PHILIPS

Data handbook

Electronic
components
and materials

Semiconductors and integrated circuits

Part 4a June 1976

Transmitting transistors

Microwave devices

Field-effect transistors

Dual transistors

Microminiature devices

SEMICONDUCTORS AND INTEGRATED CIRCUITS

Part 4a

June 1976

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 1a	**Transmitting tubes for communication and Tubes for r.f. heating Types PE05/25 – TBW15/125**	**December 1975**
Part 1b	**Transmitting tubes for communication** **Tubes for r.f. heating** **Amplifier circuit assemblies**	**January 1976**
Part 2	**Microwave products** Communication magnetrons Magnetrons for microwave heating Klystrons Travelling-wave tubes Diodes Triodes T-R Switches Microwave semiconductor devices Isolators – circulators	**May 1976**
Part 3	**Special Quality tubes;** **Miscellaneous devices**	**January 1975**
Part 4	**Receiving tubes**	**March 1975**
Part 5a	**Cathode-ray tubes**	**April 1975**
Part 5b	**Camera tubes; Image intensifier tubes**	**May 1975**
Part 6	**Products for nuclear technology** Channel electron multipliers Geiger-Mueller tubes Neutron tubes N.B. Photomultiplier tubes and Photodiodes will be issued in Part 9	**July 1975**
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	**August 1975**
Part 8	**TV Picture tubes**	**October 1975**

SEMICONDUCTORS AND INTEGRATED CIRCUITS (RED SERIES)

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

Part 1a **Rectifier diodes, thyristors, triacs** **March 1976**

Rectifier diodes
Voltage regulator diodes (> 1,5 W)
Transient suppressor diodes
Rectifier stacks
Thyristors
Triacs

Part 1b **Diodes** **October 1975**

Small signal germanium diodes
Small signal silicon diodes
Special diodes
Voltage regulator diodes (< 1,5 W)
Voltage reference diodes
Tuner diodes

Part 2 **Low-frequency transistors** **December 1975**

Part 3 **High-frequency and switching transistors** **April 1976**

Part 4a **Special semiconductors** **June 1976**

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

Part 4b **Devices for optoelectronics** **December 1974**

Photosensitive diodes and transistors
Light emitting diodes
Photocouplers
Infrared sensitive devices
Photoconductive devices

Part 5 **Linear integrated circuits** **March 1975**

Part 6 **Digital integrated circuits** **May 1976**

LOCMOS HE family
GZ family

COMPONENTS AND MATERIALS (GREEN SERIES)

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

Part 1 **Functional units, Input/output devices, Peripheral devices** **November 1975**

- High noise immunity logic FZ/30-Series
- Circuit blocks 40-Series and CSA70
- Counter modules 50-Series
- NORbits 60-Series, 61-Series
- Circuit blocks 90-Series
- Input/output devices
- Hybrid integrated circuits
- Peripheral devices

Part 2a **Resistors** **February 1976**

- Fixed resistors
- Variable resistors
- Voltage dependent resistors (VDR)
- Light dependent resistors (LDR)
- Negative temperature coefficient thermistors (NTC)
- Positive temperature coefficient thermistors (PTC)
- Test switches

Part 2b **Capacitors** **April 1976**

- Electrolytic and solid capacitors
- Paper capacitors and film capacitors
- Ceramic capacitors
- Variable capacitors

Part 3 **Radio, Audio, Television** **February 1975**

- FM tuners
- Loudspeakers
- Television tuners and aerial input assemblies
- Components for black and white television
- Components for colour television

Part 4a **Soft ferrites** **April 1975**

- Ferrites for radio, audio and television
- Beads and chokes
- Ferroxcube potcores and square cores
- Ferroxcube transformer cores

Part 4b **Piezoelectric ceramics, Permanent magnet materials** **May 1975**

Part 5 **Ferrite core memory products** **July 1975**

- Ferroxcube memory cores
- Matrix planes and stacks
- Core memory systems

Part 6 **Electric motors and accessories** **September 1975**

- Small synchronous motors
- Stepper motors
- Miniature direct current motors

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

Part 8 **Variable mains transformers** **July 1975**

Part 9 **Piezoelectric quartz devices** **March 1976**

Part 10 **Connectors** **November 1975**

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

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

Multiples of similar devices as well as multiples consisting of a main device and an auxiliary device are designated according to the code for discrete devices described above.
Multiples of dissimilar devices of other nature are designated by the second letter G.

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

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

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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) rectifier 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 hyphen (-)

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 working voltage and where appropriate the letter R [1]
The first letter indicates the nominal tolerance of the working voltage in %.

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

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

b) **for rectifier 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.

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[1] The letter R indicates reverse polarity (anode to stud). The normal polarity (cathode to stud) and symmetrical versions 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 FOR TRANSISTORS AND SIGNAL DIODES

based on IEC Publication 148

LETTER SYMBOLS FOR CURRENTS, VOLTAGES AND POWERS

Basic letters

The basic letters to be used are:

I, i = current
V, v = voltage
P, p = power

Lower-case basic letters shall be used for the representation of instantaneous values which vary with time.
In all other instances upper-case basic letters shall be used.

Subscripts

A, a	Anode terminal
(AV), (av)	Average value
B, b	Base terminal, for MOS devices: Substrate
(BR)	Breakdown
C, c	Collector terminal
D, d	Drain terminal
E, e	Emitter terminal
F, f	Forward
G, g	Gate terminal
K, k	Cathode terminal
M, m	Peak value
O, o	As third subscript: The terminal not mentioned is open circuited
R, r	As first subscript: Reverse. As second subscript: Repetitive. As third subscript: With a specified resistance between the terminal not mentioned and the reference terminal.
(RMS), (rms)	R.M.S. value
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
X, x	Specified circuit
Z, z	Replaces R to indicate the actual working voltage, current or power of voltage reference and voltage regulator diodes.

Note: No additional subscript is used for d.c. values.

Upper-case subscripts shall be used for the indication of:

a) continuous (d.c.) values (without signal)

Example I_B

b) instantaneous total values

Example i_B

c) average total values

Example $I_{B(AV)}$

d) peak total values

Example I_{BM}

e) root-mean-square total values

Example $I_{B(RMS)}$

Lower-case subscripts shall be used for the indication of values applying to the varying component alone:

a) instantaneous values

Example i_b

b) root-mean-square values

Example $I_{b(rms)}$

c) peak values

Example I_{bm}

d) average values

Example $I_{b(av)}$

Note: If more than one subscript is used, subscript for which both styles exist shall either be all upper-case or all lower-case.

Additional rules for subscripts

Subscripts for currents

Transistors: If it is necessary to indicate the terminal carrying the current, this should be done by the first subscript (conventional current flow from the external circuit into the terminal is positive).

Examples: I_B, i_B, i_b, I_{bm}

Diodes: To indicate a forward current (conventional current flow into the anode terminal) the subscript F or f should be used; for a reverse current (conventional current flow out of the anode terminal) the subscript R or r should be used.

Examples: I_F, I_R, i_F, $I_{f(rms)}$

Subscripts for voltages

Transistors: If it is necessary to indicate the points between which a voltage is measured, this should be done by the first two subscripts. The first subscript indicates the terminal at which the voltage is measured and the second the reference terminal or the circuit node. Where there is no possibility of confusion, the second subscript may be omitted.

Examples: V_{BE}, v_{BE}, v_{be}, V_{bem}

Diodes: To indicate a forward voltage (anode positive with respect to cathode), the subscript F or f should be used; for a reverse voltage (anode negative with respect to cathode) the subscript R or r should be used.

Examples: V_F, V_R, v_F, V_{rm}

Subscripts for supply voltages or supply currents

Supply voltages or supply currents shall be indicated by repeating the appropriate terminal subscript.

Examples: V_{CC}, I_{EE}

Note: If it is necessary to indicate a reference terminal, this should be done by a third subscript

Example : V_{CCE}

Subscripts for devices having more than one terminal of the same kind

If a device has more than one terminal of the same kind, the subscript is formed by the appropriate letter for the terminal followed by a number; in the case of multiple subscripts, hyphens may be necessary to avoid misunderstanding.

Examples: I_{B2} = continuous (d.c.) current flowing into the second base terminal.

V_{B2-E} = continuous (d.c.) voltage between the terminals of second base and emitter

Subscripts for multiple devices

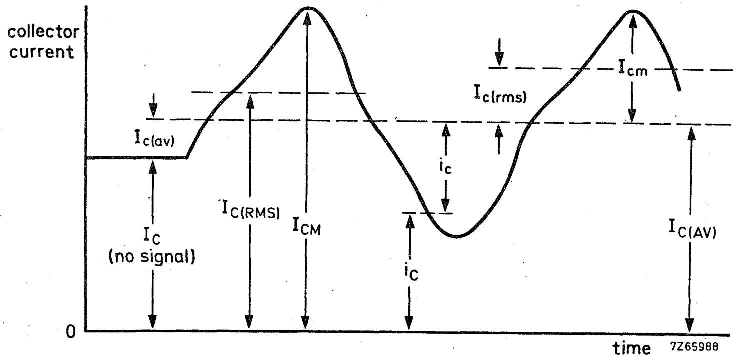
For multiple unit devices, the subscripts are modified by a number preceding the letter subscript; in the case of multiple subscripts, hyphens may be necessary to avoid misunderstanding.

Examples: I_{2C} = continuous (d.c.) current flowing into the collector terminal of the second unit

V_{1C-2C} = continuous (d.c.) voltage between the collector terminals of the first and the second unit.

Application of the rules

The figure below represents a transistor collector current as a function of time. It consists of a continuous (d.c.) current and a varying component.



LETTER SYMBOLS FOR ELECTRICAL PARAMETERS

Definition

For the purpose of this Publication, the term "electrical parameter" applies to four-pole matrix parameters, elements of electrical equivalent circuits, electrical impedances and admittances, inductances and capacitances.

Basic letters

The following is a list of the most important basic letters used for electrical parameters of semiconductor devices.

B, b = susceptance; imaginary part of an admittance
C = capacitance
G, g = conductance; real part of an admittance
H, h = hybrid parameter
L = inductance
R, r = resistance; real part of an impedance
X, x = reactance; imaginary part of an impedance
Y, y = admittance;
Z, z = impedance;

Upper-case letters shall be used for the representation of:

a) electrical parameters of external circuits and of circuits in which the device forms only a part;

b) all inductances and capacitances.

Lower-case letters shall be used for the representation of electrical parameters inherent in the device (with the exception of inductances and capacitances).

Subscripts

General subscripts

The following is a list of the most important general subscripts used for electrical parameters of semiconductor devices:

F, f = forward; forward transfer
I, i (or 1) = input
L, l = load
O, o (or 2) = output
R, r = reverse; reverse transfer
S, s = source

Examples: Z_S, h_f, h_F

The upper-case variant of a subscript shall be used for the designation of static (d.c.) values.

Examples : h_{FE} = static value of forward current transfer ratio in common-emitter configuration (d.c. current gain)
R_E = d.c. value of the external emitter resistance.

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.

The lower-case variant of a subscript shall be used for the designation of small-signal values.

Examples: h_{fe} = small-signal value of the short-circuit forward current transfer ratio in common-emitter configuration
$Z_e = R_e + jX_e$ = small-signal value of the external impedance

Note: If more than one subscript is used, subscripts for which both styles exist shall either be all upper-case or all lower-case

Examples: h_{FE}, y_{RE}, h_{fe}

Subscripts for four-pole matrix parameters

The first letter subscript (or double numeric subscript) indicates input, output, forward transfer or reverse transfer

Examples: h_i (or h_{11})
h_o (or h_{22})
h_f (or h_{21})
h_r (or h_{12})

A further subscript is used for the identification of the circuit configuration. When no confusion is possible, this further subscript may be omitted.

Examples: h_{fe} (or h_{21e}), h_{FE} (or h_{21E})

Distinction between real and imaginary parts

If it is necessary to distinguish between real and imaginary parts of electrical parameters, no additional subscripts should be used. If basic symbols for the real and imaginary parts exist, these may be used.

Examples: $Z_i = R_i + jX_i$

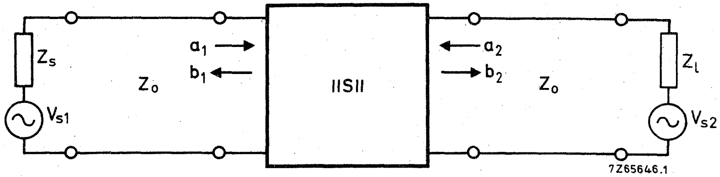
$y_{fe} = g_{fe} + jb_{fe}$

If such symbols do not exist or if they are not suitable, the following notation shall be used:

Examples: Re (h_{ib}) etc. for the real part of h_{ib}
Im (h_{ib}) etc. for the imaginary part of h_{ib}

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 waves a_1, b_1, a_2 and b_2.



$$a_1 = \frac{V_{i1}}{\sqrt{Z_o}} \qquad a_2 = \frac{V_{i2}}{\sqrt{Z_o}}$$

$$b_1 = \frac{V_{r1}}{\sqrt{Z_o}} \qquad b_2 = \frac{V_{r2}}{\sqrt{Z_o}} \qquad ^{1)}$$

Z_o = 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, r for 12, f for 21 and o for 22, it follows that:

$$s_i = s_{11} = \left.\frac{b_1}{a_1}\right|_{a_2 = 0}$$
$$s_r = s_{12} = \left.\frac{b_1}{a_2}\right|_{a_1 = 0}$$
$$s_f = s_{21} = \left.\frac{b_2}{a_1}\right|_{a_2 = 0}$$
$$s_o = s_{22} = \left.\frac{b_2}{a_2}\right|_{a_1 = 0}$$

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1) The squares of these quantities have the dimension of power.

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

s_i = s_{11} = Input reflection coefficient.
The complex ratio of the reflected wave and the incident wave at the input, under the conditions $Z_l = Z_o$ and $V_{s2} = 0$.

s_r = s_{12} = Reverse transmission coefficient.
The complex ratio of the generated wave at the input and the incident wave at the output, under the conditions $Z_s = Z_o$ and $V_{s1} = 0$.

s_f = s_{21} = Forward transmission coefficient.
The complex ratio of the generated wave at the output and the incident wave at the input, under the conditions $Z_l = Z_o$ and $V_{s2} = 0$

s_o = s_{22} = Output reflection coefficient.
The complex ratio of the reflected wave and the incident wave at the output, under the conditions $Z_s = Z_o$ and $V_{s1} = 0$.

Transmitting transistors

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, 10 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: 0, 80 Nm (+0, 05; -0, 00)
8, 0 kg cm (+0, 5 ; -0, 0)
If security against vibration is required, use a locking compound such as Lock-tite.
Do not use washers; they impair the heat transfer.

-Recommended 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 ^{o}C are safely tolerable; the transistor can withstand an interior temperature of 250 ^{o}C for about ten minutes.
The leads may be tinned, if required, by dipping them into a solder bath at about 230 ^{o}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.

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

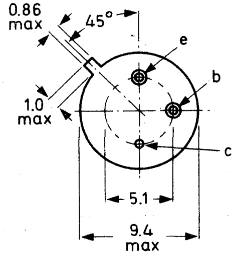
R.F. performance up to T_{mb} = 25 °C in an unneutralised common-emitter class B circuit.

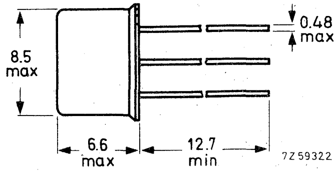
Mode of operation	V_{CC} (V)	f (MHz)	P_S (W)	P_L (W)	I_C (A)	G_p (dB)	η (%)	$\bar{z}_i$ (Ω)	$\bar{Y}_L$ (mA/V)
c.w.	13.5	175	< 0.63	4	< 0.49	> 8	> 60	3.9+j2.2	37−j22
c.w.	12.5	175	typ. 0.63	4	typ. 0.53	typ. 8	typ. 60	—	—

MECHANICAL DATA

Dimensions in mm

TO-39
Collector connected to case





Accessories supplied on request: 56218; 56245

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

Voltages

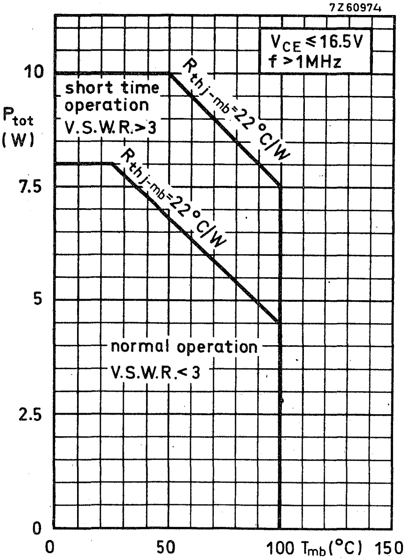
Collector-base voltage (open emitter) peak value	V_{CBOM}	max.	36	V
Collector-emitter voltage (open base)	V_{CEO}	max.	18	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4	V

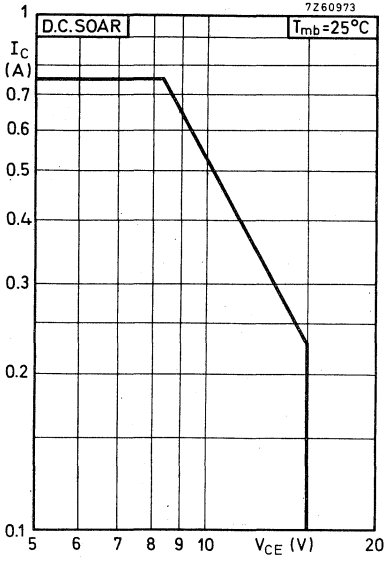
Currents

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

Power dissipation

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





Temperature

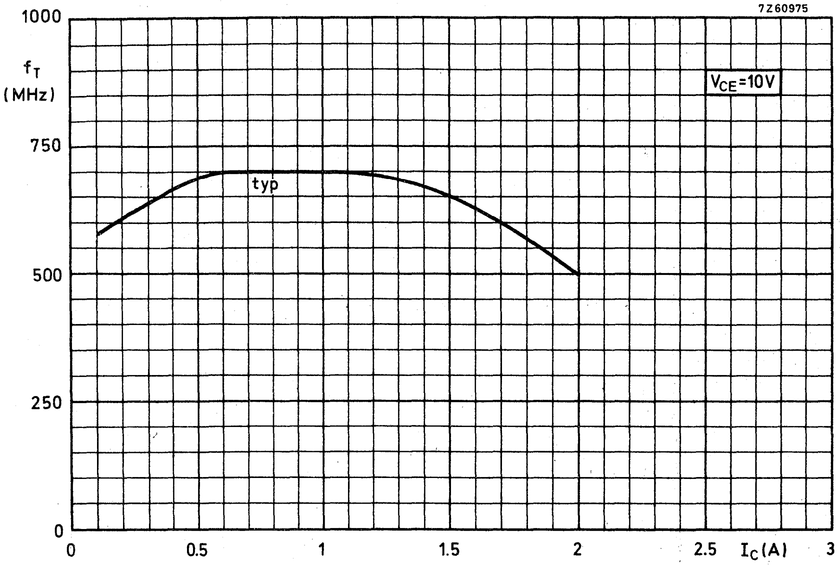
Storage temperature	T_{stg}		-65 to +200	°C
Operating junction temperature	T_j	max.	200	°C

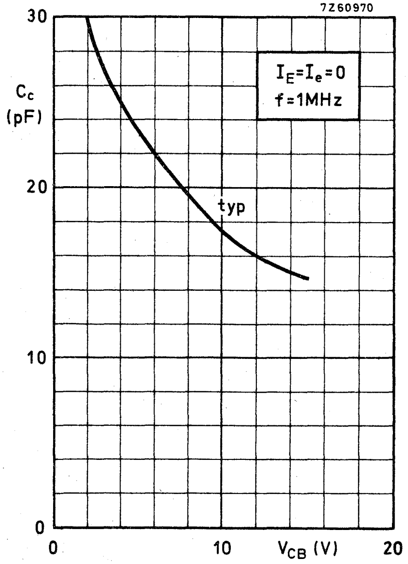
THERMAL RESISTANCE

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 $T_j = 25\,^{o}C$ 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
0
0.5
1
1.5
2
2.5
I_C (A)
3
V_{CE}=10V
typ


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

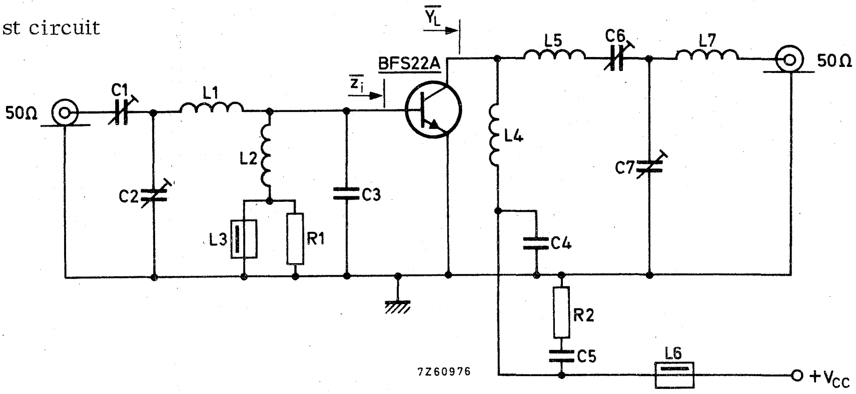
APPLICATION INFORMATION

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(%)	$\overline{z}_i$ (Ω)	$\overline{Y}_L$(mA/V)
13.5	< 0.63	4	< 0.49	> 8	> 60	3.9+j2.2	37−j22
12.5	typ. 0.63	4	typ. 0.53	typ. 8	typ. 60	–	–

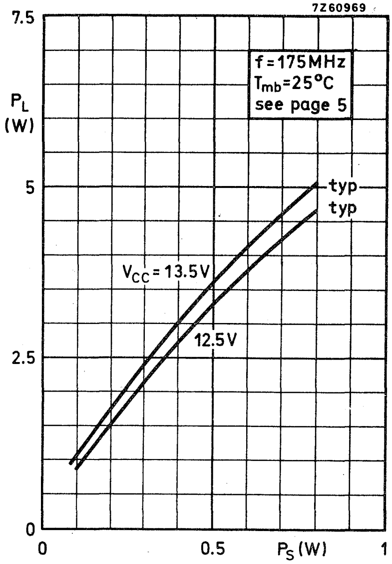
Test circuit

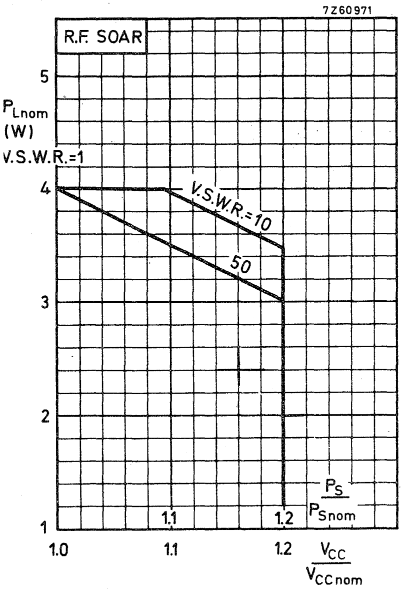


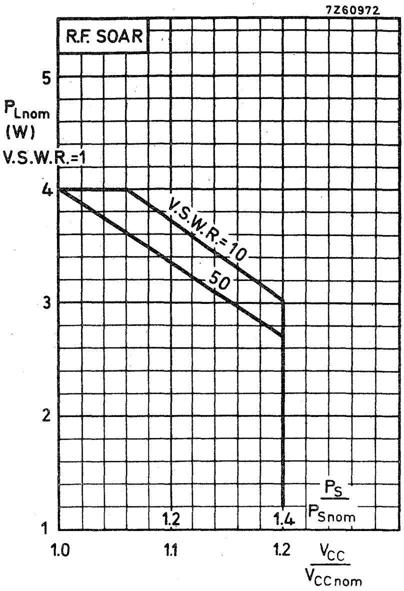
C1 = C6 = 4 to 29 pF air trimmer with insulated rotor
C2 = C7 = 4 to 29 pF air trimmer with non-insulated rotor
C3 = 39 pF ceramic
C4 = 100 pF ceramic
C5 = 15 nF polyester

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





Conditions for R.F. SOAR:

f = 175 MHz
T_{mb} = 70 °C
V_{CCnom} = 12.5 or 13.5 V

$P_{Snom} = P_S$ at $V_{CC} = V_{CCnom}$ and V.S.W.R. = 1
see also page 5

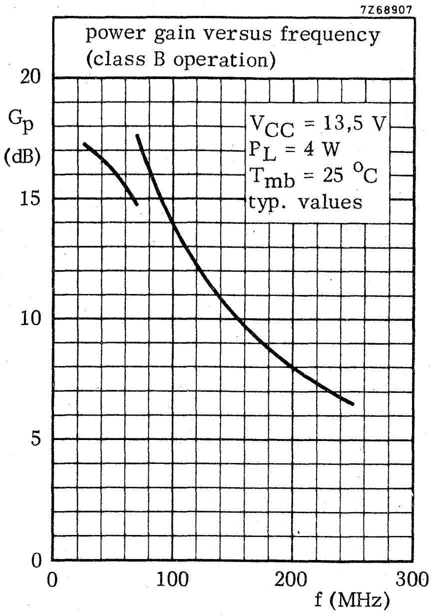
The transistor has been developed for use with unstabilized supply voltages. As the output power and drive power increase with the supply voltage, the nominal output power must be derated in accordance with the graphs above for safe operation at supply voltages other than the nominal. The graphs show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

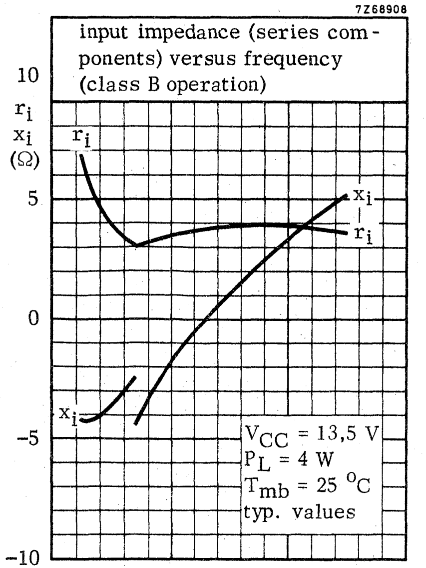
The left hand graph applies to the situation in which the drive (P_S/P_{Snom}) increases linearly with supply overvoltage ratio.

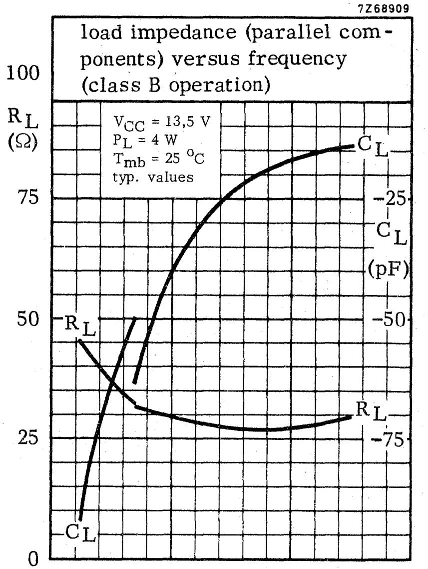
The right hand graph shows the derating factor to be applied when the drive (P_S/P_{Snom}) increases as the square of the supply overvoltage ratio (V_{CC}/V_{CCnom}).

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

OPERATING NOTE Below 70 MHz a base-emitter resistor of 10 Ω is recommended to avoid oscillation. This resistor must be effective for both d.c. and r.f.







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

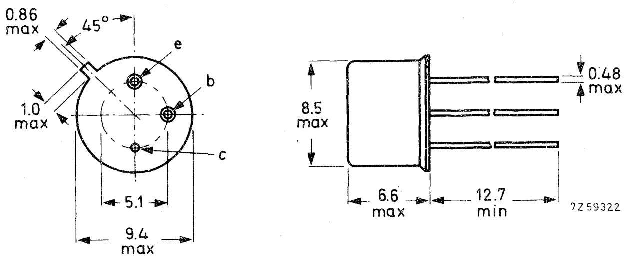
R.F. performance up to T_{mb} = 25 °C in an unneutralised common-emitter class B circuit.

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	8.9−j18.1

MECHANICAL DATA

Dimensions in mm

TO-39
Collector connected
to case



Accessories supplied on request: 56218; 56245

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

Voltages

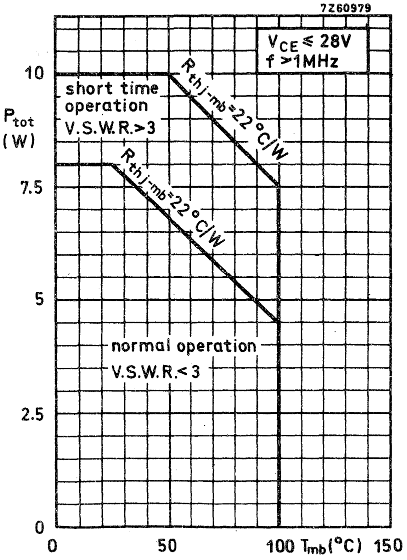
Collector-base voltage (open emitter) peak value	V_{CBOM}	max.	65	V
Collector-emitter voltage (open base)	V_{CEO}	max.	36	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4	V

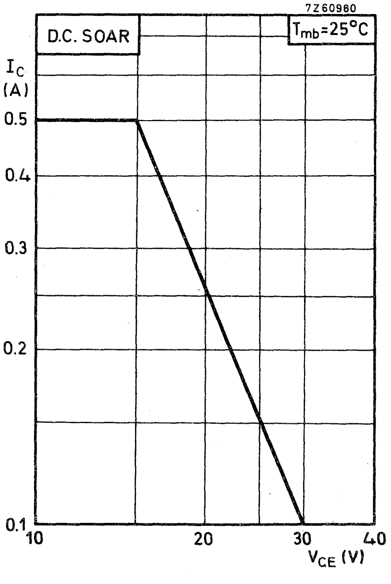
Currents

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

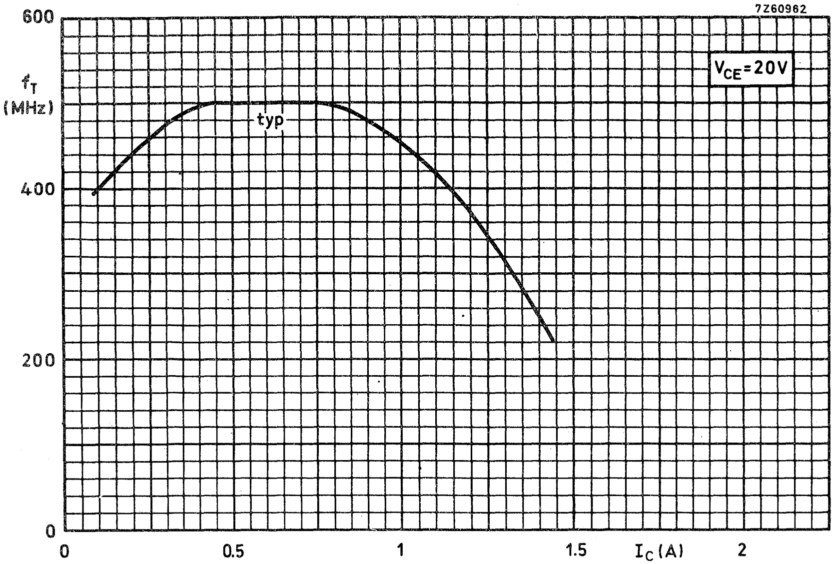
Storage temperature	T_{stg}	−65 to	+200	°C
Operating junction temperature	T_j	max.	200	°C

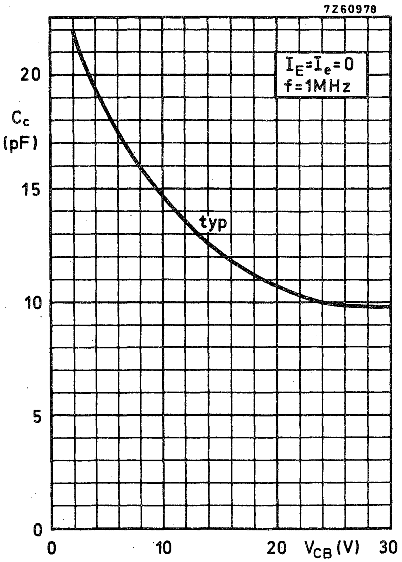
THERMAL RESISTANCE

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


7Z60962
600
f_T
(MHz)
400
200
0
0
0.5
1
1.5
I_C (A)
2
V_{CE}=20V
typ


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

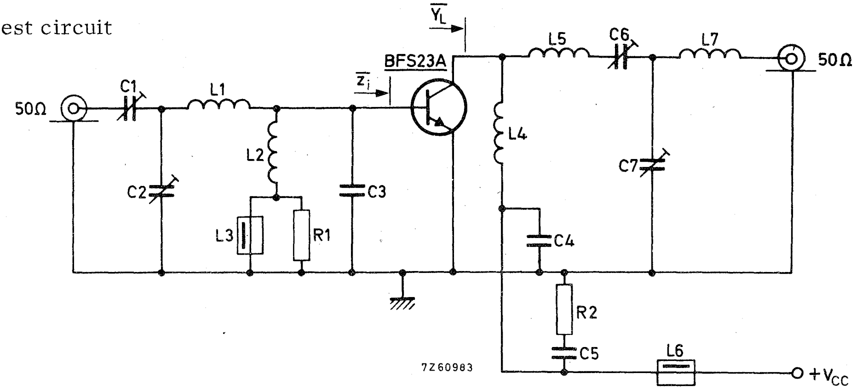
APPLICATION INFORMATION

R.F. performance in c.w. operation (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	8.9 − j18.1

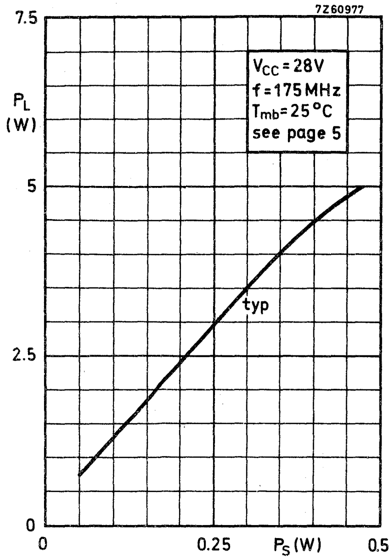
Test circuit

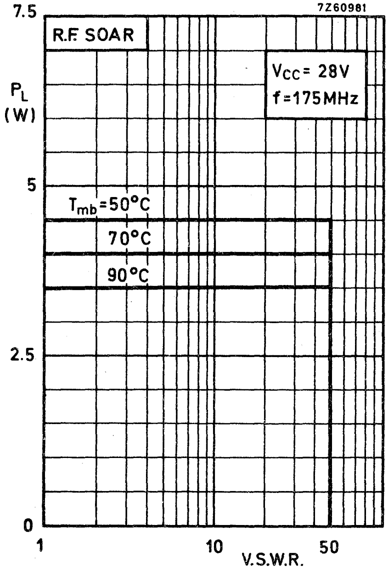


C1 = C6 = 4 to 29 pF air trimmer with insulated rotor
C2 = C7 = 4 to 29 pF air trimmer with non-insulated rotor
C3 = 39 pF ceramic
C4 = 100 pF ceramic
C5 = 15 nF polyester

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

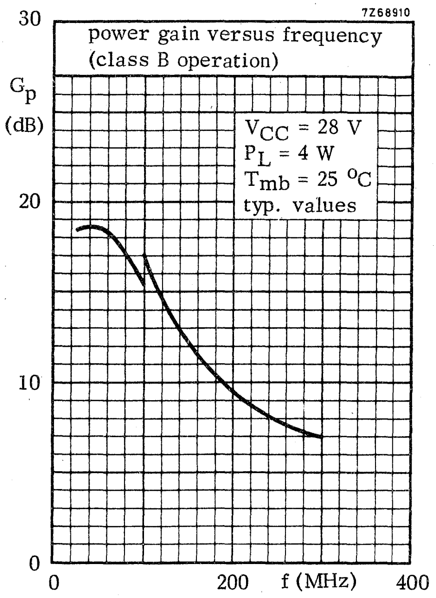
R1 = R2 = 10 Ω carbon

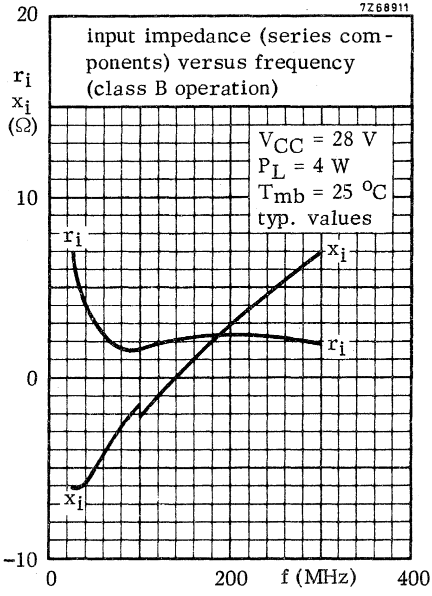


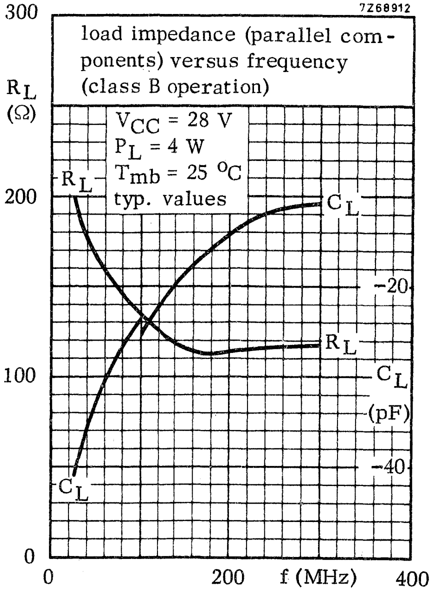


For high voltage operation, a stabilized power supply is generally used.
The graph shows the allowable output power under nominal conditions as a function of the V.S.W.R., with heat-sink temperature as parameter.

OPERATING NOTE Below 100 MHz a base-emitter resistor of 10 Ω is recommended to avoid oscillation. This resistor must be effective for both d.c. and r.f.







V.H.F. POWER TRANSISTOR

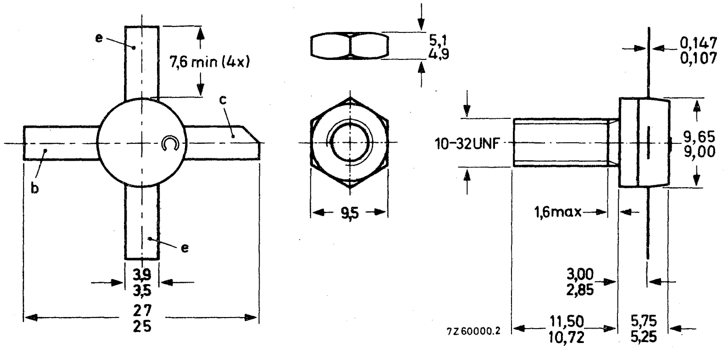
N-P-N planar epitaxial transistor intended for use in class A, B and C operated mobile, industrial and military transmitters with a supply voltage of 12,5 V. The transistor is resistance stabilized. Every transistor is tested under severe load mismatch conditions with a supply overvoltage to 15 V. It has a plastic encapsulated stripline package. All leads are isolated from the stud. Matched h_{FE} groups are available on request.

QUICK REFERENCE DATA

Operation	V_{CC} (V)	f (MHz)	P_L (W)	G_p (dB)	η (%)	d_3 (dB)	$I_{C(ZS)}$ (mA)
c.w.	12,5	175	45	> 5,5	> 75		
s.s.b.	12,5	1,6 to 28	3 - 30 (PEP)	typ. 19,5	typ. 35	typ. −33	25

MECHANICAL DATA Dimensions in mm

SOT-56



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

Torque on nut: min. 1,5 Nm (15 kg cm)
max. 1,7 Nm (17 kg cm)

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

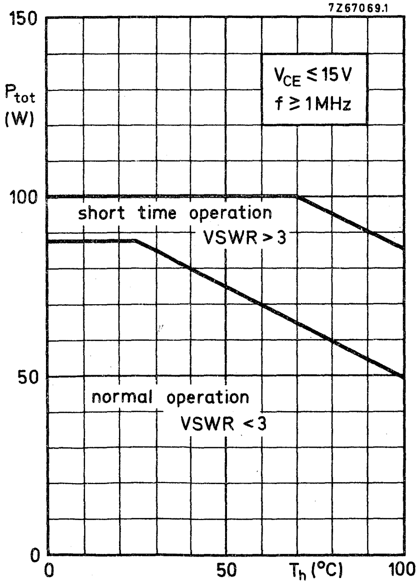
Collector-base voltage (open emitter) peak value	V_{CBOM}	max.	36	V
Collector-emitter voltage (open base)	V_{CEO}	max.	18	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4	V

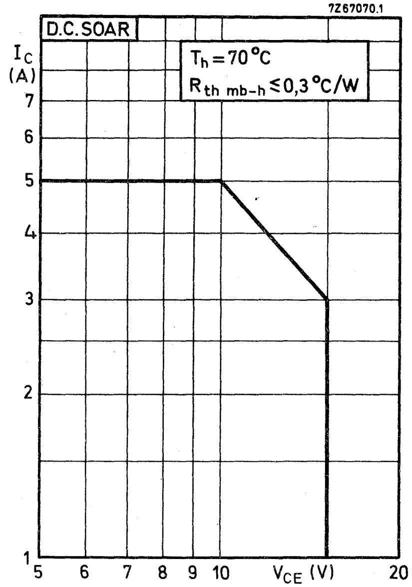
Currents

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

Power dissipation

Total power dissipation at $T_h = 70$ °C $f \geq 1$ MHz; $V_{CE} \leq 15$ V; $R_{th\ mb-h} \leq 0,3$ °C/W Derate by 0,5 W/°C for 50 °C $\leq T_h \leq$ 100 °C	P_{tot}	max.	65	W





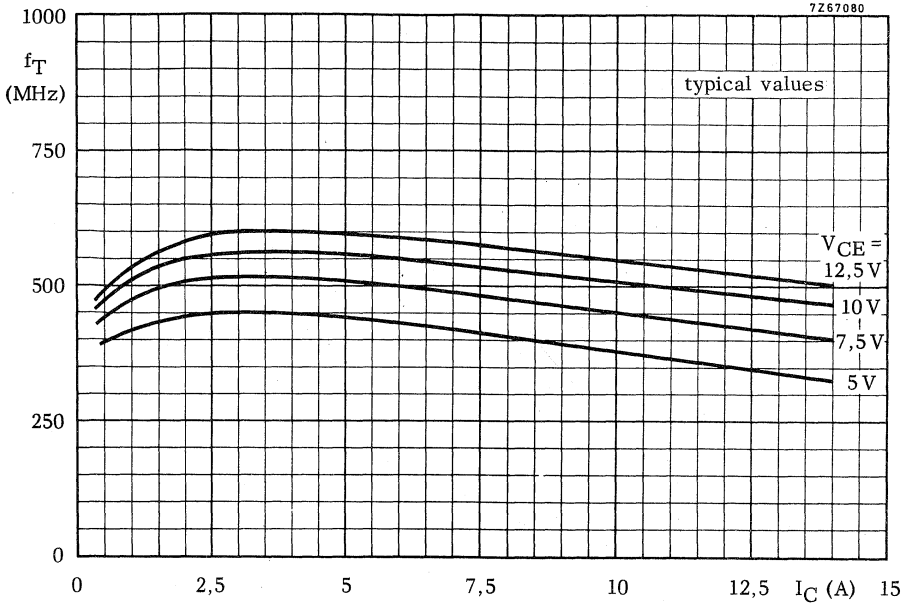
Temperature

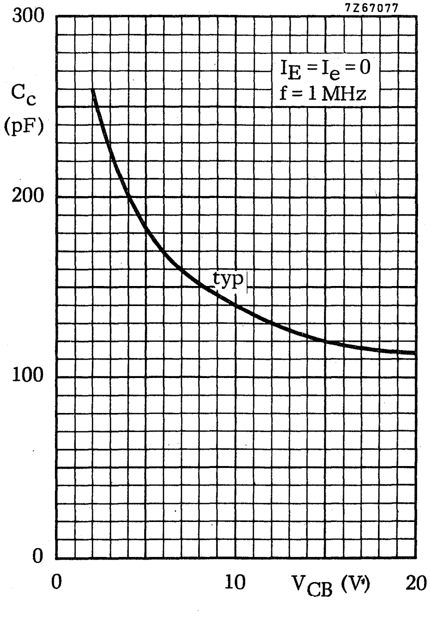
Storage temperature	T_{stg}	−65 to +200	°C

CHARACTERISTICS

T_j = 25 °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 Ω	E	>	8	mWs
D.C. current gain				
I_C = 1 A; V_{CE} = 5 V	h_{FE}		20 to 100	←
D.C. current gain ratio of matched devices				
I_C = 1 A; V_{CE} = 5 V	h_{FE1}/h_{FE2}	<	1,2	
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. <	120 160	pF pF
Feedback capacitance				
I_C = 200 mA; V_{CE} = 15 V	C_{re}	typ.	80	pF
Collector-stud capacitance	C_{cs}	typ.	2	pF


7Z67080
1000
f_T
(MHz)
750
500
250
0
typical values
V_{CE} =
12,5 V
10 V
7,5 V
5 V
0
2,5
5
7,5
10
12,5
I_C (A)
15


7Z67077
300
C_c
(pF)
200
100
0
$I_E = I_e = 0$
f = 1 MHz
typ
0
10
V_{CB} (V)
20

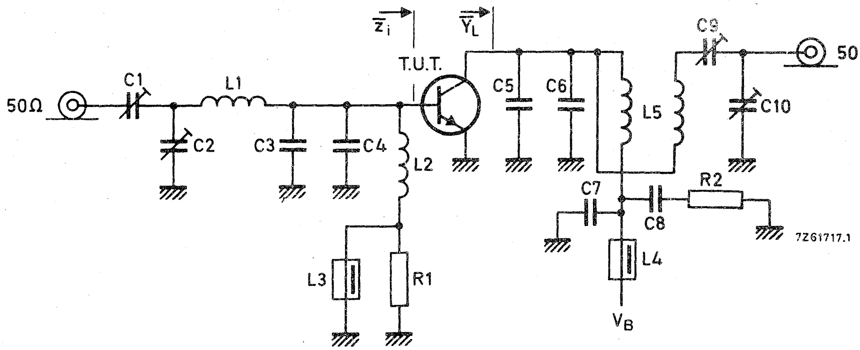
APPLICATION INFORMATION

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

f = 175 MHz; T_h up to 25 °C; $R_{th\ mb\text{-}h} \leq 0,3$ °C/W.

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	< 12, 7	45	< 4, 8	> 5, 5	> 75	1, 1 + j1, 4	310 + j95

Test circuit for 175 MHz:



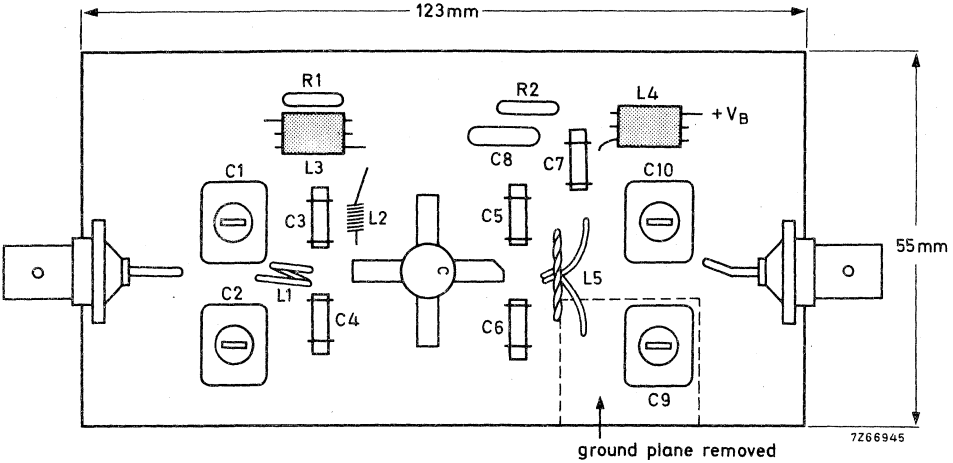
C1 = 2 to 20 pF film dielectric trimmer
C2 = 4 to 40 pF film dielectric trimmer
C3 = C4 = C5 = C6 = 56 pF ceramic capacitor
C7 = 100 pF ceramic capacitor
C8 = 100 nF polyester capacitor
C9 = 4 to 80 pF film dielectric trimmer
C10 = 4 to 60 pF film dielectric trimmer

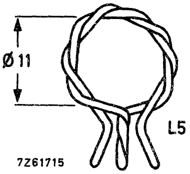
L1 = 1, 5 turns enamelled Cu wire (1, 5 mm); int. diam. 6 mm; length 4 mm; leads 2 x 5 mm
L2 = 7 turns closely wound enamelled Cu wire (0, 5 mm); int. diam. 3 mm; leads 2 x 5 mm
L3 = L4 = ferroxcube choke (code number 4312 020 36640)
L5 = bifilar wound enamelled Cu wire (1, 0 mm); see figure on page 6

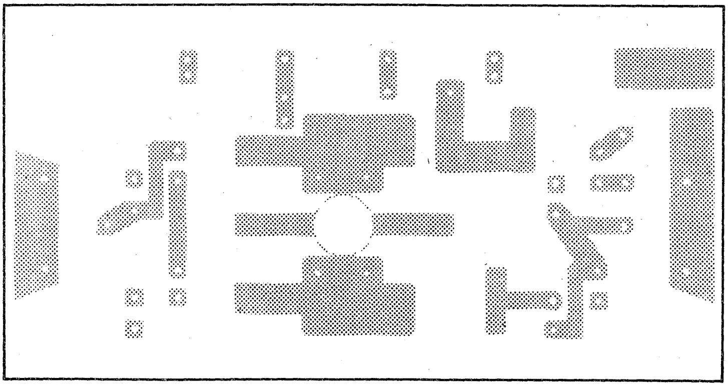
R1 = 10 Ω carbon resistor
R2 = 4, 7 Ω carbon resistor

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

APPLICATION INFORMATION (continued)

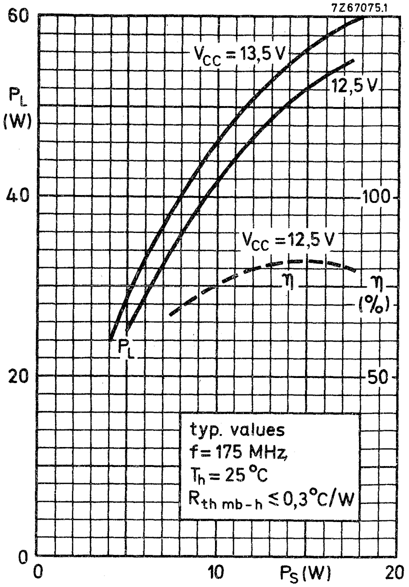




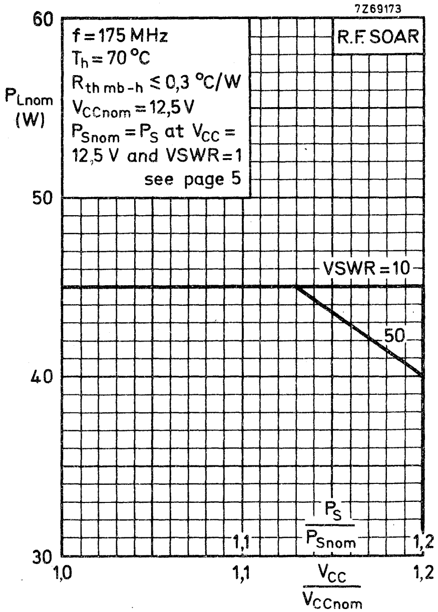


7Z66943

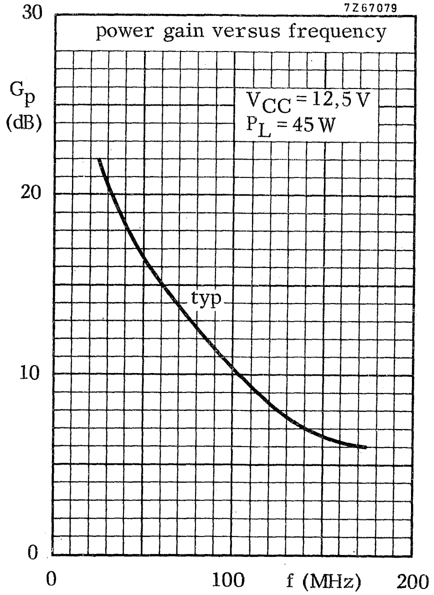
The circuit and the components are situated on one side of the epoxy fibre-glass board, the other side being fully metallized to serve as earth. Earth connections are made by means of hollow rivets.

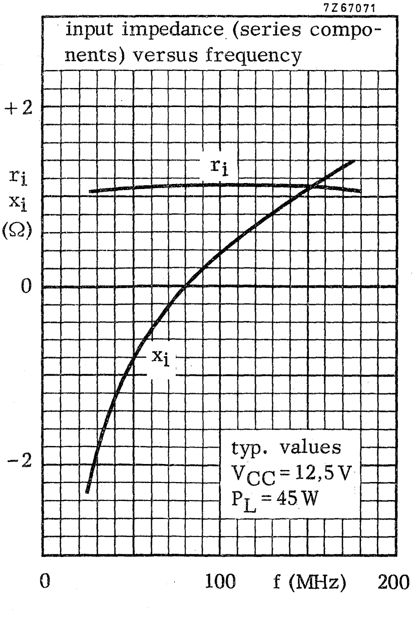


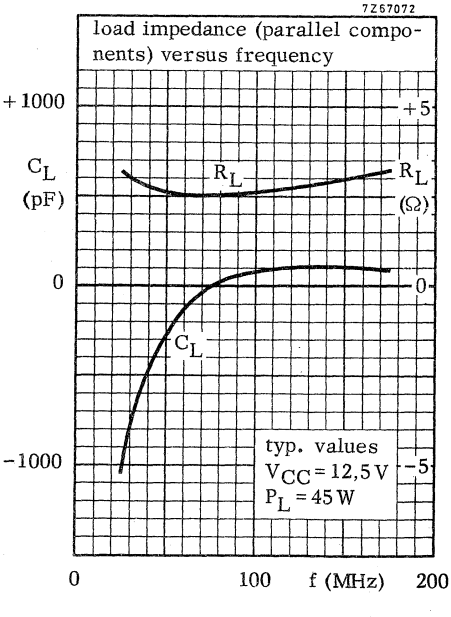
At P_L = 45 W and V_{CC} = 12,5 V, the output power at heatsink temperatures between 25 °C and 70 °C relative to that at 25 °C is diminished by 60 mW/°C.



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 voltages other than nominal.
The graph shows the allowable output power under nominal conditions as a function of the supply overvoltage ratio with VSWR 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}).


7Z67079
power gain versus frequency
30
20
10
0
Gp
(dB)
VCC = 12,5 V
PL = 45 W
typ
0
100
f (MHz)
200


7Z67071
input impedance (series components) versus frequency
+2
0
−2
ri
xi
(Ω)
ri
xi
typ. values
VCC = 12,5 V
PL = 45 W
0
100
f (MHz)
200


7Z67072
load impedance (parallel components) versus frequency
+1000
0
−1000
CL
(pF)
RL
CL
+5
0
−5
RL
(Ω)
typ. values
VCC = 12,5 V
PL = 45 W
0
100
f (MHz)
200

APPLICATION INFORMATION (continued)

R.F. performance in S.S.B. operation

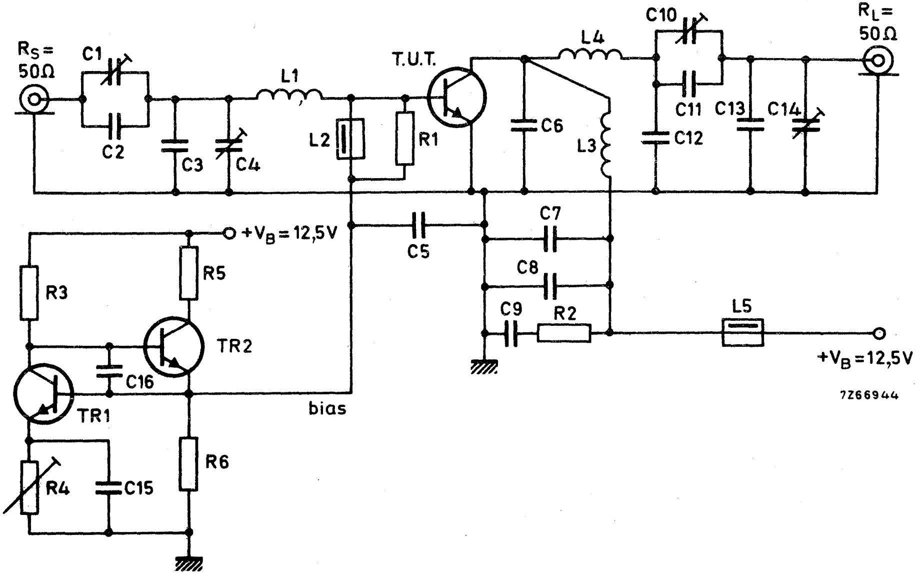
V_{CC} = 12,5 V; T_h up to 25 °C; $R_{th\ mb\text{-}h} \leq 0,3$ °C/W.

f1 = 28,000 MHz; f2 = 28,001 MHz.

Output power (W)	G_p (dB)	η_{dt} (%)	d_3 (dB) 1)	d_5 (dB) 1)	$I_{C(ZS)}$ (mA)	Class
3 to 30 (PEP)	typ. 19,5	typ. 35	typ. −33	typ. −36	25	AB

Test circuit:

S.S.B.
class AB



List of components: see page 10.

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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.

APPLICATION INFORMATION (continued)

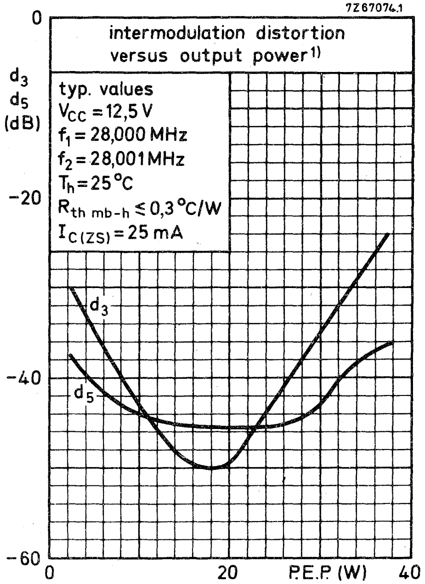
List of components:

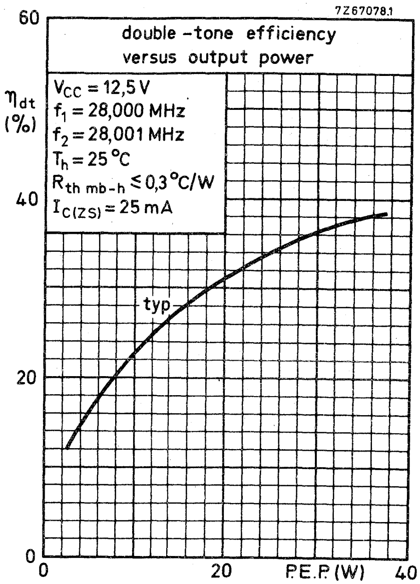
Tr1 = Tr2 = BD137

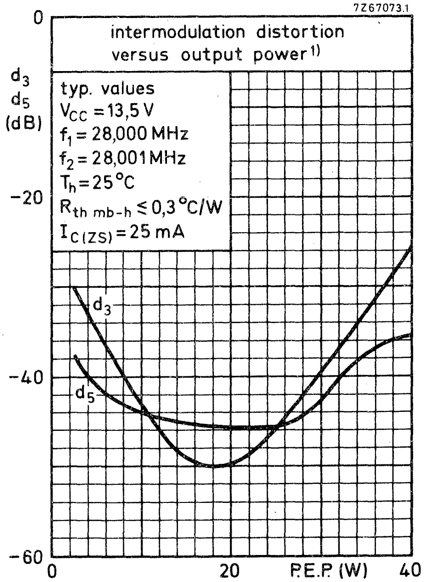
C1 = 100 pF air dielectric capacitor (single insulated rotor)
C2 = 27 pF ceramic capacitor
C3 = 180 pF ceramic capacitor
C4 = 100 pF air dielectric capacitor (single non-insulated rotor)
C5 = C7 = 3,9 nF polyester capacitor (±10%)
C6 = 2 x 270 pF polystyrene capacitors in parallel
C8 = C15 = C16 = 100 nF polyester capacitor (±10%)
C9 = 2,2 µF moulded metallized polyester capacitor
C10 = 2 x 385 pF film dielectric trimmers in parallel
C11 = 68 pF ceramic capacitor
C12 = 2 x 82 pF ceramic capacitors in parallel
C13 = 47 pF ceramic capacitor
C14 = 385 pF film dielectric trimmer

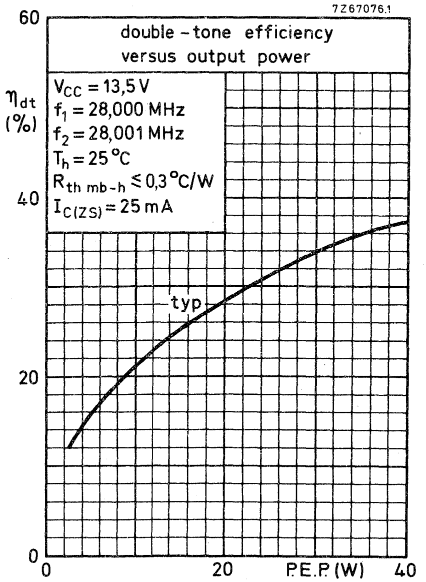
L1 = 88 nH; 3 turns Cu wire (1,0 mm); internal diameter 9 mm; coil length 6,1 mm; leads 2 x 5 mm
L2 = L5 = ferroxcube bead, grade 3B (code number 4312 020 36640)
L3 = 68 nH; 3 turns enamelled Cu wire (1,6 mm); internal diameter 8 mm; coil length 8,3 mm; leads 2 x 5 mm
L4 = 96 nH; 3 turns enamelled Cu wire (1,6 mm); internal diameter 10 mm; coil length 7,6 mm; leads 2 x 5 mm

R1 = 27 Ω carbon resistor (±5%)
R2 = 4,7 Ω carbon resistor (±5%)
R3 = 1,5 kΩ carbon resistor (±5%)
R4 = 10 Ω wire-wound potentiometer (3 W)
R5 = 47 Ω wire-wound resistor (5,5 W)
R6 = 150 Ω carbon resistor (±5%)









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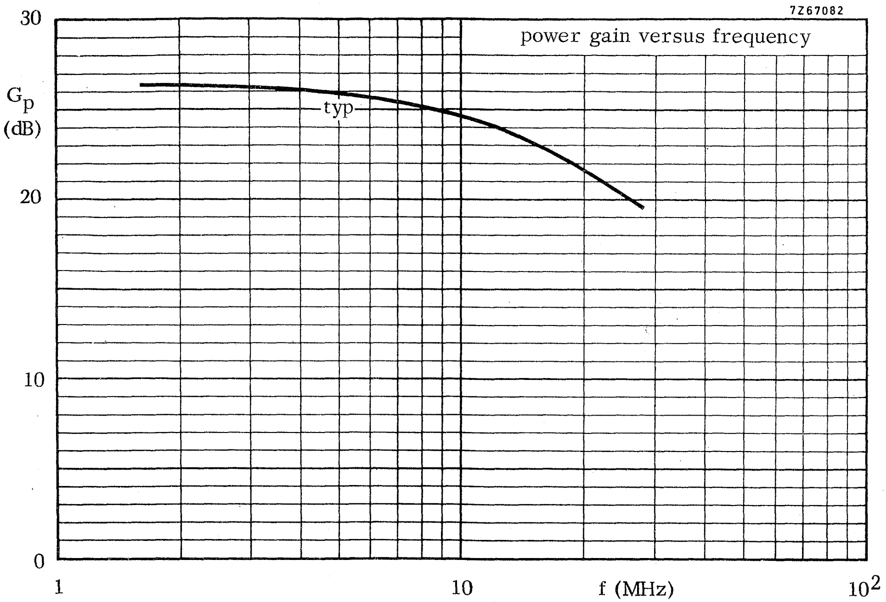
1) Stated intermodulation distortion figures are referred to the according level of either of the equal amplified tones. Relative to the according peak envelope powers these figures should be increased by 6 dB.

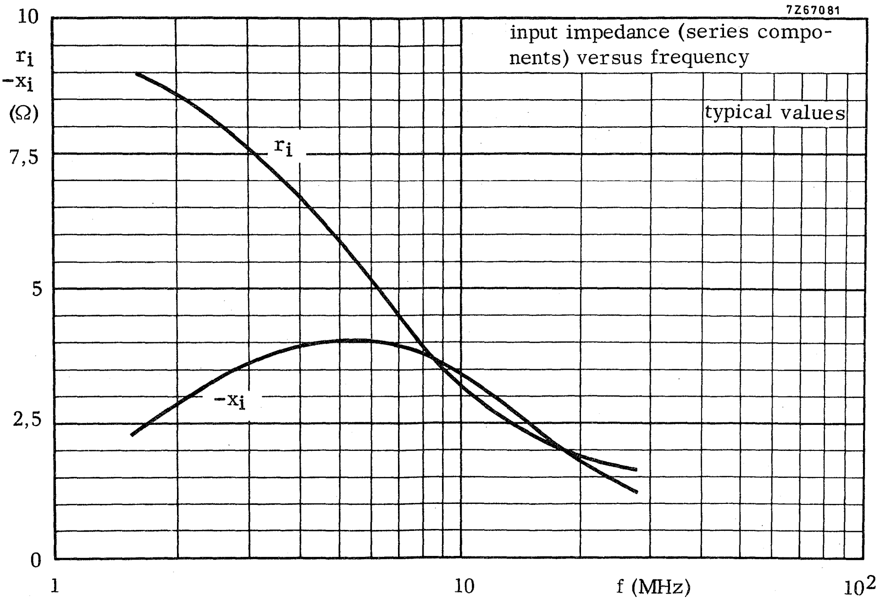


S.S.B. class AB operation

Conditions:

P_L	= 30 W (PEP)	P_L	= 35 W (PEP)
V_{CC}	= 12,5 V	V_{CC}	= 13,5 V
$I_{C(ZS)}$	= 25 mA	$I_{C(ZS)}$	= 25 mA
T_h	= 25 ^oC	T_h	= 25 ^oC
$R_{th\ mb-h}$	≤ 0,3 $^oC/W$	$R_{th\ mb-h}$	≤ 0,3 $^oC/W$
Z_L	= 1,9 Ω	Z_L	= 1,9 Ω

The curve (both conditions) holds for an unneutralized amplifier.



S.S.B. class AB operation

Conditions:

P_L	= 30 W (PEP)	P_L	= 35 W (PEP)
V_{CC}	= 12,5 V	V_{CC}	= 13,5 V
$I_{C(ZS)}$	= 25 mA	$I_{C(ZS)}$	= 25 mA
T_h	= 25 °C	T_h	= 25 °C
$R_{th\ mb-h}$	≤ 0,3 °C/W	$R_{th\ mb-h}$	≤ 0,3 °C/W
Z_L	= 1,9 Ω	Z_L	= 1,9 Ω

The curve (both conditions) holds for an unneutralized amplifier.

T.V. TRANSPOSER TRANSISTOR FOR BAND III

N-P-N silicon planar epitaxial transistor assembled in a plastic encapsulated stripline package all leads of which are isolated from the stud. Excellent d.c. dissipation properties have been obtained by means of internal emitter ballasting resistors and gold metallization. Detailed information is presented for application of this device in preamplifiers for television transposers and transmitters in band III

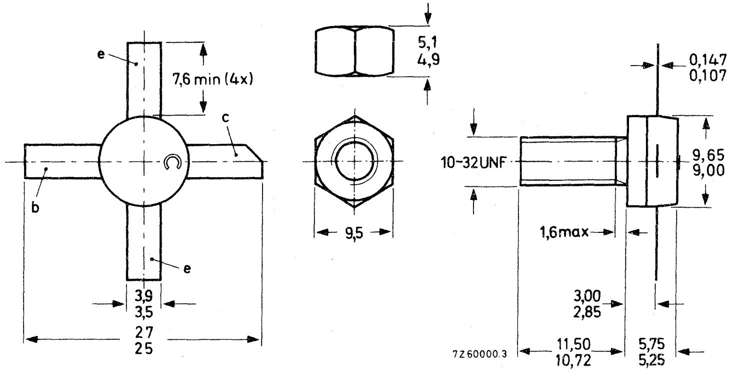
QUICK REFERENCE DATA

Collector-base voltage (open emitter; peak value)	V_{CBOM}	max.	60	V
Collector-emitter voltage (open base)	V_{CEO}	max.	32	V
Collector current (average)	$I_{C(AV)}$	max.	3	A
D.C. power dissipation up to T_h = 70 °C	P_{tot}	max.	40	W
Thermal resistance from junction to mounting base	$R_{th\ j\text{-}mb}$	=	3,0	°C/W
Transition frequency				
I_C = 4,0 A; V_{CE} = 25 V	f_T	typ.	900	MHz
Output power at f_{vision} = 224,25 MHz *)				
I_C = 1,6 A; V_{CE} = 25 V; T_h = 70 °C; d_{im} = −55 dB	$P_{o\ sync}$	>	10,0	W
I_C = 1,6 A; V_{CE} = 25 V; T_h = 70 °C; d_{im} = −52 dB	$P_{o\ sync}$	typ.	13,5	W
Power gain at f_{vision} = 224,25 MHz				
I_C = 1,6 A; V_{CE} = 25 V; T_h = 70 °C	G_p	>	9,5	dB

*) Three tone test method (vision carrier −8 dB, sound carrier −7 dB, side band signal −16 dB), zero dB corresponds to peak sync level.

MECHANICAL DATA Dimensions in mm

SOT-56



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

Torque on nut: min. 1,5 Nm
(15 kg cm)
max. 1,7 Nm
(17 kg cm)

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

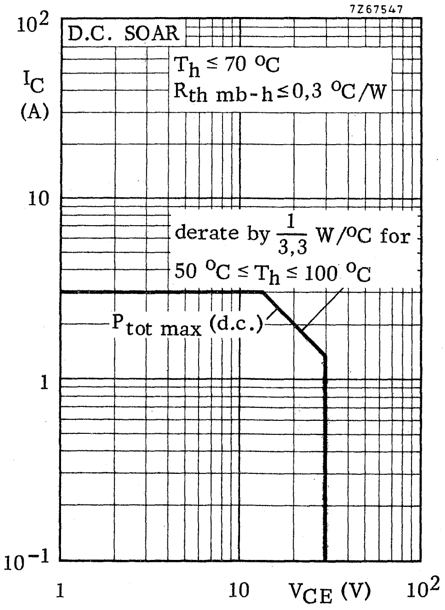
Collector-base voltage (open emitter) peak value	V_{CBOM}	max.	60	V
Collector-emitter voltage (R_{BE} = 10 Ω) peak value	V_{CERM}	max.	60	V
Collector-emitter voltage (open base)	V_{CEO}	max.	32	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4	V

Currents

Collector current (average)	$I_{C(AV)}$	max.	3,0	A
Collector current (peak value) f > 1 MHz	I_{CM}	max.	9,0	A

Power dissipation

D.C. power dissipation up to T_h = 70 °C	P_{tot}	max.	40	W



Temperatures

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

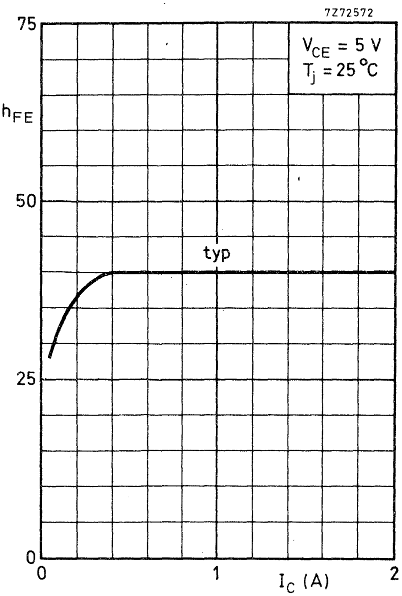
THERMAL RESISTANCE

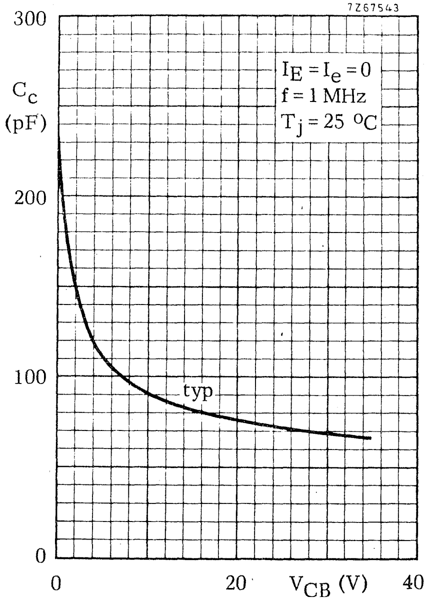
From junction to mounting base	$R_{th\ j-mb}$	=	3,0	°C/W
From mounting base to heatsink	$R_{th\ mb-h}$	=	0,3	°C/W

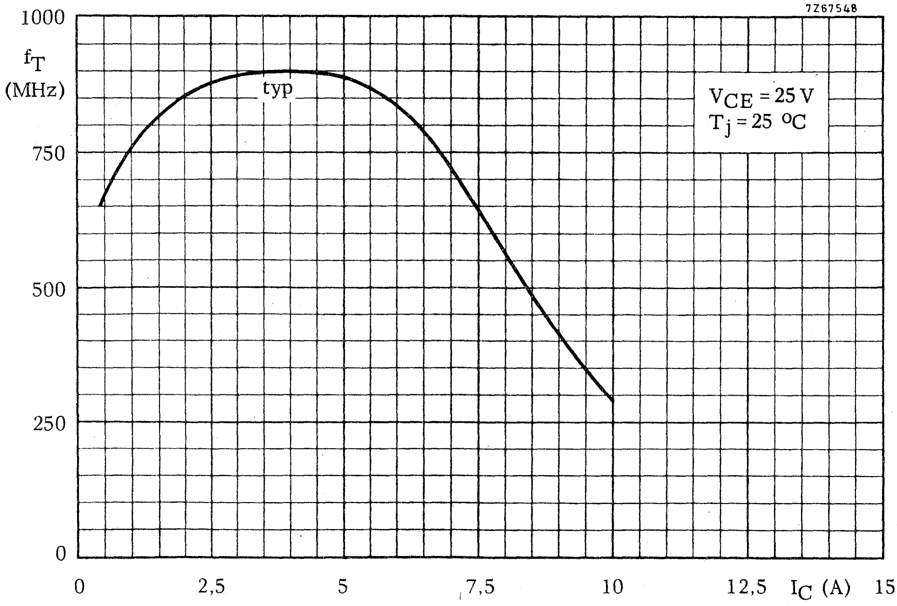
CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Breakdown voltages				
Collector-base voltage open emitter, I_C = 50 mA	$V_{(BR)CBO}$	>	60	V
Collector-emitter voltage R_{BE} = 10 Ω, I_C = 50 mA	$V_{(BR)CER}$	>	60	V
Collector-emitter voltage open base, I_C = 50 mA	$V_{(BR)CEO}$	>	32	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	>	4,5	mWs
$-V_{BE}$ = 1,5 V; R_{BE} = 33 Ω	E	>	4,5	mWs
D.C. current gain				
I_C = 1,0 A; V_{CE} = 5 V	h_{FE}	> typ.	25 40	
Transition frequency				
I_C = 4 A; V_{CE} = 25 V	f_T	typ.	900	MHz
Collector capacitance at f = 1 MHz				
I_E = I_e = 0; V_{CB} = 30 V	C_c	typ. <	68 80	pF pF
Feedback capacitance at f = 1 MHz				
I_C = 200 mA; V_{CE} = 30 V	C_{re}	typ.	39	pF
Collector-stud capacitance	C_{cs}	typ.	2	pF


7Z72572
75
50
25
0
h_{FE}
V_{CE} = 5 V
T_j = 25 °C
typ
0
1
2
I_C (A)


7Z67543
300
200
100
0
C_c
(pF)
$I_E = I_e = 0$
f = 1 MHz
T_j = 25 °C
typ
0
20
V_{CB} (V)
40

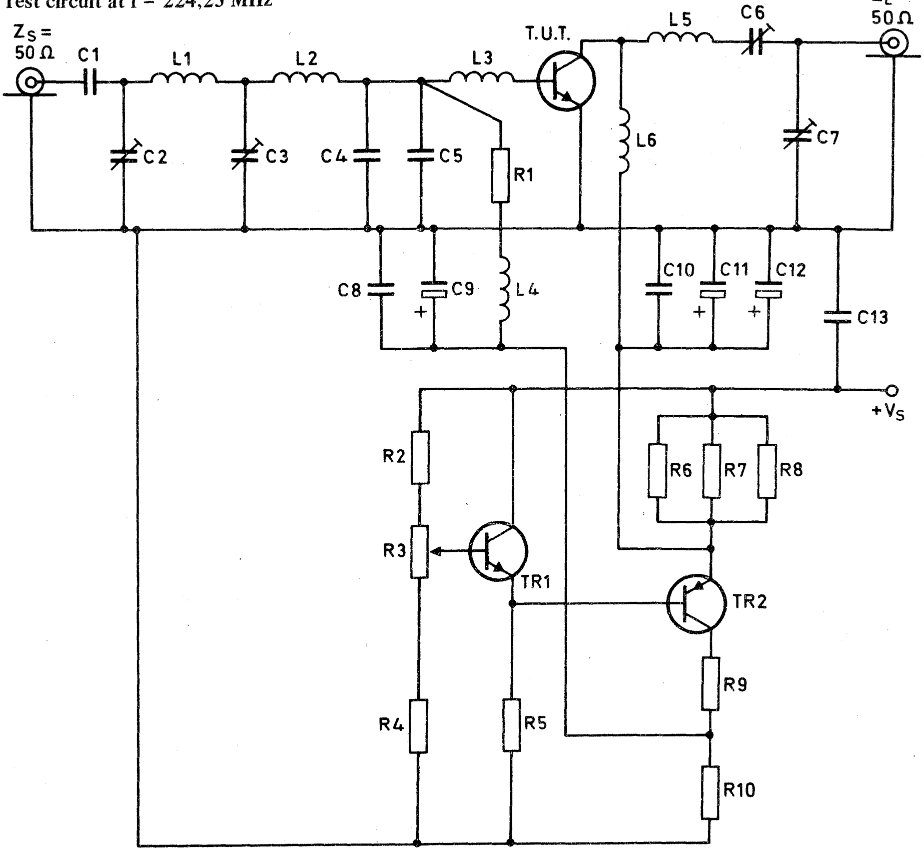

7Z67548
1000
750
500
250
0
f_T
(MHz)
typ
V_{CE} = 25 V
T_j = 25 °C
0
2,5
5
7,5
10
12,5
I_C (A)
15

APPLICATION INFORMATION

d_{im} *) (dB)	f_{vision} (MHz)	V_{CE} (V)	I_C (A)	G_p (dB)	$P_{o\ sync}$ *) (W)	T_h (^oC)	$R_{th\ mb-h}$ ($^oC/W$)
−55	224, 25	25	1, 6	> 9, 5	> 10, 0	70	≤ 0, 3
−52	224, 25	25	1, 6	> 9, 5	typ. 13, 5	70	≤ 0, 3

*) Three-tone test method (vision carrier −8 dB, sound carrier −7 dB, side band signal −16 dB), zero dB corresponds to peak sync level.

Test circuit at f = 224,25 MHz



List of components: see page 6.

Component lay-out and printed circuit board for f = 224, 25 MHz test circuit on page 7.

APPLICATION INFORMATION (continued)

List of components:

Tr 1 = BD135
Tr 2 = BD136

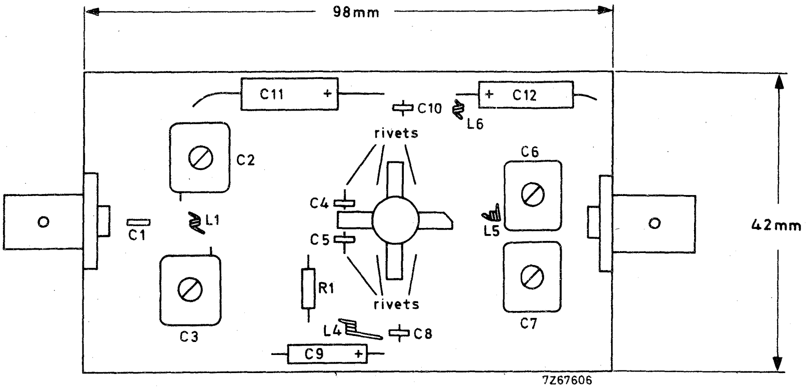
C1 = 330 pF chip capacitor
C2 = 4 to 40 pF film dielectric trimmer
C3 = 4 to 60 pF film dielectric trimmer
C4 = C5 = 82 pF chip capacitor, placed 5 mm from transistor edge
C6 = 4 to 100 pF film dielectric trimmer
C7 = 4 to 60 pF film dielectric trimmer
C8 = C10 = 820 pF chip capacitor
C9 = 47 μF electrolytic capacitor 6, 3 V
C11 = 22 μF electrolytic capacitor 40 V
C12 = 47 μF electrolytic capacitor 40 V
C13 = 100 nF polyester capacitor

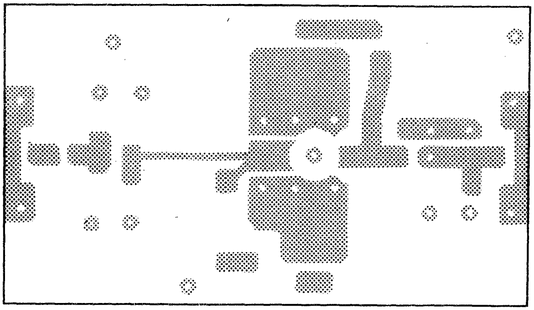
L1 = 24, 7 nH; 1, 5 turns closely wound enamelled Cu wire (0, 7 mm); int. diam. 4, 5 mm; leads 2 x 5 mm.
L2 = 8, 3 nH formed by metallization on printed board.
L3 = formed by metallization on printed board.
L4 = 100 nH; 3, 5 turns closely wound enamelled Cu wire (0, 7 mm); int. diam. 5, 5 mm; leads 2 x 5 mm.
L5 = 22 nH; 1, 5 turns closely wound enamelled Cu wire (1, 6 mm); int. diam. 4, 5 mm; leads 2 x 8 mm.
L6 = 36 nH; 1, 5 turns closely wound enamelled Cu wire (1, 6 mm); int. diam. 4, 0 mm; leads 2 x 10 mm.

R1 = 4, 7 Ω carbon resistor
R2 = 330 Ω
R3 = 470 Ω potentiometer
R4 = 4, 7 kΩ
R5 = 2, 7 kΩ
R6 = R7 = R8 = 4, 7 Ω (5, 5 W)
R9 = 180 Ω (5, 5 W)
R10 = 68 Ω

APPLICATION INFORMATION (continued)

Component lay-out and printed circuit board for f = 224,25 MHz test circuit.

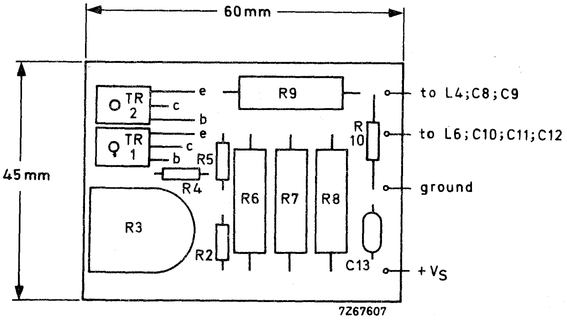


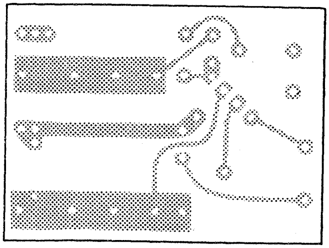


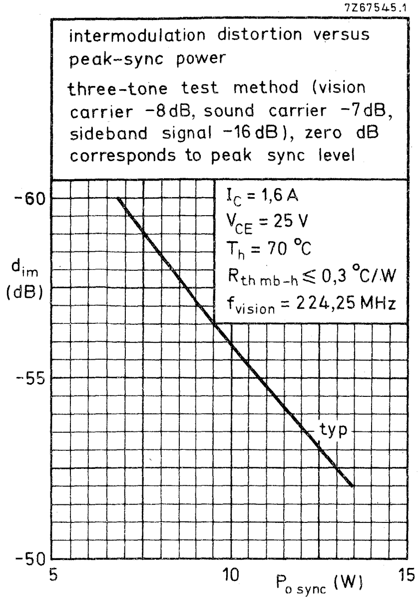
Thickness: 1, 6 mm

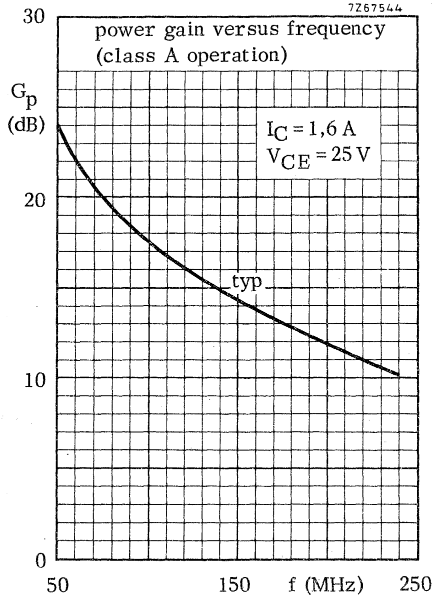
The circuit and the components are situated on one side of the epoxy fibre-glass board, the other side being fully metallized to serve as earth. Earth connections are made by means of hollow rivets.

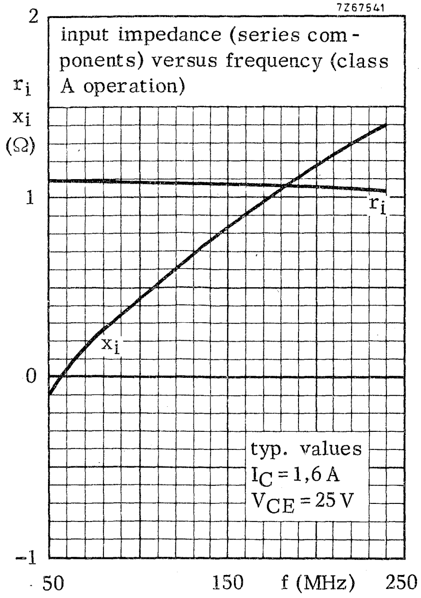
Component lay-out and printed circuit board for bias circuit.

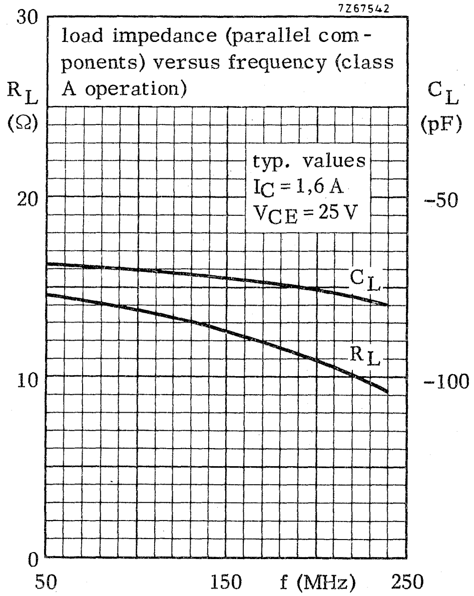





7Z67545.1
intermodulation distortion versus peak-sync power
three-tone test method (vision carrier −8 dB, sound carrier −7 dB, sideband signal −16 dB), zero dB corresponds to peak sync level
I_C = 1,6 A
V_{CE} = 25 V
T_h = 70 °C
$R_{th\ mb-h} \leq$ 0,3 °C/W
f_{vision} = 224,25 MHz
d_{im} (dB)
-60
-55
-50
typ
5
10
15
$P_{o\ sync}$ (W)


7Z67544
power gain versus frequency (class A operation)
G_p (dB)
30
20
10
0
I_C = 1,6 A
V_{CE} = 25 V
typ
50
150
f (MHz)
250


7Z67541
input impedance (series components) versus frequency (class A operation)
r_i
x_i
(Ω)
2
1
0
−1
r_i
x_i
typ. values
I_C = 1,6 A
V_{CE} = 25 V
50
150
f (MHz)
250


7Z67542
load impedance (parallel components) versus frequency (class A operation)
R_L (Ω)
C_L (pF)
30
20
10
0
−50
−100
typ. values
I_C = 1,6 A
V_{CE} = 25 V
C_L
R_L
50
150
f (MHz)
250

TV TRANSPOSER TRANSISTOR FOR BAND III

N-P-N silicon planar epitaxial transistor assembled in a stripline package with a ceramic cap. All leads are isolated from the stud. Excellent d.c. dissipation properties have been obtained by means of internal emitter-ballasting resistors and gold metallization. Detailed information is presented for application of this device in preamplifiers for television transposers and transmitters in band III.

QUICK REFERENCE DATA

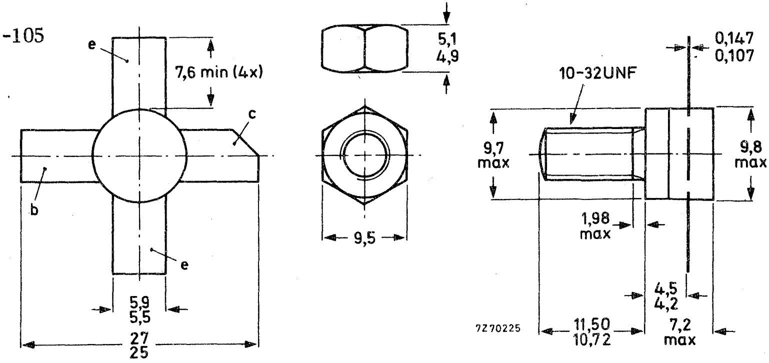
Collector-base voltage (open emitter; peak value)	V_{CBOM}	max.	60	V
Collector-emitter voltage (open base)	V_{CEO}	max.	32	V
Collector current (average)	$I_{C(AV)}$	max.	4	A
D.C. power dissipation at T_h = 70 °C	P_{tot}	max.	60	W
Thermal resistance from junction to mounting base	$R_{th\ j\text{-}mb}$	=	1,9	°C/W
Transition frequency				
I_C = 6,0 A; V_{CE} = 25 V	f_T	typ.	800	MHz
Output power at f vision = 224, 25 MHz *)				
I_C = 2,4 A; V_{CE} = 25 V; T_h = 70 °C; d_{im} = −55 dB	$P_{o\ sync}$	>	14,0	W
I_C = 2,4 A; V_{CE} = 25 V; T_h = 70 °C; d_{im} = −52 dB	$P_{o\ sync}$	typ.	19,5	W
Power gain at f vision = 224, 25 MHz				
I_C = 2,4 A; V_{CE} = 25 V; T_h = 70 °C	G_p	>	8,0	dB

*) Three-tone test method (vision carrier −8 dB, sound carrier −7 dB, sideband signal −16 dB), zero dB corresponds to peak sync level.

MECHANICAL DATA

Dimensions in mm

SOT-105



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

Torque on nut: min. 1,5 Nm
(15 kg cm)
max. 1,7 Nm
(17 kg cm)

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

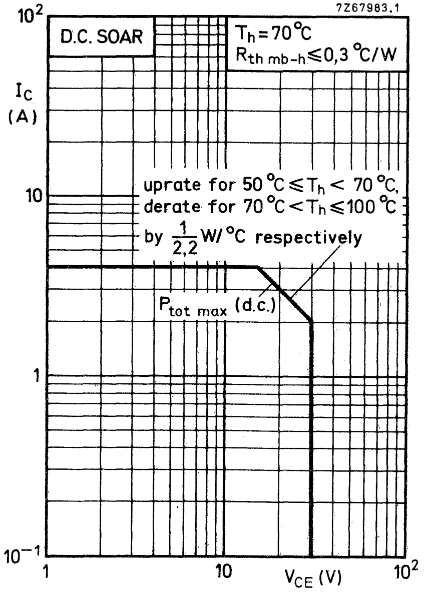
Collector-base voltage (open emitter) peak value	V_{CBOM}	max.	60	V
Collector-emitter voltage (R_{BE} = 10 Ω) peak value	V_{CERM}	max.	60	V
Collector-emitter voltage (open base)	V_{CEO}	max.	32	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4	V

Currents

Collector current (average)	$I_{C(AV)}$	max.	4,0	A
Collector current (peak value) f > 1 MHz	I_{CM}	max.	12,0	A

Power dissipation

D.C. power dissipation at T_h = 70 °C	P_{tot}	max.	60	W



uprate for 50 °C ≤ T_h < 70 °C, derate for 70 °C < T_h ≤ 100 °C by $\frac{1}{2{,}2}$ W/°C respectively

Temperatures

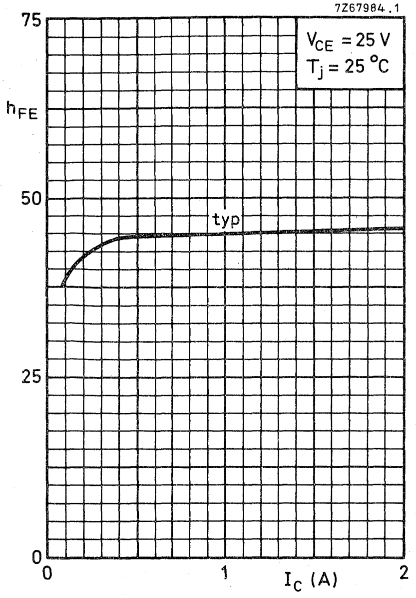
Storage temperature	T_{stg}	−65 to +125		°C
Operating junction temperature	T_j	max.	200	°C

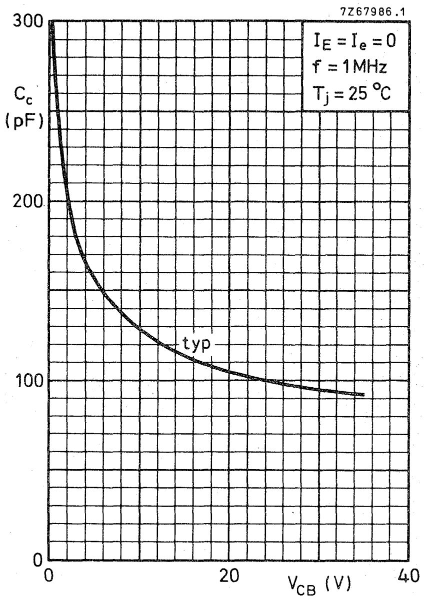
THERMAL RESISTANCE

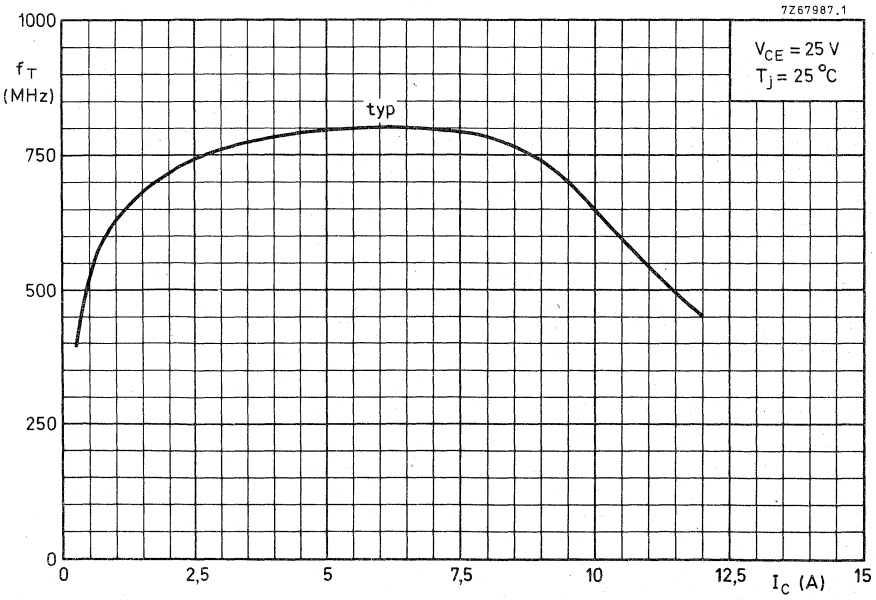
From junction to mounting base	$R_{th\ j-mb}$	=	1,9	°C/W
From mounting base to heatsink	$R_{th\ mb-h}$	=	0,3	°C/W

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

Breakdown voltages				
Collector-base voltage open emitter, $I_C = 50$ mA	$V_{(BR)CBO}$	>	60	V
Collector-emitter voltage $R_{BE} = 10\ \Omega$, $I_C = 50$ mA	$V_{(BR)CER}$	>	60	V
Collector-emitter voltage open base, $I_C = 50$ mA	$V_{(BR)CEO}$	>	32	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	>	8,0	mWs
$-V_{BE} = 1,5$ V; $R_{BE} = 33\ \Omega$	E	>	8,0	mWs
D.C. current gain				
$I_C = 2,0$ A; $V_{CE} = 25$ V	h_{FE}	> typ.	20 45	
Transition frequency				
$I_C = 6,0$ A; $V_{CE} = 25$ V	f_T	typ.	800	MHz
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; $V_{CB} = 30$ V	C_c	typ. <	95 120	pF pF
Feedback capacitance at f = 1 MHz				
$I_C = 0,2$ A; $V_{CE} = 30$ V	C_{re}	typ.	55	pF
Collector-stud capacitance	C_{cs}	typ.	2	pF


7Z67984.1
V_{CE} = 25 V
T_j = 25 °C
h_{FE}
75
50
25
0
typ
0
1
2
I_C (A)


7Z67986.1
$I_E = I_e = 0$
f = 1 MHz
T_j = 25 °C
C_c (pF)
300
200
100
0
typ
0
20
40
V_{CB} (V)

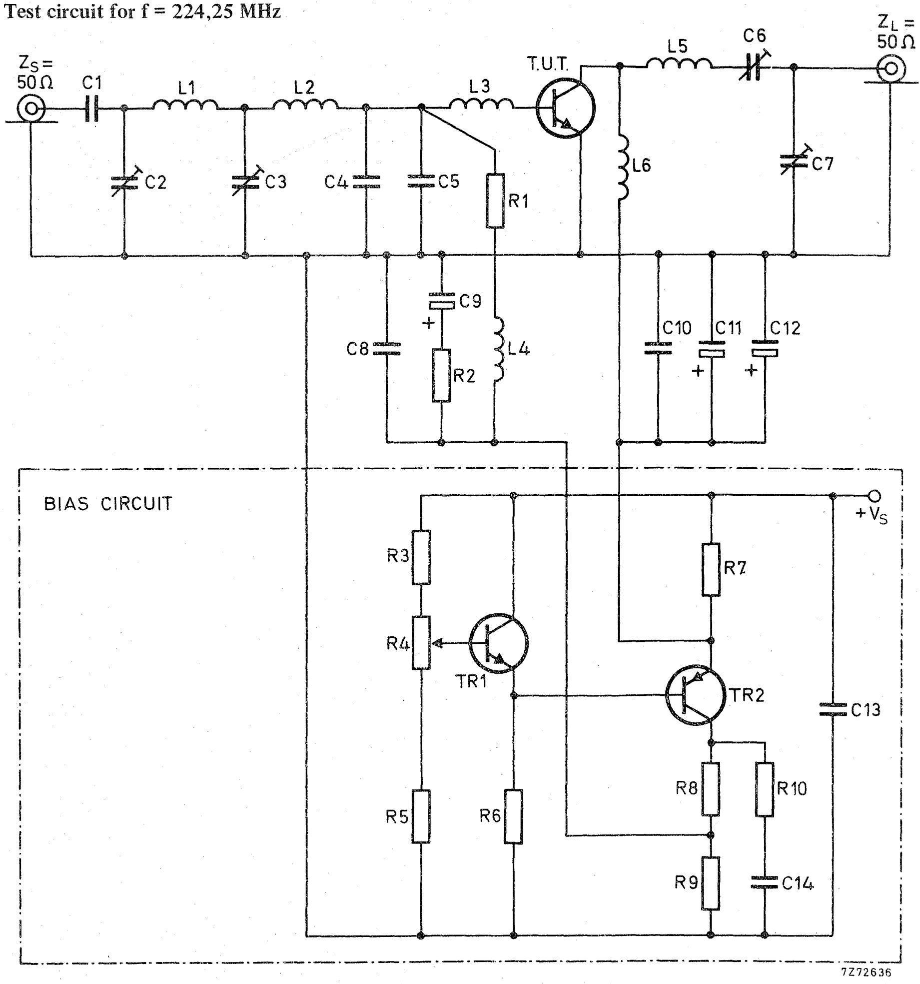

7Z67987.1
V_{CE} = 25 V
T_j = 25 °C
f_T (MHz)
1000
750
500
250
0
typ
0
2,5
5
7,5
10
12,5
15
I_C (A)

APPLICATION INFORMATION

d_{im} *) (dB)	f_{vision} (MHz)	V_{CE} (V)	I_C (A)	G_p (dB)	$P_{o\ sync}$ *) (W)	T_h (^oC)	$R_{th\ mb-h}$ ($^oC/W$)
−55	224, 25	25	2, 4	> 8, 0	> 14, 0	70	≤ 0, 3
−52	224, 25	25	2, 4	> 8, 0	typ. 19, 5	70	≤ 0, 3

*) Three-tone test method (vision carrier −8 dB, sound carrier −7 dB, sideband signal −16 dB), zero dB corresponds to peak sync level.

Test circuit for f = 224,25 MHz



List of components: see page 6.

Component layout and printed-circuit board for f = 224, 25 MHz test circuit on page 7.

APPLICATION INFORMATION (continued)

List of components:

TR1 = BD135
TR2 = BD136

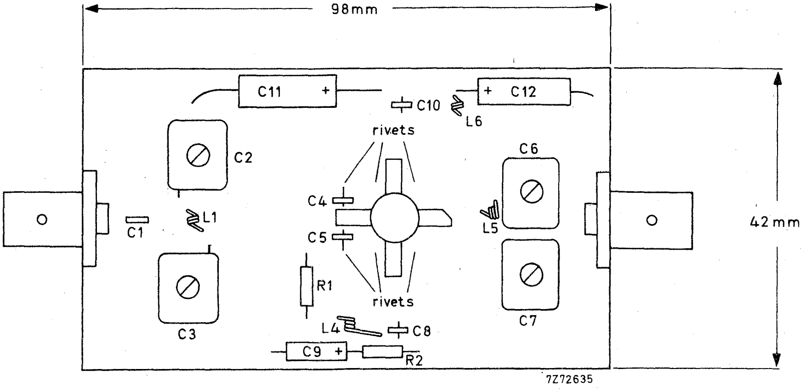
C1 = 220 pF ceramic plate capacitor
C2 = 4 to 40 pF film dielectric trimmer
C3 = 5 to 60 pF film dielectric trimmer
C4 = C5 = 82 pF chip capacitor, placed 1 mm from transistor edge
C6 = 7 to 100 pF film dielectric trimmer
C7 = 4 to 40 pF film dielectric trimmer
C8 = C10 = 820 pF chip capacitor
C9 = 220 µF electrolytic capacitor 10 V
C11 = 47 µF electrolytic capacitor 40 V
C12 = 47 µF electrolytic capacitor 40 V
C13 = 100 nF polyester capacitor
C14 = 33 nF polyester capacitor

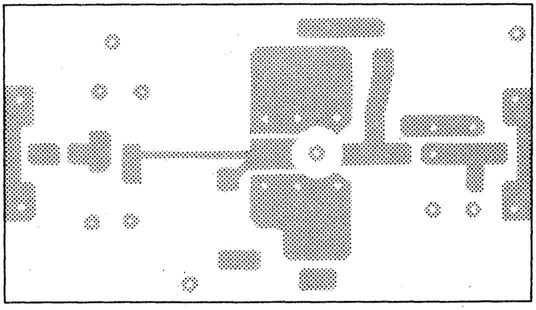
L1 = 24,7 nH; 1,5 turns closely wound enamelled Cu wire (0,7 mm); int. dia. 4,5 mm; leads 2 x 5 mm.
L2 = 8,3 nH formed by metallization on printed-circuit board
L3 = 0,7 nH formed by metallization on printed-circuit board
L4 = 100 nH; 3,5 turns closely wound enamelled Cu wire (0,7 mm); int. dia. 5,5 mm; leads 2 x 5 mm.
L5 = 15,0 nH; 1 turn enamelled Cu wire (1,6 mm); int. dia. 4,5 mm; leads 2 x 8 mm.
L6 = 26,4 nH; 1,5 turns closely wound enamelled Cu wire (1,6 mm); int. dia. 5,1 mm; leads 2 x 10 mm.

R1 = 4,7 Ω carbon resistor
R2 = 15 Ω carbon resistor
R3 = 180 Ω carbon resistor (1 W)
R4 = 470 Ω potentiometer
R5 = 4,7 kΩ carbon resistor
R6 = 2,7 kΩ carbon resistor
R7 = 4 x 4,7 Ω (2 W); in parallel
R8 = 150 Ω (5,5 W)
R9 = 68 Ω carbon resistor (1 W)
R10 = 10 Ω carbon resistor

APPLICATION INFORMATION (continued)

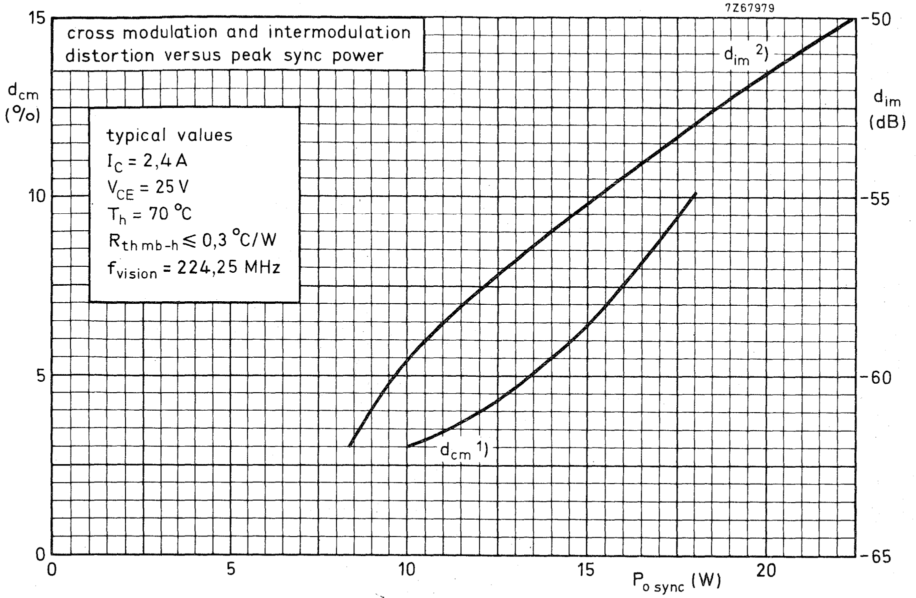
Component layout and printed-circuit board for f = 224, 25 MHz test circuit without bias circuit.





Thickness: 1, 6 mm

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.



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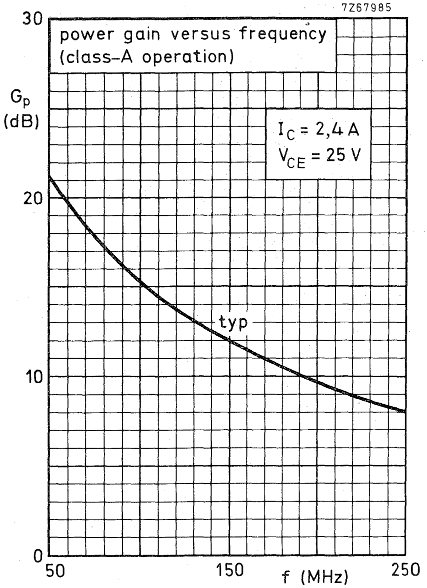
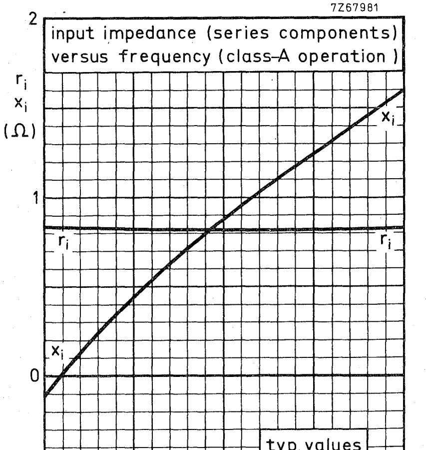
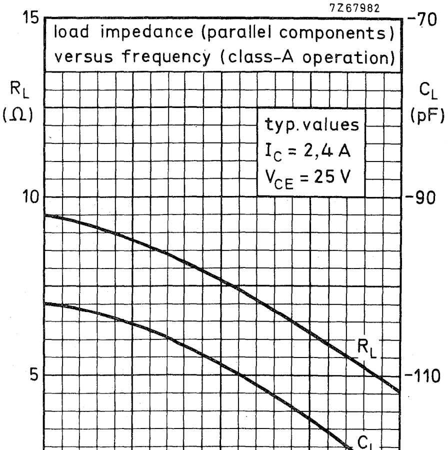
1) Two-tone test method (vision carrier 0 dB, sound carrier −7 dB), zero dB corresponds to peak sync level.

2) Three-tone test method (vision carrier −8 dB, sound carrier −7 dB, sideband signal −16 dB), zero dB corresponds to peak sync level.

In the application information a collector-emitter voltage V_{CE} = 25 V and collector current I_C = 2,4 A are recommended.
If a higher collector voltage (within the limiting values) is used, precautions must be taken to ensure that the impedance presented to the collector circuit does not vary excessively with frequency. This is especially important in wideband circuits where a relatively wide variation of load impedance over the frequency band may be expected. Tuning of the output circuit at high level should be avoided or, if essential, it should be performed very carefully, otherwise very high load impedances may occur during which the maximum ratings of the transistor can be exceeded.


7Z67985
power gain versus frequency
(class-A operation)
G_p
(dB)
I_C = 2,4 A
V_{CE} = 25 V
typ
30
20
10
0
50
150
f (MHz)
250


7Z67981
input impedance (series components)
versus frequency (class-A operation)
r_i
x_i
(Ω)
x_i
r_i
r_i
x_i
typ. values
I_C = 2,4 A
V_{CE} = 25 V
2
1
0
−1
50
150
f (MHz)
250


7Z67982
load impedance (parallel components)
versus frequency (class-A operation)
R_L
(Ω)
C_L
(pF)
typ. values
I_C = 2,4 A
V_{CE} = 25 V
R_L
C_L
15
10
5
0
−70
−90
−110
−130
50
150
f (MHz)
250

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.

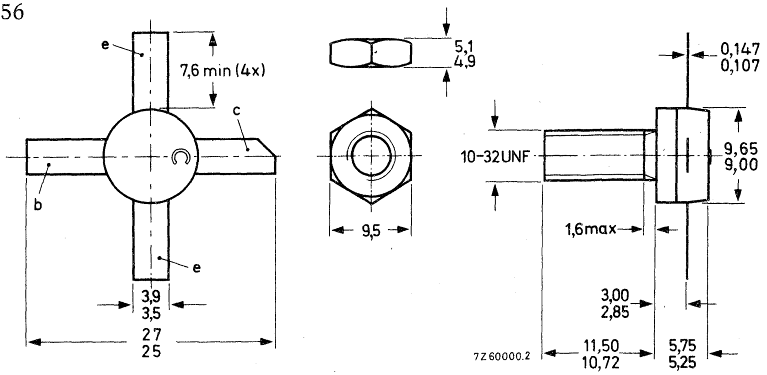
QUICK REFERENCE DATA

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

SOT-56



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

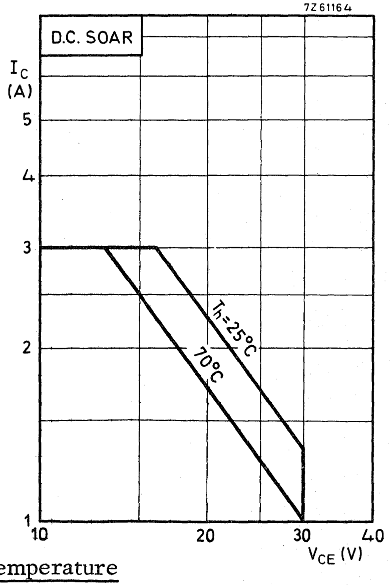
Collector-base voltage (open emitter) peak value	V_{CBOM}	max.	65	V
Collector-emitter voltage (open base)	V_{CEO}	max.	36	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4.0	V

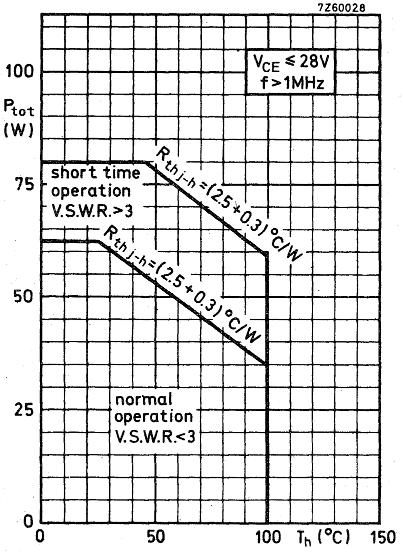
Currents

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

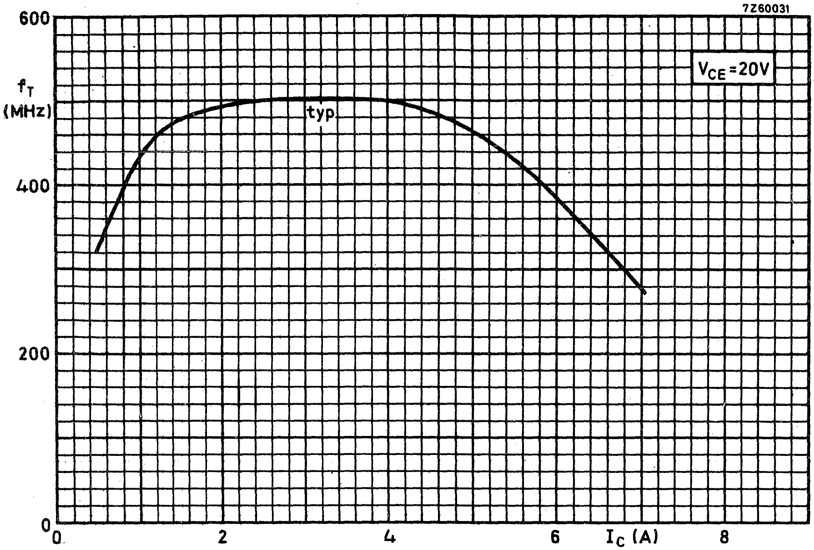
Storage temperature	T_{stg}	−30 to +200		°C
Operating junction temperature	T_j	max.	200	°C

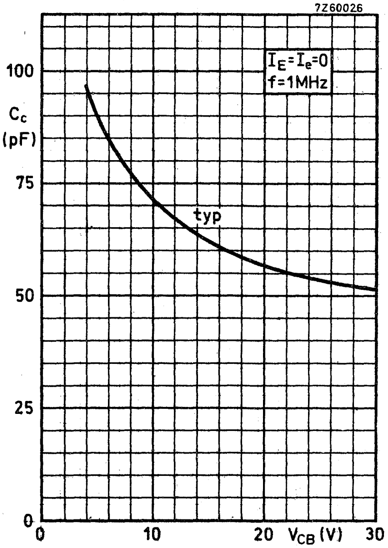
THERMAL RESISTANCE

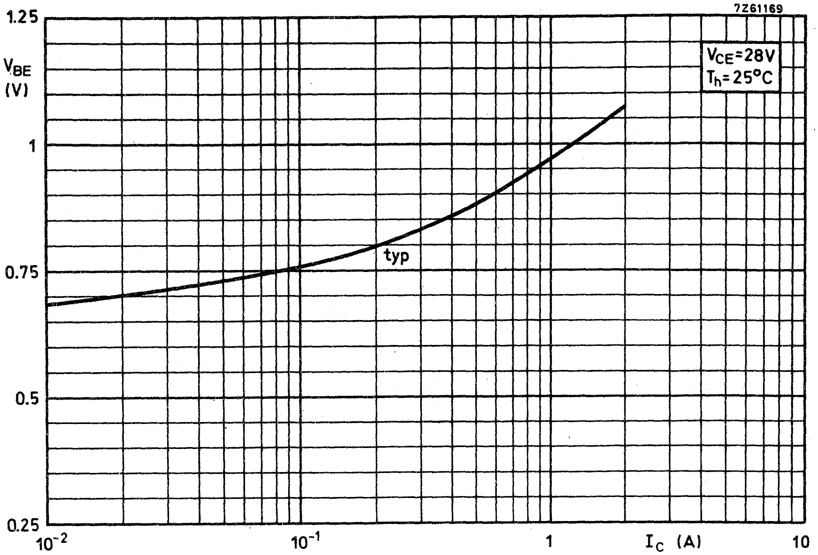
From junction to mounting base	$R_{th\,j-mb}$	=	2.5	°C/W
From mounting base to heatsink	$R_{th\,mb-h}$	=	0.3	°C/W

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	$V_{(BR)EBO}$	>	4.0	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. 10	50 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 65	pF 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
400
200
0
f_T (MHz)
V_{CE} = 20V
typ
0
2
4
6
I_C (A)
8


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


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

APPLICATION INFORMATION

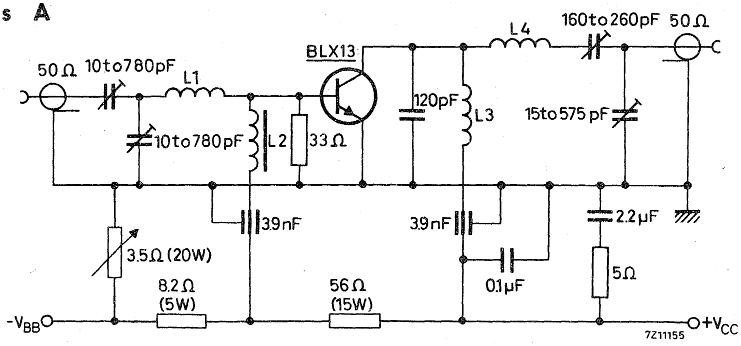
R.F. performance in S.S.B. operation (linear power amplifier)

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

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

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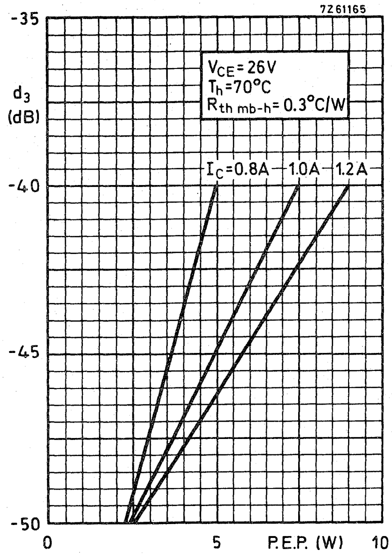
[1] Stated figures are maxima encountered at any driving level between the specified values of PEP and are referred to the according level of either of the equal ampl. tones. Relative to the according peak envelope power these figures should be increased by 6 dB.


7Z61165
-35
-40
-45
-50
d3
(dB)
VCE = 26V
Th = 70°C
Rth mb-h = 0.3°C/W
IC = 0.8A
1.0A
1.2A
0
5
10
P.E.P. (W)

APPLICATION INFORMATION

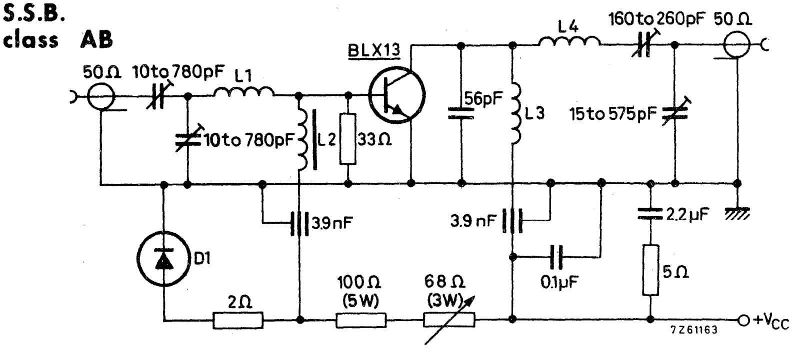
R.F. performance in S.S.B. operation (linear power amplifier)

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

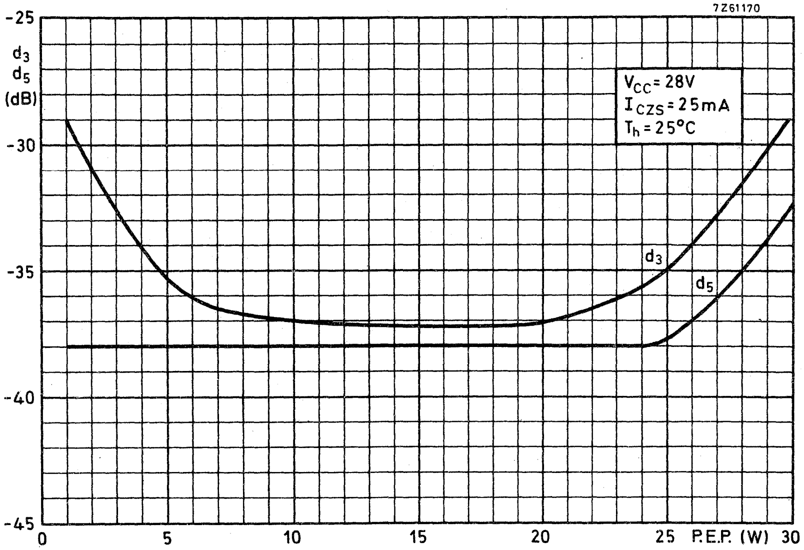
L2 = 7 turns enamelled Cu wire (0.7 mm) on 3H1 toroid; 60 μH (code number of 3H1: 4322 020 36620)

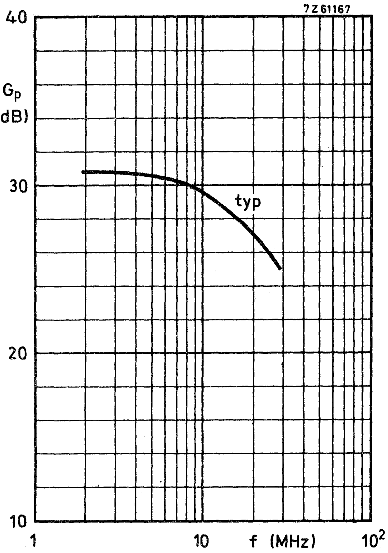
L3 = 4 turns enamelled Cu wire (1.5 mm); winding pitch 2.5 mm; int. diam. 10 mm

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:

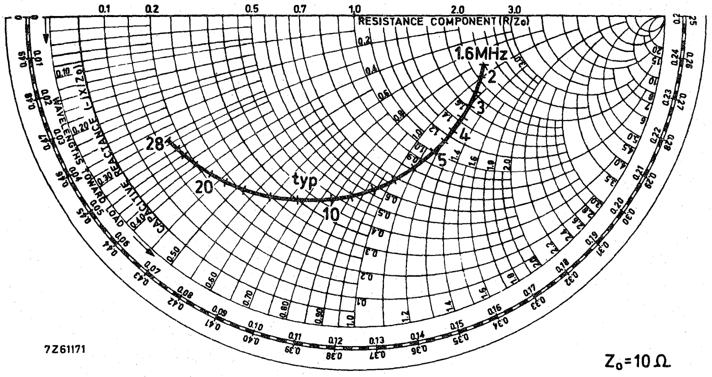
P_L = 25 W PEP

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

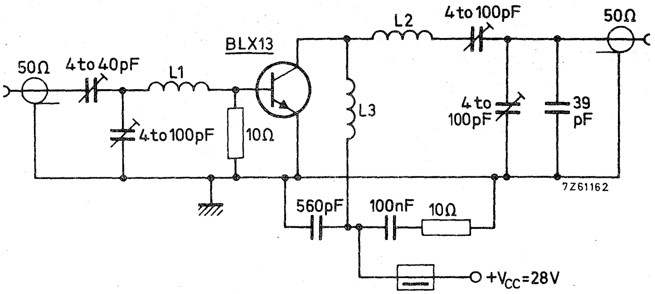
R.F. performance in c.w. operation (class B)

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 (%)	$\overline{z_i}$ (Ω)	$\overline{Y_L}$ (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

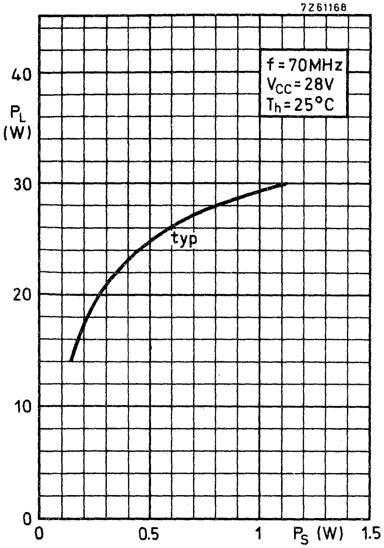


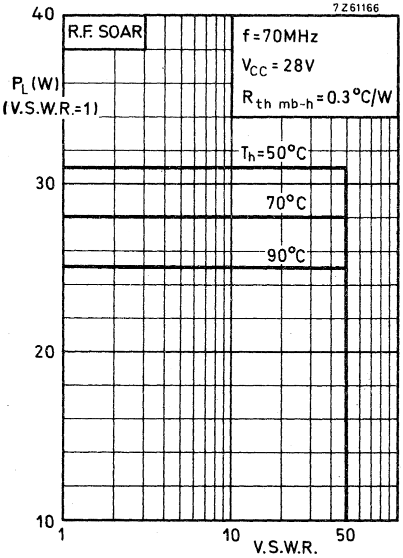
L1 = 93 nH; 3 turns enamelled Cu wire (1.5 mm); int. diam. 10 mm; length 8 mm; leads 2 x 5 mm

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

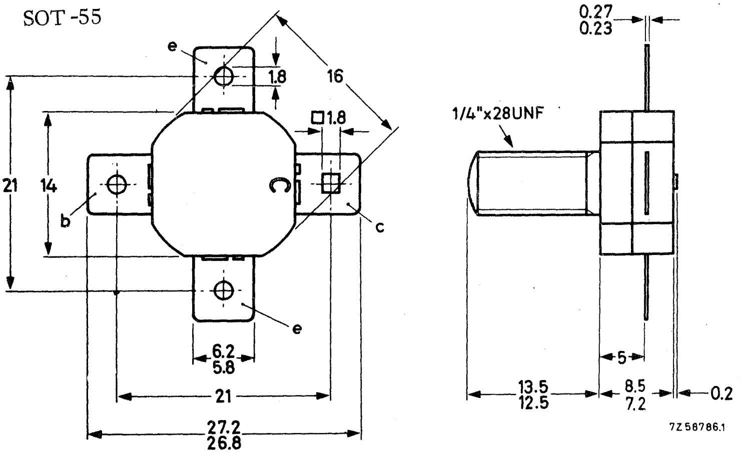
QUICK REFERENCE DATA

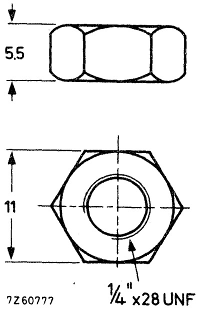
Operation	Class	V_{CC} (V)	f (MHz)	P_L (W)	Gp (dB)	d3 (dB)	$I_{C(ZS)}$ (A)
s.s.b.	A	28	1.6 to 28	15 (PEP)	> 13	typ. -40	2.0
s.s.b.	AB	28	1.6 to 28	7.5-50 (PEP)	> 13	< -30	0.1
c.w.	B	28	70	50	> 7.5		
c.w.	B	28	30	50	typ. 16		

MECHANICAL DATA

Dimensions in mm

SOT-55





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

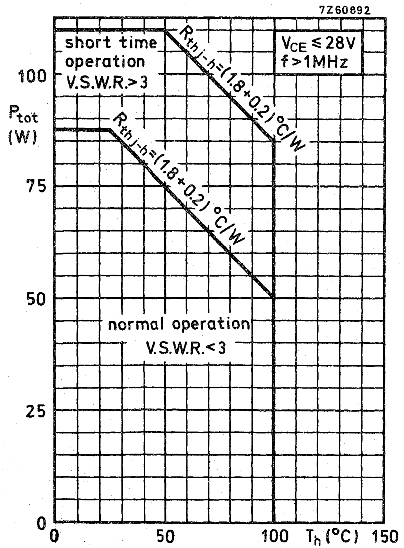
Collector-base voltage (open emitter) peak value	V_{CBOM}	max.	85	V
Collector-emitter voltage (R_{BE} = 10 Ω) peak value	V_{CERM}	max.	85	V
Collector-emitter voltage (open base)	V_{CEO}	max.	36	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4.0	V

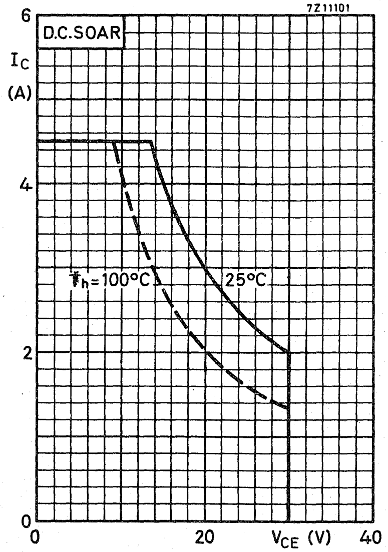
Currents

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

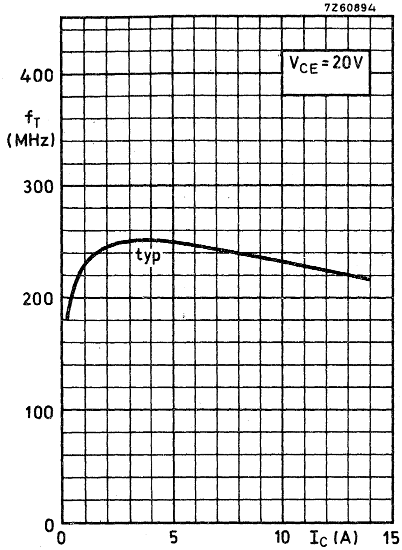
THERMAL RESISTANCE

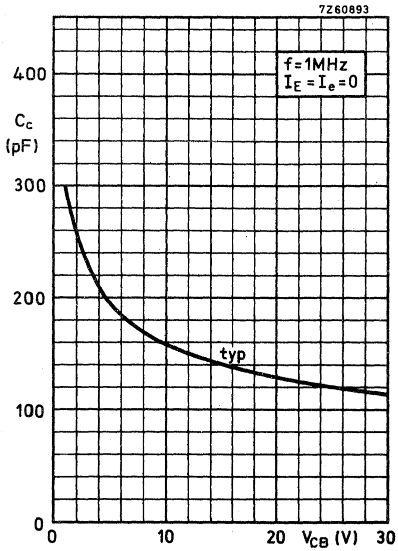
From junction to mounting base	$R_{th\,j-mb}$	=	1.8	°C/W
From mounting base to heatsink	$R_{th\,mb-h}$	=	0.2	°C/W

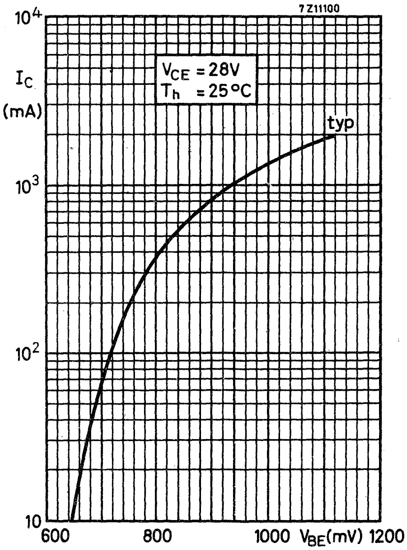
CHARACTERISTICS

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

Breakdown voltages				
Collector-base voltage open emitter; $I_C = 25$ mA	$V_{(BR)CBO}$	>	85	V
Collector-emitter voltage $R_{BE} = 10\ \Omega$; $I_C = 25$ 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; $R_{BE} = 33\Omega$	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
$V_{CE} = 20V$
f_T (MHz)
400
300
200
100
0
typ
0
5
10
I_C (A)
15


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


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

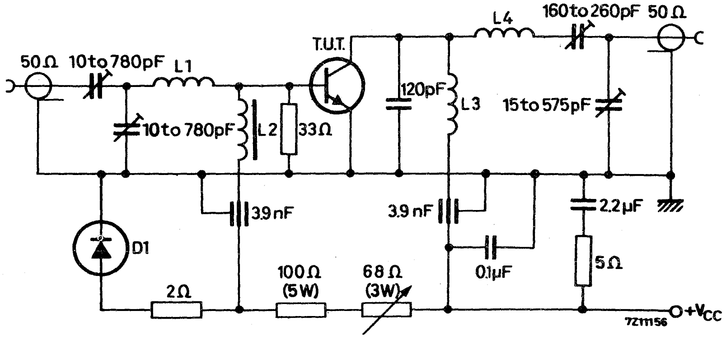
f_1 = 28.000 MHz; f_2 = 28.001 MHz

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

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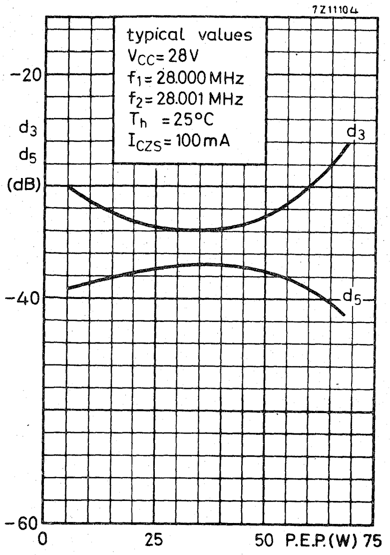
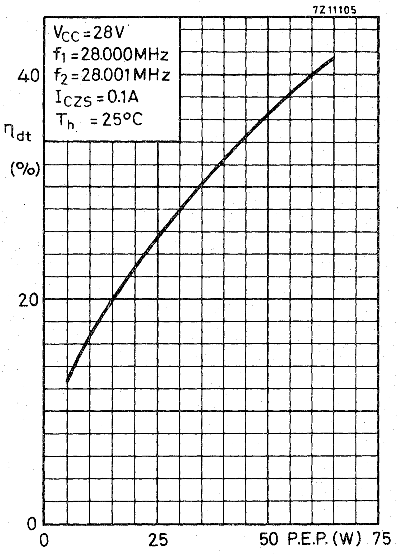
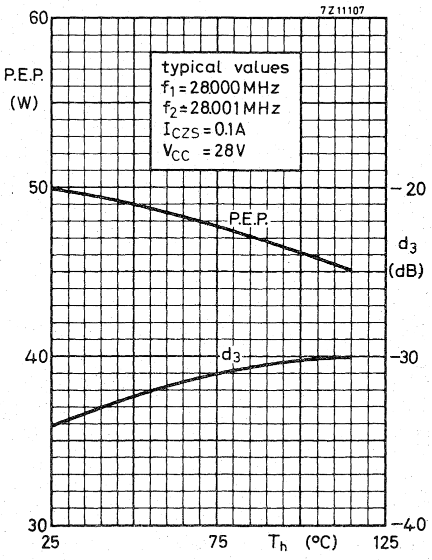
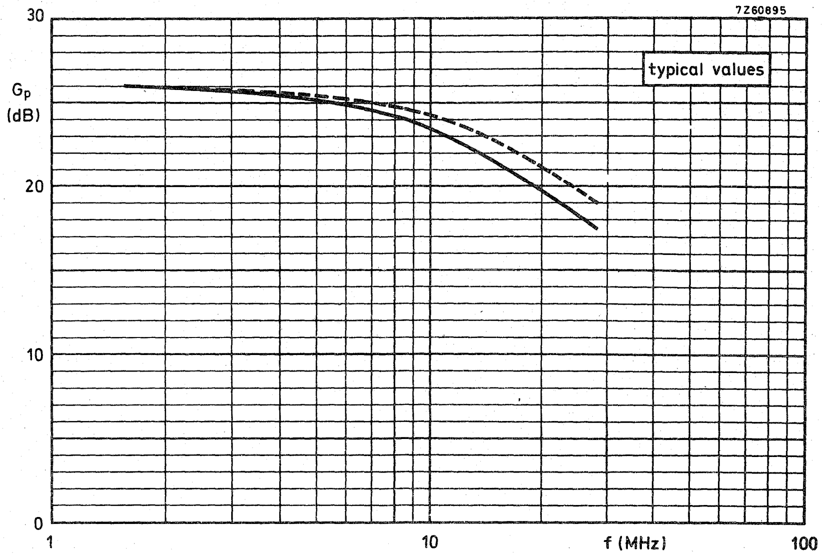
[1] Stated figures are maxima encountered at any driving level between the specified values of PEP and are referred to the according level of either of the equal ampl. tones. Relative to the according peak envelope power these figures should be increased by 6 dB.


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
0
25
50
75
P.E.P. (W)
d_3
d_5


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
75
P.E.P. (W)


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
25
75
125
T_h (°C)
P.E.P.
d_3
d_3
(dB)
−20
−30
−40

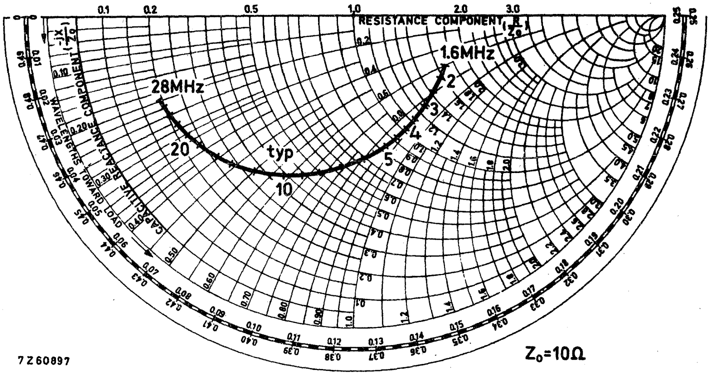


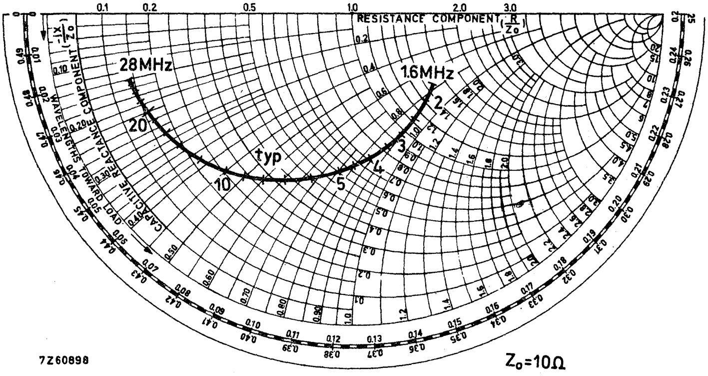
S.S.B. class AB operation

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)

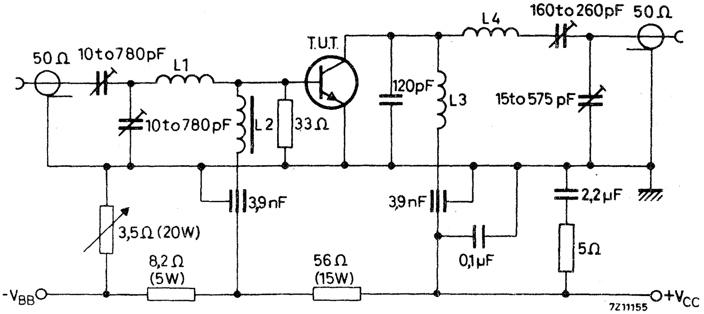
R.F. performance in s.s.b. operation (linear power amplifier)

V_{CC} = 28 V; T_h up to 25 °C
f_1 = 28,000 MHz; f_2 = 28,001 MHz

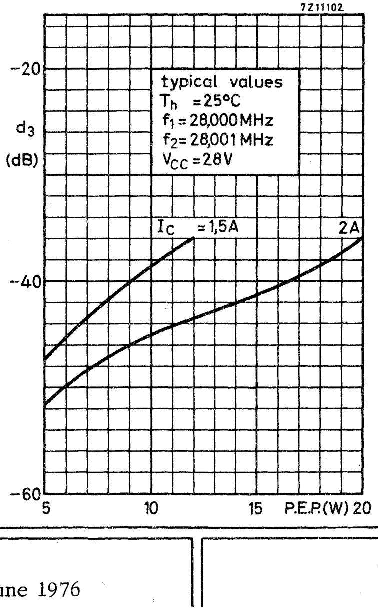
output power (W)	G_p (dB)	d_3 (dB) [1]	d_5 (dB) [1]	I_C (A)	Class
15 PEP	> 13	typ. −40	typ. −45	2,0	A

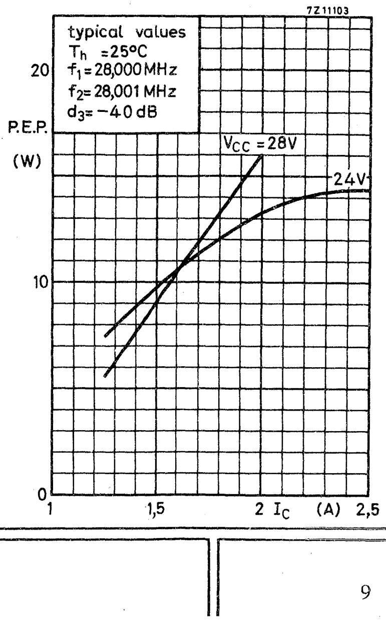
Test circuit:

S.S.B. class-A



L1 = 3 turns enamelled Cu wire (1,5 mm); winding pitch 2,5 mm; int. dia. 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. dia. 10 mm
L4 = 7 turns enamelled Cu wire (1,5 mm); winding pitch 2,5 mm; int. dia. 12 mm





APPLICATION INFORMATION

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

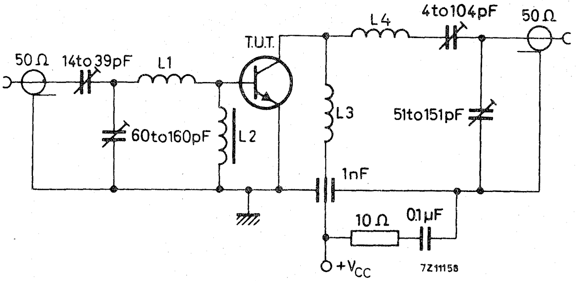
V_{CC} = 28 V; T_h up to 25 °C

f (MHz)	P_S (W)	P_L (W)	I_C (A)	G_p (dB)	η (%)	$\overline{z_i}$ (Ω)	$\overline{Y_L}$ (mA/V)
70	< 8.9	50	< 3.25	> 7.5	> 55	1.0+j0.2	120 − j75
50	typ. 4	50	typ. 3.25	typ. 11	typ. 55	–	–
30	typ. 1.2	50	typ. 3.25	typ. 16	typ. 55	–	–

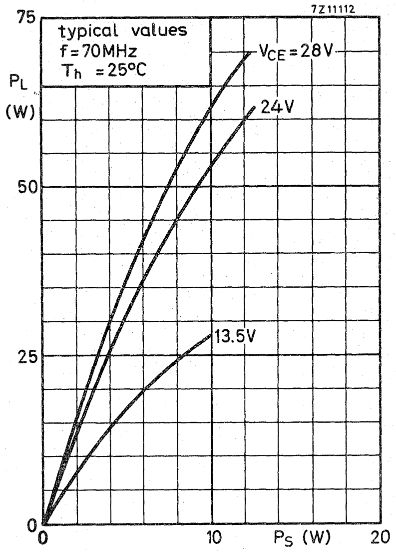
At temperatures up to 90 °C the output power relative to that at 25 °C is diminished by a factor −40 mW/°C.

