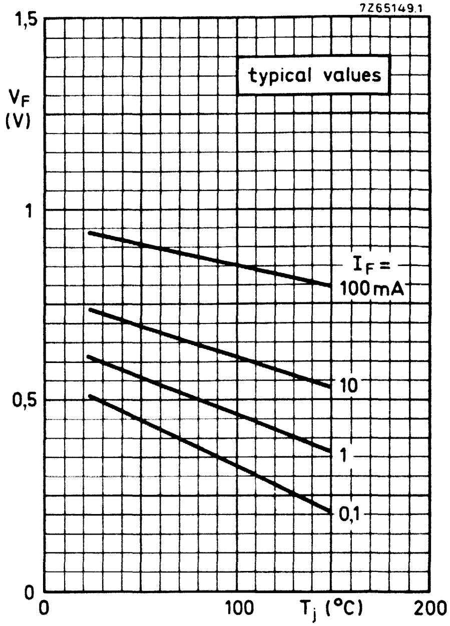
Reverse pulse: Rise time t_r = 0.6 ns Oscilloscope Rise time t_r = 0.35 ns

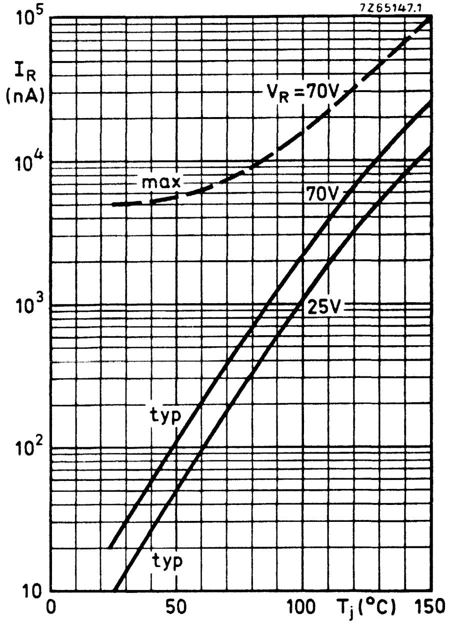
Pulse duration t_p = 100 ns

Duty cycle δ = 0.05

Circuit capacitance C < 1 pF (C = Oscilloscope + parasitical capacitance)


7Z65148
I_F (mA)
150
100
50
0
$T_j = 25\ °C$
typ
max
0
1
V_F (V)
2


7Z65149.1
V_F (V)
1,5
1
0,5
0
typical values
$I_F =$ 100 mA
10
1
0,1
0
100
T_j (°C)
200


7Z65147.1
I_R (nA)
10^5
10^4
10^3
10^2
10
$V_R = 70V$
max
70V
25V
typ
typ
0
50
100
T_j (°C)
150

SILICON PLANAR EPITAXIAL HIGH SPEED DIODES

The device consists of two diodes connected in series in a micro miniature plastic envelope. It is intended for high speed switching in thick- and thin-film circuits.

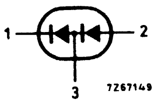
QUICK REFERENCE DATA				
Continuous reverse voltage	V_R	max.	70	V
Repetitive peak reverse voltage	V_{RRM}	max.	70	V
Repetitive peak forward current	I_{FRM}	max.	200	mA
Junction temperature	T_j	-65 to	+150	°C
Forward voltage at I_F = 50 mA	V_F	<	1,1	V
Reverse recovery time when switched from I_F = 10 mA to V_R = 1 V; R_L = 100 Ω measured at I_R = 1 mA	t_{rr}	<	6	ns
Recovered charge when switched from I_F = 10 mA to V_R = 5 V; R_L = 500 Ω	Q_s	<	45	pC

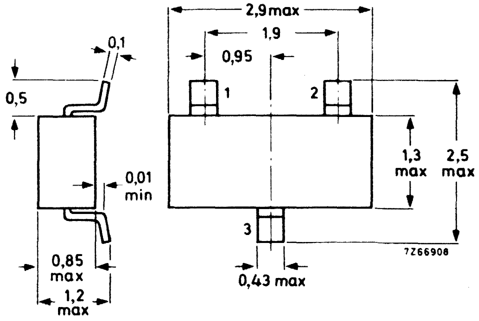
MECHANICAL DATA

Dimensions in mm

SOT-23

Code: A7





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

Voltages

Continuous reverse voltage	V_R	max.	70	V	
Repetitive peak reverse voltage	V_{RRM}	max.	70	V	

Currents

Averaged rectified forward current	$I_{F(AV)}$	max.	100	mA	1)
Forward current (d.c.)	I_F	max.	100	mA	
Repetitive peak forward current	I_{FRM}	max.	200	mA	

Temperatures

Storage temperature	T_{stg}	-65 to +150		°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE (per diode)

From junction to ambient mounted on a ceramic substrate of 7 mm x 5 mm x 0,5 mm

both diodes loaded simultaneously	$R_{th\ j\text{-}a}$	=	1,1	°C/mW
one diode loaded	$R_{th\ j\text{-}a}$	=	0,67	°C/mW

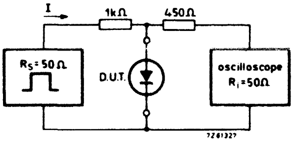
---

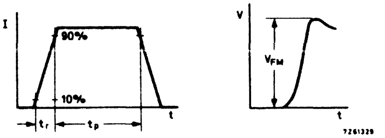
1) Measured under pulse conditions; pulse time $t_p \leq 0{,}5$ ms.
For sinusoidal operation $I_{F(AV)}$ = 65 mA; averaging time $t_{(av)} \leq 1$ ms.

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

Forward voltage				
$I_F = 1$ mA	V_F	<	715	mV
$I_F = 10$ mA	V_F	<	855	mV
$I_F = 50$ mA	V_F	<	1100	mV
$I_F = 100$ mA	V_F	<	1300	mV
Reverse current				
$V_R = 25$ V; $T_j = 150\ ^{o}C$	I_R	<	30	µA
$V_R = 70$ V	I_R	<	2,5	µA
$V_R = 70$ V; $T_j = 150\ ^{o}C$	I_R	<	50	µA
Diode capacitance at f = 1 MHz; $V_R = 0$	C_d	<	1,5	pF
Forward recovery voltage				
$I_F = 10$ mA; $t_r = 20$ ns	V_{FM}	<	1,75	V

Test circuit:





input pulse

output pulse

Current pulse: Rise time $t_r = 20$ ns

Pulse duration $t_p = 120$ ns

Duty cycle $\delta = 0{,}01$

Oscilloscope: Rise time $t_r = 0{,}35$ ns

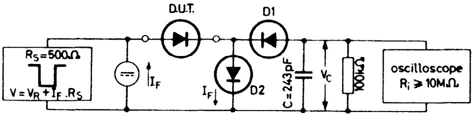
Circuit capacitance $C < 1$ pF (C = Oscilloscope + parasitical capacitance)

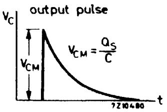
CHARACTERISTICS (continued) (per diode) $T_j = 25\ ^oC$ unless otherwise specified

Recovered charge when switched from

$I_F = 10$ mA to $V_R = 5$ V; $R_L = 500\ \Omega$ Q_s < 45 pC

Test circuit:





D1 = BAW62

D2 = diode with minority carrier life time at 10 mA: < 200 ps

Reverse pulse: Rise time t_r = 2 ns

Pulse duration t_p = 400 ns

Duty cycle δ = 0,02

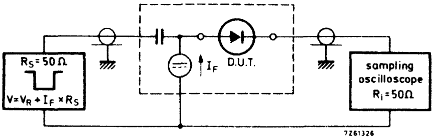
Circuit capacitance $C \leq 7$ pF (C = Oscilloscope + parasitical capacitance)

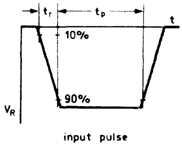
Reverse recovery time when switched from

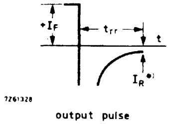
$I_F = 10$ mA to $V_R = 1$ V; $R_L = 100\ \Omega$

measured at $I_R = 1$ mA t_{rr} < 6 ns

Test circuit:







*) $I_R = 1$ mA

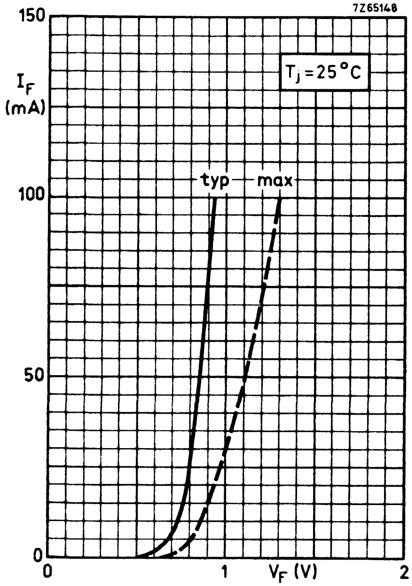
Reverse pulse: Rise time t_r = 0,6 ns

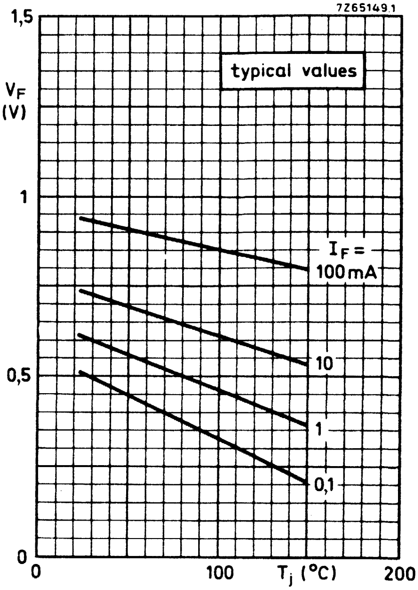
Pulse duration t_p = 100 ns

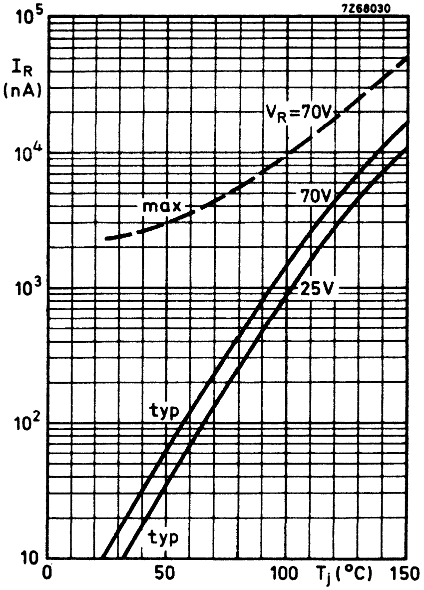
Duty cycle δ = 0,05

Oscilloscope: Rise time $t_r = 0{,}35$ ns

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


7Z65148
150
I_F
(mA)
$T_j = 25\,°C$
typ
max
100
50
0
0
1
V_F (V)
2


7Z65149.1
1,5
V_F
(V)
typical values
1
I_F =
100 mA
10
0,5
1
0,1
0
0
100
T_j (°C)
200


7Z68030
10^5
I_R
(nA)
V_R=70V
10^4
max
70V
10^3
25V
typ
10^2
typ
10
0
50
100
T_j (°C)
150

SILICON PLANAR EPITAXIAL HIGH SPEED DIODES

The BAW56 consists of two diodes in a micro miniature plastic envelope. The anodes are commoned and the unit is intended for high speed switching in thick and thin film circuits.

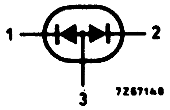
QUICK REFERENCE DATA (per diode)

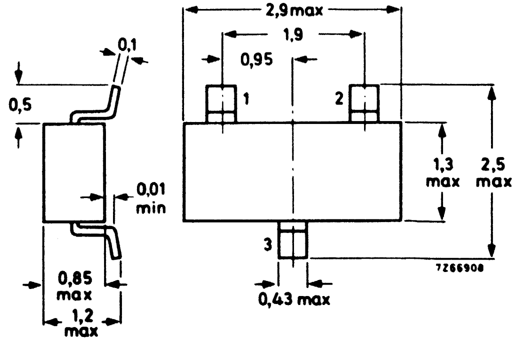
Continuous reverse voltage	V_R	max.	70	V
Repetitive peak reverse voltage	V_{RRM}	max.	70	V
Repetitive peak forward current	I_{FRM}	max.	200	mA
Junction temperature	T_j		−65 to +150	°C
Forward voltage at I_F = 50 mA	V_F	<	1.1	V
Reverse recovery time when switched from I_F = 10 mA to V_R = 1 V; R_L = 100 Ω measured at I_R = 1 mA	t_{rr}	<	6	ns
Recovered charge when switched from I_F = 10 mA to V_R = 5 V; R_L = 500 Ω	Q_s	<	45	pC

MECHANICAL DATA Dimensions in mm

SOT-23

Code: A1





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

→ Voltages

Continuous reverse voltage	V_R	max.	70	V
Repetitive peak reverse voltage	V_{RRM}	max.	70	V

→ Currents

Averaged rectified forward current (averaged over any 20 ms period)	I_{FAV}	max.	100	mA [1]
Forward current (d.c.)	I_F	max.	100	mA
Repetitive peak forward current	I_{FRM}	max.	200	mA

→ Temperatures

Storage temperature	T_{stg}		−65 to +150	°C
Junction temperature	T_j	max.	150	°C

→ **THERMAL RESISTANCE** (per diode)

From junction to ambient mounted on a **ceramic substrate of 7 mm x 5 mm x 0.5 mm**

both diodes loaded simultaneously	$R_{th\ j-a}$	=	1.1	°C/mW
one diode loaded	$R_{th\ j-a}$	=	0.67	°C/mW

---

[1] Measured under pulse conditions: pulse time $t_p \leq 0.5$ ms.
For sinusoidal operation $I_{F(AV)} = 65$ mA; averaging time $t_{(av)} \leq 1$ ms.

CHARACTERISTICS (per diode) T_j = 25 °C unless otherwise specified

Forward voltage

I_F = 1 mA	V_F	<	715	mV
I_F = 10 mA	V_F	<	855	mV
I_F = 50 mA	V_F	<	1100	mV
I_F = 100 mA	V_F	<	1300	mV

Reverse current

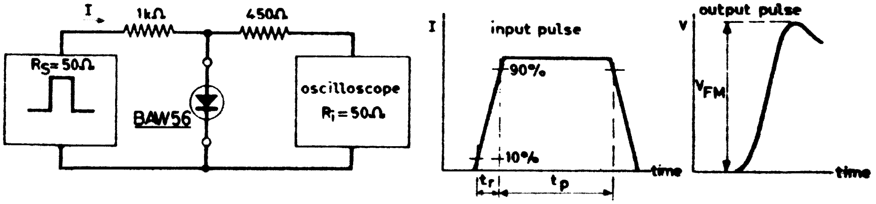
V_R = 25 V; T_j = 150 °C	I_R	<	30	µA
V_R = 70 V	I_R	<	2,5	µA
V_R = 70 V; T_j = 150 °C	I_R	<	50	µA

Diode capacitance at f = 1 MHz; V_R = 0	C_d	<	2	pF

Forward recovery voltage

I_F = 10 mA; t_r = 20 ns	V_{FM}	<	1.75	V

Test circuit:



Current pulse: Rise time t_r = 20 ns Oscilloscope: Rise time t_r = 0.35 ns

Pulse duration t_p = 120 ns

Duty cycle δ = 0.01

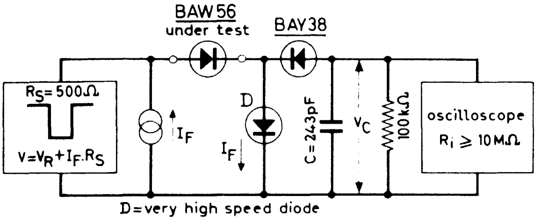
Circuit capacitance C < 1 pF (C = Oscilloscope + parasitical capacitance)

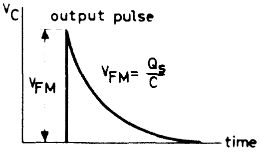
CHARACTERISTICS (continued) T_j = 25 °C unless otherwise specified

Recovered charge when switched from

I_F = 10 mA to V_R = 5 V; R_L = 500 Ω Q_s < 45 pC

Test circuit:





Reverse pulse: Rise time t_r = 2 ns

Pulse duration t_p = 400 ns

Duty cycle δ = 0.02

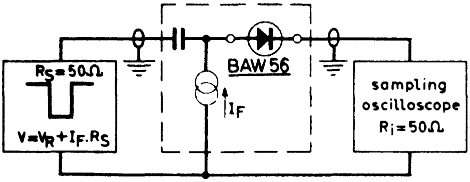
Circuit capacitance C < 7 pF (C = Oscilloscope + parasitical capacitance)

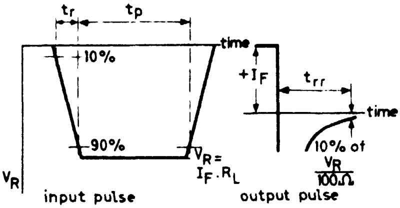
Reverse recovery time when switched from

I_F = 10 mA to V_R = 1 V; R_L = 100 Ω

measured at I_R = 1 mA t_{rr} < 6 ns

Test circuit:



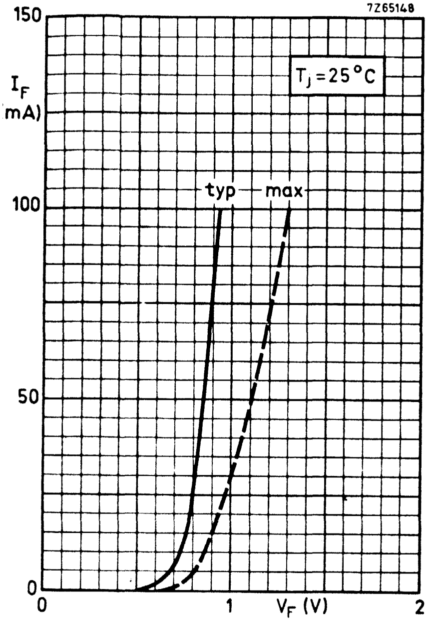


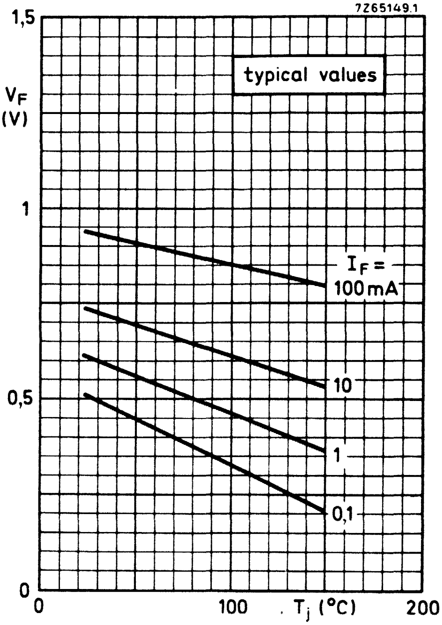
Reverse pulse: Rise time t_r = 0.6 ns Oscilloscope: Rise time t_r = 0.35 ns

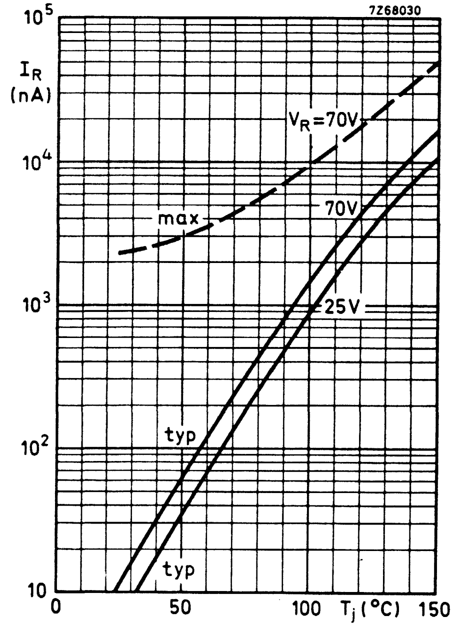
Pulse duration t_p = 100 ns

Duty cycle δ = 0.05

Circuit capacitance C < 1 pF (C = Oscilloscope + parasitical capacitance)


7Z65148
150
100
50
0
I_F
(mA)
$T_j = 25\,°C$
typ
max
0
1
V_F (V)
2


7Z65149.1
1,5
1
0,5
0
V_F
(V)
typical values
I_F =
100 mA
10
1
0,1
0
100
T_j (°C)
200


7Z68030
10^5
10^4
10^3
10^2
10
I_R
(nA)
V_R = 70V
max
70V
25V
typ
typ
0
50
100
T_j (°C)
150

VARIABLE CAPACITANCE DIODE

Silicon planar variable capacitance diode in a micro miniature envelope.
It is intended for electronic tuning applications in hybrid thick- and thin-film circuits.

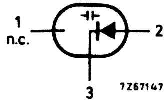
QUICK REFERENCE DATA

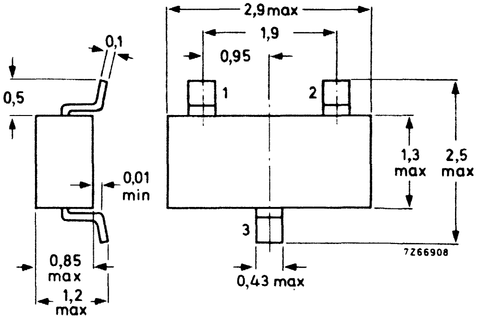
Reverse voltage	V_R	max.	28	V
Reverse current at V_R = 28 V	I_R	<	100	nA
Diode capacitance at f = 1 MHz V_R = 25 V	C_d		1,8 to 2,8	pF
Capacitance ratio at f = 1 MHz	$\frac{C_d(V_R = 3\,V)}{C_d(V_R = 25\,V)}$	typ.	5	
Series resistance at f = 470 MHz V_R is that value at which C_d = 9 pF	r_D	<	1,2	Ω

MECHANICAL DATA Dimensions in mm

SOT-23

Code: S1





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

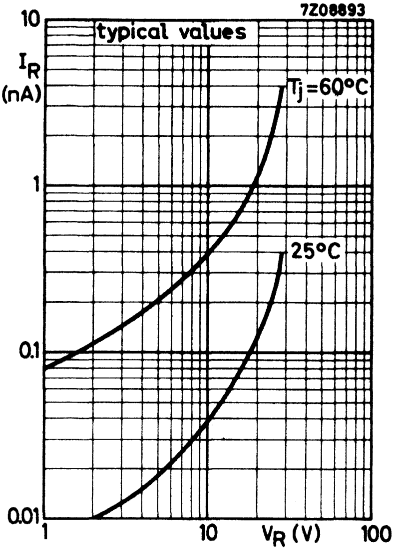
Continuous reverse voltage	V_R	max.	28	V
Reverse voltage (peak value)	V_{RM}	max.	30	V
Forward current (d.c.)	I_F	max.	20	mA
Storage temperature	T_{stg}	−65 to +100		°C
Operating junction temperature	T_j	max.	60	°C

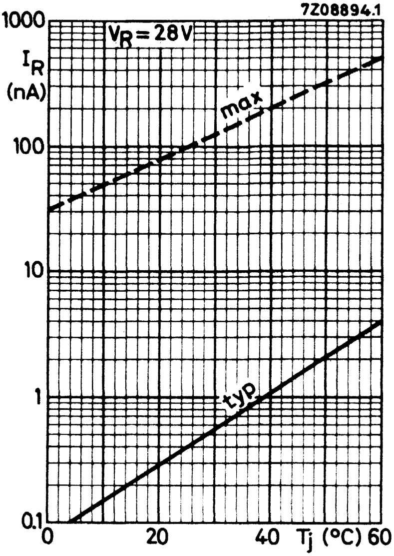
→ **THERMAL RESISTANCE**

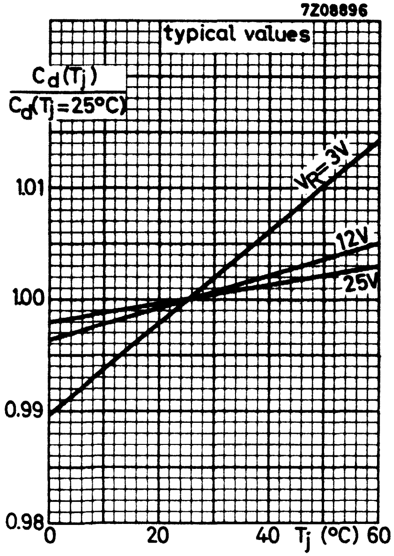
From junction to ambient mounted on a ceramic substrate of 7 mm x 5 mm x 0,5 mm	$R_{th\,j\text{-}a}$	=	0,62	°C/mW

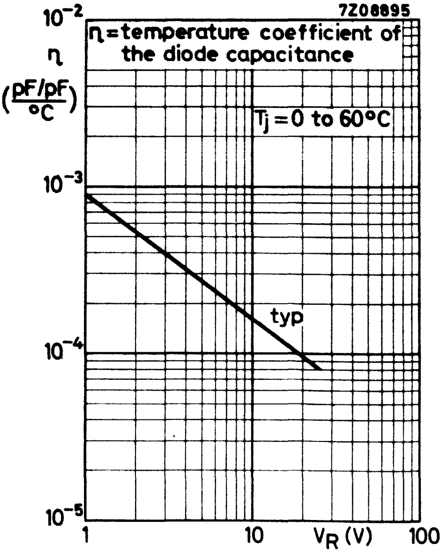
CHARACTERISTICS T_j = 25 °C unless otherwise specified

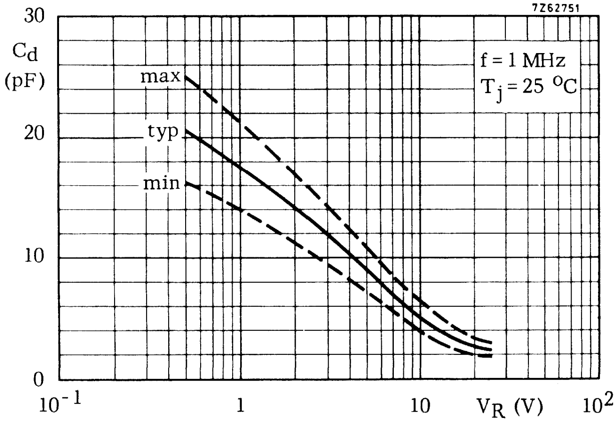
Reverse current				
$V_R = 28\,V$	I_R	<	100	nA
$V_R = 28\,V$; $T_j = 60\,^{\circ}C$	I_R	<	0,5	μA
Diode capacitance at f = 1 MHz				
$V_R = 1\,V$	C_d	typ.	17,5	pF
$V_R = 3\,V$	C_d	typ.	11,5	pF
$V_R = 25\,V$	C_d	1,8 to	2,8	pF
Capacitance ratio at f = 1 MHz	$\frac{C_d(V_R = 3\,V)}{C_d(V_R = 25\,V)}$	typ.	5	
Series resistance				
at f = 470 MHz and at that value of V_R at which $C_d = 9\,pF$	r_D	<	1,2	Ω


7Z08893
typical values
I_R (nA)
10
1
0.1
0.01
$T_j = 60°C$
25°C
1
10
V_R (V)
100


7Z08894.1
$V_R = 28V$
I_R (nA)
1000
100
10
1
0.1
max
typ
0
20
40
T_j (°C)
60


7Z08896
typical values
$\frac{C_d(T_j)}{C_d(T_j=25°C)}$
1.01
1.00
0.99
0.98
$V_R = 3V$
12V
25V
0
20
40
T_j (°C)
60


7Z08895
η = temperature coefficient of the diode capacitance
η $\left(\frac{pF/pF}{°C}\right)$
10^{-2}
10^{-3}
10^{-4}
10^{-5}
$T_j = 0$ to 60°C
typ
1
10
V_R (V)
100


7Z62751
30
20
10
0
C_d
(pF)
max
typ
min
f = 1 MHz
$T_j = 25\ ^oC$
10^{-1}
1
10
V_R (V)
10^2

SILICON PLANAR EPITAXIAL TRANSISTORS

P-N-P transistors in a micro miniature plastic envelope.
They are intended for low level general purpose applications in thick and thin film circuits.

QUICK REFERENCE DATA

			BCW29	BCW30	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	30	30	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	20	20	V
Collector current (peak value)	$-I_{CM}$	max.	200	200	mA
Total power dissipation up to $T_{amb} = 25\ ^{o}C$	P_{tot}	max.	200	200	mW
Junction temperature	T_j	max.	150	150	^{o}C
D.C. current gain at $T_j = 25\ ^{o}C$ $-I_C = 2$ mA; $-V_{CE} = 5$ V	h_{FE}	> <	120 260	215 500	
Transition frequency at f = 35 MHz $-I_C = 10$ mA; $-V_{CE} = 5$ V	f_T	typ.	150	150	MHz
Noise figure at $R_S = 2\ k\Omega$ $-I_C = 200\ \mu A$; $-V_{CE} = 5$ V f = 1 kHz; B = 200 Hz	F	<	10	10	dB

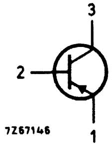
MECHANICAL DATA

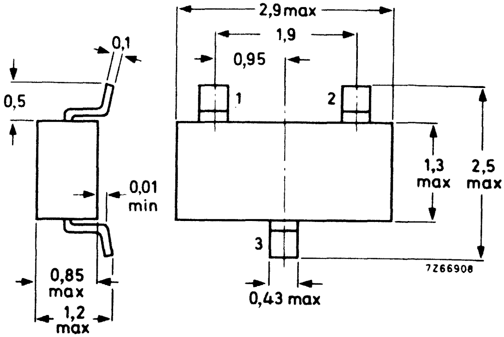
Dimensions in mm

SOT-23

Code:

BCW29 C1
BCW30 C2





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 (V_{BE} = 0)	$-V_{CES}$	max.	30	V
Collector-emitter voltage (open base) $-I_C$ = 2 mA	$-V_{CEO}$	max.	20	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5	V

Currents

→ Collector current (d.c.)	$-I_C$	max.	100	mA
Collector current (peak value)	$-I_{CM}$	max.	200	mA

→ Power dissipation

Total power dissipation up to T_{amb} = 25 °C mounted on a **ceramic substrate of 7 mm x 5 mm x 0.5 mm**	P_{tot}	max.	200	mW

→ Temperatures

Storage temperature	T_{stg}		-65 to +150	°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

From junction to ambient → mounted on **ceramic substrate of 7 mm x 5 mm x 0.5 mm**	$R_{th\ j-a}$	=	0.62	°C/mW

CHARACTERISTICS

Collector cut-off current

I_E = 0; $-V_{CB}$ = 20 V; T_j = 25 °C	$-I_{CBO}$	<	100	nA
T_j = 100 °C	$-I_{CBO}$	<	10	μA

Base-emitter voltage

$-I_C$ = 2 mA; $-V_{CE}$ = 5 V; T_j = 25 °C	$-V_{BE}$		600 to 750	mV

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

Saturation voltages

$-I_C$ = 10 mA; $-I_B$ = 0.5 mA	$-V_{CEsat}$	typ.	80	mV	
		<	300	mV	
	$-V_{BEsat}$	typ.	720	mV	
$-I_C$ = 50 mA; $-I_B$ = 2.5 mA	$-V_{CEsat}$	typ.	150	mV	←
	$-V_{BEsat}$	typ.	810	mV	

D.C. current gain

			BCW29	BCW30
$-I_C$ = 10 μA; $-V_{CE}$ = 5 V	h_{FE}	typ.	90	150
$-I_C$ = 2 mA; $-V_{CE}$ = 5 V	h_{FE}	>	120	215
		<	260	500

Collector capacitance at f = 1 MHz

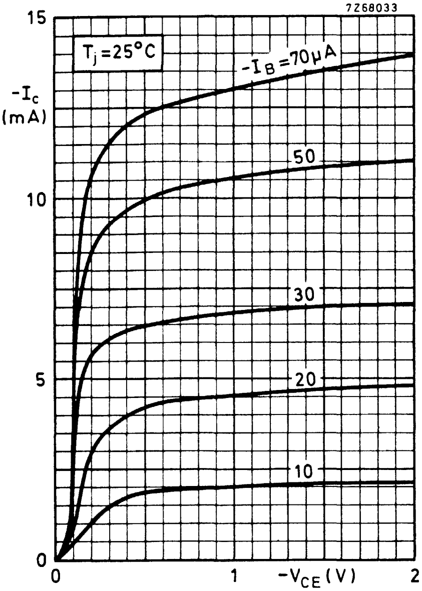
$I_E = I_e$ = 0; $-V_{CB}$ = 10 V	C_c	<	7.0	pF

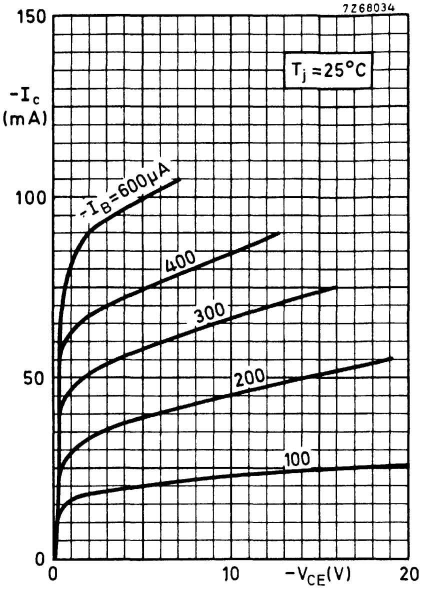
Transition frequency at f = 35 MHz

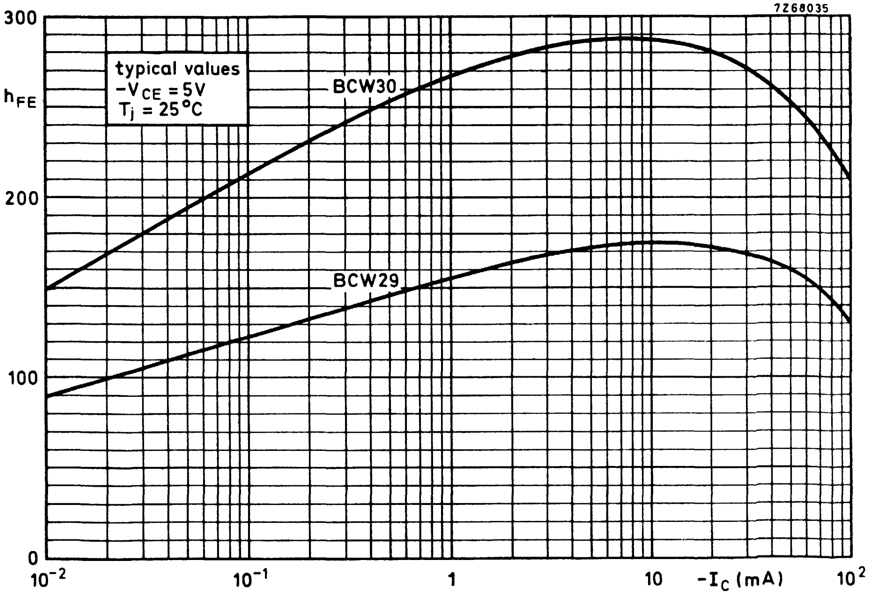
$-I_C$ = 10 mA; $-V_{CE}$ = 5 V	f_T	typ.	150	MHz

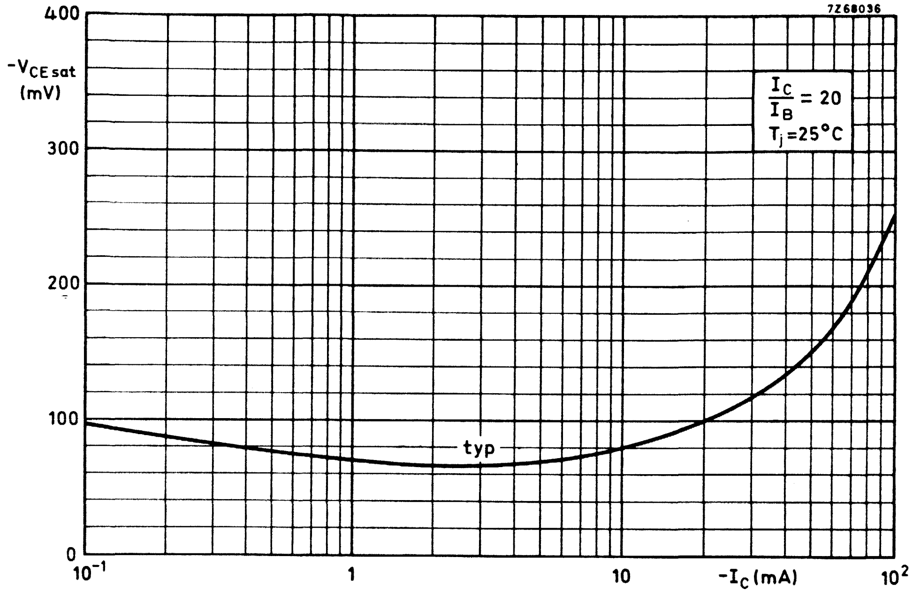
Noise figure at R_S = 2 kΩ

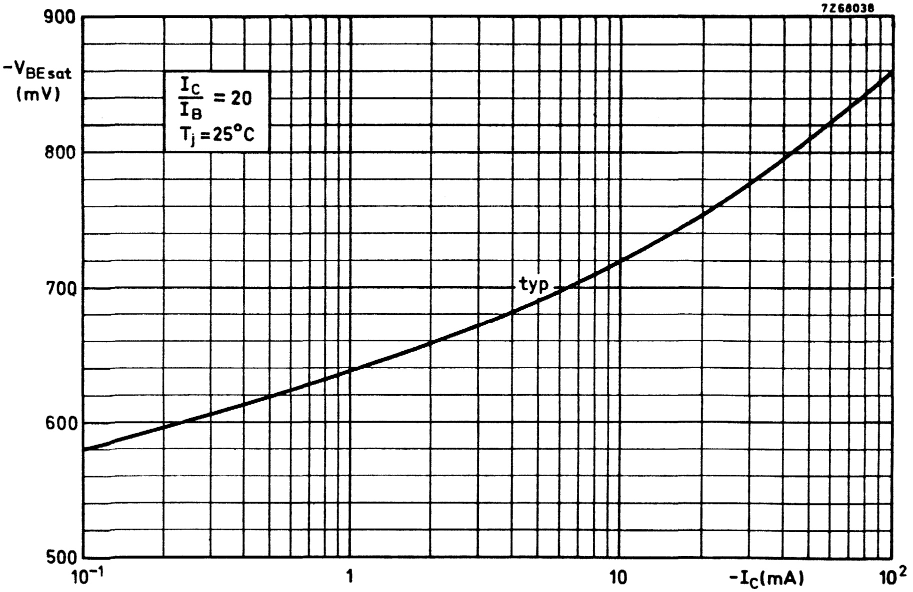
$-I_C$ = 200 μA; $-V_{CE}$ = 5 V f = 1 kHz; B = 200 Hz	F	<	10	dB

