Discrete semiconductors for
Hybrid thick and thin-film circuits
Discrete semiconductors for
Hybrid thick and thin-film circuits
GENERAL

SOLDERING RECOMMENDATIONS

TYPE NUMBER SURVEY

SELECTION GUIDE

DEVICE DATA
DATA HANDBOOK SYSTEM:

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

ELECTRON TUBES

SEMICONDUCTORS AND INTEGRATED CIRCUITS

COMPONENTS AND MATERIALS

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.

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October 1977
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Part 1a March 1976 SC1a 03-76 Rectifier diodes, thyristors, triacs
Rectifier diodes, voltage regulator diodes (> 1.5 W),
transient suppressor diodes, rectifier stacks, thyristors, triacs

Part 1b May 1977 SC1b 05-77 Diodes
Small signal germanium diodes, small signal silicon diodes,
special diodes, voltage regulator diodes (< 1.5 W), voltage
reference diodes, tuner diodes

Part 2 November 1977 SC2 11-77 Low-frequency and dual transistors

Part 3 January 1978 SC3 01-78 High-frequency, switching and field-effect transistors

Part 4a June 1976 SC4a 06-76 Special semiconductors*
Transmitting transistors, field-effect transistors, dual
transistors, microminiature devices for thick and thin-film
circuits

Part 4b July 1978 SC4b 07-78 Devices for optoelectronics
Photosensitive diodes and transistors, light emitting diodes,
outputs, photocouplers, infrared sensitive devices,
photoconductive devices

Part 4c July 1978 SC4c 07-78 Discrete semiconductors for hybrid thick and thin-film circuits

Part 5a November 1976 SC5a 11-76 Professional analogue integrated circuits

Part 5b March 1977 SC5b 03-77 Consumer integrated circuits
Radio-audio, television

Part 6 October 1977 SC6 10-77 Digital integrated circuits
LOCMOS HE4000B family

Signetics integrated circuits 1978 Bipolar and MOS memories
Bipolar and MOS microprocessors
Analogue circuits

* The most recent information on field-effect transistors can be found in SC3 01-78, on dual transistors
in SC2 11-77, and on microminiature devices in SC4c 05-78.
COMPONENTS AND MATERIALS (GREEN SERIES)

Part 1  June 1977  CM1 06-77  Assemblies for industrial use
High noise immunity logic FZ/30-series, counter modules
50-series, NORbits 60-series, 61-series, circuit blocks
90-series, circuit block CSA70(L), PLC modules, input/
output devices, hybrid circuits, peripheral devices, ferrite
core memory products

Part 2a October 1977  CM2a 10-77  Resistors
Fixed resistors, variable resistors, voltage dependent resistors
(VDR), light dependent resistors (LDR), negative tempera-
ture coefficient thermistors (NTC), positive temperature
coefficient thermistors (PTC), test switches

Part 2b February 1978  CM2b 02-78  Capacitors
Electrolytic and solid capacitors, film capacitors, ceramic
capacitors, variable capacitors

Part 3  January 1977  CM3 01-77  Radio, audio, television
FM tuners, loudspeakers, television tuners and aerial input
assemblies, components for black and white television,
components for colour television

Part 4a October 1976  CM4a 10-76  Soft ferrites
Ferrites for radio, audio and television, beads and chokes,
Ferroxcube potcores and square cores, Ferroxcube trans-
former cores

Part 4b December 1976  CM4b 12-76  Piezoelectric ceramics, permanent magnet materials

Part 5 July 1975  CM5 07-75  Ferrite core memory products
Ferroxcube memory cores, matrix planes and stacks, core
memory systems

Part 6  April 1977  CM6 04-77  Electric motors and accessories
Small synchronous motors, stepper motors, miniature
direct current motors

Part 7 September 1971  CM7 09-71  Circuit blocks
Circuit blocks 100 kHz-series, circuit blocks 1-series, circuit
blocks 10-series, circuit blocks for ferrite core memory drive

Part 8  February 1977  CM8 02-77  Variable mains transformers

Part 9  March 1976  CM9 03-76  Piezoelectric quartz devices

Part 10 April 1978  CM10 04-78  Connectors
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**AD** = Silicon alloyed diodes  
**GB** = Germanium gold bonded diodes  
**HFSW** = High-frequency and switching transistors  
**LF** = Low-frequency transistors  
**Mm** = Discrete semiconductors for hybrid thick and thin-film circuits  
**P** = Low-frequency power transistors  
**PC** = Germanium point contact diodes  
**R** = Rectifier diodes  
**Sp** = Special diodes  
**T** = Tuner diodes  
**Vrg** = Voltage regulator diodes  
**WD** = Silicon whiskerless diodes

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DT = Dual transistors
FET = Field-effect transistors
LF = Low-frequency transistors
Mm = Discrete semiconductors for hybrid thick and thin-film circuits
P = Low-frequency power transistors
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FET = Field-effect transistors  
HFSW = High-frequency and switching transistors  
Mm = Discrete semiconductors for hybrid thick and thin-film circuits  
P = Low-frequency power transistors

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FET = Field-effect transistors  
R = Rectifier diodes  
HFSW = High-frequency and switching transistors  
Th = Thyristors  
Mm = Discrete semiconductors for hybrid thick and thin-film circuits  
Tra = Transmitting transistors  
PDT = Photodiodes or transistors
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FET = Field-effect transistors  
HFSW = High-frequency and switching transistors  
Mm = Discrete semiconductors for hybrid thick and thin-film circuits  
P = Low-frequency power transistors  
R = Rectifier diodes  
Th = Thyristors  
Tri = Triacs  
TS = Transient suppressor diodes  
Vrf = Voltage reference diodes  
Vrg = Voltage regulator diodes
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**AD** = Silicon alloyed diodes  
**D** = Displays  
**GB** = Germanium gold bonded diodes  
**I** = Infrared devices  
**LED** = Light-emitting diodes  
**Mm** = Discrete semiconductors for hybrid thick and thin-film circuits  
**PC** = Germanium point contact diodes  
**Ph** = Photoconductive devices  
**PhC** = Photocouplers  
**St** = Rectifier stacks  
**V_rf** = Voltage reference diodes  
**V_rv** = Voltage regulator diodes  
**WD** = Silicon whiskerless diodes
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A = Accessories  
DH = Diecast heatsinks  
FET = Field-effect transistors  
HE = Heatsink extrusions  
HFSW = High-frequency and switching transistors  
I = Infrared devices  
LF = Low-frequency transistors  
P = Low-frequency power transistors  
Tra = Transmitting transistors  
Vrg = Voltage regulator diodes
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A = Accessories

DH = Diecast heatsinks
GENERAL

Pro Electron Type designation
Rating Systems
Letter Symbols
S-parameters
PRO ELECTRON TYPE DESIGNATION CODE
FOR SEMICONDUCTOR DEVICES

This type designation code applies to discrete semiconductor devices—as opposed to integrated circuits—, multiples of such devices and semiconductor chips.

A basic type number consists of:

**TWO LETTERS FOLLOWED BY A SERIAL NUMBER**

**FIRST LETTER**

The first letter gives information about the material used for the active part of the devices.

A. GERMANIUM or other material with band gap of 0,6 to 1,0 eV.
B. SILICON or other material with band gap of 1,0 to 1,3 eV.
C. GALLIUM-ARSENIDE or other material with band gap of 1,3 eV or more.
R. COMPOUND MATERIALS (e.g. Cadmium-Sulphide).

**SECOND LETTER**

The second letter indicates the function for which the device is primarily designed.

A. DIODE; signal, low power
B. DIODE; variable capacitance
C. TRANSISTOR; low power, audio frequency ($R_{th\,j-mb} > 15\,\text{°C/W}$)
D. TRANSISTOR; power, audio frequency ($R_{th\,j-mb} < 15\,\text{°C/W}$)
E. DIODE; tunnel
F. TRANSISTOR; low power, high frequency ($R_{th\,j-mb} > 15\,\text{°C/W}$)
G. MULTIPLE OF DISSIMILAR DEVICES — MISCELLANEOUS; e.g. oscillator
H. DIODE; magnetic sensitive
L. TRANSISTOR; power, high frequency ($R_{th\,j-mb} < 15\,\text{°C/W}$)
N. PHOTO-COUPLER
P. RADIATION DETECTOR; e.g. high sensitivity phototransistor
Q. RADIATION GENERATOR; e.g. light-emitting diode (LED)
R. CONTROL AND SWITCHING DEVICE; e.g. thyristor, low power ($R_{th\,j-mb} > 15\,\text{°C/W}$)
S. TRANSISTOR; low power, switching ($R_{th\,j-mb} > 15\,\text{°C/W}$)
T. CONTROL AND SWITCHING DEVICE; e.g. thyristor, power ($R_{th\,j-mb} < 15\,\text{°C/W}$)
U. TRANSISTOR; power, switching ($R_{th\,j-mb} < 15\,\text{°C/W}$)
X. DIODE; multiplier, e.g. varactor, step recovery
Y. DIODE; rectifying, booster
Z. DIODE; voltage reference or regulator (transient suppressor diode, with third letter W)
SERIAL NUMBER

Three figures, running from 100 to 999, for devices primarily intended for consumer equipment. One letter (Z, Y, X, etc.) and two figures, running from 10 to 99, for devices primarily intended for industrial/professional equipment.

This letter has no fixed meaning except W, which is used for transient suppressor diodes.

VERSION LETTER

It indicates a minor variant of the basic type either electrically or mechanically. The letter never has a fixed meaning, except letter R, indicating reverse voltage, e.g. collector to case or anode to stud.

SUFFIX

Sub-classification can be used for devices supplied in a wide range of variants called associated types. Following sub-coding suffixes are in use:

1. VOLTAGE REFERENCE and VOLTAGE REGULATOR DIODES: ONE LETTER and ONE NUMBER
   The LETTER indicates the nominal tolerance of the Zener (regulation, working or reference) voltage:
   A. 1% (according to IEC 63: series E96)
   B. 2% (according to IEC 63: series E48)
   C. 5% (according to IEC 63: series E24)
   D. 10% (according to IEC 63: series E12)
   E. 20% (according to IEC 63: series E6)
   The number denotes the typical operating (Zener) voltage related to the nominal current rating for the whole range.
   The letter ‘V’ is used instead of the decimal point.

2. TRANSIENT SUPPRESSOR DIODES: ONE NUMBER
   The NUMBER indicates the maximum recommended continuous reversed (stand-off) voltage V_R. The letter ‘V’ is used as above.

3. CONVENTIONAL and CONTROLLED AVALANCHE RECTIFIER DIODES and THYRISTORS: ONE NUMBER
   The NUMBER indicates the rated maximum repetitive peak reverse voltage (V_{RRM}) or the rated repetitive peak off-state voltage (V_{DPM}), whichever is the lower. Reversed polarity is indicated by letter R, immediately after the number.

4. RADIATION DETECTORS: ONE NUMBER, preceded by a hyphen (−)
   The NUMBER indicates the depletion layer in μm. The resolution is indicated by a version LETTER.

5. ARRAY OF RADIATION DETECTORS and GENERATORS: ONE NUMBER, preceded by a stroke (/).
   The NUMBER indicates how many basic devices are assembled into the array.
RATING SYSTEMS

The rating systems described are those recommended by the International Electrotechnical Commission (IEC) in its Publication 134.

DEFINITIONS OF TERMS USED

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

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

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.

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.

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.

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.

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.

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.
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.

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.
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
As first or second subscript: Source terminal (for FETS only)
S, s
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.

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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 $I_B(\text{AV})$

d) peak total values
   Example $I_B(\text{M})$

e) root-mean-square total values
   Example $I_B(\text{RMS})$

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 $I_b(\text{rms})$

c) peak values
   Example $I_{bm}$

d) average values
   Example $I_b(\text{av})$

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: $I_F$, $I_R$, $i_F$, $I_f(\text{rms})$
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:

- $F, f = \text{forward; forward transfer}$
- $i, i (\text{or } 1) = \text{input}$
- $L, l = \text{load}$
- $O, o (\text{or } 2) = \text{output}$
- $R, r = \text{reverse; reverse transfer}$
- $S, s = \text{source}$

Examples: $Z_s$, $h_f^T$, $h_F$

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

Examples: $h_{FE}^T = \text{static value of forward current transfer ratio in common-emitter configuration (d.c. current gain)}$

$R_E = \text{d.c. value of the external emitter resistance.}$

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: $h_{fe}^T = \text{small-signal value of the short-circuit forward current transfer ratio in common-emitter configuration}$

$Z_e = R_e + jX_e = \text{small-signal value of the external impedance}$

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: $h_{FE}^T$, $y_{RE}^T$, $h_{fe}^T$
Subscripts for four-pole matrix parameters:

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

Examples: h\textsubscript{1} (or h\textsubscript{11})
\hphantom{1} h\textsubscript{0} (or h\textsubscript{22})
\hphantom{0} h\textsubscript{1} (or h\textsubscript{21})
\hphantom{1} h\textsubscript{r} (or h\textsubscript{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\textsubscript{fe} (or h\textsubscript{21e}); h\textsubscript{FE} (or h\textsubscript{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: \textit{Z}\textsubscript{1} = R\textsubscript{1} + jX\textsubscript{1} \hphantom{1}
y\textsubscript{fe} = g\textsubscript{fe} + jb\textsubscript{fe}

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

Examples: Re (h\textsubscript{ib}) etc. for the real part of h\textsubscript{ib}
Im (h\textsubscript{ib}) etc. for the imaginary part of h\textsubscript{ib}
In distinction to the conventional h, y and z-parameters, s-parameters relate to traveling wave conditions. The figure below shows a two-port network with the incident and reflected waves \( a_1, b_1, a_2 \) and \( b_2 \).

\[
\begin{align*}
Z_0 &= \text{characteristic impedance of the transmission line in which the two-port is connected.} \\
V_i &= \text{incident voltage} \\
V_r &= \text{reflected (generated) voltage}
\end{align*}
\]

The four-pole equations for s-parameters are:

\[
\begin{align*}
b_1 &= s_{11}a_1 + s_{12}a_2 \\
b_2 &= s_{21}a_1 + s_{22}a_2
\end{align*}
\]

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

\[
\begin{align*}
s_i &= s_{11} = \frac{b_1}{a_1} \quad a_2 = 0 \\
s_r &= s_{12} = \frac{b_1}{a_2} \quad a_1 = 0 \\
s_f &= s_{21} = \frac{b_2}{a_1} \quad a_2 = 0 \\
s_o &= s_{22} = \frac{b_2}{a_2} \quad a_1 = 0
\end{align*}
\]

\footnotesize{1)} The squares of these quantities have the dimension of power.
The s-parameters can be named and expressed as follows:

\[ s_1 = s_{11} \] = Input reflection coefficient.
The complex ratio of the reflected wave and the incident wave at the input, under the conditions \( Z_1 = Z_0 \) 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 \( Z_s = Z_0 \) 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 \( Z_1 = Z_0 \) 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 \( Z_s = Z_0 \) and \( V_{s1} = 0 \).
SOLDERING RECOMMENDATIONS
SOLDERING RECOMMENDATIONS SOT-23 AND SOT-89

REFLOW SOLDERING
The preferred technique for mounting microminiature components on hybrid thick and thin-film is the method of reflow soldering.

The tags of both SOT-23 and SOT-89 envelopes are pre-tinned and the best results are obtained if 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 a solder paste.

For reliable connections it should be kept in mind that:
- The maximum temperature of the leads or tab during the soldering cycle does not exceed 275 °C.
- The flux must affect neither components nor connectors.
- The residue of the flux must be easy to remove.

Good flux or solder paste with these properties are available on the market.

The most economic method of soldering is a process in which all different components are soldered simultaneously for example SOT-23 or SOT-89 devices, capacitors and resistors.

Having first been fluxed, all components are positioned on the substrate. The slight adhesive force of the flux is sufficient to keep the components in place. 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 heating plate or on a conveyor belt running through an infrared tunnel. The maximum allowed temperature of the plastic body of a device must be kept below 250 °C during the soldering cycle. For further temperature behaviour during the soldering process see Figs 1 and 2.

The surface tension of the liquid solder tends to draw the tags of the device towards the centre of the soldering area and has thus 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 the substrate and the components are not concentrically arranged. This problem can be solved using a standard contact pattern, which leaves sufficient scope for the self-positioning effect.

After the solder has set and cooled the connections are visually inspected and, where necessary, put right with a soldering iron. Finally the remnants of the flux must be removed carefully.

IMMERSION SOLDERING
Maximum allowed temperature of the soldering bath is 235 °C. Maximum duration of soldering cycle is 5 seconds and forced cooling must be applied.

HAND SOLDERING
It is possible to solder SOT-23 and SOT-89 devices with a miniature hand-held soldering iron, but this method has particular drawbacks and should therefore be restricted to laboratory use and/or incidental repairs on production circuits.
1. It is time-consuming and expensive.
2. The device cannot be positioned accurately and therefore the connecting tags may come into contact with the substrate and damage it.
3. There is a great risk of breaking either substrate or internal connections inside the encapsulation.
4. The envelope may be damaged by the iron.
SOLDERING RECOMMENDATIONS

Fig. 1 Reflow soldering without pre-heating.

Fig. 2 Reflow soldering with pre-heating.

$T_{\text{max}} = \text{Maximum lead or tab temperature is } 275\, ^\circ\text{C}.$

$T_f = \text{Flow temperature of the solder is } 239\, ^\circ\text{C}.$

$T_m = \text{Melting point of the solder is } 179\, ^\circ\text{C}.$

$\alpha = \text{Maximum permissible rate of temperature change is } 75\, ^\circ\text{C}/\text{s}.$

$T_{\text{amb}} = 25\, ^\circ\text{C}.$
SOLDERING RECOMMENDATIONS

Minimum required dimensions of metal connection pads on hybrid thick and thin-film substrates.
Dimensions in mm

Fig. 3 SOT-23 pattern.

Fig. 4 SOT-89 pattern.

GENERAL NOTES

Recommended metal-alloy
a. 62 Sn/36 Pb/2 Ag (85% metal weight, when solder paste is used).
b. 60 Sn/40 Pb.

Pre-heating
Pre-heating is recommended for good soldering and avoiding damage to the SOT-23 or SOT-89 devices, other components and the substrate. Maximum pre-heating temperature is 165 °C while the maximum pre-heating duration may be 10 seconds.

Duration of soldering cycle
The maximum duration of soldering cycle without pre-heating is 14 seconds; with pre-heating 22 seconds (see Figs 1 and 2). Pre-heating duration may be 10 seconds.
TYPE NUMBER SURVEY

NUMERICAL INDEX
REVERSE TYPES
Mark and Marking code
Nearest conventional types
The full type number is marked on the encapsulation of semiconductors mounted in SOT-89. Types in SOT-23 are marked with a code.

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March 1978
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<tr>
<td>BCX19;R</td>
<td>50</td>
<td>45</td>
<td>500</td>
<td>310</td>
<td>100/600 100/1 0,62</td>
<td>500/50 100</td>
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<td>BCX54</td>
<td>45</td>
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<td>500/50 100</td>
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<td>40/250 150/2 0,50</td>
<td>500/50 100</td>
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#### VIDEO B/W AND COLOUR TELEVISION

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<tr>
<th>type</th>
<th>( V_{CBO} ) V</th>
<th>( V_{CEO} ) V</th>
<th>( I_c ) mA</th>
<th>( P_{tot} ) mW</th>
<th>( h_{FE} ) min/max at ( I_c/V_{CE} ) mA/V</th>
<th>( V_{CEsat} ) max at ( I_c/I_B ) mA</th>
<th>( f_T ) typ. MHz</th>
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<tr>
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<tr>
<td>BF623</td>
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<td>20</td>
<td>1000</td>
<td>50/- 25/20</td>
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<td>BF622</td>
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April 1978
### HIGH-FREQUENCY TRANSISTORS

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<tr>
<th>Type</th>
<th>Ratings</th>
<th>$h_{FE}$</th>
<th>$f_T$</th>
<th>$C_{re}$</th>
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<td>BF550;R</td>
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<td>50/- 1/10</td>
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<td>325 0,5</td>
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<td>BFS18;R</td>
<td>30 20 30 200</td>
<td>35/125 1/10</td>
<td>4 100</td>
<td>200 0,85</td>
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<td>4 100</td>
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<tr>
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<td>450 0,35</td>
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### SWITCHING TRANSISTORS

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<th>Type</th>
<th>Ratings</th>
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<th>$V_{CEsat}$</th>
<th>$t_{max}$</th>
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<td>BSR12;R</td>
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<td>30/120 50/1</td>
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<td>BSR30</td>
<td>70 60 1000 1000</td>
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<td>500/650 100/5</td>
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<tr>
<td>BSR31</td>
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<td>500/650 100/5</td>
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<tr>
<td>BSR32</td>
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<td>1,2 500/50</td>
<td>500/650 100/5</td>
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<td>BSR33</td>
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<td>500/650 100/5</td>
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<td>BSS63;R</td>
<td>110 100 100 200</td>
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<td>2,5 25/2,5</td>
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<td>BSR40</td>
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<td>250/1000 100/5</td>
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<td>250/1000 100/5</td>
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<tr>
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<td>1,2 500/50</td>
<td>250/1000 100/5</td>
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<td>BSR43</td>
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<td>100/300 100/5</td>
<td>1,2 500/50</td>
<td>250/1000 100/5</td>
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<tr>
<td>BSS64;R</td>
<td>120 80 100 200</td>
<td>20/80 10/1</td>
<td>0,2 50/15</td>
<td>1000 15/1</td>
</tr>
<tr>
<td>BSV52;R</td>
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<td>40/120 10/1</td>
<td>0,4 50/5</td>
<td>12/18 10/3</td>
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<tr>
<td>P-N-P-N</td>
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<td></td>
<td></td>
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<tr>
<td>BRY61</td>
<td>$V_C$ max. 70 V; $I_A$ max. 175 mA; $I_p$ = 5/1 μA; $I_V$ = 30/50 μA</td>
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### WIDEBAND TRANSISTORS

<table>
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<tr>
<th>type</th>
<th>V&lt;sub&gt;CBO&lt;/sub&gt;</th>
<th>V&lt;sub&gt;CE&lt;/sub&gt;</th>
<th>I&lt;sub&gt;c&lt;/sub&gt;</th>
<th>P&lt;sub&gt;tot&lt;/sub&gt;</th>
<th>h&lt;sub&gt;FE&lt;/sub&gt; min/max at I&lt;sub&gt;c&lt;/sub&gt;/V&lt;sub&gt;CE&lt;/sub&gt;</th>
<th>f&lt;sub&gt;t&lt;/sub&gt; typ. at f</th>
<th>G&lt;sub&gt;um&lt;/sub&gt; at f = MHz</th>
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</thead>
<tbody>
<tr>
<td>P-N-P</td>
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</tr>
<tr>
<td>BFT92;R</td>
<td>20</td>
<td>15</td>
<td>25</td>
<td>180</td>
<td>20/−</td>
<td>14/10</td>
<td>5</td>
</tr>
<tr>
<td>BFT93;R</td>
<td>15</td>
<td>12</td>
<td>35</td>
<td>180</td>
<td>20/−</td>
<td>30/5</td>
<td>5</td>
</tr>
<tr>
<td>N-P-N</td>
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<td></td>
<td></td>
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<tr>
<td>BFQ17</td>
<td>40</td>
<td>25</td>
<td>150</td>
<td>1000</td>
<td>25/−</td>
<td>150/5</td>
<td>1,2</td>
</tr>
<tr>
<td>BFQ18A</td>
<td>25</td>
<td>15</td>
<td>150</td>
<td>1000</td>
<td>25/−</td>
<td>100/10</td>
<td>3,6</td>
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<tr>
<td>BFQ19</td>
<td>20</td>
<td>15</td>
<td>75</td>
<td>500</td>
<td>25/−</td>
<td>75/10</td>
<td>5,0</td>
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<tr>
<td>BFR53;R</td>
<td>18</td>
<td>10</td>
<td>50</td>
<td>180</td>
<td>25/−</td>
<td>50/5</td>
<td>2,0</td>
</tr>
<tr>
<td>BFR92;R</td>
<td>20</td>
<td>15</td>
<td>25</td>
<td>180</td>
<td>25/−</td>
<td>14/10</td>
<td>5,0</td>
</tr>
<tr>
<td>BFR93;R</td>
<td>15</td>
<td>12</td>
<td>35</td>
<td>180</td>
<td>25/−</td>
<td>30/5</td>
<td>5,0</td>
</tr>
<tr>
<td>BFS17;R</td>
<td>25</td>
<td>15</td>
<td>25</td>
<td>200</td>
<td>20/150</td>
<td>2/1</td>
<td>1,3</td>
</tr>
<tr>
<td>BFT25;R</td>
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<td>2,5</td>
<td>30</td>
<td>20/−</td>
<td>1/1</td>
<td>2,3</td>
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### FIELD-EFFECT TRANSISTORS

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<th>V&lt;sub&gt;GS&lt;/sub&gt;</th>
<th>I&lt;sub&gt;D&lt;/sub&gt;</th>
<th>P&lt;sub&gt;tot&lt;/sub&gt;</th>
<th>I&lt;sub&gt;GSS&lt;/sub&gt; max.</th>
<th>I&lt;sub&gt;DSS&lt;/sub&gt; min/max.</th>
<th>V&lt;sub&gt;PGS&lt;/sub&gt; max.</th>
<th>V&lt;sub&gt;f&lt;/sub&gt; min.</th>
<th>C&lt;sub&gt;rs&lt;/sub&gt; max.</th>
<th>V&lt;sub&gt;n&lt;/sub&gt; max.</th>
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</thead>
<tbody>
<tr>
<td>BFR30</td>
<td>25</td>
<td>25</td>
<td>10</td>
<td>200</td>
<td>0,2</td>
<td>4/10</td>
<td>5</td>
<td>1</td>
<td>1,5</td>
<td>0,5</td>
</tr>
<tr>
<td>BFR31</td>
<td>25</td>
<td>25</td>
<td>10</td>
<td>200</td>
<td>0,2</td>
<td>1/5</td>
<td>2,5</td>
<td>1,5</td>
<td>1,5</td>
<td>0,5</td>
</tr>
<tr>
<td>BFT46</td>
<td>25</td>
<td>25</td>
<td>10</td>
<td>200</td>
<td>0,2</td>
<td>0,2/1,5</td>
<td>1,0</td>
<td>1,0</td>
<td>1,5</td>
<td>0,5</td>
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<tr>
<td>BSR56</td>
<td>40</td>
<td>40</td>
<td>–</td>
<td>200</td>
<td>1</td>
<td>50/−</td>
<td>10</td>
<td>5</td>
<td>−</td>
<td>−</td>
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<tr>
<td>BSR57</td>
<td>40</td>
<td>40</td>
<td>–</td>
<td>200</td>
<td>1</td>
<td>20/100</td>
<td>6</td>
<td>5</td>
<td>−</td>
<td>−</td>
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<tr>
<td>BSR58</td>
<td>40</td>
<td>40</td>
<td>–</td>
<td>200</td>
<td>1</td>
<td>8/80</td>
<td>4</td>
<td>5</td>
<td>−</td>
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## SWITCHING DIODES

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<tr>
<th>Type</th>
<th>Description</th>
<th>$V_R$</th>
<th>$I_F$</th>
<th>$t_{rr}$ max.</th>
<th>$V_F$ max. $V$ at $I_F = mA$</th>
<th>$C_d$ max. pF</th>
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<tbody>
<tr>
<td>BAS16</td>
<td>high-speed switch</td>
<td>75</td>
<td>100</td>
<td>6</td>
<td>855/1300</td>
<td>2</td>
</tr>
<tr>
<td>BAT17</td>
<td>Schottky barrier</td>
<td>4</td>
<td>30</td>
<td></td>
<td>600/27</td>
<td>1</td>
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<tr>
<td>BAT18</td>
<td>band switch</td>
<td>35</td>
<td>100</td>
<td></td>
<td>855/1300</td>
<td>1</td>
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<tr>
<td>BAV70</td>
<td>common cathode double diode</td>
<td>70</td>
<td>100</td>
<td>6</td>
<td>855/1300</td>
<td>1.5</td>
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<td>BAV99</td>
<td>two diodes in series</td>
<td>70</td>
<td>100</td>
<td>6</td>
<td>855/1300</td>
<td>1.5</td>
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<td>BAW56</td>
<td>common anode double diode</td>
<td>70</td>
<td>100</td>
<td>6</td>
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## VARIABLE CAPACITANCE DIODE

<table>
<thead>
<tr>
<th>Type</th>
<th>RATING $V_R$</th>
<th>$I_F$</th>
<th>$I_R$ at $V_R$</th>
<th>$C_d$ at $V_R$</th>
<th>Capacitance ratio typ.</th>
<th>$r_D$</th>
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<td>BBY31</td>
<td>28</td>
<td>20</td>
<td>&lt;50</td>
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<td>typ. 17,5/1</td>
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## VOLTAGE REGULATOR DIODES BZX84-series

<table>
<thead>
<tr>
<th>Type suffix</th>
<th>$V_{Znom}$</th>
<th>$r_{diff}$</th>
<th>$S_Z$ mV/°C</th>
<th>Type suffix</th>
<th>$V_{Znom}$</th>
<th>$r_{diff}$</th>
<th>$S_Z$ mV/°C</th>
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<tr>
<td>-C4V7</td>
<td>4.7</td>
<td>80</td>
<td>0.2</td>
<td>-C20</td>
<td>20</td>
<td>55</td>
<td>18.0</td>
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<tr>
<td>-C5V1</td>
<td>5.1</td>
<td>60</td>
<td>1.2</td>
<td>-C22</td>
<td>22</td>
<td>55</td>
<td>20.0</td>
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<tr>
<td>-C5V6</td>
<td>5.6</td>
<td>40</td>
<td>2.5</td>
<td>-C24</td>
<td>24</td>
<td>70</td>
<td>22.0</td>
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<tr>
<td>-C6V2</td>
<td>6.2</td>
<td>10</td>
<td>3.7</td>
<td>-C27</td>
<td>27</td>
<td>80</td>
<td>25.3</td>
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<tr>
<td>-C6V8</td>
<td>6.8</td>
<td>15</td>
<td>4.5</td>
<td>-C30</td>
<td>30</td>
<td>80</td>
<td>29.4</td>
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<td>-C7V5</td>
<td>7.5</td>
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<td>33</td>
<td>80</td>
<td>33.4</td>
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<td>-C8V2</td>
<td>8.2</td>
<td>15</td>
<td>6.2</td>
<td>-C36</td>
<td>36</td>
<td>90</td>
<td>37.4</td>
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<td>-C9V1</td>
<td>9.1</td>
<td>15</td>
<td>7.0</td>
<td>-C39</td>
<td>39</td>
<td>130</td>
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<td>-C10</td>
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<td>20</td>
<td>8.0</td>
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<td>150</td>
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<td>-C11</td>
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<td>20</td>
<td>9.0</td>
<td>-C47</td>
<td>47</td>
<td>170</td>
<td>51.8</td>
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<td>-C12</td>
<td>12</td>
<td>25</td>
<td>10.0</td>
<td>-C51</td>
<td>51</td>
<td>180</td>
<td>57.2</td>
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<td>-C13</td>
<td>13</td>
<td>30</td>
<td>11.0</td>
<td>-C56</td>
<td>56</td>
<td>200</td>
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<td>-C15</td>
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<td>30</td>
<td>13.0</td>
<td>-C62</td>
<td>62</td>
<td>215</td>
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<td>-C16</td>
<td>16</td>
<td>40</td>
<td>14.0</td>
<td>-C68</td>
<td>68</td>
<td>240</td>
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<td>-C18</td>
<td>18</td>
<td>45</td>
<td>16.0</td>
<td>-C75</td>
<td>75</td>
<td>255</td>
<td>88.8</td>
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</table>

-C4V7 to -C24 at $I_Z = 5$ mA; -C27 to -C75 at $I_Z = 2$ mA.
BZX84 series; $I_{F RM} = I_{Z RM} = 200$ mA; $P_{tot} = 200$ mW.
Silicon epitaxial high-speed diode in a microminiature plastic envelope. It is intended for high-speed switching in hybrid thick and thin-film circuits.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
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<tbody>
<tr>
<td>Continuous reverse voltage</td>
<td>VR max. 75 V</td>
</tr>
<tr>
<td>Repetitive peak reverse voltage</td>
<td>VRRM max. 85 V</td>
</tr>
<tr>
<td>Repetitive peak forward current</td>
<td>IFRM max. 200 mA</td>
</tr>
<tr>
<td>Junction temperature</td>
<td>TJ max. 150 °C</td>
</tr>
<tr>
<td>Forward voltage at IF = 50 mA</td>
<td>VF &lt; 1,1 V</td>
</tr>
<tr>
<td>Reverse recovery time when switched from</td>
<td>trr &lt; 6 ns</td>
</tr>
<tr>
<td>IF = 10 mA to IR = 10 mA; RL = 100 Ω; measured at IR = 1 mA</td>
<td></td>
</tr>
<tr>
<td>Recovery charge when switched from</td>
<td>Qs &lt; 45 pC</td>
</tr>
<tr>
<td>IF = 10 mA to VR = 5 V; RL = 500 Ω</td>
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</tr>
</tbody>
</table>

MECHANICAL DATA

Fig. 1 SOT-23.