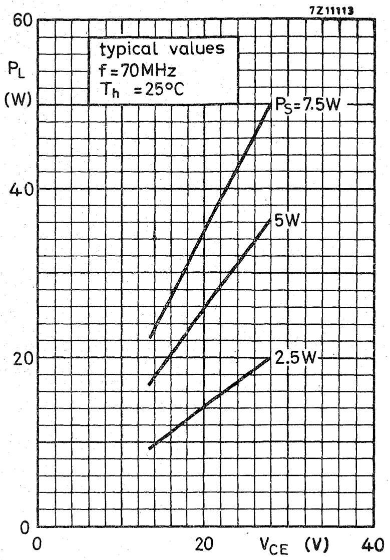
Test circuit :

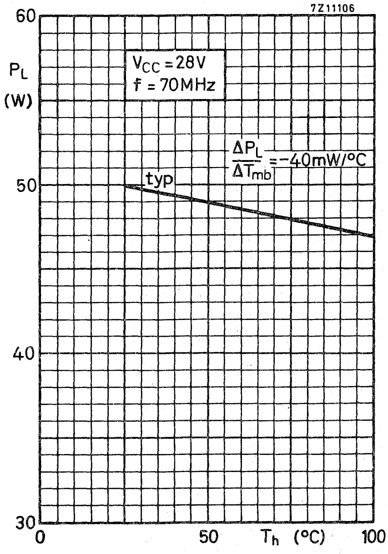
C.W.
70 MHz



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; internal diam. 10 mm; leads 55 mm totally
L4 = 3 turns enamelled Cu wire (1.5 mm); winding pitch 2.5 mm; internal diam. 10 mm; leads 50 mm totally


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

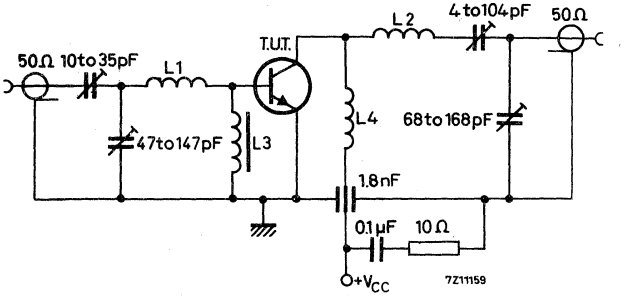

7Z11113
typical values
f=70MHz
T_h =25°C
P_L
(W)
60
40
20
0
P_S=7.5W
5W
2.5W
0
20
V_{CE} (V)
40


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

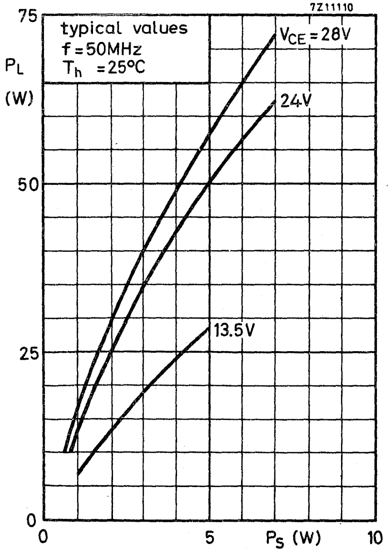
APPLICATION INFORMATION (continued)

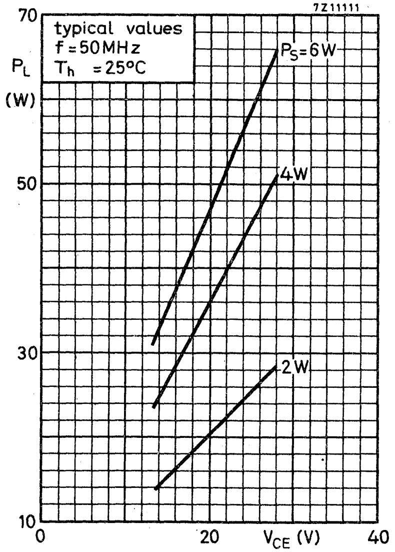
Test circuit:

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

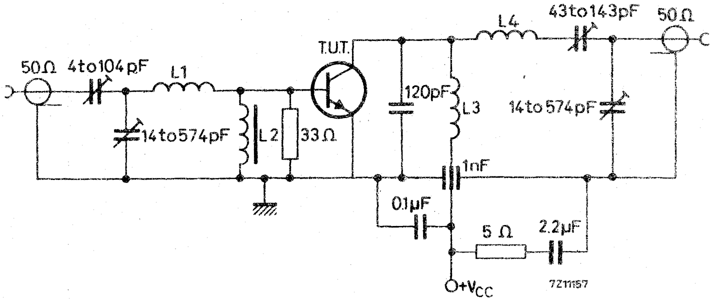




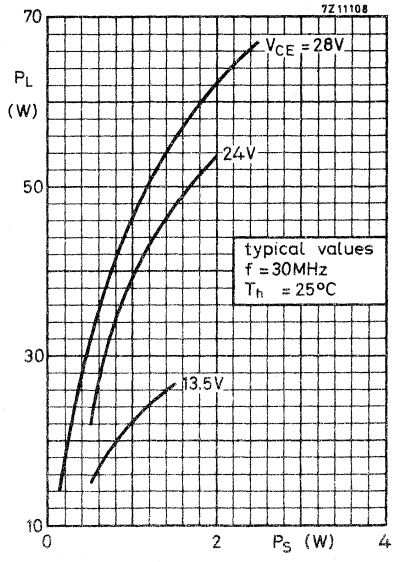
APPLICATION INFORMATION (continued)

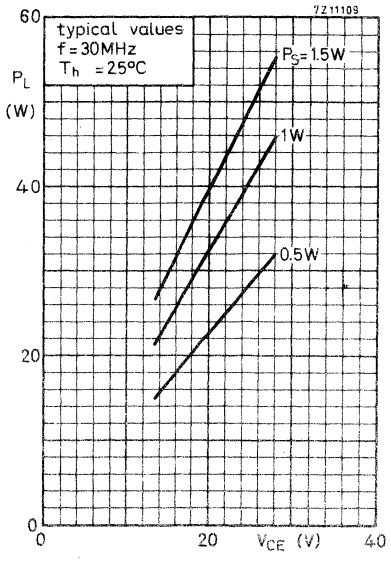
Test circuit :

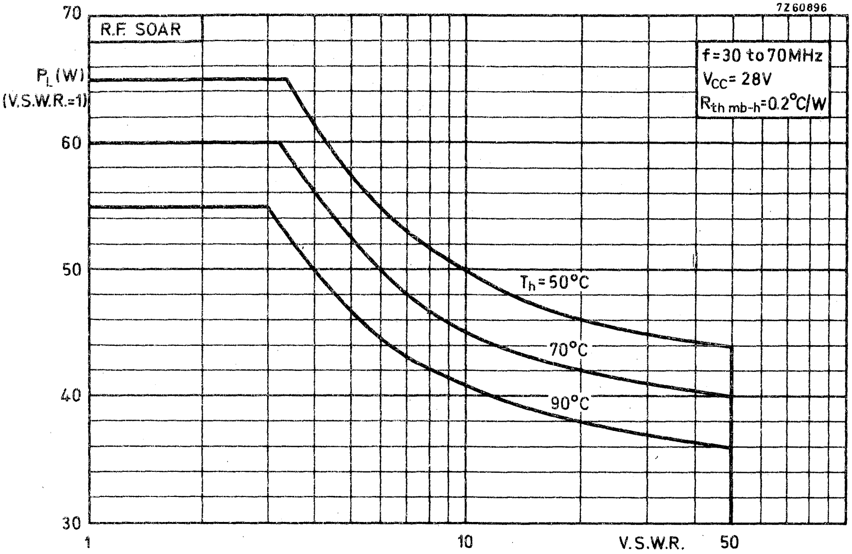
C.W.
30 MHz



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

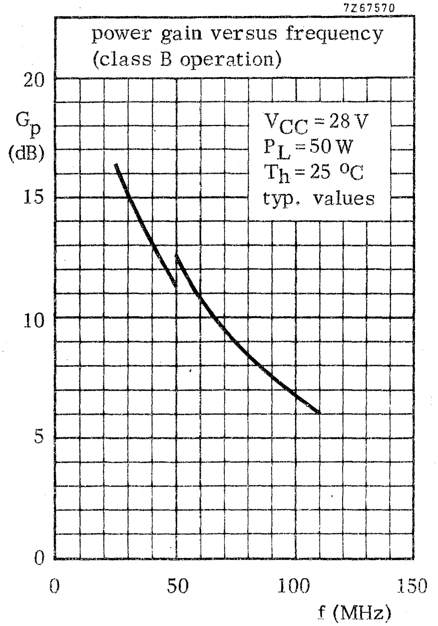


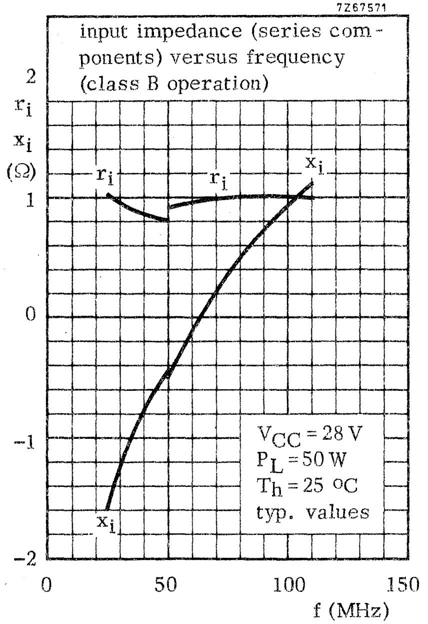


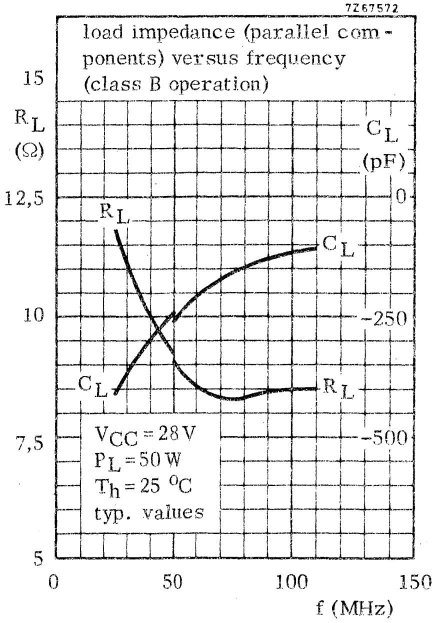


For high voltage operation, a stabilized power supply is generally used.
The graph shows the allowable output power under nominal conditions as a function of the V.S.W.R., with heatsink temperature as parameter.

OPERATING NOTE Below 50 MHz a base-emitter resistor of 6,8 Ω is recommended to avoid oscillation. This resistor must be effective for both d.c. and r.f.







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:

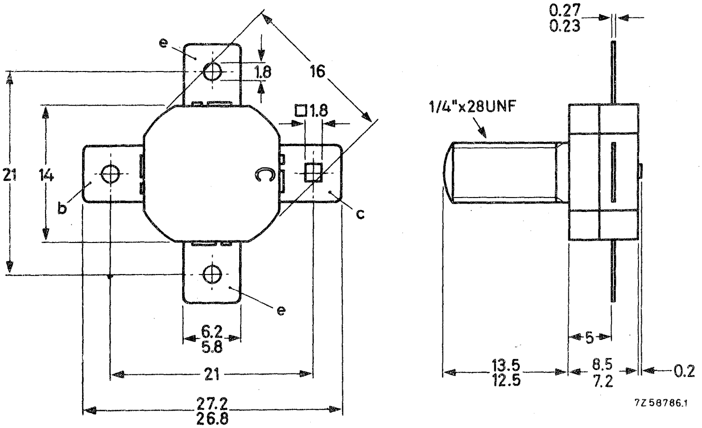
- rated for 150 W PEP at 1,6 MHz to 28 MHz
  (intermodulation distortion better than 30 dB down)
- rated at 150 W output power for frequencies up to 108 MHz in c.w. operation
- supply voltage up to 50 V
- plastic encapsulated strip-line package
- delivered in matched h_{FE} groups

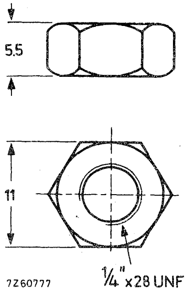
QUICK REFERENCE DATA

Operation	Class	V_{CE} (V)	f (MHz)	P_L (W)	G_p (dB)	d3 (dB)	I_{CZS} (A)
s.s.b.	AB	50	1,6 to 28	20 to 150 (PEP)	> 14	< −30	0,10
s.s.b.	A	40	1,6 to 28	typ. 30 (PEP)	> 14	< −40	2,5
c.w.	B	50	70	150	> 10	–	–
c.w.	B	50	108	150	typ. 7,5	–	–

MECHANICAL DATA Dimensions in mm

SOT-55





Torque on nut: min. 2,3 Nm
(23 kg cm)
max. 2,7 Nm
(27 kg cm)

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 (IEC134)

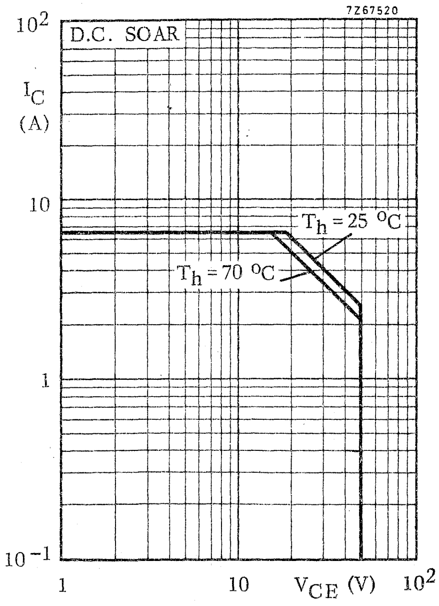
Voltages

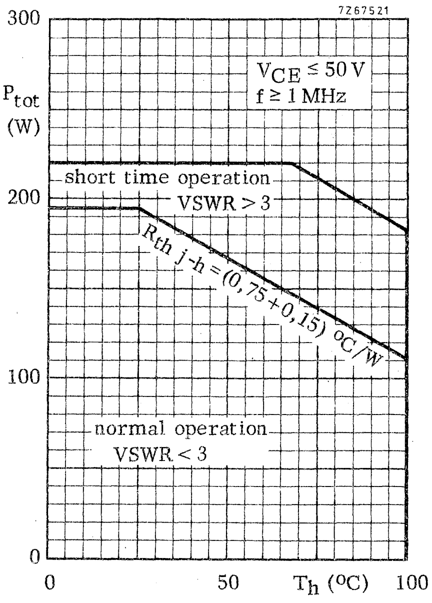
Collector-base voltage (open emitter) peak value	V_{CBOM}	max.	110	V
Collector-emitter voltage ($R_{BE} = 10\Omega$) peak value	V_{CERM}	max.	110	V
Collector-emitter voltage (open base)	V_{CEO}	max.	53	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4,0	V

Currents

Collector current (average)	$I_{C(AV)}$	max.	6,5	A
Collector current (peak value) f > 1 MHz	I_{CM}	max.	20	A

Power dissipation





Temperatures

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

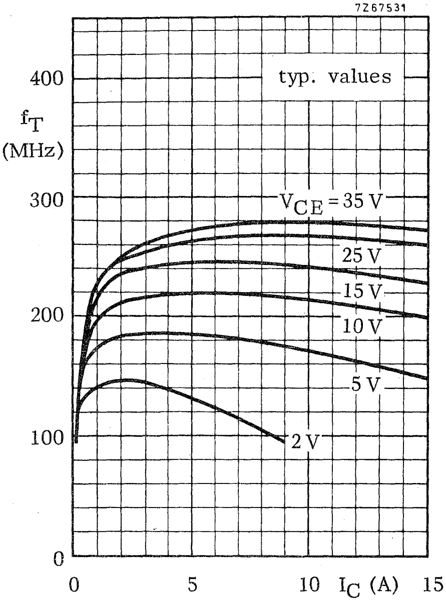
THERMAL RESISTANCE

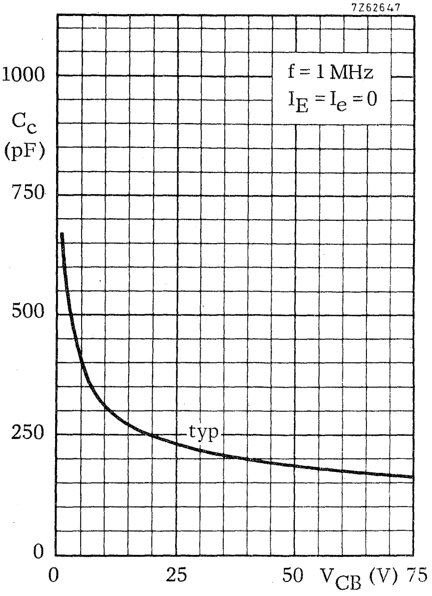
From junction to mounting base	$R_{th\ j\text{-}mb}$	=	0,75	°C/W
From mounting base to heatsink	$R_{th\ mb\text{-}h}$	=	0,15	°C/W

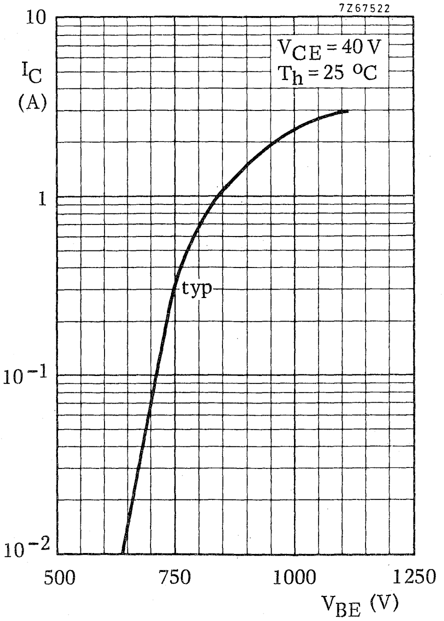
CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Breakdown voltages				
Collector-base voltage open emitter ; I_C = 100 mA	$V_{(BR)CBO}$	>	110	V
Collector-emitter voltage R_{BE} = 5 Ω ; I_C = 100 mA	$V_{(BR)CER}$	>	110	V
Collector-emitter voltage open base ; I_C = 100 mA	$V_{(BR)CEO}$	>	53	V
Emitter-base voltage open collector; I_E = 20 mA	$V_{(BR)EBO}$	>	4,0	V
Transient energy				
L = 25 mH; f = 50 Hz				
open base	E	>	12,5	mWs
$-V_{BE}$ = 1,5 V; R_{BE} = 33 Ω	E	>	12,5	mWs
D.C. current gain				
I_C = 1,4 A ; V_{CE} = 6 V	h_{FE}		15 to 50	
D.C. current gain ratio of matched devices				
I_C = 1,4 A ; V_{CE} = 6 V	h_{FE1}/h_{FE2}	<	1,2	
Transition frequency				
I_C = 6,0 A ; V_{CE} = 35 V	f_T	typ.	275	MHz
Collector capacitance at f = 1 MHz				
I_E = I_e = 0 ; V_{CB} = 50 V	C_c	typ. <	185 220	pF pF
Feedback capacitance at f = 1 MHz				
I_C = 150 mA; V_{CE} = 50 V	C_{re}	typ.	115	pF
Collector-stud capacitance	C_{cs}	typ.	3,5	pF


7Z67531
typ. values
f_T (MHz)
400
300
200
100
0
$V_{CE} = 35$ V
25 V
15 V
10 V
5 V
2 V
0
5
10
I_C (A)
15


7Z62647
f = 1 MHz
$I_E = I_e = 0$
C_c (pF)
1000
750
500
250
0
typ
0
25
50
V_{CB} (V)
75


7Z67522
$V_{CE} = 40$ V
$T_h = 25$ °C
I_C (A)
10
1
10^{-1}
10^{-2}
typ
500
750
1000
1250
V_{BE} (V)

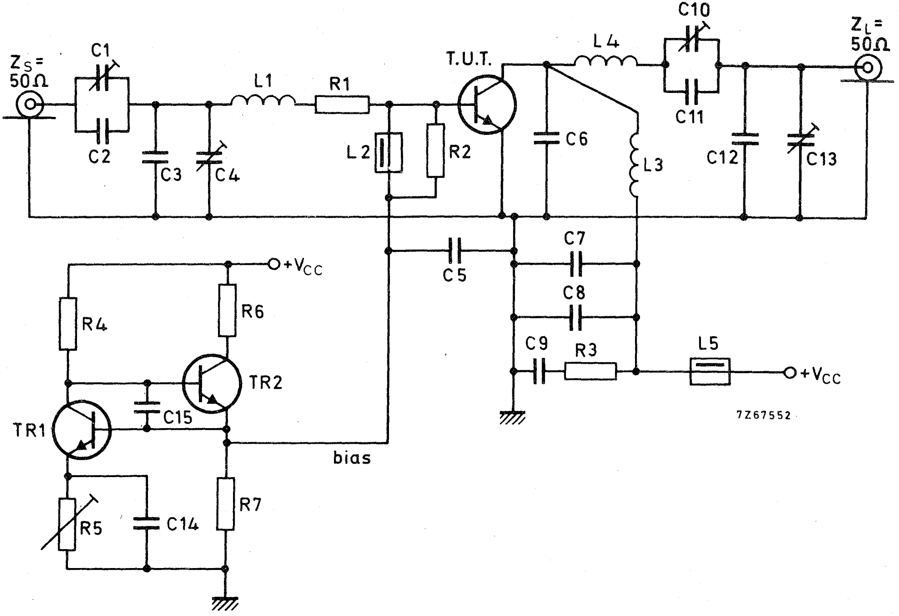
APPLICATION INFORMATION

R.F. performance in s.s.b. operation (linear power amplifier)

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)	V_{CE} (V)	Class
20 to 150 (PEP)	> 14	> 37,5	< −30	< −30	0,10	< 4	50	AB
typ. 30 (PEP)	> 14	typ. 15	< −40	< −40	2,5	–	40	A

S.S.B. test circuit class AB; f = 28 MHz



List of components: see page 6.

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[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 amplified tones. Relative to the according peak envelope power these figures should be increased by 6 dB.

APPLICATION INFORMATION (continued)

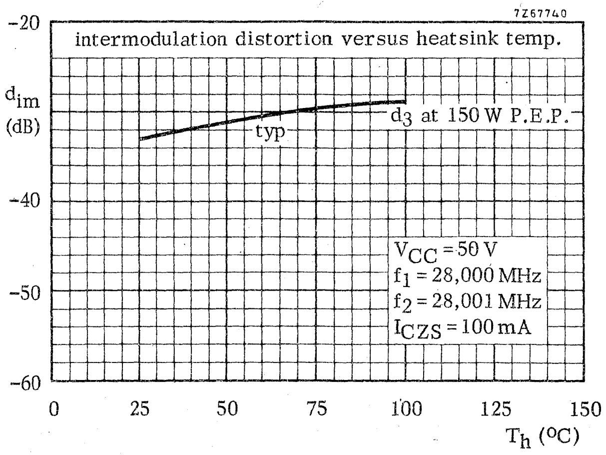
List of components:

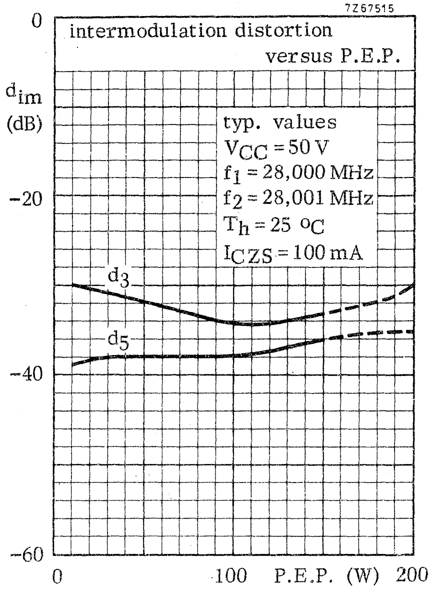
Tr1 = BD135
Tr2 = BD228

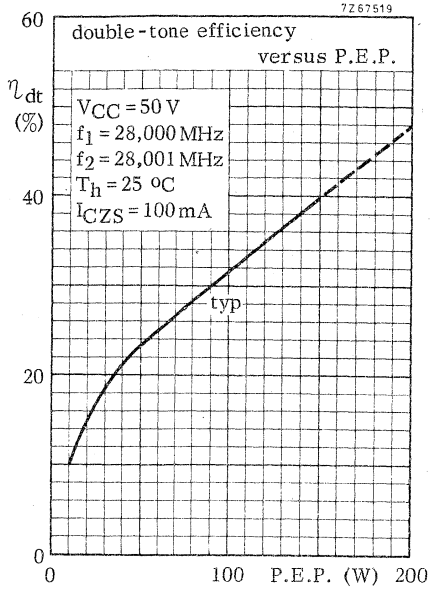
C1 = C10 = 100 pF air dielectric capacitor (single insulated rotor type)
C2 = C6 = 27 pF ceramic capacitor
C3 = 180 pF ceramic capacitor
C4 = C13 = 100 pF air dielectric capacitor (single non-insulated rotor)
C5 = C7 = 3,9 nF polyester capacitor (±10%)
C8 = C14 = C15 = 100 nF polyester capacitor (±10%)
C9 = 2,2 μF moulded metallized polyester capacitor
C11 = 68 pF ceramic capacitor
C12 = 220 pF ceramic capacitor

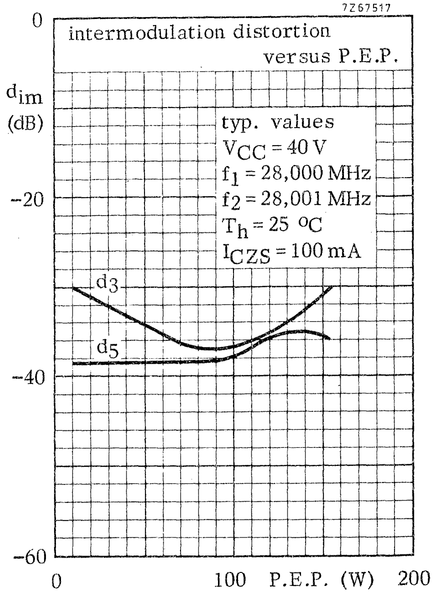
L1 = 88 nH; 3 turns Cu wire (1,0 mm); internal diameter 9 mm; coil length 6,1 mm; leads 2 x 5 mm
L2 = L5 = ferroxcube bead, grade 3B (code number 4312 020 36640)
L3 = 180 nH; 4 turns enamelled Cu wire (1,5 mm); internal diameter 12 mm; coil length 9,9 mm; leads 2 x 10 mm
L4 = 350 nH; 7 turns enamelled Cu wire (1,5 mm); internal diameter 12 mm; coil length 19,1 mm; leads 2 x 10 mm

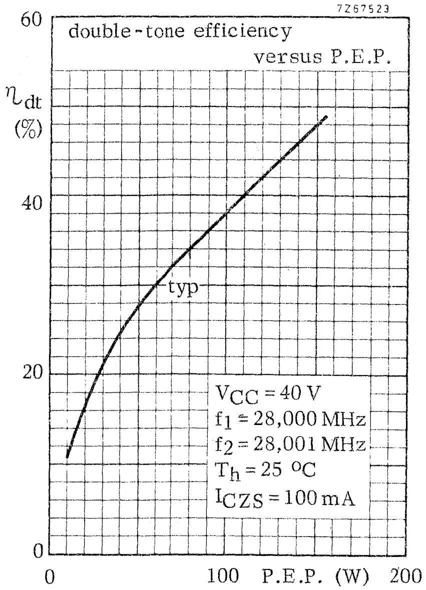
R1 = 0,66 Ω parallel connection of 5 x 3,3 Ω carbon resistors (±5%; 0,5 W each)
R2 = 27 Ω carbon resistor (±5%; 0,5 W)
R3 = 4,7 Ω carbon resistor (±5%; 0,5 W)
R4 = 5,6 kΩ carbon resistor (±5%; 1 W)
R5 = 15 Ω wire-wound potentiometer (3W)
R6 = 157 Ω parallel connection of 3 x 470 Ω wire-wound resistors (5,5W each)
R7 = 68 Ω carbon resistor (±5%; 0,5 W)

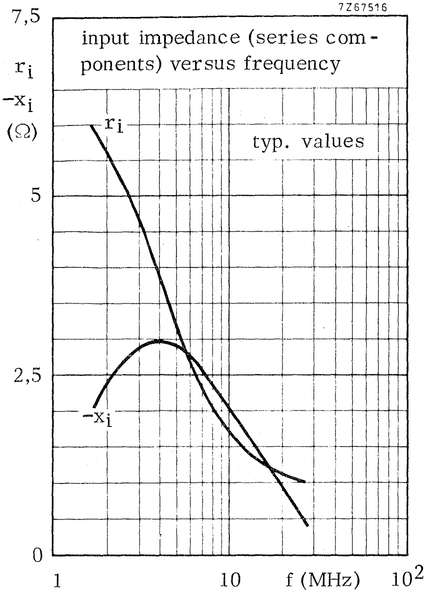


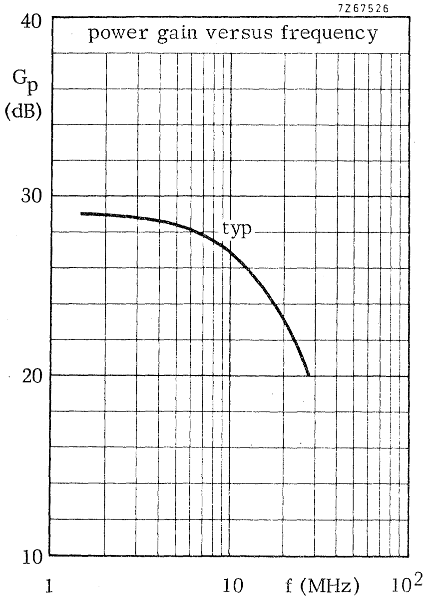

7Z67515
intermodulation distortion versus P.E.P.
typ. values
$V_{CC} = 50$ V
$f_1 = 28,000$ MHz
$f_2 = 28,001$ MHz
$T_h = 25$ °C
$I_{CZS} = 100$ mA
d_{im} (dB)
0
-20
-40
-60
d_3
d_5
0
100
P.E.P. (W)
200


7Z67519
double-tone efficiency versus P.E.P.
$V_{CC} = 50$ V
$f_1 = 28,000$ MHz
$f_2 = 28,001$ MHz
$T_h = 25$ °C
$I_{CZS} = 100$ mA
η_{dt} (%)
60
40
20
0
typ
0
100
P.E.P. (W)
200


7Z67517
intermodulation distortion versus P.E.P.
typ. values
$V_{CC} = 40$ V
$f_1 = 28,000$ MHz
$f_2 = 28,001$ MHz
$T_h = 25$ °C
$I_{CZS} = 100$ mA
d_{im} (dB)
0
-20
-40
-60
d_3
d_5
0
100
P.E.P. (W)
200


7Z67523
double-tone efficiency versus P.E.P.
$V_{CC} = 40$ V
$f_1 = 28,000$ MHz
$f_2 = 28,001$ MHz
$T_h = 25$ °C
$I_{CZS} = 100$ mA
η_{dt} (%)
60
40
20
0
typ
0
100
P.E.P. (W)
200

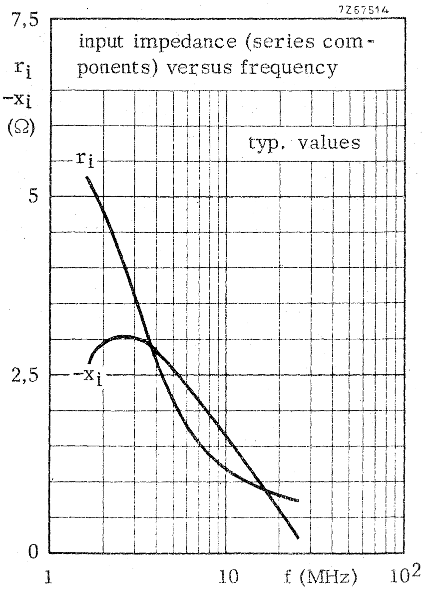


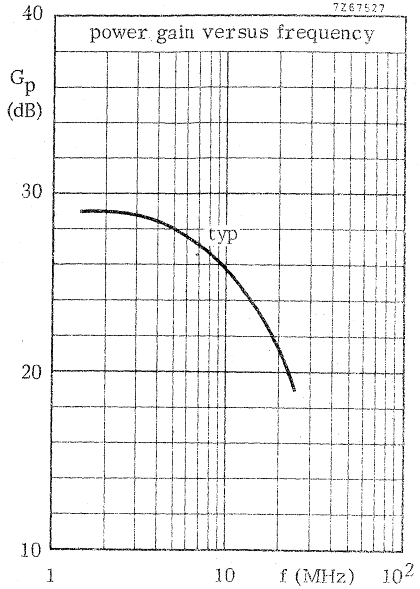


S.S.B. class AB operation

P_L = 150 W (PEP)
V_{CC} = 50 V
I_{CZS} = 100 mA
T_h = 25 °C
Z_L = 6,25 Ω in series with 10,4 nH (in parallel with −267 pF)

The graphs hold for one transistor of a push-pull amplifier with cross neutralization; collector (Tr1) - base (Tr2), neutralizing capacitor: 82 pF.





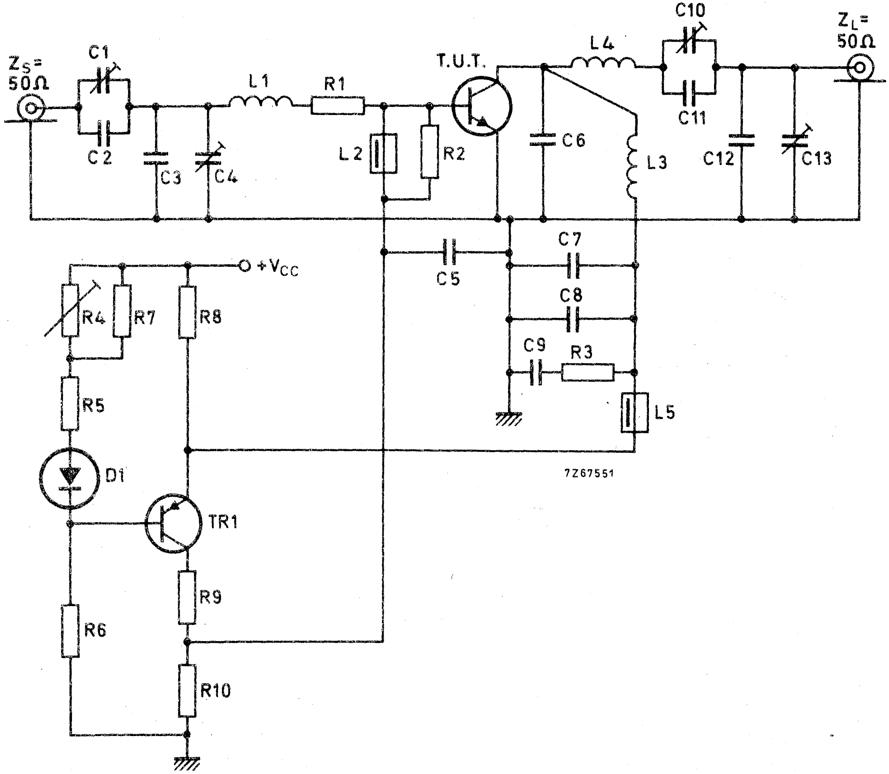
S.S.B. class AB operation

P_L = 150 W (PEP)
V_{CC} = 50 V
I_{CZS} = 100 mA
T_h = 25 °C
Z_L = 6,25 Ω in series with 7,3 nH (in parallel with −188 pF)

The graphs hold for an unneutralized amplifier.

APPLICATION INFORMATION (continued)

S.S.B. test circuit class-A; f = 28 MHz



List of components: (see also page 11)

→ D1 = BY206
TR1 = BD204

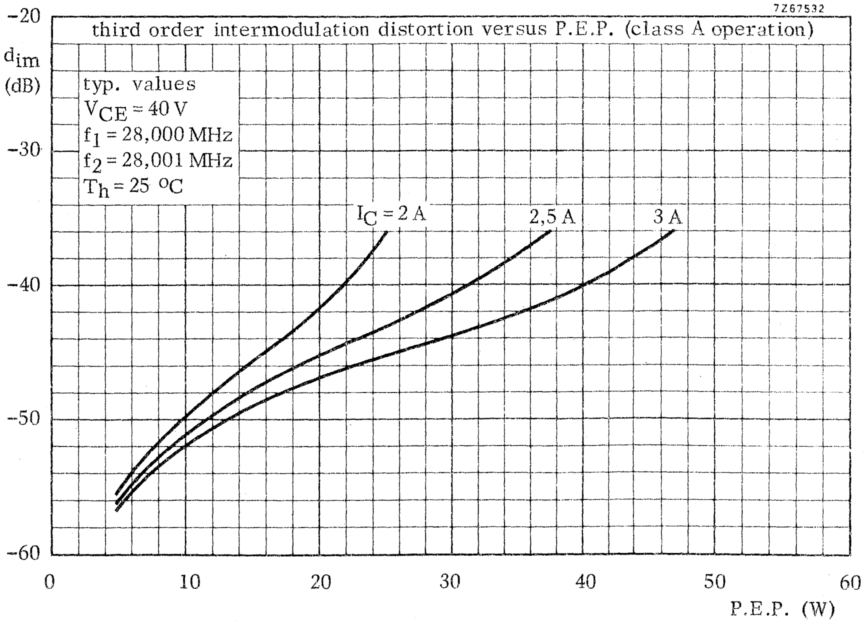
C1 = C10 = 100 pF air dielectric capacitor (single insulated rotor type)
C2 = C6 = 27 pF ceramic capacitor
C3 = 180 pF ceramic capacitor
C4 = C13 = 100 pF air dielectric capacitor (single non-insulated rotor)
C5 = C7 = 3,9 nF polyester capacitor (±10%)
C8 = 100 nF polyester capacitor (±10%)
C9 = 2,2 μF moulded metallized polyester capacitor
C11 = 68 pF ceramic capacitor
C12 = 220 pF ceramic capacitor

APPLICATION INFORMATION (continued)

List of components: (continued)

L1 = 88 nH; 3 turns Cu wire (1,0 mm); internal diameter 9 mm; coil length 6,1 mm; leads 2 x 5 mm
L2 = L5 = ferroxcube bead, grade 3B (code number 4312 020 36440)
L3 = 180 nH; 4 turns enamelled Cu wire (1,5 mm); internal diameter 12 mm; coil length 9,9 mm; leads 2 x 10 mm
L4 = 350 nH; 7 turns enamelled Cu wire (1,5 mm); internal diameter 12 mm; coil length 19,1 mm; leads 2 x 10 mm

R1 = 0,66 Ω parallel connection of 5 x 3,3 Ω carbon resistors (±5%; 0,5 W each)
R2 = 27 Ω carbon resistor (±5%; 0,5 W)
R3 = 4,7 Ω carbon resistor (±5%; 0,5 W)
R4 = 50 Ω wire-wound potentiometer (1 W)
R5 = 10 Ω carbon resistor (±5%; 1 W)
R6 = 560 Ω enamelled wire-wound resistor (5,5 W)
R7 = 270 Ω carbon resistor (±5%; 1 W)
R8 = 0,6 Ω parallel connection of 3 x 1,8 Ω wire-wound resistors (8 W each)
R9 = 90 Ω parallel connection of 3 x 270 Ω enamelled wire-wound resistor (5,5 W each)
R10 = 12 Ω carbon resistor (±5%; 1 W)



APPLICATION INFORMATION (continued)

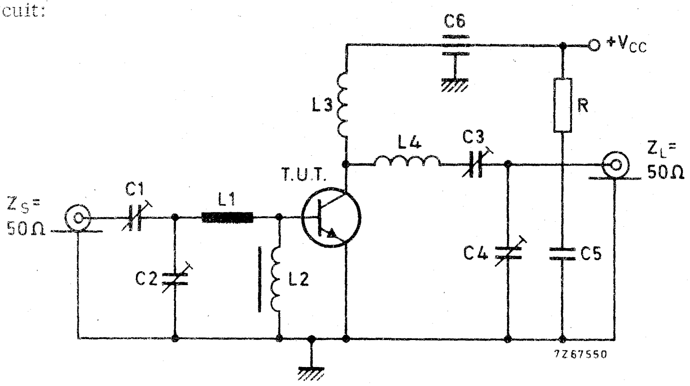
R.F. performance in c.w. operation (class B)

V_{CC} = 50 V; T_h up to 25 °C

f (MHz)	P_S (W)	P_L (W)	I_C (A)	G_p (dB)	η (%)
70	< 19	150	< 4,6	> 10	> 65
108	typ. 30	150	typ. 4,0	typ. 7,5	typ. 75

Test circuit:

C.W.
70 MHz



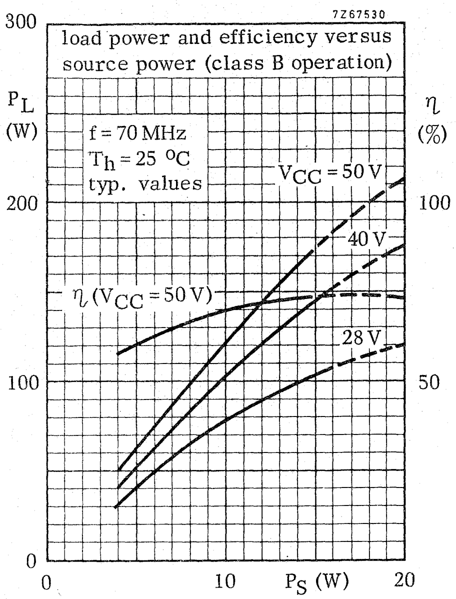
List of components:

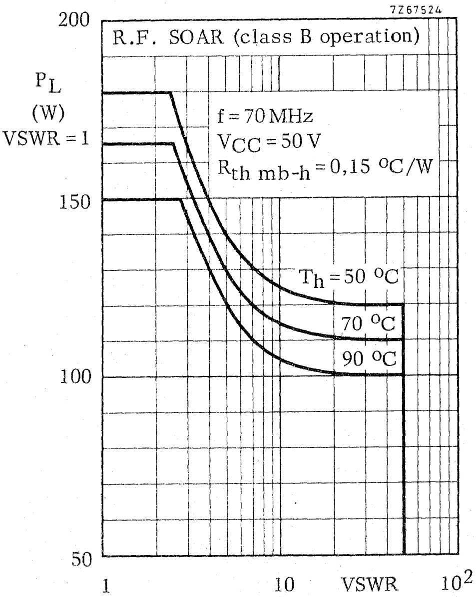
L1 = 60 mm straight enamelled Cu wire (1,5 mm); 9 mm above chassis
L2 = FXC choke coil, grade 3B (code number 4312 020 36640)
L3 = 18 turns enamelled Cu wire (1,5 mm); internal diameter 10 mm; pitch 2 mm; leads 55 mm totally
L4 = 3 turns enamelled Cu wire (1,5 mm); internal diameter 10 mm; pitch 2,5 mm; leads 50 mm totally

C1 = 4 to 29 pF concentric air trimmer in parallel with 10 pF ceramic capacitor
C2 = 4 to 104 pF film dielectric trimmer in parallel with 56 pF ceramic capacitor
C3 = 4 to 104 pF film dielectric trimmer
C4 = 4 to 104 pF film dielectric trimmer in parallel with 47 pF ceramic capacitor
C5 = 100 nF polyester capacitor (± 10%)
C6 = 1 nF ceramic feed through capacitor

R = 10 Ω carbon resistor (0,5 W)

At P_L = 150 W and V_{CC} = 50 V, the output power at heatsink temperature between 25 °C and 75 °C relative to that at 25 °C is diminished by 100 mW/°C.



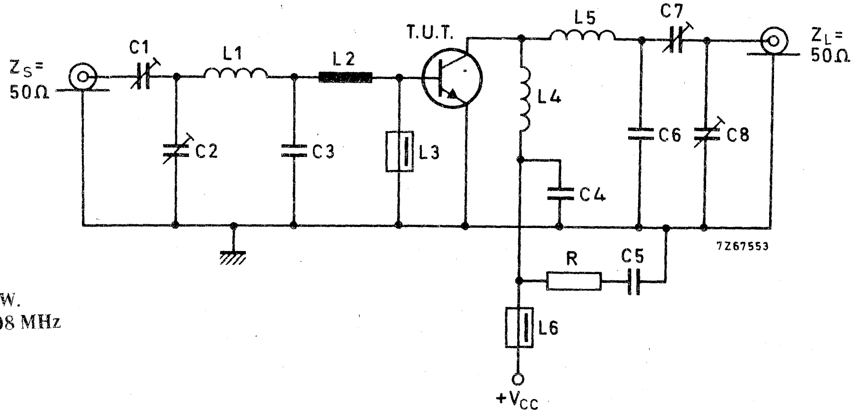


Indicated load power as a function of overload.

The graph has been derived from an evaluation of the performance of transistors matched up to 180 W load power in the test amplifier on page 12 and subsequently subjected to various mismatch conditions at 50 V with VSWR up to 50 and elevated heatsink temperatures.
This indicates a restriction to the load power matched under nominal conditions in the recommended test configuration.

APPLICATION INFORMATION (continued)

Test circuit:



C.W.
108 MHz

List of components:

C1 = C2 = 40 pF film dielectric trimmer
C3 = 400 pF parallel connection of 4 x 100 pF ceramic capacitors
C4 = 270 pF ceramic capacitor
C5 = 100 nF polyester capacitor (± 10%)
C6 = 20 pF parallel connection of 2 x 10 pF ceramic capacitors
C7 = C8 = 60 pF film dielectric trimmer

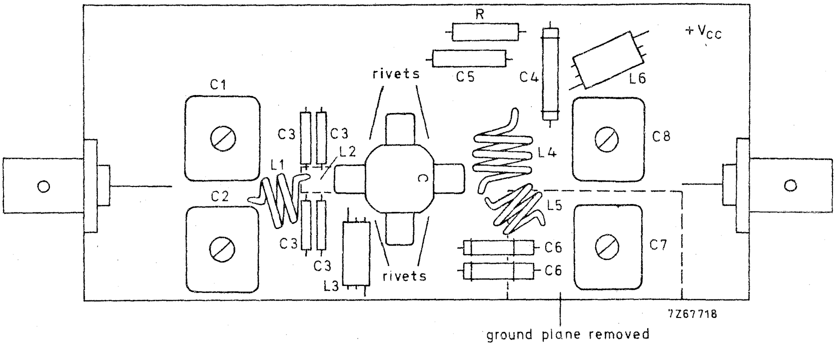
L1 = 49 nH; 2 turns enamelled Cu wire (1,5 mm); internal diameter 9 mm; coil length 4,8 mm; leads 2 x 5 mm
L2 = strip-line (7,7 mm x 6 mm); tap for C3 is 7,5 mm from transistor edge
L3 = L6 = ferroxcube bead, grade 3B (code number 4312 020 36640)
L4 = 67 nH; 3 turns enamelled Cu wire (1,5 mm); internal diameter 8 mm; coil length 8,3 mm; leads 2 x 5 mm
L5 = 57 nH; 2 turns enamelled Cu wire (1,5 mm); internal diameter 10 mm; coil length 4,5 mm; leads 2 x 5 mm

R = 10 Ω carbon resistor (0,5 W)

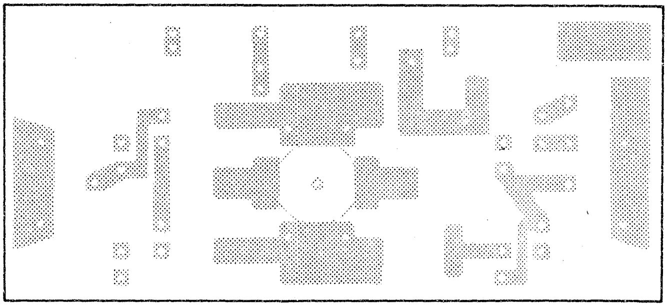
Component lay-out for 108 MHz test circuit see page 15.

APPLICATION INFORMATION (continued)

Component lay-out and printed circuit board for 108 MHz test circuit.

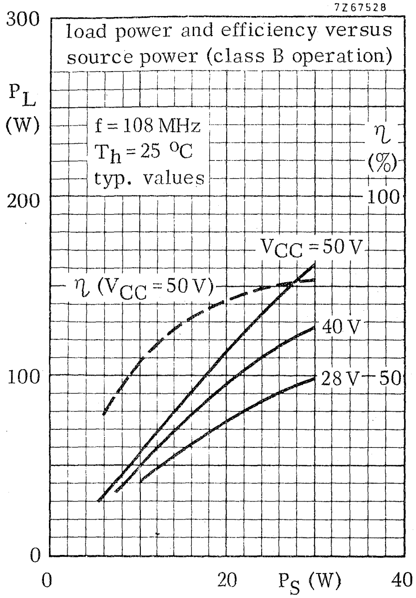


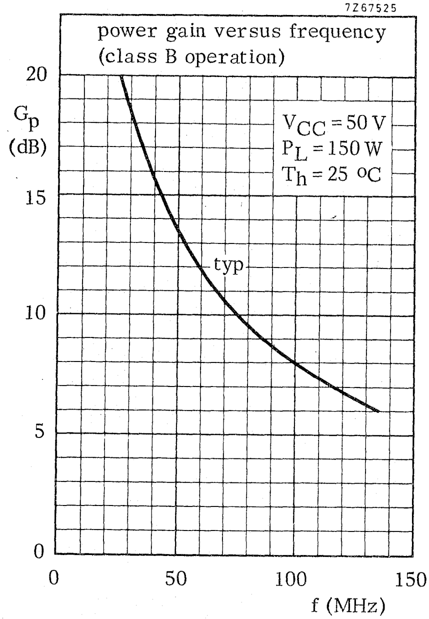
Dimensions of printed circuit board 123 mm x 55 mm.

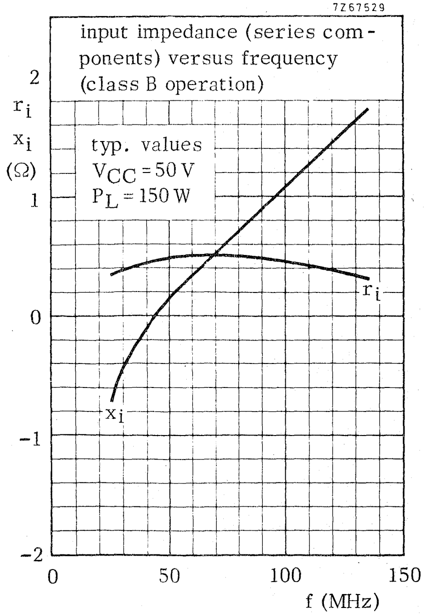


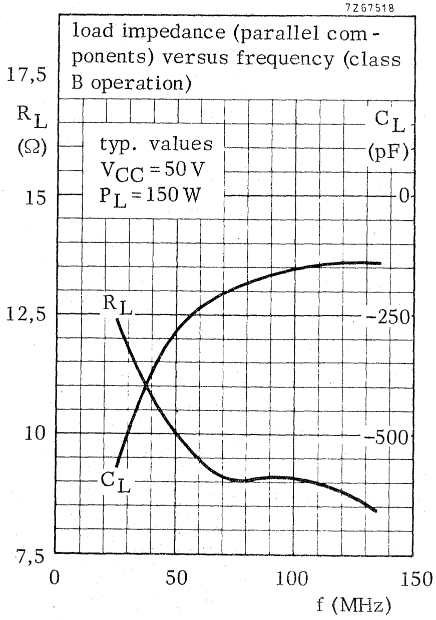
7Z67664

The circuit has been built on epoxy fibre-glass double copper clad printed circuit board (thickness 1/16"). To minimize the dielectric losses, the ground plane under the interconnection of L5, C6 and C7 has been removed.


7Z67528
load power and efficiency versus source power (class B operation)
300
P_L
(W)
200
100
0
f = 108 MHz
T_h = 25 °C
typ. values
η
(%)
100
50
V_{CC} = 50 V
η (V_{CC} = 50 V)
40 V
28 V
0
20
P_S (W)
40


7Z67525
power gain versus frequency (class B operation)
20
G_p
(dB)
15
10
5
0
V_{CC} = 50 V
P_L = 150 W
T_h = 25 °C
typ
0
50
100
150
f (MHz)


7Z67529
input impedance (series components) versus frequency (class B operation)
2
r_i
x_i
(Ω)
1
0
-1
-2
typ. values
V_{CC} = 50 V
P_L = 150 W
r_i
x_i
0
50
100
150
f (MHz)


7Z67518
load impedance (parallel components) versus frequency (class B operation)
17,5
R_L
(Ω)
15
12,5
10
7,5
typ. values
V_{CC} = 50 V
P_L = 150 W
C_L
(pF)
0
-250
-500
R_L
C_L
0
50
100
150
f (MHz)

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

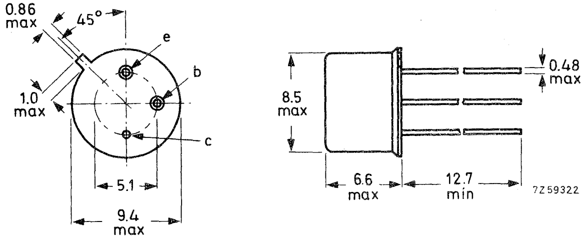
R.F. performance up to T_{case} = 25 °C in an unneutralized common-emitter class B circuit.

Mode of operation	V_{CC} (V)	f (MHz)	P_S (W)	P_L (W)	I_C (A)	G_p (dB)	η (%)	$\overline{z}_i$ (Ω)	$\overline{Y}_L$ (mA/V)
c.w.	13.8	470	typ. 0.4	2.0	typ. 0.22	typ. 7	typ. 66	5 + j11	17 − j19
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

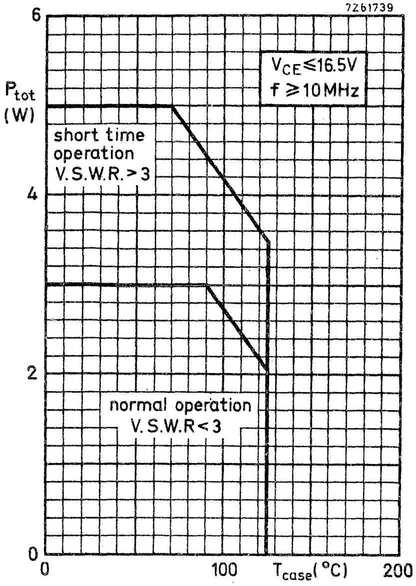
Dimensions in mm

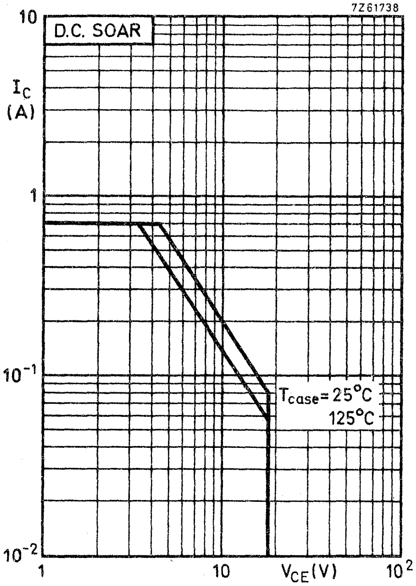
TO-39
Collector connected to case



Max. lead diameter guaranteed only for 12.7 mm

Accessories supplied on request: 56218, 56245


7Z61739
P_{tot} (W)
6
4
2
0
$V_{CE} \leq 16.5V$
$f \geq 10MHz$
short time operation V.S.W.R.>3
normal operation V.S.W.R<3
0
100
T_{case} (°C)
200


7Z61738
D.C. SOAR
I_C (A)
10
1
10^{-1}
10^{-2}
T_{case} = 25°C
125°C
1
10
V_{CE} (V)
10^2

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

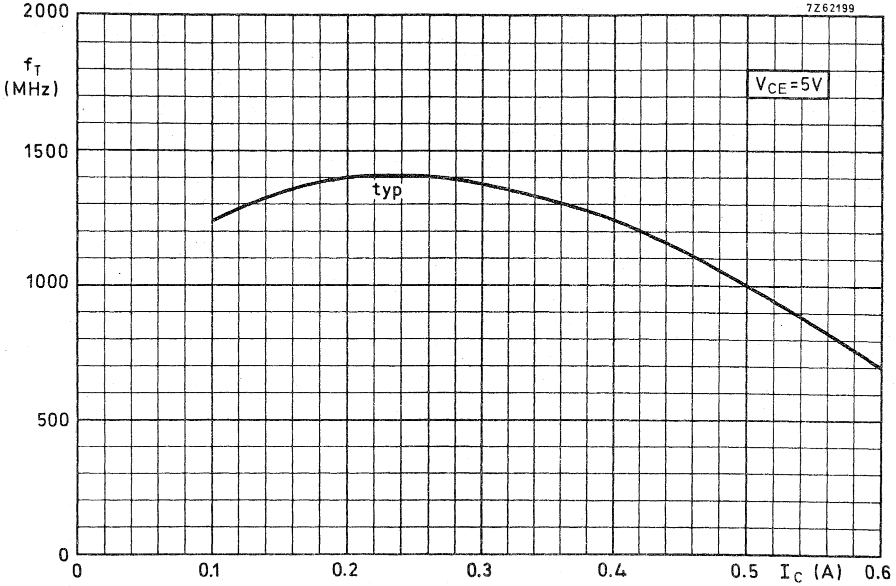
THERMAL RESISTANCE

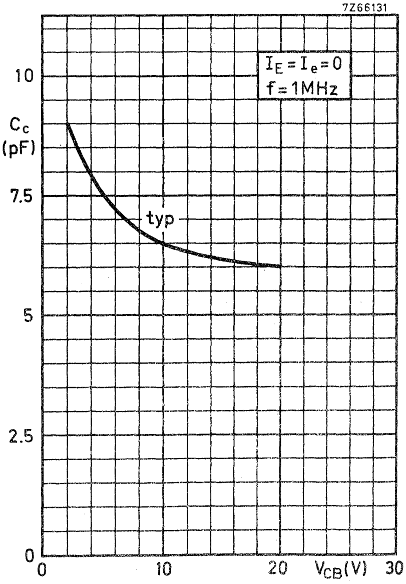
From junction to case	$R_{th\ j-c}$	=	25	°C/W
From mounting base to heatsink with a boron nitride washer for electrical insulation	$R_{th\ mb-h}$	=	2.5	°C/W

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

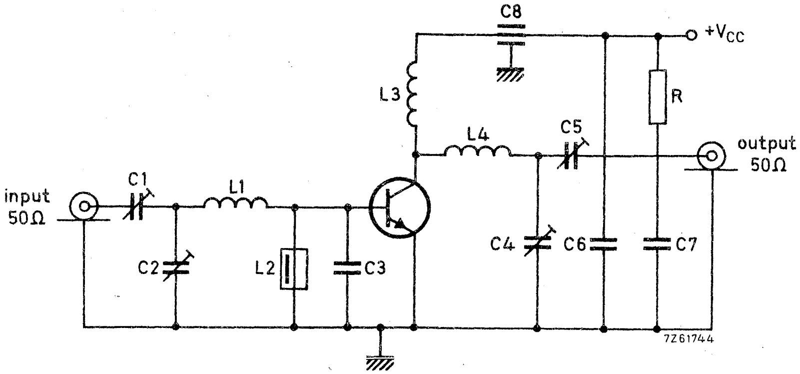
APPLICATION INFORMATION

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

T_{case} up to 25 ^{o}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 + j11	17 − j19
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

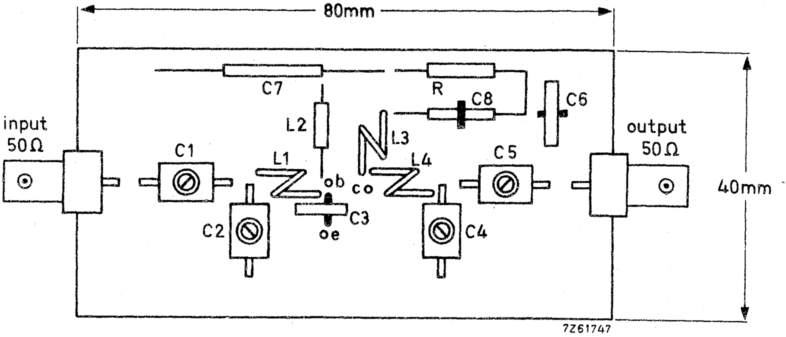
At P_L = 2.0 W and V_{CC} = 12.5 V the output power at case temperatures between 25 ^{o}C and 90 ^{o}C relative to that at 25 ^{o}C is diminished by typ. 5 mW/^{o}C.

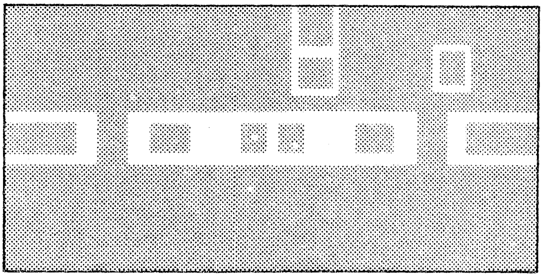
The transistor is designed to withstand full load mismatch in the test circuit under the following conditions: V_{CC} = 16.5 V; f = 470 MHz; T_{case} = 70 ^{o}C
V.S.W.R. = 50 : 1 through all phases; $P_S = P_{Snom}$ + 20 %
where $P_{Snom} = P_S$ for 1.4 W transistor output into 50 Ω load at V_{CC} =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

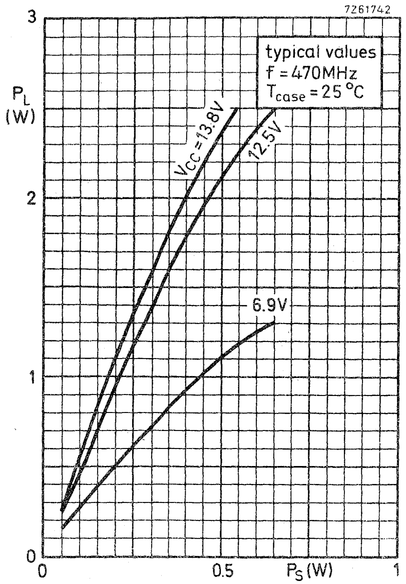


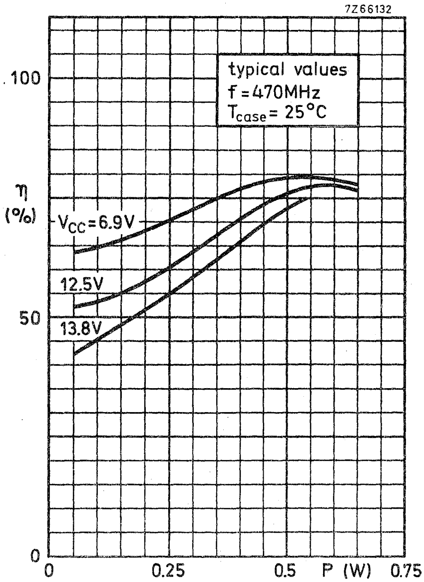

7Z61746.1

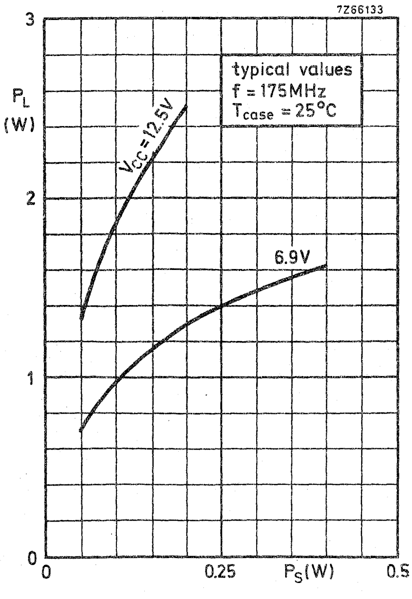
Shaded area copper

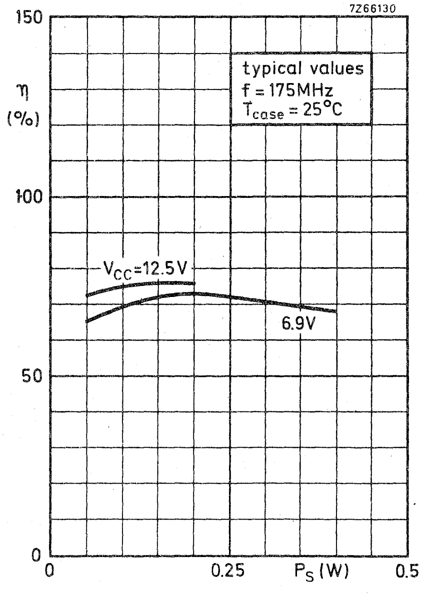
Back area not metalized

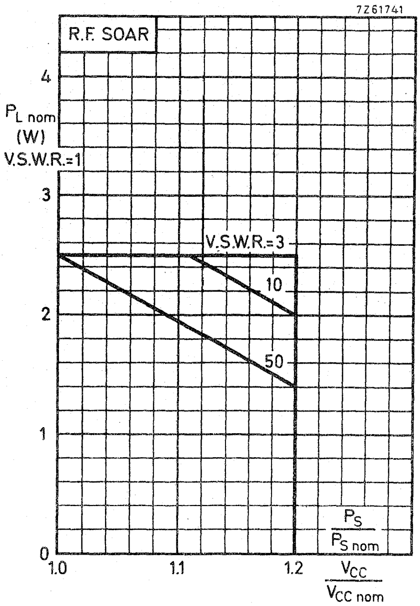
Material of printed circuit board: 1.5 mm epoxy fibre-glass


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


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


7Z66133
typical values
f = 175MHz
T_{case} = 25°C
P_L (W)
V_{CC} = 12.5V
6.9V
P_S (W)
3
2
1
0
0
0.25
0.5


7Z66130
typical values
f = 175MHz
T_{case} = 25°C
η (%)
V_{CC} = 12.5V
6.9V
P_S (W)
150
100
50
0
0
0.25
0.5



Conditions for R.F. SOAR

f = 470 MHz

T_{case} = 70 °C

V_{CCnom} = 13.8 V

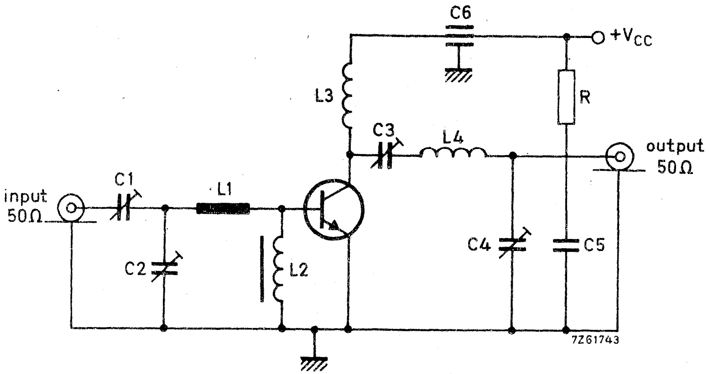
$P_{Snom} = P_S$ at $V_{CC} = V_{CCnom}$ and V.S.W.R. = 1

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, 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

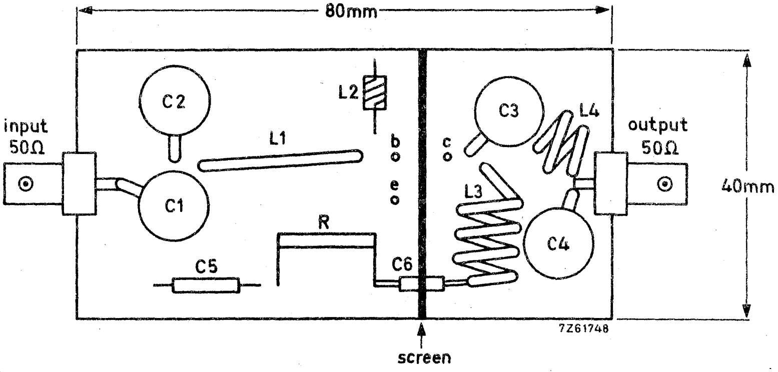
R = 10 Ω carbon

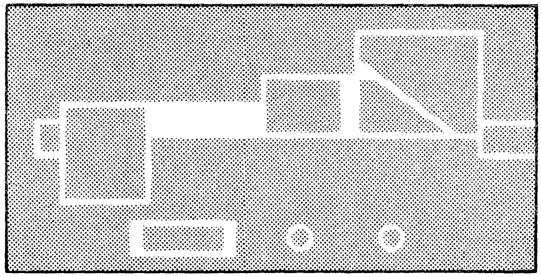
Graphs (P_L versus P_S and η versus P_S) for 175 MHz on page 8.

Component lay-out for 175 MHz on page 11.

APPLICATION INFORMATION (continued)

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





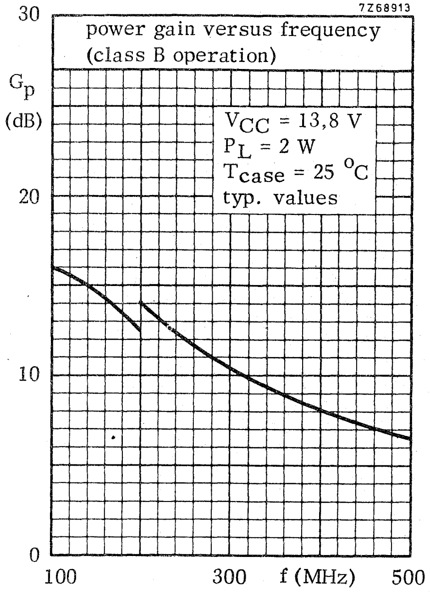
7Z61745.1

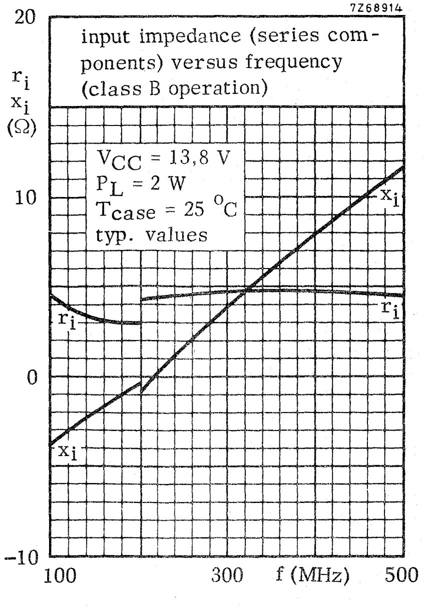
Shaded area copper

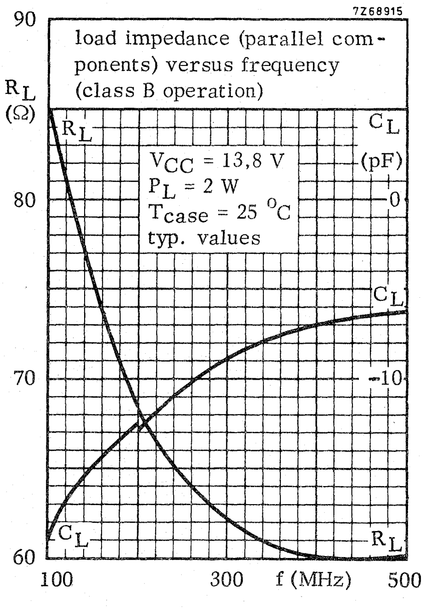
Back area not metallized

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

OPERATING NOTE Below 200 MHz a base-emitter resistor of 10 Ω is recommended to avoid oscillation. This resistor must be effective for both d.c. and r.f.







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

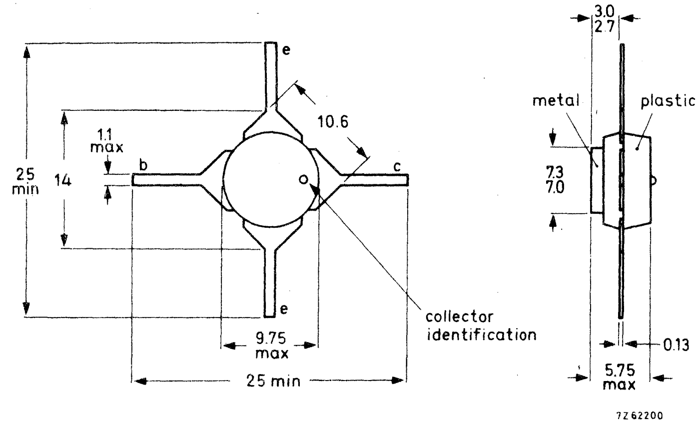
R.F. performance up to T_{mb} = 25 °C in an unneutralized common-emitter class B circuit.

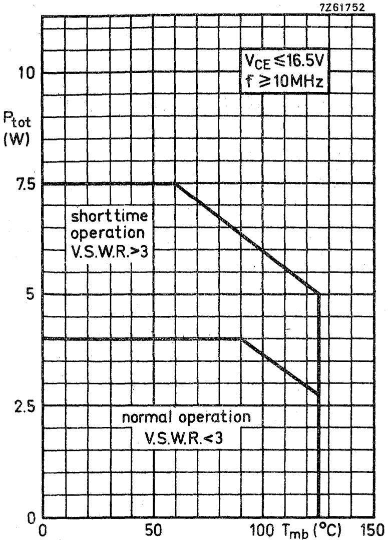
Mode of operation	V_{CC} (V)	f (MHz)	P_S (W)	P_L (W)	I_C (A)	G_p (dB)	η (%)	$\bar{z}_i$ (Ω)	$\bar{Y}_L$ (mA/V)
c.w.	13.8	470	typ. 0.15	1.5	typ. 0.17	typ. 10	typ. 65	-	-
c.w.	13.8	470	typ. 0.28	2.5	typ. 0.24	typ. 9.5	typ. 75	2.6+j4.8	23 - j23
c.w.	12.5	470	< 0.35	2.5	< 0.31	> 8.5	> 65	-	-
c.w.	12.5	175	typ. 0.03	3.0	typ. 0.29	typ. 20	typ. 84	-	-

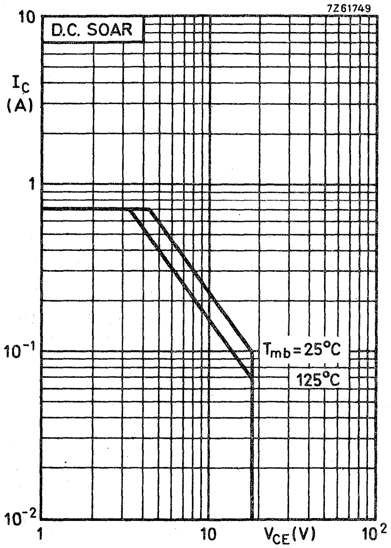
MECHANICAL DATA

Dimensions in mm

SOT-48 (without stud)




7Z61752
$V_{CE} \leq 16.5V$
$f \geq 10MHz$
P_{tot} (W)
10
7.5
5
2.5
0
shorttime 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 $T_{mb} = 90\,^{o}C$ f > 10 MHz	P_{tot}	max.	4.0	W
Temperatures				
Storage temperature	T_{stg}		-65 to +150	^{o}C
Junction temperature	T_j	max.	150	^{o}C

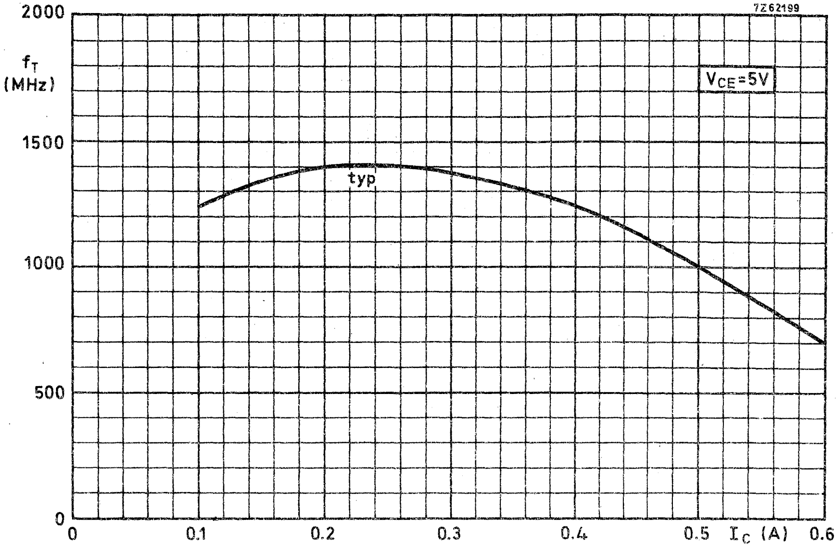
THERMAL RESISTANCE

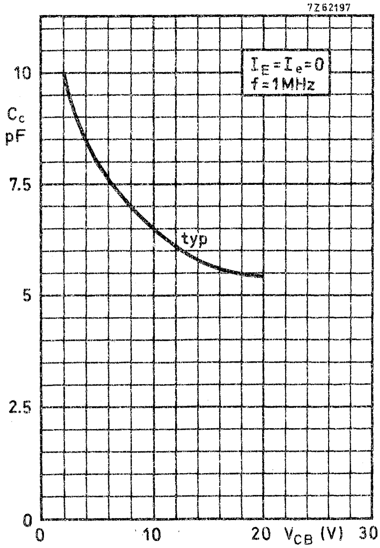
From junction to mounting base	$R_{th\ j\text{-}mb}$	=	12	$^{o}C/W$

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
Collector-stud capacitance	C_{cs}	typ.	2	pF


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


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

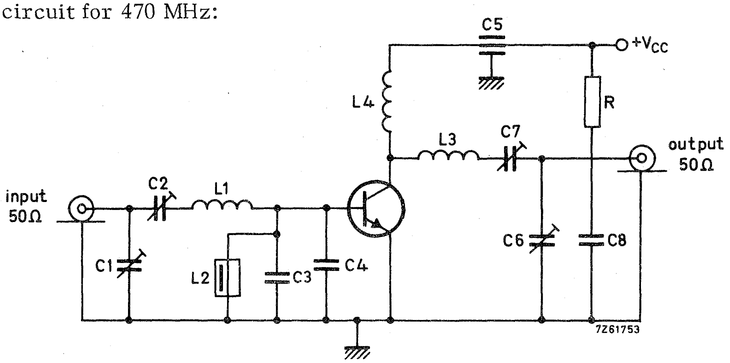
APPLICATION INFORMATION

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	2.6+j4.8	23 − j23
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	-	-

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

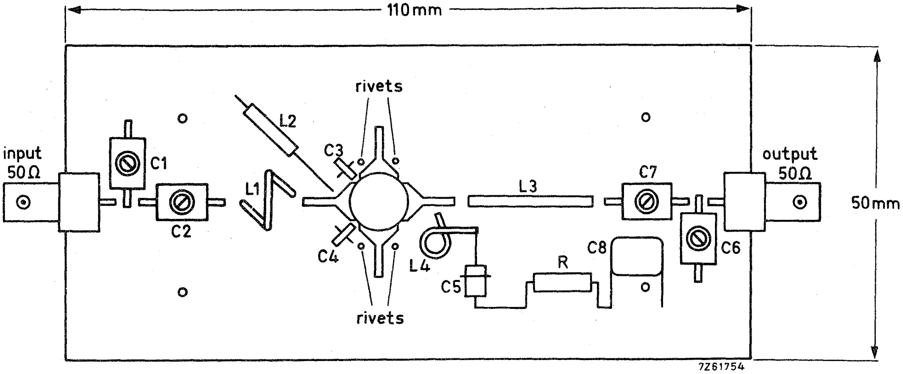
At P_L = 2.5 W and V_{CC} = 12.5 V the output power at mounting-base temperatures between 25 °C and 90 °C relative to that at 25 °C is diminished by typ. 5 mW/°C

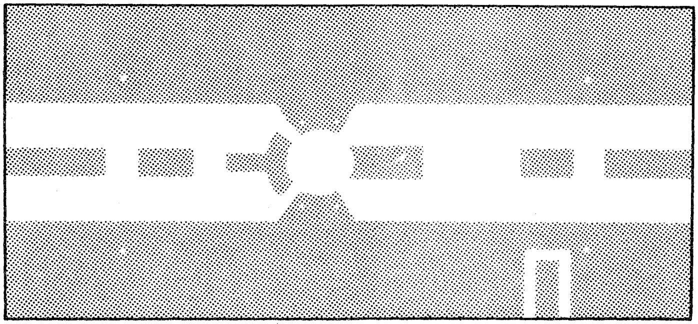
The transistor is designed to withstand full load mismatch in the test circuit under the following conditions: V_{CC} = 16.5 V; f = 470 MHz; T_{mb} = 70 °C;
V.S.W.R. = 50 : 1 through all phases; $P_S = P_{Snom}$ + 20 %
where $P_{Snom} = P_S$ for 2.5 W transistor output into 50 Ω load at V_{CC} = 13.8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

Component lay-out for 470 MHz see page 7

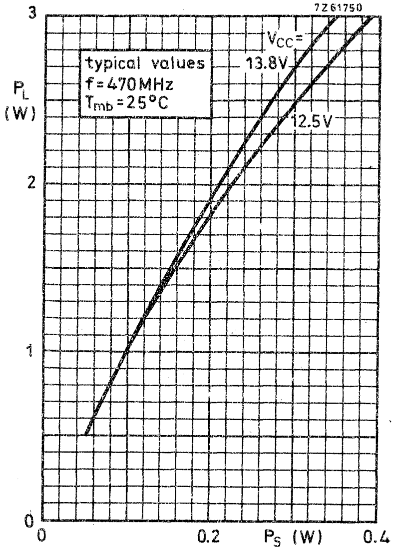
APPLICATION INFORMATION (continued)

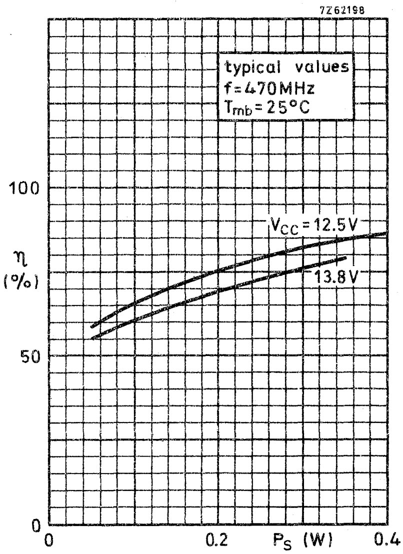
Component lay-out and printed circuit board for 470 MHz test circuit.

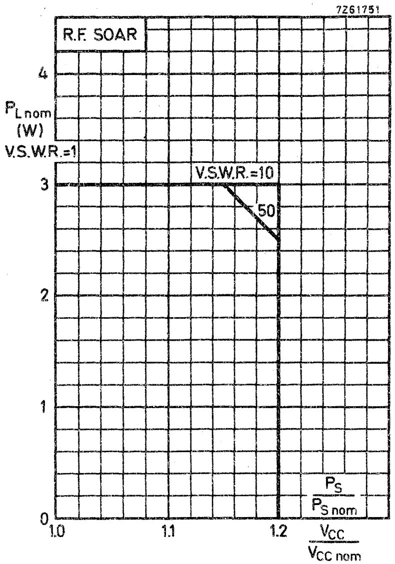




Shaded area copper
Back area completely copper clad
Material of printed circuit board: 1.5 mm epoxy fibre glass


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


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



Conditions for R.F. SOAR

f = 470 MHz

T_{mb} = 70 °C

V_{CCnom} = 13.8 V

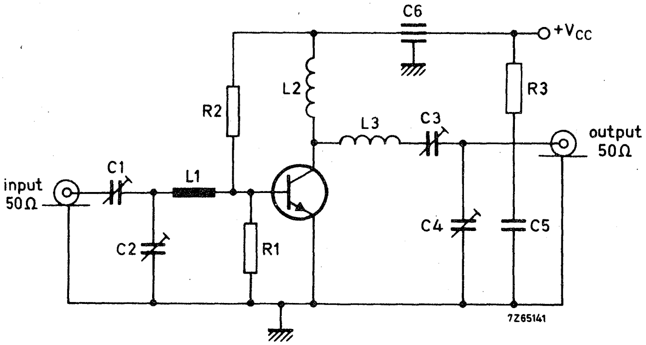
$P_{Snom} = P_S$ at $V_{CC} = V_{CCnom}$ and V.S.W.R. = 1

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 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

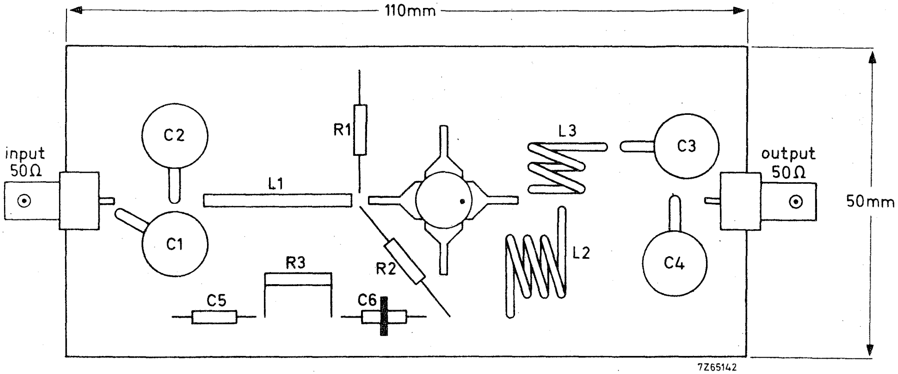
L1 = 25 mm straight Cu wire (1.2 mm); height above print max. 3 mm
L2 = 3 turns closely wound Cu wire (1.2 mm); int. diam. 10 mm; max. lead lenght 5 mm
L3 = 2 turns closely wound Cu wire (1.7 mm); int. diam. 12 mm; max. lead lenght 5 mm

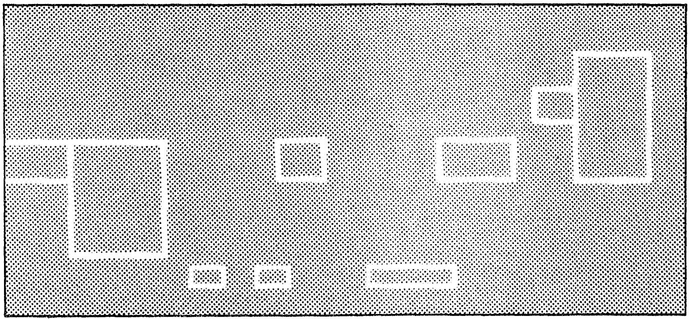
R1 = 50 Ω carbon
R2 = 1.2 kΩ carbon
R3 = 5 Ω carbon

Component lay-out for 175 MHz see page 11.

APPLICATION INFORMATION (continued)

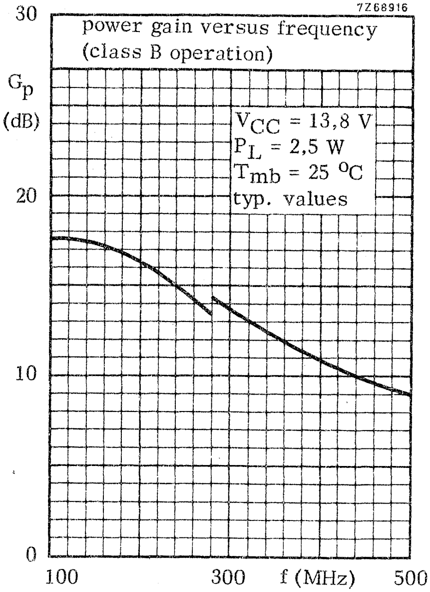
Component lay-out and printed circuit board for 175 MHz test circuit.

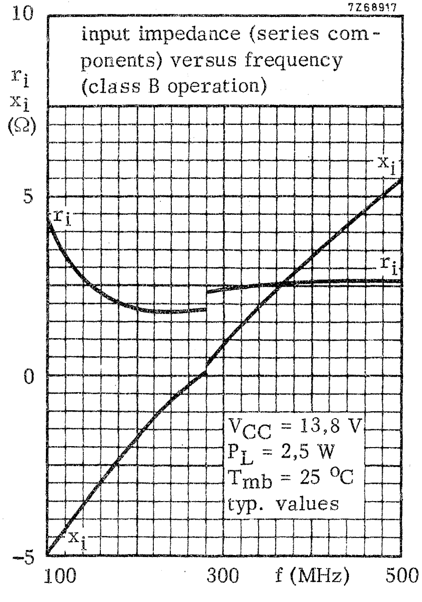


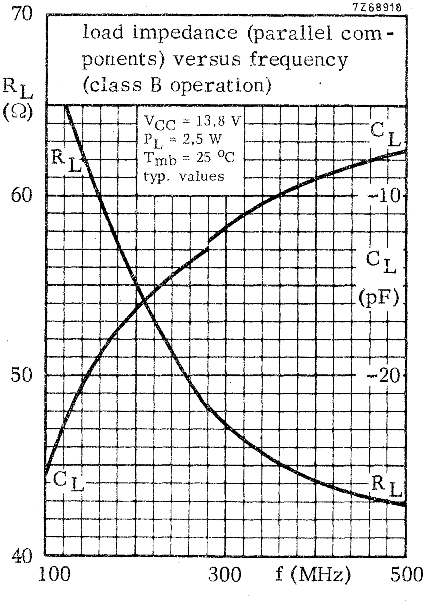


Shaded area copper
Back area not metallized
Material of printed circuit board: 1.5 mm epoxy fibre glass

OPERATING NOTE Below 280 MHz a base-emitter resistor of 10 Ω is recommended to avoid oscillation. This resistor must be effective for both d.c. and r.f.







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

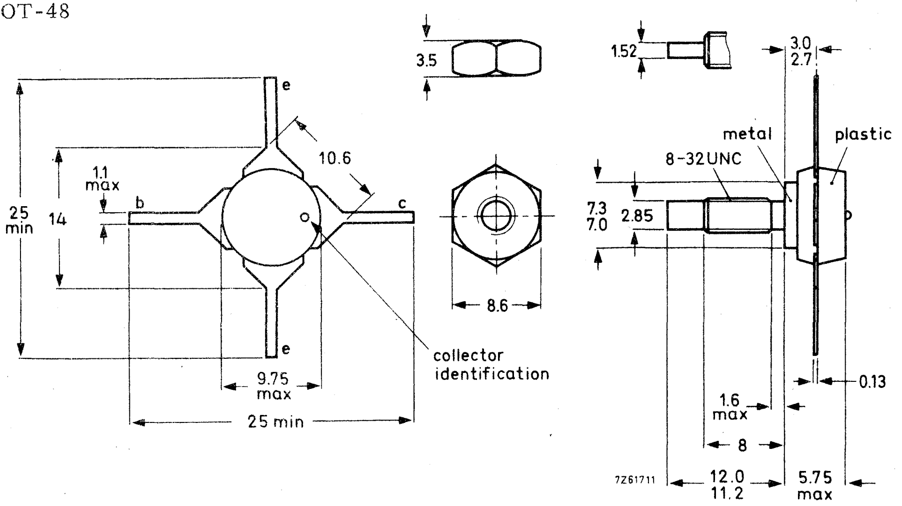
R.F. performance up to T_h = 25 °C in an unneutralized common-emitter class B circuit

Mode of operation	V_{CC} (V)	f (MHz)	P_S (W)	P_L (W)	I_C (A)	G_p (dB)	η (%)	$\overline{z}_i$ (Ω)	$\overline{Y}_L$ (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	2.9+j5.1	27 − j21
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	-	-

MECHANICAL DATA

Dimensions in mm

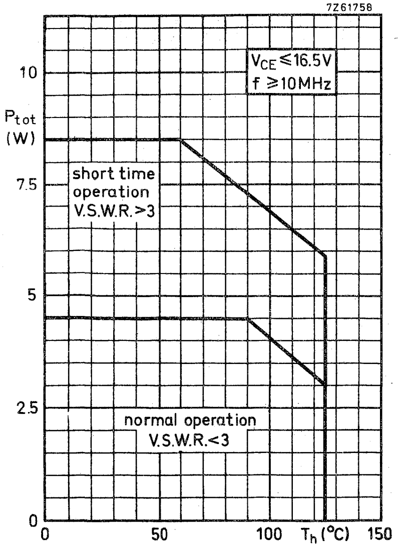
SOT-48

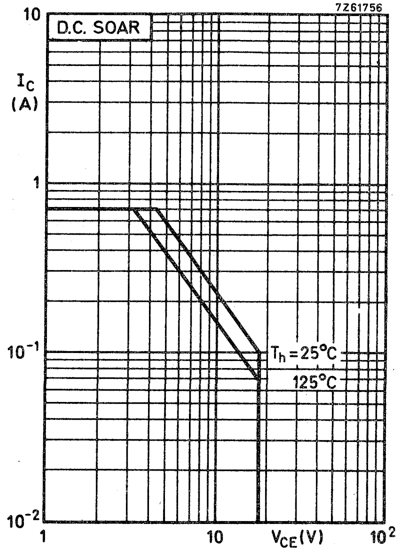


When locking is required an adhesive instead of a lock washer is preferred

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
P_{tot} (W)
10
7.5
5
2.5
0
0
50
100
T_h (°C)
150
$V_{CE} \leqslant 16.5 V$
$f \geqslant 10 MHz$
short time operation V.S.W.R.>3
normal operation V.S.W.R.<3


7Z61756
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

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

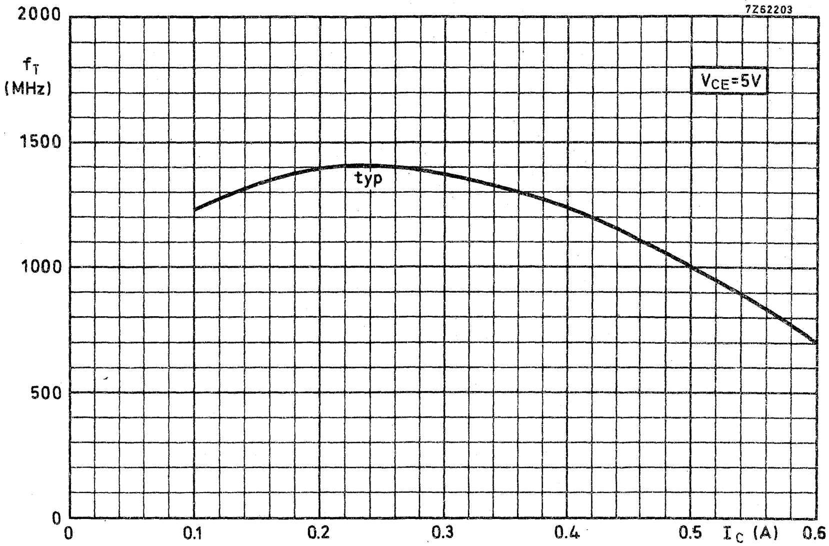
THERMAL RESISTANCE

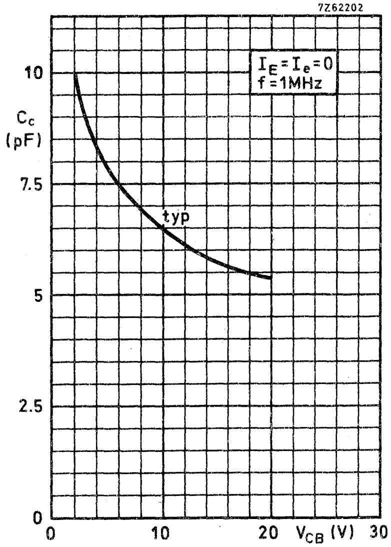
From junction to mounting base	$R_{th\ j\text{-}mb}$ =	12	°C/W
From mounting base to heatsink	$R_{th\ mb\text{-}h}$ =	0.6	°C/W

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


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

APPLICATION INFORMATION

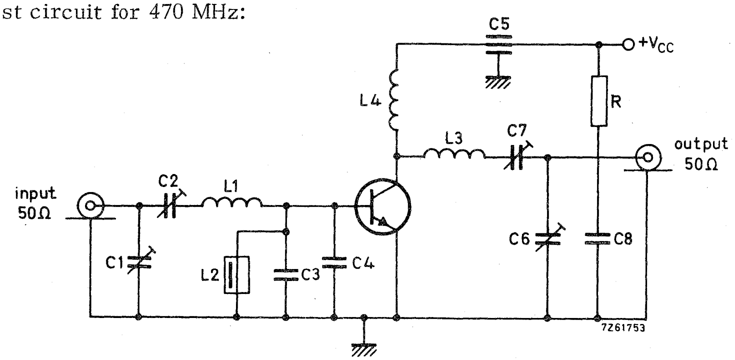
T_j = 25 °C unless otherwise specified

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	2.9 + j5.1	27 − j21
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	-	-

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

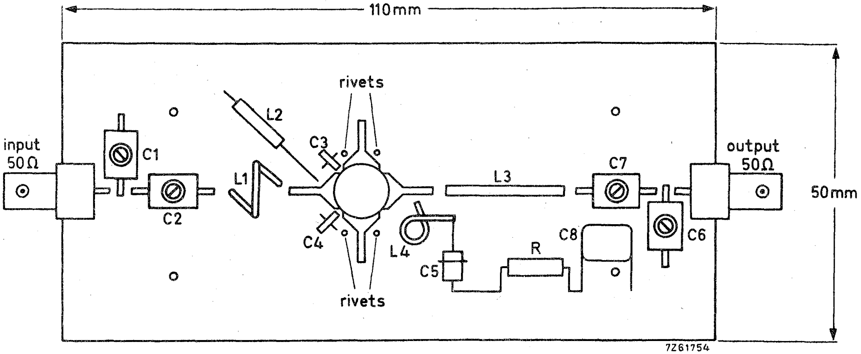
At P_L = 2.5 W and V_{CC} = 12.5 V, the output power at heatsink temperatures between 25 °C and 90 °C relative to that at 25 °C is diminished by typ. 5 mW/°C.

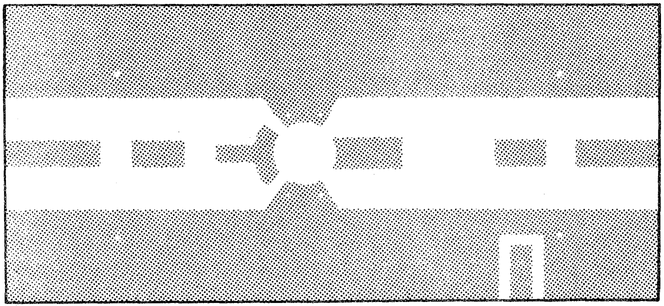
The transistor is designed to withstand full load mismatch in the test circuit under the following conditions: V_{CC} = 16.5 V; f = 470 MHz; T_h = 70 °C;
V.S.W.R. = 50 : 1 through all phases; $P_S = P_{Snom}$ + 20 %
where $P_{Snom} = P_S$ for 2.5 W transistor output into 50 Ω load and V_{CC} = 13.8 V

Component lay-out for 470 MHz see page 7

APPLICATION INFORMATION (continued)

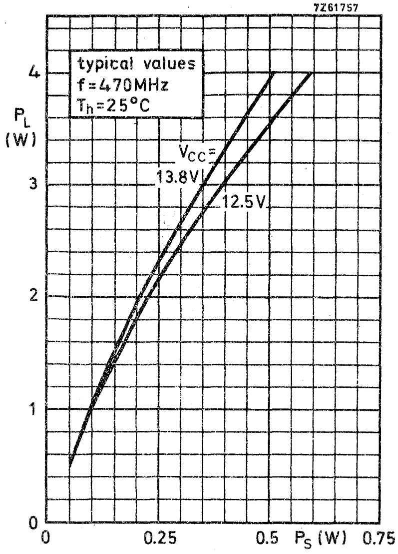
Component lay-out and printed circuit board for 470 MHz test circuit.

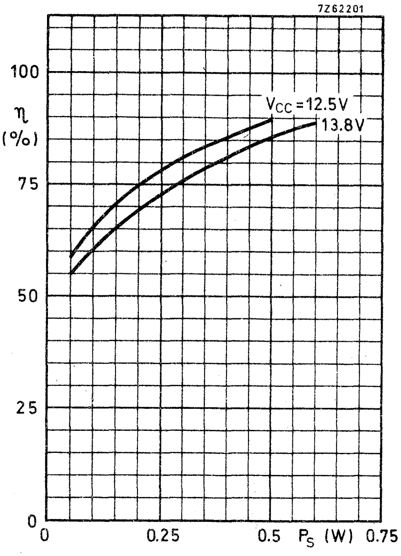


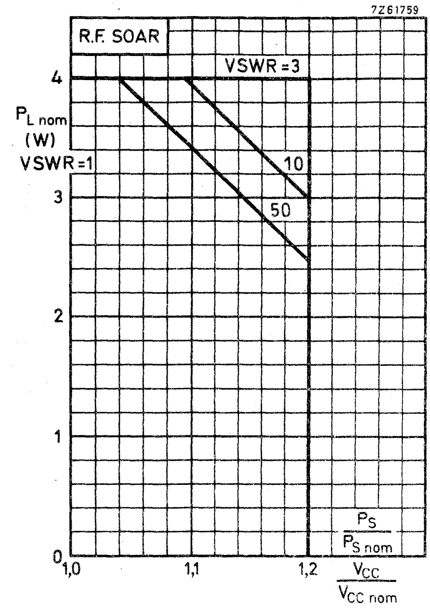


7Z61755.1

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


7Z61757
typical values
f=470MHz
Th=25°C
PL
(W)
4
3
2
1
0
VCC=
13.8V
12.5V
0
0.25
0.5
PS (W)
0.75


7Z62201
η
(%)
100
75
50
25
0
VCC=12.5V
13.8V
0
0.25
0.5
PS (W)
0.75



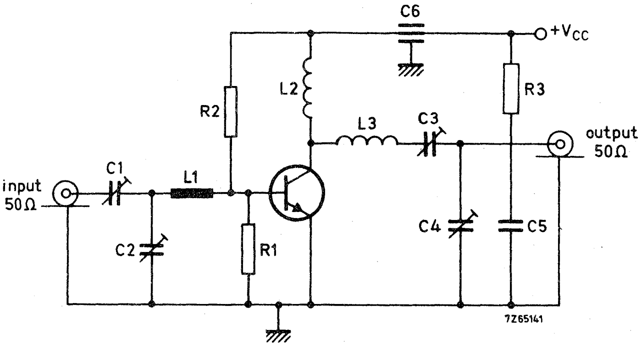
Conditions for R.F. SOAR

f = 470 MHz	$P_{Snom} = P_S$ at $V_{CC} = V_{CCnom}$ and VSWR = 1
T_h = 70 °C	$R_{th\ mb\text{-}h} = 0,6$ °C/W
$V_{CCnom} = 13,8$ 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 VSWR from 1 to 50.
It shows the max. permissible output power under nominal conditions in order not to exceed the max. permissible power dissipation under conditions of supply over-voltage ($V_{CC} > V_{CCnom}$) and load mismatch (VSWR > 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

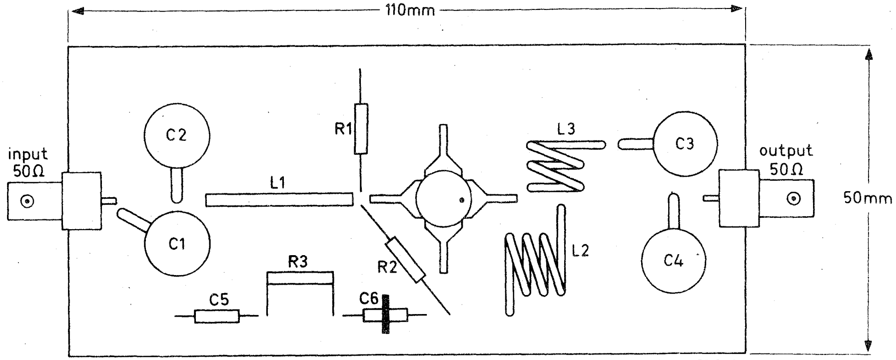
L1 = 25 mm straight Cu wire (1.2 mm); height above print max. 3 mm
L2 = 3 turns closely wound Cu wire (1.2 mm); int. diam. 10 mm; lead length 5 mm
L3 = 2 turns closely wound Cu wire (1.7 mm); int. diam. 12 mm; lead length 5 mm

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

Component lay-out for 175 MHz see page 11.

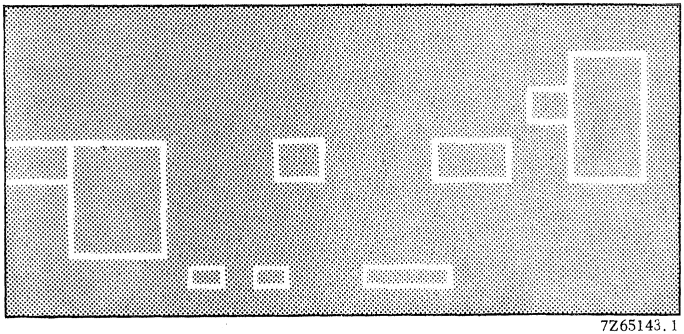
APPLICATION INFORMATION (continued)

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



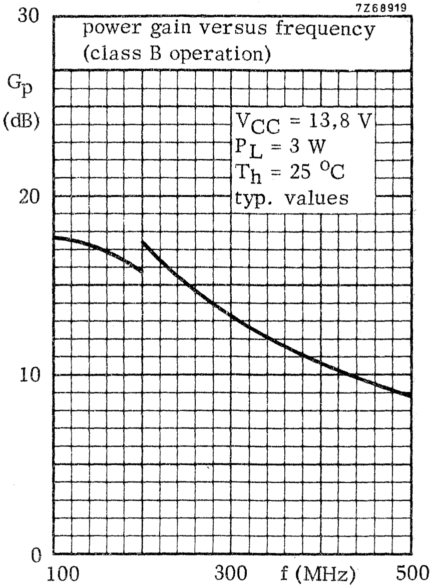
7Z65142

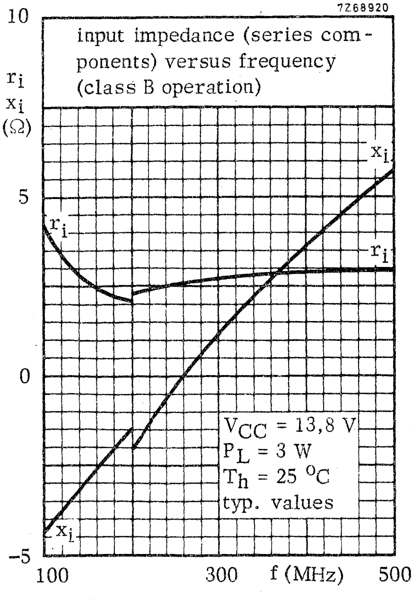
Shaded area copper
Back area not metalized
Material of pcb : 1.5 mm epoxy fibre glass

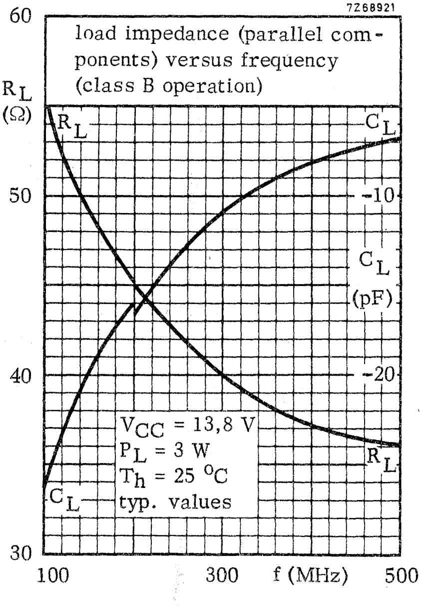


7Z65143.1

OPERATING NOTE Below 200 MHz a base-emitter resistor of 10 Ω is recommended to avoid oscillation. This resistor must be effective for both d.c. and r.f.







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

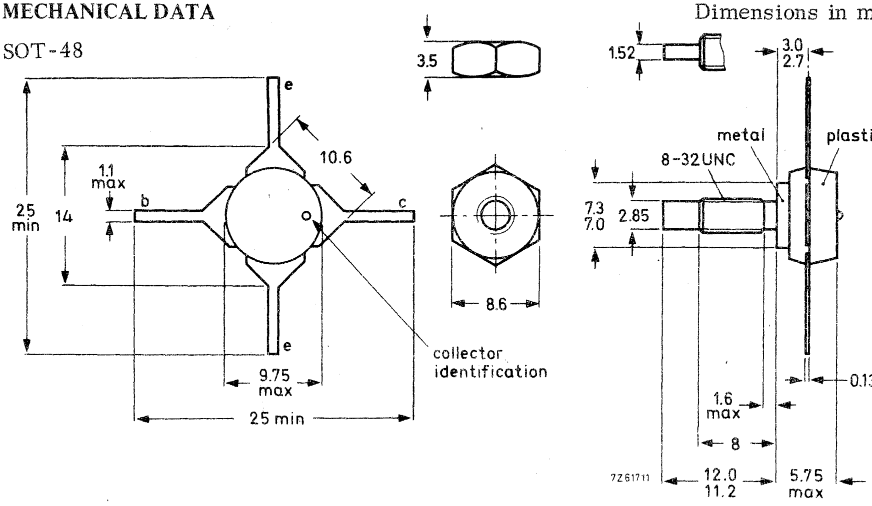
R.F. performance up to T_h = 25 °C in an unneutralised common-emitter class B circuit.

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	2.4+j6.7	60 – j20
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	–	–

MECHANICAL DATA

Dimensions in mm

SOT-48



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

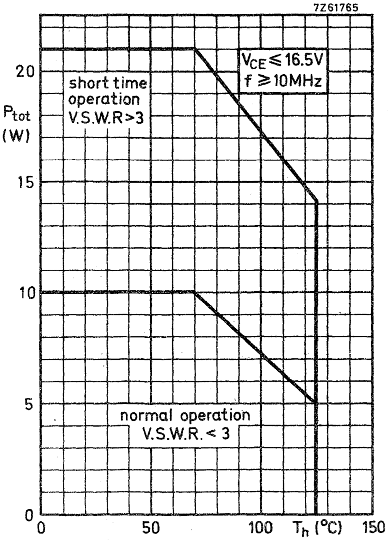
Total power dissipation up to T_h = 70 °C f > 10 MHz	P_{tot}	max.	10	W

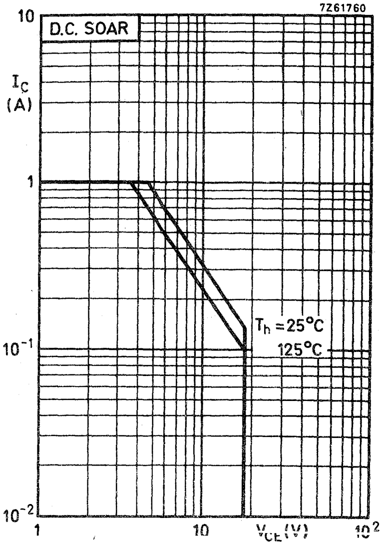
Temperatures

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

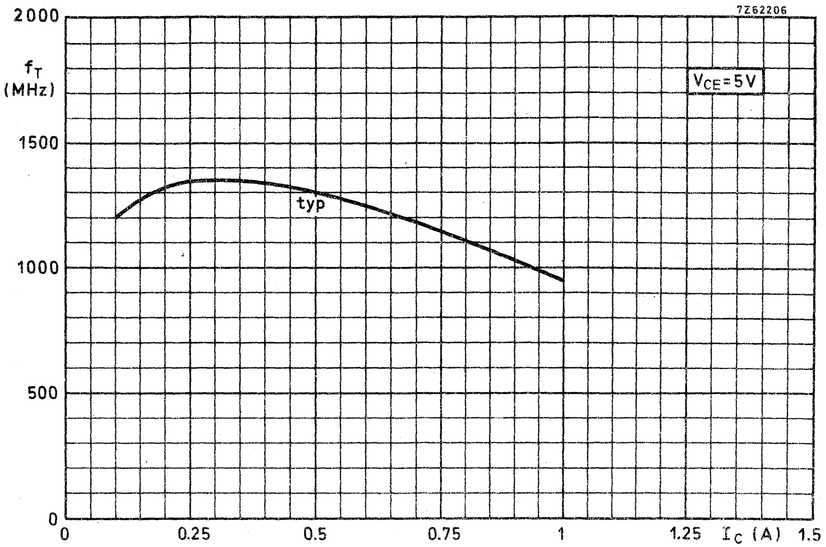

7Z61765
P_{tot} (W)
T_h (°C)
short time operation V.S.W.R>3
$V_{CE} \leq 16.5$V
f ≥ 10MHz
normal operation V.S.W.R. < 3
0
5
10
15
20
0
50
100
150

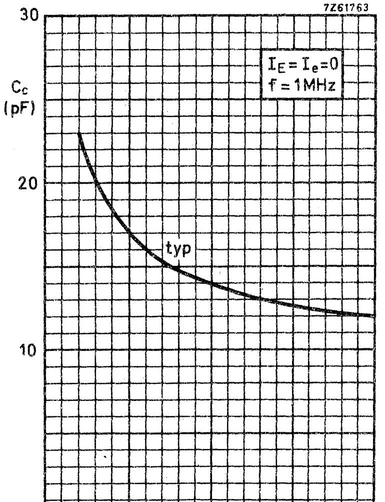

7Z61760
D.C. SOAR
I_C (A)
V_{CE} (V)
T_h = 25°C
125°C
10
1
10^{-1}
10^{-2}
1
10
10^2

CHARACTERISTICS

$T_j = 25\ ^{o}C$ 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
f_T (MHz)
2000
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
C_c (pF)
30
20
10
0
0
10
V_{CB}(V)
20
$I_E = I_e = 0$
f = 1 MHz
typ

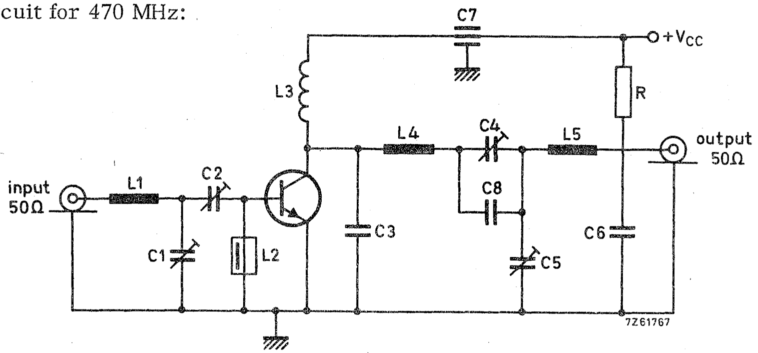
APPLICATION INFORMATION

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	2.4+j6.7	60 – j20
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	–	–

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

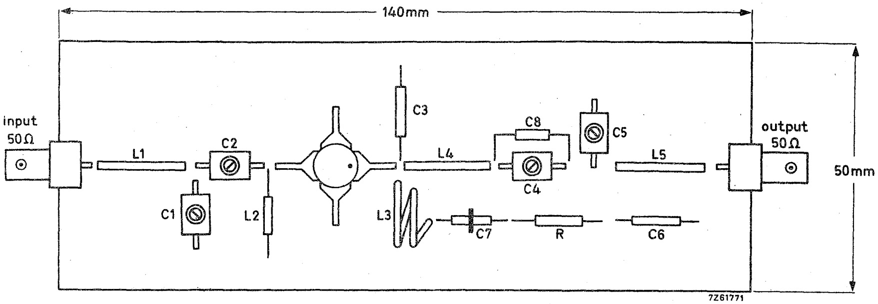
At P_L = 7.0 W and V_{CC} = 12.5 V the output power at heatsink temperatures between 25 °C and 90 °C relative to that at 25 °C is diminished by typ. 10 mW/°C

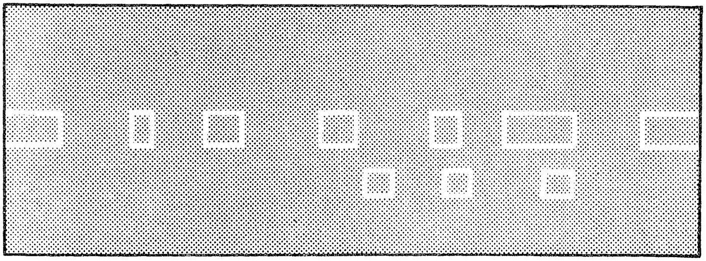
The transistor is designed to withstand full load mismatch in the test circuit under the following conditions: V_{CC} = 16.5 V; f = 470 MHz; T_h = 70 °C;
V.S.W.R. = 50 : 1 through all phases; $P_S = P_{Snom}$ + 20 %
where $P_{Snom} = P_S$ for 7.0 W transistor output into 50 Ω load at V_{CC} = 13.8 V

Component lay-out for 470 MHz see page 7

APPLICATION INFORMATION (continued)

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



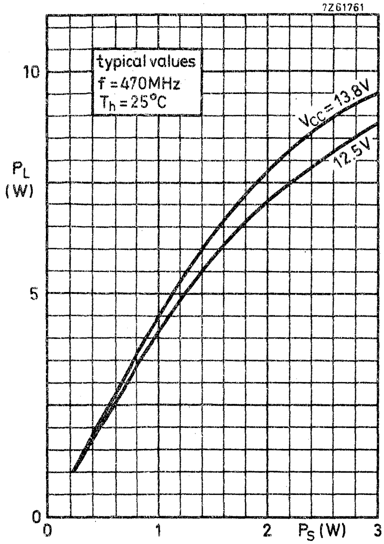


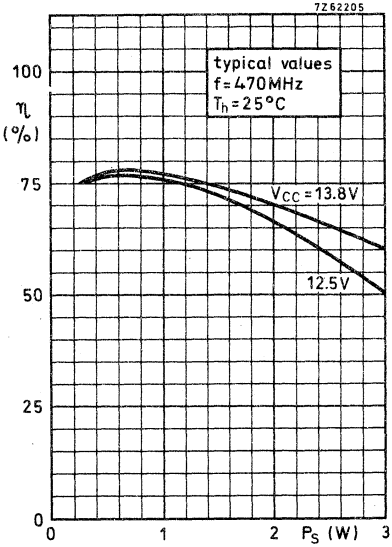
7Z61770.1

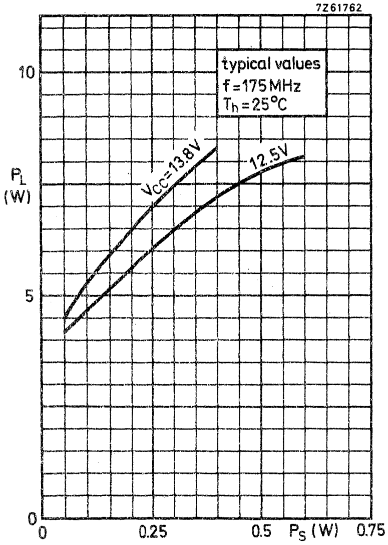
Shaded area copper

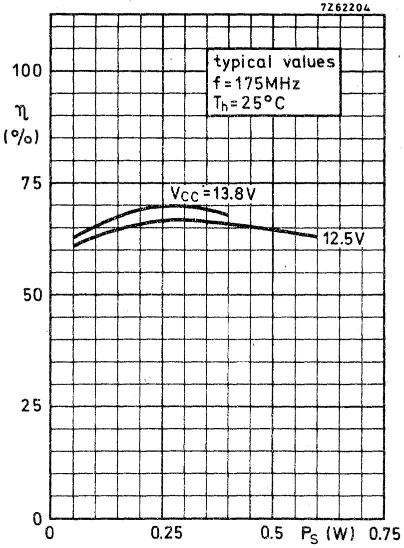
Back area completely copper clad

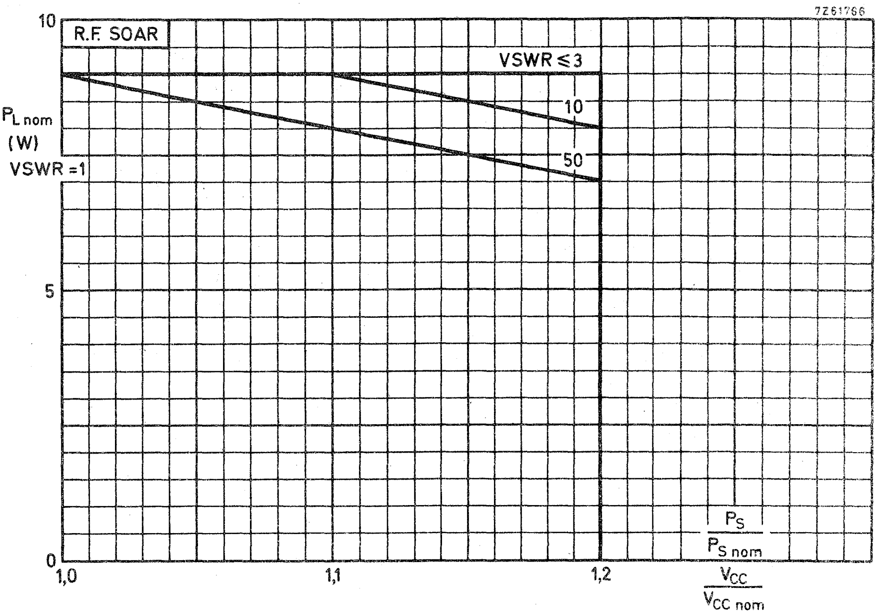
Material of printed circuit board: 1.5 mm epoxy fibre glass


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


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


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


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

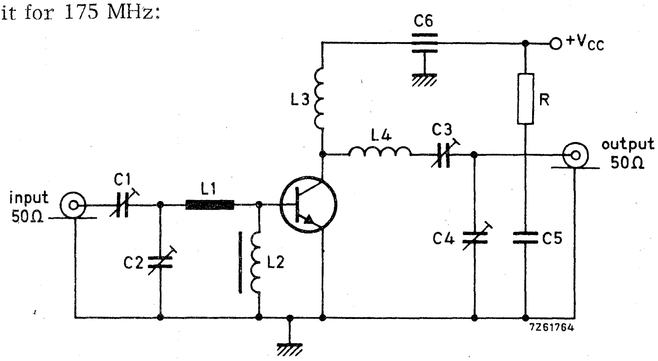
$P_{Snom} = P_S$ at $V_{CC} = V_{CCnom}$ and VSWR = 1

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 VSWR from 1 to 50. It shows the max. permissible output power under nominal conditions in order not to exceed the max. permissible power dissipation under conditions of supply over-voltage ($V_{CC} > V_{CCnom}$) and load mismatch (VSWR > 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 = 4.0 nF feed-through capacitor

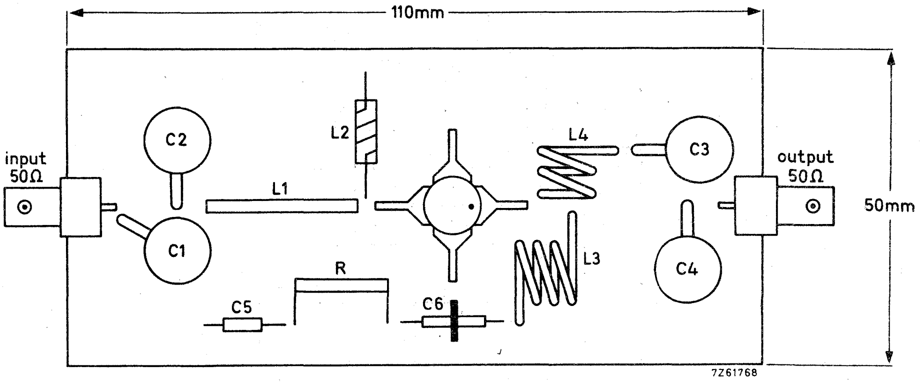
L1 = 25 mm straight Cu wire (1.2 mm); height above print 3 mm
L2 = 3 turns Cu wire (0.5 mm) on Ferrite FX1115, d = 2 mm, D = 4 mm, l = 5 mm material 3B (code number 3113 991 16740)
L3 = 5 turns closely wound Cu wire (1.2 mm); int. diam. 10 mm; lead length 5 mm
L4 = 3 turns closely wound Cu wire (1.2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

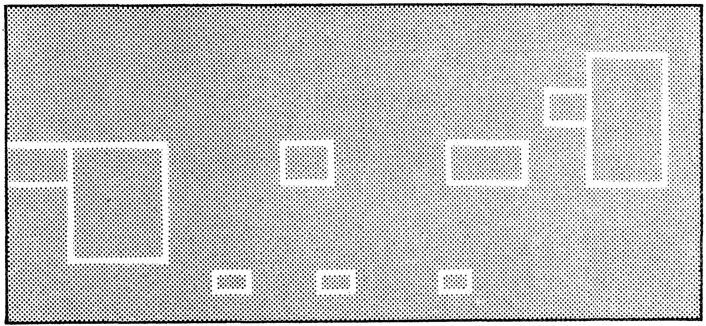
R = 10 Ω carbon

Graphs (P_L versus P_S and η versus P_S) for 175 MHz on page 8.
Component lay-out for 175 MHz on page 11.

APPLICATION INFORMATION (continued)

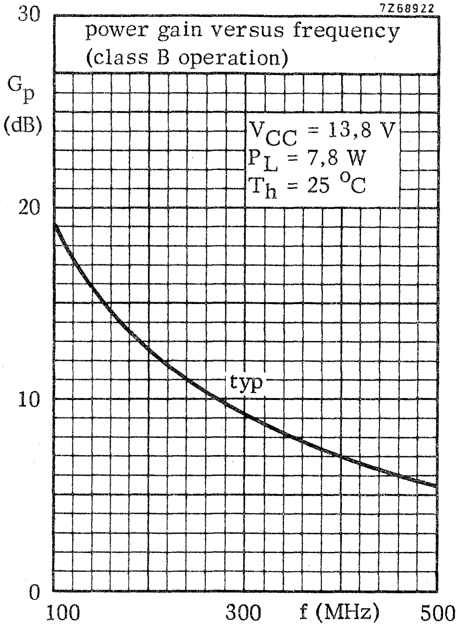
Component lay-out and printed circuit board for 175 MHz test circuit

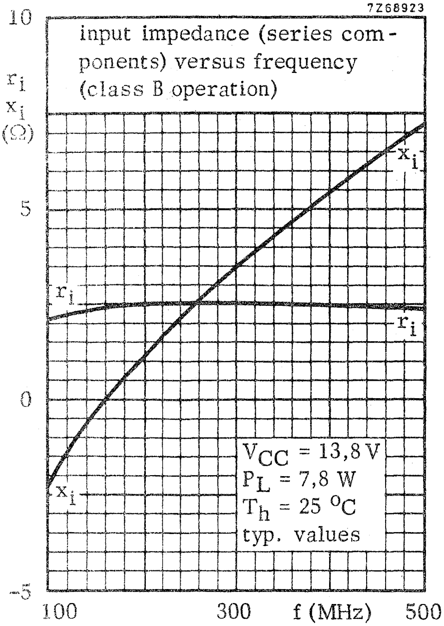


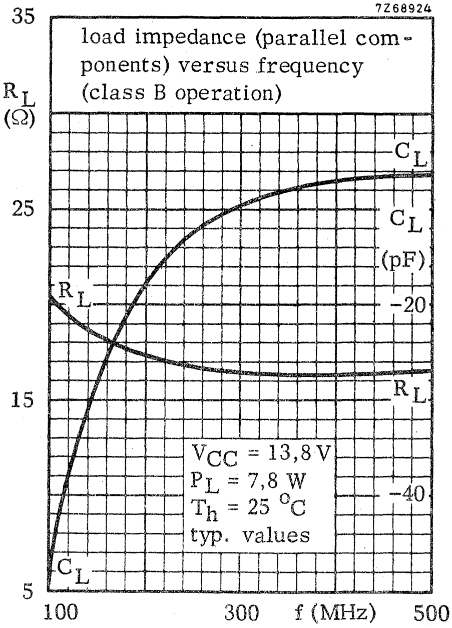


7Z61769.1

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


7Z68922
power gain versus frequency
(class B operation)
G_p
(dB)
30
20
10
0
V_{CC} = 13,8 V
P_L = 7,8 W
T_h = 25 °C
typ
100
300
f (MHz)
500


7Z68923
input impedance (series components) versus frequency
(class B operation)
r_i
x_i
(Ω)
10
5
0
-5
x_i
r_i
r_i
x_i
V_{CC} = 13,8 V
P_L = 7,8 W
T_h = 25 °C
typ. values
100
300
f (MHz)
500


7Z68924
load impedance (parallel components) versus frequency
(class B operation)
R_L
(Ω)
35
25
15
5
C_L
C_L
(pF)
-20
-40
R_L
R_L
C_L
V_{CC} = 13,8 V
P_L = 7,8 W
T_h = 25 °C
typ. values
100
300
f (MHz)
500

U.H.F. POWER TRANSISTOR

N-P-N silicon planar epitaxial 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. Gold metallization ensures extremely high reliability. 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.

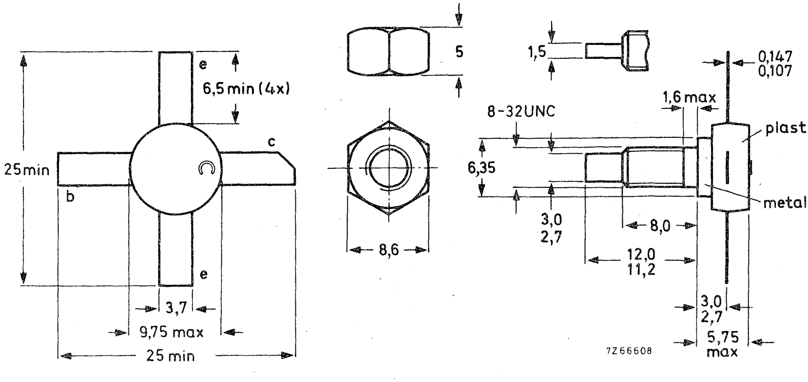
QUICK REFERENCE DATA

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	< 8,0	20	< 2,28	> 4	> 65	1,2+j4,5	163 − j35
c.w.	12,5	470	< 6,8	17	< 2,09	> 4	> 65	–	–

MECHANICAL DATA Dimensions in mm

SOT-48



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 (IEC 134)

Voltages

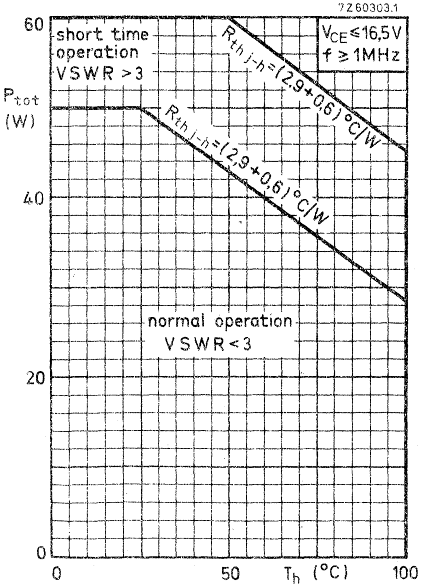
Collector-base voltage (open emitter) peak value	V_{CBOM}	max.	36	V
Collector-emitter voltage (open base)	V_{CEO}	max.	18	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4	V

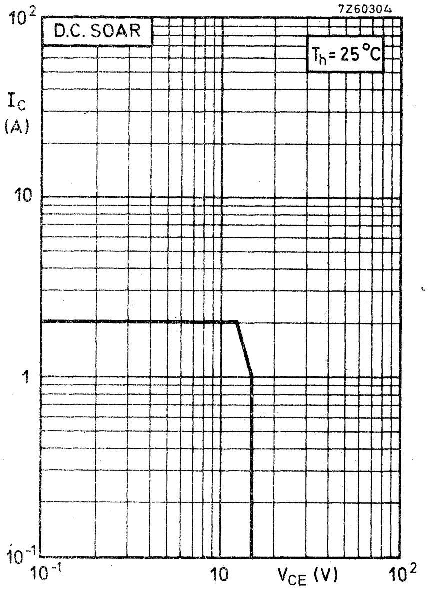
Currents

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 $T_h = 25\ ^oC$ $f \geq 1$ MHz	P_{tot}	max.	50	W





Temperatures

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

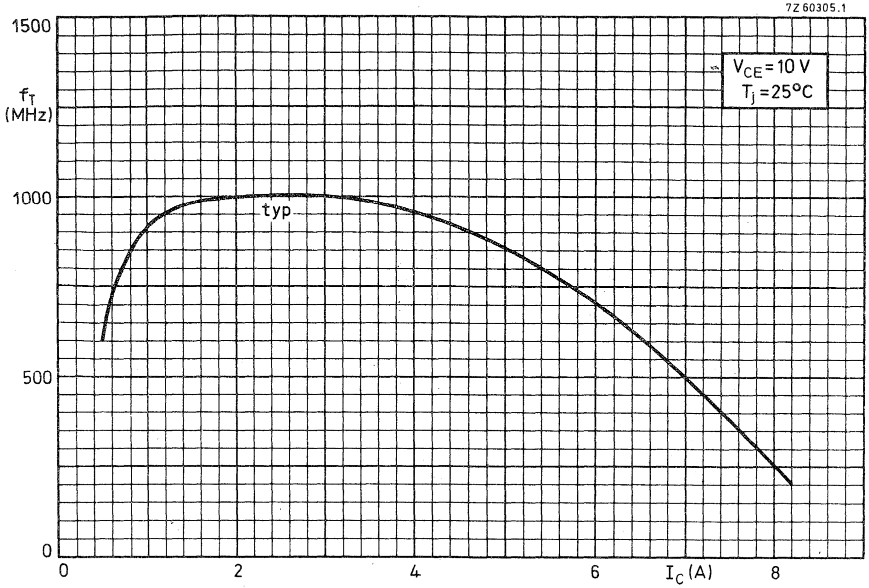
THERMAL RESISTANCE

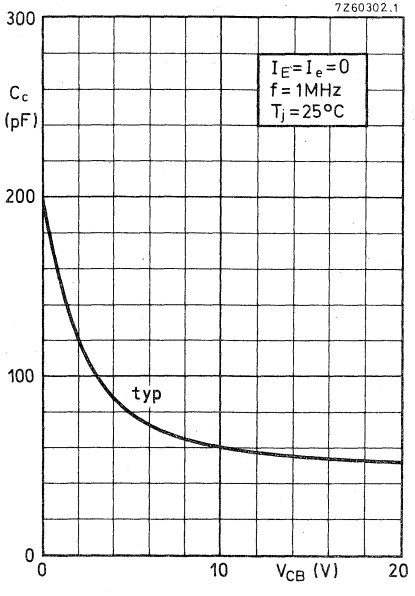
From junction to mounting base	$R_{th\ j-mb}$	=	2,9	$^oC/W$
From mounting base to heatsink	$R_{th\ mb-h}$	=	0,6	$^oC/W$

CHARACTERISTICS

T_j = 25 °C unless otherwise 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 Ω	E	>	3,1	mWs
D.C. current gain				
I_C = 1 A; V_{CE} = 5 V	h_{FE}	>	10	
		typ.	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	pF
		<	70	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 60305.1
1500
f_T
(MHz)
1000
500
0
0
2
4
6
I_C (A)
8
V_{CE} = 10 V
T_j = 25 °C
typ


7Z60302.1
300
C_c
(pF)
200
100
0
0
10
V_{CB} (V)
20
$I_E = I_e = 0$
f = 1 MHz
T_j = 25 °C
typ

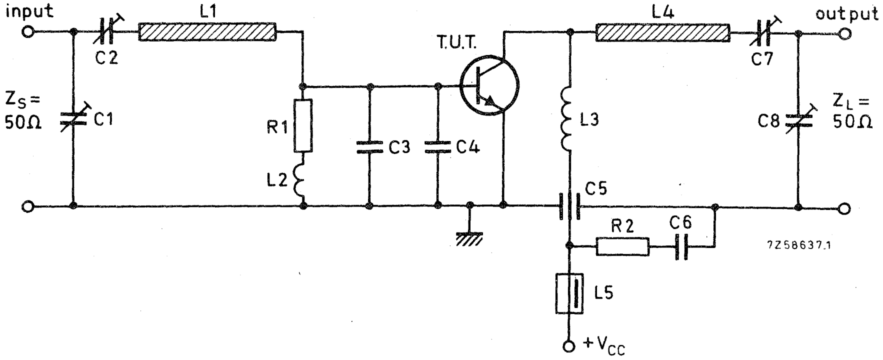
APPLICATION INFORMATION

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

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	< 8,00	20	< 2,28	> 4	> 65	1,2+j4,5	163 − j35
470	12,5	< 6,80	17	< 2,09	> 4	> 65	−	−
175	12,5	typ. 1,35	17	typ. 2,30	typ. 11	typ. 60	−	−

Test circuit for 470 MHz:



List of components :

C1 = C2 = C7 = C8 = 2,0 to 9,0 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

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

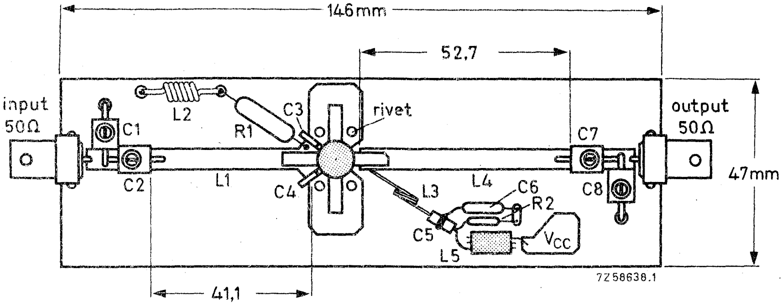
L1 = stripline (41,1 mm x 5,0 mm)
L2 = 13 turns closely wound enamelled Cu wire (0,5 mm); int. diam. 4,0 mm (0,32 μH)
L3 = 2 turns Cu wire (1 mm); winding pitch 1,5 mm; int. diam. 4 mm; leads 2 x 5 mm
L4 = stripline (52,7 mm x 5,0 mm)
L5 = ferroxcube choke coil. Z (at f = 50 MHz) = 750 Ω ± 20% (code number 4312 020 36640)

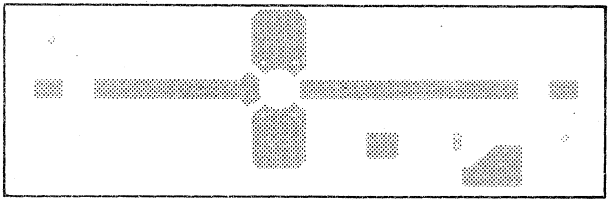
L1 and L4 are striplines on a double Cu clad print plate with teflon fibre-glass dielectric. (ϵ_r = 2,74); thickness 1,45 mm.

Component lay-out for 470 MHz test circuit: see page 6.

APPLICATION INFORMATION (continued)

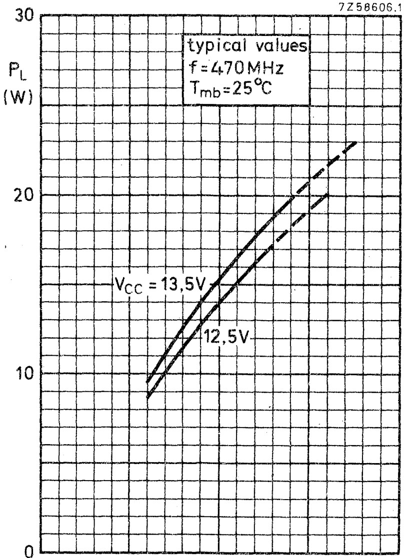
Component lay-out and printed circuit board for 470 MHz test circuit.

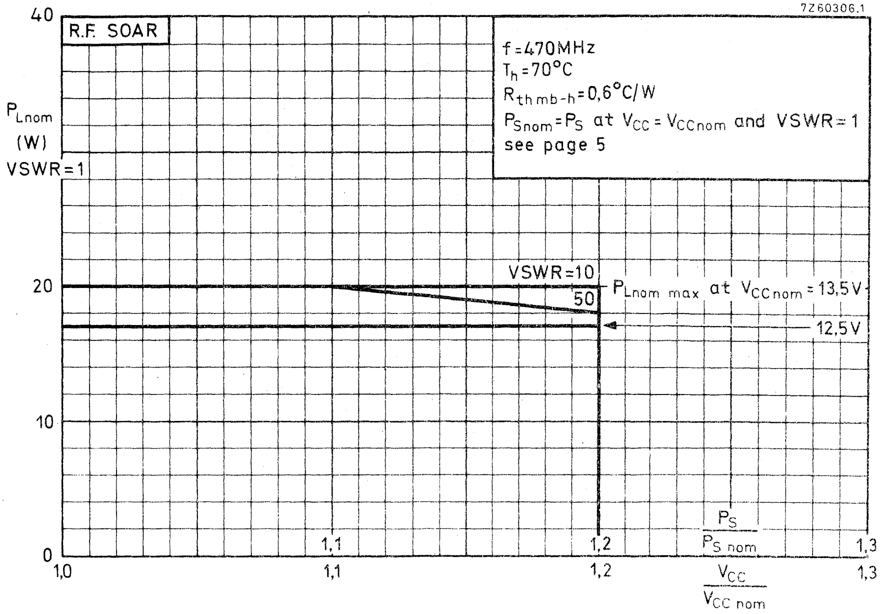




7Z66443.1

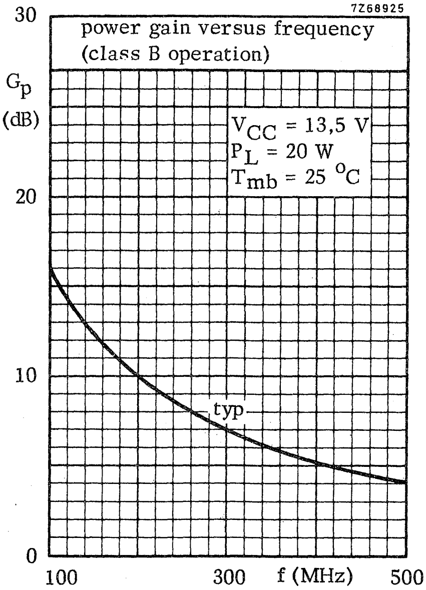
The circuit and the components are situated on one side of the teflon fibre-glass board, the other side being fully metallized to serve as earth. Earth connections are made by means of hollow rivets.

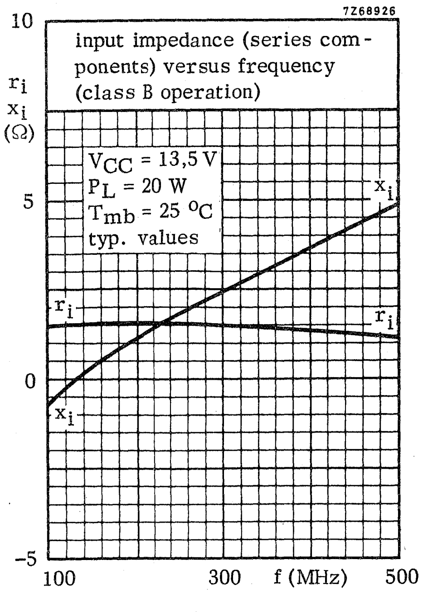


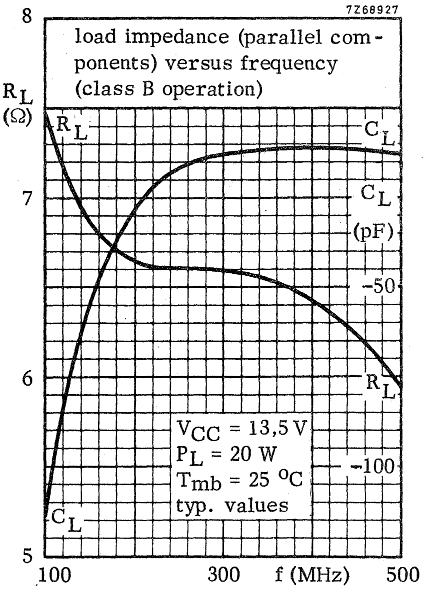


The transistor has been developed for use with unstabilized supply voltages. As the output power and drive power increase with the supply voltage, the nominal output power must be derated in accordance with the graph above for safe operation at supply voltages other than the nominal. The graph shows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

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.


7Z68925
power gain versus frequency
(class B operation)
G_p
(dB)
30
20
10
0
V_{CC} = 13,5 V
P_L = 20 W
T_{mb} = 25 °C
typ
100
300
f (MHz)
500


7Z68926
input impedance (series components) versus frequency
(class B operation)
r_i
x_i
(Ω)
10
5
0
−5
V_{CC} = 13,5 V
P_L = 20 W
T_{mb} = 25 °C
typ. values
x_i
r_i
r_i
x_i
100
300
f (MHz)
500


7Z68927
load impedance (parallel components) versus frequency
(class B operation)
R_L
(Ω)
8
7
6
5
R_L
C_L
C_L
(pF)
−50
R_L
−100
C_L
V_{CC} = 13,5 V
P_L = 20 W
T_{mb} = 25 °C
typ. values
100
300
f (MHz)
500

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.
Gold metallization ensures extremely high reliability.
It has a capstan envelope with a moulded cap. All leads are isolated from the stud.

