

High-voltage and Switching NPN Power Transistors

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Philips Semiconductors



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Note

Information on Low-frequency Power Transistors and Hybrid IC Power Modules is in the Discrete Semiconductors Data Handbook SC05.

SELECTION GUIDE

High-voltage and Switching NPN Power Transistors

Selection Guide

This selection guide lists the devices in the book, grouped in accordance with the collector-emitter voltage (V_{CESM}) parameter and in order of the collector current (I_C) parameter. For an alphanumeric listing of all devices included, please consult the index at the back of this book.

TYPE	ENVELOPE	V_{CESM} (V)	V_{CEO} (V)	I_C (A)	P_{tot} (W)	PAGE
BUV26F	SOT186	180	90	14	18	267
BUV26	TO-220AB	180	90	14	65	263
BUV26AF	SOT186	200	100	14	18	267
BUV26A	TO-220AB	200	100	14	65	263
BUV27	TO-220AB	240	120	12	65	275
BUV27F	SOT186	240	120	12	18	279
BUV27A	TO-220AB	300	150	12	65	275
BUV27AF	SOT186	300	150	12	18	279
BU407	TO-220	330	150	7	65	29
BU407F	SOT186	330	150	7	18	37
TIP47	TO-220AB	350	250	1	40	439
TIP48	TO-220AB	400	300	1	40	439
BU406	TO-220	400	200	7	65	29
BU406F	SOT186	400	200	7	18	37
BUV28F	SOT186	400	200	10	18	289
BUV28	TO-220AB	400	200	10	65	285
TIP49	TO-220AB	450	350	1	40	439
BUV28AF	SOT186	450	225	10	18	289
BUV28A	TO-220AB	450	225	10	65	285
TIP50	TO-220AB	500	400	1	40	439
ESM3045D(V)	SOT227A/B	600	450	24	125	423
ESM4045D(V)	SOT227A/B	600	450	60	175	427
ESM5045D(V)	SOT227A/B	600	450	60	175	431
ESM6045D(V)	SOT227A/B	600	450	84	250	435
BUV90F	SOT199	650	400	12	34	317
BUV90	SOT93	650	400	12	125	313
BUX99	TO-126	730	300	1.5	28	419
BUX86	TO-126	800	400	0.5	20	411
BUX84F	SOT186	800	400	2	18	409
BUX84	TO-220AB	800	400	2	40	399
BUW84	SOT82	800	400	2	50	389
BU826	SOT93	800	375	6	125	127
BU724A	SOT82	850	400	2	1.5	119
BUT11F	SOT186	850	400	5	32	219
BUT11	TO-220AB	850	400	5	100	211
BUW11	SOT93	850	400	5	100	335

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TYPE	ENVELOPE	V_{CESM} (V)	V_{CEO} (V)	I_C (A)	P_{tot} (W)	PAGE
BUW11F	SOT199	850	450	5	32	343
BUT18F	SOT186	850	450	6	33	255
BUT18	TO-220AB	850	400	6	110	247
BUT12F	SOT186	850	400	8	23	239
BUW12F	SOT199	850	400	8	34	359
BUT12	TO-220AB	850	400	8	125	231
BUW12	SOT93	850	450	8	125	351
BUV47	SOT93	850	400	9	120	295
BUW13F	SOT199	850	400	15	37	375
BUV48	SOT93	850	400	15	150	301
BUW13	SOT93	850	450	15	175	367
BUV98(V)	SOT227A/B	850	450	30	150	321
BUV298(V)	SOT227A/B	850	450	60	250	331
BUW14	SOT82	1000	450	0.5	20	383
BUX87	TO-126	1000	450	0.5	20	411
BUX85F	SOT186	1000	450	2	18	409
BUX85	TO-220AB	1000	450	2	40	399
BUW85	SOT82	1000	450	3	50	389
BUT18AF	SOT186	1000	450	4	33	255
BUT11AF	SOT186	1000	450	5	20	219
BUW11AF	SOT199	1000	450	5	32	343
BUT11A	TO-220AB	1000	450	5	100	211
BUW11A	SOT93	1000	450	5	100	335
BUT18A	TO-220AB	1000	450	6	110	247
BU826A	SOT93	1000	450	6	125	127
BUW12AF	SOT199	1000	450	8	34	359
BUT12AF	SOT186	1000	450	8	23	239
BUW12A	SOT93	1000	450	8	125	351
BUT12A	TO-220AB	1000	450	8	125	231
BUV47A	SOT93	1000	450	9	120	295
BUW13AF	SOT199	1000	450	15	37	375
BUV48A	SOT93	1000	450	15	150	301
BUW13A	SOT93	1000	450	15	175	367
ESM3045A(V)	SOT227A/B	1000	450	24	125	423
BUV98A(V)	SOT227A/B	1000	450	30	150	321
ESM4045A(V)	SOT227A/B	1000	450	42	150	427
BUV298A(V)	SOT227A/B	1000	450	60	250	331
BUV89	SOT93	1200	800	8	125	307
BU603	TO-220AB	1350	550	5	100	87

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TYPE	ENVELOPE	V_{CESM} (V)	V_{CEO} (V)	I_C (A)	P_{tot} (W)	PAGE
BU903	SOT93	1350	550	6	125	133
BU505F	SOT186	1500	700	2.5	20	51
BU505DF	SOT186	1500	700	2.5	20	51
BU705F	SOT199	1500	700	2.5	29	97
BU705DF	SOT199	1500	700	2.5	29	97
BU705	SOT93A	1500	700	2.5	75	91
BU705D	SOT93A	1500	700	2.5	75	91
BU505	TO-220AB	1500	700	2.5	75	45
BU505D	TO-220AB	1500	700	2.5	75	45
BU706	SOT93A	1500	700	5	100	105
BU706D	SOT93A	1500	700	5	100	105
BU706F	SOT199	1500	700	5	32	111
BU706DF	SOT199	1500	700	5	32	111
BU506	TO-220AB	1500	700	5	100	59
BU506D	TO-220AB	1500	700	5	100	59
BU506F	SOT186	1500	700	5	20	65
BU506DF	SOT186	1500	700	5	20	65
BU508AF	SOT199	1500	700	8	34	79
BU508DF	SOT199	1500	700	8	34	79
BU508A	SOT93A	1500	700	8	125	73
BU508D	SOT93A	1500	700	8	125	73
BU1508AX	SOT186A	1500	700	8	35	141
BU1508DX	SOT186A	1500	700	8	35	145
BU2508A	SOT93	1500	700	8	125	149
BU2508AF	SOT199	1500	700	8	45	155
BU2508D	SOT93	1500	700	8	125	161
BU2508DF	SOT199	1500	700	8	45	167
BU2520A	SOT93	1500	800	10	125	173
BU2520AF	SOT199	1500	800	10	45	179
BU2520D	SOT93	1500	800	10	125	187
BU2520DF	SOT93	1500	800	10	45	193
BU2525A	SOT93	1500	800	12	125	199
BU2525AF	SOT199	1500	800	12	45	205

GENERAL

Pro-electron type numbering system

Letter symbols

Transistor ratings

Transistor safe operating area (SOAR)

High-voltage and Switching NPN Power Transistors

General

PRO ELECTRON TYPE NUMBERING SYSTEM

Basic type number

This type designation code applies to discrete semiconductor devices (not integrated circuits), multiples of such devices, semiconductor chips and darlington transistors.

FIRST LETTER

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

- A germanium or other material with a band gap of 0.6 to 1 eV
- B silicon or other material with a band gap of 1 to 1.3 eV
- C gallium arsenide (GaAs) or other material with a 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. The same letter can be used for multi-chip devices with similar elements. In the following list low power types are defined by $R_{th\ j-mb} > 15\ K/W$ and power types by $R_{th\ j-mb} \leq 15\ K/W$.

- A diode; signal, low power
- B diode; variable capacitance
- C transistor; low power, audio frequency
- D transistor; power, audio frequency
- E diode; tunnel
- F transistor; low power, high frequency
- G multiple of dissimilar devices/miscellaneous devices; e.g. oscillators. Also with special third letter, see under 'Serial number'
- H diode; magnetic sensitive
- L transistor; power, high frequency
- N photocoupler
- P radiation detector; e.g. high sensitivity photo-transistor; with special third letter

- Q radiation generator; e.g. LED, laser; with special third letter
- R control and switching device; e.g. thyristor, low power; with special third letter
- S transistor; low power, switching
- T control and switching device; e.g. thyristor, power; with special third letter
- U transistor; power, switching
- W surface acoustic wave device
- X diode; multiplier, e.g. varactor, step recovery
- Y diode; rectifying, booster
- Z diode; voltage reference or regulator, transient suppressor diode; with special third letter

SERIAL NUMBER/SPECIAL THIRD LETTER

The number comprises three figures running from 100 to 999 for devices primarily intended for consumer equipment, or one letter (Z, Y, X, etc.) and two figures running from 10 to 99 for devices primarily intended for industrial or professional equipment.⁽¹⁾ The letter has no fixed meaning, except in the following cases:

- A for triacs, after second letter 'R' or 'T'
- F for emitters and receivers in fibre-optic communication, after second letter 'G', 'P' or 'Q'. When the second letter is 'G', the first letter should be defined in accordance with the material of the main optical device.
- L for lasers in non-fibre-optic applications, after second letter 'G' or 'Q'. When the second letter is 'G', the first letter should be defined in accordance with the material of the main optical device.
- O for opto-triacs, after second letter 'R'
- T for 3-state bicolour LEDs, after second letter 'Q'
- W for transient voltage suppressor diodes, after second letter 'Z'.

(1) When the supply of these serial numbers is exhausted, the serial number may be expanded to three figures for industrial types and four figures for consumer types.

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General

EXAMPLES OF BASIC TYPE NUMBERS

- AA112: germanium, low-power signal diode (consumer type)
 ACY32: germanium, low-power AF transistor (industrial type)
 BD232: silicon, power AF transistor (consumer type)
 CQY17: GaAs, light-emitting diode (industrial type)
 RPY84: CdS, photo-conductive cell (industrial type).

Version letter(s)

One or two letters may be added to the basic type number to indicate minor electrical or mechanical variants of the basic type. The letters never have a fixed meaning, except that the letter 'R' indicates reverse polarity and the letter 'W' indicates a surface mounted device (SMD).

Suffix

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

VOLTAGE REFERENCE AND VOLTAGE REGULATOR DIODES

One letter and one number, preceded by a hyphen (-). The letter, if required, indicates the nominal tolerance of the Zener voltage.

- A 1% (in accordance with IEC 63, series E96)
- B 2% (in accordance with IEC 63, series E48)
- C 5% (in accordance with IEC 63, series E24)
- D 10% (in accordance with IEC 63, series E12)
- E 20% (in accordance with IEC 63, series E6).

In the case of a 3% tolerance, the letter 'F' is used.

The number denotes the typical operating (Zener) voltage, related to the nominal current rating for the entire range. The letter 'V' is used in place of the decimal point.

Example: BZY74-C6V3 or -C10.

TRANSIENT VOLTAGE SUPPRESSOR DIODES

One number, preceded by a hyphen (-). The number indicates the maximum recommended continuous reversed (stand-off) voltage, V_R . The letter 'V' is used in place of the decimal point.

Example: BZW70-9V1 or -39.

The letter 'B' may be used immediately after the last number, to indicate a bidirectional suppressor diode.

Example: BZW10-15B.

CONVENTIONAL AND CONTROLLED AVALANCHE RECTIFIER DIODES AND THYRISTORS

One number, preceded by a hyphen (-). The number indicates the rated maximum repetitive peak reverse voltage, V_{RRM} , or the rated repetitive peak off-state voltage, V_{DRM} , whichever is the lower. Reversed polarity with respect to the case is indicated by the letter 'R' immediately after the number.

Example: BYT-100 or -100R.

RADIATION DETECTORS

One number, preceded by a hyphen (-). The number indicates the depletion layer in micrometres (μm). The resolution is indicated by a version letter.

Example: BPX10-2A.

ARRAY OF RADIATION DETECTORS AND GENERATORS

One number, preceded by a hyphen (-). The number indicates the number of basic devices assembled into the array.

Examples: BPW50-6, BPW50-9, BPW50-12.

HIGH FREQUENCY POWER TRANSISTORS

One number, preceded by a hyphen (-). The number indicates the supply voltage.

Example: BLU80-24.

RATING SYSTEMS

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

Definition of terms used

ELECTRONIC DEVICE

An electronic tube or valve, transistor or other semiconductor device. This definition excludes inductors, capacitors, resistors and similar components.

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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 that are directly related to the application.

RATING

A value that 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. Limiting conditions may be either maxima or minima.

RATING SYSTEM

The set of principles upon which ratings are established and which determine their interpretation. 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 the life of the device, 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 the life of the device, no design maximum value for the intended service is exceeded with a bogey electronic 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.

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General

LETTER SYMBOLS

The letter symbols for transistors and signal diodes detailed in this section are based on IEC publication number 148.

Letter symbols for currents, voltages and powers

BASIC LETTERS

I, i Current

V, v Voltage

P, p Power.

Upper-case letter symbols are used to represent all values except instantaneous values that vary with time, these are represented by lower-case letters.

SUBSCRIPTS

A, a	Anode terminal
(AV), (av)	Average value
B, b	Base terminal (for MOS devices: Substrate)
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-circuit
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)	Root-mean-square value
S, s	As first or second subscript: source terminal (FETs only). As second subscript: non-repetitive (not 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.

No additional subscript is used for DC values.

Upper-case subscripts are used for the indication of:

1. Continuous (DC) values (without signal), e.g. I_B
2. Instantaneous total values, e.g. i_B
3. Average total values, e.g. $I_{B(AV)}$
4. Peak total values, e.g. I_{BM}
5. Root-mean-square total values, e.g. $I_{B(RMS)}$

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

1. Instantaneous values, e.g. i_b
2. Root-mean-square values, e.g. $i_{b(rms)}$
3. Peak values, e.g. i_{bm}
4. Average values, e.g. $i_{b(av)}$

If more than one subscript is used, the subscript for which both styles exist are either all upper-case or all lower-case.

ADDITIONAL RULES FOR SUBSCRIPTS

Transistor currents

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_{bm} .

Diode currents

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

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

Transistor voltages

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} .

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General

Diode voltages

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_m .

Supply voltages or currents

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

Examples: V_{CC} , I_{EE} .

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

Example: V_{CCE} .

Subscripts for devices with 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 confusion.

Examples:

- I_{B2} continuous (DC) current flowing into the second base terminal
- V_{B2-E} continuous (DC) 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 necessary to avoid confusion.

Examples:

- I_{2C} continuous (DC) current flowing into the collector terminal of the second unit
- V_{1C-2C} continuous (DC) voltage between the collector terminals of the first and second units.

Application of the rules

Fig.1 represents a transistor collector current as a function of time. It comprises a continuous (DC) current and a varying component.

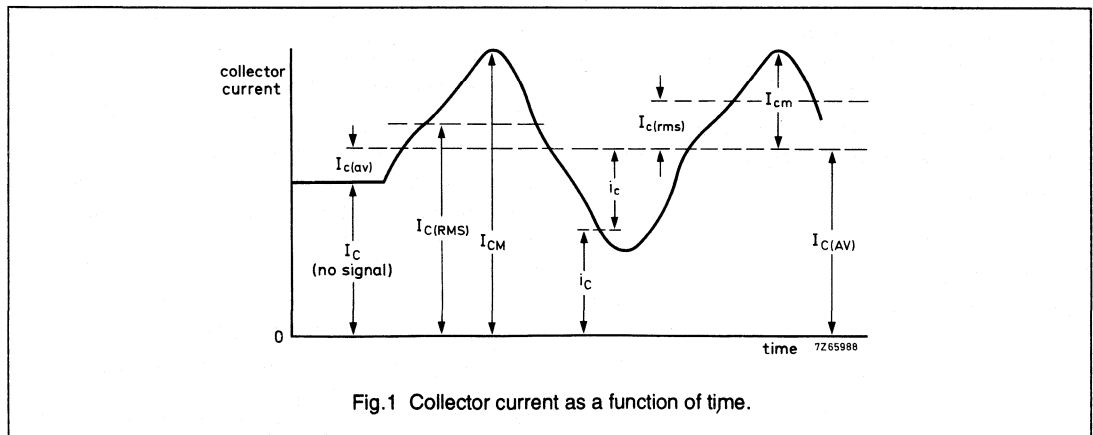


Fig.1 Collector current as a function of time.

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General

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 list comprises 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 are used for the representation of:

1. Electrical parameters of external circuits and of circuits in which the device forms only a part
2. All inductances and capacitances.

Lower-case letters are used for the representation of electrical parameters inherent in the device, with the exception of inductances and capacitances.

SUBSCRIPTS

General subscripts

The following list comprises the most important general subscripts used for electrical parameters of semiconductor devices.

- F, f Forward (forward transfer)
- I, i (or 1) Input
- L, l Load
- O, o (or 2) Output
- R, r Reverse (reverse transfer)
- S, s Source.

Examples: Z_s , h_i , h_F .

The upper-case variant of a subscript is used for the

designation of static (DC) values.

Examples:

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

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 is used for the designation of small-signal values.

Examples:

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

If more than one subscript is used, subscripts for which both styles exist are either all upper-case or all lower-case.

Example: h_{FE} , Y_{RE} , h_{ie} .

Subscripts for four-pole matrix parameters

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

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

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

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

DISTINCTION BETWEEN REAL AND IMAGINARY PARTS

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

Examples: $Z_i = R_i + jX_i$, $y_{ie} = g_{ie} + jb_{ie}$.

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

Examples:

- Re (h_b) etc. for the real part of h_b
- Im (h_b) etc. for the imaginary part of h_b .

High-voltage and Switching NPN Power Transistors

General

TRANSISTOR RATINGS

Voltage ratings

COLLECTOR TO BASE

V_{CBmax} The maximum permissible instantaneous voltage between collector and base terminals. The collector voltage is negative with respect to base in pnp transistors and positive with respect to base in npn types.

$V_{CBmax} (I_E = 0)$ The maximum permissible instantaneous voltage between collector and base terminals when the emitter terminal is open-circuit.

EMITTER TO BASE

V_{EBmax} The maximum permissible instantaneous voltage between emitter and base terminals. The emitter voltage is negative with respect to base in pnp transistors and positive with respect to base in npn types.

$V_{EBmax} (I_C = 0)$ The maximum permissible instantaneous voltage between emitter and base terminals when the collector terminal is open-circuit.

COLLECTOR TO EMITTER

V_{CEmax} The maximum permissible instantaneous voltage between collector and emitter terminals. The collector voltage is negative with respect to emitter in pnp transistors and positive with respect to emitter in npn types. This rating is very dependent on circuit conditions and collector current, and it is necessary to refer to the curve of V_{CE} versus I_C for the appropriate circuit condition in order to obtain the correct rating.

V_{CEmax} (Cut-off) The maximum permissible instantaneous voltage between collector and emitter terminals when the emitter current is reduced to zero by means of a reverse emitter base voltage, i.e. the base voltage is normally positive with respect to emitter for pnp transistors and negative with respect to emitter for npn types. The term '(Cut-off)' is sometimes replaced by $V_{BE} > x V$, or $R_B/R_E \leq y$, which are equivalent conditions under which the transistor may be cut off.

$V_{CEmax} (I_C = x \text{ mA})$ The maximum permissible instantaneous voltage between collector and emitter terminals when the collector current is at a high value, often the maximum rated value.

$V_{CEmax} (I_B = 0)$ The maximum permissible instantaneous voltage between collector and emitter terminals when the base terminal is open-circuit or when a very high resistance is in series with the base terminal. Special care must be taken to ensure that thermal runaway due to excessive collector leakage current does not occur in this condition.

Due to the current dependency of V_{CE} it is usual to present this information as a voltage rating chart, a curve of collector current as a function of collector-to-emitter voltage (see Fig.2). The permissible area of operation under all conditions of base drive (provided the dissipation rating is not exceeded) is shown as area 1 and operation under certain specified conditions is shown as area 2. To assist in determining the rating in area 2, further curves can relate the voltage rating to external circuit conditions, for example: R_B/R_E , R_B , $Z_{B\theta}$, V_{BE} , I_B or V_{BB}/R_B . An example of this type of curve is given in Fig.3 with V_{CE} as a function of R_B/R_E for two values of collector current.

It should be noted that when R_E is shunted by a capacitor, during switching, the collector voltage V_{CE} must be restricted to a value that does not rely on the effect of R_E .

In the case of an inductive load, when an energy rating is given, it may be safe to operate outside the rated area provided the specified energy rating is not exceeded.

High-voltage and Switching NPN Power Transistors

General

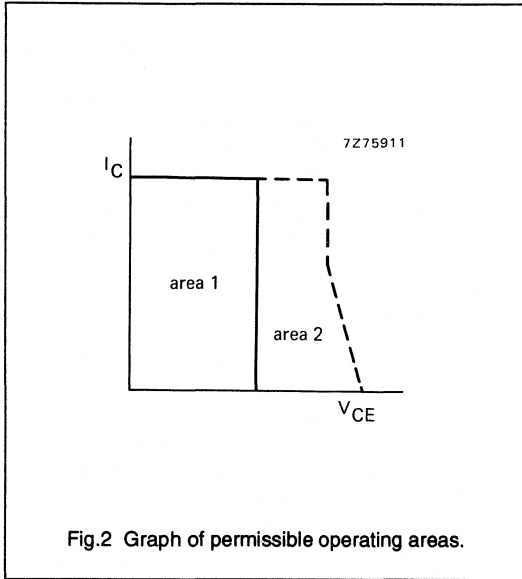


Fig.2 Graph of permissible operating areas.

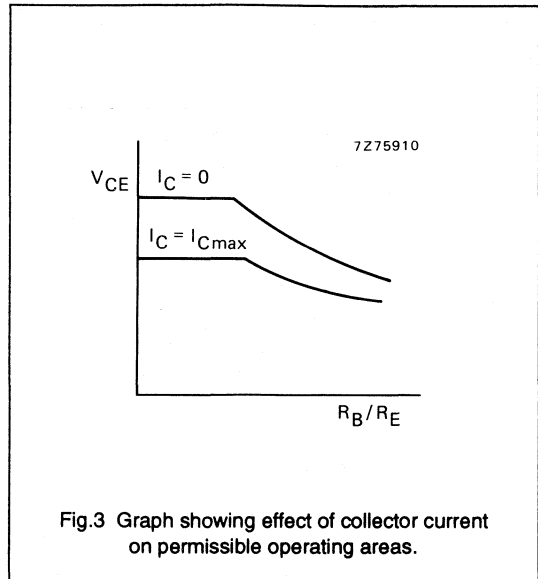


Fig.3 Graph showing effect of collector current on permissible operating areas.

Current ratings

COLLECTOR

- I_{Cmax} The maximum permissible collector current. Without further qualification, the DC value is implied.
- $I_{C(AV)max}$ The maximum permissible average value of the total collector current.
- I_{CM} The maximum permissible instantaneous value of the total collector current.

EMITTER

- I_{Emax} The maximum permissible emitter current. Without further qualification, the DC value is implied.
- $I_{E(AV)max}$ The maximum permissible average value of the total emitter current.
- $I_{ER(AV)max}$ The maximum permissible average value of the total emitter current when operating in the reverse emitter-base breakdown region.
- I_{EM} The maximum permissible instantaneous value of the total emitter current.
- I_{ERM} The maximum permissible instantaneous value of the total emitter current when operating in the reverse breakdown region.

BASE

- I_{Bmax} The maximum permissible base current. Without further qualification, the DC value is implied.
- $I_{B(AV)max}$ The maximum permissible average value of the total base current.
- $I_{BR(AV)max}$ The maximum permissible average value of the total base current when operating in the reverse breakdown region.
- I_{BM} The maximum permissible instantaneous value of the total base current. The rating also includes the switch-off current.
- I_{BRM} The maximum permissible instantaneous value of the total reverse current allowable in the reverse breakdown region.

High-voltage and Switching NPN Power Transistors

General

Power ratings

The total maximum permissible continuous power dissipation in the transistor, $P_{tot\ max}$, includes collector-base dissipation and emitter-base dissipation. Under steady state conditions, the total power is given as:

$$P_{tot} = V_{CE} \times I_C + V_{BE} \times I_B$$

In order to distinguish between 'steady state' and 'pulse' conditions, the terms 'steady state power (P_S)' and 'pulse power (P_p)' can be used. The permissible total power dissipation is dependent on temperature; this relationship is shown in Fig.4.

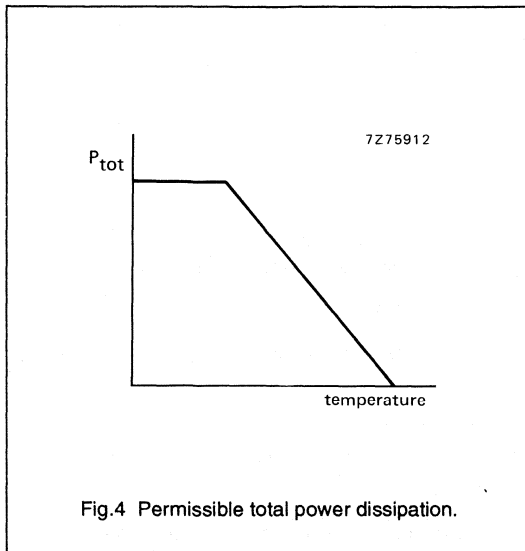


Fig.4 Permissible total power dissipation.

The temperature may be the ambient, the case or the mounting base temperature. Where a cooling clip or heatsink is attached to the device, the allowable power dissipation is also dependent on the efficiency of the heatsink.

The efficiency of this clip or heatsink is measured in terms of its thermal resistance ($R_{th\ h}$) normally expressed in degrees kelvin per watt (K/W). For mounting-base rated devices, the added effect of the contact resistance ($R_{th\ i}$) must be taken into account.

The effect of heatsinks of various thermal and contact resistance is often included in the graph of permissible total power dissipation.

The relationship between maximum power dissipation, ambient temperature and thermal heatsink resistance is given by:

$$P_{tot} = \frac{T_j - T_{amb}}{R_{th\ j-a}}$$

where $R_{th\ j-a}$ is the thermal resistance from the transistor junction to the ambient. For case rated or mounting-base rated devices, the thermal resistance $R_{th\ j}$ is made up of the thermal resistance junction to case or mounting-base ($R_{th\ j-mb}$), the contact thermal resistance ($R_{th\ i}$) and the heatsink thermal resistance ($R_{th\ h}$).

For the calculation of pulse power operation, the maximum pulse power is obtained using a graph as shown in Fig.5.

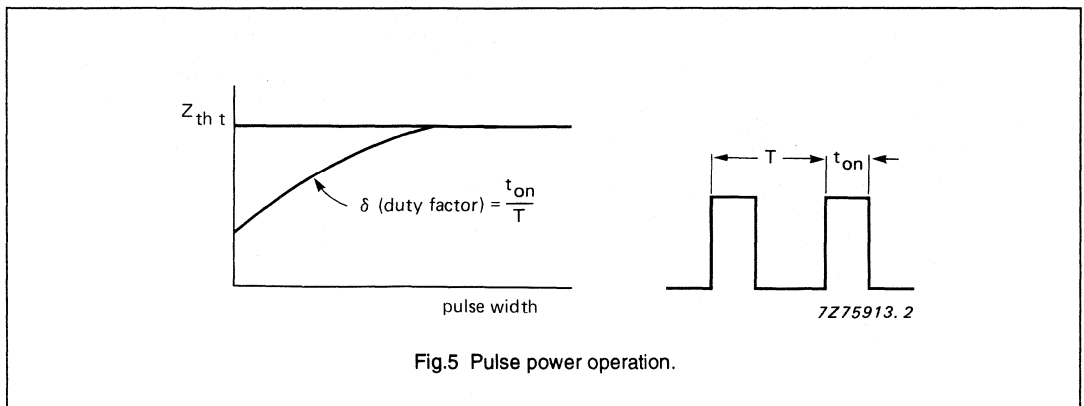


Fig.5 Pulse power operation.

High-voltage and Switching NPN Power Transistors

General

The general expression from which the maximum pulse power dissipation can be calculated is:

$$P_P = \frac{T_j - T_{amb} - P_S \times R_{th\ j-a}}{Z_{th\ i} + \delta (R_{th\ c-a})}$$

where $Z_{th\ i}$ and δ are given in Fig.5 and $R_{th\ c-a}$ is the thermal resistance between case and ambient for a case rated device. For a mounting-base rated device, it is equal to $R_{th\ h} + R_{th\ i}$ and is zero for a free-air rated device because the effect of the temperature rise of the case over the ambient for a pulse train is already included in $Z_{th\ i}$.

Temperature ratings

$T_{j\ max}$ The maximum permissible junction temperature which is used as the basis for the calculation of power ratings. Unless otherwise stated, the continuous value is implied.

$T_{j\ max}$ (continuous operation): indicates the maximum permissible continuous value.

$T_{j\ max}$ (intermittent operation): indicates the maximum permissible instantaneous junction temperature usually allowed for a total duration of 200 hours.

T_{mb} The temperature of the surface in contact with the heatsink. This is confined to devices where a flange or stud for fixing onto a heatsink forms an integral part of the envelope.

T_{case} The temperature of the envelope. This is confined to devices that may have a clip-on cooling fin attachment.

TRANSISTOR SAFE OPERATING AREA (SOAR)

There are two main limiting factors which affect the power handling ability of a transistor; the average junction temperature and the second breakdown. To indicate these limitations, the data sheets contain safe operating area curves specific to the type and, for reliable operation of the transistor, the I_C/V_{CE} limits shown by these curves must never be exceeded. The following advice on SOAR will enable design engineers to make optimum use of the information in the data sheets.

Average junction temperature

Heat dissipation in the collector-base junction flows through the thermal resistance $R_{th\ j-mb}$ between junction and mounting base, see Fig.6.

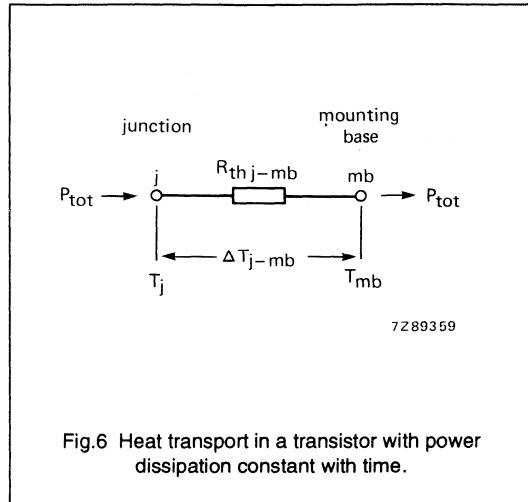


Fig.6 Heat transport in a transistor with power dissipation constant with time.

For steady-state (DC) operation the junction temperature will increase to:

$$T_j = T_{mb} + P_{tot} R_{th\ j-mb}$$

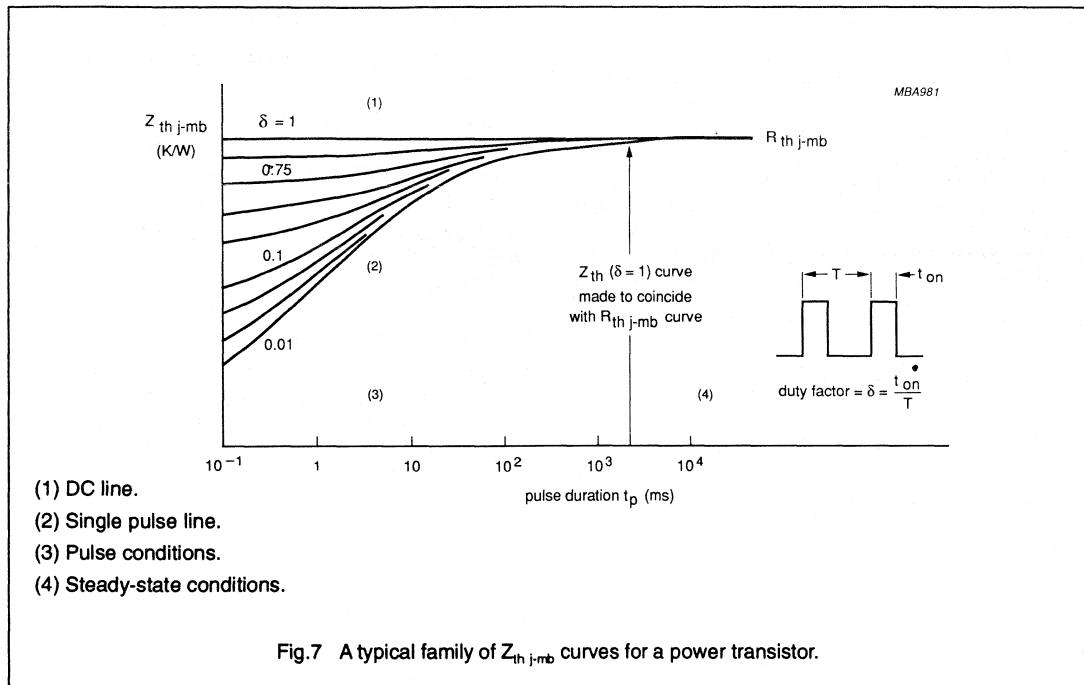
and for pulse operation the junction temperature will be:

$$T_j = T_{mb} + P_{tot} Z_{th\ j-mb}$$

During pulse operation the junction has no time to be fully heated and will wholly or partly cool during the interval between pulses. For this reason a higher dissipation is permitted, see Fig.7.

This curve may be represented by absolute values ($Z_{th\ j-mb}$) or as normalized thermal impedance (NTI), where:

$$NTI = \frac{Z_{th\ j-mb}}{R_{th\ j-mb}}$$



Maximum allowable dissipation

Total power dissipation in a transistor is given by:

$$P_{tot} = I_C V_{CE} + I_B V_{BE}$$

The second term can usually be disregarded, so

$$P_{tot} \approx I_C V_{CE}$$

The maximum allowable power dissipation is limited to the maximum allowable junction temperature for the constant power curves (P_{tot}) and by second breakdown curves, see Fig.8.

Constant power curves

Calculation of P_{tot} can be as follows:

for steady-state (DC) conditions

$$P_{tot} = \frac{T_{j\ max} - T_{mb}}{R_{th\ j-mb}}$$

for pulsed conditions

$$P_{tot} = \frac{T_{j\ max} - T_{mb}}{Z_{th\ j-mb}}$$

The maximum power dissipation ($P_{tot\ max}$ DC) mostly specified in a data sheet is for a given mounting base temperature, this is usually $T_{mb} = 25^\circ\text{C}$ but may be much higher.

The maximum power dissipation cannot be referred to the mounting base for transistors in fully isolated envelopes (SOT186, SOT199 and SOT227 (ISOTOP)). For these, the data sheets specify a given heatsink temperature (T_h), which may be calculated as follows:

for steady-state (DC) conditions

$$P_{tot} = \frac{T_{j\ max} - T_h}{R_{th\ j-mb}}$$

for pulsed conditions

$$P_{tot} = \frac{T_{j\ max} - T_h}{Z_{th\ j-mb}}$$

The temperature specified in a data sheet is usually $T_h = 25^\circ\text{C}$ but may be much higher. The total thermal resistance/impedance includes the transfer resistance from the case to heatsink under specific mounting conditions.

High-voltage and Switching NPN Power Transistors

General

Second breakdown curves

In the forward biased condition, second breakdown is a thermally-triggered avalanche effect which, once started, will destroy the transistor. The mechanism can be understood by considering the device as a large number of elemental transistors in parallel, some of which will have a lower forward voltage drop than others. Current will tend to gather in these, raising their temperature and further lowering their forward voltage drop. Current will concentrate still further, leading to local overheating and eventually a short circuit between emitter and collector.

This effect can occur under various conditions:

- forward biased up to V_{CE0max}
- forward biased with $V_{CE} > V_{CE0max}$
- reverse biased up to V_{CESmax}

In the data sheets, safe operating area curves for the first condition are given for every power transistor; curves showing extensions for the safe operating area for the other two conditions are specified only for power switching transistors.

Forward biased safe operation area up to V_{CE0max}

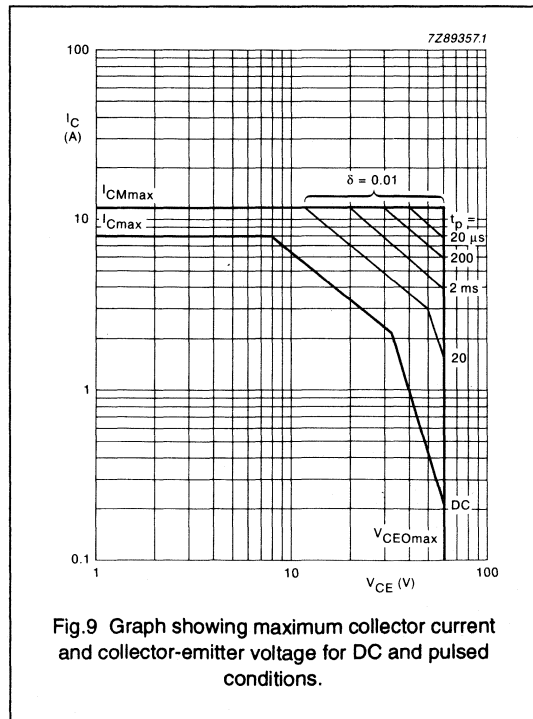
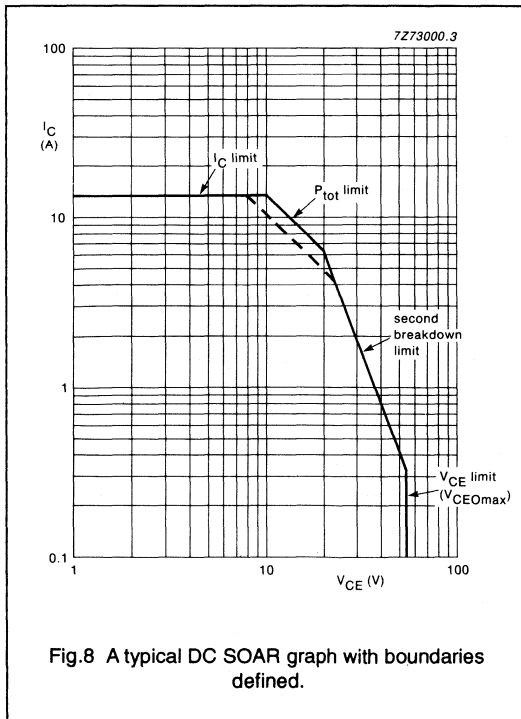
Four operating limits form the boundaries of the forward biased safe operating area up to V_{CE0max} :

- maximum collector current, I_C or I_{CM}
- maximum collector-emitter voltage, V_{CE0max}
- maximum power dissipation, P_{tot}
- second breakdown limit, S/B_{set} .

Forward biased SOAR curves are specified for both DC and pulse operation to cover the widest range of applications.

IN STEADY STATE CONDITIONS

A DC forward biased SOAR curve plotted on a log-log grid is shown in Fig.8. The right-hand boundary is formed by V_{CE0max} which extends up to a collector current of 300 mA, above this point as I_{Cmax} is increased V_{CE} must be reduced to prevent second breakdown.



High-voltage and Switching NPN Power Transistors

General

The upper boundary is formed by I_{Cmax} , which extends to where the product of I_{Cmax} and V_{CE} equals the maximum power dissipation. From this point I_C must be reduced as V_{CE} is increased, thus forming the constant power curve of the maximum power dissipation boundary.

This maximum power dissipation boundary will normally intersect the second breakdown boundary at some point. However, for values of T_{mb} above the T_{mb} specified, $P_{tot max}$ must be reduced (as shown by the broken line in Fig.8), so that the boundary of maximum power dissipation intersects the second breakdown boundary at a lower point.

IN PULSED CONDITIONS

With the exception of DC forward biased SOAR, data sheets for power transistors contain a set of curves that apply under specific pulse conditions, normally at a duty factor of $\delta = 0.01$ and at pulse lengths of 20 ms or less. An example of the forward biased SOAR extension for single-shot and repetitive pulsed operation is shown in Fig.9.

The curves for pulsed conditions shown in Fig.9 are derived from the DC curve with the aid of the thermal impedance curves shown in Fig.7.

All curves apply to the temperature stated in the data sheet (T_{mb} or T_h). Derating must be applied for the allowable P_{tot} at any T_{mb} or T_h up to $T_{j max}$, an example of a power derating curve is shown in Fig.10. The second breakdown curve is valid for all temperatures up to $T_{j max}$ unless an I_{SB} (second breakdown current) derating curve is specified, in which case derating has to be applied.

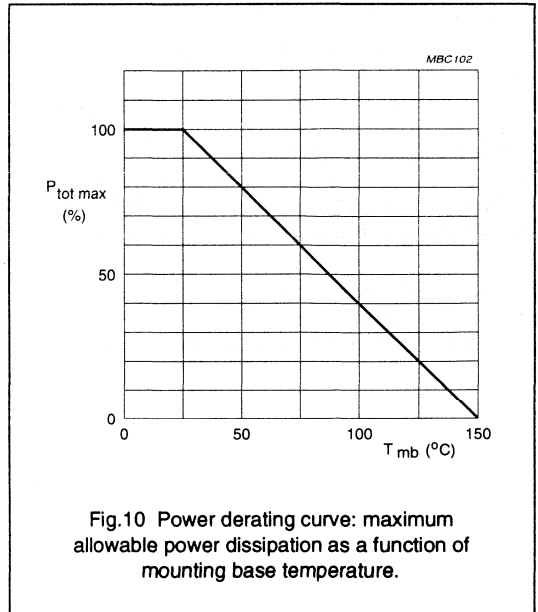


Fig.10 Power derating curve: maximum allowable power dissipation as a function of mounting base temperature.

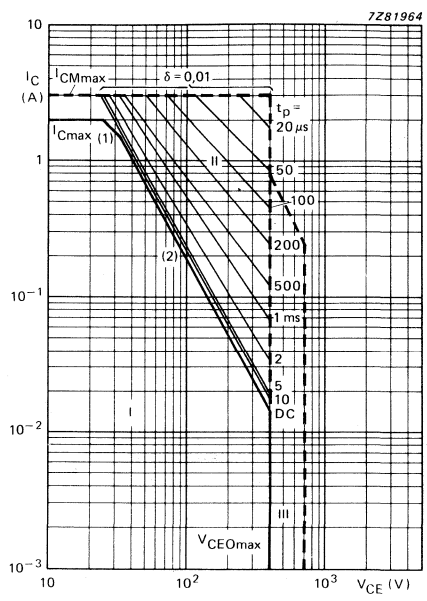
High-voltage and Switching NPN Power Transistors

General

Forward biased safe operating area with $V_{CE} > V_{CE0max}$

For switching power transistors in inductive load applications such as flyback converters, the collector-emitter voltage normally exceeds the rated V_{CE0max} limit in the non-inductive stage. The collector current will rise steeply at turn-on while the collector-emitter voltage is still greater than V_{CE0max} . Under these conditions the collector current must be held at a safe level by means of load line shaping or similar circuits.

Figure 11 shows forward biased SOAR with an extension for turn-on (area III); this is not temperature dependent and therefore derating at higher temperatures is not necessary.



- I Region of permissible DC operation.
 - II Permissible extension for repetitive pulse operation.
 - III Area of permissible operation during turn-on in single-transistor converters, provided $R_{BE} \leq 100 \Omega$ and $t_p \leq 6.0 \mu s$.
- (1) $P_{tot max}$ and $P_{tot peak}$ maximum lines.
 (2) Second breakdown limits.

Fig. 11 Safe operating area at $T_{amb} \leq 25 \text{ }^\circ\text{C}$.

High-voltage and Switching NPN Power Transistors

General

Reversed biased safe operating area up to V_{CESmax}

Most inductively loaded transistors operate with their base to emitter junction reverse biased. At turn-off, the inductive loading causes the collector to emitter voltage to rise steeply to a high level while the collector continues to conduct. Under these conditions the collector voltage must be held to a safe level by means of a clamping, snubbing or similar circuit.

The SOAR extension for this reverse biased operation is shown in the relevant data sheets in a graph as in Fig.12. This turn-off extension is not temperature dependent and so derating at higher temperatures is not necessary.

Using data sheet SOAR information

Select a power transistor for a particular function or application using the following criteria from QUICK REFERENCE DATA:

- collector current, I_C or I_{CM}
- collector voltage, V_{CEO} or V_{CES}
- maximum allowable dissipation, P_{tot}
- maximum allowable junction temperature, T_j
- required gain, h_{FE}
- required speed, t_r or f_T .

Determine the following parameters for the intended application:

- duty factor, δ
- maximum operating ambient temperature, T_{amb}
- maximum operational, worst-case average dissipation, P_{WC} .

Calculate the thermal resistance of the heatsink, $R_{th\ h-a}$:
for directly mounted devices

$$R_{th\ h-a} = \frac{T_j - T_{mb}}{P_{WC}} - (R_{th\ j-mb} + R_{th\ mb-h})$$

or for fully isolated devices

$$R_{th\ h-a} = \frac{T_j - T_{mb}}{P_{WC}} - R_{th\ j-mb}$$

Calculate the mounting base temperature, T_{mb} or T_h :

for directly mounted devices

$$T_{mb} = T_{amb} + P_{WC}(R_{th\ h-a} + R_{th\ mb-h})$$

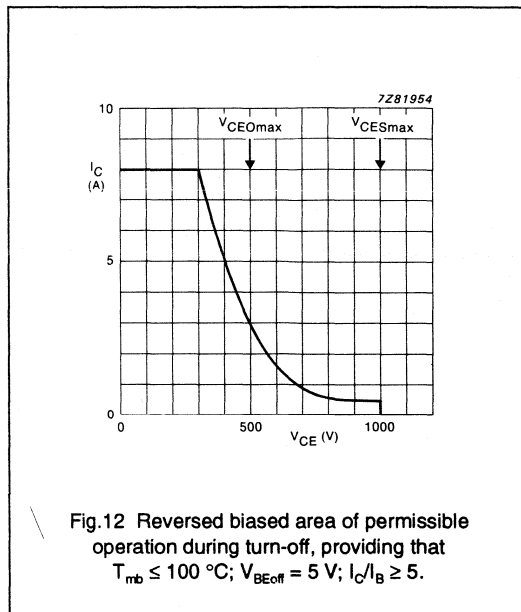


Fig.12 Reversed biased area of permissible operation during turn-off, providing that $T_{mb} \leq 100\text{ }^\circ\text{C}$; $V_{BEoff} = 5\text{ V}$; $I_C/I_B \geq 5$.

or for fully isolated devices

$$T_h = T_{amb} + P_{WC} \times R_{th\ h-a}$$

Use the data sheet SOAR curves, thermal impedance and derating to construct a safe operating area for the device (this can be adapted to the conditions for the application, e.g. T_{mb} , pulse time, duty factor).

Measure the I_C/V_{CE} locus in the application and check that it does not exceed the previously-constructed SOAR graph. In switching applications check also the extensions for turn-on and turn-off.

If the SOAR of the preferred transistor does not fit the requirements, select the nearest suitable device or modify the application circuit.

TRANSISTOR DATA

Silicon diffused power transistors

BU406/BU407

DESCRIPTION

High-voltage, high-speed, glass-passivated npn power transistors in a TO-220 envelope, intended for use in converters, inverters, switching regulators, motor control systems, etc.

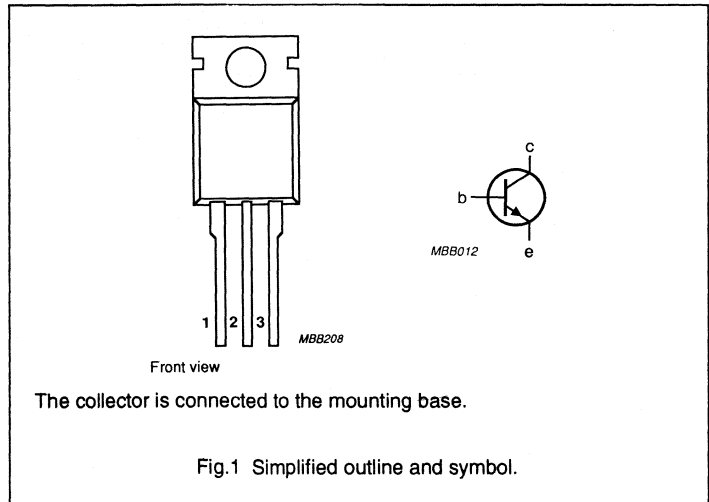
PINNING

PIN	DESCRIPTION
1	base
2	collector
3	emitter

QUICK REFERENCE DATA

SYMBOL	PARAMETER	CONDITIONS	MAX.	UNIT
V_{CESM}	collector-emitter voltage	peak value; $V_{BE} = 0$	400	V
	BU406		330	V
V_{CEO}	collector-emitter voltage	open base	200	V
	BU406		150	V
$V_{CE\ sat}$	collector-emitter saturation voltage		1	V
I_C	collector current	DC value	7	A
I_{CM}	collector current	peak value	15	A
$I_{C\ sat}$	collector saturation current		5	A
P_{tot}	total power dissipation	up to $T_{mb} = 25\ ^\circ C$	65	W
t_{off}	turn-off time	inductive load	0.75	μs

PIN CONFIGURATION



Silicon diffused power transistors

BU406/BU407

LIMITING VALUES

In accordance with the Absolute Maximum System (IEC 134).

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_{CESM}	collector-emitter voltage	peak value; $V_{BE} = 0$	-	400	V
	BU406				
V_{CEO}	collector-emitter voltage	open base	-	200	V
	BU407				
I_C	collector current	DC value	-	7	A
I_{CM}	collector current	peak value	-	15	A
I_B	base current	DC value	-	4	A
I_{BM}	base current	peak value	-	6	A
P_{tot}	total power dissipation	up to $T_{mb} = 25\text{ }^\circ\text{C}$	-	65	W
T_{stg}	storage temperature range		-65	150	$^\circ\text{C}$
T_j	junction temperature		-	150	$^\circ\text{C}$

THERMAL RESISTANCE

SYMBOL	PARAMETER	VALUE	UNIT
$R_{th\ j-mb}$	from junction to mounting base	1.92	K/W

Silicon diffused power transistors

BU406/BU407

CHARACTERISTICS $T_j = 25\text{ °C}$ unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
I_{CES}	collector cut-off current (note 1)	$V_{CE} = V_{CES\text{ max}}$ $V_{BE} = 0$	–	5	mA
	BU406	$V_{CE} = 250\text{ V}$; $V_{BE} = 0$	–	0.1	mA
	BU406	$V_{CE} = 350\text{ V}$; $V_{BE} = 0$; $T_j = 150\text{ °C}$	–	1	mA
	BU407	$V_{CE} = 200\text{ V}$; $V_{BE} = 0$	–	0.1	mA
	BU407	$V_{CE} = 200\text{ V}$; $V_{BE} = 0$; $T_j = 150\text{ °C}$	–	1	mA
I_{EBO}	emitter cut-off current	$V_{EB} = 5\text{ V}$; $I_C = 0$	–	1	mA
$V_{CE\text{ sat}}$	collector-emitter saturation voltage	$I_C = 5\text{ A}$; $I_B = 0.5\text{ A}$	–	1	V
$V_{BE\text{ sat}}$	base-emitter saturation voltage	$I_C = 5\text{ A}$; $I_B = 0.5\text{ A}$	–	1.2	V
f_T	transition frequency	$V_{CE} = 10\text{ V}$; $I_C = 0.5\text{ A}$	4	–	MHz
$V_{CEO\text{ sust}}$	collector-emitter sustaining voltage	$I_C = 200\text{ mA}$; $I_B = 0$; $L = 25\text{ mH}$			
	BU406		200	–	V
	BU407		150	–	V
Switching times inductive load (See Figs 2 and 3)					
t_{off}	turn-off time	$I_{C\text{ on}} = 5\text{ A}$; $I_{B\text{ on}} = 0.5\text{ A}$	–	0.75	μs

Note

1. Measured with a half sine wave voltage (curve tracer).

Silicon diffused power transistors

BU406/BU407

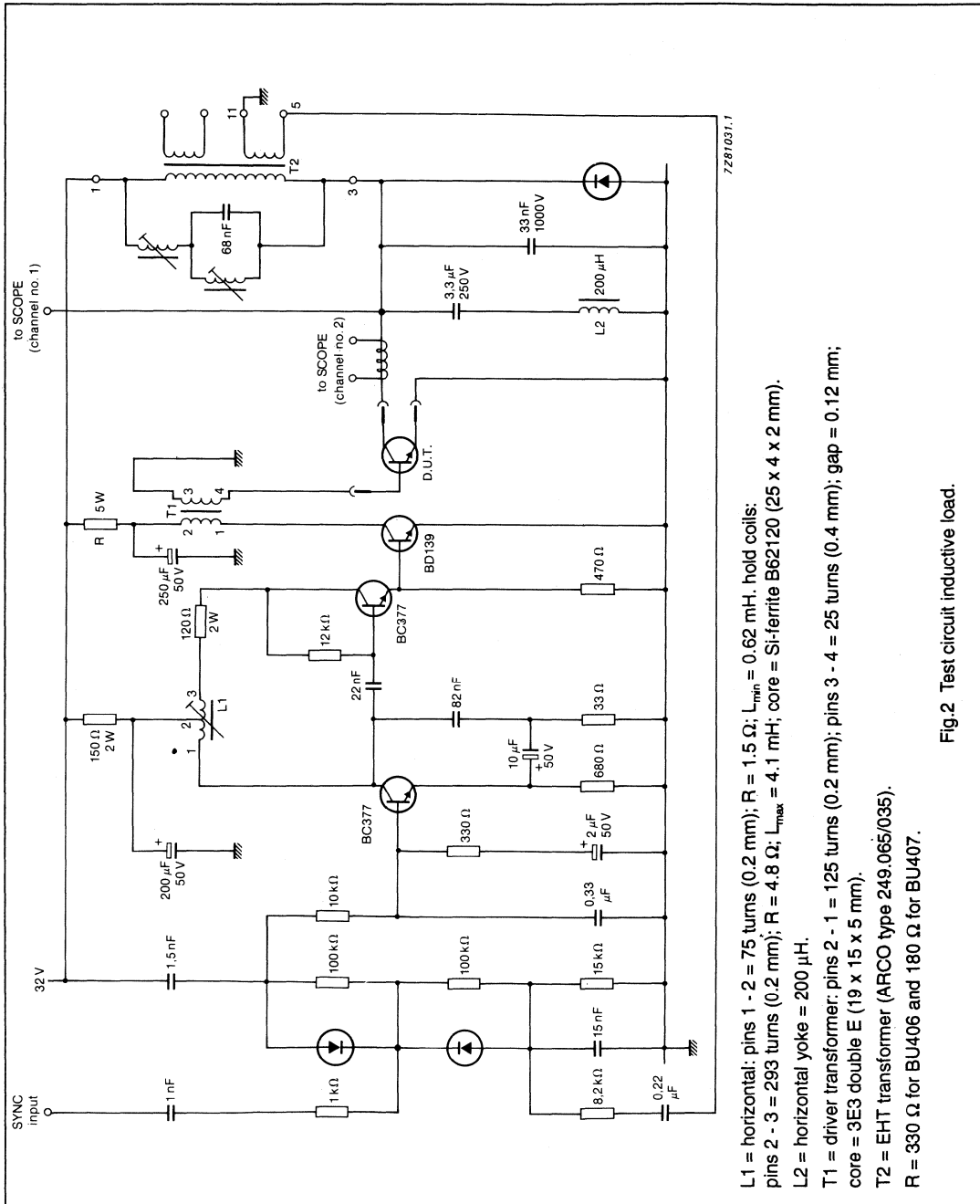
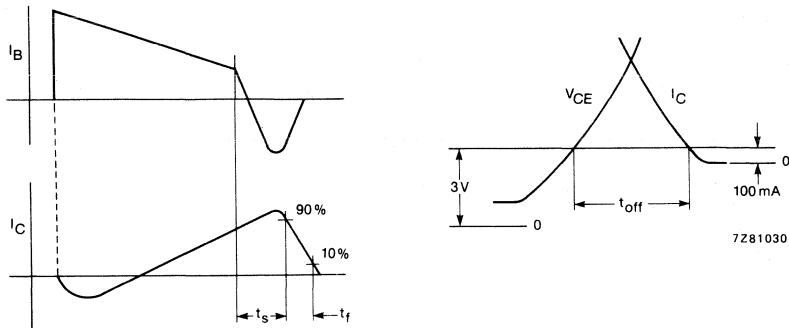


Fig.2 Test circuit inductive load.

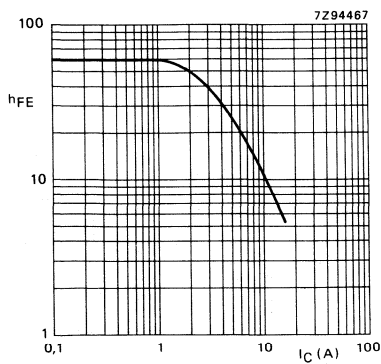
Silicon diffused power transistors

BU406/BU407



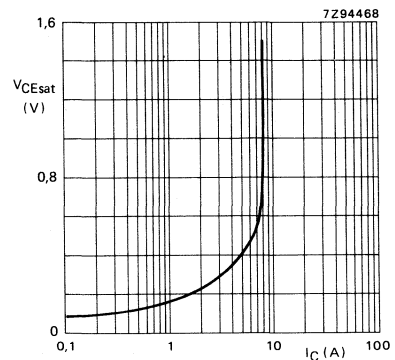
The turn-off time is the time taken for I_C to decrease to 100 mA after V_{CE} has risen 3 V into its flyback position.

Fig.3 Waveforms for fall, storage and turn-off times.



BU406.
 $V_{CE} = 5 \text{ V}; T_j = 25 \text{ }^\circ\text{C}.$

Fig.4 DC current gain, typical values.

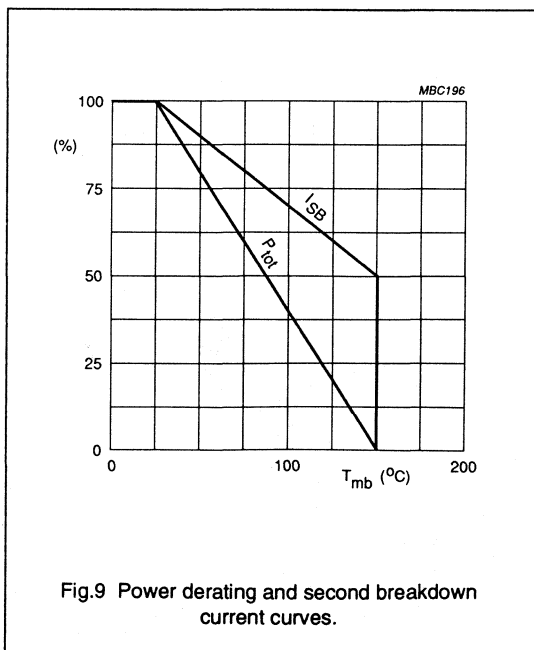
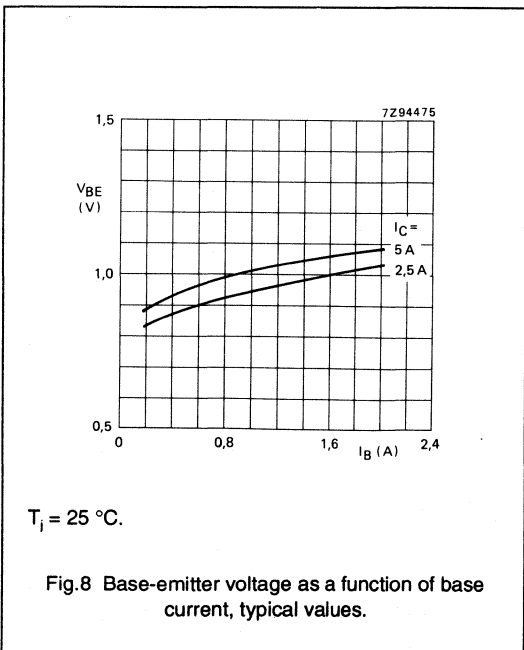
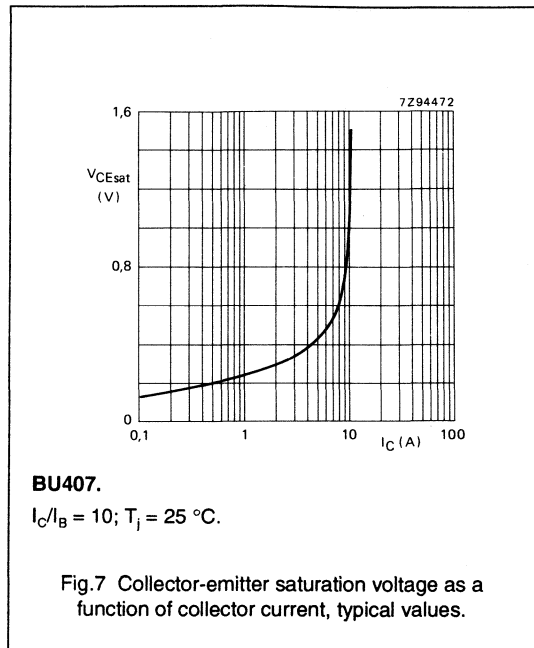
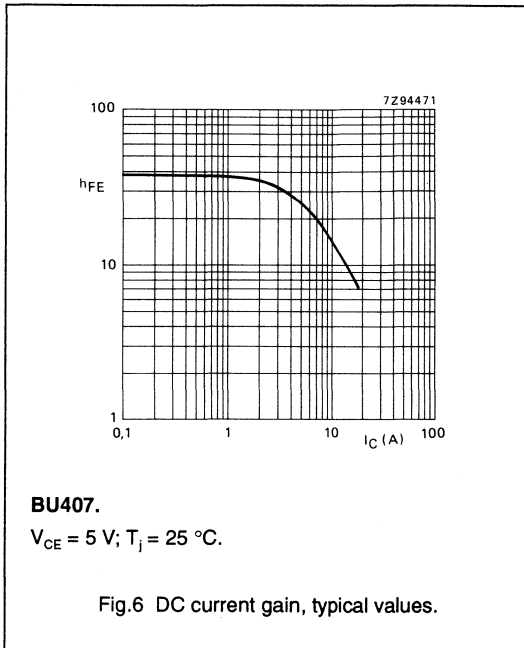


BU406.
 $I_C/I_B = 10; T_j = 25 \text{ }^\circ\text{C}.$

Fig.5 Collector-emitter saturation voltage as a function of collector current, typical values.

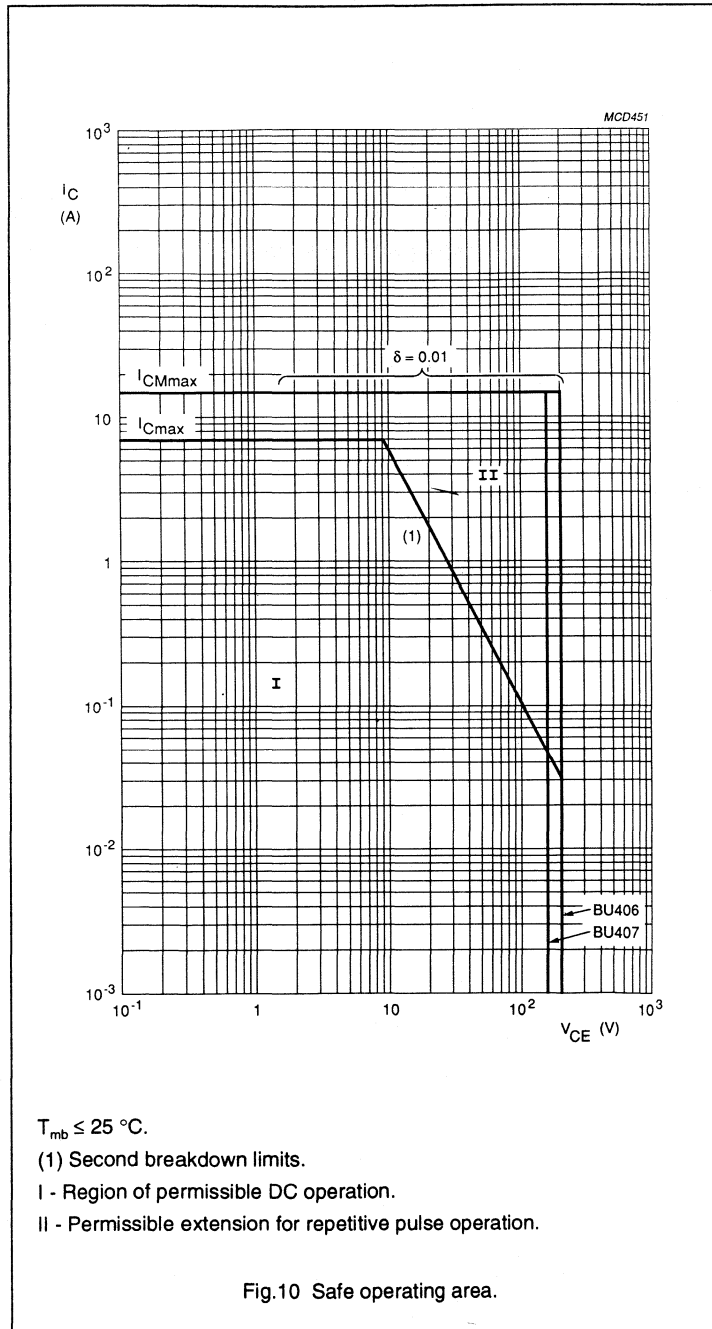
Silicon diffused power transistors

BU406/BU407



Silicon diffused power transistors

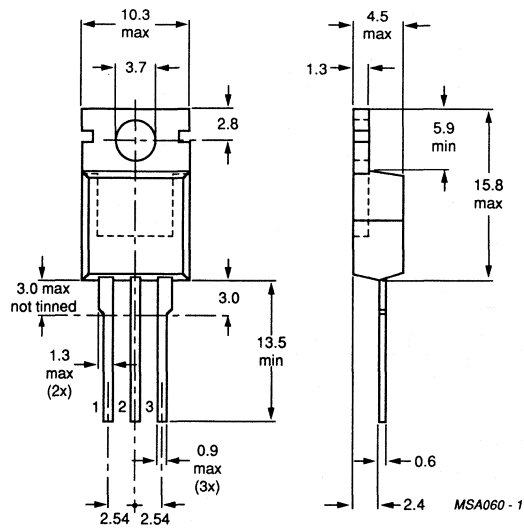
BU406/BU407



Silicon diffused power transistors

BU406/BU407

PACKAGE OUTLINE



Dimensions in mm.

Fig.11 TO-220AB.

SILICON DIFFUSED POWER TRANSISTORS

High-voltage, high-speed, glass-passivated npn power transistor in a SOT186 envelope with electrically isolated mounting base, intended for use in converters, inverters, switching regulators and motor control systems etc.

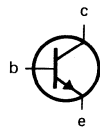
QUICK REFERENCE DATA

		BU406F	407F
Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM}	max. 400	330 V
	V_{CEO}	max. 200	150 V
	V_{CEsat}	max. 1.0	V
Collector-emitter saturation voltage			
Collector current saturation DC peak value	I_{Csat}	max. 5.0	A
	I_C	max. 7.0	A
	I_{CM}	max. 15	A
Total power dissipation up to $T_h = 25^\circ C$	P_{tot}	max. 18	W
Turn off time (inductive load)	t_{off}	max. 0.75	μs

MECHANICAL DATA

Dimensions in mm

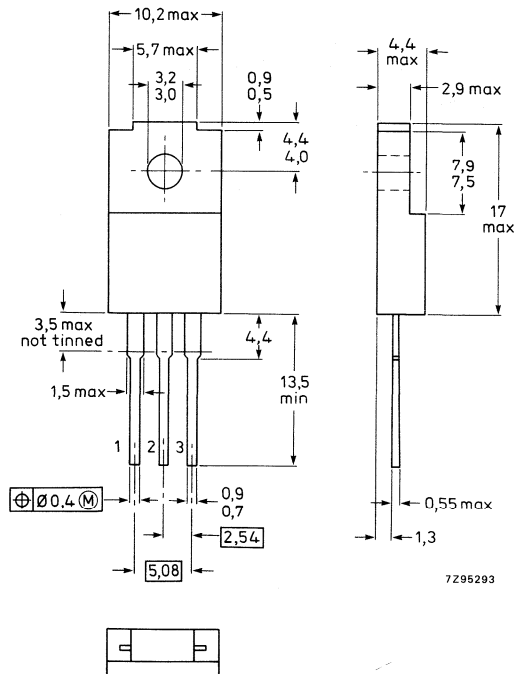
Fig. 1 SOT186 .



Pinning:

- 1 = base
- 2 = collector
- 3 = emitter

Mounting base is electrically isolated from all terminals.



7295293

RATINGS

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

			BU406F	407F
Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM}	max.	400	330 V
	V_{CEO}	max.	200	150 V
Collector current DC peak value	I_C	max.	7.0	A
	I_{CM}	max.	15	A
Base current DC peak value	I_B	max.	4.0	A
	I_{BM}	max.	6.0	A
Total power dissipation up to $T_h = 25^\circ\text{C}$	P_{tot}	max.	18	W
Storage temperature range	T_{stg}		-65 to + 150 °C	
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

From junction to external heatsink (1)	$R_{th\ j-h}$	=	7.0	K/W
From junction to external heatsink (2)	$R_{th\ j-h}$	=	4.5	K/W
From junction to ambient	$R_{th\ j-a}$	=	55	K/W

ISOLATION

Isolation voltage from all terminals to external heatsink (peak value) (3)	V_{TH}	max.	1500	V
Isolation capacitance from collector to external heatsink	C_{TH}	typ.	12	pF

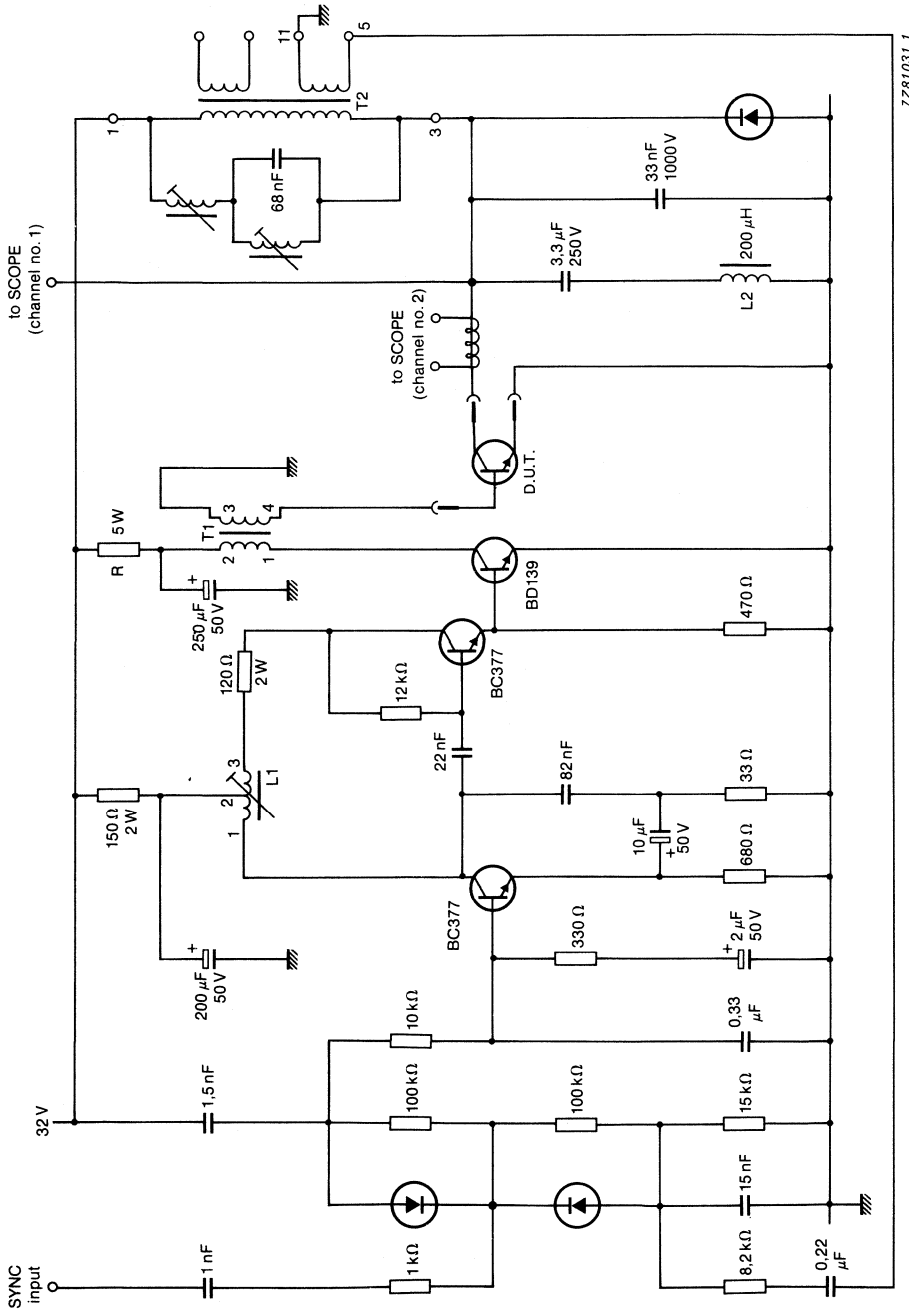
Notes

1. Mounted without heatsink compound and 30 ± 5 newtons pressure on centre of envelope.
2. Mounted with heatsink compound and 30 ± 5 newtons pressure on centre of envelope.
3. Repetitive peak operation with $RH \leq 65\%$ under clean and dust free conditions.

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

		BU406F	407F
Collector cut-off currents*			
$V_{CE} = V_{CESmax}; V_{BE} = 0$	I_{CES}	max. 5.0	5.0 mA
$V_{CE} = 250\text{ V}; V_{BE} = 0$	I_{CES}	max. 0.1	— mA
$V_{CE} = 350\text{ V}; V_{BE} = 0; T_j = 150\text{ }^\circ\text{C}$	I_{CES}	max. 1.0	— mA
$V_{CE} = 200\text{ V}; V_{BE} = 0$	I_{CES}	max. —	0.1 mA
$V_{CE} = 200\text{ V}; V_{BE} = 0; T_j = 150\text{ }^\circ\text{C}$	I_{CES}	max. —	1.0 mA
Collector-emitter sustaining voltage			
$I_C = 200\text{ mA}; I_B = 0; L = 25\text{ mH}$	$V_{CEO_{sust}}$	min. 200	150 V
Emitter cut-off current			
$I_C = 0; V_{EB} = 5\text{ V}$	I_{EBO}	max. 1.0	mA
Saturation voltages			
$I_C = 5\text{ A}; I_B = 0.5\text{ A}$	V_{CEsat}	max. 1.0	V
	V_{BEsat}	max. 1.2	V
Transition frequency			
$I_C = 0.5\text{ A}; V_{CE} = 10\text{ V}$	f_T	min. 4.0	MHz
Switching times inductive load (Figs 2 and 3)			
$I_{Con} = 5\text{ A}; I_{Bon} = 0.5\text{ A}$	t_{off}	max. 0.75	μs

* Measured with a half-sinewave voltage (curve tracer).



7Z87031.1

L1 = horizontal hold coils: pins 1-2 = 75 turns (0.2 mm); pins 2-3 = 293 turns (0.2 mm); core = Si-ferrite B62120 (25 x 4 x 2 mm)
L2 = horizontal yoke = 200 μH

T1 = driver transformer: pins 2-1 = 125 turns (0.2 mm); pins 3-4 = 25 turns (0.4 mm); gap = 0.12 mm; core = 3E3 double E (19 x 15 x 5 mm)

T2 = EHT transformer (ARCO type 249.065/035)
R = 330 Ω for BU406F; 180 Ω for BU407F

Fig. 2 Test circuit inductive load.

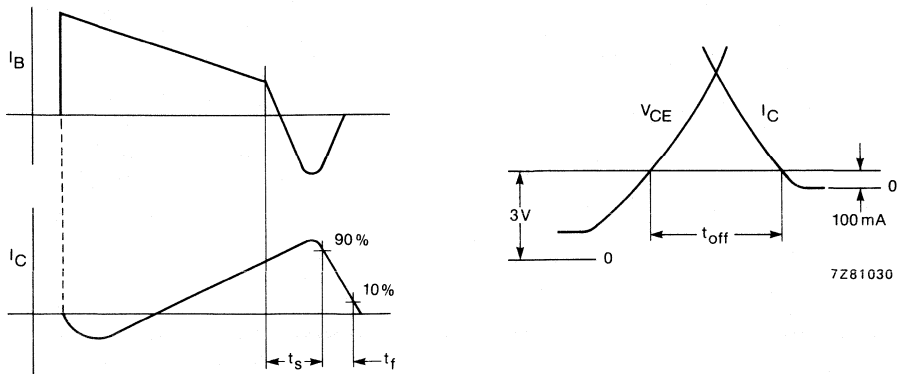


Fig. 3 Waveforms fall and storage time and turn-off time: turn-off time is the time for I_C to decrease to 100 mA after V_{CE} has risen 3 V into its flyback excursion.

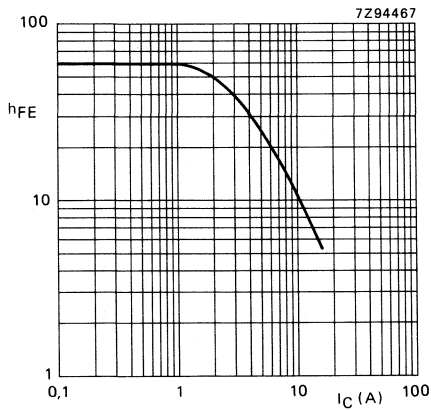


Fig. 4 BU406F: $V_{CE} = 5 \text{ V}$;
 $T_j = 25 \text{ }^\circ\text{C}$; typical values.

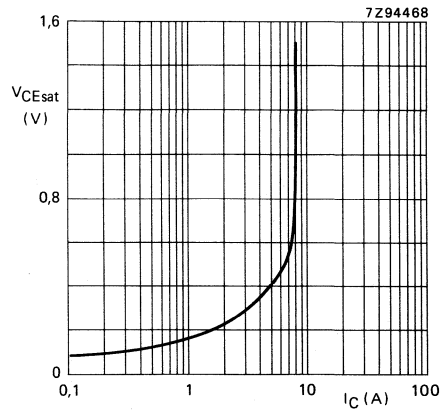


Fig. 5 BU406F: $I_C/I_B = 10$;
 $T_j = 25 \text{ }^\circ\text{C}$; typical values.

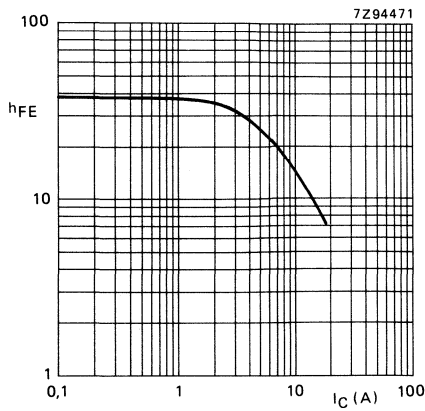


Fig. 6 BU407F: $V_{CE} = 5$ V;
 $T_j = 25$ °C; typical values.

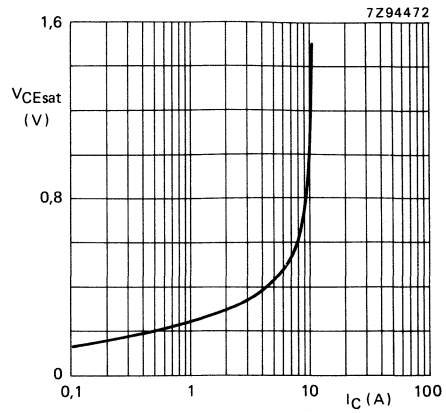


Fig. 7 BU407F: $I_C/I_B = 10$;
 $T_j = 25$ °C; typical values.

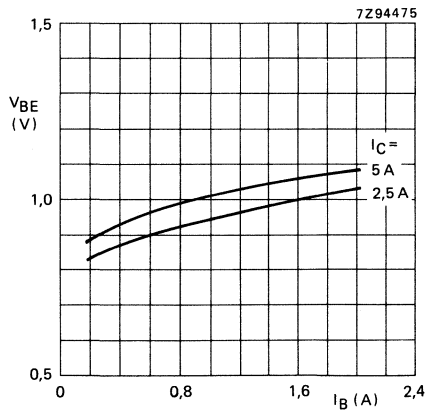


Fig. 8 BU406F/BU407F: $T_j = 25$ °C;
typical values.

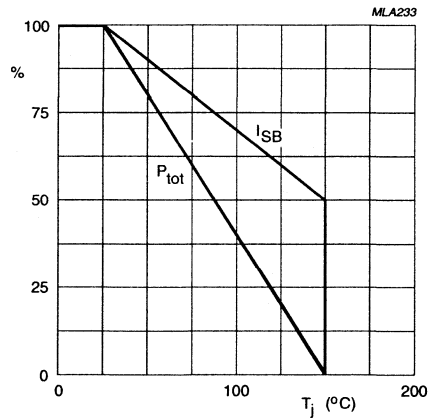
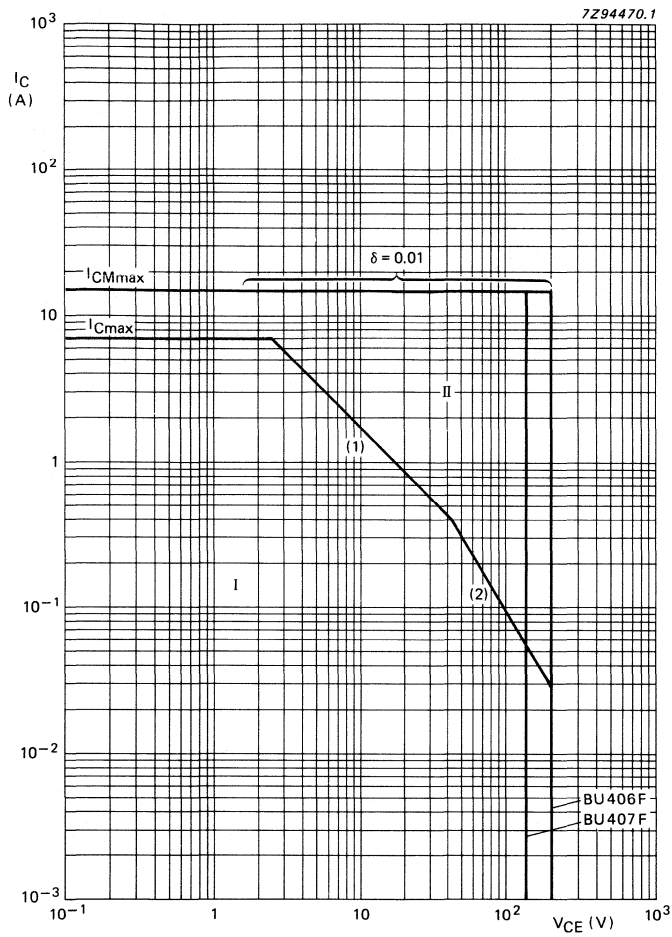
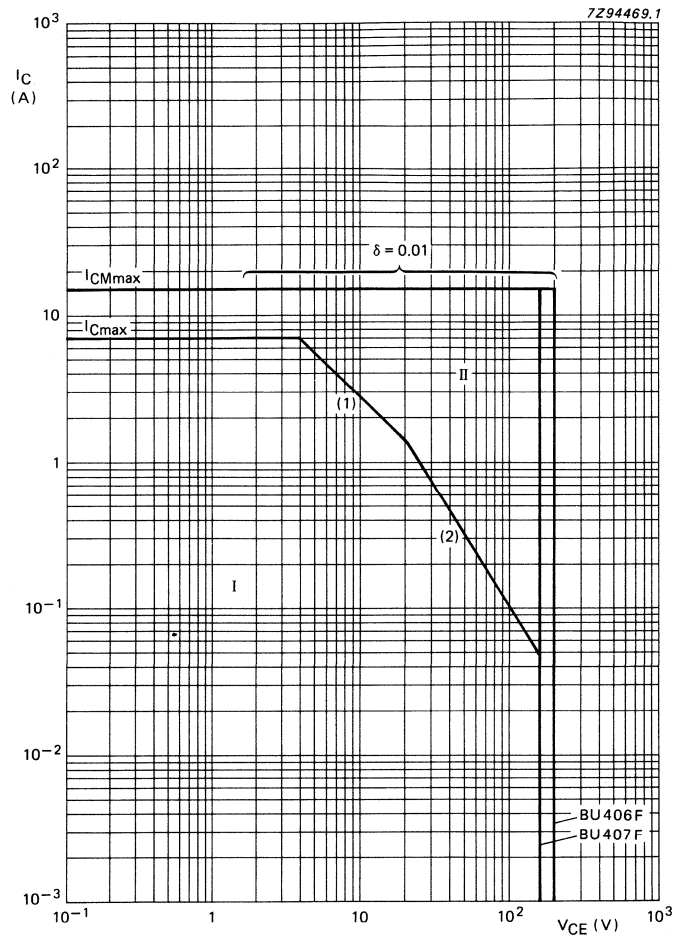


Fig. 9 BU406F/BU407F: total
power dissipation and second-
breakdown current derating curve.



- (1) P_{tot} max line.
- (2) Second-breakdown limits.
- I Region of permissible DC operation.
- II Permissible extension for repetitive pulse operation.

Fig. 10 Safe operating area at $T_{mb} < 25$ °C. Mounted without heatsink compound and 30 ± 5 newtons pressure on the centre of the envelope.



- (1) P_{tot} max line.
- (2) Second-breakdown limits.
- I Region of permissible DC operation.
- II Permissible extension for repetitive pulse operation.

Fig. 11 Safe operating area at $T_{mb} < 25^\circ\text{C}$. Mounted with heatsink compound and 30 ± 5 newtons pressure on the centre of the envelope.

SILICON DIFFUSED POWER TRANSISTOR

High-voltage, high-speed switching npn power transistor in a TO-220 envelope intended for use in horizontal deflection circuits of colour television receivers. The BU505D has an integrated efficiency diode.

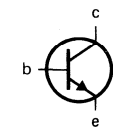
QUICK REFERENCE DATA

Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM} V_{CEO}	max.	1500 V 700 V
Collector-emitter saturation voltage	V_{CEsat}	max.	1.0 V
Collector current saturation DC	I_{Csat} I_C	max.	2.0 A 2.5 A
peak value	I_{CM}	max.	4.0 A
Diode forward voltage (BU505D)	V_F	max.	1.8 V
Total power dissipation up to $T_{mb} = 25^\circ\text{C}$	P_{tot}	max.	75 W
Fall time; inductive load	t_f	typ.	0.9 μs

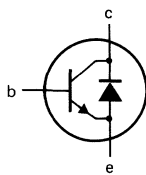
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-220AB.



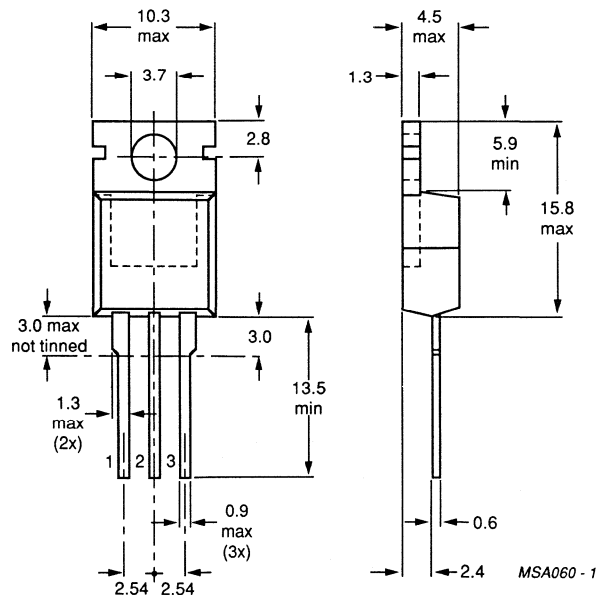
BU505



BU505D

Pinning:

- 1 = base
- 2 = collector
- 3 = emitter



Collector connected to mounting base.

RATINGS

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

Collector-emitter voltage				
peak value; $V_{BE} = 0$	V_{CES}	max.	1500 V	
open base	V_{CEO}	max.	700 V	
Collector current				
saturation	I_{Csat}	max.	2.0 A	
DC	I_C	max.	2.5 A	
peak	I_{CM}	max.	4.0 A	
Base current				
DC	I_B	max.	2.0 A	
peak	I_{BM}	max.	4.0 A	
Total power dissipation				
up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	75 W	
Storage temperature range	T_{stg}		-65 to +150 $^\circ\text{C}$	
Junction temperature	T_j	max.	150 $^\circ\text{C}$	
THERMAL RESISTANCE				
From junction to mounting base	$R_{th\ j-mb}$	=	1.67 K/W	

CHARACTERISTICS

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

Collector cut-off current*

 $V_{BE} = 0; V_{CE} = V_{CESmax}$ I_{CES} max. 0.15 mA $V_{BE} = 0; V_{CE} = V_{CESmax};$ $T_j = 125\text{ }^\circ\text{C}$ I_{CES} max. 1.0 mA

Emitter cut-off current

 $I_C = 0; V_{EB} = 5\text{ V}$ I_{EBO} max. 1.0 mA

Emitter-base voltage

 $I_E = 10\text{ mA}; I_C = 0\text{ A}$ V_{EBO} 6.0 VCollector-emitter sustaining
voltage (Figs 2 and 3) $V_{CEO_{sust}}$ min. 700 V

Saturation voltage

 $I_C = 2.0\text{ A}; I_B = 0.9\text{ A}$ $V_{CE_{sat}}$ max. 1.0 V $V_{BE_{sat}}$ max. 1.3 V

DC current gain

 $I_C = 100\text{ mA}; V_{CE} = 5\text{ V}$ h_{FE} min. 6 h_{FE} typ. 13 h_{FE} max. 30

Diode forward voltage (BU505D)

 $I_F = 2\text{ A}$ V_F max. 1.8 V

Second breakdown current

 $V_{CE} = 120\text{ V}; t = 200\text{ }\mu\text{s}$ I_{SB} min. 2.0 ATransition frequency at $f = 5\text{ MHz}$ $I_C = 0.1\text{ A}; V_{CE} = 5\text{ V}$ f_T typ. 7.0 MHzCollector capacitance at $f = 1\text{ MHz}$ $I_E = I_e = 0; V_{CB} = 10\text{ V}$ C_C typ. 65 pFSwitching times (in horizontal deflection circuit)
(Fig. 4) $I_{CM} = 2\text{ A}; I_{B(end)} = 0.9\text{ A}; V_{dr} = -4\text{ V}$ $L_B = 10\text{ }\mu\text{H}$ t_s typ. 6.5 μs t_f typ. 0.9 μs $L_B = 15\text{ }\mu\text{H}$ t_s typ. 7.5 μs t_f typ. 0.9 μs $L_B = 25\text{ }\mu\text{H}$ t_s typ. 9.5 μs t_f typ. 0.85 μs

* Measured with a half-sinewave voltage (curve tracer).

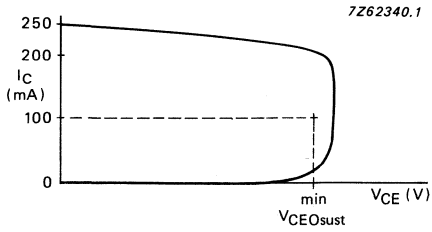


Fig. 2 Oscilloscope display for sustaining voltage.

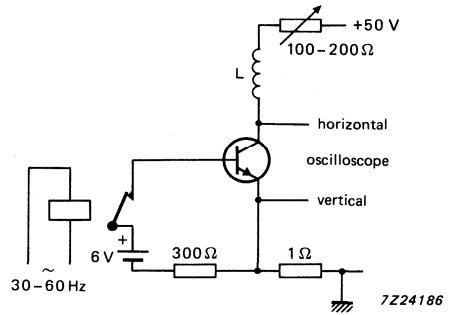


Fig. 3 Test circuit for V_{CEOsat} .

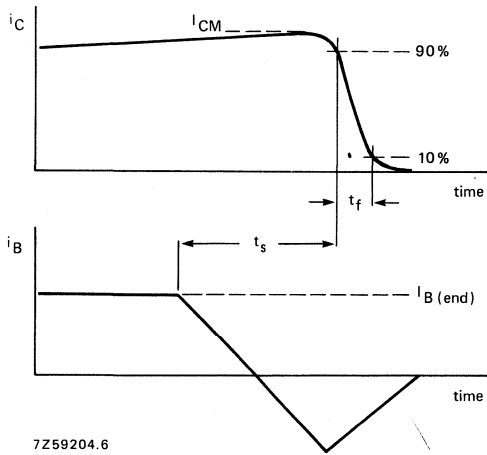


Fig. 4 Switching times waveforms.

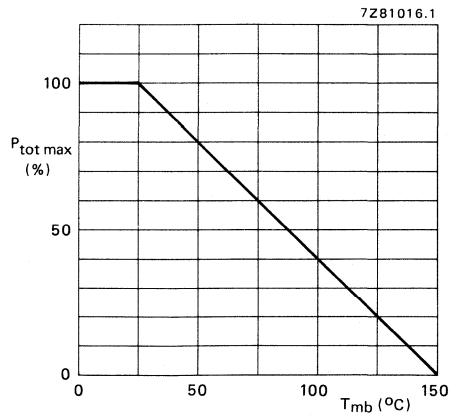
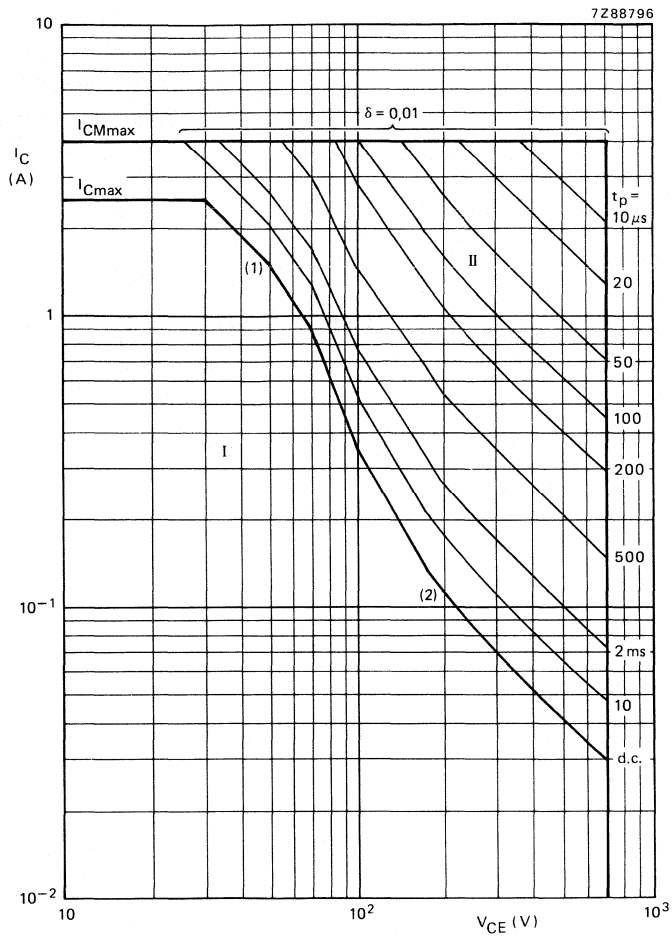


Fig. 5 Power derating curve.



- I Region of permissible DC operation.
- II Permissible extension for repetitive pulse operation.

- (1) P_{tot} max and P_{tot} peak max lines.
- (2) Second breakdown limits.

Fig. 6 Safe operating area at $T_m = 25^\circ C$.

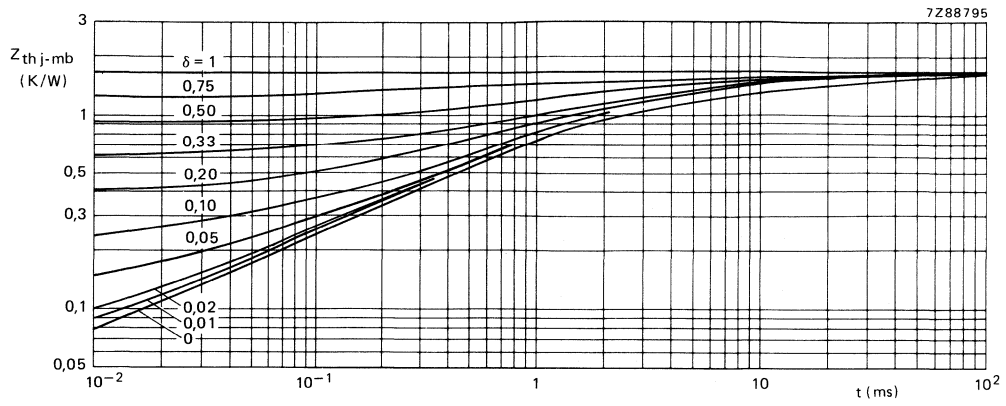


Fig. 7 Pulse power rating chart.

SILICON DIFFUSED POWER TRANSISTORS

High-voltage, high-speed, glass-passivated npn power transistor in a SOT186 envelope with electrically isolated mounting base, intended for use in horizontal deflection circuits of colour television receivers. The BU505DF has an integrated efficiency diode.

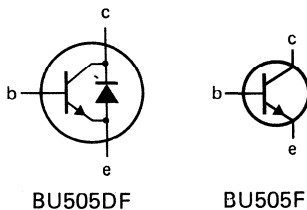
QUICK REFERENCE DATA

Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM}	max.	1500 V
	V_{CEO}	max.	700 V
Collector-emitter saturation voltage	V_{CEsat}	max.	1.0 V
Collector current saturation	I_{Csat}	max.	2.0 A
DC	I_C	max.	2.5 A
peak value	I_{CM}	max.	4.0 A
Diode forward voltage (BU505DF)	V_F	max.	1.8 V
Total power dissipation up to $T_h = 25\text{ }^\circ\text{C}$	P_{tot}	max.	20 W
Fall time inductive load	t_f	typ.	0.7 μs

MECHANICAL DATA

Dimensions in mm

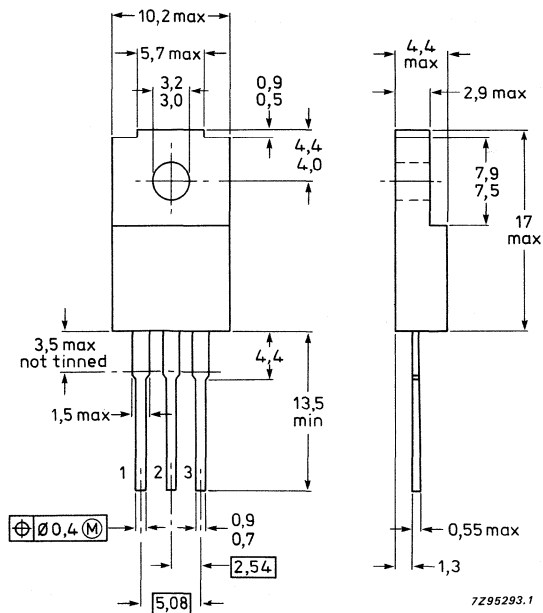
Fig. 1 SOT186.



Pinning:

- 1 = base
- 2 = collector
- 3 = emitter

Mounting base is electrically isolated from all terminals.



RATINGS

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

Collector-emitter voltage peak value; $V_{BE} = 0$	V_{CESM}	max.	1500 V
open base	V_{CEO}	max.	700 V
Collector current saturation	I_{Csat}		2.0 A
DC	I_C	max.	2.5 A
peak	I_{CM}	max.	4.0 A
Base current DC	I_B	max.	2.0 A
peak	I_{BM}	max.	4.0 A
Total power dissipation up to $T_h = 25\text{ }^\circ\text{C}$	P_{tot}	max.	20 W
Storage temperature range	T_{stg}		-65 to + 150 $^\circ\text{C}$
Junction temperature	T_j	max.	150 $^\circ\text{C}$

THERMAL RESISTANCE

From junction to external heatsink (note 1)	$R_{th\ j-h}$	max.	6.35 K/W
From junction to external heatsink (note 2)	$R_{th\ j-h}$	max.	3.85 K/W
From junction to ambient	$R_{th\ j-a}$	max.	55 K/W

ISOLATION

Isolation voltage from all terminals to external heatsink; peak value	V_{isol}	max.	1500 V
Isolation capacitance from collector to external heatsink	C_{isol}	typ.	12 pF

Notes

1. Mounted without heatsink compound and 30 ± 5 newtons pressure on the centre of the envelope.
2. Mounted with heatsink compound and 30 ± 5 newtons pressure on the centre of the envelope.

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

Collector cut-off current*

 $V_{BE} = 0; V_{CE} = V_{CESmax}$ I_{CES} max. 0.15 mA $V_{BE} = 0; V_{CE} = V_{CESmax}; T_j = 125\text{ }^\circ\text{C}$ I_{CES} max. 1.0 mA

Emitter cut-off current

 $V_{EB} = 5\text{ V}; I_C = 0$ I_{EBO} max. 1.0 mA

Second-breakdown current

 $V_{CE} = 120\text{ V}; t_p = 200\text{ }\mu\text{s}$ I_{SB} min. 2.0 A

Collector-emitter sustaining voltage

 $I_C = 0.1\text{ A}; I_B = 0;$
 $L = 25\text{ mH};$ (Figs 2 and 3) $V_{CEO_{sust}}$ min. 700 V

Saturation voltage

 $I_C = 2.0\text{ A}; I_B = 0.9\text{ A}$ $V_{CE_{sat}}$ max. 1.0 V
 $V_{BE_{sat}}$ max. 1.3 V

Diode forward voltage (BU505DF)

 $I_F = 2\text{ A}$ V_F max. 1.8 V

DC current gain

 $I_C = 2.0\text{ A}; V_{CE} = 5\text{ V}$ h_{FE} min. 2.22 $I_C = 100\text{ mA}; V_{CE} = 5\text{ V}$ h_{FE} min. 6 h_{FE} typ. 13 h_{FE} max. 30Transition frequency at $f = 1\text{ MHz}$ $I_C = 0.1\text{ A}; V_{CE} = 5\text{ V}$ f_T typ. 7.0 MHzCollector capacitance at $f = 1\text{ MHz}$ $I_E = I_e = 0; V_{CB} = 10\text{ V}$ C_C typ. 65 pF

Switching times (in horizontal deflection circuit)

(Fig. 4)

 $I_{CM} = 2\text{ A}; I_{B(end)} = 0.9\text{ A}; V_{dr} = -4\text{ V}$ $L_B = 10\text{ }\mu\text{H}$ t_s typ. 6.5 μs t_f typ. 0.9 μs $L_B = 15\text{ }\mu\text{H}$ t_s typ. 7.5 μs t_f typ. 0.9 μs $L_B = 25\text{ }\mu\text{H}$ t_s typ. 9.5 μs t_f typ. 0.85 μs

* Measured with a half-sinewave voltage (curve tracer).

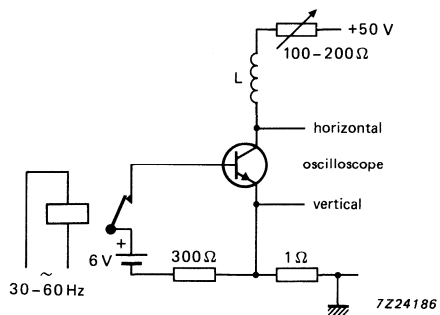


Fig. 2 Test circuit for $V_{CEOsust}$.

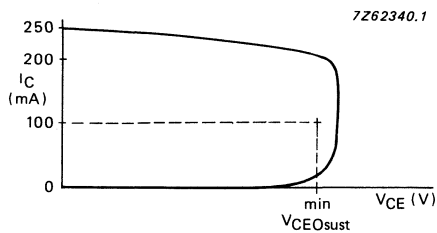


Fig. 3 Oscilloscope display for sustaining voltage.

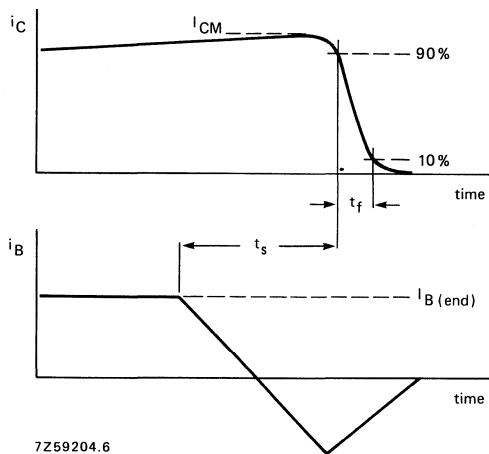


Fig. 4 Switching times waveforms.

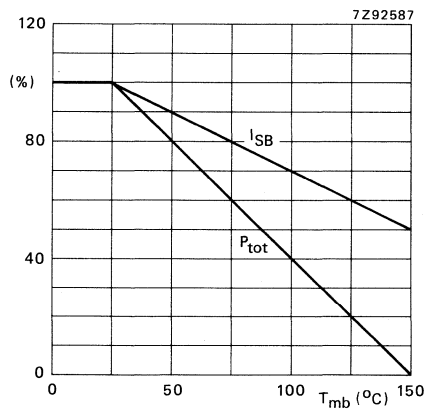
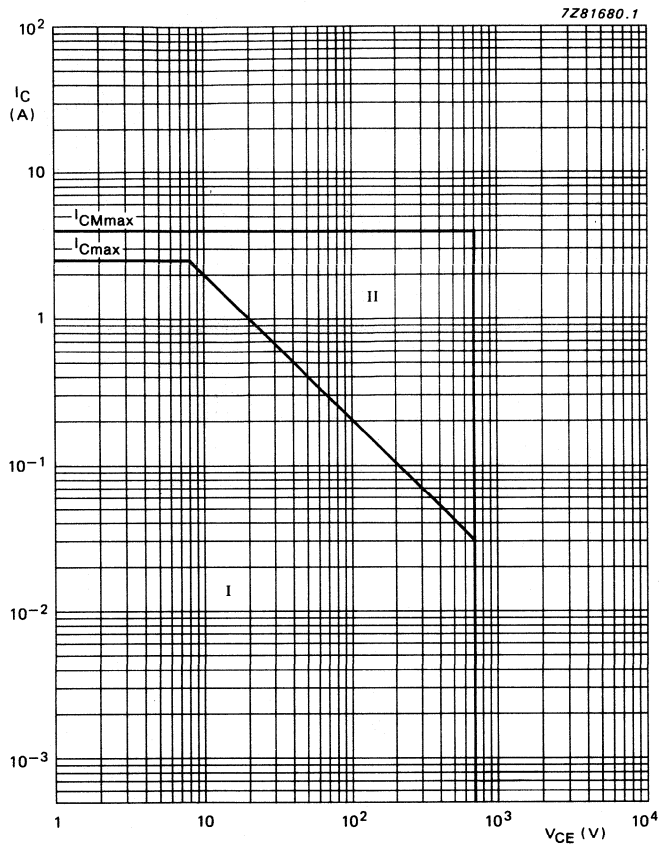
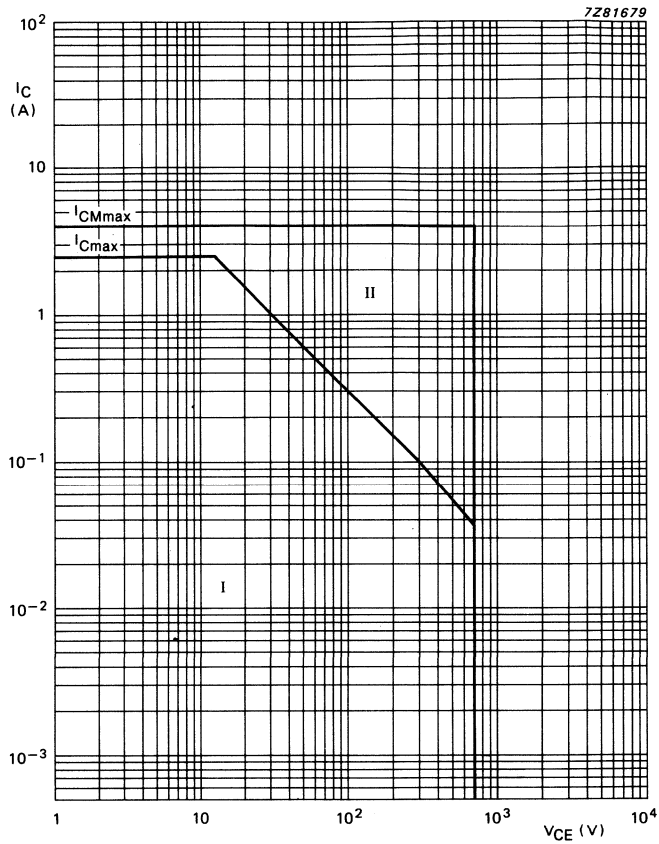


Fig. 5 Total power dissipation and second-breakdown current derating curve.



- I Region of permissible DC operation.
- II Permissible extension for repetitive pulse operation.

Fig. 6 Safe operating area; $T_h = 25$ °C; mounted without heatsink compound and 30 ± 5 newtons pressure on the centre of the envelope.



- I Region of permissible DC operation.
- II Permissible extension for repetitive pulse operation.

Fig. 7 Safe operating area; $T_h = 25\text{ }^\circ\text{C}$; mounted with heatsink compound and 30 ± 5 newtons pressure on the centre of the envelope.

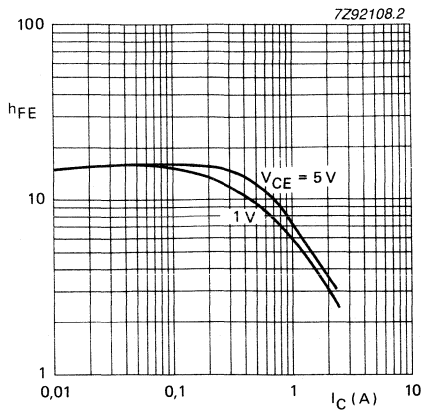


Fig. 8 Typical DC current gain; $T_j = 25\text{ }^\circ\text{C}$.

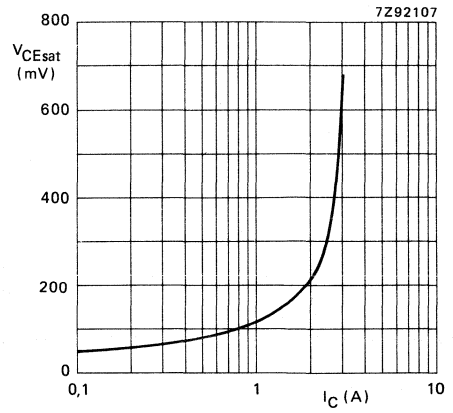


Fig. 9 Collector-emitter saturation voltage; $I_C/I_B = 2$; $T_j = 25\text{ }^\circ\text{C}$.

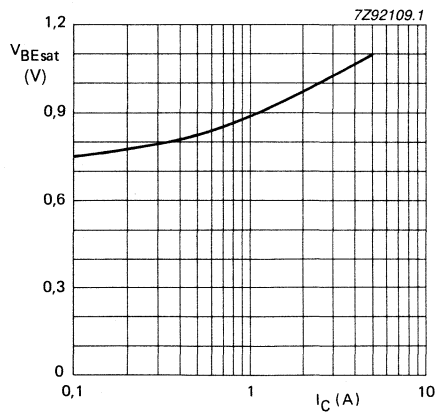


Fig. 10 Base-emitter saturation voltage; $I_C/I_B = 2$; $T_j = 25\text{ }^\circ\text{C}$.

SILICON DIFFUSED POWER TRANSISTORS

High-voltage, high-speed switching npn transistor in a plastic envelope intended for use in horizontal deflection circuits of colour television receivers and for line operated switch-mode applications. The BU506D has an integrated efficiency diode.

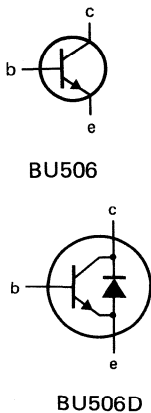
QUICK REFERENCE DATA

Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM}	max.	1500 V
	V_{CEO}	max.	700 V
Collector-emitter saturation voltage	V_{CEsat}	max.	1.0 V
Collector current saturation	I_{Csat}		3.0 A
DC	I_C	max.	5.0 A
peak value	I_{CM}	max.	8.0 A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	100 W
Diode forward voltage (BU506D) $I_F = 3\text{ A}$	V_F	typ.	1.5 V
Fall time inductive load	t_f	typ.	0.7 μs

MECHANICAL DATA

Dimensions in mm

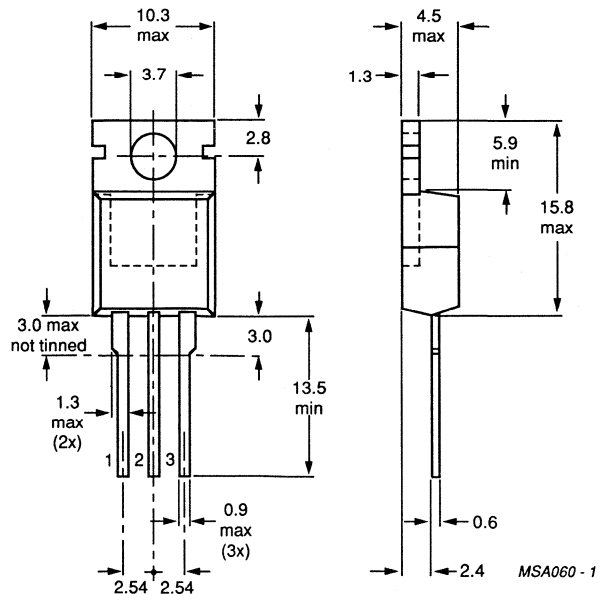
Fig. 1 TO-220AB.



Pinning:

- 1 = base
- 2 = collector
- 3 = emitter

Collector connected to case.



RATINGS

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

Collector-emitter voltage			
peak value; $V_{BE} = 0$	V_{CESM}	max.	1500 V
open base	V_{CEO}	max.	700 V
Collector current			
saturation	I_{Csat}		3.0 A
DC	I_C	max.	5.0 A
peak	I_{CM}	max.	8.0 A
Base current			
DC	I_B	max.	3.0 A
peak	I_{BM}	max.	5.0 A
Total power dissipation			
up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	100 W
Storage temperature range	T_{stg}		-65 to + 150 $^\circ\text{C}$
Junction temperature	T_j	max.	150 $^\circ\text{C}$
THERMAL RESISTANCE			
From junction to mounting base	$R_{th\ j-mb}$	max.	1.25 K/W

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

Collector cut-off current*

 $V_{BE} = 0; V_{CE} = V_{CESMmax}$ $V_{BE} = 0; V_{CE} = V_{CESMmax}; T_j = 125\text{ }^\circ\text{C}$

I_{CES}	max.	0.5 mA
I_{CES}	max.	1.0 mA

Emitter cut-off current

 $I_C = 0; V_{EB} = 6\text{ V}$

I_{EBO}	max.	10 mA
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Collector-emitter sustaining voltage (Figs 2 and 3)

$V_{CEOsust}$	min.	700 V
---------------	------	-------

Saturation voltage

 $I_C = 3\text{ A}; I_B = 1.33\text{ A}$

V_{CEsat}	max.	1.0 V
V_{BEsat}	max.	1.3 V

DC current gain

 $I_C = 100\text{ mA}; V_{CE} = 5\text{ V}$

h_{FE}	min.	6
h_{FE}	typ.	13
h_{FE}	max.	30

Diode forward voltage (BU506D)

 $I_F = 3\text{ A}$

V_F	typ.	1.5 V
V_F	max.	2.2 V

Second breakdown current

 $V_{CE} = 120\text{ V}; t = 100\text{ }\mu\text{s}$

I_{SB}	min.	1.0 A
----------	------	-------

Switching times (in line deflection circuit)

(Fig. 4)

 $I_{CM} = 3\text{ A}; I_{B(end)} = 1\text{ A};$ $L_B = 12\text{ }\mu\text{H}$

t_f	typ.	0.7 μs
t_s	typ.	6.5 μs

* Measured with a half-sinewave voltage (curve tracer).

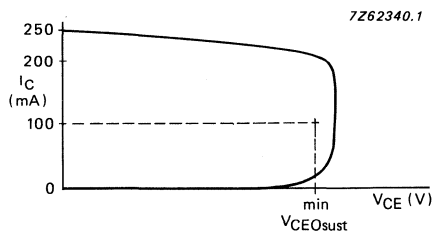


Fig. 2 Oscilloscope display for $V_{CEOsust}$.

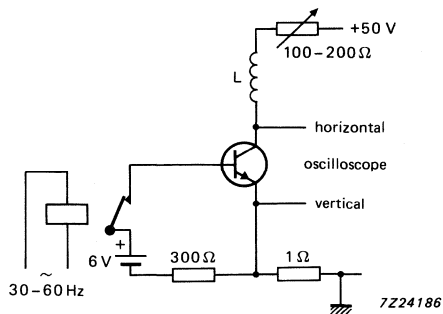


Fig. 3 Test circuit for $V_{CEOsust}$.

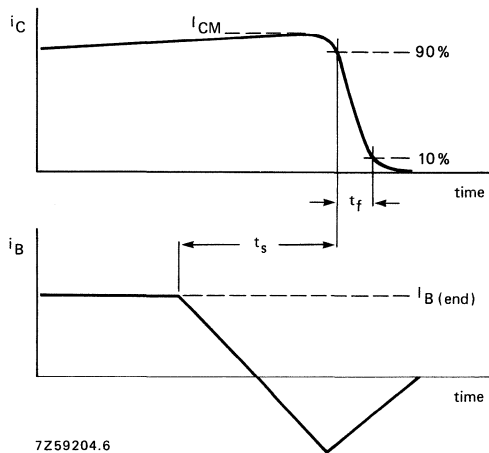


Fig. 4 Switching times waveforms.

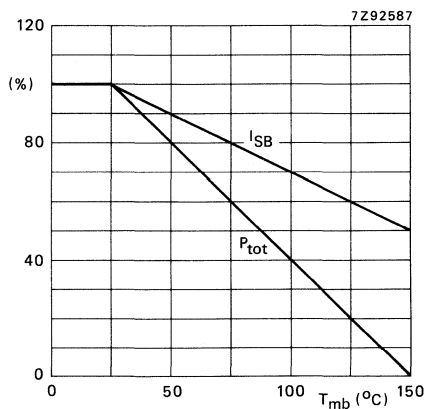
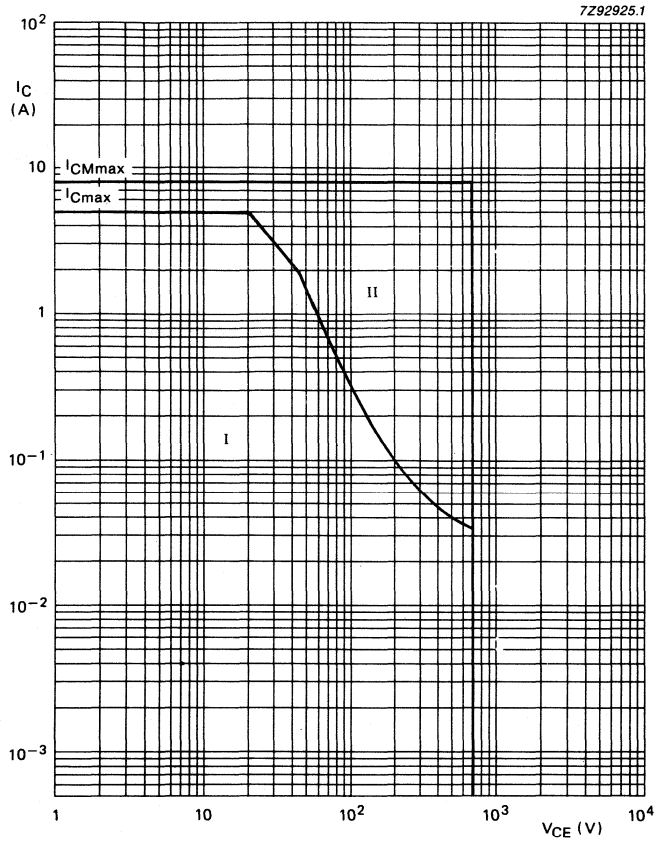


Fig. 5 Total power dissipation and second-current breakdown curve.



- I Region of permissible DC operation.
- II Permissible extension for repetitive pulse operation.

Fig. 6 Safe operating area at $T_{mb} = 25\text{ }^\circ\text{C}$.

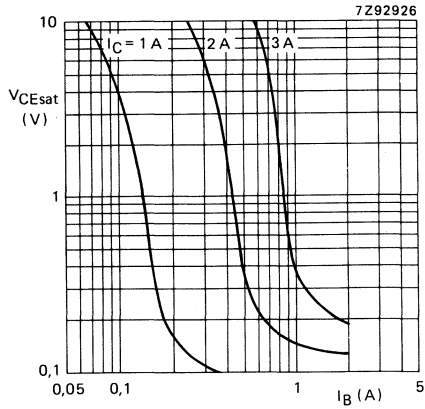


Fig. 7 Typical collector-emitter saturation voltage; $T_{mb} = 25\text{ }^\circ\text{C}$.

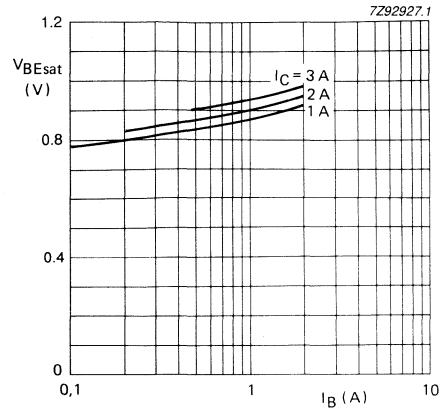


Fig. 8 Typical base-emitter saturation voltage; $T_{mb} = 25\text{ }^\circ\text{C}$.

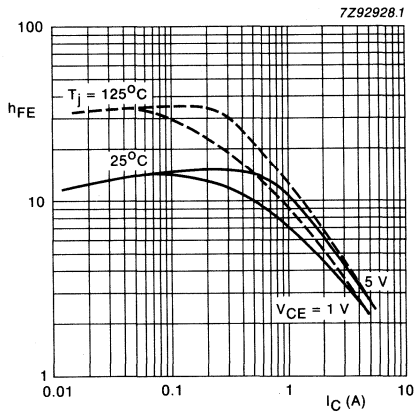


Fig. 9 Typical DC current gain.

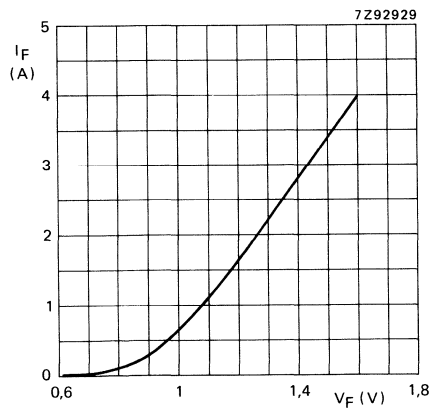


Fig. 10 Diode forward voltage; $T_{mb} = 25\text{ }^\circ\text{C}$.

SILICON DIFFUSED POWER TRANSISTORS

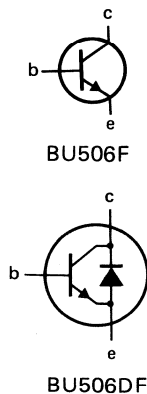
High-voltage, high-speed switching npn transistor in a SOT186 envelope, intended for use in horizontal deflection circuits of colour television receivers and in line-operated switch-mode applications. The BU506DF has an integrated efficiency diode.

QUICK REFERENCE DATA

Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM}	max.	1500 V
	V_{CEO}	max.	700 V
Collector-emitter saturation voltage	V_{CEsat}	max.	1.0 V
Collector current saturation	I_{Csat}	max.	3.0 A
DC	I_C	max.	5.0 A
peak value	I_{CM}	max.	8.0 A
Total power dissipation up to $T_h = 25^\circ\text{C}$	P_{tot}	max.	20 W
Diode forward voltage at $I_F = 3\text{ A}$ (BU506DF)	V_F	typ.	1.5 V
Fall time; inductive load	t_f	typ.	0.7 μs

MECHANICAL DATA

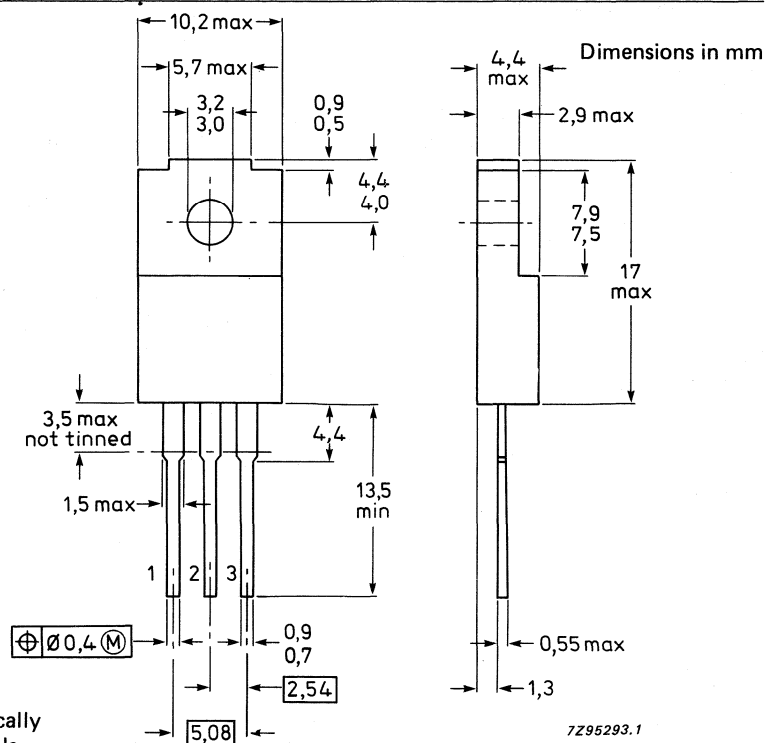
Fig. 1 SOT186.



Pinning:

- 1 = base
- 2 = collector
- 3 = emitter

Mounting base is electrically isolated from all terminals.



RATINGS

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

Collector-emitter voltage			
peak value; $V_{BE} = 0$	V_{CESM}	max.	1500 V
open base	V_{CEO}	max.	700 V
Collector current			
saturation	I_{Csat}	max.	3.0 A
DC	I_C	max.	5.0 A
peak value	I_{CM}	max.	8.0 A
Base current			
DC	I_B	max.	3.0 A
peak value	I_{BM}	max.	5.0 A
Total power dissipation			
up to $T_h = 25\text{ }^\circ\text{C}$	P_{tot}	max.	20 W
Storage temperature range	T_{stg}		-65 to + 150 $^\circ\text{C}$
Junction temperature	T_j	max.	150 $^\circ\text{C}$

THERMAL RESISTANCE

From junction to external heatsink (note 1)	$R_{th\ j-h}$	=	6.35 K/W
From junction to external heatsink (note 2)	$R_{th\ j-h}$	=	3.85 K/W
From junction to ambient	R_{th-a}	=	55 K/W

ISOLATION

Isolation voltage from all terminals to external heatsink (peak value)	V_{isol}	max.	1500 V
Isolation capacitance from collector to external heatsink	C_{isol}	typ.	12 pF

Notes

1. Mounted without heatsink compound and 30 ± 5 newtons pressure on centre of envelope.
2. Mounted with heatsink compound and 30 ± 5 newtons pressure on centre of envelope.

CHARACTERISTICS

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

Collector cut-off current

$V_{CE} = V_{CESmax}; V_{BE} = 0$

$V_{CE} = V_{CESmax}; V_{BE} = 0; T_j = 125\text{ }^\circ\text{C}$

I_{CES}	max.	0.5 mA
I_{CES}	max.	1.0 mA

Emitter cut-off current

$I_C = 0; V_{EB} = 6\text{ V}$

I_{EBO}	max.	10 mA
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Saturation voltage

$I_C = 3\text{ A}; I_B = 1.33\text{ A}$

V_{CEsat}	max.	1.0 V
V_{BEsat}	max.	1.3 V

Collector saturation current

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

I_C	typ.	3.0 A
-------	------	-------

DC current gain

$I_C = 3\text{ A}; V_{CE} = 5\text{ V}$

h_{FE}	min.	2.25
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$I_C = 100\text{ mA}; V_{CE} = 5\text{ V}$

h_{FE}	min.	6
h_{FE}	typ.	13
h_{FE}	max.	30

Second breakdown current

$V_{CE} = 300\text{ V}; t_p = 200\text{ }\mu\text{s}$

I_{SB}	min.	1.0 A
----------	------	-------

Collector emitter sustaining voltage (Figs 2 and 3)

$I_C = 100\text{ mA}; I_B = 0; L = 25\text{ mH}$

$V_{CEOsust}$	min.	700 V
---------------	------	-------

Diode forward voltage

$I_F = 3\text{ A (BU506DF)}$

V_F	typ.	1.5 V
V_F	max.	2.2 V

Switching times in horizontal deflection circuit

(Fig. 4)

$I_{CM} = 3\text{ A}; L_B = 12\text{ }\mu\text{H};$

$I_B(\text{end}) = 1\text{ A};$

$\frac{-d I_B}{dt} = 0.33\text{ A}/\mu\text{s}$

t_f	typ.	0.7 μs
t_s	typ.	6.5 μs

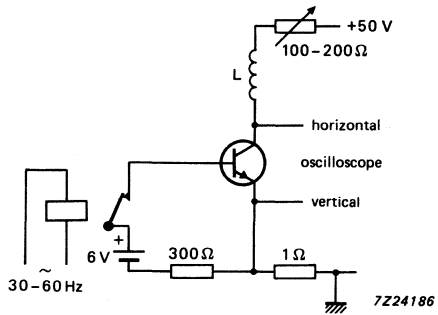


Fig. 2 Test circuit for $V_{CE0sust}$.

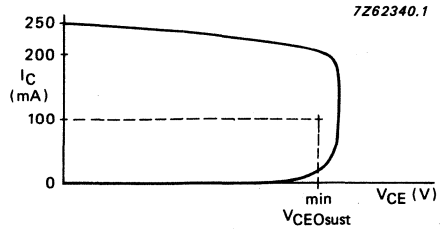


Fig. 3 Oscilloscope display for sustaining voltage.

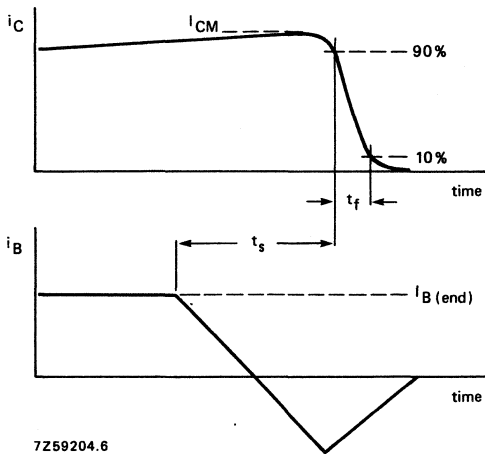


Fig. 4 Switching times waveforms.

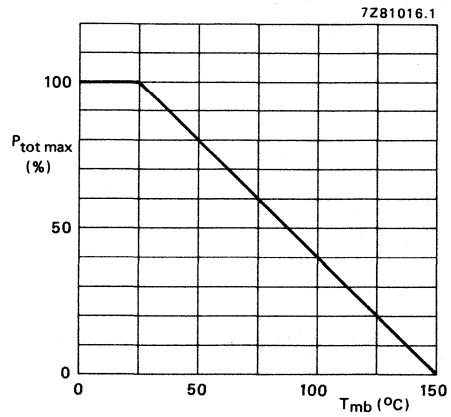


Fig. 5 Power derating curve.

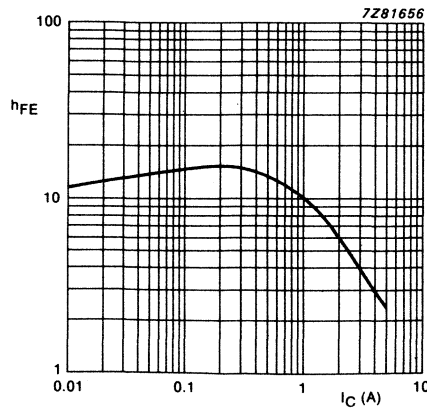
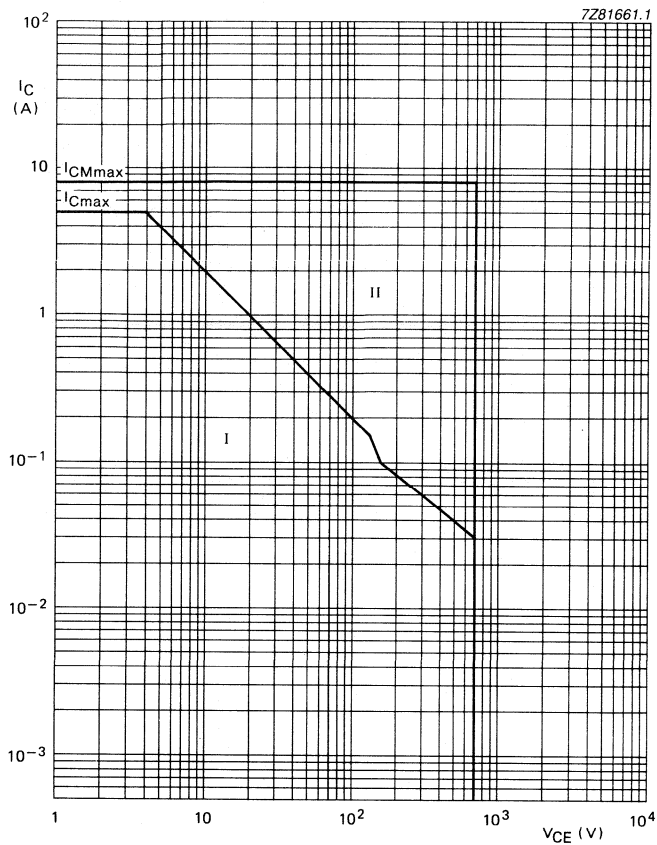


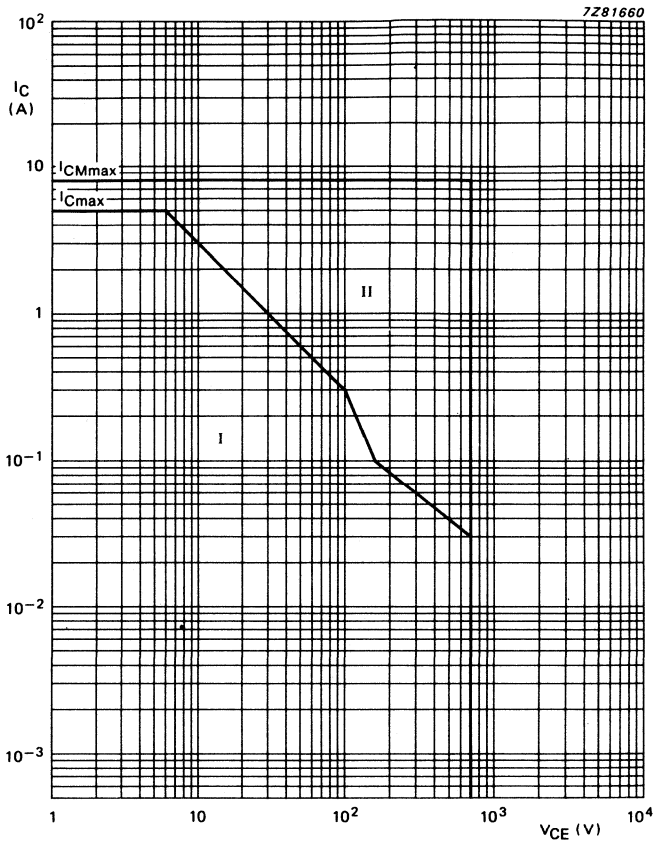
Fig. 6 Typical DC current gain; $V_{CE} = 5\text{ V}$; $T_j = 25\text{ }^\circ\text{C}$.



I Region of permissible DC operation.

II Permissible extension for repetitive pulse operation.

Fig. 7 Safe operating area at $T_{mb} = 25^\circ\text{C}$; mounted without heatsink compound and 30 ± 5 newtons pressure on centre of envelope.



I Region of permissible DC operation.

II Permissible extension for repetitive pulse operation.

Fig. 8 Safe operating area at $T_{mb} = 25^\circ\text{C}$; mounted with heatsink compound and 30 ± 5 newtons pressure on centre of envelope.

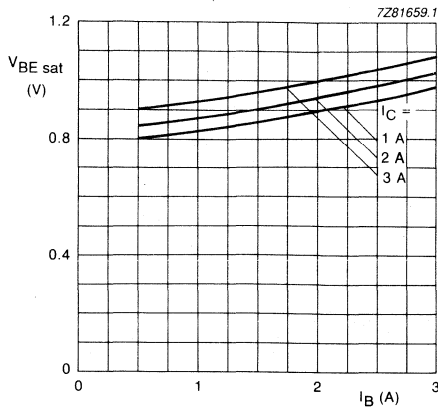


Fig. 9 Typical values $V_{BE\text{sat}}$; $T_j = 25^\circ\text{C}$.

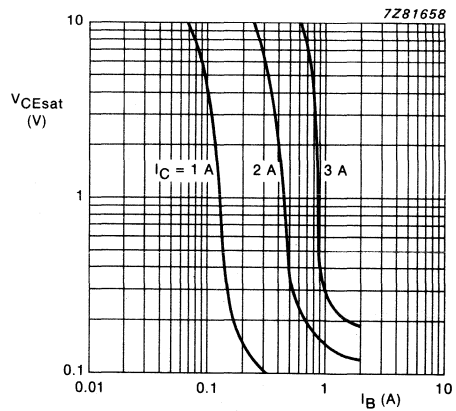


Fig. 10 Typical collector-emitter saturation voltage; $T_j = 25^\circ\text{C}$.

