DISCRETE SEMICONDUCTORS

High-voltage and Switching Power transistors

BOOK SC06 1989

Philips Components

PHILIPS

HIGH-VOLTAGE AND SWITCHING POWER TRANSISTORS

NOTE Information on low-frequency power transistors and hybrid IC power modules is in the Discrete Semiconductor data handbook SC05.

SELECTION GUIDE

The selection guide lists the devices in this book grouped in accordance with the collector-emitter voltage parameter (V_{CESM}) and in order of the collector current parameter (I_C). The devices are listed in alphanumeric order, with page numbers, in the following Type Number Survey section.

type	V_{CESM} (V)	V_{CEO} (V)	I_C (A)	P_{tot} (W)	envelope
BUV26F	180	90	14	18	SOT186
BUV26	180	90	14	65	TO-220AB
BUV26AF	200	100	14	18	SOT186
BUV26A	200	100	14	65	TO-220AB
BUW86	240	120	15	62.5	TO-3
BUV27F	240	120	12	18	SOT186
BUV27	240	120	12	65	TO-220AB
BUW87	300	150	10	62.5	TO-3
BUV27AF	300	150	12	18	SOT186
BUV27A	300	150	12	65	TO-220AB
BU407F	330	150	7	18	SOT186
TIP47	350	250	1	40	TO-220AB
TIP48	400	300	1	40	TO-220AB
BU406F	400	200	7	18	SOT186
BUW87A	400	200	10	62.5	TO-3
BUV28F	400	200	12	18	SOT186
BUV28	400	200	12	65	TO-220AB
TIP49	450	350	1	40	TO-220AB
BUV28AF	450	225	12	18	SOT186
BUV28A	450	225	12	65	TO-220AB
TIP50	500	400	1	40	TO-220AB

type	V_{CESM} (V)	V_{CEO} (V)	I_C (A)	P_{tot} (W)	envelope
PH13002	600	300	5	20	SOT186
MJE13004	600	300	4	75	TO-220AB
BU306F	600	300	8	20	SOT186
MJE13006	600	300	8	80	TO-220AB
MJE13008	600	300	12	100	TO-220AB
ESM3045D(V)	600	450	24	125	SOT227A/B
ESM4045D(V)	600	450	60	175	SOT227A/B
ESM5045D(V)	600	450	60	175	SOT227A/B
ESM6045D(V)	600	450	84	250	SOT227A/B
BU724	650	375	2	1.5	SOT82
BUV90F	650	400	12	34	SOT199
BUV90	650	400	12	125	SOT93
PH13003	700	400	1.5	28	TO-126
MJE13005	700	400	2	75	TO-220AB
BU307F	700	400	5	20	SOT186
MJE13007	700	400	8	80	TO-220AB
MJE13009	700	400	12	100	TO-220AB
BUX99	730	300	1.5	28	TO-126
BUT21BF	750	400	5	20	SOT186
BUS21B	750	400	5	100	TO-3
BUT21B	750	400	5	100	TO-220AB
BUT22BF	750	400	8	23	SOT186
BUP22BF	750	400	8	34	SOT199
BUP22B	750	400	8	125	SOT93
BUT22B	750	400	8	125	TO-220AB
BUS22B	750	400	8	125	TO-3
BUP23BF	750	400	15	37	SOT199
BUP23B	750	400	15	175	SOT93
BUS23B	750	400	15	175	TO-3
BUS24B	750	400	30	250	TO-3

type	V_{CESM} (V)	V_{CEO} (V)	I_C (A)	P_{tot} (W)	envelope
BUX86	800	400	0.5	20	TO-126
BUX84F	800	400	2	18	SOT186
BUX84	800	400	2	40	TO-220AB
BUW84	800	400	2	50	SOT82
BU826	800	375	6	125	SOT93
BU724A	850	400	2	1.5	SOT82
BUX46	850	400	3.5	85	TO-3
BUT11F	850	400	5	20	SOT186
BUT21CF	850	450	5	20	SOT186
BUW11F	850	400	5	32	SOT199
BUT131	850	450	5	80	TO-220AB
BUT131H	850	450	5	80	TO-220AB
BUW131	850	450	5	80	SOT93
BUW131H	850	450	5	80	SOT93
BUT21C	850	450	5	100	TO-220AB
BUS11	850	400	5	100	TO-3
BUS21C	850	450	5	100	TO-3
BUT11	850	400	5	100	TO-220AB
BUW11	850	400	5	100	SOT93
BUS131	850	450	5	125	TO-3
BUS131H	850	450	5	125	TO-3
BUT18F	850	450	6	33	SOT186
BUV82	850	500	6	100	SOT93
BUT18	850	400	6	110	TO-220AB
BUT12F	850	400	8	23	SOT186
BUT22CF	850	400	8	23	SOT186
BUW12F	850	400	8	34	SOT199
BUS12	850	400	8	125	TO-3
BUT12	850	400	8	125	TO-220AB
BUP22C	850	450	8	125	SOT93
BUS22C	850	450	8	125	TO-3
BUW132	850	450	8	125	SOT93
BUW132H	850	450	8	125	SOT93
BUT22C	850	450	8	125	TO-220AB
BUW12	850	450	8	125	SOT93

type	V_{CESM} (V)	V_{CEO} (V)	I_C (A)	P_{tot} (W)	envelope
BUS132	850	450	8	150	TO-3
BUS132H	850	450	8	150	TO-3
BUP22CF	850	450	8	250	SOT199
BUV47	850	400	9	120	SOT93
BUV47B	850	400	9	120	SOT93
BUX47	850	400	9	125	TO-3
BUW13F	850	400	15	37	SOT199
BUW133	850	450	15	135	SOT93
BUW133H	850	450	15	135	SOT93
BUV48	850	400	15	150	SOT93
BUP23C	850	450	10	175	SOT93
BUS13	850	400	15	175	TO-3
BUS23C	850	450	15	175	TO-3
BUS133	850	450	15	175	TO-3
BUS133H	850	450	15	175	TO-3
BUW13	850	450	15	175	SOT93
BUX48	850	400	15	175	TO-3
BUP23CF	850	450	15	250	SOT199
BUV98(V)	850	450	30	150	SOT227A/B
BUS14	850	400	30	250	TO-3
BUS24C	850	450	30	250	TO-3
BUX98	850	400	30	250	TO-3
BUV298(V)	850	450	60	250	SOT227A/B
BUX87	1000	450	0.5	20	TO-126
BUX85F	1000	450	2	18	SOT186
BUX85	1000	450	2	40	TO-220AB
BUW85	1000	450	3	50	SOT82
BUX46A	1000	450	3.5	85	TO-3
BUT11AF	1000	450	5	20	SOT186
BUW11AF	1000	450	5	32	SOT199
BUT131A	1000	500	5	80	TO-220AB
BUS11A	1000	450	5	100	TO-3
BUT11A	1000	450	5	100	TO-220AB
BUW11A	1000	450	5	100	SOT93
BUS131A	1000	500	5	125	TO-3

type	V_{CESM} (V)	V_{CEO} (V)	I_C (A)	P_{tot} (W)	envelope
BUT81AF	1000	450	4	33	SOT186
BUV83	1000	450	6	100	SOT93
BUT18A	1000	450	6	110	TO-220AB
BU826A	1000	450	6	125	SOT93
BUW12AF	1000	450	6	125	SOT199
BUT12AF	1000	450	8	23	SOT186
BUS12A	1000	450	8	125	TO-3
BUW12A	1000	450	8	125	SOT93
BUT12A	1000	450	8	125	TO-220AB
BUW132A	1000	500	8	125	SOT93
BUS132A	1000	500	8	150	TO-3
BUV47A	1000	450	9	120	SOT93
BUX47A	1000	450	9	125	TO-3
BUW13AF	1000	450	15	37	SOT199
BUW133A	1000	500	15	135	SOT93
BUV48A	1000	450	15	150	SOT93
BUS13A	1000	450	15	175	TO-3
BUS133A	1000	500	15	175	TO-3
BUX48A	1000	450	15	175	TO-3
BUW13A	1000	450	15	175	SOT93
ESM3045A(V)	1000	450	24	125	SOT227A/B
BUV98A(V)	1000	450	30	150	SOT227A/B
BUS14A	1000	450	30	250	TO-3
BUX98A	1000	450	30	250	TO-3
ESM4045A(V)	1000	450	42	150	SOT227A/B
BUV298A(V)	1000	450	60	250	SOT227A/B
ESM6045A(V)	1000	450	84	250	SOT227A/B
BUV89	1200	800	8	125	SOT93
BUX88	1200	800	12	160	TO-3
BU603	1350	550	5	100	TO-220AB
BU903	1350	550	6	125	SOT93

type	V_{CESM} (V)	V_{CEO} (V)	I_C (A)	P_{tot} (W)	envelope
BU705F	1500	700	2.5	29	SOT199
BU705DF	1500	700	2.5	29	SOT199
BU705	1500	700	2.5	75	SOT93A
BU705D	1500	700	2.5	75	SOT93A
BU505	1500	700	2.5	75	TO-220AB
BU505D	1500	700	2.5	75	TO-220AB
BU706	1500	700	5	100	SOT93A
BU706D	1500	700	5	100	SOT93A
BU706F	1500	700	5	32	SOT199
BU706DF	1500	700	5	32	SOT199
BU506	1500	700	5	100	TO-220AB
BU506D	1500	700	5	100	TO-220AB
BU506F	1500	700	5	20	SOT186
BU506DF	1500	700	5	20	SOT186
BU505F	1500	700	5.5	20	SOT186
BU505DF	1500	700	5.5	20	SOT186
BUY89	1500	800	6	80	TO-3
BU508AF	1500	700	8	34	SOT199
BU508DF	1500	700	8	34	SOT199
BU508A	1500	700	8	125	SOT93A
BU508D	1500	700	8	125	SOT93A
BU808	1500	700	12	160	TO-3

TYPE NUMBER SURVEY

TYPE NUMBER SURVEY POWER TRANSISTORS

type	polarity	page
BU306F	npn	41
BU307F	npn	41
BU406F	npn	47
BU407F	npn	47
BU505	npn	55
BU505D	npn	55
BU505DF	npn	61
BU505F	npn	61
BU506	npn	69
BU506D	npn	69
BU506DF	npn	75
BU506F	npn	75
BU508A	npn	83
BU508AF	npn	89
BU508D	npn	83
BU508DF	npn	89
BU603	npn	97
BU705	npn	101
BU705D	npn	101
BU705DF	npn	107
BU705F	npn	107
BU706	npn	115
BU706D	npn	115
BU706DF	npn	121
BU706F	npn	121
BU724	npn	129
BU724A	npn	129
BU808	npn	137
BU826	npn	143
BU826A	npn	143
BU903	npn	149
BUP22B	npn	157
BUP22BF	npn	165
BUP22C	npn	157
BUP22CF	npn	165

type	polarity	page
BUP23B	npn	173
BUP23BF	npn	181
BUP23C	npn	173
BUP23CF	npn	181
BUS11	npn	189
BUS11A	npn	189
BUS12	npn	197
BUS12A	npn	197
BUS13	npn	205
BUS13A	npn	205
BUS14	npn	213
BUS14A	npn	213
BUS21B	npn	221
BUS21C	npn	221
BUS22B	npn	223
BUS22C	npn	223
BUS23B	npn	231
BUS23C	npn	231
BUS24B	npn	239
BUS24C	npn	239
BUS131	npn	247
BUS131A	npn	247
BUS131H	npn	247
BUS132	npn	255
BUS132A	npn	255
BUS132H	npn	255
BUS133	npn	263
BUS133A	npn	263
BUS133H	npn	263
BUT11	npn	271
BUT11A	npn	271
BUT11AF	npn	279
BUT11F	npn	279
BUT12	npn	283
BUT12A	npn	283

type	polarity	page
BUT12AF	npn	291
BUT12F	npn	291
BUT18	npn	299
BUT18A	npn	299
BUT18AF	npn	307
BUT18F	npn	307
BUT21B	npn	315
BUT21BF	npn	323
BUT21C	npn	315
BUT21CF	npn	323
BUT22B	npn	331
BUT22BF	npn	339
BUT22C	npn	331
BUT22CF	npn	339
BUT131	npn	347
BUT131A	npn	347
BUT131H	npn	347
BUV26	npn	355
BUV26A	npn	355
BUV26AF	npn	359
BUV26F	npn	359
BUV27	npn	367
BUV27A	npn	367
BUV27AF	npn	371
BUV27F	npn	371
BUV28	npn	377
BUV28A	npn	377
BUV28AF	npn	381
BUV28F	npn	381
BUV47	npn	387
BUV47A	npn	387
BUV48	npn	393
BUV48A	npn	393
BUV82	npn	399
BUV83	npn	399
BUV89	npn	407
BUV90	npn	413
BUV90F	npn	417
BUV98(V)	npn	421
BUV98A(V)	npn	421

type	polarity	page
BUV298(V)	npn	431
BUV298A(V)	npn	431
BUW11	npn	435
BUW11A	npn	435
BUW11AF	npn	443
BUW11F	npn	443
BUW12	npn	451
BUW12A	npn	451
BUW12AF	npn	459
BUW12F	npn	459
BUW13	npn	467
BUW13A	npn	467
BUW13AF	npn	475
BUW13F	npn	475
BUW84	npn	483
BUW85	npn	483
BUW86	npn	493
BUW87	npn	493
BUW87A	npn	493
BUW131	npn	501
BUW131A	npn	501
BUW131H	npn	501
BUW132	npn	509
BUW132A	npn	509
BUW132H	npn	509
BUW133	npn	517
BUW133A	npn	517
BUW133H	npn	517
BUX46	npn	525
BUX46A	npn	525
BUX47	npn	533
BUX47A	npn	533
BUX48	npn	541
BUX48A	npn	541
BUX84	npn	549
BUX84F	npn	559
BUX85	npn	549
BUX85F	npn	559
BUX86	npn	561
BUX87	npn	561

type	polarity	page
BUX88	npn	569
BUX98	npn	573
BUX98A	npn	573
BUX99	npn	581
BUY89	npn	585
ESM3045A(V)	npn	591
ESM3045D(V)	npn	591
ESM4045A(V)	npn	595
ESM4045D(V)	npn	595
ESM5045D(V)	npn	599
ESM6045A(V)	npn	603
ESM6045D(V)	npn	603
MJE13004	npn	607
MJE13005	npn	607
MJE13006	npn	611
MJE13007	npn	611
MJE13008	npn	617
MJE13009	npn	617
PH13002	npn	621
PH13003	npn	621
TIP47	npn	627
TIP48	npn	627
TIP49	npn	627
TIP50	npn	627

GENERAL

Rating systems
Transistor ratings
Letter symbols
SOAR curves

RATING SYSTEMS

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

DEFINITIONS OF TERMS USED

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

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

Characteristic. A characteristic is an inherent and measurable property of a device. Such a property may be electrical, mechanical, thermal, hydraulic, electro-magnetic, or nuclear, and can be expressed as a value for stated or recognized conditions. A characteristic may also be a set of related values, usually shown in graphical form.

Bogey electronic device. An electronic device whose characteristics have the published nominal values for the type. A bogey electronic device for any particular application can be obtained by considering only those characteristics which are directly related to the application.

Rating. A value which establishes either a limiting capability or a limiting condition for an electronic device. It is determined for specified values of environment and operation, and may be stated in any suitable terms.

Note
Limiting conditions may be either maxima or minima.

Rating system. The set of principles upon which ratings are established and which determine their interpretation.

Note
The rating system indicates the division of responsibility between the device manufacturer and the circuit designer, with the object of ensuring that the working conditions do not exceed the ratings.

ABSOLUTE MAXIMUM RATING SYSTEM

Absolute maximum ratings are limiting values of operating and environmental conditions applicable to any electronic device of a specified type as defined by its published data, which should not be exceeded under the worst probable conditions.

These values are chosen by the device manufacturer to provide acceptable serviceability of the device, taking no responsibility for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the device under consideration and of all other electronic devices in the equipment.

The equipment manufacturer should design so that, initially and throughout life, no absolute maximum value for the intended service is exceeded with any device under the worst probable operating conditions with respect to supply voltage variation, equipment component variation, equipment control adjustment, load variations, signal variation, environmental conditions, and variations in characteristics of the device under consideration and of all other electronic devices in the equipment.

DESIGN MAXIMUM RATING SYSTEM

Design maximum ratings are limiting values of operating and environmental conditions applicable to a bogey electronic device of a specified type as defined by its published data, and should not be exceeded under the worst probable conditions.

These values are chosen by the device manufacturer to provide acceptable serviceability of the device, taking responsibility for the effects of changes in operating conditions due to variations in the characteristics of the electronic device under consideration.

The equipment manufacturer should design so that, initially and throughout life, no design maximum value for the intended service is exceeded with a bogey device under the worst probable operating conditions with respect to supply voltage variation, equipment component variation, variation in characteristics of all other devices in the equipment, equipment control adjustment, load variation, signal variation and environmental conditions.

DESIGN CENTRE RATING SYSTEM

Design centre ratings are limiting values of operating and environmental conditions applicable to a bogey electronic device of a specified type as defined by its published data, and should not be exceeded under normal conditions.

These values are chosen by the device manufacturer to provide acceptable serviceability of the device in average applications, taking responsibility for normal changes in operating conditions due to rated supply voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of all electronic devices.

The equipment manufacturer should design so that, initially, no design centre value for the intended service is exceeded with a bogey electronic device in equipment operating at the stated normal supply voltage.

TRANSISTOR RATINGS

The ratings are presented as voltage, current, power and temperature ratings. The list of these ratings and their definitions is given as follows:

Transistor voltage ratings

Collector to base voltage ratings

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} (IE = 0) — The maximum permissible instantaneous voltage between collector and base terminals, when the emitter terminal is open-circuited.

Emitter to base voltage ratings

V_{EBmax} — The maximum permissible instantaneous reverse voltage between emitter and base terminal. The emitter voltage is negative with respect to base for pnp transistor and positive with respect to base for npn types.

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

Collector to emitter voltage ratings

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 transistor and negative with respect to emitter for npn types.

NOTE: The term "cut-off" is sometimes replaced by $V_{BE} > x$ volts, or $\frac{R_B}{R_E}$, $\leqslant y$ which are equivalent conditions under which the device may be cut-off.

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

V_{CEmax} ($I_B = 0$) — The maximum permissible instantaneous voltage between collector and emitter terminals when the base terminal is open circuited 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 which is a curve of collector as a function of collector to emitter voltage (see Fig. 1).

Fig. 1 is divided into two areas:

The permissible area of operation under all conditions of base drive provided the dissipation rating is not exceeded (area 1) and the area where operation is allowable under certain specified conditions (area 2). To assist in determining the rating in this second area, further curves are provided relating the voltage rating to external circuit conditions, for example:

$$\frac{R_B}{R_E},\ R_B, Z_{Bg}, V_{BE}, I_B \text{ or } \frac{V_{BB}}{R_B}.$$

An example of this type of curve is given in Fig. 2 as V_{CE} as a function of $\frac{R_B}{R_E}$ for two different values of collector current.

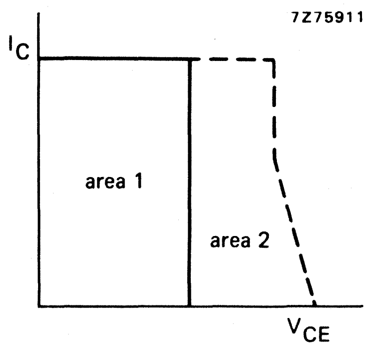


Fig. 1 Permissible operation areas.

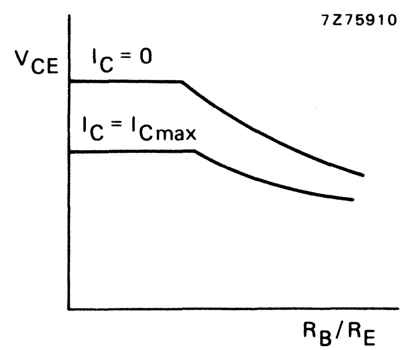


Fig. 2 Effect of collector current on permissible operation areas.

It should be noted that when R_E is shunted by a capacitor, the collector voltage V_{CE}, during switching, must be restricted to a value which 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 permissible to operate outside the rated area provided the specified energy rating is not exceeded.

Transistor current ratings

Collector current ratings

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 current ratings

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 reverse emitter current allowable in the reverse breakdown region.

Base current ratings

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 reverse base current allowable 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.

Transistor power ratings

P_{tot} max: The total maximum permissible continuous power dissipation in the transistor, which includes both the collector-base dissipation and the 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)" are often used. The permissible total power dissipation is dependent upon temperature and its relationship is shown in Fig. 3.

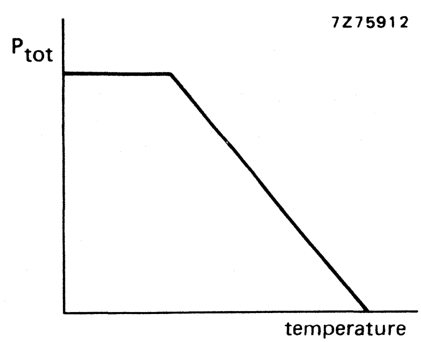


Fig. 3 Permissible total power dissipation.

The temperature may be the ambient, case or mounting base temperature. Where a colling clip or a 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 resistance and contact resistance is often included in Fig. 3.

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

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

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

For the calculation of pulse power operation P_P, the maximum pulse power is obtained using Fig. 4.

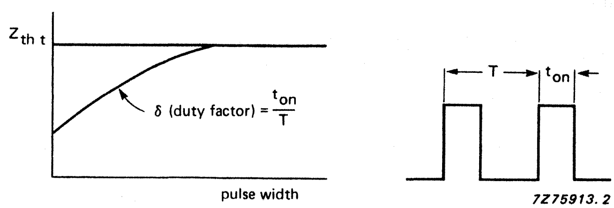


Fig. 4 Pulse power operation.

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

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

where $Z_{th\ t}$ and d are given in Fig. 4 and $R_{th\ c\text{-}a}$ is the thermal resistance between case and ambient for case rated device. For mounting base rated device, it is equal to $R_{th\ h} + R_{th\ i}$ and is zero for 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 $Z_{th\ t}$.

Temperature ratings

T_{jmax}	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_{jmax} (continuous operation)	The maximum permissible continuous value.
T_{jmax} (intermittent operation)	The maximum permissible instantaneous junction temperature usually allowed for a total duration of 200 hours.
T_{mb}	The temperature of the surface making contact with a 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 to which may be attached a clip-on cooling fin.

LETTER SYMBOLS FOR TRANSISTORS AND SIGNAL DIODES

based on IEC Publication 148

LETTER SYMBOLS FOR CURRENTS, VOLTAGES AND POWERS

Basic letters

The basic letters to be used are:

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

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

Subscripts

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

Note: No additional subscript is used for DC values.

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

a) continuous (DC) values (without signal)

Example I_B

b) instantaneous total values

Example i_B

c) average total values

Example $I_{B(AV)}$

d) peak total values

Example I_{BM}

e) root-mean-square total values

Example $I_{B(RMS)}$

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

a) instantaneous values

Example i_b

b) root-mean-square values

Example $I_{b(rms)}$

c) peak values

Example I_{bm}

d) average values

Example $I_{b(av)}$

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

Additional rules for subscripts

Subscripts for currents

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

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

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

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

Subscripts for voltages

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

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

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

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

Subscripts for supply voltages or supply currents

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

Examples: V_{CC}, I_{EE}

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

Example : V_{CCE}

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

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

Examples: I_{B2} = continuous (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

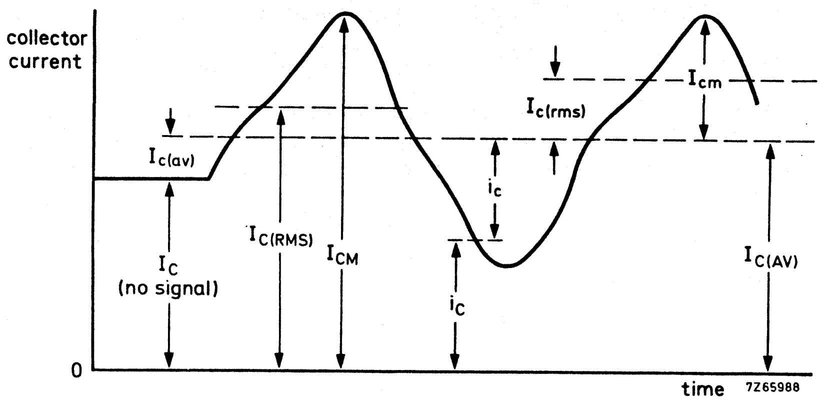
For multiple unit devices, the subscripts are modified by a number preceding the letter subscript; in the case of multiple subscripts, hyphens may be necessary to avoid misunderstanding.

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 the second unit.

Application of the rules

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



LETTER SYMBOLS FOR ELECTRICAL PARAMETERS

Defenition

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

Basic letters

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

B, b = susceptance; imaginary part of an admittance

C = capacitance

G, g = conductance; real part of an admittance

H, h = hybrid parameter

L = inductance

R, r = resistance; real part of an impedance

X, x = reactance; imaginary part of an impedance

Y, y = admittance;

Z, z = impedance;

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

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

b) all inductances and capacitances.

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

Subscripts

General subscripts

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

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

Examples: Z_S, h_f, h_F

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

Examples : h_{FE} = static value of forward current transfer ratio in common-emitter configuration (DC current gain)

R_E = DC value of the external emitter resistance

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

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

Examples: h_{fe} = small-signal value of the short-circuit forward current transfer ratio in common-emitter configuration

$Z_e = R_e + jX_e$ = small-signal value of the external impedance

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

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

Subscripts for four-pole matrix parameters

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

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

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

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

Distinction between real and imaginary parts

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

Examples: $Z_i = R_i + jX_i$
$y_{fe} = g_{fe} + jb_{fe}$

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

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

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 purpose of this chapter is to enable design engineers to make optimum use of the information.

Average junction temperature

Heat dissipation in the collector-base junction flows through the thermal resistance $R_{th\ j\text{-}mb}$ between junction and mounting base, see Fig. 1.

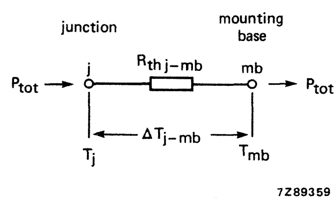


Fig. 1 Heat transport in a transistor with power dissipation constant with respect to time.

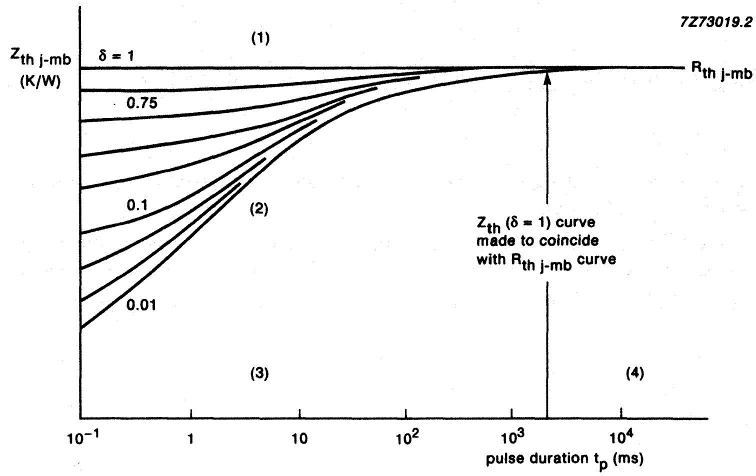
For steady-state (DC) operation the junction temperature will increase to:

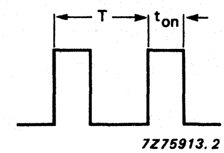
$$T_j = T_{mb} + P_{tot} \times R_{th\ j\text{-}mb}$$

For pulse operation the junction temperature will be:

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

During pulsed 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 heat dissipation is permitted, see Fig. 2.





(1) DC line.
(2) Single pulse line.
(3) Pulse conditions.
(4) Steady-state conditions.

Fig. 2 A typical family of $Z_{th\ j\text{-}mb}$ curves for a power transistor.

This curve may be presented with either absolute figures ($Z_{th\ j\text{-}mb}$) or as normalized thermal impedance (NTI), where:

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

Maximum allowable dissipation

Total power dissipation in a transistor is given by:

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

The second term can usually be disregarded so $P_{tot} \approx I_C \times V_{CE}$.

The maximum allowable power dissipation is limited by the maximum allowable junction temperature for the constant power curves (P_{tot}) and by second breakdown for the second-breakdown curves, see Fig. 3.

Constant power curves

P_{tot} can be calculated as follows:

For steady-state conditions (DC);

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

For pulsed conditions;

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

In most cases the maximum power dissipation ($P_{tot\ max}$ DC) specified in a data sheet is for a given mounting base temperature. This is usually T_{mb} = 25 °C but may be much higher.

For transistors in fully isolated envelopes (SOT186 and SOT199, ISOTOP), the maximum dissipation can not be referenced to the mounting base, therefore, the data sheets specify a given heatsink temperature (T_h) which may be calculated as follows:

For steady-state conditions (DC)

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

For pulsed conditions

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

Again the temperature specified in a data sheet is usually T_h = 25 °C but may be much higher. The total thermal resistance/impedance includes the transfer resistance from the case to heatsink under specific mounting conditions.

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_{CEOmax}
Forward Biased with $V_{CE} > V_{CEO\ max}$
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 last two conditions are only specified for power switching transistors.

FORWARD BIASED SAFE OPERATION AREA UP TO V_{CEOmax}

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

Maximum collector current I_C or I_{CM}
Maximum collector-emitter voltage V_{CEOmax}
Maximum power dissipation P_{tot}
Second-breakdown limit S/B sat

To cover the widest range of applications FB-SOAR curves are specified for both DC and pulse operation.

At steady state conditions (DC)

Fig. 3 shows a DC FB-SOAR curve plotted on a log-log grid. The right-hand boundary is formed by V_{CEOmax} which extends up to a collector current of 300 V, above this point as I_{CE} is increased V_{CE} must be reduced to prevent second-breakdown.

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 with increasing V_{CE} 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.

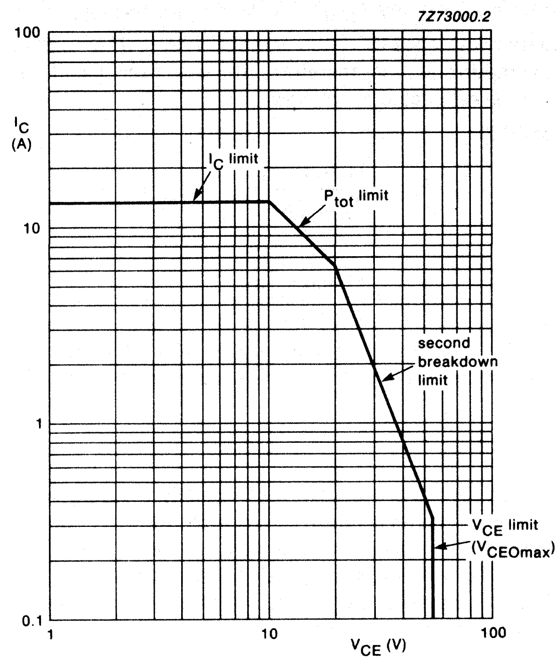
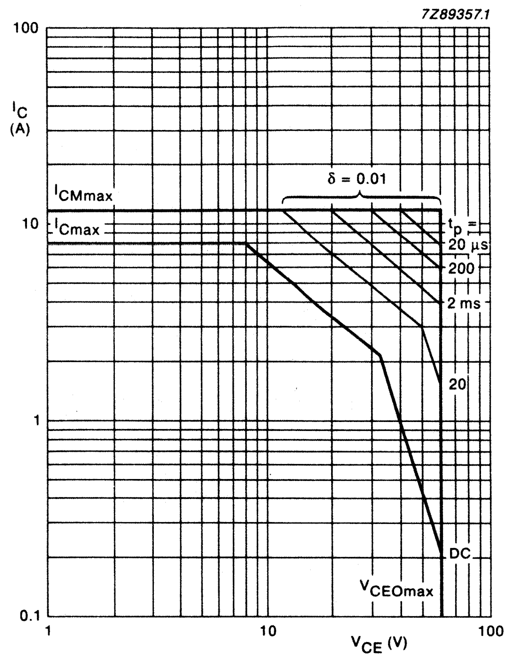


Fig. 3 A typical DC SOAR graph with boundaries defined.

At pulsed conditions

With the exception of DC FB-SOAR data sheets for power transistors contain a set of curves that apply under specific pulse conditions, that are normally at a duty factor of $\delta = 0.01$ and a pulse length of 20 ms or less.

An example of the FB-SOAR extension for single-shot and repetitive pulsed operation is shown in Fig. 4.



These curves for pulsed conditions are derived from the DC curve with the aid of the thermal impedance curves shown in Fig. 2.

All curves apply to the stated temperature (T_{mb} or T_h) above which derating must be applied.
A power derating curve of the form shown in Fig. 5 is given in the data sheets from which maximum allowable power dissipation for P_{tot} and S/B sat can be calculated for any T_{mb} or T_h up to $T_{j\ max}$.

Fig. 4 Maximum collector current and collector-emitter voltage for DC and pulsed conditions.

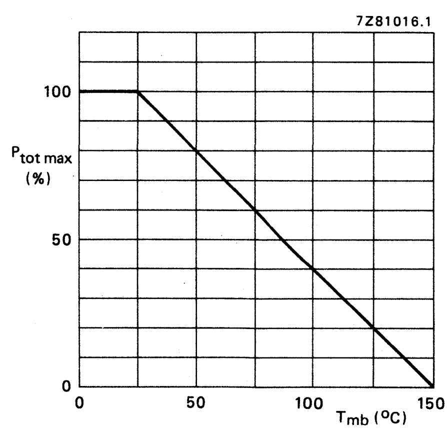
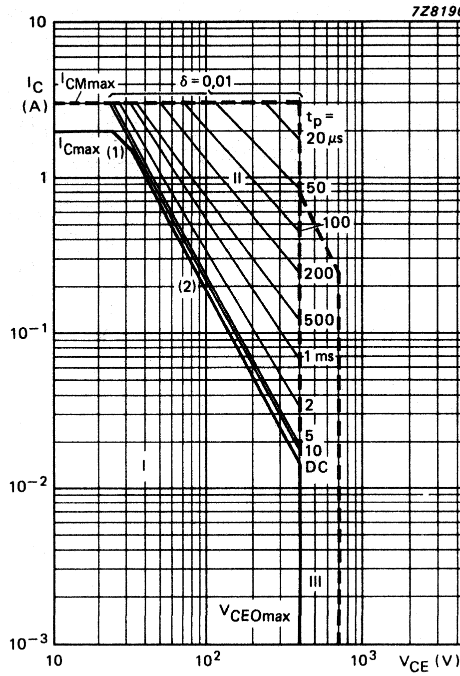


Fig. 5 Power derating curve, maximum permissible dissipation as a function of mounting base temperature.

FORWARD BIASED SAFE OPERATING AREA WITH $V_{CE} > V_{CEOmax}$



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, providing $R_{BE} \leqslant 100\ \Omega$ and $t_p \leqslant 6.0\ \mu s$.

Fig. 6 Safe operating area at $T_{mb} \leqslant 25\ ^oC$.

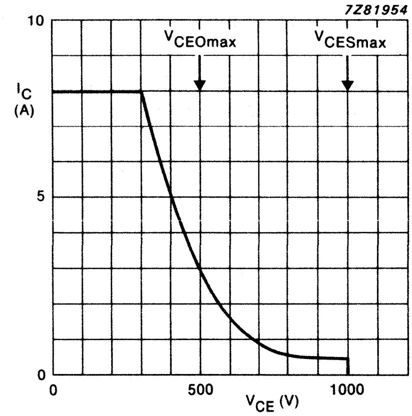
For switching power transistors in inductive load applications such as flyback converters, the collector-emitter voltage normally exceeds the rated V_{CEOmax} limit in the non-inductive stage. The collector current will rise steeply at turn on while the collector-emitter voltage is still greater than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

Fig. 6 shows FB-SOAR with an extension for turn-on (area III), (this is not temperature dependent and therefore derating at higher temperatures is not necessary).

REVERSE BIASED SAFE OPERATING AREA UP TO V_{CESmax} (RB-SOAR)

At turn-off of inductive loaded transistors, where in most cases the base to emitter junction is reverse biased, the collector to emitter voltage will rise steeply to a high level while the collector is still conducting. Under these conditions the collector voltage must be held to a safe level by means of clamping, snubbing etc.

The safe level of operation is contained in the data sheets in the form shown in Fig. 7.



This turn-off extension is not temperature dependent and so derating at higher temperatures is not necessary.

Fig. 7 Reverse biased area of permissible operation during turn-off, providing that $T_{mb} \leqslant 100\ ^{o}C$; $V_{BE\ off} = 5$ V; $I_C/I_B \geqslant 5$.

HOW TO USE THE SOAR INFORMATION FROM THE DATA SHEETS

When the intended function of the power transistor and its application is decided, a suitable device can be selected using the following ratings from the 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_f or f_T

Now determine the following parameters for the intended application.

Duty factor	d
Maximum operational ambient temperature	T_{amb}
Maximum operational worse case average dissipation	P_{wc}

The next step is to calculate the required thermal resistance of the heatsink ($R_{th\ h\text{-}a}$) as follows:

For direct mounted devices:

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

For fully isolated devices:

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

Also calculate the mounting base temperature (T_{mb} or T_h) as follows:

For direct mounted devices:

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

For fully isolated devices:

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

The SOAR data sheet curves, thermal impedance and derating may now be used to construct a safe operating area for the device, (this is adaptable to the conditions for the application e.g. T_{mb} , pulse time and duty factor).

The last step is to measure the I_C/V_{CE} locus in your 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 prefered transistor does not fit, select the nearest suitable device or modify the circuitry.

TRANSISTOR DATA

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 switching regulators, inverters, motor controls, solenoid/relay drivers and deflection circuits.

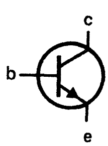
QUICK REFERENCE DATA

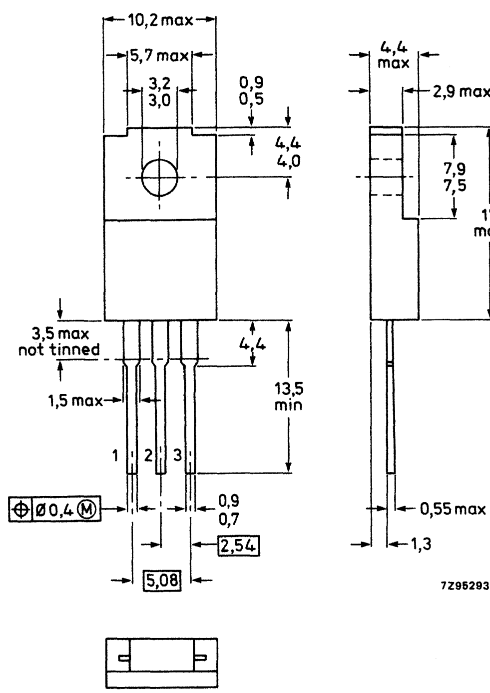
			BU306F	307F	
Collector-emitter voltage					
peak value; $V_{BE} = 0$	V_{CESM}	max.	600	700	V
open base	V_{CEO}	max.	300	400	V
Collector-emitter saturation voltage	V_{CEsat}	max.	1.5		V
Collector current					
saturation	I_{Csat}	max.	5.0		A
DC	I_C	max.	8.0		A
peak value	I_{CM}	max.	16		A
Total power dissipation					
up to $T_h = 25\ ^oC$	P_{tot}	max.	20		W

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)

			BU306F	307F	
Collector-emitter voltage					
peak value; $V_{BE} = 0$	V_{CESM}	max.	600	700	V
open base	V_{CEO}	max.	300	400	V
Collector current					
DC	I_C	max.	8.0		A
peak value	I_{CM}	max.	16		A
Base current					
DC	I_B	max.	4.0		A
peak value	I_{BM}	max.	8.0		A
Total power dissipation					
up to $T_h = 25\ ^oC$	P_{tot}	max.	20		W
Storage temperature	T_{stg}		−65 to + 150		^oC
Junction temperature	T_j	max.	150		^oC

THERMAL RESISTANCE

From junction to heatsink (note 1)	$R_{th\ j\text{-}h}$	=	6.12	K/W
From junction to heatsink (note 2)	$R_{th\ j\text{-}h}$	=	3.62	K/W
From junction to ambient	$R_{th\ j\text{-}a}$	=	55	K/W

ISOLATION

Isolation voltage from all terminals to external heatsink (peak value)	V_{isol}	max.	1000	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 °C unless otherwise specified

Collector cut-off current				
$V_{CE} = V_{CESmax}$; $V_{BE} = -1.5$ V	I_{CES}	max.	1.0	mA
$V_{CE} = V_{CESmax}$; $V_{BE} = -1.5$ V; T_j = 100 °C	I_{CES}	max.	5.0	mA
Emitter cut-off current				
V_{EB} = 9 V; I_C = 0	I_{EBO}	max.	1.0	mA
Current gain				
I_C = 0.5 A; V_{CE} = 5 V	h_{FE}		15 to 50	
I_C = 2 A; V_{CE} = 5 V	h_{FE}		8 to 40	
I_C = 5 A; V_{CE} = 5 V	h_{FE}		6 to 30	
Collector-emitter saturation voltage				
I_C = 2 A; I_B = 0.4 A	V_{CEsat}	max.	1.0	V
I_C = 5 A; I_B = 1.0 A	V_{CEsat}	max.	1.5	V
I_C = 8 A; I_B = 2.0 A	V_{CEsat}	max.	3.0	V
I_C = 5 A; I_B = 1.0 A; T_j = 100 °C	V_{CEsat}	max.	2.0	V
Base-emitter saturation voltage				
I_C = 2 A; I_B = 0.4 A	V_{BEsat}	max.	1.2	V
I_C = 5 A; I_B = 1.0 A	V_{BEsat}	max.	1.6	V
I_C = 5 A; I_B = 1.0 A; T_j = 100 °C	V_{BEsat}	max.	1.5	V
Transition frequency				
I_C = 0.5 A; V_{CE} = 10 V; f = 1 MHz	f_T	typ.	4.0	MHz
Collector capacitance				
V_{CB} = 10 V; I_E = 0	C_{cb}	typ.	80	pF

			BU306F	307F	
Collector-emitter sustaining voltage (Figs 2 and 3)					
I_C = 100 mA; I_B = 0; L = 25 mH	$V_{CEOsust}$	min.	300	400	V

Switching times resistive load (Figs 4 and 5)				
V_{CC} = 125 V; I_C = 5 A; t_p = 25 μs				
δ = 0.01; $I_{B\,on} = I_{B\,off}$ = 1.0 A	t_d	max.	0.1	μs
	t_r	max.	1.0	μs
	t_s	typ.	3.0	μs
	t_f	max.	0.7	μs
Switching times inductive load (Figs 6 and 7)				
I_C = 5 A; $I_{B\,on}$ = 1.0 A;				
V_{clamp} = 300 V; V_{BE} = −5 V;				
T_C = 100 °C; L_B = 1 μH	t_s	typ.	0.86	μs
	t_s	max.	2.30	μs
	t_c	typ.	0.14	μs
	t_c	max.	0.70	μs

DEVELOPMENT DATA

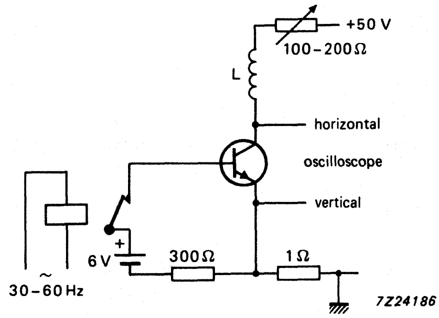


Fig. 2 Test circuit for $V_{CEOsust}$.

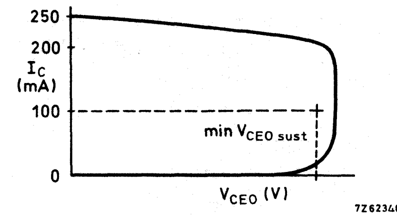


Fig. 3 Oscilloscope display for sustaining voltage.

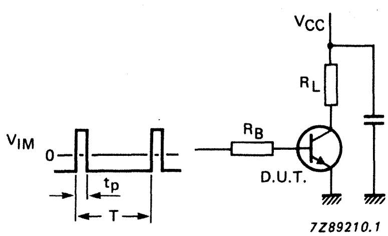


Fig. 4 Test circuit resistive load.

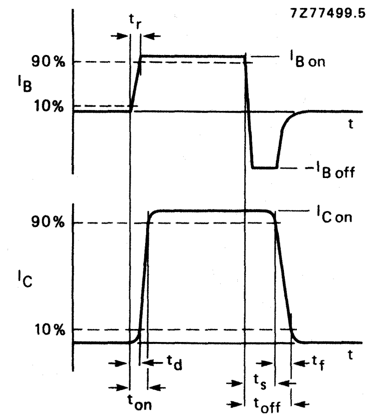


Fig. 5 Switching times waveforms with resistive load; $t_r \leq 30$ ns.

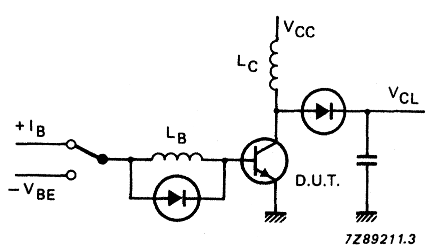


Fig. 6 Test circuit inductive load.

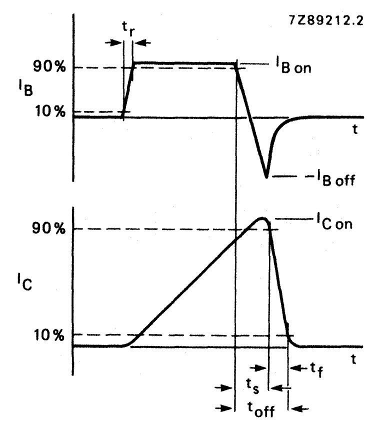


Fig. 7 Switching times waveforms with inductive load.

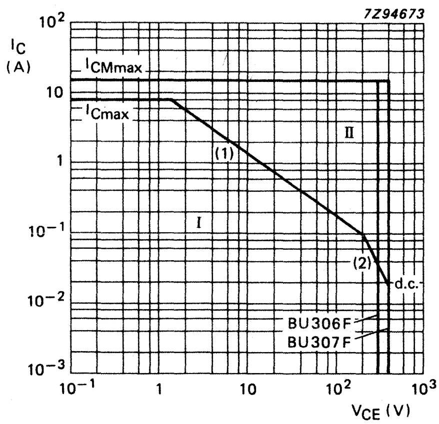


Fig. 8 Safe operating area; mounted *without* heatsink compound.

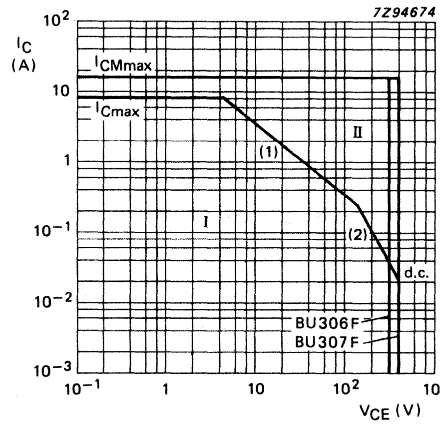


Fig. 9 Safe operating area; mounted *with* heatsink compound.

Conditions for Figs 8 and 9:

T_{mb} = 25 °C
(1) = $P_{tot\,max}$ line
(2) = second-breakdown limits
I = region of permissible DC operation
II = permissible extension for repetitive pulse operation

DEVELOPMENT DATA

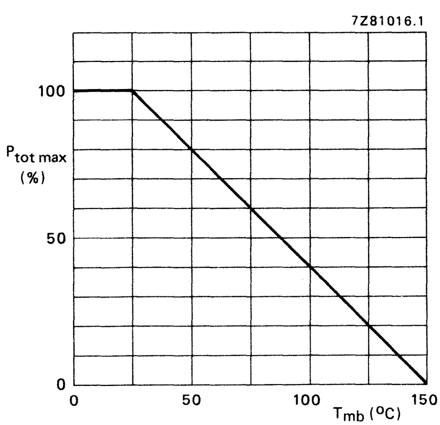


Fig. 10 Power derating curve.

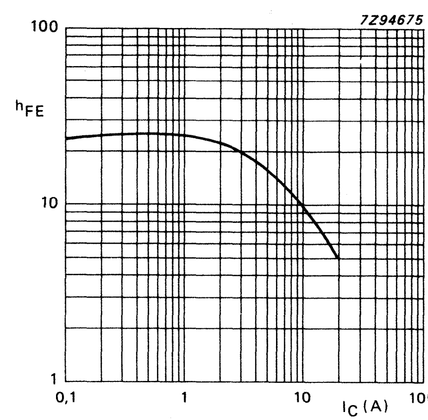


Fig. 11 DC current gain; V_{CE} = 5 V; T_j = 25 °C.

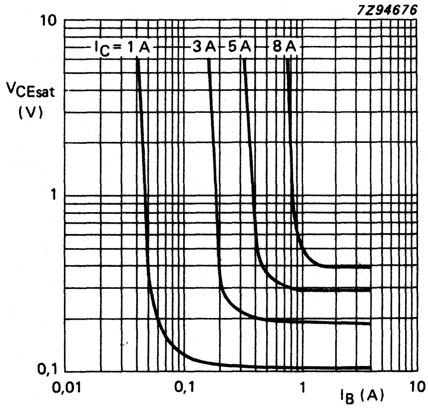


Fig. 12 Collector-emitter saturation voltage; T_j = 25 °C.

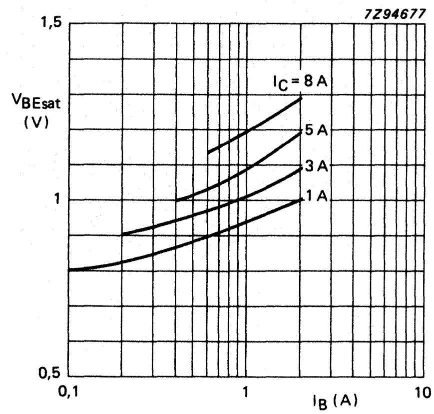


Fig. 13 Base-emitter saturation voltage; T_j = 25 °C.

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.

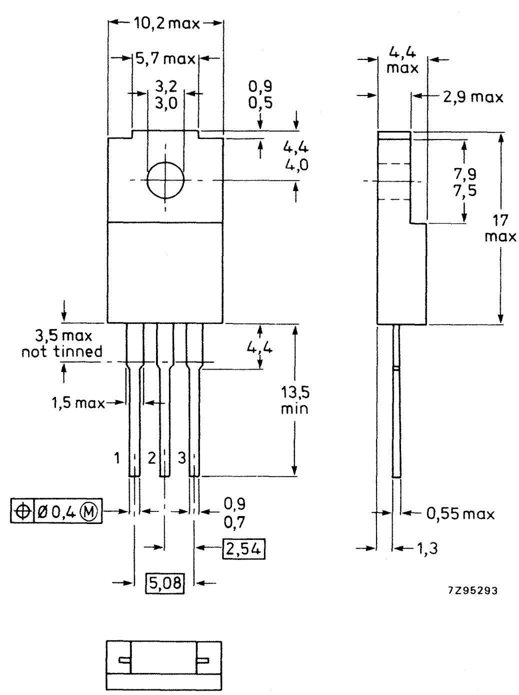
QUICK REFERENCE DATA

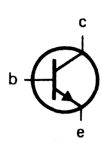
			BU406F	407F	
Collector-emitter voltage					
peak value; $V_{BE} = 0$	V_{CESM}	max.	400	330	V
open base	V_{CEO}	max.	200	150	V
Collector-emitter saturation voltage	V_{CEsat}	max.	1.0		V
Collector current					
saturation	I_{Csat}	max.	5.0		A
DC	I_C	max.	7.0		A
peak value	I_{CM}	max.	15		A
Total power dissipation					
up to $T_h = 25\ ^oC$	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.

RATINGS

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

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

THERMAL RESISTANCE

From junction to external heatsink (1)	$R_{th\ j\text{-}h}$	=	7.0	K/W
From junction to external heatsink (2)	$R_{th\ j\text{-}h}$	=	4.5	K/W
From junction to ambient	$R_{th\ j\text{-}a}$	=	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 ⩽ 65 % under clean and dust free conditions.

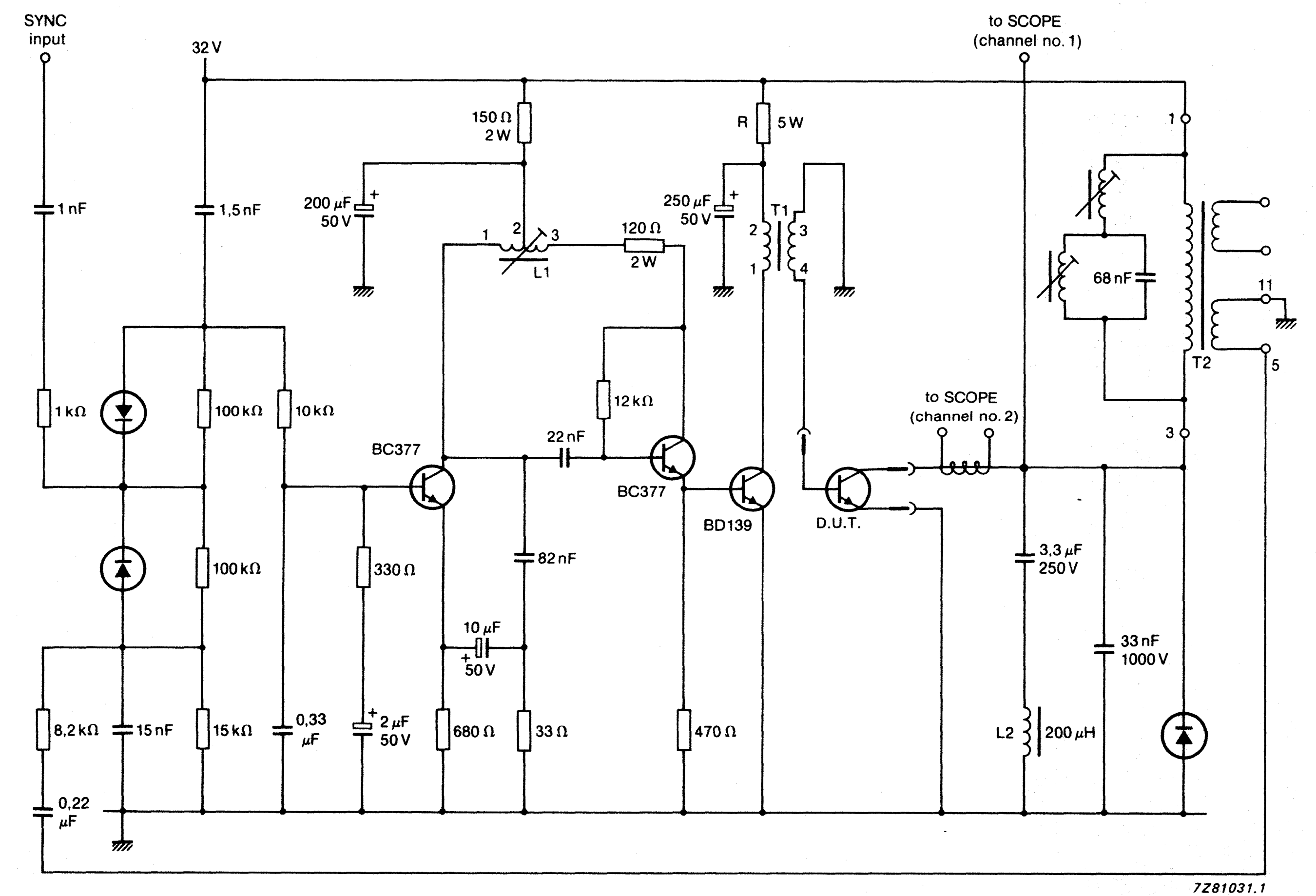
DEVELOPMENT DATA

CHARACTERISTICS

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

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



L1 = horizontal hold coils: pins 1–2 = 75 turns (0.2 mm); R = 1.5 Ω; L_{min} = 0.62 mH
pins 2–3 = 293 turns (0.2 mm); R = 4.8 Ω; L_{max} = 4.1 mH
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.

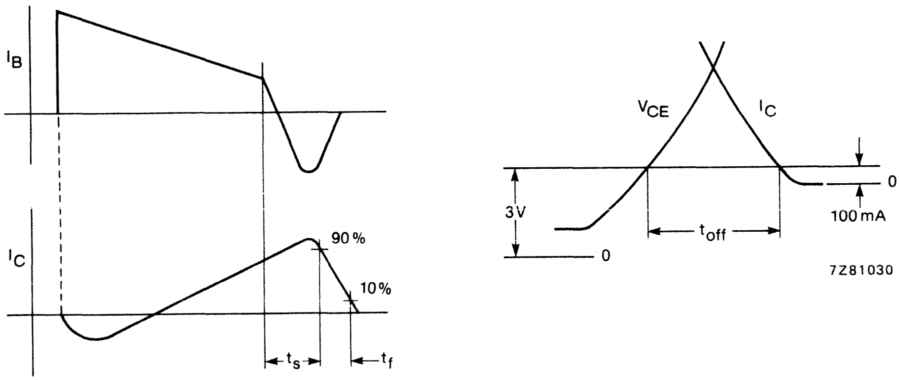


Fig. 3 Waveforms fall and storage time and turn-off time: turn-off time is the time for I_C to decrease to 100 mA after V_{CE} has risen 3 V into its flyback excursion.

DEVELOPMENT DATA

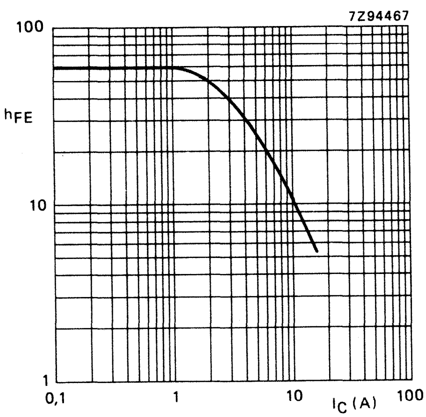


Fig. 4 BU406F: V_{CE} = 5 V; T_j = 25 °C; typical values.

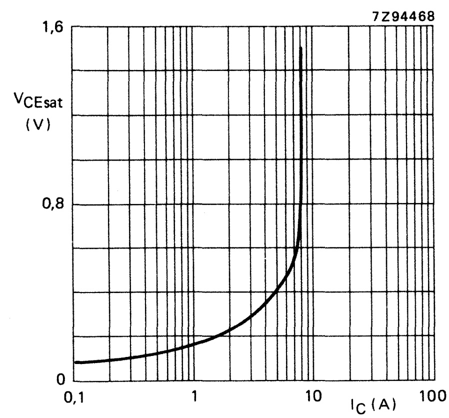


Fig. 5 BU406F: I_C/I_B = 10; T_j = 25 °C; typical values.

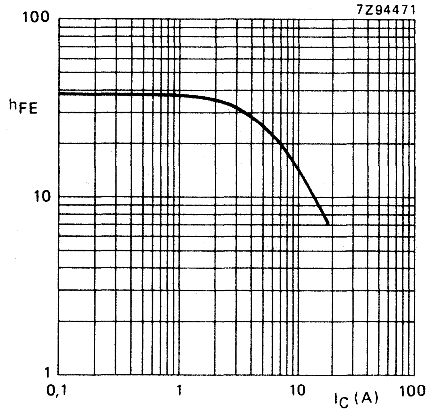


Fig. 6 BU407F: V_{CE} = 5 V;
T_j = 25 °C; typical values.

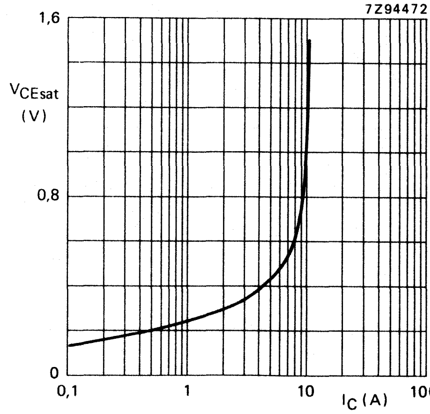


Fig. 7 BU407F: I_C/I_B = 10;
T_j = 25 °C; typical values.

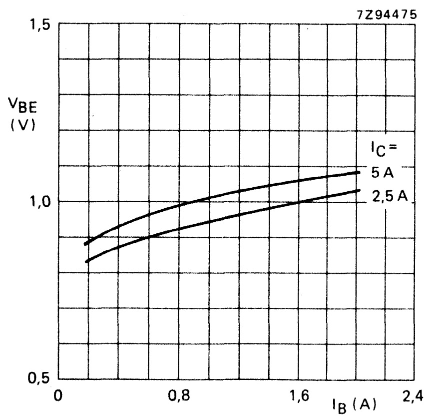


Fig. 8 BU406F/BU407F: T_j = 25 °C;
typical values.

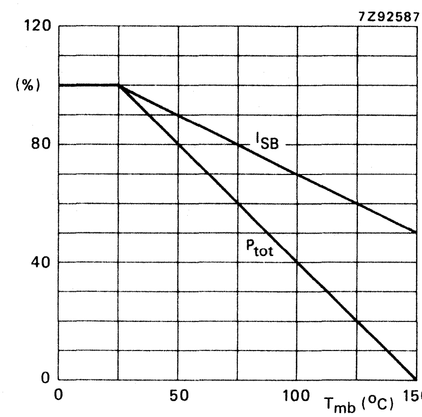
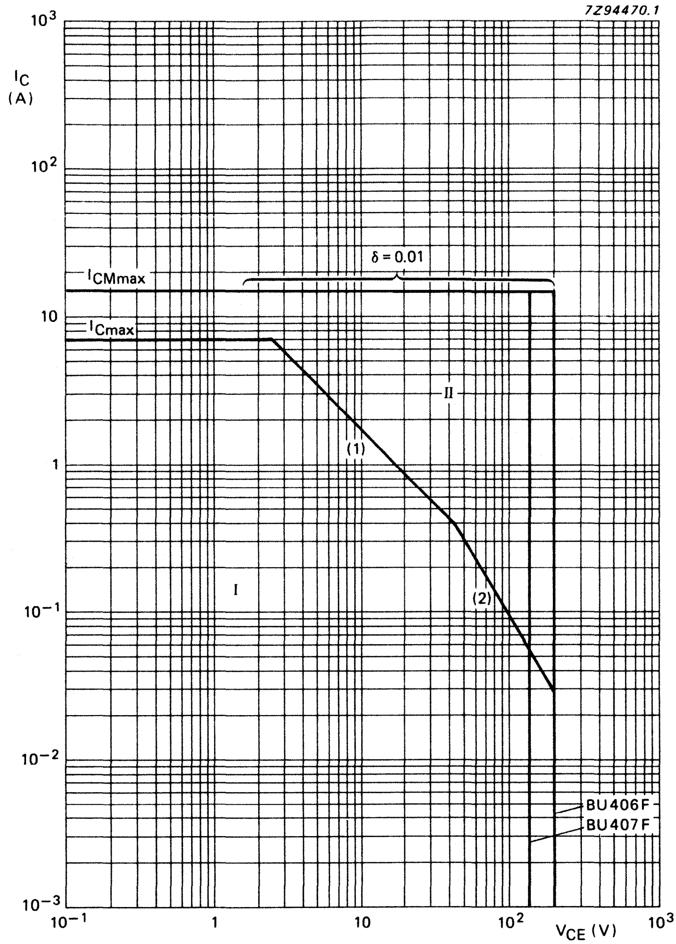


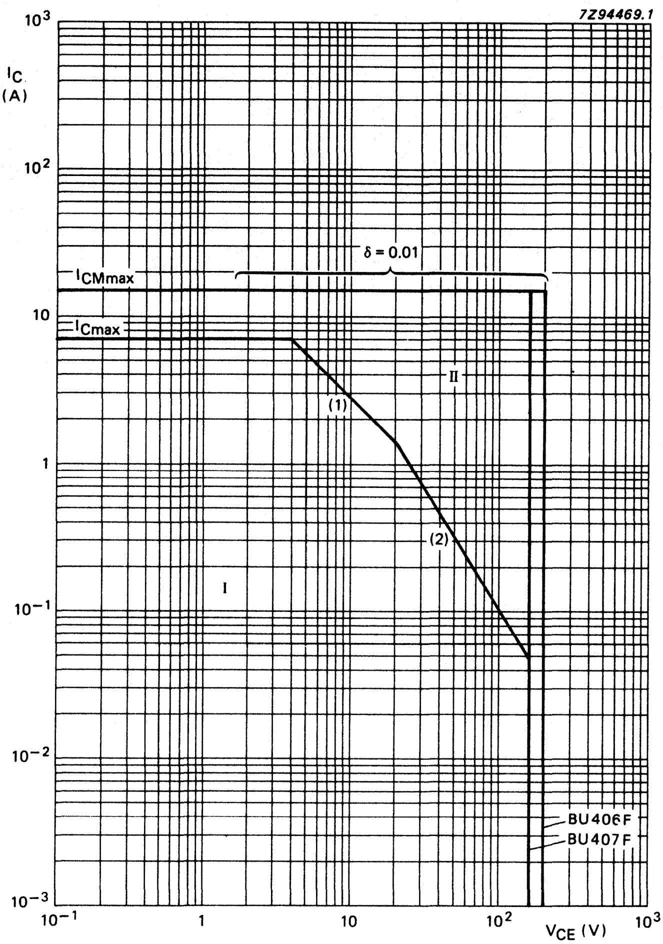
Fig. 9 BU406F/BU407F: total power dissipation and second-breakdown current derating curve.



(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 $T_{mb} < 25\ ^{o}C$. Mounted without heatsink compound and 30 ± 5 newtons pressure on the centre of the envelope.

DEVELOPMENT DATA



(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 $T_{mb} < 25\ ^oC$. 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.

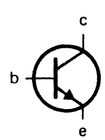
QUICK REFERENCE DATA

Collector-emitter voltage			
peak value; $V_{BE} = 0$	V_{CESM}	max.	1500 V
open base	V_{CEO}	max.	700 V
Collector-emitter saturation voltage	V_{CEsat}	max.	5.0 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 (BU505D)	V_F	max.	1.8 V
Total power dissipation up to $T_{mb} = 25\ ^oC$	P_{tot}	max.	75 W
Fall time; inductive load	t_f	typ.	0.9 μs

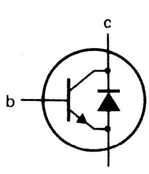
MECHANICAL DATA

Dimensions in mm

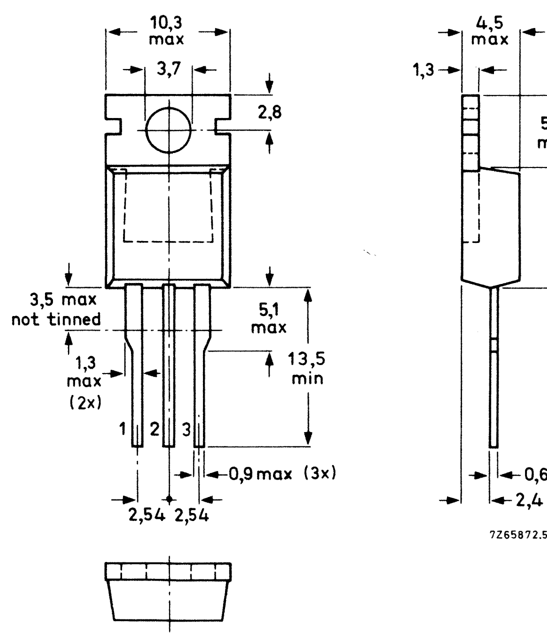
Fig. 1 TO-220AB.



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 $T_{mb} = 25\ ^oC$	P_{tot}	max.	75	W
Storage temperature range	T_{stg}		−65 to +150	^oC
Junction temperature	T_j	max.	150	^oC

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	1.67	K/W

CHARACTERISTICS

T_j = 25 °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 °C	I_{CES}	max.	1.0	mA
Emitter cut-off current				
I_C = 0; V_{EB} = 5 V	I_{EBO}	max.	1.0	mA
Emitter-base voltage				
I_E = 10 mA; I_C = 0 A	V_{EBO}		6.0	V
Collector-emitter sustaining voltage (Figs 2 and 3)	$V_{CEOsust}$	min.	700	V
Saturation voltage				
I_C = 2.0 A; I_B = 0.9 mA	V_{CEsat}	max.	5.0	V
	V_{BEsat}	max.	1.3	V
Diode forward voltage (BU505D)				
I_F = 2 A	V_F	max.	1.8	V
Second breakdown current				
V_{CE} = 120 V; t = 200 μs	I_{SB}	min.	2.0	A
Transition frequency at f = 5 MHz				
I_C = 0.1 A; V_{CE} = 5 V	f_T	typ.	7.0	MHz
Collector capacitance at f = 1 MHz				
I_E = I_e = 0; V_{CB} = 10 V	C_c	typ.	65	pF
Switching times (in horizontal deflection circuit) (Fig. 4)				
I_{CM} = 2 V; $I_{B(end)}$ = 0.9 A; V_{dr} = –4 V; T_{mb} = 85 °C				
L_B = 10 μH	t_s	typ.	6.5	μs
	t_f	typ.	0.9	μs
L_B = 15 μH	t_s	typ.	7.5	μs
	t_f	typ.	0.9	μs
L_B = 25 μH	t_s	typ.	9.5	μs
	t_f	typ.	0.85	μs

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

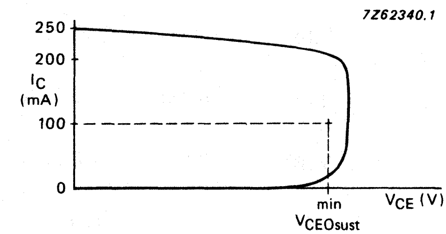


Fig. 2 Oscilloscope display for sustaining voltage.

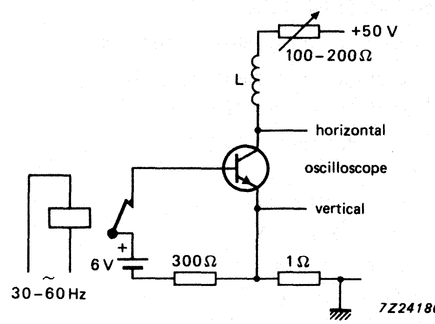


Fig. 3 Test circuit for V_{CEOsat}.

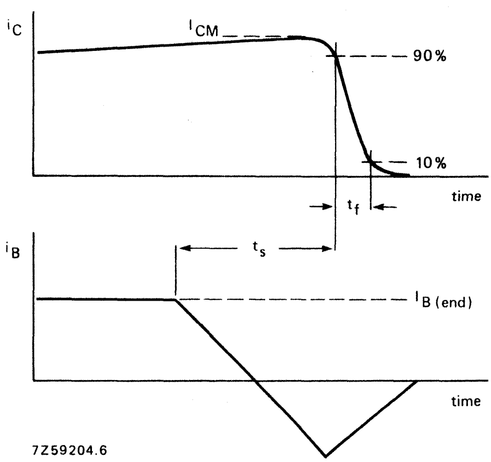


Fig. 4 Switching times waveforms.