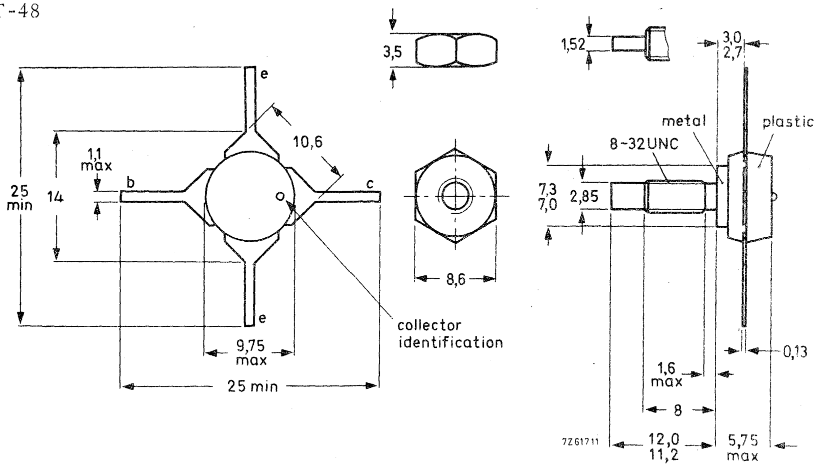
QUICK REFERENCE DATA

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 (mW)	P_L (W)	I_C (mA)	G_p (dB)	η (%)	$\overline{z_i}$ (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	2,5 + j0,2	3,4 – j16
c.w.	28	1000	typ. 400	1,4	typ. 100	typ. 5,4	typ. 50	–	–

MECHANICAL DATA Dimensions in mm

SOT-48



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

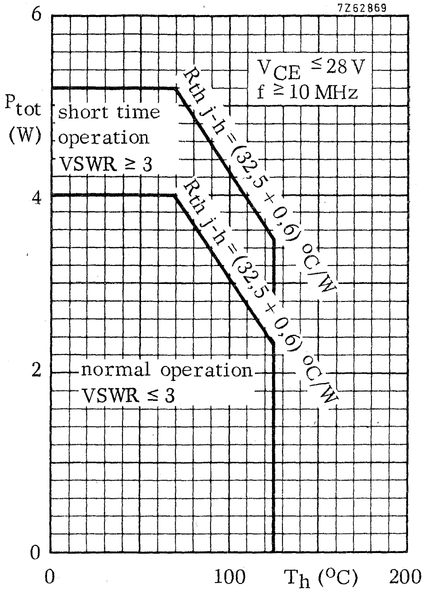
Total power dissipation up to T_h = 70 °C f ≥ 10 MHz (see also page 3)	P_{tot}	max.	4,0	W

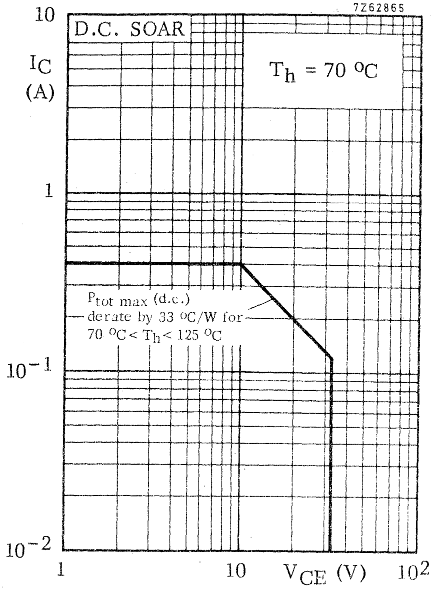
Temperatures

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

THERMAL RESISTANCE

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

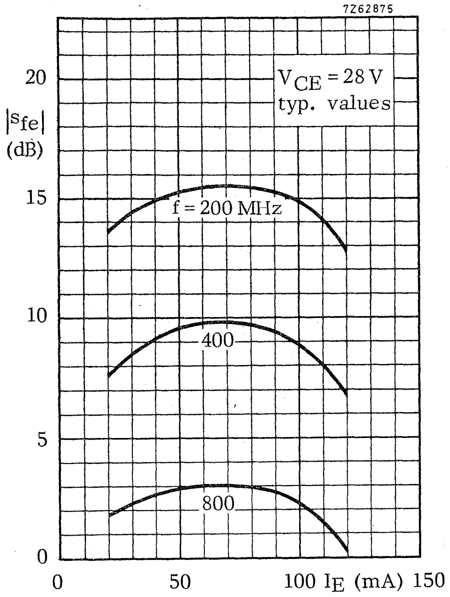

7Z62869
P_{tot} (W)
6
4
2
0
0
100
200
T_h (°C)
$V_{CE} \leq 28$ V
f ≥ 10 MHz
short time operation VSWR ≥ 3
normal operation VSWR ≤ 3
$R_{th\ j-h}$ = (32,5 + 0,6) °C/W
$R_{th\ j-h}$ = (32,5 + 0,6) °C/W

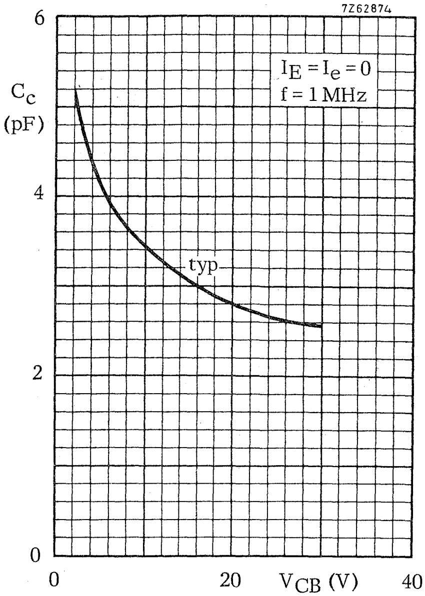

7Z62865
D.C. SOAR
I_C (A)
10
1
10^{-1}
10^{-2}
1
10
10^2
V_{CE} (V)
T_h = 70 °C
$P_{tot\ max}$ (d.c.)
derate by 33 °C/W for
70 °C < T_h < 125 °C

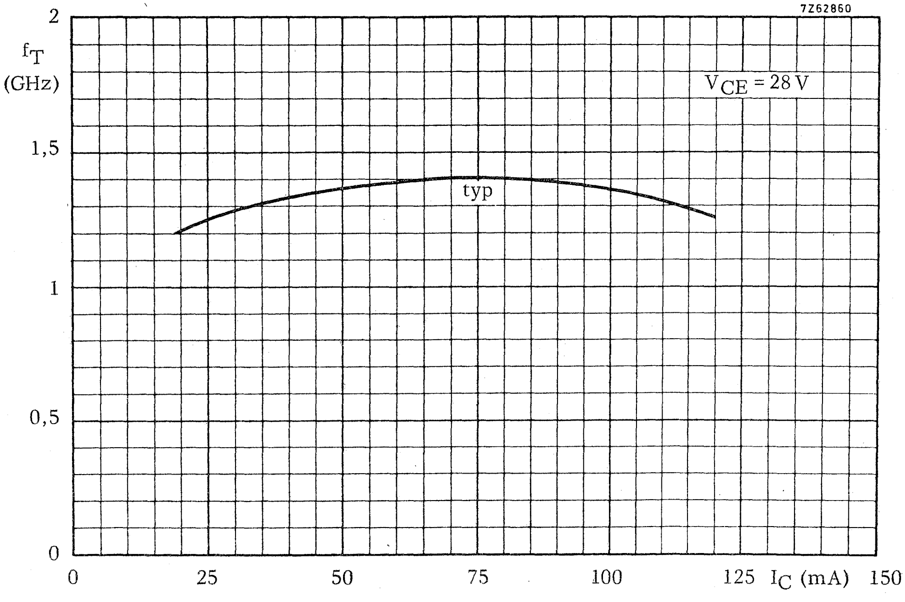
CHARACTERISTICS

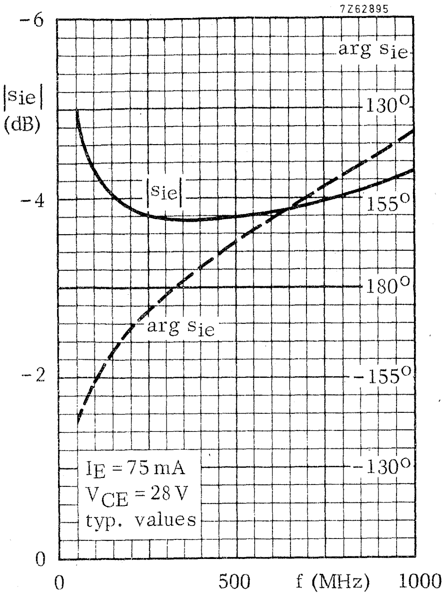
$T_j = 25\,^{\circ}C$ unless otherwise specified

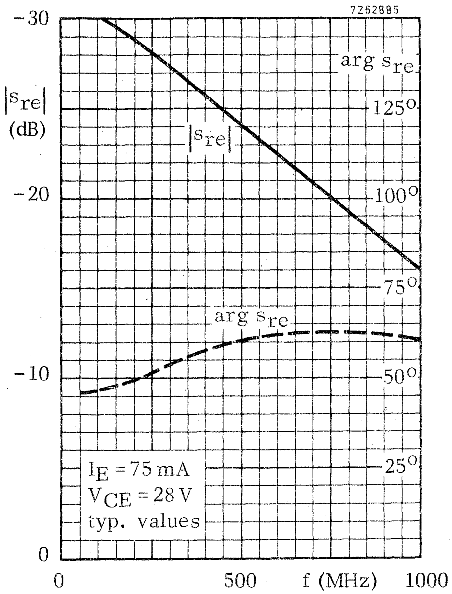
Breakdown voltages				
Collector-base voltage open emitter, $I_C = 10$ mA	$V_{(BR)CBO}$	>	65	V
Collector-emitter voltage $V_{BE} = 0$, $I_C = 10$ mA	$V_{(BR)CES}$	>	65	V
Collector-emitter voltage open base, $I_C = 25$ mA	$V_{(BR)CEO}$	>	33	V
Emitter-base voltage open collector, $I_E = 1{,}0$ mA	$V_{(BR)EBO}$	>	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

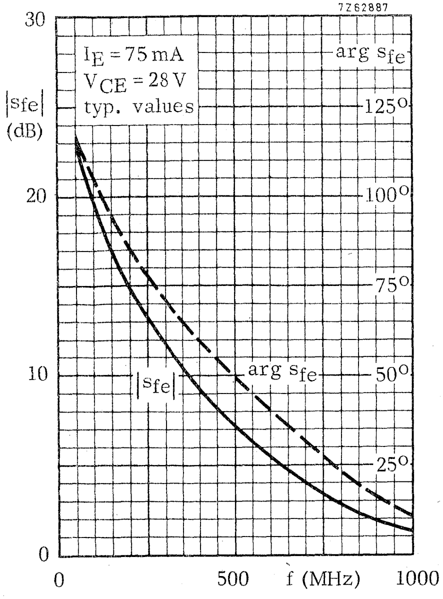

7Z62875
20
15
10
5
0
$|s_{fe}|$
(dB)
V_{CE} = 28 V
typ. values
f = 200 MHz
400
800
0
50
100
150
I_E (mA)

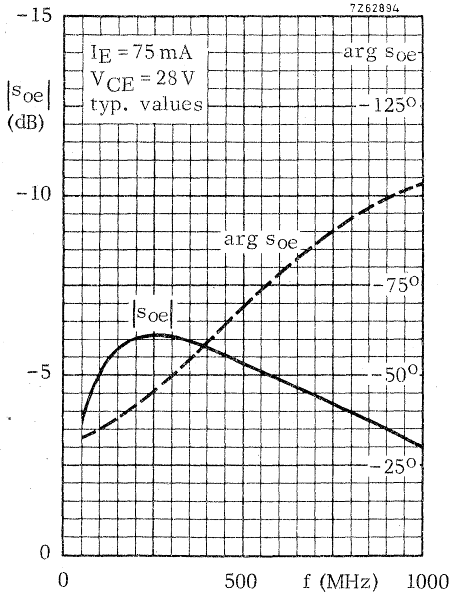

7Z62874
6
4
2
0
C_c
(pF)
$I_E = I_e = 0$
f = 1 MHz
typ
0
20
40
V_{CB} (V)


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


7Z62895
arg s_{ie}
$|s_{ie}|$ (dB)
$|s_{ie}|$
arg s_{ie}
130°
155°
180°
−155°
−130°
−6
−4
−2
0
0
500
f (MHz)
1000
I_E = 75 mA
V_{CE} = 28 V
typ. values


7Z62885
arg s_{re}
$|s_{re}|$ (dB)
$|s_{re}|$
arg s_{re}
125°
100°
75°
50°
25°
−30
−20
−10
0
0
500
f (MHz)
1000
I_E = 75 mA
V_{CE} = 28 V
typ. values


7Z62887
I_E = 75 mA
V_{CE} = 28 V
typ. values
arg s_{fe}
$|s_{fe}|$ (dB)
$|s_{fe}|$
arg s_{fe}
125°
100°
75°
50°
25°
30
20
10
0
0
500
f (MHz)
1000


7Z62894
I_E = 75 mA
V_{CE} = 28 V
typ. values
arg s_{oe}
$|s_{oe}|$ (dB)
arg s_{oe}
$|s_{oe}|$
−125°
−75°
−50°
−25°
−15
−10
−5
0
0
500
f (MHz)
1000

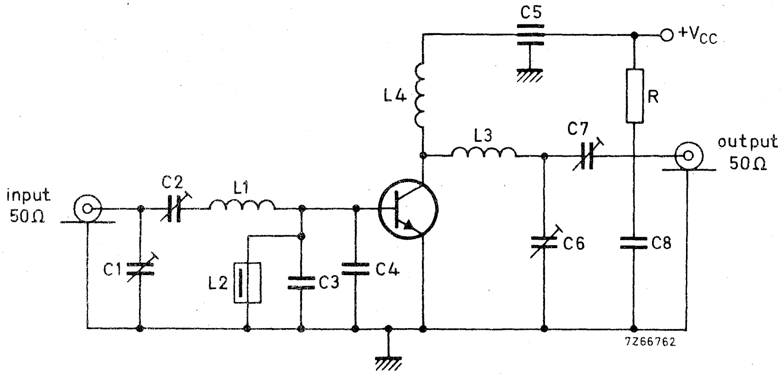
APPLICATION INFORMATION

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)	η (%)	$\overline{z_i}$ (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	2,5 + j0,2	3,4 – j16
28	1000	typ. 400	1,4	typ. 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. dia. 5 mm; lead length = 2 mm
L2 = 0,47 μH choke
L3 = 4 turns closely wound enamelled Cu wire (1,2 mm); int. dia. 6,5 mm; lead length = 4 mm
L4 = 5 turns closely wound enamelled Cu wire (0,5 mm); int. dia. 4 mm; lead length = 5 mm

R = 10 Ω carbon

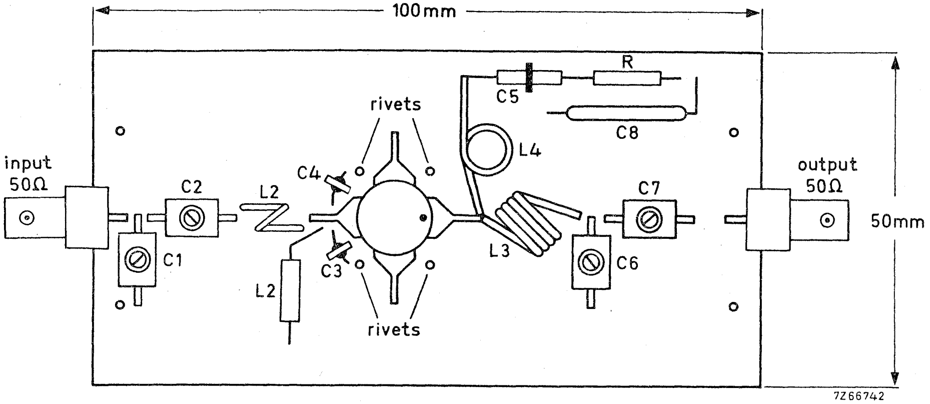
At P_L = 1,0 W and V_{CC} = 28 V, the output power at heatsink temperatures between 25 °C and 90 °C relative to that at 25 °C is diminished by typ. 2 mW/°C.

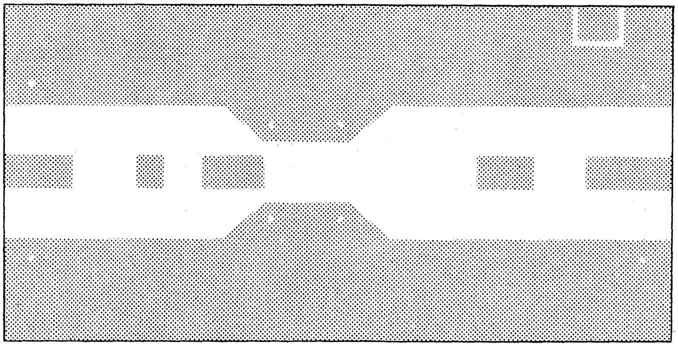
The transistor is designed to withstand full load mismatch in the test circuit under the following conditions: V_{CC} = 28 V; f = 470 MHz; T_h = 90 °C.
VSWR = 50 : 1 through all phases; P_L = 1,2 W.

Component layout for 470 MHz test circuit see page 8.

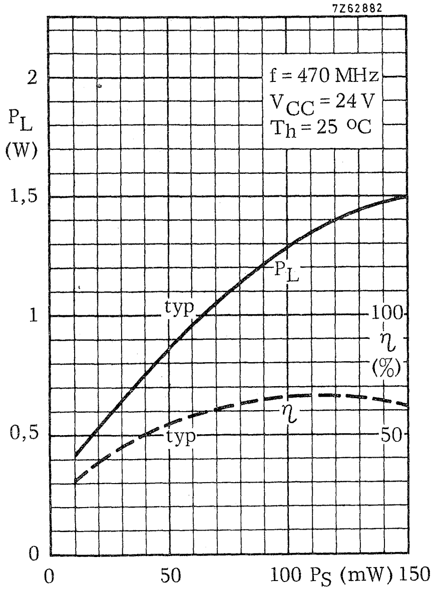
APPLICATION INFORMATION (continued)

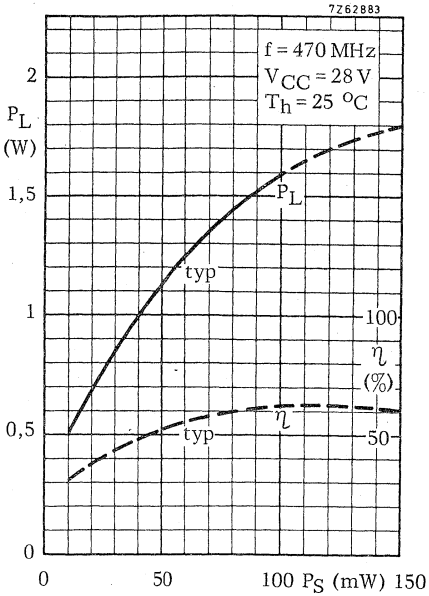
Component layout and printed-circuit board for 470 MHz test circuit.

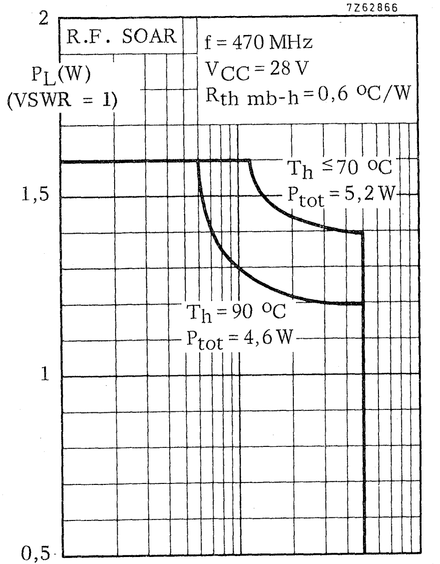




Shaded area copper
Back area completely copper clad
Material of printed-circuit board: 1,5 mm epoxy fibre-glass



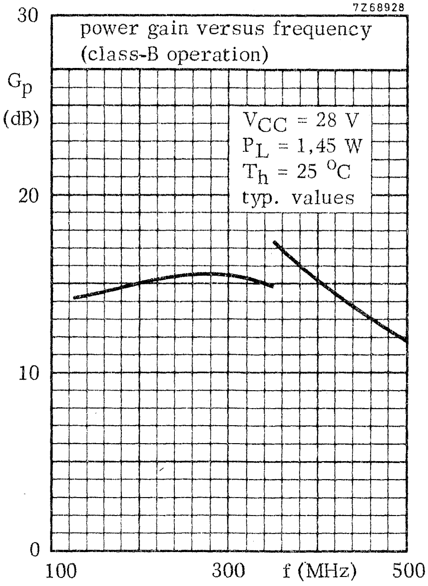


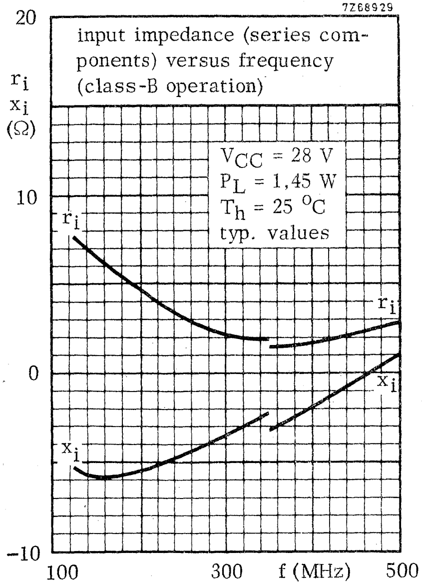


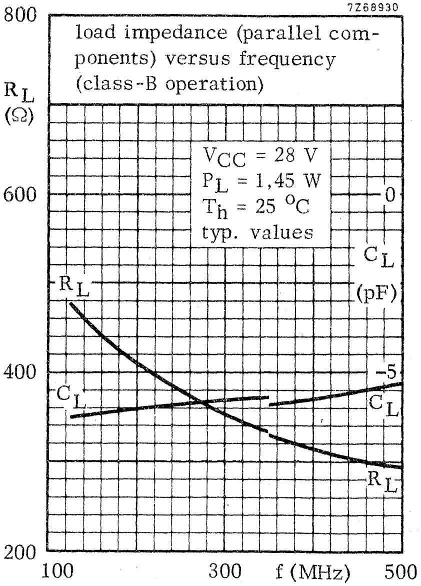
Indicated load power as a function of overload

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 VSWR up to 50 and elevated heatsink temperatures. This indicates a restriction to the load power matched under nominal conditions in the recommended test configuration.

OPERATING NOTE Below 350 MHz a base-emitter resistor of 10 Ω is recommended to avoid oscillation. This resistor must be effective for both d.c. and r.f.







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.
Gold metallization ensures extremely high reliability. ←
It has a capstan envelope with a moulded cap. All leads are isolated from the stud.

QUICK REFERENCE DATA

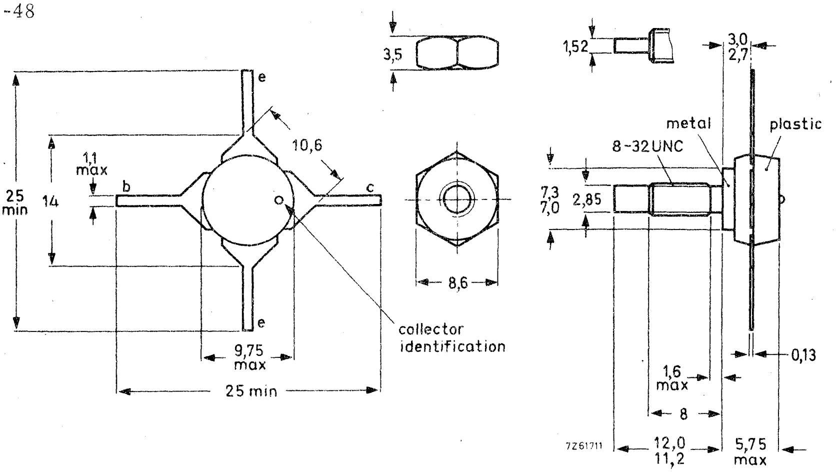
R.F. performance up to T_h = 25 °C in an unneutralized common-emitter class-B circuit.

Mode of operation	V_{CC} (V)	f (MHz)	P_S (W)	P_L (W)	I_C (mA)	G_p (dB)	η (%)	$\overline{z_i}$ (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	1,8 + j2,8	7,2 – j24
c.w.	28	1000	typ. 0,7	2,5	typ. 179	typ. 5,5	typ. 50	–	–

MECHANICAL DATA

Dimensions in mm

SOT-48



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

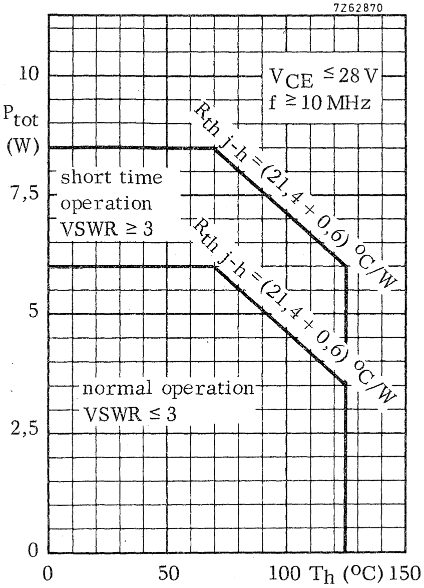
Total power dissipation up to T_h = 70 °C f ≥ 10 MHz (see also page 3)	P_{tot}	max.	6,0	W

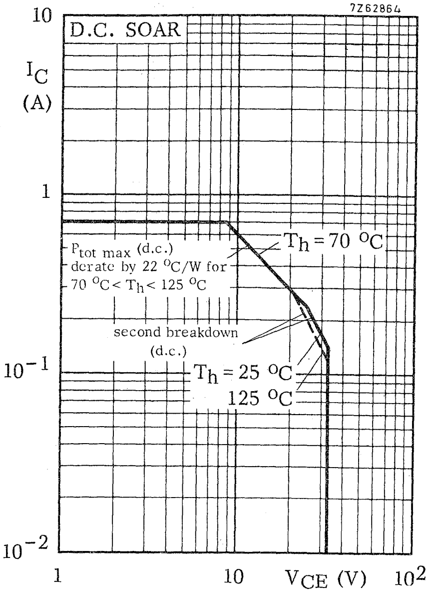
Temperatures

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

THERMAL RESISTANCE

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

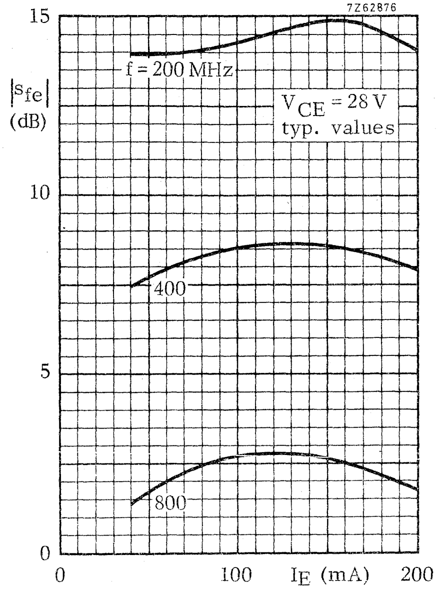

7Z62870
10
P_{tot}
(W)
7,5
5
2,5
0
0
50
100 T_h (°C) 150
$V_{CE} \leq 28$ V
f ≥ 10 MHz
$R_{th\ j\text{-}h} = (21{,}4 + 0{,}6)$ °C/W
$R_{th\ j\text{-}h} = (21{,}4 + 0{,}6)$ °C/W
short time operation VSWR ≥ 3
normal operation VSWR ≤ 3

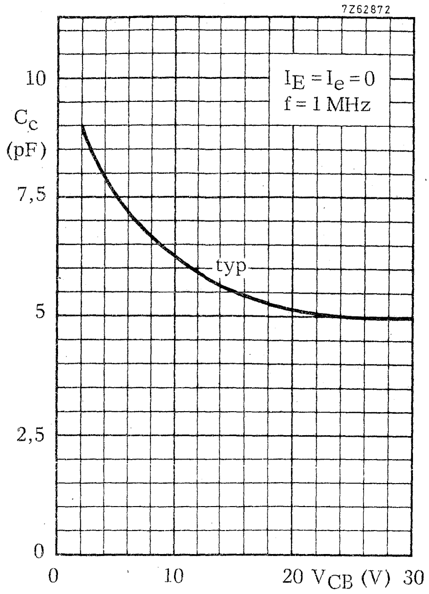

7Z62864
10
I_C
(A)
1
10^{-1}
10^{-2}
1
10
V_{CE} (V)
10^2
D.C. SOAR
$P_{tot\ max}$ (d.c.) derate by 22 °C/W for 70 °C < T_h < 125 °C
T_h = 70 °C
second breakdown (d.c.)
T_h = 25 °C
125 °C

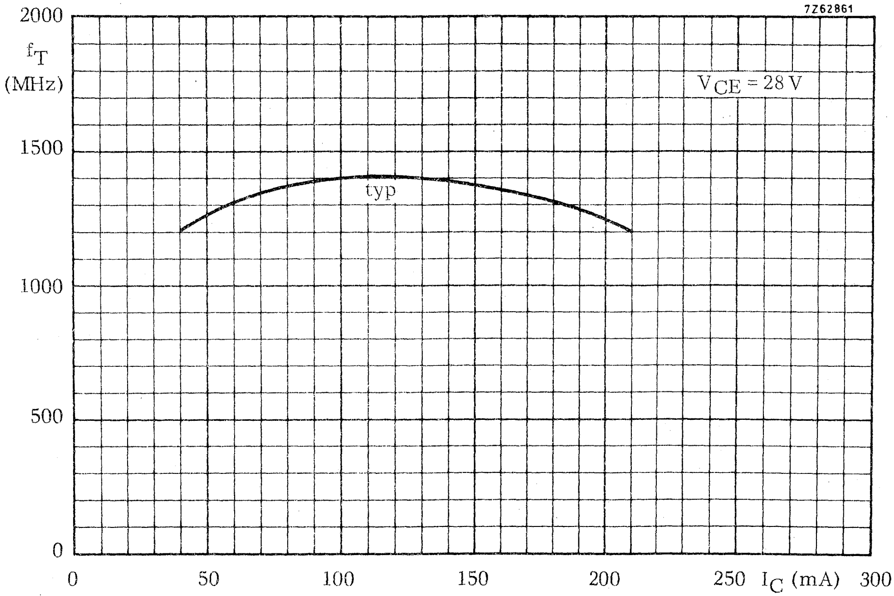
CHARACTERISTICS

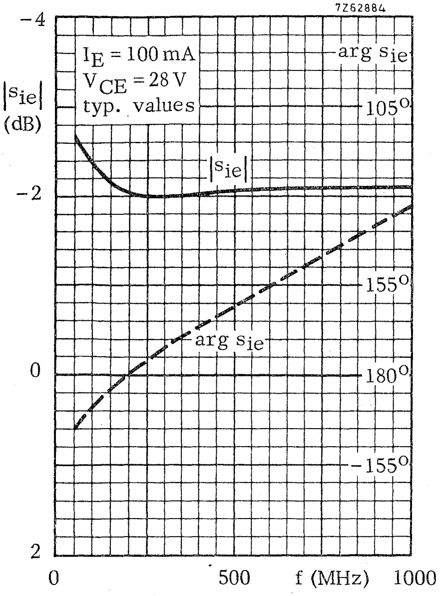
$T_j = 25\ ^{\circ}C$ unless otherwise specified

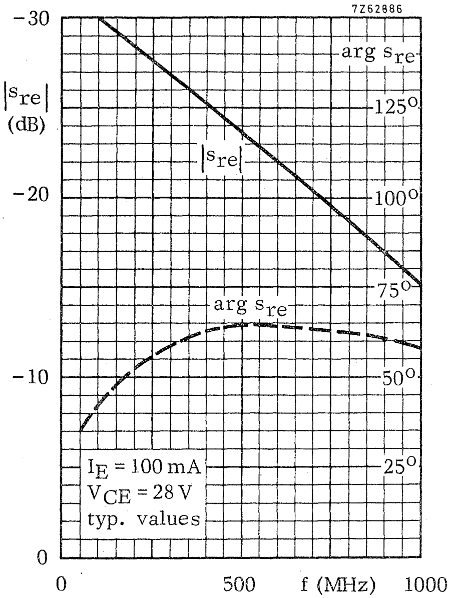
Breakdown voltages				
Collector-base voltage open emitter, $I_C = 10$ mA	$V_{(BR)CBO}$	>	65	V
Collector-emitter voltage $V_{BE} = 0$, $I_C = 10$ mA	$V_{(BR)CES}$	>	65	V
Collector-emitter voltage open base, $I_C = 25$ mA	$V_{(BR)CEO}$	>	33	V
Emitter-base voltage open collector, $I_E = 1{,}0$ mA	$V_{(BR)EBO}$	>	4,0	V
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

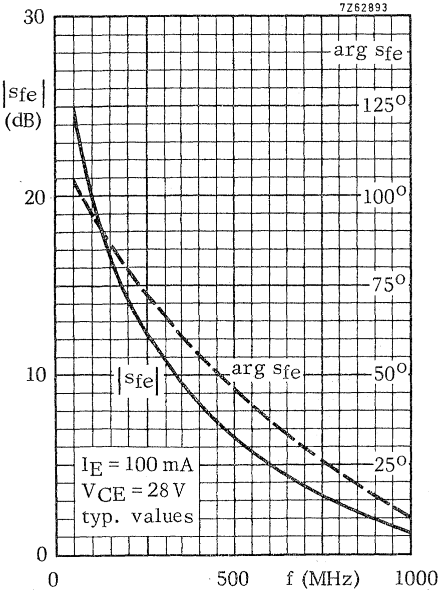

7Z62876
15
10
5
0
|s_fe|
(dB)
f = 200 MHz
400
800
V_CE = 28 V
typ. values
0
100
I_E (mA)
200

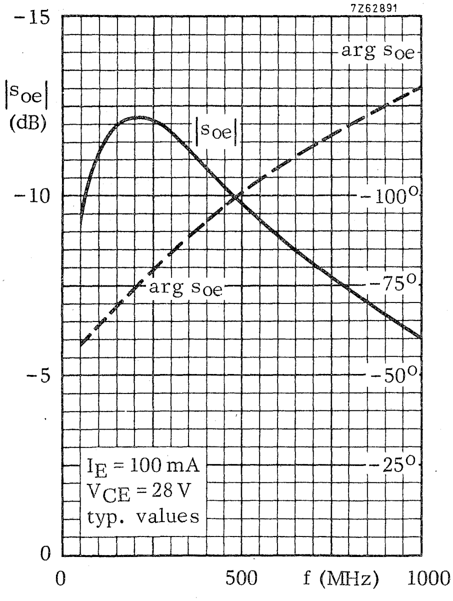

7Z62872
10
7,5
5
2,5
0
C_c
(pF)
I_E = I_e = 0
f = 1 MHz
typ
0
10
20 V_CB (V) 30


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

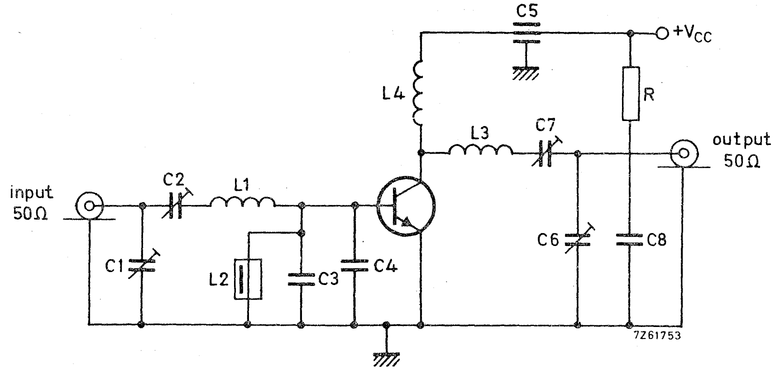
APPLICATION INFORMATION

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)	η (%)	$\overline{z_i}$ (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	1,8 + j2,8	7,2 – j24
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. dia. 5 mm; lead length = 2 mm
L2 = 0,47 μH choke
L3 = 2 turns closely wound enamelled Cu wire (1,2 mm); int. dia. 6,5 mm; lead length = 4 mm
L4 = 3 turns closely wound enamelled Cu wire (0,5 mm); int. dia. 4,0 mm; lead length = 5 mm

R = 10 Ω carbon

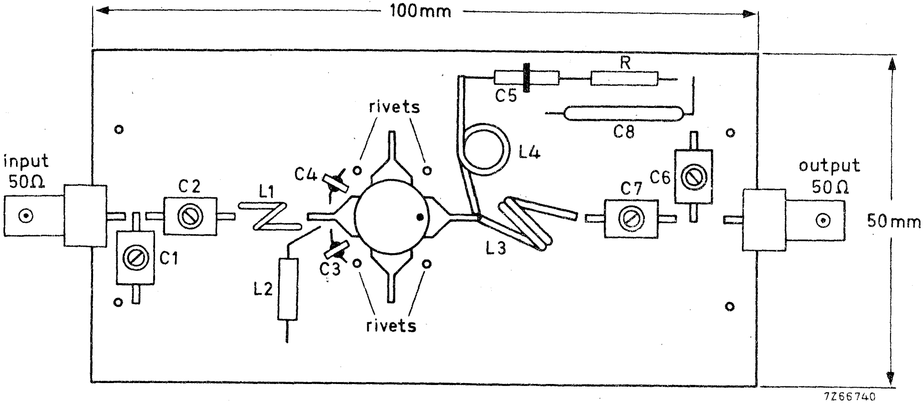
At P_L = 2,5 W and V_{CC} = 28 V, the output power at heatsink temperatures between 25 °C and 90 °C relative to that at 25 °C is diminished by typ. 5 mW/°C.

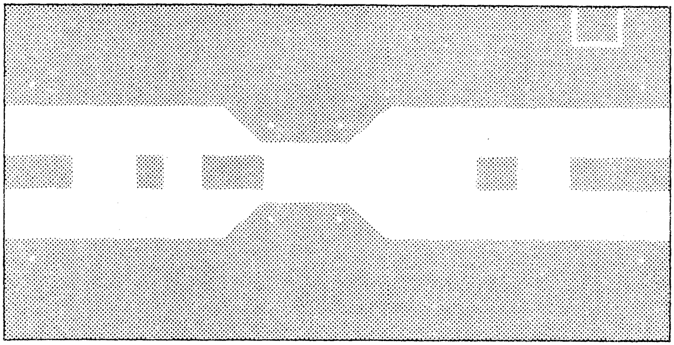
The transistor is designed to withstand full load mismatch in the test circuit under the following conditions: V_{CC} = 28 V; f = 470 MHz; T_h = 90 °C.
VSWR = 50 : 1 through all phases; P_L = 2,5 W.

Component layout for 470 MHz test circuit see page 8.

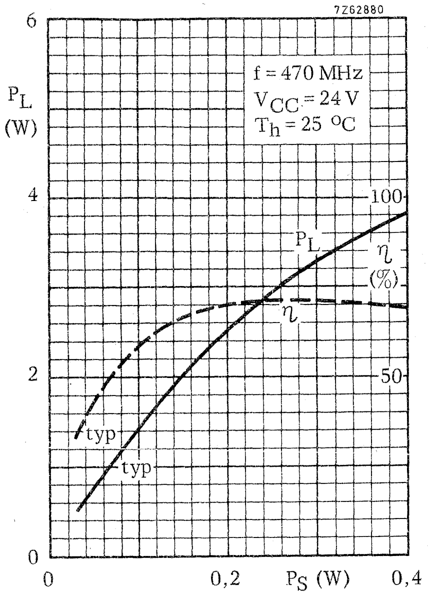
APPLICATION INFORMATION (continued)

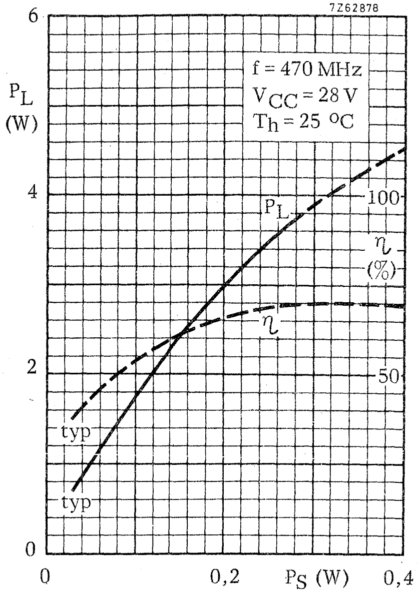
Component layout and printed-circuit board for 470 MHz test circuit.

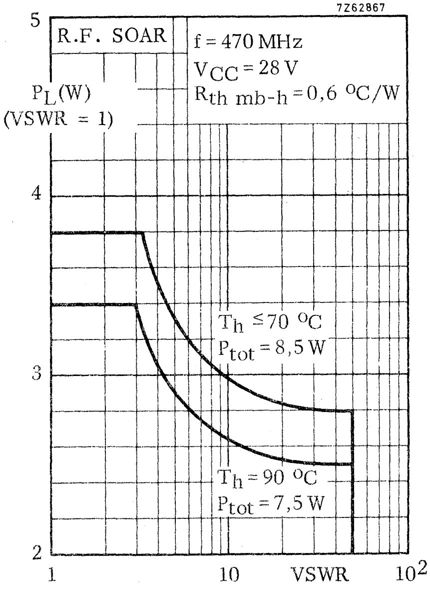




Shade area copper
Back area completely copper clad
Material of printed-circuit board: 1,5 mm epoxy fibre-glass



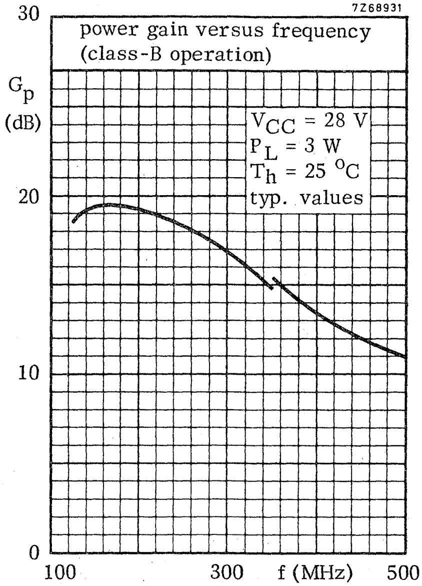


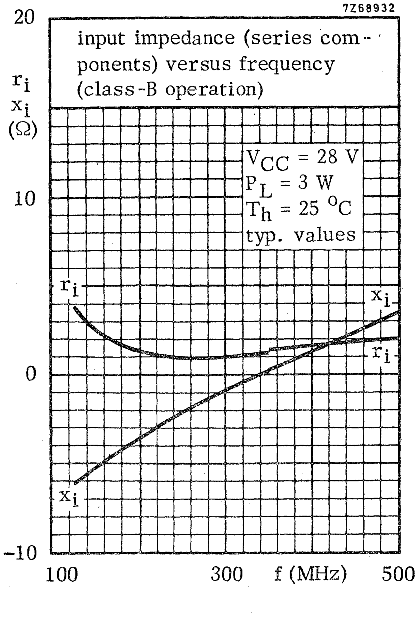


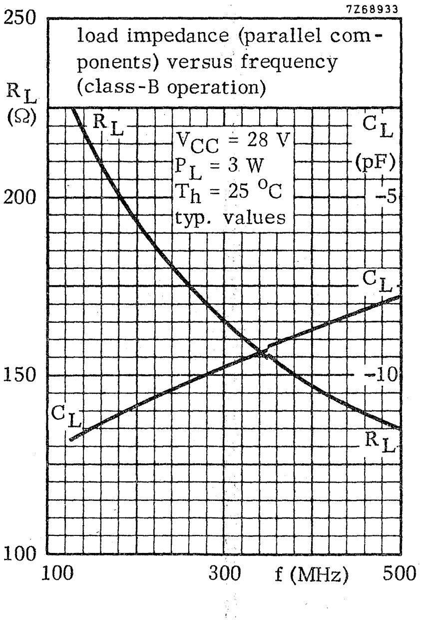
Indicated load power as a function of overload

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 VSWR up to 50 and elevated heatsink temperatures.
This indicates a restriction to the load power matched under nominal conditions in the recommended test configuration.

OPERATING NOTE Below 350 MHz a base-emitter resistor of 10 Ω is recommended to avoid oscillation. This resistor must be effective for both d.c. and r.f.







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.
Gold metallization ensures extremely high reliability.
It has a capstan envelope with a moulded cap. All leads are isolated from the stud.

QUICK REFERENCE DATA

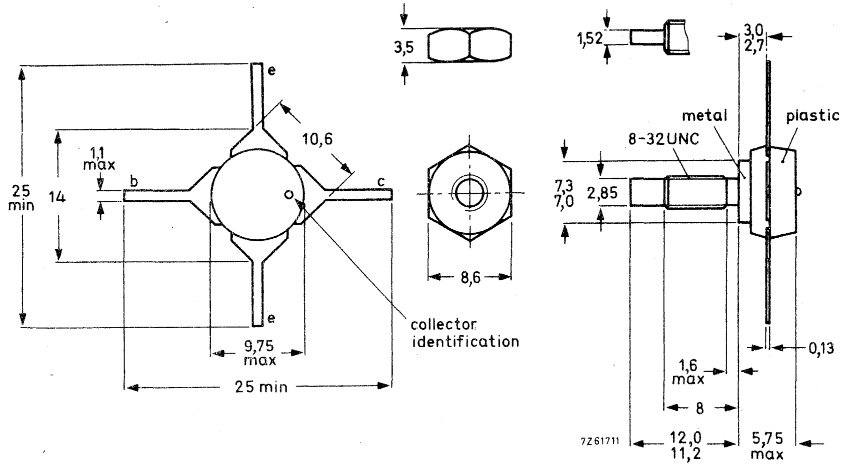
R.F. performance up to T_h = 25 °C in an unneutralized common-emitter class-B circuit.

Mode of operation	V_{CC} (V)	f (MHz)	P_S (W)	P_L (W)	I_C (A)	G_p (dB)	η (%)	$\overline{z_i}$ (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	1,8 + j5,3	19 – j32
c.w.	28	1000	typ. 1,5	5,0	typ. 0,40	typ. 5,2	typ. 45	–	–

MECHANICAL DATA

Dimensions in mm

SOT-48



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

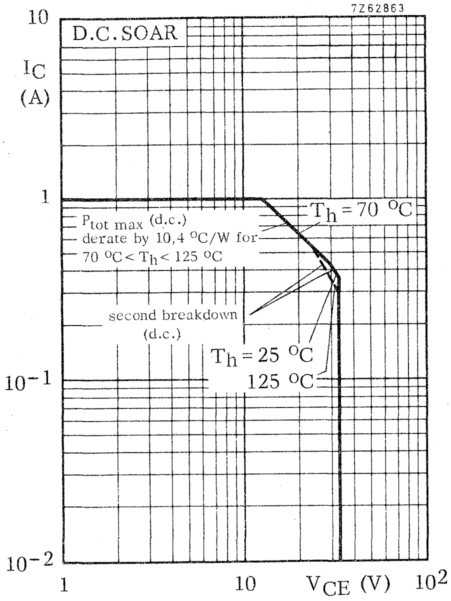
Total power dissipation up to $T_h = 70$ °C f ≥ 10 MHz (see also page 3)	P_{tot}	max.	12,5	W

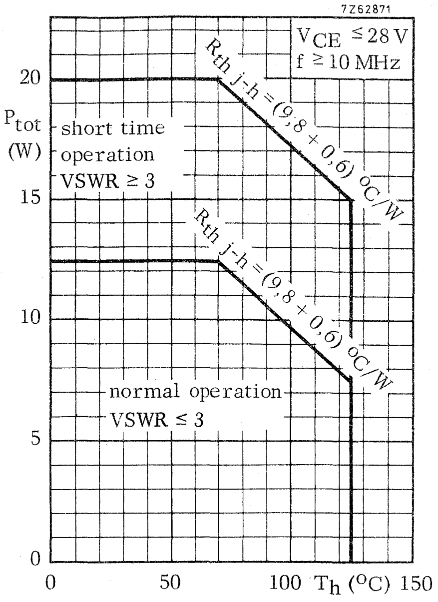
Temperatures

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

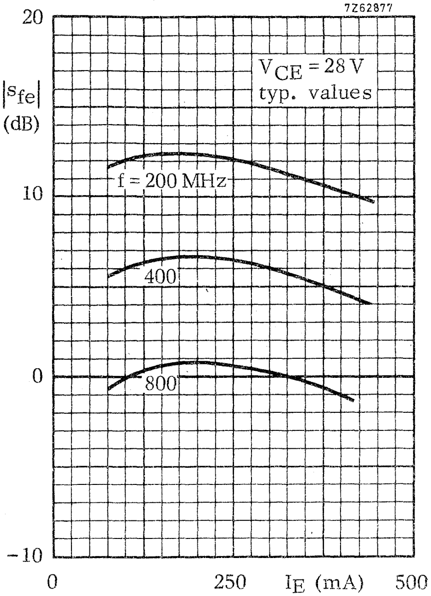

7Z62863
D.C.SOAR
I_C (A)
10
1
10^{-1}
10^{-2}
1
10
V_{CE} (V)
10^2
T_h = 70 °C
$P_{tot\ max}$ (d.c.)
derate by 10,4 °C/W for
70 °C < T_h < 125 °C
second breakdown
(d.c.)
T_h = 25 °C
125 °C

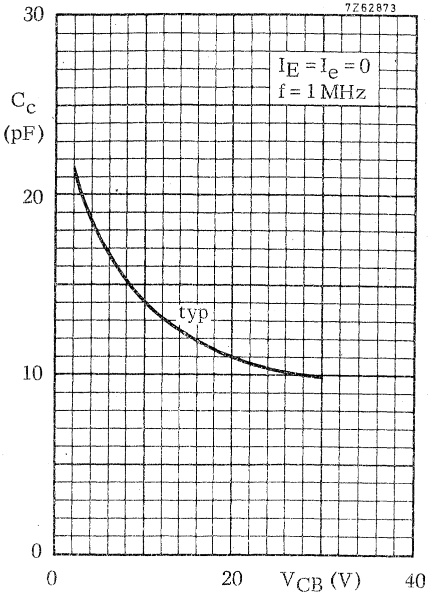

7Z62871
V_{CE} ≤ 28 V
f ≥ 10 MHz
$R_{th\ j-h}$ = (9,8 + 0,6) °C/W
$R_{th\ j-h}$ = (9,8 + 0,6) °C/W
P_{tot} (W)
20
15
10
5
0
short time
operation
VSWR ≥ 3
normal operation
VSWR ≤ 3
0
50
100
T_h (°C)
150

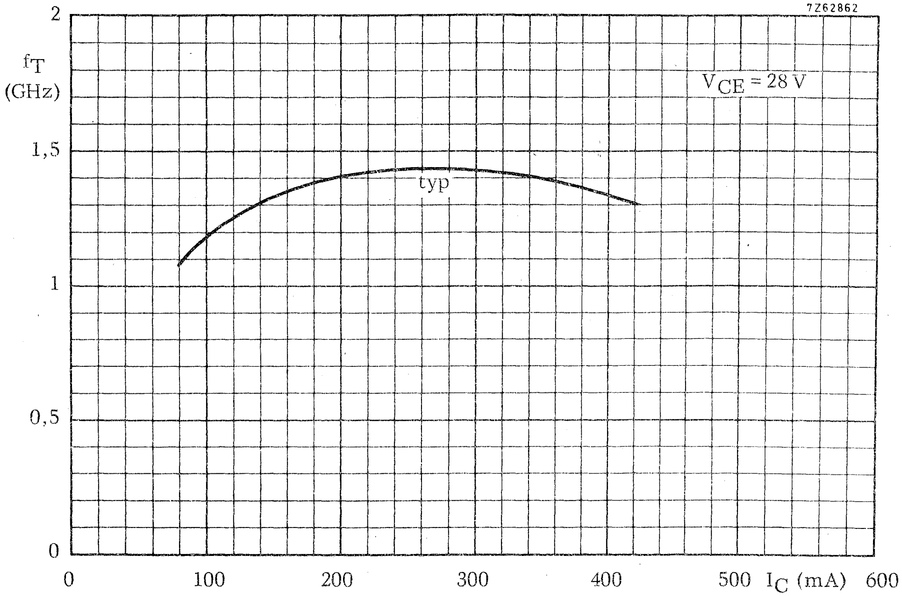
CHARACTERISTICS

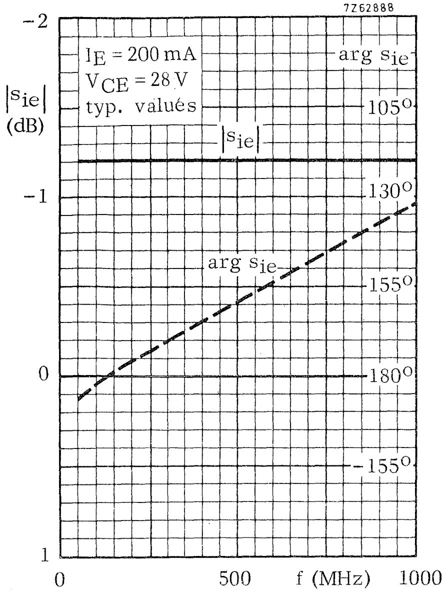
$T_j = 25\ ^{o}C$ unless otherwise specified

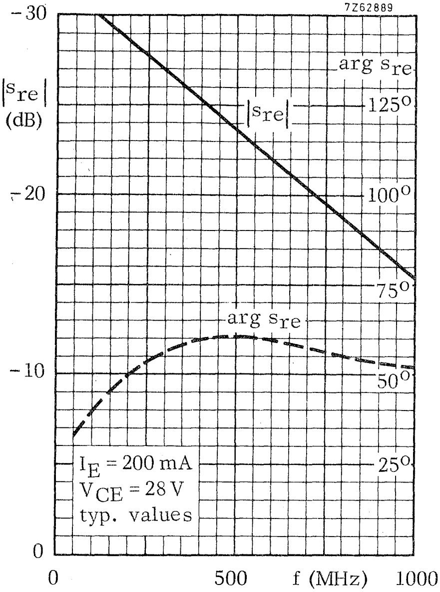
Breakdown voltages				
Collector-base voltage open emitter, $I_C = 10$ mA	$V_{(BR)CBO}$	>	65	V
Collector-emitter voltage open base, $I_C = 10$ mA	$V_{(BR)CES}$	>	65	V
Collector-emitter voltage open base, $I_C = 25$ mA	$V_{(BR)CEO}$	>	33	V
Emitter-base voltage open collector, $I_E = 1,0$ mA	$V_{(BR)EBO}$	>	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

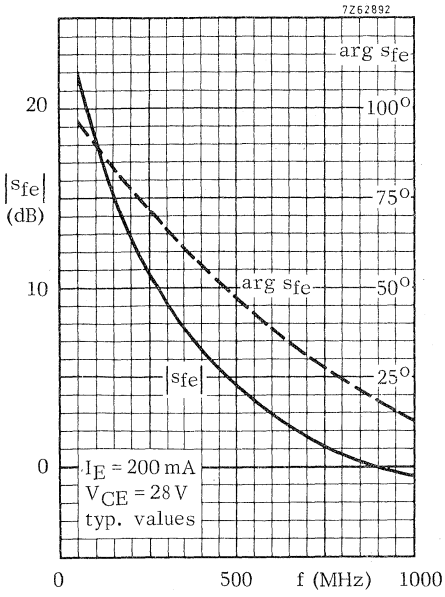

7Z62877
20
$|s_{fe}|$
(dB)
10
0
−10
V_{CE} = 28 V
typ. values
f = 200 MHz
400
800
0
250
I_E (mA)
500

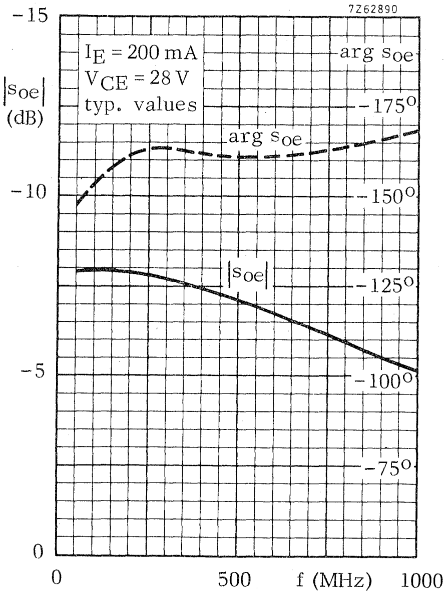

7Z62873
30
C_c
(pF)
20
10
0
$I_E = I_e = 0$
f = 1 MHz
typ
0
20
V_{CB} (V)
40


7Z62862
2
f_T
(GHz)
1,5
1
0,5
0
V_{CE} = 28 V
typ
0
100
200
300
400
500
I_C (mA)
600


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


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


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


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

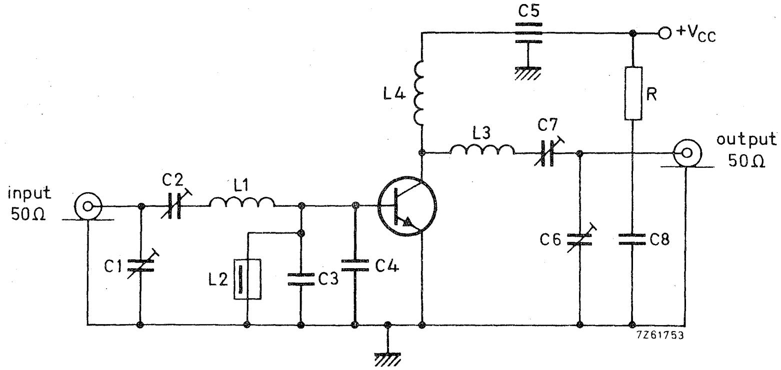
APPLICATION INFORMATION

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)	η (%)	$\overline{z_i}$ (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	1,8 + j5,3	19 – j32
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. dia. 5 mm; lead length = 2 mm
L2 = 0,47 μH choke
L3 = 2 turns closely wound enamelled Cu wire (1,2 mm); int. dia. 6,5 mm; lead length = 4 mm
L4 = 3 turns closely wound enamelled Cu wire (0,5 mm); int. dia. 4,0 mm; lead length = 5 mm

R = 10 Ω carbon

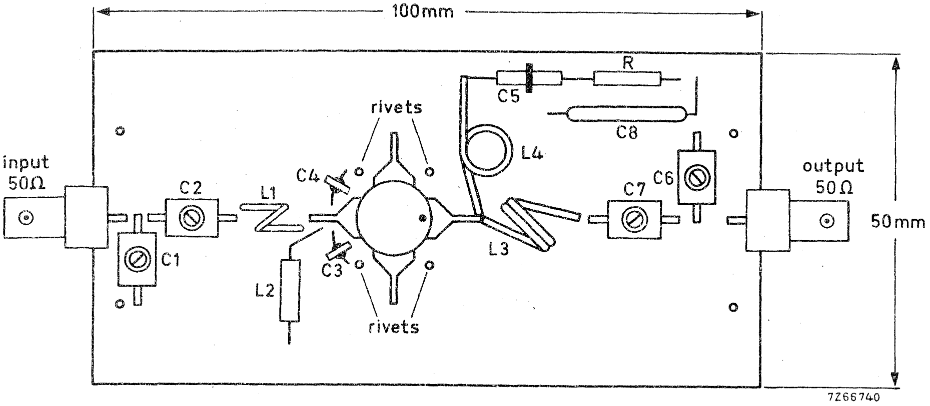
At P_L = 7,0 W and V_{CC} = 28 V, the output power at heatsink temperatures between 25 °C and 90 °C relative to that at 25 °C is diminished by typ. 10 mW/°C.

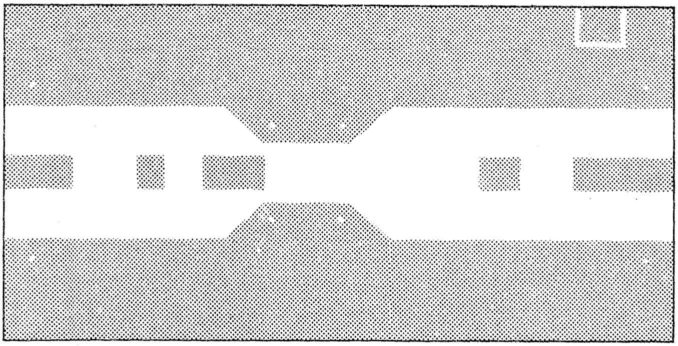
The transistor is designed to withstand full load mismatch in the test circuit under the following conditions: V_{CC} = 28 V; f = 470 MHz; T_h = 90 °C.
VSWR = 50 : 1 through all phases; P_L = 7,0 W.

Component layout for 470 MHz test circuit see page 8.

APPLICATION INFORMATION (continued)

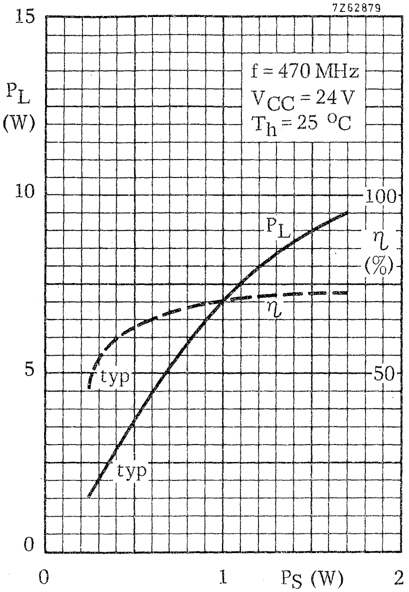
Component layout and printed-circuit board for 470 MHz test circuit.

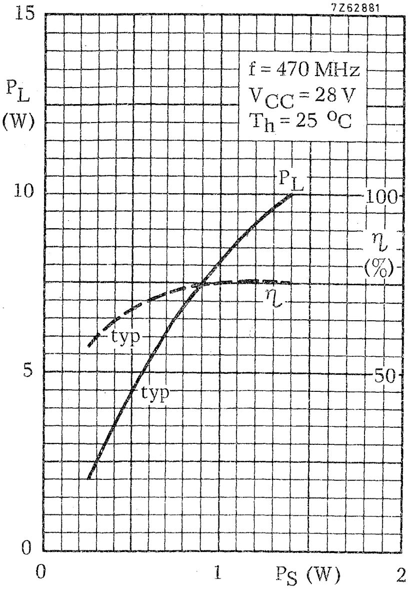


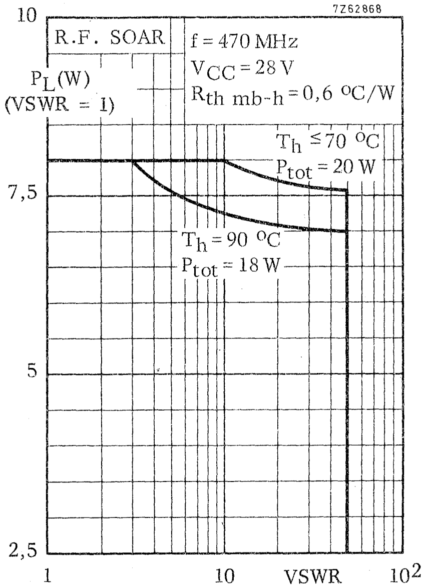


7Z66741.1

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



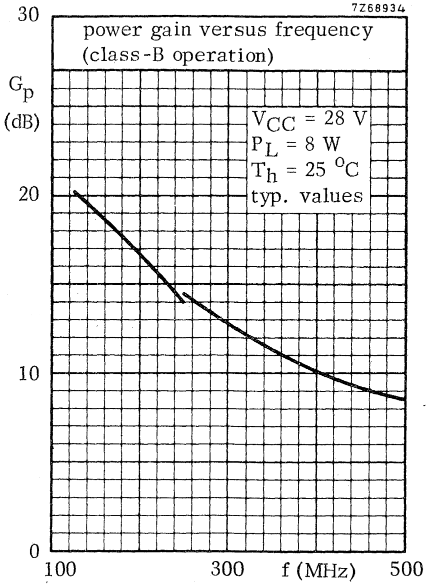


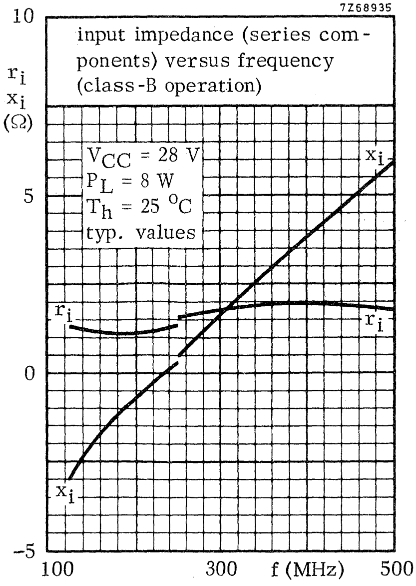


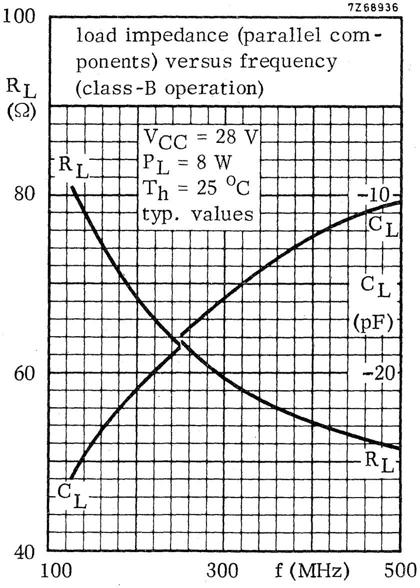
Indicated load power as a function of overload

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 VSWR up to 50 and elevated heatsink temperatures. This indicates a restriction to the load power matched under nominal conditions in the recommended test configuration.

OPERATING NOTE Below 250 MHz a base-emitter resistor of 10 Ω is recommended to avoid oscillation. This resistor must be effective for both d.c. and r.f.







U.H.F. POWER TRANSISTOR

N-P-N silicon planar epitaxial transistor for use in class A, B or C amplifiers in U.H.F. transmitters with supply voltages up to 28 V.
The transistor is resistance stabilized and tested under conditions of severe load mismatch. Gold metallization ensures extremely high reliability.
The transistor is housed in a plastic encapsulated stripline package. All leads are isolated from the stud.

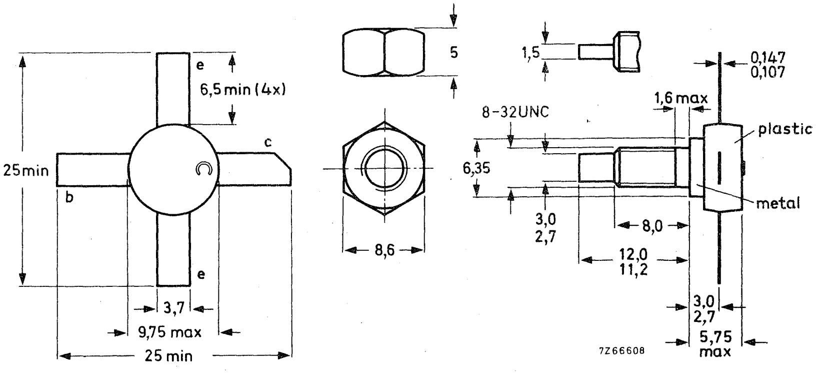
QUICK REFERENCE DATA

R.F. performance up to T_{mb} = 25 °C in an 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	$< 6,25$	25	$< 1,62$	> 6	> 55	0, 8 + j4, 3	62 − j64

MECHANICAL DATA Dimensions in mm

SOT-48



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

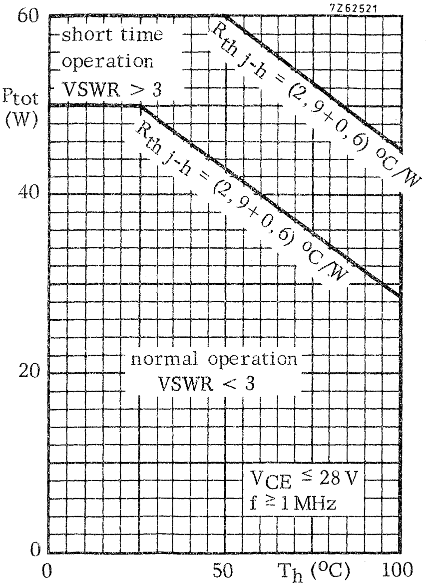
Collector-base voltage (open emitter) peak value	V_{CBOM}	max.	65	V
Collector-emitter voltage (open base)	V_{CEO}	max.	30	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4	V

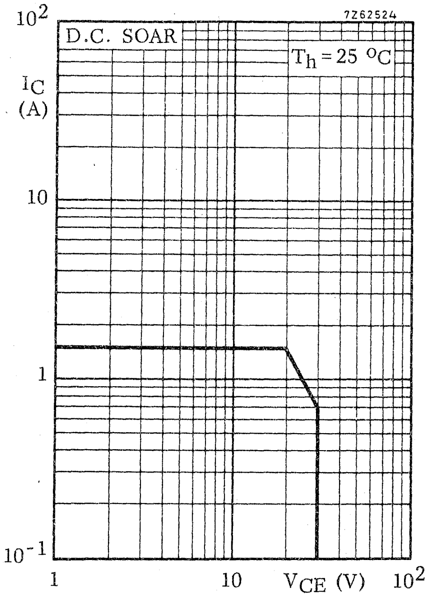
Currents

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}	−65 to +200	°C
Junction temperature	T_j	max. 200	°C

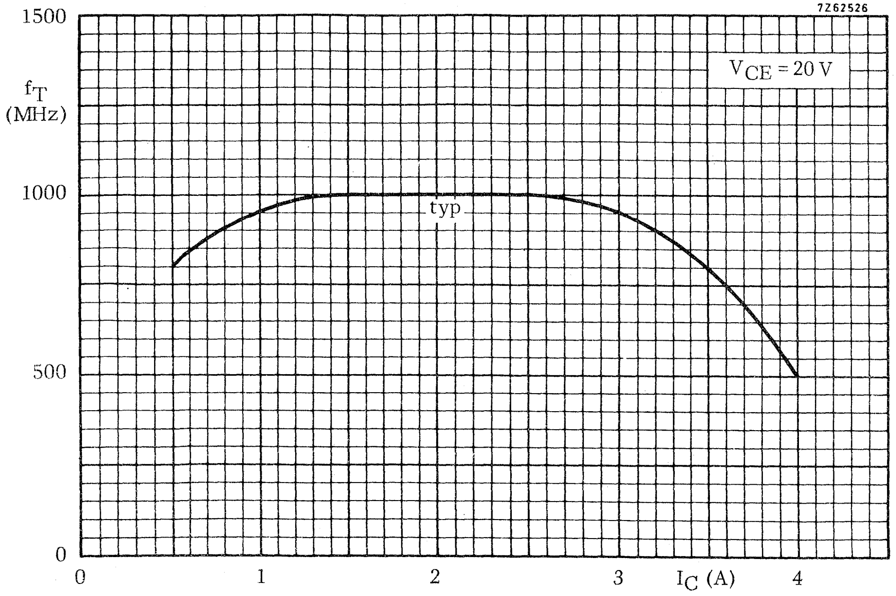
THERMAL RESISTANCE

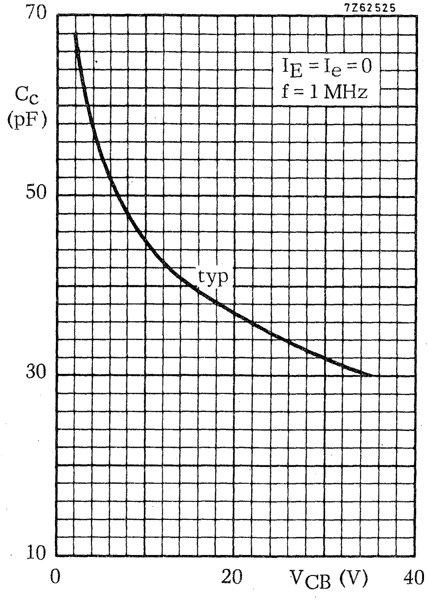
From junction to mounting base	$R_{th\ j\text{-}mb}$	=	2,9	°C/W
From mounting base to heatsink	$R_{th\ mb\text{-}h}$	=	0,6	°C/W

CHARACTERISTICS

$T_j = 25\ ^{\circ}C$ 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	$V_{(BR)CEO}$	>	30	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}	> 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
f_T
(MHz)
1000
500
0
$V_{CE} = 20$ V
typ
0
1
2
3
I_C (A)
4


7Z62525
70
C_c
(pF)
50
30
10
$I_E = I_e = 0$
f = 1 MHz
typ
0
20
V_{CB} (V)
40

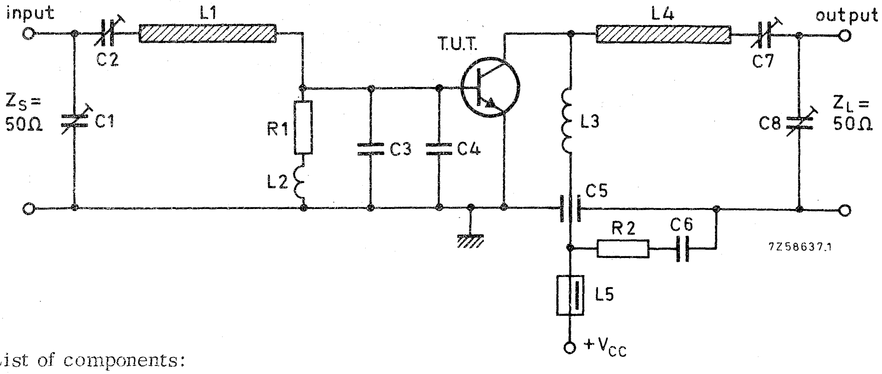
APPLICATION INFORMATION

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	< 6,25	25	< 1,62	> 6	> 55	0,8 + j4,3	62 − j64

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)

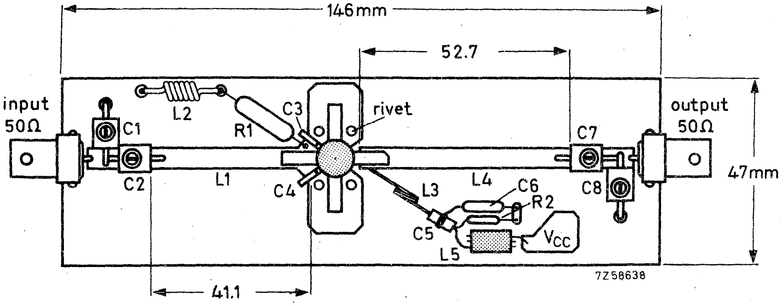
R1 = 1 Ω carbon resistor
R2 = 10 Ω carbon resistor

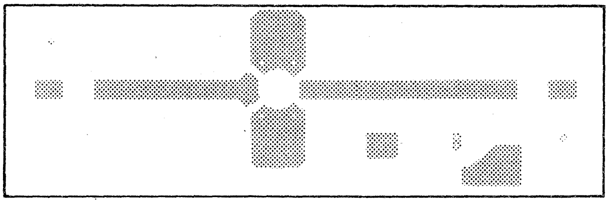
L1 = stripline (40,8 mm x 5,0 mm)
L2 = 13 turns closely wound enamelled Cu wire (0,5 mm); int. diam. 4,0 mm
L3 = 2 turns Cu wire (1 mm); winding pitch 1,5 mm; int. diam. 4 mm; leads 2 x 5 mm
L4 = stripline (52,4 mm x 5,0 mm)
L5 = ferroxcube choke coil. Z (at f = 50 MHz) = 750 Ω ±20%
(code number 4312 020 36640)

L1 and L4 are striplines on a double Cu clad print plate with teflon fibre-glass dielectric. (ϵ_r = 2,74); thickness 1,45 mm.

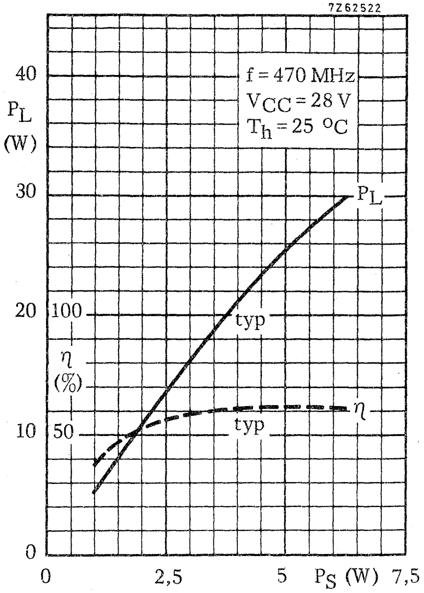
APPLICATION INFORMATION (continued)

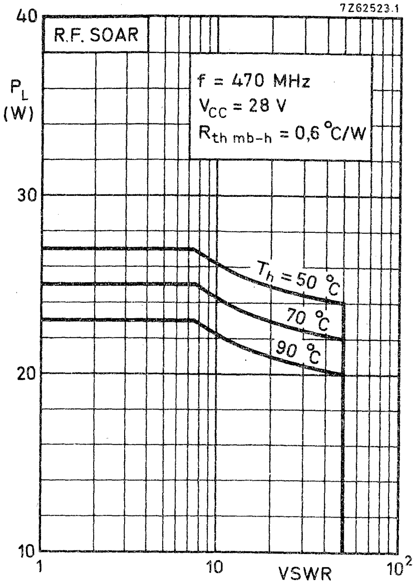
Component lay-out and printed circuit board for 470 MHz test circuit.



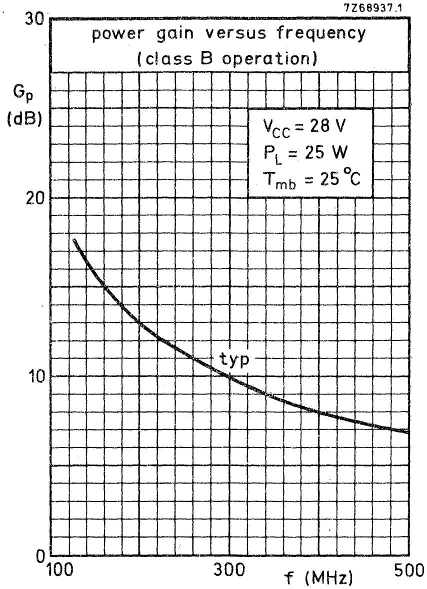


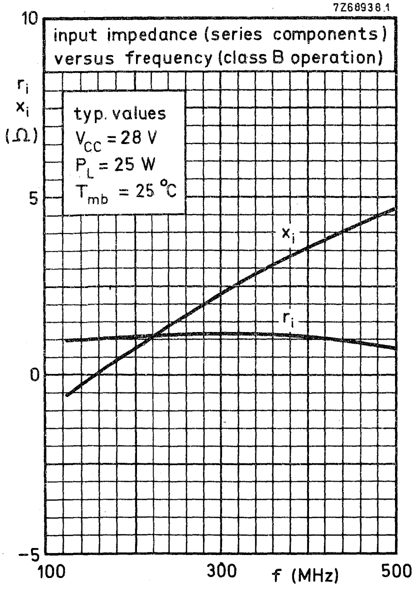
The circuit and the components are situated on one side of the teflon fibre-glass board, the other side being fully metallised to serve as earth. Earth connections are made by means of hollow rivets.

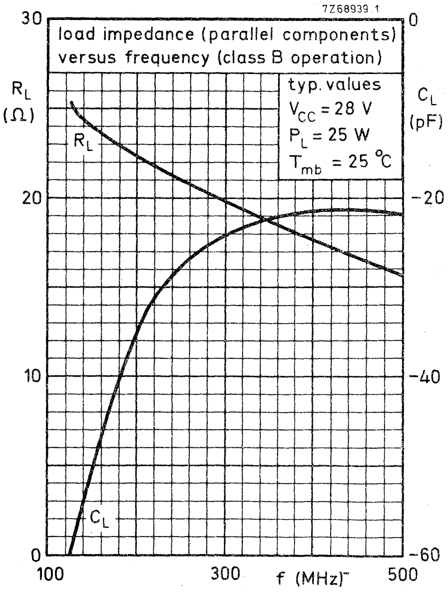




For high voltage operation, a stabilized power supply is generally used.
The graph shows the allowable output power under nominal conditions as a function of the VSWR, with heatsink temperature as parameter.


7Z68937.1
power gain versus frequency
(class B operation)
G_p
(dB)
V_{CC} = 28 V
P_L = 25 W
T_{mb} = 25 °C
typ
30
20
10
0
100
300
500
f (MHz)


7Z68938.1
input impedance (series components)
versus frequency (class B operation)
r_i
x_i
(Ω)
typ. values
V_{CC} = 28 V
P_L = 25 W
T_{mb} = 25 °C
x_i
r_i
10
5
0
−5
100
300
500
f (MHz)


7Z68939.1
load impedance (parallel components)
versus frequency (class B operation)
R_L
(Ω)
C_L
(pF)
typ. values
V_{CC} = 28 V
P_L = 25 W
T_{mb} = 25 °C
R_L
C_L
30
20
10
0
0
−20
−40
−60
100
300
500
f (MHz)

U.H.F. POWER TRANSISTOR

N-P-N silicon planar epitaxial transistor intended for transmitting applications in class A, B or C in the u.h.f. frequency range for supply voltages up to 28 V.
The transistor is resistance stabilized and is tested under severe load mismatch conditions. Due to a gold metallization excellent reliability properties have been obtained. The transistor is housed in a capstan envelope with a moulded cap. All leads are isolated from the stud.

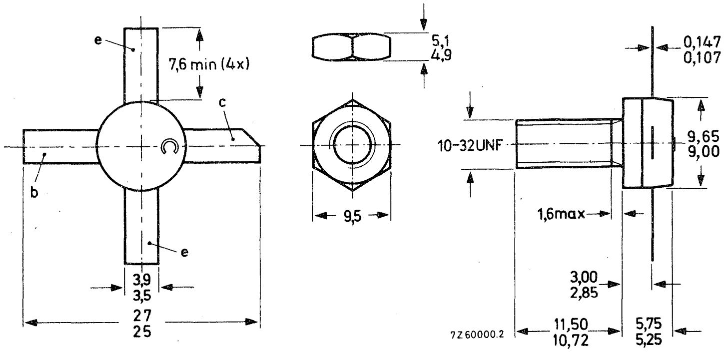
QUICK REFERENCE DATA

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 (%)
c.w.	28	470	< 14,2	40	< 2,4	> 4,5	> 60
c.w.	28	175	typ. 3,2	40	typ. 1,9	typ. 11	typ. 75

MECHANICAL DATA Dimensions in mm

SOT-56



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

Torque on nut: min. 1,5 Nm
(15 kg cm)
max. 1,7 Nm
(17 kg cm)

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)

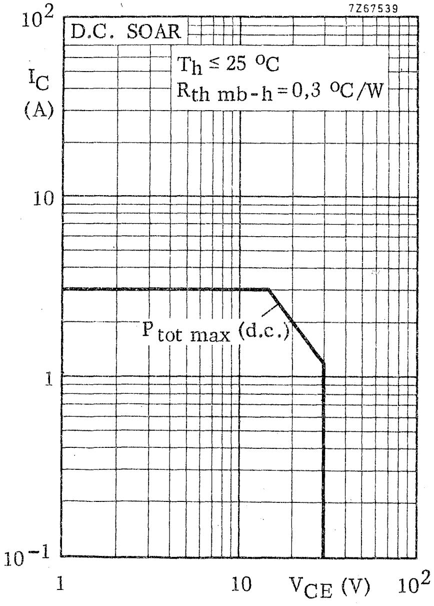
Voltages

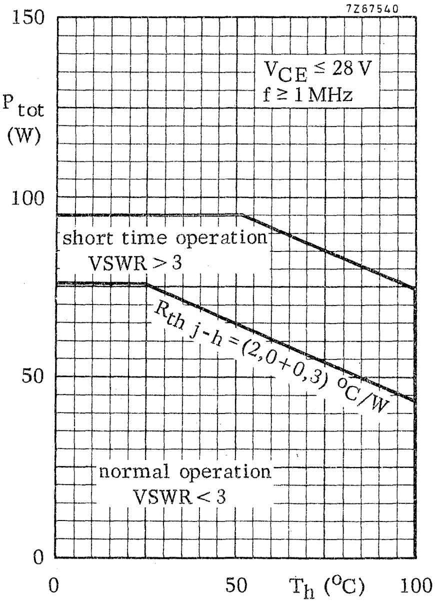
Collector-base voltage (open emitter) peak value	V_{CBOM}	max.	65	V
Collector-emitter voltage ($R_{BE} = 10\,\Omega$) peak value	V_{CERM}	max.	65	V
→ Collector-emitter voltage (open base)	V_{CEO}	max.	30	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4	V

Currents

Collector current (average)	$I_{C(AV)}$	max.	3,0	A
Collector current (peak value) f > 1 MHz	I_{CM}	max.	10,0	A

Power dissipation





Temperatures

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

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j-mb}$	=	2,0	°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 R_{BE} = 10 Ω, I_C = 50 mA	$V_{(BR)CER}$	>	65	V	
Collector-emitter voltage open base, I_C = 50 mA	$V_{(BR)CEO}$	>	30	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	>	4,5	mWs
$-V_{BE}$ = 1,5 V; R_{BE} = 33 Ω	E	>	4,5	mWs

D.C. current gain

I_C = 1,0 A; V_{CE} = 5 V	h_{FE}	25 to 100	←

Transition frequency

I_C = 4 A; V_{CE} = 25 V	f_T	typ.	900	MHz

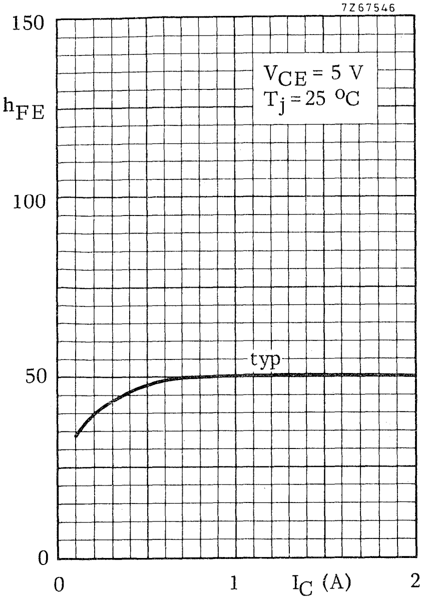
Collector capacitance at f = 1 MHz

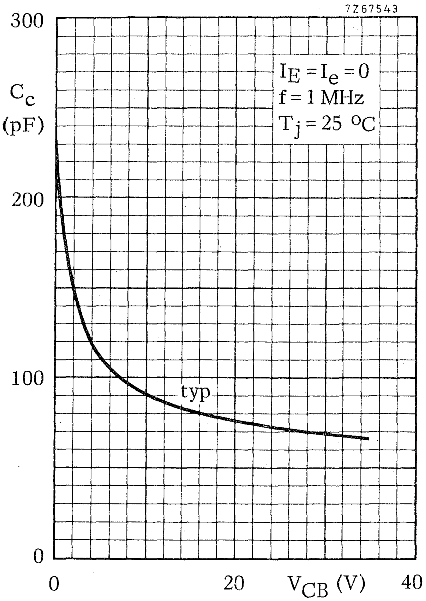
$I_E = I_e$ = 0; V_{CB} = 30 V	C_c	typ.	68	pF
		<	80	pF

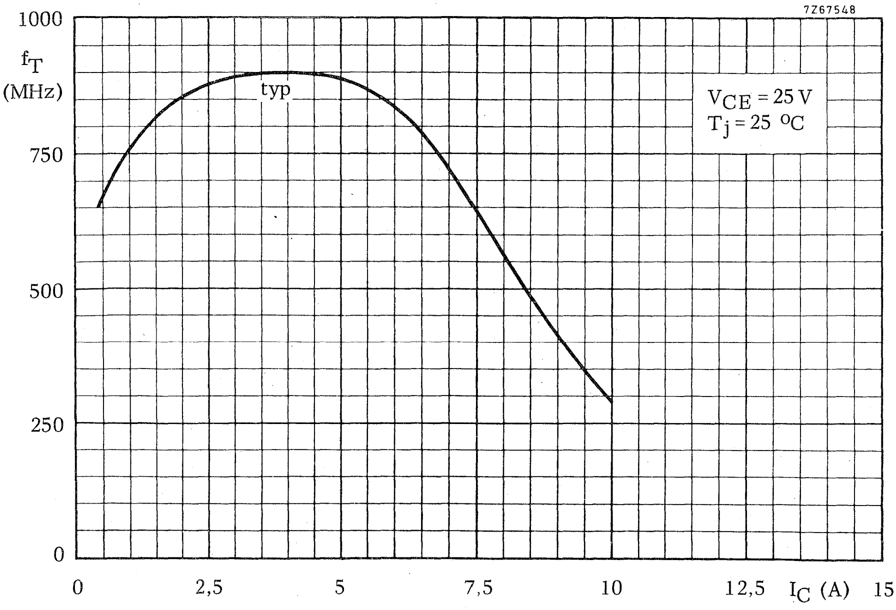
Feedback capacitance at f = 1 MHz

I_C = 200 mA; V_{CE} = 30 V	C_{re}	typ.	39	pF

Collector-stud capacitance	C_{cs}	typ.	2	pF


7Z67546
150
100
50
0
h_{FE}
V_{CE} = 5 V
T_j = 25 °C
typ
0
1
2
I_C (A)


7Z67543
300
200
100
0
C_c
(pF)
I_E = I_e = 0
f = 1 MHz
T_j = 25 °C
typ
0
20
40
V_{CB} (V)

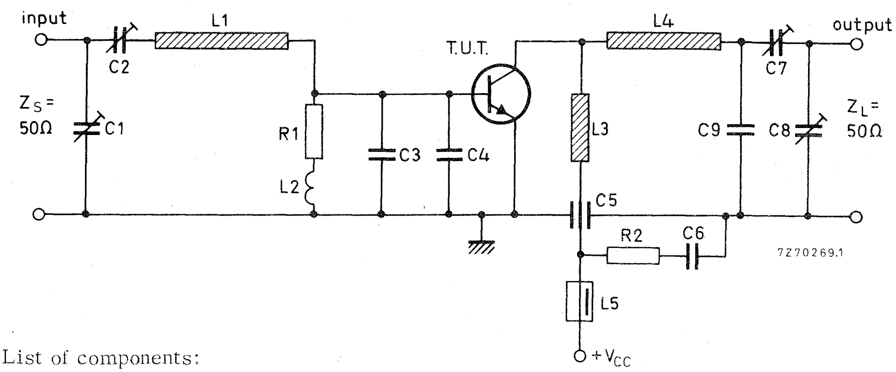

7Z67548
1000
750
500
250
0
f_T
(MHz)
typ
V_{CE} = 25 V
T_j = 25 °C
0
2,5
5
7,5
10
12,5
15
I_C (A)

APPLICATION INFORMATION

R.F. performance in c.w. operation (Unneutralized common-emitter class-B circuit)
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 (%)
470	< 14,2	40	< 2,4	> 4,5	> 60
175	typ. 3,2	40	typ. 1,9	typ. 11	typ. 75

Test circuit for 470 MHz:



List of components:

C1 = C7 = C8 = 2 to 18 pF film dielectric trimmer (code number 2222 809 09003)
C2 = 1,8 to 9 pF film dielectric trimmer (code number 2222 809 09002)
C3 = C4 = 18 pF chip capacitor
C5 = 100 pF feed-through capacitor
C6 = 33 nF polyester capacitor
C9 = 2 x 3,3 pF miniature ceramic plate capacitors (in parallel)

R1 = 1 Ω carbon resistor (0,25 W)
R2 = 10 Ω carbon resistor (0,25 W)

L1 = stripline (21,4 mm x 5,3 mm)
L2 = 13 turns closely wound enamelled Cu wire (0,5 mm); internal diameter 4,0 mm
L3 = stripline (43,8 mm x 3,0 mm)
L4 = stripline (45,5 mm x 5,3 mm)
L5 = Ferroxcube choke coil (code number 4312 020 36640)

L1; L3; L4 are striplines on a double Cu-clad print plate with teflon fibre-glass dielectric. (ϵ_r = 2,74); thickness 1/32".

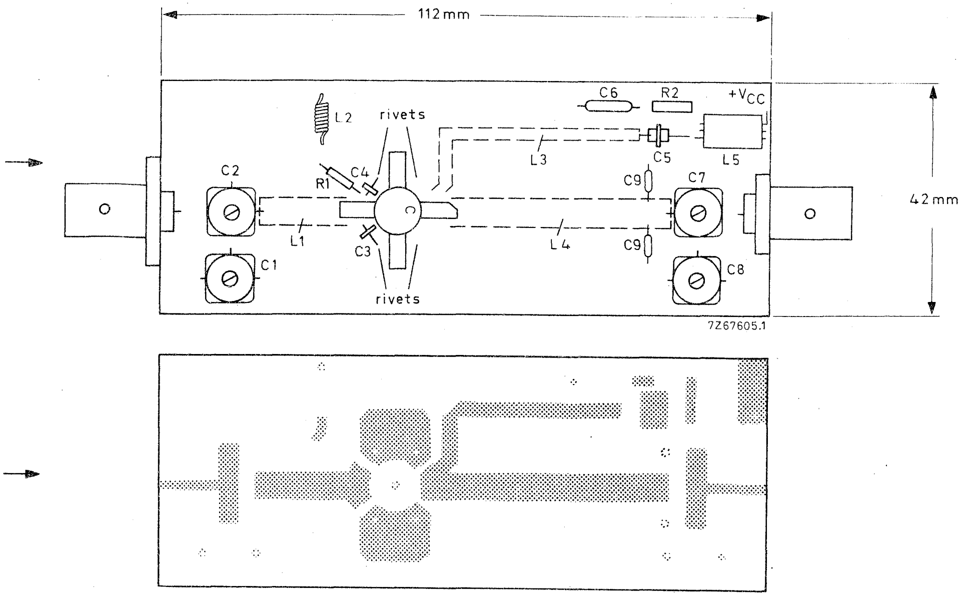
At P_L = 40 W and V_{CC} = 28 V, the output power at heatsink temperatures between 25 °C and 70 °C relative to that at 25 °C is diminished by typ. 50 mW/°C.

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 = 70 °C.
VSWR = 50 through all phases; P_L = 36 W.

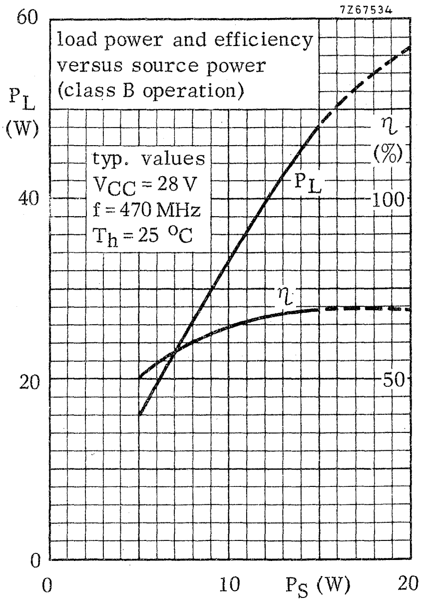
Component layout and printed-circuit board for 470 MHz test circuit see page 6.

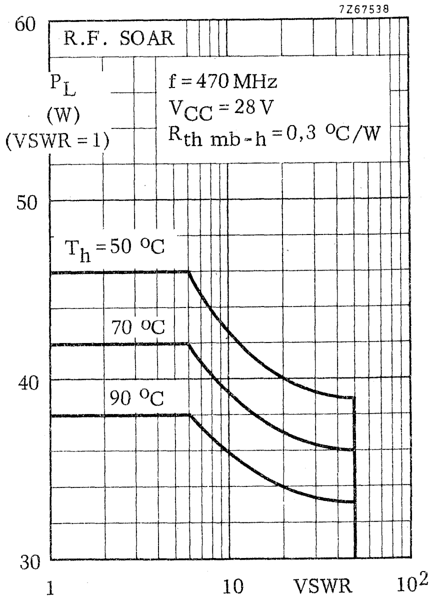
APPLICATION INFORMATION (continued)

Component layout and printed-circuit board for 470 MHz test circuit.



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



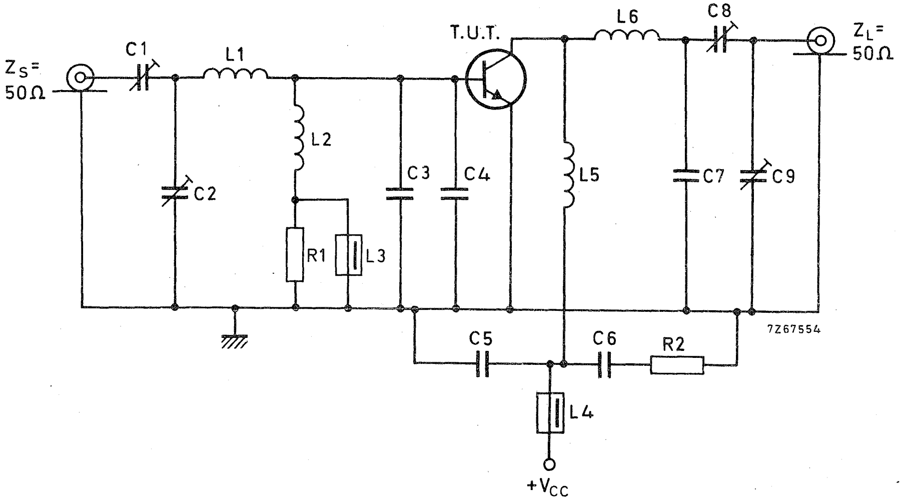


Indicated load power as a function of overload.

The graph has been derived from an evaluation of the performance of transistors matched up to 46 W load power in the test amplifier on page 5 and subsequently subjected to various mismatch conditions at 28 V with VSWR up to 50 and elevated heatsink temperatures.
This indicates a restriction to the load power matched under nominal conditions in the recommended test configuration.

APPLICATION INFORMATION (continued)

Test circuit for 175 MHz:



List of components:

C1 = 2,5 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 = 47 pF ceramic capacitor
C5 = 100 pF ceramic capacitor
C6 = 100 nF polyester capacitor
C7 = 6,8 pF ceramic capacitor
C8 = 4 to 60 pF film dielectric trimmer (code number 2222 809 07011)
C9 = 4 to 100 pF film dielectric trimmer (code number 2222 809 07015)

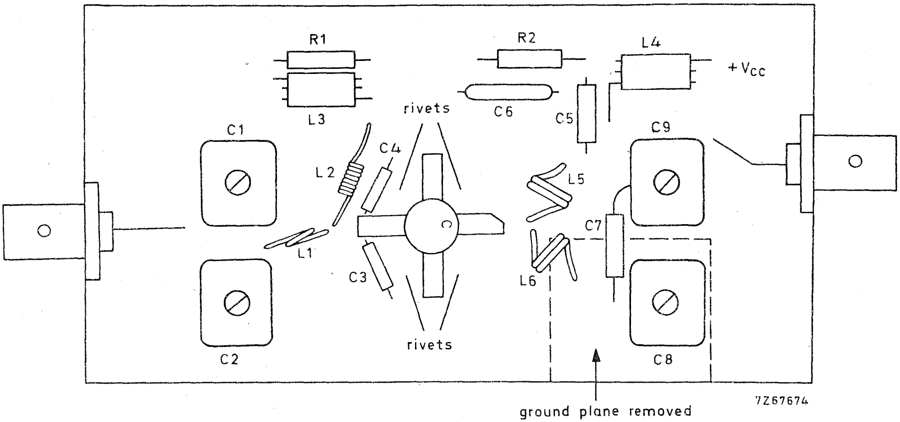
L1 = 0,5 turn enamelled Cu wire (1,5 mm); int. diam. 6 mm; lead length 2 x 6 mm
L2 = 100 nH; 7 turns closely wound enamelled Cu wire (0,5 mm); int. diam. 3 mm; lead length 2 x 5 mm
L3 = L4 = ferroxcube choke coil (code number 4312 020 36640)
L5 = 53 nH; 2 turns enamelled Cu wire (1,5 mm); int. diam. 10 mm; coil length 5,2 mm; lead length 2 x 5 mm
L6 = 46 nH; 2 turns enamelled Cu wire (1,5 mm); int. diam. 9 mm; coil length 5,4 mm; lead length 2 x 5 mm

R1 = R2 = 10 Ω carbon resistor (0,25 W)

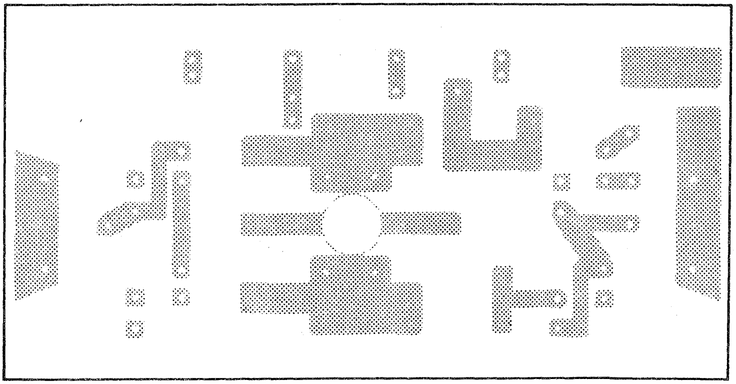
Component lay-out for 175 MHz test circuit see page 9.

APPLICATION INFORMATION (continued)

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

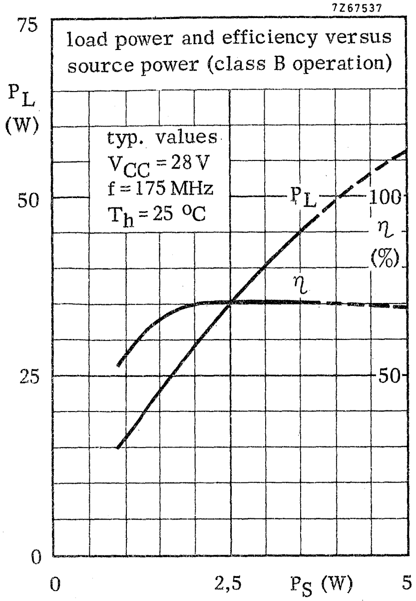


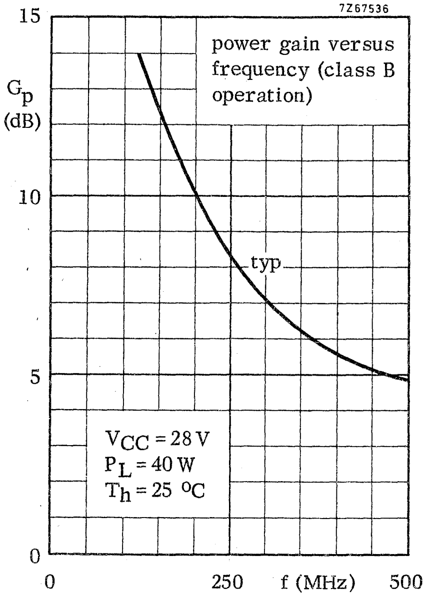
Dimensions of printed circuit board 123 mm x 55 mm.

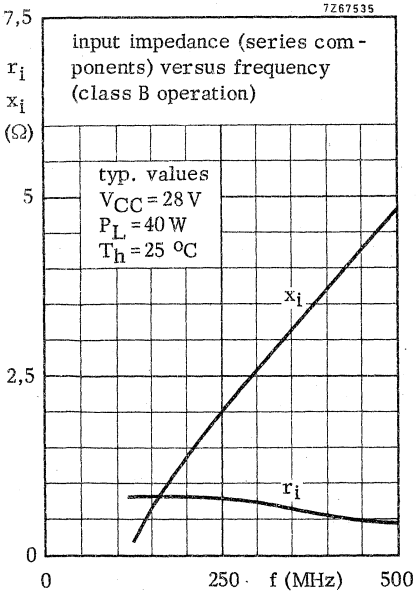


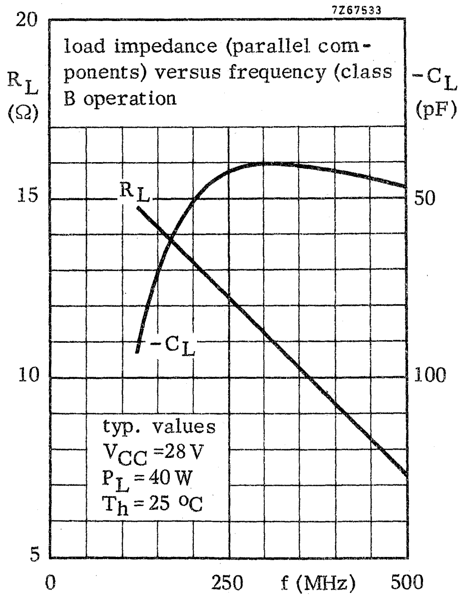
7Z66943

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.


7Z67537
load power and efficiency versus source power (class B operation)
P_L (W)
75
50
25
0
typ. values
$V_{CC} = 28\ V$
f = 175 MHz
$T_h = 25\ ^oC$
P_L
η
100
η (%)
50
0
2,5
P_S (W)
5


7Z67536
power gain versus frequency (class B operation)
G_p (dB)
15
10
5
0
typ
$V_{CC} = 28\ V$
$P_L = 40\ W$
$T_h = 25\ ^oC$
0
250
f (MHz)
500


7Z67535
input impedance (series components) versus frequency (class B operation)
r_i
x_i
(Ω)
7,5
5
2,5
0
typ. values
$V_{CC} = 28\ V$
$P_L = 40\ W$
$T_h = 25\ ^oC$
x_i
r_i
0
250
f (MHz)
500


7Z67533
load impedance (parallel components) versus frequency (class B operation
R_L (Ω)
20
15
10
5
$-C_L$ (pF)
50
100
R_L
$-C_L$
typ. values
$V_{CC} = 28\ V$
$P_L = 40\ W$
$T_h = 25\ ^oC$
0
250
f (MHz)
500

SILICON PLANAR EPITAXIAL TRANSISTOR

N-P-N multi-emitter silicon transistor in a capstan envelope. It has extremely good intermodulation properties and high power gain.
The device is primarily intended for pre-amplifiers in television transmitters and transposers.

QUICK REFERENCE DATA

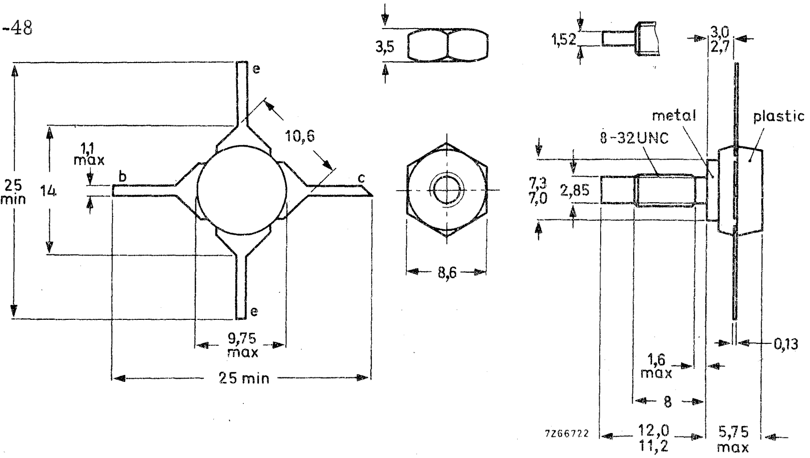
Collector-base voltage (open emitter; peak value)	V_{CBOM}	max.	40	V
Collector-emitter voltage (open base)	V_{CEO}	max.	27	V
Collector current (peak value)	I_{CM}	max.	1	A
Junction temperature	T_j	max.	200	°C
Thermal resistance from junction to mounting base	$R_{th\ j\text{-}mb}$	=	15	°C/W
Transition frequency I_C = 200 mA; V_{CE} = 20 V	f_T	>	1,2	GHz
Output power at f_{vision} = 860 MHz *) I_C = 250 mA; V_{CE} = 25 V; T_h = 25 °C; d_{im} = −60 dB	$P_{o\ sync}$	>	0,5	W
Power gain at f_{vision} = 860 MHz I_C = 250 mA; V_{CE} = 25 V; T_h = 25 °C	G_p	>	6	dB

*) Three-tone test method (vision carrier −8 dB, sound carrier −7 dB, side band signal −16 dB), zero dB corresponds to peak sync level.

MECHANICAL DATA

Dimensions in mm

SOT-48



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.
Mountinghole 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

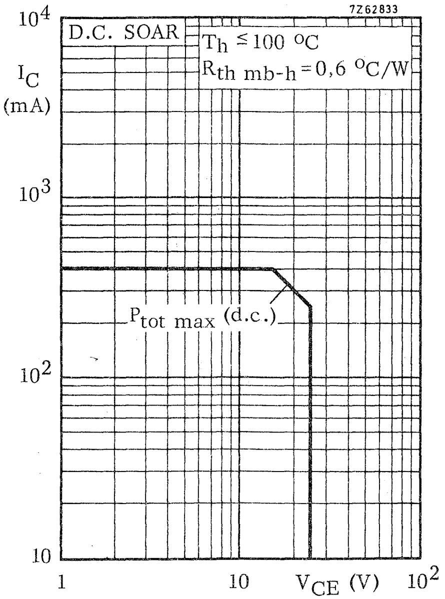
Collector-base voltage (open emitter; peak value)	V_{CBOM}	max.	40	V
Collector-emitter voltage (R_{BE} = 10 Ω; peak value)	V_{CERM}	max.	40	V
Collector-emitter voltage (open base)	V_{CEO}	max.	27	V
Emitter-base voltage (open collector)	V_{EBO}	max.	3,5	V

Currents

Collector current (d.c.)	I_C	max.	0,4	A
Collector current (peak value) f > 1 MHz	I_{CM}	max.	1	A

Power dissipation

Total power dissipation up to T_h = 100 °C	P_{tot}	max.	6,25	W



Temperatures

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

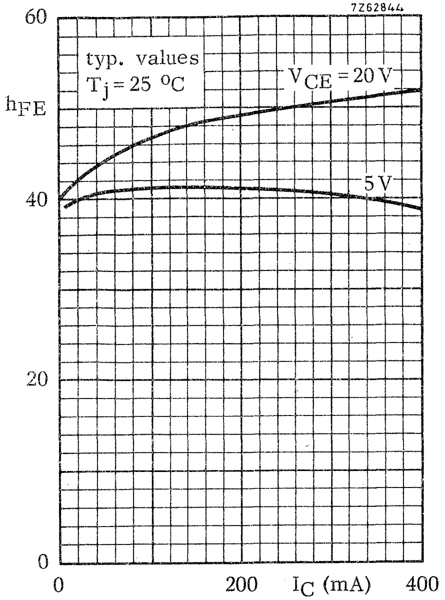
THERMAL RESISTANCE

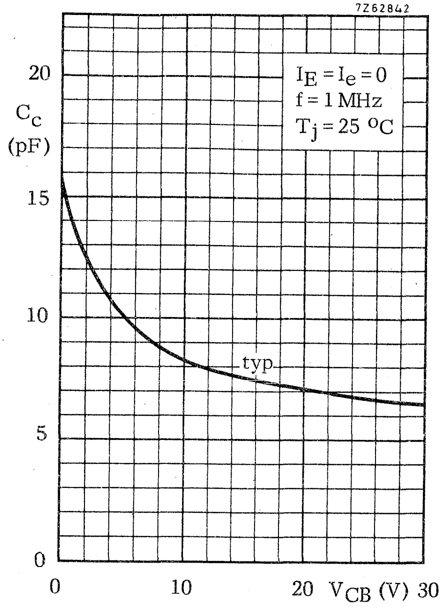
From junction to mounting base	$R_{th\ j-mb}$	=	15	°C/W
From mounting base to heatsink	$R_{th\ mb-h}$	=	0,6	°C/W

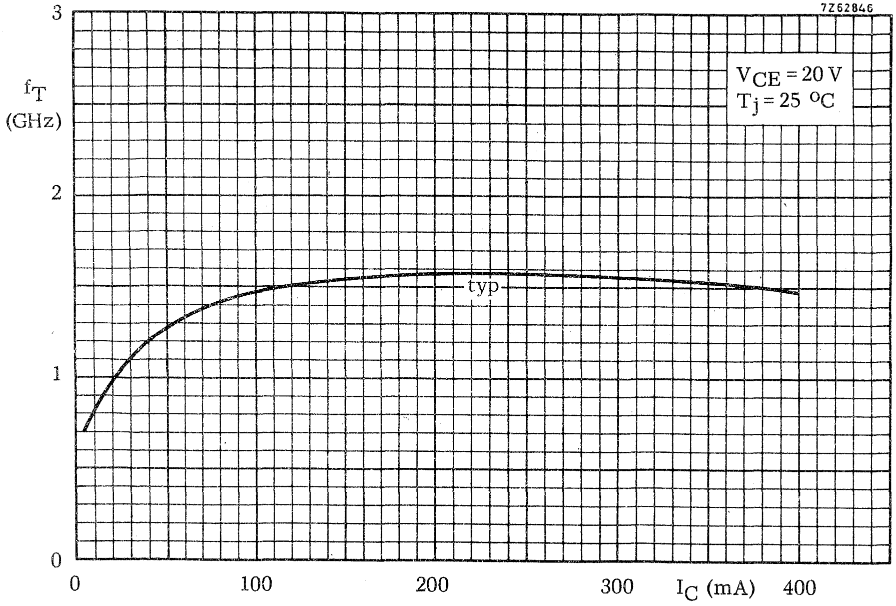
CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current				
$I_E = 0$; $V_{CB} = 20$ V	I_{CBO}	<	100	μA
Breakdown voltages				
Collector-base voltage open emitter; $I_C = 1$ mA	$V_{(BR)CBO}$	>	40	V
Collector-emitter voltage $R_{BE} = 10\ \Omega$; $I_C = 5$ mA	$V_{(BR)CER}$	>	40	V
open base; $I_C = 5$ mA	$V_{(BR)CEO}$	>	27	V
Emitter-base voltage open collector; $I_E = 1$ mA	$V_{(BR)EBO}$	>	3,5	V
Saturation voltage				
$I_C = 200$ mA; $I_B = 20$ mA	V_{CEsat}	<	0,75	V
D.C. current gain				
$I_C = 200$ mA; $V_{CE} = 20$ V	h_{FE}	>	30	
$I_C = 400$ mA; $V_{CE} = 20$ V	h_{FE}	>	20	
Transition frequency				
$I_C = 200$ mA; $V_{CE} = 20$ V	f_T	>	1,2	GHz
$I_C = 350$ mA; $V_{CE} = 20$ V	f_T	>	1,0	GHz
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; $V_{CB} = 20$ V	C_c	<	10	pF
Feedback capacitance at f = 1 MHz				
$I_C = 10$ mA; $V_{CE} = 20$ V; $T_{mb} = 25$ °C	C_{re}	typ.	3,5	pF
Collector-stud capacitance	C_{cs}	typ.	2	pF


7Z62844
typ. values
$T_j = 25\ ^oC$
$V_{CE} = 20$ V
5 V
h_{FE}
60
40
20
0
0
200
I_C (mA)
400


7Z62842
$I_E = I_e = 0$
f = 1 MHz
$T_j = 25\ ^oC$
C_c (pF)
typ
20
15
10
5
0
0
10
20
V_{CB} (V)
30

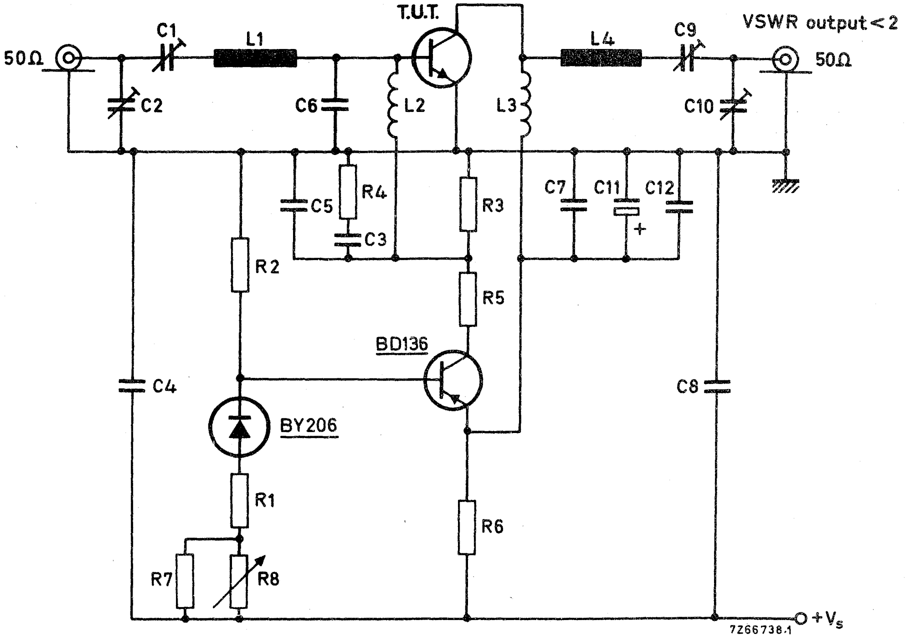

7Z62846
$V_{CE} = 20$ V
$T_j = 25\ ^oC$
f_T (GHz)
typ
3
2
1
0
0
100
200
300
I_C (mA)
400

APPLICATION INFORMATION

d_{im}(dB) *)	f_{vision} (MHz)	V_{CE} (V)	I_C (mA)	G_p (dB)	$P_{o\ sync}$ (W) *)	T_h (°C)
−60	860	25	250	> 6	> 0,5	25
−60	860	25	250	typ. 7	typ. 0,6	25

*) Three-tone test method (vision carrier −8 dB, sound carrier −7 dB, sideband signal −16 dB), zero dB corresponds to peak sync level.

Test circuit at f_{vision} = 860 MHz



List of components: (see also page 6)

C1 = C2 = C10 = 2 to 9 pF film dielectric trimmers
C3 = C4 = C12 = 100 nF polyester capacitors
C5 = C7 = C8 = 100 pF feed-through capacitors
C6 = 2 x 2,7 pF in parallel, chip capacitors
C9 = 2 to 18 pF film dielectric trimmer
C11 = 10 µF/40 V solid aluminium electrolytic capacitor

R1 = 220 Ω
R2 = 4,7 kΩ
R3 = 100 Ω
R4 = 10 Ω

R5 = 470 Ω (1 W)
R6 = 3 x 22 Ω in parallel; (1 W)
R7 = 12 kΩ
R8 = 1 kΩ

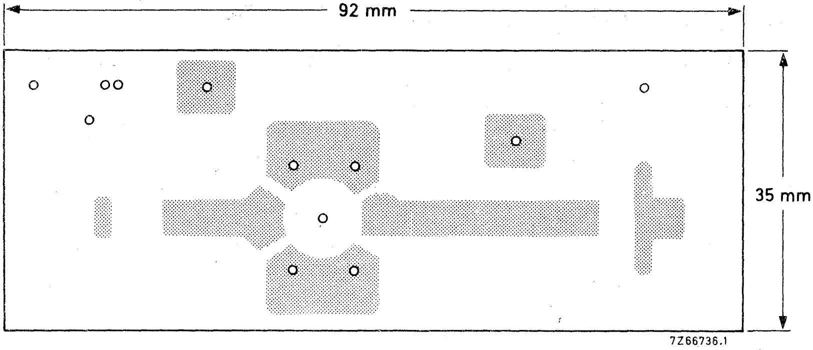
APPLICATION INFORMATION (continued)

List of components: (continued)

L1 = strip-line (14, 8 mm x 4, 3 mm)
L2 = 7 turns closely wound enamelled Cu wire (0, 5 mm): int. diam. 3 mm
L3 = 2 turns Cu wire (1 mm); winding pitch 1, 5 mm; int. diam. 4, 5 mm; leads 2 x 5 mm
L4 = strip-line (29, 5 mm x 4, 3 mm)

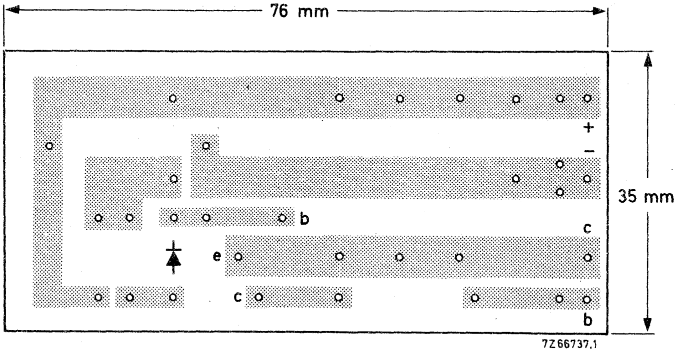
L1 and L4 are strip-lines on a double Cu clad print plate with teflon fibre-glass dielectric (ϵ_r = 2, 74); thickness 1, 45 mm.

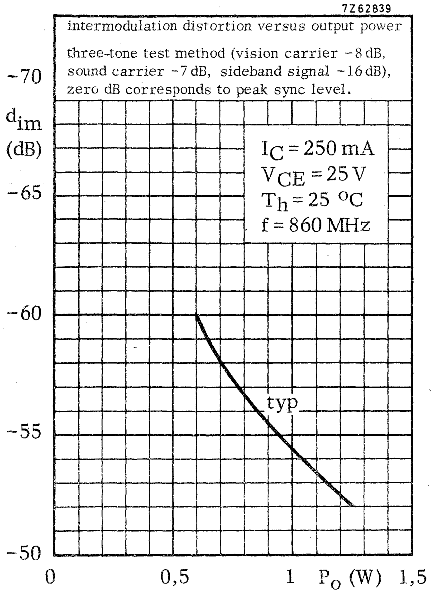
Lay-out of printed circuit board for 860 MHz test circuit.

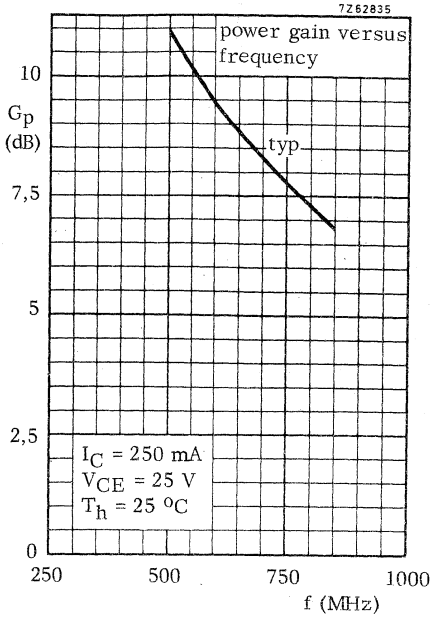


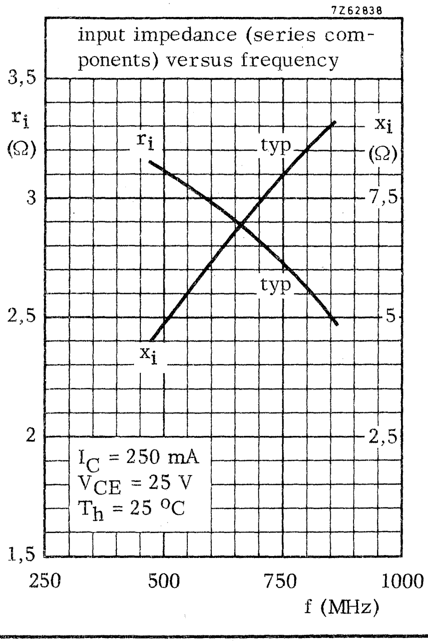
The circuit and the components are situated on one side of the teflon fibre-glass board, the other side being fully metallized to serve as earth. Earth connections are made by means of hollow rivets.

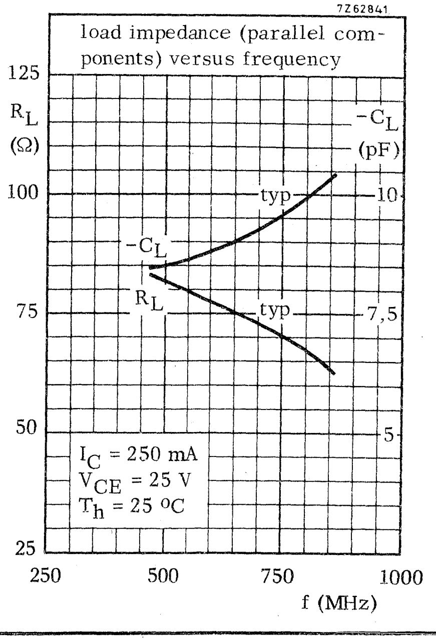
Lay-out of printed circuit board bias circuit.




7Z62839
intermodulation distortion versus output power
three-tone test method (vision carrier −8 dB, sound carrier −7 dB, sideband signal −16 dB), zero dB corresponds to peak sync level.
I_C = 250 mA
V_{CE} = 25 V
T_h = 25 °C
f = 860 MHz
d_{im} (dB)
−70
−65
−60
−55
−50
typ
0
0,5
1
P_o (W)
1,5


7Z62835
power gain versus frequency
G_p (dB)
10
7,5
5
2,5
0
typ
I_C = 250 mA
V_{CE} = 25 V
T_h = 25 °C
250
500
750
1000
f (MHz)


7Z62838
input impedance (series components) versus frequency
r_i (Ω)
3,5
3
2,5
2
1,5
x_i (Ω)
7,5
5
2,5
r_i
x_i
typ
typ
I_C = 250 mA
V_{CE} = 25 V
T_h = 25 °C
250
500
750
1000
f (MHz)


7Z62841
load impedance (parallel components) versus frequency
R_L (Ω)
125
100
75
50
25
$-C_L$ (pF)
10
7,5
5
$-C_L$
R_L
typ
typ
I_C = 250 mA
V_{CE} = 25 V
T_h = 25 °C
250
500
750
1000
f (MHz)

SILICON PLANAR EPITAXIAL TRANSISTOR

N-P-N multi-emitter silicon transistor in a capstan envelope. It has extremely good intermodulation properties and high power gain.
The device is primarily intended for pre-amplifiers in television transmitters and transposers.

QUICK REFERENCE DATA

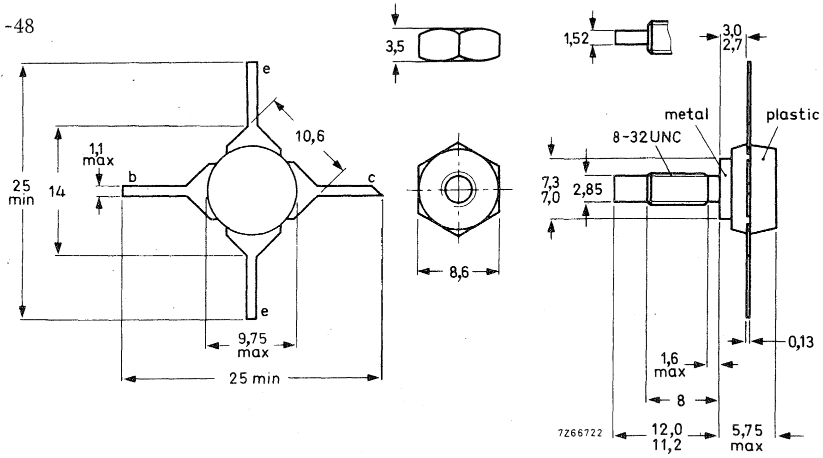
Collector-base voltage (open emitter; peak value)	V_{CBOM}	max.	40	V
Collector-emitter voltage (open base)	V_{CEO}	max.	27	V
Collector current (peak value)	I_{CM}	max.	2	A
Junction temperature	T_j	max.	200	°C
Thermal resistance from junction to mounting base	$R_{th\ j\text{-}mb}$	=	7,5	°C/W
Transition frequency I_C = 400 mA; V_{CE} = 20 V	f_T	>	1,2	GHz
Output power at f_{vision} = 860 MHz *) I_C = 500 mA; V_{CE} = 25 V; T_h = 25 °C; d_{im} = −60 dB	$P_{o\ sync}$	>	1,0	W
Power gain at f_{vision} = 860 MHz I_C = 500 mA; V_{CE} = 25 V; T_h = 25 °C	G_p	>	5,5	dB

*) Three-tone test method (vision carrier −8 dB, sound carrier −7 dB, side band signal −16 dB), zero dB corresponds to peak sync level.

MECHANICAL DATA

Dimensions in mm

SOT-48



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

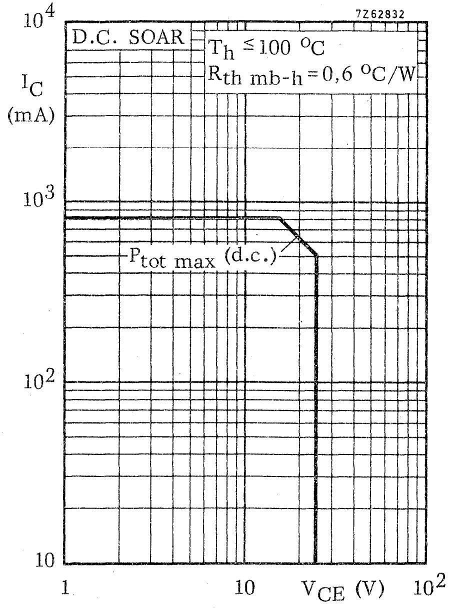
Collector-base voltage (open emitter; peak value)	V_{CBOM}	max.	40	V
Collector-emitter voltage (R_{BE} = 10 Ω; peak value)	V_{CERM}	max.	40	V
Collector-emitter voltage (open base)	V_{CEO}	max.	27	V
Emitter-base voltage (open collector)	V_{EBO}	max.	3,5	V

Currents

Collector current (d.c.)	I_C	max.	0,8	A
Collector current (peak value) f > 1 MHz	I_{CM}	max.	2	A

Power dissipation

Total power dissipation up to T_h = 100 °C	P_{tot}	max.	12,5	W



Temperatures

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

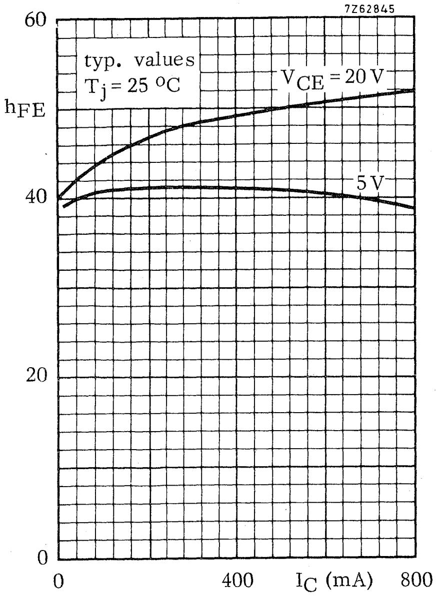
THERMAL RESISTANCE

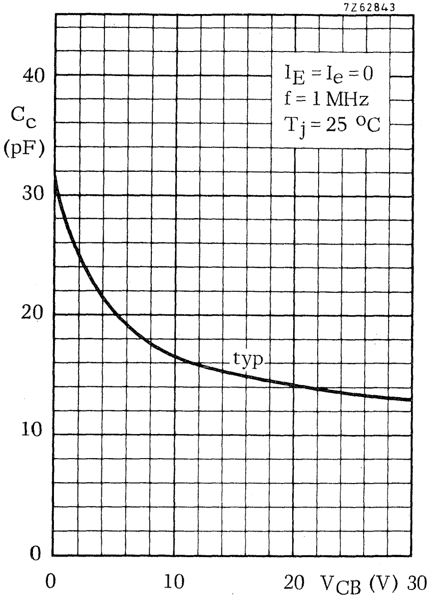
From junction to mounting base	$R_{th\ j-mb}$	=	7,5	°C/W
From mounting base to heatsink	$R_{th\ mb-h}$	=	0,6	°C/W

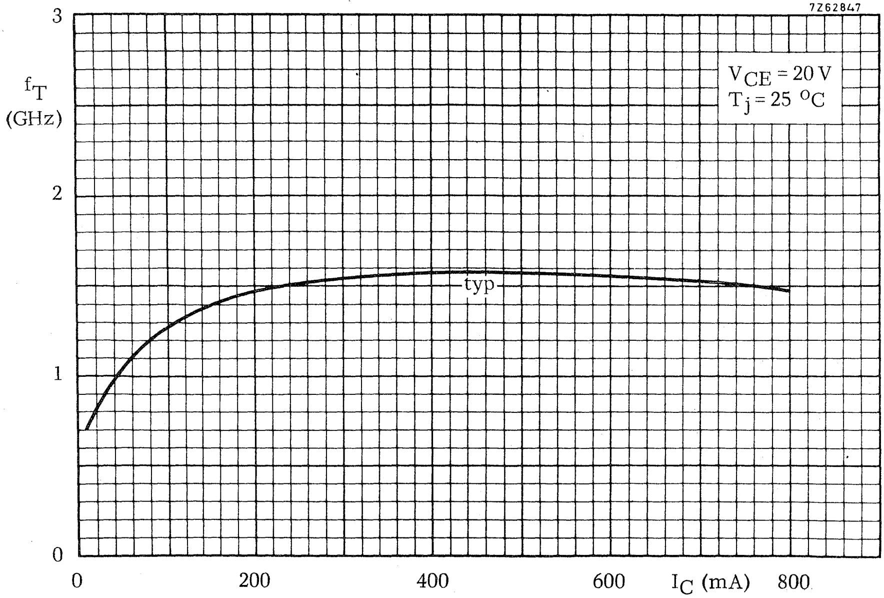
CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current				
$I_E = 0$; $V_{CB} = 20$ V	I_{CBO}	$<$	200	μA
Breakdown voltages				
Collector-base voltage open emitter; $I_C = 2$ mA	$V_{(BR)CBO}$	$>$	40	V
Collector-emitter voltage $R_{BE} = 10\ \Omega$; $I_C = 10$ mA	$V_{(BR)CER}$	$>$	40	V
open base; $I_C = 10$ mA	$V_{(BR)CEO}$	$>$	27	V
Emitter-base voltage open collector; $I_E = 2$ mA	$V_{(BR)EBO}$	$>$	3,5	V
Saturation voltage				
$I_C = 400$ mA; $I_B = 40$ mA	V_{CEsat}	$<$	0,75	V
D.C. current gain				
$I_C = 400$ mA; $V_{CE} = 20$ V	h_{FE}	$>$	30	
$I_C = 800$ mA; $V_{CE} = 20$ V	h_{FE}	$>$	20	
Transition frequency				
$I_C = 400$ mA; $V_{CE} = 20$ V	f_T	$>$	1,2	GHz
$I_C = 700$ mA; $V_{CE} = 20$ V	f_T	$>$	1,0	GHz
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; $V_{CB} = 20$ V	C_c	$<$	20	pF
Feedback capacitance at f = 1 MHz				
$I_C = 20$ mA; $V_{CE} = 20$ V; $T_{mb} = 25$ °C	C_{re}	typ.	7	pF
Collector-stud capacitance	C_{cs}	typ.	2	pF


7Z62845
60
40
20
0
hFE
typ. values
Tj = 25 °C
VCE = 20 V
5 V
0
400
IC (mA)
800


7Z62843
40
30
20
10
0
Cc
(pF)
IE = Ie = 0
f = 1 MHz
Tj = 25 °C
typ
0
10
20
VCB (V)
30

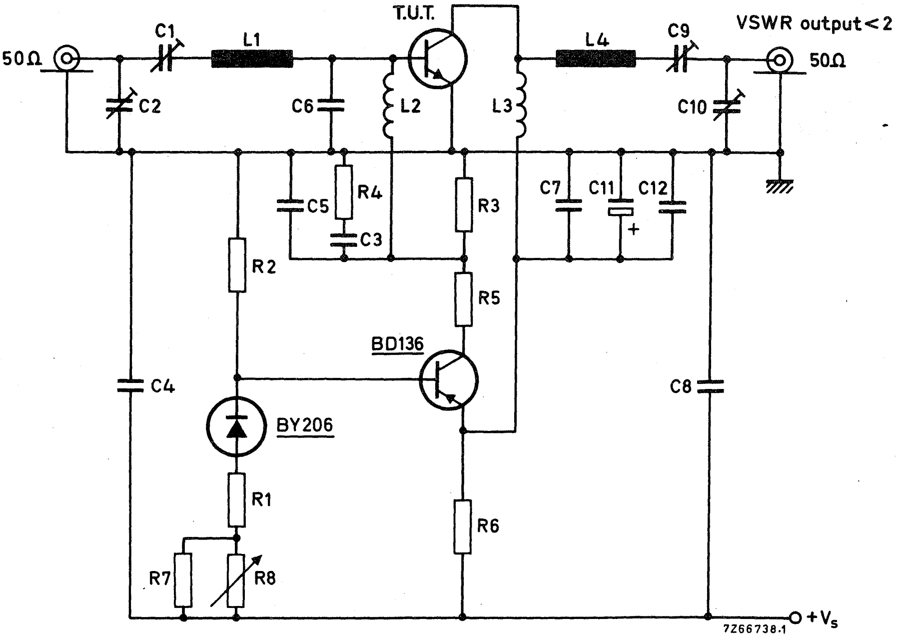

7Z62847
3
2
1
0
fT
(GHz)
VCE = 20 V
Tj = 25 °C
typ
0
200
400
600
IC (mA)
800

APPLICATION INFORMATION

d_{im} (dB) *)	f_{vision} (MHz)	V_{CE} (V)	I_C (mA)	G_p (dB)	$P_{o\ sync}$ (W) *)	T_h (°C)
−60	860	25	500	> 5,5	> 1,0	25
−60	860	25	500	typ. 6,5	typ. 1,1	25

*) Three-tone test method (vision carrier −8 dB, sound carrier −7 dB, sideband signal −16 dB), zero dB corresponds to peak sync level.

Test circuit at f_{vision} = 860 MHz



List of components: (see also page 6)

C1 = C2 = C10 = 2 to 9 pF film dielectric trimmers
C3 = C4 = C12 = 100 nF polyester capacitors
C5 = C7 = C8 = 100 pF feed-through capacitors
C6 = 2 x 2,7 pF in parallel, chip capacitors
C9 = 2 to 18 pF film dielectric trimmer
C11 = 10 μF/40 V solid aluminium electrolytic capacitor

R1 = 220 Ω
R2 = 4,7 kΩ
R3 = 100 Ω
R4 = 10 Ω

R5 = 470 Ω (1 W)
R6 = 3 x 22 Ω in parallel; (1 W)
R7 = 12 kΩ
R8 = 1 kΩ

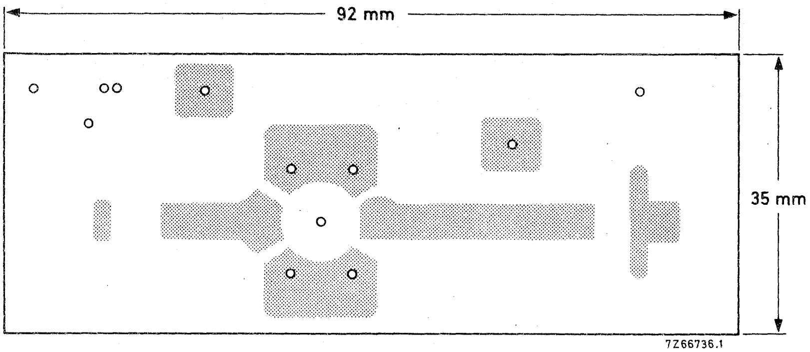
APPLICATION INFORMATION (continued)

List of components: (continued)

L1 = strip-line (14, 8 mm x 4, 3 mm)
L2 = 7 turns closely wound enamelled Cu wire (0, 5 mm); int. diam. 3 mm
L3 = 2 turns Cu wire (1 mm); winding pitch 1, 5 mm; int. diam. 4, 5 mm; leads 2x5 mm
L4 = strip line (29, 5 mm x 4, 3 mm)

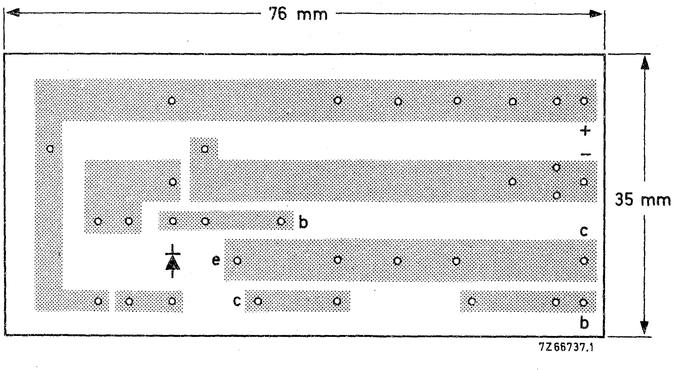
L1 and L4 are strip-lines on a double Cu clad print plate with teflon fibre-glass dielectric (ϵ_r = 2, 74); thickness 1, 45 mm.

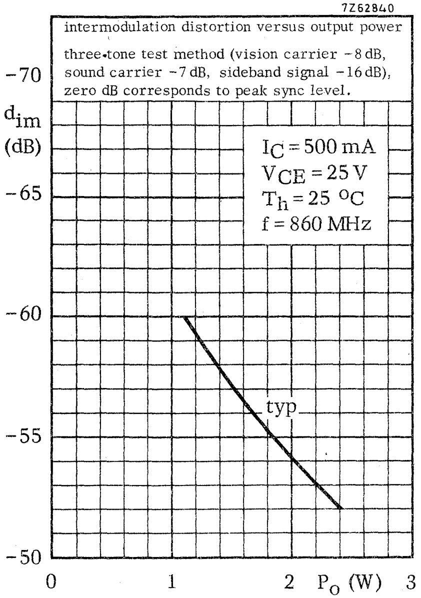
Lay-out of printed circuit board for 860 MHz test circuit.

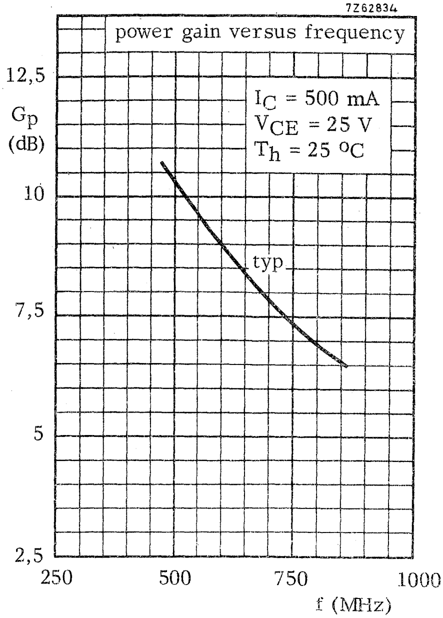


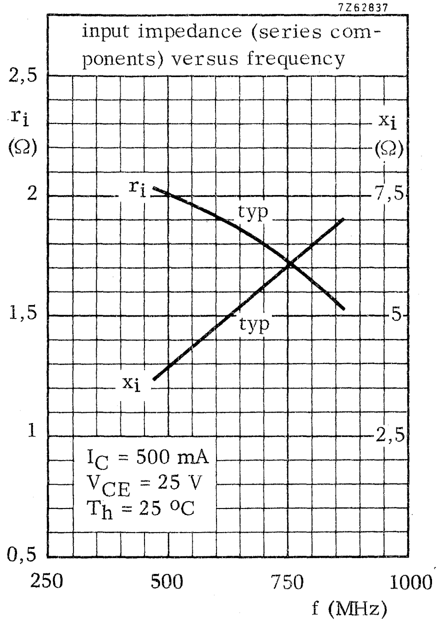
The circuit and the components are situated on one side of the teflon fibre-glass board, the other side being fully metallized to serve as earth. Earth connections are made by means of hollow rivets.

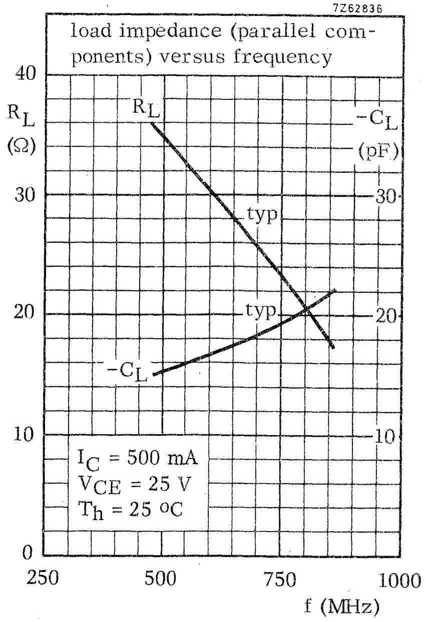
Lay-out of printed circuit board bias circuit.




7Z62840
intermodulation distortion versus output power
three-tone test method (vision carrier −8 dB, sound carrier −7 dB, sideband signal −16 dB); zero dB corresponds to peak sync level.
d_{im} (dB)
−70
−65
−60
−55
−50
$I_C = 500$ mA
$V_{CE} = 25$ V
$T_h = 25$ °C
f = 860 MHz
typ
0
1
2
P_o (W)
3


7Z62834
power gain versus frequency
G_p (dB)
12,5
10
7,5
5
2,5
$I_C = 500$ mA
$V_{CE} = 25$ V
$T_h = 25$ °C
typ
250
500
750
1000
f (MHz)


7Z62837
input impedance (series components) versus frequency
r_i (Ω)
2,5
2
1,5
1
0,5
x_i (Ω)
7,5
5
2,5
r_i
x_i
typ
typ
$I_C = 500$ mA
$V_{CE} = 25$ V
$T_h = 25$ °C
250
500
750
1000
f (MHz)


7Z62836
load impedance (parallel components) versus frequency
R_L (Ω)
40
30
20
10
0
$-C_L$ (pF)
30
20
10
R_L
$-C_L$
typ
typ
$I_C = 500$ mA
$V_{CE} = 25$ V
$T_h = 25$ °C
250
500
750
1000
f (MHz)

U.H.F. POWER TRANSISTOR

N-P-N silicon planar epitaxial transistor assembled in a plastic encapsulated stripline package all leads of which are isolated from the stud. Excellent d.c. dissipation properties have been obtained by means of internal emitter-ballasting resistors and gold metallization. Detailed information is presented for application of this device in preamplifiers for television transposers and transmitters in band IV - V.

QUICK REFERENCE DATA

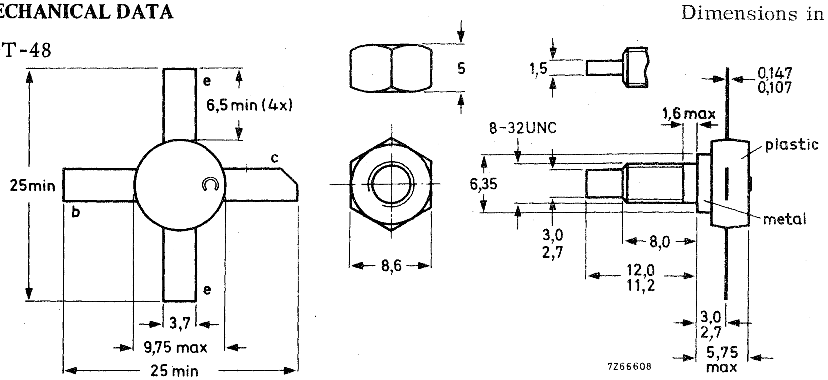
Collector-base voltage (open emitter; peak value)	V_{CBOM}	max.	50	V
Collector-emitter voltage (open base)	V_{CEO}	max.	27	V
Collector current (peak value)	I_{CM}	max.	4	A
Junction temperature	T_j	max.	200	°C
Thermal resistance from junction to mounting base	$R_{th\ j\text{-}mb}$	=	5,5	°C/W
Transition frequency I_C = 1 A; V_{CE} = 25 V	f_T	typ.	2,5	GHz
Output power at f_{vision} = 860 MHz *) I_C = 850 mA; V_{CE} = 25 V; T_h = 70 °C; d_{im} = −60 dB	$P_{o\ sync}$	>	3,5	W
Power gain at f_{vision} = 860 MHz I_C = 850 mA; V_{CE} = 25 V; T_h = 70 °C	G_p	>	5,0	dB

*) Three-tone test method (vision carrier −8 dB, sound carrier −7 dB, sideband signal −16 dB), zero dB corresponds to peak sync level.

MECHANICAL DATA

Dimensions in mm

SOT-48



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

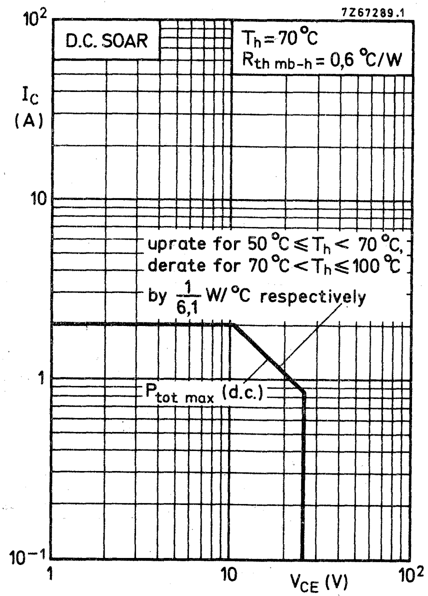
Collector-base voltage (open emitter; peak value)	V_{CBOM}	max.	50	V
Collector-emitter voltage (open base)	V_{CEO}	max.	27	V
Emitter-base voltage (open collector)	V_{EBO}	max.	3,5	V

Currents

Collector current (d.c.)	I_C	max.	2	A
Collector current (peak value) f > 1 MHz	I_{CM}	max.	4	A

Power dissipation

Total power dissipation at T_h = 70 °C	P_{tot}	max.	21,5	W



Temperatures

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

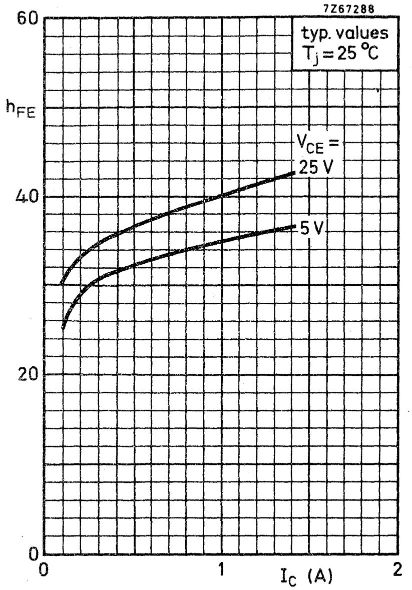
THERMAL RESISTANCE

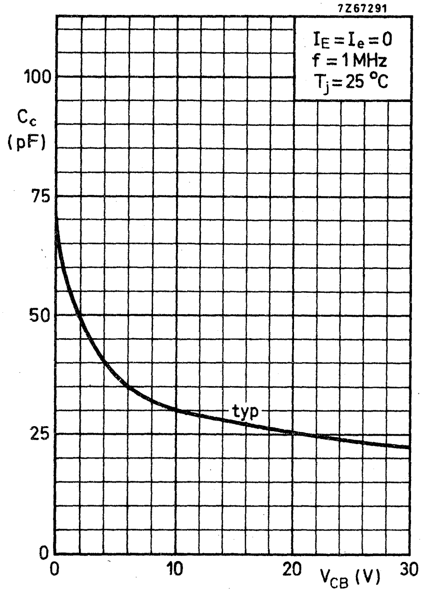
From junction to mounting base	$R_{th\ j\text{-}mb}$	=	5,5	°C/W
From mounting base to heatsink	$R_{th\ mb\text{-}h}$	=	0,6	°C/W

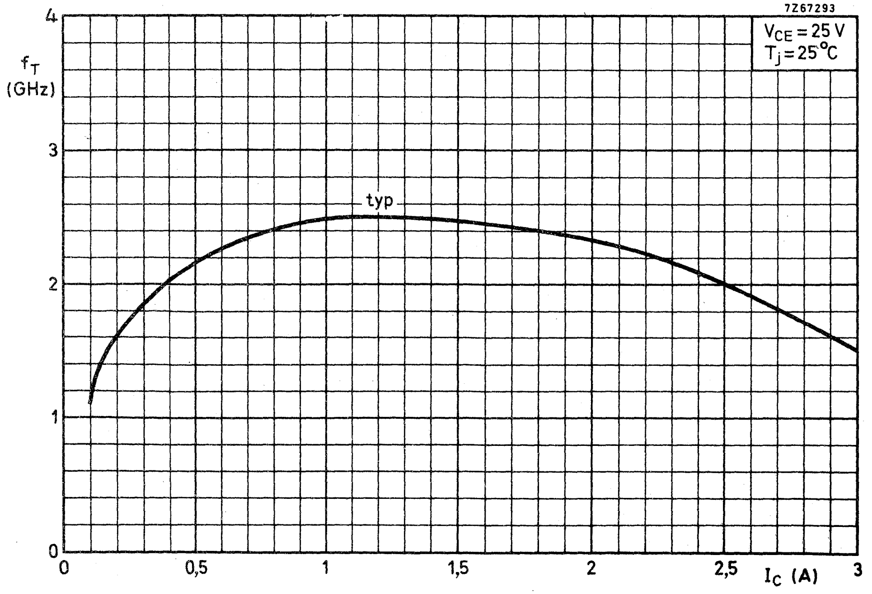
CHARACTERISTICS

$T_j = 25\ ^oC$ unless otherwise specified

Breakdown voltages				
Collector-base voltage open emitter; $I_C = 10$ mA	$V_{(BR)CBO}$	>	50	V
Collector-emitter voltage open base; $I_C = 25$ mA	$V_{(BR)CEO}$	>	27	V
Emitter-base voltage open collector; $I_E = 5$ mA	$V_{(BR)EBO}$	>	3,5	V
Saturation voltage				
$I_C = 500$ mA; $I_B = 100$ mA	V_{CEsat}	<	0,75	V
D.C. current gain				
$I_C = 1$ A; $V_{CE} = 25$ V	h_{FE}	> typ.	15 40	
Transition frequency				
$I_C = 1$ A; $V_{CE} = 25$ V	f_T	typ.	2,5	GHz
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; $V_{CB} = 25$ V	C_c	typ. <	24 30	pF pF
Feedback capacitance at f = 1 MHz				
$I_C = 50$ mA; $V_{CE} = 25$ V; $T_{mb} = 25\ ^oC$	C_{re}	typ.	15	pF
Collector-stud capacitance	C_{cs}	typ.	2	pF


7Z67288
typ. values
$T_j = 25\ ^\circ C$
h_{FE}
V_{CE} =
25 V
5 V
60
40
20
0
0
1
2
I_C (A)


7Z67291
$I_E = I_e = 0$
f = 1 MHz
$T_j = 25\ ^\circ C$
C_c
(pF)
typ
100
75
50
25
0
0
10
20
30
V_{CB} (V)

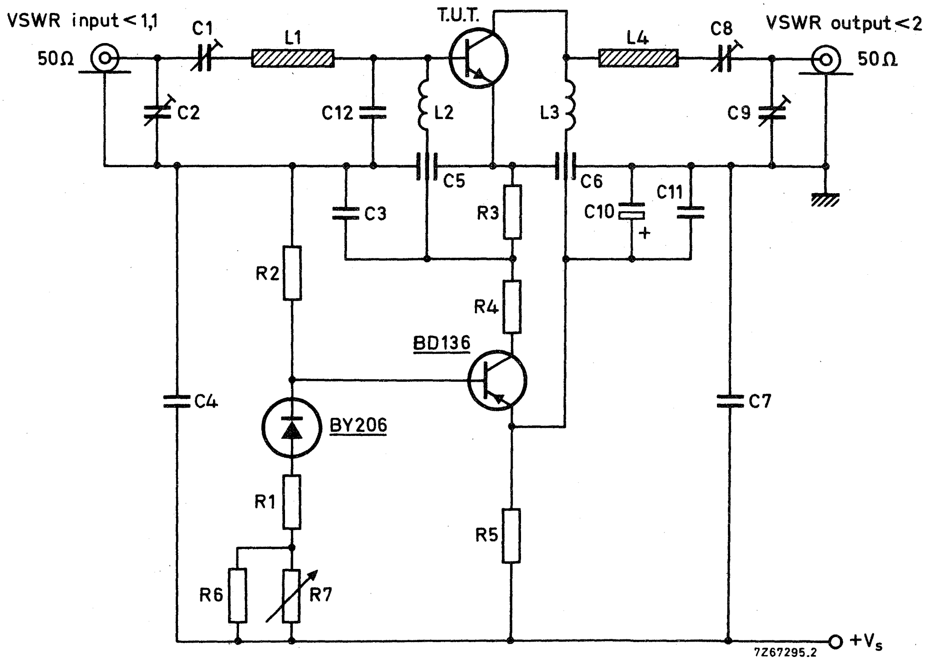

7Z67293
$V_{CE} = 25$ V
$T_j = 25\ ^\circ C$
f_T
(GHz)
typ
4
3
2
1
0
0
0,5
1
1,5
2
2,5
3
I_C (A)

APPLICATION INFORMATION

d_{im} (dB) *)	f_{vision} (MHz)	V_{CE} (V)	I_C (mA)	G_p (dB)	$P_{o\ sync}$ (W) *)	T_h (°C)
-60	860	25	850	> 5,0	> 3,5	70
-60	860	25	850	typ. 5,5	typ. 4,0	70

*) Three-tone test method (vision carrier -8 dB, sound carrier -7 dB, sideband signal -16 dB), zero dB corresponds to peak sync level.