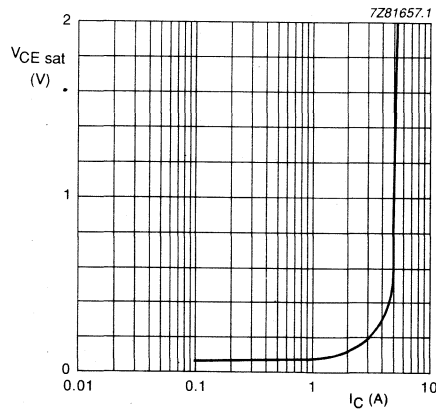


Fig. 11 Typical values $V_{CE\text{sat}}$; $I_C/I_B = 2$; $T_j = 25^\circ\text{C}$.

SILICON DIFFUSED POWER TRANSISTOR

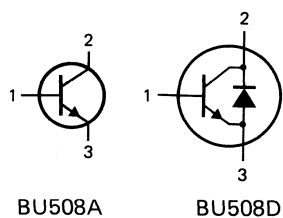
High-voltage, high-speed switching npn transistor in SOT93A envelope intended for use in horizontal deflection circuits of colour television receivers. The BU508D has an integrated efficiency diode.

QUICK REFERENCE DATA

Collector-emitter voltage peak value; $V_{BE} = 0$	V_{CESM}	max.	1500 V
Collector-emitter voltage (open base)	V_{CEO}	max.	700 V
Collector current (DC)	I_C	max.	8 A
Collector current peak value	I_{CM}	max.	15 A
Total power dissipation up to $T_{mb} = 25^\circ\text{C}$	P_{tot}	max.	125 W
Collector-saturation voltage $I_C = 4.5\text{ A}; I_B = 2\text{ A}$	V_{CEsat}	max.	1 V
Saturation collector current	I_{Csat}	typ.	4.5 A
Diode forward voltage (BU508D) $I_F = 4.5\text{ A}$	V_F	typ.	1.6 V
Fall time $I_{CM} = 4.5\text{ A}; I_{B(on)} = 1.4\text{ A}$	t_f	typ.	0.7 μs

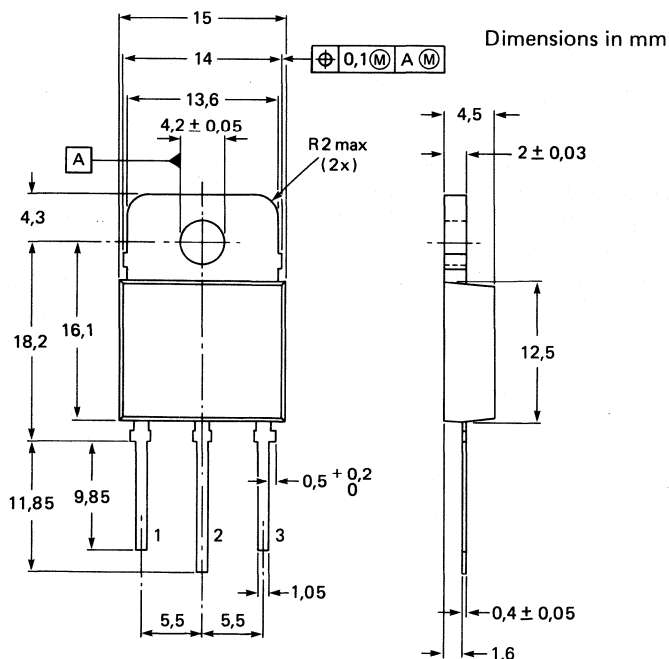
MECHANICAL DATA

Fig. 1 SOT93A.



1 = base
2 = collector
3 = emitter

Collector connected
to mounting base.



7295744

RATINGS

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

Collector-emitter voltage peak value; $V_{BE} = 0$	V_{CESM}	max.	1500 V
Collector-emitter voltage (open base)	V_{CEO}	max.	700 V
Collector current (DC)	I_C	max.	8 A
Collector current peak value	I_{CM}	max.	15 A
Base current (DC)	I_B	max.	4 A
Base current (peak value)	I_{BM}	max.	6 A
Reverse base current (DC or average over any 20 ms period)	$-I_{B(AV)}$	max.	100 mA
Reverse base current* (peak value)	$-I_{BM}$	max.	5 A
Total power dissipation up to $T_{mb} = 25^\circ\text{C}$	P_{tot}	max.	125 W
Storage temperature range	T_{stg}		-65 to $+150^\circ\text{C}$
Junction temperature	T_j	max.	150°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j-mb}$	=	1 K/W
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CHARACTERISTICS

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

Collector cut-off current** $V_{BE} = 0$; $V_{CE} = V_{CESMmax}$ $V_{BE} = 0$; $V_{CE} = V_{CESMmax}$; $T_j = 125^\circ\text{C}$	I_{CES}	max.	1 mA
	I_{CES}	max.	2 mA
Emitter cut-off current $V_{EB} = 6\text{ V}$; $I_C = 0$	I_{EBO}	max.	10 mA
Collector-emitter sustaining voltage $I_B = 0$; $I_C = 100\text{ mA}$; $L = 25\text{ mH}$	$V_{CEO\text{sust}}$	min.	700 V
Saturation voltages $I_C = 4.5\text{ A}$; $I_B = 2\text{ A}$	$V_{CE\text{sat}}$	max.	1 V
	$V_{BE\text{sat}}$	max.	1.3 V
DC current gain $I_C = 100\text{ mA}$; $V_{CE} = 5\text{ V}$	h_{FE}	min.	6
	h_{FE}	typ.	13
	h_{FE}	max.	30
Transition frequency at $f = 5\text{ MHz}$ $I_C = 0.1\text{ A}$; $V_{CE} = 5\text{ V}$	f_T	typ.	7 MHz
Collector capacitance at $f = 1\text{ MHz}$ $I_E = I_e = 0$; $V_{CB} = 10\text{ V}$	C_c	typ.	125 pF

* Turn-off current.

** Measured with half-sinewave voltage (curve tracer).

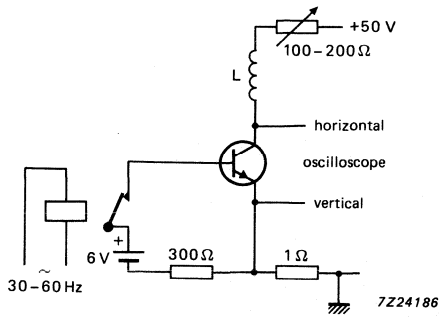


Fig. 2 Test circuit for $V_{CEOsust}$.

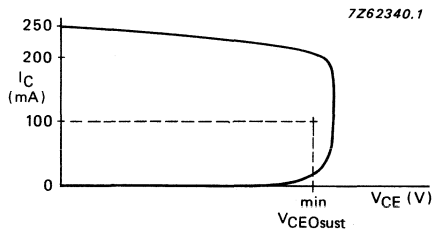


Fig. 3 Oscilloscope display for $V_{CEOsust}$.

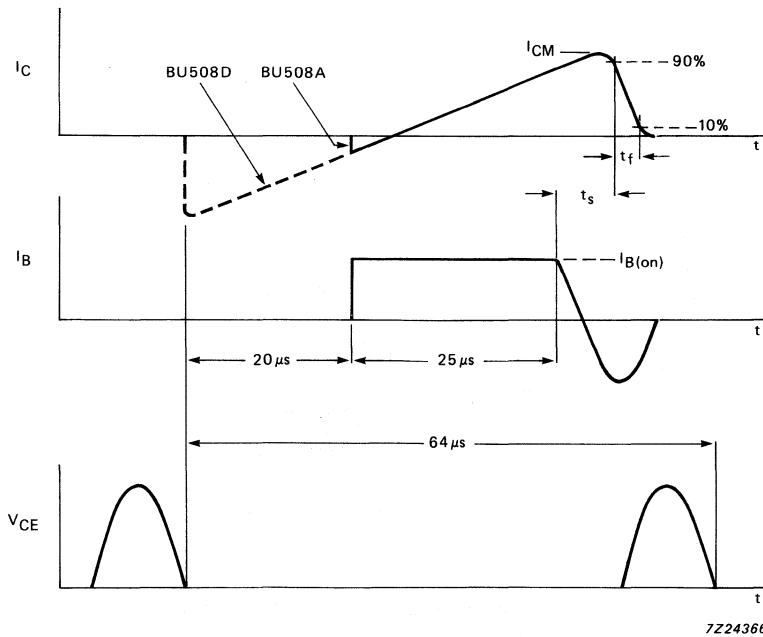


Fig. 4 Switching times waveforms; $I_{CM} = 4.5 \text{ A}$; $I_{B(on)} = 1.4 \text{ A}$; $L_B = 6 \mu\text{H}$; $-V_{BB} = 4 \text{ V}$; $-dI_B/dt = 0.6 \text{ A}/\mu\text{s}$; typical value of $t_s = 6.5 \mu\text{s}$; typical value of $t_f = 0.7 \mu\text{s}$.

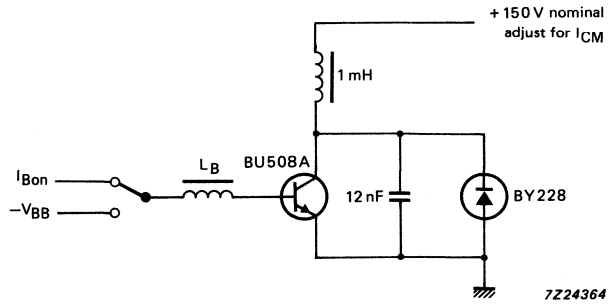


Fig. 5 Switching times test circuit (BU508A).

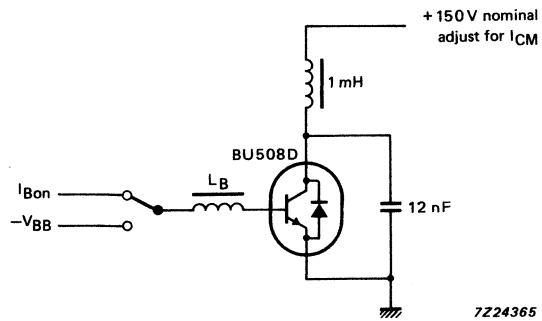
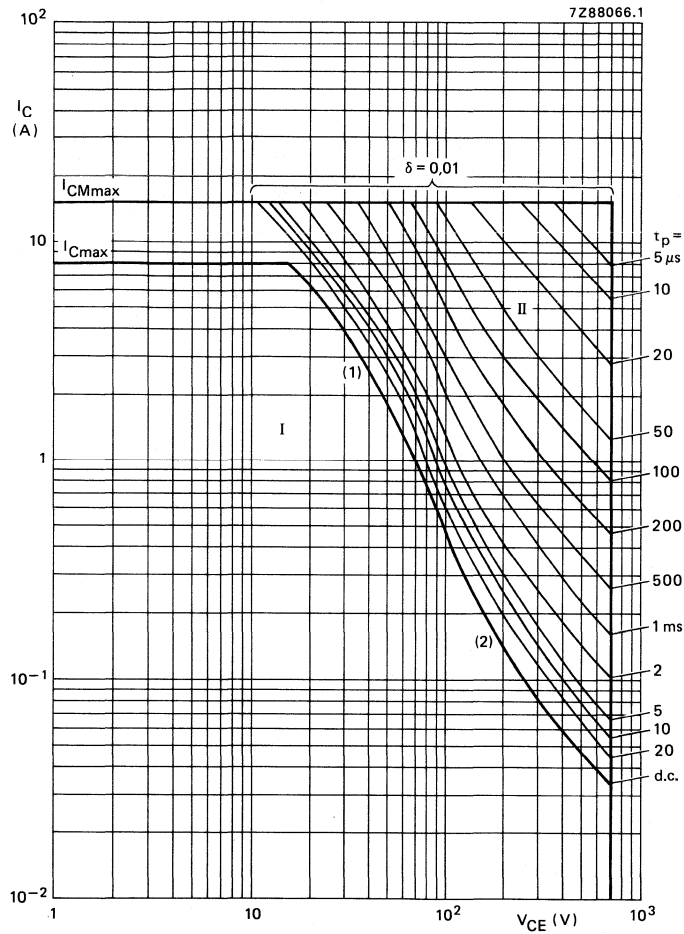


Fig. 6 Switching times test circuit (BU508D).



- (1) P_{tot} max line.
- (2) Second-breakdown limits (independent of temperature).
- I Region of permissible DC operation.
- II Permissible extension for repetitive pulse operation.

Fig. 7 Safe operating area; $T_{mb} < 25$ °C.

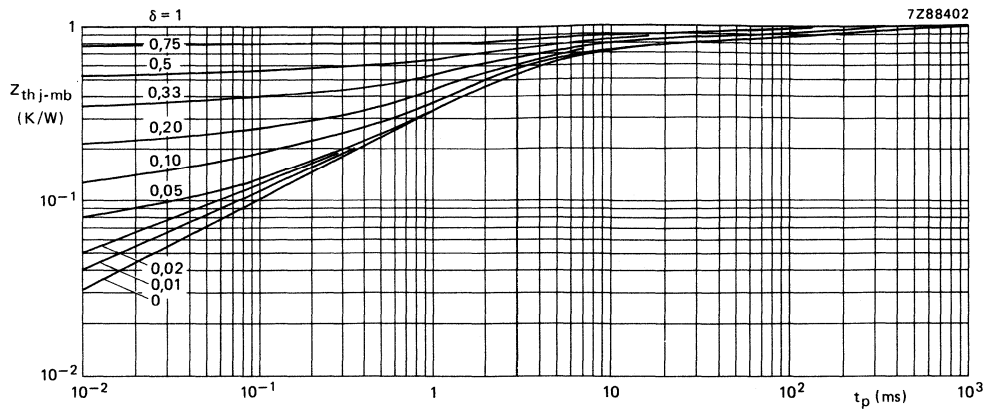


Fig. 8 Pulse power rating chart.

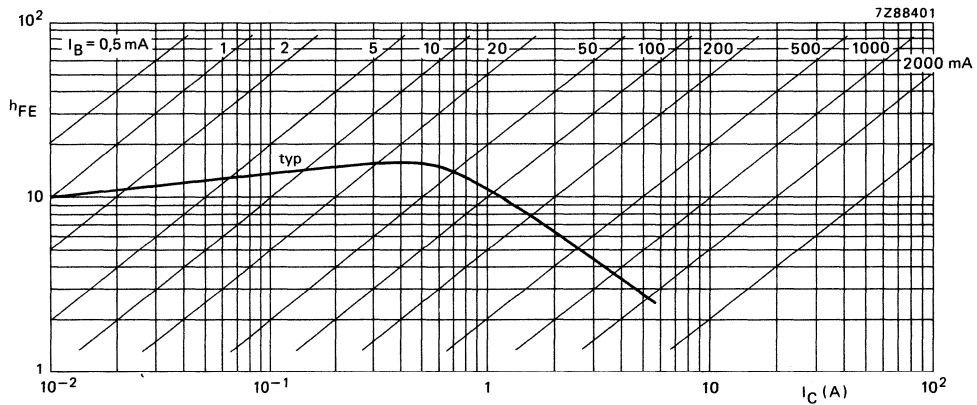


Fig. 9 Typical values DC current gain at $V_{CE} = 5\text{ V}$; $T_{mb} = 25\text{ }^\circ\text{C}$.

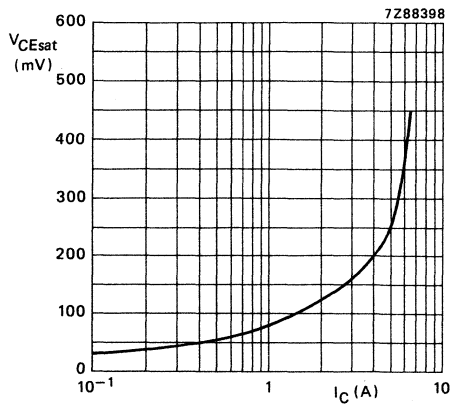


Fig. 10 Typical values $I_C/I_B = 2$; $T_j = 25\text{ }^\circ\text{C}$.

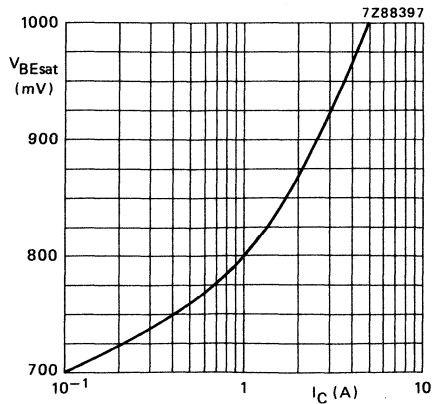


Fig. 11 Typical values $I_C/I_B = 2$; $T_j = 25\text{ }^\circ\text{C}$.

SILICON DIFFUSED POWER TRANSISTORS

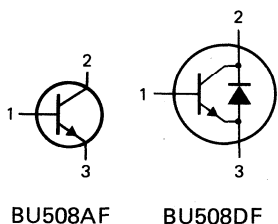
High-voltage, high-speed switching npn transistors in a fully isolated SOT199 envelope (with integrated efficiency diode for the BU508DF), primarily intended for use in horizontal deflection circuits of colour television receivers.

QUICK REFERENCE DATA

Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM} V_{CEO}	max.	1500 V 700 V
Collector saturation current	I_{Csat}	max.	4,5 A
Collector current (DC)	I_C	max.	8 A
Collector current (peak value)	I_{CM}	max.	15 A
Total power dissipation up to $T_h = 25^\circ C$	P_{tot}	max.	34 W
Collector-emitter saturation voltage	V_{CEsat}	max.	1 V
Diode forward voltage $I_F = 4,5 A$ (BU508DF)	V_F	typ.	1,6 V
Fall time	t_f	typ.	0,7 μs

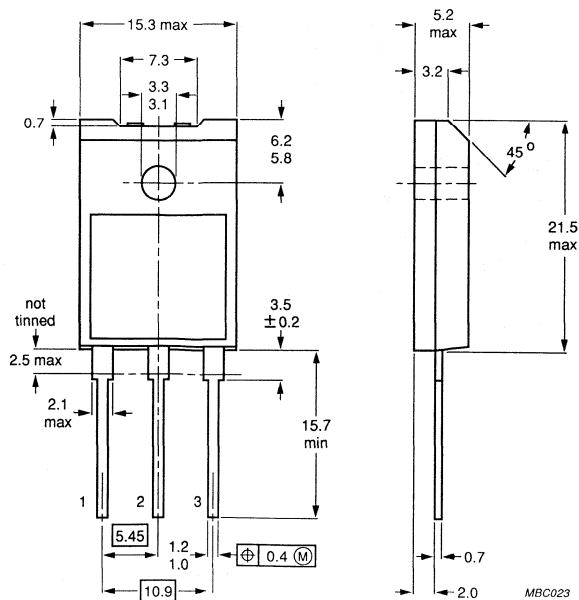
MECHANICAL DATA

Fig. 1 SOT199.



1 = base
2 = collector
3 = emitter
Mounting base is electrically isolated from all terminals.

Dimensions in mm



RATINGS

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

Collector-emitter voltage			
peak value; $V_{BE} = 0$	V_{CESM}	max.	1500 V
open base	V_{CEO}	max.	700 V
Collector current			
DC	I_C	max.	8 A
peak value	I_{CM}	max.	15 A
saturation	I_{Csat}	max.	4,5 A
Base current			
DC	I_B	max.	4 A
peak value	I_{BM}	max.	6 A
Total power dissipation			
up to $T_h = 25\text{ }^\circ\text{C}^*$	P_{tot}	max.	34 W
Storage temperature	T_{stg}		-65 to + 150 $^\circ\text{C}$
Junction temperature	T_j	max.	150 $^\circ\text{C}$

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j-mb}$	=	1 K/W
From junction to external heatsink *	$R_{th\ j-h}$	=	3,7 K/W
From junction to external heatsink **	$R_{th\ j-h}$	=	2,8 K/W
From junction to ambient	$R_{th\ j-a}$	=	35 K/W

ISOLATION

Isolation voltage from all terminals to external heatsink (peak value)	V_{isol}	max.	1500 V
Isolation capacitance from collector to external heatsink	C_{isol}	typ.	21 pF

CHARACTERISTICS

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

Collector cut-off current			
$V_{CE} = V_{CESmax}; V_{BE} = 0$	I_{CES}	max.	1 mA
$V_{CE} = V_{CESmax}; V_{BE} = 0; T_j = 125\text{ }^\circ\text{C}$	I_{CES}	max.	2 mA
Emitter cut-off current			
$V_{EB} = 6\text{ V}; I_C = 0$	I_{EBO}	max.	10 mA
DC current gain			
$I_C = 100\text{ mA}; V_{CE} = 5\text{ V}$	h_{FE}	min.	6
	h_{FE}	typ.	13
	h_{FE}	max.	30

* Mounted without heatsink compound and 30 ± 5 newtons pressure on centre of envelope.
** Mounted with heatsink compound and 30 ± 5 newtons pressure on centre of envelope.

Saturation voltages

$$I_C = I_{C\text{sat}}; I_B = 2 \text{ A}$$

Diode forward voltage

$$I_F = 4,5 \text{ A (BU508DF)}$$

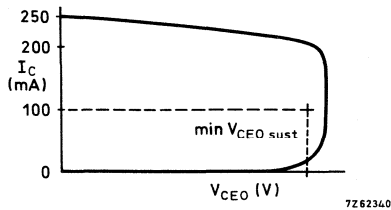
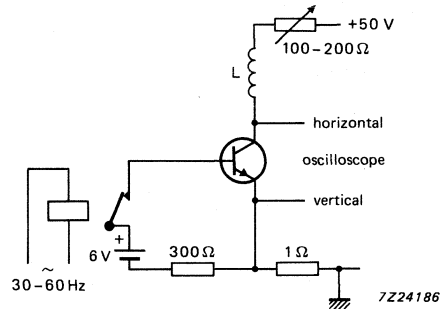
Collector-emitter sustaining voltage

$$I_C = 0,1 \text{ A}; I_B = 0; L = 25 \text{ mH}$$

$V_{CE\text{sat}}$	max.	1 V
$V_{BE\text{sat}}$	max.	1,3 V

V_F	max.	2 V
V_F	typ.	1,6 V

$V_{CE0\text{sus}}$	min.	700 V
---------------------	------	-------

Fig. 2 Oscilloscope display for $V_{CE0\text{sus}}$.Fig. 3 Test circuit for $V_{CE0\text{sus}}$.

Second-breakdown current

$$V_{CE} = 120 \text{ V}; T = 200 \mu\text{s}$$

Transition frequency at $f = 5 \text{ MHz}$

$$I_C = 0,1 \text{ A}; V_{CE} = 5 \text{ V}$$

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

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

Switching times in horizontal deflection circuit

$$-V_{IM} = 4 \text{ V}; L_B = 6 \mu\text{H}$$

$$I_C = I_{C\text{sat}}; I_B(\text{end}) = 1,4 \text{ A}$$

$$(-dI_B/dt = 0,6 \text{ A}/\mu\text{s})$$

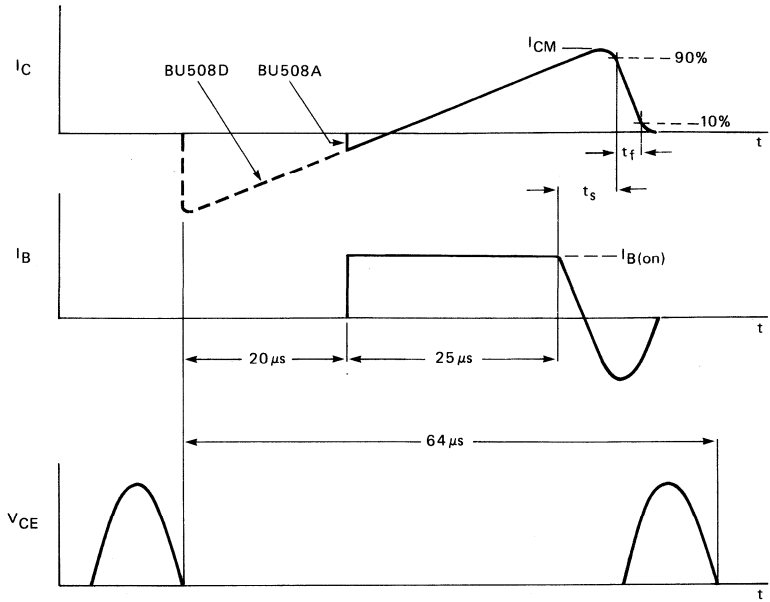
I_{SB}	min.	11 A
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f_T	typ.	7 MHz
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C_c	typ.	125 pF
-------	------	--------

t_f	typ.	0,7 μs
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t_s	typ.	6,5 μs
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Fig. 4 Switching times waveforms.

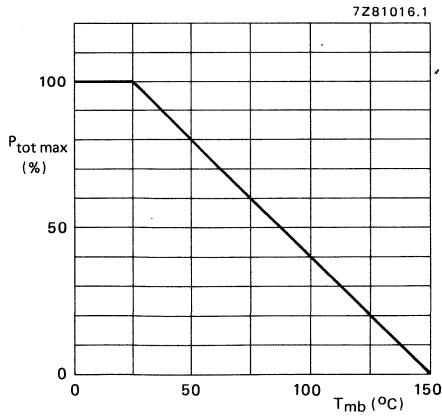


Fig. 5 Power derating curve.

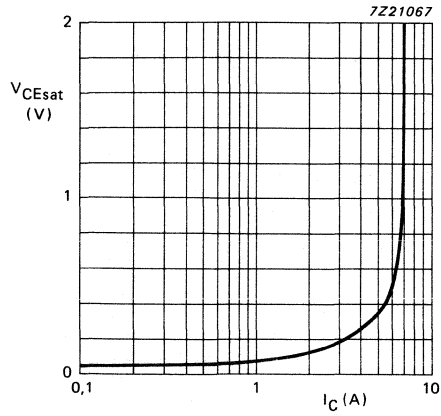


Fig. 6 Typical values $I_C/I_B = 2$; $T_j = 25$ °C.

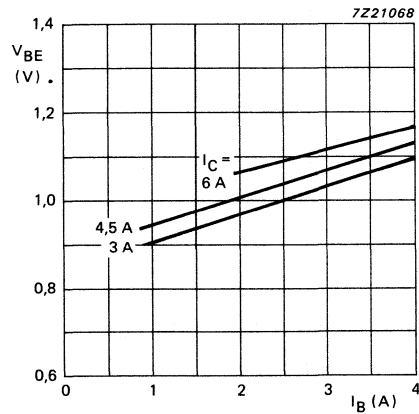


Fig. 7 Typical values base-emitter voltage at $T_j = 25$ °C.

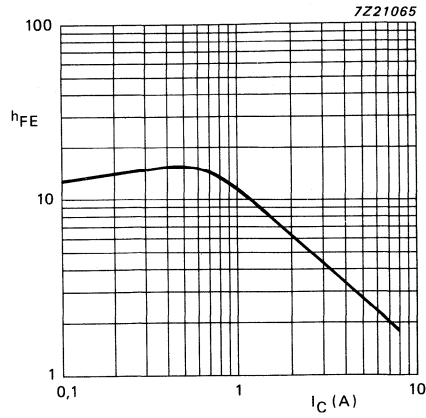


Fig. 8 Typical values DC current gain at $V_{CE} = 5$ V; $T_j = 25$ °C.

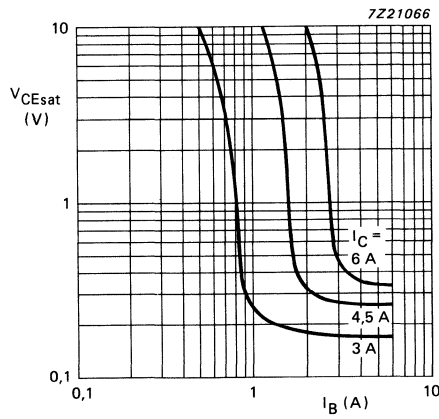
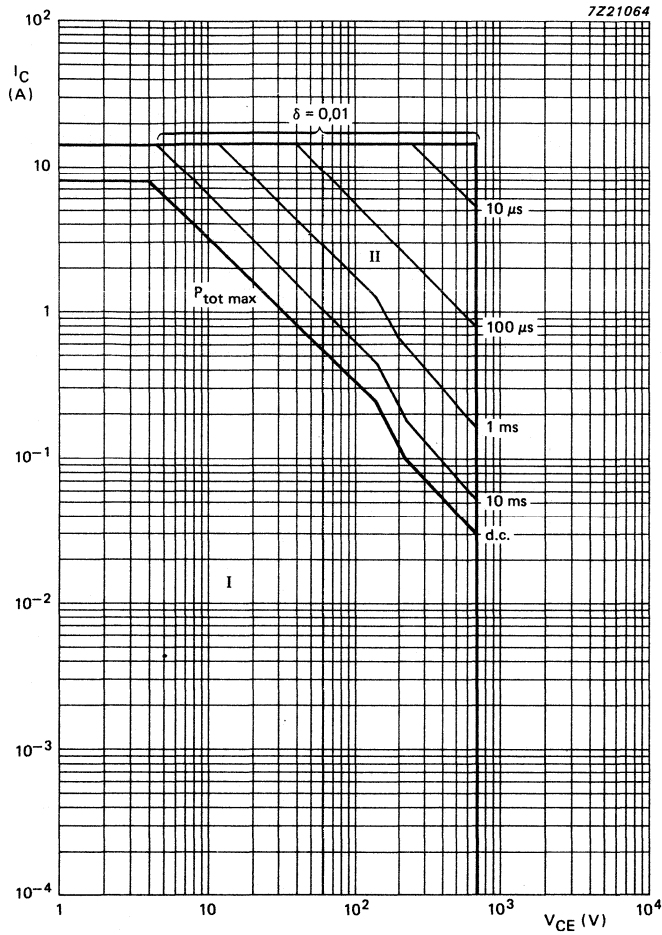


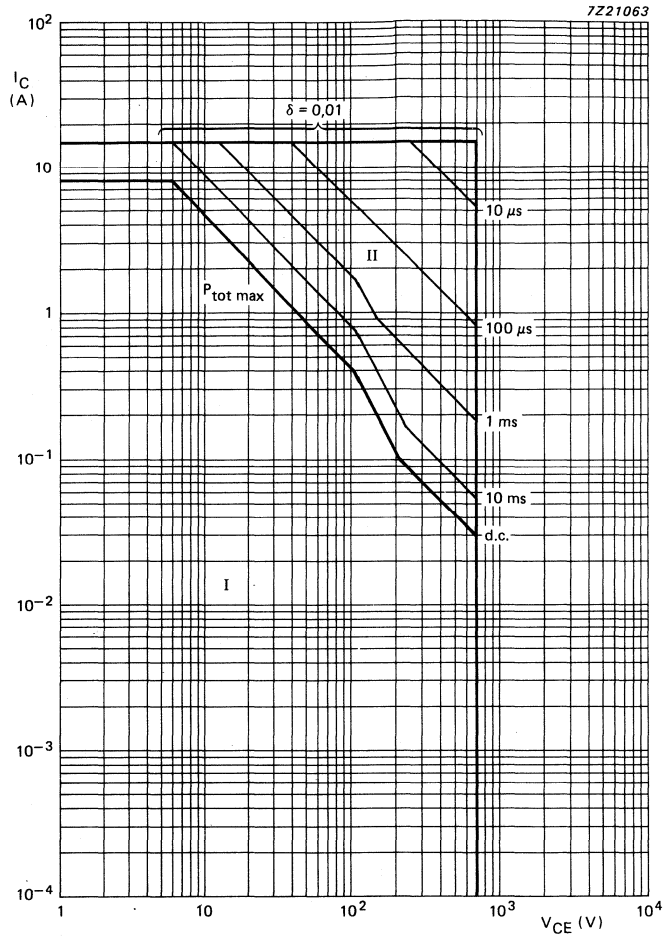
Fig. 9 Typical values collector-emitter voltage at $T_j = 25$ °C.



- I Region of permissible DC operation.
- II Permissible extension for repetitive pulse operation.

Note: Mounted without heatsink compound and 30 ± 5 newtons pressure on the centre of the envelope.

Fig. 10 Safe Operating Area; $T_h = 25^\circ\text{C}$.



- I Region of permissible DC operation.
 - II Permissible extension for repetitive pulse operation.
- Note: Mounted with heatsink compound and 30 ± 5 newtons pressure on the centre of the envelope.

Fig. 11 Safe Operating Area; $T_h = 25^\circ\text{C}$.

SILICON DIFFUSED POWER TRANSISTORS

High-voltage, high-speed, glass-passivated npn power transistors in a TO-220 envelope intended for use in power supplies and deflection circuits for colour receivers and monitors.

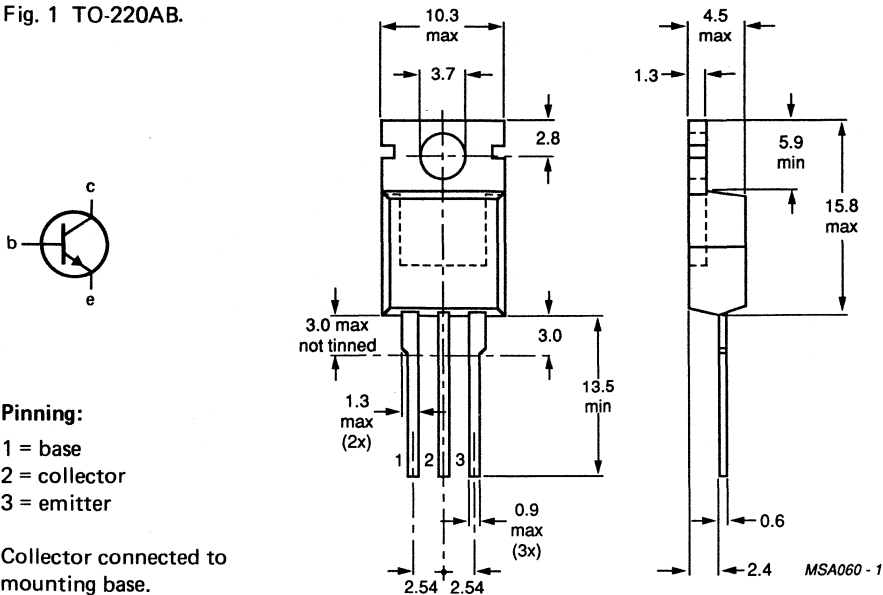
QUICK REFERENCE DATA

Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM}	max.	1350 V
	V_{CEO}	max.	550 V
Saturation voltages	V_{CEsat}	max.	2.0 V
	V_{BEsat}	max.	1.5 V
Collector current saturation	I_{Csat}	max.	2.0 A
DC	I_C	max.	5.0 A
peak value	I_{CM}	max.	8.0 A
Total power dissipation up to $T_{mb} = 25^\circ\text{C}$	P_{tot}	max.	100 W
DC current gain $I_C = 2.0\text{ A}; V_{CE} = 2\text{ V}$	h_{FE}	min.	6.0
Switching times; resistive load fall time	t_f	max.	0.7 μs

MECHANICAL DATA

Fig. 1 TO-220AB.

Dimensions in mm



RATINGS

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

Collector-emitter voltage			
peak value; $V_{BE} = 0$	V_{CESM}	max.	1350 V
open base	V_{CEO}	max.	550 V
Emitter-base voltage	V_{EBO}	min.	6.0 V
Collector current			
DC	I_C	max.	5.0 A
peak value	I_{CM}	max.	8.0 A
Base current			
DC	I_B	max.	2.0 A
peak value	I_{BM}	max.	4.0 A
Emitter current			
DC	I_E	max.	7.0 A
peak value	I_{EM}	max.	12 A
Total power dissipation			
up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	100 W
Storage temperature range	T_{stg}		-65 to + 150 $^\circ\text{C}$
Junction temperature	T_j	max.	150 $^\circ\text{C}$
THERMAL RESISTANCE			
From junction to mounting base	$R_{th\ j-mb}$	max.	1.25 K/W

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

Collector cut-off current

 $V_{BE} = 0; V_{CE} = V_{CESmax}$ $V_{BE} = 0; V_{CE} = V_{CESmax}; T_j = 125\text{ }^\circ\text{C}$

I_{CES}	max.	1.0 mA
I_{CES}	max.	2.0 mA

Emitter cut-off current

 $I_C = 0; V_{EB} = 6\text{ V}$

I_{EBO}	max.	1.0 mA
-----------	------	--------

Collector-emitter breakdown voltage

 $I_C = 100\text{ mA}; I_B = 0$

V_{CEO}	min.	550 V
-----------	------	-------

Saturation voltage

 $I_C = 2.0\text{ A}; I_B = 0.33\text{ A}$ $I_C = 4.0\text{ A}; I_B = 1.33\text{ A}$

V_{CEsat}	max.	2.0 V
V_{CEsat}	max.	3.0 V

DC current gain

 $I_C = 10\text{ mA}; V_{CE} = 5\text{ V}$ $I_C = 1.0\text{ A}; V_{CE} = 5\text{ V}$ $I_C = 2.0\text{ A}; V_{CE} = 2\text{ V}$ $I_C = 4.0\text{ A}; V_{CE} = 3\text{ V}$

h_{FE}	min.	6.0
h_{FE}	min.	8.0
h_{FE}	min.	6.0
h_{FE}	min.	3.0

Switching times; resistive load (Figs 2 and 3)

 $I_{C\text{ on}} = 2.0\text{ A}; I_{B\text{ on}} = -I_{B\text{ off}} = 0.33\text{ A}$

turn-on

t_{on}	max.	0.5 μs
----------	------	-------------------

turn-off; storage time

t_s	max.	6.0 μs
-------	------	-------------------

fall time

t_f	max.	0.7 μs
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Switching times; inductive load (Figs 4 and 5)

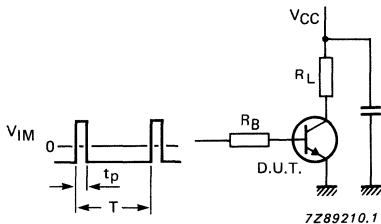
 $I_{C\text{ on}} = 2.0\text{ A}; I_{B\text{ on}} = 0.33\text{ A}$

turn-off; storage time

t_s	max.	2.5 μs
-------	------	-------------------

fall time

t_f	max.	0.8 μs
-------	------	-------------------



$t_p = 0.01$
 $\frac{T}{t_p} = 20 \mu s$

Fig. 2 Test circuit resistive load; $V_{CC} = 250 V$; $V_{IM} = -6$ to $+8 V$.

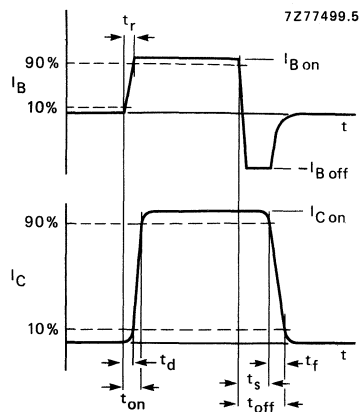
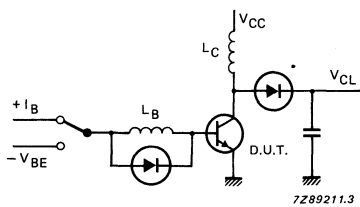


Fig. 3 Switching times waveforms with resistive load; $t_r < 50 ns$.



$V_{CL} = 300 V$
 $V_{CC} = 30 V$
 $-V_{BE} = -5 V$
 $L_B = 2.5 \mu H$
 $L_C = 200 \mu H$

Fig. 4 Test circuit inductive load.

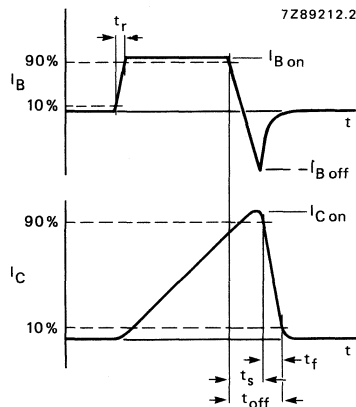


Fig. 5 Switching times waveforms with inductive load.

SILICON DIFFUSED POWER TRANSISTOR

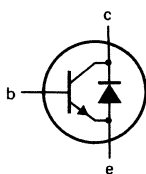
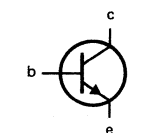
High-voltage, high-speed switching, glass passivated npn power transistor in a SOT93A envelope, intended for use in horizontal deflection circuits of television receivers. The BU705D has an integrated efficiency diode

QUICK REFERENCE DATA

Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM} V_{CEO}	max. max.	1500 V 700 V
Collector-emitter saturation voltage	V_{CEsat}	max.	1 V
Collector current saturation DC	I_{Csat} I_C	max. max.	2 A 2.5 A
peak value	I_{CM}	max.	4 A
Diode forward voltage (BU705D)	V_F	typ.	1.8 V
Total power dissipation up to $T_{mb} = 25^\circ C$	P_{tot}	max.	75 W
Fall time inductive load	t_f	typ.	0.7 μs

MECHANICAL DATA

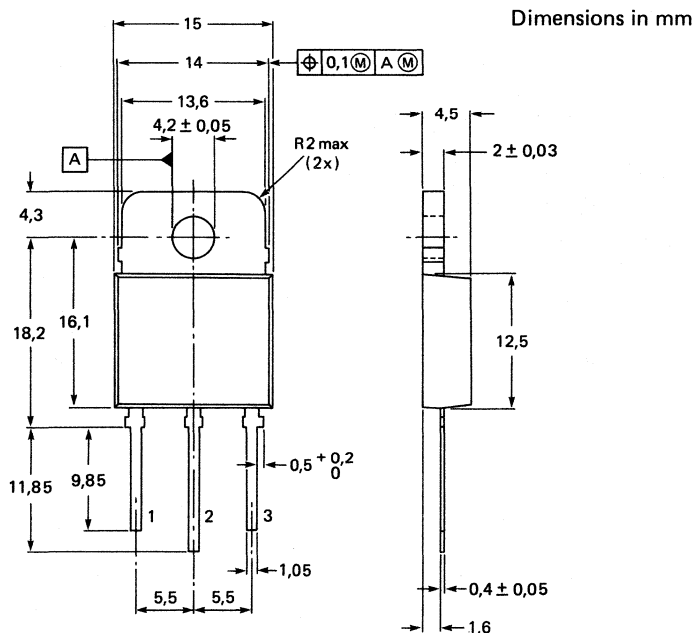
Fig. 1 SOT93A.



Pinning

- 1 = base
- 2 = collector
- 3 = emitter

Collector connected to tab.



7295744

RATINGS

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

Collector-emitter voltage (peak value; $V_{BE} = 0$)	V_{CESM}	max.	1500 V
Collector-emitter voltage (open base)	V_{CEO}	max.	700 V
Collector current (DC)	I_C	max.	2,5 A
Collector current (peak value; $t_p < 2$ ms)	I_{CM}	max.	4 A
Base current	I_B	max.	2 A
Base current (peak value; $t_p < 2$ ms)	I_{BM}	max.	4 A
Total power dissipation up to $T_{mb} = 25$ °C	P_{tot}	max.	75 W
Storage temperature range	T_{stg}		-65 to +150 °C
Junction temperature	T_j	max.	150 °C

THERMAL RESISTANCE

From junction to mounting base	R_{thj-mb}	=	1,67 K/W
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CHARACTERISTICS

$T_j = 25$ °C unless otherwise specified

Collector cut-off current*

$V_{CE} = V_{CESMmax}; V_{BE} = 0$	I_{CES}	max.	0,15 mA
$V_{CE} = V_{CESMmax}; V_{BE} = 0; T_j = 125$ °C	I_{CES}	max.	1 mA

Emitter cut-off current

$I_C = 0; V_{EB} = 5$ V	I_{EBO}	max.	1 mA
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Emitter-base voltage

$I_C = 0; I_E = 10$ mA	V_{EBO}	min.	6 V
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Saturation voltage

$I_C = 2$ A; $I_B = 0,9$ A	V_{CEsat}	max.	1 V
	V_{BEsat}	max.	1,3 V

Diode forward-voltage (BU705D)

$I_F = 3$ A	V_F	typ.	1,8 V
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Collector-emitter sustaining voltage

$I_C = 100$ mA; $I_B = 0; L = 25$ mH	$V_{CEO_{sust}}$	min.	700 V
--------------------------------------	------------------	------	-------

Collector saturation current

$V_{CE} = 5$ V	I_{Csat}	typ.	2 A
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DC current gain

$I_C = 2$ A; $V_{CE} = 5$ V	h_{FE}	min.	2,2
$I_C = 100$ mA; $V_{CE} = 5$ V	h_{FE}	min.	6
	h_{FE}	typ.	13
	h_{FE}	max.	30

Second breakdown current

$V_{CE} = 120$ V; $t = 200$ μ s	I_{SB}	max.	2,0 A
-------------------------------------	----------	------	-------

Transition frequency at $f = 5$ MHz

$I_C = 0,1$ A; $V_{CE} = 5$ V	f_T	typ.	7 MHz
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* Measured with a half-sinewave voltage (curve tracer).

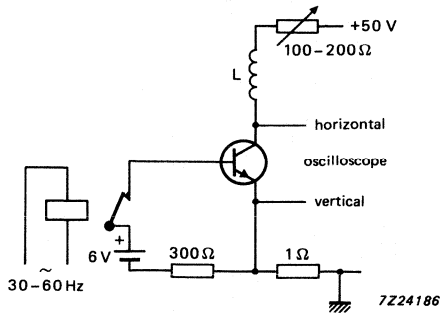


Fig. 2 Test circuit for sustaining voltage.

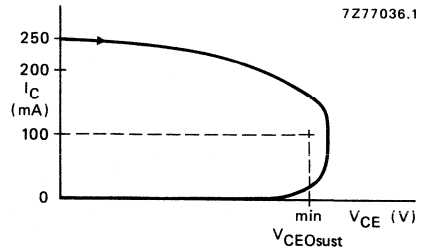


Fig. 3 Oscilloscope display for sustaining voltage.

Switching times (in horizontal deflection circuit)

$-V_{dr} = 4 \text{ V}; L_B = 15 \mu\text{H}; I_{CM} = 2 \text{ A}$

$I_{B(\text{end})} = 0,9 \text{ A};$

fall time

storage time

t_f	typ.	0,9 μs
t_s	typ.	7,5 μs

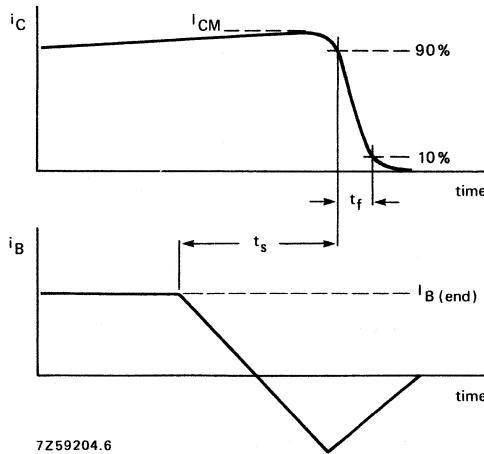
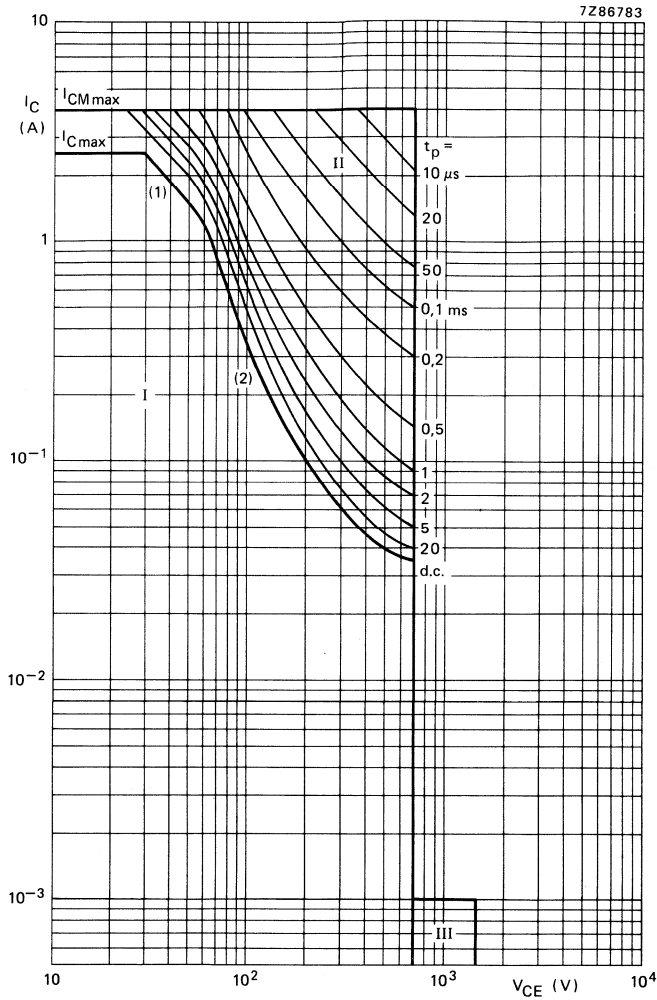


Fig. 4 Switching times waveform.



- (1) $P_{tot\ max}$ and $P_{peak\ max}$ lines.
- (2) Second breakdown limits.
- I Region of permissible DC operation.
- II Permissible extension for repetitive pulse operation.
- III Repetitive pulse operation in this region is allowable, provided $R_{BE} < 100\ \Omega$, $t_p = 20\ \mu s$, $d = 0,25$.

Fig. 5 Safe operating area; $T_{mb} = 25\ ^\circ C$.

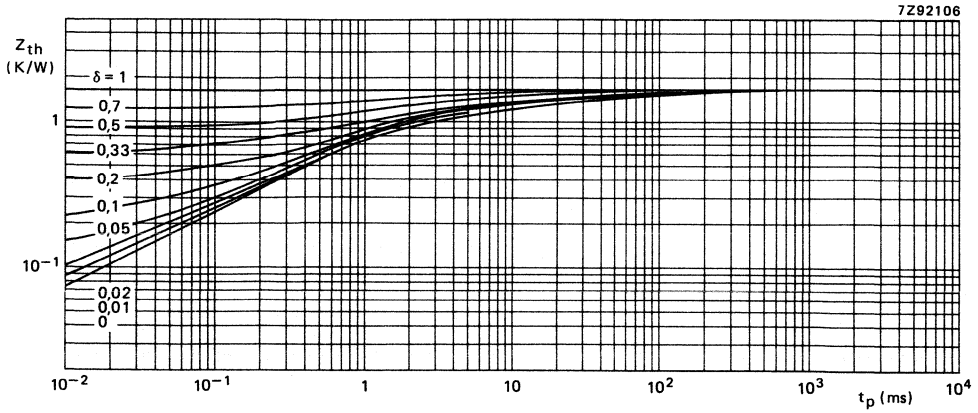


Fig. 6 Pulse power rating chart.

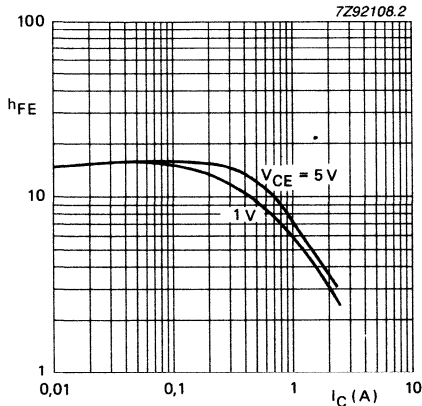


Fig. 7 Typical DC current gain; $T_j = 25\text{ }^\circ\text{C}$.

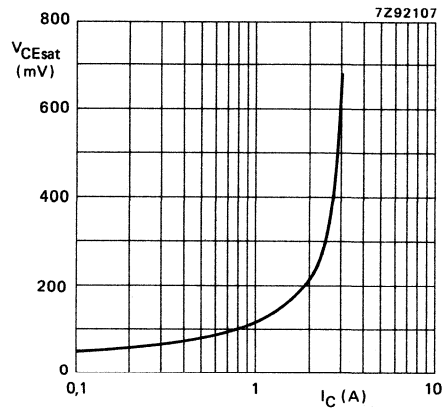


Fig. 8 Typical values V_{CEsat}
 $I_C/I_B = 2$; $T_j = 25\text{ }^\circ\text{C}$.

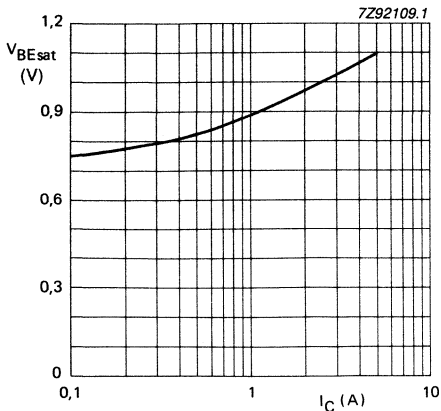


Fig. 9 Typical values V_{BEsat} ; $I_C/I_B = 2$; $T_j = 25\text{ }^\circ\text{C}$.

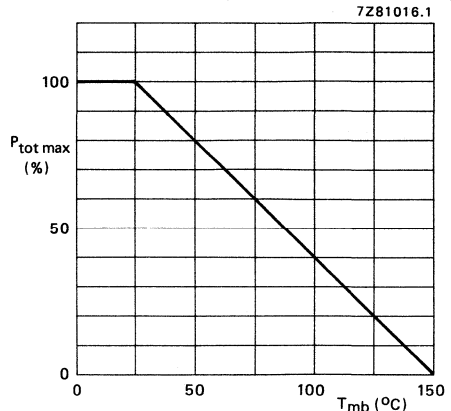


Fig. 10 Power derating curve.

SILICON DIFFUSED POWER TRANSISTORS

High-voltage, high-speed switching npn power transistors in a SOT199 envelope intended for use in horizontal deflection circuits of television receivers. The BU705DF has an integrated efficiency diode.

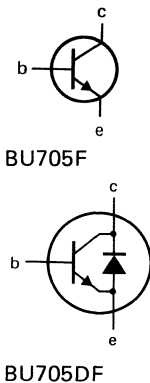
QUICK REFERENCE DATA

Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM}	max.	1500	V
	V_{CEO}	max.	700	V
Collector-emitter saturation voltage	V_{CEsat}	max.	1.0	V
Collector current saturation	I_{Csat}	max.	2.0	A
DC	I_C	max.	2.5	A
peak value	I_{CM}	max.	4.0	A
Diode Forward voltage (BU705DF)	V_F	max.	1.8	V
Total power dissipation up to $T_{mb} = 25^\circ\text{C}$	P_{tot}	max.	29	W
Fall time; inductive load	t_f	typ.	0.9	μs

MECHANICAL DATA

Dimensions in mm

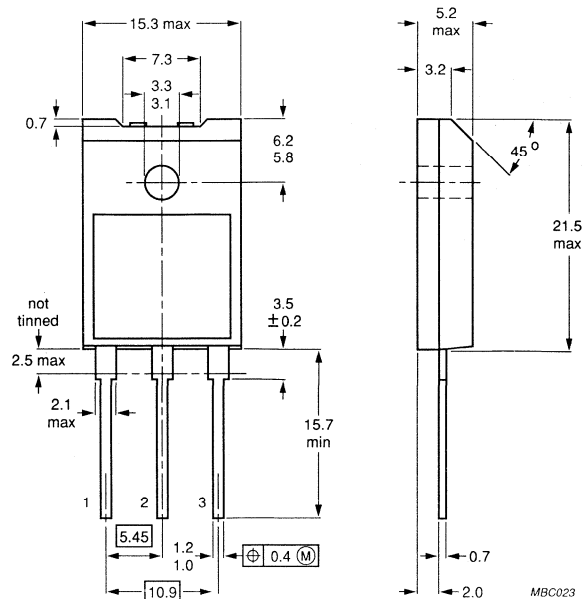
Fig. 1 SOT199.



Pinning:

- 1 = base
- 2 = collector
- 3 = emitter

Mounting base is electrically isolated from all terminals



RATINGS

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

Collector-emitter voltage			
peak value; $V_{BE} = 0$	V_{CESM}	max.	1500 V
open base	V_{CEO}	max.	700 V
Collector current			
saturation	I_{Csat}		2.0 A
DC	I_C	max.	2.5 A
peak	I_{CM}	max.	4.0 A
Base current			
DC	I_B	max.	2.0 A
peak	I_{BM}	max.	4.0 A
Total power dissipation			
up to $T_h = 25\text{ }^\circ\text{C}$	P_{tot}	max.	29 W
Storage temperature range			
	T_{stg}		-65 to + 150 $^\circ\text{C}$
Junction temperature			
	T_j	max.	150 $^\circ\text{C}$

THERMAL RESISTANCE

From junction to external heatsink (note 1)	$R_{th\ j-h}$	=	4.37 K/W
From junction to external heatsink (note 2)	$R_{th\ j-h}$	=	3.47 K/W
From junction to ambient	R_{th-a}	=	35 K/W

ISOLATION

Isolation voltage from all terminals to external heatsink (peak value) (note 3)	V_{isol}	max.	2000 V
Isolation capacitance from collector to external heatsink	C_{isol}	typ.	21 pF

Notes

1. Mounted without heatsink compound and 30 ± 5 newtons pressure on centre envelope.
2. Mounted with heatsink compound and 30 ± 5 newtons pressure on centre envelope.
3. Repetitive peak operation with $RH \leq 65\%$ under clean and dust-free conditions.

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

Collector cut-off current

$V_{CE} = V_{CESmax}; V_{BE} = 0$

$V_{CE} = V_{CESmax}; V_{BE} = 0; T_j = 125\text{ }^\circ\text{C}$

I_{CES}	max.	0.15 mA
I_{CES}	max.	1.0 mA

Emitter cut-off current

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

I_{EBO}	max.	1.0 mA
-----------	------	--------

Saturation voltage

$I_C = 2\text{ A}; I_B = 0.9\text{ A}$

V_{CEsat}	max.	1.0 V
V_{BEsat}	max.	1.3 V

Diode forward voltage

$I_F = 2.0\text{ A}$

V_F	max.	1.8 V
-------	------	-------

Collector saturation current

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

I_{Csat}	typ.	2.0 A
------------	------	-------

DC current gain

$I_C = 2\text{ A}; V_{CE} = 5\text{ V}$

$I_C = 100\text{ mA}; V_{CE} = 5\text{ V}$

h_{FE}	min.	2.2
h_{FE}	min.	6
h_{FE}	typ.	13
h_{FE}	max.	30

Second breakdown current

$V_{CE} = 120\text{ V}; t = 200\text{ }\mu\text{s}$

I_{SB}	min.	2.0 A
----------	------	-------

Transition frequency at $f = 5\text{ MHz}$

$I_C = 0.1\text{ A}; V_{CE} = 5\text{ V}$

f_T	typ.	7.0 MHz
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Collector capacitance at $f = 1\text{ MHz}$

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

C_c	typ.	65 pF
-------	------	-------

Collector emitter sustaining voltage
(Figs 2 and 3)

$I_C = 100\text{ mA}; I_B = 0; L = 25\text{ mH}$

$V_{CEO\text{sust}}$	min.	700 V
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Switching times in horizontal
deflection circuit (Fig. 4)

$I_{CM} = 2\text{ A}; L_B = 15\text{ }\mu\text{H}$

$I_{B(\text{end})} = 0.9\text{ A}; -V_{dr} = 4\text{ V}$

t_f	typ.	0.9 μs
t_s	typ.	7.5 μs

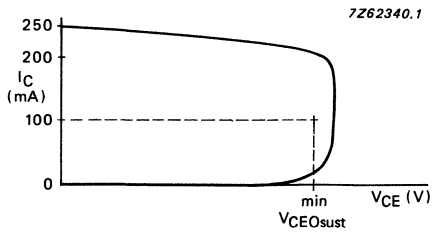


Fig. 2 Oscilloscope display for sustaining voltage.

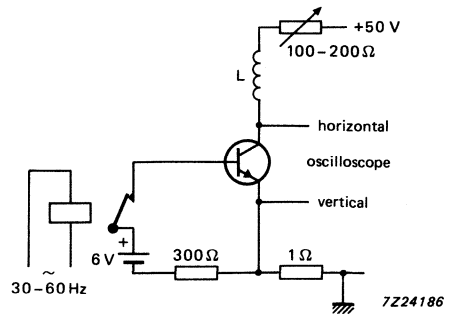


Fig. 3 Test circuit for $V_{CEOsust}$.

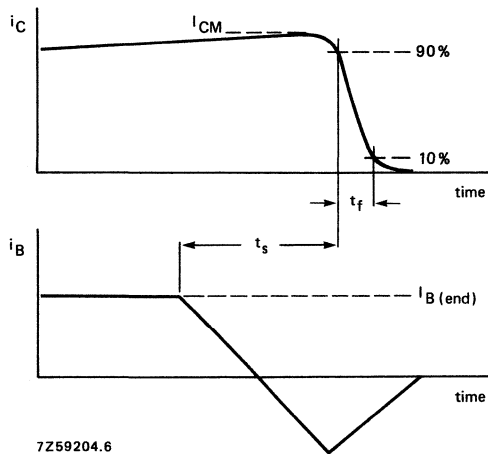


Fig. 4 Switching times waveforms.

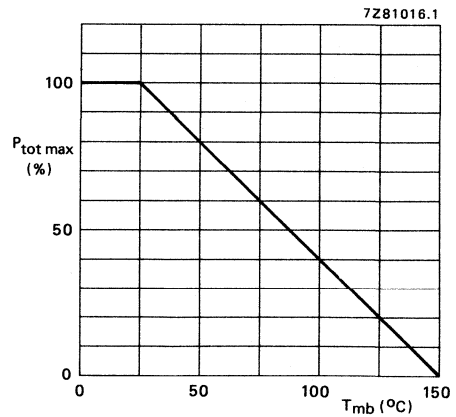
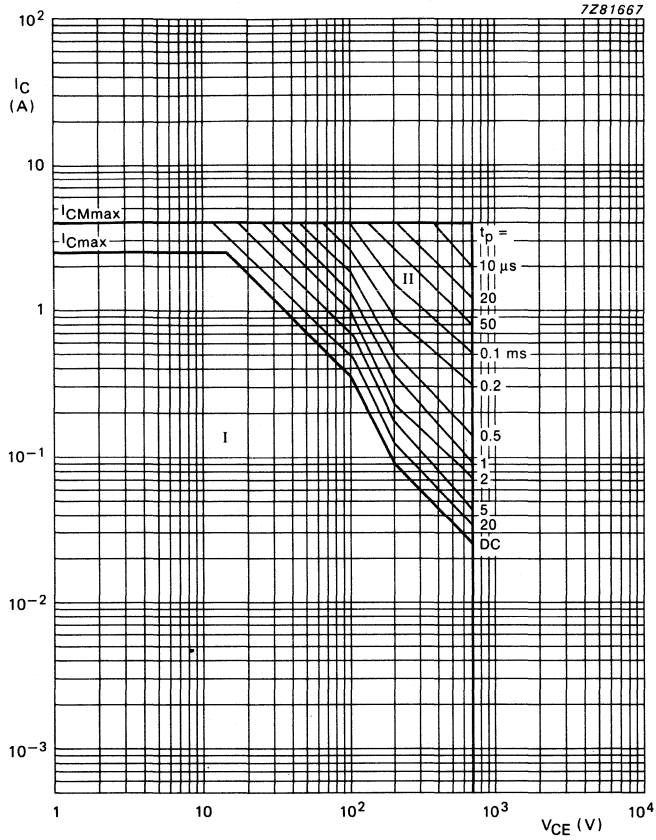


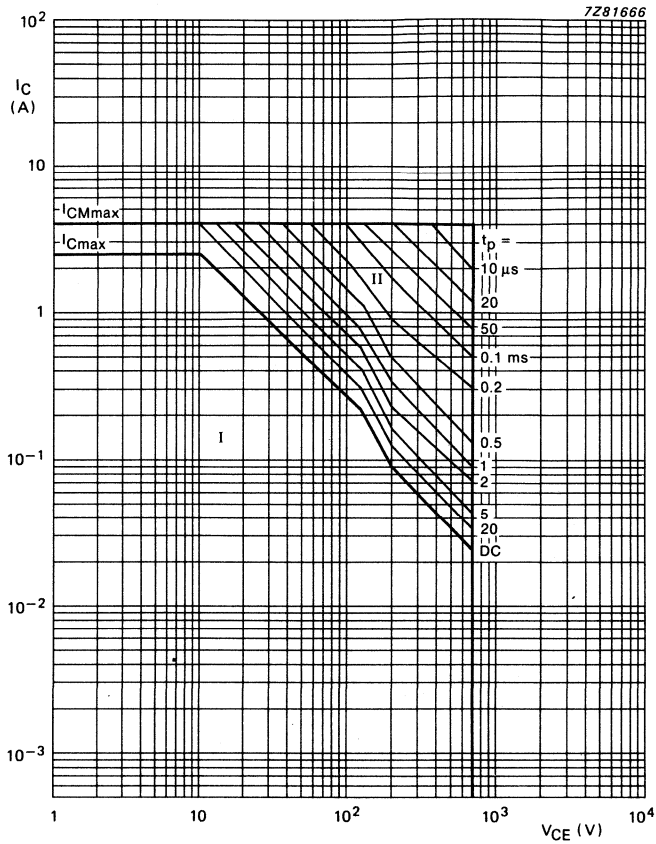
Fig. 5 Power derating curve.



- I Region of permissible DC operation.
- II Permissible extension for repetitive pulse operation.

Note: mounted with heatsink compound and 30 ± 5 newtons pressure on centre of envelope.

Fig. 6 Safe operating area at $T_{mb} = 25 \text{ }^\circ\text{C}$.



- I Region of permissible DC operation.
- II Permissible extension for repetitive pulse operation.

Note: mounted without heatsink compound and 30 ± 5 newtons pressure on centre of envelope.

Fig. 7 Safe operating area at $T_{mb} = 25$ °C.

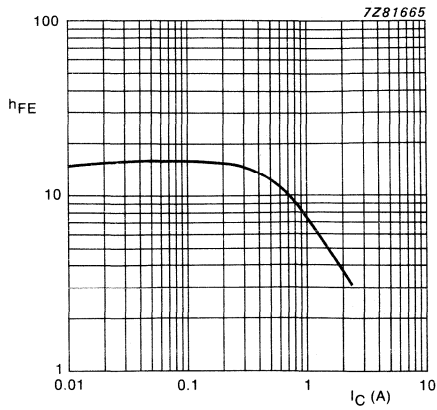


Fig. 8 Typical DC current gain;
 $V_{CE} = 5$ V; $T_j = 25$ °C.

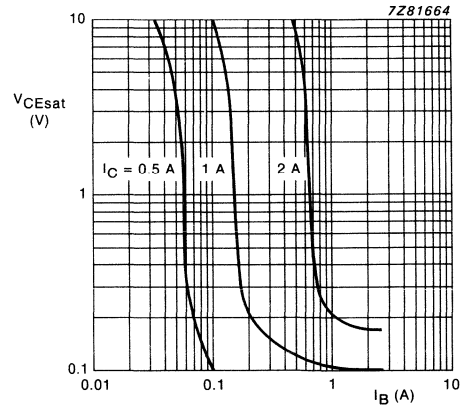


Fig. 9 Typical collector-emitter
saturation voltage; $T_j = 25$ °C.

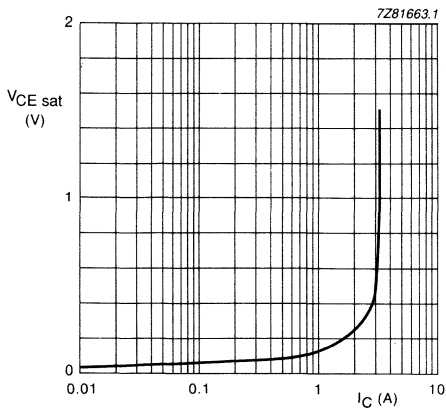


Fig. 10 Typical values V_{CEsat} ;
 $I_C/I_B = 2$; $T_j = 25$ °C.

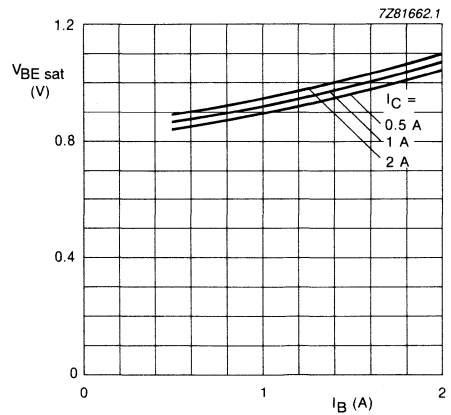


Fig. 11 Typical values V_{BEsat} ;
 $T_j = 25$ °C.

SILICON DIFFUSED POWER TRANSISTORS

High-voltage, high-speed switching npn transistors in a plastic envelope intended for use in horizontal deflection circuits of colour television receivers and line operated switch-mode applications. The BU706D has an integrated efficiency diode.

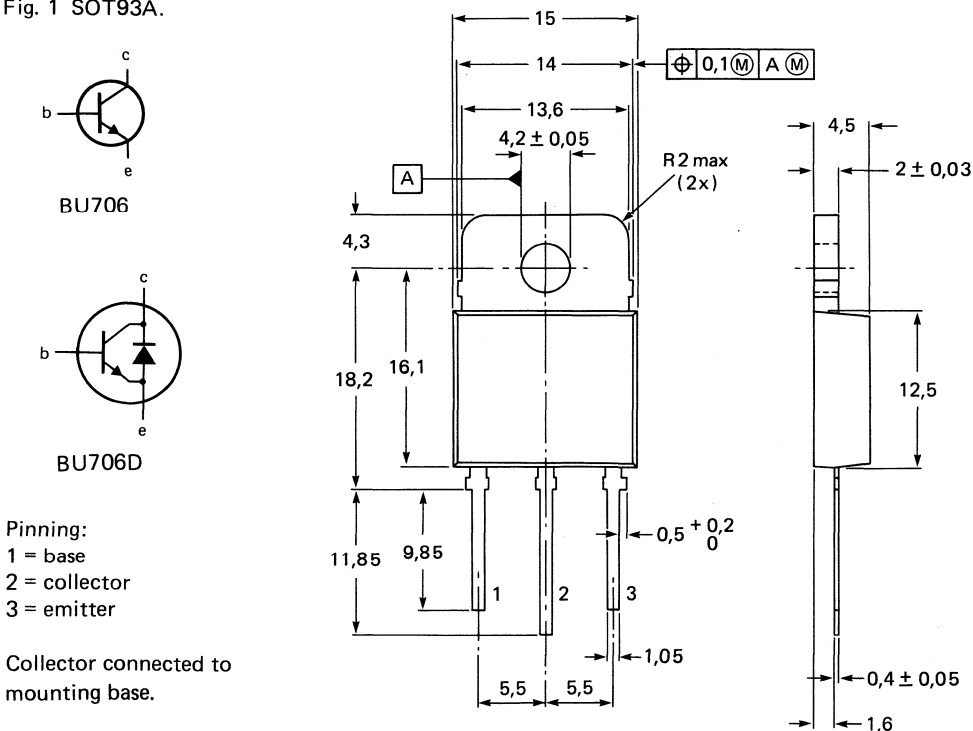
QUICK REFERENCE DATA

Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM}	max.	1500 V
	V_{CEO}	max.	700 V
Collector-emitter saturation voltage	V_{CEsat}	max.	1.0 V
Collector current saturation DC	I_{Csat}	max.	3.0 A
	I_C	max.	5.0 A
peak value	I_{CM}	max.	8.0 A
Diode forward voltage (BU706D)	V_F	typ.	1.5 V
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	100 W
Fall time; inductive load	t_f	typ.	0.7 μs

MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT93A.



7295744

RATINGS

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

Collector-emitter voltage			
peak value; $V_{BE} = 0$	V_{CESM}	max.	1500 V
open base	V_{CEO}	max.	700 V
Collector current			
saturation	I_{Csat}		3.0 A
DC	I_C	max.	5.0 A
peak	I_{CM}	max.	8.0 A
Base current			
DC	I_B	max.	3.0 A
peak	I_{BM}	max.	5.0 A
Total power dissipation			
up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	100 W
Storage temperature range	T_{stg}		-65 to + 150 $^\circ\text{C}$
Junction temperature	T_j	max.	150 $^\circ\text{C}$
THERMAL RESISTANCE			
From junction to mounting base	R_{thj-mb}	=	1.25 K/W

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

Collector cut-off current*

 $V_{BE} = 0; V_{CE} = V_{CESMmax}$ $V_{BE} = 0; V_{CE} = V_{CESMmax}; T_j = 125\text{ }^\circ\text{C}$ I_{CES} max. 0.5 mA I_{CES} max. 1.0 mA

Emitter cut-off current

 $V_{EB} = 6\text{ V}; I_C = 0$ I_{EBO} max. 10 mA

Second breakdown current

 $V_{CE} = 300\text{ V}; t_p = 200\text{ }\mu\text{s}$ I_{SB} min. 1.0 A

Collector-emitter sustaining voltage

 $I_C = 0.1\text{ A}; I_B = 0;$ $L = 25\text{ mH}$ (Figs 2 and 3) $V_{CEOsust}$ min. 700 V

Saturation voltage

 $I_C = 3.0\text{ A}; I_B = 1.33\text{ mA}$ V_{CEsat} max. 1.0 V V_{BEsat} max. 1.3 V

DC current gain

 $I_C = 100\text{ mA}; V_{CE} = 5\text{ V}$ h_{FE} min. 6 h_{FE} typ. 13 h_{FE} max. 30

Diode forward voltage (BU706D)

 $I_F = 3\text{ A}$ V_F typ. 1.5 V V_F max. 2.2 V

Switching times (in line deflection circuit) (Fig. 4)

 $I_{CM} = 3.0\text{ A}; I_{B(end)} = 1.0\text{ A};$ $L_B = 12\text{ }\mu\text{H}$ $-dI_B/dt = 0.33\text{ A}/\mu\text{s}$ t_f typ. 0.7 μs t_s typ. 6.5 μs

* Measured with a half-sinewave voltage (curve tracer).

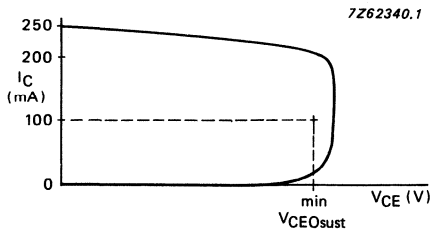


Fig. 2 Oscilloscope display for sustaining voltage.

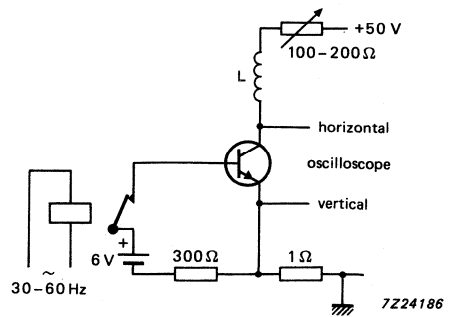


Fig. 3 Test circuit for $V_{CEO\text{sust}}$.

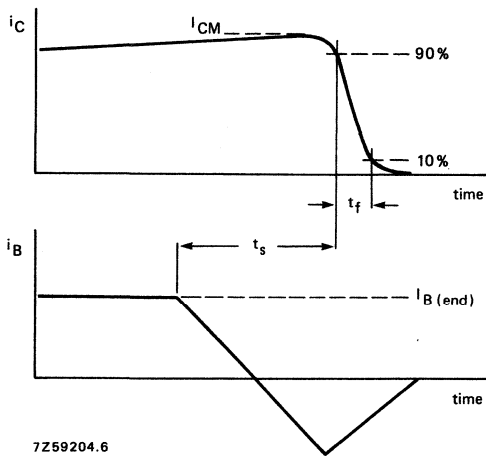


Fig. 4 Switching times waveforms.

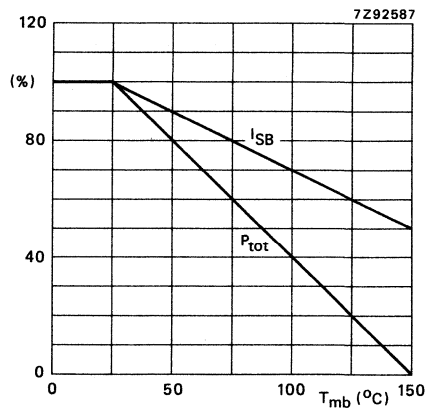
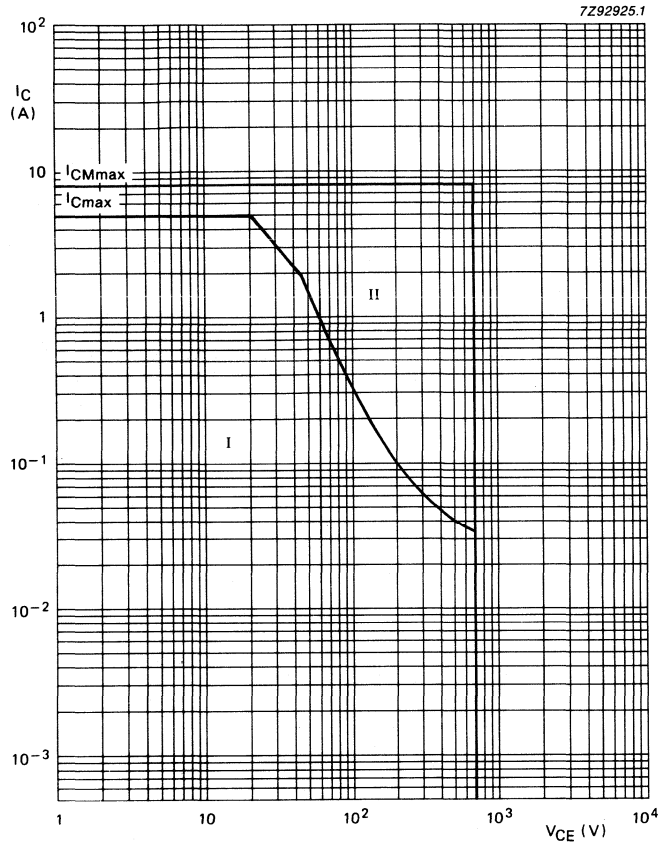


Fig. 5 Total power dissipation and second-breakdown current derating curve.



- I Region of permissible DC operation.
- II Permissible extension for repetitive pulse operation.

Fig. 6 Safe operating area.

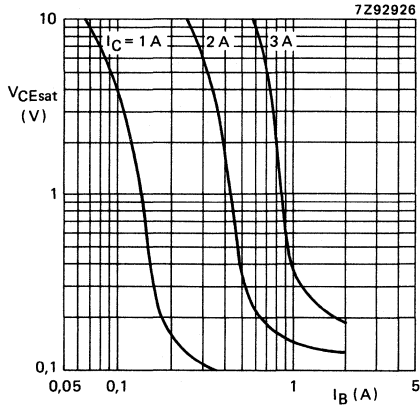


Fig. 7 Typical collector emitter saturation voltage; $T_{mb} = 25\text{ }^\circ\text{C}$.

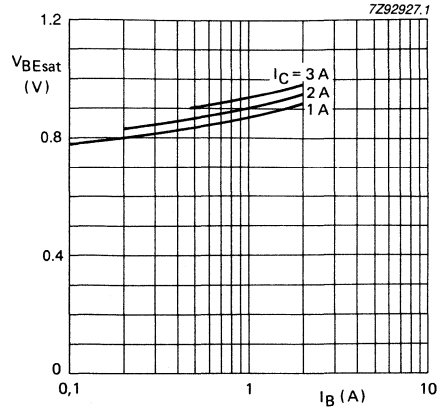


Fig. 8 Typical base-emitter saturation voltage; $T_{mb} = 25\text{ }^\circ\text{C}$.

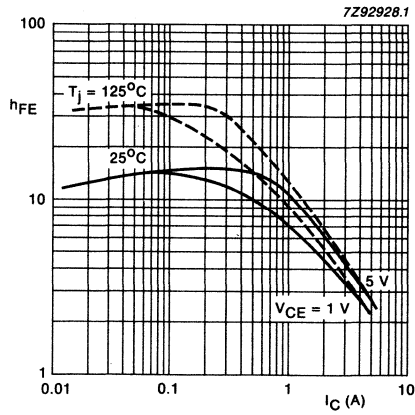


Fig. 9 Typical DC current gain.

SILICON DIFFUSED POWER TRANSISTORS

High-voltage, high-speed switching npn transistor in a SOT199 envelope, intended for use in horizontal deflection circuits of colour television receivers and in line-operated switch-mode applications. The BU706DF has an integrated efficiency diode.

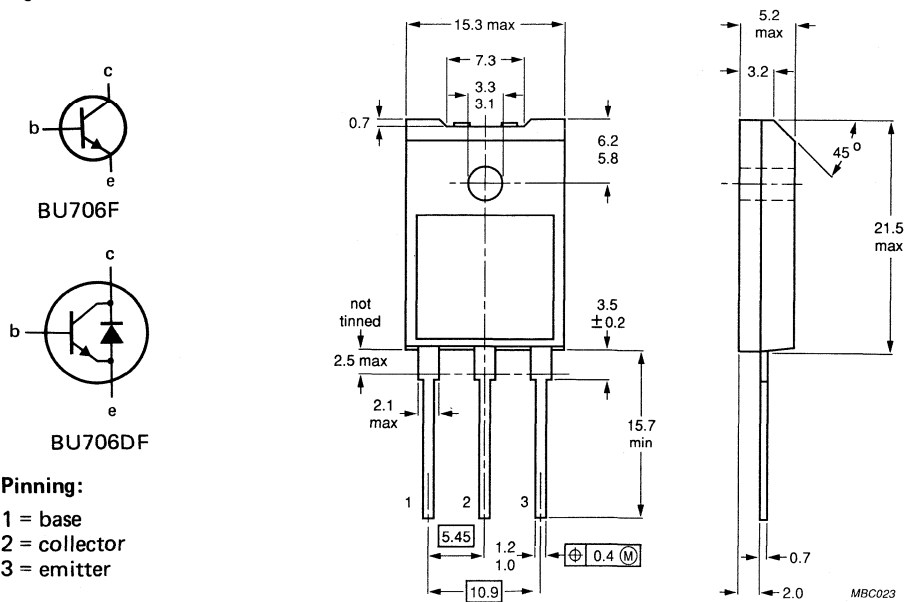
QUICK REFERENCE DATA

Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM}	max.	1500 V
	V_{CEO}	max.	700 V
Collector-emitter saturation voltage	V_{CEsat}	max.	1.0 V
Collector current saturation	I_{Csat}	max.	3.0 A
DC	I_C	max.	5.0 A
peak value	I_{CM}	max.	8.0 A
Total power dissipation up to $T_h = 25\text{ }^\circ\text{C}$	P_{tot}	max.	32 W
Diode forward voltage at $I_F = 3\text{ A}$ (BU706DF)	V_F	typ.	1.0 V
Fall time; inductive load	t_f	typ.	0.7 μs

MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT199.



Pinning:

- 1 = base
- 2 = collector
- 3 = emitter

Mounting base is electrically isolated from all terminals.

RATINGS

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

Collector-emitter voltage			
peak value; $V_{BE} = 0$	V_{CESM}	max.	1500 V
open base	V_{CEO}	max.	700 V
Collector current			
saturation	I_{Csat}		3.0 A
DC	I_C	max.	5.0 A
peak value	I_{CM}	max.	8.0 A
Base current			
DC	I_B	max.	3.0 A
peak value	I_{BM}	max.	5.0 A
Total power dissipation			
up to $T_h = 25\text{ }^\circ\text{C}$	P_{tot}	max.	32 W
Storage temperature range	T_{stg}		-65 to + 150 $^\circ\text{C}$
Junction temperature	T_j	max.	150 $^\circ\text{C}$

THERMAL RESISTANCE

From junction to external heatsink (note 1)	$R_{th\ j-h}$	=	3.95 K/W
From junction to external heatsink (note 2)	$R_{th\ j-h}$	=	3.05 K/W
From junction to ambient	R_{th-a}	=	35 K/W

ISOLATION

Isolation voltage from all terminals to external heatsink (peak value)	V_{isol}	max.	1500 V
Isolation capacitance from collector to external heatsink	C_{isol}	typ.	21 pF

Notes

1. Mounted without heatsink compound and 30 ± 5 newtons pressure on centre of envelope.
2. Mounted with heatsink compound and 30 ± 5 newtons pressure on centre of envelope.

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

Collector cut-off current

$V_{CE} = V_{CESmax}; V_{BE} = 0$

$V_{CE} = V_{CESmax}; V_{BE} = 0; T_j = 125\text{ }^\circ\text{C}$

I_{CES}	max.	0.5 mA
I_{CES}	max.	1.0 mA

Emitter cut-off current

$I_C = 0; V_{EB} = 6\text{ V}$

I_{EBO}	max.	10 mA
-----------	------	-------

Saturation voltage

$I_C = 3\text{ A}; I_B = 1.33\text{ A}$

V_{CEsat}	max.	1.0 V
V_{BEsat}	max.	1.3 V

Collector saturation current

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

I_C	typ.	3.0 A
-------	------	-------

DC current gain

$I_C = 3\text{ A}; V_{CE} = 5\text{ V}$

$I_C = 100\text{ mA}; V_{CE} = 5\text{ V}$

h_{FE}	min.	2.25
h_{FE}	min.	6
h_{FE}	typ.	13
h_{FE}	max.	30

Second breakdown current

$V_{CE} = 300\text{ V}; t_p = 200\text{ }\mu\text{s}$

I_{SB}	min.	1.0 A
----------	------	-------

Collector emitter sustaining voltage (Figs 2 and 3)

$I_C = 100\text{ mA}; I_B = 0; L = 25\text{ mH}$

$V_{CEO sust}$	min.	700 V
----------------	------	-------

Diode forward voltage

$I_F = 3\text{ A (BU706DF)}$

V_F	typ.	1.5 V
V_F	max.	2.2 V

Switching times in horizontal deflection circuit

(Fig. 4)

$I_{CM} = 3\text{ A}; L_B = 12\text{ }\mu\text{H};$

$I_B(\text{end}) = 1\text{ A};$

$\frac{-d I_B}{dt} = 0.33\text{ A}/\mu\text{s}$

t_f	typ.	0.7 μs
t_s	typ.	6.5 μs

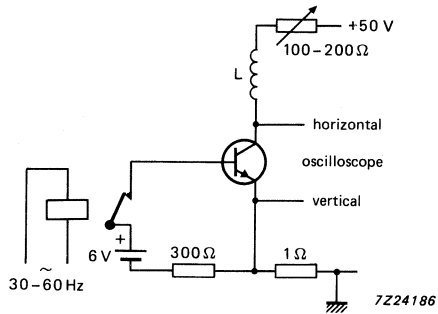


Fig. 2 Test circuit for $V_{CEOsust}$.

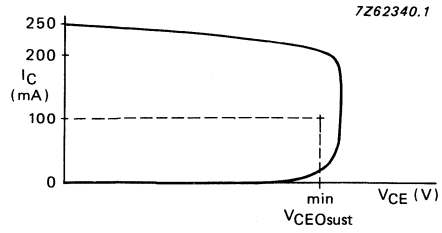
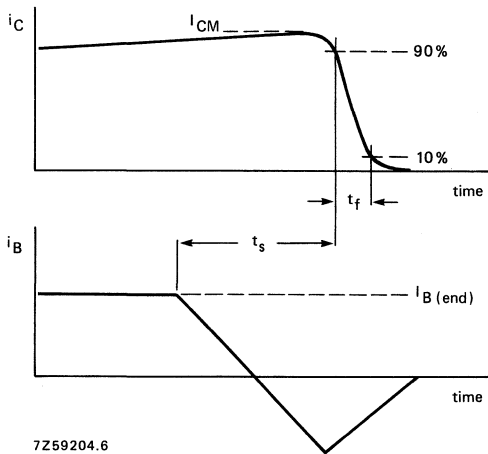


Fig. 3 Oscilloscope display for sustaining voltage.



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Fig. 4 Switching times waveforms.

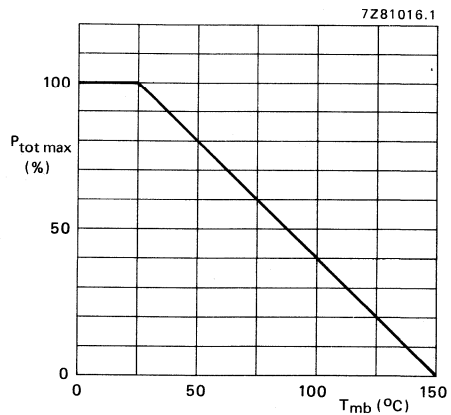


Fig. 5 Power derating curve.

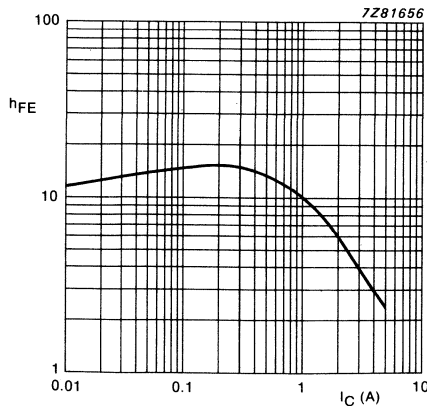
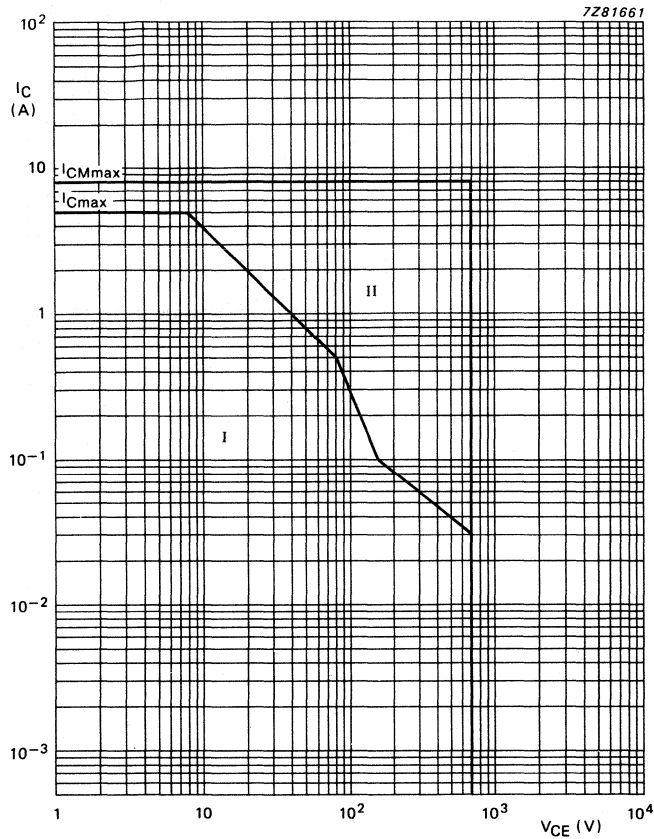


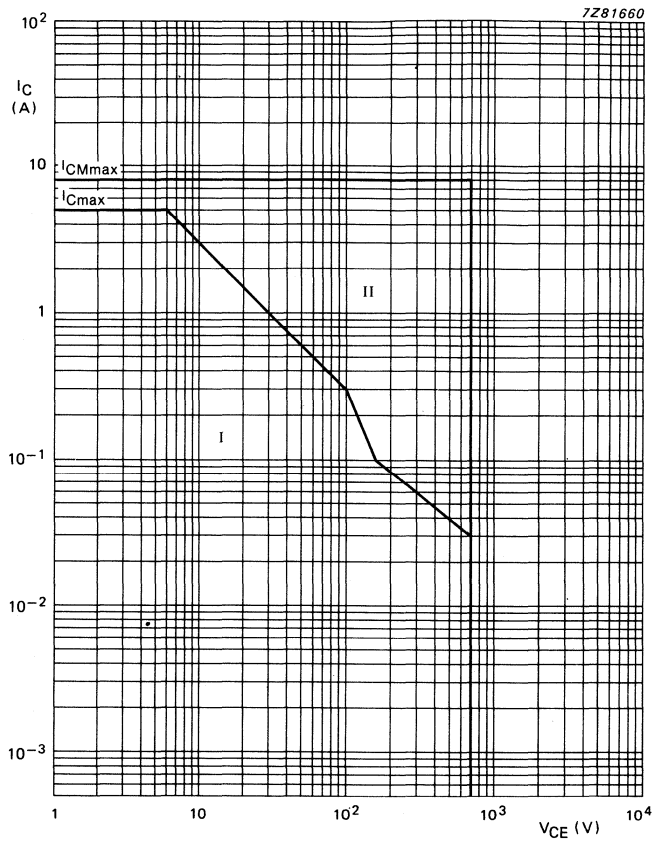
Fig. 6 Typical DC current gain; $V_{CE} = 5\text{ V}$; $T_j = 25\text{ }^\circ\text{C}$.



I Region of permissible DC operation.

II Permissible extension for repetitive pulse operation.

Fig. 7 Safe operating area at $T_{mb} = 25^\circ\text{C}$; mounted with heatsink compound and 30 ± 5 newtons pressure on centre of envelope.



- I Region of permissible DC operation.
- II Permissible extension for repetitive pulse operation.

Fig. 8 Safe operating area at $T_{mb} = 25^{\circ}\text{C}$; mounted without heatsink compound and 30 ± 5 newtons pressure on centre of envelope.

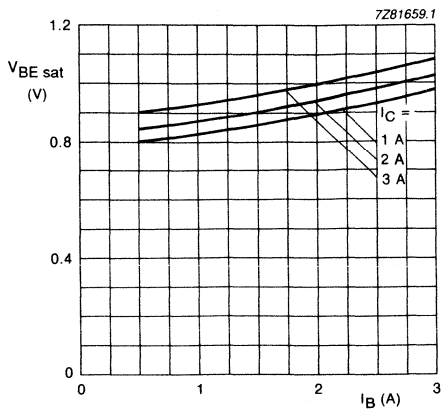


Fig. 9 Typical values $V_{BE\text{ sat}}$; $T_j = 25\text{ }^\circ\text{C}$.

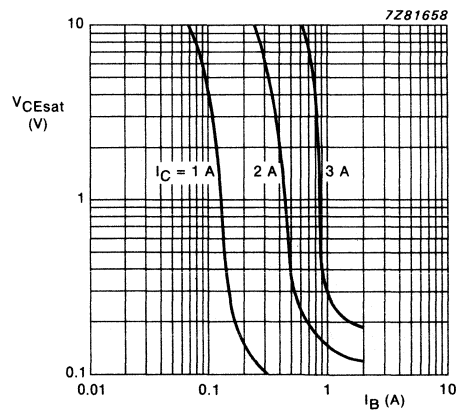


Fig. 10 Typical collector-emitter saturation voltage; $T_j = 25\text{ }^\circ\text{C}$.

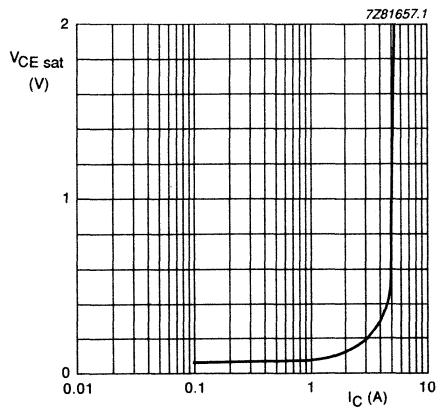


Fig. 11 Typical values $V_{CE\text{ sat}}$; $I_C/I_B = 2$; $T_j = 25\text{ }^\circ\text{C}$.

SILICON DIFFUSED POWER TRANSISTORS

Monolithic high-voltage npn Darlington transistors with integrated speed-up diode in a SOT82 envelope, intended for fast switching applications such as small motor control and switch-mode power supplies (SMPS).

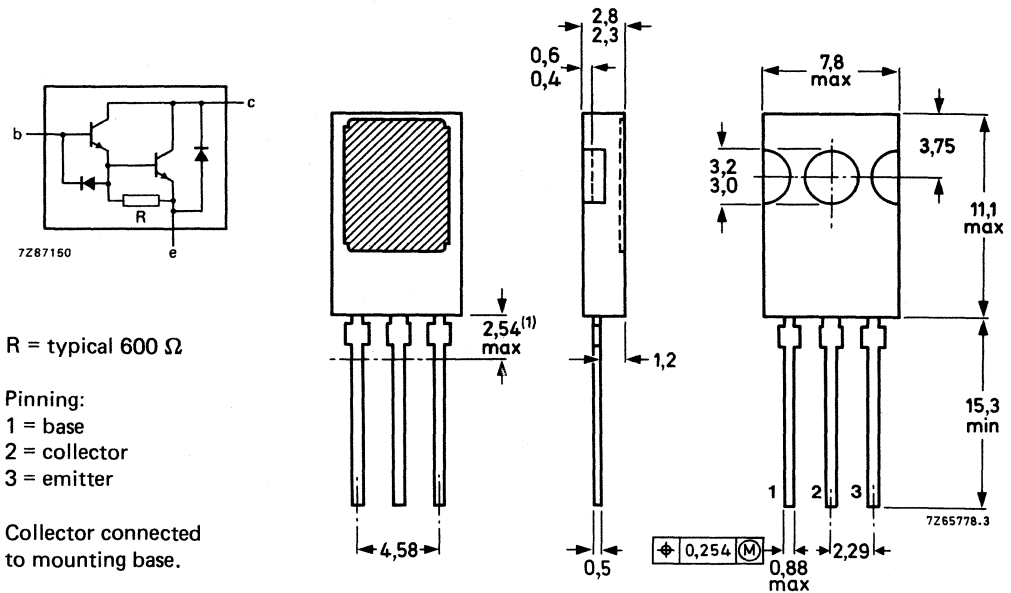
QUICK REFERENCE DATA

Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM}	max.	850	V
	V_{CEO}	max.	400	V
Collector-emitter saturation voltage	V_{CEsat}	max.	3.0	V
Collector current saturation	I_{Csat}	max.	0.3	A
DC	I_C	max.	2.0	A
peak value	I_{CM}	max.	3.0	A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	1.5	W

MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT82.



RATINGS

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

Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM} V_{CEO}	max. max.	850 400	V V
Collector current saturation DC peak value	I_{Csat} I_C I_{CM}	max. max. max.	0.3 2.0 3.0	A A A
Base current DC peak value	I_B I_{BM}	max. max.	0.2 1.0	A A
Total power dissipation up to $T_{amb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	1.5	W
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	25	W
Storage temperature range	T_{stg}		-65 to + 150	$^\circ\text{C}$
Junction temperature	T_j	max.	150	$^\circ\text{C}$

THERMAL RESISTANCE

From junction to mounting base	R_{thj-mb}	=	5.0	K/W
From junction to ambient	$R_{thj-amb}$	=	83	K/W

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

Collector cut-off currents*

 $V_{CE} = V_{CESM\text{ max}}; V_{BE} = 0.3\text{ V}$ $V_{CE} = V_{CES\text{ max}}; V_{BE} = 0.3\text{ V}; T_j = 125\text{ }^\circ\text{C}$ I_{CES} max. 0.1 mA I_{CES} max. 0.2 mA

Emitter cut-off current

 $V_{EB} = 5\text{ V}; I_C = 0$ I_{EBO} max. 2.0 mA I_{EBO} min. 3.3 mA

Collector-emitter sustaining voltage

 $I_B = 0; I_C = 10\text{ mA}$ V_{CEO} min. 400 V

Saturation voltages

 $I_C = 300\text{ mA}; I_B = 1.0\text{ mA}$ V_{CEsat} max. 3.0 V V_{BEsat} max. 2.0 V

Parasitic collector current

 $V_{CE} = 10\text{ V}; -I_B = 250\text{ mA}$ I_{cp} max. 100 μA

Switching times resistive load

 $I_{C\text{ on}} = 0.4\text{ A}; I_{BM} = 9\text{ mA}$ $-V_{EE} = 1\text{ V}; V_{CC} = 250\text{ V}$ $I_B = 1\text{ mA}; T_{mb} = 100\text{ }^\circ\text{C}$

rise time

 t_{on} max. 1.0 μs

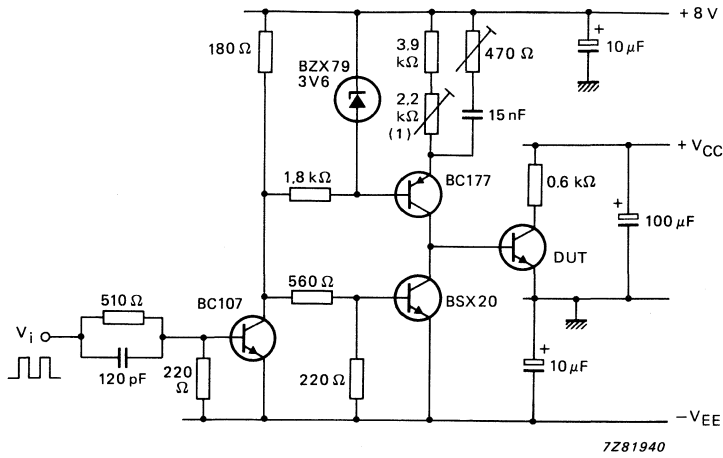
storage time

 t_s max. 1.5 μs

fall time

 t_f max. 1.5 μs

* Measured with a half-sinewave voltage (curve tracer).



(1) For adjustment of $I_B = 1 \text{ mA}$ let $V_{EE} = 0 \text{ V}$.

Fig. 2 Switching times test circuit.

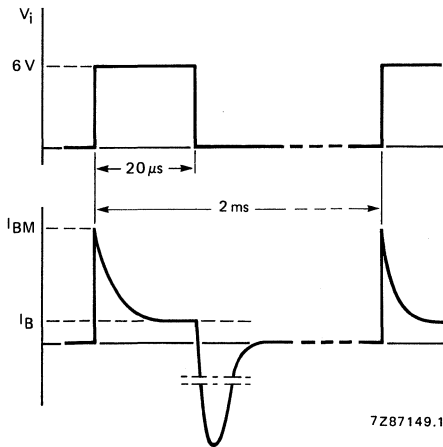


Fig. 3 Input current and current waveforms.

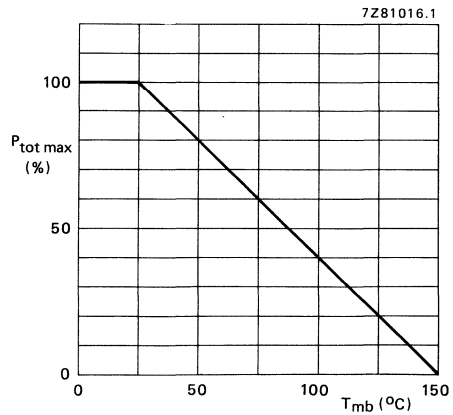
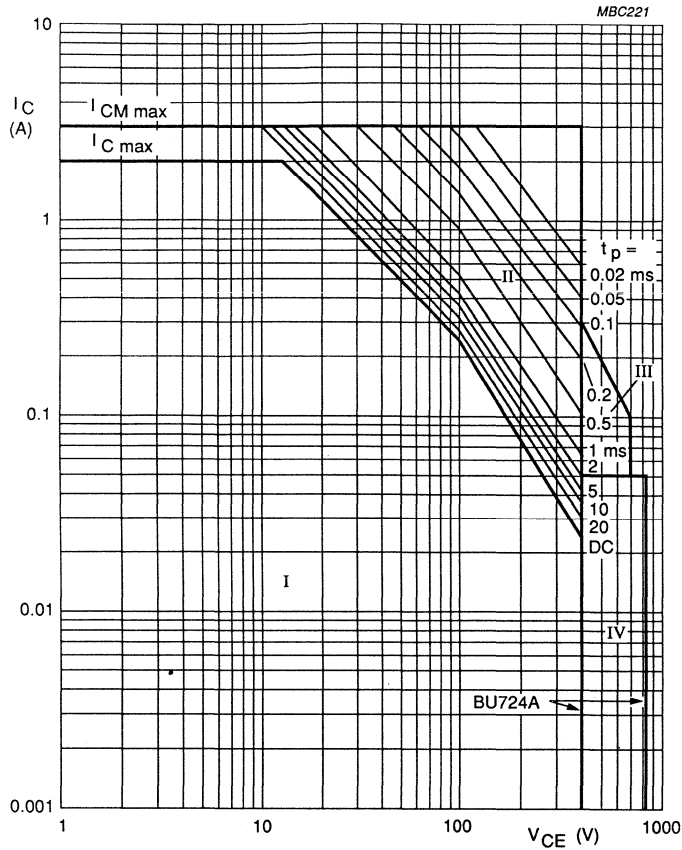


Fig. 4 Power derating curve.



- I Region of permissible DC operation.
- II Permissible extension for repetitive pulse operation.
- III Permissible extension for turn-on provided $t_p \leq 0.4\ \mu\text{s}$ and $R_{BE} \leq 100\ \Omega$.
- IV Permissible extension for turn-off provided $I_E = 0$; $t_p \leq 0.4\ \mu\text{s}$ and $dV_{CB}/dt \leq 5000\ \text{V}/\mu\text{s}$.

Fig. 5 Safe operating area; $T_{mb} = 25\ ^\circ\text{C}$.

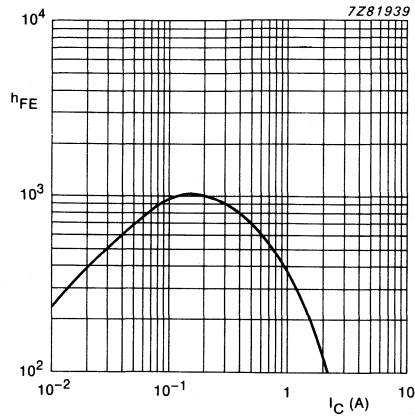


Fig. 6 Typical DC current gain; $V_{CE} = 5\text{ V}$; $T_{mb} = 25\text{ }^{\circ}\text{C}$.

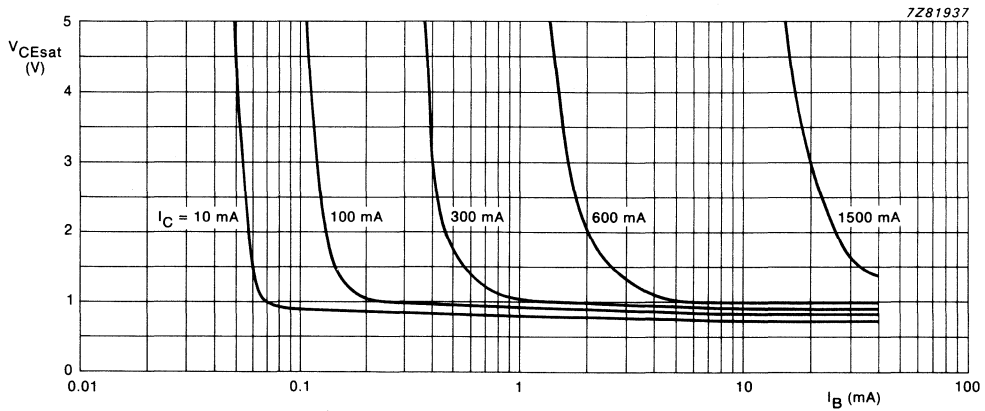


Fig. 7 Typical collector-emitter saturation voltage as a function of base current; $T_{mb} = 25\text{ }^{\circ}\text{C}$.

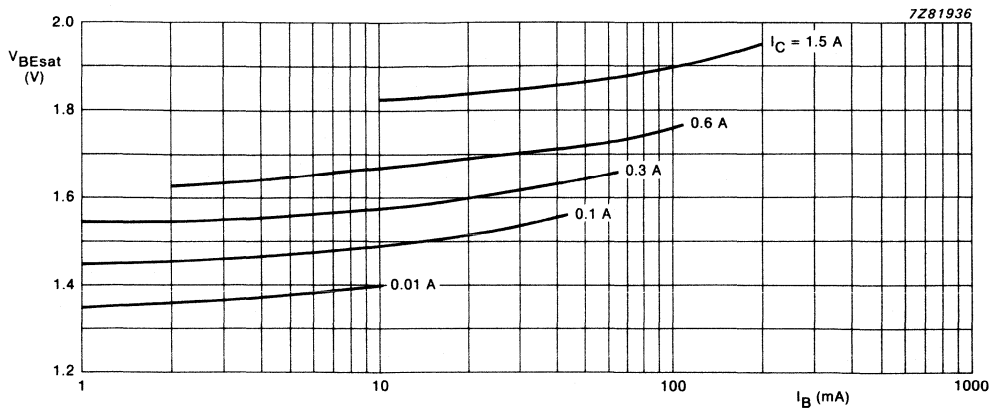


Fig. 8 Typical base-emitter saturation voltage as a function of base current.

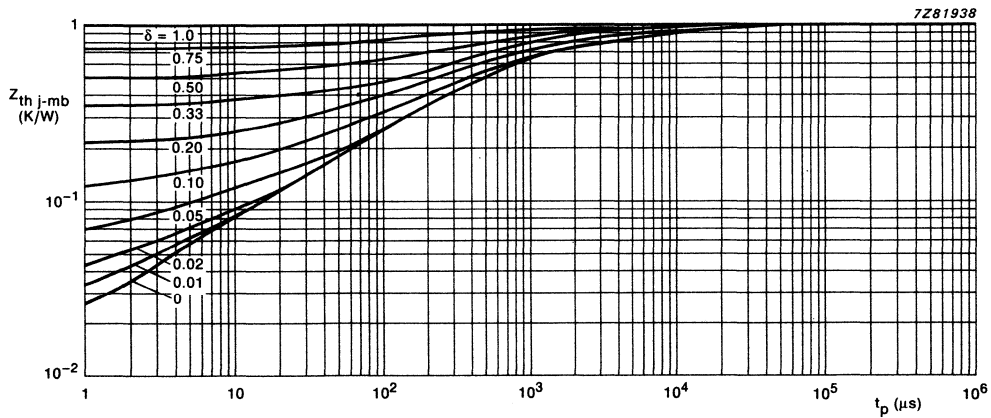


Fig. 9 Normalized thermal response at pulse power conditions.

SILICON DARLINGTON POWER TRANSISTOR

Monolithic high voltage npn Darlington circuit with integrated speed-up diode in a plastic SOT93 envelope, intended for fast switching application.

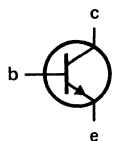
QUICK REFERENCE DATA

		BU826	BU826A
Collector-emitter voltage (peak value; $V_{BE} = 0$)	V_{CESM}	max. 800	900 V
Collector-emitter voltage (open base)	V_{CEO}	max. 375	400 V
Collector-emitter saturation voltage	V_{CEsat}	max. 2,0	V
Collector current (DC)	I_C	max. 6	A
Collector current (peak value)	I_{CM}	max. 8	A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max. 125	W
Collector saturation current	I_{Csat}	max. 2,5	A
Fall time	t_f	typ. 0,2	μs

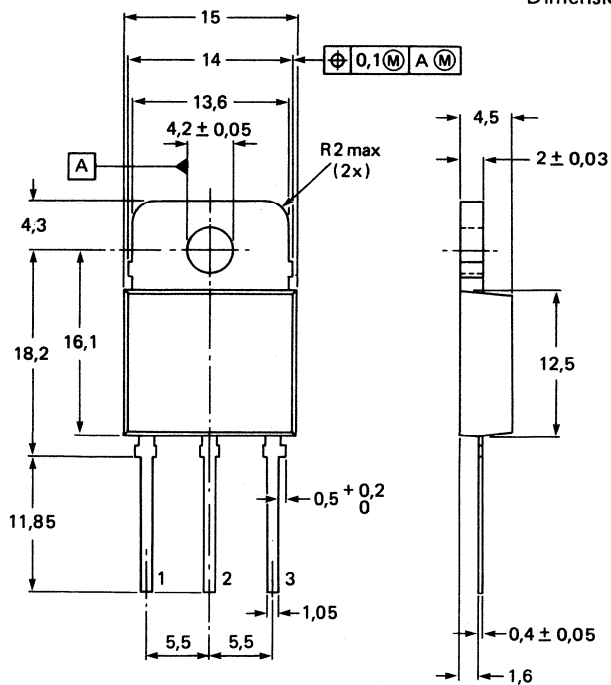
MECHANICAL DATA

Fig. 1 SOT93.

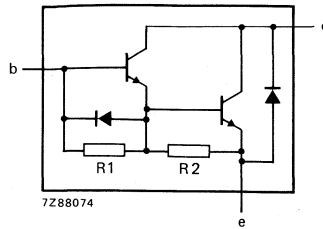
Collector connected to mounting base.



Pinning:
1 = base
2 = collector
3 = emitter



7296696



R1 typ. 200 Ω
R2 typ. 100 Ω

Fig. 2 Circuit diagram.

RATINGS

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

		BU826	BU826A
Collector-emitter voltage (peak value; $V_{BE} = 0$)	V_{CESM} max.	800	900 V
Collector-emitter voltage (open base)	V_{CEO} max.	375	400 V
Collector current (DC)	I_C max.	6	A
Collector current (peak value)	I_{CM} max.	8	A
Saturation	I_{Csat} max.	2,5	A
Base current (DC)	I_B max.	2	A
Base current (peak value)	I_{BM} max.	3	A
Total power dissipation up to $T_{mb} = 25$ °C	P_{tot} max.	125	W
Storage temperature range	T_{stg}	-65 to +150	°C
Junction temperature*	T_j max.	150	°C

THERMAL RESISTANCE*

From junction to mounting base	$R_{th\ j-mb}$ =	1,0	K/W
--------------------------------	------------------	-----	-----

* Based on maximum average junction temperature in line with common industrial practice. The resulting higher junction temperature of the output transistor part is taken into account.

CHARACTERISTICS

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

Collector cut-off current*

$$V_{CE} = V_{CESMmax}; V_{BE} = 0$$

$$V_{CE} = V_{CESMmax}; V_{BE} = 0; T_j = 125\text{ }^\circ\text{C}$$

Emitter cut-off current

$$I_C = 0; V_{EB} = 8\text{ V}$$

Collector-emitter sustaining voltage

$$I_C = 100\text{ mA}; I_{Boff} = 0; L = 25\text{ mH}$$

Saturation voltages

$$I_C = 2,5\text{ A}; I_B = 55\text{ mA}$$

$$I_C = 4\text{ A}; I_B = 200\text{ mA}$$

$$I_{CES} \quad \text{max.} \quad 1\text{ mA}$$

$$I_{CES} \quad \text{max.} \quad 2\text{ mA}$$

$$I_{EBO} \quad \text{max.} \quad 150\text{ mA}$$

$$I_{EBO} \quad \text{min.} \quad 50\text{ mA}$$

$$V_{CEOsust} \quad \text{min.} \quad 375\text{ V}$$

$$V_{CEsat} \quad \text{max.} \quad 2,0\text{ V}$$

$$V_{BEsat} \quad \text{max.} \quad 2,2\text{ V}$$

$$V_{CEsat} \quad \text{max.} \quad 2,5\text{ V}$$

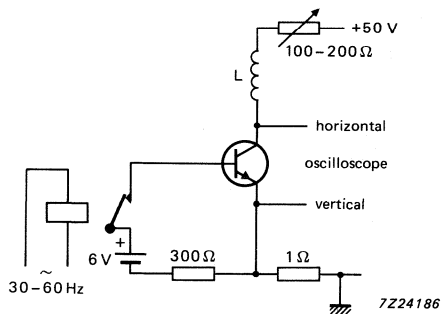


Fig. 3 Test circuit for $V_{CEOsust}$.

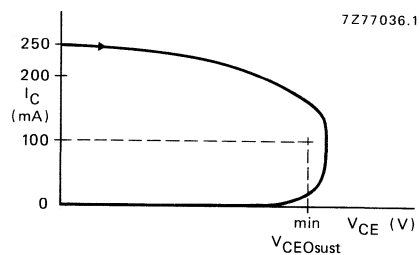


Fig. 4 Oscilloscope display for $V_{CEOsust}$.

* Measured with a half-sinewave voltage (curve tracer).

CHARACTERISTICS (continued)

Switching times (between 10% and 90% levels)

$I_{C\text{on}} = 2,5 \text{ A}$; $V_{CC} = 250 \text{ V}$

$I_{B\text{on}} = 55 \text{ mA}$; $-I_{B\text{off}} = 1 \text{ A}$

Turn-on time

t_{on} max. $1,3 \mu\text{s}$

Turn-off time: Storage time

t_s max. $2,0 \mu\text{s}$

Fall time

t_f typ. $0,2 \mu\text{s}$

Fall time; $T_{\text{mb}} = 100 \text{ }^\circ\text{C}$

t_f max. $0,6 \mu\text{s}$

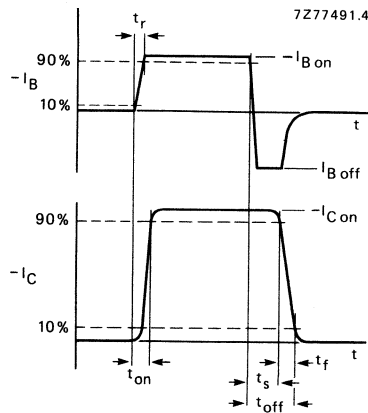


Fig. 5 Waveforms.

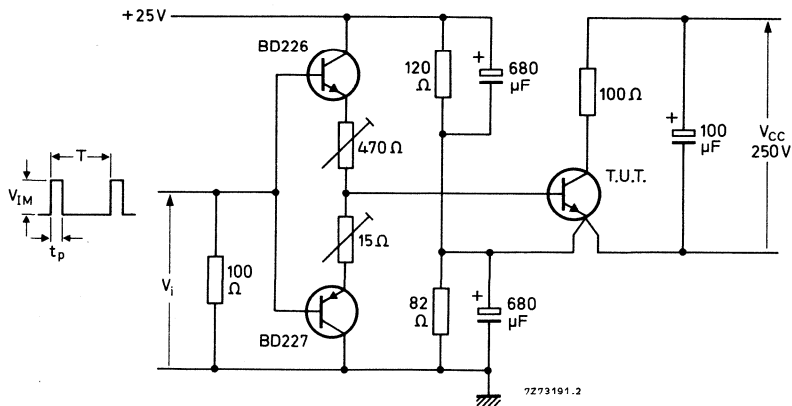
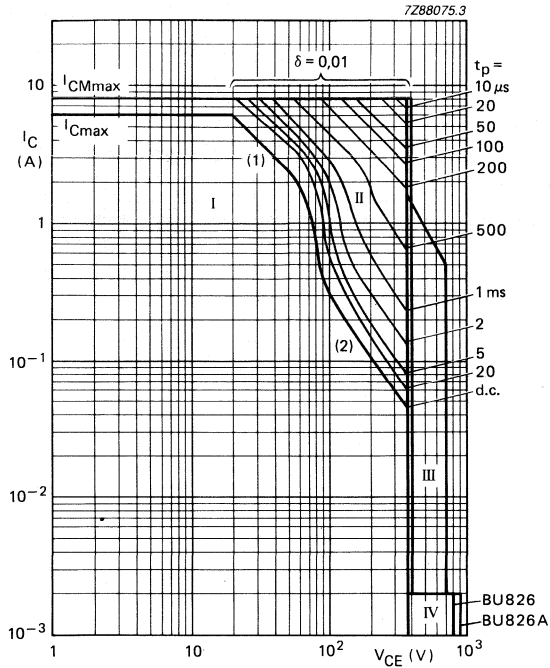


Fig. 6 Test circuit. $T = 2 \text{ ms}$; $t_p = 20 \mu\text{s}$; $V_{IM} = 15 \text{ V}$.



- I Region of permissible DC operation.
 - II Permissible extension for repetitive pulse operation.
 - III Area of permissible operation during turn-on in single-transistor converters, provided $t_p < 1,3 \mu$ s.
 - IV Repetitive pulse operation in this region is permissible, provided $V_{BE} \leq 0$ and $t_p \leq 2$ ms.
- (1) $P_{tot \max}$ and $P_{peak \max}$ lines.
 (2) Second-breakdown limits.

Fig. 7 Safe operating area at $T_{amb} = 25 \text{ }^\circ\text{C}$.

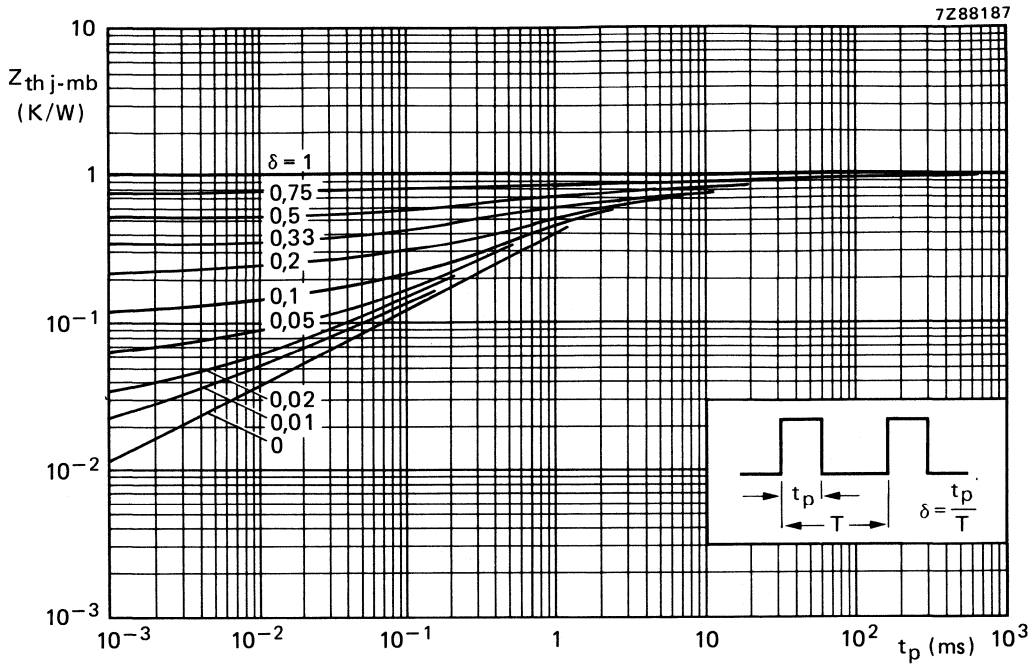


Fig. 8 Pulse power rating chart.

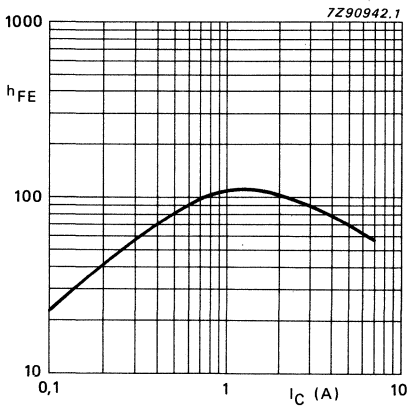


Fig. 9 DC current gain; $V_{CE} = 5 \text{ V}$;
 $T_j = 25^\circ \text{C}$.

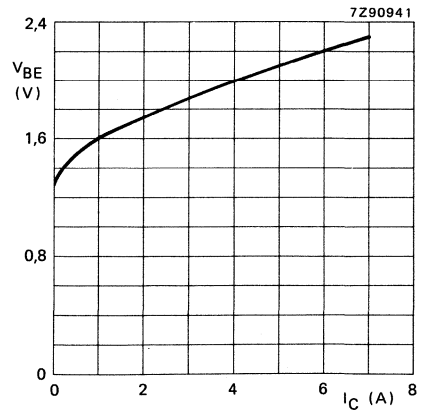


Fig. 10 V_{BEsat} curve; $T_j = 25^\circ \text{C}$;
typical values.

SILICON DIFFUSED POWER TRANSISTORS

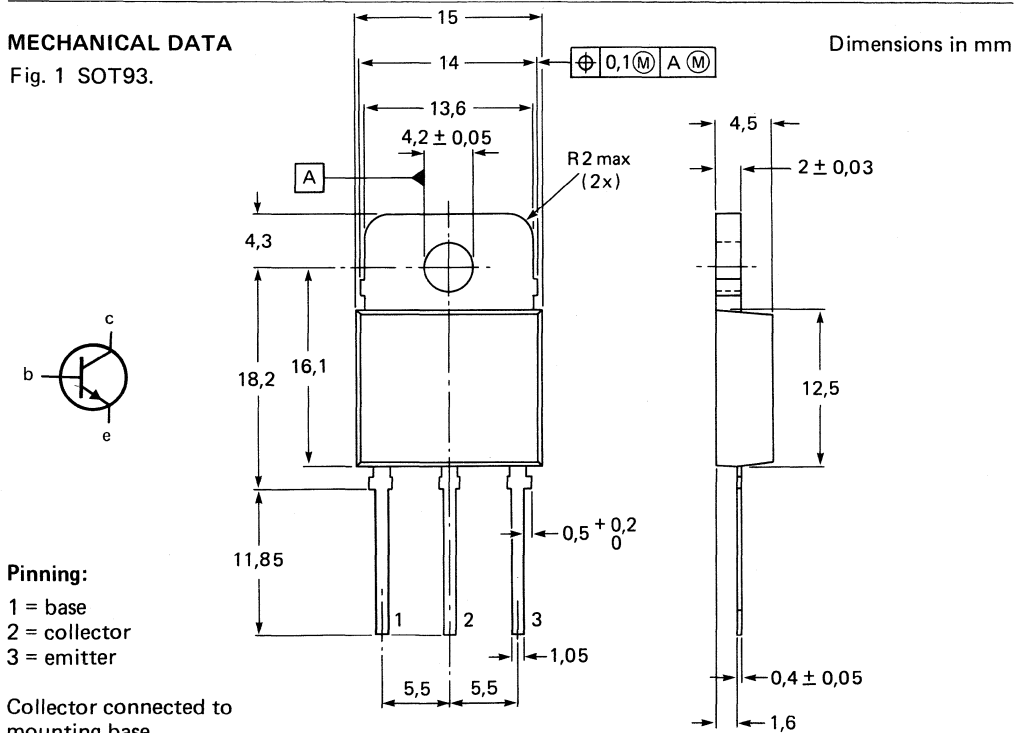
High-voltage, high-speed, glass-passivated npn power transistors in a SOT93 envelope intended for use in power supplies and deflection circuits for colour receivers and monitors.

QUICK REFERENCE DATA

Collector-emitter voltage			
peak value; $V_{BE} = 0$	V_{CESM}	max.	1350 V
open base	V_{CEO}	max.	550 V
Saturation voltages	V_{CEsat}	max.	2.0 V
	V_{BEsat}	max.	1.5 V
Collector current			
saturation	I_{Csat}	max.	3.2 A
DC	I_C	max.	6.0 A
peak value	I_{CM}	max.	8.0 A
Total power dissipation			
up to $T_{mb} = 25^\circ C$	P_{tot}	max.	125 W
DC current gain			
$I_C = 3.2 A$; $V_{CE} = 2 V$	h_{FE}	min.	6.0
Switching times; resistive load			
fall time	t_f	max.	0.7 μs

MECHANICAL DATA

Fig. 1 SOT93.



7Z96696

RATINGS

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

Collector-emitter voltage			
peak value; $V_{BE} = 0$	V_{CESM}	max.	1350 V
open base	V_{CEO}	max.	550 V
Emitter-base voltage	V_{EBO}	max.	6.0 V
Collector current			
DC	I_C	max.	6.0 A
peak value	I_{CM}	max.	8.0 A
Base current			
DC	I_B	max.	2.0 A
peak value	I_{BM}	max.	4.0 A
Emitter current			
DC	I_E	max.	8.0 A
peak value	I_{EM}	max.	12 A
Total power dissipation			
up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	125 W
Storage temperature range	T_{stg}		-65 to + 150 $^\circ\text{C}$
Junction temperature	T_j	max.	150 $^\circ\text{C}$

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j-mb}$	=	1.0 K/W
--------------------------------	----------------	---	---------

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

Collector cut-off current

 $V_{BE} = 0; V_{CE} = V_{CESmax}$ $V_{BE} = 0; V_{CE} = V_{CESmax}; T_j = 125\text{ }^\circ\text{C}$

I_{CES}	max.	1.0 mA
I_{CES}	max.	2.0 mA

Emitter cut-off current

 $I_C = 0; V_{EB} = 6\text{ V}$

I_{EBO}	max.	1.0 mA
-----------	------	--------

Collector-emitter breakdown voltage

 $I_C = 100\text{ mA}; I_B = 0$

V_{CEO}	min.	550 V
-----------	------	-------

Saturation voltage

 $I_C = 3.2\text{ A}; I_B = 0.53\text{ A}$ $I_C = 6.0\text{ A}; I_B = 2.0\text{ A}$

V_{CEsat}	max.	2.0 V
V_{CEsat}	max.	1.8 V

DC current gain

 $I_C = 10\text{ mA}; V_{CE} = 5\text{ V}$ $I_C = 1.5\text{ A}; V_{CE} = 5\text{ V}$ $I_C = 3.2\text{ A}; V_{CE} = 2\text{ V}$ $I_C = 4.0\text{ A}; V_{CE} = 3\text{ V}$

h_{FE}	min.	6.0
h_{FE}	min.	8.0
h_{FE}	min.	6.0
h_{FE}	min.	5.5

Switching times; resistive load (Figs 2 and 3)

 $I_{Con} = 3.2\text{ A}; I_{Bon} = -I_{Boff} = 0.53\text{ A}$

turn-on

t_{on}	max.	0.5 μs
----------	------	-------------------

turn-off; storage time

t_s	max.	6.0 μs
-------	------	-------------------

fall time

t_f	max.	0.7 μs
-------	------	-------------------

Switching times; inductive load (Figs 4 and 5)

 $I_{Con} = 3.2\text{ A}; I_{Bon} = 0.53\text{ A}$

turn-off; storage time

t_s	max.	2.5 μs
-------	------	-------------------

fall time

t_f	max.	0.8 μs
-------	------	-------------------

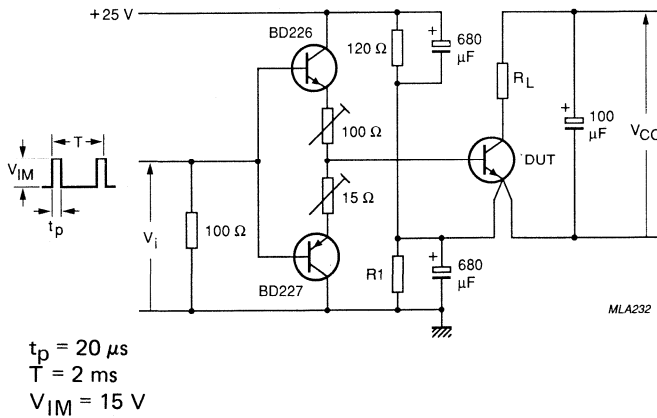


Fig. 2 Test circuit resistive load; $V_{CC} = 240 V$; $R_L = 75 \Omega$; $R_1 = 33 \Omega$.

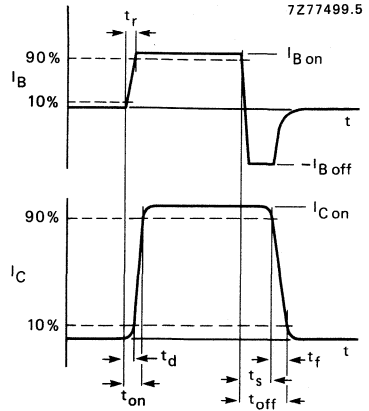


Fig. 3 Switching times waveforms with resistive load; $t_r \leq 30 ns$.

- $V_{CL} = 450 V$
- $V_{CC} = 30 V$
- $-V_{BE} = -5 V$
- $L_B = 2.5 \mu H$
- $L_C = 200 \mu H$

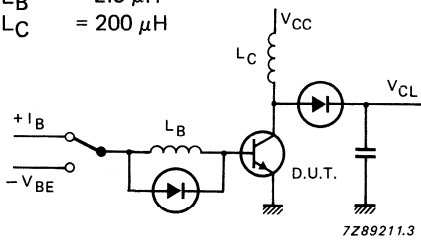


Fig. 4 Test circuit inductive load.

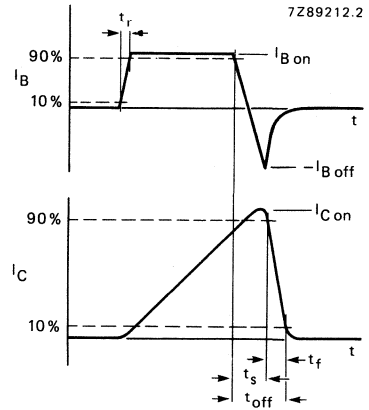


Fig. 5 Switching times waveforms with inductive load.

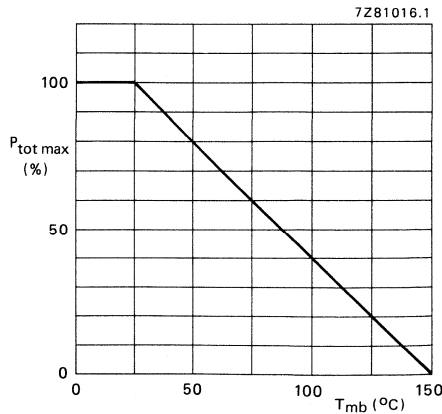
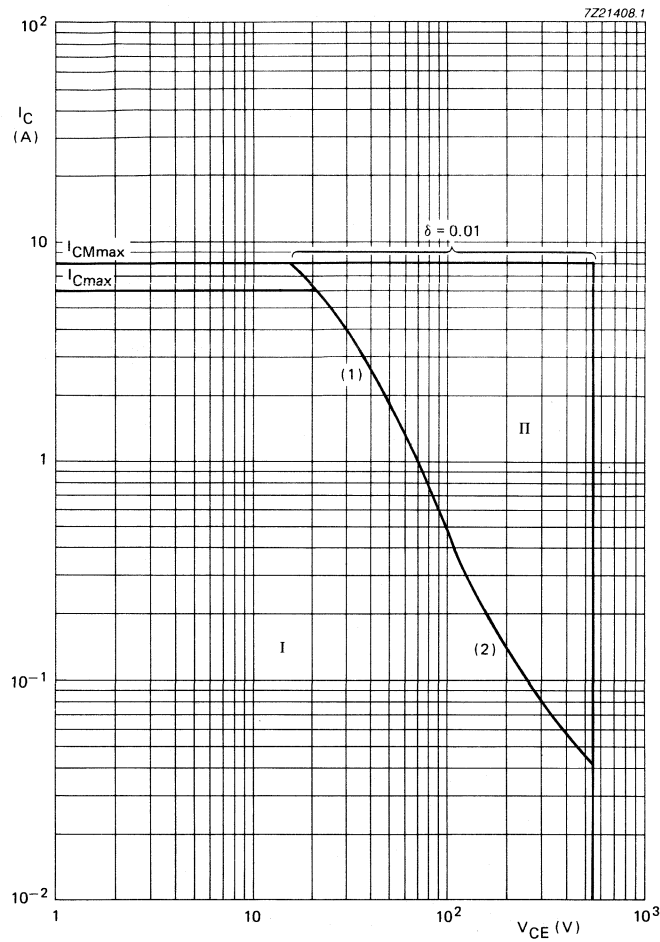


Fig. 6 Power derating curve.



- (1) P_{tot} max line.
- (2) Second-breakdown limits (independent of temperature).
- I Region of permissible DC operation.
- II Permissible extension for repetitive pulse operation.

Fig. 7 Forward bias SOAR.

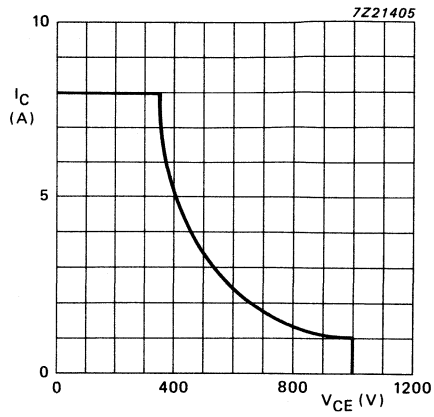


Fig. 8 Reverse bias SOAR; $-V_{BE} = 5 \text{ V}$; $I_C/I_B \leq 4$; $T_j \leq 100 \text{ }^\circ\text{C}$.

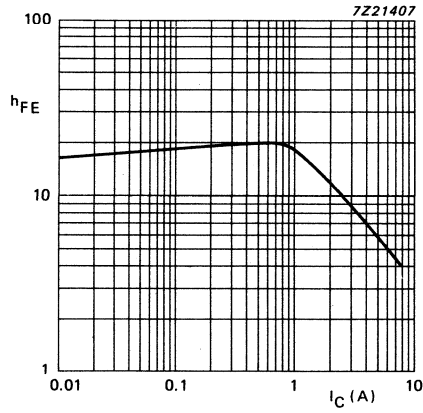


Fig. 9 Typical values DC current gain; $V_{CE} = 5 \text{ V}$.

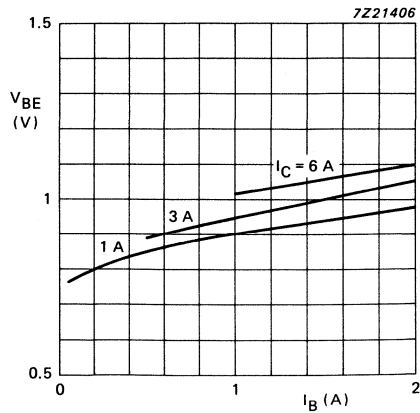


Fig. 10 Base-emitter voltage as a function of base current.

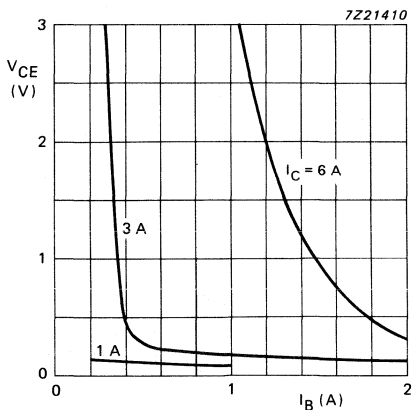


Fig. 11 Collector-emitter voltage as a function of base current.

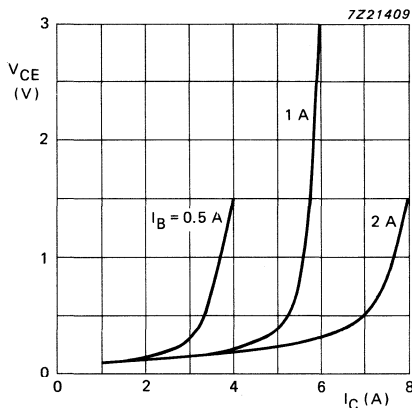


Fig. 12 Collector-emitter voltage as a function of collector current.