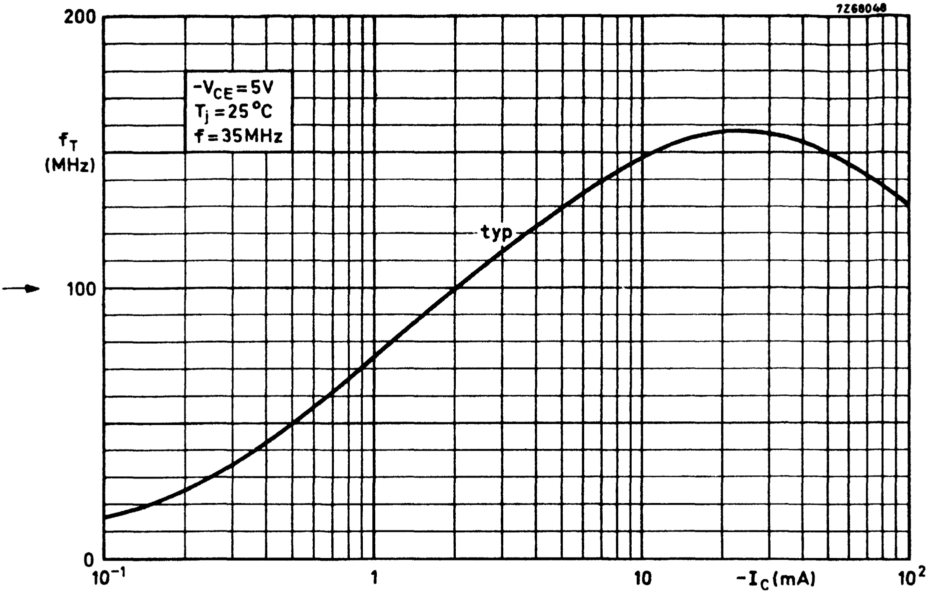

7Z68033
$T_j = 25°C$
$-I_C$ (mA)
$-I_B = 70 \mu A$
50
30
20
10
15
10
5
0
0
1
2
$-V_{CE}$ (V)

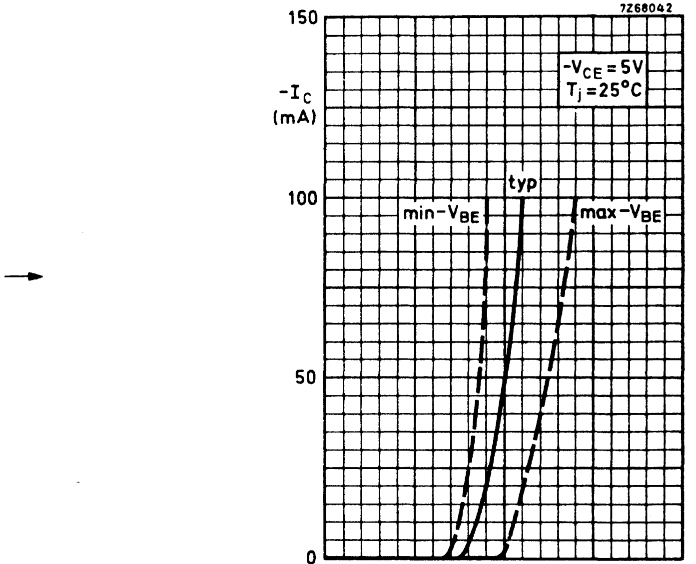

7Z68034
$T_j = 25°C$
$-I_C$ (mA)
$-I_B = 600 \mu A$
400
300
200
100
150
100
50
0
0
10
20
$-V_{CE}$ (V)

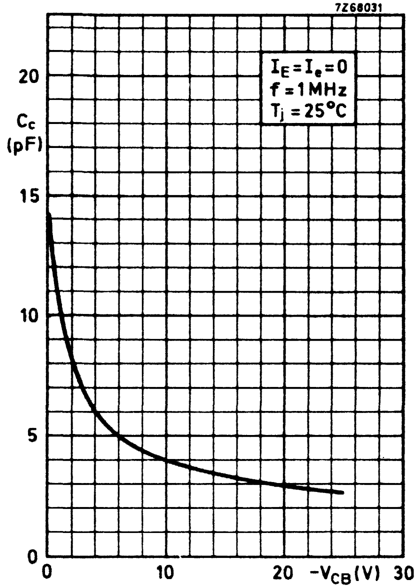

7Z68035
typical values
$-V_{CE} = 5V$
$T_j = 25°C$
h_{FE}
BCW30
BCW29
300
200
100
0
10^{-2}
10^{-1}
1
10
10^2
$-I_C$ (mA)

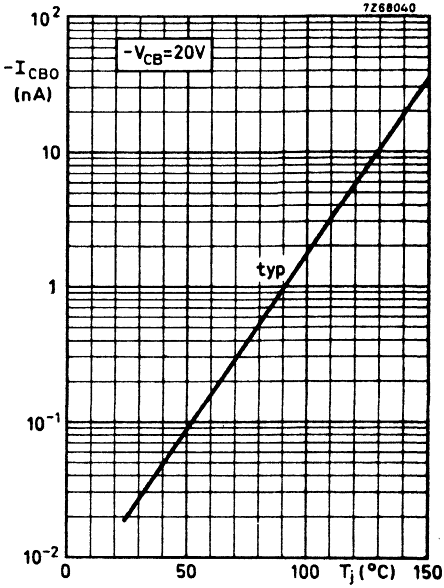

7Z68036
400
300
200
100
0
$-V_{CE\,sat}$ (mV)
$\frac{I_C}{I_B} = 20$
$T_j = 25\,°C$
typ
10^{-1}
1
10
$-I_C$ (mA)
10^2


7Z68038
900
800
700
600
500
$-V_{BE\,sat}$ (mV)
$\frac{I_C}{I_B} = 20$
$T_j = 25\,°C$
typ
10^{-1}
1
10
$-I_C$ (mA)
10^2


7Z68048
200
100
0
f_T (MHz)
$-V_{CE} = 5V$
$T_j = 25°C$
f = 35MHz
typ
10^{-1}
1
10
$-I_C$(mA)
10^2


7Z68042
150
100
50
0
$-I_C$ (mA)
$-V_{CE} = 5V$
$T_j = 25°C$
typ
min $-V_{BE}$
max $-V_{BE}$
250
500
750
1000
$-V_{BE}$(mV)


7Z68031
$I_E = I_e = 0$
f = 1 MHz
$T_j = 25°C$
C_c (pF)
20
15
10
5
0
0
10
20
$-V_{CB}$ (V)
30


7Z68040
10^2
$-I_{CBO}$ (nA)
$-V_{CB} = 20V$
10
1
10^{-1}
10^{-2}
typ
0
50
100
T_j (°C)
150

SILICON PLANAR EPITAXIAL TRANSISTORS

N-P-N transistors in a micro miniature plastic envelope.
They are intended for low level general purpose applications in thick and thin film circuits.

QUICK REFERENCE DATA

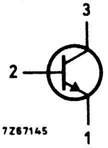
			BCW31	BCW32	BCW33	
Collector-base voltage (open emitter)	V_{CBO}	max.	30	30	30	V
Collector-emitter voltage (open base)	V_{CEO}	max.	20	20	20	V
Collector current (peak value)	I_{CM}	max.	200	200	200	mA
Total power dissipation up to $T_{amb} = 25\ ^{o}C$	P_{tot}	max.	200	200	200	mW
Junction temperature	T_j	max.	150	150	150	^{o}C
D.C. current gain at $T_j = 25\ ^{o}C$ $I_C = 2$ mA; $V_{CE} = 5$ V	h_{FE}	>	110	200	420	
		<	220	450	800	
Transition frequency at f = 35 MHz $I_C = 10$ mA; $V_{CE} = 5$ V	f_T	typ.	300	300	300	MHz
Noise figure at $R_S = 2$ kΩ $I_C = 200\ \mu A$; $V_{CE} = 5$ V f = 1 kHz; B = 200 Hz	F	<	10	10	10	dB

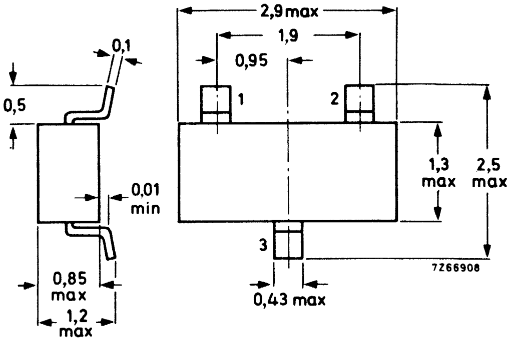
MECHANICAL DATA Dimensions in mm

SOT-23

Code:

BCW31 D1
BCW32 D2
BCW33 D3





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) I_C = 2 mA	V_{CEO}	max.	20	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	V
Currents				
Collector current (d.c.)	I_C	max.	100	mA
Collector current (peak value)	I_{CM}	max.	200	mA
Power dissipation				
Total power dissipation up to T_{amb} = 25 °C mounted on a **ceramic substrate of 7 mm x 5 mm x 0.5 mm**	P_{tot}	max.	200	mW
Temperatures				
Storage temperature	T_{stg}	-65 to +150		°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

From junction to ambient mounted on **ceramic substrate of 7 mm x 5 mm x 0.5 mm**	$R_{th\ j\text{-}a}$	=	**0.62**	°C/mW

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; $T_j = 100$ °C	I_{CBO}	<	10	μA
Base-emitter voltage				
$I_C = 2$ mA; $V_{CE} = 5$ V	V_{BE}	550 to	700	mV

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

Saturation voltages

I_C = 10 mA; I_B = 0.5 mA	V_{CEsat}	typ.	120	mV	
		<	250	mV	
	V_{BEsat}	typ.	750	mV	
I_C = 50 mA; I_B = 2.5 mA	V_{CEsat}	typ.	210	mV	←
	V_{BEsat}	typ.	850	mV	←

D.C. current gain

			BCW31	BCW32	BCW33
I_C = 10 μA; V_{CE} = 5 V	h_{FE}	typ.	90	150	270
I_C = 2 mA; V_{CE} = 5 V	h_{FE}	>	110	200	420
		<	220	450	800

Collector capacitance at f = 1 MHz

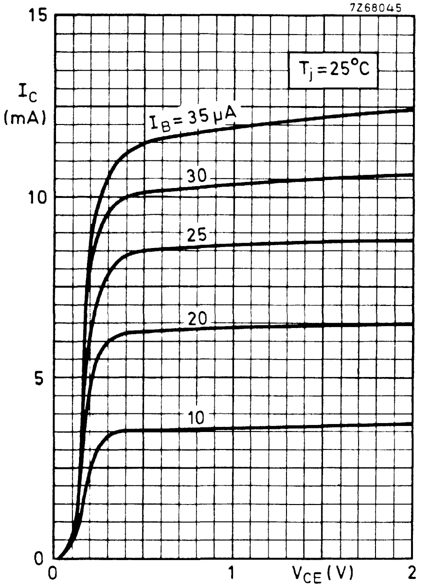
$I_E = I_e = 0$; V_{CB} = 10 V	C_c	<	4.0	pF

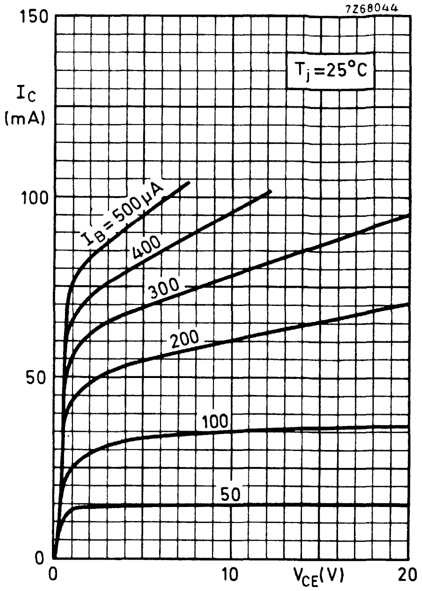
Transition frequency at f = 35 MHz

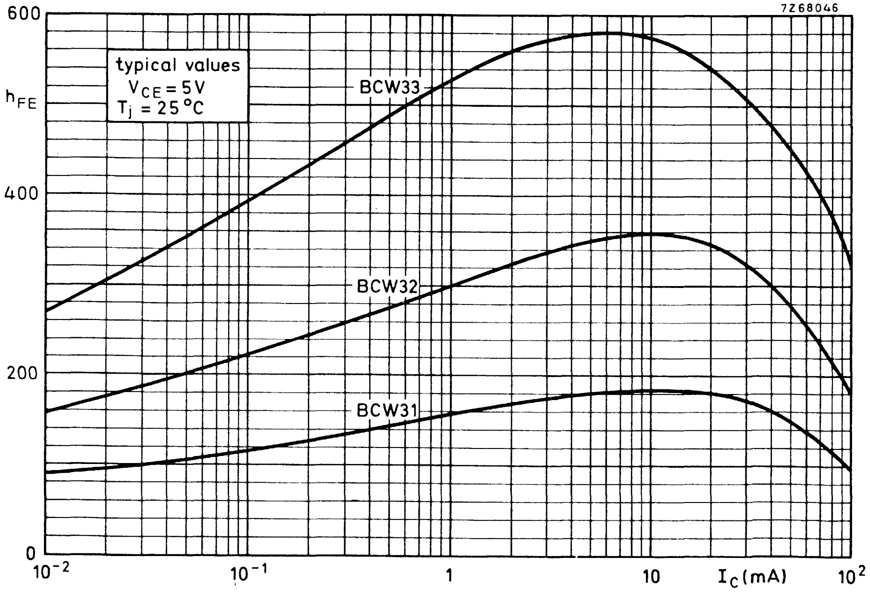
I_C = 10 mA; V_{CE} = 5 V	f_T	typ.	300	MHz

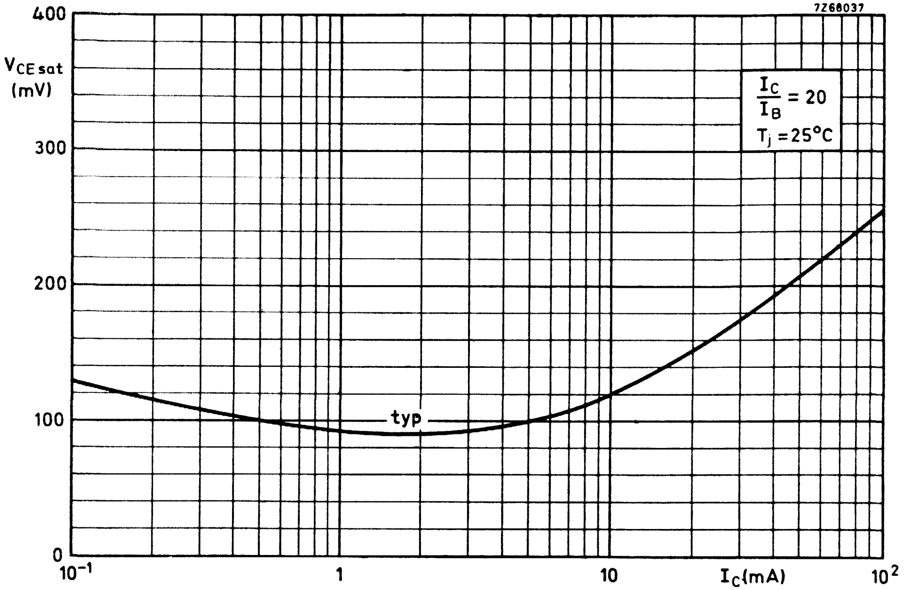
Noise figure at R_S = 2 kΩ

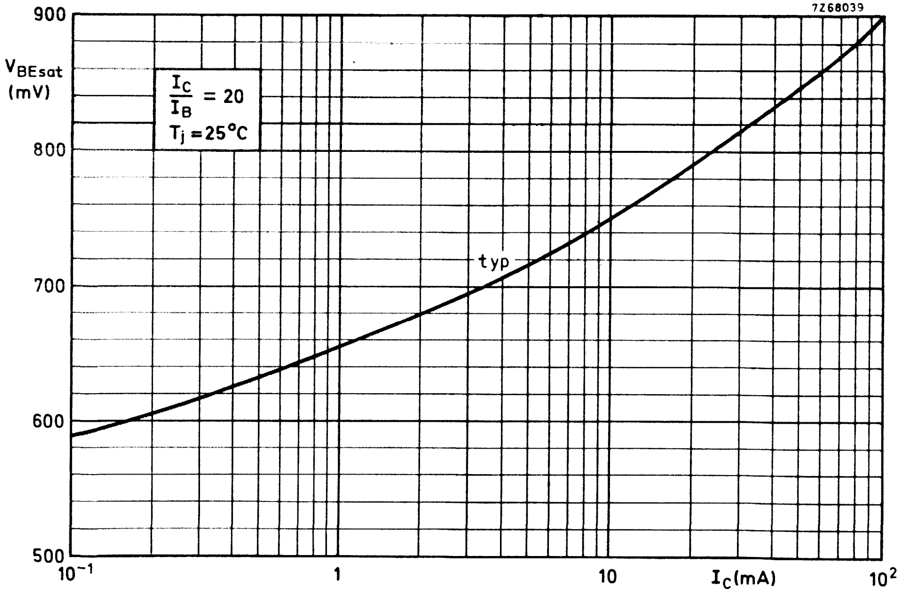
I_C = 200 μA; V_{CE} = 5 V f = 1 kHz; B = 200 Hz	F	<	10	dB

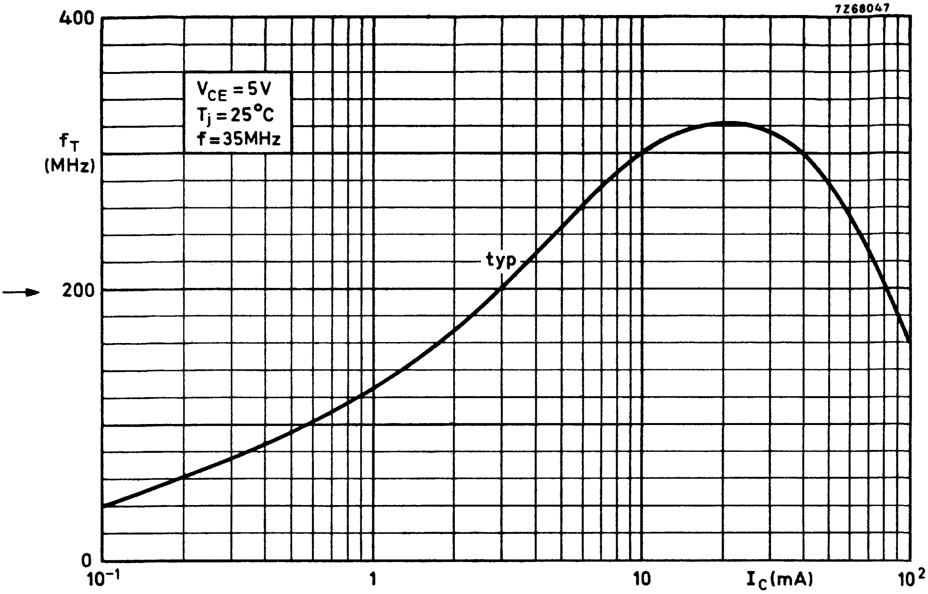

7Z68045
$T_j = 25°C$
I_C (mA)
15
10
5
0
$I_B = 35 \mu A$
30
25
20
10
0
1
V_{CE} (V)
2

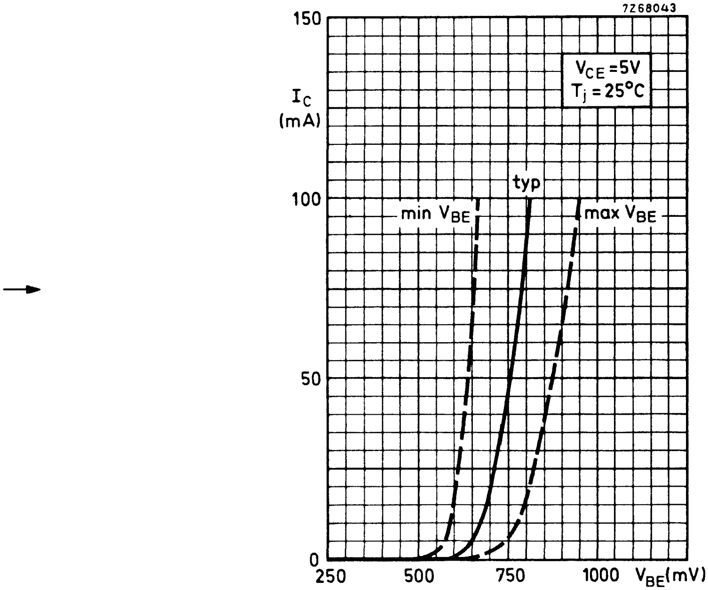

7Z68044
$T_j = 25°C$
I_C (mA)
150
100
50
0
$I_B = 500 \mu A$
400
300
200
100
50
0
10
V_{CE} (V)
20

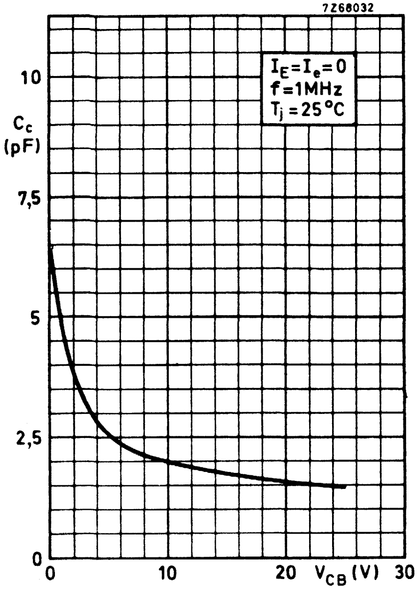

7Z68046
typical values
$V_{CE} = 5 V$
$T_j = 25 °C$
h_{FE}
600
400
200
0
BCW33
BCW32
BCW31
10^{-2}
10^{-1}
1
10
I_C (mA)
10^2

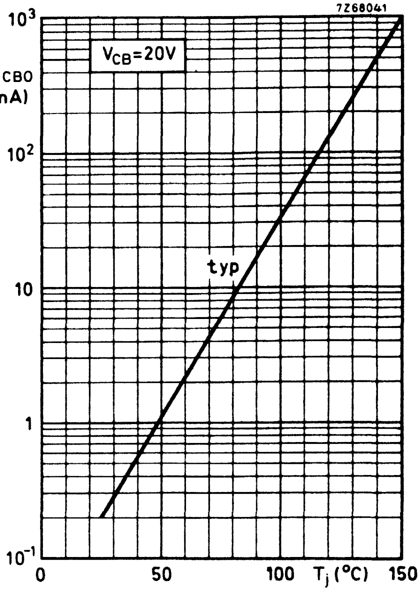

7Z68037
V_CEsat (mV)
400
300
200
100
0
$\frac{I_C}{I_B} = 20$
$T_j = 25°C$
typ
10⁻¹
1
10
I_C (mA)
10²


7Z68039
V_BEsat (mV)
900
800
700
600
500
$\frac{I_C}{I_B} = 20$
$T_j = 25°C$
typ
10⁻¹
1
10
I_C (mA)
10²


7Z68047
400
200
0
f_T
(MHz)
$V_{CE} = 5V$
$T_j = 25°C$
f = 35MHz
typ
10^{-1}
1
10
I_C(mA)
10^2


7Z68043
150
100
50
0
I_C
(mA)
$V_{CE} = 5V$
$T_j = 25°C$
typ
min V_{BE}
max V_{BE}
250
500
750
1000
V_{BE}(mV)


7Z68032
$I_E = I_e = 0$
f = 1MHz
$T_j = 25\,°C$
C_c (pF)
10
7,5
5
2,5
0
0
10
20
V_{CB} (V)
30


7Z68041
$V_{CB} = 20\,V$
I_{CBO} (nA)
10^3
10^2
10
1
10^{-1}
typ
0
50
100
T_j (°C)
150

SILICON PLANAR EPITAXIAL TRANSISTORS

P-N-P transistors in a micro miniature plastic envelope.
They are intended for low level general purpose applications in thick and thin film circuits.

QUICK REFERENCE DATA

			BCW69	BCW70	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	50	50	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	45	45	V
Collector current (peak value)	$-I_{CM}$	max.	200	200	mA
Total power dissipation up to $T_{amb} = 25\,^{o}C$	P_{tot}	max.	200	200	mW
Junction temperature	T_j	max.	150	150	^{o}C
D.C. current gain at $T_j = 25\,^{o}C$ $-I_C = 2$ mA; $-V_{CE} = 5$ V	h_{FE}	> <	120 260	215 500	
Transition frequency at f = 35 MHz $-I_C = 10$ mA; $-V_{CE} = 5$ V	f_T	typ.	150	150	MHz
Noise figure at $R_S = 2\ k\Omega$ $-I_C = 200\ \mu A$; $-V_{CE} = 5$ V f = 1 kHz; B = 200 Hz	F	<	10	10	dB

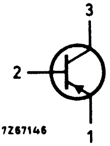
MECHANICAL DATA

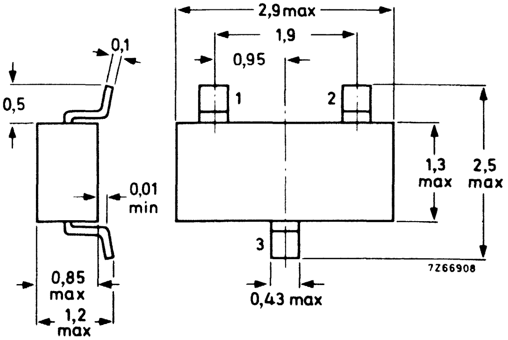
Dimensions in mm

SOT-23

Code:

BCW69 H1
BCW70 H2





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

Voltages

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	50	V
Collector-emitter voltage ($V_{BE} = 0$)	$-V_{CES}$	max.	50	V
Collector-emitter voltage (open base) $-I_C = 2$ mA	$-V_{CEO}$	max.	45	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5	V

Currents

→ Collector current (d.c.)	$-I_C$	max.	100	mA
Collector current (peak value)	$-I_{CM}$	max.	200	mA

→ Power dissipation

Total power dissipation up to $T_{amb} = 25$ °C mounted on a ceramic substrate of 7 mm x 5 mm x 0.5 mm	P_{tot}	max.	200	mW

→ Temperatures

Storage temperature	T_{stg}	−65 to	+150	°C
Junction temperature	T_j	max.	150	°C

→ **THERMAL RESISTANCE**

From junction to ambient mounted on a ceramic substrate of 7 mm x 5 mm x 0.5 mm	$R_{th\ j-a}$	=	0.62	°C/mW

CHARACTERISTICS

Collector cut-off current

$I_E = 0$; $-V_{CB} = 20$ V; $T_j = 25$ °C	$-I_{CBO}$	<	100	nA
$T_j = 100$ °C	$-I_{CBO}$	<	10	μA

Base-emitter voltage

$-I_C = 2$ mA; $-V_{CE} = 5$ V; $T_j = 25$ °C	$-V_{BE}$	600 to	750	mV

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

Saturation voltages

$-I_C$ = 10 mA; $-I_B$ = 0.5 mA	$-V_{CEsat}$	typ.	80	mV
		<	300	mV
	$-V_{BEsat}$	typ.	720	mV
$-I_C$ = 50 mA; $-I_B$ = 2.5 mA	$-V_{CEsat}$	typ.	150	mV ←
	$-V_{BEsat}$	typ.	810	mV

D.C. current gain

			BCW69	BCW70
$-I_C$ = 10 μA; $-V_{CE}$ = 5 V	h_{FE}	typ.	90	150
$-I_C$ = 2 mA; $-V_{CE}$ = 5 V	h_{FE}	>	120	215
		<	260	500

Collector capacitance at f = 1 MHz

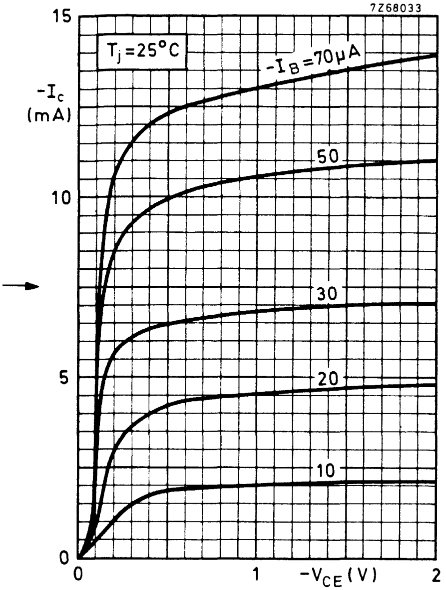
$I_E = I_e$ = 0; $-V_{CB}$ = 10 V	C_c	<	7.0	pF

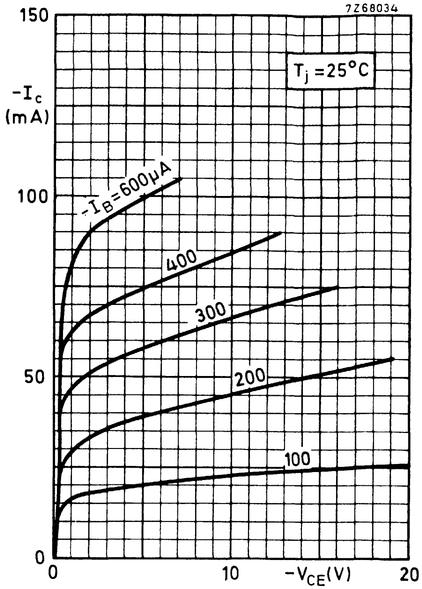
Transition frequency at f = 35 MHz

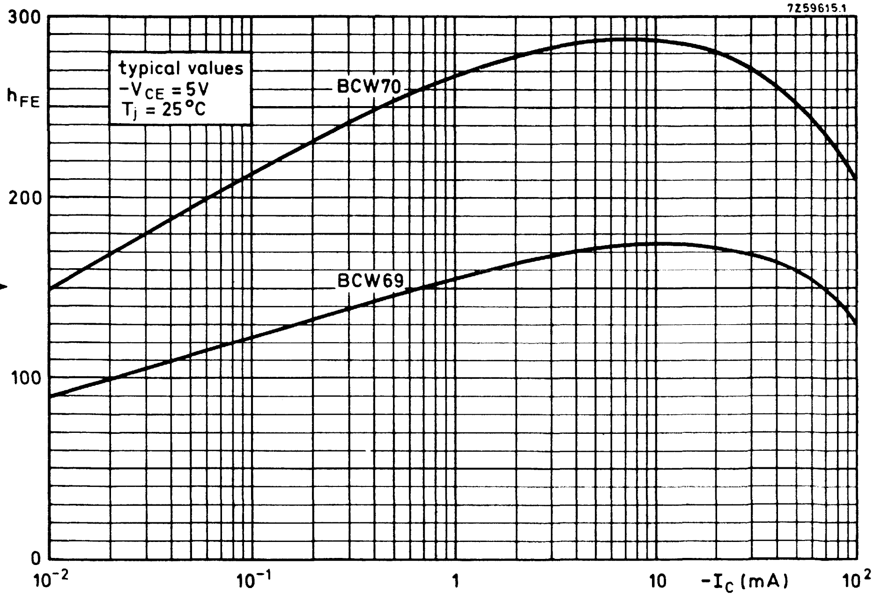
$-I_C$ = 10 mA; $-V_{CE}$ = 5 V	f_T	typ.	150	MHz

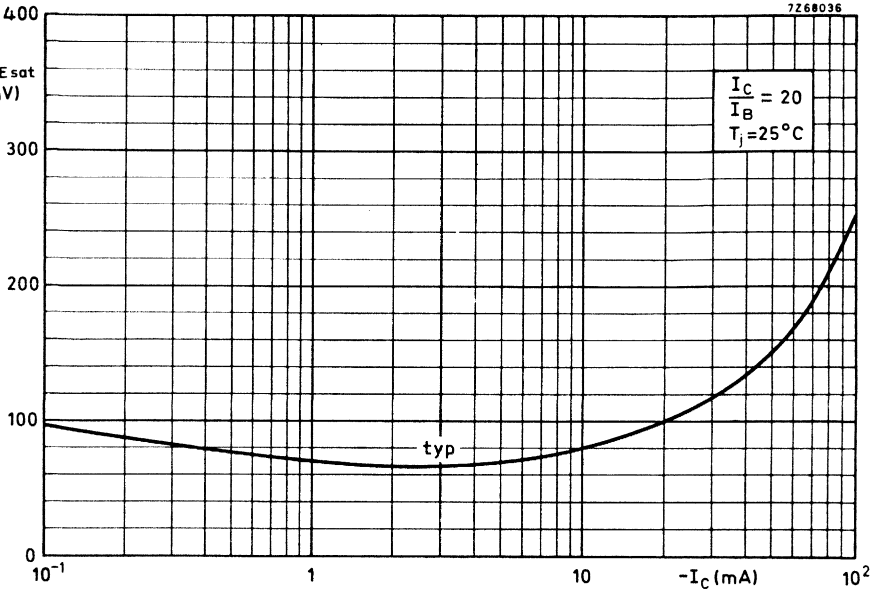
Noise figure at R_S = 2 kΩ

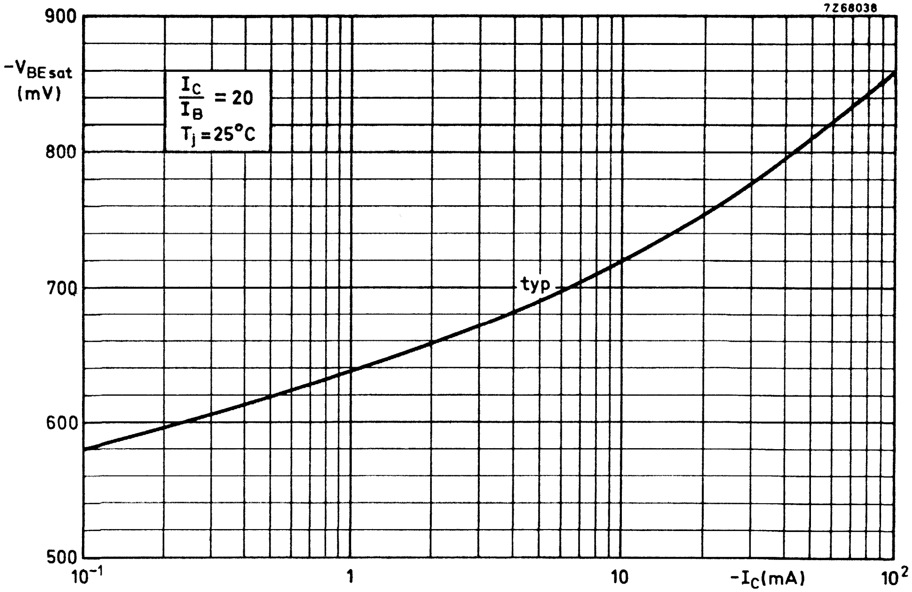
$-I_C$ = 200 μA; $-V_{CE}$ = 5 V f = 1 kHz; B = 200 Hz	F	<	10	dB

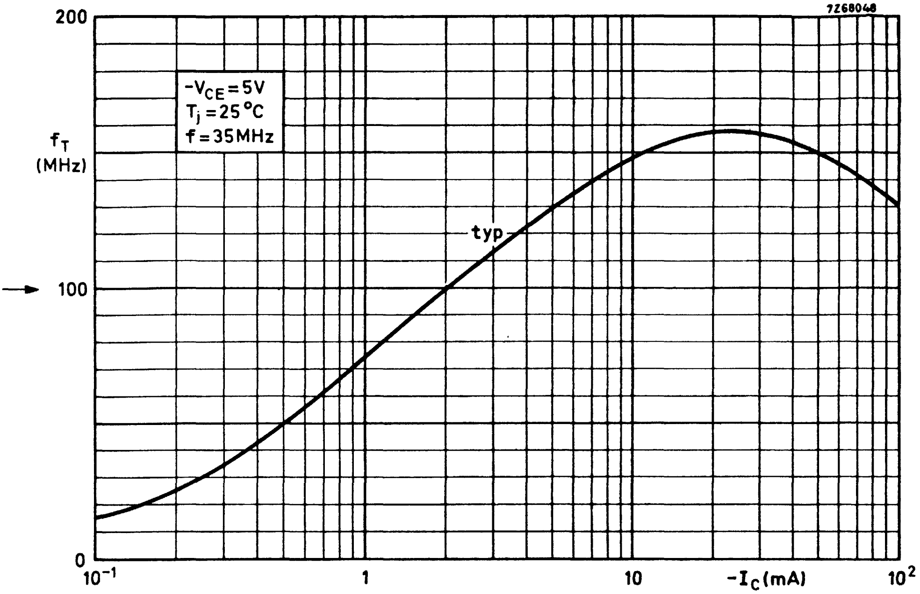

7Z68033
$T_j = 25°C$
$-I_C$ (mA)
$-I_B = 70 \mu A$
50
30
20
10
15
10
5
0
0
1
2
$-V_{CE}$ (V)

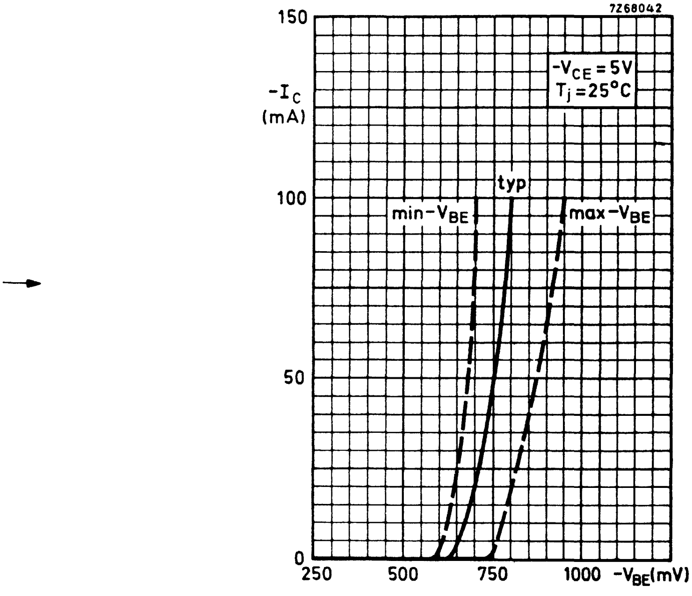

7Z68034
$T_j = 25°C$
$-I_C$ (mA)
$-I_B = 600 \mu A$
400
300
200
100
150
100
50
0
0
10
20
$-V_{CE}$ (V)

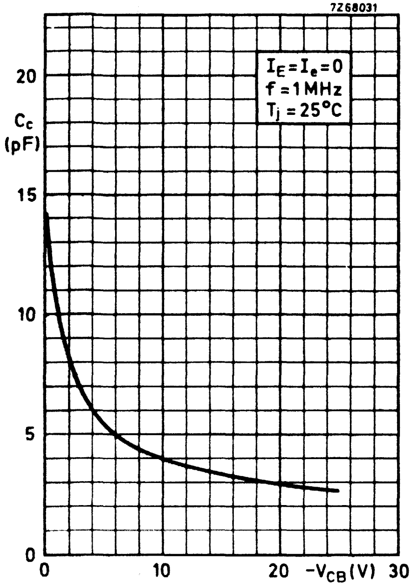

7Z59615.1
typical values
$-V_{CE} = 5V$
$T_j = 25°C$
h_{FE}
BCW70
BCW69
300
200
100
0
10^{-2}
10^{-1}
1
10
10^2
$-I_C$ (mA)

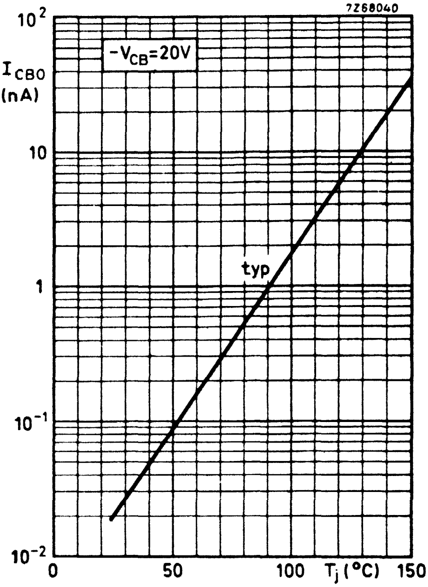

7Z68036
$-V_{CE\,sat}$ (mV)
400
300
200
100
0
$\frac{I_C}{I_B} = 20$
$T_j = 25°C$
typ
10^{-1}
1
10
$-I_C$ (mA)
10^2


7Z68038
$-V_{BE\,sat}$ (mV)
900
800
700
600
500
$\frac{I_C}{I_B} = 20$
$T_j = 25°C$
typ
10^{-1}
1
10
$-I_C$ (mA)
10^2


7Z68048
200
100
0
f_T (MHz)
$-V_{CE} = 5V$
$T_j = 25\,°C$
f = 35MHz
typ
10^{-1}
1
10
$-I_C$ (mA)
10^2


7Z68042
150
100
50
0
$-I_C$ (mA)
$-V_{CE} = 5V$
$T_j = 25°C$
typ
min-V_{BE}
max-V_{BE}
250
500
750
1000
$-V_{BE}$(mV)


7Z68031
$I_E = I_e = 0$
f = 1 MHz
$T_j = 25°C$
C_c (pF)
0
5
10
15
20
0
10
20
$-V_{CB}$ (V)
30


7Z68040
$-V_{CB} = 20V$
$-I_{CBO}$ (nA)
10^2
10
1
10^{-1}
10^{-2}
typ
0
50
100
T_j (°C)
150

SILICON PLANAR EPITAXIAL TRANSISTORS

N-P-N transistors in a micro miniature plastic envelope.
They are intended for low level general purpose applications in thick and thin film circuits.