Test circuit at f_{vision} = 860 MHz



List of components : (see also page 6)

C1 = C2 = 1,4 to 5,5 pF film dielectric trimmers (2222 809 09001)
C3 = C4 = 100 nF polyester capacitors
C5 = C6 = 1 nF feed-through capacitors
C7 = 5,6 pF ceramic capacitor
C8 = 2 to 18 pF film dielectric trimmer (2222 809 09003)
C9 = 2 to 9 pF film dielectric trimmer (2222 809 09002)
C10 = 10 μF/40 V solid aluminium electrolytic capacitor
C11 = 470 nF polyester capacitor
C12 = 2 x 3,3 pF chip capacitors (in parallel)

APPLICATION INFORMATION (continued)

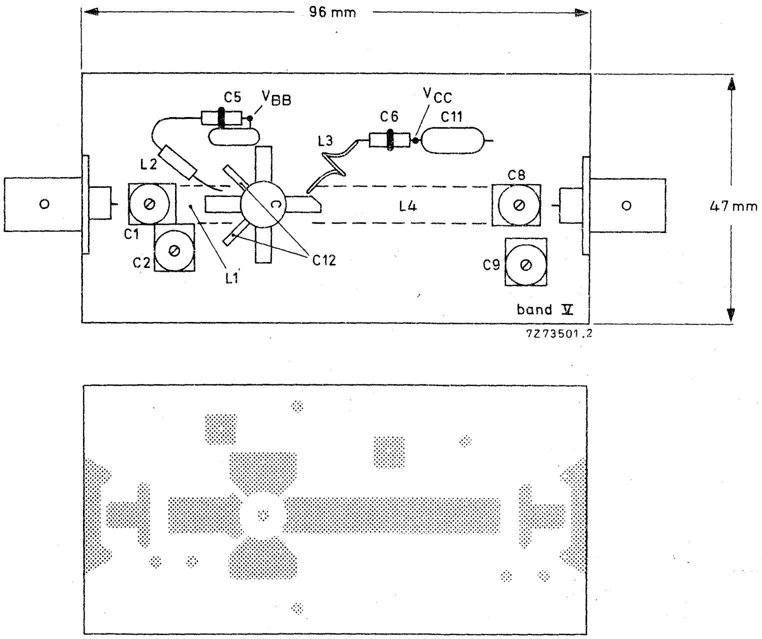
List of components (continued)

R1 = 150 Ω	R5 = 4 x 12 Ω in parallel (4 x 1 W)
R2 = 1,8 kΩ	R6 = 1 kΩ
R3 = 33 Ω	R7 = 220 Ω (potentiometer)
R4 = 220 Ω (1 W)	

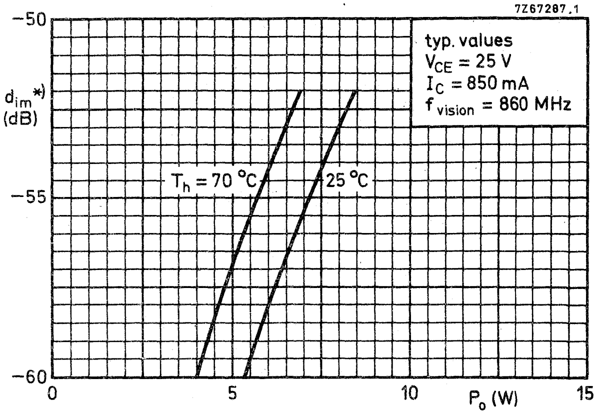
L1 = stripline (13,6 mm x 6,9 mm)
L2 = micro choke 0,47 μH (4322 057 04770)
L3 = 1 turn Cu wire (1 mm); internal diameter 5,5 mm; leads 2 x 5 mm
L4 = stripline (40,8 mm x 6,9 mm)

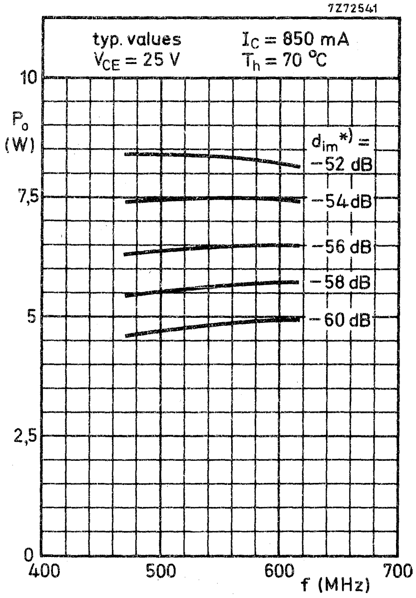
L1 and L4 are striplines on a double Cu-clad print plate with teflon fibre-glass dielectric ($\epsilon_r = 2,74$); thickness 1,45 mm.

Component layout and printed-circuit board for 860 MHz test circuit.

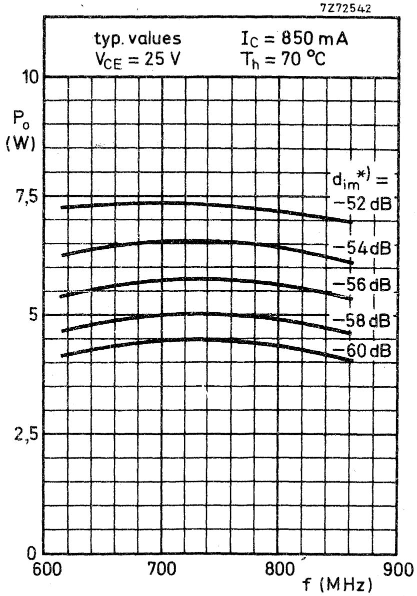


The circuit and the components are situated on one side of the teflon fibre-glass board, the other side being fully metallized to serve as earth. Earth connections are made by means of hollow rivets.





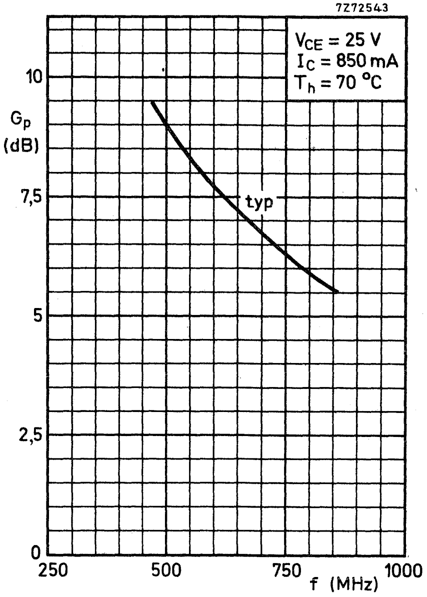
Measured in a TV band IV circuit.

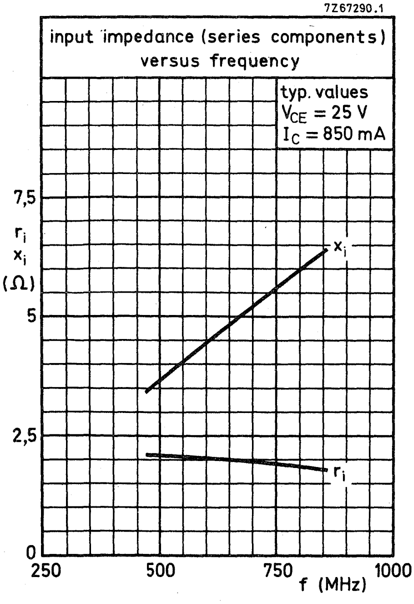


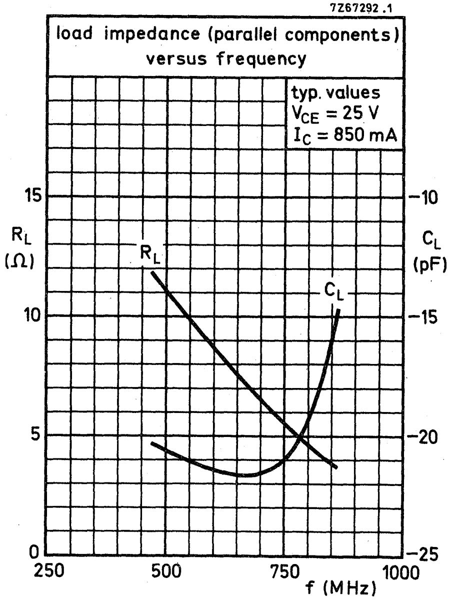
Measured in a TV band V circuit.

Detailed information concerning these circuits, available on request.

*) Three-tone test method (vision carrier −8 dB, sound carrier −7 dB, sideband signal −16 dB), zero dB corresponds to peak sync level.
Intermodulation distortion of input signal ≤ −75 dB.


7Z72543
V_{CE} = 25 V
I_C = 850 mA
T_h = 70 °C
G_p (dB)
10
7,5
5
2,5
0
typ
250
500
750
1000
f (MHz)


7Z67290.1
input impedance (series components) versus frequency
typ. values
V_{CE} = 25 V
I_C = 850 mA
r_i
x_i
(Ω)
7,5
5
2,5
0
x_i
r_i
250
500
750
1000
f (MHz)


7Z67292.1
load impedance (parallel components) versus frequency
typ. values
V_{CE} = 25 V
I_C = 850 mA
R_L (Ω)
15
10
5
0
C_L (pF)
−10
−15
−20
−25
R_L
C_L
250
500
750
1000
f (MHz)

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

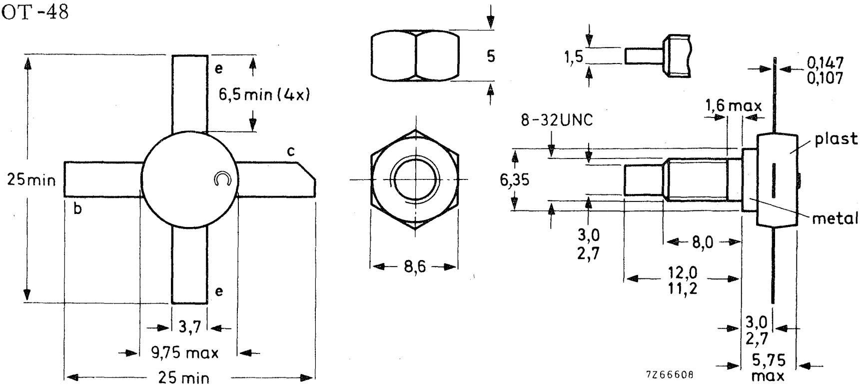
R.F. performance up to T_{mb} = 25 °C in an unneutralised common-emitter class B circuit.

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	2.8 + j1.2	76 − j16
c.w.	12.5	175	typ. 1.0	8	typ. 0.91	typ. 9	typ. 70	–	–

MECHANICAL DATA

Dimensions in mm

SOT-48



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

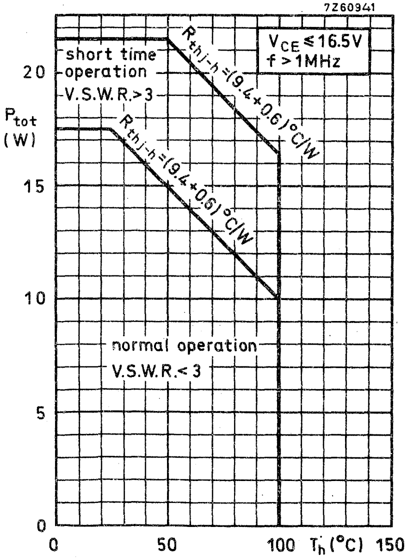
Collector-base voltage (open emitter) peak value	V_{CBOM}	max.	36	V
Collector-emitter voltage (open base)	V_{CEO}	max.	18	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4	V

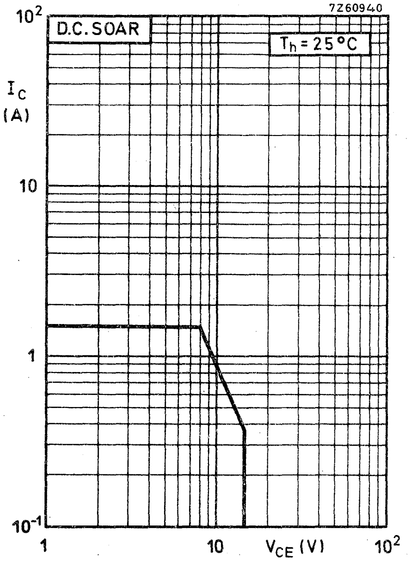
Currents

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

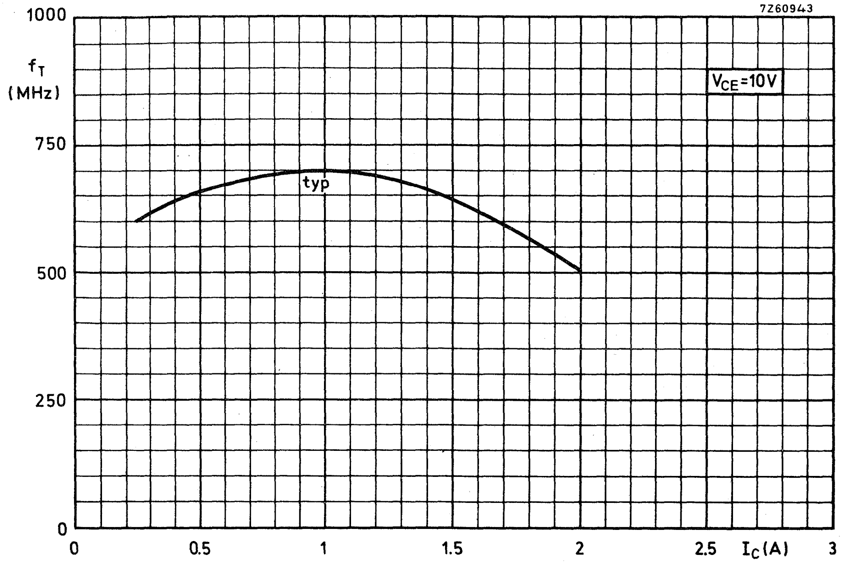
Storage temperature	T_{stg}		−30 to +200	°C
Operating junction temperature	T_j	max.	200	°C

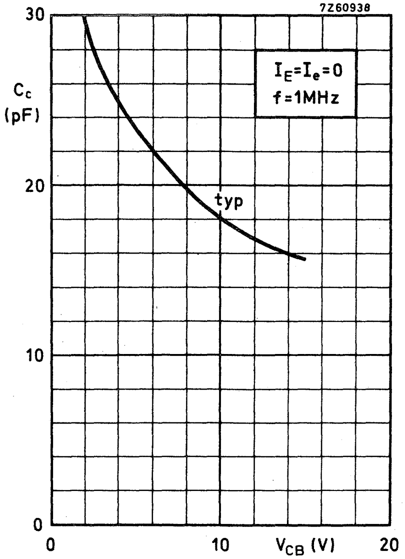
THERMAL RESISTANCE

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 $T_j = 25\,^{\circ}C$ 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				
$I_C = 500\,mA$; $V_{CE} = 10\,V$	f_T	typ.	700	MHz
Collector capacitance at $f = 1\,MHz$				
$I_E = I_e = 0$; $V_{CB} = 15\,V$	C_c	typ. $<$	15 20	pF pF
Feedback capacitance at $f = 1\,MHz$				
$I_C = 100\,mA$; $V_{CE} = 15\,V$	C_{re}	typ.	11	pF
Collector-stud capacitance	C_{cs}	typ.	2	pF


7Z60943
f_T (MHz)
1000
750
500
250
0
V_CE=10V
typ
0
0.5
1
1.5
2
2.5
I_C (A)
3


7Z60938
C_c (pF)
30
20
10
0
I_E=I_e=0
f=1MHz
typ
0
10
V_CB (V)
20

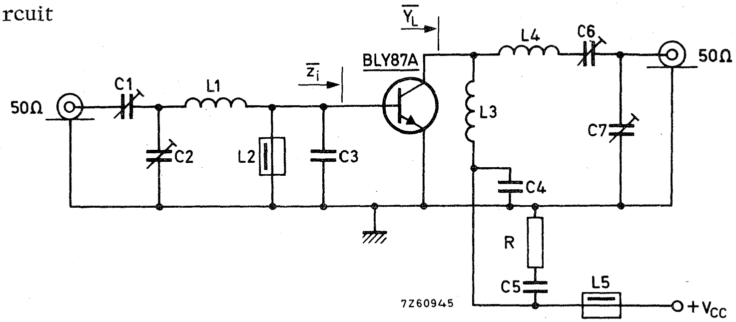
APPLICATION INFORMATION

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	< 1.0	8	< 0.85	> 9	> 70	2.8 + j1.2	76 − j16
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

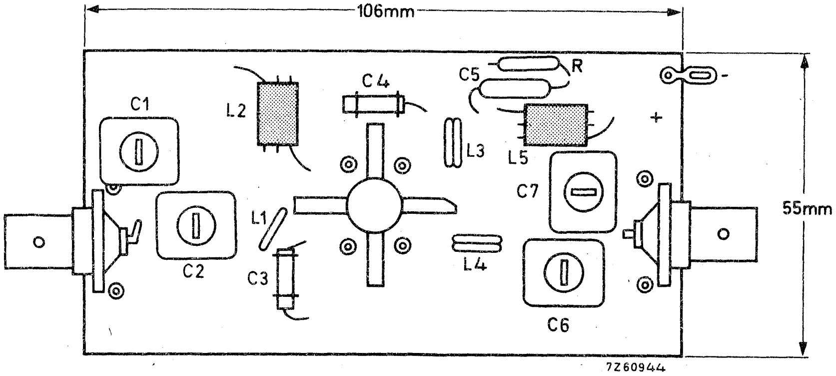
L1 = 0.5 turn enamelled Cu wire (1.5 mm); int. diam. 6 mm; leads 2 x 10 mm
L2 = L5 = ferroxcube choke (code number 4312 020 36640)
L3 = 2.5 turns closely wound enamelled Cu wire (1.5 mm); int. diam. 6 mm; leads 2 x 10 mm
L4 = 4.5 turns enamelled Cu wire (1.5 mm); int. diam. 6 mm; leads 2 x 10 mm

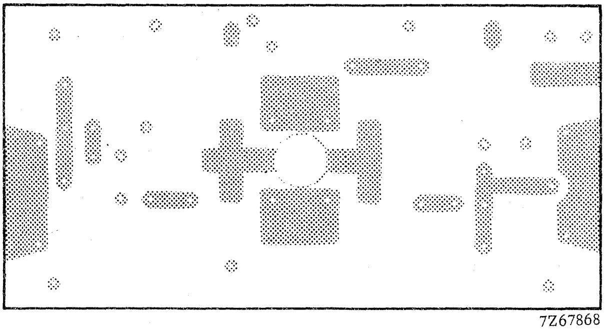
R = 10 Ω carbon

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

APPLICATION INFORMATION (continued)

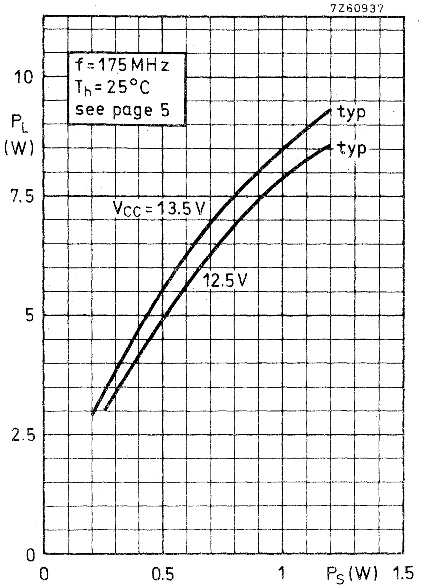
Component lay-out and printed circuit board for 175 MHz test circuit.

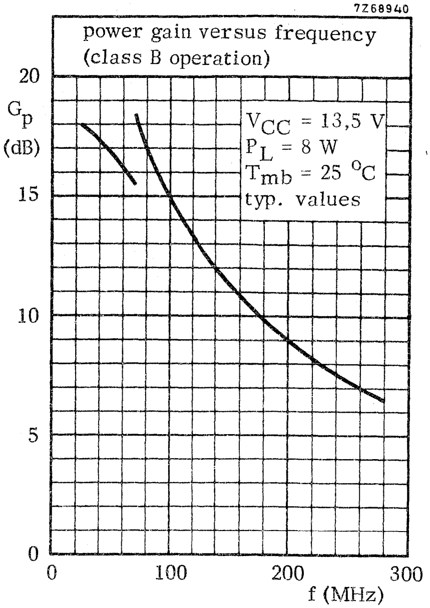


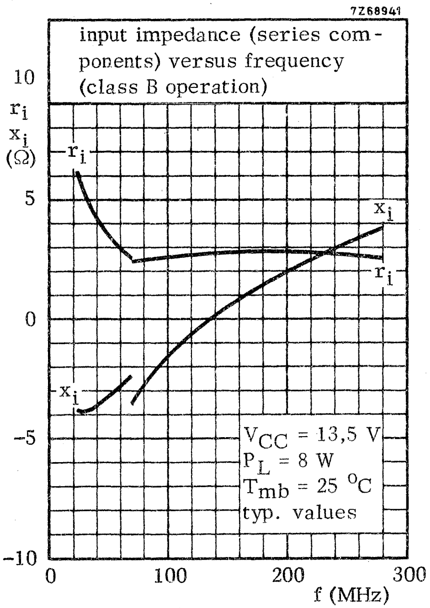


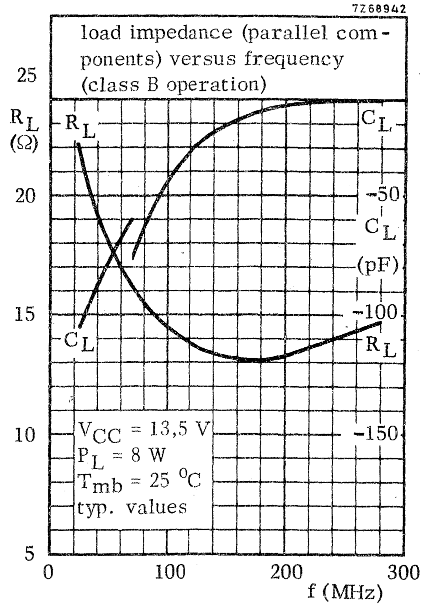
The circuit and the components are situated on one side of the epoxy fibre-glass board, the other side being fully metallised to serve as earth. Earth connections are made by means of hollow rivets.

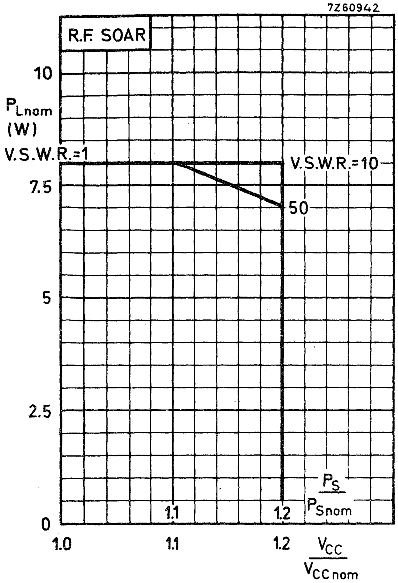
OPERATING NOTE Below 70 MHz a base-emitter resistor of 10 Ω is recommended to avoid oscillation. This resistor must be effective for both d.c. and r.f.

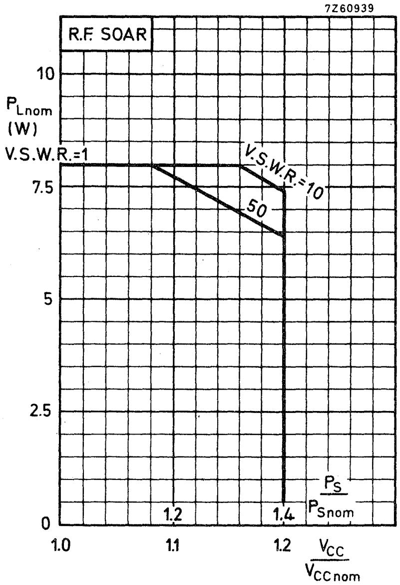












Conditions for R.F. SOAR:

f = 175 MHz $P_{Snom} = P_S$ at $V_{CC} = V_{CCnom}$ and V.S.W.R. = 1
T_h = 70 °C $R_{th\ mb-h} = 0.6$ °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

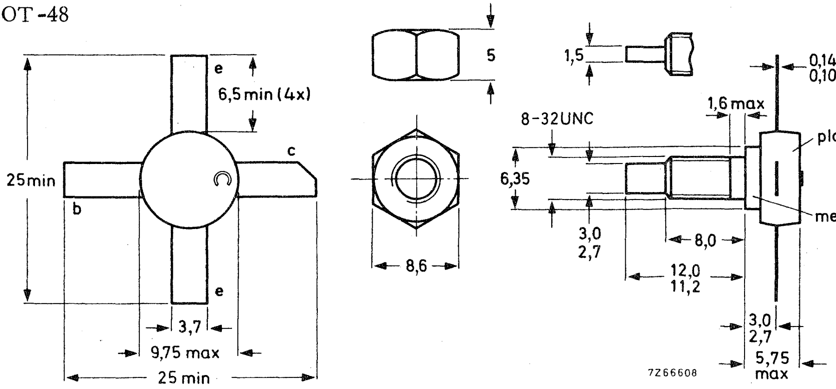
R. F. performance up to T_{mb} = 25 °C in an unneutralised common-emitter class B circuit.

Mode of operation	V_{CC} (V)	f (MHz)	P_S (W)	P_L (W)	I_C (A)	G_p (dB)	η (%)	$\overline{z}_i$ (Ω)	$\overline{Y}_L$ (mA/V)
c.w.	13.5	175	< 2.65	15	< 1.71	> 7.5	> 65	2.3+j2.2	128−j4.4
c.w.	12.5	175	typ. 2.65	15	typ. 1.85	typ. 7.5	typ. 65	–	–

MECHANICAL DATA

Dimensions in mm

SOT-48



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

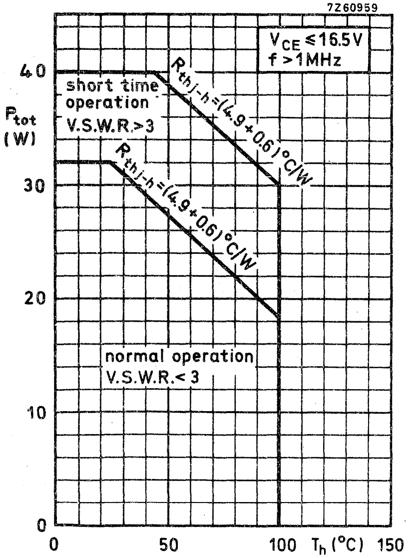
Collector-base voltage (open emitter) peak value	V_{CBOM}	max.	36	V
Collector-emitter voltage (open base)	V_{CEO}	max.	18	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4	V

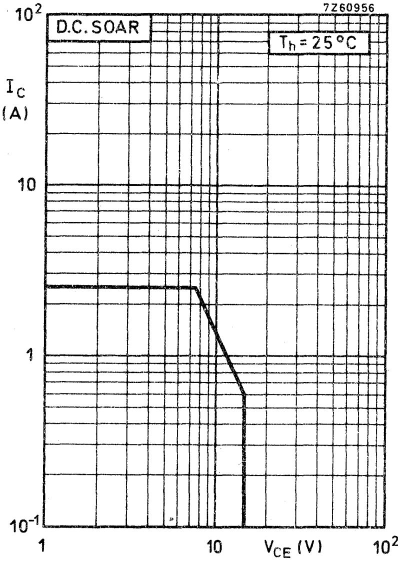
Currents

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

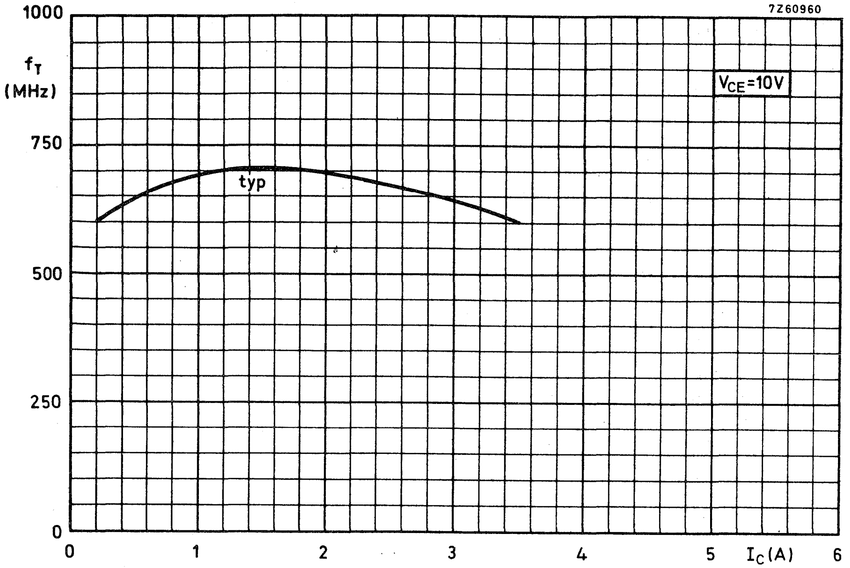
Storage temperature	T_{stg}		−30 to +200	°C
Operating junction temperature	T_j	max.	200	°C

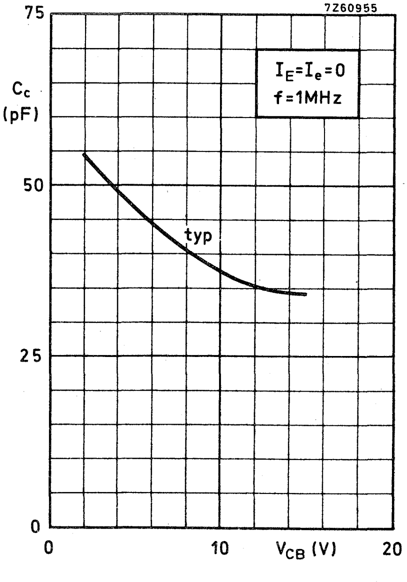
THERMAL RESISTANCE

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 $T_j = 25\ ^{o}C$ 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
f_T (MHz)
1000
750
500
250
0
0
1
2
3
4
5
6
I_C (A)
V_{CE}=10V
typ


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

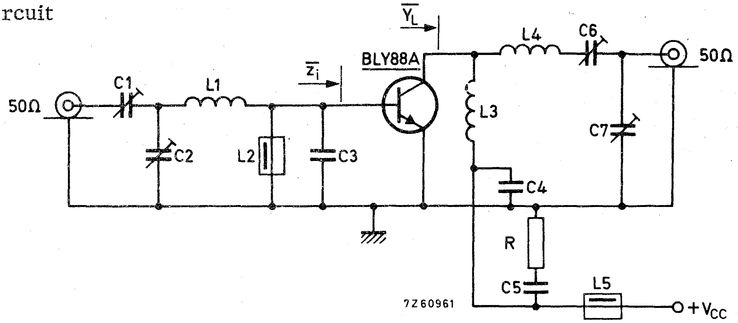
APPLICATION INFORMATION

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(%)	$\overline{z_i}$(Ω)	$\overline{Y_L}$(mA/V)
13.5	< 2.65	15	< 1.71	> 7.5	> 65	2.3+j2.2	128−j4.4
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

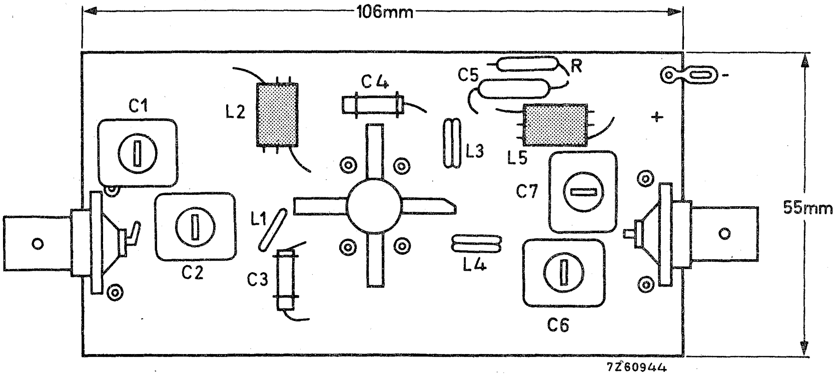
L1=	0.5 turn enamelled Cu wire (1.5 mm); int. diam. 6 mm; leads 2 x 10 mm
L2=L5=	ferroxcube choke (code number 4312 020 36640)
L3=	2.5 turns closely wound enamelled Cu wire (1.5 mm); int. diam. 6 mm; leads 2 x 10 mm
L4=	2.5 turns enamelled Cu wire (1.5 mm); int. diam. 6 mm; leads 2 x 10 mm

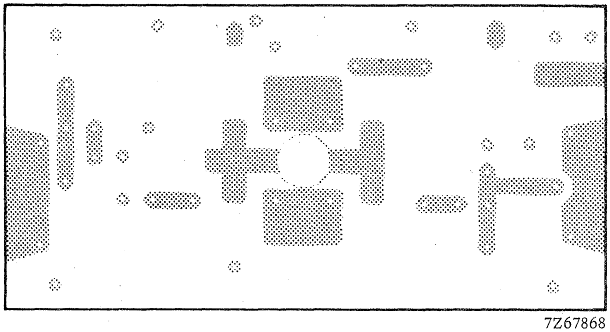
R = 10 Ω carbon

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

APPLICATION INFORMATION (continued)

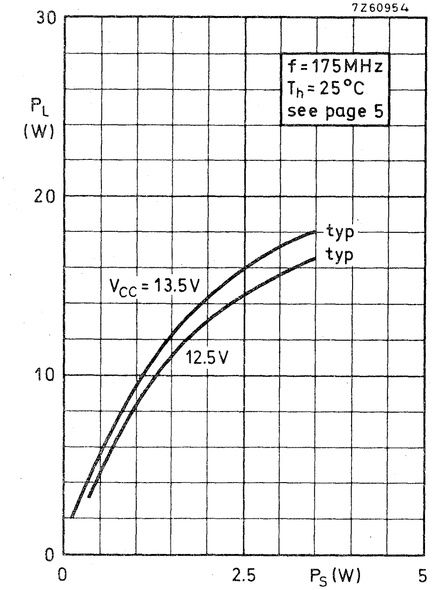
Component lay-out and printed circuit board for 175 MHz test circuit.

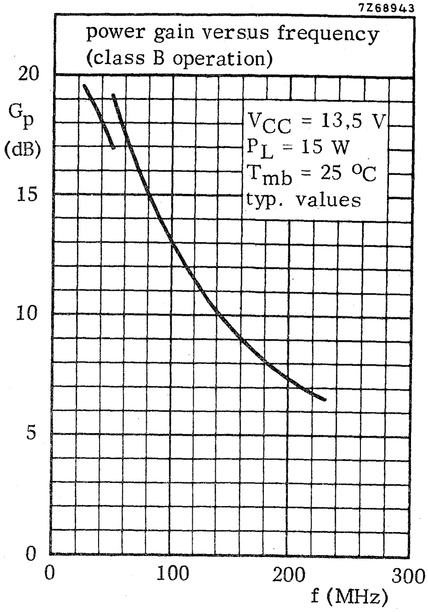


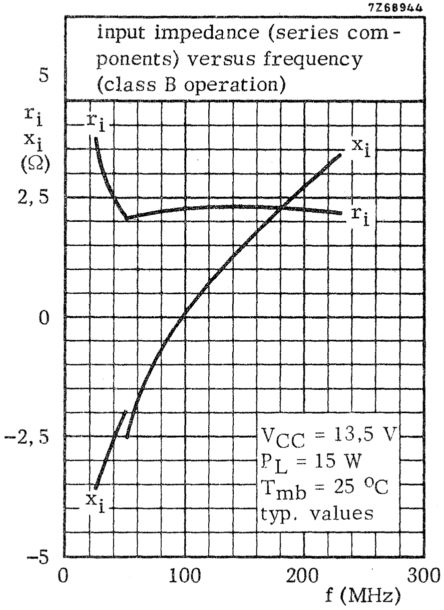


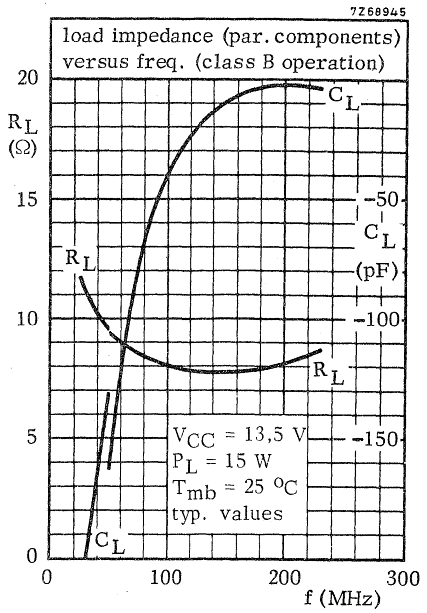
The circuit and the components are situated on one side of the epoxy fibre-glass board, the other side being fully metallised to serve as earth. Earth connections are made by means of hollow rivets.

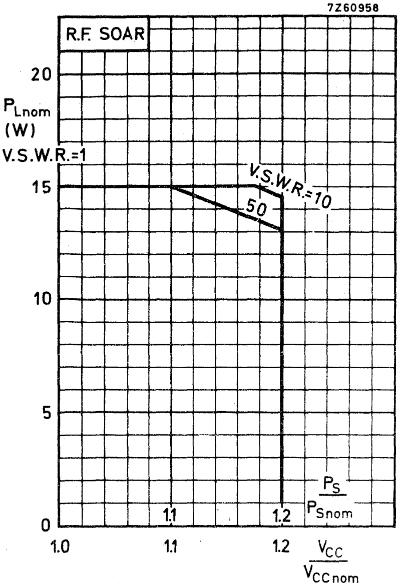
OPERATING NOTE Below 50 MHz a base-emitter resistor of 10 Ω is recommended to avoid oscillation. This resistor must be effective for both d.c. and r.f.

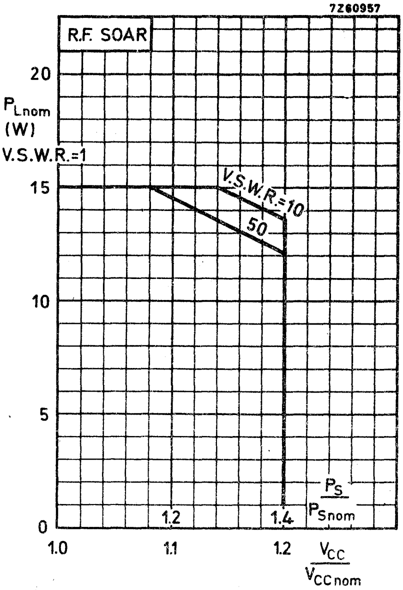












Conditions for R.F. SOAR:

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

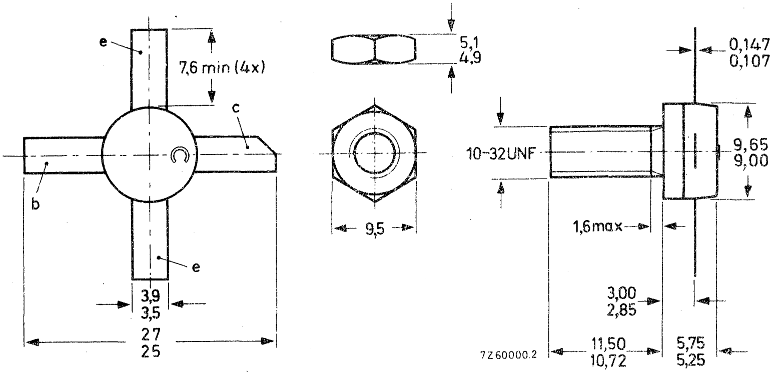
R. F. performance up to T_{mb} = 25 °C in an unneutralised common-emitter class B circuit.

Mode of operation	V_{CC} (V)	f (MHz)	P_S (W)	P_L (W)	I_C (A)	G_p (dB)	η (%)	$\overline{z}_i$ (Ω)	$\overline{Y}_L$ (mA/V)
c.w.	13.5	175	< 6.25	25	<2.64	> 6	>70	1.6+j1.4	213 + j5.5

MECHANICAL DATA

Dimensions in mm

SOT-56



Torque on nut: min. 1.5 Nm
(15 kg cm)
1.7 Nm
(17 kg cm)

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

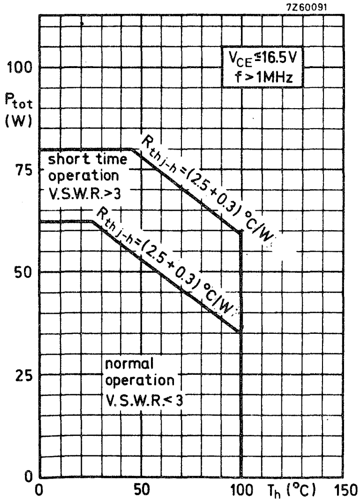
Collector-base voltage (open emitter) peak value	V_{CBOM}	max.	36	V
Collector-emitter voltage (open base)	V_{CEO}	max.	18	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4	V

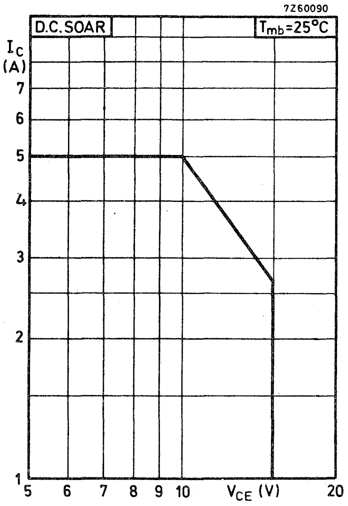
Currents

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

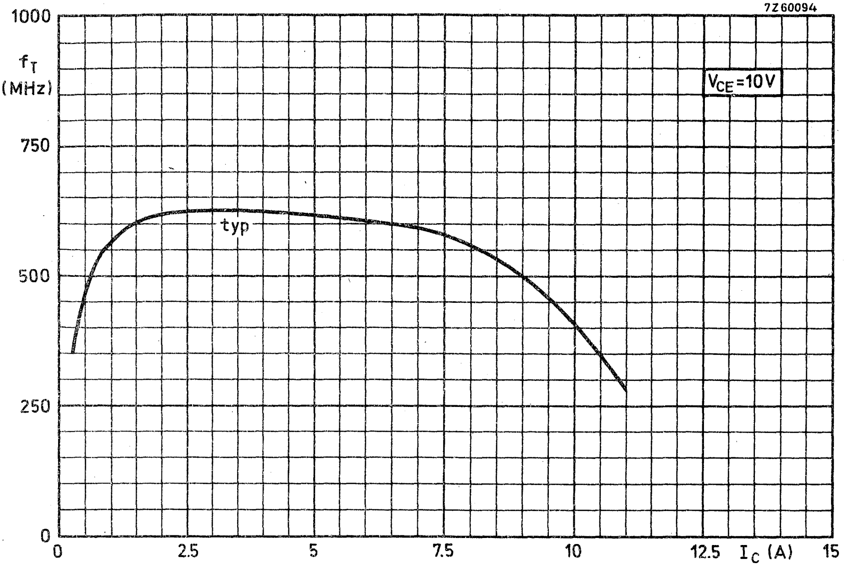
Storage temperature	T_{stg}		−30 to +200	°C
Operating junction temperature	T_j	max.	200	°C

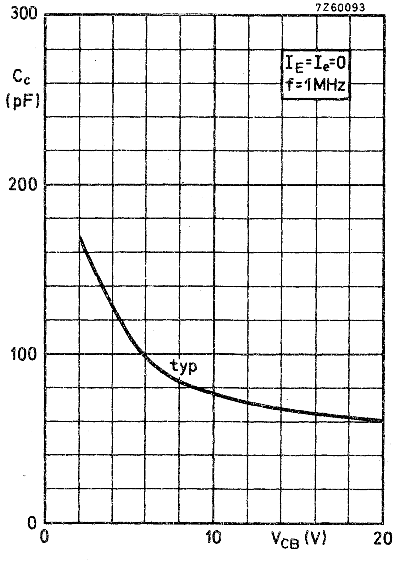
THERMAL RESISTANCE

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 $T_j = 25\,^{\circ}C$ 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.	50	
		10 to	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	pF
		<	90	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
1000
f_T
(MHz)
750
500
250
0
V_{CE}=10V
typ
0
2.5
5
7.5
10
12.5
I_C (A)
15


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

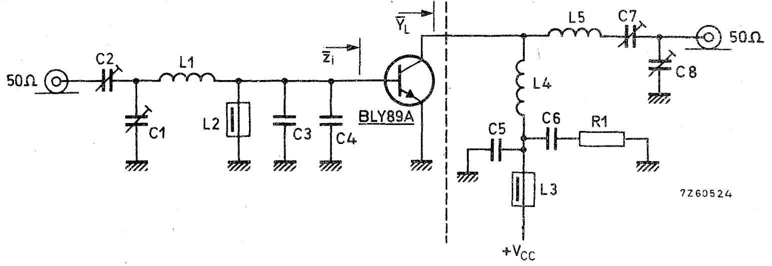
APPLICATION INFORMATION

R. F. performance in c. w. operation (unneutralised common-emitter class B 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	1.6+j1.4	213 + j5.5

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)

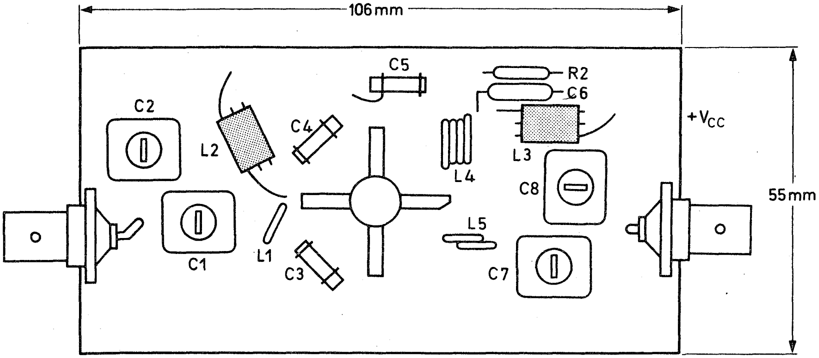
L1 = 0.5 turn enamelled Cu wire (1.5 mm); int.diam. 6 mm; leads 2 x 6 mm
L2 = L3 = ferroxcube choke (code number 4312 020 36640)
L4 = 3.5 turns closely wound enamelled Cu wire (1.5 mm); int.diam. 6 mm; leads 2 x 6 mm
L5 = 1 turn enamelled Cu wire (1.5 mm); int.diam. 6 mm; leads 2 x 6 mm

R1 = 10 Ω carbon

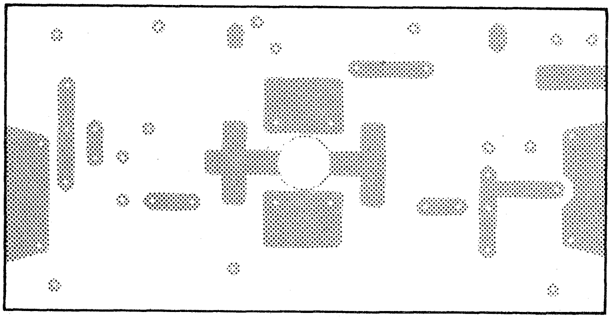
Component lay-out for 175 MHz see page 6.

APPLICATION INFORMATION (continued)

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

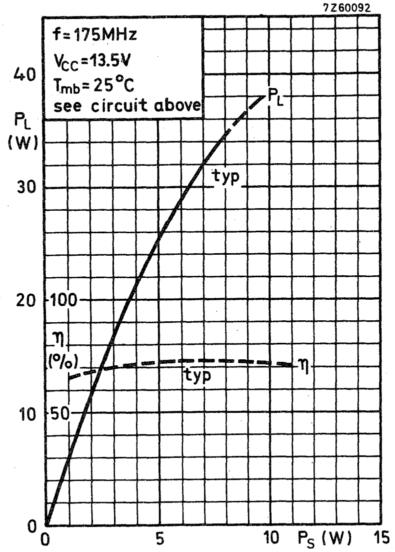


7Z60525



7Z67868

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.

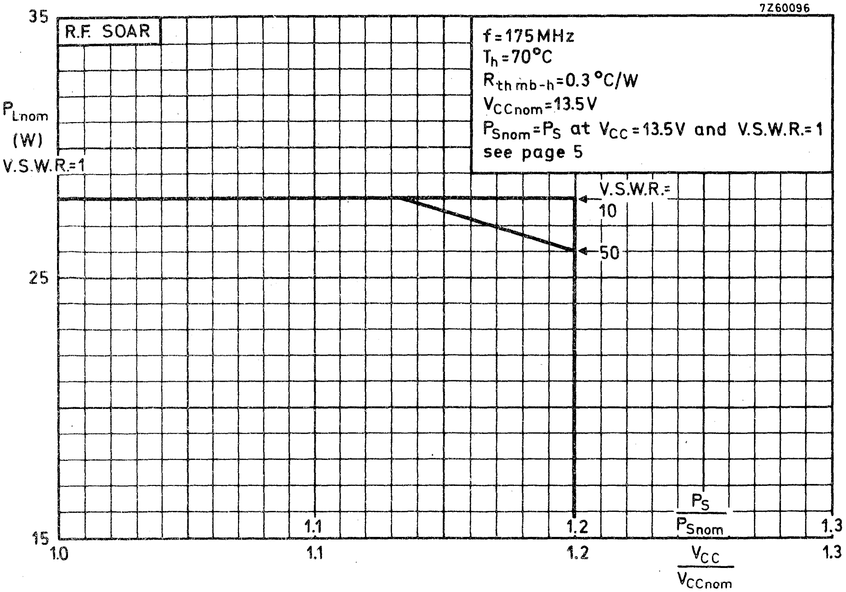


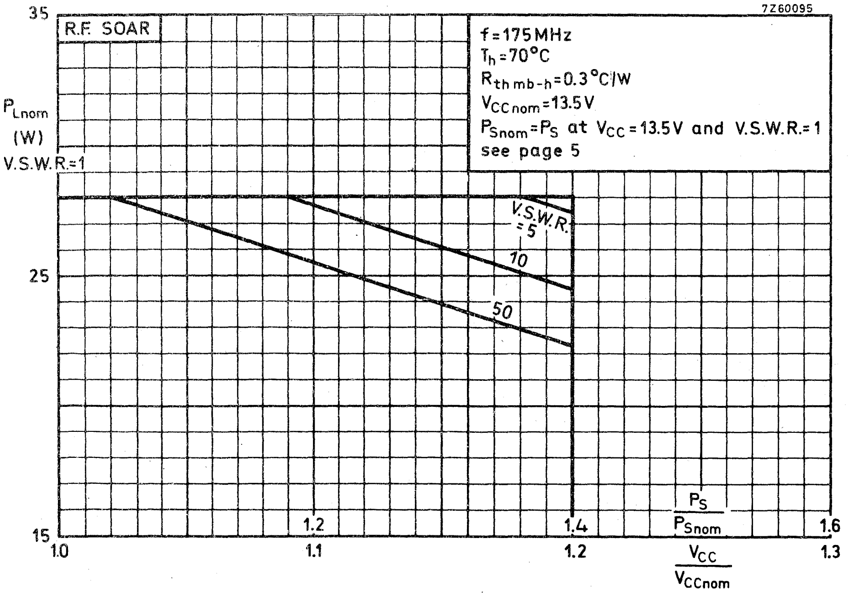
The transistor has been developed for use with unstabilized supply voltages. As the output power and drive power increase with the supply voltage, the nominal output power must be derated in accordance with the graphs on page 8 for safe operation at supply voltages other than the nominal. The graphs 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.

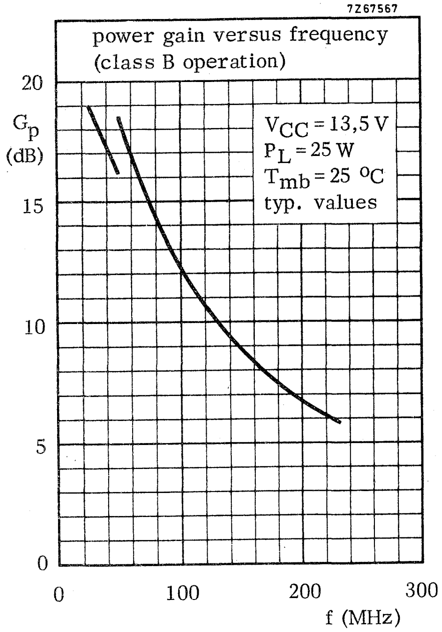
The lower graph shows the derating factor to be applied when the drive (P_S/P_{Snom}) increases as the square of the supply overvoltage ratio (V_{CC}/V_{CCnom}).

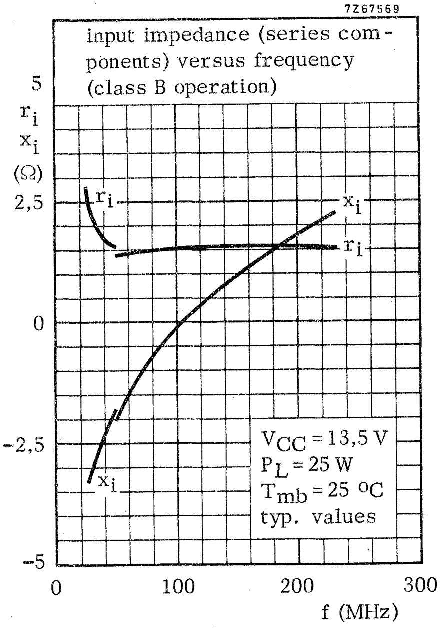
Depending on the operating conditions, the appropriate derating factor may lie in the region between the linear and the square-law functions.

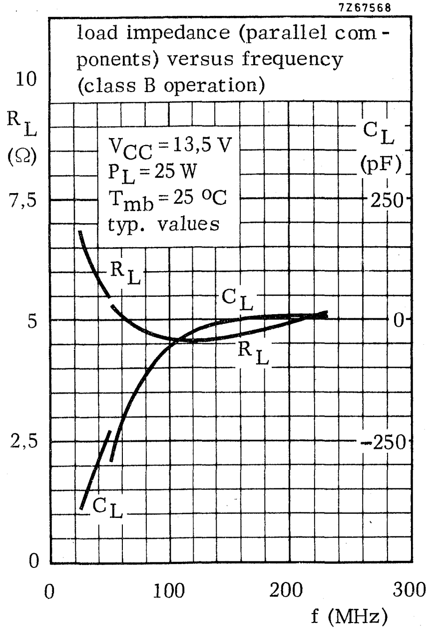

7Z60096
R.F. SOAR
f = 175 MHz
T_h = 70°C
$R_{th\,mb-h}$ = 0.3 °C/W
V_{CCnom} = 13.5 V
$P_{Snom} = P_S$ at V_{CC} = 13.5 V and V.S.W.R. = 1
see page 5
P_{Lnom} (W) V.S.W.R. = 1
35
25
15
V.S.W.R. = 10
50
$\frac{P_S}{P_{Snom}}$
1.1
1.2
1.3
$\frac{V_{CC}}{V_{CCnom}}$
1.0
1.1
1.2
1.3


7Z60095
R.F. SOAR
f = 175 MHz
T_h = 70°C
$R_{th\,mb-h}$ = 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
$\frac{P_S}{P_{Snom}}$
1.2
1.4
1.6
$\frac{V_{CC}}{V_{CCnom}}$
1.0
1.1
1.2
1.3

OPERATING NOTE Below 50 MHz a base-emitter resistor of 10 Ω is recommended to avoid oscillation. This resistor must be effective for both d.c. and r.f.







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

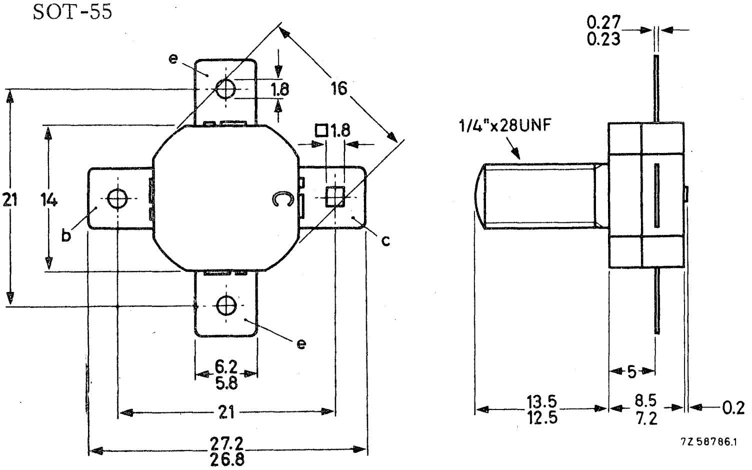
R.F. performance up to T_h = 25 °C in an unneutralised common-emitter class B circuit.

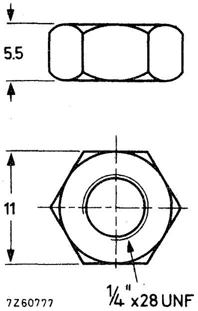
Mode of operation	V_{CC} (V)	f (MHz)	P_S (W)	P_L (W)	I_C (A)	G_p (dB)	η (%)	$\overline{z_i}$ (Ω)	$\overline{Y_L}$ (mA/V)
c.w.	12.5	175	< 15.8	50	< 5.33	> 5.0	> 75	1.3+j1.6	270+j170

MECHANICAL DATA

Dimensions in mm

SOT-55





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

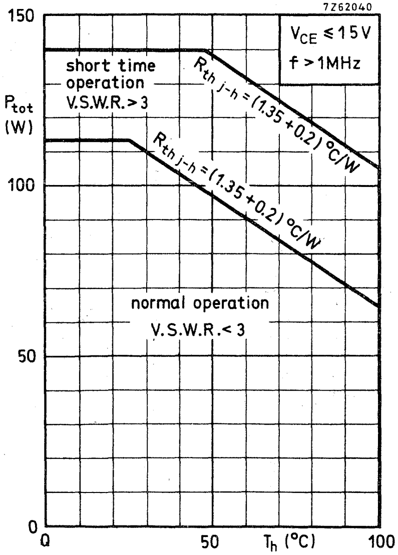
Collector-base voltage (open emitter) peak value	V_{CBOM}	max.	36	V
Collector-emitter voltage (open base)	V_{CEO}	max.	18	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4	V

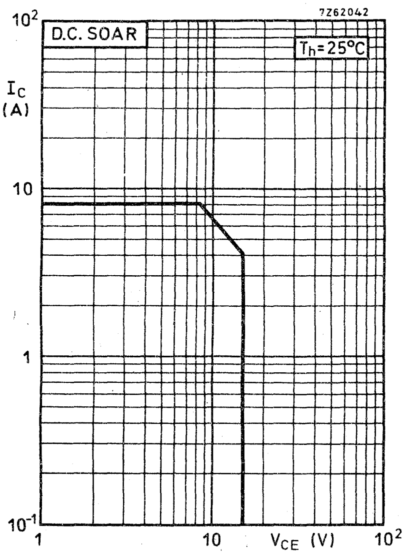
Currents

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

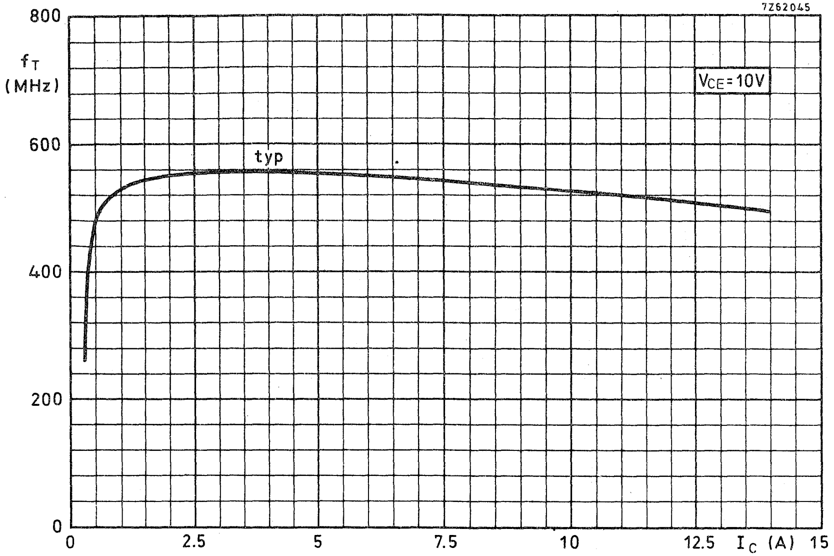
Storage temperature	T_{stg}	−65 to +200		°C
Operating junction temperature	T_j	max.	200	°C

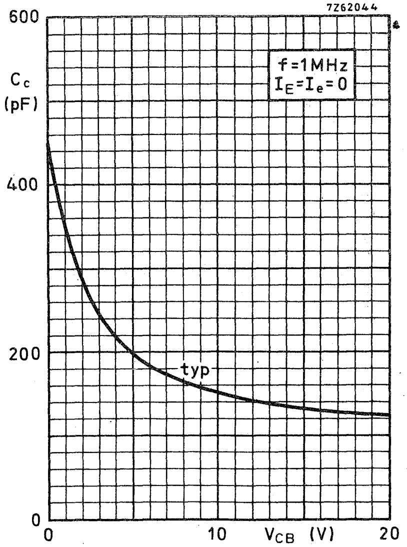
THERMAL RESISTANCE

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 $T_j = 25\ ^{o}C$ 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
typ
V_{CE} = 10V
0
2.5
5
7.5
10
12.5
I_C (A)
15


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

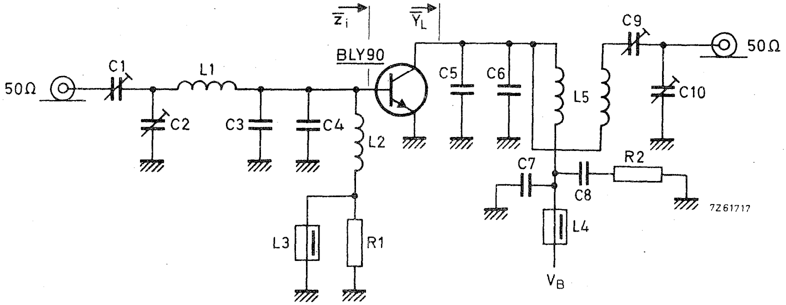
APPLICATION INFORMATION

R.F. performance in c.w. operation (unneutralized 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 + j 1,6	270 + j 170

Test circuit for 175 MHz:



C1 = 2 to 20 pF film dielectric trimmer
C2 = 4 to 40 pF film dielectric trimmer
C3 = C4 = 27 pF ceramic capacitor
C5 = C6 = 56 pF ceramic capacitor
C7 = 100 pF ceramic capacitor
C8 = 100 nF polyester capacitor
C9 = 4 to 80 pF film dielectric trimmer
C10 = 4 to 60 pF film dielectric trimmer

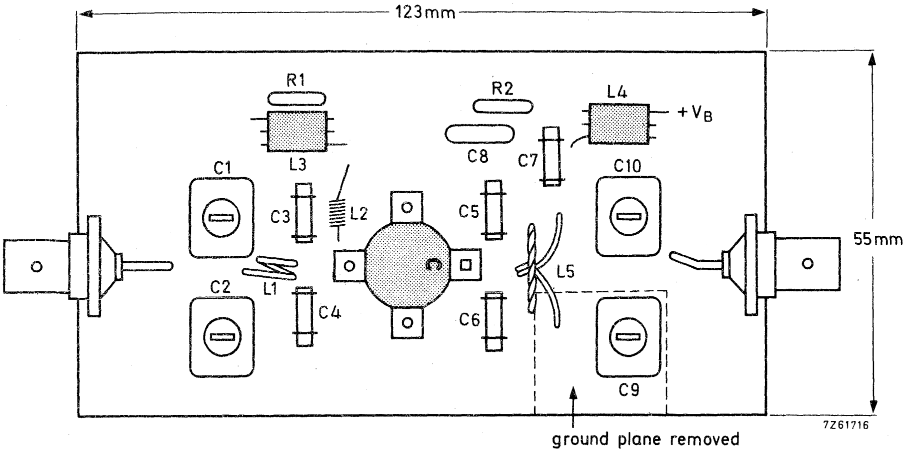
L1 = 1,5 turns enamelled Cu wire (1,5 mm); int. dia. 6 mm; length 4 mm; leads 2 x 5 mm
L2 = 7 turns closely wound enamelled Cu wire (0,5 mm); int. dia. 3 mm; leads 2 x 5 mm
L3 = L4 = Ferroxcube choke (code number 4312 020 36640)
L5 = bifilar wound enamelled Cu wire (1,0 mm); see figure on page 6

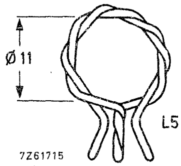
R1 = 10 Ω carbon resistor
R2 = 4,7 Ω carbon resistor

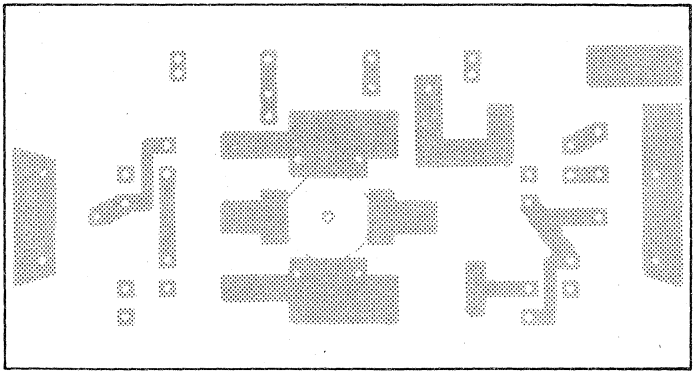
Component layout and printed-circuit board for 175 MHz test circuit see page 6.

APPLICATION INFORMATION (continued)

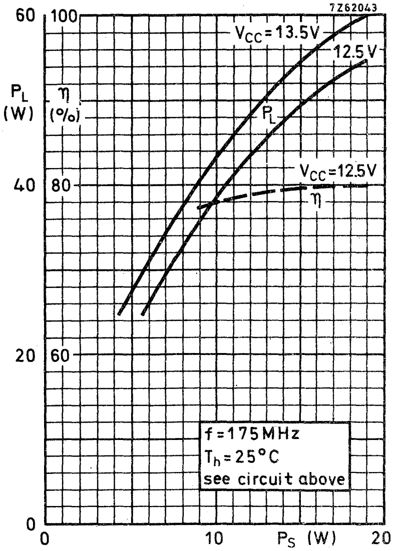
Component lay-out and printed circuit board for 175 MHz test circuit.

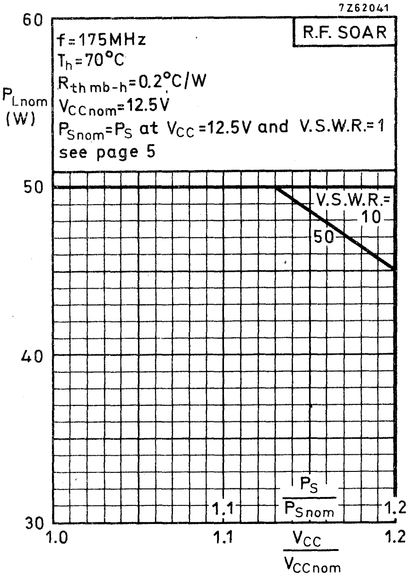




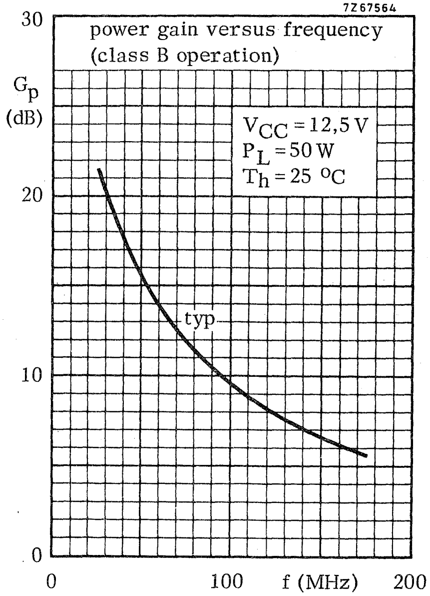


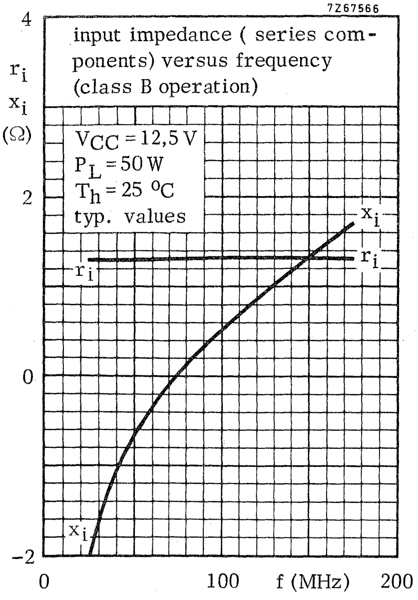
The circuit and the components are situated on one side of the epoxy fibre-glass board, the other side being fully metallized to serve as earth. Earth connections are made by means of hollow rivets.

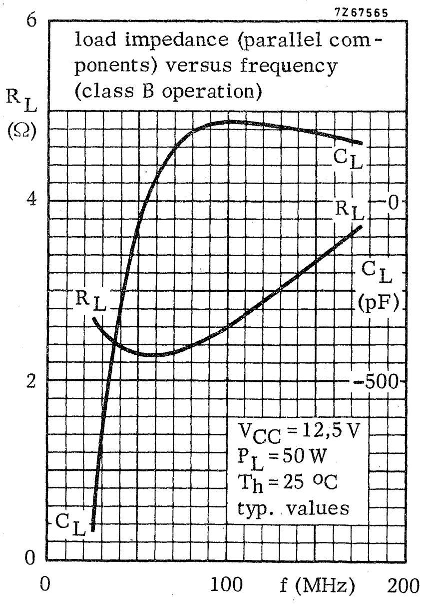




The transistor has been developed for use with unstabilized supply voltages. As the output power and drive power increase with the supply voltage, the nominal output power (P_{Lnom}) must be derated in accordance with the adjacent graph for safe operation at supply voltage other than the nominal. The 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}).


7Z67564
power gain versus frequency
(class B operation)
G_p
(dB)
30
20
10
0
V_{CC} = 12,5 V
P_L = 50 W
T_h = 25 °C
typ
0
100
f (MHz)
200


7Z67566
input impedance (series components) versus frequency
(class B operation)
r_i
x_i
(Ω)
4
2
0
−2
V_{CC} = 12,5 V
P_L = 50 W
T_h = 25 °C
typ. values
x_i
r_i
r_i
x_i
0
100
f (MHz)
200


7Z67565
load impedance (parallel components) versus frequency
(class B operation)
R_L
(Ω)
6
4
2
0
C_L
R_L
0
C_L
(pF)
R_L
−500
V_{CC} = 12,5 V
P_L = 50 W
T_h = 25 °C
typ. values
C_L
0
100
f (MHz)
200

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

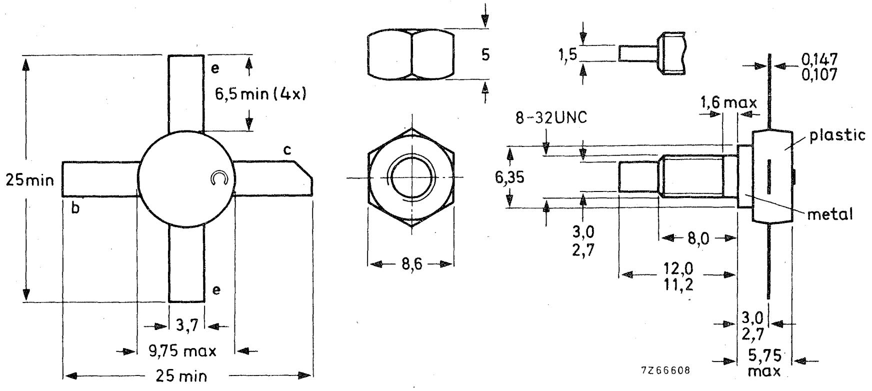
R.F. performance up to T_{mb} = 25 °C in an unneutralised common-emitter class B circuit

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+j0.7	18−j20

MECHANICAL DATA

Dimensions in mm

SOT-48



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

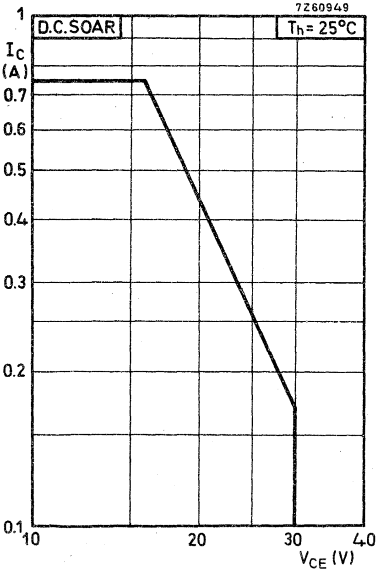
Collector-base voltage (open emitter) peak value	V_{CBOM}	max.	65	V
Collector-emitter voltage (open base)	V_{CEO}	max.	36	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4	V

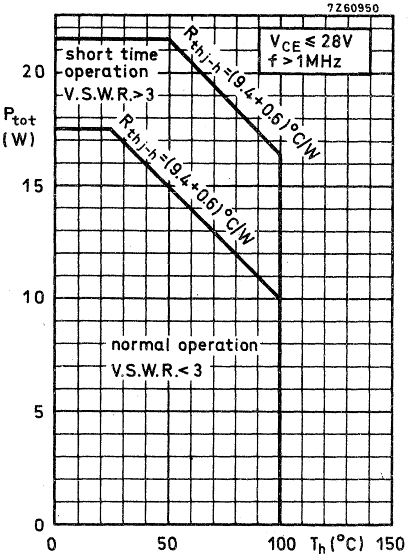
Currents

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

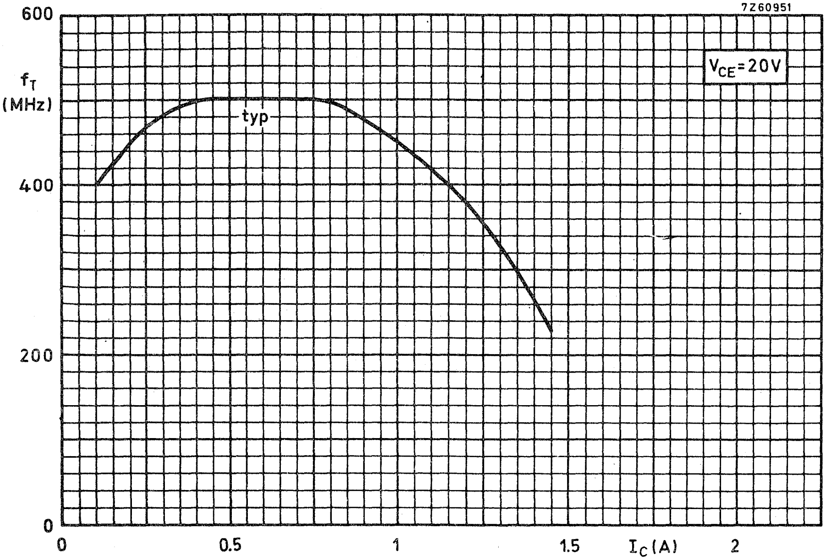
THERMAL RESISTANCE

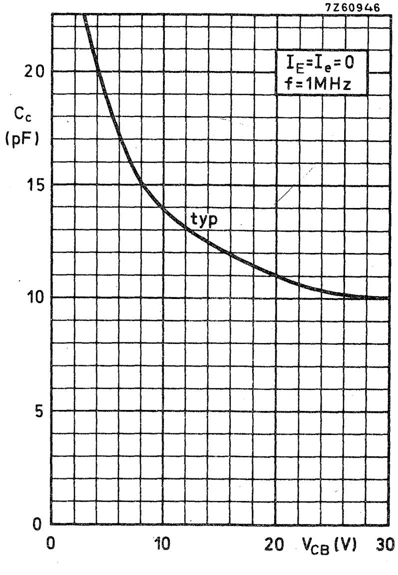
From junction to mounting base	$R_{th\ j-mb}$	=	9.4	°C/W
From mounting base to heatsink	$R_{th\ mb-h}$	=	0.6	°C/W

CHARACTERISTICS

$T_j = 25\ ^{o}C$ 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)
$V_{CE} = 20V$
typ
0
0.5
1
1.5
I_C (A)
2


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

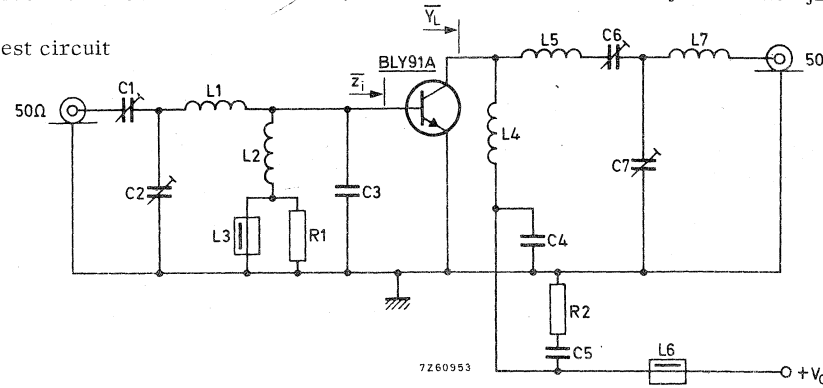
APPLICATION INFORMATION

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	< 0.50	8	< 0.44	≥ 12	> 65	1.8+j0.7	18−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

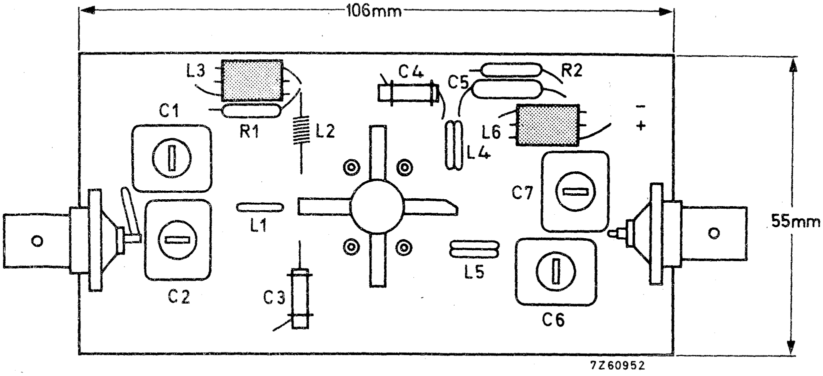
L1 = 0.5 turn enamelled Cu wire (1.5 mm); int. diam. 6 mm; leads 2 x 10 mm
L2 = 6.5 turns closely wound enamelled Cu wire (0.7 mm); int. diam. 4 mm; leads 2 x 5 mm
L3 = L6 = ferroxcube choke (code number 4312 020 36640)
L4 = 7.5 turns enamelled Cu wire (0.7 mm); int. diam. 4 mm; leads 2 x 5 mm
L5 = 4.5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

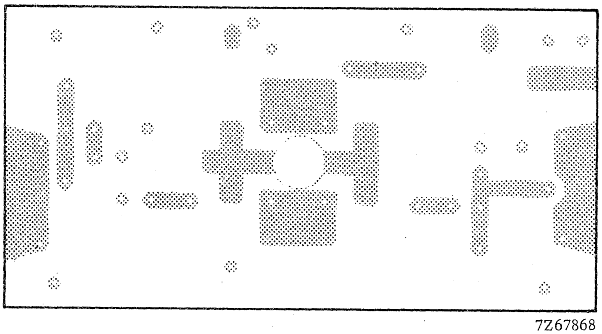
R1 = R2 = 10 Ω carbon

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

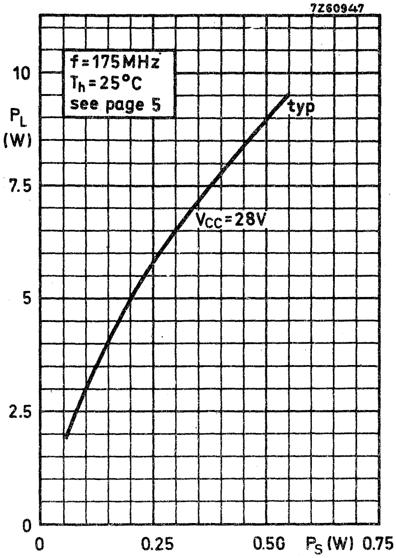
APPLICATION INFORMATION (continued)

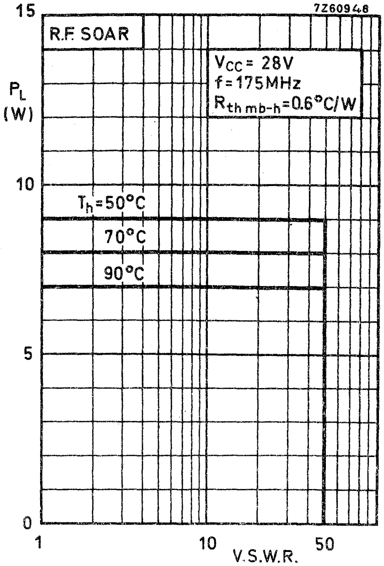
Component lay-out and printed circuit board for 175 MHz test circuit.





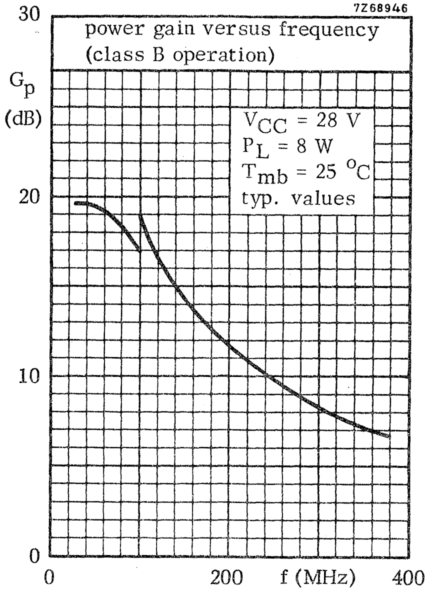
The circuit and the components are situated on one side of the epoxy fibre-glass board, the other side being fully metallised to serve as earth. Earth connections are made by means of hollow rivets.

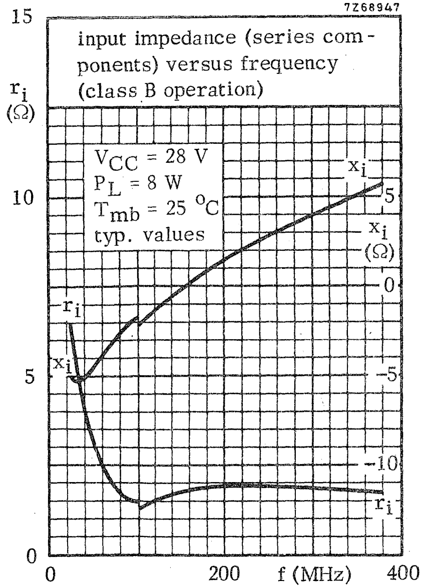


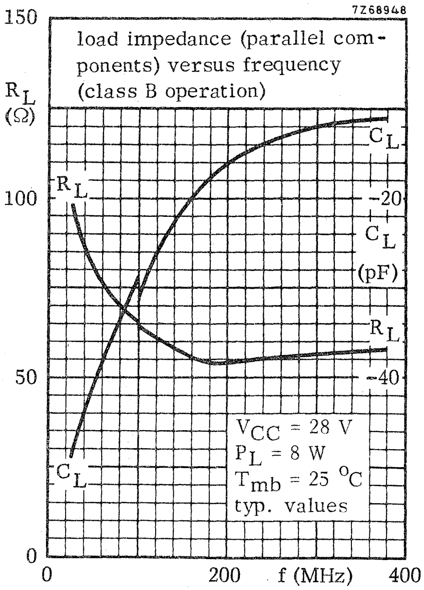


For high voltage operation, a stabilized power supply is generally used.
The graph shows the allowable output power under nominal conditions as a function of the V.S.W.R., with heat-sink temperature as parameter.

OPERATING NOTE Below 100 MHz a base-emitter resistor of 10 Ω is recommended to avoid oscillation. This resistor must be effective for both d.c. and r.f.







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

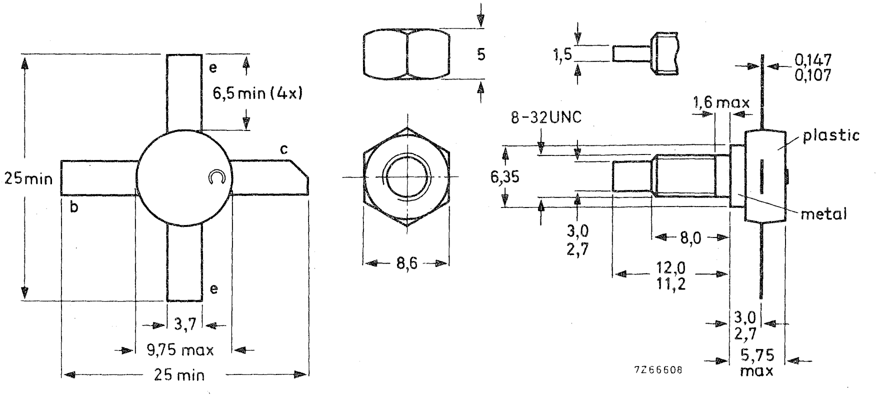
R.F. performance up to T_{mb} = 25 °C in an unneutralised common-emitter class B circuit

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	< 1.5	15	< 0.83	> 10	> 65	1.4+j1.85	33−j27.5

MECHANICAL DATA

Dimensions in mm

SOT-48



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 (IEC 134)

Voltages

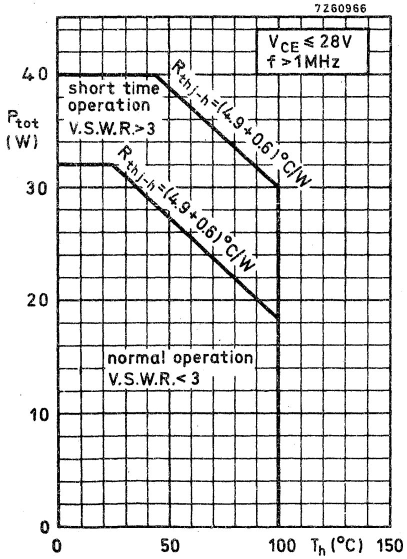
Collector-base voltage (open emitter) peak value	V_{CBOM}	max.	65	V
Collector-emitter voltage (open base)	V_{CEO}	max.	36	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4	V

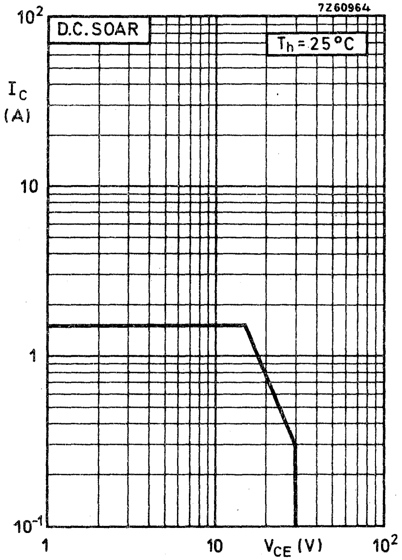
Currents

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 $T_h = 25\ ^\circ C$ f > 1 MHz	P_{tot}	max.	32	W





Temperatures

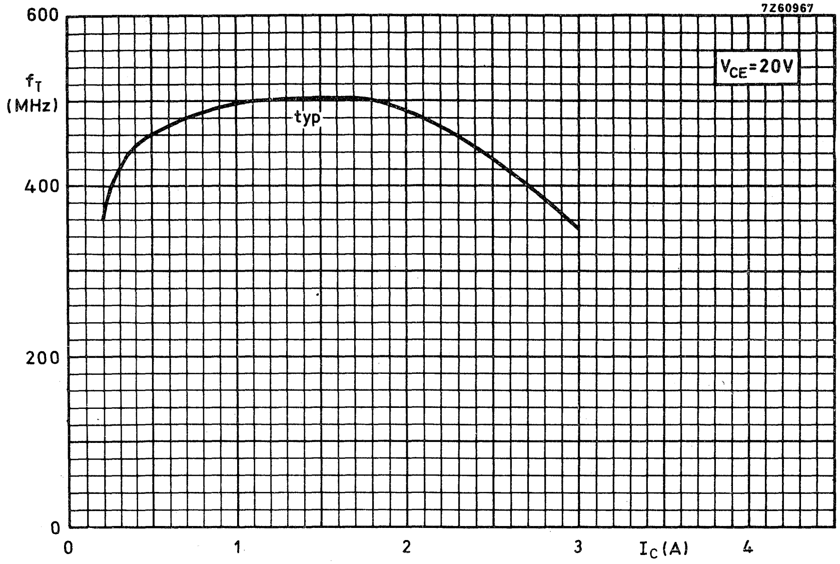
Storage temperature	T_{stg}	−30 to	+200	°C
Operating junction temperature	T_j	max.	200	°C

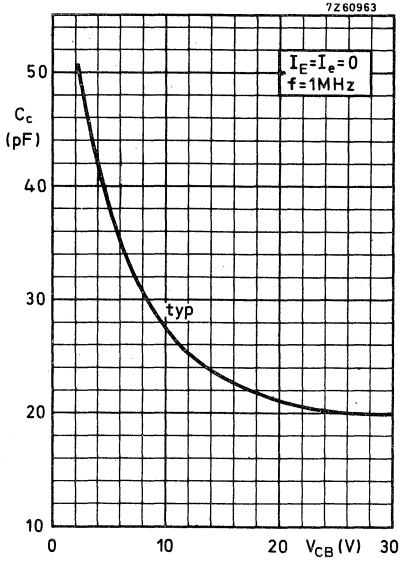
THERMAL RESISTANCE

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)
V_{CE}=20V
typ
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

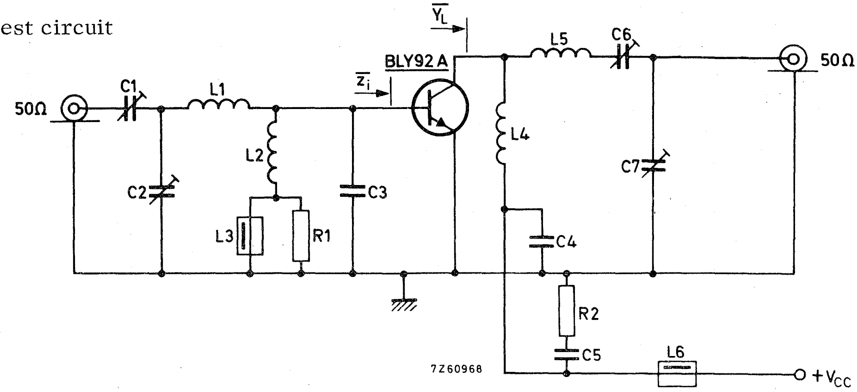
APPLICATION INFORMATION

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+j1.85	33−j27.5

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

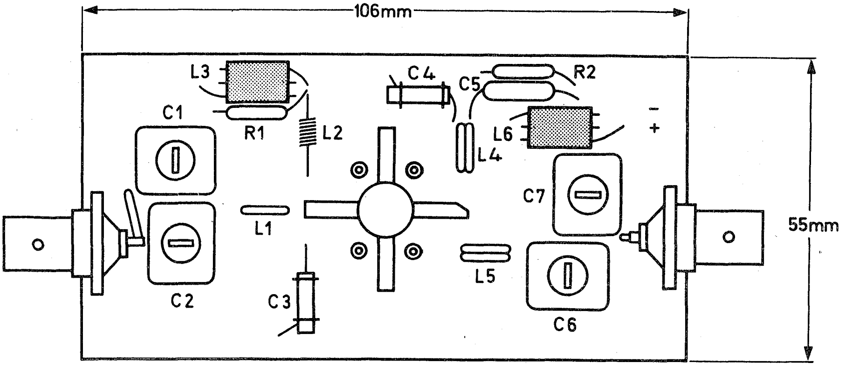
L1 = 0.5 turn enamelled Cu wire (1.5 mm); int. diam. 6 mm; leads 2 x 10 mm
L2 = 6.5 turns closely wound enamelled Cu wire (0.7 mm); int. diam. 4 mm; leads 2 x 5 mm
L3 = L5 = ferroxcube choke (code number 4312 020 36640)
L4 = 2.5 turns enamelled Cu wire (0.7 mm); int. diam. 6 mm; leads 2 x 7 mm
L6 = 4.5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

R1 = R2 = 10 Ω carbon

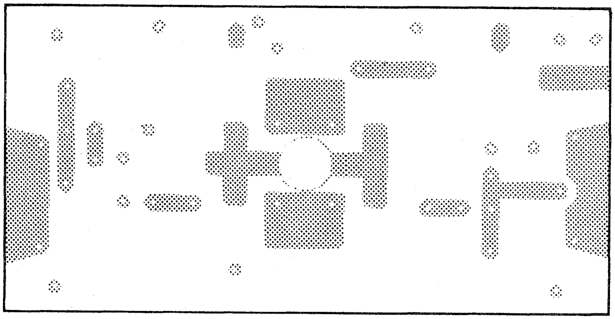
Component lay-out for 175 MHz test circuit see page 6.

APPLICATION INFORMATION (continued)

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

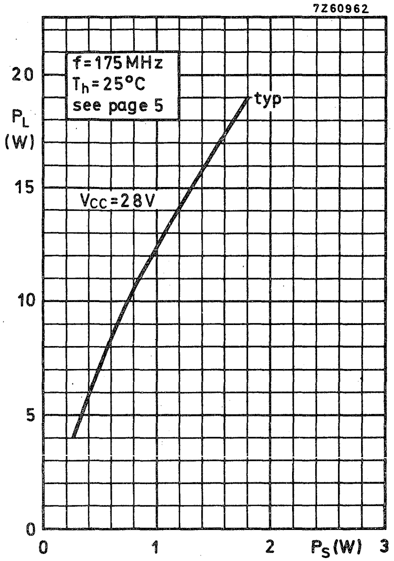


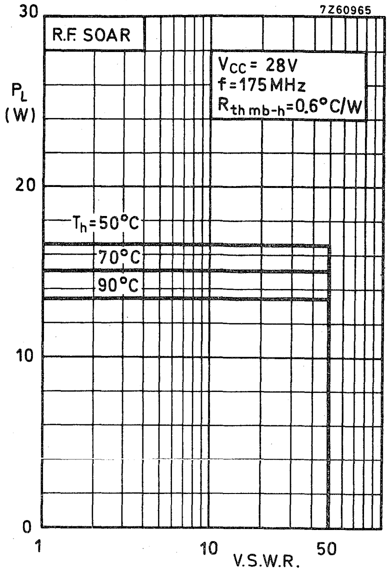
7Z60952



7Z67868

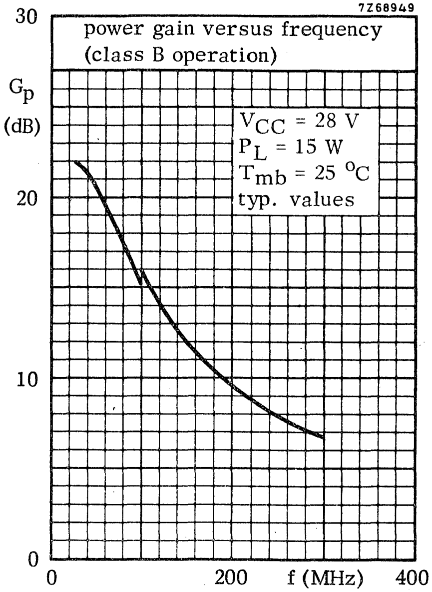
The circuit and the components are situated on one side of the epoxy fibre-glass board, the other side being fully metallised to serve as earth. Earth connections are made by means of hollow rivets.

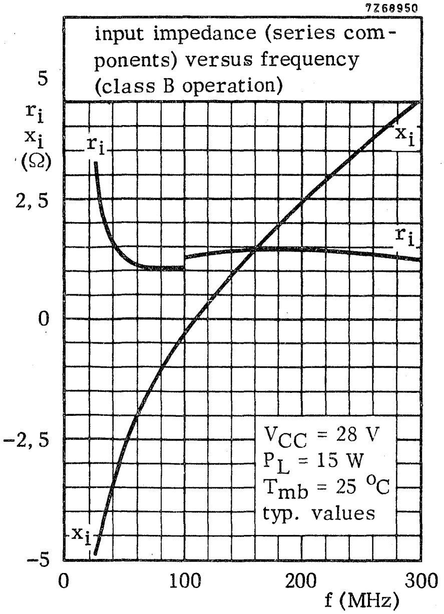


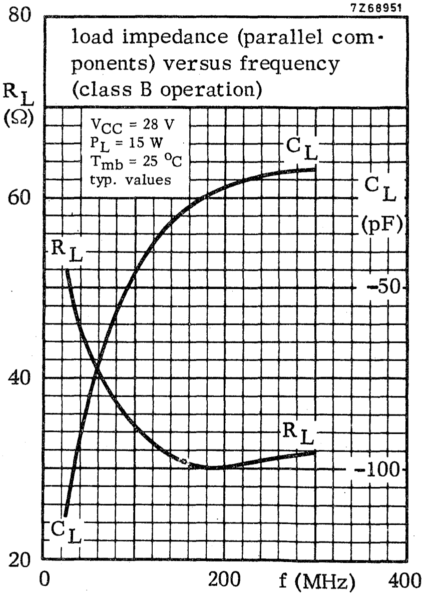


For high voltage operation, a stabilized power supply is generally used.
The graph shows the allowable output power under nominal conditions as a function of the V.S.W.R., with heat-sink temperature as parameter.

OPERATING NOTE Below 100 MHz a base-emitter resistor of 10 Ω is recommended to avoid oscillation. This resistor must be effective for both d.c. and r.f.







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 1/4" capstan envelope with a moulded cap. All leads are isolated from the stud.

QUICK REFERENCE DATA

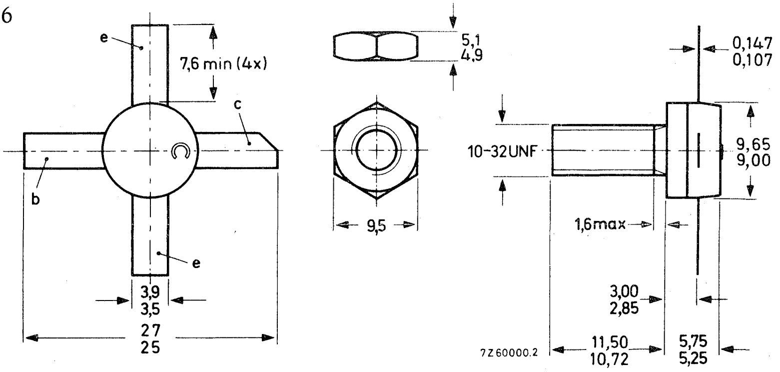
R.F. performance up to T_{mb} = 25 °C in an unneutralised common-emitter class B circuit.

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	58.8−j53.8

MECHANICAL DATA

Dimensions in mm

SOT-56



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

Diameter of clearance hole in heatsink: max. 5.0 mm.
Mountinghole 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

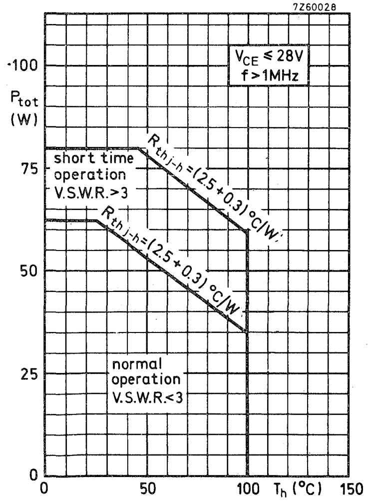
Collector-base voltage (open emitter) peak value	V_{CBOM}	max.	65	V
Collector-emitter voltage (open base)	V_{CEO}	max.	36	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4	V

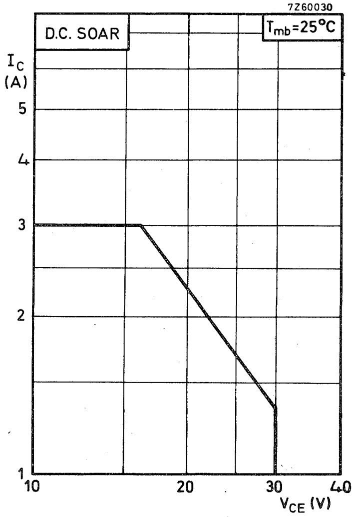
Currents

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

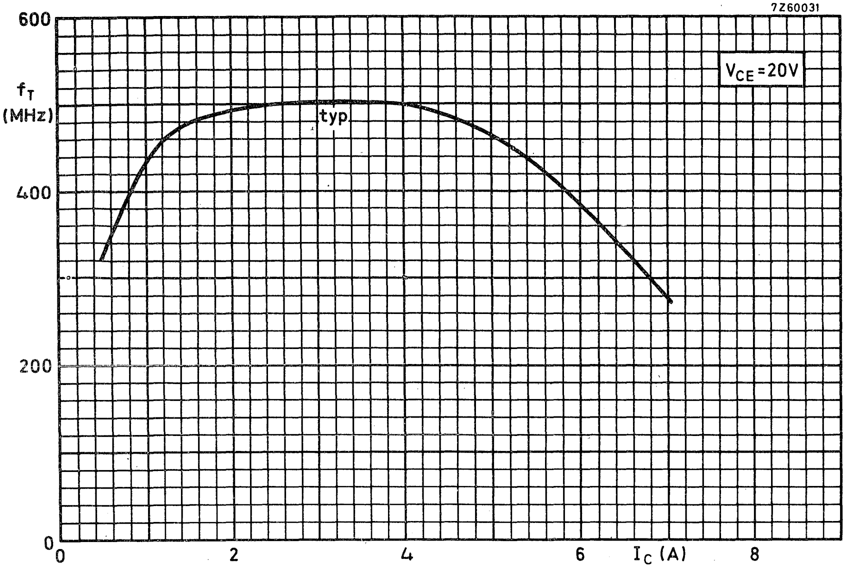
Storage temperature	T_{stg}		−30 to +200	°C
Operating junction temperature	T_j	max.	200	°C

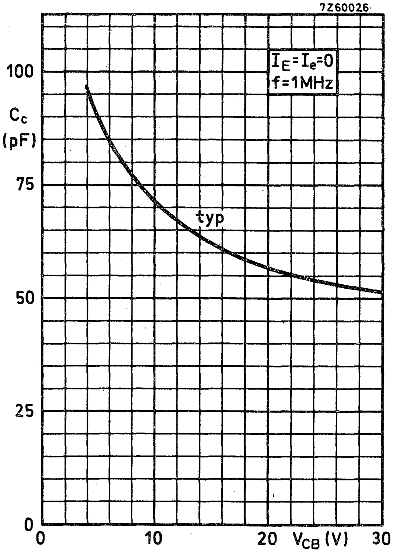
THERMAL RESISTANCE

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

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

Breakdown voltages				
Collector-base voltage open emitter, $I_C = 50$ mA	$V_{(BR)CBO}$	>	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; $R_{BE} = 33\ \Omega$	E	>	8	mWs
D.C. current gain				
$I_C = 1$ A; $V_{CE} = 5$ V	h_{FE}	typ. 10 to	50 120	
Transition frequency				
$I_C = 3$ 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 65	pF 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
75
50
25
0
C_c
(pF)
$I_E = I_e = 0$
f = 1MHz
typ
0
10
20
V_{CB} (V)
30

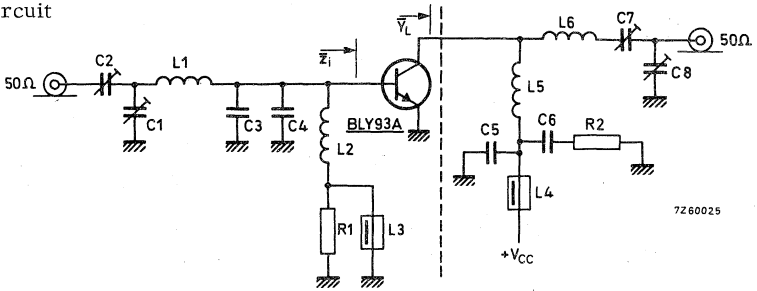
APPLICATION INFORMATION

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

V_{CC} = 28 V; T_{mb} = 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	< 3.1	25	< 1.5	> 9	> 60	1.0+j1.2	58.8−j53.8

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)

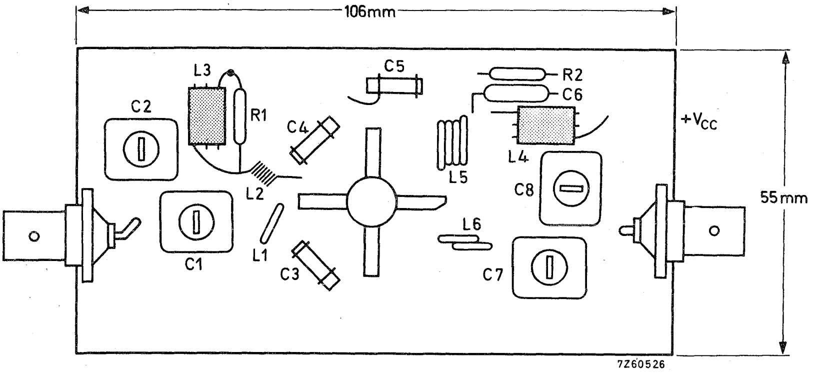
L1 = 0.5 turn enamelled Cu wire (1.5 mm); int.diam. 6 mm; leads 2 x 6 mm
L2 = 6 turns closely wound enamelled Cu wire (0.7 mm); int.diam. 4 mm; leads 2 x 4 mm
L3 = L4 = ferroxcube choke (code number 4312 020 36640)
L5 = 3.5 turns enamelled Cu wire (1.5 mm); int.diam. 6 mm; leads 2 x 6 mm
L6 = 1.5 turns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

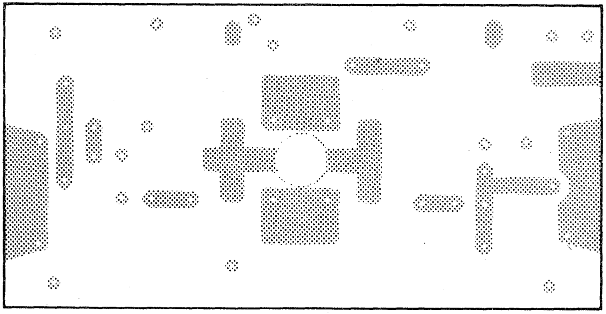
R1 = R2 = 10 Ω carbon

Component lay-out for 175 MHz see page 6.

APPLICATION INFORMATION (continued)

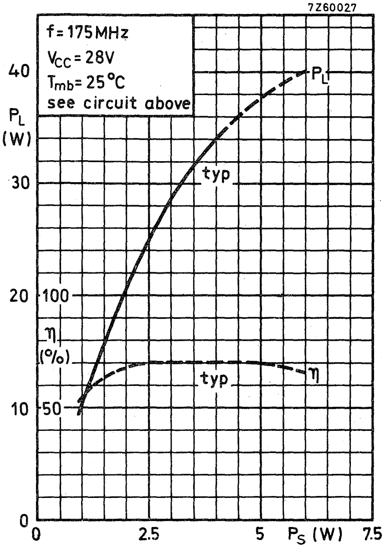
Component lay-out and printed circuit board for 175 MHz test circuit.

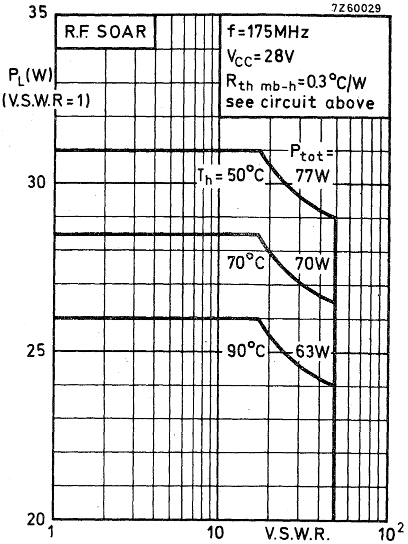




7Z67868

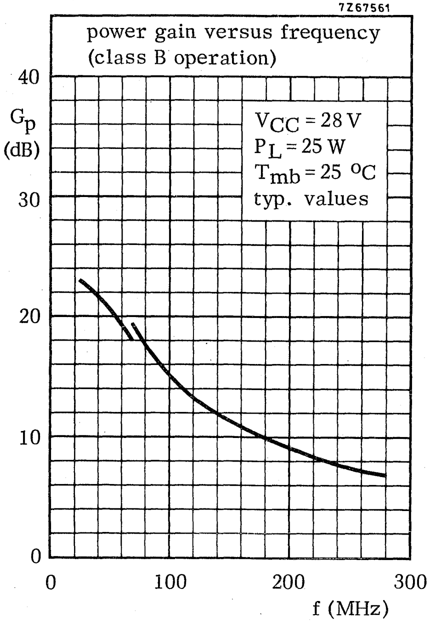
The circuit and the components are situated on one side of the epoxy fibre-glass board, the other side being fully metallised to serve as earth. Earth connections are made by means of hollow rivets.

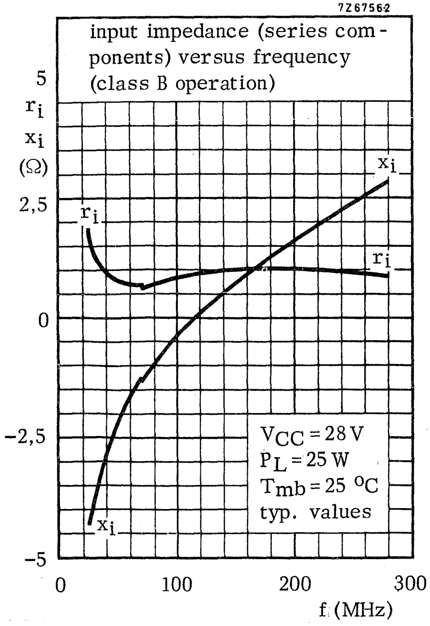


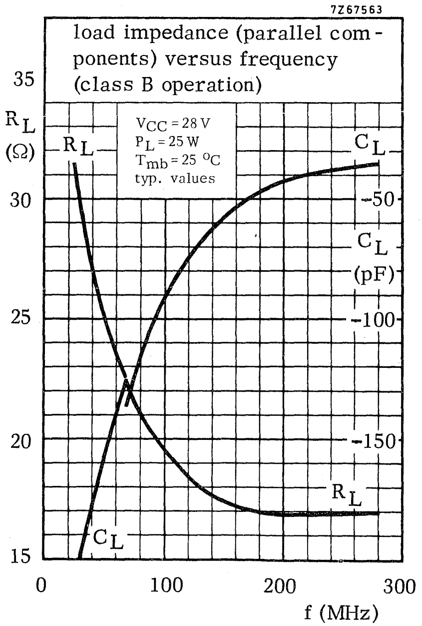


For high voltage operation, a stabilized power supply is generally used.
The graph shows the allowable output power under nominal conditions as a function of the V.S.W.R., with heat-sink temperature as parameter.

OPERATING NOTE Below 70 MHz a base-emitter resistor of 10 Ω is recommended to avoid oscillation. This resistor must be effective for both d.c. and r.f.







V.H.F. POWER TRANSISTOR

N-P-N planar epitaxial 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

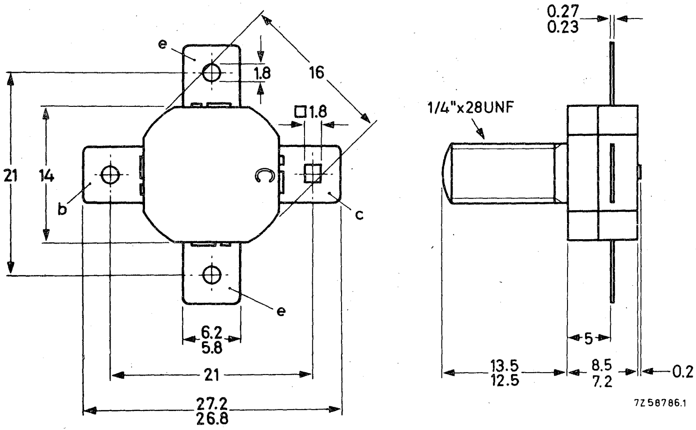
R.F. performance up to T_{mb} = 25 °C in an unneutralized common-emitter class B circuit.

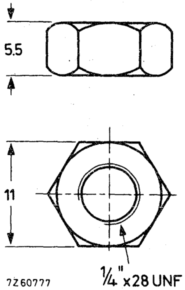
Mode of operation	V_{CC} (V)	f (MHz)	P_S (W)	P_L (W)	I_C (A)	G_p (dB)	η (%)	$\overline{z_i}$ (Ω)	$\overline{Y_L}$ (mA/V)
c.w.	28	175	< 10	50	< 2,75	> 7	> 65	0,8 + j1,45	125 − j66

MECHANICAL DATA

Dimensions in mm

SOT-55





Torque on nut: min. 2,3 Nm
(23 kg cm)
max. 2,7 Nm
(27 kg cm)

Diameter of clearance hole in heatsink: max. 6,5 mm.
Mountinghole 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

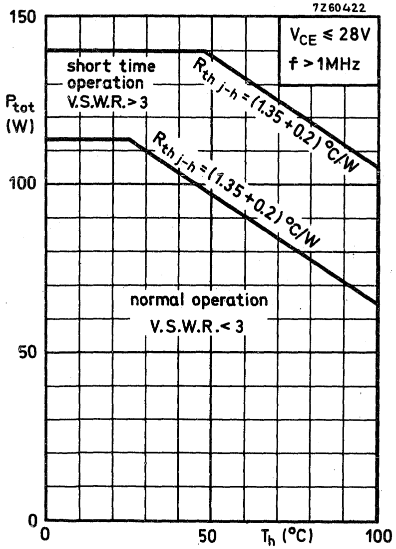
Collector-base voltage (open emitter) peak value	V_{CBOM}	max.	65	V
Collector-emitter voltage (open base)	V_{CEO}	max.	36	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4	V

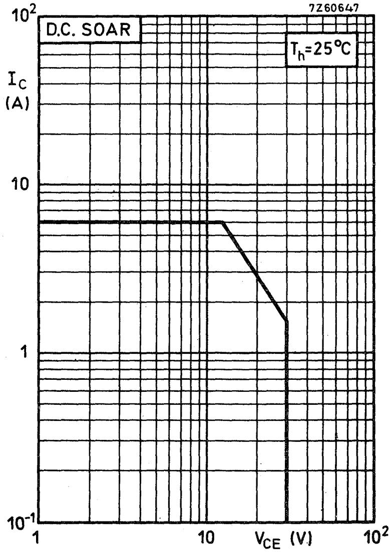
Currents

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 °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

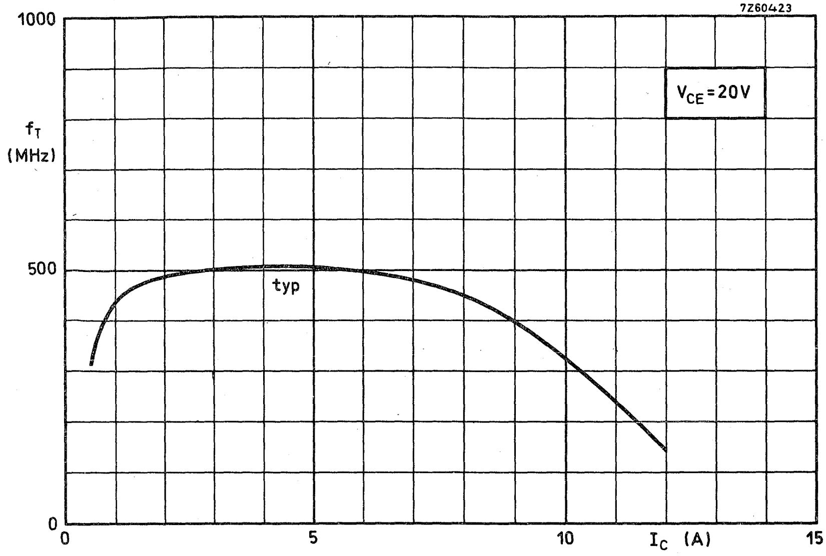
THERMAL RESISTANCE

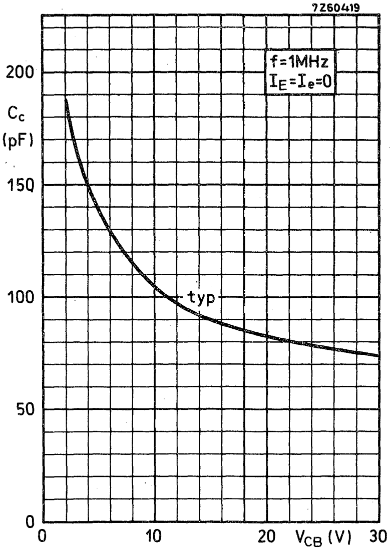
From junction to mounting base	$R_{th\ j-mb}$	=	1.35	°C/W
From mounting base to heatsink	$R_{th\ mb-h}$	=	0.2	°C/W

CHARACTERISTICS

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

Breakdown voltages				
Collector-base voltage open emitter, $I_C = 100$ mA	$V_{(BR)CBO}$	>	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; $R_{BE} = 33\ \Omega$	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

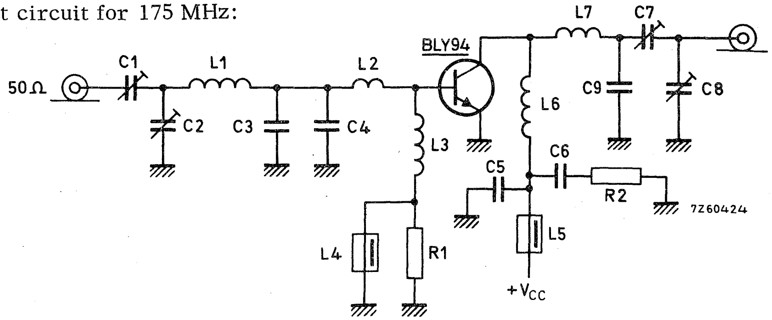
APPLICATION INFORMATION

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	0.8+j1.45	125 − j66

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

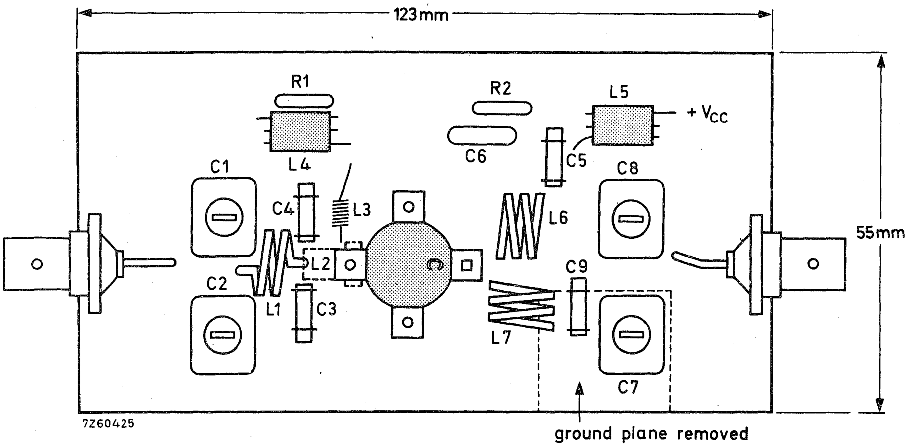
L1 = 36 nH; 2 turns enamelled Cu wire (1.5 mm); int. diam. 7 mm; length 5 mm; lead length 2 x 5 mm
L2 = formed by the metallization on the p.c. board; see component lay-out
L3 = 100 nH; 7 turns closely wound enamelled Cu wire (0.5 mm); int. diam 3 mm; lead length 2 x 5 mm
L4 = L5 = ferroxcube choke (code 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

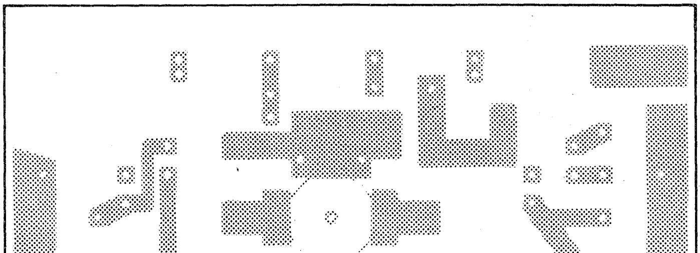
R1 = R2 = 10 Ω carbon

Component lay-out see page 6

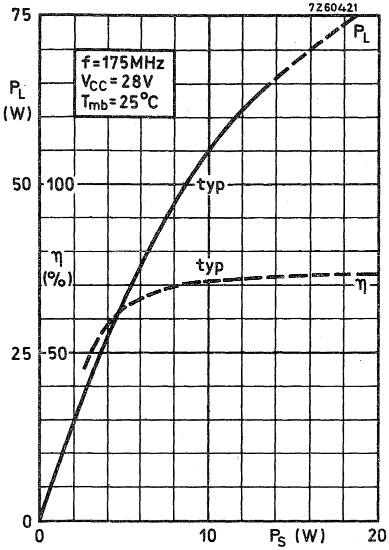
APPLICATION INFORMATION (continued)

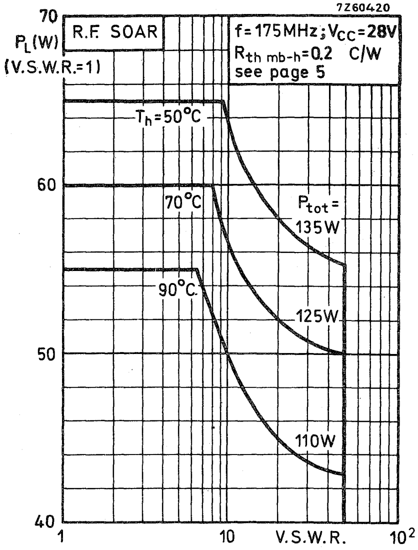
Component lay-out and printed circuit board for 175 MHz test circuit.





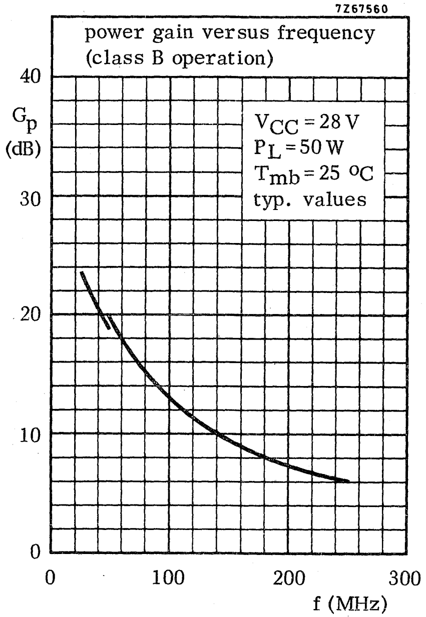
The circuit and the components are situated on one side of the epoxy fibre-glass board, the other side being fully metallised to serve as earth. Earth connections are made by means of hollow rivets.

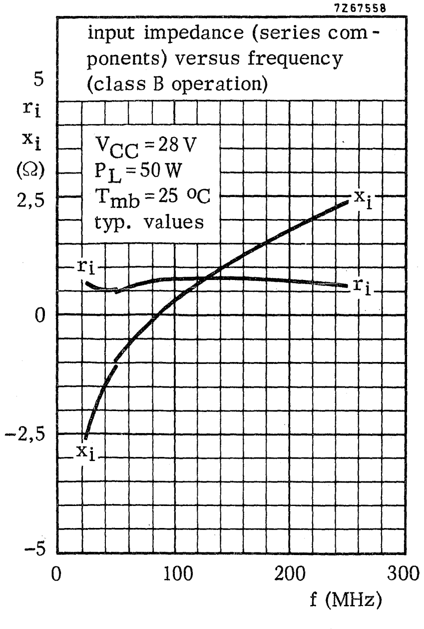


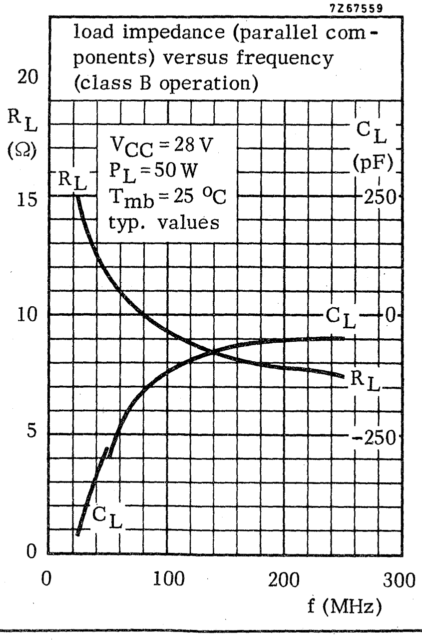


For high voltage operation, a stabilized power supply is generally used.
The graph shows the allowable output power under nominal conditions as a function of the V.S.W.R., with heat-sink temperature as parameter.

OPERATING NOTE Below 50 MHz a base-emitter resistor of 10 Ω is recommended to avoid oscillation. This resistor must be effective for both d.c. and r.f.







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

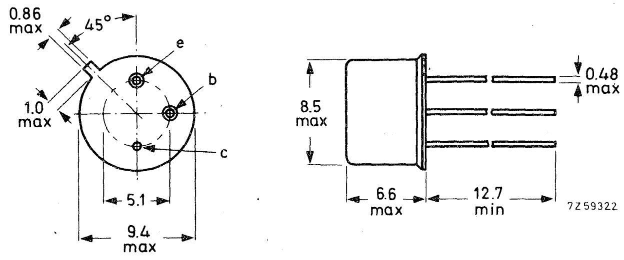
R.F. performance at V_{CE} = 28 V

	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

MECHANICAL DATA (continued)

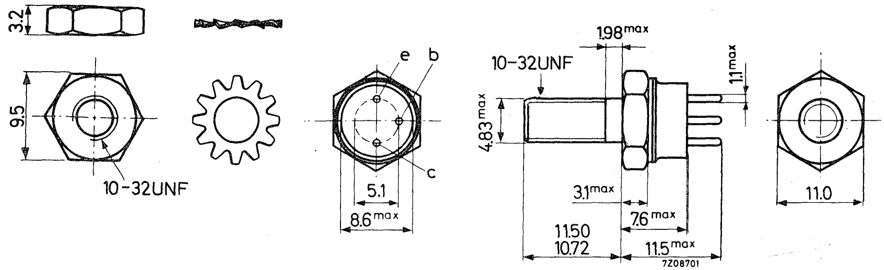
2N3375
2N3632

Dimensions in mm

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

TO-60
The top pins should not be bent

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

			2N3553	2N3375	2N3632	
Currents [2]						
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	^{o}C/W
From mounting base to heatsink	$R_{th\ mb\text{-}h}$ =		0.6	0.6	^{o}C/W
From mounting base to heatsink mounted with top clamping washer of 56218	$R_{th\ mb\text{-}h}$ =	1.0			^{o}C/W
top clamping washer of 56218 and a boron nitride washer for electrical insulation	$R_{th\ mb\text{-}h}$ =	2.5			^{o}C/W

CHARACTERISTICS

T_j = 25 ^{o}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						
$I_E = 0$; $I_C = 250$ μA	$V_{(BR)CBO}$	>	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
$I_C = 0$; $I_E = 250$ 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}	<	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	15		
		<	200	200		
I_C = 250 mA; V_{CE} = 5 V	h_{FE}	>	10	10	10	
		<	100	100	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

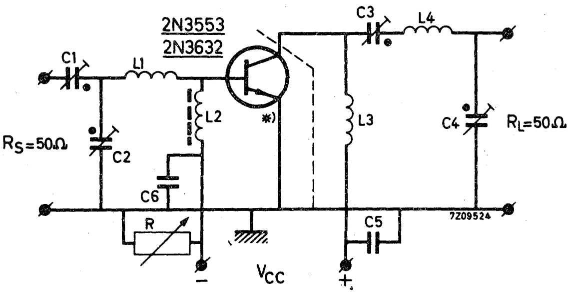
	f (MHz)	P_o (W)	P_i (W)	I_C (mA)	η %	Test circuit at page
2N3553	175	2.5	< 0.25	< 180	> 50	5
2N3375	100	7.5	< 1	< 410	> 65	6
2N3375	400	> 3	1	270	> 40	7
2N3632	175	> 13.5	3.5	690	> 70	5

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

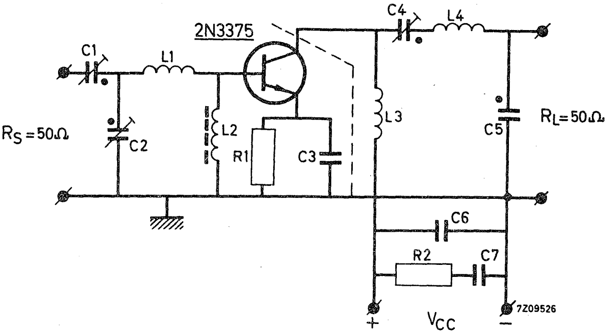
L4 = 3 turns closely wound enamelled Cu wire (1.5 mm); int. diam. 12 mm; leads 2 x 20 mm

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

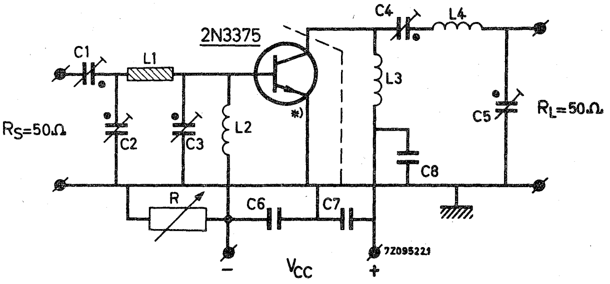
L4 = 5 turns closely wound enamelled Cu wire (1.5 mm); int. diam. 12 mm; leads 2 x 10 mm

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

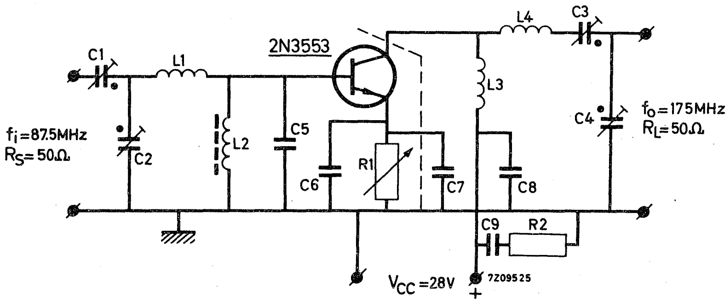
L3 = 7 turns closely wound enamelled Cu wire (0.5 mm); int. diam. 3 mm

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

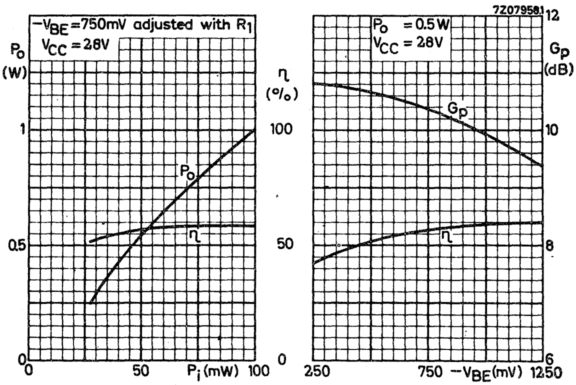
R_1 = 0 to 50 Ω
R_2 = 10 Ω carbon

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)

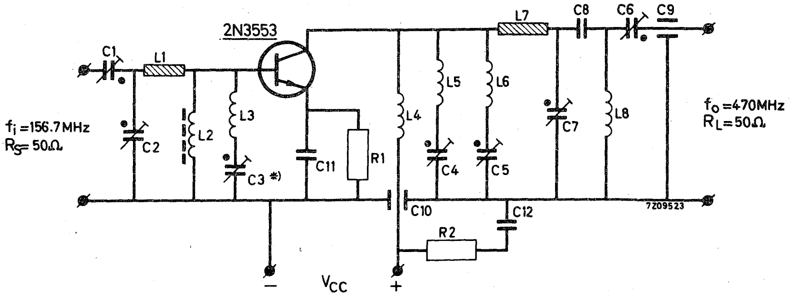
L3 = 15 turns closely wound enamelled Cu wire (0.7 mm); int. diam. 4 mm

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

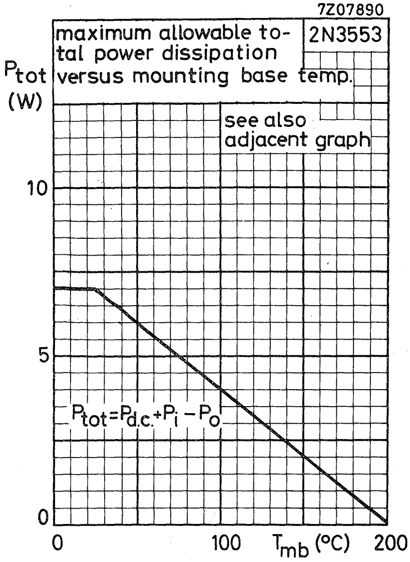
C1 = C2 = C3 = C4 = 4 to 29 pF air trimmer
C5 = C6 = C7 = 4 to 10.4 pF air trimmer
C8 = 1.0 pF ceramic
C9 = 12 pF ceramic; feed through
C10 = 100 pF ceramic; feed through
C11 = 1000 pF ceramic
C12 = 15 nF polyester

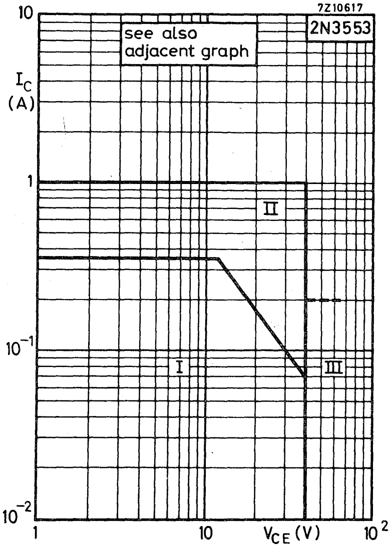
R_1 = 2.2 Ω carbon
R_2 = 10 Ω carbon

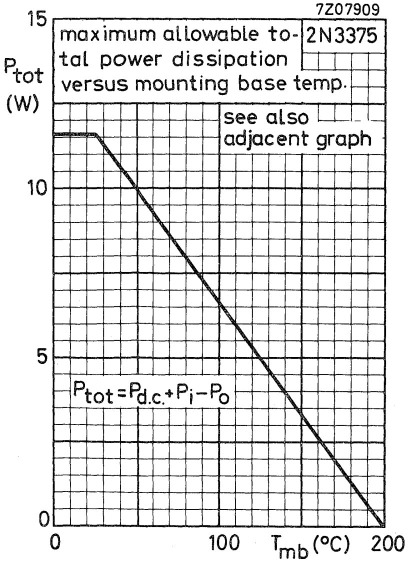
L1 = 35 mm straight Cu wire; diam. 1 mm; spaced 5.5 mm from chassis
L2 = Ferroxcube choke coil; Z (at f = 156.7 MHz) = 600 Ω ± 20% (code number 4312 020 36640)
L3 = 18 mm straight Cu wire; diam. 1 mm; spaced 5.5. mm from chassis
L4 = 7 turns closely wound enamelled Cu wire (0.5 mm); int. diam. 3.5 mm
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

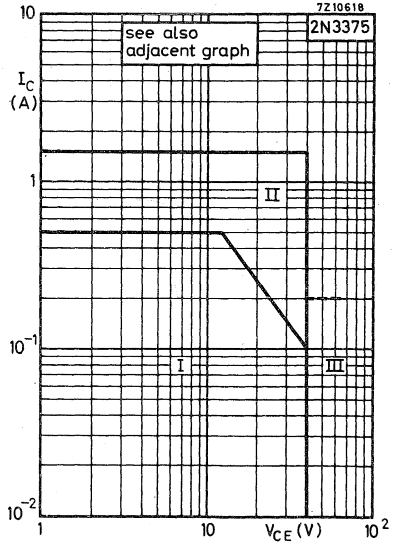
Typical performance at V_{CC} = 28 V

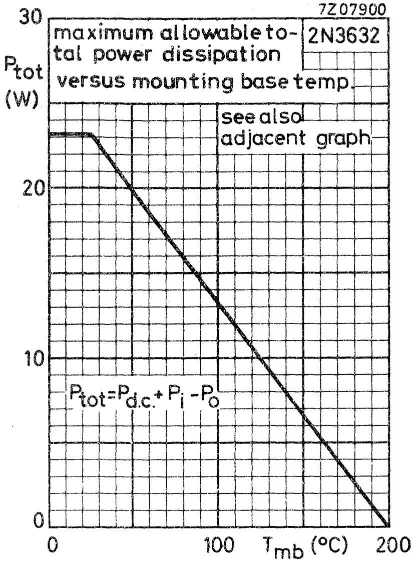
P_o (W)	P_i (W)	G_p (dB)	I_C (mA)	η %
1.5	0.27	7.5	125	43
2.0	0.39	7.1	156	46

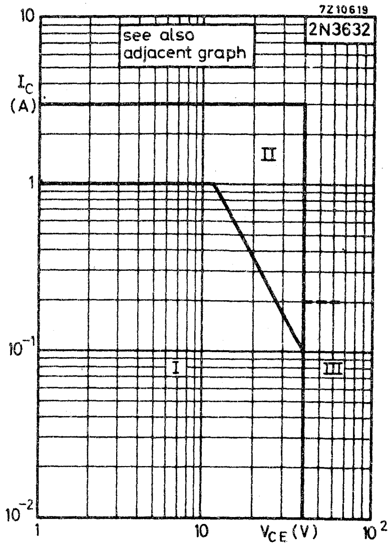

7Z07890
maximum allowable total power dissipation versus mounting base temp.
2N3553
P_{tot} (W)
see also adjacent graph
$P_{tot} = P_{d.c.} + P_i - P_o$
0
5
10
0
100
T_{mb} (°C)
200


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


7Z07909
maximum allowable total power dissipation versus mounting base temp.
2N3375
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


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

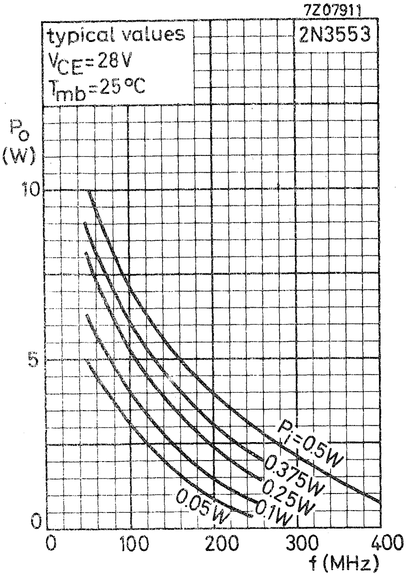


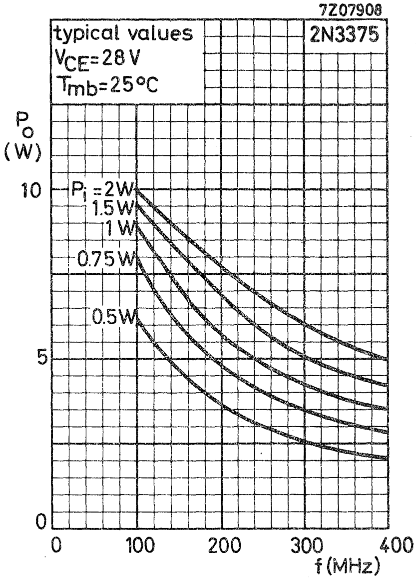


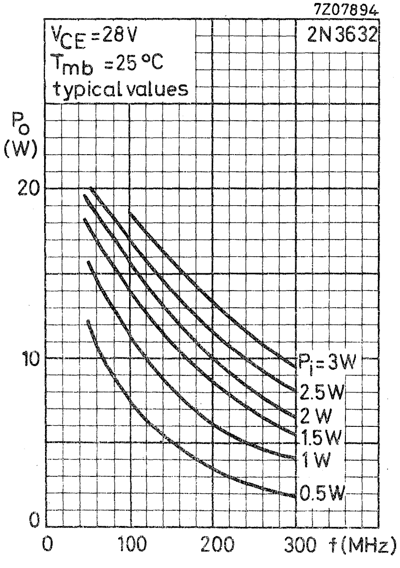
I Region of permissible operation under all base-emitter conditions and at all frequencies, including d.c.

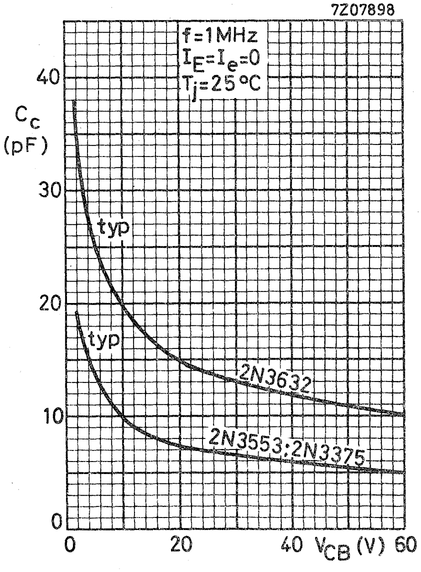
II Additional region of operation at f ≥ 1 MHz.
Care must be taken to reduce the d.c. adjustment to region I before removing the a.c. signal. This may be achieved by an appropriate bias in class A, B or C.

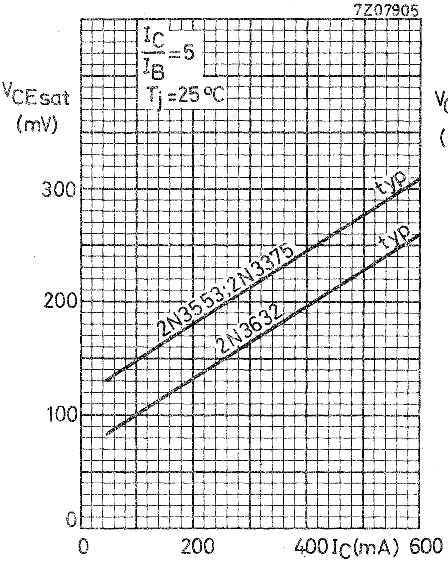
III Operating during switching off in this region is allowed, provided the transistor is cut-off with $-V_{BB} \leq 1.5$ V and $R_{BE} \geq 33\ \Omega$, $I_C \leq 200$ mA and the transient energy does not exceed 0.5 mWs.