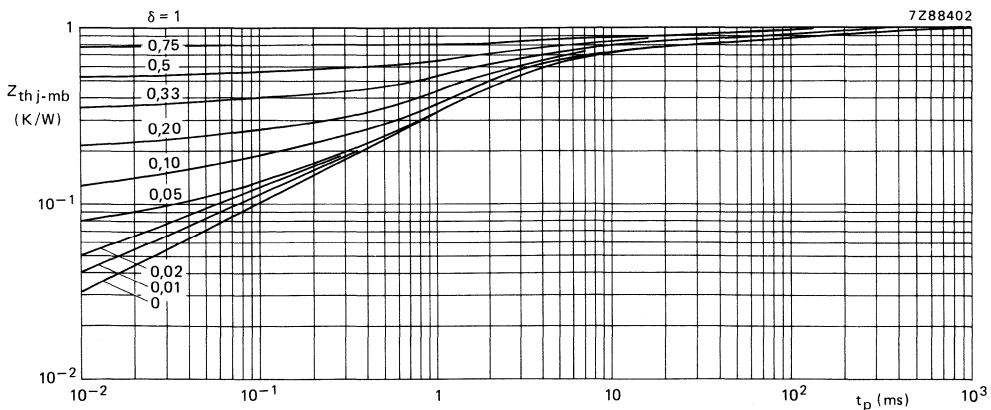


Fig. 13 Pulse power rating chart.

Silicon diffused power transistor

BU1508AX

GENERAL DESCRIPTION

Enhanced performance, new generation, high-voltage, high-speed switching npn transistor in a plastic full-pack envelope intended for use in horizontal deflection circuits of colour television receivers. Features exceptional tolerance to base drive and collector current load variations resulting in a very low worst case dissipation.

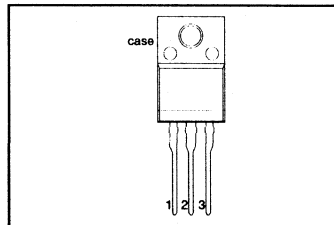
QUICK REFERENCE DATA

SYMBOL	PARAMETER	CONDITIONS	TYP.	MAX.	UNIT
V_{CESM}	Collector-emitter voltage peak value	$V_{BE} = 0$ V	-	1500	V
V_{CEO}	Collector-emitter voltage (open base)		-	700	V
I_C	Collector current (DC)		-	8	A
I_{CM}	Collector current peak value		-	15	A
P_{tot}	Total power dissipation	$T_{hs} \leq 25$ °C	-	35	W
V_{CESat}	Collector-emitter saturation voltage	$I_C = 4.5$ A; $I_B = 1.29$ A	-	1.0	V
V_{CEsat}	Collector-emitter saturation voltage	$I_C = 4.5$ A; $I_B = 1.1$ A	-	5.0	V
I_{Csat}	Collector saturation current		4.5	-	A
t_f	Fall time	$I_{CM} = 4.5$ A; $I_{B(on)} = 1.1$ A	0.4	-	µs

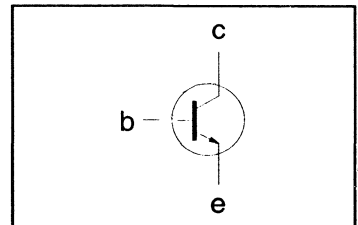
PINNING - SOT186A

PIN	DESCRIPTION
1	base
2	collector
3	emitter
case	isolated

PIN CONFIGURATION



SYMBOL



LIMITING VALUES

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

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_{CESM}	Collector-emitter voltage peak value	$V_{BE} = 0$ V	-	1500	V
V_{CEO}	Collector-emitter voltage (open base)		-	700	V
I_C	Collector current (DC)		-	8	A
I_{CM}	Collector current peak value		-	15	A
I_B	Base current (DC)		-	4	A
I_{BM}	Base current peak value		-	6	A
$-I_{B(AV)}$	Reverse base current	average over any 20 ms period	-	100	mA
$-I_{BM}$	Reverse base current peak value ¹		-	5	A
P_{tot}	Total power dissipation	$T_{hs} \leq 25$ °C	-	35	W
T_{stg}	Storage temperature		-65	150	°C
T_j	Junction temperature		-	150	°C

THERMAL RESISTANCES

SYMBOL	PARAMETER	CONDITIONS	TYP.	MAX.	UNIT
$R_{th\ j-hs}$	Junction to heatsink	with heatsink compound	-	3.6	K/W
$R_{th\ j-a}$	Junction to ambient	in free air	55	-	K/W

¹ Turn-off current.

Silicon diffused power transistor

BU1508AX

ISOLATION

T_{hs} = 25 °C unless otherwise specified

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
V _{isol(rms)}	R.M.S. isolation voltage from all three terminals to external heatsink	f = 50-60 Hz; sinusoidal waveform;	-	-	2500	V _{RMS}
C _{isol}	Capacitance from T2 to external heatsink	R.H. ≤ 65% ; clean and dustfree f = 1 MHz	-	10	-	pF

STATIC CHARACTERISTICS

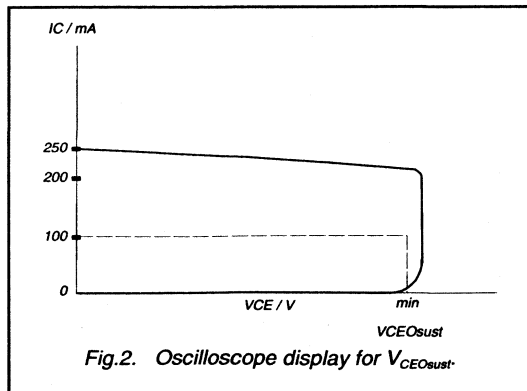
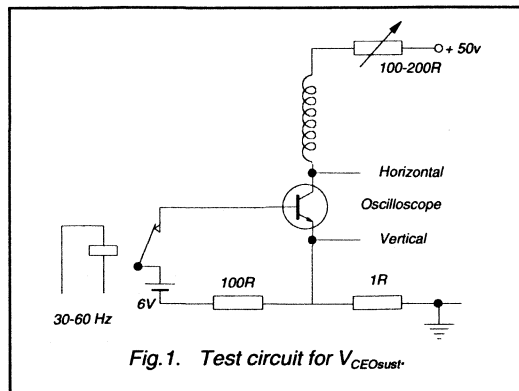
T_{hs} = 25 °C unless otherwise specified

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
I _{CES}	Collector cut-off current ²	V _{BE} = 0 V; V _{CE} = V _{CESMmax}	-	-	1.0	mA
I _{CES}		V _{BE} = 0 V; V _{CE} = V _{CESMmax} T _j = 125 °C	-	-	2.0	mA
I _{EBO}	Emitter cut-off current	V _{EB} = 7.5 V; I _C = 0 A	-	-	1.0	mA
V _{CEOsust}	Collector-emitter sustaining voltage. Fig.1 and Fig.2.	I _B = 0 A; I _C = 100 mA; L = 25 mH	700	-	-	V
V _{CEsat}	Collector-emitter saturation voltages	I _C = 4.5 A; I _B = 1.1 A	-	-	5.0	V
V _{CEsat}		I _C = 4.5 A; I _B = 1.29 A	-	-	1.0	V
V _{BEsat}		I _C = 4.5 A; I _B = 1.7 A	-	-	1.3	V
h _{FE}	Base-emitter saturation voltage	I _C = 100 mA; V _{CE} = 5 V	6	13	26	
h _{FE}		I _C = 4.5 A; V _{CE} = 1 V	3.5	5.5	-	

DYNAMIC CHARACTERISTICS

T_{hs} = 25 °C unless otherwise specified

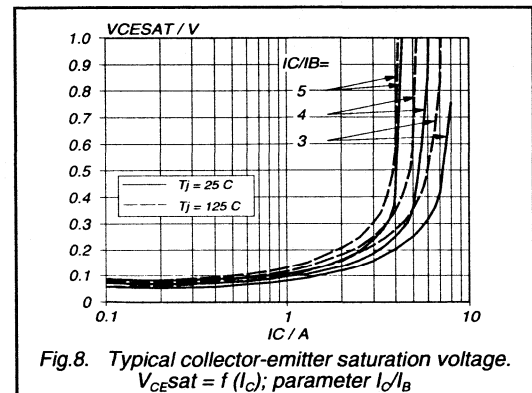
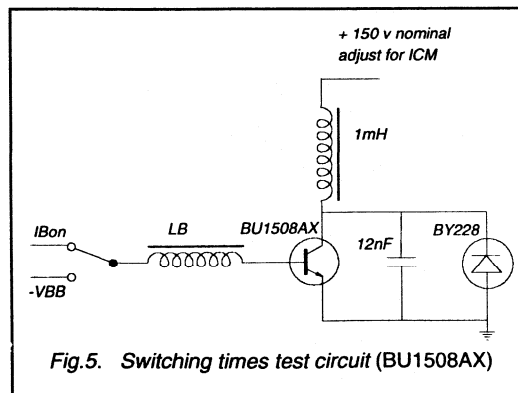
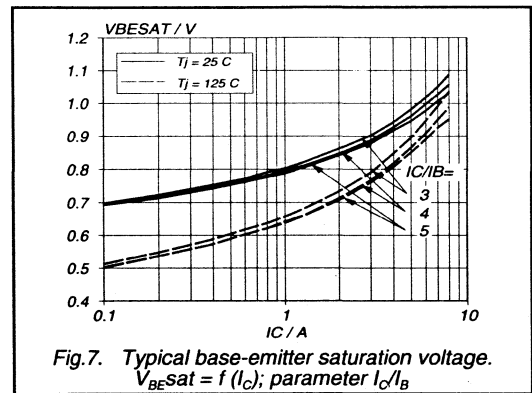
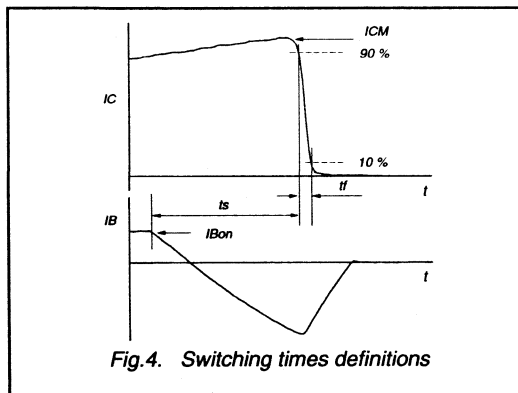
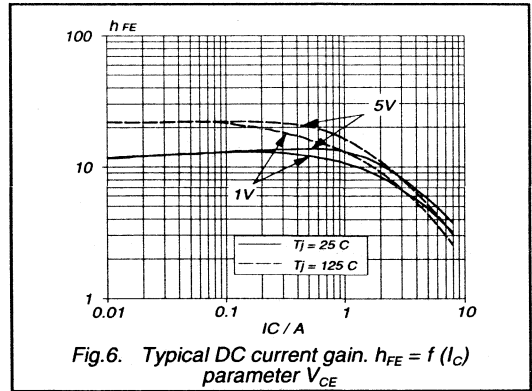
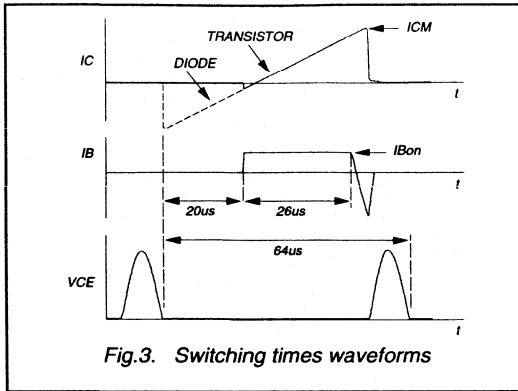
SYMBOL	PARAMETER	CONDITIONS	TYP.	MAX.	UNIT
C _c	Collector capacitance	I _E = 0 A; V _{CB} = 10 V; f = 1 MHz	80	-	pF
t _s	Switching times (line deflection circuit). Fig.3, Fig.4 and Fig.5. Turn-off storage time	I _{CM} = 4.5 A; I _{B(end)} = 1.1 A; L _B = 6 μH; -V _{BB} = 4 V; (-di _B /dt = 0.6 A/μs)	5.0	6.0	μs
t _f			Turn-off fall time	0.4	0.6



² Measured with half sine-wave voltage (curve tracer).

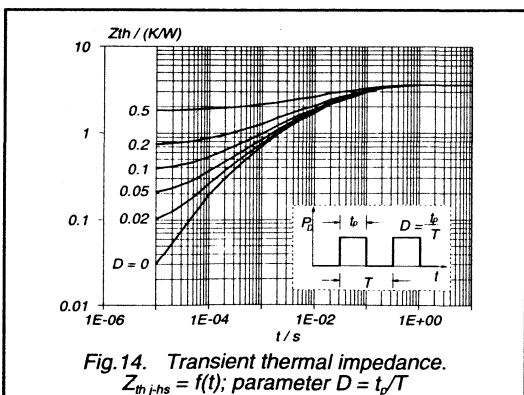
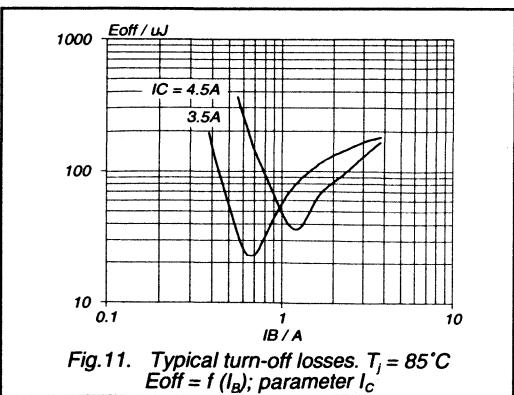
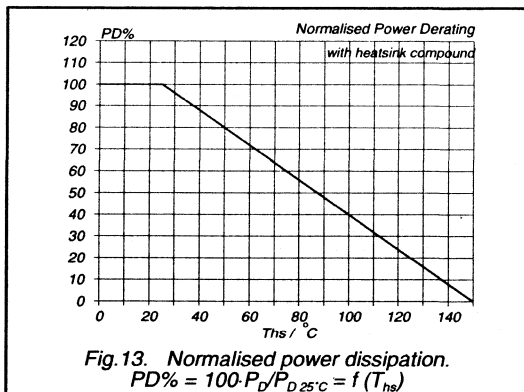
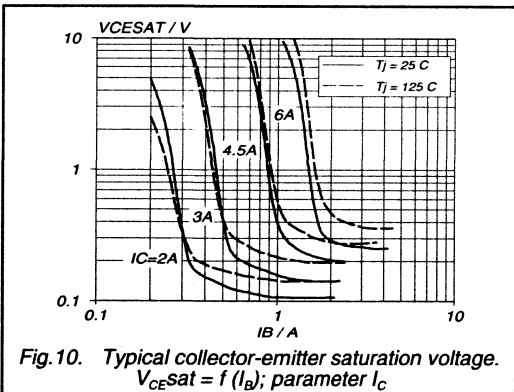
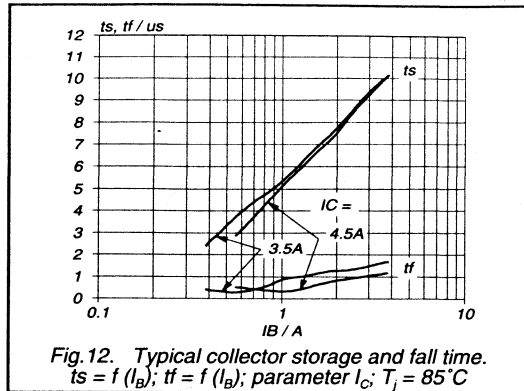
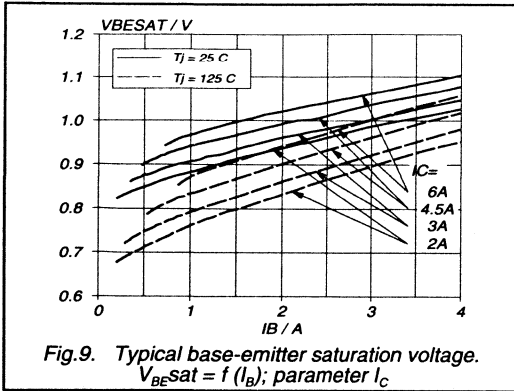
Silicon diffused power transistor

BU1508AX



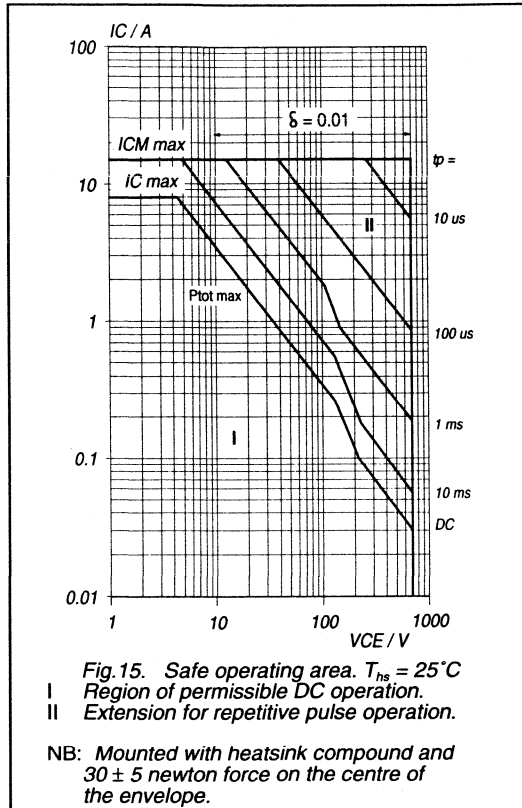
Silicon diffused power transistor

BU1508AX



Silicon diffused power transistor

BU1508AX



Silicon diffused power transistor

BU1508AX

MECHANICAL DATA

Dimensions in mm

Net Mass: 2 g

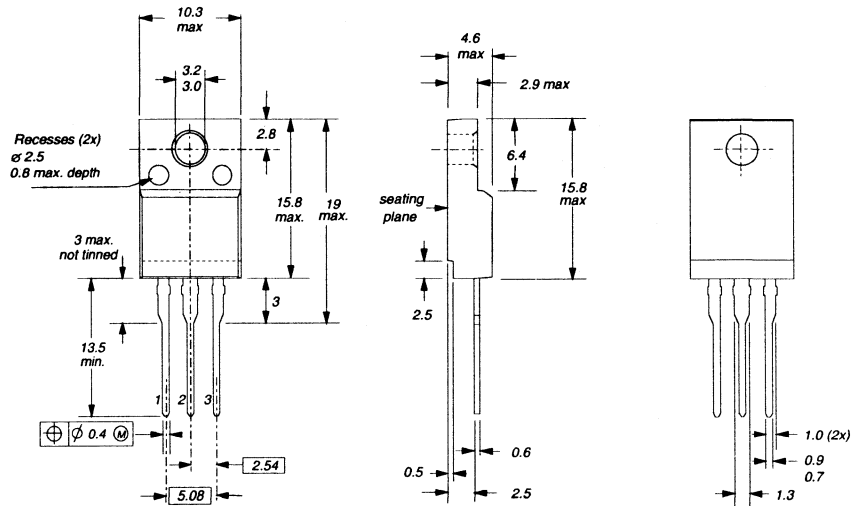


Fig. 16. SOT186A; The seating plane is electrically isolated from all terminals.

Notes

1. Accessories supplied on request: refer to mounting instructions for F-pack envelopes.
2. The improved isolation rating applies only to the SOT186 version A envelope.

Silicon diffused power transistor

BU1508DX

GENERAL DESCRIPTION

Enhanced performance, new generation, high-voltage, high-speed switching npn transistor with an integrated damper diode in a plastic full-pack envelope intended for use in horizontal deflection circuits of colour television receivers. Features exceptional tolerance to base drive and collector current load variations resulting in a very low worst case dissipation.

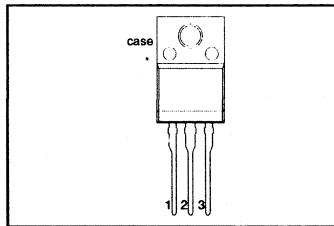
QUICK REFERENCE DATA

SYMBOL	PARAMETER	CONDITIONS	TYP.	MAX.	UNIT
V_{CESM}	Collector-emitter voltage peak value	$V_{BE} = 0\text{ V}$	-	1500	V
V_{CEO}	Collector-emitter voltage (open base)		-	700	V
I_C	Collector current (DC)		-	8	A
I_{CM}	Collector current peak value		-	15	A
P_{tot}	Total power dissipation	$T_{hs} \leq 25\text{ }^\circ\text{C}$	-	35	W
V_{CEsat}	Collector-emitter saturation voltage	$I_C = 4.5\text{ A}; I_B = 1.29\text{ A}$	-	1.0	V
V_{CEsat}	Collector-emitter saturation voltage	$I_C = 4.5\text{ A}; I_B = 1.1\text{ A}$	-	5.0	V
I_{Csat}	Collector saturation current		4.5	-	A
V_F	Diode forward voltage	$I_F = 4.5\text{ A}$	1.6	-	V
t_f	Fall time	$I_{CM} = 4.5\text{ A}; I_{B(on)} = 1.1\text{ A}$	0.4	-	μs

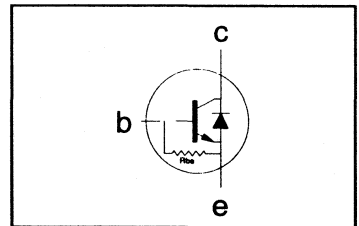
PINNING - SOT186A

PIN	DESCRIPTION
1	base
2	collector
3	emitter
case	isolated

PIN CONFIGURATION



SYMBOL



LIMITING VALUES

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

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_{CESM}	Collector-emitter voltage peak value	$V_{BE} = 0\text{ V}$	-	1500	V
V_{CEO}	Collector-emitter voltage (open base)		-	700	V
I_C	Collector current (DC)		-	8	A
I_{CM}	Collector current peak value		-	15	A
I_B	Base current (DC)		-	4	A
I_{BM}	Base current peak value		-	6	A
$-I_{B(AV)}$	Reverse base current	average over any 20 ms period	-	100	mA
$-I_{BM}$	Reverse base current peak value ¹		-	5	A
P_{tot}	Total power dissipation	$T_{hs} \leq 25\text{ }^\circ\text{C}$	-	35	W
T_{stg}	Storage temperature		-65	150	$^\circ\text{C}$
T_j	Junction temperature		-	150	$^\circ\text{C}$

¹ Turn-off current.

Silicon diffused power transistor

BU1508DX

THERMAL RESISTANCES

SYMBOL	PARAMETER	CONDITIONS	TYP.	MAX.	UNIT
$R_{th\ j-hs}$	Junction to heatsink	with heatsink compound	-	3.6	K/W
$R_{th\ j-a}$	Junction to ambient	in free air	55	-	K/W

ISOLATION

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

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
$V_{isol(mrs)}$	R.M.S. isolation voltage from all three terminals to external heatsink	$f = 50\text{-}60\text{ Hz}$; sinusoidal waveform; R.H. $\leq 65\%$; clean and dustfree	-	-	2500	V_{RMS}
C_{isol}	Capacitance from T2 to external heatsink	$f = 1\text{ MHz}$	-	10	-	pF

STATIC CHARACTERISTICS

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

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
I_{CES}	Collector cut-off current ²	$V_{BE} = 0\text{ V}$; $V_{CE} = V_{CESMmax}$; $V_{BE} = 0\text{ V}$; $V_{CE} = V_{CESMmax}$; $T_j = 125\text{ }^{\circ}\text{C}$	-	-	1.0	mA
I_{CES}			-	-	2.0	mA
I_{EBO}	Emitter cut-off current	$V_{EB} = 7.5\text{ V}$; $I_C = 0\text{ A}$	140	-	390	mA
R_{tbe}	Base-emitter resistance	$V_{EB} = 7.5\text{ V}$	-	33	-	Ω
$V_{CEOsust}$	Collector-emitter sustaining voltage.	$I_B = 0\text{ A}$; $I_C = 100\text{ mA}$; $L = 25\text{ mH}$	700	-	-	V
V_{CEsat}	Collector-emitter saturation voltages	$I_C = 4.5\text{ A}$; $I_B = 1.1\text{ A}$	-	-	5.0	V
V_{CEsat}		$I_C = 4.5\text{ A}$; $I_B = 1.29\text{ A}$	-	-	1.0	V
V_{BEsat}	Base-emitter saturation voltage	$I_C = 4.5\text{ A}$; $I_B = 1.7\text{ A}$	-	-	1.3	V
h_{FE}	DC current gain	$I_C = 1\text{ A}$; $V_{CE} = 5\text{ V}$	-	-	23	
h_{FE}		$I_C = 4.5\text{ A}$; $V_{CE} = 1\text{ V}$	3.5	5.5	-	
V_F	Diode forward voltage	$I_F = 4.5\text{ A}$	-	1.6	2.0	V

DYNAMIC CHARACTERISTICS

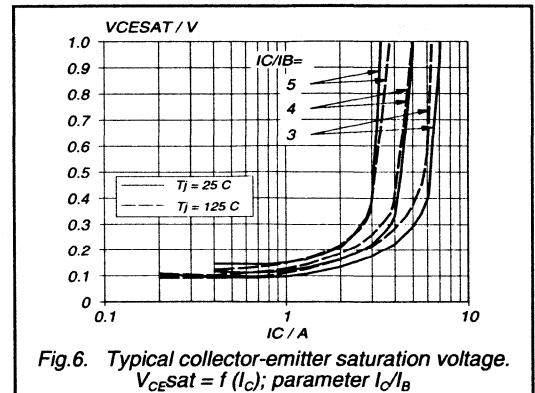
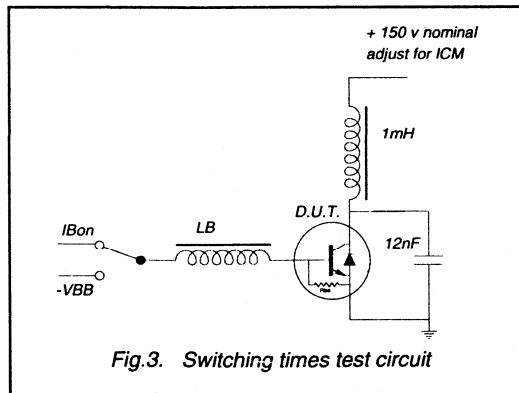
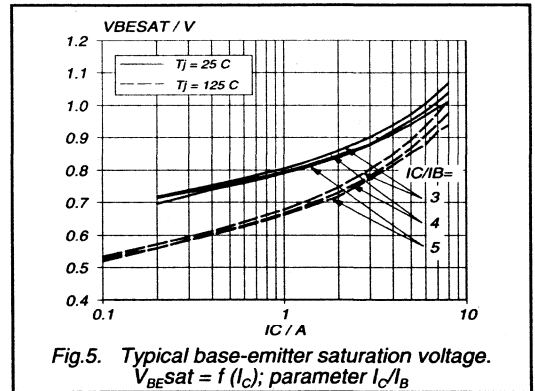
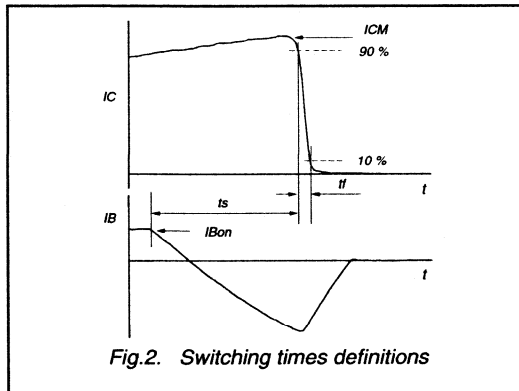
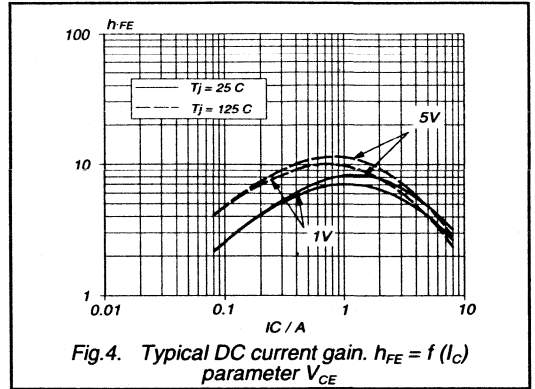
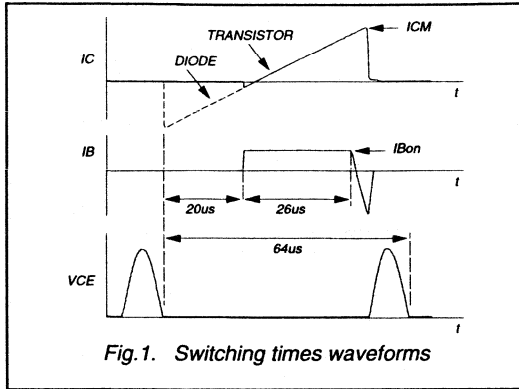
 $T_{hs} = 25\text{ }^{\circ}\text{C}$ unless otherwise specified

SYMBOL	PARAMETER	CONDITIONS	TYP.	MAX.	UNIT
C_c	Collector capacitance	$I_E = 0\text{ A}$; $V_{CB} = 10\text{ V}$; $f = 1\text{ MHz}$	80	-	pF
t_s	Switching times (line deflection circuit). Fig.1, Fig.2 and Fig.3.	$I_{CM} = 4.5\text{ A}$; $I_{B(end)} = 1.1\text{ A}$; $L_B = 6\text{ }\mu\text{H}$; $-V_{BB} = 4\text{ V}$; $(-di_B/dt = 0.6\text{ A}/\mu\text{s})$			
t_t	Turn-off storage time		5.0	6.0	μs
t_f	Turn-off fall time		0.4	0.6	μs

² Measured with half sine-wave voltage (curve tracer).

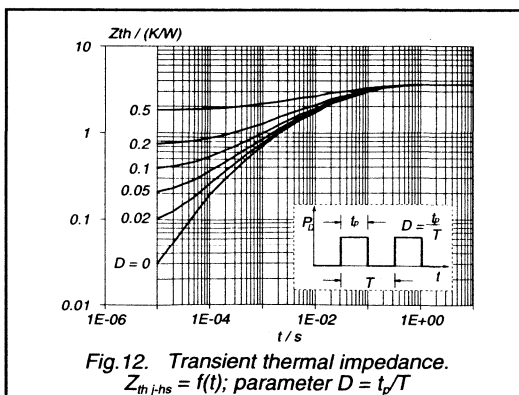
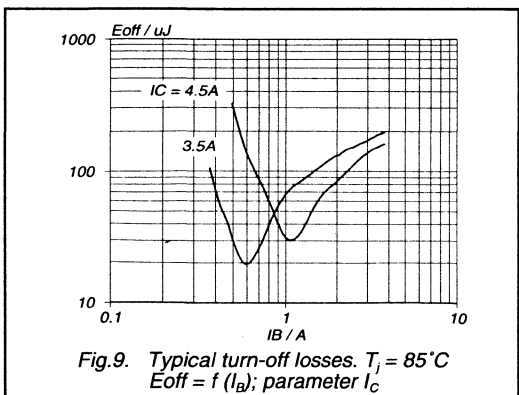
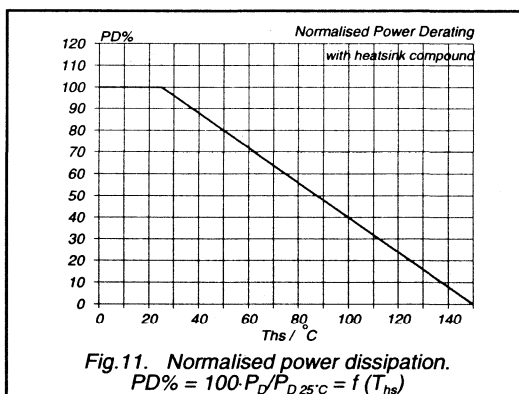
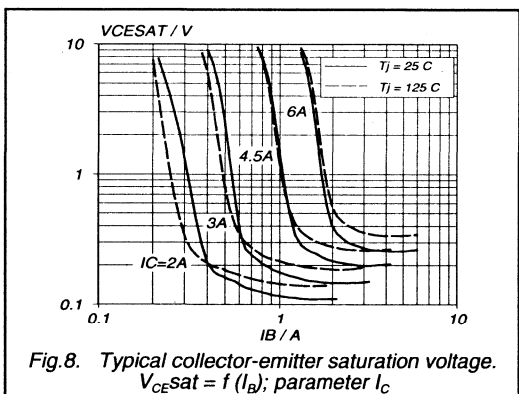
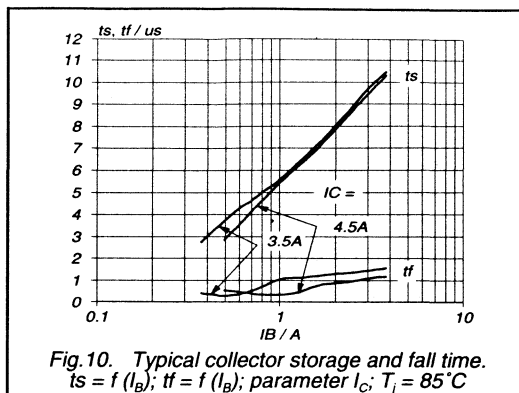
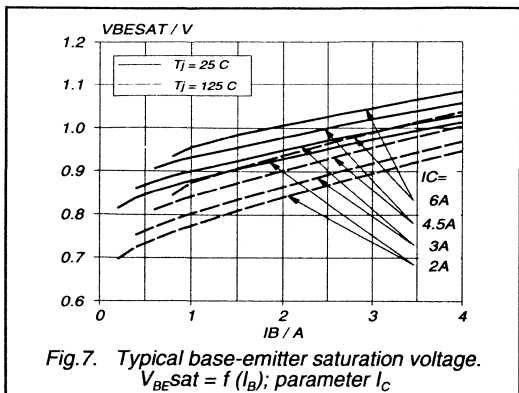
Silicon diffused power transistor

BU1508DX



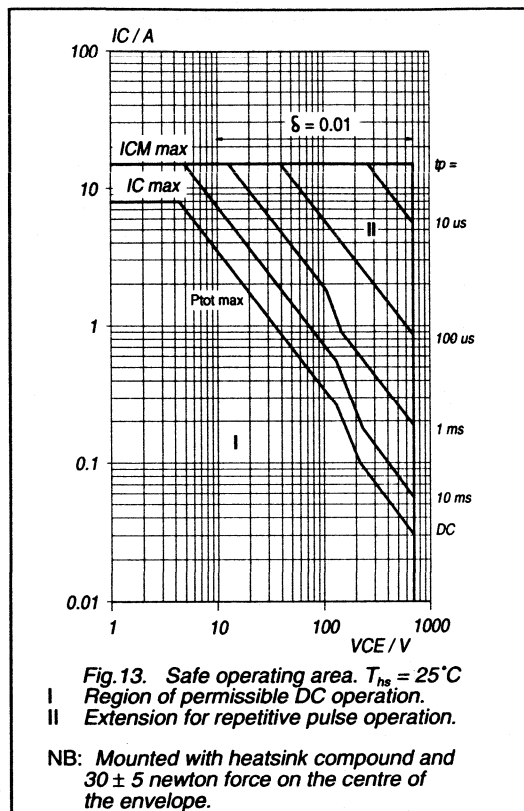
Silicon diffused power transistor

BU1508DX



Silicon diffused power transistor

BU1508DX



Silicon diffused power transistor

BU1508DX

MECHANICAL DATA

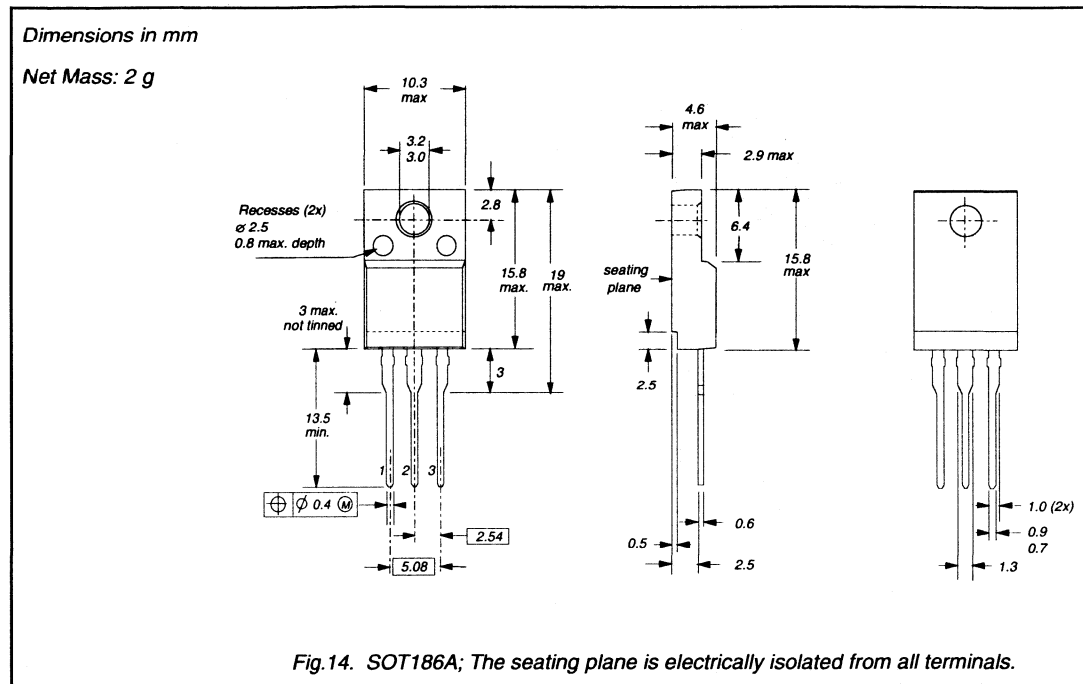


Fig.14. SOT186A; The seating plane is electrically isolated from all terminals.

Silicon Diffused Power Transistor

BU2508A

GENERAL DESCRIPTION

Enhanced performance, new generation, high-voltage, high-speed switching npn transistor in a plastic envelope intended for use in horizontal deflection circuits of colour television receivers. Features exceptional tolerance to base drive and collector current load variations resulting in a very low worst case dissipation.

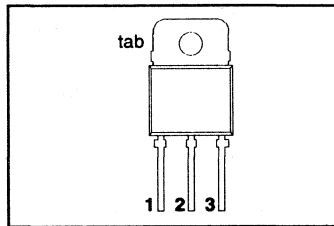
QUICK REFERENCE DATA

SYMBOL	PARAMETER	CONDITIONS	TYP.	MAX.	UNIT
V_{CESM}	Collector-emitter voltage peak value	$V_{BE} = 0\text{ V}$	-	1500	V
V_{CEO}	Collector-emitter voltage (open base)		-	700	V
I_C	Collector current (DC)		-	8	A
I_{CM}	Collector current peak value		-	15	A
P_{tot}	Total power dissipation	$T_{mb} \leq 25\text{ }^\circ\text{C}$	-	125	W
V_{CEsat}	Collector-emitter saturation voltage	$I_C = 4.5\text{ A}; I_B = 1.29\text{ A}$	-	1.0	V
V_{CEsat}	Collector-emitter saturation voltage	$I_C = 4.5\text{ A}; I_B = 1.1\text{ A}$	-	5.0	V
I_{Csat}	Collector saturation current		4.5	-	A
t_f	Fall time	$I_{CM} = 4.5\text{ A}; I_{B(on)} = 1.1\text{ A}$	0.4	-	μs

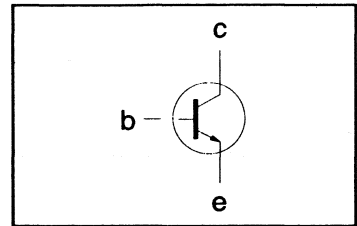
PINNING - SOT93

PIN	DESCRIPTION
1	base
2	collector
3	emitter
tab	collector

PIN CONFIGURATION



SYMBOL



LIMITING VALUES

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

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_{CESM}	Collector-emitter voltage peak value	$V_{BE} = 0\text{ V}$	-	1500	V
V_{CEO}	Collector-emitter voltage (open base)		-	700	V
I_C	Collector current (DC)		-	8	A
I_{CM}	Collector current peak value		-	15	A
I_B	Base current (DC)		-	4	A
I_{BM}	Base current peak value		-	6	A
$-I_{B(AV)}$	Reverse base current	average over any 20 ms period	-	100	mA
$-I_{BM}$	Reverse base current peak value ¹		-	5	A
P_{tot}	Total power dissipation	$T_{mb} \leq 25\text{ }^\circ\text{C}$	-	125	W
T_{stg}	Storage temperature		-65	150	$^\circ\text{C}$
T_j	Junction temperature		-	150	$^\circ\text{C}$

THERMAL RESISTANCES

SYMBOL	PARAMETER	CONDITIONS	TYP.	MAX.	UNIT
$R_{th\ j-mb}$	Junction to mounting base	-	-	1.0	K/W
$R_{th\ j-a}$	Junction to ambient	in free air	45	-	K/W

¹ Turn-off current.

Silicon Diffused Power Transistor

BU2508A

STATIC CHARACTERISTICS

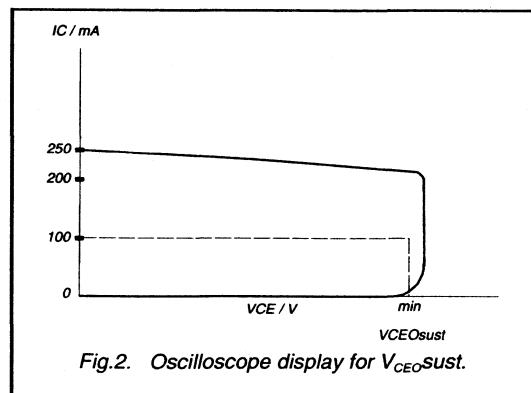
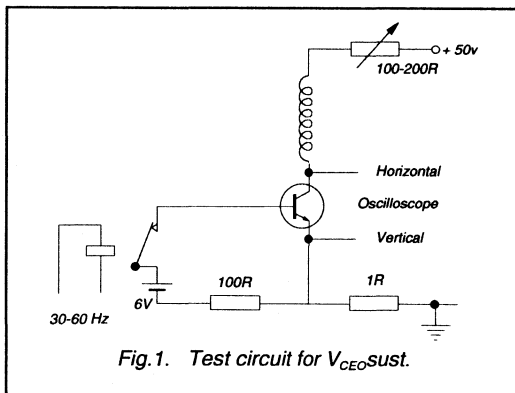
$T_{mb} = 25\text{ }^\circ\text{C}$ unless otherwise specified

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
I_{CES}	Collector cut-off current ²	$V_{BE} = 0\text{ V}; V_{CE} = V_{CESMmax}$	-	-	1.0	mA
I_{CES}		$V_{BE} = 0\text{ V}; V_{CE} = V_{CESMmax}; T_j = 125\text{ }^\circ\text{C}$	-	-	2.0	mA
I_{EBO}	Emitter cut-off current	$V_{EB} = 7.5\text{ V}; I_C = 0\text{ A}$	-	-	1.0	mA
$V_{CEOsust}$	Collector-emitter sustaining voltage. Fig.1 and Fig.2	$I_B = 0\text{ A}; I_C = 100\text{ mA}; L = 25\text{ mH}$	700	-	-	V
V_{CEsat}	Collector-emitter saturation voltages	$I_C = 4.5\text{ A}; I_B = 1.1\text{ A}$	-	-	5.0	V
V_{CEsat}		$I_C = 4.5\text{ A}; I_B = 1.29\text{ A}$	-	-	1.0	V
V_{BEsat}	Base-emitter saturation voltage	$I_C = 4.5\text{ A}; I_B = 1.7\text{ A}$	-	-	1.3	V
h_{FE}	DC current gain	$I_C = 100\text{ mA}; V_{CE} = 5\text{ V}$	6	13	26	
h_{FE}		$I_C = 4.5\text{ A}; V_{CE} = 1\text{ V}$	3.5	5.5	-	
I_{SB}	Second breakdown current	$V_{CE} = 120\text{ V}; t = 200\text{ }\mu\text{s}$	11	-	-	A

DYNAMIC CHARACTERISTICS

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

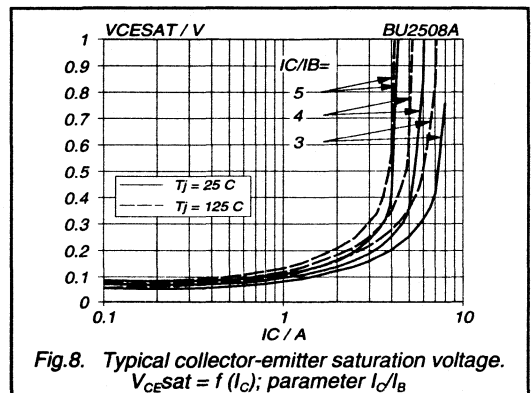
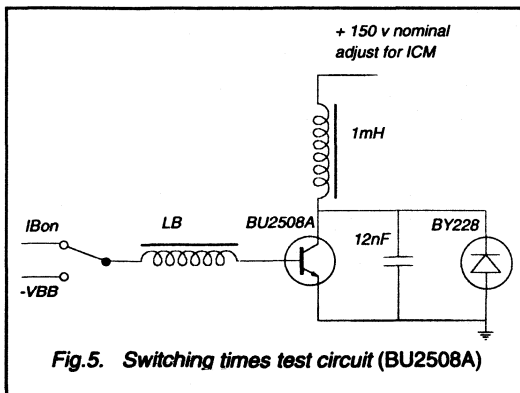
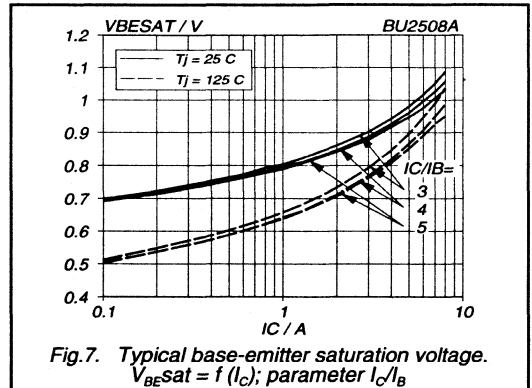
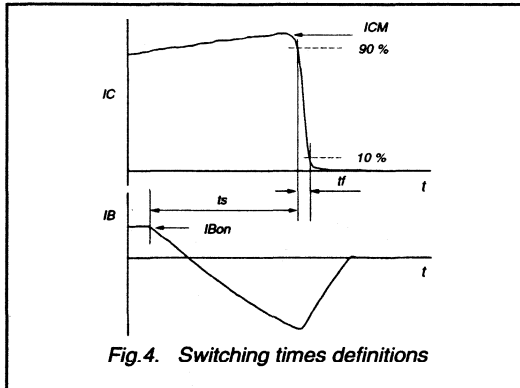
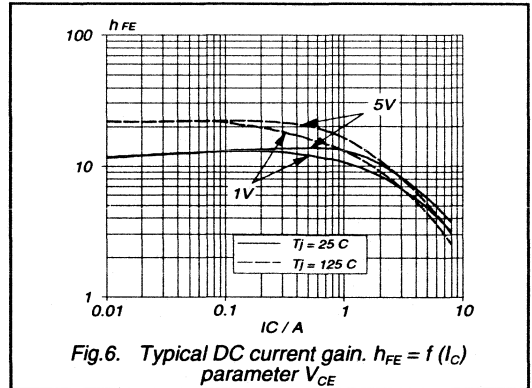
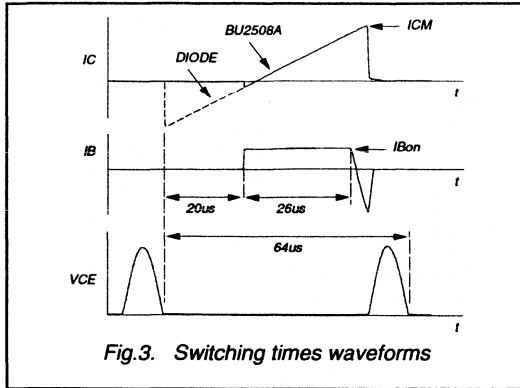
SYMBOL	PARAMETER	CONDITIONS	TYP.	MAX.	UNIT
C_c	Collector capacitance	$I_E = 0\text{ A}; V_{CB} = 10\text{ V}; f = 1\text{ MHz}$	90	-	pF
t_s	Switching times (line deflection circuit). Fig.3, Fig.4 and Fig.5.	$I_{CM} = 4.5\text{ A}; I_{B(end)} = 1.1\text{ A}; L_B = 6\text{ }\mu\text{H}; -V_{BB} = 4\text{ V}; (-di/dt = 0.6\text{ A}/\mu\text{s})$	5.0	6.0	μs
t_f					
t_f	Turn-off fall time		0.4	0.6	μs



² Measured with half sine-wave voltage (curve tracer).

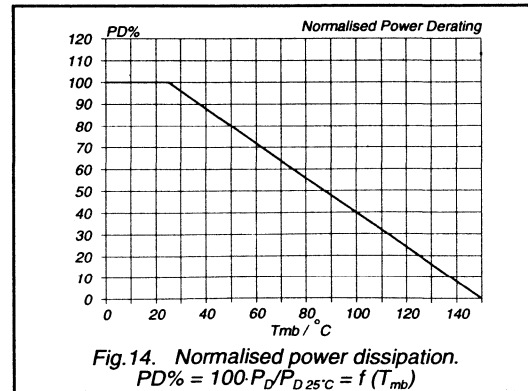
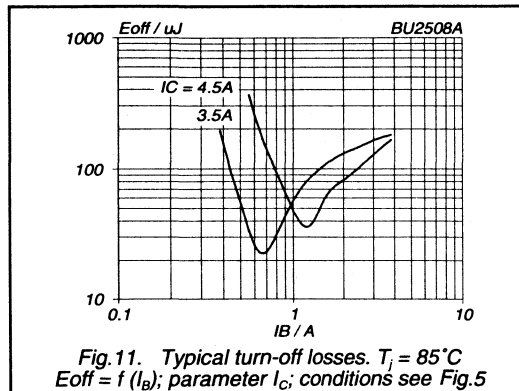
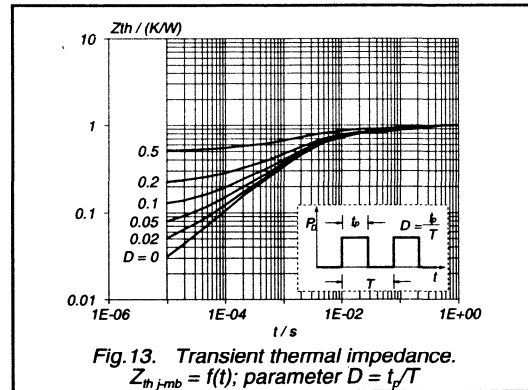
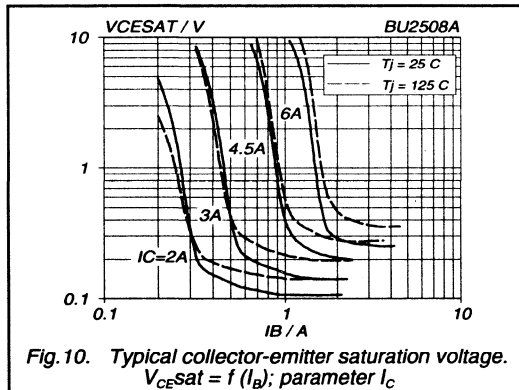
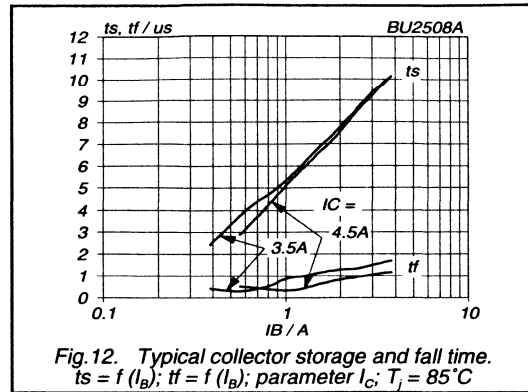
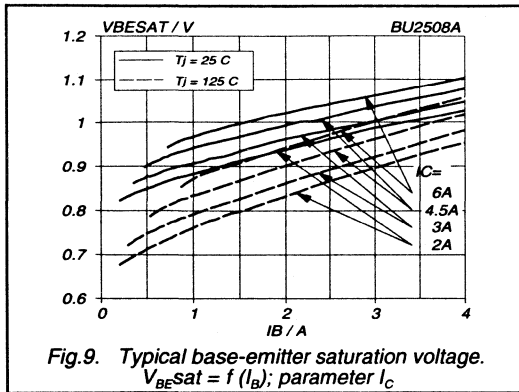
Silicon Diffused Power Transistor

BU2508A



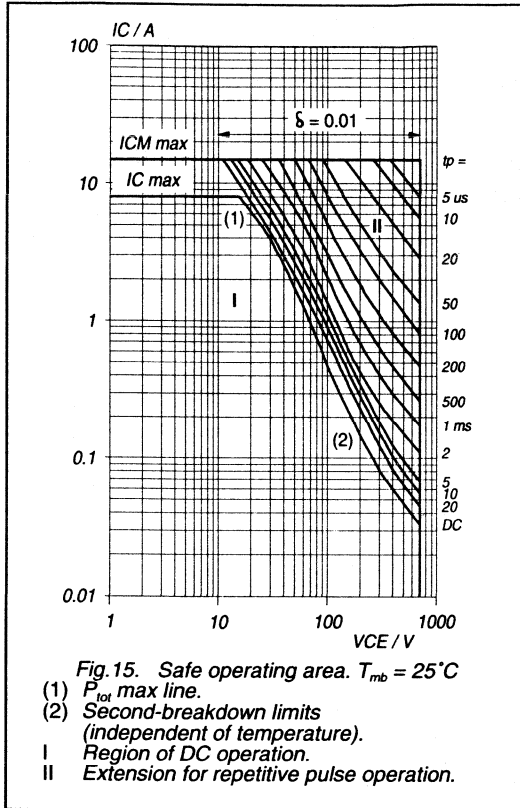
Silicon Diffused Power Transistor

BU2508A



Silicon Diffused Power Transistor

BU2508A



Silicon Diffused Power Transistor

BU2508A

MECHANICAL DATA

Dimensions in mm

Net Mass: 5 g

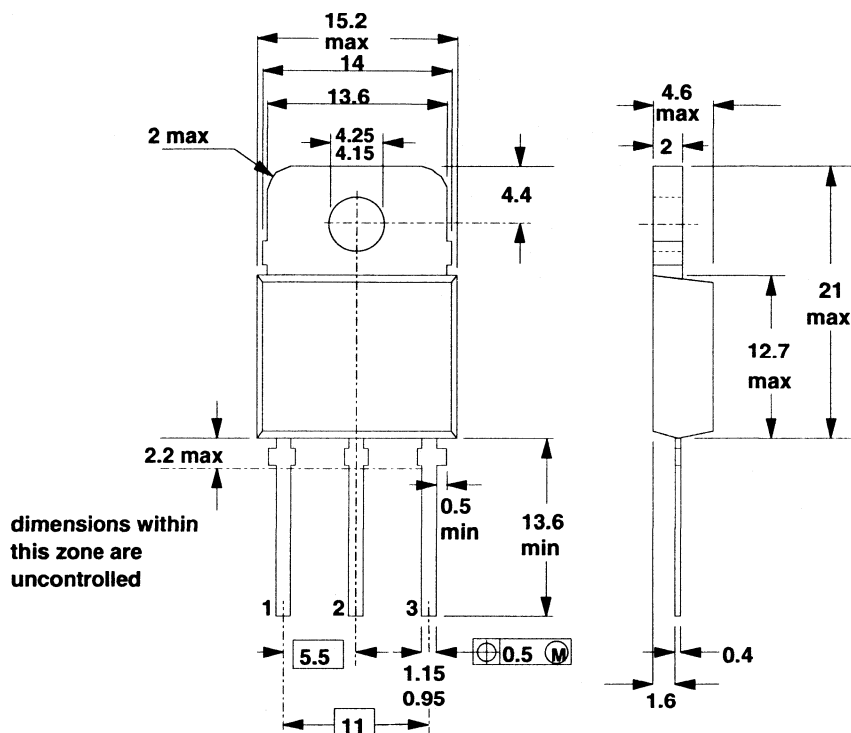


Fig.16. SOT93; pin 2 connected to mounting base.

Notes

1. Accessories supplied on request: refer to mounting instructions for SOT93 envelope.

Silicon Diffused Power Transistor

BU2508AF

GENERAL DESCRIPTION

Enhanced performance, new generation, high-voltage, high-speed switching npn transistor in a plastic full-pack envelope intended for use in horizontal deflection circuits of colour television receivers. Features exceptional tolerance to base drive and collector current load variations resulting in a very low worst case dissipation.

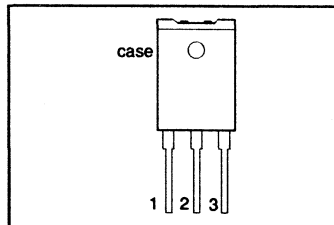
QUICK REFERENCE DATA

SYMBOL	PARAMETER	CONDITIONS	TYP.	MAX.	UNIT
V_{CESM}	Collector-emitter voltage peak value	$V_{BE} = 0$ V	-	1500	V
V_{CEO}	Collector-emitter voltage (open base)		-	700	V
I_C	Collector current (DC)		-	8	A
I_{CM}	Collector current peak value		-	15	A
P_{tot}	Total power dissipation	$T_{hs} \leq 25$ °C	-	45	W
V_{CEsat}	Collector-emitter saturation voltage	$I_C = 4.5$ A; $I_B = 1.29$ A	-	1.0	V
V_{CEsat}	Collector-emitter saturation voltage	$I_C = 4.5$ A; $I_B = 1.1$ A	-	5.0	V
I_{Csat}	Collector saturation current		4.5	-	A
t_f	Fall time	$I_{CM} = 4.5$ A; $I_{B(on)} = 1.1$ A	0.4	-	μ s

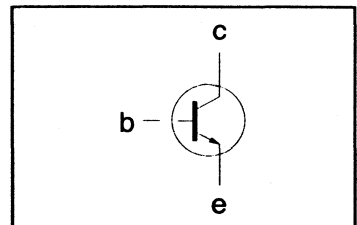
PINNING - SOT199

PIN	DESCRIPTION
1	base
2	collector
3	emitter
case	isolated

PIN CONFIGURATION



SYMBOL



LIMITING VALUES

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

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_{CESM}	Collector-emitter voltage peak value	$V_{BE} = 0$ V	-	1500	V
V_{CEO}	Collector-emitter voltage (open base)		-	700	V
I_C	Collector current (DC)		-	8	A
I_{CM}	Collector current peak value		-	15	A
I_B	Base current (DC)		-	4	A
I_{BM}	Base current peak value		-	6	A
$-I_{B(AV)}$	Reverse base current	average over any 20 ms period	-	100	mA
$-I_{BM}$	Reverse base current peak value ¹		-	5	A
P_{tot}	Total power dissipation	$T_{hs} \leq 25$ °C	-	45	W
T_{stg}	Storage temperature		-65	150	°C
T_j	Junction temperature		-	150	°C

THERMAL RESISTANCES

SYMBOL	PARAMETER	CONDITIONS	TYP.	MAX.	UNIT
$R_{th\ j-hs}$	Junction to heatsink	without heatsink compound	-	3.7	K/W
$R_{th\ j-hs}$	Junction to heatsink	with heatsink compound	-	2.8	K/W
$R_{th\ j-a}$	Junction to ambient	in free air	35	-	K/W

¹ Turn-off current.

Silicon Diffused Power Transistor

BU2508AF

ISOLATION

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

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
V_{isol}	Repetitive peak voltage from all three terminals to external heatsink	R.H. $\leq 65\%$; clean and dustfree	-	-	2500	V
C_{isol}	Capacitance from T2 to external heatsink	$f = 1\text{ MHz}$	-	22	-	pF

STATIC CHARACTERISTICS

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

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
I_{CES}	Collector cut-off current ²	$V_{BE} = 0\text{ V}; V_{CE} = V_{CESMmax}$	-	-	1.0	mA
I_{CES}		$V_{BE} = 0\text{ V}; V_{CE} = V_{CESMmax}; T_j = 125\text{ }^{\circ}\text{C}$	-	-	2.0	mA
I_{EBO}	Emitter cut-off current	$V_{EB} = 7.5\text{ V}; I_C = 0\text{ A}$	-	-	1.0	mA
$V_{CE(sust)}$	Collector-emitter sustaining voltage. Fig.1 and Fig.2.	$I_B = 0\text{ A}; I_C = 100\text{ mA}; L = 25\text{ mH}$	700	-	-	V
$V_{CE(sat)}$	Collector-emitter saturation voltages	$I_C = 4.5\text{ A}; I_B = 1.1\text{ A}$	-	-	5.0	V
$V_{CE(sat)}$		$I_C = 4.5\text{ A}; I_B = 1.29\text{ A}$	-	-	1.0	V
$V_{BE(sat)}$	Base-emitter saturation voltage	$I_C = 4.5\text{ A}; I_B = 1.7\text{ A}$	-	-	1.3	V
h_{FE}	DC current gain	$I_C = 100\text{ mA}; V_{CE} = 5\text{ V}$	6	13	26	
h_{FE}		$I_C = 4.5\text{ A}; V_{CE} = 1\text{ V}$	3.5	5.5	-	
I_{SB}	Second breakdown current	$V_{CE} = 120\text{ V}; t = 200\text{ }\mu\text{s}$	11	-	-	A

DYNAMIC CHARACTERISTICS

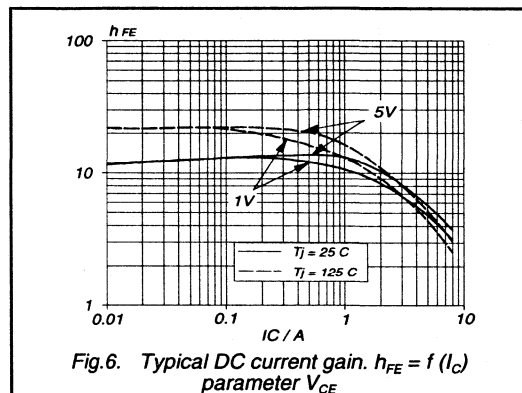
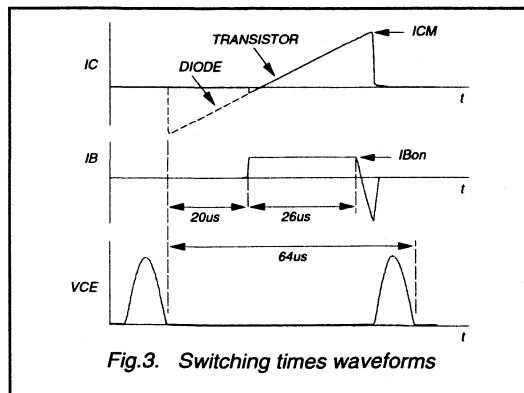
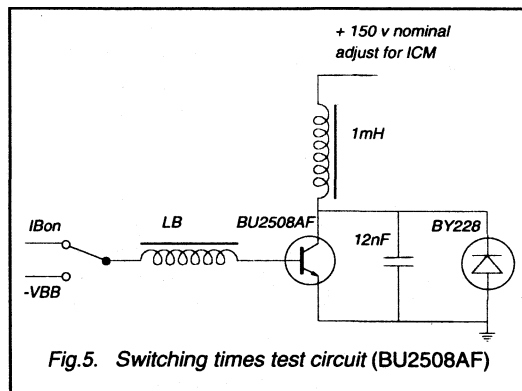
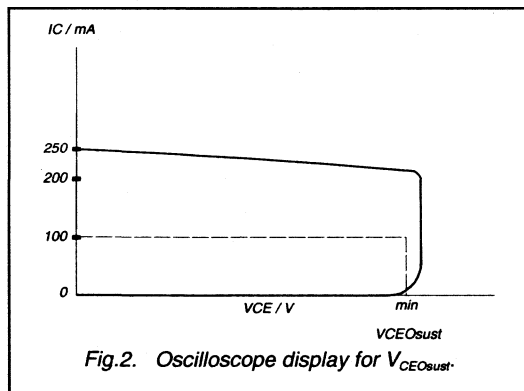
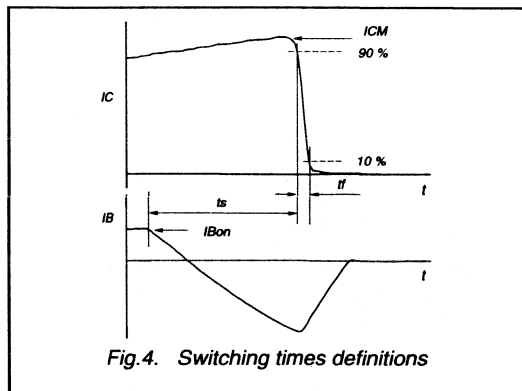
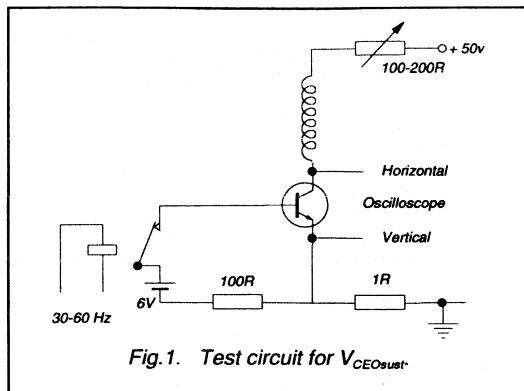
 $T_{hs} = 25\text{ }^{\circ}\text{C}$ unless otherwise specified

SYMBOL	PARAMETER	CONDITIONS	TYP.	MAX.	UNIT
C_c	Collector capacitance	$I_E = 0\text{ A}; V_{CB} = 10\text{ V}; f = 1\text{ MHz}$	90	-	pF
t_s	Switching times (line deflection circuit). Fig.3, Fig.4 and Fig.5.	$I_{CM} = 4.5\text{ A}; I_{B(end)} = 1.1\text{ A}; L_B = 6\text{ }\mu\text{H}; -V_{BB} = 4\text{ V}; (-di_B/dt = 0.6\text{ A}/\mu\text{s})$			
t_s	Turn-off storage time		5.0	6.0	μs
t_f	Turn-off fall time		0.4	0.6	μs

² Measured with half sine-wave voltage (curve tracer).

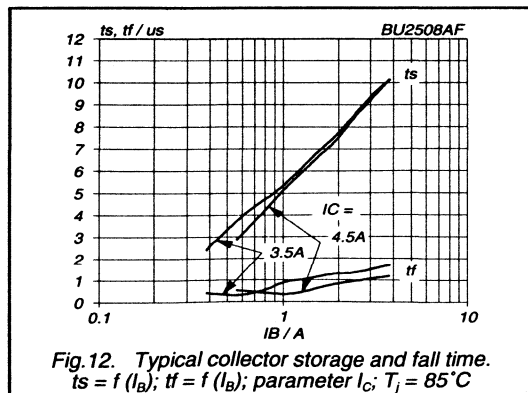
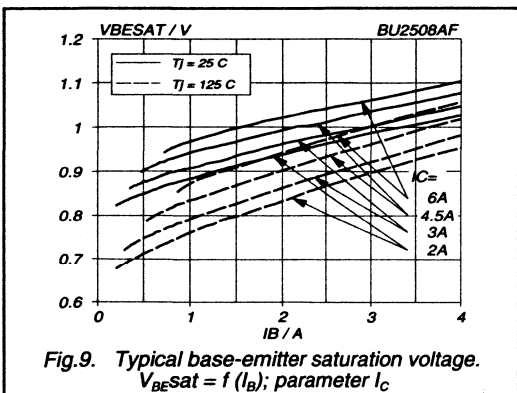
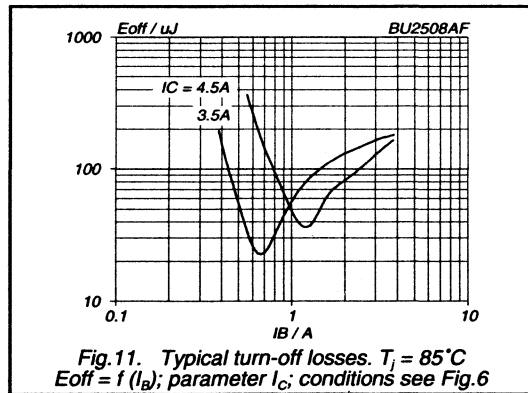
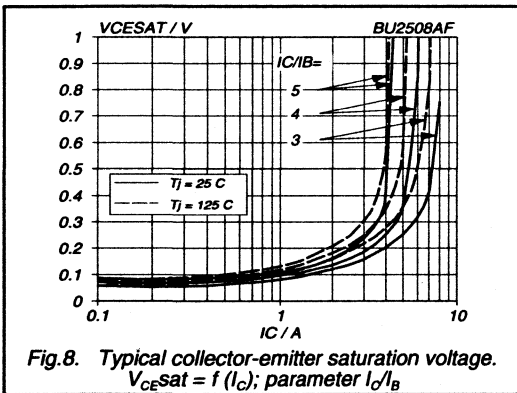
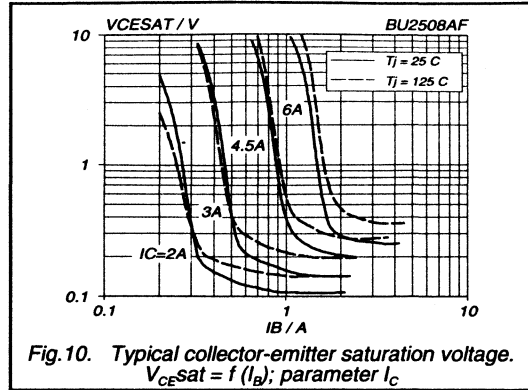
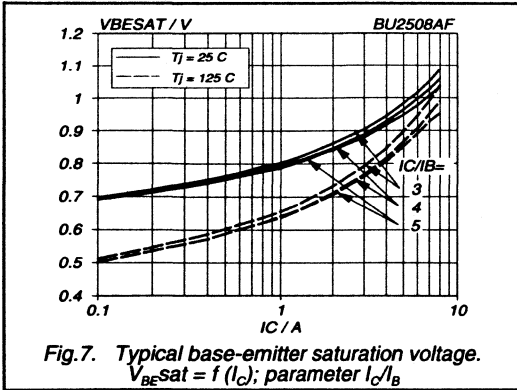
Silicon Diffused Power Transistor

BU2508AF



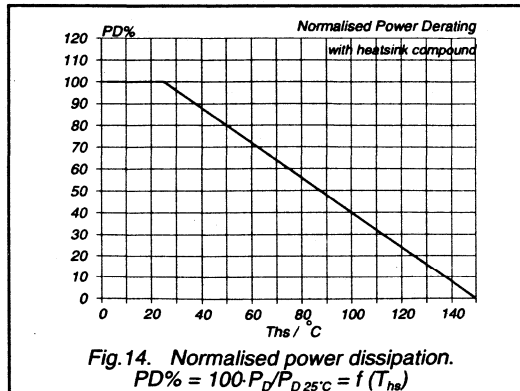
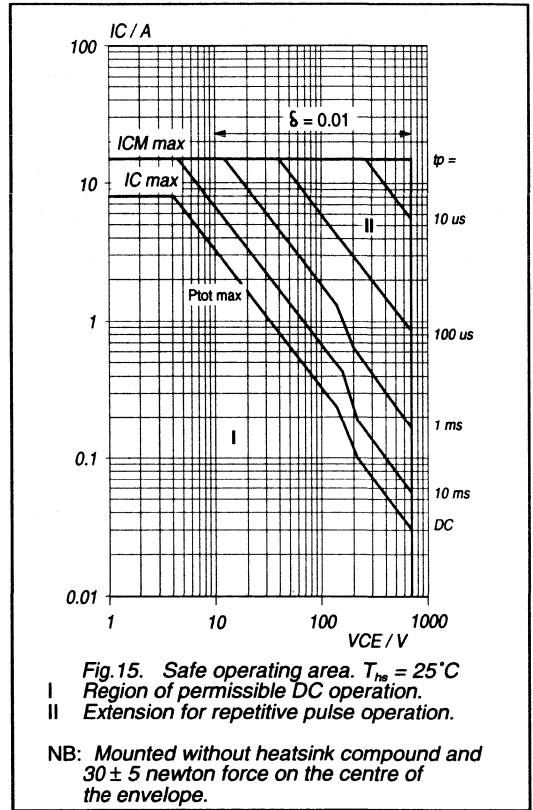
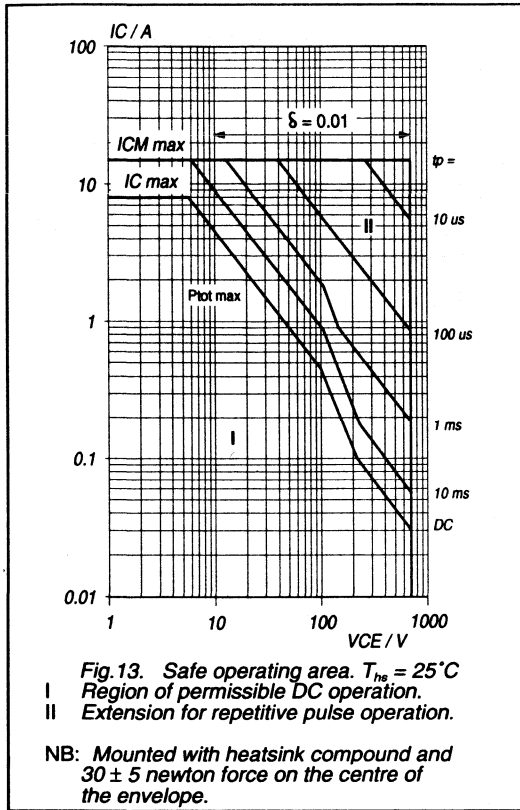
Silicon Diffused Power Transistor

BU2508AF



Silicon Diffused Power Transistor

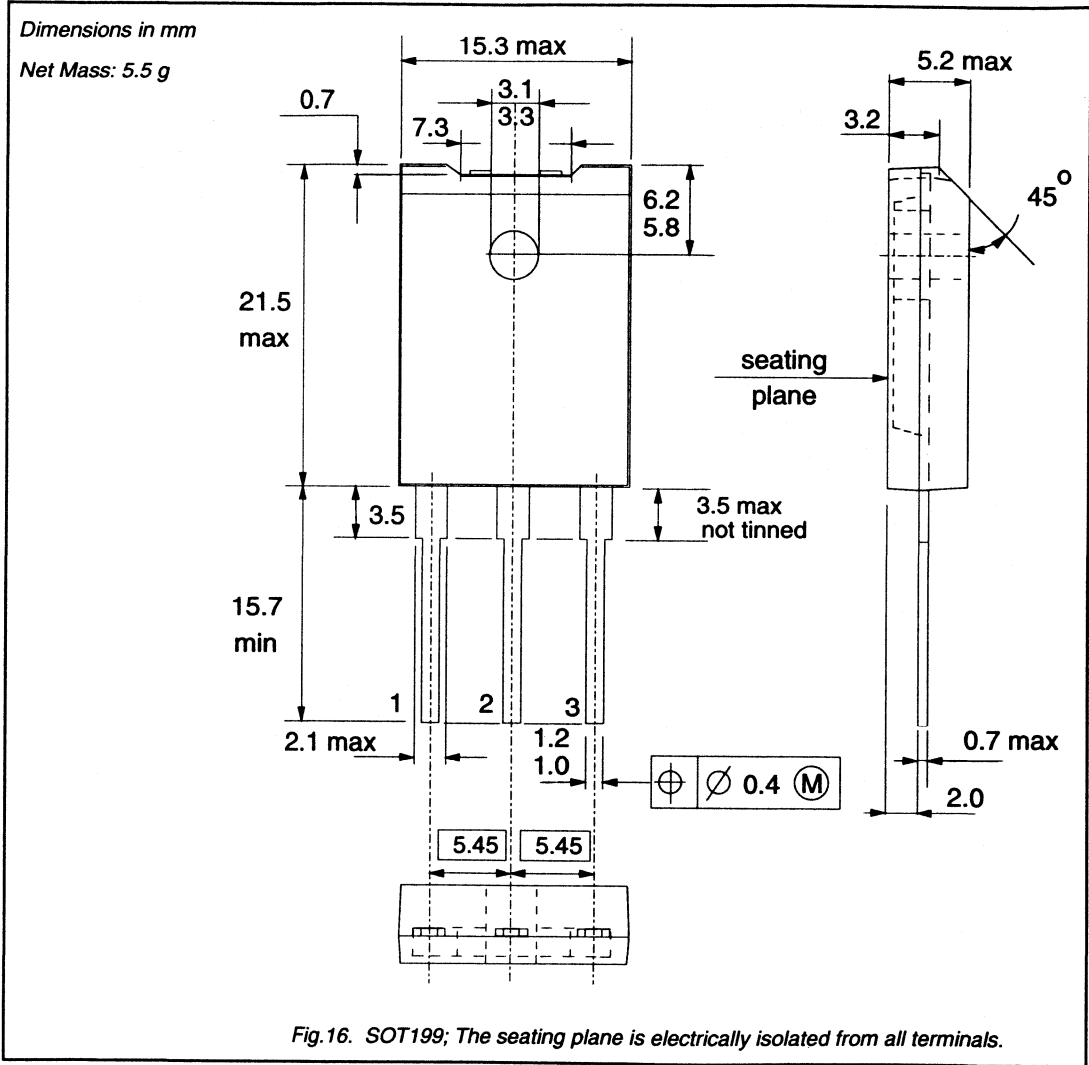
BU2508AF



Silicon Diffused Power Transistor

BU2508AF

MECHANICAL DATA



Notes

1. Accessories supplied on request: refer to mounting instructions for F-pack envelopes.

Silicon Diffused Power Transistor

BU2508D

GENERAL DESCRIPTION

Enhanced performance, new generation, high-voltage, high-speed switching npn transistor with an integrated damper diode in a plastic envelope intended for use in horizontal deflection circuits of colour television receivers. Features exceptional tolerance to base drive and collector current load variations resulting in a very low worst case dissipation.

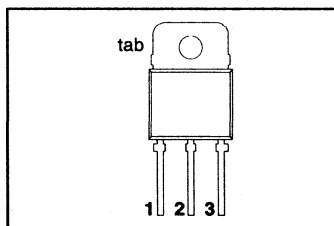
QUICK REFERENCE DATA

SYMBOL	PARAMETER	CONDITIONS	TYP.	MAX.	UNIT
V_{CESM}	Collector-emitter voltage peak value	$V_{BE} = 0 \text{ V}$	-	1500	V
V_{CEO}	Collector-emitter voltage (open base)		-	700	V
I_C	Collector current (DC)		-	8	A
I_{CM}	Collector current peak value		-	15	A
P_{tot}	Total power dissipation	$T_{mb} \leq 25 \text{ }^\circ\text{C}$	-	125	W
V_{CEsat}	Collector-emitter saturation voltage	$I_C = 4.5 \text{ A}; I_B = 1.29 \text{ A}$	-	1.0	V
V_{CEsat}	Collector-emitter saturation voltage	$I_C = 4.5 \text{ A}; I_B = 1.1 \text{ A}$	-	5.0	V
I_{Csat}	Collector saturation current		4.5	-	A
V_F	Diode forward voltage	$I_F = 4.5 \text{ A}$	1.6	-	V
t_f	Fall time	$I_{CM} = 4.5 \text{ A}; I_{B(on)} = 1.1 \text{ A}$	0.4	-	μs

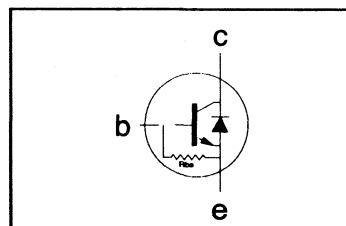
PINNING - SOT93

PIN	DESCRIPTION
1	base
2	collector
3	emitter
tab	collector

PIN CONFIGURATION



SYMBOL



LIMITING VALUES

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

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_{CESM}	Collector-emitter voltage peak value	$V_{BE} = 0 \text{ V}$	-	1500	V
V_{CEO}	Collector-emitter voltage (open base)		-	700	V
I_C	Collector current (DC)		-	8	A
I_{CM}	Collector current peak value		-	15	A
I_B	Base current (DC)		-	4	A
I_{BM}	Base current peak value		-	6	A
$-I_{B(AV)}$	Reverse base current	average over any 20 ms period	-	100	mA
$-I_{BM}$	Reverse base current peak value ¹		-	5	A
P_{tot}	Total power dissipation	$T_{mb} \leq 25 \text{ }^\circ\text{C}$	-	125	W
T_{stg}	Storage temperature		-65	150	$^\circ\text{C}$
T_J	Junction temperature		-	150	$^\circ\text{C}$

¹ Turn-off current.

Silicon Diffused Power Transistor

BU2508D

THERMAL RESISTANCES

SYMBOL	PARAMETER	CONDITIONS	TYP.	MAX.	UNIT
$R_{th\text{-}j\text{-}mb}$	Junction to mounting base	-	-	1.0	K/W
$R_{th\text{-}j\text{-}a}$	Junction to ambient	in free air	45	-	K/W

STATIC CHARACTERISTICS

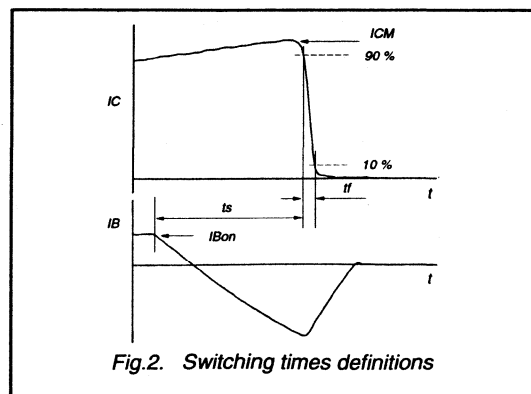
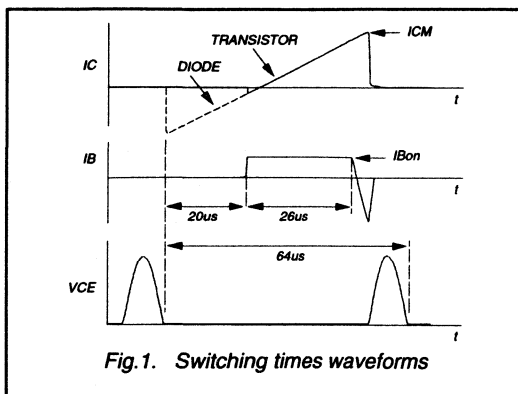
 $T_{mb} = 25\text{ }^{\circ}\text{C}$ unless otherwise specified

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
I_{CES}	Collector cut-off current ²	$V_{BE} = 0\text{ V}; V_{CE} = V_{CESMmax}$	-	-	1.0	mA
I_{CES}		$V_{BE} = 0\text{ V}; V_{CE} = V_{CESMmax}; T_j = 125\text{ }^{\circ}\text{C}$	-	-	2.0	mA
I_{EBO}	Emitter cut-off current	$V_{EB} = 7.5\text{ V}; I_C = 0\text{ A}$	140	-	390	mA
R_{be}	Base-emitter resistance	$V_{EB} = 7.5\text{ V}$	-	33	-	Ω
V_{CE0sat}	Collector-emitter sustaining voltage.	$I_B = 0\text{ A}; I_C = 100\text{ mA}; L = 25\text{ mH}$	700	-	-	V
V_{CEsat}	Collector-emitter saturation voltages	$I_C = 4.5\text{ A}; I_B = 1.1\text{ A}$	-	-	5.0	V
V_{CEsat}		$I_C = 4.5\text{ A}; I_B = 1.29\text{ A}$	-	-	1.0	V
V_{BEsat}	Base-emitter saturation voltage	$I_C = 4.5\text{ A}; I_B = 1.7\text{ A}$	-	-	1.3	V
h_{FE}	DC current gain	$I_C = 1\text{ A}; V_{CE} = 5\text{ V}$	-	-	23	-
h_{FE}		$I_C = 4.5\text{ A}; V_{CE} = 1\text{ V}$	3.5	5.5	-	-
V_F	Diode forward voltage	$I_F = 4.5\text{ A}$	-	1.6	2.0	V
I_{SB}	Second breakdown current	$V_{CE} = 120\text{ V}; t = 200\text{ }\mu\text{s}$	11	-	-	A

DYNAMIC CHARACTERISTICS

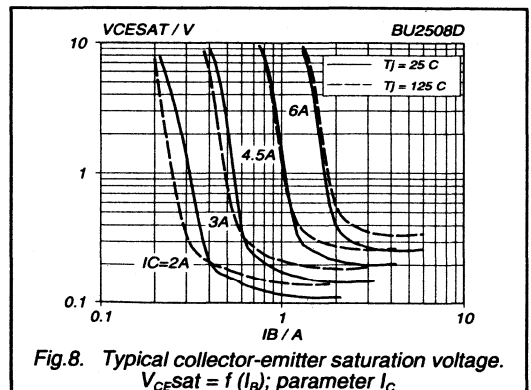
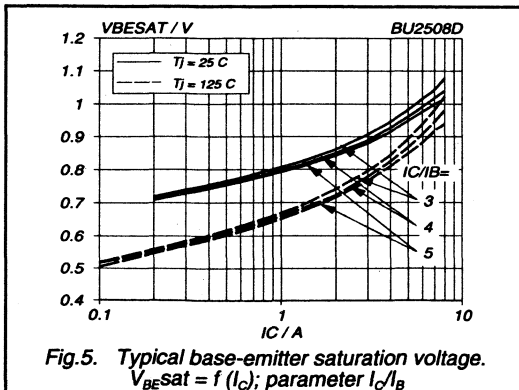
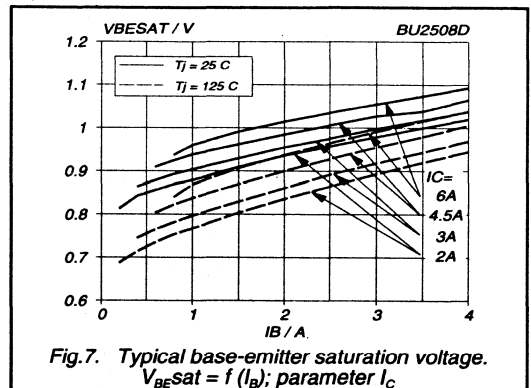
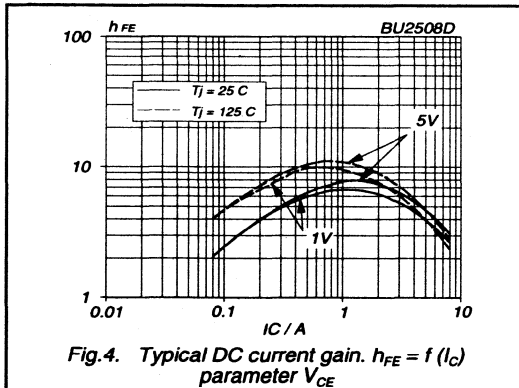
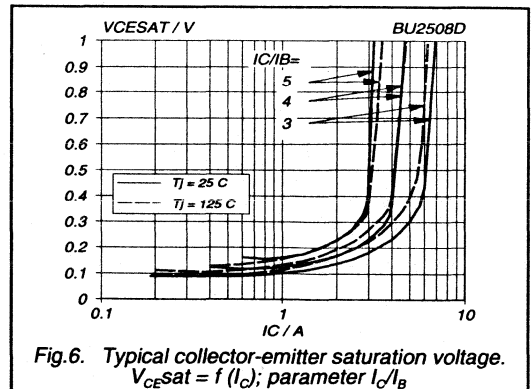
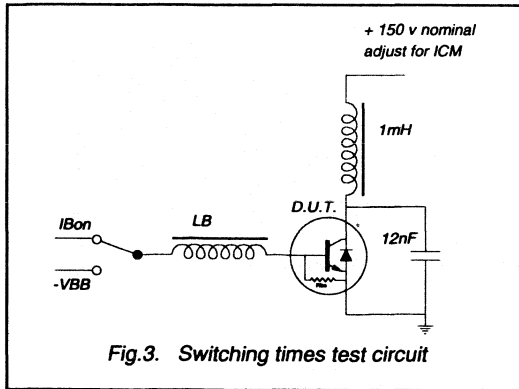
 $T_{mb} = 25\text{ }^{\circ}\text{C}$ unless otherwise specified

SYMBOL	PARAMETER	CONDITIONS	TYP.	MAX.	UNIT
C_c	Collector capacitance	$I_E = 0\text{ A}; V_{CB} = 10\text{ V}; f = 1\text{ MHz}$	90	-	pF
t_t	Switching times (line deflection circuit). Fig.1, Fig.2 and Fig.3.	$I_{CM} = 4.5\text{ A}; I_{B(end)} = 1.1\text{ A}; L_B = 6\text{ }\mu\text{H}; -V_{BB} = 4\text{ V}; (-di_g/dt = 0.6\text{ A}/\mu\text{s})$	5.0	6.0	μs
t_f			Turn-off storage time	0.4	0.6
t_f	Turn-off fall time				

² Measured with half sine-wave voltage (curve tracer).

Silicon Diffused Power Transistor

BU2508D



Silicon Diffused Power Transistor

BU2508D

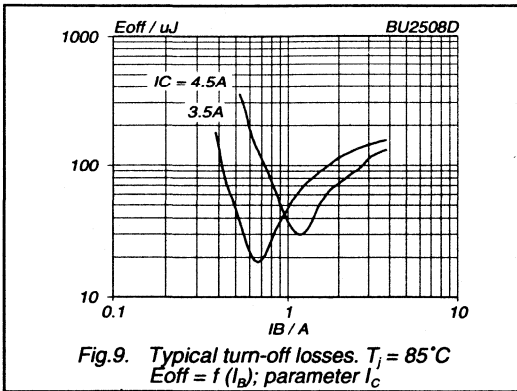


Fig.9. Typical turn-off losses. $T_j = 85^\circ C$
 $E_{off} = f(I_B)$; parameter I_C

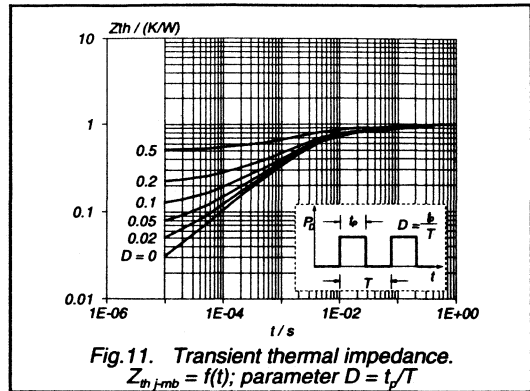


Fig.11. Transient thermal impedance.
 $Z_{th,mb} = f(t)$; parameter $D = t/T$

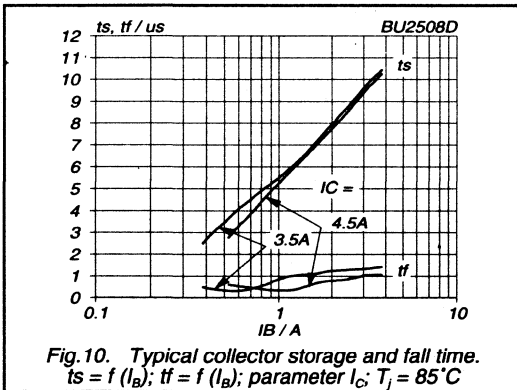


Fig.10. Typical collector storage and fall time.
 $t_s = f(I_B)$; $t_f = f(I_B)$; parameter I_C ; $T_j = 85^\circ C$

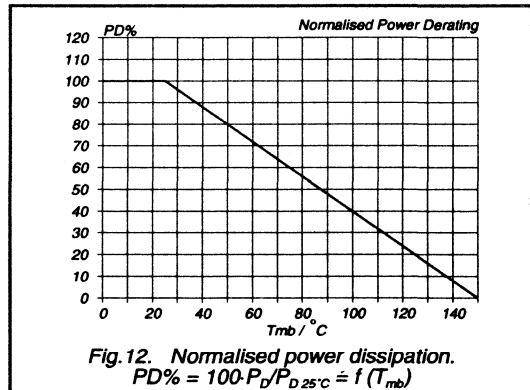
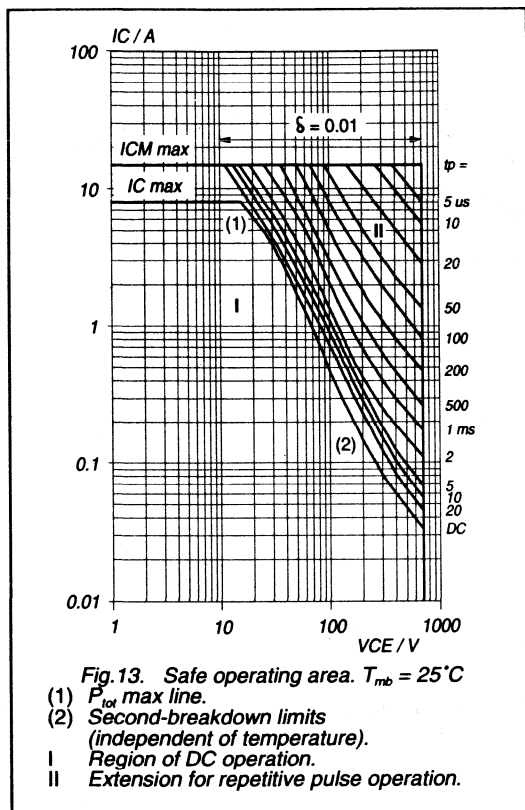


Fig.12. Normalised power dissipation.
 $PD\% = 100 \cdot P_D / P_{D,25^\circ C} = f(T_{mb})$

Silicon Diffused Power Transistor

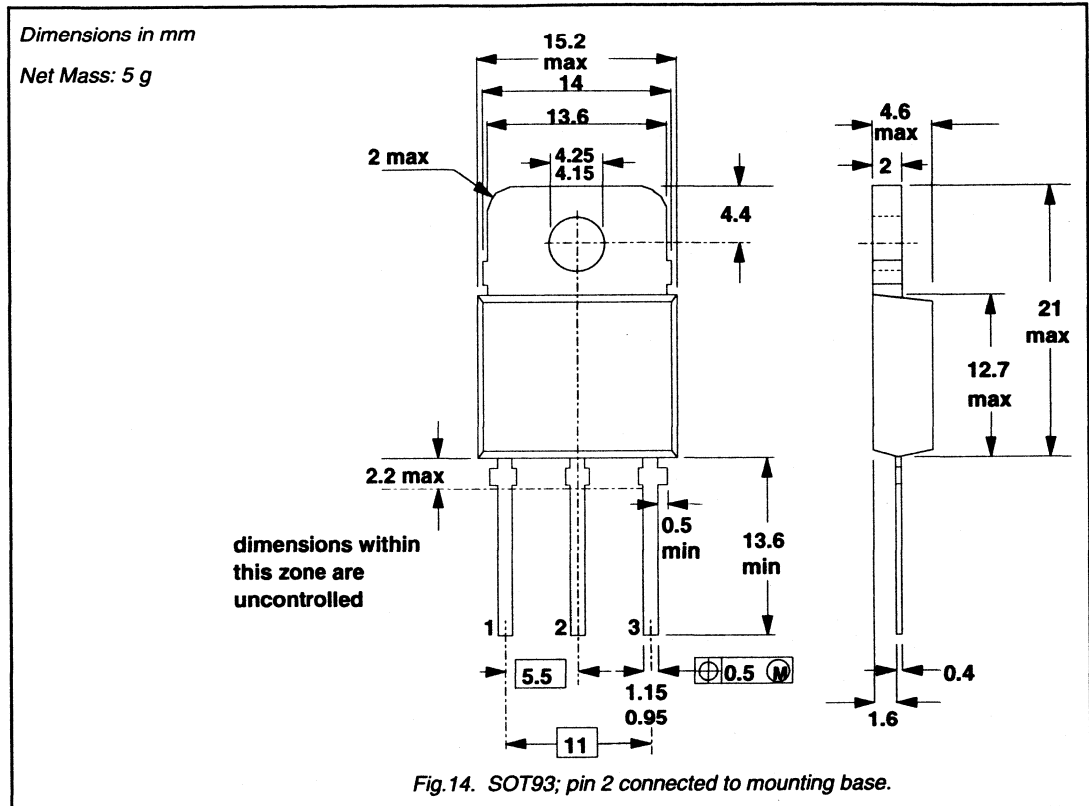
BU2508D



Silicon Diffused Power Transistor

BU2508D

MECHANICAL DATA



Notes

- Accessories supplied on request: refer to mounting instructions for SOT93 envelope.

Silicon Diffused Power Transistor

BU2508DF

GENERAL DESCRIPTION

Enhanced performance, new generation, high-voltage, high-speed switching npn transistor with an integrated damper diode in a plastic full-pack envelope intended for use in horizontal deflection circuits of colour television receivers. Features exceptional tolerance to base drive and collector current load variations resulting in a very low worst case dissipation.

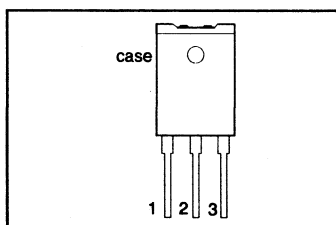
QUICK REFERENCE DATA

SYMBOL	PARAMETER	CONDITIONS	TYP.	MAX.	UNIT
V_{CESM}	Collector-emitter voltage peak value	$V_{BE} = 0 \text{ V}$	-	1500	V
V_{CEO}	Collector-emitter voltage (open base)		-	700	V
I_C	Collector current (DC)		-	8	A
I_{CM}	Collector current peak value		-	15	A
P_{tot}	Total power dissipation	$T_{hs} \leq 25 \text{ }^\circ\text{C}$	-	45	W
V_{CEsat}	Collector-emitter saturation voltage	$I_C = 4.5 \text{ A}; I_B = 1.29 \text{ A}$	-	1.0	V
V_{CEsat}	Collector-emitter saturation voltage	$I_C = 4.5 \text{ A}; I_B = 1.1 \text{ A}$	-	5.0	V
I_{Csat}	Collector saturation current		4.5	-	A
V_F	Diode forward voltage	$I_F = 4.5 \text{ A}$	1.6	-	V
t_f	Fall time	$I_{CM} = 4.5 \text{ A}; I_{B(on)} = 1.1 \text{ A}$	0.4	-	μs

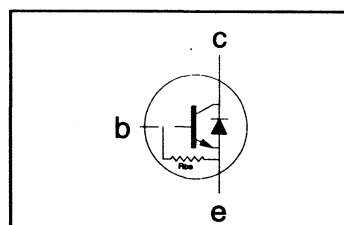
PINNING - SOT199

PIN	DESCRIPTION
1	base
2	collector
3	emitter
case	isolated

PIN CONFIGURATION



SYMBOL



LIMITING VALUES

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

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_{CESM}	Collector-emitter voltage peak value	$V_{BE} = 0 \text{ V}$	-	1500	V
V_{CEO}	Collector-emitter voltage (open base)		-	700	V
I_C	Collector current (DC)		-	8	A
I_{CM}	Collector current peak value		-	15	A
I_B	Base current (DC)		-	4	A
I_{BM}	Base current peak value		-	6	A
$-I_{B(AV)}$	Reverse base current	average over any 20 ms period	-	100	mA
$-I_{BM}$	Reverse base current peak value ¹		-	5	A
P_{tot}	Total power dissipation	$T_{hs} \leq 25 \text{ }^\circ\text{C}$	-	45	W
T_{stg}	Storage temperature		-65	150	$^\circ\text{C}$
T_J	Junction temperature		-	150	$^\circ\text{C}$

¹ Turn-off current.

Silicon Diffused Power Transistor

BU2508DF

THERMAL RESISTANCES

SYMBOL	PARAMETER	CONDITIONS	TYP.	MAX.	UNIT
$R_{th(j-hs)}$	Junction to heatsink	without heatsink compound	-	3.7	K/W
$R_{th(j-hs)}$	Junction to heatsink	with heatsink compound	-	2.8	K/W
$R_{th(j-a)}$	Junction to ambient	in free air	35	-	K/W

ISOLATION

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

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
V_{isol}	Repetitive peak voltage from all three terminals to external heatsink	R.H. $\leq 65\%$; clean and dustfree	-	-	2500	V
C_{isol}	Capacitance from T2 to external heatsink	$f = 1\text{ MHz}$	-	22	-	pF

STATIC CHARACTERISTICS

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

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
I_{CES}	Collector cut-off current ²	$V_{BE} = 0\text{ V}; V_{CE} = V_{CESMmax}$	-	-	1.0	mA
I_{CES}		$V_{BE} = 0\text{ V}; V_{CE} = V_{CESMmax}$ $T_j = 125\text{ }^{\circ}\text{C}$	-	-	2.0	mA
I_{EBO}	Emitter cut-off current	$V_{EB} = 7.5\text{ V}; I_C = 0\text{ A}$	140	-	390	mA
R_{be}	Base-emitter resistance	$V_{EB} = 7.5\text{ V}$	-	33	-	Ω
$V_{CE(sust)}$	Collector-emitter sustaining voltage.	$I_B = 0\text{ A}; I_C = 100\text{ mA};$ $L = 25\text{ mH}$	700	-	-	V
$V_{CE(sat)}$	Collector-emitter saturation voltages	$I_C = 4.5\text{ A}; I_B = 1.1\text{ A}$	-	-	5.0	V
$V_{CE(sat)}$		$I_C = 4.5\text{ A}; I_B = 1.29\text{ A}$	-	-	1.0	V
$V_{BE(sat)}$	Base-emitter saturation voltage	$I_C = 4.5\text{ A}; I_B = 1.7\text{ A}$	-	-	1.3	V
η_{FE}	DC current gain	$I_C = 1\text{ A}; V_{CE} = 5\text{ V}$	-	-	23	-
η_{FE}		$I_C = 4.5\text{ A}; V_{CE} = 1\text{ V}$	3.5	5.5	-	-
V_F	Diode forward voltage	$I_F = 4.5\text{ A}$	-	1.6	2.0	V
I_{SB}	Second breakdown current	$V_{CE} = 120\text{ V}; t = 200\text{ }\mu\text{s}$	11	-	-	A

DYNAMIC CHARACTERISTICS

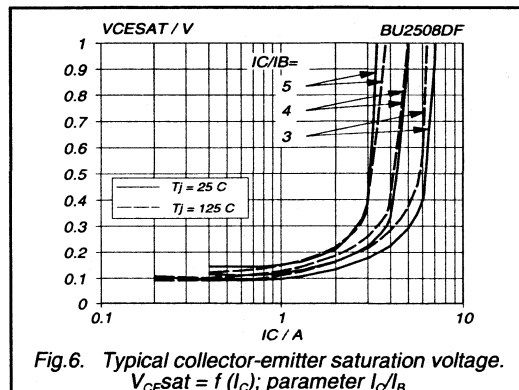
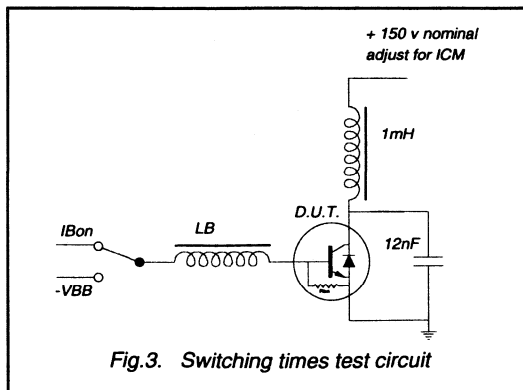
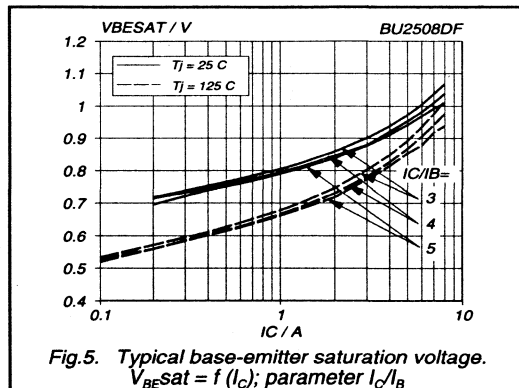
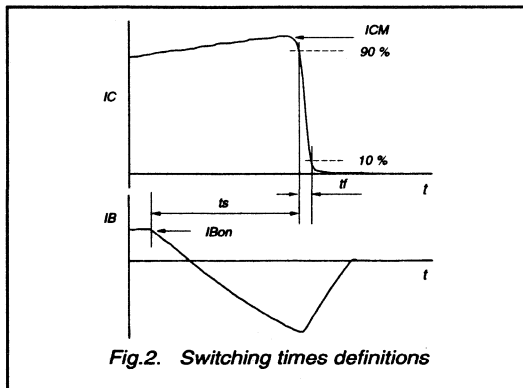
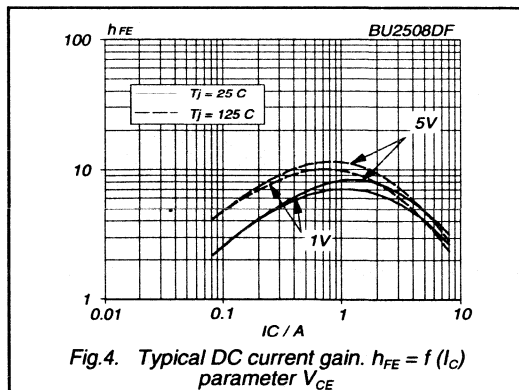
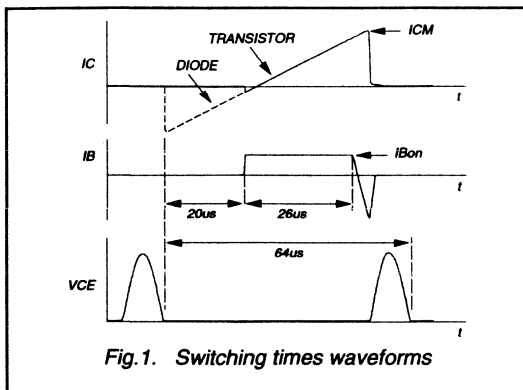
 $T_{hs} = 25\text{ }^{\circ}\text{C}$ unless otherwise specified

SYMBOL	PARAMETER	CONDITIONS	TYP.	MAX.	UNIT
C_c	Collector capacitance	$I_E = 0\text{ A}; V_{CB} = 10\text{ V}; f = 1\text{ MHz}$	90	-	pF
t_s	Switching times (line deflection circuit). Fig.1, Fig.2 and Fig.3. Turn-off storage time	$I_{CM} = 4.5\text{ A}; I_{B(ond)} = 1.1\text{ A}; L_B = 6\text{ }\mu\text{H};$ $-V_{BB} = 4\text{ V}; (-di_B/dt = 0.6\text{ A}/\mu\text{s})$	5.0	6.0	μs
t_f			Turn-off fall time	0.4	0.6

2 Measured with half sine-wave voltage (curve tracer).

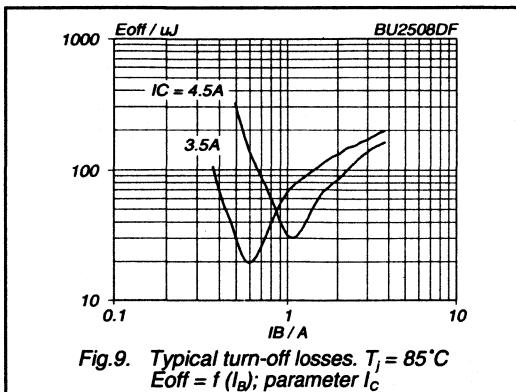
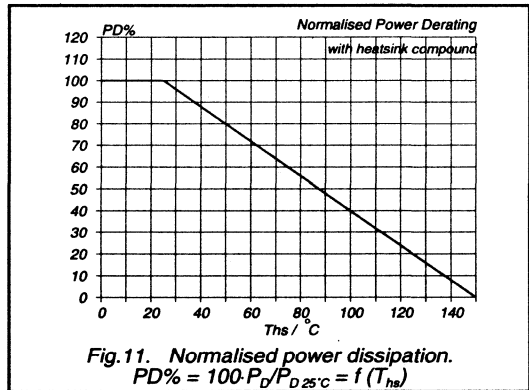
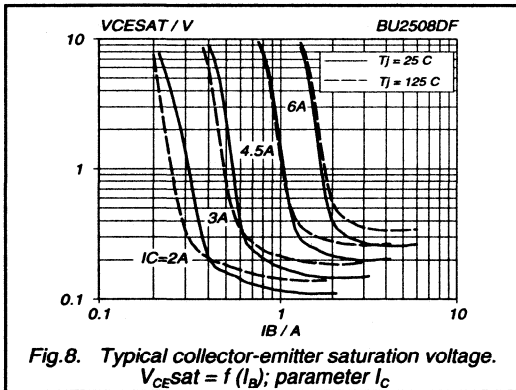
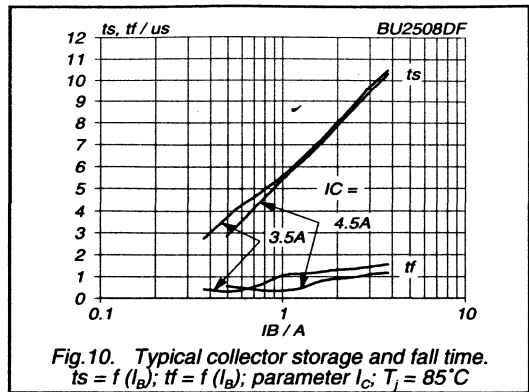
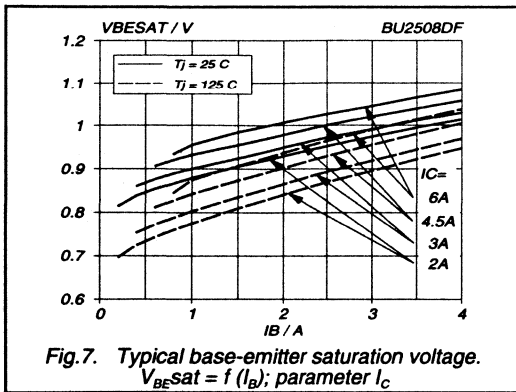
Silicon Diffused Power Transistor

BU2508DF



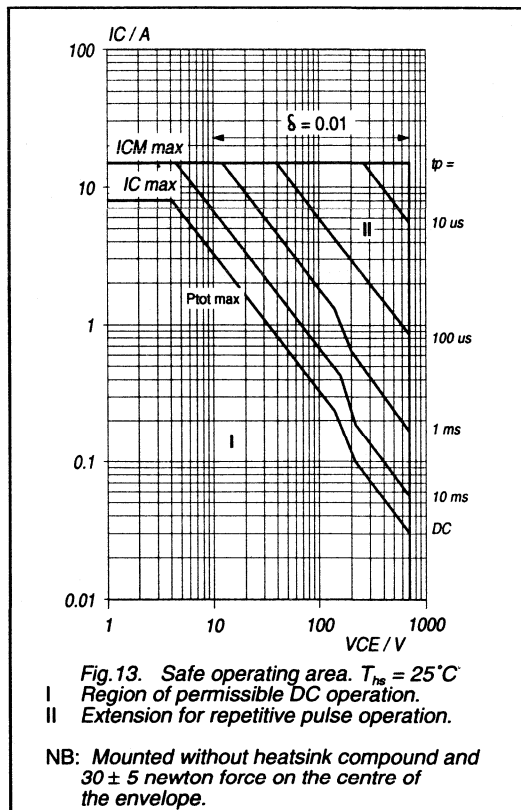
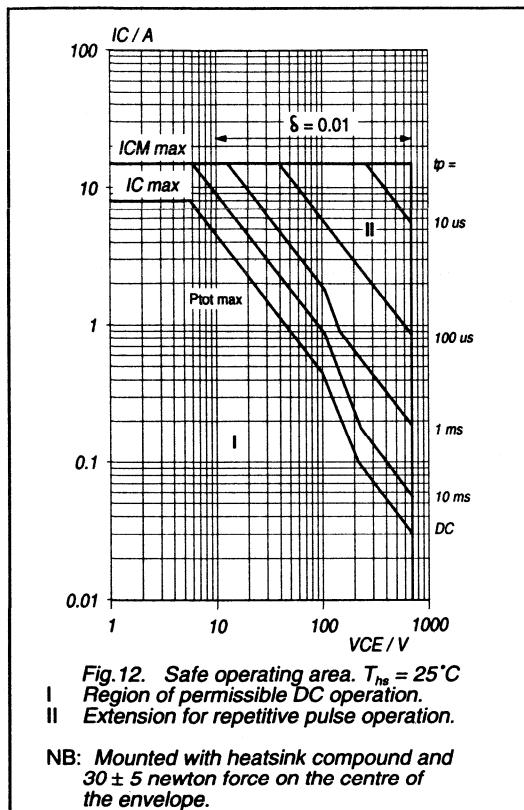
Silicon Diffused Power Transistor

BU2508DF



Silicon Diffused Power Transistor

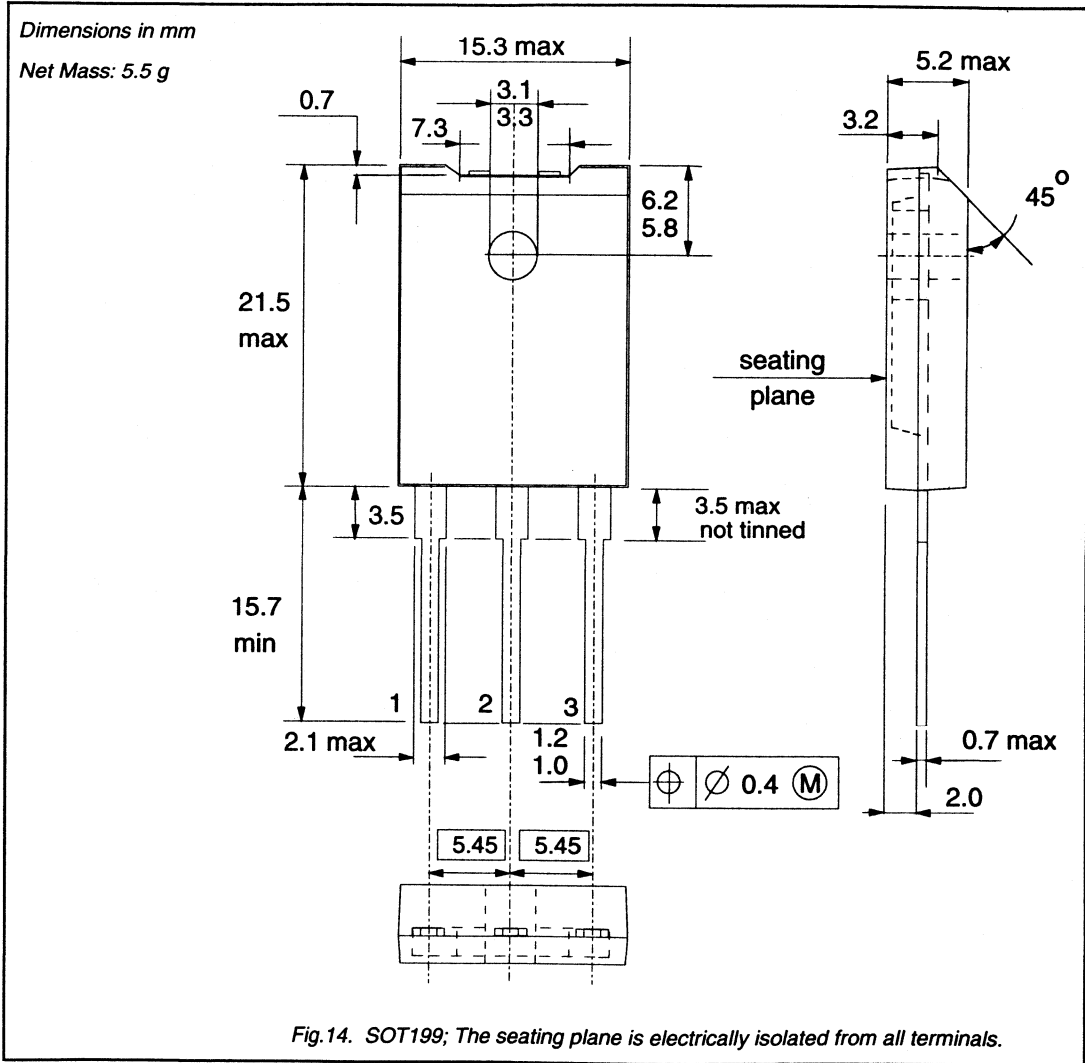
BU2508DF



Silicon Diffused Power Transistor

BU2508DF

MECHANICAL DATA



Notes

1. Accessories supplied on request: refer to mounting instructions for F-pack envelopes.

Silicon Diffused Power Transistor

BU2520A

GENERAL DESCRIPTION

New generation, high-voltage, high-speed switching npn transistor in a plastic envelope intended for use in horizontal deflection circuits of large screen colour television receivers up to 32 kHz.

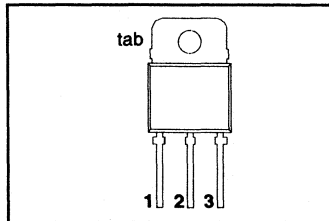
QUICK REFERENCE DATA

SYMBOL	PARAMETER	CONDITIONS	TYP.	MAX.	UNIT
V_{CESM}	Collector-emitter voltage peak value	$V_{BE} = 0 \text{ V}$	-	1500	V
V_{CEO}	Collector-emitter voltage (open base)		-	800	V
I_C	Collector current (DC)		-	10	A
I_{CM}	Collector current peak value		-	25	A
P_{tot}	Total power dissipation	$T_{mb} \leq 25 \text{ }^\circ\text{C}$	-	125	W
V_{CEsat}	Collector-emitter saturation voltage	$I_C = 6.0 \text{ A}; I_B = 1.2 \text{ A}$	-	5.0	V
I_{Csat}	Collector saturation current		6	-	A
t_f	Fall time	$I_{CM} = 6.0 \text{ A}; I_{B(on)} = 0.85 \text{ A}$	0.2	-	μs

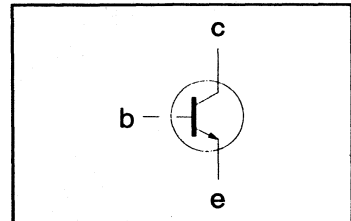
PINNING - SOT93

PIN	DESCRIPTION
1	base
2	collector
3	emitter
tab	collector

PIN CONFIGURATION



SYMBOL



LIMITING VALUES

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

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_{CESM}	Collector-emitter voltage peak value	$V_{BE} = 0 \text{ V}$	-	1500	V
V_{CEO}	Collector-emitter voltage (open base)		-	800	V
I_C	Collector current (DC)		-	10	A
I_{CM}	Collector current peak value		-	25	A
I_B	Base current (DC)		-	6	A
I_{BM}	Base current peak value		-	9	A
$-I_{B(AV)}$	Reverse base current	average over any 20 ms period	-	150	mA
$-I_{BM}$	Reverse base current peak value ¹		-	6	A
P_{tot}	Total power dissipation	$T_{mb} \leq 25 \text{ }^\circ\text{C}$	-	125	W
T_{stg}	Storage temperature		-65	150	$^\circ\text{C}$
T_J	Junction temperature		-	150	$^\circ\text{C}$

THERMAL RESISTANCES

SYMBOL	PARAMETER	CONDITIONS	TYP.	MAX.	UNIT
$R_{th\ j-mb}$	Junction to mounting base	-	-	1.0	K/W
$R_{th\ j-a}$	Junction to ambient	in free air	45	-	K/W

¹ Turn-off current.

Silicon Diffused Power Transistor

BU2520A

STATIC CHARACTERISTICS

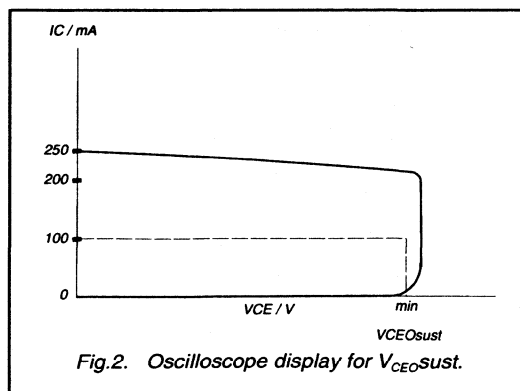
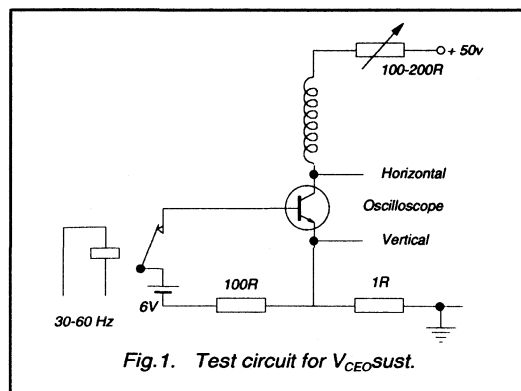
 $T_{mb} = 25\text{ }^{\circ}\text{C}$ unless otherwise specified

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
I_{CES}	Collector cut-off current ²	$V_{BE} = 0\text{ V}; V_{CE} = V_{CESMmax}$	-	-	1.0	mA
I_{CES}		$V_{BE} = 0\text{ V}; V_{CE} = V_{CESMmax}$ $T_J = 125\text{ }^{\circ}\text{C}$	-	-	2.0	mA
I_{EBO}	Emitter cut-off current	$V_{EB} = 7.5\text{ V}; I_C = 0\text{ A}$	-	-	1.0	mA
$V_{CEOsust}$	Collector-emitter sustaining voltage Fig.1 and Fig.2	$I_B = 0\text{ A}; I_C = 100\text{ mA};$ $L = 25\text{ mH}$	800	-	-	V
V_{CEsat}	Collector-emitter saturation voltage	$I_C = 6.0\text{ A}; I_B = 1.2\text{ A}$	-	-	5.0	V
V_{BEsat}	Base-emitter saturation voltage	$I_C = 6.0\text{ A}; I_B = 1.2\text{ A}$	-	-	1.3	V
h_{FE}	DC current gain	$I_C = 100\text{ mA}; V_{CE} = 5\text{ V}$	6	13	26	
h_{FE}		$I_C = 6\text{ A}; V_{CE} = 5\text{ V}$	5	7	-	

DYNAMIC CHARACTERISTICS

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

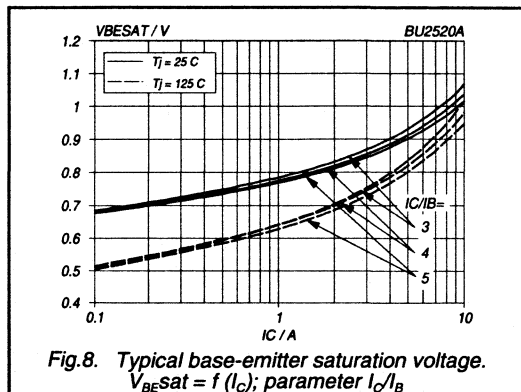
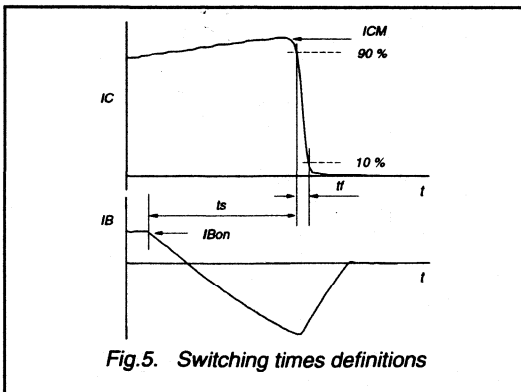
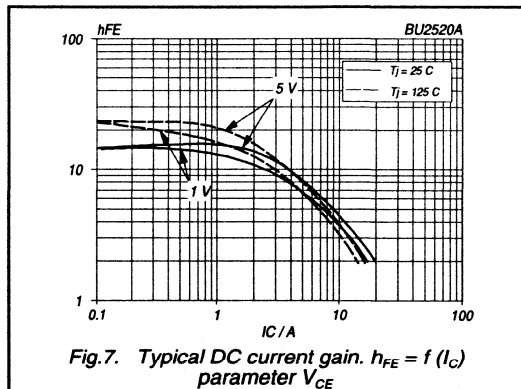
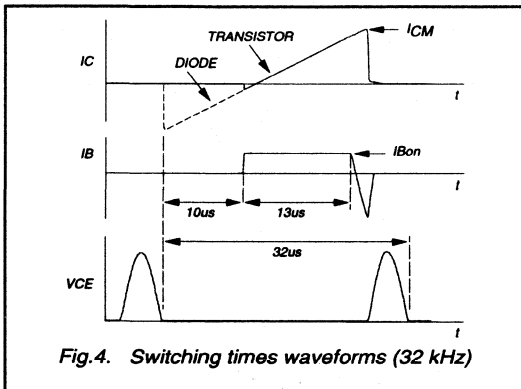
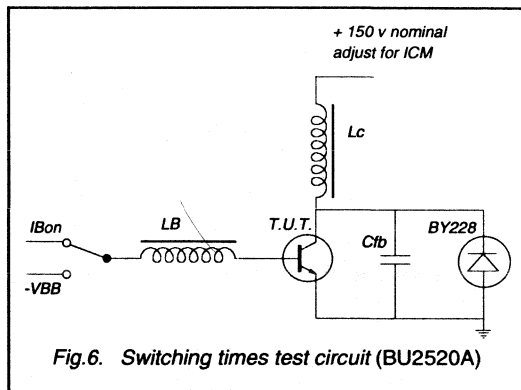
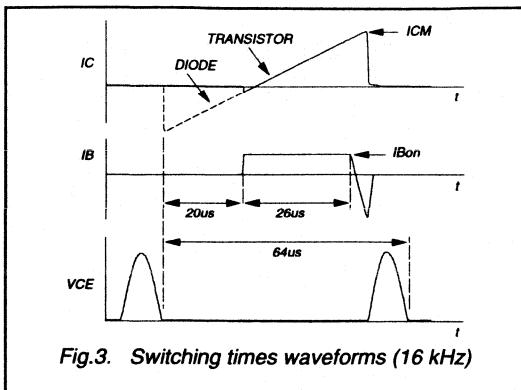
SYMBOL	PARAMETER	CONDITIONS	TYP.	MAX.	UNIT
C_c	Collector capacitance	$I_E = 0\text{ A}; V_{CB} = 10\text{ V}; f = 1\text{ MHz}$	115	-	pF
t_s	Switching times (32 kHz line deflection circuit). Fig.4, Fig.5 and Fig.6	$I_{CM} = 6.0\text{ A}; L_C = 330\text{ }\mu\text{H}; C_{fb} = 9\text{ nF};$ $I_{B(end)} = 0.85\text{ A}; L_B = 3.45\text{ }\mu\text{H};$ $-V_{BB} = 4\text{ V}; (-di_B/dt = 1.2\text{ A}/\mu\text{s})$			
t_f	Turn-off storage time		3.0	4.0	μs
t_f	Turn-off fall time		0.2	0.35	μs
t_s	Switching times (16 kHz line deflection circuit). Fig.3, Fig.5 and Fig.6	$I_{CM} = 6.0\text{ A}; L_C = 650\text{ }\mu\text{H}; C_{fb} = 19\text{ nF};$ $I_{B(end)} = 1.0\text{ A}; L_B = 5.3\text{ }\mu\text{H}; -V_{BB} = 4\text{ V};$ $(-di_B/dt = 0.8\text{ A}/\mu\text{s})$			
t_s	Turn-off storage time		4.5	5.5	μs
t_f	Turn-off fall time		0.35	0.5	μs



2 Measured with half sine-wave voltage (curve tracer).

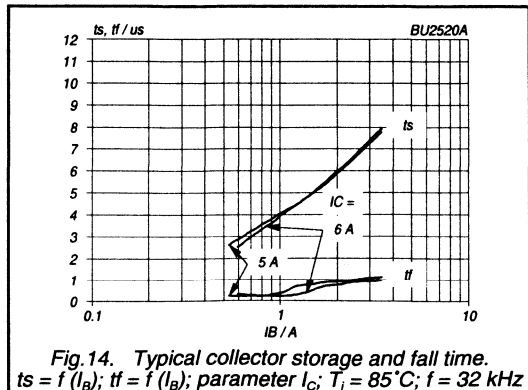
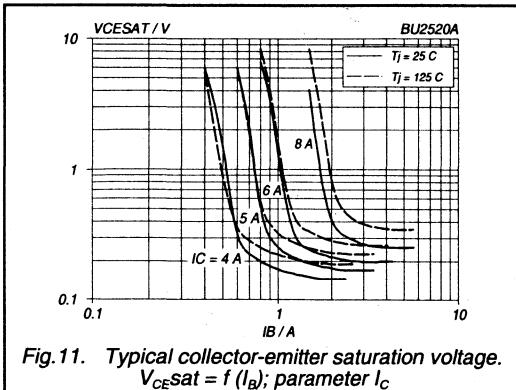
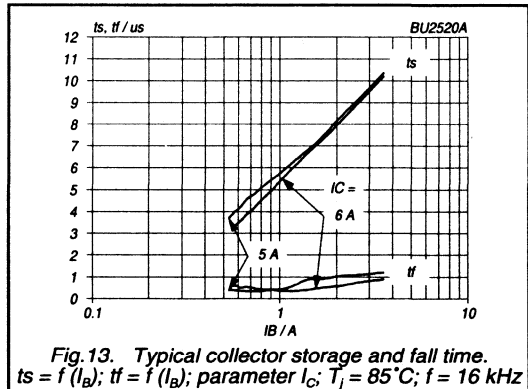
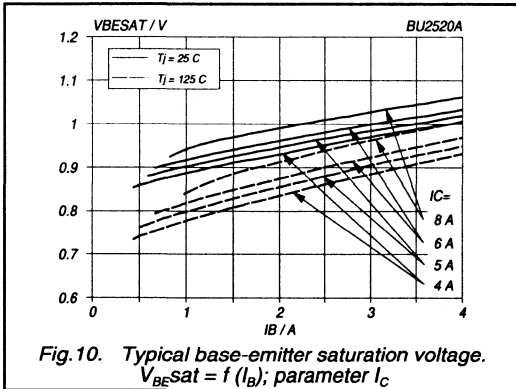
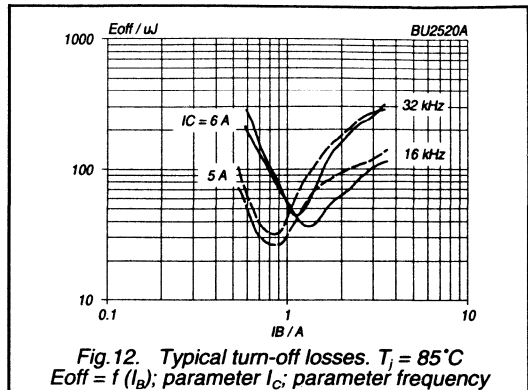
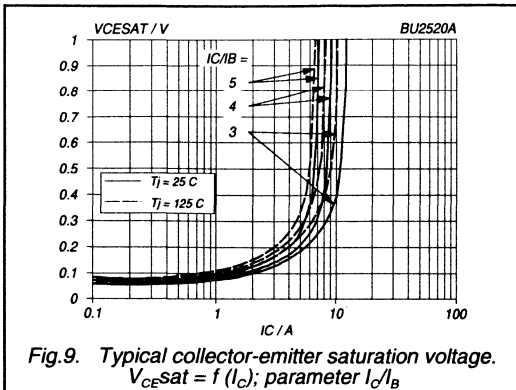
Silicon Diffused Power Transistor

BU2520A



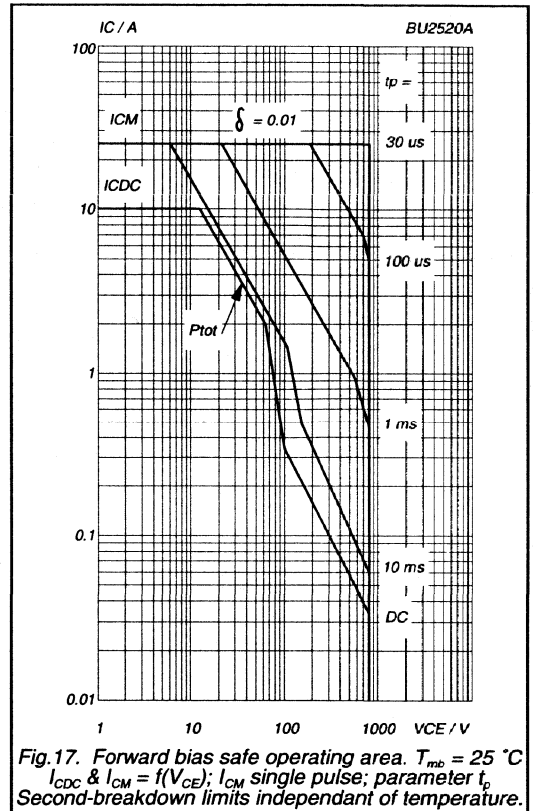
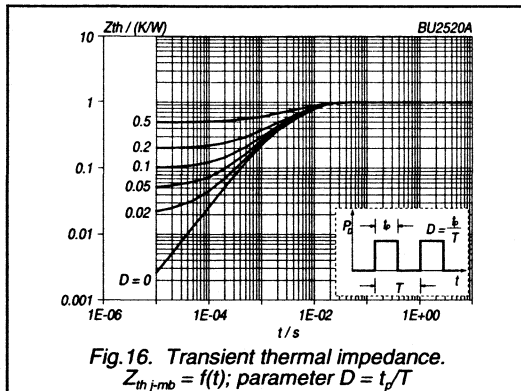
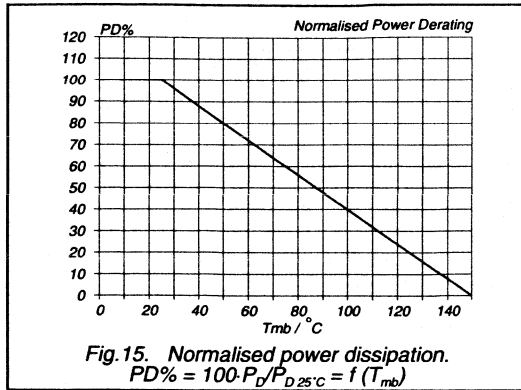
Silicon Diffused Power Transistor

BU2520A



Silicon Diffused Power Transistor

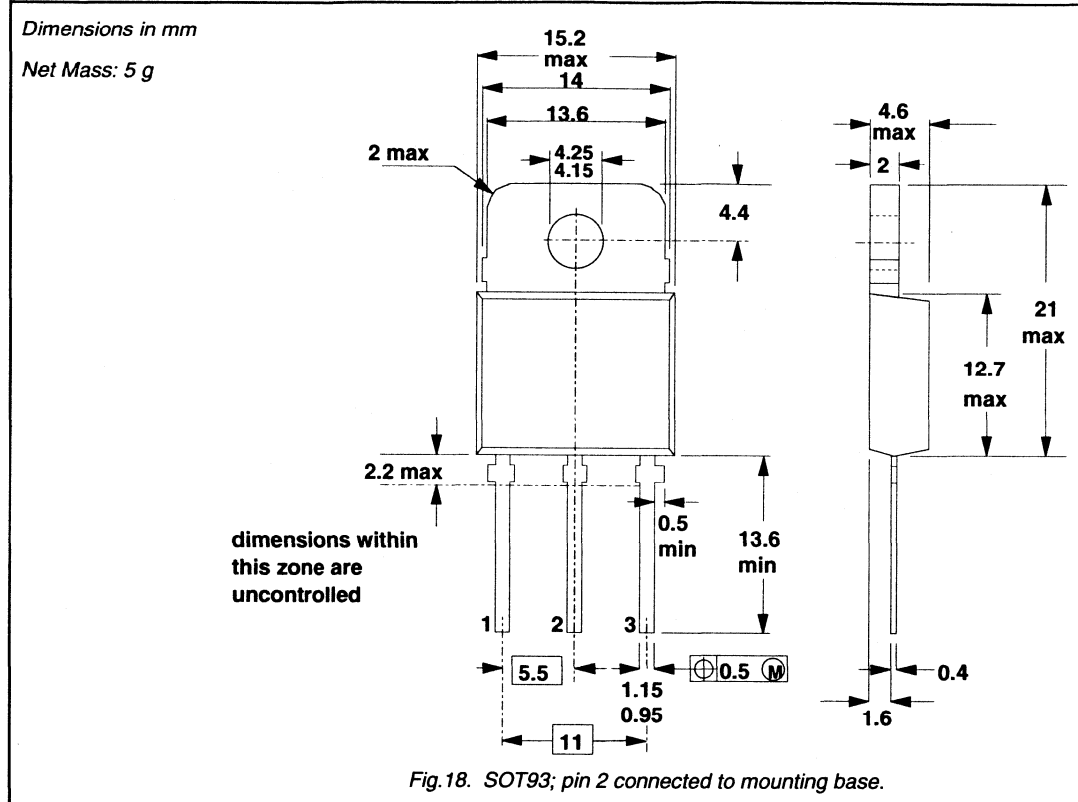
BU2520A



Silicon Diffused Power Transistor

BU2520A

MECHANICAL DATA



Notes

- Accessories supplied on request: refer to mounting instructions for SOT93 envelope.

Silicon Diffused Power Transistor

BU2520AF

GENERAL DESCRIPTION

New generation, high-voltage, high-speed switching npn transistor in a plastic full-pack envelope intended for use in horizontal deflection circuits of large screen colour television receivers up to 32 kHz.