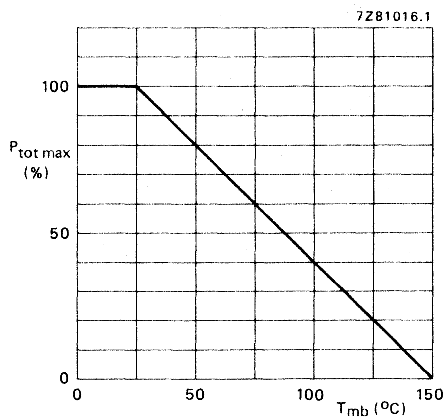
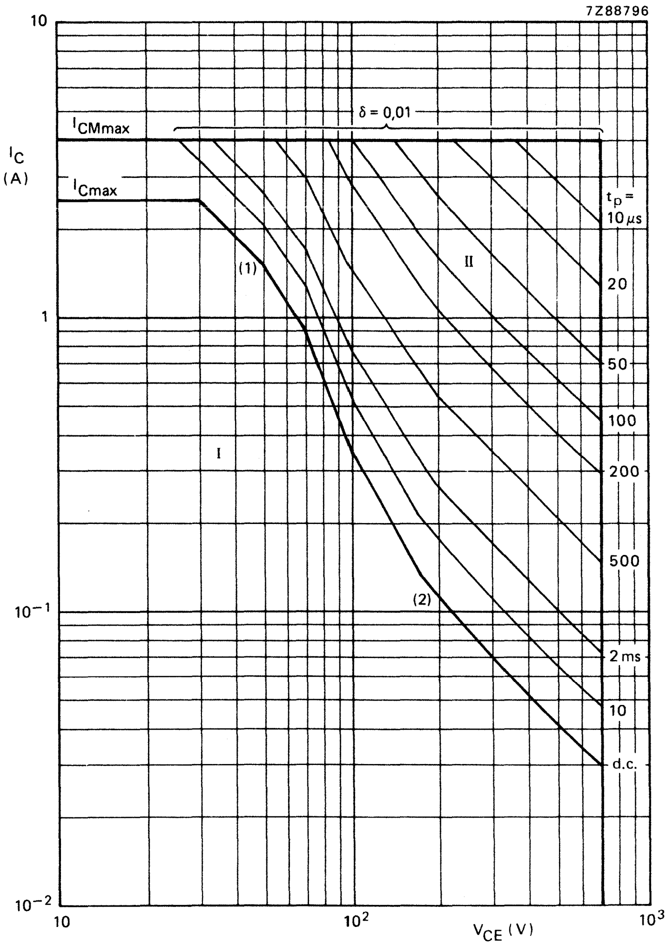


Fig. 5 Power derating curve.



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 °C.

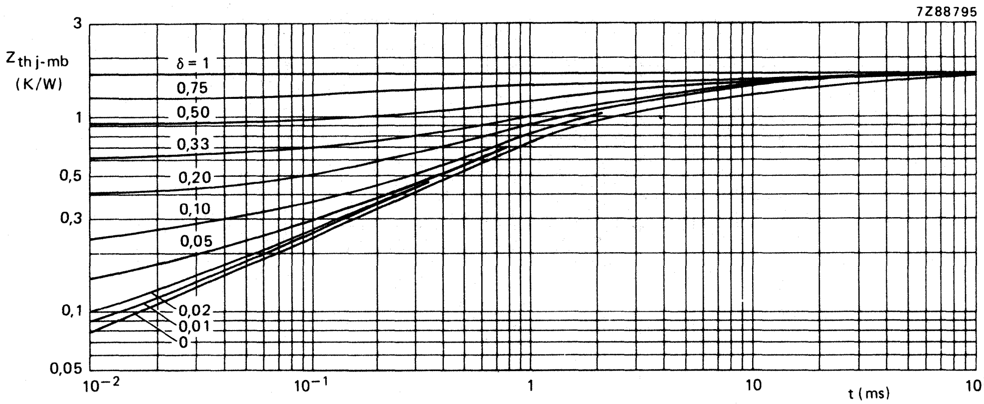


Fig. 7 Pulse power rating chart.

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.

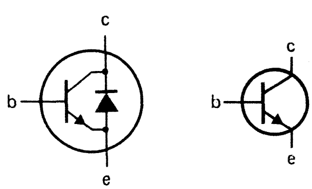
QUICK REFERENCE DATA

Collector-emitter voltage				
peak value; $V_{BE} = 0$	V_{CESM}	max.	1500	V
$V_{BE} = 0$	V_{CES}	max.	1000	V
open base	V_{CEO}	max.	700	V
Collector-emitter saturation voltage	V_{CEsat}	max.	5.0	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 $T_h = 25\ ^oC$	P_{tot}	max.	20	W
Fall time inductive load	t_f	typ.	0.7	μs

MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT186.

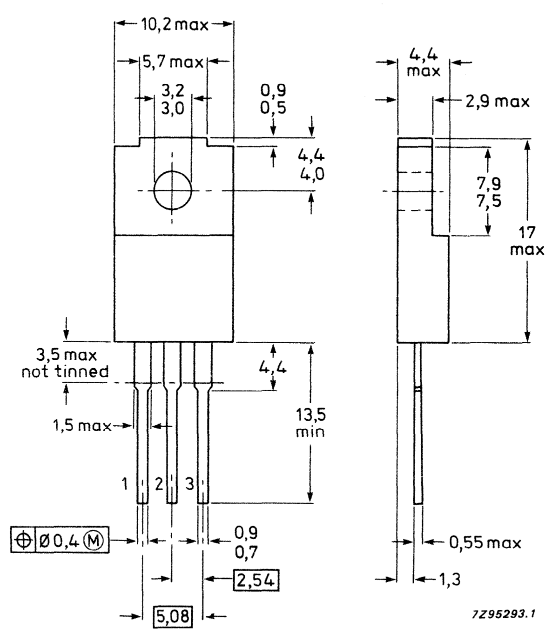


BU505DF BU505F

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 $T_h = 25$ °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 external heatsink (note 1)	$R_{th\ j\text{-}h}$	max.	6.35 K/W
From junction to external heatsink (note 2)	$R_{th\ j\text{-}h}$	max.	3.85 K/W
From junction to ambient	$R_{th\ j\text{-}a}$	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 °C unless otherwise specified

Collector cut-off current*			
V_{BE} = 0; V_{CE} = V_{CES}	I_{CES}	max.	1.0 mA
V_{BE} = 0; V_{CE} = V_{CESmax}; T_j = 125 °C	I_{CES}	max.	1.0 mA
Emitter cut-off current			
V_{EB} = 5 V; I_C = 0	I_{EBO}	max.	1.0 mA
Second-breakdown current			
V_{CE} = 120 V; t_p = 200 μs	I_{SB}	min.	2.0 A
Collector-emitter sustaining voltage			
I_C = 0.1 A; I_B = 0; L = 25 mH; (Figs 2 and 3)	$V_{CEOsust}$	min.	700 V
Saturation voltage			
I_C = 2.0 A; I_B = 0.9 A	V_{CEsat}	max.	5.0 V
	V_{BEsat}	max.	1.3 V
Diode forward voltage (BU505DF)			
I_F = 2 A	V_F	max.	1.8 V
DC current gain			
I_C = 2.0 A; V_{CE} = 5 V	h_{FE}	min.	2.22
Transition frequency at f = 1 MHz			
I_C = 0.1 A; V_{CE} = 5 V	f_T	typ.	7.0 MHz
Collector capacitance at f = 1 MHz			
I_E = I_e = 0; V_{CB} = 10 V	C_c	typ.	65 pF
Switching times (in horizontal deflection circuit) (Fig. 4)			
I_{CB} = 2 V; $I_{B(end)}$ = 0.9 A; V_{dr} = −4 V; T_{mb} = 85 °C			
L_B = 10 μH	t_s	typ.	6.5 μs
	t_f	typ.	0.9 μs
L_B = 15 μH	t_s	typ.	7.5 μs
	t_f	typ.	0.9 μs
L_B = 25 μH	t_s	typ.	9.5 μs
	t_f	typ.	0.85 μs

DEVELOPMENT DATA

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

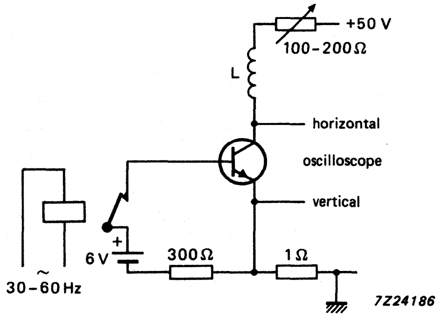


Fig. 2 Test circuit for $V_{CEOsust}$.

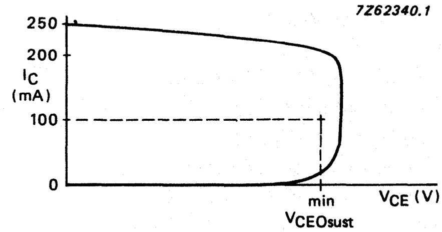


Fig. 3 Oscilloscope display for sustaining voltage.

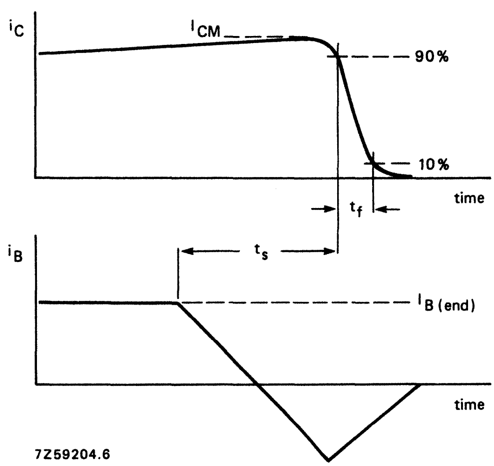


Fig. 4 Switching times waveforms.

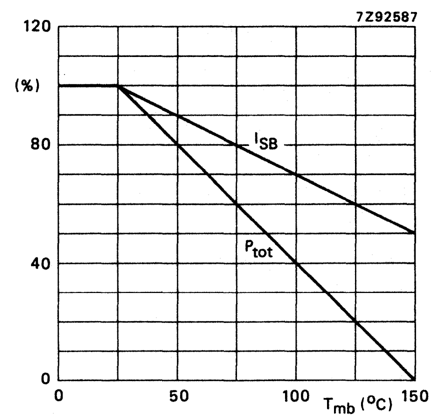
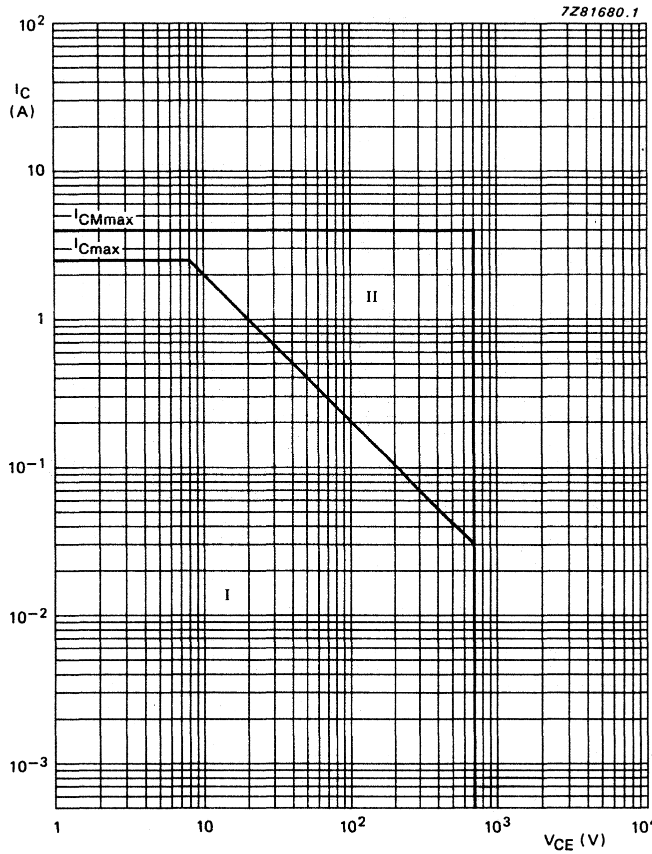


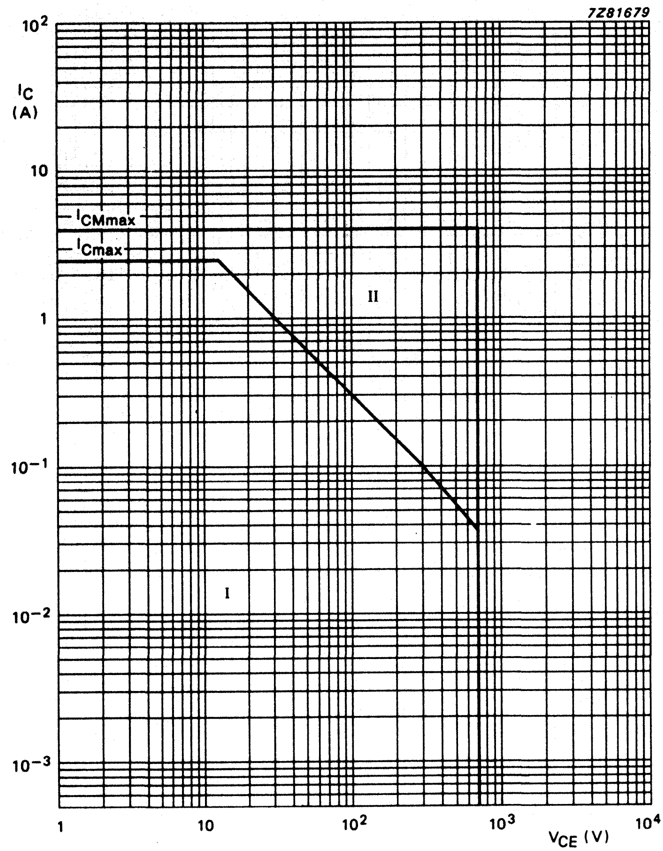
Fig. 5 Total power dissipation and second-breakdown current derating curve.

DEVELOPMENT DATA



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 °C; mounted with heatsink compound and 30 ± 5 newtons pressure on the centre of the envelope.

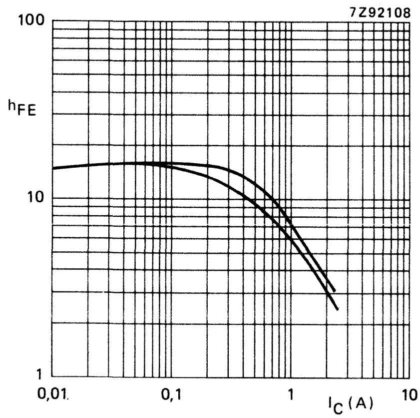


Fig. 8 Typical DC current gain.

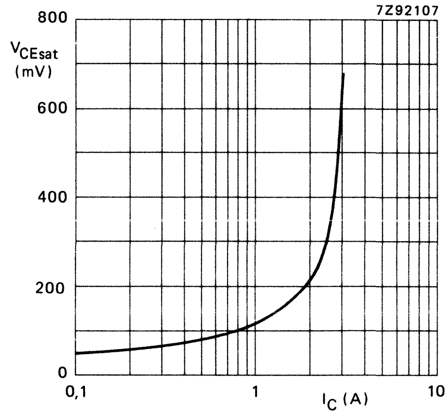


Fig. 9 Collector-emitter saturation voltage; $I_C/I_B = 2$; $T_j = 25$ °C.

DEVELOPMENT DATA

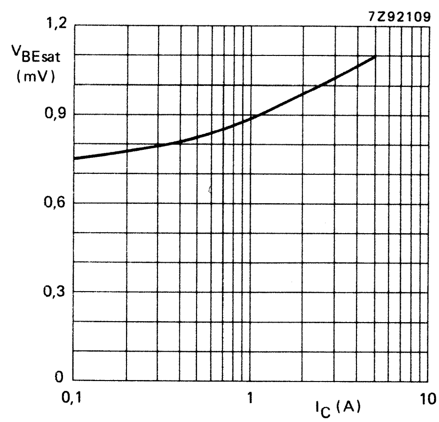


Fig. 10 Base-emitter saturation voltage; $I_C/I_B = 2$; $T_j = 25$ °C.

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.

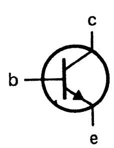
QUICK REFERENCE DATA

Collector-emitter voltage				
peak value; $V_{BE} = 0$	V_{CESM}	max.	1500	V
open base	V_{CEO}	max.	700	V
Collector-emitter saturation voltage	V_{CEsat}	max.	5.0	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 $T_{mb} = 25\ ^oC$	P_{tot}	max.	100	W
Diode forward voltage (BU506D)				
$I_F = 3$ A	V_F	typ.	1.5	V
Fall time inductive load	t_f	typ.	0.7	μs

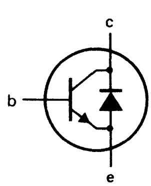
MECHANICAL DATA

Dimensions in mm

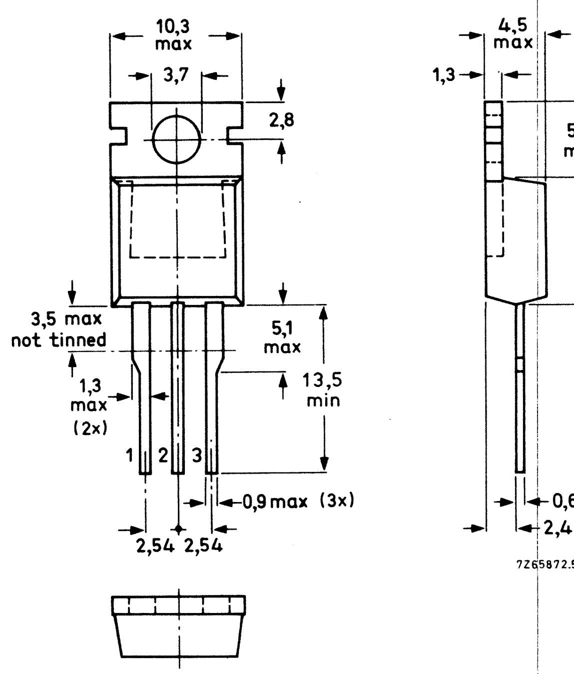
Fig. 1 TO-220AB.



BU506



BU506D



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 $T_{mb} = 25\ ^oC$	P_{tot}	max.	100	W
Storage temperature range	T_{stg}		−65 to + 150	^oC
Junction temperature	T_j	max.	150	^oC

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	max.	1.25	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current*			
$V_{BE} = 0$; $V_{CE} = V_{CESMmax}$	I_{CES}	max.	0.5 mA
$V_{BE} = 0$; $V_{CE} = V_{CESMmax}$; T_j = 125 °C	I_{CES}	max.	1.0 mA
Emitter cut-off current			
$I_C = 0$; V_{EB} = 6 V	I_{EBO}	max.	10 mA
Collector-emitter sustaining voltage (Figs 2 and 3)	$V_{CEOsust}$	min.	700 V
Saturation voltage			
I_C = 3 A; I_B = 1.33 A	V_{CEsat}	max.	5.0 V
	V_{BEsat}	max.	1.3 V
Diode forward voltage (BU506D)			
I_F = 3 A	V_F	typ.	1.5 V
	V_F	max.	2.2 V
Second breakdown current			
V_{CE} = 120V; t = 100 μs	I_{SB}	min.	1.0 A
Switching times (in line deflection circuit) (Fig. 4)			
I_{CM} = 3 A; $I_{B(end)}$ = 1 A; L_B = 12 μH	t_f	typ.	0.7 μs
	t_s	typ.	6.5 μs

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

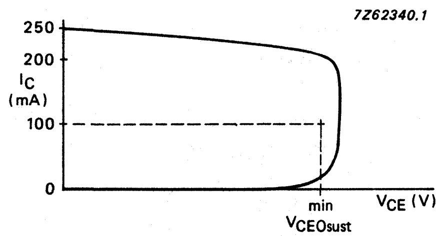


Fig. 2 Oscilloscope display for $V_{CEOsust}$.

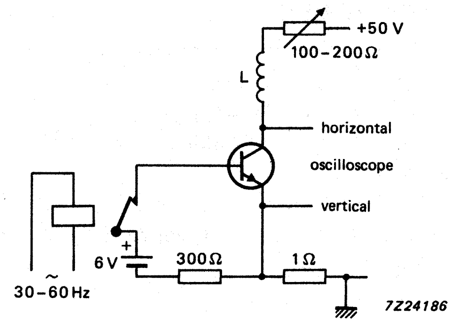


Fig. 3 Test circuit for $V_{CEOsust}$.

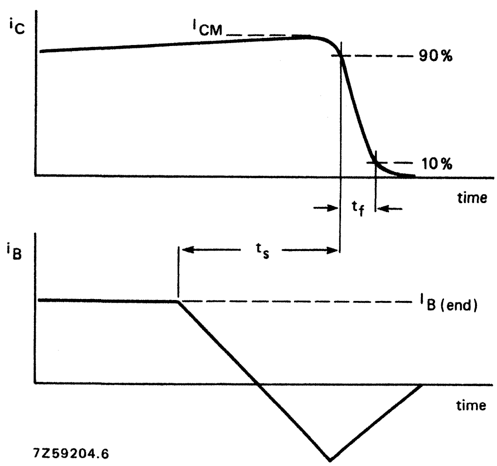


Fig. 4 Switching times waveforms.

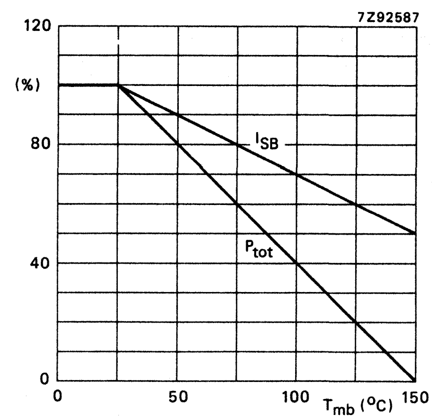
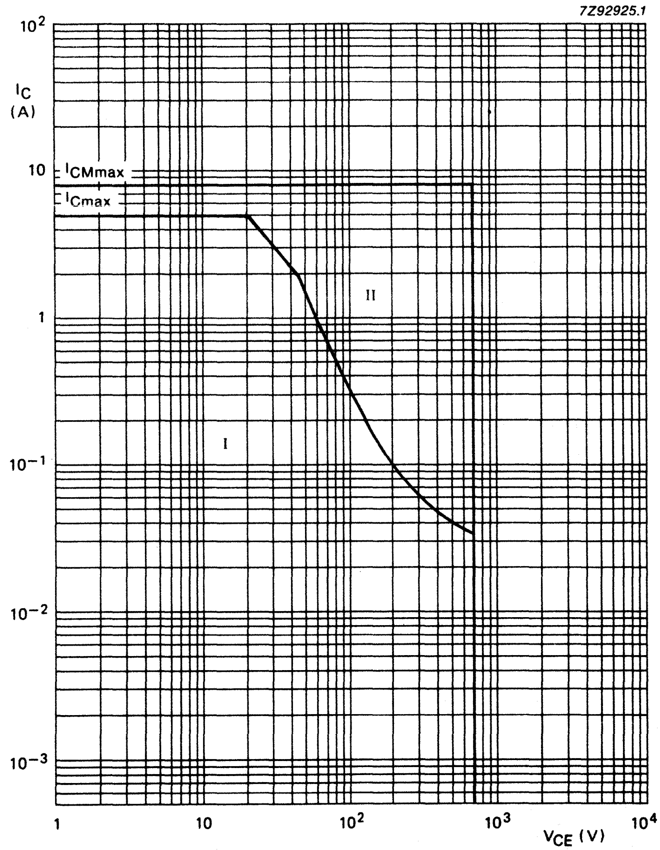


Fig. 5 Total power dissipation and second-current breakdown curve.



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

Fig. 6 Safe operating area at T_{mb} = 25 °C.

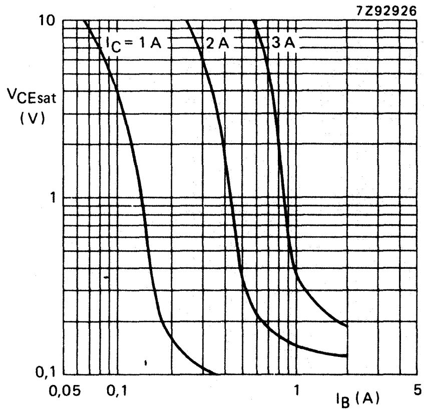


Fig. 7 Typical collector-emitter saturation voltage; T_{mb} = 25 °C.

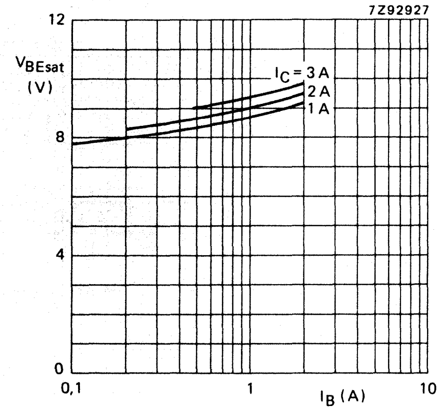


Fig. 8 Typical base-emitter saturation voltage; T_{mb} = 25 °C.

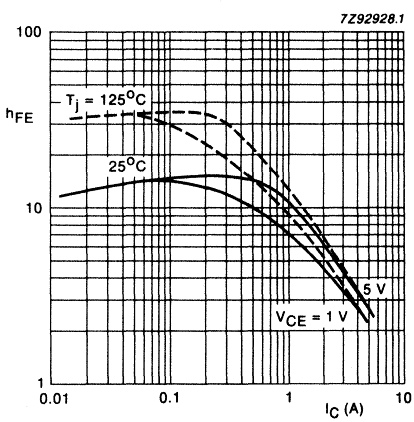


Fig. 9 Typical DC current gain.

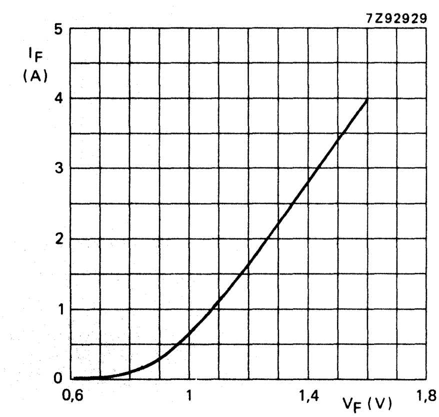


Fig. 10 Diode forward voltage; T_{mb} = 25 °C.

SILICON DIFFUSED POWER TRANSISTORS

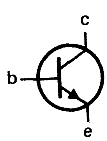
High-voltage, high-speed switching npn transistor in a SOT186 envelope, intended for use in horizontal deflection circuits of colour television receivers and in line-operated switch-mode applications.
The BUS506DF has an integrated efficiency diode.

QUICK REFERENCE DATA

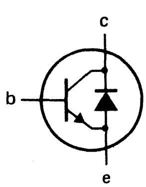
Collector-emitter voltage			
peak value; $V_{BE} = 0$	V_{CESM}	max.	1500 V
open base	V_{CEO}	max.	700 V
Collector-emitter saturation voltage	V_{CEsat}	max.	5.0 V
Collector current			
saturation	I_{Csat}	max.	3.0 A
DC	I_C	max.	5.0 A
peak value	I_{CM}	max.	8.0 A
Total power dissipation			
up to $T_h =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

MECHANICAL DATA

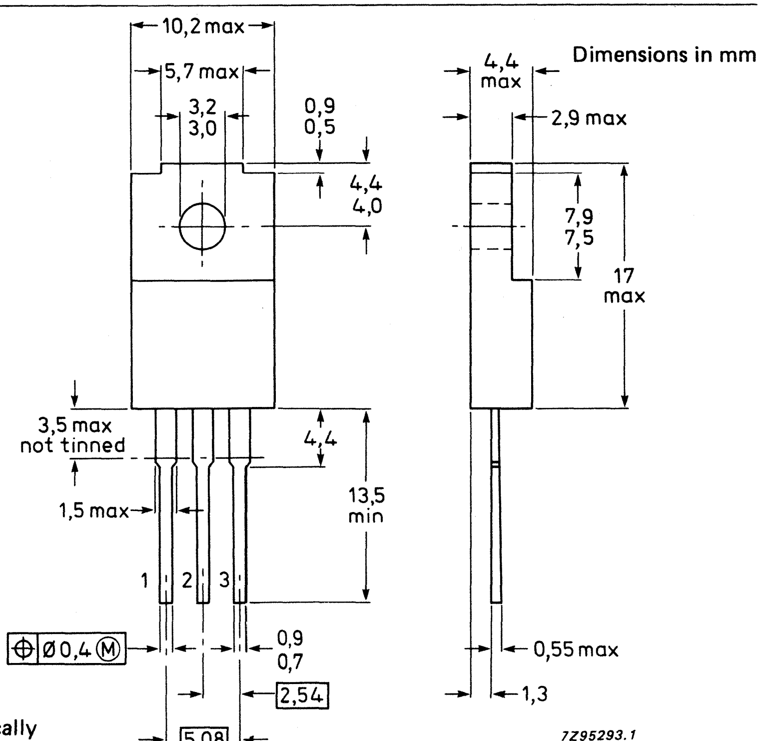
Fig. 1 SOT186.



BU506F



BU506DF



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 $T_h = 25\ ^oC$	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 external heatsink (note 1)	$R_{th\ j\text{-}h}$	=	6.35 K/W
From junction to external heatsink (note 2)	$R_{th\ j\text{-}h}$	=	3.85 K/W
From junction to ambient	$R_{th\text{-}a}$	=	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 °C unless otherwise specified

Collector cut-off current			
$V_{CE} = V_{CESmax}$; $V_{BE} = 0$	I_{CES}	max.	0.5 mA
$V_{CE} = V_{CESmax}$; $V_{BE} = 0$; $T_j = 125$ °C	I_{CES}	max.	1.0 mA
Emitter cut-off current			
$I_C = 0$; $V_{EB} = 6$ V	I_{EBO}	max.	10 mA
Saturation voltage			
$I_C = 3$ A; $I_B = 1.33$ A	V_{CEsat}	max.	5.0 V
	V_{BEsat}	max.	1.3 V
Collector saturation current			
$V_{CE} = 5$ V	I_C	typ.	3.0 A
DC current gain			
$I_C = 3$ A; $V_{CE} = 5$ V	h_{FE}	min.	2.25
Second breakdown current			
$V_{CE} = 300$ V; $t_p = 200$ µs	I_{SB}	min.	1.0 A
Collector emitter sustaining voltage (Figs 2 and 3)			
$I_C = 100$ mA; $I_B = 0$; $L = 25$ mH	$V_{CEOsust}$	min.	700 V
Diode forward voltage			
$I_F = 3$ A (BU506DF)	V_F	typ.	1.5 V
	V_F	max.	2.2 V
Switching times in horizontal deflection circuit (Fig. 4)			
$I_{CM} = 3$ A; $L_B = 12$ µH;			
$I_{B(end)} = 1$ A;			
$\frac{-dI_B}{dt} = 0.33$ A/µs	t_f	typ.	0.7 µs
	t_s	typ.	6.5 µs

DEVELOPMENT DATA

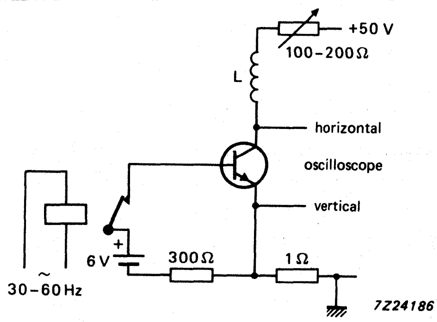


Fig. 2 Test circuit for $V_{CEOsust}$.

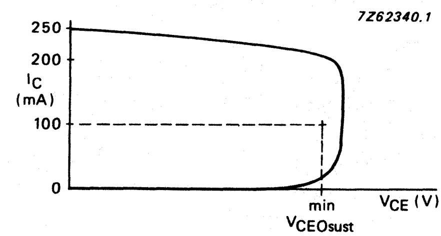


Fig. 3 Oscilloscope display for sustaining voltage.

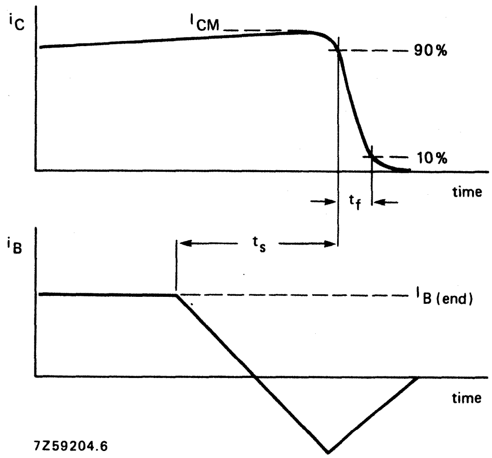


Fig. 4 Switching times waveforms.

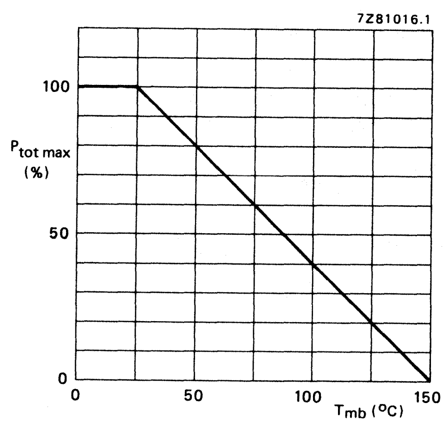


Fig. 5 Power derating curve.

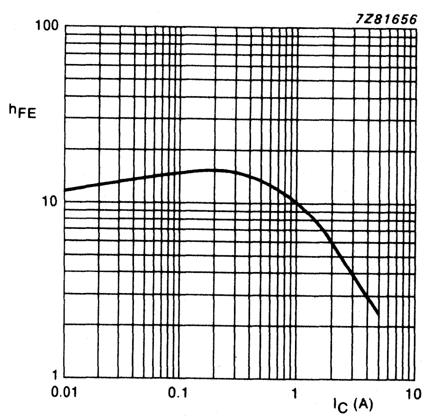
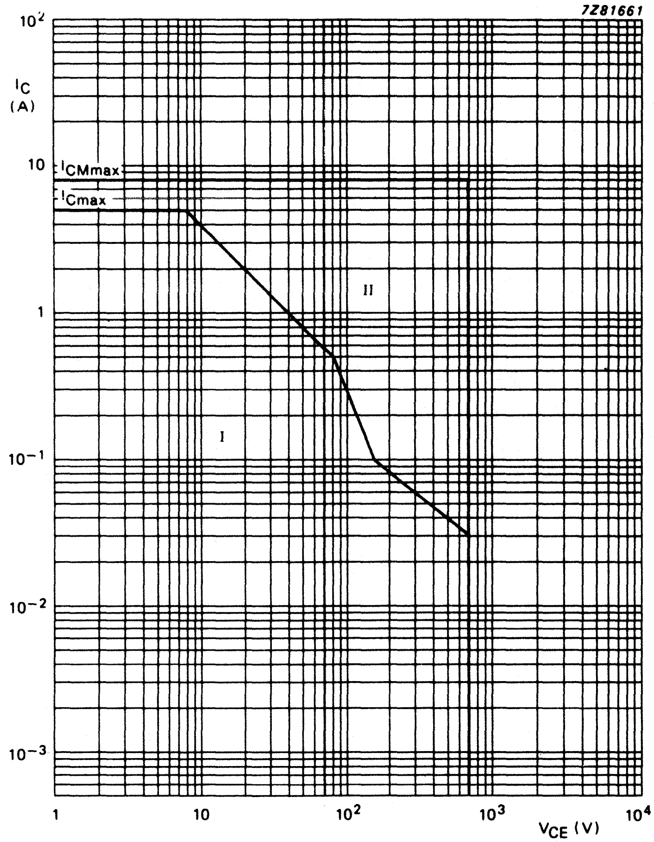


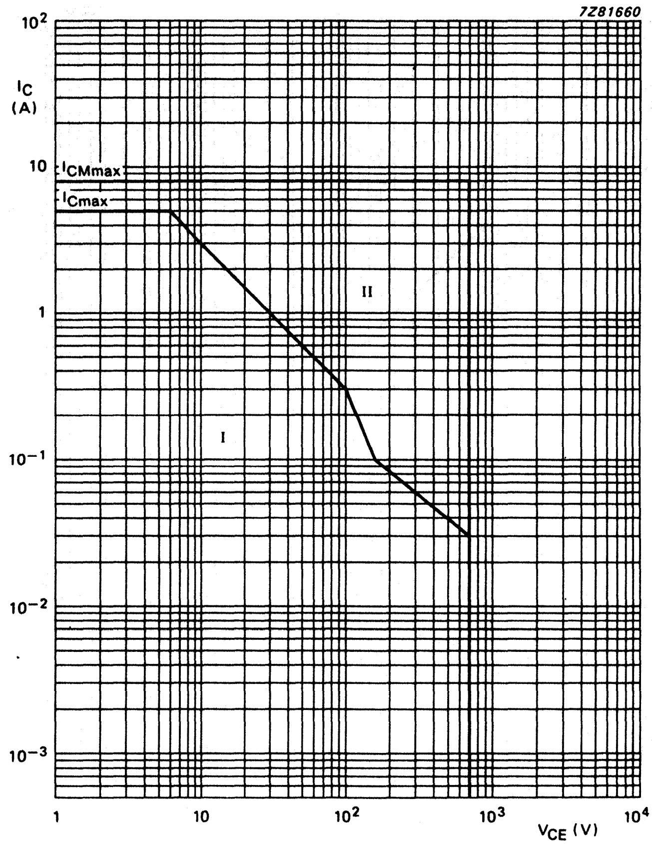
Fig. 6 Typical DC current gain; V_{CE} = 5 V; T_j = 25 °C.



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

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

DEVELOPMENT DATA



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

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

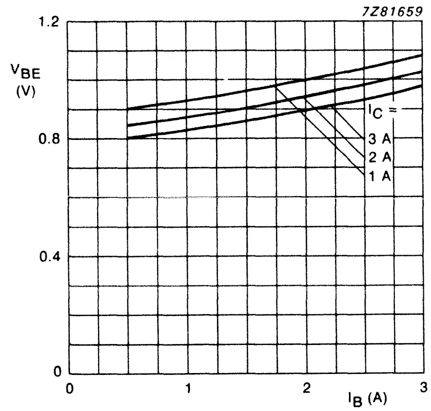


Fig. 9 Typical values V_{BE}; T_j = 25 °C.

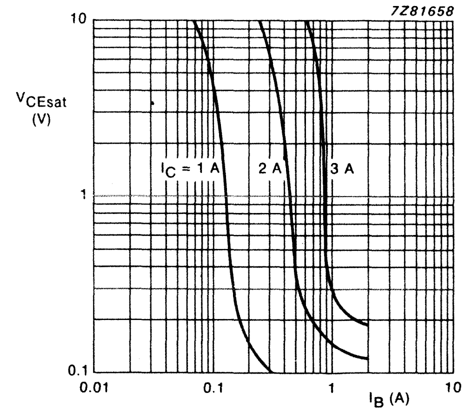


Fig. 10 Typical collector-emitter saturation voltage; T_j = 25 °C.

DEVELOPMENT DATA

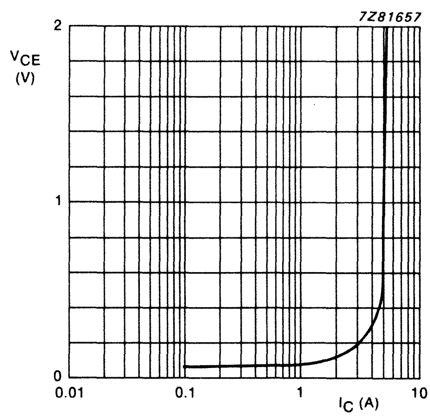


Fig. 11 Typical values V_{CE}; I_C/I_B = 2; T_j = 25 °C.

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.

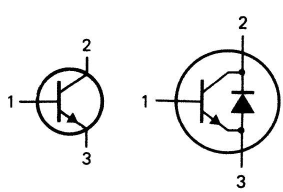
QUICK REFERENCE DATA

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 $T_{mb} = 25\ ^oC$	P_{tot}	max.	125 W
Collector-saturation voltage $I_C = 4.5$ A; $I_B = 2$ A	V_{CEsat}	max.	1 V
Saturation collector current	I_{Csat}	typ.	4.5 A
Diode forward voltage (BU508D) $I_F = 4.5$ A	V_F	typ.	1.6 V
Fall time $I_{CM} = 4.5$ A; $I_{B(on)} = 1.4$ A	t_f	typ.	0.7 μs

MECHANICAL DATA

Dimensions in mm

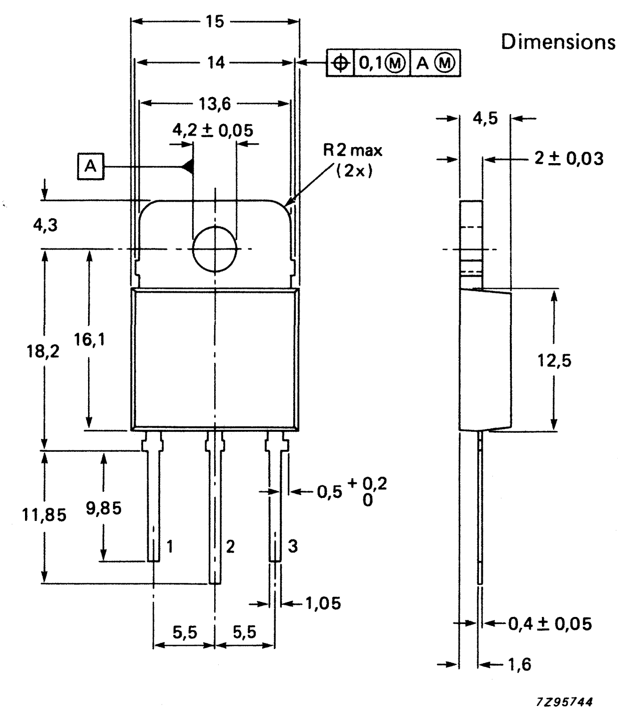
Fig. 1 SOT93A.



BU508A BU508D

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
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 $T_{mb} = 25\ ^oC$	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	$R_{th\ j\text{-}mb}$	=	1 K/W

CHARACTERISTICS

$T_j = 25\ ^oC$ unless otherwise specified

Collector cut-off current**			
$V_{BE} = 0$; $V_{CE} = V_{CESMmax}$	I_{CES}	max.	1 mA
$V_{BE} = 0$; $V_{CE} = V_{CESMmax}$; $T_j = 125\ ^oC$	I_{CES}	max.	2 mA
Emitter cut-off current $V_{EB} = 6$ V; $I_C = 0$	I_{EBO}	max.	10 mA
Collector-emitter sustaining voltage $I_B = 0$; $I_C = 100$ mA; L = 25 mH	$V_{CEOsust}$	min.	700 V
Saturation voltages $I_C = 4.5$ A; $I_B = 2$ A	V_{CEsat}	max.	1 V
	V_{BEsat}	max.	1.3 V
Transition frequency at f = 5 MHz $I_C = 0.1$ A; $V_{CE} = 5$ V	f_T	typ.	7 MHz
Collector capacitance at f = 1 MHz $I_E = I_e = 0$; $V_{VB} = 10$ V	C_c	typ.	125 pF
Diode forward voltage (BU508D) $I_F = 4.5$ A	V_F	typ.	1.6 V
	V_F	max.	2.0 V
Second-breakdown current $V_{CE} = 120$ V; t = 200 μs	I_{SB}	min.	11 A

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

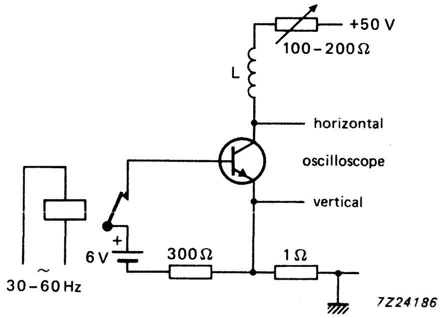


Fig. 2 Test circuit for $V_{CEOsust}$.

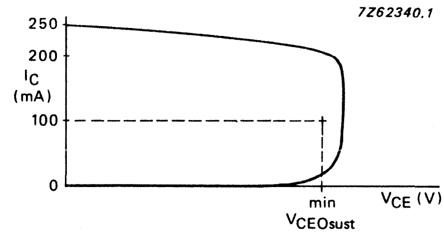


Fig. 3 Oscilloscope display for $V_{CEOsust}$.

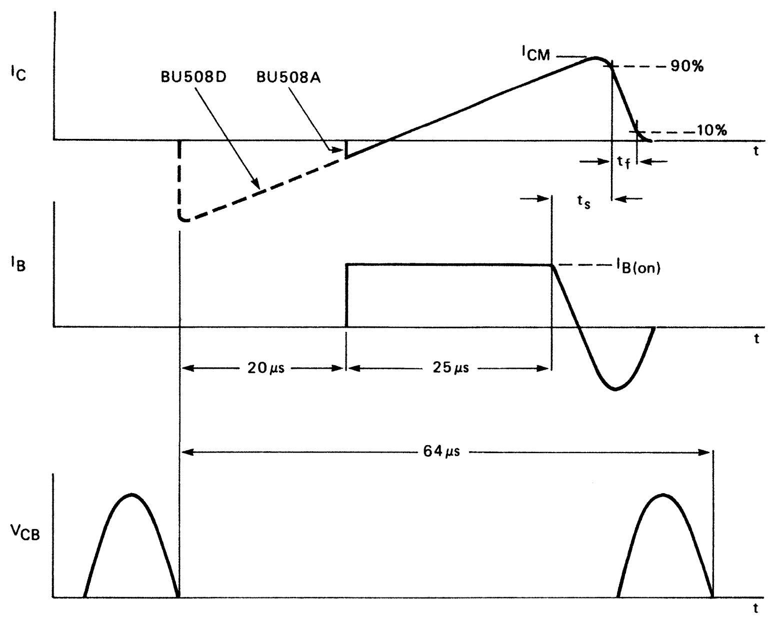


Fig. 4 Switching times waveforms; I_{CM} = 4.5 A; $I_{B(on)}$ = 1.4 A; L_B = 6 μH; $-V_{BB}$ = 4 V; $-dI_B/dt$ = 0.6 A/μs; typical value of t_s = 6.5 μs; typical value of t_f = 0.7 μs.

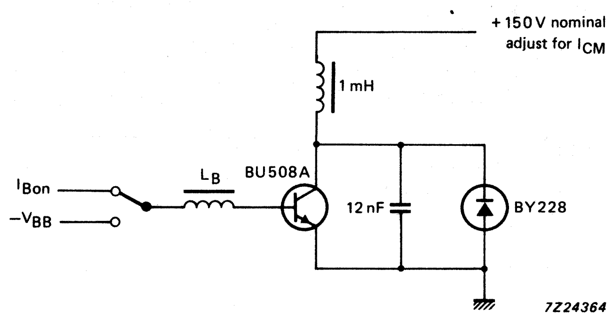


Fig. 5 Switching times test circuit (BU508A).

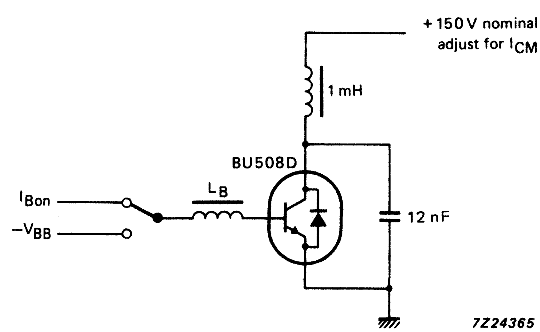
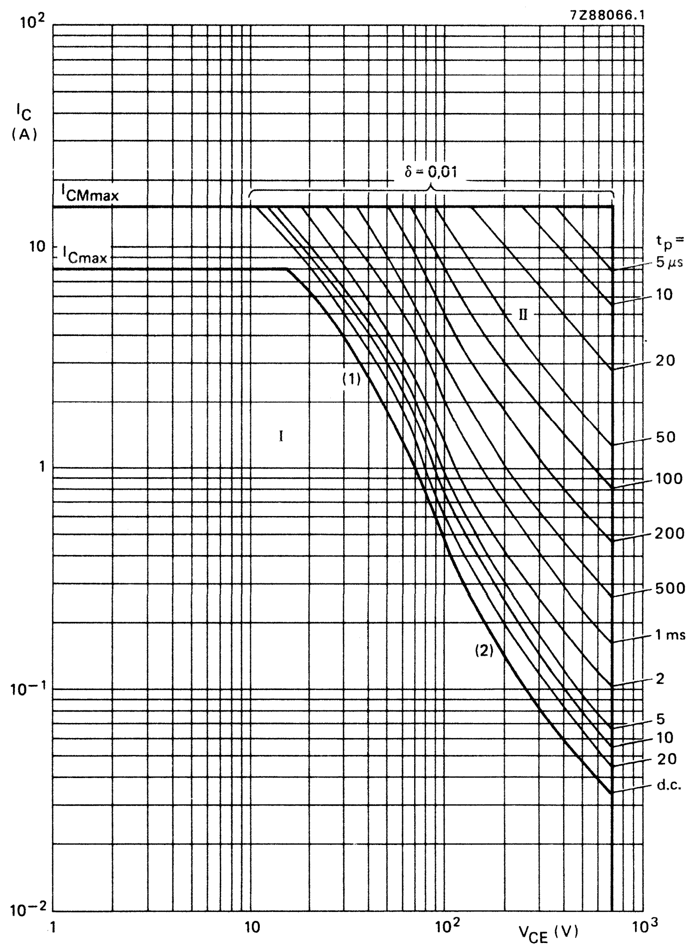


Fig. 6 Switching times test circuit (BU508D).



(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; $T_{mb} < 25\ ^oC$.

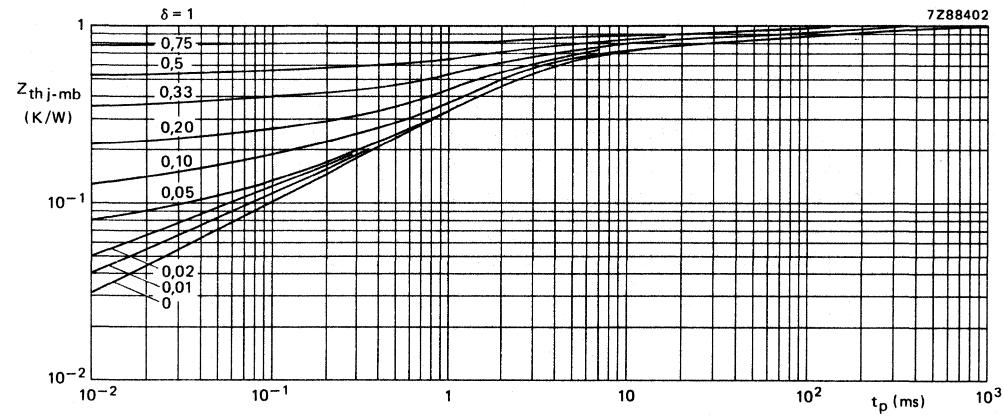


Fig. 8 Pulse power rating chart.

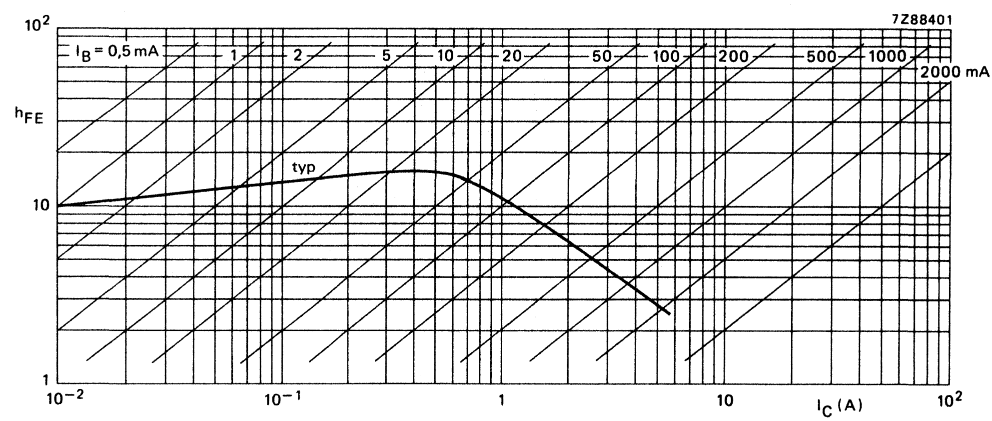


Fig. 9 Typical values DC current gain at V_{CE} = 5 V; T_{mb} = 25 °C.

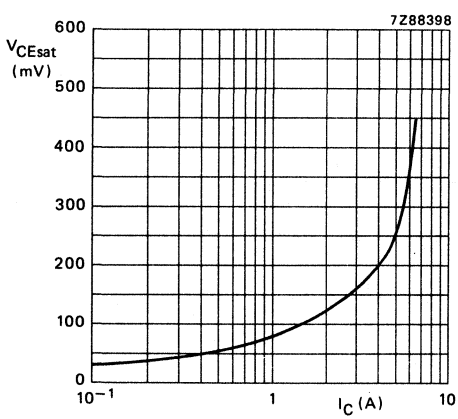


Fig. 10 Typical values I_C/I_B = 2; T_j = 25 °C.

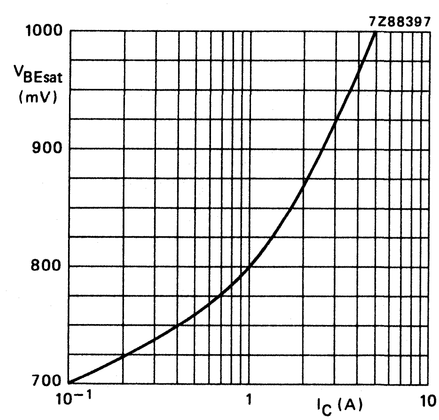


Fig. 11 Typical values I_C/I_B = 2; T_j = 25 °C.

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.

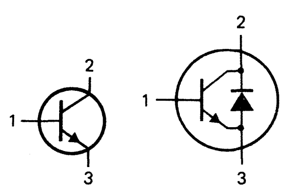
QUICK REFERENCE DATA

Collector-emitter voltage				
peak value; $V_{BE} = 0$	V_{CESM}	max.	1500	V
open base	V_{CEO}	max.	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 $T_h = 25\ ^oC$	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

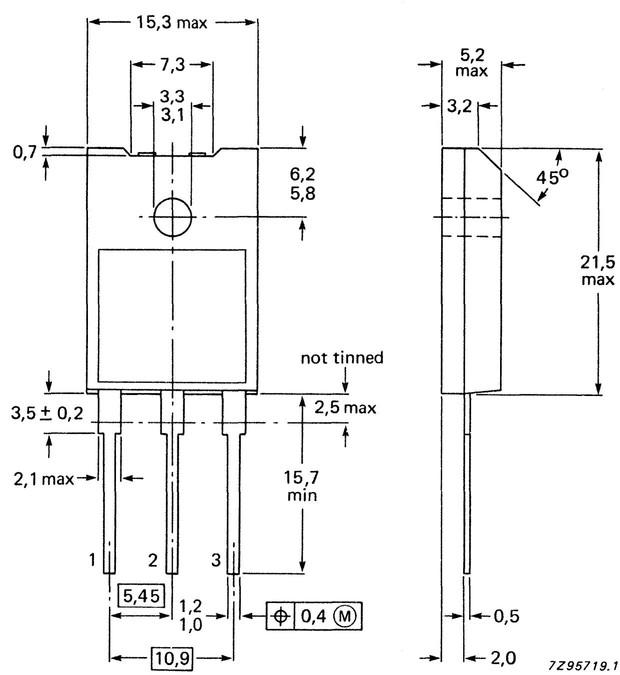
Dimensions in mm

Fig. 1 SOT199.



BU508AF BU508DF

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				
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 $T_h = 25\ ^oC$*	P_{tot}	max.	34	W
Storage temperature	T_{stg}		−65 to + 150	^oC
Junction temperature	T_j	max.	150	^oC

THERMAL RESISTANCE

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

$T_j = 25\ ^oC$ unless otherwise specified

Collector cut-off current				
$V_{CE} = V_{CESmax}$; $V_{BE} = 0$	I_{CES}	max.	1	mA
$V_{CE} = V_{CESmax}$; $V_{BE} = 0$; $T_j = 125\ ^oC$	I_{CES}	max.	2	mA
Emitter cut-off current				
$V_{EB} = 6$ V; $I_C = 0$	I_{EBO}	max.	10	mA

* 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			
$I_C = I_{Csat}$; $I_B = 2$ A	V_{CEsat}	max.	1 V
	V_{BEsat}	max.	1,3 V
Diode forward voltage			
$I_F = 4{,}5$ A (BU508DF)	V_F	max.	2 V
	V_F	typ.	1,6 V
Collector-emitter sustaining voltage			
$I_C = 0{,}1$ A; $I_B = 0$; L = 25 mH	V_{CEOsus}	min.	700 V

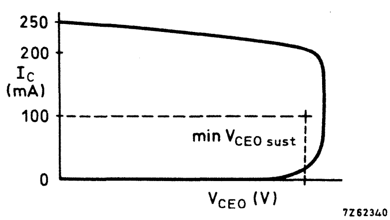


Fig. 2 Oscilloscope display for $V_{CEOsust}$.

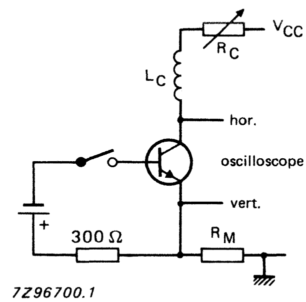


Fig. 3 Test circuit for $V_{CEOsust}$.

DEVELOPMENT DATA

Second-breakdown current			
$V_{CE} = 120$ V; T = 200 μs	I_{SB}	min.	11 A
Transition frequency at f = 5 MHz			
$I_C = 0{,}1$ A; $V_{CE} = 5$ V	f_T	typ.	7 MHz
Collector capacitance at f = 1 MHz			
$I_E = i_e = 0$; $V_{CB} = 10$ V	C_c	typ.	125 pF
Switching times in horizontal deflection circuit			
$-V_{IM} = 4$ V; $L_B = 6$ μH			
$I_C = I_{Csat}$; $I_{B(end)} = 1{,}4$ A	t_f	typ.	0,7 μs
($-dI_B/dt = 0{,}6$ A/μs)	t_s	typ.	6,5 μs

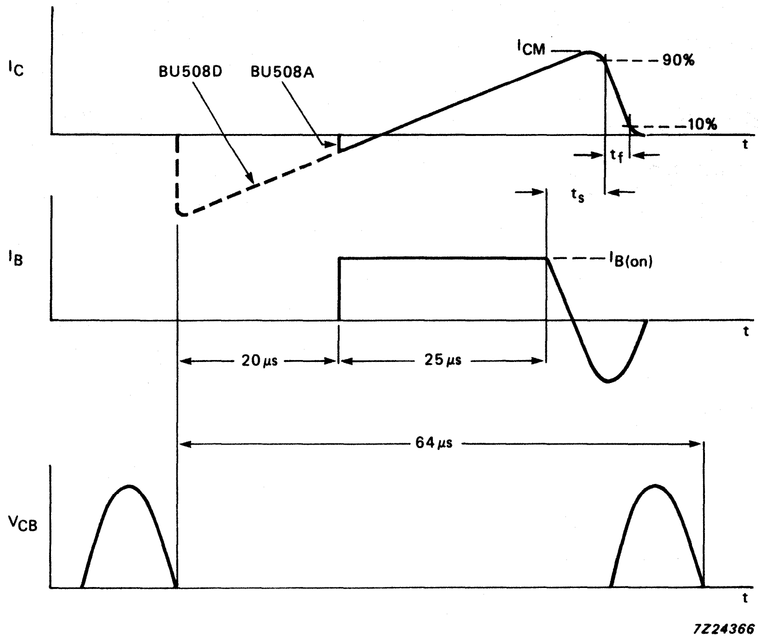


Fig. 4 Switching times waveforms.

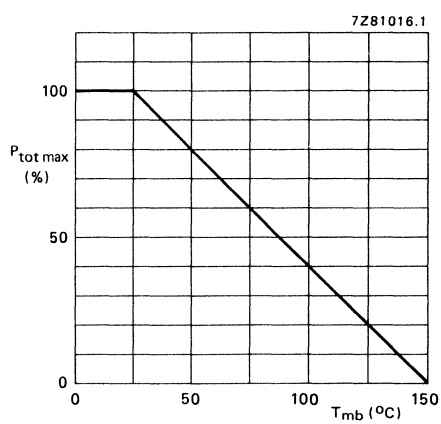


Fig. 5 Power derating curve.

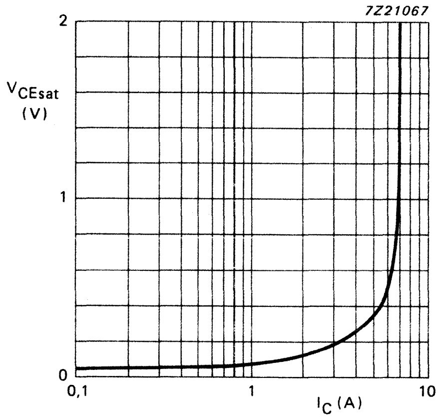


Fig. 6 Typical values $I_C/I_B = 2$; $T_j = 25\ ^oC$.

DEVELOPMENT DATA

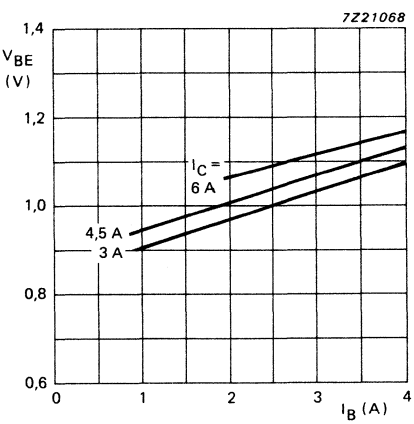


Fig. 7 Typical values base-emitter voltage at $T_j = 25\ ^oC$.

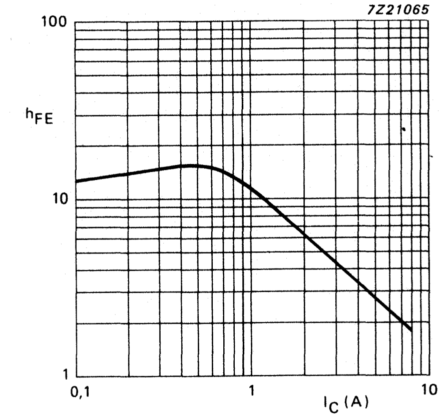


Fig. 8 Typical values DC current gain at V_{CE} = 5 V; T_j = 25 °C.

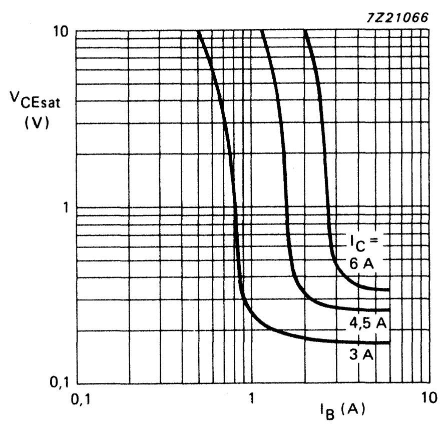
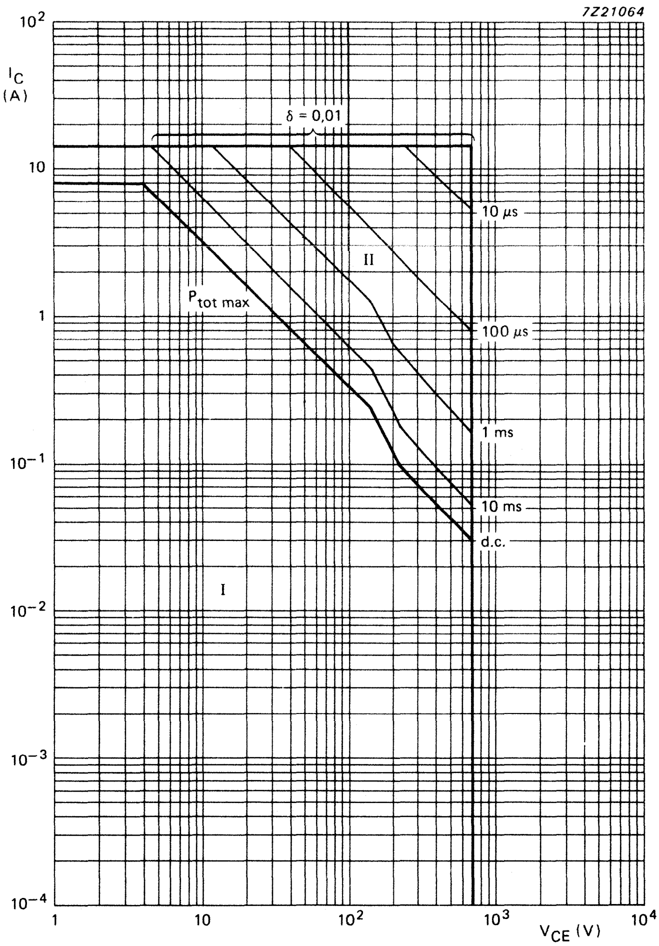


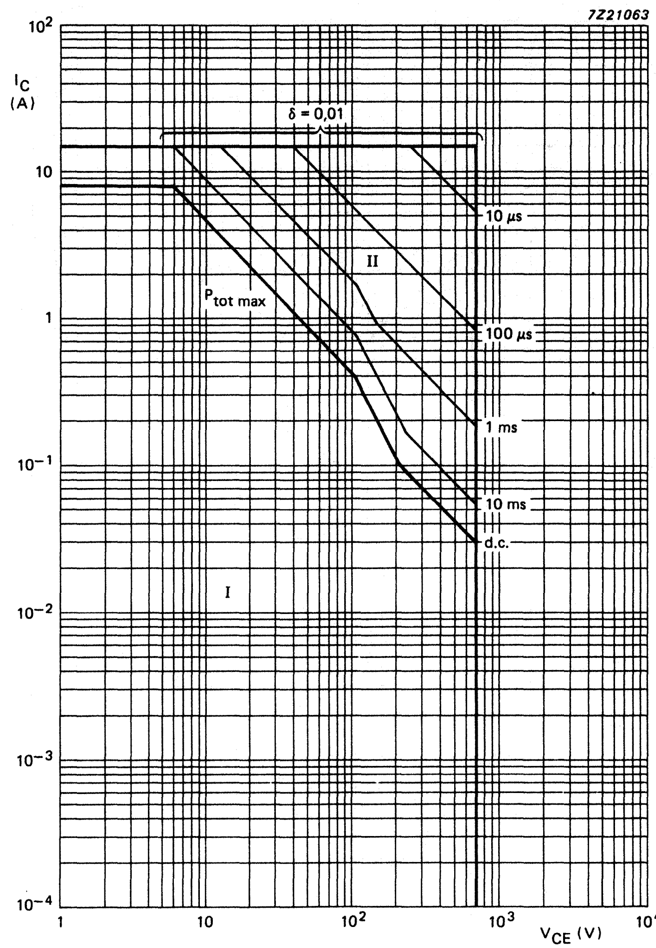
Fig. 9 Typical values collector-emitter voltage at T_j = 25 °C.



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 °C.

DEVELOPMENT DATA



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; $T_h = 25\,^{\circ}C$.

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.

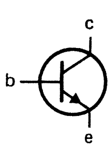
QUICK REFERENCE DATA

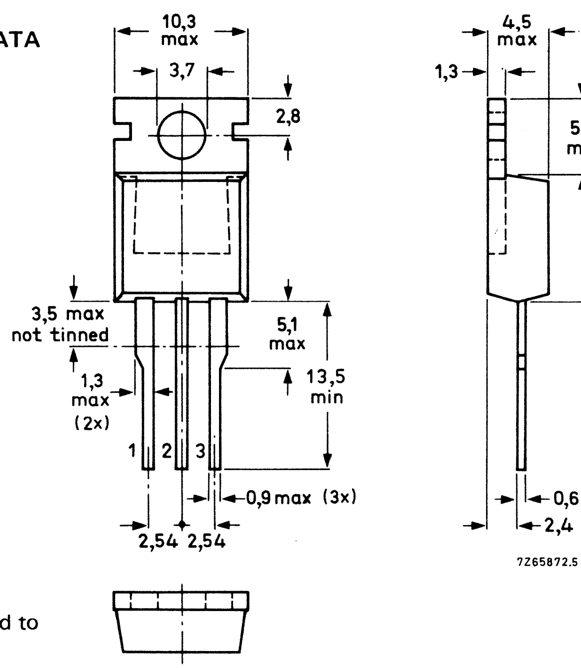
Collector-emitter voltage			
peak value; $V_{BE} = 0$	V_{CESM}	max.	1350 V
open base	V_{CEO}	max.	550 V
Saturation voltages	V_{CEsat}	max.	2.0 V
	V_{BEsat}	max.	1.5 V
Collector current			
saturation	I_{Csat}	max.	2.0 A
DC	I_C	max.	5.0 A
peak value	I_{CM}	max.	8.0 A
Total power dissipation			
up to $T_{mb}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

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 $T_{mb} = 25\ ^oC$	P_{tot}	max.	100 W
Storage temperature range	T_{stg}		−65 to + 150 ^oC
Junction temperature	T_j	max.	150 ^oC

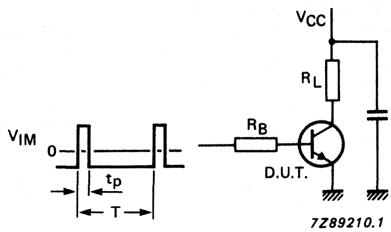
THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	max.	1.25 K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current			
$V_{BE} = 0$; $V_{CE} = V_{CESmax}$	I_{CES}	max.	1.0 mA
$V_{BE} = 0$; $V_{CE} = V_{CESmax}$; $T_j = 125$ °C	I_{CES}	max.	2.0 mA
Emitter cut-off current			
$I_C = 0$; $V_{EB} = 6$ V	I_{EBO}	max.	1.0 mA
Collector-emitter breakdown voltage			
$I_C = 100$ mA; $I_B = 0$	V_{CEO}	min.	550 V
Saturation voltage			
$I_C = 2.0$ A; $I_B = 0.33$ A	V_{CEsat}	max.	2.0 V
$I_C = 4.0$ A; $I_B = 1.33$ A	V_{CEsat}	max.	3.0 V
DC current gain			
$I_C = 10$ mA; $V_{CE} = 5$ V	h_{FE}	min.	6.0
$I_C = 1.0$ A; $V_{CE} = 5$ V	h_{FE}	min.	8.0
$I_C = 2.0$ A; $V_{CE} = 2$ V	h_{FE}	min.	6.0
$I_C = 4.0$ A; $V_{CE} = 3$ V	h_{FE}	min.	3.0
Switching times; resistive load (Figs 2 and 3)			
$I_{C\,on} = 2.0$ A; $I_{B\,on} = -I_{B\,off} = 0.33$ 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)			
$I_{C\,on} = 2.0$ A; $I_{B\,on} = 0.33$ 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.