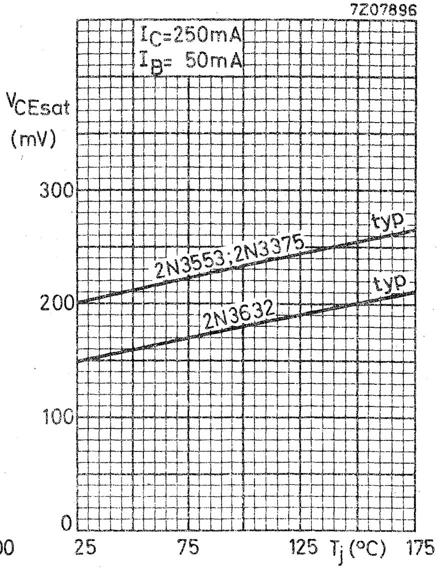

7Z07911
typical values
V_{CE} = 28 V
T_{mb} = 25 °C
2N3553
P_o (W)
10
5
0
0
100
200
300
400
f (MHz)
P_i = 0.5 W
0.375 W
0.25 W
0.1 W
0.05 W

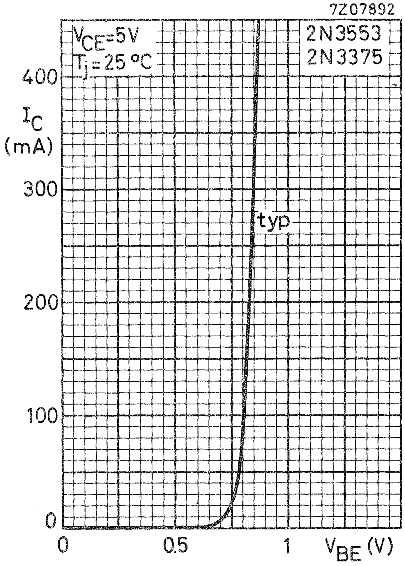

7Z07908
typical values
V_{CE} = 28 V
T_{mb} = 25 °C
2N3375
P_o (W)
10
5
0
P_i = 2 W
1.5 W
1 W
0.75 W
0.5 W
0
100
200
300
400
f (MHz)

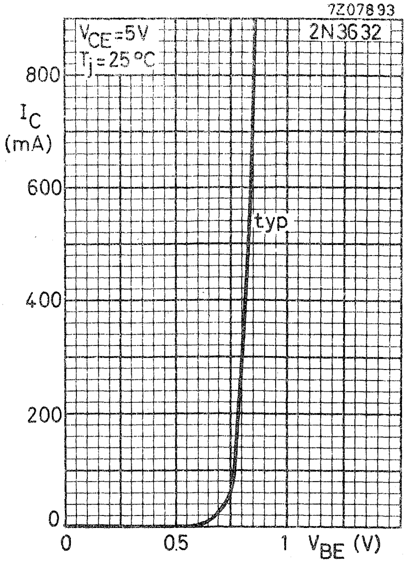

7Z07894
V_{CE} = 28 V
T_{mb} = 25 °C
typical values
2N3632
P_o (W)
20
10
0
P_i = 3 W
2.5 W
2 W
1.5 W
1 W
0.5 W
0
100
200
300
f (MHz)

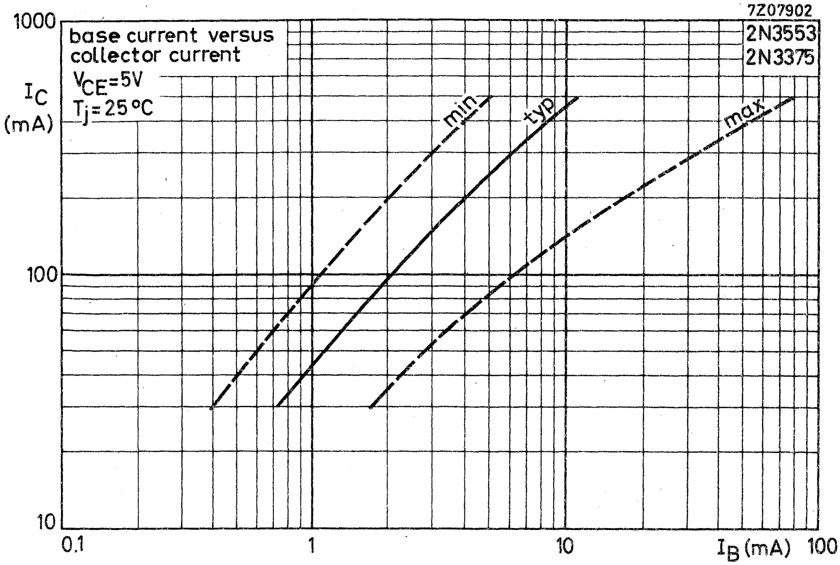

7Z07898
f = 1 MHz
I_E = I_e = 0
T_j = 25 °C
C_c (pF)
40
30
20
10
0
typ
typ
2N3632
2N3553; 2N3375
0
20
40
V_{CB} (V)
60

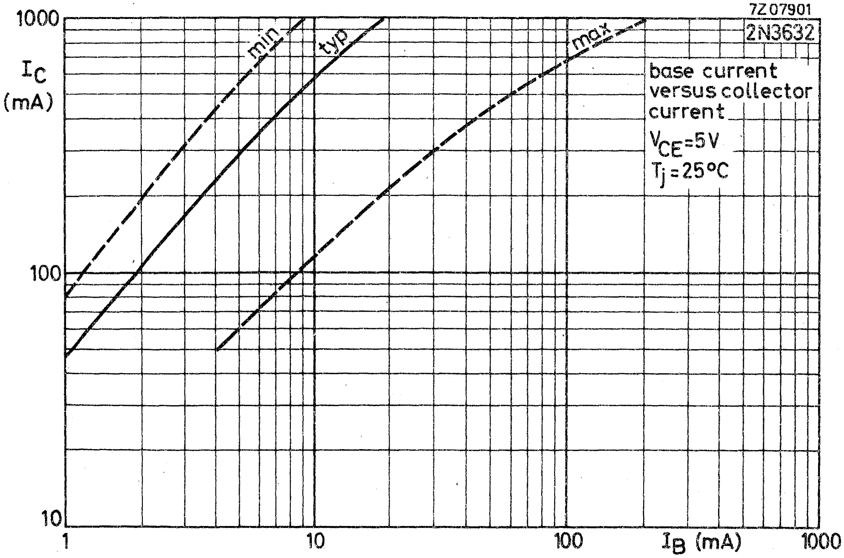

7Z07905
$\frac{I_C}{I_B} = 5$
$T_j = 25\ °C$
V_{CEsat} (mV)
300
200
100
0
0
200
400
I_C (mA)
600
typ
typ
2N3553;2N3375
2N3632

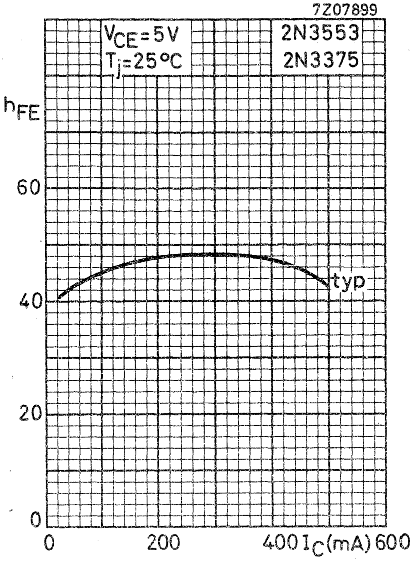

7Z07896
$I_C = 250\ mA$
$I_B = 50\ mA$
V_{CEsat} (mV)
300
200
100
0
25
75
125
T_j (°C)
175
typ
typ
2N3553;2N3375
2N3632

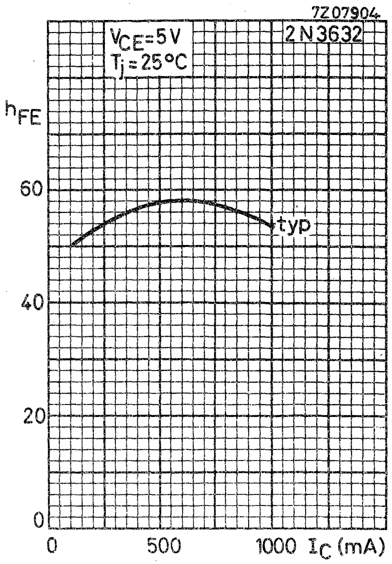

7Z07892
$V_{CE} = 5\ V$
$T_j = 25\ °C$
2N3553
2N3375
I_C (mA)
400
300
200
100
0
0
0.5
1
V_{BE} (V)
typ

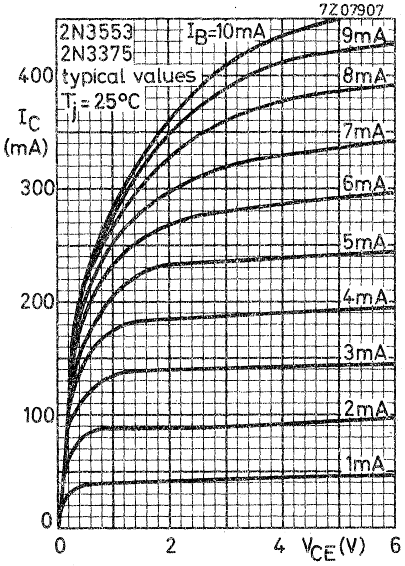

7Z07893
$V_{CE} = 5\ V$
$T_j = 25\ °C$
2N3632
I_C (mA)
800
600
400
200
0
0
0.5
1
V_{BE} (V)
typ

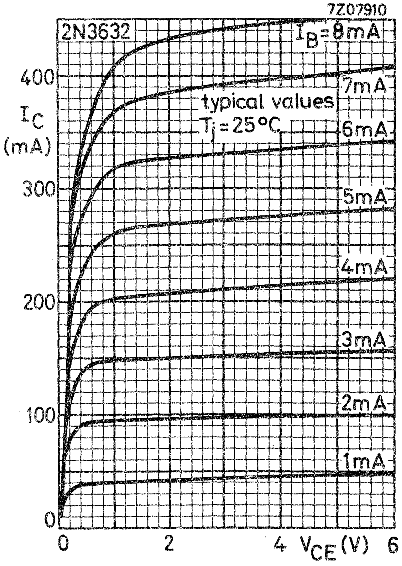

7Z07902
2N3553
2N3375
base current versus collector current
V_{CE}=5V
T_j=25 °C
I_C (mA)
1000
100
10
0.1
1
10
100
I_B (mA)
min
typ
max

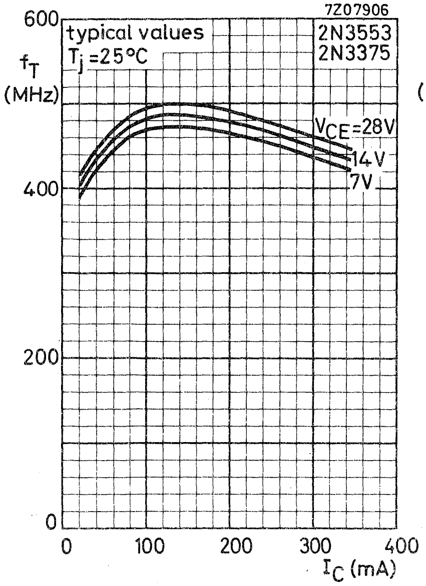

7Z07901
2N3632
base current versus collector current
V_{CE}=5V
T_j=25°C
I_C (mA)
1000
100
10
1
10
100
1000
I_B (mA)
min
typ
max

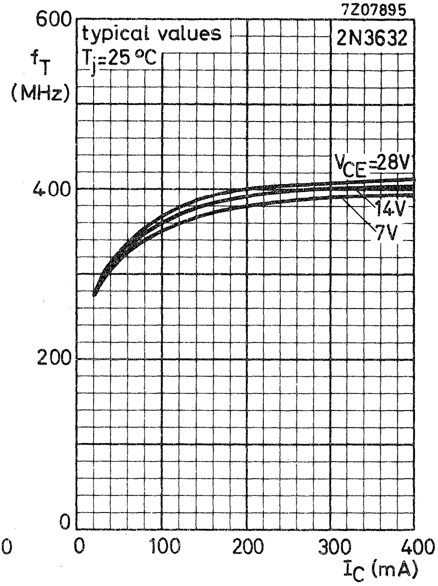

7Z07899
V_{CE} = 5 V
T_j = 25 °C
2N3553
2N3375
h_{FE}
60
40
20
0
typ
0
200
400
I_C (mA)
600

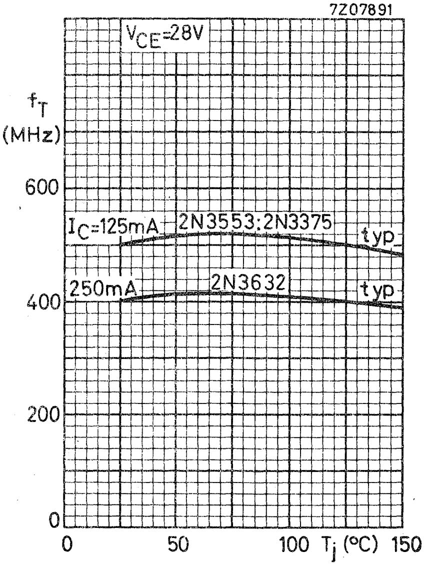

7Z07904
V_{CE} = 5 V
T_j = 25 °C
2N3632
h_{FE}
60
40
20
0
typ
0
500
1000
I_C (mA)

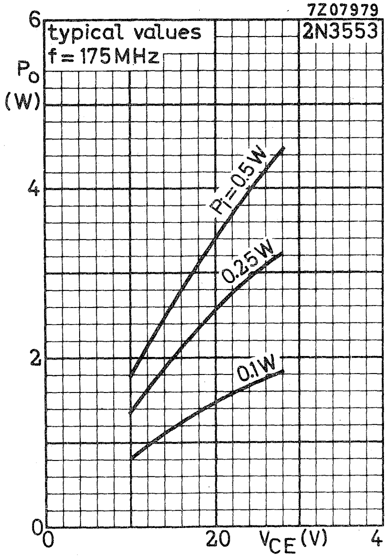

7Z07907
2N3553
2N3375
typical values
T_j = 25 °C
I_B = 10 mA
9 mA
8 mA
7 mA
6 mA
5 mA
4 mA
3 mA
2 mA
1 mA
I_C (mA)
400
300
200
100
0
0
2
4
V_{CE} (V)
6

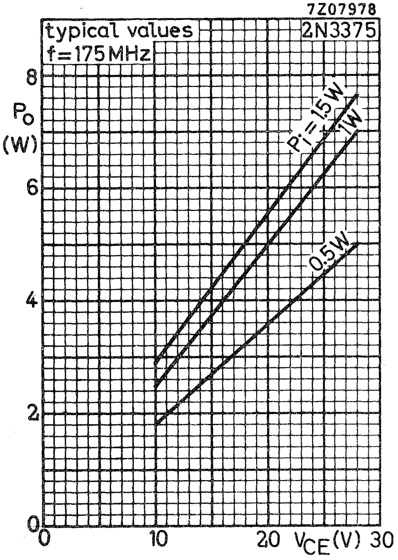

7Z07910
2N3632
I_B = 8 mA
7 mA
typical values
T_j = 25 °C
6 mA
5 mA
4 mA
3 mA
2 mA
1 mA
I_C (mA)
400
300
200
100
0
0
2
4
V_{CE} (V)
6

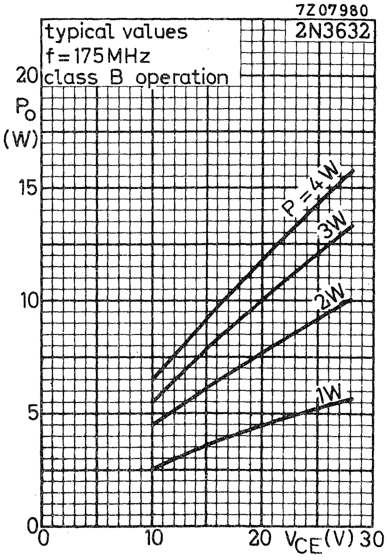

7Z07906
typical values
$T_j = 25\,^{\circ}C$
2N3553
2N3375
f_T (MHz)
600
400
200
0
V_{CE} = 28V
14V
7V
0
100
200
300
400
I_C (mA)


7Z07895
typical values
$T_j = 25\,^{\circ}C$
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
150
T_j (°C)


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


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


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 = 4 W
3 W
2 W
1 W

SILICON PLANAR EPITAXIAL 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

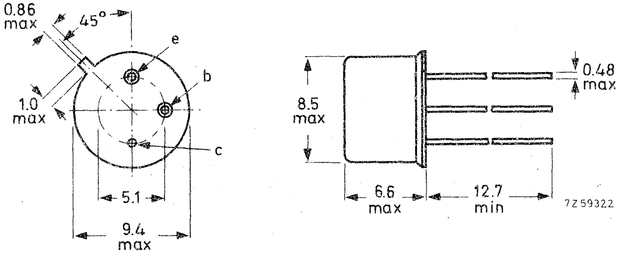
			2N3866	2N4427	
Collector-emitter voltage R_{BE} = 10 Ω	V_{CER}	max.	55	40	V
Collector-emitter voltage (open base)	V_{CEO}	max.	30	20	V
Collector current (d.c. or averaged over any 20 ms period)	I_C	max.	0.4	0.4	A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	5	3.5	W
Junction temperature	T_j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

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 $R_{BE} = 10\ \Omega$	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 $T_{mb} = 25\ ^{o}C$	P_{tot}	max.	5	3.5	W

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

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	200	$^{o}C/W$
From junction to mounting base	$R_{th\ j-mb}$	=	35	$^{o}C/W$
From mounting base to heatsink mounted with top clamping washer of 56218	$R_{th\ mb-h}$	=	1.0	$^{o}C/W$
top clamping washer of 56218 **and a boron nitride washer** for electrical insulation	$R_{th\ mb-h}$	=	**2.5**	$^{o}C/W$

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[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; $R_{BE} = 10\ \Omega$	$V_{(BR)CER}$	>	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	

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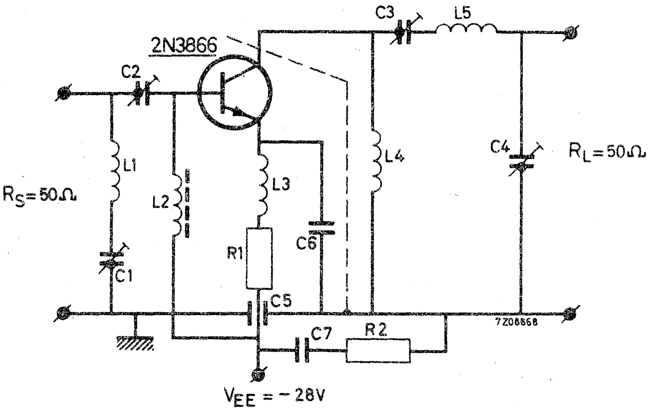
*) The transistor can withstand an output V.S.W.R. of 3:1 varied through all phases for conditions, mentioned in the table above.

CHARACTERISTICS (continued)

Test circuit with the 2N3866 at f = 400 MHz



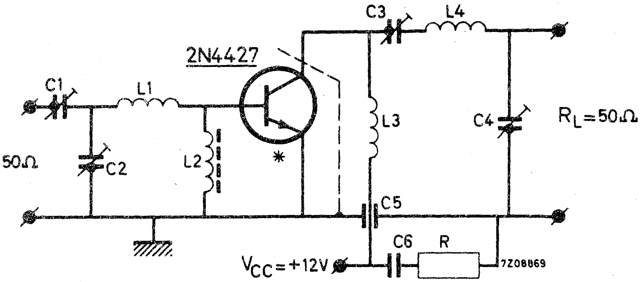
C1 = C2 = C3 = 4 to 29 pF air trimmer
C4 = 4 to 14 pF air trimmer
C5 = 1 nF feed through
C6 = 12 pF
C7 = 12 nF

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

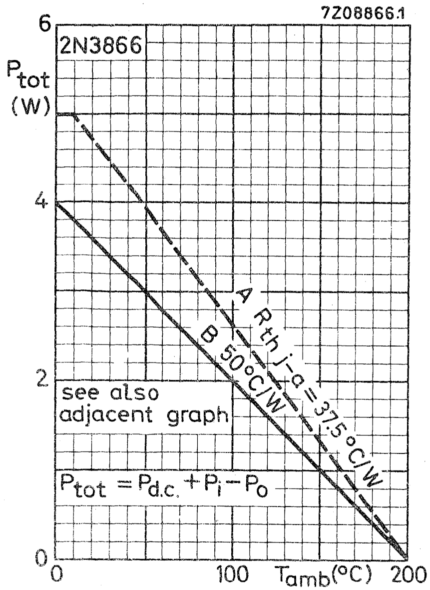


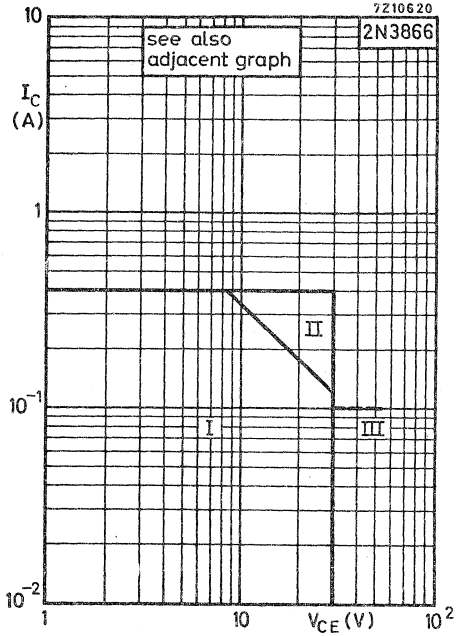
*) The length of the external emitter wire is 1.6 mm

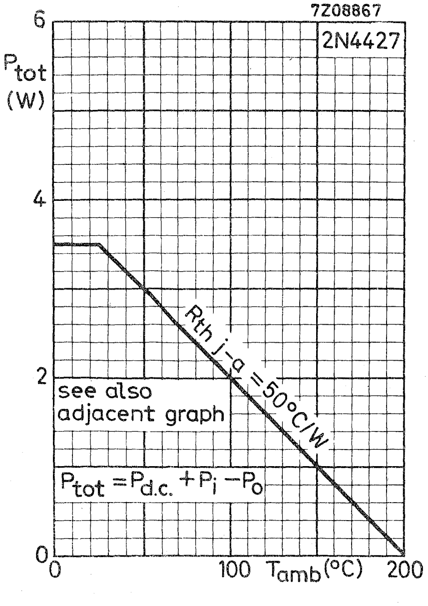
C1 = C2 = C3 = C4 = 4 to 29 pF air trimmer
C5 = 1 nF feed through
C6 = 12 nF

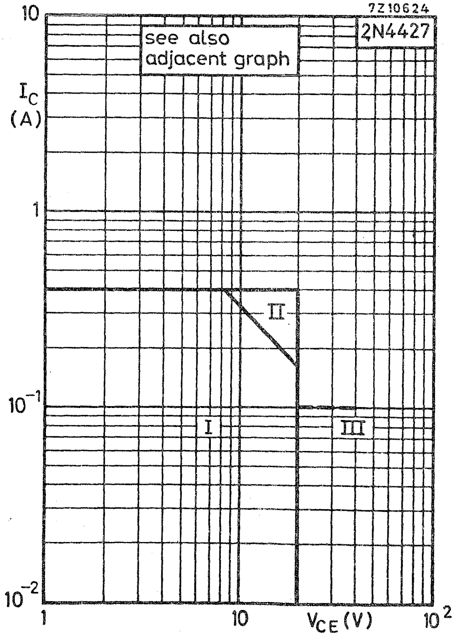
R = 10 Ω

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
6
P_{tot}
(W)
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
10
I_C
(A)
1
10^{-1}
10^{-2}
1
10
V_{CE} (V)
10^2
I
II
III

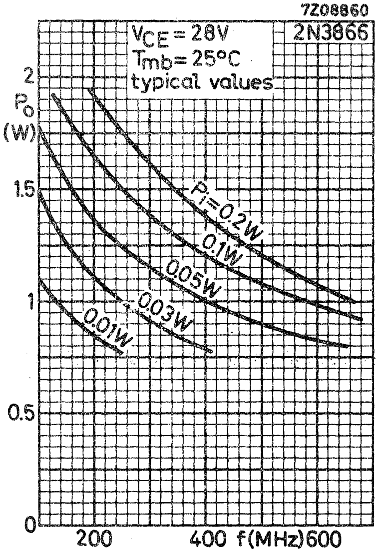

7Z08867
2N4427
6
P_{tot}
(W)
4
2
0
0
100
T_{amb}(°C)
200
$R_{th\,j-a}$ = 50°C/W
see also adjacent graph
$P_{tot} = P_{d.c.} + P_i - P_o$

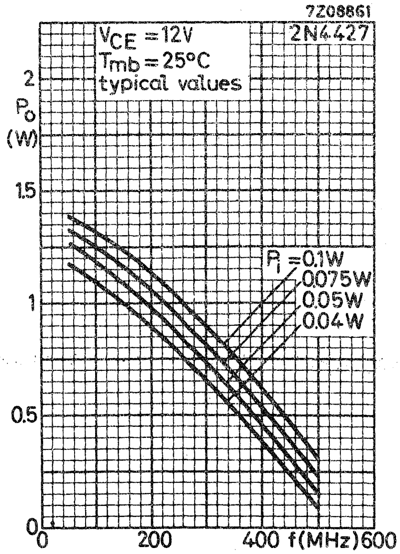

7Z10624
2N4427
see also adjacent graph
10
I_C
(A)
1
10^{-1}
10^{-2}
1
10
V_{CE} (V)
10^2
I
II
III

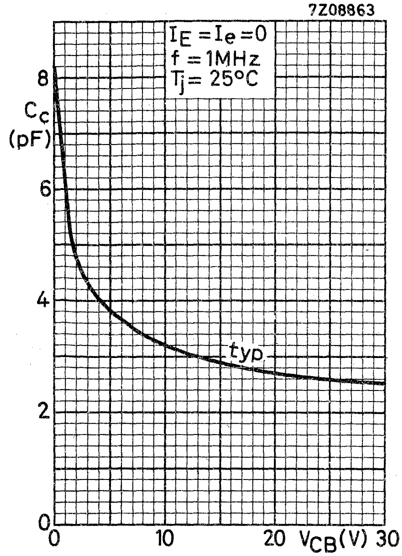
I Region of permissible operation under all base-emitter conditions and at all frequencies, including d.c.

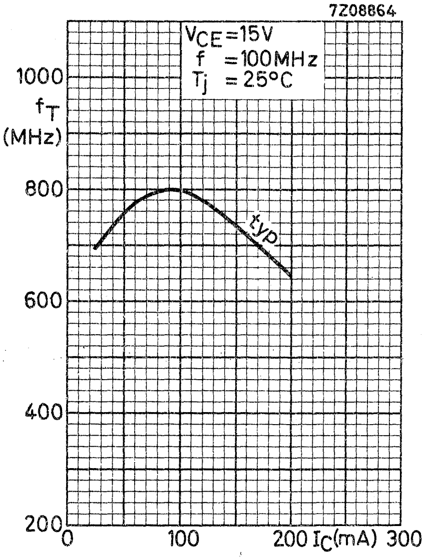
II Additional region of operation at f ≥ 1 MHz.
Care must be taken to reduce the d.c. adjustment to region I before removing the a.c. signal. This may be achieved by an appropriate bias in class A, B or C.

III Operating during switching off in this region is allowed, provided the transistor is cut-off with $-V_{BB} \le 1.5$ V and $R_{BE} \ge 33\ \Omega$, $I_C \le 100$ mA and the transient energy does not exceed 0.125 mWs.

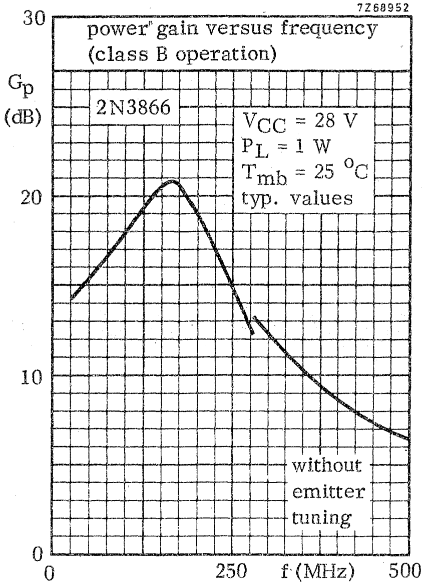


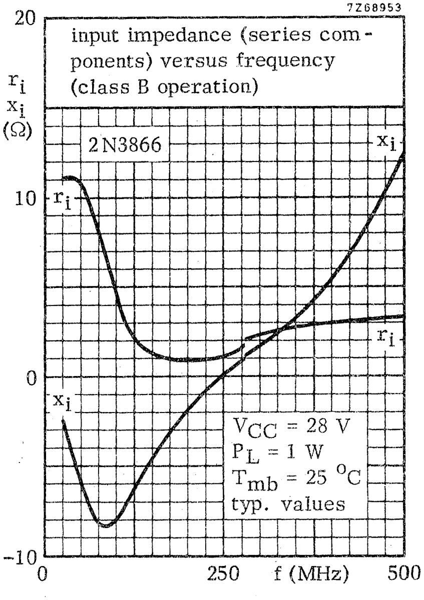


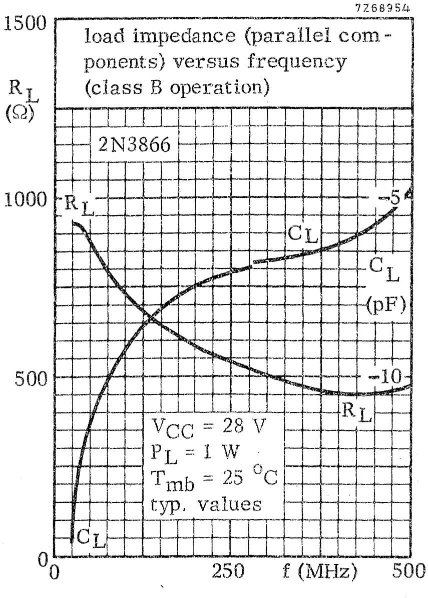

7Z08863
$I_E = I_e = 0$
f = 1MHz
T_j = 25°C
C_c (pF)
8
6
4
2
0
0
10
20
V_{CB}(V)
30
typ


7Z08864
V_{CE} = 15V
f = 100MHz
T_j = 25°C
f_T (MHz)
1000
800
600
400
200
0
100
200
I_C(mA)
300
typ

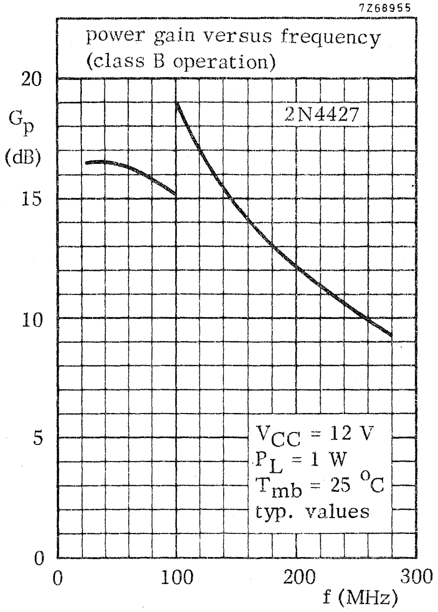
OPERATING NOTE Below 280 MHz a base-emitter resistor of 10 Ω is recommended to avoid oscillation. This resistor must be effective for both d.c. and r.f.

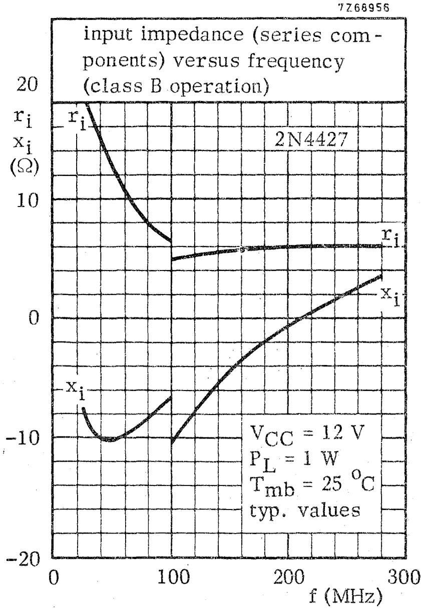


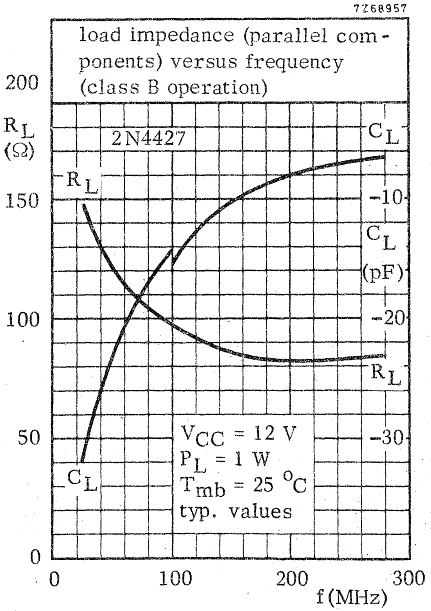




OPERATING NOTE Below 100 MHz a base-emitter resistor of 22 Ω is recommended to avoid oscillation. This resistor must be effective for both d.c. and r.f.







SILICON PLANAR EPITAXIAL 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

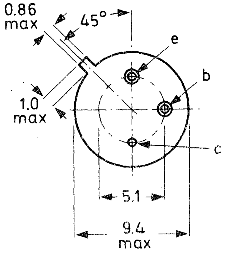
R.F. performance at $V_{CE} = 13.5$ V; f = 175 MHz

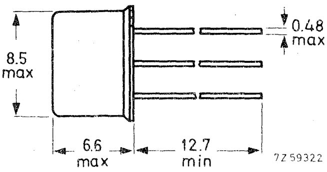
	P_o (W)	P_i (W)	η (%)
2N3924	4	< 1	> 70
2N3926	7	< 2	> 70
2N3927	12	< 4	> 80

MECHANICAL DATA

Dimensions in mm

2N3924
Collector connected to case
TO-39





Accessories available: 56218, 56245

MECHANICAL DATA (continued)

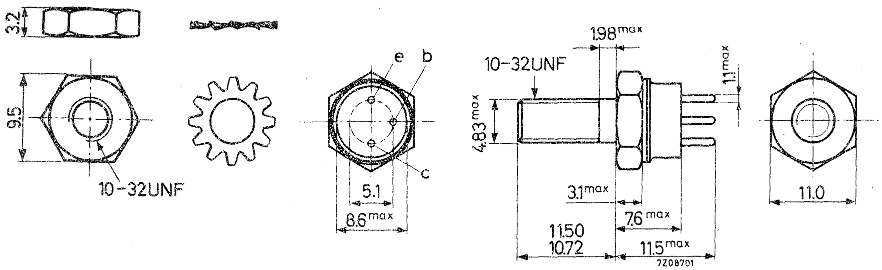
Dimensions in mm

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	^{o}C/W
From mounting base to heatsink	$R_{th\ mb\text{-}h}$	=		0.6	0.6	^{o}C/W
From mounting base to heatsink mounted with						
top clamping washer of 56218	$R_{th\ mb\text{-}h}$	=	1.0			^{o}C/W
top clamping washer of 56218 and a boron nitride washer for electrical insulation	$R_{th\ mb\text{-}h}$	=	2.5			^{o}C/W

CHARACTERISTICS

T_j = 25 ^{o}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; $T_j = 150$ ^{o}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; $R_B = 33$ Ω 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	$\mathrm{Re}(h_{ie})$	<	20	20		Ω
I_C = 200 mA; V_{CE} = 13.5 V	$\mathrm{Re}(h_{ie})$	<			20	Ω

R.F. performance at V_{CE} = 13.5 V; f = 175 MHz

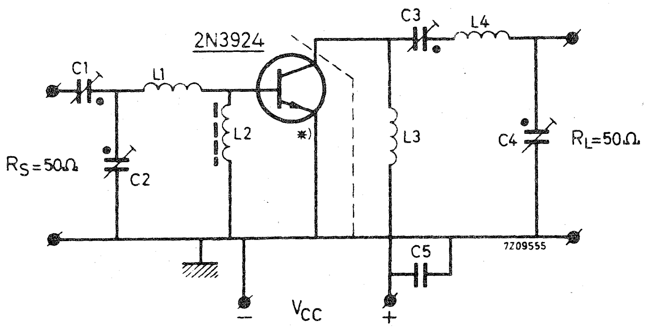
	P_o (W)	P_i (W)	I_C (mA)	η %	Test circuit at page
2N3924	4	< 1	< 420	> 70	5
2N3926	7	< 2	< 740	> 70	6
2N3927	12	< 4	< 1100	> 80	6

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

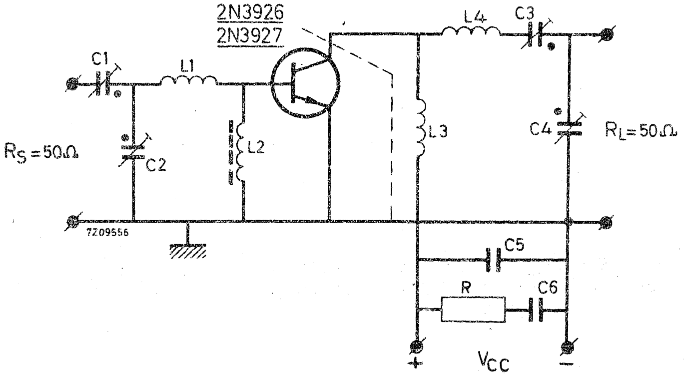
L2 = Ferroxcube choke coil. Z (at f = 175 MHz) = 550 Ω ± 20% (code number 4312 020 36640)

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

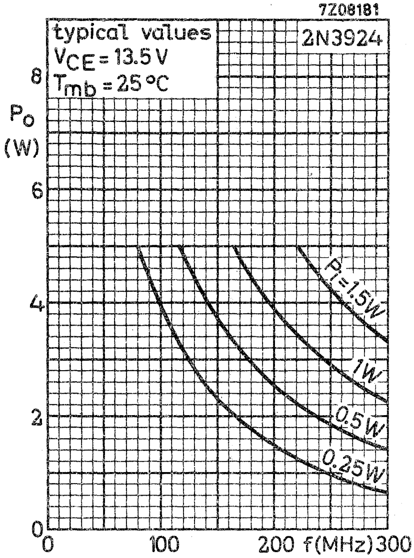
L1 = 1 turn Cu wire (1.0 mm); int. diam. 10 mm; leads 2 x 10 mm

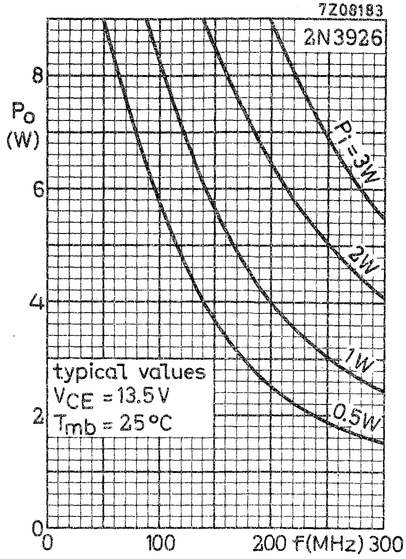
L2 = Ferroxcube choke coil. Z (at f = 175 MHz) = 550 Ω ± 20% (code number 4312 020 36640)

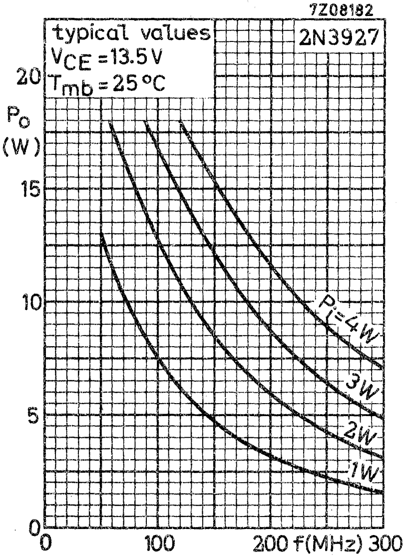
L3 = 15 turns closely wound enamelled Cu wire (0.7 mm); int. diam. 4 mm

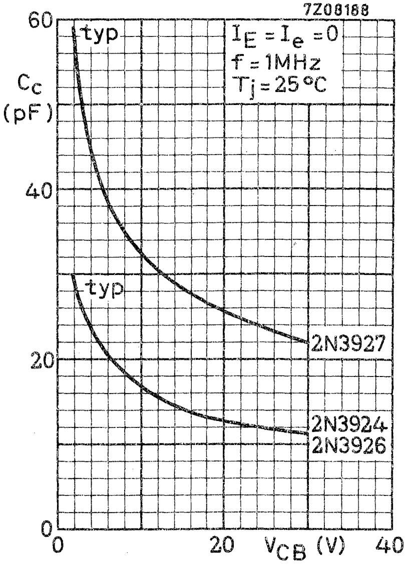
L4 = 2 turns closely wound enamelled Cu wire (1.5 mm); int. diam. 8.5 mm; leads 2 x 20 mm

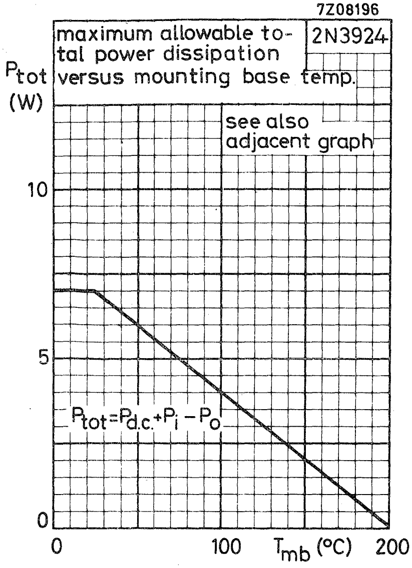
R = 10 Ω carbon

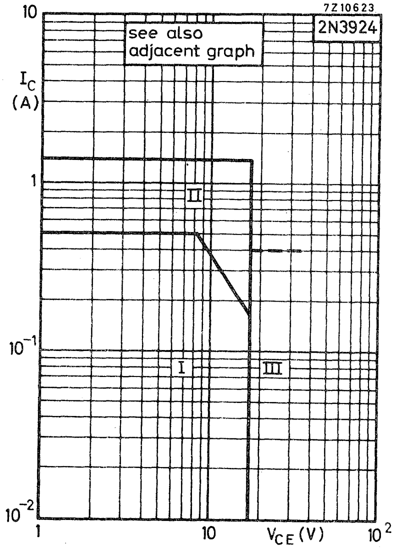

7Z08181
typical values
V_{CE} = 13.5 V
T_{mb} = 25 °C
2N3924
P_o
(W)
8
6
4
2
0
0
100
200
f(MHz)
300
P_i = 1.5W
1W
0.5 W
0.25W

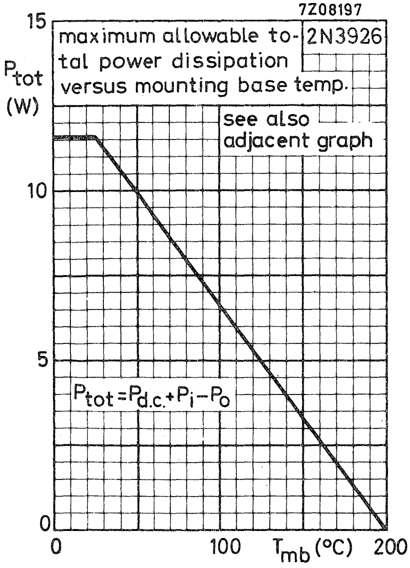

7Z08183
2N3926
P_o
(W)
8
6
4
2
0
0
100
200
f(MHz)
300
P_i = 3W
2W
1W
0.5W
typical values
V_{CE} = 13.5 V
T_{mb} = 25 °C

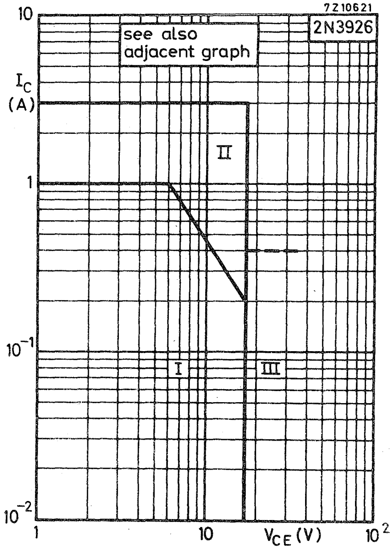

7Z08182
typical values
V_{CE} = 13.5 V
T_{mb} = 25 °C
2N3927
P_o
(W)
20
15
10
5
0
0
100
200
f(MHz)
300
P_i = 4W
3W
2W
1W

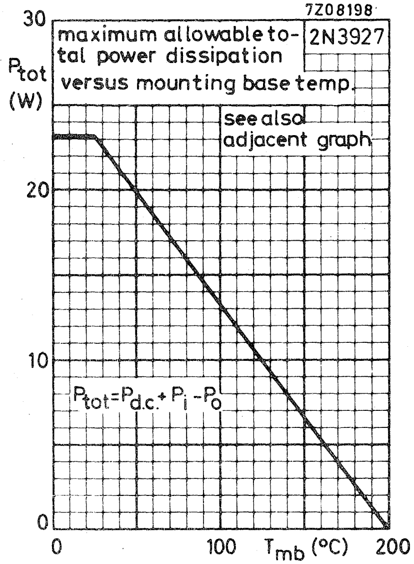

7Z08188
C_c
(pF)
60
40
20
0
0
20
V_{CB} (V)
40
typ
typ
$I_E = I_e = 0$
f = 1MHz
T_j = 25 °C
2N3927
2N3924
2N3926

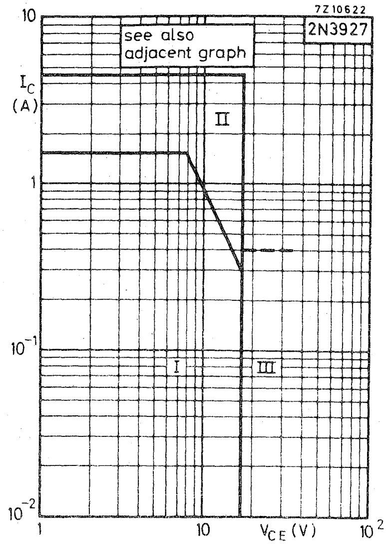

7Z08196
maximum allowable total power dissipation versus mounting base temp.
2N3924
P_{tot} (W)
see also adjacent graph
10
5
0
$P_{tot} = P_{d.c.} + P_i - P_o$
0
100
T_{mb} (°C)
200


7Z10623
2N3924
10
see also adjacent graph
I_C (A)
1
II
10^{-1}
I
III
10^{-2}
1
10
V_{CE} (V)
10^2


7Z08197
15
maximum allowable total power dissipation versus mounting base temp.
2N3926
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


7Z10621
2N3926
10
see also adjacent graph
I_C (A)
II
1
10^{-1}
I
III
10^{-2}
1
10
V_{CE} (V)
10^2

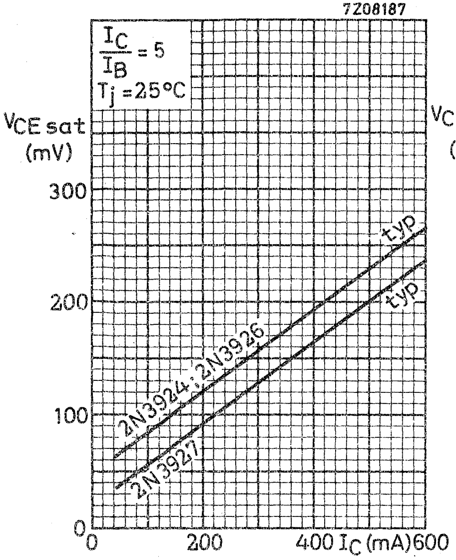


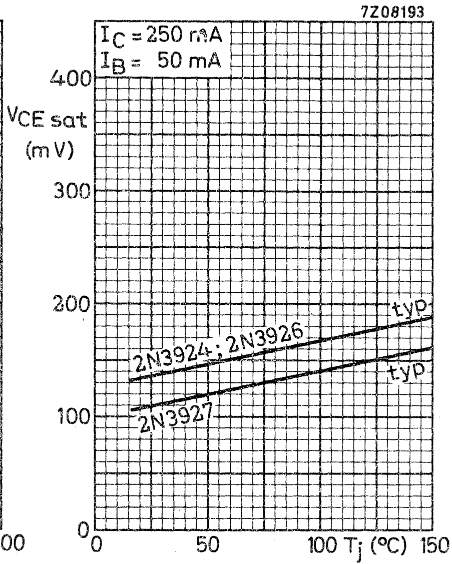


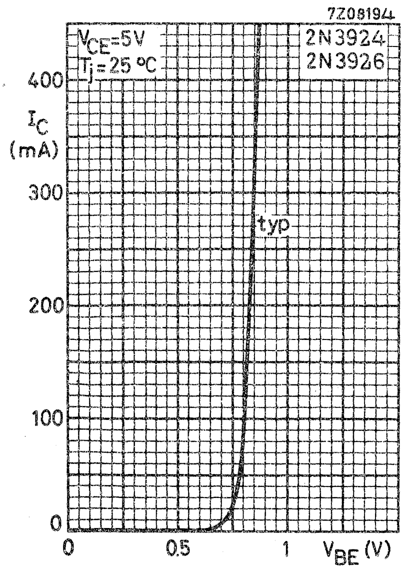
I Region of permissible operation under all base-emitter conditions and at all frequencies, including d.c.

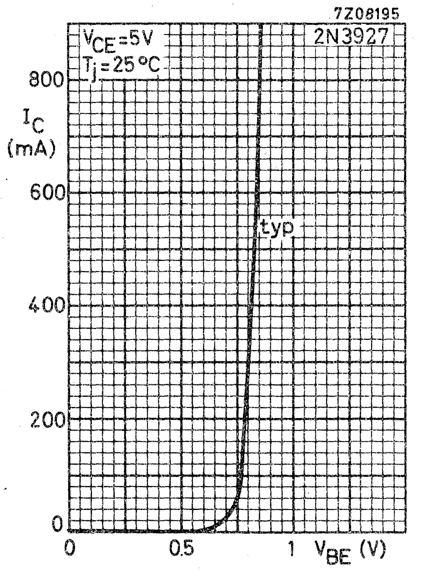
II Additional region of operation at $f \geq 1$ MHz.
Care must be taken to reduce the d.c. adjustment to region I before removing the a.c. signal. This may be achieved by an appropriate bias in class A, B or C.

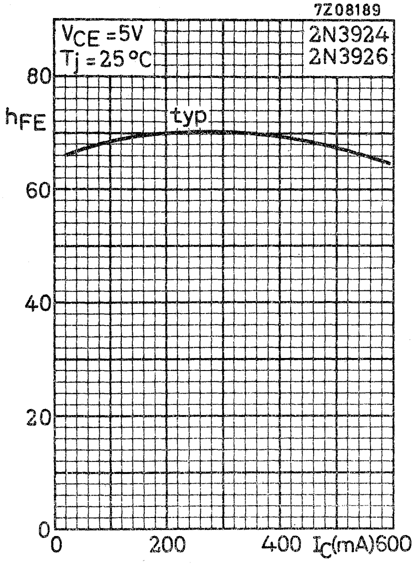
III Operating during switching off in this region is allowed, provided the transistor is cut-off with $-V_{BB} \leq 1.5$ V and $R_{BE} \geq 33\ \Omega$, $I_C \leq 400$ mA and the transient energy does not exceed 2 mWs.

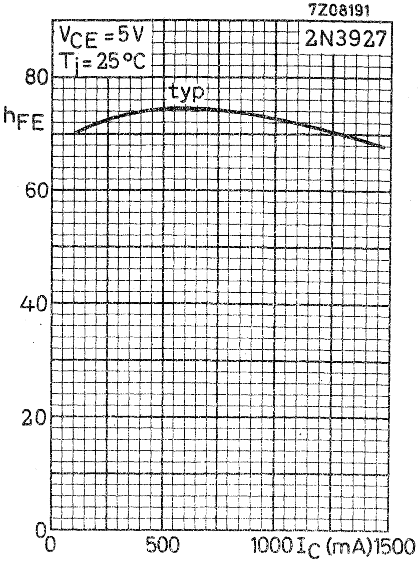

7Z08187
$\frac{I_C}{I_B} = 5$
$T_j = 25\,°C$
$V_{CE\,sat}$ (mV)
300
200
100
0
0
200
400 I_C (mA) 600
typ
typ
2N3924; 2N3926
2N3927

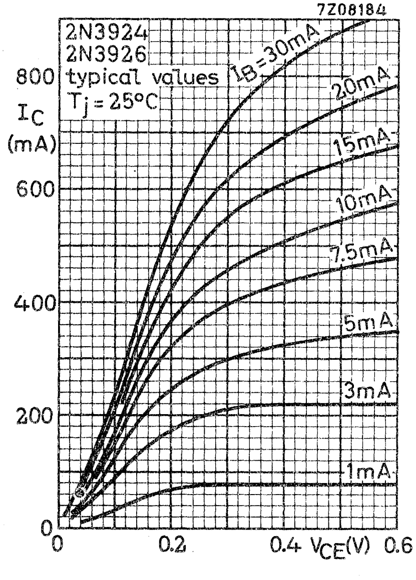

7Z08193
$I_C = 250$ mA
$I_B = 50$ mA
400
$V_{CE\,sat}$ (mV)
300
200
100
0
0
50
100 T_j (°C) 150
typ
2N3924; 2N3926
typ
2N3927

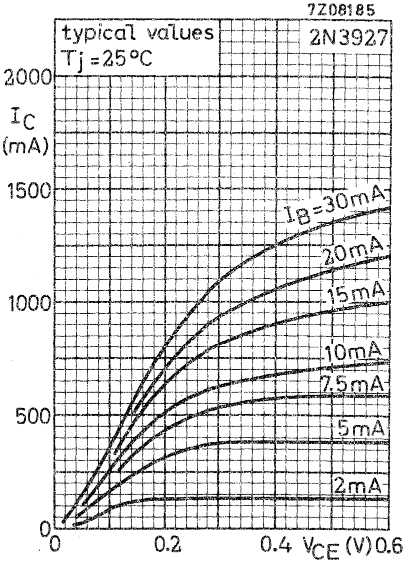

7Z08194
$V_{CE} = 5$ V
$T_j = 25$ °C
2N3924
2N3926
400
I_C (mA)
300
200
100
0
0
0.5
1
V_{BE} (V)
typ

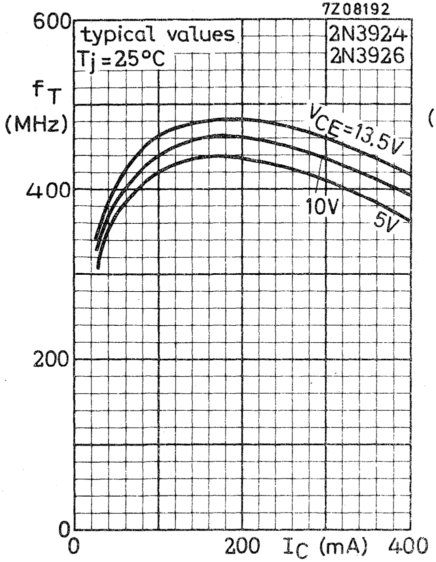

7Z08195
$V_{CE} = 5$ V
$T_j = 25$ °C
2N3927
800
I_C (mA)
600
400
200
0
0
0.5
1
V_{BE} (V)
typ

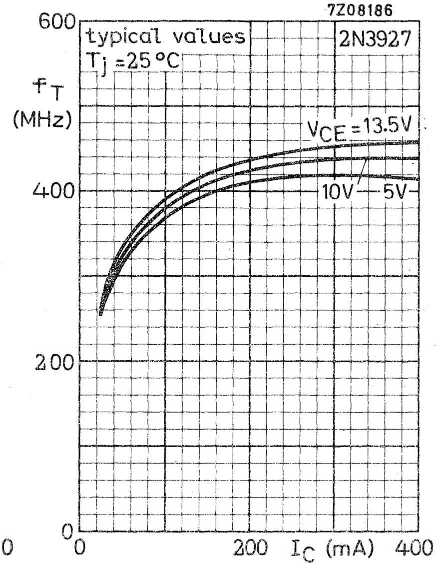

7Z08189
V_{CE} = 5V
T_j = 25 °C
2N3924
2N3926
typ
h_{FE}
80
60
40
20
0
0
200
400
I_C(mA)600

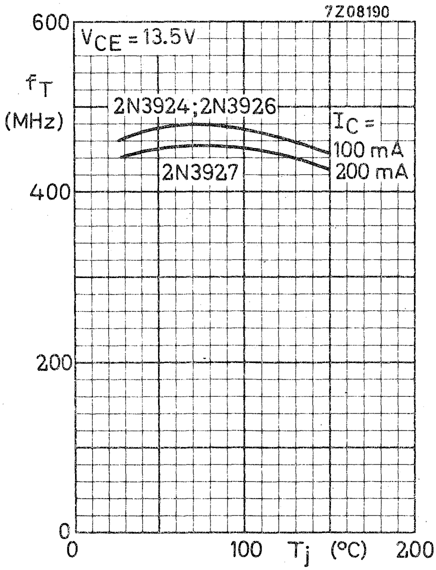

7Z08191
V_{CE} = 5 V
T_j = 25 °C
2N3927
typ
h_{FE}
80
60
40
20
0
0
500
1000 I_C (mA)1500


7Z08184
2N3924
2N3926
typical values
T_j = 25°C
I_B = 30mA
20mA
15mA
10mA
7.5mA
5mA
3mA
1mA
800
I_C
(mA)
600
400
200
0
0
0.2
0.4 V_{CE}(V) 0.6


7Z08185
typical values
T_j = 25 °C
2N3927
I_B = 30mA
20mA
15mA
10mA
7.5mA
5mA
2mA
2000
I_C
(mA)
1500
1000
500
0
0
0.2
0.4 V_{CE} (V) 0.6


7Z08192
600
400
200
0
fT
(MHz)
typical values
Tj = 25 °C
2N3924
2N3926
VCE = 13.5V
10V
5V
0
200
IC (mA)
400


7Z08186
600
400
200
0
fT
(MHz)
typical values
Tj = 25 °C
2N3927
VCE = 13.5V
10V
5V
0
200
IC (mA)
400


7Z08190
600
400
200
0
fT
(MHz)
VCE = 13.5V
2N3924;2N3926
2N3927
IC =
100 mA
200 mA
0
100
Tj (°C)
200

SILICON EPITAXIAL PLANAR OVERLAY TRANSISTOR

For data of this transistor please refer to type 2N3866

Microwave devices

For data concerning the microwave devices mentioned below, please refer to our Data Handbook **"Microwave products"**.

Type No.	Description	Application
AEY29; AEY29R	Microwave detector diodes	Low level detector at J-band
AEY31; AEY31A	Microwave detector diodes	Broad band low level detector at X-band
BAV46	Microwave detector diode	Schottky barrier diode doppler radar systems and intruder alarms
BAV96A to D	Microwave mixer diodes	Schottky barrier diodes mixer circuits at X-band
BAV97	Microwave detector diode	Schottky barrier diode detector over the frequency range 1 to 18 GHz
BAW95D to G	Microwave mixer diodes	Schottky barrier diodes mixer circuits at X-band
BAY96	Varactor diode	Frequency multiplier for use in the v.h.f. and u.h.f. regions
CXY11A to C	Gunn effect diodes	C.W. oscillators at X-band
1N5152; 1N5153	Varactor diodes	Frequency multiplier circuits up to S-band
1N5155	Varactor diode	Frequency multiplier circuits up to C-band
1N5157	Varactor diode	Frequency multiplier circuits up to X-band

Field-effect transistors

N-CHANNEL SILICON FIELD-EFFECT TRANSISTORS

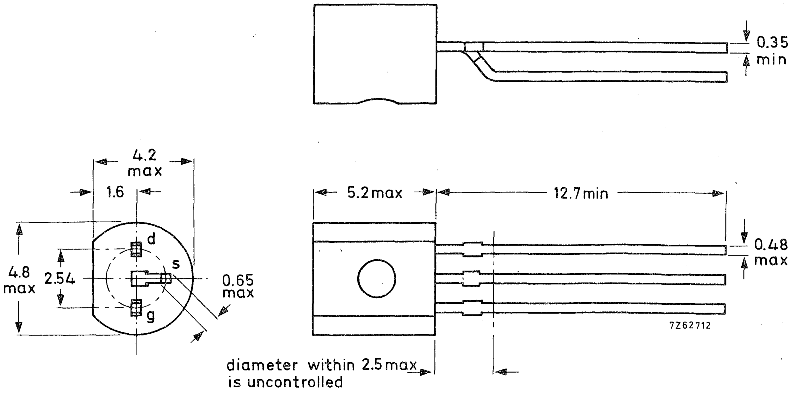
Planar epitaxial junction field-effect transistors in a plastic TO-92 variant; intended for hi-fi amplifiers and other audio frequency equipment.

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

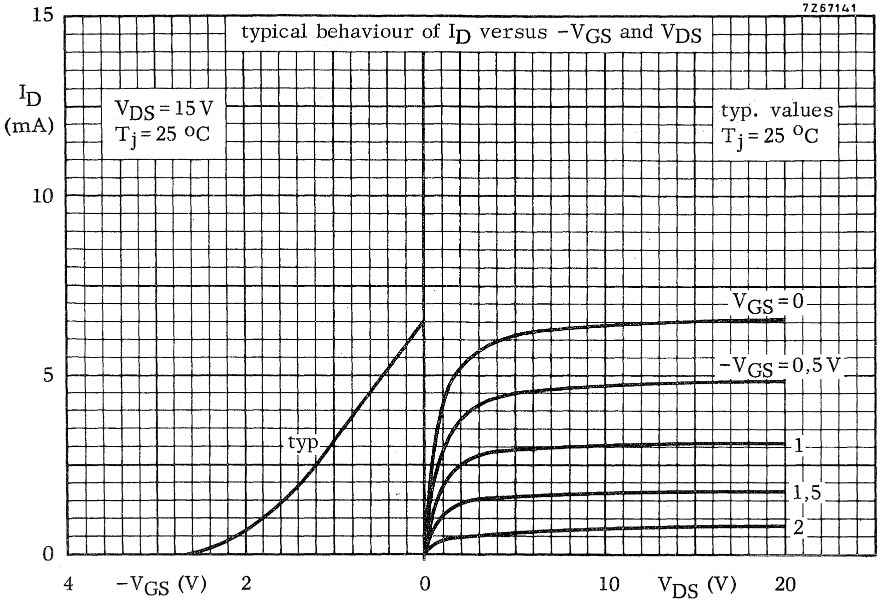
CHARACTERISTICS T_j = 25 °C unless otherwise specified

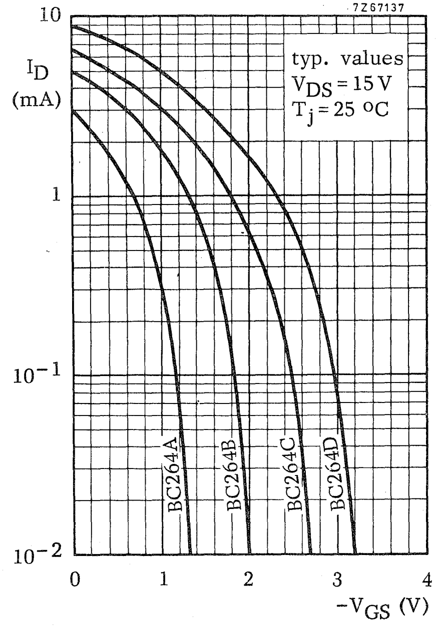
			BC264A	B	C	D	
Gate cut-off current							
$-V_{GS}$ = 20 V; V_{DS} = 0	$-I_{GSS}$	<	10	10	10	10	nA
Drain current 1)							
V_{DS} = 15 V; V_{GS} = 0	I_{DSS}	>	2,0	3,5	5,0	7,0	mA
		<	4,5	6,5	8,0	12,0	mA
Gate-source breakdown voltage							
$-I_G$ = 1 μA; V_{DS} = 0	$-V_{(BR)GSS}$	>	30	30	30	30	V
Gate-source 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	$\lvert y_{fs} \rvert$	>	2,5	3,0	3,5	4,0	mA/V

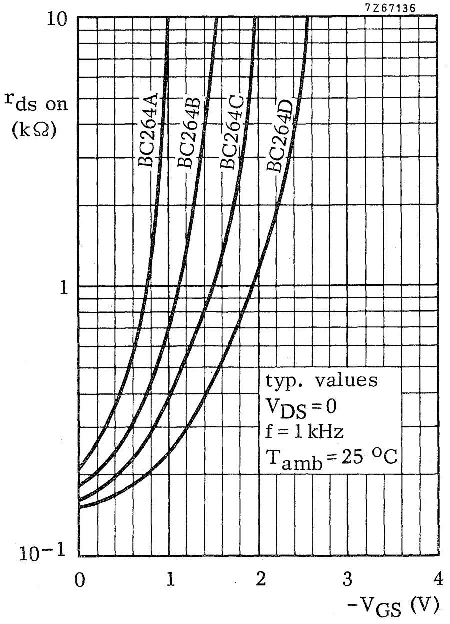
V_{DS} = 15 V; $-V_{GS}$ = 1 V; f = 1 MHz				
Input capacitance	C_{is}	typ.	4,0	pF
Feedback capacitance	C_{rs}	typ.	1,2	pF
Output capacitance	C_{os}	typ.	1,6	pF
Noise figure at f = 1 kHz; R_G = 1 MΩ				
V_{DS} = 15 V; V_{GS} = 0; T_{amb} = 25 °C	F	typ.	0,5	dB
		<	2	dB
Equivalent noise voltage at T_{amb} = 25 °C				
V_{DS} = 15 V; V_{GS} = 0; f = 10 Hz	$V_n / \sqrt{B}$	typ.	40	nV/$\sqrt{Hz}$

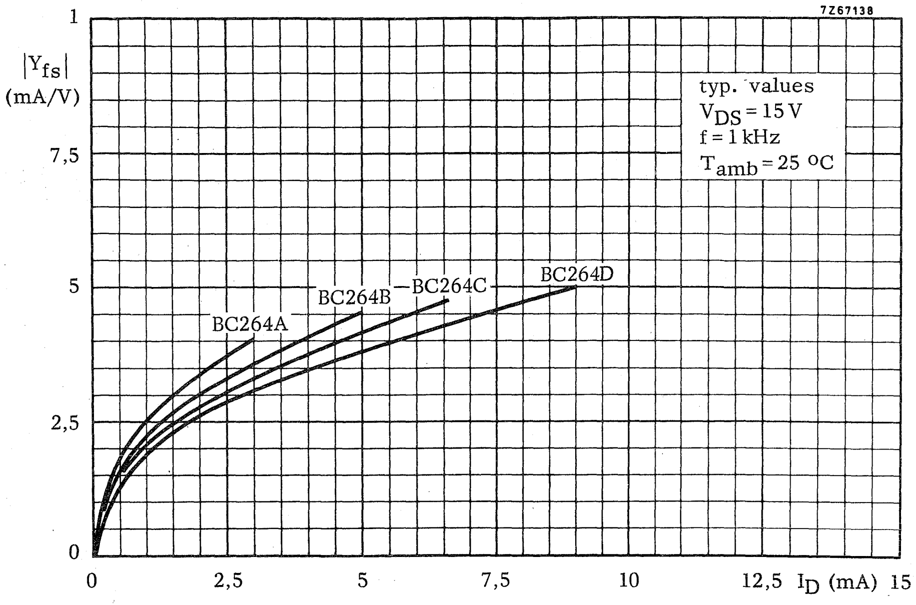
---

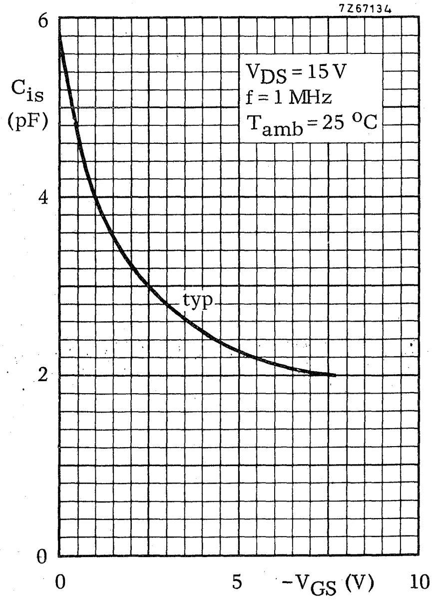
1) Measured under pulse conditions.

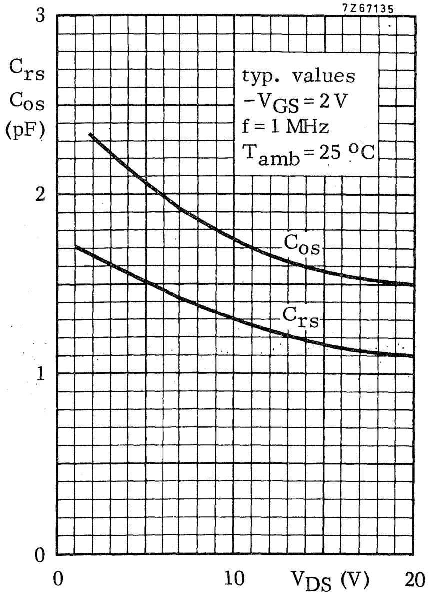

7Z67141
typical behaviour of I_D versus $-V_{GS}$ and V_{DS}
I_D (mA)
15
10
5
0
V_{DS} = 15 V
T_j = 25 °C
typ. values
T_j = 25 °C
typ
V_{GS} = 0
$-V_{GS}$ = 0,5 V
1
1,5
2
4
$-V_{GS}$ (V)
2
0
10
V_{DS} (V)
20

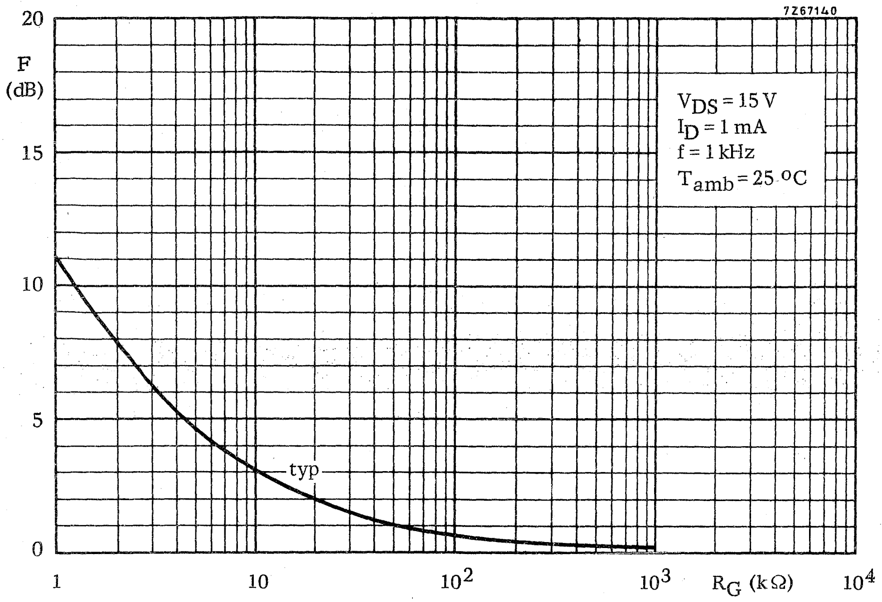

7Z67137
I_D (mA)
10
1
10^{-1}
10^{-2}
typ. values
V_{DS} = 15 V
T_j = 25 °C
BC264A
BC264B
BC264C
BC264D
0
1
2
3
4
$-V_{GS}$ (V)


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
typ. values
V$_{DS}$ = 15 V
f = 1 kHz
T$_{amb}$ = 25 °C
BC264A
BC264B
BC264C
BC264D
0
2,5
5
7,5
10
12,5
I$_D$ (mA)
15


7Z67134
C$_{is}$
(pF)
6
4
2
0
V$_{DS}$ = 15 V
f = 1 MHz
T$_{amb}$ = 25 °C
typ
0
5
−V$_{GS}$ (V)
10


7Z67135
C$_{rs}$
C$_{os}$
(pF)
3
2
1
0
typ. values
−V$_{GS}$ = 2 V
f = 1 MHz
T$_{amb}$ = 25 °C
C$_{os}$
C$_{rs}$
0
10
V$_{DS}$ (V)
20


7Z67140
20
F
(dB)
15
10
5
0
1
10
10^2
10^3
R_G (kΩ)
10^4
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.

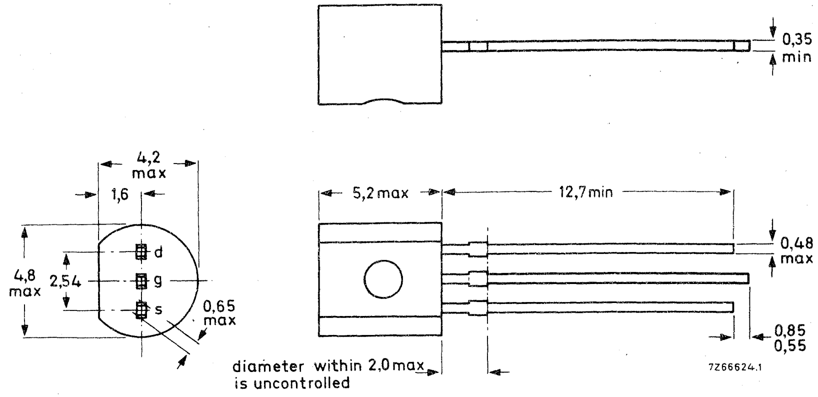
QUICK REFERENCE DATA

Drain-source voltage	$\pm V_{DS}$	max.	30			V
Gate-source voltage (open drain)	$-V_{GSO}$	max.	30			V
Total power dissipation up to $T_{amb} = 75\ ^{o}C$	P_{tot}	max.	300			mW
			BF244A	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 $V_{DS} = 20$ V; $-V_{GS} = 1$ V	C_{rs}	typ.	1, 1			pF
Transfer admittance (common source) $V_{DS} = 15$ V; $V_{GS} = 0$	$\lvert y_{fs}\rvert$		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	$R_{th\ j\text{-}a}$	=	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

$T_j = 25\ ^{o}C$ 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; $V_{DS} = 0$; $T_j = 125\ ^{o}C$	$-I_{GSS}$	<	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 $T_{amb} = 25\ ^{o}C$ (common source)					
$V_{DS} = 15$ V; $V_{GS} = 0$					
f = 1 kHz	Transfer admittance	$\|y_{fs}\|$		3,0 to 6,5	mA/V
	Output admittance	$\|y_{os}\|$	typ.	25	μA/V
f = 200 MHz	Input conductance	g_{is}	typ.	250	μA/V
	Reverse transfer admittance	$\|y_{rs}\|$	typ.	1,4	mA/V
	Transfer admittance	$\|y_{fs}\|$	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; $V_{GS} = 0$; $T_{amb} = 25\ ^{o}C$ input tuned to minimum noise		F	typ.	1,5	dB

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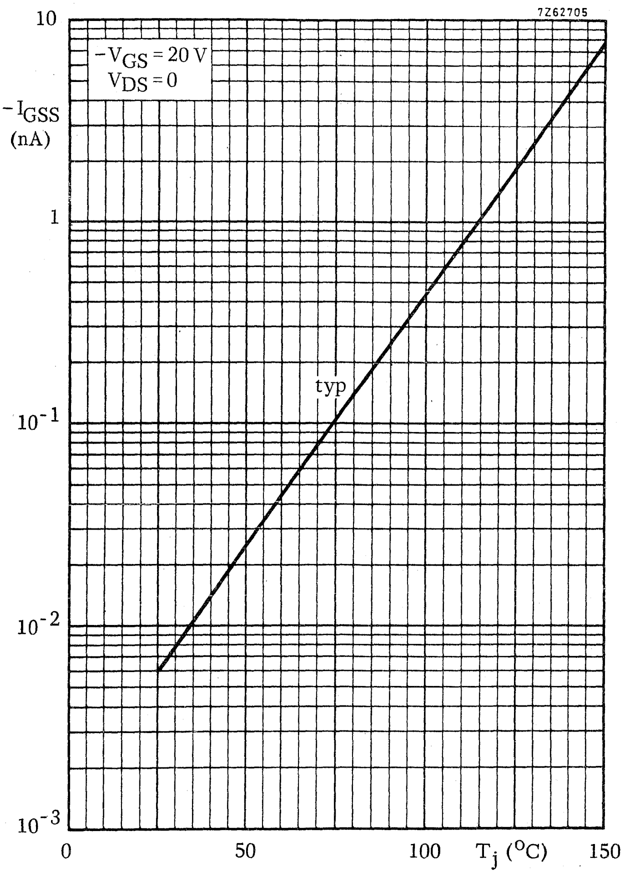
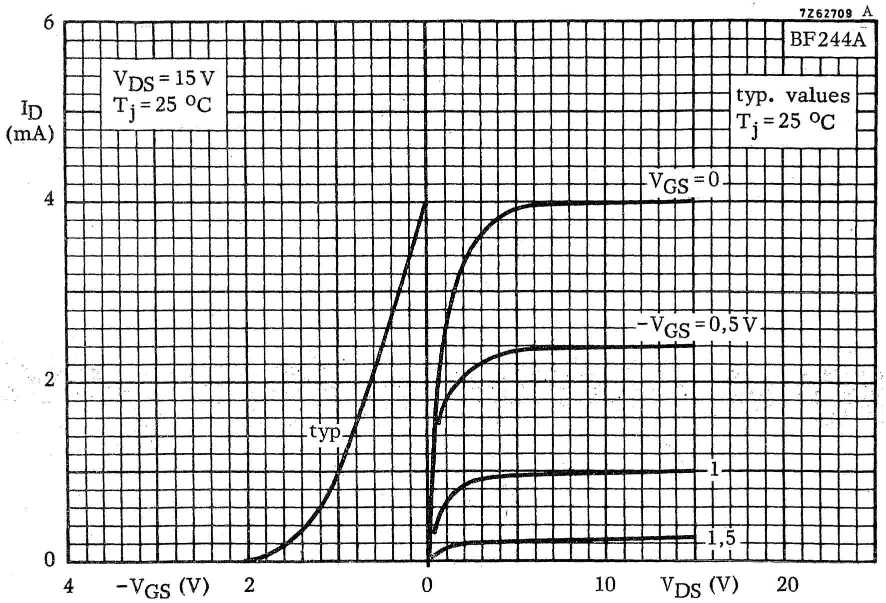
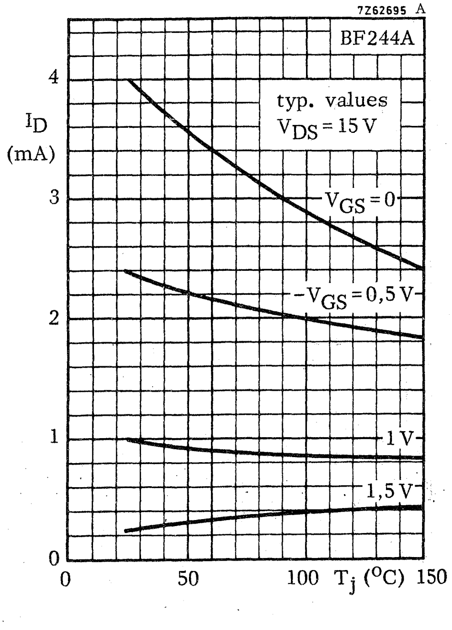
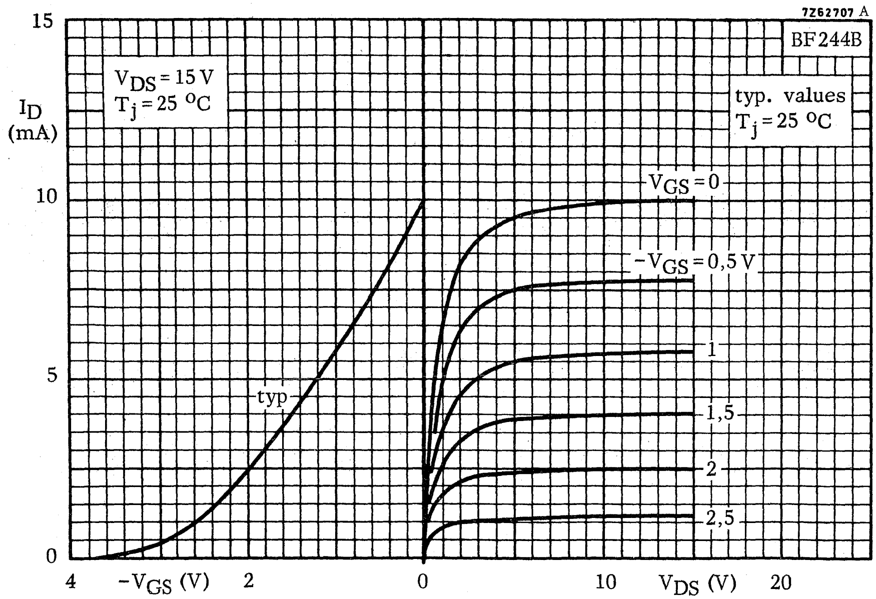
1) Measured under pulse condition: $t_p = 300$ μs; $\delta \leq 0,02$

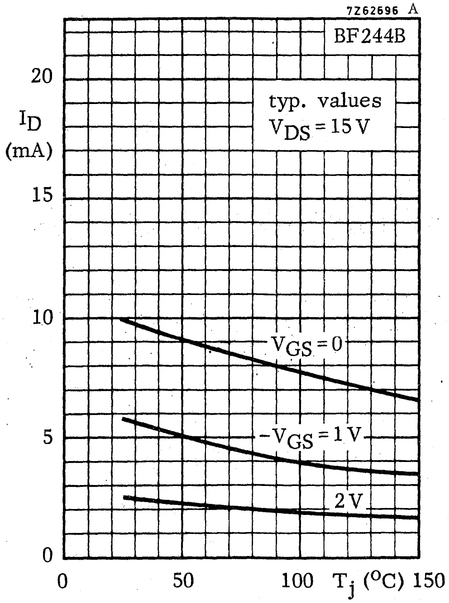
2) The frequency at which g_{fs} is 0,7 of its value at 1 kHz.

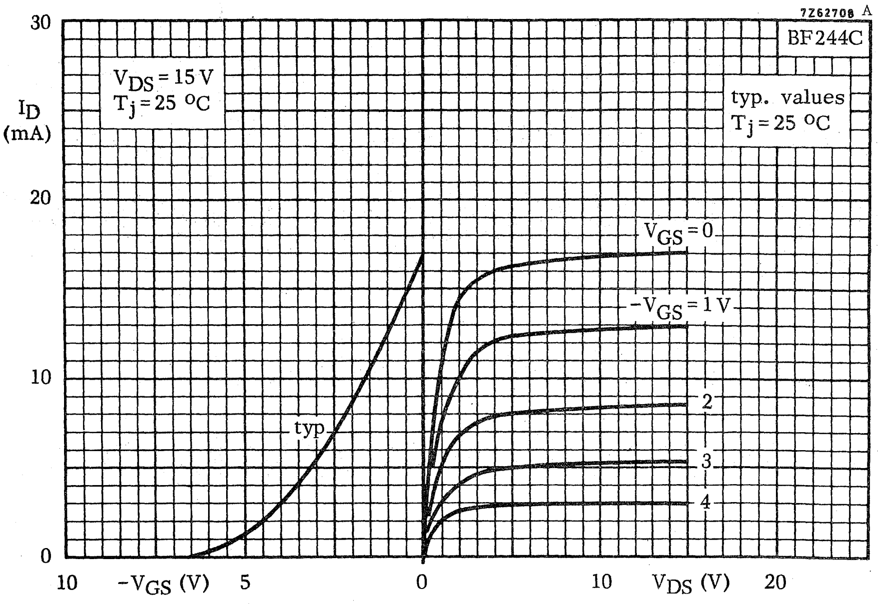

7Z62705
$-V_{GS} = 20\ V$
$V_{DS} = 0$
$-I_{GSS}$ (nA)
10
1
10^{-1}
10^{-2}
10^{-3}
typ
0
50
100
T_j (°C)
150

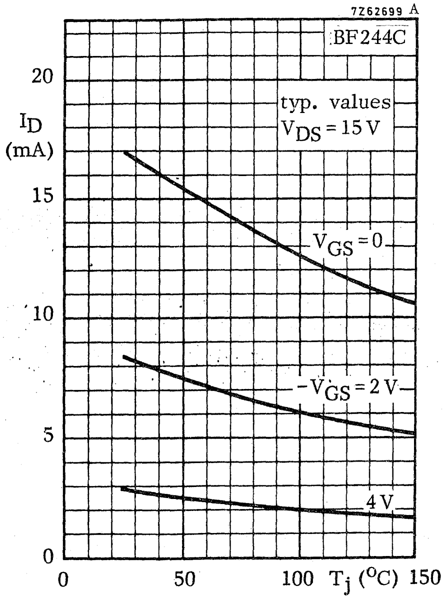

7Z62709 A
BF244A
V_{DS} = 15 V
T_j = 25 °C
typ. values
T_j = 25 °C
I_D (mA)
6
4
2
0
V_{GS} = 0
$-V_{GS}$ = 0,5 V
1
1,5
typ
4
$-V_{GS}$ (V)
2
0
10
V_{DS} (V)
20

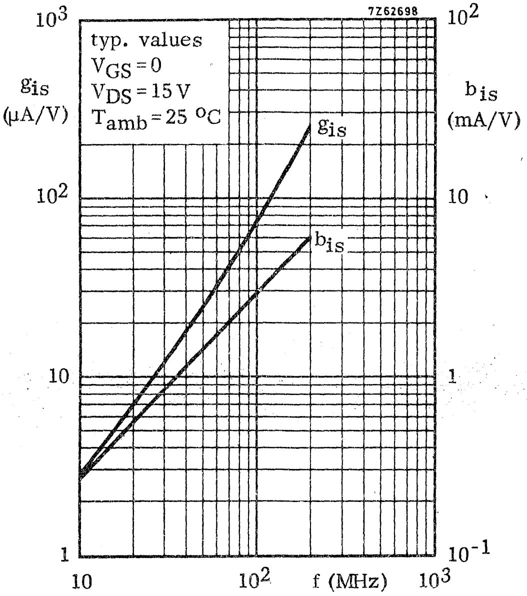

7Z62695 A
BF244A
typ. values
V_{DS} = 15 V
I_D (mA)
4
3
2
1
0
V_{GS} = 0
$-V_{GS}$ = 0,5 V
1 V
1,5 V
0
50
100
T_j (°C)
150

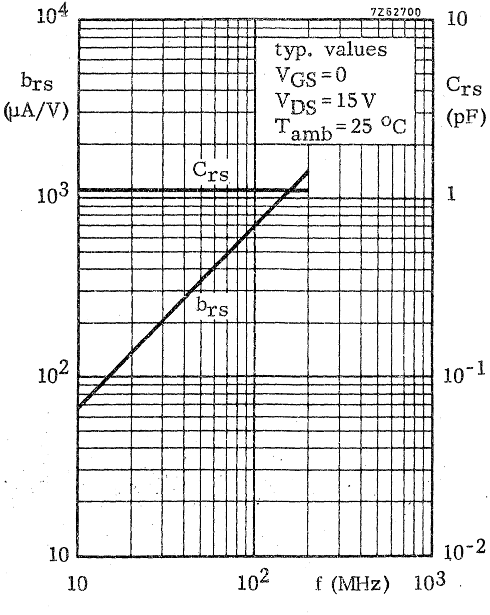

7Z62707 A
BF244B
15
10
5
0
I_D (mA)
V_{DS} = 15 V
T_j = 25 °C
typ. values
T_j = 25 °C
typ
V_{GS} = 0
$-V_{GS}$ = 0,5 V
1
1,5
2
2,5
4
$-V_{GS}$ (V)
2
0
10
V_{DS} (V)
20

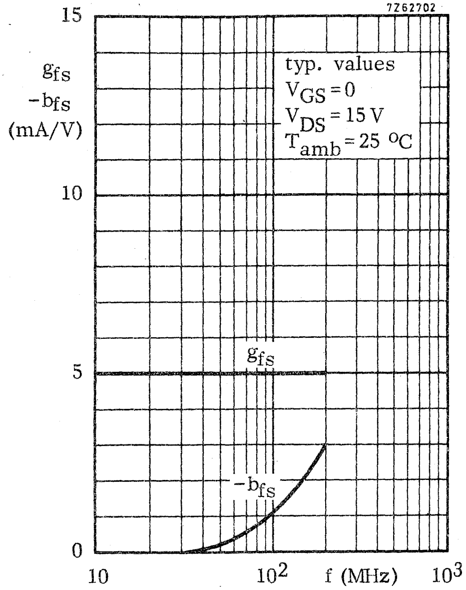

7Z62696 A
BF244B
typ. values
V_{DS} = 15 V
I_D (mA)
20
15
10
5
0
V_{GS} = 0
$-V_{GS}$ = 1 V
2 V
0
50
100
T_j (°C)
150

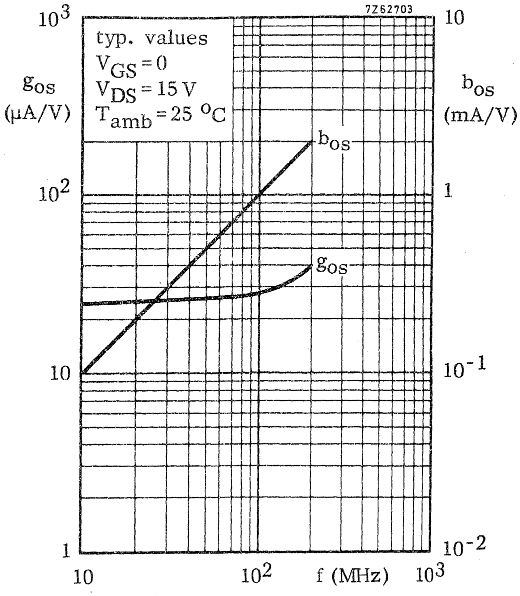

7Z62708 A
BF244C
V_{DS} = 15 V
T_j = 25 °C
typ. values
T_j = 25 °C
I_D (mA)
30
20
10
0
typ
V_{GS} = 0
$-V_{GS}$ = 1 V
2
3
4
10
$-V_{GS}$ (V)
5
0
10
V_{DS} (V)
20

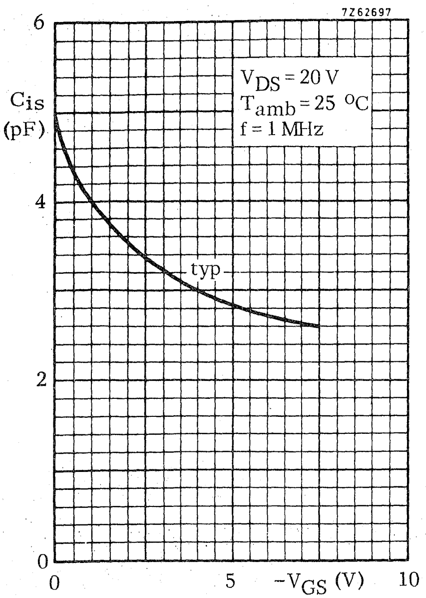

7Z62699 A
BF244C
typ. values
V_{DS} = 15 V
I_D (mA)
20
15
10
5
0
V_{GS} = 0
$-V_{GS}$ = 2 V
4 V
0
50
100
T_j (°C)
150

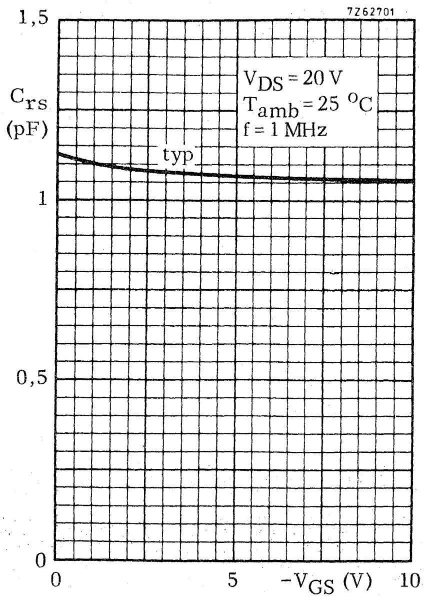

7Z62698
typ. values
$V_{GS} = 0$
$V_{DS} = 15$ V
$T_{amb} = 25$ °C
g_{is} (µA/V)
b_{is} (mA/V)
g_{is}
b_{is}
10^3
10^2
10
1
10^2
10
1
10^{-1}
10
10^2
f (MHz)
10^3

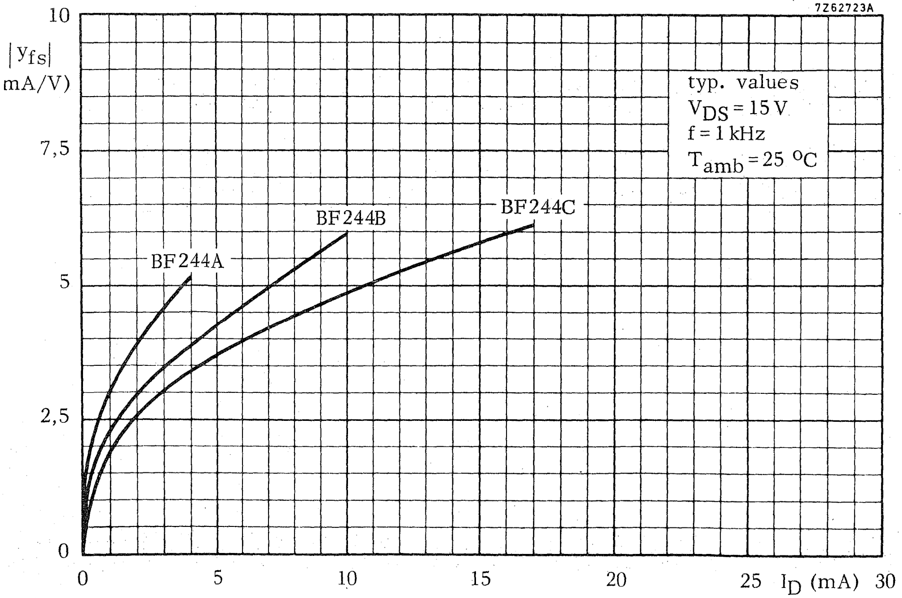

7Z62700
typ. values
$V_{GS} = 0$
$V_{DS} = 15$ V
$T_{amb} = 25$ °C
b_{rs} (µA/V)
C_{rs} (pF)
C_{rs}
b_{rs}
10^4
10^3
10^2
10
10
1
10^{-1}
10^{-2}
10
10^2
f (MHz)
10^3

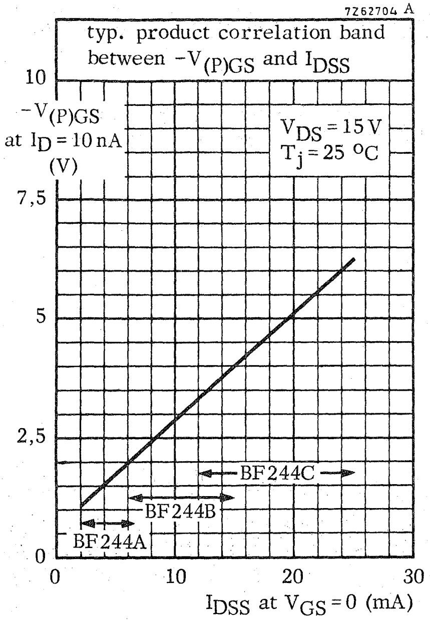

7Z62702
15
10
5
0
g_{fs}
$-b_{fs}$
(mA/V)
typ. values
$V_{GS} = 0$
$V_{DS} = 15$ V
$T_{amb} = 25$ °C
g_{fs}
$-b_{fs}$
10
10^2
f (MHz)
10^3

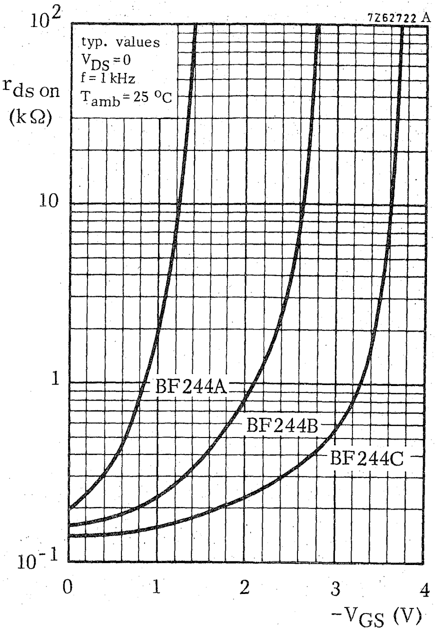

7Z62703
10^3
10^2
10
1
g_{os}
(μA/V)
10
1
10^{-1}
10^{-2}
b_{os}
(mA/V)
typ. values
$V_{GS} = 0$
$V_{DS} = 15$ V
$T_{amb} = 25$ °C
b_{os}
g_{os}
10
10^2
f (MHz)
10^3

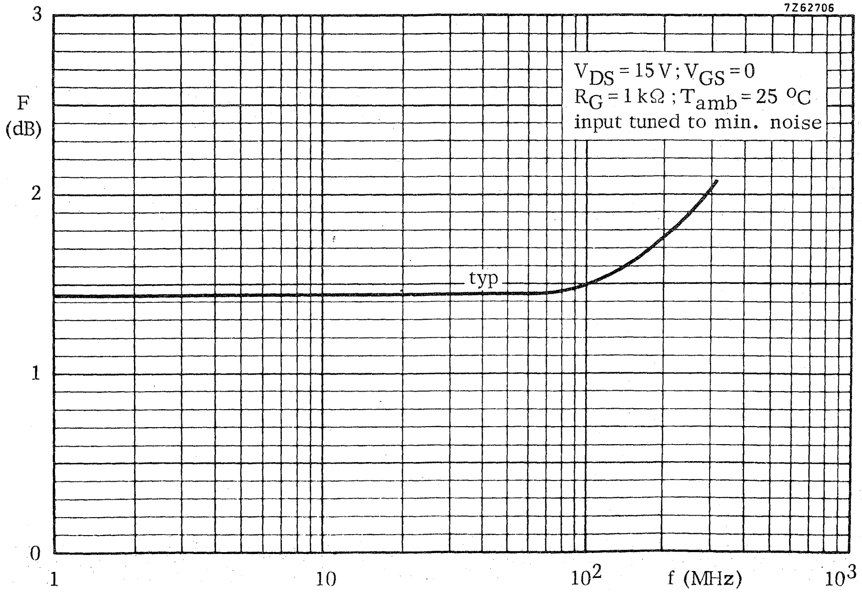

7Z62697
Cis
(pF)
6
4
2
0
V_{DS} = 20 V
T_{amb} = 25 °C
f = 1 MHz
typ
0
5
$-V_{GS}$ (V)
10


7Z62701
Crs
(pF)
1,5
1
0,5
0
V_{DS} = 20 V
T_{amb} = 25 °C
f = 1 MHz
typ
0
5
$-V_{GS}$ (V)
10


7Z62723A
|yfs|
mA/V)
10
7,5
5
2,5
0
typ. values
V_{DS} = 15 V
f = 1 kHz
T_{amb} = 25 °C
BF244A
BF244B
BF244C
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
typ. values
V_{DS} = 0
f = 1 kHz
T_{amb} = 25 °C
$r_{ds\ on}$ (kΩ)
10^2
10
1
10^{-1}
BF244A
BF244B
BF244C
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

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.

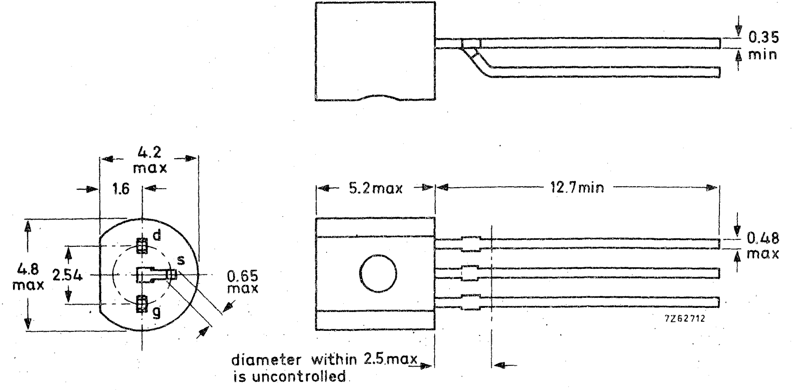
QUICK REFERENCE DATA

			BF245A	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 $T_{amb} = 75\ ^{o}C$	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 $V_{DS} = 20$ V; $-V_{GS} = 1$ V	C_{rs}	typ.			1,1	pF
Transfer admittance (common source) $V_{DS} = 15$ V; $V_{GS} = 0$	$\lvert y_{fs} \rvert$				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

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

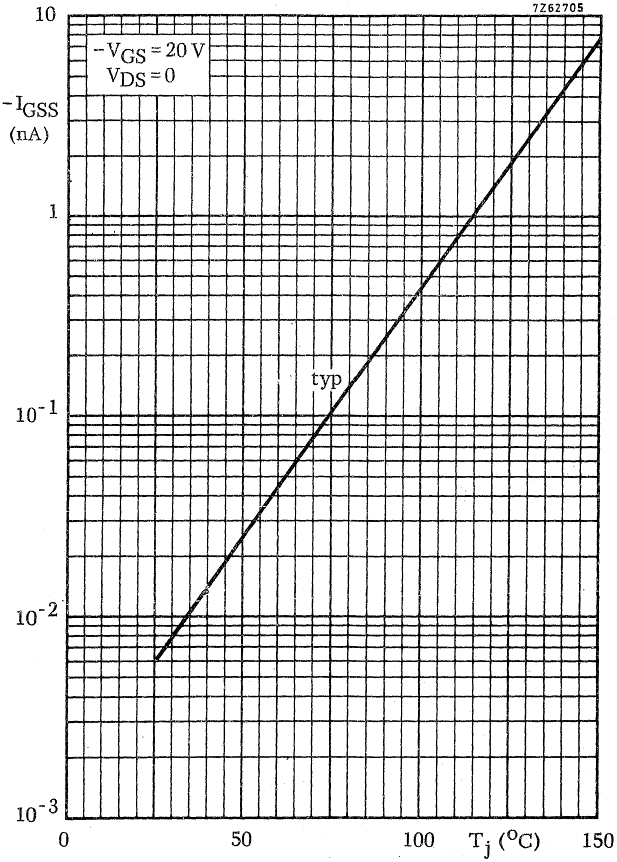
		BF245A	B	C	
Gate cut-off current					
$-V_{GS} = 20$ V; $V_{DS} = 0$	$-I_{GSS}$	< 5	5	5	nA
$-V_{GS} = 20$ V; $V_{DS} = 0$; $T_j = 125\ ^{\circ}C$	$-I_{GSS}$	< 0,5	0,5	0,5	μA
Drain current 1)					
$V_{DS} = 15$ V; $V_{GS} = 0$	I_{DSS}	> 2	6,0	12	mA
		< 6,5	15,0	25	mA
Gate-source breakdown voltage					
$-I_G = 1$ 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

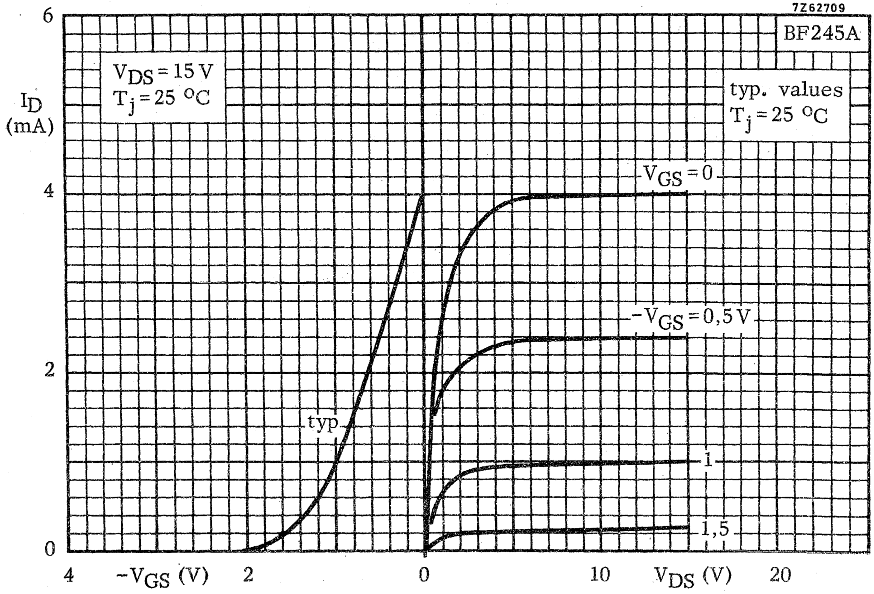
Gate-source cut-off voltage					
$I_D = 10$ nA; $V_{DS} = 15$ V		$-V_{(P)GS}$		0,5 to 8,0	V
y-parameters at $T_{amb} = 25\ ^{\circ}C$ (common source)					
$V_{DS} = 15$ V; $V_{GS} = 0$					
f = 1 kHz	Transfer admittance	$\|y_{fs}\|$		3,0 to 6,5	mA/V
	Output admittance	$\|y_{os}\|$	typ.	25	μA/V
f = 200 MHz	Input conductance	g_{is}	typ.	250	μA/V
	Reverse transfer admittance	$\|y_{rs}\|$	typ.	1,4	mA/V
	Transfer admittance	$\|y_{fs}\|$	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; $V_{GS} = 0$; $T_{amb} = 25\ ^{\circ}C$ input tuned to minimum noise		F	typ.	1,5	dB

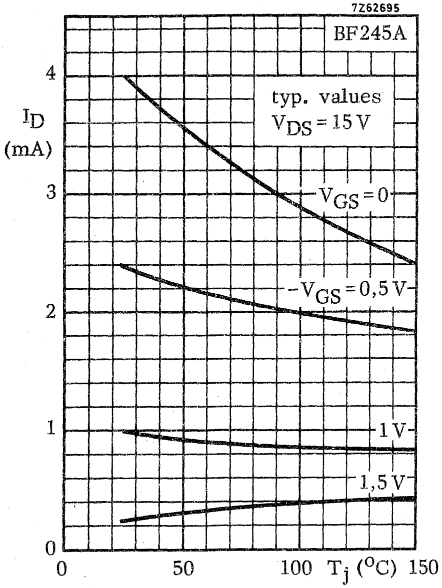
---

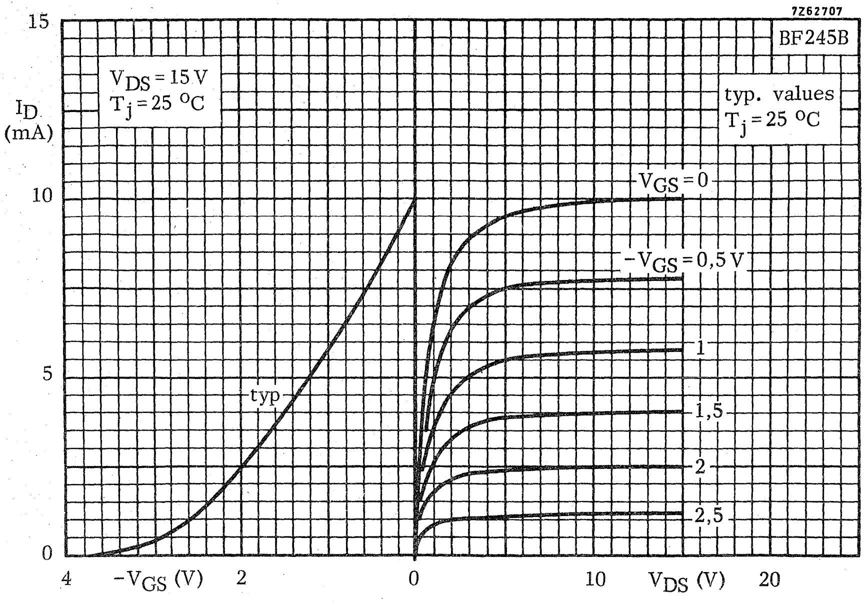
1) Measured under pulse condition: $t_p = 300$ μs; $\delta \leq 0,02$

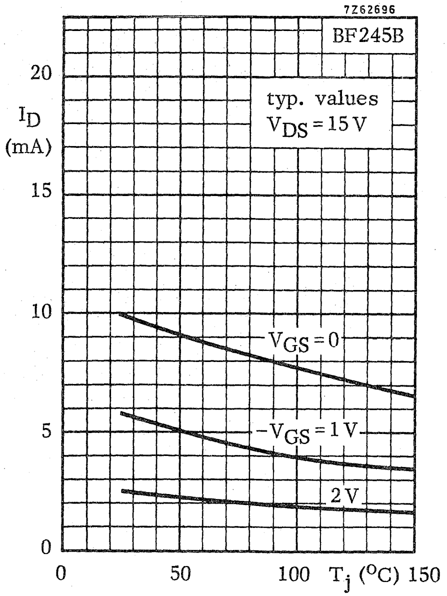
2) The frequency at which g_{fs} is 0,7 of its value at 1 kHz.

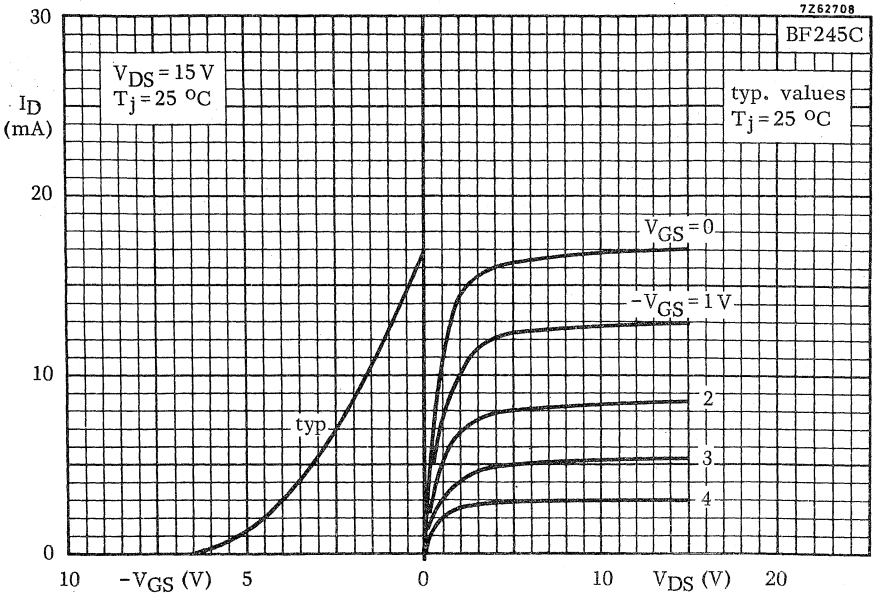

7Z62705
$-V_{GS} = 20$ V
$V_{DS} = 0$
$-I_{GSS}$ (nA)
10
1
10^{-1}
10^{-2}
10^{-3}
typ
0
50
100
T_j (°C)
150

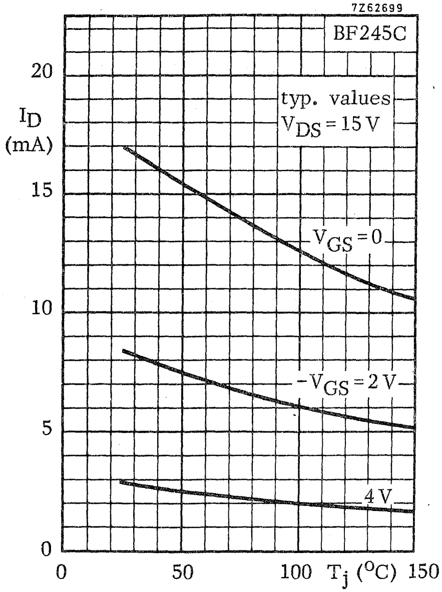

7Z62709
BF245A
V_{DS} = 15 V
T_j = 25 °C
I_D (mA)
typ. values
T_j = 25 °C
V_{GS} = 0
$-V_{GS}$ = 0,5 V
1
1,5
typ
6
4
2
0
4
$-V_{GS}$ (V)
2
0
10
V_{DS} (V)
20

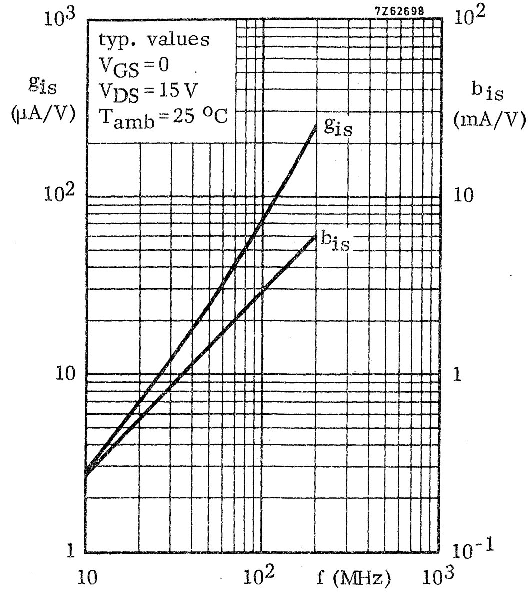

7Z62695
BF245A
typ. values
V_{DS} = 15 V
I_D (mA)
V_{GS} = 0
$-V_{GS}$ = 0,5 V
1 V
1,5 V
4
3
2
1
0
0
50
100
T_j (°C)
150

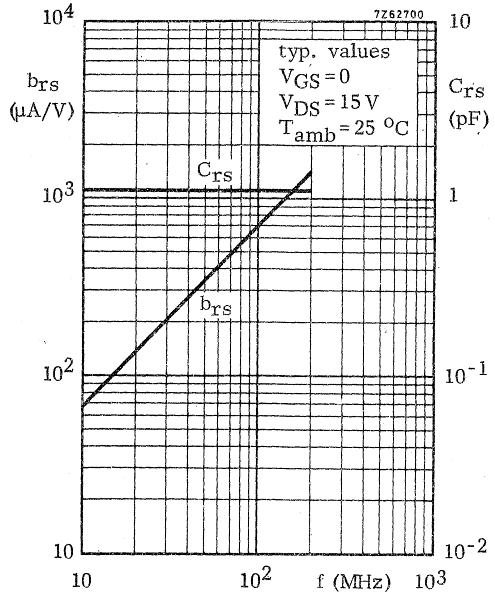

7Z62707
BF245B
V_{DS} = 15 V
T_j = 25 °C
I_D (mA)
typ. values
T_j = 25 °C
V_{GS} = 0
$-V_{GS}$ = 0,5 V
1
1,5
2
2,5
typ
15
10
5
0
4
$-V_{GS}$ (V)
2
0
10
V_{DS} (V)
20

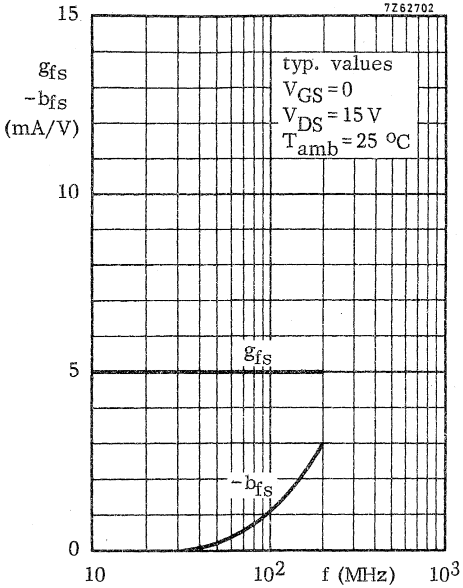

7Z62696
BF245B
typ. values
V_{DS} = 15 V
I_D (mA)
20
15
10
5
0
V_{GS} = 0
$-V_{GS}$ = 1 V
2 V
0
50
100
T_j (°C)
150

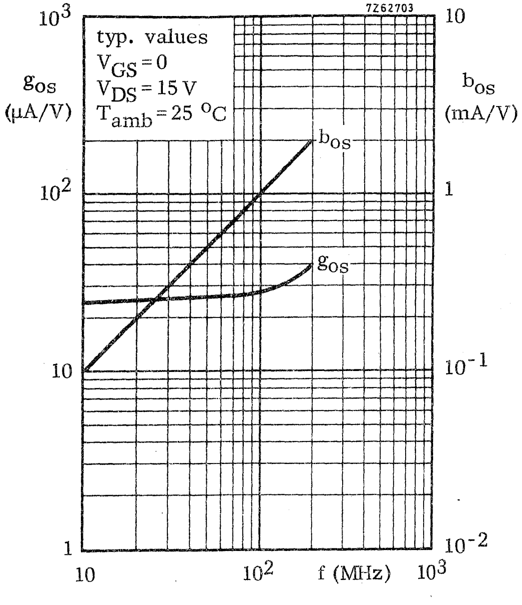

7Z62708
BF245C
$V_{DS} = 15$ V
$T_j = 25$ °C
I_D (mA)
typ. values
$T_j = 25$ °C
30
20
10
0
$V_{GS} = 0$
$-V_{GS} = 1$ V
2
3
4
typ
10
$-V_{GS}$ (V)
5
0
10
V_{DS} (V)
20

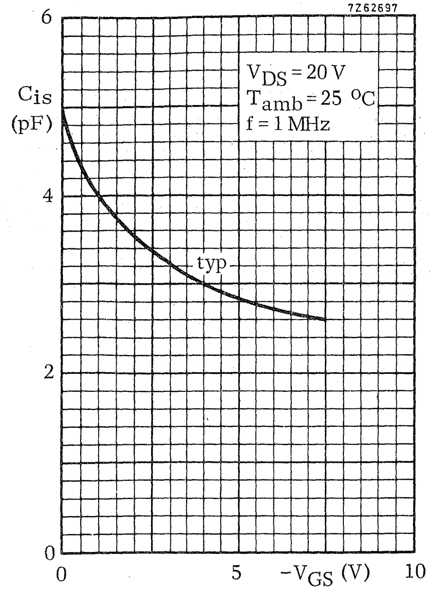

7Z62699
BF245C
typ. values
$V_{DS} = 15$ V
I_D (mA)
20
15
10
5
0
$V_{GS} = 0$
$-V_{GS} = 2$ V
4 V
0
50
100
T_j (°C)
150

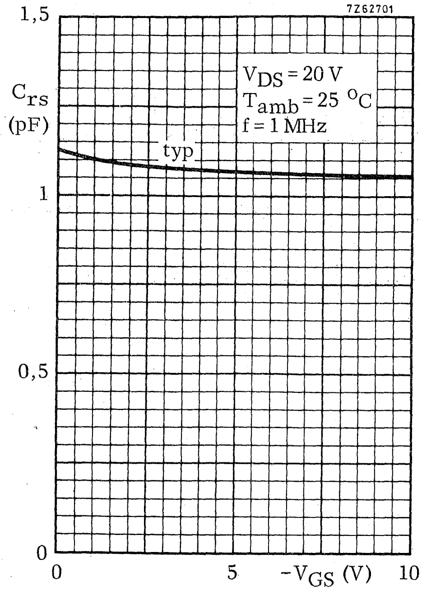

7Z62698
typ. values
$V_{GS} = 0$
$V_{DS} = 15$ V
$T_{amb} = 25$ °C
g_{is} (μA/V)
b_{is} (mA/V)
g_{is}
b_{is}
10^3
10^2
10
1
10^2
10
1
10^{-1}
10
10^2
f (MHz)
10^3

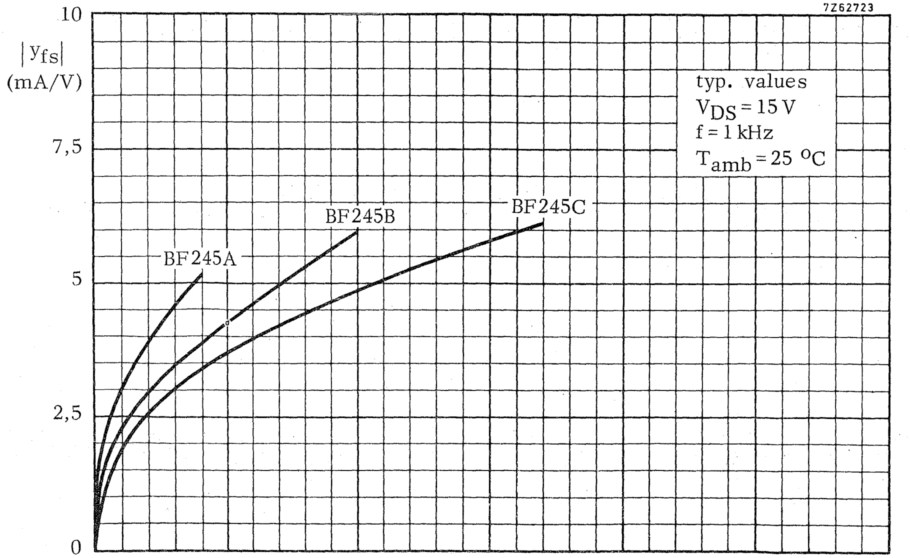

7Z62700
typ. values
$V_{GS} = 0$
$V_{DS} = 15$ V
$T_{amb} = 25$ °C
b_{rs} (μA/V)
C_{rs} (pF)
C_{rs}
b_{rs}
10^4
10^3
10^2
10
10
1
10^{-1}
10^{-2}
10
10^2
f (MHz)
10^3

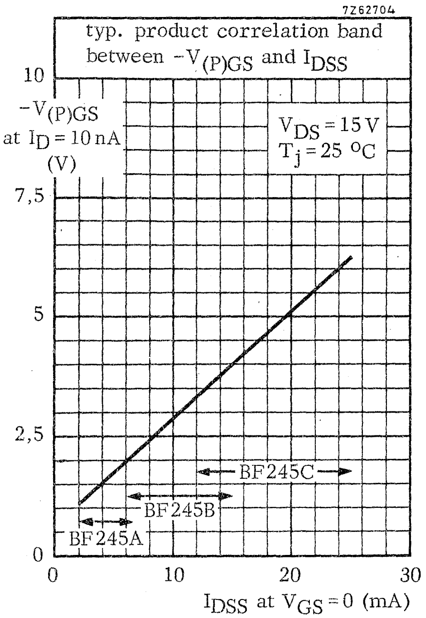

7Z62702
15
g_{fs}
$-b_{fs}$
(mA/V)
10
5
0
typ. values
$V_{GS} = 0$
$V_{DS} = 15$ V
$T_{amb} = 25$ °C
g_{fs}
$-b_{fs}$
10
10^2
f (MHz)
10^3

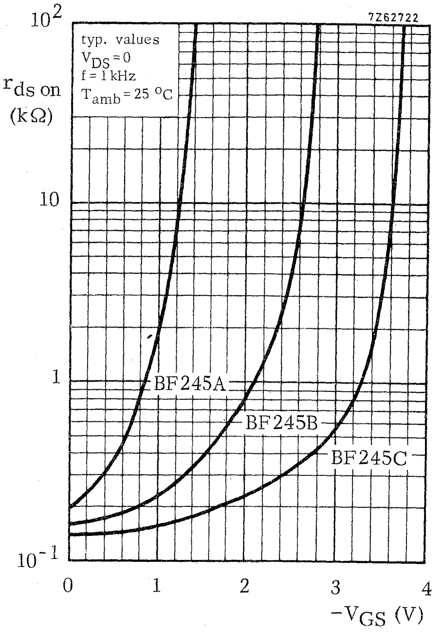

7Z62703
10^3
g_{os}
(μA/V)
10^2
10
1
10
b_{os}
(mA/V)
1
10^{-1}
10^{-2}
typ. values
$V_{GS} = 0$
$V_{DS} = 15$ V
$T_{amb} = 25$ °C
b_{os}
g_{os}
10
10^2
f (MHz)
10^3

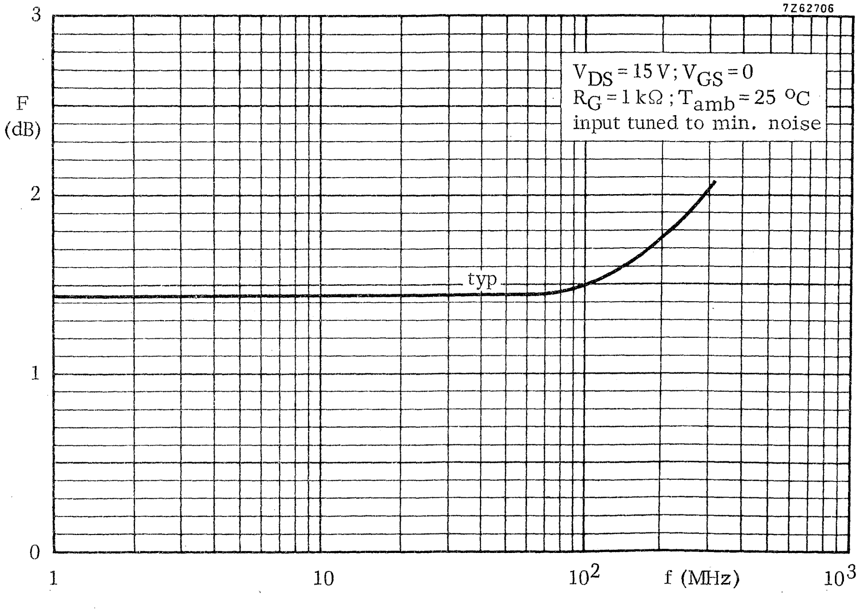

7Z62697
6
4
2
0
Cis
(pF)
VDS = 20 V
Tamb = 25 °C
f = 1 MHz
typ
0
5
−VGS (V)
10


7Z62701
1,5
1
0,5
0
Crs
(pF)
VDS = 20 V
Tamb = 25 °C
f = 1 MHz
typ
0
5
−VGS (V)
10


7Z62723
10
7,5
5
2,5
0
|yfs|
(mA/V)
typ. values
VDS = 15 V
f = 1 kHz
Tamb = 25 °C
BF245A
BF245B
BF245C
0
5
10
15
20
25
ID (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
$r_{ds\ on}$ (kΩ)
typ. values
$V_{DS} = 0$
f = 1 kHz
$T_{amb} = 25$ °C
10^2
10
1
10^{-1}
BF245A
BF245B
BF245C
0
1
2
3
4
$-V_{GS}$ (V)


7Z62706
F (dB)
$V_{DS} = 15$ V; $V_{GS} = 0$
$R_G = 1$ kΩ; $T_{amb} = 25$ °C
input tuned to min. noise
3
2
1
0
typ
1
10
10^2
f (MHz)
10^3

N-CHANNEL SILICON FIELD-EFFECT TRANSISTORS

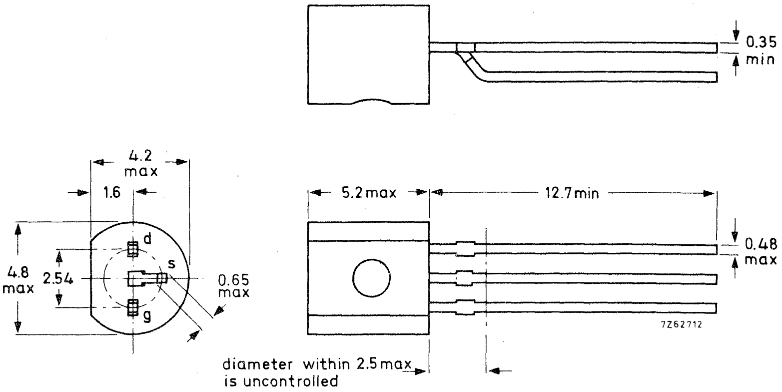
Symmetrical N-channel planar epitaxial junction field-effect transistors in a plastic TO-92 variant; intended for v.h.f. and u.h.f. applications.

QUICK REFERENCE DATA

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
			BF256A	B	C	
Drain current V_{DS} = 15 V; V_{GS} = 0	I_{DSS}	>	3	6	11	mA
		<	7	13	18	mA
Feedback capacitance at f = 1 MHz V_{DS} = 20 V; $-V_{GS}$ = 1 V; T_{amb} = 25 °C	C_{rs}	typ.	0,7			pF
Transfer admittance (common source) V_{DS} = 15 V; V_{GS} = 0; f = 1 kHz; T_{amb} = 25 °C	$\lvert y_{fs} \rvert$	>	4,5			mA/V
Power gain at f = 800 MHz V_{DS} = 15 V; R_S = 47 Ω	G_p	typ.	11			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} = 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_{amb} = 25 °C unless otherwise specified

Gate cut-off current

$-V_{GS}$ = 20 V; V_{DS} = 0	$-I_{GSS}$	<	5	nA	

Drain current

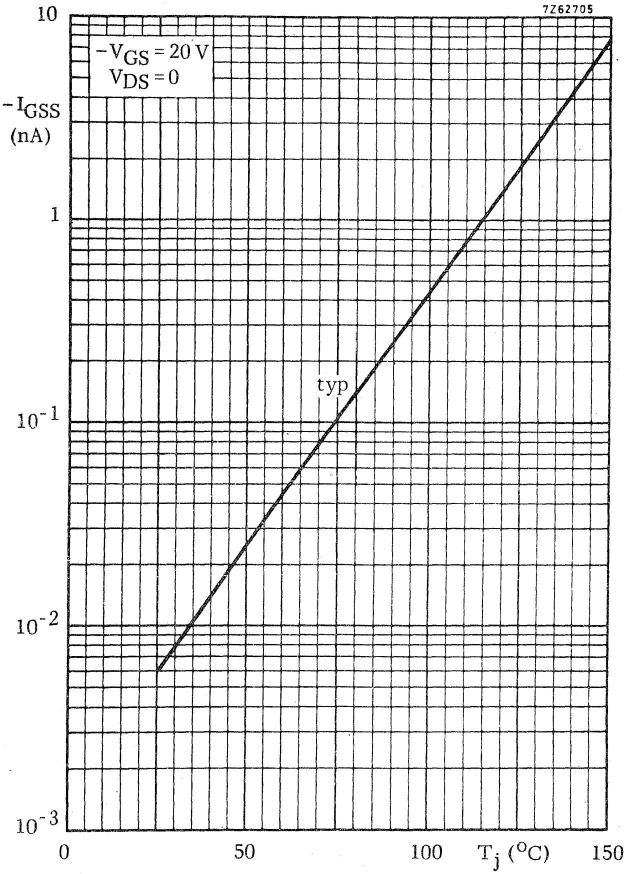
			BF256A	B	C		
V_{DS} = 15 V; V_{GS} = 0	I_{DSS}	>	3	6	11	mA	1)
		<	7	13	18	mA	1)

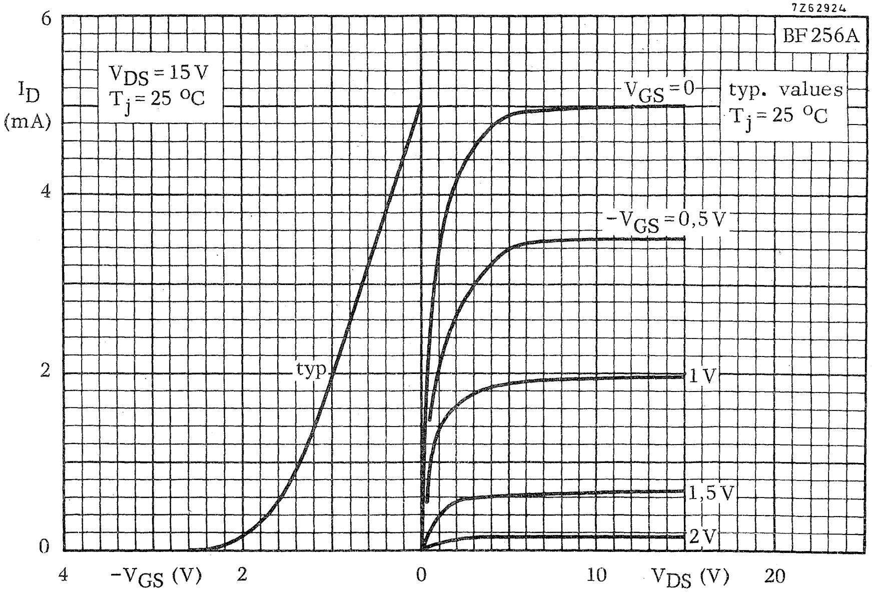
Gate-source breakdown voltage					
$-I_G$ = 1 μA; V_{DS} = 0	$-V_{(BR)GSS}$	>	30	V	
Gate-source voltage					
I_D = 200 μA; V_{DS} = 15 V	$-V_{GS}$		0,5 to 7,5	V	
y-parameters (common source)					
Transfer admittance at f = 1 kHz V_{DS} = 15 V; V_{GS} = 0	$\lvert y_{fs} \rvert$	> typ.	4,5 5	mA/V mA/V	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	

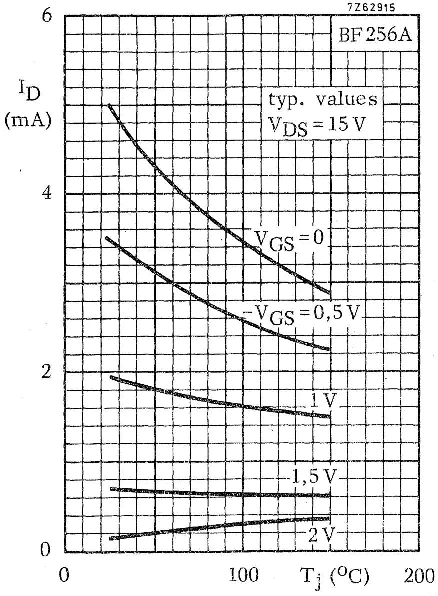
---

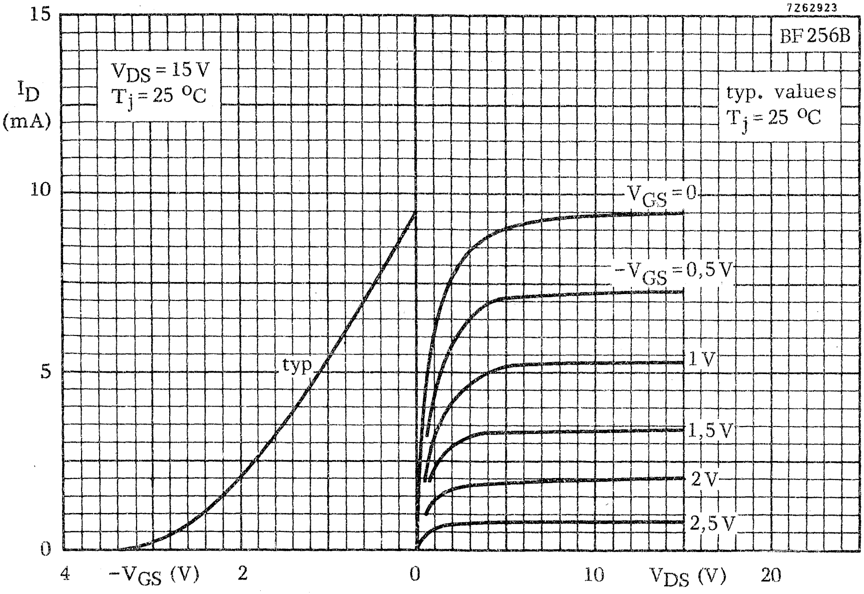
1) Measured under pulse conditions: t_p = 300 μs; $\delta \leq 0{,}02$

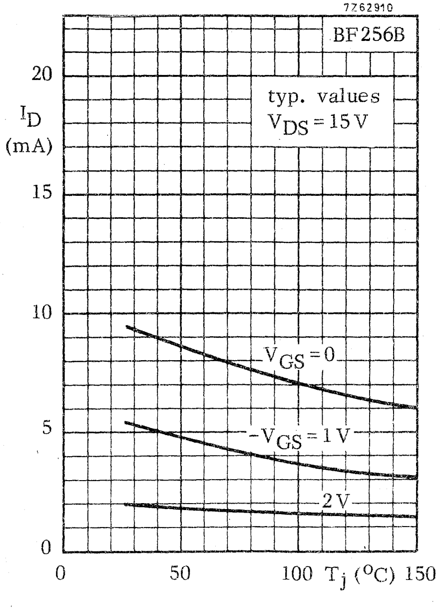
2) The frequency at which g_{fs} is 0,7 of its value at 1 kHz.