See also Soldering recommendations.
RATINGS

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

Continuous reverse voltage
\[ V_R \leq 75 \text{ V} \]
Repetitive peak reverse voltage
\[ V_{RRM} \leq 85 \text{ V} \]
Average rectified forward current *
(averaged over any 20 ms period)
\[ I_{F(AV)} \leq 100 \text{ mA} \]
Forward current (d.c.)
\[ I_F \leq 100 \text{ mA} \]
Repetitive peak forward current
\[ I_{FRM} \leq 200 \text{ mA} \]
Storage temperature
\[ T_{stg} \leq -65 \text{ to } +150 \text{ °C} \]
Junction temperature
\[ T_j \leq 150 \text{ °C} \]

THERMAL RESISTANCE

From junction to ambient mounted on a ceramic substrate of 7 mm x 5 mm x 0.5 mm
\[ R_{thj-a} = 0.62 \text{ °C/mW} \]

CHARACTERISTICS

\[ T_j = 25 \text{ °C} \] unless otherwise specified.

Forward voltage
\[
\begin{align*}
  I_F &= 1 \text{ mA} \quad V_F < 715 \text{ mV} \\
  I_F &= 10 \text{ mA} \quad V_F < 855 \text{ mV} \\
  I_F &= 50 \text{ mA} \quad V_F < 1100 \text{ mV} \\
  I_F &= 100 \text{ mA} \quad V_F < 1300 \text{ mV}
\end{align*}
\]
Reverse current
\[
\begin{align*}
  V_R &= 25 \text{ V} \text{; } T_j = 150 \text{ °C} \\
  V_R &= 75 \text{ V} \\
  V_R &= 75 \text{ V} \text{; } T_j = 150 \text{ °C} \\
  I_R &< 30 \text{ \mu A} \\
  I_R &< 1 \text{ \mu A} \\
  I_R &< 50 \text{ \mu A}
\end{align*}
\]
Diode capacitance
\[ V_R = 0; f = 1 \text{ MHz} \]
\[ C_d < 2 \text{ pF} \]
Forward recovery voltage (see also Fig. 2)
\[ V_{fr} < 1.75 \text{ V} \]
when switched to \( I_F = 10 \text{ mA} \); \( t_p = 20 \text{ ns} \)
Reverse recovery time (see also Fig. 3)
\[ t_{rr} < 6 \text{ ns} \]
when switched from \( I_F = 10 \text{ mA} \) to \( I_R = 10 \text{ mA} \);
\[ R_L = 100 \Omega; \text{ measured at } I_R = 1 \text{ mA} \]
Recovery charge (see also Fig. 4)
\[ Q_s < 45 \text{ pC} \]
when switched from \( I_F = 10 \text{ mA} \) to \( V_R = 5 \text{ V} \);
\[ R_L = 500 \Omega \]

* Measured under pulse conditions. Pulse time = \( t_p \leq 0.5 \text{ ms} \).
For sinusoidal operation \( I_F(AV) = 65 \text{ mA} \) averaging time \( t_{av} \leq 1 \text{ ms} \).
Fig. 2 Forward recovery voltage test circuit and waveforms.

Input signal: forward pulse rise time \( t_r = 20 \, \text{ns} \); forward current pulse duration \( t_p = 120 \, \text{ns} \); duty factor \( \delta = 0,01 \).

Oscilloscope: rise time \( t_r = 0,35 \, \text{ns} \).

Circuit capacitance \( C \leq 1 \, \text{pF} \) (\( C = \text{oscilloscope input capacitance} + \text{parasitic capacitance} \)).

Fig. 3 Reverse recovery time test circuit and waveforms.

Input signal: reverse pulse rise time \( t_r = 0,6 \, \text{ns} \); reverse pulse duration \( t_p = 100 \, \text{ns} \); duty factor \( \delta = 0,05 \). * \( t_{rr} \) up to \( I_R = 1 \, \text{mA} \).

Oscilloscope: rise time \( t_r = 0,35 \, \text{ns} \).

Circuit capacitance \( C \leq 1 \, \text{pF} \) (\( C = \text{oscilloscope input capacitance} + \text{parasitic capacitance} \)).

Fig. 4 Recovery charge test circuit and waveform.

D1 = BAW62; D2 = diode with minority carrier life time at 10 mA: \( < 200 \, \text{ps} \)

Input signal

- Rise time of the reverse pulse \( t_r = 2 \, \text{ns} \)
- Reverse pulse duration \( t_p = 400 \, \text{ns} \)
- Duty factor \( \delta = 0,02 \)

Circuit capacitance \( C \leq 7 \, \text{pF} \) (\( C = \text{oscilloscope input capacitance} + \text{parasitic capacitance} \)).
Fig. 5. 

Fig. 6. 

Fig. 7.
SCHOTTKY BARRIER DIODE

Silicon epitaxial diode in a microminiature plastic envelope. Intended for u.h.f. mixer and fast switching applications in thick and thin-film circuits.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous reverse voltage</td>
<td>$V_R$ max. 4 V</td>
</tr>
<tr>
<td>Forward current (d.c.)</td>
<td>$I_F$ max. 30 mA</td>
</tr>
<tr>
<td>Junction temperature</td>
<td>$T_j$ max. 100 °C</td>
</tr>
<tr>
<td>Thermal resistance from junction to ambient</td>
<td>$R_{thj-a} = 0,62$ °C/mW</td>
</tr>
<tr>
<td>Forward voltage at $I_F = 10$ mA</td>
<td>$V_F &lt; 600$ mV</td>
</tr>
<tr>
<td>Diode capacitance at $V_R = 0$; $f = 1$ MHz</td>
<td>$C_d &lt; 1,0$ pF</td>
</tr>
<tr>
<td>Noise figure at $f = 900$ MHz</td>
<td>$F &lt; 8,0$ dB</td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Fig.1 SOT-23.

See also Soldering recommendations.
RATINGS

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

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous reverse voltage</td>
<td>$V_R$ max. 4 V</td>
</tr>
<tr>
<td>Forward current (d.c.)</td>
<td>$I_F$ max. 30 mA</td>
</tr>
<tr>
<td>Storage temperature</td>
<td>$T_{stg}$ -65 to +100 °C</td>
</tr>
<tr>
<td>Junction temperature</td>
<td>$T_j$ max. 100 °C</td>
</tr>
</tbody>
</table>

THERMAL RESISTANCE

From junction to ambient mounted on a ceramic substrate of 7 mm x 5 mm x 0,5 mm

$R_{th j-a} = 0,62 \degree C/mW$

CHARACTERISTICS

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

Reverse current

- $V_R = 3 V$
- $V_R = 3 V; T_{amb} = 60 \degree C$
- $I_R < 0,25 \mu A$
- $I_R < 1,25 \mu A$

Reverse breakdown voltage

- $I_R = 10 \mu A$
- $V_{(BR)R} > 4 V$

Forward voltage

- $I_F = 10 mA$
- $V_F < 600 mV$

Diode capacitance

- $V_R = 0; f = 1 MHz$
- $C_d < 1,0 \text{ pF}$

Noise figure at $f = 900 MHz$

- $F < 8,0 \text{ dB}$

Series resistance at $f = 1 kHz$

- $I_F = 5 mA$
- $r_D < 15 \Omega$

* The local oscillator is adjusted for a diode current of 2 mA. I.F. amplifier noise $F_{iF} = 1,5 \text{ dB}$; $f = 35 MHz$. 

March 1978
Fig. 2.
SILICON PLANAR DIODE

Switching diode in a microminiature plastic envelope. Intended for thick and thin-film circuits.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous reverse voltage</td>
<td>$V_R$ max. 35 V</td>
</tr>
<tr>
<td>Forward current (d.c.)</td>
<td>$I_F$ max. 100 mA</td>
</tr>
<tr>
<td>Junction temperature</td>
<td>$T_j$ max. 100 °C</td>
</tr>
<tr>
<td>Diode capacitance at $f = 1$ MHz</td>
<td>$C_d$ typ. 0.8 pF</td>
</tr>
<tr>
<td>Series resistance at $f = 200$ MHz</td>
<td>$r_D$ typ. 0.5 Ω</td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Fig. 1 SOT-23.

Dimensions in mm

Marking code

BAT18 = A2

See also Soldering recommendations.
RATINGS

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

Continuous reverse voltage \( V_R \) max. 35 V
Forward current (d.c.) \( I_F \) max. 100 mA
Storage temperature \( T_{stg} \) -55 to +100 °C
Junction temperature \( T_j \) max. 100 °C

THERMAL RESISTANCE

From junction to ambient mounted on a ceramic substrate of 7 mm x 5 mm x 0,5 mm
\[ R_{th,j-a} = 0,62 \text{ °C/mW} \]

CHARACTERISTICS

\( T_j = 25 \) °C unless otherwise specified

Forward voltage at \( I_F = 100 \) mA \( V_F \) < 1,2 V
Reverse current
\( V_R = 20 \) V
\( I_R \) < 100 nA
\( V_R = 20 \) V; \( T_j = 60 \) °C
\( I_R \) < 1 \( \mu \)A
Diode capacitance at \( f = 1 \) MHz
\( V_R = 20 \) V
\( C_d \) typ. 0,8 pF
Series resistance at \( f = 200 \) MHz
\( I_F = 5 \) mA
\( r_D \) typ. 0,5 \( \Omega \)
Silicon planar diode

Fig. 2. Typical values.

Fig. 3.

Fig. 4.

Fig. 5.
Fig. 6.

- $r_D$ (Ω)
- $I_F$ (mA)

- $f = 200$ MHz
- $T_J = 25$ °C

- max
- typ
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)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous reverse voltage</td>
<td>$V_R$ max. 70 V</td>
</tr>
<tr>
<td>Repetitive peak reverse voltage</td>
<td>$V_{RRM}$ max. 70 V</td>
</tr>
<tr>
<td>Repetitive peak forward current</td>
<td>$I_{FRM}$ max. 200 mA</td>
</tr>
<tr>
<td>Junction temperature</td>
<td>$T_j$ max. 150 °C</td>
</tr>
<tr>
<td>Forward voltage at $I_F = 50$ mA</td>
<td>$V_F &lt; 1.1$ V</td>
</tr>
<tr>
<td>Reverse recovery time when switched from</td>
<td>$t_{rr} &lt; 6$ ns</td>
</tr>
<tr>
<td>$I_F = 10$ mA to $I_R = 10$ mA; $R_L = 100$ Ω;</td>
<td></td>
</tr>
<tr>
<td>measured at $I_R = 1$ mA</td>
<td></td>
</tr>
<tr>
<td>Recovery charge when switched from</td>
<td>$Q_s &lt; 45$ pC</td>
</tr>
<tr>
<td>$I_F = 10$ mA to $V_R = 5$ V; $R_L = 500$ Ω</td>
<td></td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Dimensions in mm

Marking code

BAV70 = A4

See also Soldering recommendations.
**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
- 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

<table>
<thead>
<tr>
<th>Condition</th>
<th>( R_{th\ j-a} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>both diodes loaded simultaneously</td>
<td>1.10 °C/mW</td>
</tr>
<tr>
<td>one diode loaded</td>
<td>0.67 °C/mW</td>
</tr>
</tbody>
</table>

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)  

Forward voltage  
\[ \begin{align*}  
I_F &= 1 \text{ mA} \quad V_F < 715 \text{ mV} \\
I_F &= 10 \text{ mA} \quad V_F < 855 \text{ mV} \\
I_F &= 50 \text{ mA} \quad V_F < 1100 \text{ mV} \\
I_F &= 100 \text{ mA} \quad V_F < 1300 \text{ mV} 
\end{align*} \]

Reverse current  
\[ \begin{align*}  
V_R &= 25 \text{ V}; T_j = 150 \text{ °C} \quad I_R < 60 \text{ } \mu \text{A} \\
V_R &= 70 \text{ V} \quad I_R < 5 \text{ } \mu \text{A} \\
V_R &= 70 \text{ V}; T_j = 150 \text{ °C} \quad I_R < 100 \text{ } \mu \text{A} 
\end{align*} \]

Diode capacitance  
\[ V_R = 0; \ f = 1 \text{ MHz} \quad C_d < 1.5 \text{ pF} \]

Forward recovery voltage when switched to  
\[ I_F = 10 \text{ mA}; \ t_r = 20 \text{ ns} \quad V_{fr} < 1.75 \text{ V} \]

Test circuit and waveforms:

\[ \text{Input signal: } \text{Rise time of the forward pulse} \quad t_r = 20 \text{ ns} \]
\[ \text{Forward current pulse duration} \quad t_p = 120 \text{ ns} \]
\[ \text{Duty factor} \quad \delta = 0.01 \]

Oscilloscope: Rise time \[ t_r = 0.35 \text{ ns} \]

Circuit capacitance \[ C \leq 1 \text{ pF} \] (\[ C = \text{oscilloscope input capacitance} + \text{parasitic capacitance} \]
CHARACTERISTICS (per diode) (continued)

Reverse recovery time when switched from

\( I_F = 10 \text{ mA} \) to \( I_R = 10 \text{ mA}; R_L = 100 \Omega; \)

measured at \( I_R = 1 \text{ mA} \)

\( t_{rr} < 6 \text{ ns} \)

Test circuit and waveforms:

Input signal : Rise time of the reverse pulse \( t_r = 0,6 \text{ ns} \)

Reverse pulse duration \( t_p = 100 \text{ ns} \)

Duty factor \( \delta = 0,05 \)

Oscilloscope: Rise time \( t_r = 0,35 \text{ ns} \)

Circuit capacitance \( C \leq 1 \text{ pF} \) (\( C = \text{oscilloscope input capacitance + parasitic capacitance} \))

Recovery charge when switched from

\( I_F = 10 \text{ mA} \) to \( V_R = 5 \text{ V}; R_L = 500 \Omega \)

\( Q_S < 45 \text{ pC} \)

Test circuit and waveform:

D1 = BAW62

D2 = diode with minority carrier life time at 10 mA: \( < 200 \text{ ps} \)

Input signal : Rise time of the reverse pulse \( t_r = 2 \text{ ns} \)

Reverse pulse duration \( t_p = 400 \text{ ns} \)

Duty factor \( \delta = 0,02 \)

Circuit capacitance \( C \leq 7 \text{ pF} \) (\( C = \text{oscilloscope input capacitance + parasitic capacitance} \))
SILICON PLANAR EPITAXIAL HIGH-SPEED DIODES

The BAV99 consists of two diodes in a microminiature plastic envelope. The diodes are connected in series and the unit is intended for high-speed switching in thick and thin-film circuits.

QUICK REFERENCE DATA (per diode)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous reverse voltage</td>
<td>$V_R$ max. 70 V</td>
</tr>
<tr>
<td>Repetitive peak reverse voltage</td>
<td>$V_{RRM}$ max. 70 V</td>
</tr>
<tr>
<td>Repetitive peak forward current</td>
<td>$I_{FRM}$ max. 200 mA</td>
</tr>
<tr>
<td>Junction temperature</td>
<td>$T_j$ max. 150 °C</td>
</tr>
<tr>
<td>Forward voltage at $I_F = 50$ mA</td>
<td>$V_F &lt; 1.1$ V</td>
</tr>
<tr>
<td>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</td>
<td>$t_{rr} &lt; 6$ ns</td>
</tr>
<tr>
<td>Recovery charge when switched from $I_F = 10$ mA to $V_R = 5$ V; $R_L = 500$ Ω</td>
<td>$Q_s &lt; 45$ pC</td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Fig. 1 SOT-23.

Dimensions in mm

Marking code

BAV99 = A7

See also Soldering recommendations.
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 \( R_{th j-a} = 1.10 \) °C/mW
one diode loaded \( R_{th j-a} = 0.67 \) °C/mW

1) Measured under pulse conditions: pulse time \( t_p \leq 0.5 \) ms.
For sinusoidal operation \( I_{F(AV)} = 65 \) mA; averaging time \( t_{(av)} \leq 1 \) ms.
CHARACTERISTICS (per diode)  

Forward voltage  

<table>
<thead>
<tr>
<th>Current (IF)</th>
<th>Voltage (V_F)</th>
<th>T_j = 25 °C unless otherwise specified</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 mA</td>
<td>715 mV</td>
<td></td>
</tr>
<tr>
<td>10 mA</td>
<td>855 mV</td>
<td></td>
</tr>
<tr>
<td>50 mA</td>
<td>1100 mV</td>
<td></td>
</tr>
<tr>
<td>100 mA</td>
<td>1300 mV</td>
<td></td>
</tr>
</tbody>
</table>

Reverse current  

<table>
<thead>
<tr>
<th>Voltage (V_R)</th>
<th>Current (I_R)</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 V; T_j = 150 °C</td>
<td>&lt; 30 μA</td>
</tr>
<tr>
<td>70 V</td>
<td>&lt; 2,5 μA</td>
</tr>
<tr>
<td>70 V; T_j = 150 °C</td>
<td>&lt; 50 μA</td>
</tr>
</tbody>
</table>

Diode capacitance  

| Capacitance (C_d) | < 1.5 pF     |

Forward recovery voltage when switched to  

IF = 10 mA; t_R = 20 ns  

V_f < 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_T = 0.35 ns
- Circuit capacitance C \leq 1 pF (C = oscilloscope input capacitance + parasitic capacitance)
CHARACTERISTICS (per diode) (continued)

Reverse recovery time when switched from $I_F = 10 \text{ mA}$ to $I_R = 10 \text{ mA}$; $R_L = 100 \Omega$; measured at $I_R = 1 \text{ mA}$

$$t_{rr} < 6 \text{ ns}$$

Test circuit and waveforms:

Input signal: Rise time of the reverse pulse $t_r = 0.6 \text{ ns}$
Reverse pulse duration $t_p = 100 \text{ ns}$
Duty factor $\delta = 0.05$

Oscilloscope: Rise time $t_r = 0.35 \text{ ns}$

Circuit capacitance $C \leq 1 \text{ pF}$ (C = oscilloscope input capacitance + parasitic capacitance)

Recovery charge when switched from $I_F = 10 \text{ mA}$ to $V_R = 5 \text{ V}$; $R_L = 500 \Omega$

$$Q_s < 45 \text{ pC}$$

Test circuit and waveform:

D1 = BAW62
D2 = diode with minority carrier life time at 10 mA: < 200 ps

Input signal: Rise time of the reverse pulse $t_r = 2 \text{ ns}$
Reverse pulse duration $t_p = 400 \text{ ns}$
Duty factor $\delta = 0.02$

Circuit capacitance $C \leq 7 \text{ pF}$ (C = oscilloscope input capacitance + parasitic capacitance)
SILICON PLANAR EPITAXIAL HIGH-SPEED DIODES

The BAW56 consists of two diodes in a microminiature plastic envelope. The anodes are commomned and the unit is intended for high-speed switching in thick and thin-film circuits.

QUICK REFERENCE DATA (per diode)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous reverse voltage</td>
<td>( V_R ) max. 70 V</td>
</tr>
<tr>
<td>Repetitive peak reverse voltage</td>
<td>( V_{RRM} ) max. 70 V</td>
</tr>
<tr>
<td>Repetitive peak forward current</td>
<td>( I_{FRM} ) max. 200 mA</td>
</tr>
<tr>
<td>Junction temperature</td>
<td>( T_J ) max. 150 °C</td>
</tr>
<tr>
<td>Forward voltage at ( I_F = 50 ) mA</td>
<td>( V_F ) &lt; 1.1 V</td>
</tr>
<tr>
<td>Reverse recovery time when switched from</td>
<td>( t_{rr} ) &lt; 6 ns</td>
</tr>
<tr>
<td>( I_F = 10 ) mA to ( I_R = 10 ) mA; ( R_L = 100 ) ( \Omega ); measured at ( I_R = 1 ) mA</td>
<td></td>
</tr>
<tr>
<td>Recovery charge when switched from</td>
<td>( Q_S ) &lt; 45 pC</td>
</tr>
<tr>
<td>( I_F = 10 ) mA to ( V_R = 5 ) V; ( R_L = 500 ) ( \Omega )</td>
<td></td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Fig. 1 SOT-23.

Dimensions in mm

Marking code

BAW56 = A1

See also Soldering recommendations.

January 1978
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 $R_{th j-a} = 1,10 ^\circ C/mW$
one diode loaded $R_{th j-a} = 0,67 ^\circ C/mW$

---

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)**

**Forward voltage**

<table>
<thead>
<tr>
<th>Current (IF)</th>
<th>Voltage (VF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 mA</td>
<td>&lt; 715 mV</td>
</tr>
<tr>
<td>10 mA</td>
<td>&lt; 855 mV</td>
</tr>
<tr>
<td>50 mA</td>
<td>&lt; 1100 mV</td>
</tr>
<tr>
<td>100 mA</td>
<td>&lt; 1300 mV</td>
</tr>
</tbody>
</table>

**Reverse current**

<table>
<thead>
<tr>
<th>Current (IR)</th>
<th>Voltage (VR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 30 µA</td>
<td>25 V; Tj = 150 °C</td>
</tr>
<tr>
<td>&lt; 2.5 µA</td>
<td>70 V</td>
</tr>
<tr>
<td>&lt; 50 µA</td>
<td>70 V; Tj = 150 °C</td>
</tr>
</tbody>
</table>

**Diode capacitance**

- **Forward recovery voltage when switched to**
  - IF = 10 mA; tf = 20 ns
  - Vfr < 1.75 V

**Test circuit and waveforms:**

- Input signal: Rise time of the forward pulse t_f = 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)

Reverse recovery time when switched from

\[ I_F = 10 \text{ mA to } I_R = 10 \text{ mA; } R_L = 100 \text{ } \Omega; \]
measured at \( I_R = 1 \text{ mA} \)

\[ t_{rr} < 6 \text{ ns} \]

Test circuit and waveforms:

- **Input signal**: Rise time of the reverse pulse \( t_r = 0.6 \text{ ns} \)
- **Reverse pulse duration**: \( t_p = 100 \text{ ns} \)
- **Duty factor**: \( \delta = 0.05 \)

Oscilloscope: Rise time \( t_r = 0.35 \text{ ns} \)

Circuit capacitance \( C \leq 1 \text{ pF} \) (\( C \) = oscilloscope input capacitance + parasitic capacitance)

**Recovery charge** when switched from

\[ I_F = 10 \text{ mA to } V_R = 5 \text{ V; } R_L = 500 \text{ } \Omega \]

\[ Q_S < 45 \text{ pC} \]

Test circuit and waveform:

- **D1 = BAW62**
- **D2 = diode with minority carrier life time at 10 mA**: \(< 200 \text{ ps} \)

**Input signal**: Rise time of the reverse pulse \( t_r = 2 \text{ ns} \)
- **Reverse pulse duration**: \( t_p = 400 \text{ ns} \)
- **Duty factor**: \( \delta = 0.02 \)

Circuit capacitance \( C \leq 7 \text{ pF} \) (\( C \) = oscilloscope input capacitance + parasitic capacitance)
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

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reverse voltage</td>
<td>VR</td>
<td>max. 28 V</td>
</tr>
<tr>
<td>Reverse current at $V_R = 28$ V</td>
<td>$I_R$</td>
<td>&lt; 50 nA</td>
</tr>
<tr>
<td>Diode capacitance at $f = 1$ MHz, $V_R = 25$ V</td>
<td>$C_d$</td>
<td>1.8 to 2.8 pF</td>
</tr>
<tr>
<td>Capacitance ratio at $f = 1$ MHz</td>
<td>$C_d$</td>
<td>typ. 5</td>
</tr>
<tr>
<td>Series resistance at $f = 470$ MHz, $V_R$</td>
<td>$r_D$</td>
<td>&lt; 1.2 Ω</td>
</tr>
<tr>
<td>$V_R$ = that value at which $C_d = 9$ pF</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Fig. 1 SOT-23.

Dimensions in mm

Marking code

BBY31 = S1

See also Soldering recommendations.
**BBY31**

**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. 85 °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**

**Reverse current**
- $V_R = 28$ V
- $V_R = 28$ V; $T_j = 85$ °C
- $I_R < 50$ nA
- $I_R < 1000$ 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
- $C_d$ typ. 1.8 to 2.8 pF

**Capacitance ratio at f = 1 MHz**
- $C_d(V_R = 3$ V)
- $C_d(V_R = 25$ V)
- typ. 5

**Series resistance**
- at f = 470 MHz and at that value of $V_R$ at which $C_d = 9$ pF
- $r_D < 1.2$ Ω

**March 1978**
March 1978
$C_d$ (pF) vs. $V_R$ (V)

- Max
- Typ
- Min

$f = 1$ MHz
$T_\text{j} = 25^\circ\text{C}$

May 1972
# SILICON PLANAR EPITAXIAL TRANSISTORS

P-N-P transistors, in a microminiature plastic envelope, intended for low level general purpose applications in thick and thin-film circuits.

## QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Parameter</th>
<th>BCW29</th>
<th>BCW29R</th>
<th>BCW30</th>
<th>BCW30R</th>
</tr>
</thead>
<tbody>
<tr>
<td>D.C. current gain at $T_j = 25 , ^\circ C$</td>
<td>$I_C = 2 , mA$; $V_{CE} = 5 , V$</td>
<td>$h_{FE} &gt;$</td>
<td>120</td>
<td>215</td>
</tr>
<tr>
<td>Collector-emitter voltage (open base)</td>
<td>$V_{CEO}^{\max.}$</td>
<td>30</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Collector current (peak value)</td>
<td>$I_{CM}^{\max.}$</td>
<td>20</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Total power dissipation up to $T_{amb} = 25 , ^\circ C$</td>
<td>$P_{\text{tot}}^{\max.}$</td>
<td>200</td>
<td>mW</td>
<td></td>
</tr>
<tr>
<td>Junction temperature</td>
<td>$T_j^{\max.}$</td>
<td>150</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>Transition frequency at $f = 35 , MHz$</td>
<td>$f_T^{\text{typ.}}$</td>
<td>150</td>
<td>MHz</td>
<td></td>
</tr>
<tr>
<td>Noise figure at $R_S = 2 , k\Omega$</td>
<td>$I_C = 200 , \mu A$; $V_{CE} = 5 , V$; $f = 1 , kHz$; $B = 200 , Hz$</td>
<td>$F &lt;$</td>
<td>10</td>
<td>dB</td>
</tr>
</tbody>
</table>

## MECHANICAL DATA

![Diagram of transistor dimensions](image)

Fig. 1 SOT-23.