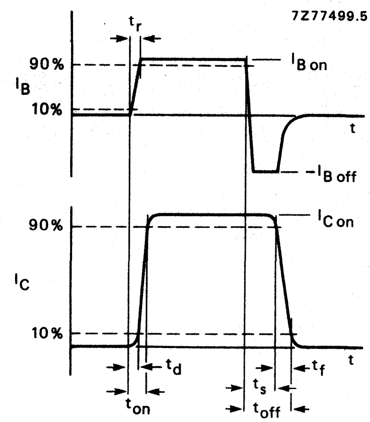
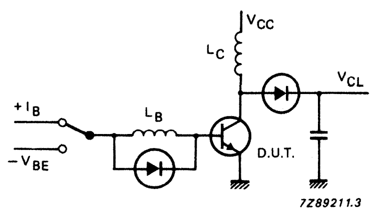


Fig. 3 Switching times waveforms with resistive load; $t_r < 50$ ns.



V_{CL} = 300 V

V_{CC} = 30 V

$-V_{BE}$ = −5 V

L_B = 2.5 μH

L_C = 200 μH

Fig. 4 Test circuit inductive load.

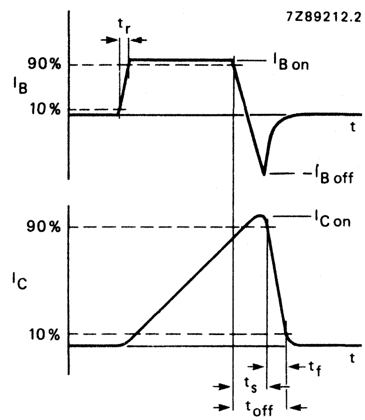


Fig. 5 Switching times waveforms with inductive load.

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

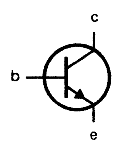
QUICK REFERENCE DATA

Collector-emitter voltage				
peak value; $V_{BE} = 0$	V_{CESM}	max.	1500	V
open base	V_{CEO}	max.	700	V
Collector-emitter saturation voltage	V_{CEsat}	max.	5	V
Collector current				
saturation	I_{Csat}	max.	2	A
DC	I_C	max.	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 $T_{mb} = 25\ ^oC$	P_{tot}	max.	75	W
Fall time inductive load	t_f	typ.	0.7	μs

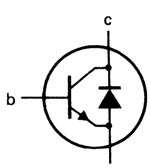
MECHANICAL DATA

Dimensions in mm

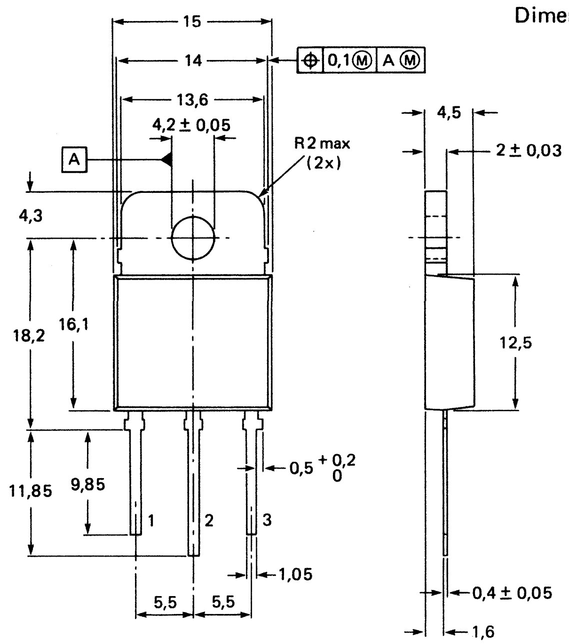
Fig. 1 SOT93A.



BU705



BU705D



7Z95744

Pinning

1 = base
2 = collector
3 = emitter

Collector connected to tab.

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 $T_{mb} = 25\ ^oC$	P_{tot}	max.	75	W
Storage temperature range	T_{stg}		−65 to +150	^oC
Junction temperature	T_j	max.	150	^oC

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	1,67	K/W

CHARACTERISTICS

$T_j = 25\ ^oC$ unless otherwise specified

Collector cut-off current*				
$V_{CE} = V_{CESMmax}$; $V_{BE} = 0$	I_{CES}	max.	0,15	mA
$V_{CE} = V_{CESMmax}$; $V_{BE} = 0$; $T_j = 125\ ^oC$	I_{CES}	max.	1	mA
Emitter cut-off current				
$I_C = 0$; $V_{EB} = 5$ V	I_{EBO}	max.	1	mA
Emitter-base voltage				
$I_C = 0$; $I_E = 10$ mA	V_{EBO}	min.	6	V
Saturation voltage				
$I_C = 2$ A; $I_B = 0,9$ A	V_{CEsat}	max.	5	V
	V_{BEsat}	max.	1,3	V
Diode forward voltage (BU705D)				
$I_F = 3$A	V_F	typ.	1,8	V
Collector-emitter sustaining voltage				
$I_C = 100$ mA; $I_B = 0$; L = 25 mH	$V_{CEOsust}$	min.	700	V
Collector saturation current				
$V_{CE} = 5$ V	I_{Csat}	typ.	2	A
DC current gain				
$I_C = 2$ A; $V_{CE} = 5$ V	h_{FE}	max.	2,2	
Second breakdown current				
$V_{CE} = 120$ V; t = 200 μs	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
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; $V_{CB} = 10$ V	C_c	typ.	65	pF

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

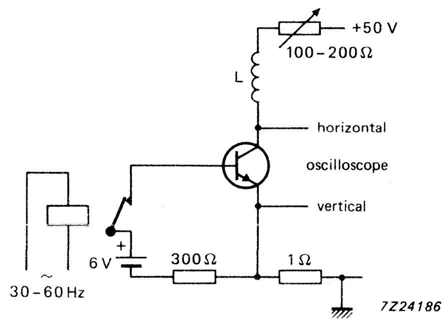


Fig. 2 Test circuit for sustaining voltage.

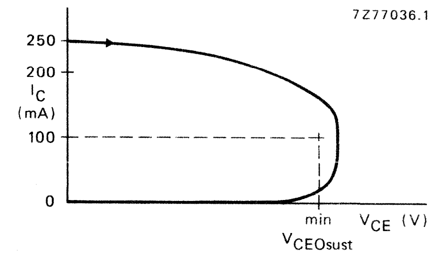


Fig. 3 Oscilloscope display for sustaining voltage.

Switching times (in horizontal deflection circuit)
$-V_{IM} = 4$ V; $L_B = 25$ μH; $I_{CM} = 2$ A
$I_{B(end)} = 0{,}9$ A;

fall time	t_f	typ.	0,7	μs
storage time	t_s	typ.	10	μs

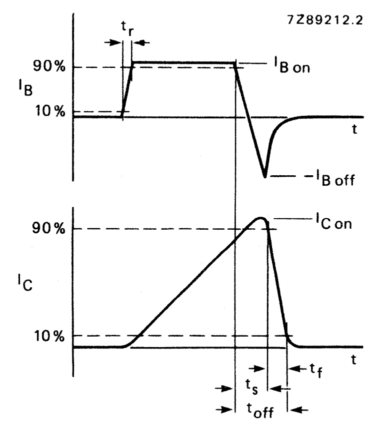
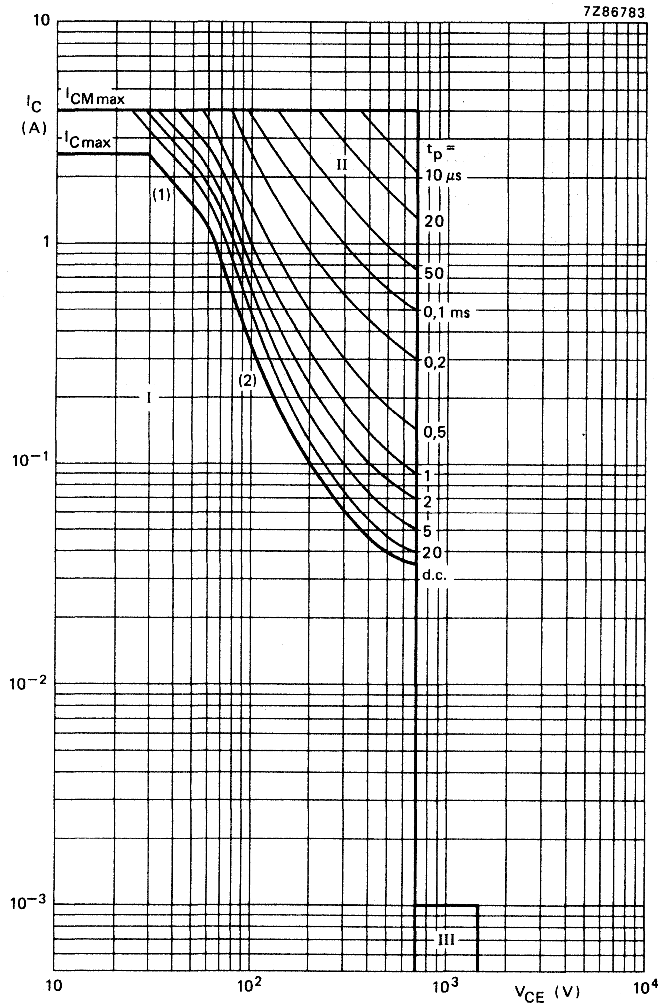


Fig. 4 Switching times waveform.



(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; $T_{mb} = 25\ ^oC$.

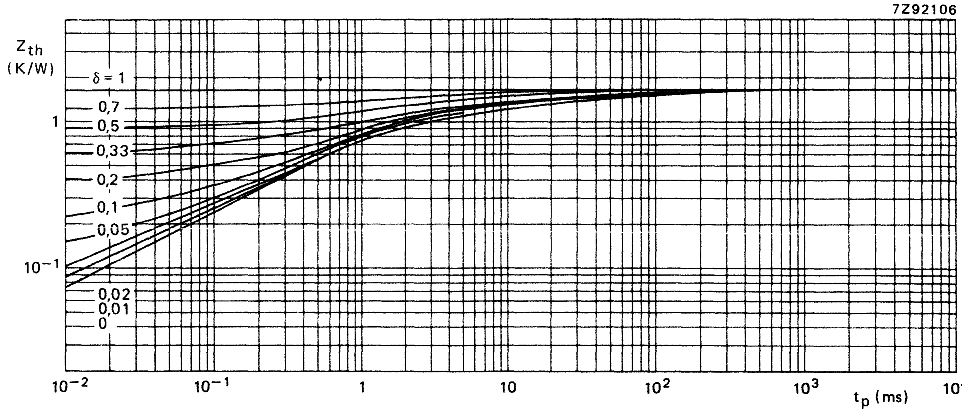


Fig. 6 Pulse power rating chart.

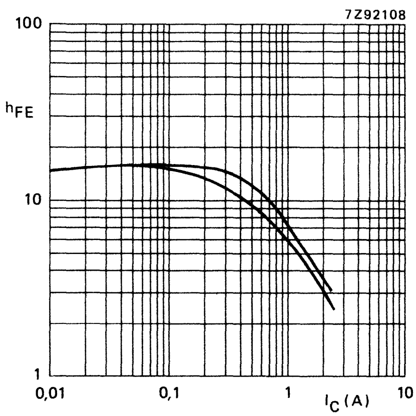


Fig. 7 Typical DC current gain.

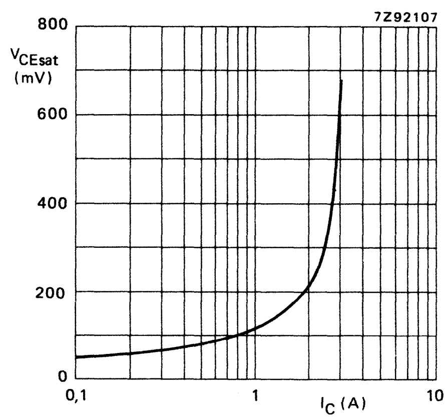


Fig. 8 Typical values V_{CEsat} $I_C/I_B = 2$; $T_j = 25$ °C.

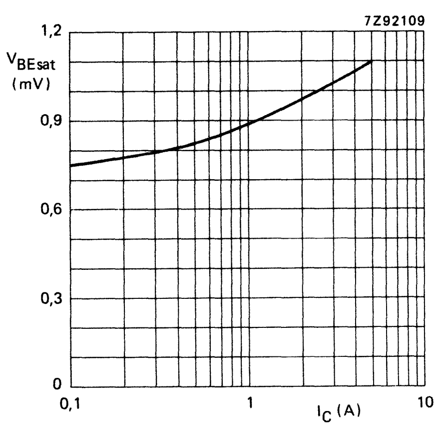


Fig. 9 Typical values V_{BEsat}; $I_C/I_B = 2$; $T_j = 25$ °C.

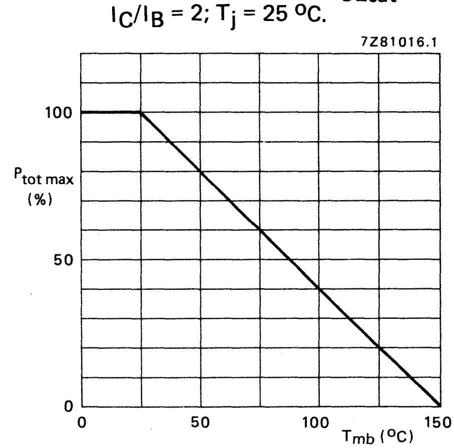


Fig. 10 Power derating curve.

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.

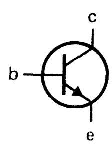
QUICK REFERENCE DATA

Collector-emitter voltage				
peak value; $V_{BE} = 0$	V_{CESM}	max.	1500	V
open base	V_{CEO}	max.	700	V
Collector-emitter saturation voltage	V_{CEsat}	max.	5.0	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 °C	P_{tot}	max.	29	W
Fall time; inductive load	t_f	typ.	0.9	µs

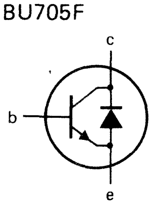
MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT199.



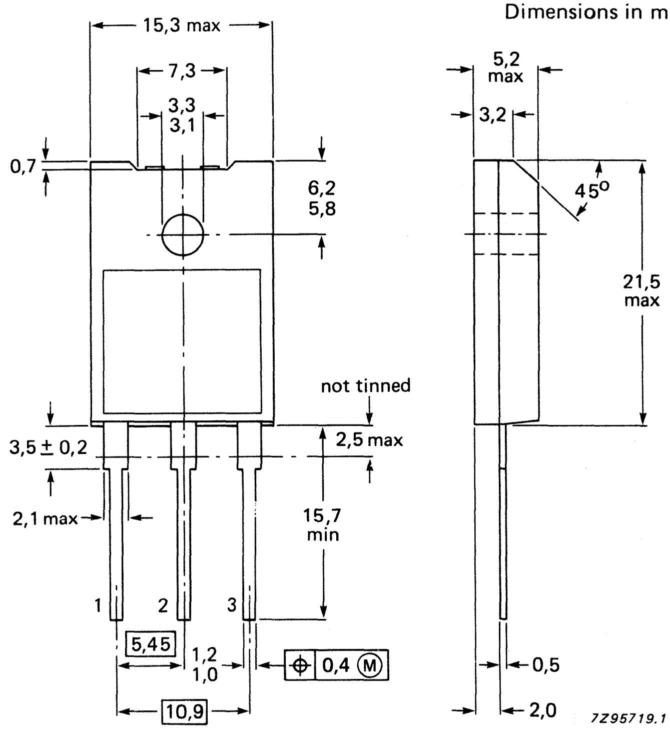
BU705F



BU705DF

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 $T_h = 25$ °C	P_{tot}	max.	29 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)	$R_{th\ j\text{-}h}$	=	4.37 K/W
From junction to external heatsink (note 2)	$R_{th\ j\text{-}h}$	=	3.47 K/W
From junction to ambient	$R_{th\text{-}a}$	=	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 ⩽ 65% under clean and dust-free conditions.

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current			
$V_{CE} = V_{CESmax}$; $V_{BE} = 0$	I_{CES}	max.	0.15 mA
$V_{CE} = V_{CESmax}$; $V_{BE} = 0$; T_j = 125 °C	I_{CES}	max.	1.0 mA
Emitter cut-off current			
$I_C = 0$; V_{EB} = 5 V	I_{EBO}	max.	1.0 mA
Saturation voltage			
I_C = 2 A; I_B = 0.9 A	V_{CEsat}	max.	5.0 V
	V_{BEsat}	max.	1.3 V
Diode forward voltage			
I_F = 2.0 A	V_F	max.	1.8 V
Collector saturation current			
V_{CE} = 5 V	I_{Csat}	typ.	2.0 A
DC current gain			
I_C = 2 A; V_{CE} = 5 V	h_{FE}	min.	2.2
Second breakdown current			
V_{CE} = 120 V; t = 200 μs	I_{SB}	min.	2.0 A
Transition frequency at f = 5 MHz			
I_C = 0.1 A; V_{CE} = 5 V	f_T	typ.	7.0 MHz
Collector capacitance at f = 1 MHz			
$I_E = I_e = 0$; V_{CB} = 10 V	C_c	typ.	65 pF
Collector emitter sustaining voltage (Figs 2 and 3)			
I_C = 100 mA; I_B = 0; L = 25 mH	$V_{CEOsust}$	min.	700 V
Switching times in horizontal deflection circuit (Fig. 4)			
I_{CM} = 2 A; L_B = 15 μH			
$I_{B(end)}$ = 0.9 A; $-V_{dr}$ = 4 V			
	t_f	typ.	0.9 μs
	t_s	typ.	7.5 μs

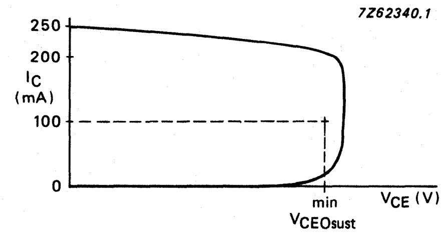


Fig. 2 Oscilloscope display for sustaining voltage.

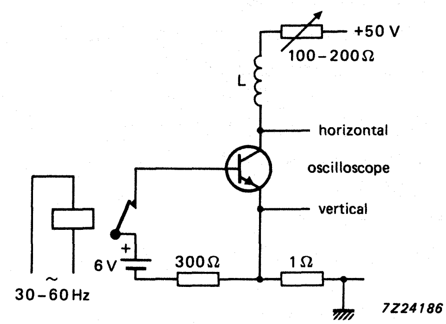


Fig. 3 Test circuit for $V_{CEOsust}$.

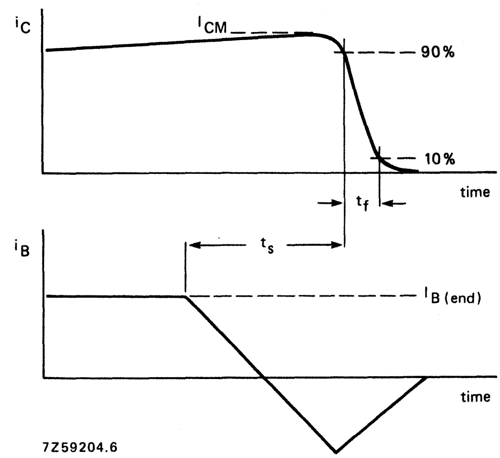


Fig. 4 Switching times waveforms.

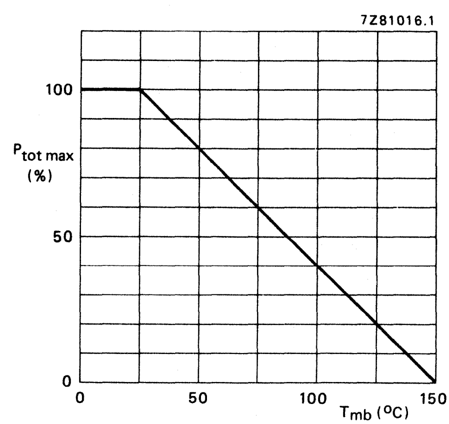
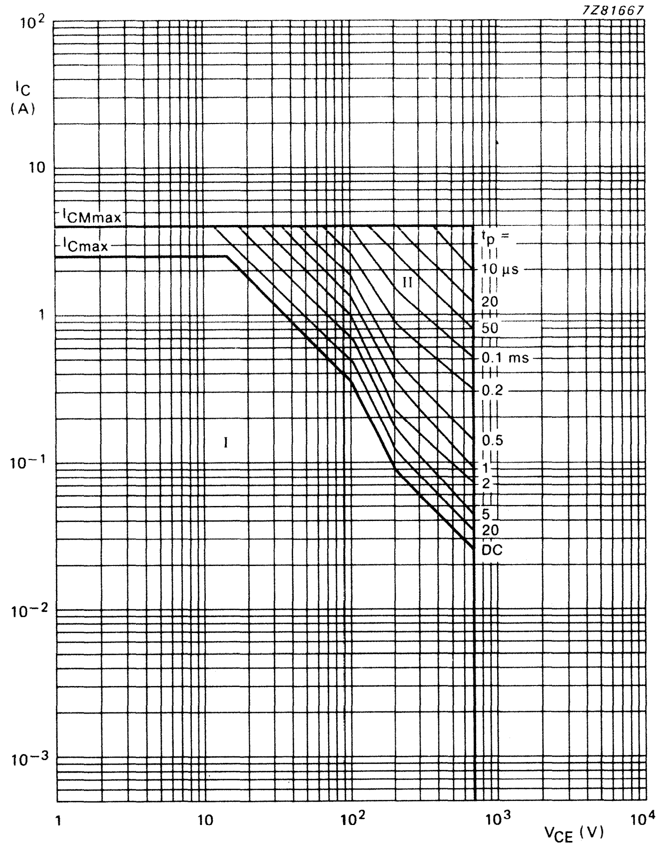


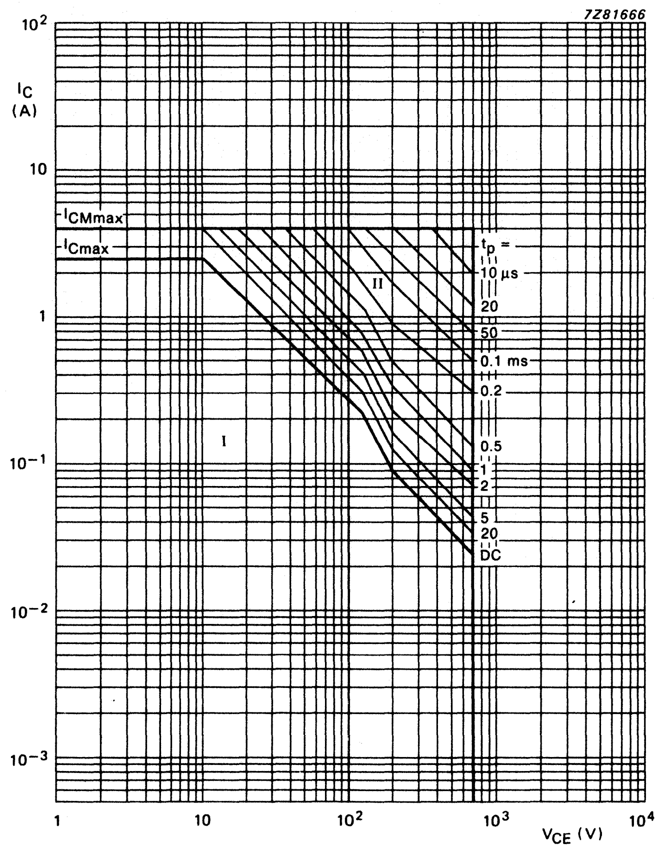
Fig. 5 Power derating curve.



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 °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.

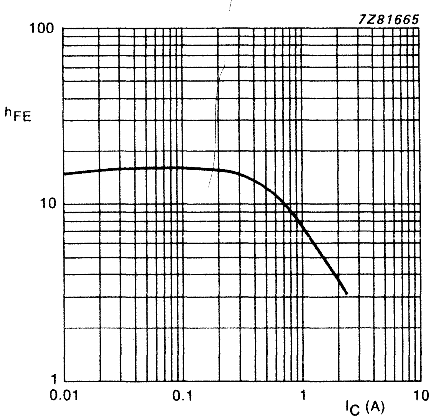


Fig. 8 Typical DC current gain;
$V_{CE} = 5$ V; $T_j = 25$ °C.

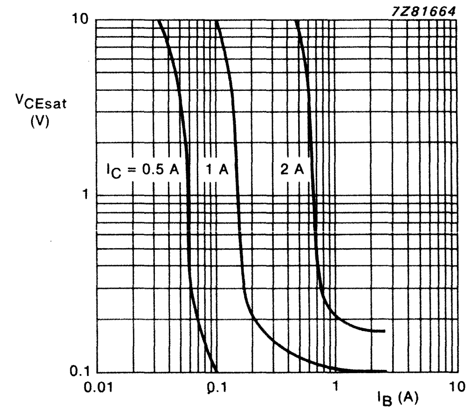


Fig. 9 Typical collector-emitter saturation voltage; $T_j = 25$ °C.

DEVELOPMENT DATA

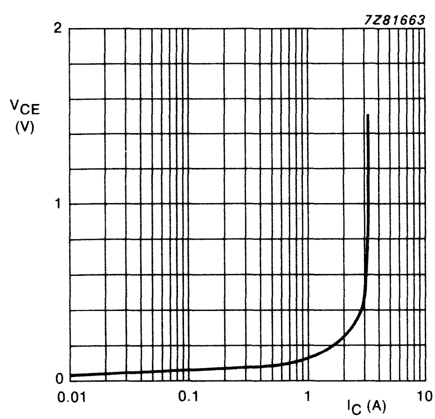


Fig. 10 Typical values V_{CE};
$I_C/I_B = 2$; $T_j = 25$ °C.

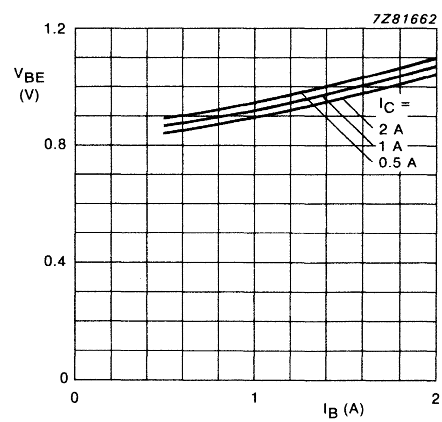


Fig. 11 Typical values V_{BE};
$T_j = 25$ °C.

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.

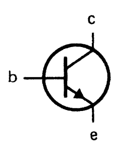
QUICK REFERENCE DATA

Collector-emitter voltage				
peak value; $V_{BE} = 0$	V_{CESM}	max.	1500	V
open base	V_{CEO}	max.	700	V
Collector-emitter saturation voltage	V_{CEsat}	max.	5.0	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
Diode forward voltage (BU706D)	V_F	typ.	1.5	V
Total power dissipation				
up to $T_{mb} = 25\ ^oC$	P_{tot}	max.	100	W
Fall time; inductive load	t_f	typ.	0.7	μs

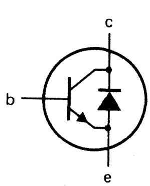
MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT93A.



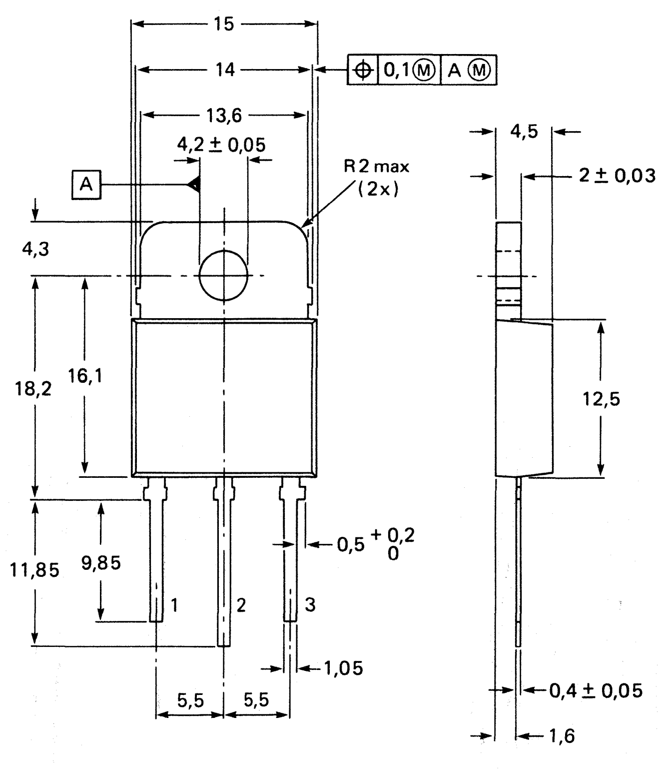
BU706



BU706D

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_{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 $T_{mb} = 25\ ^oC$	P_{tot}	max.	100	W
Storage temperature range	T_{stg}	−65 to + 150		^oC
Junction temperature	T_j	max.	150	^oC

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	1.25	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current*			
$V_{BE} = 0$; $V_{CE} = V_{CESMmax}$	I_{CES}	max.	0.5 mA
$V_{BE} = 0$; $V_{CE} = V_{CESMmax}$; T_j = 125 °C	I_{CES}	max.	1.0 mA
Emitter cut-off current			
V_{EB} = 6 V; $I_C = 0$	I_{EBO}	max.	10 mA
Second breakdown current			
V_{CE} = 300 V; t_p = 200 μs	I_{SB}	min.	1.0 A
Collector-emitter sustaining voltage			
I_C = 0.1 A; I_B = 0; L = 25 mH (Figs 2 and 3)	$V_{CEOsust}$	min.	700 V
Saturation voltage			
I_C = 3.0 A; I_B = 1.33 mA	V_{CEsat}	max.	5.0 V
	V_{BEsat}	max.	1.3 V
Diode forward voltage (BU706D)	V_F	typ.	1.5 V
I_F = 3 A	V_F	max.	2.2 V
Switching times (in line deflection circuit) (Fig. 4)			
I_{CM} = 3.0 A; $I_{B(end)}$ = 1.0 A; L_B = 12 μH; $-dI_B/dt$ = 0.33 A/μs	t_f	typ.	0.7 μs
	t_s	typ.	6.5 μs

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

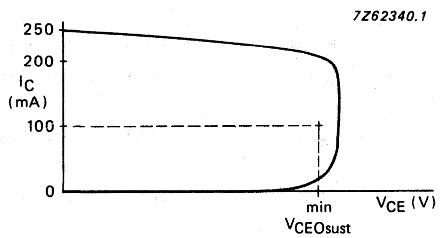


Fig. 2 Oscilloscope display for sustaining voltage.

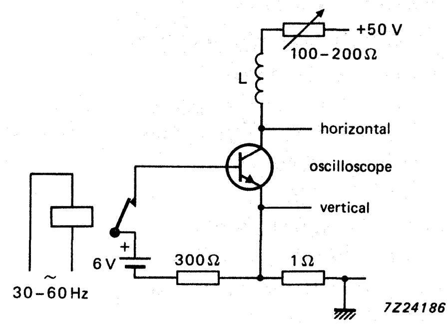


Fig. 3 Test circuit for $V_{CEOsust}$.

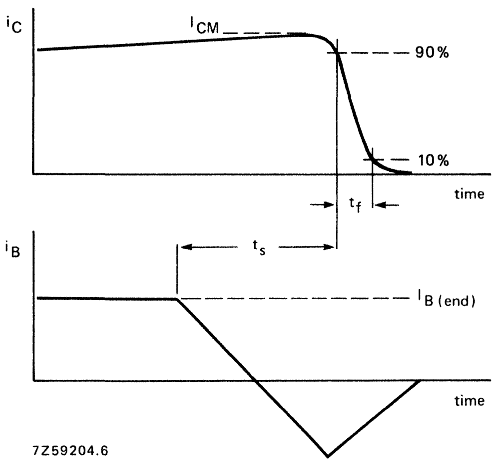


Fig. 4 Switching times waveforms.

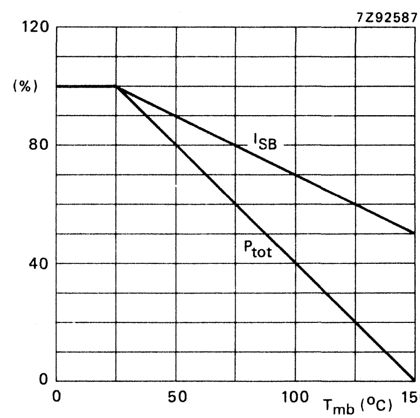
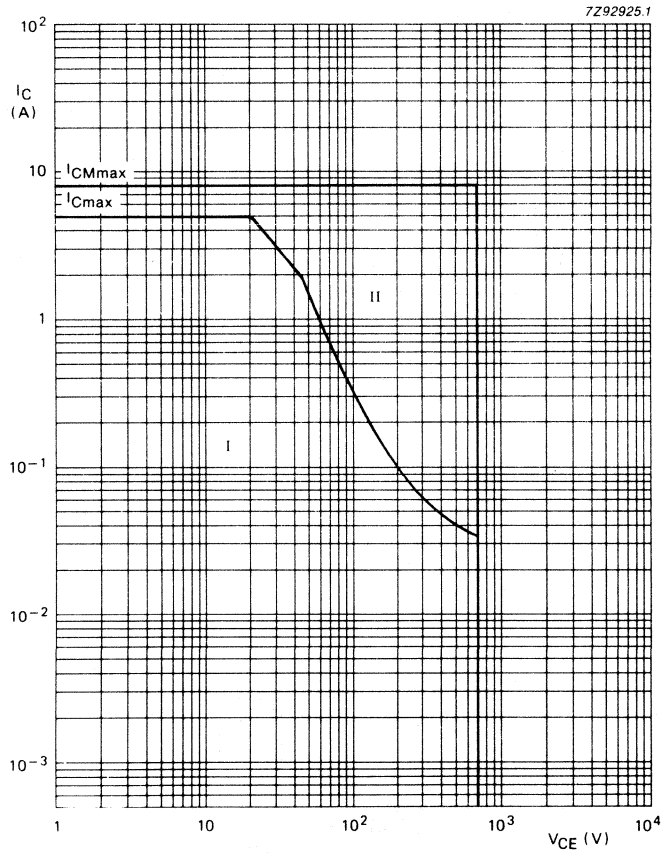


Fig. 5 Total power dissipation and second-breakdown current derating curve.



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

Fig. 6 Safe operating area.

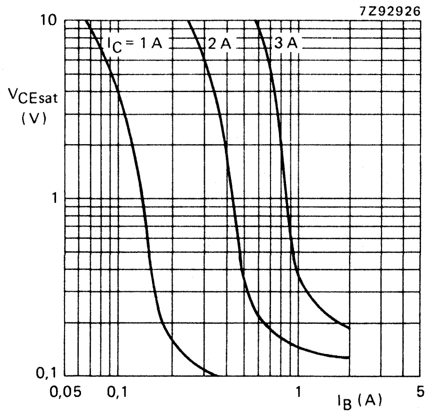


Fig. 7 Typical collector emitter saturation voltage; T_{mb} = 25 °C.

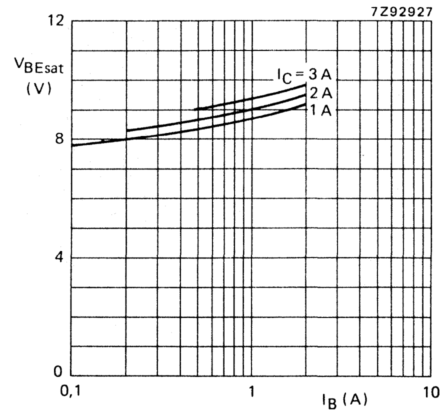


Fig. 8 Typical base-emitter saturation voltage; T_{mb} = 25 °C.

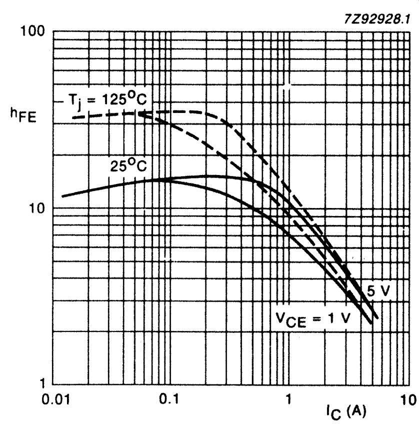


Fig. 9 Typical DC current gain.

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.

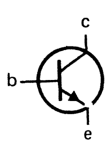
QUICK REFERENCE DATA

Collector-emitter voltage			
peak value; $V_{BE} = 0$	V_{CESM}	max.	1500 V
open base	V_{CEO}	max.	700 V
Collector-emitter saturation voltage	V_{CEsat}	max.	5.0 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 $T_h = 25\ ^oC$	P_{tot}	max.	32 W
Diode forward voltage			
at $I_F = 3$ A (BU706DF)	V_F	typ.	1.5 V
Fall time; inductive load	t_f	typ.	0.7 μs

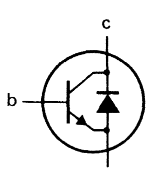
MECHANICAL DATA

Dimensions in mm

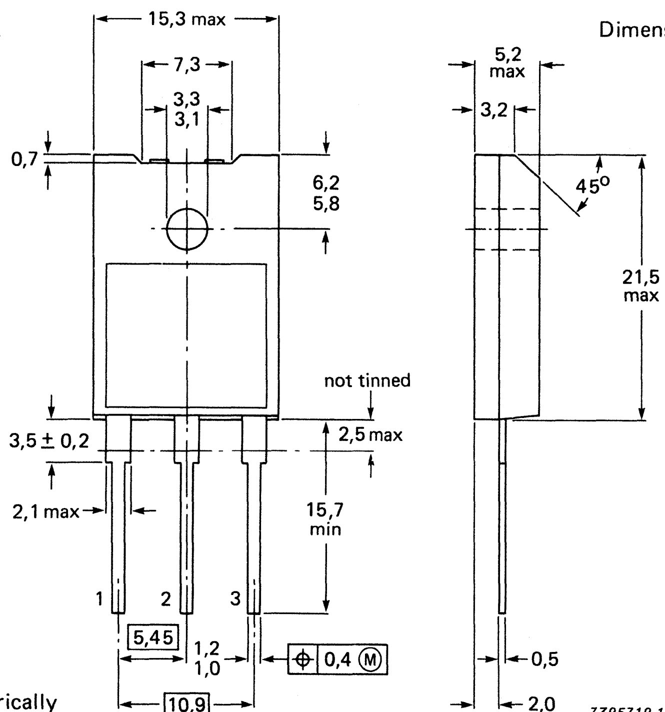
Fig. 1 SOT199.



BU706F



BU706DF



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 $T_h = 25\ ^oC$	P_{tot}	max.	32 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)	$R_{th\ j\text{-}h}$	=	3.95 K/W
From junction to external heatsink (note 2)	$R_{th\ j\text{-}h}$	=	3.05 K/W
From junction to ambient	$R_{th\text{-}a}$	=	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 °C unless otherwise specified

Collector cut-off current			
$V_{CE} = V_{CESmax}$; $V_{BE} = 0$	I_{CES}	max.	0.5 mA
$V_{CE} = V_{CESmax}$; $V_{BE} = 0$; $T_j = 125$ °C	I_{CES}	max.	1.0 mA
Emitter cut-off current			
$I_C = 0$; $V_{EB} = 6$ V	I_{EBO}	max.	10 mA
Saturation voltage			
$I_C = 3$ A; $I_B = 1.33$ A	V_{CEsat}	max.	5.0 V
	V_{BEsat}	max.	1.3 V
Collector saturation current			
$V_{CE} = 5$ V	I_C	typ.	3.0 A
DC current gain			
$I_C = 3$ A; $V_{CE} = 5$ V	h_{FE}	min.	2.25
Second breakdown current			
$V_{CE} = 300$ V; $t_p = 200$ μs	I_{SB}	min.	1.0 A
Collector emitter sustaining voltage (Figs 2 and 3)			
$I_C = 100$ mA; $I_B = 0$; $L = 25$ mH	$V_{CEOsust}$	min.	700 V
Diode forward voltage			
$I_F = 3$ A (BU706DF)	V_F	typ.	1.5 V
	V_F	max.	2.2 V
Switching times in horizontal deflection circuit (Fig. 4)			
$I_{CM} = 3$ A; $L_B = 12$ μH;			
$I_{B\,(end)} = 1$ A;			
$\frac{-d\,I_B}{dt} = 0.33$ A/μs	t_f	typ.	0.7 μs
	t_s	typ.	6.5 μs

DEVELOPMENT DATA

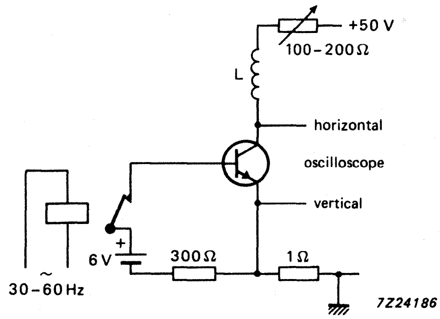


Fig. 2 Test circuit for $V_{CEOsust}$.

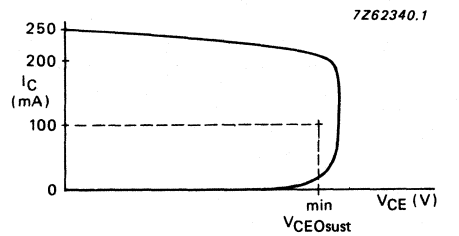


Fig. 3 Oscilloscope display for sustaining voltage.

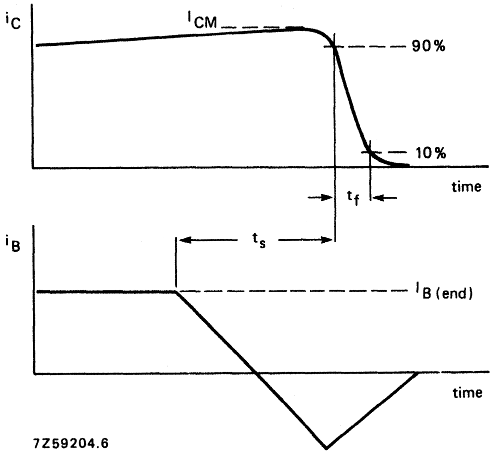


Fig. 4 Switching times waveforms.

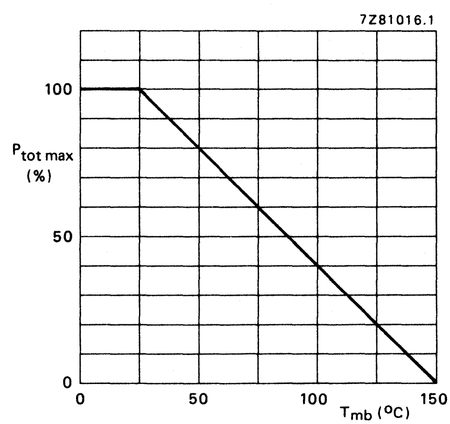


Fig. 5 Power derating curve.

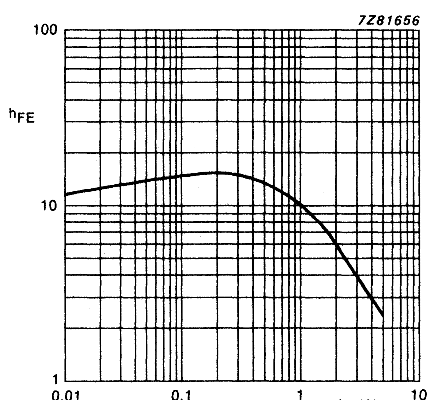
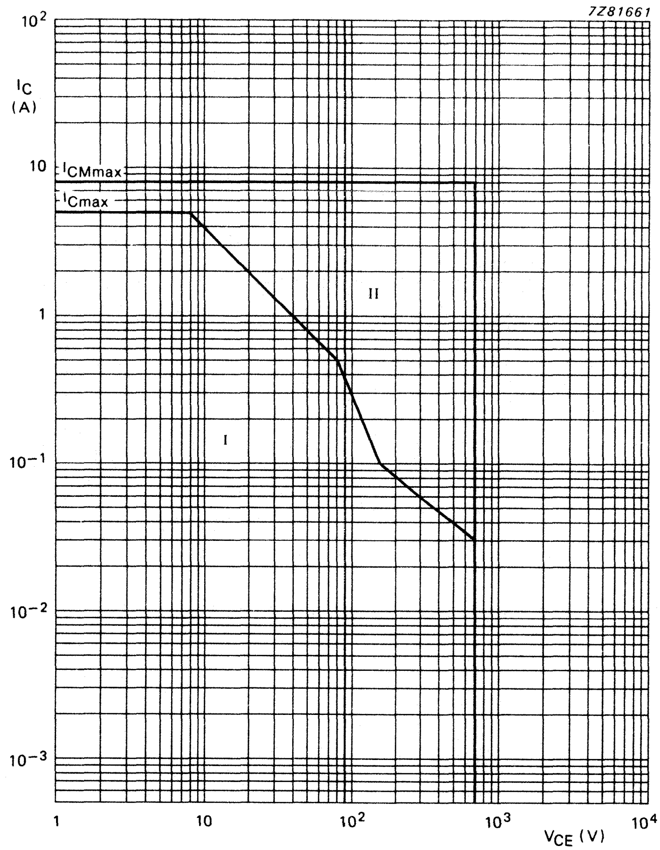


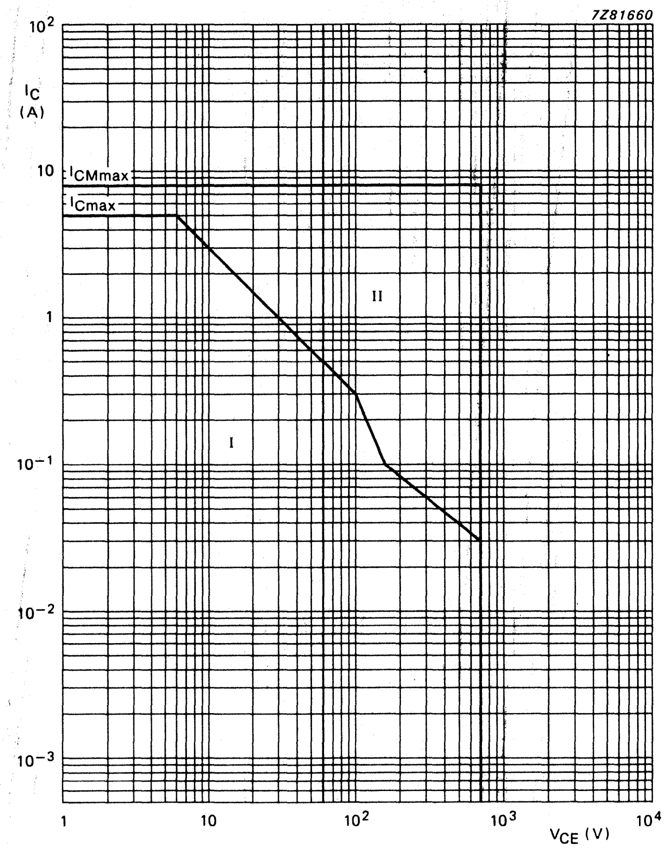
Fig. 6 Typical DC current gain; V_{CE} = 5 V; T_j = 25 °C.



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

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

DEVELOPMENT DATA



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

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

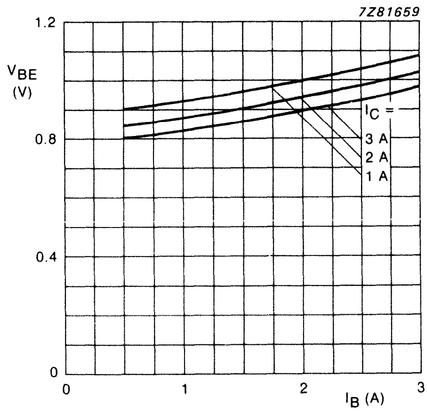


Fig. 9 Typical values V_{BE}; T_j = 25 °C.

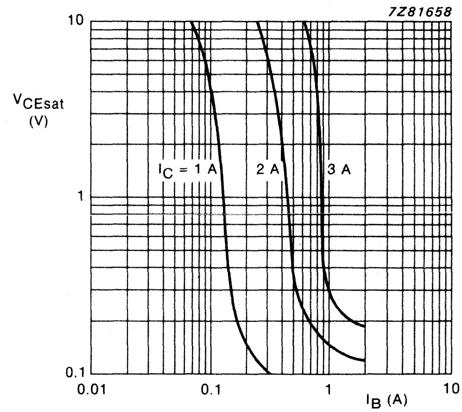


Fig. 10 Typical collector-emitter saturation voltage; T_j = 25 °C.

DEVELOPMENT DATA

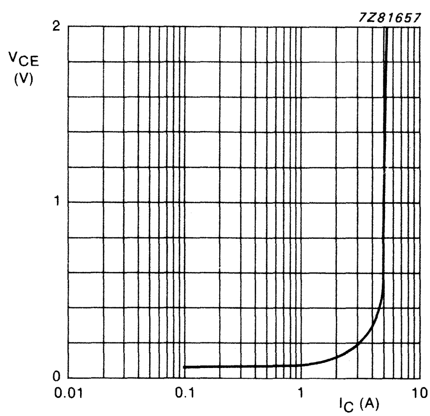


Fig. 11 Typical values V_{CE}; I_C/I_B = 2; T_j = 25 °C.

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).

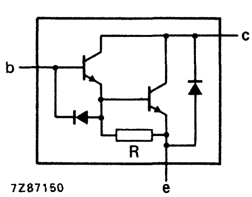
QUICK REFERENCE DATA

			BU724	724A	
Collector-emitter voltage					
peak value; $V_{BE} = 0$	V_{CESM}	max.	650	850	V
open base	V_{CEO}	max.	375	400	V
Collector-emitter saturation voltage	V_{CEsat}	max.	3.0		V
Collector current					
saturation	I_{Csat}	max.	0.4	0.3	A
DC	I_C	max.	2.0		A
peak value	I_{CM}	max.	3.0		A
Total power dissipation					
up to $T_{mb} = 25\ ^oC$	P_{tot}	max.	1.5		W

MECHANICAL DATA

Dimensions in mm

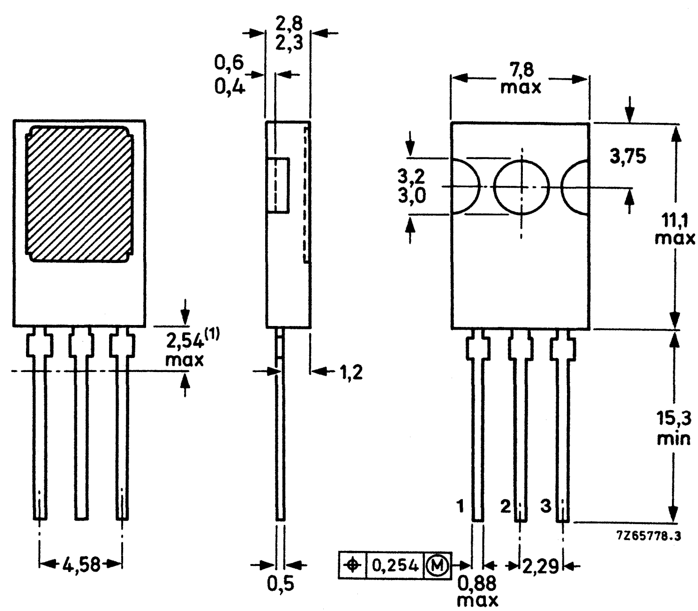
Fig. 1 SOT82.



R = typical 600 Ω

Pinning:
1 = base
2 = collector
3 = emitter

Collector connected to mounting base.



RATINGS

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

			BU724	724A	
Collector-emitter voltage					
peak value; $V_{BE} = 0$	V_{CESM}	max.	650	850	V
open base	V_{CEO}	max.	375	400	V
Collector current					
saturation	I_{Csat}	max.	0.4	0.3	A
DC	I_C	max.	2.0		A
peak value	I_{CM}	max.	3.0		A
Base current					
DC	I_B	max.	0.2		A
peak value	I_{BM}	max.	1.0		A
Total power dissipation up to $T_{amb} = 25\ ^oC$	P_{tot}	max.	1.5		W
Total power dissipation up to $T_{mb} = 25\ ^oC$	P_{tot}	max.	25		W
Storage temperature range	T_{stg}		−65 to + 150		^oC
Junction temperature	T_j	max.	150		^oC

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	5.0	K/W
From junction to ambient	$R_{th\ j\text{-}amb}$	=	83	K/W

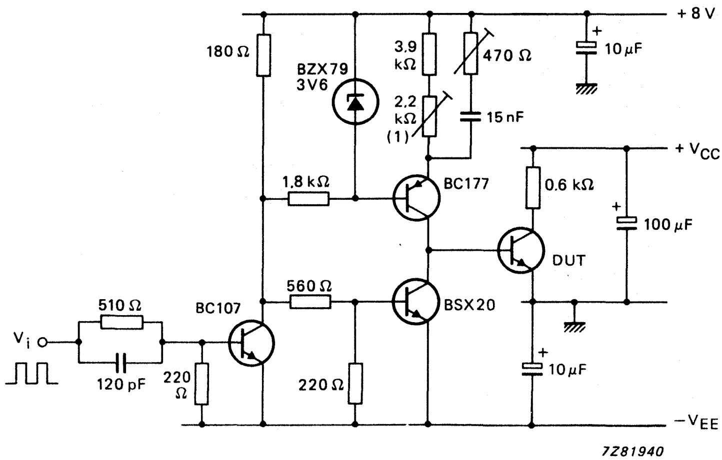
CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off currents*					
$V_{CE} = V_{CESM\,max}$; V_{BE} = 0.3 V	I_{CES}	max.	0.1		mA
$V_{CE} = V_{CES\,max}$; V_{BE} = 0.3 V; T_j = 125 °C	I_{CES}	max.	0.2		mA
Emitter cut-off current					
V_{EB} = 5 V; I_C = 0	I_{EBO}	max.	2.0		mA
	I_{EBO}	min.	3.3		mA
			BU724	724A	
Collector-emitter sustaining voltage					
I_B = 0; I_C = 10 mA	V_{CEO}	min.	375	400	V
Saturation voltages					
I_C = 400 mA; I_B = 1.0 mA	V_{CEsat}	max.	5.0	–	V
I_C = 300 mA; I_B = 1.0 mA	V_{CEsat}	max.	–	3.0	V
	V_{BEsat}	max.	2.0		V
Parasitic collector current					
V_{CE} = 10 V; $-I_B$ = 250 mA	I_{cp}	max.	100		μA
Switching times resistive load					
$I_{C\,on}$ = 0.4 A; I_{BM} = 9 mA					
$-V_{EE}$ = 1 V; V_{CC} = 250 V					
I_B = 1 mA; T_{mb} = 100 °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

DEVELOPMENT DATA

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



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

Fig. 2 Switching times test circuit.

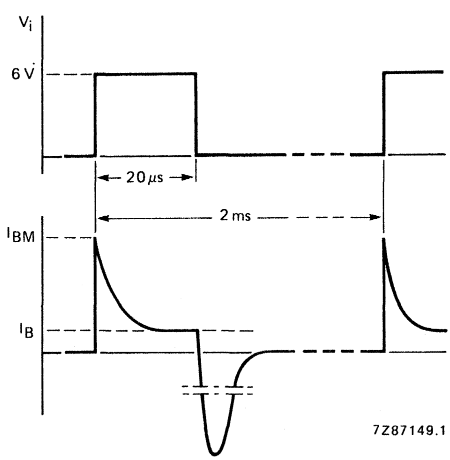


Fig. 3 Input current and current waveforms.

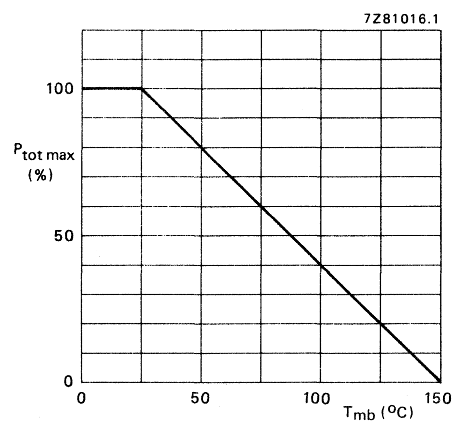
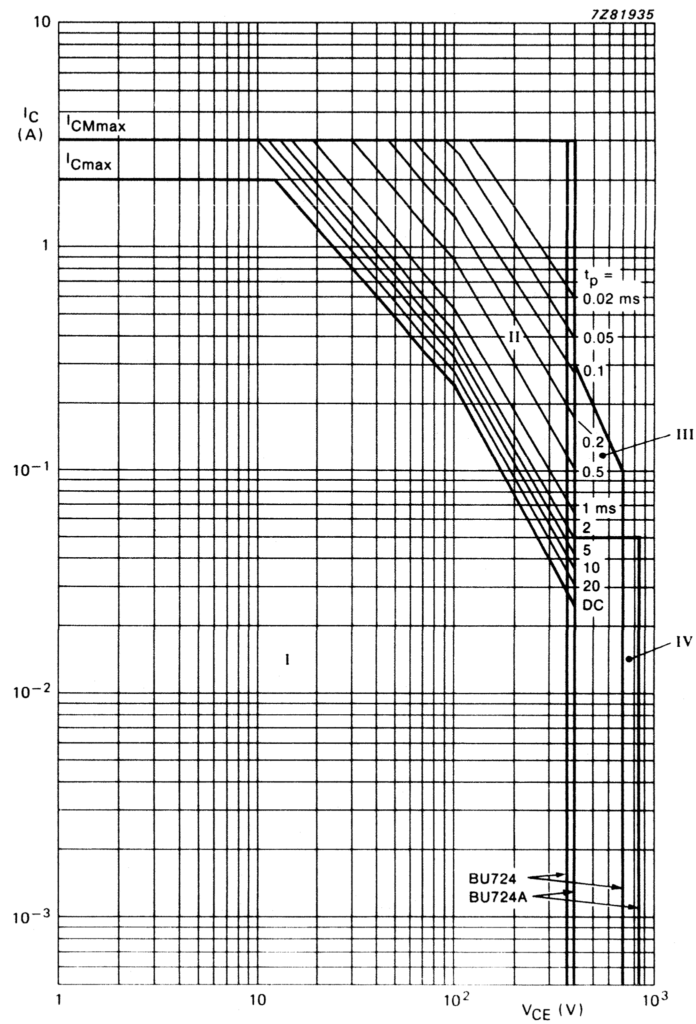


Fig. 4 Power derating curve.



I Region of permissible DC operation.

II Permissible extension for repetitive pulse operation.

III Permissible extension for turn-on provided $t_p \leq 0.4\ \mu s$ and $R_{BE} \leq 100\ \Omega$.

IV Permissible extension for turn-off provided $I_E = 0$; $t_p \leq 0.4\ \mu s$ and $dV_{CB}/d_t \leq 5000\ V/\mu s$.

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

DEVELOPMENT DATA

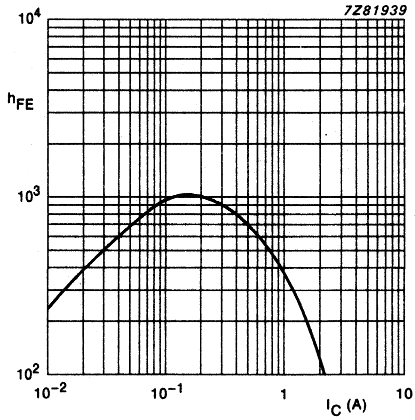


Fig. 6 Typical DC current gain; V_{CE} = 5 V; T_{mb} = 25 °C.

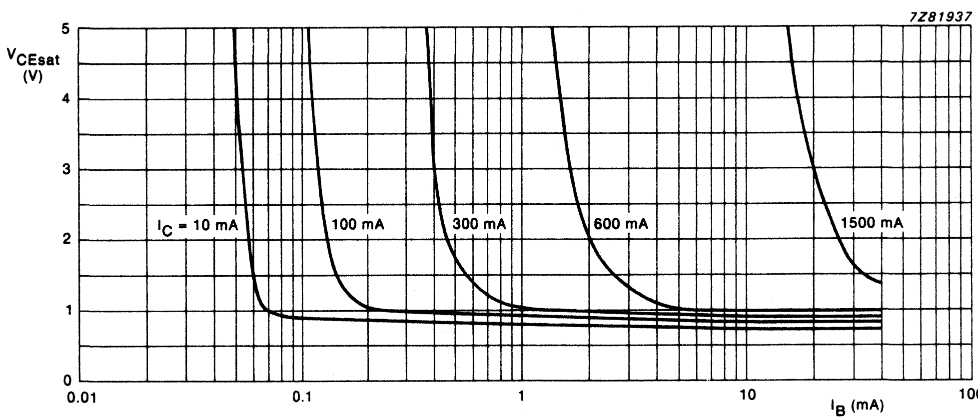


Fig. 7 Typical collector-emitter saturation voltage as a function of base current; T_{mb} = 25 °C.

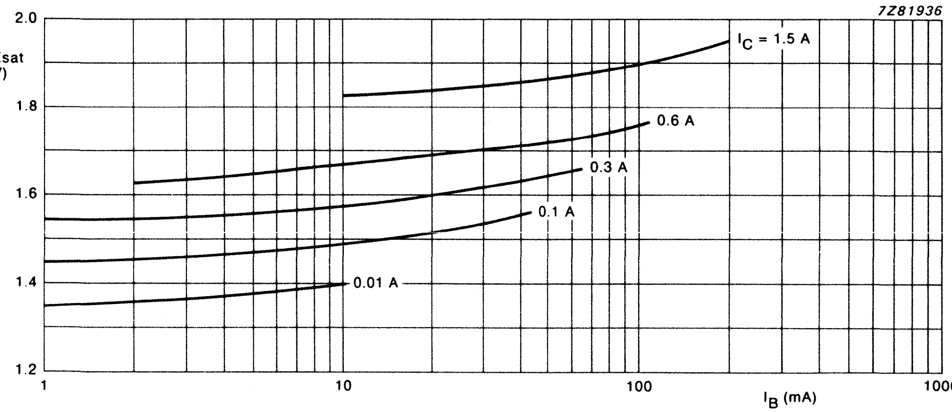


Fig. 8 Typical base-emitter saturation voltage as a function of base current.

DEVELOPMENT DATA

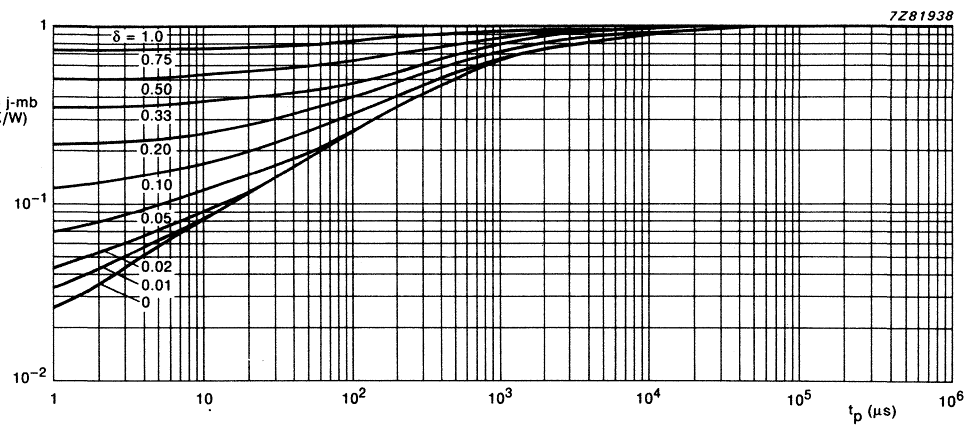


Fig. 9 Normalized thermal response at pulse power conditions.

SILICON DIFFUSED POWER TRANSISTOR

High-voltage, high-speed, glass-passivated npn switching transistor in a TO-3 envelope, intended for use in three-phase AC motor control systems.

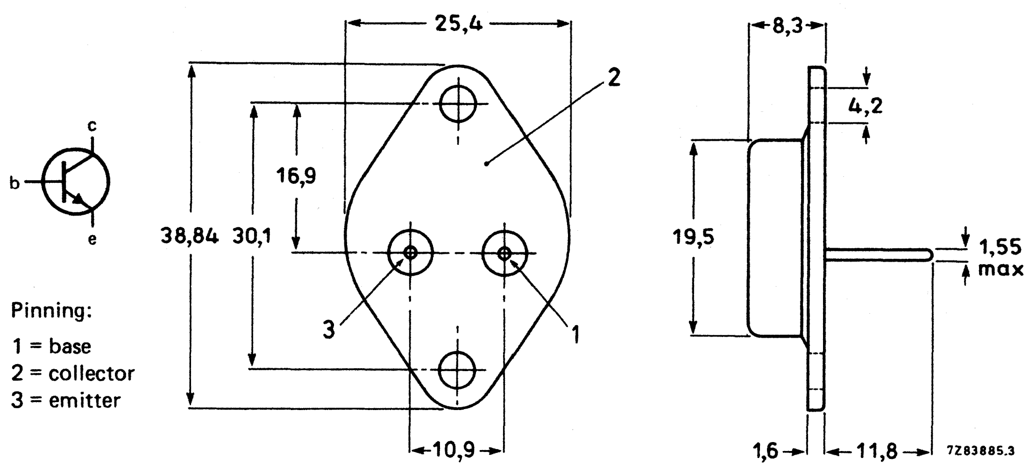
QUICK REFERENCE DATA

Collector-emitter voltage (peak value; $V_{BE} = 0$)	V_{CESM}	max.	1500	V
Collector-emitter voltage (open base)	V_{CEO}	max.	700	V
Collector-emitter saturation voltage	V_{CEsat}	max.	1	V
Collector current (DC)	I_C	max.	12	A
Collector current (peak value)	I_{CM}	max.	20	A
Total power dissipation up to $T_{mb} = 25\ ^oC$	P_{tot}	max.	160	W
Collector saturation current	I_{Csat}	typ.	9	A
Fall time	t_f	typ.	0,5	µs

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-3.



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
Collector-emitter voltage (open base)	V_{CEO}	max.	700	V
Collector current (DC)	I_C	max.	12	A
Collector current (peak value)	I_{CM}	max.	20	A
Base current (DC)	I_B	max.	8	A
Base current (peak value)	I_{BM}	max.	12	A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	160	W
Storage temperature range	T_{stg}	−65 to + 150		°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	0,78	K/W

CHARACTERISTICS

T_j = 25 °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 °C	I_{CES}	max.	4	mA
Emitter cut-off current				
I_C = 0; V_{EB} = 5 V	I_{EBO}	max.	10	mA
Saturation voltages				
I_C = 9 A; I_B = 4 A	V_{CEsat}	max.	1	V
	V_{BEsat}	max.	1,5	V
I_C = 12 A; I_B = 6 A	V_{CEsat}	max.	3	V
Collector-emitter sustaining voltage				
I_C = 200 mA; I_B = 0; L = 25 mH	$V_{CEOsust}$	min.	700	V
Second breakdown collector current				
V_{CE} = 100 V; t_p = 1 s	$I_{(SB)C}$	min.	0,4	A
Transition frequency at f = 5 MHz				
I_C = 0,1 A; V_{CE} = 5 V	f_T	typ.	7	MHz
Collector capacitance at f = 1 MHz				
$I_E = I_e$ = 0; V_{CB} = 10 V	C_C	typ.	200	pF

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

Switching times resistive load (Figs 2 and 3)

I_{Con} = 9 A; I_{Bon} = $-I_{Boff}$ = 4 A

Turn-on time	t_{on}	typ.	1,5	μs
Turn-off: Storage time	t_s	typ.	4,5	μs
Fall time	t_f	typ.	0,5	μs

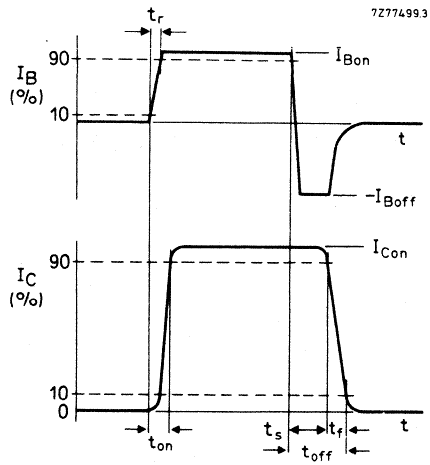


Fig. 2 Switching times waveforms with resistive load.

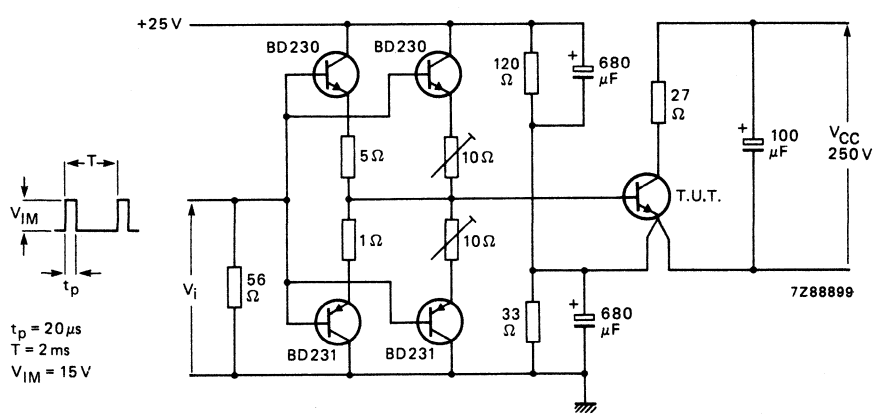
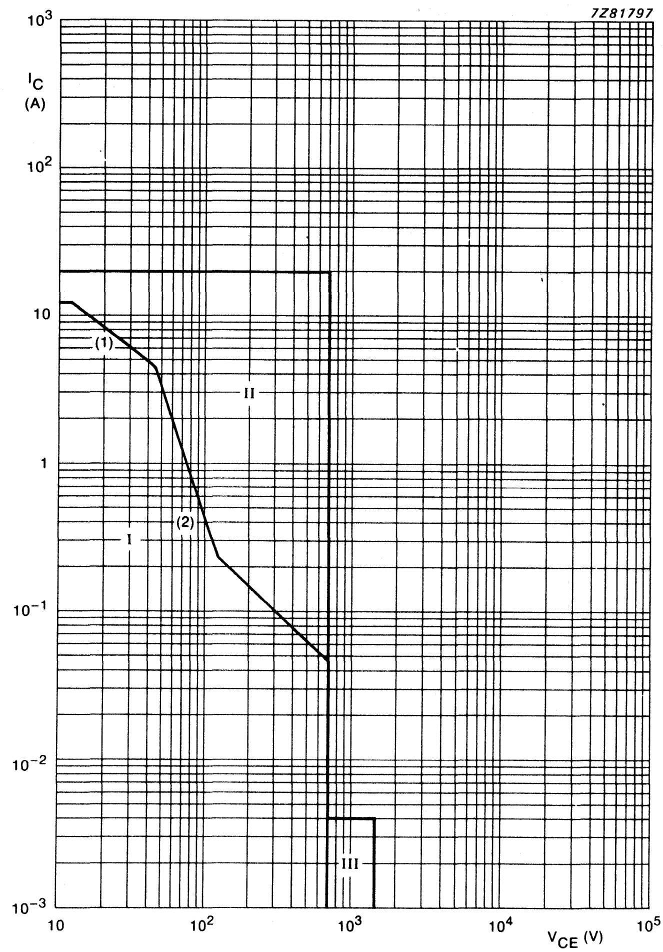


Fig. 3 Test circuit resistive load.