QUICK REFERENCE DATA

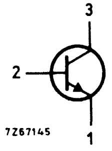
			BCW71	BCW72	
Collector-base voltage (open emitter)	V_{CBO}	max.	50	50	V
Collector-emitter voltage (open base)	V_{CEO}	max.	45	45	V
Collector current (peak value)	I_{CM}	max.	200	200	mA
Total power dissipation up to $T_{amb} = 25\,^{o}C$	P_{tot}	max.	200	200	mW
Junction temperature	T_j	max.	150	150	^{o}C
D.C. current gain at $T_j = 25\,^{o}C$ $I_C = 2$ mA; $V_{CE} = 5$ V	h_{FE}	>	110	200	
		<	220	450	
Transition frequency at f = 35 MHz $I_C = 10$ mA; $V_{CE} = 5$ V	f_T	typ.	300	300	MHz
Noise figure at $R_S = 2$ kΩ $I_C = 200\ \mu A$; $V_{CE} = 5$ V f = 1 kHz; B = 200 Hz	F	<	10	10	dB

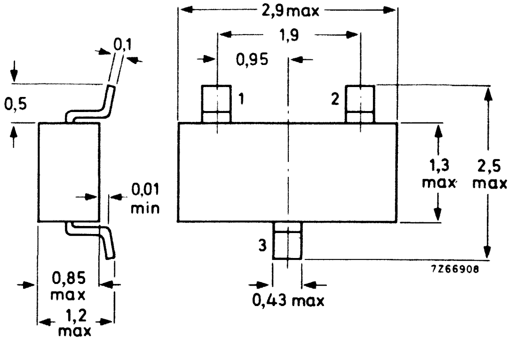
MECHANICAL DATA Dimensions in mm

SOT-23

Code:

BCW71 K1
BCW72 K2





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

Voltages

Collector-base voltage (open emitter)	V_{CBO}	max.	50	V
Collector-emitter voltage (open base) I_C = 2 mA	V_{CEO}	max.	45	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	V

Currents

→ Collector current (d.c.)	I_C	max.	100	mA
Collector current (peak value)	I_{CM}	max.	200	mA

→ Power dissipation

Total power dissipation up to T_{amb} = 25 °C mounted on a ceramic substrate of 7 mm x 5 mm x 0.5 mm	P_{tot}	max.	200	mW

→ Temperatures

Storage temperature	T_{stg}	−65 to	+150	°C
Junction temperature	T_j	max.	150	°C

→ **THERMAL RESISTANCE**

From junction to ambient mounted on a ceramic substrate of 7 mm x 5 mm x 0.5 mm	$R_{th\ j\text{-}a}$	=	0.62	°C/mW

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 = 100 °C	I_{CBO}	<	10	μA

Base emitter voltage

I_C = 2 mA; V_{CE} = 5 V	V_{BE}	550 to	700	mV

CHARACTERISTICS (continued)

T_j = 25 °C unless otherwise specified

Saturation voltages

I_C = 10 mA; I_B = 0.5 mA	V_{CEsat}	typ.	120	mV	
		<	250	mV	
	V_{BEsat}	typ.	750	mV	
I_C = 50 mA; I_B = 2.5 mA	V_{CEsat}	typ.	210	mV	←
	V_{BEsat}	typ.	850	mV	←

D.C. current gain

			BCW71	BCW72
I_C = 10 µA; V_{CE} = 5 V	h_{FE}	typ.	90	150
I_C = 2 mA; V_{CE} = 5 V	h_{FE}	>	110	200
		<	220	450

Collector capacitance at f = 1 MHz

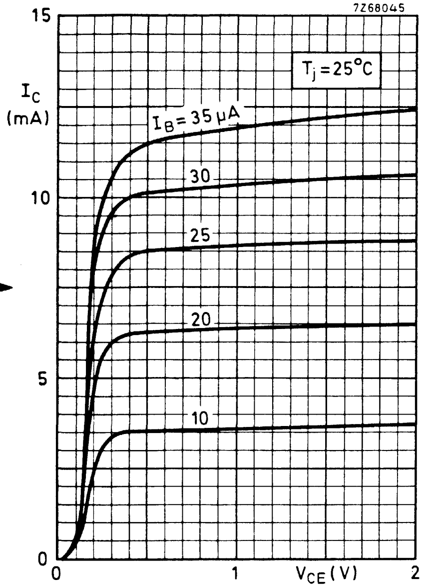
$I_E = I_e = 0$; V_{CB} = 10 V	C_c	<	4.0	pF

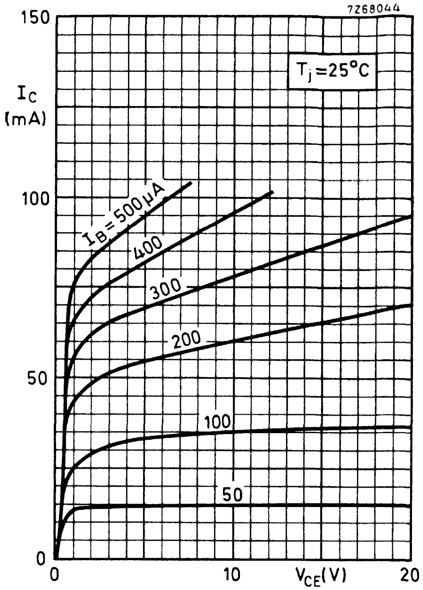
Transition frequency at f = 35 MHz

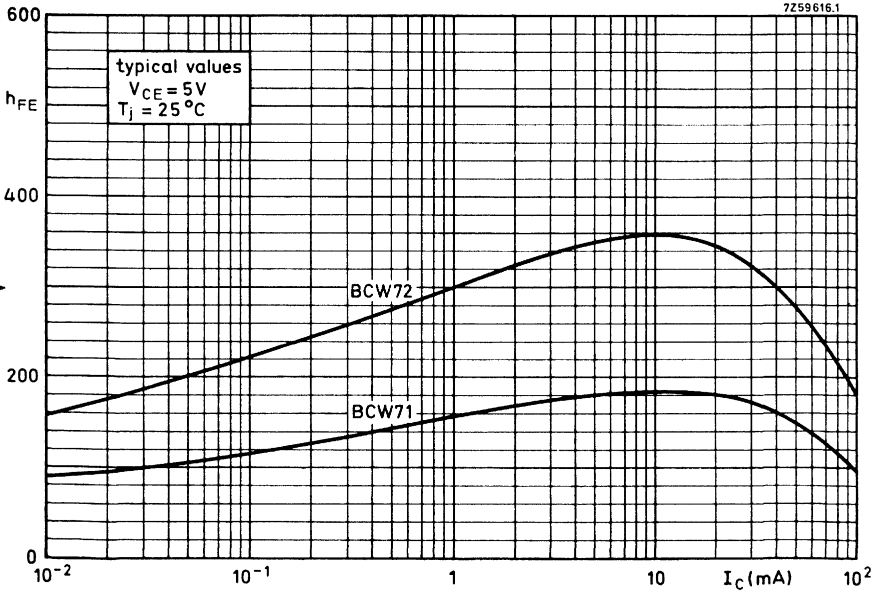
I_C = 10 mA; V_{CE} = 5 V	f_T	typ.	300	MHz

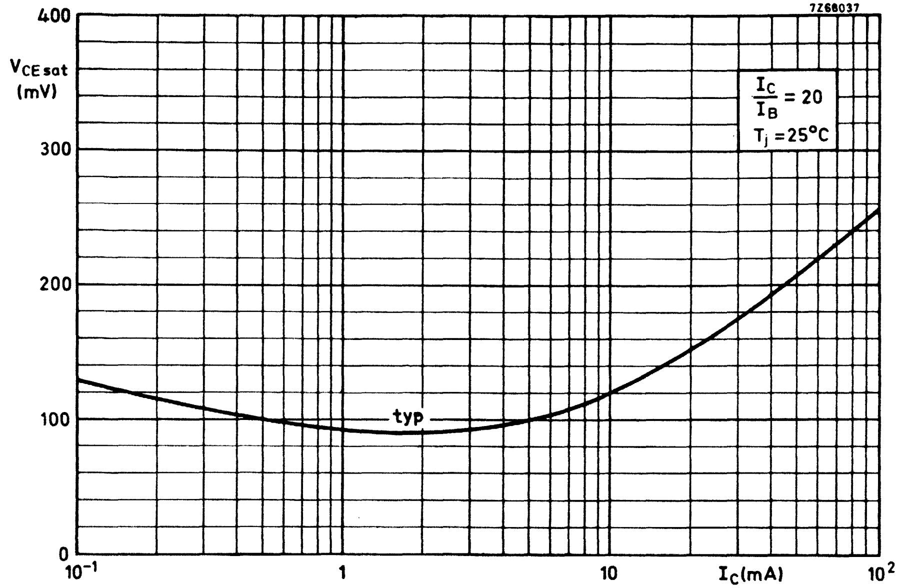
Noise figure at R_S = 2 kΩ

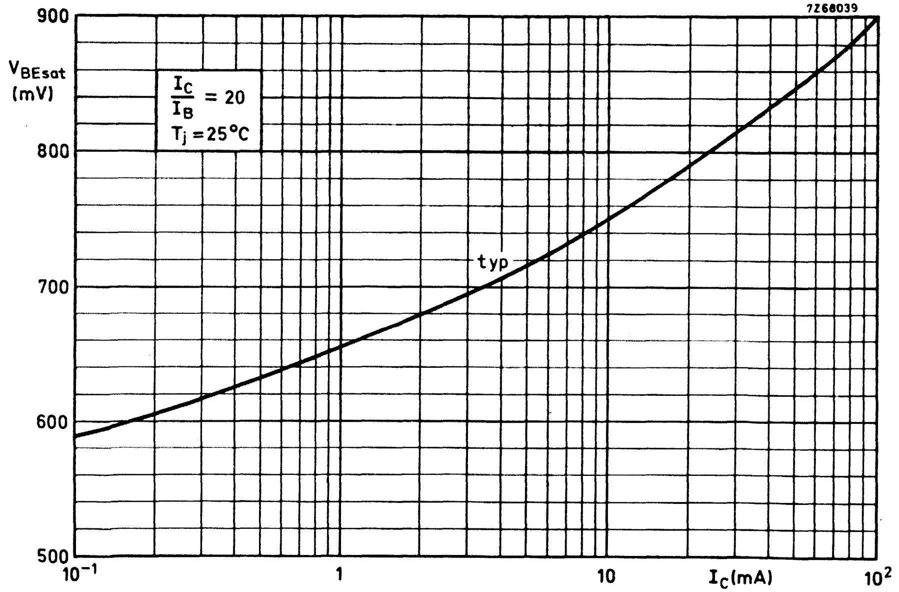
I_C = 200 µA; V_{CE} = 5 V f = 1 kHz; B = 200 Hz	F	<	10	dB

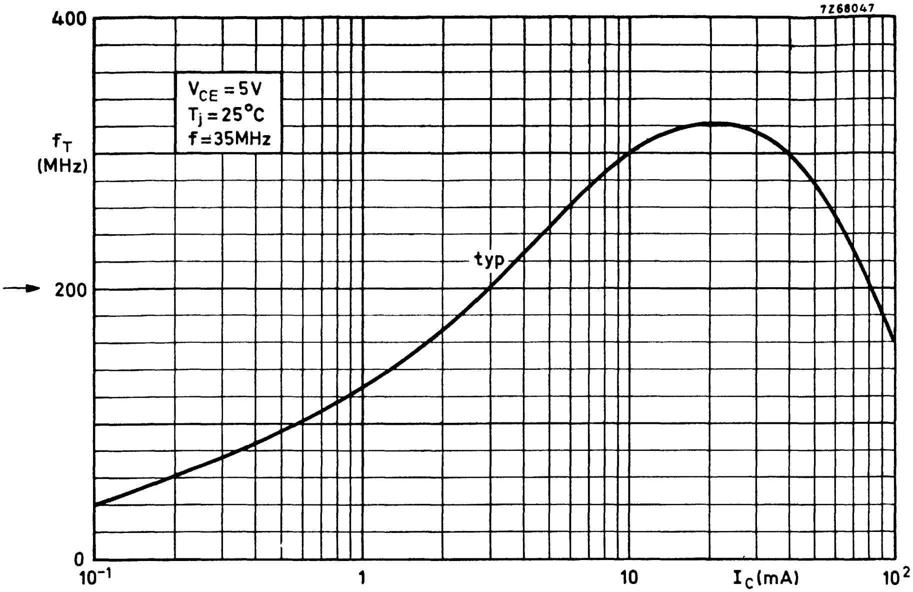

7Z68045
$T_j = 25°C$
I_C (mA)
$I_B = 35\ \mu A$
30
25
20
10
15
10
5
0
0
1
2
V_{CE} (V)

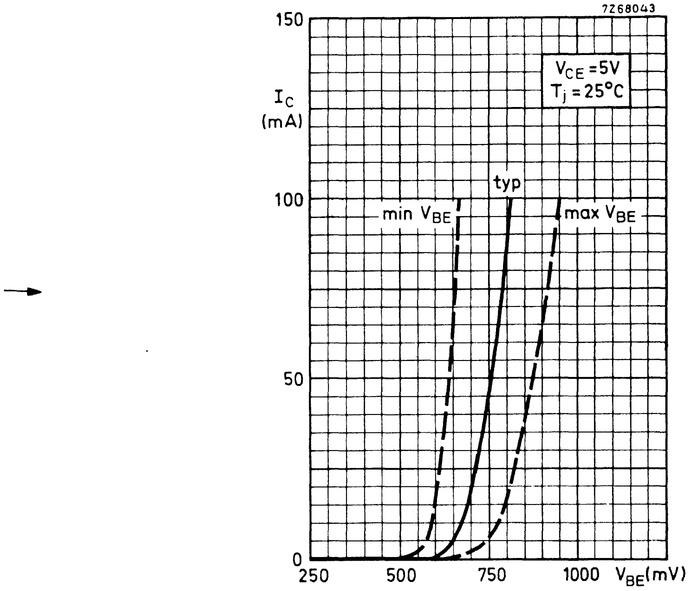

7Z68044
$T_j = 25°C$
I_C (mA)
$I_B = 500\ \mu A$
400
300
200
100
50
150
100
50
0
0
10
20
V_{CE} (V)

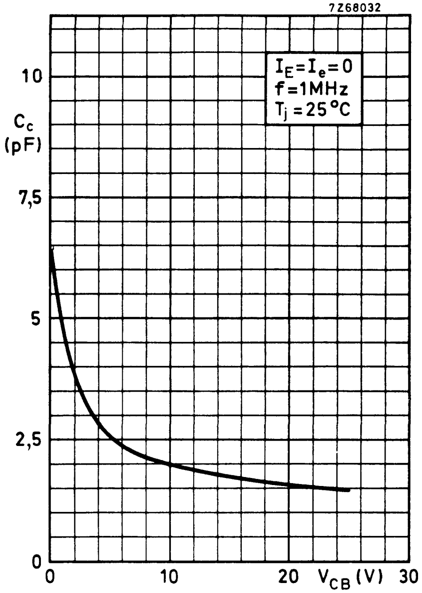

7Z59616.1
typical values
$V_{CE} = 5\ V$
$T_j = 25\ °C$
h_{FE}
BCW72
BCW71
600
400
200
0
10^{-2}
10^{-1}
1
10
10^2
I_C (mA)

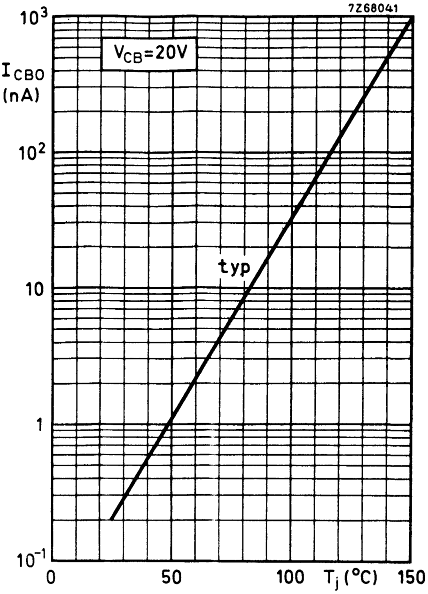

7Z66037
400
300
200
100
0
V_{CEsat} (mV)
$\frac{I_C}{I_B} = 20$
$T_j = 25\,^\circ C$
typ
10^{-1}
1
10
I_C (mA)
10^2


7Z66039
900
800
700
600
500
V_{BEsat} (mV)
$\frac{I_C}{I_B} = 20$
$T_j = 25\,^\circ C$
typ
10^{-1}
1
10
I_C (mA)
10^2


7Z68047
400
200
0
f_T
(MHz)
$V_{CE} = 5V$
$T_j = 25°C$
f = 35MHz
typ
10^{-1}
1
10
I_C(mA)
10^2


7Z68043
150
100
50
0
I_C
(mA)
$V_{CE} = 5V$
$T_j = 25°C$
typ
min V_{BE}
max V_{BE}
250
500
750
1000
V_{BE}(mV)


7Z68032
$I_E = I_e = 0$
f = 1MHz
$T_j = 25\,°C$
C_c
(pF)
10
7,5
5
2,5
0
0
10
20
V_{CB} (V)
30


7Z68041
10^3
$V_{CB} = 20V$
I_{CBO}
(nA)
10^2
typ
10
1
10^{-1}
0
50
100
T_j (°C)
150

BCX17
BCX18

SILICON PLANAR EPITAXIAL TRANSISTORS

P-N-P transistors in a micro miniature plastic envelope intended for application in thick- and thin-film circuits. These transistors are intended for general purposes as well as saturated switching and driver applications for industrial service.
The BCX17 and BCX18 are complementary to the BCX19 and BCX20 respectivily.

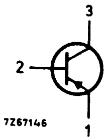
QUICK REFERENCE DATA

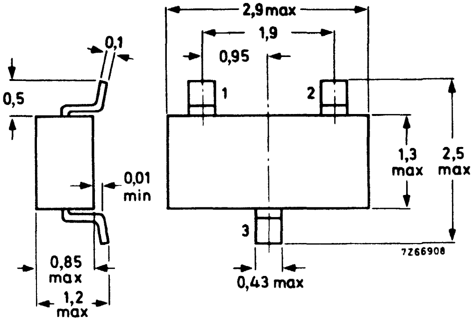
			BCX17	BCX18	
Collector-emitter voltage ($V_{BE} = 0$)	$-V_{CES}$	max.	50	30	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	45	25	V
Collector current (peak value)	$-I_{CM}$	max.	1000		mA
Total power dissipation up to $T_{amb} = 25\ ^{o}C$	P_{tot}	max.	310		mW
Junction temperature	T_j	max.	150		^{o}C
D.C. current gain $-I_C = 100$ mA; $-V_{CE} = 1$ V	h_{FE}		100 to 600		
Transition frequency $-I_C = 10$ mA; $-V_{CE} = 5$ V; f = 35 MHz	f_T	typ.	100		MHz

MECHANICAL DATA Dimensions in mm

SOT-23

Code:
BCX17 T1
BCX18 T2





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

Voltages

			BCX17	BCX18	
Collector-emitter voltage (V_{BE} = 0)	$-V_{CES}$	max.	50	30	V
Collector-emitter voltage (open base) $-I_C$ = 10 mA	$-V_{CEO}$	max.	45	25	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5	5	V

Currents

Collector current (d.c.)	$-I_C$	max.	500	mA
Collector current (peak value)	$-I_{CM}$	max.	1000	mA
Emitter current (peak value)	I_{EM}	max.	1000	mA
Base current (d.c.)	$-I_B$	max.	100	mA
Base current (peak value)	$-I_{BM}$	max.	200	mA

Power dissipation

Total power dissipation up to T_{amb} = 25 °C mounted on a ceramic substrate of 15 mm x 15 mm x 0,5 mm	P_{tot}	max.	310	mW

Temperatures

Storage temperature	T_{stg}		−65 to +150	°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

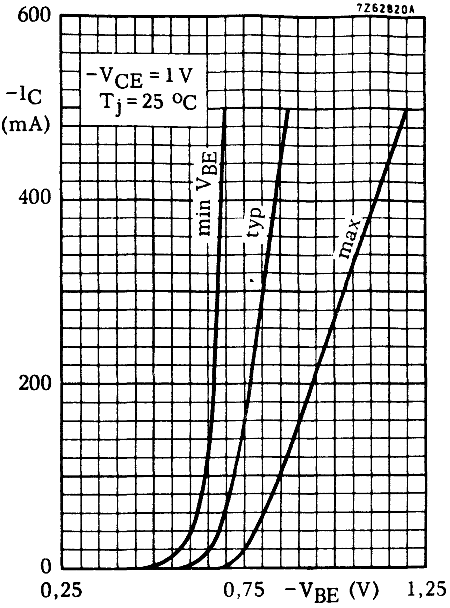
From junction to ambient in free air mounted on a ceramic substrate of 15 mm x 15 mm x 0,5 mm	$R_{th\ j\text{-}a}$	=	0,4	°C/mW

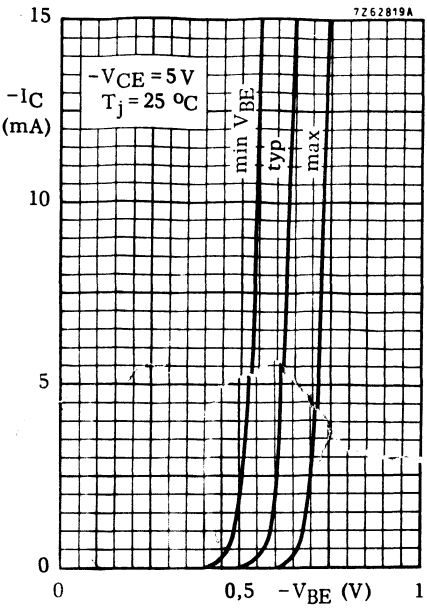
CHARACTERISTICS $T_j = 25\ ^oC$ unless otherwise specified

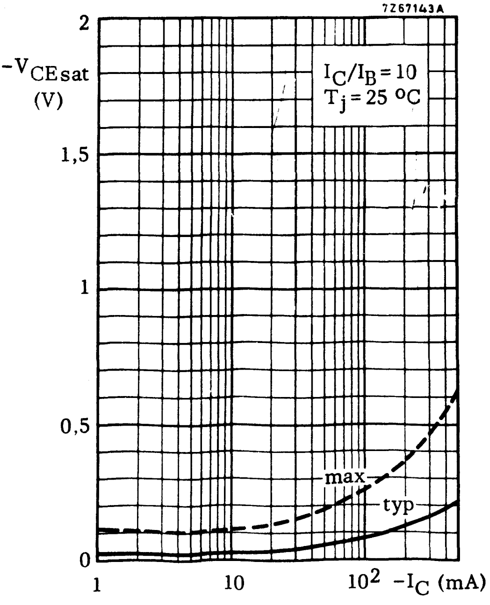
Collector cut-off current				
$I_E = 0;\ -V_{CB} = 20\ V$	$-I_{CBO}$	<	100	nA
$I_E = 0;\ -V_{CB} = 20\ V;\ T_j = 150\ ^oC$	$-I_{CBO}$	<	5	μA
Emitter cut-off current				
$I_C = 0;\ -V_{EB} = 5\ V$	$-I_{EBO}$	<	10	μA
Base emitter voltage [1]				
$-I_C = 500\ mA;\ -V_{CE} = 1\ V$	$-V_{BE}$	<	1,2	V
Saturation voltage				
$-I_C = 500\ mA;\ -I_B = 50\ mA$	$-V_{CEsat}$	<	620	mV
D.C. current gain				
$-I_C = 100\ mA;\ -V_{CE} = 1\ V$	h_{FE}	100 to	600	
$-I_C = 300\ mA;\ -V_{CE} = 1\ V$	h_{FE}	>	70	
$-I_C = 500\ mA;\ -V_{CE} = 1\ V$	h_{FE}	>	40	
Transition frequency at f = 35 MHz				
$-I_C = 10\ mA;\ -V_{CE} = 5\ V$	f_T	typ.	100	MHz
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0;\ -V_{CB} = 10\ V$	C_c	typ.	8	pF

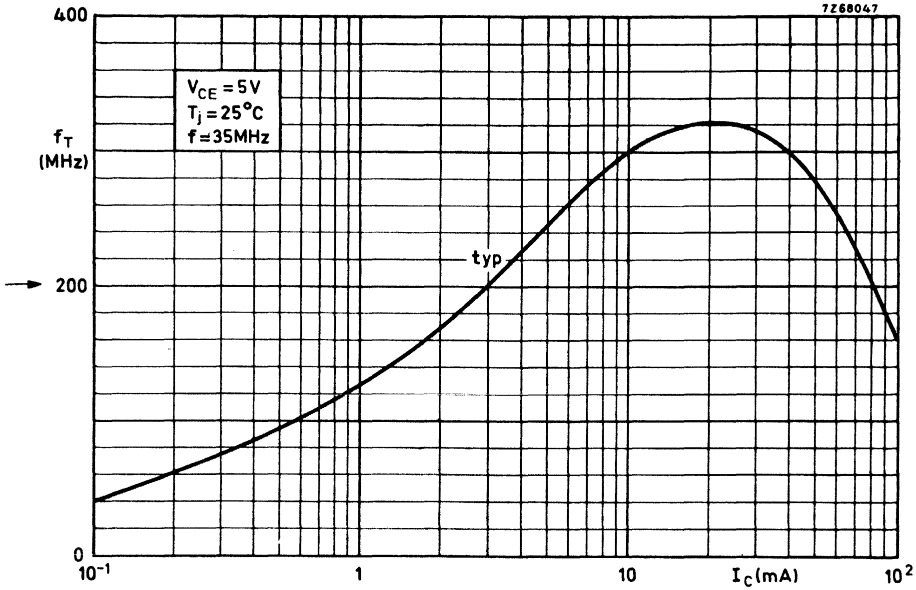
---

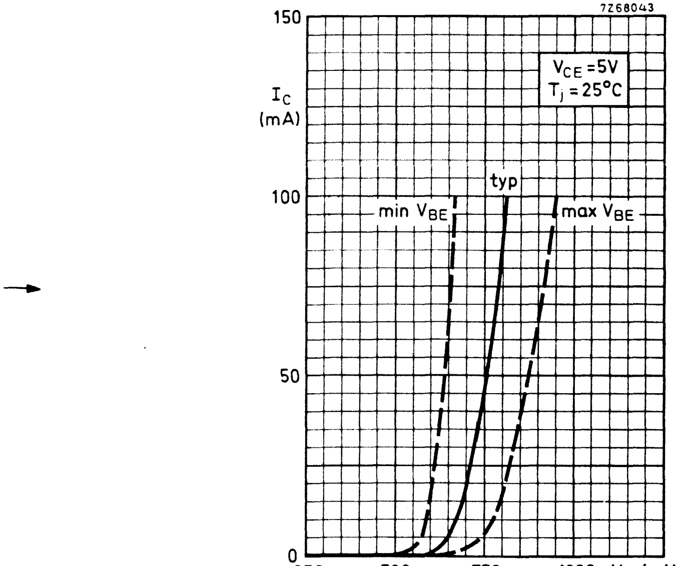
[1] $-V_{BE}$ decreases by about 2 mV/^oC with increasing temperature.

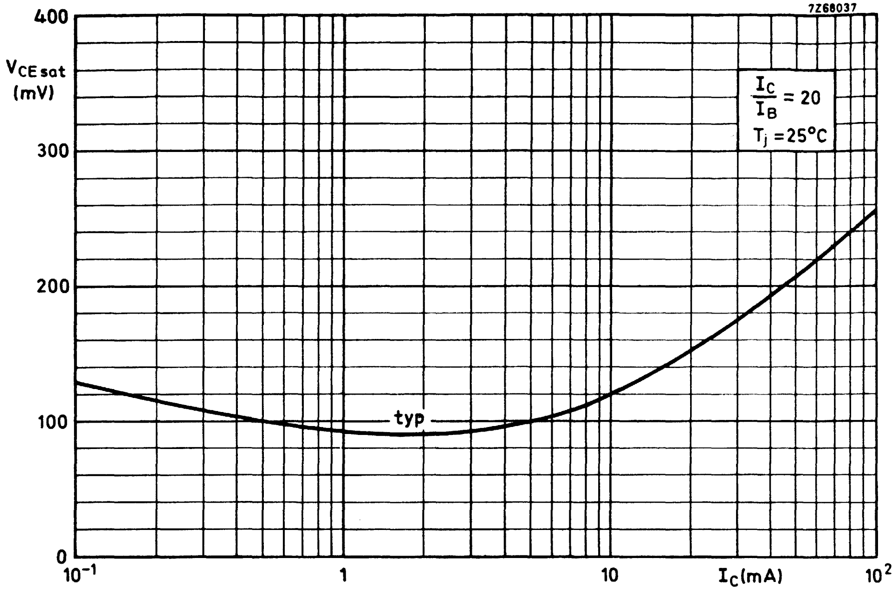

7Z62820A
600
400
200
0
$-I_C$
(mA)
$-V_{CE} = 1$ V
$T_j = 25$ °C
min V_{BE}
typ
max
0,25
0,75
$-V_{BE}$ (V)
1,25

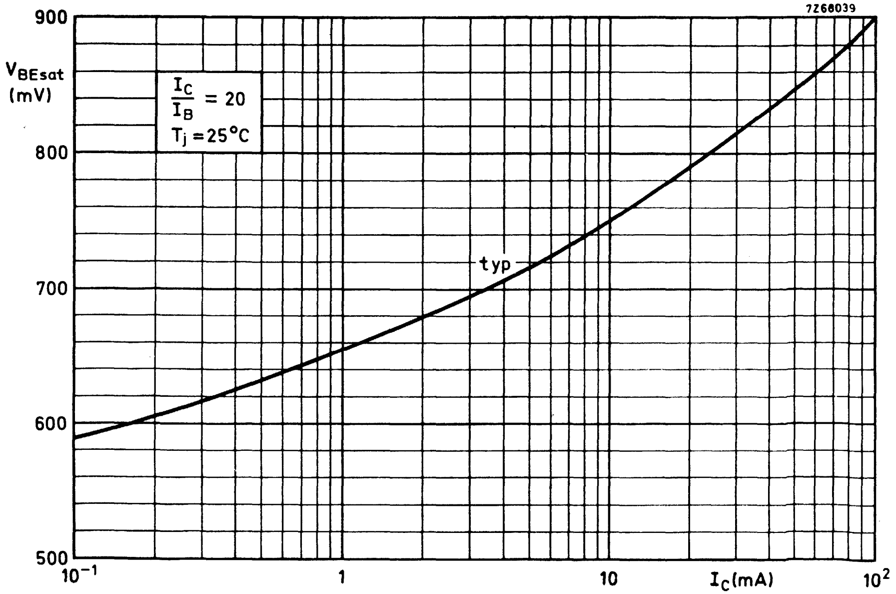

7Z62819A
15
10
5
0
$-I_C$
(mA)
$-V_{CE} = 5$ V
$T_j = 25$ °C
min V_{BE}
typ
max
0
0,5
$-V_{BE}$ (V)
1

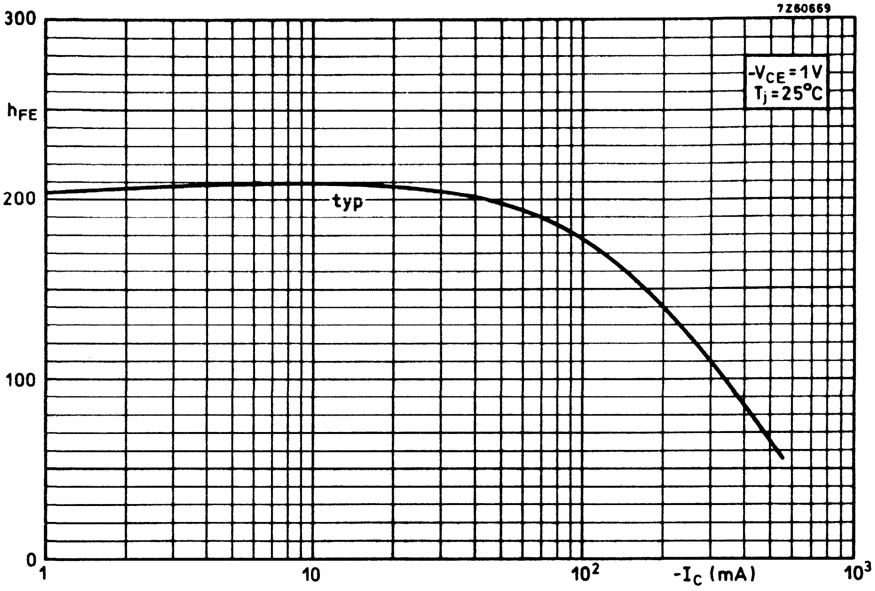

7Z67143A
2
1,5
1
0,5
0
$-V_{CEsat}$
(V)
$I_C/I_B = 10$
$T_j = 25$ °C
max
typ
1
10
10^2
$-I_C$ (mA)

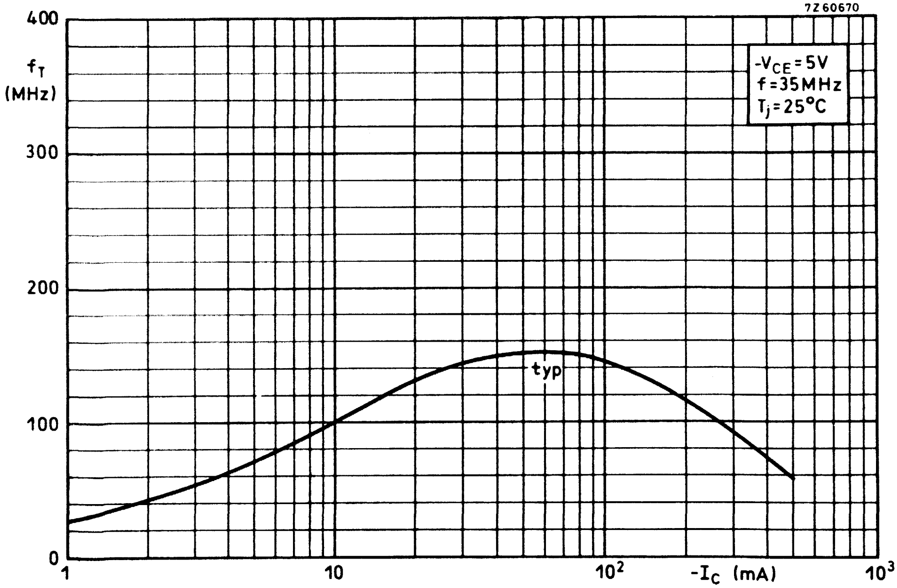

7Z68047
400
200
0
f_T
(MHz)
$V_{CE} = 5V$
$T_j = 25°C$
f = 35MHz
typ
10^{-1}
1
10
I_C (mA)
10^2


7Z68043
150
100
50
0
I_C
(mA)
$V_{CE} = 5V$
$T_j = 25°C$
typ
min V_{BE}
max V_{BE}
250
500
750
1000
V_{BE}(mV)


7Z68037
400
300
200
100
0
V_{CEsat} (mV)
$\frac{I_C}{I_B} = 20$
$T_j = 25°C$
typ
10^{-1}
1
10
I_C(mA)
10^2


7Z68039
900
800
700
600
500
V_{BEsat} (mV)
$\frac{I_C}{I_B} = 20$
$T_j = 25°C$
typ
10^{-1}
1
10
I_C(mA)
10^2


7Z60669
300
h_{FE}
200
100
0
1
10
10^2
$-I_C$ (mA)
10^3
$-V_{CE} = 1$ V
$T_j = 25$ °C
typ


7Z60670
400
f_T
(MHz)
300
200
100
0
1
10
10^2
$-I_C$ (mA)
10^3
$-V_{CE} = 5$ V
f = 35 MHz
$T_j = 25$ °C
typ

SILICON PLANAR EPITAXIAL TRANSISTORS

N-P-N transistors in a micro miniature plastic envelope intended for application in thick- and thin-film circuits. These transistors are intended for general purposes as well as saturated switching and driver applications for industrial service.
The BCX19 and BCX20 are complementary to the BCX17 and BCX18 respectivily.