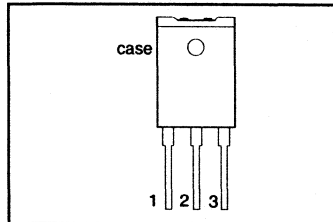
QUICK REFERENCE DATA

SYMBOL	PARAMETER	CONDITIONS	TYP.	MAX.	UNIT
V_{CESM}	Collector-emitter voltage peak value	$V_{BE} = 0 \text{ V}$	-	1500	V
V_{CEO}	Collector-emitter voltage (open base)		-	800	V
I_C	Collector current (DC)		-	10	A
I_{CM}	Collector current peak value		-	25	A
P_{tot}	Total power dissipation	$T_{hs} \leq 25 \text{ }^\circ\text{C}$	-	45	W
V_{CEsat}	Collector-emitter saturation voltage	$I_C = 6.0 \text{ A}; I_B = 1.2 \text{ A}$	-	5.0	V
I_{Csat}	Collector saturation current		6.0	-	A
t_f	Fall time	$I_{CM} = 6.0 \text{ A}; I_{B(on)} = 0.85 \text{ A}$	0.2	-	μs

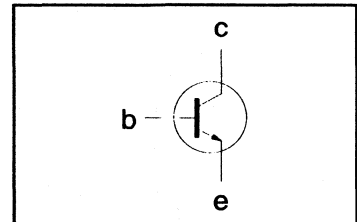
PINNING - SOT199

PIN	DESCRIPTION
1	base
2	collector
3	emitter
case	isolated

PIN CONFIGURATION



SYMBOL



LIMITING VALUES

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

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_{CESM}	Collector-emitter voltage peak value	$V_{BE} = 0 \text{ V}$	-	1500	V
V_{CEO}	Collector-emitter voltage (open base)		-	800	V
I_C	Collector current (DC)		-	10	A
I_{CM}	Collector current peak value		-	25	A
I_B	Base current (DC)		-	6	A
I_{BM}	Base current peak value		-	9	A
$-I_{B(AV)}$	Reverse base current	average over any 20 ms period	-	150	mA
$-I_{BM}$	Reverse base current peak value ¹		-	6	A
P_{tot}	Total power dissipation	$T_{hs} \leq 25 \text{ }^\circ\text{C}$	-	45	W
T_{stg}	Storage temperature		-65	150	$^\circ\text{C}$
T_j	Junction temperature		-	150	$^\circ\text{C}$

THERMAL RESISTANCES

SYMBOL	PARAMETER	CONDITIONS	TYP.	MAX.	UNIT
$R_{th(j-hs)}$	Junction to heatsink	without heatsink compound	-	3.7	K/W
$R_{th(j-hs)}$	Junction to heatsink	with heatsink compound	-	2.8	K/W
$R_{th(j-a)}$	Junction to ambient	in free air	35	-	K/W

¹ Turn-off current.

Silicon Diffused Power Transistor

BU2520AF

ISOLATION

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

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
V_{isol}	Repetitive peak voltage from all three terminals to external heatsink	R.H. $\leq 65\%$; clean and dustfree	-	-	2500	V
C_{isol}	Capacitance from T2 to external heatsink	$f = 1\text{ MHz}$	-	22	-	pF

STATIC CHARACTERISTICS

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

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
I_{CES}	Collector cut-off current ²	$V_{BE} = 0\text{ V}$; $V_{CE} = V_{CESMmax}$	-	-	1.0	mA
I_{CES}		$V_{BE} = 0\text{ V}$; $V_{CE} = V_{CESMmax}$; $T_J = 125\text{ }^{\circ}\text{C}$	-	-	2.0	mA
I_{EBO}	Emitter cut-off current	$V_{EB} = 7.5\text{ V}$; $I_C = 0\text{ A}$	-	-	1.0	mA
$V_{CEOsust}$	Collector-emitter sustaining voltage Fig.1 and Fig.2	$I_B = 0\text{ A}$; $I_C = 100\text{ mA}$; $L = 25\text{ mH}$	800	-	-	V
V_{CEsat}	Collector-emitter saturation voltage	$I_C = 6.0\text{ A}$; $I_B = 1.2\text{ A}$	-	-	5.0	V
V_{BEsat}	Base-emitter saturation voltage	$I_C = 6.0\text{ A}$; $I_B = 1.2\text{ A}$	-	-	1.3	V
h_{FE}	DC current gain	$I_C = 100\text{ mA}$; $V_{CE} = 5\text{ V}$	6	13	26	
h_{FE}		$I_C = 6\text{ A}$; $V_{CE} = 5\text{ V}$	5	7	-	

DYNAMIC CHARACTERISTICS

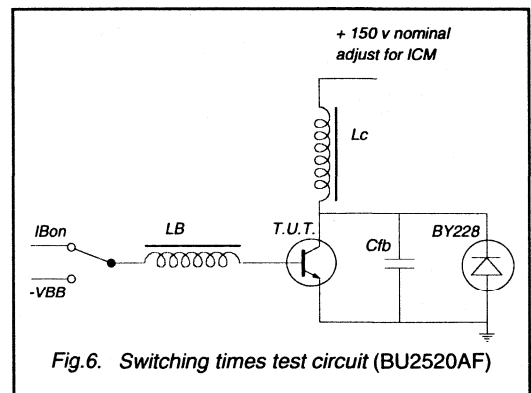
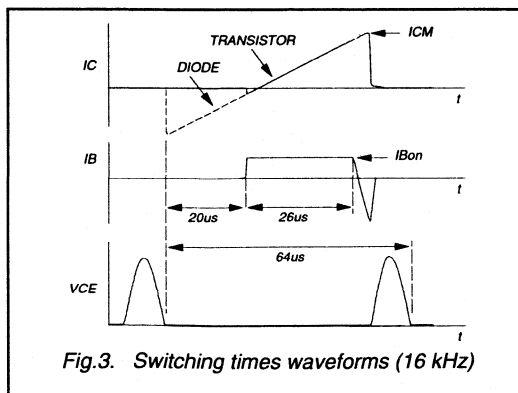
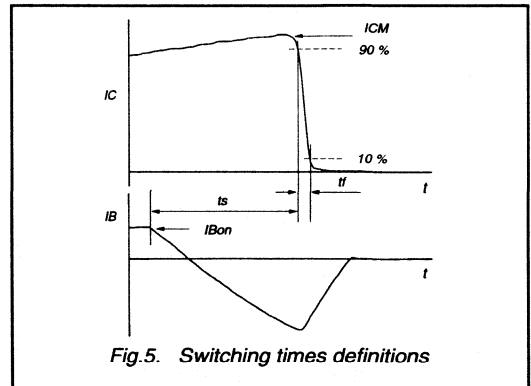
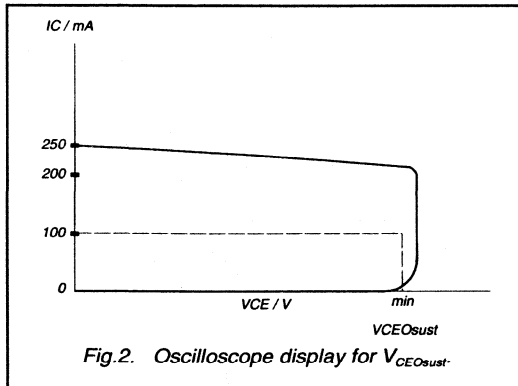
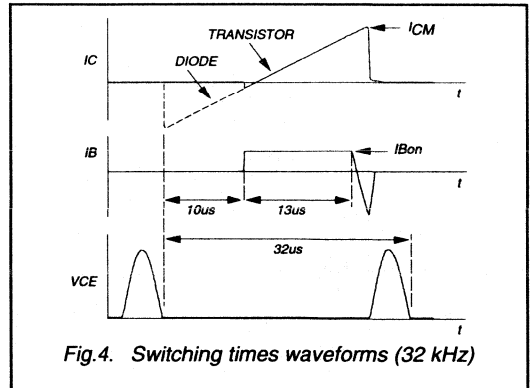
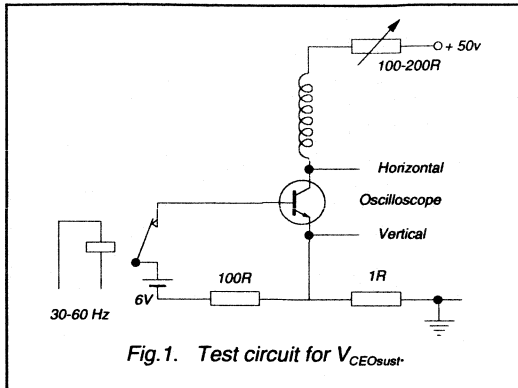
 $T_{hs} = 25\text{ }^{\circ}\text{C}$ unless otherwise specified

SYMBOL	PARAMETER	CONDITIONS	TYP.	MAX.	UNIT
C_c	Collector capacitance	$I_E = 0\text{ A}$; $V_{CB} = 10\text{ V}$; $f = 1\text{ MHz}$	115	-	pF
t_s	Switching times (32 kHz line deflection circuit) Fig.4, Fig.5 and Fig.6	$I_{CM} = 6.0\text{ A}$; $L_C = 330\text{ }\mu\text{H}$; $C_{fb} = 9\text{ nF}$; $I_{B(end)} = 0.85\text{ A}$; $L_B = 3.45\text{ }\mu\text{H}$; $-V_{BB} = 4\text{ V}$; $(-di_B/dt = 1.2\text{ A}/\mu\text{s})$			
t_f	Turn-off storage time		3.0	4.0	μs
t_f	Turn-off fall time		0.2	0.35	μs
t_s	Switching times (16 kHz line deflection circuit) Fig.3, Fig.5 and Fig.6	$I_{CM} = 6.0\text{ A}$; $L_C = 650\text{ }\mu\text{H}$; $C_{fb} = 19\text{ nF}$; $I_{B(end)} = 1.0\text{ A}$; $L_B = 5.3\text{ }\mu\text{H}$; $-V_{BB} = 4\text{ V}$; $(-di_B/dt = 0.8\text{ A}/\mu\text{s})$			
t_s	Turn-off storage time		4.5	5.5	μs
t_f	Turn-off fall time		0.35	0.5	μs

² Measured with half sine-wave voltage (curve tracer).

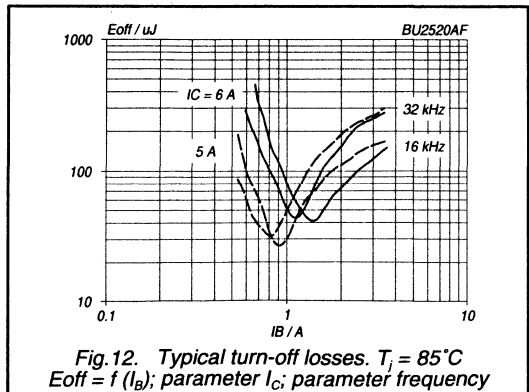
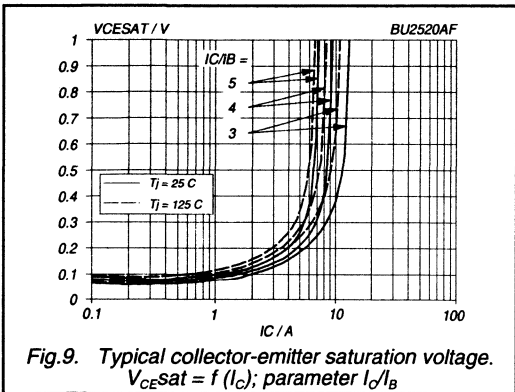
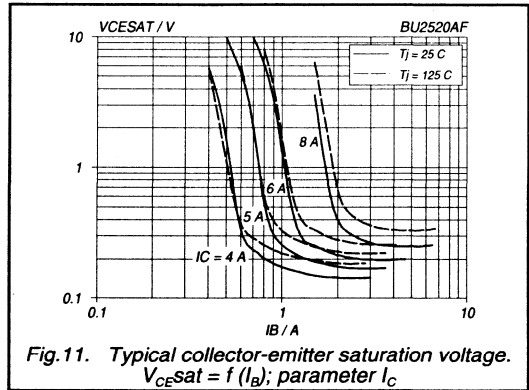
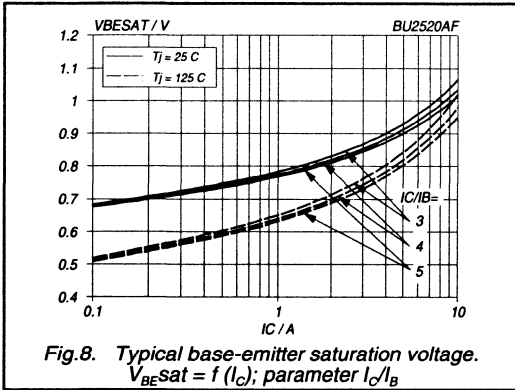
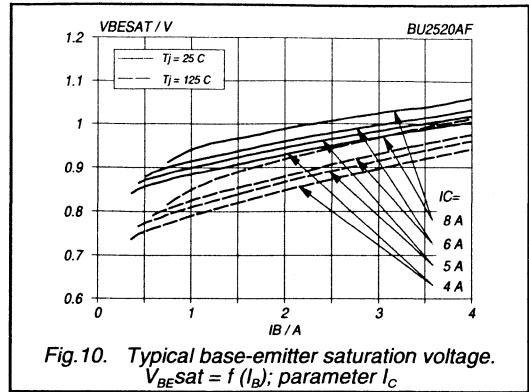
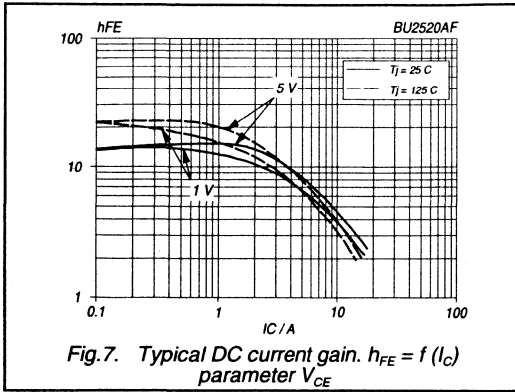
Silicon Diffused Power Transistor

BU2520AF



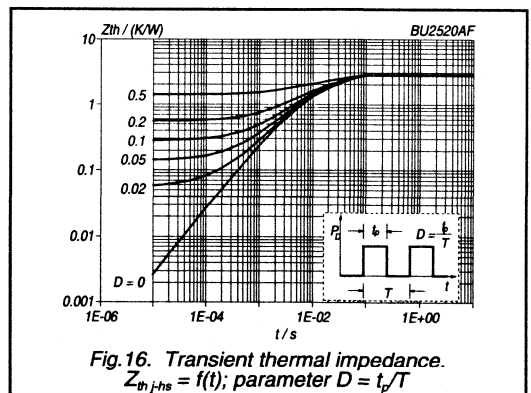
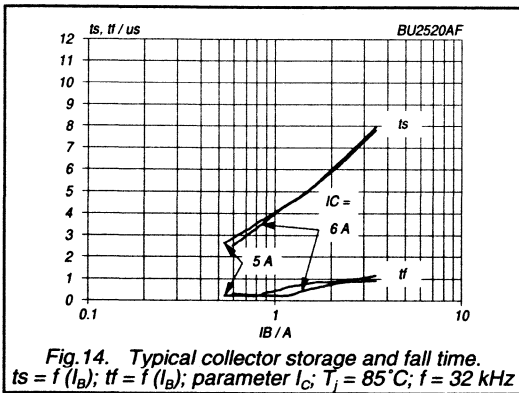
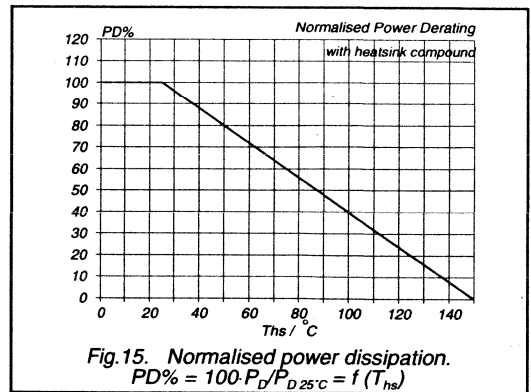
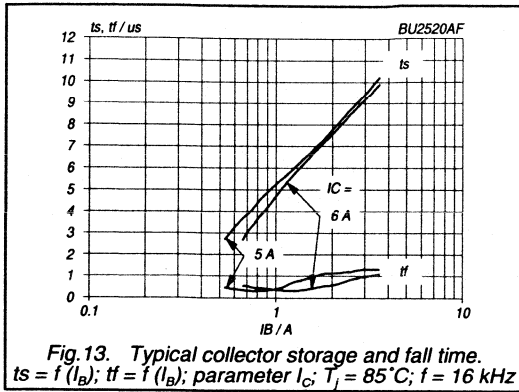
Silicon Diffused Power Transistor

BU2520AF



Silicon Diffused Power Transistor

BU2520AF



Silicon Diffused Power Transistor

BU2520AF

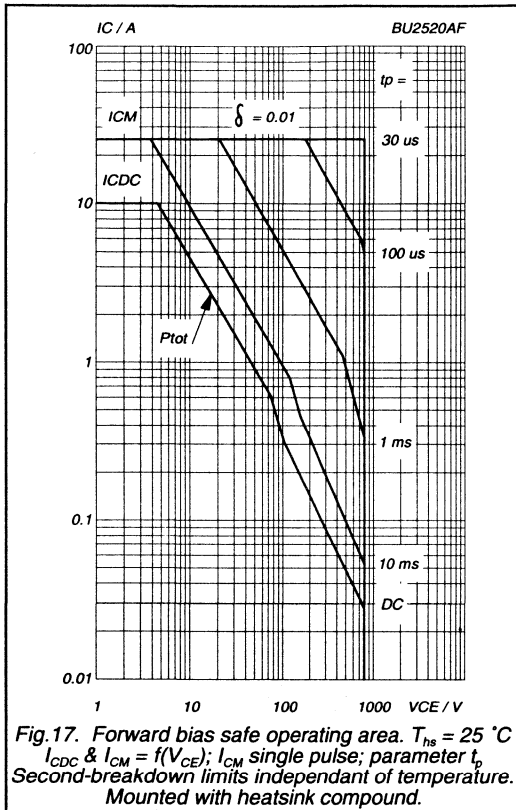
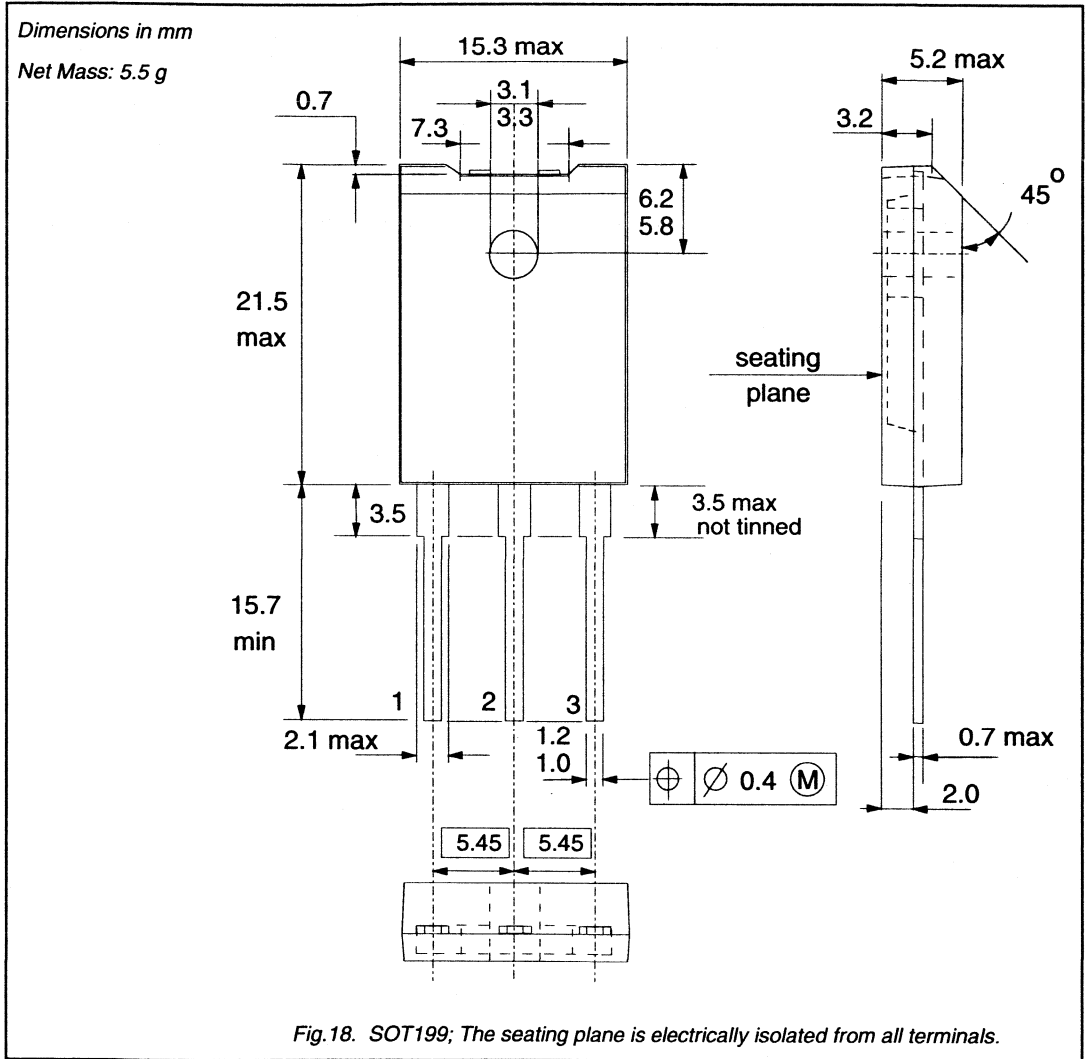


Fig.17. Forward bias safe operating area. $T_{hs} = 25\text{ }^\circ\text{C}$
 I_{CDC} & $I_{CM} = f(V_{CE})$; I_{CM} single pulse; parameter t_p
 Second-breakdown limits independent of temperature.
 Mounted with heatsink compound.

Silicon Diffused Power Transistor

BU2520AF

MECHANICAL DATA



Notes

1. Accessories supplied on request: refer to mounting instructions for F-pack envelopes.

Silicon diffused power transistor

BU2520D

GENERAL DESCRIPTION

New generation, high-voltage, high-speed switching npn transistor with an integrated damper diode in a plastic envelope intended for use in horizontal deflection circuits of large screen colour television receivers.

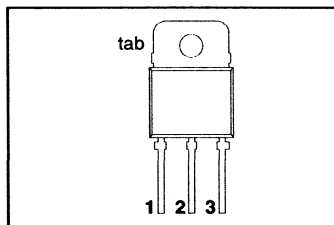
QUICK REFERENCE DATA

SYMBOL	PARAMETER	CONDITIONS	TYP.	MAX.	UNIT
V_{CESM}	Collector-emitter voltage peak value	$V_{BE} = 0 \text{ V}$	-	1500	V
V_{CEO}	Collector-emitter voltage (open base)		-	800	V
I_C	Collector current (DC)		-	10	A
I_{CM}	Collector current peak value		-	25	A
P_{tot}	Total power dissipation	$T_{mb} \leq 25 \text{ }^\circ\text{C}$	-	125	W
V_{CESat}	Collector-emitter saturation voltage	$I_C = 6.0 \text{ A}; I_B = 1.2 \text{ A}$	-	5.0	V
I_{CSat}	Collector saturation current		6	-	A
V_F	Diode forward voltage	$I_F = 6.0 \text{ A}$	-	2.2	V
t_f	Fall time	$I_{CM} = 6.0 \text{ A}; I_{B(on)} = 1.0 \text{ A}$	0.35	-	μs

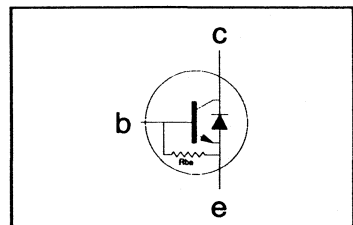
PINNING - SOT93

PIN	DESCRIPTION
1	base
2	collector
3	emitter
tab	collector

PIN CONFIGURATION



SYMBOL



LIMITING VALUES

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

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_{CESM}	Collector-emitter voltage peak value	$V_{BE} = 0 \text{ V}$	-	1500	V
V_{CEO}	Collector-emitter voltage (open base)		-	800	V
I_C	Collector current (DC)		-	10	A
I_{CM}	Collector current peak value		-	25	A
I_B	Base current (DC)		-	6	A
I_{BM}	Base current peak value		-	9	A
$-I_{B(AV)}$	Reverse base current	average over any 20 ms period	-	150	mA
$-I_{BM}$	Reverse base current peak value ¹		-	6	A
P_{tot}	Total power dissipation	$T_{mb} \leq 25 \text{ }^\circ\text{C}$	-	125	W
T_{stg}	Storage temperature		-65	150	$^\circ\text{C}$
T_j	Junction temperature		-	150	$^\circ\text{C}$

THERMAL RESISTANCES

SYMBOL	PARAMETER	CONDITIONS	TYP.	MAX.	UNIT
$R_{th-j-mb}$	Junction to mounting base	-	-	1.0	K/W
R_{th-j-a}	Junction to ambient	in free air	45	-	K/W

¹ Turn-off current.

Silicon diffused power transistor

BU2520D

STATIC CHARACTERISTICS

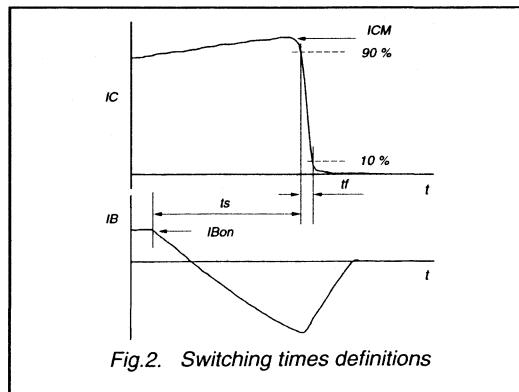
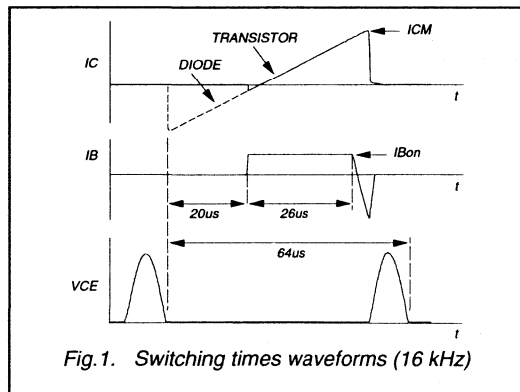
$T_{mb} = 25\text{ }^\circ\text{C}$ unless otherwise specified

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
I_{CES}	Collector cut-off current ²	$V_{BE} = 0\text{ V}; V_{CE} = V_{CESMmax}$	-	-	1.0	mA
I_{CES}		$V_{BE} = 0\text{ V}; V_{CE} = V_{CESMmax}; T_j = 125\text{ }^\circ\text{C}$	-	-	2.0	mA
I_{EBO}	Emitter cut-off current	$V_{EB} = 7.5\text{ V}; I_C = 0\text{ A}$	100	-	300	mA
R_{be}	Base-emitter resistance	$V_{EB} = 7.5\text{ V}$	-	50	-	Ω
V_{CE0ust}	Collector-emitter sustaining voltage	$I_B = 0\text{ A}; I_C = 100\text{ mA}; L = 25\text{ mH}$	800	-	-	V
V_{CEsat}	Collector-emitter saturation voltage	$I_C = 6.0\text{ A}; I_B = 1.2\text{ A}$	-	-	5.0	V
V_{BEsat}	Base-emitter saturation voltage	$I_C = 6.0\text{ A}; I_B = 1.2\text{ A}$	-	-	1.3	V
h_{FE}	DC current gain	$I_C = 1.0\text{ A}; V_{CE} = 5\text{ V}$	-	-	23	
h_{FE}		$I_C = 6\text{ A}; V_{CE} = 5\text{ V}$	5	7	-	
V_F	Diode forward voltage	$I_F = 6\text{ A}$	-	-	2.2	V

DYNAMIC CHARACTERISTICS

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

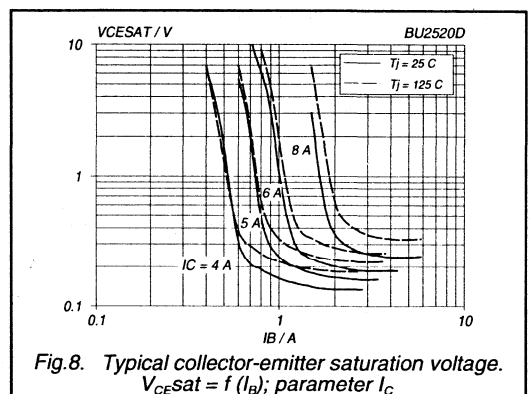
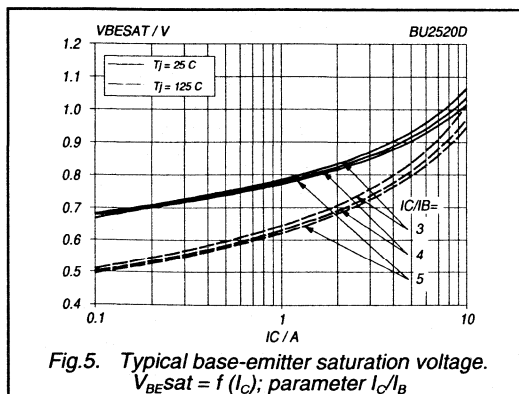
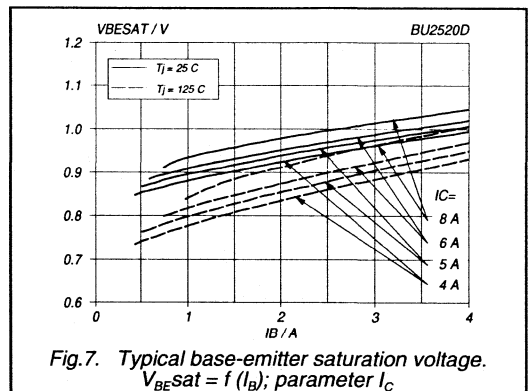
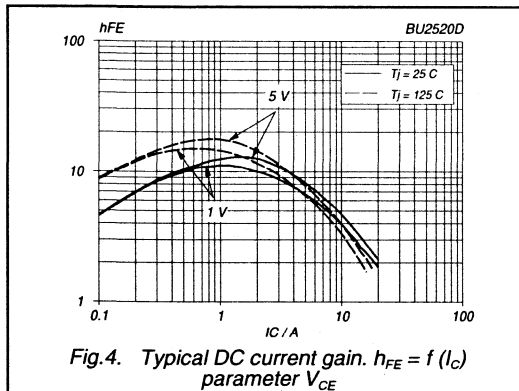
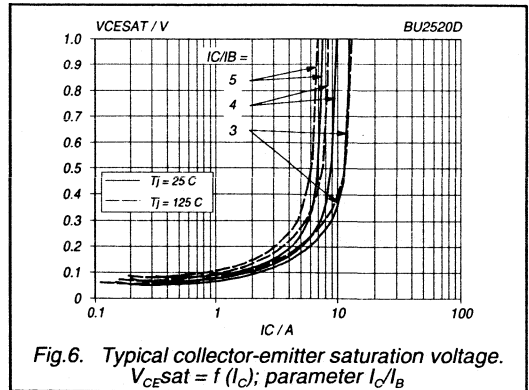
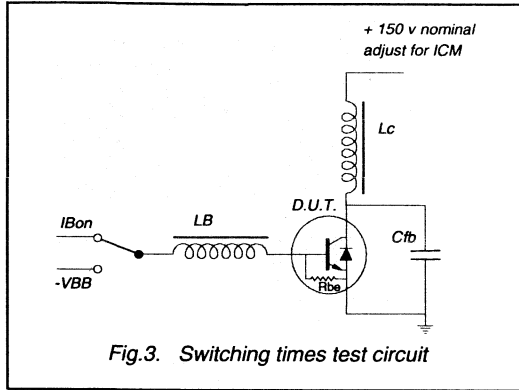
SYMBOL	PARAMETER	CONDITIONS	TYP.	MAX.	UNIT
C_c	Collector capacitance	$I_E = 0\text{ A}; V_{CB} = 10\text{ V}; f = 1\text{ MHz}$	85	-	pF
t_s	Switching times (16 kHz line deflection circuit). Fig.1, Fig.2 and Fig.3	$I_{CM} = 6.0\text{ A}; L_C = 650\text{ }\mu\text{H}; C_{fb} = 19\text{ nF}; I_{B(end)} = 1.0\text{ A}; L_B = 5.3\text{ }\mu\text{H}; -V_{BB} = 4\text{ V}; (-di_B/dt = 0.8\text{ A}/\mu\text{s})$			
t_s	Turn-off storage time		4.5	5.5	μs
t_f	Turn-off fall time		0.35	0.5	μs



² Measured with half sine-wave voltage (curve tracer).

Silicon diffused power transistor

BU2520D



Silicon diffused power transistor

BU2520D

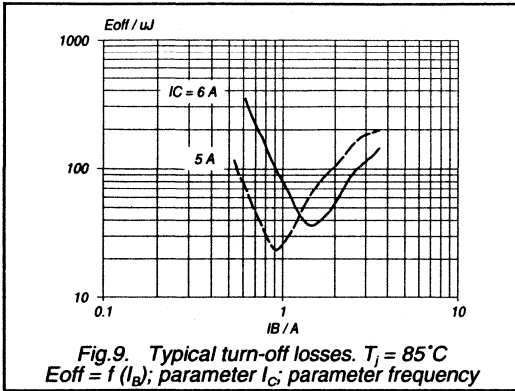


Fig. 9. Typical turn-off losses. $T_j = 85^\circ C$
 $E_{off} = f(I_B)$; parameter I_C ; parameter frequency

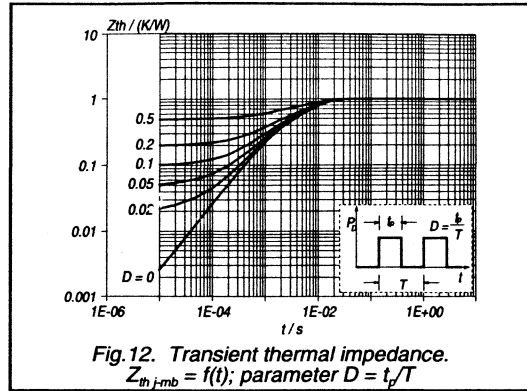


Fig. 12. Transient thermal impedance.
 $Z_{th-j-mb} = f(t)$; parameter $D = t/T$

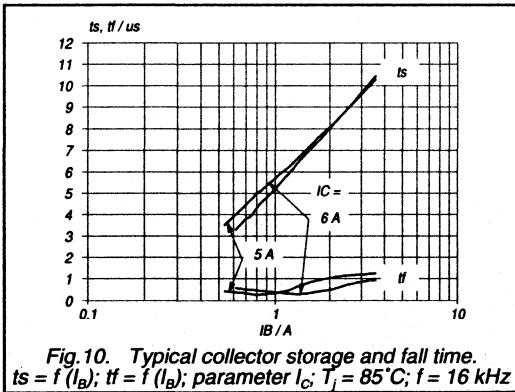


Fig. 10. Typical collector storage and fall time.
 $t_s = f(I_B)$; $t_f = f(I_B)$; parameter I_C ; $T_j = 85^\circ C$; $f = 16 kHz$

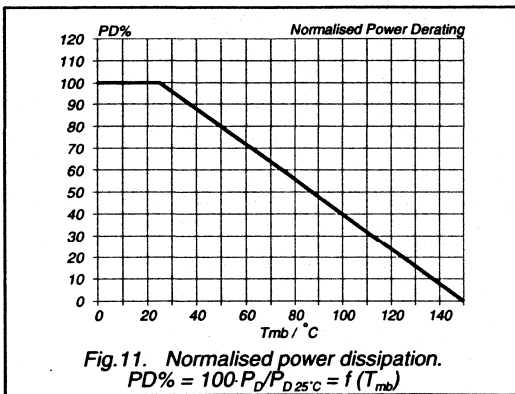


Fig. 11. Normalised power dissipation.
 $PD\% = 100 \cdot P_D / P_{D25^\circ C} = f(T_{mb})$

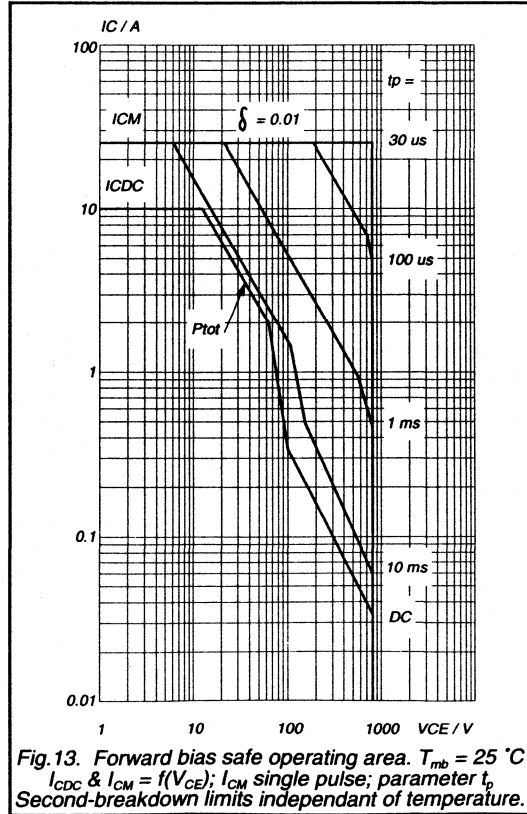
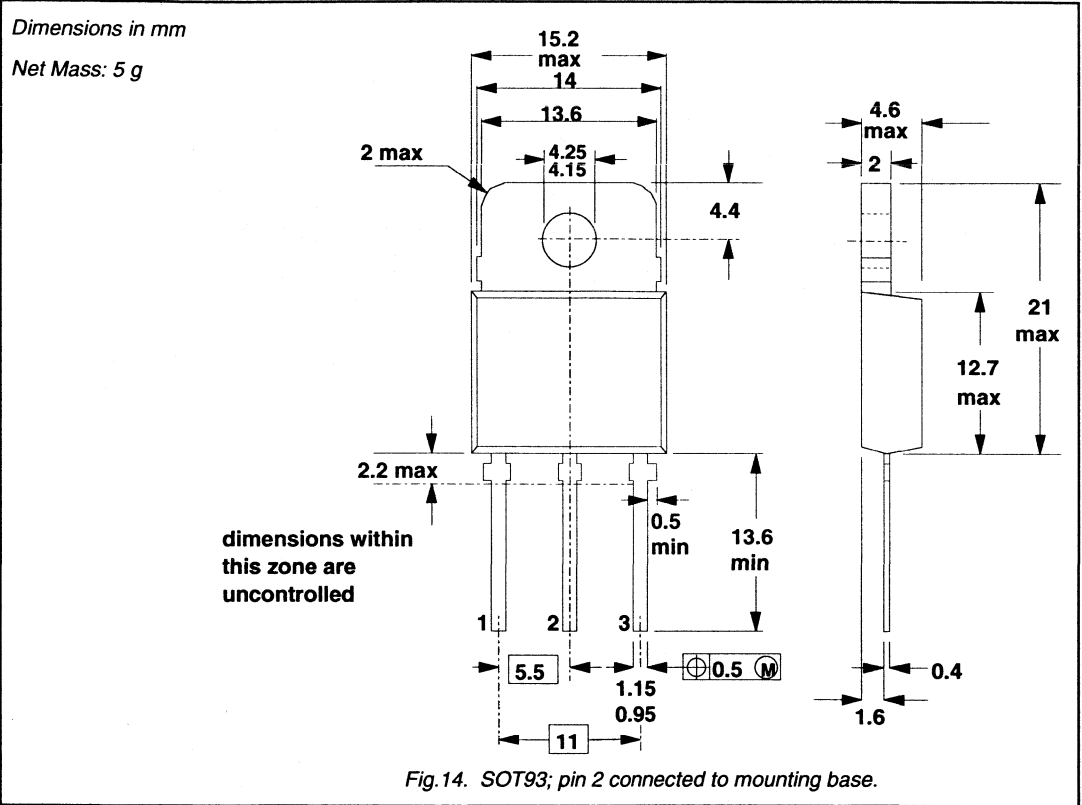


Fig. 13. Forward bias safe operating area. $T_{mb} = 25^\circ C$
 I_{CDC} & $I_{CM} = f(V_{CE})$; I_{CM} single pulse; parameter t_p
 Second-breakdown limits independent of temperature.

Silicon diffused power transistor

BU2520D

MECHANICAL DATA



Notes

1. Accessories supplied on request: refer to mounting instructions for SOT93 envelope.

Silicon diffused power transistor

BU2520DF

GENERAL DESCRIPTION

New generation, high-voltage, high-speed switching npn transistor with an integrated damper diode in a full plastic envelope intended for use in horizontal deflection circuits of large screen colour television receivers.

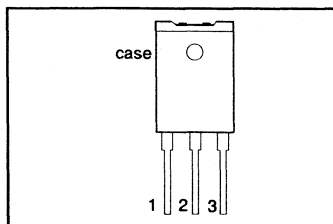
QUICK REFERENCE DATA

SYMBOL	PARAMETER	CONDITIONS	TYP.	MAX.	UNIT
V_{CESM}	Collector-emitter voltage peak value	$V_{BE} = 0 \text{ V}$	-	1500	V
V_{CEO}	Collector-emitter voltage (open base)		-	800	V
I_C	Collector current (DC)		-	10	A
I_{CM}	Collector current peak value		-	25	A
P_{tot}	Total power dissipation	$T_{hs} \leq 25 \text{ }^\circ\text{C}$	-	45	W
V_{CESat}	Collector-emitter saturation voltage	$I_C = 6.0 \text{ A}; I_B = 1.2 \text{ A}$	-	5.0	V
I_{CSat}	Collector saturation current		6	-	A
V_F	Diode forward voltage	$I_F = 6.0 \text{ A}$	-	2.2	V
t_t	Fall time	$I_{CM} = 6.0 \text{ A}; I_{B(on)} = 1.0 \text{ A}$	0.35	-	μs

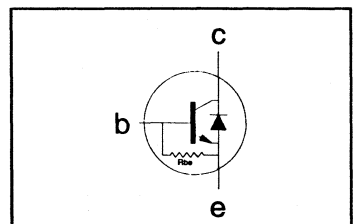
PINNING - SOT199

PIN	DESCRIPTION
1	base
2	collector
3	emitter
case	isolated

PIN CONFIGURATION



SYMBOL



LIMITING VALUES

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

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_{CESM}	Collector-emitter voltage peak value	$V_{BE} = 0 \text{ V}$	-	1500	V
V_{CEO}	Collector-emitter voltage (open base)		-	800	V
I_C	Collector current (DC)		-	10	A
I_{CM}	Collector current peak value		-	25	A
I_B	Base current (DC)		-	6	A
I_{BM}	Base current peak value		-	9	A
$-I_{B(AV)}$	Reverse base current	average over any 20 ms period	-	150	mA
$-I_{B1}$	Reverse base current peak value ¹		-	6	A
P_{tot}	Total power dissipation	$T_{hs} \leq 25 \text{ }^\circ\text{C}$	-	45	W
T_{sig}	Storage temperature		-65	150	$^\circ\text{C}$
T_J	Junction temperature		-	150	$^\circ\text{C}$

THERMAL RESISTANCES

SYMBOL	PARAMETER	CONDITIONS	TYP.	MAX.	UNIT
R_{th-jhs}	Junction to mounting base	-	-	2.8	K/W
R_{th-ja}	Junction to ambient	in free air	35	-	K/W

¹ Turn-off current.

Silicon diffused power transistor

BU2520DF

ISOLATION

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

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
V_{isol}	Repetitive peak voltage from all three terminals to external heatsink	R.H. $\leq 65\%$; clean and dustfree	-	-	2500	V
C_{isol}	Capacitance from T2 to external heatsink	$f = 1\text{ MHz}$	-	22	-	pF

STATIC CHARACTERISTICS

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

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
I_{CES}	Collector cut-off current ²	$V_{BE} = 0\text{ V}$; $V_{CE} = V_{CESMmax}$	-	-	1.0	mA
I_{CES}		$V_{BE} = 0\text{ V}$; $V_{CE} = V_{CESMmax}$ $T_j = 125\text{ }^{\circ}\text{C}$	-	-	2.0	mA
I_{EBO}	Emitter cut-off current	$V_{EB} = 7.5\text{ V}$; $I_C = 0\text{ A}$	100	-	300	mA
R_{be}	Base-emitter resistance	$V_{EB} = 7.5\text{ V}$	-	50	-	Ω
$V_{CEOsust}$	Collector-emitter sustaining voltage	$I_B = 0\text{ A}$; $I_C = 100\text{ mA}$; $L = 25\text{ mH}$	800	-	-	V
V_{CEsat}	Collector-emitter saturation voltage	$I_C = 6.0\text{ A}$; $I_B = 1.2\text{ A}$	-	-	5.0	V
V_{BEsat}	Base-emitter saturation voltage	$I_C = 6.0\text{ A}$; $I_B = 1.2\text{ A}$	-	-	1.3	V
h_{FE}	DC current gain	$I_C = 1.0\text{ A}$; $V_{CE} = 5\text{ V}$	-	-	23	
h_{FE}		$I_C = 6\text{ A}$; $V_{CE} = 5\text{ V}$	5	7	-	
V_F	Diode forward voltage	$I_F = 6\text{ A}$	-	-	2.2	V

DYNAMIC CHARACTERISTICS

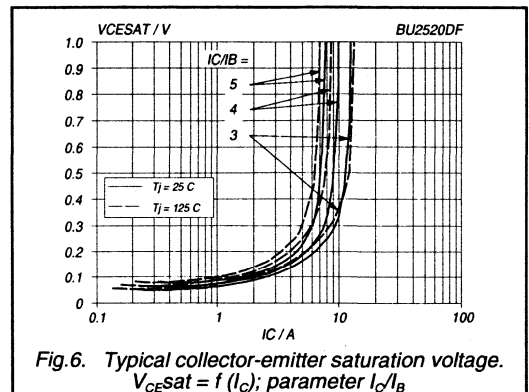
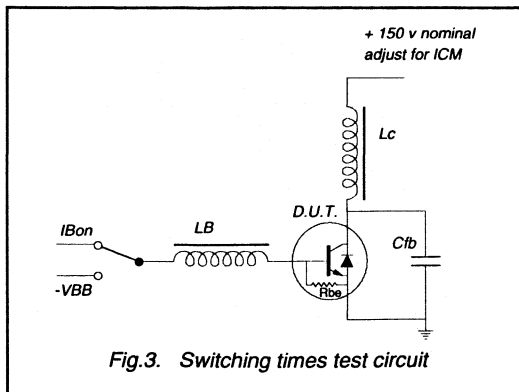
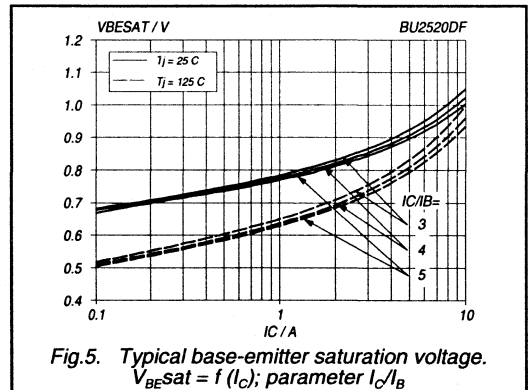
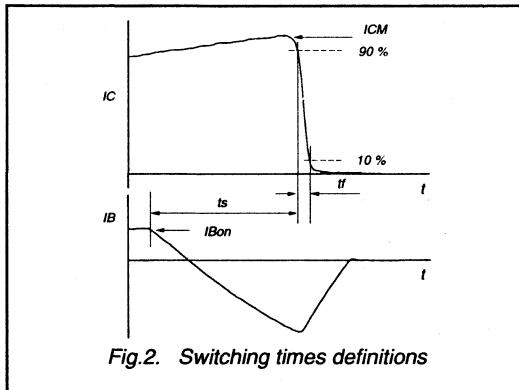
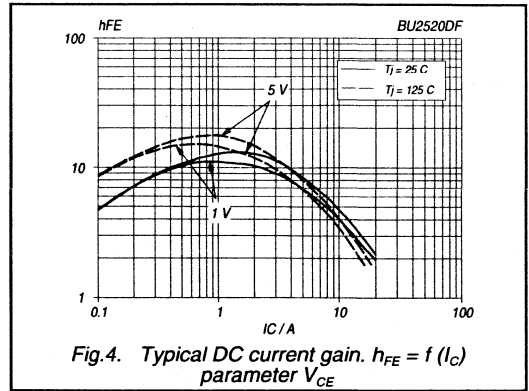
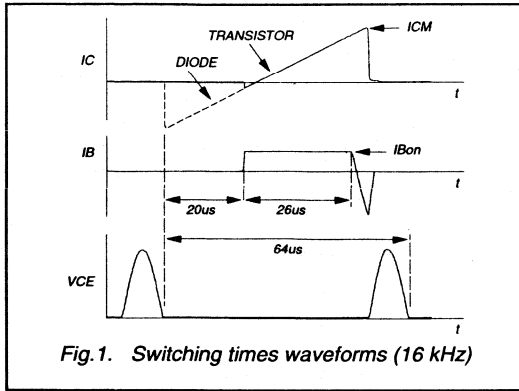
 $T_{mb} = 25\text{ }^{\circ}\text{C}$ unless otherwise specified

SYMBOL	PARAMETER	CONDITIONS	TYP.	MAX.	UNIT
C_c	Collector capacitance	$I_E = 0\text{ A}$; $V_{CB} = 10\text{ V}$; $f = 1\text{ MHz}$	85	-	pF
	Switching times (16 kHz line deflection circuit). Fig.1, Fig.2 and Fig.3	$I_{CM} = 6.0\text{ A}$; $L_C = 650\text{ }\mu\text{H}$; $C_{Tb} = 19\text{ nF}$; $I_{B(end)} = 1.0\text{ A}$; $L_B = 5.3\text{ }\mu\text{H}$; $-V_{BB} = 4\text{ V}$; ($-di_B/dt = 0.8\text{ A}/\mu\text{s}$)			
t_s	Turn-off storage time		4.5	5.5	μs
t_f	Turn-off fall time		0.35	0.5	μs

2 Measured with half sine-wave voltage (curve tracer).

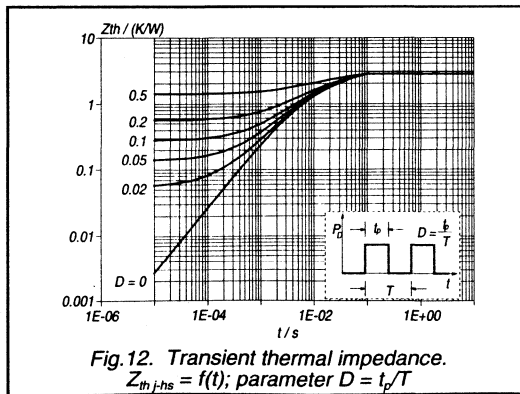
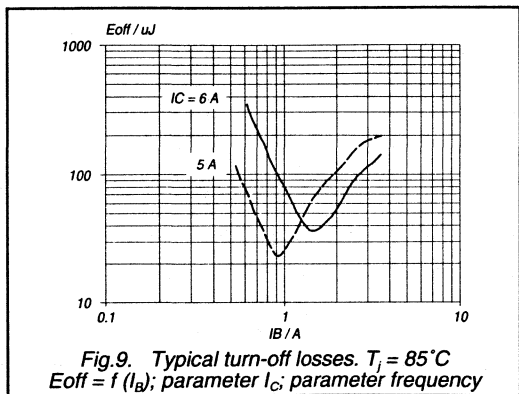
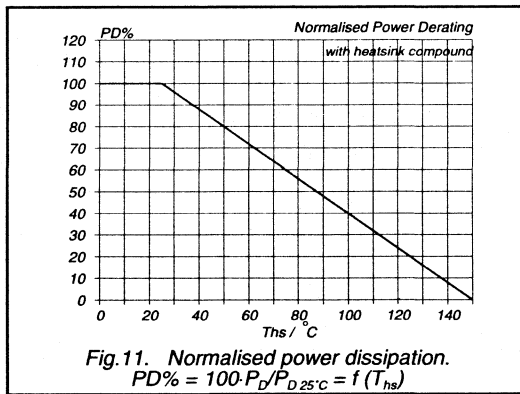
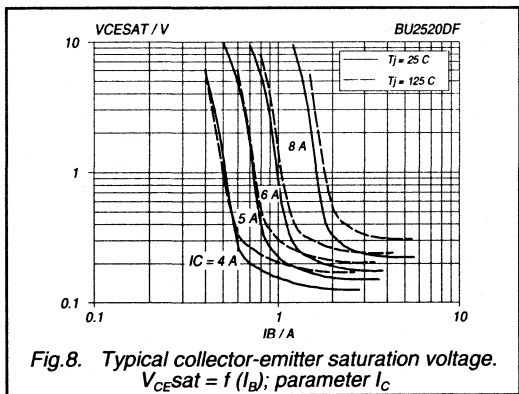
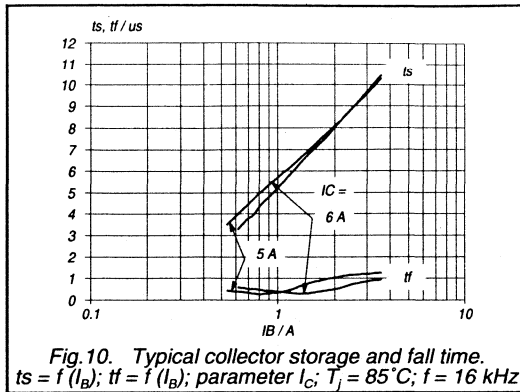
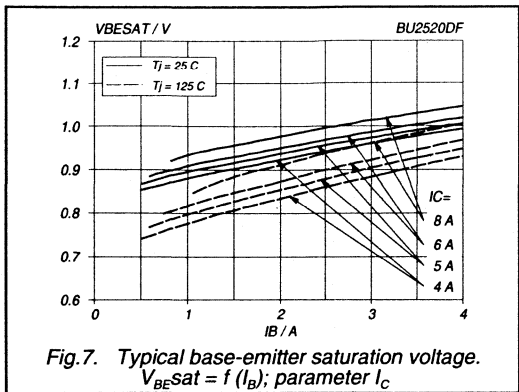
Silicon diffused power transistor

BU2520DF



Silicon diffused power transistor

BU2520DF



Silicon diffused power transistor

BU2520DF

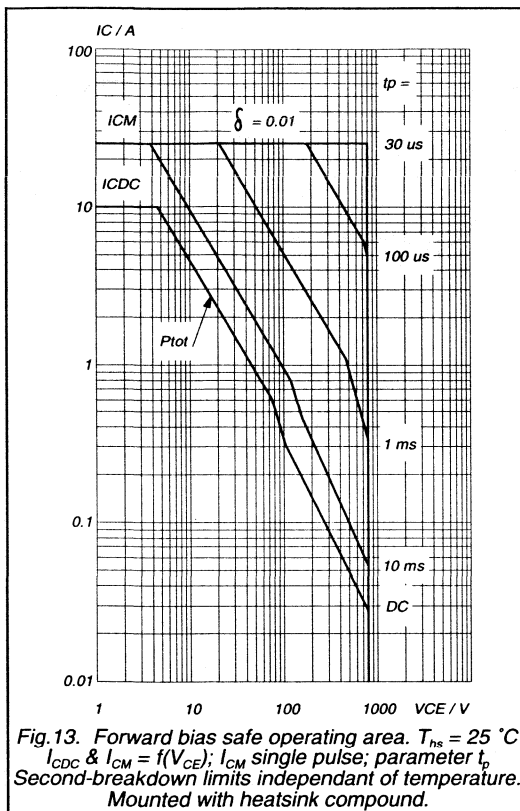
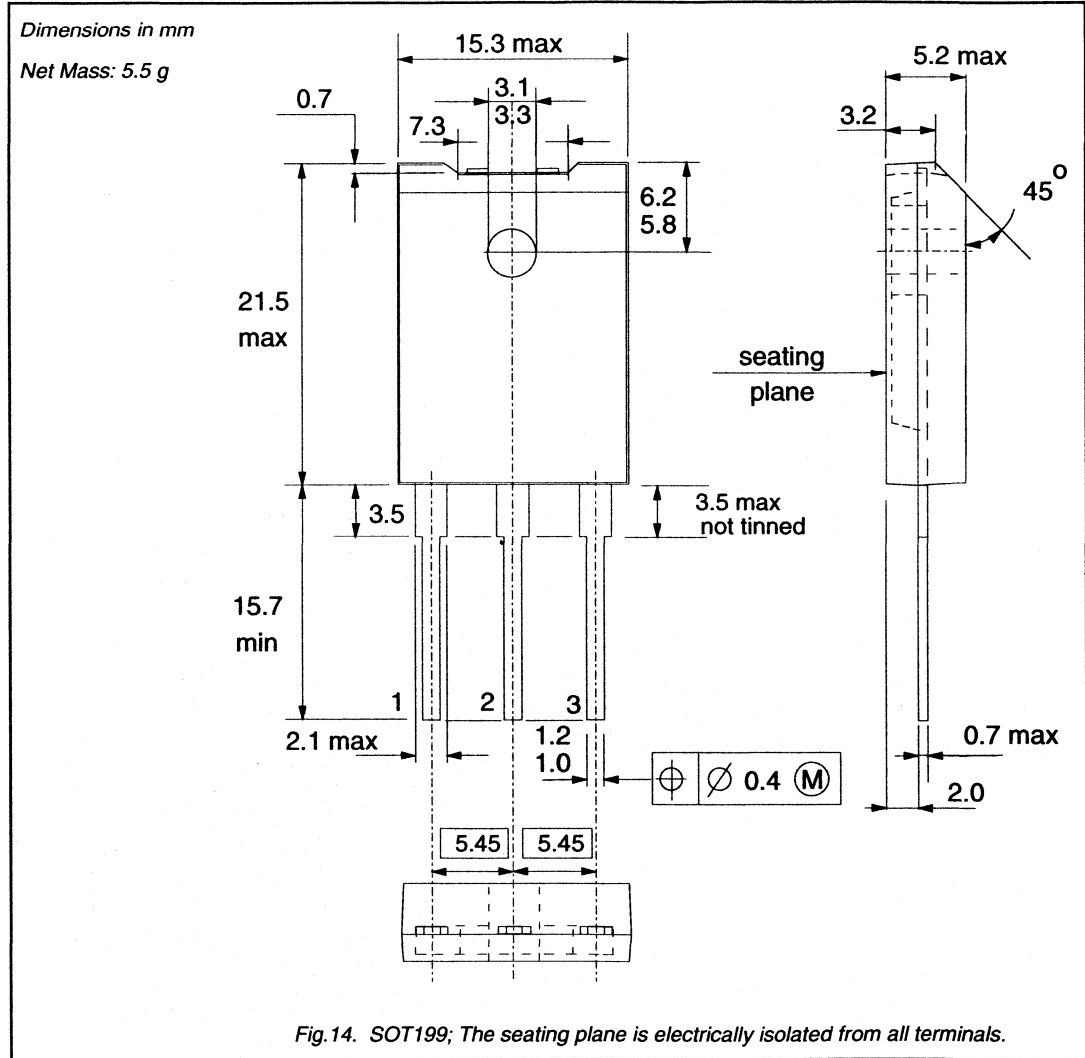


Fig.13. Forward bias safe operating area. $T_{hs} = 25^\circ C$
 I_{CDC} & $I_{CM} = f(V_{CE})$; I_{CM} single pulse; parameter t_p
 Second-breakdown limits independent of temperature.
 Mounted with heatsink compound.

Silicon diffused power transistor

BU2520DF

MECHANICAL DATA



Notes

- 1. Accessories supplied on request: refer to mounting instructions for F-pack envelopes.

Silicon Diffused Power Transistor

BU2525A

GENERAL DESCRIPTION

New generation, high-voltage, high-speed switching npn transistor in a plastic envelope intended for use in horizontal deflection circuits of large screen colour television receivers up to 32 kHz.

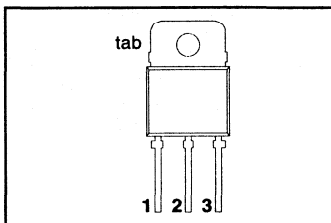
QUICK REFERENCE DATA

SYMBOL	PARAMETER	CONDITIONS	TYP.	MAX.	UNIT
V_{CESM}	Collector-emitter voltage peak value	$V_{BE} = 0$	-	1500	V
V_{CEO}	Collector-emitter voltage (open base)		-	800	V
I_C	Collector current (DC)		-	12	A
I_{CM}	Collector current peak value		-	30	A
P_{tot}	Total power dissipation	$T_{mb} \leq 25^\circ\text{C}$	-	125	W
V_{CEsat}	Collector-emitter saturation voltage	$I_C = 8.0\text{ A}; I_B = 1.6\text{ A}$	-	5.0	V
I_{Csat}	Collector saturation current		8	-	A
t_f	Fall time	$I_{CM} = 8.0\text{ A}; I_{B(on)} = 1.1\text{ A}$	0.2	-	μs

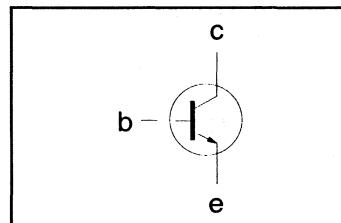
PINNING - SOT93

PIN	DESCRIPTION
1	base
2	collector
3	emitter
tab	collector

PIN CONFIGURATION



SYMBOL



LIMITING VALUES

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

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_{CESM}	Collector-emitter voltage peak value	$V_{BE} = 0\text{ V}$	-	1500	V
V_{CEO}	Collector-emitter voltage (open base)		-	800	V
I_C	Collector current (DC)		-	12	A
I_{CM}	Collector current peak value		-	30	A
I_B	Base current (DC)		-	8	A
I_{BM}	Base current peak value		-	12	A
$-I_{B(AV)}$	Reverse base current	average over any 20 ms period	-	200	mA
$-I_{BM}$	Reverse base current peak value ¹		-	7	A
P_{tot}	Total power dissipation	$T_{mb} \leq 25^\circ\text{C}$	-	125	W
T_{stg}	Storage temperature		-65	150	$^\circ\text{C}$
T_j	Junction temperature		-	150	$^\circ\text{C}$

THERMAL RESISTANCES

SYMBOL	PARAMETER	CONDITIONS	TYP.	MAX.	UNIT
$R_{th\ j-mb}$	Junction to mounting base	-	-	1.0	K/W
$R_{th\ j-a}$	Junction to ambient	in free air	45	-	K/W

¹ Turn-off current.

Silicon Diffused Power Transistor

BU2525A

STATIC CHARACTERISTICS

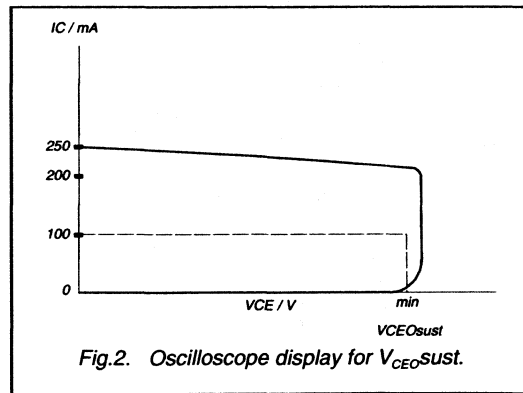
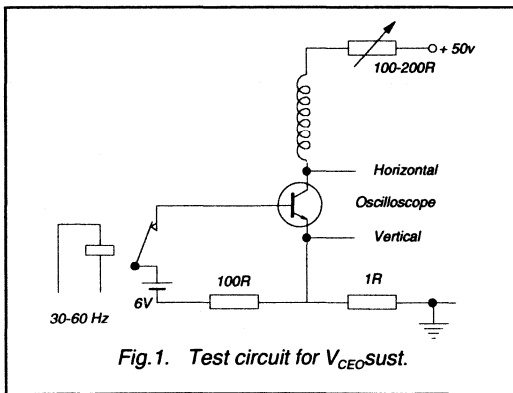
$T_{mb} = 25\text{ }^\circ\text{C}$ unless otherwise specified

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
I_{CES}	Collector cut-off current ²	$V_{BE} = 0\text{ V}; V_{CE} = V_{CESMmax}$	-	-	1.0	mA
I_{CES}		$V_{BE} = 0\text{ V}; V_{CE} = V_{CESMmax}; T_j = 125\text{ }^\circ\text{C}$	-	-	2.0	mA
I_{EBO}	Emitter cut-off current	$V_{EB} = 7.5\text{ V}; I_C = 0\text{ A}$	-	-	1.0	mA
$V_{CEOsust}$	Collector-emitter sustaining voltage Fig.1 and Fig.2	$I_B = 0\text{ A}; I_C = 100\text{ mA}; L = 25\text{ mH}$	800	-	-	V
V_{CEsat}	Collector-emitter saturation voltage	$I_C = 8.0\text{ A}; I_B = 1.6\text{ A}$	-	-	5.0	V
V_{BEsat}	Base-emitter saturation voltage	$I_C = 8.0\text{ A}; I_B = 1.6\text{ A}$	-	-	1.3	V
β_{FE}	DC current gain	$I_C = 100\text{ mA}; V_{CE} = 5\text{ V}$	6	13	26	
β_{FE}		$I_C = 8\text{ A}; V_{CE} = 5\text{ V}$	5	7	-	

DYNAMIC CHARACTERISTICS

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

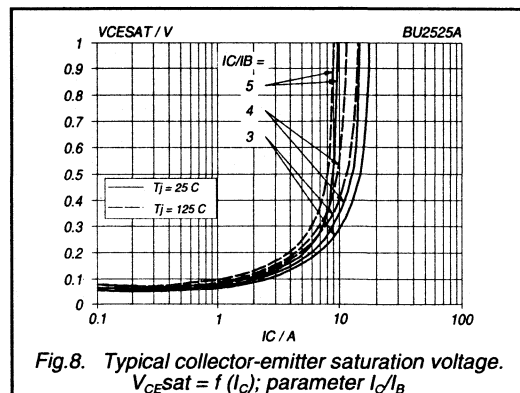
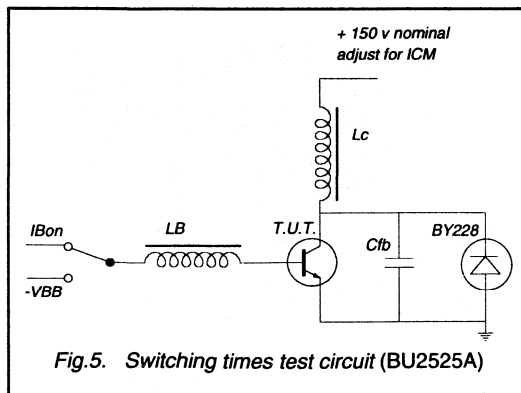
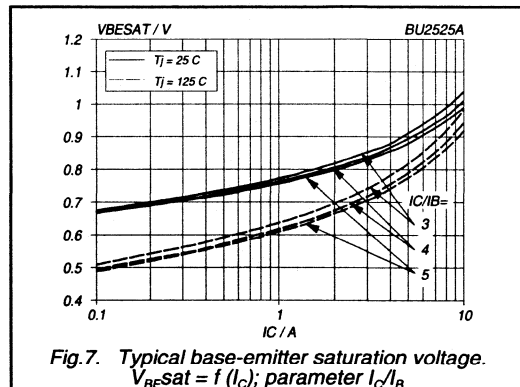
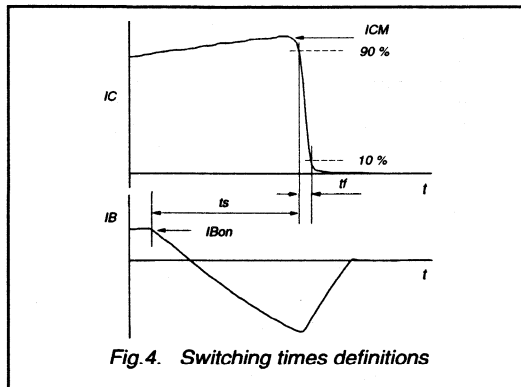
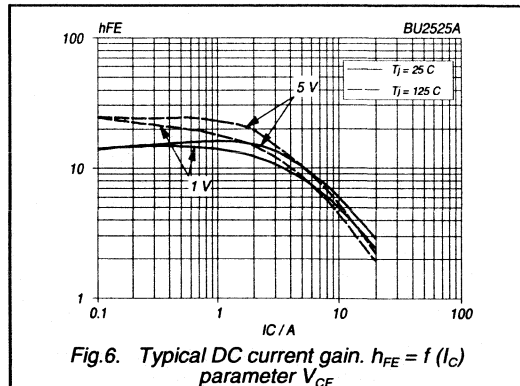
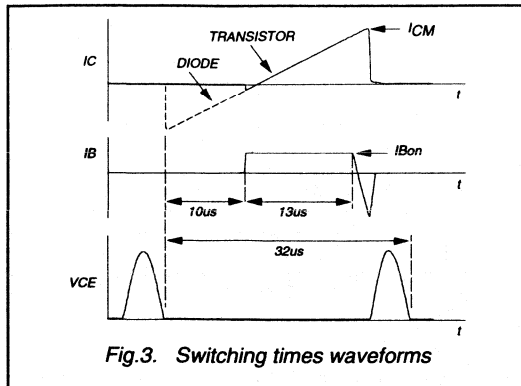
SYMBOL	PARAMETER	CONDITIONS	TYP.	MAX.	UNIT
C_c	Collector capacitance	$I_E = 0\text{ A}; V_{CB} = 10\text{ V}; f = 1\text{ MHz}$	145	-	pF
t_s	Switching times (32 kHz line deflection circuit) Fig.3, Fig.4 and Fig.5	$I_{CM} = 8.0\text{ A}; L_C = 260\text{ }\mu\text{H}; C_{Tb} = 13\text{ nF}; I_{B(end)} = 1.1\text{ A}; L_B = 2.5\text{ }\mu\text{H}; -V_{BB} = 4\text{ V}; (-di_B/dt = 1.6\text{ A}/\mu\text{s})$			
t_f			Turn-off storage time	3.0	4.0
t_f	Turn-off fall time		0.2	0.35	μs



² Measured with half sine-wave voltage (curve tracer).

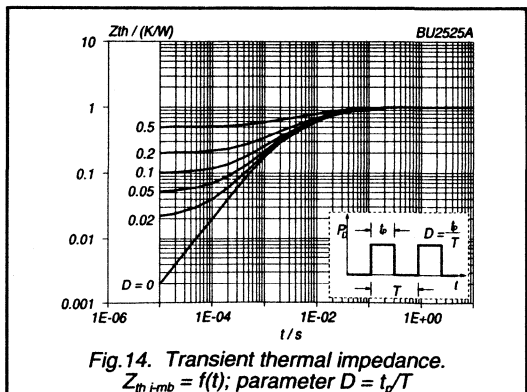
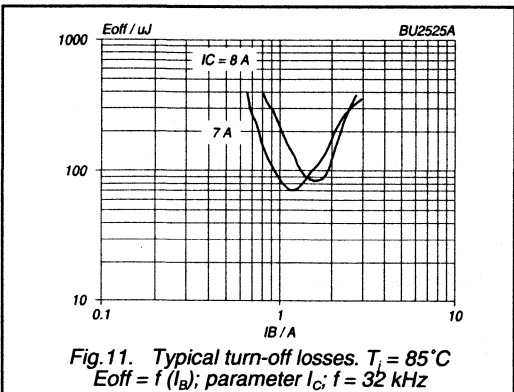
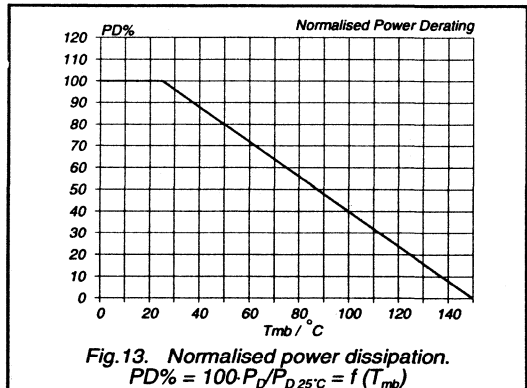
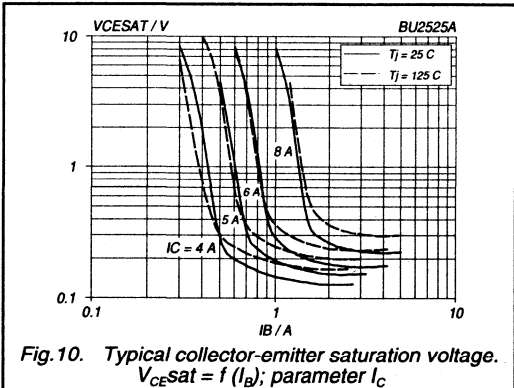
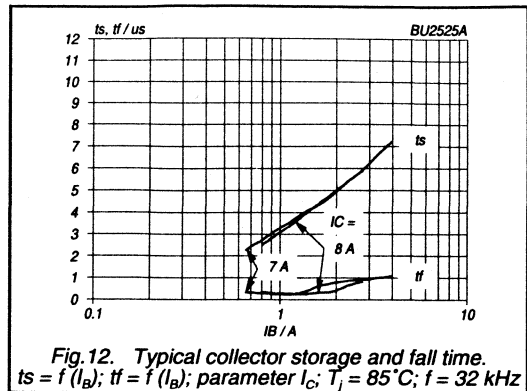
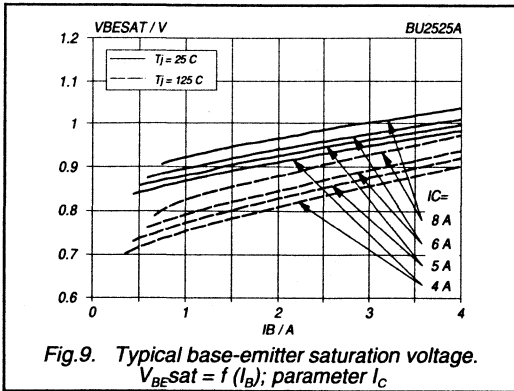
Silicon Diffused Power Transistor

BU2525A



Silicon Diffused Power Transistor

BU2525A



Silicon Diffused Power Transistor

BU2525A

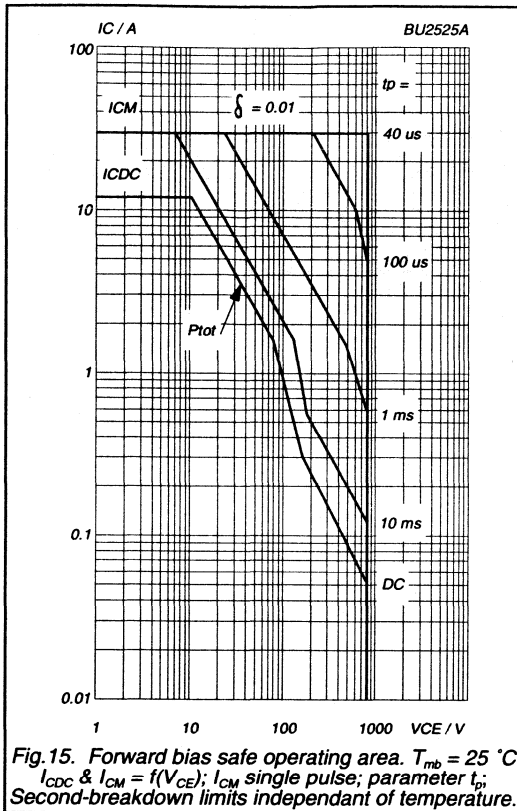
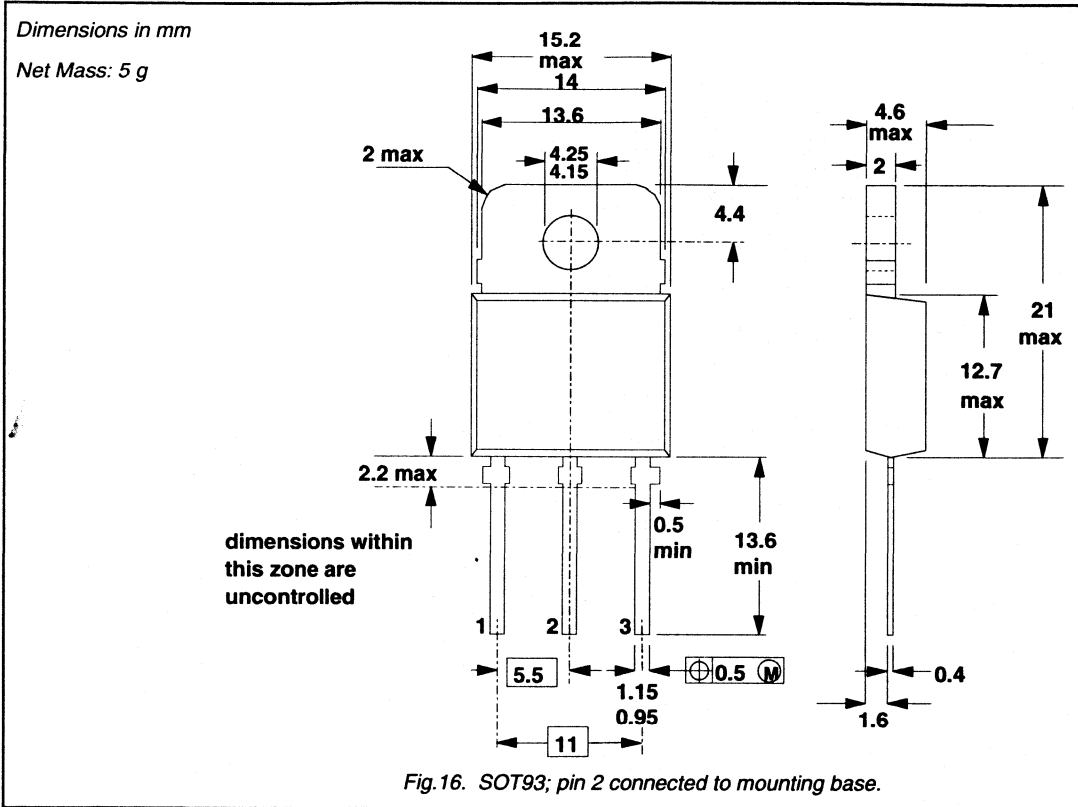


Fig.15. Forward bias safe operating area. $T_{mb} = 25\text{ }^\circ\text{C}$
 I_{CDC} & $I_{CM} = f(V_{CE})$; I_{CM} single pulse; parameter t_p ;
 Second-breakdown limits independent of temperature.

Silicon Diffused Power Transistor

BU2525A

MECHANICAL DATA



Notes

1. Accessories supplied on request: refer to mounting instructions for SOT93 envelope.

Silicon Diffused Power Transistor

BU2525AF

GENERAL DESCRIPTION

New generation, high-voltage, high-speed switching npn transistor in a plastic full-pack envelope intended for use in horizontal deflection circuits of large screen colour television receivers up to 32 kHz.

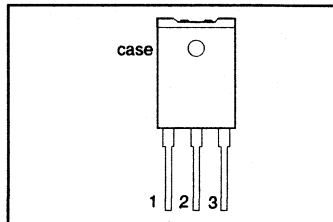
QUICK REFERENCE DATA

SYMBOL	PARAMETER	CONDITIONS	TYP.	MAX.	UNIT
V_{CESM}	Collector-emitter voltage peak value	$V_{BE} = 0 \text{ V}$	-	1500	V
V_{CEO}	Collector-emitter voltage (open base)		-	800	V
I_C	Collector current (DC)		-	12	A
I_{CM}	Collector current peak value		-	30	A
P_{tot}	Total power dissipation	$T_{hs} \leq 25 \text{ }^\circ\text{C}$	-	45	W
V_{CEsat}	Collector-emitter saturation voltage	$I_C = 8.0 \text{ A}; I_B = 1.6 \text{ A}$	-	5.0	V
I_{Csat}	Collector saturation current		8.0	-	A
t_f	Fall time	$I_{CM} = 8.0 \text{ A}; I_{B(on)} = 1.1 \text{ A}$	0.2	-	μs

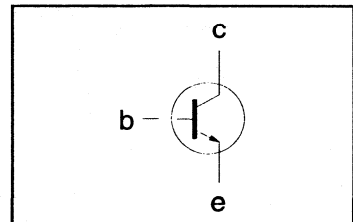
PINNING - SOT199

PIN	DESCRIPTION
1	base
2	collector
3	emitter
case	isolated

PIN CONFIGURATION



SYMBOL



LIMITING VALUES

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

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_{CESM}	Collector-emitter voltage peak value	$V_{BE} = 0 \text{ V}$	-	1500	V
V_{CEO}	Collector-emitter voltage (open base)		-	800	V
I_C	Collector current (DC)		-	12	A
I_{CM}	Collector current peak value		-	30	A
I_B	Base current (DC)		-	8	A
I_{BM}	Base current peak value		-	12	A
$-I_{B(AV)}$	Reverse base current	average over any 20 ms period	-	200	mA
$-I_{BM}$	Reverse base current peak value ¹		-	7	A
P_{tot}	Total power dissipation	$T_{hs} \leq 25 \text{ }^\circ\text{C}$	-	45	W
T_{stg}	Storage temperature		-65	150	$^\circ\text{C}$
T_j	Junction temperature		-	150	$^\circ\text{C}$

THERMAL RESISTANCES

SYMBOL	PARAMETER	CONDITIONS	TYP.	MAX.	UNIT
$R_{th\ jhs}$	Junction to heatsink	without heatsink compound	-	3.7	K/W
$R_{th\ jhs}$	Junction to heatsink	with heatsink compound	-	2.8	K/W
$R_{th\ ja}$	Junction to ambient	in free air	35	-	K/W

¹ Turn-off current.

Silicon Diffused Power Transistor

BU2525AF

ISOLATION

T_{hs} = 25 °C unless otherwise specified

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
V _{isol}	Repetitive peak voltage from all three terminals to external heatsink	R.H. ≤ 65 % ; clean and dustfree	-	-	2500	V
C _{isol}	Capacitance from T2 to external heatsink	f = 1 MHz	-	22	-	pF

STATIC CHARACTERISTICS

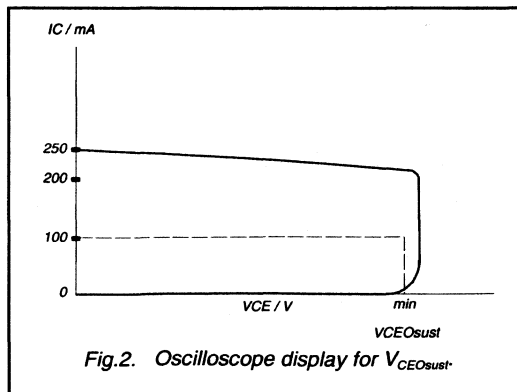
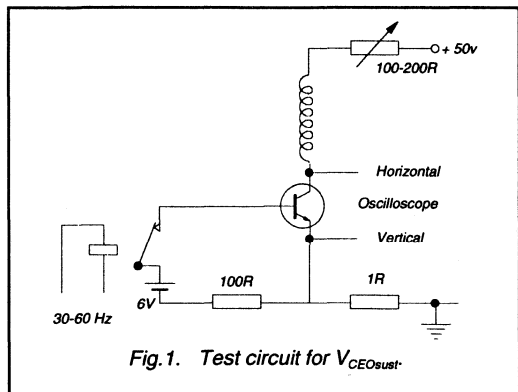
T_{hs} = 25 °C unless otherwise specified

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
I _{CES}	Collector cut-off current ²	V _{BE} = 0 V; V _{CE} = V _{CESMmax}	-	-	1.0	mA
I _{ES}	Emitter cut-off current	V _{BE} = 0 V; V _{CE} = V _{CESMmax} ; T _j = 125 °C	-	-	2.0	mA
I _{EBO}	Collector-emitter sustaining voltage	V _{EB} = 7.5 V; I _C = 0 A	-	-	1.0	mA
V _{CEOsust}	Collector-emitter sustaining voltage Fig.1 and Fig.2	I _B = 0 A; I _C = 100 mA; L = 25 mH	800	-	-	V
V _{CEsat}	Collector-emitter saturation voltage	I _C = 8.0 A; I _B = 1.6 A	-	-	5.0	V
V _{BEsat}	Base-emitter saturation voltage	I _C = 8.0 A; I _B = 1.6 A	-	-	1.3	V
h _{FE}	DC current gain	I _C = 100 mA; V _{CE} = 5 V	6	13	26	
h _{FE}		I _C = 8 A; V _{CE} = 5 V	5	7	-	

DYNAMIC CHARACTERISTICS

T_{hs} = 25 °C unless otherwise specified

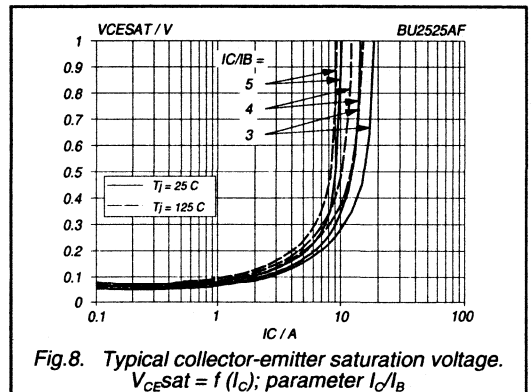
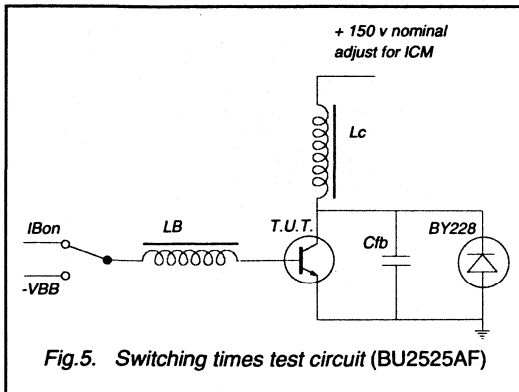
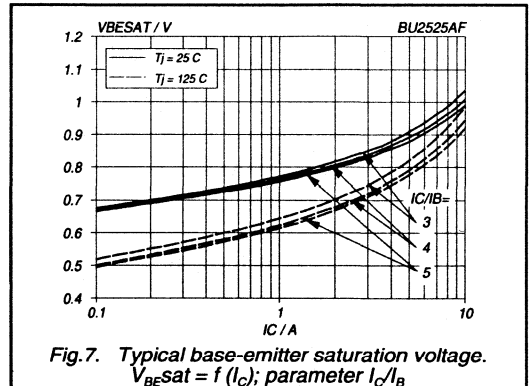
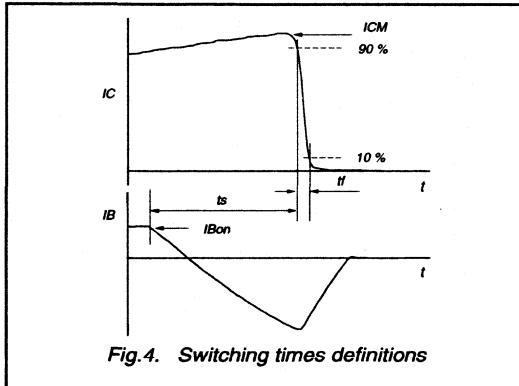
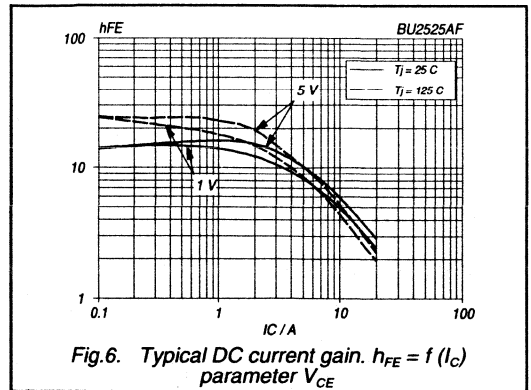
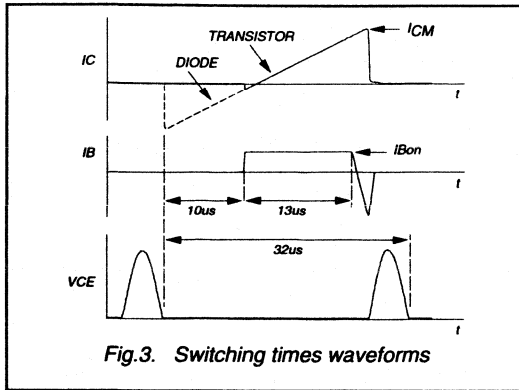
SYMBOL	PARAMETER	CONDITIONS	TYP.	MAX.	UNIT
C _c	Collector capacitance	I _E = 0 A; V _{CB} = 10 V; f = 1 MHz	145	-	pF
t _s	Switching times (32 kHz line deflection circuit) Fig.3, Fig.4 and Fig.5	I _{CM} = 8.0 A; L _C = 260 μH; C _{tb} = 13 nF; I _{B(end)} = 1.1 A; L _B = 2.5 μH; -V _{BB} = 4 V; (-di _B /dt = 1.6 A/μs)			
t _f	Turn-off storage time		3.0	4.0	μs
t _f	Turn-off fall time		0.2	0.35	μs



2 Measured with half sine-wave voltage (curve tracer).

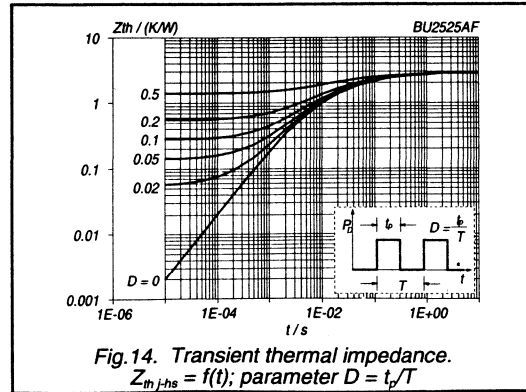
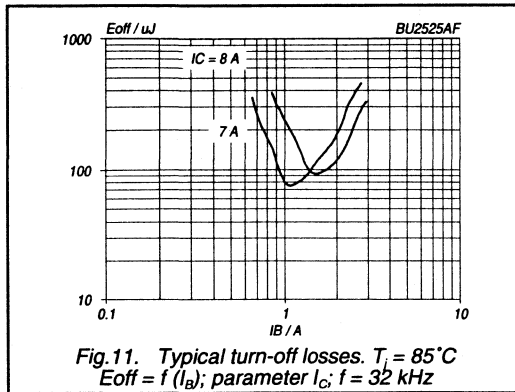
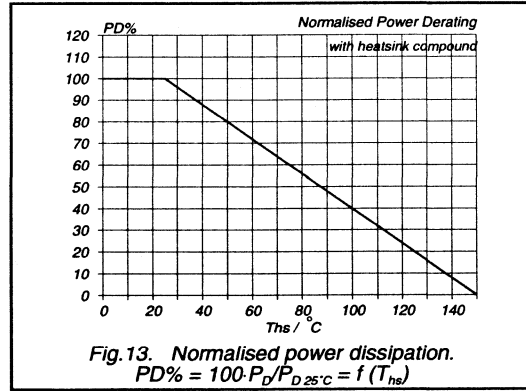
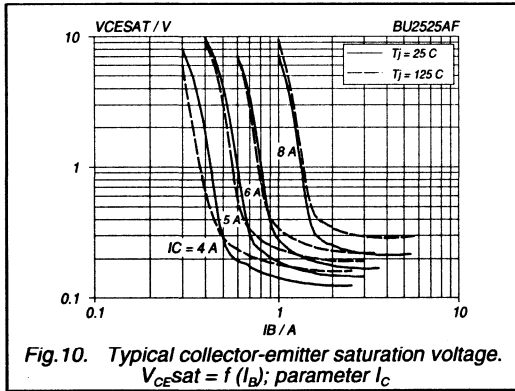
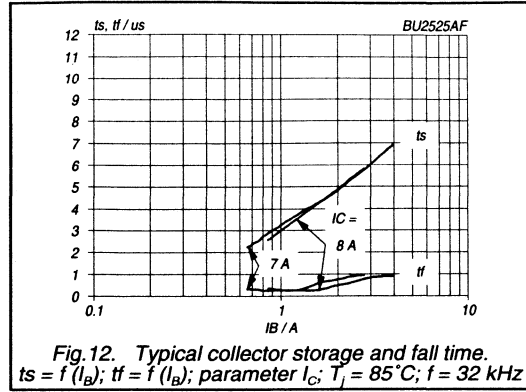
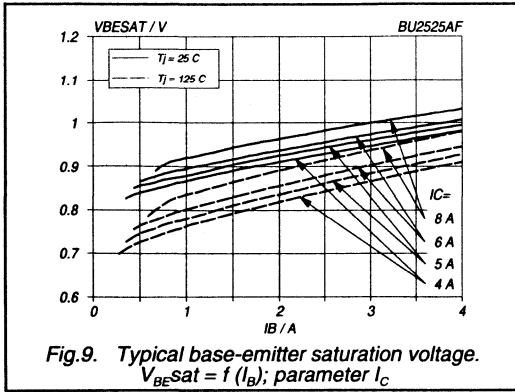
Silicon Diffused Power Transistor

BU2525AF



Silicon Diffused Power Transistor

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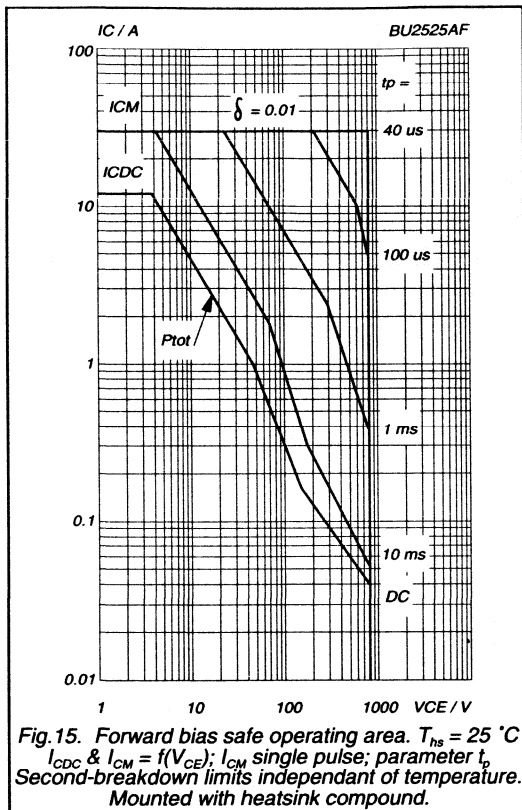
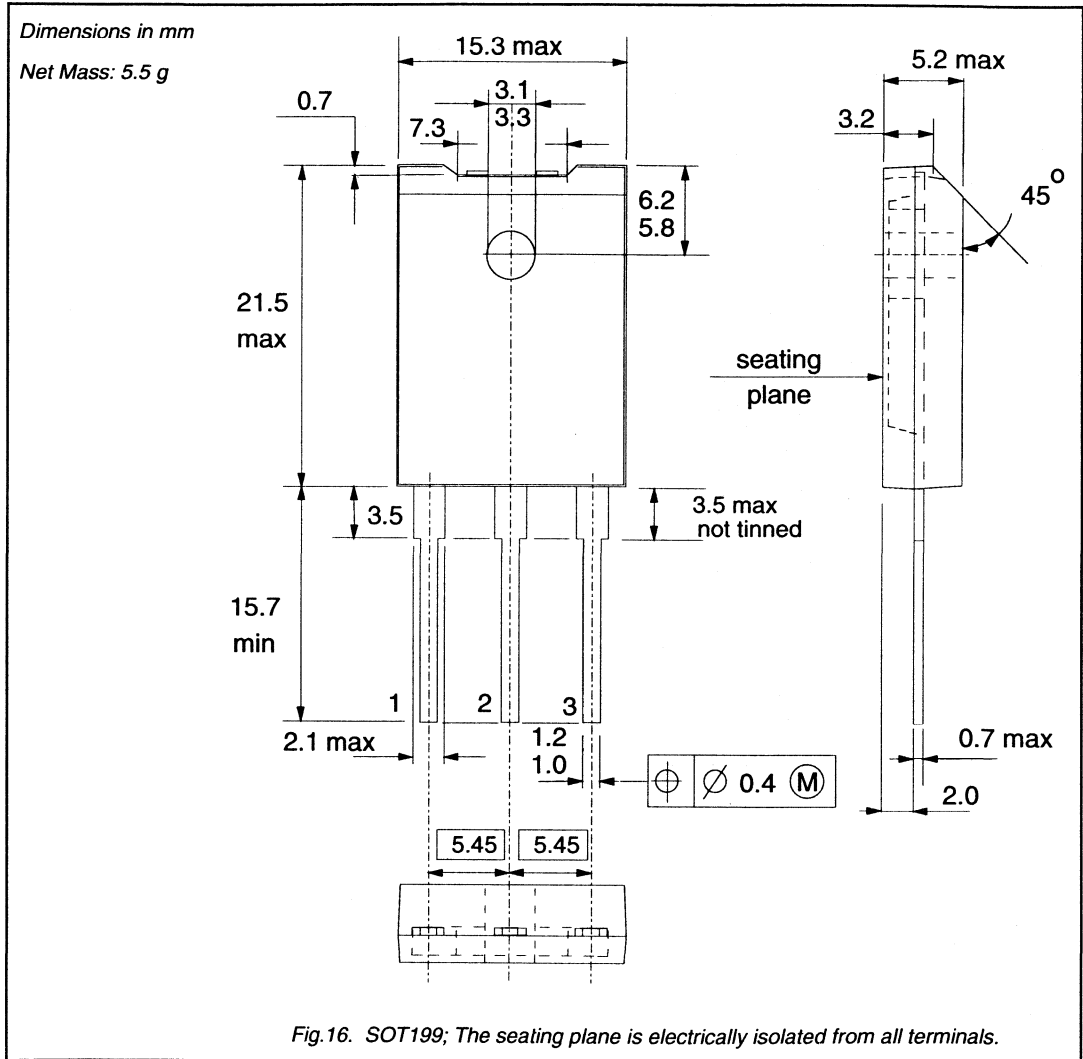


Fig.15. Forward bias safe operating area. $T_{hs} = 25\text{ }^\circ\text{C}$
 I_{CDC} & $I_{CM} = f(V_{CE})$; I_{CM} single pulse; parameter t_p
 Second-breakdown limits independant of temperature.
 Mounted with heatsink compound.

Silicon Diffused Power Transistor

BU2525AF

MECHANICAL DATA



Notes

1. Accessories supplied on request: refer to mounting instructions for F-pack envelopes.

SILICON DIFFUSED POWER TRANSISTORS

High-voltage, high-speed, glass-passivated npn power transistors in a TO-220 envelope, intended for use in converters, inverters, switching regulators, motor control systems etc.

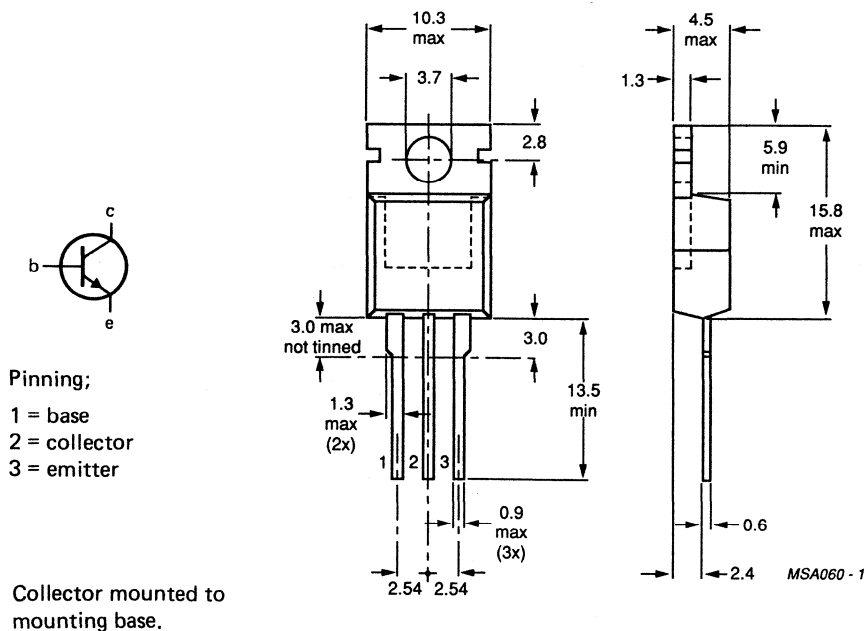
QUICK REFERENCE DATA

		BUT11	BUT11A
Collector-emitter voltage (peak value; $V_{BE} = 0$)	V_{CESM}	max. 850	1000 V
Collector-emitter voltage (open base)	V_{CEO}	max. 400	450 V
Collector-emitter saturation voltage	V_{CEsat}	max. 1,5	V
Collector current (DC)	I_C	max. 5	A
Collector current (peak value)	I_{CM}	max. 10	A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max. 100	W
Fall time	t_f	max. 0,8	μs

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-220AB.



RATINGS

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

		BUT11	BUT11A
Collector-emitter voltage (peak value, $V_{BE} = 0$)	V_{CESM} max.	850	1000 V
Collector-emitter voltage (open base)	V_{CEO} max.	400	450 V
Collector current (DC)	I_C max.	5	A
Collector current (peak value) $t_p < 2$ ms	I_{CM} max.	10	A
Base current (DC)	I_B max.	2	A
Base current (peak value); $t_p < 2$ ms	I_{BM} max.	4	A
Total power dissipation up to $T_{mb} = 25$ °C	P_{tot} max.	100	W
Storage temperature range	T_{stg}	-65 to +150	°C
Junction temperature	T_j max.	150	°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th j-mb} =$	1,25	K/W
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CHARACTERISTICS

$T_j = 25$ °C unless otherwise specified

Collector cut-off current *

$V_{CE} = V_{CESMmax}; V_{BE} = 0$	I_{CES} max.	1	mA
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$V_{CE} = V_{CESMmax}; V_{BE} = 0; T_j = 125$ °C	I_{CES} max.	2	mA
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Emitter cut-off current

$I_C = 0; V_{EB} = 9$ V	I_{EBO} max.	10	mA
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Saturation voltages

$I_C = 3$ A; $I_B = 0,6$ A	V_{CEsat} max.	1,5	- V
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	V_{BEsat} max.	1,3	- V
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$I_C = 2,5$ A; $I_B = 0,5$ A	V_{CEsat} max.	-	1,5 V
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	V_{BEsat} max.	-	1,3 V
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Collector-emitter sustaining voltage

$I_C = 100$ mA; $I_{Boff} = 0; L = 25$ mH	$V_{CEO_{sust}min.}$	400	450 V
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DC current gain

$I_C = 5$ mA; $V_{CE} = 5$ V	h_{FE} min.	10	
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	h_{FE} typ.	18	
--	---------------	----	--

	h_{FE} max.	35	
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$I_C = 500$ mA; $V_{CE} = 5$ V	h_{FE} min.	10	
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	h_{FE} typ.	20	
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	h_{FE} max.	35	
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* Measured with a half-sinewave voltage (curve tracer).

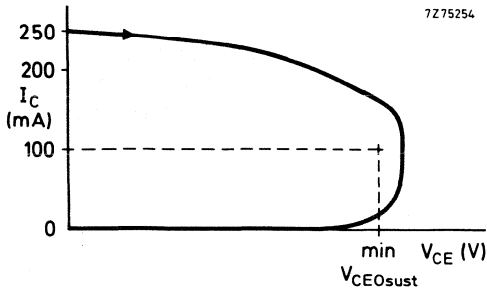


Fig. 2 Oscilloscope display for sustaining voltage.

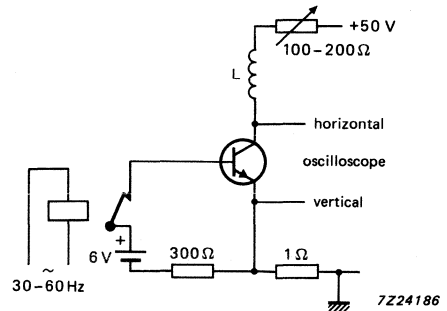


Fig. 3 Test circuit for $V_{CE0sust}$.

Switching times resistive load (Figs 4 and 5)

$I_{Con} = 3 \text{ A}; I_{Bon} = -I_{Boff} = 0,6 \text{ A}$

Turn-on time

Turn-off: Storage time
Fall time

$I_{Con} = 2,5 \text{ A}; I_{Bon} = -I_{Boff} = 0,5 \text{ A}$

Turn-on time

Turn-off: Storage time
Fall time

Switching times inductive load (Figs 6 and 7)

$I_{Con} = 3 \text{ A}; I_B = 0,6 \text{ A}$

Turn-off: Storage time

Fall time

$I_{Con} = 3 \text{ A}; I_B = 0,6 \text{ A}; T_j = 100 \text{ }^\circ\text{C}$

Turn-off: Storage time

Fall time

Switching times inductive load (Figs 6 and 7)

$I_{Con} = 2,5 \text{ A}; I_B = 0,5 \text{ A}$

Turn-off: Storage time

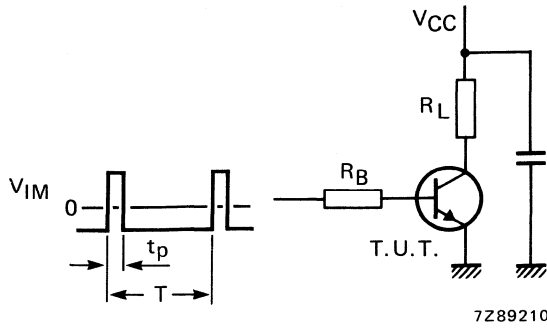
Fall time

$I_{Con} = 2,5 \text{ A}; I_B = 0,5 \text{ A}; T_j = 100 \text{ }^\circ\text{C}$

Turn-off: Storage time

Fall time

		BUT11	BUT11A
t_{on}	max.	1	— μs
t_s	max.	4	— μs
t_f	max.	0,8	— μs
t_{on}	max.	—	1 μs
t_s	max.	—	4 μs
t_f	max.	—	0,8 μs
t_s	typ.	1,1	— μs
	max.	1,4	— μs
t_f	typ.	80	— ns
	max.	150	— ns
t_s	typ.	1,2	— μs
	max.	1,5	— μs
t_f	typ.	140	— ns
	max.	300	— ns
t_s	typ.	—	1,1 μs
	max.	—	1,4 μs
t_f	typ.	—	80 ns
	max.	—	150 ns
t_s	typ.	—	1,2 μs
	max.	—	1,5 μs
t_f	typ.	—	140 ns
	max.	—	300 ns



$V_{CC} = 250 \text{ V}$
 $V_{IM} = -6 \text{ to } +8 \text{ V}$
 $\frac{t_p}{T} = 0,01$
 $t_p = 20 \mu\text{s}$

The values of R_B and R_L are selected in accordance with I_{Con} and I_B requirements.

Fig. 4 Test circuit resistive load.

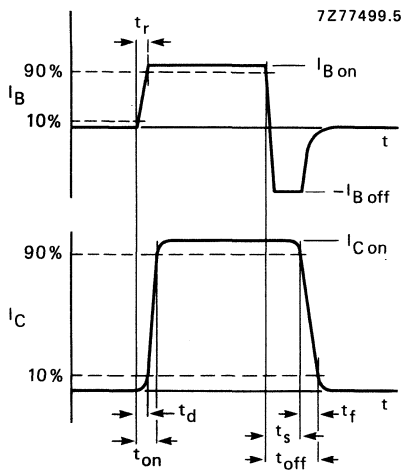


Fig. 5 Switching times waveforms with resistive load.

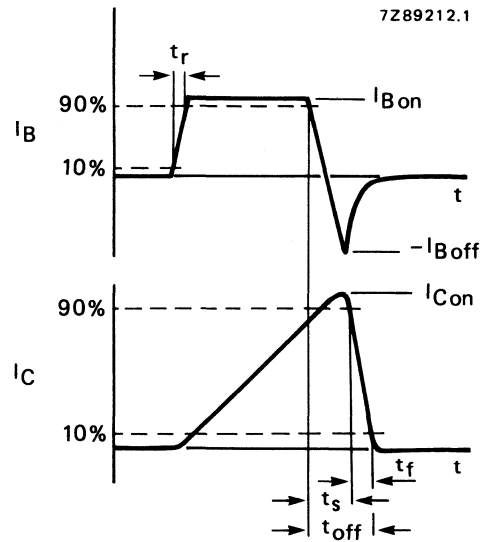
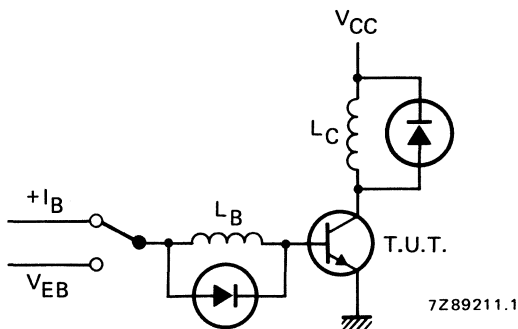
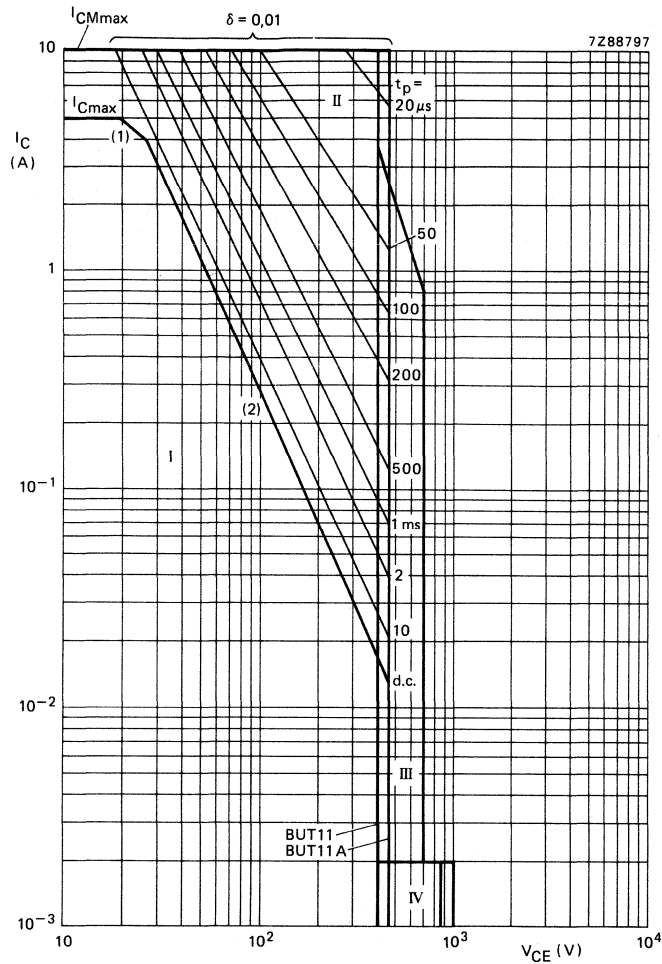


Fig. 6 Switching times waveforms with inductive load.



$V_{CC} = 300 \text{ V}$
 $V_{EB} = 5 \text{ V}$
 $L_B = 1 \mu\text{H}$

Fig. 7 Test circuit inductive load.



- (1) $P_{tot\ max}$ and $P_{tot\ peak\ max.}$ lines.
 (2) Second-breakdown limits
- I Region of permissible DC operation
 II Permissible extension for repetitive pulse operation
 III Area of permissible operation during turn-on in single transistor converters, provided $R_{BE} \leq 100\ \Omega$ and $t_p \leq 0,6\ \mu s$.
 IV Repetitive pulse operation in this region is permissible provided $V_{BE} \leq 0$ and $t_p \leq 5\ ms$.

Fig. 8 Safe operating area at $T_{mb} \leq 25\ ^\circ C$.

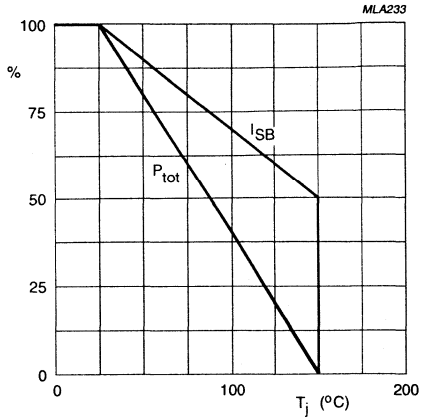


Fig. 9 Total power dissipation and second-breakdown current derating curve.

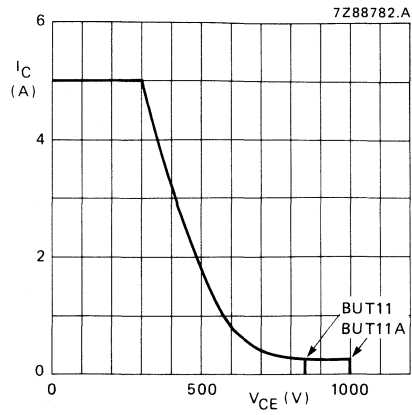


Fig. 10 Reverse bias SOAR.

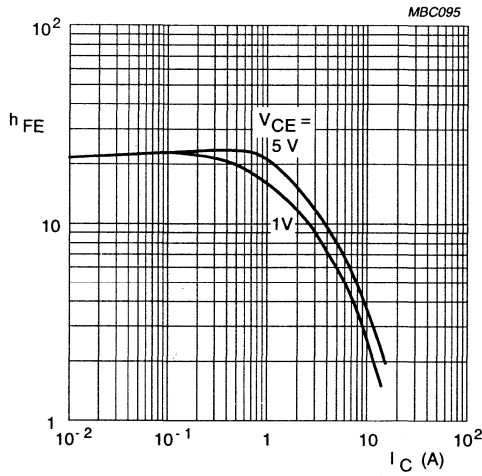


Fig.11 Typical DC current gain.

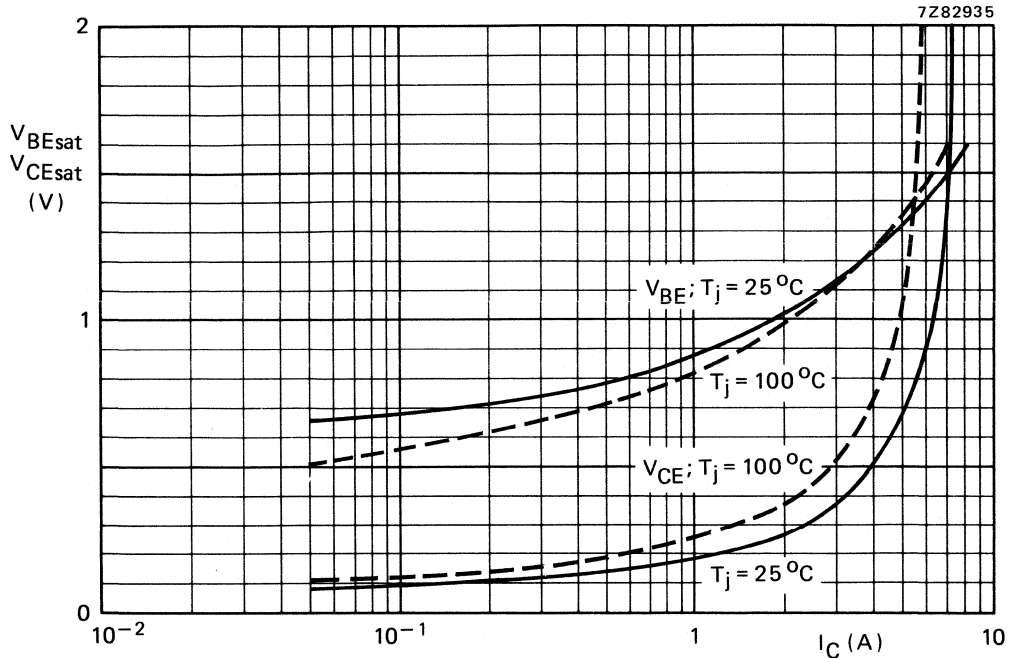


Fig. 12 Typical values base-emitter and collector-emitter voltage, $I_C/I_B = 5$.

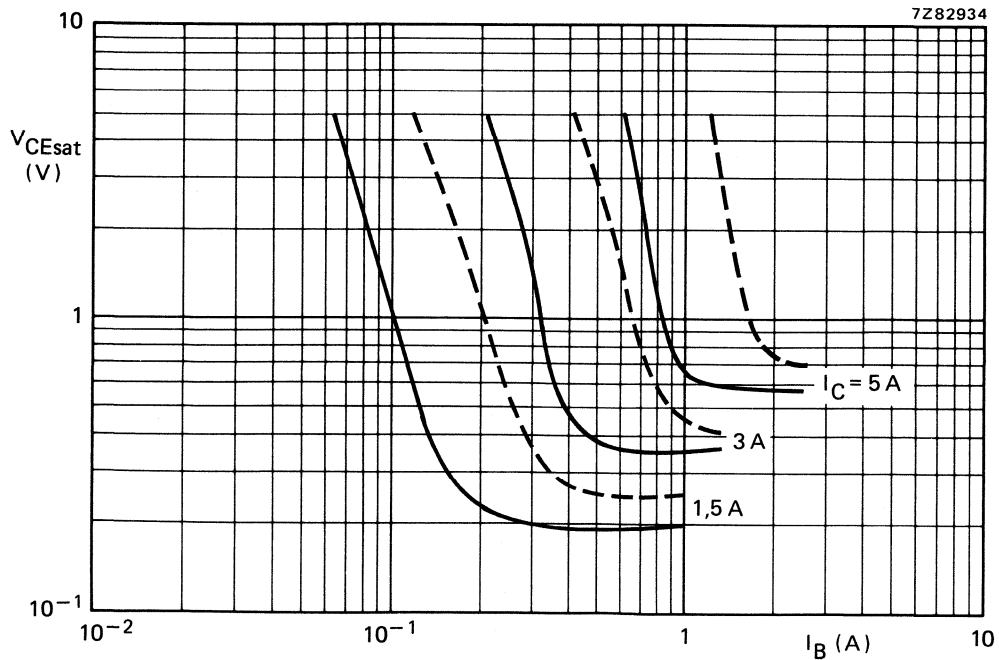


Fig. 13 Typ. (—) and max. (---) values collector-emitter saturation voltage at $T_j = 25^\circ\text{C}$.

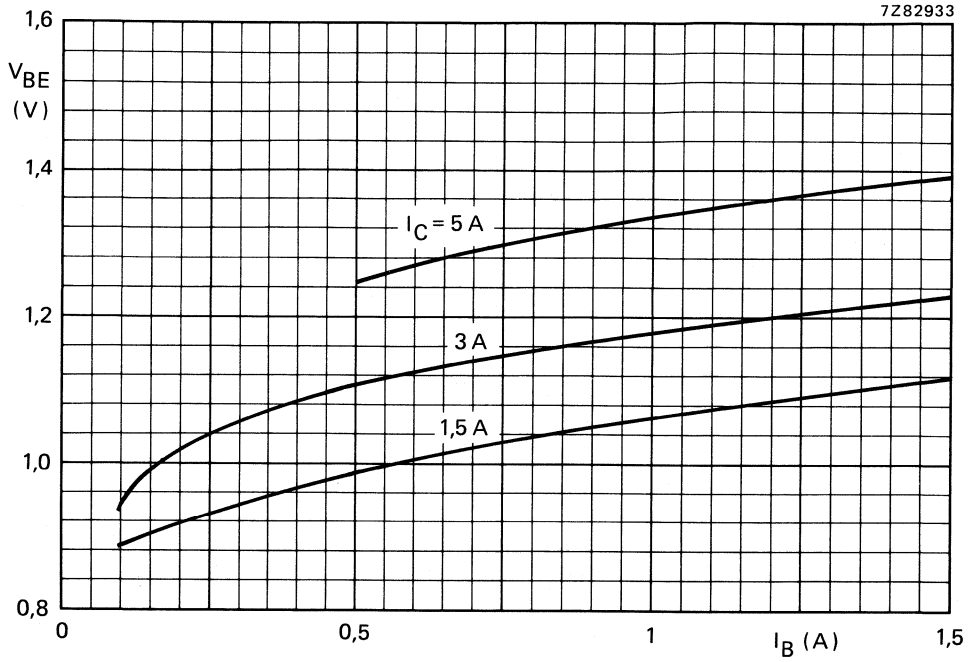


Fig. 14 Typical values at $T_j = 25$ °C.

Silicon diffused power transistors

BUT11F/BUT11AF

DESCRIPTION

High-voltage, high-speed, glass-passivated npn power transistors in a SOT186 envelope with electrically insulated mounting base, intended for use in converters, inverters, switching regulators, motor control systems, etc.

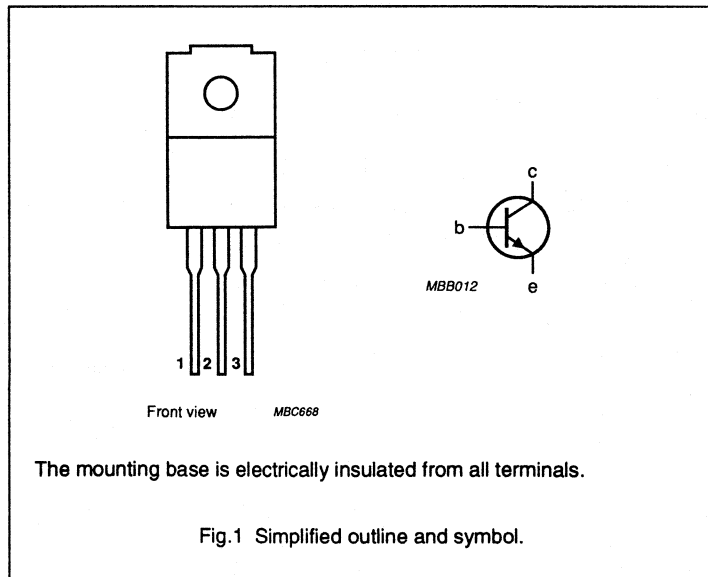
PINNING

PIN	DESCRIPTION
1	base
2	collector
3	emitter

QUICK REFERENCE DATA

SYMBOL	PARAMETER	CONDITIONS	MAX.	UNIT
V_{CESM}	collector-emitter voltage	peak value; $V_{BE} = 0$	850	V
	BUT11F BUT11AF		1000	V
V_{CEO}	collector-emitter voltage	open base	400	V
	BUT11F BUT11AF		450	V
$V_{CE sat}$	collector-emitter saturation voltage		1.5	V
I_C	collector current	DC value	5	A
I_{CM}	collector current	peak value	10	A
$I_{C sat}$	collector saturation current		3	A
	BUT11F BUT11AF		2.5	A
P_{tot}	total power dissipation	up to $T_h = 25\text{ }^\circ\text{C}$	20	W
t_f	fall time		0.8	μs

PIN CONFIGURATION



Silicon diffused power transistors

BUT11F/BUT11AF

LIMITING VALUES

In accordance with the Absolute Maximum System (IEC 134).

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_{CESM}	collector-emitter voltage	peak value;			
	BUT11F	$V_{BE} = 0$	–	850	V
V_{CEO}	collector-emitter voltage	open base			
	BUT11F		–	400	V
	BUT11AF		–	450	V
I_C	collector current	DC value	–	5	A
I_{CM}	collector current	peak value	–	10	A
I_B	base current	DC value	–	2	A
I_{BM}	base current	peak value	–	4	A
P_{tot}	total power dissipation	up to $T_h = 25\text{ °C}$ (note 1)	–	20	W
T_{stg}	storage temperature range		–65	150	°C
T_j	junction temperature		–	150	°C

THERMAL RESISTANCE

SYMBOL	PARAMETER	VALUE	UNIT
$R_{th\ j-mb}$	from junction to mounting base	1.45	K/W
$R_{th\ j-h}$	from junction to external heatsink (note 1)	6.45	K/W
$R_{th\ j-h}$	from junction to external heatsink (note 2)	3.95	K/W
$R_{th\ j-a}$	from junction to ambient	55	K/W

Notes

1. Mounted without heatsink compound and 30 ± 5 N pressure on centre of envelope.
2. Mounted with heatsink compound and 30 ± 5 N pressure on centre of envelope.

ISOLATION

SYMBOL	PARAMETER	TYP.	MAX.	UNIT
V_{isol}	isolation voltage from all terminals to external heatsink (peak value)	–	1500	V
C_{isol}	isolation capacitance from collector to external heatsink	12	–	pF

Silicon diffused power transistors

BUT11F/BUT11AF

CHARACTERISTICS

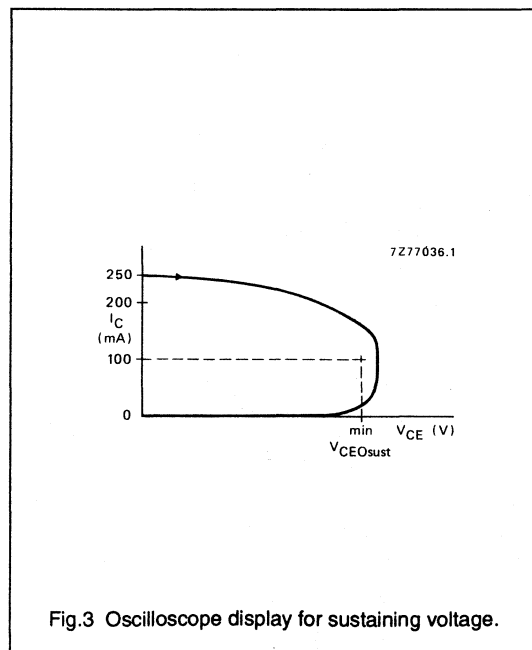
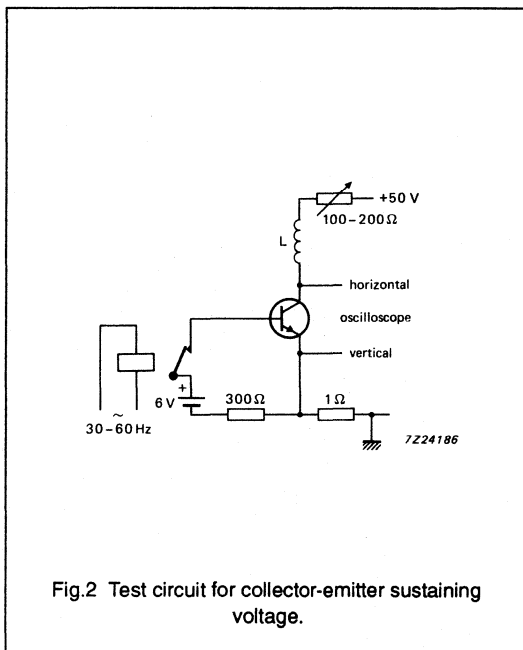
 $T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
I_{CES}	collector cut-off current	$V_{CE} = V_{CES\text{ max}};$ $V_{BE} = 0$	–	–	1	mA
		$V_{CE} = V_{CES\text{ max}};$ $V_{BE} = 0;$ $T_j = 125\text{ }^\circ\text{C}$	–	–	2	mA
I_{EBO}	emitter cut-off current	$V_{EB} = 9\text{ V};$ $I_C = 0$	–	–	10	mA
h_{FE}	DC current gain	$V_{CE} = 5\text{ V};$ $I_C = 5\text{ mA}$	10	18	35	
		$V_{CE} = 5\text{ V};$ $I_C = 500\text{ mA}$	10	20	35	
$V_{CE\text{ sat}}$	collector-emitter saturation voltage BUT11F	$I_C = 3\text{ A};$ $I_B = 0.6\text{ A}$	–	–	1.5	V
	BUT11AF	$I_C = 2.5\text{ A};$ $I_B = 0.5\text{ A}$	–	–	1.5	V
$V_{BE\text{ sat}}$	base-emitter saturation voltage BUT11F	$I_C = 3\text{ A};$ $I_B = 0.6\text{ A}$	–	–	1.3	V
	BUT11AF	$I_C = 2.5\text{ A};$ $I_B = 0.5\text{ A}$	–	–	1.3	V
$V_{CEO\text{ sust}}$	collector-emitter sustaining voltage BUT11F	$I_C = 100\text{ mA};$ $I_B = 0;$ $L = 25\text{ mH};$ (See Figs 2 and 3)	400	–	–	V
	BUT11AF		450	–	–	V
Switching times resistive load (See Figs 4 and 5)						
t_{on}	turn-on time BUT11F	$I_{C\text{ on}} = 3\text{ A};$ $I_{B\text{ on}} = I_{B\text{ off}} = 0.6\text{ A}$	–	–	1	μs
	BUT11AF	$I_{C\text{ on}} = 2.5\text{ A};$ $I_{B\text{ on}} = I_{B\text{ off}} = 0.5\text{ A}$	–	–	1	μs
t_s	storage time BUT11F	$I_{C\text{ on}} = 3\text{ A};$ $I_{B\text{ on}} = I_{B\text{ off}} = 0.6\text{ A}$	–	–	4	μs
	BUT11AF	$I_{C\text{ on}} = 2.5\text{ A};$ $I_{B\text{ on}} = I_{B\text{ off}} = 0.5\text{ A}$	–	–	4	μs
t_f	fall time BUT11F	$I_{C\text{ on}} = 3\text{ A};$ $I_{B\text{ on}} = I_{B\text{ off}} = 0.6\text{ A}$	–	–	0.8	μs
	BUT11AF	$I_{C\text{ on}} = 2.5\text{ A};$ $I_{B\text{ on}} = I_{B\text{ off}} = 0.5\text{ A}$	–	–	0.8	μs

Silicon diffused power transistors

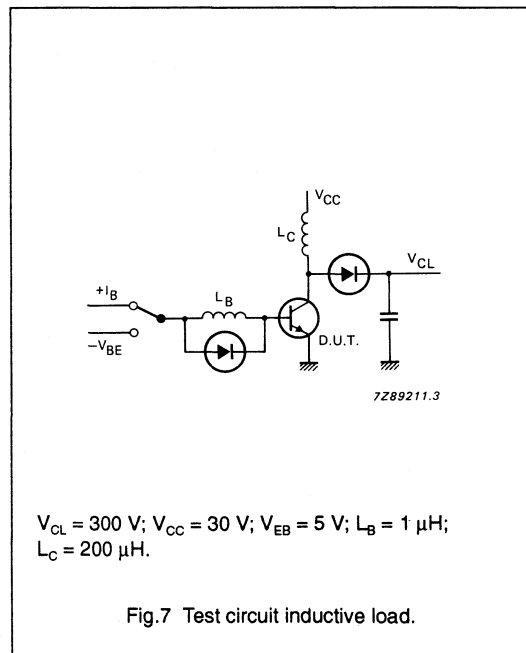
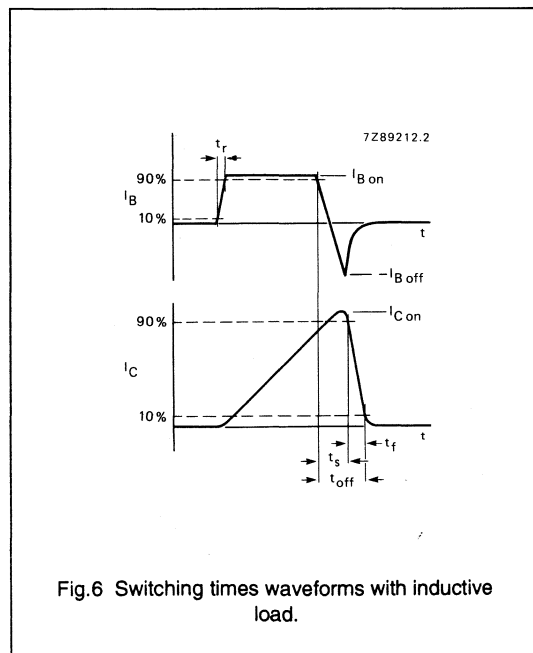
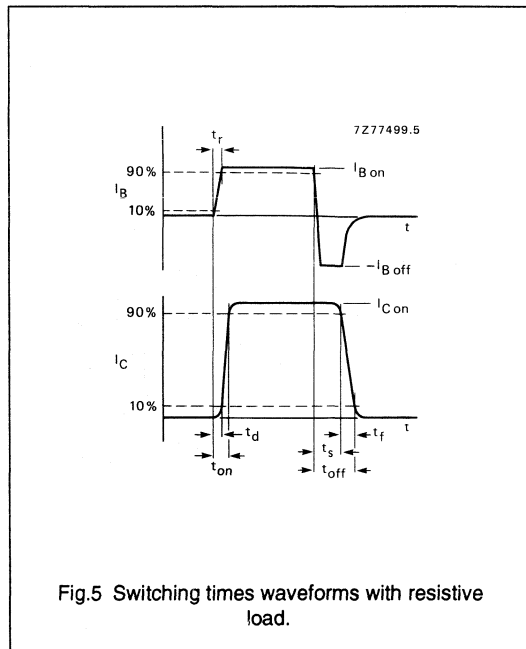
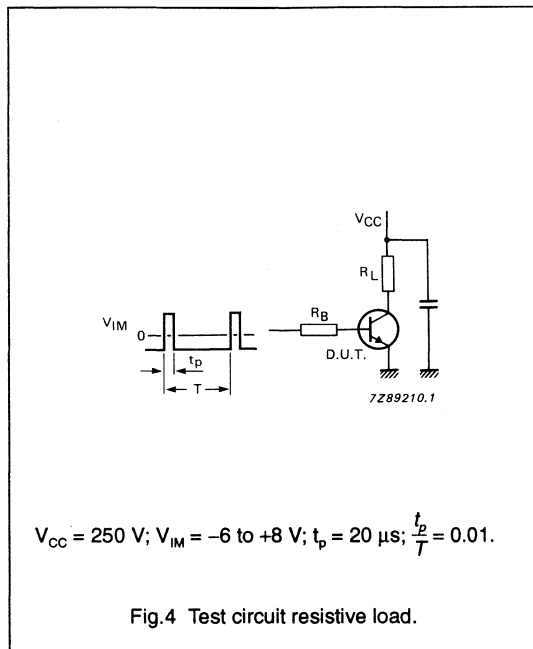
BUT11F/BUT11AF

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Switching times inductive load (See Figs 6 and 7)						
t_s	storage time, BUT11F	$I_{C\ on} = 3\ A;$ $I_B = 0.6\ A$	-	1.1	1.4	μs
		$I_{C\ on} = 3\ A;$ $I_B = 0.6\ A; T_j = 100\ ^\circ C$	-	1.2	1.5	μs
t_s	storage time, BUT11AF	$I_{C\ on} = 2.5\ A;$ $I_B = 0.5\ A$	-	1.1	1.4	μs
		$I_{C\ on} = 2.5\ A;$ $I_B = 0.5\ A; T_j = 100\ ^\circ C$	-	1.2	1.5	μs
t_f	fall time, BUT11F	$I_{C\ on} = 3\ A;$ $I_B = 0.6\ A$	-	80	150	ns
		$I_{C\ on} = 3\ A;$ $I_B = 0.6\ A; T_j = 100\ ^\circ C$	-	140	300	ns
t_f	fall time, BUT11AF	$I_{C\ on} = 2.5\ A;$ $I_B = 0.5\ A$	-	80	150	ns
		$I_{C\ on} = 2.5\ A;$ $I_B = 0.5\ A; T_j = 100\ ^\circ C$	-	140	300	ns



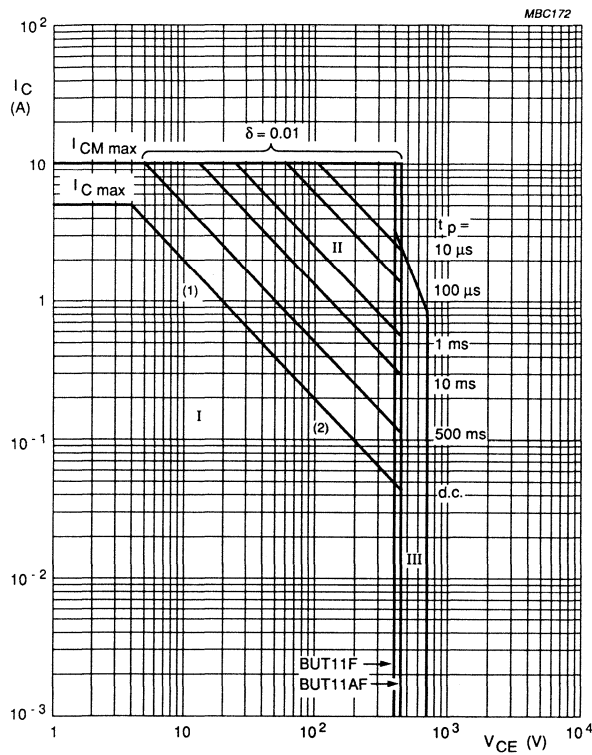
Silicon diffused power transistors

BUT11F/BUT11AF



Silicon diffused power transistors

BUT11F/BUT11AF



Mounted without heatsink compound and 30 ± 5 N force on centre of envelope.

$T_h \leq 25$ °C.

(1) $P_{tot\ max}$ and $P_{tot\ peak\ max}$ lines.

(2) Second breakdown limits.

I - Region of permissible DC operation.

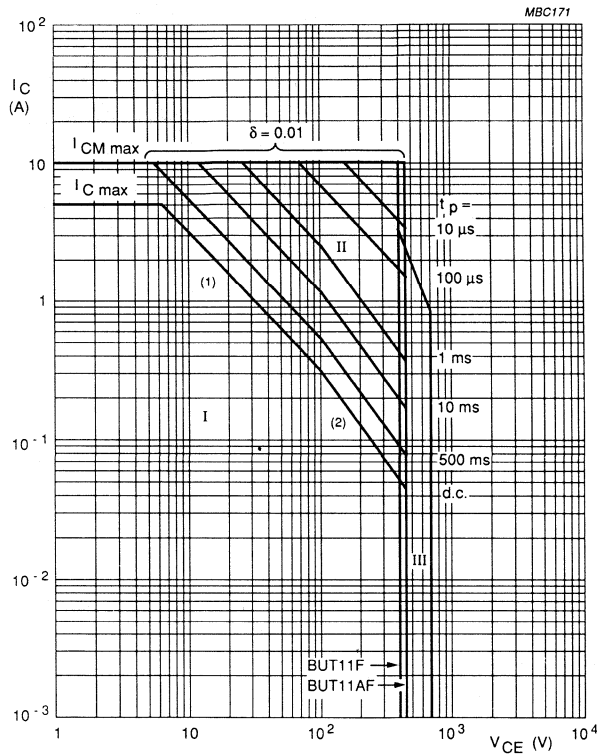
II - Permissible extension for repetitive pulse operation.