(1) $P_{tot\,max}$ line.
(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 permissible, provided $V_{BE} \leqslant 0$ and $t_p \leqslant 5$ ms.

Fig. 4 Safe operating area at $T_{mb} \leqslant 25$ °C.

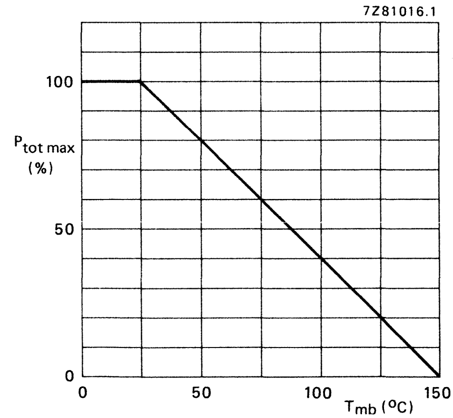


Fig. 5 Power derating curve.

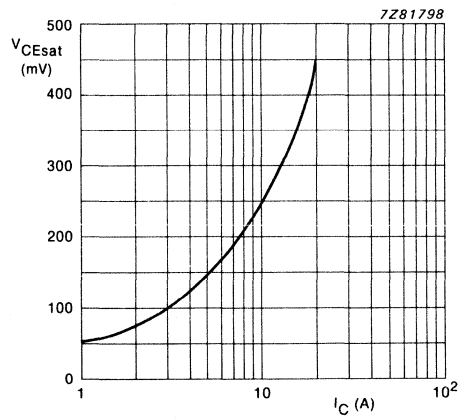


Fig. 6 Typical values $I_C/I_B = 2$; $T_j = 25$ °C.

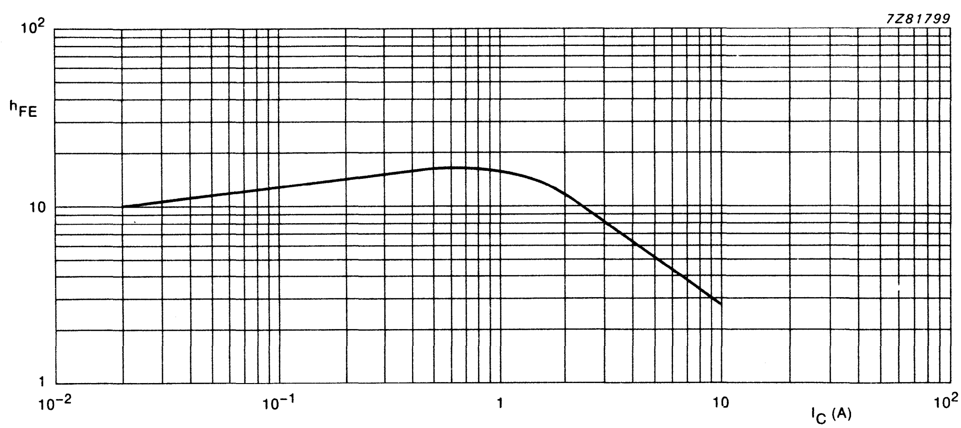


Fig. 7 Typical values DC current gain at $V_{CE} = 5$ V; $T_{mb} = 25$ °C.

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

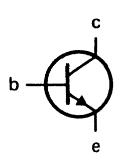
			BU826	BU826A	
Collector-emitter voltage (peak value; $V_{BE} = 0$)	V_{CESM}	max.	800	1000	V
Collector-emitter voltage (open base)	V_{CEO}	max.	375	400	V
Collector-emitter saturation voltage	V_{CEsat}	max.	2,0		V
Collector current (DC)	I_C	max.	6		A
Collector current (peak value)	I_{CM}	max.	8		A
Total power dissipation up to $T_{mb} = 25\ ^oC$	P_{tot}	max.	125		W
Collector saturation current	I_{Csat}	max.	2,5		A
Fall time	t_f	typ.	0,2		μs

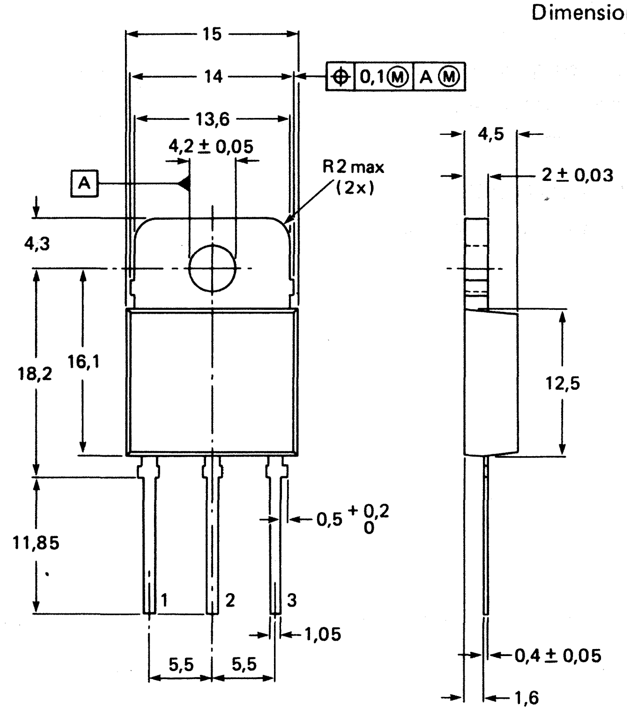
MECHANICAL DATA

Dimensions in mm

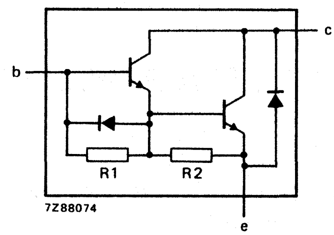
Fig. 1 SOT93.

Collector connected to mounting base.





Pinning:
1 = base
2 = collector
3 = emitter



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	1000	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 $T_{mb} = 25\ ^oC$	P_{tot}	max.	125		W
Storage temperature range	T_{stg}		−65 to + 150		^oC
Junction temperature*	T_j	max.	150		^oC

THERMAL RESISTANCE*

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	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 °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 °C	I_{CES}	max.	2	mA
Emitter cut-off current				
$I_C = 0$; V_{EB} = 8 V	I_{EBO}	max.	150	mA
		min.	50	mA
Collector-emitter sustaining voltage				
I_C = 100 mA; I_{Boff} = 0; L = 25 mH	$V_{CEOsust}$	min.	375	V
Saturation voltages				
I_C = 2,5 A; I_B = 55 mA	V_{CEsat}	max.	2,0	V
	V_{BEsat}	max.	2,2	V
I_C = 4 A; I_B = 200 mA	V_{CEsat}	max.	2,5	V

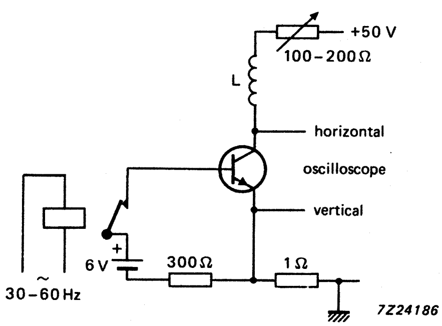


Fig. 3 Test circuit for $V_{CEOsust}$.

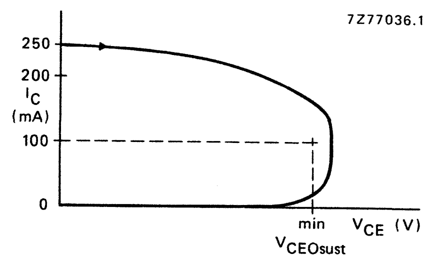


Fig. 4 Oscilloscope display for $V_{CEOsust}$.

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

CHARACTERISTICS (continued)

Switching times (between 10% and 90% levels)

I_{Con} = 2,5 A; V_{CC} = 250 V

I_{Bon} = 55 mA; $-I_{Boff}$ = 1 A

Turn-on time		t_{on}	max.	1,3 μs
Turn-off time:	Storage time	t_s	max.	2,0 μs
	Fall time	t_f	typ.	0,2 μs
	Fall time; T_{mb} = 100 °C	t_f	max.	0,6 μs

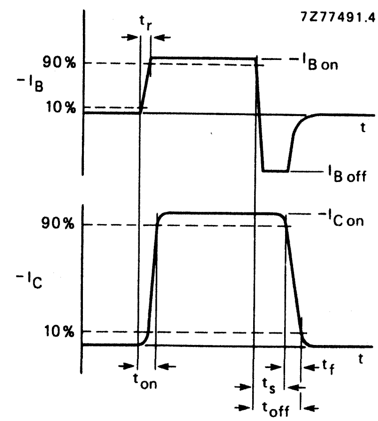


Fig. 5 Waveforms.

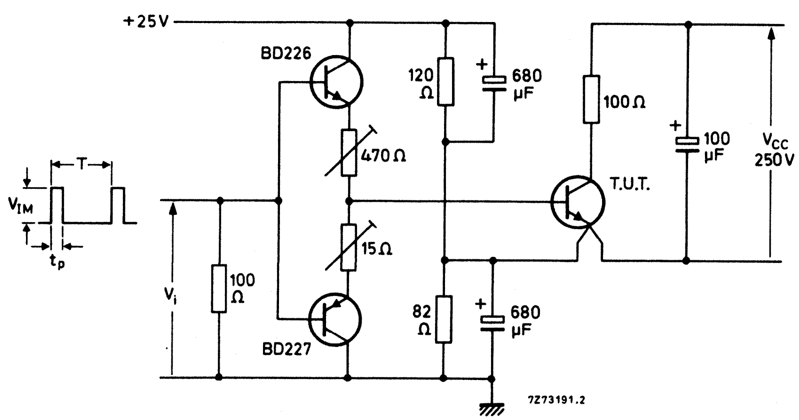
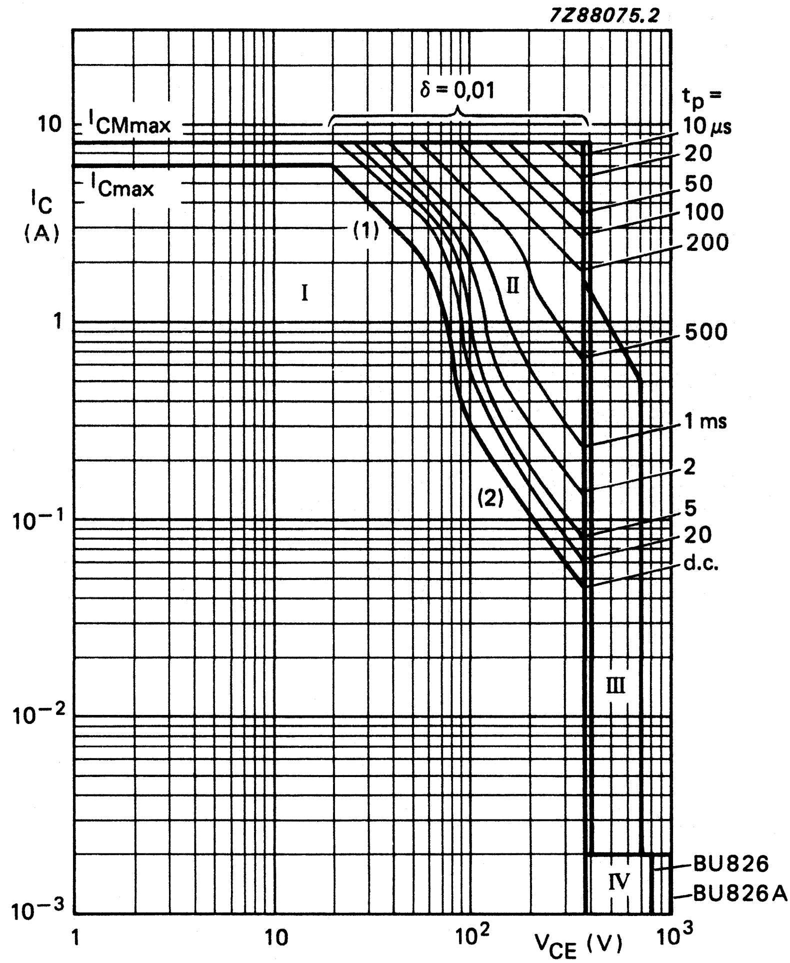


Fig. 6 Test circuit. T = 2 ms; t_p = 20 μs; V_{IM} = 15 V.



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 $t_p < 1{,}3$ μs.
IV Repetitive pulse operation in this region is permissible, provided $V_{BE} \leqslant 0$ and $t_p \leqslant 2$ ms.
(1) $P_{tot\ max}$ and $P_{peak\ max}$ lines.
(2) Second-breakdown limits.

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

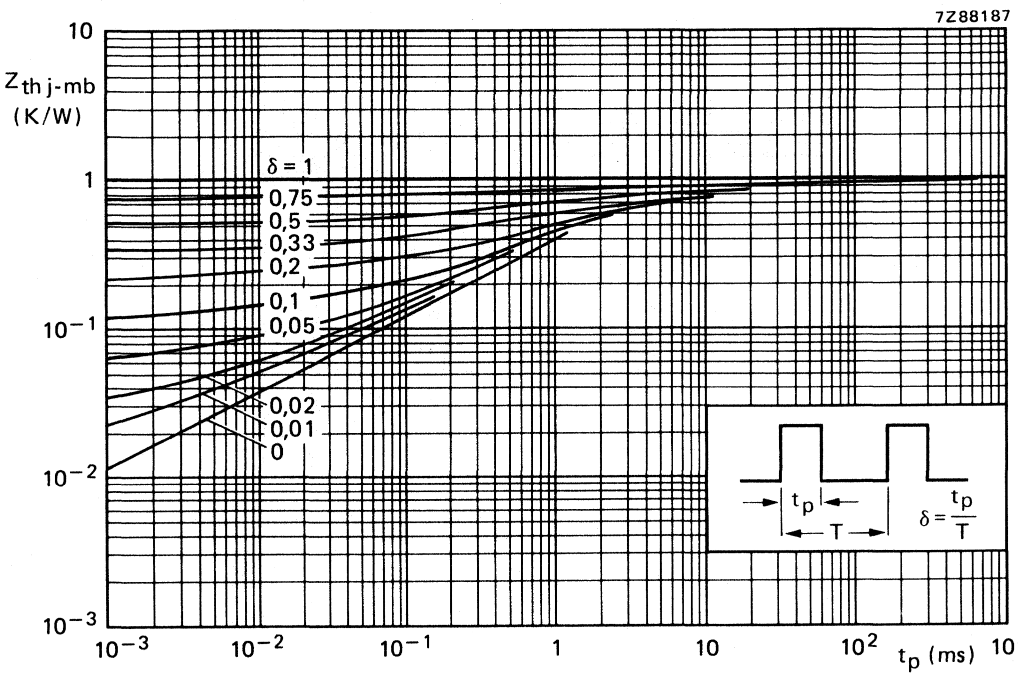


Fig. 8 Pulse power rating chart.

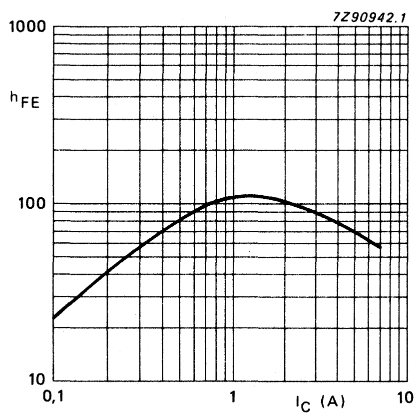


Fig. 9 DC current gain.

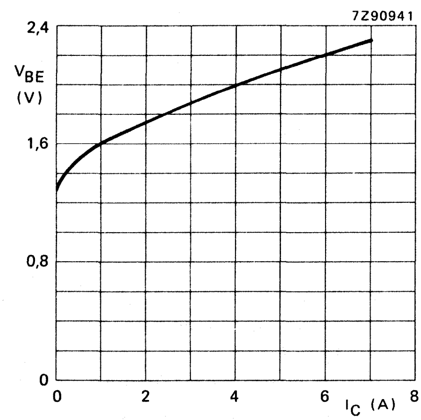


Fig. 10 V_{BEsat} curve; $T_j = 25^{\circ}$ C; typical values.

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.

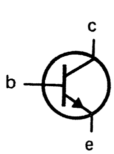
QUICK REFERENCE DATA

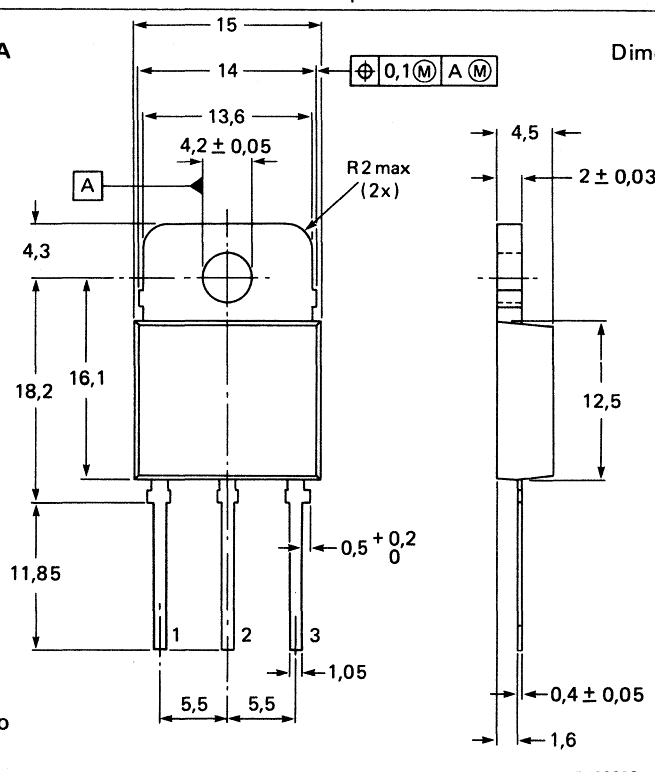
Collector-emitter voltage			
peak value; $V_{BE} = 0$	V_{CESM}	max.	1350 V
open base	V_{CEO}	max.	550 V
Saturation voltages	V_{CEsat}	max.	2.0 V
	V_{BEsat}	max.	1.5 V
Collector current			
saturation	I_{Csat}	max.	3.2 A
DC	I_C	max.	6.0 A
peak value	I_{CM}	max.	8.0 A
Total power dissipation			
up to $T_{mb} = 25\ ^oC$	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

Dimensions in mm

Fig. 1 SOT93.





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_{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.	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 $T_{mb} = 25\ ^oC$	P_{tot}	max.	125 W
Storage temperature range	T_{stg}		−65 to + 150 ^oC
Junction temperature	T_j	max.	150 ^oC

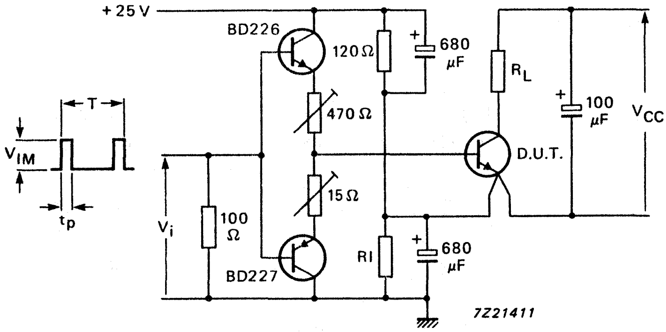
THERMAL RESISTANCE

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

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current			
$V_{BE} = 0$; $V_{CE} = V_{CESmax}$	I_{CES}	max.	1.0 mA
$V_{BE} = 0$; $V_{CE} = V_{CESmax}$; T_j = 125 °C	I_{CES}	max.	2.0 mA
Emitter cut-off current			
$I_C = 0$; V_{EB} = 6 V	I_{EBO}	max.	1.0 mA
Collector-emitter breakdown voltage			
I_C = 100 mA; $I_B = 0$	V_{CEO}	min.	550 V
Saturation voltage			
I_C = 3.2 A; I_B = 0.53 A	V_{CEsat}	max.	2.0 V
I_C = 6.0 A; I_B = 2.0 A	V_{CEsat}	max.	1.8 V
DC current gain			
I_C = 10 mA; V_{CE} = 5 V	h_{FE}	min.	6.0
I_C = 1.5 A; V_{CE} = 5 V	h_{FE}	min.	8.0
I_C = 3.2 A; V_{CE} = 2 V	h_{FE}	min.	6.0
I_C = 4.0 A; V_{CE} = 3 V	h_{FE}	min.	5.5
Switching times; resistive load (Figs 2 and 3)			
I_{Con} = 3.2 A; I_{Bon} = 0.53 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 A; I_{Bon} = 0.53 A			
turn-off; storage time	t_s	max.	2.5 μs
fall time	t_f	max.	0.8 μs



t_p = 20 µs
T = 2 ms
V_{IM} = 15 V

Fig. 2 Test circuit resistive load;
V_{CC} = 240 V; R_L = 75 Ω; R1 = 82 Ω.

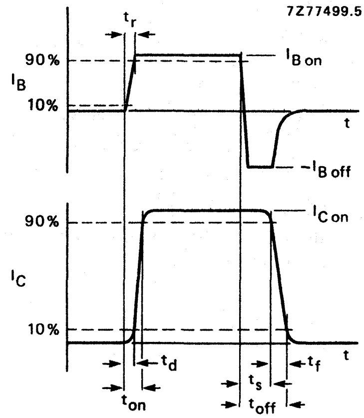


Fig. 3 Switching times waveforms with resistive load; $t_r \leqslant 30$ ns.

V_{CL} = 450 V
V_{CC} = 30 V
$-V_{BE}$ = −5 V
L_B = 2.5 µH
L_C = 200 µH

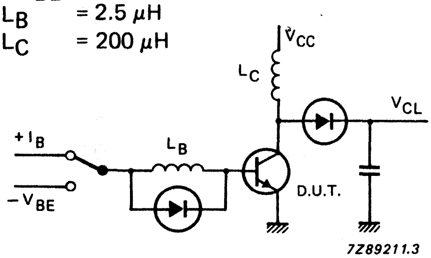


Fig. 4 Test circuit inductive load.

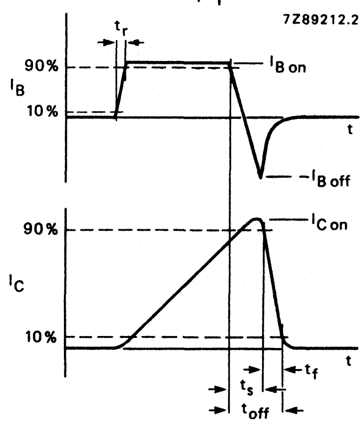


Fig. 5 Switching times waveforms with inductive load.

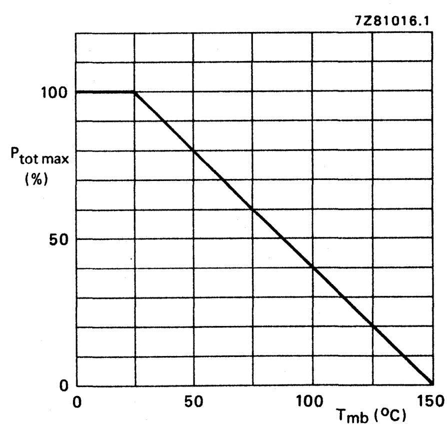
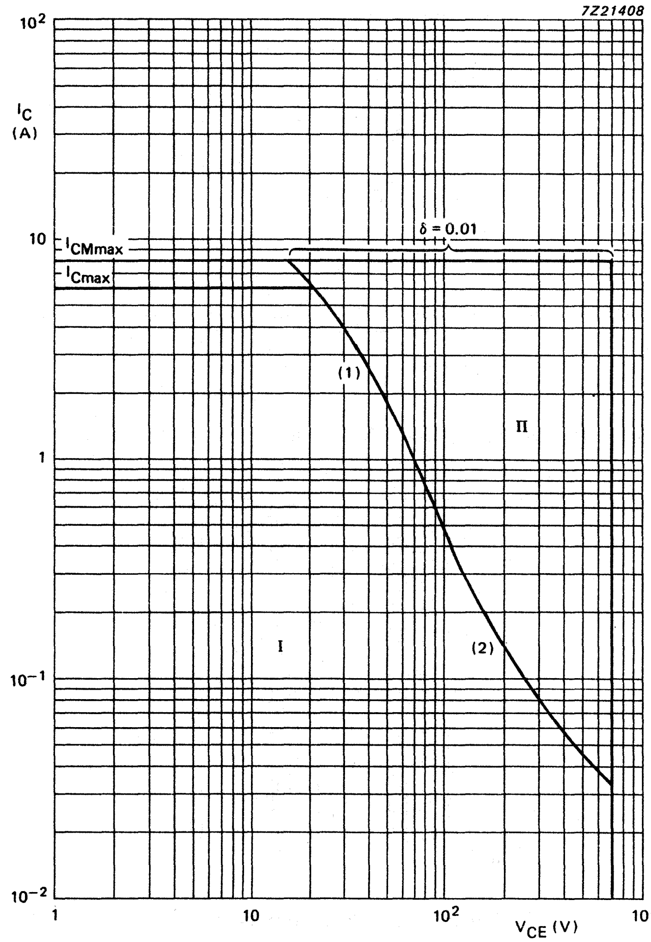


Fig. 6 Power derating curve.



(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.

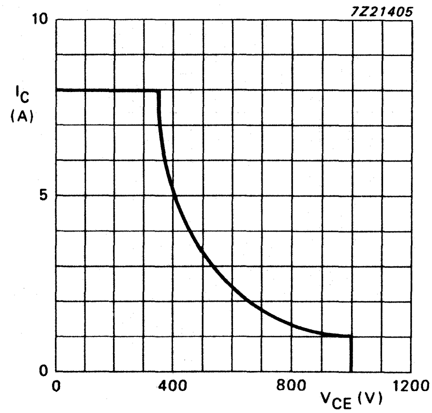


Fig. 8 Reverse bias SOAR; $-V_{BE} = 5$ V; $\beta_F \leqslant 4$; $T_j \leqslant 100$ °C.

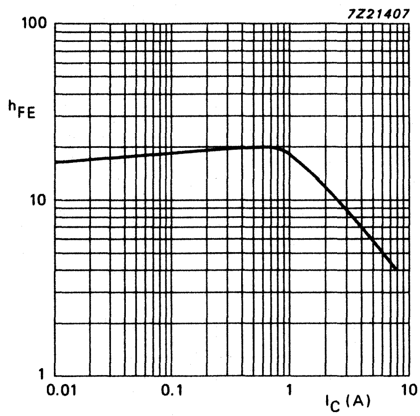


Fig. 9 Typical values DC current gain; $V_{CE} = 5$ V.

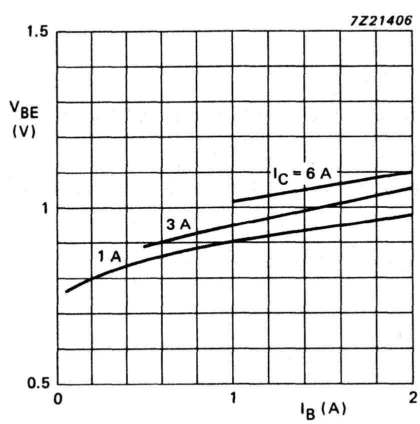


Fig. 10 Base-emitter voltage as a function of base current.

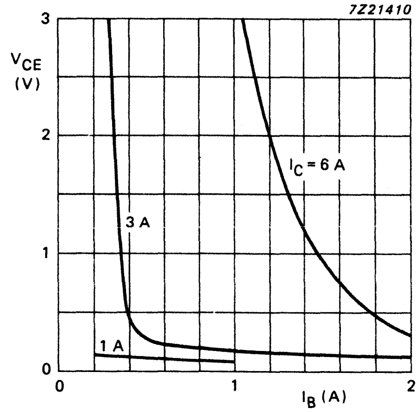


Fig. 11 Collector-emitter voltage as a function of base current.

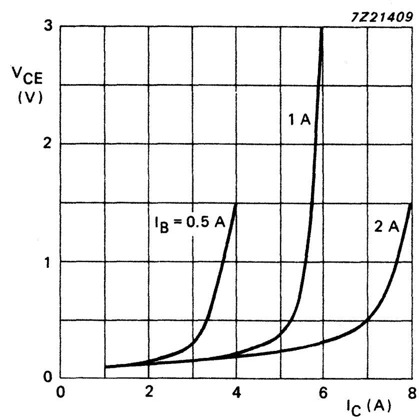


Fig. 12 Collector-emitter voltage as a function of collector current.

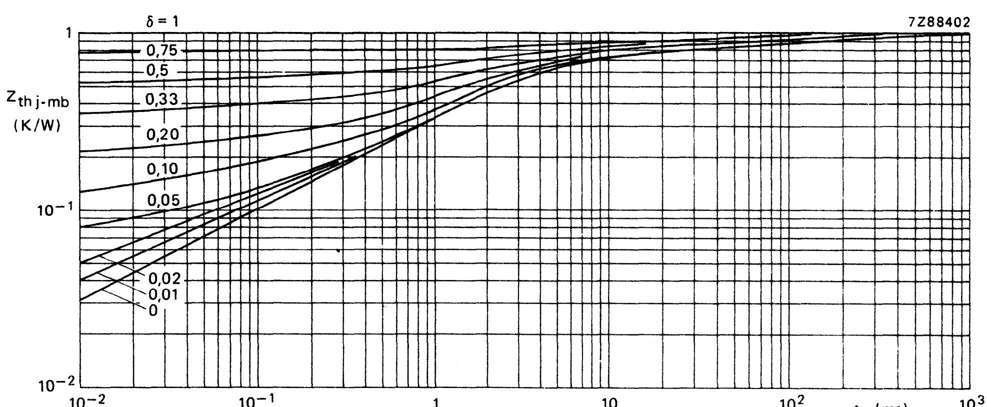


Fig. 13 Pulse power rating chart.

SILICON DIFFUSED POWER 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

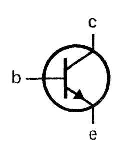
			BUP22B	BUP22C	
Collector-emitter voltage peak value; $V_{BE} = 0$	V_{CESM}	max.	750	850	V
Collector-emitter voltage open base	V_{CEO}	max.	400	450	V
Collector-emitter saturation voltage	V_{CEsat}	max.	1.5		V
Collector saturation current	I_{Csat}	max.	6		A
Collector current (DC)	I_C	max.	8		A
Collector current (peak value)	I_{CM}	max.	20		A
Total power dissipation up to $T_{mb} = 25\ ^oC$	P_{tot}	max.	125		W

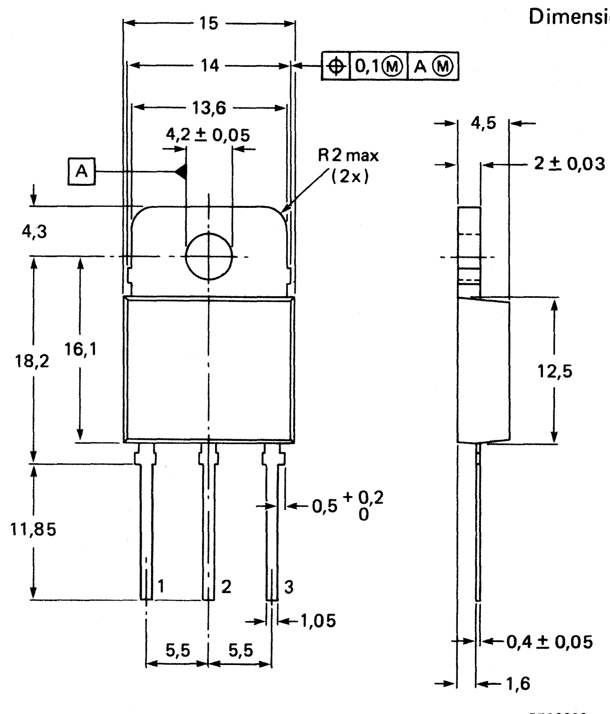
MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT93.

Collector connected to mounting base.





Pinning:

1 = base
2 = collector
3 = emitter

RATINGS

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

			BUP22B	BUP22C	
Collector-emitter voltage peak value; $V_{BE} = 0$	V_{CESM}	max.	750	850	V
Collector-emitter voltage open base	V_{CEO}	max.	400	450	V
Collector current (DC)	I_C	max.	8		A
Collector current (peak value)	I_{CM}	max.	20		A
Base current (DC)	I_B	max.	4		A
Peak value	I_{BM}	max.	6		A
Total power dissipation up to $T_{mb} = 25\ ^oC$	P_{tot}	max.	125		W
Storage temperature range	T_{stg}		−65 to + 150		^oC
Junction temperature	T_j	max.	150		^oC

THERMAL RESISTANCE

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

CHARACTERISTICS

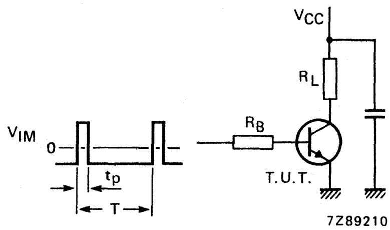
$T_j = 25\ ^oC$ unless otherwise specified

Collector cut-off current* $V_{CE} = V_{CESMmax}$; $V_{BE} = 0$	I_{CES}	max.	1	mA
$V_{CE} = V_{CESMmax}$; $V_{BE} = 0$; $T_j = 125\ ^oC$	I_{CES}	max.	2	mA
Emitter cut-off current $I_C = 0$; $V_{EB} = 9$ V	I_{EBO}	max.	10	mA
DC current gain $I_C = 1$ A; $V_{CE} = 5$ V	h_{FE}	typ.	25	

			BUP22B	BUP22C	
Collector-emitter sustaining voltage $I_B = 0$; $I_C = 0.1$ A; L = 25 mH	$V_{CEOsust}$	min.	400	450	V
Saturation voltages $I_C = 6$ A; $I_B = 0.8$ A	V_{CEsat}	max.	1.5	−	V
	V_{BEsat}	max.	1.5	−	V
$I_C = 6$ A; $I_B = 1$ A	V_{CEsat}	max.	−	1.5	V
	V_{BEsat}	max.	−	1.5	V

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

			BUP22B	BUP22C
Switching times resistive load (Figs 2 and 3)				
$I_{C\,on} = 6$ A; $I_{B\,on} = -I_{B\,off} = 0.8$ A	t_{on}	typ.	0.5	— μs
	t_s	typ.	3.0	— μs
	t_f	typ.	0.3	— μs
$I_{C\,on} = 6$ A; $I_{B\,on} = -I_{B\,off} = 1$ A	t_{on}	typ.	—	0.5 μs
	t_s	typ.	—	3.0 μs
	t_f	typ.	—	0.3 μs
Switching times inductive load (Figs 4 and 5)				
$I_{C\,on} = 6$ A; $I_{B\,on} = 0.8$ A	t_s	typ.	1.1	— μs
	t_f	typ.	40	— ns
$I_{C\,on} = 6$ A; $I_{B\,on} = 1$ A	t_s	typ.	—	1.1 μs
	t_f	typ.	—	40 ns



V_{CC} = 250 V
V_{IM} = −6 to +8 V
$\frac{t_p}{T}$ = 0,01
t_p = 20 μs
The values of R_B and R_L are selected in accordance with I_{Con} and I_B requirements.

Fig. 2 Test circuit resistive load.

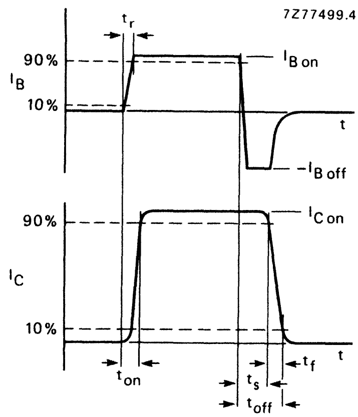


Fig. 3 Switching times waveforms with resistive load.

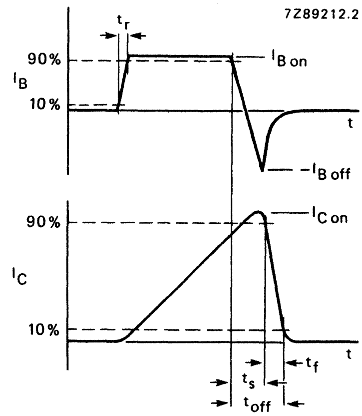
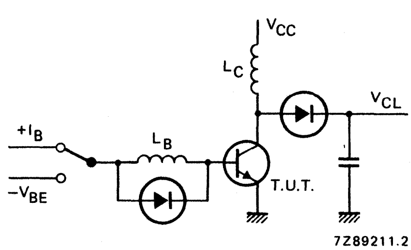
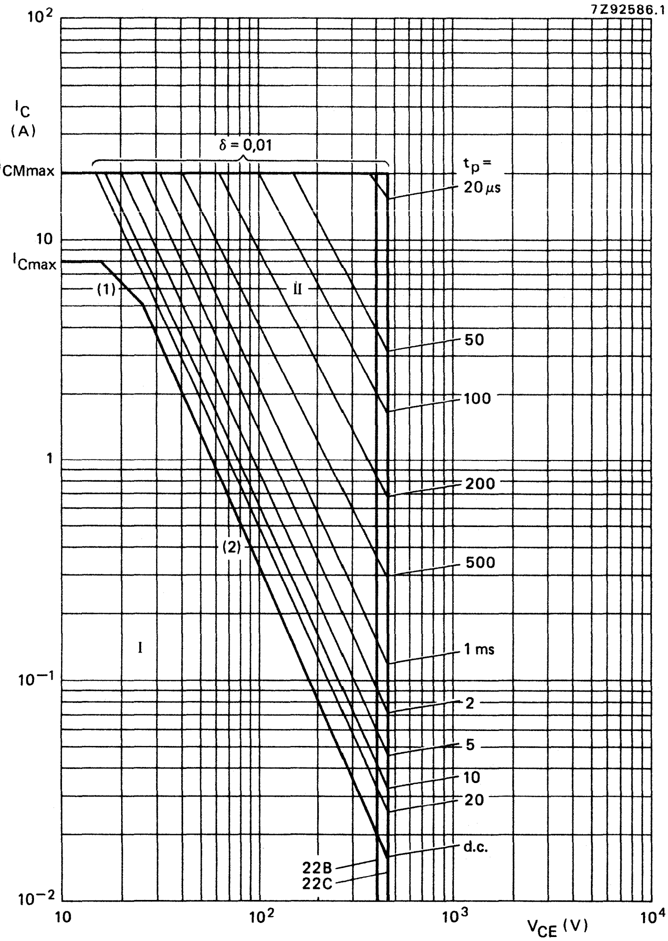


Fig. 4 Switching times waveforms with inductive load.



V_{CL} = 250 V
V_{CC} = 30 V
$-V_{BE}$ = 5 V
L_B = 1 μH
L_C = 200 μH

Fig. 5 Test circuit inductive load.



(1) Lines for $P_{tot\ max}$ and $P_{tot\ peak\ max}$.
(2) Second-breakdown limits.

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

Fig. 6 Safe operating area at $T_{mb} \leqslant 250\ ^oC$.

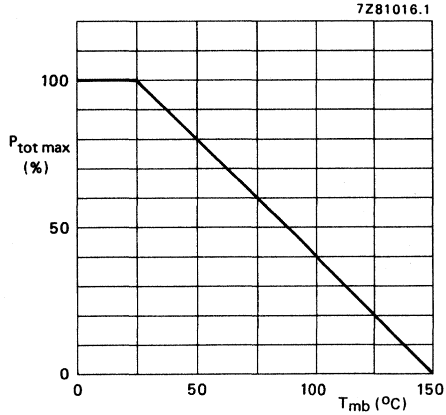


Fig. 7 Total power derating curve.

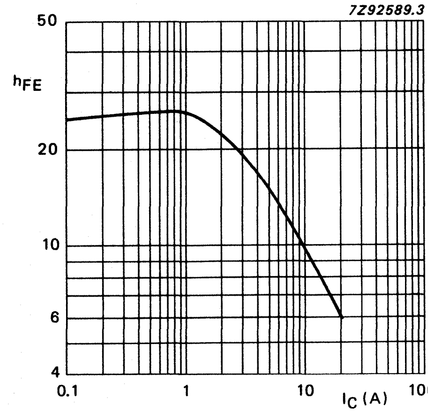


Fig. 8 Typical values DC current gain at T_{mb} = 25 °C.

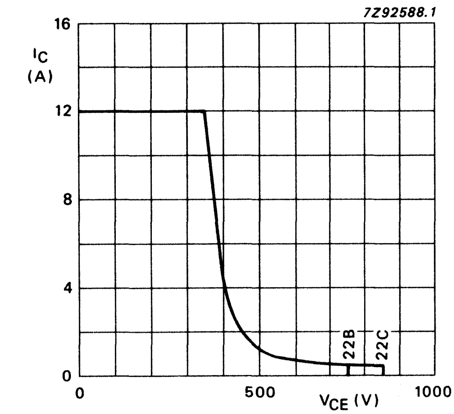


Fig. 9 Reverse bias SOAR; T_{mb} = 100 °C; $V_{BE(off)}$ = 1 to 5 V; L_B = 0 to 3 μH.

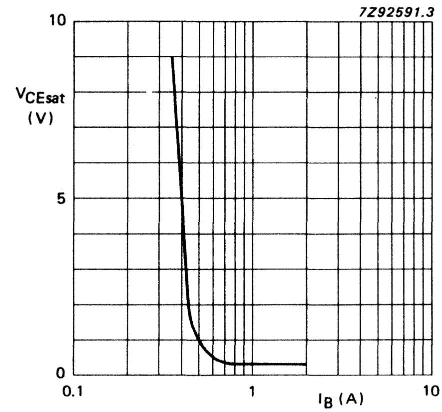


Fig. 10 Typical values V_{CEsat} at T_j = 25 °C; I_C = 6 A.

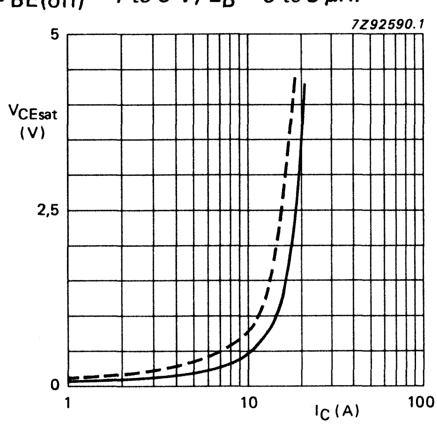


Fig. 11 Typical values collector voltage at T_j = 25 °C; I_C/I_B = 7, 5 and 6 for BUP22B and BUP22C resp; (——) = BUP22B; (– –) = BUP22C.

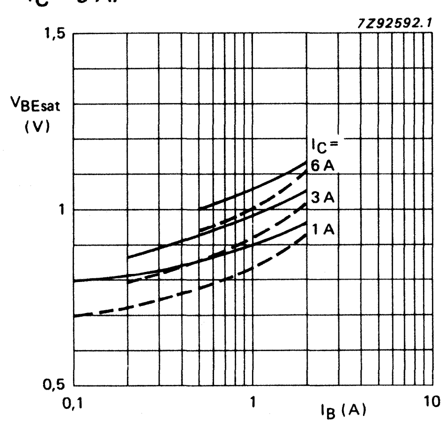


Fig. 12 Typical values V_{BE} at T_j = 25 °C; (——) = BUP22B; (– – –) = BUP22C.

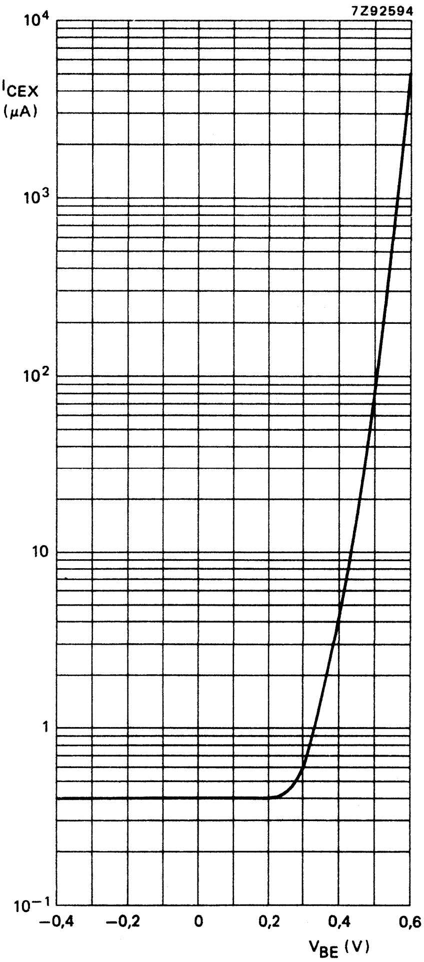


Fig. 13 Typical values collector cut-off current at T_j = 25 °C; V_{CE} = 250 V.

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.

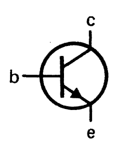
QUICK REFERENCE DATA

			BUP22BF	BUP22CF	
Collector-emitter voltage					
peak value; $V_{BE} = 0$	V_{CESM}	max.	750	850	V
open base	V_{CEO}	max.	400	450	V
Collector-emitter saturation voltage	V_{CEsat}	max.	1.5		V
Collector current					
saturation	I_{Csat}	max.	6.0		A
DC	I_C	max.	8.0		A
peak value; $t_p \leqslant 20$ ms	I_{CM}	max.	20		A
Total power dissipation					
up to $T_h = 25$ °C	P_{tot}	max.	34		W
Fall time; inductive load	t_f	max.	250		ns

MECHANICAL DATA

Dimensions in mm

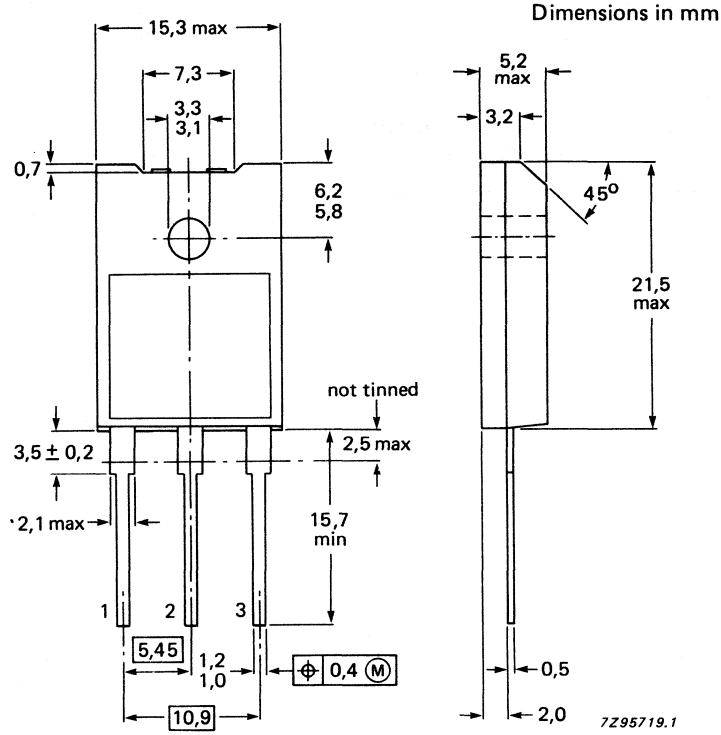
Fig. 1 SOT199.



Pinning:

1 = base
2 = collector
3 = emitter

Terminals are electrically isolated.



RATINGS

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

			BUP22BF	BUP22CF	
Collector-emitter voltage					
peak value; $V_{BE} = 0$	V_{CESM}	max.	750	850	V
open base	V_{CEO}	max.	400	450	V
Collector current					
saturation	I_{Csat}		6.0		A
DC	I_C	max.	8.0		A
peak value; $t_p < 20$ ms	I_{CM}	max.	20		A
Base current					
DC	I_B	max.	4.0		A
peak value; $t_p < 20$ ms	I_{BM}	max.	6.0		A
Total power dissipation up to $T_h = 25$ °C (note 1)	P_{tot}	max.	34		W
Total power dissipation up to $T_h = 25$ °C (note 2)	P_{tot}	max.	45		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)	$R_{th\ j\text{-}h}$	=	3.7	K/W
(note 2)	$R_{th\ j\text{-}h}$	=	2.8	K/W
From junction to ambient	$R_{th\ j\text{-}a}$	=	35	K/W

ISOLATION

Isolation voltage from all terminals to external heatsink (peak value)	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 of the envelope.
2. Mounted with heatsink compound and 30 ± 5 newtons pressure on centre of the envelope.

DEVELOPMENT DATA

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off currents*				
$V_{CE} = V_{CESMmax}$; $V_{BE} = 0$	I_{CES}	max.	1.0	mA
$V_{CE} = V_{CESMmax}$; $V_{BE} = 0$; T_j = 125 °C	I_{CES}	max.	2.0	mA
Emitter cut-off current				
V_{EB} = 9 V; $I_C = 0$	I_{EBO}	max.	10	mA
DC current gain				
I_C = 1.0 A; V_{CE} = 5 V	h_{FE}	typ.	25	

			BUP22BF	BUP22CF	
Saturation voltages					
I_C = 6 A; I_B = 0.8 A	V_{CEsat}	max.	1.5	–	V
	V_{BEsat}	max.	1.5	–	V
I_C = 6 A; I_B = 1.0 A	V_{CEsat}	max.	–	1.5	V
	V_{BEsat}	max.	–	1.5	V
Collector-emitter sustaining voltage (Figs 2 and 3)					
I_C = 100 mA; $I_{B\,off}$ = 0; L = 25 mH	$V_{CEOsust}$	min.	400	450	V
Collector saturation current					
V_{CE} = 1.5 V	I_{Csat}		6.0	6.0	A
Switching times resistive load (Figs 4 and 5)					
$I_{C\,on}$ = 6 A; $I_{B\,on} = I_{B\,off}$ = 0.8 A					
Turn-on time	t_{on}	max.	1.0	–	μs
Turn-off; storage time	t_s	max.	4.5	–	μs
fall time	t_f	max.	0.7	–	μs
$I_{C\,on}$ = 6 A; $I_{B\,on} = I_{B\,off}$ = 1 A					
Turn-on time	t_{on}	max.	–	1.0	μs
Turn-off; storage time	t_s	max.	–	4.5	μs
fall time	t_f	max.	–	0.7	μs
Switching times inductive load (Figs 6 and 7)					
$I_{C\,on}$ = 6 A; I_B = 0.8 A; V_{CL} = 250 V; T_c = 100 °C					
Turn-off; storage time	t_s	typ.	2.0	–	μs
	t_s	max.	2.5	–	μs
fall time	t_f	typ.	100	–	ns
	t_f	max.	250	–	ns
$I_{C\,on}$ = 6 A; I_B = 1 A; V_{CL} = 250 V; T_c = 100 °C					
Turn-off; storage time	t_s	typ.	–	2.0	μs
	t_s	max.	–	2.5	μs
fall time	t_f	typ.	–	100	ns
	t_f	max.	–	250	ns

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

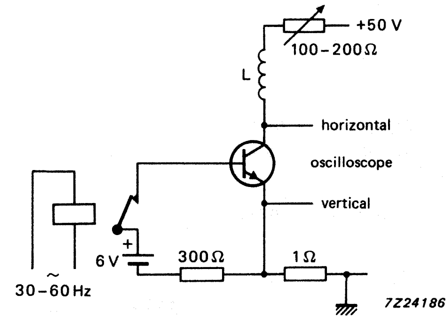


Fig. 2 Test circuit for $V_{CEOsust}$.

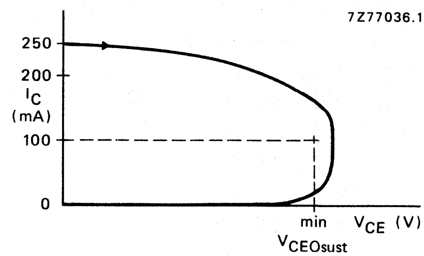
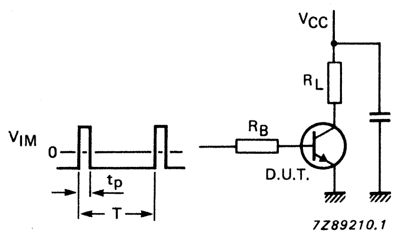


Fig. 3 Oscilloscope display for sustaining voltage.



V_{CC} = 250 V
t_p = 20 μs
V_{IM} = −6 to +8 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.

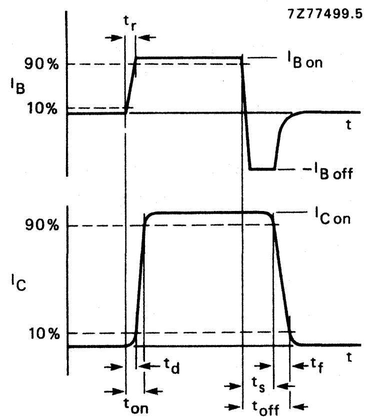
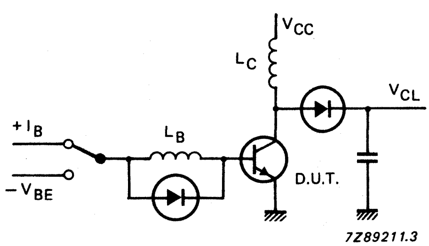


Fig. 5 Switching times waveforms with resistive load; $t_r \leqslant$ 20 ns.



V_{CL} = up to 850 V
V_{CC} = 30 V
$-V_{BE}$ = 5 V
L_B = 1.0 μH
L_C = 200 μH

Fig. 6 Test circuit inductive load and reverse bias SOAR.

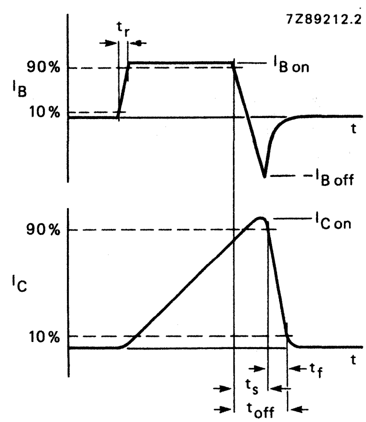
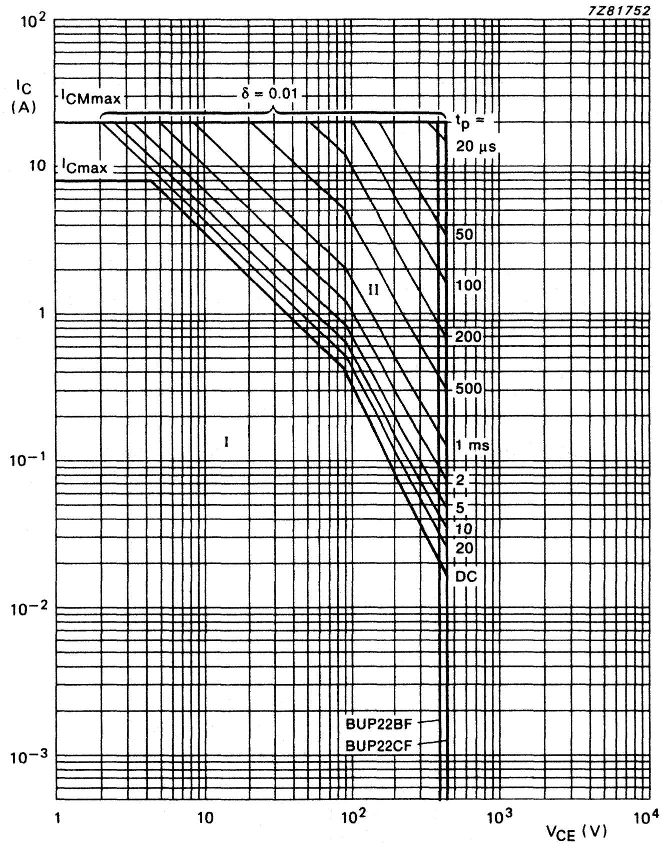


Fig. 7 Switching times waveforms with inductive load.



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.

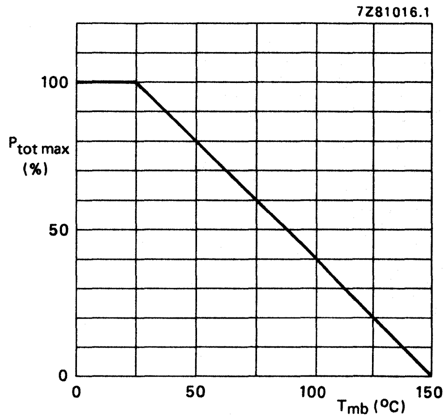


Fig. 9 Power dissipation curve.

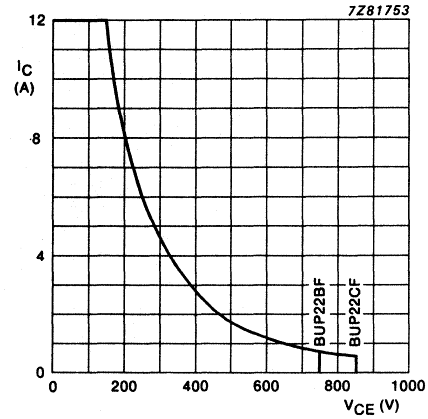


Fig. 10 Reverse bias SOAR; $V_{BE} = -1$ V to -5 V; $T_j < 100$ °C.

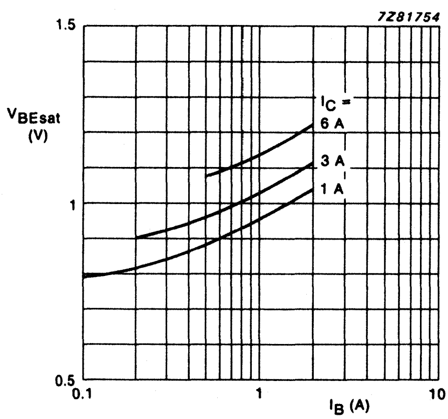
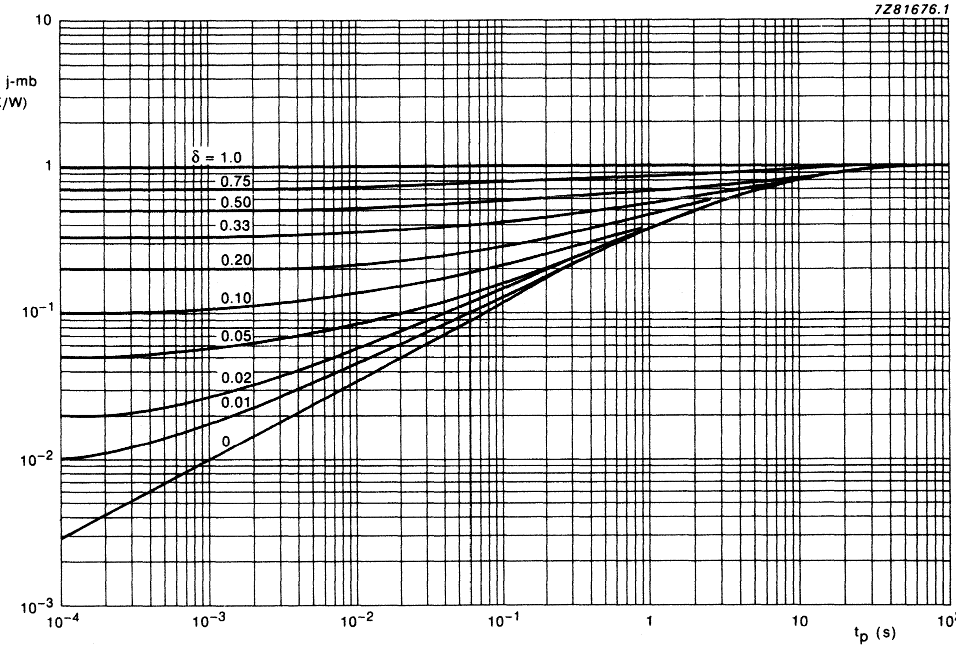


Fig. 11 Base-emitter saturation voltages as a function of base current; $T_j = 25$ °C.



DEVELOPMENT DATA

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

Fig. 12 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

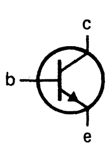
			BUP23B	BUP23C	
Collector-emitter voltage peak value; $V_{BE} = 0$	V_{CESM}	max.	750	850	V
Collector-emitter voltage open base	V_{CEO}	max.	400	450	V
Collector-emitter saturation voltage	V_{CEsat}	max.	1.5		V
Collector saturation current	I_{Csat}	max.	10		A
Collector current (DC)	I_C	max.	15		A
Collector current (peak value)	I_{CM}	max.	30		A
Total power dissipation up to $T_{mb} = 25\ ^oC$	P_{tot}	max.	175		W

MECHANICAL DATA

Dimensions in mm

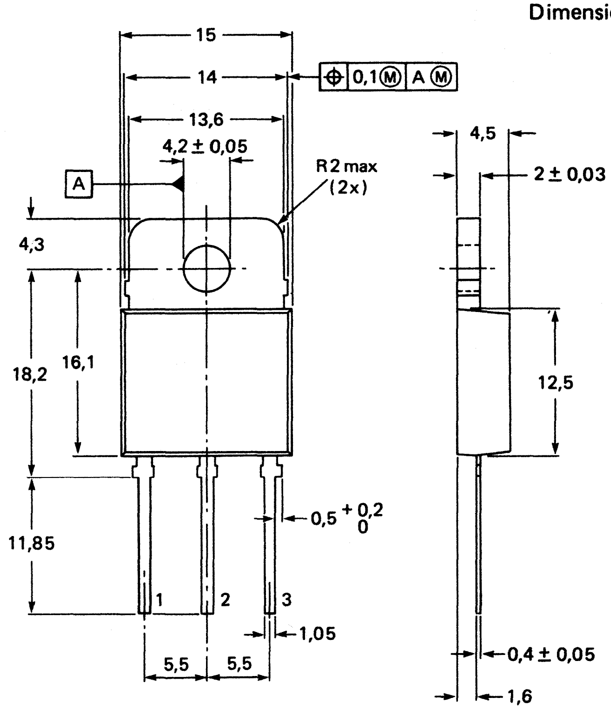
Fig. 1 SOT93.

Collector connected to mounting base.



Pinning:

1 = base
2 = collector
3 = emitter



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RATINGS

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

			BUP23B	BUP23C	
Collector-emitter voltage V_{BE} = 0; peak value	V_{CESM}	max.	750	850	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
Base current (DEC)	I_B	max.	6		A
Peak value	I_{BM}	max.	9		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	$R_{th\ j\text{-}mb}$	=	0.7	K/W

CHARACTERISTICS

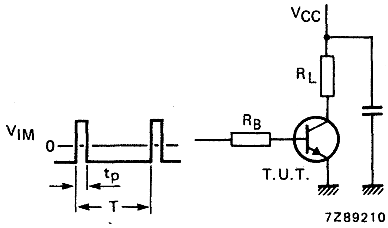
T_j = 25 °C unless otherwise specified

Collector cut-off current* $V_{CE} = V_{CESMmax}$; V_{BE} = 0	I_{CES}	max.	1	mA
Emitter cut-off current I_C = 0; V_{EB} = 9 V	I_{EBO}	max.	10	mA
DC current gain I_C = 1 A; V_{CE} = 5 V	h_{FE}	typ.	25	

			BUP23B	BUP23C	
Collector-emitter sustaining voltage I_B = 0; I_C = 0.1 A; L = 25 mH	$V_{CEOsust}$	min.	400	450	V
Saturation voltages I_C = 10 A; I_B = 1.33 A	V_{CEsat}	max.	1.5	−	V
	V_{BEsat}	max.	1.5	−	V
I_C = 10 A; I_B = 1.67 A	V_{CEsat}	max.	−	1.5	V
	V_{BEsat}	max.	−	1.5	V

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

			BUP23B	BUP23C
Switching times resistive load (Figs 2 and 3)				
$I_{C\ on} = 10$ A; $I_{B\ on} = -I_{B\ off} = 1.33$ A	t_{on}	typ.	0.7	— μs
	t_s	typ.	2.0	— μs
	t_f	typ.	0.27	— μs
$I_{C\ on} = 10$ A; $I_{B\ on} = -I_{B\ off} = 1.67$ A	t_{on}	typ.	—	0.7 μs
	t_s	typ.	—	2.0 μs
	t_f	typ.	—	0.27 μs
Switching times inductive load (Figs 4 and 5)				
$I_{C\ on} = 10$ A, $I_{B\ on} = 1.33$ A	t_s	typ.	2.1	— μs
	t_f	typ.	40	— ns
$I_{C\ on} = 10$ A; $I_{B\ on} = 1.67$ A	t_s	typ.	—	2.1 μs
	t_f	typ.	—	40 ns



V_{CC} = 250 V
V_{IM} = −6 to +8 V
$\frac{t_p}{T}$ = 0,01
t_p = 20 μs
The values of R_B and R_L are selected in accordance with I_{Con} and I_B requirements.

Fig. 2 Test circuit resistive load.

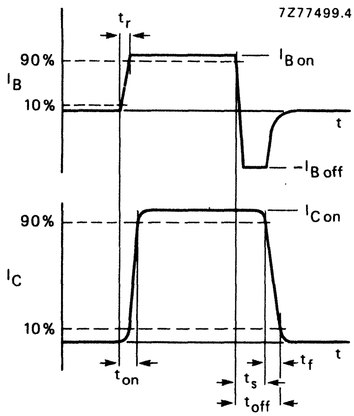


Fig. 3 Switching times waveforms with resistive load.

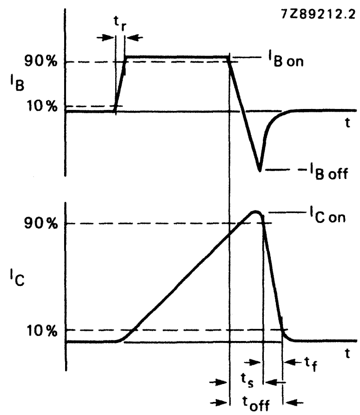
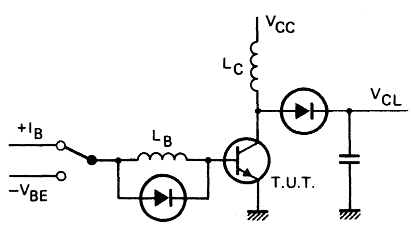
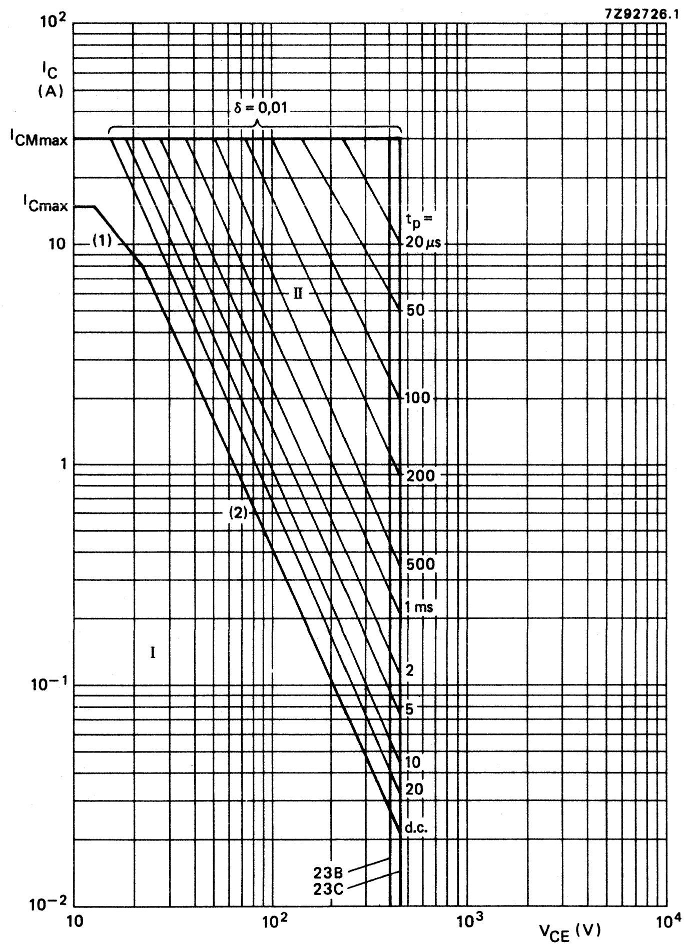


Fig. 4 Switching times waveforms with inductive load.



V_{CL} = 250 V
V_{CC} = 30 V
$-V_{BE}$ = 5 V
L_B = 1 μH
L_C = 200 μH

Fig. 5 Test circuit inductive load.



(1) Lines for $P_{tot\ max}$ and $P_{tot\ peak\ max}$.
(2) Second-breakdown limits.

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

Fig. 6 Safe operating area at $T_{mb} \leqslant 25$ °C.

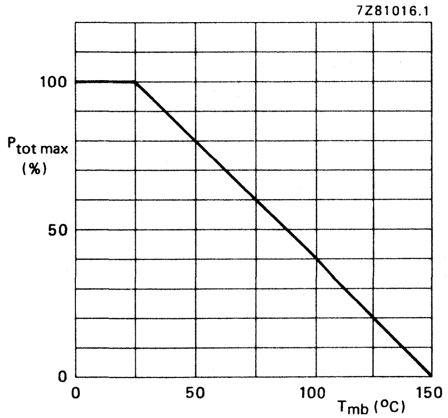


Fig. 7 Total power dissipation derating curve.

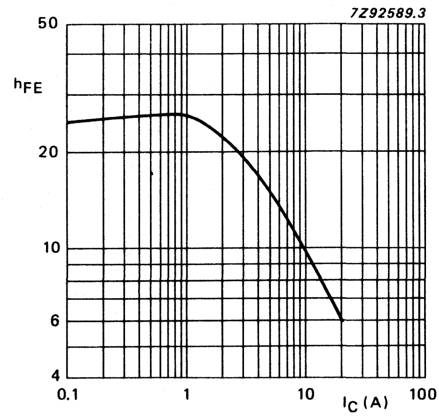


Fig. 8 Typical values DC current gain at T_{mb} = 25 °C.

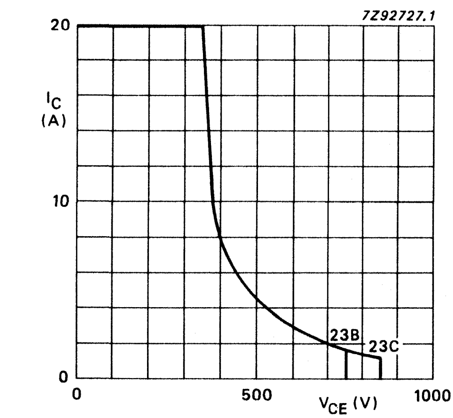


Fig. 9 Reverse bias SOAR; T_{mb} = 100 °C; $V_{BE(off)}$ = 1 to 5 V; L_B = 0 to 3 μH.