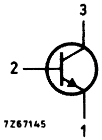
QUICK REFERENCE DATA

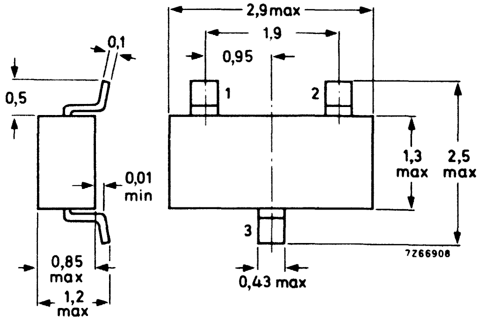
			BCX19	BCX20	
Collector-emitter voltage ($V_{BE} = 0$)	V_{CES}	max.	50	30	V
Collector-emitter voltage (open base)	V_{CEO}	max.	45	25	V
Collector current (peak value)	I_{CM}	max.	1000		mA
Total power dissipation up to $T_{amb} = 25\ ^{\circ}C$	P_{tot}	max.	310		mW
Junction temperature	T_j	max.	150		$^{\circ}C$
D.C. current gain $I_C = 100$ mA; $V_{CE} = 1$ V	h_{FE}		100 to 600		
Transition frequency $I_C = 10$ mA; $V_{CE} = 5$ V; f = 35 MHz	f_T	typ.	200		MHz

MECHANICAL DATA Dimensions in mm

SOT-23

Code:
BCX19 U1
BCX20 U2





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

Voltages

			BCX19	BCX20	
Collector-emitter voltage (V_{BE} = 0)	V_{CES}	max.	50	30	V
Collector-emitter voltage (open base) I_C = 10 mA	V_{CEO}	max.	45	25	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	5	V

Currents

Collector current (d.c.)	I_C	max.	500	mA
Collector current (peak value)	I_{CM}	max.	1000	mA
Emitter current (peak value)	$-I_{EM}$	max.	1000	mA
Base current (d.c.)	I_B	max.	100	mA
Base current (peak value)	I_{BM}	max.	200	mA

Power dissipation

Total power dissipation up to T_{amb} = 25 °C mounted on a ceramic substrate of 15 mm x 15 mm x 0,5 mm	P_{tot}	max.	310	mW

Temperatures

Storage temperature	T_{stg}		−65 to +150	°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

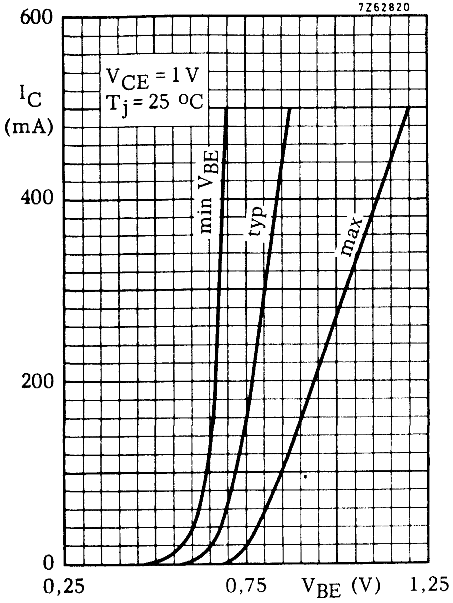
From junction to ambient in free air mounted on a ceramic substrate of 15 mm x 15 mm x 0,5 mm	$R_{th\,j\text{-}a}$	=	0,4	°C/mW

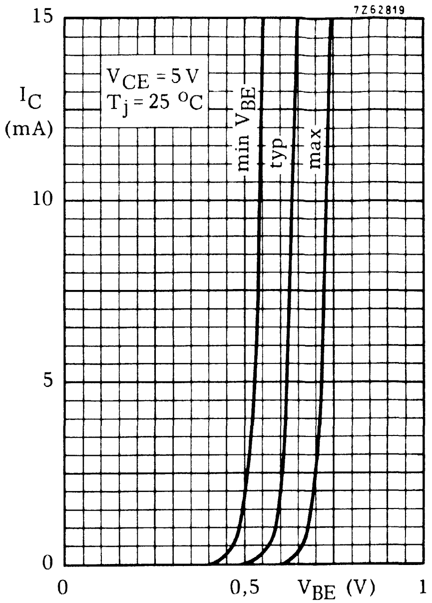
CHARACTERISTICS T_j = 25 °C unless otherwise specified

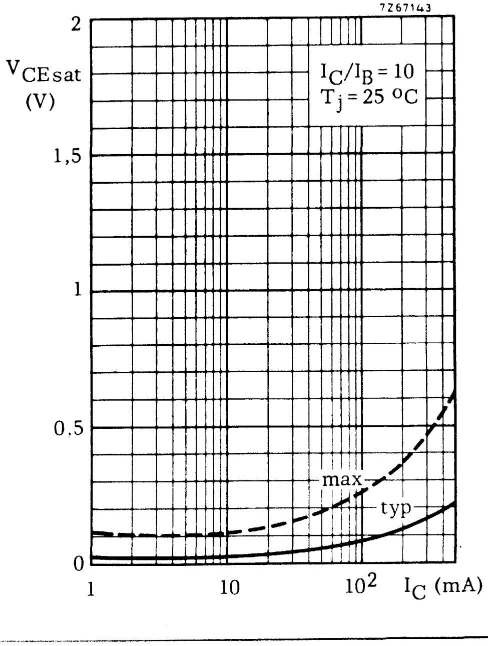
Collector cut-off current				
$I_E = 0$; $V_{CB} = 20$ V	I_{CBO}	<	100	nA
$I_E = 0$; $V_{CB} = 20$ V; $T_j = 150$ °C	I_{CBO}	<	5	μA
Emitter cut-off current				
$I_C = 0$; $V_{EB} = 5$ V	I_{EBO}	<	10	μA
Base emitter voltage [1]				
$I_C = 500$ mA; $V_{CE} = 1$ V	V_{BE}	<	1,2	V
Saturation voltage				
$I_C = 500$ mA; $I_B = 50$ mA	V_{CEsat}	<	620	mV
D.C. current gain				
$I_C = 100$ mA; $V_{CE} = 1$ V	h_{FE}	100 to	600	
$I_C = 300$ mA; $V_{CE} = 1$ V	h_{FE}	>	70	
$I_C = 500$ mA; $V_{CE} = 1$ V	h_{FE}	>	40	
Transition frequency at f = 35 MHz				
$I_C = 10$ mA; $V_{CE} = 5$ V	f_T	typ.	200	MHz
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; $V_{CB} = 10$ V	C_c	typ.	5	pF

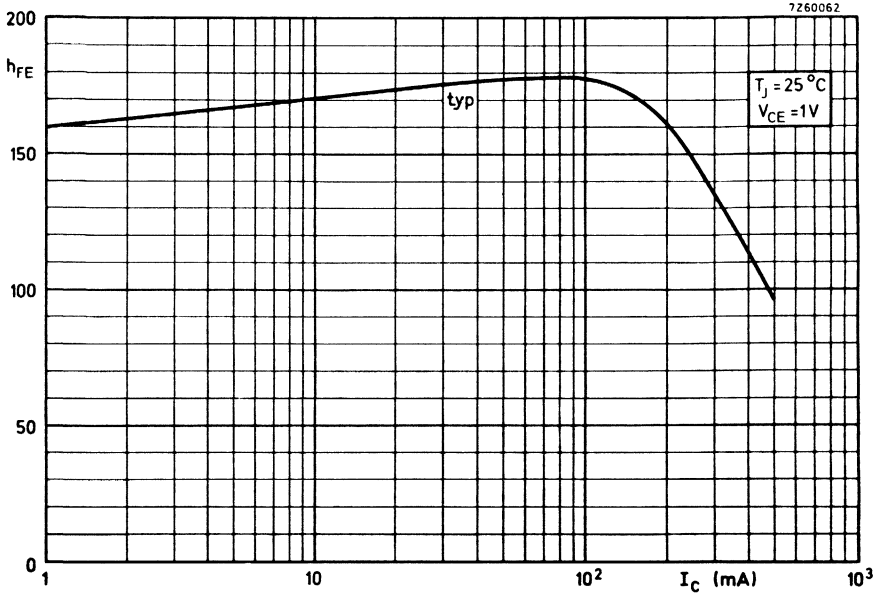
---

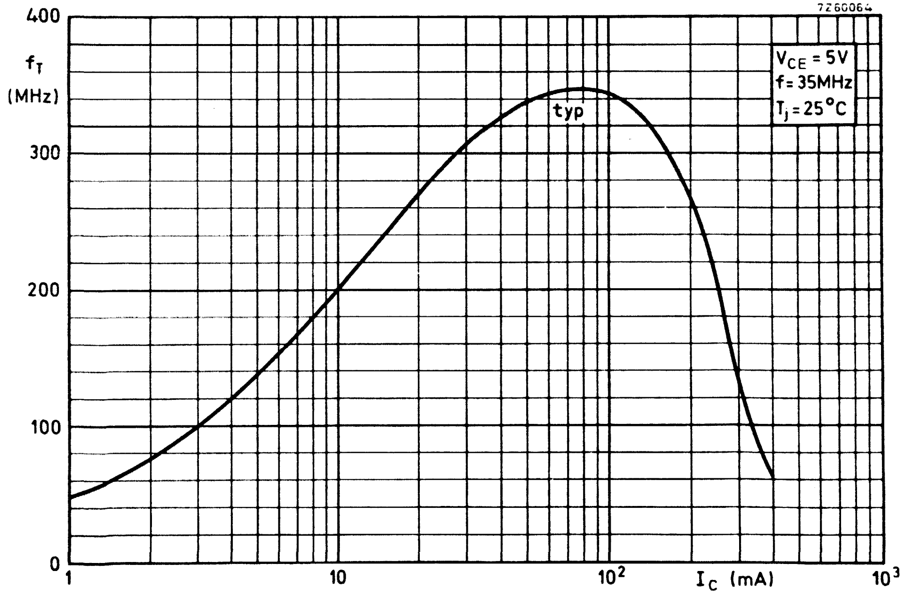
1) V_{BE} decreases by about 2 mV/°C with increasing temperature.


7Z62820
600
400
200
0
I_C
(mA)
$V_{CE} = 1$ V
$T_j = 25$ °C
min V_{BE}
typ
max
0,25
0,75
V_{BE} (V)
1,25


7Z62819
15
10
5
0
I_C
(mA)
$V_{CE} = 5$ V
$T_j = 25$ °C
min V_{BE}
typ
max
0
0,5
V_{BE} (V)
1


7Z67143
2
1,5
1
0,5
0
V_{CEsat}
(V)
$I_C/I_B = 10$
$T_j = 25$ °C
max
typ
1
10
10^2
I_C (mA)


7Z60062
200
h_{FE}
150
100
50
0
1
10
10^2
I_C (mA)
10^3
typ
$T_j = 25\,^\circ C$
$V_{CE} = 1V$


7Z60064
400
f_T
(MHz)
300
200
100
0
1
10
10^2
I_C (mA)
10^3
typ
$V_{CE} = 5V$
f= 35MHz
$T_j = 25\,^\circ C$

N-CHANNEL SILICON FIELD EFFECT TRANSISTOR

Planar epitaxial junction field effect transistor in a micro miniature plastic envelope. It is intended for low level general purpose amplifiers in thick- and thin-film circuits.

QUICK REFERENCE DATA

			BFR30	BFR31	
Drain-source voltage	±V_{DS}	max.	25		V
Gate-source voltage (open drain)	$-V_{GSO}$	max.	25		V
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	200		mW
Drain current V_{DS} = 10 V; V_{GS} = 0	I_{DSS}	> <	4 10	1 5	mA mA
Transfer admittance (common source) I_D = 1 mA; V_{DS} = 10 V; f = 1 kHz	$\lvert y_{fs} \rvert$	> <	1.0 4.0	1.5 4.5	mA/V mA/V

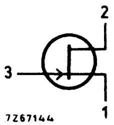
MECHANICAL DATA

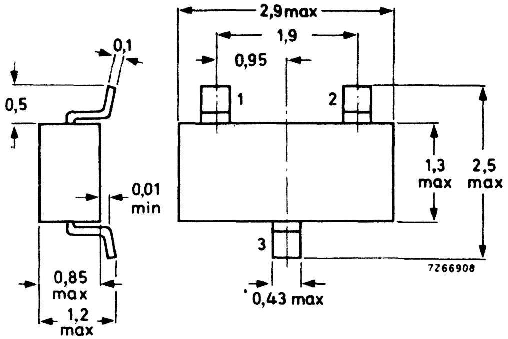
Dimensions in mm

SOT-23

Code:

BFR30 M1
BFR31 M2





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

Voltages				
Drain-source voltage	$\pm V_{DS}$	max.	25	V
Drain-gate voltage (open source)	V_{DGO}	max.	25	V
Gate-source voltage (open drain)	$-V_{GSO}$	max.	25	V
Current				
Drain current	I_D	max.	10	mA
Gate current	I_G	max.	5	mA
→ Power dissipation				
Total power dissipation up to T_{amb} = 25 °C mounted on a ceramic substrate of 7 mm x 5 mm x 0.5 mm	P_{tot}	max.	200	mW
→ Temperatures				
Storage temperature	T_{stg}	−65 to	+150	°C
Junction temperature	T_j	max.	150	°C

→ THERMAL RESISTANCE

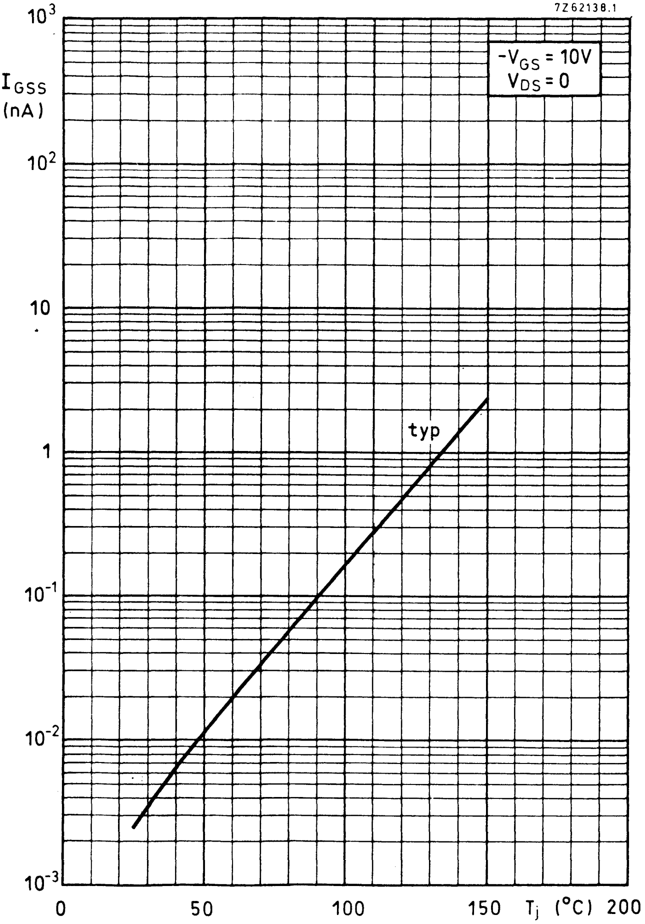
From junction to ambient mounted on a ceramic substrate of 7 mm x 5 mm x 0.5 mm	$R_{th\ j\text{-}a}$	=	0.62	°C/mW

CHARACTERISTICS

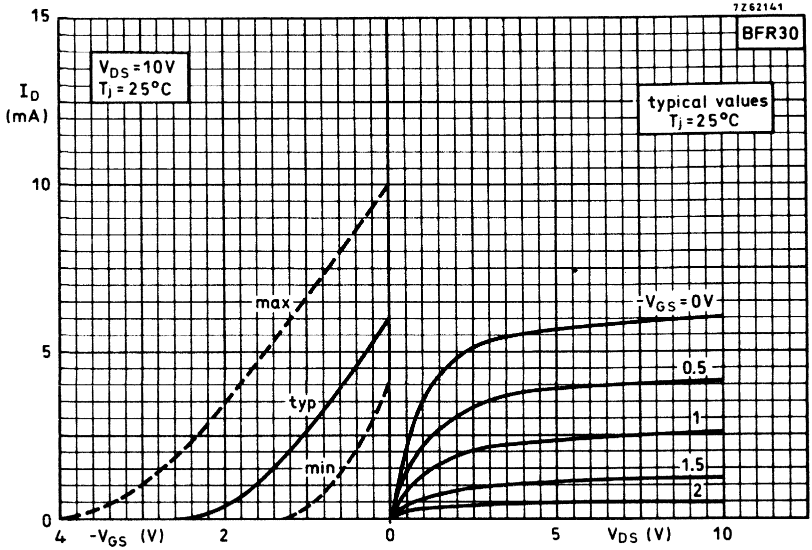
T_j = 25 °C unless otherwise specified

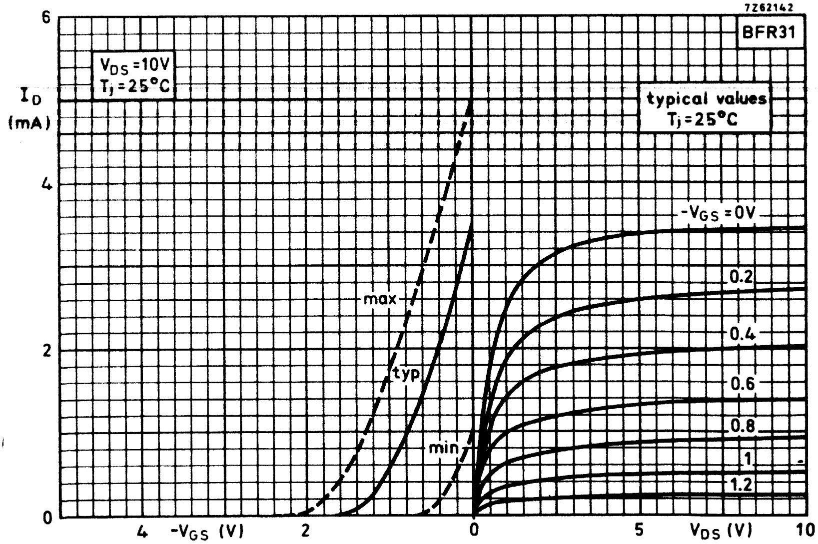
			BFR30	BFR31	
Gate cut-off current					
$-V_{GS}$ = 10 V; V_{DS} = 0	$-I_{GSS}$	<	0.2	0.2	nA
Drain current					
V_{DS} = 10 V; V_{GS} = 0	I_{DSS}	>	4	1	mA
		<	10	5	mA
Gate-source voltage					
I_D = 1 mA; V_{DS} = 10 V	$-V_{GS}$	>	0.7	0	V
		<	3.0	1.3	V
I_D = 50 μA; V_{DS} = 10 V	$-V_{GS}$	<	4.0	2.0	V
Gate-source cut-off voltage					
I_D = 0.5 nA; V_{DS} = 10 V	$-V_{(P)GS}$	<	5	2.5	V
y parameters					
Transfer admittance at f = 1 kHz; T_{amb} = 25 °C					
I_D = 1 mA; V_{DS} = 10 V	$\|y_{fs}\|$	>	1.0	1.5	mA/V
		<	4.0	4.5	mA/V
I_D = 200 μA; V_{DS} = 10 V	$\|y_{fs}\|$	>	0.5	0.75	mA/V
Output admittance at f = 1 kHz					
I_D = 1 mA; V_{DS} = 10 V	$\|y_{os}\|$	<	40	25	μA/V
I_D = 200 μA; V_{DS} = 10 V	$\|y_{os}\|$	<	20	15	μA/V
Input capacitance at f = 1 MHz					
I_D = 1 mA; V_{DS} = 10 V	C_{is}	<	4	4	pF
I_D = 200 μA; V_{DS} = 10 V	C_{is}	<	4	4	pF
Feedback capacitance at f = 1 MHz; T_{amb} = 25 °C					
I_D = 1 mA; V_{DS} = 10 V	C_{rs}	<	1.5	1.5	pF
I_D = 200 μA; V_{DS} = 10 V	C_{rs}	<	1.5	1.5	pF
Equivalent noise voltage					
I_D = 200 μA; V_{DS} = 10 V B = 0.6 to 100 Hz	V_n	<	0.5	0.5	μV

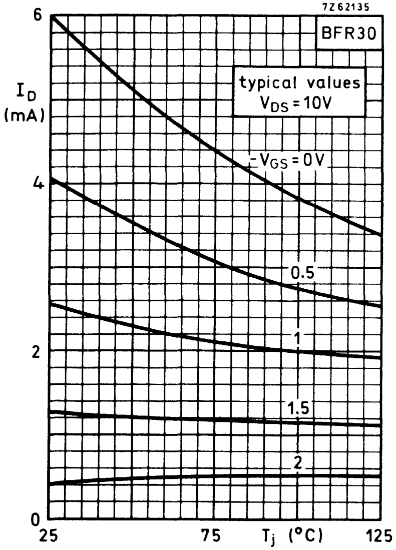
→

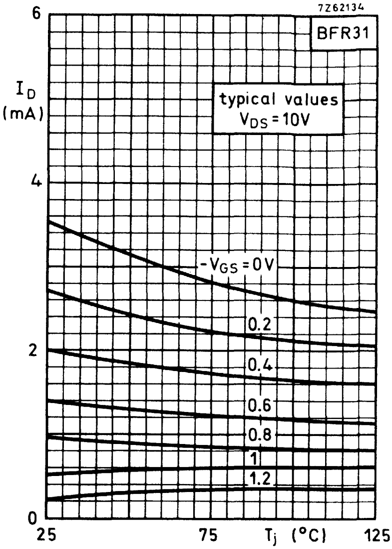


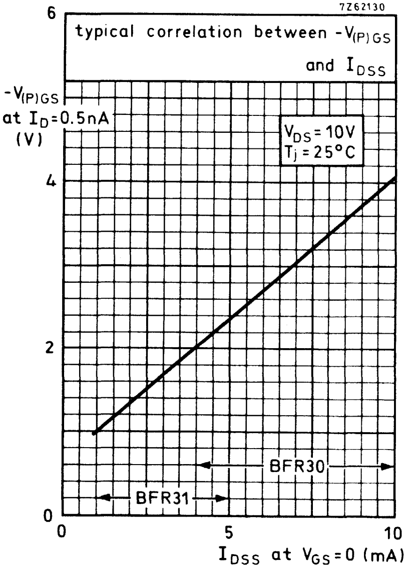
7Z62138.1
I_{GSS}
(nA)
10^3
10^2
10
1
10^{-1}
10^{-2}
10^{-3}
$-V_{GS} = 10V$
$V_{DS} = 0$
typ
0
50
100
150
T_j (°C)
200

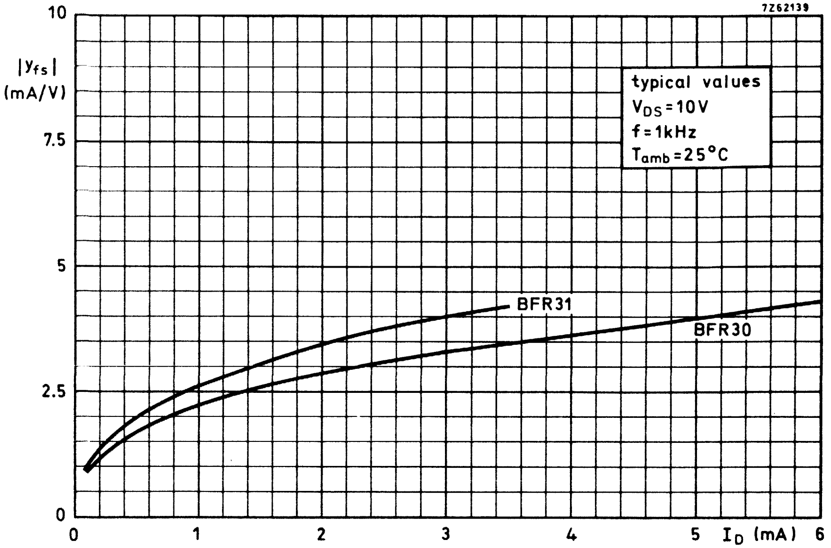

7Z62141
BFR30
V_{DS} = 10 V
T_j = 25 °C
I_D
(mA)
15
10
5
0
typical values
T_j = 25 °C
max
typ
min
$-V_{GS}$ = 0 V
0.5
1
1.5
2
4
$-V_{GS}$ (V)
2
0
5
V_{DS} (V)
10

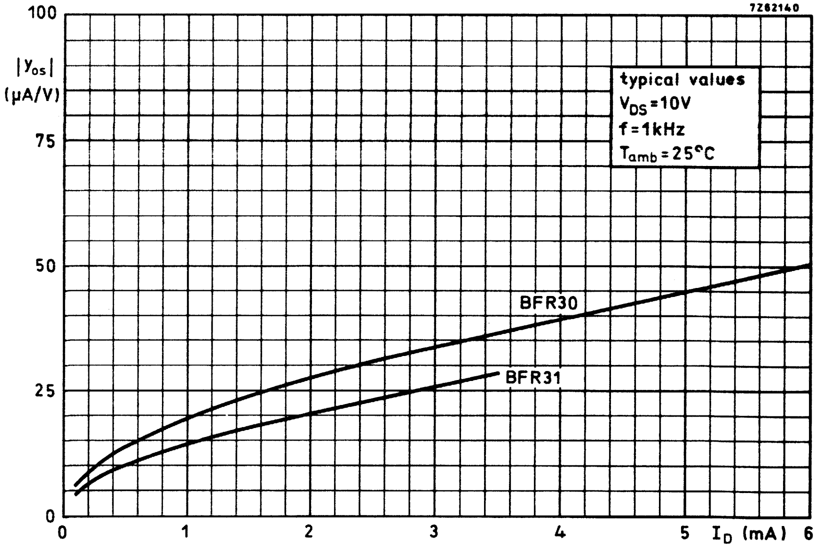

7Z62142
BFR31
V_{DS} = 10 V
T_j = 25 °C
I_D
(mA)
6
4
2
0
typical values
T_j = 25 °C
max
typ
min
$-V_{GS}$ = 0 V
0.2
0.4
0.6
0.8
1
1.2
4
$-V_{GS}$ (V)
2
0
5
V_{DS} (V)
10

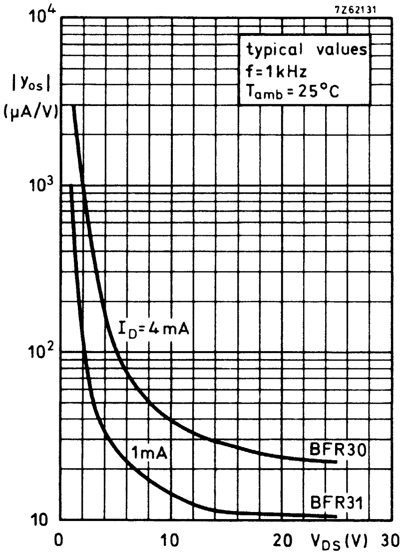

7Z62135
BFR30
typical values
V_{DS} = 10V
I_D (mA)
6
4
2
0
$-V_{GS}$ = 0V
0.5
1
1.5
2
25
75
T_j (°C)
125

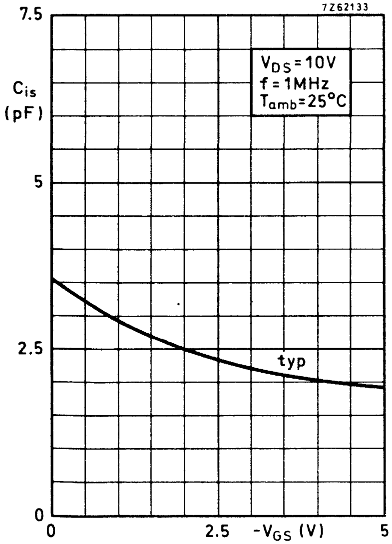

7Z62134
BFR31
typical values
V_{DS} = 10V
I_D (mA)
6
4
2
0
$-V_{GS}$ = 0V
0.2
0.4
0.6
0.8
1
1.2
25
75
T_j (°C)
125

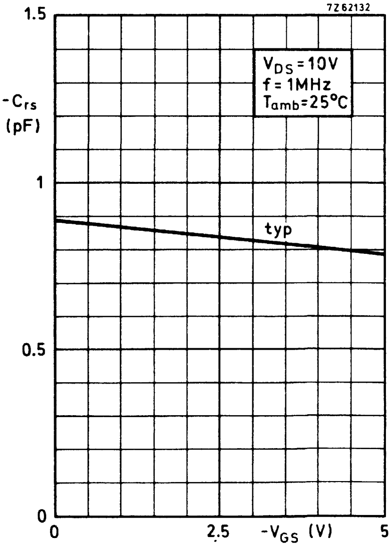

7Z62130
typical correlation between $-V_{(P)GS}$ and I_{DSS}
$-V_{(P)GS}$ at I_D = 0.5nA (V)
V_{DS} = 10V
T_j = 25°C
6
4
2
0
BFR30
BFR31
0
5
10
I_{DSS} at V_{GS} = 0 (mA)

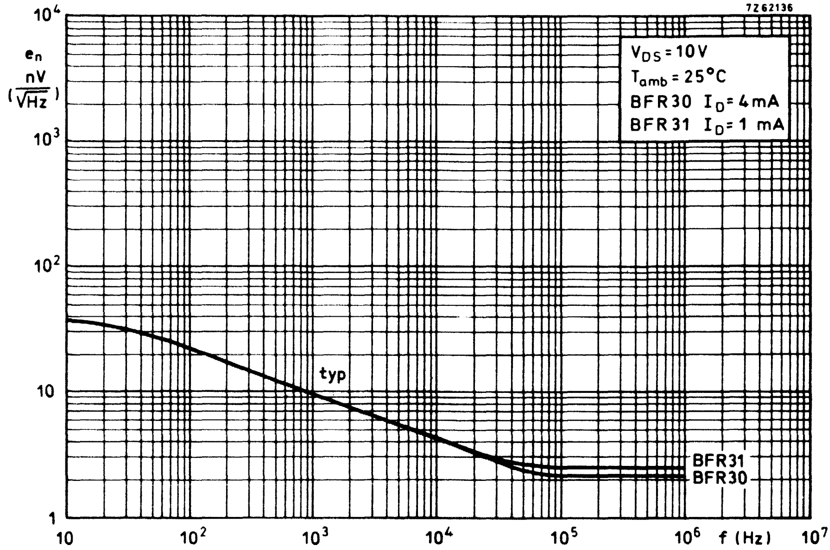

7Z62139
|y_fs|
(mA/V)
10
7.5
5
2.5
0
0
1
2
3
4
5
6
I_D (mA)
typical values
V_DS = 10V
f = 1kHz
T_amb = 25°C
BFR31
BFR30

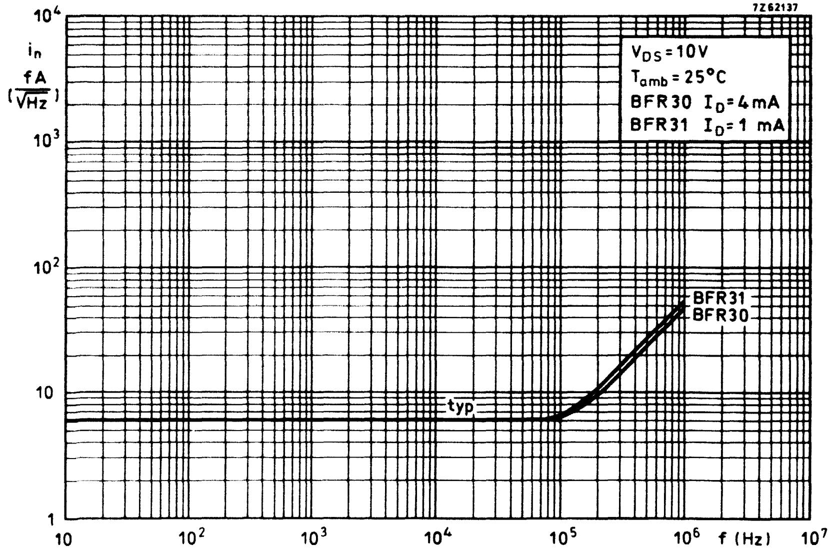

7Z62140
|y_os|
(μA/V)
100
75
50
25
0
0
1
2
3
4
5
6
I_D (mA)
typical values
V_DS = 10V
f = 1kHz
T_amb = 25°C
BFR30
BFR31


7Z62131
10^4
$|y_{os}|$
(μA/V)
10^3
10^2
10
typical values
f = 1 kHz
T_{amb} = 25 °C
I_D = 4 mA
1mA
BFR30
BFR31
0
10
20
V_{DS} (V)
30


7Z62133
7.5
C_{is}
(pF)
5
2.5
0
V_{DS} = 10V
f = 1MHz
T_{amb} = 25°C
typ
0
2.5
$-V_{GS}$ (V)
5


7Z62132
1.5
$-C_{rs}$
(pF)
1
0.5
0
V_{DS} = 10V
f = 1MHz
T_{amb} = 25°C
typ
0
2.5
$-V_{GS}$ (V)
5


7Z62136
e_n
$(\frac{nV}{\sqrt{Hz}})$
10^4
10^3
10^2
10
1
$V_{DS} = 10\,V$
$T_{amb} = 25\,°C$
BFR30 $I_D = 4\,mA$
BFR31 $I_D = 1\,mA$
typ
BFR31
BFR30
10
10^2
10^3
10^4
10^5
10^6
f (Hz)
10^7


7Z62137
i_n
$(\frac{fA}{\sqrt{Hz}})$
10^4
10^3
10^2
10
1
$V_{DS} = 10\,V$
$T_{amb} = 25\,°C$
BFR30 $I_D = 4\,mA$
BFR31 $I_D = 1\,mA$
typ
BFR31
BFR30
10
10^2
10^3
10^4
10^5
10^6
f (Hz)
10^7

SILICON PLANAR EPITAXIAL TRANSISTOR

N-P-N multi-emitter transistor in a micro miniature plastic envelope intended for application in thick- and thin-film circuits.

The transistor has very low intermodulation distortion and very high power gain.

It is primarily intended for:

- Wideband vertical amplifiers in high speed oscilloscopes.
- Television distribution amplifiers.

QUICK REFERENCE DATA

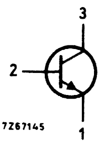
Collector-base voltage (open emitter)	V_{CBO}	max.	18	V
Collector-emitter voltage (open base)	V_{CEO}	max.	10	V
Collector current (peak value; f > 1 MHz)	I_{CM}	max.	100	mA
Total power dissipation up to T_{amb} = 60 °C	P_{tot}	max.	180	mW
Junction temperature	T_j	max.	150	°C
Feedback capacitance at f = 1 MHz				
I_C = 2 mA; V_{CE} = 5 V; T_{amb} = 25 °C	$-C_{re}$	typ.	0.9	pF
Transition frequency at f = 500 MHz				
I_C = 25 mA; V_{CE} = 5 V	f_T	typ.	2.0	GHz
Max. unilateral power gain (see page 3)				
I_C = 30 mA; V_{CE} = 5 V; f = 200 MHz; T_{amb} = 25 °C	G_{UM}	typ.	22	dB
I_C = 30 mA; V_{CE} = 5 V; f = 800 MHz; T_{amb} = 25 °C	G_{UM}	typ.	10.5	dB
Intermodulation distortion at T_{amb} = 25 °C				
I_C = 30 mA; V_{CE} = 5 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

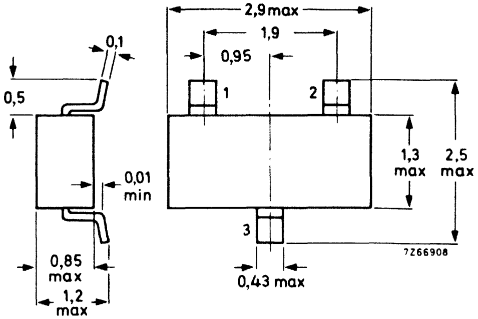
MECHANICAL DATA

Dimensions in mm

SOT-23

Code: N1





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

Voltages				
Collector-base voltage (open emitter)	V_{CBO}	max.	18	V
Collector-emitter voltage (open base)	V_{CEO}	max.	10	V
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} = 60 °C mounted on a ceramic substrate of 15 mm x 10 mm x 0.5 mm	P_{tot}	max.	180	mW
Temperatures				
Storage temperature	T_{stg}	-65 to +150		°C
Junction temperature	T_j	max.	150	°C

→ **THERMAL RESISTANCE**

From junction to ambient in free air mounted on a ceramic substrate of 15 mm x 10 mm x 0.5	$R_{th\ j-a}$	=	0.50	°C/mW

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

Collector cut-off current				
$I_E = 0$; $V_{CB} = 10$ V	I_{CBO}	<	50	nA
D.C. current gain [1]				
$I_C = 25$ mA; $V_{CE} = 5$ V	h_{FE}	>	25	
$I_C = 50$ mA; $V_{CE} = 5$ V	h_{FE}	>	25	
Transition frequency at f = 500 MHz [1]				
$I_C = 25$ mA; $V_{CE} = 5$ V	f_T	typ.	2.0	GHz
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; $V_{CB} = 5$ V	C_c	typ.	0.9	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; $T_{amb} = 25\ ^{o}C$	$-C_{re}$	typ.	0.9	pF
Noise figure at f = 500 MHz [2]				
$I_C = 2$ mA; $V_{CE} = 5$ V; $T_{amb} = 25\ ^{o}C$ $G_S = 20$ mA/V; B_S is tuned	F	<	5	dB

→ Max. unilateral power gain (s_{re} assumed to be zero)

$$G_{UM}\ \text{(in dB)} = 10 \log \frac{|s_{fe}|^2}{(1 - |s_{ie}|^2)(1 - |s_{oe}|^2)}$$

$I_C = 30$ mA; $V_{CE} = 5$ V; f = 200 MHz; $T_{amb} = 25\ ^{o}C$	G_{UM}	typ.	22	dB
$I_C = 30$ mA; $V_{CE} = 5$ V; f = 800 MHz; $T_{amb} = 25\ ^{o}C$	G_{UM}	typ.	10.5	dB

---

[1] Measured under pulse conditions.