Dimensions in mm

<table>
<thead>
<tr>
<th>Component</th>
<th>BCW29</th>
<th>BCW29R</th>
<th>BCW30</th>
<th>BCW30R</th>
</tr>
</thead>
<tbody>
<tr>
<td>Min Max</td>
<td>0,01</td>
<td>0,95</td>
<td>1,3</td>
<td>2,5</td>
</tr>
</tbody>
</table>

Marking code

- BCW29 = C1
- BCW30 = C2
- BCW29R = C4
- BCW30R = C5

See also Soldering recommendations.

January 1978
**RATINGS** Limiting values in accordance with the Absolute Maximum System (IEC134)

**Voltagess**
- Collector-base voltage (open emitter) $-V_{CBO}$ max. 30 V
- Collector-emitter voltage ($V_{BE} = 0$) $-V_{CES}$ max. 30 V
- Collector-emitter voltage (open base) $-I_C = 2$ mA $-V_{CEO}$ max. 20 V
- Emitter-base voltage (open collector) $-V_{EBO}$ max. 5 V

**Currents**
- Collector current (d.c.) $-I_C$ max. 100 mA
- Collector current (peak value) $-I_{CM}$ max. 200 mA

**Power dissipation**
- Total power dissipation up to $T_{amb} = 25$ °C mounted on a ceramic substrate of 7 mm x 5 mm x 0.5 mm $P_{tot}$ max. 200 mW

**Temperatures**
- Storage temperature $T_{stg}$ -65 to +150 °C
- Junction temperature $T_j$ max. 150 °C

**THERMAL RESISTANCE**
- From junction to ambient mounted on ceramic substrate of 7 mm x 5 mm x 0.5 mm $R_{th j-a} = 0.62$ °C/mW

**CHARACTERISTICS**

**Collector cut-off current**
- $I_E = 0; -V_{CB} = 20$ V; $T_j = 25$ °C $-I_{CBO} < 100$ nA
- $T_j = 100$ °C $-I_{CBO} < 10$ µA

**Base-emitter voltage**
- $I_C = 2$ mA; $-V_{CE} = 5$ V; $T_j = 25$ °C $-V_{BE}$ 600 to 750 mV
CHARACTERISTICS (continued)

Saturation voltages

- $I_C = 10 \text{ mA}; -I_B = 0.5 \text{ mA}$
- $I_C = 50 \text{ mA}; -I_B = 2.5 \text{ mA}$

D.C. current gain

- $I_C = 10 \mu A; -V_{CE} = 5 \text{ V}$
- $I_C = 2 \text{ mA}; -V_{CE} = 5 \text{ V}$

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

$C_C < 7.0 \text{ pF}$

Transition frequency at $f = 35 \text{ MHz}$

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

Noise figure at $R_S = 2 \text{ k}\Omega$

- $I_C = 200 \mu A; -V_{CE} = 5 \text{ V}$
  $f = 1 \text{ kHz}; B = 200 \text{ Hz}$

$F < 10 \text{ dB}$

<table>
<thead>
<tr>
<th>$-V_{Cesat}$</th>
<th>$-V_{Besat}$</th>
<th>$h_{FE}$</th>
<th>$C_C$</th>
<th>$f_T$</th>
<th>$F$</th>
</tr>
</thead>
<tbody>
<tr>
<td>typ. 80 mV</td>
<td>&lt; 300 mV</td>
<td>typ. 90</td>
<td>&lt; 7.0</td>
<td>typ. 150 MHz</td>
<td>&lt; 10 dB</td>
</tr>
<tr>
<td>typ. 720 mV</td>
<td>typ. 150 mV</td>
<td>&gt; 120</td>
<td>215</td>
<td>500</td>
<td></td>
</tr>
<tr>
<td>typ. 810 mV</td>
<td></td>
<td>&lt; 260</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

$T_j = 25 \degree C$ unless otherwise specified
December 1972
$I_E = I_e = 0$

$\mu = 1 \text{ MHz}$

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

- $C_c$ (pF)
- $I_{CBO}$ (nA)

$V_{CB} = 20V$

$V_{CB} = 20V$
SILICON PLANAR EPITAXIAL TRANSISTORS

N-P-N transistors in a microminiature plastic envelope. They are intended for low level general purpose applications in thick and thin-film circuits.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Parameter</th>
<th>BCW31</th>
<th>BCW31R</th>
<th>BCW32</th>
<th>BCW32R</th>
<th>BCW33</th>
<th>BCW33R</th>
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</thead>
<tbody>
<tr>
<td>D.C. current gain at $T_j = 25$ °C</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_C = 2$ mA; $V_{CE} = 5$ V</td>
<td>$h_F E &gt; 110$</td>
<td>$220$</td>
<td>$200$</td>
<td>$450$</td>
<td>$800$</td>
<td></td>
</tr>
<tr>
<td>Collector-base voltage (open emitter)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{CBO}$ max.</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Collector-emitter voltage (open base)</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{CEO}$ max.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collector current (peak value)</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_{CM}$ max.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total power dissipation up to $T_{amb} = 25$ °C</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$P_{tot}$ max.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Junction temperature</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transition frequency at $f = 35$ MHz</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_C = 2$ mA; $V_{CE} = 5$ V</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$f_T$ typ.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Noise figure at $R_S = 2$ kΩ</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_C = 200$ $\mu$A; $V_{CE} = 5$ V; $f = 1$ kHz; $B = 200$ Hz</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$F &lt; 10$ dB</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Fig. 1 SOT-23.

Dimensions in mm

Marking code

See also Soldering recommendations.
RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltages

Collector-base voltage (open emitter) \( V_{CBO} \) max. 30 V
Collector-emitter voltage (open base) \( V_{CEO} \) max. 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 \( T_{amb} = 25 \text{°C} \)
mounted on a ceramic substrate of
7 mm x 5 mm x 0.5 mm \( P_{tot} \) max. 200 mW

Temperatures

Storage temperature \( T_{stg} \) -65 to +150 °C
Junction temperature \( T_j \) max. 150 °C

THERMAL RESISTANCE

From junction to ambient
mounted on ceramic substrate of
7 mm x 5 mm x 0.5 mm \( R_{th j-a} = 0.62 \text{°C/mW} \)

CHARACTERISTICS

Collector cut-off current
\( I_E = 0; V_{CB} = 20 \text{ V} \)
\( I_E = 0; V_{CB} = 20 \text{ V}; T_j = 100 \text{ °C} \)

Base-emitter voltage
\( I_C = 2 \text{ mA}; V_{CE} = 5 \text{ V} \)
\( V_{BE} \) 550 to 700 mV

\( T_j = 25 \text{ °C} \) unless otherwise specified

December 1972
CHARACTERISTICS (continued)  

Saturation voltages  

\[ I_C = 10 \, \text{mA}; I_B = 0.5 \, \text{mA} \]
\[ I_C = 50 \, \text{mA}; I_B = 2.5 \, \text{mA} \]

D.C. current gain  

\[ I_C = 10 \, \mu A; V_{CE} = 5 \, \text{V} \]
\[ I_C = 2 \, \text{mA}; V_{CE} = 5 \, \text{V} \]

Collector capacitance at \( f = 1 \, \text{MHz} \)

\[ I_E = I_e = 0; V_{CB} = 10 \, \text{V} \]

Transition frequency at \( f = 35 \, \text{MHz} \)

\[ I_C = 10 \, \text{mA}; V_{CE} = 5 \, \text{V} \]

Noise figure at \( R_S = 2 \, \text{k}\Omega \)

\[ I_C = 200 \, \mu A; V_{CE} = 5 \, \text{V} \]
\[ f = 1 \, \text{kHz}; B = 200 \, \text{Hz} \]

\[ T_j = 25 \, ^\circ \text{C} \] unless otherwise specified

<table>
<thead>
<tr>
<th>BCW31</th>
<th>BCW32</th>
<th>BCW33</th>
</tr>
</thead>
<tbody>
<tr>
<td>( V_{CE_{sat}} ) typ.</td>
<td>120 mV</td>
<td>250 mV</td>
</tr>
<tr>
<td>( V_{BE_{sat}} ) typ.</td>
<td>750 mV</td>
<td>500 mV</td>
</tr>
<tr>
<td>( h_{FE} ) typ.</td>
<td>90</td>
<td>150</td>
</tr>
<tr>
<td>( h_{FE} ) &gt;</td>
<td>110</td>
<td>200</td>
</tr>
<tr>
<td>( h_{FE} ) &lt;</td>
<td>220</td>
<td>450</td>
</tr>
<tr>
<td>( C_C )</td>
<td>&lt; 4.0 pF</td>
<td></td>
</tr>
<tr>
<td>( f_T ) typ.</td>
<td>300 MHz</td>
<td></td>
</tr>
<tr>
<td>( F )</td>
<td>&lt; 10 dB</td>
<td></td>
</tr>
</tbody>
</table>
BCW31 to 33

\[ I_C (\text{mA}) \]
\[ V_{CE} (\text{V}) \]

Typical values:
- \( V_{CE} = 5 \text{V} \)
- \( T_j = 25 \text{°C} \)

\[ h_{FE} \]

December 1972
SILICON PLANAR EPITAXIAL TRANSISTORS

P-N-P transistors, in a microminiature plastic envelope, intended for low level general purpose applications in thick and thin-film circuits.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th></th>
<th>BCW69</th>
<th>BCW69R</th>
<th>BCW70</th>
<th>BCW70R</th>
</tr>
</thead>
<tbody>
<tr>
<td>D.C. current gain at $T_j = 25 , ^\circ C$</td>
<td>$-I_C = 2 , mA$; $-V_{CE} = 5 , V$</td>
<td>$h_{FE} &gt;$</td>
<td>120</td>
<td>215</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>260</td>
<td>500</td>
</tr>
<tr>
<td>Collector-base voltage (open emitter)</td>
<td>$-V_{CBO}$ max.</td>
<td>50</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Collector-emitter voltage (open base)</td>
<td>$-V_{CEO}$ max.</td>
<td>45</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Collector current (peak value)</td>
<td>$-I_{CM}$ max.</td>
<td>200</td>
<td>mA</td>
<td></td>
</tr>
<tr>
<td>Total power dissipation up to $T_{amb} = 25 , ^\circ C$</td>
<td>$P_{tot}$ max.</td>
<td>200</td>
<td>mW</td>
<td></td>
</tr>
<tr>
<td>Junction temperature</td>
<td>$T_j$ max.</td>
<td>150</td>
<td>$^\circ C$</td>
<td></td>
</tr>
<tr>
<td>Transition frequency at $f = 35 , MHz$</td>
<td></td>
<td>$f_T$ typ.</td>
<td>150</td>
<td>MHz</td>
</tr>
<tr>
<td>Noise figure at $R_S = 2 , k\Omega$</td>
<td></td>
<td>$F &lt;$</td>
<td>10</td>
<td>dB</td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Fig. 1 SOT-23.

See also Soldering recommendations.
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 \(T_{amb} = 25\ ^\circ C\) mounted on a ceramic substrate of 7 mm x 5 mm x 0.5 mm \(P_{tot}\) max. 200 mW

Temperatures

Storage temperature \(T_{stg}\) -65 to +150 °C

Junction temperature \(T_j\) max. 150 °C

THERMAL RESISTANCE

From junction to ambient mounted on a ceramic substrate of 7 mm x 5 mm x 0.5 mm \(R_{th\ j-a}\) = 0.62 °C/mW

CHARACTERISTICS

Collector cut-off current

\(I_E = 0; -V_{CB} = 20\ V; T_j = 25\ ^\circ C\) \(-I_{CBO}\) < 100 nA

\(T_j = 100\ ^\circ C\) \(-I_{CBO}\) < 10 μA

Base-emitter voltage

\(-I_C = 2\ mA; -V_{CE} = 5\ V; T_j = 25\ ^\circ C\) \(-V_{BE}\) 600 to 750 mV

December 1972
CHARACTERISTICS (continued)

Saturation voltages

\[-I_C = 10 \text{ mA}; -I_B = 0.5 \text{ mA}\]
\[-I_C = 50 \text{ mA}; -I_B = 2.5 \text{ mA}\]

D. C. current gain

\[-I_C = 10 \mu\text{A}; -V_{CE} = 5 \text{ V}\]
\[-I_C = 2 \text{ mA}; -V_{CE} = 5 \text{ V}\]

Collector capacitance at f = 1 MHz

\[I_E = I_C = 0; -V_{CB} = 10 \text{ V}\]

Transition frequency at f = 35 MHz

\[-I_C = 10 \text{ mA}; -V_{CE} = 5 \text{ V}\]

Noise figure at \(R_S = 2 \text{ k}\Omega\)

\[-I_C = 200 \mu\text{A}; -V_{CE} = 5 \text{ V}\]
\[f = 1 \text{ kHz}; B = 200 \text{ Hz}\]

\[
\begin{array}{lcl}
-\text{V}_{CE\text{sat}} & \text{typ.} & 80 \text{ mV} \\
-\text{V}_{BE\text{sat}} & \text{typ.} & 720 \text{ mV} \\
-\text{V}_{CE\text{sat}} & \text{typ.} & 150 \text{ mV} \\
-\text{V}_{BE\text{sat}} & \text{typ.} & 810 \text{ mV} \\
\end{array}
\]

\[
\begin{array}{lcl}
\text{h}_{FE} & \text{typ.} & 90 \text{ } \text{ } 150 \\
\text{h}_{FE} & \text{typ.} & 120 \text{ } \text{ } 215 \\
\text{h}_{FE} & \text{typ.} & 260 \text{ } \text{ } 500 \\
\text{C}_c & \text{typ.} & 7.0 \text{ pF} \\
\text{f}_T & \text{typ.} & 150 \text{ MHz} \\
\text{F} & \text{typ.} & 10 \text{ dB} \\
\end{array}
\]

\(T_j = 25 \text{ °C unless otherwise specified}\)
$V_{CE} = 5V$
$T_j = 25^\circ C$
$f = 35MHz$

$-V_{CE} = 5V$
$T_j = 25^\circ C$

$-I_C(mA)$

$-V_{BE}(mV)$

December 1972
SILICON PLANAR EPITAXIAL TRANSISTORS

N-P-N transistors, in a microminiature plastic envelope, intended for low level general purpose applications in thick and thin-film circuits.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>D.C. current gain at $T_j = 25 \degree C$</td>
<td>$h_{FE} &gt; 110$</td>
</tr>
<tr>
<td>$I_C = 2 \text{ mA}; V_{CE} = 5 \text{ V}$</td>
<td>$BCW71$</td>
</tr>
<tr>
<td>Collector-base voltage (open emitter)</td>
<td>$V_{CBO}$</td>
</tr>
<tr>
<td>Collector-emitter voltage (open base)</td>
<td>$V_{CEO}$</td>
</tr>
<tr>
<td>Collector current (peak value)</td>
<td>$I_{CM}$</td>
</tr>
<tr>
<td>Total power dissipation up to $T_{amb} = 25 \degree C$</td>
<td>$P_{tot}$</td>
</tr>
<tr>
<td>Junction temperature</td>
<td>$T_j$</td>
</tr>
<tr>
<td>Transition frequency at $f = 35 \text{ MHz}$</td>
<td>$f_T$</td>
</tr>
<tr>
<td>Noise figure at $R_S = 2 \text{ k}\Omega$</td>
<td>$F &lt; 10 \text{ dB}$</td>
</tr>
<tr>
<td>$I_C = 10 \text{ mA}; V_{CE} = 5 \text{ V}$</td>
<td>$BCW72R$</td>
</tr>
<tr>
<td>$I_C = 200 \mu\text{A}; V_{CE} = 5 \text{ V}$</td>
<td>$BCW72$</td>
</tr>
<tr>
<td>$f = 1 \text{ kHz}; B = 200 \text{ Hz}$</td>
<td></td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Fig. 1 SOT-23.

Dimensions in mm

Marking code

$BCW71 = K1$
$BCW72 = K2$

$BCW71R = K4$
$BCW72R = K5$

See also Soldering recommendations.

January 1978
### RATINGS
Limiting values in accordance with the Absolute Maximum System (IEC 134)

<table>
<thead>
<tr>
<th>Voltagess</th>
<th>Limiting Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collector-base voltage (open emitter)</td>
<td>$V_{CBO}$ max. 50 V</td>
</tr>
<tr>
<td>Collector-emitter voltage (open base)</td>
<td>$V_{CEO}$ max. 45 V</td>
</tr>
<tr>
<td>Emitter-base voltage (open collector)</td>
<td>$V_{EBO}$ max. 5 V</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Currents</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collector current (d.c.)</td>
<td>$I_C$ max. 100 mA</td>
</tr>
<tr>
<td>Collector current (peak value)</td>
<td>$I_{CM}$ max. 200 mA</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Power dissipation</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total power dissipation up to $T_{amb} = 25^\circ C$ mounted on a ceramic substrate of 7 mm x 5 mm x 0.5 mm</td>
<td>$P_{tot}$ max. 200 mW</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Temperatures</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage temperature</td>
<td>$T_{stg}$ -65 to +150 $^\circ C$</td>
</tr>
<tr>
<td>Junction temperature</td>
<td>$T_j$ max. 150 $^\circ C$</td>
</tr>
</tbody>
</table>

### THERMAL RESISTANCE
From junction to ambient mounted on a ceramic substrate of 7 mm x 5 mm x 0.5 mm

<table>
<thead>
<tr>
<th>Thermal Resistance</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R_{th j-a}$</td>
<td>0.62 $^\circ C/mW$</td>
</tr>
</tbody>
</table>

### CHARACTERISTICS

<table>
<thead>
<tr>
<th>Collector cut-off current</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_E = 0; V_{CB} = 20 V$</td>
<td>$I_{CBO}$ &lt; 100 nA</td>
</tr>
<tr>
<td>$I_E = 0; V_{CB} = 20 V; T_j = 100^\circ C$</td>
<td>$I_{CBO}$ &lt; 10 $\mu A$</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Base emitter voltage</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_C = 2$ mA; $V_{CE} = 5$ V</td>
<td>$V_{BE}$ 550 to 700 mV</td>
</tr>
</tbody>
</table>

---

December 1972
CHARACTERISTICS (continued)

Saturation voltages

\[ I_C = 10 \, \text{mA}; \, I_B = 0.5 \, \text{mA} \]

\[ I_C = 50 \, \text{mA}; \, I_B = 2.5 \, \text{mA} \]

D.C. current gain

\[ I_C = 10 \, \mu\text{A}; \, V_{CE} = 5 \, \text{V} \]

\[ I_C = 2 \, \text{mA}; \, V_{CE} = 5 \, \text{V} \]

Collector capacitance at \( f = 1 \, \text{MHz} \)

\[ I_E = I_C = 0; \, V_{CB} = 10 \, \text{V} \]

Transition frequency at \( f = 35 \, \text{MHz} \)

\[ I_C = 10 \, \text{mA}; \, V_{CE} = 5 \, \text{V} \]

Noise figure at \( R_S = 2 \, \text{k}\Omega \)

\[ I_C = 200 \, \mu\text{A}; \, V_{CE} = 5 \, \text{V} \]

\[ f = 1 \, \text{kHz}; \, B = 200 \, \text{Hz} \]

\[ T_J = 25^\circ\text{C} \text{ unless otherwise specified} \]

\[ V_{CE\text{sat}} \text{ typ.} < 120 \, \text{mV} \]

\[ V_{BE\text{sat}} \text{ typ.} < 250 \, \text{mV} \]

\[ V_{CE\text{sat}} \text{ typ.} < 750 \, \text{mV} \]

\[ V_{BE\text{sat}} \text{ typ.} < 210 \, \text{mV} \]

\[ V_{BE\text{sat}} \text{ typ.} < 850 \, \text{mV} \]

\[ h_{FE} \text{ typ.} < 90 \]

\[ h_{FE} > 110 \]

\[ h_{FE} < 220 \]

\[ C_c < 4.0 \, \text{pF} \]

\[ f_T \text{ typ.} < 300 \, \text{MHz} \]

\[ F < 10 \, \text{dB} \]

December 1972
BCW71  
BCW72

$V_{CE} = 5V$  
$T_J = 25^\circ C$  
$f = 35MHz$

$I_C$ (mA) vs. $f_T$ (MHz)

$I_C$ (mA) vs. $V_{BE}$ (mV)

December 1972
SILICON PLANAR EPITAXIAL TRANSISTORS

P-N-P transistors, in a microminiature 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.
N-P-N complements are BCX19; 19R and BCX20; 20R respectively.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th></th>
<th>BCX17</th>
<th>BCX17R</th>
<th>BCX18</th>
<th>BCX18R</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collector-emitter voltage (V_{BE} = 0)</td>
<td>V_{CES} max.</td>
<td>50</td>
<td>30</td>
<td>V</td>
</tr>
<tr>
<td>Collector-emitter voltage (open base)</td>
<td>V_{CEO} max.</td>
<td>45</td>
<td>25</td>
<td>V</td>
</tr>
<tr>
<td>Collector current (peak value)</td>
<td>I_{CM} max.</td>
<td>1000</td>
<td>mA</td>
<td></td>
</tr>
<tr>
<td>Total power dissipation up to T_{amb} = 25 °C</td>
<td>P_{tot} max.</td>
<td>310</td>
<td>mW</td>
<td></td>
</tr>
<tr>
<td>Junction temperature</td>
<td>T_{j} max.</td>
<td>150</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>D.C. current gain</td>
<td>h_{FE}</td>
<td>100 to 600</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transition frequency</td>
<td>f_{T} typ.</td>
<td>100</td>
<td>MHz</td>
<td></td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Dimensions in mm

Marking code

BCX17 = T1
BCX18 = T2

0,5

0,1

0,01

min

0,85

0,75

1,2

0,8

0,95

2,9

2,8

1,9

1,3

2,5

1,2

2,1

0,43

0,37

3

1

2

3

BCX17 = T4
BCX18 = T5

See also Soldering recommendations.

January 1978
RATINGS Limiting values in accordance with the Absolute Maximum System (IEC134)

### Voltages

<table>
<thead>
<tr>
<th></th>
<th>BCX17</th>
<th>BCX18</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collector-emitter voltage (V_{BE} = 0)</td>
<td>-V_{CES} max.</td>
<td>50 V</td>
</tr>
<tr>
<td>Collector-emitter voltage (open base)</td>
<td>-V_{CEO} max.</td>
<td>45 V</td>
</tr>
<tr>
<td>Collector-emitter voltage (open collector)</td>
<td>-V_{EBO} max.</td>
<td>5 V</td>
</tr>
</tbody>
</table>

### Currents

<table>
<thead>
<tr>
<th></th>
<th>BCX17</th>
<th>BCX18</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collector current (d.c.)</td>
<td>-I_{C} max.</td>
<td>500 mA</td>
</tr>
<tr>
<td>Collector current (peak value)</td>
<td>-I_{CM} max.</td>
<td>1000 mA</td>
</tr>
<tr>
<td>Emitter current (peak value)</td>
<td>-I_{EM} max.</td>
<td>1000 mA</td>
</tr>
<tr>
<td>Base current (d.c.)</td>
<td>-I_{B} max.</td>
<td>100 mA</td>
</tr>
<tr>
<td>Base current (peak value)</td>
<td>-I_{BM} max.</td>
<td>200 mA</td>
</tr>
</tbody>
</table>

### 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

<table>
<thead>
<tr>
<th></th>
<th>BCX17</th>
<th>BCX18</th>
</tr>
</thead>
<tbody>
<tr>
<td>P_{tot} max.</td>
<td>310 mW</td>
<td></td>
</tr>
</tbody>
</table>

### Temperatures

<table>
<thead>
<tr>
<th></th>
<th>BCX17</th>
<th>BCX18</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage temperature</td>
<td>T_{stg}</td>
<td>-65 to +150 °C</td>
</tr>
<tr>
<td>Junction temperature</td>
<td>T_{J} max.</td>
<td>150 °C</td>
</tr>
</tbody>
</table>

### THERMAL RESISTANCE

From junction to ambient in free air
mounted on a ceramic substrate of
15 mm x 15 mm x 0.5 mm

<table>
<thead>
<tr>
<th></th>
<th>BCX17</th>
<th>BCX18</th>
</tr>
</thead>
<tbody>
<tr>
<td>R_{th j-a} =</td>
<td>0.4 °C/mW</td>
<td></td>
</tr>
</tbody>
</table>
### CHARACTERISTICS

#### Collector cut-off current

- $I_E = 0; \ -V_{CB} = 20 \text{ V}$
- $I_E = 0; \ -V_{CB} = 20 \text{ V}; T_j = 150 \degree \text{C}$

\[ -I_{CBO} < 100 \text{ nA} \]
\[ -I_{CBO} < 5 \text{ µA} \]

#### Emitter cut-off current

- $I_C = 0; \ -V_{EB} = 5 \text{ V}$

\[ -I_{EBO} < 10 \text{ µA} \]

#### Base emitter voltage \(^1\)

- $-I_C = 500 \text{ mA}; \ -V_{CE} = 1 \text{ V}$

\[ -V_{BE} < 1.2 \text{ V} \]

#### Saturation voltage

- $-I_C = 500 \text{ mA}; \ -I_B = 50 \text{ mA}$

\[ -V_{CE_{sat}} < 620 \text{ mV} \]

#### D.C. current gain

- $-I_C = 100 \text{ mA}; \ -V_{CE} = 1 \text{ V}$

\[ h_{FE} \text{ 100 to 600} \]

- $-I_C = 300 \text{ mA}; \ -V_{CE} = 1 \text{ V}$

\[ h_{FE} > 70 \]

- $-I_C = 500 \text{ mA}; \ -V_{CE} = 1 \text{ V}$

\[ h_{FE'} > 40 \]

#### Transition frequency at $f = 35 \text{ MHz}$

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

\[ f_T \text{ 100 MHz} \]

#### Collector capacitance at $f = 1 \text{ MHz}$

- $I_E = I_C = 0; \ -V_{CB} = 10 \text{ V}$

\[ C_c \text{ 8 pF} \]

---

\(^1\) $-V_{BE}$ decreases by about 2 mV/°C with increasing temperature.
$h_{FE}$

$t_{typ}$

$V_{CE} = 1V$

$T_j = 25^\circ C$

$f_T = 35 MHz$

$T_j = 25^\circ C$

December 1972
SILICON PLANAR EPITAXIAL TRANSISTORS

N-P-N transistors, in a microminiature 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.
P-N-P complements are BCX17; 17R and BCX18; 18R respectively.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collector-emitter voltage (V_{BE} = 0)</td>
<td>V_{CES} max. 50 V</td>
</tr>
<tr>
<td>Collector-emitter voltage (open base)</td>
<td>V_{CEO} max. 45 V</td>
</tr>
<tr>
<td>Collector current (peak value)</td>
<td>I_{CM} max. 1000 mA</td>
</tr>
<tr>
<td>Total power dissipation up to T_{amb} = 25 °C</td>
<td>P_{tot} max. 310 mW</td>
</tr>
<tr>
<td>Junction temperature</td>
<td>T_{j} max. 150 °C</td>
</tr>
<tr>
<td>D.C. current gain</td>
<td>h_{FE} 100 to 600</td>
</tr>
<tr>
<td>Transition frequency</td>
<td>f_{T} typ. 200 MHz</td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Dimensions in mm

See also Soldering recommendations.
**RATINGS** Limiting values in accordance with the Absolute Maximum System (IEC134)

<table>
<thead>
<tr>
<th>Voltages</th>
<th>BCX19</th>
<th>BCX20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collector-emitter voltage (V_{BE} = 0)</td>
<td>V_{CES} max.</td>
<td>50</td>
</tr>
<tr>
<td>Collector-emitter voltage (open base)</td>
<td>V_{CEO} max.</td>
<td>45</td>
</tr>
<tr>
<td>Emitter-base voltage (open collector)</td>
<td>V_{EBO} max.</td>
<td>5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Currents</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Collector current (d.c.)</td>
<td>I_C max.</td>
<td>500</td>
</tr>
<tr>
<td>Collector current (peak value)</td>
<td>I_{CM} max.</td>
<td>1000</td>
</tr>
<tr>
<td>Emitter current (peak value)</td>
<td>-I_{EM} max.</td>
<td>1000</td>
</tr>
<tr>
<td>Base current (d.c.)</td>
<td>I_B max.</td>
<td>100</td>
</tr>
<tr>
<td>Base current (peak value)</td>
<td>I_{BM} max.</td>
<td>200</td>
</tr>
</tbody>
</table>

**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**

<table>
<thead>
<tr>
<th>Storage temperature</th>
<th>T_{stg}</th>
<th>-65 to +150</th>
<th>°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Junction temperature</td>
<td>T_{j} max.</td>
<td>150</td>
<td>°C</td>
</tr>
</tbody>
</table>

**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_{thj-a} = 0,4 °C/mW
CHARACTERISTICS

T_j = 25 °C unless otherwise specified.

**Collector cut-off current**

I_E = 0; V_CCB = 20 V

I_E = 0; V_CCB = 20 V; T_j = 150 °C

**Emitter cut-off current**

I_C = 0; V_EBB = 5 V

**Base emitter voltage**

I_C = 500 mA; V_CCE = 1 V

**Saturation voltage**

I_C = 500 mA; I_B = 50 mA

**D.C. current gain**

I_C = 100 mA; V_CCE = 1 V

I_C = 300 mA; V_CCE = 1 V

I_C = 500 mA; V_CCE = 1 V

**Transition frequency at f = 35 MHz**

I_C = 10 mA; V_CCE = 5 V

**Collector capacitance at f = 1 MHz**

I_E = I_e = 0; V_CCB = 10 V

---

1) V_BE decreases by about 2 mV/°C with increasing temperature.

December 1972
SILICON PLANAR EPITAXIAL TRANSISTORS

Medium power p-n-p transistors in a miniature plastic envelope intended for applications in thick and thin-film circuits. These transistors are intended for general purposes as well as for use in driver stages of audio amplifiers.