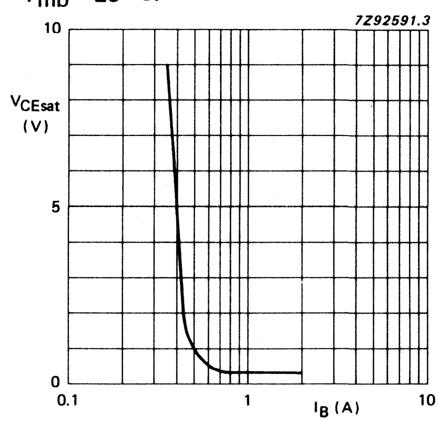


Fig. 10 Typical values V_{CEsat} at T_j = 25 °C; I_C = 10 A.

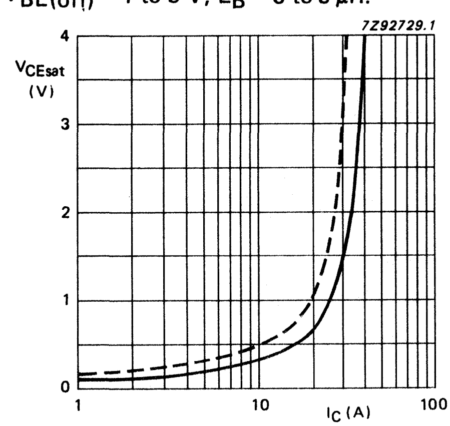


Fig. 11 Typical values collector voltage at T_j = 25 °C; I_C/I_B = 7, 5 and 6 for BUP22B and BUP23C resp; (——) = BUP23B; (– –) = BUP23C.

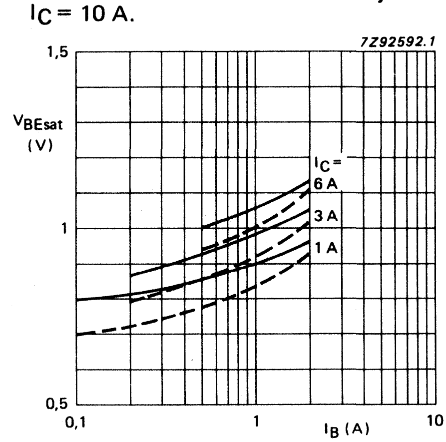


Fig. 12 Typical values V_{BE} at T_j = 25 °C; (——) = BUP23B; (– – –) = BUP23C.

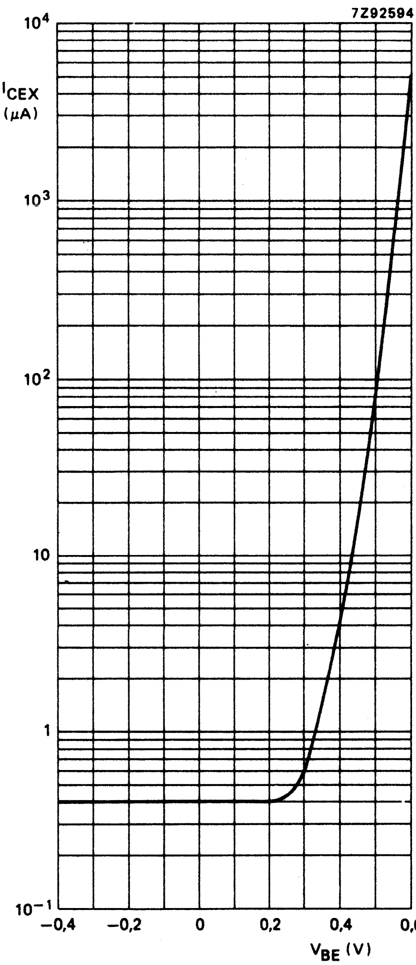


Fig. 13 Typical values collector cut-off current at T_j = 25 °C; V_{CE} = 250 V.

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.

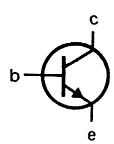
QUICK REFERENCE DATA

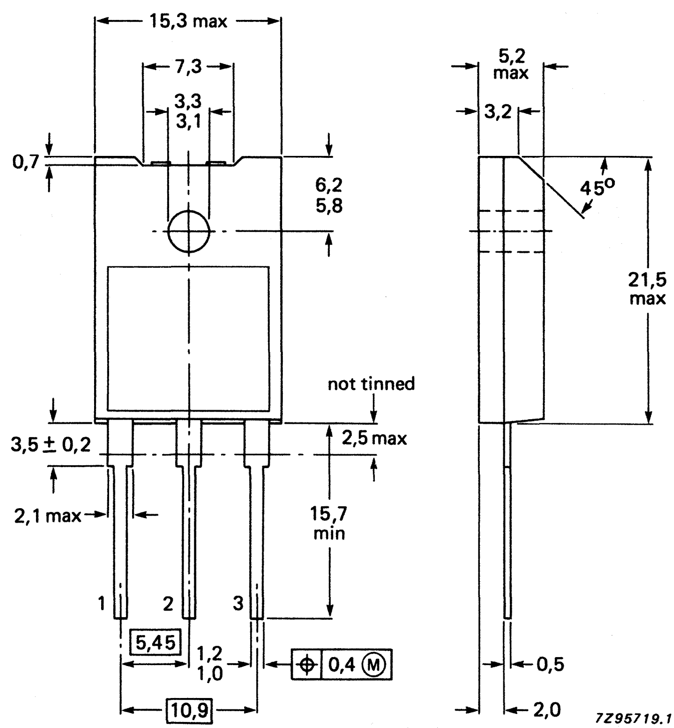
			BUP23BF	23CF	
Collector-emitter voltage					
peak value; $V_{BE} = 0$	V_{CESM}	max.	750	850	V
open base	V_{CEO}	max.	400	450	V
Collector-emitter saturation voltage	V_{CEsat}	max.	1.5		V
Collector current					
saturation	I_{Csat}	max.	10		A
DC	I_C	max.	15		A
peak value; $t_p < 20$ ms	I_{CM}	max.	30		A
Total power dissipation up to $T_{mb} = 25\ ^oC$	P_{tot}	max.	37		W
Fall time; inductive load	t_f	max.	250		ns

MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT199.





Pinning:

1 = base
2 = collector
3 = emitter

Terminals are electrically isolated

RATINGS

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

			BUP23BF	23CF	
Collector-emitter voltage					
peak value; $V_{BE} = 0$	V_{CESM}	max.	750	850	V
open base	V_{CEO}	max.	400	450	V
Collector current					
saturation	I_{Csat}		10		A
DC	I_C	max.	15		A
peak value; $t_p < 20$ ms	I_{CM}	max.	30		A
Base current					
DC	I_B	max.	6.0		A
peak value; $t_p < 20$ ms	I_{BM}	max.	9.0		A
Total power dissipation					
up to $T_h = 25$ °C (note 1)	P_{tot}	max.	37		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)	$R_{th\,j\text{-}h}$	=	3.4	K/W
(note 2)	$R_{th\,j\text{-}h}$	=	2.5	K/W
From junction to ambient	$R_{th\,j\text{-}a}$	=	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.

DEVELOPMENT DATA

CHARACTERISTICS

T_j = 25 ^oC unless otherwise specified

Collector cut-off currents *					
$V_{CE} = V_{CESMmax}$; $V_{BE} = 0$	I_{CES}	max.	1.0		mA
$V_{CE} = V_{CESMmax}$; $V_{BE} = 0$; T_j = 125 ^oC	I_{CES}	max.	3.0		mA
Emitter cut-off current					
V_{EB} = 9 V; $I_C = 0$	I_{EBO}	max.	10		mA
DC current gain					
I_C = 1.5 V; V_{CE} = 5 V	h_{FE}	typ.	25		
			BUP23BF	23CF	
Saturation voltages					
I_C = 10 A; I_B = 1.33 A	V_{CEsat}	max.	1.5	–	V
	V_{BEsat}	max.	1.5	–	V
I_C = 10 A; I_B = 1.67 A	V_{CEsat}	max.	–	1.5	V
	V_{BEsat}	max.	–	1.5	V
Collector-emitter sustaining voltage (Figs 2 and 3)					
I_C = 100 mA; $I_{B\,off}$ = 0; L = 25 mH	$V_{CEOsust}$	min.	400	450	V
Collector saturation current					
V_{CE} = 1.5 V	I_{Csat}	max.	10	10	A
Switching times; resistive load (Figs 4 and 5)					
$I_{C\,on}$ = 10 A; $I_{B\,on} = I_{B\,off}$ = 1.33 A					
Turn-on time	t_{on}	max.	1.0	–	μs
Turn-off; storage time	t_s	max.	4.5	–	μs
fall time	t_f	max.	0.7	–	μs
$I_{C\,on}$ = 10 A; $I_{B\,on} = I_{B\,off}$ = 1.67 A					
Turn-on time	t_{on}	max.	–	1.0	μs
Turn-off; storage time	t_s	max.	–	4.5	μs
fall time	t_f	max.	–	0.7	μs
Switching times; inductive load (Figs 6 and 7)					
$I_{C\,on}$ = 10 A; I_B = 1.33 A; V_{CL} = 250 V; T_{mb} = 100 ^oC					
Turn-off; storage time	t_s	typ.	2.5	–	μs
	t_s	max.	3.0	–	μs
fall time	t_f	typ.	100	–	ns
	t_f	max.	250	–	ns
$I_{C\,on}$ = 10 A; I_B = 1.67 A; V_{CL} = 250 V; T_{mb} = 100 ^oC					
Turn-off; storage time	t_s	typ.	–	2.5	μs
	t_s	max.	–	3.0	μs
fall time	t_f	typ.	–	100	ns
	t_f	max.	–	250	ns

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

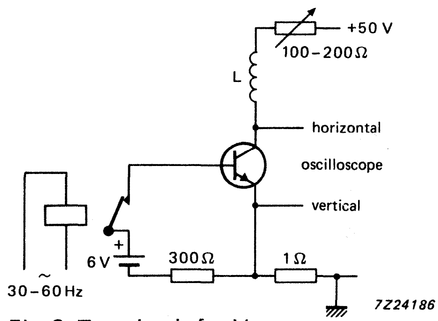


Fig. 2 Test circuit for $V_{CEOsust}$.

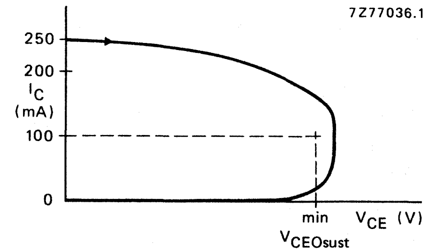


Fig. 3 Oscilloscope display for sustaining voltage.

V_{CC} = 250 V
t_p = 20 μs
V_{IM} = −6 to + 8 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.

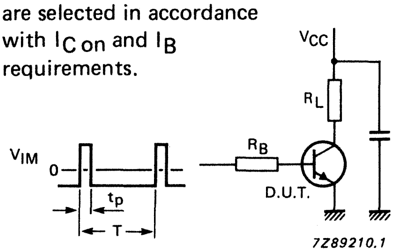


Fig. 4 Test circuit resistive load.

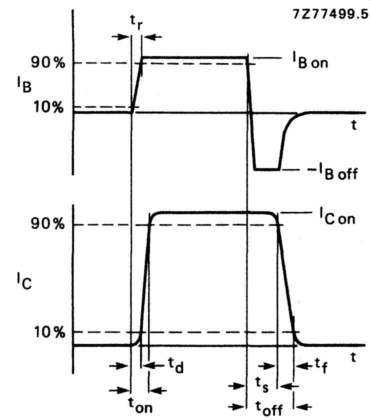


Fig. 5 Switching times waveforms with resistive load; $t_r \leqslant 20$ ns.

V_{CL} ⩽ 850 V
V_{CC} = 30 V
$-V_{BE}$ = 5 V
L_B = 1.0 μH
L_C = 200 μH

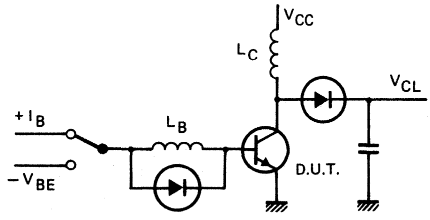


Fig. 6 Test circuit inductive load and reverse bias SOAR.

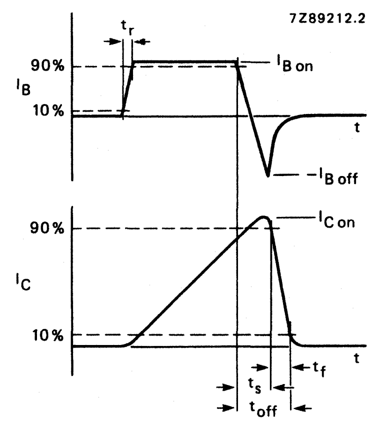
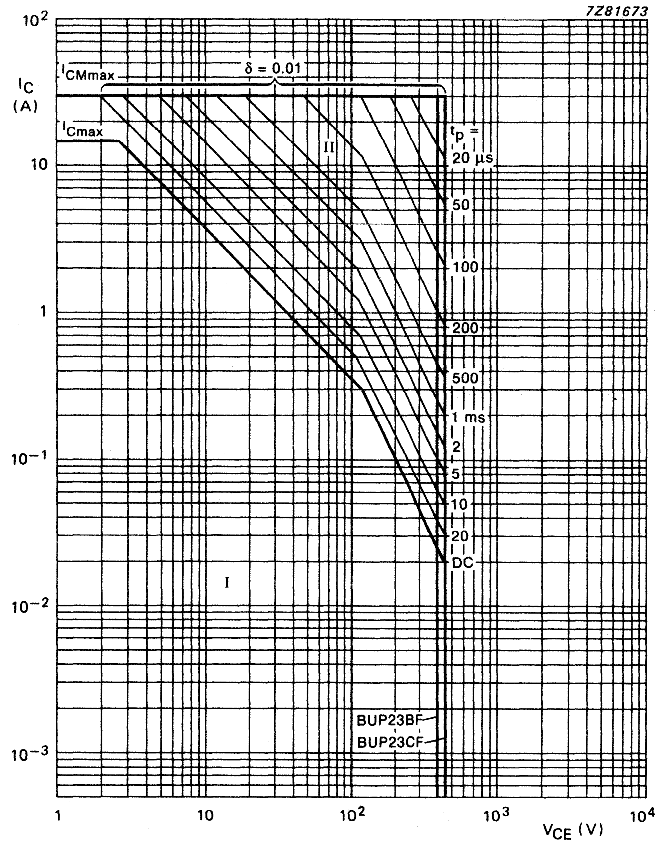


Fig. 7 Switching times waveforms with inductive load.



Mounted without heatsink compound and 30 ± 5 newton 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 $T_{mb} < 25\ ^{o}C$.

DEVELOPMENT DATA

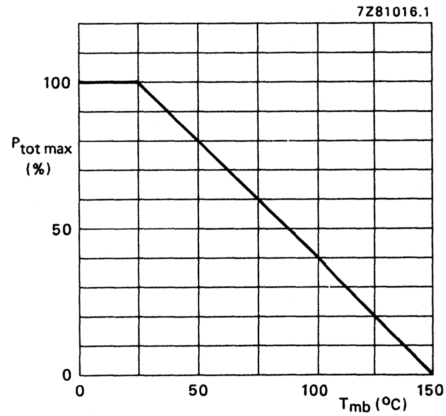


Fig. 9 Power dissipation curve.

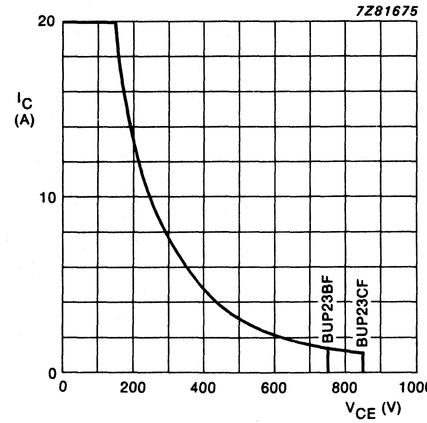


Fig. 10 Reverse bias SOAR; $V_{BE} = -1$ V to -5 V; $T_{mb} \leqslant 100$ °C.

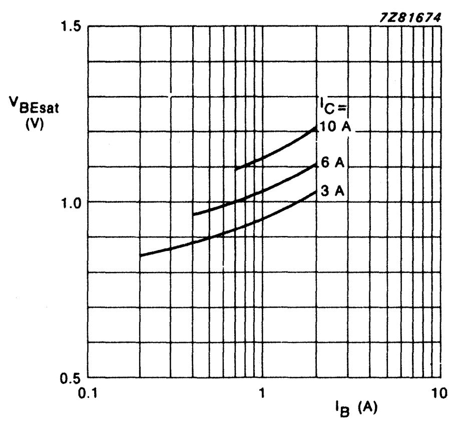
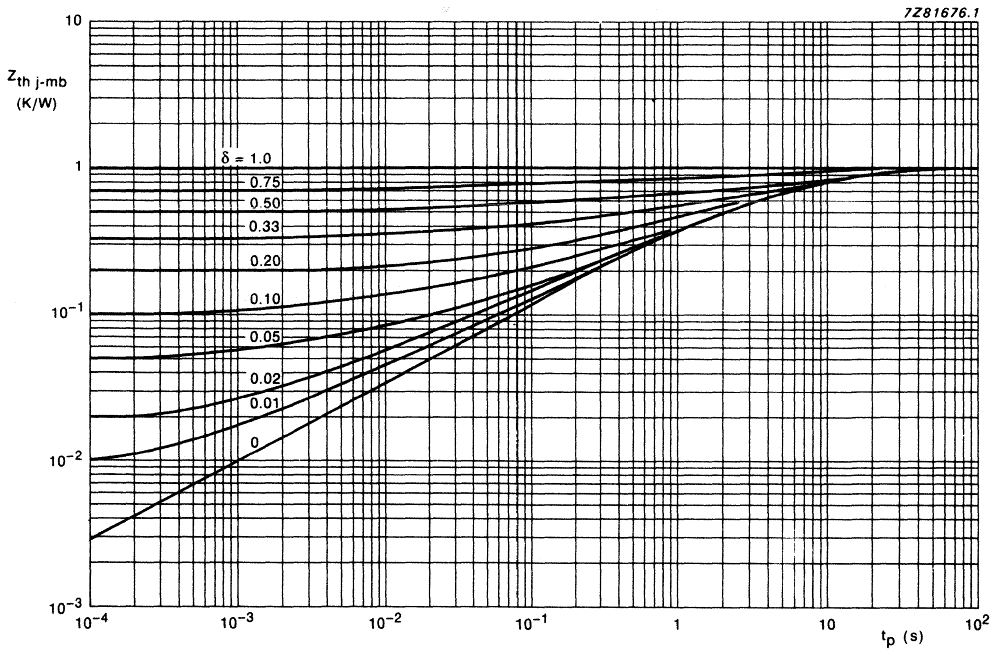


Fig. 11 Base-emitter saturation voltages as a function of base current; $T_j = 25$ °C.



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

Fig. 12 Normalized thermal response at pulse power conditions.

DEVELOPMENT DATA

SILICON DIFFUSED POWER TRANSISTORS

High-voltage, high-speed, glass-passivated npn power transistors in a TO-3 envelope, intended for use in converters, inverters, switching regulators, motor control systems etc.

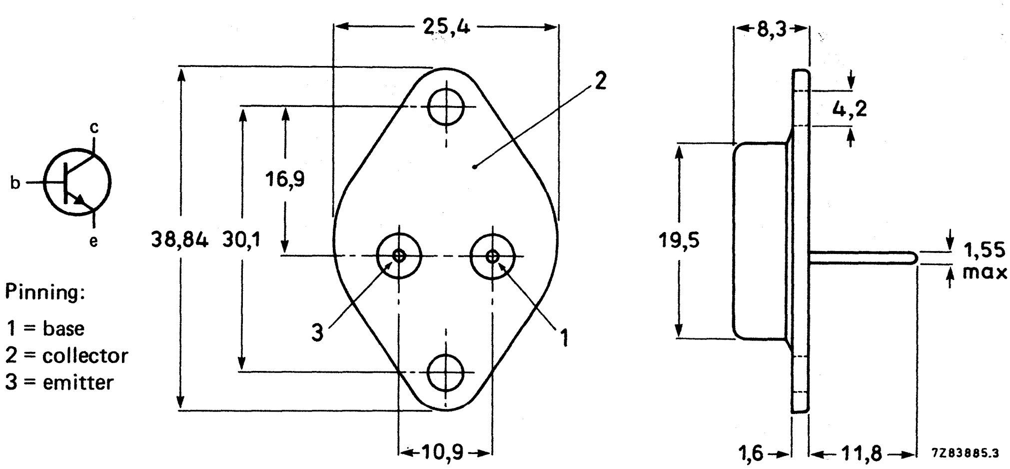
QUICK REFERENCE DATA

			BUS11	BUS11A	
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 $T_{mb} = 25\ ^{o}C$	P_{tot}	max.	100		W
Fall time; resistive load	t_f	max.	0,8		μs

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-3.



Pinning:
1 = base
2 = collector
3 = emitter

Collector connected to case.

Products approved to CECC 50 004-124 available on request.

RATINGS

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

			BUS11	BUS11A	
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)	I_{CM}	max.	10		A
Base current (DC)	I_B	max.	2		A
Base current (peak value)	I_{BM}	max.	4		A
Total power dissipation up to $T_{mb} = 25\ ^oC$	P_{tot}	max.	100		W
Storage temperature range	T_{stg}		−65 to +200		^oC
Junction temperature	T_j	max.	200		^oC

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	1,75	K/W

CHARACTERISTICS

$T_j = 25\ ^oC$ unless otherwise specified

Collector cut-off current *				
$V_{CE} = V_{CESMmax}$; $V_{BE} = 0$	I_{CES}	max.	1	mA
$V_{CE} = V_{CESMmax}$; $V_{BE} = 0$; $T_j = 125\ ^oC$	I_{CES}	max.	2	mA
Emitter cut-off current				
$I_C = 0$; $V_{EB} = 9$ V	I_{EBO}	max.	10	mA

			BUS11	BUS11A	
Saturation voltages					
$I_C = 3$ A; $I_B = 0,6$ A	V_{CEsat}	max.	1,5	–	V
$I_C = 2,5$ A; $I_B = 0,5$ A	V_{CEsat}	max.	–	1,5	V
$I_C = 3$ A; $I_B = 0,6$ A	V_{BEsat}	max.	1,4	–	V
$I_C = 2,5$ A; $I_B = 0,5$ A	V_{BEsat}	max.	–	1,4	V
Collector-emitter sustaining voltage					
$I_C = 100$ mA; $I_{Boff} = 0$; $L = 25$ mH	$V_{CEOsust}$	min.	400	450	V

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

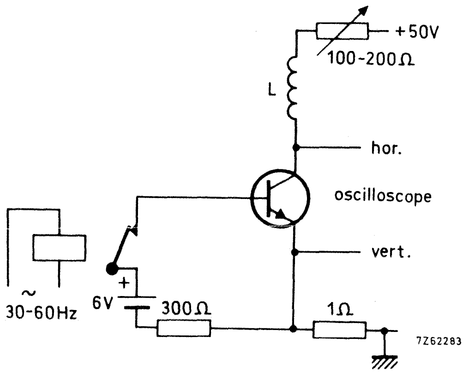


Fig. 2 Test circuit for $V_{CEOsust}$.

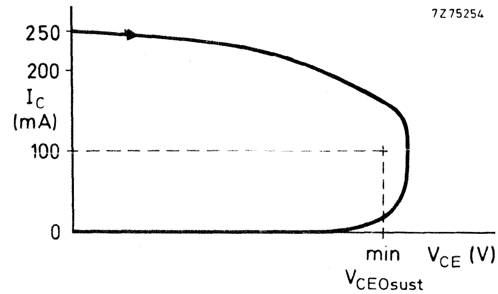


Fig. 3 Oscilloscope display for sustaining voltage.

			BUS11	BUS11A	
Switching times resistive load (Figs 4 and 5)					
I_{Con} = 3 A; I_{Bon} = I_{Boff} = 0,6 A					
Turn-on time	t_{on}	max.	1	–	μs
Turn-off: Storage time	t_s	max.	4	–	μs
Fall time	t_f	max.	0,8	–	μs
I_{Con} = 2,5 A; I_{Bon} = $-I_{Boff}$ = 0,5 A					
Turn-on time	t_{on}	max.	–	1	μs
Turn-off: Storage time	t_s	max.	–	4	μs
Fall time	t_f	max.	–	0,8	μs
Switching times inductive load (Figs 6 and 7)					
I_{Con} = 3 A; I_B = 0,6 A					
Turn-off: Storage time	t_s	typ.	1,1	–	μs
		max.	1,4	–	μs
Fall time	t_f	typ.	80	–	ns
		max.	150	–	ns
I_{Con} = 3 A; I_B = 0,6 A; T_j = 100 °C					
Turn-off: Storage time	t_s	typ.	1,2	–	μs
		max.	1,5	–	μs
Fall time	t_f	typ.	140	–	ns
		max.	300	–	ns
Switching times inductive load (Figs 6 and 7)					
I_{Con} = 2,5 A; I_B = 0,5 A					
Turn-off: Storage time	t_s	typ.	–	1,1	μs
		max.	–	1,4	μs
Fall time	t_f	typ.	–	80	ns
		max.	–	150	ns
I_{Con} = 2,5 A; I_B = 0,5 A; T_j = 100 °C					
Turn-off: Storage time	t_s	typ.	–	1,2	μs
		max.	–	1,5	μs
Fall time	t_f	typ.	–	140	ns
		max.	–	300	ns

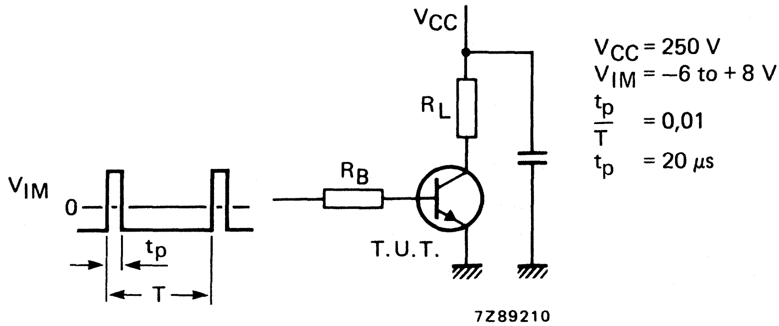


Fig. 4 Test circuit resistive load.

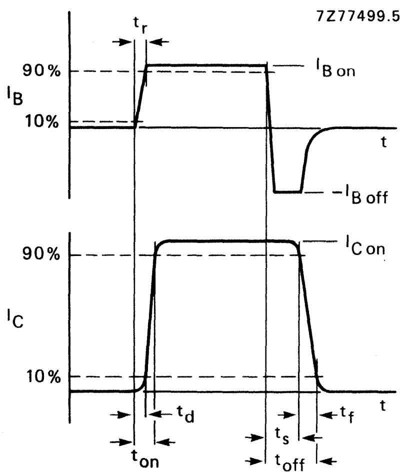


Fig. 5 Switching times waveforms with resistive load.

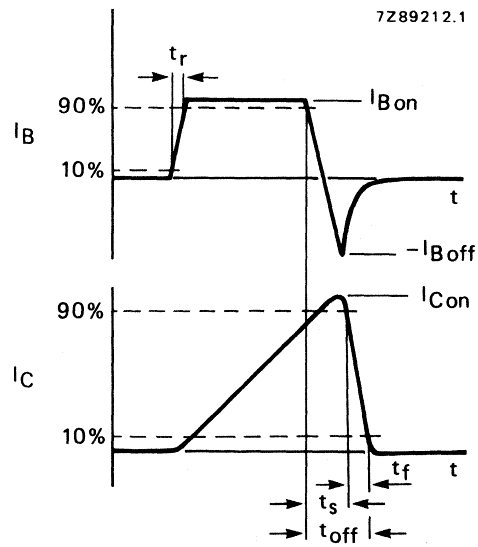


Fig. 6 Switching times waveforms with inductive load.

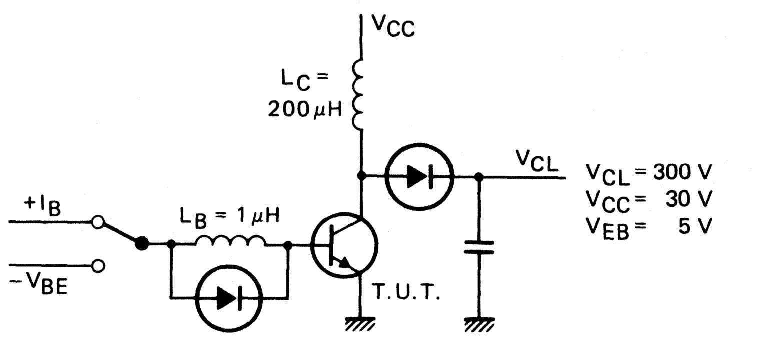
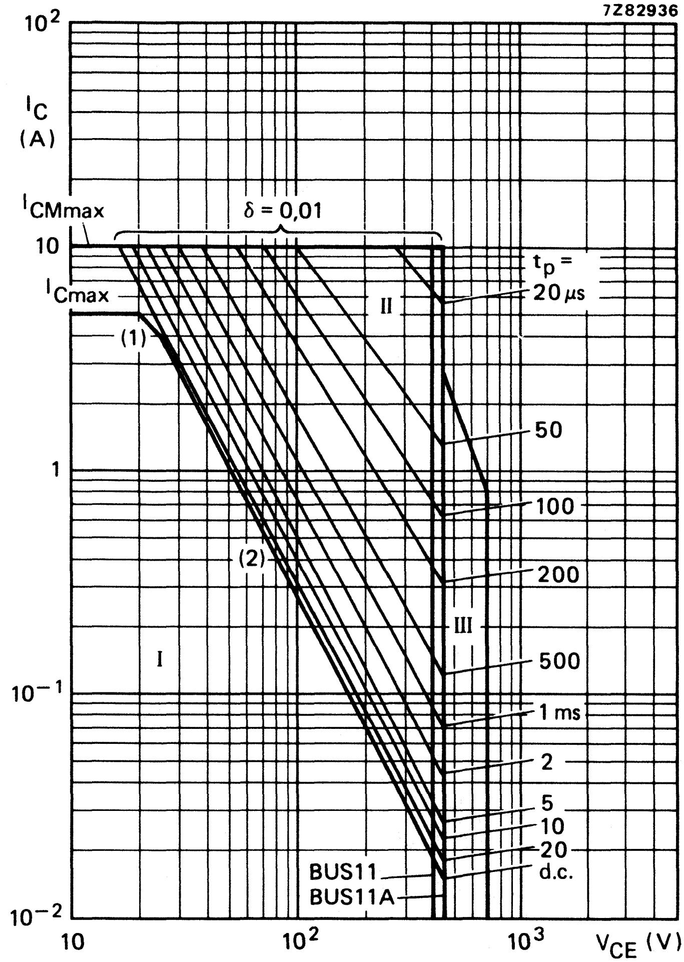
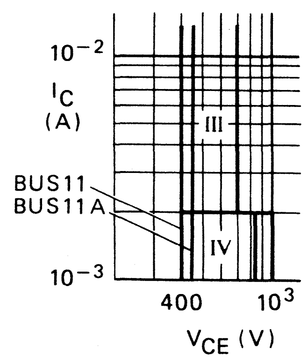


Fig. 7 Test circuit inductive load.





(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 $R_{BE} \leqslant 100\ \Omega$ and $t_p \leqslant 0{,}6\ \mu s$.
IV Repetitive pulse operation in this region is permissible provided $V_{BE} \leqslant 0$ and $t_p \leqslant 2$ ms.

Fig. 8 Safe operating area at $T_{mb} \leqslant 25\ ^oC$.

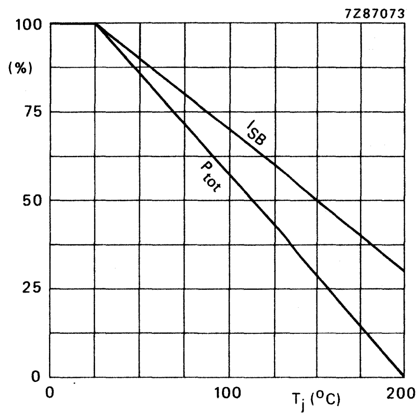


Fig. 9 Total power dissipation and second-breakdown current derating curve.

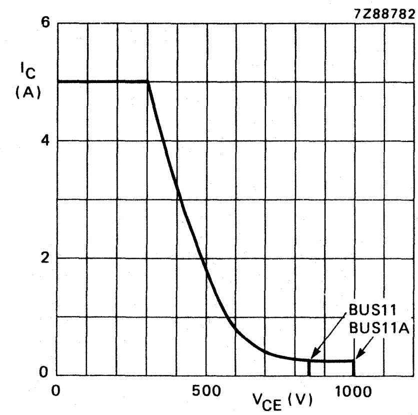


Fig. 10 Reverse bias SOAR.

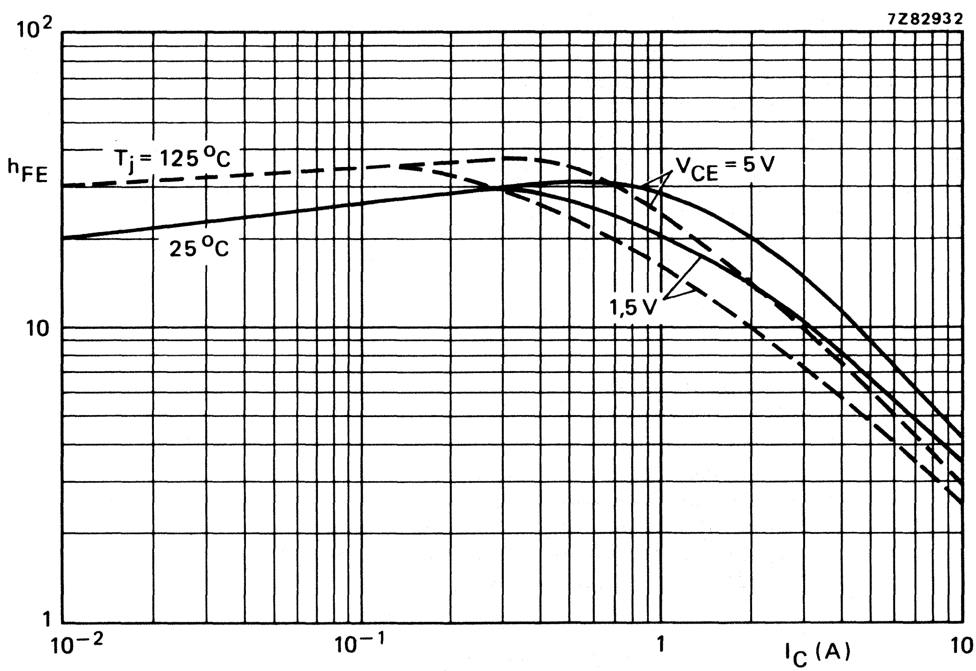


Fig. 11 DC current gain.

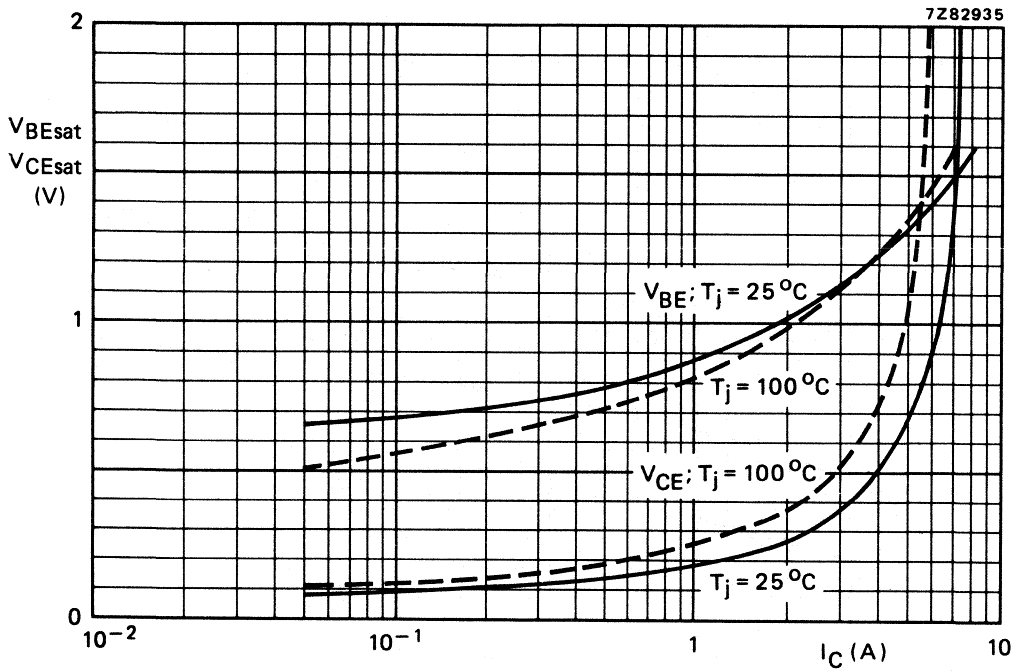


Fig. 12 Typical values base-emitter and collector-emitter voltage, $I_C/I_B = 5$.

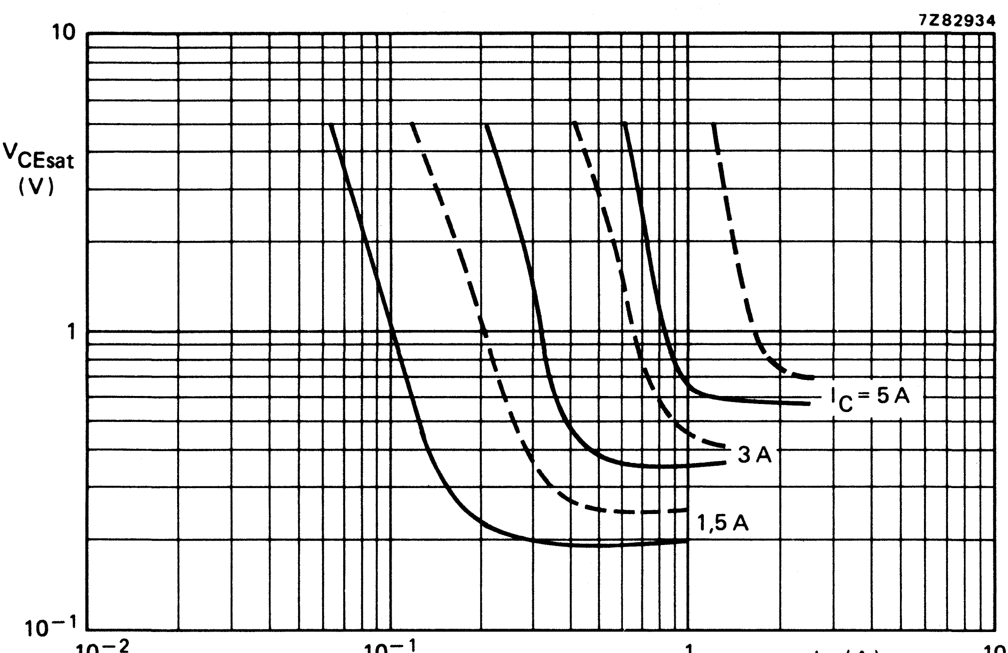


Fig. 13 Typ. (———) and max. (– – –) values collector-emitter saturation voltage at T_j = 25 °C.

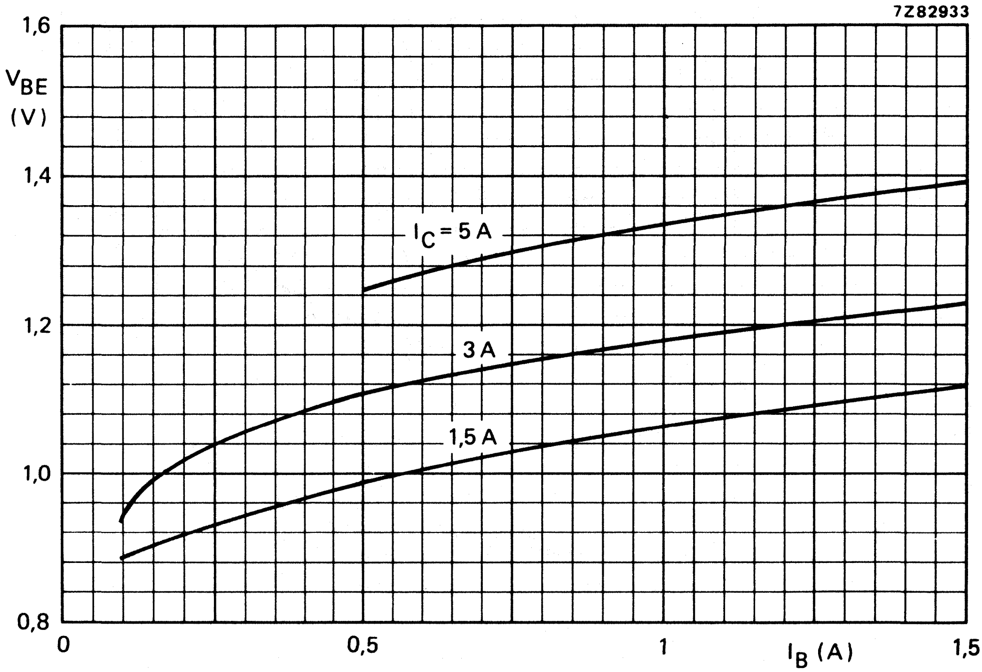


Fig. 14 Typical values at T_j = 25 °C.

SILICON DIFFUSED POWER TRANSISTORS

High-voltage, high-speed, glass-passivated npn power transistors in a TO-3 envelope, intended for use in converters, inverters, switching regulators, motor control systems etc.

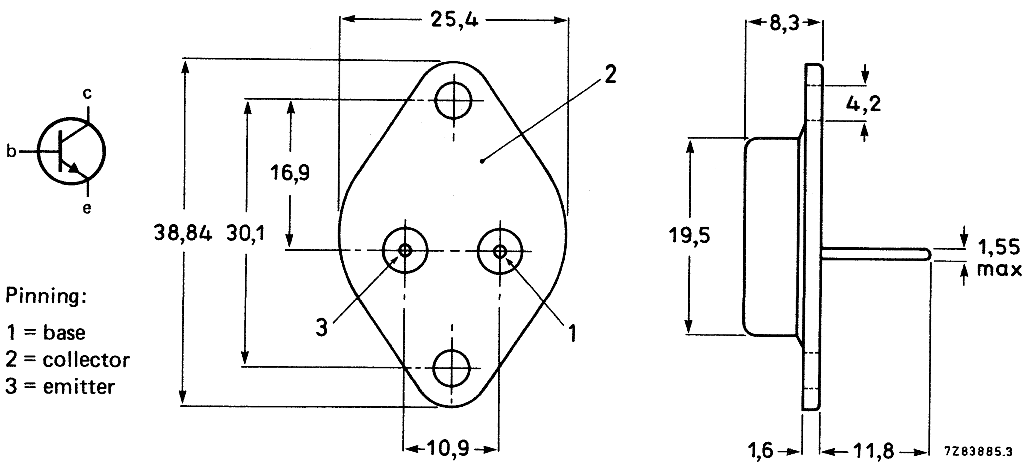
QUICK REFERENCE DATA

			BUS12	BUS12A	
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 °C	P_{tot}	max.	125		W
Fall time; resistive load	t_f	max.	0,8		μs

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-3.



Pinning:

1 = base
2 = collector
3 = emitter

Collector connected to case.

Products approved to CECC50 004-106 available on request.

RATINGS

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

			BUS12	BUS12A	
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 $T_{mb} = 25\ ^oC$	P_{tot}	max.	125		W
Storage temperature range	T_{stg}		−65 to +200		^oC
Junction temperature	T_j	max.	200		^oC

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	1,4	K/W

CHARACTERISTICS

$T_j = 25\ ^oC$ unless otherwise specified

Collector cut-off current *				
$V_{CE} = V_{CESMmax}$; $V_{BE} = 0$	I_{CES}	max.	1	mA
$V_{CE} = V_{CESMmax}$; $V_{BE} = 0$; $T_j = 125\ ^oC$	I_{CES}	max.	3	mA
Emitter cut-off current				
$I_C = 0$; $V_{EB} = 9$ V	I_{EBO}	max.	10	mA

			BUS12	BUS12A	
Saturation voltages					
$I_C = 6$ A; $I_B = 1,2$ A	V_{CEsat}	max.	1,5	–	V
$I_C = 5$ A; $I_B = 1$ A	V_{CEsat}	max.	–	1,5	V
$I_C = 6$ A; $I_B = 1,2$ A	V_{BEsat}	max.	1,5	–	V
$I_C = 5$ A; $I_B = 1$ A	V_{BEsat}	max.	–	1,5	V
Collector-emitter sustaining voltage					
$I_C = 100$ mA; $I_{Boff} = 0$; $L = 25$ mH	$V_{CEOsust}$	min.	400	450	V

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

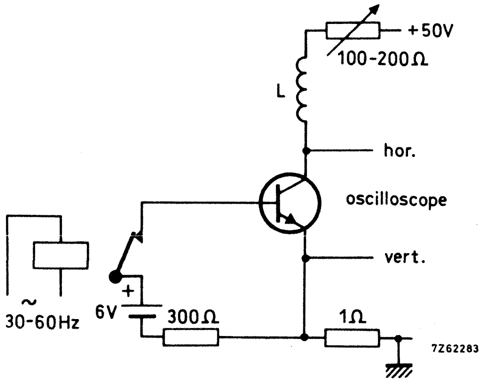


Fig. 2 Test circuit for $V_{CEOsust}$.

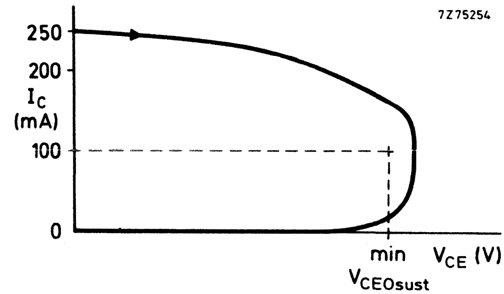


Fig. 3 Oscilloscope display for sustaining voltage.

			BUS12	BUS12A	
Switching times resistive load (Figs 4 and 5)					
I_{Con} = 6 A; I_{Bon} = $-I_{Boff}$ = 1,2 A					
Turn-on time	t_{on}	max.	1	—	µs
Turn-off: Storage time	t_s	max.	4	—	µs
Fall time	t_f	max.	0,8	—	µs
I_{Con} = 5 A; I_{Bon} = $-I_{Boff}$ = 1 A					
Turn-on time	t_{on}	max.	—	1	µs
Turn-off: Storage time	t_s	max.	—	4	µs
Fall time	t_f	max.	—	0,8	µs
Switching times inductive load (Figs 6 and 7)					
I_{Con} = 6 A; I_B = 1,2 A					
Turn-off: Storage time	t_s	typ.	1,6	—	µs
		max.	2,1	—	µs
Fall time	t_f	typ.	80	—	ns
		max.	150	—	ns
I_{Con} = 6 A; I_B = 1,2 A; T_j = 100 °C					
Turn-off: Storage time	t_s	typ.	1,8	—	µs
		max.	2,3	—	µs
Fall time	t_f	typ.	140	—	ns
		max.	300	—	ns
Switching times inductive load (Figs 6 and 7)					
I_{Con} = 5 A; I_B = 1 A					
Turn-off: Storage time	t_s	typ.	—	1,6	µs
		max.	—	2,1	µs
Fall time	t_f	typ.	—	80	ns
		max.	—	150	ns
I_{Con} = 5 A; I_B = 1 A; T_j = 100 °C					
Turn-off: Storage time	t_s	typ.	—	1,8	µs
		max.	—	2,3	µs
Fall time	t_f	typ.	—	140	ns
		max.	—	300	ns

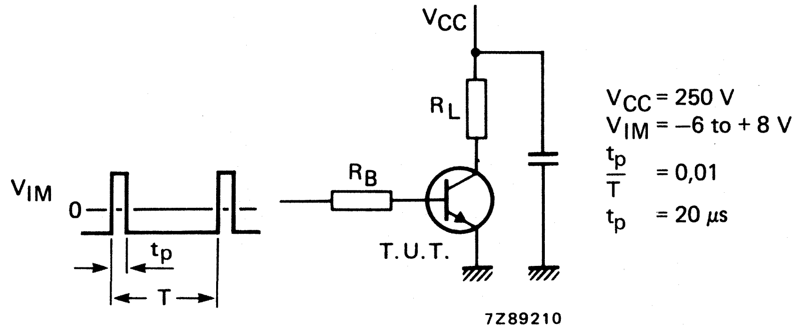


Fig. 4 Test circuit resistive load.

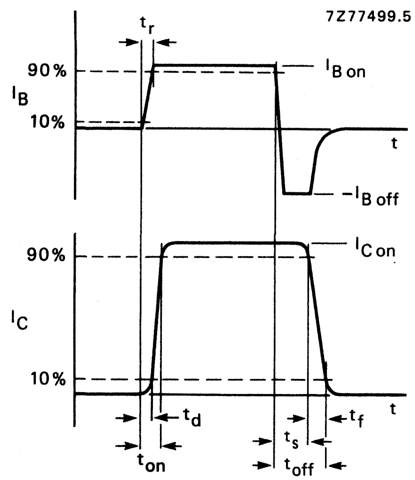


Fig. 5 Switching times waveforms with resistive load.

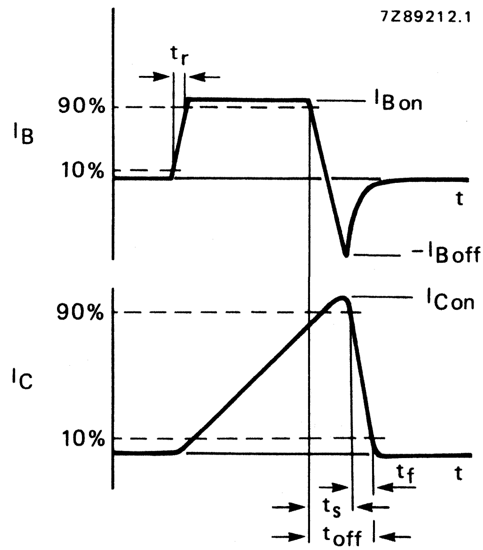


Fig. 6 Switching times waveforms with inductive load.

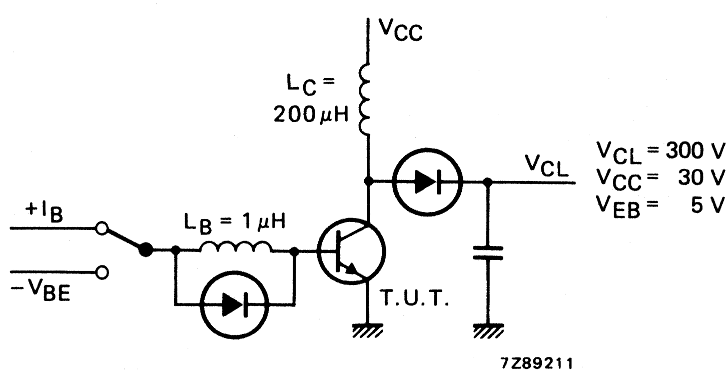
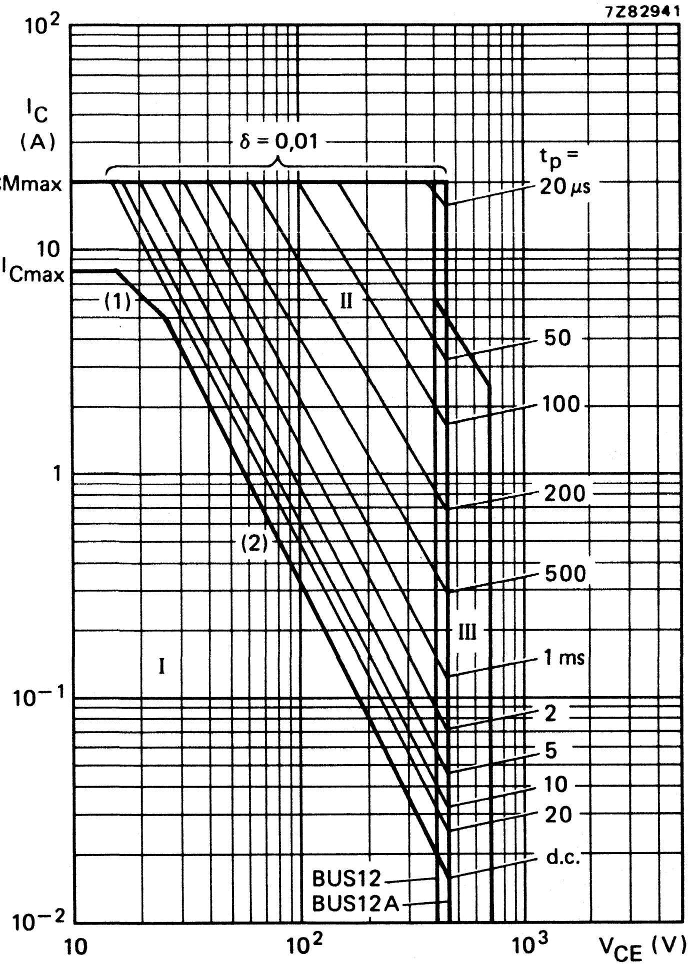
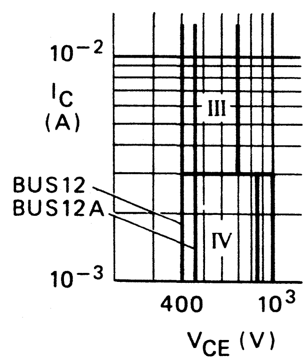


Fig. 7 Test circuit inductive load.





(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 $R_{BE} \leqslant 100\ \Omega$ and $t_p \leqslant 0.6\ \mu s$.
IV Repetitive pulse operation in this region is permissible provided $V_{BE} \leqslant 0$ and $t_p \leqslant 2$ ms.

Fig. 8 Safe operating area at $T_{mb} \leqslant 25\ ^oC$.

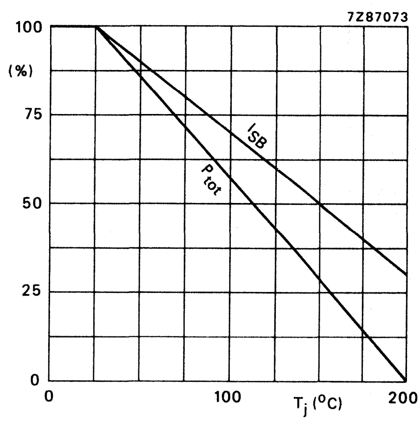


Fig. 9 Total power dissipation and second-breakdown current derating curve.

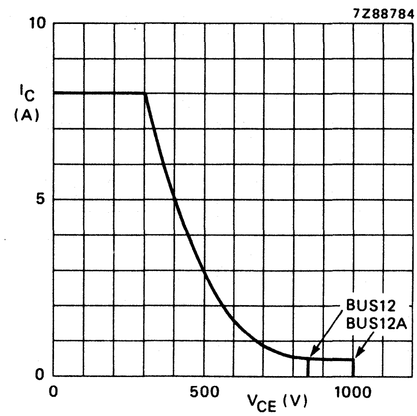


Fig. 10 Reverse bias SOAR.

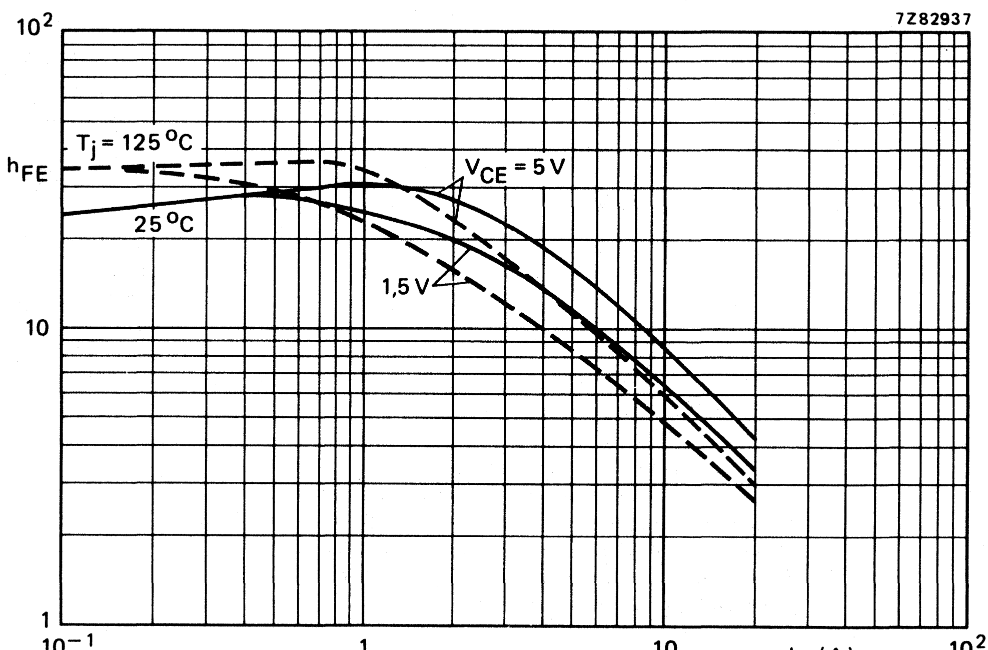


Fig. 11 Typical values DC current gain.

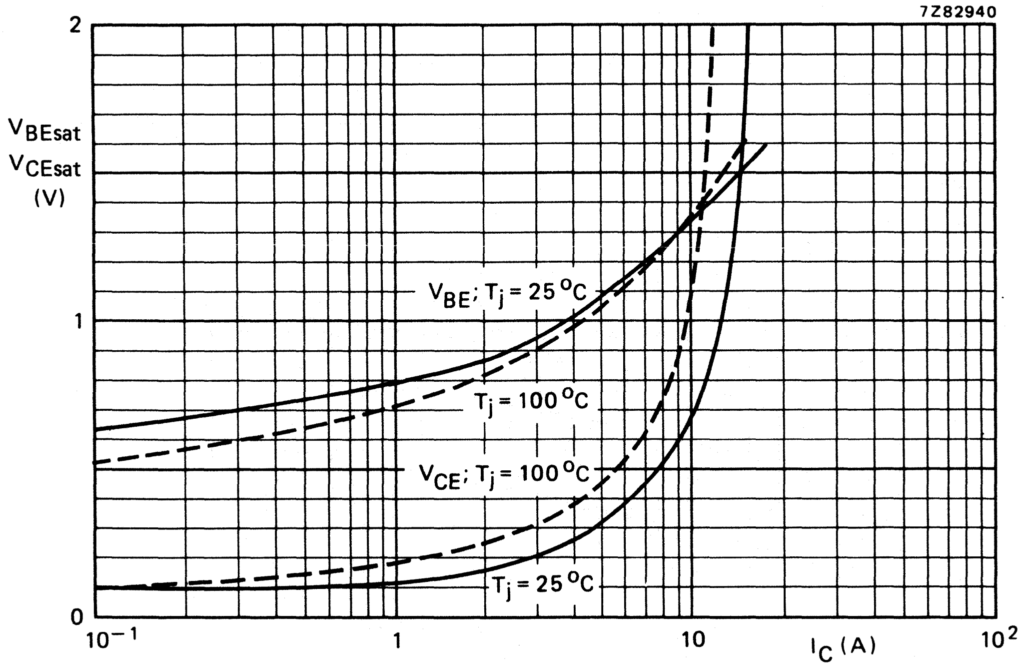


Fig. 12 Typical values base and collector voltage at $I_C/I_B = 5$.

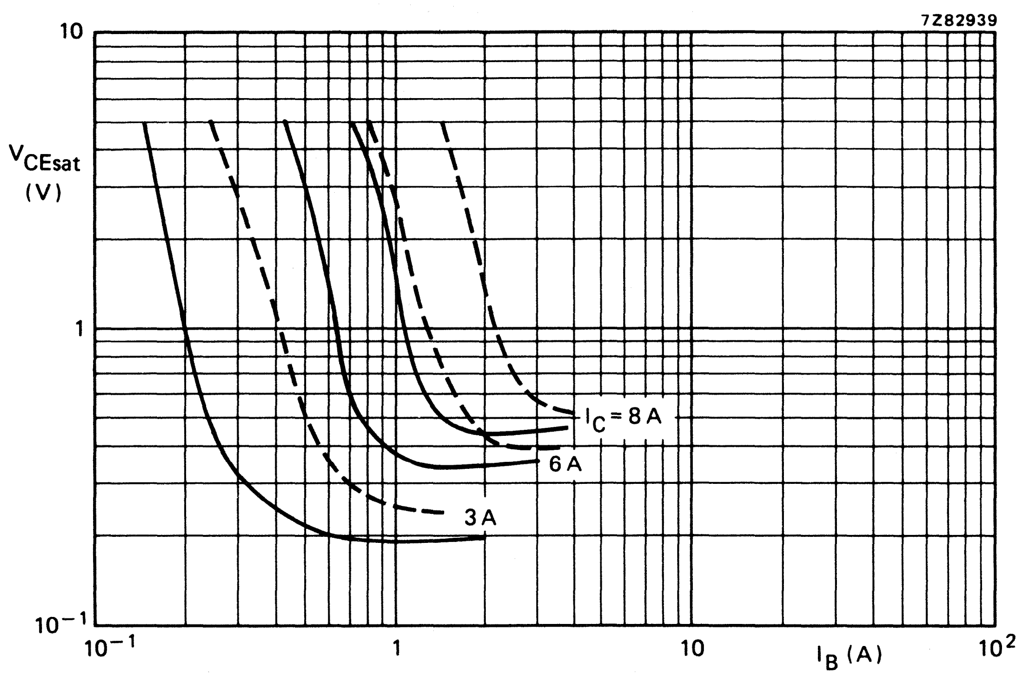


Fig. 13 Typ. (——) and max. (– – –) values collector-emitter saturation voltage at T_j = 25 °C.

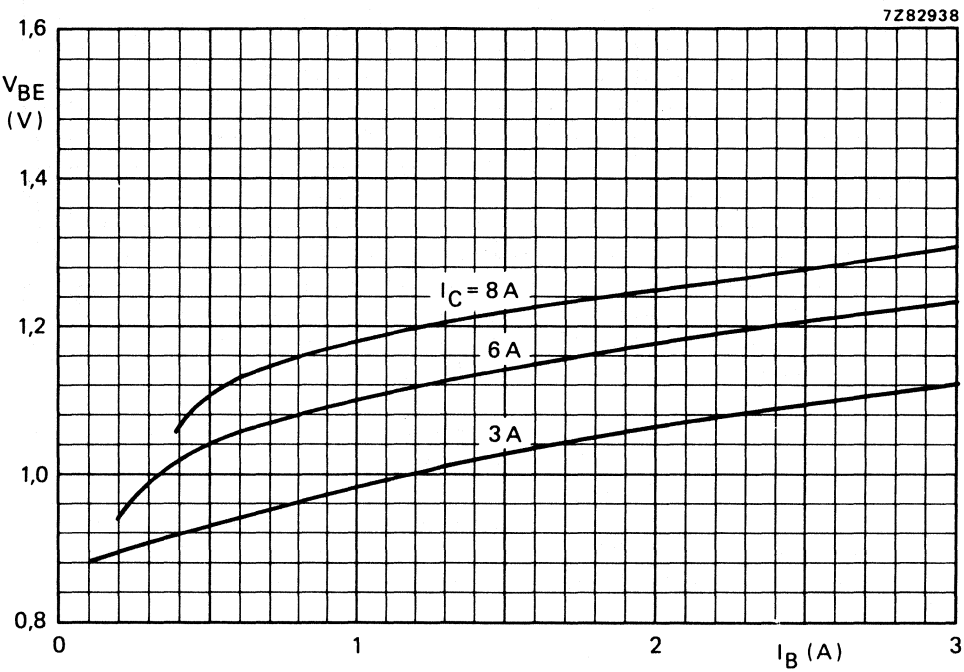


Fig. 14 Typical values base-emitter voltage at T_j = 25 °C.

SILICON DIFFUSED POWER TRANSISTORS

High-voltage, high-speed, glass-passivated npn power transistors in a TO-3 envelope, intended for use in converters, inverters, switching regulators, motor control systems etc.

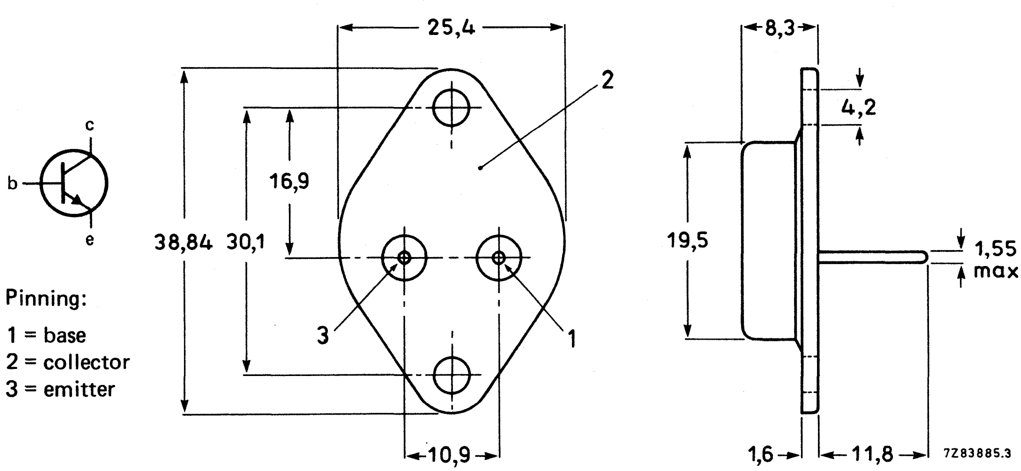
QUICK REFERENCE DATA

			BUS13	BUS13A	
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 $T_{mb} = 25\ ^oC$	P_{tot}	max.	175		W
Fall time (resistive load)	t_f	max.	0,8		μs

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-3.



Pinning:
1 = base
2 = collector
3 = emitter

Collector connected to case.

Products approved to CECC 50 004-125 available on request.

RATINGS

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

			BUS13	BUS13A	
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 +200		°C
Junction temperature	T_j	max.	200		°C

THERMAL RESISTANCE

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

CHARACTERISTICS

T_j = 25 °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 °C	I_{CES}	max.	4	mA
Emitter cut-off current				
I_C = 0; V_{EB} = 9 V	I_{EBO}	max.	10	mA

			BUS13	BUS13A	
Saturation voltages					
I_C = 10 A; I_B = 2 A	V_{CEsat}	max.	1,5	–	V
I_C = 8 A; I_B = 1,6 A	V_{CEsat}	max.	–	1,5	V
I_C = 10 A; I_B = 2 A	V_{BEsat}	max.	1,6	–	V
I_C = 8 A; I_B = 1,6 A	V_{BEsat}	max.	–	1,6	V
Collector-emitter sustaining voltage					
I_C = 100 mA; I_{Boff} = 0; L = 25 mH	$V_{CEOsust}$	min.	400	450	V

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

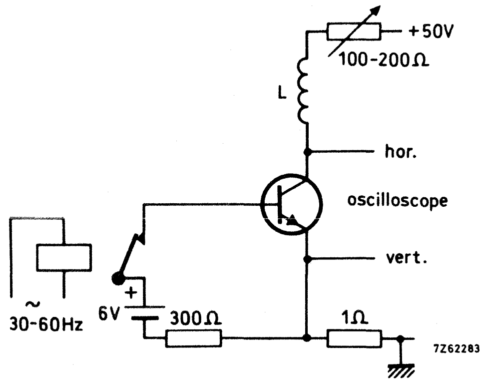


Fig. 2 Test circuit for $V_{CEOsust}$.

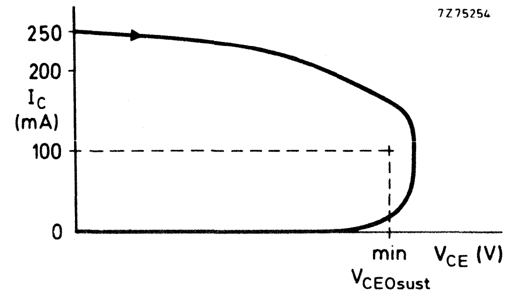


Fig. 3 Oscilloscope display for sustaining voltage.

			BUS13	BUS13A	
Switching times resistive load (Figs 4 and 5)					
I_{Con} = 10 A; $I_{B\,on}$ = $-I_{B\,off}$ = 2 A					
Turn-on time	t_{on}	max.	1	–	μs
Turn-off: Storage time	t_s	max.	4	–	μs
Fall time	t_f	max.	0,8	–	μs
I_{Con} = 8 A; $I_{B\,on}$ = $-I_{B\,off}$ = 1,6 A					
Turn-on time	t_{on}	max.	–	1	μs
Turn-off: Storage time	t_s	max.	–	4	μs
Fall time	t_f	max.	–	0,8	μs
Switching times inductive load (Figs 6 and 7)					
I_{Con} = 10 A; I_B = 2 A					
Turn-off: Storage time	t_s	typ.	2,3	–	μs
		max.	3,0	–	μs
Fall time	t_f	typ.	80	–	ns
		max.	150	–	ns
I_{Con} = 10 A; I_B = 2 A; T_j = 100 °C					
Turn-off: Storage time	t_s	typ.	2,5	–	μs
		max.	3,2	–	μs
Fall time	t_f	typ.	140	–	ns
		max.	300	–	ns
Switching times inductive load (Figs 6 and 7)					
I_{Con} = 8 A; I_B = 1,6 A					
Turn-off: Storage time	t_s	typ.	–	2,3	μs
		max.	–	3,0	μs
Fall time	t_f	typ.	–	80	ns
		max.	–	150	ns
I_{Con} = 8 A; I_B = 1,6 A; T_j = 100 °C					
Turn-off: Storage time	t_s	typ.	–	2,5	μs
		max.	–	3,2	μs
Fall time	t_f	typ.	–	140	ns
		max.	–	300	ns

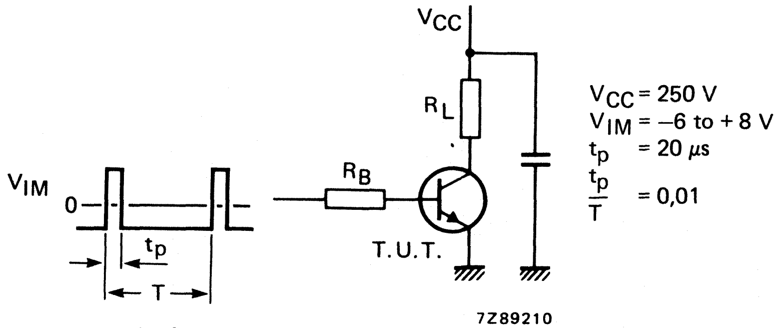


Fig. 4 Test circuit resistive load.

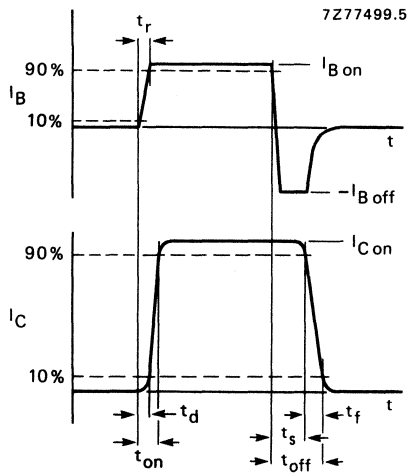


Fig. 5 Switching times waveforms with resistive load.