[2] Crystal mounted in a BFW30 envelope.

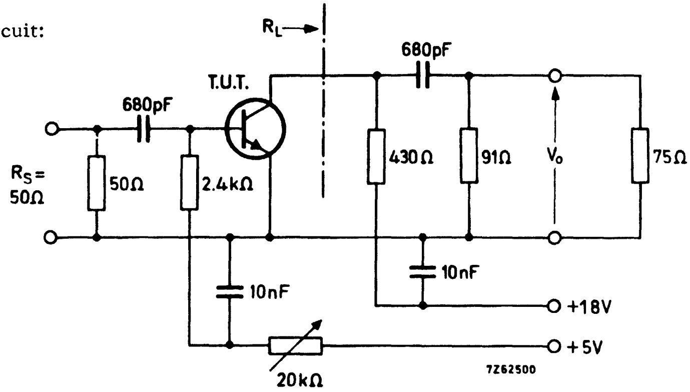
CHARACTERISTICS (continued) T_{amb} = 25 °C unless otherwise specified

Intermodulation distortion [1]

I_C = 30 mA; V_{CE} = 5 V; R_L = 37.5 Ω

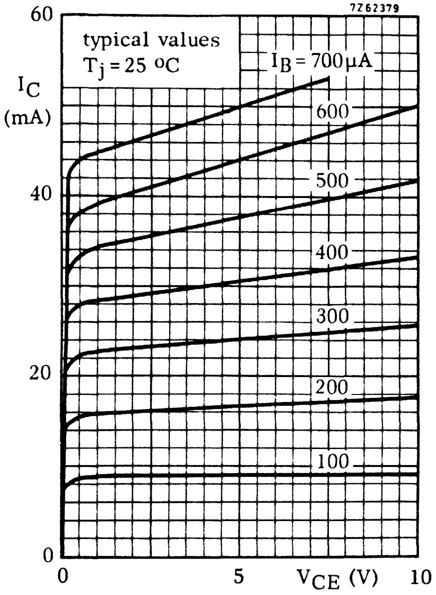
V_o = 100 mV at f_p = 183 MHz
V_o = 100 mV at f_q = 200 MHz
Measured at $f_{(2q-p)}$ = 217 MHz d_{im} typ. −60 dB

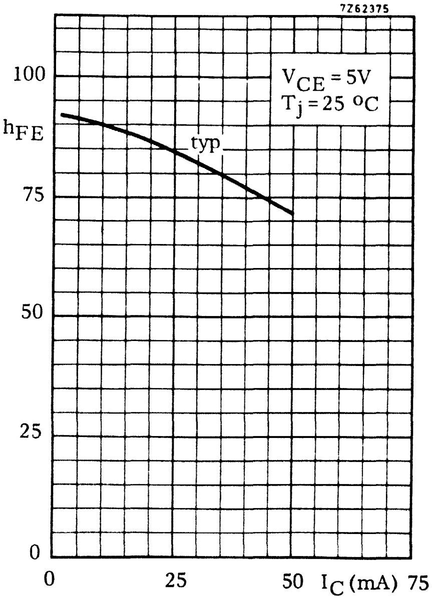
Test circuit:

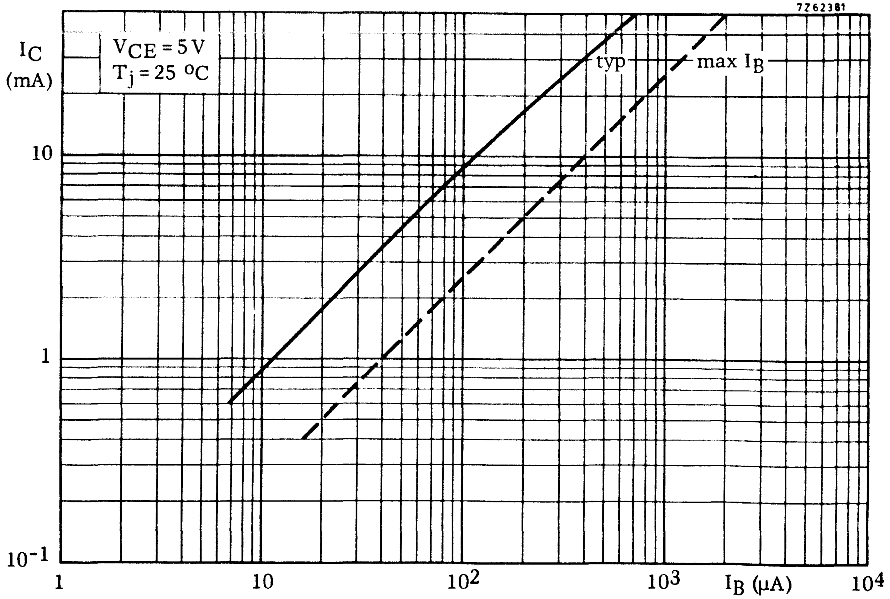


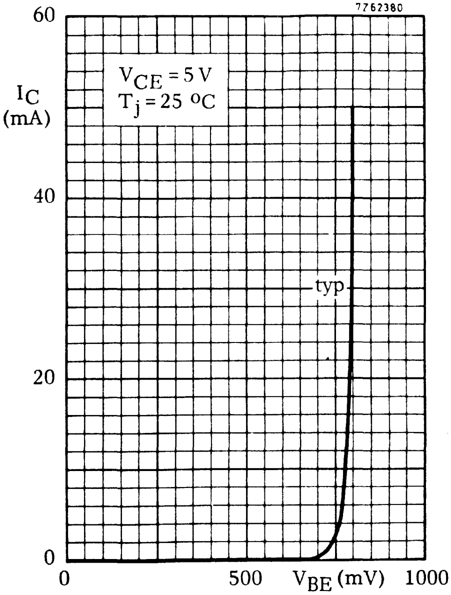
---

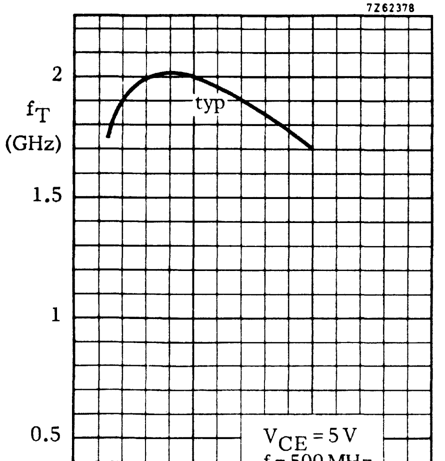
[1] Crystal mounted in a BFW30 envelope.

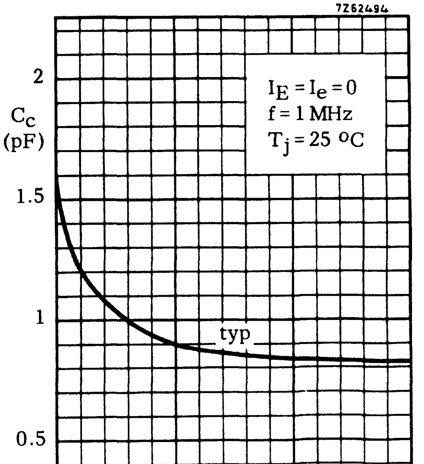

7Z62379
typical values
$T_j = 25\ ^oC$
$I_B = 700\ \mu A$
600
500
400
300
200
100
I_C (mA)
60
40
20
0
0
5
V_{CE} (V)
10


7Z62375
$V_{CE} = 5V$
$T_j = 25\ ^oC$
typ
h_{FE}
100
75
50
25
0
0
25
50
I_C (mA)
75

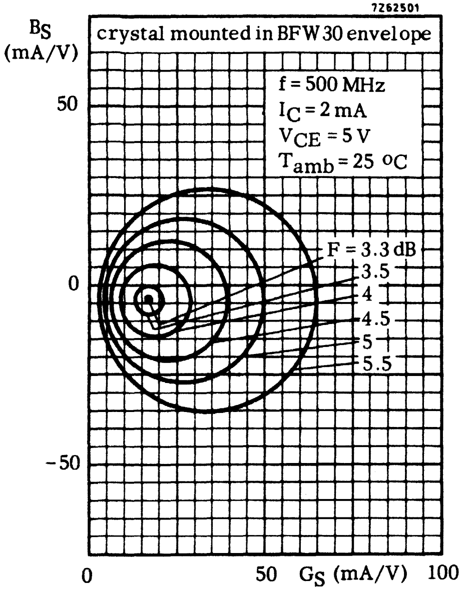

7Z62381
$V_{CE} = 5\ V$
$T_j = 25\ ^oC$
typ
max I_B
I_C (mA)
10
1
10^{-1}
1
10
10^2
10^3
I_B (μA)
10^4

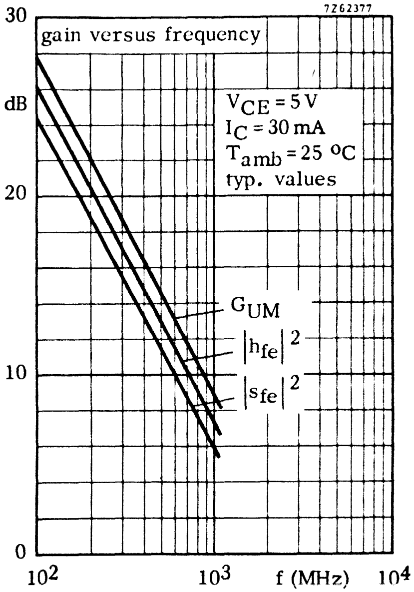

7Z62380
$V_{CE} = 5$ V
$T_j = 25$ °C
I_C (mA)
60
40
20
0
typ
0
500
V_{BE} (mV)
1000

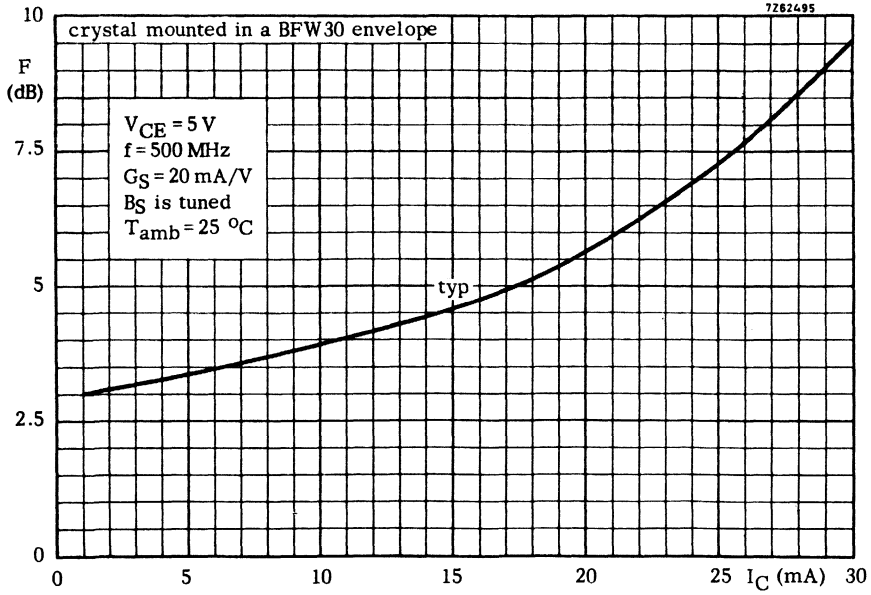

7Z62378
f_T (GHz)
2
1.5
1
0.5
0
typ
$V_{CE} = 5$ V
f = 500 MHz
$T_j = 25$ °C
0
25
50
I_C (mA)
75


7Z62494
C_c (pF)
2
1.5
1
0.5
0
$I_E = I_e = 0$
f = 1 MHz
$T_j = 25$ °C
typ
0
5
10
V_{CB} (V)
15

circles of constant noise figure



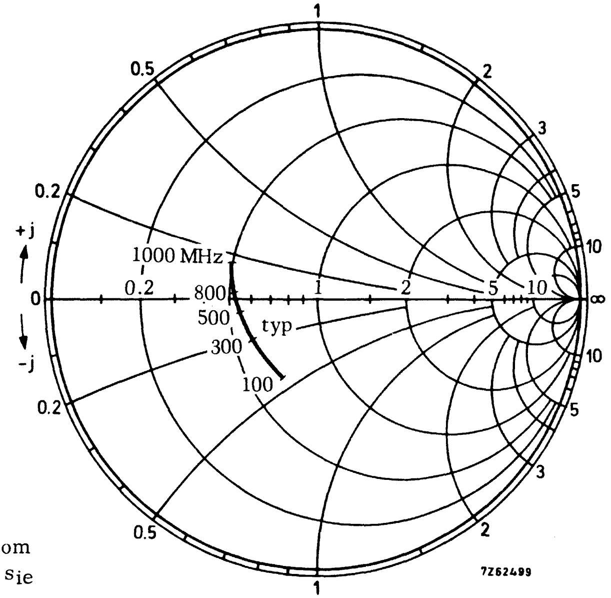




V_{CE} = 5 V

I_C = 30 mA

T_{amb} = 25 ^oC

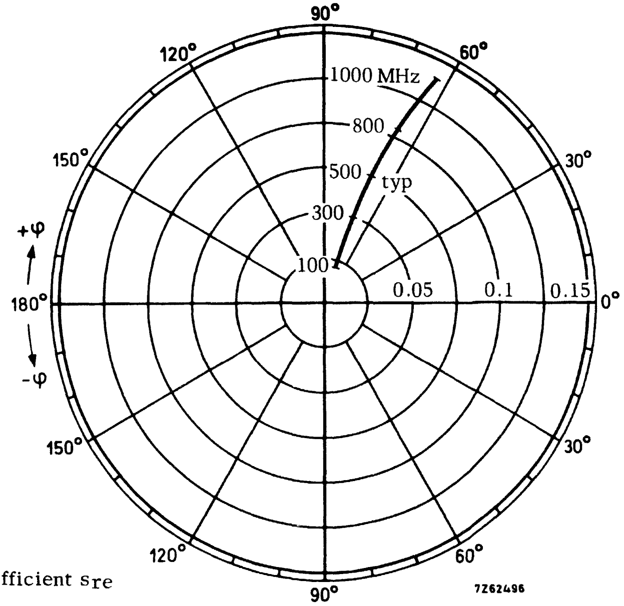


Input impedance derived from input reflection coefficient s_{ie} coordinates in ohm x 50

V_{CE} = 5 V

I_C = 30 mA

T_{amb} = 25 ^oC

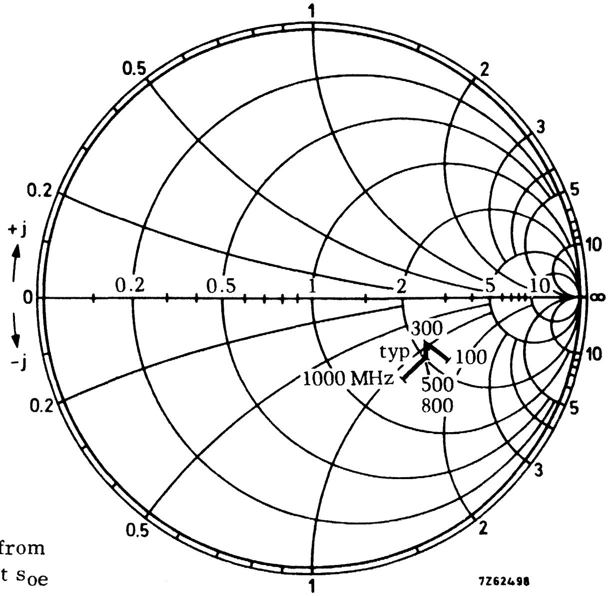


→ Reverse transmission coefficient s_{re}

V_{CE} = 5 V

I_C = 30 mA

T_{amb} = 25 °C

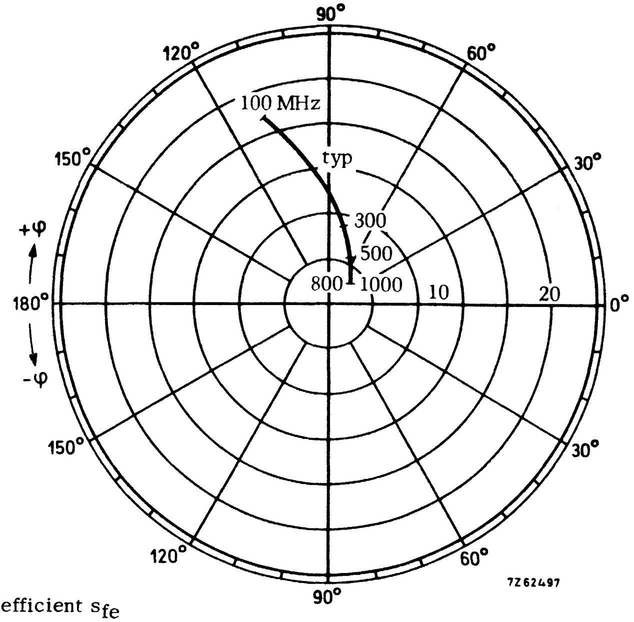


Output impedance derived from output reflection coefficient s_{oe} coordinates in ohm x 50

V_{CE} = 5 V

I_C = 30 mA

T_{amb} = 25 °C



► Forward transmission coefficient s_{fe}

SILICON PLANAR EPITAXIAL TRANSISTOR

N-P-N transistor in a microminiature plastic envelope. It is primarily intended for use in u.h.f. and microwave amplifiers in thick- and thin-film circuits, such as in aerial amplifiers, radar systems, oscilloscopes, spectrum analysers etc.
The transistor features low intermodulation distortion and high power gain; thanks to its very high transition frequency, it also has excellent wideband properties and low noise up to high frequencies.

QUICK REFERENCE DATA

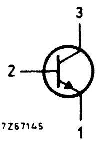
Collector-base voltage (open emitter)	V_{CBO}	max.	20	V
Collector-emitter voltage (open base)	V_{CEO}	max.	15	V
Collector current (d.c.)	I_C	max.	25	mA
Total power dissipation up to T_{amb} = 60 °C	P_{tot}	max.	180	mW
Junction temperature	T_j	max.	150	°C
Transition frequency at f = 500 MHz				
I_C = 14 mA; V_{CE} = 10 V	f_T	typ.	5	GHz
Feedback capacitance at f = 1 MHz				
I_C = 2 mA; V_{CE} = 10 V; T_{amb} = 25 °C	C_{re}	typ.	0,7	pF
Noise figure at optimum source impedance				
I_C = 2 mA; V_{CE} = 10 V; f = 500 MHz; T_{amb} = 25 °C	F	typ.	2,4	dB
Max. unilateral power gain (see page 3)				
I_C = 14 mA; V_{CE} = 10 V; f = 500 MHz; T_{amb} = 25 °C	G_{UM}	typ.	18	dB
Intermodulation distortion at T_{amb} = 25 °C				
I_C = 14 mA; V_{CE} = 10 V; R_L = 75 Ω; V_o = 150 mV				
$f_{(p+q-r)}$ = 493,25 MHz (see page 4)	d_{im}	typ.	−60	dB

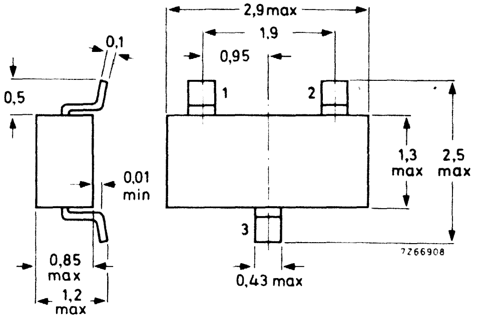
MECHANICAL DATA

Dimensions in mm

SOT-23

Code: P1





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

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.	2,0	V

Current

Collector current (d.c.)	I_C	max.	25	mA

Power dissipation

Total power dissipation up to T_{amb} = 60 °C mounted on a ceramic substrate of 15 mm x 10 mm x 0,5 mm	P_{tot}	max.	180	mW

Temperatures

Storage temperature	T_{stg}	-65 to +150		°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

From junction to ambient in free air mounted on a ceramic substrate of 15 mm x 10 mm x 0,5 mm	$R_{th\ j\text{-}a}$	=	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 [1]				
$I_C = 14$ mA; $V_{CE} = 10$ V	h_{FE}	> typ.	25 50	
Transition frequency at f = 500 MHz [1]				
$I_C = 14$ mA; $V_{CE} = 10$ V	f_T	typ.	5	GHz
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; $V_{CB} = 10$ V	C_c	typ.	0,75	pF
Emitter capacitance at f = 1 MHz				
$I_C = I_c = 0$; $V_{EB} = 0{,}5$ V	C_e	typ.	0,8	pF
Feedback capacitance at f = 1 MHz				
$I_C = 2$ mA; $V_{CE} = 10$ V; $T_{amb} = 25$ °C	C_{re}	typ.	0,7	pF
Noise figure at optimum source impedance [2]				
$I_C = 2$ mA; $V_{CE} = 10$ V; f = 500 MHz; $T_{amb} = 25$ °C	F	typ.	2,4	dB

→ Max. unilateral power gain (s_{re} assumed to be zero)

$$G_{UM} \text{ (in dB)} \doteq 10 \log \frac{|s_{fe}|^2}{(1 - |s_{ie}|^2)(1 - |s_{oe}|^2)}$$

$I_C = 14$ mA; $V_{CE} = 10$ V; f = 500 MHz; $T_{amb} = 25$ °C	G_{UM}	typ.	18	dB

---

[1] Measured under pulse conditions.

[2] Crystal mounted in a BFR90 envelope.

CHARACTERISTICS (continued)

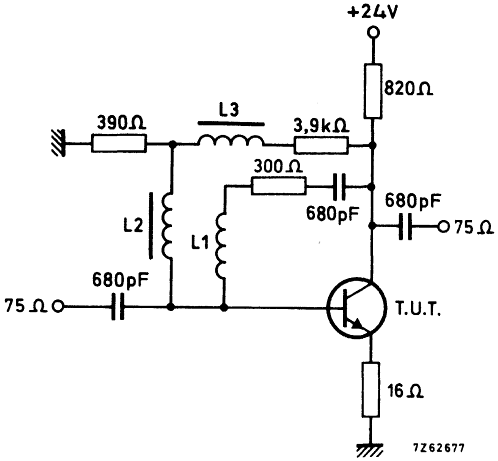
Intermodulation distortion at T_{amb} = 25 °C

I_C = 14 mA; V_{CE} = 10 V; R_L = 75 Ω; V.S.W.R. < 2

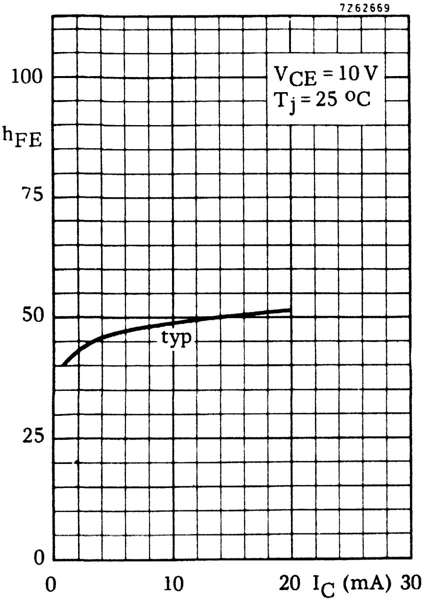
$V_p = V_o$ = 150 mV at f_p = 495,25 MHz
$V_q = V_o$ −6 dB at f_q = 503,25 MHz
$V_r = V_o$ −6 dB at f_r = 505,25 MHz

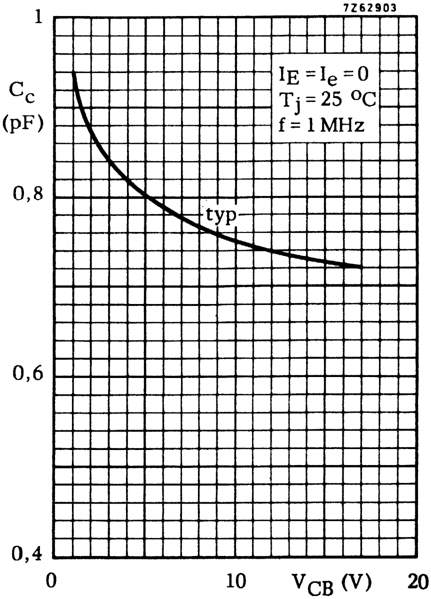
Measured at $f_{(p+q-r)}$ = 493,25 MHz	d_{im}	typ.	−60	dB

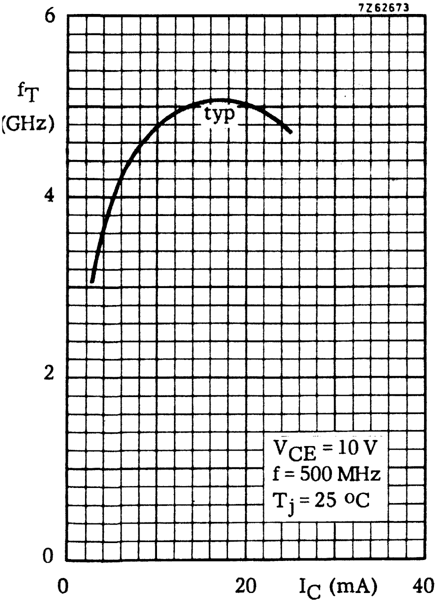
Intermodulation test circuit:

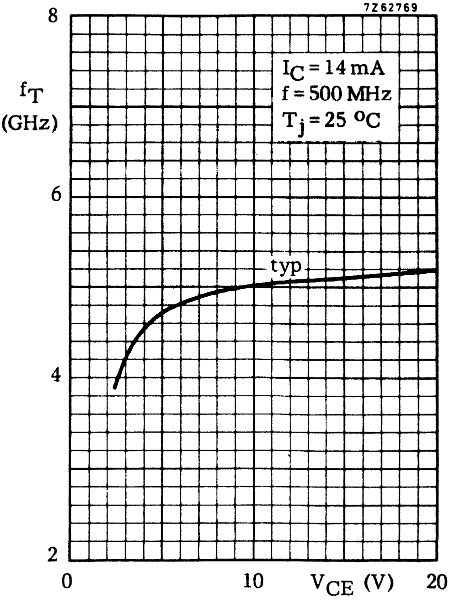


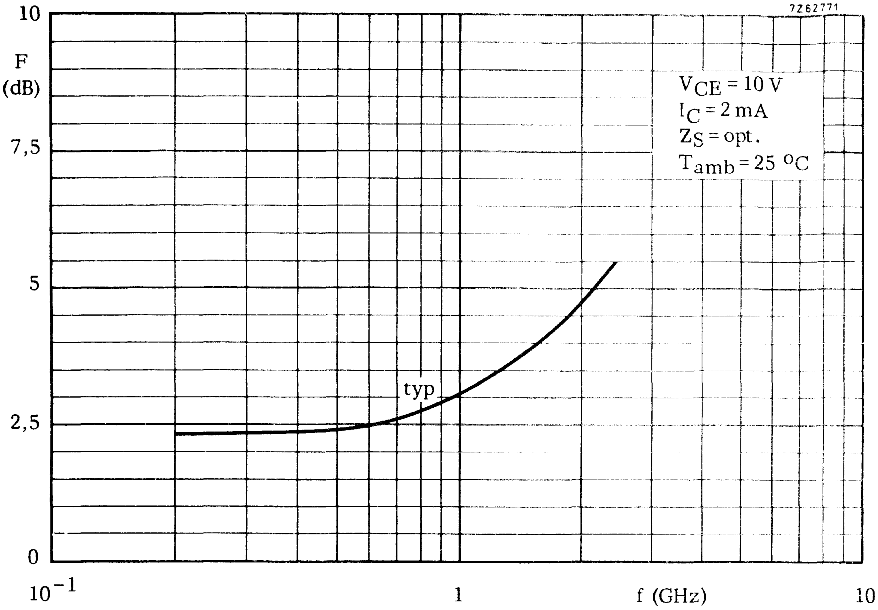
L1 = 4 turns Cu wire (0,35 mm); winding pitch 1 mm; int. diam. 4 mm
L2 = L3 = 5 μH (code number: 3122 108 20150)

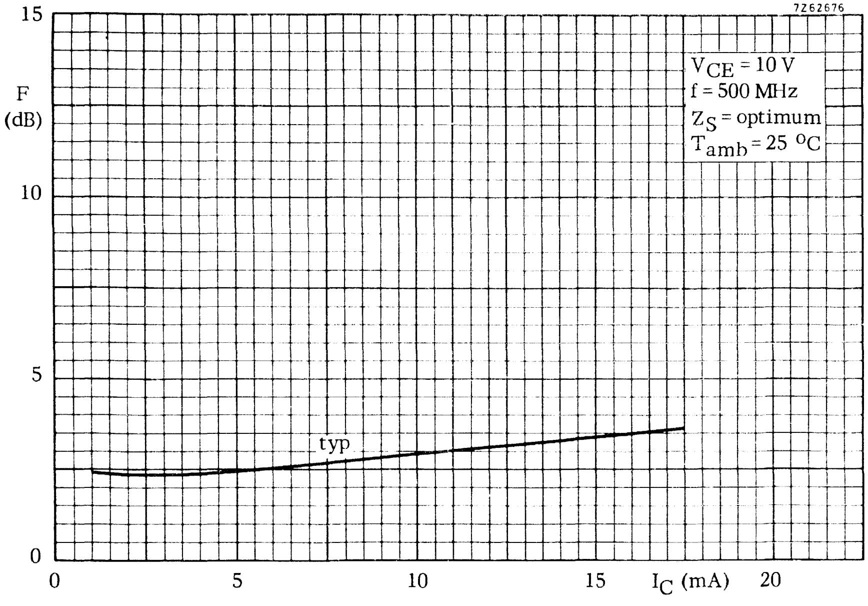

7Z62669
VCE = 10 V
Tj = 25 °C
hFE
100
75
50
25
0
typ
0
10
20
IC (mA)
30

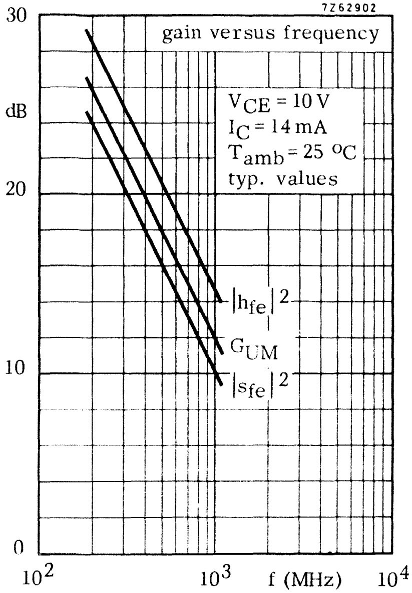

7Z62903
1
Cc
(pF)
0,8
0,6
0,4
IE = Ie = 0
Tj = 25 °C
f = 1 MHz
typ
0
10
VCB (V)
20


7Z62673
6
fT
(GHz)
4
2
0
typ
VCE = 10 V
f = 500 MHz
Tj = 25 °C
0
20
IC (mA)
40

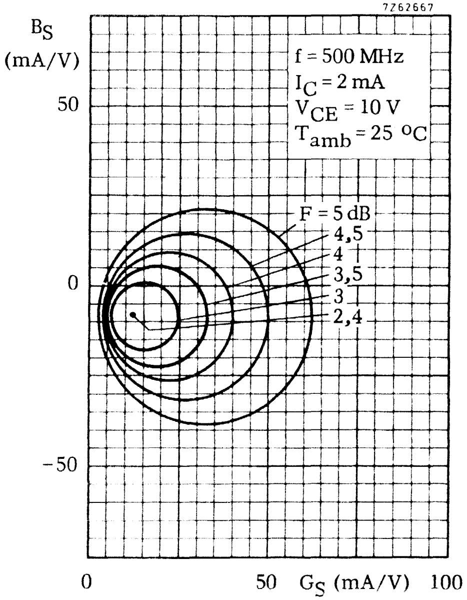

7Z62769
8
fT
(GHz)
6
4
2
IC = 14 mA
f = 500 MHz
Tj = 25 °C
typ
0
10
VCE (V)
20


7Z62771
10
F
(dB)
7,5
5
2,5
0
10^{-1}
1
f (GHz)
10
V_{CE} = 10 V
I_C = 2 mA
Z_S = opt.
T_{amb} = 25 °C
typ

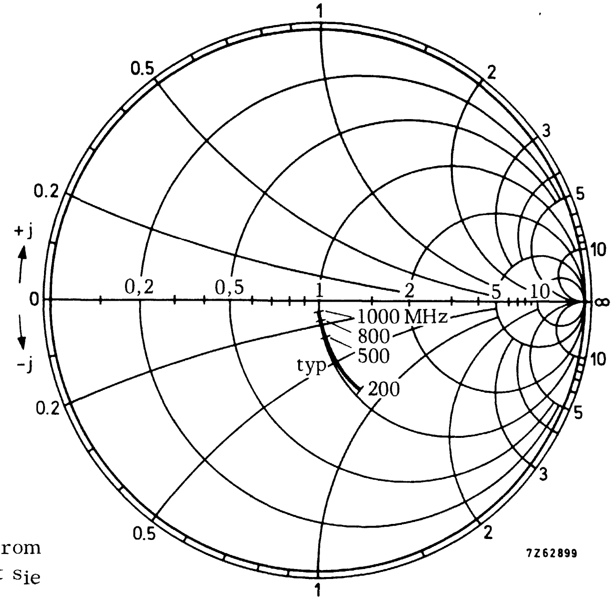

7Z62676
15
F
(dB)
10
5
0
0
5
10
15
I_C (mA)
20
V_{CE} = 10 V
f = 500 MHz
Z_S = optimum
T_{amb} = 25 °C
typ



circles of constant noise figure

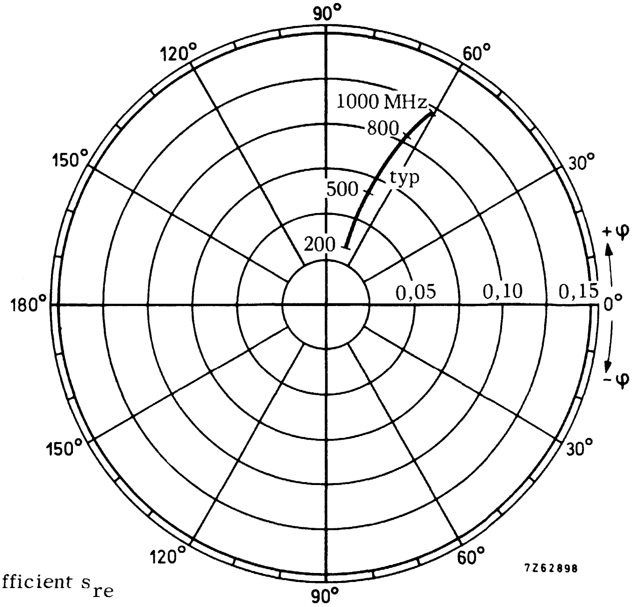


V_{CE} = 10 V
I_C = 14 mA
T_{amb} = 25 °C



Input impedance derived from input reflection coefficient s_{ie} coordinates in ohm x 50

V_{CE} = 10 V
I_C = 14 mA
T_{amb} = 25 °C

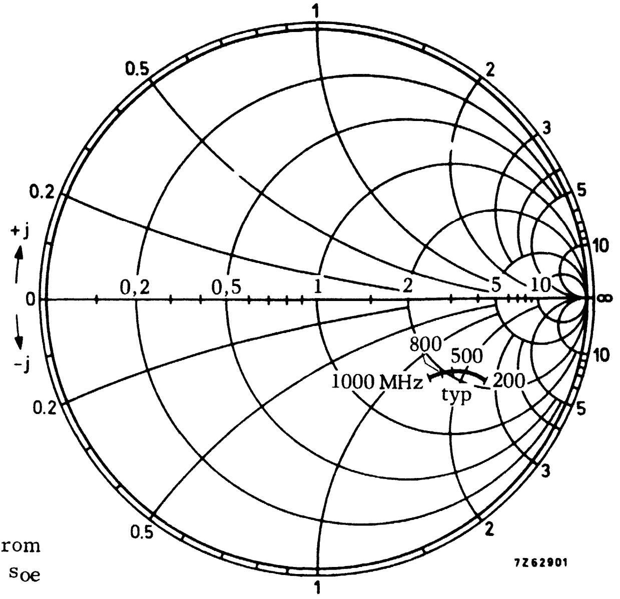


→ Reverse transmission coefficient s_{re}

V_{CE} = 10 V

I_C = 14 mA

T_{amb} = 25 °C

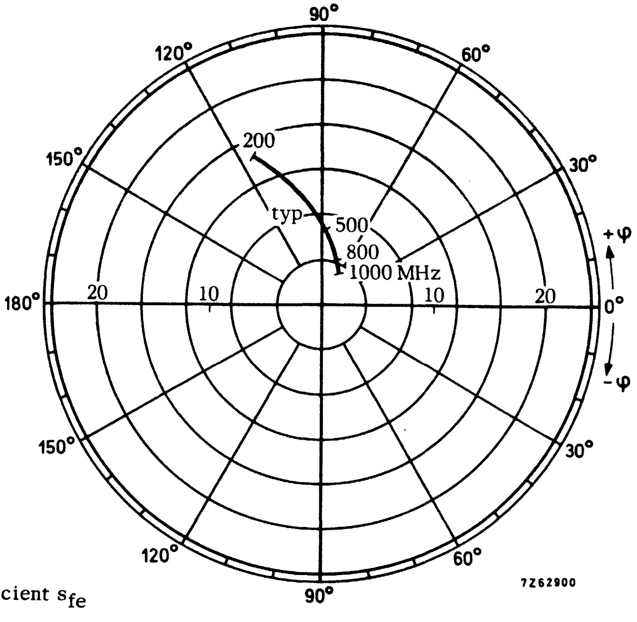


Output impedance derived from output reflection coefficient s_{oe} coordinates in ohm x 50

V_{CE} = 10 V

I_C = 14 mA

T_{amb} = 25 °C



→ Forward transmission coefficient s_{fe}

SILICON PLANAR EPITAXIAL TRANSISTOR

N-P-N transistor in a micro miniature plastic envelope. It is primarily intended for use in u.h.f. and microwave amplifiers in thick-and thin-film circuits, such as in aerial amplifiers, radar systems, oscilloscopes, spectrum analysers etc.
The transistor features very low intermodulation distortion and high power gain: thanks to its very high transition frequency, it also has excellent wideband properties and low noise up to high frequencies.