III - Area of permissible operation during turn-on in single transistor converters provided that $R_{BE} \leq 100$ Ω and $t_p \leq 0.6$ μ s.

Fig.8 Forward bias safe operating area.

Silicon diffused power transistors

BUT11F/BUT11AF



Mounted with heatsink compound and 30 ± 5 N force on centre of envelope.

$T_h \leq 25$ °C.

(1) $P_{tot \max}$ and $P_{tot \text{ peak } \max}$ lines.

(2) Second breakdown limits.

I - Region of permissible DC operation.

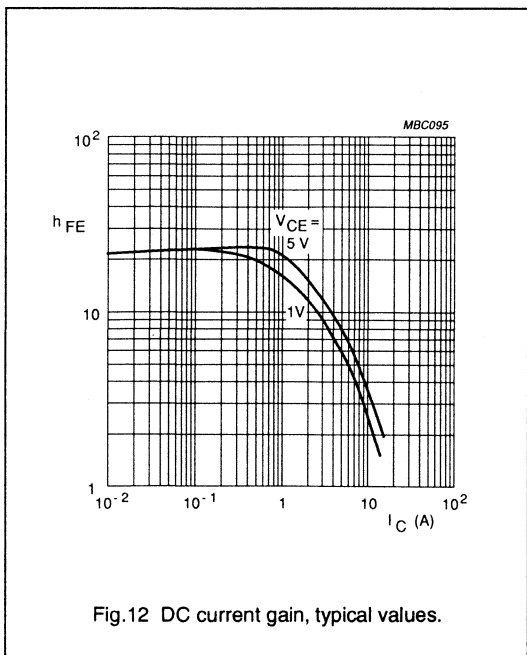
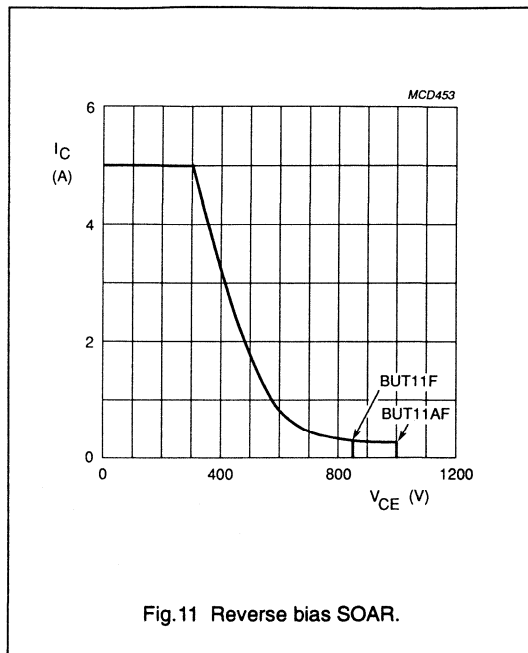
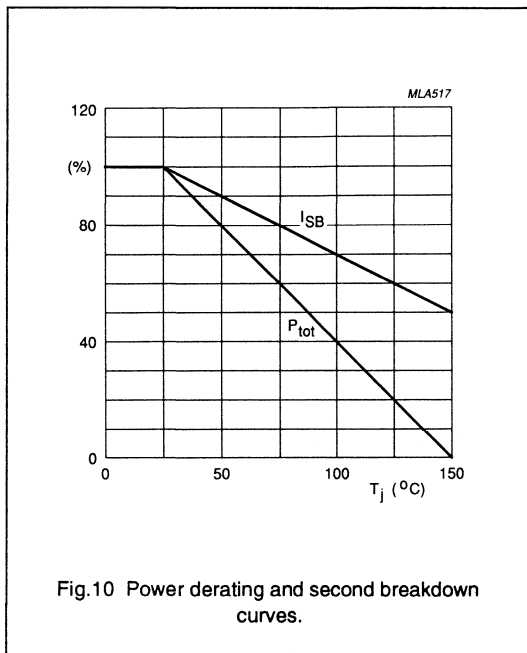
II - Permissible extension for repetitive pulse operation.

III - Area of permissible operation during turn-on in single transistor converters provided that $R_{BE} \leq 100 \Omega$ and $t_p \leq 0.6 \mu\text{s}$.

Fig.9 Forward bias safe operating area.

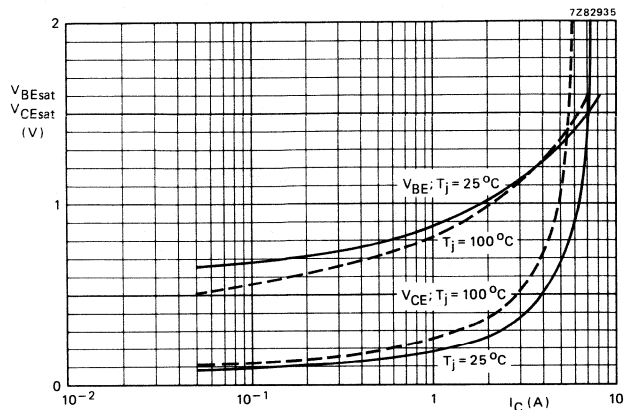
Silicon diffused power transistors

BUT11F/BUT11AF



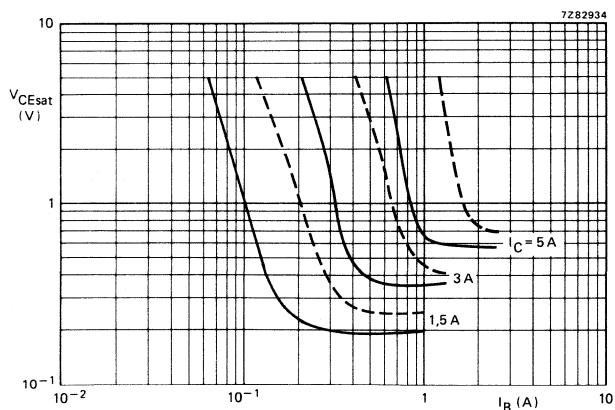
Silicon diffused power transistors

BUT11F/BUT11AF



$I_C/I_B = 5$.

Fig.13 Base-emitter and collector-emitter saturation voltages as functions of collector current, typical values.



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

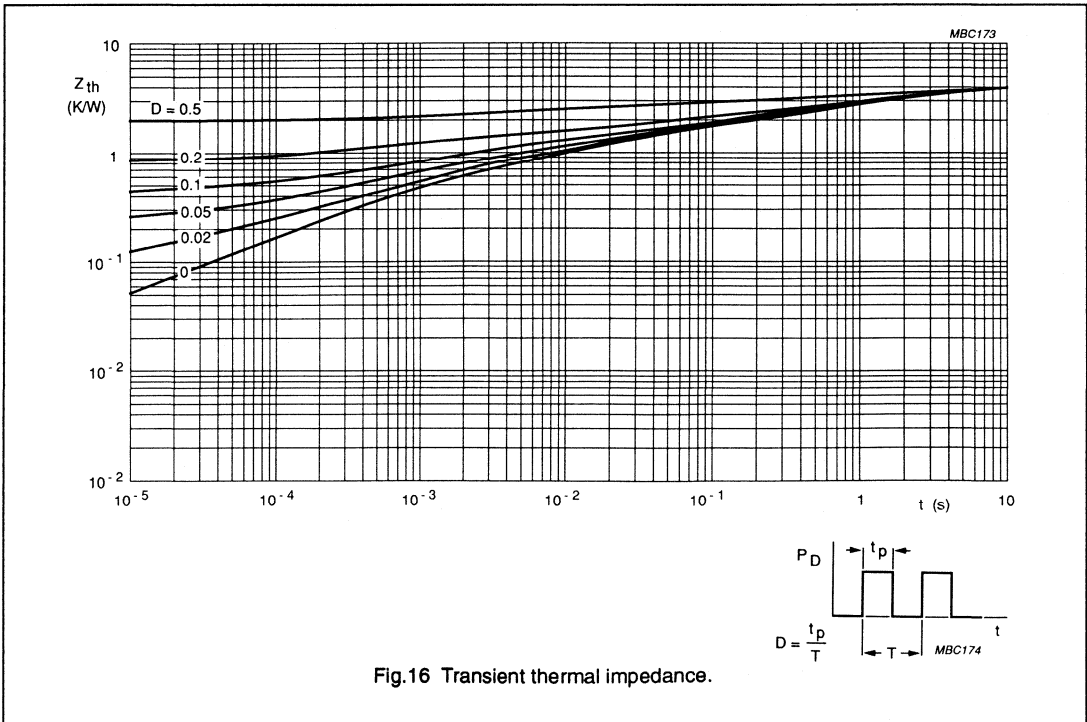
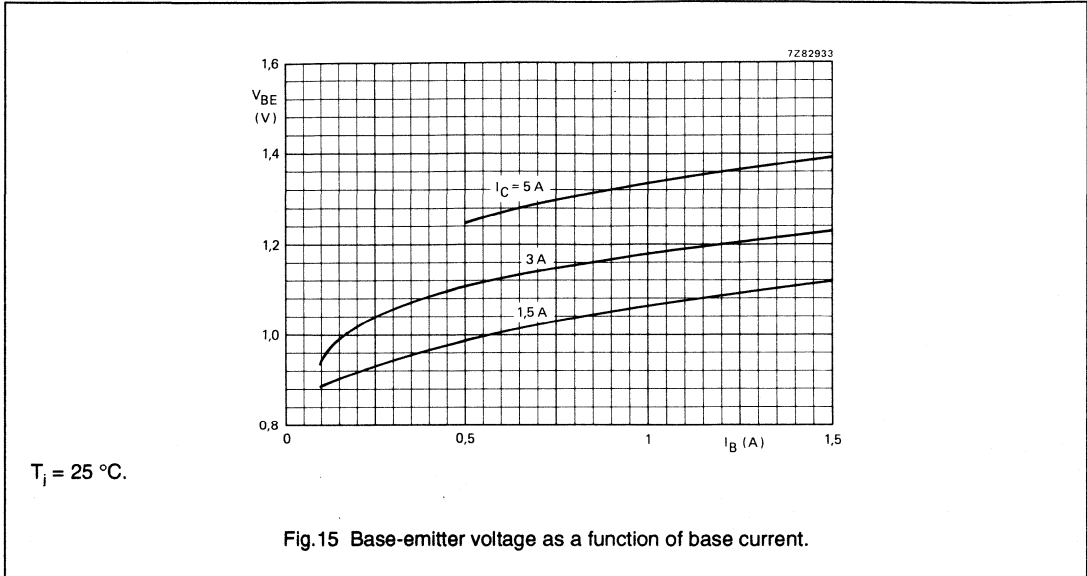
Solid line = typical values.

Dotted line = maximum values.

Fig.14 Collector-emitter saturation voltage as a function of base current.

Silicon diffused power transistors

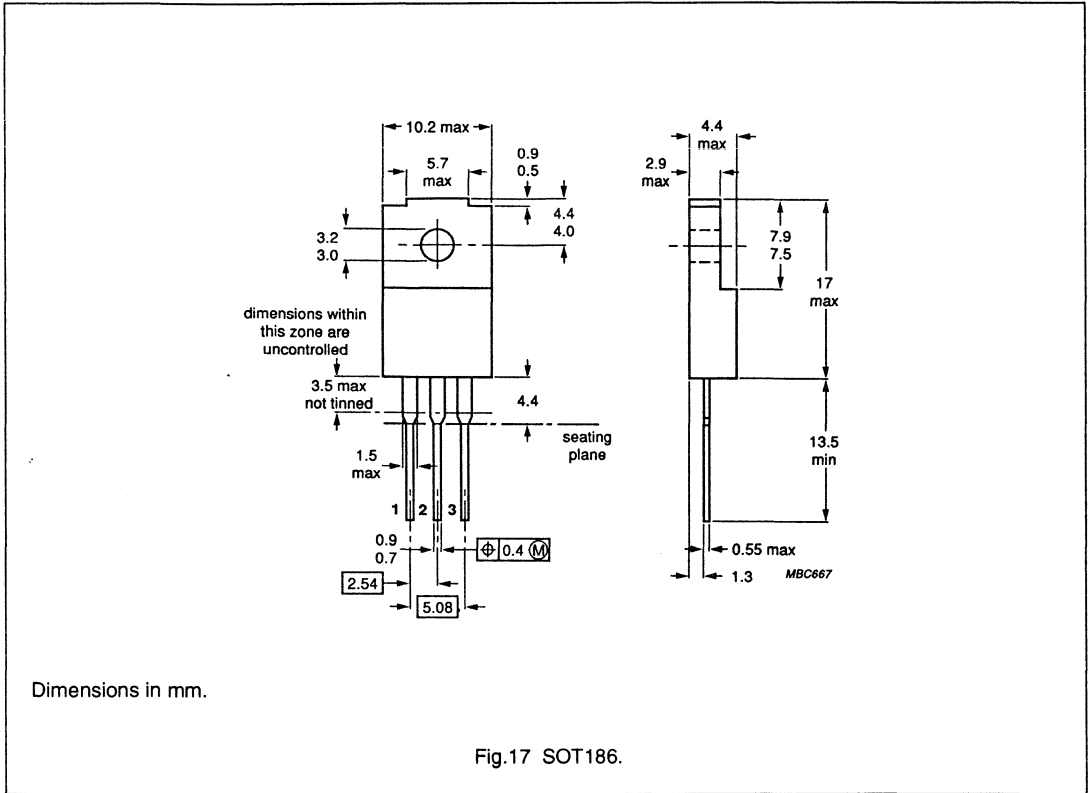
BUT11F/BUT11AF



Silicon diffused power transistors

BUT11F/BUT11AF

PACKAGE OUTLINE



SILICON DIFFUSED POWER TRANSISTORS

High-voltage, high-speed, glass-passivated npn power transistors in a TO220 envelope intended for use in converters, inverters, switching regulators, motor control systems, etc.

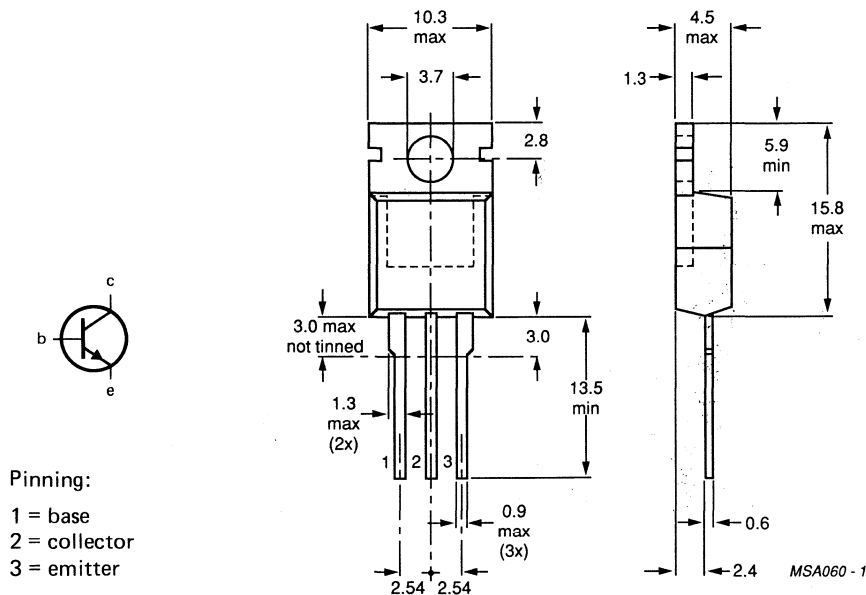
QUICK REFERENCE DATA

		BUT12	BUT12A
Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM}	max. 850	1000 V
	V_{CEO}	max. 400	450 V
Collector-emitter saturation voltage	V_{CEsat}	max. 1.5	1.5 V
Collector current saturation DC	I_{Csat}	max. 6.0	5.0 A
	I_C	max. 8	A
	I_{CM}	max. 20	A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max. 125	W
	t_f	max. 0.8	μs

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO220AB.



Pinning:

- 1 = base
- 2 = collector
- 3 = emitter

Collector connected to mounting base.

BUT12 BUT12A

RATINGS

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

		BUT12	BUT12A
Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM}	max. 850	1000 V
	V_{CEO}	max. 400	450 V
Collector current saturation DC	I_{Csat}	6.0	5.0 A
	I_C	max. 8	A
	peak value	I_{CM}	max. 20
Base current DC	I_B	max. 4.0	A
	peak value	I_{BM}	max. 6.0
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max. 125	W
Storage temperature range	T_{stg}	-65 to +150	$^\circ\text{C}$
Junction temperature	T_j	max. 150	$^\circ\text{C}$

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j-mb}$	=	1.0	K/W
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CHARACTERISTICS

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

Collector cut-off currents*

$$V_{CE} = V_{CESmax}; V_{BE} = 0$$

$$V_{CE} = V_{CESmax}; V_{BE} = 0; T_j = 125\text{ }^\circ\text{C}$$

I_{CES}	max.	1.0	mA
I_{CES}	max.	3.0	mA

Emitter cut-off current

$$V_{EB} = 9\text{ V}; I_C = 0$$

I_{EBO}	max.	10	mA
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* Measured with a half-sinewave voltage (curve tracer).

		BUT12	BUT12A
Saturation voltages			
$I_C = 6 \text{ A}; I_B = 1.2 \text{ A}$	V_{CEsat}	max. 1.5	— V
	V_{BEsat}	max. 1.5	— V
$I_C = 5 \text{ A}; I_B = 1.0 \text{ A}$	V_{CEsat}	max. —	1.5 V
	V_{BEsat}	max. —	1.5 V
DC current gain			
$I_C = 10 \text{ mA}; V_{CE} = 5 \text{ V}$	h_{FE}	min. 10	
	h_{FE}	typ. 18	
	h_{FE}	max. 35	
$I_C = 1 \text{ A}; V_{CE} = 5 \text{ V}$	h_{FE}	min. 10	
	h_{FE}	typ. 20	
	h_{FE}	max. 35	
Collector-emitter sustaining voltage (Figs 2 and 3)			
$I_C = 100 \text{ mA}; I_{B \text{ off}} = 0; L = 25 \text{ mH}$	$V_{CEOsust}$	min. 400	450 V
Switching times resistive load (Figs 4 and 5)			
$I_{C \text{ on}} = 6 \text{ A}; I_{B \text{ on}} = -I_{B \text{ off}} = 1.2 \text{ A}$			
Turn-on time	t_{on}	max. 1.0	— μs
Turn-off;			
storage time	t_s	max. 4.0	— μs
fall time	t_f	max. 0.8	— μs
$I_{C \text{ on}} = 5 \text{ A}; I_{B \text{ on}} = -I_{B \text{ off}} = 1.0 \text{ A}$			
Turn-on time	t_{on}	max. —	1.0 μs
Turn-off;			
storage time	t_s	max. —	4.0 μs
fall time	t_f	max. —	0.8 μs
Switching times inductive load (Figs 5 and 6)			
$I_{C \text{ on}} = 6 \text{ A}; I_{B \text{ on}} = 1.2 \text{ A}$			
$V_{CL} = 250 \text{ V}; T_c = 100 \text{ }^\circ\text{C}$			
Turn-off;			
storage time	t_s	typ. 1.9	— μs
	t_s	max. 2.5	— μs
fall time	t_f	typ. 200	— ns
	t_f	max. 300	— ns
$I_{C \text{ on}} = 5 \text{ A}; I_{B \text{ on}} = 1.0 \text{ A}$			
$V_{CL} = 300 \text{ V}; T_c = 100 \text{ }^\circ\text{C}$			
Turn-off;			
storage time	t_s	typ. —	1.9 μs
	t_s	max. —	2.5 μs
fall time	t_f	typ. —	200 ns
	t_f	max. —	300 ns

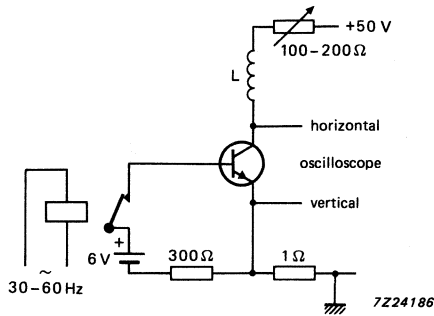


Fig. 2 Test circuit for $V_{CEOsust}$.

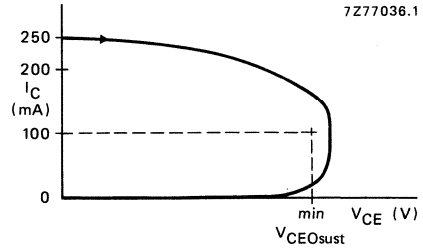
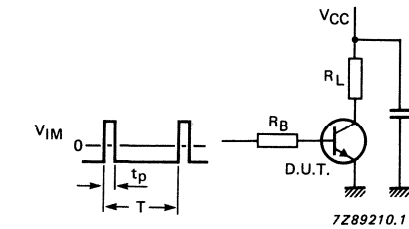


Fig. 3 Oscilloscope display for sustaining voltage.



$V_{CC} = 250 \text{ V}$
 $t_p = 20 \mu\text{s}$
 $V_{IM} = -6 \text{ to } +8 \text{ V}$
 $\frac{t_p}{T} = 0.01$

The values of R_B and R_L are selected in accordance with $I_{C on}$ and I_B requirements.

Fig. 4 Test circuit resistive load.

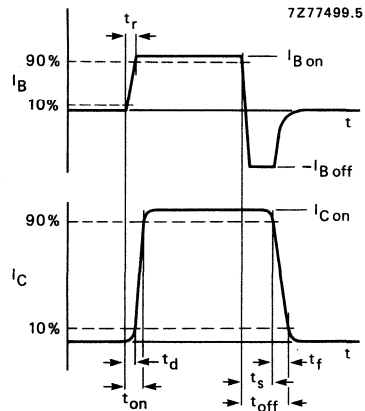
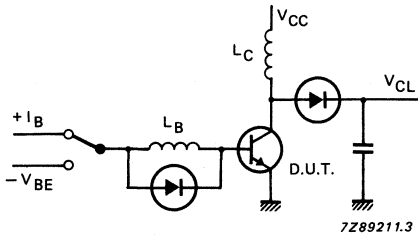


Fig. 5 Switching times waveforms with resistive load; $t_r \leq 20 \text{ ns}$.



$V_{CL} = \text{up to } 1000 \text{ V}$
 $V_{CC} = 30 \text{ V}$
 $-V_{BE} = 1 \text{ to } 5 \text{ V}$
 $L_B = 1.0 \mu\text{H}$
 $L_C = 200 \mu\text{H}$

Fig. 6 Test circuit inductive load and reverse bias SOAR.

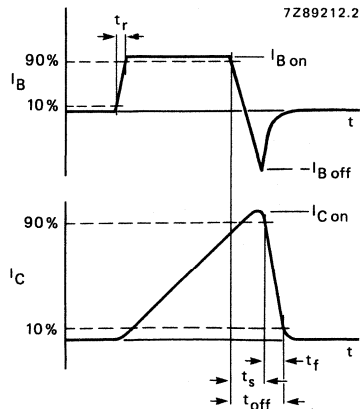
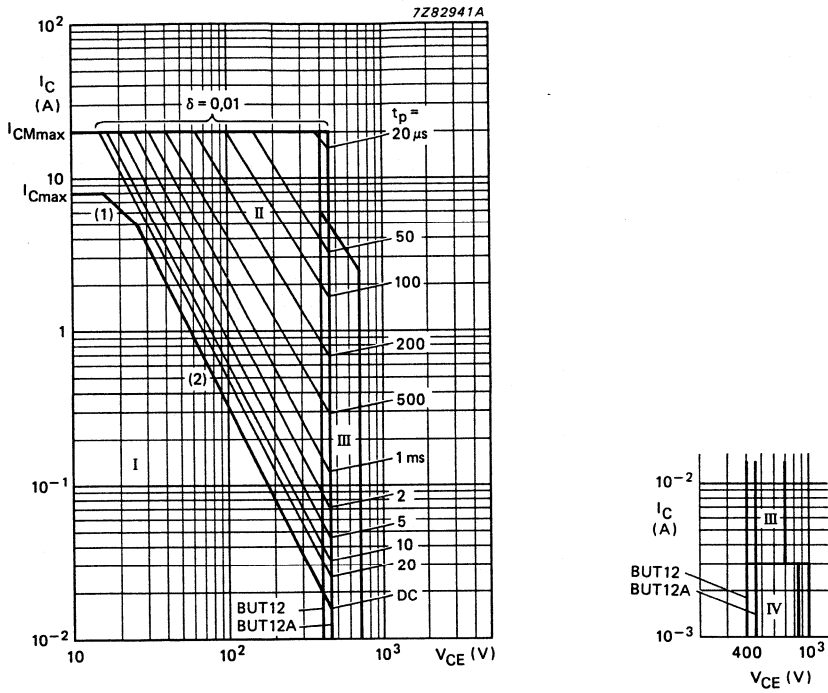


Fig. 7 Switching times waveforms with inductive load.



- (1) P_{tot} max and P_{tot} peak max lines.
- (2) Second-breakdown limits.
- I Region of permissible DC operation
- II Permissible extension for repetitive pulse operation

Fig. 8 Safe operating area at $T_{mb} < 25 \text{ }^\circ\text{C}$.

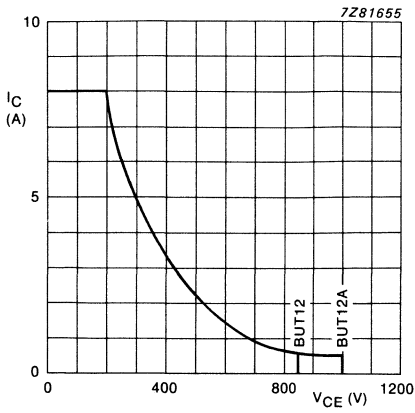


Fig. 9 Reverse bias SOAR; $T_C = 100^\circ\text{C}$;
 $V_{BE} = -1\text{ V to } -5\text{ V}$.

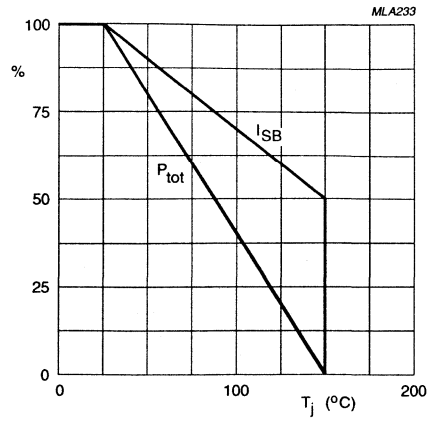


Fig. 10 Total power dissipation and second
breakdown current derating curve.

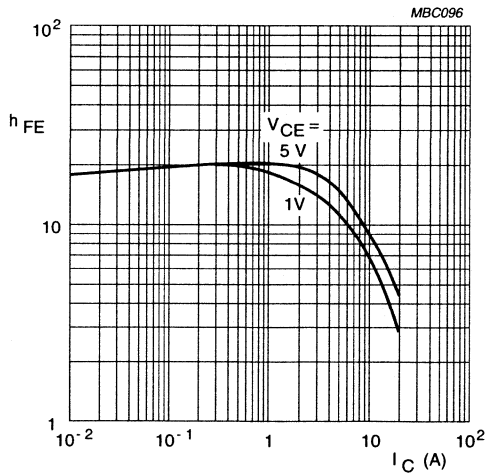


Fig. 11 Typical values DC current gain.

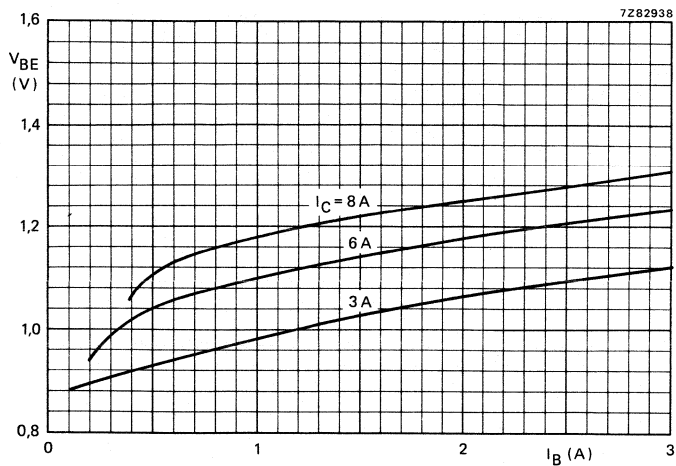


Fig. 12 Base-emitter voltage as a function of base current at $T_j = 25^\circ\text{C}$.

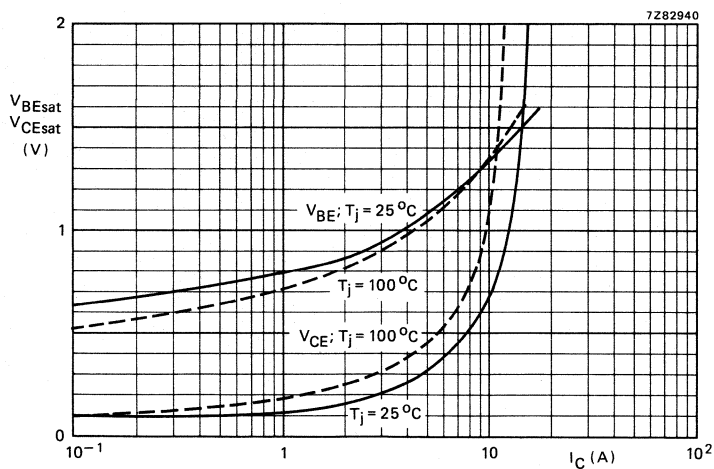


Fig. 13 Typical values base and collector voltage at $I_C/I_B = 5$.

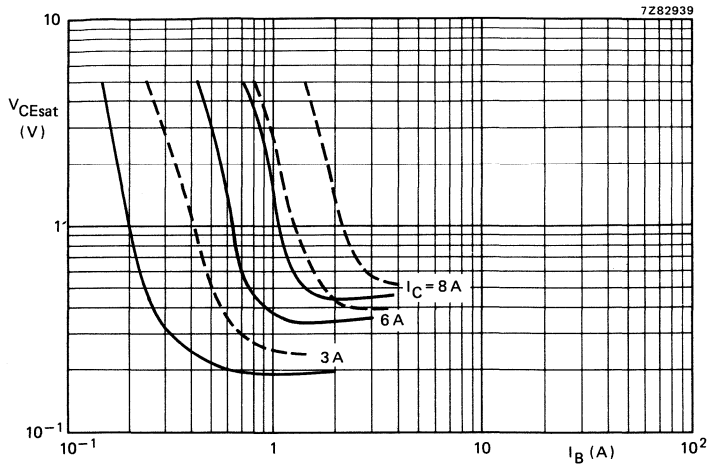


Fig. 14 Typical (—) and max. (---) values collector emitter saturation voltage at $T_j = 25^\circ\text{C}$.

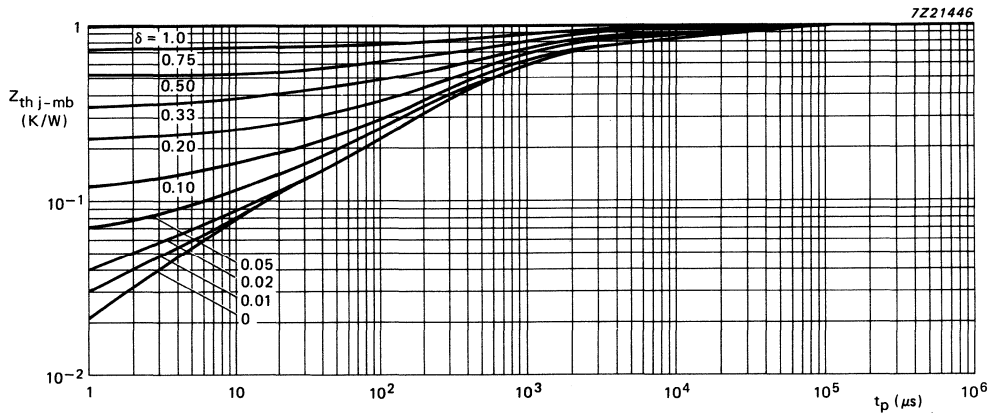


Fig. 15 Thermal response at pulse power conditions.

SILICON DIFFUSED POWER TRANSISTORS

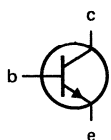
High-voltage, high-speed, glass-passivated npn power transistors in a SOT186 envelope intended for use in converters, inverters, switching regulators, motor control systems, etc.

QUICK REFERENCE DATA

			BUT12F	BUT12AF
Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM}	max.	850	1000 V
	V_{CEO}	max.	400	450 V
Collector-emitter saturation voltage	V_{CEsat}	max.	1.5	1.5 V
Collector current saturation DC peak value	I_{Csat}	max.	6.0	5.0 A
	I_C	max.	8	A
	I_{CM}	max.	20	A
Total power dissipation up to $T_h = 25^\circ C$	P_{tot}	max.	23	W
Fall time	t_f	max.	0.8	μs

MECHANICAL DATA

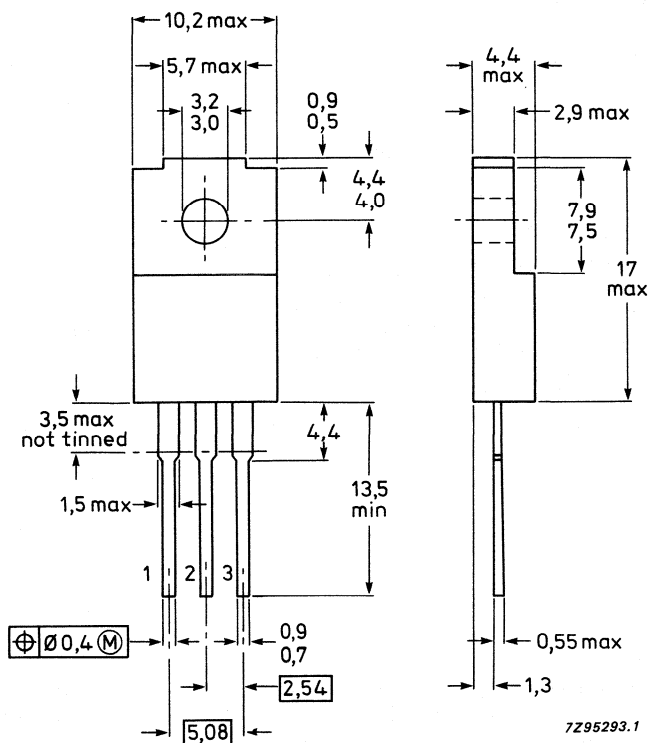
Fig. 1 SOT186.



Pinning:

- 1 = base
- 2 = collector
- 3 = emitter

Mounting base is electrically isolated from all terminals.



7295293.1

RATINGS

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

		BUT12F	BUT12AF
Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM}	max. 850	1000 V
	V_{CEO}	max. 400	450 V
Collector current saturation DC peak value	I_{Csat}	6.0	5.0 A
	I_C	max. 8	A
	I_{CM}	max. 20	A
Base current DC peak value	I_B	max. 4.0	A
	I_{BM}	max. 6.0	A
Total power dissipation up to $T_h = 25\text{ }^\circ\text{C}$ (note 1)	P_{tot}	max. 23	W
Storage temperature range	T_{stg}	-65 to +150	$^\circ\text{C}$
Junction temperature	T_j	max. 150	$^\circ\text{C}$

THERMAL RESISTANCE

From junction to external heatsink (note 1)	$R_{th\ j-h}$	=	5.5	K/W
From junction to external heatsink (note 2)	$R_{th\ j-h}$	=	3.9	K/W
From junction to ambient	$R_{th\ j-a}$	=	55	K/W

ISOLATION

Isolation voltage from all terminals to external heatsink (peak value)	V_{isol}	max. 1500	V
Isolation capacitance from collector to external heatsink	C_{isol}	max. 12	pF

CHARACTERISTICS

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

Collector cut-off currents* (note 3)

$V_{CE} = V_{CESmax}; V_{BE} = 0$

$V_{CE} = V_{CESmax}; V_{BE} = 0; T_j = 125\text{ }^\circ\text{C}$

I_{CES}	max. 1.0	mA
I_{CES}	max. 3.0	mA

Emitter cut-off current

$V_{EB} = 9\text{ V}; I_C = 0$

I_{EBO}	max. 10	mA
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Notes

1. Mounted without heatsink compound and 30 ± 5 newtons pressure on centre of the envelope.
2. Mounted with heatsink compound and 30 ± 5 newtons pressure on centre of the envelope.
3. Measured with a half-sinewave voltage (curve tracer).

			BUT12F	BUT12AF
Saturation voltages				
$I_C = 6 \text{ A}; I_B = 1.2 \text{ A}$	V_{CEsat}	max.	1.5	— V
	V_{BEsat}	max.	1.5	— V
$I_C = 5 \text{ A}; I_B = 1.0 \text{ A}$	V_{CEsat}	max.	—	1.5 V
	V_{BEsat}	max.	—	1.5 V
DC current gain				
$I_C = 10 \text{ mA}; V_{CE} = 5 \text{ V}$	h_{FE}	min.	10	
	h_{FE}	typ.	18	
	h_{FE}	max.	35	
$I_C = 1 \text{ A}; V_{CE} = 5 \text{ V}$	h_{FE}	min.	10	
	h_{FE}	typ.	20	
	h_{FE}	max.	35	
Collector-emitter sustaining voltage (Figs 2 and 3)				
$I_C = 100 \text{ mA}; I_{B \text{ off}} = 0; L = 25 \text{ mH}$	$V_{CEOsust}$	min.	400	450 V
Switching times resistive load (Figs 4 and 5)				
$I_{C \text{ on}} = 6 \text{ A}; I_{B \text{ on}} = -I_{B \text{ off}} = 1.2 \text{ A}$				
Turn-on time	t_{on}	max.	1.0	— μs
Turn-off;				
storage time	t_s	max.	4.0	— μs
fall time	t_f	max.	0.8	— μs
$I_{C \text{ on}} = 5 \text{ A}; I_{B \text{ on}} = -I_{B \text{ off}} = 1.0 \text{ A}$				
Turn-on time	t_{on}	max.	—	1.0 μs
Turn-off;				
storage time	t_s	max.	—	4.0 μs
fall time	t_f	max.	—	0.8 μs
Switching times inductive load (Figs 6 and 7)				
$I_{C \text{ on}} = 6 \text{ A}; I_{B \text{ on}} = 1.2 \text{ A}$ $V_{CL} = 250 \text{ V}; T_c = 100 \text{ }^\circ\text{C}$				
Turn-off;				
storage time	t_s	typ.	1.9	— μs
	t_s	max.	2.5	— μs
fall time	t_f	typ.	200	— ns
	t_f	max.	300	— ns
$I_{C \text{ on}} = 5 \text{ A}; I_{B \text{ on}} = 1.0 \text{ A}$ $V_{CL} = 300 \text{ V}; T_c = 100 \text{ }^\circ\text{C}$				
Turn-off;				
storage time	t_s	typ.	—	1.9 μs
	t_s	max.	—	2.5 μs
fall time	t_f	typ.	—	200 ns
	t_f	max.	—	300 ns

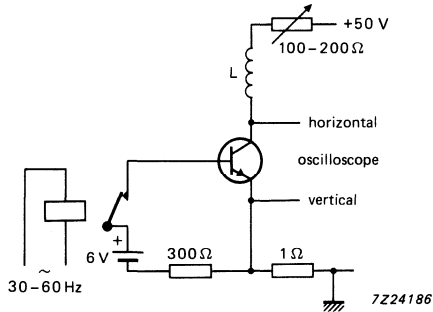


Fig. 2 Test circuit for $V_{CEOsust}$.

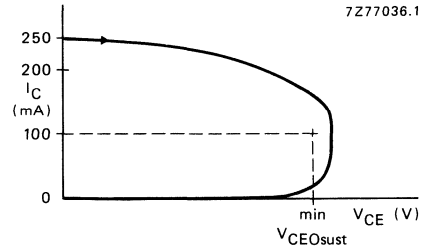
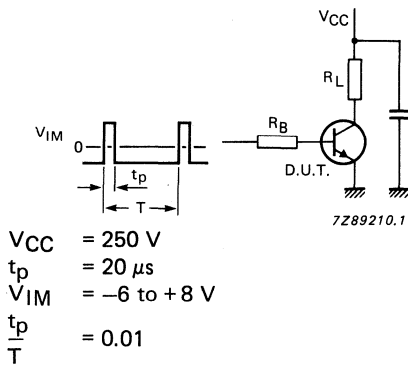


Fig. 3 Oscilloscope display for sustaining voltage.



The values of R_B and R_L are selected in accordance with $I_{C\ on}$ and I_B requirements.

Fig. 4 Test circuit resistive load.

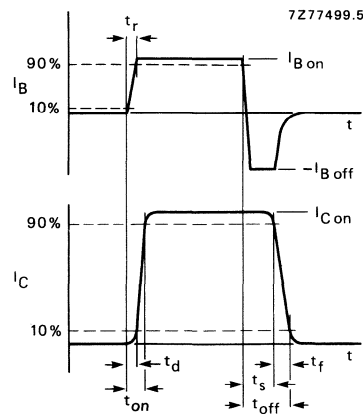
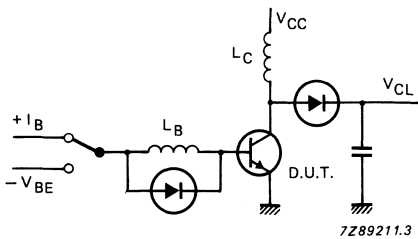


Fig. 5 Switching times waveforms with resistive load; $t_r \leq 20 \text{ ns}$.



$V_{CL} = \text{up to } 1000 \text{ V}$
 $V_{CC} = 30 \text{ V}$
 $-V_{BE} = 1 \text{ to } 5 \text{ V}$
 $L_B = 1.0 \mu\text{H}$
 $L_C = 200 \mu\text{H}$

Fig. 6 Test circuit inductive load and reverse bias SOAR.

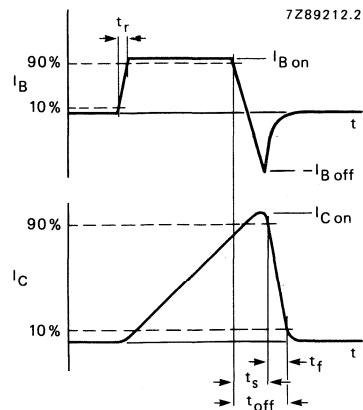
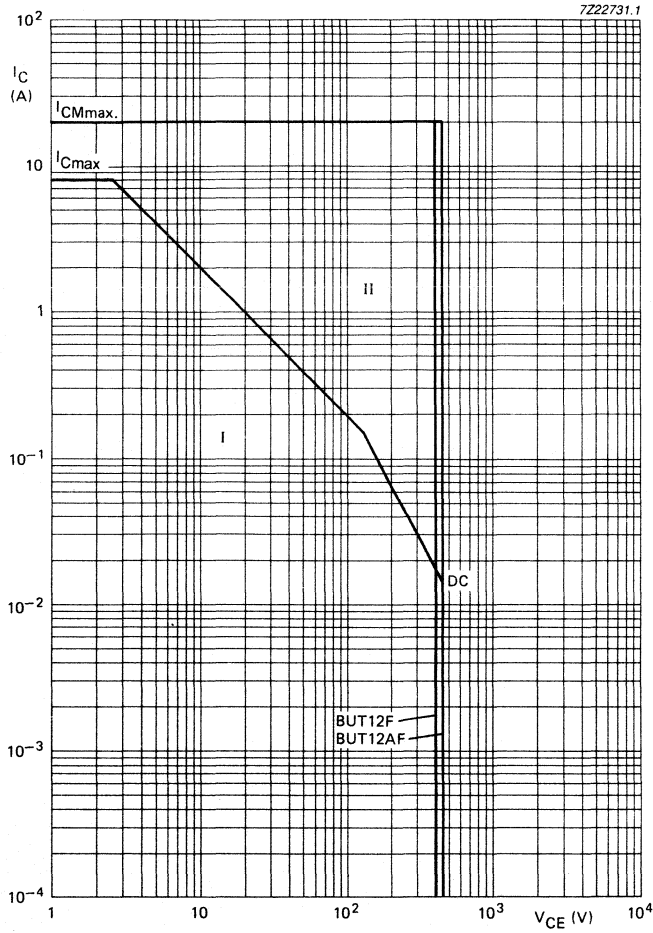


Fig. 7 Switching times waveforms with inductive load.



- I Region of permissible DC operation
- II Permissible extension for repetitive pulse operation

Fig. 8 Safe operating area at $T_{mb} < 25^\circ\text{C}$.

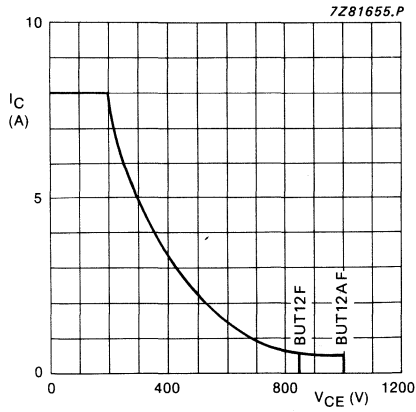


Fig. 9 Reverse bias SOAR; $T_{mb} = 100\text{ }^{\circ}\text{C}$;
 $V_{BE} = -1\text{ V to } -5\text{ V}$.

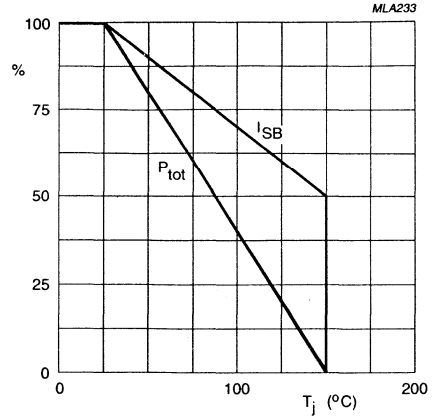


Fig. 10 Total power dissipation and second
breakdown current derating curve.

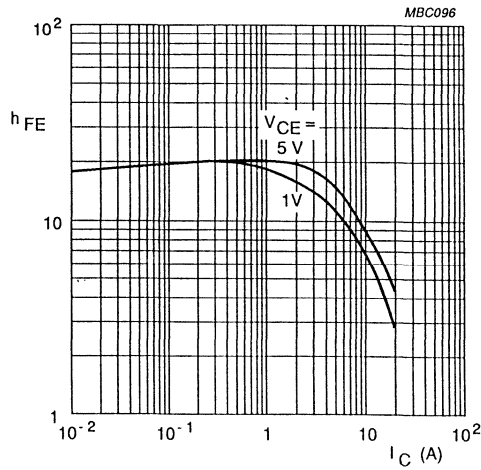


Fig. 11 Typical values DC current gain.

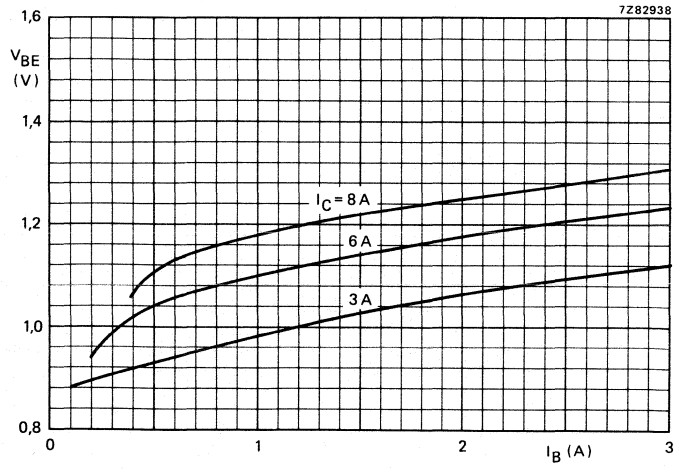


Fig. 12 Base-emitter voltage as a function of base current at $T_j = 25^\circ\text{C}$.

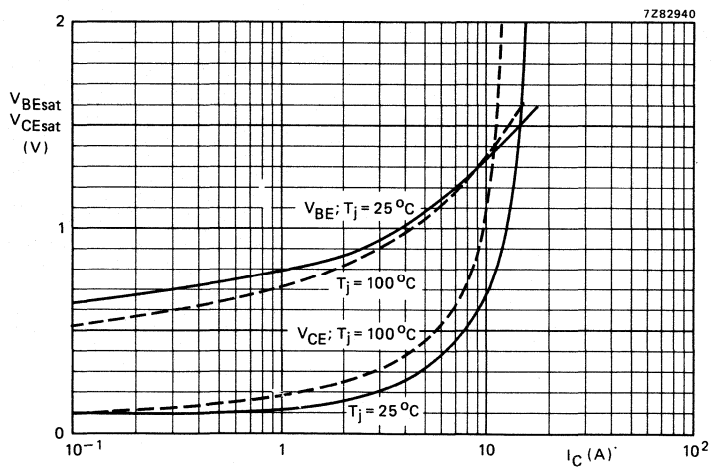


Fig. 13 Typical values base and collector voltage at $I_C/I_B = 5$.

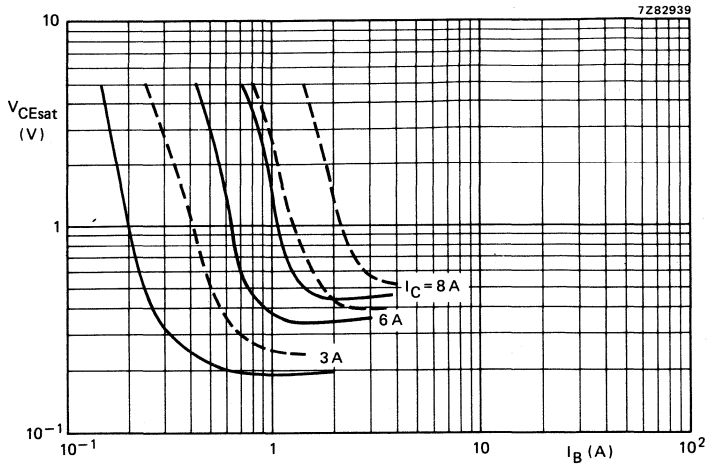


Fig. 14 Typical (—) and max. (---) values collector emitter saturation voltage at $T_j = 25\text{ }^\circ\text{C}$.

SILICON DIFFUSED POWER TRANSISTORS

High-voltage, high-speed, glass-passivated npn power transistors in a TO-220 envelope, intended for use in converters, inverters, switching regulators, motor control systems, etc.

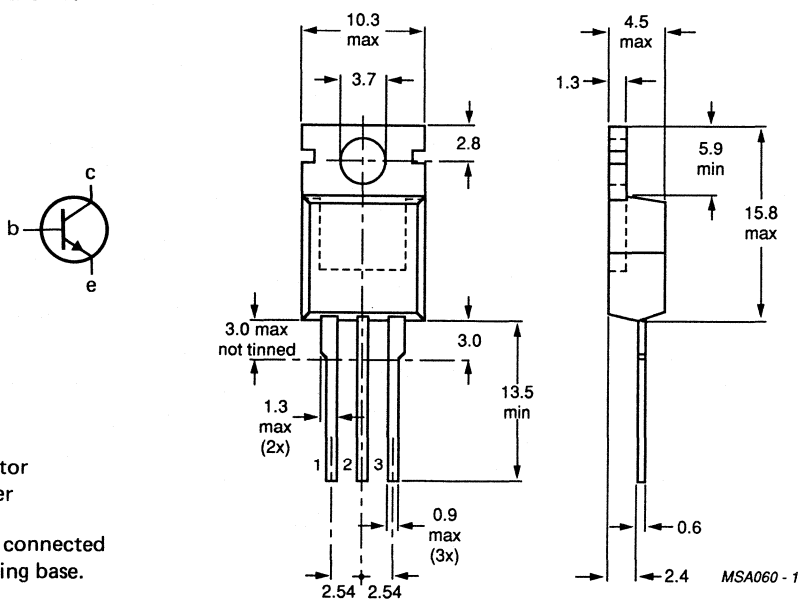
QUICK REFERENCE DATA

		BUT18	BUT18A
Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM}	max. 850	1000 V
	V_{CEO}	max. 400	450 V
Collector-emitter saturation voltage	V_{CEsat}	max. 1.5	V
Collector current saturation DC peak value	I_{Csat}		4.0 A
	I_C	max. 6.0	A
	I_{CM}	max. 12	A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max. 110	W
Fall time	t_f	max. 0.8	μs

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-220AB.



Pinning:

- 1 = base
- 2 = collector
- 3 = emitter

Collector connected
to mounting base.

RATINGS

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

		BUT18	BUT18A
Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM}	max. 850	1000 V
	V_{CEO}	max. 400	450 V
Collector current	saturation		4.0 A
	DC	I_C max.	6.0 A
	peak value	I_{CM} max.	12 A
Base current	DC	I_B max.	3.0 A
	peak value	I_{BM} max.	6.0 A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max. 110	W
Storage temperature range	T_{stg}		-65 to + 150 $^\circ\text{C}$
Junction temperature	T_j	max. 150	$^\circ\text{C}$
THERMAL RESISTANCE			
From junction to mounting base	$R_{th\ j-mb}$	=	1.15 K/W

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

Collector cut-off currents*

$V_{CE} = V_{CESmax}; V_{BE} = 0$

$V_{CE} = V_{CESmax}; V_{BE} = 0; T_j = 125\text{ }^\circ\text{C}$

I_{CES}	max.	1.0	mA
I_{CES}	max.	2.0	mA

Emitter cut-off current

$V_{EB} = 9\text{ V}; I_C = 0$

I_{EBO}	max.	10	mA
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Collector-emitter sustaining voltage

$I_C = 0.1\text{ A}; I_{B\text{ off}} = 0; L = 25\text{ mH}$ (Figs 2 and 3)

$V_{CEOsust}$	min.	400	450	V
---------------	------	-----	-----	---

Saturation voltages

$I_C = 4\text{ A}; I_B = 0.8\text{ A}$

V_{CEsat}	max.	1.5	V
V_{BEsat}	max.	1.3	V

DC current gain

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

h_{FE}	min.	10	
h_{FE}	typ.	18	
h_{FE}	max.	35	
h_{FE}	min.	10	
h_{FE}	typ.	20	
h_{FE}	max.	35	

$I_C = 1\text{ A}; V_{CE} = 5\text{ V}$

Switching times resistive load (Figs 4 and 5)

$I_{C\text{ on}} = 4\text{ A}; I_{B\text{ on}} = -I_{B\text{ off}} = 0.8\text{ A}$

Turn-on time

t_{on}	max.	1.0	μs
----------	------	-----	---------------

Turn-off; storage time

t_s	max.	4.0	μs
-------	------	-----	---------------

fall time

t_f	max.	0.8	μs
-------	------	-----	---------------

Switching times inductive load (Figs 6 and 7)

$I_{C\text{ on}} = 4\text{ A}; I_{B\text{ on}} = 0.8\text{ A}; V_{CL} = 250\text{ V}$

Turn-off; storage time

t_s	typ.	1.6	μs
-------	------	-----	---------------

t_s	max.	2.5	μs
-------	------	-----	---------------

fall time

t_f	typ.	150	ns
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t_f	max.	400	ns
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* Measured with a half-sinewave voltage (curve tracer).

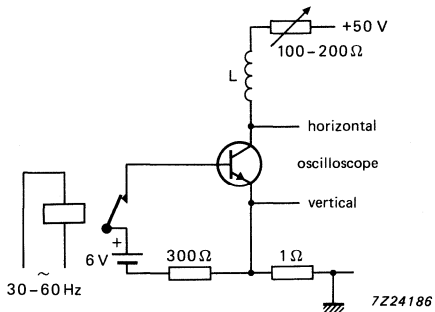
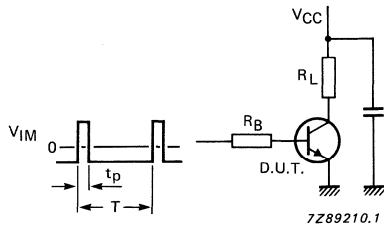


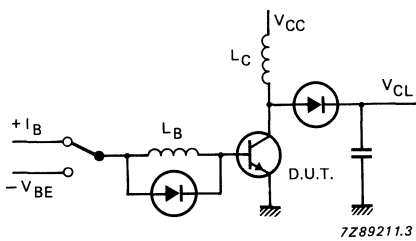
Fig. 2 Test circuit for $V_{CEOsust}$.



$V_{CC} = 250 \text{ V}$
 $t_p = 20 \mu\text{s}$
 $V_{IM} = -6 \text{ to } +8 \text{ V}$
 $\frac{t_p}{T} = 0.01$

The values of R_B and R_L are selected in accordance with $I_{C on}$ and I_B requirements.

Fig. 4 Test circuit resistive load.



$V_{CL} = \text{up to } 1000 \text{ V}$
 $V_{CC} = 30 \text{ V}$
 $-V_{BE} = 5 \text{ V}$
 $L_B = 1 \mu\text{H}$ (0 for RB SOAR)
 $L_C = 200 \mu\text{H}$

Fig. 6 Test circuit inductive load and RB SOAR.

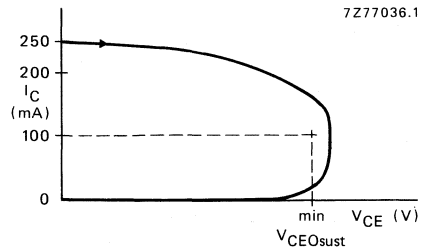


Fig. 3 Oscilloscope display for sustaining voltage.

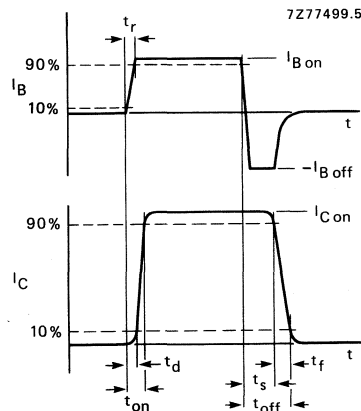


Fig. 5 Switching times waveforms with resistive load; $t_r \leq 30 \text{ ns}$.

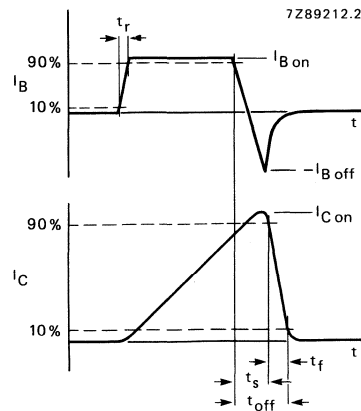
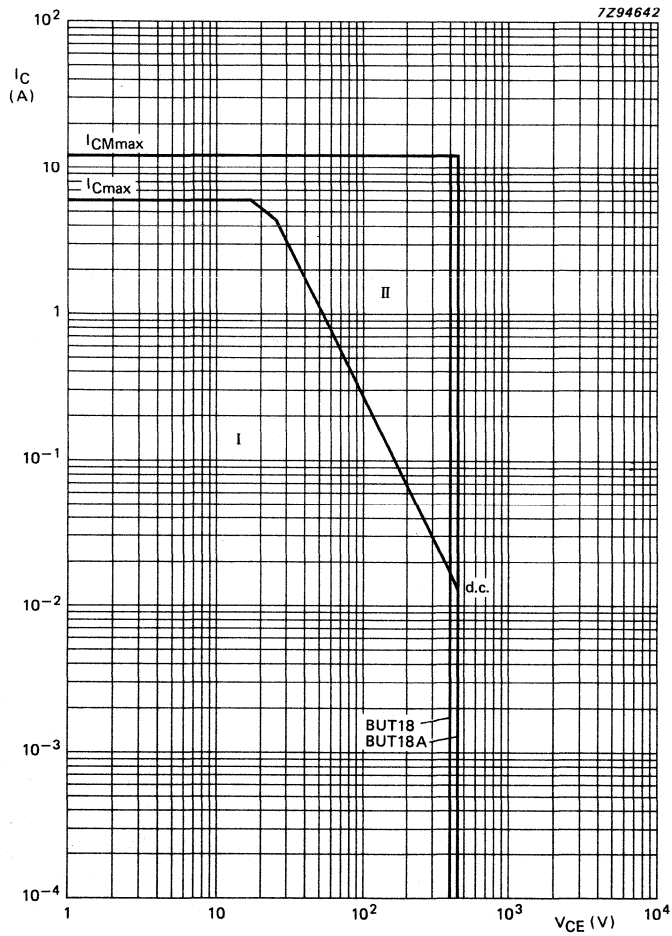


Fig. 7 Switching times waveforms with inductive load.



- I Region of permissible DC operation.
II Permissible extension for repetitive pulse operation.

Fig. 8 Safe operating area at $T_{mb} = 25^\circ\text{C}$.

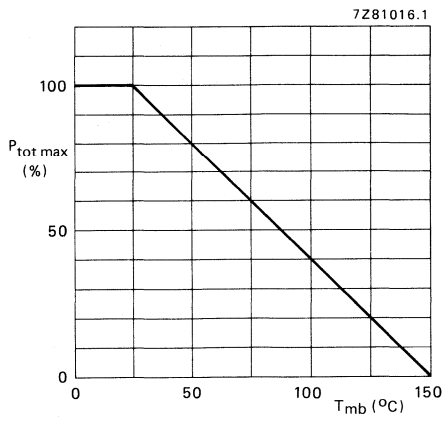


Fig. 9 Power derating curve.

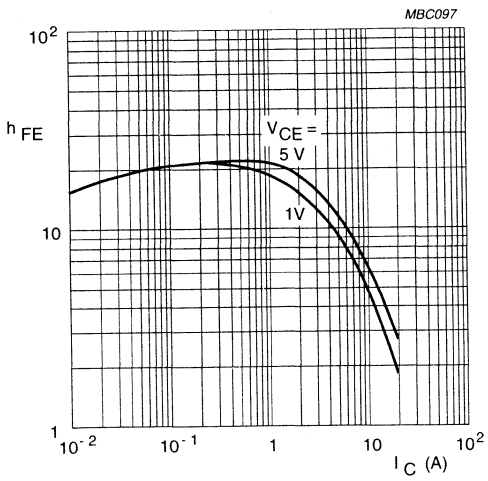


Fig.10 Typical values DC current gain;
 $V_{CE} = 5\text{ V}; T_j = 25\text{ }^\circ\text{C}.$

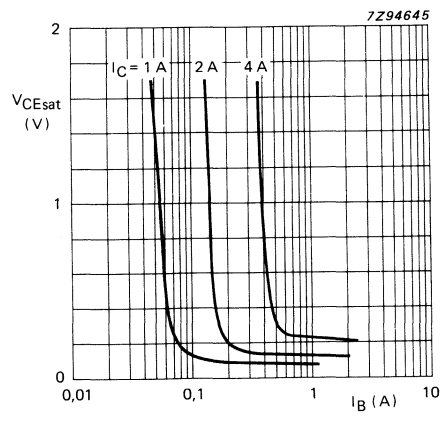


Fig.11 Collector-emitter saturation
voltage as a function of base current;
 $T_j = 25\text{ }^\circ\text{C}.$



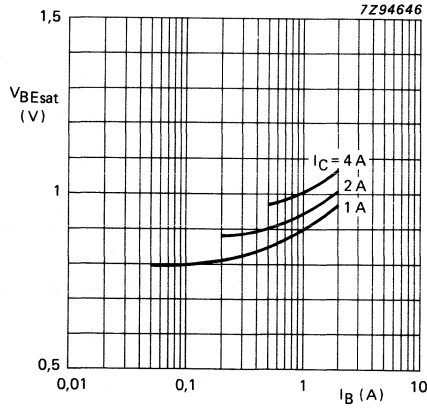


Fig. 12 Base-emitter saturation voltage as a function of base current; $T_j = 25^\circ\text{C}$.

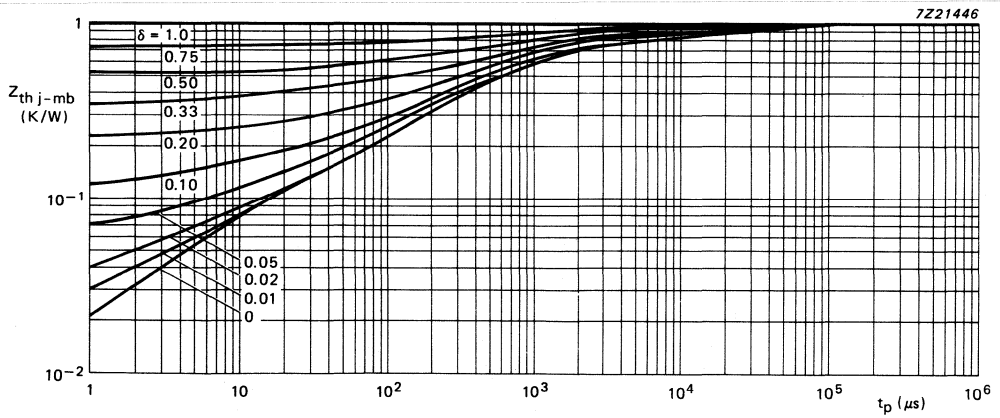


Fig. 13 Thermal response at pulse power conditions.

SILICON DIFFUSED POWER TRANSISTORS

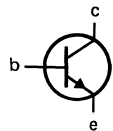
High-voltage, high-speed, glass-passivated npn power transistors in a SOT186 envelope with electrically isolated mounting base, intended for use in converters, inverters, switching regulators, motor control systems etc.

QUICK REFERENCE DATA

			BUT18F	18AF
Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM}	max.	850	1000 V
	V_{CEO}	max.	400	450 V
Collector-emitter saturation voltage	V_{CEsat}	max.	1.5	V
Collector current saturation DC peak value	I_{Csat}	max.	4.0	A
	I_C	max.	6.0	A
	I_{CM}	max.	12	A
Total power dissipation up to $T_{mb} = 25^\circ\text{C}$	P_{tot}	max.	33	W
Fall time; resistive load	t_f	max.	0.8	μs

MECHANICAL DATA

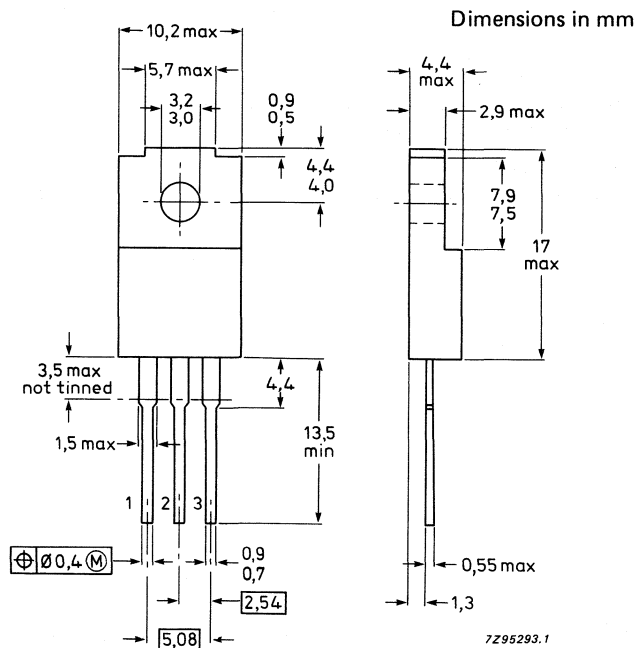
Fig. 1 SOT186.



Pinning:

- 1 = base
- 2 = collector
- 3 = emitter

Mounting base is electrically isolated from all terminals.



BUT18F BUT18AF

RATINGS

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

		BUT18F	18AF
Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM} max.	850	1000 V
	V_{CEO} max.	400	450 V
Collector current saturation DC peak value	I_{Csat}	4.0	A
	I_C max.	6.0	A
	I_{CM} max.	12	A
Base current DC peak value	I_B max.	3.0	A
	I_{BM} max.	6.0	A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$ without heatsink compound with heatsink compound	P_{tot} max.	20	W
	P_{tot} max.	33	W
Storage temperature range	T_{stg}	-65 to + 150	$^\circ\text{C}$
Junction temperature	T_j max.	150	$^\circ\text{C}$

THERMAL RESISTANCE

From junction to external heatsink (note 1)

without heatsink compound	$R_{th\ j-h}$	=	6.15	K/W
with heatsink compound	$R_{th\ j-h}$	=	3.65	K/W

ISOLATION

Isolation voltage from all terminals to external heatsink (peak value)	V_{isol}	max.	1500	V
Isolation capacitance from collector to external heatsink	C_{isol}	typ.	12	pF

Note

1. 30 ± 5 newtons pressure on the centre of the envelope.

CHARACTERISTICS

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

Collector cut-off currents*

$V_{CE} = V_{CESMmax}; V_{BE} = 0$

$V_{CE} = V_{CESMmax}; V_{BE} = 0; T_j = 125\text{ }^\circ\text{C}$

I_{CES}	max.	1.0	mA
I_{CES}	max.	2.0	mA

Emitter cut-off current

$V_{EB} = 9\text{ V}; I_C = 0$

I_{EBO}	max.	10	mA
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Collector-emitter sustaining voltage (Figs 2 and 3)

$I_C = 100\text{ mA}; I_{B\text{ off}} = 0; L = 25\text{ mH}$

		BUT18F	18AF	
$V_{CEO\text{ sust}}$	min.	400	450	V

Saturation voltages

$I_C = 4\text{ A}; I_B = 0.8\text{ A}$

$V_{CE\text{ sat}}$	max.	1.5	V
$V_{BE\text{ sat}}$	max.	1.3	V

DC current gain

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

h_{FE}	min.	10	
h_{FE}	typ.	18	
h_{FE}	max.	35	

$I_C = 1\text{ A}; V_{CE} = 5\text{ V}$

h_{FE}	min.	10	
h_{FE}	typ.	20	
h_{FE}	max.	35	

Switching times resistive load (Figs 4 and 5)

$I_{C\text{ on}} = 4\text{ A}; I_{B\text{ on}} = -I_{B\text{ off}} = 0.8\text{ A}$

turn-on time

t_{on}	max.	1.0	μs
----------	------	-----	---------------

turn-off; storage time

t_s	max.	4.0	μs
-------	------	-----	---------------

fall time

t_f	max.	0.8	μs
-------	------	-----	---------------

Switching times inductive load (Figs 6 and 7)

$I_{C\text{ on}} = 4\text{ A}; I_{B\text{ on}} = 0.8\text{ A}$

turn-off; storage time

t_s	typ.	1.6	μs
-------	------	-----	---------------

t_s	max.	2.5	μs
-------	------	-----	---------------

fall time

t_f	typ.	150	ns
-------	------	-----	----

t_f	max.	400	ns
-------	------	-----	----

* Measured with a half-sinewave voltage (curve tracer).

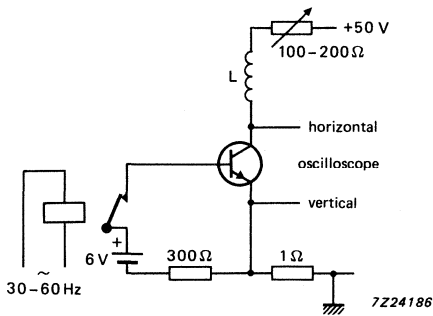


Fig. 2 Test circuit for $V_{CE0sust}$.

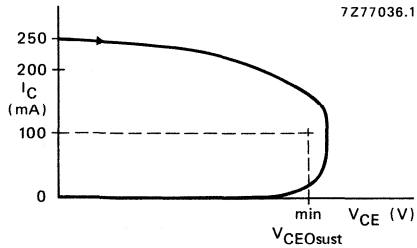
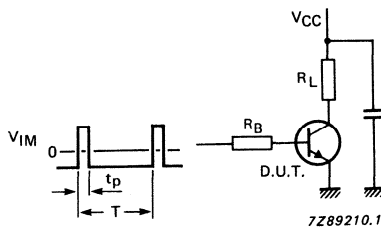


Fig. 3 Oscilloscope display for sustaining voltage.



$V_{CC} = 250 \text{ V}$
 $t_p = 20 \mu\text{s}$
 $V_{IN} = -6 \text{ to } +8 \text{ V}$
 $\frac{t_p}{T} = 0.01$

The values of R_B and R_L are selected in accordance with $I_{C \text{ on}}$ and I_B requirements.

Fig. 4 Test circuit resistive load.

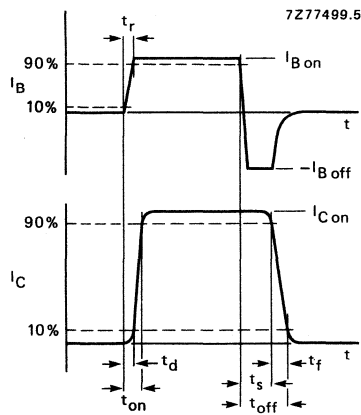
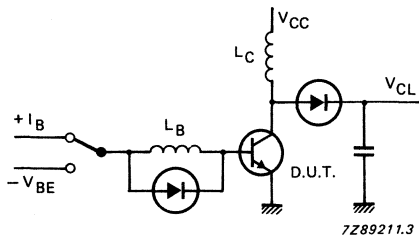


Fig. 5 Switching times waveforms with resistive load; $t_r \leq 20 \text{ ns}$.



$V_{CL} = 300 \text{ V}$
 $V_{CC} = 30 \text{ V}$
 $-V_{BE} = 5 \text{ V}$
 $L_B = 1 \mu\text{H}$
 $L_C = 200 \mu\text{H}$

Fig. 6 Test circuit inductive load.

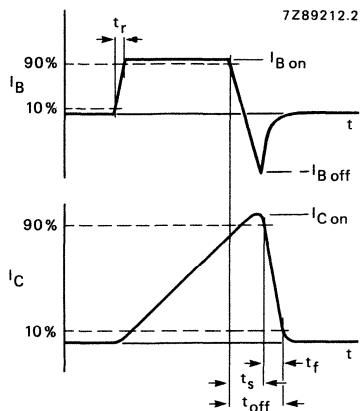
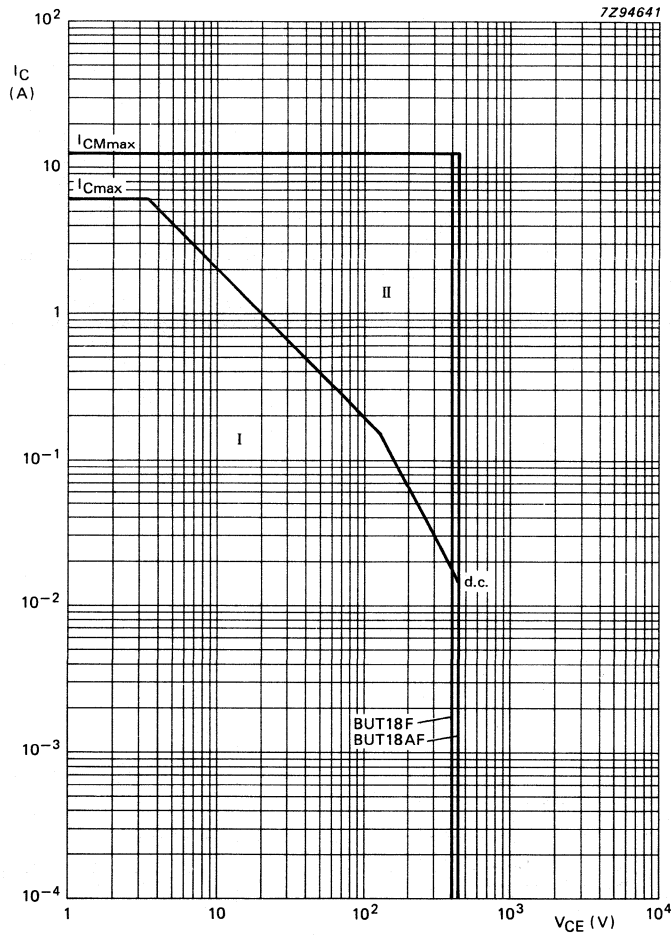


Fig. 7 Switching times waveforms with inductive load.



I Region of permissible DC operation.

II Permissible extension for repetitive pulse operation.

Fig. 8 Safe operating area at $T_{mb} < 25^\circ\text{C}$;
mounted without heatsink compound and
 30 ± 5 newtons pressure on the centre of
the envelope.

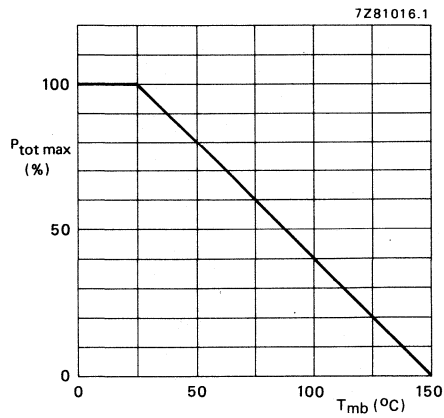


Fig. 9 Power derating curve.

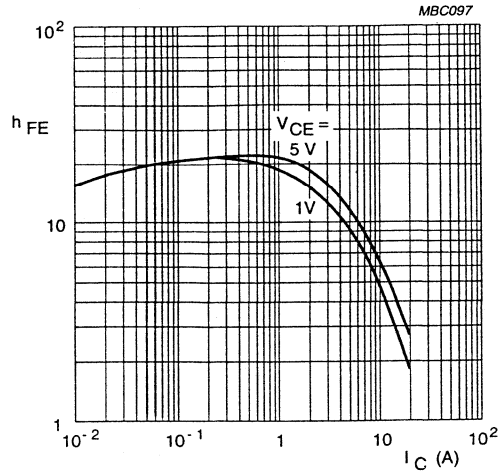


Fig. 10 Typical values DC current gain;
 $V_C = 5\text{ V}$; $T_j = 25\text{ }^\circ\text{C}$.

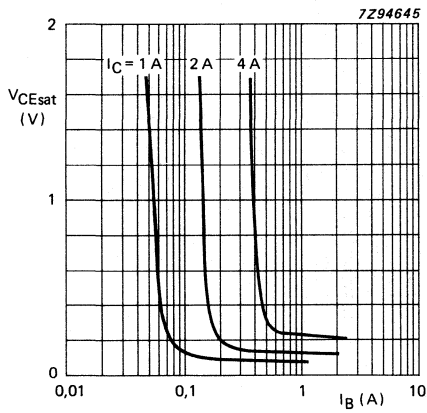


Fig. 11 Collector-emitter saturation voltage as a function of base current;
 $T_j = 25\text{ }^\circ\text{C}$.

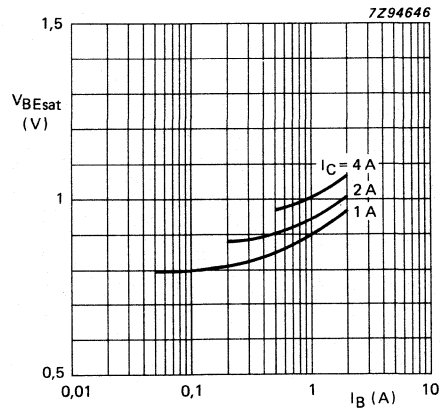


Fig. 12 Base-emitter saturation voltage as a function of base current; $T_j = 25\text{ }^\circ\text{C}$

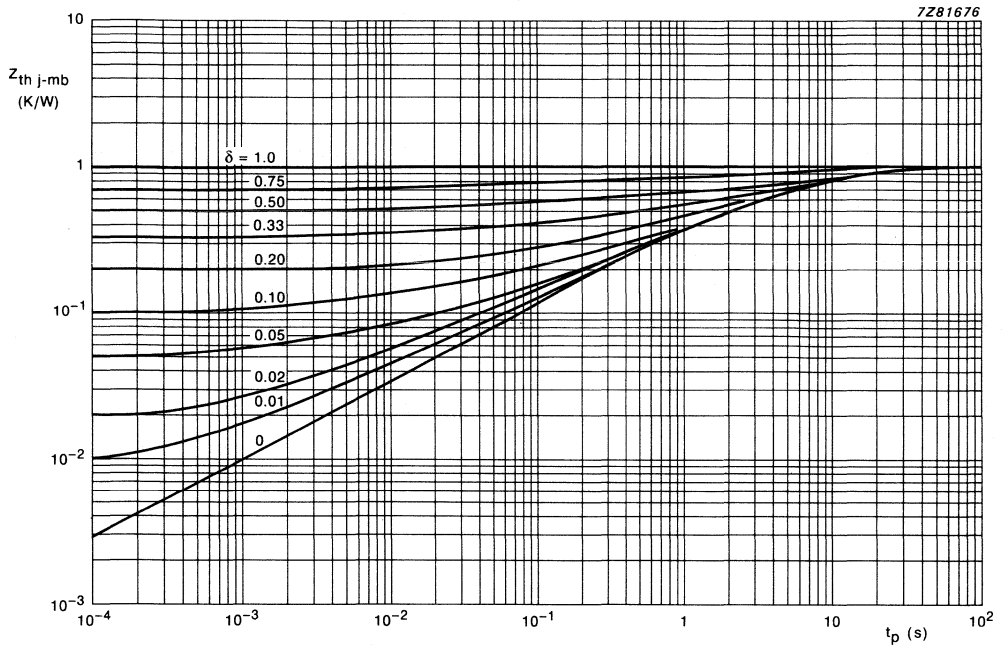


Fig. 13 Normalized thermal resistance.

SILICON POWER TRANSISTORS

High-speed, glass-passivated npn power transistors in a TO-220 envelope intended for fast switching applications such as high frequency and efficiency converters, switching regulators and motor control.

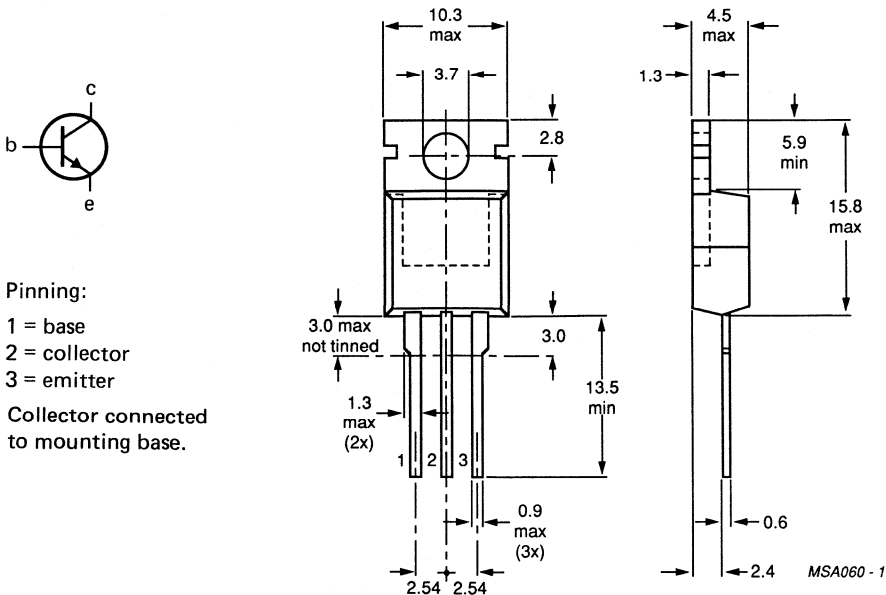
QUICK REFERENCE DATA

		BUV26		26A	
Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM}	max.	180	200	V
	V_{CEO}	max.	90	100	V
Collector-emitter saturation voltage	V_{CEsat}	max.	1,5	1,0	V
Collector current saturation DC peak value	I_{Csat}	max.	12	10	A
	I_C	max.	14		A
	I_{CM}	max.	25		A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	65		W
Fall time; inductive load	t_f	typ.	40		ns

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-220AB.



RATINGS

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

		BUV26		26A	
Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM}	max.	180	200	V
	V_{CEO}	max.	90	100	V
Collector current saturation DC peak value	I_{Csat}	max.	12	10	A
	I_C	max.		14	A
	I_{CM}	max.		25	A
Base current DC peak value	I_B	max.	4,0		A
	I_{BM}	max.	6,0		A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	65		W
Storage temperature range	T_{stg}		-65 to + 150		$^\circ\text{C}$
Junction temperature	T_j	max.	150		$^\circ\text{C}$
THERMAL RESISTANCE					
From junction to mounting base	$R_{th\ j-mb}$	=	1,92		K/W

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

Collector cut-off currents*

 $V_{CE} = V_{CESmax}; V_{BE} = -1,5\text{ V};$
 $T_j = 125\text{ }^\circ\text{C}$
 I_{CEX} max. 1,0 mA

 $V_{CE} = V_{CESmax}; R_{BE} = 50\ \Omega;$
 $T_j = 125\text{ }^\circ\text{C}$
 I_{CER} max. 3,0 mA

Emitter cut-off current

 $V_{EB} = 5\text{ V}; I_C = 0$
 I_{EBO} max. 1,0 mA

Collector-emitter sustaining voltage

(Figs 2 and 3)

 $I_B = 0; I_C = 0,2\text{ A}; L = 25\text{ mH}$

		BUV26	26A	
$V_{CEO_{sust}}$	min.	90	100	V

Saturation voltages

 $I_C = I_{Csat}; I_B = I_{Csat}/10$
 V_{CEsat} max. 1,5 V

 V_{BEsat} max. 2,0 V

 $I_C = I_{Csat}/2; I_B = I_{Csat}/20$
 V_{CEsat} max. 0,6 V

 V_{BEsat} max. 1,2 V

Switching times resistive load

(Figs 4 and 5)

 $I_{C\ on} = I_{Csat}; I_{B\ on} = I_{Csat}/10;$
 $I_{B\ off} = 2I_{B\ on}; V_{CE} = 50\text{ V}$

Turn-on time

 t_{on} typ. 0,4 μs

Turn-off;

storage time

 t_s typ. 0,45 μs

fall time

 t_f typ. 0,12 μs

Turn-on time

 t_{on} max. 0,6 μs

Turn-off;

storage time

 t_s max. 1,0 μs

fall time

 t_f max. 0,25 μs

Switching times inductive load

(Figs 6 and 7)

 $I_{C\ on} = I_{Csat}; I_{B\ on} = I_{Csat}/10$

Turn-off

storage time

 t_s typ. 0,5 μs

fall time

 t_f typ. 40 μs

 Turn-off; $T_j = 125\text{ }^\circ\text{C}$

storage time

 t_s max. 2,0 μs

fall time

 t_f max. 150 ns

* Measured with a half-sinewave voltage (curve tracer).

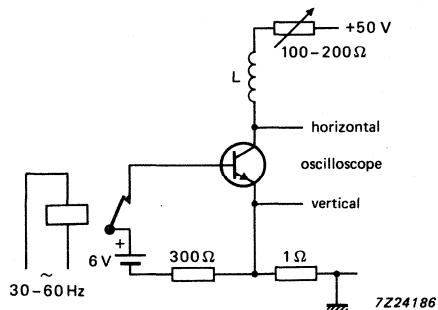


Fig. 2 Test circuit for V_{CEsust} .

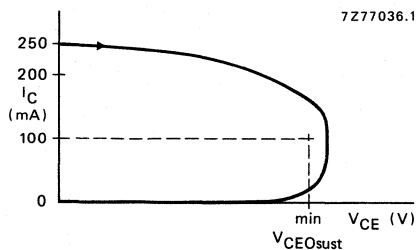


Fig. 3 Oscilloscope display for sustaining voltage.

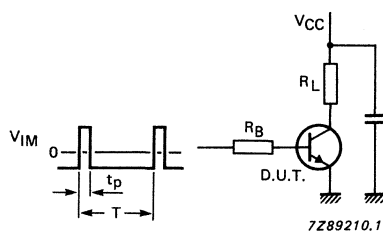


Fig. 4 Test circuit resistive load.

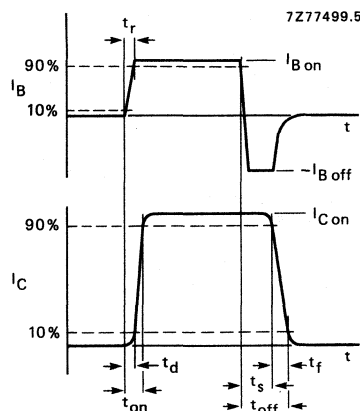
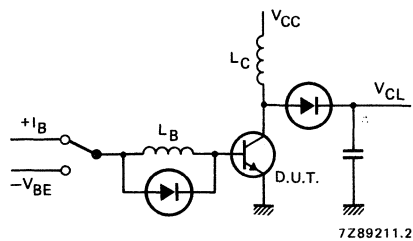


Fig. 5 Switching times waveforms with resistive load; $t_r \leq 30$ ns.



$L_B = 0,5 \mu H$
 $L_C = 200 \mu H$
 $V_{CC} = 50 V$
 $-V_{BE} = 5 V$
 $V_{CL} = 50 V$

Fig. 6 Test circuit inductive load.

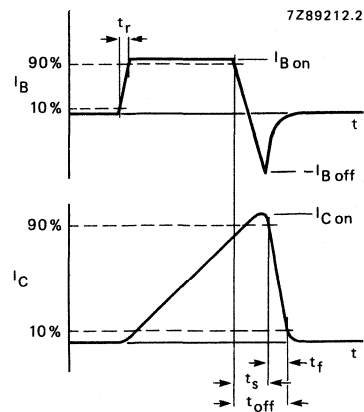


Fig. 7 Switching times waveforms with inductive load.

SILICON DIFFUSED POWER TRANSISTORS

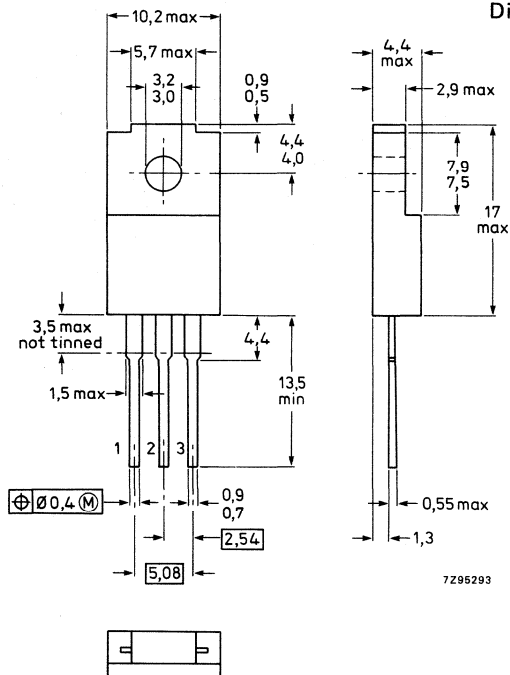
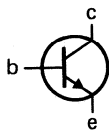
High-voltage, high-speed, glass-passivated npn power transistor in a SOT186 envelope with electrically isolated mounting base, intended for use in converters, inverters, switching regulators, motor control systems, etc.

QUICK REFERENCE DATA

		BUV26F		26AF
Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM}	max.	180	200 V
	V_{CEO}	max.	90	100 V
Collector-emitter saturation voltage	V_{CEsat}	max.	1,5	1,0 V
Collector current saturation DC peak value	I_{CSat}	max.	12	10 A
	I_C	max.		14 A
	I_{CM}	max.		25 A
Total power dissipation up to $T_h = 25\text{ }^\circ\text{C}$	P_{tot}	max.		18 W
Fall time; inductive load	t_f	typ.		40 ns

MECHANICAL DATA

Fig. 1 SOT186.



Pinning:

- 1 = base
- 2 = collector
- 3 = emitter

Mounting base is electrically isolated from all terminals.

RATINGS

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

		BUV26F		26AF	
Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM}	max.	180	200	V
	V_{CEO}	max.	90	100	V
Collector current saturation DC peak value	I_{Csat}		12	10	A
	I_C	max.	14		A
	I_{CM}	max.	25		A
Base current DC peak value	I_B	max.	4,0		A
	I_{BM}	max.	6,0		A
Total power dissipation up to $T_h = 25\text{ }^\circ\text{C}$	P_{tot}	max.	18		W
Storage temperature range	T_{stg}		-65 to + 150		$^\circ\text{C}$
Junction temperature	T_j	max.	150		$^\circ\text{C}$
THERMAL RESISTANCE					
From junction to external heatsink (1)	$R_{th\ j-h}$	=	7,0		K/W
From junction to external heatsink (2)	$R_{th\ j-h}$	=	4,5		K/W
From junction to ambient	$R_{th\ j-a}$	=	55		K/W
ISOLATION					
Isolation voltage from all terminals to external heatsink (peak value)	V_{isol}	max.	1500		V
Isolation capacitance from collector to external heatsink	C_{isol}	typ.	12		pF

Notes

1. Mounted without heatsink compound and 30 ± 5 newtons pressure on centre of envelope.
2. Mounted with heatsink compound and 30 ± 5 newtons pressure on centre of envelope.

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

Collector cut-off currents

 $V_{CE} = V_{CESmax}; V_{BE} = -1,5\text{ V}; T_j = 125\text{ }^\circ\text{C}$
 $V_{CE} = V_{CESmax}; V_{BE} = 0; T_j = 125\text{ }^\circ\text{C}$

I_{CEX}	max.	1,0	mA
I_{CES}	max.	3,0	mA

Emitter cut-off current

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

I_{EBO}	max.	1,0	mA
-----------	------	-----	----

Saturation voltages

 $I_C = I_{Csat}; I_B = I_{Csat}/10$
 $I_C = 6\text{ A}; I_B = I_{Csat}/20$
 $I_C = 5\text{ A}; I_B = I_{Csat}/20$

		BUV26F	26AF
V_{CEsat}	max.	1,5	1,0 V
V_{BEsat}	max.	2,0	1,5 V
V_{CEsat}	max.	0,6	— V
V_{BEsat}	max.	1,2	— V
V_{CEsat}	max.	—	0,5 V
V_{BEsat}	max.	—	1,2 V

 Collector-emitter sustaining voltage
 (Figs 2 and 3)

 $I_C = 200\text{ mA}; I_B = 0; L = 25\text{ mH}$

$V_{CEOsust}$	min.	90	100 V
---------------	------	----	-------

 Switching times resistive load
 (Figs 4 and 5)

 $I_{C\text{ on}} = I_{Csat}; I_{B\text{ on}} = I_{Csat}/10$

Turn-on time

t_{on}	typ.	0,4	μs
----------	------	-----	---------------

Turn-off;

storage time

fall time

t_s	typ.	0,45	μs
t_f	typ.	0,12	μs

 $I_{C\text{ on}} = I_{Csat}; I_{B\text{ off}} = 2 I_{B\text{ on}}$

Turn-on time

t_{on}	max.	0,6	μs
----------	------	-----	---------------

Turn-off;

storage time

fall time

t_s	max.	1,0	μs
t_f	max.	0,25	μs

 Switching times inductive load
 (Figs 6 and 7)

 $I_{C\text{ on}} = I_{Csat}; I_{B\text{ on}} = I_{Csat}/10$

Turn-off;

storage time

fall time

t_s	typ.	0,5	μs
t_f	typ.	40	ns

Turn off;

 $T_j = 125\text{ }^\circ\text{C}$

storage time

fall time

t_s	max.	2,0	μs
t_f	max.	150	ns

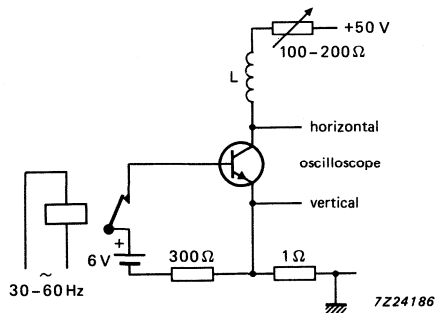


Fig. 2 Test circuit for $V_{CEOsust}$.

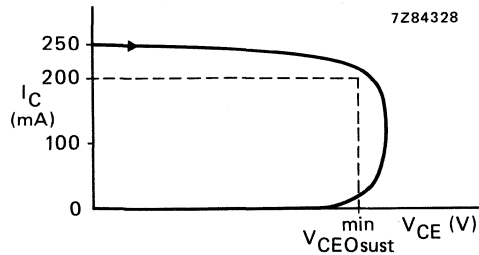


Fig. 3 Oscilloscope display for sustaining voltage.

$V_{CC} = 50\text{ V}$
 $t_p = 20\ \mu\text{s}$
 $V_{IM} = -6\text{ to }+4,5\text{ V}$
 $\frac{t_p}{T} = 0,01$

The values of R_B and R_L are selected in accordance with $I_{C\ on}$ and I_B requirements.

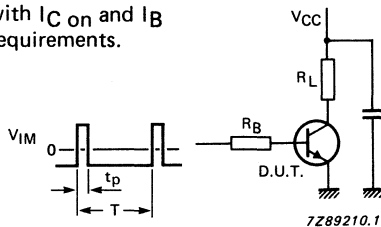


Fig. 4 Test circuit resistive load.

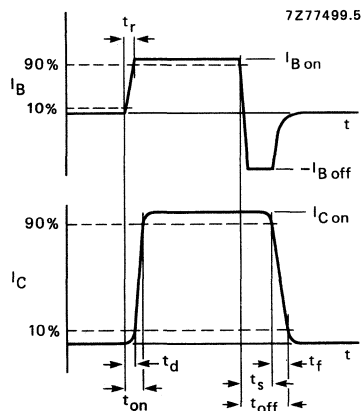


Fig. 5 Switching times waveforms with resistive load; $t_r \leq 30\text{ ns}$.

$V_{CL} = \text{up to } 50\text{ V}$
 $V_{CC} = 30\text{ V}$
 $-V_{BE} = 5\text{ V}$
 $L_B = 0,5\ \mu\text{H}$
 $L_C = 200\ \mu\text{H}$

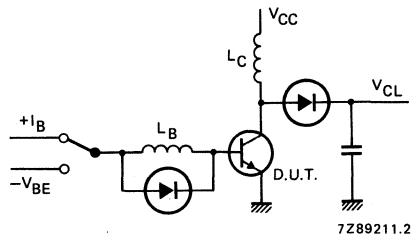


Fig. 6 Test circuit inductive load.

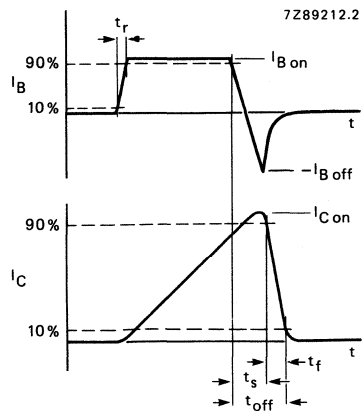
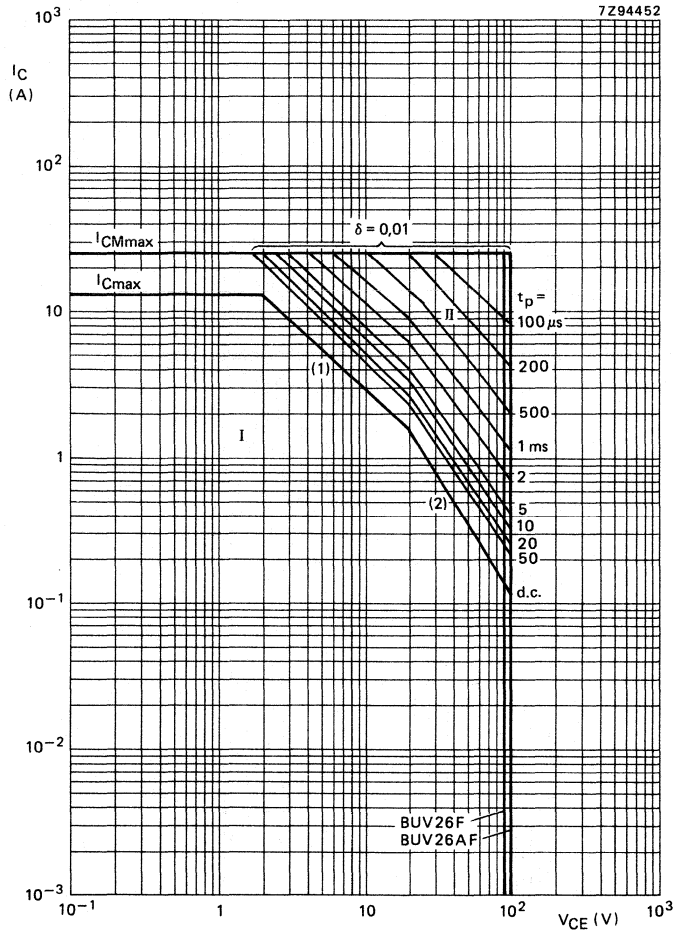
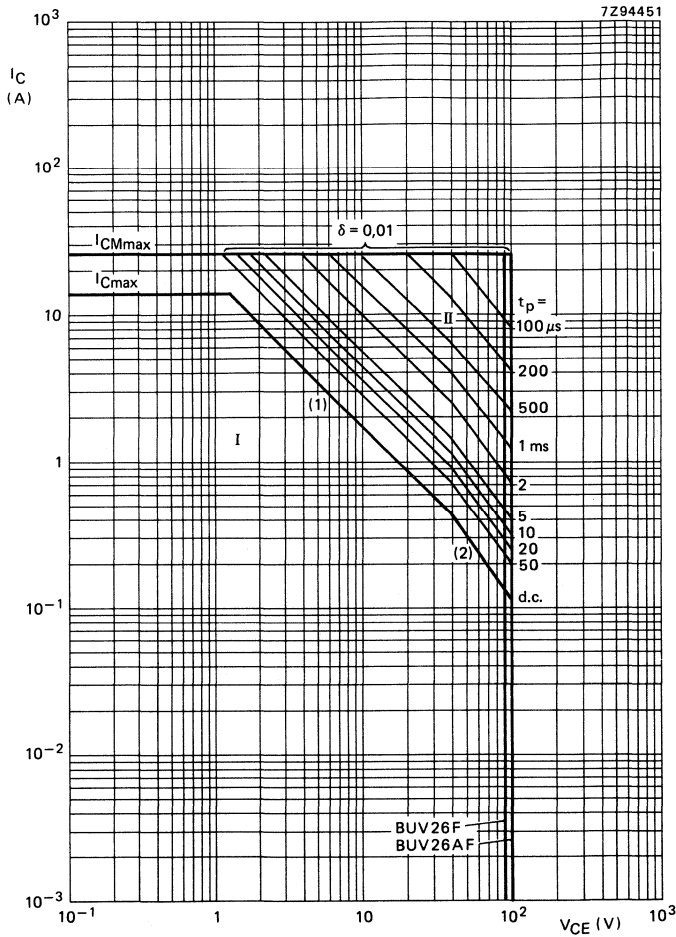


Fig. 7 Switching times waveforms with inductive load.



- I Region of permissible DC operation
- II Permissible extension for repetitive pulse operation
- (1) $P_{tot\ max}$ and $P_{peak\ max}$ lines
- (2) Second-breakdown limits

Fig. 8 Safe operating area at $T_{mb} < 25\ ^\circ\text{C}$; mounted with heatsink compound and 30 ± 5 newtons pressure on the centre of the envelope.



- I Region of permissible DC operation
- II Permissible extension for repetitive pulse operation
- (1) $P_{tot\ max}$ and $P_{peak\ max}$ lines
- (2) Second-breakdown limits

Fig. 9 Safe operating area at $T_{mb} < 25\ ^\circ\text{C}$; mounted without heatsink compound and 30 ± 5 newtons pressure on the centre of the envelope.

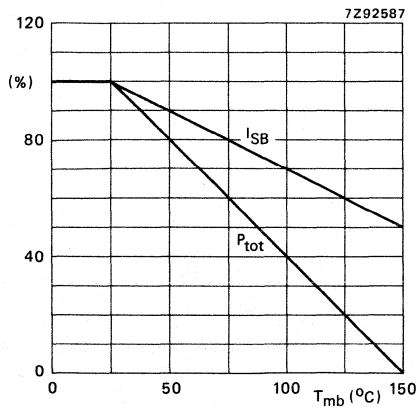


Fig. 10 Total power dissipation and second-breakdown current derating curve.

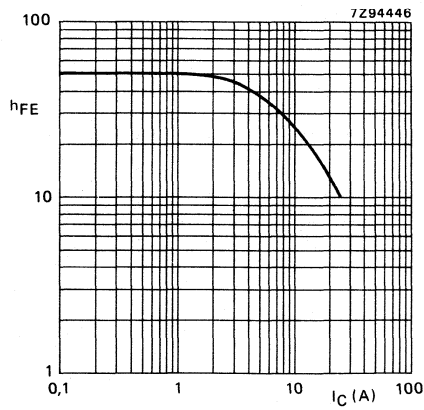


Fig. 11 Typical DC current gain (BUV26F); $V_{CE} = 5$ V; $T_j = 25$ °C.

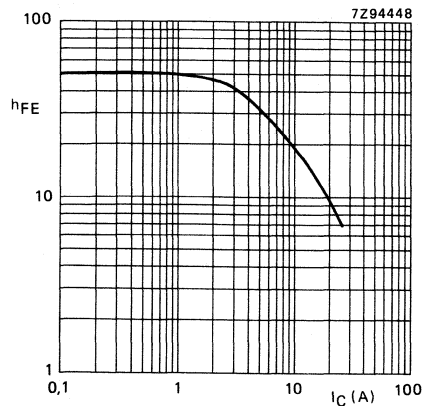


Fig. 12 Typical DC current gain (BUV26AF); $V_{CE} = 5$ V; $T_j = 25$ °C.

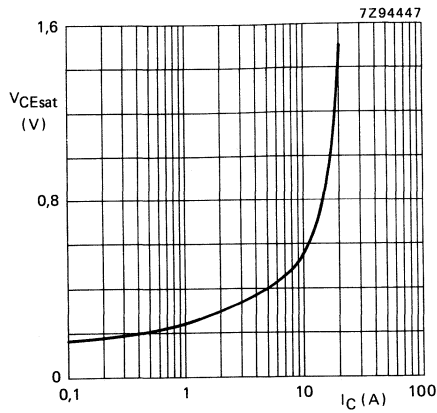


Fig. 13 Collector-emitter saturation voltage as a function of collector current (BUV26F); $I_C/I_B = 10$.

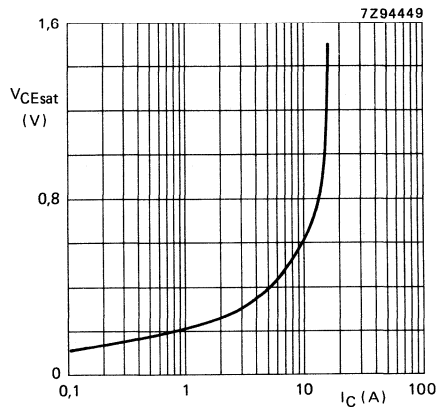


Fig. 14 Collector-emitter saturation voltage as a function of collector current (BUV26AF); $I_C/I_B = 10$.

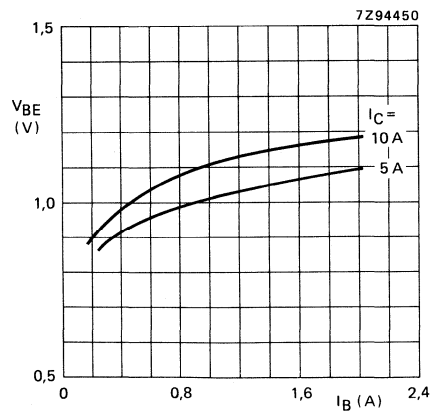


Fig. 15 Base-emitter voltage as a function of base current; $T_j = 25$ °C.

SILICON POWER TRANSISTORS

High-speed, glass-passivated npn power transistors in a TO-220 envelope intended for fast switching applications such as high frequency and efficiency converters, switching regulators and motor control.

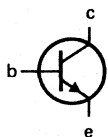
QUICK REFERENCE DATA

		BUV27		27A	
Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM}	max.	240	300	V
	V_{CEO}	max.	120	150	V
Collector-emitter saturation voltage	V_{CEsat}	max.	1,5	1,0	V
Collector current saturation DC peak value	I_{Csat}		8,0	7,0	A
	I_C	max.	12		A
	I_{CM}	max.	20		A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	65		W
Fall time; inductive load	t_f	typ.	40		ns

MECHANICAL DATA

Dimensions in mm

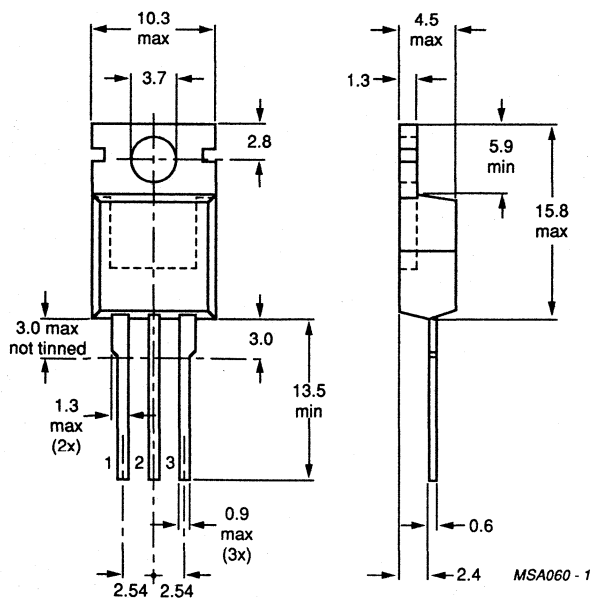
Fig. 1 TO-220AB.



Pinning:

b = base
c = collector
e = emitter

Collector connected to
mounting base.



RATINGS

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

		BUV27	27A	
Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM}	max. 240	300	V
	V_{CEO}	max. 120	150	V
Collector current saturation DC peak value	I_{Csat}	8,0	7,0	A
	I_C	max. 12		A
	I_{CM}	max. 20		A
Base current DC peak value	I_B	max. 4,0		A
	I_{BM}	max. 6,0		A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max. 65		W
Storage temperature	T_{stg}		-65 to + 150	$^\circ\text{C}$
Junction temperature	T_j	max. 150		$^\circ\text{C}$
THERMAL RESISTANCE				
From junction to mounting base	$R_{th\ j-mb}$	=	1,92	K/W

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

Collector cut-off currents*

 $V_{CE} = V_{CESmax}; V_{BE} = -1,5\text{ V};$
 $T_j = 125\text{ }^\circ\text{C}$ I_{CEX} max. 1,0 mA $V_{CE} = V_{CESmax}; R_{BE} = 50\ \Omega;$
 $T_j = 125\text{ }^\circ\text{C}$ I_{CER} max. 3,0 mA

Emitter cut-off current

 $V_{EB} = 5\text{ V}; I_C = 0$ I_{EBO} max. 1,0 mACollector-emitter sustaining voltage
(Figs 2 and 3) $I_B = 0; I_C = 0,2\text{ A}; L = 25\text{ mH}$

		BUV27	27A	
V_{CEO} sust	min.	120	150	V

Saturation voltages

 $I_C = I_{Csat}; I_B = I_{Csat}/10$ V_{CEsat} max. 1,5 V V_{BEsat} max. 2,0 V $I_C = I_{Csat}/2; I_B = I_{Csat}/20$ V_{CEsat} max. 0,7 VSwitching times resistive load
(Figs 4 and 5) $I_{Con} = I_{Csat}; I_{Bon} = I_{Csat}/10;$
 $I_{Boff} = 2I_{Bon}; V_{CE} = 50\text{ V}$

Turn-on time

 t_{on} typ. 0,4 μs Turn-off; storage time
fall time t_s typ. 0,5 μs t_f typ. 0,12 μs

Turn-on time

 t_{on} max. 0,8 μs Turn-off; storage time
fall time t_s max. 1,2 μs t_f max. 0,4 μs Switching times inductive load
(Figs 6 and 7) $I_{Con} = I_{Csat}; I_{Bon} = I_{Csat}/10;$
 $V_{CC} = V_{CL} = 50\text{ V}; L_B = 1\ \mu\text{H};$
 $-V_B = 5\text{ V}$ Turn-off; storage time at $T_j = 25\text{ }^\circ\text{C}$ t_s typ. 0,6 μs t_f typ. 40 nsfall time at $T_j = 125\text{ }^\circ\text{C}$ t_s max. 2,0 μs t_f max. 150 ns

* Measured with a half-sinewave voltage (curve tracer).

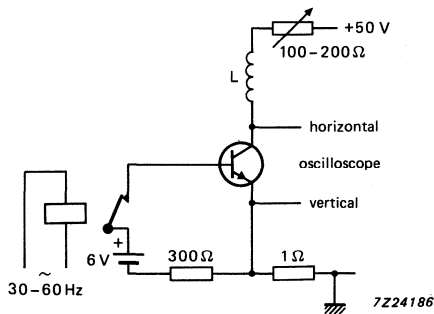


Fig. 2 Test circuit for V_{CEsust} .

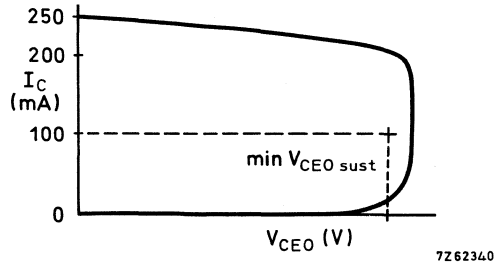


Fig. 3 Oscilloscope display for sustaining voltage.

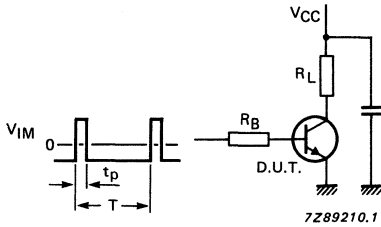


Fig. 4 Test circuit resistive load.

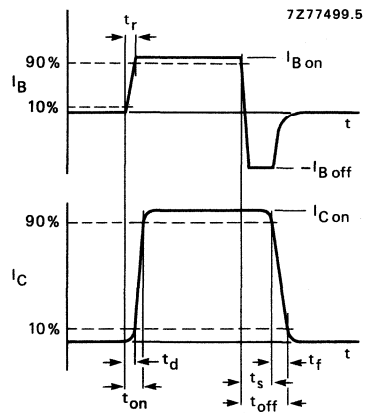


Fig. 5 Switching times waveforms with restrictive load; $t_r \leq 30$ ns.

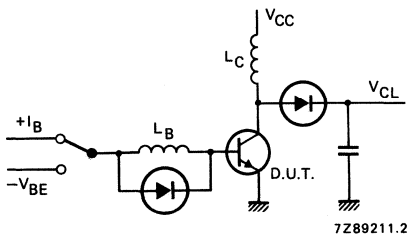


Fig. 6 Test circuit inductive load.
 $V_{CC} = 50$ V; $V_{CL} = 50$ V.

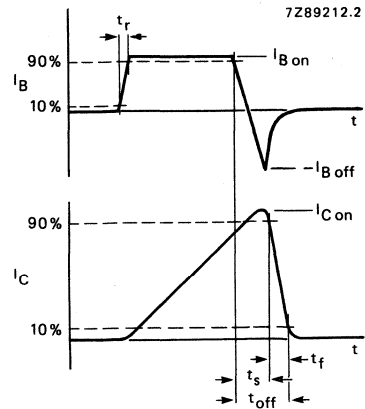


Fig. 7 Switching times waveforms with inductive load.

SILICON DIFFUSED POWER TRANSISTORS

High-voltage, high-speed, glass-passivated npn power transistor in a SOT186 envelope with electrically isolated mounting base, intended for use in converters, inverters, switching regulators, motor control systems, etc.

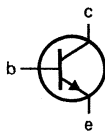
QUICK REFERENCE DATA

		BUV27F	27AF
Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM}	max. 240	300 V
	V_{CEO}	max. 120	150 V
Collector-emitter saturation voltage	V_{CEsat}	max. 1.0	1.5 V
Collector current saturation DC peak value	I_{Csat}	max. 8.0	7.0 A
	I_C	max.	A
	I_{CM}	max.	A
Total power dissipation up to $T_h = 25^\circ C$	P_{tot}	max. 18	W
Fall time; inductive load	t_f	typ. 40	ns

MECHANICAL DATA

Dimensions in mm

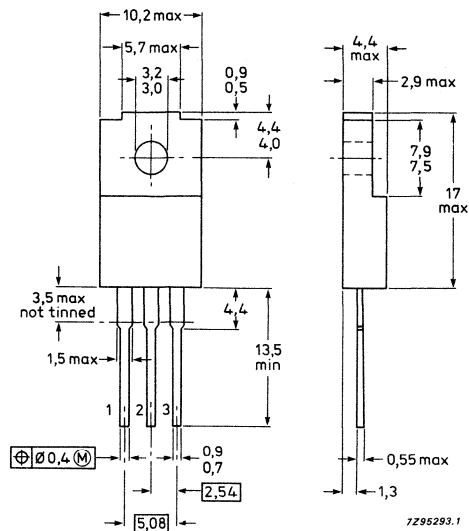
Fig. 1 SOT186.



Pinning:

- 1 = base
- 2 = collector
- 3 = emitter

Mounting base is electrically isolated from all terminals.



7295293.1

RATINGS

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

			BUV27F	27AF
Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM}	max.	240	300 V
	V_{CEO}	max.	120	150 V
Collector current saturation DC peak value	I_{Csat}	max.	8.0	7.0 A
	I_C	max.		12 A
	I_{CM}	max.		20 A
Base current DC peak value	I_B	max.	4.0	A
	I_{BM}	max.	6.0	A
Total power dissipation up to $T_h = 25\text{ }^\circ\text{C}$	P_{tot}	max.	18	W
Storage temperature range	T_{stg}		-65 to + 150	$^\circ\text{C}$
Junction temperature	T_j	max.	150	$^\circ\text{C}$

THERMAL RESISTANCE

From junction to mounting base (note 1)	$R_{th\ j-mb}$	=	7.0	K/W
From junction to mounting base (note 2)	$R_{th\ j-mb}$	=	4.5	K/W
From junction to ambient	$R_{th\ j-a}$	=	55	K/W

INSULATION

Insulation voltage from all terminals to external heatsink (peak value)	V_{isol}	max.	1500	V
Insulation capacitance from collector to external heatsink	C_{isol}	typ.	12	pF

Notes

1. Mounted without heatsink compound and 30 ± 5 newtons pressure on centre of envelope.
2. Mounted with heatsink compound and 30 ± 5 newtons pressure on centre of envelope.

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

Collector cut-off currents

 $V_{CE} = V_{CESmax}; V_{BE} = -1.5\text{ V}; T_j = 125\text{ }^\circ\text{C}$
 $V_{CE} = V_{CESmax}; V_{BE} = 0\text{ V}; T_j = 125\text{ }^\circ\text{C}$
 I_{CEX} max. 1.0 mA

 I_{CES} max. 3.0 mA

Emitter cut-off current

 $V_{EB} = 5\text{ V}; I_C = 0$
 I_{EBO} max. 1.0 mA

Saturation voltages

 $I_C = I_{Csat}; I_B = I_{Csat}/10$

		BUV27F	27AF
V_{CEsat}	max.	1.5	1.0 V
V_{BEsat}	max.	2.0	2.0 V

Collector-emitter sustaining voltage (Figs 2 and 3)

 $I_C = 200\text{ mA}; I_B = 0; L = 25\text{ mH}$
 $V_{CEO_{sust}}$ min. 120 150 V

Switching times resistive load (Figs 4 and 5)

 $I_C = I_{Csat}; I_{B\text{ on}} = I_{Csat}/10; I_{B\text{ off}} = 2I_{B\text{ on}}$

Turn-on time

 t_{on} typ. 0.4 μs

Turn-off; storage time

 t_s typ. 0.5 μs

fall time

 t_f typ. 0.12 μs

Turn-on time

 t_{on} max. 0.8 μs

Turn-off; storage time

 t_s max. 1.2 μs

fall time

 t_f max. 0.4 μs

Switching times inductive load (Figs 6 and 7)

 $I_C = I_{Csat}; I_{B\text{ on}} = I_{Csat}/10$
 $V_{BE\text{ off}} = -5\text{ V}$

 Turn-off; storage time at $T_j = 25\text{ }^\circ\text{C}$
 t_s typ. 0.6 μs

fall time

 t_f typ. 40 ns

 Turn-off; storage time at $T_j = 125\text{ }^\circ\text{C}$
 t_s max. 2.0 μs

fall time

 t_f max. 150 ns

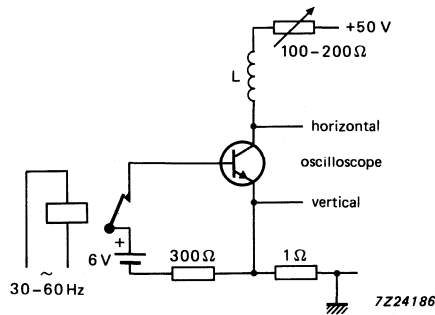


Fig. 2 Test circuit for $V_{CEOsust}$.

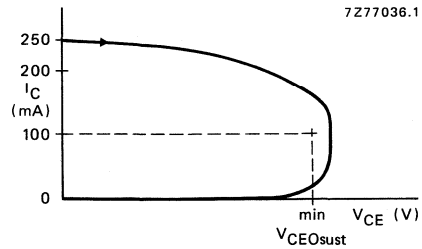
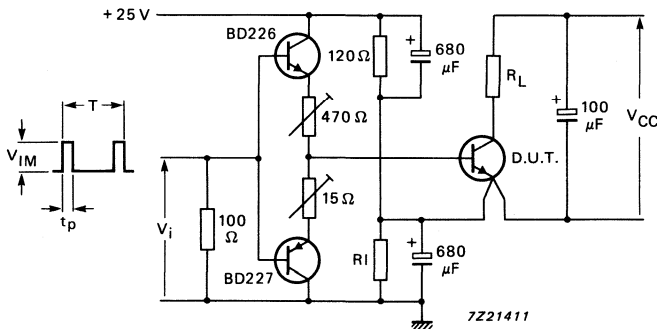


Fig. 3 Oscilloscope display for sustaining voltage.



$t_p = 20 \mu s$
 $T = 2 ms$
 $V_{IM} = 15 V$

Fig. 4 Test circuit resistive load; $V_{CC} = 50 V$;
 $R_L = 100 \Omega$; $R_1 = 82 \Omega$.

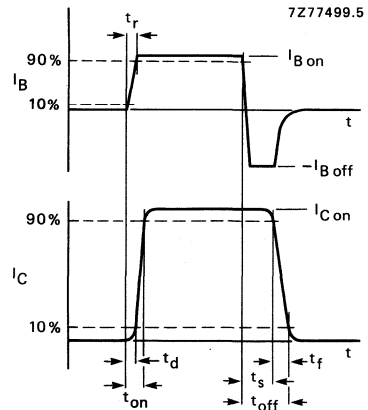
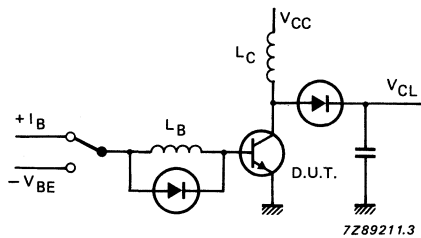


Fig. 5 Switching time waveforms with resistive load; $t_r \leq 30 ns$.



$V_{clamp} = 40 V$
 $-V_{BE} = -5 V$

Fig. 6 Test circuit inductive load; $V_{CC} = 50 V$;
 $L_C = 200 \mu H$.

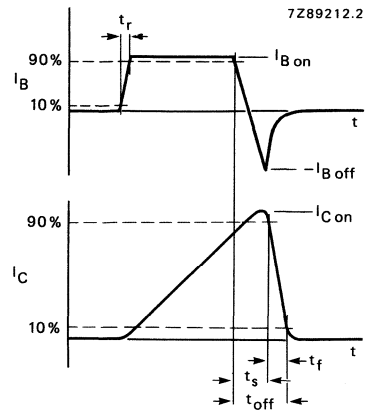
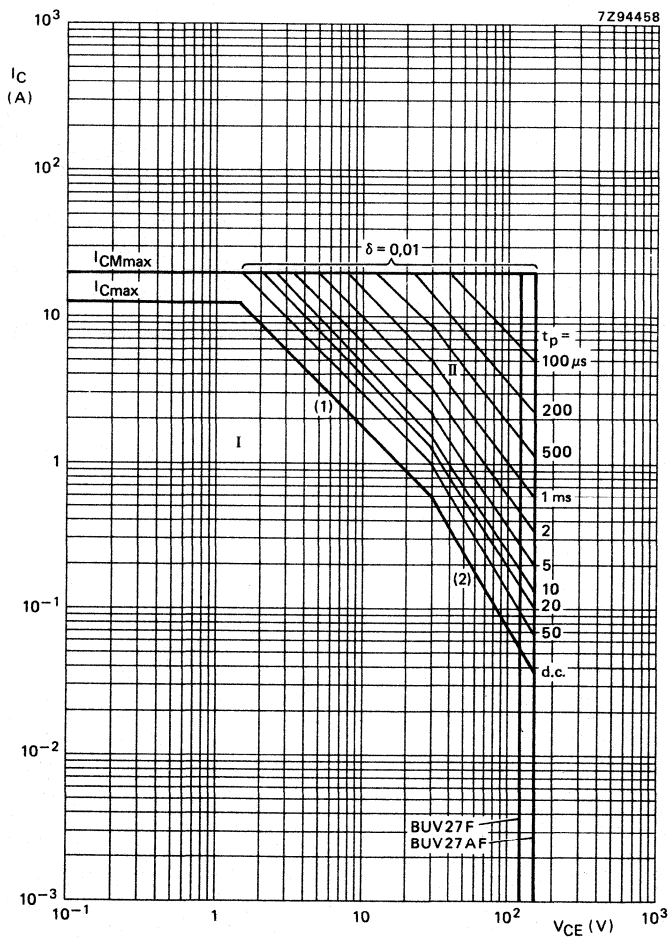


Fig. 7 Switching times waveforms with inductive load.



- I Region of permissible DC operation
- II Permissible extension for repetitive pulse operation
- (1) P_{tot} and P_{tot} max lines.
- (2) Second-breakdown limits (independent of temperature).

Fig. 8 Forward bias SOAR at $T_{mb} < 25^\circ C$; mounted without heatsink compound and 30 ± 5 newtons pressure on the centre of the envelope.

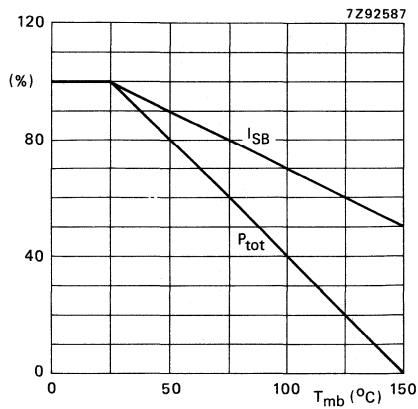


Fig. 9 Power dissipation and second-breakdown current derating curve.

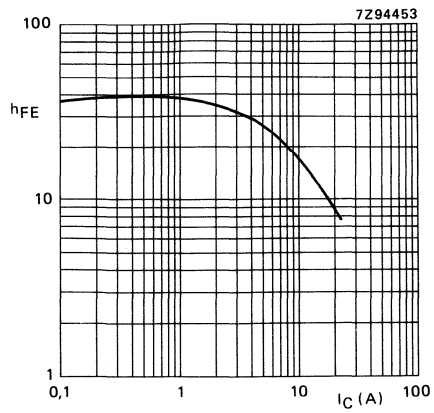


Fig. 10 Typical DC current gain; $V_{CE} = 5\text{ V}$; $T_j = 25\text{ }^\circ\text{C}$.

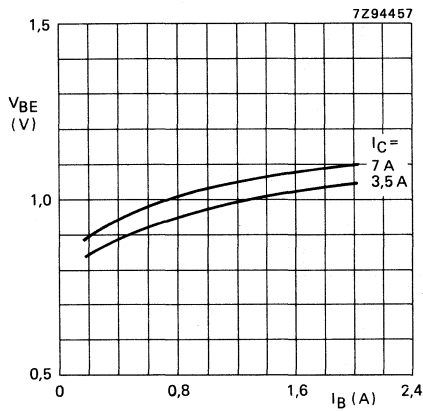


Fig. 11 Base-emitter voltage as a function of base current.

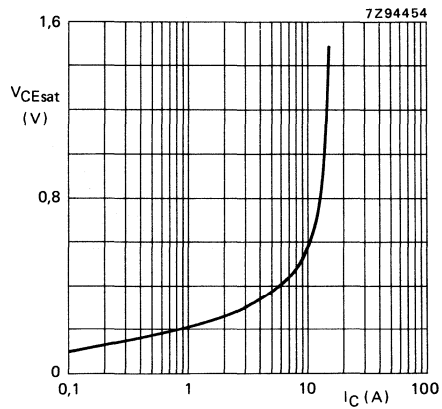


Fig. 12 Collector-emitter saturation voltage as a function of collector current; $I_C/I_B = 10$.

SILICON DIFFUSED POWER TRANSISTORS

High-speed, glass-passivated npn transistors in a TO-220 envelope intended for fast switching applications such as high frequency and efficiency converters, switching regulators and motor controls.

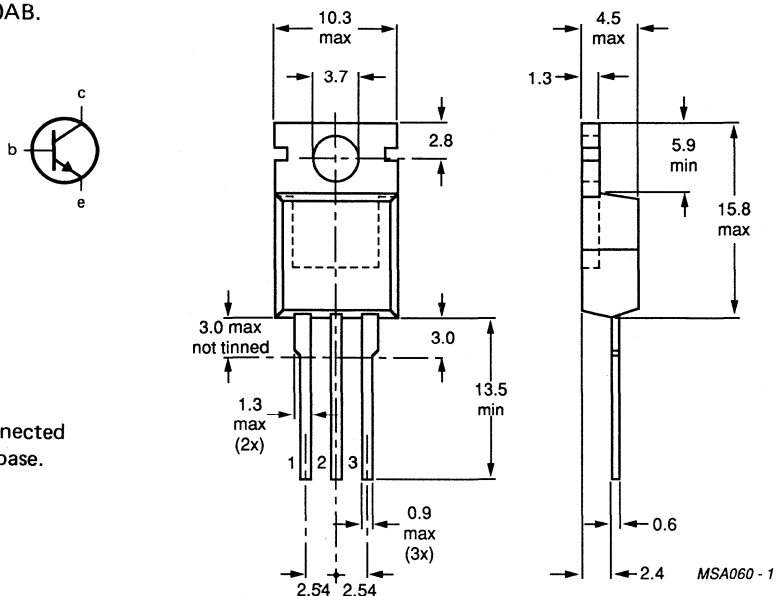
QUICK REFERENCE DATA

		BUV28	28A
Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM}	max. 400	450 V
	V_{CEO}	max. 200	225 V
Collector-emitter saturation voltage $I_C = I_{Csat}$	V_{CEsat}	max. 1,5	V
Collector current saturation DC	I_{Csat}	max. 6,0	4,0 A
	I_C	max. 10	A
	I_{CM}	max. 20	A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max. 65	W
Fall time inductive load	t_f	typ. 40	ns

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-220AB.



Pinning:

- 1 = base
- 2 = collector
- 3 = emitter

Collector connected to mounting base.

RATINGS

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

			BUV28	28A
Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM}	max.	400	450 V
	V_{CEO}	max.	200	225 V
Collector current saturation DC peak value	I_{Csat}	max.	6,0	4,0 A
	I_C	max.	10	A
	I_{CM}	max.	20	A
Base current DC peak value	I_B	max.	2,0	A
	I_{BM}	max.	4,0	A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	65	W
Storage temperature range	T_{stg}		-65 to + 150	$^\circ\text{C}$
Junction temperature	T_j	max.	150	$^\circ\text{C}$
THERMAL RESISTANCE				
From junction to mounting base	$R_{th\ j-mb}$	=	1,92	K/W

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

Collector cut-off currents*

$$V_{CE} = V_{CESMmax}; V_{BE} = -1,5\text{ V}$$

$$T_j = 125\text{ }^\circ\text{C}$$

$$V_{CE} = V_{CESMmax}; R_{BE} = 50\ \Omega;$$

$$T_j = 125\text{ }^\circ\text{C}$$

Emitter cut-off current

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

Saturation voltages

$$I_C = I_{Csat}; I_B = I_{Csat}/10$$

$$I_C = I_{Csat}/2; I_B = I_{Csat}/20$$

Collector-emitter sustaining voltage

(Figs 2 and 3)

$$I_C = 0,2\text{ A}; I_B = 0; L = 25\text{ mH}$$

Switching times resistive load

(Figs 4 and 5)

$$I_{C\text{ on}} = I_{Csat}; I_{B\text{ on}} = I_{Csat}/10;$$

$$I_{B\text{ off}} = 2I_{B\text{ on}}; V_{CE} = 50\text{ V}$$

Turn-on time

Turn-off;

storage time

fall time

Turn-on time

Turn-off;

storage time

fall time

Switching times inductive load

(Figs 6 and 7)

$$I_{C\text{ on}} = I_{Csat}; I_{B\text{ on}} = I_{Csat}/10;$$

$$L_B = 3\ \mu\text{H}; -V_B = 5\text{ V};$$

$$V_{CC} = V_{CL} = 50\text{ V}$$

Turn-off;

 storage time at $T_j = 25\text{ }^\circ\text{C}$

fall time

Turn-off;

 storage time at $T_j = 125\text{ }^\circ\text{C}$

fall time

 I_{CEX} max. 1,0 mA

 I_{CER} max. 3,0 mA

 I_{EBO} max. 1,0 mA

	BUV28	28A
V_{CEsat}	max. 1,5	1,5 V
V_{BEsat}	max. 2,0	2,0 V
V_{CEsat}	max. 0,7	0,7 V
$V_{CEOsust}$	min. 200	225 V
t_{on}	typ. 0,3	μs
t_s	typ. 0,5	μs
t_f	typ. 0,1	μs
t_{on}	max. 1,0	μs
t_s	max. 1,5	μs
t_f	max. 0,25	μs
t_s	typ. 1,0	μs
t_f	typ. 40	ns
t_s	max. 3,0	μs
t_f	max. 200	ns

* Measured with a half-sinewave voltage (curve tracer).

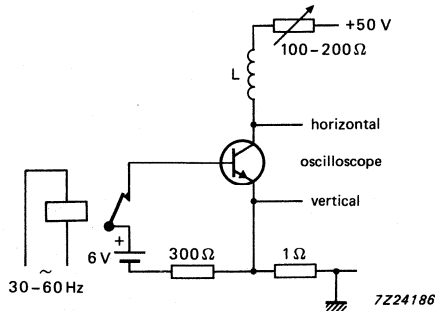


Fig. 2 Test circuit for $V_{CEOsust}$.

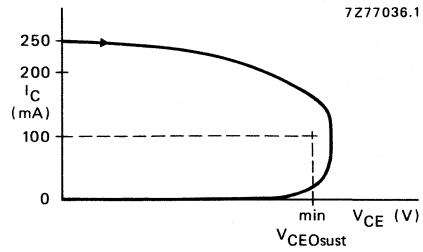
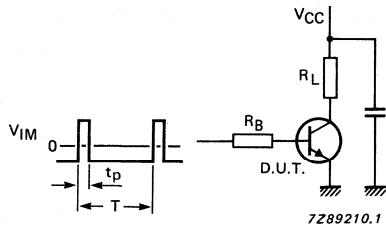


Fig. 3 Oscilloscope display for sustaining voltage.



$V_{CC} = 50 \text{ V}$
 $t_p = 20 \mu\text{s}$
 $V_{IM} = -6 \text{ to } +4,5 \text{ V}$
 $\frac{t_p}{T} = 0,01$

The values of R_B and R_L are selected in accordance with I_C and I_B requirements.

Fig. 4 Test circuit resistive load.

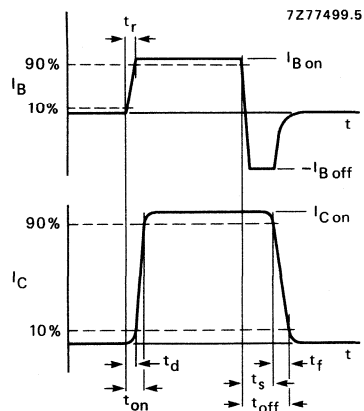
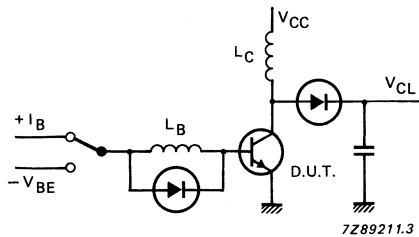


Fig. 5 Switching times waveforms with resistive load; $t_r \leq 30 \text{ ns}$.



$V_{CL} = \text{up to } 50 \text{ V}$
 $V_{CC} = 30 \text{ V}$
 $-V_{BE} = 5 \text{ V}$
 $L_B = 0,5 \mu\text{H}$
 $L_C = 200 \mu\text{H}$

Fig. 6 Test circuit inductive load.

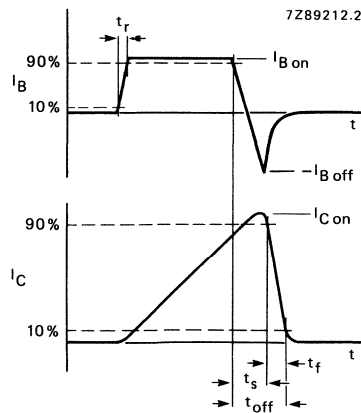


Fig. 7 Switching times waveforms with inductive load.

SILICON DIFFUSED POWER TRANSISTORS

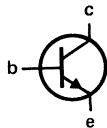
High-voltage, high-speed, glass-passivated npn power transistor in a SOT186 envelope with electrically isolated mounting base, intended for use in converters, inverters, switching regulators, motor control systems, etc.