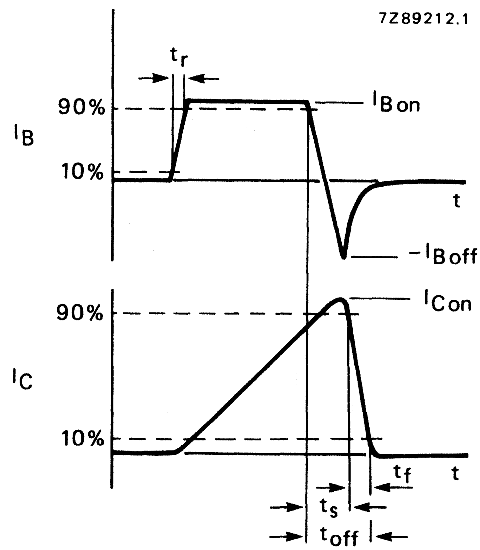


Fig. 6 Switching times waveforms with inductive load.

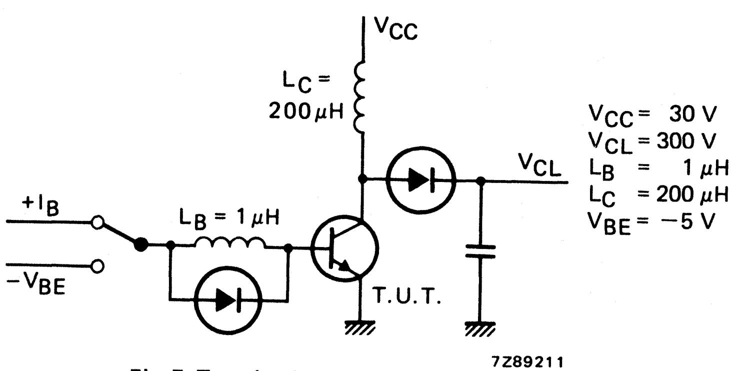
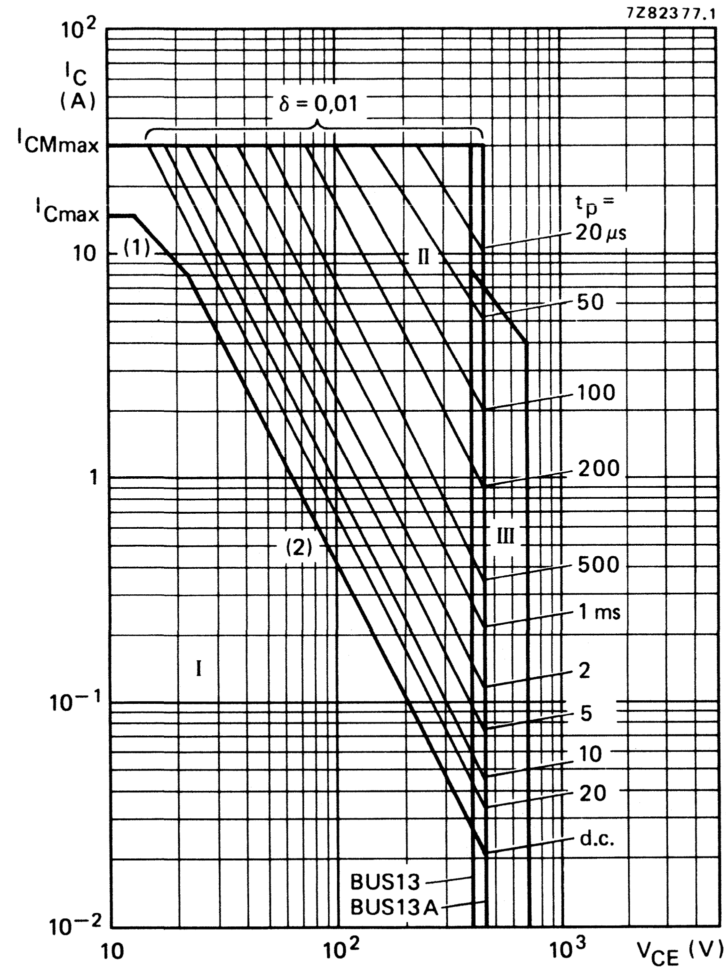
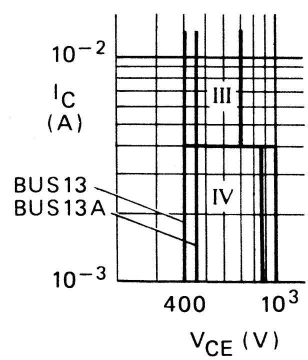


Fig. 7 Test circuit inductive load.





(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 $R_{BE} \leqslant 100\ \Omega$ and $t_p \leqslant 0{,}6\ \mu s$.
IV Repetitive pulse operation in this region is permissible provided $V_{BE} \leqslant 0$ and $t_p \leqslant 2$ ms.

Fig. 8 Safe operating area at $T_{mb} \leqslant 25\ ^oC$.

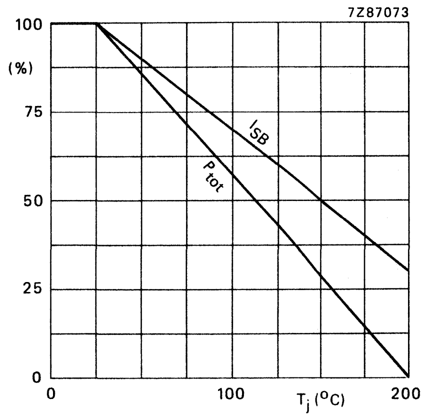


Fig. 9 Total power dissipation and second-breakdown current derating curve.

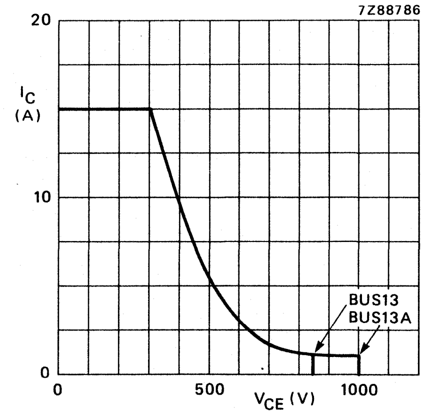


Fig. 10 Reverse bias SOAR.

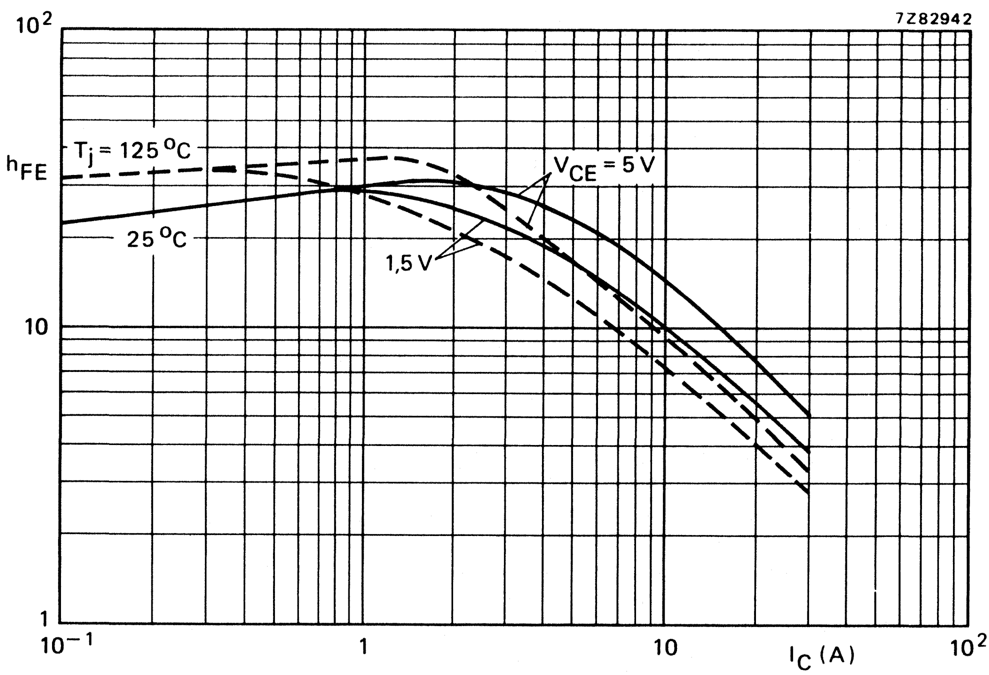


Fig. 11 Typical values DC current gain.

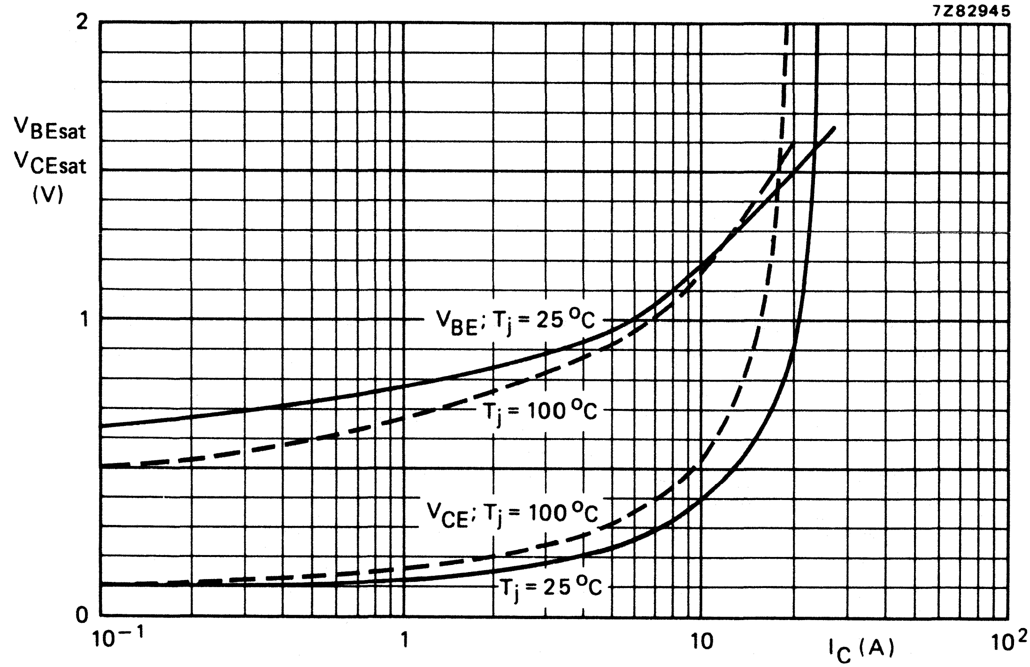


Fig. 12 Typical values base and collector voltage at I_C/I_B = 5.

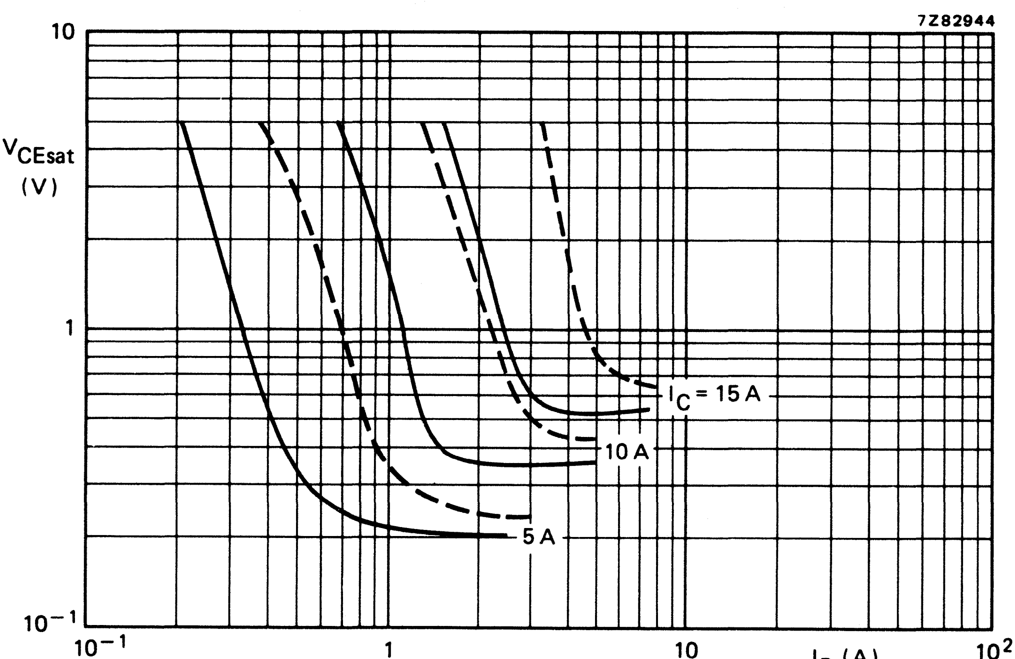


Fig. 13 Typical (——) and maximum (– – –) values saturation voltage. T_j = 25 °C.

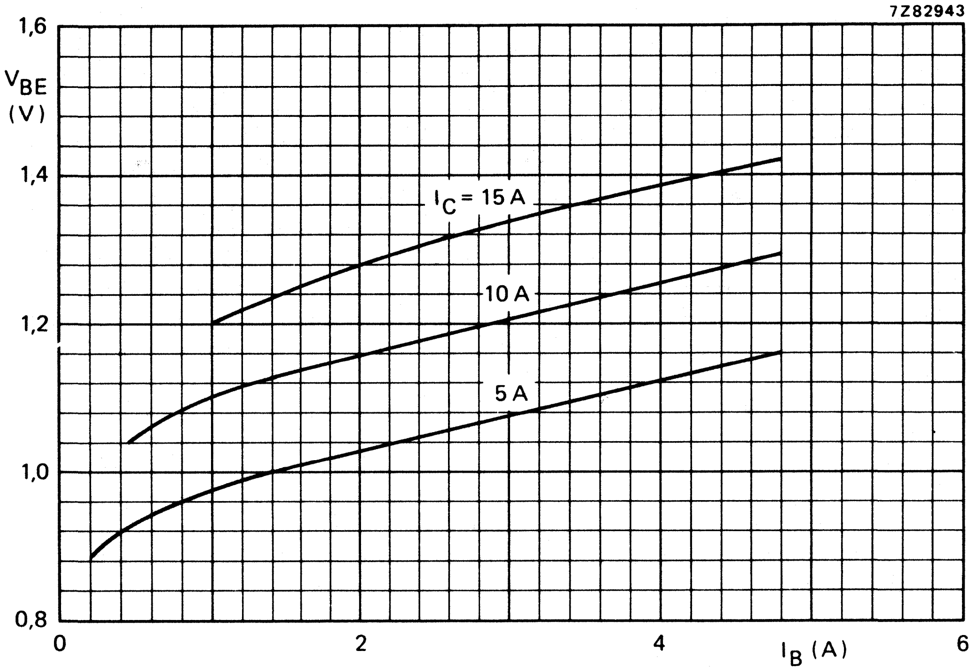


Fig. 14 Typical values base-emitter voltage at T_j = 25 °C.

SILICON DIFFUSED POWER TRANSISTORS

High-voltage, high-speed, glass-passivated npn power transistors in a TO-3 envelope, intended for use in converters, inverters, switching regulators, motor control systems etc.

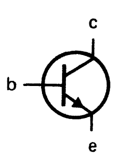
QUICK REFERENCE DATA

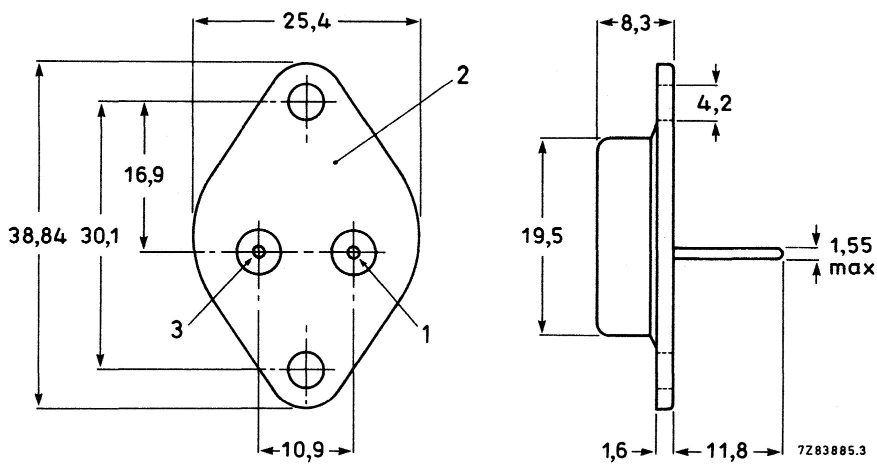
			BUS14	BUS14A	
Collector-emitter voltage (peak value; $V_{BE} = 0$)	V_{CESM}	max.	850	1000	V
Collector-emitter voltage (open base)	V_{CEO}	max.	400	450	V
Collector-emitter saturation voltage	V_{CEsat}	max.	1,5		V
Collector current (DC)	I_C	max.	30		A
Collector current (peak value)	I_{CM}	max.	50		A
Total power dissipation up to $T_{mb} = 25\ ^oC$	P_{tot}	max.	250		W
Fall time; resistive load	t_f	max.	0,8		μs

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-3.





Pinning

1 = base
2 = collector
3 = emitter

Collector connected to the case.

RATINGS

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

			BUS14	BUS14A	
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.	30		A
Collector current (peak value); $t_p < 2$ ms	I_{CM}	max.	50		A
Base current (DC)	I_B	max.	6		A
Base current (peak value); $t_p < 2$ ms	I_{BM}	max.	10		A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	250		W
Storage temperature range	T_{stg}		−65 to +200		°C
Junction temperature	T_j	max.	200		°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	0,7	K/W

CHARACTERISTICS

T_j = 25 °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 °C	I_{CES}	max.	5	mA
Emitter cut-off current				
$I_C = 0$; V_{EB} = 9 V	I_{EBO}	max.	10	mA

			BUS14	BUS14A	
Saturation voltages					
I_C = 20 A; I_B = 4 A	V_{CEsat}	max.	1,5	–	V
I_C = 16 A; I_B = 3,2 A	V_{CEsat}	max.	–	1,5	V
I_C = 20 A; I_B = 4 A	V_{BEsat}	max.	1,7	–	V
I_C = 16 A; I_B = 3,2 A	V_{BEsat}	max.	–	1,7	V
Collector-emitter sustaining voltage					
I_C = 100 mA; I_{Boff} = 0; l = 25 mH	$V_{CEOsust}$	min.	400	450	V

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

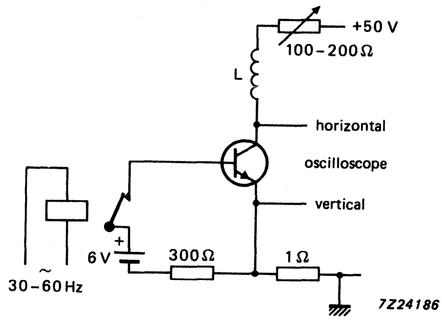


Fig. 2 Test circuit for $V_{CEOsust}$.

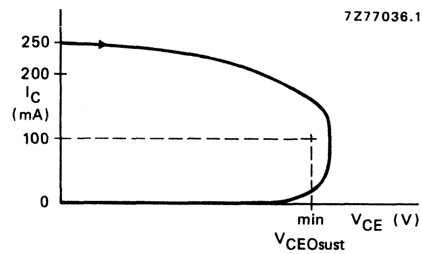
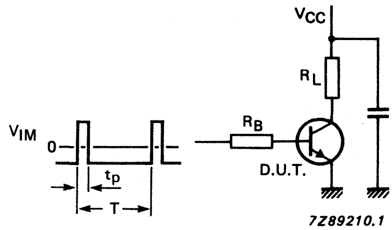


Fig. 3 Oscilloscope display for sustaining voltage.

			BUS14	BUS14A	
Switching times resistive load (Figs 4 and 5)					
I_{Con} = 20 A; $I_{Bon} = -I_{Boff}$ = 4 A					
Turn-on time	t_{on}	max.	1	–	μs
Turn-off: Storage time	t_s	max.	4	–	μs
Fall time	t_f	max.	0,8	–	μs
I_{Con} = 16 A; $I_{Bon} = -I_{Boff}$ = 3,2 A					
Turn-on time	t_{on}	max.	–	1	μs
Turn-off: Storage time	t_s	max.	–	4	μs
Fall time	t_f	max.	–	0,8	μs
Switching times inductive load (Figs 6 and 7)					
I_{Con} = 20 A; I_B = 4 A					
Turn-off: Storage time	t_s	typ.	2,8	–	μs
		max.	3,6	–	μs
Fall time	t_f	typ.	80	–	ns
		max.	150	–	ns
I_{Con} = 20 A; I_B = 4 A; T_j = 100 °C					
Turn-off: Storage time	t_s	typ.	3,1	–	μs
		max.	4,0	–	μs
Fall time	t_f	typ.	140	–	ns
		max.	300	–	ns
Switching times inductive load (Figs 6 and 7)					
I_{Con} = 16 A; I_B = 3,2 A					
Turn-off: Storage time	t_s	typ.	–	28	μs
		max.	–	3,6	μs
Fall time	t_f	typ.	–	80	ns
		max.	–	150	ns
I_{Con} = 16 A; I_B = 3,2 A; T_j = 100 °C					
Turn-off: Storage time	t_s	typ.	–	3,1	μs
		max.	–	4,0	μs
Fall time	t_f	typ.	–	140	ns
		max.	–	300	ns



V_{CC} = 250 V
V_{IM} = −6 to +8 V
t_p = 20 μs
$\frac{t_p}{T}$ = 0,01

Fig. 4 Test circuit resistive load.

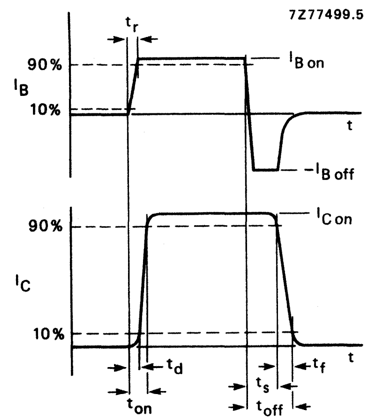


Fig. 5 Switching times waveforms with resistive load.

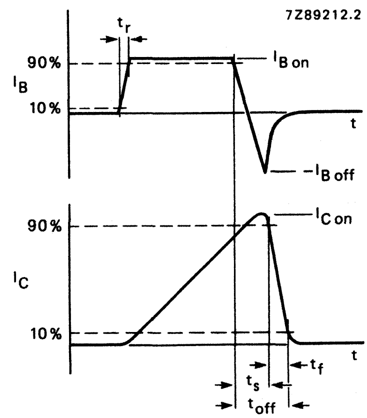
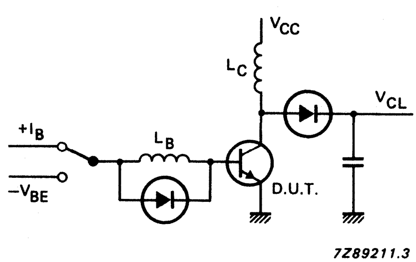
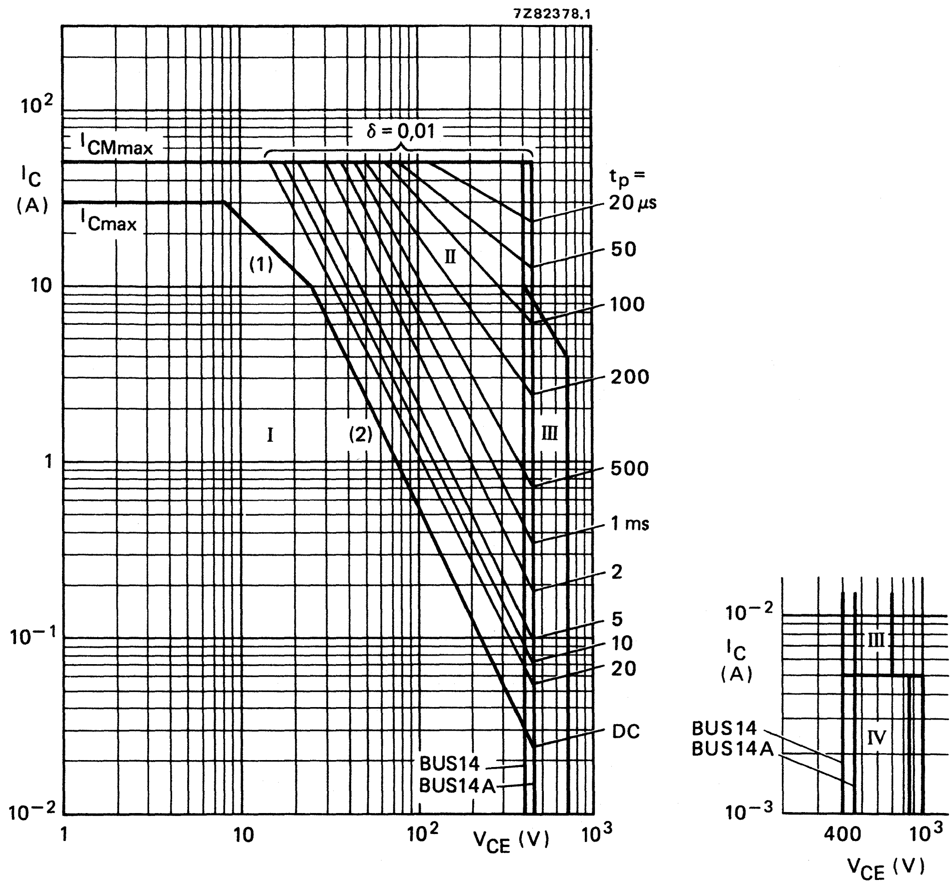


Fig. 6 Switching times waveforms with inductive load.



V_{CC} = 30 V
V_{CL} = 300 V
L_B = 1 μH
L_C = 200 μH
V_{BE} = 5 V

Fig. 7 Test circuit inductive load.



(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 $R_{BE} \leqslant 100\ \Omega$ and $t_p \leqslant 0,6\ \mu s$
IV Repetitive pulse operation in this region is permissible provided $V_{BE} \leqslant 0$ and $t_p \leqslant 2$ ms.

Fig. 8 Safe operating area at $T_{mb} \leqslant 25\ ^oC$.

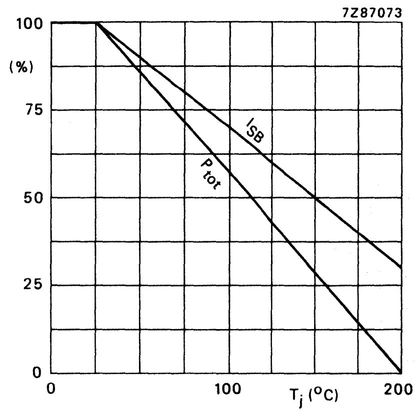


Fig. 9 Total power dissipation and second-breakdown current derating curve.

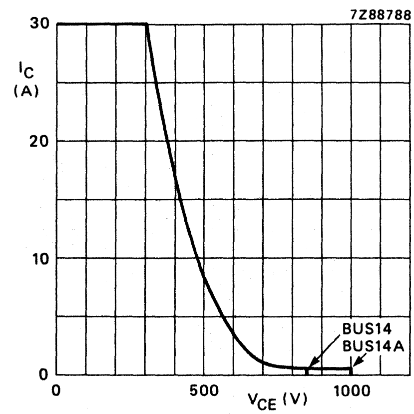


Fig. 10 Reverse bias SOAR.

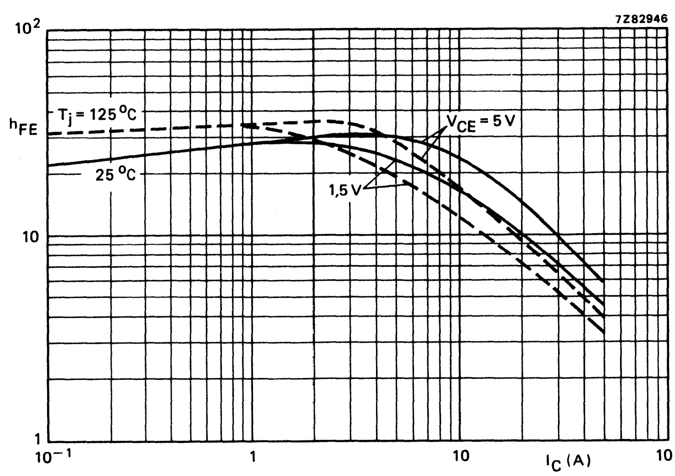


Fig. 11 Typical values DC current gain.

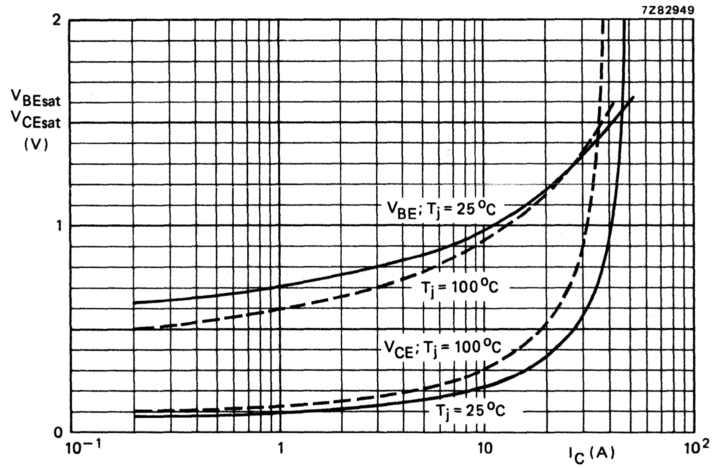


Fig. 12 Typical values base and collector voltage. $I_C/I_B = 5$.

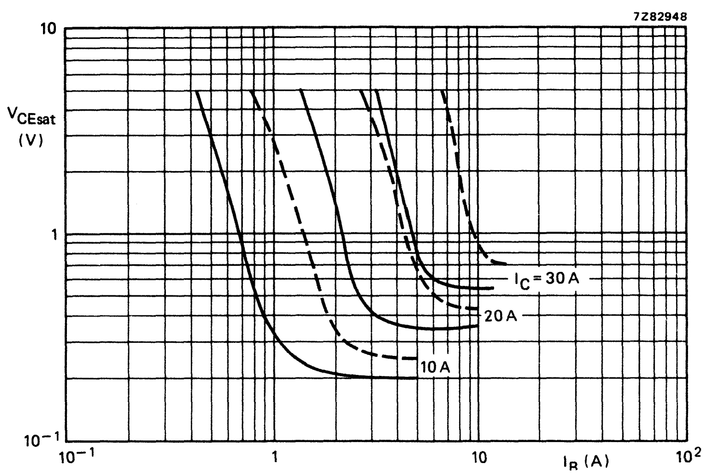


Fig. 13 Typical (——) and maximum (– – –) values saturation voltage. T_j = 25 °C.

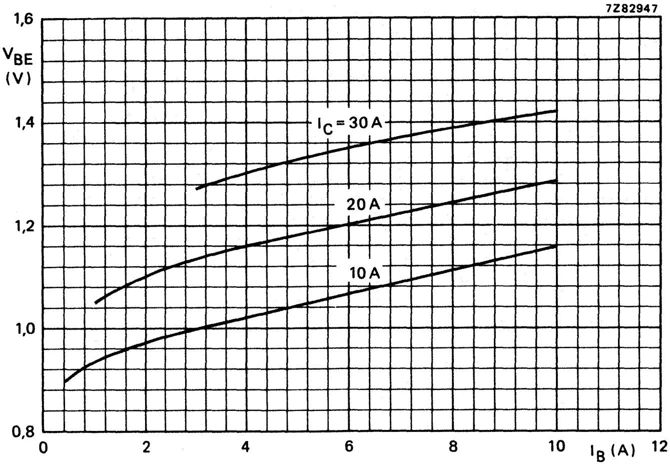


Fig. 14 Typical values at T_j = 25 °C.

SILICON DIFFUSED POWER TRANSISTORS

High-voltage, high-speed, glass-passivated npn power transistors in a TO-3 envelope, intended for use in converters, inverters, switching regulators, motor control systems etc.

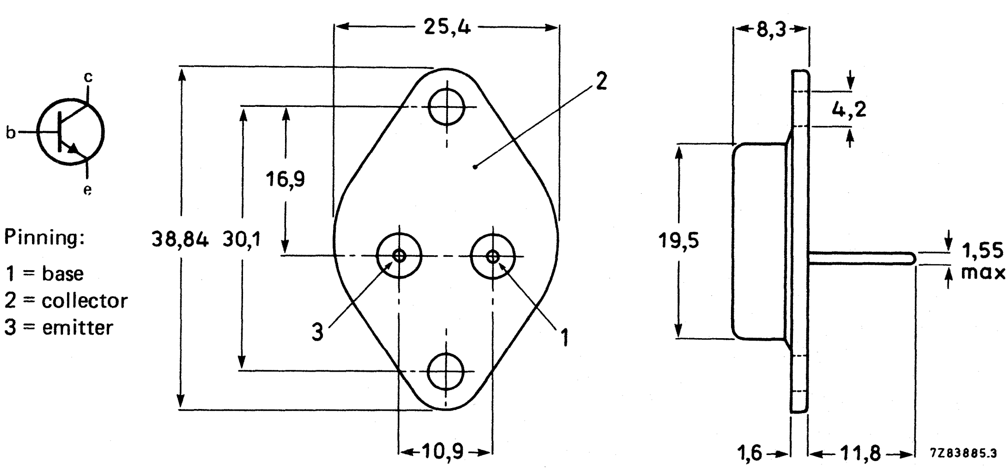
QUICK REFERENCE DATA

			BUS21B	BUS21C	
Collector-emitter voltage peak value; $V_{BE} = 0$	V_{CESM}	max.	750	850	V
Collector-emitter voltage open base	V_{CEO}	max.	400	450	V
Collector-emitter saturation voltage	V_{CEsat}	max.	1,5		V
Collector saturation current	I_{Csat}	max.	3		A
Collector current (DC)	I_C	max.	5		A
Collector current (peak value)	I_{CM}	max.	10		A
Total power dissipation $T_{mb} \leq 25\ ^oC$	P_{tot}	max.	100		W

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-3.



Collector connected to case.

RATINGS

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

			BUS21B	BUS21C	
Collector-emitter voltage peak value; $V_{BE} = 0$	V_{CESM}	max.	750	850	V
Collector-emitter voltage open base	V_{CEO}	max.	400	450	V
Collector current (DC)	I_C	max.	5		A
Collector current (peak value)	I_{CM}	max.	10		A
Base current (DC)	I_B	max.	2		A
Base current (peak value)	I_{BM}	max.	4		A
Total power dissipation up to $T_{mb} = 25\ ^oC$	P_{tot}	max.	100		W
Storage temperature range	T_{stg}		–65 to +200		^oC
Junction temperature	T_j	max.	200		^oC

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	1,75	K/W

CHARACTERISTICS

$T_j = 25\ ^oC$ unless otherwise specified

Collector cut-off current* $V_{CE} = V_{CESMmax}$; $V_{BE} = 0$	I_{CES}	max.	1	mA
Emitter cut-off current $I_C = 0$; $V_{EB} = 9\ V$	I_{EBO}	max.	10	mA

			BUS21B	BUS21C	
DC current gain $I_C = 0,5\ A$; $V_{CE} = 10\ V$	h_{FE}	typ.	25	25	
$I_C = 3\ A$; $V_{CE} = 1,5\ V$	h_{FE}	min.	7,5	6	
Collector-emitter sustaining voltage $I_B = 0$; $I_C = 0,1\ A$; $L = 25\ mH$	$V_{CEOsust}$	min.	400	450	V
Saturation voltages $I_C = 3\ A$; $I_B = 0,4\ A$	V_{CEsat}	max.	1,5		V
	V_{BEsat}	max.	1,5		V
$I_C = 3\ A$; $I_B = 0,5\ A$	V_{CEsat}	max.		1,5	V
	V_{BEsat}	max.		1,5	V

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

SILICON DIFFUSED POWER TRANSISTORS

High-voltage, high-speed, glass-passivated npn power transistors in a TO-3 envelope, intended for use in converters, inverters, switching regulators, motor control systems etc.

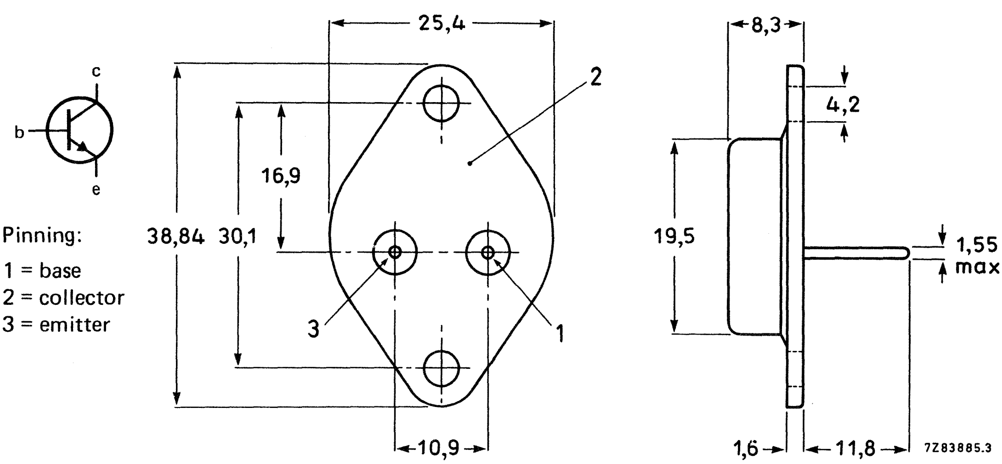
QUICK REFERENCE DATA

			BUS22B	BUS22C	
Collector-emitter voltage peak value; $V_{BE} = 0$	V_{CESM}	max.	750	850	V
Collector-emitter voltage; open base	V_{CEO}	max.	400	450	V
Collector-emitter saturation voltage	V_{CEsat}	max.	1,5		V
Collector saturation current	I_{Csat}	typ.	6		A
Collector current (DC)	I_C	max.	8		A
Collector current (peak value)	I_{CM}	max.	20		A
Total power dissipation $T_{mb} \leq 25\ ^{o}C$	P_{tot}	max.	125		W

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-3.



Pinning:
1 = base
2 = collector
3 = emitter

Collector connected to case.

RATINGS

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

			BUS22B	BUS22C	
Collector-emitter voltage peak value; $V_{BE} = 0$	V_{CESM}	max.	750	850	V
Collector-emitter voltage; open base	V_{CEO}	max.	400	450	V
Collector current (DC)	I_C	max.	8		A
Collector current (peak value)	I_{CM}	max.	20		A
Base current (DC)	I_B	max.	4		A
Base current (peak value)	I_{BM}	max.	6		A
Total power dissipation up to $T_{mb} = 25$ °C	P_{tot}	max.	125		W
Storage temperature range	T_{stg}		−65 to +200		°C
Junction temperature	T_j	max.	200		°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	1,4	K/W

CHARACTERISTICS

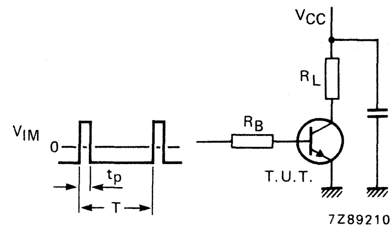
$T_j = 25$ °C unless otherwise specified

Collector cut-off current* $V_{CE} = V_{CESMmax}$; $V_{BE} = 0$	I_{CES}	max.	1	mA
Emitter cut-off current $I_C = 0$; $V_{EB} = 9$ V	I_{EBO}	max.	10	mA
DC current gain $I_C = 1$ A; $V_{CE} = 5$ V	h_{FE}	typ.	18	

			BUS22B	BUS22C	
Collector-emitter sustaining voltage $I_B = 0$; $I_C = 0{,}1$ A; L = 25 mH	$V_{CEOsust}$	min.	400	450	V
Saturation voltages $I_C = 6$ A; $I_B = 0{,}8$ A	V_{CEsat}	max.	1,5	–	V
	V_{BEsat}	max.	1,5	–	V
$I_C = 6$ A; $I_B = 1$ A	V_{CEsat}	max.	–	1,5	V
	V_{BEsat}	max.	–	1,5	V
Switching times resistive load (Figs 2 and 3) $I_{Con} = 6$ A; $I_{Bon} = -I_{Boff} = 0{,}8$ A	t_{on}	typ.	0,5	–	μs
	t_s	typ.	3,0	–	μs
	t_f	typ.	0,3	–	μs
$I_{Con} = 6$ A; $I_{Bon} = -I_{Boff} = 1$ A	t_{on}	typ.	–	0,5	μs
	t_s	typ.	–	3,0	μs
	t_f	typ.	–	0,3	μs

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

			BUS22B	BUS22C	
Switching times inductive load (Figs 4 and 5)					
I_{Con} = 6 A; I_{Bon} = 0,8 A	t_s	typ.	1,1	—	μs
	t_f	typ.	80	—	μs
I_{Con} = 6 A; I_{Bon} = 1 A	t_s	typ.	—	1,1	μs
	t_f	typ.	—	80	μs



V_{CC} = 250 V
V_{IM} = −6 to +8 V
$\frac{t_p}{T}$ = 0,01
t_p = 20 μs
The values of R_B and R_L are selected in accordance with I_{Con} and I_B requirements.

Fig. 2 Test circuit resistive load.

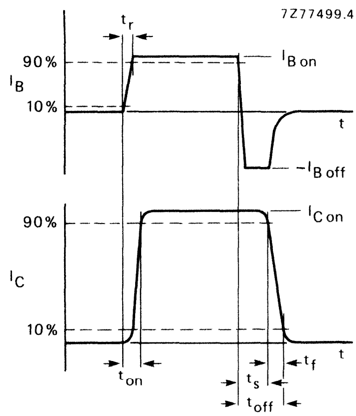


Fig. 3 Switching times waveforms with resistive load.

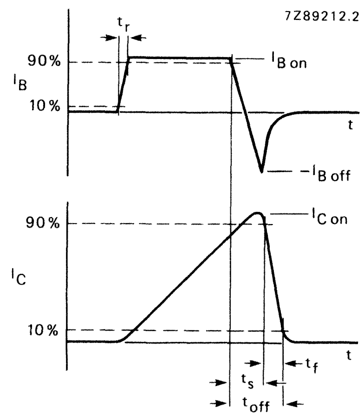
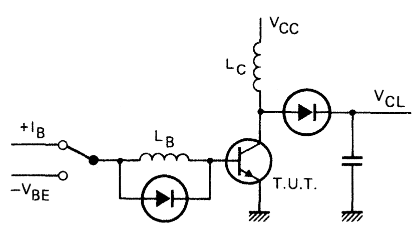
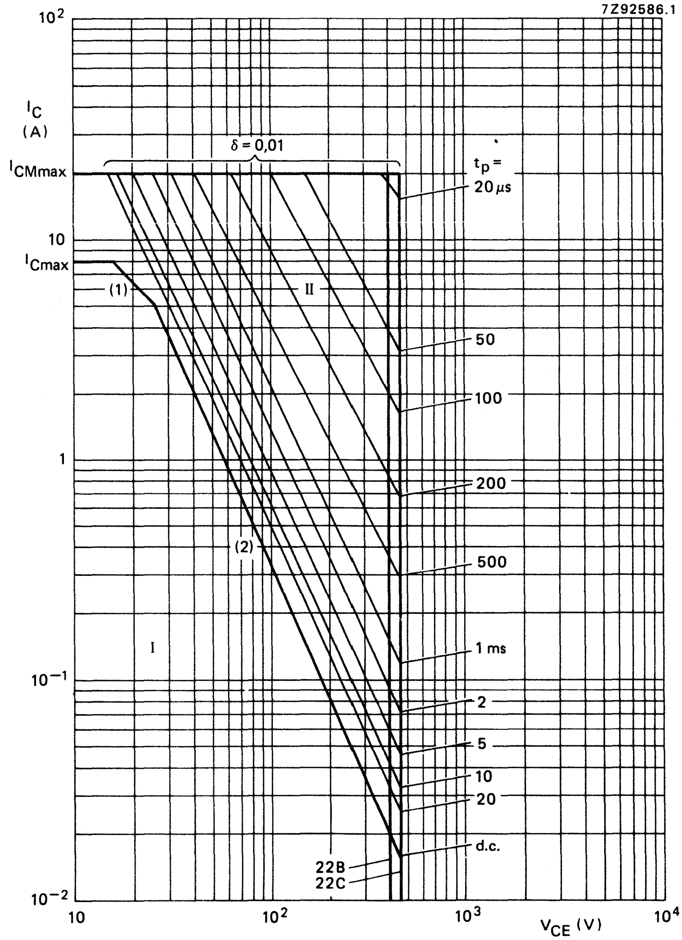


Fig. 4 Switching times waveforms with inductive load.



V_{CL} = 250 V
V_{CC} = 30 V
$-V_{BE}$ = 5 V
L_B = 1 μH
L_C = 200 μH

Fig. 5 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.

Fig. 6 Safe operating area at $T_{mb} < 25\ ^oC$.

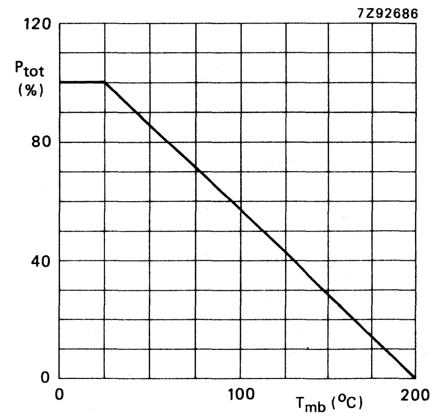


Fig. 7 Total power dissipation.

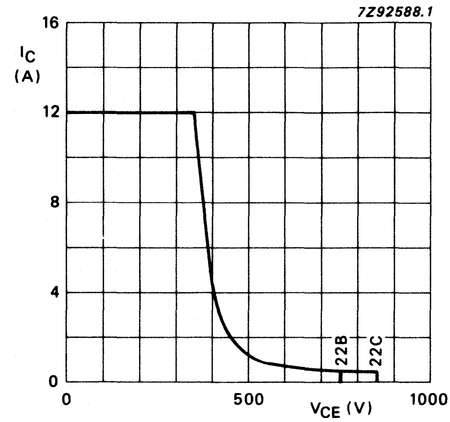


Fig. 8 Reverse bias SOAR; T_{mb} = 100 °C; $V_{BE(off)}$ = 1 to 5 V; L_B = 0 to 3 μH.

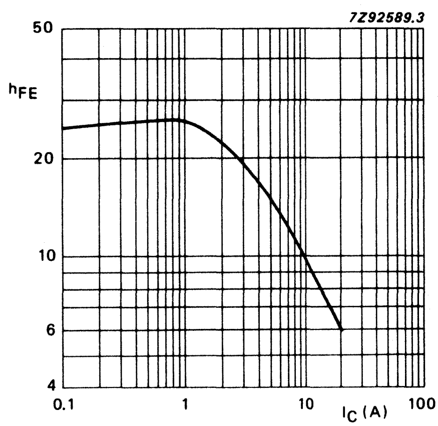


Fig. 9 Typical values DC current gain at T_{mb} = 25 °C.

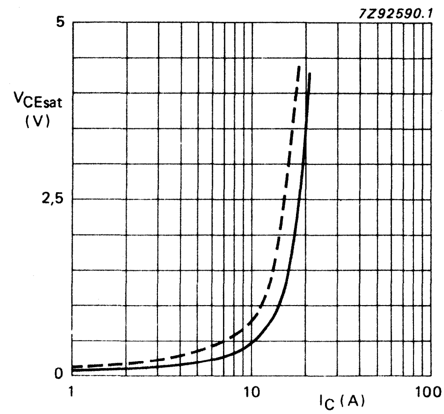


Fig. 10 Typical values collector voltage at T_j = 25 °C; I_C/I_B = 7, 5 and 6 for BUS22B and BUS22C respectively.

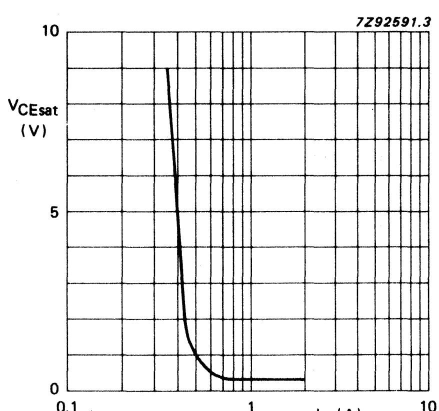


Fig. 11 Typical values V_{CEsat} at T_j = 25 °C; I_C = 6 A.

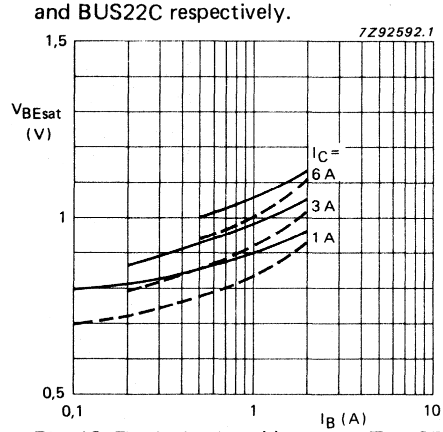


Fig. 12 Typical values V_{BEsat} at T_j = 25 °C; (——) = BUS22B; (– – –) = BUS22C.

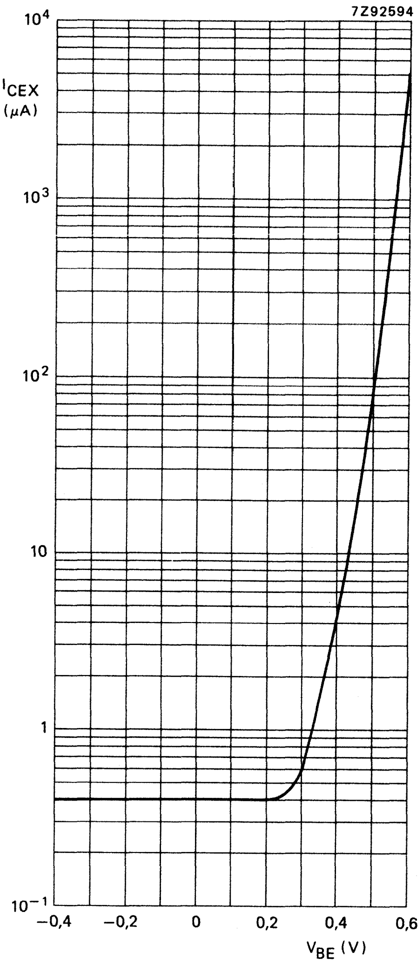


Fig. 13 Typical values collector cut-off current at T_j = 25 °C; V_{CE} = 250 V.

SILICON DIFFUSED POWER TRANSISTORS

High-voltage, high-speed, glass-passivated npn power transistors in a TO-3 envelope, intended for use in converters, inverters, switching regulators, motor control systems etc.

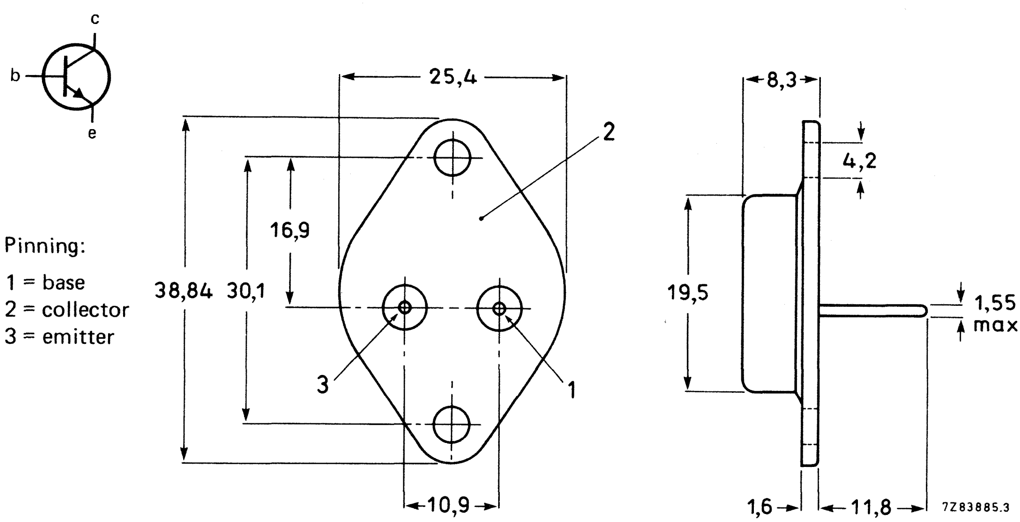
QUICK REFERENCE DATA

			BUS23B	C	
Collector-emitter voltage peak value; $V_{BE} = 0$	V_{CESM}	max.	750	850	V
Collector-emitter voltage open base	V_{CEO}	max.	400	450	V
Collector-emitter saturation voltage	V_{CEsat}	max.	1.5		V
Collector saturation current	I_{Csat}	max.	10		A
Collector current (DC)	I_C	max.	15		A
Collector current (peak value)	I_{CM}	max.	30		A
Total power dissipation up to $T_{mb} = 25\ ^oC$	P_{tot}	max.	175		W

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-3.



Collector connected to case.

RATINGS

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

			BUS23B	C	
Collector-emitter voltage peak value; $V_{BE} = 0$	V_{CESM}	max.	750	850	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
Base current (DC)	I_B	max.	6		A
Base current (peak value)	I_{BM}	max.	9		A
Total power dissipation up to $T_{mb} = 25\ ^oC$	P_{tot}	max.	175		W
Storage temperature range	T_{stg}		−65 to + 150		^oC
Junction temperature	T_j	max.	150		^oC

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	0.7	K/W

CHARACTERISTICS

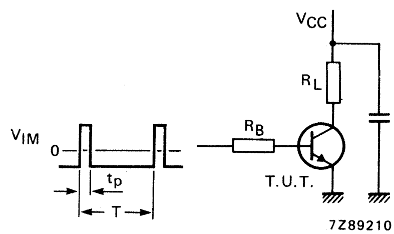
$T_j = 25\ ^oC$ unless otherwise specified

Collector cut-off current* $V_{CE} = V_{CESMmax}$; $V_{BE} = 0$	I_{CES}	max.	1	mA
Emitter cut-off current $I_C = 0$; $V_{EB} = 9$ V	I_{EBO}	max.	10	mA
DC current gain $I_C = 1.5$ A; $V_{CE} = 5$ V	h_{FE}	typ.	25	

			BUS23B	C	
Collector-emitter sustaining voltage $I_B = 0$; $I_C = 0.1$ A; L = 25 mH	$V_{CEOsust}$	min.	400	450	V
Saturation voltages $I_C = 10$ A; $I_B = 1.33$ A	V_{CEsat}	max.	1.5	−	V
	V_{BEsat}	max.	1.5	−	V
$I_C = 10$ A; $I_B = 1.67$ A	V_{CEsat}	max.	−	1.5	V
	V_{BEsat}	max.	−	1.5	V

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

			BUS23B	C	
Switching times resistive load (Figs 2 and 3)					
I_{Con} = 10 A;	t_{on}	typ.	0.7	—	μs
$I_{Bon} = -I_{Boff}$ = 1.33 A	t_s	typ.	2.0	—	μs
	t_f	typ.	0.27	—	μs
I_{Con} = 10 A;	t_{on}	typ.	—	0.7	μs
$I_{Bon} = -I_{Boff}$ = 1.67 A	t_s	typ.	—	2.0	μs
	t_f	typ.	—	0.27	μs
Switching times inductance load (Figs 4 and 5)					
I_{Con} = 10 A; I_{Bon} = 1.33 A	t_s	typ.	2.1	—	μs
	t_f	typ.	40	—	ns
I_{Con} = 10 A; I_{Bon} = 1.67 A	t_s	typ.	—	2.1	μs
	t_f	typ.	—	40	ns



V_{CC} = 250 V
V_{IM} = −6 to + 8 V
$\frac{t_p}{T}$ = 0,01
t_p = 20 μs
The values of R_B and R_L are selected in accordance with I_{Con} and I_B requirements.

Fig. 2 Test circuit resistive load.

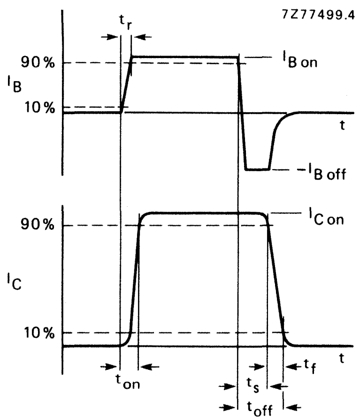


Fig. 3 Switching times waveforms with resistive load.

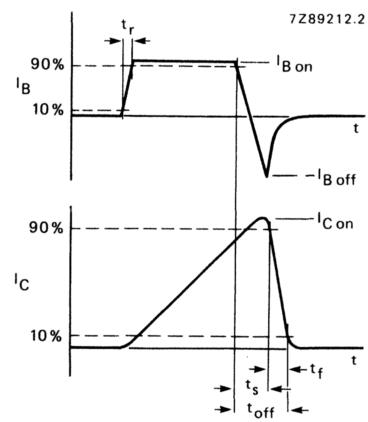
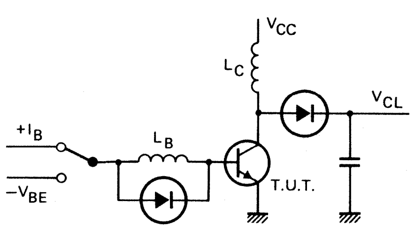
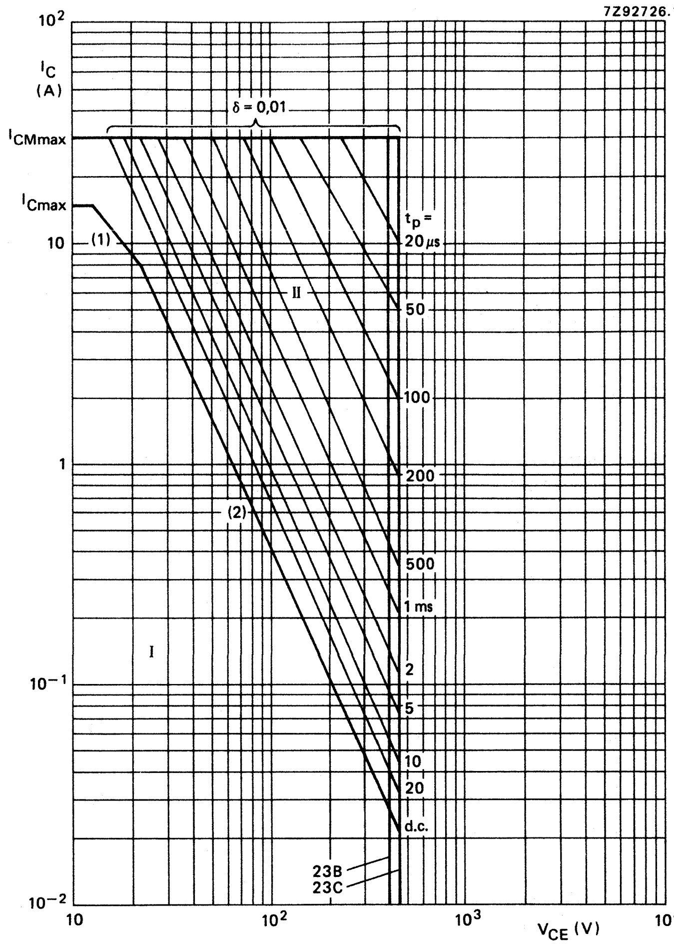


Fig. 4 Switching times waveforms with inductive load.



V_{CL} = 250 V
V_{CC} = 30 V
$-V_{BE}$ = 5 V
L_B = 1 μH
L_C = 200 μH

Fig. 5 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.

Fig. 6 Safe operating area at $T_{mb} \leqslant 25\ ^{o}C$.

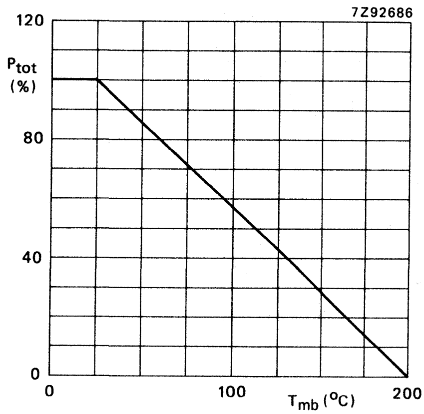


Fig. 7 Total power dissipation.

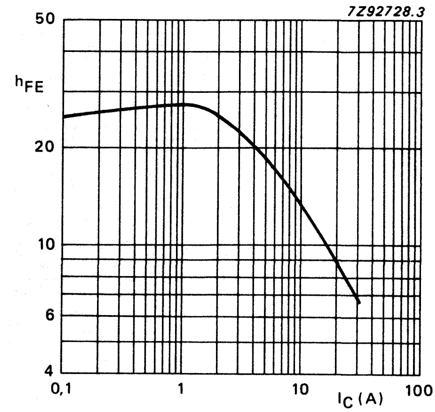


Fig. 8 Typical values DC current gain at T_j = 25 °C.

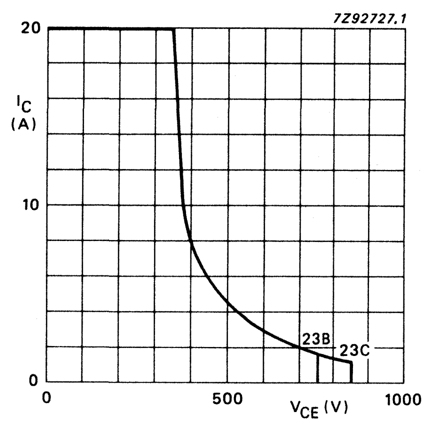


Fig. 9 Reverse bias SOAR; T_{mb} = 100 °C; $V_{BE(off)}$ = 1 to 5 V; L_B = 0 to 3 μH.

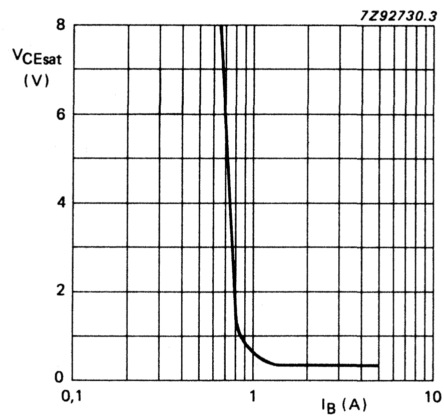


Fig. 10 Typical values V_{CEsat} at T_j = 25 °C; I_C = 10 A.

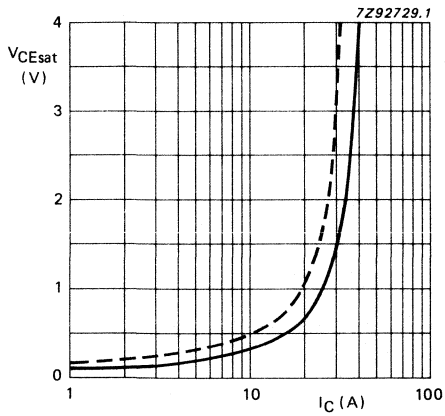


Fig. 11 Typical values collector voltage at T_j = 25 °C; I_C/I_B = 7,5 and 6 for BUS23B and BUS23C respectively; (——) = BUS23B; (– – –) = BUS23C.

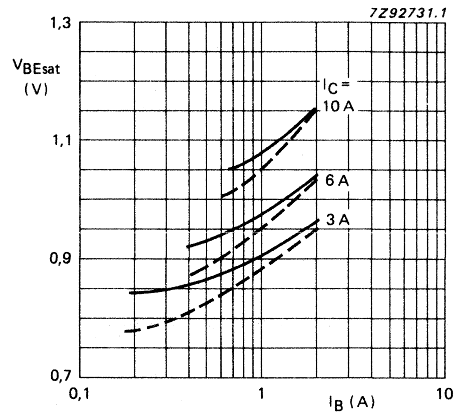


Fig. 12 Typical values V_{BE} at T_j = 25 °C; (——) = BUS23B; (– – –) = BUS23C.

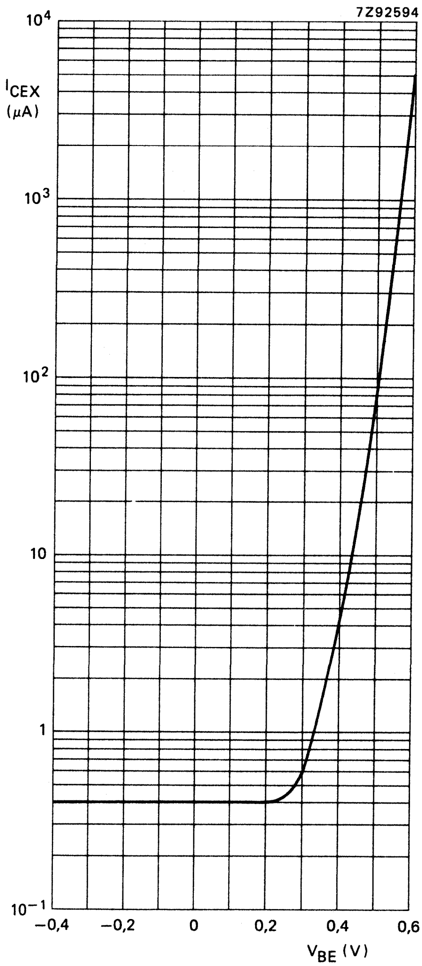


Fig. 13 Typical values collector cut-off current at T_j = 25 °C; V_{CE} = 250 V.

SILICON DIFFUSED POWER TRANSISTORS

High-voltage, high-speed, glass-passivated npn power transistors in a TO-3 envelope, intended for use in converters, inverters, switching regulators, motor control systems etc.

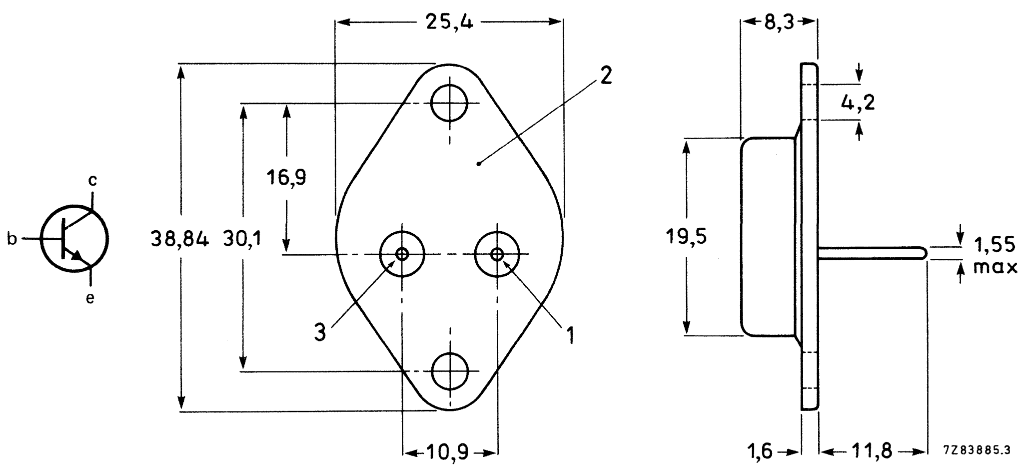
QUICK REFERENCE DATA

			BUS24B	24C	
Collector-emitter voltage					
peak value; $V_{BE} = 0$	V_{CESM}	max.	750	850	V
open base	V_{CEO}	max.	400	450	V
Collector-emitter saturation					
voltage $I_C = 20$ A	V_{CEsat}	max.	1.5		V
Collector current					
saturation	I_{Csat}	max.	20		A
DC	I_C	max.	30		A
peak value	I_{CM}	max.	50		A
Total power dissipation					
up to $T_{mb} = 25\ ^oC$	P_{tot}	max.	250		W
Fall time; resistive load	t_f	max.	0.7		μs

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-3.



Pinning:

1 = base
2 = collector
3 = emitter

Collector connected to case.

RATINGS

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

			BUS24B	24C	
Collector-emitter voltage					
peak value; $V_{BE} = 0$	V_{CESM}	max.	750	850	V
open base	V_{CEO}	max.	400	450	V
Collector current					
saturation	I_{Csat}	max.		20	A
DC	I_C	max.		30	A
peak value	I_{CM}	max.		50	A
Base current					
DC	I_B	max.		6.0	A
peak value	I_{BM}	max.		10	A
Total power dissipation					
up to $T_{mb} = 25\ ^oC$	P_{tot}	max.		250	W
Storage temperature range	T_{stg}			−65 to + 200	^oC
Junction temperature	T_j	max.		200	^oC

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	0.7	K/W

DEVELOPMENT DATA

CHARACTERISTICS

$T_j = 25\ ^oC$ unless otherwise specified

Collector cut-off current*						
$V_{CE} = V_{CESMmax}$; $V_{BE} = 0$		I_{CES}	max.	1.0		mA
Emitter cut-off current						
$V_{EB} = 9$ V; $I_C = 0$		I_{EBO}	max.	10		mA
				BUS24B	**24C**	
Collector-emitter sustaining voltage (Figs 2 and 3)						
$I_B = 0$; $I_C = 0.1$ A; L = 25 mH		$V_{CEOsust}$	min.	400	450	V
Saturation voltages						
$I_C = 20$ A; $I_B = 2.66$ A	BUS24B	V_{CEsat}	max.	1.5		V
		V_{BEsat}	max.	1.5		V
$I_B = 3.34$ A	BUS24C	V_{CEsat}	max.	1.5		V
		V_{BEsat}	max.	1.5		V
Current gain						
$I_C = 3$ A; $V_{CE} = 5$ V		h_{FE}	typ.	25		
Switching times resistive load (Figs 4 and 5)						
$I_{C\ on} = 20$ A; $V_{CC} = 250$ V						
$I_{B\ on} = I_{B\ off} = 2.66$ A	BUS24B	t_{on}	max.	1.0		μs
		t_s	max.	4.5		μs
		t_f	max.	0.7		μs
$I_{B\ on} = I_{B\ off} = 3.34$ A	BUS24C	t_{on}	max.	1.0		μs
		t_s	max.	4.5		μs
		t_f	max.	0.7		μs
Switching times inductive load (Figs 6 and 7)						
$I_{C\ on} = 20$ A						
$I_{B\ on} = I_{B\ off}$ as resistive load						
$V_{BE} = -5$ V; $L_B = 1\ \mu H$;						
$V_{CL} = 250$ V; $T_{mb} = 100\ ^oC$.		t_s	typ.	2.5		μs
		t_s	max.	3.0		μs
		t_f	typ.	0.1		μs
		t_f	max.	0.25		μs

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

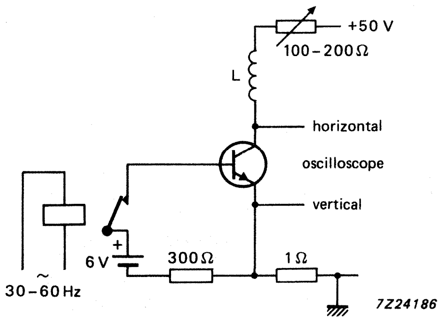


Fig. 2 Test circuit for $V_{CEOsust}$.

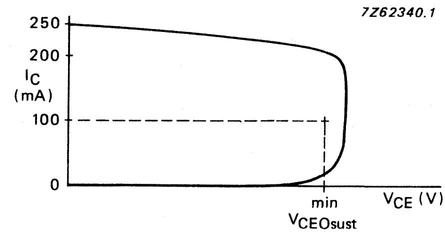


Fig. 3 Oscilloscope display for sustaining voltage.