QUICK REFERENCE DATA

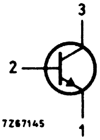
Collector-base voltage (open emitter)	V_{CBO}	max.	15	V
Collector-emitter voltage (open base)	V_{CEO}	max.	12	V
Collector current (d.c.)	I_C	max.	35	mA
Total power dissipation up to T_{amb} = 60 °C	P_{tot}	max.	180	mW
Junction temperature	T_j	max.	150	°C
Transition frequency at f = 500 MHz I_C = 30 mA; V_{CE} = 5 V	f_T	typ.	5	GHz
Feedback capacitance at f = 1 MHz I_C = 2 mA; V_{CE} = 5 V; T_{amb} = 25 °C	C_{re}	typ.	0, 8	pF
Noise figure at optimum source impedance I_C = 2 mA; V_{CE} = 5 V; f = 500 MHz; T_{amb} = 25 °C	F	typ.	1, 9	dB
Max. unilateral power gain (see page 3) I_C = 30 mA; V_{CE} = 5 V; f = 500 MHz; T_{amb} = 25 °C	G_{UM}	typ.	16, 5	dB
Intermodulation distortion at T_{amb} = 25 °C I_C = 30 mA; V_{CE} = 5 V; R_L = 75 Ω; V_o = 300 mV f(p + q − r) = 493, 25 MHz (see page 4)	d_{im}	typ.	−60	dB

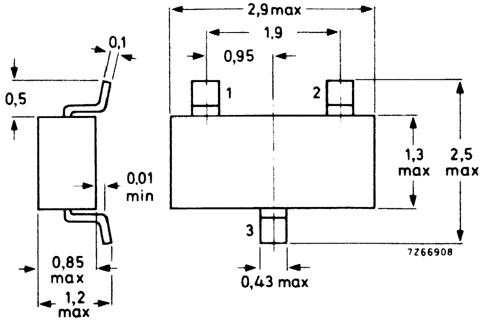
MECHANICAL DATA

Dimensions in mm

SOT-23

Code: R1





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

Voltages				
Collector-base voltage (open emitter)	V_{CBO}	max.	15	V
Collector-emitter voltage (open base)	V_{CEO}	max.	12	V
Emitter-base voltage (open collector)	V_{EBO}	max.	2,0	V
Current				
Collector current (d.c.)	I_C	max.	35	mA
Power dissipation				
Total power dissipation up to T_{amb} = 60 °C mounted on a ceramic substrate of 15 mm x 10 mm x 0,5 mm	P_{tot}	max.	180	mW
Temperatures				
Storage temperature	T_{stg}		−65 to +150	°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

From junction to ambient in free air mounted on a ceramic substrate of 15 mm x 10 mm x 0,5 mm	$R_{th\ j\text{-}a}$	=	0,50	°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 1)				
$I_C = 30$ mA; $V_{CE} = 5$ V	h_{FE}	> typ.	25 50	
Transition frequency at f = 500 MHz 1)				
$I_C = 30$ mA; $V_{CE} = 5$ V	f_T	typ.	5	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.	1,8	pF
Feedback capacitance at f = 1 MHz				
$I_C = 2$ mA; $V_{CE} = 5$ V; $T_{amb} = 25$ °C	C_{re}	typ.	0,8	pF
Noise figure at optimum source impedance 2)				
$I_C = 2$ mA; $V_{CE} = 5$ V; f = 500 MHz; $T_{amb} = 25$ °C	F	typ.	1,9	dB
→ Max. unilateral power gain (s_{re} assumed to be zero)				
G_{UM} (in dB) $= 10 \log \dfrac{\lvert s_{fe}\rvert^2}{(1-\lvert s_{ie}\rvert^2)(1-\lvert s_{oe}\rvert^2)}$				
$I_C = 30$ mA; $V_{CE} = 5$ V; f = 500 MHz; $T_{amb} = 25$ °C	G_{UM}	typ.	16,5	dB

---

1) Measured under pulse conditions.

2) Crystal mounted in a BFR91 envelope.

CHARACTERISTICS (continued)

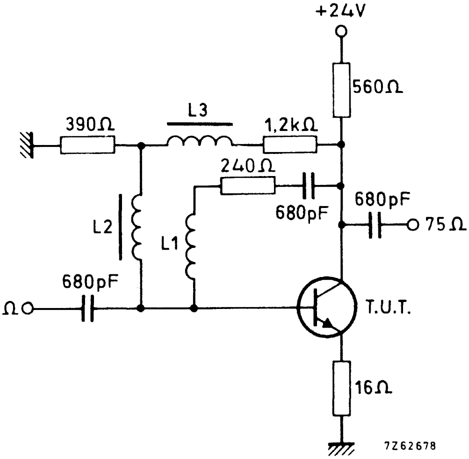
Intermodulation distortion at T_{amb} = 25 °C

I_C = 30 mA; V_{CE} = 5 V; R_L = 75 Ω; V.S.W.R. < 2

$V_p = V_o$ = 300 mV at f_p = 495, 25 MHz
$V_q = V_o$ -6 dB at f_q = 503, 25 MHz
$V_r = V_o$ -6 dB at f_r = 505, 25 MHz

Measured at $f_{(p+q-r)}$ = 493, 25 MHz d_{im} typ. -60 dB [1]

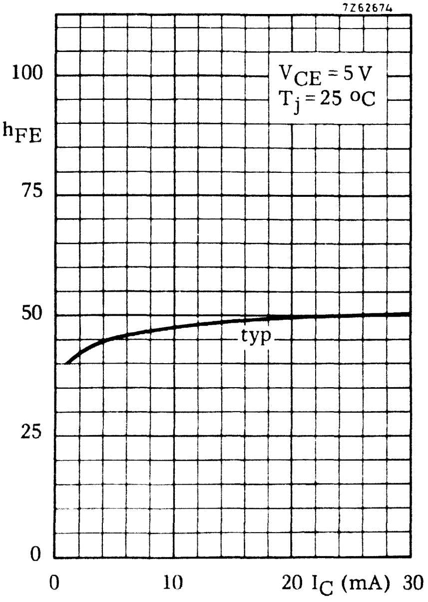
Intermodulation test circuit:

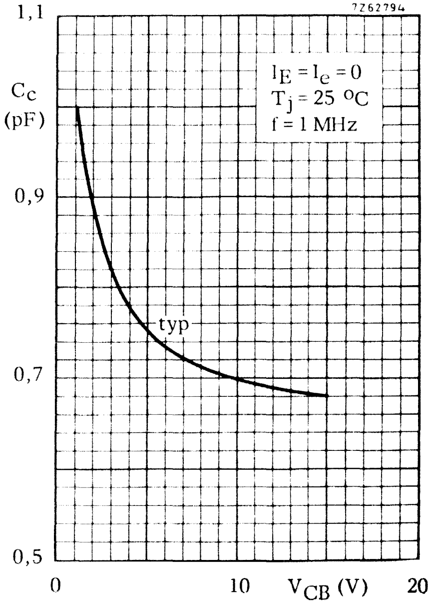


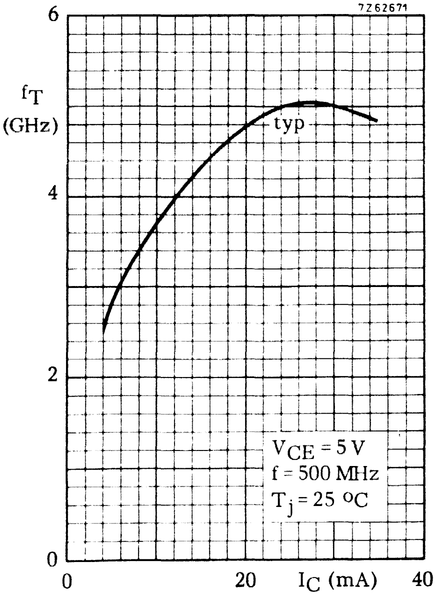
L1 = 4 turns Cu wire (0, 35); winding pitch 1 mm; int.diam. 4 mm
L2 and L3 5 μH (code number: 3122 108 20150)

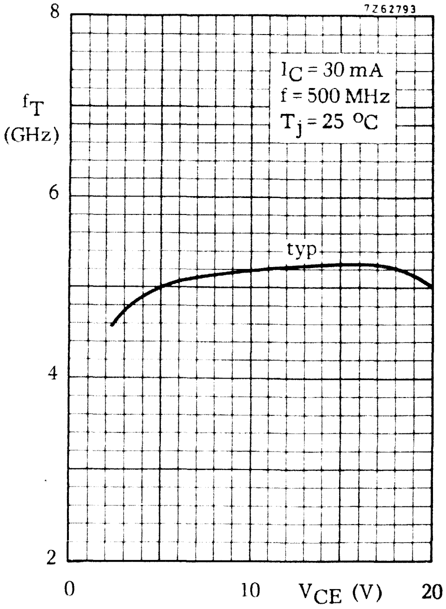
---

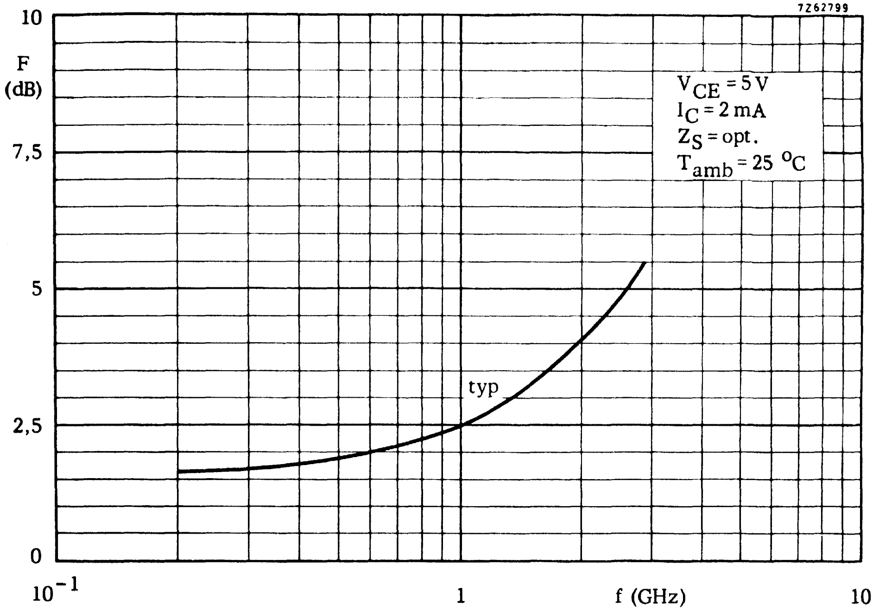
[1] Crystal mounted in a BFR91 envelope.

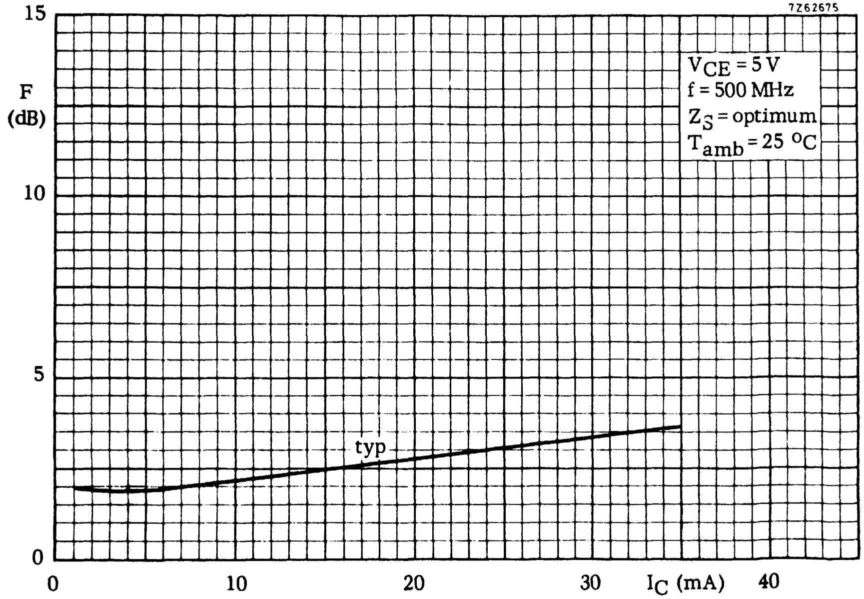

7Z62674
100
75
50
25
0
hFE
VCE = 5 V
Tj = 25 oC
typ
0
10
20 IC (mA) 30

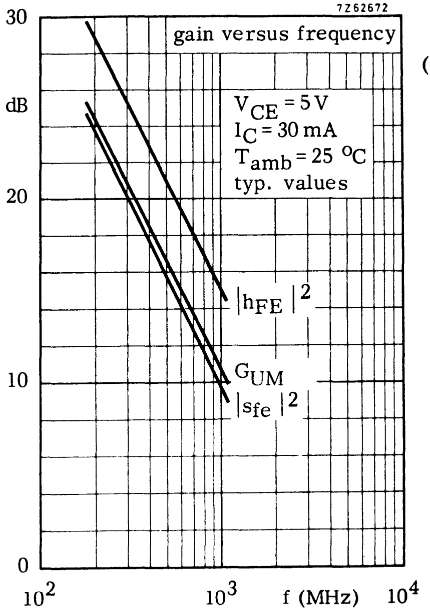

7Z62794
1,1
0,9
0,7
0,5
Cc
(pF)
IE = Ie = 0
Tj = 25 oC
f = 1 MHz
typ
0
10
VCB (V)
20


7Z62671
6
4
2
0
fT
(GHz)
typ
VCE = 5 V
f = 500 MHz
Tj = 25 oC
0
20
IC (mA)
40

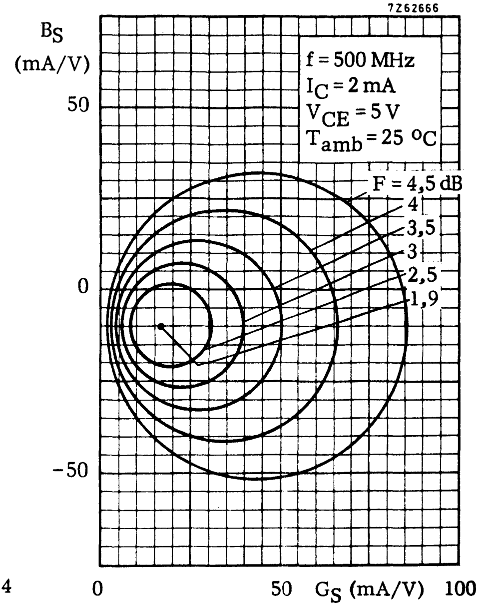

7Z62793
8
6
4
2
fT
(GHz)
IC = 30 mA
f = 500 MHz
Tj = 25 oC
typ
0
10
VCE (V)
20


7Z62799
10
F
(dB)
7,5
5
2,5
0
10^{-1}
1
f (GHz)
10
V_{CE} = 5 V
I_C = 2 mA
Z_S = opt.
T_{amb} = 25 °C
typ

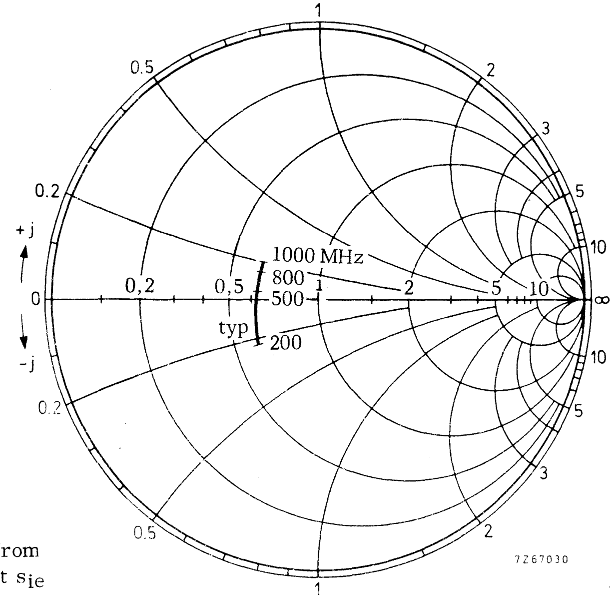

7Z62675
15
F
(dB)
10
5
0
0
10
20
30
I_C (mA)
40
V_{CE} = 5 V
f = 500 MHz
Z_S = optimum
T_{amb} = 25 °C
typ



circles of constant noise figure

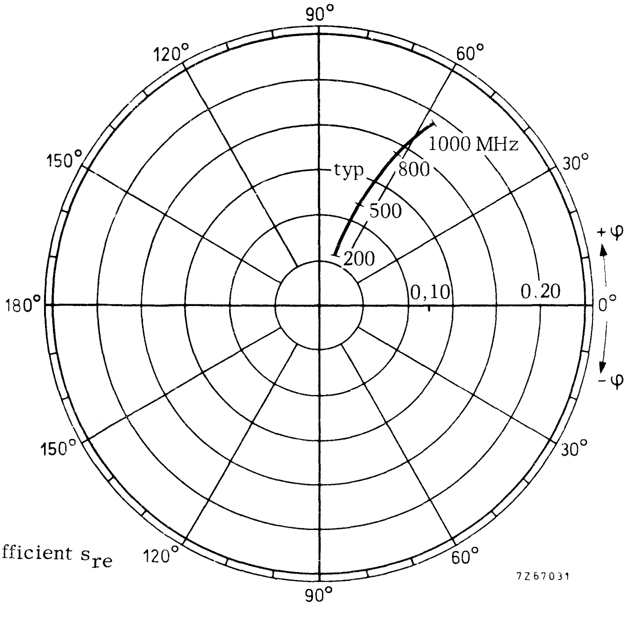


V_{CE} = 5 V
I_C = 30 mA
T_{amb} = 25 °C



Input impedance derived from input reflection coefficient s_{ie} coordinates in ohm x 50

V_{CE} = 5 V
I_C = 30 mA
T_{amb} = 25 °C

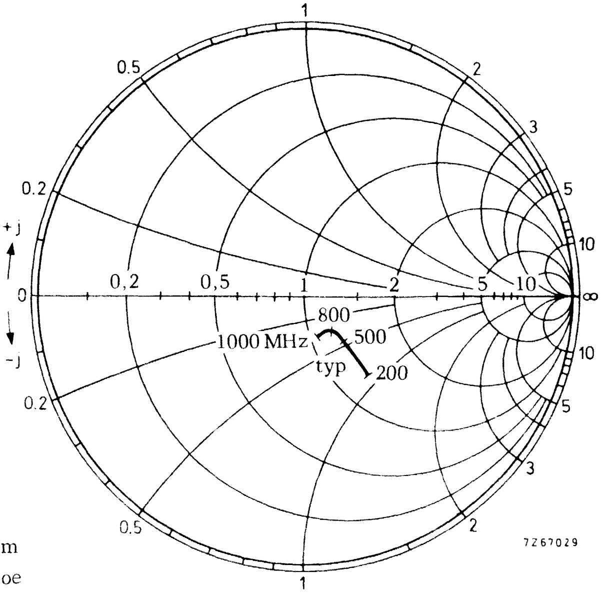


→ Reverse transmission coefficient s_{re}

V_{CE} = 5 V

I_C = 30 mA

T_{amb} = 25 °C

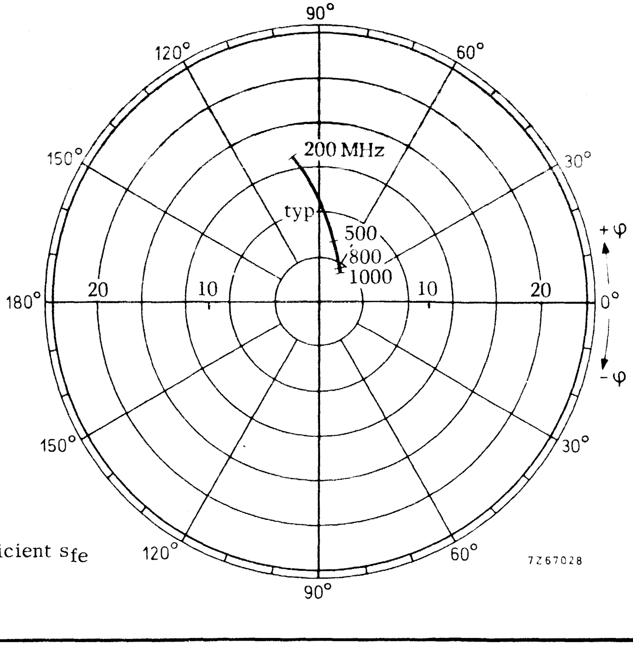


Output impedance derived from output reflection coefficient s_{oe} coordinates in ohm x 50

V_{CE} = 5 V

I_C = 30 mA

T_{amb} = 25 °C



→ Forward transmission coefficient s_{fe}

SILICON PLANAR EPITAXIAL TRANSISTOR

N-P-N transistor in a micro miniature plastic envelope.
It is intended for a wide range of v.h.f. and u.h.f. applications in thick and thin film circuits.

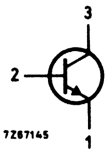
QUICK REFERENCE DATA

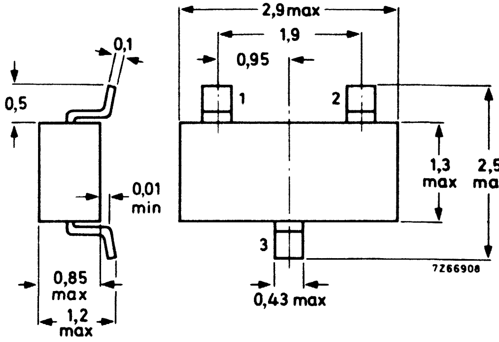
Collector-base voltage (open emitter; peak value)	V_{CBOM}	max.	25	V
Collector-emitter voltage (open base)	V_{CEO}	max.	15	V
Collector current (peak value)	I_{CM}	max.	50	mA
Total power dissipation up to $T_{amb} = 25\ ^oC$	P_{tot}	max.	200	mW
Junction temperature	T_j	max.	150	^oC
D.C. current gain $I_C = 2$ mA; $V_{CE} = 1$ V	h_{FE}		20 to 150	
Transition frequency $I_C = 25$ mA; $V_{CE} = 5$ V; f = 500 MHz	f_T	typ.	1.3	GHz
Noise figure $I_C = 2$ mA; $V_{CE} = 5$ V $R_S = 50\ \Omega$; f = 500 MHz	F	typ.	4.5	dB

MECHANICAL DATA Dimensions in mm

SOT-23

Code: E1





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

Voltages

Collector-base voltage (open emitter; peak value)	V_{CBOM}	max.	25	V
Collector-emitter voltage (open base) I_C = 10 mA	V_{CEO}	max.	15	V
Emitter-base voltage (open collector)	V_{EBO}	max.	2.5	V

Currents

Collector current (d.c.)	I_C	max.	25	mA
Collector current (peak value)	I_{CM}	max.	50	mA

→ Power dissipation

Total power dissipation up to T_{amb} = 25 °C mounted on a **ceramic substrate of 7 mm x 5 mm x 0.5 mm**	P_{tot}	max.	200	mW

→ Temperatures

Storage temperature	T_{stg}		-65 to +150	°C
Junction temperature	T_j	max.	150	°C

→ **THERMAL RESISTANCE**

From junction to ambient mounted on a **ceramic substrate of 7 mm x 5 mm x 0.5 mm**	$R_{th\ j\text{-}a}$	=	0.62	°C/mW

CHARACTERISTICS T_j = 25 °C unless otherwise specified

Collector cut-off current

$I_E = 0$; V_{CB} = 10 V	I_{CBO}	<	10	nA
$I_E = 0$; V_{CB} = 10 V; T_j = 100 °C	I_{CBO}	<	10	μA

D.C. current gain

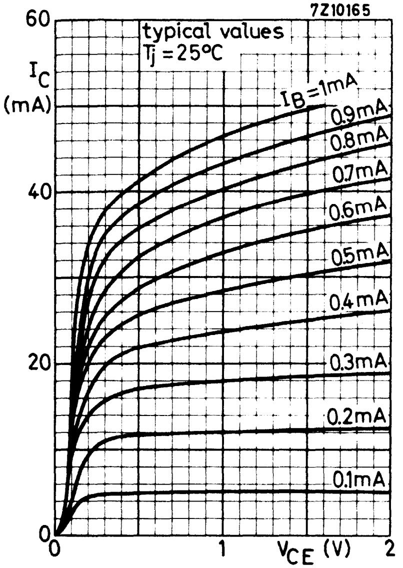
I_C = 2 mA; V_{CE} = 1 V	h_{FE}	20 to	150	
I_C = 25 mA; V_{CE} = 1 V	h_{FE}	>	20	

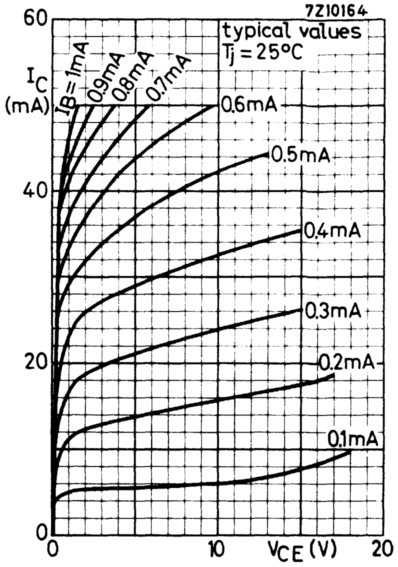
CHARACTERISTICS (continued) T_j = 25 °C unless otherwise specified

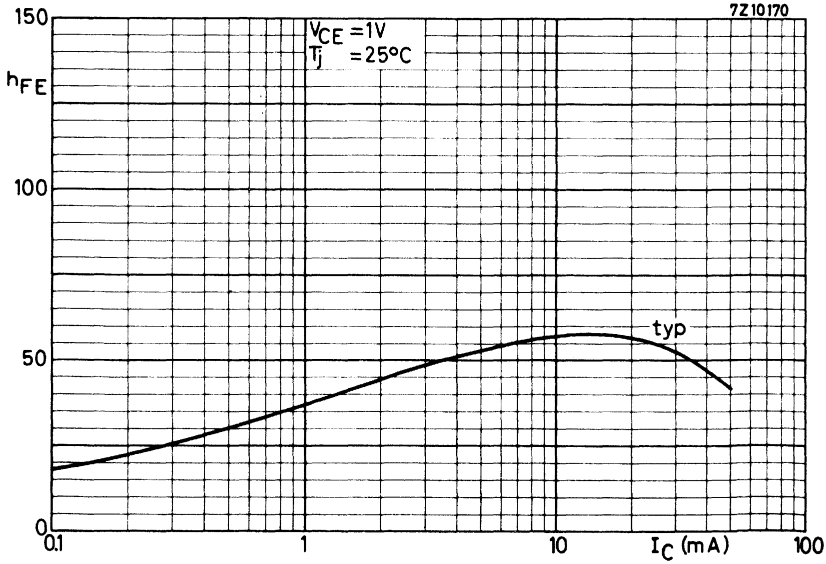
Transition frequency				
I_C = 2 mA; V_{CE} = 5 V; f = 500 MHz	f_T	typ.	1.0	GHz
I_C = 25 mA; V_{CE} = 5 V; f = 500 MHz	f_T	typ.	1.3	GHz
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; V_{CB} = 10 V	C_c	<	1.5	pF
Emitter capacitance at f = 1 MHz				
$I_C = I_c = 0$; V_{EB} = 0.5 V	C_e	<	2.0	pF
Feedback capacitance at f = 1 MHz				
I_C = 2 mA; V_{CE} = 5 V	$-C_{re}$	typ.	0.65	pF
Noise figure				
I_C = 2 mA; V_{CE} = 5 V f = 500 MHz; R_S = 50 Ω	F	typ.	4.5	dB[1]
Intermodulation distortion				
I_C = 10 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.	-45	dB

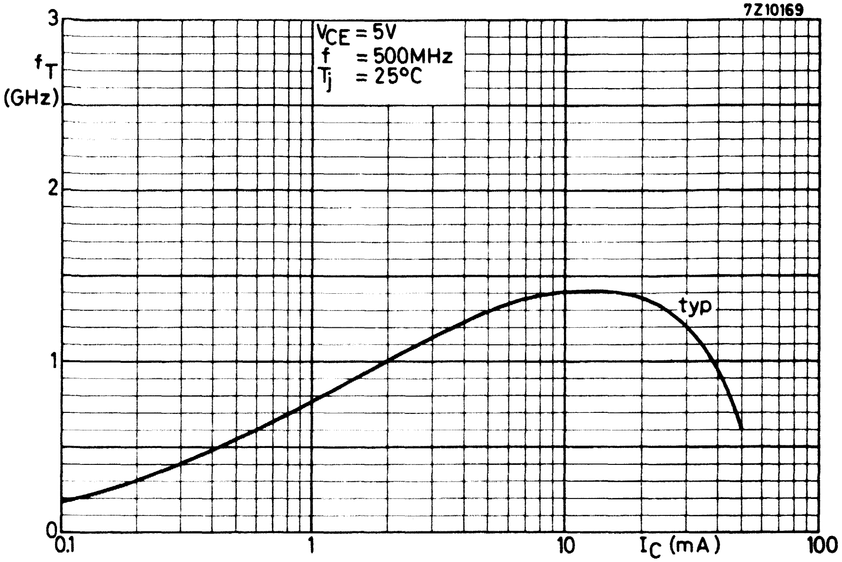
---

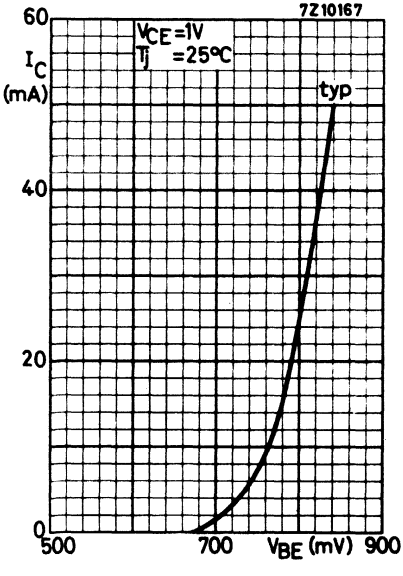
[1]) Crystal mounted in a BFY90 envelope.

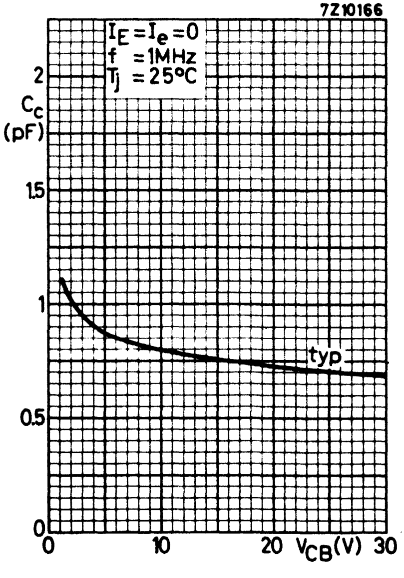

7Z10165
typical values
$T_j = 25°C$
I_C (mA)
60
40
20
0
I_B=1mA
0.9mA
0.8mA
0.7mA
0.6mA
0.5mA
0.4mA
0.3mA
0.2mA
0.1mA
0
1
V_{CE} (V)
2

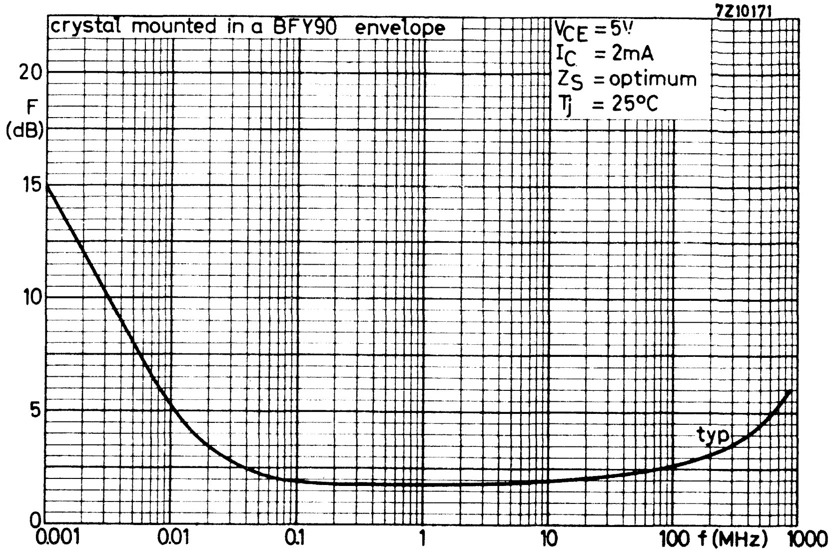

7Z10164
typical values
$T_j = 25°C$
I_C (mA)
60
40
20
0
I_B=1mA
0.9mA
0.8mA
0.7mA
0.6mA
0.5mA
0.4mA
0.3mA
0.2mA
0.1mA
0
10
V_{CE} (V)
20

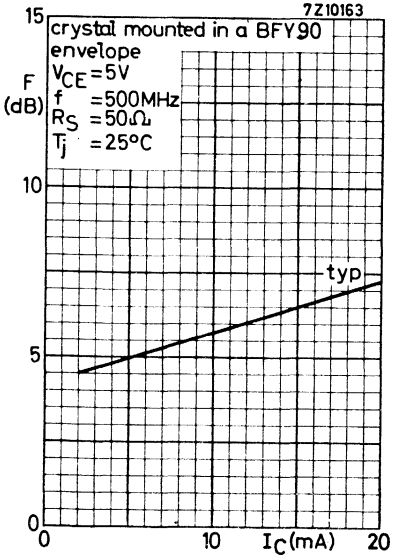

7Z10170
V_{CE} = 1V
T_j = 25°C
h_{FE}
150
100
50
0
typ
0.1
1
10
I_C (mA)
100

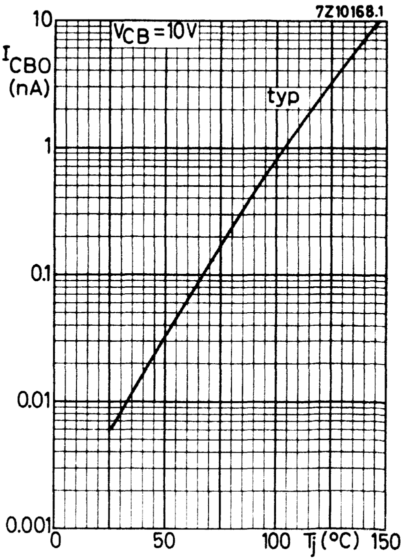

7Z10169
V_{CE} = 5V
f = 500MHz
T_j = 25°C
f_T (GHz)
3
2
1
0
typ
0.1
1
10
I_C (mA)
100


7Z10167
V_{CE}=1V
T_j =25°C
I_C (mA)
60
40
20
0
typ
500
700
V_{BE} (mV)
900


7Z10166
$I_E = I_e = 0$
f = 1MHz
T_j = 25°C
C_c (pF)
2
1.5
1
0.5
0
typ
0
10
20
V_{CB}(V)
30


7Z10171
crystal mounted in a BFY90 envelope
V_{CE} = 5V
I_C = 2mA
Z_S = optimum
T_j = 25°C
F (dB)
20
15
10
5
0
0.001
0.01
0.1
1
10
100
f (MHz)
1000
typ


7Z10163
crystal mounted in a BFY90 envelope
V_{CE} = 5V
f = 500MHz
R_S = 50Ω
T_j = 25°C
F (dB)
15
10
5
0
0
10
I_C (mA)
20
typ


7Z10168.1
V_{CB} = 10V
I_{CBO} (nA)
10
1
0.1
0.01
0.001
0
50
100
T_j (°C)
150
typ

SILICON PLANAR EPITAXIAL TRANSISTORS

N-P-N transistors in a micro miniature plastic envelope.
They are intended for general purpose and h.f. applications in thick and thin film circuits.