QUICK REFERENCE DATA

		BUV28F	28AF
Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM} max.	400	450 V
	V_{CEO} max.	200	225 V
Collector-emitter saturation voltage	V_{CEsat} max.	1.5	1.5 V
Collector current saturation DC peak value	I_{Csat} max.	6.0	4.0 A
	I_C max.		10 A
	I_{CM} max.		20 A
Total power dissipation up to $T_h = 25^\circ\text{C}$	P_{tot} max.		18 W
Fall time; inductive load	t_f typ.		40 ns

MECHANICAL DATA

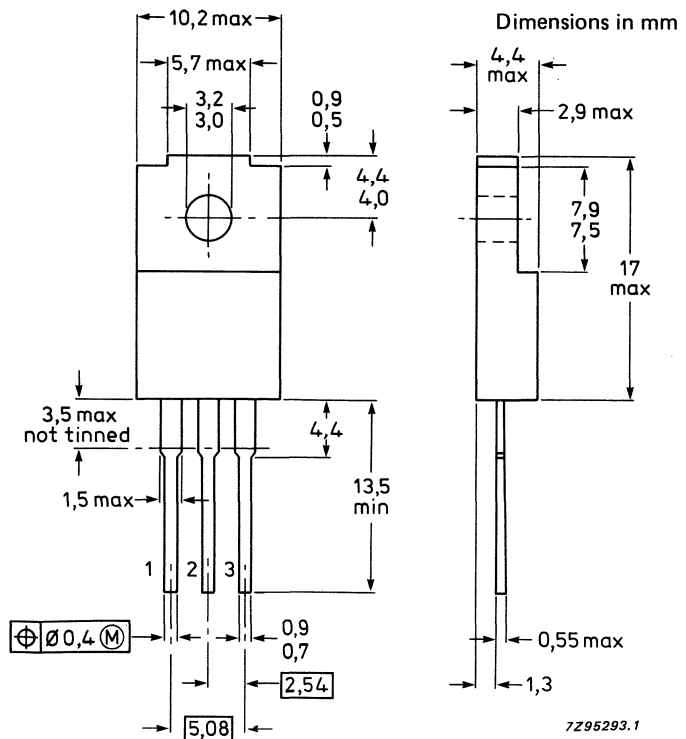
Fig. 1 SOT186.



Pinning:

- 1 = base
- 2 = collector
- 3 = emitter

Mounting base is electrically isolated from all terminals.



RATINGS

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

			BUV28F	28AF
Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM}	max.	400	450 V
	V_{CEO}	max.	200	225 V
Collector current saturation DC peak value	I_{Csat}	max.	6.0	4.0 A
	I_C	max.	10	A
	I_{CM}	max.	20	A
Base current DC peak value	I_B	max.	2.0	A
	I_{BM}	max.	4.0	A
Total power dissipation up to $T_h = 25\text{ }^\circ\text{C}$	P_{tot}	max.	18	W
Storage temperature range	T_{stg}		-65 to + 150	$^\circ\text{C}$
Junction temperature	T_j	max.	150	$^\circ\text{C}$
THERMAL RESISTANCE				
From junction to heatsink (note 1)	$R_{th\ j-h}$	=	7.0	K/W
From junction to heatsink (note 2)	$R_{th\ j-h}$	=	4.5	K/W
From junction to ambient	$R_{th\ j-a}$	=	55	K/W
ISOLATION				
Isolation voltage from all terminals to external heatsink (peak value)	V_{isol}	max.	1500	V
Isolation capacitance from collector to external heatsink	C_{isol}	typ.	12	pF

Notes

1. Mounted without heatsink compound and 30 ± 5 newtons pressure on centre of envelope.
2. Mounted with heatsink compound and 30 ± 5 newtons pressure on centre of envelope.

CHARACTERISTICS

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

Collector cut-off currents

 $V_{CE} = V_{CESmax}; V_{BE} = -1.5\text{ V}; T_j = 125\text{ }^\circ\text{C}$ $V_{CE} = V_{CESmax}; V_{BE} = 0\text{ V}; T_j = 125\text{ }^\circ\text{C}$

I_{CEX}	max.	1.0	mA
I_{CES}	max.	3.0	mA

Emitter cut-off current

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

I_{EBO}	max.	1.0	mA
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Saturation voltages

 $I_C = I_{Csat}; I_B = I_{Csat}/10$

		BUV28F	28AF
V_{CEsat}	max.	1.5	1.5 V
V_{BEsat}	max.	2.0	2.0 V

Collector-emitter sustaining voltage (Figs 2 and 3)

 $I_C = 200\text{ mA}; I_B = 0; L = 25\text{ mH}$

$V_{CEOsust}$	min.	200	225 V
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Switching times resistive load (Figs 4 and 5)

 $I_C\text{ on} = I_{Csat}; I_B\text{ on} = I_{Csat}/10; I_{Boff} = 2I_{Bon}$

Turn-on time

t_{on}	typ.	0.3	μs
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Turn-off; storage time

fall time

t_s	typ.	0.5	μs
t_f	typ.	0.1	μs

Turn-on time

t_{on}	max.	1.0	μs
----------	------	-----	---------------

Turn-off; storage time

fall time

t_s	max.	1.5	μs
t_f	max.	0.25	μs

Switching times inductive load (Figs 6 and 7)

 $I_C = I_{Csat}; I_B\text{ on} = I_{Csat}/10$ at $T_j = 25\text{ }^\circ\text{C}$ Turn-off; storage time at $T_j = 25\text{ }^\circ\text{C}$

fall time

t_s	typ.	1.0	μs
t_f	typ.	40	ns

Turn-off; storage time at $T_j = 125\text{ }^\circ\text{C}$

fall time

t_s	typ.	3.0	μs
t_f	max.	200	ns

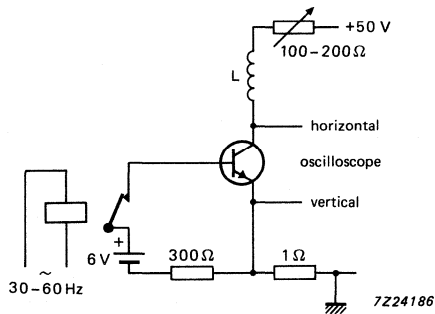


Fig. 2 Test circuit for $V_{CE0sust}$.

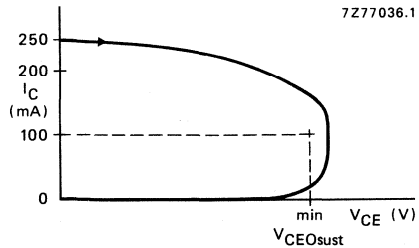
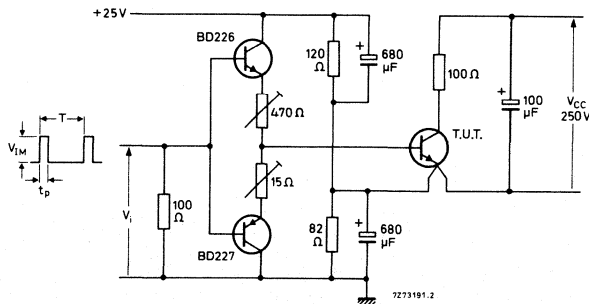


Fig. 3 Oscilloscope display for sustaining voltage.



$t_p = 20 \mu s$
 $T = 2 ms$
 $V_{IM} = 15 V$

Fig. 4 Test circuit resistive load; $V_{CC} = 50 V$;
 $R_L = 4 \Omega$; $R_1 = 82 \Omega$.

$V_{clamp} = 40 V$
 $-V_{BE} = -5 V$
 $L_B = 0.5 \mu H$

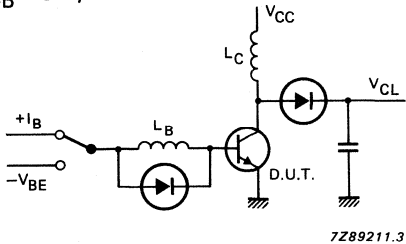


Fig. 6 Test circuit inductive load; $V_{CC} = 30 V$;
 $L_C = 200 \mu H$.

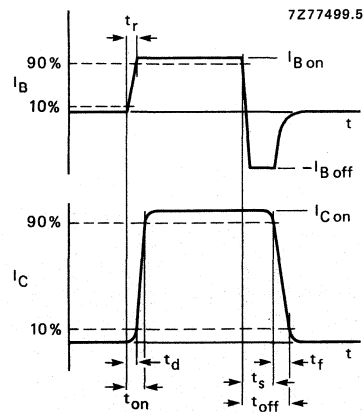


Fig. 5 Switching times waveforms with resistive load; $t_r \leq 30 ns$.

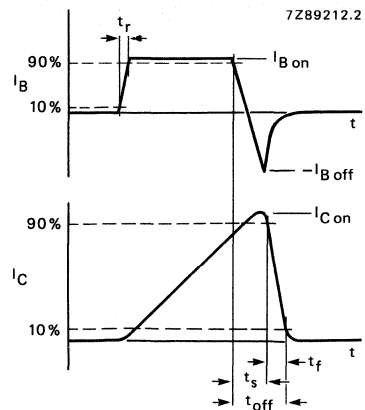
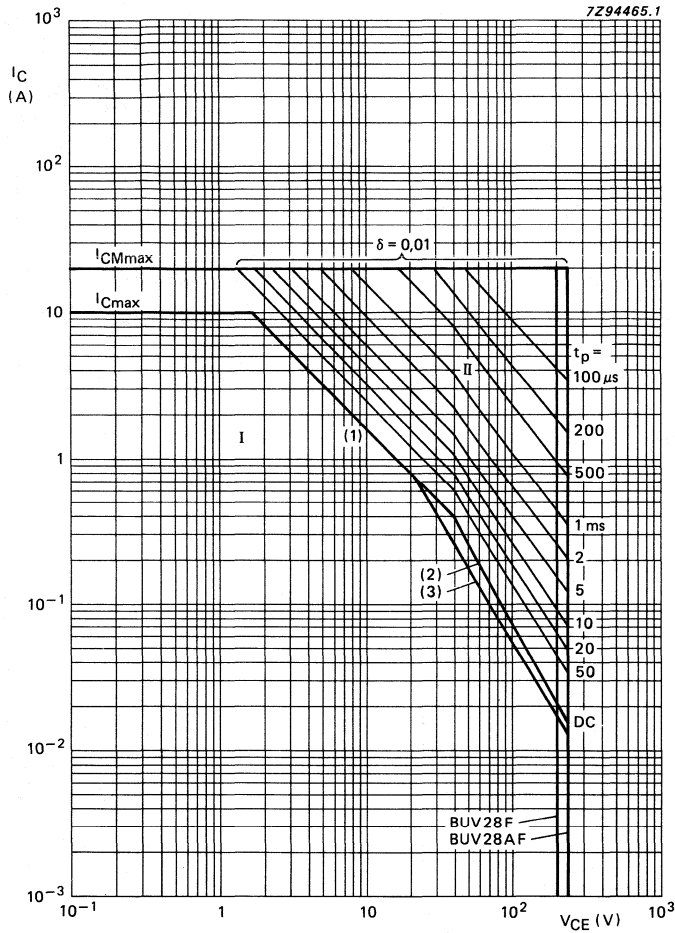


Fig. 7 Switching times waveforms with inductive load.



- I Region of permissible DC operation
- II Permissible extension for repetitive pulse operation
- (1) P_{tot} and P_{tot} max lines
- (2) Second-breakdown limits without heatsink compound
- (3) Second-breakdown limits with heatsink compound.

Fig. 8 Forward bias SOAR at $T_{mb} < 25^\circ C$.

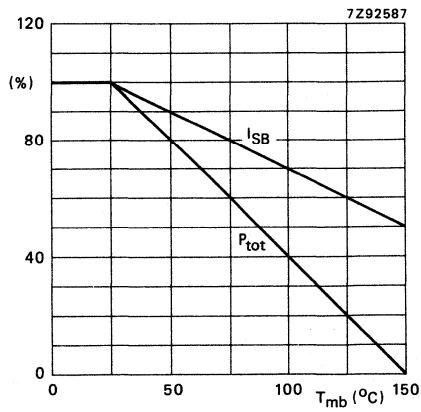


Fig. 9 Power dissipation and second-breakdown current derating curve.

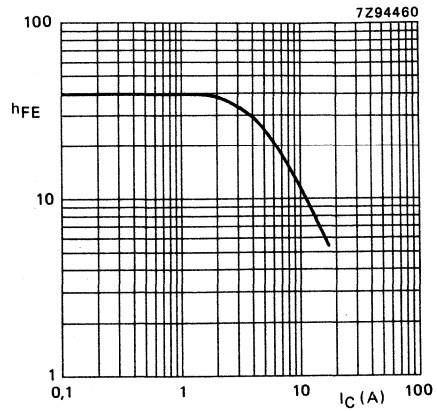


Fig. 10 Typical DC current gain; $V_{CE} = 5 \text{ V}$; $T_j = 25 \text{ }^\circ\text{C}$.

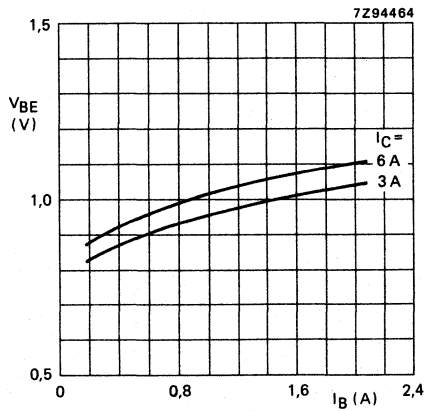


Fig. 11 Base-emitter voltage as a function of base current.

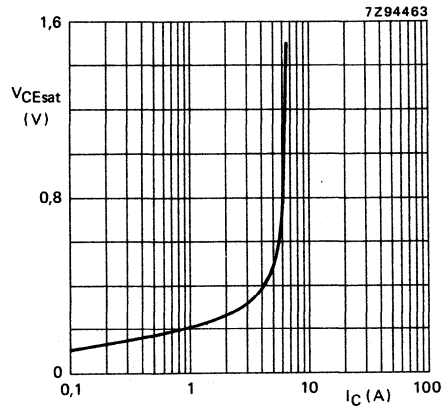


Fig. 12 Collector-emitter saturation voltage as a function of collector current; $I_C/I_B = 10$.

SILICON DIFFUSED POWER TRANSISTORS

High-voltage, high-speed, glass-passivated npn power transistors in a SOT93 envelope, intended for use in converters, inverters, switching regulators, motor control systems etc.

QUICK REFERENCE DATA

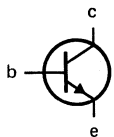
		BUV47	47A
Collector-emitter voltage (peak value; $V_{BE} = 0$)	V_{CESM} max.	850	1000 V
Collector-emitter voltage (open base)	V_{CEO} max.	400	450 V
Collector current (DC)	I_C max.		9 A
Collector current (peak value)	I_{CM} max.		15 A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot} max.	120	W
Collector-emitter saturation voltage $I_C = 5\text{ V}; I_B = 1,0\text{ A}$	V_{CEsat} max.	1,5	1,5 V
Fall time (resistive load) $I_{Con} = 5\text{ A}; I_{Bon} = -I_{Boff} = 1,0\text{ A}$	t_f max.	0,8	0,8 μs

MECHANICAL DATA

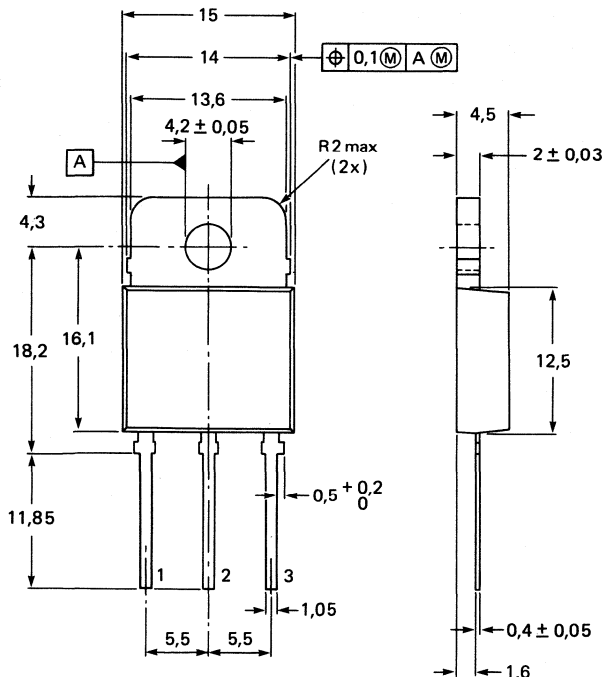
Dimensions in mm

Fig. 1 SOT93.

Collector connected to mounting base.



Pinning:
1 = base
2 = collector
3 = emitter



7Z96696

RATINGS

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

		BUV47	47A
Collector-emitter voltage (peak value; $V_{BE} = 0$)	V_{CESM} max.	850	1000 V
Collector-emitter voltage (open base)	V_{CEO} max.	400	450 V
Emitter-base voltage	V_{EBO} max.		7 V
Collector current (DC)	I_C max.		9 A
Collector current (peak value)	I_{CM} max.		15 A
Base current (DC)	I_B max.		3 A
Base current (peak value)	I_{BM} max.		6 A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot} max.		120 W
Storage temperature	T_{stg}	-65 to + 175 $^\circ\text{C}$	
Junction temperature	T_j max.		175 $^\circ\text{C}$

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j-mb}$ =	1,25	K/W
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CHARACTERISTICS

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

Collector cut-off current*

$V_{CE} = V_{CESMmax}; V_{BE} = -2,5\text{ V}$

I_{CEX} max.	0,15	mA
----------------	------	----

$V_{CE} = V_{CESMmax}; V_{BE} = -2,5\text{ V}; T_j = 125\text{ }^\circ\text{C}$

I_{CEX} max.	1,5	mA
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$V_{CE} = V_{CESMmax}; R_{BE} = 10\ \Omega$

I_{CER} max.	0,4	mA
----------------	-----	----

$V_{CE} = V_{CESMmax}; R_{BE} = 10\ \Omega; T_j = 125\text{ }^\circ\text{C}$

I_{CER} max.	3,0	mA
----------------	-----	----

Emitter cut-off current

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

I_{EBO} max.	1,0	mA
----------------	-----	----

Collector-emitter sustaining voltage

$I_C = 100\text{ mA}; I_B = 0; L = 25\text{ mH}$

$V_{CEO_{sust}}$ min.	400	450 V
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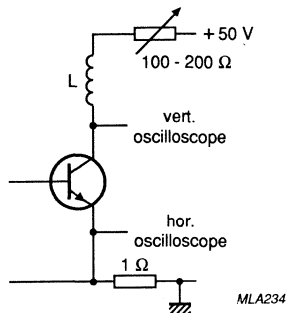


Fig. 2 Test circuit for $V_{CEO_{sust}}$.

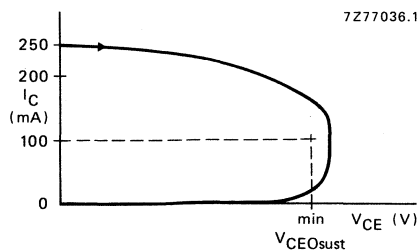


Fig. 3 Oscilloscope display for sustaining voltage.

* Measured with a half-sinewave voltage (curve tracer).

Saturation voltages

$I_C = 8 \text{ A}; I_B = 2,5 \text{ A}$

$I_C = 5 \text{ A}; I_B = 1 \text{ A}$

Switching times resistive load (Figs 4 and 5)

$I_{Con} = 5 \text{ A}; I_{Bon} = -I_{Boff} = 1 \text{ A}$

Turn-on time

Turn-off: Storage time

Fall time

BUV47 | 47A

V_{CEsat}	max.	3	3 V
V_{CEsat}	typ.	0,6	0,6 V
V_{CEsat}	max.	1,5	1,5 V
V_{BEsat}	max.	1,6	1,6 V
t_{on}	typ.	0,34	0,34 μs
t_{on}	max.	1,0	1,0 μs
t_s	typ.	1,75	1,75 μs
t_s	max.	3,0	3,0 μs
t_f	typ.	0,36	0,36 μs
t_f	max.	0,8	0,8 μs

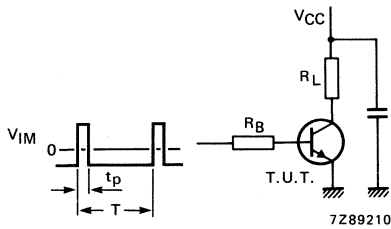


Fig. 4 Test circuit resistive load.
 $V_{CC} = 150 \text{ V}; V_{IM} = -6 \text{ to } +8 \text{ V};$
 $t_p/T = 0,01; t_p = 20 \mu\text{s}.$

The values of R_B and R_L are selected in accordance with I_{Con} and I_B requirements.

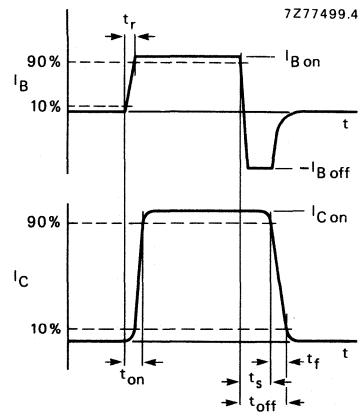


Fig. 5 Switching times waveforms with resistive load.

CHARACTERISTICS (continued)

Switching times inductive load (Figs 6 and 7)

$I_{Con} = 5\text{ A}$; $I_{Bon} = 1,0\text{ A}$

Turn-off: Storage time
Fall time

$I_{Con} = 5\text{ A}$; $I_{Bon} = 1,0\text{ A}$; $T_j = 100\text{ }^\circ\text{C}$

Turn-off: Storage time
Fall time

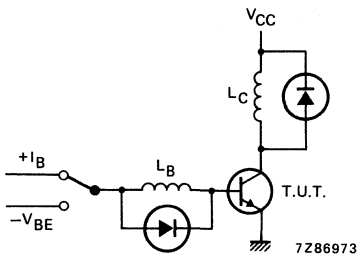


Fig. 6 Test circuit inductive load.
 $V_{CC} = 300\text{ V}$; $-V_{BE} = 5\text{ V}$;
 $L_B = 3\text{ }\mu\text{H}$; $L_C = 1\text{ mH}$.

		BUV47	47A
t_s	typ.	90	90 ns
t_f	typ.		
t_s	max.	0,4	0,4 μs
t_f	max.		

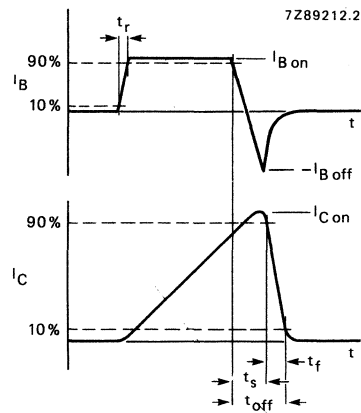
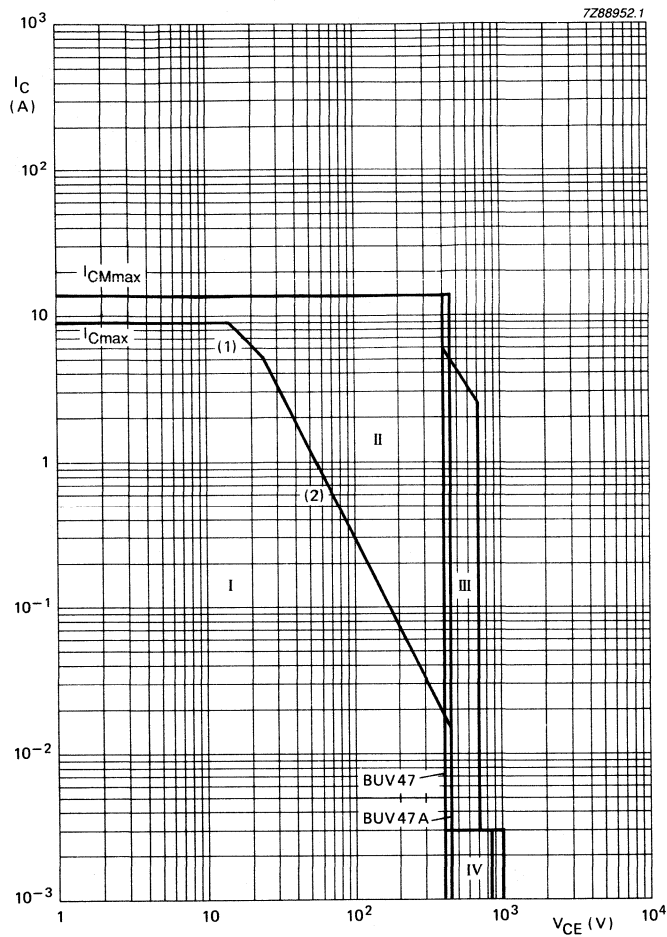


Fig. 7 Switching times waveforms with inductive load.



- (1) P_{tot} max.
 (2) Second-breakdown limits (independent of temperature).
- I Region of permissible DC operation.
 II Permissible extension for repetitive pulse operation.
 III Area of permissible operation during turn-on in single transistor converters, provided $R_{BE} \leq 100 \Omega$ and $t_p \leq 0,6 \mu s$.
 IV Repetitive pulse operation in this region is permissible provided $V_{BE} \leq 0$ and $t_p \leq 2$ ms.

Fig. 8 Safe Operating Area at $T_{mb} \leq 25$ °C.

SILICON DIFFUSED POWER TRANSISTORS

High-voltage, high-speed, glass-passivated npn power transistors in a SOT93 envelope, intended for use in converters, inverters, switching regulators, motor control systems etc.

QUICK REFERENCE DATA

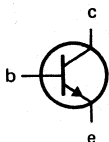
		BUV48		BUV48A	
Collector-emitter voltage (peak value; $V_{BE} = 0$)	V_{CESM}	max.	850	1000	V
Collector-emitter voltage (open base)	V_{CEO}	max.	400	450	V
Collector current (DC)	I_C	max.	15		A
Collector current (peak value)	I_{CM}	max.	30		A
Total power dissipation up to $T_{mb} = 25\text{ }^{\circ}\text{C}$	P_{tot}	max.	150		W
Collector-emitter saturation voltage					
$I_C = 10\text{ A}; I_B = 2\text{ A}$	V_{CEsat}	max.	1.5	—	V
$I_C = 8\text{ A}; I_B = 1.6\text{ A}$	V_{CEsat}	max.	—	1.5	V
Fall time (resistive load)					
$I_{Con} = 10\text{ A}; I_{Bon} = -I_{Boff} = 2\text{ A}$	t_f	max.	0.8	—	μs
$I_{Con} = 8\text{ A}; I_{Bon} = -I_{Boff} = 1.6\text{ A}$	t_f	max.	—	0.8	μs

MECHANICAL DATA

Dimensions in mm

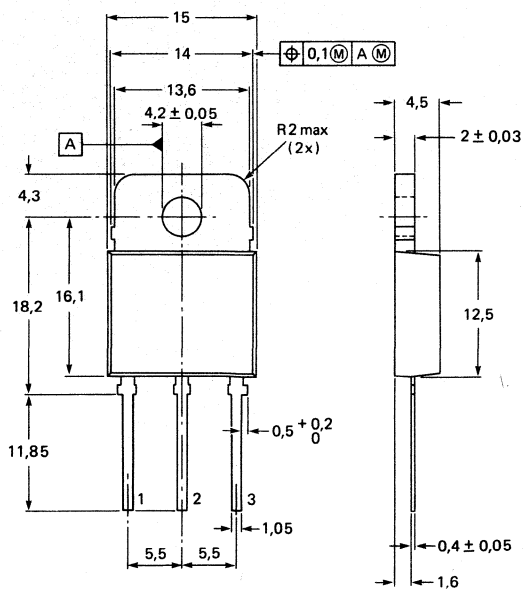
Fig.1 SOT93.

Collector connected to mounting base.



Pinning:

- 1 = base
- 2 = collector
- 3 = emitter



7296696

RATINGS

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

			BUV48	BUV48A	
Collector-emitter voltage (peak value; $V_{BE} = 0$)	V_{CESM}	max.	850	1000	V
Collector-emitter voltage (open base)	V_{CEO}	max.	400	450	V
Emitter-base voltage	V_{EBO}	max.	7		V
Collector current (DC)	I_C	max.	15		A
Collector current (peak value)	I_{CM}	max.	30		A
Base current (DC)	I_B	max.	4		A
Base current (peak value)	I_{BM}	max.	20		A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	150		W
Storage temperature	T_{stg}		-65 to +175		$^\circ\text{C}$
Junction temperature	T_j	max.	175		$^\circ\text{C}$

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j-mb}$	=	1,0	K/W
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CHARACTERISTICS

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

Collector cut-off current*

$V_{CE} = V_{CESMmax}; V_{BE} = 0$	I_{CES}	max.	0,2	mA
$V_{CE} = V_{CESMmax}; V_{BE} = 0; T_{mb} = 125\text{ }^\circ\text{C}$	I_{CES}	max.	2	mA
$V_{CE} = V_{CESMmax}; R_{BE} \leq 10\ \Omega$	I_{CER}	max.	0,5	mA
$V_{CE} = V_{CESMmax}; R_{BE} \leq 10\ \Omega; T_{mb} = 125\text{ }^\circ\text{C}$	I_{CER}	max.	4	mA

Emitter cut-off current

$I_C = 0; V_{EB} = 5\text{ V}$	I_{EBO}	max.	1	mA
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Emitter-base breakdown voltage

$I_C = 0; I_B = 50\text{ mA}$	$V_{(BR)EBO}$		7 to 30	V
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Saturation voltages

			BUV48	BUV48A	
$I_C = 15\text{ A}; I_B = 4\text{ A}$	V_{CEsat}	max.	3,5	-	V
$I_C = 10\text{ A}; I_B = 2\text{ A}$	V_{CEsat}	max.	1,5	-	V
	V_{BEsat}	max.	1,6	-	V
$I_C = 12\text{ A}; I_B = 2,4\text{ A}$	V_{CEsat}	max.	-	5	V
$I_C = 8\text{ A}; I_B = 1,6\text{ A}$	V_{CEsat}	max.	-	1,5	V
	V_{BEsat}	max.	-	1,6	V

* Measured with a half-sinewave voltage (curve tracer).

Collector-emitter sustaining voltage
 $I_C = 200 \text{ mA}$; $I_{B\text{off}} = 0$; $L = 25 \text{ mH}$

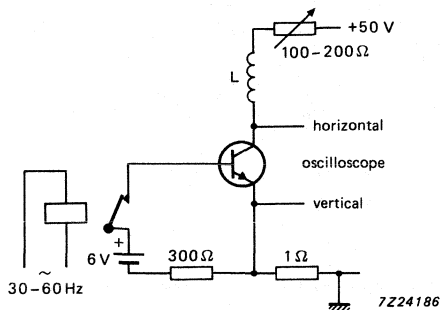


Fig. 2 Test circuit for $V_{CEOsust}$.

	BUV48	BUV48A	
$V_{CEOsust}$ min.	400	450	V

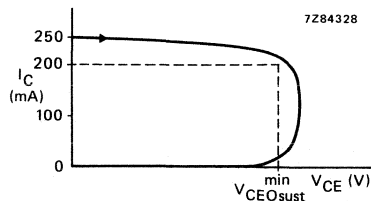


Fig. 3 Oscilloscope display for sustaining voltage.

Switching times resistive load (Figs 4 and 5)

$I_{Con} = 10 \text{ A}$; $I_{Bon} = -I_{Boff} = 2 \text{ A}$
 Turn-on time

Turn-off: Storage time

Fall time

$I_{Con} = 8 \text{ A}$; $I_{Bon} = -I_{Boff} = 1,6 \text{ A}$
 Turn-on time

Turn-off: Storage time

Fall time

		BUV48	BUV48A	
t_{on}	typ.	0,55	—	μs
	max.	1,0	—	μs
t_s	typ.	1,5	—	μs
	max.	3,0	—	μs
t_f	typ.	0,3	—	μs
	max.	0,8	—	μs
t_{on}	typ.	—	0,55	μs
	max.	—	1,0	μs
t_s	typ.	—	1,5	μs
	max.	—	3,0	μs
t_f	typ.	—	0,3	μs
	max.	—	0,8	μs

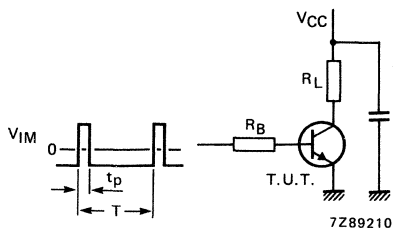


Fig. 4 Test circuit resistive load.

$V_{CC} = 150 \text{ V}$; $V_{IM} = -6 \text{ to } +8 \text{ V}$;
 $t_p = 20 \mu\text{s}$; $\delta = t_p/T = 0,01$.

The values of R_B and R_L are selected in accordance with I_{Con} and I_B requirements.

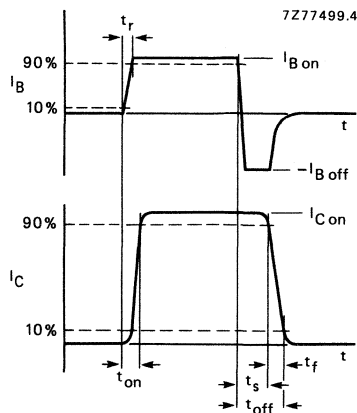


Fig. 5 Switching times waveforms with resistive load.

Switching times inductive load (Figs 6 and 7)

$I_{Con} = 10\text{ A}; I_{Bon} = 2\text{ A};$

Turn-off: Storage time

Fall time

$I_{Con} = 10\text{ A}; I_{Bon} = 2\text{ A}; T_j = 100\text{ }^\circ\text{C}$

Turn-off: Storage time

Fall time

$I_{Con} = 8\text{ A}; I_{Bon} = 1,6\text{ A};$

Turn-off: Storage time

Fall time

$I_{Con} = 8\text{ A}; I_{Bon} = 1,6\text{ A}; T_j = 100\text{ }^\circ\text{C}$

Turn-off: Storage time

Fall time

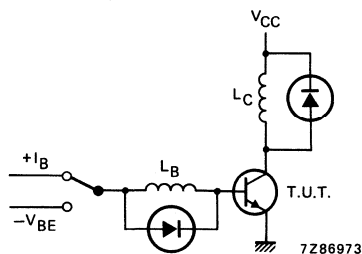


Fig. 6 Test circuit inductive load.

$V_{CC} = 300\text{ V}; -V_{BE} = 5\text{ V}; L_B = 3\text{ }\mu\text{H};$

$L_C = 1\text{ mH}$

		BUV48	BUV48A	
t_s	typ.	3,5	—	μs
t_f	typ.	0,08	—	μs
t_s	max.	5,0	—	μs
t_f	max.	0,4	—	μs
t_s	typ.	—	3,5	μs
t_f	typ.	—	0,08	μs
t_s	max.	—	5,0	μs
t_f	max.	—	0,4	μs

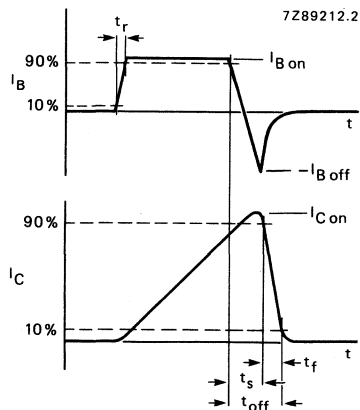
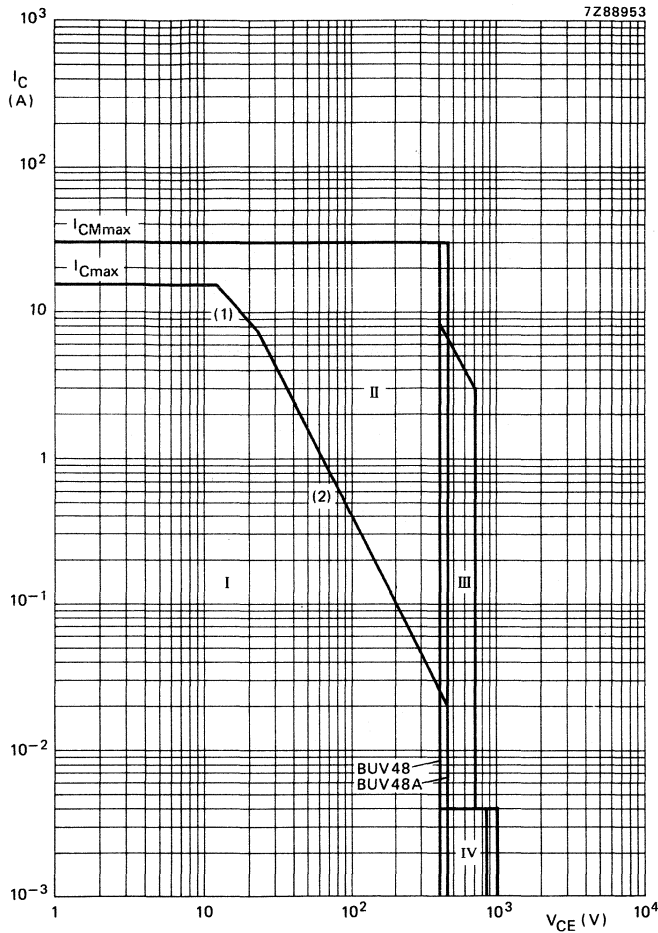


Fig. 7 Switching times waveforms with inductive load.



- (1) P_{tot} max values.
 (2) Second-breakdown limits (independent of temperature).
 I Region of permissible DC operation.
 II Permissible extension for repetitive pulse operation.
 III Area of permissible operation during turn-on in single transistor converters, provided $R_{BE} \leq 100 \Omega$ and $t_p \leq 0,6 \mu s$.
 IV Repetitive pulse operation in this region is permissible provided $V_{BE} \leq 0$ and $t_p \leq 2$ ms.

Fig. 8 Safe Operating Area at $T_{mb} \leq 25$ °C.

SILICON DIFFUSED POWER TRANSISTOR

High-voltage, high-speed switching npn transistor in a plastic SOT93 envelope especially intended for use in AC motor control systems from three-phase mains.

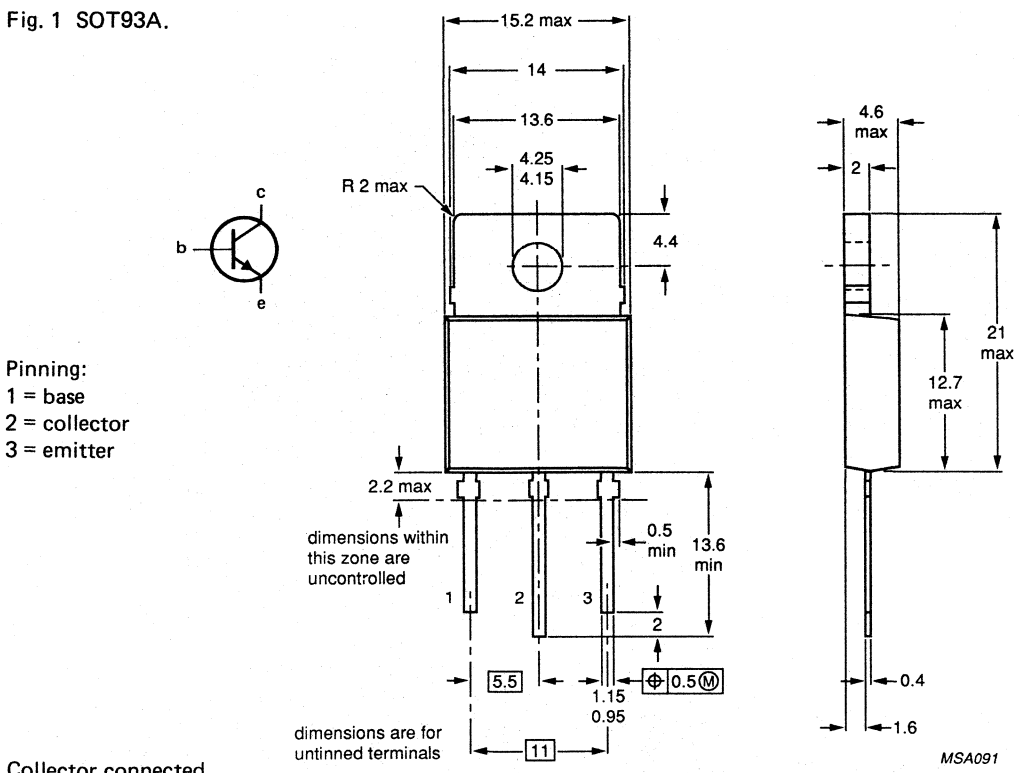
QUICK REFERENCE DATA

Collector-emitter voltage (peak value; $V_{BE} = 0$)	V_{CESM}	max.	1200 V
Collector-emitter voltage (open base)	V_{CEO}	max.	800 V
Collector-emitter saturation voltage	V_{CEsat}	max.	1 V
Collector current (DC)	I_C	max.	8 A
Collector current (peak value)	I_{CM}	max.	15 A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	125 W
Turn-off fall time	t_f	typ.	0.5 μs

MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT93A.



Collector connected to the mounting base.

MSA091

RATINGS

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

Collector-emitter voltage (peak value; $V_{BE} = 0$)	V_{CESM}	max.	1200 V
Collector-emitter voltage (open base)	V_{CEO}	max.	800 V
Collector current (DC)	I_C	max.	8 A
Collector current (peak value)	I_{CM}	max.	15 A
Base current (DC)	I_B	max.	4 A
Base current (peak value)	I_{BM}	max.	6 A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	125 W
Storage temperature range	T_{stg}		-65 to + 150 $^\circ\text{C}$
Junction temperature	T_j	max.	150 $^\circ\text{C}$

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j-mb}$	=	1,0 K/W
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CHARACTERISTICS

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

Collector cut-off current*

$V_{BE} = 0; V_{CE} = V_{CESMmax}$	I_{CES}	max.	1,0 mA
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$V_{BE} = 0; V_{CE} = V_{CESMmax}; T_j = 125\text{ }^\circ\text{C}$	I_{CES}	max.	2,0 mA
---	-----------	------	--------

Emitter cut-off current

$V_{EB} = 5\text{ V}; I_C = 0$	I_{EBO}	max.	10 mA
--------------------------------	-----------	------	-------

Collector-emitter sustaining voltage

$I_B = 0; I_C = 100\text{ mA}; L = 25\text{ mH}$	$V_{CEO_{sust}}$	min.	800 V
--	------------------	------	-------

Saturation voltage

$I_C = 4,5\text{ A}; I_B = 2\text{ A}$	V_{CEsat}	max.	1 V
--	-------------	------	-----

$I_C = 6\text{ A}; I_B = 3\text{ A}$	V_{BEsat}	max.	1,3 V
--------------------------------------	-------------	------	-------

	V_{CEsat}	typ.	1 V
--	-------------	------	-----

Transition frequency at $f = 5\text{ MHz}$

$I_C = 0,1\text{ A}; V_{CE} = 5\text{ V}$	f_T	typ.	7 MHz
---	-------	------	-------

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

$I_E = I_e = 0; V_{CB} = 10\text{ V}$	C_c	typ.	125 pF
---------------------------------------	-------	------	--------

Switching times in resistive switching circuit (Fig. 5)

$I_{Con} = 4,5\text{ A}; I_{Bon} = -I_{Boff} = 2\text{ A}$			
--	--	--	--

Turn-on time	t_{on}	typ.	0,2 μs
--------------	----------	------	-------------------

Storage time	t_s	typ.	3,5 μs
--------------	-------	------	-------------------

Fall time	t_f	typ.	0,5 μs
-----------	-------	------	-------------------

Second-breakdown current

$V_{CE} = 100\text{ V}; t_p = 1\text{ s}$	I_{SB}	min.	0,3 A
---	----------	------	-------

* Measured with a half-sinewave voltage (curve tracer).

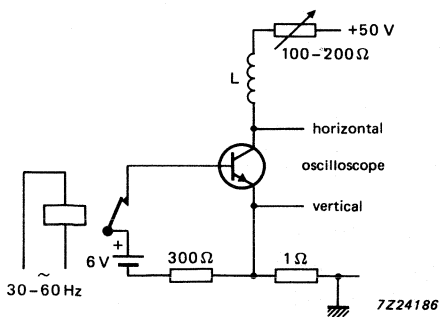


Fig. 2 Test circuit for $V_{CEOsust}$

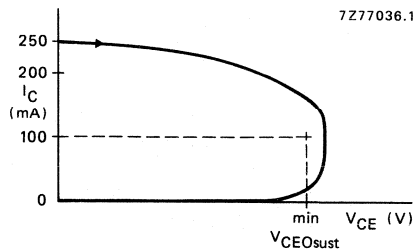


Fig. 3 Oscilloscope display for $V_{CEOsust}$

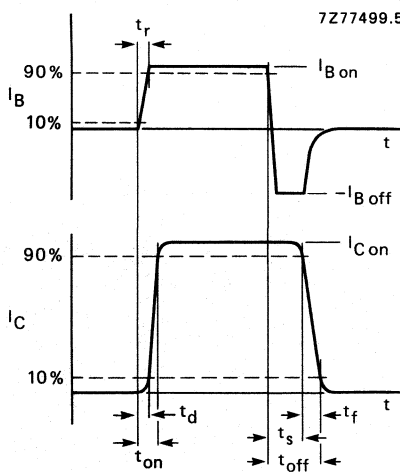


Fig. 4 Waveforms.

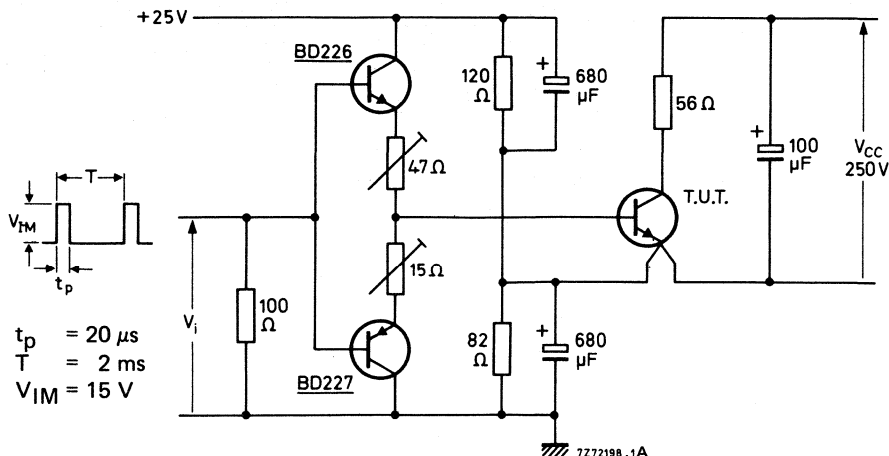
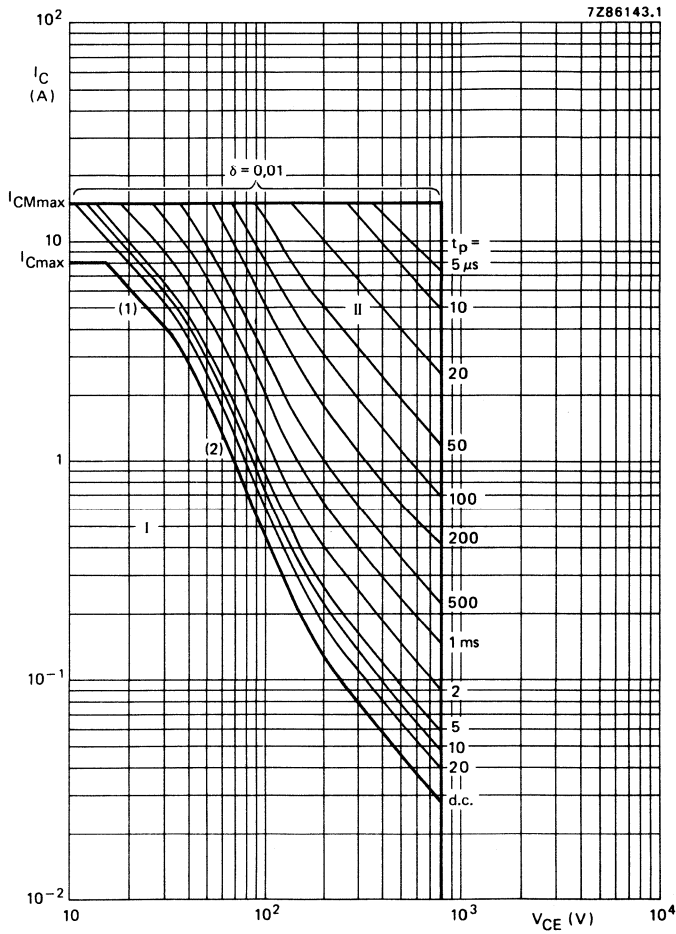


Fig. 5 Switching times test circuit.



1. $P_{tot\ max}$ and $P_{tot\ peak\ max}$ lines.
 2. Second-breakdown limits.
- I Region of permissible DC operation.
 II Permissible extension for repetitive pulse operation.

Fig. 6 Safe operating area; $T_{mb} \leq 25\ ^\circ\text{C}$.

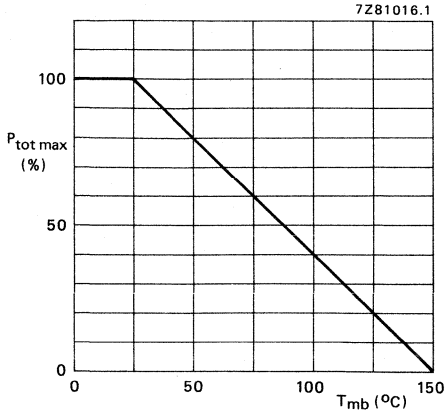


Fig. 7 Power derating curve.

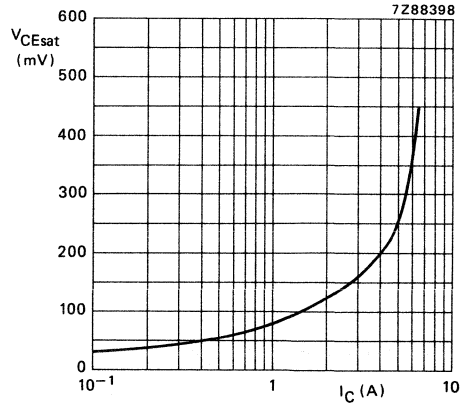


Fig. 8 Typical values $I_C/I_B = 2$;
 $T_j = 25^\circ\text{C}$.

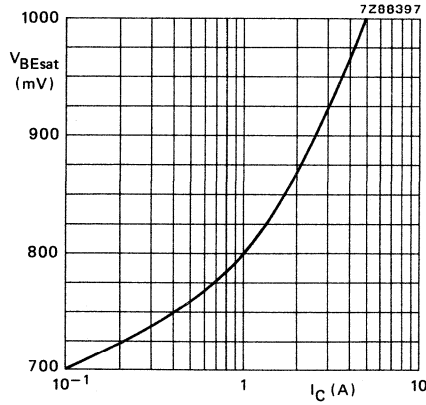


Fig. 9 Typical values $I_C/I_B = 2$; $T_j = 25^\circ\text{C}$.

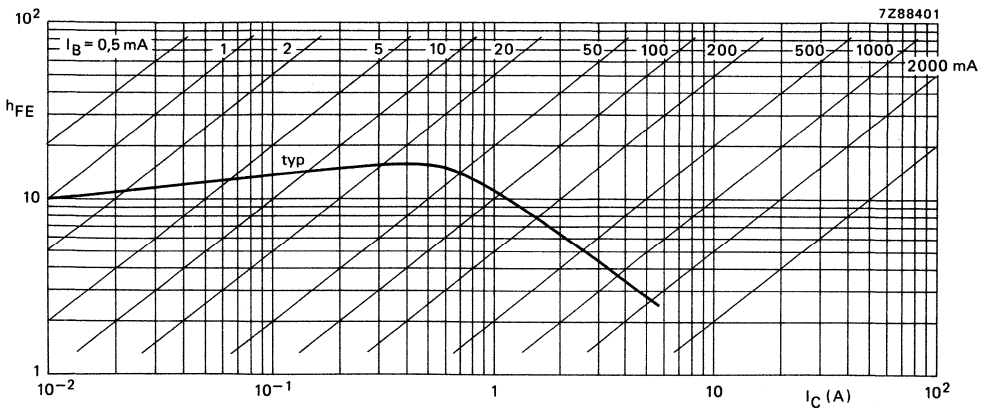


Fig. 10 Typical values DC current gain at $V_{CE} = 5\text{ V}$; $T_{mb} = 25^\circ\text{C}$.

SILICON DIFFUSED DARLINGTON POWER TRANSISTORS

High-voltage, monolithic npn power Darlington transistors in an SOT93 envelope, intended for use in car ignition systems, DC and AC motor controls, solenoid drivers, etc.

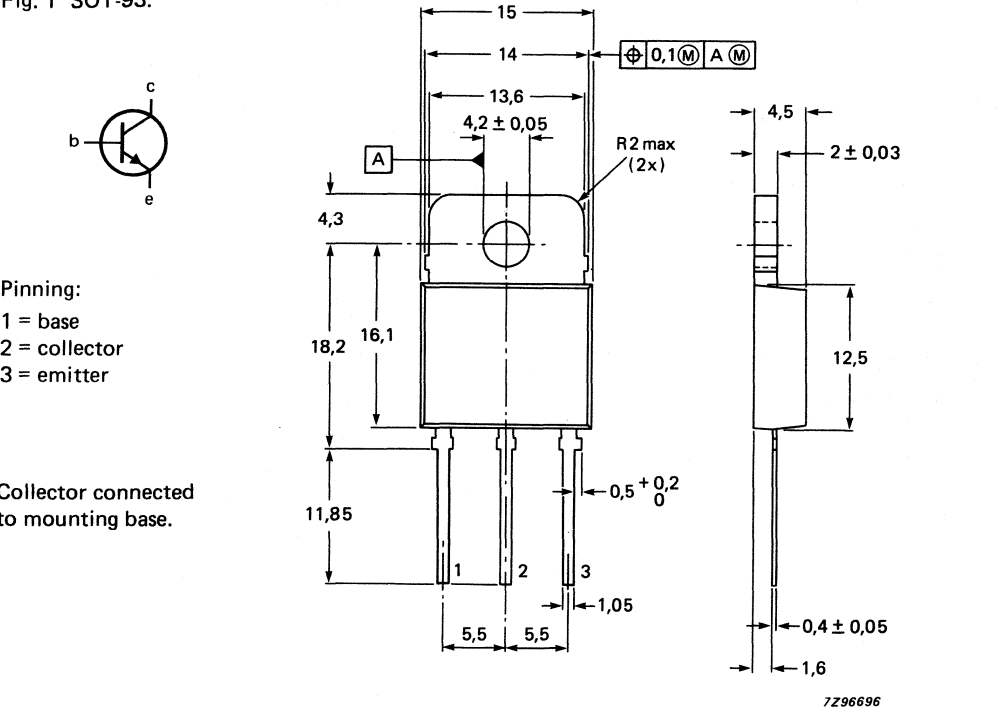
QUICK REFERENCE DATA

Collector-emitter voltage (peak value; $V_{BE} = 0$)	V_{CESM}	max.	650 V
Collector-emitter voltage (open base)	V_{CEO}	max.	400 V
Collector-emitter saturation voltage	V_{CEsat}	max.	2 V
Collector saturation current	I_{Csat}		10 A
Collector current (DC)	I_C	max.	12 A
Collector current (peak value)	I_{CM}	max.	30 A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	125 W
Fall time (inductive switching)	t_f	typ.	1 μs

MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT-93.



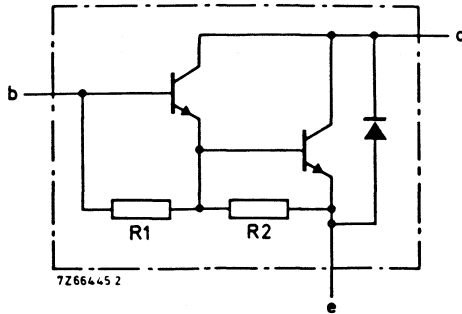


Fig. 2 Darlington circuit diagram
 R1 typical 500 Ω
 R2 typical 300 Ω

RATINGS

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

Collector-emitter voltage (peak value; $V_{BE} = 0$)	V_{CESM}	max.	650	V
Collector-emitter voltage (open base)	V_{CEO}	max.	400	V
Collector current (DC)	I_C	max.	12	A
Collector current (peak value)	I_{CM}	max.	30	A
Base current (DC)	I_B	max.	4	A
Base current (peak value)	I_{BM}	max.	6	A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	125	W
Storage temperature range	T_{stg}		-65 to +150	$^\circ\text{C}$
Junction temperature	T_j	max.	150	$^\circ\text{C}$

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j-mb}$	=	1	K/W
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CHARACTERISTICS

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

Collector cut-off current*

$V_{CE} = V_{CESMmax}; V_{BE} = 0$	I_{CES}	max.	1	mA
------------------------------------	-----------	------	---	----

$V_{CE} = V_{CESMmax}; V_{BE} = 0; T_j = 125\text{ }^\circ\text{C}$	I_{CES}	max.	3	mA
---	-----------	------	---	----

Emitter cut-off current

$I_C = 0; V_{EB} = 6\text{ V}$	I_{EBO}	max.	20	mA
--------------------------------	-----------	------	----	----

Collector-emitter sustaining voltage

$I_C = 5\text{ A}; I_B = 0; L = 8\text{ mH}$	$V_{CEO\text{sust}}$	min.	400	V
--	----------------------	------	-----	---

Diode forward voltage

$I_F = 8\text{ A}; I_B = 0$	V_F	max.	3	V
-----------------------------	-------	------	---	---

*Measured with a half-sinewave voltage (curve tracer).

Saturation voltages

$I_C = 5 \text{ A}; I_B = 50 \text{ mA}$

$I_C = 5 \text{ A}; I_B = 60 \text{ mA}; T_j = -40 \text{ }^\circ\text{C}$

$I_C = 6 \text{ A}; I_B = 100 \text{ mA}; T_j = 150 \text{ }^\circ\text{C}$

$I_C = 10 \text{ A}; I_B = 300 \text{ mA}$

V_{CEsat}	max.	1.5 V
V_{BEsat}	max.	2 V
V_{CEsat}	max.	1.5 V
V_{BEsat}	max.	2 V
V_{CEsat}	max.	1.5 V
V_{BEsat}	max.	2 V
V_{CEsat}	max.	2 V
V_{BEsat}	max.	2.5 V

Turn-off breakdown energy, with inductive load (Fig. 3)

$I_{Con} = 10 \text{ A}; I_{Bon} = 300 \text{ mA}$
 $L_C = 8 \text{ mH}; V_{CL} = 400 \text{ V}$

Turn-on test (Fig. 4)

$E(BR)$	min.	400 mJ
V_{CEon}	min.	400 V

Fall time; inductive switching (Fig. 5)

$I_{Con} = 5 \text{ A}; I_{Bon} = 50 \text{ mA}; L_C = 200 \text{ } \mu\text{H}$
 $I_{Con} = 10 \text{ A}; I_{Bon} = 300 \text{ mA}; L_C = 200 \text{ } \mu\text{H}$

t_f	typ.	0.7 μs
t_f	typ.	1 μs

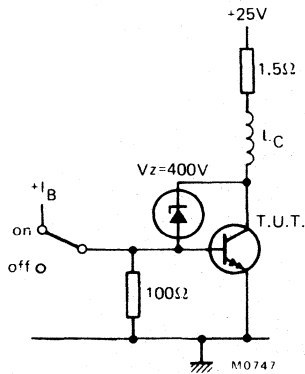


Fig. 3 Energy test.

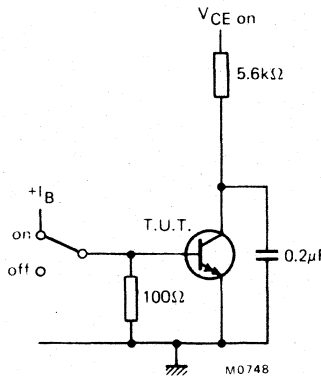


Fig. 4 Turn-on test.

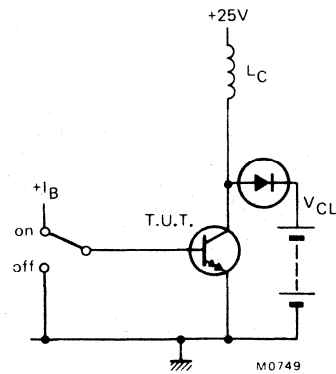
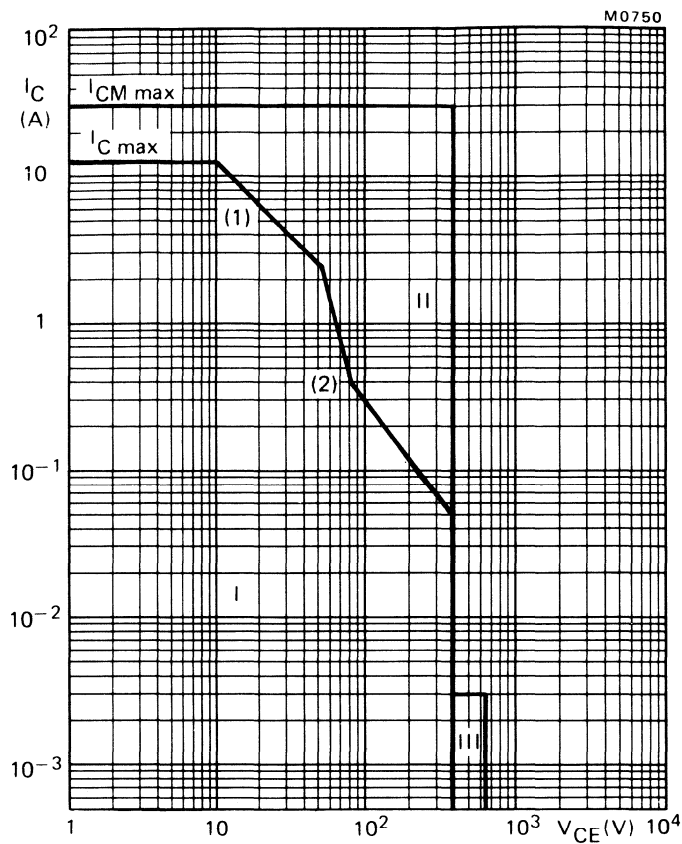


Fig. 5 Inductive switching.



- I Region of permissible DC operation
 - II Permissible extension for repetitive pulse operation
 - III Repetitive pulse operation in this region is permissible, provided $V_{BE} < 0$ and $t_p < 5$ ms.
- (1) $P_{tot\ max}$ line.
 (2) Second-breakdown limits.

Fig. 6 Safe operating area; $T_{mb} \leq 25$ °C.

SILICON DIFFUSED DARLINGTON POWER TRANSISTORS

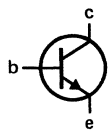
High-voltage, monolithic npn power Darlington transistors in a SOT199 envelope intended for use in car ignition systems, DC and AC motor controls, solenoid drivers, etc.

QUICK REFERENCE DATA

Collector-emitter voltage (peak value; $V_{BE} = 0$)	V_{CESM}	max.	650	V
Collector-emitter voltage (open base)	V_{CEO}	max.	400	V
Collector saturation current	I_{Csat}	max.	10	A
Collector current (DC)	I_C	max.	12	A
Collector current (peak value)	I_{CM}	max.	30	A
Total power dissipation up to $T_{mb} = 25^\circ\text{C}$	P_{tot}	max.	34	W
Collector-emitter saturation voltage	V_{CEsat}	max.	1.5	V
$I_C = 5\text{ A}; I_B = 0.05\text{ A}$	V_{CEsat}	max.	2	V
$I_C = 10\text{ A}; I_B = 0.3\text{ A}$				
Fall time (inductive switching)	t_f	typ.	0.7	μs
$I_{Con} = 5\text{ A}; I_{Bon} = 50\text{ mA}; L_C = 200\text{ }\mu\text{H}$	t_f	typ.	1	μs
$I_{Con} = 10\text{ A}; I_{Bon} = 300\text{ mA}; L_C = 200\text{ }\mu\text{H}$				

MECHANICAL DATA

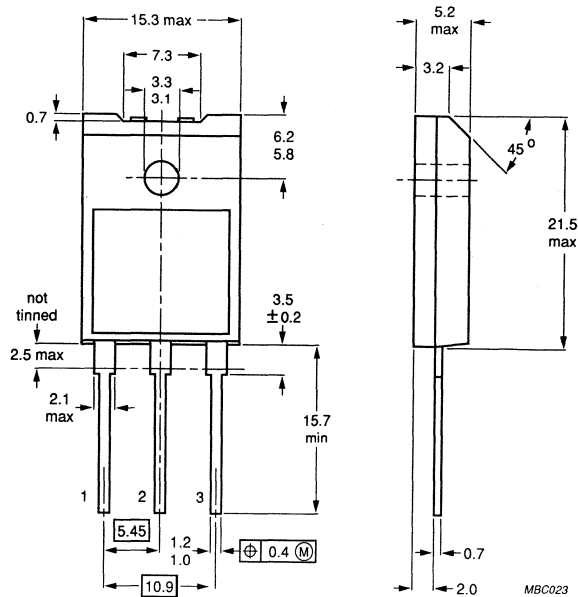
Fig. 1 SOT199.

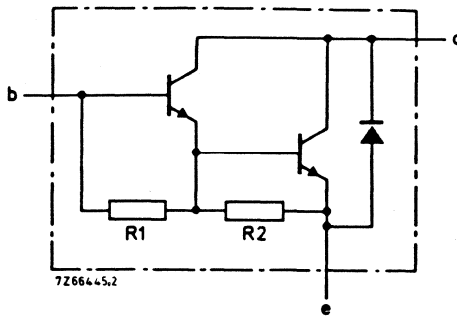


Pinning:

- 1 = base
- 2 = collector
- 3 = emitter

Mounting base is electrically isolated





R1 typical value 500 Ω

R2 typical value 500 Ω

Fig. 2 Darlington circuit diagram.

RATINGS

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

Collector-emitter voltage (peak value; $V_{BE} = 0$)	V_{CESM}	max.	650	V
Collector-emitter voltage (open base)	V_{CEO}	max.	400	V
Collector current (DC)	I_C	max.	12	A
Collector current (peak value)	I_{CM}	max.	30	A
Base current (DC)	I_B	max.	4	A
Base current (peak value)	I_{BM}	max.	6	A
Total power dissipation up to $T_{mb} = 25^\circ\text{C}$	P_{tot}	max.	34	W
Storage temperature range	T_{stg}		-65 to +150	$^\circ\text{C}$
Junction temperature	T_j	max.	150	$^\circ\text{C}$

THERMAL RESISTANCE

From junction to external heatsink (note 1)	R_{thj-h}	=	3.7	K/W
From junction to external heatsink (note 2)	R_{thj-h}	=	2.8	K/W

ISOLATION

Isolation voltage from all terminals to external heatsink (peak value)	V_{isol}	max.	1500	V
Isolation capacitance from collector to external heatsink	C_{isol}	typ.	21	pF

Notes

1. Mounted without heatsink compound and ± 30 newtons pressure on centre of envelope.
2. Mounted with heatsink compound and ± 30 newtons pressure on centre of envelope.

CHARACTERISTICS

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

Collector cut-off current *

$V_{CE} = V_{CESMmax}; V_{BE} = 0$
 $V_{CE} = V_{CESMmax}; V_{BE} = 0; T_j = 125\text{ }^\circ\text{C}$

I_{CES}	max.	1	mA
I_{CES}	max.	3	mA

Emitter cut-off current

$I_C = 0; V_{EB} = 6\text{ V}$

I_{EBO}	max.	20	mA
-----------	------	----	----

Collector-emitter sustaining voltage

$I_C = 5\text{ A}; I_B = 0; L = 8\text{ mH}$

$V_{CEOsust}$	min.	400	V
---------------	------	-----	---

Diode forward voltage

$I_F = 8\text{ A}; I_B = 0$

V_F	max.	3	V
-------	------	---	---

Saturation voltages

$I_C = 5\text{ A}; I_B = 0.05\text{ A}$

V_{CEsat}	max.	1.5	V
-------------	------	-----	---

$I_C = 5\text{ A}; I_B = 0.06\text{ A}; T_j = -40\text{ }^\circ\text{C}$

V_{BEsat}	max.	2.0	V
-------------	------	-----	---

V_{CEsat}	max.	1.5	V
-------------	------	-----	---

V_{BEsat}	max.	2.0	V
-------------	------	-----	---

$I_C = 6\text{ A}; I_B = 0.1\text{ A}; T_j = 150\text{ }^\circ\text{C}$

V_{CEsat}	max.	1.5	V
-------------	------	-----	---

V_{BEsat}	max.	2.0	V
-------------	------	-----	---

$I_C = 10\text{ A}; I_B = 0.3\text{ A}$

V_{CEsat}	max.	2.0	V
-------------	------	-----	---

V_{BEsat}	max.	2.5	V
-------------	------	-----	---

Turn-off breakdown energy with inductive load (see Fig. 3)

$I_C = 10\text{ A}; I_B = 0.3\text{ A}; L_C = 8\text{ mH}; V_{CL} = 400\text{ V}$

$E(BR)$	min.	400	mJ
---------	------	-----	----

Turn-on test (see Fig. 4)

V_{CEon}	min.	400	V
------------	------	-----	---

Full-time, inductive switching

$I_{Con} = 5\text{ A}; I_{Bon} = 50\text{ mA}; L_C = 200\text{ }\mu\text{H}$

t_f	typ.	0.7	μs
-------	------	-----	---------------

$I_{Con} = 10\text{ A}; I_{Bon} = 300\text{ mA}; L_C = 200\text{ }\mu\text{H}$

t_f	typ.	1	μs
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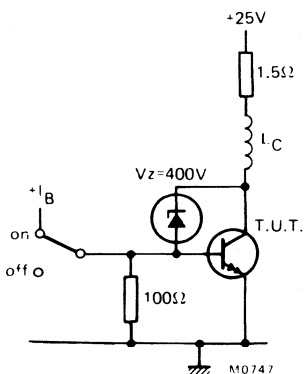


Fig.3 Energy test.

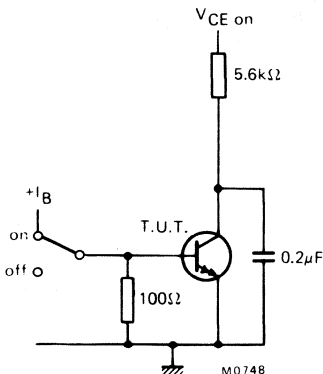


Fig.4 Turn-on test.

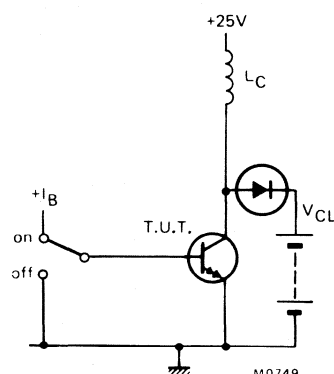
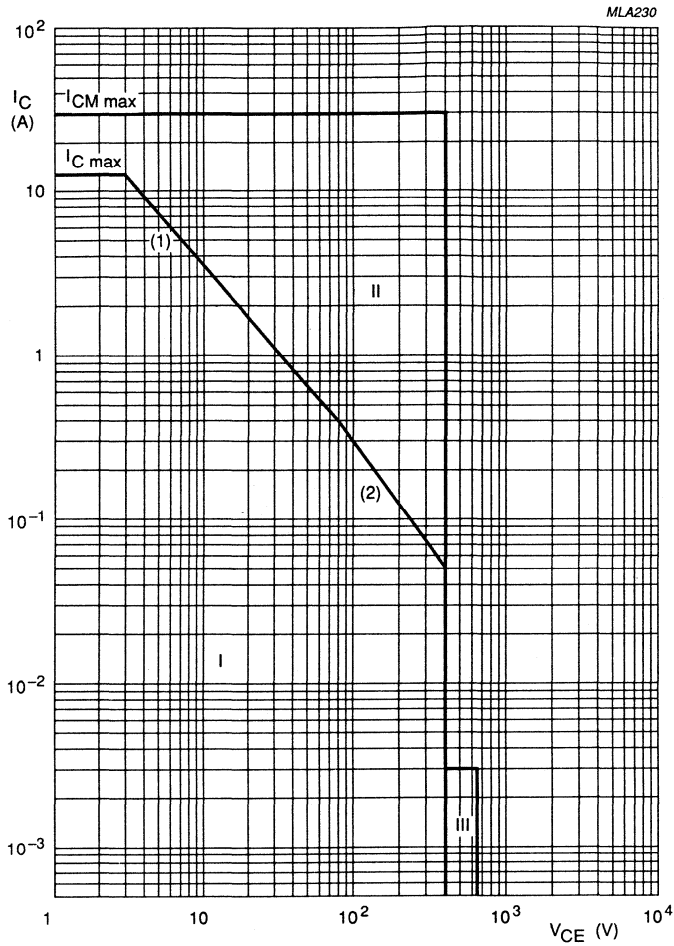


Fig.5 Inductive switching.

* Measured with a half-sinewave voltage (curve tracer)



- I Region of permissible DC operation
- II Permissible extension for repetitive pulse operation
- III Repetitive pulse operation in this region is permissible, provided $V_{BE} < 0$ and $t_p < 5$ ms.
- (1) P_{tot} max line.
- (2) Second-breakdown limits (independent of temperature).

Fig. 6 Safe operating area; $T_{mb} \leq 25$ °C; mounted without heatsink compound and ± 30 newtons pressure on centre of envelope.

SILICON DIFFUSED POWER TRANSISTORS

High-voltage, high-current, high-speed transistors, assembled in the isolated ISOTOP package; intended for use in inverters, converters and motor control applications on 220 V to 380 V mains supplies.

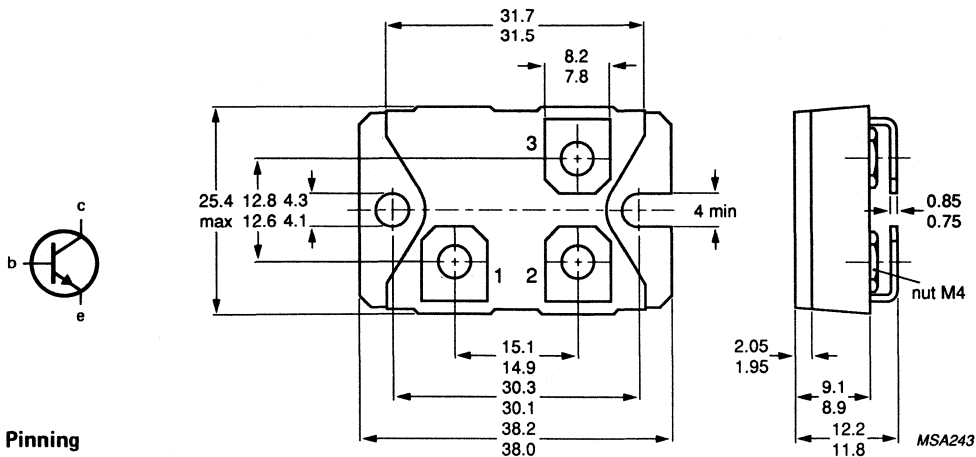
QUICK REFERENCE DATA

			BUV98(V)	98A(V)	
Collector-emitter peak value; $V_{BE} = 0$ open base	V_{CESM}	max.	850	1000	V
	V_{CEO}	max.	450	450	V
Collector-emitter saturation voltage	V_{CEsat}	max.	1.5		V
Collector current saturation DC peak value	I_{Csat}	max.	20	16	A
	I_C	max.	30		A
	I_{CM}	max.	60		A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	150	W	
Fall time	t_f	typ.	80	ns	

MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT227B (BUV98V and BUV98AV).

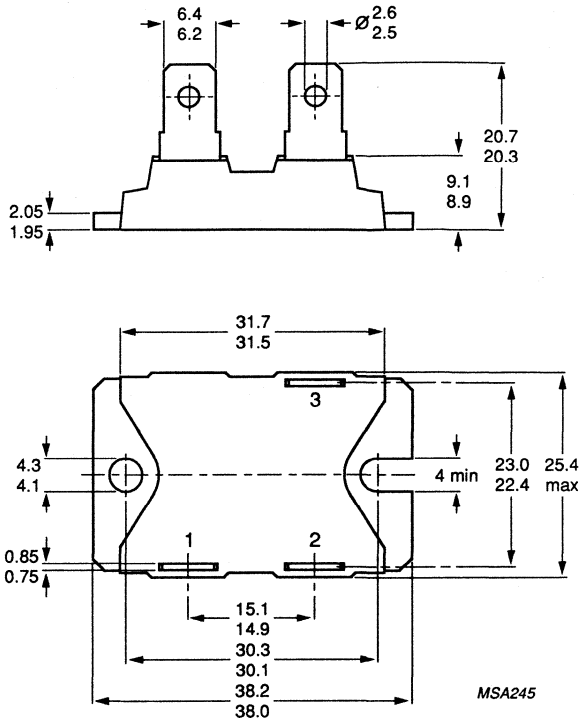
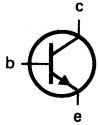


Pinning

- 1 = emitter
- 2 = base
- 3 = collector

Baseplate is electrically isolated from all terminals.

BUV98(V)
BUV98A(V)



Pinning

- 1 = emitter
- 2 = base
- 3 = collector

Baseplate is electrically isolated from all terminals

Fig. 2 SOT227A, with Faston terminals (BUV98 and BUV98A).

RATINGS

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

			BUV98(V)	98A(V)	
Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM}	max.	850	1000	V
	V_{CEO}	max.	450	450	V
Collector current saturation DC peak value	I_{Csat}		20	16	A
	I_C	max.		30	A
	I_{CM}	max.		60	A
Base current DC peak value	I_B	max.		8.0	A
	I_{BM}	max.		30	A
Total power dissipation up to $T_{mb} = 25^\circ C$	P_{tot}	max.		150	W
Storage temperature range	T_{stg}			-65 to +150	$^\circ C$
Junction temperature	T_j	max.		150	$^\circ C$

THERMAL RESISTANCE

 From junction to mounting base
 with heatsink compound

$$R_{th\ j-mb} = 0.83\ \text{K/W}$$

ISOLATION

 Isolation voltage from all terminals to
 external heatsink (RMS value)

$$V_{isol} \text{ max.} = 2500\ \text{V}$$

 Isolation capacitance from collector
 to external heatsink

$$C_{isol} \text{ typ.} = 45\ \text{pF}$$

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

Collector cut-off currents

$$V_{CE} = V_{CESMmax}; V_{BE} = 0\ \text{V}$$

$$I_{CES} \text{ max.} = 0.4\ \text{mA}$$

$$V_{CE} = V_{CESMmax}; V_{BE} = 0\ \text{V};$$

$$T_j = 125\ ^\circ\text{C}$$

$$I_{CES} \text{ max.} = 4.0\ \text{mA}$$

Emitter cut-off current

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

$$I_{EBO} \text{ max.} = 2.0\ \text{mA}$$

Saturation voltages

$$I_C = I_{Csat}; I_B = I_{Csat}/5$$

$$V_{CEsat} \text{ max.} = 1.5\ \text{V}$$

$$V_{BEsat} \text{ max.} = 1.6\ \text{V}$$

 Collector-emitter sustaining voltage
 (Figs 2 and 3)

$$I_C = 200\ \text{mA}; I_B = 0; L = 25\ \text{mH}$$

$$V_{CEO\text{sust}} \text{ min.} = 450\ \text{V}$$

 Switching times resistive load
 (Figs 4 and 5)

$$I_C = I_{Csat}; I_{B\ on} = I_{Csat}/5;$$

$$I_{B\ off} = I_{B\ on}$$

turn-on time

$$t_{on} \text{ typ.} = 0.55\ \mu\text{s}$$

$$\text{max.} = 1.0\ \mu\text{s}$$

turn-off; storage time

$$t_s \text{ typ.} = 1.5\ \mu\text{s}$$

$$\text{max.} = 3.0\ \mu\text{s}$$

fall time

$$t_f \text{ typ.} = 0.3\ \mu\text{s}$$

$$\text{max.} = 0.8\ \mu\text{s}$$

 Switching times inductive load
 (Figs 6 and 7)

$$I_C = I_{Csat}; I_{B\ on} = I_{Csat}/5;$$

$$V_{BE} = -5\ \text{V}$$

turn-off; storage time

$$t_s \text{ typ.} = 3.5\ \mu\text{s}$$

fall time

$$t_f \text{ typ.} = 80\ \text{ns}$$

 $T_j = 100\ ^\circ\text{C}$

turn-off; storage time

$$t_s \text{ max.} = 5.0\ \mu\text{s}$$

fall time

$$t_f \text{ max.} = 400\ \text{ns}$$

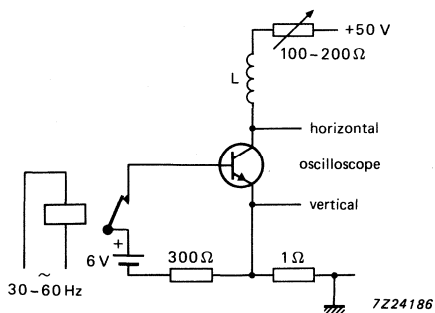


Fig. 3 Test circuit for $V_{CE0sust}$.

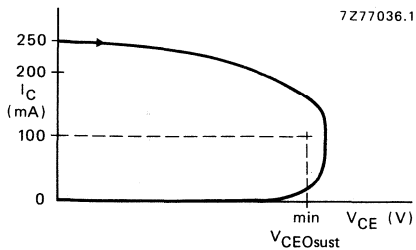


Fig. 4 Oscilloscope display for sustaining voltage.

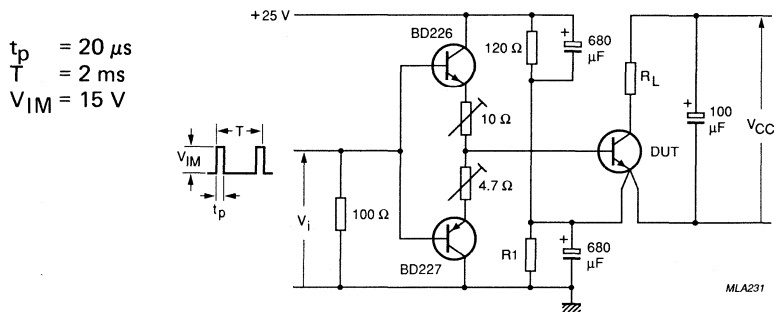


Fig. 5 Test circuit resistive load; $V_{CC} = 150\text{ V}$; $R_L = 83\ \Omega$; $R_1 = 33\ \Omega$.

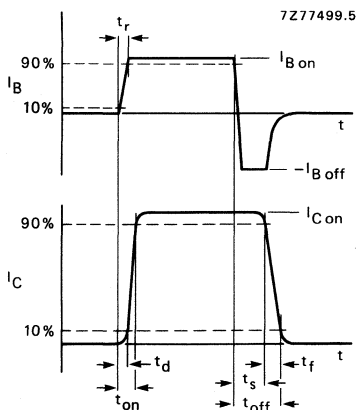


Fig. 6 Switching times waveforms with resistive load; $t_r \leq 30\text{ ns}$.

For inductive load:

$V_{\text{clamp}} = 300 \text{ V}$

$-V_{\text{BE}} = -5 \text{ V}$

$L_{\text{B}} = 1.5 \mu\text{H}$

For RB SOAR:

V_{clamp} up to 1000 V

$-V_{\text{BE}}$ to be adjusted

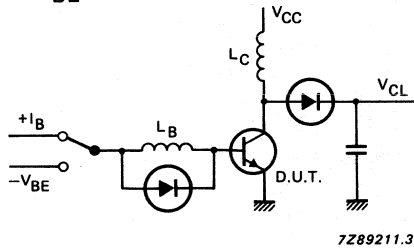


Fig. 7 Test circuit inductive load and RB SOAR; $V_{\text{CC}} = 30 \text{ V}$; $L_{\text{C}} = 200 \mu\text{H}$.

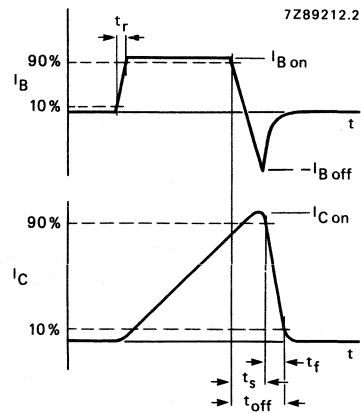
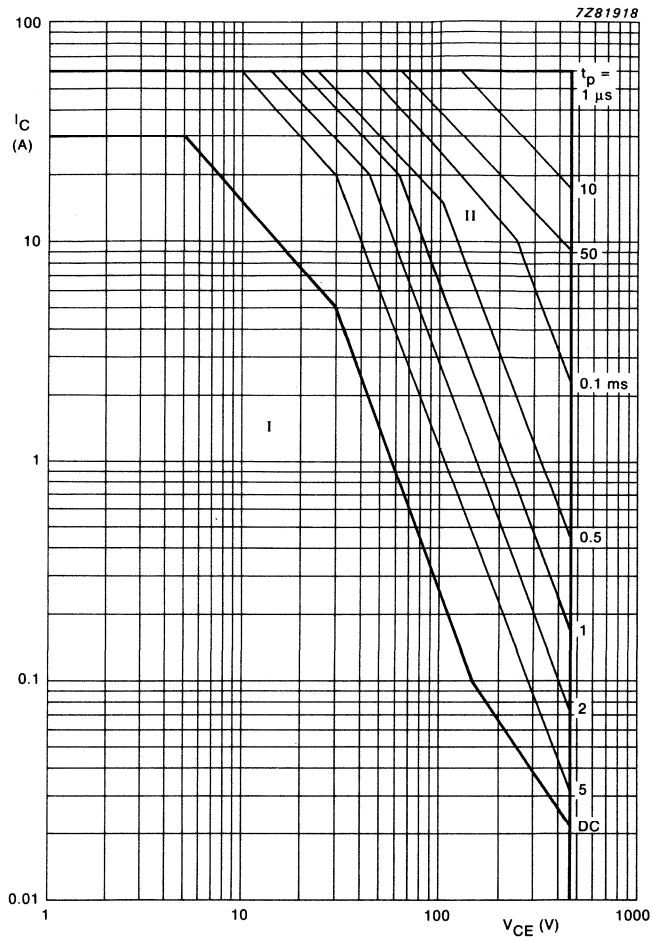


Fig. 8 Switching times waveforms with inductive load.



- I Region of permissible DC operation.
- II Permissible extension for single pulse operation.

Fig. 9 Safe operating area at $T_{mb} < 25^\circ\text{C}$.

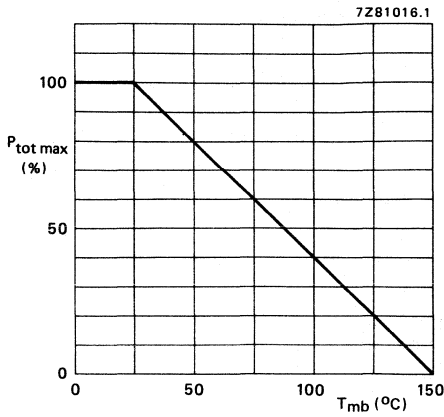


Fig. 10 Total power dissipation.

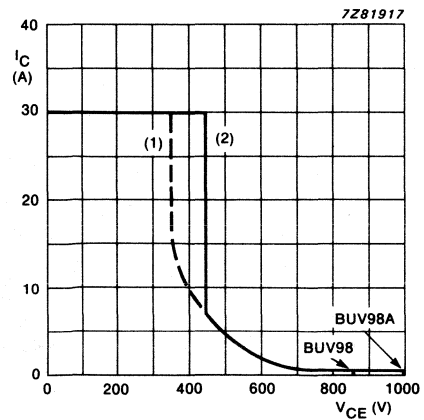


Fig. 11 Reverse bias SOAR; $V_{BE} = -5\text{ V}$;
 $I_C/I_B \geq 5$; $T_j \leq 125\text{ }^\circ\text{C}$.
(1) Hard saturation.
(2) With anti-saturation network.

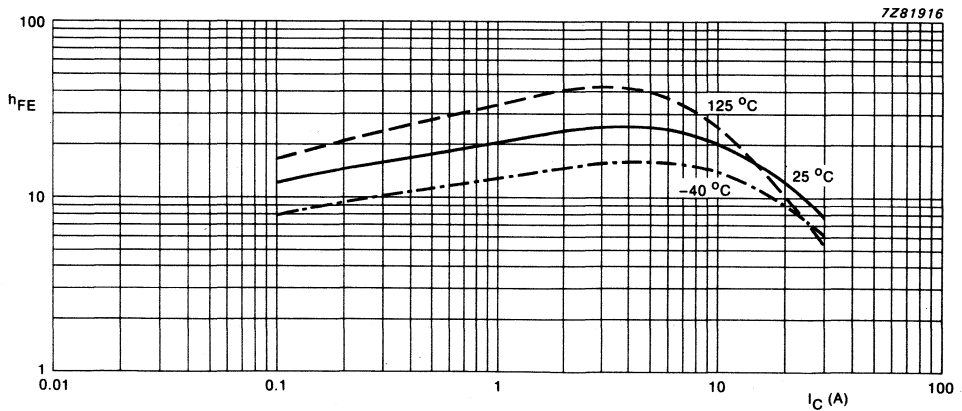


Fig. 12 Typical DC current gain at $V_{CE} = 5\text{ V}$.

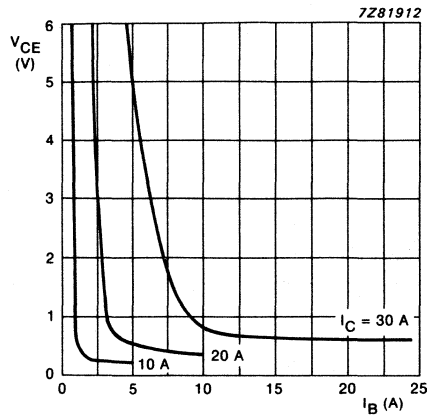


Fig. 13 Collector-emitter voltage as a function of base current; $T_j = 25\text{ }^\circ\text{C}$.

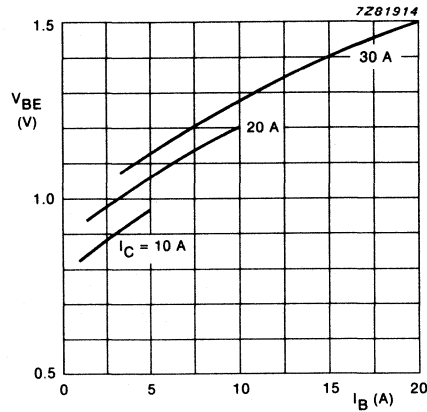


Fig. 14 Base-emitter saturation voltage as a function of base current; $T_j = 25\text{ }^\circ\text{C}$.

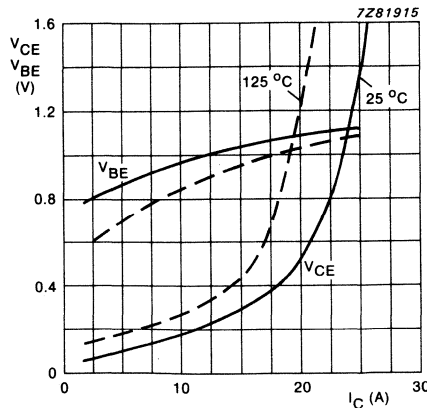


Fig. 15 Typical V_{CEsat} and V_{BEsat} as a function of collector current; $I_C/I_B = 5$.

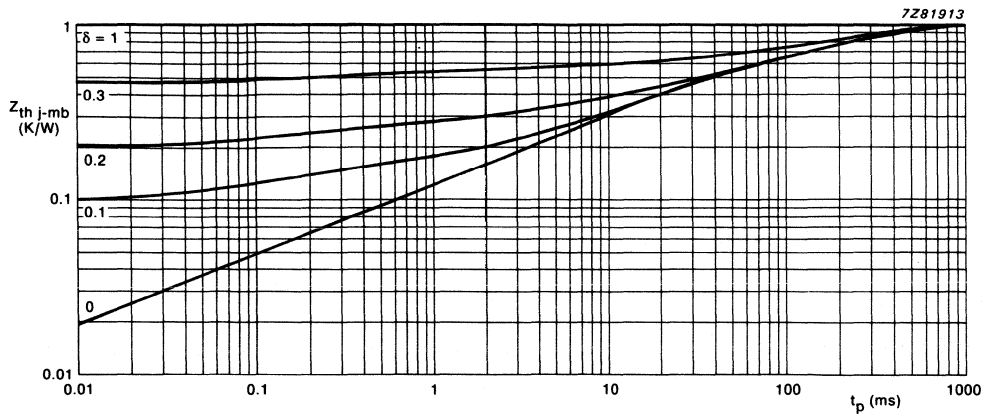


Fig. 16 Thermal response at pulse power conditions.

SILICON DIFFUSED POWER TRANSISTORS

High-voltage, high-current, high-speed transistors, assembled in the isolated ISOTOP package; intended for use in inverters, converters and motor control applications on 220 V to 380 V mains supply.

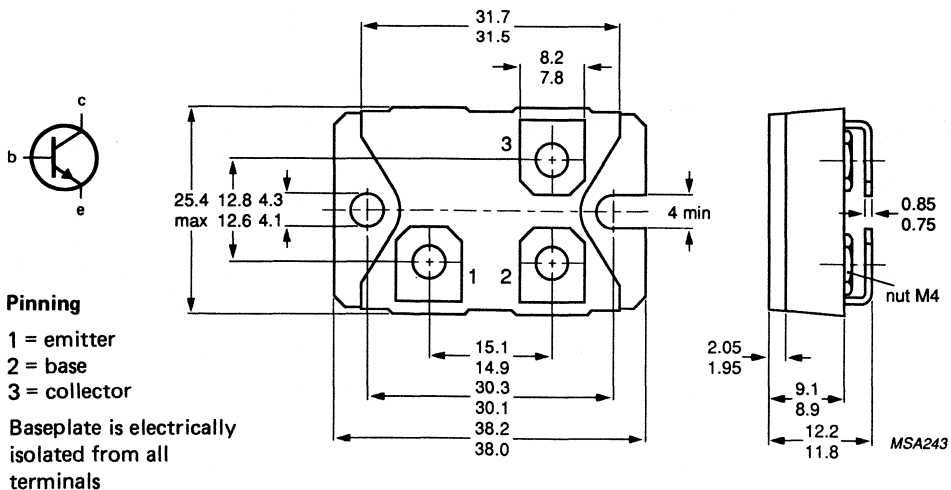
QUICK REFERENCE DATA

			BUV298(V)	298A(V)	
Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM}	max.	850	1000	V
	V_{CEO}	max.	450	450	V
Collector-emitter saturation voltage	V_{CEsat}	max.	1.2	1.2	V
Collector current saturation DC peak value	I_{Csat}	max.	40	32	A
	I_C	max.		60	A
	I_{CM}	max.		90	A
Total power dissipation up to $T_{mb} = 25^\circ\text{C}$	P_{tot}	max.		250	W
Fall time inductive load at 100°C	t_f	max.		0.4	μs

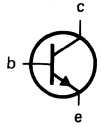
MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT227B (BUV298V and BUV298AV).



BUV298(V)
BUV298A(V)



Baseplate is electrically isolated from all terminals

Pinning

- 1 = emitter
- 2 = base
- 3 = collector

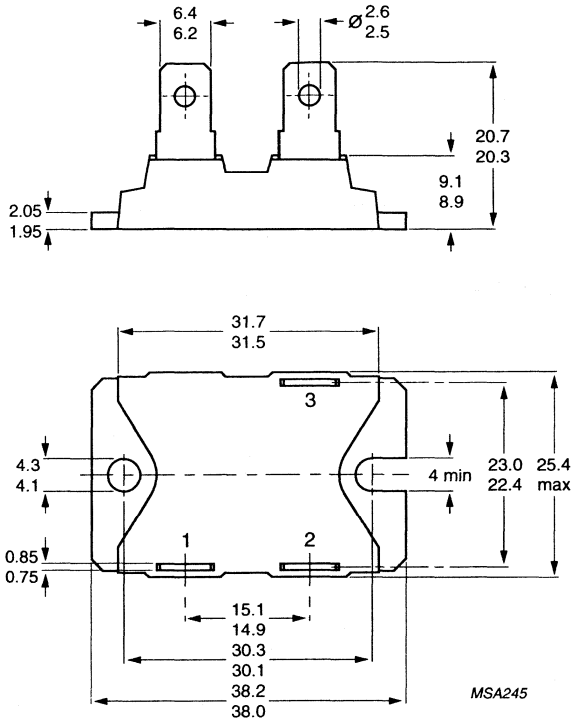


Fig. 2 SOT227A, with Faston terminals (BUV298 and BUV298A).

RATINGS

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

			BUV298(V)	298A(V)	
Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM}	max.	850	1000	V
	V_{CEO}	max.	450	450	V
Collector current saturation DC peak value	I_{Csat}		40	32	A
	I_C	max.	60	60	A
	I_{CM}	max.	90	90	A
Base current DC peak value	I_B	max.	12	10	A
	I_{BM}	max.	20	16	A
Total power dissipation up to $T_{mb} = 25^\circ C$	P_{tot}	max.	250	250	W
Storage temperature range	T_{stg}		-65 to +150		$^\circ C$
Junction temperature	T_j	max.	150		$^\circ C$

THERMAL RESISTANCEFrom junction to mounting base
with heatsink compound

$$R_{th\ j-mb} = 0.5\ K/W$$

ISOLATIONIsolation voltage from all terminals to
external heatsink (RMS value)

$$V_{isol(rms)}\ max. = 2500\ V$$

Isolation capacitance from collector
to external heatsink

$$C_{isol}\ typ. = 45\ pF$$

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

Collector cut-off currents

$$V_{CE} = V_{CESMmax}; V_{BE} = 0\ V$$

$$I_{CES}\ max. = 0.4\ mA$$

$$V_{CE} = V_{CESMmax}; V_{BE} = 0\ V;$$

$$T_j = 100\ ^\circ C$$

$$I_{CES}\ max. = 2.0\ mA$$

Emitter cut-off current

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

$$I_{EBO}\ max. = 2.0\ mA$$

Saturation voltages

$$I_C = I_{Csat}; I_B = I_{Csat}/5$$

$$V_{CEsat}\ max. = 1.2\ V$$

$$V_{BEsat}\ max. = 1.5\ V$$

Collector-emitter sustaining voltage

$$I_C = 200\ mA; I_B = 0; L = 25\ mH$$

$$V_{CEO\ sust}\ min. = 450\ V$$

Switching times inductive load

$$T_j = 100\ ^\circ C$$

turn-off; storage time
fall time

$$t_s\ max. = 4.5\ \mu s$$

$$t_f\ max. = 0.4\ \mu s$$

SILICON DIFFUSED POWER TRANSISTORS

High-voltage, high-speed, glass-passivated npn power transistors in a SOT93 envelope, intended for use in converters, inverters, switching regulators, motor control systems etc.

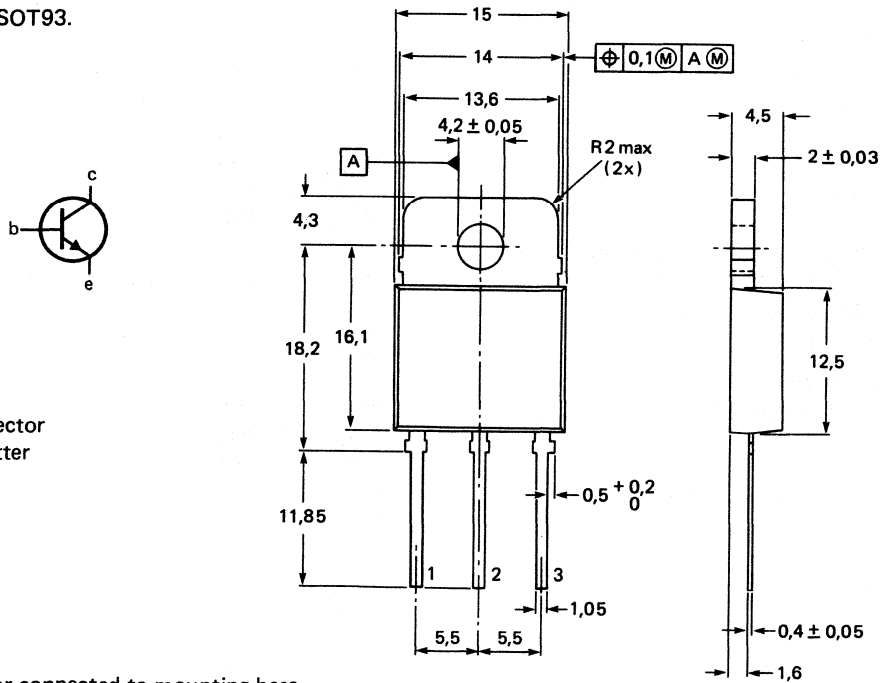
QUICK REFERENCE DATA

		BUW11	BUW11A	
Collector-emitter voltage (peak value; $V_{BE} = 0$)	V_{CESM} max.	850	1000	V
Collector-emitter voltage (open base)	V_{CEO} max.	400	450	V
Collector-emitter saturation voltage	V_{CEsat} max.	1.5		V
Collector current (DC)	I_C max.	5		A
Collector current (peak value)	I_{CM} max.	10		A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot} max.	100		W
Fall time (resistive load)	t_f max.	0.8		μs

MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT93.



Pinning:
1 = base
2 = collector
3 = emitter

Collector connected to mounting base.

7296696

RATINGS

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

			BUW11	BUW11A	
Collector-emitter voltage (peak value; $V_{BE} = 0$)	V_{CESM}	max.	850	1000	V
Collector-emitter voltage (open base)	V_{CEO}	max.	400	450	V
Collector current (DC)	I_C	max.	5		A
Collector current (peak value) $t_p < 2$ ms	I_{CM}	max.	10		A
Base current (DC)	I_B	max.	2		A
Base current (peak value); $t_p < 2$ ms	I_{BM}	max.	4		A
Total power dissipation up to $T_{mb} = 25$ °C	P_{tot}	max.	100		W
Storage temperature range	T_{stg}		-65 to +150		°C
Junction temperature	T_j	max.	150		°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j-mb}$	=	1,25		K/W
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CHARACTERISTICS

$T_j = 25$ °C unless otherwise specified

Collector cut-off current*

$V_{CE} = V_{CESMmax}; V_{BE} = 0$

$V_{CE} = V_{CESMmax}; V_{BE} = 0; T_j = 125$ °C

I_{CES}	max.	1		mA
I_{CES}	max.	2		mA

Emitter cut-off current

$I_C = 0; V_{EB} = 9$ V

I_{EBO}	max.	10		mA
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Saturation voltages

$I_C = 3$ A; $I_B = 0,6$ A

$I_C = 2,5$ A; $I_B = 0,5$ A

		BUW11	BUW11A	
V_{CEsat}	max.	1,5	—	V
V_{BEsat}	max.	1,4	—	V
V_{CEsat}	max.	—	1,5	V
V_{BEsat}	max.	—	1,4	V

Collector-emitter sustaining voltage

$I_C = 100$ mA; $I_{Boff} = 0$; $L = 25$ mH

$V_{CEO_{sust}}$	min.	400	450	V
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Collector saturation current

$V_{CE} = 1,5$ V

I_{Csat}	max.	3	2,5	A
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DC current gain

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

h_{FE}	min.	10		
h_{FE}	typ.	18		
h_{FE}	max.	35		

$I_C = 500$ mA; $V_{CE} = 5$ V

h_{FE}	min.	10		
h_{FE}	typ.	20		
h_{FE}	max.	35		

* Measured with a half sinewave voltage (curve tracer).

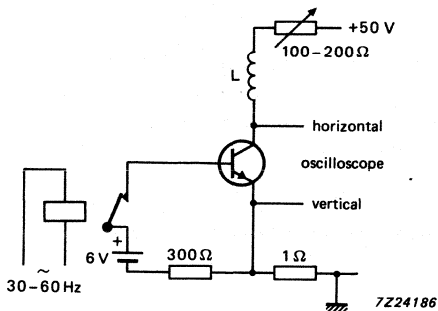


Fig. 2 Test circuit for V_{CEsust} .

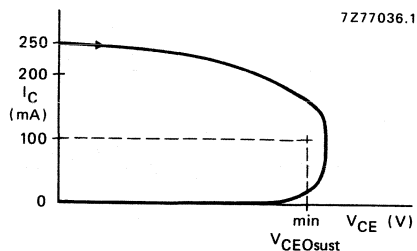


Fig. 3 Oscilloscope display for sustaining voltage.

Switching times resistive load (Figs 4 and 5)

$I_{Con} = 3 \text{ A}; I_{Bon} = I_{Boff} = 0,6 \text{ A}$

Turn-on time

Turn-off: Storage time

Fall time

$I_{Con} = 2,5 \text{ A}; I_{Bon} = -I_{Boff} = 0,5 \text{ A}$

Turn-on time

Turn-off: Storage time

Fall time

Switching times inductive load (Figs 6 and 7)

$I_{Con} = 3 \text{ A}; I_B = 0,6 \text{ A}$

Turn-off: Storage time

Fall time

$I_{Con} = 3 \text{ A}; I_B = 0,6 \text{ A}; T_j = 100 \text{ }^\circ\text{C}$

Turn-off: Storage time

Fall time

Switching times inductive load (Figs 6 and 7)

$I_{Con} = 2,5 \text{ A}; I_B = 0,5 \text{ A}$

Turn-off: Storage time

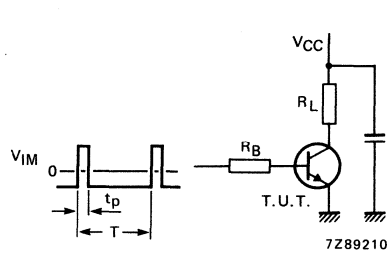
Fall time

$I_{Con} = 2,5 \text{ A}; I_B = 0,5 \text{ A}; T_j = 100 \text{ }^\circ\text{C}$

Turn-off: Storage time

Fall time

		BUW11	BUW11A	
t_{on}	max.	1	—	μs
t_s	max.	4	—	μs
t_f	max.	0,8	—	μs
t_{on}	max.	—	1	μs
t_s	max.	—	4	μs
t_f	max.	—	0,8	μs
t_s	typ.	1,1	—	μs
	max.	1,4	—	μs
t_f	typ.	80	—	ns
	max.	150	—	ns
t_s	typ.	1,2	—	μs
	max.	1,5	—	μs
t_f	typ.	140	—	ns
	max.	300	—	ns
t_s	typ.	—	1,1	μs
	max.	—	1,4	μs
t_f	typ.	—	80	ns
	max.	—	150	ns
t_s	typ.	—	1,2	μs
	max.	—	1,5	μs
	typ.	—	140	ns
	max.	—	300	ns



$V_{CC} = 250 \text{ V}$
 $V_{IM} = -6 \text{ to } +8 \text{ V}$
 $\frac{t_p}{T} = 0,01$
 $t_p = 20 \mu\text{s}$
 The values of R_B and R_L are selected in accordance with I_{Con} and I_B requirements.

Fig. 4 Test circuit resistive load.

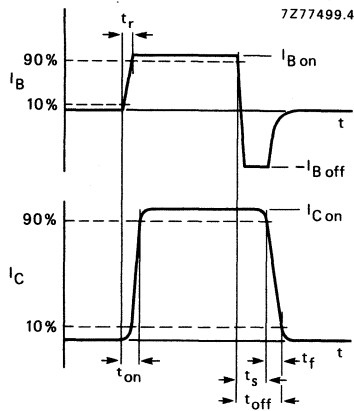


Fig. 5 Switching times waveforms with resistive load.

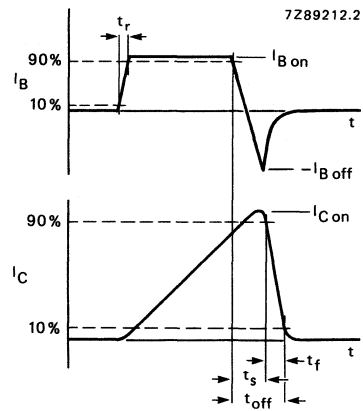
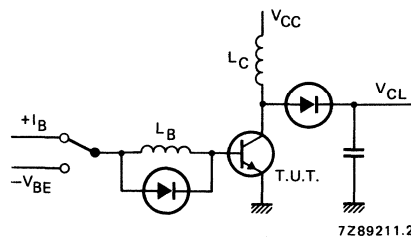
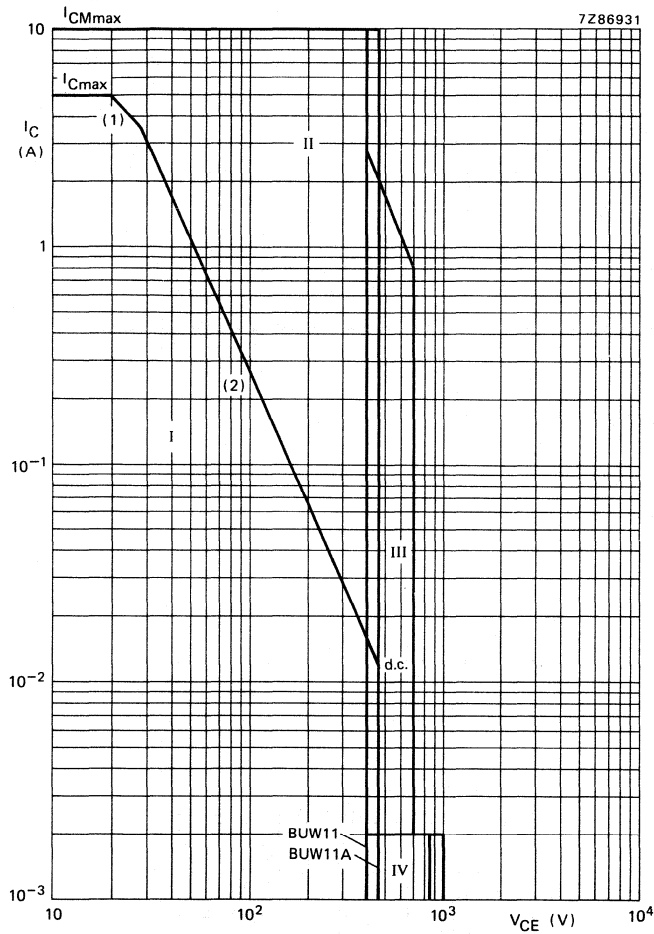


Fig. 6 Switching times waveforms with inductive load.



$V_{CL} = 300 \text{ V}$
 $V_{CC} = 30 \text{ V}$
 $-V_{BE} = 5 \text{ V}$
 $L_B = 1 \mu\text{H}$
 $L_C = 200 \mu\text{H}$

Fig. 7 Test circuit inductive load.



- (1) P_{tot} max line.
 (2) Second-breakdown limits.
- I Region of permissible DC operation
 II Permissible extension for repetitive pulse operation
 III Area of permissible operation during turn-on in single transistor converters, provided $R_{BE} \leq 100 \Omega$ and $t_p \leq 0,6 \mu s$.
 IV Repetitive pulse operation in this region is permissible provided $V_{BE} \leq 0$ and $t_p \leq 5$ ms.

Fig. 8 Safe operating area at $T_{mb} \leq 25^\circ C$.

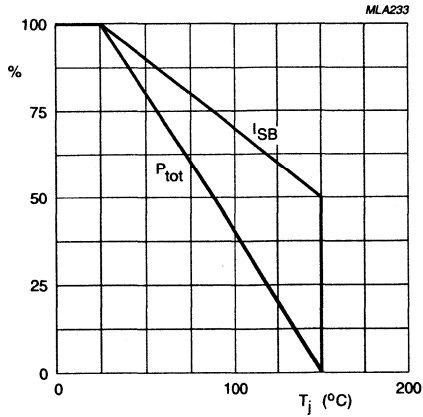


Fig. 9 Total power dissipation derating curve.

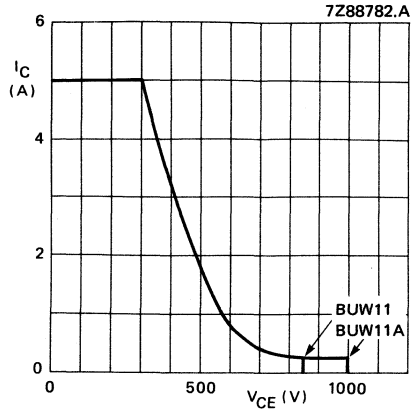


Fig. 10 Reverse bias SOAR.

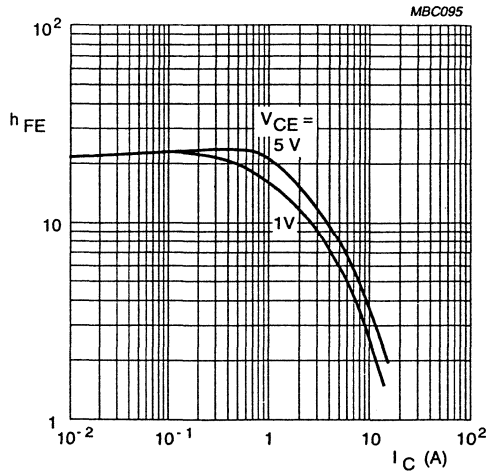


Fig. 11 Typical values DC current gain.

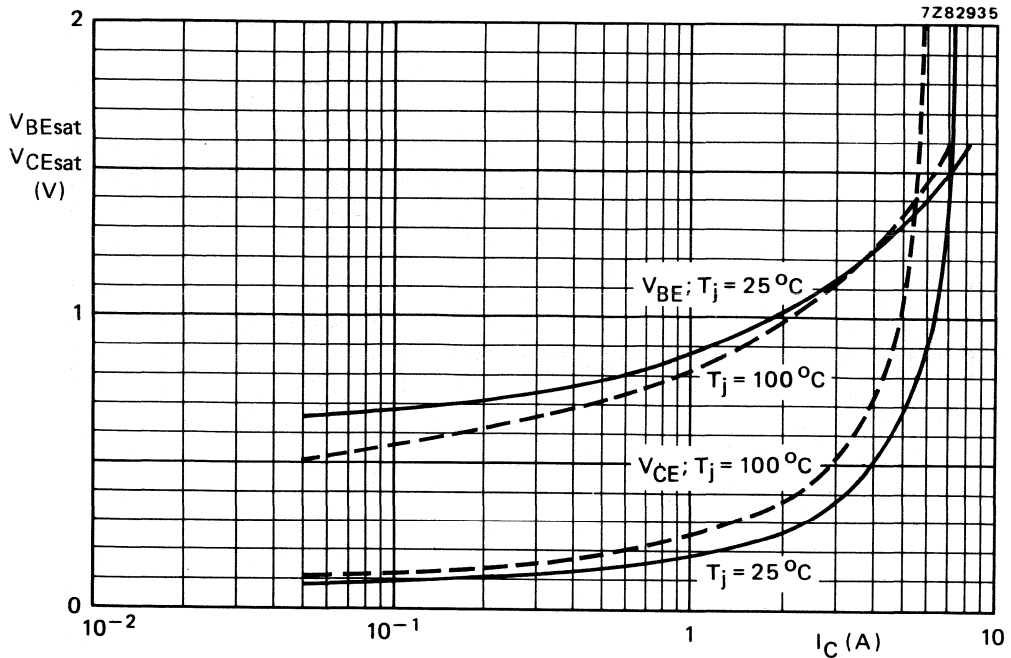


Fig. 12 Typical values base-emitter and collector-emitter voltage, $I_C/I_B = 5$.

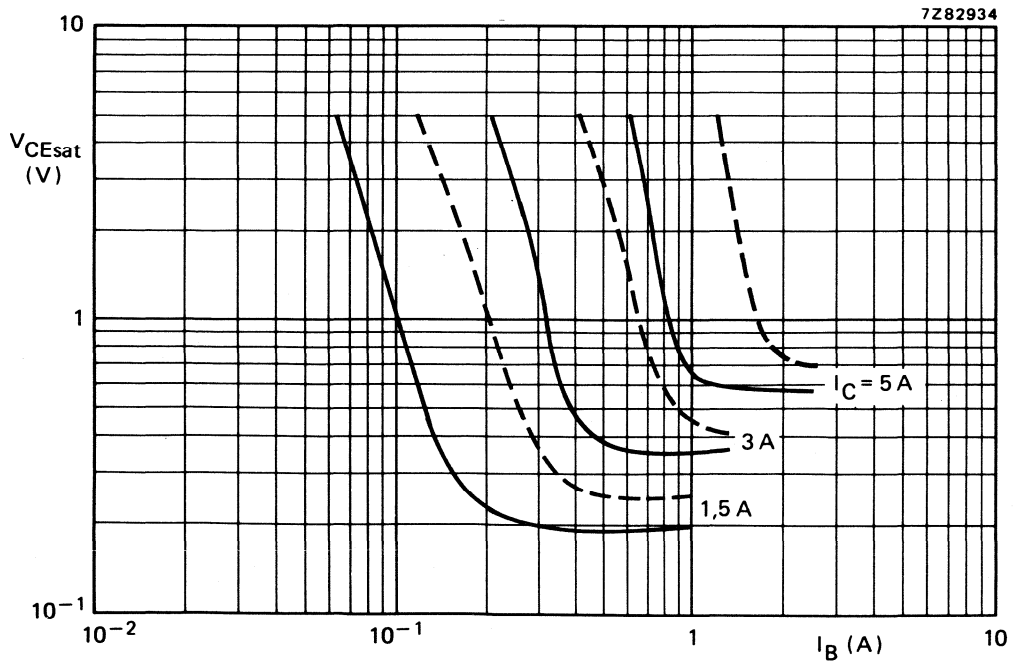


Fig. 13 Typ. (—) and max. (---) values collector-emitter saturation voltage at $T_j = 25^\circ\text{C}$.

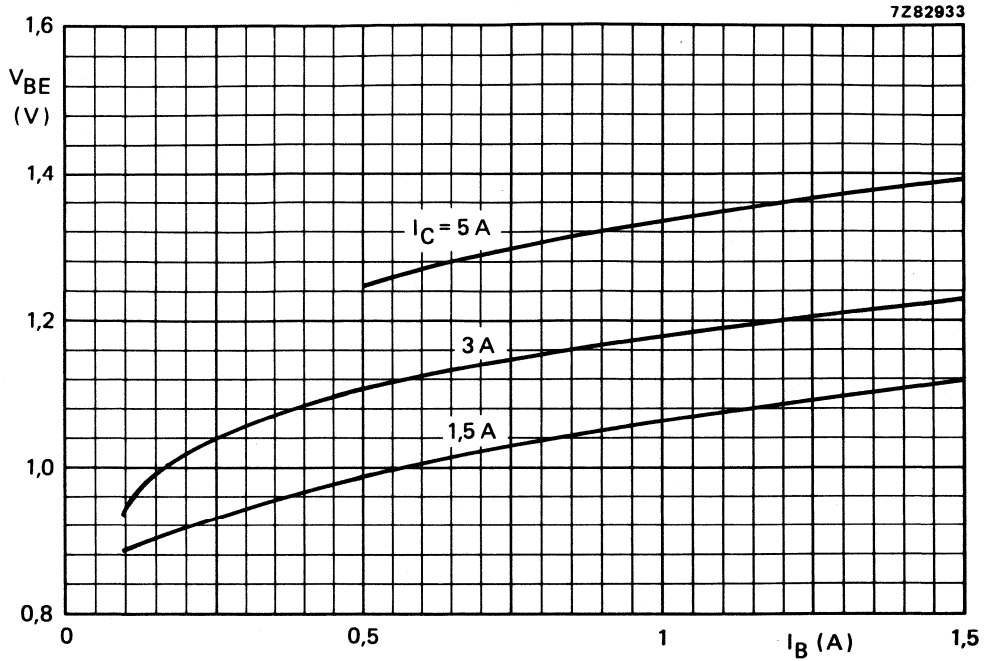


Fig. 14 Typical values at $T_j = 25$ °C.

SILICON DIFFUSED POWER TRANSISTORS

High-voltage, high-speed, glass-passivated npn power transistor in a SOT199 envelope intended for use in converters, inverters, switching regulators, motor control systems, etc.

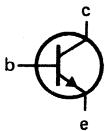
QUICK REFERENCE DATA

		BUW11F	BUW11AF
Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM} max.	850	1000 V
	V_{CEO} max.	400	450 V
Collector-emitter saturation voltage	V_{CEsat} max.	1.5	1.5 V
Collector current saturation DC peak value; $t_p < 20$ ms	I_{Csat} max.	3.0	2.5 A
	I_C max.	5.0	A
	I_{CM} max.	10	A
Total power dissipation up to $T_{mb} = 25$ °C	P_{tot} max.	32	W
Fall time	t_f max.	0.8	μs

MECHANICAL DATA

Fig. 1 SOT199.

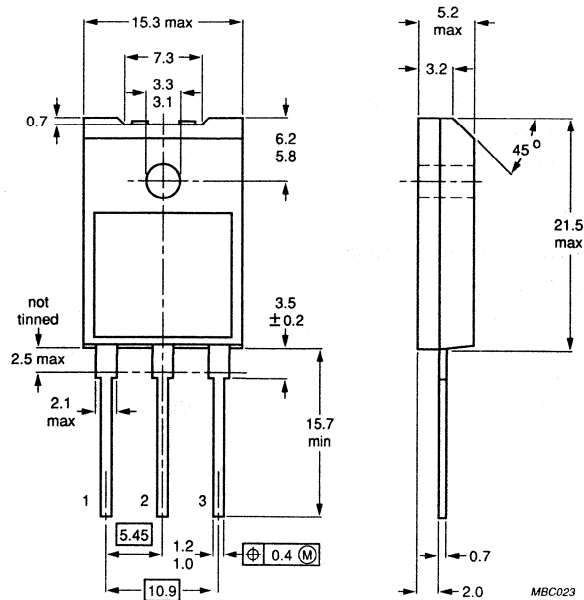
Dimensions in mm



Pinning:

- 1 = base
- 2 = collector
- 3 = emitter

Mounting base is electrically isolated.



RATINGS

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

		BUW11F	BUW11AF
Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM} max.	850	1000 V
	V_{CEO} max.	400	450 V
Collector current saturation DC	I_{Csat}	3.0	2.5
	I_C max.	5.0	A
	I_{CM} max.	10	A
Base current DC	I_B max.	2.0	A
	I_{BM} max.	4.0	A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$ (note 1)	P_{tot} max.	32	W
	P_{tot} max.	41	W
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$ (note 2)	T_{stg}	-65 to + 150	$^\circ\text{C}$
	T_j max.	150	$^\circ\text{C}$

THERMAL RESISTANCE

From junction to external heatsink (note 1)	$R_{th\ j-h}$ =	3.95	K/W
From junction to external heatsink (note 2)	$R_{th\ j-h}$ =	3.05	K/W
From junction to ambient	$R_{th\ j-a}$ =	35	K/W

ISOLATION

Isolation voltage from all terminals to external heatsink (peak value)	V_{isol} max.	1500	V
Isolation capacitance from collector to external heatsink	C_{isol} max.	21	pF

CHARACTERISTICS

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

Collector cut-off currents (note 3)

$V_{CE} = V_{CESMmax}; V_{BE} = 0$	I_{CES} max.	1.0	mA
$V_{CE} = V_{CESMmax}; V_{BE} = 0; T_j = 125\text{ }^\circ\text{C}$	I_{CES} max.	2.0	mA

Emitter cut-off current

$V_{EB} = 9\text{ V}; I_C = 0$	I_{EBO} max.	10	mA
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Notes

1. Mounted without heatsink compound and 30 ± 5 newtons pressure on centre of envelope.
2. Mounted with heatsink compound and 30 ± 5 newtons pressure on centre of envelope.
3. Measured with a half-sinewave voltage (curvé tracer).

			BUW11F	BUW11AF
Saturation voltages				
$I_C = 3 \text{ A}; I_B = 0.6 \text{ A}$	V_{CEsat}	max.	1.5	— V
	V_{BEsat}	max.	1.4	— V
$I_C = 2.5 \text{ A}; I_B = 0.5 \text{ A}$	V_{CEsat}	max.	—	1.5 V
	V_{BEsat}	max.	—	1.4 V
Collector-emitter sustaining voltage (Figs 2 and 3)				
$I_C = 100 \text{ mA}; I_B \text{ off} = 0; L = 25 \text{ mH}$	$V_{CEOsust}$	min.	400	450 V
Collector saturation current $V_{CE} = 1.5 \text{ V}$				
	I_{Csat}	max.	3.0	2.5 A
DC current gain				
$I_C = 5 \text{ mA}; V_{CE} = 5 \text{ V}$	h_{FE}	min.	10	
	h_{FE}	typ.	18	
	h_{FE}	max.	35	
$I_C = 500 \text{ mA}; V_{CE} = 5 \text{ V}$	h_{FE}	min.	10	
	h_{FE}	typ.	20	
	h_{FE}	max.	35	
Switching times resistive load (Figs 4 and 5)				
$I_C \text{ on} = 3 \text{ A}; I_B \text{ on} = I_B \text{ off} = 0.6 \text{ A}$				
Turn-on time	t_{on}	max.	1.0	— μs
Turn-off; storage time fall time	t_s	max.	4.0	— μs
	t_f	max.	0.8	— μs
$I_C \text{ on} = 2.5 \text{ A}; I_B \text{ on} = I_B \text{ off} = 0.5 \text{ A}$				
Turn-on time	t_{on}	max.	—	1.0 μs
Turn-off; storage time fall time	t_s	max.	—	4.0 μs
	t_f	max.	—	0.8 μs
Switching times inductive load (Figs 6 and 7)				
$I_C \text{ on} = 3 \text{ A}; I_B = 0.6 \text{ A}; V_{CL} = 250 \text{ V}; T_c = 100 \text{ }^\circ\text{C}$				
Turn-off; storage time	t_s	typ.	2.0	— μs
	t_s	max.	2.5	— μs
fall time	t_f	typ.	200	— ns
	t_f	max.	300	— ns
$I_C \text{ on} = 2.5 \text{ A}; I_B = 0.5 \text{ A}; V_{CL} = 300 \text{ V}; T_c = 100 \text{ }^\circ\text{C}$				
Turn-off; storage time	t_s	typ.	—	2.0 μs
	t_s	max.	—	2.5 μs
fall time	t_f	typ.	—	200 ns
	t_f	max.	—	300 ns

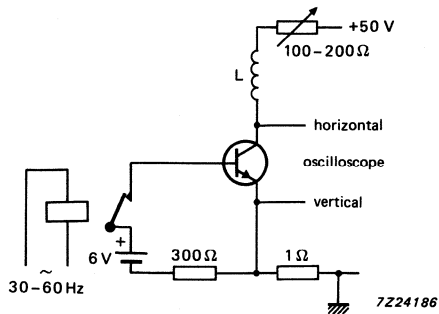


Fig. 2 Test circuit for $V_{CE0sust}$.

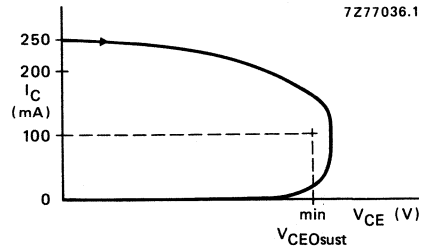


Fig. 3 Oscilloscope display for sustaining voltage.

$V_{CC} = 250 \text{ V}$
 $t_p = 20 \mu\text{s}$
 $V_{IM} = -6 \text{ to } +8 \text{ V}$
 $\frac{t_p}{T} = 0.01$

The values of R_B and R_L are selected in accordance with I_C on and I_B requirements.

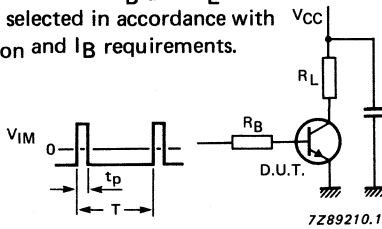


Fig. 4 Test circuit resistive load.

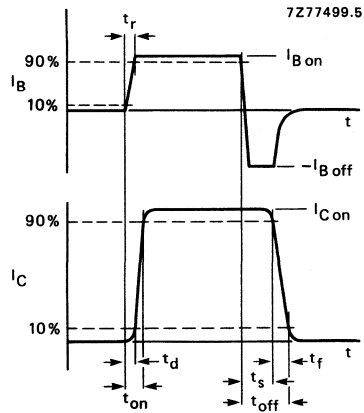


Fig. 5 Switching times waveforms with resistive load; $t_r \leq 20 \text{ ns}$.

$V_{CL} = \text{up to } 1000 \text{ V}$
 $V_{CC} = 30 \text{ V}$
 $-V_{BE} = 1 \text{ V to } 5 \text{ V}$
 $L_B = 1.0 \mu\text{H}$
 $L_C = 200 \mu\text{H}$

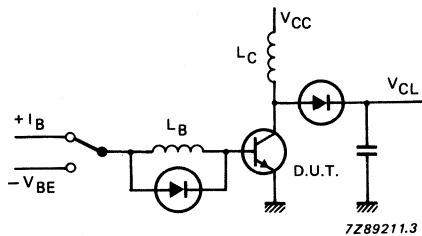


Fig. 6 Test circuit inductive load and reverse bias SOAR.

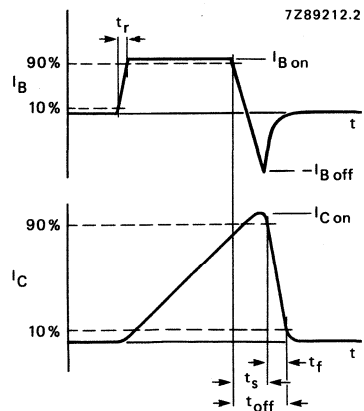
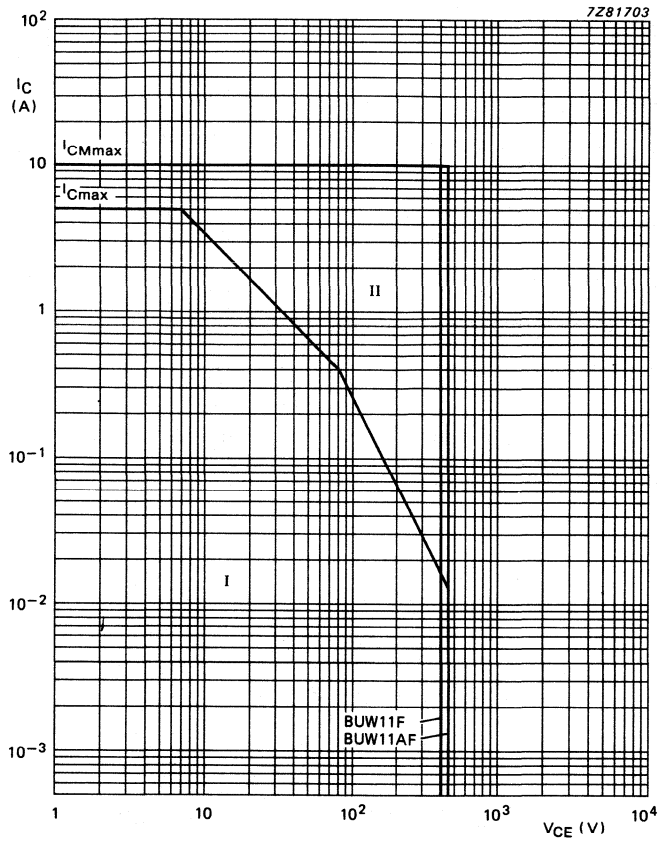


Fig. 7 Switching times waveforms with inductive load.



Mounted without heatsink compound and 30 ± 5 newtons pressure on the centre of the envelope.

- I Region of permissible DC operation.
- II Permissible extension for repetitive pulse operation.

Fig. 8 Safe operating area at $T_{mb} < 25$ °C.

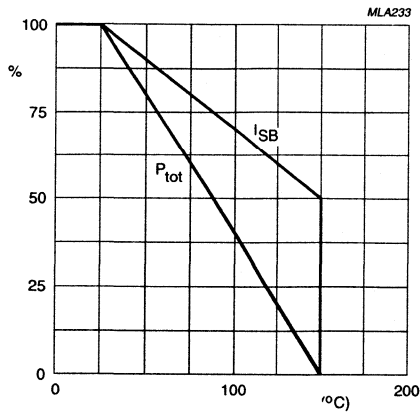


Fig. 9 Total power dissipation and second break down current curve.

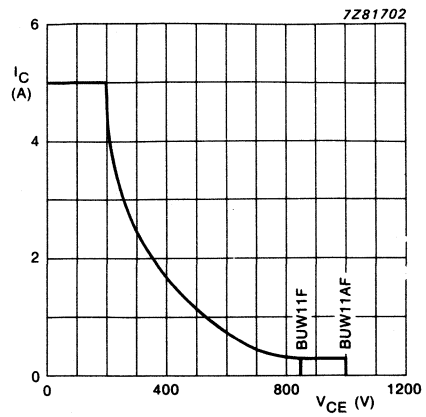


Fig. 10 RB SOAR; $T_C \leq 100^\circ\text{C}$;
 $V_{BE} = -1\text{ V to } -5\text{ V}$.

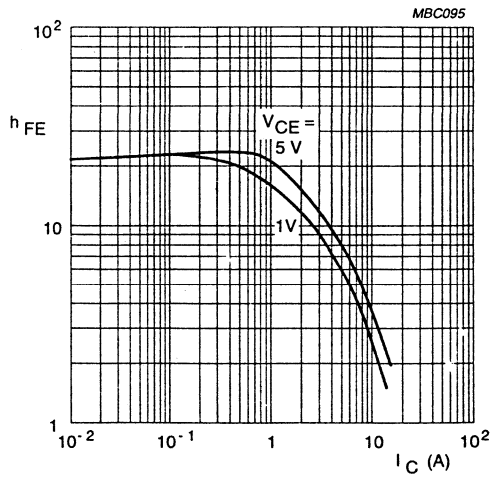


Fig. 11 Typical values DC current gain; $T_j = 125^\circ\text{C}$.

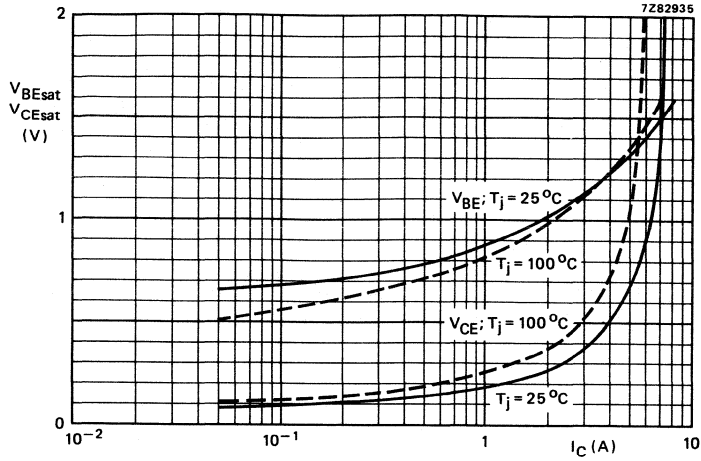


Fig. 12 Typical values base and collector voltages at $I_C/I_B = 5$.

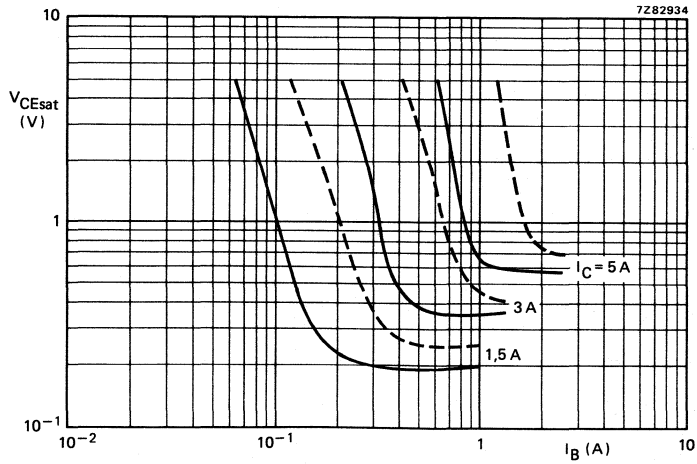


Fig. 13 Typical (—) and maximum (---) values saturation voltage; $T_j = 25^\circ C$.

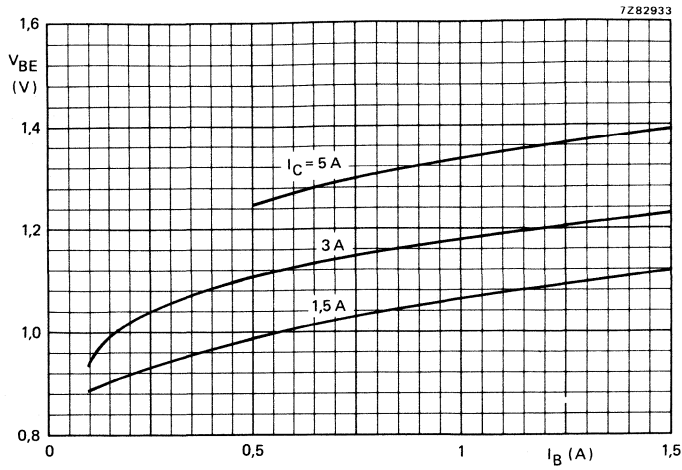


Fig. 14 Typical values base-emitter voltage at $T_j = 25$ °C.

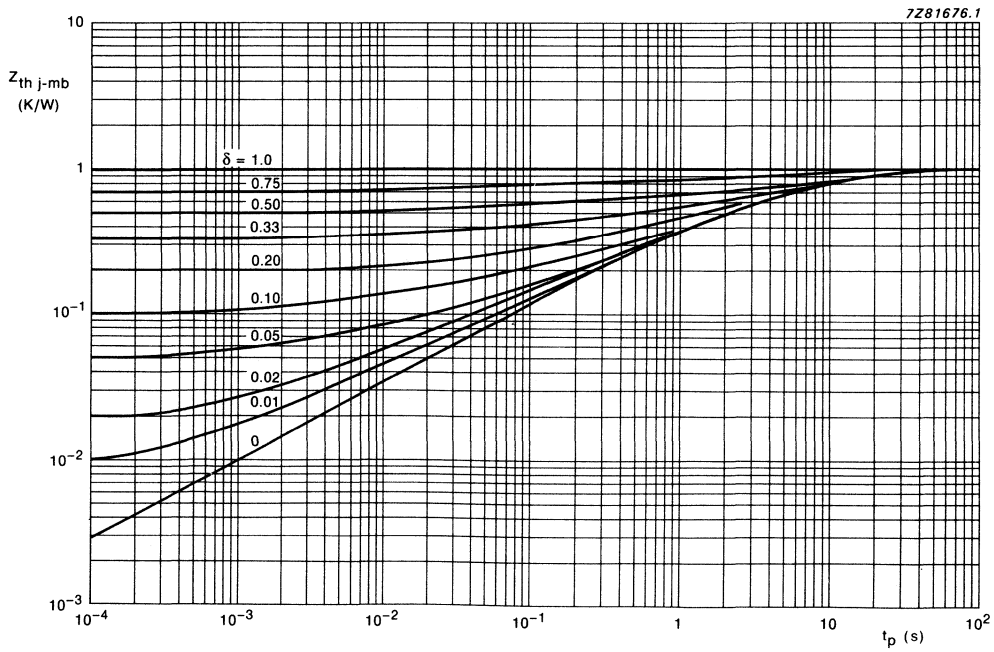


Fig. 15 Normalized thermal response at pulse power conditions.