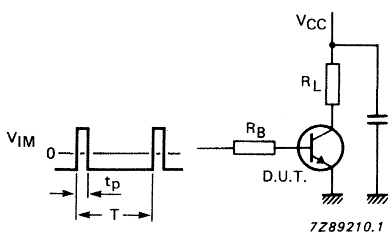


Fig. 4 Test circuit resistive load.

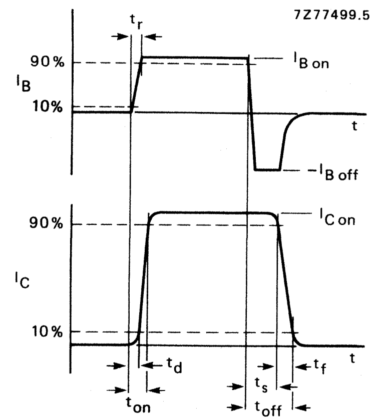


Fig. 5 Switching times waveforms with resistive load; $t_r \leqslant 20$ ns.

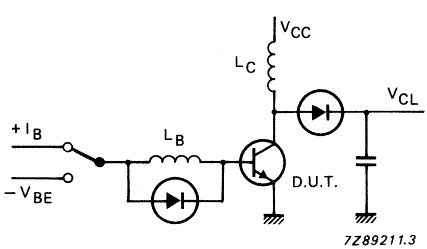


Fig. 6 Test circuit inductive load.

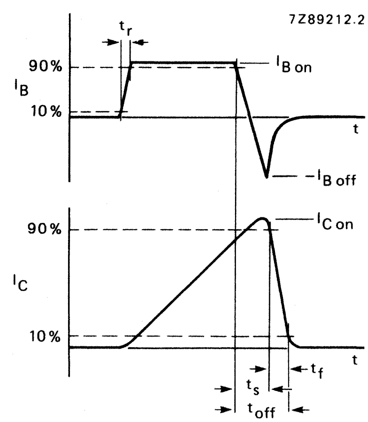
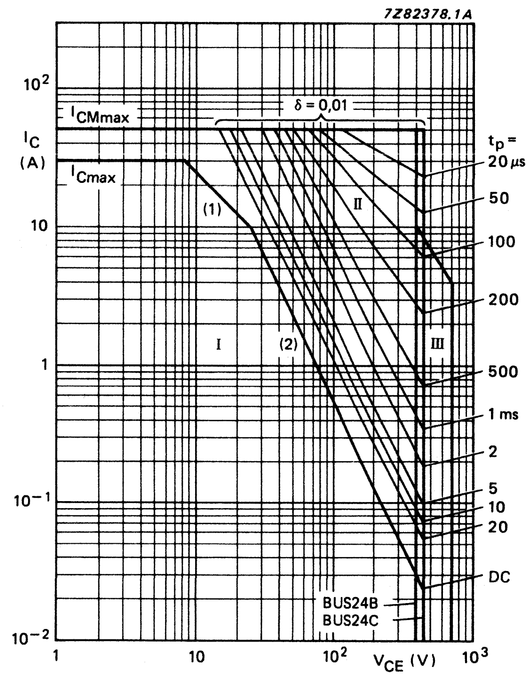


Fig. 7 Switching times waveforms with inductive load.



(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 $R_{BE} \leqslant 100\ \Omega$ and $t_p \leqslant 0.6\ \mu s$.

Fig. 8 Forward biased Safe Operating area at T_{mb} = 25 °C.

DEVELOPMENT DATA

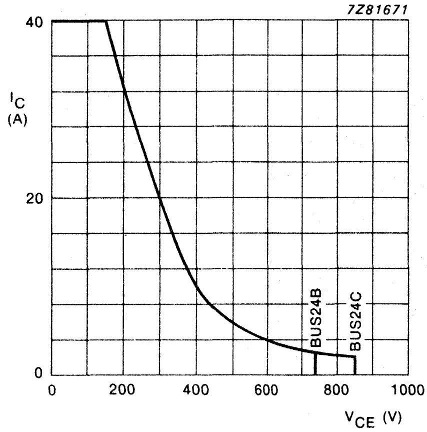


Fig. 9 Reverse bias SOAR; $T_{mb} \leq 100$ °C; $V_{BE} = -1$ V to -5 V.

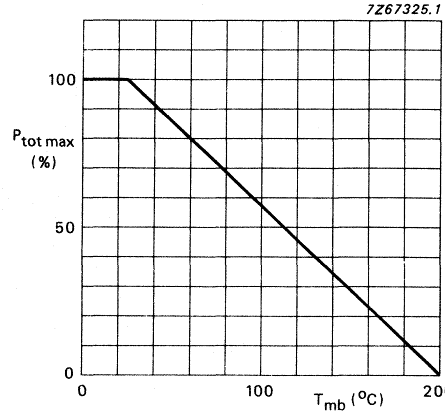


Fig. 10 Power derating curve.

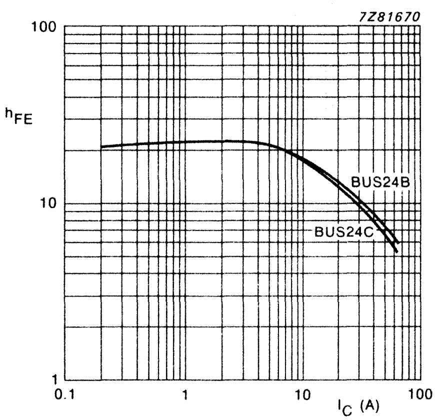


Fig. 11 DC current gain; $V_{CE} = 1.5$ V; $T_j = 25$ °C.

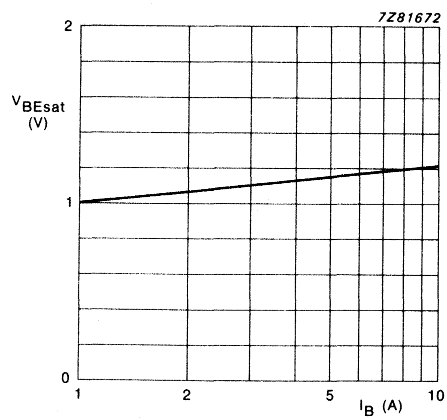


Fig. 12 Base-emitter saturation voltage as a function of base current; $I_C = 20$ mA; $T_{mb} = 25$ °C.

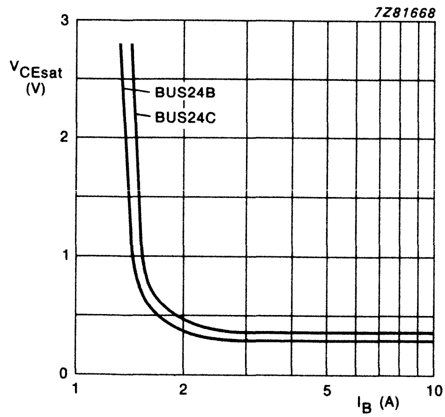


Fig. 13 Collector-emitter saturation voltage as a function of base current; I_C = 20 A; T_j = 25 °C.

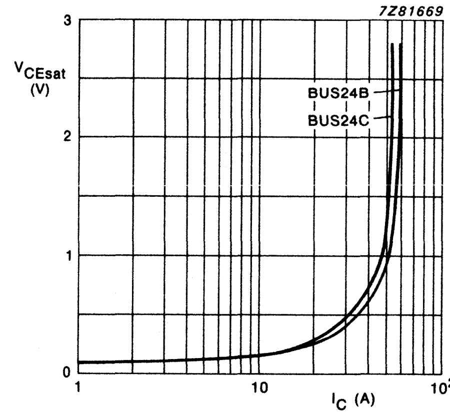


Fig. 14 Collector-emitter saturation voltage as a function of collector current:
I_C/I_B = 7.5 for BUS24B;
I_C/I_B = 6.0 for BUS24C.

NPN SILICON POWER TRANSISTORS

High-voltage, glass-passivated power transistors in TO-3 envelope, intended for use in very fast switching applications in inductive circuits.

BUS131H is a high gain selection for applications where drive current is limited.

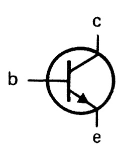
QUICK REFERENCE DATA

			BUS131	131A	131H	
Collector-emitter voltage						
peak value; $V_{BE} = 0$	V_{CESM}	max.	850	1000	850	V
open base	V_{CEO}	max.	450	500	450	V
Collector-emitter saturation voltage	V_{CEsat}	max.		2.5		V
Collector current						
saturation	I_{Csat}	max.		3.0		A
DC	I_C	max.		5.0		A
peak value	I_{CM}	max.		10		A
Total power dissipation						
up to $T_{mb} = 25\ ^{o}C$	P_{tot}	max.		125		W
Fall time; resistive load	t_f	typ.	0.07	0.07	0.12	μs

MECHANICAL DATA

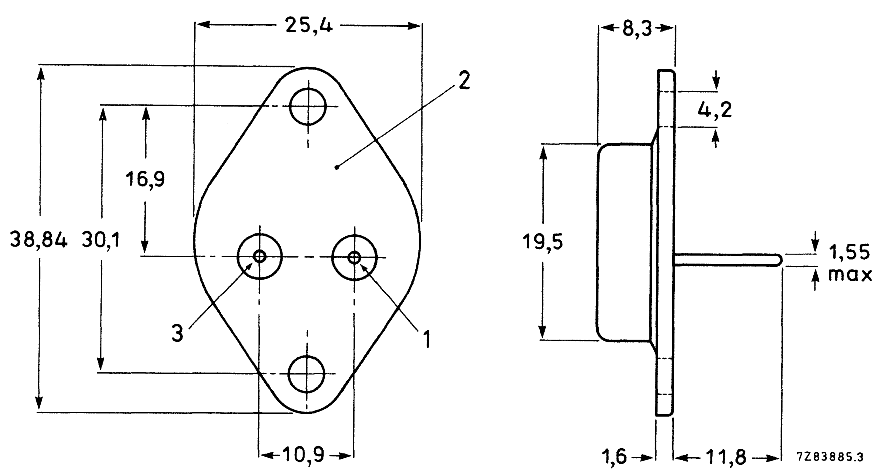
Dimensions in mm

Fig. 1 TO-3.



Pinning:

1 = base
2 = collector
3 = emitter



Collector connected to case.

RATINGS

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

			BUS131	131A	131H	
Collector-emitter voltage						
peak value; $V_{BE} = 0$	V_{CESM}	max.	850	1000	850	V
open base	V_{CEO}	max.	450	500	450	V
Collector current						
DC	I_C	max.		5.0		A
peak value; t_p = 5 ms; d = 10%	I_{CM}	max.		10		A
Base current						
DC	I_B	max.		4.0		A
peak value; t_p = 5 ms; d = 10%	I_{BM}	max.		8.0		A
Total power dissipation						
up to T_{mb} = 25 °C	P_{tot}	max.		125		W
Storage temperature range	T_{stg}			−65 to +200		°C
Junction temperature	T_j	max.		200		°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j-mb}$	=	1.4	K/W

DEVELOPMENT DATA

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			BUS131	131A	131H	
Collector cut-off current*						
$V_{CE} = V_{CESMmax}$; $V_{BE} = -1.5$ V	I_{CEV}	max.		0.25		mA
$V_{CE} = V_{CESMmax}$; $V_{BE} = -1.5$ V; T_j = 100 °C	I_{CEV}	max.		1.5		mA
Emitter cut-off current						
V_{EB} = 6.0 V; I_C = 0	I_{EBO}	max.		1.0		mA
Collector-emitter sustaining voltage						
I_C = 100 mA; I_B = 0; L = 10 mH (see Figs 2 and 3)	$V_{CEOsust}$	min.	450	500	450	V
Saturation voltage						
T_C = 25 °C and 100 °C						
I_C = 1.5 A; I_B = 0.2 A (BUS131) I_C = 1.5 A; I_B = 0.2 A (BUS131A) I_C = 1.5 A; I_B = 0.15 A (BUS131H)	V_{CEsat}	max.		1.0		V
I_C = 3 A; I_B = 0.4 A (BUS131) I_C = 3 A; I_B = 0.4 A (BUS131A)	V_{CEsat}	max.		2.5		V
I_C = 3 A; I_B = 0.3 A (BUS131H)	V_{BEsat}	max.		1.5		V
DC current gain						
I_C = 5 A; V_{CE} = 5 V	h_{FE}	min.	5	5	7	
Switching times resistive load (see Figs 4 and 5)						
$I_{C\,on}$ = 3 A; $I_{B\,on}$ = 0.4 A; $I_{B\,off}$ = 0.8 A						
Turn-on time	t_{on}	typ.	0.35	0.35	–	μs
Turn-off; storage time	t_s	typ.	1.2	1.2	–	μs
fall time	t_f	typ.	0.07	0.07	–	μs
$I_{C\,on}$ = 3 A; $I_{B\,on}$ = 0.3 A; $I_{B\,off}$ = 0.6 A						
Turn-on time	t_{on}	typ.	–	–	0.40	μs
Turn-off; storage time	t_s	typ.	–	–	1.2	μs
fall time	t_f	typ.	–	–	0.12	μs
Switching times inductive load (see Figs 6 and 7)						
$I_{C\,on}$ = 3 A; $I_{B\,on}$ = 0.4 A	t_{sv}	typ.	0.60	0.60	–	μs
$V_{BE\,off}$ = 5 V; $V_{CE(pk)}$ = 400 V;	t_{fi}	typ.	0.07	0.07	–	μs
T_j = 100 °C	t_c	typ.	0.20	0.20	–	μs
$I_{C\,on}$ = 3 A; $I_{B\,on}$ = 0.3 A	t_{sv}	typ.	–	–	0.50	μs
$V_{BE\,off}$ = 5 V; $V_{CE(pk)}$ = 400 V;	t_{fi}	typ.	–	–	0.07	μs
T_j = 100 °C	t_c	typ.	–	–	0.18	μs
Output capacitance						
V_{CB} = 10 V; I_E = 0; f_{test} = 1 kHz	C_{ob}	max.		200		pF

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

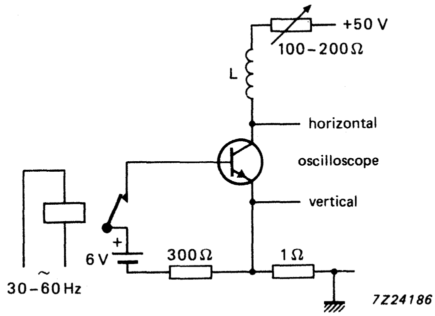


Fig. 2 Test circuit for $V_{CEOsust}$.

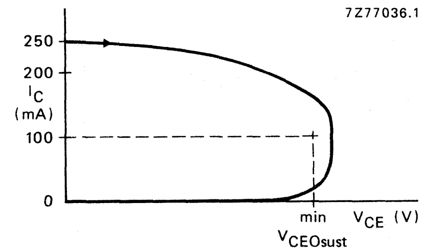
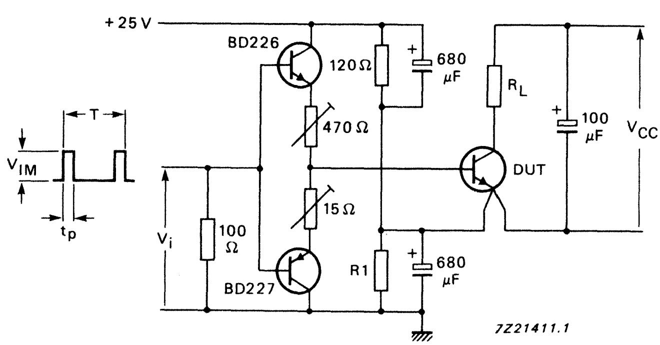


Fig. 3 Oscilloscope display for sustaining voltage.



t_p = 20 µs
T = 2 ms
V_{IM} = 15 V

Fig. 4 Test circuit resistive load; V_{CC} = 240 V; R_L = 82 Ω; R1 = 39 Ω.

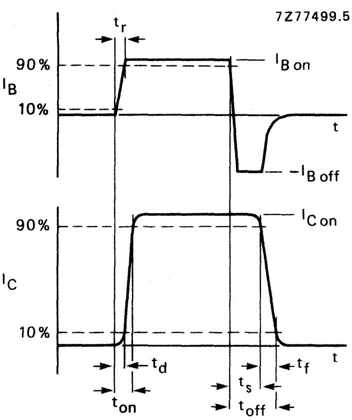
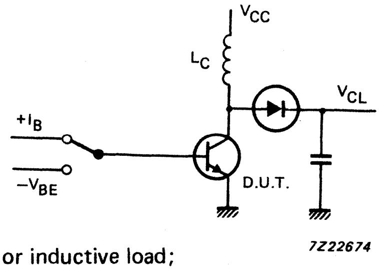


Fig. 5 Switching times waveforms with resistive load; $t_r \leqslant 30$ ns.



For inductive load;
V_{CL} = 400 V
$-V_{BE}$ = 5 V
For RB SOAR;
V_{CL} up to 1000 V
$-V_{BEoff}$ to be adjusted

Fig. 6 Test circuit inductive load and RB SOAR; V_{CC} = 20 V; L_C = 200 μH.

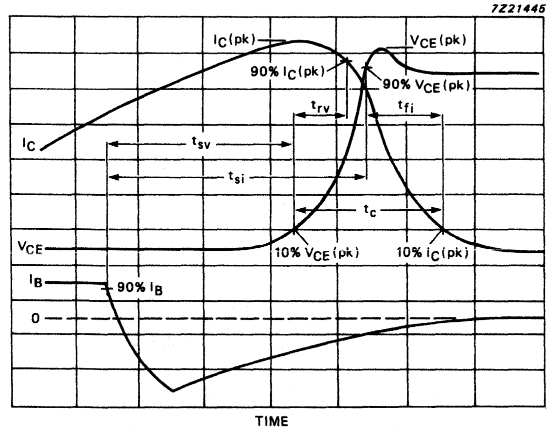


Fig. 7 Switching times waveforms with inductive load.

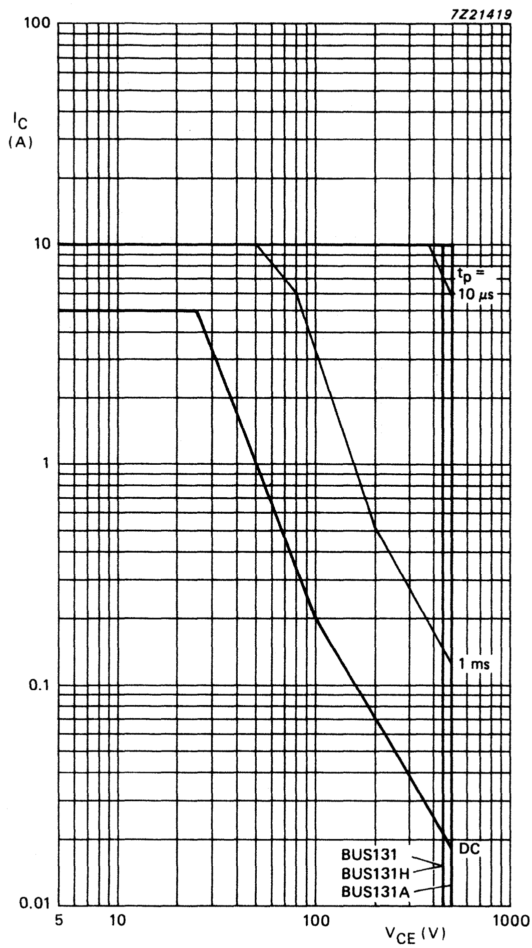


Fig. 8 Forward biased SOAR; T_{mb} = 25 °C.

DEVELOPMENT DATA

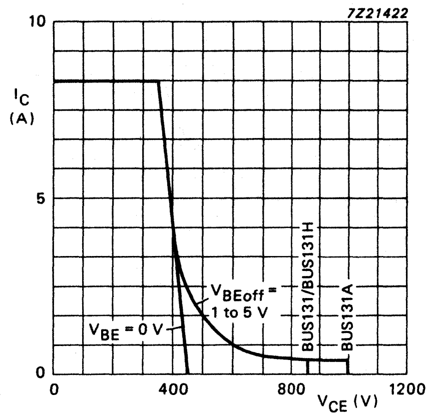


Fig. 9 Reverse bias SOAR; $I_C/I_B = 4$; $T_{mb} \leq 100\ ^oC$.

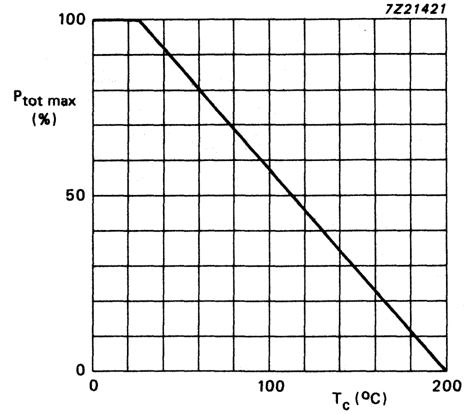


Fig. 10 Power derating curve.

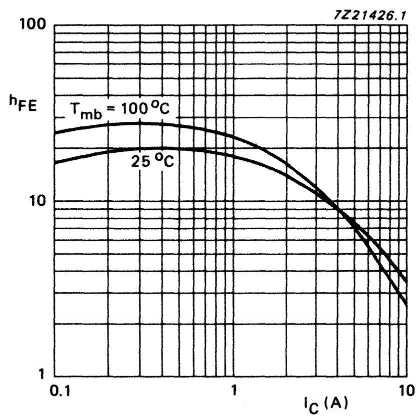


Fig. 11 Typical DC current gain; $V_{CE} = 5$ V.

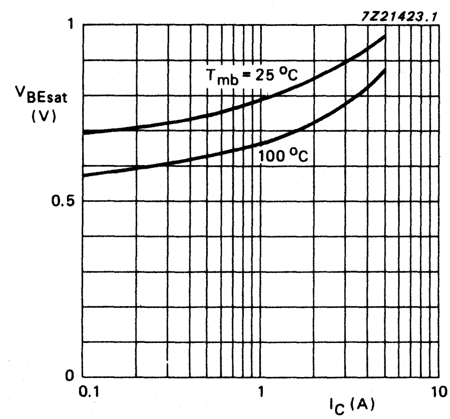


Fig. 12 Base-emitter saturation voltage as a function of collector current; $I_C/I_B = 10$.

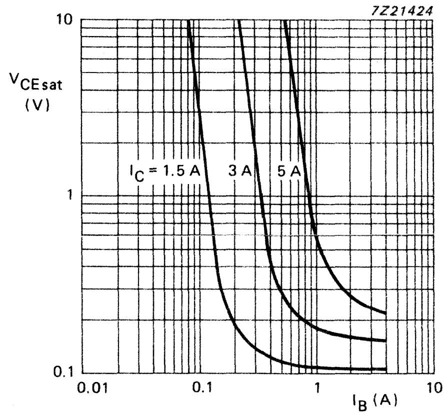


Fig. 13 Collector-emitter voltage as a function of base current; T_C = 25 °C.

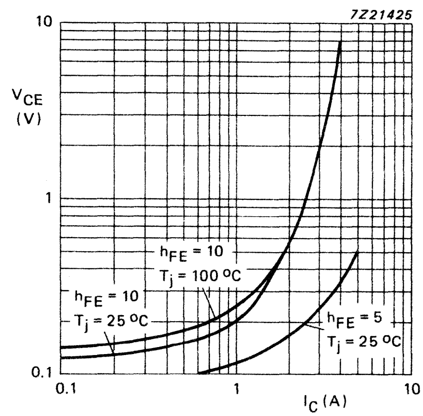


Fig. 14 Collector-emitter voltage as a function of collector current.

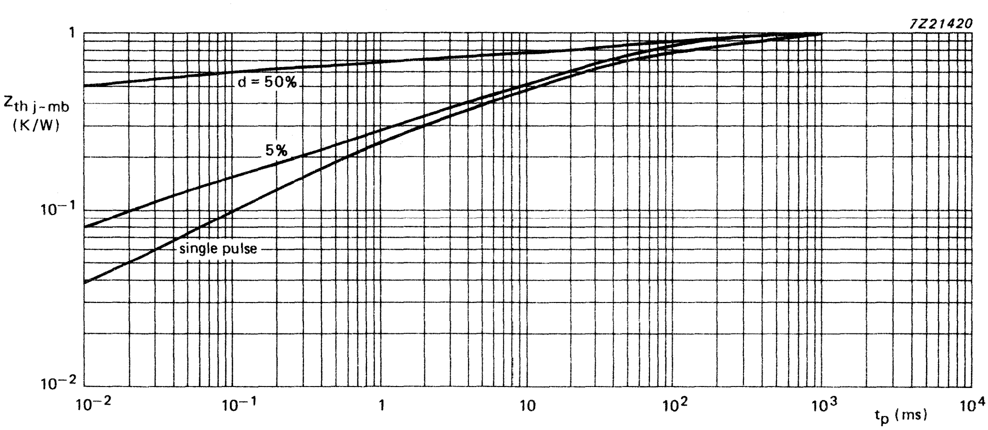


Fig. 15 Transient thermal impedance; (normalized).

SILICON DIFFUSED POWER TRANSISTORS

High-voltage, glass-passivated power transistors in TO-3 envelope, intended for use in very fast switching applications in inductive circuits.

BUS132H is a high gain selection for applications where drive current is limited.

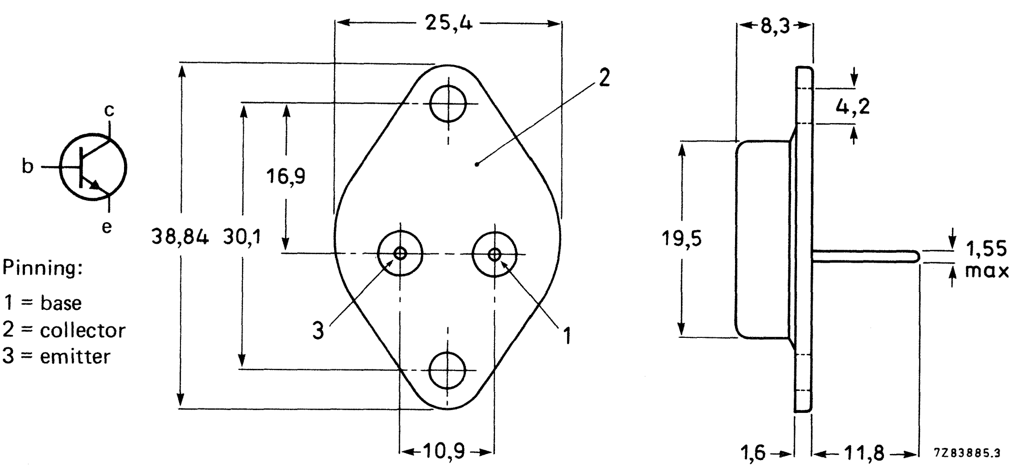
QUICK REFERENCE DATA

			BUS132	132A	132H	
Collector-emitter voltage						
peak value; $V_{BE} = 0$	V_{CESM}	max.	850	1000	850	V
open base	V_{CEO}	max.	450	500	450	V
Collector-emitter saturation voltage	V_{CEsat}	max.	3.0	1.5	3.0	V
Collector current						
saturation	I_{Csat}	max.		5.0		A
DC	I_C	max.		8.0		A
peak value	I_{CM}	max.		16		A
Total power dissipation						
up to $T_{mb} = 25\ ^oC$	P_{tot}	max.		150		W
Fall time; resistive load	t_f	typ.		0.1		μs

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-3.



Pinning:

1 = base
2 = collector
3 = emitter

Collector connected to case.

RATINGS

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

			BUS132	132A	132H	
Collector-emitter voltage						
peak value; $V_{BE} = 0$	V_{CESM}	max.	850	1000	850	V
open base	V_{CEO}	max.	450	500	450	V
Collector current						
DC	I_C	max.		8.0		A
peak value ; $t_p = 5$ ms; d = 10%	I_{CM}	max.		16		A
Base current						
DC	I_B	max.		6.0		A
peak value; $t_p = 5$ ms; d = 10%	I_{BM}	max.		12		A
Total power dissipation						
up to $T_{mb} = 25$ °C	P_{tot}	max.		150		W
Storage temperature range	T_{stg}			−65 to +200		°C
Junction temperature	T_j	max.		200		°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	1.17	K/W

DEVELOPMENT DATA

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			BUS132	132A	132H	
Collector cut-off current*						
$V_{CE} = V_{CESMmax}$; $V_{BE} = -1.5$ V	I_{CEV}	max.		0.25		mA
$V_{CE} = V_{CESMmax}$; $V_{BE} = -1.5$ V; T_j = 100 °C	I_{CEV}	max.		1.5		mA
Emitter cut-off current						
V_{EB} = 6.0 V; I_C = 0	I_{EBO}	max.		1.0		mA
Collector-emitter sustaining voltage (see Figs 2 and 3)						
I_C = 100 mA; I_B = 0; L = 10 mH	$V_{CEOsust}$	min.	450	500	450	V
Saturation voltage T_{mb} = 25 °C and 100 °C						
I_C = 3 A; I_B = 0.4 A (BUS132); I_C = 3 A; I_B = 0.6 A (BUS132A); I_C = 3 A; I_B = 0.3 A (BUS132H)	V_{CEsat}	max.	2.5	1.0	2.5	V
I_C = 5 A; I_B = 0.66 A (BUS132); I_C = 5 A; I_B = 1.0 A (BUS132A); I_C = 5 A; I_B = 0.5 A (BUS132H)	V_{CEsat}	max.	3.0	1.5	3.0	V
	V_{BEsat}	max.	1.5	1.5	1.5	V
DC current gain						
I_C = 8 A; V_{CE} = 5 V	h_{FE}	min.	5	5	7	
Switching times resistive load (see Figs 4 and 5)						
$I_{C\,on}$ = 5 A; $I_{B\,on}$ = 0.66 A; $I_{B\,off}$ = 1.3 A						
Turn-on time	t_{on}	typ.	0.35	0.35	–	μs
Turn-off; storage time	t_s	typ.	1.5	1.5	–	μs
fall time	t_f	typ.	0.1	0.1	–	μs
$I_{C\,on}$ = 5 A; $I_{B\,on}$ = 0.5 A; $I_{B\,off}$ = 1.0 A						
Turn-on time	t_{on}	typ.	–	–	0.4	μs
Turn-off; storage time	t_s	typ.	–	–	1.5	μs
fall time	t_f	typ.	–	–	0.1	μs
Switching times inductive load (see Figs 6 and 7)						
$I_{C\,on}$ = 5 A, $I_{B\,on}$ = 0.66 A	t_{sv}	typ.	0.8	0.8	–	μs
$V_{BE\,off}$ = 5 V; $V_{CE(pk)}$ = 400 V;	t_{fi}	typ.	0.08	0.08	–	μs
T_j = 100 °C	t_c	typ.	0.25	0.25	–	μs
$I_{C\,on}$ = 5 A; $I_{B\,on}$ = 0.5 A	t_{sv}	typ.			0.6	μs
$V_{BE\,off}$ = 5 V; $V_{CE(pk)}$ = 400 V;	t_{fi}	typ.			0.07	μs
T_j = 100 °C	t_c	typ.			0.2	μs
Output capacitance						
V_{CB} = 10 V; I_E = 0; f_{test} = 1 kHz	C_{ob}	max.		350		pF

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

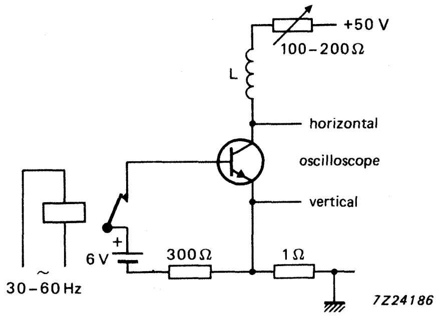


Fig. 2 Test circuit for $V_{CEOsust}$.

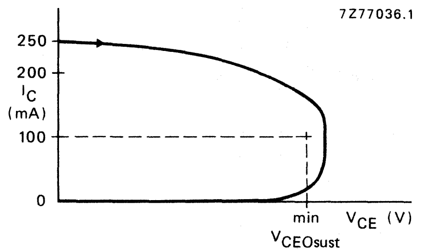
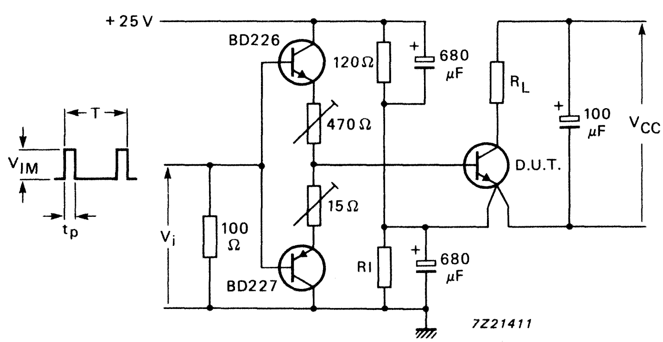


Fig. 3 Oscilloscope display for sustaining voltage.



t_p = 20 μs
T = 2 ms
V_{IM} = 15 V

Fig. 4 Test circuit resistive load; V_{CC} = 250 V; R_L = 50 Ω; R1 = 39 Ω.

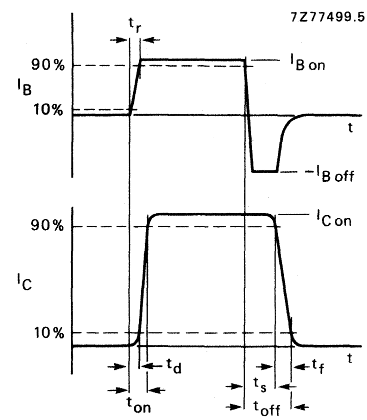


Fig. 5 Switching times waveforms with resistive load; $t_r \leqslant 30$ ns.

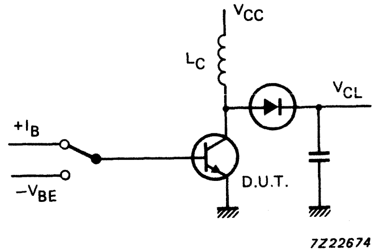


Fig. 6 Test circuit inductive load and RB SOAR; V_{CC} = 20 V; L_C = 200 μH.

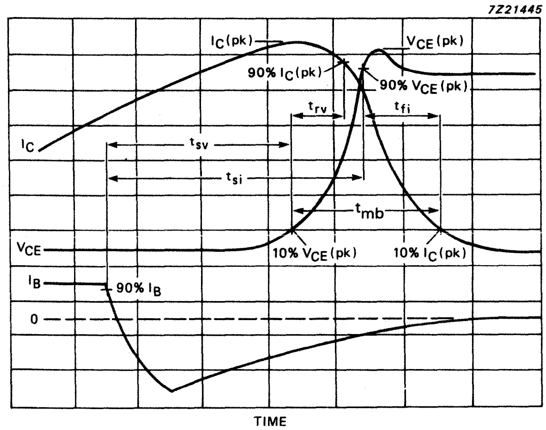


Fig. 7 Switching times waveforms with inductive load.

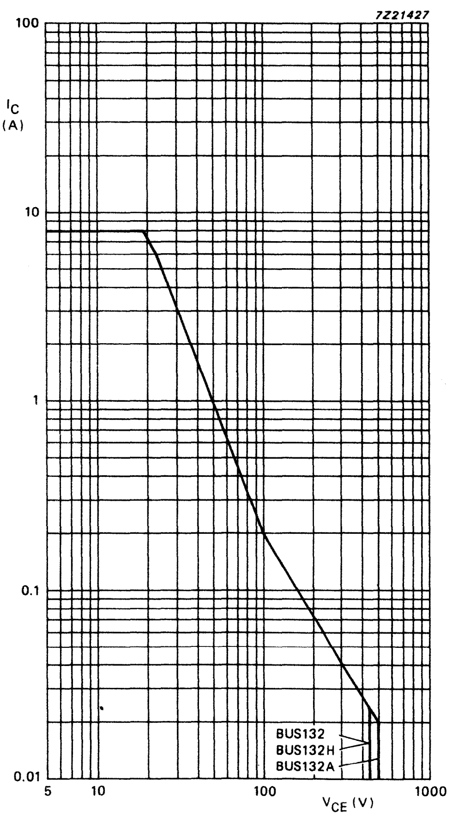


Fig. 8 Forward biased SOAR; T_{mb} = 25 °C.

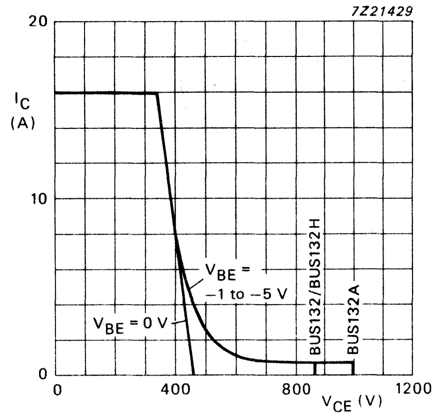


Fig. 9 Reverse bias SOAR;
$I_C/I_B = 4$; $T_{mb} \leqslant 25$ °C.

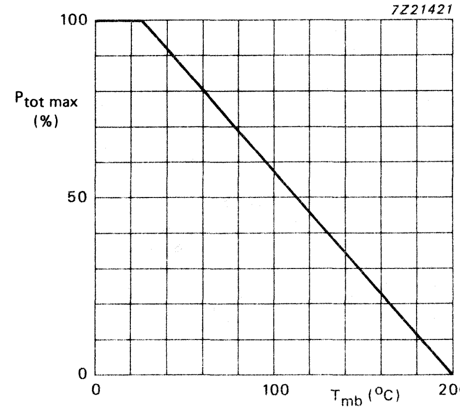


Fig. 10 Power derating curve.

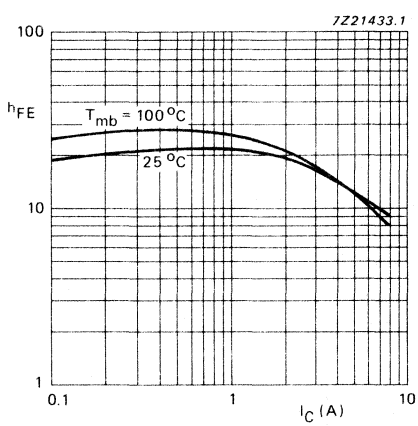


Fig. 11 Typical DC current gain; $V_{CE} = 5$ V.

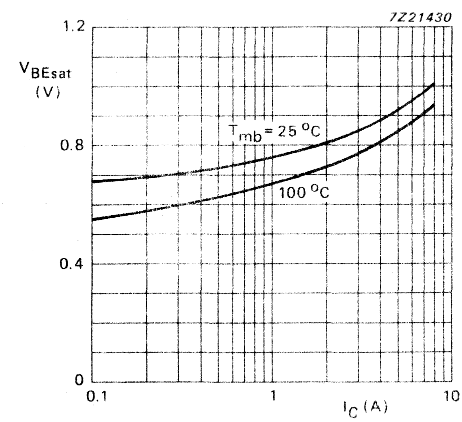


Fig. 12 Base-emitter saturation voltage as a function of collector current; $I_C/I_B = 10$.

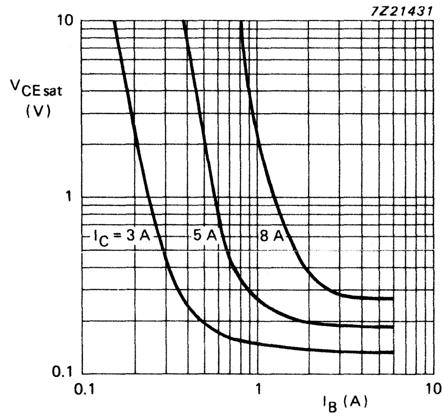


Fig. 13 Collector-emitter voltage as a function of base current; T_{mb} = 25 °C.

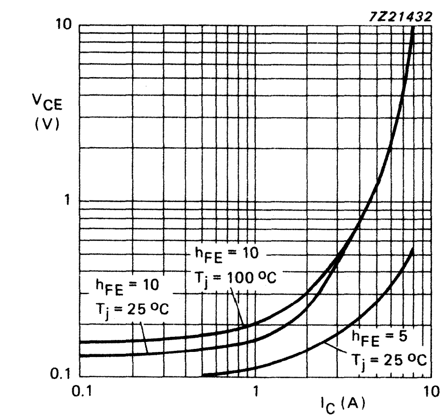


Fig. 14 Collector-emitter voltage as a function of collector current.

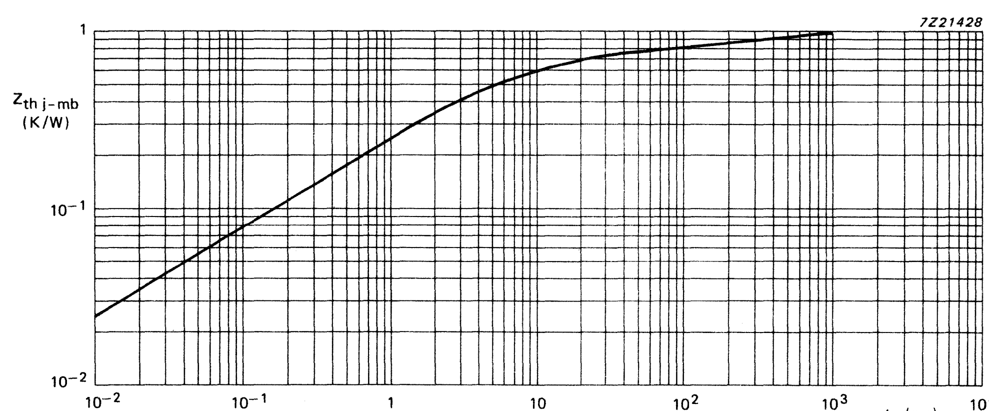


Fig. 15 Transient thermal impedance; (normalized).

DEVELOPMENT DATA

SILICON DIFFUSED POWER TRANSISTORS

High-voltage, glass-passivated power transistors in TO-3 envelope, intended for use in very fast switching applications in inductive circuits.

BUS133H is a high gain selection for applications where drive current is limited.

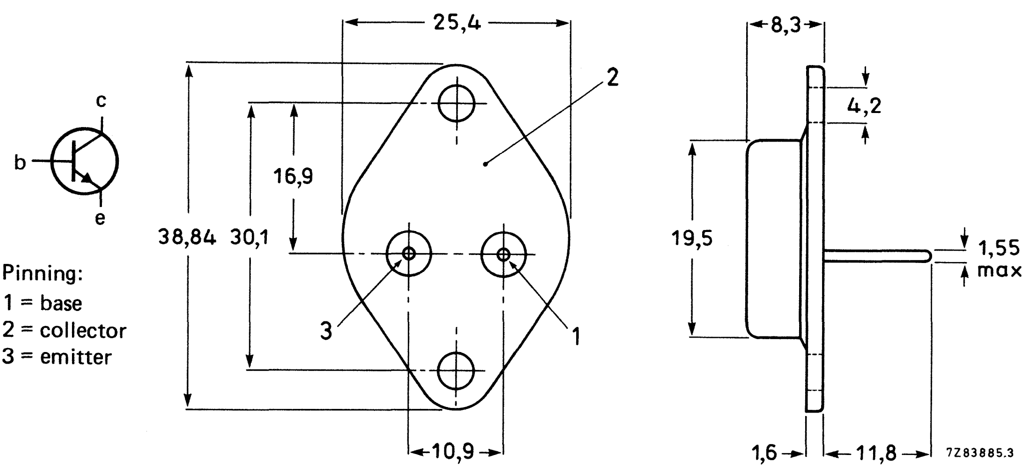
QUICK REFERENCE DATA

			BUS133	133A	133H	
Collector-emitter voltage						
peak value; $V_{BE} = 0$	V_{CESM}	max.	850	1000	850	V
open base	V_{CEO}	max.	450	500	450	V
Collector-emitter saturation voltage	V_{CEsat}	max.	3.0	1.5	3.0	V
Collector current						
saturation current	I_{Csat}	max.		10		A
DC	I_C	max.		15		A
peak value	I_{CM}	max.		20		A
Total power dissipation						
up to $T_{mb} = 25\ ^oC$	P_{tot}	max.		175		W
Fall time (resistive load)	t_f	typ.		0.15		μs

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-3.



Pinning:
1 = base
2 = collector
3 = emitter

Collector connected to case.

RATINGS

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

			BUS133	133A	133H	
Collector-emitter voltage peak value; $V_{BE} = 0$	V_{CESM}	max.	850	1000	850	V
Collector-emitter voltage open base	V_{CEO}	max.	450	500	450	V

Collector current				
DC	I_C	max.	15	A
peak value; t_p = 5 ms; d = 10%	I_{CM}	max.	20	A
Base current				
DC	I_B	max.	10	A
peak value; t_p = 5 ms; d = 10%	I_{BM}	max.	15	A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	175	W
Storage temperature range	T_{stg}		−65 to +200	°C
Junction temperature	T_j	max.	200	°C

THERMAL RESISTANCE

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

DEVELOPMENT DATA

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current*						
$V_{CE} = V_{CESMmax}$; $V_{BE} = -1.5$ V	I_{CEV}	max.		0.25		mA
$V_{CE} = V_{CESMmax}$; $V_{BE} = -1.5$ V; T_j = 100 °C	I_{CEV}	max.		1.5		mA
Emitter cut-off current						
V_{EB} = 6.0 V; I_C = 0	I_{EBO}	max.		1.0		mA
			BUS133	133A	133H	
Collector-emitter sustaining voltage						
I_C = 100 mA; I_B = 0; L = 10 mH	$V_{CEOsust}$	min.	450	500	450	V
Saturation voltage						
T_{mb} = 25 °C and 100 °C						
I_C = 5 A; I_B = 0.7 A (BUS133) I_C = 5 A; I_B = 1.0 A (BUS133A) I_C = 5 A; I_B = 0.5 A (BUS133H)	V_{CEsat}	max.	2.5	1.0	2.5	V
I_C = 10 A; I_B = 1.3 A (BUS133) I_C = 10 A; I_B = 2.0 A (BUS133A)	V_{CEsat}	max.	3.0	1.5	3.0	V
I_C = 10 A; I_B = 1.0 A (BUS133H)	V_{BEsat}	max.	1.5	1.5	1.5	V
DC current gain						
I_C = 15 A; V_{CE} = 5 V	h_{FE}	min.	5	5	7	
Switching times resistive load (see Figs 4 and 5)						
$I_{C\,on}$ = 10 A; $I_{B\,on}$ = 1.3 A; $I_{B\,off}$ = 2.6 A						
Turn-on time	t_{on}	typ.	0.4	0.45	–	µs
Turn-off; storage time	t_s	typ.	1.3	1.3	–	µs
fall time	t_f	typ.	0.15	0.15	–	µs
$I_{C\,on}$ = 10 A; $I_{B\,on}$ = 1 A; $I_{B\,off}$ = 2.0 A						
Turn-on time	t_{on}	typ.	–	–	0.4	µs
Turn-off; storage time	t_s	typ.	–	–	1.3	µs
fall time	t_f	typ.	–	–	0.15	µs
Switching times inductive load (see Figs 6 and 7)						
$I_{C\,on}$ = 10 A; $I_{B\,on}$ = 1.3 A;	t_{sv}	typ.	0.9	0.9	–	µs
$V_{BE\,off}$ = 5 V; $V_{CE(pk)}$ = 400 V;	t_{fi}	typ.	0.05	0.05	–	µs
T_C = 100 °C	t_c	typ.	0.16	0.16	–	µs
$I_{C\,on}$ = 10 A; $I_{B\,on}$ = 1 A;	t_{sv}	typ.	–	–	0.65	µs
$V_{BE\,off}$ = 5 V; $V_{CE(pk)}$ = 400 V;	t_{fi}	typ.	–	–	0.03	µs
T_C = 100 °C	t_c	typ.	–	–	0.15	µs
Output capacitance						
V_{CB} = 10 V; I_E = 0; f_{test} = 1 kHz	C_{ob}	max.		400		pF

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

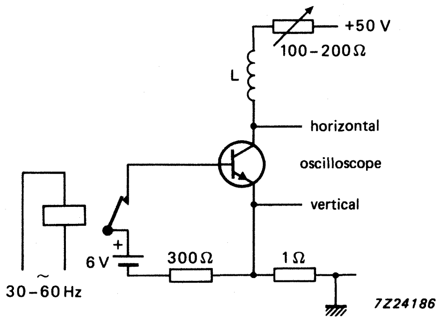


Fig. 2 Test circuit for $V_{CEOsust}$.

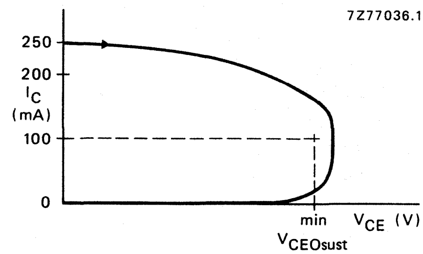
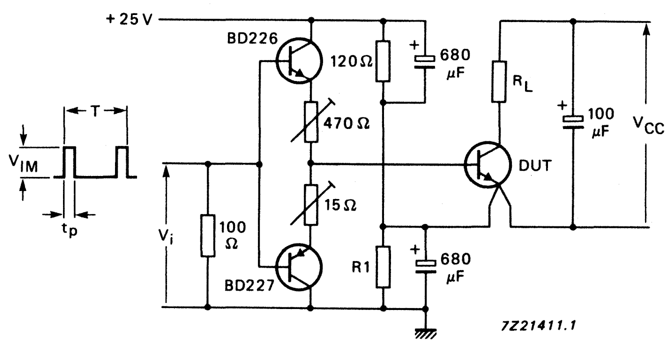
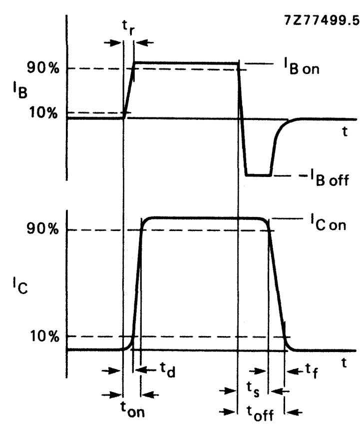


Fig. 3 Oscilloscope display for sustaining voltage.



t_p = 20 μs
T = 2 ms
V_{IM} = 15 V

Fig. 4 Test circuit resistive load; V_{CC} = 250 V; R_L = 25 Ω; R1 = 39 Ω.



For inductive load;
V_{clamp} = 400 V
$-V_{BE}$ = 5 V
For RB SOAR;
V_{clamp} up to 1000 V
$-V_{BE}$ to be adjusted.

Fig. 5 Switching times waveforms with resistive load; $t_r \leqslant$ 30 ns.

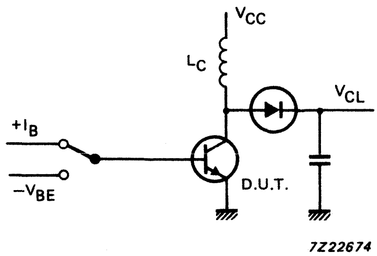


Fig. 6 Test circuit inductive load and RB SOAR; V_{CC} = 20 V; L_C = 200 μH.

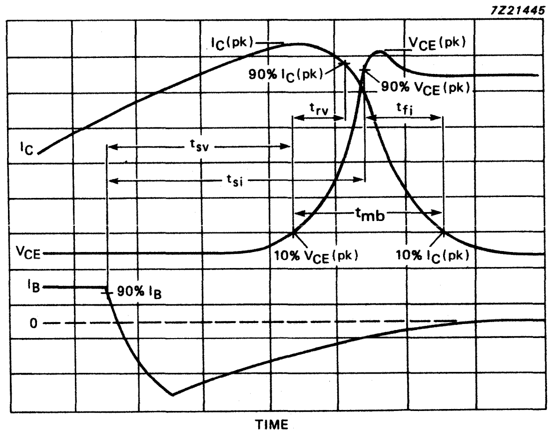


Fig. 7 Switching times waveforms with inductive load.

DEVELOPMENT DATA

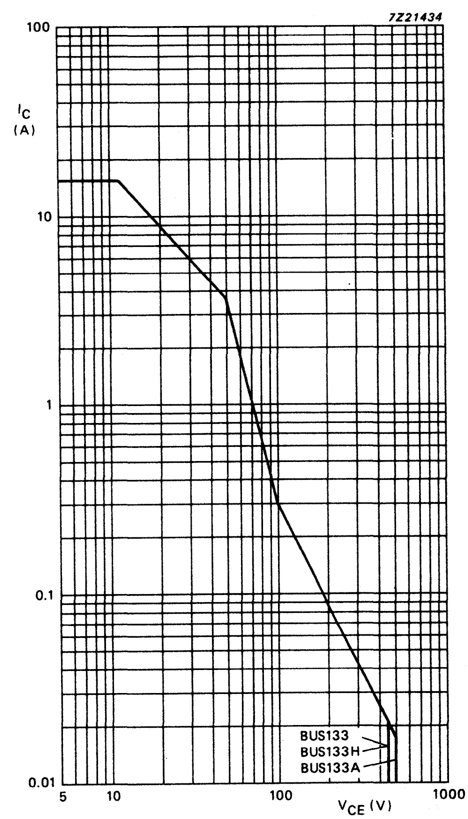


Fig. 8 Forward biased SOAR; T_{mb} = 25 °C.

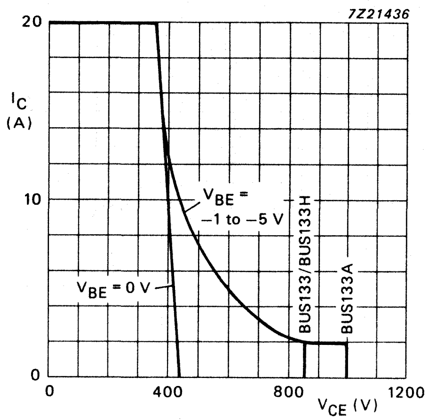


Fig. 9 Reverse bias SOAR;
$I_C/I_B = 4$; $T_{mb} = 25\ ^oC$.

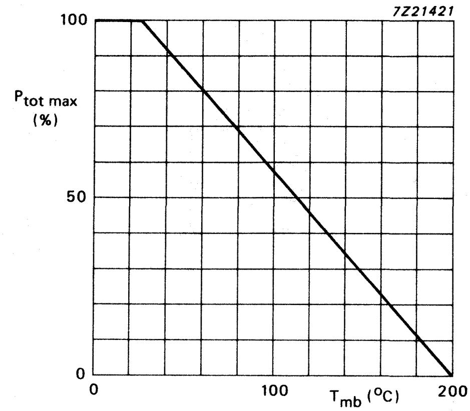


Fig. 10 Power derating curve.

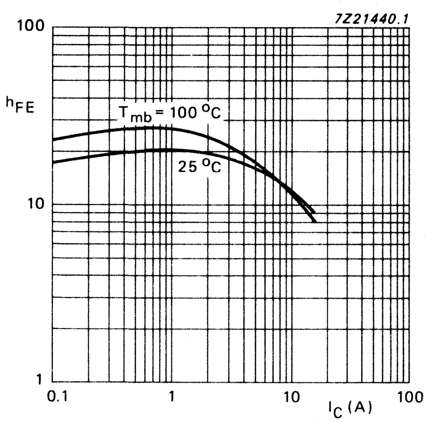


Fig. 11 Typical DC current gain; $V_{CE} = 5$ V.

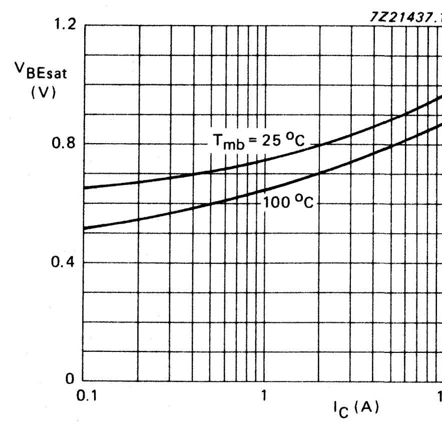


Fig. 12 Base-emitter saturation voltage as a function of collector current; $I_C/I_B = 10$.

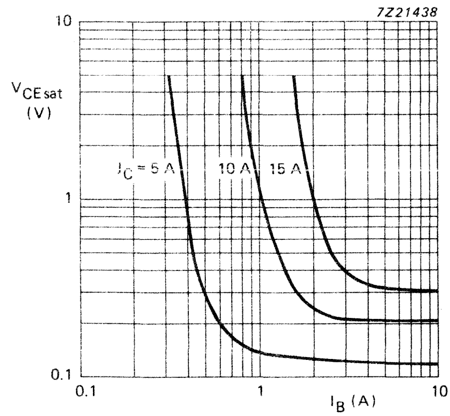


Fig. 13 Collector-emitter saturation voltage as a function of base current; T_{mb} = 25 °C.

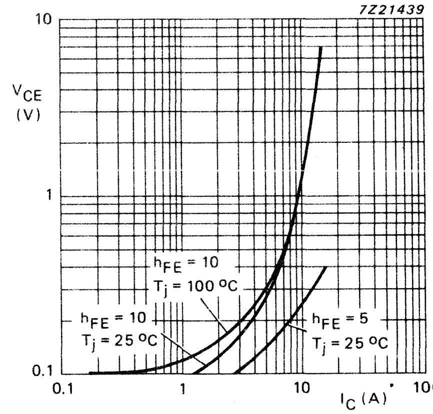


Fig. 14 Collector-emitter voltage as a function of collector current.

DEVELOPMENT DATA

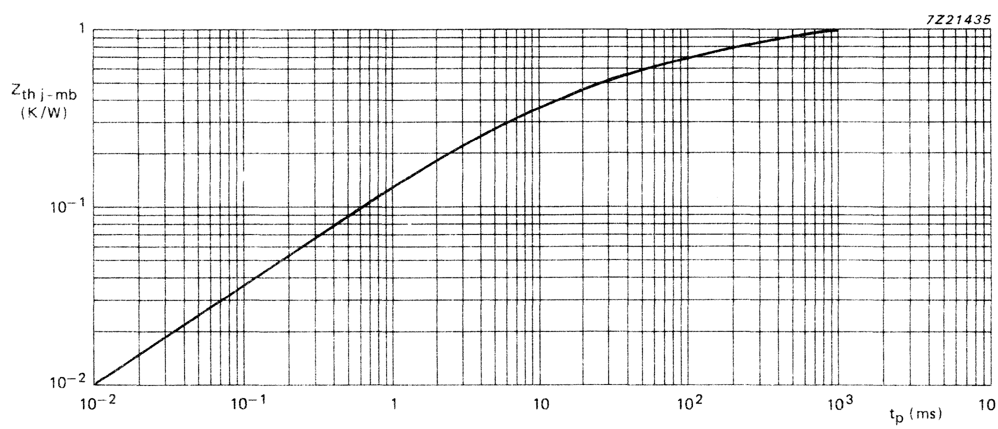


Fig. 15 Transient thermal impedance; (normalized).

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.

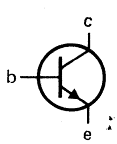
QUICK REFERENCE DATA

			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 $T_{mb} = 25\ ^oC$	P_{tot}	max.	100		W
Fall time	t_f	max.	0,8		μs

MECHANICAL DATA

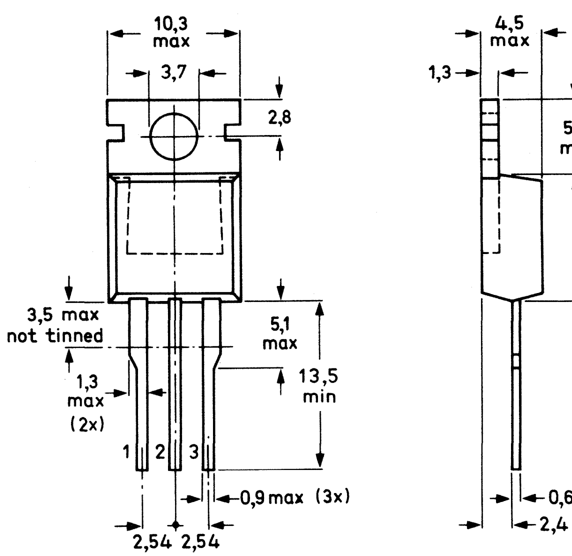
Dimensions in mm

Fig. 1 TO-220AB.

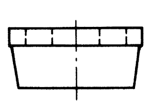


Pinning;

1 = base
2 = collector
3 = emitter



Collector connected to mounting base.



RATINGS

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

			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	$R_{th\ j\text{-}mb}$	=	1,25	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			BUT11	BUT11A	
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 °C	I_{CES}	max.	2		mA
Emitter cut-off current					
$I_C = 0$; V_{EB} = 9 V	I_{EBO}	max.	10		mA
Saturation voltages					
I_C = 3 A; I_B = 0,6 A	V_{CEsat}	max.	1,5	–	V
	V_{BEsat}	max.	1,3	–	V
I_C = 2,5 A; I_B = 0,5 A	V_{CEsat}	max.	–	1,5	V
	V_{BEsat}	max.	–	1,3	V
Collector-emitter sustaining voltage					
I_C = 100 mA; I_{Boff} = 0; L = 25 mA	$V_{CEOsust}$	min.	400	450	V

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

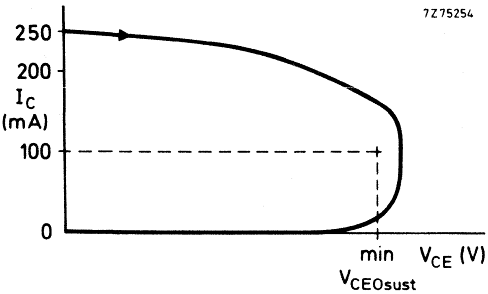


Fig. 2 Oscilloscope display for sustaining voltage.

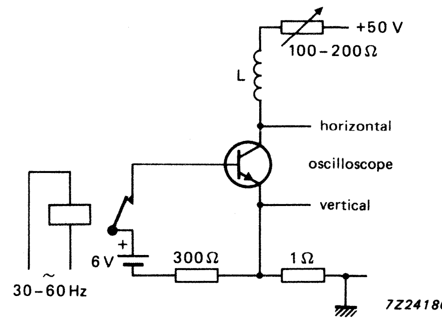
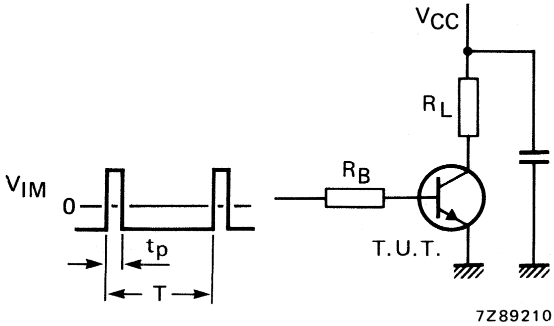


Fig. 3 Test circuit for $V_{CEOsust}$.

			BUT11	BUT11A	
Switching times resistive load (Figs 4 and 5)					
I_{Con} = 3 A; I_{Bon} = $-I_{Boff}$ = 0,6 A					
Turn-on time	t_{on}	max.	1	—	μs
Turn-off: Storage time	t_s	max.	4	—	μs
Fall time	t_f	max.	0,8	—	μs
I_{Con} = 2,5 A; I_{Bon} = $-I_{Boff}$ = 0,5 A					
Turn-on time	t_{on}	max.	—	1	μs
Turn-off: Storage time	t_s	max.	—	4	μs
Fall time	t_f	max.	—	0,8	μs
Switching times inductive load (Figs 6 and 7)					
I_{Con} = 3 A; I_B = 0,6 A					
Turn-off: Storage time	t_s	typ.	1,1	—	μs
		max.	1,4	—	μs
Fall time	t_f	typ.	80	—	ns
		max.	150	—	ns
I_{Con} = 3 A; I_B = 0,6 A; T_j = 100 °C					
Turn-off: Storage time	t_s	typ.	1,2	—	μs
		max.	1,5	—	μs
Fall time	t_f	typ.	140	—	ns
		max.	300	—	ns
Switching times inductive load (Figs 6 and 7)					
I_{Con} = 2,5 A; I_B = 0,5 A					
Turn-off: Storage time	t_s	typ.	—	1,1	μs
		max.	—	1,4	μs
Fall time	t_f	typ.	—	80	ns
		max.	—	150	ns
I_{Con} = 2,5 A; I_B = 0,5 A; T_j = 100 °C					
Turn-off: Storage time	t_s	typ.	—	1,2	μs
		max.	—	1,5	μs
Fall time	t_f	typ.	—	140	ns
		max.	—	300	ns



V_{CC} = 250 V
V_{IM} = −6 to +8 V
$\frac{t_p}{T}$ = 0,01
t_p = 20 μs

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.

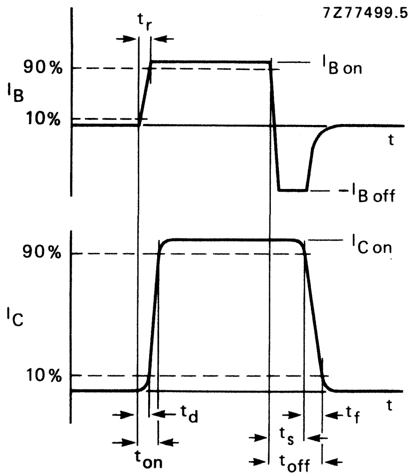


Fig. 5 Switching times waveforms with resistive load.

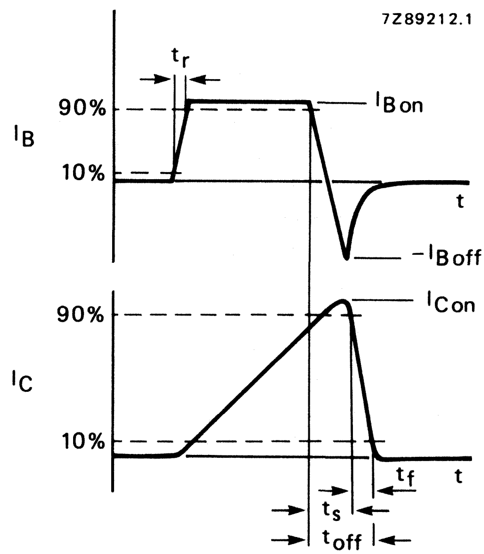
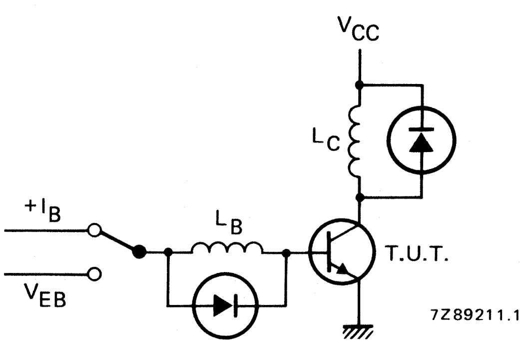
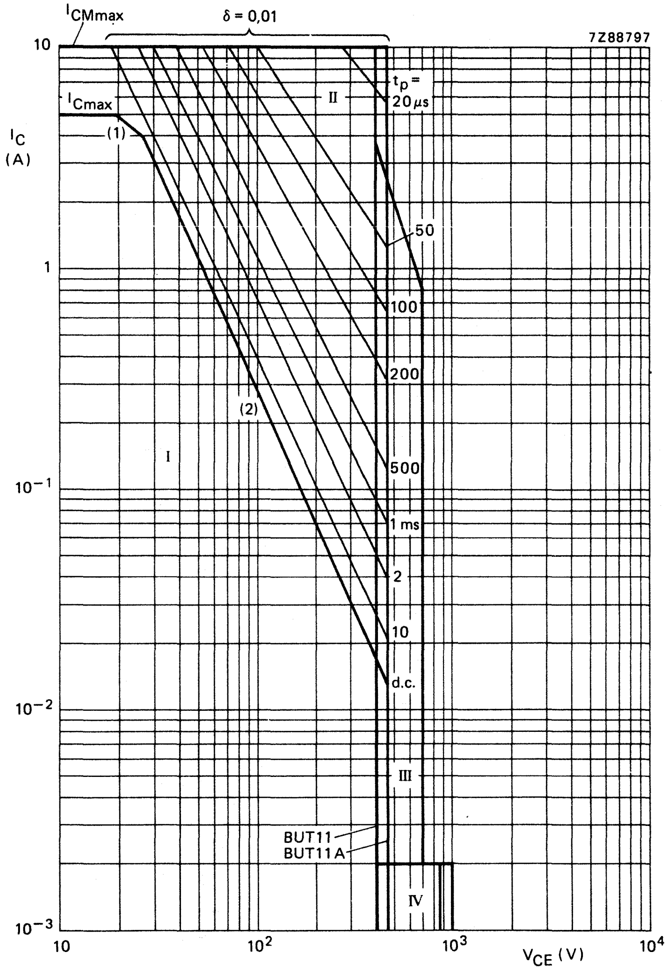


Fig. 6 Switching times waveforms with inductive load.



V_{CL} = 300 V
V_{CC} = 30 V
V_{EB} = 5 V
L_B = 1 μH

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 $R_{BE} \leqslant 100\ \Omega$ and $t_p \leqslant 0{,}6\ \mu s$.
IV Repetitive pulse operation in this region is permissible provided $V_{BE} \leqslant 0$ and $t_p \leqslant 5$ ms.

Fig. 8 Safe operating area at $T_{mb} \leqslant 25\ ^oC$.

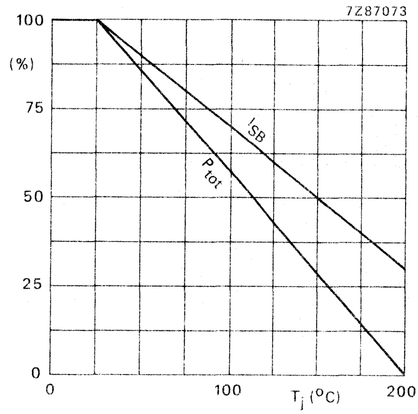


Fig. 9 Total power dissipation and second-breakdown current derating curve.

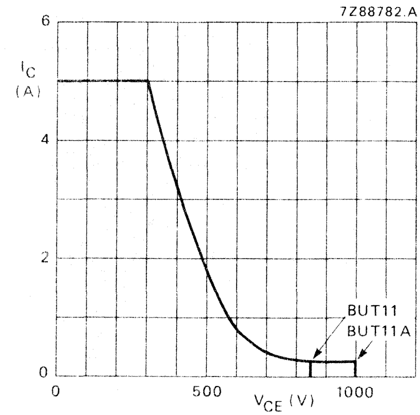


Fig. 10 Reverse bias SOAR.