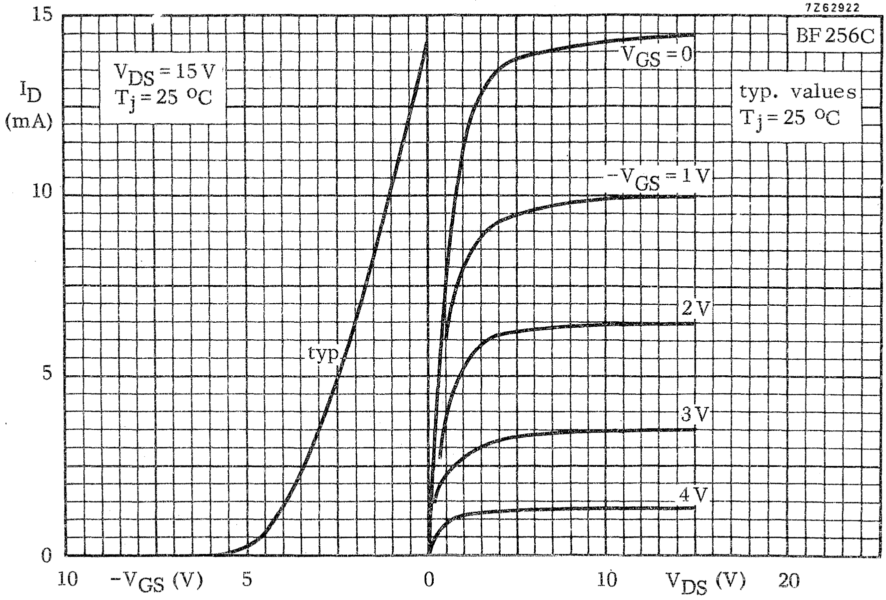

7Z62705
$-V_{GS} = 20$ V
$V_{DS} = 0$
$-I_{GSS}$ (nA)
10
1
10^{-1}
10^{-2}
10^{-3}
typ
0
50
100
T_j (°C)
150

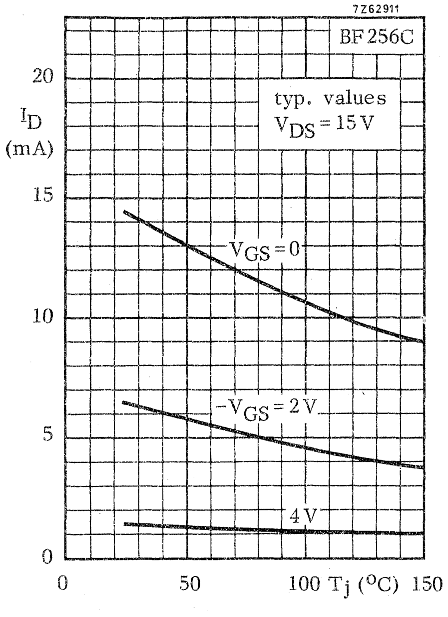

7Z62924
BF256A
I_D (mA)
$V_{DS} = 15$ V
$T_j = 25$ °C
typ. values
$T_j = 25$ °C
$V_{GS} = 0$
$-V_{GS} = 0{,}5$ V
1 V
1,5 V
2 V
typ
6
4
2
0
4
$-V_{GS}$ (V)
2
0
10
V_{DS} (V)
20

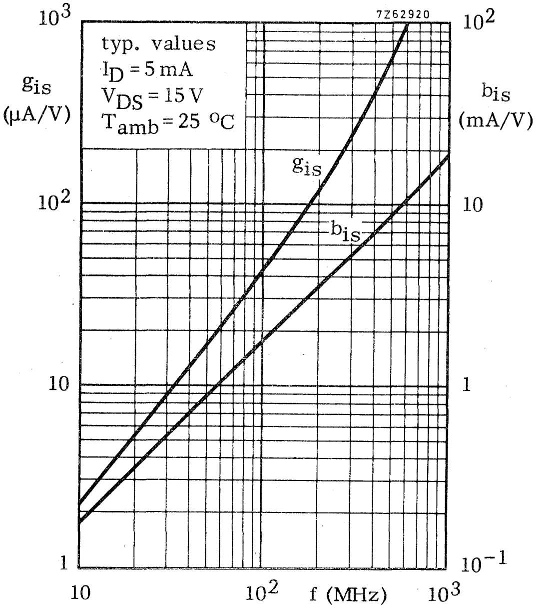

7Z62915
BF256A
I_D (mA)
typ. values
$V_{DS} = 15$ V
$V_{GS} = 0$
$-V_{GS} = 0{,}5$ V
1 V
1,5 V
2 V
6
4
2
0
0
100
T_j (°C)
200

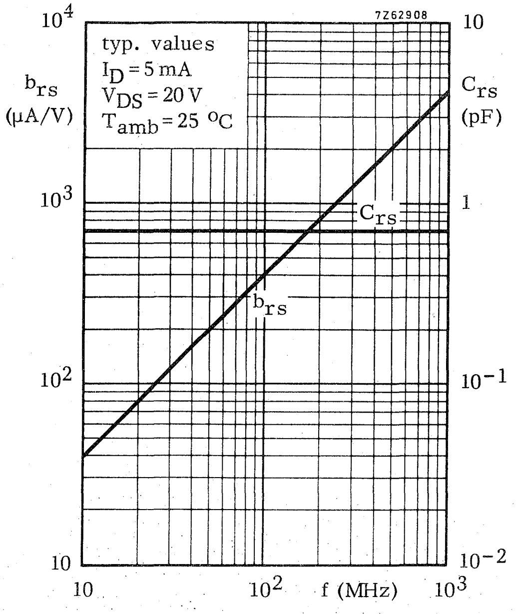

7Z62923
BF256B
V_{DS} = 15 V
T_j = 25 °C
I_D (mA)
typ. values
T_j = 25 °C
15
10
5
0
typ
V_{GS} = 0
$-V_{GS}$ = 0,5 V
1 V
1,5 V
2 V
2,5 V
4
$-V_{GS}$ (V)
2
0
10
V_{DS} (V)
20

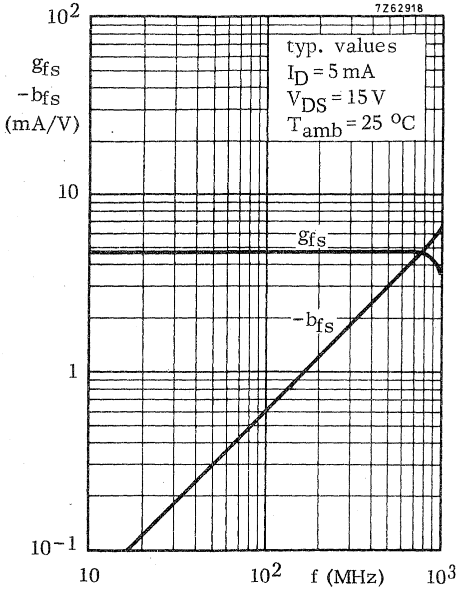

7Z62910
BF256B
I_D (mA)
typ. values
V_{DS} = 15 V
20
15
10
5
0
V_{GS} = 0
$-V_{GS}$ = 1 V
2 V
0
50
100
T_j (°C)
150

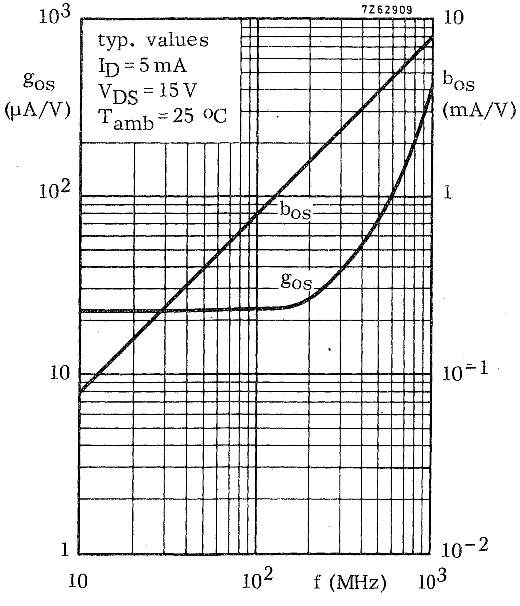

7Z62922
BF256C
15
10
5
0
I_D (mA)
$V_{DS} = 15$ V
$T_j = 25$ °C
typ
$V_{GS} = 0$
$-V_{GS} = 1$ V
2 V
3 V
4 V
typ. values
$T_j = 25$ °C
10
$-V_{GS}$ (V)
5
0
10
V_{DS} (V)
20

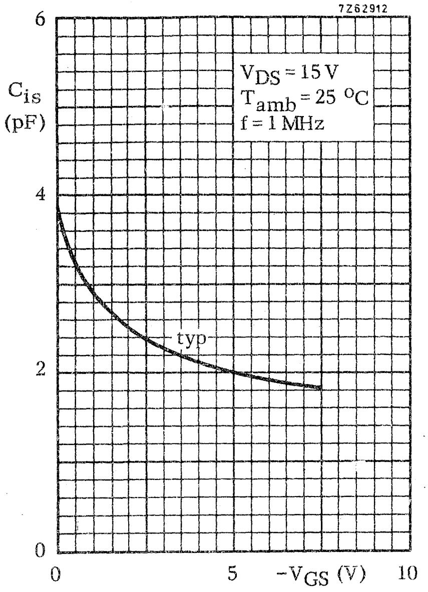

7Z62911
BF256C
20
15
10
5
0
I_D (mA)
typ. values
$V_{DS} = 15$ V
$V_{GS} = 0$
$-V_{GS} = 2$ V
4 V
0
50
100
T_j (°C)
150

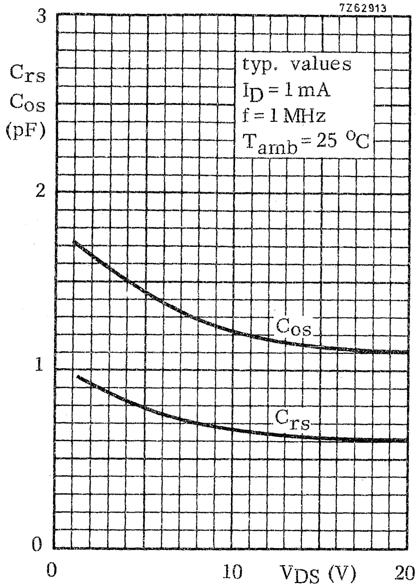

7Z62920
typ. values
I_D = 5 mA
V_{DS} = 15 V
T_{amb} = 25 °C
g_{is}
(μA/V)
10^3
10^2
10
1
b_{is}
(mA/V)
10^2
10
1
10^{-1}
g_{is}
b_{is}
10
10^2
f (MHz)
10^3

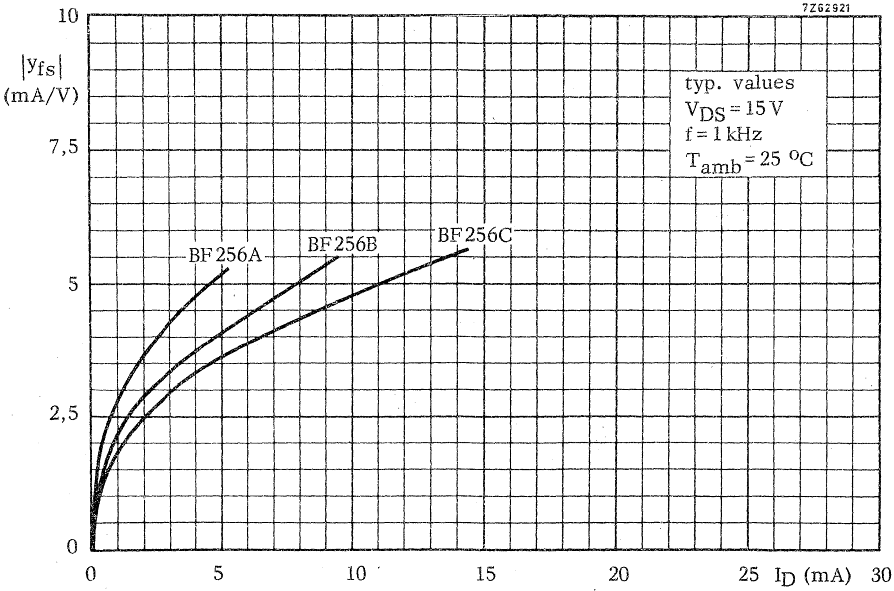

7Z62908
typ. values
I_D = 5 mA
V_{DS} = 20 V
T_{amb} = 25 °C
b_{rs}
(μA/V)
10^4
10^3
10^2
10
C_{rs}
(pF)
10
1
10^{-1}
10^{-2}
C_{rs}
b_{rs}
10
10^2
f (MHz)
10^3

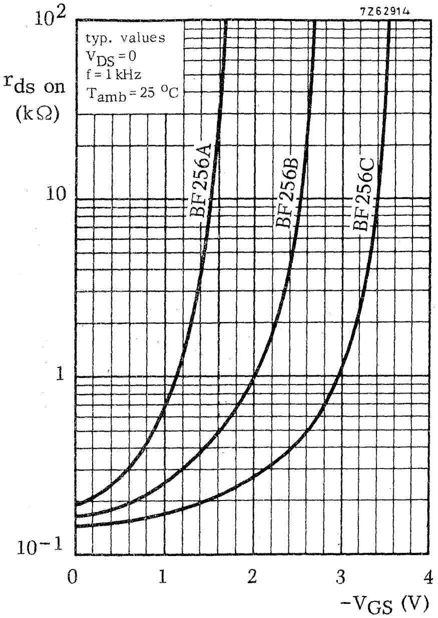

7Z62918
10^2
g_{fs}
$-b_{fs}$
(mA/V)
typ. values
$I_D = 5$ mA
$V_{DS} = 15$ V
$T_{amb} = 25$ °C
10
g_{fs}
$-b_{fs}$
1
10^{-1}
10
10^2
f (MHz)
10^3

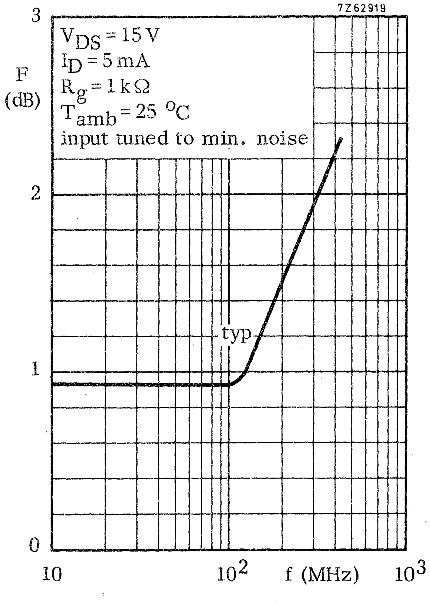

7Z62909
10^3
g_{os}
(μA/V)
typ. values
$I_D = 5$ mA
$V_{DS} = 15$ V
$T_{amb} = 25$ °C
10
b_{os}
(mA/V)
10^2
1
b_{os}
g_{os}
10
10^{-1}
1
10^{-2}
10
10^2
f (MHz)
10^3

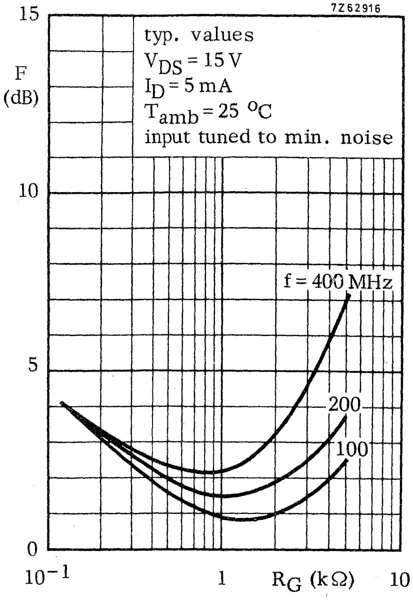

7Z62912
C_{is}
(pF)
6
4
2
0
V_{DS} = 15 V
T_{amb} = 25 °C
f = 1 MHz
typ
0
5
$-V_{GS}$ (V)
10


7Z62913
C_{rs}
C_{os}
(pF)
3
2
1
0
typ. values
I_D = 1 mA
f = 1 MHz
T_{amb} = 25 °C
C_{os}
C_{rs}
0
10
V_{DS} (V)
20


7Z62921
$|y_{fs}|$
(mA/V)
10
7,5
5
2,5
0
typ. values
V_{DS} = 15 V
f = 1 kHz
T_{amb} = 25 °C
BF256A
BF256B
BF256C
0
5
10
15
20
25
I_D (mA)
30


7Z62914
typ. values
$V_{DS} = 0$
f = 1 kHz
$T_{amb} = 25\ ^{o}C$
$r_{ds\ on}$ (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
$T_{amb} = 25\ ^{o}C$
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
$T_{amb} = 25\ ^{o}C$
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

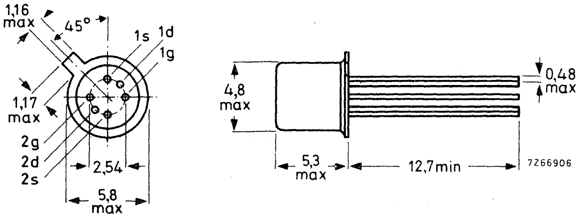
Characteristics measured at T_{amb} = 25 °C; I_D = 200 µA; V_{DG} = 15 V

			BFQ10	11	12	13	14	15	16	
Difference in gate current	$\|\Delta I_G\|$	<	10	10	10	10	10	10	10	pA
Gate-source voltage difference	$\|\Delta V_{GS}\|$	<	5	10	10	10	15	20	50	mV
Thermal drift of gate-source voltage difference	$\left\|\frac{d\,\Delta V_{GS}}{dT}\right\|$	<	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	$\left\|\Delta \frac{1}{g_{fs}}\right\|$	<	6	6	12	12	12	20	30	Ω
Difference in penetration factor	$\left\|\Delta \frac{g_{os}}{g_{fs}}\right\|$	<	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	μV/°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	μV/V
Common mode rejection ratio[4]	CMRR	>	100	90	90	90	90	90	80	dB

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[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

$$\text{CMRR (in dB)} = -20 \log \left\lvert \Delta \frac{g_{os}}{g_{fs}} \right\rvert$$

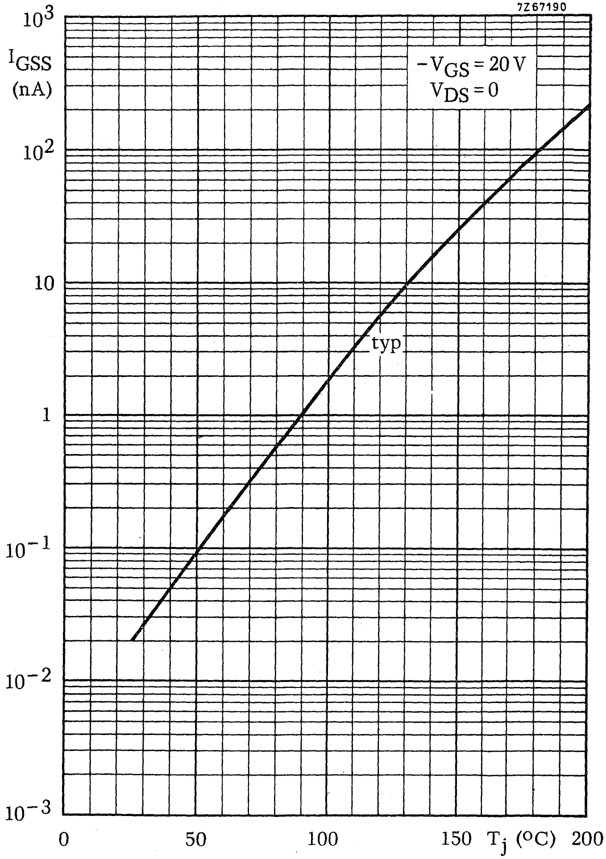
CHARACTERISTICS (Individual transistor) T_{amb} = 25 °C unless otherwise specified

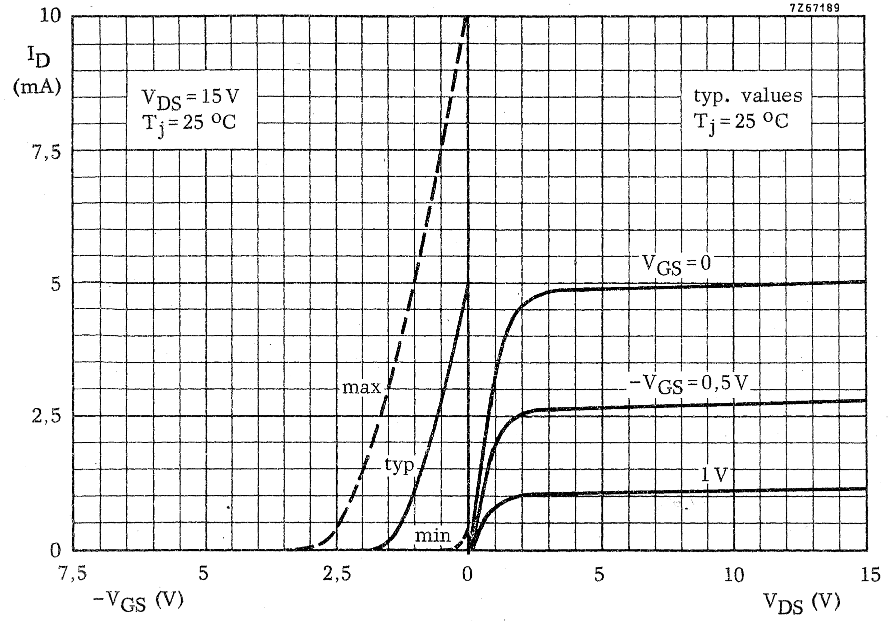
Gate cut-off current				
$-V_{GS}$ = 20 V; V_{DS} = 0	$-I_{GSS}$	<	100	pA
$-V_{GS}$ = 20 V; V_{DS} = 0; T_{amb} = 125 °C	$-I_{GSS}$	<	20	nA
Gate current				
I_D = 200 µA; V_{DG} = 15 V; T_{amb} = 125 °C	I_G	<	10	nA
Drain current				
V_{DS} = 15 V; V_{GS} = 0	I_{DSS}		0,5 to 10	mA 1)
Gate-source voltage				
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

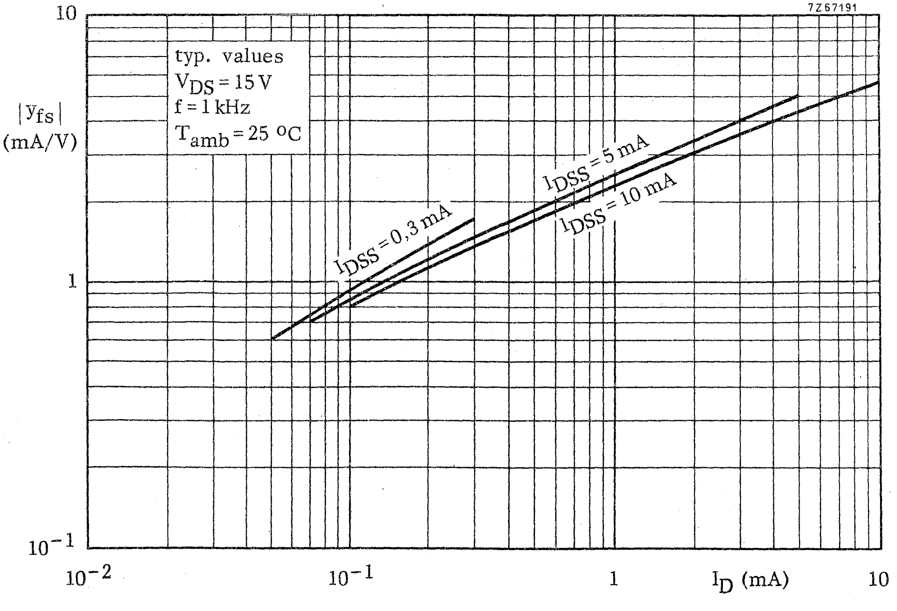
---

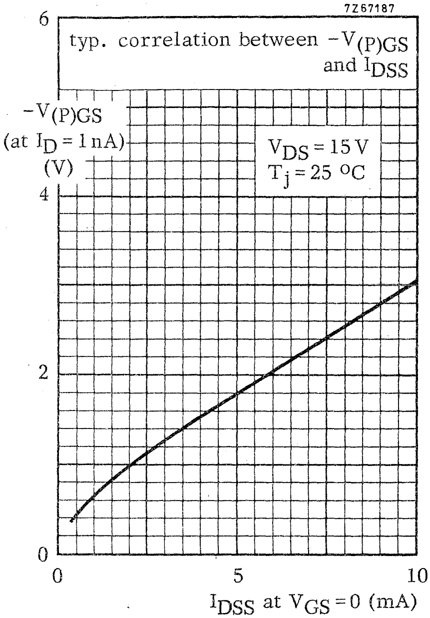
1) Measured under pulse conditions.

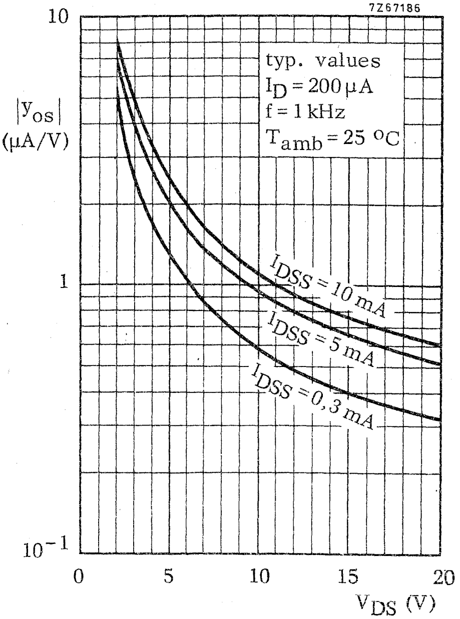
2) Measured with case grounded.

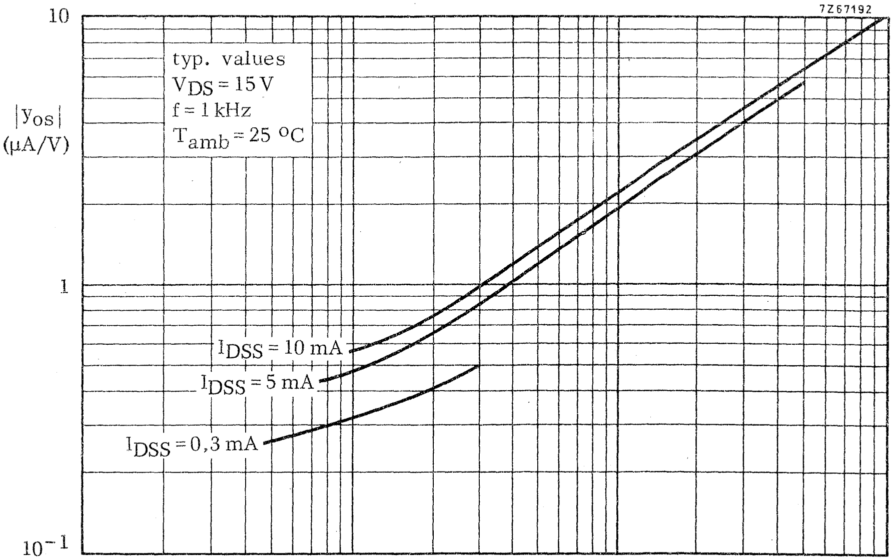

7Z67190
I_{GSS} (nA)
10^3
10^2
10
1
10^{-1}
10^{-2}
10^{-3}
$-V_{GS} = 20$ V
$V_{DS} = 0$
typ
0
50
100
150
T_j (°C)
200

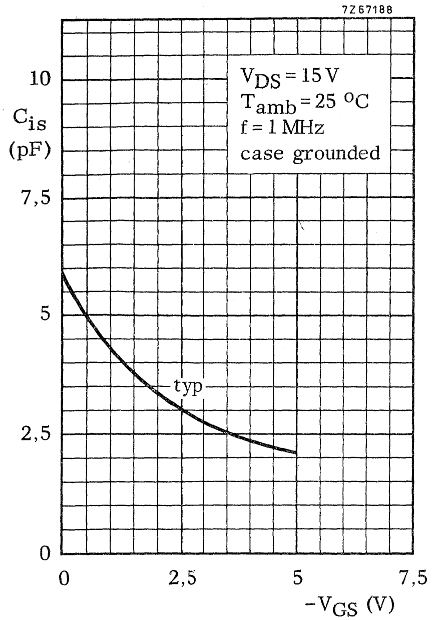

7Z67189
10
I_D
(mA)
7,5
5
2,5
0
$V_{DS} = 15$ V
$T_j = 25$ °C
typ. values
$T_j = 25$ °C
$V_{GS} = 0$
$-V_{GS} = 0,5$ V
1 V
max
typ
min
7,5
5
2,5
0
5
10
15
$-V_{GS}$ (V)
V_{DS} (V)

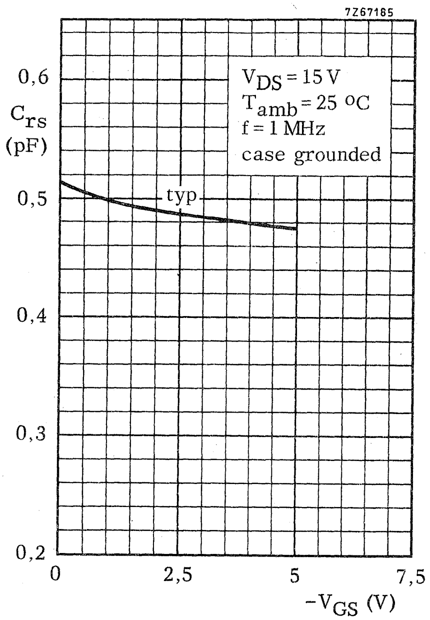

7Z67191
10
1
10^{-1}
$|y_{fs}|$
(mA/V)
typ. values
$V_{DS} = 15$ V
f = 1 kHz
$T_{amb} = 25$ °C
$I_{DSS} = 0,3$ mA
$I_{DSS} = 5$ mA
$I_{DSS} = 10$ mA
10^{-2}
10^{-1}
1
I_D (mA)
10

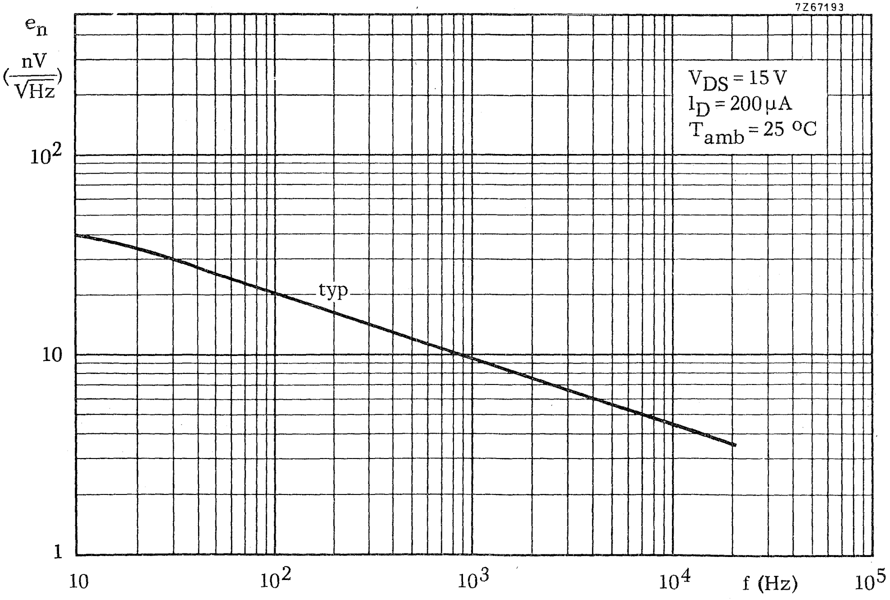

7Z67187
typ. correlation between $-V_{(P)GS}$ and I_{DSS}
$-V_{(P)GS}$ (at $I_D = 1$ nA) (V)
$V_{DS} = 15$ V
$T_j = 25$ °C
6
4
2
0
0
5
10
I_{DSS} at $V_{GS} = 0$ (mA)


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
C_{is} (pF)
10
7,5
5
2,5
0
0
2,5
5
7,5
$-V_{GS}$ (V)
$V_{DS} = 15$ V
$T_{amb} = 25$ °C
f = 1 MHz
case grounded
typ


7Z67185
C_{rs} (pF)
0,6
0,5
0,4
0,3
0,2
0
2,5
5
7,5
$-V_{GS}$ (V)
$V_{DS} = 15$ V
$T_{amb} = 25$ °C
f = 1 MHz
case grounded
typ


7Z67193
e_n $(\frac{nV}{\sqrt{Hz}})$
10^2
10
1
10
10^2
10^3
10^4
f (Hz)
10^5
$V_{DS} = 15$ V
$I_D = 200$ µA
$T_{amb} = 25$ °C
typ

N-CHANNEL INSULATED GATE FIELD EFFECT TRANSISTOR

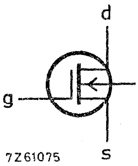
Depletion type insulated gate field effect transistor in a TO-72 metal envelope with the substrate connected to the case.
It is intended for linear applications in the audio as well as the i.f. and v.h.f. frequency region, and in cases where high input impedance, low gate leakage currents and low noise figures are of importance.

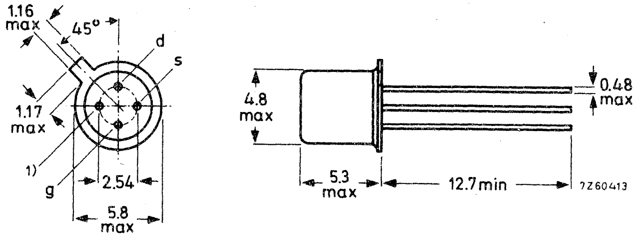
QUICK REFERENCE DATA				
Drain-substrate voltage	V_{DB}	max.	30	V
Gate-substrate voltage	V_{GB}	max. min.	10 −10	V V
Drain current V_{DS} = 15 V; V_{GS} = 0	I_{DSS}	10 to	40	mA
Transfer admittance I_D = 5 mA; V_{DS} = 15 V; f = 1 kHz	$\|y_{fs}\|$	>	6	mA/V
Feedback capacitance I_D = 5 mA; V_{DS} = 15 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 $G_S = 1\ m\Omega^{-1}$; $B_S = B_{Sopt}$	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	$nV/\sqrt{Hz}$

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)

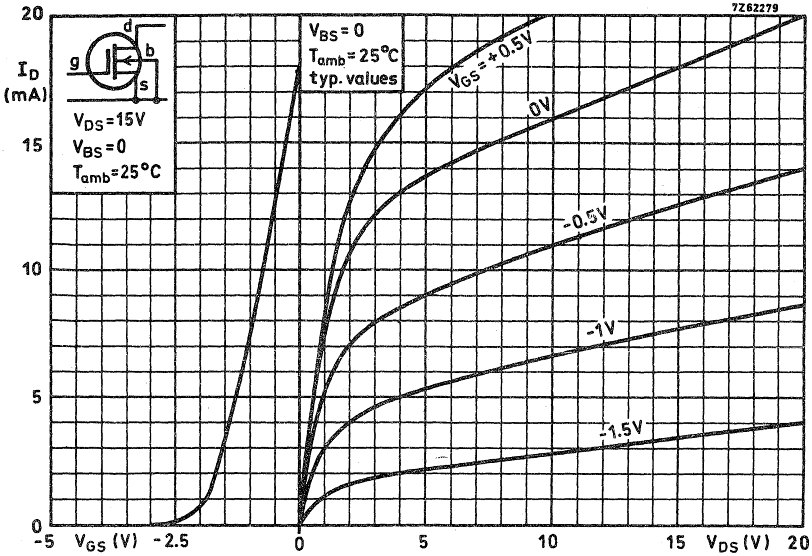
Voltages				
Drain-substrate voltage	V_{DB}	max.	30	V
Source-substrate voltage	V_{SB}	max.	30	V
Gate-substrate voltage (continuous)	V_{GB}	max. min.	10 −10	V V
Repetitive peak gate to all other terminals voltage $V_{SB} = V_{DB} = 0$; $f > 100$ Hz	$V_{G\text{-}N}$	max. min.	15 −15	V V
Currents				
Drain 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 $T_{amb} = 25\,^{\circ}C$	P_{tot}	max.	200	mW
Temperatures				
Storage temperature	T_{stg}	−65 to +125		°C
Junction temperature	T_j	max.	125	°C

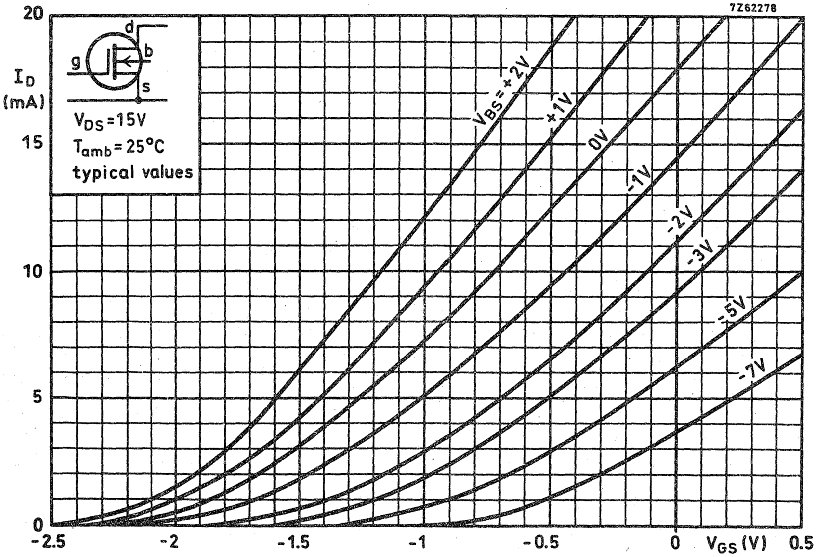
THERMAL RESISTANCE

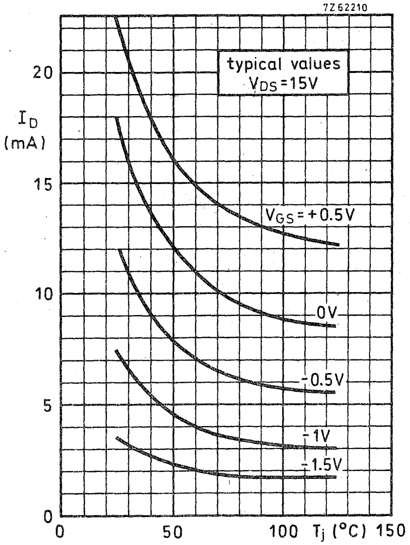
From junction to ambient in free air $R_{th\,j\text{-}a}$ = 0.5 °C/mW

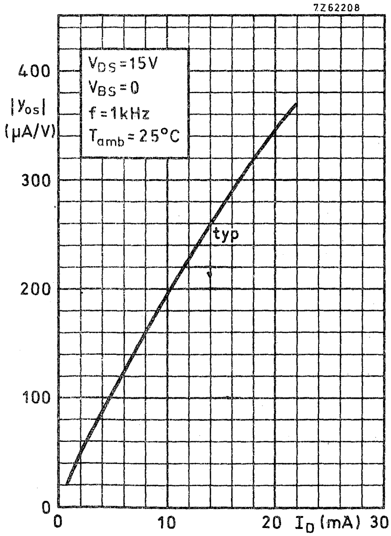
CHARACTERISTICS $T_j = 25\ ^{\circ}C$ unless otherwise specified

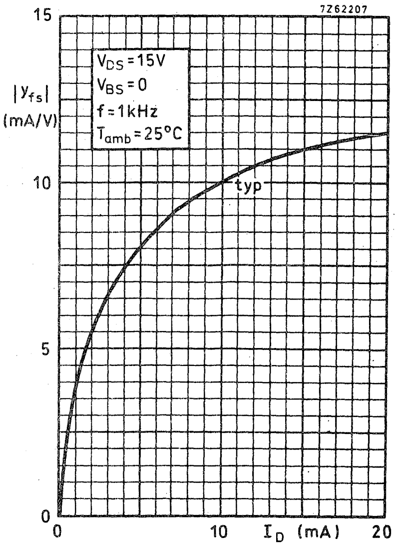
Gate currents; $V_{BS} = 0$				
$-V_{GS} = 10\ V;\ V_{DS} = 0$	$-I_{GSS}$	$<$	10	pA
$V_{GS} = 10\ V;\ V_{DS} = 0$	I_{GSS}	$<$	10	pA
$-V_{GS} = 10\ V;\ V_{DS} = 0;\ T_j = 125\ ^{\circ}C$	$-I_{GSS}$	$<$	200	pA
$V_{GS} = 10\ V;\ V_{DS} = 0;\ T_j = 125\ ^{\circ}C$	I_{GSS}	$<$	200	pA
Bulk currents; $V_{GB} = 0$				
$-V_{BD} = 30\ V;\ I_S = 0$	$-I_{BDO}$	$<$	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 $T_{amb} = 25\ ^{\circ}C$				
$I_D = 5\ mA;\ V_{DS} = 15\ V$				
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 $T_{amb} = 25\ ^{\circ}C$				
$I_D = 5\ mA;\ V_{DS} = 15\ V$				
$G_S = 1\ m\Omega^{-1};\ B_S = B_{Sopt}$	F	$<$	5	dB
Equivalent noise voltage $T_{amb} = 25\ ^{\circ}C$				
$I_D = 5\ mA;\ V_{DS} = 15\ V;\ f = 120\ Hz$	$V_n/\sqrt{B}$	typ.	300	$nV/\sqrt{Hz}$
$f = 1\ kHz$	$V_n/\sqrt{B}$	typ.	100	$nV/\sqrt{Hz}$
$f = 10\ kHz$	$V_n/\sqrt{B}$	typ.	35	$nV/\sqrt{Hz}$

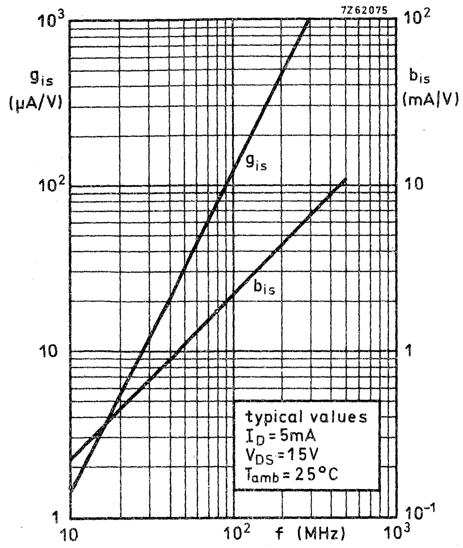

7Z62279
I_D (mA)
20
15
10
5
0
-5
V_{GS} (V)
-2.5
0
5
10
15
V_{DS} (V)
20
d
g
b
s
V_{DS} = 15V
V_{BS} = 0
T_{amb} = 25°C
V_{BS} = 0
T_{amb} = 25°C
typ. values
V_{GS} = +0.5V
0V
-0.5V
-1V
-1.5V

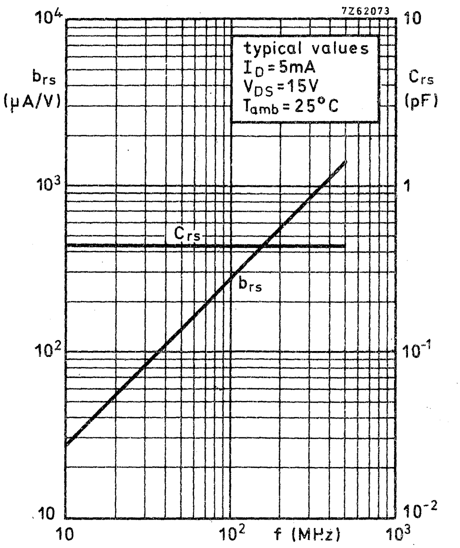

7Z62278
I_D (mA)
20
15
10
5
0
-2.5
-2
-1.5
-1
-0.5
0
V_{GS} (V)
0.5
d
g
b
s
V_{DS} = 15V
T_{amb} = 25°C
typical values
V_{BS} = +2V
+1V
0V
-1V
-2V
-3V
-5V
-7V

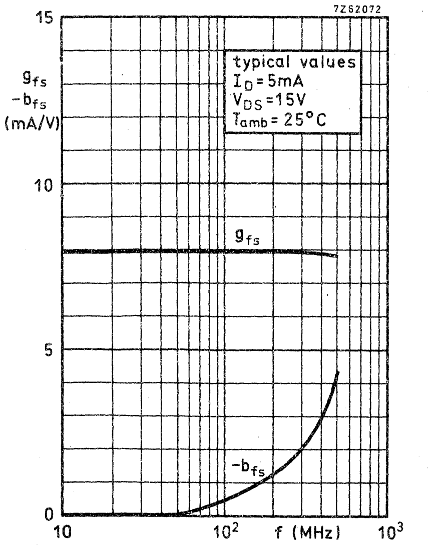

7Z62210
typical values
V_{DS} = 15V
I_D (mA)
20
15
10
5
0
V_{GS} = +0.5V
0V
−0.5V
−1V
−1.5V
0
50
100
T_j (°C)
150

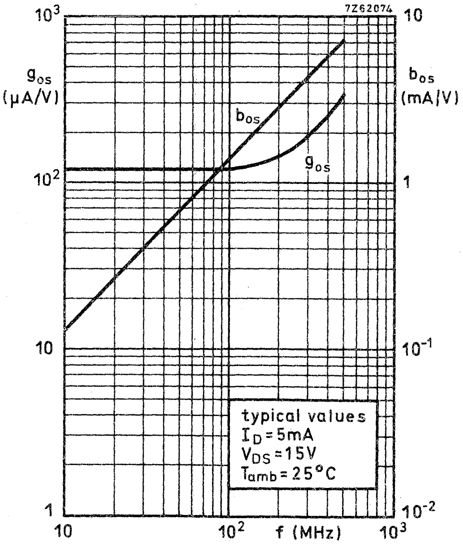

7Z62208
V_{DS} = 15V
V_{BS} = 0
f = 1kHz
T_{amb} = 25°C
|y_{os}|
(μA/V)
400
300
200
100
0
typ
0
10
20
I_D (mA)
30

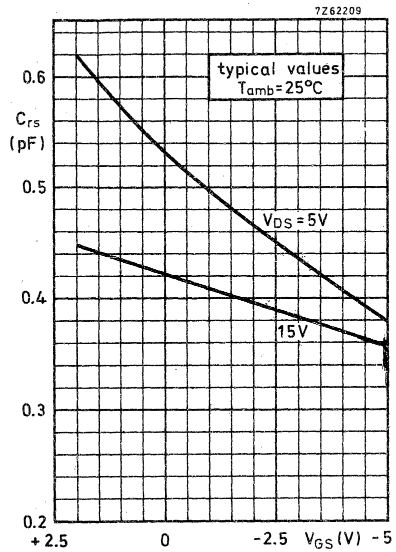

7Z62207
15
V_{DS} = 15V
V_{BS} = 0
f = 1kHz
T_{amb} = 25°C
|y_{fs}|
(mA/V)
10
5
0
typ
0
10
I_D (mA)
20

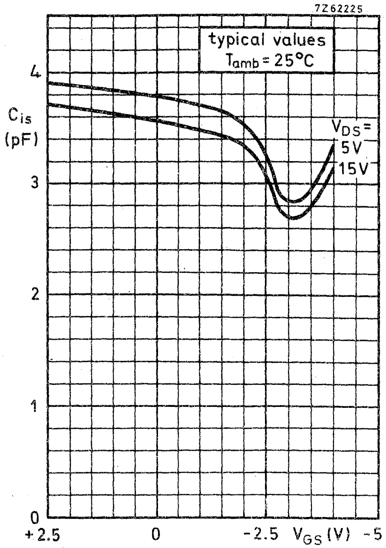

7Z62075
10^3
g_{is} (µA/V)
10^2
10
1
10^2
b_{is} (mA/V)
10
1
10^{-1}
g_{is}
b_{is}
typical values
$I_D = 5mA$
$V_{DS} = 15V$
$T_{amb} = 25°C$
10
10^2
f (MHz)
10^3


7Z62073
10^4
b_{rs} (µA/V)
10^3
10^2
10
10
C_{rs} (pF)
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
15
g_{fs}
$-b_{fs}$
(mA/V)
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
10^3
g_{os} (µA/V)
10^2
10
1
10
b_{os} (mA/V)
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
Tamb = 25°C
Crs
(pF)
0.6
0.5
0.4
0.3
0.2
VDS = 5V
15V
+2.5
0
-2.5
VGS (V)
-5


7Z62225
typical values
Tamb = 25°C
Cis
(pF)
4
3
2
1
0
VDS =
5V
15V
+2.5
0
-2.5
VGS (V)
-5

For data and curves of these types please refer to section
Microminiature devices for thick- and thin-film circuits

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, intended for a wide range of v.h.f. applications, such as v.h.f. television tuners, f.m. tuners, as well as for applications in communication, instrumentation and control.

This MOS-FET tetrode is protected against excessive input voltage surges by integrated back-to-back diodes between gates and source.

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.

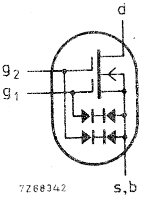
QUICK REFERENCE DATA

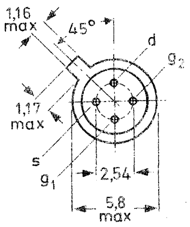
Drain-source voltage	V_{DS}	max.	20	V
Drain current	I_D	max.	50	mA
Total power dissipation up to $T_{amb} = 25\ ^{o}C$	P_{tot}	max.	300	mW
Junction temperature	T_j	max.	175	^{o}C
Transfer admittance at f = 1 kHz $I_D = 10$ mA; $V_{DS} = 10$ V; $+V_{G2-S} = 4$ V	$\lvert y_{fs} \rvert$	typ.	15	mA/V
Feedback capacitance at f = 1 MHz $I_D = 10$ mA; $V_{DS} = 10$ V; $+V_{G2-S} = 4$ V	C_{rs}	typ.	30	fF
Noise figure at optimum source admittance $I_D = 10$ mA; $V_{DS} = 10$ V; $+V_{G2-S} = 4$ V $G_S = 1,2$ mA/V; $-B_S = 5,7$ mA/V; f = 200 MHz	F	typ.	2,3	dB

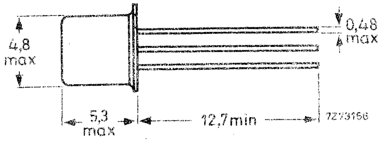
MECHANICAL DATA

Dimensions in mm

TO-72
Source and substrate
connected to the case







Accessories supplied on request: 56246 (distance disc); 56263 (cooling fin).

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

Voltage

Drain-source voltage	V_{DS}	max.	20	V

Currents

Drain current (d.c. or average)	I_D	max.	50	mA
Drain current (peak value)	I_{DM}	max.	100	mA
Gate 1-source current	$\pm I_{G1-S}$	max.	10	mA
Gate 2-source current	$\pm I_{G2-S}$	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 + 175		°C
Junction temperature	T_j	max.	175	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	0,5	°C/mW

STATIC CHARACTERISTICS

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

Gate cut-off currents

$\pm V_{G1-S} = 5$ V; $V_{G2-S} = V_{DS} = 0$	$\pm I_{G1-SS}$	<	10	nA
$\pm V_{G1-S} = 5$ V; $V_{G2-S} = V_{DS} = 0$; $T_j = 150\ ^{o}C$	$\pm I_{G1-SS}$	<	10	μA
$\pm V_{G2-S} = 5$ V; $V_{G1-S} = V_{DS} = 0$	$\pm I_{G2-SS}$	<	10	nA
$\pm V_{G2-S} = 5$ V; $V_{G1-S} = V_{DS} = 0$; $T_j = 150\ ^{o}C$	$\pm I_{G2-SS}$	<	10	μA

Gate-source breakdown voltages

$\pm I_{G1-SS} = 0,1$ mA; $V_{G2-S} = V_{DS} = 0$	$\pm V_{(BR)G1-SS}$	6,0 to 20	V
$\pm I_{G2-SS} = 0,1$ mA; $V_{G1-S} = V_{DS} = 0$	$\pm V_{(BR)G2-SS}$	6,0 to 20	V

Drain current

$V_{DS} = 10$ V; $V_{G1-S} = 0$; $+V_{G2-S} = 4$ V	I_{DSS}	20 to 55	mA 1) ←

Gate 1-source voltage

$I_D = 10$ mA; $V_{DS} = 10$ V; $+V_{G2-S} = 4$ V	$-V_{G1-S}$	0,6 to 2,1	V

Gate-source cut-off voltages

$I_D = 10\ \mu A$; $V_{DS} = 10$ V; $+V_{G2-S} = 4$ V	$-V_{(P)G1-S}$	1,5 to 3,8	V
$I_D = 10\ \mu A$; $V_{DS} = 10$ V; $V_{G1-S} = 0$	$-V_{(P)G2-S}$	1,5 to 3,4	V

---

1) Measured under pulse conditions.

DYNAMIC CHARACTERISTICS

Measuring conditions (common source): I_D = 10 mA; V_{DS} = 10 V; $+V_{G2-S}$ = 4 V; T_{amb} = 25 °C

Transfer admittance at f = 1 kHz	$\lvert y_{fs} \rvert$	>	12	mA/V
		typ.	15	mA/V
Input capacitance at f = 1 MHz	C_{is}	typ.	5, 5	pF
Feedback capacitance at f = 1 MHz	C_{rs}	typ.	30	fF
Output capacitance at f = 1 MHz	C_{os}	typ.	3, 5	pF
Noise figure at optimum source admittance				
G_S = 0, 95 mA/V; $-B_S$ = 5, 0 mA/V; f = 100 MHz	F	typ.	1, 9	dB
G_S = 1, 20 mA/V; $-B_S$ = 5, 7 mA/V; f = 200 MHz	F	typ.	2, 3	dB
		<	3, 0	dB
Cross modulation at f = 200 MHz				
Wanted signal at f_o = 197, 5 MHz				
Unwanted signal at f_{int} = 202, 5 MHz				
Interference voltage at g_1 for K = 1%	V_{int}	typ.	100	mV [1]

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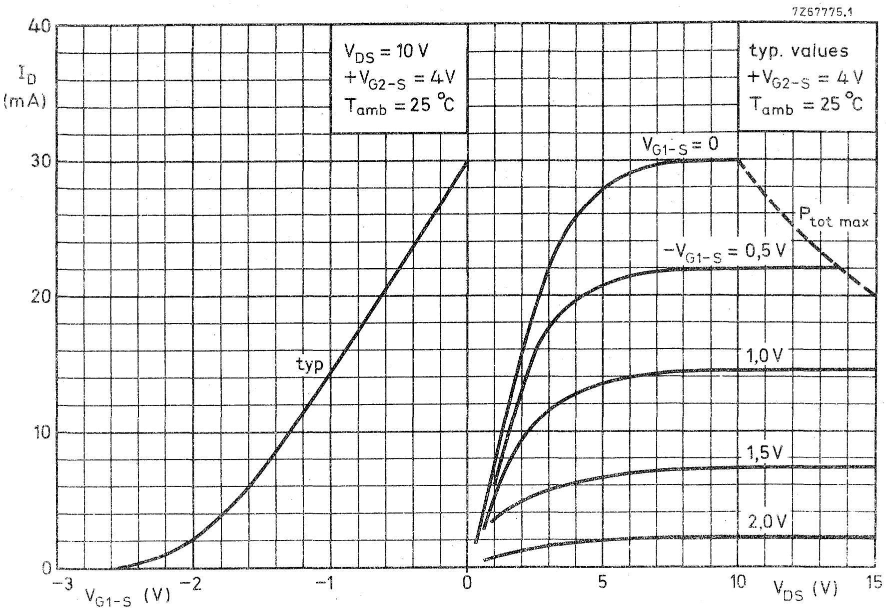
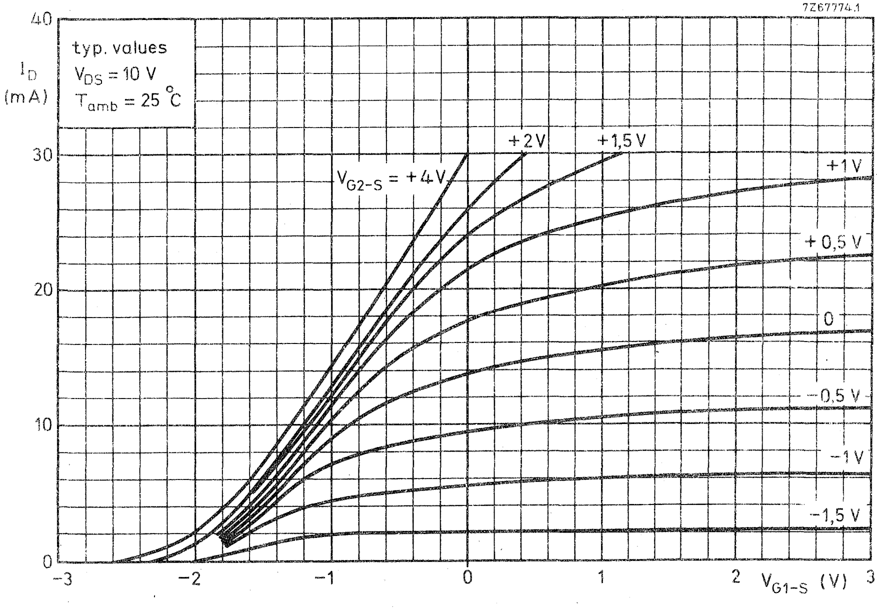
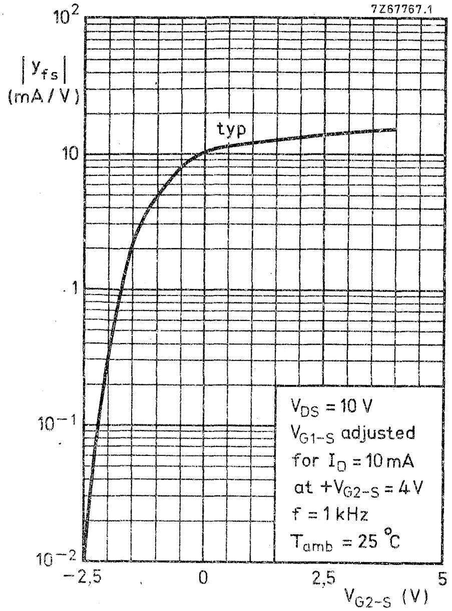
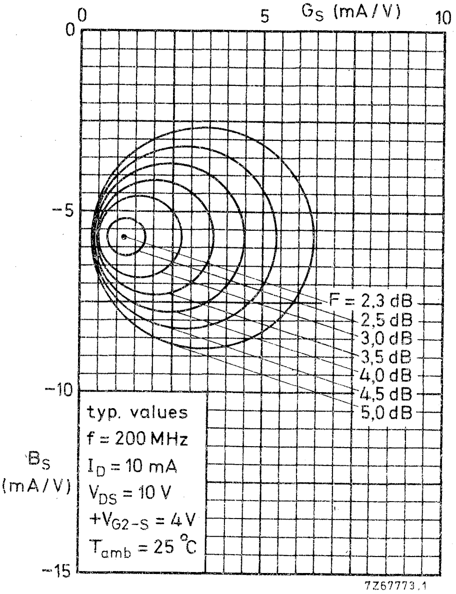
[1] Cross modulation is defined here as the voltage at g_1 of an unwanted signal with 80% modulation depth, giving 0, 8% modulation depth on the wanted signal (a.m. definition).


7Z67775.1
I_D (mA)
40
30
20
10
0
V_DS = 10 V
+V_G2-S = 4 V
T_amb = 25 °C
typ. values
+V_G2-S = 4 V
T_amb = 25 °C
typ
V_G1-S = 0
P_tot max
−V_G1-S = 0,5 V
1,0 V
1,5 V
2,0 V
−3
−2
−1
0
V_G1-S (V)
5
10
15
V_DS (V)


7Z67774.1
I_D (mA)
40
30
20
10
0
typ. values
V_DS = 10 V
T_amb = 25 °C
V_G2-S = +4 V
+2 V
+1,5 V
+1 V
+0,5 V
0
−0,5 V
−1 V
−1,5 V
−3
−2
−1
0
1
2
3
V_G1-S (V)





circles of constant noise figure

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.

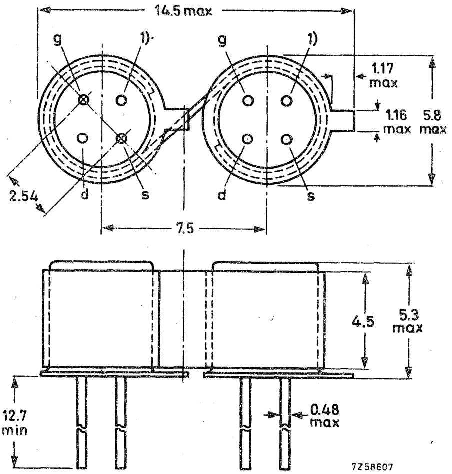
QUICK REFERENCE DATA

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	$\|\Delta V_{GS}\|$	<	20	10	mV
Thermal drift of gate-source voltage difference	$\left\|\frac{d\ \Delta V_{GS}}{dT}\right\|$	<	75	40	$\mu V/^{o}C$
Difference of penetration factor	$\left\|\Delta \frac{g_{os}}{g_{fs}}\right\|$	<	1	0.5	10^{-3}
Difference of transfer impedance	$\left\|\Delta \frac{1}{g_{fs}}\right\|$	<	15	7.5	Ω
Common mode rejection ratio	CMRR	>	60	66	dB

TOTAL DEVICE

MECHANICAL DATA

Dimensions in mm



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					
$I_D = 500\ \mu A$; $V_{DG} = 15$ V	$\lvert \Delta V_{GS} \rvert$	<	20	10	mV
$I_D = 100\ \mu A$; $V_{DG} = 15$ V	$\lvert \Delta V_{GS} \rvert$	<	20	10	mV
Thermal drift of gate-source voltage difference					
$I_D = 500\ \mu A$; $V_{DG} = 15$ V	$\left\lvert \frac{d\ \Delta V_{GS}}{dT} \right\rvert$	<	75	40	µV/°C
$I_D = 100\ \mu A$; $V_{DG} = 15$ 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					
$I_D = 500\ \mu A$; $V_{DG} = 15$ V	$\lvert \Delta V_{GS}(T_{amb2}) - \Delta V_{GS}(T_{amb1}) \rvert$	<	6	3	mV
$I_D = 100\ \mu A$; $V_{DG} = 15$ V	$\lvert \Delta V_{GS}(T_{amb2}) - \Delta V_{GS}(T_{amb1}) \rvert$	<	6	3	mV
Difference of penetration factors [1]					
$I_D = 500\ \mu A$; $V_{DG} = 15$ V	$\left\lvert \Delta \frac{g_{os}}{g_{fs}} \right\rvert$	<	1	0.5	10^{-3}
$I_D = 100\ \mu A$; $V_{DG} = 15$ V	$\left\lvert \Delta \frac{g_{os}}{g_{fs}} \right\rvert$	<	1	0.5	10^{-3}
Difference of transfer impedances [2]					
$I_D = 500\ \mu A$; $V_{DG} = 15$ V	$\left\lvert \Delta \frac{1}{g_{fs}} \right\rvert$	<	15	7.5	Ω
$I_D = 100\ \mu A$; $V_{DG} = 15$ 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.

$$(\Delta \frac{g_{os}}{g_{fs}} = \frac{d\ \Delta V_{GS}}{d\ V_{DG}} \text{ at } I_D = \text{constant})$$

[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.

$$(\Delta \frac{1}{g_{fs}} = \frac{d\ \Delta V_{GS}}{d\ I_D} \text{ at } V_{DG} = \text{constant})$$

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^{o}	P_{tot}	max.	300	mW
Temperatures				
Storage temperature	T_{stg}		-65 to +200	^{o}C
Junction temperature	T_j	max.	200	^{o}C

THERMAL RESISTANCE

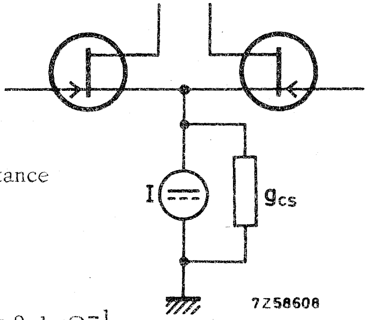
From junction to ambient in free air (for individual transistor without S-clip)	$R_{th\ j-a}$	=	0.59	^{o}C/mW

---

[1] Common mode rejection ratio

$$(C\,M\,R\,R)^{-1} = \Delta \frac{g_{os}}{g_{fs}} + \frac{1}{2} g_{cs} \Delta \frac{1}{g_{fs}}$$

where g_{cs} in this formula is the output conductance of the summing current source.



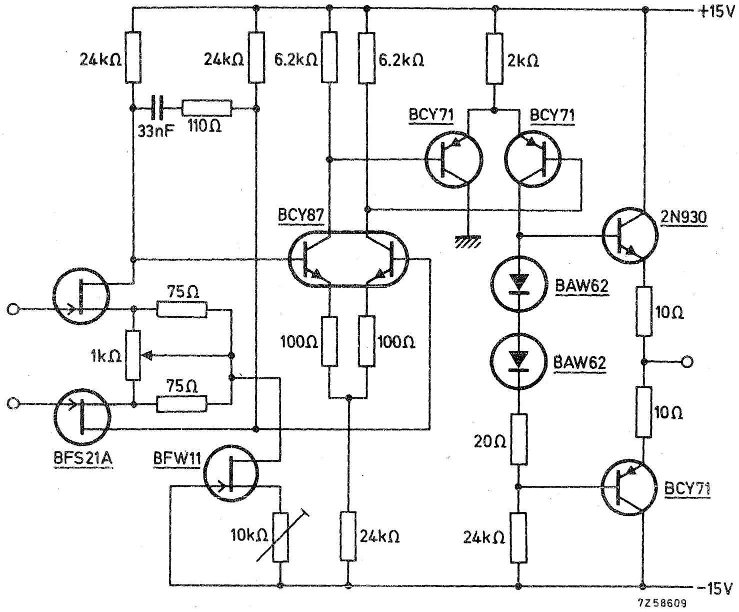
The guaranteed values of CMRR apply at g_{cs} = 0.1 $\mu\Omega^{-1}$

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 °C	typ.	50	pA
; T_{amb} = 100 °C	<	25	nA
Off-set current ; T_{amb} = 25 °C	typ.	20	pA
; T_{amb} = 100 °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

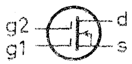
Drain-source voltage	V_{DS}	max.	20	V
Gate 1-source voltage	$\pm V_{G1-S}$	max.	8	V
Gate 2-source voltage	$\pm V_{G2-S}$	max.	8	V
Drain current	I_D	max.	20	mA
Total power dissipation up to $T_{amb} = 25\,^{o}C$	P_{tot}	max.	200	mW
Junction temperature	T_j	max.	135	^{o}C
Transfer admittance at f = 1 kHz $I_D = 10$ mA; $V_{DS} = 13$ V; $+V_{G2-S} = 4$ V	$\lvert y_{fs}\rvert$	> 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

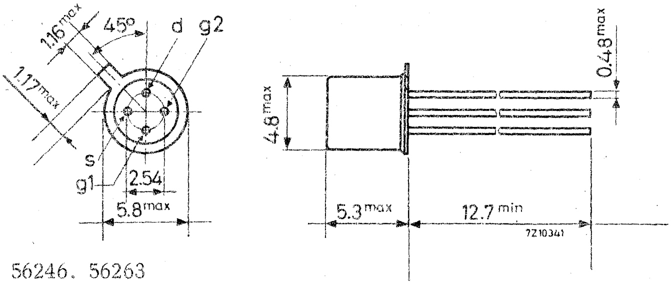
MECHANICAL DATA see page 2.

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

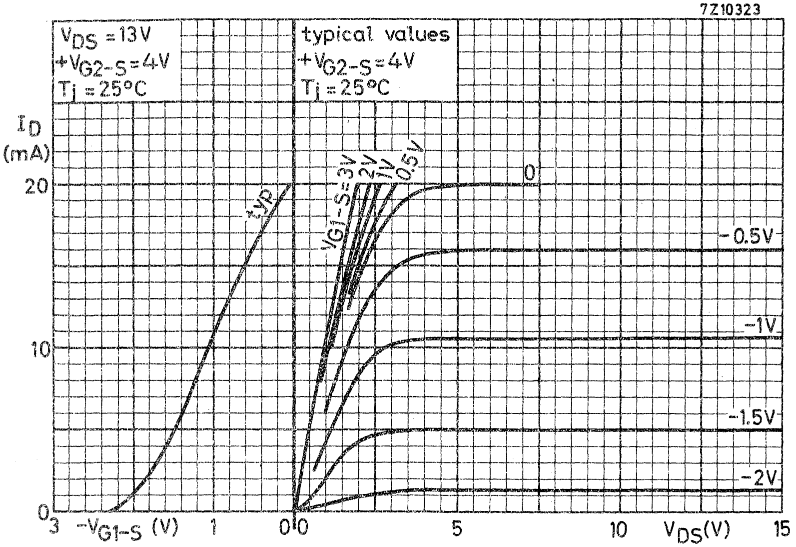
Voltages				
Drain-source voltage	V_{DS}	max.	20	V
Gate 1-source voltage	$\pm V_{G1-S}$	max.	8	V
Gate 2-source voltage	$\pm V_{G2-S}$	max.	8	V
Non repetitive peak voltage ($t \leq 10$ ms)				
gate 1-source voltage	$\pm V_{G1-SM}$	max.	50	V
gate 2-source voltage	$\pm V_{G2-SM}$	max.	50	V
Current				
Drain 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

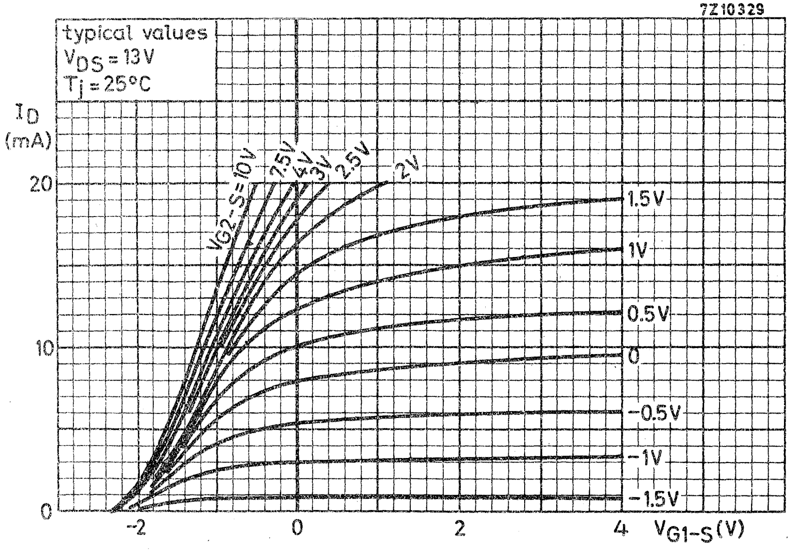
THERMAL RESISTANCE

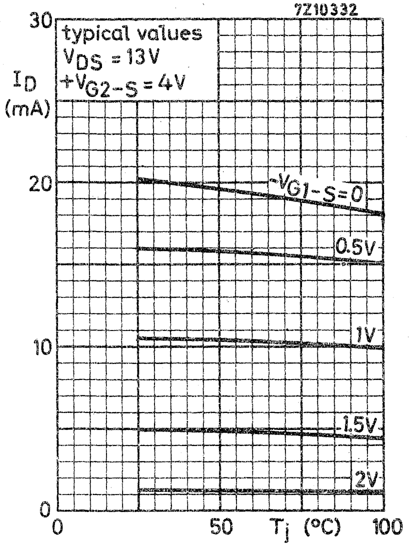
From junction to ambient in free air $R_{th\ j-a}$ = 0.55 °C/mW

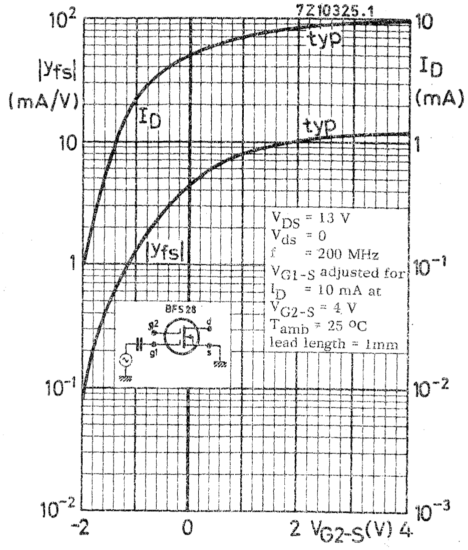
CHARACTERISTICS T_j = 25 °C unless otherwise specified

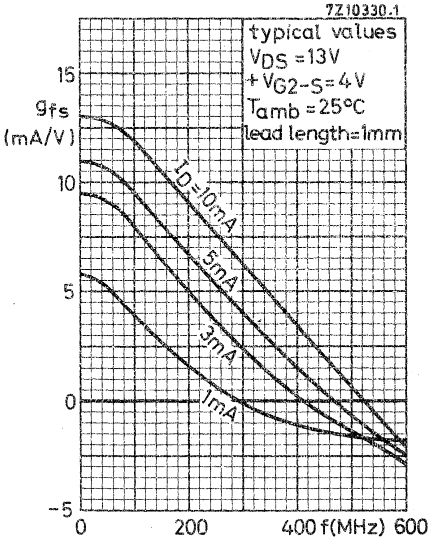
Gate 1 cut-off current				
$\pm V_{G1-S}$ = 8 V; V_{G2-S} = 0; V_{DS} = 0; T_j = 135 °C	$\pm I_{G1-SS}$	<	1	nA
Gate 2 cut-off current				
$\pm V_{G2-S}$ = 8 V; V_{G1-S} = 0; V_{DS} = 0; T_j = 135 °C	$\pm I_{G2-SS}$	<	1	nA
Gate 1-source voltage				
I_D = 10 mA; V_{DS} = 13 V; $+V_{G2-S}$ = 4 V	$-V_{G1-S}$		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	$\lvert y_{fs}\rvert$	> typ.	8 13	mA/V mA/V
f = 200 MHz	$\lvert y_{fs}\rvert$	typ.	12.1	mA/V
f = 500 MHz	$\lvert y_{fs}\rvert$	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 = $10 \log \frac{\lvert y_{fs}\rvert^2}{4 g_{is} g_{os}}$				
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

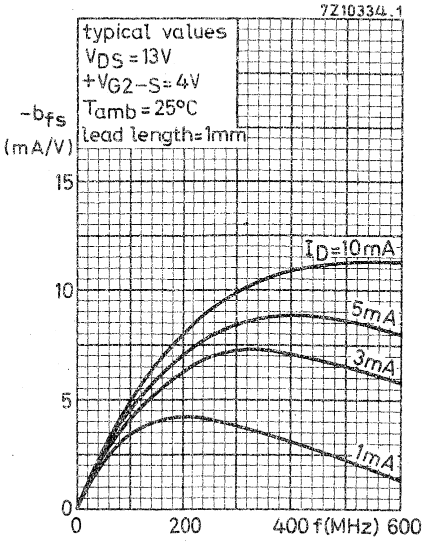

7Z10323
V_{DS} = 13V
$+V_{G2-S}$ = 4V
T_j = 25°C
typical values
$+V_{G2-S}$ = 4V
T_j = 25°C
I_D (mA)
20
10
0
typ
V_{G1-S} = 3V
2V
1V
0.5V
0
−0.5V
−1V
−1.5V
−2V
3
$-V_{G1-S}$ (V)
1
0
0
5
10
V_{DS}(V)
15

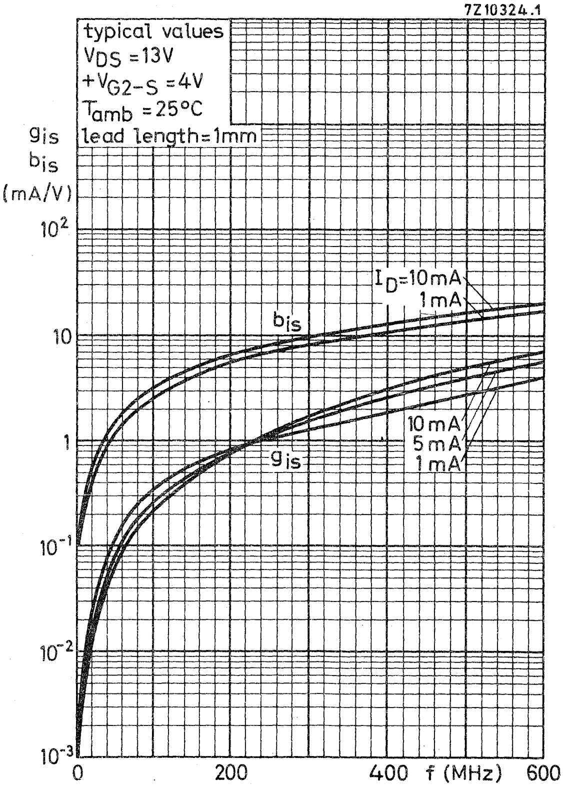

7Z10329
typical values
V_{DS} = 13V
T_j = 25°C
I_D (mA)
20
10
0
V_{G2-S} = 10V
7.5V
4V
3V
2.5V
2V
1.5V
1V
0.5V
0
−0.5V
−1V
−1.5V
−2
0
2
4
V_{G1-S}(V)

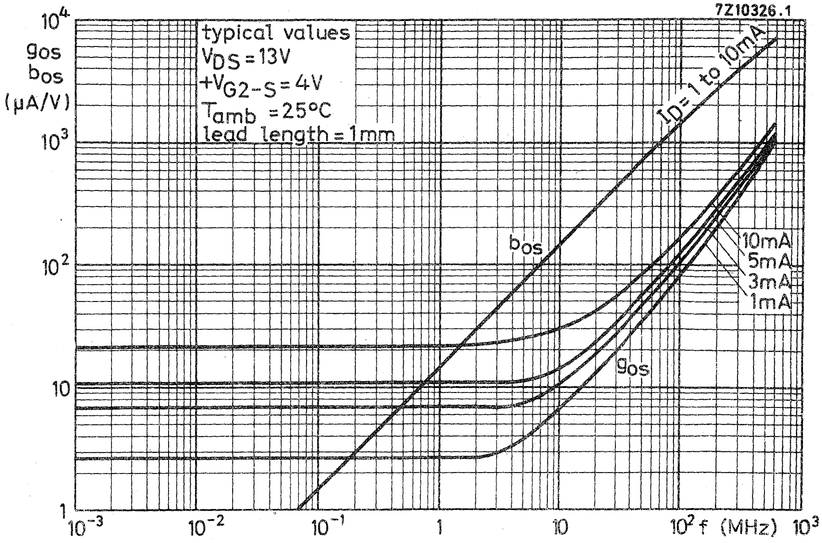

7Z10332
typical values
V_{DS} = 13 V
+V_{G2-S} = 4 V
I_D (mA)
30
20
10
0
$-V_{G1-S}$ = 0
0.5V
1V
1.5V
2V
0
50
T_j (°C)
100

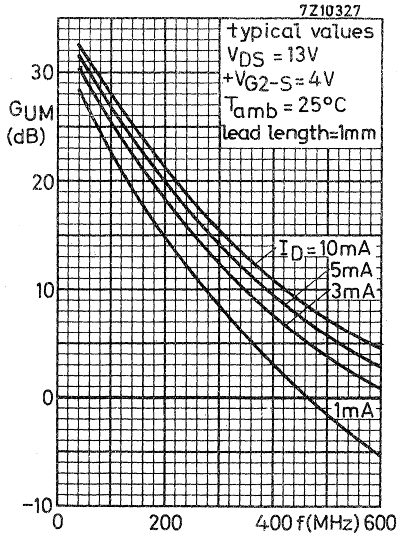

7Z10325.1
10^2
$|y_{fs}|$ (mA/V)
10
1
10^{-1}
10^{-2}
10
I_D (mA)
1
10^{-1}
10^{-2}
10^{-3}
typ
I_D
typ
$|y_{fs}|$
V_{DS} = 13 V
V_{ds} = 0
f = 200 MHz
V_{G1-S} adjusted for
I_D = 10 mA at
V_{G2-S} = 4 V
T_{amb} = 25 °C
lead length = 1mm
BFS 28
g2
g1
d
s
−2
0
2
V_{G2-S}(V)
4

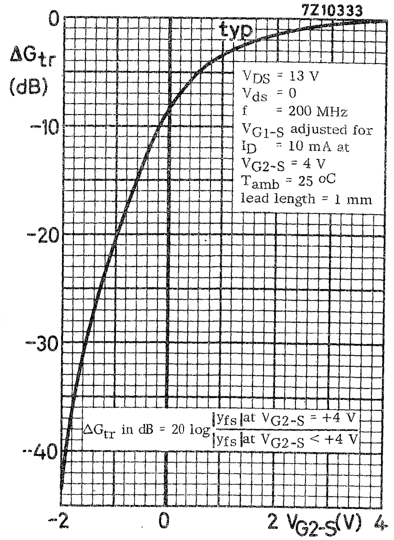

7Z10330.1
typical values
V_{DS} = 13 V
+V_{G2-S} = 4 V
T_{amb} = 25 °C
lead length = 1mm
g_{fs} (mA/V)
15
10
5
0
−5
I_D = 10 mA
5mA
3mA
1mA
0
200
400
f(MHz)
600

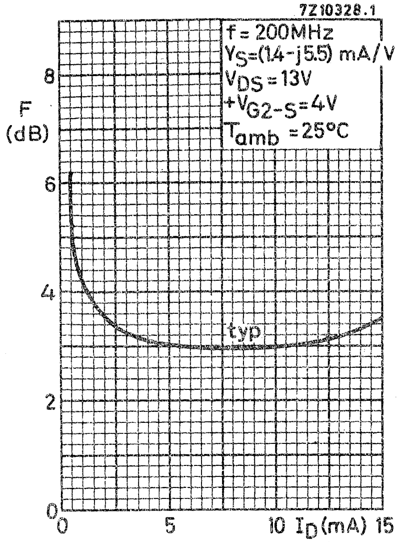

7Z10334.1
typical values
V_{DS} = 13 V
+V_{G2-S} = 4 V
T_{amb} = 25 °C
lead length = 1mm
$-b_{fs}$ (mA/V)
15
10
5
0
I_D = 10 mA
5mA
3mA
1mA
0
200
400
f(MHz)
600

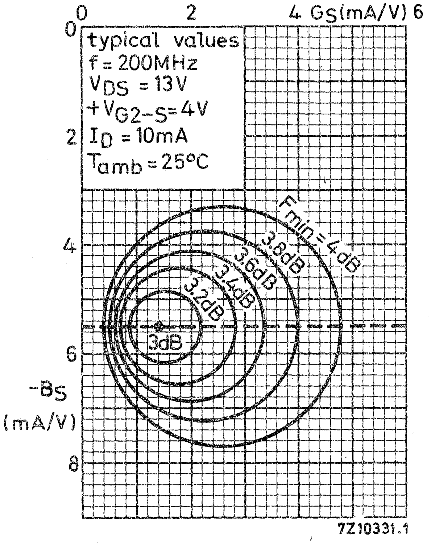

7Z10324.1
typical values
V_{DS} = 13V
$+V_{G2-S}$ = 4V
T_{amb} = 25°C
lead length = 1mm
g_{is}
b_{is}
(mA/V)
10^2
10
1
10^{-1}
10^{-2}
10^{-3}
I_D = 10 mA
1 mA
b_{is}
10 mA
5 mA
1 mA
g_{is}
0
200
400
f (MHz)
600


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}
g_{os}
10mA
5mA
3mA
1mA
10^{-3}
10^{-2}
10^{-1}
1
10
10^2
f (MHz)
10^3


7Z10327
typical values
$V_{DS} = 13V$
$+V_{G2-S} = 4V$
$T_{amb} = 25°C$
lead length=1mm
30
G_{UM}
(dB)
20
10
0
−10
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 °C
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
Y_S=(1.4-j5.5) mA/V
V_{DS} = 13V
$+V_{G2-S}$=4V
T_{amb} = 25°C
F
(dB)
8
6
4
2
0
0
5
10
15
I_D(mA)
typ


0
2
4
6
G_S(mA/V)
0
2
4
6
8
$-B_S$
(mA/V)
typical values
f = 200MHz
V_{DS} = 13V
$+V_{G2-S}$=4V
I_D = 10mA
T_{amb} = 25°C
F_{min} = 4dB
3.8dB
3.6dB
3.4dB
3.2dB
3dB
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.

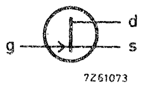
QUICK REFERENCE DATA

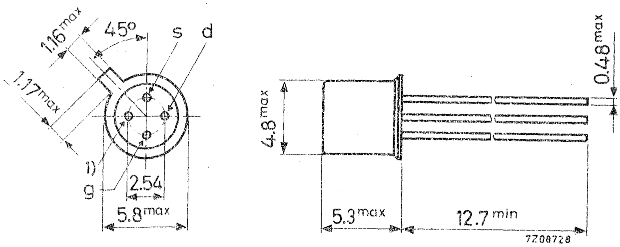
Drain-source voltage	$\pm V_{DS}$	max.	30		V
Gate-source voltage (open drain)	$-V_{GSO}$	max.	30		V
Total power dissipation up to $T_{amb} = 25\,^{o}C$	P_{tot}	max.	300		mW
			BFW10	BFW11	
Drain current $V_{DS} = 15$ V; $V_{GS} = 0$	I_{DSS}	>	8	4	mA
		<	20	10	mA
Gate-source cut-off voltage $I_D = 0.5$ 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	$\|y_{fs}\|$	>	3.2	3.2	mA/V
Noise figure at $V_{DS} = 15$ V; $V_{GS} = 0$ f = 100 MHz; $R_G = 1\ k\Omega$	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 $T_{amb} = 25\ ^oC$	P_{tot}	max.	300	mW

Temperatures

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

THERMAL RESISTANCE

From junction to ambient	$R_{th\ j-a}$	=	0.59	$^oC/mW$

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	$\|y_{fs}\|$	>	3.5	3.0	mA/V
		<	6.5	6.5	mA/V
Output admittance	$\|y_{os}\|$	<	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	$\|y_{fs}\|$	>	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/$\sqrt{Hz}$

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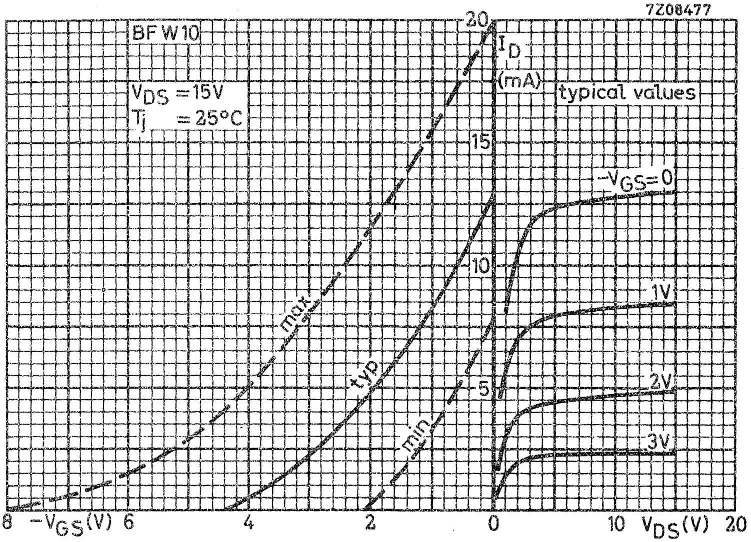
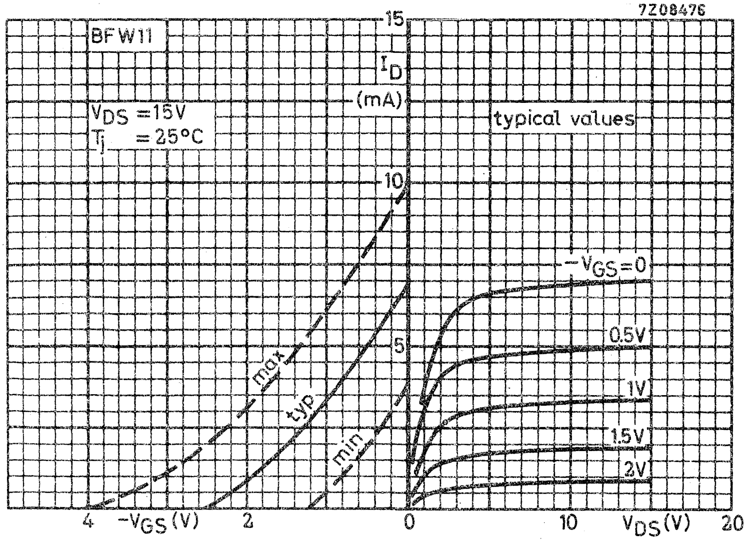
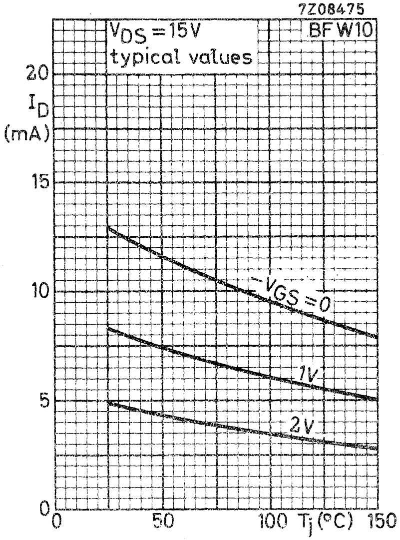
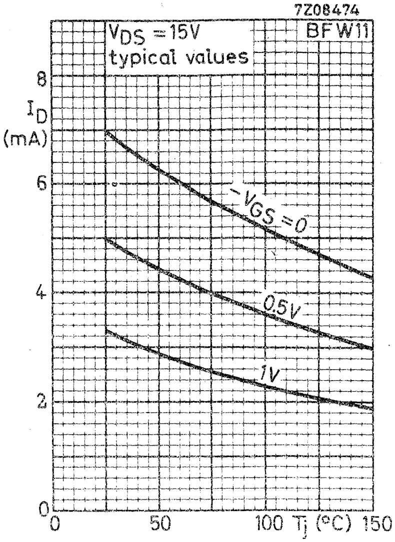
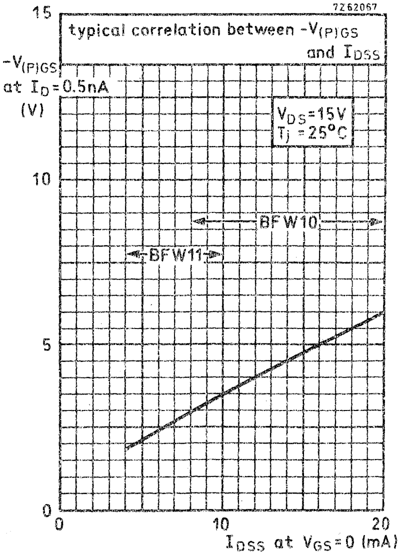
[1] Measured under pulsed conditions.

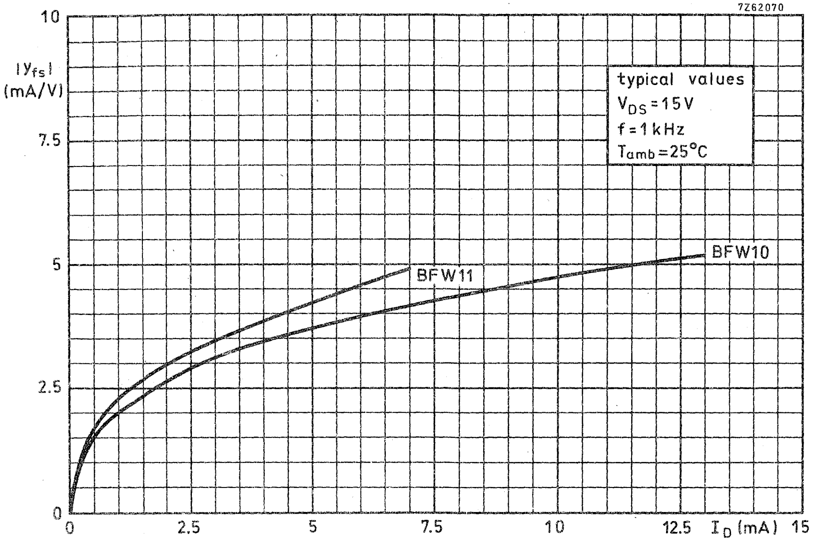

7Z08477
BFW10
V_DS = 15V
Tj = 25°C
I_D (mA)
typical values
max
typ
min
-V_GS = 0
1V
2V
3V
20
15
10
5
8
-V_GS (V)
6
4
2
0
10
V_DS (V)
20

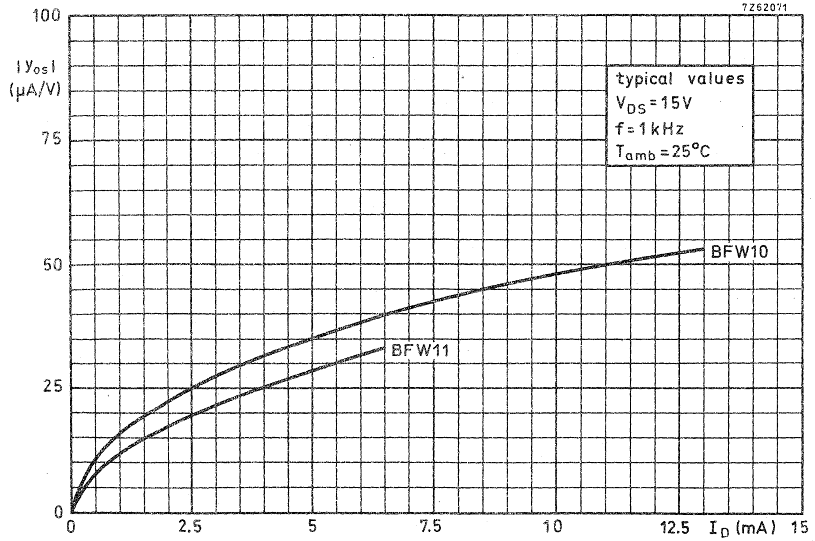

7Z08476
BFW11
V_DS = 15V
Tj = 25°C
I_D (mA)
typical values
max
typ
min
-V_GS = 0
0.5V
1V
1.5V
2V
15
10
5
4
-V_GS (V)
2
0
10
V_DS (V)
20

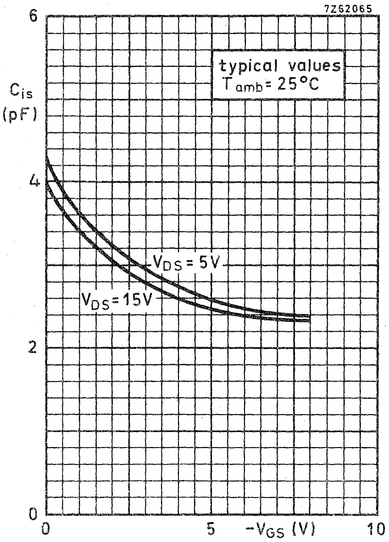

7Z08475
V_{DS} = 15V
typical values
BFW10
I_D (mA)
20
15
10
5
0
$-V_{GS}$ = 0
1V
2V
0
50
100
T_j (°C)
150

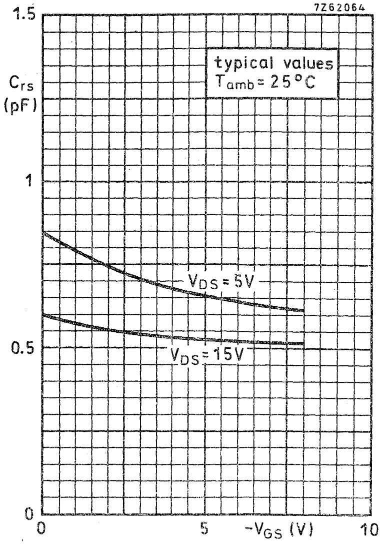

7Z08474
V_{DS} = 15V
typical values
BFW11
I_D (mA)
8
6
4
2
0
$-V_{GS}$ = 0
0.5V
1V
0
50
100
T_j (°C)
150

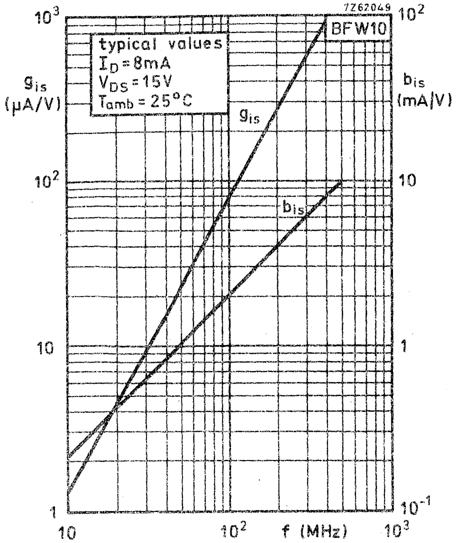

7Z62067
typical correlation between $-V_{(P)GS}$ and I_{DSS}
$-V_{(P)GS}$ at I_D = 0.5nA (V)
15
10
5
0
V_{DS} = 15V
T_j = 25°C
BFW10
BFW11
0
10
20
I_{DSS} at V_{GS} = 0 (mA)

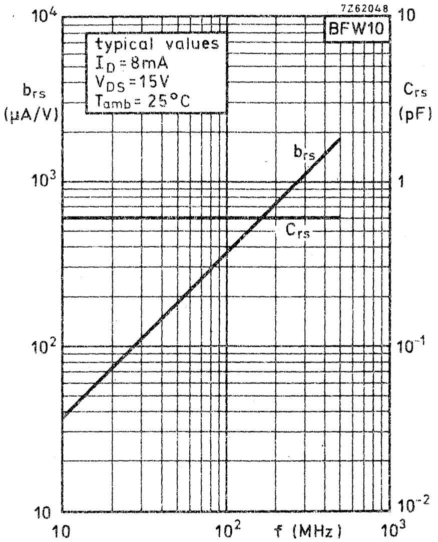

7Z62070
10
7.5
5
2.5
0
$|y_{fs}|$ (mA/V)
typical values
V_{DS} = 15 V
f = 1 kHz
T_{amb} = 25°C
BFW10
BFW11
0
2.5
5
7.5
10
12.5
I_D (mA)
15

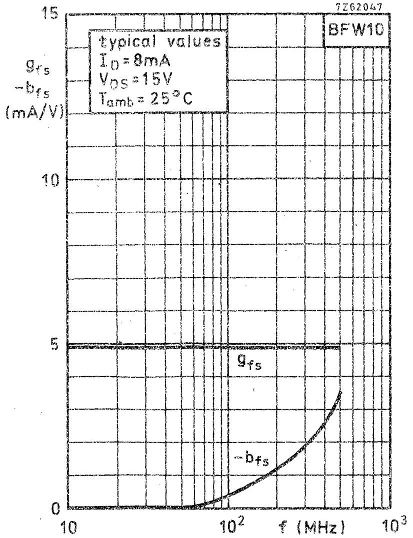

7Z62071
100
75
50
25
0
$|y_{os}|$ (μA/V)
typical values
V_{DS} = 15 V
f = 1 kHz
T_{amb} = 25°C
BFW10
BFW11
0
2.5
5
7.5
10
12.5
I_D (mA)
15

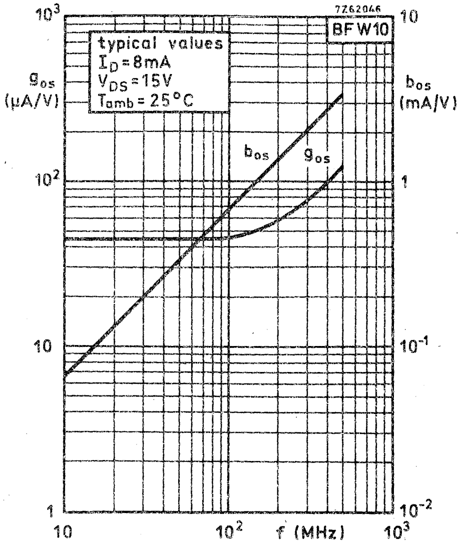

7Z62065
typical values
T_{amb} = 25°C
C_{is} (pF)
V_{DS} = 5V
V_{DS} = 15V
0
2
4
6
0
5
10
$-V_{GS}$ (V)

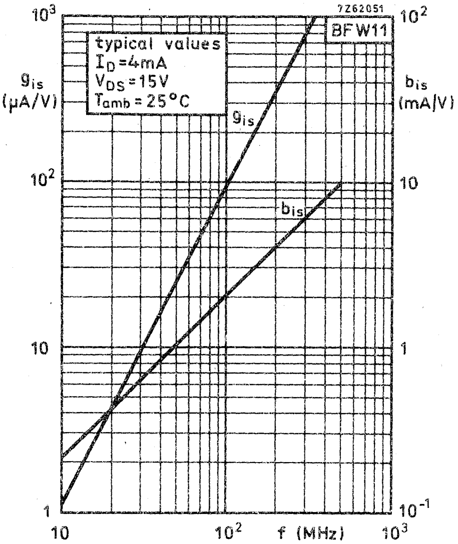

7Z62064
typical values
T_{amb} = 25°C
C_{rs} (pF)
V_{DS} = 5V
V_{DS} = 15V
0
0.5
1
1.5
0
5
10
$-V_{GS}$ (V)

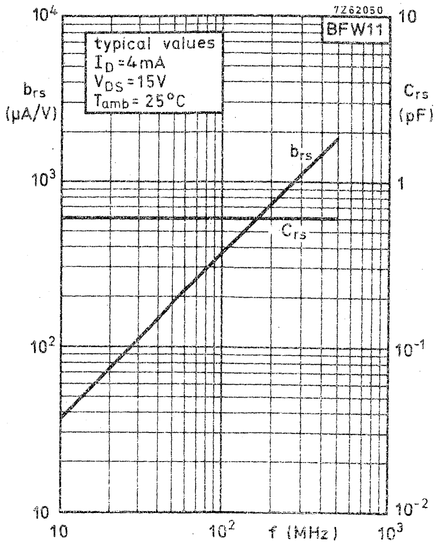

7Z62049
BFW10
typical values
$I_D = 8mA$
$V_{DS} = 15V$
$T_{amb} = 25°C$
g_{is} (μA/V)
b_{is} (mA/V)
g_{is}
b_{is}
10^3
10^2
10
1
10^2
10
1
10^{-1}
10
10^2
f (MHz)
10^3

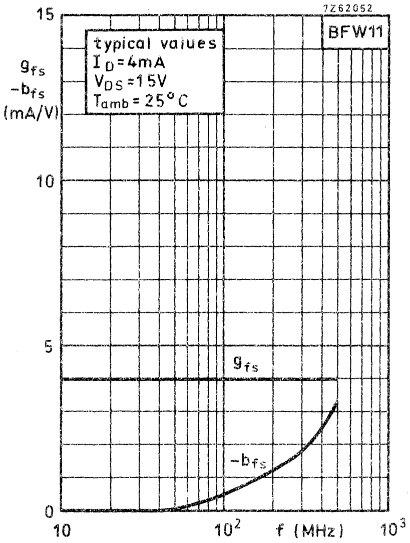

7Z62048
BFW10
typical values
$I_D = 8mA$
$V_{DS} = 15V$
$T_{amb} = 25°C$
b_{rs} (μA/V)
C_{rs} (pF)
b_{rs}
C_{rs}
10^4
10^3
10^2
10
10
1
10^{-1}
10^{-2}
10
10^2
f (MHz)
10^3

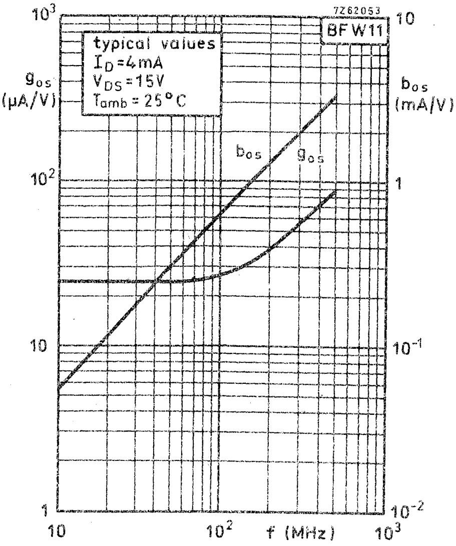

7Z62047
BFW10
typical values
$I_D = 8mA$
$V_{DS} = 15V$
$T_{amb} = 25°C$
g_{fs}
$-b_{fs}$
(mA/V)
g_{fs}
$-b_{fs}$
15
10
5
0
10
10^2
f (MHz)
10^3

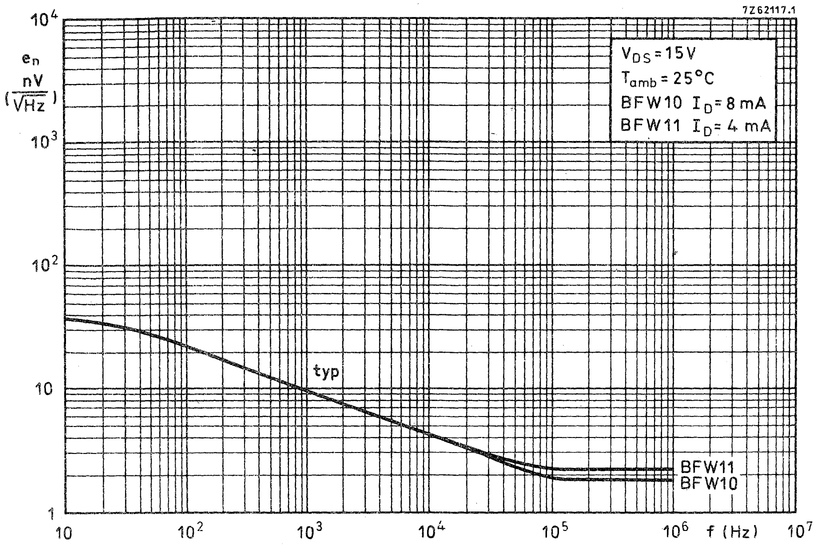

7Z62046
BFW10
typical values
$I_D = 8mA$
$V_{DS} = 15V$
$T_{amb} = 25°C$
g_{os} (μA/V)
b_{os} (mA/V)
b_{os}
g_{os}
10^3
10^2
10
1
10
1
10^{-1}
10^{-2}
10
10^2
f (MHz)
10^3

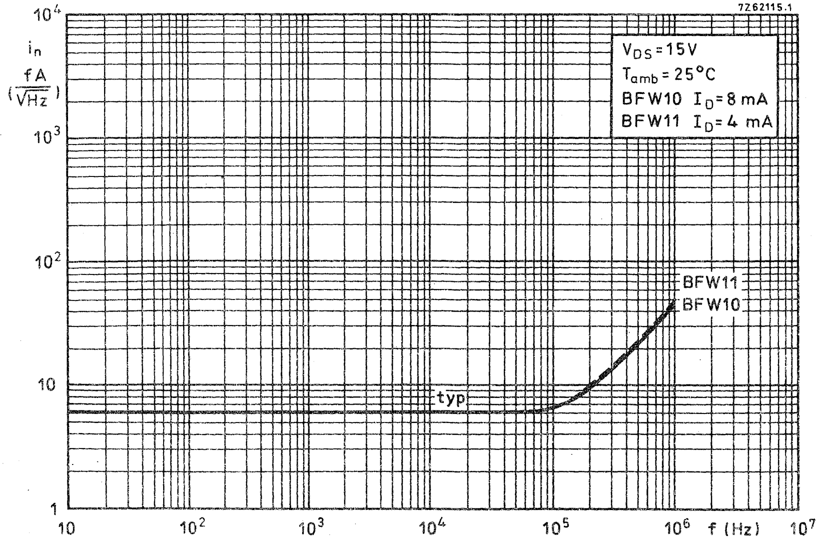

7Z62051
BFW11
typical values
I_D = 4 mA
V_{DS} = 15 V
T_{amb} = 25 °C
g_{is} (μA/V)
b_{is} (mA/V)
g_{is}
b_{is}
10^3
10^2
10
1
10^2
10
1
10^{-1}
10
10^2
f (MHz)
10^3

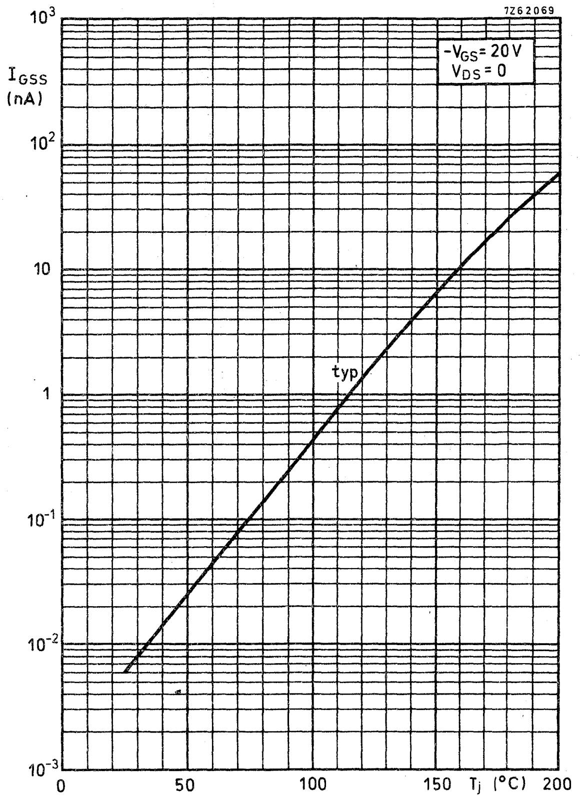

7Z62050
BFW11
typical values
I_D = 4 mA
V_{DS} = 15 V
T_{amb} = 25 °C
b_{rs} (μA/V)
C_{rs} (pF)
b_{rs}
C_{rs}
10^4
10^3
10^2
10
10
1
10^{-1}
10^{-2}
10
10^2
f (MHz)
10^3


7Z62052
BFW11
typical values
I_D = 4 mA
V_{DS} = 15 V
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 = 4 mA
V_{DS} = 15 V
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

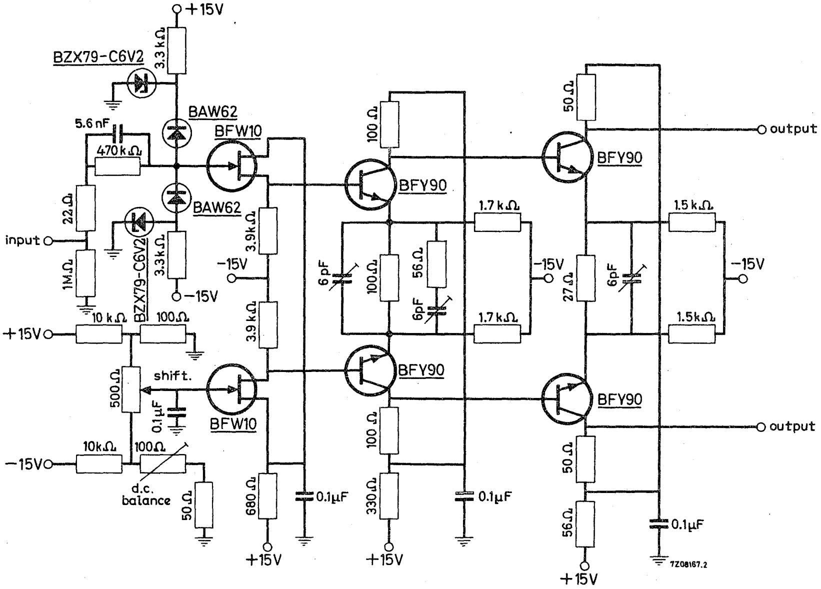

7Z62117.1
e_n
$(\frac{nV}{\sqrt{Hz}})$
10^4
10^3
10^2
10
1
10
10^2
10^3
10^4
10^5
10^6
f (Hz)
10^7
V_{DS} = 15 V
T_{amb} = 25 °C
BFW10 I_D = 8 mA
BFW11 I_D = 4 mA
typ
BFW11
BFW10


7Z62115.1
i_n
$(\frac{fA}{\sqrt{Hz}})$
10^4
10^3
10^2
10
1
10
10^2
10^3
10^4
10^5
10^6
f (Hz)
10^7
V_{DS} = 15 V
T_{amb} = 25 °C
BFW10 I_D = 8 mA
BFW11 I_D = 4 mA
typ
BFW11
BFW10


7Z62069
I_{GSS} (nA)
$-V_{GS}$ = 20 V
V_{DS} = 0
typ
10^3
10^2
10
1
10^{-1}
10^{-2}
10^{-3}
0
50
100
150
T_j (°C)
200

APPLICATION INFORMATION

Input amplifier circuit for an oscilloscope.

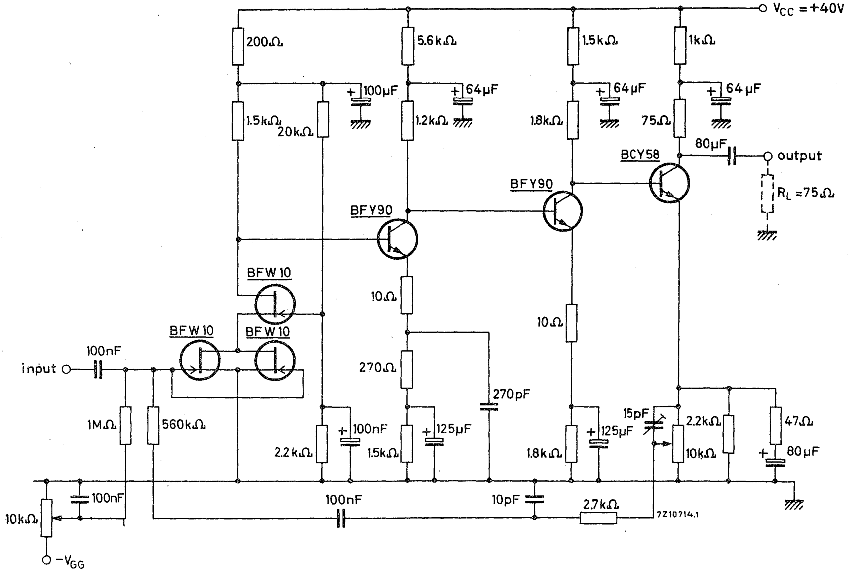


Performance:

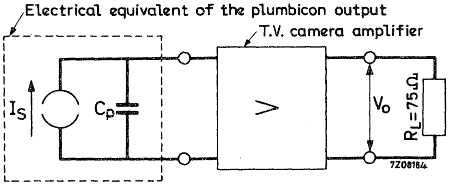
Input resistance	1 MΩ
Input capacitance	7.5 pF
Bandwidth	From d.c. to 300 MHz
Rise time	< 1 ns
Voltage gain	3.6
R.M.S. noise voltage (B = 300 MHz)	≤ 0.2 mV (input short-circuited)
Input sensitivity	This input amplifier is intended for an oscilloscope with a maximum input sensitivity of 5 or 10 mV/cm 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

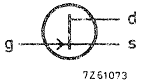
Drain-source voltage	$\pm V_{DS}$	max.	30	V
Gate-source voltage (open drain)	$-V_{GSO}$	max.	30	V
Total power dissipation up to $T_{amb} = 110\,^{\circ}C$	P_{tot}	max.	150	mW

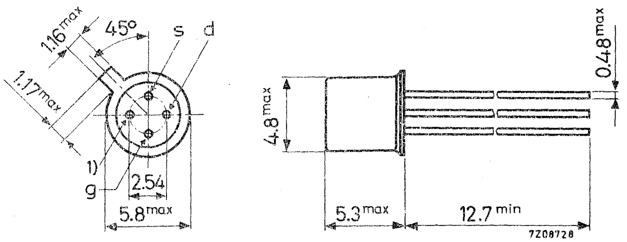
			BFW12	BFW13	
Drain current $V_{DS} = 15$ V; $V_{GS} = 0$	I_{DSS}	>	1	0.2	mA
		<	5	1.5	mA
Gate-source cut-off voltage $I_D = 0.5$ nA; $V_{DS} = 15$ V	$-V_{(P)GS}$	<	2.5	1.2	V
Feedback capacitance at f = 1 MHz $V_{DS} = 15$ V; $V_{GS} = 0$	C_{rs}	<	0.80	0.80	pF
Transfer admittance (common source) $V_{DS} = 15$ 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	$R_{th\ j-a}$	=	0.59	°C/mW

CHARACTERISTICS

$T_j = 25\ ^oC$ 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; $V_{DS} = 0$; $T_j = 150\ ^oC$	$-I_{GSS}$	<	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					
$I_D = 50\ \mu A$; $V_{DS} = 15$ 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; $T_{amb} = 25\ ^oC$					
$V_{DS} = 15$ 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; $I_D = 500\ \mu A$					
Transfer admittance	$\|y_{fs}\|$	>	1.5	-	mA/V
Output admittance	$\|y_{os}\|$	<	10	-	μA/V
$V_{DS} = 15$ V; $I_D = 200\ \mu A$					
Transfer admittance	$\|y_{fs}\|$	>	0.5	0.5	mA/V
Output admittance	$\|y_{os}\|$	<	5	5	μA/V
f = 1 MHz; $T_{amb} = 25\ ^oC$					
$V_{DS} = 15$ 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; $I_D = 200\ \mu A$; $T_{amb} = 25\ ^oC$ B = 0.6 to 100 Hz	V_n	<	0.5	0.5	μV

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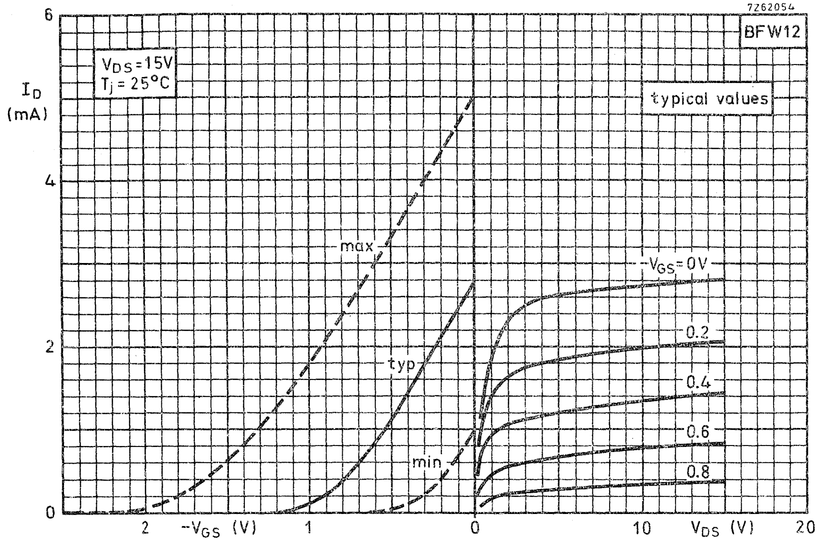
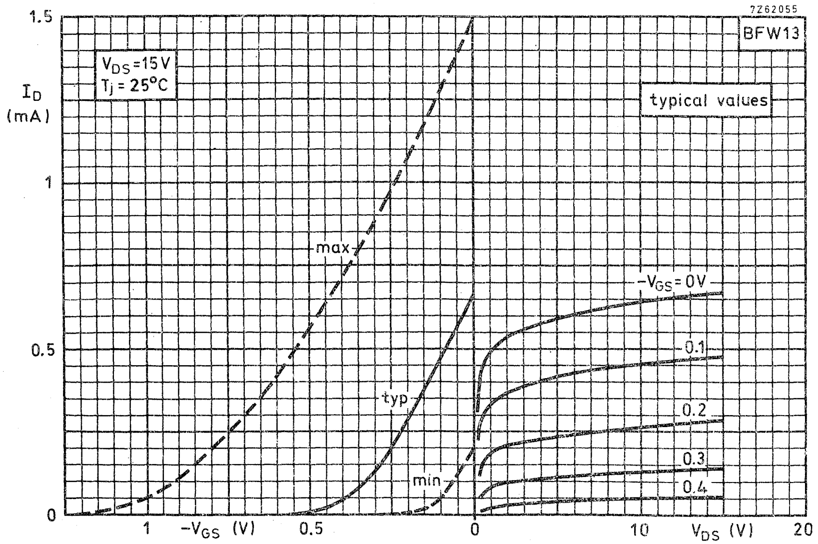
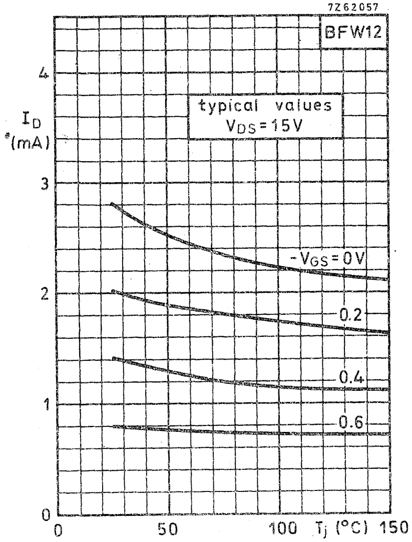
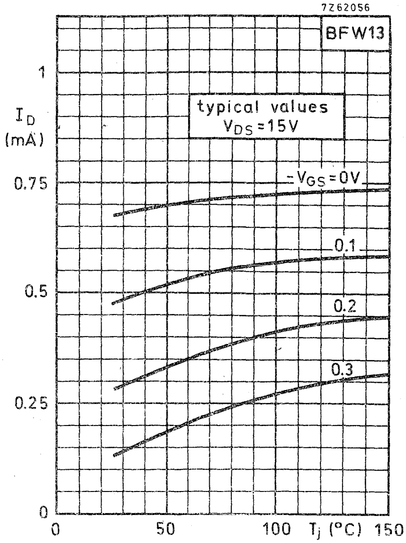
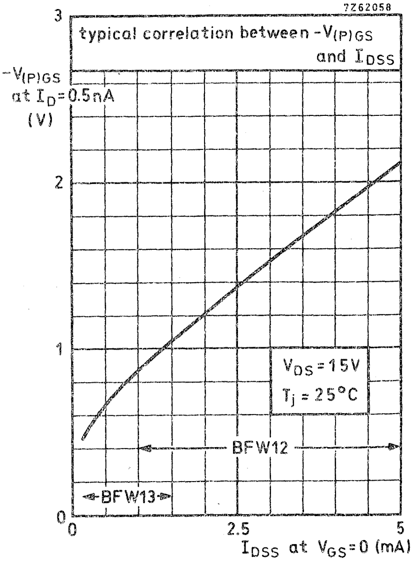
[1]) Measured under pulse conditions.

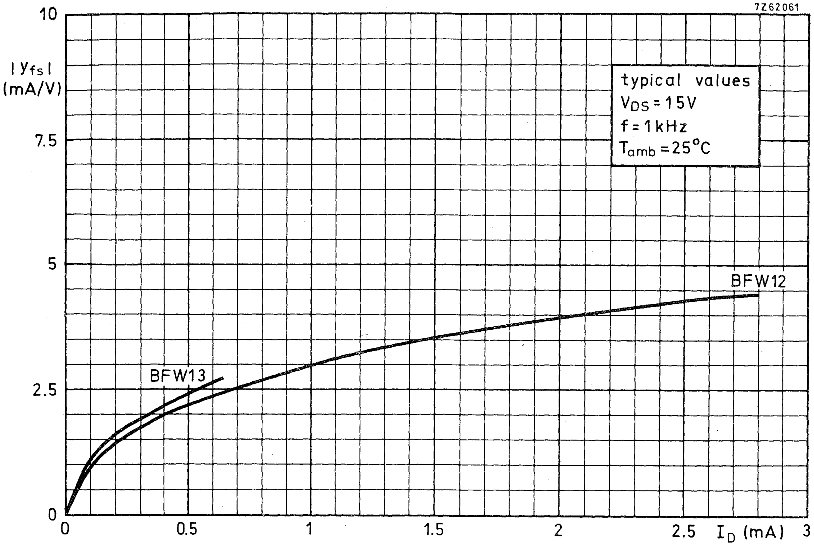

7Z62054
BFW12
V_{DS} = 15 V
T_j = 25°C
I_D (mA)
typical values
max
typ
min
$-V_{GS}$ = 0 V
0.2
0.4
0.6
0.8
6
4
2
0
2
$-V_{GS}$ (V)
1
0
10
V_{DS} (V)
20

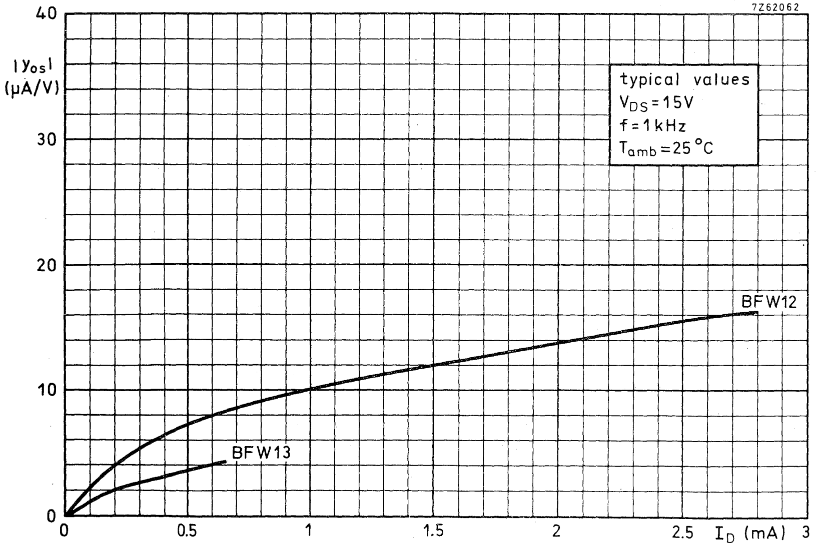

7Z62055
BFW13
V_{DS} = 15 V
T_j = 25°C
I_D (mA)
typical values
max
typ
min
$-V_{GS}$ = 0 V
0.1
0.2
0.3
0.4
1.5
1
0.5
0
1
$-V_{GS}$ (V)
0.5
0
10
V_{DS} (V)
20

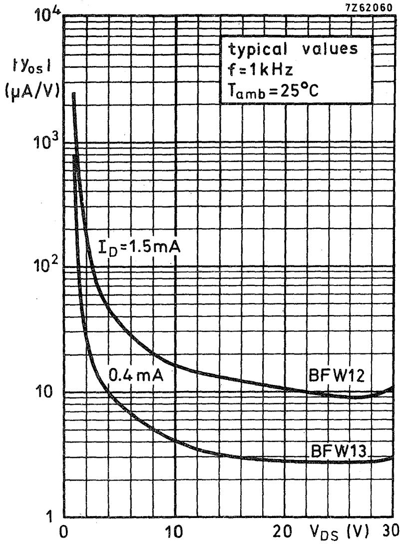

7Z62057
BFW12
typical values
V_{DS} = 15 V
I_D (mA)
4
3
2
1
0
$-V_{GS}$ = 0 V
0.2
0.4
0.6
0
50
100
T_j (°C)
150

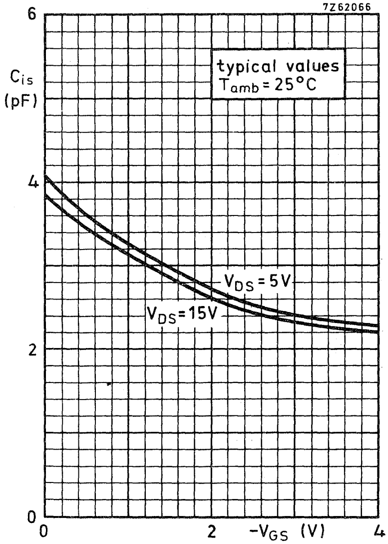

7Z62056
BFW13
typical values
V_{DS} = 15 V
I_D (mA)
1
0.75
0.5
0.25
0
$-V_{GS}$ = 0 V
0.1
0.2
0.3
0
50
100
T_j (°C)
150

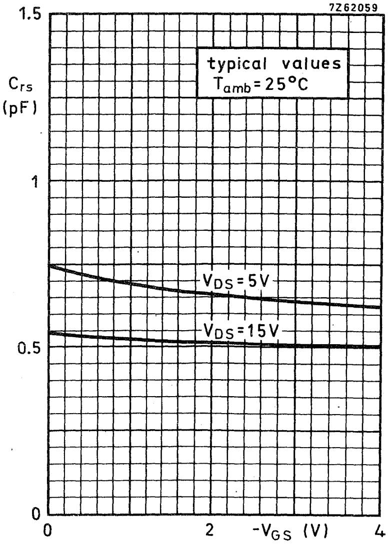

7Z62058
typical correlation between $-V_{(P)GS}$ and I_{DSS}
$-V_{(P)GS}$ at I_D = 0.5 nA (V)
3
2
1
0
V_{DS} = 15 V
T_j = 25 °C
BFW12
BFW13
0
2.5
5
I_{DSS} at V_{GS} = 0 (mA)

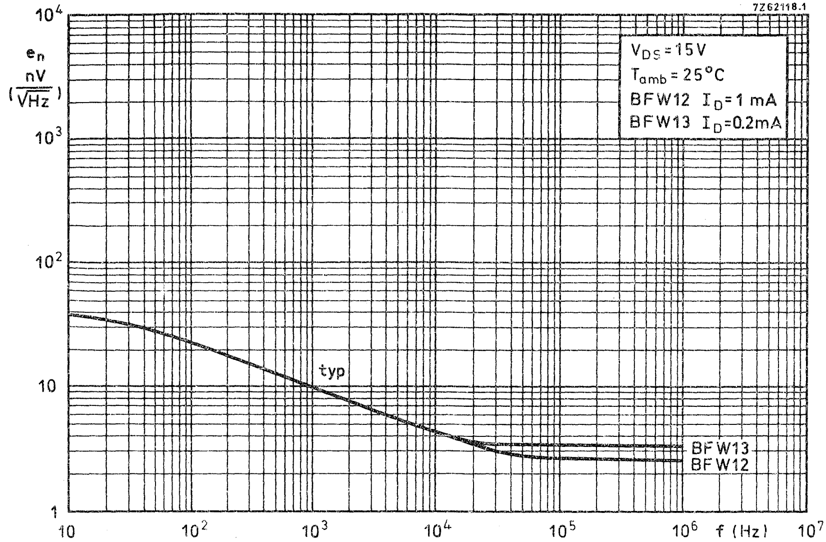

7Z62061
10
|yfs|
(mA/V)
7.5
5
2.5
0
0
0.5
1
1.5
2
2.5
ID (mA)
3
typical values
VDS = 15V
f = 1kHz
Tamb = 25°C
BFW12
BFW13

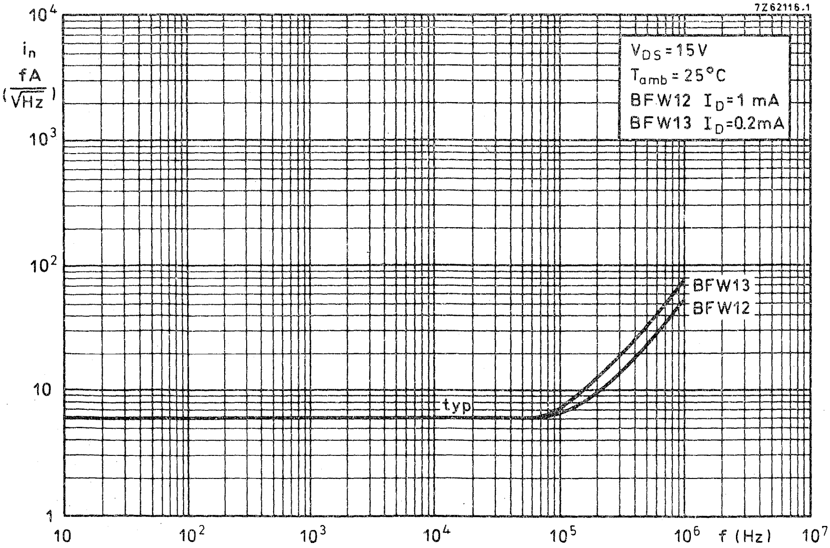

7Z62062
40
|yos|
(μA/V)
30
20
10
0
0
0.5
1
1.5
2
2.5
ID (mA)
3
typical values
VDS = 15V
f = 1kHz
Tamb = 25 °C
BFW12
BFW13

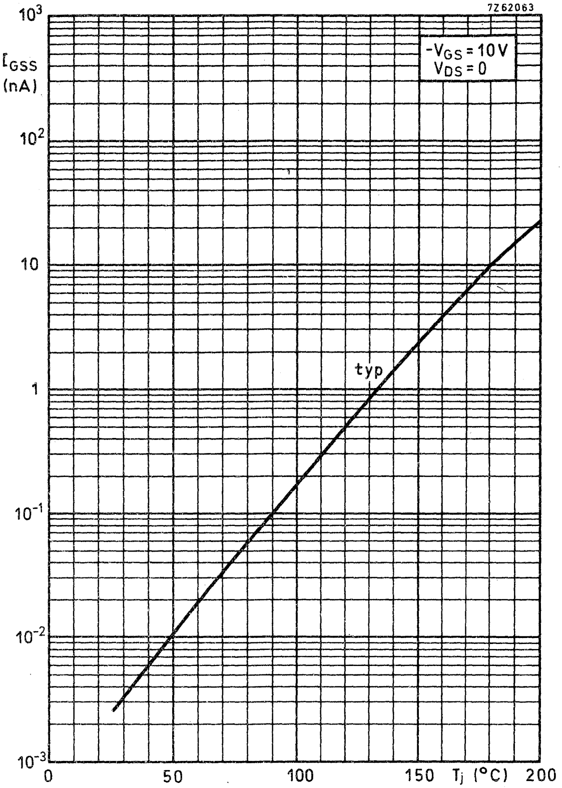

7Z62060
$|y_{os}|$ (μA/V)
10^4
10^3
10^2
10
1
typical values
f = 1 kHz
T_{amb} = 25°C
I_D = 1.5 mA
0.4 mA
BFW12
BFW13
0
10
20
V_{DS} (V)
30


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
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
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
BFW13
BFW12
typ
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

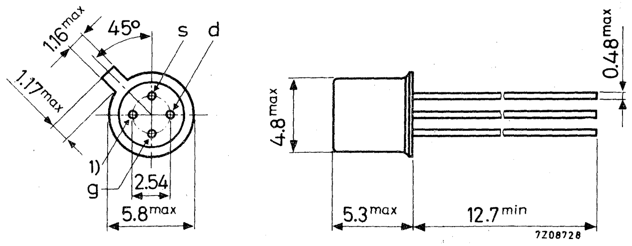
N-channel silicon epitaxial planar junction field effect transistor in a TO-72 metal envelope with the shield lead connected to the case.
The transistor is designed for general purpose amplifiers.

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	$\|y_{fs}\|$	>	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	$m\Omega^{-1}$

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[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.

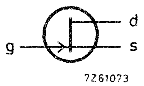
QUICK REFERENCE DATA

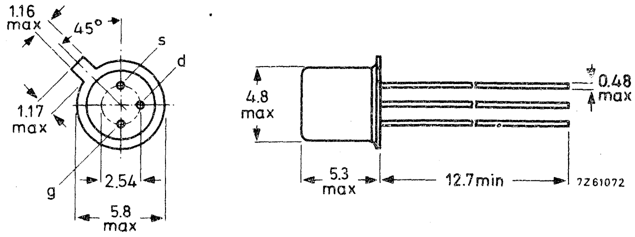
			BSV78	BSV79	BSV80	
Drain-source voltage	V_{DS}	max.	40			V
Total power dissipation up to $T_{amb} = 25\,^{o}C$	P_{tot}	max.	350			mW
Drain current $V_{DS} = 15\,V$; $V_{GS} = 0$	I_{DSS}	>	50	20	10	mA
Gate-source cut-off voltage $I_D = 1\,nA$; $V_{GS} = 15\,V$	$-V_{(P)GS}$	>	3.75	2.0	1.0	V
		<	11	7.0	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 $T_{amb} = 25\,^{o}C$	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	$R_{th\ j\text{-}a}$	=	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 °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

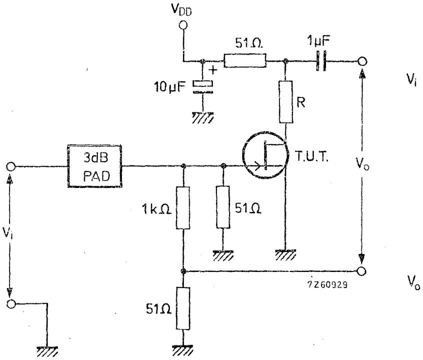
			BSV78	BSV79	BSV80	
delay time	t_d	<	5	10	8	ns
rise time	t_r	<	5	5	7	ns
turn on time	t_{on}	<	10	15	15	ns

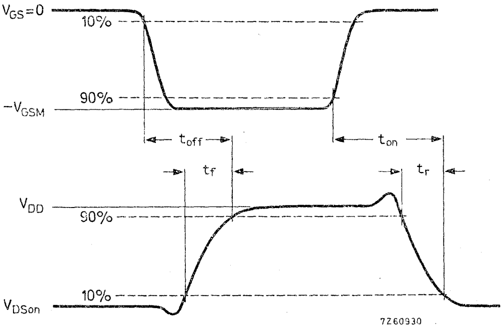
Turn off time when switched from

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:





$$R_L = \frac{10 - V_{DSon}}{I_{Don}} - 51 \quad \Omega$$

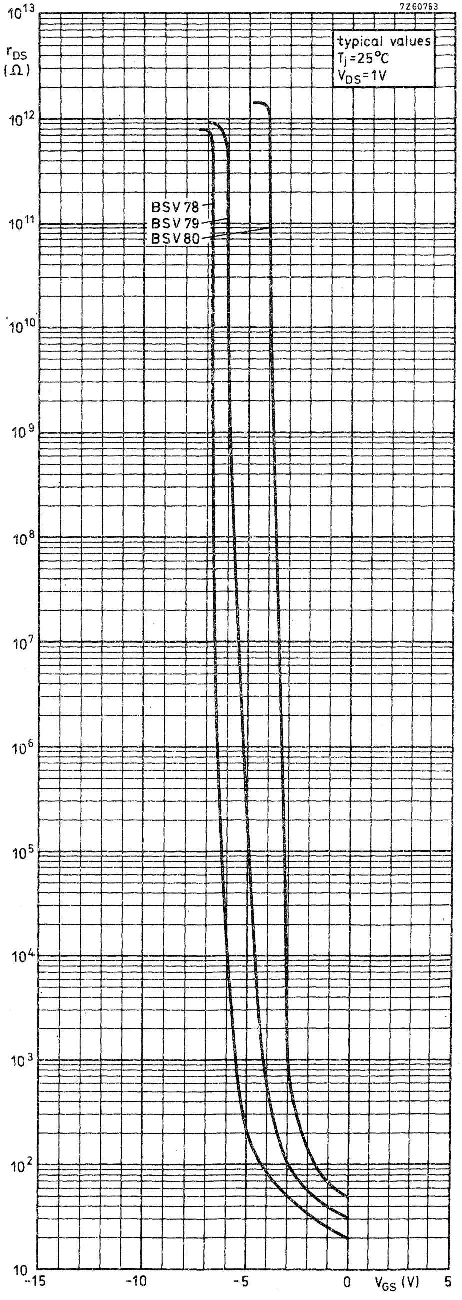
		BSV78	BSV79	BSV80	
R_L	=	424	909	1885	Ω

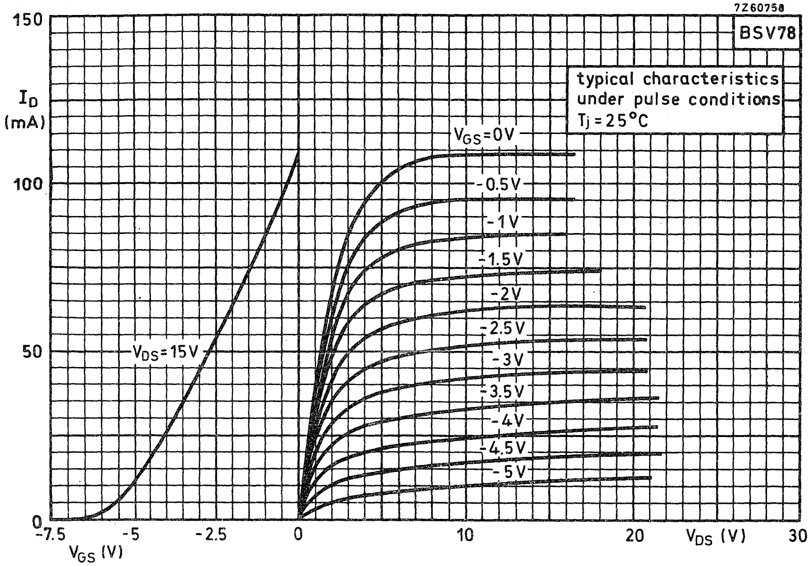
Pulse generator:

R_i = 50 Ω
t_r < 0.5 ns
t_f < 5 ns

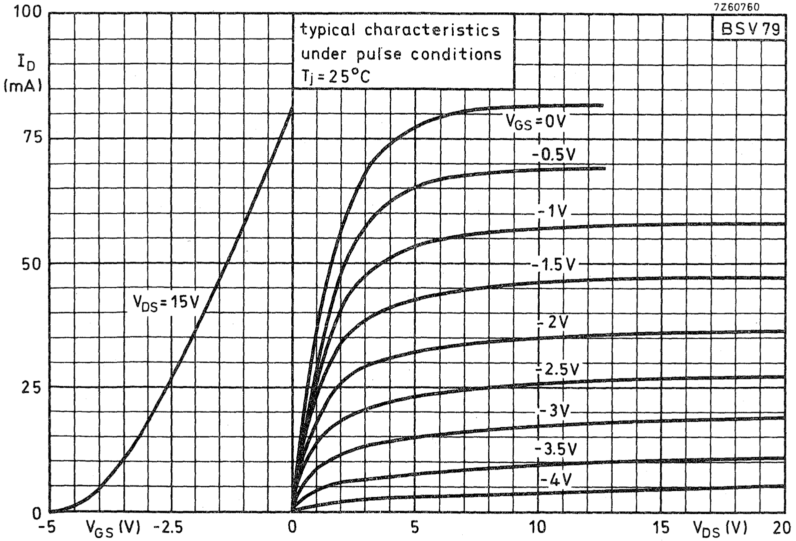
Oscilloscope:

R_i = 50 Ω
t_r < 1 ns
t_f < 1 ns

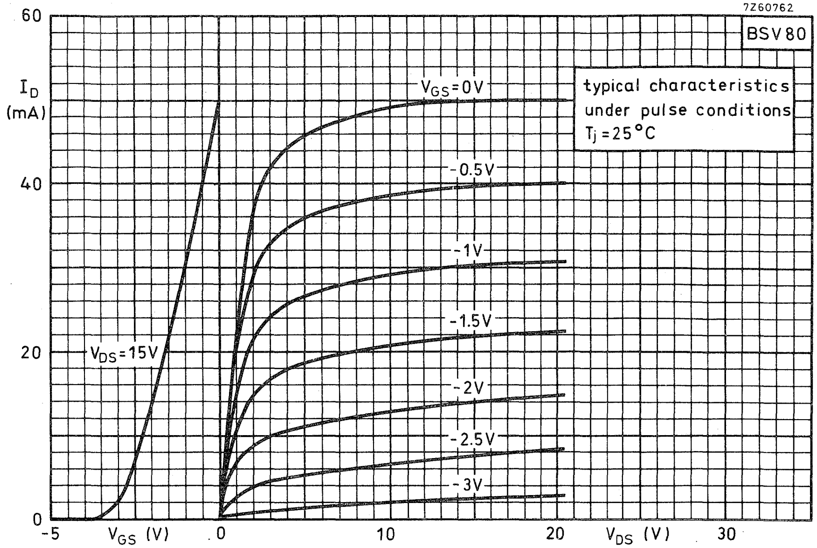

7Z60763
typical values
$T_j = 25\,^\circ C$
$V_{DS} = 1\,V$
r_{DS} (Ω)
10^{13}
10^{12}
10^{11}
10^{10}
10^{9}
10^{8}
10^{7}
10^{6}
10^{5}
10^{4}
10^{3}
10^{2}
10
BSV 78
BSV 79
BSV 80
−15
−10
−5
0
V_{GS} (V)
5

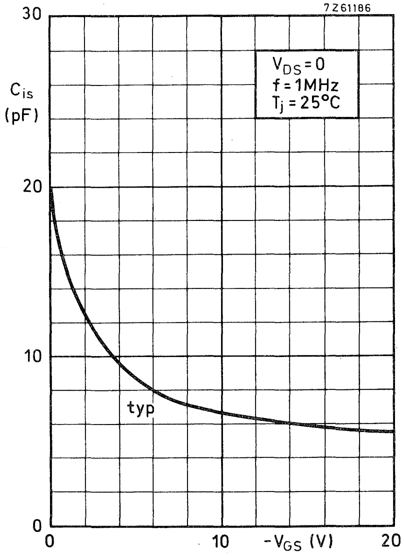


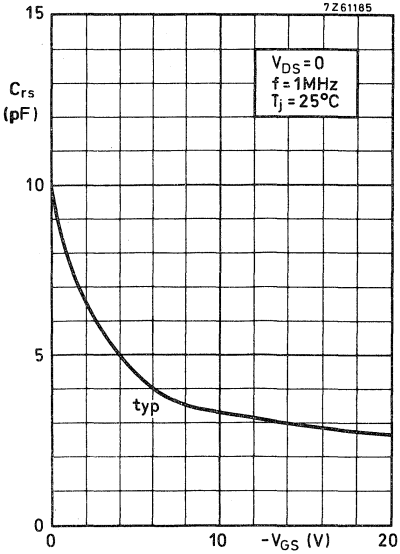
7Z60758
BSV78
typical characteristics under pulse conditions
Tj = 25°C
150
I_D (mA)
100
50
0
-7.5
-5
-2.5
0
10
20
30
V_GS (V)
V_DS (V)
V_DS = 15V
V_GS = 0V
-0.5V
-1V
-1.5V
-2V
-2.5V
-3V
-3.5V
-4V
-4.5V
-5V

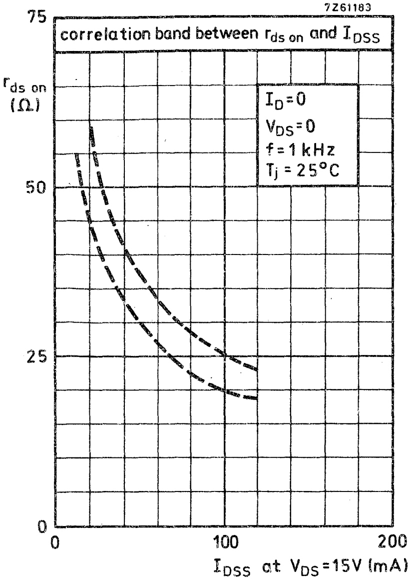


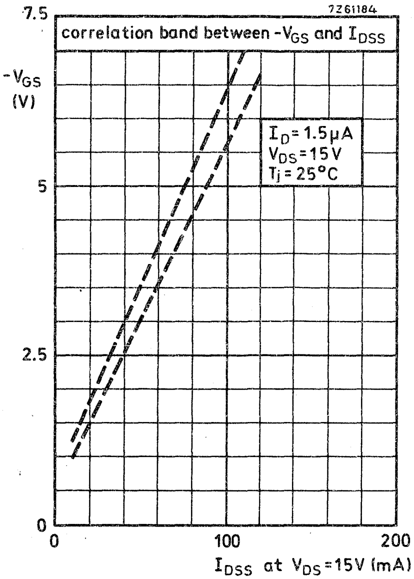
7Z60760
BSV79
typical characteristics under pulse conditions
Tj = 25°C
100
I_D (mA)
75
50
25
0
-5
-2.5
0
5
10
15
20
V_GS (V)
V_DS (V)
V_DS = 15V
V_GS = 0V
-0.5V
-1V
-1.5V
-2V
-2.5V
-3V
-3.5V
-4V


7Z60762
BSV80
typical characteristics
under pulse conditions
$T_j = 25°C$
I_D (mA)
60
40
20
0
$V_{GS} = 0V$
-0.5V
-1V
-1.5V
-2V
-2.5V
-3V
$V_{DS} = 15V$
-5
V_{GS} (V)
0
0
10
20
V_{DS} (V)
30


7Z61186
$V_{DS} = 0$
f = 1MHz
$T_j = 25°C$
C_{is} (pF)
30
20
10
0
typ
0
10
$-V_{GS}$ (V)
20

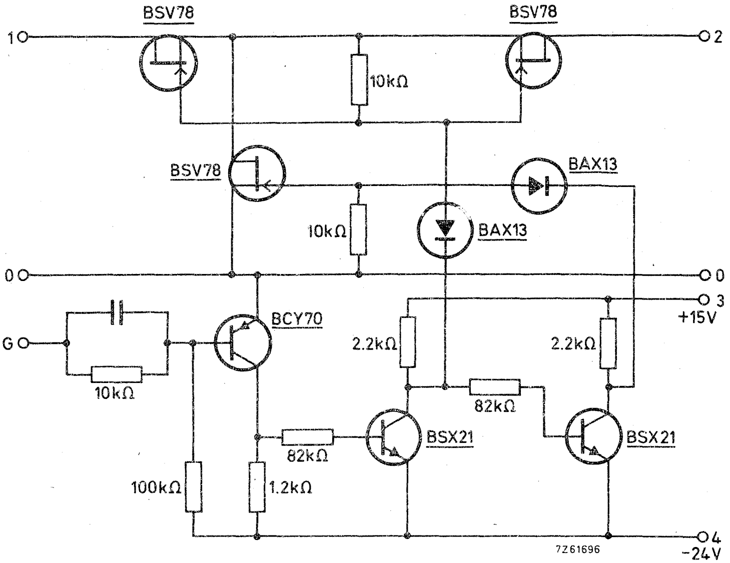

7Z61185
$V_{DS} = 0$
f = 1MHz
$T_j = 25°C$
C_{rs} (pF)
15
10
5
0
typ
0
10
$-V_{GS}$ (V)
20


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		off-state	
I_3	= 20 mA	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

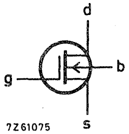
N-CHANNEL INSULATED GATE FIELD-EFFECT TRANSISTOR

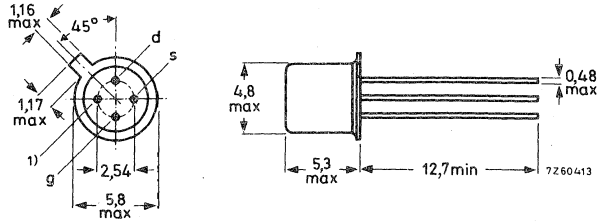
Symmetrical depletion type field-effect transistor in a TO-72 metal envelope with the substrate connected to the case.
It is intended for chopper and other special switching applications, e.g. timing circuits, multiplex circuits, etc. The features are a very low drain-source 'on' resistance, a very high 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_{dson}	<	50	Ω
Drain-source resistance (off)				
V_{DS} = 10 V; $-V_{GS}$ = 5 V; V_{BS} = 0	$r_{DS\,off}$	>	10	GΩ
Feedback capacitance 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}	<	0,5	pF

MECHANICAL DATA Dimensions in mm

TO-72





[1]) Substrate connected to case

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 (IEC134)

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
Non-repetitive peak gate to all other terminals voltage $V_{SB} = V_{DB} = 0$; $t < 10$ ms	$V_{G\text{-}N}$	max. min.	50 −50	V V

Currents

Drain current (peak value) $t_r = 20$ ms; $\delta = 0{,}1$	I_{DM}	max.	50	mA
Source current (peak value) $t_r = 20$ ms; $\delta = 0{,}1$	I_{SM}	max.	50	mA

Power dissipation

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

Temperatures

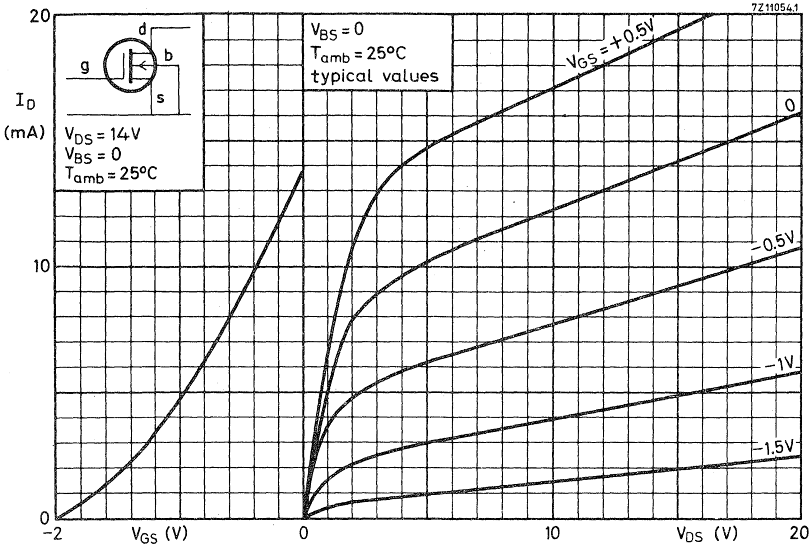
Storage temperature	T_{stg}		−65 to +125	°C
Junction temperature	T_j	max.	125	°C

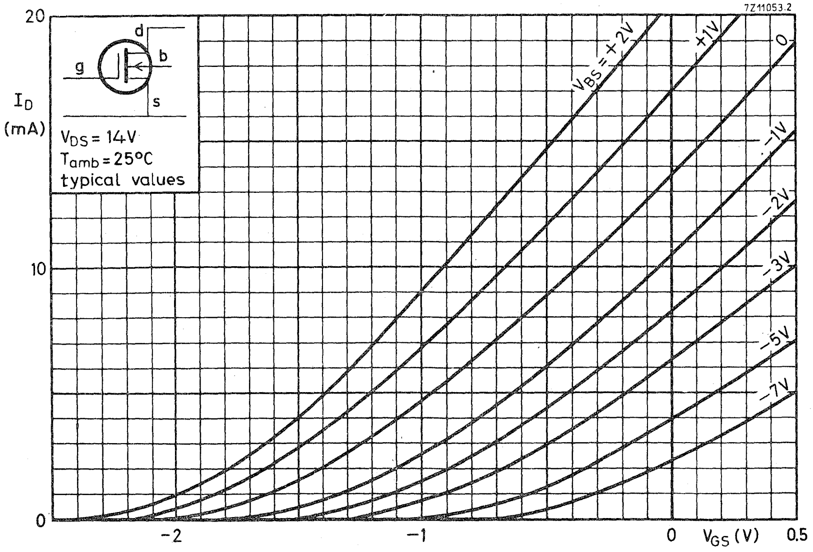
THERMAL RESISTANCE

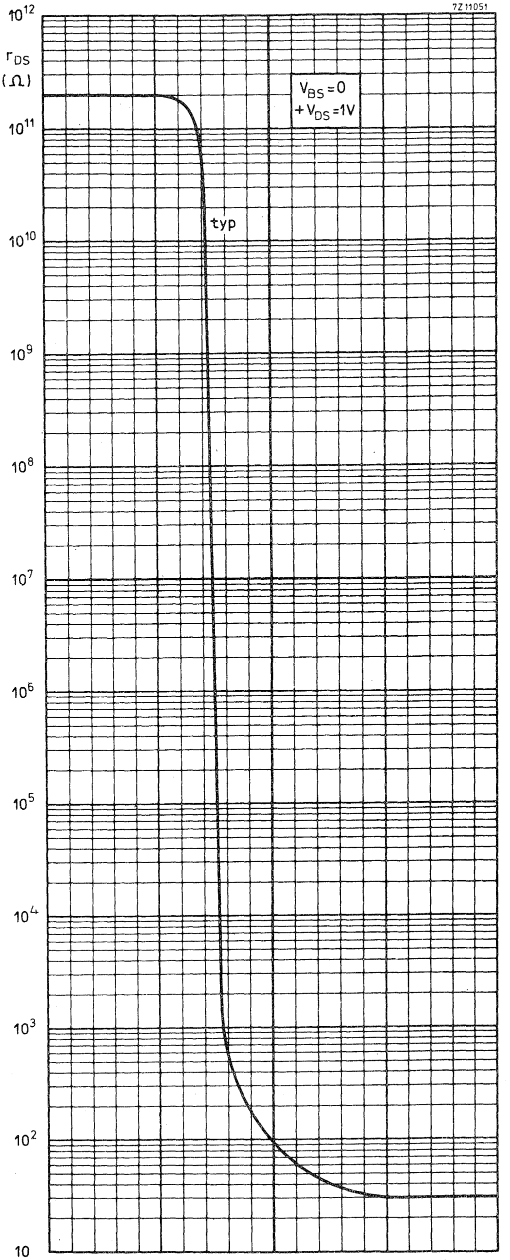
From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	0,5	°C/mW

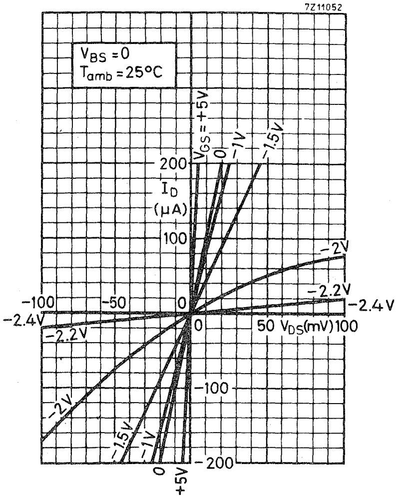
CHARACTERISTICS $T_j = 25\ ^{o}C$ unless otherwise specified

Drain cut-off currents; $V_{BS} = 0$					
$V_{DS} = 10\ V;\ -V_{GS} = 5\ V$	I_{DSX}	$<$	1	nA	
$V_{DS} = 10\ V;\ -V_{GS} = 5\ V;\ T_j = 125\ ^{o}C$	I_{DSX}	$<$	1	μA	
Source cut-off currents; $V_{BD} = 0$					
$V_{SD} = 10\ V;\ -V_{GD} = 5\ V$	I_{SDX}	$<$	1	nA	
$V_{SD} = 10\ V;\ -V_{GD} = 5\ V;\ T_j = 125\ ^{o}C$	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	
$-V_{GS} = 10\ V;\ V_{DS} = 0;\ T_j = 125\ ^{o}C$	$-I_{GSS}$	$<$	200	pA	
$V_{GS} = 10\ V;\ V_{DS} = 0;\ T_j = 125\ ^{o}C$	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	
$V_{GS} = 0\ ;\ V_{DS} = 0;\ T_j = 125\ ^{o}C$	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}	$<$	0,5	pF	←
Gate to all other terminals capacitance at f = 1 MHz					
$-V_{GB} = 5\ V;\ V_{SB} = V_{DB} = 0$	C_{g-n}	$<$	6	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
r_{DS}
(Ω)
10^{12}
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
50 V_{DS}(mV) 100
−2.4V
−2.2V
−100
−2V
−1.5V
−1V
0
+5V
−200

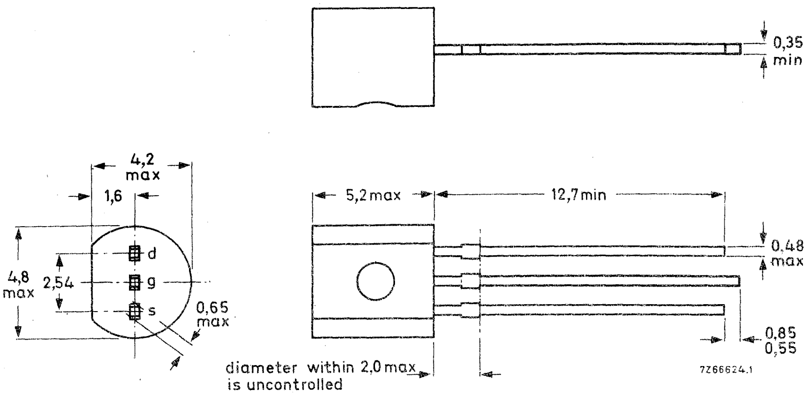
N-CHANNEL SILICON FIELD-EFFECT TRANSISTOR

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 V_{DS} = 15 V; V_{GS} = 0	C_{rs}	<	4	pF
Transfer admittance (common source) V_{DS} = 15 V; V_{GS} = 0	$\lvert y_{fs} \rvert$		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	$R_{th\ j-a}$	=	347	°C/W

CHARACTERISTICS T_{amb} = 25 °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 °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 µA; V_{DS} = 0		$-V_{(BR)GSS}$	>	25	V	
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 = 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

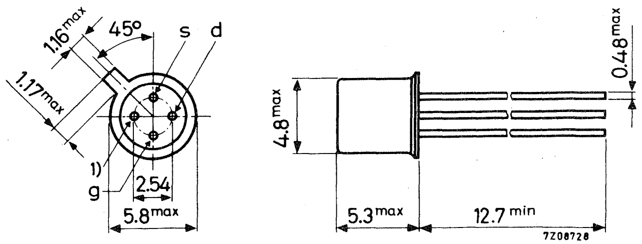
Silicon N-channel depletion type junction-triode field effect transistor in a TO-72 metal envelope, primarily intended for depletion mode operation in low power i.f.-r.f. amplifiers for industrial applications.