N-P-N complements are BCX54, BCX55 and BCX56 respectively.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Parameter</th>
<th>BCX51</th>
<th>BCX52</th>
<th>BCX53</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collector-base voltage (open emitter)</td>
<td>-V_{CBO} max. 45</td>
<td>60</td>
<td>100 V</td>
</tr>
<tr>
<td>Collector-emitter voltage (open base)</td>
<td>-V_{CEO} max. 45</td>
<td>60</td>
<td>80 V</td>
</tr>
<tr>
<td>Collector-emitter voltage (R_{BE} = 1 kΩ)</td>
<td>-V_{CER} max. 45</td>
<td>60</td>
<td>100 V</td>
</tr>
<tr>
<td>Collector current (peak value)</td>
<td>-I_{CM} max. 1,5</td>
<td>1,5</td>
<td>1,5 A</td>
</tr>
<tr>
<td>Total power dissipation up to T_{amb} = 25 °C</td>
<td>P_{tot} max. 1</td>
<td>1</td>
<td>1 W</td>
</tr>
<tr>
<td>Junction temperature</td>
<td>T_{j} max. 150</td>
<td>150</td>
<td>150 °C</td>
</tr>
<tr>
<td>D.C. current gain</td>
<td>h_{FE} &gt; 40</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>Transition frequency at f = 35 MHz</td>
<td>f_{T} typ. 50</td>
<td>50</td>
<td>50 MHz</td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Fig. 1 SOT-89.

See also Soldering recommendations.
RATINGS  Limiting values in accordance with the Absolute Maximum System (IEC 134)

**Voltagess**

<table>
<thead>
<tr>
<th>Collector-base voltage (open emitter)</th>
<th>V_{CBO}</th>
<th>max.</th>
<th>BCX51</th>
<th>BCX52</th>
<th>BCX53</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collector-emitter voltage (open base)</td>
<td>V_{CEO}</td>
<td>max.</td>
<td>45</td>
<td>60</td>
<td>100</td>
</tr>
<tr>
<td>Collector-emitter voltage (R_{BE} = 1 kΩ)</td>
<td>V_{CER}</td>
<td>max.</td>
<td>45</td>
<td>60</td>
<td>100</td>
</tr>
<tr>
<td>Emitter-base voltage (open collector)</td>
<td>V_{EBO}</td>
<td>max.</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
</tbody>
</table>

**Currents**

<table>
<thead>
<tr>
<th>Collector current (d.c.)</th>
<th>I_{C}</th>
<th>max.</th>
<th>1,0</th>
<th>A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collector current (peak value)</td>
<td>I_{CM}</td>
<td>max.</td>
<td>1,5</td>
<td>A</td>
</tr>
<tr>
<td>Base current (d.c.)</td>
<td>I_{B}</td>
<td>max.</td>
<td>0,1</td>
<td>A</td>
</tr>
<tr>
<td>Base current (peak value)</td>
<td>I_{BM}</td>
<td>max.</td>
<td>0,2</td>
<td>A</td>
</tr>
</tbody>
</table>

**Power dissipation**

Total power dissipation up to T_{amb} = 25 °C mounted on a ceramic substrate

area = 2,5 cm²; thickness = 0,7 mm

P_{tot} max. 1,0 W

**Temperatures**

<table>
<thead>
<tr>
<th>Storage temperature</th>
<th>T_{stg}</th>
<th>-65 to +150 °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Junction temperature</td>
<td>T_{j}</td>
<td>max. 150 °C</td>
</tr>
</tbody>
</table>

**THERMAL RESISTANCE**

From junction to collector tab

R_{thj-tab} = 10 °C/W

From junction to ambient in free air mounted on a ceramic substrate

area = 2,5 cm²; thickness = 0,7 mm

R_{thj-a} = 125 °C/W
CHARACTERISTICS

Collector cut-off current
\[ I_E = 0; -V_{CB} = 30 \text{ V} \]
\[ I_E = 0; -V_{CB} = 30 \text{ V}; T_j = 125 \text{ °C} \]

Emitter cut-off current
\[ I_C = 0; -V_{EB} = 5 \text{ V} \]

Base-emitter voltage
\[ -I_C = 500 \text{ mA}; -V_{CE} = 2 \text{ V} \]

Saturation voltage
\[ -I_C = 500 \text{ mA}; -I_B = 50 \text{ mA} \]

D.C. current gain

<table>
<thead>
<tr>
<th>( -I_C )</th>
<th>( V_{CE} = 2 \text{ V} )</th>
<th>BCX51</th>
<th>BCX52</th>
<th>BCX53</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 mA</td>
<td>( &gt; 25 \text{ mA} )</td>
<td>25</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>150 mA</td>
<td>( &gt; 250 \text{ mA} )</td>
<td>40</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>500 mA</td>
<td>( &gt; 250 \text{ mA} )</td>
<td>160</td>
<td>160</td>
<td>160</td>
</tr>
</tbody>
</table>

Transition frequency at \( f = 35 \text{ MHz} \)
\[ -I_C = 10 \text{ mA}; -V_{CE} = 5 \text{ V} \]

T_{amb} = 25 \text{ °C} unless otherwise specified

- \( I_{CBO} < 100 \text{ nA} \)
- \( I_{CBO} < 10 \text{ µA} \)
- \( I_{EBO} < 10 \text{ µA} \)
- \( V_{BE} < 1 \text{ V} \)
- \( V_{CE_{sat}} < 0.5 \text{ V} \)
BCX51 to 53

Graph 1: $h_{FE}$ vs. $-I_C$ (mA) for $V_{CE} = 2$ V and $T_j = 25$ °C.

Graph 2: $-I_C$ (mA) vs. $-V_{BE}$ (V) for $V_{CE} = 2$ V and $T_j = 25$ °C.

October 1976
SILICON PLANAR EPITAXIAL TRANSISTORS

Medium power n-p-n transistors in a miniature plastic envelope intended for applications in thick and thin-film circuits. These transistors are intended for general purposes as well as for use in driver stages of audio amplifiers.

P-N-P complements are BCX51, BCX52 and BCX53 respectively.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th></th>
<th>BCX54</th>
<th>BCX55</th>
<th>BCX56</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collector-base voltage (open emitter)</td>
<td>$V_{CBO}$ max.</td>
<td>45</td>
<td>60</td>
</tr>
<tr>
<td>Collector-emitter voltage (open base)</td>
<td>$V_{CEO}$ max.</td>
<td>45</td>
<td>60</td>
</tr>
<tr>
<td>Collector-emitter voltage ($R_{BE} = 1 , k\Omega$)</td>
<td>$V_{CER}$ max.</td>
<td>45</td>
<td>60</td>
</tr>
<tr>
<td>Collector current (peak value)</td>
<td>$I_{CM}$ max.</td>
<td>1,5</td>
<td>1,5</td>
</tr>
<tr>
<td>Total power dissipation up to $T_{amb} = 25 , ^\circ C$</td>
<td>$P_{tot}$ max.</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Junction temperature</td>
<td>$T_J$ max.</td>
<td>150</td>
<td>150</td>
</tr>
<tr>
<td>D.C. current gain</td>
<td>$I_C = 150 , mA; V_{CE} = 2 , V$</td>
<td>$h_{FE} &gt;$</td>
<td>40</td>
</tr>
<tr>
<td>Transition frequency at $f = 35 , MHz$</td>
<td>$I_C = 10 , mA; V_{CE} = 5 , V$</td>
<td>$f_T$ typ.</td>
<td>130</td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Fig. 1 SOT-89.

See also Soldering recommendations.
**RATINGS** Limiting values in accordance with the Absolute Maximum System (IEC 134)

<table>
<thead>
<tr>
<th>Voltages</th>
<th>BCX54</th>
<th>BCX55</th>
<th>BCX56</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collector-base voltage (open emitter)</td>
<td>VCBO</td>
<td>max.</td>
<td>45</td>
</tr>
<tr>
<td>Collector-emitter voltage (open base)</td>
<td>VCEO</td>
<td>max.</td>
<td>45</td>
</tr>
<tr>
<td>Collector-emitter voltage (RBE = 1 kΩ)</td>
<td>VCER</td>
<td>max.</td>
<td>45</td>
</tr>
<tr>
<td>Emitter-base voltage (open collector)</td>
<td>VEBO</td>
<td>max.</td>
<td>5</td>
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</table>

**Currents**

<table>
<thead>
<tr>
<th>Currents</th>
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</thead>
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<tr>
<td>Collector current (d.c.)</td>
<td>IC</td>
</tr>
<tr>
<td>Collector current (peak value)</td>
<td>ICM</td>
</tr>
<tr>
<td>Base current (d.c.)</td>
<td>IB</td>
</tr>
<tr>
<td>Base current (peak value)</td>
<td>IBM</td>
</tr>
</tbody>
</table>

**Power dissipation**

| Total power dissipation up to $T_{amb} = 25°C$ |
|-----------------------------------------------|-------|
| mounted on a ceramic substrate area = 2,5 cm²; thickness = 0,7 mm | $P_{tot}$ max. | 1,0 | W |

**Temperatures**

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

**THERMAL RESISTANCE**

| From junction to collector tab | $R_{thj-tab}$ | 10 °C/W |
| From junction to ambient in free air | $R_{thj-a}$ | 125 °C/W |
CHARACTERISTICS

Collector cut-off current

\[ I_E = 0; \ V_{CB} = 30 \ \text{V} \]
\[ I_E = 0; \ V_{CB} = 30 \ \text{V}; \ T_j = 125 \ ^\circ \text{C} \]

\[ I_{CBO} < 100 \ \text{nA} \]
\[ I_{CBO} < 10 \ \text{µA} \]

Emitter cut-off current

\[ I_C = 0; \ V_{EB} = 5 \ \text{V} \]

\[ I_{EBO} < 10 \ \text{µA} \]

Base-emitter voltage

\[ I_C = 500 \ \text{mA}; \ V_{CE} = 2 \ \text{V} \]

\[ V_{BE} < 1 \ \text{V} \]

Saturation voltage

\[ I_C = 500 \ \text{mA}; \ I_B = 50 \ \text{mA} \]

\[ V_{CE_{sat}} < 0.5 \ \text{V} \]

D.C. current gain

\[ I_C = 5 \ \text{mA}; \ V_{CB} = 2 \ \text{V} \]

\[ h_{FE} > 25 \]

\| \begin{array}{c|c|c|c}
                  & BCX54 & BCX55 & BCX56 \\
\hline
h_{FE}            & > 25   & > 40  & > 40  \\
\hline
h_{FE}            & > 250  & > 160 & > 160 \\
\hline
\end{array} \]

Transition frequency at \( f = 35 \ \text{MHz} \)

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

\[ f_T \ \text{typ.} = 130 \ \text{MHz} \]
DEVELOPMENT SAMPLE DATA

This information is derived from development samples made available for evaluation. It does not form part of our data handbook system and does not necessarily imply that the device will go into production.

BF550
BF550R

SILICON PLANAR EPITAXIAL TRANSISTOR

P-N-P transistor, in a microminiature plastic envelope, intended for applications in thick and thin-film circuits. This transistor is primarily intended for use in i.f. detection applications.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Value</th>
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</thead>
<tbody>
<tr>
<td>Collector-base voltage (open emitter)</td>
<td>V_CBO</td>
<td>max. 40 V</td>
</tr>
<tr>
<td>Collector-emitter voltage (open base)</td>
<td>V_CEO</td>
<td>max. 40 V</td>
</tr>
<tr>
<td>Collector current (d.c.)</td>
<td>I_C</td>
<td>max. 25 mA</td>
</tr>
<tr>
<td>Total power dissipation up to T_amb = 60 °C</td>
<td>P_tot</td>
<td>max. 180 mW</td>
</tr>
<tr>
<td>Junction temperature</td>
<td>T_J</td>
<td>max. 150 °C</td>
</tr>
<tr>
<td>D.C. current gain at T_j = 25 °C</td>
<td>h_FE</td>
<td>&gt; 50</td>
</tr>
<tr>
<td>Transition frequency at f = 100 MHz</td>
<td>f_T</td>
<td>typ. 325 MHz</td>
</tr>
<tr>
<td>Noise figure at R_S = 300 Ω</td>
<td>F</td>
<td>typ. 2 dB</td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT-23

Marking code

BF550 = G2
BF550R = G5

See also Soldering Recommendations.

March 1978

1
RATINGS

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

Collector-base voltage (open emitter) \(-V_{CBO}\) max. 40 V
Collector-emitter voltage (open base) \(-V_{CEO}\) max. 40 V
Emitter-base voltage (open collector) \(-V_{EBO}\) max. 4 V
Collector current (d.c.) \(-I_C\) max. 25 mA
Total power dissipation up to \(T_{amb} = 60 \, ^\circ\text{C}\) *

Storage temperature \(T_{stg}\) -55 to +150 \(^\circ\text{C}\)
Junction temperature \(T_j\) max. 150 \(^\circ\text{C}\)

THERMAL RESISTANCE *

From junction to ambient \(R_{th\,j-a}\) = 0,5 \(^\circ\text{C}/\text{mW}\)

CHARACTERISTICS

\(T_{amb} = 25 \, ^\circ\text{C}\) unless otherwise specified

Collector cut-off current \(I_E = 0; -V_{CB} = 30 \, \text{V}\)

Emitter cut-off current \(I_C = 0; -V_{EB} = 3 \, \text{V}\)

Base-emitter voltage \(-I_C = 1 \, \text{mA}; -V_{CE} = 10 \, \text{V}\)

D.C. current gain \(h_F = 1 \, \text{mA}; -V_{CE} = 10 \, \text{V}\)

Transition frequency at \(f = 100 \, \text{MHz}\)

Feedback capacitance at \(f = 1 \, \text{MHz}\)

Noise figure at \(R_S = 300 \, \Omega\)

* Mounted on a ceramic substrate of 15 mm x 10 mm x 0,5 mm.
SILICON EPITAXIAL TRANSISTOR

- for video output stages

N-P-N transistor in a miniature plastic envelope intended for application in thick and thin-film circuits. This device is intended for class-B video output stages in colour television receivers.

P-N-P complement is BF623.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
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</thead>
<tbody>
<tr>
<td>Collector-base voltage (open emitter)</td>
<td>V_{CBO} max. 250 V</td>
</tr>
<tr>
<td>Collector-emitter voltage (open base)</td>
<td>V_{CEO} max. 250 V</td>
</tr>
<tr>
<td>Collector current (peak value)</td>
<td>I_{CM} max. 100 mA</td>
</tr>
<tr>
<td>Total power dissipation up to T_{amb} = 25 °C</td>
<td>P_{tot} max. 1 W</td>
</tr>
<tr>
<td>Junction temperature</td>
<td>T_{j} max. 150 °C</td>
</tr>
<tr>
<td>D.C. current gain</td>
<td>h_{FE} &gt; 50</td>
</tr>
<tr>
<td>Transition frequency at f = 35 MHz</td>
<td>f_{T} &gt; 60 MHz</td>
</tr>
<tr>
<td>Feedback capacitance at f = 1 MHz</td>
<td>C_{re} &lt; 1,6 pF</td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Dimensions in mm

Mark

Fig. 1 SOT-89.

See also Soldering recommendations.
RATINGS

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

Collector-base voltage (open emitter)  \( V_{CBO} \) max. 250 V
Collector-emitter voltage (open base)  \( V_{CEO} \) max. 250 V
Emitter-base voltage (open collector)  \( V_{EBO} \) max. 5 V
Collector current (d.c.)  \( I_C \) max. 20 mA
Collector current (peak value)  \( I_{CM} \) max. 100 mA

Total power dissipation up to \( T_{amb} = 25 \, ^\circ C \)
mounted on a ceramic substrate
area = 2,5 cm\(^2\); thickness = 0,7 mm

Storage temperature

Junction temperature

THERMAL RESISTANCE

From junction to collector tab

\[ R_{th \ j-tab} = 25 \, ^\circ C/W \]

From junction to ambient in free air
mounted on a ceramic substrate
area = 2,5 cm\(^2\); thickness = 0,7 mm

\[ R_{th \ j-a} = 125 \, ^\circ C/W \]
CHARACTERISTICS

$T_j = 25 \degree C$ unless otherwise specified

Collector cut-off current
$I_E = 0; V_{CB} = 200 \text{ V}$
$R_{BE} = 10 \text{ k} \Omega; V_{CE} = 200 \text{ V}; T_j = 150 \degree C$

Emitter cut-off current
$I_C = 0; V_{EB} = 5 \text{ V}$

Base-emitter voltage
$I_C = 25 \text{ mA}; V_{CE} = 20 \text{ V}$

D.C. current gain
$I_C = 25 \text{ mA}; V_{CE} = 20 \text{ V}$

High-frequency knee voltage at $T_j = 150 \degree C$ *
$I_C = 25 \text{ mA}$

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

Feedback capacitance at $f = 1 \text{ MHz}$
$I_C = 0; V_{CE} = 30 \text{ V}$

Feedback time constant at $f = 10,7 \text{ MHz}^{**}$
$I_C = 10 \text{ mA}; V_{CE} = 20 \text{ V}$

$\begin{align*}
I_{CBO} &< 10 \text{ nA} \\
I_{CER} &< 50 \text{ } \mu\text{A} \\
I_{EBO} &< 10 \text{ } \mu\text{A} \\
V_{BE} &\text{ typ. } 0,73 \text{ V} \\
h_{FE} &> 50 \\
V_{CEK} &\text{ typ. } 20 \text{ V} \\
f_T &> 60 \text{ MHz} \\
C_{re} &< 1,6 \text{ pF} \\
r_{bb' C' b' c} &< 70 \text{ ps}
\end{align*}$

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

** $r_{bb' C' c} = \frac{|h_{rb}|}{\omega}$. 
Fig. 2 Typical values at $T_j = 25 \, ^\circ\text{C}$.

Fig. 3 $V_{CE} = 20 \, \text{V}; T_j = 25 \, ^\circ\text{C}$.

Fig. 4 $V_{CE} = 10 \, \text{V}; T_j = 25 \, ^\circ\text{C}; f = 35 \, \text{MHz}$.
Silicon epitaxial transistor

Fig. 5 $I_C = 25\, \text{mA}; V_{CE} = 20\, \text{V}$.

Fig. 6 $V_{CB} = 200\, \text{V}$.

Fig. 7 $I_C = 0; f = 1\, \text{MHz}; T_j = 25\, \text{°C}$.
Fig. 8  $V_{CE} = 20$ V; $T_j = 25$ °C.
SILICON EPITAXIAL TRANSISTOR

- for video output stages

P-N-P transistor in a miniature plastic envelope intended for application in thick and thin-film circuits. This device is intended for class-B video output stages in colour television receivers. N-P-N complement is BF622.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collector-base voltage (open emitter)</td>
<td>-V_{CBO} max. 250 V</td>
</tr>
<tr>
<td>Collector-emitter voltage (open base)</td>
<td>-V_{CEO} max. 250 V</td>
</tr>
<tr>
<td>Collector current (peak value)</td>
<td>-I_{CM} max. 100 mA</td>
</tr>
<tr>
<td>Total power dissipation up to T_{amb} = 25 °C</td>
<td>P_{tot} max. 1 W</td>
</tr>
<tr>
<td>Junction temperature</td>
<td>T_{j} max. 150 °C</td>
</tr>
<tr>
<td>D.C. current gain</td>
<td>h_{FE} &gt; 50</td>
</tr>
<tr>
<td>Transition frequency at f = 35 MHz</td>
<td>f_{T} &gt; 60 MHz</td>
</tr>
<tr>
<td>Feedback capacitance at f = 1 MHz</td>
<td>C_{re} &lt; 1.6 pF</td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Dimensions in mm

Mark

Fig. 1 SOT-89.  BF623

See also Soldering recommendations.
RATINGS

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

Collector-base voltage (open emitter) $-V_{CBO}$ max. 250 V
Collector-emitter voltage (open base) $-V_{CEO}$ max. 250 V
Emitter-base voltage (open collector) $-V_{EBO}$ max. 5 V
Collector current (d.c.) $-I_C$ max. 20 mA
Collector current (peak value) $-I_{CM}$ max. 100 mA

Total power dissipation up to $T_{amb} = 25 \, ^\circ\text{C}$
mounted on a ceramic substrate
area = 2.5 cm$^2$; thickness = 0.7 mm

$P_{tot}$ max. 1 W
$T_{stg}$ -65 to +150 °C
$T_j$ max. 150 °C

Storage temperature
Junction temperature

THERMAL RESISTANCE

From junction to collector tab
$R_{th\, j-tab} = 25 \, ^\circ\text{C/W}$

From junction to ambient in free air
mounted on a ceramic substrate
area = 2.5 cm$^2$; thickness = 0.7 mm

$R_{th\, j-a} = 125 \, ^\circ\text{C/W}$
CHARACTERISTICS

Tj = 25 °C unless otherwise specified

Collector cut-off current
\[ I_E = 0; -V_{CB} = 200 \text{ V} \]
\[ R_{BE} = 10 \text{ k\Omega}; -V_{CE} = 200 \text{ V}; T_j = 150 \text{ °C} \]

Emitter cut-off current
\[ I_C = 0; -V_{EB} = 5 \text{ V} \]

Base-emitter voltage
\[ I_C = 25 \text{ mA}; -V_{CE} = 20 \text{ V} \]

D.C. current gain
\[ I_C = 25 \text{ mA}; -V_{CE} = 20 \text{ V} \]

High-frequency knee voltage at Tj = 150 °C *
\[ I_C = 25 \text{ mA} \]

Transition frequency at f = 35 MHz
\[ I_C = 10 \text{ mA}; -V_{CE} = 10 \text{ V} \]

Feedback capacitance at f = 1 MHz
\[ I_C = 0; -V_{CE} = 30 \text{ V} \]

Feedback time constant at f = 10,7 MHz **
\[ I_C = 10 \text{ mA}; -V_{CE} = 20 \text{ V} \]

\[ I_CBO < 10 \text{ nA} \]
\[ I_CER < 50 \mu\text{A} \]
\[ I_EBO < 10 \mu\text{A} \]
\[ V_{BE} \text{ typ.} 0,75 \text{ V} \]
\[ h_{FE} > 50 \]
\[ V_{CEK} \text{ typ.} 20 \text{ V} \]
\[ f_T > 60 \text{ MHz} \]
\[ C_{re} < 1,6 \text{ pF} \]
\[ r_{bb'Cb'}c < 70 \text{ ps} \]

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

** \[ r_{bb'Cb'}c = \frac{|h_{rb}|}{\omega} \].
Fig. 2 Typical values at $T_j = 25^\circ$C.

Fig. 3 $V_{CE} = 20$ V; $T_j = 25^\circ$C.

Fig. 4 $V_{CE} = 10$ V; $T_j = 25^\circ$C; $f = 35$ MHz.
Silicon epitaxial transistor

Fig. 5 $I_C = 25 \text{ mA}; -V_{CE} = 20 \text{ V}$.

Fig. 6 $-V_{CB} = 200 \text{ V}$.

Fig. 7 $I_C = 0; f = 1 \text{ MHz}; T_j = 25 \text{ °C}$.
Fig. 8  \(-V_{CE} = 20 \text{ V}; T_j = 25 \text{°C}.\)
SILICON PLANAR EPITAXIAL TRANSISTOR

N-P-N multi-emitter transistor in a miniature plastic envelope intended for application in thick and thin-film circuits. The transistor has extremely good intermodulation properties and a high power gain. It is primarily intended for:
- Output and driver stages of channel and band serial amplifiers with high output power for bands I, II, III and IV/V (40–860 MHz).
- Output and driver stages of wideband amplifiers.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collector-base voltage (open emitter; peak value)</td>
<td>V_CBOM</td>
</tr>
<tr>
<td>Collector-emitter voltage (open base)</td>
<td>V_CEo</td>
</tr>
<tr>
<td>Collector current (peak value; f &gt; 1 MHz)</td>
<td>I_CM</td>
</tr>
<tr>
<td>Total power dissipation up to T_amb = 25 °C</td>
<td>P_tot</td>
</tr>
<tr>
<td>Junction temperature</td>
<td>T_j</td>
</tr>
<tr>
<td>Transition frequency at f = 500 MHz</td>
<td>f_T</td>
</tr>
<tr>
<td>Feedback capacitance at f = 1 MHz</td>
<td>C_re</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>max</th>
<th>typ</th>
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</thead>
<tbody>
<tr>
<td>V_CBOM</td>
<td>40 V</td>
<td></td>
</tr>
<tr>
<td>V_CEo</td>
<td>25 V</td>
<td></td>
</tr>
<tr>
<td>I_CM</td>
<td>300 mA</td>
<td></td>
</tr>
<tr>
<td>P_tot</td>
<td>1 W</td>
<td></td>
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<tr>
<td>T_j</td>
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<tr>
<td>f_T</td>
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<tr>
<td>C_re</td>
<td>1.9 pF</td>
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</tbody>
</table>

MECHANICAL DATA

Fig. 1 SOT-89.

Mark

BFQ17

See also Soldering recommendations.
RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltages
Collector-base voltage (open emitter; peak value) \( V_{CBOM} \) max. 40 V
Collector-emitter voltage (R_{BE} \leq 50 \Omega; peak value) \( V_{CERM} \) max. 40 V 1)
Collector-emitter voltage (open base) \( V_{CEO} \) max. 25 V 1)
Emitter-base voltage (open collector) \( V_{EBO} \) max. 2 V

Currents
Collector current (d.c.) \( I_C \) max. 150 mA
Collector current (peak value; f > 1 MHz) \( I_{CM} \) max. 300 mA

Power dissipation
Total power dissipation up to \( T_{amb} = 25 \) °C mounted on a ceramic substrate area = 2.5 cm²; thickness = 0.7 mm \( P_{tot} \) max. 1 W

Temperatures
Storage temperature \( T_{stg} \) -65 to +150 °C
Junction temperature \( T_j \) max. 150 °C

THERMAL RESISTANCE
From junction to collector tab \( R_{thj-tab} = 30 \) °C/W
From junction to ambient in free air mounted on a ceramic substrate area = 2.5 cm²; thickness = 0.7 mm \( R_{thj-a} = 125 \) °C/W

1) \( I_C = 10 \) mA.
CHARACTERISTICS

Collector cut-off current

I_E = 0; V_CB = 20 V; T_j = 150 °C

Saturation voltage

I_C = 100 mA; I_B = 10 mA

V_CESat < 0.5 V

D.C. current gain

I_C = 50 mA; V_CE = 5 V

h_FE > 25

I_C = 150 mA; V_CE = 5 V

h_FE > 25

Transition frequency at f = 500 MHz 1)

I_C = 150 mA; V_CE = 15 V

f_T typ. 1.2 GHz

Collector capacitance at f = 1 MHz

I_E = I_e = 0; V_CB = 15 V

C_C < 4 pF

Feedback capacitance at f = 1 MHz

I_C = 10 mA; V_CE = 15 V; T_amb = 25 °C

C_re typ. 1.9 pF

Max. unilateral power gain (s_re assumed to be zero)

\[ G_{UM} (\text{in dB}) = 10 \log \left( \frac{|s_{fe}|^2}{(1 - |s_{fe}|^2)(1 - |s_{oe}|^2)} \right) \]

I_C = 60 mA; V_CE = 15 V; T_amb = 25 °C;

f = 200 MHz

G_{UM} typ. 16 dB

f = 800 MHz

G_{UM} typ. 6.5 dB

T_j = 25 °C unless otherwise specified

I_CBO < 20 µA

1) Measured under pulse conditions.
DEVELOPMENT SAMPLE DATA
This information is derived from development samples made available for evaluation. It does not form part of our data handbook system and does not necessarily imply that the device will go into production.

SILICON PLANAR EPITAXIAL TRANSISTOR

N-P-N transistor in a miniature plastic envelope intended for application in thick and thin-film circuits. It is primarily intended for MATV purposes.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collector-base voltage (open emitter)</td>
<td>V_CBO max. 25 V</td>
</tr>
<tr>
<td>Collector-emitter voltage (open base)</td>
<td>V_CEO max. 15 V</td>
</tr>
<tr>
<td>Collector current (d.c.)</td>
<td>I_C max. 150 mA</td>
</tr>
<tr>
<td>Total power dissipation up to T_amb = 25 °C</td>
<td>P_tot max. 1 W</td>
</tr>
<tr>
<td>Junction temperature</td>
<td>T_j max. 150 °C</td>
</tr>
<tr>
<td>Transition frequency at f = 500 MHz</td>
<td>f_T typ. 3.6 GHz</td>
</tr>
<tr>
<td>Feedback capacitance at f = 10.7 MHz</td>
<td>C_re typ. 1.2 pF</td>
</tr>
<tr>
<td>Intermodulation distortion</td>
<td>d_i &lt; -60 dB</td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Fig. 1 SOT-89.

Dimensions in mm

Mark
BFQ18A

See also Soldering recommendations.