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 °C	P_{tot}	max.	200		mW
Junction temperature	T_j	max.	150		°C
D.C. current gain			BFS18	BFS19	
I_C = 1 mA; V_{CE} = 10 V	h_{FE}		35 to 125	65 to 225	
Transition frequency at f = 100 MHz					
I_C = 1 mA; V_{CE} = 10 V	f_T	typ.	200	260	MHz
Noise figure at f = 100 MHz					
I_C = 1 mA; V_{CE} = 10 V; G_S = 10 mΩ^{-1}	F	typ.	4		dB

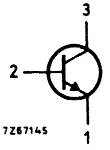
MECHANICAL DATA

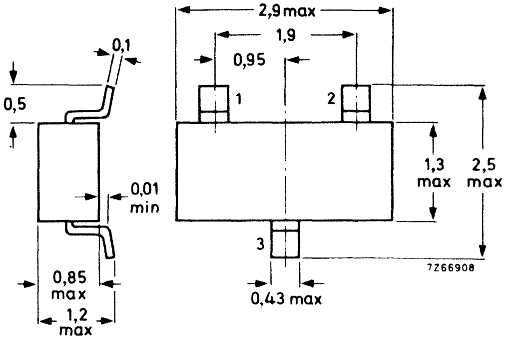
Dimensions in mm

SOT-23

Code:

BFS18 F1
BFS19 F2





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) I_C = 2 mA	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
Colector current (peak value)	I_{CM}	max.	30	mA

→ Power dissipation

Total power dissipation up to T_{amb} = 25 °C mounted on a **ceramic substrate of 7 mm x 5 mm x 0.5 mm**	P_{tot}	max.	200	mW

→ Temperatures

Storage temperature	T_{stg}		-65 to +150	°C
Junction temperature	T_j	max.	150	°C

→ **THERMAL RESISTANCE**

From junction to ambient mounted on a **ceramic substrate of 7 mm x 5 mm x 0.5 mm**	Rth j-a	=	0.62	°C/mW

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 = 100 °C	I_{CBO}	<	10	μA

Base-emitter voltage

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

CHARACTERISTICS (continued)

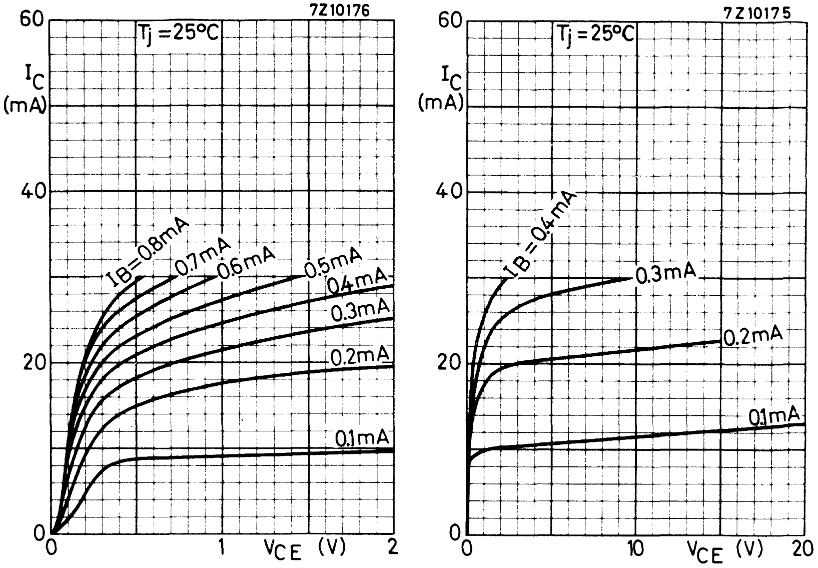
$T_j = 25$ °C unless otherwise specified

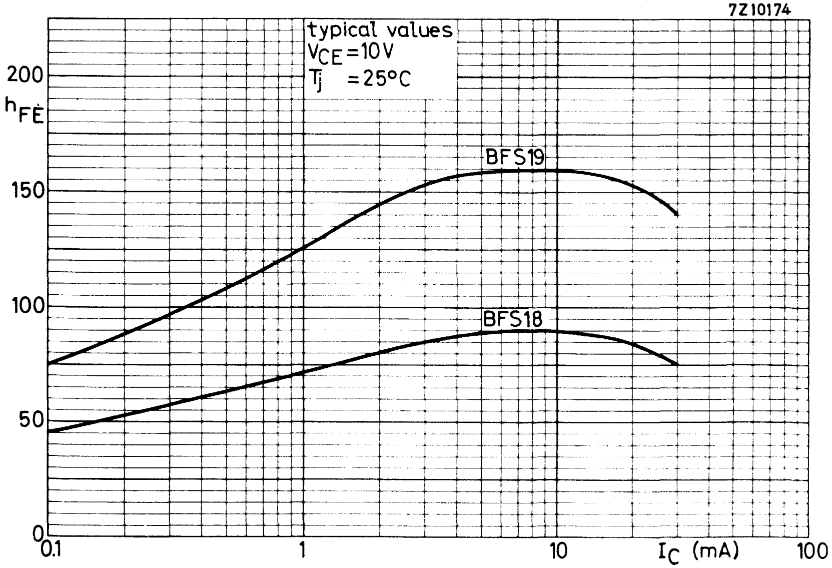
			BFS18	BFS19	
D.C. current gain					
$I_C = 1$ mA; $V_{CE} = 10$ V	h_{FE}		35 to 125	65 to 225	
Transition frequency at f = 100 MHz					
$I_C = 1$ mA; $V_{CE} = 10$ V	f_T	typ.	200	260	MHz
Collector capacitance at f = 1 MHz					
$I_E = I_e = 0$; $V_{CB} = 10$ V	C_c	typ.	1		pF
Feedback capacitance at f = 1 MHz					
$I_C = 1$ mA; $V_{CE} = 10$ V	$-C_{re}$	typ.	0.85		pF
Noise figure					
$I_C = 1$ mA; $V_{CE} = 10$ V $G_S = 10\ m\Omega^{-1}$; f = 100 MHz	F	typ.	4		dB [1]

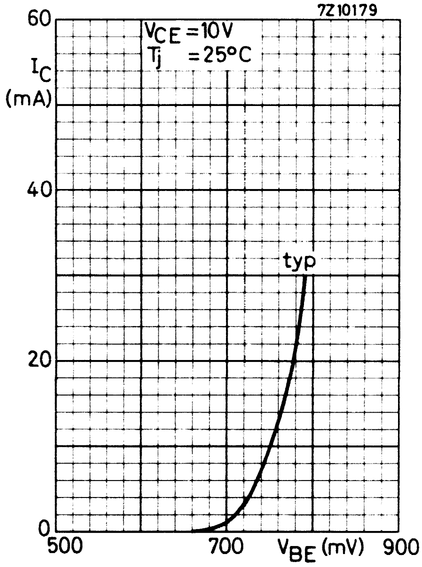
---

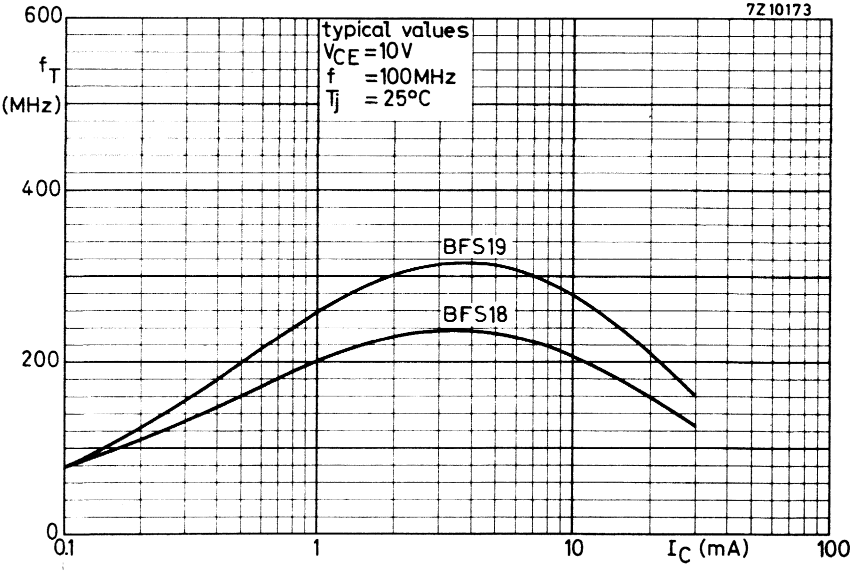
[1] Crystal mounted in a BF115 envelope.

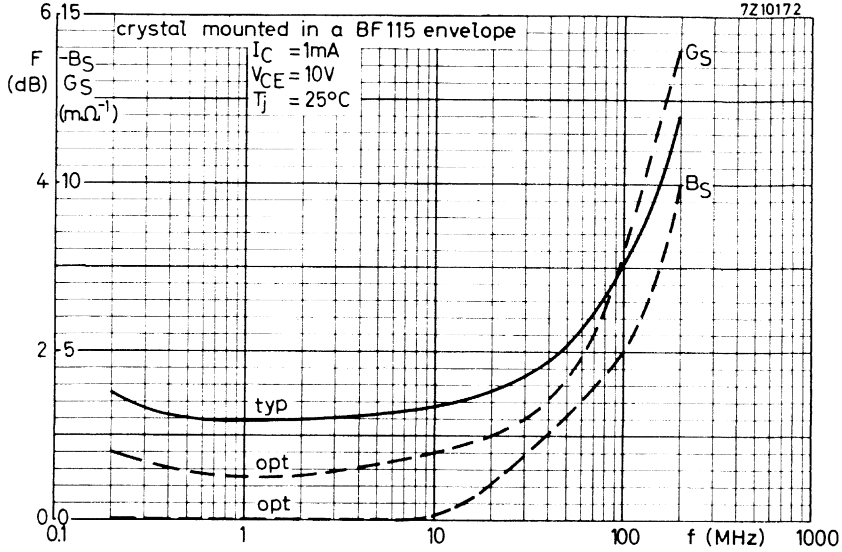
Typical behaviour of collector current versus collector-emitter voltage

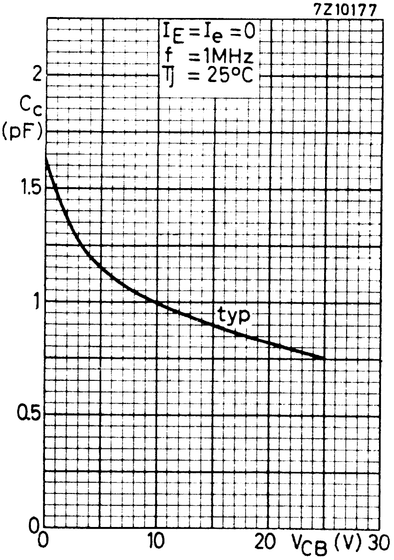


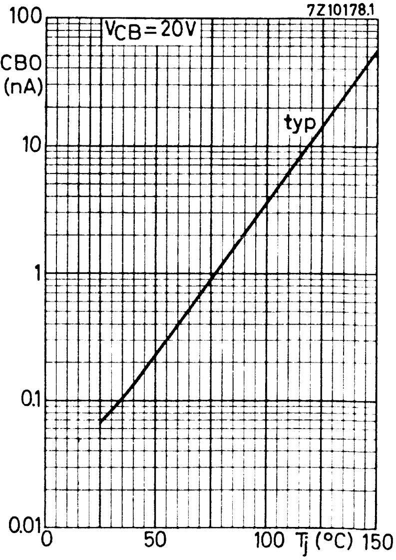



7Z10179
V_{CE} = 10 V
T_j = 25°C
I_C (mA)
60
40
20
0
typ
500
700
V_{BE} (mV)
900


7Z10173
typical values
V_{CE} = 10 V
f = 100 MHz
T_j = 25°C
f_T (MHz)
600
400
200
0
BFS19
BFS18
0.1
1
10
I_C (mA)
100


7Z10172
crystal mounted in a BF115 envelope
I_C = 1mA
V_{CE} = 10V
T_j = 25°C
F (dB)
$-B_S$
G_S
(mΩ^{-1})
6
4
2
0
15
10
5
0
0.1
1
10
100
1000
f (MHz)
G_S
B_S
typ
opt
opt


7Z10177
$I_E = I_e = 0$
f = 1MHz
T_j = 25°C
C_c (pF)
2
1.5
1
0.5
0
0
10
20
30
V_{CB} (V)
typ


7Z10178.1
V_{CB} = 20V
I_{CBO} (nA)
100
10
1
0.1
0.01
0
50
100
150
T_j (°C)
typ

SILICON PLANAR EPITAXIAL TRANSISTOR

N-P-N transistor in a micro miniature plastic envelope.
It has a very low feedback capacitance and is intended for i.f. and v.h.f. applications in thick and thin film circuit.

QUICK REFERENCE DATA

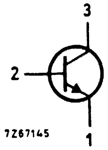
Collector-base voltage (open emitter)	V_{CBO}	max.	30	V
Collector-emitter voltage (open base)	V_{CEO}	max.	20	V
Collector current (d.c.)	I_C	max.	25	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	200	mW
Junction temperature	T_j	max.	150	°C
D.C. current gain I_C = 7 mA; V_{CE} = 10 V	h_{FE}	>	40	
Transition frequency at f = 100 MHz I_C = 5 mA; V_{CE} = 5 V	f_T	typ.	450	MHz
Feedback capacitance at f = 1 MHz I_C = 1 mA; V_{CE} = 10 V	$-C_{re}$	typ.	400	fF

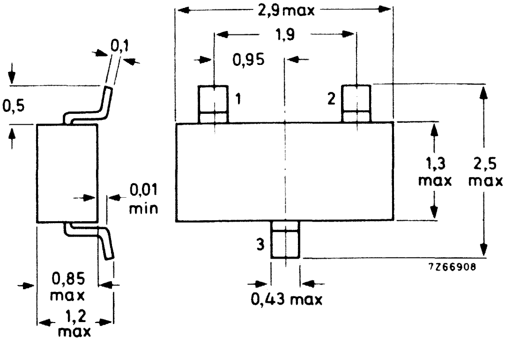
MECHANICAL DATA

Dimensions in mm

SOT-23

Code: G1





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) I_C = 2 mA	V_{CEO}	max.	20	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} = 25 °C mounted on a ceramic substrate of 7 mm x 5 mm x 0.5 mm	P_{tot}	max.	200	mW

→ Temperatures

Storage temperature	T_{stg}		-65 to +150	°C
Junction temperature	T_j	max.	150	°C

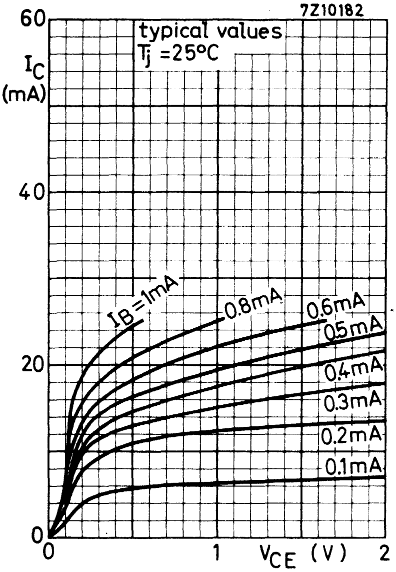
→ **THERMAL RESISTANCE**

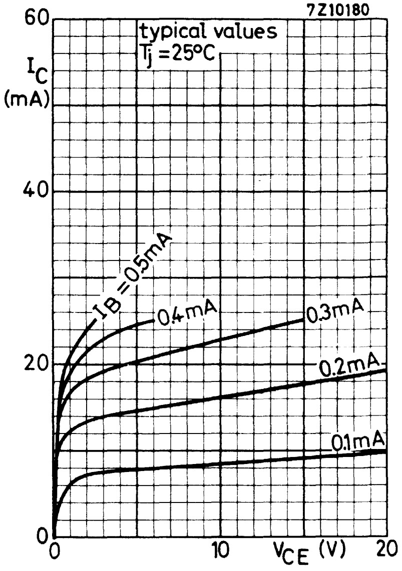
From junction to ambient mounted on a ceramic substrate of 7 mm x 5 mm x 0.5 mmm	$R_{th\ j\text{-}a}$	=	0.62	°C/mW

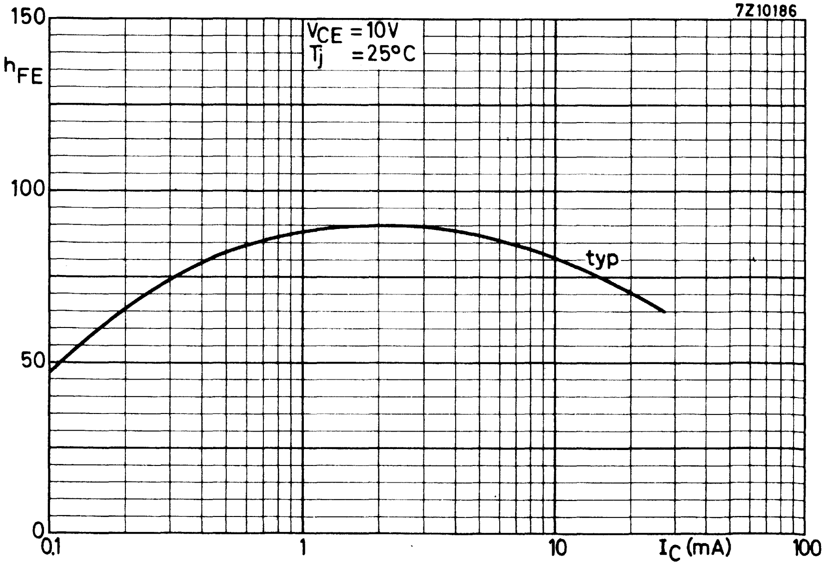
CHARACTERISTICS

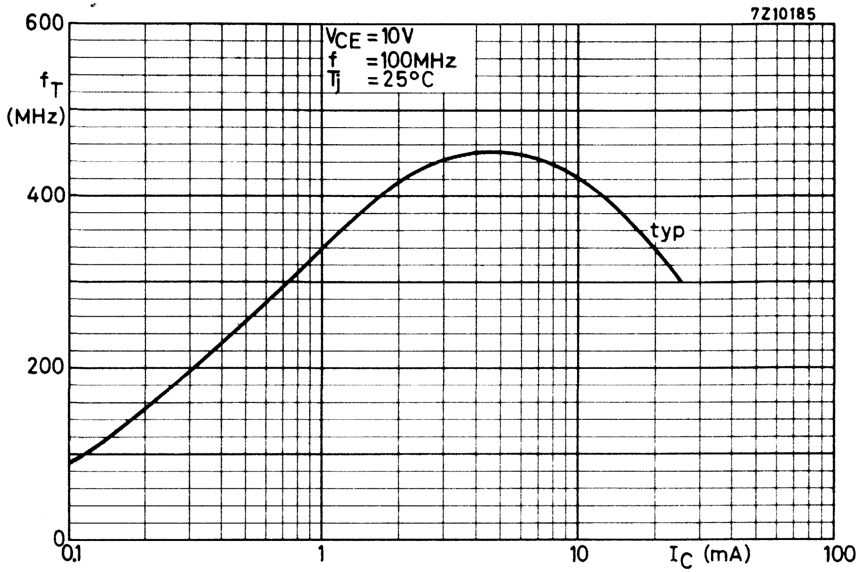
$T_j = 25\ ^{\circ}C$ unless otherwise specified

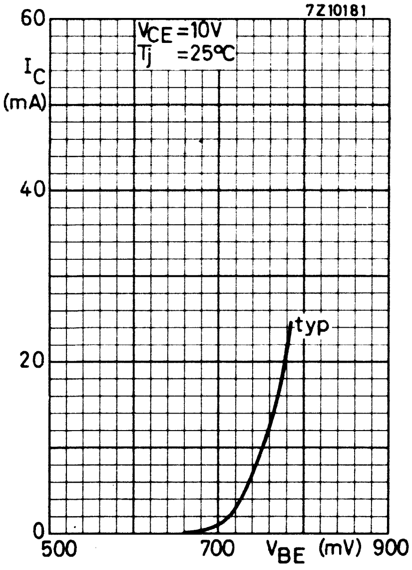
Collector cut-off current				
$I_E = 0$; $V_{CB} = 20$ V	I_{CBO}	<	100	nA
$I_E = 0$; $V_{CB} = 20$ V; $T_j = 100\ ^{\circ}C$	I_{CBO}	<	10	μA
Base-emitter voltage				
$I_C = 7$ mA; $V_{CE} = 10$ V	V_{BE}	typ.	740	mV
		<	900	mV
D.C. current gain				
$I_C = 7$ mA; $V_{CE} = 10$ V	h_{FE}	>	40	
		typ.	85	
Transition frequency at f = 100 MHz				
$I_C = 5$ mA; $V_{CE} = 10$ V	f_T	>	275	MHz
		typ.	450	MHz
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; $V_{CB} = 10$ V	C_c	typ.	0.8	pF
Feedback capacitance at f = 1 MHz				
$I_C = 1$ mA; $V_{CE} = 10$ V	$-C_{re}$	typ.	350	fF

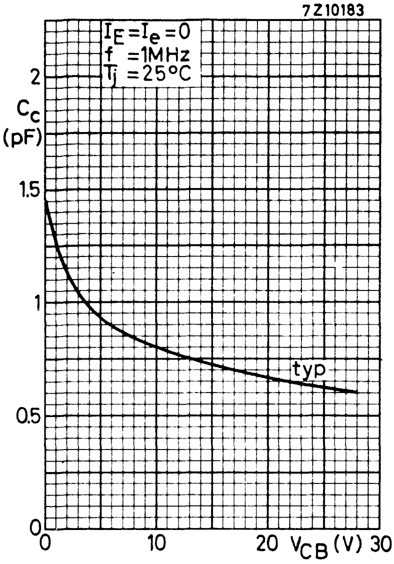

7Z10182
typical values
$T_j = 25°C$
I_C (mA)
60
40
20
0
$I_B = 1mA$
0.8mA
0.6mA
0.5mA
0.4mA
0.3mA
0.2mA
0.1mA
0
1
V_{CE} (V)
2

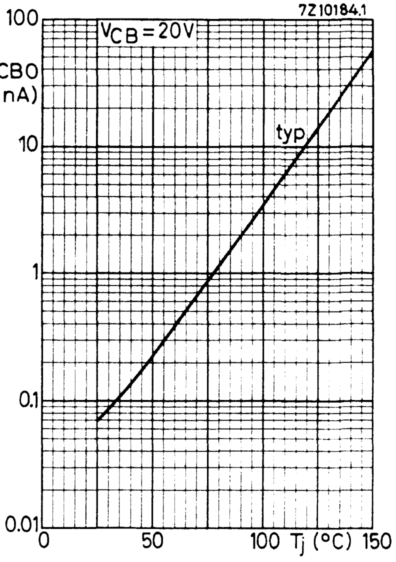

7Z10180
typical values
$T_j = 25°C$
I_C (mA)
60
40
20
0
$I_B = 0.5mA$
0.4mA
0.3mA
0.2mA
0.1mA
0
10
V_{CE} (V)
20


7Z10186
$V_{CE} = 10V$
$T_j = 25°C$
150
h_{FE}
100
50
0
typ
0.1
1
10
I_C (mA)
100


7Z10185
f_T (MHz)
600
400
200
0
V_{CE} = 10V
f = 100MHz
T_j = 25°C
typ
0.1
1
10
I_C (mA)
100


7Z10181
I_C (mA)
60
40
20
0
V_{CE} = 10V
T_j = 25°C
typ
500
700
V_{BE} (mV)
900


7Z10183
$I_E = I_e = 0$
f = 1MHz
T_j = 25°C
C_c (pF)
2
1.5
1
0.5
0
typ
0
10
20
30
V_{CB} (V)


7Z10184.1
V_{CB} = 20V
I_{CBO} (nA)
100
10
1
0.1
0.01
typ
0
50
100
150
T_j (°C)

SILICON PLANAR EPITAXIAL HIGH SPEED SWITCHING TRANSISTOR

N-P-N transistor in a microminiature plastic envelope. It is intended for very high-speed saturated switching in thick and thin film circuits.

QUICK REFERENCE DATA

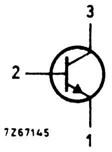
Collector-base voltage (open emitter)	V_{CBO}	max.	20	V
Collector-emitter voltage (V_{BE} = 0)	V_{CES}	max.	20	V
Collector-emitter voltage (open base)	V_{CEO}	max.	12	V
Collector current (peak value)	I_{CM}	max.	200	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	200	mW
Junction temperature	T_j	-65 to	+150	°C
D.C. current gain				
I_C = 10 mA; V_{CE} = 1 V	h_{FE}	40 to	120	
I_C = 50 mA; V_{CE} = 1 V	h_{FE}	>	25	
Transition frequency at f = 100 MHz				
I_C = 10 mA; V_{CE} = 10 V	f_T	>	400	MHz
		typ.	500	MHz
Storage time				
I_C = I_B = $-I_{BM}$ = 10 mA	t_s	<	13	ns

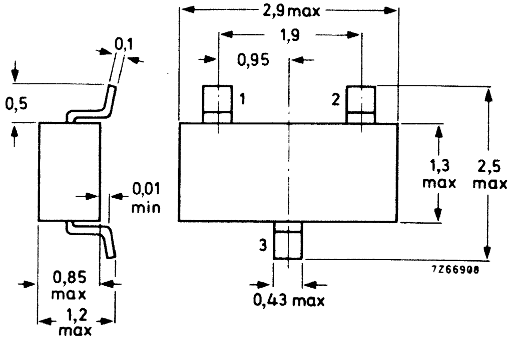
MECHANICAL DATA

Dimensions in mm

SOT-23

Code: B2





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 ($V_{BE} = 0$)	V_{CES}	max.	20	V
Collector-emitter voltage (open base) $I_C = 10$ mA	V_{CEO}	max.	12	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	V

Currents

→ Collector current (d.c.)	I_C	max.	100	mA
Collector current (peak value)	I_{CM}	max.	200	mA

→ Power dissipation

Total power dissipation up to $T_{amb} = 25$ °C mounted on a ceramic substrate of 7 mm x 5 mm x 0.5 mm	P_{tot}	max.	200	mW

→ Temperatures

Storage temperature	T_{stg}	-65 to +150	°C
Junction temperature	T_j	max. 150	°C

→ **THERMAL RESISTANCE**

From junction to ambient mounted on a ceramic substrate of 7 mm x 5 mm x 0.5 mm	$R_{th\ j\text{-}a}$	=	0.62	°C/mW

CHARACTERISTICS $T_j = 25$ °C unless otherwise specified

Collector cut-off current

$I_E = 0$; $V_{CB} = 10$ V	I_{CBO}	<	100	nA
$I_E = 0$; $V_{CB} = 10$ V; $T_j = 125$ °C	I_{CBO}	<	5	μA

Saturation voltages

$I_C = 10$ mA; $I_B = 300$ μA	V_{CEsat}	<	300	mV
$I_C = 10$ mA; $I_B = 1$ mA	V_{CEsat}	<	250	mV
	V_{BEsat}		700 to 850	mV
$I_C = 50$ mA; $I_B = 5$ mA	V_{CEsat}	<	400	mV
	V_{BEsat}	<	1200	mV

CHARACTERISTICS (continued)

D.C. current gain

I_C = 1 mA; V_{CE} = 1 V	h_{FE}	>	25	
I_C = 10 mA; V_{CE} = 1 V	h_{FE}		40 to 120	
I_C = 50 mA; V_{CE} = 1 V	h_{FE}	>	25	

Transition frequency at f = 100 MHz

I_C = 10 mA; V_{CE} = 10 V	f_T	> typ.	400 500	MHz MHz

Collector capacitance at f = 1 MHz

I_E = I_e = 0; V_{CB} = 5 V	C_c	<	4	pF

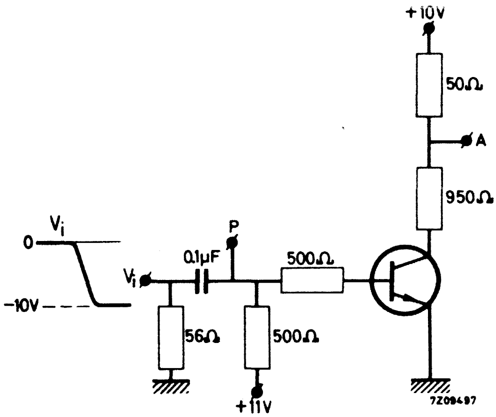
Emitter capacitance at f = 1 MHz

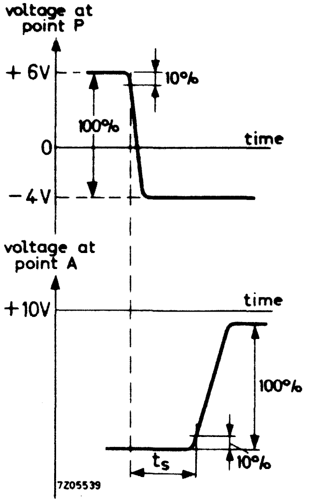
I_C = I_c = 0; V_{EB} = 1 V	C_e	<	4.5	pF

Switching times

Storage time I_C = I_B = $-I_{BM}$ = 10 mA	t_s	<	13	ns

Test circuit:





Pulse generator:

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

Oscilloscope:

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

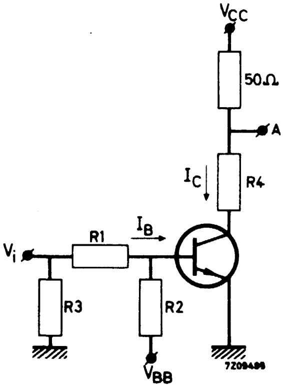
CHARACTERISTICS (continued) T_j = 25 °C unless otherwise specified

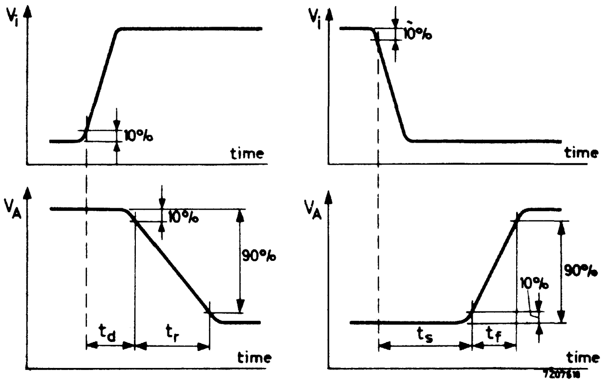
Switching times

Turn on time when switched from
$-V_{BE}$ = 1.5 V to I_C = 10 mA; I_B = 3 mA t_{on} < 12 ns

Turn off time when switched from
I_C = 10 mA; I_B = 3 mA
to cut-off with $-I_{BM}$ = 1.5 mA t_{off} < 18 ns

Test circuit:





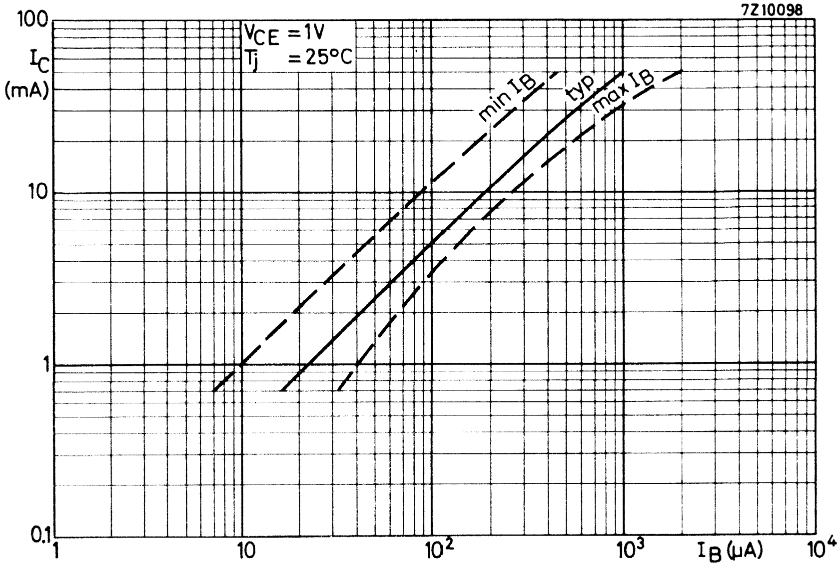
Pulse generator:			
Rise time	t_r	<	1 ns
Pulse duration	t	>	300 ns
Duty cycle	δ	<	0.02
Source impedance	R_S	=	50 Ω

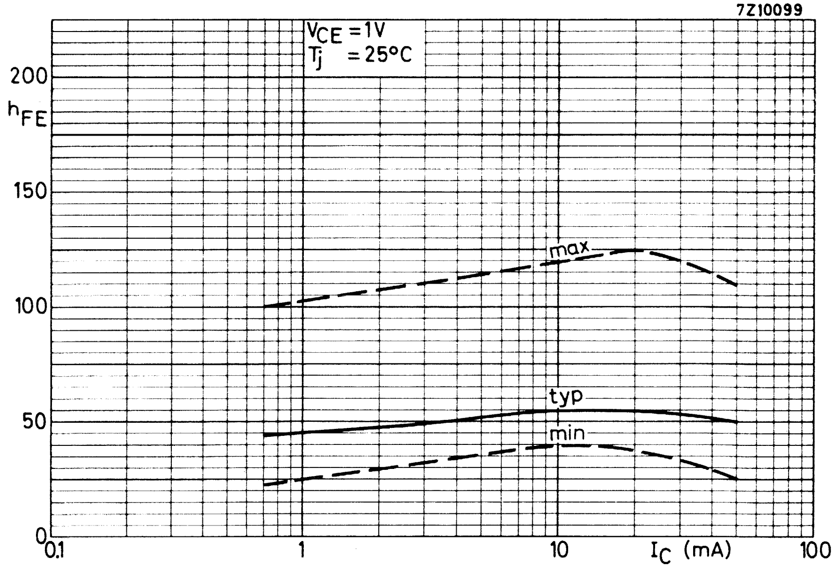
Oscilloscope:			
Input impedance	R_i	=	50 Ω
Rise time	t_r	<	1 ns

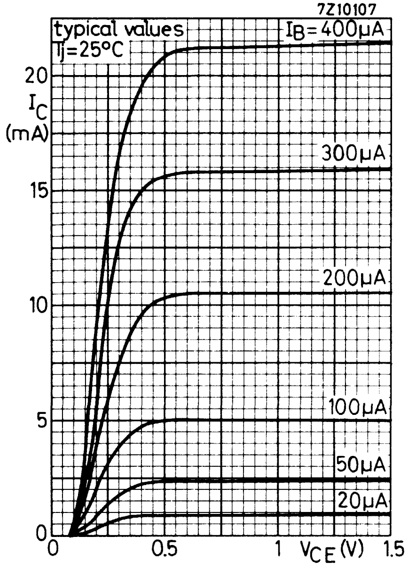
							turn on time			turn off time	
I_C (mA)	I_B (mA)	$-I_{BM}$ (mA)	V_{CC} (V)	R_1;R_2 (kΩ)	R_3 (Ω)	R_4 (Ω)	$-V_{BB}$ (V)	$-V_{BE}$ (V)	V_i (V)	V_{BB} (V)	$-V_i$ (V)
10	3	1.5	3	3.3	50	220	3.0	1.5	15	12.0	15

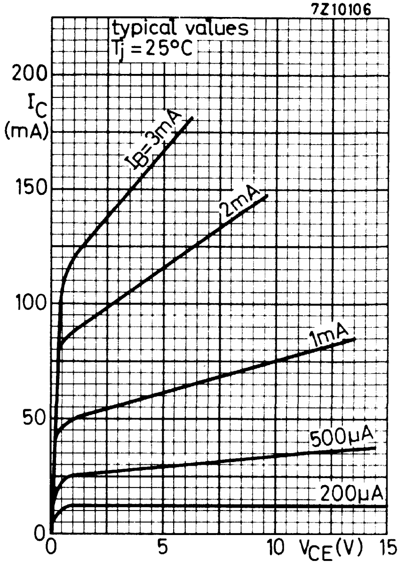
Note

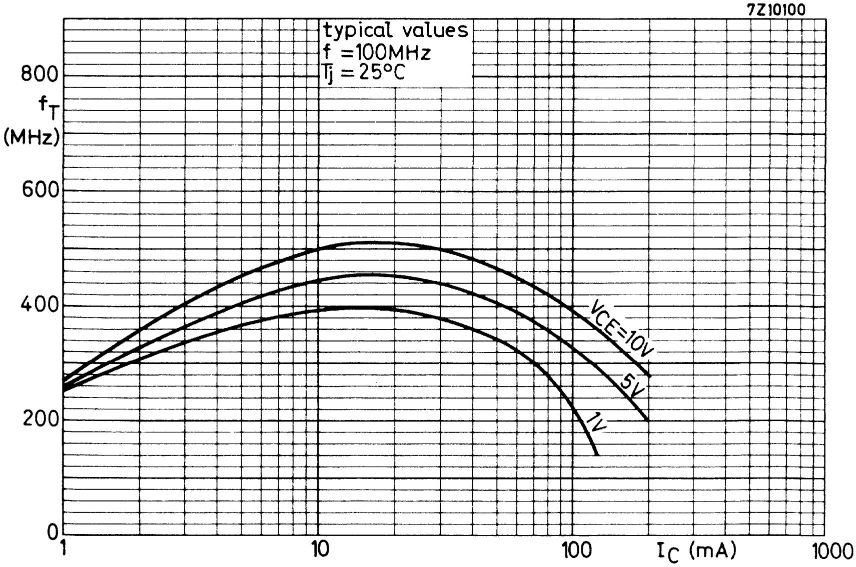
$-I_{BM}$ is the reverse current that can flow during switching off. The indicated $-I_{BM}$ is determined and limited by the applied cut-off voltage and series resistance.