QUICK REFERENCE DATA

Drain-source voltage	V_{DS}	max.	30	V
Gate-source voltage	$-V_{GS}$	max.	30	V
Total power dissipation up to $T_{amb} = 25\ ^{o}C$	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 $T_{amb} = 25\ ^{o}C$	$\lvert y_{fs} \rvert$	$>$	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 $T_{amb} = 25\ ^oC$	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 $T_j = 25\ ^oC$ unless otherwise specified

Gate cut-off current				
$-V_{GS} = 20$ V; $V_{DS} = 0$	$-I_{GSS}$	<	0.5	nA
$-V_{GS} = 20$ V; $V_{DS} = 0$; $T_j = 150\ ^oC$	$-I_{GSS}$	<	0.5	μA
Drain current [1]				
$V_{DS} = 15$ V; $V_{GS} = 0$	I_{DSS}	4 to	20	mA
Gate-source voltage				
$I_D = 400\ \mu A$; $V_{DS} = 15$ 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				
$-I_G = 1\ \mu A$; $V_{DS} = 0$	$-V_{(BR)GSS}$	>	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

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[1] Measured under pulsed conditions; Pulse duration t = 100 ms; duty cycle $\delta \leqslant 0.1$

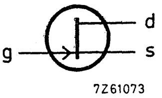
N-CHANNEL SILICON FIELD EFFECT TRANSISTOR

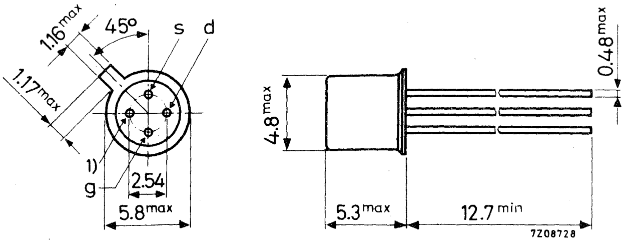
N-channel silicon epitaxial planar junction field effect transistor in a TO-72 metal envelope with the shield lead connected to the case.
The transistor is suitable in a variety of low power switching applications, e.g. in multiplexing systems.

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 $T_{amb} = 25\ ^oC$	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)

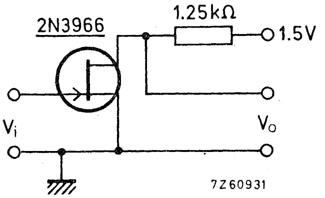
Switching times

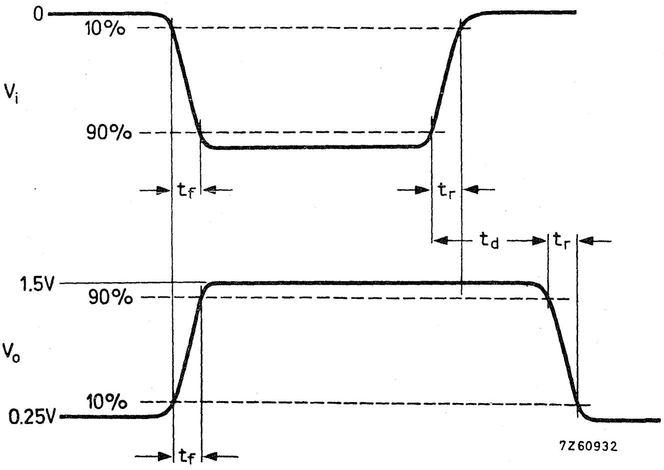
$V_{DD} = 1.5$ V; $I_{D\,on} = 1.0$ mA

$V_{GS\,on} = 0$; $-V_{GS\,off} = 6$ 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.

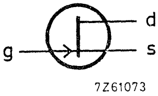
QUICK REFERENCE DATA

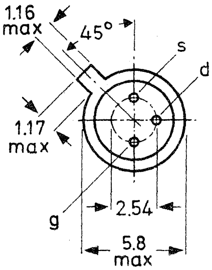
			2N4091	2N4092	2N4093	
Drain-source voltage	$\pm V_{DS}$	max.	40			V
Total power dissipation up to T_{case} = 25 °C	P_{tot}	max.	1.8			W
Drain current V_{DS} = 20 V; V_{GS} = 0	I_{DSS}	>	30	15	8	mA
Gate-source cut-off voltage I_D = 1 nA; V_{DS} = 20 V	$-V_{(P)GS}$	>	5.0	2.0	1.0	V
		<	10	7.0	5.0	V
Drain-source 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

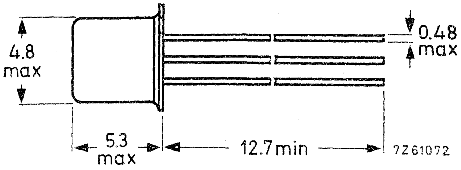
MECHANICAL DATA

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 $T_{case} = 25\ ^{o}C$	P_{tot}	max.	1.8	W
Temperatures				
Storage temperature	T_{stg}	-55 to	+200	^{o}C
Junction temperature	T_j	max.	200	^{o}C

THERMAL RESISTANCE

From junction to case in free air	$R_{th\ j-c}$	=	0.1	$^{o}C/mW$

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

Drain current				
$V_{DG} = 20$ V; $I_S = 0$	I_{DGO}	<	0.2	nA
$V_{DG} = 20$ V; $I_S = 0$; $T_{amb} = 150\ ^{\circ}C$	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; $T_{amb} = 150\ ^{\circ}C$	I_{DSX}	<	0.4	–	–	µA
$V_{DS} = 20$ V; $-V_{GS} = 8$ V; $T_{amb} = 150\ ^{\circ}C$	I_{DSX}	<	–	0.4	–	µA
$V_{DS} = 20$ V; $-V_{GS} = 6$ V; $T_{amb} = 150\ ^{\circ}C$	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

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[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)

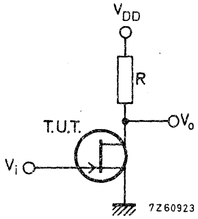
Input capacitance				
V_{DS} = 20 V ; V_{GS} = 0	C_{is}	<	16	pF
Feedback capacitance				
→ V_{DS} = 0 ; $-V_{GS}$ = 20 V	C_{rs}	<	5	pF

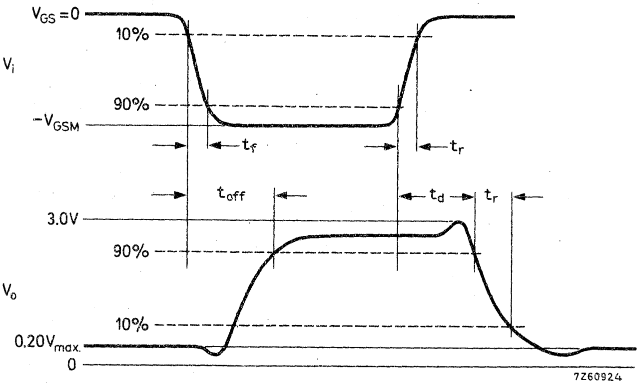
Switching times

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
C_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.

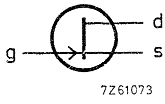
QUICK REFERENCE DATA

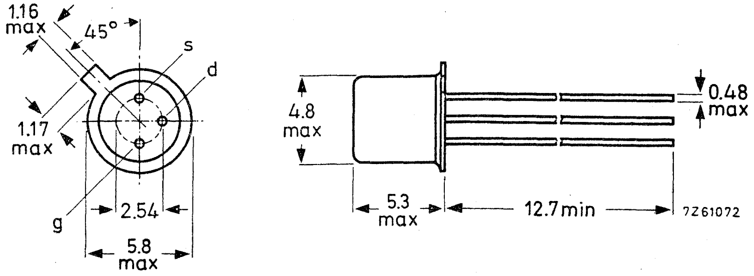
			2N4391	2N4392	2N4393	
Drain-source voltage	$\pm V_{DS}$	max.	40			V
Total power dissipation up to T_{case} = 25 °C	P_{tot}	max.	1.8			W
Drain current V_{DS} = 20 V; V_{GS} = 0	I_{DSS}	>	50	25	5	mA
Gate source cut-off voltage I_D = 1 nA; V_{DS} = 20 V	$-V_{(P)GS}$	>	4.0	2.0	0.5	V
		<	10	5.0	3.0	V
Drain-source 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





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

Gate cut-off current

$-V_{GS} = 20$ V; $V_{DS} = 0$	$-I_{GSS} <$	0.1	nA
$-V_{GS} = 20$ V; $V_{DS} = 0$; $T_{amb} = 150\,^{o}C$	$-I_{GSS} <$	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; $T_{amb} = 150\,^{o}C$	$I_{DSX} <$	0.2	–	–	μA
$V_{DS} = 20$ V; $-V_{GS} = 7$ V; $T_{amb} = 150\,^{o}C$	$I_{DSX} <$	–	0.2	–	μA
$V_{DS} = 20$ V; $-V_{GS} = 5$ V; $T_{amb} = 150\,^{o}C$	$I_{DSX} <$	–	–	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

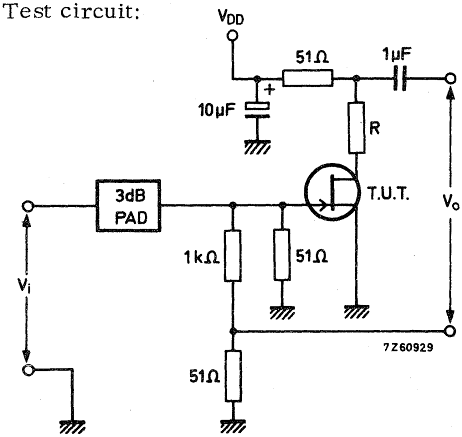
CHARACTERISTICS (continued) $T_{amb} = 25\,^{o}C$ unless otherwise specified

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

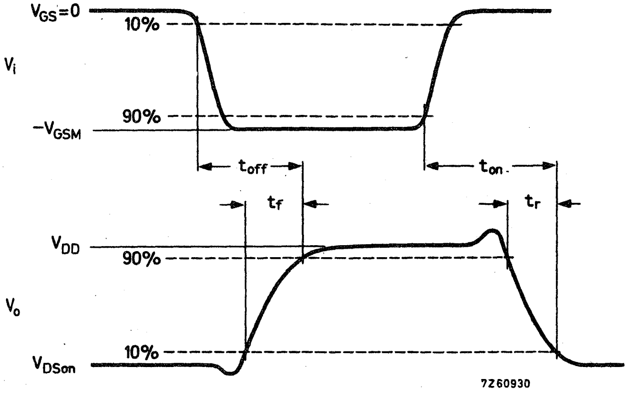
t_f < 0.5 ns

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.

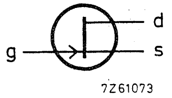
QUICK REFERENCE DATA

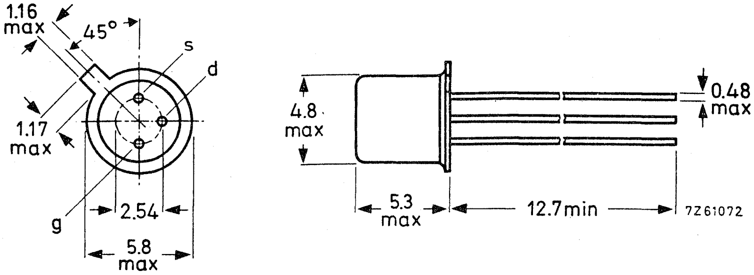
Drain-source voltage 2N4856 to 2N4858	±V_{DS}	max.	40			V
Drain-source voltage 2N4859 to 2N4861	±V_{DS}	max.	30			V
Total power dissipation up to $T_{amb} = 25\ ^{o}C$	P_{tot}	max.	360			mW
			2N4856 2N4859	2N4857 2N4860	2N4858 2N4861	
Drain current $V_{DS} = 15\ V$; $V_{GS} = 0$	I_{DSS}	>	50	20	8	mA
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 $T_{amb} = 25\,^{o}C$	P_{tot}	max.	360		mW
Temperatures					
Storage temperature	T_{stg}	−65 to	+200		^{o}C
Junction temperature	T_j	max.	200		^{o}C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	0.49	$^{o}C/mW$

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 °C	$-I_{GSS}$	<	0.5	–	µA
$-V_{GS}$ = 15 V; V_{DS} = 0; T_{amb} = 150 °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 °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 µA; 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

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[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)

$-V_{GS} = 10\,V;\ V_{DS} = 0$

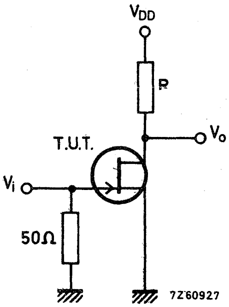
Input capacitance	C_{is}	<	18	pF
Feedback capacitance	C_{rs}	<	8	pF

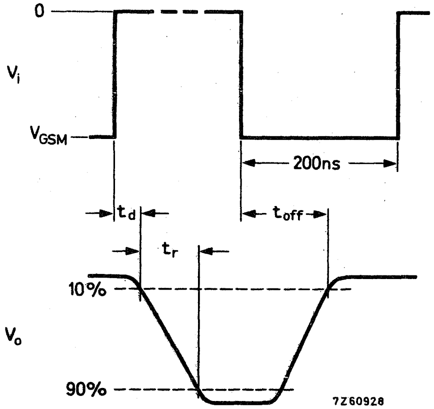
Switching times

$V_{DD} = 10\,V;\ V_{GS} = 0$

			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	≤	1	ns
t_f	≤	1	ns
δ	=	0.02	
Z_o	=	50	Ω

Oscilloscope:

t_r	≤	0.75	ns
R_i	≥	1	MΩ
C_i	≤	2.5	pF

Dual transistors

N-P-N SILICON PLANAR LOW-LEVEL DUAL TRANSISTORS FOR DIFFERENTIAL AMPLIFIERS

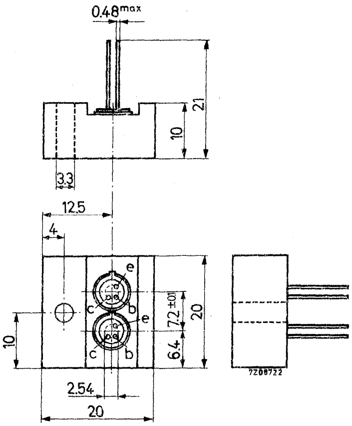
Two special matched transistors in a TO-18 metal envelope, housed together in an aluminium cube.
The BCY55 is intended for very low level, low noise and low drift differential amplifiers.

QUICK REFERENCE DATA

Equivalent differential voltage change referred to the input $\left\|I_{1E} + I_{2E}\right\| \leq 200\ \mu A$ $V_{1C-1E} = V_{2C-2E} \leq 20\ V$ $\left\|V_{1B-1E} - V_{2B-2E}\right\| \leq 100\ \mu V$ T_{amb}: −20 to +90 °C	$\left\|\frac{\Delta V}{\Delta T}\right\|$	typ. <	1 3	μV/°C 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 1.5	nA/°C nA/°C

MECHANICAL DATA Dimensions in mm

SOT-41



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

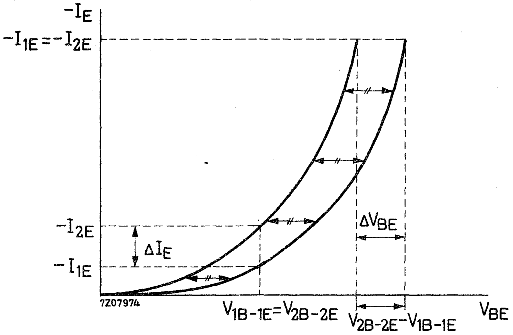
$\frac{I_{1C}}{I_{2C}}$ 0.85 to 1
typ. 0.93

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:



$$\frac{I_{2E}}{I_{1E}} = \text{exp.}\ \frac{q}{kT}\ .\ \Delta V_{BE}$$

$\frac{I_{2E}}{I_{1E}}$ measured at $\Delta V_{BE} = 0$

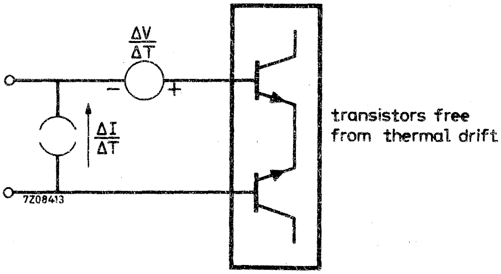
ΔV_{BE} measured at $\frac{I_{2E}}{I_{1E}} = 1$

CHARACTERISTICS of the complete device (continued)

Equivalent circuit for drift

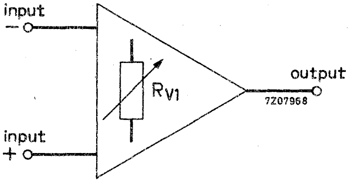
In the equivalent circuit the transistors are considered to be drift free. All temperature coefficients are concentrated in the voltage source $\frac{\Delta V}{\Delta T}$ and in the current source $\frac{\Delta I}{\Delta T}$.

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

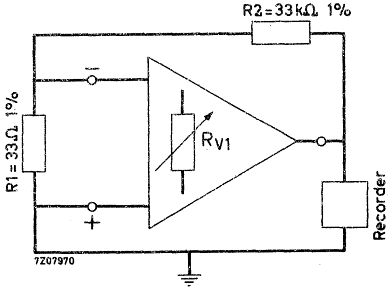
Equivalent differential current change with temperature referred to the input.

$I_{1C} + I_{2C} = 100\ \mu A$

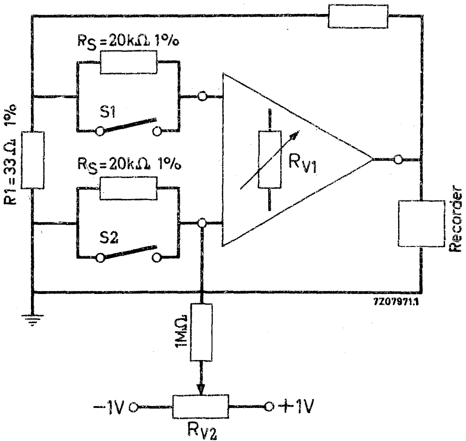
$\frac{\Delta I}{\Delta T}$	typ.	0.5	nA/°C
	<	1.5	nA/°C

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.

$$\text{Then: } \frac{\Delta V}{\Delta T} = \frac{V_{T2} - V_{T1}}{T_2 - T_1} \cdot \frac{R1}{R2} \quad \text{or} \quad \frac{\Delta I}{\Delta T} = \frac{V_{T2} - V_{T1}}{T_2 - T_1} \cdot \frac{R1}{R2} \cdot \frac{1}{2R_S}$$

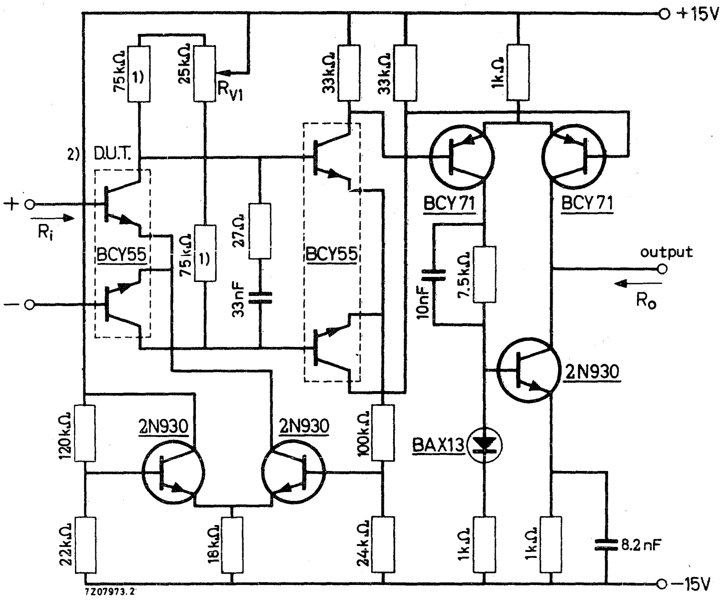
---

[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.



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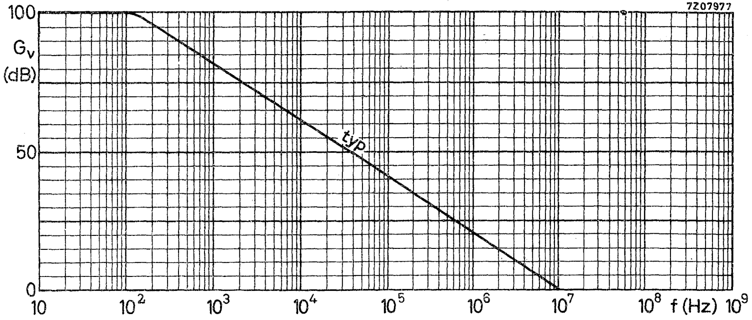
[1] Relative temperature coefficient < $10^{-5}/^{\circ}C$

[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 $T_{amb} = 25\ ^oC$	P_{tot}	max.	300	mW
Temperatures				
Storage temperature	T_{stg}	-50 to +125		°C
Junction temperature	T_j	max.	125	°C

THERMAL RESISTANCE

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

(This value applies to one transistor at equal dissipation or difference in dissipation < 20% in both transistors of the unit)

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[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.

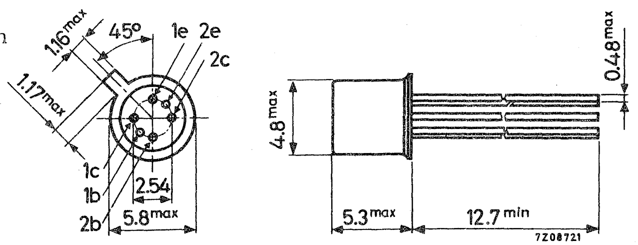
		BCY87	BCY88	BCY89	
Ratio of collector currents at $V_{1B-1E} = V_{2B-2E}$	I_{1C}/I_{2C}	0.9-1.11	0.8-1.25	0.67-1.5	
Base current difference at $V_{1B-1E} = V_{2B-2E}$	$\lvert I_{1B}-I_{2B}\rvert$	< 25	80	300	nA
Equivalent differential voltage change with temperature	$\left\lvert\frac{\Delta V}{\Delta T}\right\rvert$ 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



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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						
$I_C = 5$ µA; $V_{CB} = 10$ V	h_{FE}	>	80	–	–	
$I_C = 50$ µA; $V_{CB} = 10$ V	h_{FE}	>	100	100	100	
		<	450	450	450	
$I_C = 500$ µA; $V_{CB} = 10$ V	h_{FE}	>	–	120	–	
		<	–	600	–	
$I_C = 10$ mA; $V_{CB} = 10$ V	h_{FE}	>	–	–	100	
		<	–	–	600	
Transition frequency						
$-I_E = 50$ µA; $V_{CB} = 10$ V	f_T	>	10	10	10	MHz
$-I_E = 500$ µA; $V_{CB} = 10$ 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						
$I_C = 50$ µA; $V_{CE} = 5$ V; $R_S = 10$ kΩ Bandwidth 10 Hz to 15 kHz	F	<	3	4	4	dB
1 kHz spot noise figure $I_C = 50$ µA; $V_{CE} = 5$ 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:

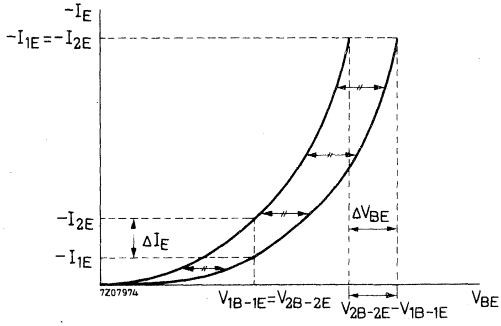
a. Collector-base voltage of both transistors not exceeding 10 V ($V_{1C-1B} = V_{2C-2B} \leq 10$ V)

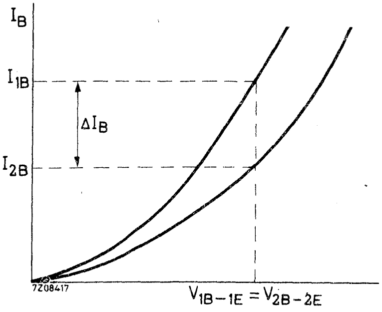
b. Sum of the emitter currents from 10 to 100 μA
$-(I_{1E} + I_{2E}) = 10$ to 100 μA

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:





$$\frac{I_{2E}}{I_{1E}} = \exp.\frac{q}{KT} \cdot \Delta V_{BE}$$

$\dfrac{I_{2E}}{I_{1E}}$ measured at $\Delta V_{BE} = 0$

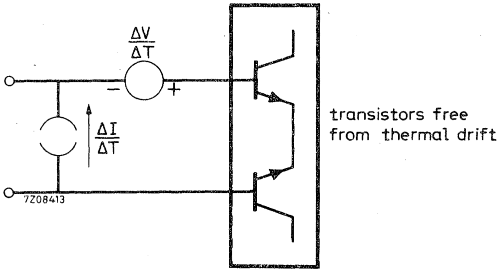
ΔV_{BE} measured at $\dfrac{I_{2E}}{I_{1E}} = 1$

CHARACTERISTICS of the complete device (continued)

Equivalent circuit for drift

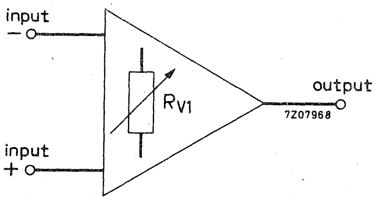
In the equivalent circuit the transistors are considered to be drift free. All temperature coefficients are concentrated in the voltage source $\frac{\Delta V}{\Delta T}$ and in the current source $\frac{\Delta I}{\Delta T}$.

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:

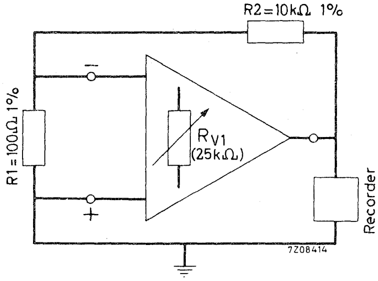


CHARACTERISTICS of the complete device (continued)

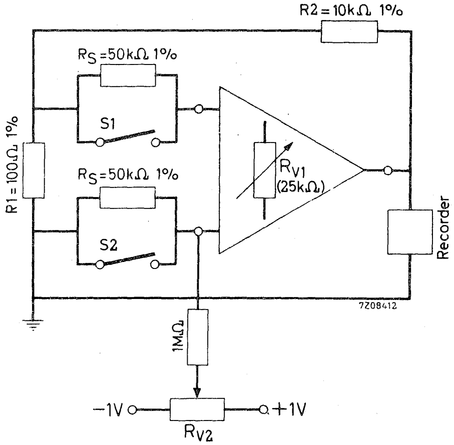
			BCY87	BCY88	BCY89	
Equivalent differential voltage change with temperature						
T_{amb} = -20 to +90 °C	$\left\lvert\frac{\Delta V}{\Delta T}\right\rvert$	typ.	1	2	4	µV/°C
		<	3	6	10	µV/°C
Equivalent differential current change with temperature						
T_{amb} = -20 to +90 °C	$\left\lvert\frac{\Delta I}{\Delta T}\right\rvert$	<	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.

Then: $\frac{\Delta V}{\Delta T} = \frac{V_{T2} - V_{T1}}{T_2 - T_1} \cdot \frac{R1}{R2}$ or $\frac{\Delta I}{\Delta T} = \frac{V_{T2} - V_{T1}}{T_2 - T_1} \cdot \frac{R1}{R2} \cdot \frac{1}{2R_S}$

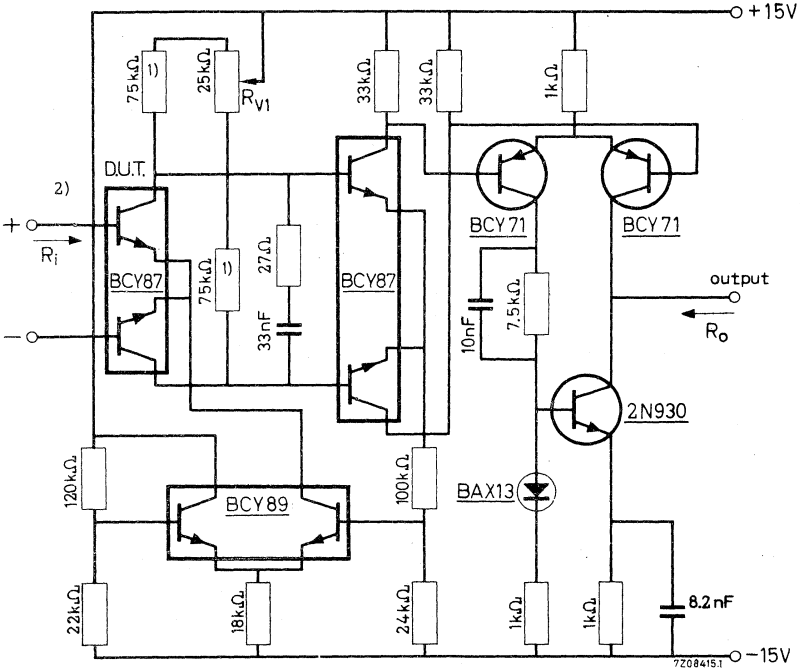
---

[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.



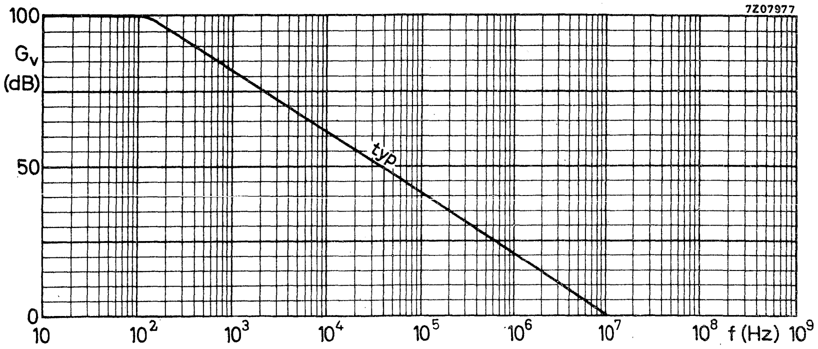
---

1) Relative temperature coefficient < $10^{-5}/^{o}C$

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

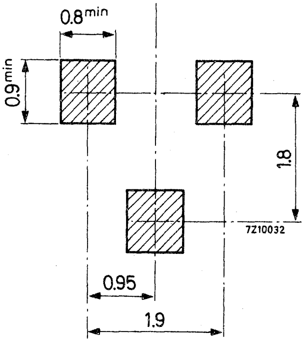
The preferred technique for mounting micro miniature components on hybrid thick- and thin-film circuits is reflow soldering. The fernico-tags of the SOT-23 envelope are pre-tinned with a solder that melts at about 185 °C. The best results are obtained when a similar solder is applied to the corresponding 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
BFT25	V1	BFT25R	V4
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 BAV70 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)

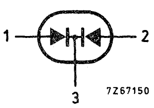
Continuous reverse voltage	V_R	max.	70	V
Repetitive peak reverse voltage	V_{RRM}	max.	70	V
Repetitive peak forward current	I_{FRM}	max.	200	mA
Junction temperature	T_j	max.	150	°C
Forward voltage at I_F = 50 mA	V_F	<	1,1	V
Reverse recovery time when switched from I_F = 10 mA to I_R = 10 mA; R_L = 100 Ω; measured at I_R = 1 mA	t_{rr}	<	6	ns
Recovery charge when switched from I_F = 10 mA to V_R = 5 V; R_L = 500 Ω	Q_s	<	45	pC

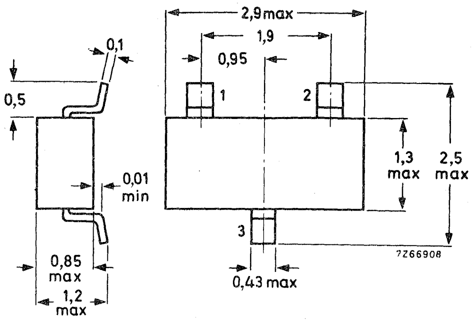
MECHANICAL DATA

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

Average 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	$R_{th\ j\text{-}a}$	=	1,10	°C/mW
one diode loaded	$R_{th\ j\text{-}a}$	=	0,67	°C/mW

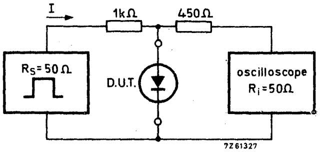
---

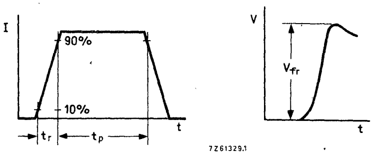
1) Measured under pulse conditions: pulse time $t_p \leq 0,5$ ms.
For sinusoidal operation $I_{F(AV)} = 65$ mA; averaging time $t_{(av)} \leq 1$ ms).

CHARACTERISTICS (per diode) $T_j = 25\ ^oC$ 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; $T_j = 150\ ^oC$	I_R	<	60	µA
$V_R = 70$ V	I_R	<	5	µA
$V_R = 70$ V; $T_j = 150\ ^oC$	I_R	<	100	µA
Diode capacitance				
$V_R = 0$; f = 1 MHz	C_d	<	1,5	pF
Forward recovery voltage when switched to				
$I_F = 10$ mA; $t_r = 20$ ns	V_{fr}	<	1,75	V

Test circuit and waveforms :





input signal output signal

Input signal : Rise time of the forward pulse $t_r = 20$ ns

Forward current pulse duration $t_p = 120$ ns

Duty factor $\delta = 0,01$

Oscilloscope: Rise time $t_r = 0,35$ ns

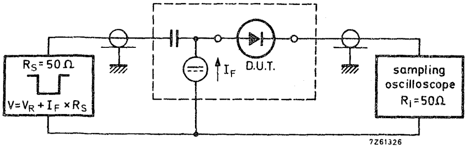
Circuit capacitance $C \leq 1$ pF (C = oscilloscope input capacitance + parasitic capacitance)

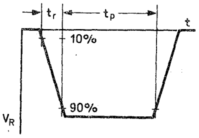
CHARACTERISTICS (per diode) (continued) $T_j = 25\ ^oC$

→ Reverse recovery time when switched from

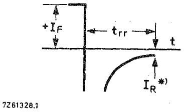
I_F = 10 mA to I_R = 10 mA; R_L = 100 Ω;
measured at I_R = 1 mA t_{rr} < 6 ns

Test circuit and waveforms:





input signal



output signal

Input signal : Rise time of the reverse pulse t_r = 0,6 ns *) I_R = 1 mA

Reverse pulse duration t_p = 100 ns

Duty factor δ = 0,05

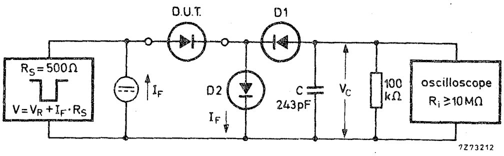
Oscilloscope: Rise time t_r = 0,35 ns

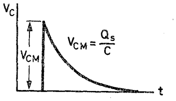
Circuit capacitance C ≤ 1 pF (C = oscilloscope input capacitance + parasitic capacitance)

Recovery charge when switched from

I_F = 10 mA to V_R = 5 V; R_L = 500 Ω Q_s < 45 pC

Test circuit and waveform:





output signal

D1 = BAW62

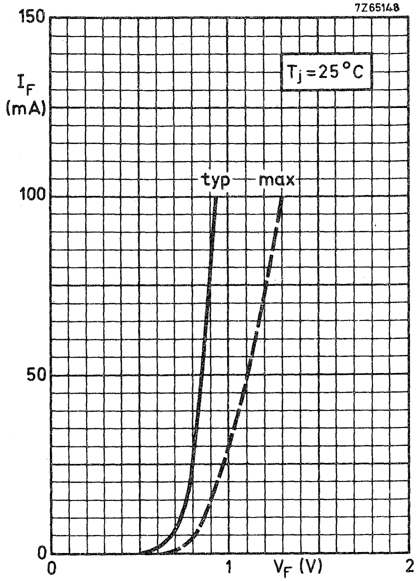
D2 = diode with minority carrier life time at 10 mA: < 200 ps

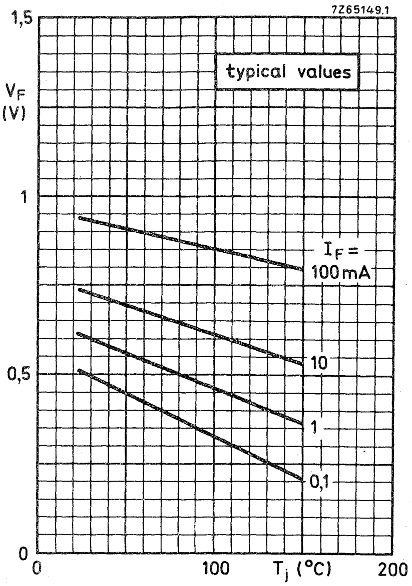
Input signal : Rise time of the reverse pulse t_r = 2 ns

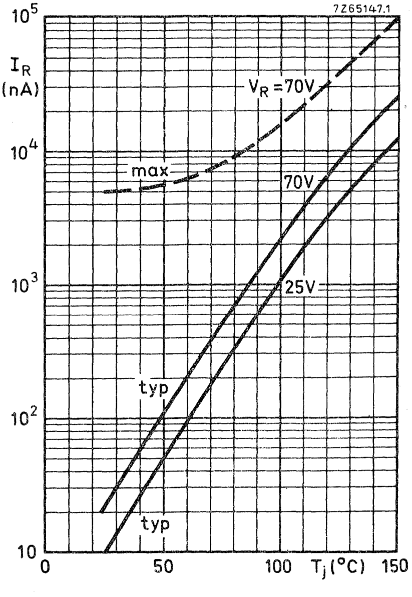
Reverse pulse duration t_p = 400 ns

Duty factor δ = 0,02

Circuit capacitance C ≤ 7 pF (C = oscilloscope input capacitance + parasitic capacitance)


7Z65148
$T_j = 25\,°C$
I_F (mA)
150
100
50
0
typ
max
0
1
V_F (V)
2


7Z65149.1
typical values
V_F (V)
1,5
1
0,5
0
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 BAV99 consists of two diodes connected in series in a microminiature envelope. The unit is intended for high-speed switching in thick- and thin-film circuits.

QUICK REFERENCE DATA (per diode)

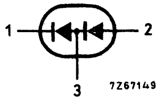
Continuous reverse voltage	V_R	max.	70	V
Repetitive peak reverse voltage	V_{RRM}	max.	70	V
Repetitive peak forward current	I_{FRM}	max.	200	mA
Junction temperature	T_j	max.	150	°C
Forward voltage at I_F = 50 mA	V_F	<	1,1	V
Reverse recovery time when switched from I_F = 10 mA to I_R = 10 mA; R_L = 100 Ω; measured at I_R = 1 mA	t_{rr}	<	6	ns
Recovery charge when switched from I_F = 10 mA to V_R = 5 V; R_L = 500 Ω	Q_s	<	45	pC

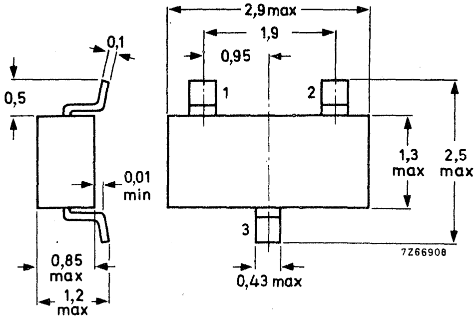
MECHANICAL DATA

Dimensions in mm

SOT-23

Code: A7





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

Voltages

Continuous reverse voltage	V_R	max.	70	V
Repetitive peak reverse voltage	V_{RRM}	max.	70	V

Currents

Average 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, 10	°C/mW
one diode loaded	$R_{th\ j\text{-}a}$	=	0, 67	°C/mW

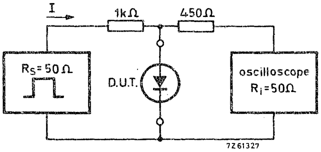
---

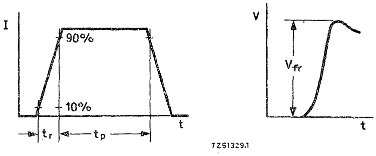
1) Measured under pulse conditions: pulse time $t_p \leq 0,5$ ms.
For sinusoidal operation $I_{F(AV)} = 65$ mA; averaging time $t_{(av)} \leq 1$ ms.

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 °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				
V_R = 0; f = 1 MHz	C_d	<	1,5	pF
Forward recovery voltage when switched to				
I_F = 10 mA; t_r = 20 ns	V_{fr}	<	1,75	V

Test circuit and waveforms:





Input signal : Rise time of the forward pulse t_r = 20 ns
Forward current pulse duration t_p = 120 ns
Duty factor δ = 0,01

Oscilloscope: Rise time t_r = 0,35 ns

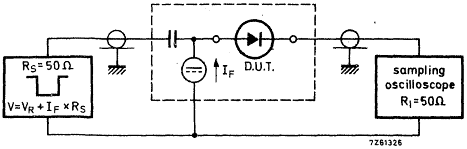
Circuit capacitance C ≤ 1 pF (C = oscilloscope input capacitance + parasitic capacitance)

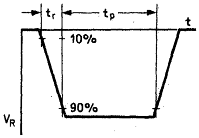
CHARACTERISTICS (per diode) (continued) $T_j = 25\ ^{o}C$

→ Reverse recovery time whe switched from

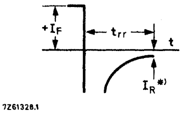
I_F = 10 mA to I_R = 10 mA; R_L = 100 Ω;
measured at I_R = 1 mA t_{rr} < 6 ns

Test circuit and waveforms:





input signal



output signal

Input signal : Rise time of the reverse pulse t_r = 0,6 ns *) I_R = 1 mA

Reverse pulse duration t_p = 100 ns

Duty factor δ = 0,05

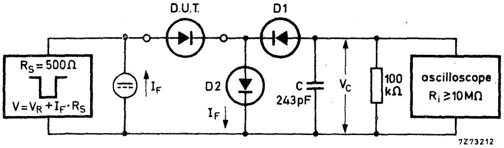
Oscilloscope : Rise time t_r = 0,35 ns

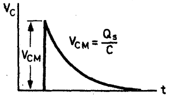
Circuit capacitance C ≤ 1 pF (C = oscilloscope input capacitance + parasitic capacitance)

Recovery charge when switched from

I_F = 10 mA to V_R = 5 V; R_L = 500 Ω Q_s < 45 pC

Test circuit and waveform:





output signal

D1 = BAW62

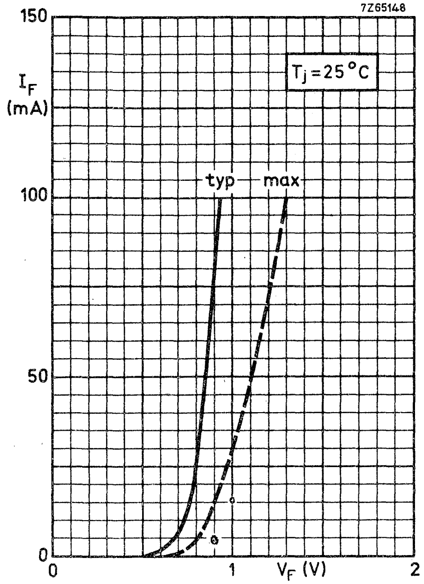
D2 = diode with minority carrier life time at 10 mA: < 200 ps

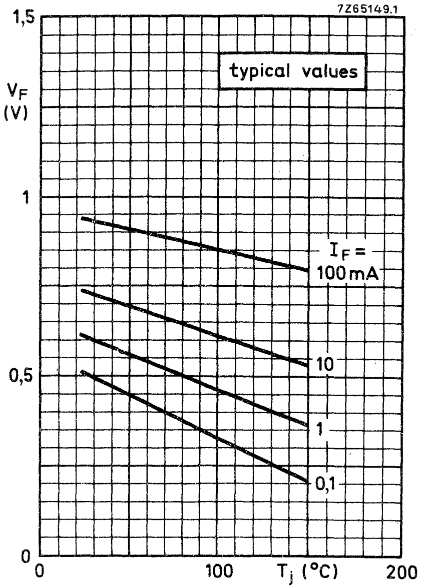
Input signal : Rise time of the reverse pulse t_r = 2 ns

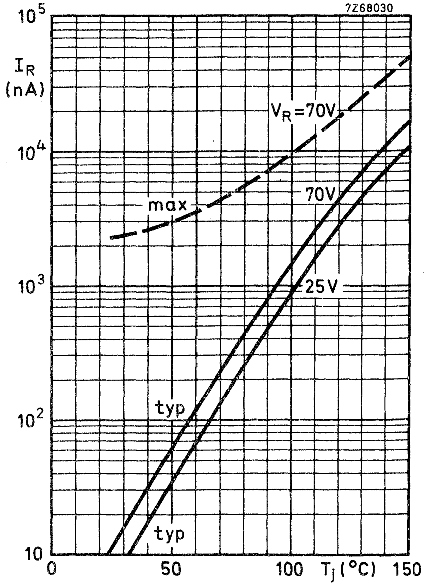
Reverse pulse duration t_p = 400 ns

Duty factor δ = 0,02

Circuit capacitance C ≤ 7 pF (C = oscilloscope input capacitance + parasitic 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


7Z68030
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 BAW56 consists of two diodes in a microminiature 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)

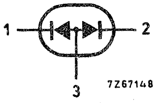
Continuous reverse voltage	V_R	max.	70	V
Repetitive peak reverse voltage	V_{RRM}	max.	70	V
Repetitive peak forward	I_{FRM}	max.	200	mA
Junction temperature	T_j	max.	150	°C
Forward voltage at I_F = 50 mA	V_F	$<$	1,1	V
Reverse recovery time when switched from I_F = 10 mA to I_R = 10 mA; R_L = 100 Ω; measured at I_R = 1 mA	t_{rr}	$<$	6	ns
Recovery charge when switched from I_F = 10 mA to V_R = 5 V; R_L = 500 Ω	Q_s	$<$	45	pC

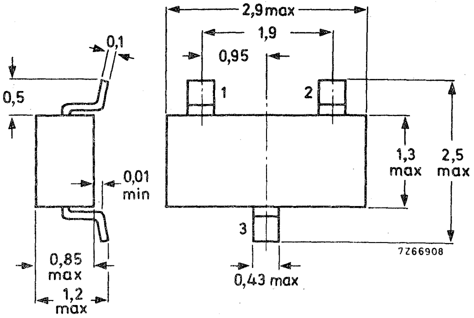
MECHANICAL DATA

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				
Average 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	$R_{th\ j\text{-}a}$	=	1,10	°C/mW
one diode loaded	$R_{th\ j\text{-}a}$	=	0,67	°C/mW

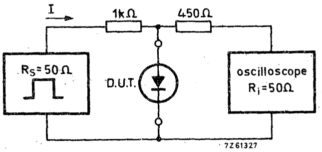
---

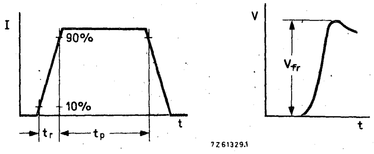
[1] Measured under pulse conditions : pulse time $t_p \leq 0,5$ ms.
For sinusoidal operation $I_{F(AV)} = 65$ mA; averaging time $t_{(av)} \leq 1$ ms.

CHARACTERISTICS (per diode) $T_j = 25\ ^oC$ 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; $T_j = 150\ ^oC$	I_R	<	30	µA
$V_R = 70$ V	I_R	<	2,5	µA
$V_R = 70$ V; $T_j = 150\ ^oC$	I_R	<	50	µA
Diode capacitance				
$V_R = 0$; f = 1 MHz	C_d	<	2	pF
Forward recovery voltage when switched to				
$I_F = 10$ mA; $t_r = 20$ ns	V_{fr}	<	1,75	V

Test circuit and waveforms:





input signal output signal

Input signal : Rise time of the forward pulse $t_r =$ 20 ns

Forward current pulse duration $t_p =$ 120 ns

Duty factor $\delta = 0,01$

Oscilloscope: Rise time $t_r = 0,35$ ns

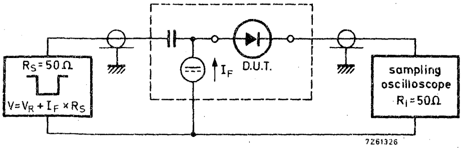
Circuit capacitance $C \leq 1$ pF (C = oscilloscope input capacitance + parasitic capacitance)

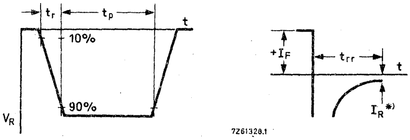
CHARACTERISTICS (per diode) (continued) $T_j = 25\ ^oC$

Reverse recovery time when switched from

$I_F = 10$ mA to $I_R = 10$ mA; $R_L = 100\ \Omega$;
measured at $I_R = 1$ mA t_{rr} < 6 ns

Test circuit and waveforms:





input signal

output signal

Input signal : Rise time of the reverse pulse $t_r = 0,6$ ns *) $I_R = 1$ mA

Reverse pulse duration $t_p = 100$ ns

Duty factor $\delta = 0,05$

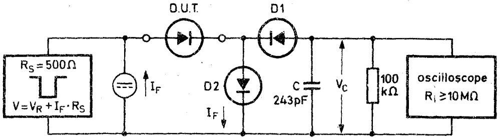
Oscilloscope: Rise time $t_r = 0,35$ ns

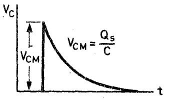
Circuit capacitance C ≤ 1 pF (C = oscilloscope input capacitance + parasitic capacitance)

Recovery charge when switched from

$I_F = 10$ mA to $V_R = 5$ V; $R_L = 500\ \Omega$ Q_s < 45 pC

Test circuit and waveform:





output signal

D1 = BAW62

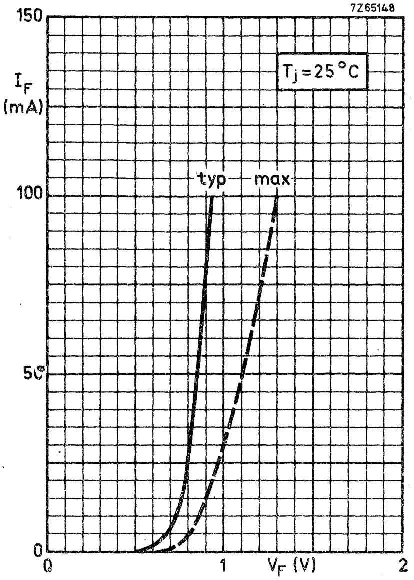
D2 = diode with minority carrier life time at 10 mA: < 200 ps

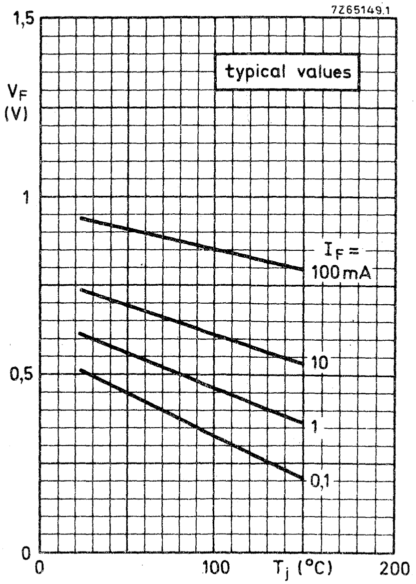
Input signal : Rise time of the reverse pulse $t_r = 2$ ns

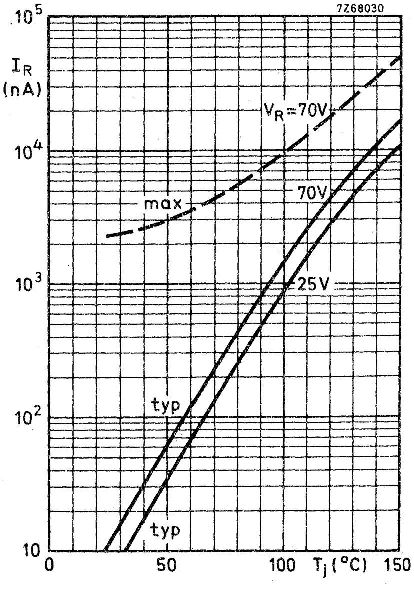
Reverse pulse duration $t_p = 400$ ns

Duty factor $\delta = 0,02$

Circuit capacitance C ≤ 7 pF (C = oscilloscope input capacitance + parasitic capacitance)


7Z65148
I_F (mA)
150
100
50
0
0
1
V_F (V)
2
T_j = 25 °C
typ
max


7Z65149.1
V_F (V)
1,5
1
0,5
0
0
100
T_j (°C)
200
typical values
I_F = 100 mA
10
1
0,1


7Z68030
I_R (nA)
10^5
10^4
10^3
10^2
10
0
50
100
T_j (°C)
150
V_R = 70V
max
70V
25V
typ
typ

VARIABLE CAPACITANCE DIODE

Silicon planar variable capacitance diode in a microminiature envelope.
It is intended for electronic tuning applications in thick- and thin-film circuits.

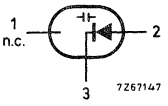
QUICK REFERENCE DATA

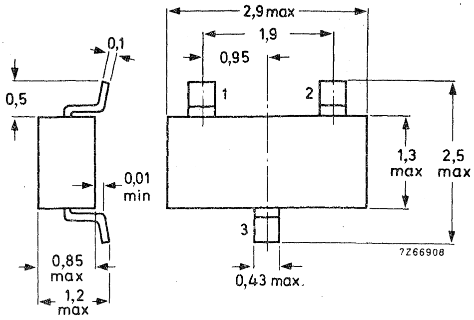
Reverse voltage	V_R	max.	28	V
Reverse current at V_R = 28 V	I_R	<	50	nA
Diode capacitance at f = 1 MHz V_R = 25 V	C_d		1,8 to 2,8	pF
Capacitance ratio at f = 1 MHz	$\frac{C_d(V_R = 3\ V)}{C_d(V_R = 25\ V)}$	typ.	5	
Series resistance at f = 470 MHz V_R is that value at which C_d = 9 pF	r_D	<	1,2	Ω

MECHANICAL DATA Dimensions in mm

SOT-23

Code: S1





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

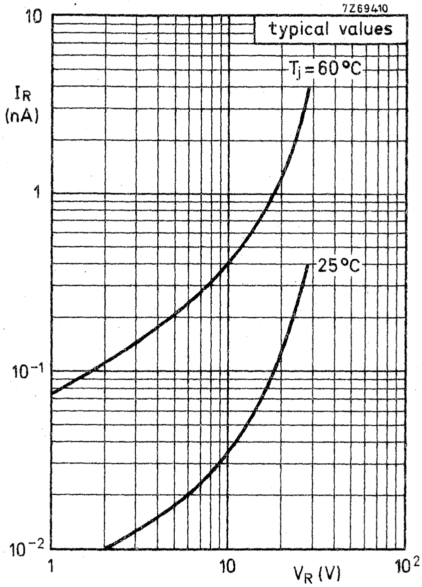
Continuous reverse voltage	V_R	max.	28	V
Reverse voltage (peak value)	V_{RM}	max.	30	V
Forward current (d.c.)	I_F	max.	20	mA
Storage temperature	T_{stg}		−65 to +100	°C
Operating junction temperature	T_j	max.	60	°C

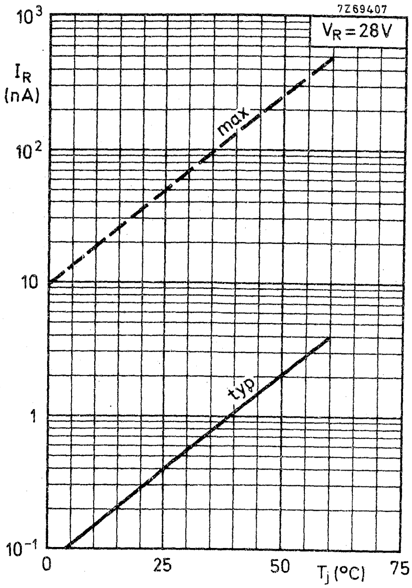
THERMAL RESISTANCE

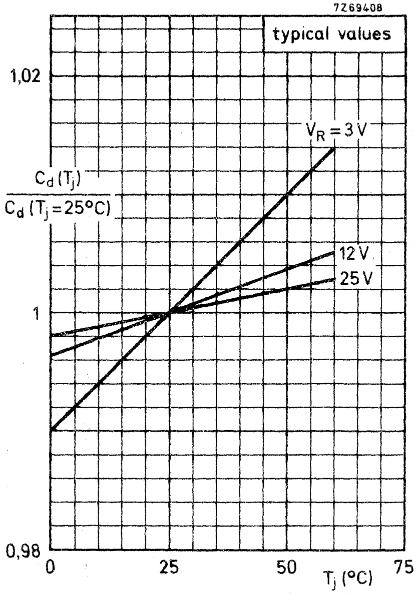
From junction to ambient mounted on a ceramic substrate of 7 mm x 5 mm x 0,5 mm	$R_{th\ j\text{-}a}$	=	0,62	°C/mW

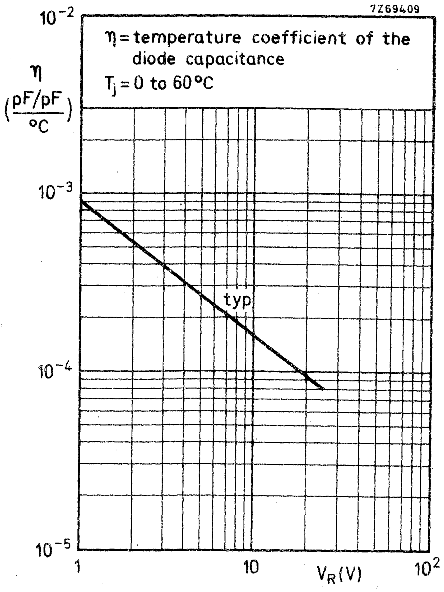
CHARACTERISTICS $T_j = 25$ °C unless otherwise specified

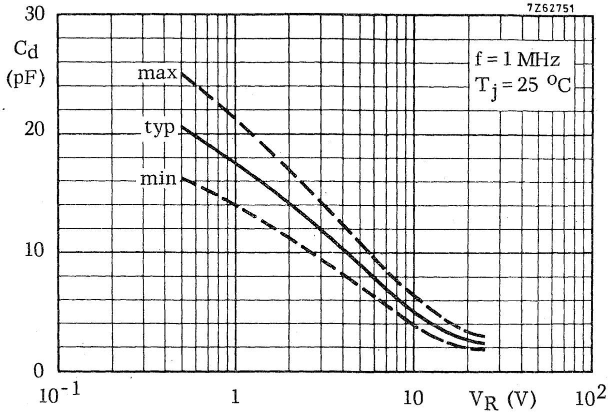
Reverse current				
→ $V_R = 28$ V	I_R	$<$	50	nA
$V_R = 28$ V; $T_j = 60$ °C	I_R	$<$	500	nA
Diode capacitance at f = 1 MHz				
$V_R = 1$ V	C_d	typ.	17,5	pF
$V_R = 3$ V	C_d	typ.	11,5	pF
$V_R = 25$ V	C_d		1,8 to 2,8	pF
Capacitance ratio at f = 1 MHz	$\frac{C_d(V_R = 3\ \text{V})}{C_d(V_R = 25\ \text{V})}$	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


7Z69410
typical values
I_R (nA)
10
1
10^{-1}
10^{-2}
$T_j = 60\,°C$
25 °C
1
10
10^2
V_R (V)


7Z69407
$V_R = 28\,V$
I_R (nA)
10^3
10^2
10
1
10^{-1}
max
typ
0
25
50
75
T_j (°C)


7Z69408
typical values
$\frac{C_d(T_j)}{C_d(T_j = 25°C)}$
1,02
1
0,98
$V_R = 3\,V$
12 V
25 V
0
25
50
75
T_j (°C)


7Z69409
η = temperature coefficient of the diode capacitance
$T_j = 0$ to $60\,°C$
η $\left(\frac{pF/pF}{°C}\right)$
10^{-2}
10^{-3}
10^{-4}
10^{-5}
typ
1
10
10^2
V_R(V)


7Z62751
30
C_d
(pF)
20
10
0
max
typ
min
f = 1 MHz
T_j = 25 °C
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 $R_S = 2$ kΩ $-I_C = 200\ \mu A$; $-V_{CE} = 5$ V f = 1 kHz; B = 200 Hz	F	<	10	10	dB

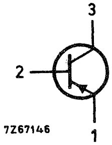
MECHANICAL DATA

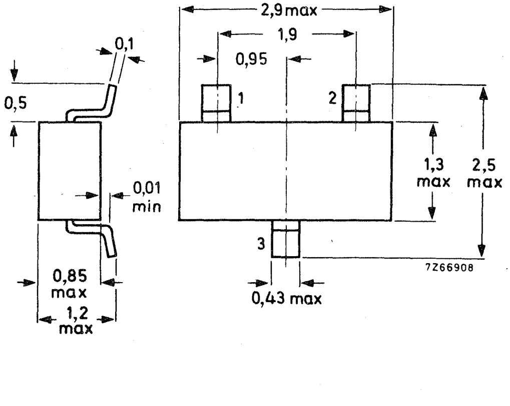
Dimensions in mm

SOT-23

Code:

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**	$R_{th\ j\text{-}a}$	=	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

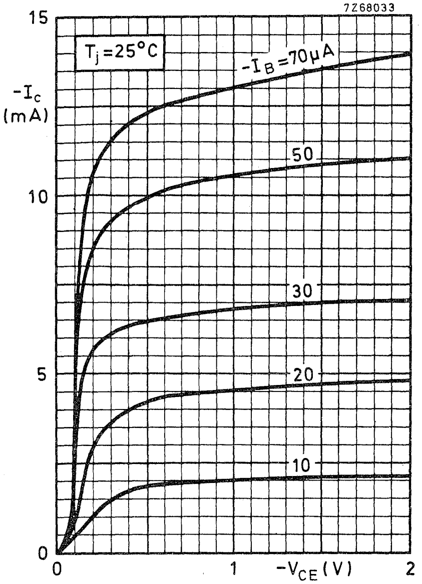
Saturation voltages

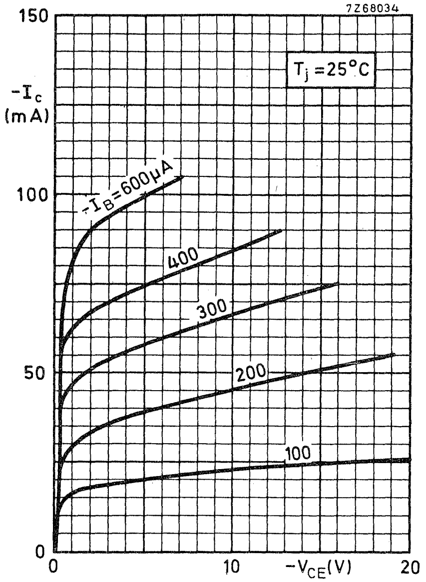
$-I_C$ = 10 mA; $-I_B$ = 0.5 mA	$-V_{CEsat}$	typ.	80	mV
		<	300	mV
	$-V_{BEsat}$	typ.	720	mV
$-I_C$ = 50 mA; $-I_B$ = 2.5 mA	$-V_{CEsat}$	typ.	150	mV
	$-V_{BEsat}$	typ.	810	mV

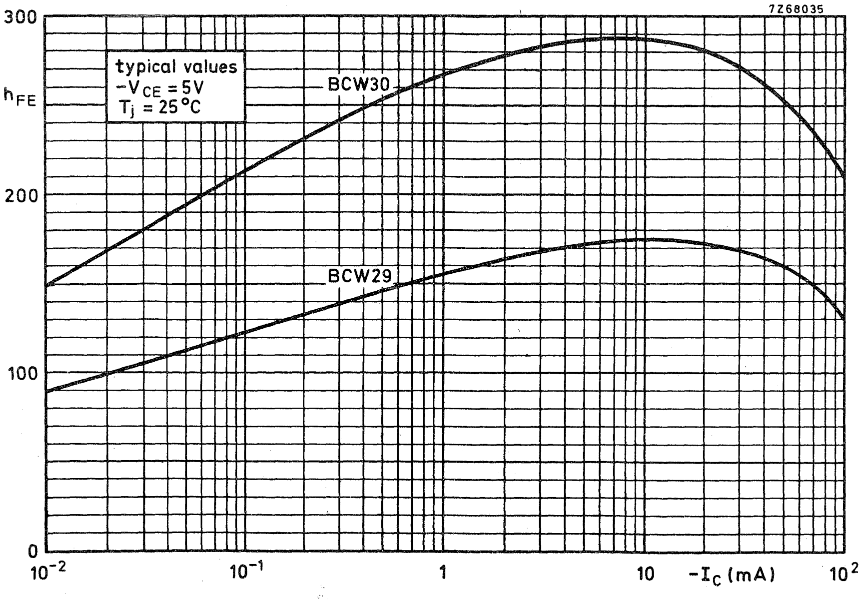
D.C. current gain

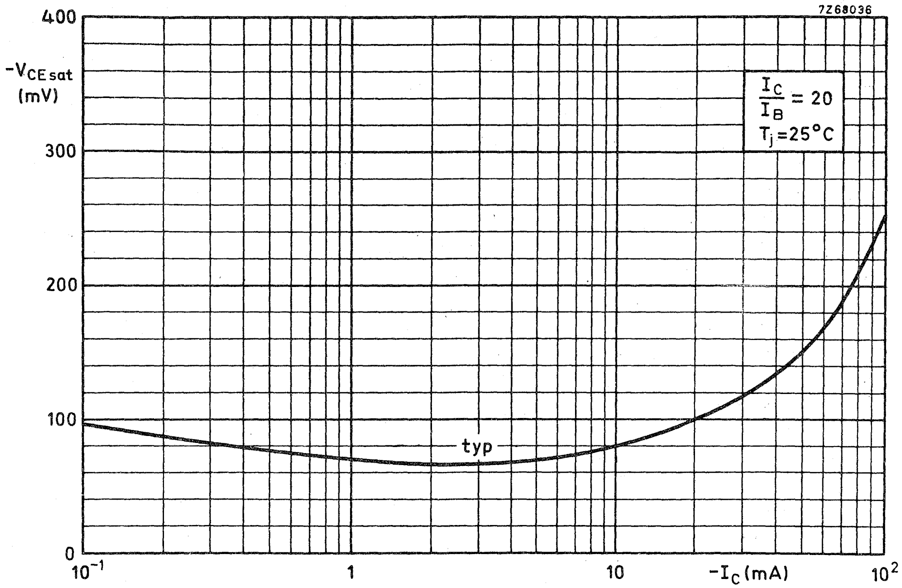
			BCW29	BCW30
$-I_C$ = 10 µA; $-V_{CE}$ = 5 V	h_{FE}	typ.	90	150
$-I_C$ = 2 mA; $-V_{CE}$ = 5 V	h_{FE}	>	120	215
		<	260	500

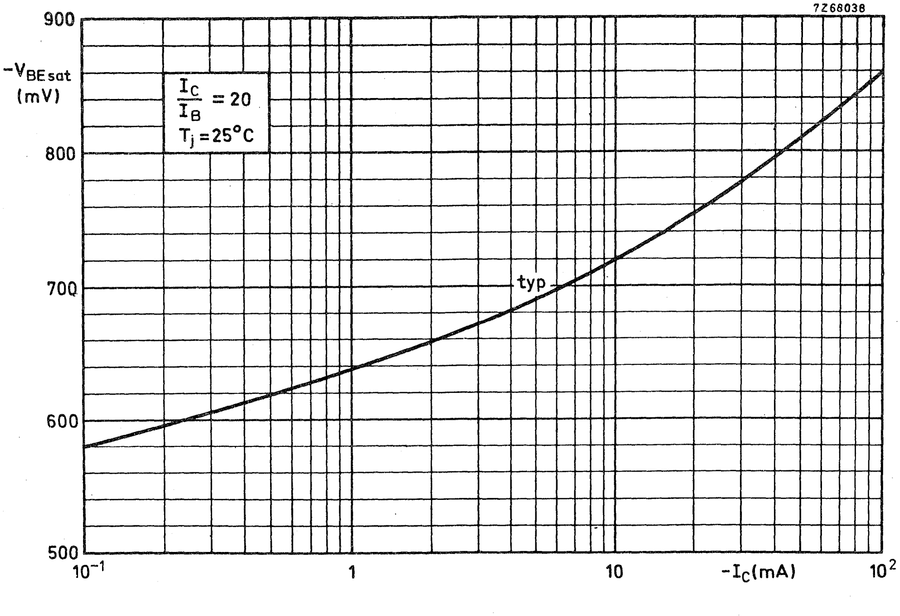
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; $-V_{CB}$ = 10 V	C_c	<	7.0	pF
Transition frequency at f = 35 MHz				
$-I_C$ = 10 mA; $-V_{CE}$ = 5 V	f_T	typ.	150	MHz
Noise figure at R_S = 2 kΩ				
$-I_C$ = 200 µA; $-V_{CE}$ = 5 V f = 1 kHz; B = 200 Hz	F	<	10	dB

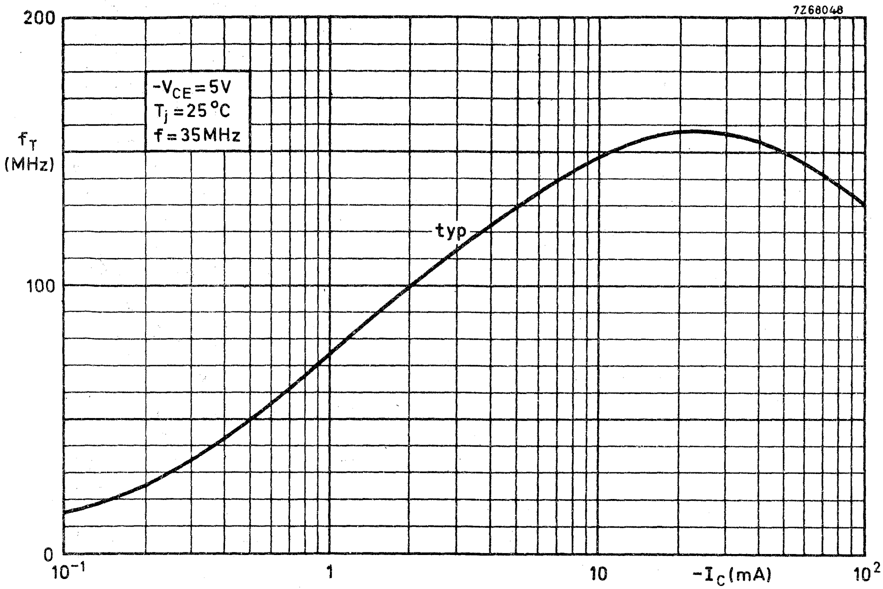

7Z68033
$T_j = 25°C$
$-I_B = 70 \mu A$
50
30
20
10
$-I_C$ (mA)
15
10
5
0
0
1
2
$-V_{CE}$ (V)

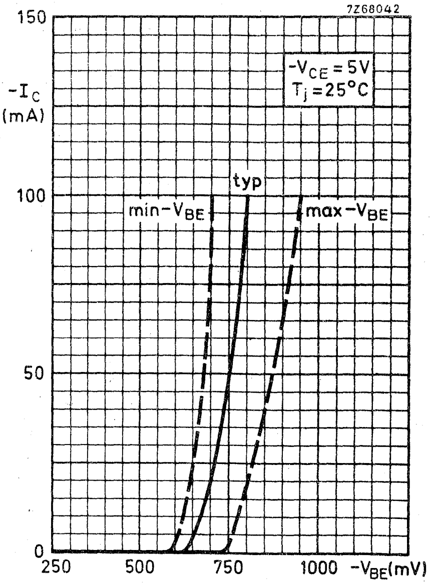

7Z68034
$T_j = 25°C$
$-I_B = 600 \mu A$
400
300
200
100
$-I_C$ (mA)
150
100
50
0
0
10
20
$-V_{CE}$ (V)

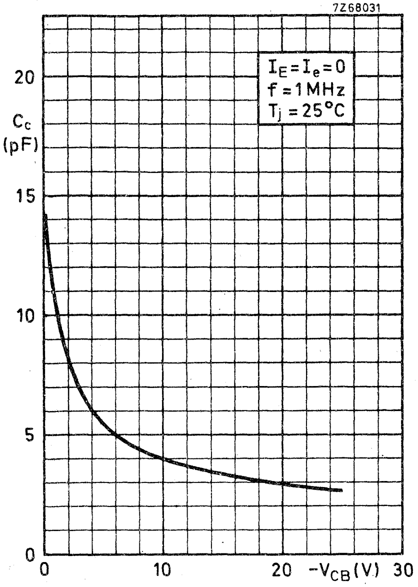

7Z68035
typical values
$-V_{CE} = 5V$
$T_j = 25°C$
BCW30
BCW29
h_{FE}
300
200
100
0
10^{-2}
10^{-1}
1
10
10^2
$-I_C$ (mA)

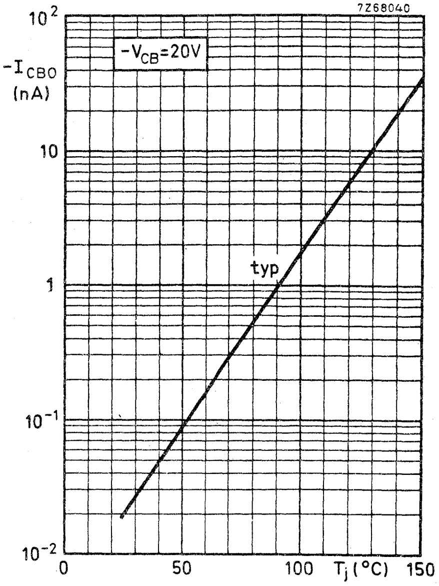

7Z68036
$-V_{CE\,sat}$ (mV)
400
300
200
100
0
$\frac{I_C}{I_B} = 20$
$T_j = 25°C$
typ
10^{-1}
1
10
$-I_C$ (mA)
10^2


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

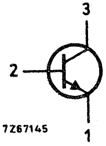
			BCW31	BCW32	BCW33	
Collector-base voltage (open emitter)	V_{CBO}	max.	30	30	30	V
Collector-emitter voltage (open base)	V_{CEO}	max.	20	20	20	V
Collector current (peak value)	I_{CM}	max.	200	200	200	mA
Total power dissipation up to $T_{amb} = 25\ ^{\circ}C$	P_{tot}	max.	200	200	200	mW
Junction temperature	T_j	max.	150	150	150	$^{\circ}C$
D.C. current gain at $T_j = 25\ ^{\circ}C$ $I_C = 2$ mA; $V_{CE} = 5$ V	h_{FE}	$>$ $<$	110 220	200 450	420 800	
Transition frequency at f = 35 MHz $I_C = 10$ mA; $V_{CE} = 5$ V	f_T	typ.	300	300	300	MHz
Noise figure at $R_S = 2\ k\Omega$ $I_C = 200\ \mu A$; $V_{CE} = 5$ V f = 1 kHz; B = 200 Hz	F	$<$	10	10	10	dB

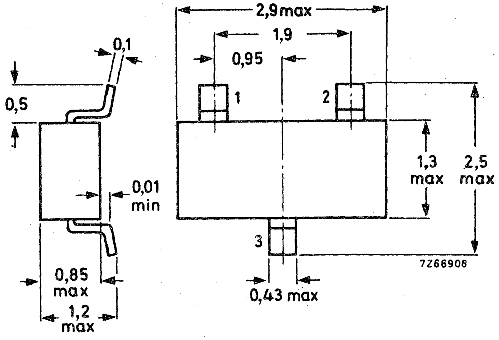
MECHANICAL DATA Dimensions in mm

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

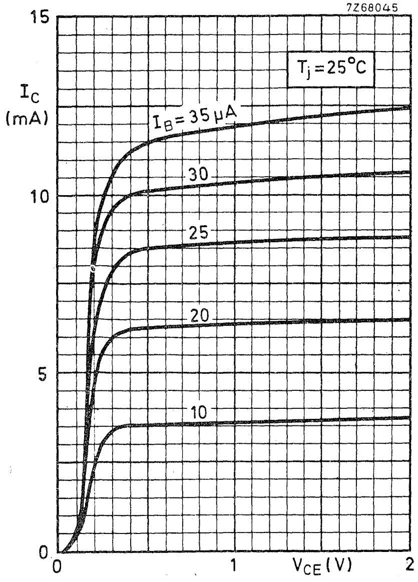
I_E = I_e = 0; V_{CB} = 10 V	C_c	<	4.0	pF

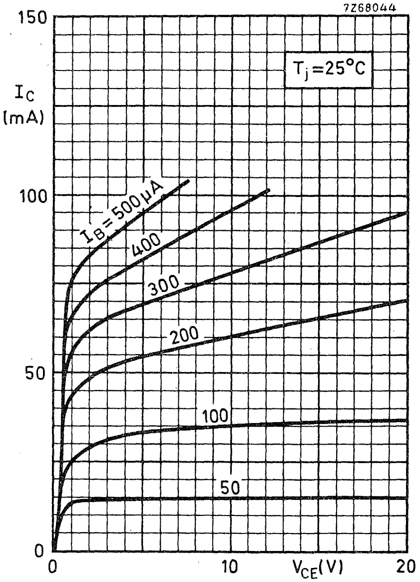
Transition frequency at f = 35 MHz

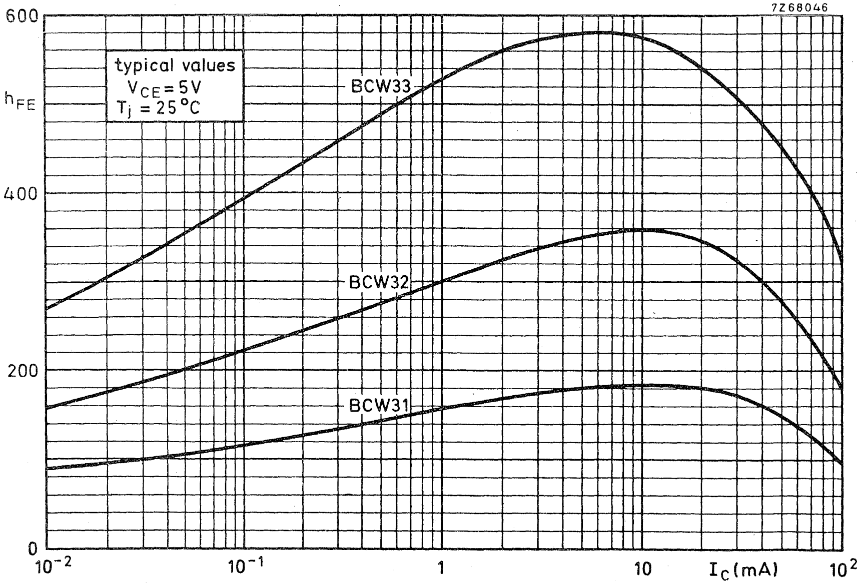
I_C = 10 mA; V_{CE} = 5 V	f_T	typ.	300	MHz

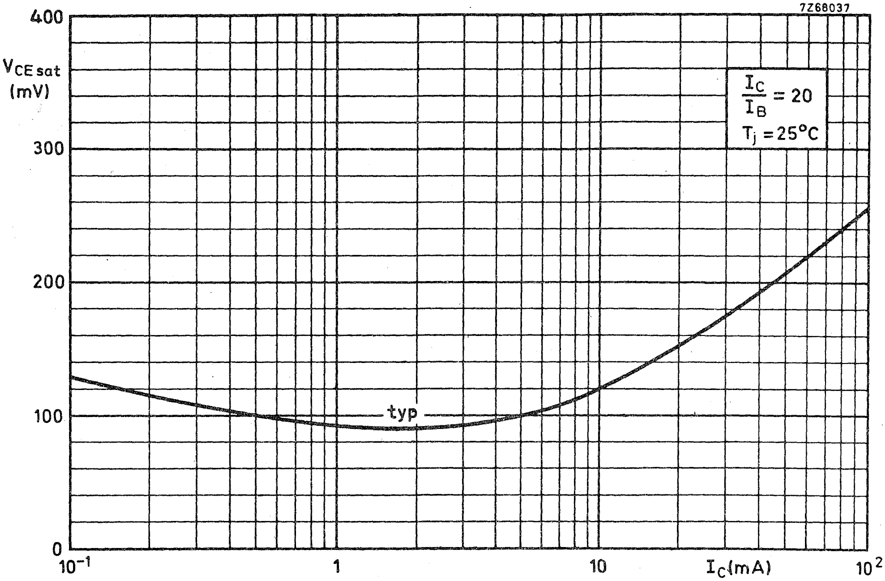
Noise figure at R_S = 2 kΩ

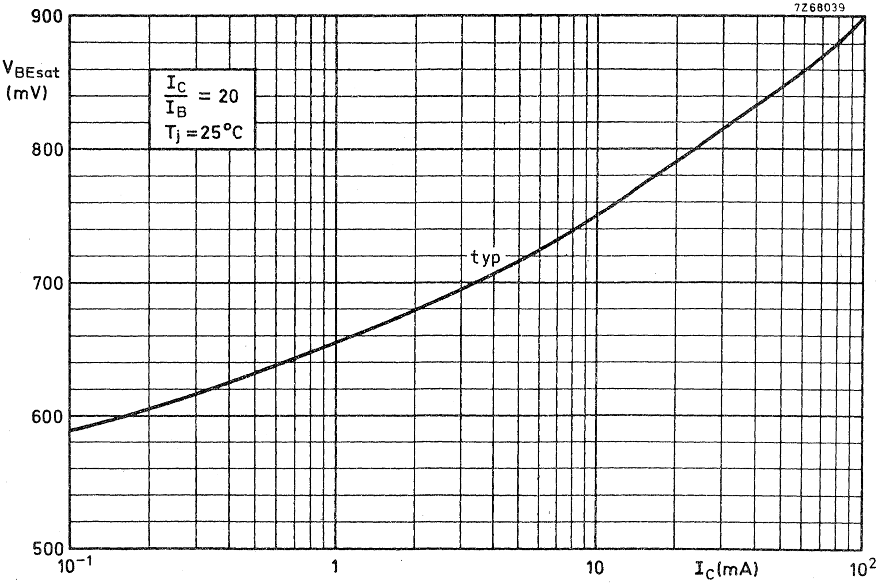
I_C = 200 μA; V_{CE} = 5 V f = 1 kHz; B = 200 Hz	F	<	10	dB

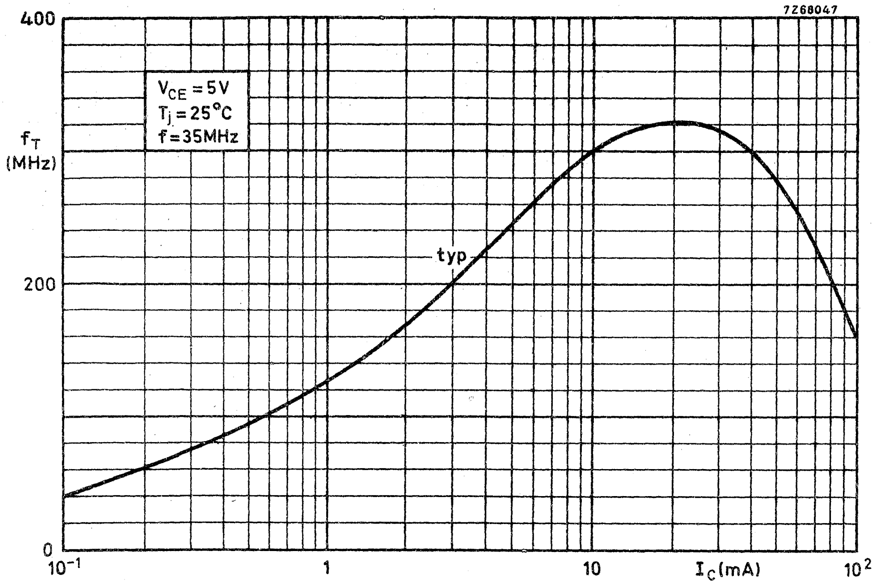

7Z68045
15
10
5
0
I_C
(mA)
$T_j = 25°C$
$I_B = 35\ \mu A$
30
25
20
10
0
1
V_{CE} (V)
2

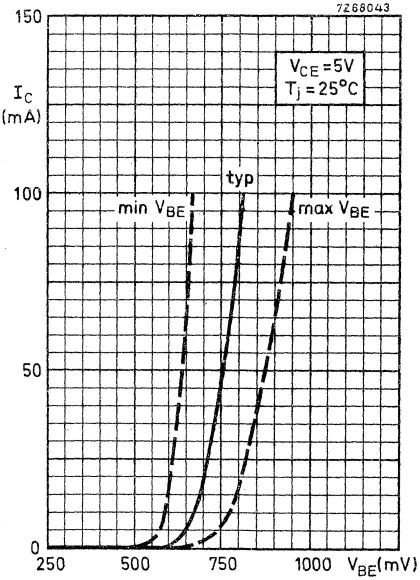

7Z68044
150
100
50
0
I_C
(mA)
$T_j = 25°C$
$I_B = 500\ \mu A$
400
300
200
100
50
0
10
V_{CE}(V)
20

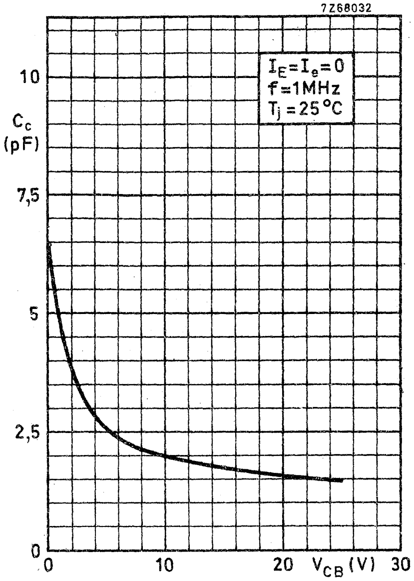

7Z68046
600
400
200
0
h_{FE}
typical values
$V_{CE} = 5V$
$T_j = 25°C$
BCW33
BCW32
BCW31
10^{-2}
10^{-1}
1
10
I_C(mA)
10^2

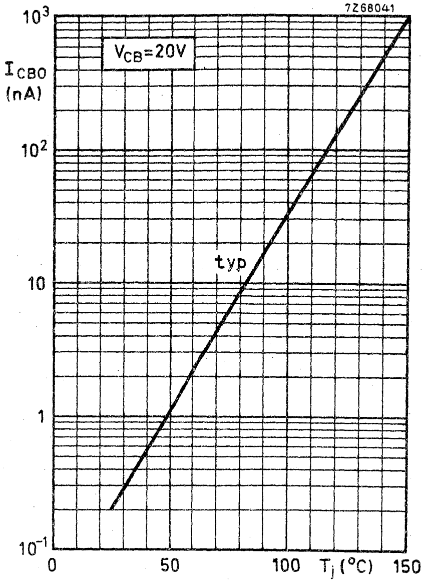

7Z68037
V_{CEsat} (mV)
400
300
200
100
0
$\frac{I_C}{I_B} = 20$
$T_j = 25°C$
typ
10^{-1}
1
10
I_C(mA)
10^2


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)
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
$V_{CB} = 20V$
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

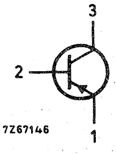
			BCW69	BCW70	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	50	50	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	45	45	V
Collector current (peak value)	$-I_{CM}$	max.	200	200	mA
Total power dissipation up to $T_{amb} = 25\ ^{o}C$	P_{tot}	max.	200	200	mW
Junction temperature	T_j	max.	150	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

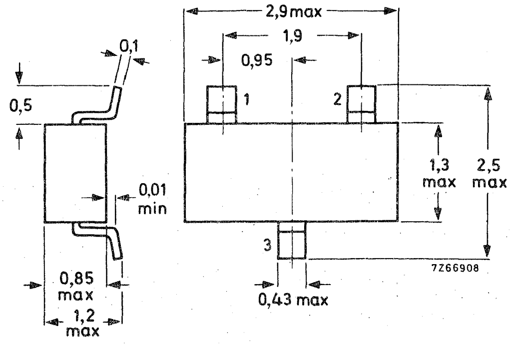
MECHANICAL DATA Dimensions in mm

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 $T_{amb} = 25\ ^{o}C$ 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	^{o}C
Junction temperature	T_j	max.	150	^{o}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	$^{o}C/mW$

CHARACTERISTICS

Collector cut-off current

$I_E = 0$; $-V_{CB} = 20$ V; $T_j = 25\ ^{o}C$	$-I_{CBO}$	<	100	nA
$T_j = 100\ ^{o}C$	$-I_{CBO}$	<	10	µA

Base-emitter voltage

$-I_C = 2$ mA; $-V_{CE} = 5$ V; $T_j = 25\ ^{o}C$	$-V_{BE}$	600 to	750	mV

CHARACTERISTICS (continued)

$T_j = 25\ ^{o}C$ 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
$-I_C = 10\ \mu A$; $-V_{CE} = 5$ 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

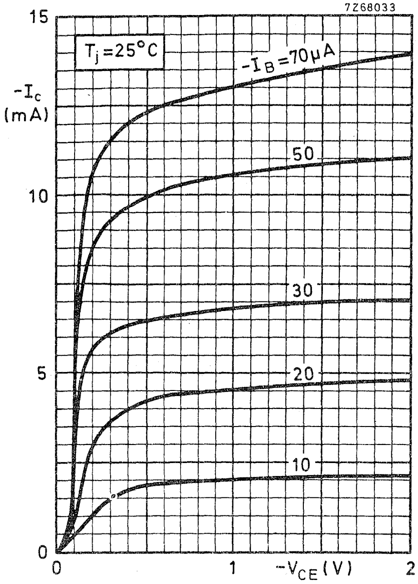
$I_E = I_e = 0$; $-V_{CB} = 10$ V	C_c	<	7.0	pF

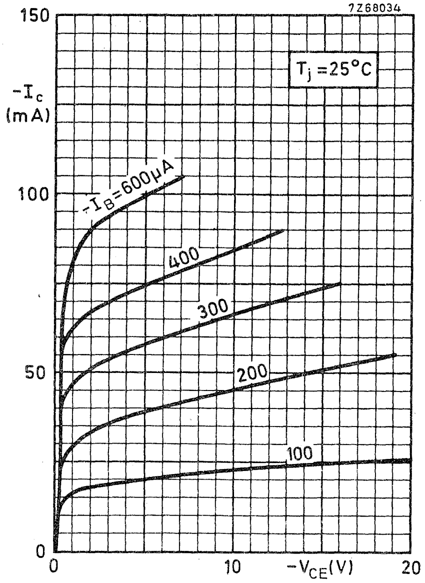
Transition frequency at f = 35 MHz

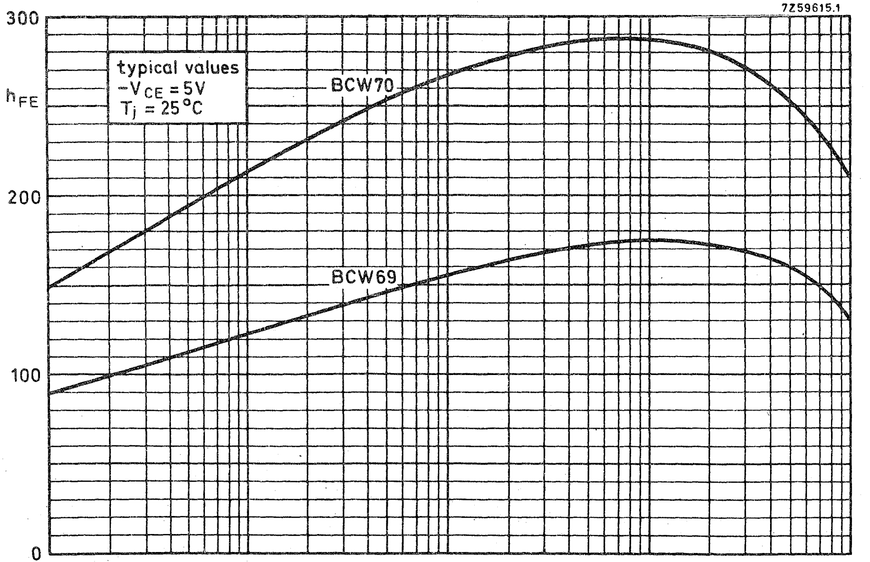
$-I_C = 10$ mA; $-V_{CE} = 5$ V	f_T	typ.	150	MHz

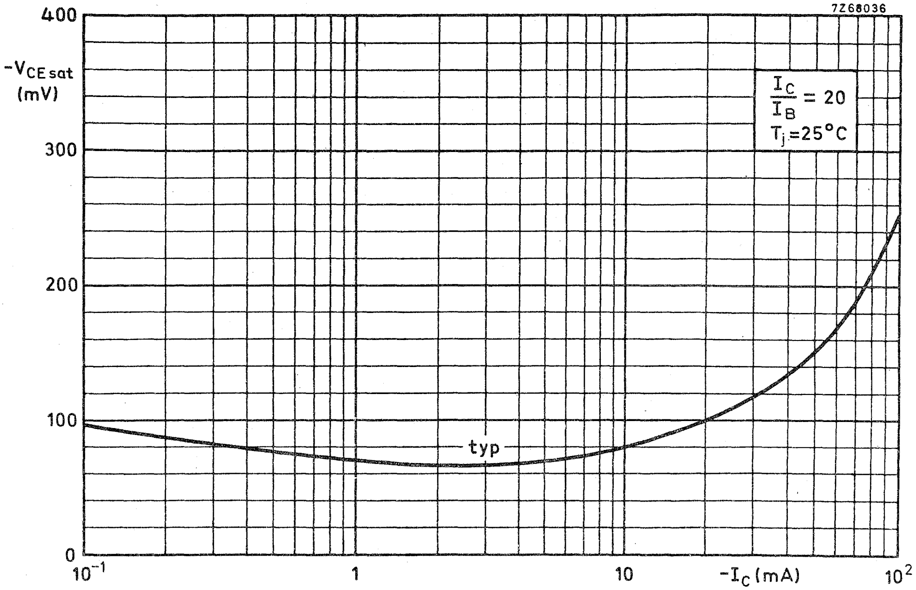
Noise figure at $R_S = 2\ k\Omega$

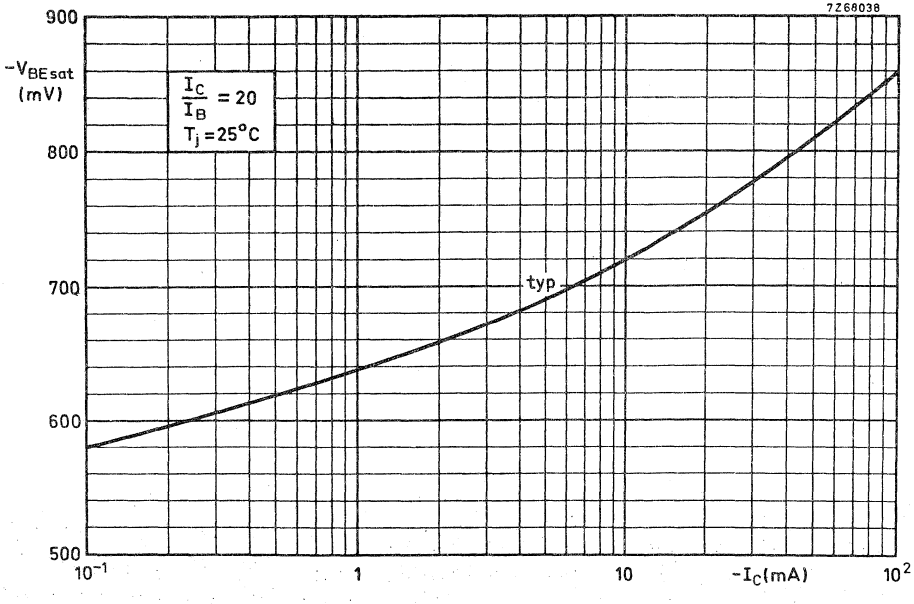
$-I_C = 200\ \mu A$; $-V_{CE} = 5$ V f = 1 kHz; B = 200 Hz	F	<	10	dB

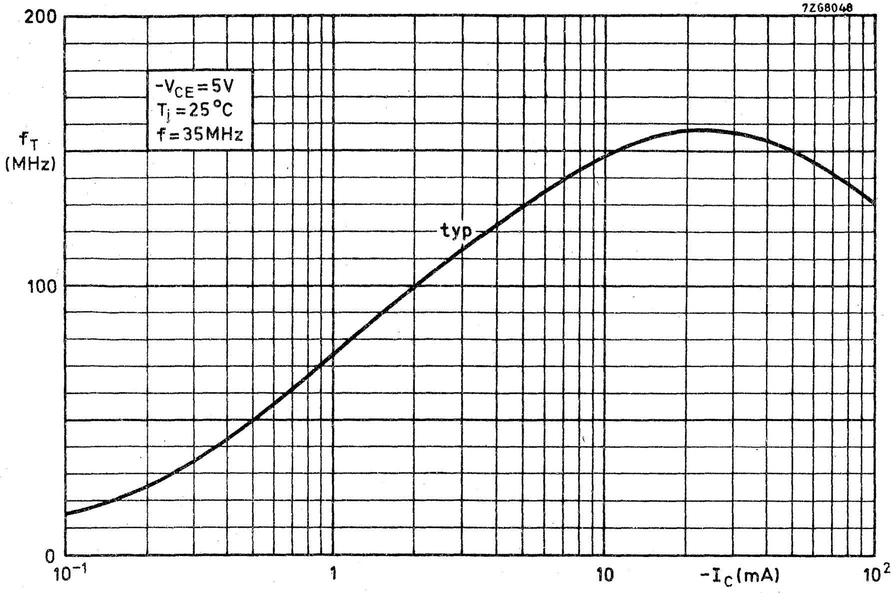

7Z68033
$T_j = 25°C$
$-I_B = 70 \mu A$
50
30
20
10
$-I_C$ (mA)
15
10
5
0
0
1
2
$-V_{CE}$ (V)

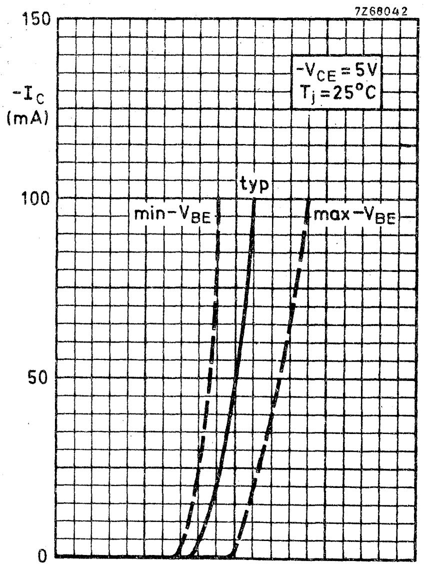

7Z68034
$T_j = 25°C$
$-I_B = 600 \mu A$
400
300
200
100
$-I_C$ (mA)
150
100
50
0
0
10
20
$-V_{CE}$(V)

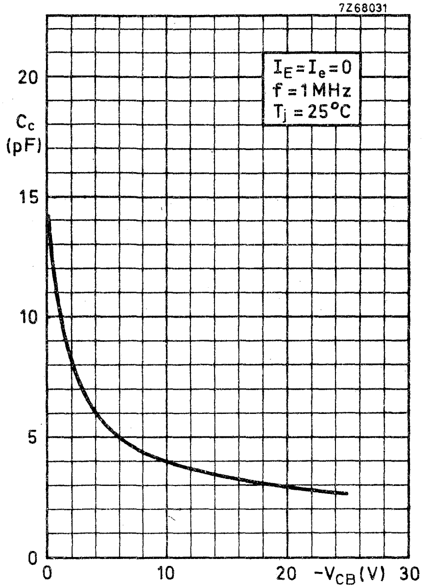

7Z59615.1
typical values
$-V_{CE} = 5V$
$T_j = 25°C$
BCW70
BCW69
h_{FE}
300
200
100
0
10^{-2}
10^{-1}
1
10
10^2
$-I_C$ (mA)

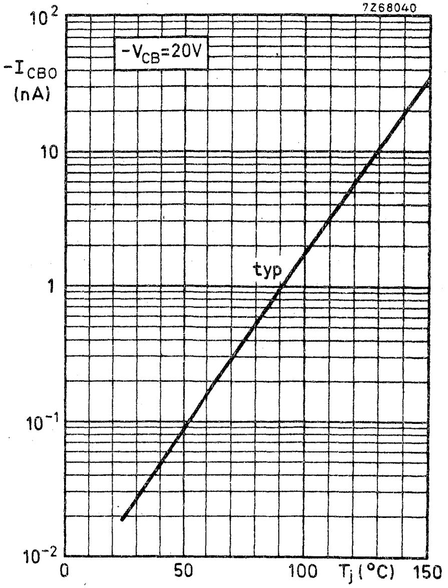

7Z68036
400
$-V_{CE\,sat}$ (mV)
300
200
100
0
$\frac{I_C}{I_B} = 20$
$T_j = 25°C$
typ
10^{-1}
1
10
$-I_C$ (mA)
10^2


7Z68038
900
$-V_{BE\,sat}$ (mV)
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)
$-V_{CE} = 5V$
$T_j = 25\,°C$
min-V_{BE}
typ
max-V_{BE}
250
500
750
1000
$-V_{BE}$(mV)


7Z68031
$I_E = I_e = 0$
f = 1 MHz
$T_j = 25\,^\circ C$
C_c (pF)
20
15
10
5
0
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

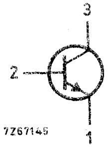
			BCW71	BCW72	
Collector-base voltage (open emitter)	V_{CBO}	max.	50	50	V
Collector-emitter voltage (open base)	V_{CEO}	max.	45	45	V
Collector current (peak value)	I_{CM}	max.	200	200	mA
Total power dissipation up to $T_{amb} = 25\,^{o}C$	P_{tot}	max.	200	200	mW
Junction temperature	T_j	max.	150	150	^{o}C
D.C. current gain at $T_j = 25\,^{o}C$ $I_C = 2$ mA; $V_{CE} = 5$ V	h_{FE}	$>$ $<$	110 220	200 450	
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 $I_C = 200$ µA; $V_{CE} = 5$ V f = 1 kHz; B = 200 Hz	F	$<$	10	10	dB

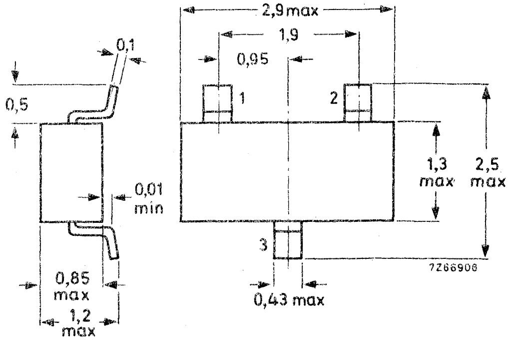
MECHANICAL DATA Dimensions in mm

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	$R_{th\ j-a}$	=	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)

$T_j = 25\,^{\circ}C$ 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
$I_C = 10\ \mu A$; $V_{CE} = 5$ 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

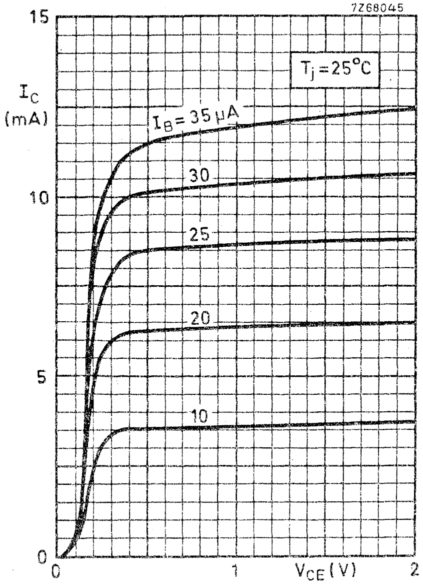
$I_E = I_e = 0$; $V_{CB} = 10$ V	C_c	<	4.0	pF

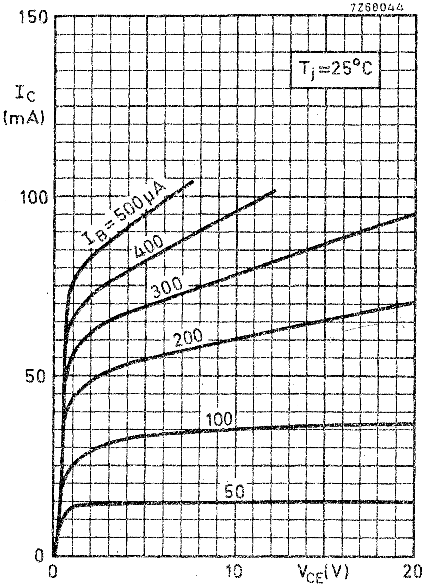
Transition frequency at f = 35 MHz

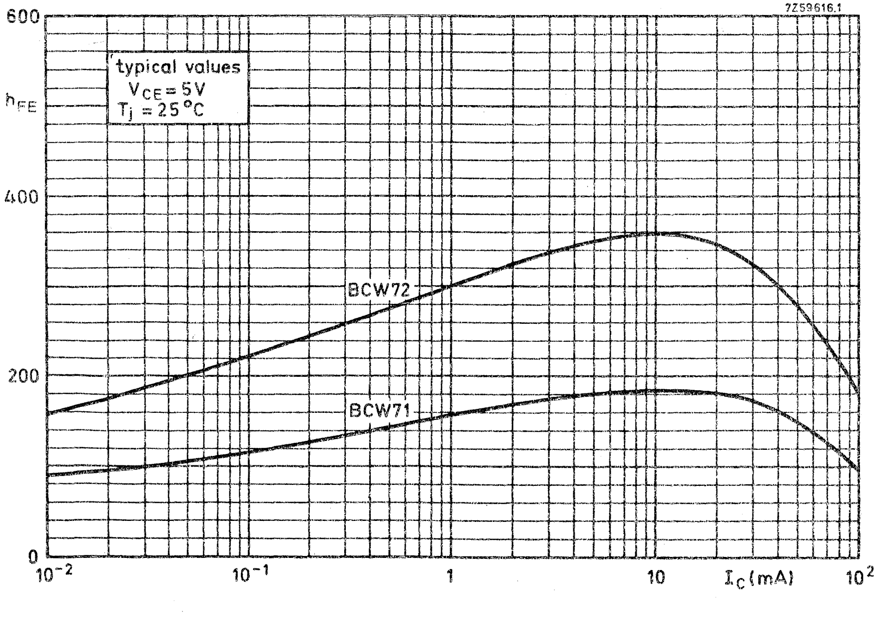
$I_C = 10$ mA; $V_{CE} = 5$ V	f_T	typ.	300	MHz

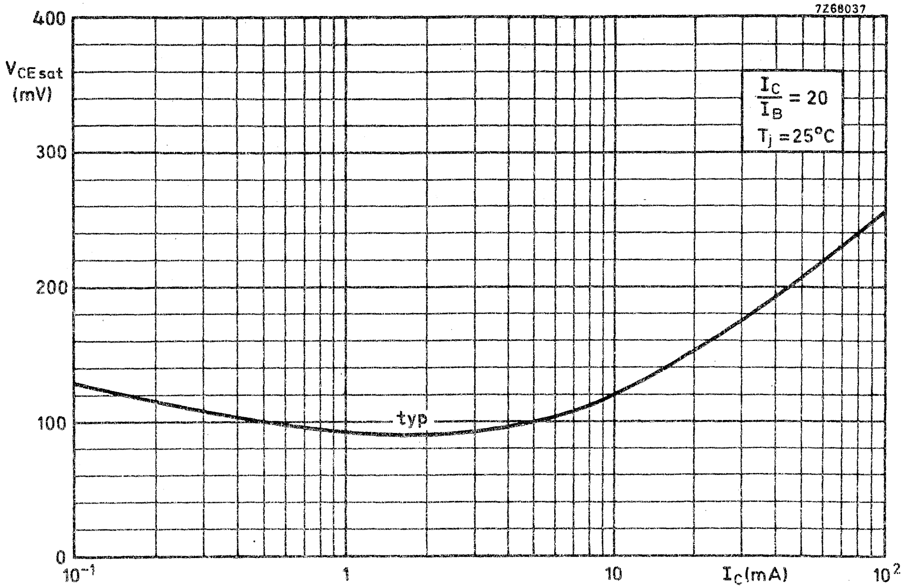
Noise figure at $R_S = 2\ k\Omega$

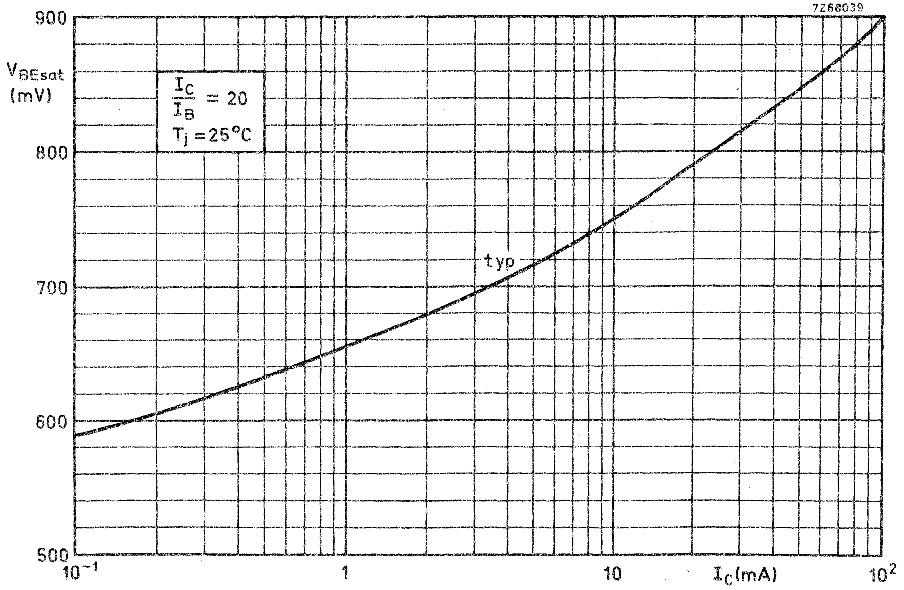
$I_C = 200\ \mu A$; $V_{CE} = 5$ V f = 1 kHz; B = 200 Hz	F	<	10	dB

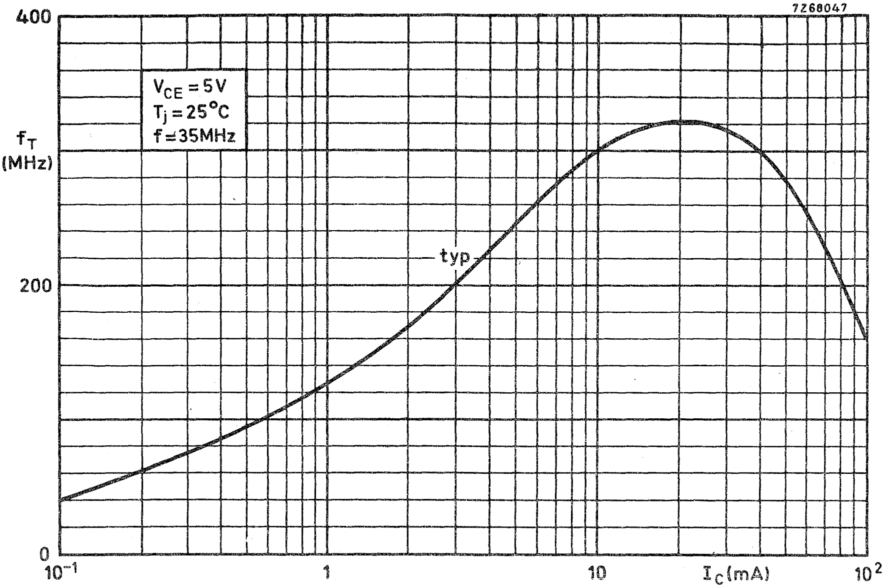

7Z68045
15
10
5
0
I_C (mA)
$T_j = 25^\circ C$
$I_B = 35\ \mu A$
30
25
20
10
0
1
V_{CE} (V)
2

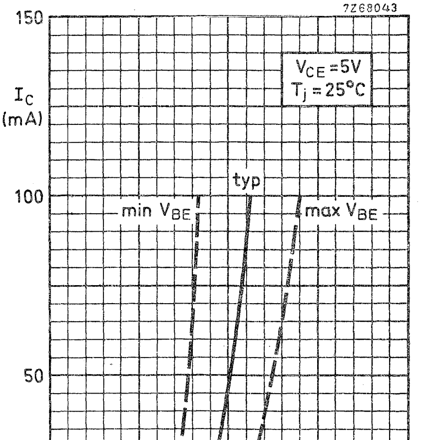

7Z68044
150
100
50
0
I_C (mA)
$T_j = 25^\circ C$
$I_B = 500\ \mu A$
400
300
200
100
50
0
10
V_{CE} (V)
20

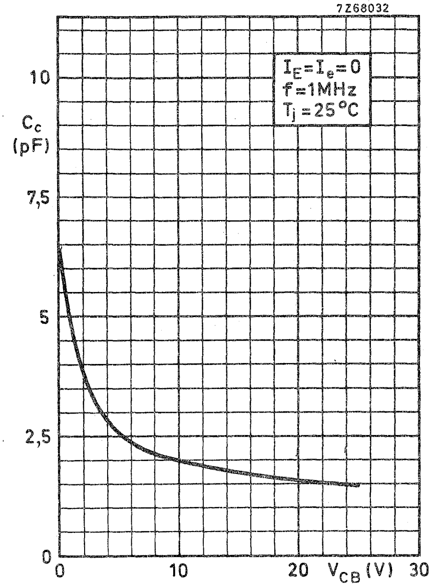

7Z59616.1
600
400
200
0
h_{FE}
typical values
$V_{CE} = 5\ V$
$T_j = 25\ ^\circ C$
BCW72
BCW71
10^{-2}
10^{-1}
1
10
I_C (mA)
10^2

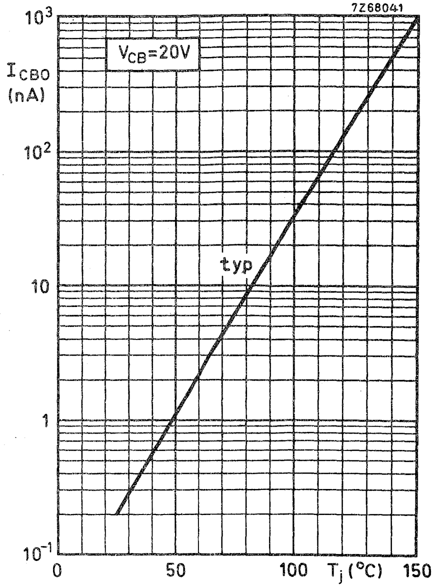

7Z68037
400
V_{CEsat}
(mV)
300
200
100
0
$\frac{I_C}{I_B} = 20$
$T_j = 25^\circ C$
typ
10^{-1}
1
10
I_C(mA)
10^2


7Z68039
900
V_{BEsat}
(mV)
800
700
600
500
$\frac{I_C}{I_B} = 20$
$T_j = 25^\circ C$
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
$T_j = 25\,^{\circ}C$
C_c
(pF)
10
7,5
5
2,5
0
0
10
20
V_{CB} (V)
30


7Z68041
$V_{CB} = 20V$
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 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

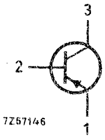
			BCX17	BCX18	
Collector-emitter voltage ($V_{BE} = 0$)	$-V_{CES}$	max.	50	30	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	45	25	V
Collector current (peak value)	$-I_{CM}$	max.	1000		mA
Total power dissipation up to $T_{amb} = 25\ ^{o}C$	P_{tot}	max.	310		mW
Junction temperature	T_j	max.	150		^{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

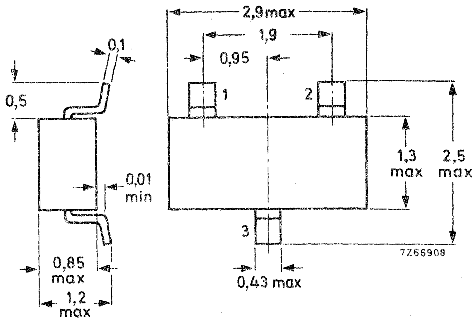
MECHANICAL DATA

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 $T_j = 25\ ^{o}C$ 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; $T_j = 150\ ^{o}C$	$-I_{CBO}$	$<$	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.	100	MHz
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; $-V_{CB} = 10$ V	C_c	typ.	8	pF

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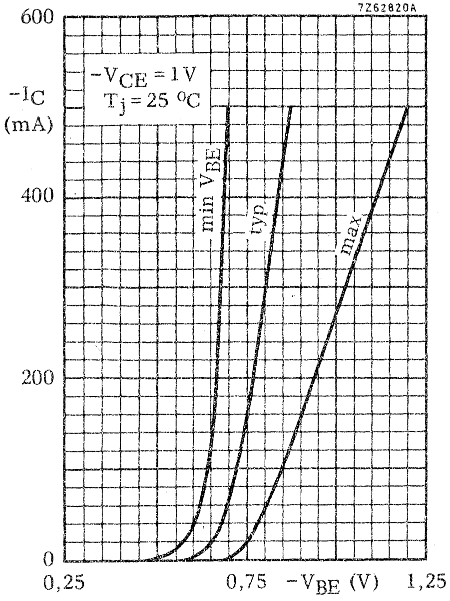
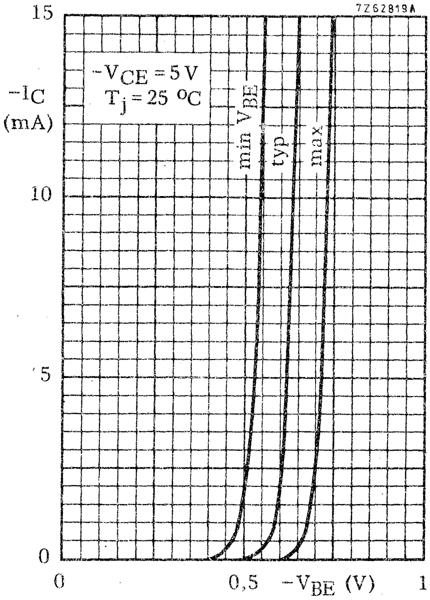
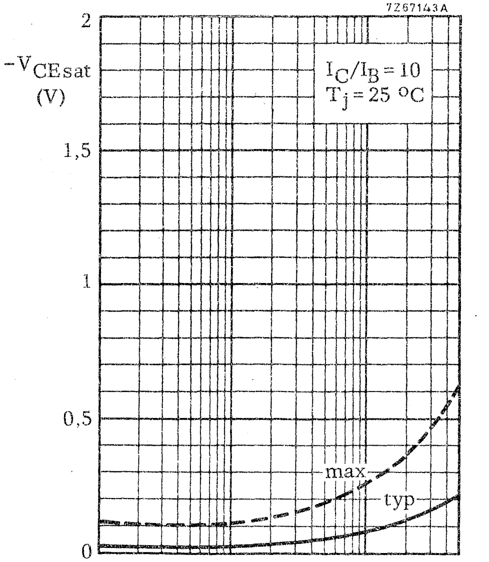
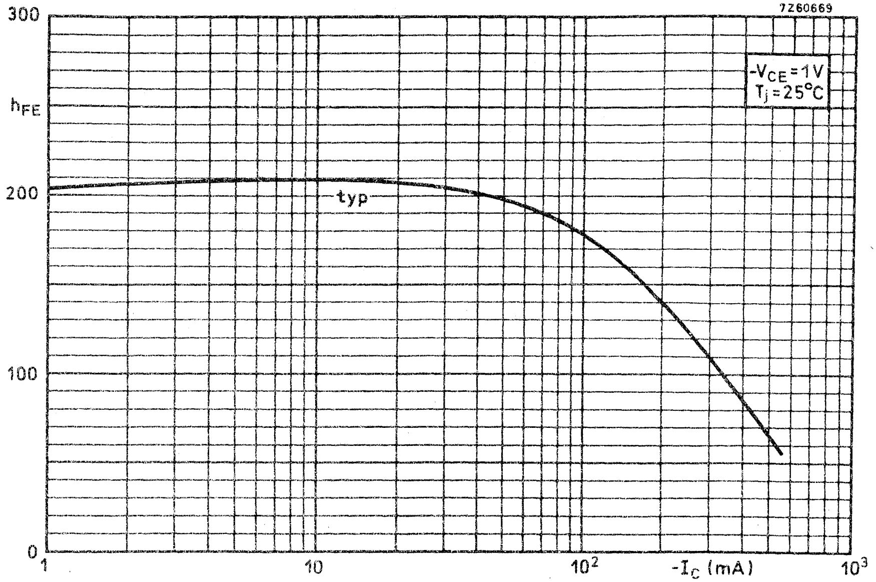
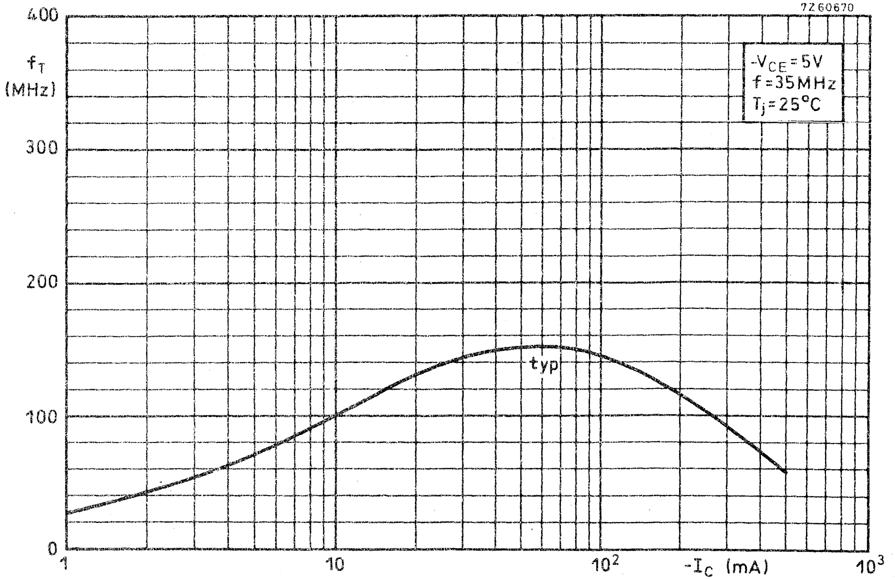
[1] $-V_{BE}$ decreases by about 2 mV/^{o}C with increasing temperature.


7Z62820A
600
400
200
0
$-I_C$
(mA)
$-V_{CE} = 1\,V$
$T_j = 25\,^oC$
min V_{BE}
typ
max
0,25
0,75
$-V_{BE}$ (V)
1,25


7Z62819A
15
10
5
0
$-I_C$
(mA)
$-V_{CE} = 5\,V$
$T_j = 25\,^oC$
min V_{BE}
typ
max
0
0,5
$-V_{BE}$ (V)
1


7Z67143A
2
1,5
1
0,5
0
$-V_{CEsat}$
(V)
$I_C/I_B = 10$
$T_j = 25\,^oC$
max
typ
1
10
10^2
$-I_C$ (mA)


7Z60669
300
h_{FE}
200
100
0
$-V_{CE}=1V$
$T_j=25°C$
typ
1
10
10^2
$-I_C$ (mA)
10^3


7Z60670
400
f_T
(MHz)
300
200
100
0
$-V_{CE}=5V$
f = 35MHz
$T_j=25°C$
typ
1
10
10^2
$-I_C$ (mA)
10^3

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.

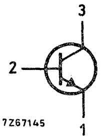
QUICK REFERENCE DATA

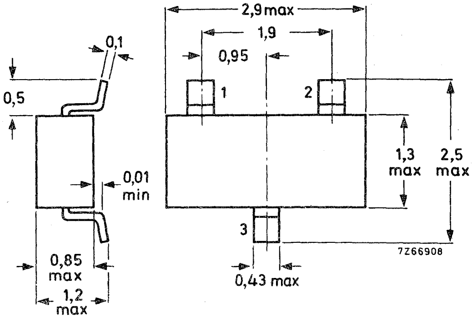
			BCX19	BCX20	
Collector-emitter voltage (V_{BE} = 0)	V_{CES}	max.	50	30	V
Collector-emitter voltage (open base)	V_{CEO}	max.	45	25	V
Collector current (peak value)	I_{CM}	max.	1000		mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	310		mW
Junction temperature	T_j	max.	150		°C
D.C. current 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	$R_{th\ j-a}$	=	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

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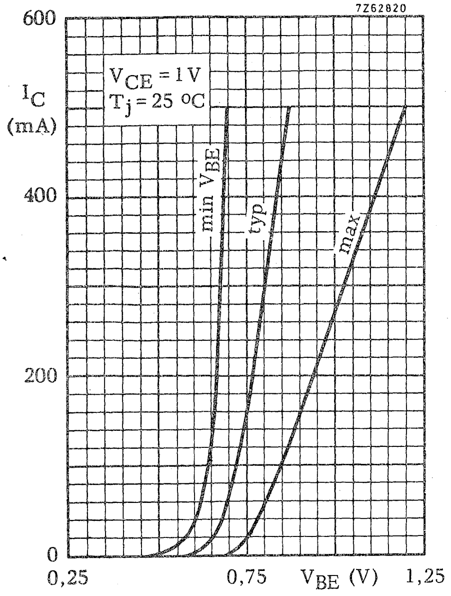
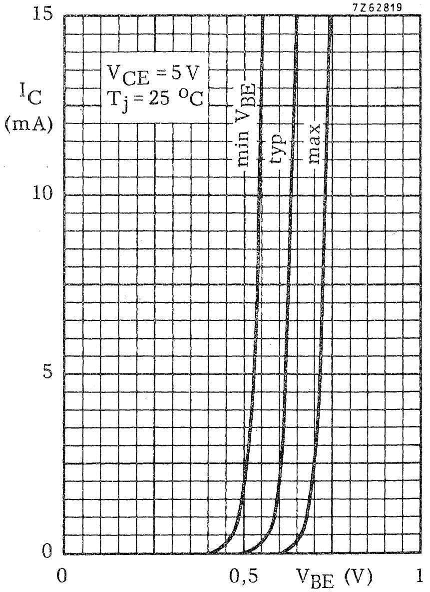
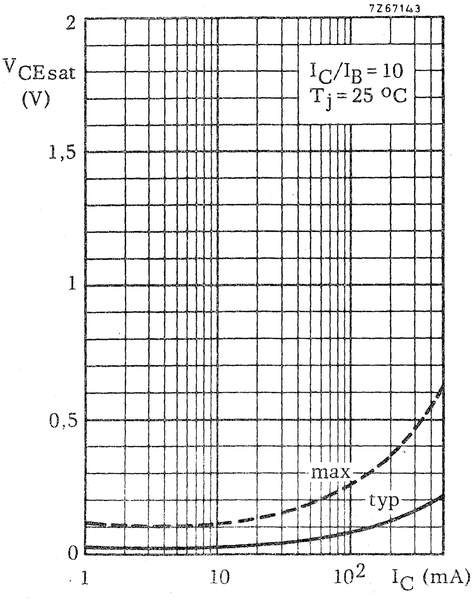
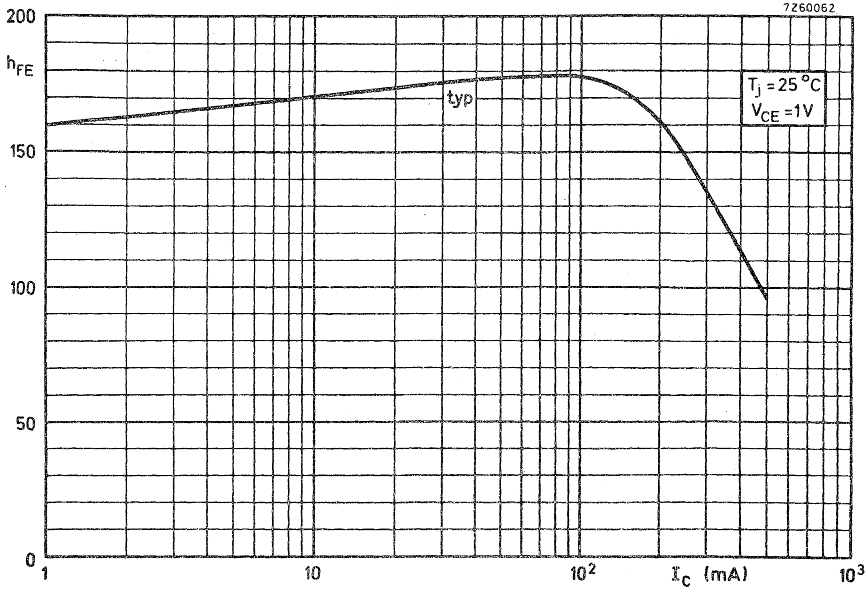
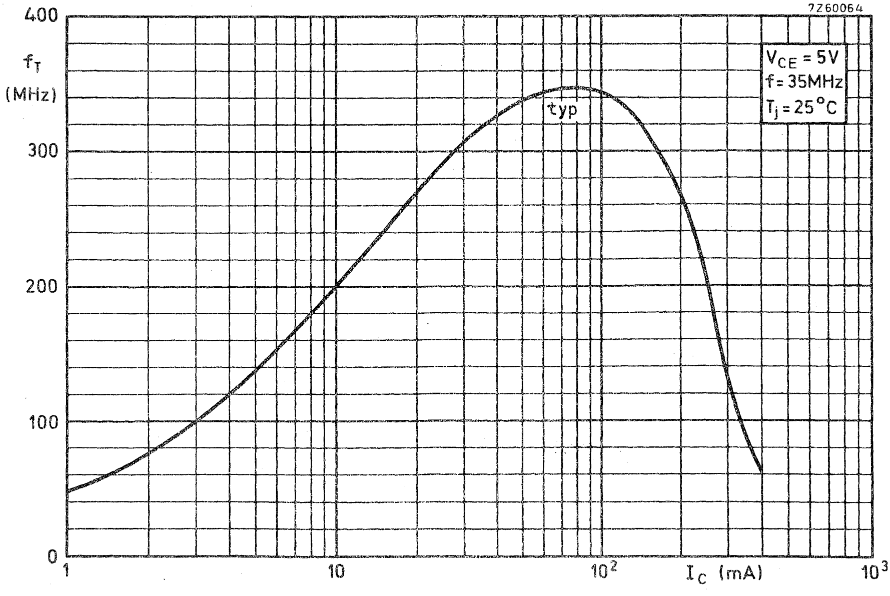
[1] V_{BE} decreases by about 2 mV/°C with increasing temperature.


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
typ
$T_j = 25\,^{\circ}C$
$V_{CE} = 1V$
1
10
10^2
I_C (mA)
10^3


7Z60064
400
f_T
(MHz)
300
200
100
0
typ
$V_{CE} = 5V$
f = 35MHz
$T_j = 25\,^{\circ}C$
1
10
10^2
I_C (mA)
10^3

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

Drain-source voltage	$\pm V_{DS}$	max.	25		V
Gate-source voltage (open drain)	$-V_{GSO}$	max.	25		V
Total power dissipation up to $T_{amb} = 25\,^{\circ}C$	P_{tot}	max.	200		mW
			BFR30	BFR31	
Drain current $V_{DS} = 10$ V; $V_{GS} = 0$	I_{DSS}	>	4	1	mA
		<	10	5	mA
Transfer admittance (common source) $I_D = 1$ mA; $V_{DS} = 10$ V; f = 1 kHz	$\lvert y_{fs} \rvert$	>	1.0	1.5	mA/V
		<	4.0	4.5	mA/V

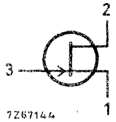
MECHANICAL DATA

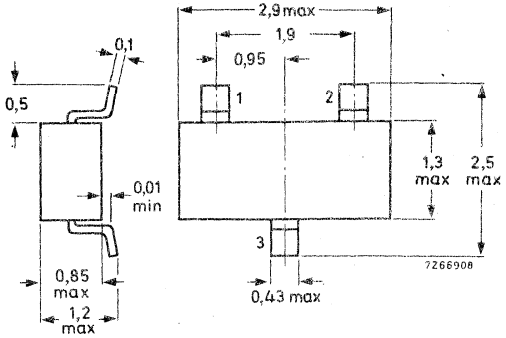
Dimensions in mm

SOT-23

Code:

BFR30 M1
BFR31 M2





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

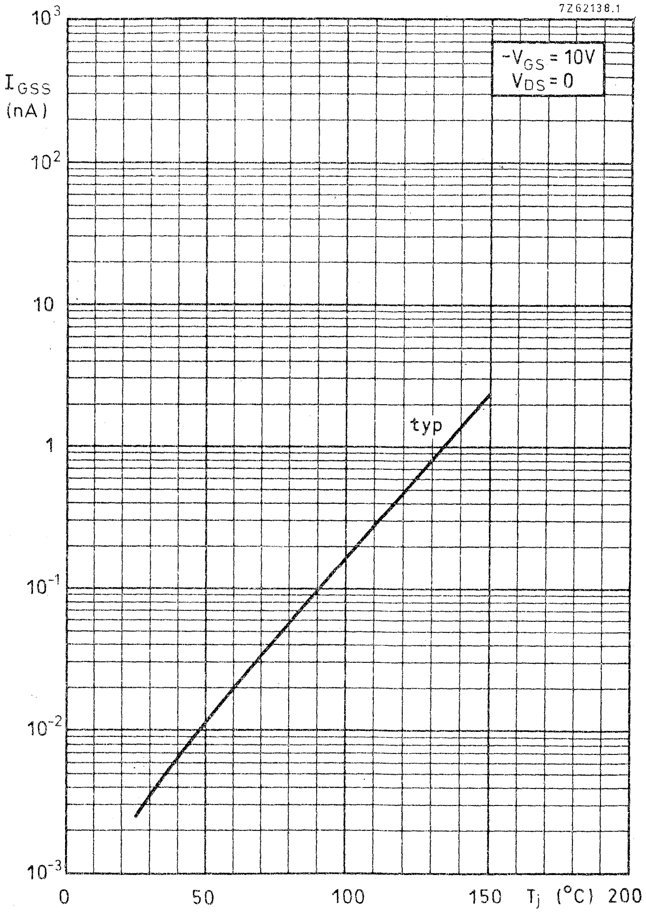
Voltages				
Drain-source voltage	$\pm V_{DS}$	max.	25	V
Drain-gate voltage (open source)	V_{DGO}	max.	25	V
Gate-source voltage (open drain)	$-V_{GSO}$	max.	25	V
Current				
Drain current	I_D	max.	10	mA
Gate current	I_G	max.	5	mA
Power dissipation				
Total power dissipation up to T_{amb} = 25 °C mounted 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

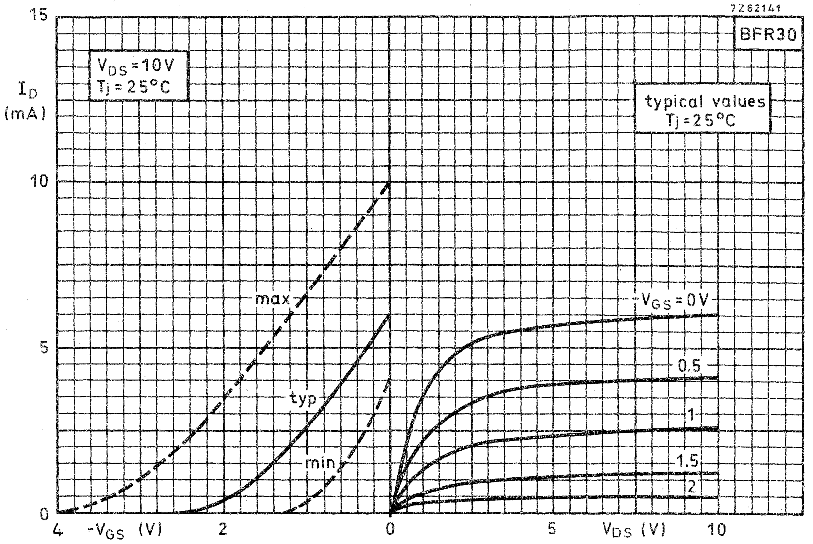
THERMAL RESISTANCE

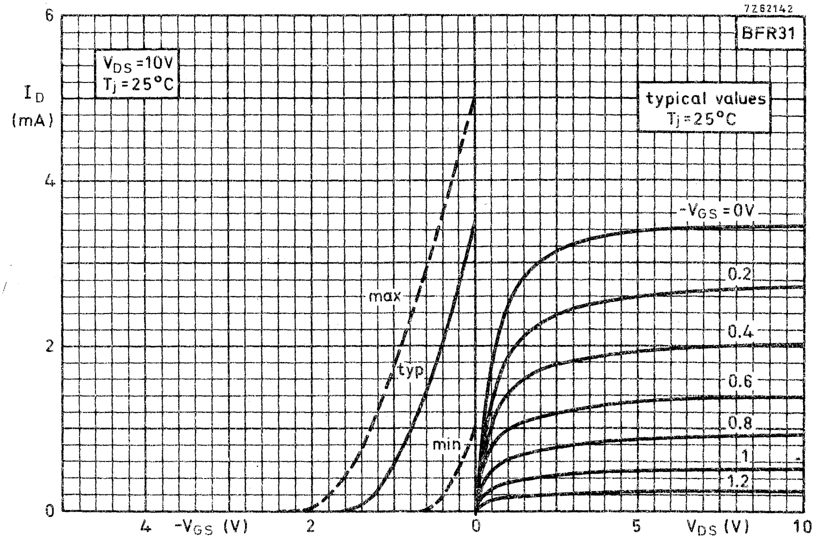
From junction to ambient mounted on a ceramic substrate of 7 mm x 5 mm x 0.5 mm	$R_{th\ j\text{-}a}$	=	0.62	°C/mW

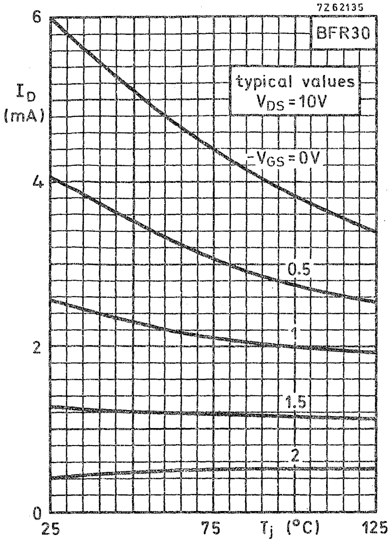
CHARACTERISTICS T_j = 25 °C unless otherwise specified

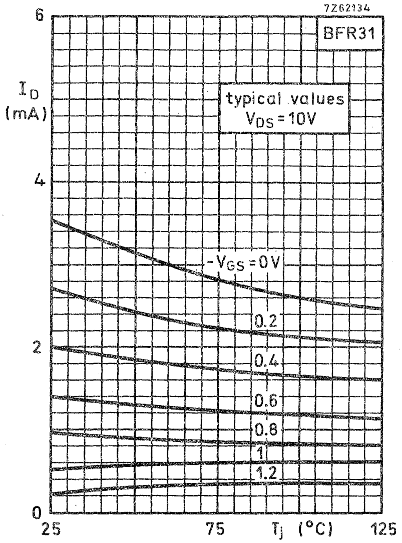
			BFR30	BFR31	
Gate cut-off current					
$-V_{GS}$ = 10 V; V_{DS} = 0	$-I_{GSS}$	<	0.2	0.2	nA
Drain current					
V_{DS} = 10 V; V_{GS} = 0	I_{DSS}	>	4	1	mA
		<	10	5	mA
Gate-source voltage					
I_D = 1 mA; V_{DS} = 10 V	$-V_{GS}$	>	0.7	0	V
		<	3.0	1.3	V
I_D = 50 µA; V_{DS} = 10 V	$-V_{GS}$	<	4.0	2.0	V
Gate-source 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	$\lvert y_{fs} \rvert$	>	1.0	1.5	mA/V
		<	4.0	4.5	mA/V
I_D = 200 µA ; V_{DS} = 10 V	$\lvert y_{fs} \rvert$	>	0.5	0.75	mA/V
Output admittance at f = 1 kHz					
I_D = 1 mA; V_{DS} = 10 V	$\lvert y_{os} \rvert$	<	40	25	µA/V
I_D = 200 µA ; V_{DS} = 10 V	$\lvert y_{os} \rvert$	<	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

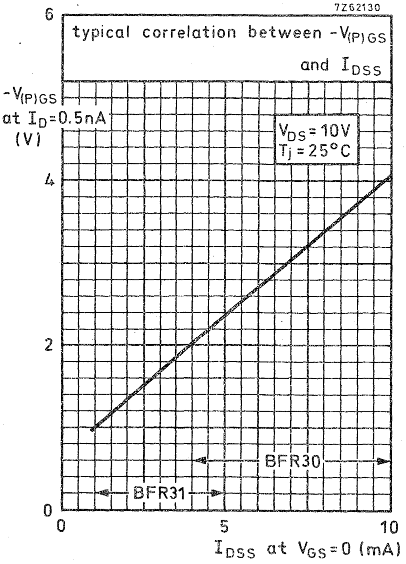

7Z62138.1
I_{GSS} (nA)
10^3
10^2
10
1
10^{-1}
10^{-2}
10^{-3}
$-V_{GS} = 10V$
$V_{DS} = 0$
typ
0
50
100
150
T_j (°C)
200

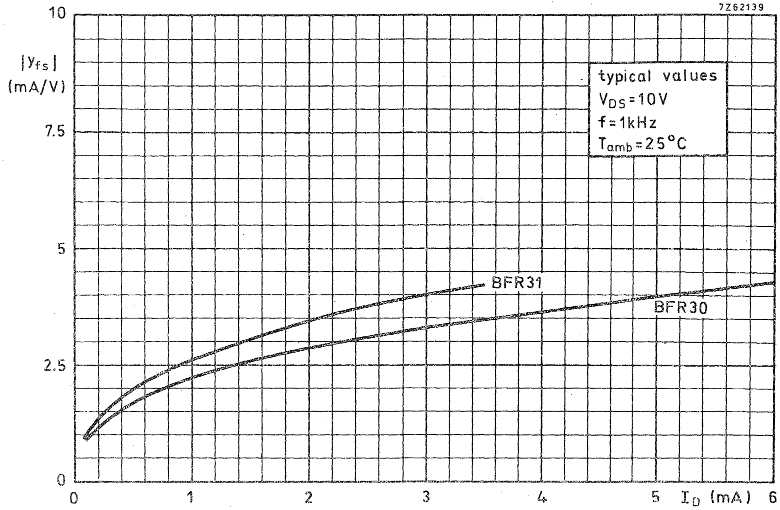

7Z62141
BFR30
V_{DS} = 10 V
T_j = 25 °C
I_D (mA)
15
10
5
0
typical values
T_j = 25 °C
max
typ
min
$-V_{GS}$ = 0 V
0.5
1
1.5
2
4
$-V_{GS}$ (V)
2
0
5
V_{DS} (V)
10

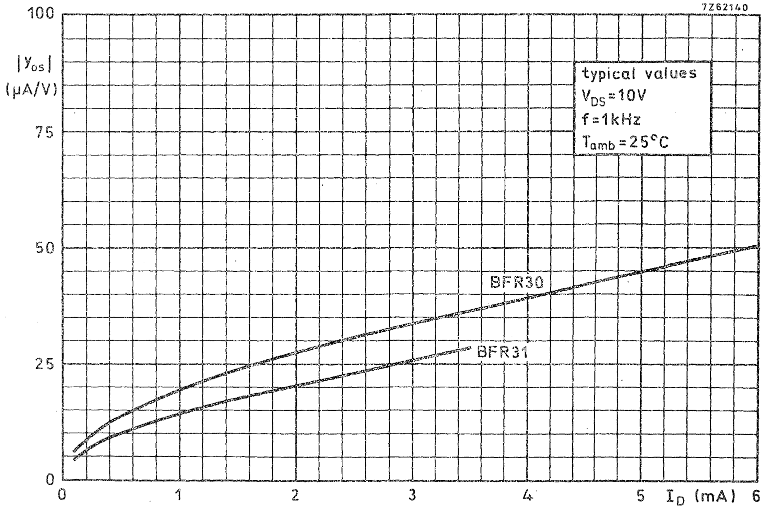

7Z62142
BFR31
V_{DS} = 10 V
T_j = 25 °C
I_D (mA)
6
4
2
0
typical values
T_j = 25 °C
max
typ
min
$-V_{GS}$ = 0 V
0.2
0.4
0.6
0.8
1
1.2
4
$-V_{GS}$ (V)
2
0
5
V_{DS} (V)
10

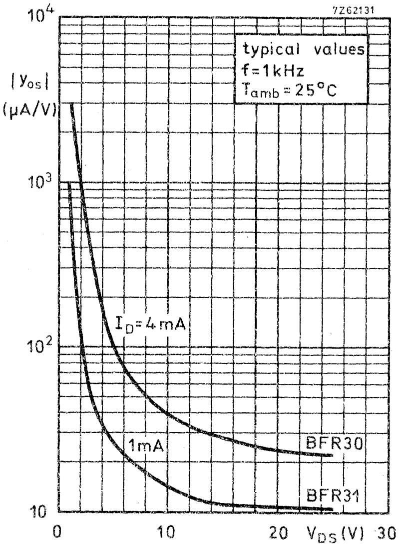

7Z62135
BFR30
typical values
V_{DS} = 10V
I_D (mA)
$-V_{GS}$ = 0V
0.5
1
1.5
2
6
4
2
0
25
75
T_j (°C)
125

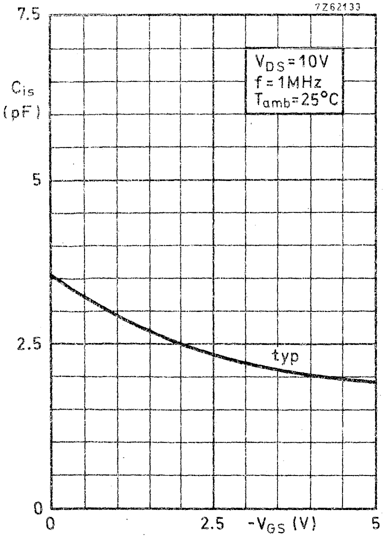

7Z62134
BFR31
typical values
V_{DS} = 10V
I_D (mA)
$-V_{GS}$ = 0V
0.2
0.4
0.6
0.8
1
1.2
6
4
2
0
25
75
T_j (°C)
125

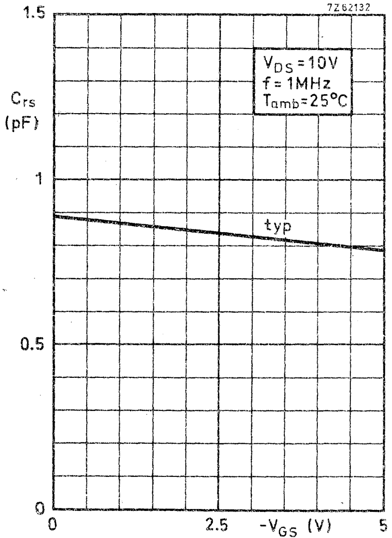

7Z62130
typical correlation between $-V_{(P)GS}$ and I_{DSS}
$-V_{(P)GS}$ at I_D = 0.5nA (V)
V_{DS} = 10V
T_j = 25°C
BFR30
BFR31
6
4
2
0
0
5
10
I_{DSS} at V_{GS} = 0 (mA)

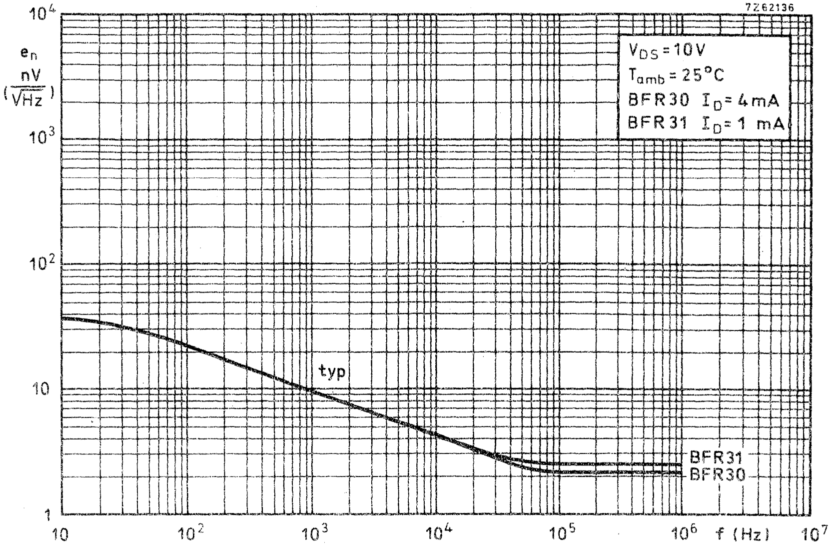

7Z62139
|yfs| (mA/V)
10
7.5
5
2.5
0
0
1
2
3
4
5
ID (mA)
6
typical values
VDS=10V
f=1kHz
Tamb=25°C
BFR31
BFR30

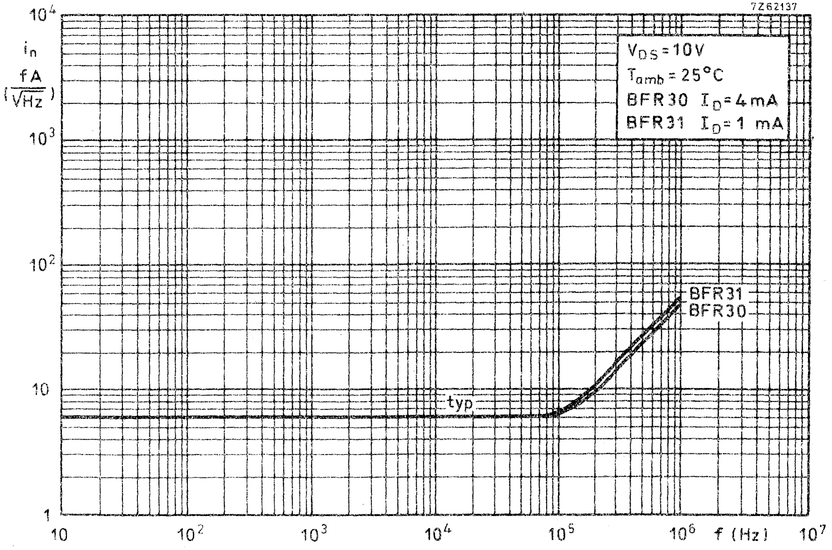

7Z62140
|yos| (μA/V)
100
75
50
25
0
0
1
2
3
4
5
ID (mA)
6
typical values
VDS=10V
f=1kHz
Tamb=25°C
BFR30
BFR31


7Z62131
10^4
10^3
10^2
10
|y_os|
(μA/V)
typical values
f = 1 kHz
T_amb = 25 °C
I_D = 4 mA
1 mA
BFR30
BFR31
0
10
20
V_DS (V)
30


7Z62133
7.5
5
2.5
0
C_is
(pF)
V_DS = 10 V
f = 1 MHz
T_amb = 25 °C
typ
0
2.5
-V_GS (V)
5


7Z62132
1.5
1
0.5
0
C_rs
(pF)
V_DS = 10 V
f = 1 MHz
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} = 10V
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} = 10V
T_{amb} = 25°C
BFR30 I_D = 4 mA
BFR31 I_D = 1 mA
BFR31
BFR30
typ
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.