SILICON DIFFUSED POWER TRANSISTORS

High-voltage, high-speed, glass-passivated npn power transistors in a SOT93 envelope, intended for use in converters, inverters, switching regulators, motor control systems etc.

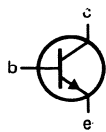
QUICK REFERENCE DATA

		BUW12	BUW12A	
Collector-emitter voltage (peak value; $V_{BE} = 0$)	V_{CESM} max.	850	1000	V
Collector-emitter voltage (open base)	V_{CEO} max.	400	450	V
Collector-emitter saturation voltage	V_{CEsat} max.	1.5		V
Collector current (DC)	I_C max.	8		A
Collector current (peak value)	I_{CM} max.	20		A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot} max.	125		W
Fall time (resistive load)	t_f max.	0.8		μs

MECHANICAL DATA

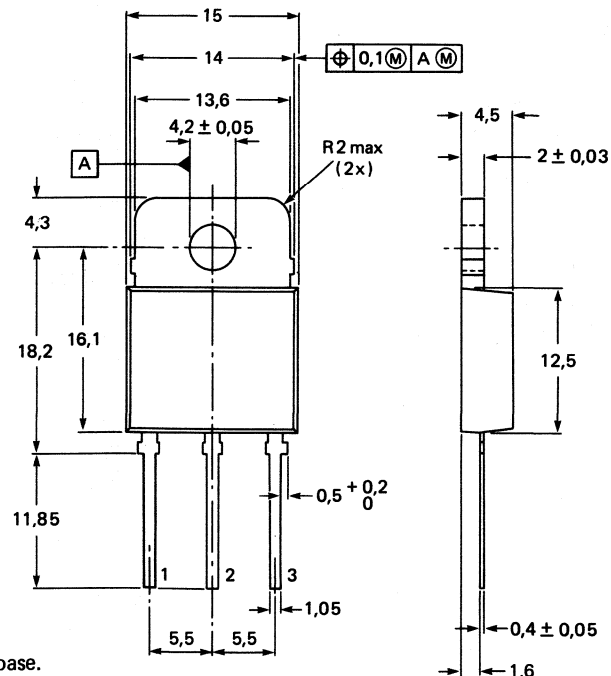
Dimensions in mm

Fig. 1 SOT93.



Pinning:

- 1 = base
- 2 = collector
- 3 = emitter



Collector connected to mounting base.

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RATINGS

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

			BUW12	BUW12A	
Collector-emitter voltage (peak value; $V_{BE} = 0$)	V_{CESM}	max.	850	1000	V
Collector-emitter voltage (open base)	V_{CEO}	max.	400	450	V
Collector current (DC)	I_C	max.	8		A
Collector current (peak value); $t_p < 2$ ms	I_{CM}	max.	20		A
Base current (DC)	I_B	max.	4		A
Base current (peak value); $t_p \leq 2$ ms	I_{BM}	max.	6		A
Total power dissipation up to $T_{mb} = 25$ °C	P_{tot}	max.	125		W
Storage temperature range	T_{stg}		-65 to + 150		°C
Junction temperature	T_j	max.	150		°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j-mb}$	=	1,0		K/W
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CHARACTERISTICS

$T_j = 25$ °C unless otherwise specified

Collector cut-off current*

$V_{CE} = V_{CESMmax}; V_{BE} = 0$

$V_{CE} = V_{CESMmax}; V_{BE} = 0; T_j = 125$ °C

I_{CES}	max.	1		mA
I_{CES}	max.	3		mA

Emitter cut-off current

$I_C = 0; V_{EB} = 9$ V

I_{EBO}	max.	10		mA
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Saturation voltages

$I_C = 6$ A; $I_B = 1,2$ A

$I_C = 5$ A; $I_B = 1,0$ A

		BUW12	BUW12A	
V_{CEsat}	max.	1,5	—	V
V_{BEsat}	max.	1,5	—	V
V_{CEsat}	max.	—	1,5	V
V_{BEsat}	max.	—	1,5	V

Collector-emitter sustaining voltage

$I_C = 100$ mA; $I_{Boff} = 0$; $L = 25$ mH

$V_{CEO_{sust}}$	min.	400	450	V
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DC current gain

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

h_{FE}	min.	10		
h_{FE}	typ.	18		
h_{FE}	max.	35		
h_{FE}	min.	10		
h_{FE}	typ.	20		
h_{FE}	max.	35		

$I_C = 1$ A; $V_{CE} = 5$ V

* Measured with a half-sinewave voltage (curve tracer).

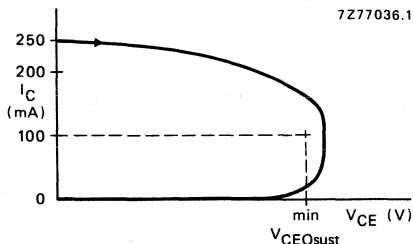


Fig. 2 Oscilloscope display for sustaining voltage.

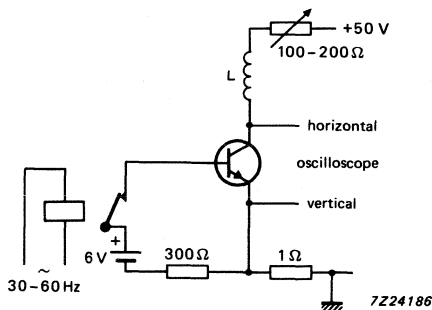


Fig. 3 Test circuit for $V_{CEOsust}$.

Switching times resistive load (Figs 4 and 5)

$I_{Con} = 6\text{ A}; I_{Bon} = -I_{Boff} = 1,2\text{ A}$

Turn-on time

Turn-off: Storage time

Fall time

$I_{Con} = 5\text{ A}; I_{Bon} = -I_{Boff} = 1\text{ A}$

Turn-on time

Turn-off: Storage time

Fall time

Switching times inductive load (Figs 6 and 7)

$I_{Con} = 6\text{ A}; I_B = 1,2\text{ A}$

Turn-off: Storage time

Fall time

$I_{Con} = 6\text{ A}; I_B = 1,2\text{ A}; T_j = 100\text{ }^\circ\text{C}$

Turn-off: Storage time

Fall time

Switching times inductive load (Figs 6 and 7)

$I_{Con} = 5\text{ A}; I_B = 1\text{ A}$

Turn-off: Storage time

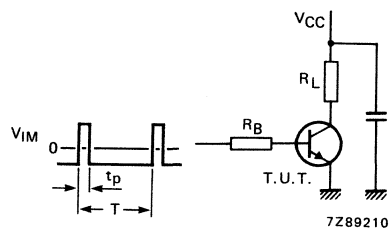
Fall time

$I_{Con} = 5\text{ A}; I_B = 1\text{ A}; T_j = 100\text{ }^\circ\text{C}$

Turn-off: Storage time

Fall time

		BUW12	BUW12A	
t_{on}	max.	1	—	μs
t_s	max.	4	—	μs
t_f	max.	0,8	—	μs
t_{on}	max.	—	1	μs
t_s	max.	—	4	μs
t_f	max.	—	0,8	μs
t_s	typ.	1,6	—	μs
	max.	2,1	—	μs
t_f	typ.	80	—	ns
	max.	150	—	ns
t_s	typ.	1,8	—	μs
	max.	2,3	—	μs
t_f	typ.	140	—	ns
	max.	300	—	ns
t_s	typ.	—	1,6	μs
	max.	—	2,1	μs
t_f	typ.	—	80	ns
	max.	—	150	ns
t_s	typ.	—	1,8	μs
	max.	—	2,3	μs
t_f	typ.	—	140	ns
	max.	—	300	ns



$V_{CC} = 250 \text{ V}$
 $V_{IM} = -6 \text{ to } +8 \text{ V}$

$$\frac{t_p}{T} = 0,01$$

$$t_p = 20 \mu\text{s}$$

The values of R_B and R_L are selected in accordance with I_{Con} and I_B requirements.

Fig. 4 Test circuit resistive load.

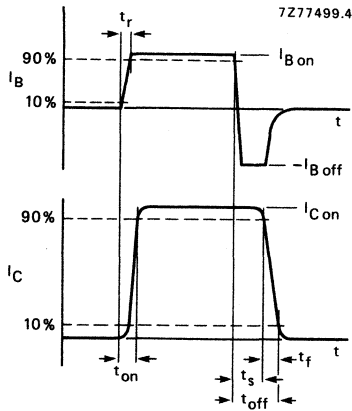


Fig. 5 Switching times waveforms with resistive load'

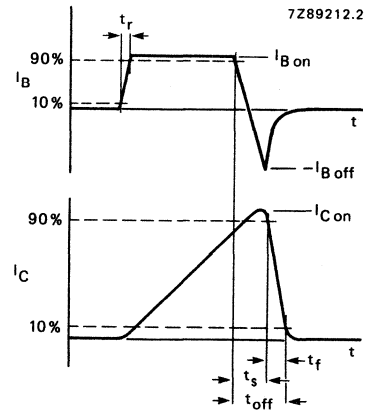
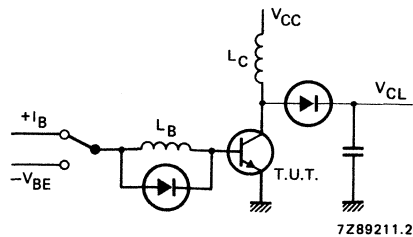
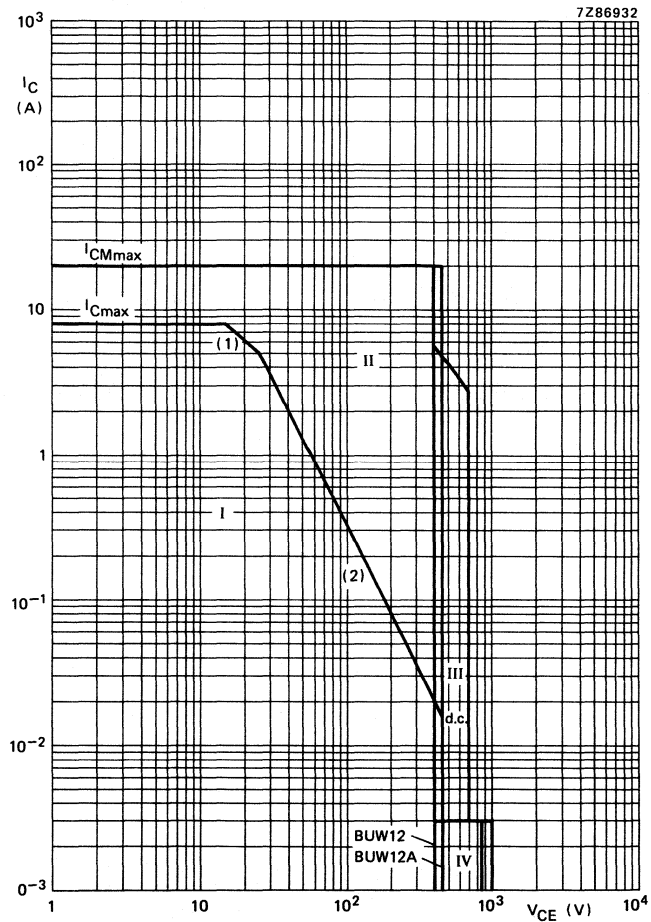


Fig. 6 Switching times waveforms with inductive load.



$V_{CL} = 300 \text{ V}$
 $V_{CC} = 30 \text{ V}$
 $-V_{BE} = 5 \text{ V}$
 $L_B = 1 \mu\text{H}$
 $L_C = 200 \mu\text{H}$

Fig. 7 Test circuit inductive load.



(1) P_{tot} max line.

(2) Second-breakdown limits.

I Region of permissible DC operation.

II Permissible extension for repetitive pulse operation.

III Area of permissible operation during turn-on in single transistor converters, provided $R_{BE} \leq 100 \Omega$ and $t_p \leq 0,6 \mu s$.

IV Repetitive pulse operation in this region is permissible provided $V_{BE} \leq 0$ and $t_p \leq 2$ ms.

Fig. 8 Safe operating area at $T_{mb} \leq 25^\circ C$.

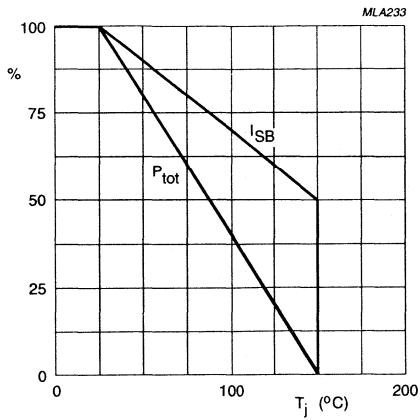


Fig. 9 Total power dissipation and second current breakdown curve.

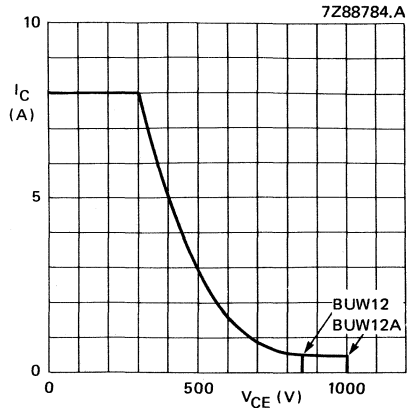


Fig. 10 Reverse bias SOAR.

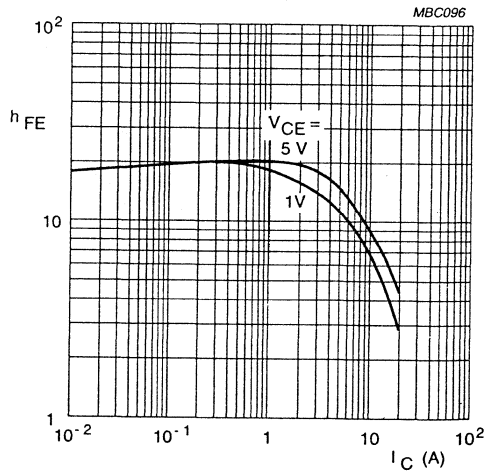


Fig. 11 Typical values DC current gain.

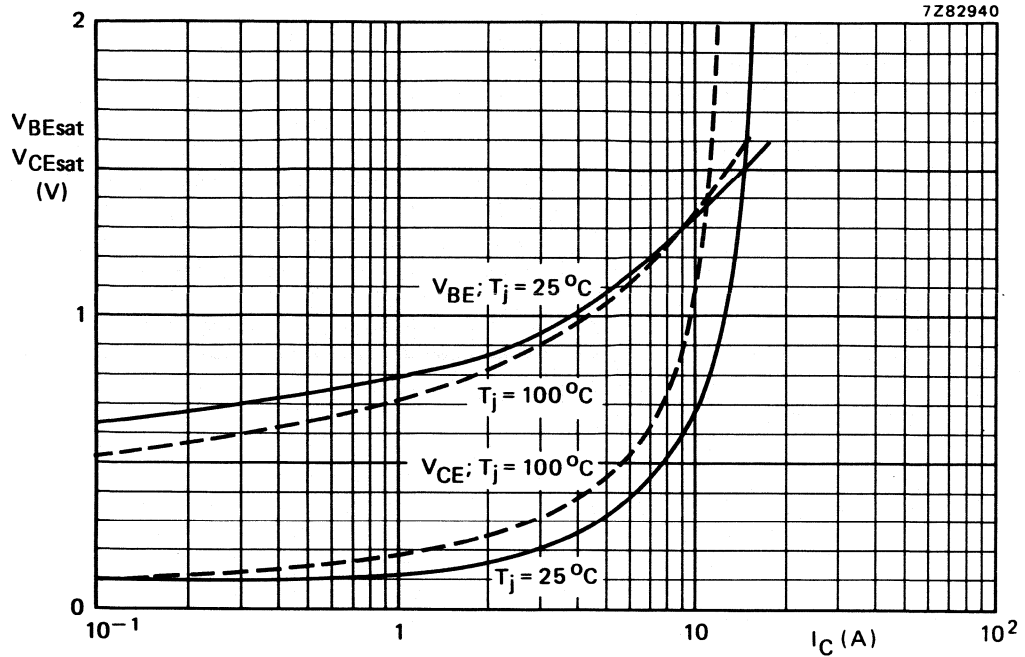


Fig. 12 Typical values base and collector voltage at $I_C/I_B = 5$.

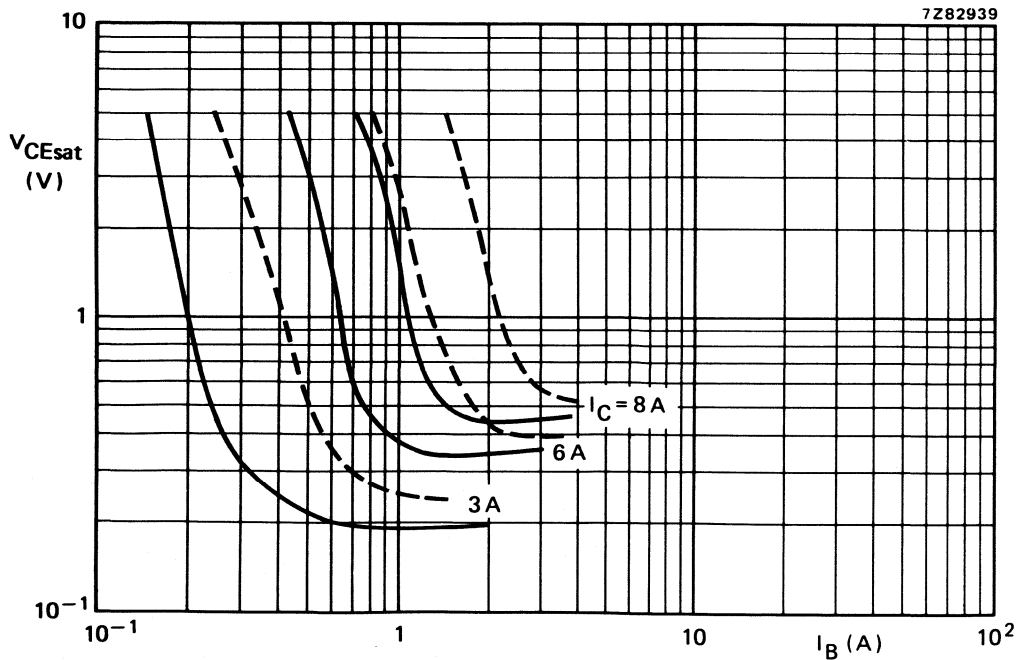


Fig. 13 Typ. (—) and max. (---) values collector-emitter saturation voltage at $T_j = 25^\circ C$.

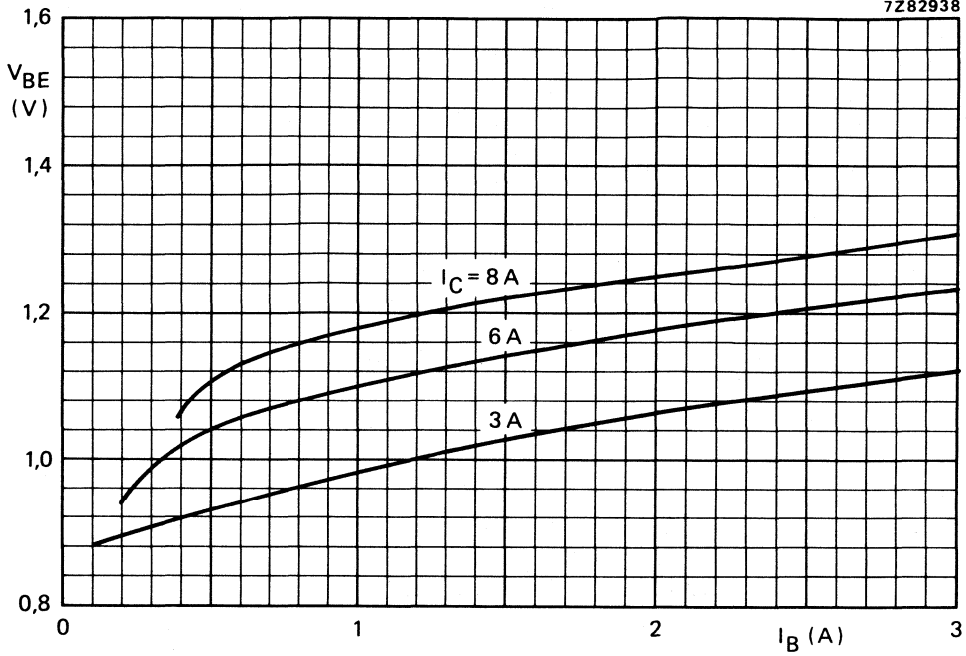


Fig. 14 Typical values base-emitter voltage at $T_j = 25$ °C.

SILICON DIFFUSED POWER TRANSISTORS

High-voltage, high-speed, glass-passivated npn power transistor in a SOT199 envelope intended for use in converters, inverters, switching regulators, motor control systems, etc.

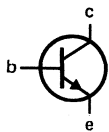
QUICK REFERENCE DATA

		BUW12F		BUW12AF	
Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM}	max.	850		1000 V
	V_{CEO}	max.	400		450 V
Collector-emitter saturation voltage	V_{CEsat}	max.	1.5		1.5 V
Collector current saturation DC peak value	I_{Csat}	max.	6.0		5.0 A
	I_C	max.	8.0		A
	I_{CM}	max.	20		A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	34		W
Fall time	t_f	max.	0.8		μs

MECHANICAL DATA

Dimensions in mm

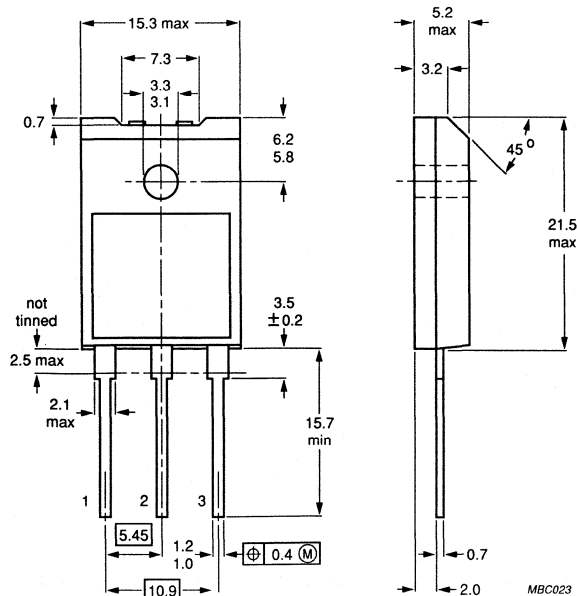
Fig. 1 SOT199.



Pinning:

- 1 = base
- 2 = collector
- 3 = emitter

Mounting base is electrically isolated.



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RATINGS

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

			BUW12F	BUW12AF
Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM}	max.	850	1000 V
	V_{CEO}	max.	400	450 V
Collector current saturation DC	I_{Csat}		6.0	5.0 A
	I_C	max.	8.0	A
	I_{CM}	max.	20	A
Base current DC	I_B	max.	4.0	A
	I_{BM}	max.	6.0	A
Total power dissipation up to $T_h = 25\text{ }^\circ\text{C}$ (note 1)	P_{tot}	max.	34	W
Total power dissipation up to $T_h = 25\text{ }^\circ\text{C}$ (note 2)	P_{tot}	max.	45	W
Storage temperature range	T_{stg}		-65 to + 150	$^\circ\text{C}$
Junction temperature	T_j	max.	150	$^\circ\text{C}$

THERMAL RESISTANCE

From junction to external heatsink (note 1)	$R_{th\ j-h}$	=	3.7	K/W
From junction to external heatsink (note 2)	$R_{th\ j-h}$	=	2.8	K/W
From junction to ambient	$R_{th\ j-a}$	=	35	K/W

ISOLATION

Isolation voltage from all terminals to external heatsink (peak value)	V_{isol}	max.	1500	V
Isolation capacitance from collector to external heatsink	C_{isol}	max.	21	pF

CHARACTERISTICS

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

Collector cut-off currents (note 3)

$V_{CE} = V_{CESMmax}; V_{BE} = 0$	I_{CES}	max.	1.0	mA
$V_{CE} = V_{CESMmax}; V_{BE} = 0; T_j = 125\text{ }^\circ\text{C}$	I_{CES}	max.	3.0	mA

Emitter cut-off current

$V_{EB} = 9\text{ V}; I_C = 0$	I_{EBO}	max.	10	mA
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Notes

1. Mounted without heatsink compound and 30 ± 5 newtons pressure on centre of envelope.
2. Mounted with heatsink compound and 30 ± 5 newtons pressure on centre of envelope.
3. Measured with a half-sinewave voltage (curve tracer).

		BUW12F	BUW12AF	
Saturation voltages $I_C = 6 \text{ A}; I_B = 1.2 \text{ A}$	V_{CEsat}	max. 1.5	— V	
	V_{BEsat}	max. 1.5	— V	
$I_C = 5 \text{ A}; I_B = 1.0 \text{ A}$	V_{CEsat}	max. —	1.5 V	
	V_{BEsat}	max. —	1.5 V	
Collector-emitter sustaining voltage (Figs 2 and 3) $I_C = 100 \text{ mA}; I_B \text{ off} = 0; L = 25 \text{ mH}$	$V_{CEOsust}$	min. 400	450 V	
Collector saturation current $V_{CE} = 1.5 \text{ V}$	I_{Csat}	max. 6.0	5.0 A	
DC current gain $I_C = 10 \text{ mA}; V_{CE} = 5 \text{ V}$	h_{FE}	min.	10	
	h_{FE}	typ.	18	
	h_{FE}	max.	35	
$I_C = 1 \text{ A}; V_{CE} = 5 \text{ V}$	h_{FE}	min.	10	
	h_{FE}	typ.	20	
	h_{FE}	max.	35	
Switching times resistive load (Figs 4 and 5) $I_{C \text{ on}} = 6 \text{ A}; I_{B \text{ on}} = I_{B \text{ off}} = 1.2 \text{ A}$				
Turn-on time	t_{on}	max. 1.0	— μs	
Turn-off; storage time fall time	t_s	max. 4.0	— μs	
	t_f	max. 0.8	— μs	
$I_{C \text{ on}} = 5 \text{ A}; I_{B \text{ on}} = I_{B \text{ off}} = 1 \text{ A}$				
Turn-on time	t_{on}	max. —	1.0 μs	
Turn-off; storage time fall time	t_s	max. —	4.0 μs	
	t_f	max. —	0.8 μs	
Switching times inductive load (Figs 6 and 7) $I_{C \text{ on}} = 6 \text{ A}; I_B = 1.2 \text{ A}; V_{CL} = 250 \text{ V}; T_C = 100 \text{ }^\circ\text{C}$				
Turn-off; storage time fall time	t_s	typ. 1.9	— μs	
	t_s	max. 2.5	— μs	
	t_f	typ. 200	— ns	
	t_f	max. 300	— ns	
$I_{C \text{ on}} = 5 \text{ A}; I_B = 1 \text{ A}; V_{CL} = 300 \text{ V}; T_C = 100 \text{ }^\circ\text{C}$ Turn-off; storage time fall time	t_s	typ. —	1.9 μs	
	t_s	max. —	2.5 μs	
	t_f	typ. —	200 ns	
	t_f	max. —	300 ns	

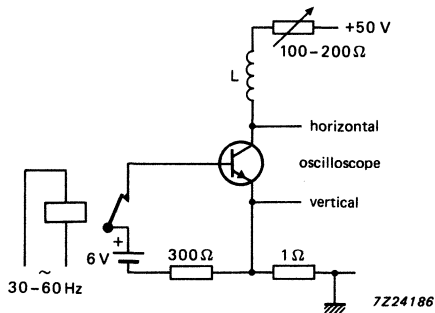


Fig. 2 Test circuit for $V_{CEOsust}$.

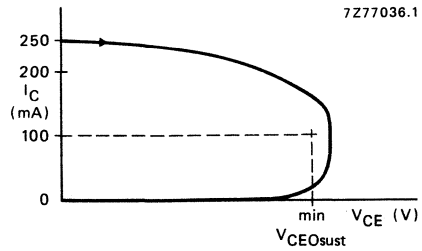


Fig. 3 Oscilloscope display for sustaining voltage.

$V_{CC} = 250 \text{ V}$
 $t_p = 20 \mu\text{s}$
 $V_{IM} = -6 \text{ to } +8 \text{ V}$
 $\frac{t_p}{T} = 0.01$

The values of R_B and R_L are selected in accordance with $I_{C\text{ on}}$ and I_B requirements

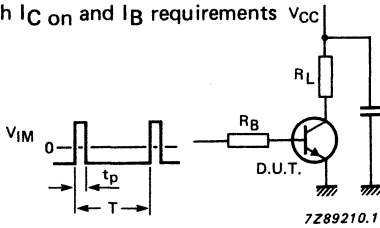


Fig. 4 Test circuit resistive load.

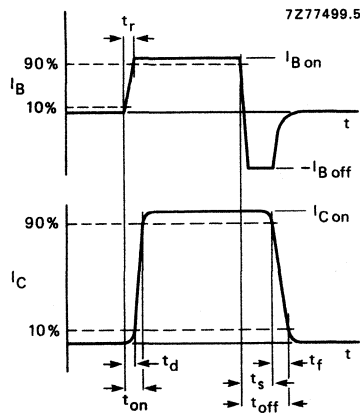


Fig. 5 Switching waveforms with resistive load; $t_r \leq 20 \text{ ns}$.

$V_{CL} = \text{up to } 1000 \text{ V}$
 $V_{CC} = 30 \text{ V}$
 $-V_{BE} = 1 \text{ V to } 5 \text{ V}$
 $L_B = 1.0 \mu\text{H}$
 $L_C = 200 \mu\text{H}$

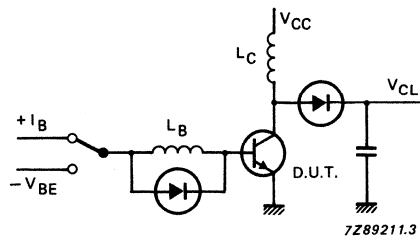


Fig. 6 Test circuit inductive load and reverse bias SOAR.

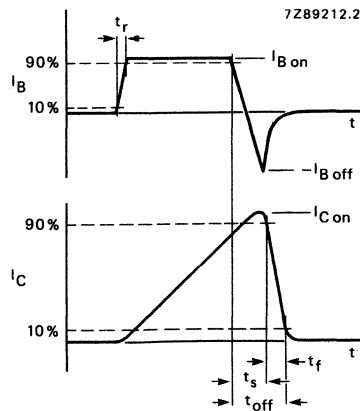
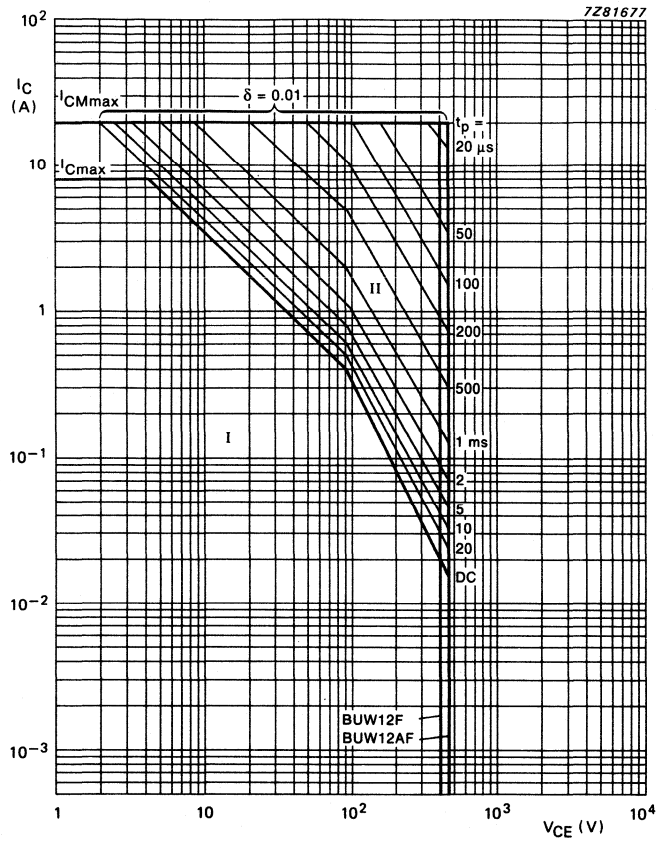


Fig. 7 Switching times waveforms with inductive load.



Mounted without heatsink compound and 30 ± 5 newtons pressure on the centre of the envelope.

- I Region of permissible DC operation.
- II Permissible extension for repetitive pulse operation.

Fig. 8 Safe operating area at $T_{mb} < 25^\circ C$.

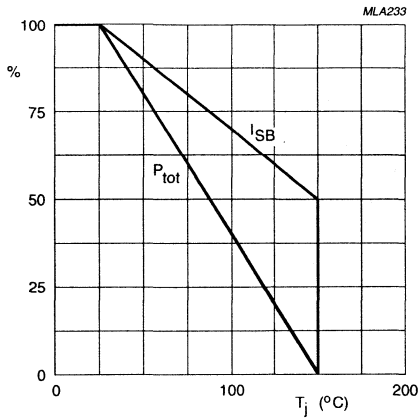


Fig. 9 Total power dissipation and second breakdown current curve.

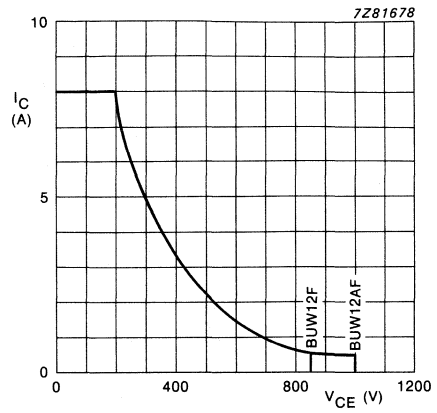


Fig. 10 RB SOAR; $T_c \leq 100^\circ\text{C}$; $V_{BE} = -1\text{ V to } -5\text{ V}$.

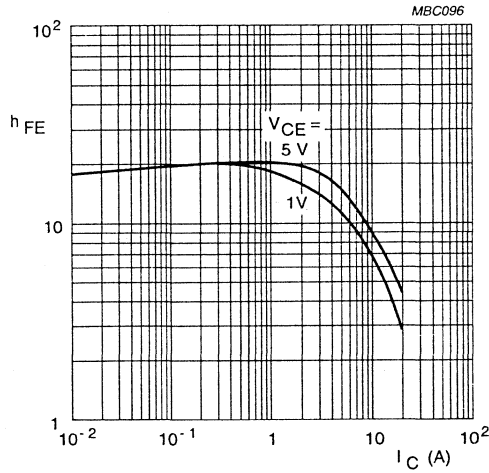


Fig. 11 Typical values DC current gain; $T_j = 125^\circ\text{C}$.

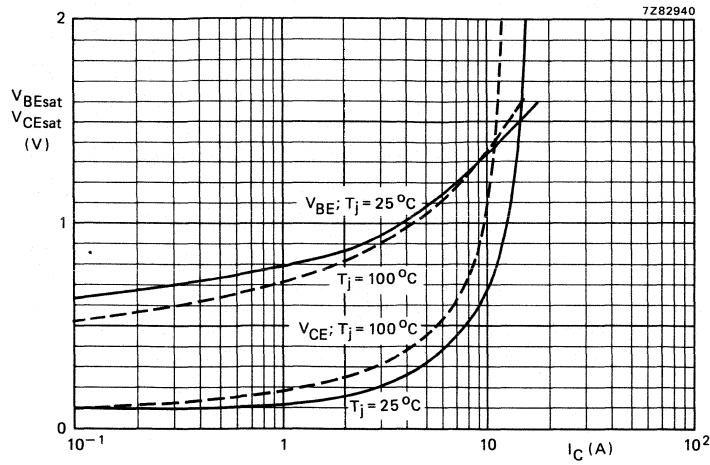


Fig. 12 Typical values base and collector voltages at $I_C/I_B = 5$.

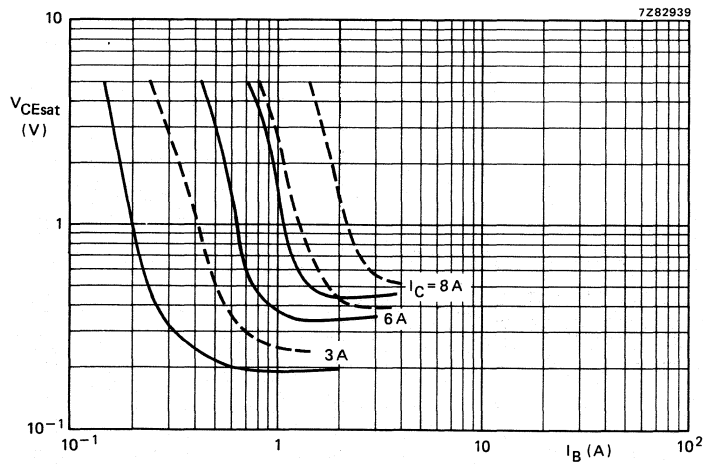


Fig. 13 Typical (—) and maximum (---) values saturation voltage; $T_j = 25^\circ\text{C}$.

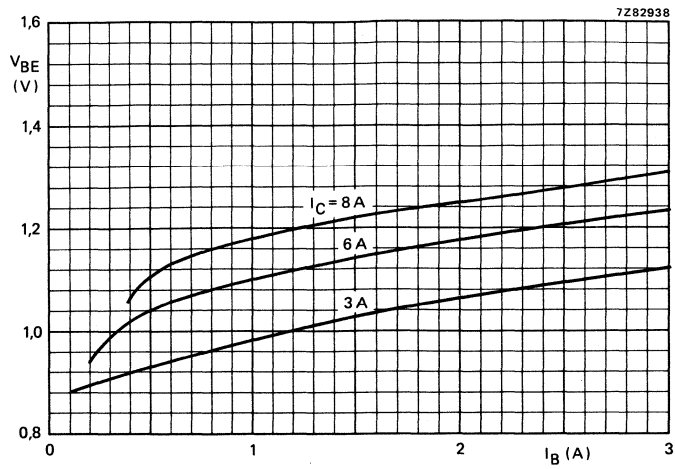


Fig. 14 Typical values base-emitter voltage at $T_j = 25 \text{ }^\circ\text{C}$.

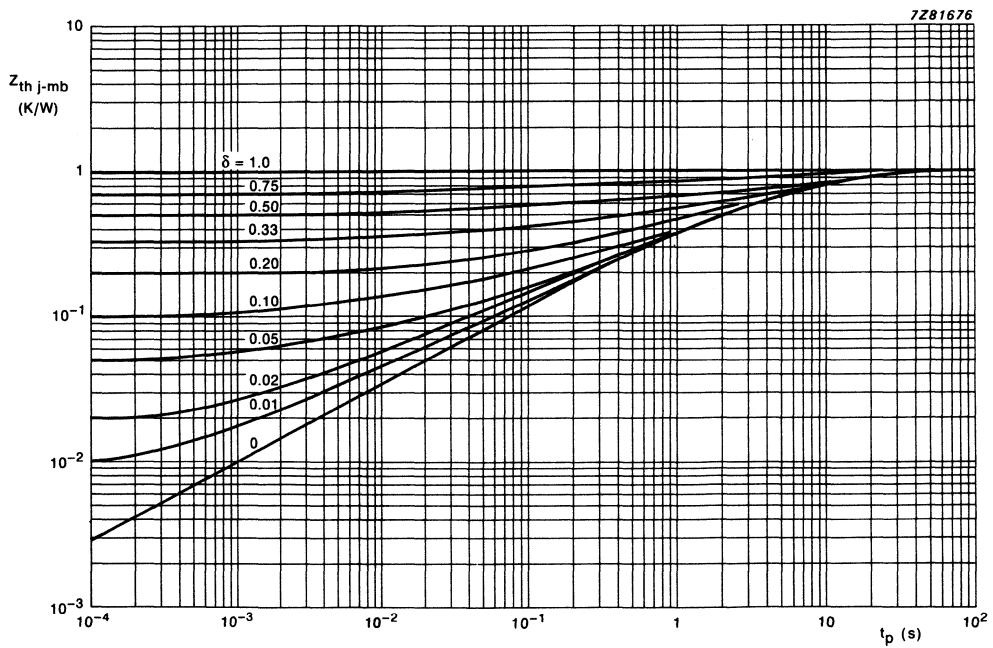


Fig. 15 Normalized thermal response at pulse power conditions.

SILICON DIFFUSED POWER TRANSISTORS

High-voltage, high-speed, glass-passivated npn power transistors in a SOT93 envelope, intended for use in converters, inverters, switching regulators, motor control systems etc.

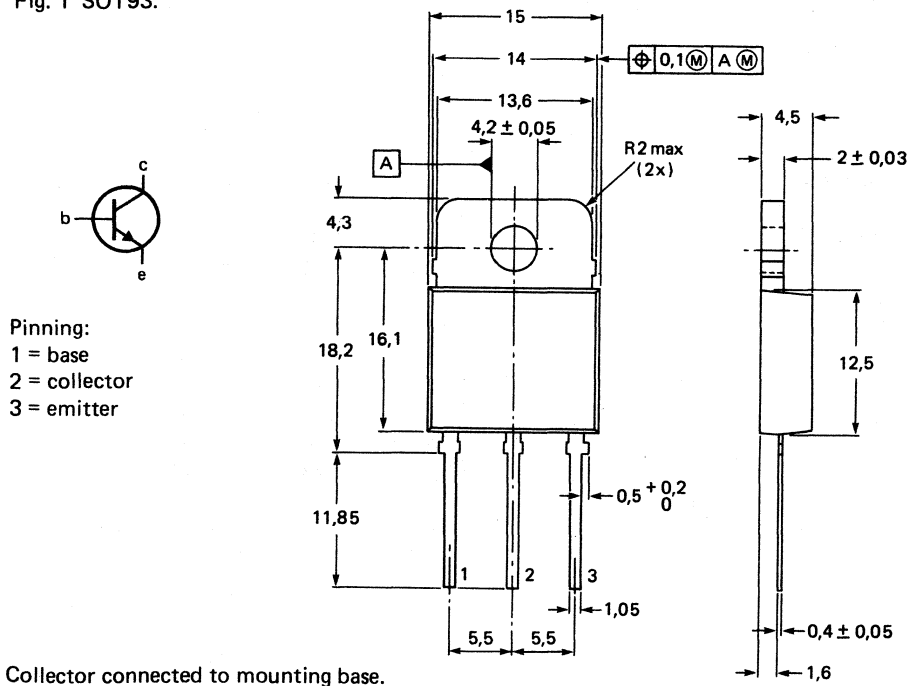
QUICK REFERENCE DATA

		BUW13	BUW13A	
Collector-emitter voltage (peak value; $V_{BE} = 0$)	V_{CESM} max.	850	1000	V
Collector-emitter voltage (open base)	V_{CEO} max.	400	450	V
Collector-emitter saturation voltage	V_{CEsat} max.	1.5		V
Collector current (DC)	I_C max.	15		A
Collector current (peak value)	I_{CM} max.	30		A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot} max.	175		W
Fall time	t_f max.	0.8		μs

MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT93.



7296696

RATINGS

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

			BUW13	BUW13A	
Collector-emitter voltage (peak value, $V_{BE} = 0$)	V_{CESM}	max.	850	1000	V
Collector-emitter voltage (open base)	V_{CEO}	max.	400	450	V
Collector current (DC)	I_C	max.	15		A
Collector current (peak value); $t_p < 2$ ms	I_{CM}	max.	30		A
Base current (DC)	I_B	max.	6		A
Base current (peak value); $t_p < 2$ ms	I_{BM}	max.	9		A
Total power dissipation up to $T_{mb} = 25$ °C	P_{tot}	max.	175		W
Storage temperature range	T_{stg}		-65 to +150		°C
Junction temperature	T_j	max.	150		°C

THERMAL RESISTANCE

From junction to mounting base	R_{thj-mb}	=	0,7		K/W
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CHARACTERISTICS

$T_j = 25$ °C unless otherwise specified

Collector cut-off current*

$V_{CE} = V_{CESMmax}; V_{BE} = 0$

$V_{CE} = V_{CESMmax}; V_{BE} = 0; T_j = 125$ °C

I_{CES}	max.	1		mA
I_{CES}	max.	4		mA

Emitter cut-off current

$I_C = 0; V_{EB} = 9$ V

I_{EBO}	max.	10		mA
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Saturation voltages

$I_C = 10$ A; $I_B = 2$ A

$I_C = 8$ A; $I_B = 1,6$ A

			BUW13	BUW13A	
V_{CEsat}	max.	1,5		—	V
V_{BEsat}	max.	1,6		—	V
V_{CEsat}	max.	—		1,5	V
V_{BEsat}	max.	—		1,6	V

DC current gain

$I_C = 20$ mA; $V_{CE} = 5$ V

$I_C = 1.5$ A; $V_{CE} = 5$ V

h_{FE}	min.	10		
h_{FE}	typ.	18		
h_{FE}	max.	35		
h_{FE}	min.	10		
h_{FE}	typ.	20		
h_{FE}	max.	35		

Collector-emitter sustaining voltage

$I_C = 100$ mA; $I_{Boff} = 0$; $L = 25$ mH

$V_{CEO sust}$	min.	400		450	V
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* Measured with a half-sinewave voltage (curve tracer).

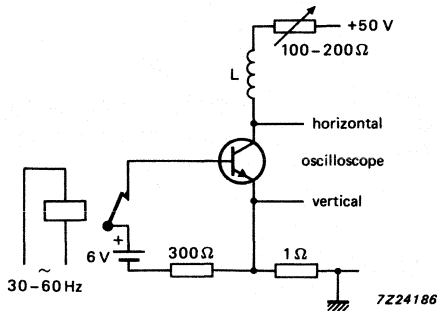


Fig. 2 Test circuit for $V_{CEOsust}$.

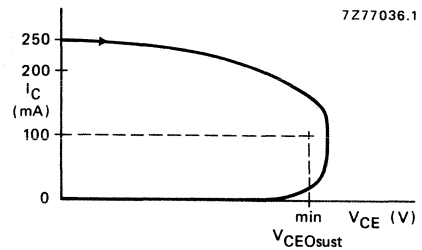


Fig. 3 Oscilloscope display for sustaining voltage.

Switching times resistive load (Figs 4 and 5)

$I_{Con} = 10 \text{ A}$; $I_{Bon} = -I_{Boff} = 2 \text{ A}$

Turn-on time

Turn-off: Storage time

Fall time

$I_{Con} = 8 \text{ A}$; $I_{Bon} = -I_{Boff} = 1,6 \text{ A}$

Turn-on time

Turn-off: Storage time

Fall time

Switching times inductive load (Figs 6 and 7)

$I_{Con} = 10 \text{ A}$; $I_B = 2 \text{ A}$

Turn-off: Storage time

Fall time

$I_{Con} = 10 \text{ A}$; $I_B = 2 \text{ A}$; $T_j = 100 \text{ }^\circ\text{C}$

Turn-off: Storage time

Fall time

Switching times inductive load (Figs 6 and 7)

$I_{Con} = 8 \text{ A}$; $I_B = 1,6 \text{ A}$

Turn-off: Storage time

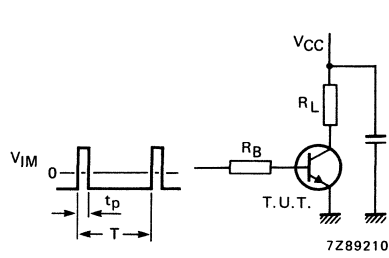
Fall time

$I_{Con} = 8 \text{ A}$; $I_B = 1,6 \text{ A}$; $T_j = 100 \text{ }^\circ\text{C}$

Turn-off: Storage time

Fall time

		BUW13	BUW13A	
t_{on}	max.	1	—	μs
t_s	max.	4	—	μs
t_f	max.	0,8	—	μs
t_{on}	max.	—	1	μs
t_s	max.	—	4	μs
t_f	max.	—	0,8	μs
t_s	typ.	2,3	—	μs
	max.	3,0	—	μs
t_f	typ.	80	—	ns
	max.	150	—	ns
t_s	typ.	2,5	—	μs
	max.	3,2	—	μs
t_f	typ.	140	—	ns
	max.	300	—	ns
t_s	typ.	—	2,3	μs
	max.	—	3,0	μs
t_f	typ.	—	80	ns
	max.	—	150	ns
t_s	typ.	—	2,5	μs
	max.	—	3,2	μs
t_f	typ.	—	140	ns
	max.	—	300	ns



$V_{CC} = 250 \text{ V}$
 $V_{IM} = -6 \text{ to } +8 \text{ V}$
 $t_p = 20 \mu\text{s}$
 $\frac{t_p}{T} = 0,01$

The values of R_B and R_L are selected in accordance with I_{Con} and I_B requirements.

Fig. 4 Test circuit resistive load.

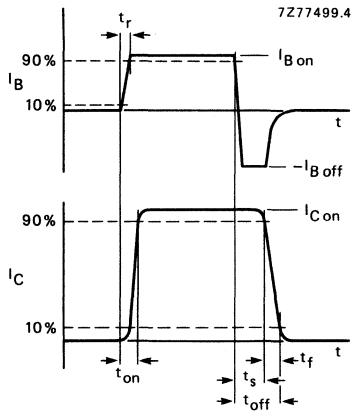


Fig. 5 Switching times waveforms with resistive load.

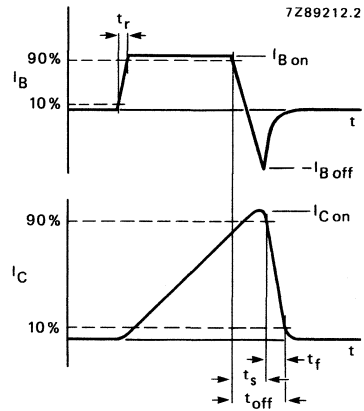
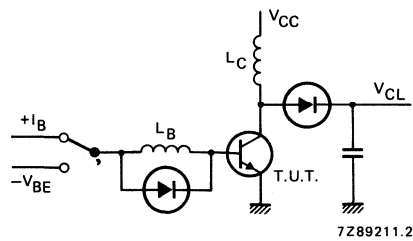
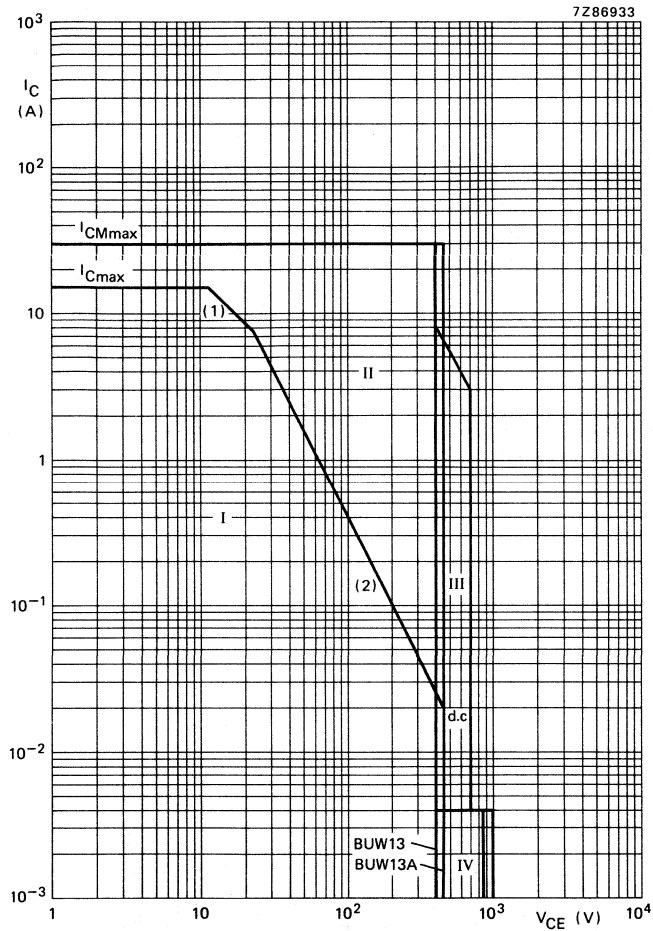


Fig. 6 Switching times waveforms with inductive load.



$V_{CL} = 300 \text{ V}$
 $V_{CC} = 30 \text{ V}$
 $-V_{BE} = 5 \text{ V}$
 $L_B = 1 \mu\text{H}$
 $L_C = 200 \mu\text{H}$

Fig. 7 Test circuit inductive load.



(1) P_{tot} max line.

(2) Second-breakdown limits.

I Region of permissible DC operation.

II Permissible extension for repetitive pulse operation.

III Area of permissible operation during turn-on in single transistor converters, provided $R_{BE} \leq 100 \Omega$ and $t_p \leq 0,6 \mu s$.

IV Repetitive pulse operation in this region is permissible provided $V_{BE} \leq 0$ and $t_p \leq 5$ ms.

Fig. 8 Safe operating area at $T_{mb} \leq 25^\circ C$.

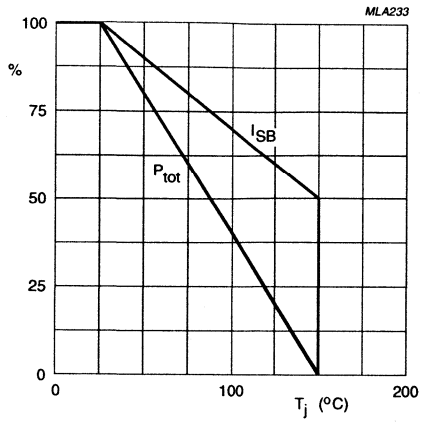


Fig. 9 Total power dissipation and second breakdown current curve.

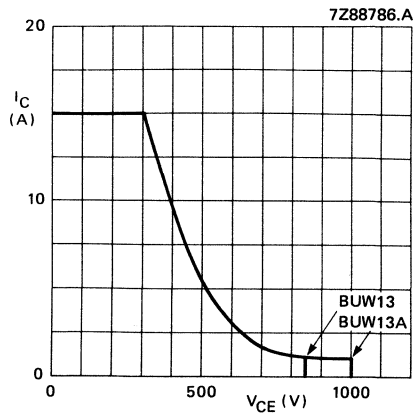


Fig. 10 Reverse bias SOAR.

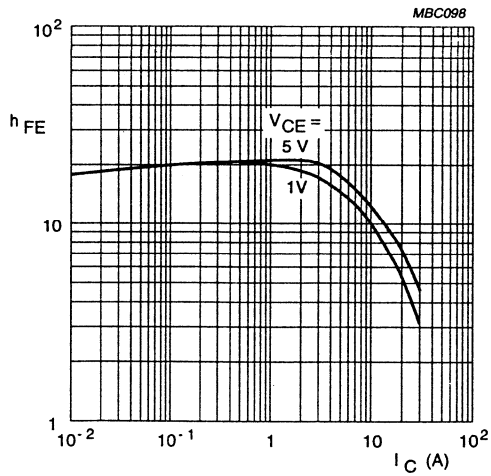


Fig.11 Typical values DC current gain.

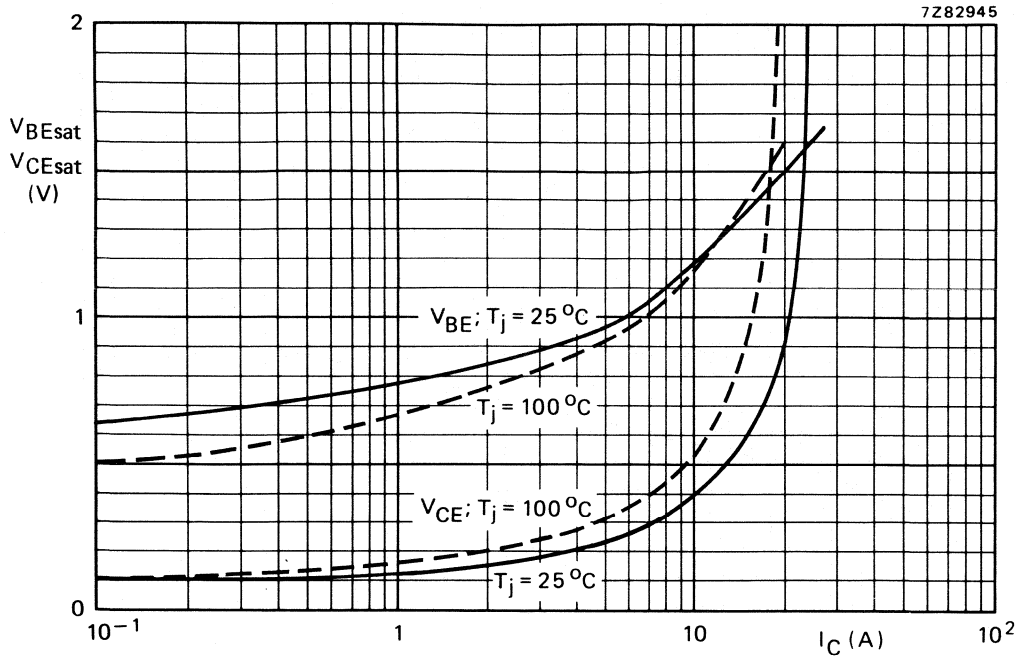


Fig. 12 Typical values base and collector voltage at $I_C/I_B = 5$.

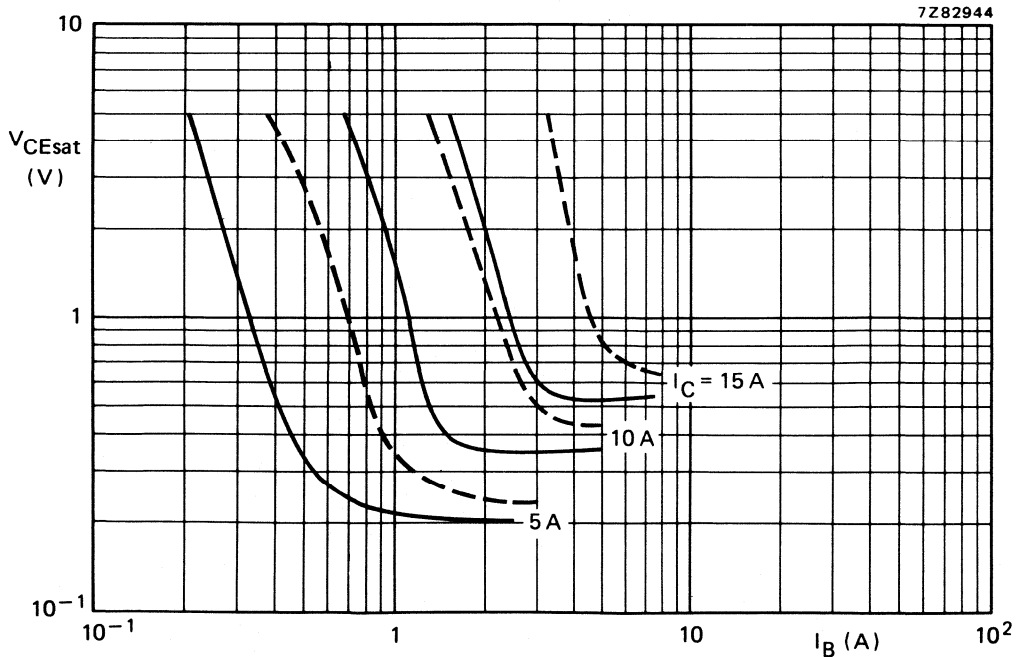


Fig. 13 Typical (—) and maximum (- - -) values saturation voltage. $T_j = 25^\circ\text{C}$.

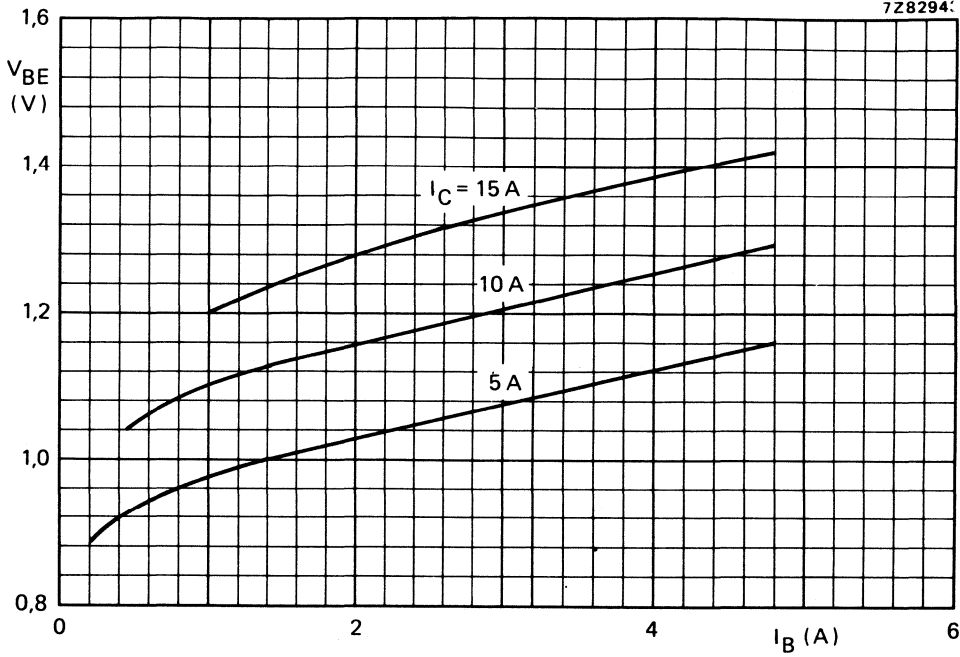


Fig. 14 Typical values base-emitter voltage at $T_j = 25$ °C.

SILICON DIFFUSED POWER TRANSISTORS

High-voltage, high-speed, glass-passivated npn power transistor in a SOT199 envelope intended for use in converters, inverters, switching regulators, motor control systems, etc.

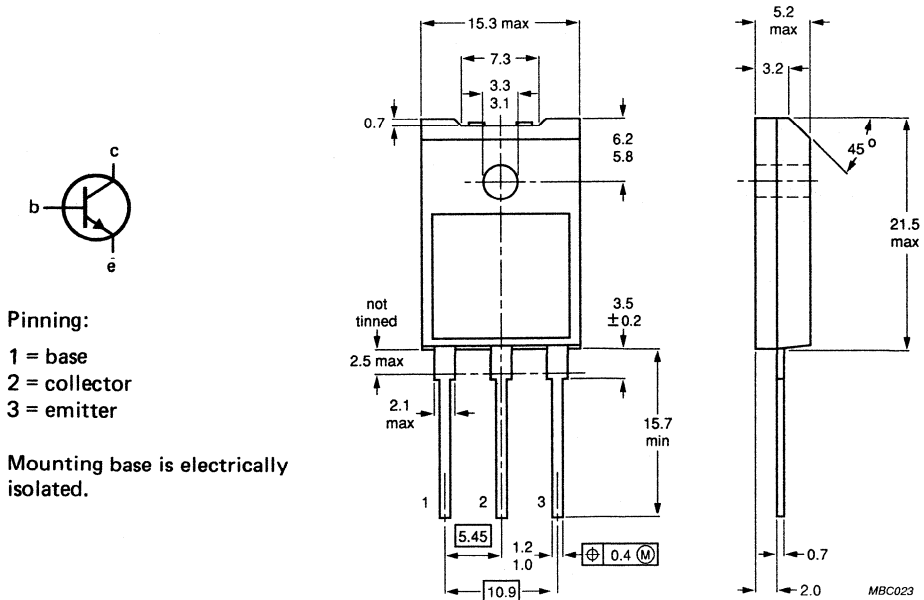
QUICK REFERENCE DATA

		BUW13F	BUW13AF
Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM}	max. 850	1000 V
	V_{CEO}	max. 400	450 V
Collector-emitter saturation voltage	V_{CEsat}	max. 1.5	1.5 V
Collector current saturation DC peak value; $t_p < 20$ ms	I_{Csat}	10.0	8.0 A
	I_C	max. 15	A
	I_{CM}	max. 30	A
Total power dissipation up to $T_h = 25$ °C	P_{tot}	max. 37	W
Fall time	t_f	max. 0.8	μs

MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT199.



RATINGS

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

		BUW13F	BUW13AF
Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM}	max. 850	1000 V
	V_{CEO}	max. 400	450 V
Collector current saturation DC peak value; $t_p < 20$ ms	I_{Csat}	10.0	8.0 A
	I_C	max. 15	A
	I_{CM}	max. 30	A
Base current DC peak value; $t_p = -20$ ms	I_B	max. 6.0	A
	I_{BM}	max. 9.0	A
Total power dissipation up to $T_h = 25$ °C (note 1)	P_{tot}	max. 37	W
	P_{tot}	max. 50	W
Total power dissipation up to $T_h = 25$ °C (note 2)	P_{tot}	max. 50	W
Storage temperature range	T_{stg}	-65 to + 150	°C
Junction temperature	T_j	max. 150	°C

THERMAL RESISTANCE

From junction to external heatsink (note 1)	$R_{th\ j-h}$	=	3.4	K/W
From junction to external heatsink (note 2)	$R_{th\ j-h}$	=	2.5	K/W
From junction to ambient	$R_{th\ j-a}$	=	35	K/W

ISOLATION

Isolation voltage from all terminals to external heatsink (peak value) (note 3)	V_{isol}	max. 2000	V
Isolation capacitance from collector to external heatsink	C_{isol}	max. 21	pF

Notes

1. Mounted without heatsink compound and 30 ± 5 newtons pressure on centre of envelope.
2. Mounted with heatsink compound and 30 ± 5 newtons pressure on centre of envelope.
3. Repetitive peak operation with $RH \leq 65\%$ under clean and dustfree conditions.

CHARACTERISTICS

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

Collector cut-off currents*

 $V_{CE} = V_{CESMmax}; V_{BE} = 0$ $V_{CE} = V_{CESMmax}; V_{BE} = 0; T_j = 125\text{ }^\circ\text{C}$

I_{CES}	max.	1.0	mA
I_{CES}	max.	4.0	mA

Emitter cut-off current

 $V_{EB} = 9\text{ V}; I_C = 0$

I_{EBO}	max.	10	mA
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Saturation voltages

 $I_C = 10\text{ A}; I_B = 2\text{ A}$

V_{CEsat}	max.	1.5	— V
V_{BEsat}	max.	1.6	— V

 $I_C = 8\text{ A}; I_B = 1.6\text{ A}$

V_{CEsat}	max.	—	1.5 V
V_{BEsat}	max.	—	1.6 V

DC current gain

 $I_C = 20\text{ mA}; V_{CE} = 5\text{ V}$

h_{FE}	min.	10	
h_{FE}	typ.	18	
h_{FE}	max.	35	

 $I_C = 1.5\text{ A}; V_{CE} = 5\text{ V}$

h_{FE}	min.	10	
h_{FE}	typ.	20	
h_{FE}	max.	35	

Collector-emitter sustaining voltage (Figs 2 and 3)

 $I_C = 100\text{ mA}; I_{B\text{ off}} = 0; L = 25\text{ mH}$

$V_{CEOsust}$	min.	400	450 V
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Collector saturation current

 $V_{CE} = 1.5\text{ V}$

I_{Csat}		10	8.0 A
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Switching times resistive load (Figs 4 and 5)

 $I_{C\text{ on}} = 10\text{ A}; I_{B\text{ on}} = I_{B\text{ off}} = 2\text{ A}$

Turn-on time

t_{on}	max.	1.0	— μs
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Turn-off; storage time

t_s	max.	4.0	— μs
-------	------	-----	-----------------

fall time

t_f	max.	0.8	— μs
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 $I_{C\text{ on}} = 8\text{ A}; I_{B\text{ on}} = I_{B\text{ off}} = 1.6\text{ A}$

Turn-on time

t_{on}	max.	—	1.0 μs
----------	------	---	-------------------

Turn-off; storage time

t_s	max.	—	4.0 μs
-------	------	---	-------------------

fall time

t_f	max.	—	0.8 μs
-------	------	---	-------------------

Switching times inductive load (Figs 6 and 7)

 $I_{C\text{ on}} = 10\text{ A}; I_B = 2\text{ A};$ $V_{CL} = 250\text{ V}; T_c = 100\text{ }^\circ\text{C}$

Turn-off; storage time

t_s	typ.	2.8	— μs
-------	------	-----	-----------------

t_s	max.	3.5	— μs
-------	------	-----	-----------------

fall time

t_f	typ.	200	— ns
-------	------	-----	------

t_f	max.	300	— ns
-------	------	-----	------

 $I_{C\text{ on}} = 8\text{ A}; I_B = 1.6\text{ A};$ $V_{CL} = 300\text{ V}; T_c = 100\text{ }^\circ\text{C}$

Turn-off; storage time

t_s	typ.	—	2.8 μs
-------	------	---	-------------------

t_s	max.	—	3.5 μs
-------	------	---	-------------------

fall time

t_f	typ.	—	200 ns
-------	------	---	--------

t_f	max.	—	300 ns
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* Measured with a half-sinewave voltage (curve tracer).

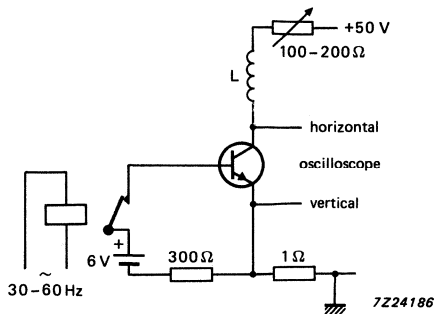


Fig. 2 Test circuit for $V_{CE0sust}$.

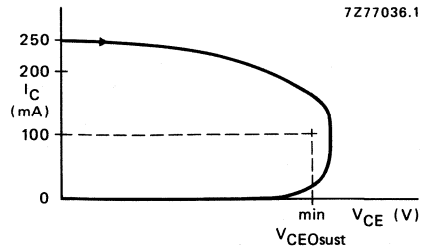
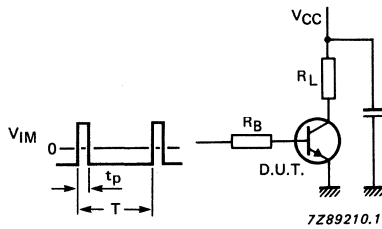


Fig. 3 Oscilloscope display for sustaining voltage.



$V_{CC} = 250 \text{ V}$
 $t_p = 20 \mu\text{s}$
 $V_{IM} = -6 \text{ to } +8 \text{ V}$
 $\frac{t_p}{T} = 0.01$

The values of R_B and R_L are selected in accordance with $I_{C \text{ on}}$ and I_B requirements.

Fig. 4 Test circuit resistive load.

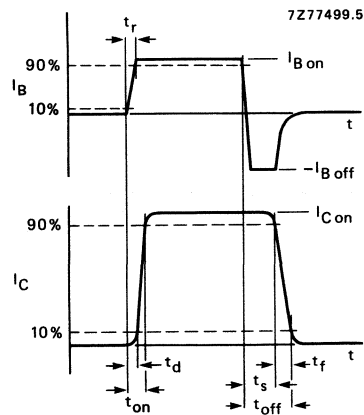
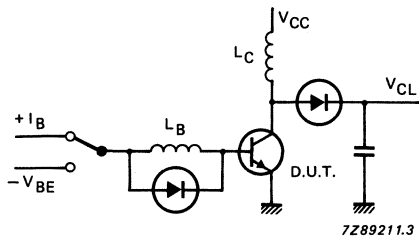


Fig. 5 Switching times waveforms with resistive load; $t_r \leq 20 \text{ ns}$.



$V_{CL} = \text{up to } 1000 \text{ V}$
 $V_{CC} = 30 \text{ V}$
 $-V_{BE} = 5 \text{ V}$
 $L_B = 1.0 \mu\text{H}$
 $L_C = 200 \mu\text{H}$

Fig. 6 Test circuit inductive load and reverse bias SOAR.

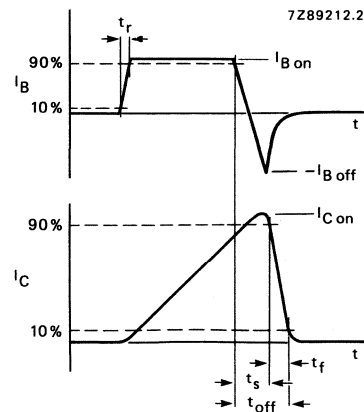
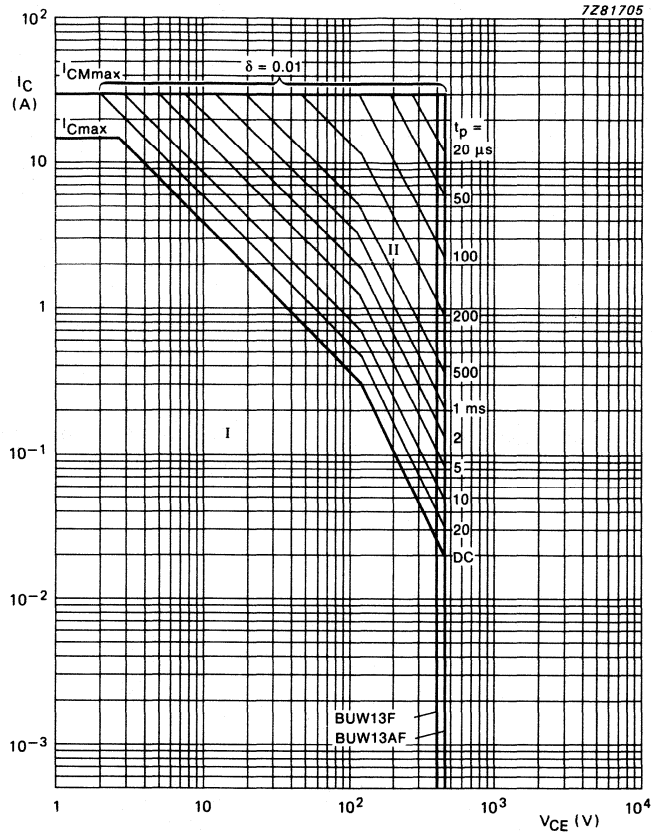


Fig. 7 Switching times waveforms with inductive load.



- (1) P_{tot} max and P_{tot} peak max lines.
- (2) Second-breakdown limits (independent of temperature).
- I Region of permissible DC operation.
- II Permissible extension for repetitive pulse operation.

Fig. 8 Safe operating area at $T_{mb} < 25$ °C.

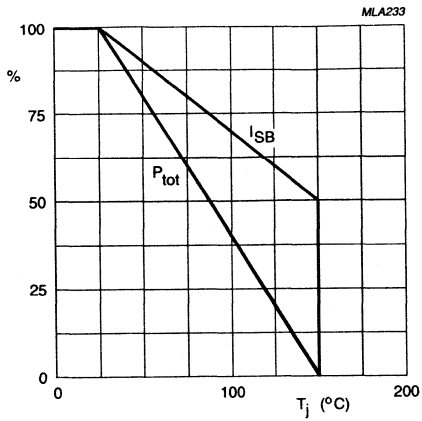


Fig. 9 Total power dissipation and second breakdown current curve.

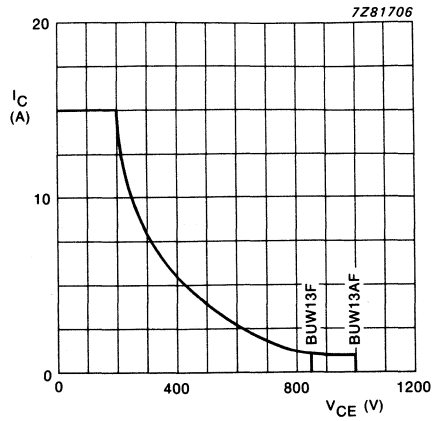


Fig. 10 RB SOAR; $T_c \leq 100\text{ }^\circ\text{C}$;
 $V_{BE} = -1\text{ V to } -5\text{ V}$.

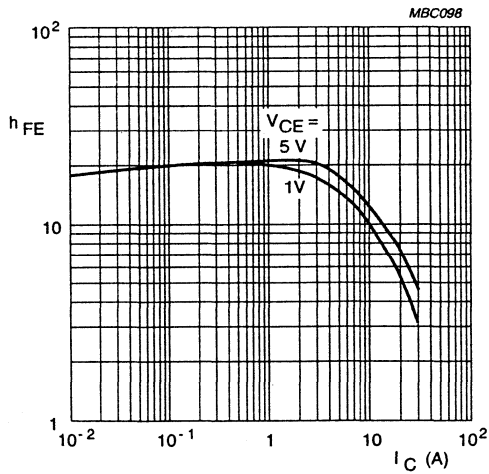


Fig. 11 Typical values DC current gain; $T_j = 125\text{ }^\circ\text{C}$.

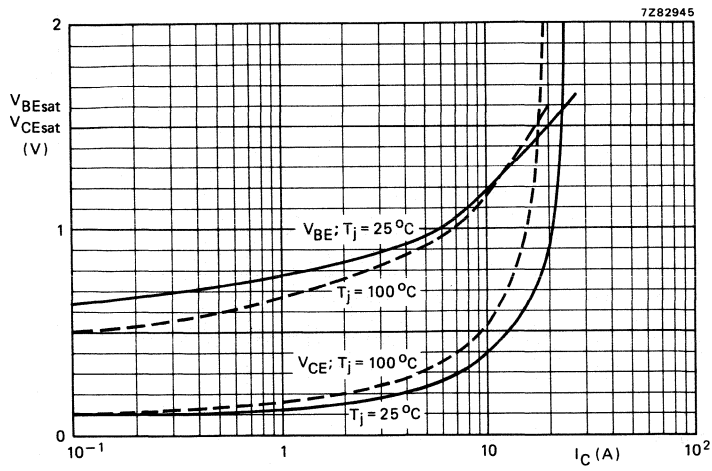


Fig. 12 Typical values base and collector voltages at $I_C/I_B = 5$.

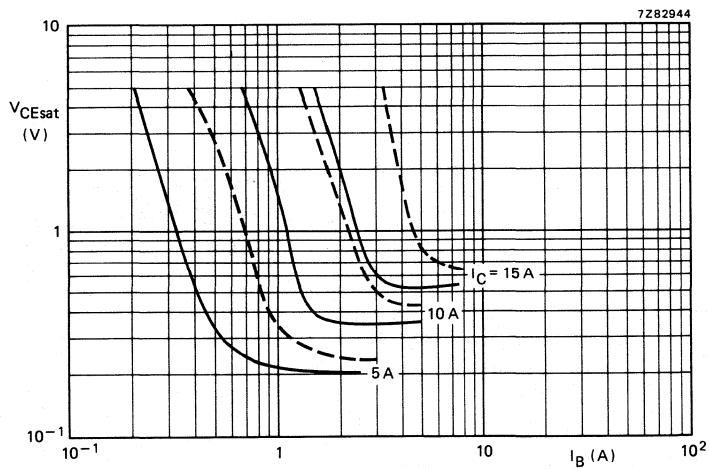


Fig. 13 Typical (—) and maximum (---) values saturation voltage; $T_j = 25^\circ\text{C}$.

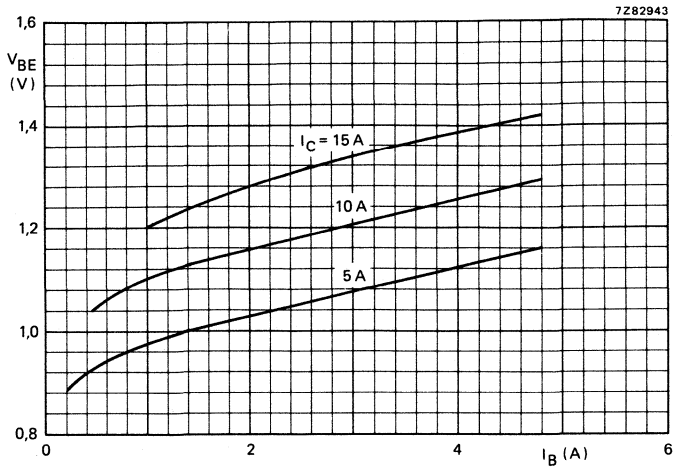


Fig. 14 Typical values base-emitter voltage at $T_j = 25$ °C.

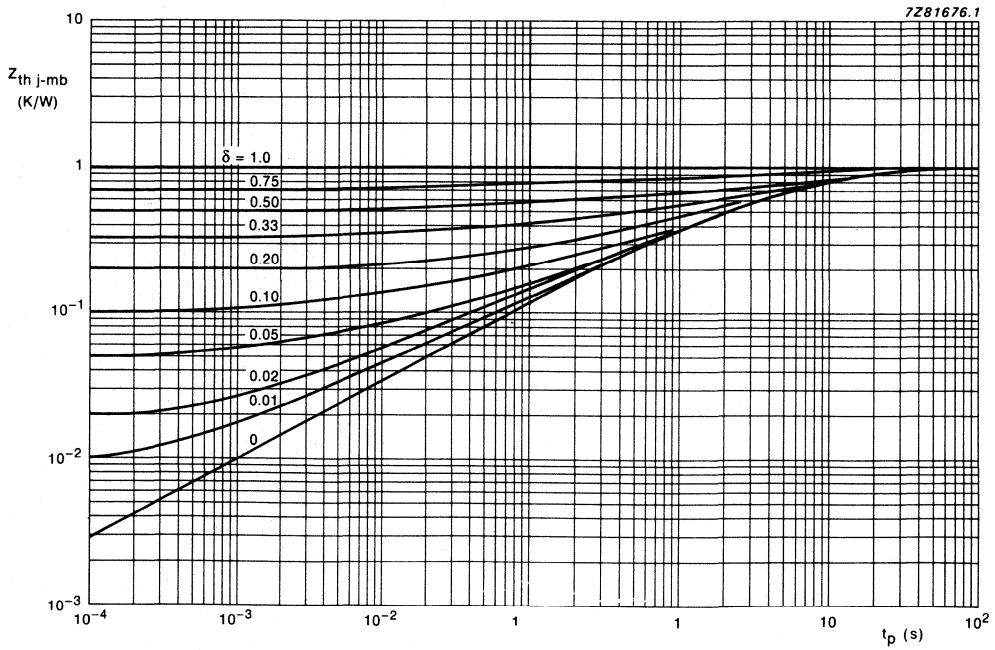


Fig. 15 Normalized thermal response at pulse power conditions.

Silicon diffused power transistor

BUW14

GENERAL DESCRIPTION

High-voltage, high-speed, glass passivated npn power transistor in a SOT82 envelope intended for use in converters, inverters, switching regulators, motor control systems and switching applications.

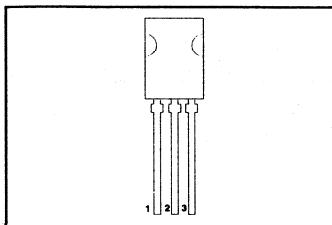
QUICK REFERENCE DATA

SYMBOL	PARAMETER	CONDITIONS	TYP.	MAX.	UNIT
V_{CESM}	Collector-emitter voltage peak value	$V_{BE} = 0 \text{ V}$	-	1000	V
V_{CEO}	Collector-emitter voltage (open base)		-	450	V
I_C	Collector current (DC)	$T_{mb} \leq 60 \text{ }^\circ\text{C}$	-	0.5	A
I_{CM}	Collector current peak value		-	1	A
P_{tot}	Total power dissipation		-	20	W
t_f	Fall time		0.4	-	μs

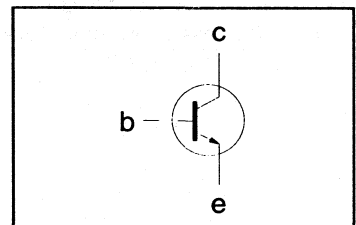
PINNING - SOT82

PIN	DESCRIPTION
1	emitter
2	collector
3	base

PIN CONFIGURATION



SYMBOL



LIMITING VALUES

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

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_{CESM}	Collector-emitter voltage peak value	$V_{BE} = 0 \text{ V}$	-	1000	V
V_{CEO}	Collector-emitter voltage (open base)		-	450	V
I_C	Collector current (DC)	$T_{mb} \leq 60 \text{ }^\circ\text{C}$	-	0.5	A
I_{CM}	Collector current peak value		-	1	A
I_B	Base current (DC)		-	0.2	A
I_{BM}	Base current peak value		-	0.3	A
$-I_{BM}$	Reverse base current peak value ¹		-	0.3	A
P_{tot}	Total power dissipation		-	20	W
T_{stg}	Storage temperature		-65	150	$^\circ\text{C}$
T_j	Junction temperature	-	150	$^\circ\text{C}$	

THERMAL RESISTANCES

SYMBOL	PARAMETER	CONDITIONS	TYP.	MAX.	UNIT
$R_{th \text{ j-mb}}$	Junction to mounting base	-	-	4.5	K/W
$R_{th \text{ j-a}}$	Junction to ambient	in free air	100	-	K/W

¹ Turn-off current.

Silicon diffused power transistor

BUW14

STATIC CHARACTERISTICS

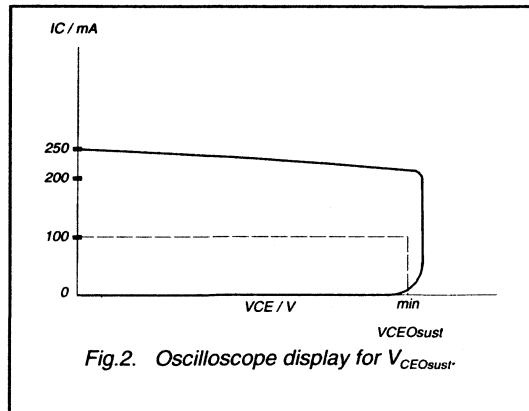
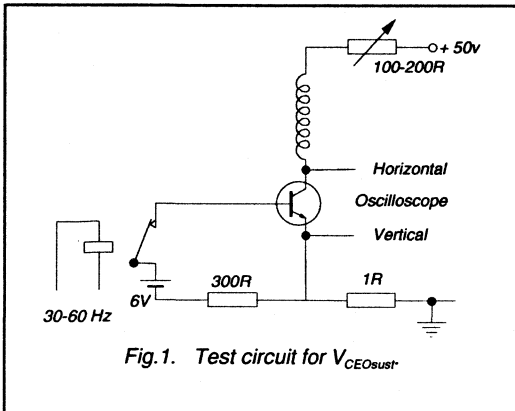
$T_{mb} = 25\text{ }^{\circ}\text{C}$ unless otherwise specified

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
I_{CES}	Collector cut-off current ²	$V_{BE} = 0\text{ V}; V_{CE} = V_{CESMmax}$	-	-	100	μA
I_{CES}		$V_{BE} = 0\text{ V}; V_{CE} = V_{CESMmax}$ $T_j = 125\text{ }^{\circ}\text{C}$	-	-	1.0	mA
I_{EBO}	Emitter cut-off current	$V_{EB} = 5\text{ V}; I_C = 0\text{ A}$	-	-	1.0	mA
$V_{CEOsust}$	Collector-emitter sustaining voltage. Fig.1 and Fig.2	$I_B = 0\text{ A}; I_C = 100\text{ mA};$ $L = 25\text{ mH}$	450	-	-	V
V_{CEsat}	Collector-emitter saturation voltage	$I_C = 0.1\text{ A}; I_B = 10\text{ mA}$	-	-	0.8	V
V_{CEsat}	Base-emitter saturation voltage	$I_C = 0.2\text{ A}; I_B = 20\text{ mA}$	-	-	1.0	V
V_{BEsat}		$I_C = 0.2\text{ A}; I_B = 20\text{ mA}$	-	-	1.0	V
h_{FE}	DC current gain	$I_C = 50\text{ mA}; V_{CE} = 5\text{ V}$	-	50	-	-
h_{FE}		$I_C = 300\text{ mA}; V_{CE} = 5\text{ V}$	25	50	100	-

DYNAMIC CHARACTERISTICS

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

SYMBOL	PARAMETER	CONDITIONS	TYP.	MAX.	UNIT
f_T	Transition frequency	$I_C = 0.2\text{ A}; V_{CE} = 10\text{ V}; f = 1\text{ MHz}$	20	-	MHz
t_{on}	Switching times (resistive load circuit). Fig.3 and Fig.4 Turn-on time Turn-off storage time Turn-off fall time Turn-off fall time	$I_{Con} = 0.2\text{ A}; I_{BOn} = 20\text{ mA};$ $-I_{Boff} = 40\text{ mA}; V_{CC} = 250\text{ V}$ $T_{mb} = 95\text{ }^{\circ}\text{C}$	0.4	0.7	μs
t_s			3.5	5.0	μs
t_f			0.4	-	μs
t_t			-	1.3	μs



² Measured with half sine-wave voltage (curve tracer).

Silicon diffused power transistor

BUW14

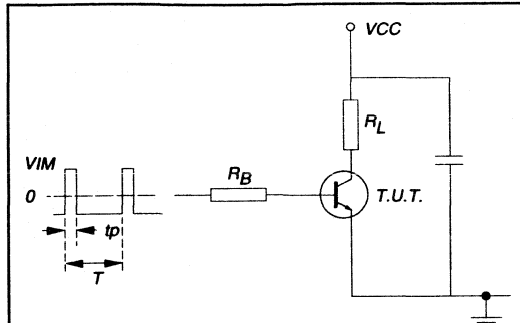


Fig.3. Test circuit resistive load. $V_{IM} = -6$ to $+8$ V
 $V_{CC} = 150$ V; $t_p = 20$ μ s; $\delta = t_p / T = 0.01$.
 R_B and R_L calculated from I_{Con} and I_{Bon} requirements.

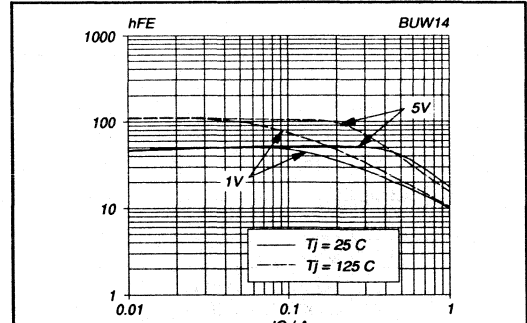


Fig.6. Typical DC current gain. $h_{FE} = f(I_C)$
 parameter V_{CE}

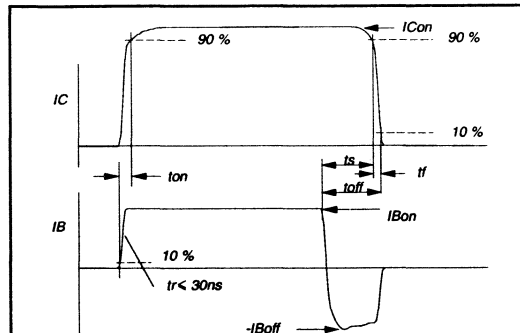


Fig.4. Switching times waveforms with resistive load

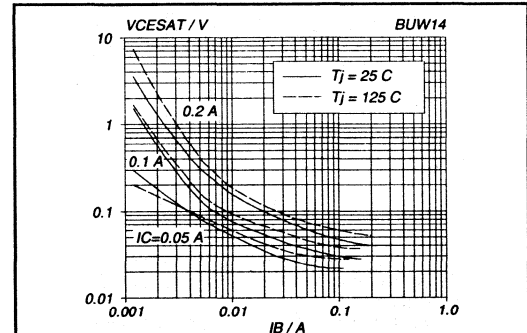


Fig.7. Typical collector-emitter saturation voltage.
 $V_{CEsat} = f(I_B)$; parameter I_C

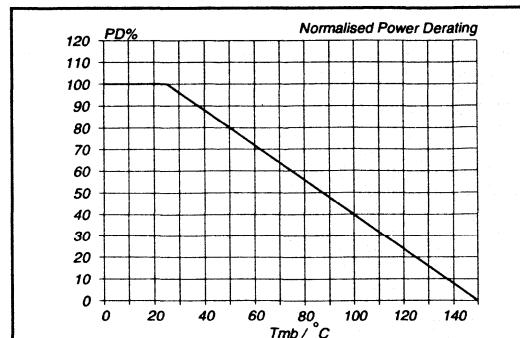


Fig.5. Normalised power dissipation.
 $PD\% = 100 \cdot P_D / P_{D25^\circ C} = f(T_{mb})$

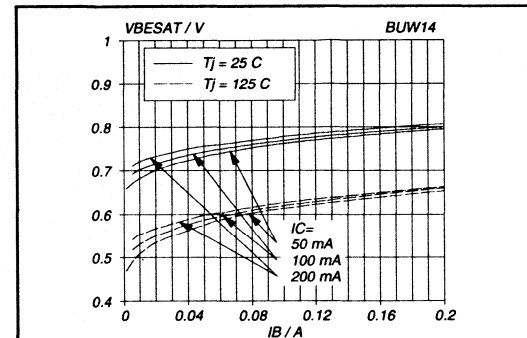


Fig.8. Typical base-emitter saturation voltage.
 $V_{BEsat} = f(I_B)$; parameter I_C

Silicon diffused power transistor

BUW14

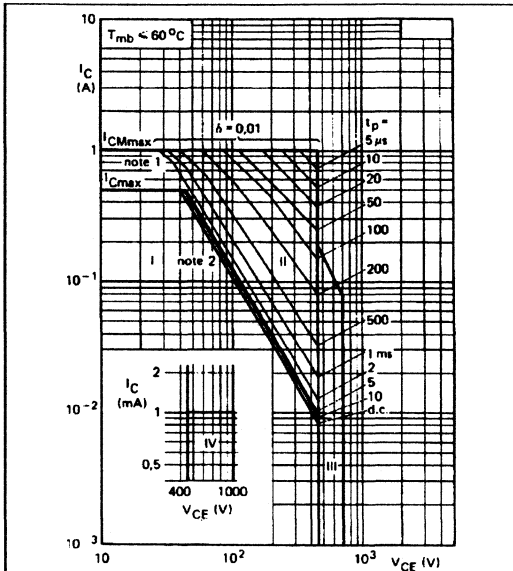


Fig. 9. Safe operating area.

- (1) P_{tot} max line.
- (2) Second-breakdown limits.
- I Region of permissible DC operation.
- II Permissible extension for repetitive pulse operation.
- III Area of permissible operation during turn-on in single transistor converters, provided $R_{BE} \leq 100 \Omega$ and $t_p \leq 0.6 \mu s$.
- IV Repetitive pulse operation in this region is permissible provided $V_{BE} \leq 2$ ms.

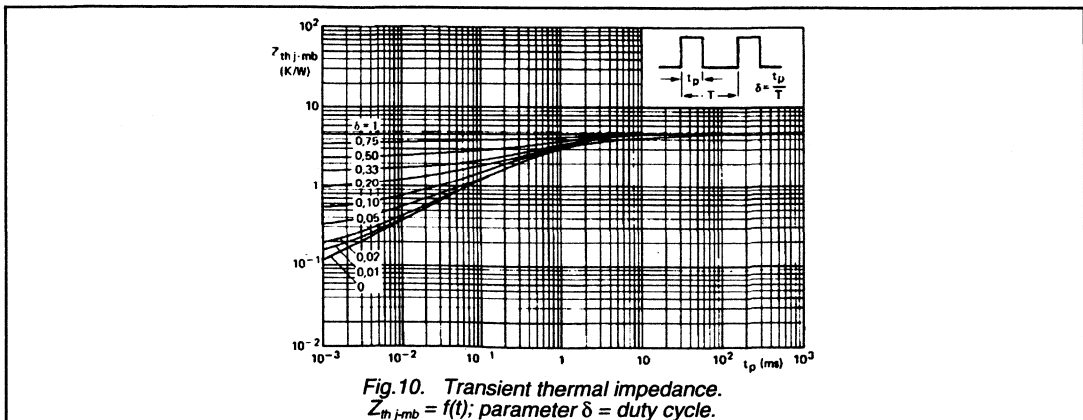
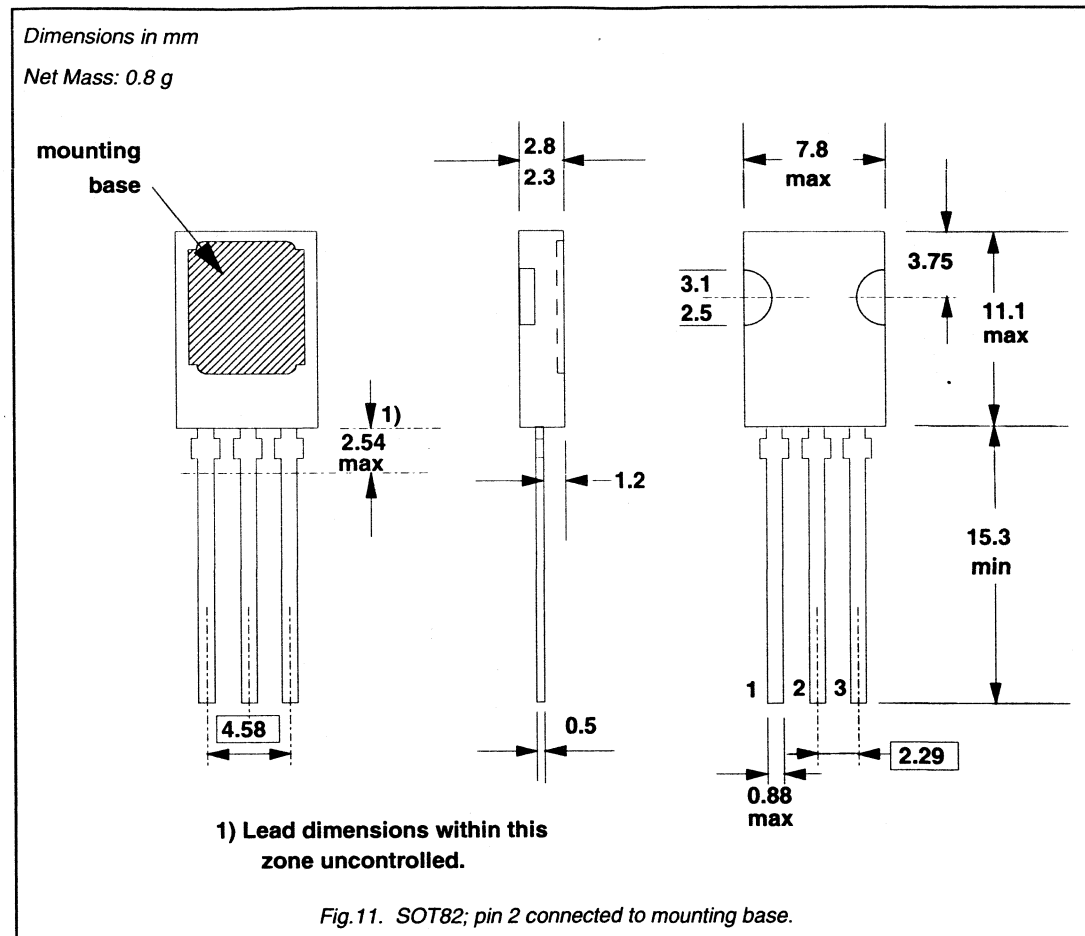


Fig. 10. Transient thermal impedance.
 $Z_{thj-mb} = f(t)$; parameter $\delta =$ duty cycle.

Silicon diffused power transistor

BUW14

MECHANICAL DATA



Notes

1. Accessories supplied on request: refer to mounting instructions for SOT82 envelopes.

RATINGS

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

		BUW84	BUW85
Collector-emitter voltage (peak value; $V_{BE} = 0$)	V_{CESM}	max. 800	1000 V
Collector-emitter voltage (open base)	V_{CEO}	max. 400	450 V
Emitter-base voltage (open collector)	V_{EBO}	max. 5	5 V
Collector current (DC)	I_C	max. 2	A
Collector current (peak value) $t_p = 2$ ms	I_{CM}	max. 3	A
Base current (DC)	I_B	max. 0.75	A
Base current (peak value)	I_{BM}	max. 1	A
Reverse base current (peak value) *	$-I_{BM}$	max. 1	A
Total power dissipation up to $T_{mb} = 45$ °C	P_{tot}	max. 50	W
Storage temperature range	T_{stg}	-65 to +150	°C
Junction temperature	T_j	max. 150	°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j-mb}$	=	2.1	K/W
From junction to ambient in free air	$R_{th\ j-a}$	=	100	K/W

CHARACTERISTICS

$T_j = 25$ °C unless otherwise specified

Collector cut-off current **

$V_{CEM} = V_{CESMmax}; V_{BE} = 0$ I_{CES} max. 200 μ A

$V_{CEM} = V_{CESMmax}; V_{BE} = 0; T_j = 125$ °C I_{CES} max. 1.5 mA

DC current gain

$I_C = 5$ mA; $V_{CE} = 5$ V h_{FE} min. 15

$I_C = 100$ mA; $V_{CE} = 5$ V h_{FE} min. 20

h_{FE} typ. 50

h_{FE} max. 100

Emitter cut-off current

$I_C = 0; V_{EB} = 5$ V I_{EBO} max. 1 mA

Saturation voltages

$I_C = 0.3$ A; $I_B = 30$ mA V_{CEsat} max. 0.8 V

$I_C = 1$ A; $I_B = 0.2$ A V_{CEsat} max. 1 V

$I_C = 1$ A; $I_B = 0.2$ A V_{BEsat} max. 1.1 V

Collector-emitter sustaining voltage

$I_C = 100$ mA; $I_{Boff} = 0; L = 25$ mH $V_{CEO_{sust}}$ min. 400 | 450 V

* Turn-off current.

** Measured with a half-sinewave voltage (curve tracer).

CHARACTERISTICS (continued)

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

Transition frequency at $f = 1\text{ MHz}$

$I_C = 0,2\text{ A}; V_{CE} = 10\text{ V}$

f_T typ. 20 MHz

Switching times

$I_{Con} = 1\text{ A}; V_{CC} = 250\text{ V}$

$I_{Bon} = 0,2\text{ A}; -I_{Boff} = 0,4\text{ A}$

Turn-on time

t_{on} typ. 0.2 μs
max. 0.5 μs

Turn-off: Storage time

t_s typ. 2 μs
max. 3.5 μs

Fall time

t_f typ. 0.4 μs

Fall time, $T_{mb} = 95\text{ }^\circ\text{C}$

t_f max. 1.4 μs

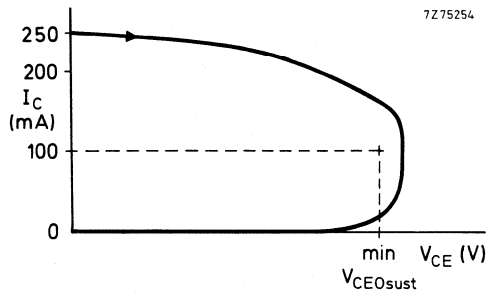


Fig. 2 Oscilloscope display for sustaining voltage.

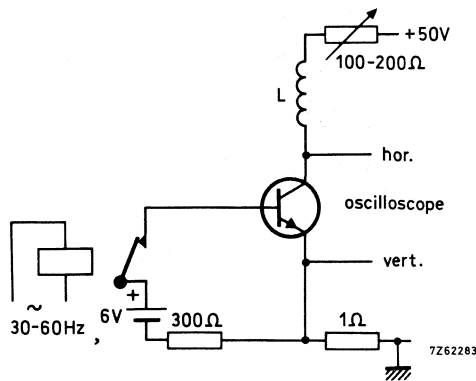


Fig. 3 Test circuit for $V_{CE0sust}$.

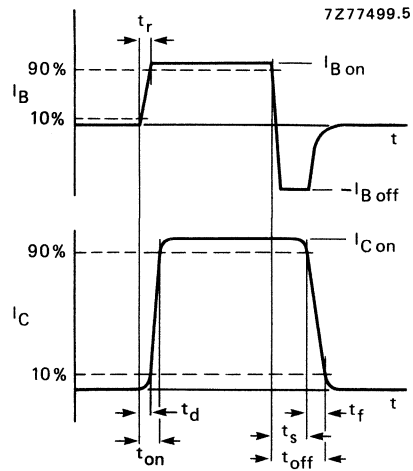


Fig. 4 Switching times waveforms with resistive load.

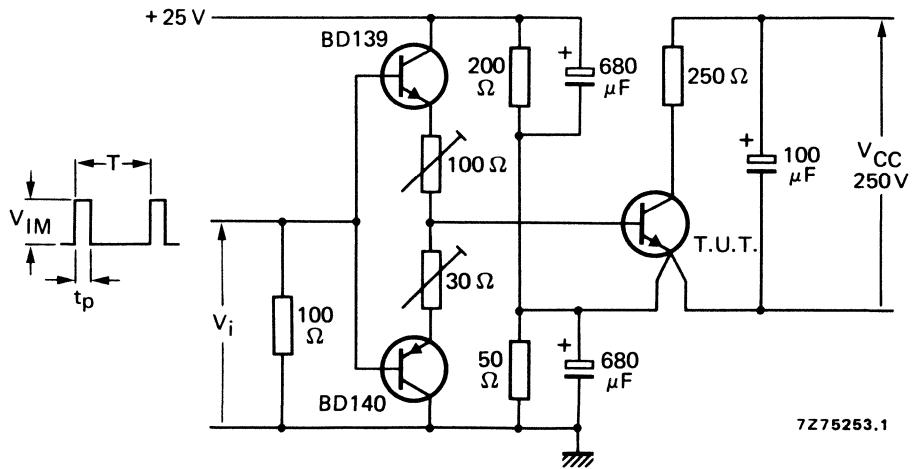
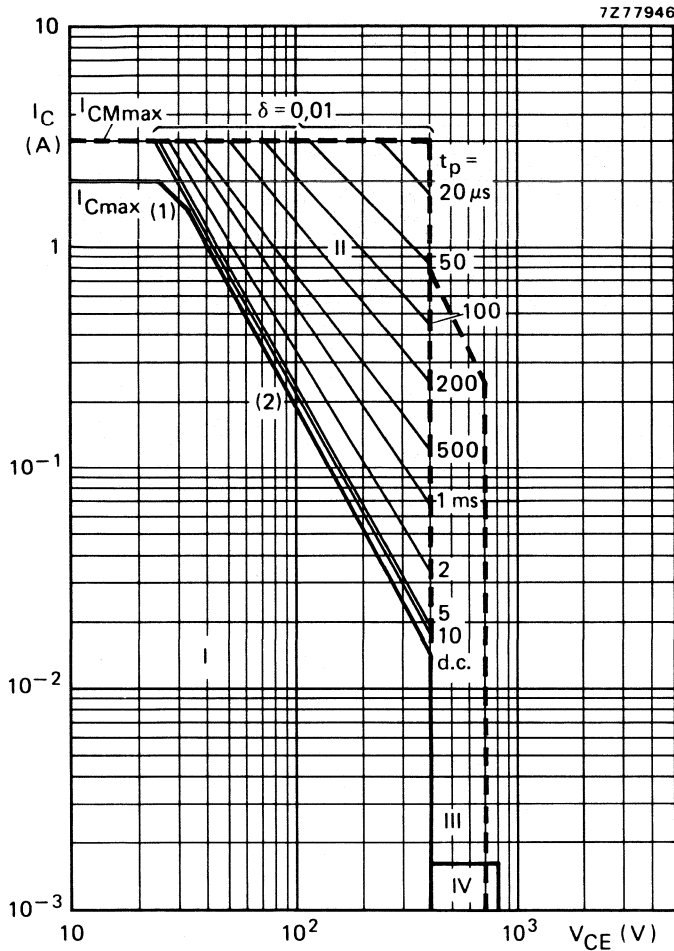


Fig. 5 Test circuit resistive load.



- I Region of permissible DC operation
 - II Permissible extension for repetitive pulse operation
 - III Area of permissible operation during turn-on in single transistor converters, provided $R_{BE} \leq 100 \Omega$ and $t_p \leq 0,6 \mu s$
 - IV Repetitive pulse operation in this region is permissible, provided $V_{BE} \leq 0$ and $t_p \leq 2 ms$
- (1) P_{tot} max line.
 (2) Second-breakdown limits.

Fig. 6 Safe operating area at $T_{mb} \leq 25 \text{ }^\circ\text{C}$ of BUW84.

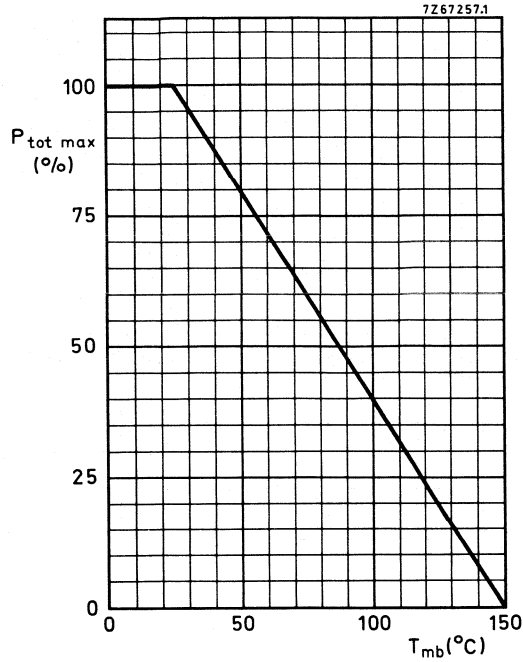


Fig. 8 Power derating curve.

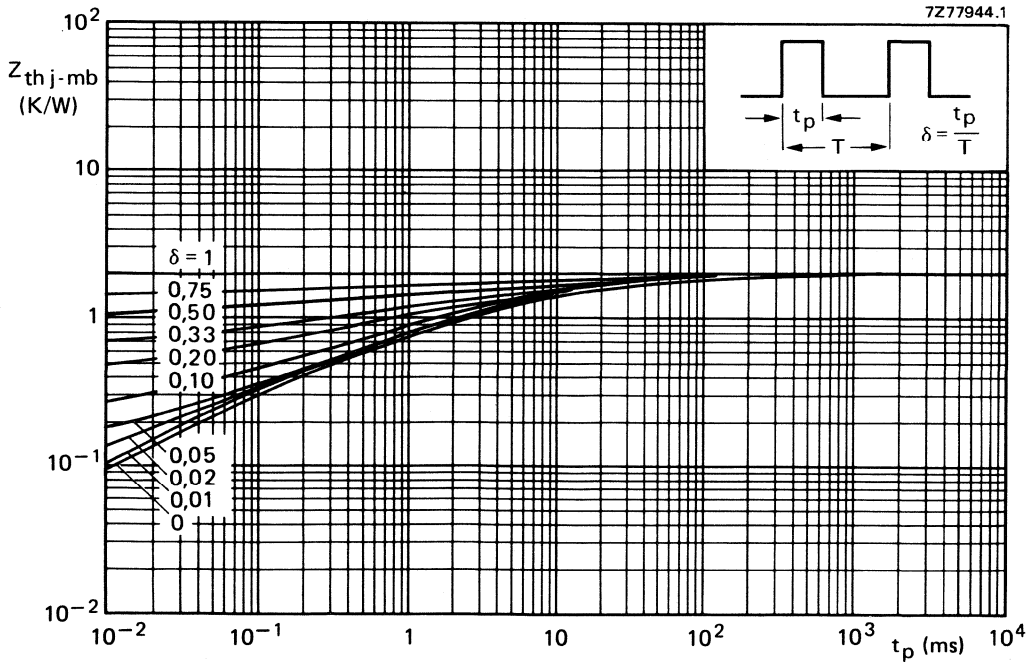


Fig. 9 Pulse power rating chart.

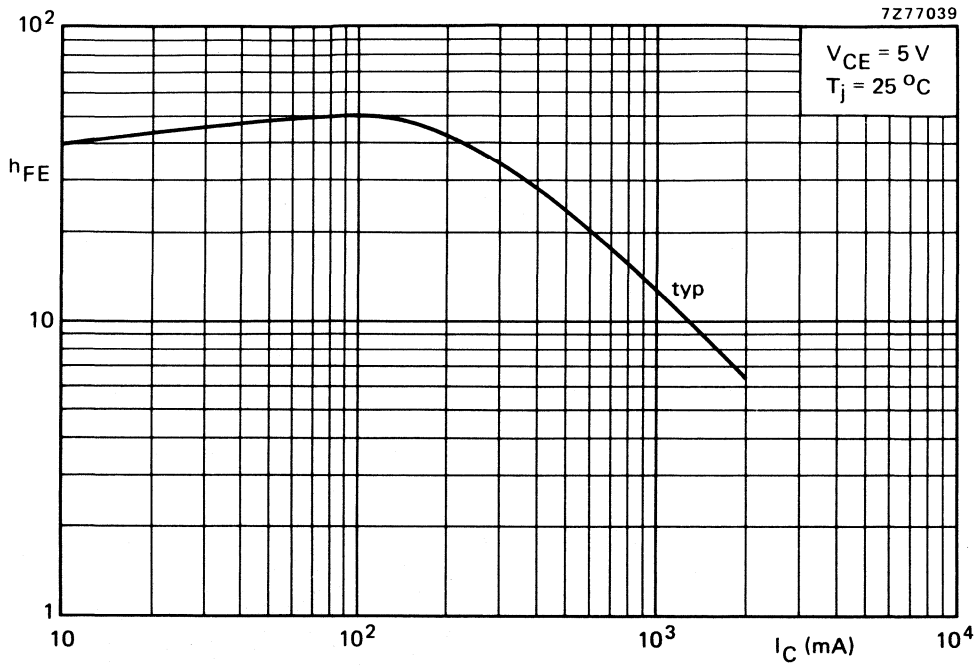


Fig. 10 Typical DC current gain.

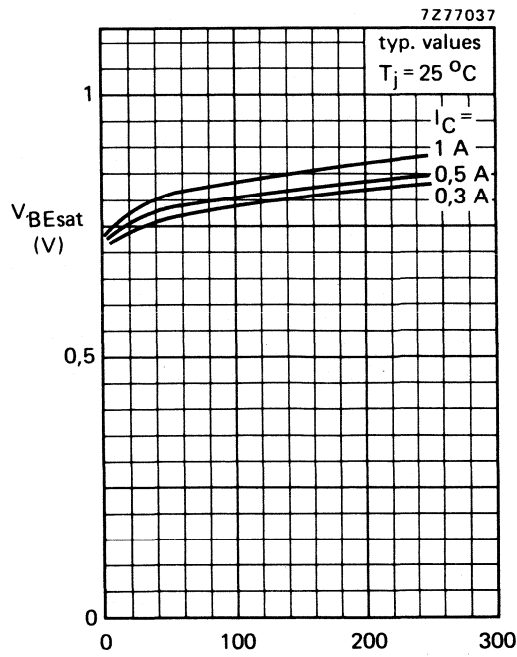


Fig. 11 Typical base-emitter saturation voltage.

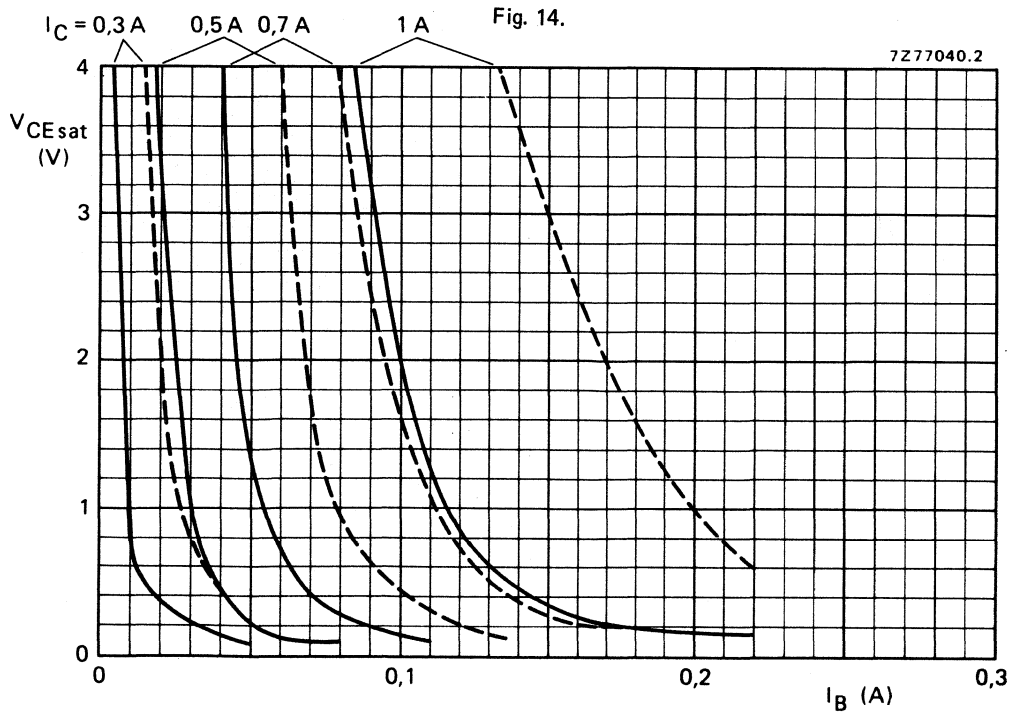


Fig. 12 Typical (—) and maximum (---) values saturation voltage at $T_j = 25\text{ }^\circ\text{C}$.

SILICON DIFFUSED POWER TRANSISTORS

High-voltage, high-speed, glass-passivated npn power transistors in TO-220 envelopes, intended for use in converters, inverters, switching regulators, motor control systems and switching applications.

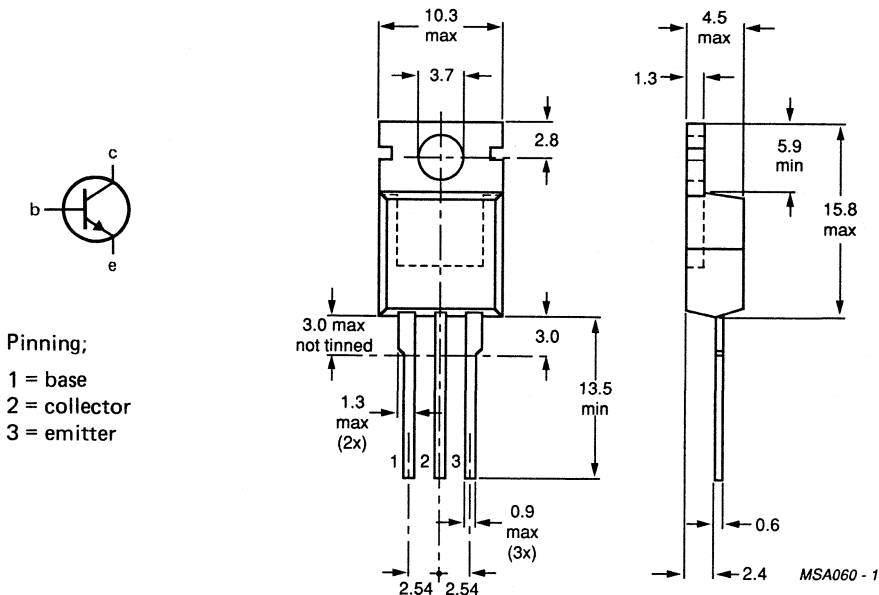
QUICK REFERENCE DATA

		BUX84	BUX85
Collector-emitter voltage (peak value; $V_{BE} = 0$)	V_{CESM} max.	800	1000 V
Collector-emitter voltage (open base)	V_{CEO} max.	400	450 V
Collector-emitter saturation voltage	V_{CEsat} max.	1	V
Collector current (DC)	I_C max.	2	A
Collector current (peak value)	I_{CM} max.	3	A
Total power dissipation up to $T_{mb} = 50\text{ }^\circ\text{C}$	P_{tot} max.	40	W
Fall time	t_f max.	0,4	μs

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-220AB.



Collector connected to tab

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

		BUX84	BUX85	
Collector-emitter voltage (peak value; $V_{BE} = 0$)	V_{CESM}	max 800	1000	V
Collector-emitter voltage (open base)	V_{CEO}	max 400	450	V
Collector current (DC)	I_C	max 2		A
Collector current (peak value) $t_p = 2$ ms	I_{CM}	max 3		A
Base current (DC)	I_B	max 0,75		A
Base current (peak value)	I_{BM}	max 1		A
Reverse base current (peak value) *	$-I_{BM}$	max 1		A
Total power dissipation up to $T_{mb} = 50$ °C	P_{tot}	max 40		W
Storage temperature range	T_{stg}	-65 to +150		°C
Junction temperature	T_j	max 150		°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j-mb}$	= 2,5		K/W
From junction to ambient in free air	$R_{th\ j-a}$	= 70		K/W

CHARACTERISTICS

$T_j = 25$ °C unless otherwise specified

Collector cut-off current **

$V_{CEM} = V_{CESMmax}; V_{BE} = 0$	I_{CES}	max. 200		μA
$V_{CEM} = V_{CESMmax}; V_{BE} = 0; T_j = 125$ °C	I_{CES}	max. 1,5		mA

DC current gain

$I_C = 5$ mA; $V_{CE} = 5$ V	h_{FE}	min. 15		
$I_C = 100$ mA; $V_{CE} = 5$ V	h_{FE}	min. 20		
	h_{FE}	typ. 50		
	h_{FE}	max. 100		

* Turn-off current.

** Measured with a half-sinewave voltage (curve tracer).

Emitter cut-off current

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

I_{EBO}	max.	1	mA
-----------	------	---	----

Saturation voltages

$I_C = 0,3 \text{ A}; I_B = 30 \text{ mA}$

V_{CEsat}	max.	0,8	V
-------------	------	-----	---

$I_C = 1 \text{ A}; I_B = 0,2 \text{ A}$

V_{CEsat}	max.	1,0	V
-------------	------	-----	---

$I_C = 1 \text{ A}; I_B = 0,2 \text{ A}$

V_{BEsat}	max.	1,1	V
-------------	------	-----	---

Collector-emitter sustaining voltage

$I_C = 100 \text{ mA}; I_{Boff} = 0; L = 25 \text{ mH}$

		<u>BUX84</u>	<u>BUX85</u>	
$V_{CEOsust}$	min.	400	450	V

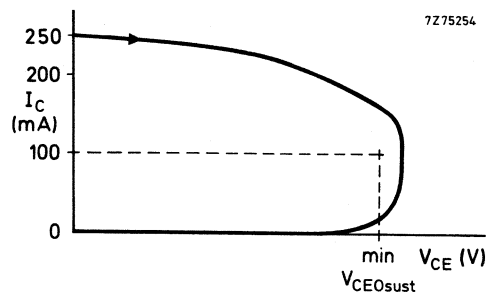


Fig. 2 Oscilloscope display for sustaining voltage.

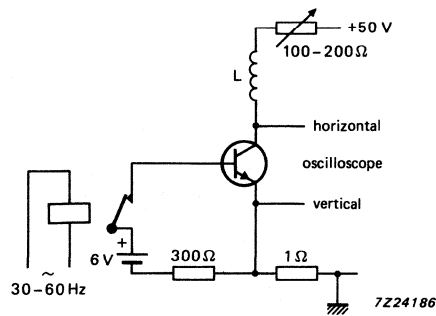


Fig. 3 Test circuit for $V_{CEOsust}$.

CHARACTERISTICS (continued)

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

Transition frequency at $f = 1\text{ MHz}$

$I_C = 0,2\text{ A}; V_{CE} = 10\text{ V}$

f_T typ 20 MHz

Switching times

$I_{Con} = 1\text{ A}; V_{CC} = 250\text{ V}$

$I_{Bon} = 0,2\text{ A}; -I_{Boff} = 0,4\text{ A}$

Turn-on time

t_{on} typ 0,2 μs
max. 0,5 μs

Turn-off: Storage time

t_s typ 2 μs
max. 3,5 μs

Fall time

t_f typ 0,4 μs

Fall time, $T_{mb} = 95\text{ }^\circ\text{C}$

t_f max. 1,4 μs

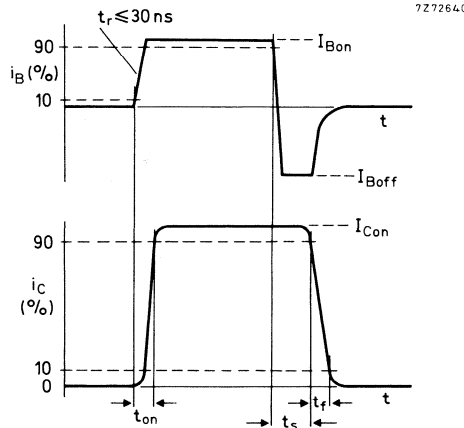


Fig. 4 Switching times waveforms with resistive load.

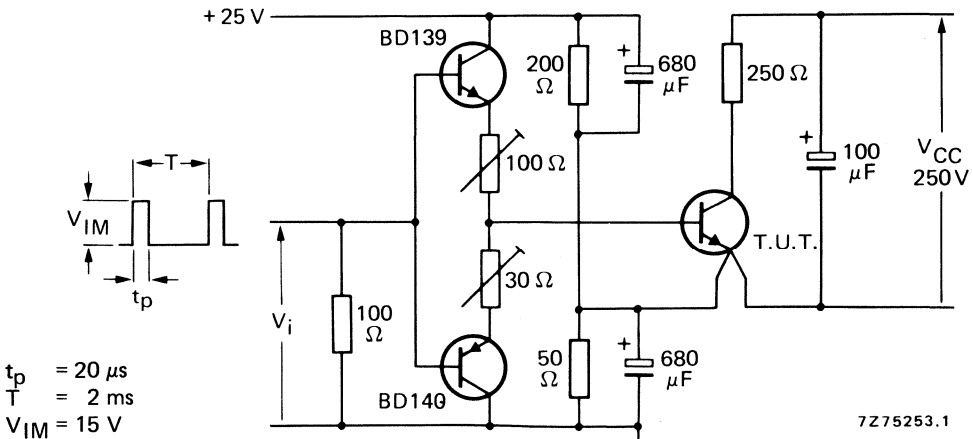
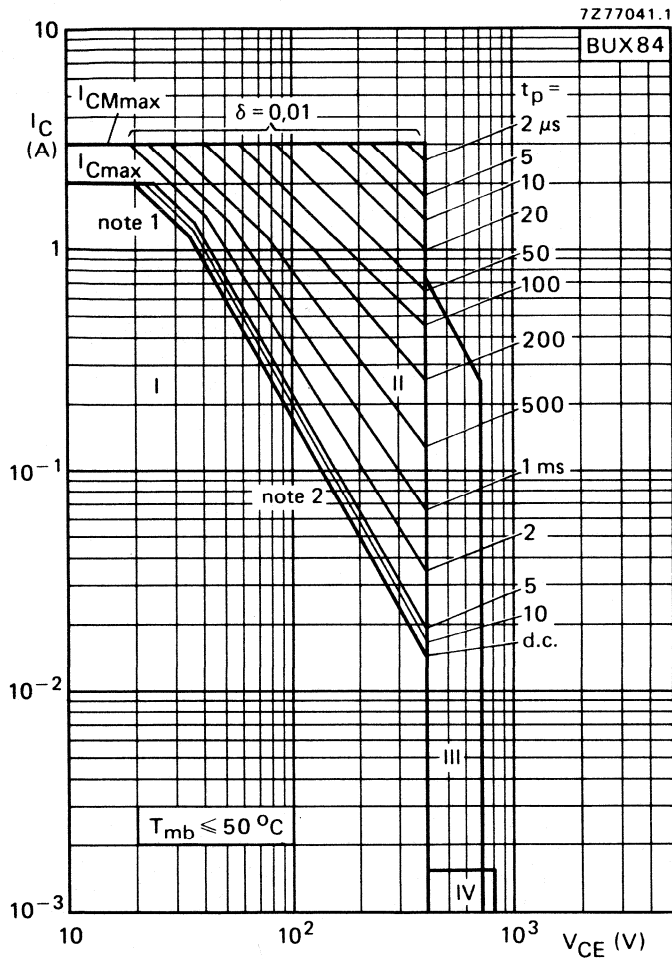


Fig. 5 Test circuit resistive load.

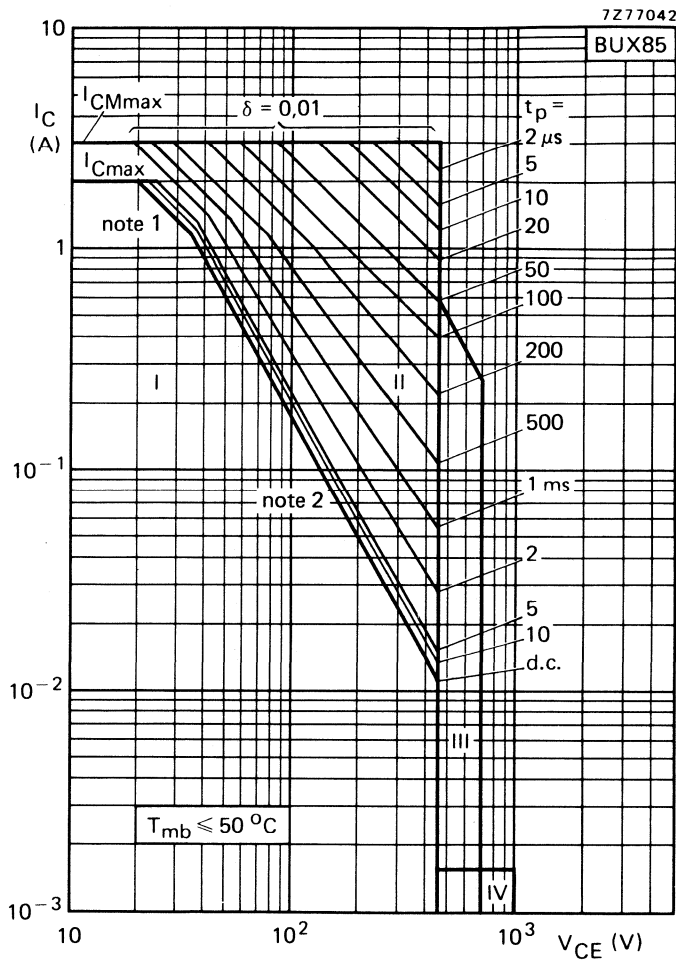
$t_p = 20\text{ } \mu\text{s}$
 $T = 2\text{ ms}$
 $V_{IM} = 15\text{ V}$



1. P_{tot} max and P_{peak} max lines.
2. Second-breakdown limits.

- I Region of permissible DC operation
- II Permissible extension for repetitive pulse operation
- III Area of permissible operation during turn-on in single transistor converters, provided $R_{BE} \leq 100 \Omega$ and $t_p \leq 0,6 \mu s$
- IV Repetitive pulse operation in this region is permissible, provided $V_{BE} \leq 0$ and $t_p \leq 2$ ms

Fig. 6 Safe operating area.



1. $P_{tot\ max}$ and $P_{peak\ max}$ lines.
 2. Second-breakdown limits.
- I Region of permissible DC operation
- II Permissible extension for repetitive pulse operation
- III Area of permissible operation during turn-on in single transistor converters, provided $R_{BE} \leq 100\ \Omega$ and $t_p \leq 0,6\ \mu s$
- IV Repetitive pulse operation in this region is permissible, provided $V_{BE} \leq 0$ and $t_p \leq 2\ ms$

Fig. 7 Safe operating area.

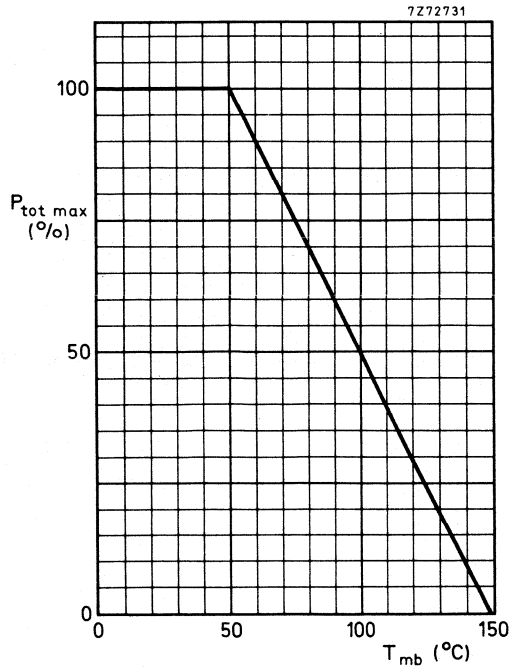


Fig. 8 Power derating curve.

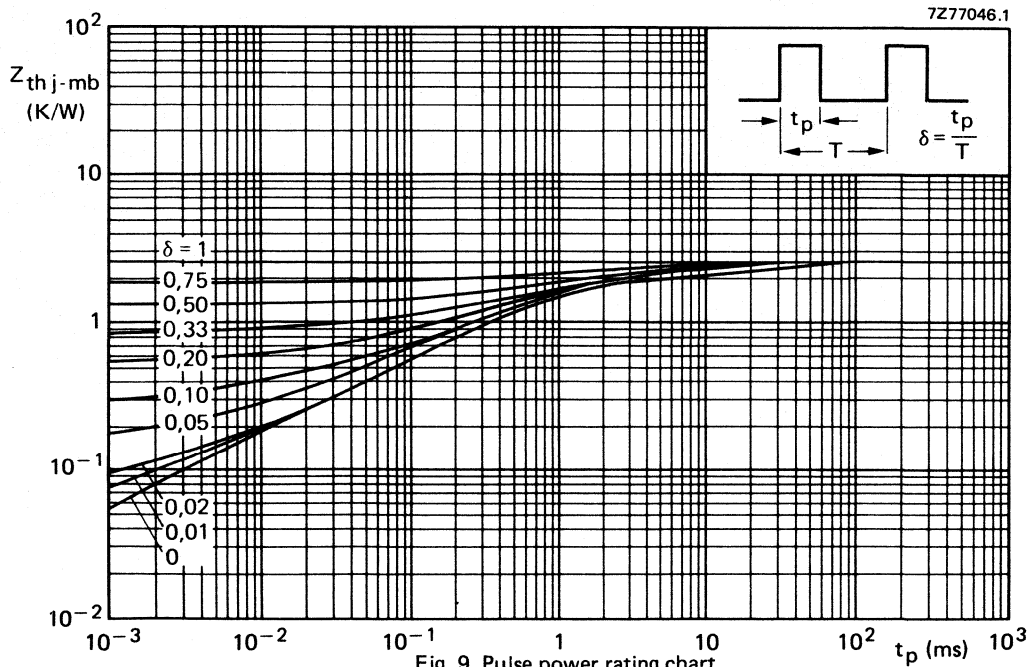


Fig. 9 Pulse power rating chart.

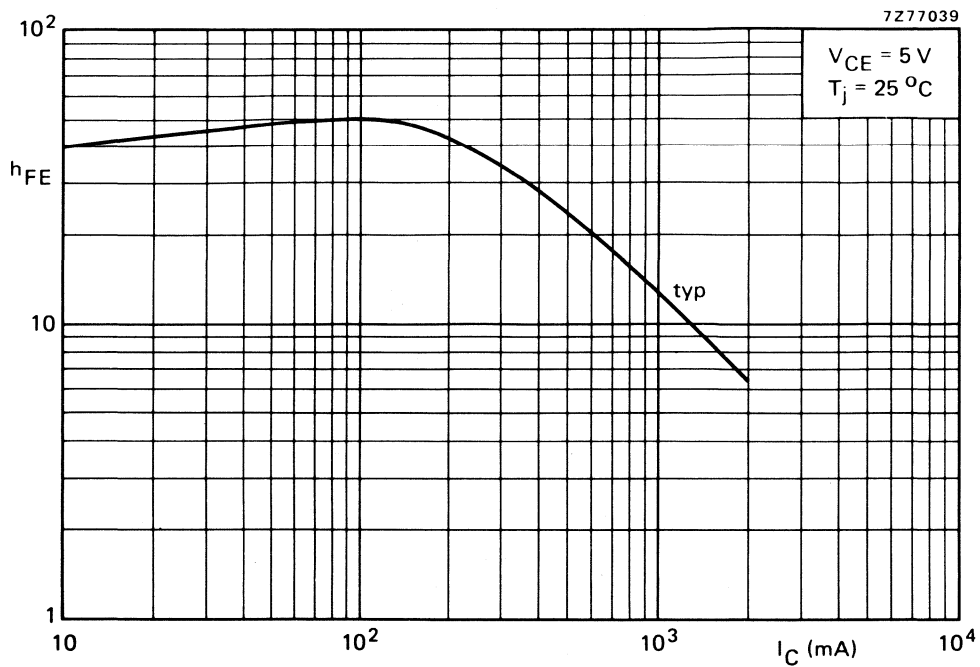


Fig. 10 Typical DC current gain.

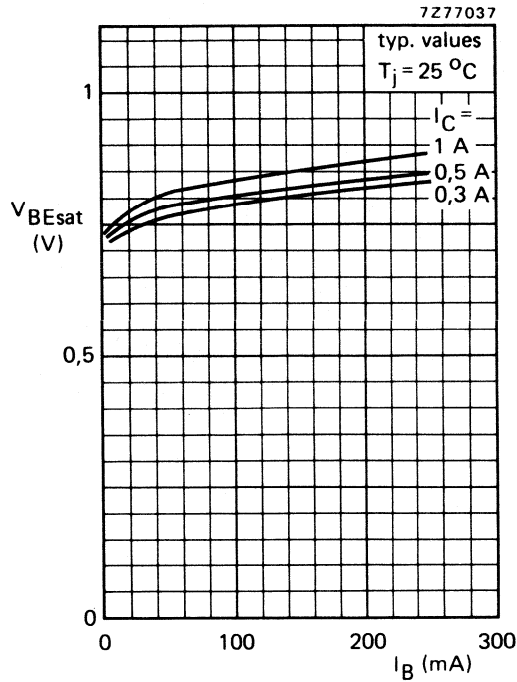


Fig. 11 Typical values saturation voltage, $T_j = 25\text{ }^\circ\text{C}$.