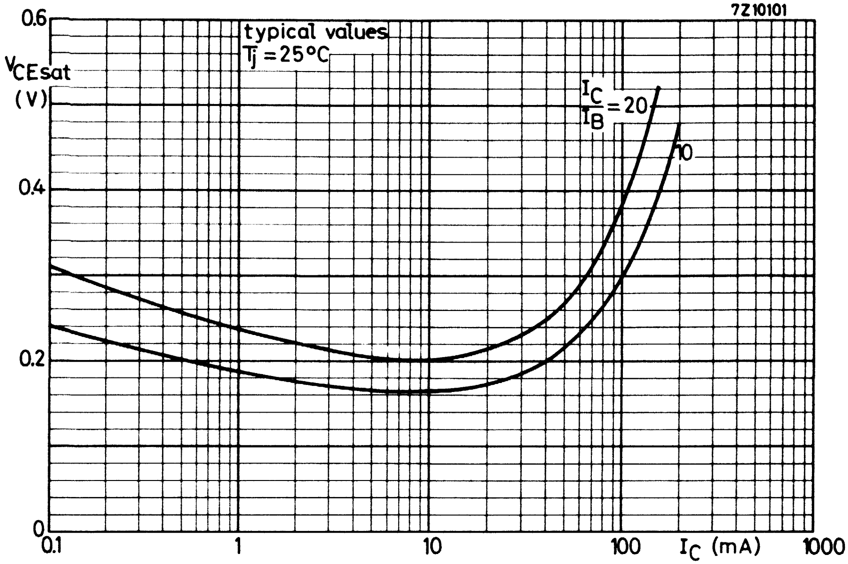

7Z10098
100
I_C
(mA)
10
1
0.1
1
10
10^2
10^3
I_B (μA)
10^4
V_{CE} = 1V
T_j = 25°C
min I_B
typ
max I_B

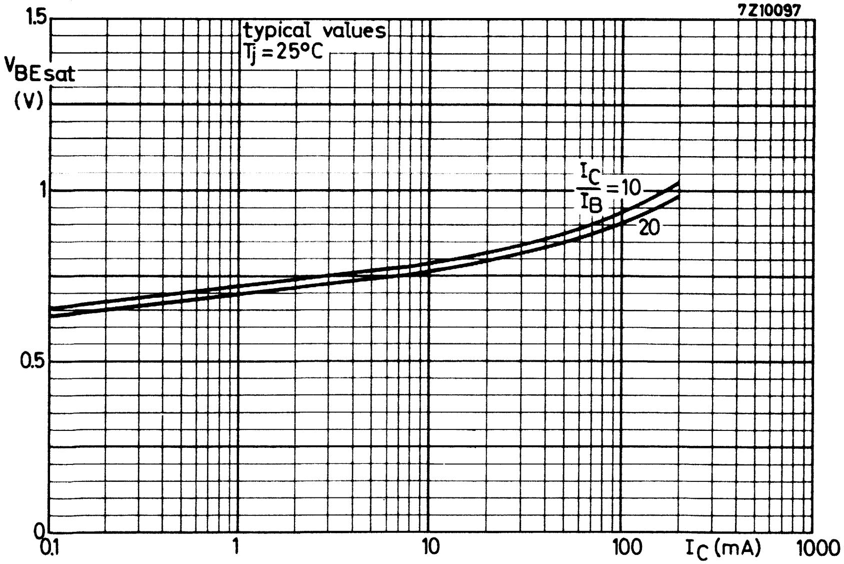

7Z10099
200
h_{FE}
150
100
50
0
0.1
1
10
I_C (mA)
100
V_{CE} = 1V
T_j = 25°C
max
typ
min

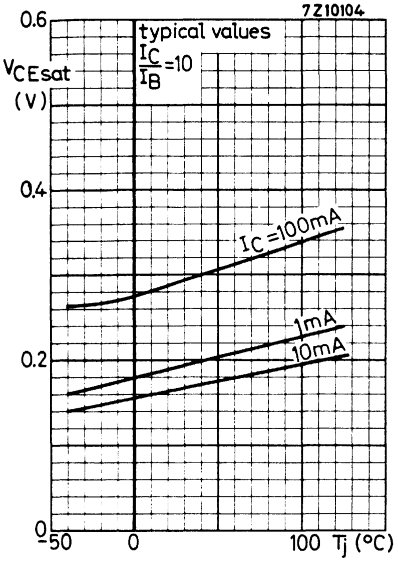

7Z10107
typical values
Tj=25°C
IB=400µA
300µA
200µA
100µA
50µA
20µA
IC (mA)
0
5
10
15
20
0
0.5
1
1.5
VCE(V)

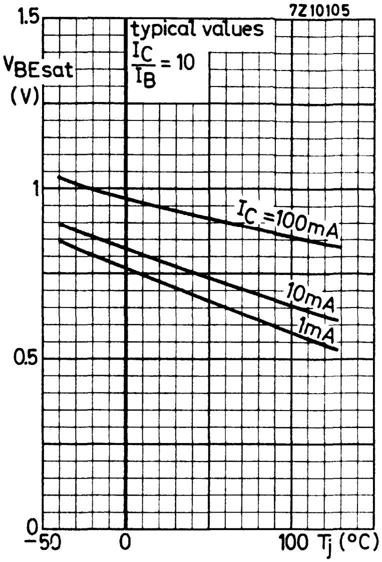

7Z10106
typical values
Tj=25°C
IB=3mA
2mA
1mA
500µA
200µA
IC (mA)
0
50
100
150
200
0
5
10
15
VCE(V)

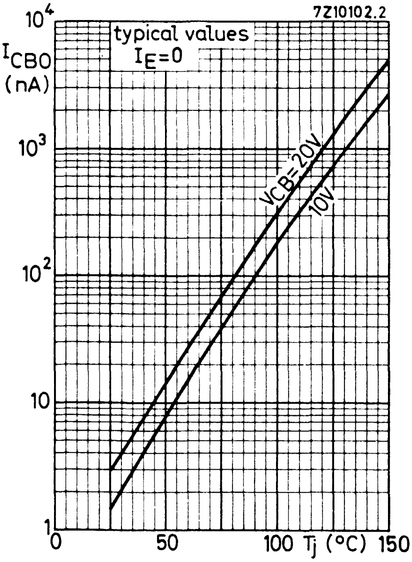

7Z10100
typical values
f =100MHz
Tj = 25°C
fT (MHz)
0
200
400
600
800
VCE=10V
5V
1V
1
10
100
1000
IC (mA)

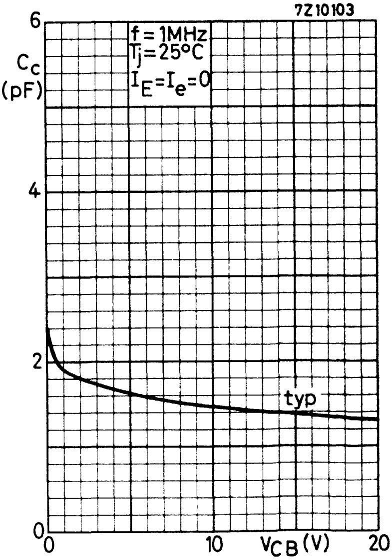

7Z10101
typical values
$T_j = 25°C$
V_{CEsat} (V)
0.6
0.4
0.2
0
0.1
1
10
100
1000
I_C (mA)
$\frac{I_C}{I_B} = 20$
10


7Z10097
typical values
$T_j = 25°C$
V_{BEsat} (V)
1.5
1
0.5
0
0.1
1
10
100
1000
I_C (mA)
$\frac{I_C}{I_B} = 10$
20


7Z10104
0.6
0.4
0.2
0
V_{CEsat} (V)
typical values
$\frac{I_C}{I_B}=10$
I_C=100mA
1mA
10mA
-50
0
100
T_j (°C)


7Z10105
1.5
1
0.5
0
V_{BEsat} (V)
typical values
$\frac{I_C}{I_B}=10$
I_C=100mA
10mA
1mA
-50
0
100
T_j (°C)


7Z10102.2
10^4
10^3
10^2
10
1
I_{CBO} (nA)
typical values
$I_E=0$
V_{CB}=20V
10V
0
50
100
T_j (°C)
150


7Z10103
6
4
2
0
C_c (pF)
f = 1MHz
T_j=25°C
$I_E=I_e=0$
typ
0
10
V_{CB} (V)
20

SILICON PLANAR VOLTAGE REGULATOR DIODES

Low power general purpose voltage regulator diodes in a micro miniature plastic envelope intended for application in thick- and thin-film circuits.
The series covers the whole normalized range of nominal operating voltages from 4,7 V to 12 V with a tolerance of ± 5%.

QUICK REFERENCE DATA				
Operating voltage range		nom.	4,7 to 12	V
Operating voltage tolerance			± 5	%
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	200	mW
Junction temperature	T_j	max.	150	°C

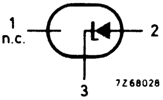
MECHANICAL DATA

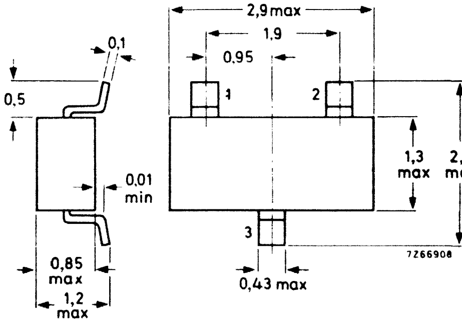
Dimensions in mm

SOT-23

Code:

BZX84-C4V7	Z1
BZX84-C5V1	Z2
BZX84-C5V6	Z3
BZX84-C6V2	Z4
BZX84-C6V8	Z5
BZX84-C7V5	Z6
BZX84-C8V2	Z7
BZX84-C9V1	Z8
BZX84-C10	Z9
BZX84-C11	Y1
BZX84-C12	Y2





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

Currents

Repetitive peak forward current	I_{FRM}	max.	200	mA
Repetitive peak operating current	I_{ZRM}	max.	200	mA

Power dissipation

Total power dissipation up to T_{amb} = 25 °C mounted on a ceramic substrate of 7 mm x 5 mm x 0,5 mm	P_{tot}	max.	200	mW

Temperatures

Storage temperature	T_{stg}	−65 to +150		°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

From junction to ambient mounted on a ceramic substrate of 7 mm x 5 mm x 0,5 mm	$R_{th\ j\text{-}a}$	=	0,62	°C/mW

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Forward voltage at I_F = 10 mA	V_F	<	0,9	V

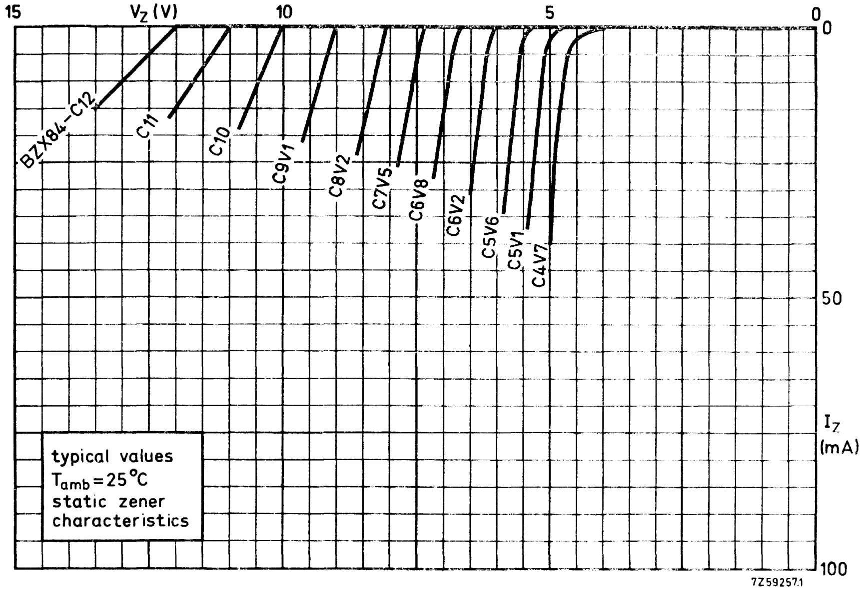
Reverse current

BZX84-C4V7	V_R = 2 V	I_R	<	3000	nA
BZX84-C5V1	V_R = 2 V	I_R	<	2000	nA
BZX84-C5V6	V_R = 2 V	I_R	<	1000	nA
BZX84-C6V2	V_R = 4 V	I_R	<	3000	nA
BZX84-C6V8	V_R = 4 V	I_R	<	2000	nA
BZX84-C7V5	V_R = 5 V	I_R	<	1000	nA
BZX84-C8V2	V_R = 5 V	I_R	<	700	nA
BZX84-C9V1	V_R = 6 V	I_R	<	500	nA
BZX84-C10	V_R = 7 V	I_R	<	200	nA
BZX84-C11	V_R = 8 V	I_R	<	100	nA
BZX84-C12	V_R = 8 V	I_R	<	100	nA

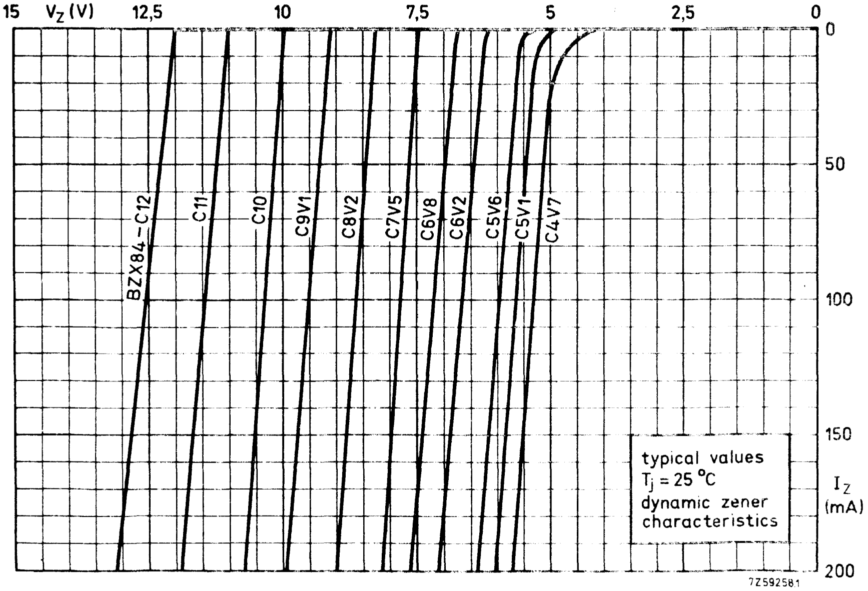
► **CHARACTERISTICS** (continued) T_j = 25 °C unless otherwise specified

BZX84-	Operating voltage V_Z (V) at I_Z = 5 mA			Differential resistance r_{diff} (Ω) at I_Z = 5 mA f = 1 kHz		Temperature coefficient S_Z (mV/°C) at I_Z = 5 mA			Diode capacitance C_d (pF) at f = 1 MHz V_R = 0	
	min.	nom.	max.	typ.	max.	min.	typ.	max.	typ.	max.
C4V7	4,4	4,7	5,0	50	80	−3,5	−1,4	0,2	130	180
C5V1	4,8	5,1	5,4	40	60	−2,7	−0,8	1,2	110	160
C5V6	5,2	5,6	6,0	15	40	−2,0	1,2	2,5	95	140
C6V2	5,8	6,2	6,6	6	10	0,4	2,3	3,7	90	130
C6V8	6,4	6,8	7,2	6	15	1,2	3,0	4,5	85	110
C7V5	7,0	7,5	7,9	6	15	2,5	4,0	5,3	80	100
C8V2	7,7	8,2	8,7	6	15	3,2	4,6	6,2	75	95
C9V1	8,5	9,1	9,6	6	15	3,8	5,5	7,0	70	90
C10	9,4	10	10,6	8	20	4,5	6,4	8,0	70	90
C11	10,4	11	11,6	10	20	5,4	7,4	9,0	65	85
C12	11,4	12	12,7	10	25	6,0	8,4	10,0	65	85

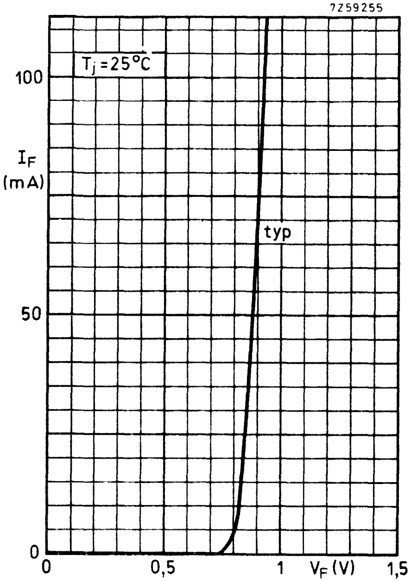
BZX84-	Operating voltage V_Z (V) at I_Z = 1 mA			Differential resistance r_{diff} (Ω) at I_Z = 1 mA f = 1 kHz		Operating voltage V_Z (V) at I_Z = 20 mA			Differential resistance r_{diff} (Ω) at I_Z = 20 mA f = 1 kHz	
	min.	nom.	max.	typ.	max.	min.	nom.	max.	typ.	max.
C4V7	3,7	4,2	4,7	425	500	4,5	5,0	5,4	8	20
C5V1	4,2	4,7	5,3	400	480	5,0	5,4	5,9	6	20
C5V6	4,8	5,4	6,0	80	400	5,2	5,7	6,3	4	20
C6V2	5,6	6,1	6,6	40	150	5,8	6,3	6,8	3	10
C6V8	6,3	6,7	7,2	30	80	6,4	6,9	7,4	2,5	10
C7V5	6,9	7,4	7,9	30	80	7,0	7,6	8,0	2,5	8
C8V2	7,6	8,1	8,7	40	80	7,7	8,3	8,8	3	8
C9V1	8,4	9,0	9,6	40	100	8,5	9,2	9,7	4	8
C10	9,3	9,9	10,6	50	150	9,4	10,1	10,7	4	10
C11	10,2	10,9	11,6	50	150	10,5	11,1	11,8	5	10
C12	11,2	11,9	12,7	50	150	11,5	12,1	12,9	5	10

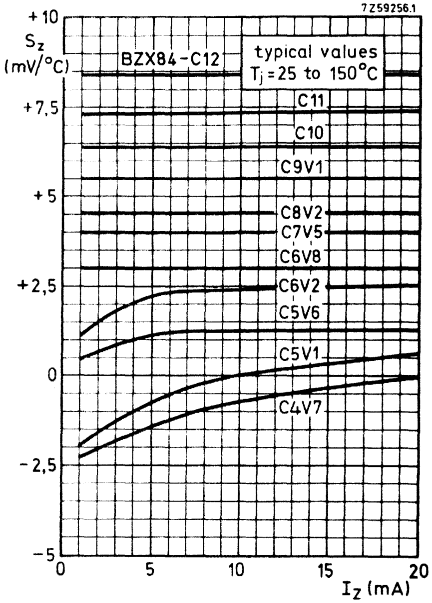


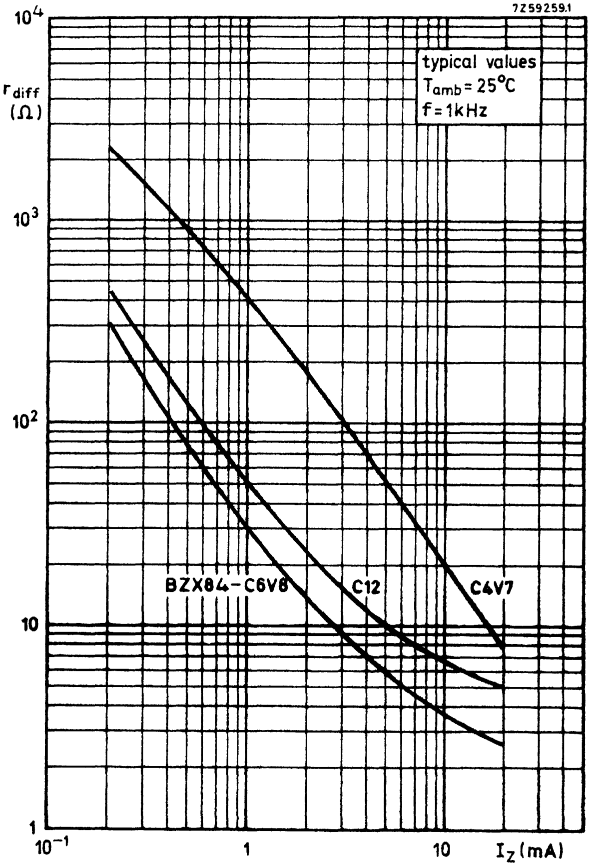
typical values
$T_{amb} = 25\,^{\circ}C$
static zener
characteristics



typical values
$T_j = 25\,^{\circ}C$
dynamic zener
characteristics


7Z59255
$T_j = 25\,^\circ C$
100
50
0
I_F (mA)
typ
0
0,5
1
V_F (V)
1,5


7Z59256.1
+10
S_z (mV/°C)
+7,5
+5
+2,5
0
−2,5
−5
typical values
$T_j = 25$ to $150\,^\circ C$
BZX84-C12
C11
C10
C9V1
C8V2
C7V5
C6V8
C6V2
C5V6
C5V1
C4V7
0
5
10
15
20
I_Z (mA)


7Z59259.1
typical values
T_{amb} = 25°C
f = 1kHz
r_{diff} (Ω)
10^4
10^3
10^2
10
1
10^{-1}
1
10
I_Z (mA)
BZX84-C6V8
C12
C4V7

Accessories

Introduction

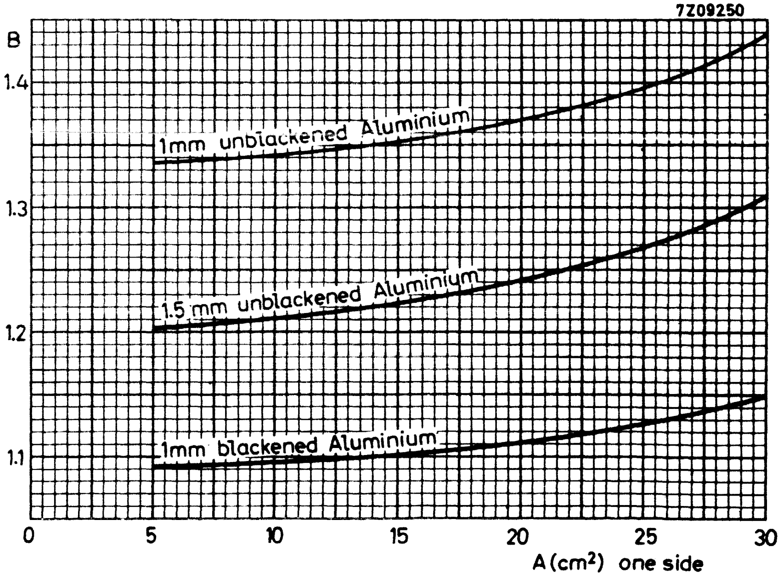
All information on thermal resistances of the accessories combined with flat heatsinks is valid for square heatsinks of 1.5 mm blackened aluminium.
For a few variations the thermal resistance may be derived as follows:

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 thinner heatsinks

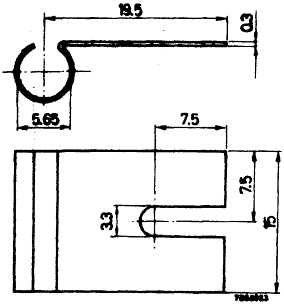
Multiply by the factor B given below as a function of the heatsink size A.



COOLING FIN

MECHANICAL DATA

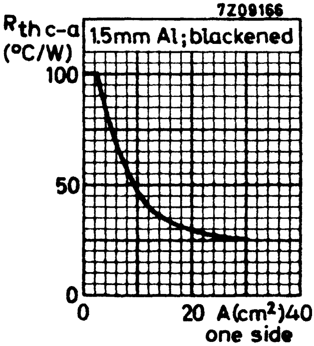
Dimensions in mm



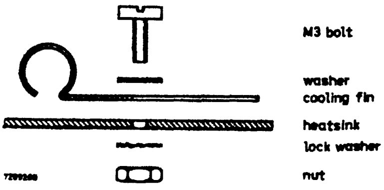
Fin material: brass, nickel plated

THERMAL RESISTANCE

From case to ambient with cooling fin only	$R_{th\ c\text{-}a}$	= 100 °C/W
with heatsink		see graph



MOUNTING INSTRUCTIONS

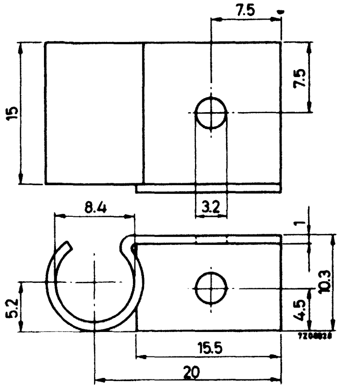


Torque on nut for good heat transfer: 5 cm kg

COOLING FIN

MECHANICAL DATA

Dimensions in mm

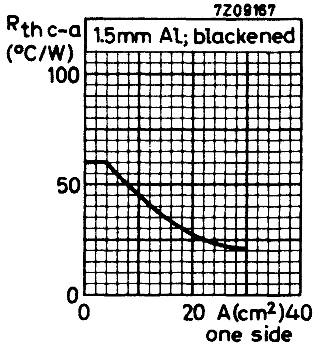


Fin material: aluminium, blackened

THERMAL RESISTANCE

From case to ambient with cooling fin only — $R_{th\ c-a}$ = 60 °C/W

with heatsink — see graph



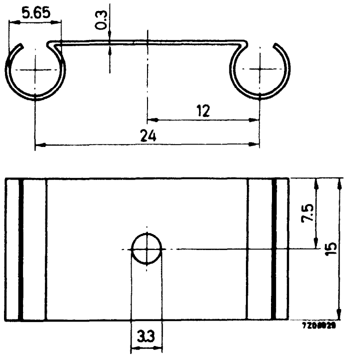
MOUNTING INSTRUCTIONS

Torque on M3 bolts for good heat transfer: 5 cmkg

COOLING FIN

MECHANICAL DATA

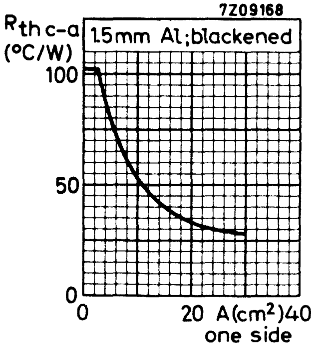
Dimensions in mm



Fin material: brass, nickel plated

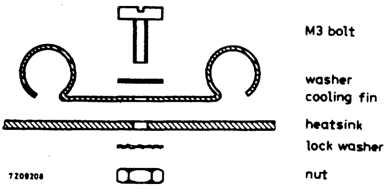
THERMAL RESISTANCE

From case to ambient with cooling fin only	$R_{th\ c-a}$	= 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

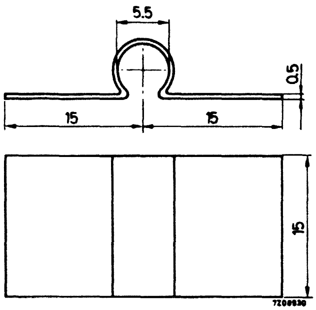


Torque on nut for good heat transfer: 5 cm kg

COOLING FIN

MECHANICAL DATA

Dimensions in mm



Fin material: brass, nickel plated

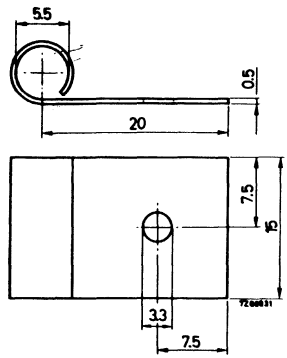
THERMAL RESISTANCE

From case to ambient with cooling fin only $R_{th\ c\text{-}a}$ = 75 °C/W

COOLING FIN

MECHANICAL DATA

Dimensions in mm

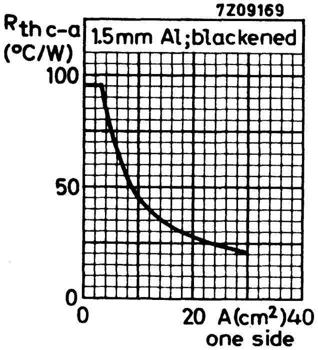


Fin material: brass, nickel plated

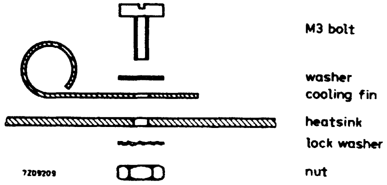
THERMAL RESISTANCE

From case to ambient with cooling fin only $R_{th\ c\text{-}a}$ = 95 °C/W

with heatsink see graph



MOUNTING INSTRUCTIONS

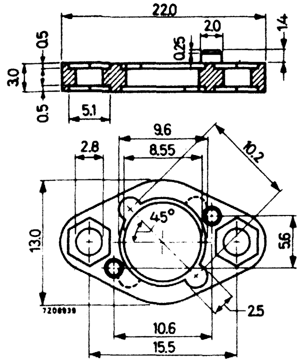


Torque on nut for good heat transfer: 5 cm kg

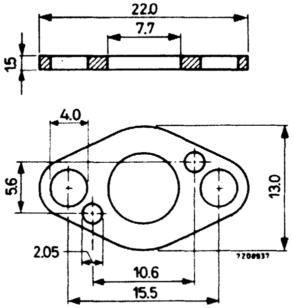
MOUNTING ACCESSORIES

MECHANICAL DATA

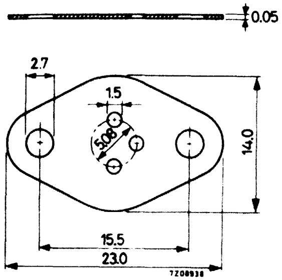
Dimensions in mm



top clamping washer
of insulating material



bottom clamping washer
material: brass, tin plated



mylar washer

THERMAL RESISTANCE

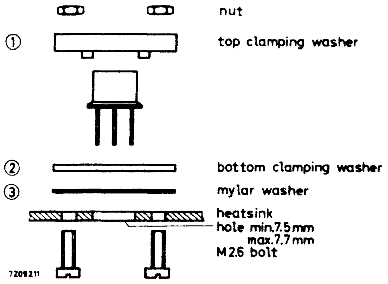
From mounting base to heatsink non insulated mounting $R_{th\ mb-h}$ = 3 °C/W

insulated mounting $R_{th\ mb-h}$ = 6 °C/W

TEMPERATURE

Maximum allowable temperature T_{max} = 100 °C

MOUNTING INSTRUCTIONS

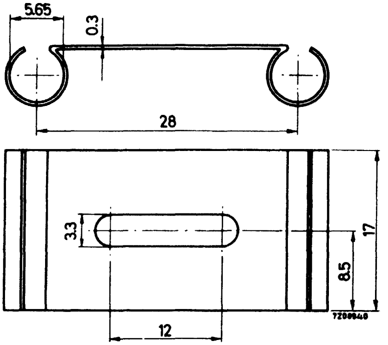


Non insulated mounting; without items 2 and 3. (Note: item 1 must than be mounted up-side down)

COOLING FIN

MECHANICAL DATA

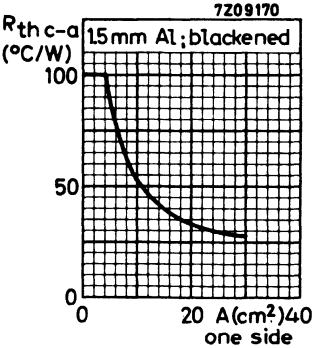
Dimensions in mm



Fin material: brass, nickel plated

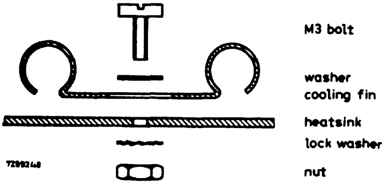
THERMAL RESISTANCE

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

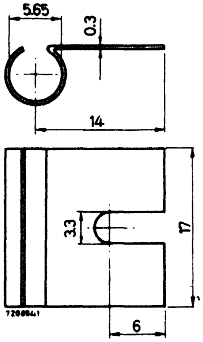


Torque on nut for good heat transfer: 5 cm kg

COOLING FIN

MECHANICAL DATA

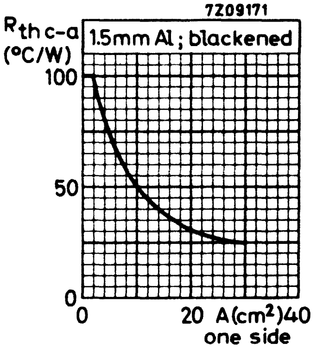
Dimensions in mm



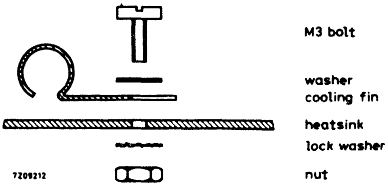
Fin material: brass, nickel plated

THERMAL RESISTANCE

From case to ambient with cooling fin only	$R_{th\ c\text{-}a}$	= 100 °C/W
with heatsink		see graph



MOUNTING INSTRUCTIONS



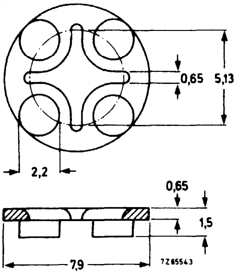
Torque on nut for good heat transfer: 5 cm kg

DISTANCE DISCS

MECHANICAL DATA

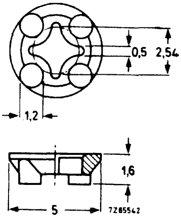
Dimensions in mm

56245



Insulating material

56246



Insulating material

TEMPERATURE

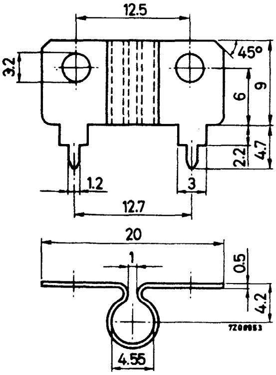
Maximum allowable temperature $T_{max} = 100\ ^{\circ}C$

56263

COOLING FIN

MECHANICAL DATA

Dimensions in mm



Fin material: copper, tin plated

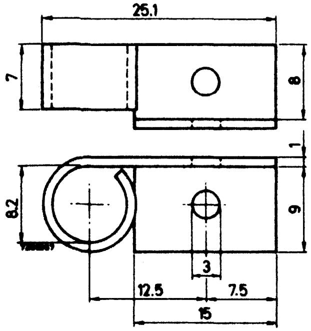
THERMAL RESISTANCE

From case to ambient $R_{th\ c\text{-}a} = 100\ ^{\circ}C/W$

COOLING FIN

MECHANICAL DATA

Dimensions in mm

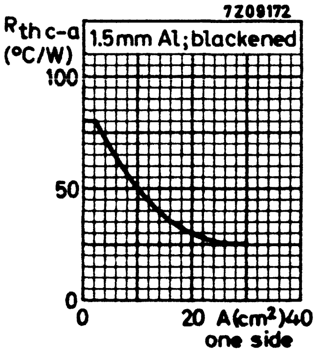


Fin material: aluminium, blackened

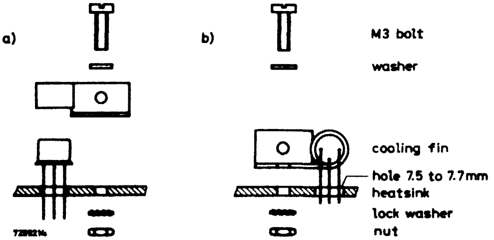
THERMAL RESISTANCE

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

INDEX OF TYPE NUMBERS

The inclusion of a type number in this publication does not necessarily imply its availability.

Type No.	Part	Section	Type No.	Part	Section	Type No.	Part	Section
AA119	1b	GePC	AEY29R	4a	Mw	BA148	1a	R
AAY21	1b	GePC	AEY31	4a	Mw	BA182	1b	T
AAY30	1b	GeGB	AEY31A	4a	Mw	BA216	1b	SiW
AAY32	1b	GeGB	AF124	3	HF	BA217	1b	SiW
AAY39	4a	Mw	AF125	3	HF	BA218	1b	SiW
AAY39A	4a	Mw	AF126	3	HF	BA219	1b	SiW
AAY51	4a	Mw	AF127	3	HF	BA220	1b	SiW
AAY51R	4a	Mw	AF139	3	HF	BA221	1b	SiW
AAY52	4a	Mw	AF239	3	HF	BA222	1b	SiW
AAY52R	4a	Mw	AF239S	3	HF	BA314	1b	SiW
AAY59	4a	Mw	AF267	3	HF	BA315	1b	SiW
AAZ13	1b	GeGB	ASY26	3	Sw	BA316	1b	SiW
AAZ15	1b	GeGB	ASY27	3	Sw	BA317	1b	SiW
AAZ17	1b	GeGB	ASY28	3	Sw	BA318	1b	SiW
AAZ18	1b	GeGB	ASY29	3	Sw	BAV10	1b	SiW
AC125	2	LF	ASY73	3	Sw	BAV18	1b	SiW
AC126	2	LF	ASY74	3	Sw	BAV19	1b	SiW
AC127	2	LF	ASY75	3	Sw	BAV20	1b	SiW
AC127/01	2	LF	ASY76	3	Sw	BAV21	1b	SiW
AC128	2	LF	ASY77	3	Sw	BAV40	1b	Sp
AC128/01	2	LF	ASY80	3	Sw	BAV41	1b	Sp
AC132	2	LF	ASZ15	2	P	BAV42	1b	Sp
AC132/01	2	LF	ASZ16	2	P	BAV43	1b	Sp
AC187	2	LF	ASZ17	2	P	BAV45	1b	Sp
AC187/01	2	LF	ASZ18	2	P	BAV46	4a	Mw
AC188	2	LF	ASZ21	3	Sw	BAV70	4a	Mm
AC188/01	2	LF	BA100	1b	SiA	BAV96A	4a	Mw
AD161	2	P	BA102	1b	T	BAV96B	4a	Mw
AD162	2	P	BA114	1b	SiA	BAV96C	4a	Mw
AEY29	4a	Mw	BA145	1a	R	BAV96D	4a	Mw

GeGB = Germanium gold bonded diodes
GePC = Germanium point contact diodes
HF = High frequency transistors
LF = Low frequency transistors
Mm = Microminiature devices for thick-and thin-film circuits
Mw = Microwave devices

P = Low frequency power transistors
R = Rectifier diodes
SiA = Silicon alloyed diodes
SiW = Silicon whiskerless diodes
Sp = Special diodes
Sw = Switching transistors
T = Tuner diodes

INDEX

Dual = Dual transistors
FET = Field-effect transistors
LF = Low frequency transistors
Mm = Microminiature devices for thick- and thin-film circuits

Mw = Microwave devices
SiW = Silicon whiskerless diodes
T = Tuner diodes

Dual = Dual transistors
FET = Field-effect transistors
HF = High frequency transistors
LF = Low frequency transistors
P = Low frequency power transistors

Defl = Deflection transistors
FET = Field-effect transistors
HF = High frequency transistors
Mm = Microminiature devices for thick- and thin-film circuits
PhDT = Photodiodes and transistors
Sw = Switching transistors
Thyr = Thyristors, diacs, triacs
Tr = Transmitting transistors

Defl = Deflection transistors
Mm = Microminiature devices for thick- and thin-film circuits
Mw = Microwave devices
P = Low frequency power transistors
R = Rectifier diodes
Sw = Switching transistors
Thyr = Thyristors, diacs, triacs
TS = Transient suppressor diodes
Vref = Voltage reference diodes
Vreg = Voltage regulator diodes

INDEX

GeGB = Germanium gold bonded diodes
GePC = Germanium point contact diodes
I = Infrared devices
Ign = Ignistors
L = Light emitting devices
Mw = Microwave devices
PhC = Photoconductive devices
SiA = Silicon alloyed diodes
SiW = Silicon whiskerless diodes
St = Rectifier stacks
Sw = Switching transistors
Vref = Voltage reference diodes
Vreg = Voltage regulator diodes

A = Accessories
FET = Field-effect transistors
HF = High frequency transistors
I = Infrared devices
LF = Low frequency transistors
P = Low frequency power transistors
Sw = Switching transistors
Tr = Transmitting transistors
Vreg = Voltage regulator diodes

Type No.	Part	Section	Type No.	Part	Section	Type No.	Part	Section
56201d	2	A	56262A	1a	A	56314	1a	DH
56201e	2	A	56263	1a to 4a	A	56315	1a	DH
56203	2	A	56264A	1a	A	56316	1a	A
56207	3, 4a	A	56265	2, 3, 4a	A	56318	1a	DH
56208	2, 3, 4a	A	56268	1a	DH	56319	1a	DH
56209	2, 3, 4a	A	56271	1a	DH	56324	2	A
56210	2, 3, 4a	A	56278	1a	DH	56325	2	A
56218	2, 3, 4a	A	56280	1a	DH	56326	2, 3	A
56226	2, 3, 4a	A	56284	1a	DH	56333	2, 3	A
56227	2, 3, 4a	A	56290	1a	HE	56334	1a	DH
56230	1a	HE	56293	1a	HE			
56231	1a	HE	56295	1a	A			
56233	1a	A	56299	1a	A			
56234	1a	A	56302	2	A			
56239	2	A	56303	2	A			
56245	2, 3, 4a	A	56309B	1a	A			
56246	1a to 4a	A	56309R	1a	A			
56253	1a	DH	56311	1a	WH			
56256	1a	DH	56312	1a	DH			
56261	2	A	56313	1a	DH			

A = Accessories
DH = Diecast heatsinks
HE = Heatsink extrusions
WH = Water cooled heatsinks

MAINTENANCE TYPE LIST

The type numbers listed below are not included in this handbook except for those marked with an asterisk.

Detailed information will be supplied on request.

- * BFY44
- * BFY70
- BLY14
- BLY17
- * BXY27
- * BXY28
- * BXY29
- * BXY32

General

Transmitting transistors

Microwave devices

Field-effect transistors

Dual transistors

Microminiature devices for thick- and thin-film circuits

Accessories

Printed in The Netherlands