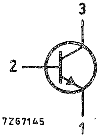
QUICK REFERENCE DATA

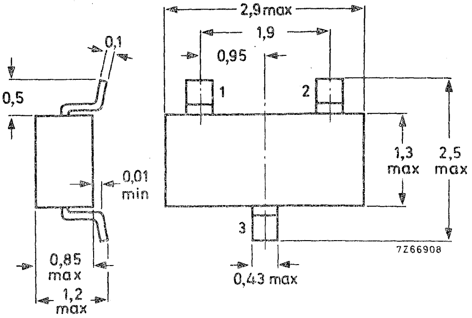
Collector-base voltage (open emitter)	V_{CBO}	max.	18	V
Collector-emitter voltage (open base)	V_{CEO}	max.	10	V
Collector current (peak value; f > 1 MHz)	I_{CM}	max.	100	mA
Total power dissipation up to T_{amb} = 60 °C	P_{tot}	max.	180	mW
Junction temperature	T_j	max.	150	°C
Feedback capacitance at f = 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 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]				
$I_C = 25$ 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; $T_{amb} = 25$ °C	C_{re}	typ.	0.9	pF
Noise figure at f = 500 MHz [2]				
$I_C = 2$ mA; $V_{CE} = 5$ V; $T_{amb} = 25$ °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; $T_{amb} = 25$ °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

---

[1] Measured under pulse conditions.

[2] Crystal mounted in a BFW30 envelope.

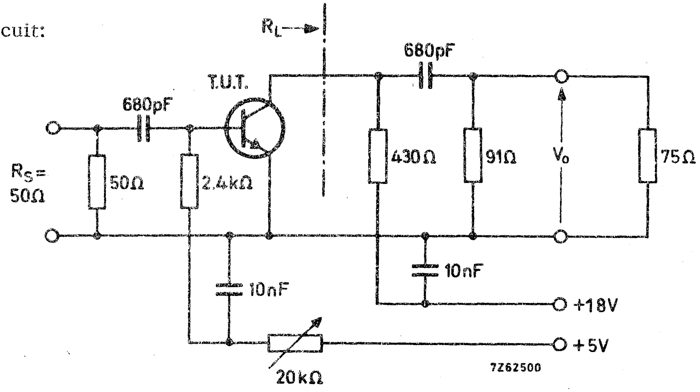
CHARACTERISTICS (continued)　　T_{amb} = 25 °C unless otherwise specified

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:



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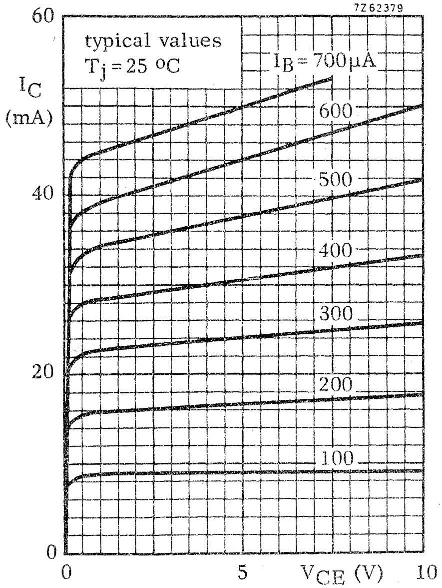
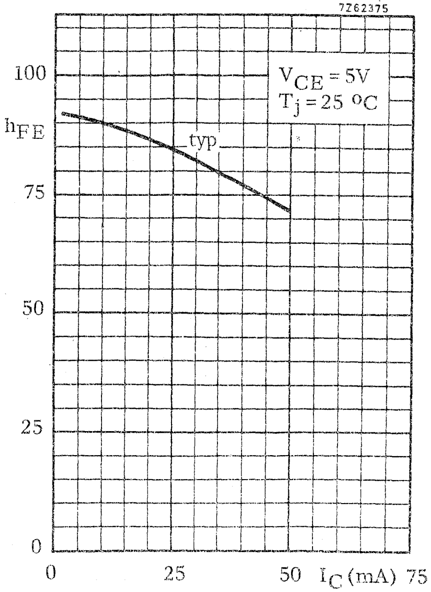
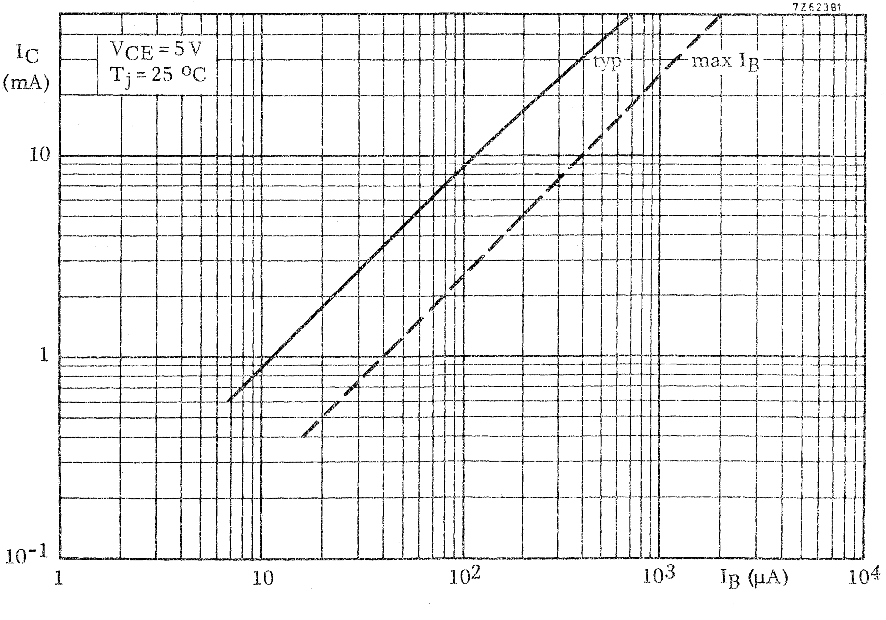
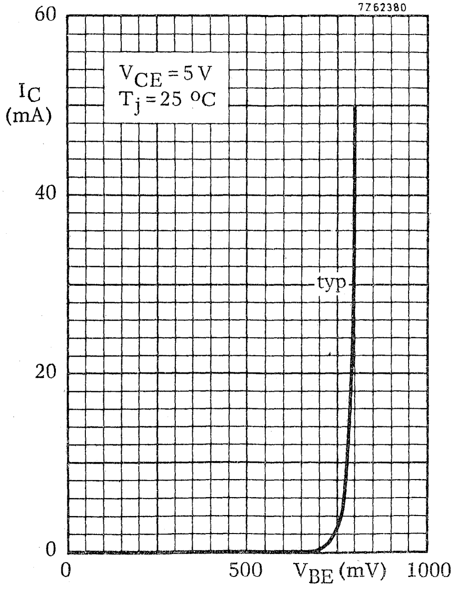
[1] Crystal mounted in a BFW30 envelope.

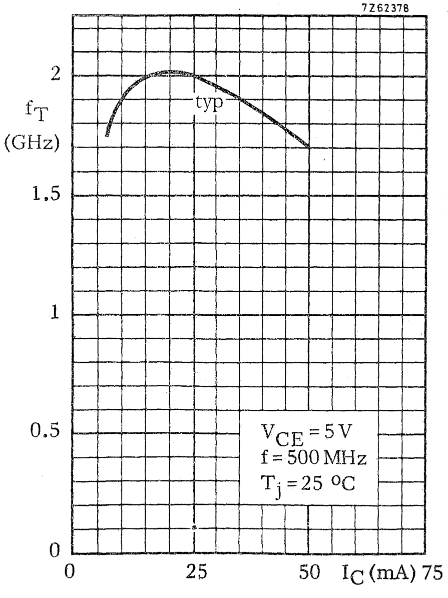
)

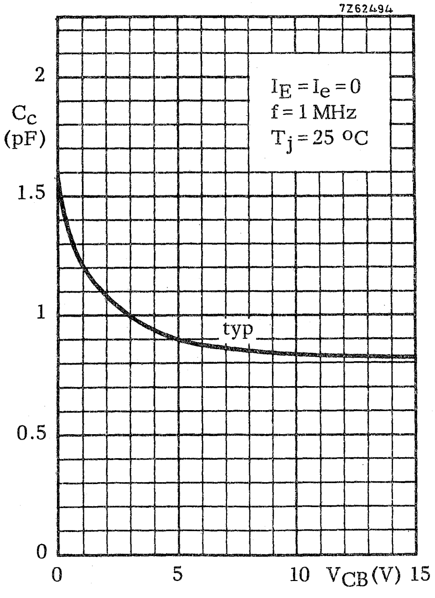

7Z62379
typical values
Tj = 25 °C
IB = 700µA
600
500
400
300
200
100
IC
(mA)
60
40
20
0
0
5
VCE (V)
10


7Z62375
VCE = 5V
Tj = 25 °C
hFE
typ
100
75
50
25
0
0
25
50
IC (mA) 75

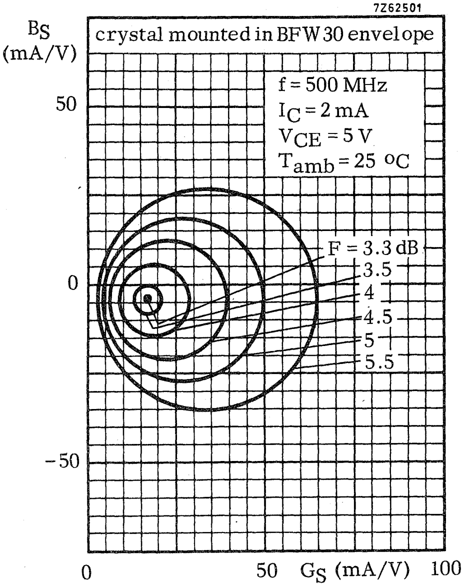

7Z62381
VCE = 5 V
Tj = 25 °C
IC
(mA)
typ
max IB
10
1
10⁻¹
1
10
10²
10³
IB (µA)
10⁴

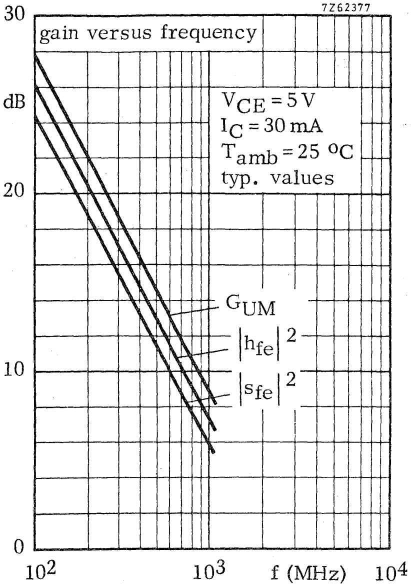

7Z62380
I_C
(mA)
60
40
20
0
$V_{CE} = 5$ V
$T_j = 25$ °C
typ
0
500
V_{BE} (mV)
1000

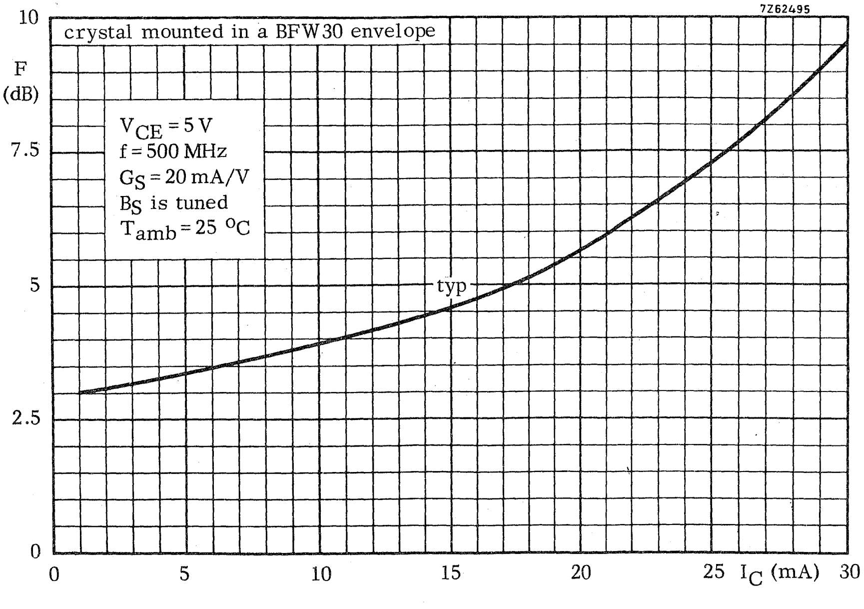

7Z62378
f_T
(GHz)
2
1.5
1
0.5
0
typ
$V_{CE} = 5$ V
f = 500 MHz
$T_j = 25$ °C
0
25
50
I_C (mA)
75


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



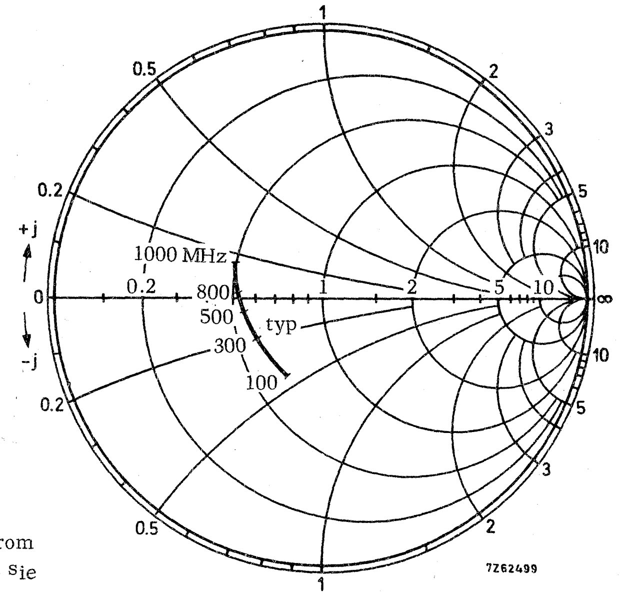




$V_{CE} = 5$ V

$I_C = 30$ mA

$T_{amb} = 25$ °C

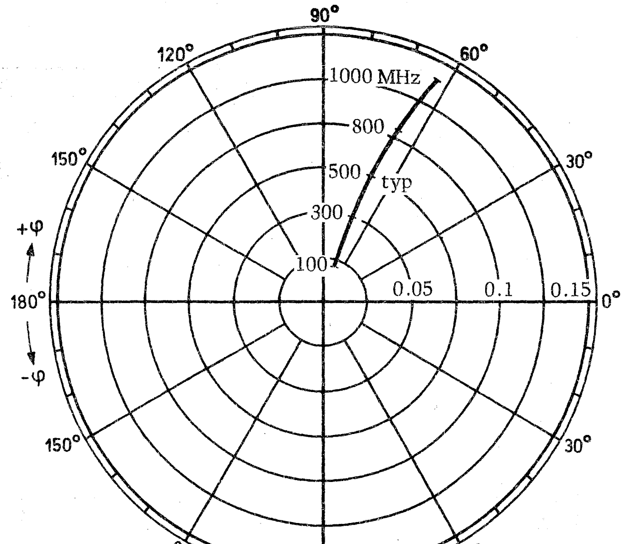


Input impedance derived from input reflection coefficient s_{ie} coordinates in ohm x 50

$V_{CE} = 5$ V

$I_C = 30$ mA

$T_{amb} = 25$ °C

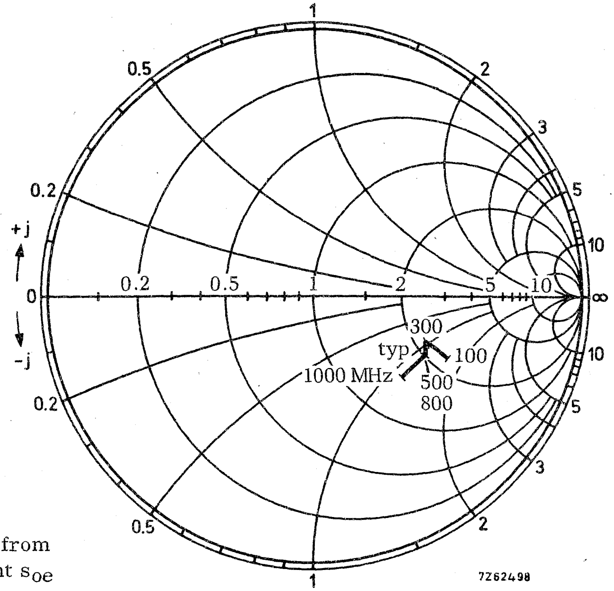


Reverse transmission coefficient s_{re}

V_{CE} = 5 V

I_C = 30 mA

T_{amb} = 25 °C

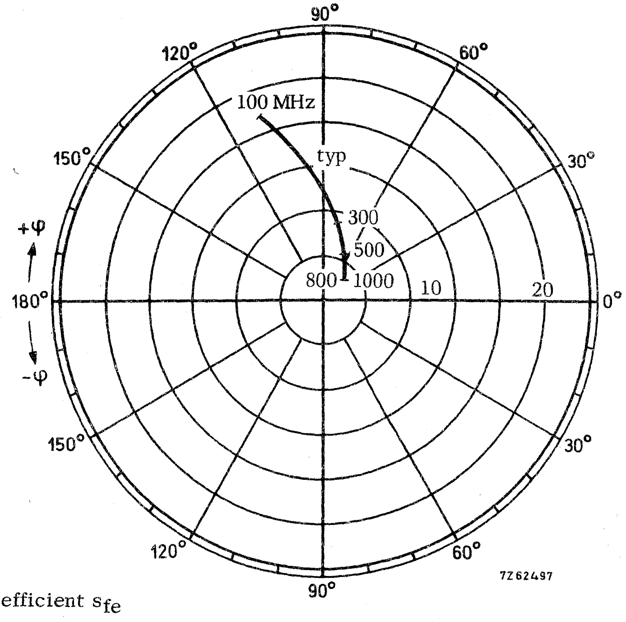


Output impedance derived from output reflection coefficient s_{oe} coordinates in ohm x 50

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 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

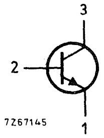
Collector-base voltage (open emitter)	V_{CBO}	max.	20	V
Collector-emitter voltage (open base)	V_{CEO}	max.	15	V
Collector current (d.c.)	I_C	max.	25	mA
Total power dissipation up to T_{amb} = 60 °C	P_{tot}	max.	180	mW
Junction temperature	T_j	max.	150	°C
Transition frequency at f = 500 MHz I_C = 14 mA; 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

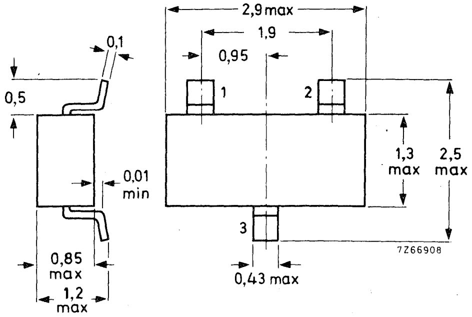
MECHANICAL DATA

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 $T_j = 25\ ^{\circ}C$ 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; $T_{amb} = 25\ ^{\circ}C$	C_{re}	typ.	0,7	pF
Noise figure at optimum source impedance [2]				
$I_C = 2$ mA; $V_{CE} = 10$ V; f = 500 MHz; $T_{amb} = 25\ ^{\circ}C$	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 ; $T_{amb} = 25\ ^{\circ}C$	G_{UM}	typ.	18	dB

---

[1] Measured under pulse conditions.

[2] Crystal mounted in a BFR90 envelope.

CHARACTERISTICS (continued)

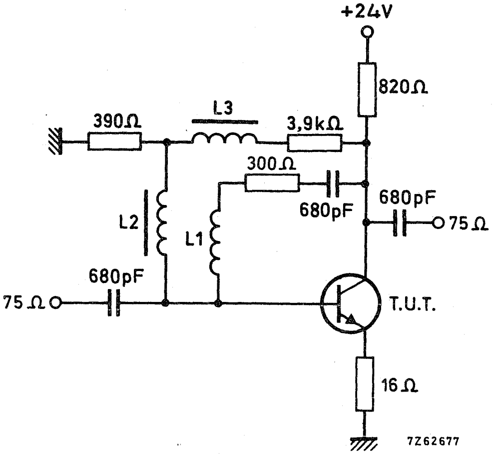
Intermodulation distortion at T_{amb} = 25 °C

I_C = 14 mA; V_{CE} = 10 V; R_L = 75 Ω; V.S.W.R. < 2

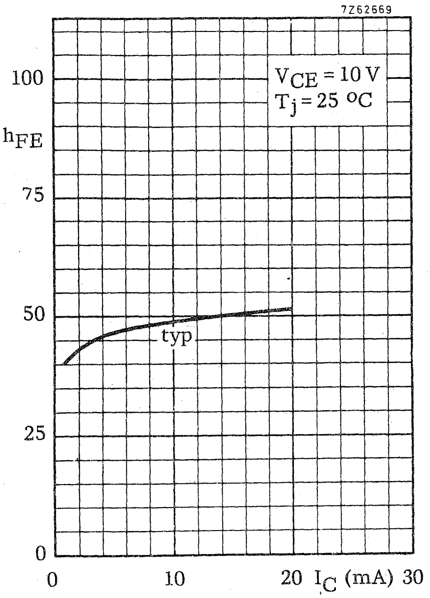
V_p = V_o = 150 mV at f_p = 495,25 MHz
V_q = V_o −6 dB at f_q = 503,25 MHz
V_r = V_o −6 dB at f_r = 505,25 MHz

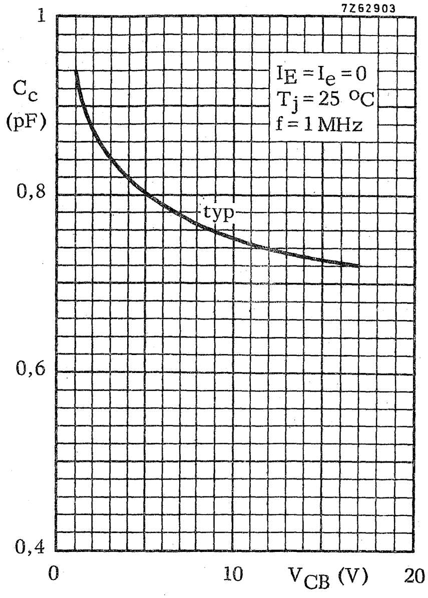
Measured at $f_{(p+q-r)}$ = 493,25 MHz d_{im} typ. −60 dB

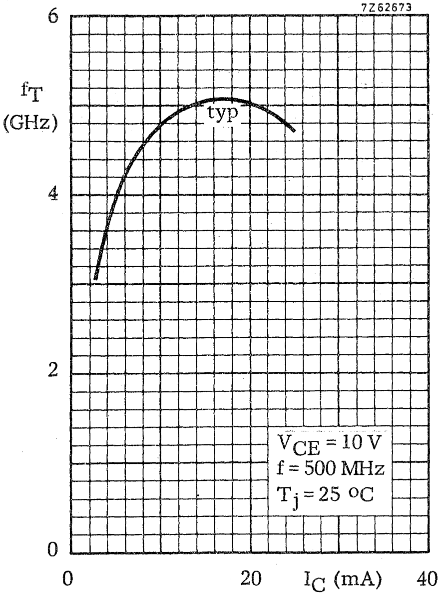
Intermodulation test circuit:

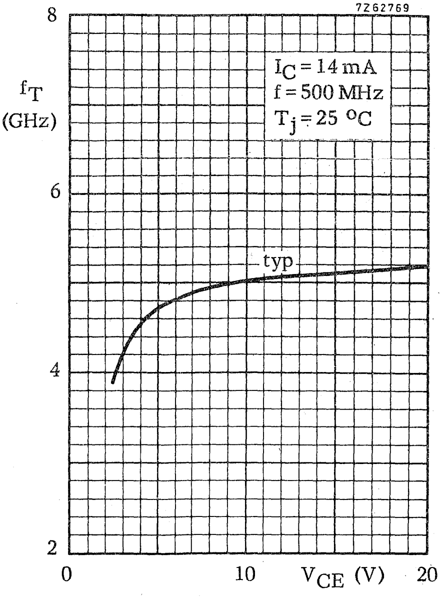


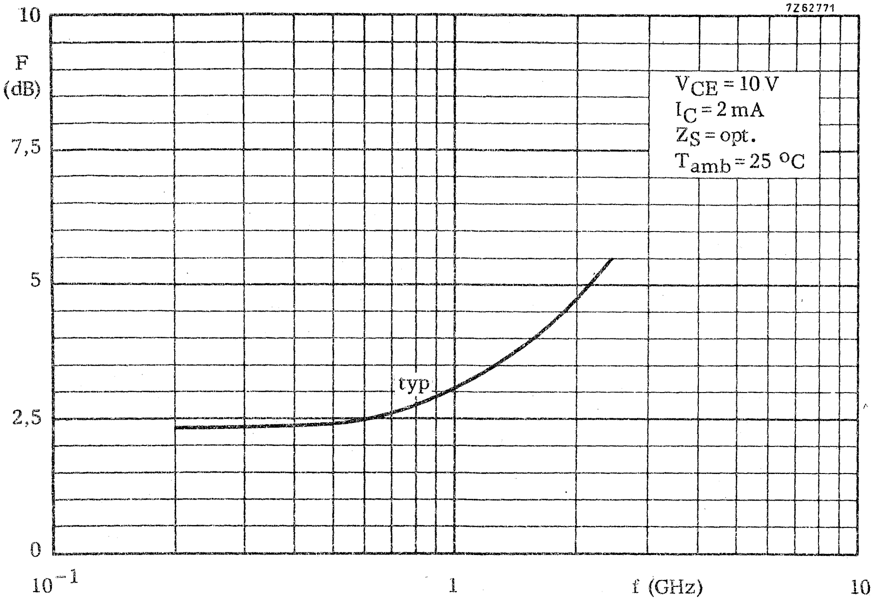
L1 = 4 turns Cu wire (0,35 mm); winding pitch 1 mm; int. diam. 4 mm
L2 = L3 = 5 μH (code number: 3122 108 20150)

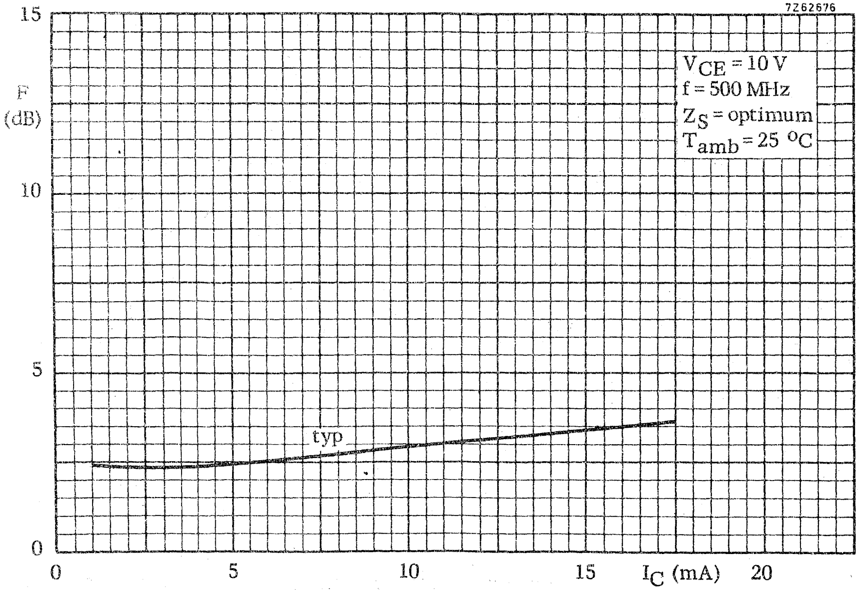

7Z62669
100
hFE
75
50
25
0
0
10
20
IC (mA)
30
VCE = 10 V
Tj = 25 °C
typ

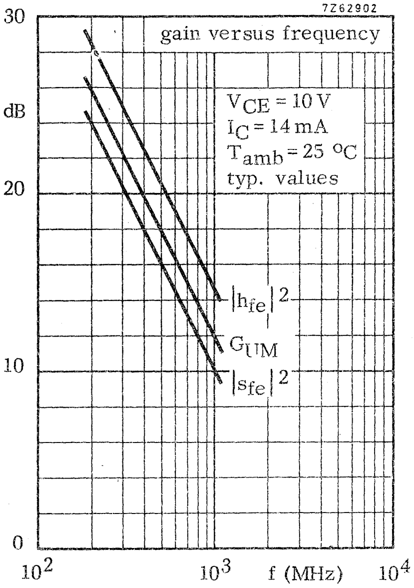

7Z62903
1
Cc
(pF)
0,8
0,6
0,4
0
10
VCB (V)
20
IE = Ie = 0
Tj = 25 °C
f = 1 MHz
typ


7Z62673
6
fT
(GHz)
4
2
0
0
20
IC (mA)
40
typ
VCE = 10 V
f = 500 MHz
Tj = 25 °C

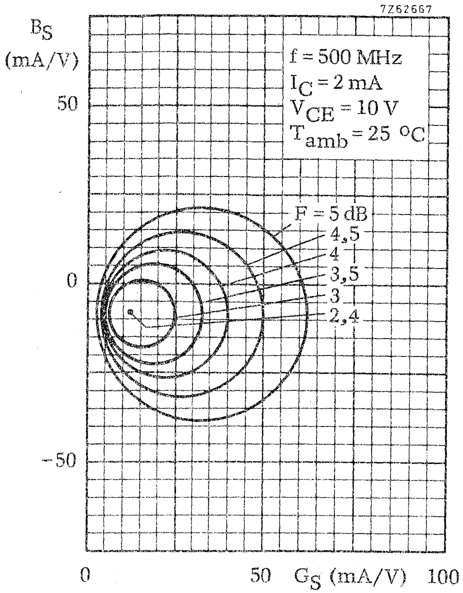

7Z62769
8
fT
(GHz)
6
4
2
0
10
VCE (V)
20
IC = 14 mA
f = 500 MHz
Tj = 25 °C
typ


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

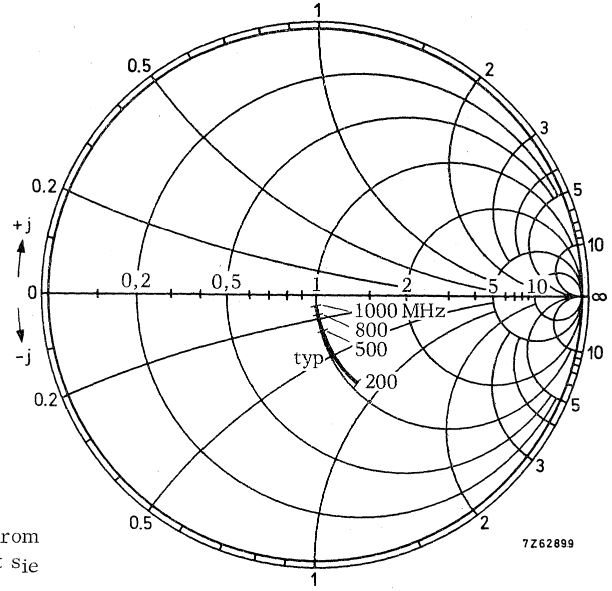

7Z62676
15
F
(dB)
10
5
0
0
5
10
15
I_C (mA)
20
V_{CE} = 10 V
f = 500 MHz
Z_S = optimum
T_{amb} = 25 °C
typ



circles of constant noise figure

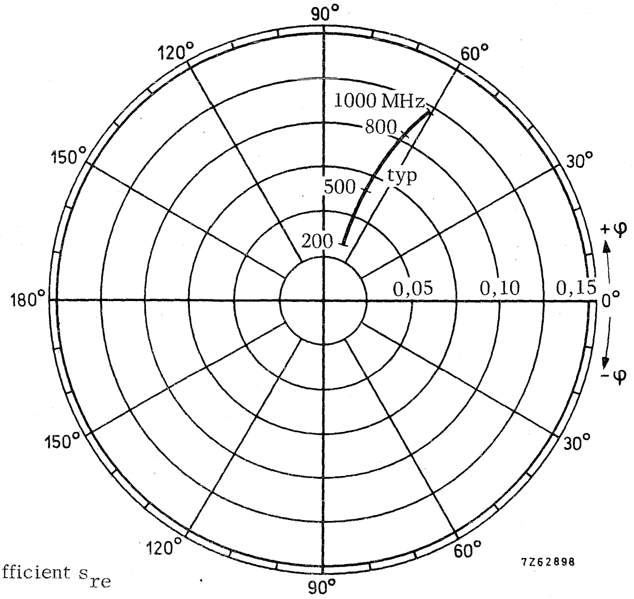


V_{CE} = 10 V
I_C = 14 mA
T_{amb} = 25 °C



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

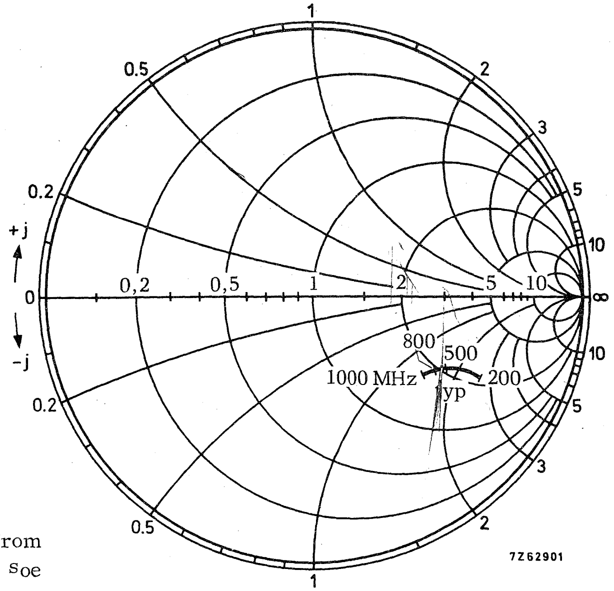


Reverse transmission coefficient s_{re}

V_{CE} = 10 V

I_C = 14 mA

T_{amb} = 25 °C

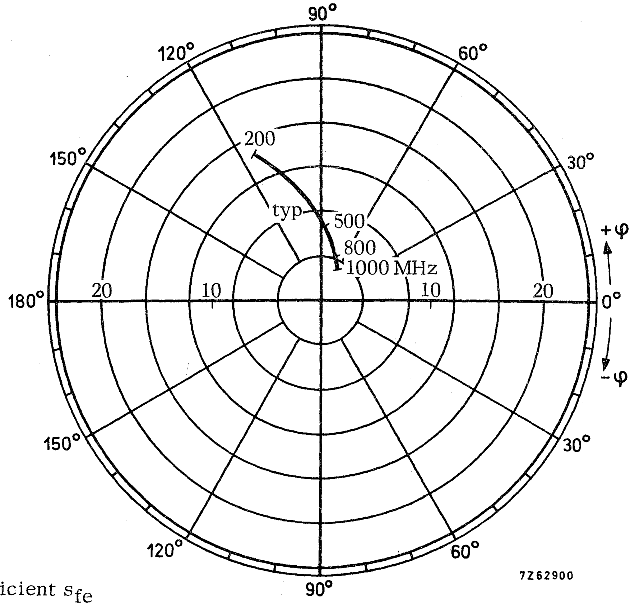


Output impedance derived from output reflection coefficient s_{oe} coordinates in ohm x 50

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.

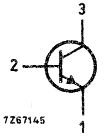
QUICK REFERENCE DATA

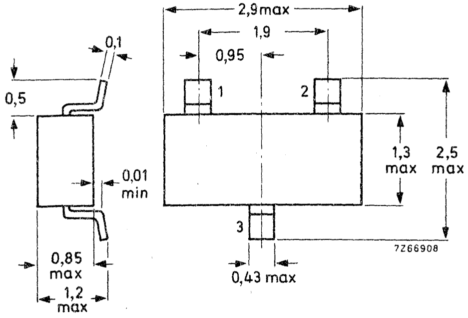
Collector-base voltage (open emitter)	V_{CBO}	max.	15	V
Collector-emitter voltage (open base)	V_{CEO}	max.	12	V
Collector current (d.c.)	I_C	max.	35	mA
Total power dissipation up to T_{amb} = 60 °C	P_{tot}	max.	180	mW
Junction temperature	T_j	max.	150	°C
Transition frequency at f = 500 MHz				
I_C = 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

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

Collector cut-off current				
$I_E = 0$; $V_{CB} = 10$ V	I_{CBO}	<	50	nA
D.C. current gain 1)				
$I_C = 30$ 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; $T_{amb} = 25\ ^{o}C$	C_{re}	typ.	0,8	pF
Noise figure at optimum source impedance 2)				
$I_C = 2$ mA; $V_{CE} = 5$ V; f = 500 MHz; $T_{amb} = 25\ ^{o}C$	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; $T_{amb} = 25\ ^{o}C$	G_{UM}	typ.	16,5	dB

---

1) Measured under pulse conditions.

2) Crystal mounted in a BFR91 envelope.

CHARACTERISTICS (continued)

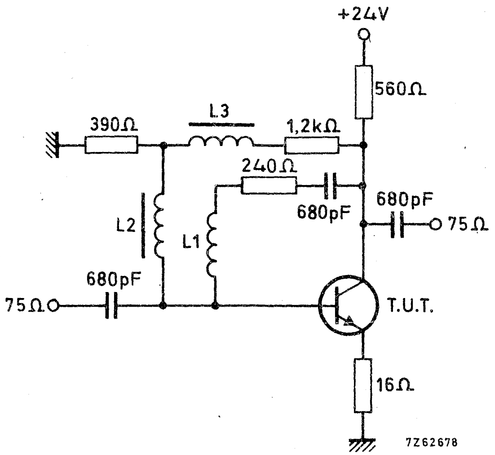
Intermodulation distortion at T_{amb} = 25 °C

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)

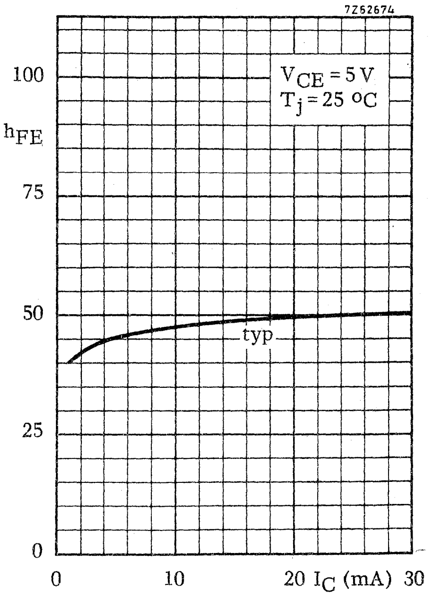
Intermodulation test circuit:

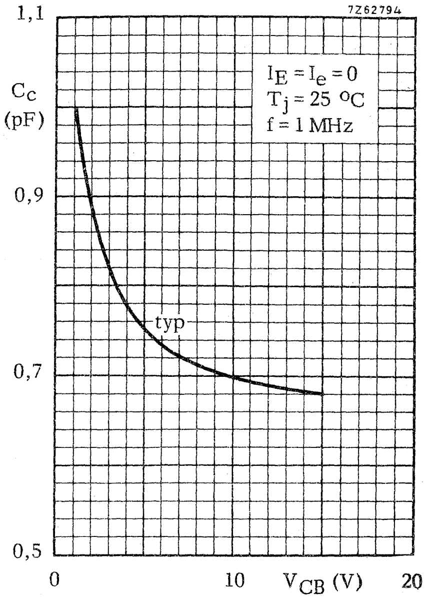


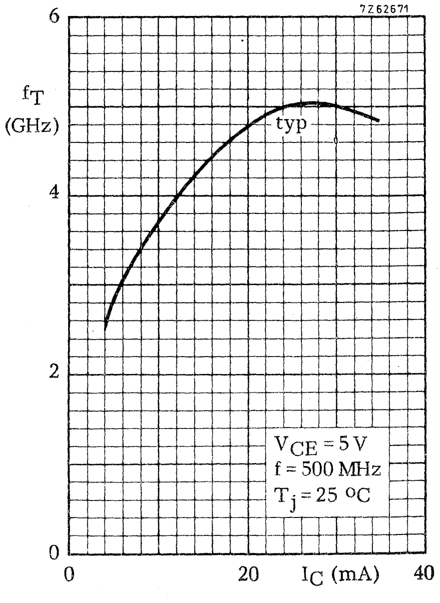
L1 = 4 turns Cu wire (0,35); winding pitch 1 mm; int.diam. 4 mm
L2 and L3 5 μH (code number: 3122 108 20150)

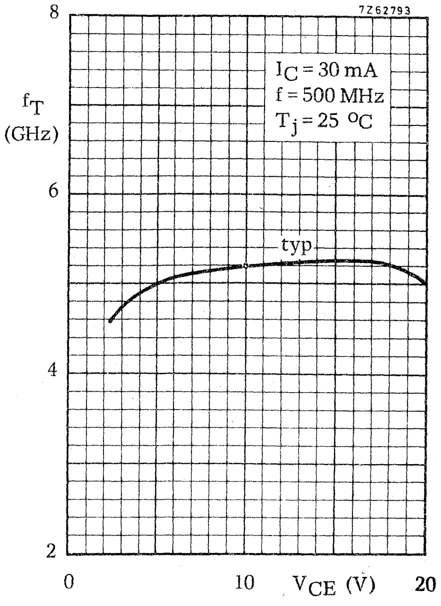
---

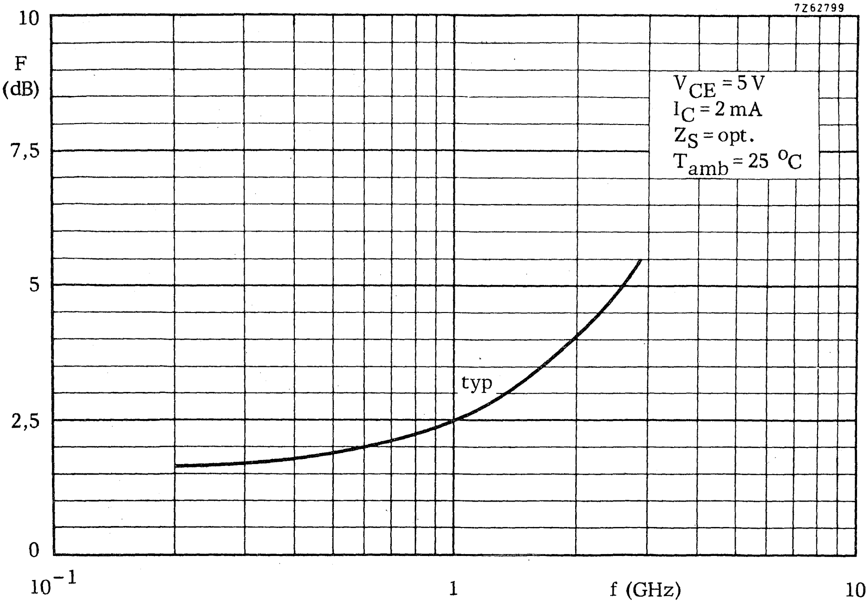
1) Crystal mounted in a BFR91 envelope.

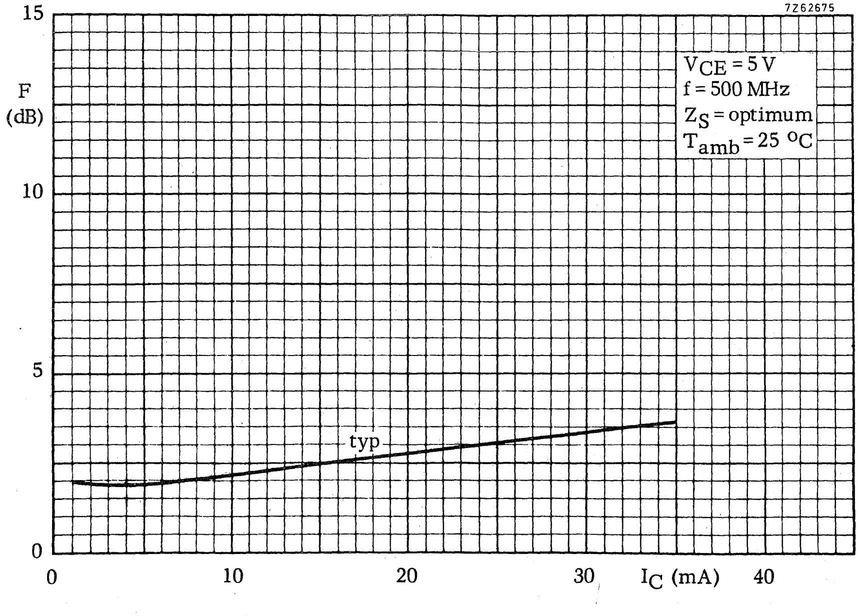

7Z62674
100
h_{FE}
75
50
25
0
V_{CE} = 5 V
T_j = 25 °C
typ
0
10
20 I_C (mA) 30

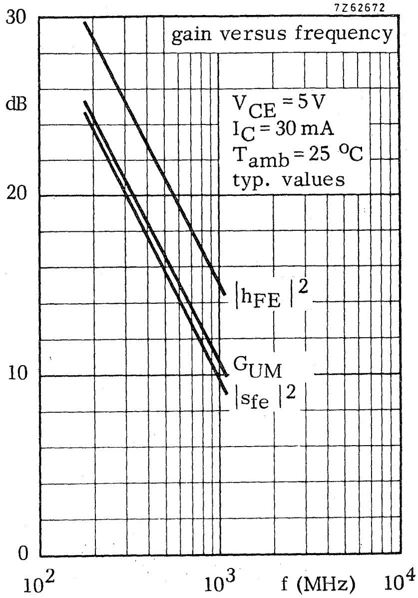

7Z62794
1,1
C_c
(pF)
0,9
0,7
0,5
$I_E = I_e = 0$
T_j = 25 °C
f = 1 MHz
typ
0
10
V_{CB} (V)
20


7Z62671
6
f_T
(GHz)
4
2
0
typ
V_{CE} = 5 V
f = 500 MHz
T_j = 25 °C
0
20
I_C (mA)
40

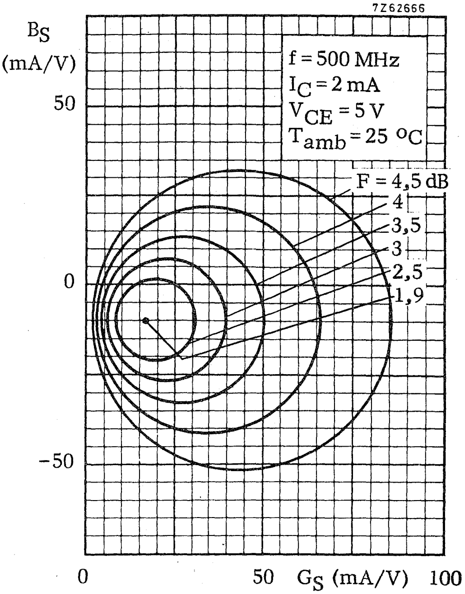

7Z62793
8
f_T
(GHz)
6
4
2
I_C = 30 mA
f = 500 MHz
T_j = 25 °C
typ
0
10
V_{CE} (V)
20


7Z62799
F (dB)
10
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

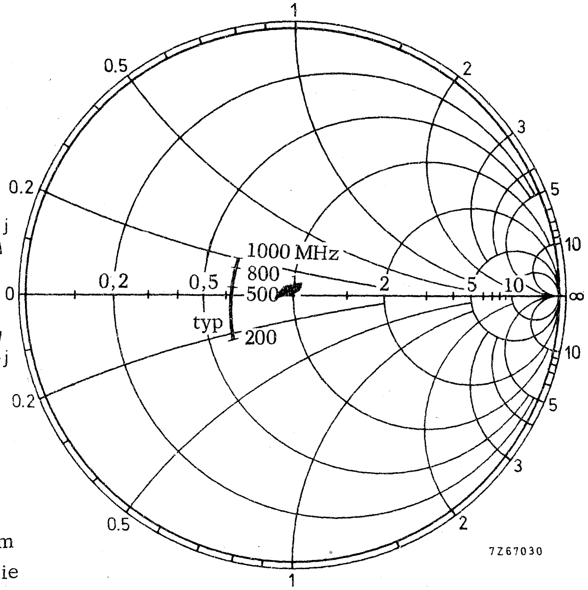

7Z62675
F (dB)
15
10
5
0
0
10
20
30
I_C (mA)
40
V_{CE} = 5 V
f = 500 MHz
Z_S = optimum
T_{amb} = 25 °C
typ



circles of constant noise figure

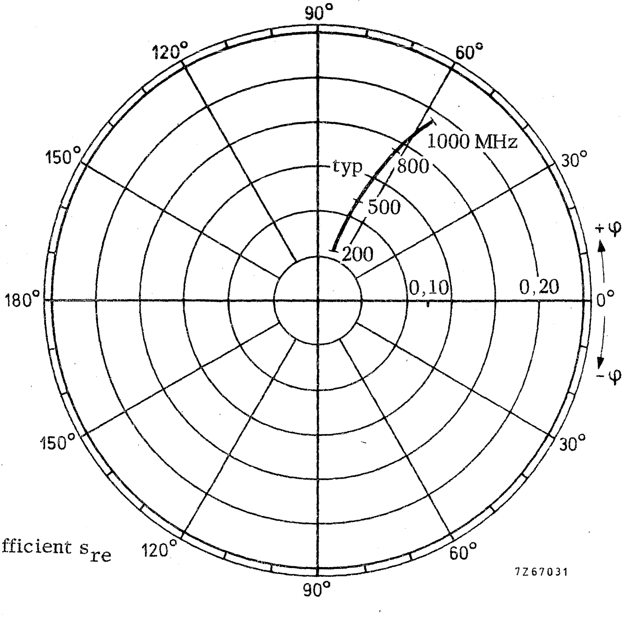


V_{CE} = 5 V
I_C = 30 mA
T_{amb} = 25 °C



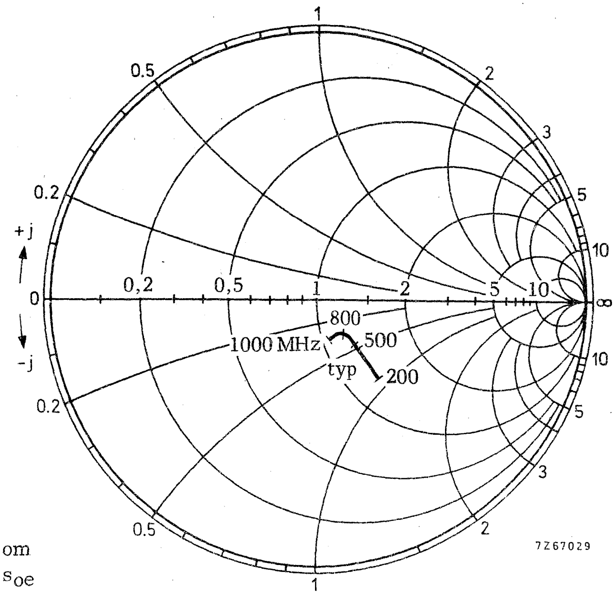
Input impedance derived from input reflection coefficient s_{ie} coordinates in ohm x 50

V_{CE} = 5 V
I_C = 30 mA
T_{amb} = 25 °C



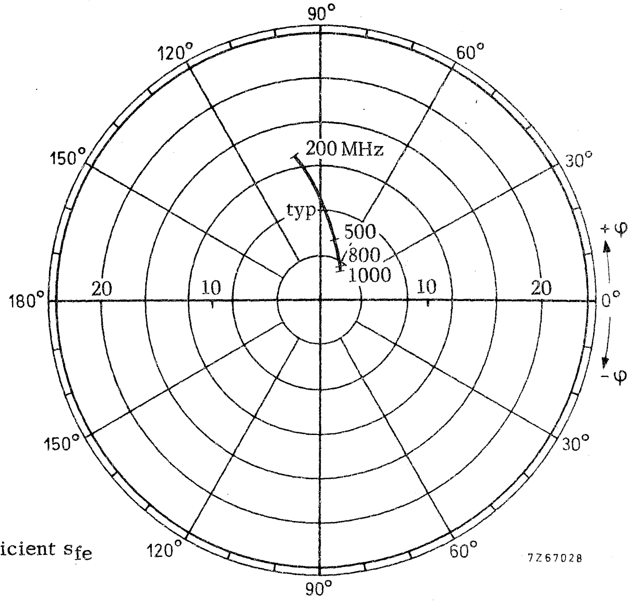
Reverse transmission coefficient s_{re}

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.

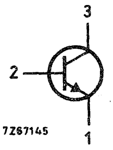
QUICK REFERENCE DATA

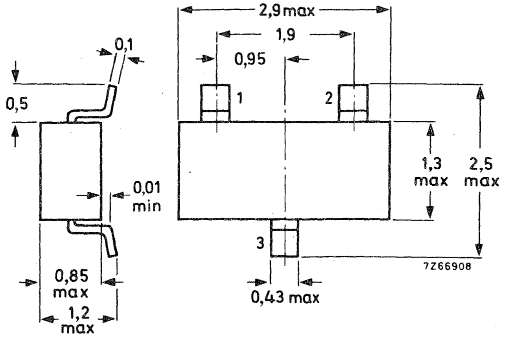
Collector-base voltage (open emitter; peak value)	V_{CBOM}	max.	25	V
Collector-emitter voltage (open base)	V_{CEO}	max.	15	V
Collector current (peak value)	I_{CM}	max.	50	mA
Total power dissipation up to $T_{amb} = 25\ ^{o}C$	P_{tot}	max.	200	mW
Junction temperature	T_j	max.	150	^{o}C
D.C. current gain $I_C = 2$ 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

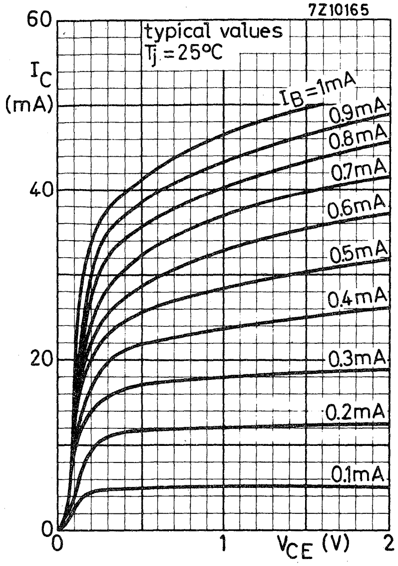
I_C = 2 mA; V_{CE} = 1 V	h_{FE}	20 to	150	
I_C = 25 mA; V_{CE} = 1 V	h_{FE}	>	20	

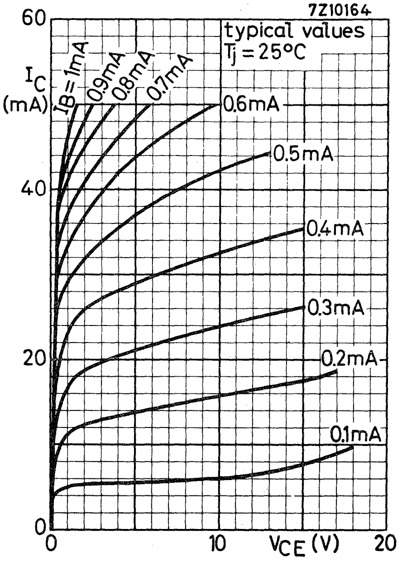
CHARACTERISTICS (continued) T_j = 25 °C unless otherwise specified

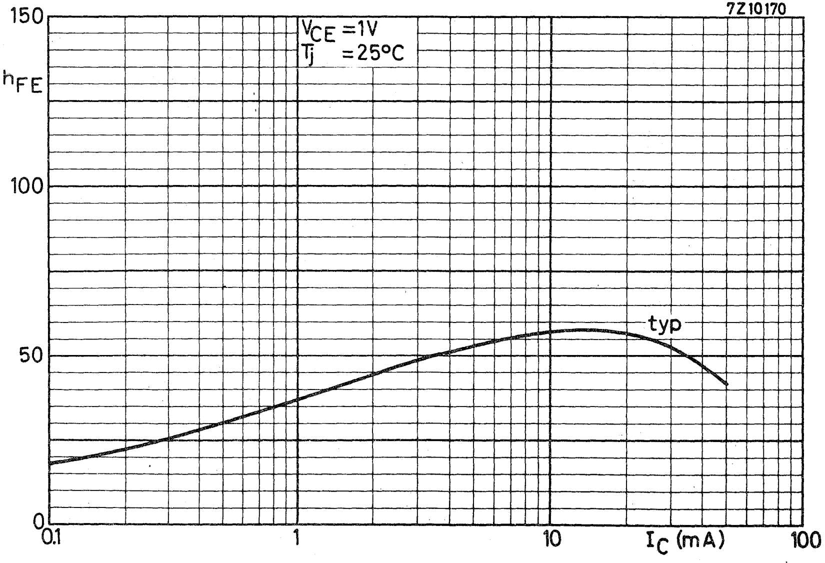
Transition frequency				
I_C = 2 mA; V_{CE} = 5 V; f = 500 MHz	f_T	typ.	1.0	GHz
I_C = 25 mA; V_{CE} = 5 V; f = 500 MHz	f_T	typ.	1.3	GHz
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; V_{CB} = 10 V	C_c	$<$	1.5	pF
Emitter capacitance at f = 1 MHz				
$I_C = I_c = 0$; V_{EB} = 0.5 V	C_e	$<$	2.0	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

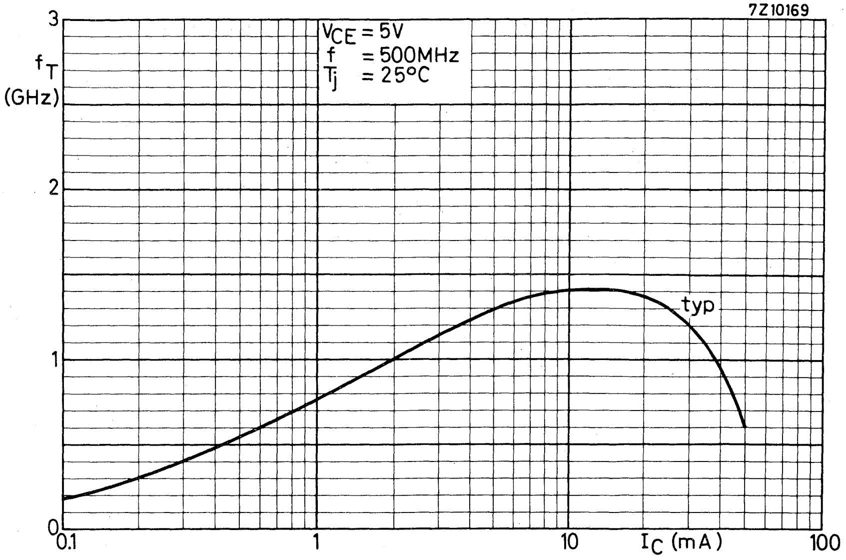
---

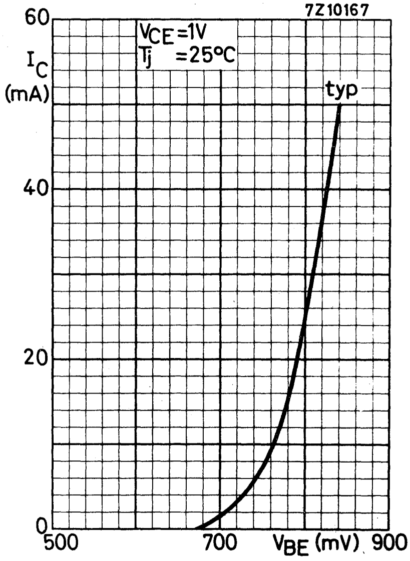
[1] Crystal mounted in a BFY90 envelope.

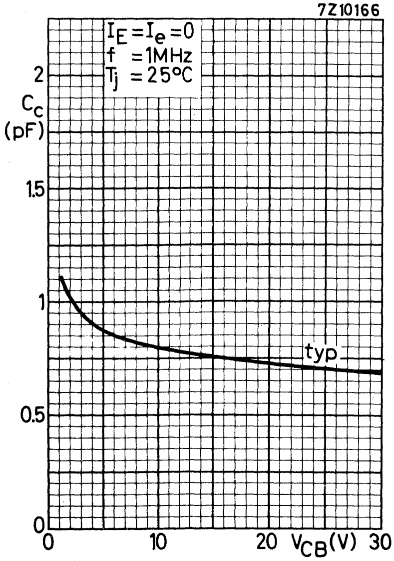

7Z10165
typical values
$T_j = 25°C$
I_C (mA)
I_B=1mA
0.9mA
0.8mA
0.7mA
0.6mA
0.5mA
0.4mA
0.3mA
0.2mA
0.1mA
60
40
20
0
0
1
2
V_{CE} (V)

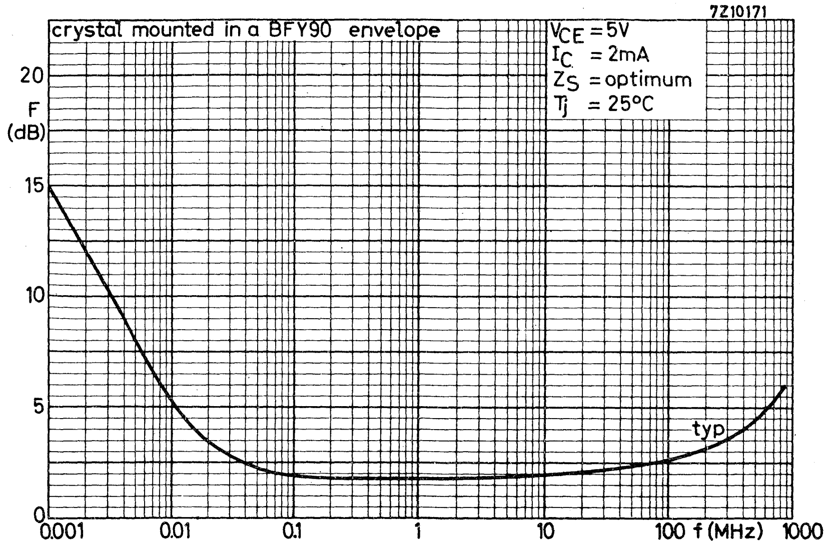

7Z10164
typical values
$T_j = 25°C$
I_C (mA)
I_B=1mA
0.9mA
0.8mA
0.7mA
0.6mA
0.5mA
0.4mA
0.3mA
0.2mA
0.1mA
60
40
20
0
0
10
20
V_{CE} (V)

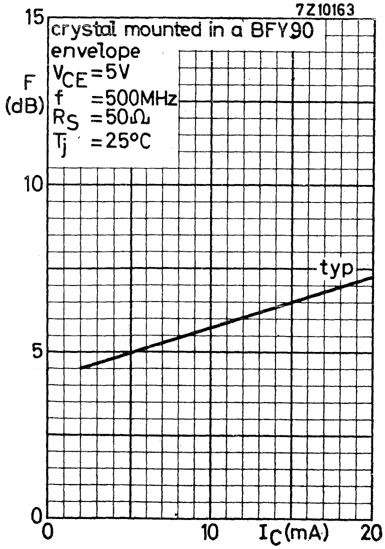

7Z10170
V_{CE} = 1V
T_j = 25°C
h_{FE}
typ
150
100
50
0
0.1
1
10
100
I_C (mA)

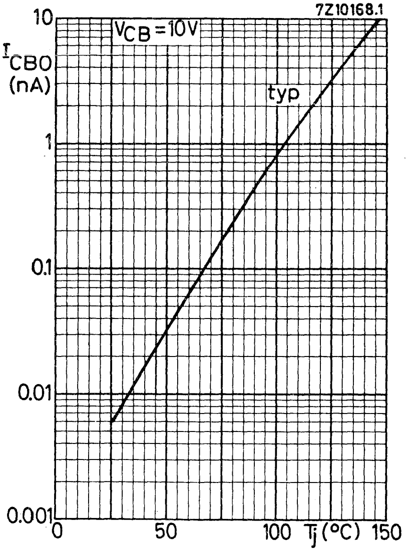

7Z10169
V_{CE} = 5V
f = 500MHz
T_j = 25°C
f_T (GHz)
3
2
1
0
0.1
1
10
I_C (mA)
100
typ


7Z10167
V_{CE}=1V
T_j =25°C
I_C (mA)
60
40
20
0
500
700
V_{BE} (mV)
900
typ


7Z10166
$I_E = I_e = 0$
f = 1MHz
T_j = 25°C
C_c (pF)
2
1.5
1
0.5
0
0
10
20
V_{CB}(V)
30
typ


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

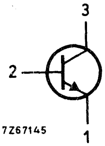
MECHANICAL DATA

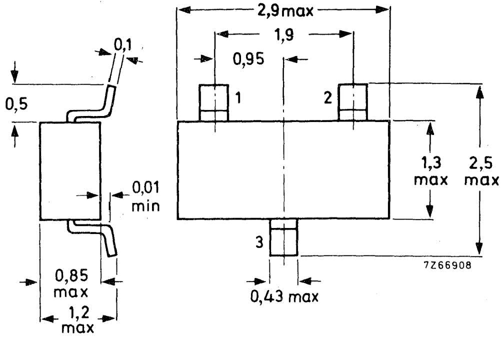
Dimensions in mm

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	$R_{th\ j-a}$	=	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 mΩ^{-1}; f = 100 MHz	F	typ.	4		dB 1)

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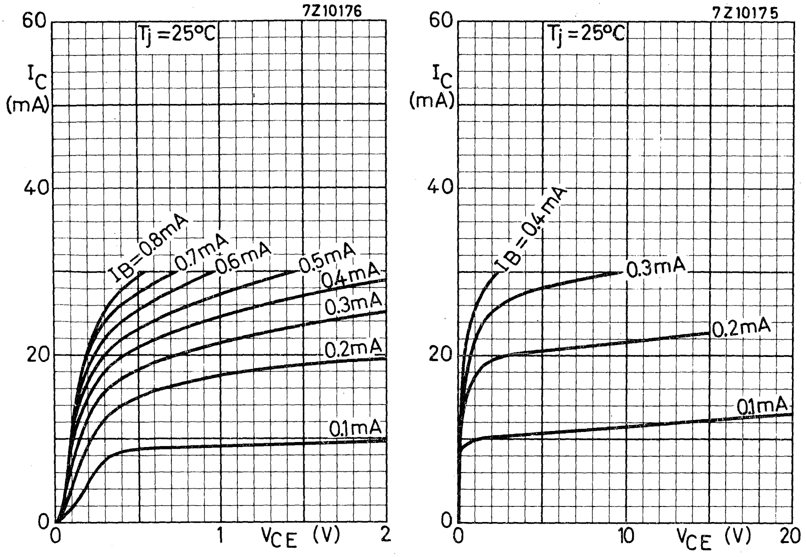
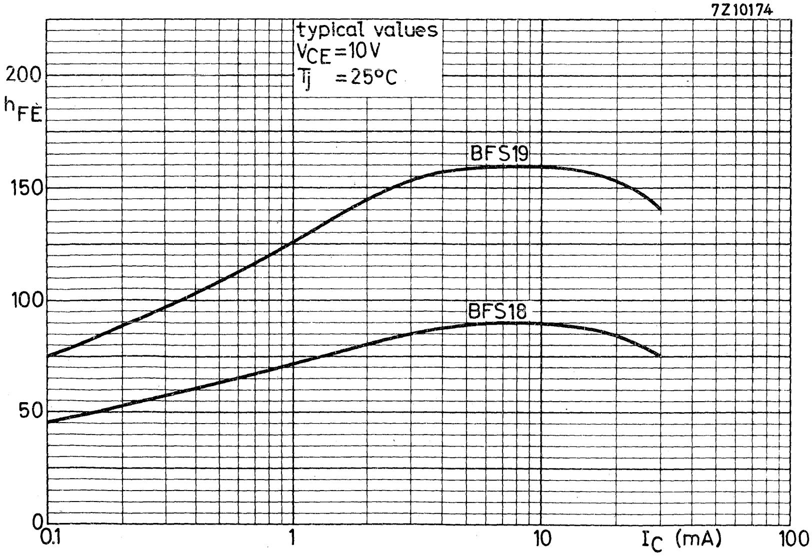
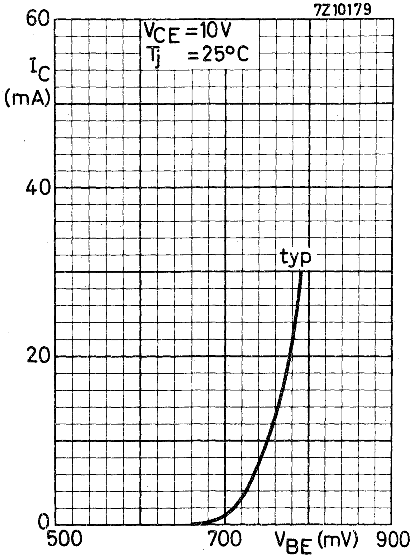
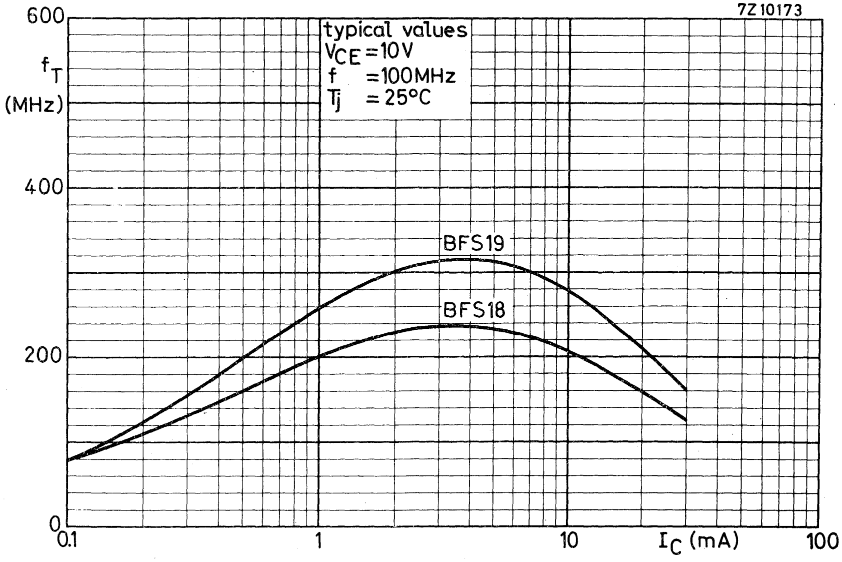
1) Crystal mounted in a BF115 envelope.

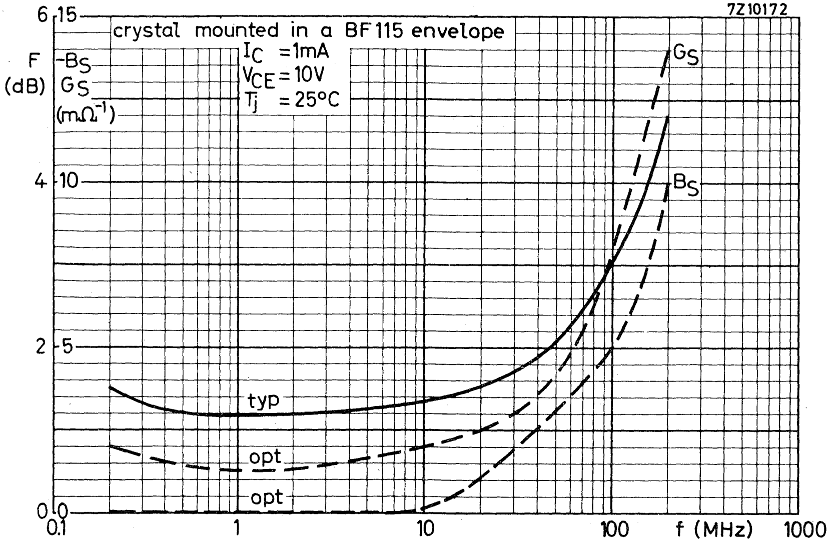
Typical behaviour of collector current versus collector-emitter voltage

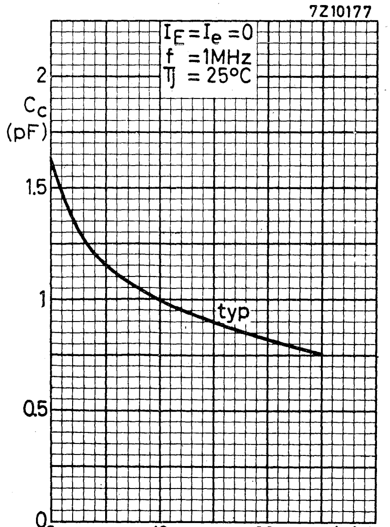


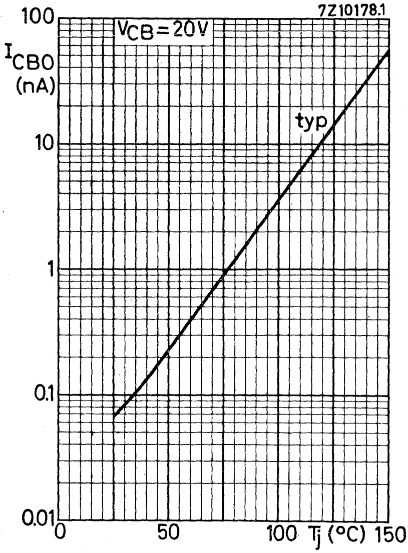



7Z10179
V_{CE} = 10 V
T_j = 25°C
I_C (mA)
60
40
20
0
500
700
900
V_{BE} (mV)
typ


7Z10173
typical values
V_{CE} = 10 V
f = 100 MHz
T_j = 25°C
f_T (MHz)
600
400
200
0
0.1
1
10
100
I_C (mA)
BFS19
BFS18


7Z10172
crystal mounted in a BF115 envelope
I_C = 1mA
V_{CE} = 10V
T_j = 25°C
F (dB)
$-B_S$
G_S
($m\Omega^{-1}$)
6 15
4 10
2 5
0 0
0.1
1
10
100
f (MHz)
1000
typ
opt
opt
G_S
B_S


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
V_{CB} (V)
30
typ


7Z10178.1
V_{CB} = 20V
I_{CBO} (nA)
100
10
1
0.1
0.01
0
50
100
T_j (°C)
150
typ

SILICON PLANAR EPITAXIAL TRANSISTOR

N-P-N transistor in a microminiature 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 circuits.

QUICK REFERENCE DATA

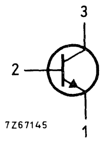
Collector-base voltage (open emitter)	V_{CBO}	max.	30	V
Collector-emitter voltage (open base)	V_{CEO}	max.	20	V
Collector current (d.c.)	I_C	max.	25	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	200	mW
Junction temperature	T_j	max.	150	°C
D.C. current gain I_C = 7 mA; V_{CE} = 10 V	h_{FE}	>	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.	350	fF

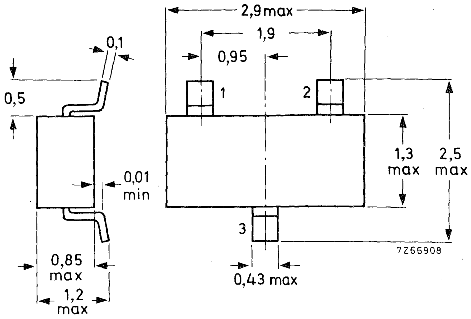
MECHANICAL DATA

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

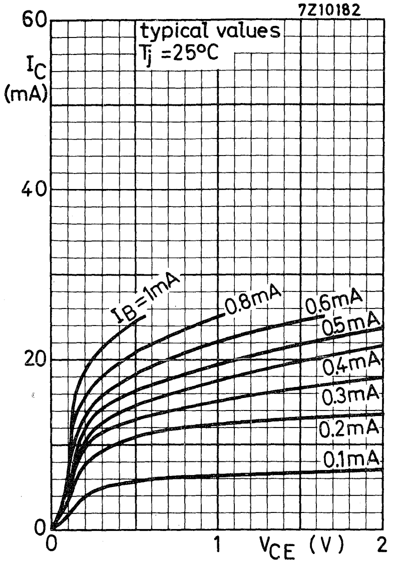
Storage temperature	T_{stg}	-65 to +150		°C
Junction temperature	T_j	max.	150	°C

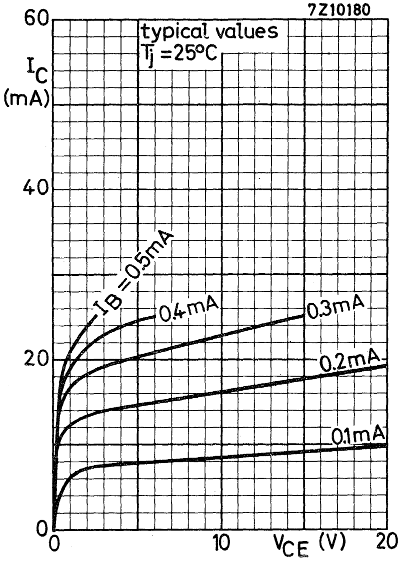
THERMAL RESISTANCE

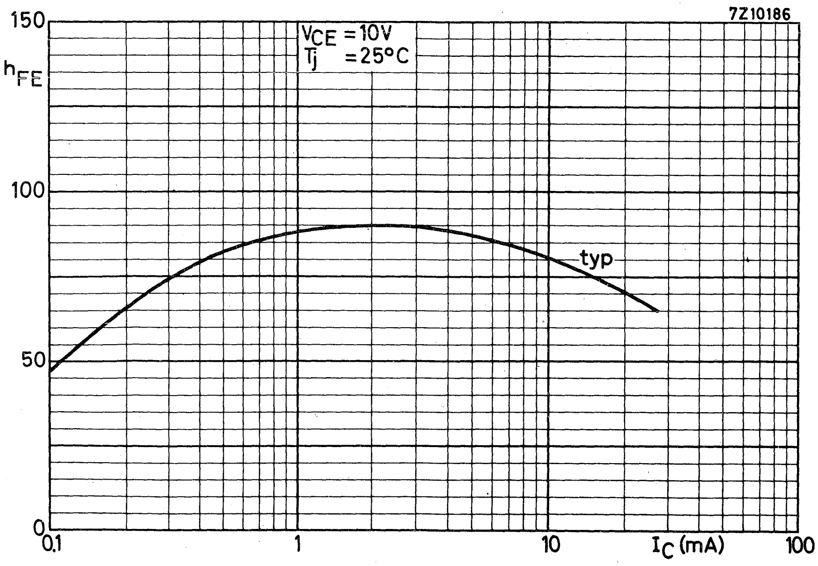
From junction to ambient mounted on a ceramic substrate of 7 mm x 5 mm x 0.5 mmm	$R_{th\ j\text{-}a}$	=	0.62	°C/mW

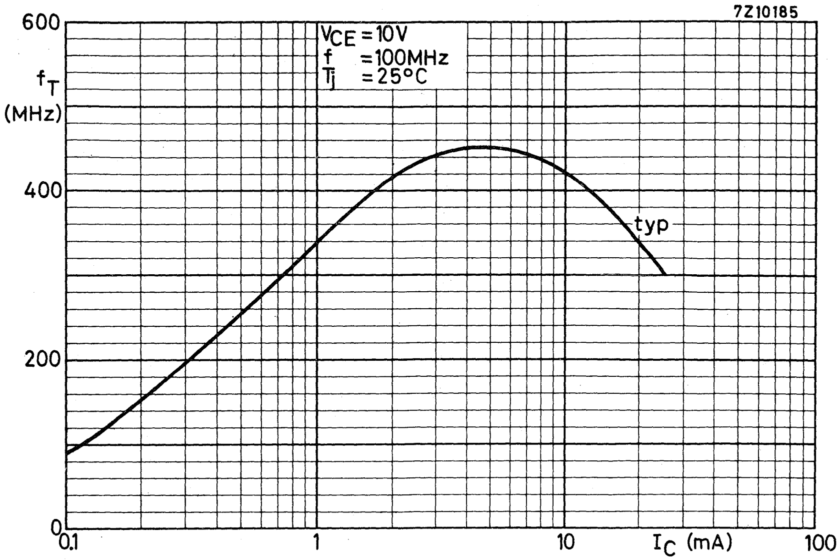
CHARACTERISTICS $T_j = 25\ ^{o}C$ unless otherwise specified

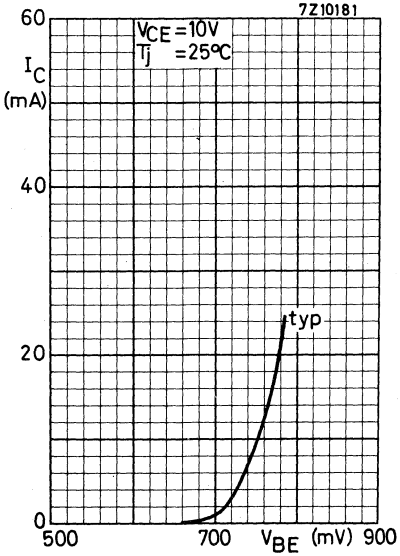
Collector cut-off current				
$I_E = 0$; $V_{CB} = 20$ V	I_{CBO}	<	100	nA
$I_E = 0$; $V_{CB} = 20$ V; $T_j = 100\ ^{o}C$	I_{CBO}	<	10	μA
Base-emitter voltage				
$I_C = 7$ mA; $V_{CE} = 10$ V	V_{BE}	typ. <	740 900	mV mV
D.C. current gain				
$I_C = 7$ mA; $V_{CE} = 10$ V	h_{FE}	> typ.	40 85	
Transition frequency at f = 100 MHz				
$I_C = 5$ mA; $V_{CE} = 10$ V	f_T	> typ.	275 450	MHz 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

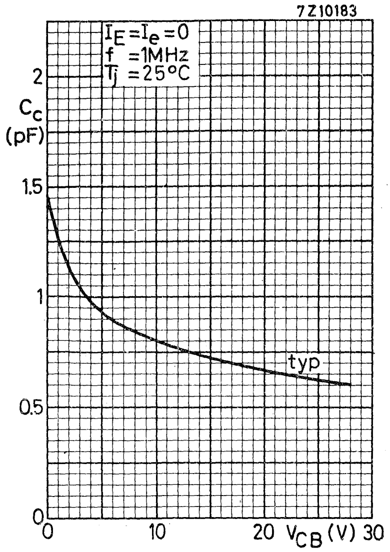

7Z10182
typical values
T_j = 25°C
I_C (mA)
60
40
20
0
0
1
2
V_{CE} (V)
I_B = 1mA
0.8mA
0.6mA
0.5mA
0.4mA
0.3mA
0.2mA
0.1mA

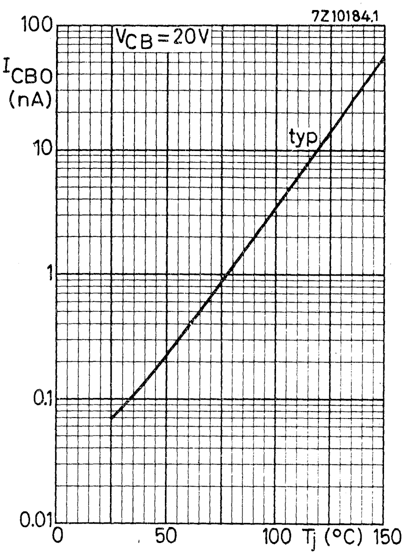

7Z10180
typical values
T_j = 25°C
I_C (mA)
60
40
20
0
0
10
20
V_{CE} (V)
I_B = 0.5mA
0.4mA
0.3mA
0.2mA
0.1mA


7Z10186
V_{CE} = 10V
T_j = 25°C
h_{FE}
150
100
50
0
0.1
1
10
100
I_C (mA)
typ


7Z10185
V_{CE} = 10 V
f = 100 MHz
T_j = 25 °C
f_T (MHz)
600
400
200
0
0.1
1
10
100
I_C (mA)
typ


7Z10181
V_{CE} = 10 V
T_j = 25 °C
I_C (mA)
60
40
20
0
500
700
900
V_{BE} (mV)
typ


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
V_{CB} (V)
30


7Z10184.1
$V_{CB} = 20V$
I_{CBO} (nA)
100
10
1
0.1
0.01
typ
0
50
100
T_j (°C)
150

SILICON PLANAR EPITAXIAL TRANSISTOR

N-P-N transistor in a micro miniature plastic envelope, primarily intended for use in u.h.f. low power amplifiers in thick- and thin-film circuits, such as in pocket phones, paging systems, etc.
The transistor features low current consumption (100µA - 1 mA); thanks to its high transition frequency, it also has excellent wideband properties and low noise up to high frequencies.

QUICK REFERENCE DATA

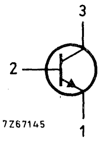
Collector-base voltage (open emitter)	V_{CBO}	max.	8	V
Collector-emitter voltage (open base)	V_{CEO}	max.	5	V
Collector current (d.c.)	I_C	max.	2,5	mA
Total power dissipation up to T_{amb} = 135 °C	P_{tot}	max.	30	mW
Junction temperature	T_j	max.	150	°C
Transition frequency at f = 500 MHz I_C = 1 mA; V_{CE} = 1 V	f_T	typ.	2,3	GHz
Feedback capacitance at f = 1 MHz I_C = 1 mA; V_{CE} = 1 V; T_{amb} = 25 °C	C_{re}	<	0,45	pF
Noise figure at optimum source impedance I_C = 1 mA; V_{CE} = 1 V; f = 500 MHz; T_{amb} = 25 °C	F	typ.	3,8	dB
Max. unilateral power gain (see page 3) I_C = 1 mA; V_{CE} = 1 V; f = 500 MHz; T_{amb} = 25 °C	G_{UM}	typ.	18	dB

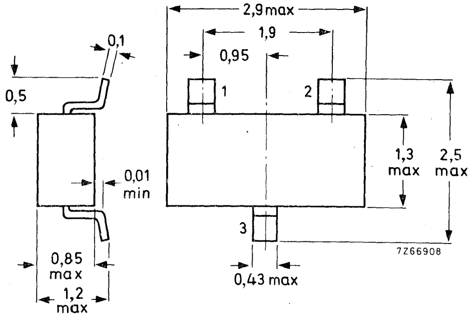
MECHANICAL DATA

Dimensions in mm

SOT-23

Code: V 1





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

Voltages

Collector-base voltage (open emitter)	V_{CBO}	max.	8	V
Collector-emitter voltage (open base)	V_{CEO}	max.	5	V
Emitter-base voltage (open collector)	V_{EBO}	max.	2	V

Currents

Collector current (d.c.)	I_C	max.	2,5	mA
Collector current (peak value; f > 1 MHz)	I_{CM}	max.	5,0	mA

Power dissipation

Total power dissipation up to T_{amb} = 135 °C mounted on a ceramic substrate of 15 mm x 10 mm x 0,5 mm	P_{tot}	max.	30	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				
$I_E = 0$; $V_{CB} = 5$ V	I_{CBO}	<	50	nA
D.C. current gain [1]				
$I_C = 10\ \mu A$; $V_{CE} = 1$ V	h_{FE}	> typ.	20 30	
$I_C = 1$ mA; $V_{CE} = 1$ V	h_{FE}	> typ.	20 40	
Saturation voltages				
$I_C = 10\ \mu A$; $I_B = 1\ \mu A$	V_{CEsat} V_{BEsat}	< <	200 750	mV mV
$I_C = 1$ mA; $I_B = 0{,}1$ mA	V_{CEsat} V_{BEsat}	< <	175 900	mV mV
Transition frequency at f = 500 MHz [1]				
$I_C = 1$ mA; $V_{CE} = 1$ V	f_T	> typ.	1,2 2,3	GHz GHz
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; $V_{CB} = 0{,}5$ V	C_c	<	0,6	pF
Emitter capacitance at f = 1 MHz				
$I_C = I_c = 0$; $V_{EB} = 0$	C_e	<	0,5	pF
Feedback capacitance at f = 1 MHz				
$I_C = 1$ mA; $V_{CE} = 1$ V; $T_{amb} = 25$ °C	C_{re}	<	0,45	pF
Noise figure at optimum source impedance				
$I_C = 0{,}1$ mA; $V_{CE} = 1$ V; f = 500 MHz; $T_{amb} = 25$ °C	F	typ.	5,5	dB
$I_C = 1$ mA; $V_{CE} = 1$ V; f = 500 MHz; $T_{amb} = 25$ °C	F	typ.	3,8	dB

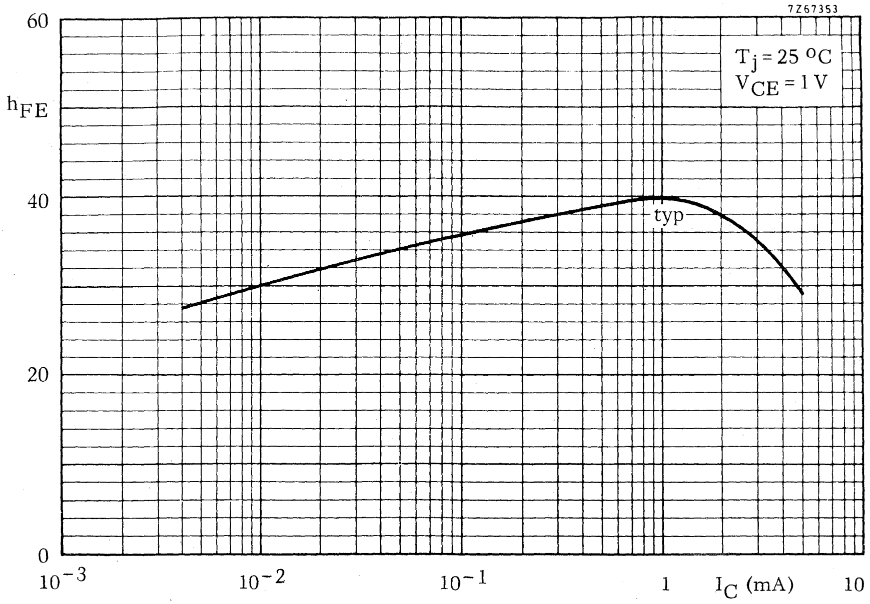
Max. unilateral power gain (s_{re} assumed to be zero)

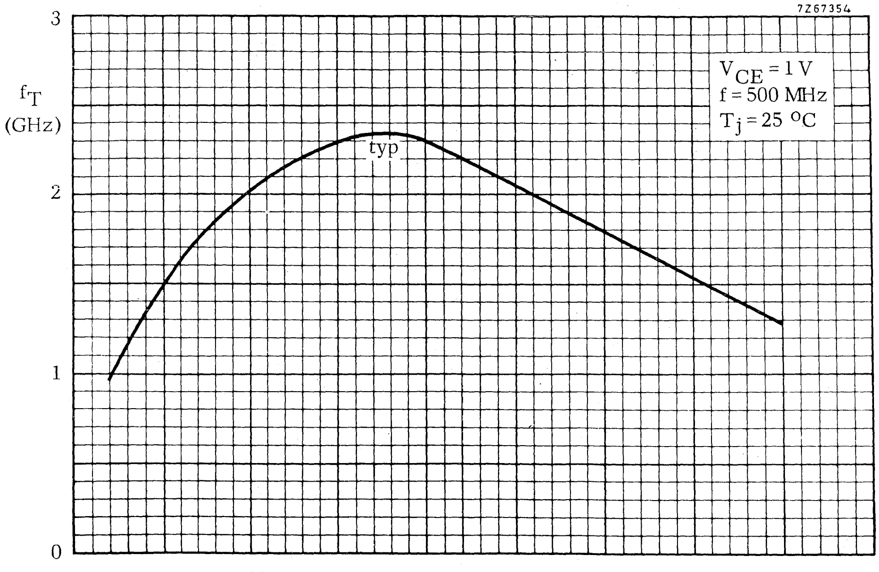
$$G_{UM}\ (\text{in dB}) = 10 \log \frac{|s_{fe}|^2}{(1 - |s_{ie}|^2)(1 - |s_{oe}|^2)}$$

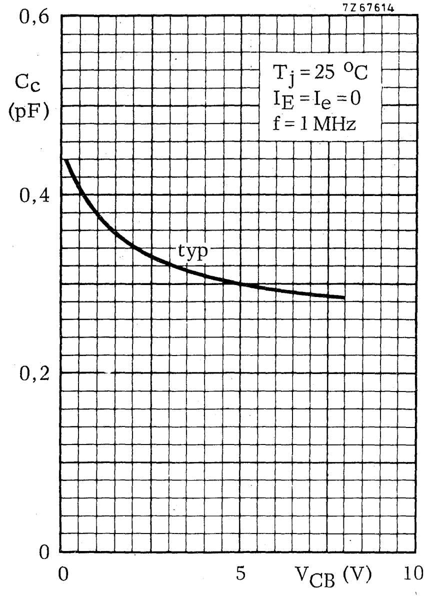
$I_C = 1$ mA; $V_{CE} = 1$ V; f = 200 MHz; $T_{amb} = 25$ °C	G_{UM}	typ.	25	dB
$I_C = 1$ mA; $V_{CE} = 1$ V; f = 500 MHz; $T_{amb} = 25$ °C	G_{UM}	typ.	18	dB
$I_C = 1$ mA; $V_{CE} = 1$ V; f = 800 MHz; $T_{amb} = 25$ °C	G_{UM}	typ.	12	dB

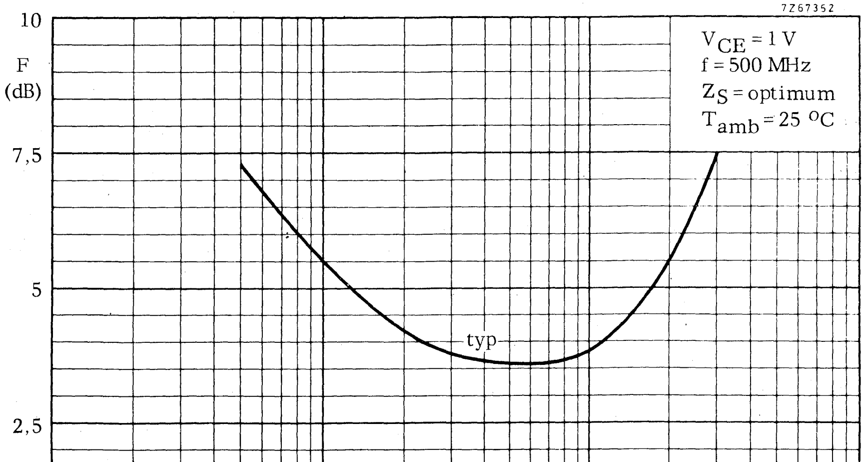
---

[1] Measured under pulse conditions.

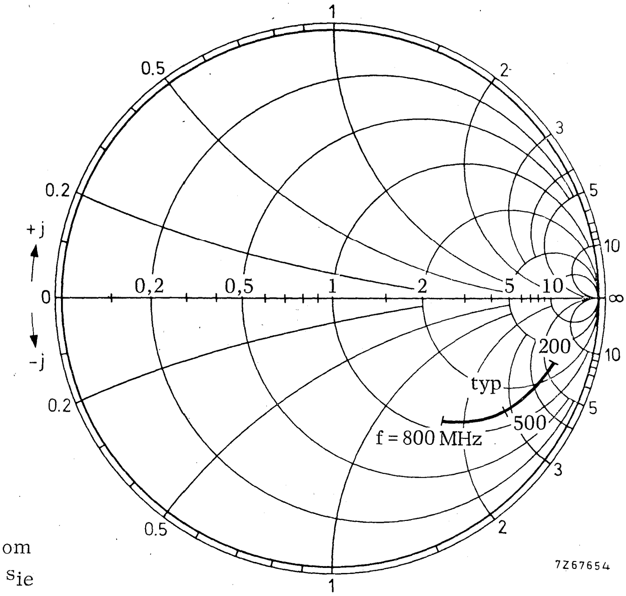

7Z67353
60
40
20
0
h_{FE}
$T_j = 25\ ^oC$
$V_{CE} = 1\ V$
typ
10^{-3}
10^{-2}
10^{-1}
1
I_C (mA)
10


7Z67354
3
2
1
0
f_T
(GHz)
$V_{CE} = 1\ V$
f = 500 MHz
$T_j = 25\ ^oC$
typ
0
500
1000
1500
I_C (μA)
2000


7Z67614
0,6
Cc
(pF)
0,4
0,2
0
0
5
VCB (V)
10
Tj = 25 °C
IE = Ie = 0
f = 1 MHz
typ

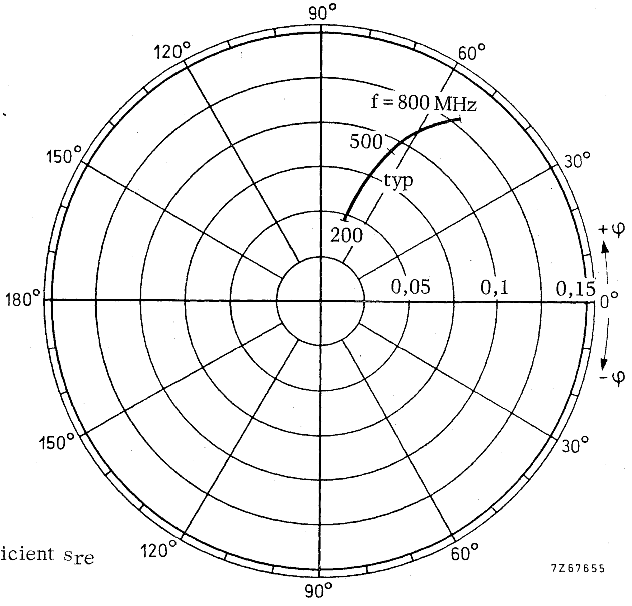

7Z67352
10
F
(dB)
7,5
5
2,5
0
10−2
10−1
1
IC (mA)
10
VCE = 1 V
f = 500 MHz
ZS = optimum
Tamb = 25 °C
typ

V_{CE} = 1 V
I_C = 1 mA
T_{amb} = 25 °C



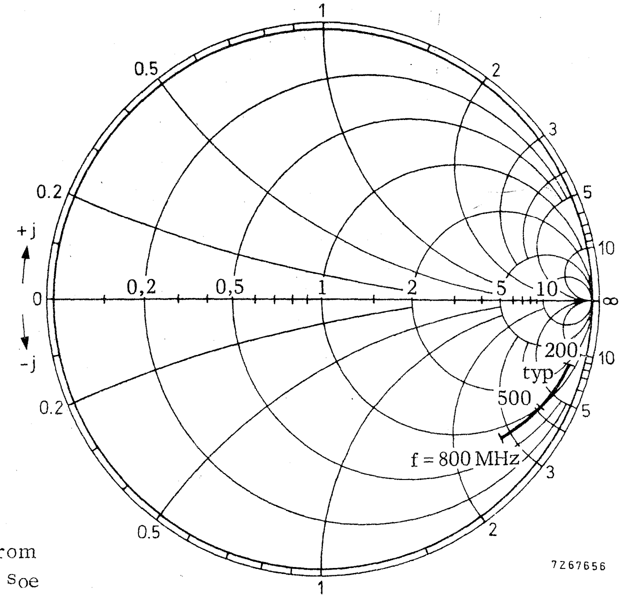
Input impedance derived from input reflection coefficient s_{ie} coordinates in ohm x 50

V_{CE} = 1 V
I_C = 1 mA
T_{amb} = 25 °C



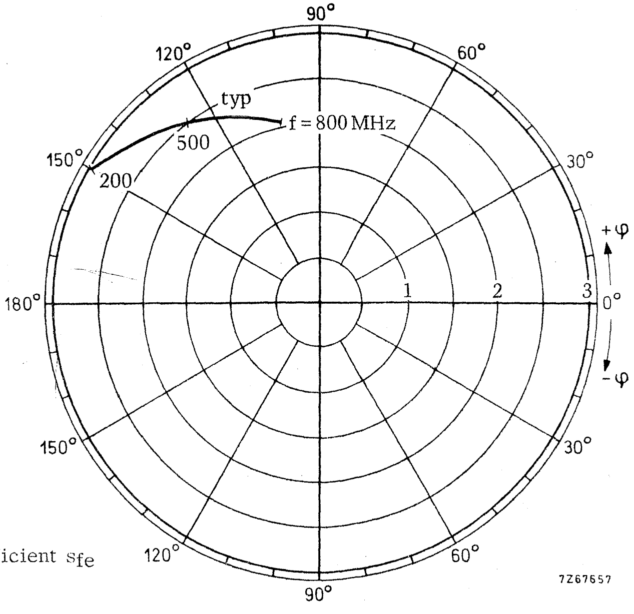
Reverse transmission coefficient s_{re}

V_{CE} = 1 V
I_C = 1 mA
T_{amb} = 25 °C



Output impedance derived from
output reflection coefficient s_{oe}
coordinates in ohm x 50

V_{CE} = 1 V
I_C = 1 mA
T_{amb} = 25 °C



Forward transmission coefficient s_{fe}

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.

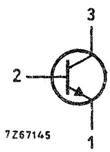
QUICK REFERENCE DATA

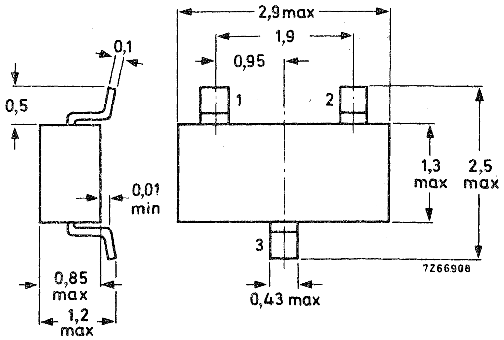
Collector-base voltage (open emitter)	V_{CBO}	max.	20	V
Collector-emitter voltage ($V_{BE} = 0$)	V_{CES}	max.	20	V
Collector-emitter voltage (open base)	V_{CEO}	max.	12	V
Collector current (peak value)	I_{CM}	max.	200	mA
Total power dissipation up to $T_{amb} = 25\,^{o}C$	P_{tot}	max.	200	mW
Junction temperature	T_j	−65 to	+ 150	^{o}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

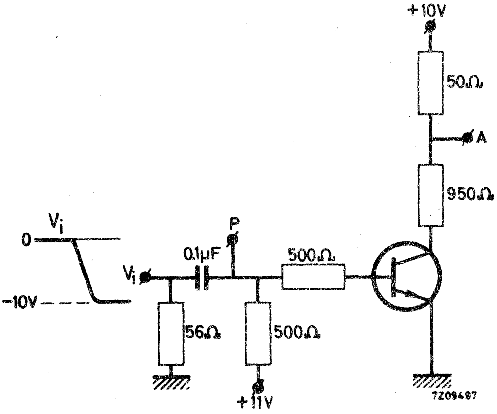
Saturation voltages

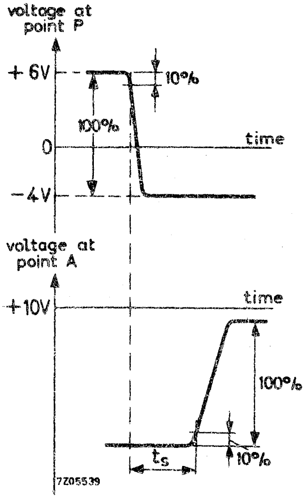
I_C = 10 mA; I_B = 300 μA	V_{CEsat}	<	300	mV
I_C = 10 mA; I_B = 1 mA	V_{CEsat}	<	250	mV
	V_{BEsat}		700 to 850	mV
I_C = 50 mA; I_B = 5 mA	V_{CEsat}	<	400	mV
	V_{BEsat}	<	1200	mV

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:

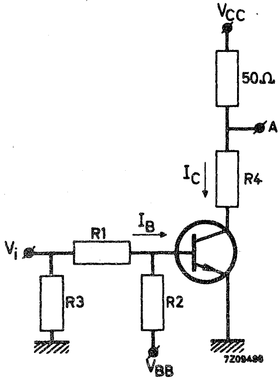
Input impedance	R_i	=	50 Ω
Rise time	t_r	<	1 ns

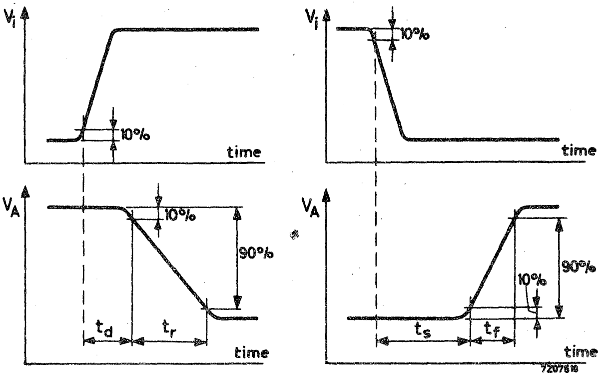
CHARACTERISTICS (continued) T_j = 25 °C unless otherwise specified

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:





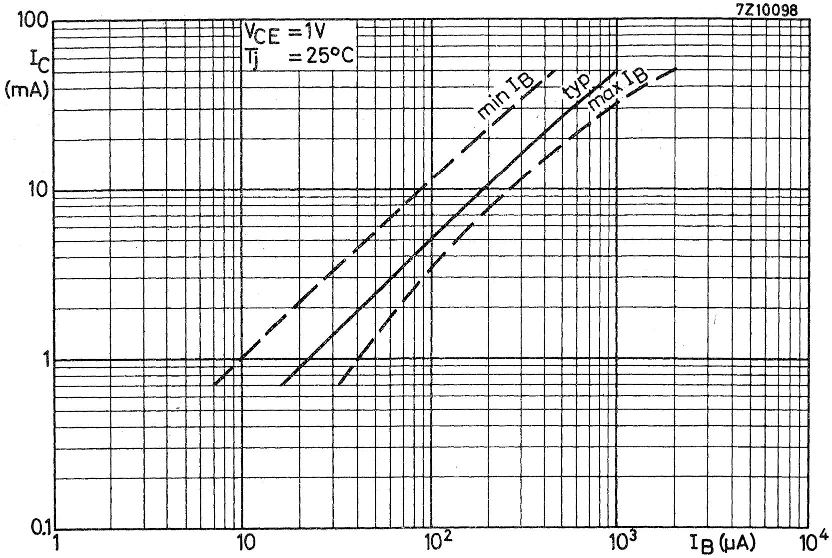
Pulse generator:			
Rise time	t_r	<	1 ns
Pulse duration	t	>	300 ns
Duty cycle	δ	<	0.02
Source impedance	R_S	=	50 Ω

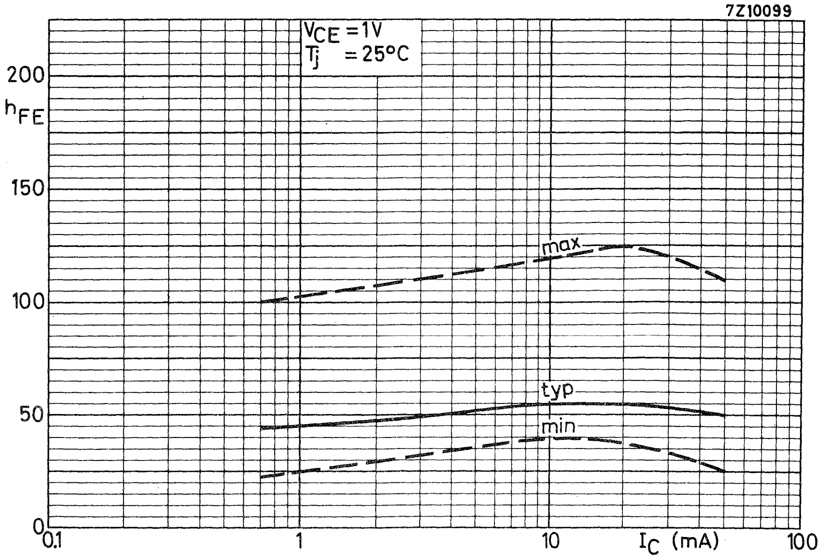
Oscilloscope:			
Input impedance	R_i	=	50 Ω
Rise time	t_r	<	1 ns

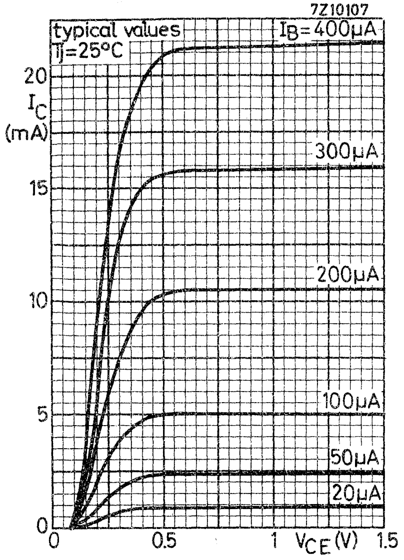
							turn on time			turn off time	
I_C (mA)	I_B (mA)	$-I_{BM}$ (mA)	V_{CC} (V)	R_1;R_2 (kΩ)	R_3 (Ω)	R_4 (Ω)	$-V_{BB}$ (V)	$-V_{BE}$ (V)	V_i (V)	$-V_{BB}$ (V)	$-V_i$ (V)
10	3	1.5	3	3.3	50	220	3.0	1.5	15	12.0	15

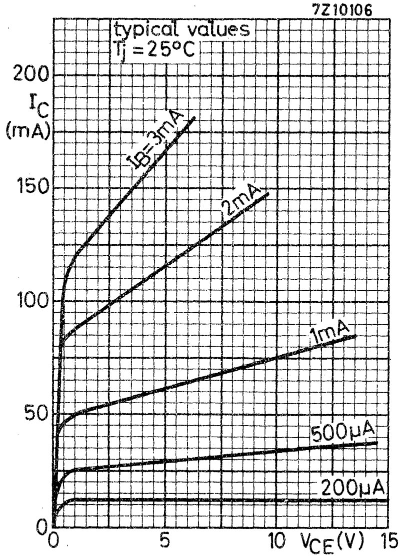
Note

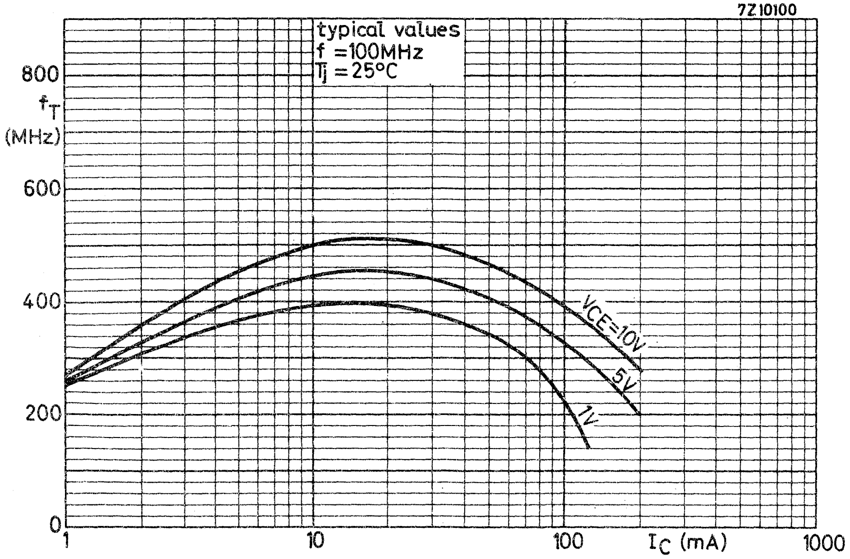
$-I_{BM}$ is the reverse current that can flow during switching off. The indicated $-I_{BM}$ is determined and limited by the applied cut-off voltage and series resistance.

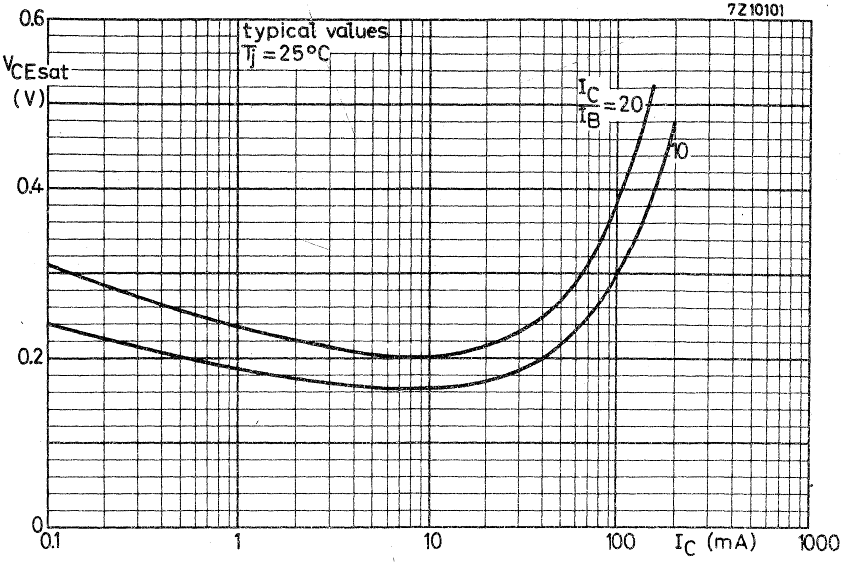

7Z10098
V_{CE} = 1V
T_j = 25°C
I_C (mA)
100
10
1
0.1
1
10
10^2
10^3
I_B (µA)
10^4
min I_B
typ
max I_B

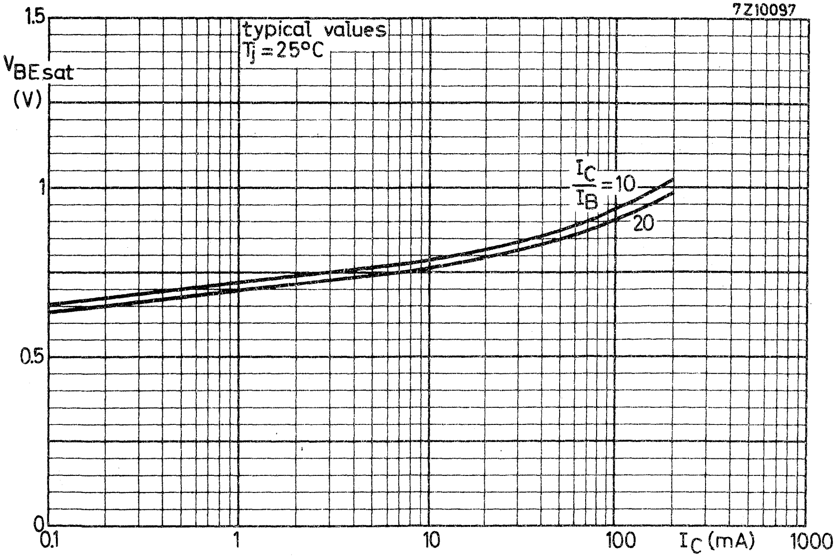

7Z10099
V_{CE} = 1V
T_j = 25°C
h_{FE}
200
150
100
50
0
0.1
1
10
I_C (mA)
100
max
typ
min

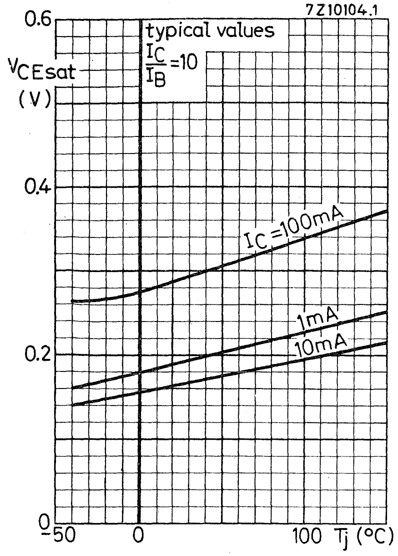

7Z10107
typical values
Tj=25°C
I_B=400μA
300μA
200μA
100μA
50μA
20μA
I_C (mA)
0
5
10
15
20
0
0.5
1
1.5
V_{CE}(V)

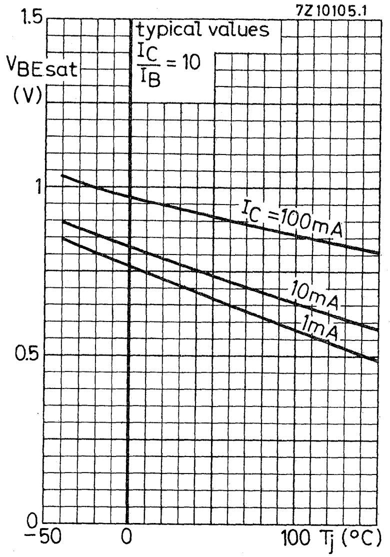

7Z10106
typical values
Tj =25°C
I_B=3mA
2mA
1mA
500μA
200μA
I_C (mA)
0
50
100
150
200
0
5
10
15
V_{CE}(V)

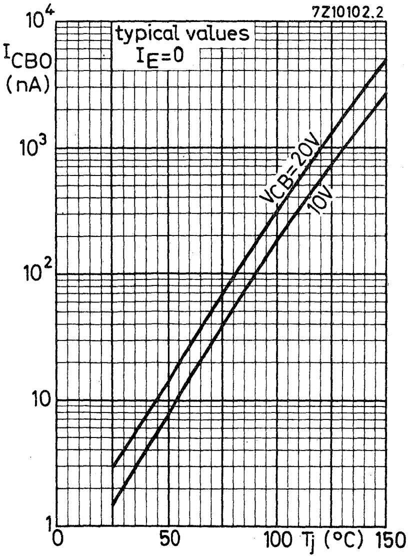

7Z10100
typical values
f =100MHz
Tj =25°C
f_T (MHz)
0
200
400
600
800
V_{CE}=10V
5V
1V
1
10
100
1000
I_C (mA)

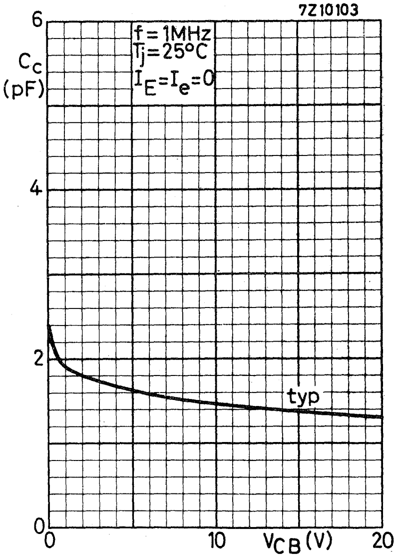

7Z10101
typical values
Tj = 25°C
V_CEsat
(V)
0.6
0.4
0.2
0
IC/IB = 20
10
0.1
1
10
100
IC (mA)
1000


7Z10097
typical values
Tj = 25°C
V_BEsat
(V)
1.5
1
0.5
0
IC/IB = 10
20
0.1
1
10
100
IC (mA)
1000


7Z10104.1
typical values
$\frac{I_C}{I_B}=10$
V_{CEsat} (V)
0.6
0.4
0.2
0
$I_C=100mA$
1mA
10mA
−50
0
100
T_j (°C)


7Z10105.1
typical values
$\frac{I_C}{I_B}=10$
V_{BEsat} (V)
1.5
1
0.5
0
$I_C=100mA$
10mA
1mA
−50
0
100
T_j (°C)


7Z10102.2
typical values
$I_E=0$
I_{CBO} (nA)
10^4
10^3
10^2
10
1
$V_{CB}=20V$
10V
0
50
100
T_j (°C)
150


7Z10103
f = 1MHz
$T_j=25°C$
$I_E=I_e=0$
C_c (pF)
6
4
2
0
typ
0
10
V_{CB} (V)
20

BZX84
SERIES

SILICON PLANAR VOLTAGE REGULATOR DIODES

Low power general purpose voltage regulator diodes in a microminiature plastic envelope intended for application in thick- and thin-film circuits.
The series covers the whole normalized range of nominal working voltages from 4,7 V to 12 V with a tolerance of ±5%.

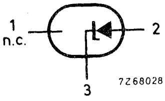
QUICK REFERENCE DATA				
Working voltage range		nom.	4,7 to 12	V
Working voltage tolerance			±5	%
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	200	mW
Junction temperature	T_j	max.	150	°C

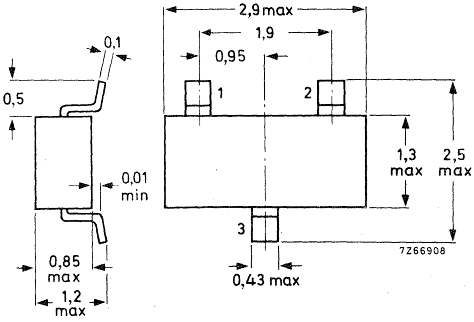
MECHANICAL DATA Dimensions in mm

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 working 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

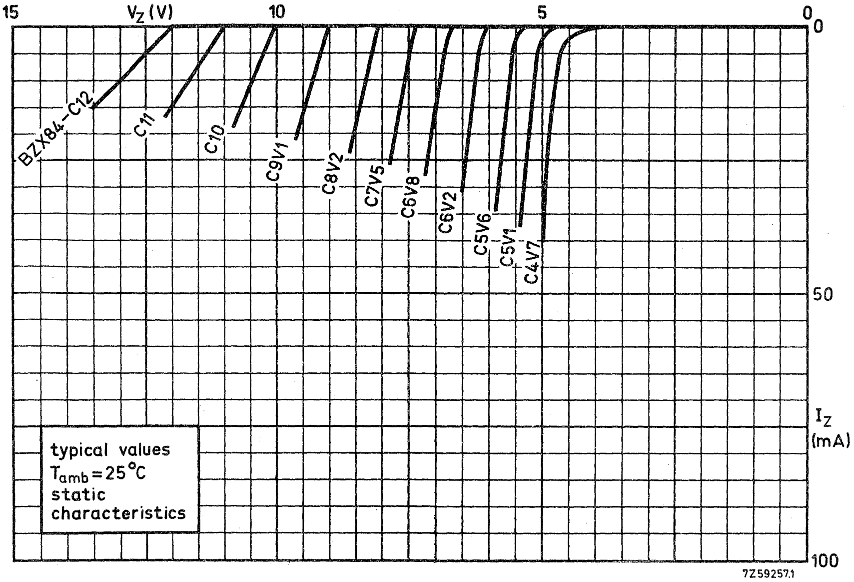
Reverse current

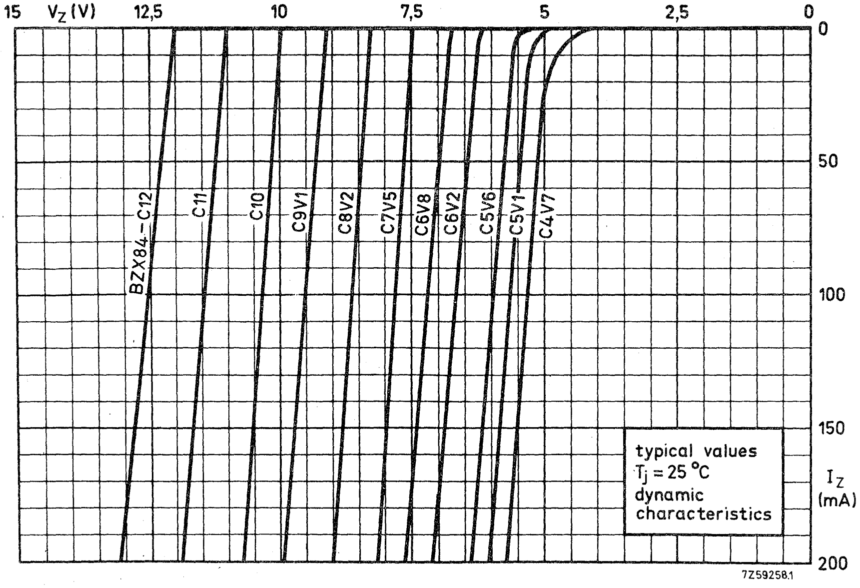
BZX84-C4V7	V_R = 2 V	I_R	<	3000	nA
BZX84-C5V1	V_R = 2 V	I_R	<	2000	nA
BZX84-C5V6	V_R = 2 V	I_R	<	1000	nA
BZX84-C6V2	V_R = 4 V	I_R	<	3000	nA
BZX84-C6V8	V_R = 4 V	I_R	<	2000	nA
BZX84-C7V5	V_R = 5 V	I_R	<	1000	nA
BZX84-C8V2	V_R = 5 V	I_R	<	700	nA
BZX84-C9V1	V_R = 6 V	I_R	<	500	nA
BZX84-C10	V_R = 7 V	I_R	<	200	nA
BZX84-C11	V_R = 8 V	I_R	<	100	nA
BZX84-C12	V_R = 8 V	I_R	<	100	nA

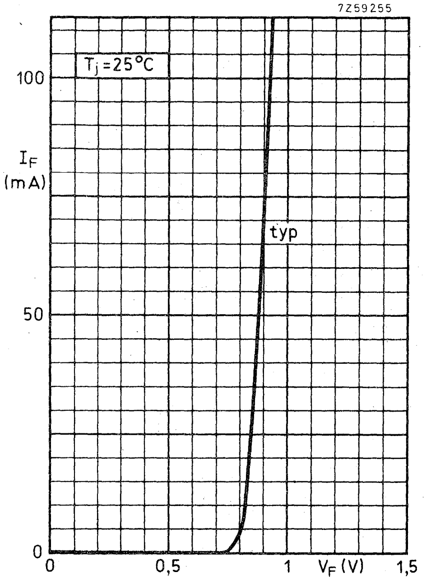
CHARACTERISTICS (continued) T_j = 25 °C unless otherwise specified

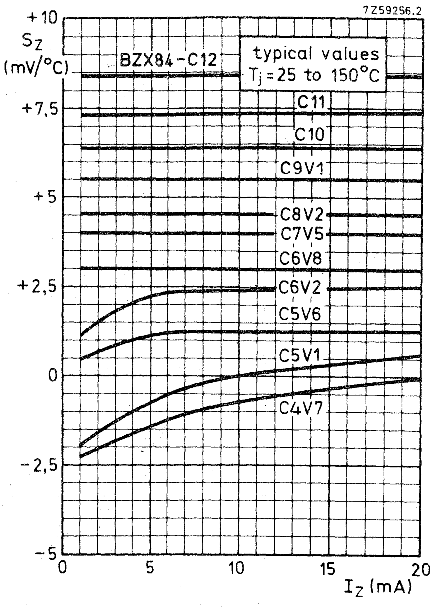
BZX84-	Working voltage V_Z (V) at I_Z = 5 mA			Differential resistance r_{diff} (Ω) at I_Z = 5 mA f = 1 kHz		Temperature coefficient S_Z (mV/°C) at I_Z = 5 mA			Diode capacitance C_d (pF) at f = 1 MHz V_R = 0	
	min.	nom.	max.	typ.	max.	min.	typ.	max.	typ.	max.
C4V7	4,4	4,7	5,0	50	80	−3,5	−1,4	0,2	130	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

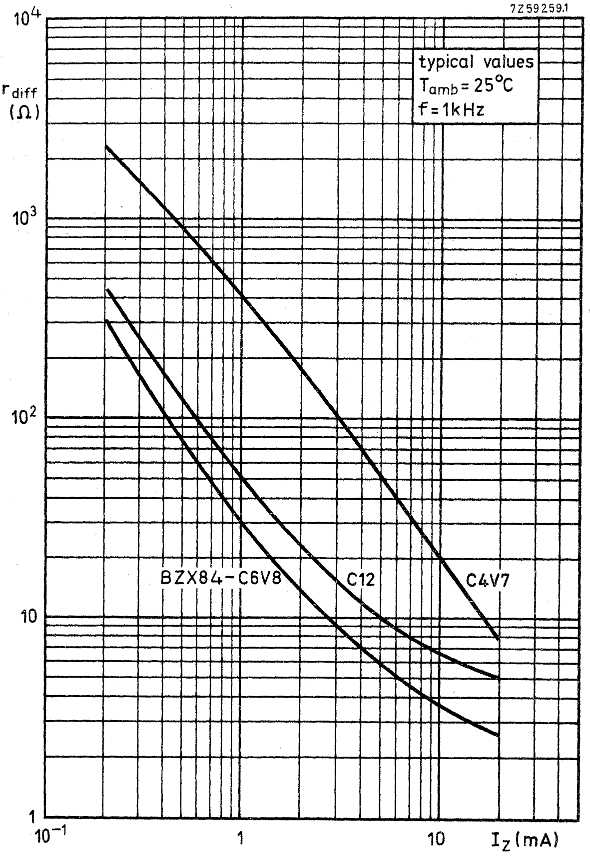
BZX84-	Working voltage V_Z (V) at I_Z = 1 mA			Differential resistance r_{diff} (Ω) at I_Z = 1 mA f = 1 kHz		Working voltage V_Z (V) at I_Z = 20 mA			Differential resistance r_{diff} (Ω) at I_Z = 20 mA f = 1 kHz	
	min.	nom.	max.	typ.	max.	min.	nom.	max.	typ.	max.
C4V7	3,7	4,2	4,7	425	500	4,5	5,0	5,4	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


15
V_Z (V)
10
5
0
0
50
100
I_Z
(mA)
BZX84–C12
C11
C10
C9V1
C8V2
C7V5
C6V8
C6V2
C5V6
C5V1
C4V7
typical values
T_{amb} = 25 °C
static
characteristics
7Z59257.1


15
V_Z (V)
12,5
10
7,5
5
2,5
0
0
50
100
150
200
I_Z
(mA)
BZX84–C12
C11
C10
C9V1
C8V2
C7V5
C6V8
C6V2
C5V6
C5V1
C4V7
typical values
T_j = 25 °C
dynamic
characteristics
7Z59258.1


7Z59255
$T_j = 25\,^\circ C$
I_F (mA)
100
50
0
typ
0
0,5
1
V_F (V)
1,5


7Z59256.2
S_Z (mV/°C)
+10
+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
10^4
r_{diff}
(Ω)
10^3
10^2
10
1
10^{-1}
1
10
I_Z (mA)
typical values
T_{amb} = 25°C
f = 1 kHz
BZX84-C6V8
C12
C4V7

Accessories

Introduction

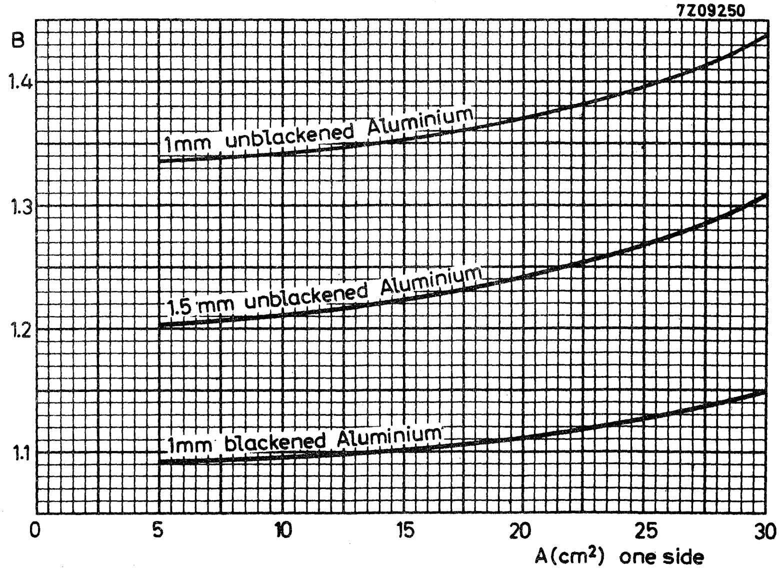
All information on thermal resistances of the accessories combined with flat heatsinks is valid for square heatsinks of 1.5 mm blackened aluminium.
For a few variations the thermal resistance may be derived as follows:

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

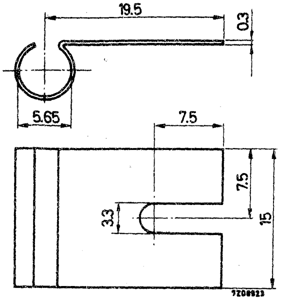
Multiply by the factor B given below as a function of the heatsink size A.



COOLING FIN

MECHANICAL DATA

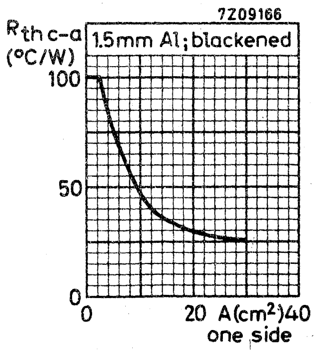
Dimensions in mm



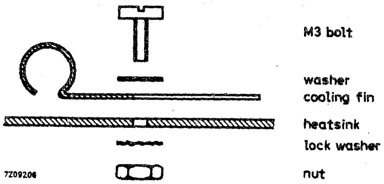
Fin material: brass, nickel plated

THERMAL RESISTANCE

From case to ambient with cooling fin only $R_{th\ c-a}$ = 100 °C/W
with heatsink see graph



MOUNTING INSTRUCTIONS

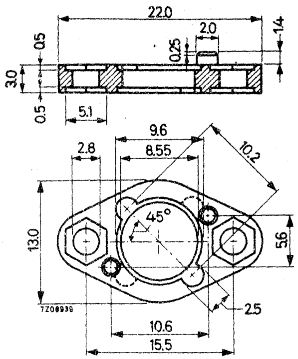


Torque on nut for good heat transfer: 5 cm kg

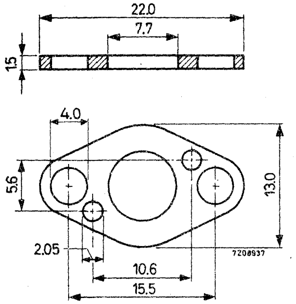
MOUNTING ACCESSORIES

MECHANICAL DATA

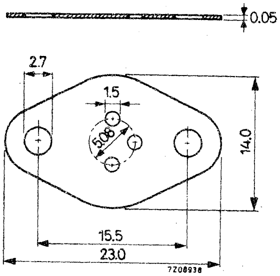
Dimensions in mm



top clamping washer
of insulating material



bottom clamping washer
material: brass, tin
plated



mylar washer

THERMAL RESISTANCE

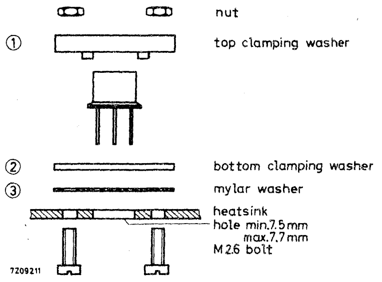
From mounting base to heatsink non insulated mounting $R_{th\ mb-h}$ = 3 °C/W

insulated mounting $R_{th\ mb-h}$ = 6 °C/W

TEMPERATURE

Maximum allowable temperature T_{max} = 100 °C

MOUNTING INSTRUCTIONS



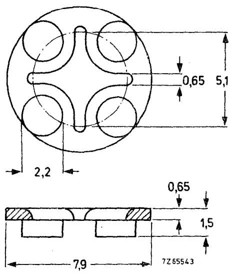
Non insulated mounting; without items 2 and 3. (Note: item 1 must than be mounted up-side down)

DISTANCE DISCS

MECHANICAL DATA

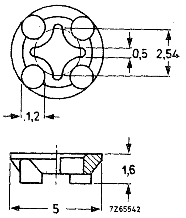
Dimensions in mm

56245



Insulating material

56246



Insulating material

TEMPERATURE

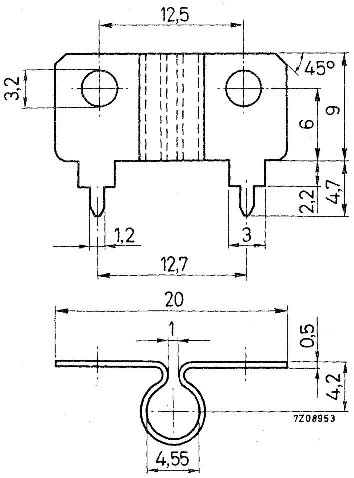
Maximum permissible temperature	T	max.	100	^{o}C

56263

COOLING FIN

MECHANICAL DATA

Dimensions in mm



Material: copper, tin plated

THERMAL RESISTANCE

From case to ambient $R_{th\ c\text{-}a}$ = 100 ^{o}C/W

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	PC	ASY27	3	Sw	BAV10	1b	WD
AAY21	1b	PC	ASY28	3	Sw	BAV18	1b	WD
AAY30	1b	GB	ASY29	3	Sw	BAV19	1b	WD
AAY32	1b	GB	ASY73	3	Sw	BAV20	1b	WD
AAZ13	1b	GB	ASY74	3	Sw	BAV21	1b	WD
AAZ15	1b	GB	ASY75	3	Sw	BAV45	1b	Sp
AAZ17	1b	GB	ASZ15	2	P	BAV70	4a	Mm
AAZ18	1b	GB	ASZ16	2	P	BAV99	4a	Mm
AC125	2	LF	ASZ17	2	P	BAW56	4a	Mm
AC126	2	LF	ASZ18	2	P	BAW62	1b	WD
AC127	2	LF	BA100	1b	AD	BAX12	1b	WD
AC128	2	LF	BA102	1b	T	BAX13	1b	WD
AC128/01	2	LF	BA145	1a	R	BAX14	1b	WD
AC132	2	LF	BA148	1a	R	BAX15	1b	WD
AC187	2	LF	BA182	1b	T	BAX16	1b	WD
AC187/01	2	LF	BA216	1b	WD	BAX17	1b	WD
AC188	2	LF	BA217	1b	WD	BAX18	1b	WD
AC188/01	2	LF	BA218	1b	WD	BB105A	1b	T
AD161	2	P	BA219	1b	WD	BB105B	1b	T
AD162	2	P	BA220	1b	WD	BB105G	1b	T
AF124	3	HF	BA221	1b	WD	BB106	1b	T
AF125	3	HF	BA222	1b	WD	BB110B	1b	T
AF126	3	HF	BA243	1b	T	BB110G	1b	T
AF127	3	HF	BA244	1b	T	BB117	1b	T
AF139	3	HF	BA314	1b	Vrg	BB204B	1b	T
AF239	3	HF	BA315	1b	Vrg	BB204G	1b	T
AF239S	3	HF	BA316	1b	WD	BB205A	1b	T
AF367	3	HF	BA317	1b	WD	BB205B	1b	T
AF369	3	HF	BA318	1b	WD	BB205G	1b	T
ASY26	3	Sw	BA379	1b	T	BBY31	4a	Mm

AD = Silicon alloyed diodes
GB = Germanium gold-bonded diodes
HF = High-frequency transistors
LF = Low-frequency transistors
Mm = Microminiature devices for thick- and thin-film circuits
P = Low-frequency power transistors

PC = Germanium point contact diodes
R = Rectifier diodes
Sp = Special diodes
Sw = Switching transistors
T = Tuner diodes
Vrg = Voltage regulator diodes
WD = Silicon whiskerless diodes

INDEX

DT = Dual transistors
FET = Field-effect transistors
LF = Low-frequency transistors
Mm = Microminiature devices for thick- and thin-film circuits
P = Low-frequency power transistors

FET = Field-effect transistors
HF = High-frequency transistors
P = Low-frequency power transistors

FET = Field-effect transistors
HF = High-frequency transistors
Mm = Microminiature devices for thick- and thin-film circuits
PDT = Photodiodes or transistors
R = Rectifier diodes
Sw = Switching transistors
Th = Thyristors, diacs
Tra = Transmitting transistors

FET = Field-effect transistors
Mm = Microminiature devices for thick- and thin-film circuits
P = Low-frequency power transistors
R = Rectifier diodes
Sw = Switching transistors
Th = Thyristors, diacs
Tri = Triacs

INDEX

AD = Silicon alloyed diodes
GB = Germanium gold-bonded diodes
I = Infrared devices
LED = Light emitting diodes
Mm = Microminiature devices for thick- and thin-film circuits
PC = Germanium point contact diodes
Ph = Photoconductive devices
PhC = Photocouplers
St = Rectifier stacks
TS = Transient suppressor diodes
Vrf = Voltage reference diodes
Vrg = Voltage regulator diodes

INDEX

FET = Field-effect transistors
HF = High-frequency transistors
LF = Low-frequency transistors
P = Low-frequency power transistors
Sw = Switching transistors

Tra = Transmitting transistors
Vrf = Voltage reference diodes
Vrg = Voltage regulator diodes
WD = Silicon whiskerless diodes

INDEX

Type No.	Part	Section	Type No.	Part	Section	Type No.	Part	Section
2N4857	4a	FET	56261	2	A	56339	2	A
2N4858	4a	FET	56262A	1a	A	56348	1a	DH
2N4859	4a	FET	56263	1a to 4a	A	56349	1a	DH
2N4860	4a	FET	56264A	1a	A	56350	1a	DH
2N4861	4a	FET	56268	1a	DH	56351	2	A
61SV	4b	I	56271	1a	DH	56352	2	A
40809	2	LF	56278	1a	DH	56353	2	A
40820	3	HF	56280	1a	DH	56354	2	A
40835	3	HF	56290	1a	HE	56356	2,3	A
40838	3	HF	56293	1a	HE	56359	2	A
56200	2,3,4a	A	56295	1a	A	56360	2	A
56201	2	A	56299	1a	A			
56201c	2	A	56309B	1a	A			
56201d	2	A	56309R	1a	A			
56203	2	A	56312	1a	DH			
56218	2,3,4a	A	56313	1a	DH			
56230	1a	HE	56314	1a	DH			
56231	1a	HE	56315	1a	DH			
56233	1a	A	56316	1a	A			
56234	1a	A	56318	1a	DH			
56239	2	A	56319	1a	DH			
56245	2,3,4a	A	56326	2,3	A			
56246	1a to 4a	A	56333	2,3	A			
56253	1a	DH	56334	1a	DH			
56256	1a	DH	56337	1a	A			

A = Accessories
DH = Diecast heatsinks
FET = Field-effect transistors
HE = Heatsink extrusions
HF = High-frequency transistors
I = Infrared devices
LF = Low-frequency transistors

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