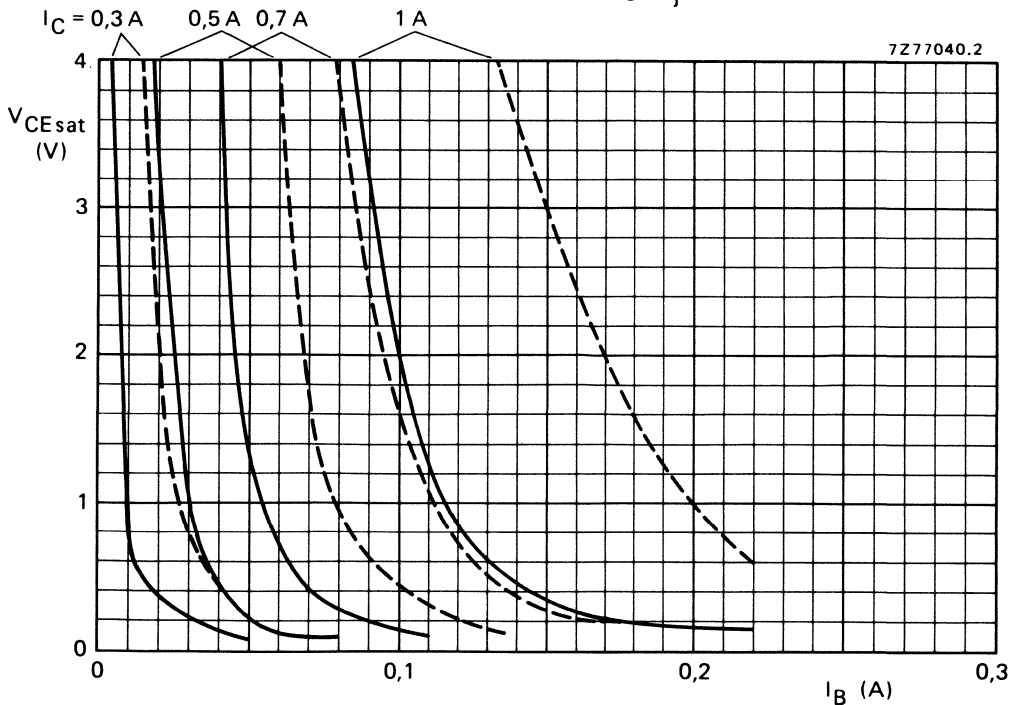


Fig. 12 Typical (—) and maximum (---) values saturation voltage at $T_j = 25\text{ }^\circ\text{C}$.

SILICON DIFFUSED POWER TRANSISTORS

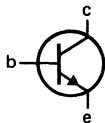
High-voltage, high-speed, glass-passivated npn power transistor in a SOT 186 envelope with an electrically isolated mounting base. The device is intended for use in converters, inverters, switching regulators, motor control systems, etc.

QUICK REFERENCE DATA

			BUX84F	BUX85F
Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM}	max.	800	1000 V
	V_{CEO}	max.	400	450 V
Collector-emitter saturation voltage	V_{CEsat}	max.	1,0	V
Collector saturation current	I_{Csat}	max.	1	A
Collector current DC peak value	I_C	max.	2	A
	I_{CM}	max.	3	A
Total power dissipation up to $T_h = 25^\circ\text{C}$	P_{tot}	max.	18	W
Fall time	t_f	typ.	0,4	μs

MECHANICAL DATA

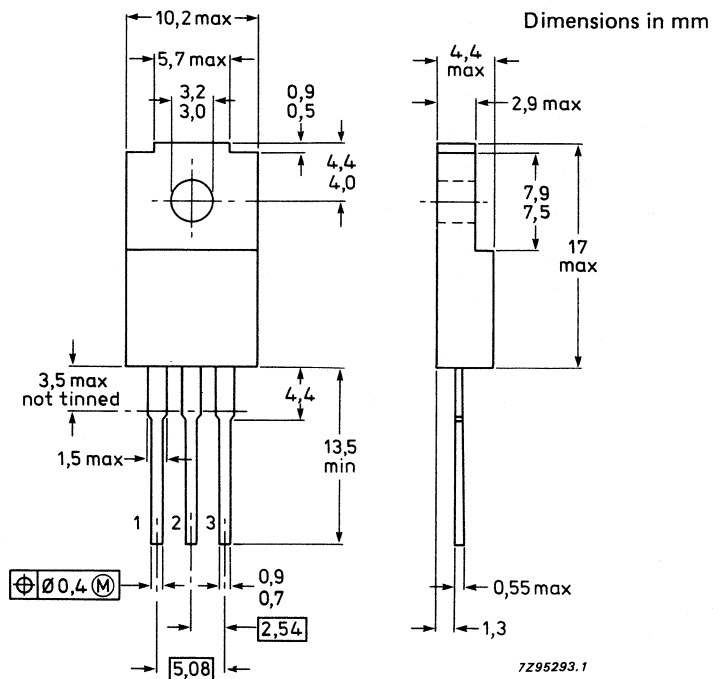
Fig. 1 SOT186.



Pinning

- 1 = base
- 2 = collector
- 3 = emitter

Mounting base is electrically isolated from all terminals.



RATINGS

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

			BUX84F	BUX85F
Collector-emitter voltage open base peak value; $V_{BE} = 0$	V_{CEO}	max.	400	450 V
	V_{CESM}	max.	800	1000 V
Collector current, DC	I_C	max.	2	A
Collector current, peak value	I_{CM}	max.	3	A
Base current, DC peak value	I_B	max.	0,75	A
	I_{BM}	max.	1	A
Total power dissipation up to $T_h = 25\text{ }^\circ\text{C}$ (note 1)	P_{tot}	max.	18	W
Storage temperature range	T_{stg}		-65 to +150	$^\circ\text{C}$
Junction temperature	T_j	max.	150	$^\circ\text{C}$

THERMAL RESISTANCE

From junction to external heatsink (note 1)	$R_{th\ j-h}$	=	7,2	K/W
From junction to external heatsink (note 2)	$R_{th\ j-h}$	=	4,7	K/W
From junction to ambient	$R_{th\ j-a}$	=	55	K/W

ISOLATION

Voltage allowed between all terminals and external heatsink, peak value	V_{isol}	max.	1500	V
Isolation capacitance between collector and external heatsink	C_{isol}	typ.	12	pF

CHARACTERISTICS

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

Collector cut-off currents $V_{CE} = V_{CESmax}; V_{BE} = 0$ $V_{CE} = V_{CESmax}; V_{BE} = 0; T_j = 125\text{ }^\circ\text{C}$	I_{CES}	max.	0,2	mA
		max.	1,5	mA
Emitter cut-off current $V_{EB} = 5\text{ V}; I_C = 0$	I_{EBO}	max.	1	mA
DC current gain $I_C = 5\text{ A}; V_{CE} = 5\text{ V}$ $I_C = 100\text{ mA}; V_{CE} = 5\text{ V}$	h_{FE}	min.	15	
		min.	20	
		typ.	50	
		max.	100	
Transition frequency at $f = 1\text{ MHz}$ $I_C = 0,2\text{ A}; V_{CE} = 10\text{ V}$	f_T	typ.	20	MHz

Notes

1. Mounted without heatsink compound and 30 ± 5 newtons pressure on centre of envelope.
2. Mounted with heatsink compound and 30 ± 5 newtons pressure on centre of envelope.

SILICON DIFFUSED POWER TRANSISTORS

High-voltage, high-speed, glass-passivated npn power transistors in TO-126 envelopes, for use in converters, inverters, switching regulators, motor control systems and switching applications.

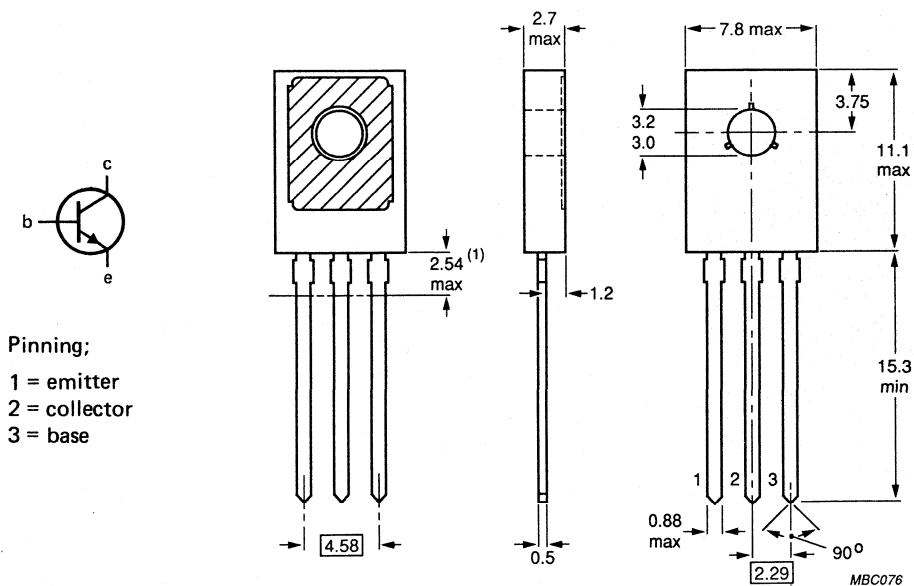
QUICK REFERENCE DATA

	BUX86	BUX87
Collector-emitter voltage (peak value; $V_B = 0$)	V_{CESM} max. 800	1000 V
Collector-emitter voltage (open base)	V_{CEO} max. 400	450 V
Collector-emitter saturation voltage	V_{CEsat} max.	1 V
Collector current (DC)	I_C max.	0,5 A
Collector current (peak value)	I_{CM} max.	1 A
Total power dissipation up to $T_{mb} = 60\text{ }^\circ\text{C}$	P_{tot} max.	20 W
Fall time	t_f typ.	0,4 μs

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-126.



Collector connected to metal part of mounting surface.

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

		BUX86	BUX87	
Collector-emitter voltage (peak value; $V_{BE} = 0$)	V_{CESM}	max. 800	1000	V
Collector-emitter voltage (open base)	V_{CEO}	max. 400	450	V
Emitter-base voltage (open collector)	V_{EBO}	max. 5	5	V
Collector current (DC)	I_C	max. 0,5		A
Collector current (peak value) $t_p = 2$ ms	I_{CM}	max. 1		A
Base current (DC)	I_B	max. 0,2		A
Base current (peak value)	I_{BM}	max. 0,3		A
Reverse base current (peak value) (note 1)	$-I_{BM}$	max. 0,3		A
Total power dissipation up to $T_{mb} = 60$ °C	P_{tot}	max. 20		W
Storage temperature range	T_{stg}	-65 to + 150		°C
Junction temperature	T_j	max. 150		°C
THERMAL RESISTANCE				
From junction to mounting base	$R_{th j-mb} =$	4,5		K/W
From junction to ambient in free air	$R_{th j-a} =$	100		K/W
CHARACTERISTICS				
$T_j = 25$ °C unless otherwise specified				
Collector-cut-off current (note 2)				
$V_{CE} = V_{CESMmax}; V_{BE} = 0$	I_{CES}	max. 100		μA
$V_{CE} = V_{CESMmax}; V_{BE} = 0; T_j = 125$ °C	I_{CES}	max. 1		mA
DC current gain				
$I_C = 50$ mA; $V_{CE} = 5$ V	h_{FE}	min. 26		
	h_{FE}	typ. 50		
	h_{FE}	max. 125		

Notes

1. Turn-off current.
2. Measured with a half-sinewave voltage (curve tracer).

Emitter cut-off current

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

I_{EBO}	max.	1	mA
-----------	------	---	----

Saturation voltage

$I_C = 0,1 \text{ A}; I_B = 10 \text{ mA}$

V_{CEsat}	max.	0,8	V
-------------	------	-----	---

$I_C = 0,2 \text{ A}; I_B = 20 \text{ mA}$

V_{CEsat}	max.	1,0	V
-------------	------	-----	---

$I_C = 0,2 \text{ A}; I_B = 20 \text{ mA}$

V_{BEsat}	max.	1,0	V
-------------	------	-----	---

Collector-emitter sustaining voltages

$I_C = 100 \text{ mA}; I_{Boff} = 0; L = 25 \text{ mH}$

		BUX86	BUX87	
$V_{CEO_{sust}}$	min.	400	450	V

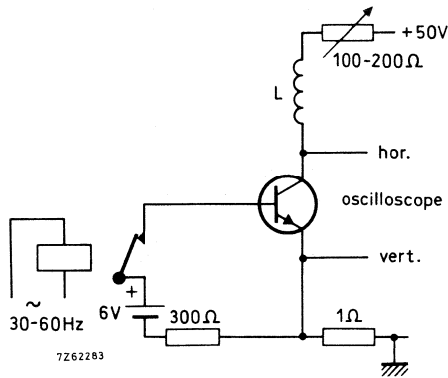


Fig. 2 Test circuit for $V_{CEO_{sust}}$.

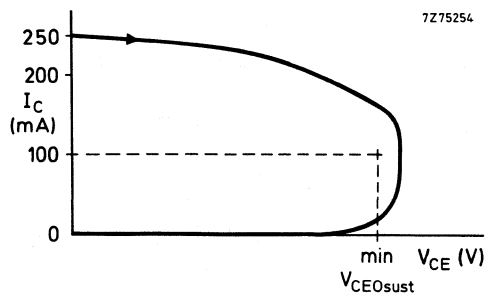


Fig. 3 Oscilloscope display for sustaining voltage.

CHARACTERISTICS (continued)

Transition frequency at $f = 1$ MHz

$I_C = 50$ mA; $V_{CE} = 10$ V

f_T typ 20 MHz

Switching times

$I_{Con} = 0,2$ A; $V_{CC} = 250$ V

$I_{Bon} = 20$ mA; $-I_{Boff} = 40$ mA

Turn-on time

t_{on} typ 0,25 μ s
max. 0,5 μ s

Turn-off: Storage time

t_s typ 2 μ s
max. 3,5 μ s

Fall time

t_f typ 0,4 μ s

Fall time, $T_{mb} = 95$ °C

t_f max. 1,3 μ s

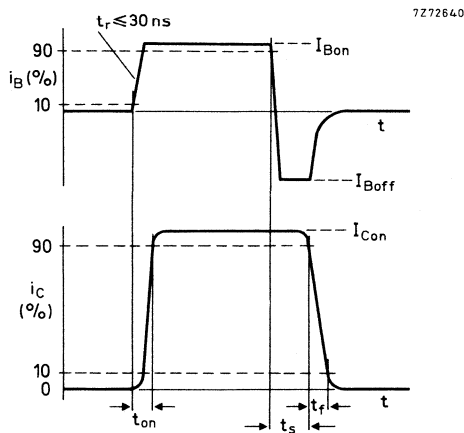
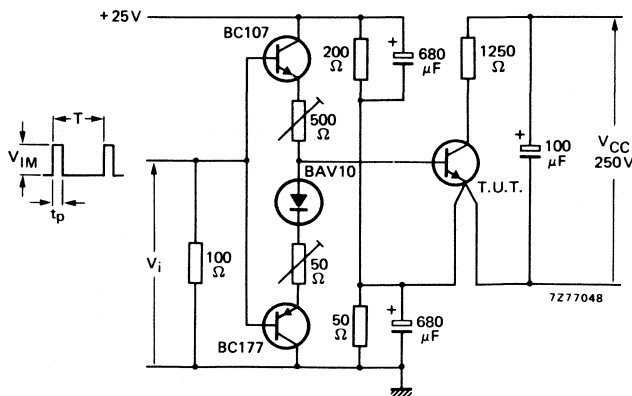
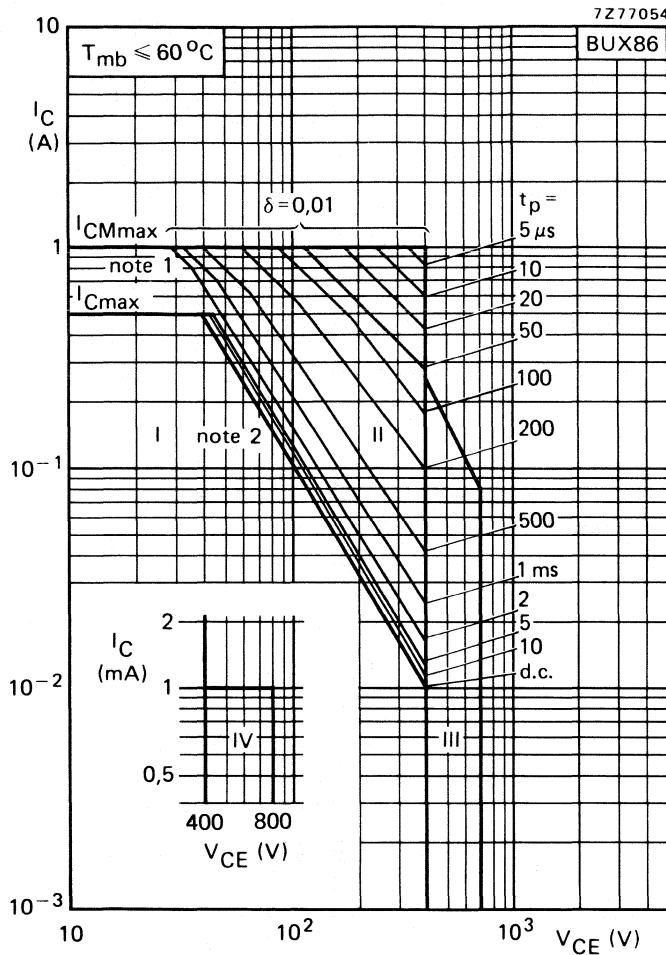


Fig. 4 Switching times waveforms with resistive load.



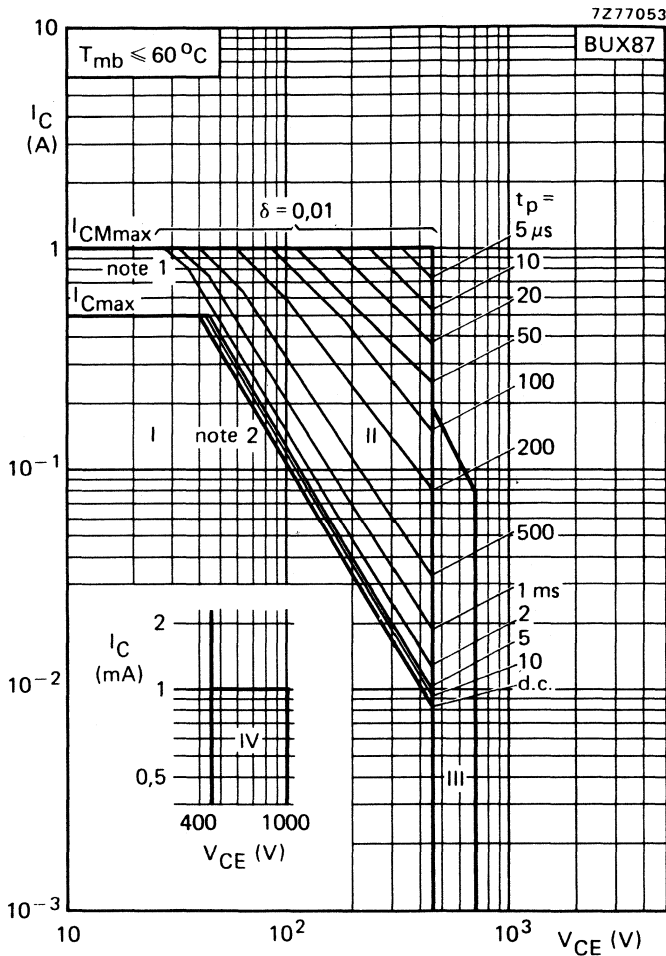
$t_p = 20$ μ s
 $T = 2$ ms
 $V_{IM} = 15$ V

Fig. 5 Test circuit resistive load.



1. Ppeak max lines.
 2. Second-breakdown limits.
- I Region of permissible DC operation
- II Permissible extension for repetitive pulse operation
- III Area of permissible operation during turn-on in single-transistor converters, provided $R_{BE} \leq 100 \Omega$ and $t_p \leq 0,6 \mu\text{s}$
- IV Repetitive pulse operation in this region is permissible, provided $V_{BE} \leq 0$ and $t_p \leq 2 \text{ ms}$

Fig. 6 Safe operating area.



1. P_{peak} max lines.
 2. Second-breakdown limits.
- I Region of permissible DC operation
- II Permissible extension for repetitive pulse operation
- III Area of permissible operation during turn-on in single-transistor converters, provided $R_{BE} \leq 100 \Omega$ and $t_p \leq 0,6 \mu s$
- IV Repetitive pulse operation in this region is permissible provided $V_{BE} \leq 0$ and $t_p \leq 2 ms$

Fig. 7 Safe operating area.

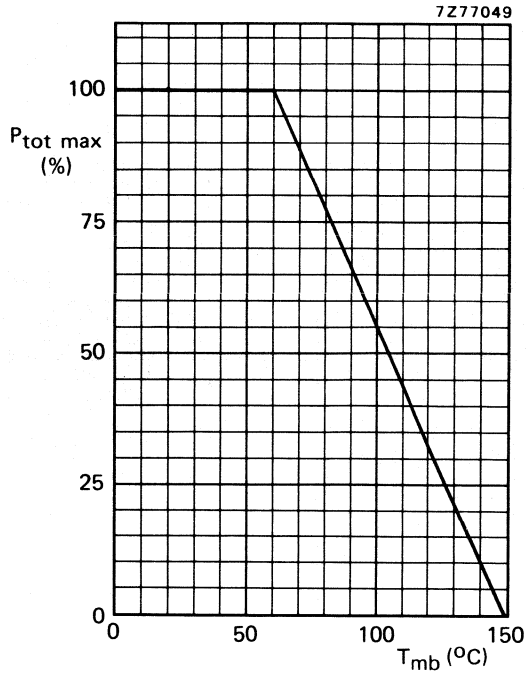


Fig. 8 Power derating curve.

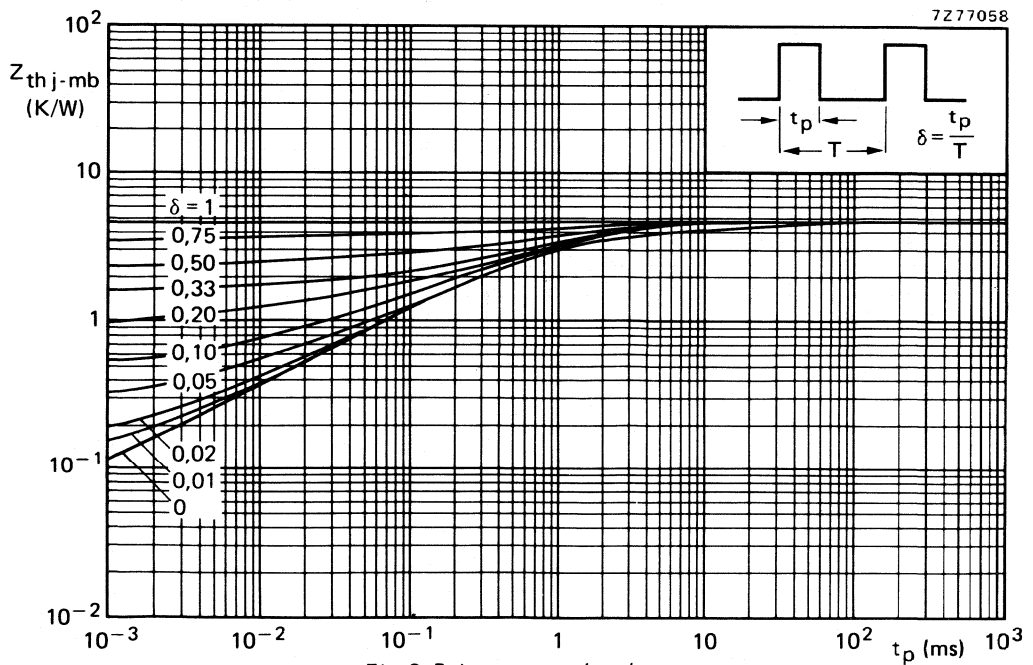


Fig. 9 Pulse power rating chart.

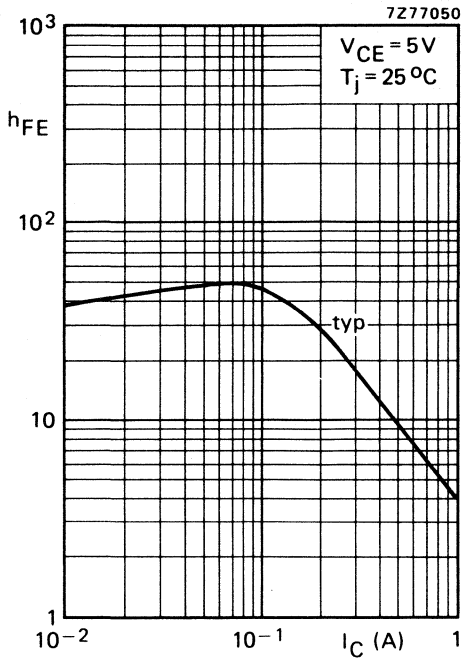


Fig. 10 Typical DC current gain.

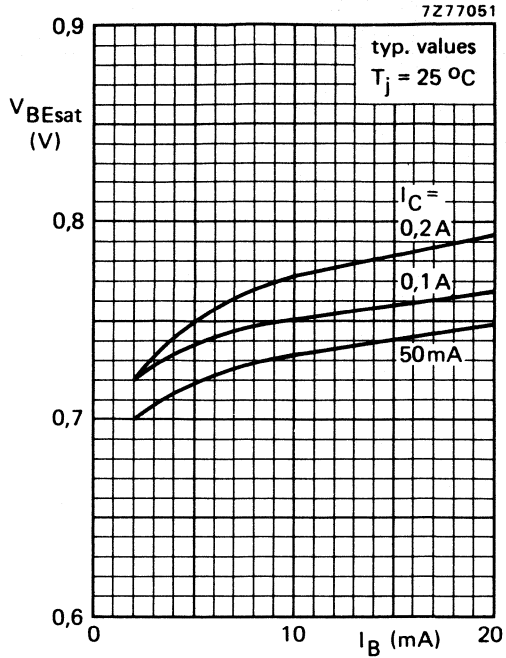


Fig. 11 Typical base-emitter voltage.

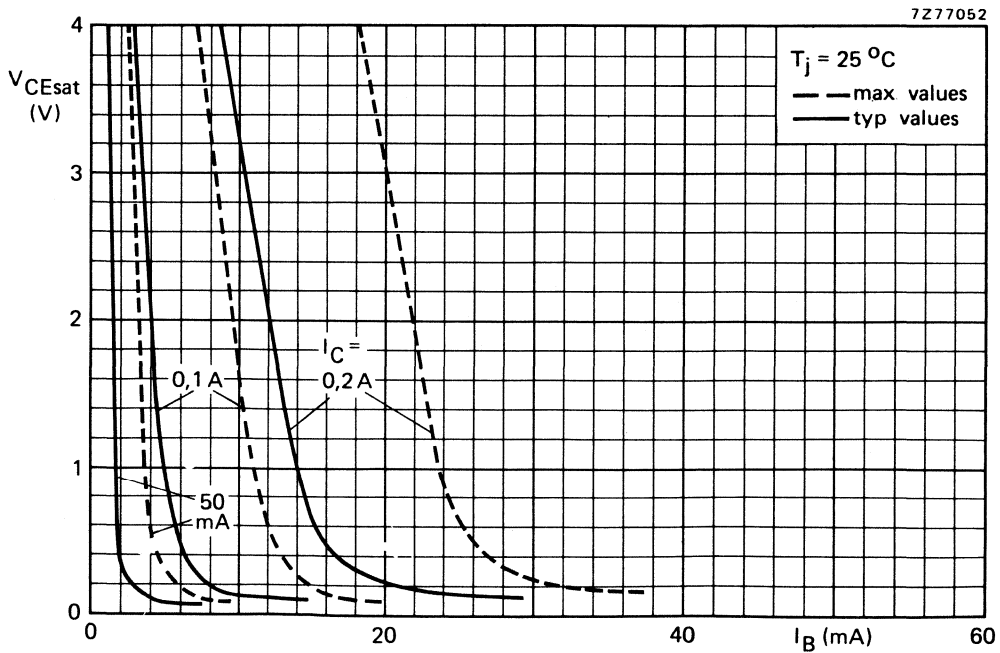


Fig. 12 Typical collector-emitter saturation voltage.

SILICON TRIPLE DIFFUSED POWER TRANSISTOR

High-voltage, high-speed, glass-passivated npn power transistor in a TO-126 envelope, intended for use in fast switching applications.

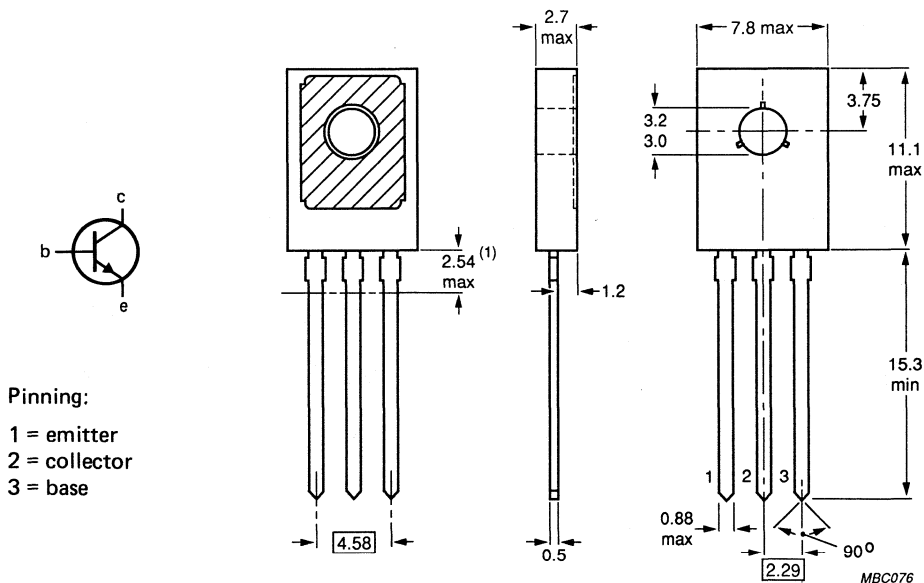
QUICK REFERENCE DATA

Collector-emitter voltage peak value; $V_{BE} = 0$	V_{CESM}	max.	730 V
Collector-emitter voltage, open base	V_{CEO}	max.	300 V
Collector-emitter saturation voltage	V_{CEsat}	max.	2 V
Collector current (DC)	I_C	max.	1,5 A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	28 W
Fall time	t_f	max.	0,8 μs

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-126.



Collector connected to metal part of mounting base.

RATINGS

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

Collector-emitter voltage peak value; $V_{BE} = 0$	V_{CESM}	max.	730 V
Collector-emitter voltage, open base	V_{CEO}	max.	300 V
Emitter-base voltage, open collector	V_{EBO}	max.	12 V
Collector current (DC)	I_C	max.	1,5 A
Collector current (peak value)	I_{CM}	max.	3 A
Base current (DC)	I_B	max.	0,75 A
Base current (peak value)	I_{BM}	max.	1,5 A
Emitter current (DC)	I_E	max.	2,25 A
Emitter current (peak value)	I_{EM}	max.	4,5 A
Total power dissipation up to $T_{mb} = 25\text{ °C}$	P_{tot}	max.	28 W
Storage temperature range	T_{stg}		-65 to +150 °C
Junction temperature	T_j	max.	150 °C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j-mb}$	=	4,5 K/W
From junction to ambient	$R_{th\ j-a}$	=	100 K/W

CHARACTERISTICS

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

Collector cut-off current $V_{CE} = 400\text{ V}; V_{BE} = 0$	I_{CES}	max.	5 μA
$V_{CE} = 730\text{ V}; V_{BE} = -1,5\text{ V}$	I_{CEX}	max.	50 μA
$V_{CE} = 730\text{ V}; V_{BE} = -1,5\text{ V}; T_j = 100\text{ °C}$		max.	250 μA
Emitter cut-off current $I_C = 0; V_{EB} = 12\text{ V}$	I_{EBO}	max.	1 mA
Collector-emitter sustaining voltage $I_B = 0; I_C = 0,1\text{ A}; L = 25\text{ mH}$	$V_{CEO_{sust}}$	min.	300 V
DC current gain $I_C = 10\text{ mA}; V_{CE} = 2\text{ V}$	h_{FE}	min.	10
$I_C = 50\text{ mA}; V_{CE} = 5\text{ V}$	h_{FE}	min.	16
	h_{FE}	typ.	25
	h_{FE}	max.	42

Transition frequency at $f = 5 \text{ MHz}$

$I_C = 0,1 \text{ A}; V_{CE} = 10 \text{ V}$

f_T typ. 4 MHz

Saturation voltages

$I_C = 0,2 \text{ A}; I_B = 20 \text{ mA}$

V_{CEsat} max. 2 V

V_{BEsat} max. 1 V

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

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

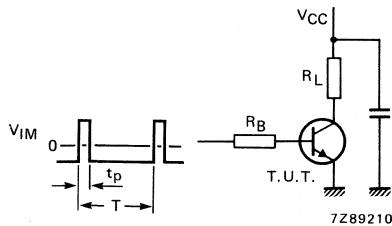
C_c typ. 12 pF

Switching times (resistive load)

$I_{Con} = 0,2 \text{ A}; I_{Bon} = 20 \text{ mA}; I_{Boff} = 40 \text{ mA}$

t_s max. 2 μs

t_f max. 0,8 μs



$V_{CC} = 250 \text{ V}$

$V_{IM} = -6 \text{ to } +8 \text{ V}$

The values of R_B and R_L are selected in accordance with the I_{Con} and I_B requirements.

Fig. 2 Test circuit resistive load.

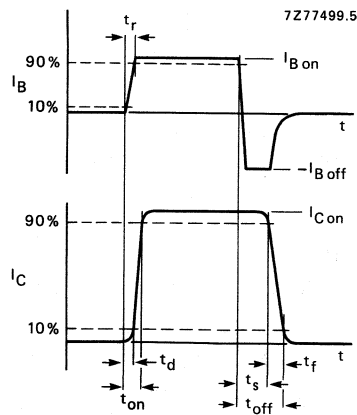
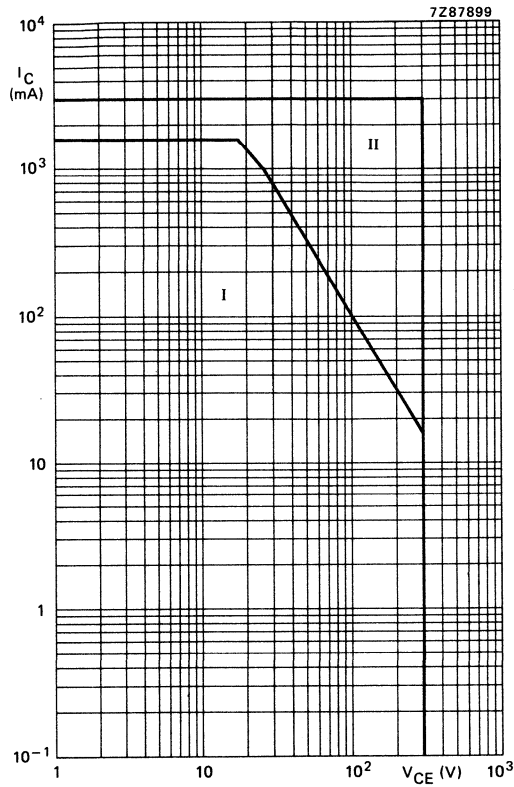


Fig. 3 Switching times waveforms with resistive load.



I Region of permissible DC operation
 II Permissible extension for repetitive pulse operation.
 Fig. 4 Safe operating area.

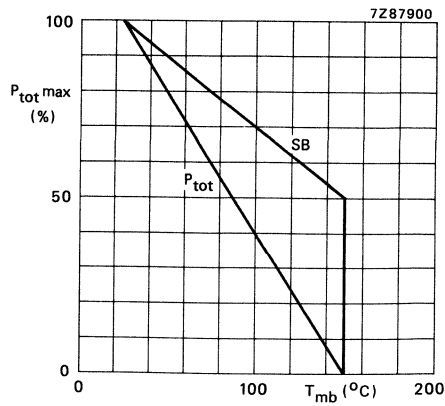


Fig. 5 Total power dissipation and second-breakdown current derating curve.

SILICON DARLINGTON POWER TRANSISTORS

NPN high-current switching Darlington transistor in ISOTOP package, intended for use in motor drives, converters, switch mode power supplies (SMPS) and uninterruptable power supplies (UPS).

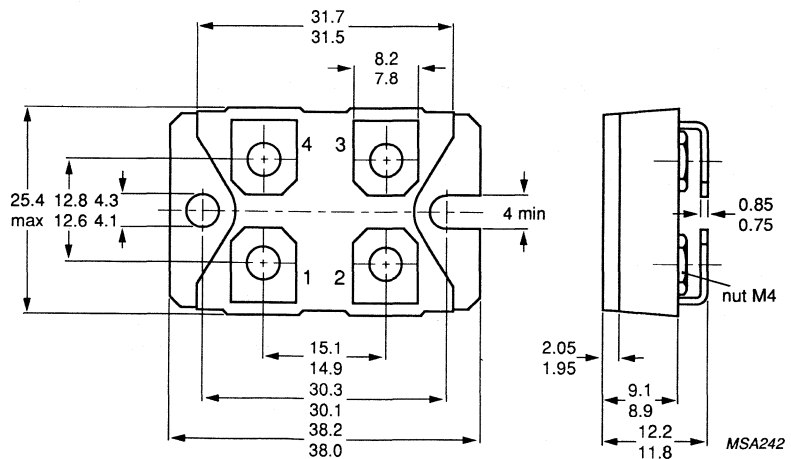
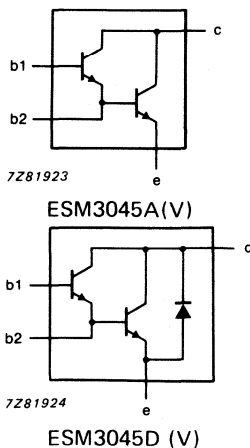
QUICK REFERENCE DATA

			ESM3045A(V)	3045D(V)
Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM}	max.	1000	600 V
	V_{CEO}	max.	450	450 V
Collector-emitter saturation voltage	V_{CEsat}	max.	2.0	V
Collector current saturation DC peak value	I_{Csat}	max.	15	A
	I_C	max.	24	A
	I_{CM}	max.	36	A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	125	W
Fall time inductive load	t_f	max.	0.5	0.4 μs

MECHANICAL DATA

Dimensions in mm

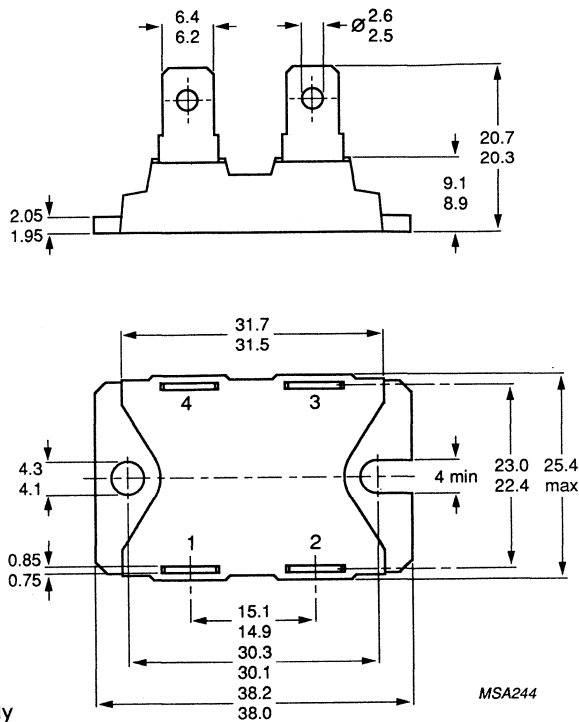
Fig. 1 SOT227B.



Pinning

- 1 = emitter
- 2 = base 1
- 3 = collector
- 4 = base 2

Baseplate is electrically isolated from all terminals.



Pinning

- 1 = emitter
- 2 = base 1
- 3 = collector
- 4 = base 2

Baseplate is electrically isolated from all terminals

Fig. 2 SOT227A, with Faston terminals.

RATINGS

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

		ESM3045A(V)		3045D(V)	
Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM}	max.	1000	600	V
	V_{CEO}	max.	450		V
Collector current	saturation	I_{Csat}	max.	15	A
	DC	I_C	max.	24	A
	peak value	I_{CM}	max.	36	A
Base current	DC	I_B	max.	2.5	A
	peak value	I_{BM}	max.	5.0	A
Total power dissipation up to $T_{mb} = 25^\circ\text{C}$	P_{tot}	max.	125		W
Junction temperature	T_j	max.	150		$^\circ\text{C}$
Storage temperature range	T_{stg}		-40 to + 150		$^\circ\text{C}$

THERMAL RESISTANCE

		ESM3045A(V)	3045D(V)
From junction to mounting base transistor	R_{thj-mb} =	1.0	K/W
From junction to mounting base diode	R_{thj-mb} =	—	2.0 K/W

ISOLATION

Isolation voltage from all terminals to external heatsink (RMS value)	V_{isol} max.	2500	V
Isolation capacitance from collector to external heatsink	C_{isol} typ.	45	pF

CHARACTERISTICS

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

Collector cut-off current

$V_{CE} = V_{CESMmax}; V_{BE} = 0$ I_{CES} max. 1.0 mA

$V_{CE} = V_{CESMmax}; V_{BE} = 0;$
 $T_j = 100\text{ }^\circ\text{C}$ I_{CES} max. 1.5 4.0 mA

Emitter cut-off current

$V_{EB} = 5\text{ V}; I_C = 0$ I_{EBO} max. 1.0 mA

Saturation voltages

$I_C = I_{Csat}; I_B = I_{Csat}/50; T_j = 125\text{ }^\circ\text{C}$ V_{CEsat} max. 2.0 V

V_{BEsat} max. 2.5 V

Collector-emitter sustaining voltage

$I_C = 200\text{ mA}; I_B = 0; L = 25\text{ mH}$ $V_{CEO sust}$ min. 450 V

Diode forward voltage drop

$I_F = 20\text{ A}; T_j = 100\text{ }^\circ\text{C}$ V_F max. — 2.0 V

Switching times, inductive load

$I_C = I_{Csat}; I_{B on} = I_{Csat}/50;$
 $V_{BE off} = -5\text{ V}; T_j = 100\text{ }^\circ\text{C};$
 $R_{BB} = 0.6\text{ }\Omega; V_{CL} = 450\text{ V}$
with anti-saturation network
and speed-up diode

t_s max. 4.0 4.0 μs

t_f max. 0.4 0.4 μs

SILICON DARLINGTON POWER TRANSISTORS

NPN high-current switching Darlington transistor in ISOTOP package, intended for use in motor drives, converters, switch mode power supplies (SMPS) and uninterruptable power supplies (UPS).

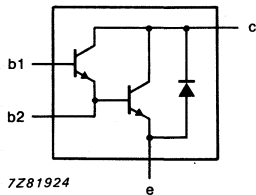
QUICK REFERENCE DATA

			ESM4045A(V)	4045D(V)
Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM}	max.	1000	600 V
	V_{CEO}	max.	450	450 V
Collector-emitter saturation voltage	V_{CEsat}	max.	2.0	V
Collector current	saturation	I_{Csat}	25	A
	DC	I_C	42	A
	peak value	I_{CM}	63	A
Total power dissipation up to $T_{mb} = 25^\circ\text{C}$	P_{tot}	max.	150	W
Fall time inductive load	t_f	max.	0.5	μs

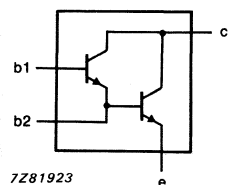
MECHANICAL DATA

Fig. 1 SOT227B.

Dimensions in mm



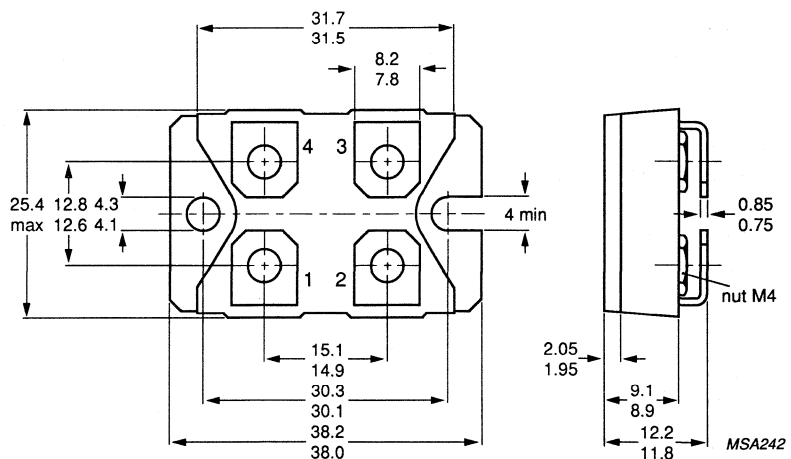
ESM4045D(V)



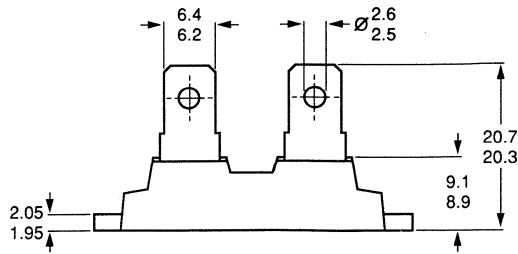
ESM4045A(V)

Pinning

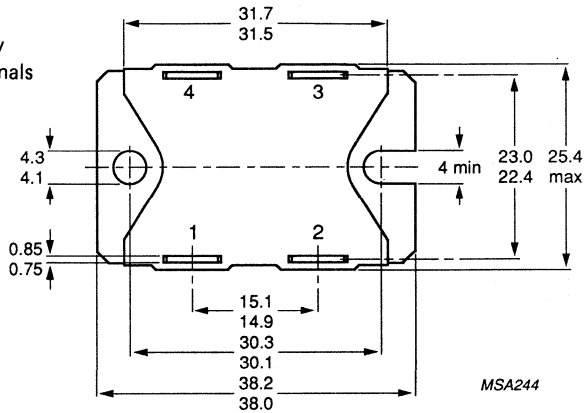
- 1 = emitter
- 2 = base 1
- 3 = collector
- 4 = base 2



Baseplate is electrically isolated from all terminals



Baseplate is electrically isolated from all terminals



Pinning

- 1 = emitter
- 2 = base 1
- 3 = collector
- 4 = base 2

Fig. 2 SOT227A, with Faston terminals.

RATINGS

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

			ESM4045A(V)	4045D(V)
Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM}	max.	1000	600 V
	V_{CEO}	max.	450	V
Collector current	I_{Csat}	max.	25	A
	I_C	max.	42	A
	I_{CM}	max.	63	A
Base current	I_B	max.	4.0	A
	I_{BM}	max.	8.0	A
Total power dissipation up to $T_{mb} = 25^\circ C$	P_{tot}	max.	150	W
Junction temperature	T_j	max.	150	$^\circ C$
Storage temperature range	T_{stg}		-40 to + 150	$^\circ C$

THERMAL RESISTANCE

		ESM4045A(V)	4045D(V)
From junction to mounting base transistor	$R_{th\ j-mb} =$	0.83	K/W
From junction to mounting base diode	$R_{th\ j-mb} =$	—	1.5

ISOLATION

Isolation voltage from all terminals to external heatsink (RMS value)	V_{isol} max.	2500	V
Isolation capacitance from collector to external heatsink	C_{isol} typ.	45	pF

CHARACTERISTICS

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

Collector cut-off current

$$V_{CE} = V_{CESMmax}; V_{BE} = 0$$

$$V_{CE} = V_{CESMmax}; V_{BE} = 0$$

$$T_j = 100\text{ }^\circ\text{C}$$

$$I_{CES} \text{ max. } 1.0 \text{ mA}$$

$$I_{CES} \text{ max. } 2.0 \text{ mA} \quad | \quad 7.0 \text{ mA}$$

Emitter cut-off current

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

$$I_{EBO} \text{ max. } 1.0 \text{ mA}$$

Saturation voltages

$$I_C = I_{Csat}; I_B = I_{Csat}/50; T_j = 125\text{ }^\circ\text{C}$$

$$V_{CEsat} \text{ max. } 2.0 \text{ V}$$

$$V_{BEsat} \text{ max. } 2.5 \text{ V}$$

Collector-emitter sustaining voltage

$$I_C = 200\text{ mA}; I_B = 0; L = 25\text{ mH}$$

$$V_{CEO\text{sust}} \text{ min. } 450 \text{ V}$$

Diode forward voltage drop

$$I_F = 35\text{ A}; T_j = 100\text{ }^\circ\text{C}$$

$$V_F \text{ max. } \text{—} \quad | \quad 1.85 \text{ V}$$

Switching times, inductive load

$$I_C = I_{Csat}; I_{B\text{ on}} = I_{Csat}/50;$$

$$V_{BE\text{ off}} = -5\text{ V}; R_{BB} = 0.6\ \Omega;$$

$$T_j = 100\text{ }^\circ\text{C}; V_{CL} = 450\text{ V}$$

with anti-saturation network

and speed-up diode

$$t_s \text{ max. } 4.5 \quad | \quad 4.5\ \mu\text{s}$$

$$t_f \text{ max. } 0.6 \quad | \quad 0.5\ \mu\text{s}$$

SILICON DARLINGTON POWER TRANSISTORS

NPN high-current switching Darlington transistor in ISOTOP package, intended for use in motor drives, converters, switch mode power supplies (SMPS) and uninterruptable power supplies (UPS).

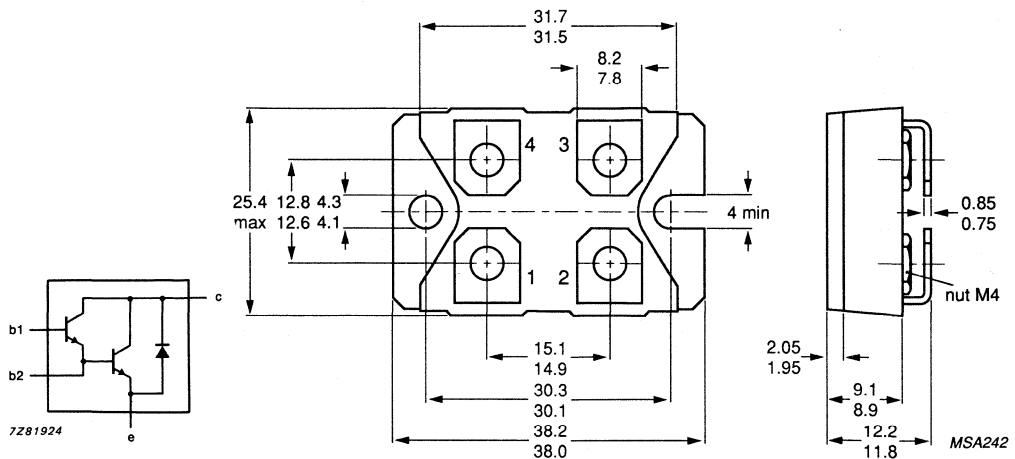
QUICK REFERENCE DATA

Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM}	max.	600 V
	V_{CEO}	max.	450 V
Collector-emitter saturation voltage	V_{CEsat}	max.	2.0 V
Collector current saturation	I_{Csat}	max.	35 A
DC	I_C	max.	60 A
peak value	I_{CM}	max.	90 A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	175 W
Fall time inductive load	t_f	max.	0.5 μs

MECHANICAL DATA

Dimensions in mm

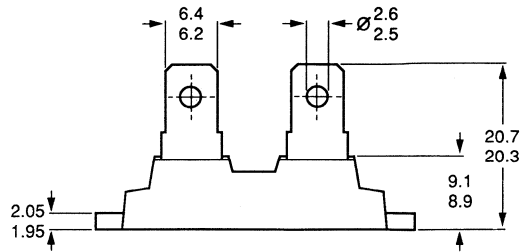
Fig. 1 SOT227B.



Pinning

- 1 = emitter
- 2 = base 1
- 3 = collector
- 4 = base 2

Baseplate is electrically isolated from all terminals

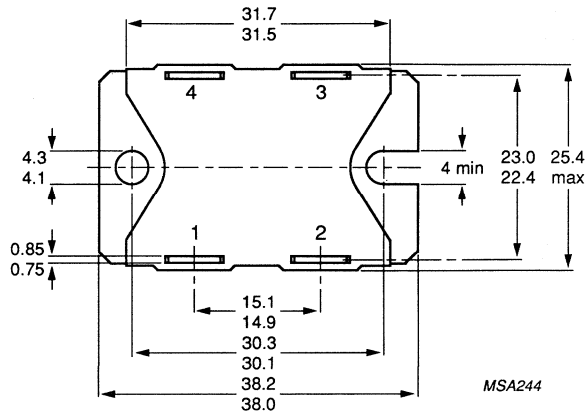


Baseplate is electrically isolated from all terminals

Pinning

- 1 = emitter
- 2 = base 1
- 3 = collector
- 4 = base 2

Fig. 2 SOT227A, with Faston terminals.



RATINGS

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

Collector-emitter voltage

$V_{BE} = 0$; peak value	V_{CESM}	max.	600 V
open base	V_{CEO}	max.	450 V

Collector current

saturation	I_{Csat}		35 A
DC	I_C	max.	60 A
peak value	I_{CM}	max.	90 A

Base current

DC	I_B	max.	6.0 A
peak value	I_{BM}	max.	12 A

Total power dissipation
up to $T_{mb} = 25\text{ }^\circ\text{C}$

P_{tot}	max.	175 W
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Junction temperature

T_j	max.	150 $^\circ\text{C}$
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Storage temperature range

T_{stg}		-40 to +150 $^\circ\text{C}$
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THERMAL RESISTANCE

From junction to mounting base
transistor

$R_{th\ j-mb}$	=	0.71 K/W
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From junction to mounting base
diode

$R_{th\ j-mb}$	=	1.2 K/W
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ISOLATION

Isolation voltage from all terminals to external heatsink (RMS value)	V_{isol}	max.	2500 V
Isolation capacitance from collector to external heatsink	C_{isol}	typ.	45 pF

CHARACTERISTICS

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

Collector cut-off current

$$V_{CE} = V_{CESMmax}; V_{BE} = 0$$

$$V_{CE} = V_{CESMmax}; V_{BE} = 0; T_j = 100\text{ }^\circ\text{C}$$

I_{CES}	max.	1.0 mA
I_{CES}	max.	13 mA

Emitter cut-off current

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

I_{EBO}	max.	1.0 mA
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Saturation voltages

$$I_C = I_{Csat}; I_B = I_{Csat}/50; T_j = 125\text{ }^\circ\text{C}$$

V_{CEsat}	max.	2.0 V
V_{BEsat}	max.	2.5 V

Collector-emitter sustaining voltage

$$I_C = 200\text{ mA}; I_B = 0; L = 25\text{ mH}$$

$V_{CEOsust}$	min.	450 V
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Diode forward voltage drop

$$I_F = 50\text{ A}$$

V_F	max.	1.8 V
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Switching times, inductive load

$$I_C = I_{Csat}; I_{B\text{ on}} = I_{Csat}/50;$$

$$V_{BE\text{ off}} = -5\text{ V}; T_j = 100\text{ }^\circ\text{C};$$

$$R_{BB} = 0.6\text{ }\Omega; V_{CL} = 450\text{ V}$$

with anti-saturation network

and speed-up diode

t_s	max.	5.0 μs
t_f	max.	0.5 μs

SILICON DARLINGTON POWER TRANSISTORS

NPN high-current switching Darlington transistor in ISOTOP package, intended for use in motor drives, converters, switch mode power supplies (SMPS) and uninterruptable power supplies (UPS).

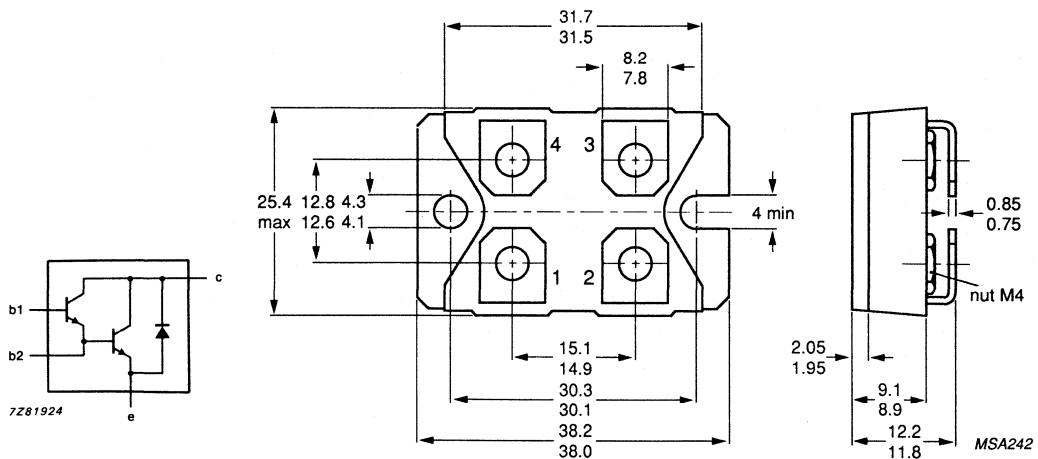
QUICK REFERENCE DATA

Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM}	max.	600	V
	V_{CEO}	max.	450	V
Collector-emitter saturation voltage	V_{CEsat}	max.	2.0	V
Collector current saturation	I_{Csat}	max.	50	A
DC	I_C	max.	84	A
peak value	I_{CM}	max.	126	A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max	250	W
Fall time inductive load	t_f	max.	0.5	μs

MECHANICAL DATA

Dimensions in mm

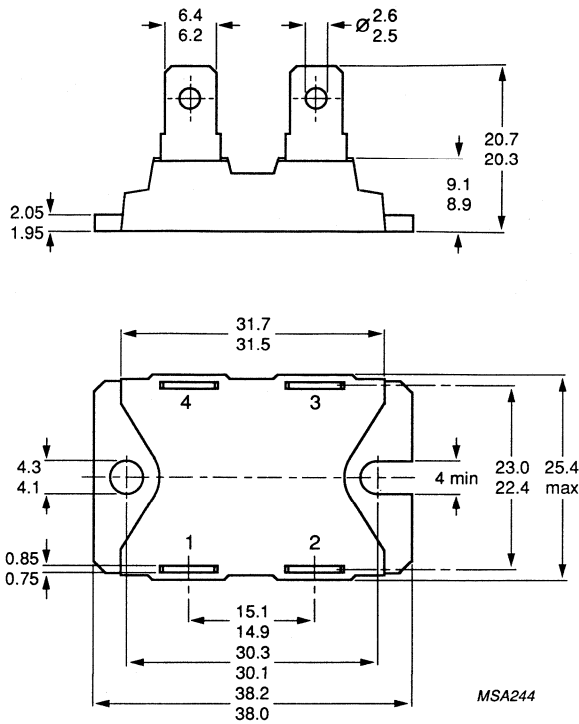
Fig. 1 SOT227B.



Pinning

- 1 = emitter
- 2 = base 1
- 3 = collector
- 4 = base 2

Baseplate is electrically isolated from all terminals



Baseplate is electrically isolated from all terminals

Pinning

- 1 = emitter
- 2 = base 1
- 3 = collector
- 4 = base 2

Fig. 2 SOT227A, with Faston terminals.

RATINGS

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

Collector-emitter voltage				
peak value; $V_{BE} = 0$	V_{CESM}	max.	600	V
open base	V_{CEO}	max.	450	V
Collector current				
saturation	I_{Csat}	max.	50	A
DC	I_C	max.	84	A
peak value	I_{CM}	max.	126	A
Base current				
DC	I_B	max.	8.0	A
peak value	I_{BM}	max.	16	A
Total power dissipation				
up to $T_{mb} = 25^\circ C$	P_{tot}	max.	250	W
Junction temperature	T_j	max.	150	$^\circ C$
Storage temperature range	T_{stg}		-40 to +50	$^\circ C$

THERMAL RESISTANCE

From junction to mounting base transistor	$R_{th\ j-mb}$	=	0.5	K/W
From junction to mounting base diode	$R_{th\ j-mb}$	=	1.2	K/W

ISOLATION

Isolation voltage from all terminals to external heatsink (rms value)	V_{iso}	max.	2500	V
Isolation capacitance from collector to external heatsink	C_{isol}	typ.	45	pF

CHARACTERISTICS

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

Collector cut-off current

$V_{CE} = V_{CESMmax}; V_{BE} = 0$	I_{CES}	max.	1.0	mA
$V_{CE} = V_{CESMmax}; V_{BE} = 0$ $T_j = 100\text{ }^\circ\text{C}$	I_{CES}	max.	15	mA

Emitter cut-off current

$V_{EB} = 5\text{ V}; I_C = 0$	I_{EBO}	max.	1.0	mA
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Saturation voltages

$I_C = I_{Csat}; I_B = I_{Csat}/50; T_j = 125\text{ }^\circ\text{C}$	V_{CEsat}	max.	2.0	V
	V_{BEsat}	max.	2.5	V

Collector-emitter sustaining voltage

$I_C = 200\text{ mA}; I_B = 0; L = 25\text{ mH}$	$V_{CEO\text{sust}}$	min.	450	V
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Diode forward voltage drop

$I_F = 70\text{ A}; T_j = 100\text{ }^\circ\text{C}$	V_F	max.	1.9	V
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Switching times, inductive load

$I_C = I_{Csat}; I_{Bon} = I_{Csat}/50;$ $V_{BE\text{ off}} = -5\text{ V}; T_j = 100\text{ }^\circ\text{C};$ $R_{BB} = 0.6\ \Omega; V_{CL} = 450\text{ V}$ with anti-saturation network and speed-up diode	t_s	max.	5.5	μs
	t_f	max.	0.5	μs

SILICON DIFFUSED POWER TRANSISTORS

Medium-voltage, high-speed, glass-passivated NPN power transistors in TO-220 envelope for amplifier and switching applications.

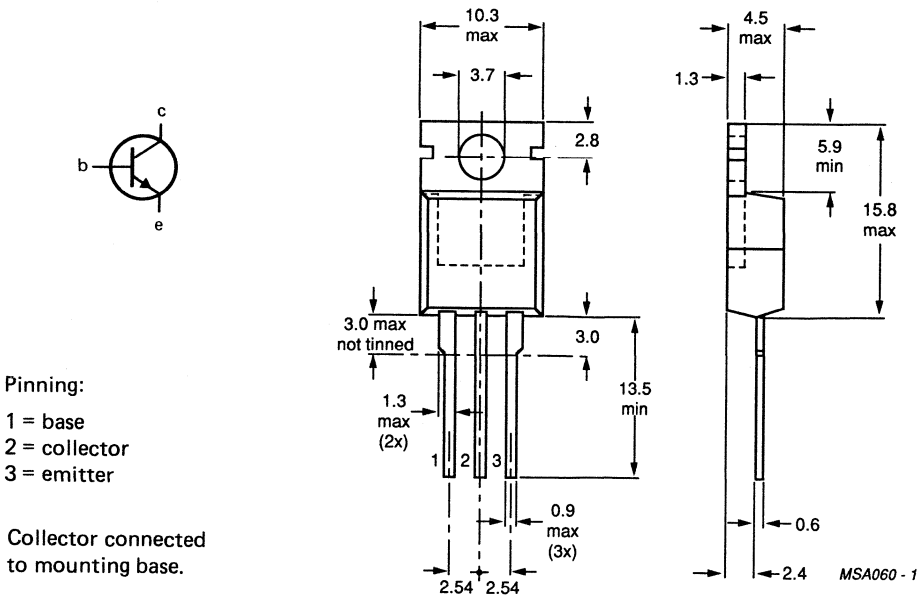
QUICK REFERENCE DATA

			TIP47	48	49	50	
Collector-base voltage (open emitter)	V_{CB0}	max.	350	400	450	500	V
Collector-emitter voltage (open base)	V_{CE0}	max.	250	300	350	400	V
Collector-emitter saturation voltage	V_{CEsat}	max.			1		V
Collector current (DC)	I_C	max.			1		A
Collector current (peak value)	I_{CM}	max.			2		A
Total power dissipation up to $T_{mb} = 25^\circ\text{C}$	P_{tot}	max.			40		W
Turn-off time	t_{off}	typ.			2		μs

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-220AB.



RATINGS

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

			TIP47	48	49	50	
Collector-base voltage (open emitter)	V_{CBO}	max.	350	400	450	500	V
Collector-emitter voltage (open base)	V_{CEO}	max.	250	300	350	400	V
Emitter-base voltage (open collector)	V_{EBO}	max.			5		V
Collector current (DC)	I_C	max.			1		A
Collector-current (peak value); $t_p = 1$ ms	I_{CM}	max.			2		A
Base current (DC)	I_B	max.			0,6		A
Total power dissipation up to $T_{mb} = 25$ °C	P_{tot}	max.			40		W
Total power dissipation in free air	P_{tot}	max.			2		W
Storage temperature range	T_{stg}		-65 to + 150				°C
Junction temperature	T_j				150		°C

THERMAL RESISTANCE

From junction to mounting base	R_{thj-mb}	=			3,12		K/W
From junction to ambient in free air	R_{thj-a}	=			62,5		K/W

CHARACTERISTICS

$T_j = 25$ °C unless otherwise specified

Collector cut-off current							
$V_{CE} = V_{CESmax}; V_{BE} = 0$	I_{CES}	max.			1		mA
$V_{CE} = 150$ V; $I_B = 0$	TIP47	I_{CEO}	max.		1		mA
$V_{CE} = 200$ V; $I_B = 0$	TIP48	I_{CEO}	max.		1		mA
$V_{CE} = 250$ V; $I_B = 0$	TIP49	I_{CEO}	max.		1		mA
$V_{CE} = 300$ V; $I_B = 0$	TIP50	I_{CEO}	max.		1		mA
Emitter cut-off current							
$V_{EB} = 5$ V; $I_C = 0$	I_{EBO}	max.			1		mA
DC current gain							
$V_{CE} = 10$ V; $I_C = 0,3$ A	h_{FE}				30 – 150		
$V_{CE} = 10$ V; $I_C = 1$ A	h_{FE}	min.			10		
Collector-emitter saturation voltage							
$I_C = 1$ A; $I_B = 0,2$ A	V_{CEsat}	max.			1,0		V
Base-emitter voltage							
$V_{CE} = 10$ V; $I_C = 1$ A	V_{BE}	max.			1,5		V
Transition frequency							
$V_{CE} = 10$ V; $I_C = 0,2$ A; $f = 2$ MHz	f_T	min.			5		MHz
Small-signal current gain							
$V_{CE} = 10$ V; $I_C = 0,2$ A; $f = 1$ kHz	h_{fe}	min.			25		

Turn-off breakdown energy

$L = 100 \text{ mH}; I_C = 0,63 \text{ A}$

$E(\text{BR})$	max.	20	mJ
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Collector-emitter sustaining voltage

$I_C = 30 \text{ mA}; I_B = 0;$

$L = 25 \text{ mH}$

TIP47	$V_{CEOsust}$	max.	250	V
TIP48	$V_{CEOsust}$	max.	300	V
TIP49	$V_{CEOsust}$	max.	350	V
TIP50	$V_{CEOsust}$	max.	400	V

Switching times

$I_C = 1 \text{ A}; I_{B\text{ on}} = -I_{B\text{ off}} = 100 \text{ mA};$

$V_{CC} = 200 \text{ V}$

turn-on time

t_{on}	typ.	0,2	μs
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turn-off time

t_{off}	typ.	2,0	μs
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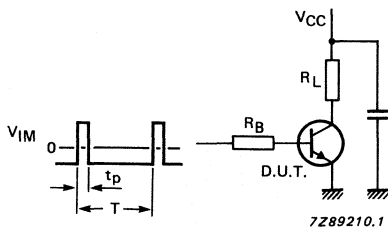


Fig. 2 Switching times test circuit with resistive load;

$V_{IM} = -5 \text{ to } +8 \text{ V}; V_{CC} = 200 \text{ V};$

$t_p = 20 \mu\text{s}; \delta = t_p/T = 1\%.$

The values of R_B and R_L are selected in accordance with $I_{C\text{ on}}$ and I_B requirements.

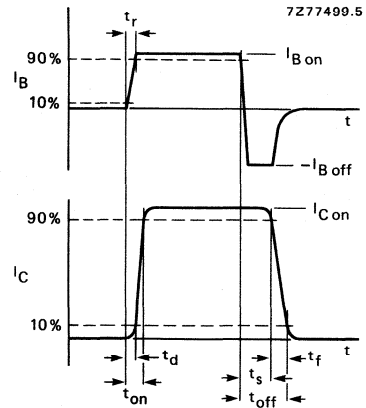
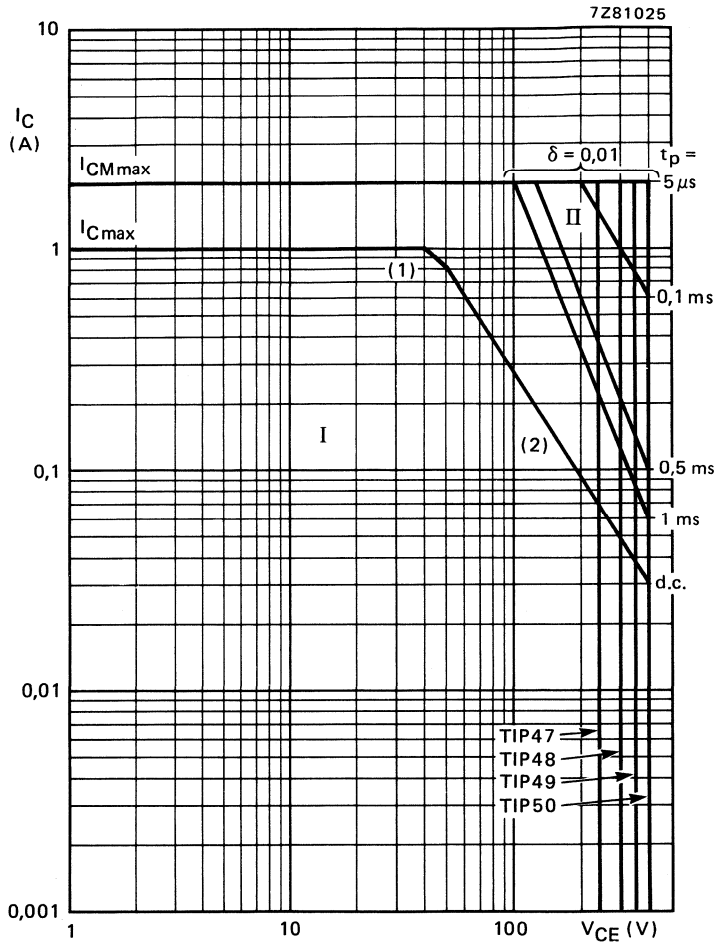


Fig. 3 Switching times waveforms.



- I Region of permissible DC operation.
- II Permissible extension for repetitive pulse operation.
- (1) $P_{tot max}$ and $P_{tot peak max}$ lines.
- (2) Second-breakdown limits.

Fig. 4 Safe operating area at $T_{mb} \leq 25 \text{ }^\circ\text{C}$.

ACCESSORIES

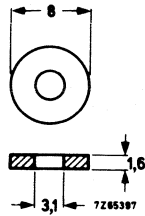
High-voltage and Switching NPN Power Transistors

Accessories

SURVEY OF ACCESSORIES

TYPE NUMBER	DESCRIPTION	ENVELOPE
56326	metal washer	TO-126
56353	spring clip	TO-126, SOT82
56354	mica washer	TO-126, SOT82
56359b	mica washer (up to 1000 V)	TO-220
56359c	insulating bush (up to 800 V)	TO-220
56359d	rectangular insulating bush (up to 1000 V)	TO-220
56360a	rectangular washer	TO-220
56363	spring clip (direct mounting)	TO-220, SOT186
56364	spring clip (insulated mounting)	TO-220
56367	alumina insulator (up to 2000 V)	TO-220
56368b	insulating bush (up to 800 V)	SOT93
56368c	mica insulator (up to 800 V)	SOT93
56369	mica insulator (up to 2000 V)	TO-220
56378	mica insulator (up to 1500 V)	SOT93
56379	spring clip	SOT93, SOT199
56387a	mica insulator (up to 300 V)	TO-126
56387b	insulating bush (up to 300 V)	TO-126

ACCESSORIES FOR TO-126 ENVELOPES

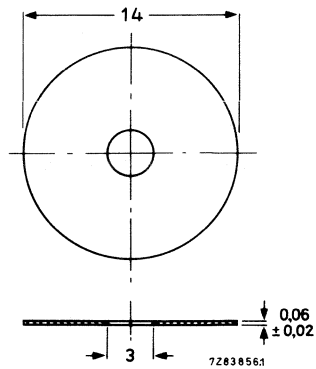


Dimensions in mm.

Material: brass, nickel plated.

Part no. 56326, for direct mounting of TO-126 envelopes.

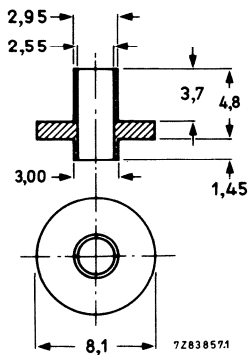
Fig.1 Metal washer.



Dimensions in mm.

Part no. 56387a, for insulated screw mounting of TO-126 envelopes up to 300 V.

Fig.2 Mica insulator.



Dimensions in mm.

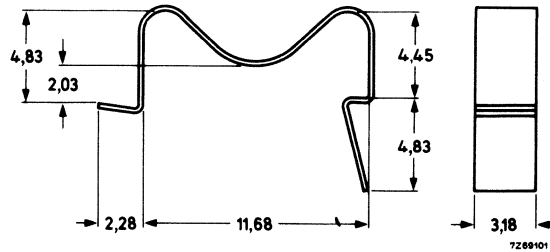
Material: polyester.

Maximum permissible temperature (T_{max}) = 150 °C.

Part no. 56387b, for insulated screw mounting of TO-126 envelopes up to 300 V.

Fig.3 Insulating bush.

ACCESSORIES FOR TO-126 AND SOT82 ENVELOPES



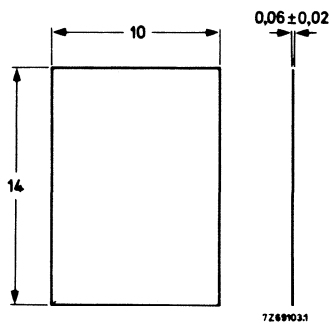
Dimensions in mm.

Material: high carbon spring steel.

Suitable for heatsink of 1.5 to 2 mm.

Part no. 56353, for TO-126 and SOT82 envelopes.

Fig.4 Spring clip.

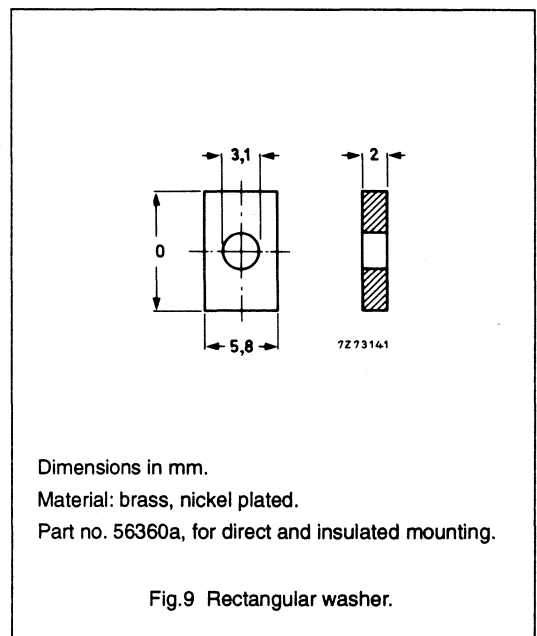
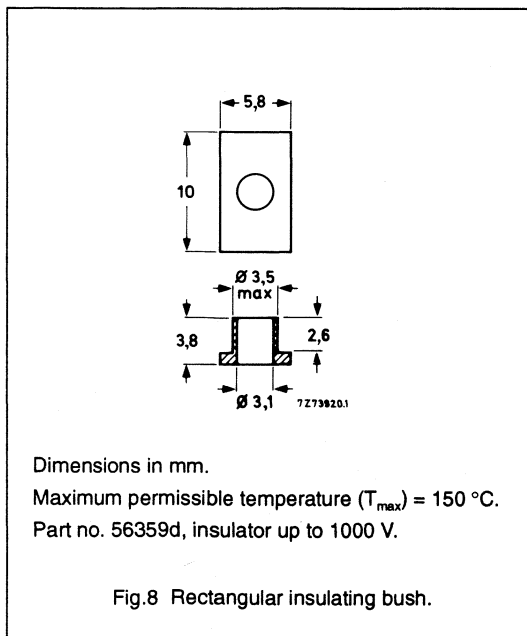
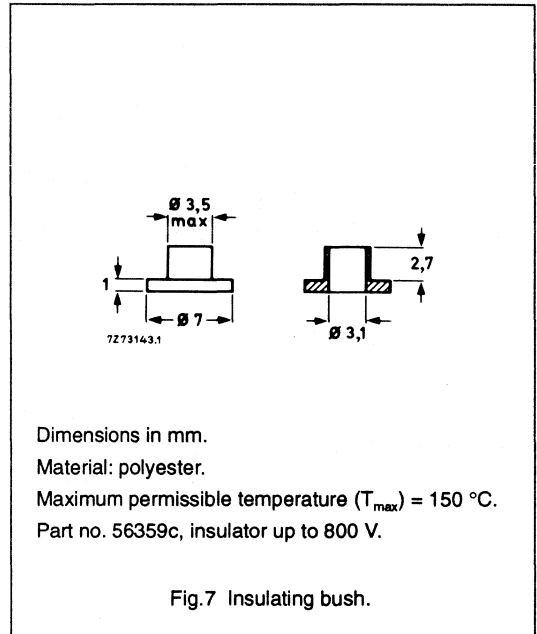
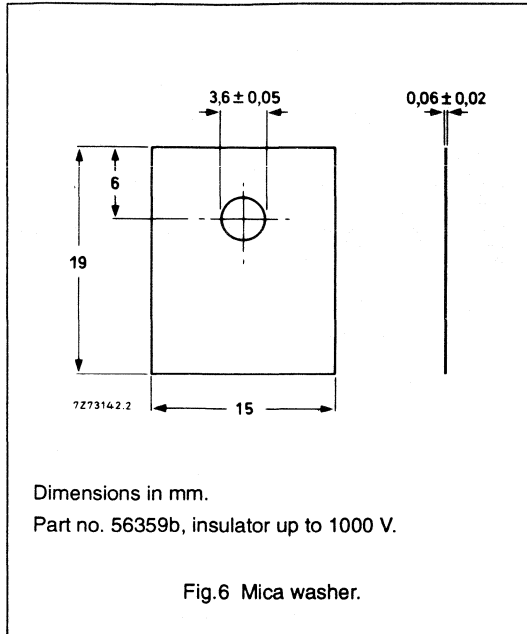


Dimensions in mm.

Part no. 56354, for TO-126 and SOT82 envelopes.

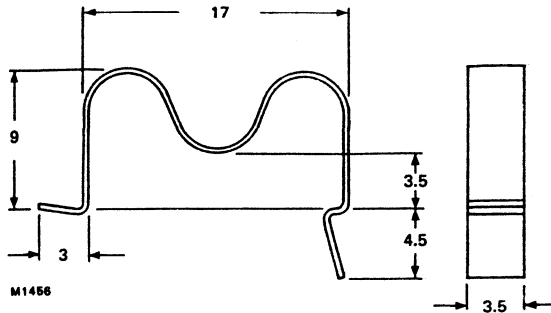
Fig.5 Mica washer.

ACCESSORIES FOR TO-220 ENVELOPES



High-voltage and Switching NPN
Power Transistors

Accessories



Dimensions in mm.

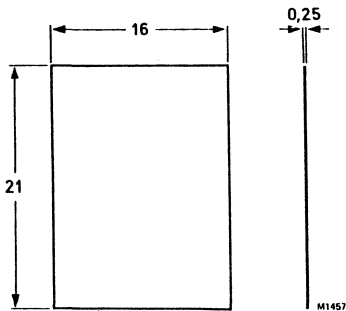
Material: stainless steel; for mounting on heatsink of 1 to 1.5 mm.

Recommended force of clip on device is 20 N (2 kgf).

To be used in conjunction with insulators 56367 and 56369.

Part no. 56364, for insulated mounting.

Fig.10 Spring clip.



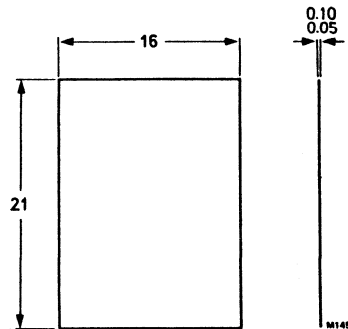
Dimensions in mm.

Material: 96-alumina.

Part no. 56367, for insulated mounting up to 2000 V.

Because alumina is brittle, extreme care must be taken not to crack the alumina when mounting devices, particularly when used without heatsink compound.

Fig.11 Alumina insulator.

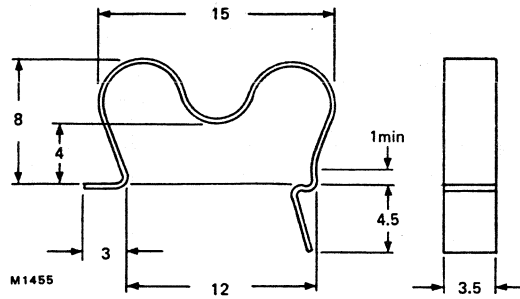


Dimensions in mm.

Part no. 56369, for insulated clip mounting up to 2000 V.

Fig.12 Mica insulator.

ACCESSORIES FOR TO-220 AND SOT186 ENVELOPES



Dimensions in mm.

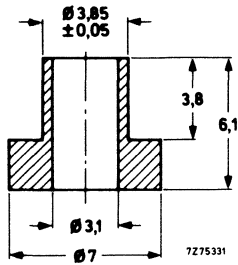
Material: stainless steel, for mounting on heatsink of 1 to 2 mm.

Recommended force of clip on device is 20 N (2 kgf).

Part no. 56363, for direct mounting.

Fig.13 Spring clip.

ACCESSORIES FOR SOT93 ENVELOPES



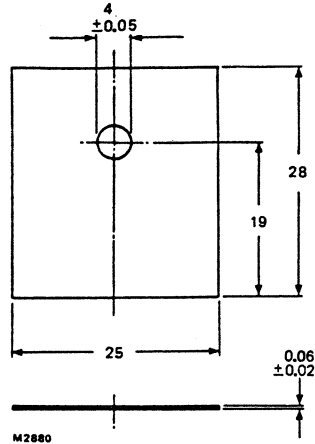
Dimensions in mm.

Material: polyester.

Maximum permissible temperature (T_{max}) = 150 °C.

Part no. 56368b, for insulated screw mounting up to 800 V.

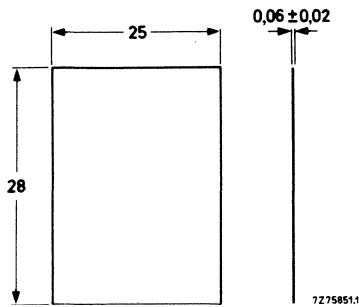
Fig.14 Insulating bush.



Dimensions in mm.

Part no. 56368c, for insulated screw mounting up to 800 V.

Fig.15 Mica insulator.

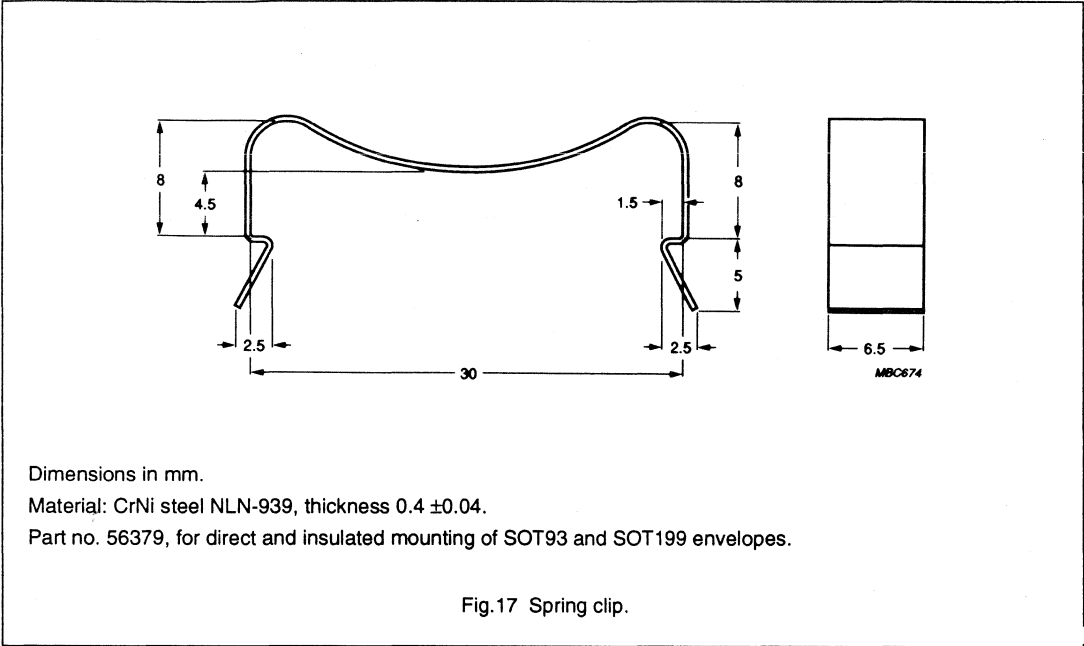


Dimensions in mm.

Part no. 56378, for clip mounting up to 1500 V.

Fig.16 Mica insulator.

ACCESSORIES FOR SOT93 AND SOT199 ENVELOPES



MOUNTING INSTRUCTIONS

Mounting Instructions

TO126/SOT82

GENERAL DATA AND INSTRUCTIONS**General rules**

1. Fasten the device to the heatsink before soldering the leads.
2. Avoid stress to the leads.
3. Keep mounting tool (e.g. screwdriver) clear of the plastic body.

Mounting methods**CLIP MOUNTING**

Mounting by means of spring clip offers:

- a) A good thermal contact under the crystal area.
- b) Safe insulation for mains and high voltage operation.

Minimum force for good heat transfer is 10 N.

Maximum force to avoid damaging the device is 80 N.

M2.5 AND M3 SCREW MOUNTING

TO126 only.

The spacing washer should be inserted between screw head and body.

Minimum torque for good heat transfer is 0.4 Nm.

Maximum torque to avoid damaging the device is 0.6 Nm.

When the driven nut or screw is in direct contact with a toothed lock washer the torques are as follows:

Minimum torque for good heat transfer is 0.55 Nm.

Maximum torque to avoid damaging the device is 0.8 Nm.

BODY MOUNTING

SOT82 only.

A SOT82 envelope can be adhesive mounted or soldered into a hybrid circuit.

For soldering, a copper plate or an anodised aluminium plate with copper layer is recommended.

With adhesive mounting, a ceramic substrate may be used.

RIVET MOUNTING

It is not permitted to rivet mount the TO126 outline.

Heatsink requirements

Flatness in the mounting area: 0.02 mm maximum per 10 mm.

Mounting holes must be deburred, for further information see clip and screw mounting instructions.

Heatsink compound

The thermal resistance from mounting base to heatsink ($R_{th,mb,h}$) can be reduced by applying a metallic oxide compound between the contact surfaces. Values given are of thermal resistance using this type of compound. Dow Corning 340 Heat sink compound is recommended. For insulated mounting, the compound should be applied to the bottom of both device and insulator.

Mounting Instructions

TO126/SOT82

Thermal data for heatsink mounting methods

Envelope	Thermal resistance from mounting base to heatsink	K/W			
		clip		screw	
		direct	insulated	direct	insulated
TO126	with heatsink compound	1.0	3.0	0.5	3.0
	without heatsink compound	3.0	6.0	1.0	6.0
SOT82	with heatsink compound	0.4	2.0	-	-
	without heatsink compound	2.0	5.0	-	-

Soldering

LEAD SOLDERING

For devices with a maximum junction temperature < 150 °C.

DIP OR WAVE SOLDERING.

Maximum permissible solder temperature is 260 °C at a distance from the body of > 5 mm and for a total contact time with soldering bath or waves of < 7 s.

HAND SOLDERING.

Maximum permissible temperature is 275 °C at a distance from the body of > 3 mm and for a total contact time with the soldering iron of < 5 s.

Maximum permissible temperature is 250 °C at a distance from the body of > 3 mm and for a total contact time with the soldering iron of < 10 s.

The body of the device must not touch anything with a temperature > 200 °C.

Avoid any force on body and leads during or after soldering; do not correct the position of the device or of its leads after soldering.

MOUNTING BASE SOLDERING

Recommended metal-alloy of solder paste (85% metal weight)
62% Sn / 36% Pb / 2% Ag or 60% Sn / 40% Pb.

Maximum soldering temperature < 200 °C (mounting base temperature).
Soldering cycle duration including pre-heating < 30 sec.

For good soldering and avoiding damage to the encapsulation pre-heating is recommended to a temperature < 165 °C at a duration < 10 s.

Lead bending

Maximum permissible tensile force on the body for 5 seconds is 20 N.

The leads can be bent, twisted or straightened. To keep forces within the above mentioned limits the leads should always be clamped rigidly near the body during bending. This is also to prevent damage to the seal of the leads within the plastic body.

Leads can be bent as near to the body as required, but adequate length should always be allowed for clamping. This is a minimum of 1.75 mm from the body to the start of a bend radius.

The internal radius of bend should never be less than the thickness of the lead. A minimum radius of at least 1.5 x lead thickness is preferred. See figure 1. Surface cracks in the dip tin coating on the lead are common when a radius less than 1.5 x lead thickness is used. Although exposing the copper material, these cracks do not affect the mechanical strength of the lead.

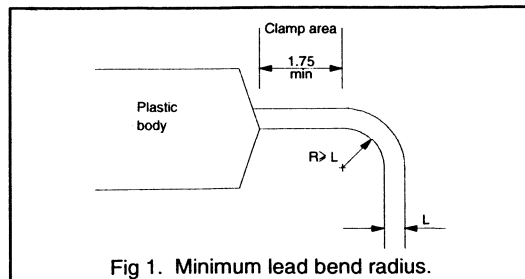
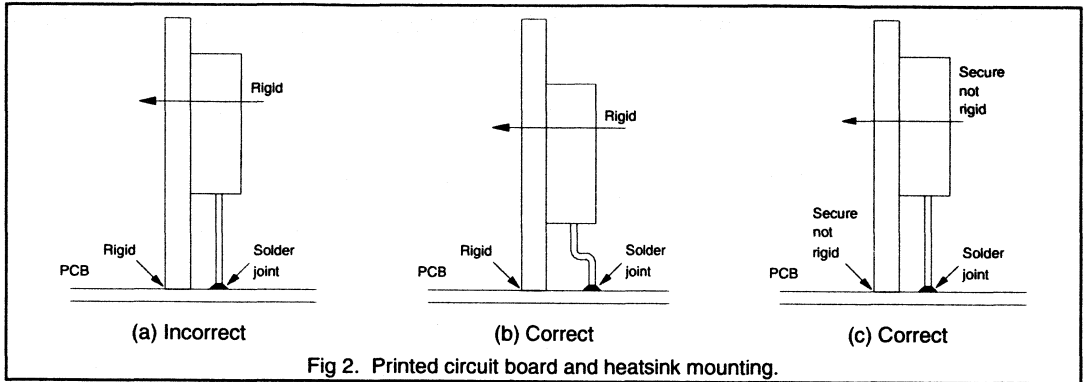


Fig 1. Minimum lead bend radius.

Additional guide-lines

It is recommended that where a device is rigidly secured to a heatsink which is in turn rigidly secured to a PCB, that a bend is put in the leads to act as an expansion loop. This will prevent differential expansion

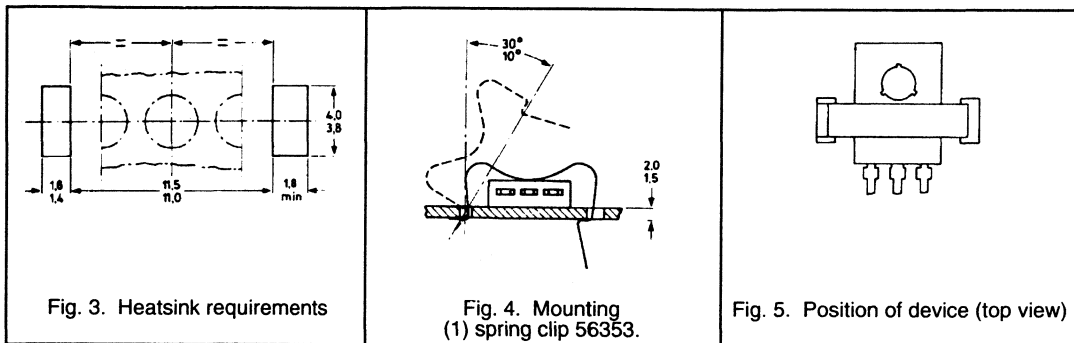
of the mounting parts transferring stress to the soldering joint, as shown in figure 2 below. This is only necessary where the device is mounted so rigidly that expansion forces are transmitted through the assembly.



INSTRUCTIONS FOR CLIP MOUNTING

Direct mounting with clip 56353

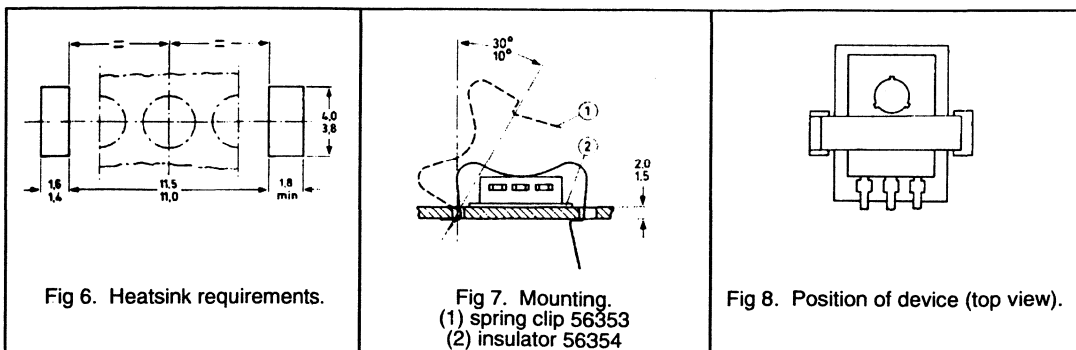
1. Apply heatsink compound to the mounting base, then place the device on the heatsink.
2. Push the short end of the clip into the narrow slot in the heatsink with the clip at an angle of 10° to 30° to the vertical. See figures 3 and 4).
3. Push down the clip over the device until the long end of the clip snaps into the wide slot in the heatsink. The clip should bear on the plastic body. See figure 5.



Insulated mounting with clip 56353

With the insulator 56354 insulation up to 1 kV is obtained.

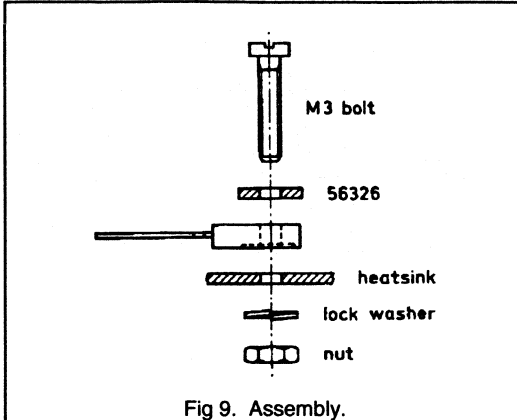
1. Apply heatsink compound to the bottom of both device and insulator, then place the device with the insulator on the heatsink.
2. Push the short end of the clip into the narrow slot in the heatsink with the clip at an angle of 10° to 30° to the vertical. See figures 6, 7 and 8).
3. Push down the clip over the device until the long end of the clip snaps into the wide slot in the heatsink. The clip should bear on the plastic body. Ensure that the device is centred on the mica insulator to prevent unwanted movement.



INSTRUCTIONS FOR SCREW MOUNTING

Direct mounting with screw and spacing washer

THROUGH HEATSINK WITH NUT.



Dimensions in mm

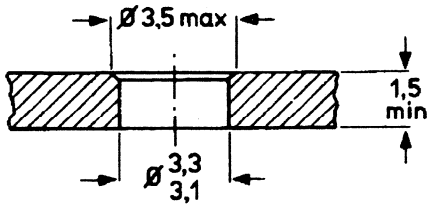
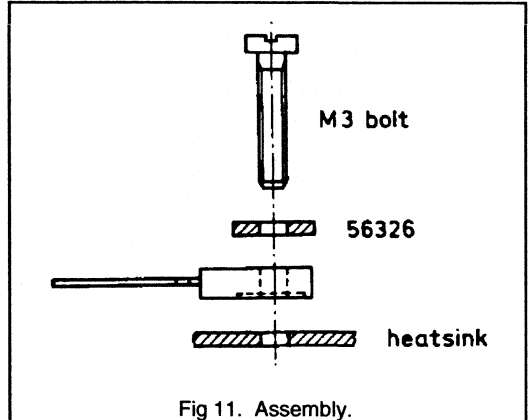


Fig 10. Heatsink requirements.

INTO TAPPED HEATSINK



Dimensions in mm

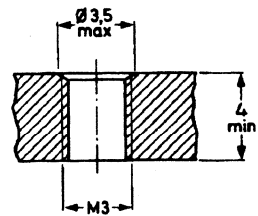


Fig 12. Heatsink requirements.

Mounting Instructions

TO126/SOT82

Insulated mounting with mica insulator

With the insulators 56387a & 56387b insulation up to 300 V is obtained.

THROUGH HEATSINK WITH NUT

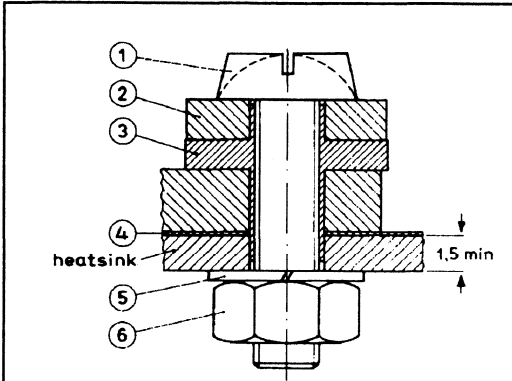


Fig 13. Assembly.

- (1) M2.5 screw
- (2) metal washer 56326
- (3) insulating bush 56387b
- (4) mica insulator 56387a
- (5) lock washer
- (6) M2.5 nut

Dimensions in mm

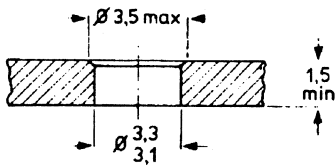


Fig 14. Heatsink requirements.

INTO TAPPED HEATSINK

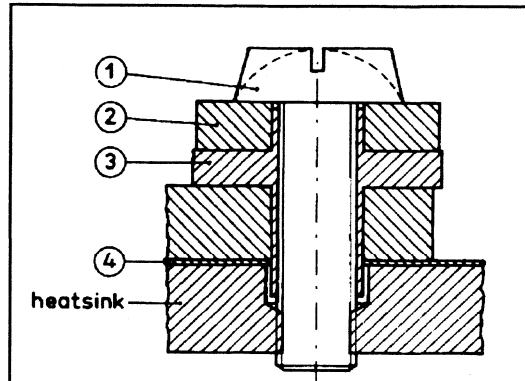


Fig 15. Assembly.

- (1) M2.5 screw
- (2) metal washer 56326
- (3) insulating bush 56387b
- (4) mica insulator 56387a

Dimensions in mm

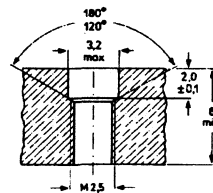


Fig 16. Heatsink requirements.

Mounting Instructions

SOT186/A / TO220AB / SOT263
SOT226 / SOT281

GENERAL DATA AND INSTRUCTIONS

General rules

1. Fasten the device to the heatsink before soldering the leads.
2. Avoid stress to the leads.
3. Keep mounting tool (e.g. screwdriver) clear of the plastic body.
4. The rectangular washer may only touch the plastic part of the body; it should not exert any force on that part (screw mounting).

Mounting methods

CLIP MOUNTING

Mounting with a spring clip gives:

- a) A good thermal contact under the crystal area, and slightly lower thermal resistance than screw mounting.
- b) Safe insulation for mains operation.

Minimum force for good heat transfer is 10 N.

Maximum force to avoid damaging the device is 80 N.

M3 SCREW MOUNTING

It is recommended that the rectangular spacing washer is inserted between screw head and mounting tab.

Do not use self-tapping screws.

Mounting torque for screw mounting:

For thread-forming screws these are final values.

Minimum torque for good heat transfer is 0.55 Nm.

Maximum torque to avoid damaging the device is 0.80 Nm.

When a nut or screw is driven directly against the tab, the torques are as follows:

Minimum torque for good heat transfer is 0.40 Nm.

Maximum torque to avoid damaging the device is 0.60 Nm.

RIVET MOUNTING NON-INSULATED.

The device should not be pop-riveted to the heatsink. It is permissible to press-rivet the metal tab providing that eyelet rivets of soft material are used, and the press forces are slowly and carefully controlled.

This method is not permitted for full-pack envelopes because it will damage the plastic encapsulation.

Heatsink requirements

Flatness in the mounting area: 0.02 mm maximum per 10 mm.
Mounting holes must be deburred, for further information see clip and screw mounting instructions.

Heatsink compound

The thermal resistance from mounting base to heatsink ($R_{th\ mb-h}$) can be reduced by applying a metallic oxide compound between the contact surfaces. Values given are of thermal resistance using this type of compound. Dow Corning 340 Heat sink compound is recommended. For insulated mounting, the compound should be applied to the bottom of both device and insulator.

Mounting Instructions

SOT186/A / TO220AB / SOT263
SOT226 / SOT281**Thermal data for heatsink mounting methods (TO220 only)**

Typical figures, for exact figures see data for each device type.

$R_{th\ mb-h}$	Thermal resistance from mounting base to heatsink	K/W	
		clip	screw
Mounting method			
	direct with heatsink compound	0.3	0.5
	direct without heatsink compound	1.4	1.4
	with heatsink compound and 0.1 mm maximum mica insulator	2.2	-
	with heatsink compound and 0.25 mm maximum alumina insulator	0.8	-
	with heatsink compound and 0.05 mm mica insulator insulated up to 500 V	-	1.4
	insulated up to 800 V / 1000 V	-	1.6
	without heatsink compound and 0.05 mm mica insulator insulated up to 500 V	-	3.0
	insulated up to 800 V / 1000 V	-	4.5

Additional insulators are generally not required when mounting the full-pack outlines.

Soldering

Recommendations for devices with a maximum junction temperature rating < 175 °C:

DIP OR WAVE SOLDERING.

Maximum permissible solder temperature is 260 °C at a distance from the body of > 5 mm and for a total contact time with soldering bath or waves of < 7 s.

HAND SOLDERING.

Maximum permissible temperature is 275 °C at a distance from the body of > 3 mm and for a total contact time with the soldering iron of < 5 s.

The body of the device must not touch anything with a temperature > 200 °C.

It is not permitted to solder the metal tab of the device to a heatsink, otherwise the junction temperature rating will be exceeded.

Avoid any force on body and leads during or after soldering; do not correct the position of the device or of its leads after soldering.

Lead bending

Maximum permissible tensile force on the body for 5 seconds is 20 N.

The leads can be bent, twisted or straightened. To keep forces within the above mentioned limits the leads should always be clamped rigidly near the body during bending. This is also to prevent damage to the seal of the leads within the plastic body.

Leads can be bent as near to the body as required, but adequate length should always be allowed for clamping. This is a minimum of 1.75 mm from the body to the start of a bend radius.

The internal radius of bend should never be less than the thickness of the lead. A minimum radius of at least 1.5 x lead thickness is preferred. See figure 1. Surface cracks in the dip tin coating on the lead are common when a radius less than 1.5 x lead thickness is used. Although exposing the copper material, these cracks do not affect the mechanical strength of the lead. Lead forming by Philips is available as an option on all products supplied in these outlines.

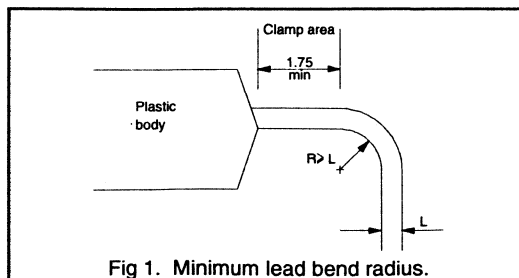


Fig 1. Minimum lead bend radius.

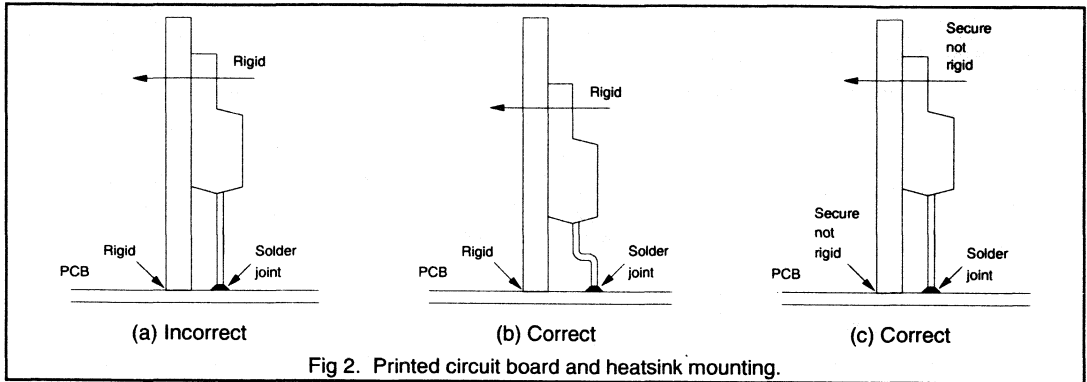
Mounting Instructions

SOT186/A / TO220AB / SOT263
SOT226 / SOT281

Additional guide-lines

It is recommended that where a device is rigidly secured to a heatsink which is in turn rigidly secured to a PCB, that a bend is put in the leads to act as an expansion loop. This will prevent differential expansion

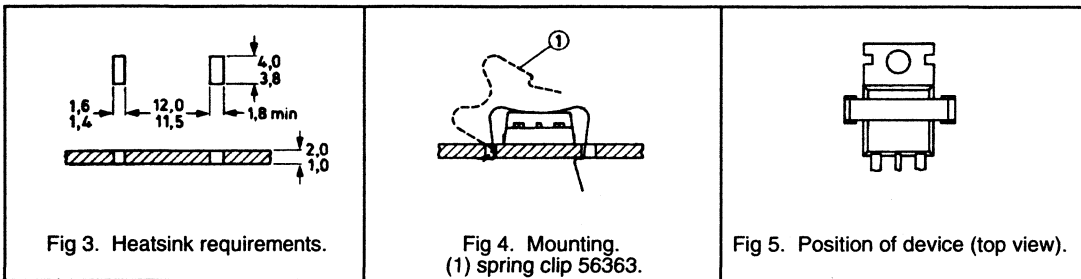
of the mounting parts transferring stress to the soldering joint, as shown in figure 2 below. This is only necessary where the device is mounted so rigidly that expansion forces are transmitted through the assembly.



INSTRUCTIONS FOR CLIP MOUNTING

Direct mounting with clip 56363

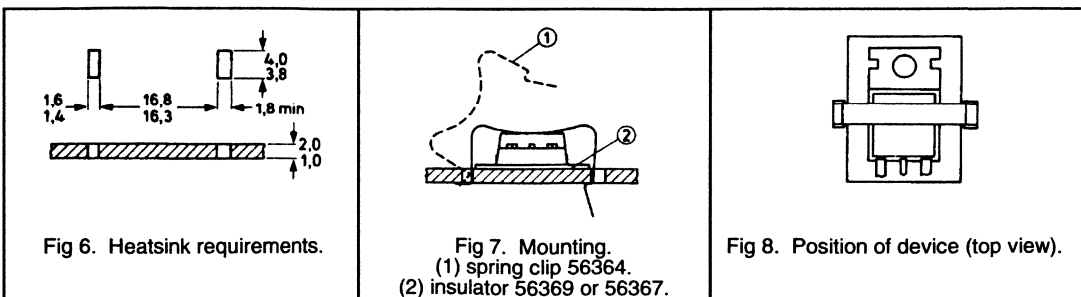
1. Apply heatsink compound to the mounting base, then place the device on the heatsink.
2. Push the short end of the clip into the narrow slot in the heatsink with the clip at an angle of 10° to 30° to the vertical. See figures 3 and 4.
3. Push down the clip over the device until the long end of the clip snaps into the wide slot in the heatsink. The clip should bear on the plastic body, not on the tab. See figure 5.



Insulated mounting with clip 56364

With the insulators 56367 or 56369 insulation up to 2 kV is obtained.

1. Apply heatsink compound to the bottom of both device and insulator, then place the device with the insulator on the heatsink.
2. Push the short end of the clip into the narrow slot in the heatsink with the clip at an angle of 10° to 30° to the vertical. See figures 6, 7 and 8.
3. Push down the clip over the device until the long end of the clip snaps into the wide slot in the heatsink. The clip should bear on the plastic body, not on the tab. Ensure that the device is centred on the mica insulator to prevent unwanted movement.



INSTRUCTIONS FOR SCREW MOUNTING

Direct mounting with screw and spacing washer

THROUGH HEATSINK WITH NUT

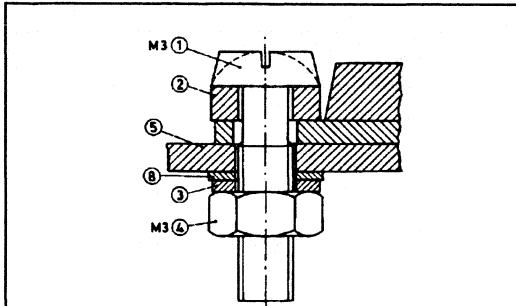


Fig 9. Assembly

- (1) M3 screw
- (2) rectangular washer (56360a)
- (3) lock washer
- (4) M3 nut
- (5) heatsink
- (8) plain washer

Item (2) not required for F-pack

Dimensions in mm

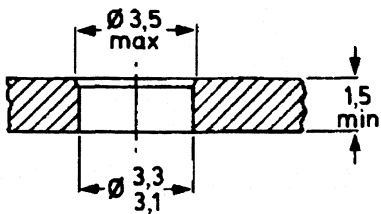


Fig 10. Heatsink requirements.

INTO TAPPED HEATSINK

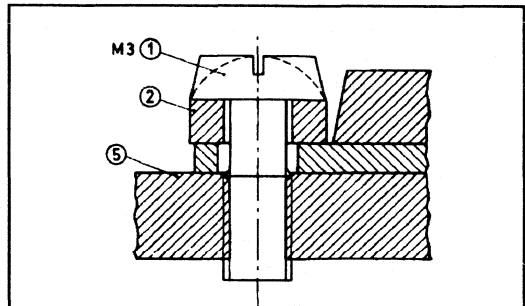


Fig 11. Assembly.

- (1) M3 screw
- (2) rectangular washer 56360a

- (5) heatsink

Item (2) not required for F-pack

Dimensions in mm

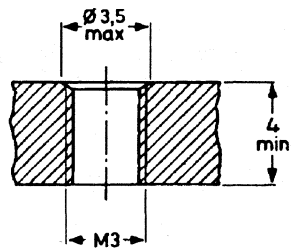


Fig 12. Heatsink requirements.

Mounting Instructions

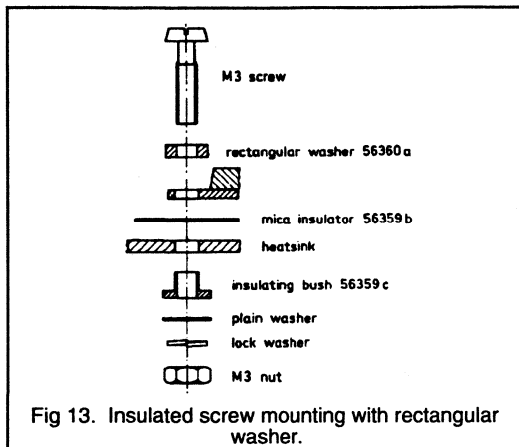
SOT186/A / TO220AB / SOT263
SOT226 / SOT281

Insulated mounting with screw and spacing washer

Not recommended where mounting tab is on mains voltage. Not applicable for F-pack.

THROUGH HEATSINK WITH NUT

Known as a "bottom mounting".



Dimensions in mm.

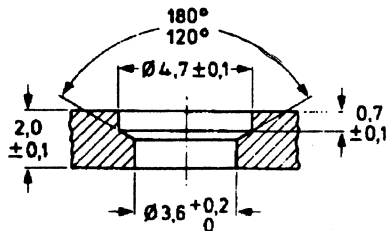


Fig 14. Heatsink requirements for 500 V insulation.

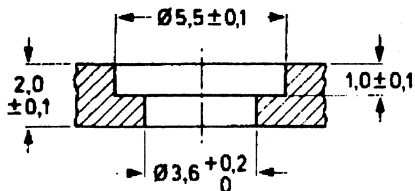
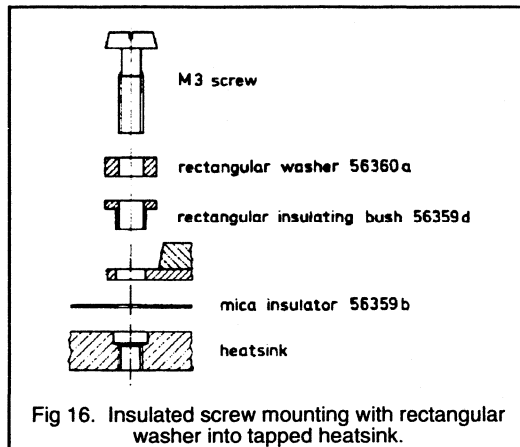


Fig 15. Heatsink requirements for 800 V insulation.

INTO TAPPED HEATSINK

Known as a "top mounting".



Dimensions in mm.

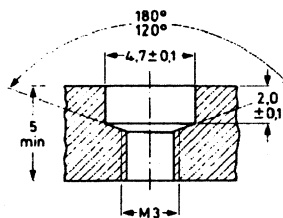


Fig 17. Heatsink requirements for 500 V insulation.

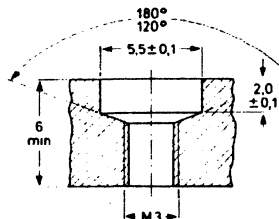


Fig 18. Heatsink requirements for 1000 V insulation.

GENERAL DATA AND INSTRUCTIONS

General rules

1. Fasten the device to the heatsink before soldering the leads.
2. Avoid stress to the leads.
3. Keep mounting tool (e.g. screwdriver) clear of the plastic body.
4. The washer may only touch the plastic part of the body; it should not exert any force on that part (screw mounting).

Mounting methods

CLIP MOUNTING

Mounting with a spring clip gives:

- a) A good thermal contact under the crystal area.
- b) Safe insulation for mains operation.

Minimum force for good heat transfer is 10 N.

Maximum force to avoid damaging the device is 80 N.

MOUNTING TORQUES

For M3 screw (insulated mounting):

Minimum torque for good heat transfer is 0.4 Nm.

Maximum torque to avoid damaging the device is 0.6 Nm.

For M4 screw (direct mounting only):

Minimum torque for good heat transfer is 0.4 Nm.

Maximum torque to avoid damaging the device is 1.0 Nm.

The M4 screw head should not touch the plastic part of the envelope.

RIVET MOUNTING NON-INSULATED

The device should not be pop-riveted to the heatsink. It is permissible to press-rivet SOT93 providing that eyelet rivets of soft material are used, and the press forces are slowly and carefully controlled.

This method is NOT recommended for F packs because it will damage the plastic encapsulation.

Heatsink requirements

Flatness in the mounting area: 0.02 mm maximum per 10 mm.

Mounting holes must be deburred, for further information see clip and screw mounting instructions.

Heatsink compound

The thermal resistance from mounting base to heatsink ($R_{th, mb-h}$) can be reduced by applying a metallic oxide compound between the contact surfaces. Values given are of thermal resistance using this type of compound. Dow Corning 340 Heat sink compound is recommended. For insulated mounting, the compound should be applied to the bottom of both device and insulator.

Mounting Instructions

SOT199 / SOT93

Thermal data for heatsink mounting methods (SOT93 only)

Typical figures, for exact figures see data for each device type.

$R_{th\ mb-h}$	Thermal resistance from mounting base to heatsink	K/W	
		clip	screw
Mounting method			
	direct with heatsink compound	0.3	0.3
	direct without heatsink compound	1.5	0.8
	with heatsink compound and 0.05 mm maximum mica insulator	0.8	0.8
	without heatsink compound and 0.05 mm maximum mica insulator	3.0	2.2

Mica washers are generally not required when mounting the SOT199 F-Pack outline.

Soldering

Recommendations for devices with a maximum junction temperature rating < 175 °C:

DIP OR WAVE SOLDERING

Maximum permissible solder temperature is 260 °C at a distance from the body of > 5 mm and for a total contact time with soldering bath or waves of < 7 s.

HAND SOLDERING

Maximum permissible temperature is 275 °C at a distance from the body of > 3 mm and for a total contact time with the soldering iron of < 5 s.

The body of the device must not touch anything with a temperature > 200 °C.

It is not permitted to solder the metal tab of the device to a heatsink, otherwise the junction temperature rating will be exceeded.

Avoid any force on body and leads during or after soldering; do not correct the position of the device or of its leads after soldering.

Lead bending

Maximum permissible tensile force on the body for 5 seconds is 20 N.

The leads can be bent, twisted or straightened. To keep forces within the above mentioned limits the leads

should always be clamped rigidly near the body during bending. This is also to prevent damage to the seal of the leads within the plastic body.

Leads can be bent as near to the body as required, but adequate length should always be allowed for clamping. This is a minimum of 1.75 mm from the body to the start of a bend radius.

The internal radius of bend should never be less than the thickness of the lead. A minimum radius of at least 1.5 x lead thickness is preferred. See figure 1 Surface cracks in the dip tin coating on the lead are common when a radius less than 1.5 x lead thickness is used. Although exposing the copper material, these cracks do not affect the mechanical strength of the lead. Lead forming by Philips is available as an option on all products supplied in these outlines.

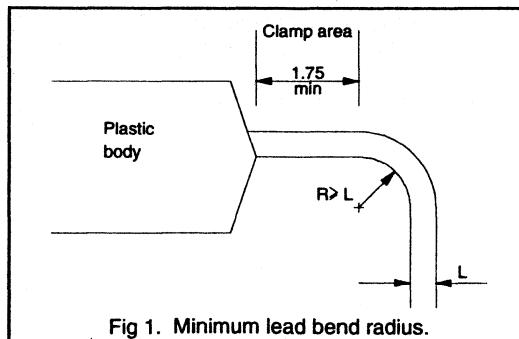
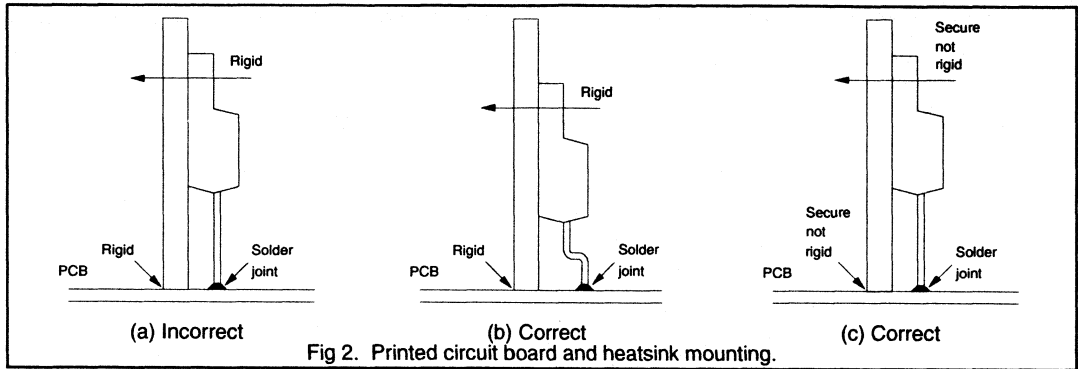


Fig 1. Minimum lead bend radius.

Additional guidelines

It is recommended that where a device is rigidly secured to a heatsink which is in turn rigidly secured to a PCB, that a bend is put in the leads to act as an expansion loop. This will prevent differential expansion

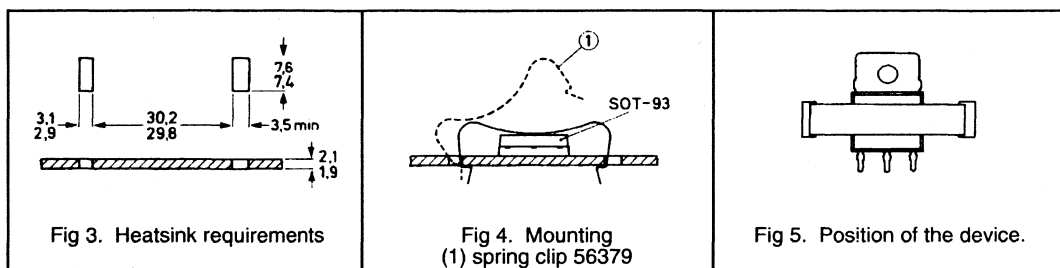
of the mounting parts transferring stress to the soldering joint, as shown in figure 2 below. This is only necessary where the device is mounted so rigidly that expansion forces are transmitted through the assembly.



INSTRUCTIONS FOR CLIP MOUNTING

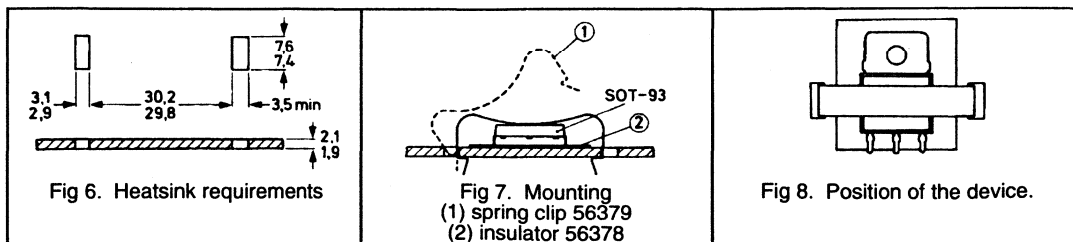
Direct mounting with clip 56379

1. Place the device on the heatsink, applying heatsink compound to the mounting base.
2. Push the short end of the clip into the narrow slot in the heatsink with the clip at an angle of 10° to 30° to the vertical. See figures 3 and 4.
3. Push down the clip over the device until the long end of the clip snaps into the wide slot in the heatsink. The clip should bear on the plastic body, not on the tab. See figure 5.

**Insulated mounting with clip 56379**

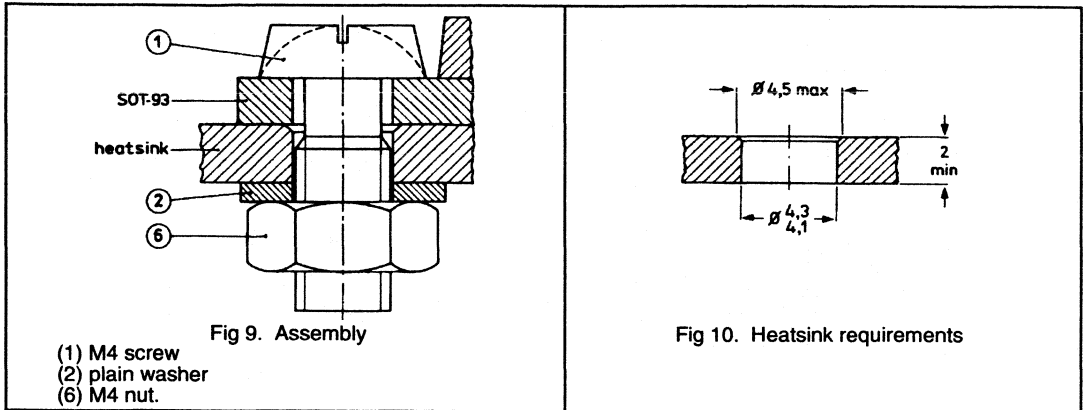
With the mica 56378 insulation up to 1500 V is obtained.

1. Place the device with the insulator on the heatsink, applying heatsink compound to the bottom of both device and insulator.
2. Push the short end of the clip into the narrow slot in the heatsink with the clip at an angle of 10° to 30° to the vertical. See figures 6, 7 and 8.
3. Push down the clip over the device until the long end of the clip snaps into the wide slot in the heatsink. The clip should bear on the plastic body, not on the tab. There should be a minimum of 3 mm distance between the device and the edge of the insulator for adequate creepage distance.



INSTRUCTIONS FOR SCREW MOUNTING

Direct mounting through heatsink with nut



When screw mounting the SOT93 envelope, it is particularly important to apply a thin, even layer of heatsink compound to the mounting base, and to apply torque to the screw slowly so that the compound has time to flow and the mounting base is not deformed. Most SOT93 envelopes contain a crystal larger than that in the other plastic envelopes, and it is more likely to crack if the mounting base is deformed.

Where vibrations are to be expected the use of a lock washer or of a curved spring washer is recommended with a plain washer between aluminium heatsink and spring washer.

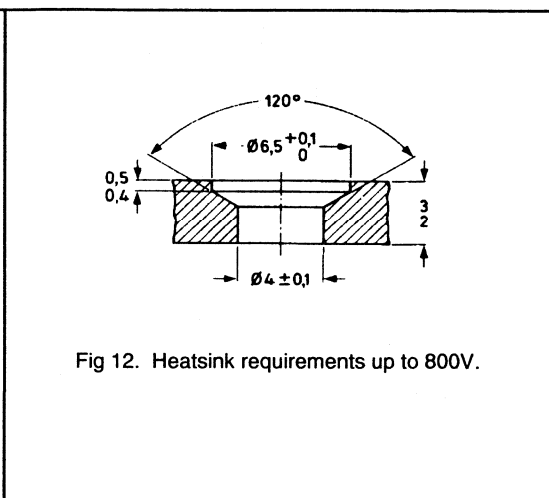
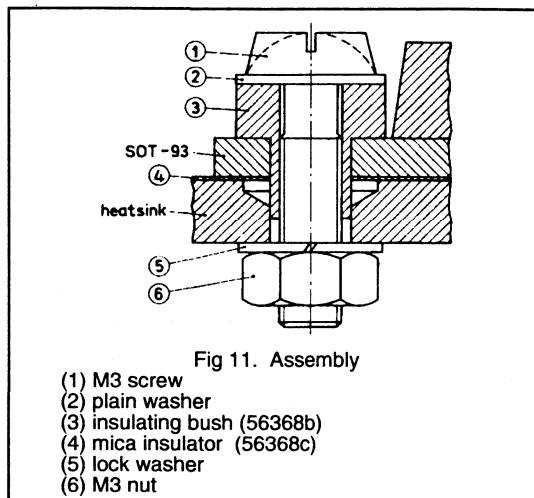
Mounting Instructions

SOT199 / SOT93

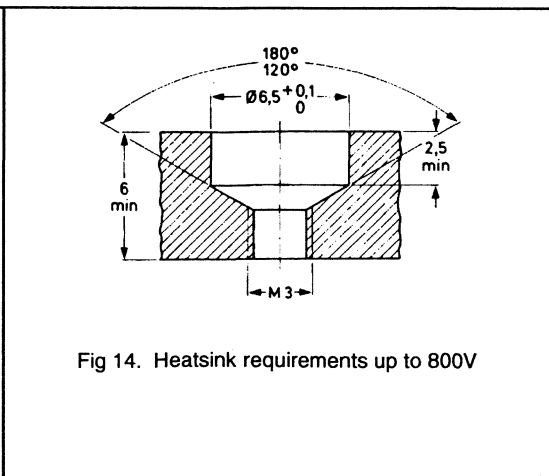
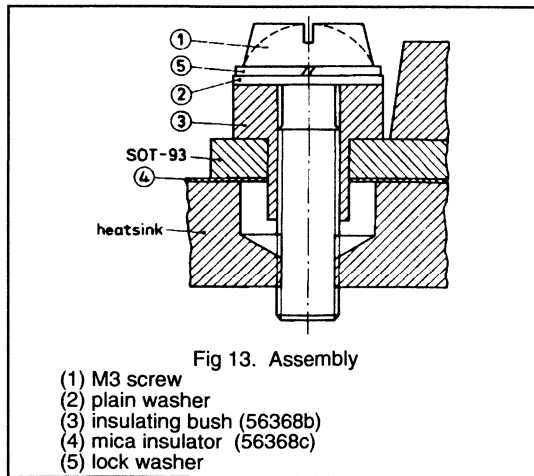
Insulated screw mounting upto 800V isolation

Axial deviation requirements must be adhered.

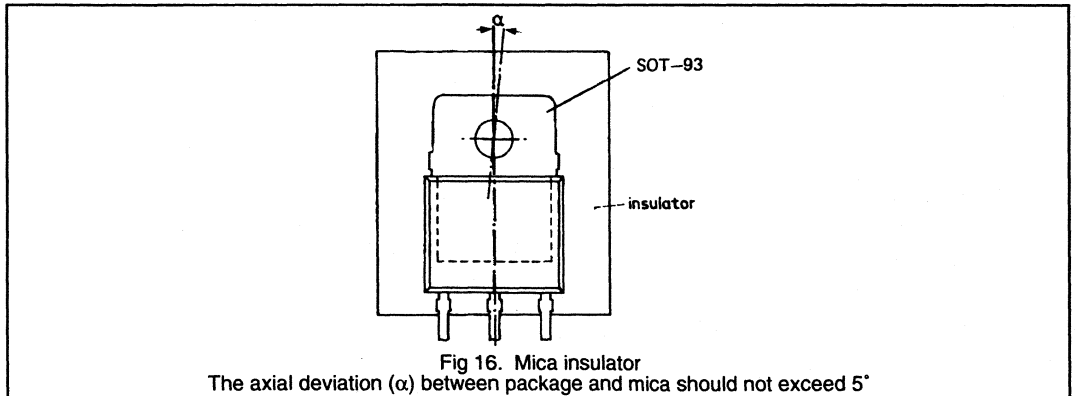
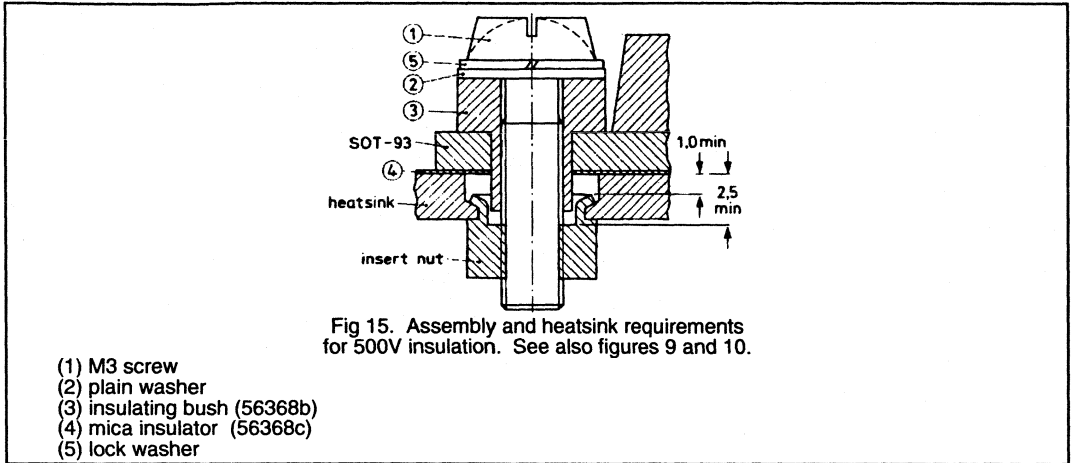
THROUGH HEATSINK WITH NUT



INTO TAPPED HEATSINK



Insulated screw mounting with insert nut; up to 500V



Mounting Instructions**SOT227A/B ISOTOP**

GENERAL DATA AND INSTRUCTIONS**General rules**

1. Fasten the device to the heatsink before connecting the leads.
2. Keep mounting tool (e.g. screwdriver) clear of the plastic body.

Mounting method**M4 SCREW MOUNTING ONLY****Mounting torque for screw mounting:**

For thread-forming screws this is the final value. Do not use self-tapping screws.

Maximum torque to avoid damaging the device is 1.5 Nm.

Connection methods

1. Push-on terminals (SOT227A).
2. Printed circuit board (SOT227B).

Maximum torque for the screw connection to avoid damaging the device 1.6 Nm.

Isolation

The device is already fully isolated between the mounting base and all terminals.

Heatsink requirements

Flatness in the mounting area: 0.05 mm maximum per 40 mm.
Mounting holes must be deburred.

Heatsink compound

The thermal resistance from mounting base to heatsink ($R_{th\,mb-h}$) can be reduced by applying a metallic oxide compound between the contact surfaces. Dow Corning 340 Heat sink compound is recommended.

Soldering

Recommendations for devices with a maximum junction temperature rating < 175 °C:

Maximum permissible temperature is 275 °C at a distance from the body of > 3 mm and for a total contact time with the soldering iron of < 5 s.

The body of the device must not touch anything with a temperature > 200 °C.

It is not permitted to solder the metal base of the device to a heatsink, otherwise the junction temperature rating will be exceeded.

Avoid any force on body and leads during or after soldering; do not correct the position of the device or of its leads after soldering.

INSTRUCTIONS FOR PUSH-ON CONNECTION

Use push-on connector size 6.35 mm.

INSTRUCTIONS FOR PCB CONNECTION

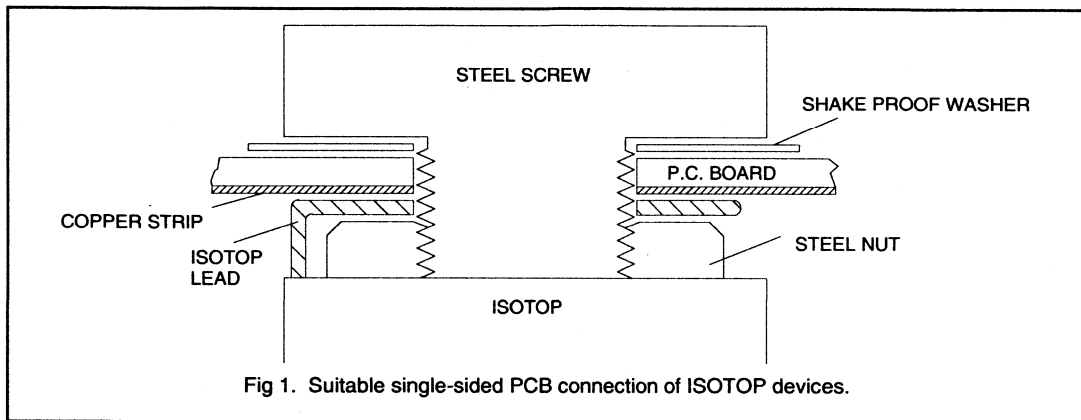
Recommended minimum copper film thickness on the PCB is 135 μm .

For high currents use of a slotted washer is recommended.

Use a torque value of 1.3 Nm for the connection.

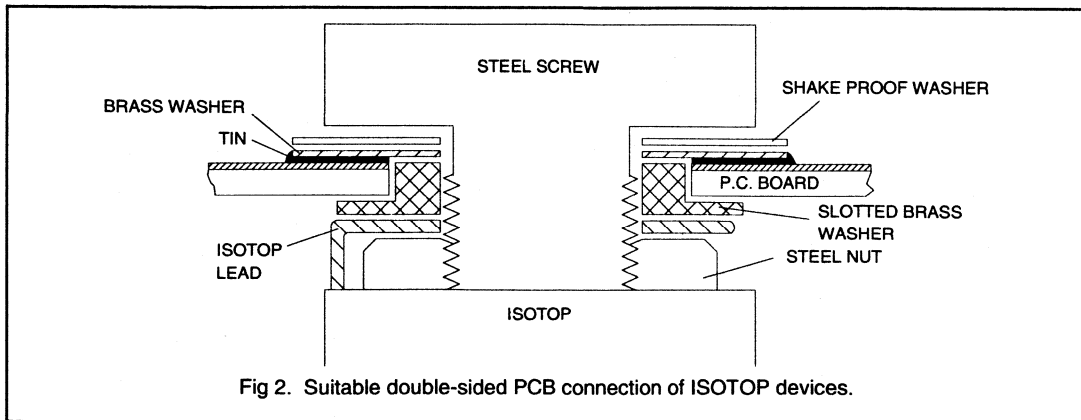
See figures 1, 2 and 3.

Single-sided PCB

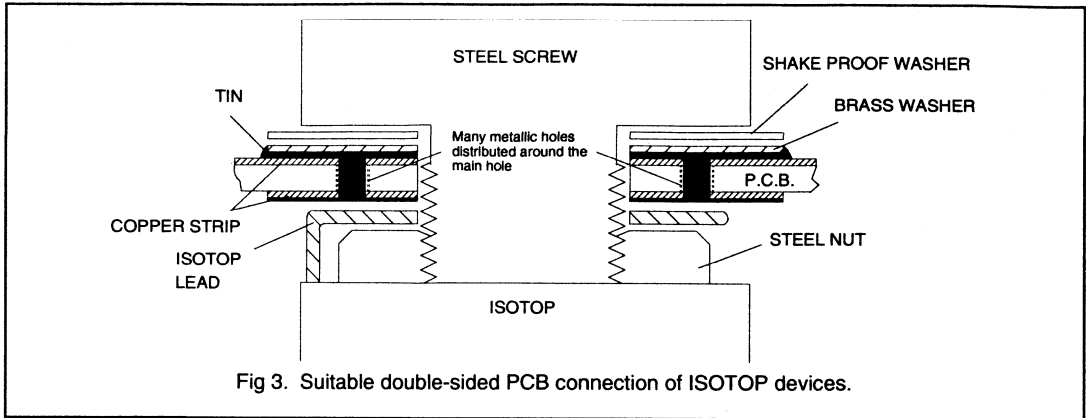


Double-sided PCB

Method 1



Method 2



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High-voltage and Switching NPN Power Transistors

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