March 1978
RATINGS
Limiting values in accordance with the Absolute Maximum System (IEC 134)

Collector-base voltage (open emitter) \( V_{CBO} \) max. 25 V
Collector-emitter voltage (open base) \( V_{CEO} \) max. 15 V
Emitter-base voltage (open collector) \( V_{EBO} \) max. 2 V
Collector current (d.c.) \( I_C \) max. 150 mA
Total power dissipation up to \( T_{amb} = 25 \, ^\circ C \) * \( P_{tot} \) max. 1 W
Storage temperature \( T_{stg} \) -65 to +150 °C
Junction temperature \( T_j \) max. 150 °C

THERMAL RESISTANCE
From junction to collector tab \( R_{th \, j-tab} \) = 25 °C/W
From junction to ambient in free air * \( R_{th \, j-a} \) = 125 °C/W

CHARACTERISTICS
\( T_{amb} = 25 \, ^\circ C \) unless otherwise specified

D.C. current gain **
\( I_C = 50 \, mA; \, V_{CE} = 10 \, V \)
\( I_C = 100 \, mA; \, V_{CE} = 10 \, V \)
\( h_{FE} \) > 25

Transition frequency at \( f = 500 \, MHz \) **
\( I_C = 50 \, mA; \, V_{CE} = 10 \, V \)
\( I_C = 100 \, mA; \, V_{CE} = 10 \, V \)
\( f_T \) typ. 3,2 GHz

Collector capacitance at \( f = 1 \, MHz \)
\( I_E = I_e = 0; \, V_{CB} = 10 \, V \)
\( C_C \) typ. 2,0 pF

Emitter capacitance at \( f = 1 \, MHz \)
\( I_C = I_C = 0; \, V_{EB} = 0,5 \, V \)
\( C_e \) typ. 11 pF

Feedback capacitance at \( f = 10,7 \, MHz \)
\( I_C = 0; \, V_{CE} = 10 \, V \)
\( C_{re} \) typ. 1,2 pF

* The device mounted on a ceramic substrate area = 2,5 cm²; thickness = 0,7 mm.
** Measured under pulse conditions.
Silicon planar epitaxial transistor

Intermodulation distortion (see Fig. 2)

$I_C = 80 \, mA; \, V_{CE} = 10 \, V; \, R_L = 75 \, \Omega$

$V_p = V_o = 700 \, mV \, at \, f_p = 795.25 \, MHz$

$V_q = V_o - 6 \, dB \, at \, f_q = 803.25 \, MHz$

$V_r = V_o - 6 \, dB \, at \, f_r = 805.25 \, MHz$

Measured at $f_{(p + q - r)} = 793.25 \, MHz$

\[ d_{im} < -60 \, dB \]

![Fig. 2 MATV-test circuit (40–860 MHz).](image)
SILICON PLANAR EPITAXIAL TRANSISTOR

N-P-N transistor in a miniature plastic envelope intended for application in thick- and thin-film circuits.
It is primarily intended for use in u.h.f. and microwave amplifiers 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**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collector-base voltage (open emitter)</td>
<td>$V_{CBO}$ max. 20 V</td>
</tr>
<tr>
<td>Collector-emitter voltage (open base)</td>
<td>$V_{CEO}$ max. 15 V</td>
</tr>
<tr>
<td>Collector current (d.c.)</td>
<td>$I_c$ max. 75 mA</td>
</tr>
<tr>
<td>Total power dissipation up to $T_{amb} = 87,5,^\circ C$</td>
<td>$P_{tot}$ max. 500 mW</td>
</tr>
<tr>
<td>Junction temperature</td>
<td>$T_j$ max. 150 °C</td>
</tr>
<tr>
<td>Transition frequency at $f = 500,MHz$</td>
<td>$f_T$ typ. 5 GHz</td>
</tr>
<tr>
<td>Feedback capacitance at $f = 1,MHz$</td>
<td>$C_{re}$ typ. 1,3 pF</td>
</tr>
<tr>
<td>Noise figure at optimum source impedance</td>
<td>$F$ typ. 3,3 dB</td>
</tr>
</tbody>
</table>

**MECHANICAL DATA**

Fig. 1 SOT-89.

Mark
BFQ19

See also Soldering recommendations.
**BFQ19**

**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. 3.0 V

**Currents**
- Collector current (d.c.) \( I_C \) max. 75 mA
- Collector current (peak value); \( f > 1 \text{ MHz} \) \( I_{CM} \) max. 150 mA

**Power dissipation**
Total power dissipation up to \( T_{amb} = 87.5 \degree C \)
mounted on a ceramic substrate
area = 2.5 cm\(^2\); thickness = 0.7 mm
\( P_{tot} \) max. 500 mW

**Temperatures**
- Storage temperature \( T_{stg} \) -65 to +150 \degree C
- Junction temperature \( T_j \) max. 150 \degree C

**THERMAL RESISTANCE**
- From junction to collector tab \( R_{thj-tab} = 40 \degree C/W \)
- From junction to ambient in free air mounted on a ceramic substrate
  area = 2.5 cm\(^2\); thickness = 0.7 mm
  \( R_{thj-a} = 125 \degree C/W \)

March 1978
CHARACTERISTICS

Collector cut-off current
\[ I_E = 0; V_{CB} = 10 \text{ V} \]

\[ I_{CBO} < 100 \text{ nA} \]

D.C. current gain \(1)\)
\[ I_C = 50 \text{ mA}; V_{CE} = 10 \text{ V} \]
\[ h_{FE} > 25 \]

\[ h_{FE} \text{ typ.} 50 \]

\[ I_C = 75 \text{ mA}; V_{CE} = 10 \text{ V} \]
\[ h_{FE} > 25 \]

\[ h_{FE} \text{ typ.} 52 \]

Transition frequency at \( f = 500 \text{ MHz} \) \(1)\)
\[ I_C = 50 \text{ mA}; V_{CE} = 10 \text{ V} \]
\[ f_T > 4,0 \text{ GHz} \]

\[ f_T \text{ typ.} 5,0 \text{ GHz} \]

\[ I_C = 75 \text{ mA}; V_{CE} = 10 \text{ V} \]
\[ f_T > 4,4 \text{ GHz} \]

\[ f_T \text{ typ.} 5,5 \text{ GHz} \]

Collector capacitance at \( f = 1 \text{ MHz} \)
\[ I_E = I_e = 0; V_{CB} = 10 \text{ V} \]
\[ C_C \text{ typ.} 1,6 \text{ pF} \]

Emitter capacitance at \( f = 1 \text{ MHz} \)
\[ I_C = I_c = 0; V_{EB} = 0,5 \text{ V} \]
\[ C_e \text{ typ.} 5,0 \text{ pF} \]

Feedback capacitance at \( f = 1 \text{ MHz} \)
\[ I_C = 10 \text{ mA}; V_{CE} = 10 \text{ V}; T_{amb} = 25 \text{ OC} \]
\[ C_{re} \text{ typ.} 1,3 \text{ pF} \]

Noise figure at optimum source impedance
\[ I_C = 50 \text{ mA}; V_{CE} = 10 \text{ V}; f = 500 \text{ MHz}; T_{amb} = 25 \text{ OC} \]
\[ F \text{ typ.} 3,3 \text{ dB} \]

Max. unilateral power gain (\(s_{re} \text{ assumed to be zero}\))
\[ G_{UM} \text{ (in dB)} = 10 \log \frac{|s_{fe}|^2}{(1 - |s_{fe}|^2)(1 - |s_{oe}|^2)} \]
\[ I_C = 50 \text{ mA}; V_{CE} = 10 \text{ V}; T_{amb} = 25 \text{ OC}; f = 200 \text{ MHz} \]
\[ G_{UM} \text{ typ.} 18,5 \text{ dB} \]

\[ f = 500 \text{ MHz} \]
\[ G_{UM} \text{ typ.} 11,5 \text{ dB} \]

\[ f = 800 \text{ MHz} \]
\[ G_{UM} \text{ typ.} 7,5 \text{ dB} \]

\(1)\) Measured under pulse conditions.
N-CHANNEL SILICON FIELD EFFECT TRANSISTOR

Planar epitaxial junction field effect transistor in a microminiature plastic envelope. It is intended for low level general purpose amplifiers in thick and thin-film circuits.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Drain-source voltage</th>
<th>±VDS max.</th>
<th>25 V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gate-source voltage (open drain)</td>
<td>-VGS max.</td>
<td>25 V</td>
</tr>
<tr>
<td>Total power dissipation up to Tamb = 25 °C</td>
<td>Ptot max.</td>
<td>200 mW</td>
</tr>
<tr>
<td>Drain current</td>
<td>VDS = 10 V; VGS = 0</td>
<td>IDSS &gt;</td>
</tr>
<tr>
<td>Transfer admittance (common source)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>ID = 1 mA; VDS = 10 V; f = 1 kHz</td>
<td>Yfs &gt;</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Fig. 1 SOT-23.

Dimensions in mm

Marking code

BFR30 = M1
BFR31 = M2

See also Soldering recommendations.
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 $T_{amb} = 25 \, ^\circ C$
  - 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 $+150 \, ^\circ C$
- Junction temperature $T_j$ max. 150 \, ^\circ 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 \, ^\circ C/mW

December 1972
CHARACTERISTICS

<table>
<thead>
<tr>
<th>Parameter</th>
<th>BFR30</th>
<th>BFR31</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gate cut-off current</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$-V_{GS} = 10 , \text{V}; , V_{DS} = 0$</td>
<td>$-I_{GSS} &lt; 0.2 , \text{nA}$</td>
<td>$0.2 , \text{nA}$</td>
</tr>
<tr>
<td>Drain current</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{DS} = 10 , \text{V}; , V_{GS} = 0$</td>
<td>$I_{DSS} &gt; 4 , \text{mA}$</td>
<td>$1 , \text{mA}$</td>
</tr>
<tr>
<td>Gate-source voltage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_D = 1 , \text{mA}; , V_{DS} = 10 , \text{V}$</td>
<td>$-V_{GS} &lt; 0.7 , \text{V}$</td>
<td>$0 , \text{V}$</td>
</tr>
<tr>
<td>$I_D = 50 , \mu\text{A}; , V_{DS} = 10 , \text{V}$</td>
<td>$-V_{GS} &lt; 4.0 , \text{V}$</td>
<td>$2.0 , \text{V}$</td>
</tr>
<tr>
<td>Gate-source cut-off voltage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_D = 0.5 , \text{nA}; , V_{DS} = 10 , \text{V}$</td>
<td>$-V_{(P)GS} &lt; 5 , \text{V}$</td>
<td>$2.5 , \text{V}$</td>
</tr>
<tr>
<td>$y$ parameters</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transfer admittance at $f = 1 , \text{kHz}; , T_{amb} = 25 , ^\circ\text{C}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_D = 1 , \text{mA}; , V_{DS} = 10 , \text{V}$</td>
<td>$</td>
<td>y_{fs}</td>
</tr>
<tr>
<td>$I_D = 200 , \mu\text{A}; , V_{DS} = 10 , \text{V}$</td>
<td>$</td>
<td>y_{fs}</td>
</tr>
<tr>
<td>Output admittance at $f = 1 , \text{kHz}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_D = 1 , \text{mA}; , V_{DS} = 10 , \text{V}$</td>
<td>$</td>
<td>y_{os}</td>
</tr>
<tr>
<td>$I_D = 200 , \mu\text{A}; , V_{DS} = 10 , \text{V}$</td>
<td>$</td>
<td>y_{os}</td>
</tr>
<tr>
<td>Input capacitance at $f = 1 , \text{MHz}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_D = 1 , \text{mA}; , V_{DS} = 10 , \text{V}$</td>
<td>$C_{is} &lt; 4 , \text{pF}$</td>
<td>$4 , \text{pF}$</td>
</tr>
<tr>
<td>$I_D = 200 , \mu\text{A}; , V_{DS} = 10 , \text{V}$</td>
<td>$C_{is} &lt; 4 , \text{pF}$</td>
<td>$4 , \text{pF}$</td>
</tr>
<tr>
<td>Feedback capacitance at $f = 1 , \text{MHz}; , T_{amb} = 25 , ^\circ\text{C}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_D = 1 , \text{mA}; , V_{DS} = 10 , \text{V}$</td>
<td>$C_{rs} &lt; 1.5 , \text{pF}$</td>
<td>$1.5 , \text{pF}$</td>
</tr>
<tr>
<td>$I_D = 200 , \mu\text{A}; , V_{DS} = 10 , \text{V}$</td>
<td>$C_{rs} &lt; 1.5 , \text{pF}$</td>
<td>$1.5 , \text{pF}$</td>
</tr>
<tr>
<td>Equivalent noise voltage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_D = 200 , \mu\text{A}; , V_{DS} = 10 , \text{V}$</td>
<td>$V_n &lt; 0.5 , \mu\text{V}$</td>
<td>$0.5 , \mu\text{V}$</td>
</tr>
</tbody>
</table>
- $V_{GS} = 10V$
- $V_{DS} = 0$

$I_{GSS}$ (nA)

Typical graph showing the relationship between $I_{GSS}$ and $T_i$ (°C) for $V_{GS} = 10V$ and $V_{DS} = 0$. The graph indicates a linear increase in $I_{GSS}$ with temperature.
BFR30; BFR31

**BFR30**

- Typical values
  - \( V_{DS} = 10 \text{V} \)

**BFR31**

- Typical values
  - \( V_{DS} = 10 \text{V} \)

---

**Typical correlation between \(-V_{P(MGS)}\) and \(I_{DSS}\)**

- \(-V_{P(MGS)}\) at \( I_{D} = 0.5 \text{mA} \)
- \( V_{DS} = 10 \text{V} \)
- \( T_{j} = 25^\circ \text{C} \)

August 1971
BFR30; BFR31

Typical values

$V_{DS} = 10V$
$f = 1kHz$
$T_{amb} = 25^\circ C$

$|Y_{fs}|$ (mA/V)

$I_D$ (mA)

0 1 2 3 4 5 6

0 2.5 5 7.5 10

BFR30

BFR31

Typical values

$V_{DS} = 10V$
$f = 1kHz$
$T_{amb} = 25^\circ C$

$|Y_{os}|$ ($\mu A/V$)

$I_D$ (mA)

0 1 2 3 4 5 6

0 25 50 75 100

BFR30

BFR31

August 1971
SILICON PLANAR EPITAXIAL TRANSISTOR

N-P-N multi-emitter transistor in a microminiature 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

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collector-base voltage (open emitter)</td>
<td>V_{CB0} max.</td>
<td>18 V</td>
</tr>
<tr>
<td>Collector-emitter voltage (open base)</td>
<td>V_{CEO} max.</td>
<td>10 V</td>
</tr>
<tr>
<td>Collector current (peak value; f &gt; 1 MHz)</td>
<td>I_{CM} max.</td>
<td>100 mA</td>
</tr>
<tr>
<td>Total power dissipation up to T_{amb} = 60 °C</td>
<td>P_{tot} max.</td>
<td>180 mW</td>
</tr>
<tr>
<td>Junction temperature</td>
<td>T_{j} max.</td>
<td>150 °C</td>
</tr>
<tr>
<td>Feedback capacitance at f = 1 MHz</td>
<td>-C_{re} typ.</td>
<td>0,9 pF</td>
</tr>
<tr>
<td>Transition frequency at f = 500 MHz</td>
<td>f_{T} typ.</td>
<td>2,0 GHz</td>
</tr>
<tr>
<td>Max. unilateral power gain (see page 3)</td>
<td>GUM typ.</td>
<td>22 dB</td>
</tr>
<tr>
<td>I_{C} = 2 mA; V_{CE} = 5 V; T_{amb} = 25 °C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I_{C} = 25 mA; V_{CE} = 5 V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I_{C} = 30 mA; V_{CE} = 5 V; f = 200 MHz; T_{amb} = 25 °C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I_{C} = 30 mA; V_{CE} = 5 V; f = 800 MHz; T_{amb} = 25 °C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intermodulation distortion at T_{amb} = 25 °C</td>
<td>d_{jm} typ.</td>
<td>-60 dB</td>
</tr>
<tr>
<td>I_{C} = 30 mA; V_{CE} = 5 V; R_{L} = 37,5 Ω</td>
<td></td>
<td></td>
</tr>
<tr>
<td>V_{O} = 100 mV at f_{P} = 183 MHz</td>
<td></td>
<td></td>
</tr>
<tr>
<td>V_{O} = 100 mV at f_{Q} = 200 MHz</td>
<td></td>
<td></td>
</tr>
<tr>
<td>measured at f_{(2q-p)} = 217 MHz</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Fig. 1 SOT-23.

See also Soldering recommendations.

Marking code

- BFR53 = N1
- BFR53R = N4

January 1978
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 $R_{th j-a} = 0.50$ °C/mW

June 1976
**CHARACTERISTICS**

T<sub>j</sub> = 25°C unless otherwise specified

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collector cut-off current</td>
<td>I&lt;sub&gt;CB&lt;/sub&gt; &lt; 50 nA</td>
</tr>
<tr>
<td>D.C. current gain 1)</td>
<td>h&lt;sub&gt;FE&lt;/sub&gt; &gt; 25</td>
</tr>
<tr>
<td>Transition frequency at f = 500 MHz 1)</td>
<td>f&lt;sub&gt;T&lt;/sub&gt; typ. 2.0 GHz</td>
</tr>
<tr>
<td>Collector capacitance at f = 1 MHz</td>
<td>C&lt;sub&gt;C&lt;/sub&gt; typ. 0.9 pF</td>
</tr>
<tr>
<td>Emitter capacitance at f = 1 MHz</td>
<td>C&lt;sub&gt;E&lt;/sub&gt; typ. 1.5 pF</td>
</tr>
<tr>
<td>Feedback capacitance at f = 1 MHz</td>
<td>C&lt;sub&gt;re&lt;/sub&gt; typ. 0.9 pF</td>
</tr>
<tr>
<td>Noise figure at f = 500 MHz 2)</td>
<td>F &lt; 5 dB</td>
</tr>
<tr>
<td>Max. unilateral power gain (s&lt;sub&gt;re&lt;/sub&gt; assumed to be zero)</td>
<td>G&lt;sub&gt;UM&lt;/sub&gt; (in dB) = 10 log</td>
</tr>
<tr>
<td></td>
<td>1 -</td>
</tr>
<tr>
<td></td>
<td>1 -</td>
</tr>
<tr>
<td></td>
<td>1 -</td>
</tr>
<tr>
<td>IC = 30 mA; V&lt;sub&gt;CE&lt;/sub&gt; = 5 V; f = 200 MHz; Tamb = 25°C</td>
<td>G&lt;sub&gt;UM&lt;/sub&gt; typ. 22 dB</td>
</tr>
<tr>
<td>IC = 30 mA; V&lt;sub&gt;CE&lt;/sub&gt; = 5 V; f = 800 MHz; Tamb = 25°C</td>
<td>G&lt;sub&gt;UM&lt;/sub&gt; typ. 10.5 dB</td>
</tr>
</tbody>
</table>

1) Measured under pulse conditions.
2) Crystal mounted in a BF30 envelope.
CHARACTERISTICS (continued)

Intermodulation distortion 1)  

I_C = 30 mA; V_C_E = 5 V; R_L = 37.5 Ω  

V_0 = 100 mV at f_p = 183 MHz  
V_0 = 100 mV at f_q = 200 MHz  
Measured at f(2q - p) = 217 MHz  

Test circuit:

---

1) Crystal mounted in a BFW30 envelope.
IC (mA) vs. VCE (V)

Typical values:
- Tj = 25 °C
- Ib = 700 μA

hFE (typ) vs. IC (mA)

VCE = 5V
- Tj = 25 °C

IC (mA) vs. IB (μA)

VCE = 5V
- Tj = 25 °C
circles of constant noise figure

![Diagram](attachment:image.png)

- **BS (mA/V)**
  - Crystal mounted in BFW30 envelope
  - F = 500 MHz
  - I_C = 2 mA
  - V_CE = 5 V
  - T_amb = 25 °C

- **Gain versus frequency**
  - V_CE = 5 V
  - I_C = 30 mA
  - T_amb = 25 °C
  - Typ. values

- **Typo**
  - F = 3.3 dB
  - 10
  - 4
  - 4.5
  - 5
  - 5.5

- **Crystal mounted in a BFW30 envelope**
  - V_CE = 5 V
  - F = 500 MHz
  - G_S = 20 mA/V
  - BS is tuned
  - T_amb = 25 °C

- **F (dB)**
  - 10
  - 7.5
  - 5
  - 5
  - 2.5

- **I_C (mA)**
  - 0
  - 15
  - 20
  - 25
  - 30

November 1972
$V_{CE} = 5 \text{ V}$

$I_C = 30 \text{ mA}$

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

Input impedance derived from input reflection coefficient $s_{ie}$ coordinates in ohm x 50

$V_{CE} = 5 \text{ V}$

$I_C = 30 \text{ mA}$

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

Reverse transmission coefficient $s_{re}$
$V_{CE} = 5 \text{ V}$
$I_C = 30 \text{ mA}$
$T_{amb} = 25 \degree \text{C}$

Output impedance derived from output reflection coefficient $s_{oe}$ coordinates in ohm x 50

$V_{CE} = 5 \text{ V}$
$I_C = 30 \text{ mA}$
$T_{amb} = 25 \degree \text{C}$

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

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collector-base voltage (open emitter)</td>
<td>VCBO max. 20 V</td>
</tr>
<tr>
<td>Collector-emitter voltage (open base)</td>
<td>VCEO max. 15 V</td>
</tr>
<tr>
<td>Collector current (d.c.)</td>
<td>IC max. 25 mA</td>
</tr>
<tr>
<td>Total power dissipation up to Tamb = 60 °C</td>
<td>Ptot max. 180 mW</td>
</tr>
<tr>
<td>Junction temperature</td>
<td>Tj max. 150 °C</td>
</tr>
<tr>
<td>Transition frequency at f = 500 MHz</td>
<td>fT typ. 5 GHz</td>
</tr>
<tr>
<td>Feedback capacitance at f = 1 MHz</td>
<td>Cr typ. 0.7 pF</td>
</tr>
<tr>
<td>Noise figure at optimum source impedance</td>
<td>F typ. 2.4 dB</td>
</tr>
<tr>
<td>Max. unilateral power gain (see page 3)</td>
<td>GUM typ. 18 dB</td>
</tr>
<tr>
<td>Intermodulation distortion at Tamb = 25 °C</td>
<td>dlim typ. −60 dB</td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Fig. 1 SOT-23.

Dimensions in mm

Marking code

BFR92 = P1

BFR92R = P4

See also Soldering recommendations.

January 1978
# RATINGS

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

<table>
<thead>
<tr>
<th>Voltages</th>
<th>VCBO max.</th>
<th>20 V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collector-base voltage (open emitter)</td>
<td>VCEO max.</td>
<td>15 V</td>
</tr>
<tr>
<td>Collector-emitter voltage (open base)</td>
<td>VEBO max.</td>
<td>2,0 V</td>
</tr>
<tr>
<td>Emitter-base voltage (open collector)</td>
<td>IC max.</td>
<td>25 mA</td>
</tr>
</tbody>
</table>

**Power dissipation**

Total power dissipation up to $T_{amb} = 60 \, ^\circ\text{C}$
mounted on a ceramic substrate of
15 mm x 10 mm x 0,5 mm

| $P_{tot}$ max. | 180 mW |

**Temperatures**

<table>
<thead>
<tr>
<th>Storage temperature</th>
<th>$T_{Stg}$ -65 to +150 $^\circ\text{C}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Junction temperature</td>
<td>$T_j$ max. 150 $^\circ\text{C}$</td>
</tr>
</tbody>
</table>

**THERMAL RESISTANCE**

From junction to ambient in free air
mounted on a ceramic substrate of
15 mm x 10 mm x 0,5 mm

$R_{th \, j-a} = 0,5 \, ^\circ\text{C}/\text{mW}$
CHARACTERISTICS

Collector cut-off current

\[ I_E = 0; \ V_{CB} = 10 \ V \]

D.C. current gain \(^1\)

\[ I_C = 14 \ mA; \ V_{CE} = 10 \ V \]

Transition frequency at \( f = 500 \ MHz \) \(^1\)

\[ I_C = 14 \ mA; \ V_{CE} = 10 \ V \]

Collector capacitance at \( f = 1 \ MHz \)

\[ I_E = I_c = 0; \ V_{CB} = 10 \ V \]

Emitter capacitance at \( f = 1 \ MHz \)

\[ I_C = I_c = 0; \ V_{EB} = 0,5 \ V \]

Feedback capacitance at \( f = 1 \ MHz \)

\[ I_C = 2 \ mA; \ V_{CE} = 10 \ V; \ T_{amb} = 25 \ ^\circ C \]

Noise figure at optimum source impedance \(^2\)

\[ I_C = 2 \ mA; \ V_{CE} = 10 \ V; \ f = 500 \ MHz; \ T_{amb} = 25 \ ^\circ C \]

Max. unilateral power gain \((s_{re} \text{ assumed to be zero})\)

\[ G_{UM} (\text{in dB}) = 10 \log \frac{|s_{fe}|^2}{(1-|s_{le}|^2)(1-|s_{oe}|^2)} \]

\[ I_C = 14 \ mA; \ V_{CE} = 10 \ V; \ f = 500 \ MHz; \ T_{amb} = 25 \ ^\circ C \]

\[ G_{UM} \text{ typ.} \ 18 \ dB \]

---

\(^1\) Measured under pulse conditions.

\(^2\) Crystal mounted in a BFR90 envelope.
CHARACTERISTICS (continued)

Intermodulation distortion at $T_{\text{amb}} = 25 \, ^\circ\text{C}$

$\begin{align*}
I_C &= 14 \, \text{mA}; \, V_{\text{CE}} = 10 \, \text{V}; \, R_L = 75 \, \Omega; \, \text{V.S.W.R.} < 2 \\
V_p &= V_o = 150 \, \text{mV} \text{ at } f_p = 495.25 \, \text{MHz} \\
V_q &= V_o - 6 \, \text{dB} \text{ at } f_q = 503.25 \, \text{MHz} \\
V_r &= V_o - 6 \, \text{dB} \text{ at } f_r = 505.25 \, \text{MHz}
\end{align*}$

Measured at $f_{(p+q-r)} = 493.25 \, \text{MHz}$

Intermodulation test circuit:

\[ \text{L1} = 4 \text{ turns Cu wire (0.35 mm); winding pitch 1 mm; int. diam. 4 mm} \]
\[ \text{L2} = L3 = 5 \mu\text{H (code number: 3122 108 20150)} \]
BFR92

\[ F \text{ (dB)} \]

\begin{align*}
10^{-1} & \quad 1 \quad f \text{ (GHz)} \quad 10 \\
\end{align*}

\[ V_{CE} = 10 \text{ V} \]
\[ I_C = 2 \text{ mA} \]
\[ Z_S = \text{opt.} \]
\[ T_{amb} = 25 \, ^\circ\text{C} \]

\[ F \text{ (dB)} \]

\begin{align*}
0 & \quad 5 \quad 10 \quad 15 \quad I_C \text{ (mA)} \quad 20 \\
\end{align*}

\[ V_{CE} = 10 \text{ V} \]
\[ f = 500 \text{ MHz} \]
\[ Z_S = \text{optimum} \]
\[ T_{amb} = 25 \, ^\circ\text{C} \]

August 1972
circles of constant noise figure

November 1972

---

BFR92

---
\[ V_{CE} = 10 \text{ V} \]
\[ I_C = 14 \text{ mA} \]
\[ T_{amb} = 25 \, ^\circ\text{C} \]

Input impedance derived from input reflection coefficient \( s_{ie} \)
coordinates in ohm x 50

\[ V_{CE} = 10 \text{ V} \]
\[ I_C = 14 \text{ mA} \]
\[ T_{amb} = 25 \, ^\circ\text{C} \]

Reverse transmission coefficient \( s_{re} \)
$V_{CE} = 10 \text{ V}$
$I_C = 14 \text{ mA}$
$T_{amb} = 25 \degree \text{C}$

Output impedance derived from output reflection coefficient $s_{oe}$ coordinates in ohm x 50

$V_{CE} = 10 \text{ V}$
$I_C = 14 \text{ mA}$
$T_{amb} = 25 \degree \text{C}$

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 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.

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<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collector-base voltage (open emitter)</td>
<td>VCBO</td>
<td>max. 15 V</td>
</tr>
<tr>
<td>Collector-emitter voltage (open base)</td>
<td>VCEO</td>
<td>max. 12 V</td>
</tr>
<tr>
<td>Collector current (d.c.)</td>
<td>IC</td>
<td>max. 35 mA</td>
</tr>
<tr>
<td>Total power dissipation up to Tamb = 60 °C</td>
<td>Ptot</td>
<td>max. 180 mW</td>
</tr>
<tr>
<td>Junction temperature</td>
<td>Tj</td>
<td>max. 150 °C</td>
</tr>
<tr>
<td>Transition frequency at f = 500 MHz</td>
<td>fT</td>
<td>typ. 5 GHz</td>
</tr>
<tr>
<td>Feedback capacitance at f = 1 MHz</td>
<td>Cre</td>
<td>typ. 0.8 pF</td>
</tr>
<tr>
<td>Noise figure at optimum source impedance</td>
<td>F</td>
<td>typ. 1.9 dB</td>
</tr>
<tr>
<td>Max. unilateral power gain (see page 3)</td>
<td>GUM</td>
<td>typ. 16.5 dB</td>
</tr>
<tr>
<td>Intermodulation distortion at Tamb = 25 °C</td>
<td>dim</td>
<td>typ. -60 dB</td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Fig. 1 SOT-23.

Dimensions in mm

Marking code

BFR93 = R1

BFR93R = R4

See also Soldering recommendations.
BFR93

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 \( R_{th j-a} = 0.50 \) °C/mW

November 1972
CHARACTERISTICS

Collector cut-off current

\[ I_E = 0; \ V_{CB} = 10 \ V \]

\[ I_{CBO} < 50 \ \text{nA} \]

D.C. current gain \( 1) \)

\[ I_C = 30 \ mA; \ V_{CE} = 5 \ V \]

\[ h_{FE} > 25 \ \text{typ.} \ 50 \]

Transition frequency at \( f = 500 \ MHz \) \( 1) \)

\[ I_C = 30 \ mA; \ V_{CE} = 5 \ V \]

\[ f_T \ \text{typ.} \ 5 \ GHz \]

Collector capacitance at \( f = 1 \ MHz \)

\[ I_E = I_e = 0; \ V_{CB} = 10 \ V \]

\[ C_c \ \text{typ.} \ 0.7 \ \text{pF} \]

Emitter capacitance at \( f = 1 \ MHz \)

\[ I_C = I_c = 0; \ V_{EB} = 0.5 \ V \]

\[ C_e \ \text{typ.} \ 1.8 \ \text{pF} \]

Feedback capacitance at \( f = 1 \ MHz \)

\[ I_C = 2 \ mA; \ V_{CE} = 5 \ V; \ T_{amb} = 25 \ ^\circ\text{C} \]

\[ C_{re} \ \text{typ.} \ 0.8 \ \text{pF} \]

Noise figure at optimum source impedance \( 2) \)

\[ I_C = 2 \ mA; \ V_{CE} = 5 \ V; \ f = 500 \ MHz; \ T_{amb} = 25 \ ^\circ\text{C} \]

\[ F \ \text{typ.} \ 1.9 \ \text{dB} \]

Max. unilateral power gain (\( s_{re} \) assumed to be zero)

\[
G_{UM} \ (\text{in dB}) = 10 \log \frac{|s_{fe}|^2}{(1-|s_{fe}|^2)(1-|s_{oe}|^2)}
\]

\[ I_C = 30 \ mA; \ V_{CE} = 5 \ V; \ f = 500 \ MHz; \ T_{amb} = 25 \ ^\circ\text{C} \]

\[ G_{UM} \ \text{typ.} \ 16.5 \ \text{dB} \]

---

1) Measured under pulse conditions.
2) Crystal mounted in a BFR91 envelope.
CHARACTERISTICS (continued)

Intermodulation distortion at $T_{\text{amb}} = 25 \, ^\circ\text{C}$

$I_C = 30 \, \text{mA}; \, V_{CE} = 5 \, \text{V}; \, R_L = 75 \, \Omega; \, \text{V.S.W.R.} < 2$

$V_P = V_O = 300 \, \text{mV} \, \text{at} \, f_P = 495, \, 25 \, \text{MHz}$

$V_Q = V_O \, -6 \, \text{dB} \, \text{at} \, f_Q = 503, \, 25 \, \text{MHz}$

$V_T = V_O \, -6 \, \text{dB} \, \text{at} \, f_T = 505, \, 25 \, \text{MHz}$

Measured at $f_{(p+q-r)} = 493, \, 25 \, \text{MHz}$

Intermodulation test circuit:

$V_{p} = V_{o} = 300 \, \text{mV}$ at $f_{p} = 495, \, 25 \, \text{MHz}$

$V_{q} = V_{o} \, -6 \, \text{dB}$ at $f_{q} = 503, \, 25 \, \text{MHz}$

$V_{r} = V_{o} \, -6 \, \text{dB}$ at $f_{r} = 505, \, 25 \, \text{MHz}$

1) Crystal mounted in a BFR91 envelope.
BFR93

**Graph 1:**
- $V_{CE} = 5$ V
- $I_C = 2$ mA
- $Z_S = $ opt.
- $T_{amb} = 25$ °C

**Graph 2:**
- $V_{CE} = 5$ V
- $f = 500$ MHz
- $Z_S = $ optimum
- $T_{amb} = 25$ °C

---

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BFR93

circles of constant noise figure

$V_{CE} = 5\, V$

$\!I_C = 30\, mA$

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

typ. values

$|h_{FE}|^2$

$G_{UM}$

$|sfe|^2$

$B_S$

(mA/V)

$50$

$20$

$10$

$0$

$10^2$

$10^3$

$10^4$

$f$ (MHz)

$50$

$0$

$-50$

$0$

$50$

$100$

$G_S$ (mA/V)

Typo values

$V_{CE} = 5\, V$

$I_C = 2\, mA$

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

$F = 4.5\, dB$

$4$

$3.5$

$3$

$2.5$

$1.9$

December 1972
BFR93

\[ V_{CE} = 5 \text{ V} \]
\[ I_C = 30 \text{ mA} \]
\[ T_{amb} = 25 \degree \text{C} \]

Input impedance derived from input reflection coefficient \( s_{te} \) coordinates in ohm x 50

\[ V_{CE} = 5 \text{ V} \]
\[ I_C = 30 \text{ mA} \]
\[ T_{amb} = 25 \degree \text{C} \]

Reverse transmission coefficient \( s_{re} \)

December .972
\[ V_{CE} = 5 \text{ V} \]
\[ I_C = 30 \text{ mA} \]
\[ T_{\text{amb}} = 25 \degree \text{C} \]

Output impedance derived from output reflection coefficient \( s_{oe} \) coordinates in ohm x 50

\[ V_{CE} = 5 \text{ V} \]
\[ I_C = 30 \text{ mA} \]
\[ T_{\text{amb}} = 25 \degree \text{C} \]

Forward transmission coefficient \( s_{fe} \)
**SILICON PLANAR EPITAXIAL TRANSISTOR**

N-P-N transistor in a microminiature 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**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
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</thead>
<tbody>
<tr>
<td>Collector-base voltage (open emitter; peak value)</td>
<td>$V_{\text{CBOM}}$ max. 25 V</td>
</tr>
<tr>
<td>Collector-emitter voltage (open base)</td>
<td>$V_{\text{CEO}}$ max. 15 V</td>
</tr>
<tr>
<td>Collector current (peak value)</td>
<td>$I_{\text{CM}}$ max. 50 mA</td>
</tr>
<tr>
<td>Total power dissipation up to $T_{\text{amb}} = 25^\circ$C</td>
<td>$P_{\text{tot}}$ max. 200 mW</td>
</tr>
<tr>
<td>Junction temperature</td>
<td>$T_{j}$ max. 150 $^\circ$C</td>
</tr>
<tr>
<td>D.C. current gain</td>
<td>$h_{\text{FE}}$ 20 to 150</td>
</tr>
<tr>
<td>Transition frequency</td>
<td>$f_{\text{T}}$ typ. 1.3 GHz</td>
</tr>
<tr>
<td>Noise figure</td>
<td>$f$ typ. 4.5 dB</td>
</tr>
</tbody>
</table>

**MECHANICAL DATA**

Fig. 1 SOT-23.

Dimensions in mm

Marking code

BFS17 = E1

BFS17R = E4

See also Soldering recommendations.

January 1978
**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): $V_{CEO}$ 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 $T_{amb} = 25^\circ C$ mounted on a ceramic substrate of $7 \text{ mm} \times 5 \text{ mm} \times 0.5 \text{ mm}$: $P_{tot}$ 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 $7 \text{ mm} \times 5 \text{ mm} \times 0.5 \text{ mm}$: $R_{th \ j-a} = 0.62 \text{ °C/mW}$

**CHARACTERISTICS**

**Collector cut-off current**
- $I_E = 0; V_{CB} = 10 \text{ V}$
- $I_E = 0; V_{CB} = 10 \text{ V}; T_j = 100 \text{ °C}$

**D.C. current gain**
- $I_C = 2 \text{ mA}; V_{CE} = 1 \text{ V}$
- $I_C = 25 \text{ mA}; V_{CE} = 1 \text{ V}$

**Collector cut-off current**
- $I_{CBO} < 10 \text{ nA}$
- $I_{CBO} < 10 \text{ µA}$

**D.C. current gain**
- $h_{FE}$ 20 to 150
- $h_{FE} > 20$

December 1972
CHARACTERISTICS (continued)  

T<sub>j</sub> = 25 °C unless otherwise specified

**Transition frequency**

- I<sub>C</sub> = 2 mA; V<sub>CE</sub> = 5 V; f = 500 MHz  
  f<sub>T</sub> typ. 1.0 GHz
- I<sub>C</sub> = 25 mA; V<sub>CE</sub> = 5 V; f = 500 MHz  
  f<sub>T</sub> typ. 1.3 GHz

**Collector capacitance at f = 1 MHz**

- I<sub>E</sub> = I<sub>e</sub> = 0; V<sub>CB</sub> = 10 V  
  C<sub>C</sub> < 1.5 pF

**Emitter capacitance at f = 1 MHz**

- I<sub>C</sub> = I<sub>C</sub> = 0; V<sub>EB</sub> = 0.5 V  
  C<sub>e</sub> < 2.0 pF

**Feedback capacitance at f = 1 MHz**

- I<sub>C</sub> = 2 mA; V<sub>CE</sub> = 5 V  
  C<sub>re</sub> typ. 0.65 pF

**Noise figure**

- I<sub>C</sub> = 2 mA; V<sub>CE</sub> = 5 V  
  f = 500 MHz; R<sub>S</sub> = 50 Ω  
  F typ. 4.5 dB<sup>1)</sup>

**Intermodulation distortion**

- I<sub>C</sub> = 10 mA; V<sub>CE</sub> = 6 V; R<sub>L</sub> = 37.5 Ω; T<sub>amb</sub> = 25 °C  
  V<sub>o</sub> = 100 mV at f<sub>p</sub> = 183 MHz  
  V<sub>o</sub> = 100 mV at f<sub>q</sub> = 200 MHz  
  measured at f (2<sub>q</sub>-p) = 217 MHz  
  d<sub>im</sub> typ. -45 dB

---

<sup>1)</sup> Crystal mounted in a BFY90 envelope.
typical values

7Z10165

$V_{CE} = 1V$

$T_J = 25^\circ C$

$I_C = 0.1mA$

$I_C = 0.2mA$

$I_C = 0.3mA$

$I_C = 0.4mA$

$I_C = 0.5mA$

$I_C = 0.6mA$

$I_C = 0.8mA$

$I_C = 0.9mA$

$7Z10164$

$T_J = 25^\circ C$

$I_C = 40mA$

$I_C = 20mA$

$I_C = 10mA$

$I_C = 5mA$

$I_C = 2mA$

$I_C = 0.5mA$

$I_C = 0.2mA$

$I_C = 0.1mA$

$h_{FE}$

$T_J = 25^\circ C$

$V_{CE} = 1V$

typ

February 1969
BFS17

$V_{CE} = 5V$

$f = 500MHz$

$T_j = 25^\circ C$

\[ f_T (GHz) \]

\[ I_C (mA) \]

\[ V_{BE} (mV) \]

\[ C_c (pF) \]

\[ V_{CB} (V) \]

February 1969
N-P-N transistors in a microminiature plastic envelope. They are intended for general purpose and h.f. applications in thick and thin-film circuits.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collector-base voltage (open emitter)</td>
<td>$V_{CBO}$ max. 30 V</td>
</tr>
<tr>
<td>Collector-emitter voltage (open base)</td>
<td>$V_{CEO}$ max. 20 V</td>
</tr>
<tr>
<td>Collector current (d.c.)</td>
<td>$I_C$ max. 30 mA</td>
</tr>
<tr>
<td>Total power dissipation up to $T_{amb} = 25 , ^{\circ}C$</td>
<td>$P_{tot}$ max. 200 mW</td>
</tr>
<tr>
<td>Junction temperature</td>
<td>$T_j$ max. 150 °C</td>
</tr>
<tr>
<td>D.C. current gain</td>
<td>$h_{FE}$ BFS18</td>
</tr>
<tr>
<td></td>
<td>BFS19</td>
</tr>
<tr>
<td>Transition frequency at $f = 100 , MHz$</td>
<td>$f_T$ typ. 200 MHz</td>
</tr>
<tr>
<td>Noise figure at $f = 100 , MHz$</td>
<td>$F$ typ. 4 dB</td>
</tr>
</tbody>
</table>

MECHANICAL DATA.

Fig. 1 SOT-23.

See also Soldering recommendations.
RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltages
- Collector-base voltage (open emitter) \( V_{CBO} \) max. 30 V
- Collector-emitter voltage (open base) \( V_{CEO} \) max. 20 V
- Emitter-base voltage (open collector) \( V_{EBO} \) max. 5 V

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

Power dissipation
- Total power dissipation up to \( T_{amb} = 25 \, ^\circ C \) 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 \, ^\circ C
- Junction temperature \( T_j \) max. 150 \, ^\circ 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 \, ^\circ C/mW

CHARACTERISTICS
- Collector cut-off current
  - \( I_E = 0; \, V_{CB} = 20 \, V \) \( I_{CBO} \) < 100 nA
  - \( I_E = 0; \, V_{CB} = 20 \, V; \, T_j = 100 \, ^\circ C \) \( I_{CBO} \) < 10 \, \mu A

- Base-emitter voltage
  - \( I_C = 1 \, mA; \, V_{CE} = 10 \, V \) \( V_{BE} \) 0.65 to 0.74 V

\( T_j = 25 \, ^\circ C \) unless otherwise specified

December 1972
CHARACTERISTICS (continued)

T<sub>j</sub> = 25 °C unless otherwise specified

<table>
<thead>
<tr>
<th></th>
<th>BFS18</th>
<th>BFS19</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>D.C. current gain</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I&lt;sub&gt;C&lt;/sub&gt; = 1 mA; V&lt;sub&gt;CE&lt;/sub&gt; = 10 V</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>h&lt;sub&gt;FE&lt;/sub&gt;</strong></td>
<td>35 to 125</td>
<td>65 to 225</td>
</tr>
<tr>
<td><strong>Transition frequency at f = 100 MHz</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I&lt;sub&gt;C&lt;/sub&gt; = 1 mA; V&lt;sub&gt;CE&lt;/sub&gt; = 10 V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>f&lt;sub&gt;T&lt;/sub&gt; typ.</td>
<td>200 MHz</td>
<td>260 MHz</td>
</tr>
<tr>
<td><strong>Collector capacitance at f = 1 MHz</strong></td>
<td></td>
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</tr>
<tr>
<td>I&lt;sub&gt;E&lt;/sub&gt; = I&lt;sub&gt;e&lt;/sub&gt; = 0; V&lt;sub&gt;CB&lt;/sub&gt; = 10 V</td>
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<td></td>
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<tr>
<td>C&lt;sub&gt;C&lt;/sub&gt; typ.</td>
<td>1 pF</td>
<td></td>
</tr>
<tr>
<td><strong>Feedback capacitance at f = 1 MHz</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I&lt;sub&gt;C&lt;/sub&gt; = 1 mA; V&lt;sub&gt;CE&lt;/sub&gt; = 10 V</td>
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<td></td>
</tr>
<tr>
<td>C&lt;sub&gt;re&lt;/sub&gt; typ.</td>
<td>0.85 pF</td>
<td></td>
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<tr>
<td><strong>Noise figure</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I&lt;sub&gt;C&lt;/sub&gt; = 1 mA; V&lt;sub&gt;CE&lt;/sub&gt; = 10 V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>G&lt;sub&gt;S&lt;/sub&gt; = 10 mΩ&lt;sup&gt;-1&lt;/sup&gt;; f = 100 MHz</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F typ.</td>
<td>4 dB</td>
<td>1)</td>
</tr>
</tbody>
</table>

1) Crystal mounted in a BF115 envelope.
Typical behaviour of collector current versus collector-emitter voltage

- **IC** versus **VCE** for **Tj = 25°C**
  - **7Z10176**
  - **7Z10175**

- **typical values**
  - **VCE = 10V**
  - **Tj = 25°C**

**BFS18**
**BFS19**

February 1969
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

<table>
<thead>
<tr>
<th>Parameter</th>
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<tbody>
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<td>Collector-base voltage (open emitter)</td>
<td>V_CBO max. 30 V</td>
</tr>
<tr>
<td>Collector-emitter voltage (open base)</td>
<td>V_CE0 max. 20 V</td>
</tr>
<tr>
<td>Collector current (d.c.)</td>
<td>I_C max. 25 mA</td>
</tr>
<tr>
<td>Total power dissipation up to T_amb = 25 °C</td>
<td>P_tot max. 200 mW</td>
</tr>
<tr>
<td>Junction temperature</td>
<td>T_j max. 150 °C</td>
</tr>
<tr>
<td>D.C. current gain</td>
<td>h_FE &gt; 40</td>
</tr>
<tr>
<td>Transition frequency at f = 100 MHz</td>
<td>f_T typ. 450 MHz</td>
</tr>
<tr>
<td>Feedback capacitance at f = 1 MHz</td>
<td>C_re typ. 350 fF</td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Fig. 1 SOT-23.

Dimensions in mm

Marking code

BFS20 = G1

BFS20R = G4

See also Soldering recommendations.
RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltages
Collector-base voltage (open emitter) \( V_{CBO} \) max. 30 V
Collector-emitter voltage (open base) \( V_{CEO} \) max. 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 \( T_{amb} = 25 \, ^\circ\text{C} \)
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 \( ^\circ\text{C} \)
Junction temperature \( T_j \) max. 150 \( ^\circ\text{C} \)

THERMAL RESISTANCE
From junction to ambient mounted on a ceramic substrate of 7 mm x 5 mm x 0.5 mm
\( R_{th \, j-a} = 0.62 \, ^\circ\text{C}/\text{mW} \)
CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current

I_E = 0; V_CB = 20 V
I_E = 0; V_CB = 20 V; T_j = 100 °C

I_{CBO} < 100 nA
I_{CBO} < 10 µA

Base-emitter voltage

I_C = 7 mA; V_CE = 10 V

V_{BE} < 900 mV

D.C. current gain

I_C = 7 mA; V_CE = 10 V

h_{FE} > 40
h_{FE} typ. 85

Transition frequency at f = 100 MHz

I_C = 5 mA; V_CE = 10 V

f_T > 275 MHz
f_T typ. 450 MHz

Collector capacitance at f = 1 MHz

I_E = I_C = 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
SILICON PLANAR EPITAXIAL TRANSISTOR

N-P-N transistor in a microminiature 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 (100 μA – 1 mA); thanks to its high transition frequency, it also has excellent wideband properties and low noise up to high frequencies.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
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<tbody>
<tr>
<td>Collector-base voltage (open emitter)</td>
<td>V_CBO max. 8 V</td>
</tr>
<tr>
<td>Collector-emitter voltage (open base)</td>
<td>V_CEO max. 5 V</td>
</tr>
<tr>
<td>Collector current (d.c.)</td>
<td>I_C max. 2.5 mA</td>
</tr>
<tr>
<td>Total power dissipation up to T_amb = 135 °C</td>
<td>P_tot max. 30 mW</td>
</tr>
<tr>
<td>Junction temperature</td>
<td>T_J max. 150 °C</td>
</tr>
<tr>
<td>Transition frequency at f = 500 MHz</td>
<td>f_T typ. 2,3 GHz</td>
</tr>
<tr>
<td>Feedback capacitance at f = 1 MHz</td>
<td>C_re &lt; 0,45 pF</td>
</tr>
<tr>
<td>Noise figure at optimum source impedance</td>
<td>F typ. 3,8 dB</td>
</tr>
<tr>
<td>Max. unilateral power gain (see page 3)</td>
<td>G_UUM typ. 18 dB</td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Fig. 1 SOT-23.

See also Soldering recommendations.
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; \( f > 1 \text{ MHz} \)) \( I_{CM} \) max. 5,0 mA

**Power dissipation**
- Total power dissipation up to \( T_{amb} = 135 \text{ °C} \) 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 \( R_{th j-a} = 0,5 \text{ °C/mW} \)
CHARACTERISTICS

Collector cut-off current
\[ I_E = 0; \ V_{CB} = 5 \ V \]

D.C. current gain \(^1\)
\[ I_C = 10 \, \mu A; \ V_{CE} = 1 \ V \]
\[ I_C = 1 \, mA; \ V_{CE} = 1 \ V \]

Saturation voltages
\[ I_C = 10 \, \mu A; \ I_B = 1 \, \mu A \]
\[ I_C = 1 \, mA; \ I_B = 0,1 \, mA \]

Transition frequency at \( f = 500 \, MHz \) \(^1\)
\[ I_C = 1 \, mA; \ V_{CE} = 1 \ V \]

Collector capacitance at \( f = 1 \, MHz \)
\[ I_E = I_e = 0; \ V_{CB} = 0,5 \ V \]

Emitter capacitance at \( f = 1 \, MHz \)
\[ I_C = I_c = 0; \ V_{EB} = 0 \]

Feedback capacitance at \( f = 1 \, MHz \)
\[ I_C = 1 \, mA; \ V_{CE} = 1 \ V; \ T_{amb} = 25 \, ^\circ C \]

Noise figure at optimum source impedance
\[ I_C = 0,1 \, mA; \ V_{CE} = 1 \ V; \ f = 500 \, MHz; \ T_{amb} = 25 \, ^\circ C \]
\[ I_C = 1 \, mA; \ V_{CE} = 1 \ V; \ f = 500 \, MHz; \ T_{amb} = 25 \, ^\circ C \]

Max. unilateral power gain (\( s_{re} \) assumed to be zero)
\[ G_{UM} \ (\text{in dB}) = 10 \log \frac{|s_{fe}|^2}{(1 - |s_{ie}|^2)(1 - |s_{oe}|^2)} \]
\[ I_C = 1 \, mA; \ V_{CE} = 1 \ V; \ f = 200 \, MHz; \ T_{amb} = 25 \, ^\circ C \]
\[ I_C = 1 \, mA; \ V_{CE} = 1 \ V; \ f = 500 \, MHz; \ T_{amb} = 25 \, ^\circ C \]
\[ I_C = 1 \, mA; \ V_{CE} = 1 \ V; \ f = 800 \, MHz; \ T_{amb} = 25 \, ^\circ C \]

\(^1\) Measured under pulse conditions.
$C_c$ (pF)

$T_J = 25 \, ^\circ\text{C}$
$\beta = I_e / I_f$
$f = 1 \, \text{MHz}$

$V_{CE} = 1 \, \text{V}$
$f = 500 \, \text{MHz}$
$Z_S = \text{optimum}$
$T_{amb} = 25 \, ^\circ\text{C}$
$V_{CE} = 1 \, V$
$I_C = 1 \, mA$
$T_{amb} = 25 \, ^{\circ}C$

Input impedance derived from input reflection coefficient $s_{ie}$ coordinates in ohm x 50

$V_{CE} = 1 \, V$
$I_C = 1 \, mA$
$T_{amb} = 25 \, ^{\circ}C$

Reverse transmission coefficient $s_{re}$
$V_{CE} = 1 \, V$
$I_C = 1 \, mA$
$T_{amb} = 25 \, ^\circ C$

Output impedance derived from output reflection coefficient $s_{oe}$
coordinates in ohm x 50

$V_{CE} = 1 \, V$
$I_C = 1 \, mA$
$T_{amb} = 25 \, ^\circ C$

Forward transmission coefficient $s_{fe}$
N-CHANNEL SILICON FET

N-channel silicon epitaxial planar junction field-effect transistor in a microminiature plastic envelope. The transistor is intended for low level general purpose amplifiers in thick and thin-film circuits.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
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</thead>
<tbody>
<tr>
<td>Drain-source voltage</td>
<td>±V_{DS} max. 25 V</td>
</tr>
<tr>
<td>Gate-source voltage (open drain)</td>
<td>−V_{GSO} max. 25 V</td>
</tr>
<tr>
<td>Total power dissipation up to T_{amb} = 25 °C</td>
<td>P_{tot} max. 200 mW</td>
</tr>
<tr>
<td>Drain current V_{DS} = 10 V; V_{GS} = 0</td>
<td>I_{DSS} &gt; 0.2 mA</td>
</tr>
<tr>
<td>Transfer admittance (common source) I_{D} = 0.2 mA; V_{DS} = 10 V; f = 1 kHz</td>
<td></td>
</tr>
<tr>
<td>Equivalent noise voltage V_{DS} = 10 V; I_{D} = 200 μA; B = 0.6 to 100 Hz</td>
<td>V_{n} &lt; 0.5 μV</td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Fig. 1 SOT-23.

dimensions in mm

Marking code

BFT46 = M3

See also Soldering recommendations.
### RATINGS

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

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Min.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drain-source voltage</td>
<td>±V_DS</td>
<td></td>
<td>25 V</td>
</tr>
<tr>
<td>Drain-gate voltage (open source)</td>
<td>V_DGO</td>
<td></td>
<td>25 V</td>
</tr>
<tr>
<td>Gate-source voltage (open drain)</td>
<td>-V_GSO</td>
<td></td>
<td>25 V</td>
</tr>
<tr>
<td>Drain current</td>
<td>I_D</td>
<td></td>
<td>10 mA</td>
</tr>
<tr>
<td>Gate current</td>
<td>I_G</td>
<td></td>
<td>5 mA</td>
</tr>
<tr>
<td>Total power dissipation up to T_amb = 25 °C *</td>
<td>P_tot</td>
<td></td>
<td>200 mW</td>
</tr>
<tr>
<td>Storage temperature</td>
<td>T_stg</td>
<td></td>
<td>-65 to +150 °C</td>
</tr>
<tr>
<td>Junction temperature</td>
<td>T_j</td>
<td></td>
<td>150 °C</td>
</tr>
</tbody>
</table>

### THERMAL RESISTANCE

from junction to ambient *

\[ R_{thj-a} = 0.62 \, °C/mW \]

### CHARACTERISTICS

T_j = 25 °C unless otherwise specified

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Min.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gate cut-off current</td>
<td>-I_GS</td>
<td>&lt;</td>
<td>0.2 nA</td>
</tr>
<tr>
<td>Drain current **</td>
<td>I_DSS</td>
<td>&gt;</td>
<td>0.2 mA</td>
</tr>
<tr>
<td>Gate-source voltage</td>
<td>-V_GS</td>
<td>&gt;</td>
<td>0.1 V</td>
</tr>
<tr>
<td>Gate-source cut-off voltage</td>
<td>-V_(P)GS</td>
<td>&lt;</td>
<td>1.2 V</td>
</tr>
<tr>
<td>Y parameters at f = 1 kHz;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( V_{DS} = 10 , V; , V_{GS} = 0; , T_{amb} = 25 °C )</td>
<td>|Y_fsl|</td>
<td>&gt;</td>
<td>1.0 mA/V</td>
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<tr>
<td>Transfer admittance</td>
<td>|Y_osl|</td>
<td>&lt;</td>
<td>10 μA/V</td>
</tr>
<tr>
<td>Output admittance</td>
<td>|Y_fsl|</td>
<td>&gt;</td>
<td>0.5 mA/V</td>
</tr>
<tr>
<td>Transfer admittance</td>
<td>|Y_osl|</td>
<td>&lt;</td>
<td>5 μA/V</td>
</tr>
<tr>
<td>Input capacitance at f = 1 MHz;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( V_{DS} = 10 , V; , V_{GS} = 0; , T_{amb} = 25 °C )</td>
<td>C_is</td>
<td>&lt;</td>
<td>5 pF</td>
</tr>
<tr>
<td>Feedback capacitance at f = 1 MHz;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( V_{DS} = 10 , V; , V_{GS} = 0; , T_{amb} = 25 °C )</td>
<td>C_rs</td>
<td>&lt;</td>
<td>1.5 pF</td>
</tr>
<tr>
<td>Equivalent noise voltage</td>
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<td></td>
</tr>
<tr>
<td>( V_{DS} = 10 , V; , I_D = 200 , μA; , T_{amb} = 25 °C )</td>
<td>V_n</td>
<td>&lt;</td>
<td>0.5 μV</td>
</tr>
</tbody>
</table>

* Mounted on a ceramic substrate of 7 mm x 5 mm x 0.5 mm.

** Measured under pulse conditions.
Fig. 2 Typical values. $V_{DS} = 10$ V; $T_j = 25$ °C.

Fig. 3 Typical values. $V_{DS} = 10$ V.

Fig. 4 Correlation between $-V_{(P)GS}$ and $I_{DSS}$. $V_{DS} = 10$ V; $T_j = 25$ °C.
Fig. 5 \( \left| Y_{fs} \right| \) versus \( I_D \).
\( V_{DS} = 10 \) V; \( f = 1 \) kHz; \( T_{amb} = 25 \) °C.

Fig. 6 \( \left| Y_{os} \right| \) versus \( I_D \).
\( V_{DS} = 10 \) V; \( f = 1 \) kHz; \( T_{amb} = 25 \) °C.

Fig. 7 \( \left| Y_{os} \right| \) versus \( V_{DS} \).
\( I_D = 0.4 \) mA; \( f = 1 \) kHz; \( T_{amb} = 25 \) °C.
Fig. 8 Typical values.
$V_{DS} = 10 \, V, \, T_{amb} = 25 \, ^{\circ}C$.

Fig. 9 Typical values.
$V_{DS} = 10 \, V, \, T_{amb} = 25 \, ^{\circ}C$.

Fig. 10 $I_{GSS}$ versus $T_j$.
$-V_{GSS} = 10 \, V; \, V_{DS} = 0$. 

N-channel silicon FET

$C_{is}$ (pF)

$C_{rs}$ (pF)

$V_{GS} (V)$

$T_j (^{\circ}C)$
Fig. 11 $V_{DS} = 10\ V; I_D = 0,2\ mA; T_{amb} = 25\ ^\circ C.$

Fig. 12 $V_{DS} = 10\ V; I_D = 0,2\ mA; T_{amb} = 25\ ^\circ C.$
SILICON PLANAR EPITAXIAL TRANSISTOR

P-N-P 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.

This type is complementary to BFR92.

QUICK REFERENCE DATA

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</tr>
<tr>
<td>Collector-emitter voltage (open base)</td>
<td>-V_{CEO} max. 15 V</td>
</tr>
<tr>
<td>Collector current (d.c.)</td>
<td>-I_C max. 25 mA</td>
</tr>
<tr>
<td>Total power dissipation up to T_{amb} = 60°C</td>
<td>P_{tot} max. 180 mW</td>
</tr>
<tr>
<td>Junction temperature</td>
<td>T_j max. 150 °C</td>
</tr>
<tr>
<td>Transition frequency at f = 500 MHz</td>
<td>f_T typ. 5 GHz</td>
</tr>
<tr>
<td>Feedback capacitance at f = 1 MHz</td>
<td>C_{re} typ. 0,7 pF</td>
</tr>
<tr>
<td>Noise figure at optimum source impedance</td>
<td>F typ. 2,7 dB</td>
</tr>
<tr>
<td>Max. unilateral power gain (see page 3)</td>
<td>G_{UM} typ. 18 dB</td>
</tr>
<tr>
<td>Intermodulation distortion at T_{amb} = 25 °C</td>
<td>d_{im} typ. -60 dB</td>
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MECHANICAL DATA

Fig. 1 SOT-23.

Dimensions in mm

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Value</th>
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<tbody>
<tr>
<td>1</td>
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</tr>
<tr>
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<td>1,9</td>
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<td>5</td>
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</tr>
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<td>0,01</td>
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Marking code

BFT92 = W1

BFT92R = W4

March 1978
RATINGS

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

Collector-base voltage (open emitter) $-V_{CBO}$ max. 20 V
Collector-emitter voltage (open base) $-V_{CEO}$ max. 15 V
Emitter-base voltage (open collector) $-V_{EBO}$ max. 2,0 V
Collector current (d.c.) $-I_{C}$ max. 25 mA
Collector current (peak value; $f > 1$ MHz) $-I_{CM}$ max. 35 mA
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
Storage temperature $T_{stg}$ from -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 $R_{th j-a}$ = 0,5 °C/mW

CHARACTERISTICS

$T_{j} = 25$ °C unless otherwise specified

Collector cut-off current $I_{E} = 0; -V_{CB} = 10$ V $-I_{CBO}$ < 50 nA
D.C. current gain * $-I_{C} = 14$ mA; $-V_{CE} = 10$ V $h_{FE}$ > 20 typ. 50
Transition frequency at $f = 500$ MHz * $-I_{C} = 14$ 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

* Measured under pulse conditions.
CHARACTERISTICS (continued)

\( T_{\text{amb}} = 25 \, ^{\circ}\text{C} \)

Feedback capacitance at \( f = 1 \, \text{MHz} \)
\(-I_C = 2 \, \text{mA}; -V_{\text{CE}} = 10 \, \text{V} \)

Noise figure at optimum source impedance *
\(-I_C = 2 \, \text{mA}; -V_{\text{CE}} = 10 \, \text{V}; f = 500 \, \text{MHz} \)

Max. unilateral power gain (\( s_{re} \) assumed to be zero)

\[
G_{\text{UM}}(\text{in d}B) = 10 \log \frac{|s_{fe}|^2}{(1 - |s_{id}|^2)(1 - |s_{oe}|^2)}
\]

\(-I_C = 14 \, \text{mA}; -V_{\text{CE}} = 10 \, \text{V}; f = 500 \, \text{MHz} \)

Intermodulation distortion *
\(-I_C = 14 \, \text{mA}; -V_{\text{CE}} = 10 \, \text{V}; R_L = 75 \, \Omega; \text{VSWR} < 2 \)
\( V_p = V_o = 150 \, \text{mV} \) at \( f_p = 495,25 \, \text{MHz} \)
\( V_q = V_o -6 \, \text{dB} \) at \( f_q = 503,25 \, \text{MHz} \)
\( V_r = V_o -6 \, \text{dB} \) at \( f_r = 505,25 \, \text{MHz} \)

Measured at \( f(p + q - r) = 493,25 \, \text{MHz} \)

\( C_{re} \) typ. 0,7 \, \text{pF}

\( F \) typ. 2,7 \, \text{dB}

\( G_{\text{UM}} \) typ. 18 \, \text{dB}

\( d_{\text{im}} \) typ. -60 \, \text{dB}

---

![Diagram](image_url)

**Fig. 2** Intermodulation test circuit.

\( L_1 = 4 \text{ turns Cu wire (0,35 mm); winding pitch 1 mm; int. dia. 4 mm.} \)
\( L_2 = L_3 = 5 \, \mu\text{H} \) (catalogue number: 3122 108 20150).

* Crystal mounted in SOT-37 envelope.
Fig. 3 $V_{CE} = 10$ V; $T_J = 25$ °C.

Fig. 4 $I_E = I_C = 0$; $T_J = 25$ °C; $f = 1$ MHz.

Fig. 5 $V_{CE} = 10$ V; $f = 500$ MHz; $T_J = 25$ °C.
Fig. 6.  
- $V_{CE} = 10$ V  
- $I_C = 2$ mA  
- $Z_S =$ opt.  
- $T_{amb} = 25$ °C

Fig. 7.  
- $V_{CE} = 10$ V  
- $f = 500$ MHz  
- $Z_S =$ opt.  
- $T_{amb} = 25$ °C
SILICON PLANAR EPITAXIAL TRANSISTOR

P-N-P 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.

This type is complementary to BFR93.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collector-base voltage (open emitter)</td>
<td>-VCBO max. 15 V</td>
</tr>
<tr>
<td>Collector-emitter voltage (open base)</td>
<td>-VCEO max. 12 V</td>
</tr>
<tr>
<td>Collector current (d.c.)</td>
<td>-IC max. 35 mA</td>
</tr>
<tr>
<td>Total power dissipation up to T_{amb} = 60 °C</td>
<td>P_{tot} max. 180 mW</td>
</tr>
<tr>
<td>Junction temperature</td>
<td>T_j max. 150 °C</td>
</tr>
<tr>
<td>Transition frequency at f = 500 MHz</td>
<td>f_T typ. 5 GHz</td>
</tr>
<tr>
<td>Feedback capacitance at f = 1 MHz</td>
<td>C_re typ. 1,0 pF</td>
</tr>
<tr>
<td>Noise figure at optimum source impedance</td>
<td>F typ. 2,4 dB</td>
</tr>
<tr>
<td>Max. unilateral power gain (see page 3)</td>
<td>G_{UM} typ. 16,5 dB</td>
</tr>
<tr>
<td>Intermodulation distortion at T_{amb} = 25 °C</td>
<td>d_{im} typ. -60 dB</td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Fig. 1 SOT-23.

Dimensions in mm

Marking code

BFT93 = X1

BFT93R = X4

March 1978
RATINGS

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

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
Collector current (d.c.) \(-I_C\) max. 35 mA
Collector current (peak value; \(f > 1\) MHz) \(-I_{CM}\) max. 50 mA
Total power dissipation up to \(T_{amb} = 60^\circ\)C
mounted on a ceramic substrate of 15 mm x 10 mm x 0,5 mm
\(P_{tot}\) max. 180 mW
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_{thj-a} = 0,5 \ \^\circ\)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 *
\(-I_C = 30\) mA; \(-V_{CE} = 5\) V
\(h_{FE} > 20\)

Transition frequency at \(f = 500\) MHz *
\(-I_C = 30\) 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. 0,95 pF

Emitter capacitance at \(f = 1\) MHz
\(I_C = I_C = 0; -V_{EB} = 0,5\) V
\(C_e\) typ. 1,8 pF

* Measured under pulse conditions.
CHARACTERISTICS (continued)

\[ T_{\text{amb}} = 25 \, ^\circ\text{C} \]

Feedback capacitance at \( f = 1 \, \text{MHz} \)
\(-I_C = 2 \, \text{mA}; -V_{CE} = 5 \, \text{V} \)

Noise figure at optimum source impedance *
\(-I_C = 2 \, \text{mA}; -V_{CE} = 5 \, \text{V}; f = 500 \, \text{MHz} \)

Max. unilateral power gain (\( s_{re} \) assumed to be zero)
\[ G_{UM}(\text{in dB}) = 10 \log \frac{|s_{fe}|^2}{(1 - |s_{ie}|^2)(1 - |s_{oe}|^2)} \]
\(-I_C = 30 \, \text{mA}; -V_{CE} = 5 \, \text{V}; f = 500 \, \text{MHz} \)

Intermodulation distortion *
\(-I_C = 30 \, \text{mA}; -V_{CE} = 5 \, \text{V}; R_L = 75 \, \Omega; \ VSWR < 2 \)
\[ V_p = V_o = 300 \, \text{mV} \text{ at } f_p = 495.25 \, \text{MHz} \]
\[ V_q = V_o - 6 \, \text{dB} \text{ at } f_q = 503.25 \, \text{MHz} \]
\[ V_r = V_o - 6 \, \text{dB} \text{ at } f_r = 505.25 \, \text{MHz} \]
Measured at \( f_{p + q - r} = 493.25 \, \text{MHz} \)

\[ d_{im} \text{ typ. } -60 \, \text{dB} \]

\[ C_{re} \text{ typ. } 1.0 \, \text{pF} \]
\[ F \text{ typ. } 2.4 \, \text{dB} \]

Fig. 2 Intermodulation test circuit.

L1 = 4 turns Cu wire (0.35); winding pitch 1 mm; int. dia. 4 mm.
L2 and L3 = 5 \, \mu\text{H} (catalogue number: 3122 108 20150).

* Crystal mounted in SOT-37 envelope.
Fig. 3 $V_{CE} = 5 \text{ V}; T_j = 25 \degree \text{C}$.

Fig. 4 $I_E = I_e = 0; T_j = 25 \degree \text{C}; f = 1 \text{ MHz}$.

Fig. 5 $V_{CE} = 5 \text{ V}; T_j = 25 \degree \text{C}; f = 500 \text{ MHz}$.
Siemens planar epitaxial transistor

Fig. 6. $V_{CE} = 5 \text{ V}$

$-I_C = 2 \text{ mA}$

$Z_S = \text{opt.}$

$T_{amb} = 25 \degree \text{C}$

Fig. 7.

$V_{CE} = 5 \text{ V}$

$-I_C = 2 \text{ mA}$

$Z_S = \text{opt.}$

$T_{amb} = 25 \degree \text{C}$
PROGRAMMABLE UNIJUNCTION TRANSISTOR

Planar p-n-p-n trigger device in a microminiature plastic envelope intended for applications in thick and thin-film circuits. It is intended for use in switching applications such as motor control, oscillators, relay replacement, timers, pulse shaper, trigger device etc.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Unit</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gate-anode voltage</td>
<td>( V_{GA} )</td>
<td>max.</td>
<td>70 V</td>
</tr>
<tr>
<td>Anode current (d.c.) up to ( T_{case} = 85 , ^\circ C )</td>
<td>( I_A )</td>
<td>max.</td>
<td>250 mA</td>
</tr>
<tr>
<td>Junction temperature</td>
<td>( T_j )</td>
<td>max.</td>
<td>150 °C</td>
</tr>
<tr>
<td>Peak point current</td>
<td>( V_S = 10 , V; , R_G = 10 , k\Omega )</td>
<td>( I_P )</td>
<td>&lt; 5 ( \mu )A</td>
</tr>
<tr>
<td>Valley point current</td>
<td>( V_S = 10 , V; , R_G = 10 , k\Omega )</td>
<td>( I_V )</td>
<td>&gt; 30 ( \mu )A</td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Dimensions in mm

Marking code

Fig. 1 SOT-23.

See also Soldering Recommendations.
RATINGS

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

Gate-anode voltage
V_{GA} max. 70 V

Anode current (d.c.) up to T_{amb} = 25 °C
I_{A} max. 175 mA

Anode current (d.c.) up to T_{case} = 85 °C
I_{A} max. 250 mA

Repetitive peak anode current
I_{ARM} max. 2.5 A

t = 10 \mu s; \delta = 0.01

Non-repetitive peak anode current
I_{ASM} max. 3 A

t = 10 \mu s; T_{j} = 150 °C

Rate of rise of anode current
\frac{dI_{A}}{dt} max. 20 A/\mu s

up to I_{A} = 2.5 A

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_{thj-a} = 0.50 °C/mW

CHARACTERISTICS

T_{amb} = 25 °C unless otherwise specified

Peak point current
V_{S} = 10 V; R_{G} = 10 k\Omega
I_{p} < 5 \mu A

V_{S} = 10 V; R_{G} = 1 M\Omega
I_{p} < 1 \mu A

Valley point current (see also Figs 3 and 4)
V_{S} = 10 V; R_{G} = 10 k\Omega
I_{V} > 30 \mu A

V_{S} = 10 V; R_{G} = 1 M\Omega
I_{V} < 50 \mu A

Offset voltage
I_{A} = 0

V_{offset} = V_{p} - V_{S} V

Fig. 2 See also Fig. 12.
Programmable unijunction transistor

Fig. 3 Practical test circuit.

Notes
Remove BCY71 during measurement of $I_p$.
Value of $R_1$ depends on the voltage range of voltmeter.

(a) BRY61 with "program" resistors $R_1$ and $R_2$.

(b) Equivalent test circuit for characteristics testing.

Gate-anode leakage current
$I_K = 0; V_{GA} = 70 \, V$

Fig. 4 Equivalent test circuit.

$I_{GAO} < 10 \, nA$

Fig. 5.
Gate-cathode leakage current
\( V_{AK} = 0 \); \( V_{GK} = 70 \) V

\[ I_{GKS} < 100 \text{ nA} \]

Anode voltage at \( I_A = 100 \) mA
Peak output voltage
\( V_{AA} = 20 \) V; \( C = 200 \) nF (see Fig. 13)
Rise time
\( V_{AA} = 20 \) V; \( C = 10 \) nF (see Fig. 13)

\[ V_A < 1.4 \text{ V} \]
\[ V_{OM} > 6 \text{ V} \]
\[ t_r < 80 \text{ ns} \]
Programmable unijunction transistor

Fig. 8.

Typical values
$T_{amb}=25^\circ C$

$I_P$ ($\mu A$)

$R_G=1k\Omega$

10k$\Omega$

100k$\Omega$

1M$\Omega$

$V_S$ (V) 0 10 20 30

Fig. 9.

Typical values
$V_S=10V$

$I_P$ ($\mu A$)

$R_G=1k\Omega$

10k$\Omega$

100k$\Omega$

1M$\Omega$

$T_{amb}(^\circ C)$ -50 0 50

Fig. 10.

Typical values
$T_{amb}=25^\circ C$

$I_V$ ($\mu A$)

$R_G=1k\Omega$

10k$\Omega$

100k$\Omega$

1M$\Omega$

$V_S=10V$

$V_S$ (V) 0 10 20 30

Fig. 11.

Typical values
$V_S=10V$

$I_V$ ($\mu A$)

$R_G=1k\Omega$

10k$\Omega$

100k$\Omega$

1M$\Omega$

$T_{amb}(^\circ C)$ -50 0 50
Fig. 12.

Fig. 13.
SILICON LOW-POWER SWITCHING TRANSISTOR

P-N-P silicon transistor in a microminiature plastic envelope. It is intended for high-speed, saturated switching applications for industrial service in thick and thin-film circuits.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
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<tr>
<td>Collector-base voltage (open emitter)</td>
<td>$-V_{CBO}$ max. 15 V</td>
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<tr>
<td>Collector-emitter voltage (open base)</td>
<td>$-V_{CEO}$ max. 15 V</td>
</tr>
<tr>
<td>Collector current (peak value)</td>
<td>$-I_{CM}$ max. 200 mA</td>
</tr>
<tr>
<td>Total power dissipation up to $T_{amb} = 25^\circ C$</td>
<td>$P_{tot}$ max. 200 mW</td>
</tr>
<tr>
<td>Junction temperature D.C. current gain</td>
<td>$h_{FE}$ &gt; 30</td>
</tr>
<tr>
<td>Transition frequency at $f = 500$ MHz</td>
<td>$f_T$ &gt; 1.5 GHz</td>
</tr>
<tr>
<td>Turn-off time</td>
<td>$t_{off}$ &lt; 30 ns</td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Marking code

BSR12 = B5

BSR12R = B8

Fig. 1 SOT-23.

See also Soldering recommendations.

March 1978
### RATINGS

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

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
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<td>Collector-base voltage (open emitter)</td>
<td>$-V_{CBO}$ max. 15 V</td>
</tr>
<tr>
<td>Collector-emitter voltage (open base)</td>
<td>$-V_{CEO}$ max. 15 V</td>
</tr>
<tr>
<td>Emitter-base voltage (open collector)</td>
<td>$-V_{EBO}$ max. 3 V</td>
</tr>
<tr>
<td>Collector current (d.c.)</td>
<td>$-I_C$ max. 100 mA</td>
</tr>
<tr>
<td>Collector current (peak value)</td>
<td>$-I_{CM}$ max. 200 mA</td>
</tr>
<tr>
<td>Total power dissipation up to $T_{amb} = 25 ^\circ C$ mounted on a ceramic substrate of 7 mm x 5 mm x 0.5 mm</td>
<td>$P_{tot}$ max. 200 mW</td>
</tr>
<tr>
<td>Storage temperature</td>
<td>$T_{stg}$ -65 to +150 $^\circ C$</td>
</tr>
<tr>
<td>Junction temperature</td>
<td>$T_j$ max. 150 $^\circ C$</td>
</tr>
</tbody>
</table>

### THERMAL RESISTANCE

- From junction to ambient mounted on a ceramic substrate of 7 mm x 5 mm x 0.5 mm

$$R_{thj-a} = 0.62 \degree C/mW$$

### CHARACTERISTICS

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

- **Collector cut-off current**
  - $I_E = 0; -V_{CB} = 10 V$
  - $I_E = 0; -V_{CB} = 10 V; T_{amb} = 125 ^\circ C$
  - $V_{BE} = 0; -V_{CE} = 10 V$

- **Breakdown voltages**
  - $I_E = 0; -I_C = 10 \mu A$
  - $V_{BE} = 0; -I_C = 10 \mu A$
  - $I_C = 0; -I_E = 100 \mu A$

- **Collector-emitter sustaining voltage**
  - $I_B = 0; -I_C = 10 mA$

- **Saturation voltages**
  - $I_C = 10 mA; -I_B = 1 mA$
  - $I_C = 50 mA; -I_B = 5 mA$
  - $I_C = 100 mA; -I_B = 10 mA$

- **$V_{CE}$**
  - $V_{BE} = 0; -V_{CE} = 15 V$
  - $V_{BE} = 0; -V_{CE} = 15 V$

- **$V_{BE}$**
  - $I_C = 100 \mu A; -I_E = 150 \mu A$

- **$R_{thj-a}$**
  - $0.62 \degree C/mW$

* Measured under pulse conditions; $t_p = 300 \mu s; \delta = 0.01.$
Silicon low-power switching transistor

D.C. current gain *
-\( I_C = 1 \text{ mA}; -V_{CE} = 1 \text{ V} \)
-\( I_C = 10 \text{ mA}; -V_{CE} = 1 \text{ V} \)
-\( I_C = 50 \text{ mA}; -V_{CE} = 1 \text{ V} \)
-\( I_C = 50 \text{ mA}; -V_{CE} = 1 \text{ V}; T_{amb} = 55 \text{ °C} \)
-\( I_C = 100 \text{ mA}; -V_{CE} = 1 \text{ V} \)
\( h_{FE} > 30 \)
\( h_{FE} > 30 \)
\( h_{FE} = 30 \text{ to } 120 \)
\( h_{FE} > 30 \)
\( h_{FE} > 20 \)

Transition frequency at \( f = 500 \text{ MHz} \)
-\( I_C = 50 \text{ mA}; -V_{CE} = 10 \text{ V} \)
\( f_T > 1,5 \text{ GHz} \)

Collector capacitance
-\( I_E = I_e = 0; -V_{CB} = 5 \text{ V} \)
\( C_C < 4,5 \text{ pF} \)

Emitter capacitance
-\( I_C = I_c = 0; -V_{EB} = 0,5 \text{ V} \)
\( C_e < 6,0 \text{ pF} \)

Switching times
Turn-on time \( t_{on} < 20 \text{ ns} \)
Turn-off time \( t_{off} < 30 \text{ ns} \)

Fig. 2 Test circuit switching times.

Pulse generator
Pulse duration \( t_p = 400 \text{ ns} \)
Rise time \( t_r < 1 \text{ ns} \)
Output impedance \( Z_o = 50 \Omega \)

Sampling scope
Rise time \( t_r < 1 \text{ ns} \)
Input impedance \( Z_i = 100 \text{ k}\Omega \)

<table>
<thead>
<tr>
<th>( V_i )</th>
<th>( V_{BB} )</th>
<th>( R1 )</th>
<th>( R2 )</th>
<th>( R3 )</th>
<th>( -I_{Con} )</th>
<th>( -I_{Bon} )</th>
<th>( I_{Boff} )</th>
<th>( C )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( t_{on} )</td>
<td>-6,85</td>
<td>0</td>
<td>94</td>
<td>1,0</td>
<td>2,0</td>
<td>30</td>
<td>3,0</td>
<td>-</td>
</tr>
<tr>
<td>( t_{off} )</td>
<td>11,7</td>
<td>-9,85</td>
<td>94</td>
<td>1,0</td>
<td>2,0</td>
<td>30</td>
<td>3,0</td>
<td>3,0</td>
</tr>
</tbody>
</table>

* Measured under pulse conditions; \( t_p = 300 \mu s; \delta = 0,01. \)
Fig. 4 $-V_{CE} = 1$ V; $T_{amb} = 25 \, ^\circ C$.

Fig. 5 $V_{CE_{sat}}$ as a function of $I_C$ at $I_C/I_B = 10$. 
Silicon low-power switching transistor

Fig. 6 $V_{BE_{sat}}$ as a function of $I_C$ at $I_C/I_B = 10$.

Fig. 7 $V_{CE_{sat}}$ as a function of $T_j$; typical values.
Upper graph at $I_C = 100$ mA; $I_B = 10$ mA. Lower graph at $I_C = 50$ mA and $I_B = 5$ mA.

March 1978
DEVELOPMENT SAMPLE DATA

This information is derived from development samples made available for evaluation. It does not form part of our data handbook system and does not necessarily imply that the device will go into production.

SILICON PLANAR EPITAXIAL TRANSISTORS

P-N-P transistors in miniature plastic envelopes intended for application in thick and thin-film circuits. They are intended for use in telephony and general industrial applications.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Parameter</th>
<th>BSR30</th>
<th>BSR31</th>
<th>BSR32</th>
<th>BSR33</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collector-base voltage (open emitter)</td>
<td>$-V_{CBO \text{ max.}}$</td>
<td>70</td>
<td>70</td>
<td>90</td>
</tr>
<tr>
<td>Collector-emitter voltage (open base)</td>
<td>$-V_{CEO \text{ max.}}$</td>
<td>60</td>
<td>60</td>
<td>80</td>
</tr>
<tr>
<td>Collector current (d.c.)</td>
<td>$-I_C \text{ max.}$</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Total power dissipation up to $T_{amb} = 25 \degree C$</td>
<td>$P_{tot \text{ max.}}$</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Junction temperature</td>
<td>$T_J \text{ max.}$</td>
<td>150</td>
<td>150</td>
<td>150</td>
</tr>
<tr>
<td>D.C. current gain</td>
<td>$h_{FE} &gt;$</td>
<td>40</td>
<td>100</td>
<td>40</td>
</tr>
<tr>
<td>Transition frequency at $f = 35 \text{ MHz}$</td>
<td>$f_T &gt;$</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT-89.

See also Soldering recommendations.

BSR30 to BSR33

BSR30
BSR31
BSR32
BSR33
### RATINGS

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

<table>
<thead>
<tr>
<th>Voltaages</th>
<th>BSR30</th>
<th>BSR31</th>
<th>BSR32</th>
<th>BSR33</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collector-base voltage (open emitter)</td>
<td>$-V_{CBO}$ max. 70</td>
<td>70</td>
<td>90</td>
<td>90 V</td>
</tr>
<tr>
<td>Collector-emitter voltage (open base)</td>
<td>$-V_{CEO}$ max. 60</td>
<td>60</td>
<td>80</td>
<td>80 V</td>
</tr>
<tr>
<td>Emitter-base voltage (open collector)</td>
<td>$-V_{EBO}$ max. 5</td>
<td>5</td>
<td>5</td>
<td>5 V</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Currents</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Collector current (d.c.)</td>
<td>$-I_{C}$ max. 1</td>
<td></td>
<td></td>
<td>A</td>
</tr>
<tr>
<td>Base current (d.c.)</td>
<td>$-I_{B}$ max. 0.1</td>
<td></td>
<td></td>
<td>A</td>
</tr>
</tbody>
</table>

### Power dissipation

Total power dissipation up to $T_{amb} = 25 \, ^{\circ}C$
mounted on a ceramic substrate
area = 2.5 cm$^2$; thickness = 0.7 mm
$P_{tot}$ max. 1 W

### Temperatures

<table>
<thead>
<tr>
<th>Temperatures</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage temperature $T_{stg}$</td>
<td>-65 to +150</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Junction temperature $T_{j}$</td>
<td>max. 150</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### THERMAL RESISTANCE

From junction to collector tab
$R_{th \, j-tab} = 10 \, ^{\circ}C/W$

From junction to ambient in free air
mounted on a ceramic substrate
area = 2.5 cm$^2$; thickness = 0.7 mm
$R_{th \, j-a} = 125 \, ^{\circ}C/W$
CHARACTERISTICS

\( T_{\text{amb}} = 25 \, ^\circ\text{C} \) unless otherwise specified

**Collector cut-off current**

\[
\begin{align*}
I_E = 0; & \quad -V_{CB} = 60 \, V \\
I_E = 0; & \quad -V_{CB} = 60 \, V; \quad T_j = 150 \, ^\circ\text{C}
\end{align*}
\]

\[
\begin{array}{ll}
-ICBO & < 100 \, \text{nA} \\
-ICBO & < 50 \, \mu\text{A}
\end{array}
\]

**Breakdown voltages**

\[
\begin{align*}
I_B = 0; & \quad -I_C = 10 \, mA \\
V_{BE} = 0; & \quad -I_C = 10 \, \mu\text{A} \\
I_C = 0; & \quad -I_E = 10 \, \mu\text{A}
\end{align*}
\]

\[
\begin{array}{llll}
-\text{V(\text{BR})CEO} & > 60 & 60 & 80 \\
-\text{V(\text{BR})CES} & > 70 & 70 & 90 \\
-\text{V(\text{BR})EBO} & > 5 & 5 & 5
\end{array}
\]

**Saturation voltages**

\[
\begin{align*}
-I_C = 150 \, mA; & \quad -I_B = 15 \, mA \\
-I_C = 500 \, mA; & \quad -I_B = 50 \, mA
\end{align*}
\]

\[
\begin{array}{llll}
-\text{VCE}_{\text{sat}} & < 0,25 & 0,25 & 0,25 \\
-\text{VBE}_{\text{sat}} & < 1,0 & 1,0 & 1,0 \\
-\text{VCE}_{\text{sat}} & < 0,5 & 0,5 & 0,5 \\
-\text{VBE}_{\text{sat}} & < 1,2 & 1,2 & 1,2
\end{array}
\]

**D.C. current gain**

\[
\begin{align*}
-I_C = 100 \, \mu\text{A}; & \quad V_{CE} = 5 \, V \\
-I_C = 100 \, mA; & \quad V_{CE} = 5 \, V \\
-I_C = 500 \, mA; & \quad V_{CE} = 5 \, V
\end{align*}
\]

\[
\begin{array}{llll}
h_{\text{FE}} & > 10 & 30 & 10 \\
h_{\text{FE}} & > 40 & 100 & 40 \\
h_{\text{FE}} & > 120 & 300 & 120
\end{array}
\]

**Transition frequency at \( f = 35 \, \text{MHz} \)**

\[
\begin{align*}
-I_C = 50 \, mA; & \quad -V_{CE} = 10 \, V
\end{align*}
\]

\[
f_T > 100 \, \text{MHz}
\]

**Collector capacitance at \( f = 1 \, \text{MHz} \)**

\[
\begin{align*}
I_E = I_e = 0; & \quad -V_{CB} = 10 \, V
\end{align*}
\]

\[
C_c < 20 \, \text{pF}
\]

**Emitter capacitance at \( f = 1 \, \text{MHz} \)**

\[
\begin{align*}
-I_C = I_c = 0; & \quad -V_{EB} = 0,5 \, V
\end{align*}
\]

\[
C_e < 120 \, \text{pF}
\]

**Switching times see page 4**

* Measured under pulse conditions: \( t_p = 300 \, \mu\text{s}; \delta < 0,01. \)
CHARACTERISTICS (continued)

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

Switching times

$-I_{Con} = 100 \, mA$; $-I_{Bon} = +I_{Boff} = 5 \, mA$

Turn-on time $t_{on} < 500 \, ns$

Turn-off time $t_{off} < 650 \, ns$

Test circuit

Pulse generator:
- Pulse duration $t_p = 10 \, \mu s$
- Rise time $t_r < 15 \, \text{ns}$
- Fall time $t_f < 15 \, \text{ns}$
- Source impedance $Z_S = 50 \, \Omega$

Oscilloscope:
- Rise time $t_r < 15 \, \text{ns}$
- Input impedance $Z_I > 100 \, \text{k}\Omega$
N-P-N transistors in miniature plastic envelopes intended for application in thick and thin-film circuits. They are intended for use in telephony and general industrial applications.

**QUICK REFERENCE DATA**

<table>
<thead>
<tr>
<th></th>
<th>BSR40</th>
<th>BSR41</th>
<th>BSR42</th>
<th>BSR43</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collector-base voltage (open emitter)</td>
<td>$V_{CBO}$ max.</td>
<td>70</td>
<td>70</td>
<td>90</td>
</tr>
<tr>
<td>Collector-emitter voltage (open base)</td>
<td>$V_{CEO}$ max.</td>
<td>60</td>
<td>60</td>
<td>80</td>
</tr>
<tr>
<td>Collector current (d.c.)</td>
<td>$I_C$ max.</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Total power dissipation up to $T_{amb} = 25 ^{\circ}C$</td>
<td>$P_{tot}$ max.</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Junction temperature</td>
<td>$T_j$ max.</td>
<td>150</td>
<td>150</td>
<td>150</td>
</tr>
<tr>
<td>D.C. current gain</td>
<td>$I_C = 100$ mA; $V_{CE} = 5$ V</td>
<td>$h_{FE}$ &gt;</td>
<td>40</td>
<td>100</td>
</tr>
<tr>
<td>Transition frequency at $f = 35$ MHz</td>
<td>$f_T$ &gt;</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

**MECHANICAL DATA**

Fig. 1 SOT-89.

Dimensions in mm

Mark

BSR40
BSR41
BSR42
BSR43

March 1978
### RATINGS

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

#### Volatges

<table>
<thead>
<tr>
<th></th>
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<th>BSR43</th>
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<tr>
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<td>$V_{CBO}$ max.</td>
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<td>70</td>
<td>90</td>
</tr>
<tr>
<td>Collector-emitter voltage (open base)</td>
<td>$V_{CEO}$ max.</td>
<td>60</td>
<td>60</td>
<td>80</td>
</tr>
<tr>
<td>Emitter-base voltage (open collector)</td>
<td>$V_{EBO}$ max.</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
</tbody>
</table>

#### Currents

<table>
<thead>
<tr>
<th></th>
<th>BSR40</th>
<th>BSR41</th>
<th>BSR42</th>
<th>BSR43</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collector current (d.c.)</td>
<td>$I_C$ max.</td>
<td>1</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>Base current (d.c.)</td>
<td>$I_B$ max.</td>
<td>0,1</td>
<td>A</td>
<td></td>
</tr>
</tbody>
</table>

#### Power dissipation

Total power dissipation up to $T_{amb} = 25$ °C
mounted on a ceramic substrate
area = 2,5 cm$^2$; thickness = 0,7 mm

$P_{tot}$ max. 1 W

#### Temperatures

<table>
<thead>
<tr>
<th></th>
<th>BSR40</th>
<th>BSR41</th>
<th>BSR42</th>
<th>BSR43</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage temperature</td>
<td>$T_{stg}$</td>
<td>-65 to +150</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>Junction temperature</td>
<td>$T_j$ max.</td>
<td>150</td>
<td>°C</td>
<td></td>
</tr>
</tbody>
</table>

#### THERMAL RESISTANCE

From junction to collector tab
$R_{th j-tab}$ = 10 °C/W

From junction to ambient in free air
mounted on a ceramic substrate
area = 2,5 cm$^2$; thickness = 0,7 m

$R_{th j-a}$ = 125 °C/W
**CHARACTERISTICS**

\( T_{\text{amb}} = 25 \, ^\circ\text{C} \) unless otherwise specified

### Collector cut-off current

| \( I_E = 0 \); \( V_{CB} = 60 \, \text{V} \) | \( I_{CBO} < 100 \) | \( \text{nA} \) |
| \( I_E = 0 \); \( V_{CB} = 60 \, \text{V}; \ T_j = 150 \, ^\circ\text{C} \) | \( I_{CBO} < 50 \) | \( \mu\text{A} \) |

### Breakdown voltages

| \( I_B = 0 \); \( I_C = 10 \, \text{mA} \) | \( V(BR)_{CEO} > 60 \) | \( \text{BSR40} \) | \( \text{BSR41} \) | \( \text{BSR42} \) | \( \text{BSR43} \) |
| \( V_{BE} = 0 \); \( I_C = 10 \, \mu\text{A} \) | \( V(BR)_{CES} > 70 \) | \( \text{V} \) | \( \text{V} \) | \( \text{V} \) | \( \text{V} \) |
| \( I_C = 0 \); \( I_E = 10 \, \mu\text{A} \) | \( V(BR)_{EBO} > 5 \) | \( \text{V} \) | \( \text{V} \) | \( \text{V} \) | \( \text{V} \) |

### Saturation voltages *

| \( I_C = 150 \, \text{mA}; \ I_B = 15 \, \text{mA} \) | \( V_{CE\text{sat}} < 0,25 \) | \( \text{V} \) | \( \text{V} \) | \( \text{V} \) | \( \text{V} \) |
| \( I_C = 500 \, \text{mA}; \ I_B = 50 \, \text{mA} \) | \( V_{BE\text{sat}} < 1,2 \) | \( \text{V} \) | \( \text{V} \) | \( \text{V} \) | \( \text{V} \) |

### D.C. current gain *

| \( I_C = 100 \, \mu\text{A}; \ V_{CE} = 5 \, \text{V} \) | \( h_{FE} > 10 \) | \( \text{BSR40} \) | \( \text{BSR41} \) | \( \text{BSR42} \) | \( \text{BSR43} \) |
| \( I_C = 100 \, \mu\text{A}; \ V_{CE} = 5 \, \text{V} \) | \( h_{FE} > 40 \) | \( \text{V} \) | \( \text{V} \) | \( \text{V} \) | \( \text{V} \) |
| \( I_C = 500 \, \mu\text{A}; \ V_{CE} = 5 \, \text{V} \) | \( h_{FE} > 120 \) | \( \text{V} \) | \( \text{V} \) | \( \text{V} \) | \( \text{V} \) |

### Transition frequency at \( f = 35 \, \text{MHz} \)

| \( I_C = 50 \, \text{mA}; \ V_{CE} = 10 \, \text{V} \) | \( f_T > 100 \) | \( \text{MHz} \) |

### Collector capacitance at \( f = 1 \, \text{MHz} \)

| \( I_E = I_\theta = 0 \); \( V_{CB} = 10 \, \text{V} \) | \( C_c < 12 \) | \( \text{pF} \) |

### Emitter capacitance at \( f = 1 \, \text{MHz} \)

| \( I_C = I_\theta = 0 \); \( V_{EB} = 0,5 \, \text{V} \) | \( C_e < 90 \) | \( \text{pF} \) |

### Switching times see page 4

* Measured under pulse conditions: \( t_p = 300 \, \mu\text{s}; \delta < 0,01. *
CHARACTERISTICS (continued)

\( T_{\text{amb}} = 25 \, ^{\circ}\text{C} \)

Switching times

\[ I_{\text{Con}} = 100 \, mA; \quad I_{\text{Bon}} = -I_{\text{Boff}} = 5 \, mA \]

Turn-on time

\[ t_{\text{on}} < 250 \, \text{ns} \]

Turn-off time

\[ t_{\text{off}} < 1000 \, \text{ns} \]

Test circuit

Pulse generator:

- Pulse duration: \( t_p = 10 \, \mu\text{s} \)
- Rise time: \( t_r \leq 15 \, \text{ns} \)
- Fall time: \( t_f \leq 15 \, \text{ns} \)
- Source impedance: \( Z_S = 50 \, \Omega \)

Oscilloscope:

- Rise time: \( t_r \leq 15 \, \text{ns} \)
- Input impedance: \( Z_l \geq 100 \, \text{k}\Omega \)

\[ +11 \, V \quad 0 \quad t_p \]
**N-CHANNEL FETS**

Silicon n-channel depletion type junction field-effect transistors in a plastic microminiature envelope intended for application in thick and thin-film circuits. The transistors are intended for low-power, chopper or switching applications in industrial service.

### QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th></th>
<th>BSR56</th>
<th>BSR57</th>
<th>BSR58</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drain-source voltage</td>
<td>±VDS</td>
<td>max.</td>
<td>40</td>
</tr>
<tr>
<td>Total power dissipation up to T_{amb} = 70 °C</td>
<td>P_{tot}</td>
<td>max.</td>
<td>200</td>
</tr>
<tr>
<td>Drain current</td>
<td>V_{DS} = 15 V; V_{GS} = 0</td>
<td>I_DSS</td>
<td>&gt;</td>
</tr>
<tr>
<td>Gate-source cut-off voltage</td>
<td>V_{DS} = 15 V; I_D = 0.5 nA</td>
<td>-V(P)GS</td>
<td>&gt;</td>
</tr>
<tr>
<td>Drain-source resistance (on) at f = 1 kHz</td>
<td>r_{ds on}</td>
<td>&lt;</td>
<td>10</td>
</tr>
<tr>
<td>Feedback capacitance at f = 1 MHz</td>
<td>V_{GS} = 10 V; V_{DS} = 0</td>
<td>C_{rs}</td>
<td>&lt;</td>
</tr>
<tr>
<td>Turn-off time</td>
<td>V_{DD} = 10 V; V_{GS} = 0</td>
<td>t_{off}</td>
<td>&lt;</td>
</tr>
<tr>
<td></td>
<td>I_D = 20 mA; -V_{GSM} = 10 V</td>
<td>t_{off}</td>
<td>&lt;</td>
</tr>
<tr>
<td></td>
<td>I_D = 10 mA; -V_{GSM} = 6 V</td>
<td>t_{off}</td>
<td>&lt;</td>
</tr>
<tr>
<td></td>
<td>I_D = 5 mA; -V_{GSM} = 4 V</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### MECHANICAL DATA

Fig. 1 SOT-23.

Dimensions in mm

- Width: 2.9 mm
- Height: 2.8 mm
- Lead pitch: 0.95 mm
- Lead length: 1.3 mm
- Lead width: 1.2 mm
- Lead height: 2.5 mm
- Marking code: BSR56 = M4, BSR57 = M5, BSR58 = M6

See also Soldering Recommendations.
RATINGS

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

- Drain-source voltage: $\pm V_{DS} \max. = 40 \text{ V}$
- Drain-gate voltage: $V_{DGO} \max. = 40 \text{ V}$
- Gate-source voltage: $-V_{GSO} \max. = 40 \text{ V}$
- Forward gate current: $I_{GF} \max. = 50 \text{ mA}$
- Total power dissipation up to $T_{amb} = 70 \text{ °C}$: $P_{tot} \max. = 200 \text{ mW}$
- Storage temperature: $T_{stg} = -55 \text{ to } +150 \text{ °C}$
- Junction temperature: $T_{j} \max. = 150 \text{ °C}$

THERMAL RESISTANCE

From junction to ambient in free air mounted on a ceramic substrate of $15 \times 15 \times 0.5 \text{ mm}$

$R_{th j-a} = 0.4 \text{ °C/mW}$

CHARACTERISTICS

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

- Gate-source cut-off current
  - $V_{DS} = 0 \text{ V}; -V_{GS} = 20 \text{ V}$: $I_{GSS} < 1 \text{ nA}$
- Drain cut-off current
  - $V_{DS} = 15 \text{ V}; -V_{GS} = 10 \text{ V}$: $I_{DSX} < 1 \text{ nA}$

<table>
<thead>
<tr>
<th>BSR56</th>
<th>BSR57</th>
<th>BSR58</th>
</tr>
</thead>
</table>
| Drain current $^*$
  - $V_{DS} = 15 \text{ V}; V_{GS} = 0$
    - $I_{DSS} > 50 \text{ mA}$
    - $I_{DS} > 20 \text{ mA}$
  - $I_{D} = 20 \text{ mA}; V_{GS} = 0$
    - $V_{DS} < 750 \text{ mV}$
  - $I_{D} = 10 \text{ mA}; V_{GS} = 0$
    - $V_{DS} < 500 \text{ mV}$
  - $I_{D} = 5 \text{ mA}; V_{GS} = 0$
    - $V_{DS} < 400 \text{ mV}$
  - $I_{D} = 0 \text{ mA}$
    - $V_{DS} < 400 \text{ mV}$
| $V_{DS}$ |
| $V_{DS}$ |
| $V_{DS}$ |
| $V_{DS}$ |
| $V_{DS}$ |

Drain current resistance (on) at $f = 1 \text{ kHz}$

- $I_{D} = 0 \text{ mA}; V_{GS} = 0$
  - $r_{ds on} < 25 \text{ mV}$

* Measured under pulsed conditions; $t_p = 100 \text{ ms}; \delta \leq 0.1$. 
N-channel FETs

Switching times*

\( V_{DD} = 10 \, V; \, V_{GS} = 0 \)

Conditions \( I_D \) and \( -V_{GSM} \)

\[ \begin{array}{c|c|c|c}
   & BSR56 & BSR57 & BSR58 \\
\hline
I_D = & 20 & 10 & 5 \, mA \\
-V_{GSM} = & 10 & 6 & 4 \, V \\
\hline
t_d < & 6 & 6 & 10 \, ns \\
t_r < & 3 & 4 & 10 \, ns \\
t_{off} < & 25 & 50 & 100 \, ns \\
\end{array} \]

 Delay time
 Rise time
 Turn-off time

Fig. 2 Switching times waveforms.

Fig. 3 Test circuit.

* Switching times measured on devices in SOT-18 envelope.
HIGH VOLTAGE P-N-P TRANSISTOR

Silicon planar epitaxial transistor in a microminiature plastic envelope intended for application in thick and thin-film circuits. This transistor is intended for high voltage general purpose and switching applications.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collector-base voltage (open emitter)</td>
<td>$-V_{CBO}$ max. 110 V</td>
</tr>
<tr>
<td>Collector-emitter voltage (open base)</td>
<td>$-V_{CEO}$ max. 100 V</td>
</tr>
<tr>
<td>Collector current (peak value)</td>
<td>$-I_{CM}$ max. 100 mA</td>
</tr>
<tr>
<td>Total power dissipation up to $T_{amb} = 25 \degree C$</td>
<td>$P_{tot}$ max. 200 mW</td>
</tr>
<tr>
<td>Junction temperature</td>
<td>$T_j$ max. 150 \degree C</td>
</tr>
<tr>
<td>D.C. current gain at $T_j = 25 \degree C$</td>
<td>$h_{FE}$ &gt; 30</td>
</tr>
<tr>
<td>Transition frequency at $f = 35 \text{ MHz}$</td>
<td>$f_T$ &gt; 50 MHz</td>
</tr>
<tr>
<td></td>
<td>typ. 85 MHz</td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Dimensions in mm

Marking code

BSS63 = T3

BSS63R = T6

See also Soldering recommendations.
RATINGS

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

Collector-base voltage (open emitter)
\(-I_C = 10 \mu A\)

Collector-emitter voltage (open base)
\(-I_C = 100 \mu A\)

Emitter-base voltage (open collector)
\(-I_E = 10 \mu A\)

Collector current (d.c.)
\(-I_C \) max.

Collector current (peak value)
\(-I_{CM} \) max.

Base current (peak value)
\(-I_{BM} \) max.

Total power dissipation up to \(T_{amb} = 25 \degree C\) *

Storage temperature

Junction temperature

THERMAL RESISTANCE

From junction to ambient in free air *

\[ R_{th j-a} = 0.62 \degree C/mW \]

CHARACTERISTICS

\( T_j = 25 \degree C \) unless otherwise specified

Collector cut-off current
\( I_E = 0; \ -V_{CB} = 90 \ V \)
\( I_E = 0; \ -V_{CB} = 90 \ V; \ T_j = 150 \degree C \)

Emitter cut-off current
\( I_C = 0; \ -V_{EB} = 6 \ V \)

Saturation voltage
\(-I_C = 25 \ mA; \ -I_B = 2.5 \ mA \)

D.C. current gain
\(-I_C = 10 \ mA; \ -V_{CE} = 1 \ V \)
\(-I_C = 25 \ mA; \ -V_{CE} = 1 \ V \)

Collector capacitance at \( f = 1 \ MHz \)
\( I_E = I_E = 0; \ -V_{CB} = 10 \ V \)

Transition frequency at \( f = 35 \ MHz \)
\(-I_C = 25 \ mA; \ -V_{CE} = 5 \ V \)

* Device mounted on a ceramic substrate of 7 mm x 5 mm x 0.5 mm.
High-voltage p-n-p transistor

Fig. 2.

- $V_{CE} = 5\, \text{V}$
- $T_j = 25\, ^\circ\text{C}$

Fig. 3.

- $V_{CE} = 5\, \text{V}$
- $f = 35\, \text{MHz}$
- $T_j = 25\, ^\circ\text{C}$

March 1978
Fig. 4 Typical values collector capacitance as a function of collector-base voltage.
$I_E = I_e = 0; T_j = 25 \, ^\circ C; f = 1 \, MHz$.

Fig. 5 Typical values collector-base current as a function of the junction temperature at a collector-base voltage of $-90 \, V$. 

April 1978
HIGH-VOLTAGE N-P-N TRANSISTOR

Silicon planar epitaxial transistor in a microminiature plastic envelope intended for application in thick and thin-film circuits. This transistor is intended for high-voltage general purpose and switching applications.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collector-base voltage (open emitter)</td>
<td>VCBO max. 120 V</td>
</tr>
<tr>
<td>Collector-emitter voltage (open base)</td>
<td>VCEO max. 80 V</td>
</tr>
<tr>
<td>Collector current (peak value)</td>
<td>ICM max. 250 mA</td>
</tr>
<tr>
<td>Total power dissipation up to T_{amb} = 25 °C</td>
<td>P_{tot} max. 200 mW</td>
</tr>
<tr>
<td>Junction temperature</td>
<td>Tj max. 150 °C</td>
</tr>
<tr>
<td>D.C. current gain</td>
<td>hFE &gt; 20</td>
</tr>
<tr>
<td>Transition frequency at f = 35 MHz</td>
<td>hFE typ. 80</td>
</tr>
<tr>
<td>Turn-off time</td>
<td>f_T &gt; 60 MHz</td>
</tr>
<tr>
<td></td>
<td>t_{off} &lt; 1 µs</td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Fig. 1 SOT-23.

Dimensions in mm

Marking code

BSS64 = U3

BSS64R = U6

See also Soldering recommendations.
RATINGS

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

Collector-base voltage (open emitter)
  $I_C = 100 \mu A$

Collector-emitter voltage (open base)
  $I_C = 4 mA$

Emitter-base voltage (open collector)
  $I_E = 100 \mu A$

Collector current
  (d.c. or averaged over any 20 ms period)
  $I_C = 100 mA$

Collector current (peak value)
  $I_{CM} = 250 mA$

Base current (peak value)
  $I_{BM} = 100 mA$

Total power dissipation up to $T_{amb} = 25^\circ C$
  $P_{tot} = 200 mW$

Storage temperature
  $T_{stg} = -65$ to $+150^\circ C$

Junction temperature
  $T_j = 150^\circ C$

THERMAL RESISTANCE

From junction to ambient in free air
  $R_{th j-a} = 0.62^\circ C/mW$

* Device mounted on a ceramic substrate of 7 mm x 5 mm x 0.5 mm.
CHARACTERISTICS

Tj = 25 °C unless otherwise specified

Collector cut-off current

\[ I_E = 0; V_{CB} = 90 \text{ V} \]

\[ I_C \text{ typ.} < 100 \text{ nA} \]

\[ I_{CBO} < 100 \text{ nA} \]

\[ I_{CBO} \text{ typ.} < 50 \mu\text{A} \]

Elliminator cut-off current

\[ I_C = 0; V_{EB} = 5 \text{ V} \]

\[ I_E \text{ typ.} < 0.5 \text{ nA} \]

\[ I_{EBO} < 200 \text{ nA} \]

Saturation voltages

\[ I_C = 4 \text{ mA}; I_B = 400 \mu\text{A} \]

\[ V_{CE_{sat}} < 150 \text{ mV} \]

\[ V_{BE_{sat}} < 1200 \text{ mV} \]

\[ V_{CE_{sat}} < 200 \text{ mV} \]

D.C. current gain

\[ I_C = 1 \text{ mA}; V_{CE} = 1 \text{ V} \]

\[ h_{FE} \text{ typ.} = 60 \]

\[ h_{FE} > 20 \]

\[ h_{FE} \text{ typ.} = 80 \]

Transition frequency at f = 35 MHz

\[ I_C = 4 \text{ mA}; V_{CE} = 10 \text{ V} \]

\[ f_T \text{ typ.} = 60 \text{ MHz} \]

Collector capacitance at f = 1 MHz

\[ I_E = I_B = 0; V_{CB} = 10 \text{ V} \]

\[ C_c < 5 \text{ pF} \]

Turn-off switching time

\[ I_{Con} = 15 \text{ mA}; I_{Bon} = -I_{Boff} = 1 \text{ mA} \]

\[ t_{off} < 1 \mu\text{s} \]
Fig. 2 Typical values transition frequency.
$V_{CE} = 10 \text{ V}$; $f = 35 \text{ MHz}$; $T_j = 25 \degree \text{C}$.

Fig. 3 Typical values collector-base currents as a function of the junction temperature at a collector-base voltage of 90 V.
SILICON PLANAR EPITAXIAL TRANSISTOR

• High-speed switching

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

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
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<tbody>
<tr>
<td>Collector-base voltage (open emitter)</td>
<td>V_CBO max. 20 V</td>
</tr>
<tr>
<td>Collector-emitter voltage (V_BE = 0)</td>
<td>V_CES max. 20 V</td>
</tr>
<tr>
<td>Collector-emitter voltage (open base)</td>
<td>V_CEO max. 12 V</td>
</tr>
<tr>
<td>Collector current (peak value)</td>
<td>I_C max. 200 mA</td>
</tr>
<tr>
<td>Total power dissipation up to T_amb = 25 °C</td>
<td>P_tot max. 200 mW</td>
</tr>
<tr>
<td>Junction temperature</td>
<td>T_j -65 to +150 °C</td>
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<tr>
<td>D.C. current gain</td>
<td>h_FE 40 to 120</td>
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<tr>
<td>Transition frequency at f = 100 MHz</td>
<td>f_T &gt; 400 MHz</td>
</tr>
<tr>
<td>Storage time</td>
<td>t_s &lt; 13 ns</td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT-23.

See also Soldering recommendations.
RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltagess

Collector-base voltage (open emitter) $V_{CB0}$ 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

$R_{th\:j-a}$ = 0.62 °C/mW

$T_j$ = 25 °C unless otherwise specified

CHARACTERISTICS

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
$I_C = 50$ mA; $I_B = 5$ mA $V_{BEsat}$ 700 to 850 mV
$V_{CESat}$ < 400 mV
$V_{BEsat}$ < 1200 mV

December 1972
CHARACTERISTICS (continued)

D.C. current gain

<table>
<thead>
<tr>
<th>IC</th>
<th>V_C E</th>
<th>hFE</th>
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</thead>
<tbody>
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<td>1 mA</td>
<td>1 V</td>
<td>&gt; 25</td>
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<tr>
<td>10 mA</td>
<td>1 V</td>
<td>40 to 120</td>
</tr>
<tr>
<td>50 mA</td>
<td>1 V</td>
<td>&gt; 25</td>
</tr>
</tbody>
</table>

Transition frequency at f = 100 MHz

<table>
<thead>
<tr>
<th>IC</th>
<th>V_C E</th>
<th>f_T</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 mA</td>
<td>10 V</td>
<td>&gt; 400 MHz</td>
</tr>
<tr>
<td></td>
<td></td>
<td>typ. 500 MHz</td>
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</tbody>
</table>

Collector capacitance at f = 1 MHz

<table>
<thead>
<tr>
<th>VE = 5 V</th>
</tr>
</thead>
<tbody>
<tr>
<td>C_C &lt; 4 pF</td>
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</tbody>
</table>

Emitter capacitance at f = 1 MHz

<table>
<thead>
<tr>
<th>VE = 1 V</th>
</tr>
</thead>
<tbody>
<tr>
<td>C_e &lt; 4.5 pF</td>
</tr>
</tbody>
</table>

Switching times

Storage time IC = IB = -I_BM = 10 mA

| t_S | < 13 ns |

Test circuit:

![Test circuit diagram]

Pulse generator:

- Rise time \( t_r < 1 \text{ ns} \)
- Pulse duration \( t > 300 \text{ ns} \)
- Duty cycle \( \delta < 0.02 \)
- Source impedance \( R_S = 50 \Omega \)

Oscilloscope:

- Input impedance \( R_I = 50 \Omega \)
- Rise time \( t_r < 1 \text{ ns} \)
CHARACTERISTICS (continued)

Switching times

Turn on time when switched from
\(-V_{BE} = 1.5 \text{ V} \) to \(I_C = 10 \text{ mA} \); \(I_B = 3 \text{ mA} \)

Turn off time when switched from
\(I_C = 10 \text{ mA} \); \(I_B = 3 \text{ mA} \)

to cut-off with \(-I_{BM} = 1.5 \text{ mA} \)

Test circuit:

Pulse generator:
- Rise time \(t_r < 1 \text{ ns} \)
- Pulse duration \(t > 300 \text{ ns} \)
- Duty cycle \(\delta < 0.02 \)
- Source impedance \(R_S = 50 \Omega \)

Oscilloscope:
- Input impedance \(R_i = 50 \Omega \)
- Rise time \(t_r < 1 \text{ ns} \)

\[
\begin{array}{|c|c|c|c|c|c|c|c|c|}
\hline
I_C & I_B & -I_{BM} & V_{CC} & R_1:R_2 & R_3 & R_4 & -V_{BB} & -V_{BE} & V_i & -V_{BB} & -V_i \\
\hline
10 & 3 & 1.5 & 3 & 3.3 & 50 & 220 & 3.0 & 1.5 & 15 & 12.0 & 15 \\
\hline
\end{array}
\]

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.
BSV52

**Typical Values**

- **7Z1007**
  - $I_C = 25^\circ C$
  - $I_g = 0 - 400 \mu A$

- **7Z1006**
  - $I_T = 25^\circ C$

**7Z1000**

- $f_T = 100 \text{ MHz}$
- $I_T = 25^\circ C$

---

*September 1970*
September 1970

**BSV52**

**V_{CEsat} (V)**

- Typical values: $T_j = 25^\circ C$
- $I_C = 20$
- $I_B$

**V_{BEsat} (V)**

- Typical values: $T_j = 25^\circ C$
- $I_C = 10$
- $I_B$
- $I_C = 20$
- $I_B$

### Graphs

- Graphs for $V_{CEsat}$ and $V_{BEsat}$ vs. $I_C$.
- Grid lines for clarity.

### Grid Lines

- X-axis: $0.1$ to $1000$ mA
- Y-axis: $0$ to $0.6$ V
- X-axis: $0.1$ to $1000$ mA
- Y-axis: $0$ to $1.5$ V
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 75 V with a tolerance of ±5%.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Working voltage range</th>
<th>V_Z nom.</th>
<th>4.7 to 75 V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Working voltage tolerance</td>
<td>P_tot max.</td>
<td>200 mW</td>
</tr>
<tr>
<td>Total power dissipation up to T_amb = 25 °C</td>
<td>T_j max.</td>
<td>150 °C</td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Dimensions in mm

See also Soldering recommendations.

Marking code

<table>
<thead>
<tr>
<th>BZX84-C4V7 = Z1</th>
<th>BZX84-C12 = Y2</th>
<th>BZX84-C33 = Y12</th>
</tr>
</thead>
<tbody>
<tr>
<td>C5V1 = Z2</td>
<td>C13 = Y3</td>
<td>C36 = Y13</td>
</tr>
<tr>
<td>C5V6 = Z3</td>
<td>C15 = Y4</td>
<td>C39 = Y14</td>
</tr>
<tr>
<td>C6V2 = Z4</td>
<td>C16 = Y5</td>
<td>C43 = Y15</td>
</tr>
<tr>
<td>C6V8 = Z5</td>
<td>C18 = Y6</td>
<td>C47 = Y16</td>
</tr>
<tr>
<td>C7V5 = Z6</td>
<td>C20 = Y7</td>
<td>C51 = Y17</td>
</tr>
<tr>
<td>C8V2 = Z7</td>
<td>C22 = Y8</td>
<td>C56 = Y18</td>
</tr>
<tr>
<td>C9V1 = Z8</td>
<td>C24 = Y9</td>
<td>C62 = Y19</td>
</tr>
<tr>
<td>C10 = Z9</td>
<td>C27 = Y10</td>
<td>C68 = Y20</td>
</tr>
<tr>
<td>C11 = Y1</td>
<td>C30 = Y11</td>
<td>C75 = Y21</td>
</tr>
</tbody>
</table>

Figure 1 SOT-23.

January 1978
**RATINGS** Limiting values in accordance with the Absolute Maximum System (IEC 134)

**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 \( T_{amb} = 25 \, ^\circ C \)
  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 \, ^\circ C
- Junction temperature: \( T_j \) max. 150 \, ^\circ C

**THERMAL RESISTANCE**
- From junction to ambient:
  mounted on a ceramic substrate of 7 mm x 5 mm x 0.5 mm
  \( R_{th j-a} = 0.62 \, ^\circ C/mW \)

**CHARACTERISTICS**

**Forward voltage**
- \( I_F = 10 \, mA \)
  \( V_F < 0.9 \, V \)

**Reverse current**
- \( V_R = 2 \, V \)
  \( I_R < 3000 \, nA \)
- \( V_R = 2 \, V \)
  \( I_R < 2000 \, nA \)
- \( V_R = 2 \, V \)
  \( I_R < 1000 \, nA \)
- \( V_R = 4 \, V \)
  \( I_R < 3000 \, nA \)
- \( V_R = 4 \, V \)
  \( I_R < 2000 \, nA \)
- \( V_R = 5 \, V \)
  \( I_R < 1000 \, nA \)
- \( V_R = 5 \, V \)
  \( I_R < 700 \, nA \)
- \( V_R = 6 \, V \)
  \( I_R < 500 \, nA \)
- \( V_R = 7 \, V \)
  \( I_R < 200 \, nA \)
- \( V_R = 8 \, V \)
  \( I_R < 100 \, nA \)
- \( V_R = 8 \, V \)
  \( I_R < 100 \, nA \)
- \( V_R = 8 \, V \)
  \( I_R < 50 \, nA \)
- \( V_R = 0.7 \, V_{Znom} \)
  \( I_R < 100 \, nA \)
CHARACTERISTICS (continued)

Tj = 25 °C

E24 (±5%) logarithmic range.

<table>
<thead>
<tr>
<th>BZX84-...</th>
<th>Working voltage Vz (V) at Iz = 5 mA</th>
<th>Differential resistance rdiff (Ω) at Iz = 5 mA</th>
<th>Temperature coefficient Sz (mV/°C) at Iz = 5 mA</th>
<th>Diode capacitance Cd (pF); f = 1 MHz VR = 0</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>min.</td>
<td>max.</td>
<td>min.</td>
<td>max.</td>
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<td>50</td>
<td>80</td>
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<td>40</td>
<td>60</td>
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<td>C6V6</td>
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<tr>
<td>C6V8</td>
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typical values
$T_{\text{amb}} = 25^\circ C$
static characteristics

December 1976
BZX84 SERIES

Typical values

$T_{amb} = 25^\circ C$

Static characteristics

Dynamic characteristics

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typical values, $T_j=25^\circ C$
dynamic characteristics

BZX84 - C75

$V_z$ (V) vs $I_z$ (mA)

typical values
$T_{amb} = 25^\circ C$
static characteristics
BIX84 SERIES

Typical values
$T_j = 25^\circ C$

$I_F$ (mA) vs. $V_F$ (V)

$S_Z$ (mV/°C)

BZX84-C12

Typical values
$T_j = 25$ to $150^\circ C$

$I_Z$ (mA) vs. $V_Z$ (V)

Typical values
$T_{amb} = 25^\circ C$

$\Delta V_Z$ (mV)

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GENERAL

SOLDERING RECOMMENDATIONS

TYPE NUMBER SURVEY

SELECTION GUIDE

DEVICE DATA