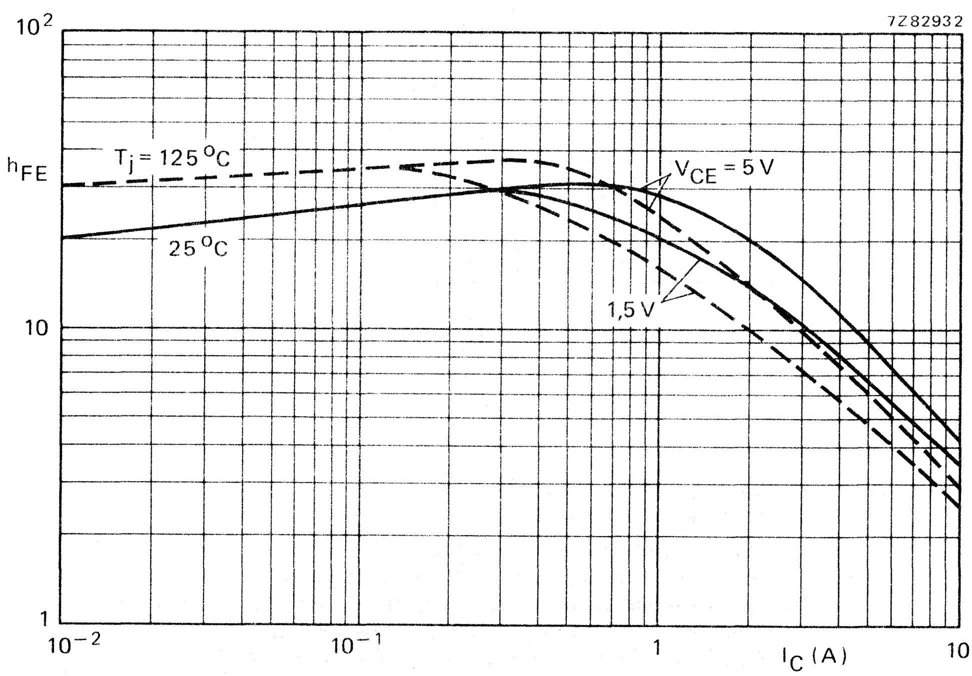


Fig. 11 Typical DC current gain.

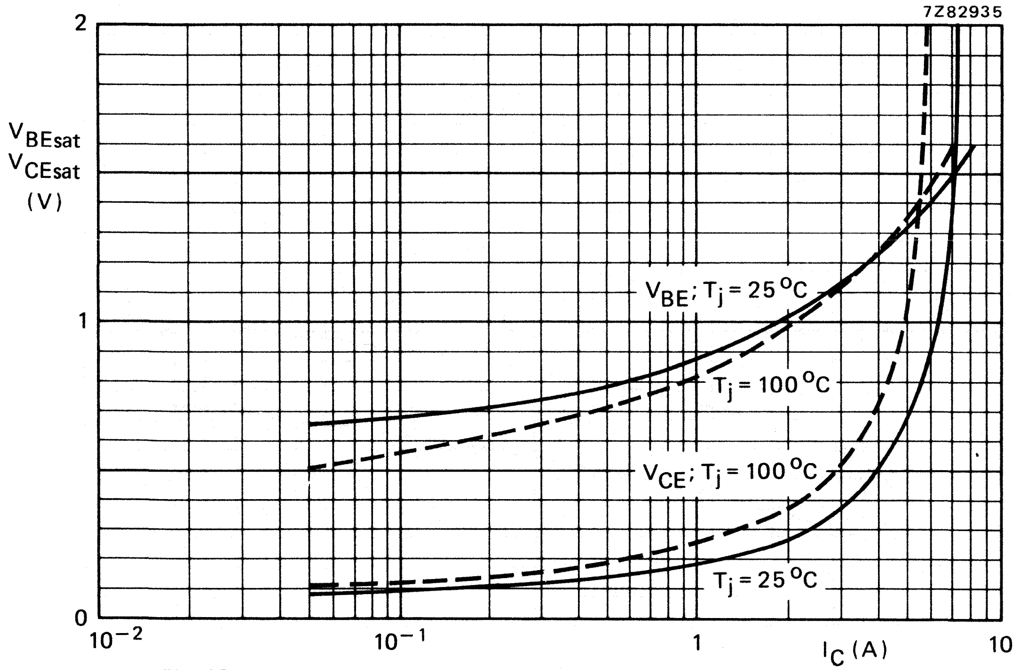


Fig. 12 Typical values base-emitter and collector-emitter voltage, $I_C/I_B = 5$.

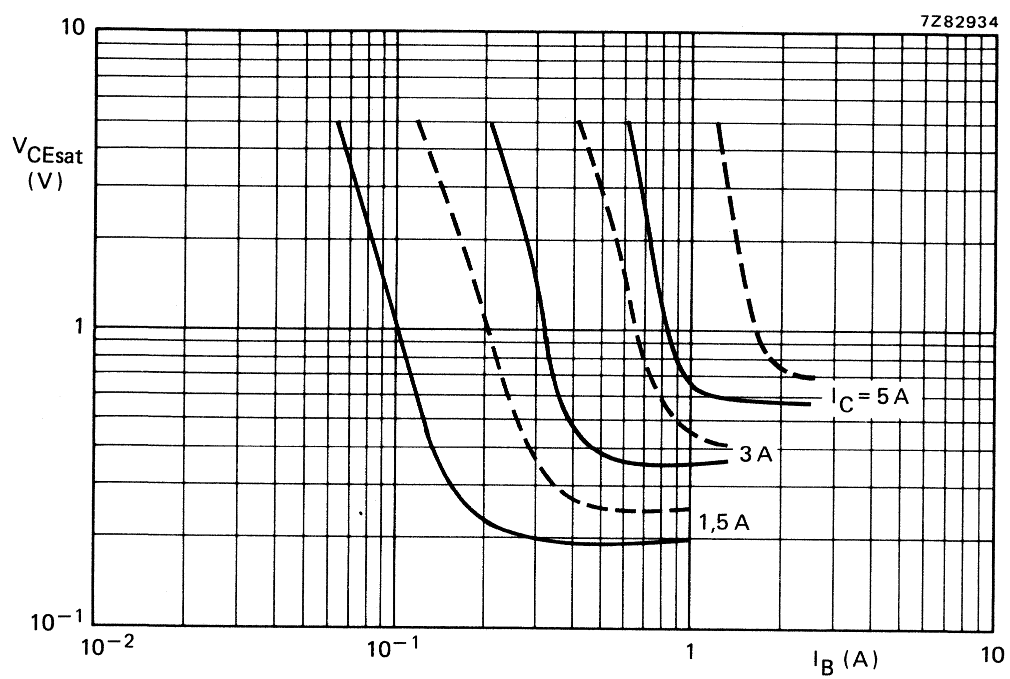


Fig. 13 Typ. (——) and max. (– – –) values collector-emitter saturation voltage at T_j = 25 °C.

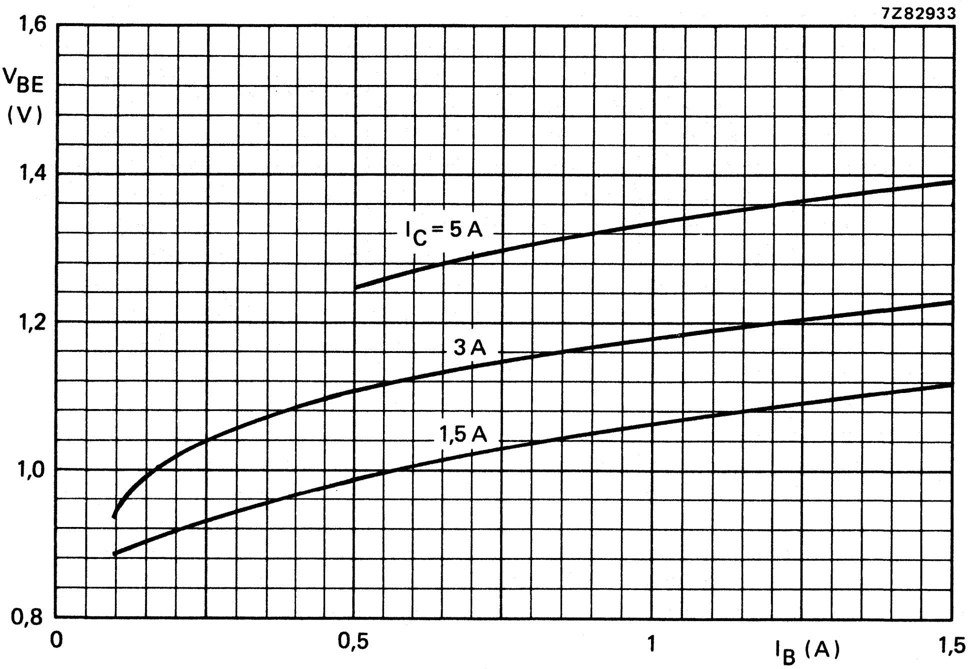


Fig. 14 Typical values at T_j = 25 °C.

SILICON DIFFUSED POWER TRANSISTOR

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

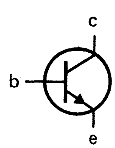
QUICK REFERENCE DATA

			BUT11F	BUT11AF	
Collector-emitter voltage					
peak value; $V_{BE} = 0$	V_{CESM}	max.	850	1000	V
open base	V_{CEO}	max.	400	450	V
Collector-emitter saturation voltage	V_{CEsat}	max.	1,5	1,5	V
Collector saturation current	I_{Csat}	max.	3	2,5	A
Collector current					
DC	I_C	max.	5	5	A
peak value	I_{CM}	max.	10	10	A
Total power dissipation up to $T_{mb} = 25\ ^{o}C$	P_{tot}	max.	20	20	W
Fall time	t_f	max.	0,8	0,8	µs

MECHANICAL DATA

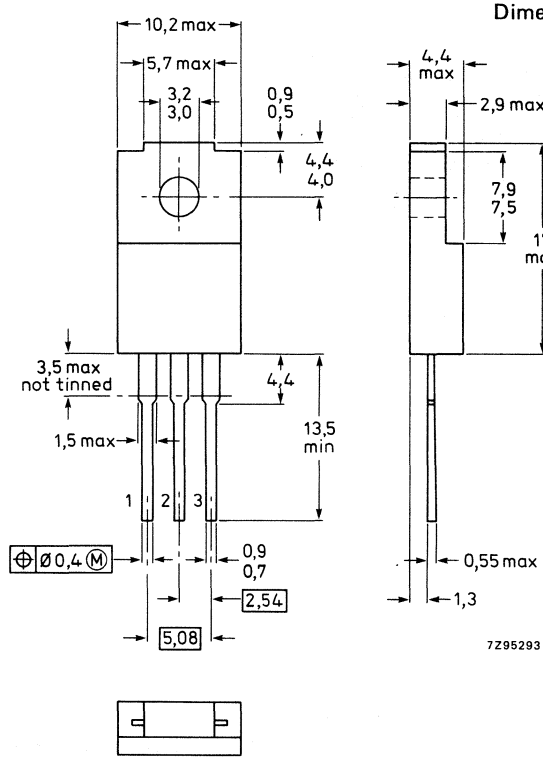
Dimensions in mm

Fig. 1 SOT186.



Pinning;

1 = base
2 = collector
3 = emitter



Mounting base is electrically insulated from all terminals.

RATINGS

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

			BUT11F	BUT11AF	
Collector-emitter voltage					
open base	V_{CEO}	max.	400	450	V
peak value; $V_{BE} = 0$	V_{CESM}	max.	850	1000	V
Collector current					
DC	I_C	max.	5		A
peak value	I_{CM}	max.	10		A
Base current					
DC	I_B	max.	2		A
peak value	I_{BM}	max.	4		A
Total power dissipation up to T_{mb} = 25 °C (note 1)	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 internal heatsink	$R_{th\ j\text{-}mb}$	=	1,45	K/W
From junction to external heatsink (note 1)	$R_{th\ j\text{-}h}$	=	6,45	K/W
From junction to external heatsink (note 2)	$R_{th\ j\text{-}h}$	=	3,95	K/W
From junction to ambient	$R_{th\ j\text{-}a}$	=	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 °C unless otherwise specified

Collector cut-off currents				
$V_{CE} = V_{CESmax}$; $V_{BE} = 0$	I_{CES}	max.	1	mA
$V_{CE} = V_{CESmax}$; $V_{BE} = 0$; T_j = 125 °C	I_{CES}	max.	2	mA
Emitter cut-off current				
V_{EB} = 9 V; $I_C = 0$	I_{EBO}	max.	10	mA
DC current gain				
I_C = 0,5 A; V_{CE} = 5 V	h_{FE}	typ.	25	

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.

			BUT11A	BUT11AF	
Collector-emitter sustaining voltage I_C = 0,1 A; I_B = 0; L = 25 μH (see Figs 2 and 3)	$V_{CEOsust}$	min.	400	450	V
Saturation voltages I_C = 3 A; I_B = 0,6 A	V_{CEsat}	max.	1,5	—	V
	V_{BEsat}	max.	1,3	—	V
I_C = 2,5 A; I_B = 0,5 A	V_{CEsat}	max.	—	1,5	V
	V_{BEsat}	max.	—	1,3	V
Switching times resistive load (Figs 4 and 5) I_{Con} = 3 A; I_{Bon} = I_{Boff} = 0,6 A	t_{on}	max.	1	—	μs
	t_s	max.	4	—	μs
	t_f	max.	0,8	—	μs
I_{Con} = 2,5 A; I_{Bon} = I_{Boff} = 0,5 A	t_{on}	max.	—	1	μs
	t_s	max.	—	4	μs
	t_f	max.	—	0,8	μs
Switching times inductive load (Figs 6 and 7) I_{Con} = 3 A; I_B = 0,6 A	t_s	typ.	1,1	—	μs
		max.	1,4	—	μs
	t_f	typ.	80	—	ns
		max.	150	—	ns
I_{Con} = 3 A; I_B = 0,6 A; T_j = 100 °C	t_s	typ.	1,2	—	μs
		max.	1,5	—	μs
	t_f	typ.	140	—	ns
		max.	300	—	ns
I_{Con} = 2,5 A; I_B = 0,5 A	t_s	typ.	—	1,1	μs
		max.	—	1,4	μs
	t_f	typ.	—	80	ns
		max.	—	150	ns
I_{Con} = 2,5 A; I_B = 0,5 A; T_j = 100 °C	t_s	typ.	—	1,2	μs
		max.	—	1,5	μs
	t_f	typ.	—	140	ns
		max.	—	300	ns

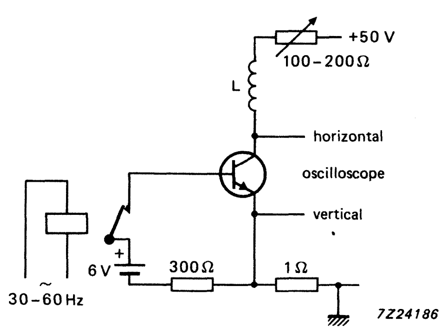


Fig. 2 Test circuit for $V_{CEOsust}$.

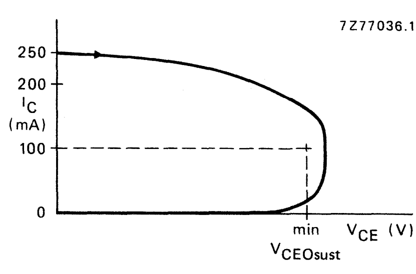


Fig. 3 Fig. 3 Oscilloscope display for sustaining voltage.

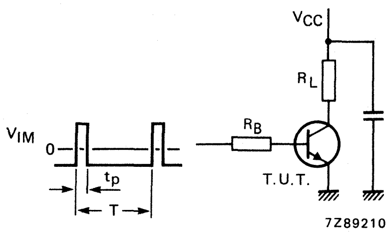


Fig. 4 Test circuit resistive load.

V_{CC} = 250 V
V_{IM} = −6 to + 8 V
t_p = 20 μs
$\frac{t_p}{T}$ = 0,01

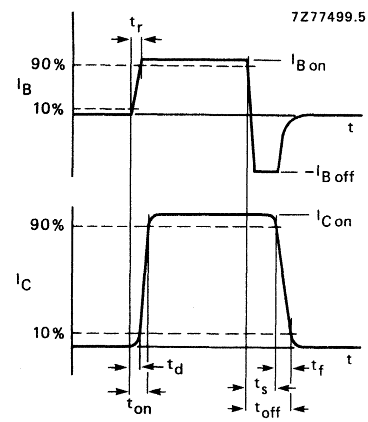


Fig. 5 Switching times waveforms with resistive load.

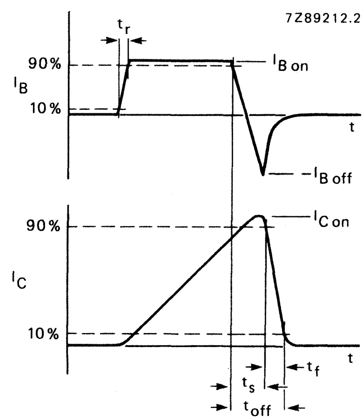


Fig. 6 Switching times waveforms with inductive load.

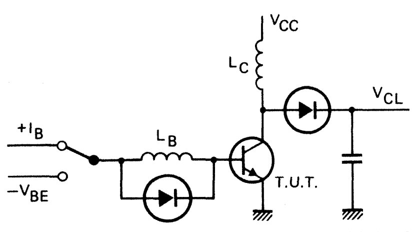


Fig. 7 Test circuit inductive load.

V_{CL} = 300 V
V_{CC} = 30 V
V_{EB} = 5 V
L_B = 1 μH
L_C = 200 μH

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.

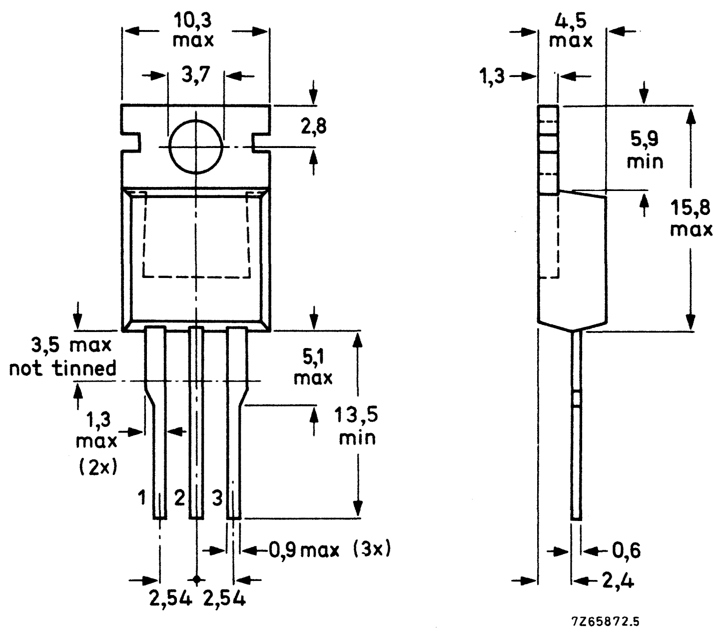
QUICK REFERENCE DATA

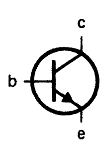
			BUT12	BUT12A	
Collector-emitter voltage					
peak value; $V_{BE} = 0$	V_{CESM}	max.	850	1000	V
open base	V_{CEO}	max.	400	450	V
Collector-emitter saturation voltage	V_{CEsat}	max.	1.5	1.5	V
Collector current					
saturation	I_{Csat}	max.	6.0	5.0	A
DC	I_C	max.	8		A
peak value	I_{CM}	max.	20		A
Total power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

RATINGS

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

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

THERMAL RESISTANCE

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

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			BUT12	BUT12A	
Collector cut-off currents*					
$V_{CE} = V_{CESmax}$; $V_{BE} = 0$	I_{CES}	max.	1.0		mA
$V_{CE} = V_{CESmax}$; $V_{BE} = 0$; T_j = 125 °C	I_{CES}	max.	3.0		mA
Emitter cut-off current					
V_{EB} = 9 V; $I_C = 0$	I_{EBO}	max.	10		mA
Saturation voltages					
I_C = 6 A; I_B = 1.2 A	V_{CEsat}	max.	1.5	–	V
	V_{BEsat}	max.	1.5	–	V
I_C = 5 A; I_B = 1.0 A	V_{CEsat}	max.	–	1.5	V
	V_{BEsat}	max.	–	1.5	V
Collector-emitter sustaining voltage (Figs 2 and 3)					
I_C = 100 mA; $I_{B\,off}$ = 0; L = 25 mH	$V_{CEOsust}$	min.	400	450	V
Switching times resistive load (Figs 4 and 5)					
$I_{C\,on}$ = 6 A; $I_{B\,on} = -I_{B\,off}$ = 1.2 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
$I_{C\,on}$ = 5 A; $I_{B\,on} = -I_{B\,off}$ = 1.0 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)					
$I_{C\,on}$ = 6 A; $I_{B\,on}$ = 1.2 A; V_{CL} = 250 V; T_c = 100 °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
$I_{C\,on}$ = 5 A; $I_{B\,on}$ = 1.0 A; V_{CL} = 300 V; T_c = 100 °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

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

DEVELOPMENT DATA

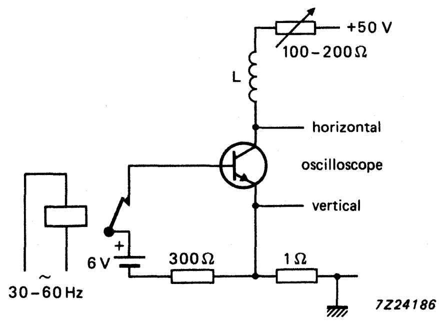


Fig. 2 Test circuit for $V_{CEOsust}$.

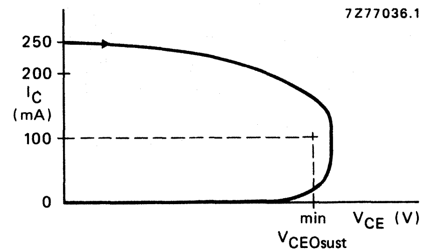
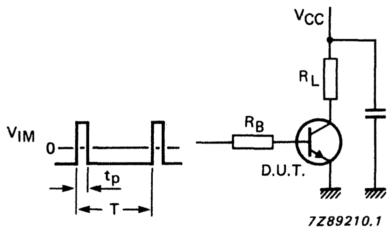


Fig. 3 Oscilloscope display for sustaining voltage.



V_{CC} = 250 V
t_p = 20 μs
V_{IM} = −6 to +8 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.

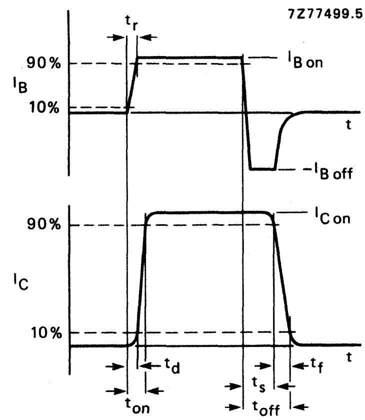
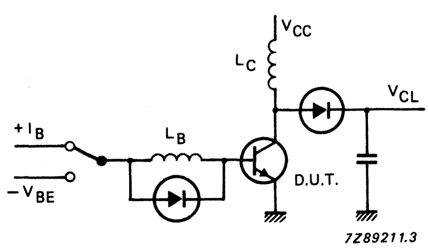


Fig. 5 Switching times waveforms with resistive load; $t_r \leqslant 20$ ns.



V_{CL} = up to 1000 V
V_{CC} = 30 V
$-V_{BE}$ = 1 to 5 V
L_B = 1.0 μH
L_C = 200 μH

Fig. 6 Test circuit inductive load and reverse bias SOAR.

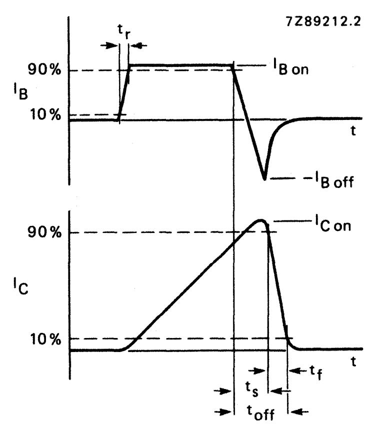
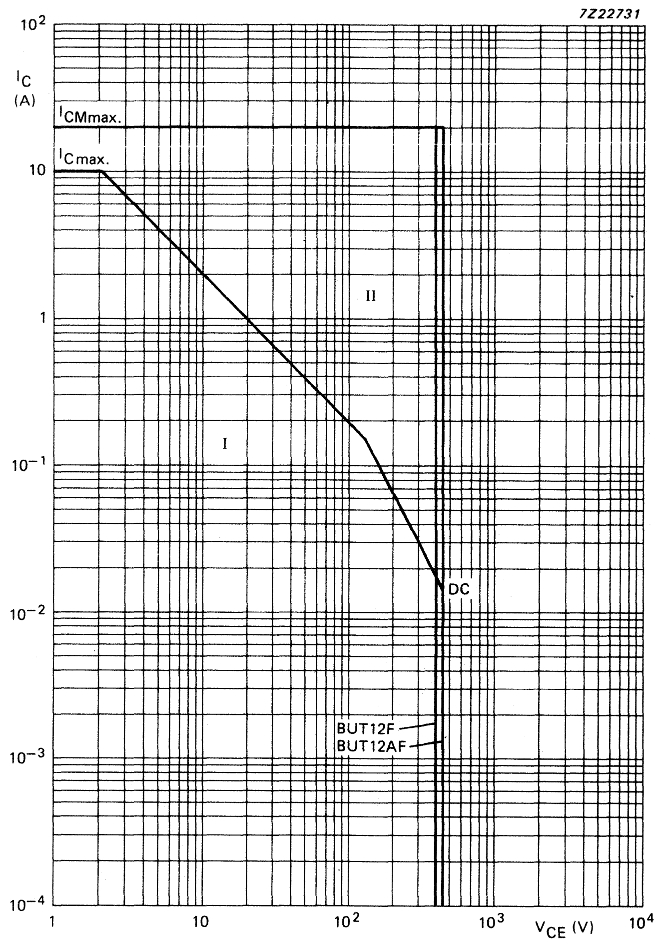


Fig. 7 Switching times waveforms with inductive load.



(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 $T_{mb} < 25\ ^{o}C$.

DEVELOPMENT DATA

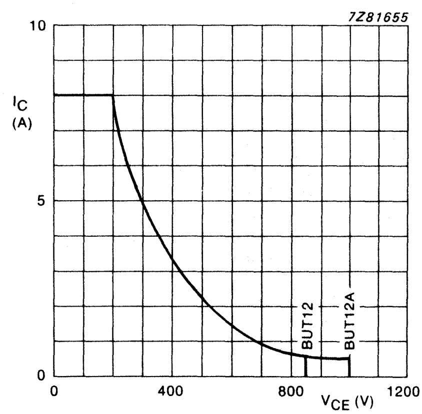


Fig. 9 Reverse bias SOAR; $T_c = 100\ ^oC$; $V_{BE} = -1$ V to -5 V.

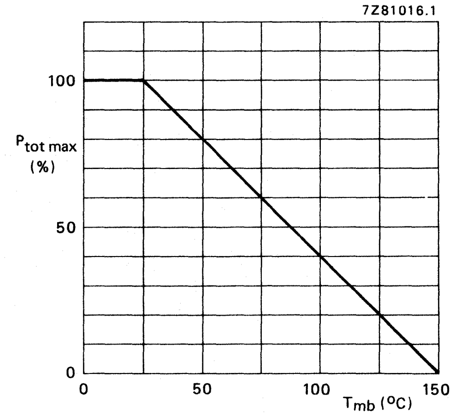


Fig. 10 Power derating curve.

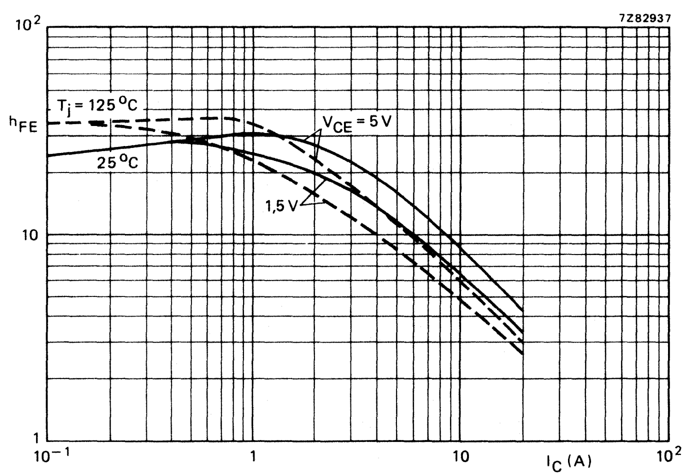


Fig. 11 Typical values DC current gain.

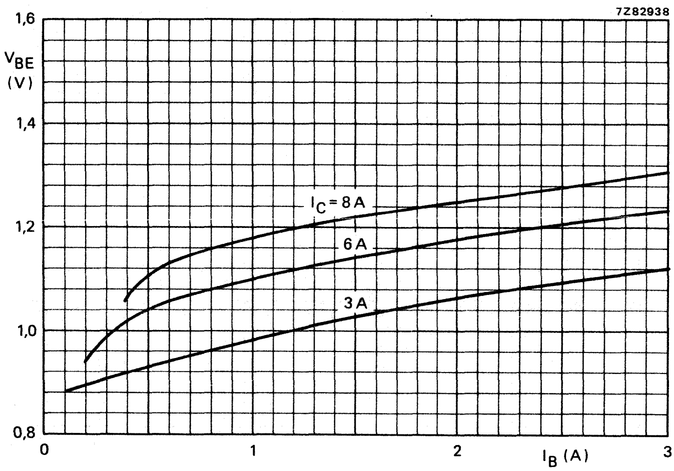


Fig. 12 Base-emitter voltage as a function of base current at T_j = 25 °C.

DEVELOPMENT DATA

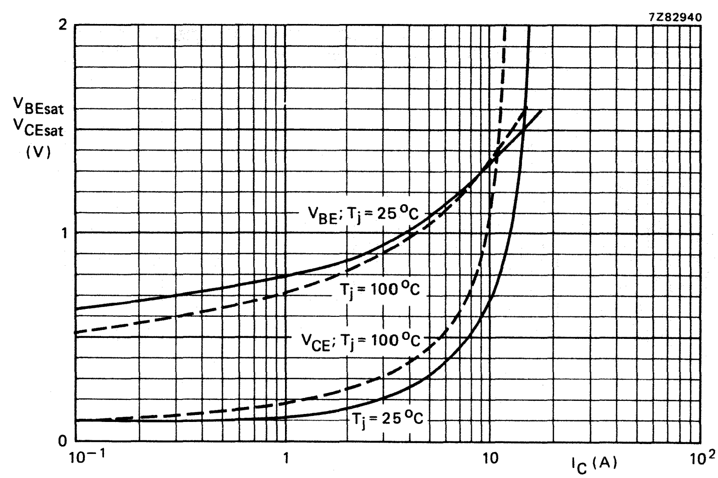


Fig. 13 Typical values base and collector voltage at I_C/I_B = 5.

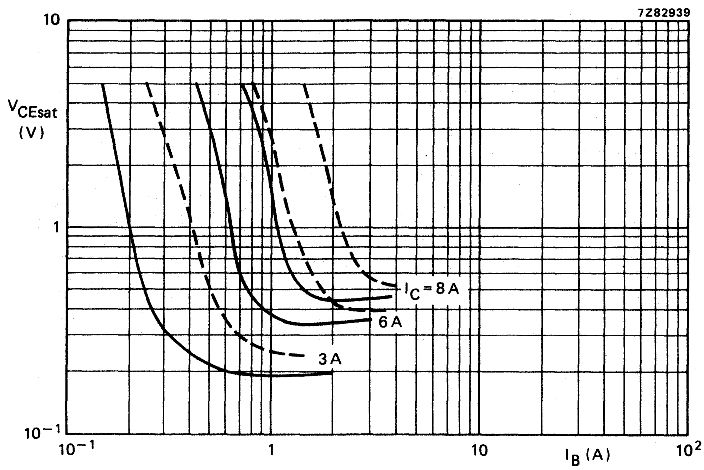


Fig. 14 Typical (——) and max. (– – –) values collector emitter saturation voltage at T_j = 25 °C.

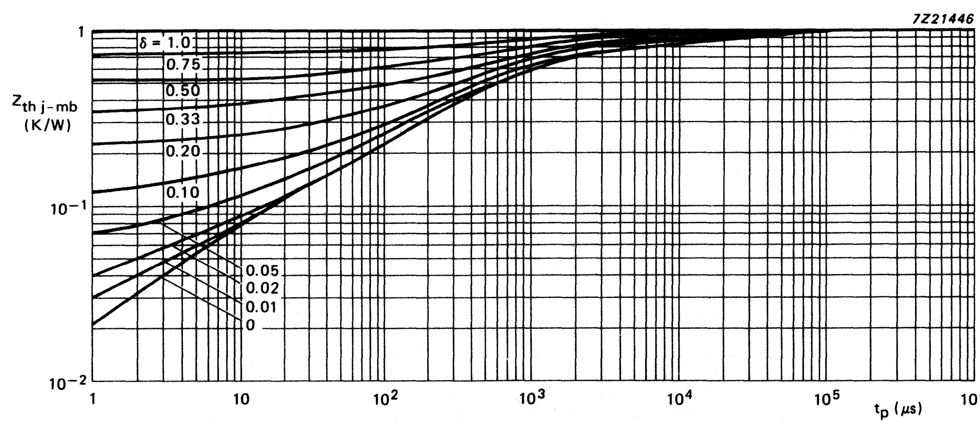


Fig. 15 Thermal response at pulse power conditions.

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.

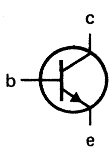
QUICK REFERENCE DATA

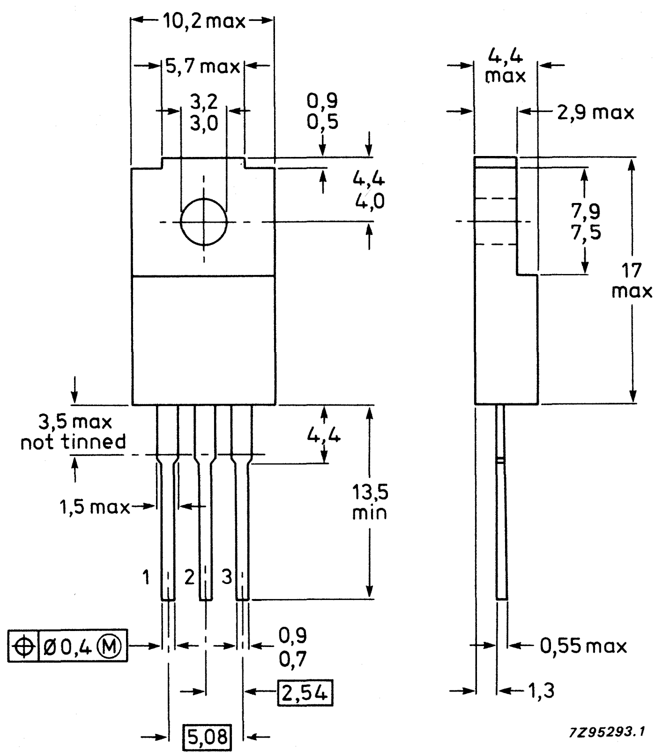
			BUT12F	BUT12AF	
Collector-emitter voltage					
peak value; $V_{BE} = 0$	V_{CESM}	max.	850	1000	V
open base	V_{CEO}	max.	400	450	V
Collector-emitter saturation voltage	V_{CEsat}	max.	1.5	1.5	V
Collector current					
saturation	I_{Csat}	max.	6.0	5.0	A
DC	I_C	max.	8		A
peak value	I_{CM}	max.	20		A
Total power dissipation					
up to $T_h = 25\ ^oC$	P_{tot}	max.	23		W
Fall time	t_f	max.	0.8		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)

			BUT12F	BUT12AF	
Collector-emitter voltage					
peak value; $V_{BE} = 0$	V_{CESM}	max.	850	1000	V
open base	V_{CEO}	max.	400	450	V
Collector current					
saturation	I_{Csat}		6.0	5.0	A
DC	I_C	max.	8		A
peak value	I_{CM}	max.	20		A
Base current					
DC	I_B	max.	4.0		A
peak value	I_{BM}	max.	6.0		A
Total power dissipation					
up to $T_h = 25\ ^oC$ (note 1)	P_{tot}	max.	23		W
Storage temperature range	T_{stg}		−65 to +150		^oC
Junction temperature	T_j	max.	150		^oC

THERMAL RESISTANCE

From junction to external heatsink (note 1)	$R_{th\ j\text{-}h}$	=	5.5	K/W
From junction to external heatsink (note 2)	$R_{th\ j\text{-}h}$	=	3.9	K/W
From junction to ambient	$R_{th\ j\text{-}a}$	=	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

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.

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off currents*				
$V_{CE} = V_{CESmax}$; $V_{BE} = 0$	I_{CES}	max.	1.0	mA
$V_{CE} = V_{CESmax}$; $V_{BE} = 0$; T_j = 125 °C	I_{CES}	max.	3.0	mA
Emitter cut-off current				
V_{EB} = 9 V; I_C = 0	I_{EBO}	max.	10	mA

			BUT12F	BUT12AF	
Saturation voltages					
I_C = 6 A; I_B = 1.2 A	V_{CEsat}	max.	1.5	–	V
	V_{BEsat}	max.	1.5	–	V
I_C = 5 A; I_B = 1.0 A	V_{CEsat}	max.	–	1.5	V
	V_{BEsat}	max.	–	1.5	V
Collector-emitter sustaining voltage (Figs 2 and 3) I_C = 100 mA; $I_{B\,off}$ = 0; L = 25 mH	$V_{CEOsust}$	min.	400	450	V
Switching times resistive load (Figs 4 and 5) $I_{C\,on}$ = 6 A; $I_{B\,on} = -I_{B\,off}$ = 1.2 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
$I_{C\,on}$ = 5 A; $I_{B\,on} = -I_{B\,off}$ = 1.0 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) $I_{C\,on}$ = 6 A; $I_{B\,on}$ = 1.2 A; V_{CL} = 250 V; T_c = 100 °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
$I_{C\,on}$ = 5 A; $I_{B\,on}$ = 1.0 A; V_{CL} = 300 V; T_c = 100 °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

DEVELOPMENT DATA

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

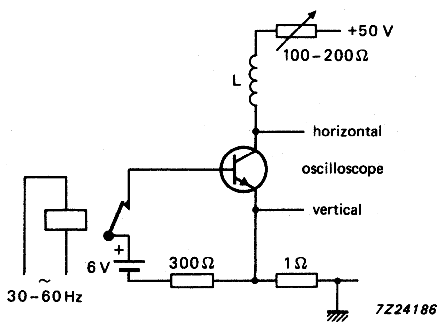


Fig. 2 Test circuit for $V_{CEOsust}$.

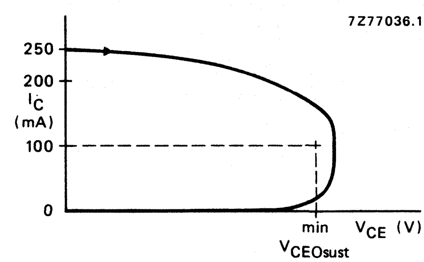
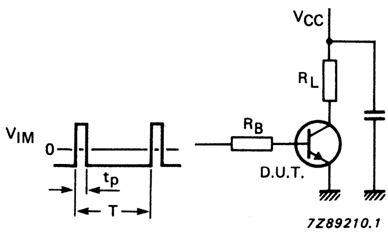


Fig. 3 Oscilloscope display for sustaining voltage.



V_{CC} = 250 V
t_p = 20 μs
V_{IM} = –6 to +8 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.

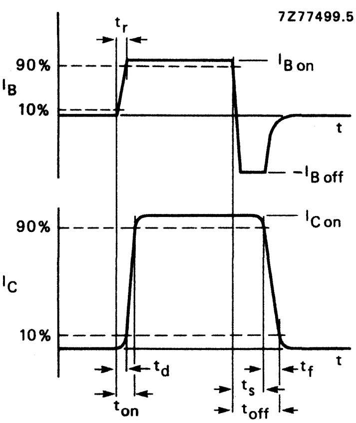
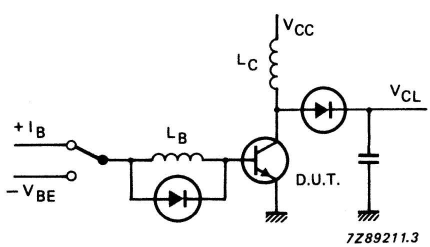


Fig. 5 Switching times waveforms with resistive load; $t_r \leq 20$ ns.



V_{CL} = up to 1000 V
V_{CC} = 30 V
$-V_{BE}$ = 1 to 5 V
L_B = 1.0 μH
L_C = 200 μH

Fig. 6 Test circuit inductive load and reverse bias SOAR.

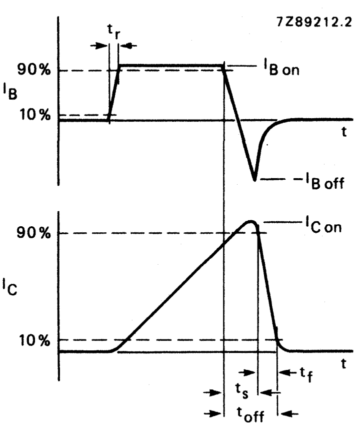
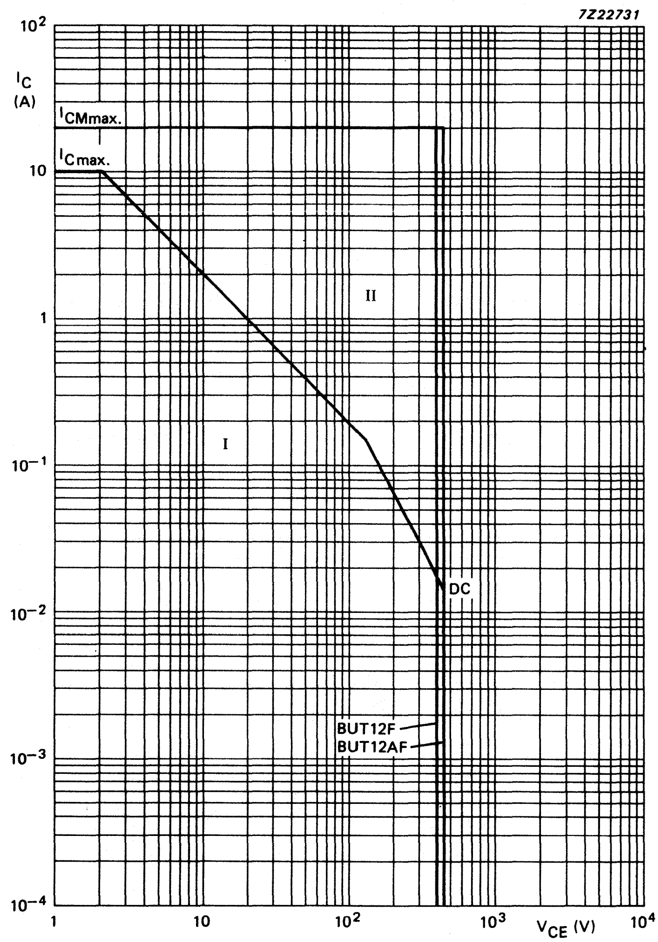


Fig. 7 Switching times waveforms with inductive load.



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

Fig. 8 Safe operating area at $T_{mb} < 25\ ^oC$.

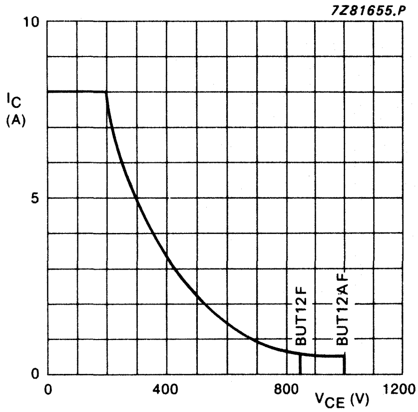


Fig. 9 Reverse bias SOAR; T_{mb} = 100 °C; V_{BE} = −1 V to −5 V.

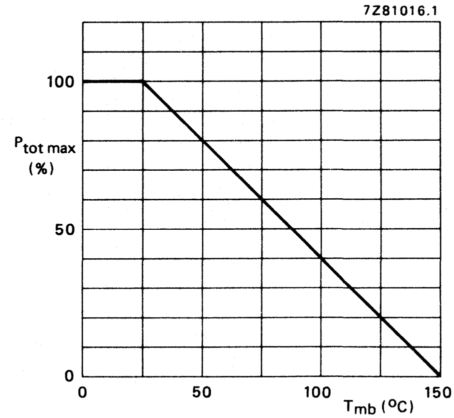


Fig. 10 Power derating curve.

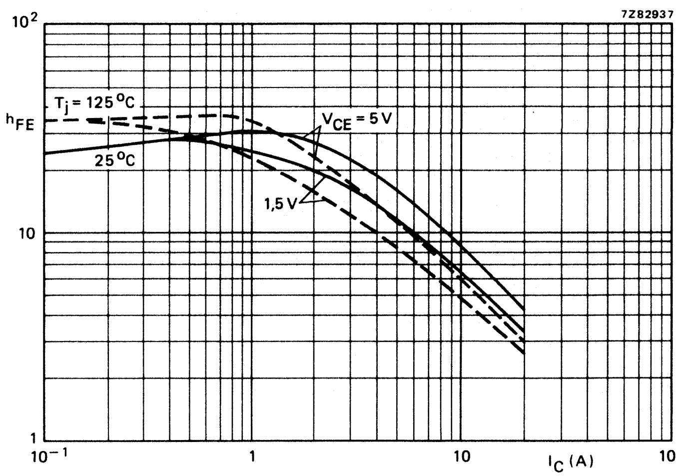


Fig. 11 Typical values DC current gain.

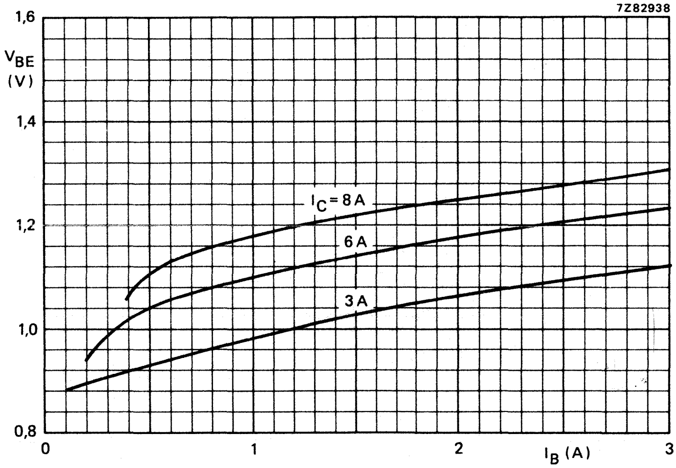


Fig. 12 Base-emitter voltage as a function of base current at T_j = 25 °C.

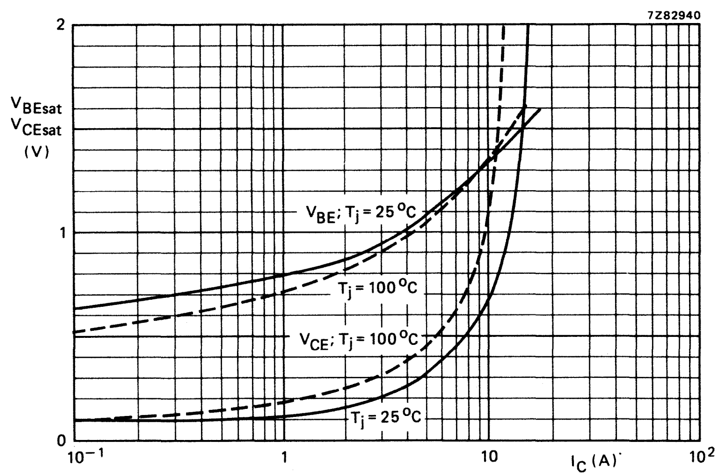


Fig. 13 Typical values base and collector voltage at I_C/I_B = 5.

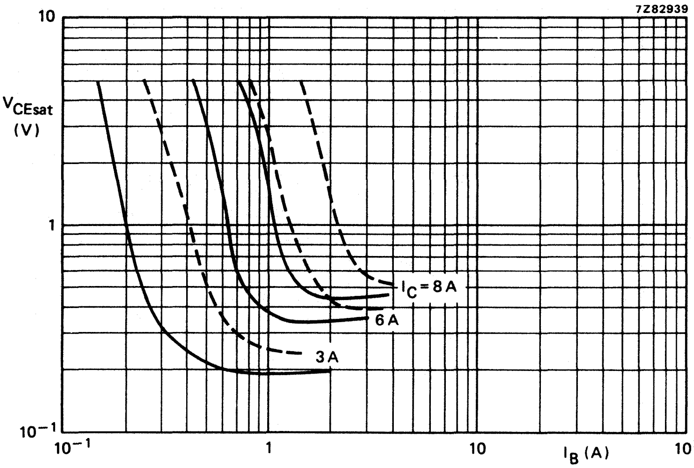


Fig. 14 Typical (——) and max. (– – –) values collector emitter saturation voltage at T_j = 25 °C.

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.

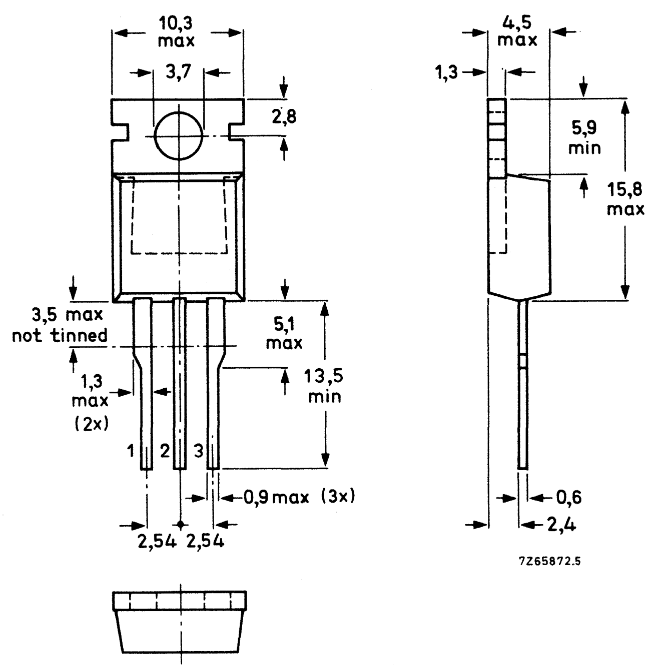
QUICK REFERENCE DATA

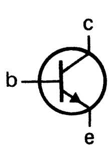
			BUT18	BUT18A	
Collector-emitter voltage					
peak value; $V_{BE} = 0$	V_{CESM}	max.	850	1000	V
open base	V_{CEO}	max.	400	450	V
Collector-emitter saturation voltage	V_{CEsat}	max.	1.5		V
Collector current					
saturation	I_{Csat}		4.0		A
DC	I_C	max.	6.0		A
peak value	I_{CM}	max.	12		A
Total power dissipation up to $T_{mb} = 25\ ^oC$	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; $V_{BE} = 0$	V_{CESM}	max.	850	1000	V
open base	V_{CEO}	max.	400	450	V
Collector current					
saturation	I_{Csat}		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 °C	P_{tot}	max.	110		W
Storage temperature range	T_{stg}		−65 to + 150		°C
Junction temperature	T_j	max.	150		°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	1.15	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			BUT18	BUT18A	
Collector cut-off currents*					
$V_{CE} = V_{CESmax}$; $V_{BE} = 0$	I_{CES}	max.	1.0		mA
$V_{CE} = V_{CESmax}$; $V_{BE} = 0$; T_j = 125 °C	I_{CES}	max.	2.0		mA
Emitter cut-off current					
V_{EB} = 9 V; $I_C = 0$	I_{EBO}	max.	10		mA
Collector-emitter sustaining voltage					
I_C = 0.1 A; $I_{B\ off}$ = 0; L = 25 mH (Figs 2 and 3)	$V_{CEOsust}$	min.	400	450	V
Saturation voltages					
I_C = 4 A; I_B = 0.8 A	V_{CEsat}	max.	1.5		V
	V_{BEsat}	max.	1.3		V
Current gain					
I_C = 10 mA; V_{CE} = 5 V	h_{FE}	min.	10		
I_C = 10 mA; V_{CE} = 5 V	h_{FE}	typ.	25		
Switching times resistive load (Figs 4 and 5)					
$I_{C\ on}$ = 4 A; $I_{B\ on} = -I_{B\ off}$ = 0.8 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)					
$I_{C\ on}$ = 4 A; $I_{B\ on}$ = 0.8 A; V_{CL} = 250 V					
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

DEVELOPMENT DATA

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

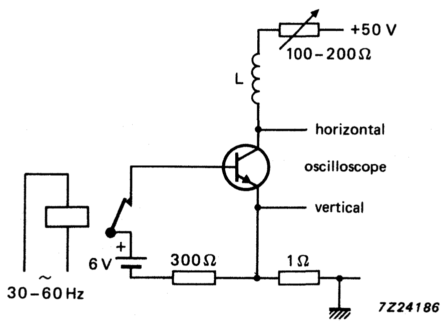


Fig. 2 Test circuit for $V_{CEOsust}$.

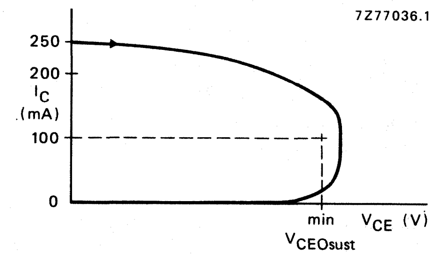
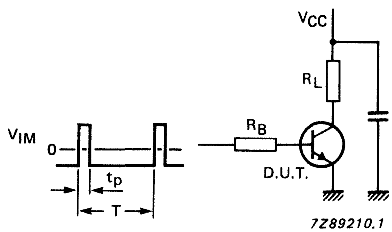


Fig. 3 Oscilloscope display for sustaining voltage.



V_{CC} = 250 V
t_p = 20 μs
V_{IN} = –6 to + 8 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.

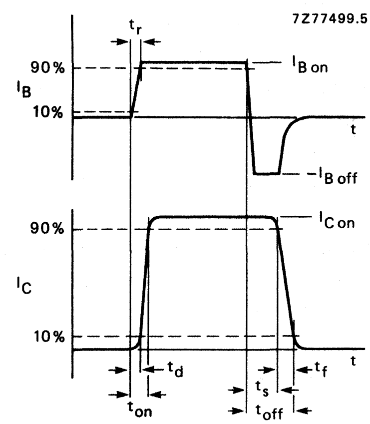
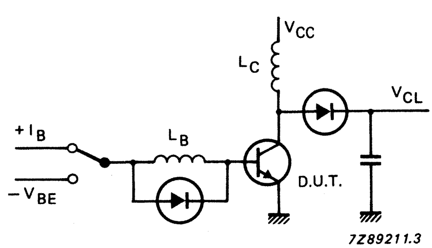


Fig. 5 Switching times waveforms with resistive load; $t_r \leqslant 30$ ns.



V_{CL} = up tp 1000 V
V_{CC} = 30 V
$-V_{BE}$ = 5 V
L_B = 1 μH (0 for RB SOAR)
L_C = 200 μH

Fig. 6 Test circuit inductive load and RB SOAR.

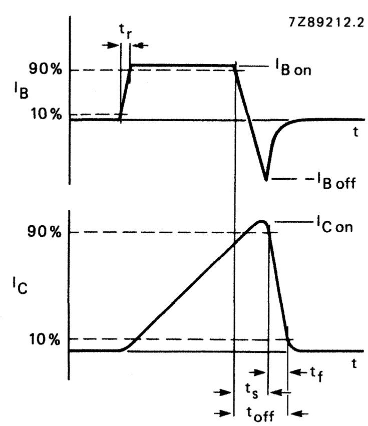
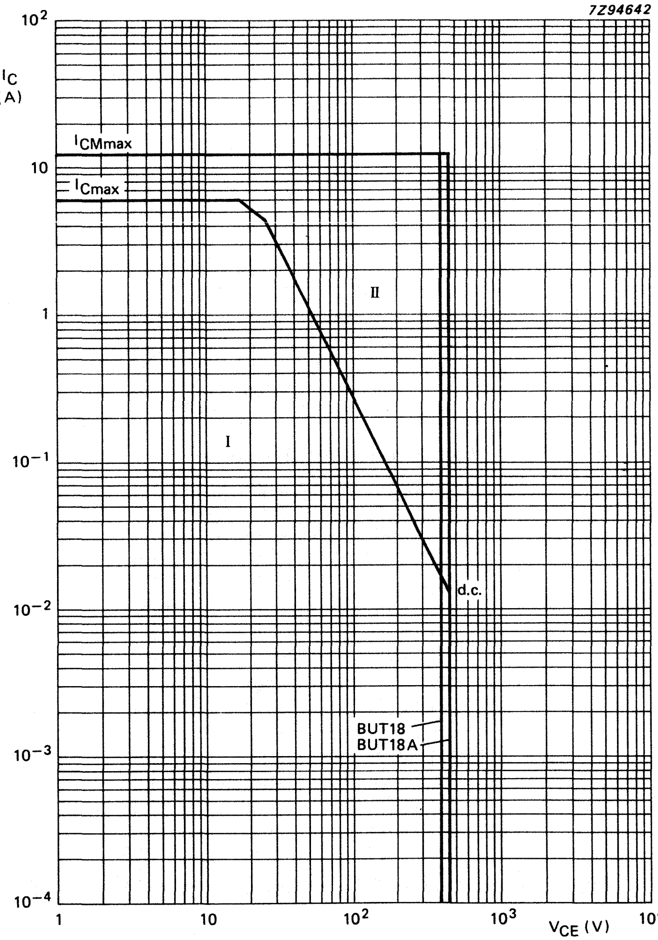


Fig. 7 Switching times waveforms with inductive load.

DEVELOPMENT DATA



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

Fig. 8 Safe operating area at T_{mb} = 25 °C.

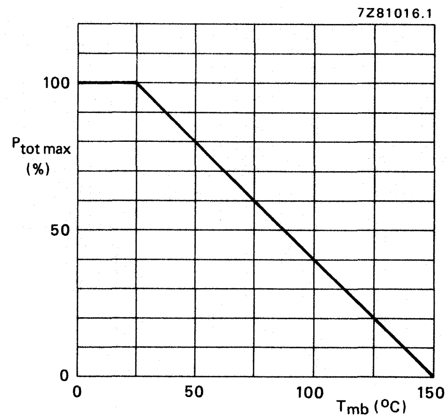


Fig. 9 Power derating curve.

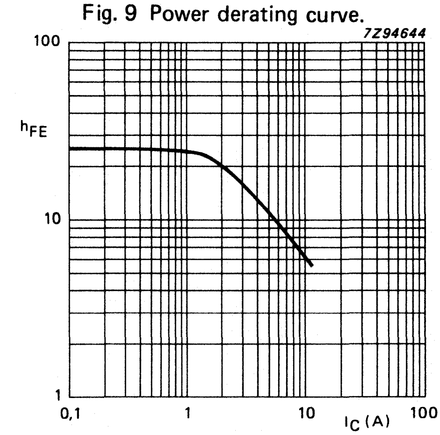


Fig. 10 Typical values DC current gain; V_{CE} = 5 V; T_j = 25 °C.

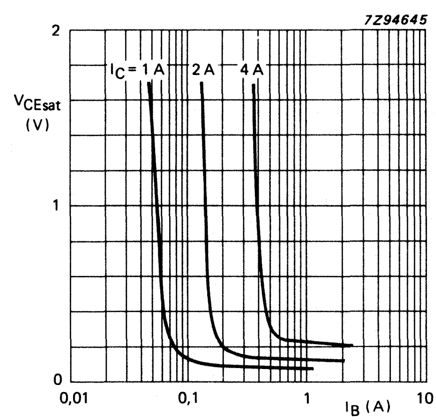


Fig. 11 Collector-emitter saturation voltage as a function of base current; T_j = 25 °C.

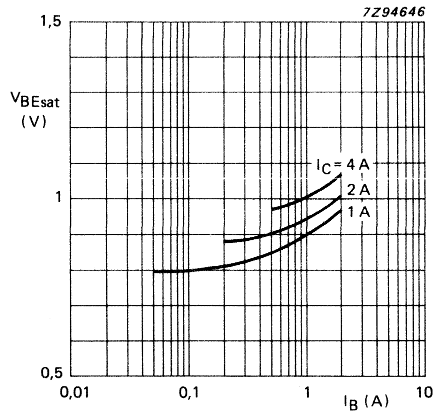


Fig. 12 Base-emitter saturation voltage as a function of base current; T_j = 25 °C.

DEVELOPMENT DATA

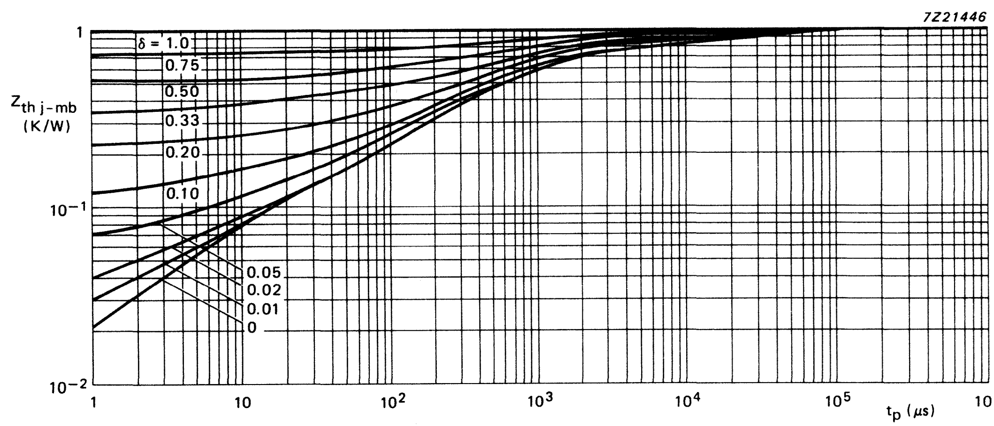


Fig. 13 Thermal response at pulse power conditions.

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.

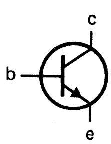
QUICK REFERENCE DATA

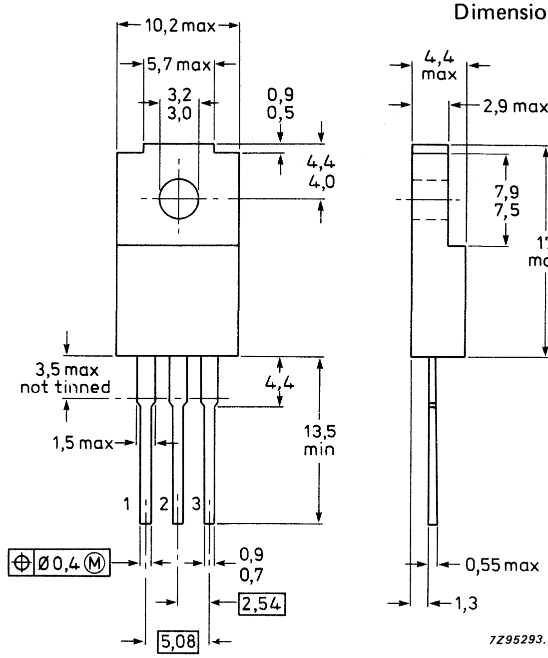
			BUT18F	18AF	
Collector-emitter voltage					
peak value; $V_{BE} = 0$	V_{CESM}	max.	850	1000	V
open base	V_{CEO}	max.	400	450	V
Collector-emitter saturation voltage	V_{CEsat}	max.	1.5		V
Collector current					
saturation	I_{Csat}	max.	4.0		A
DC	I_C	max.	6.0		A
peak value	I_{CM}	max.	12		A
Total power dissipation					
up to $T_{mb} = 25\ ^oC$	P_{tot}	max.	33		W
Fall time; resistive load	t_f	max.	0.8		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)

			BUT18F	18AF	
Collector-emitter voltage					
peak value; $V_{BE} = 0$	V_{CESM}	max.	850	1000	V
open base	V_{CEO}	max.	400	450	V
Collector current					
saturation	I_{Csat}		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 $T_{mb} = 25\ ^oC$					
without heatsink compound	P_{tot}	max.	20		W
with heatsink compound	P_{tot}	max.	33		W
Storage temperature range	T_{stg}		−65 to + 150		^oC
Junction temperature	T_j	max.	150		^oC

THERMAL RESISTANCE

From junction to external heatsink (note 1)				
without heatsink compound	$R_{th\ j\text{-}h}$	=	6.15	K/W
with heatsink compound	$R_{th\ j\text{-}h}$	=	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 °C unless otherwise specified

Collector cut-off currents*					
$V_{CE} = V_{CESMmax}$; $V_{BE} = 0$	I_{CES}	max.	1.0		mA
$V_{CE} = V_{CESMmax}$; $V_{BE} = 0$; T_j = 125 °C	I_{CES}	max.	2.0		mA
Emitter cut-off current					
V_{EB} = 9 V; $I_C = 0$	I_{EBO}	max.	10		mA
			BUT18F	**18AF**	
Collector-emitter sustaining voltage (Figs 2 and 3)					
I_C = 100 mA; $I_{B\,off}$ = 0; L = 25 mH	$V_{CEOsust}$	min.	400	450	V
Saturation voltages					
I_C = 4 A; I_B = 0.8 A	V_{CEsat}	max.	1.5		V
	V_{BEsat}	max.	1.3		V
Current gain					
I_C = 10 mA; V_{CE} = 5 V	h_{FE}	min.	10		
I_C = 0.4 mA; V_{CE} = 5 V	h_{FE}	typ.	25		
Switching times resistive load (Figs 4 and 5)					
$I_{C\,on}$ = 4 A; $I_{B\,on} = -B_{off}$ = 0.8 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)					
$I_{C\,on}$ = 4 A; $I_{B\,on}$ = 0.8 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

DEVELOPMENT DATA

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

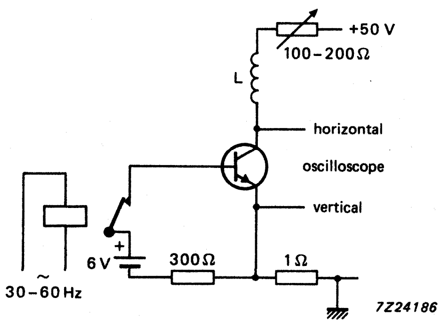


Fig. 2 Test circuit for $V_{CEOsust}$.

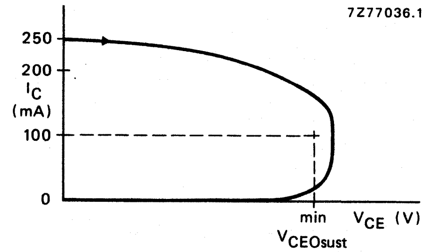
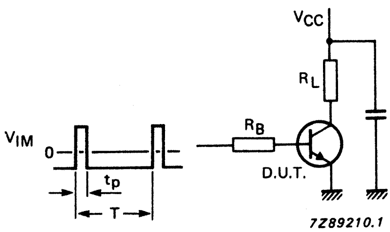


Fig. 3 Oscilloscope display for sustaining voltage.



V_{CC} = 250 V
t_p = 20 μs
V_{IN} = –6 to +8 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.

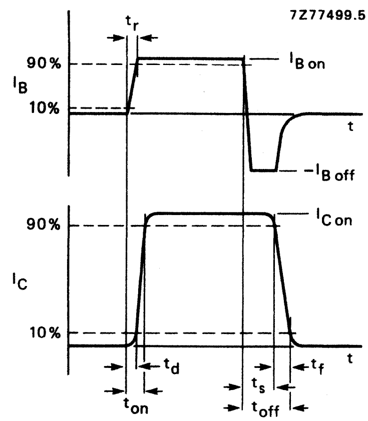
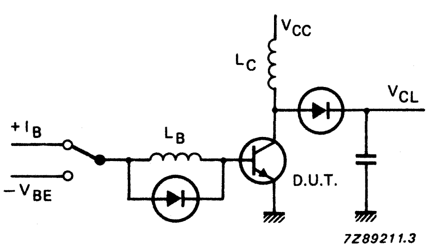


Fig. 5 Switching times waveforms with resistive load; $t_r \leqslant 20$ ns.



V_{CL} = 300 V
V_{CC} = 30 V
$-V_{BE}$ = 5 V
L_B = 1 μH
L_C = 200 μH

Fig. 6 Test circuit inductive load.

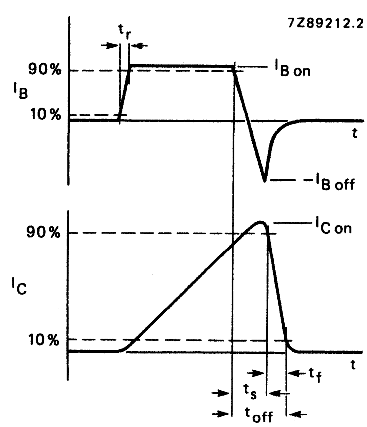
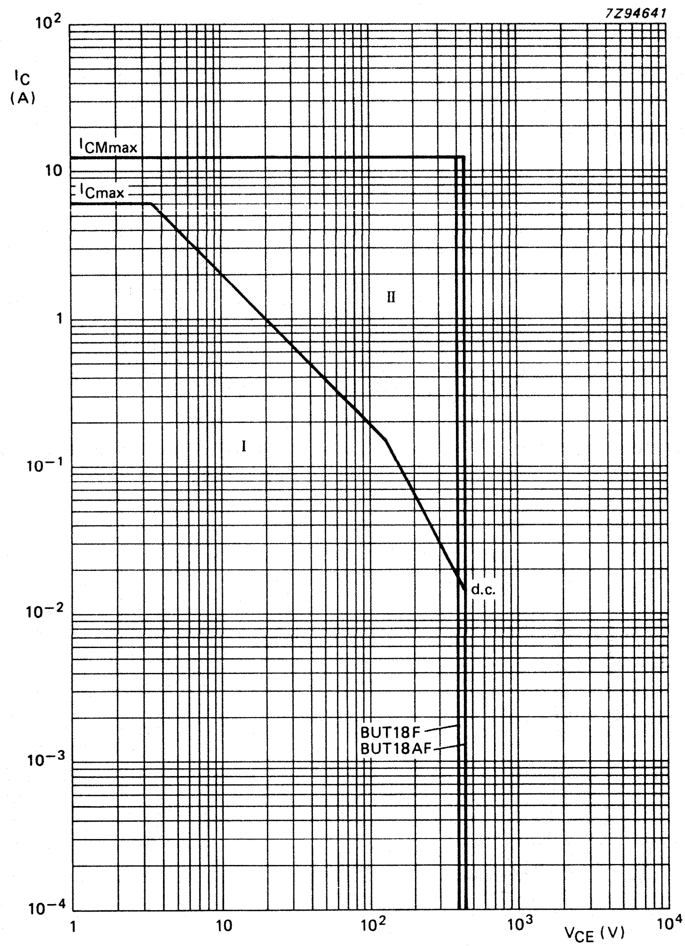


Fig. 7 Switching times waveforms with inductive load.



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

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

DEVELOPMENT DATA

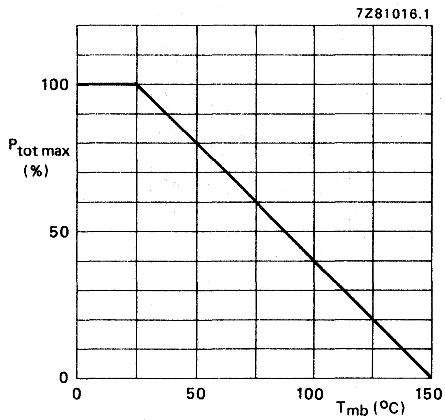


Fig. 9 Power derating curve.

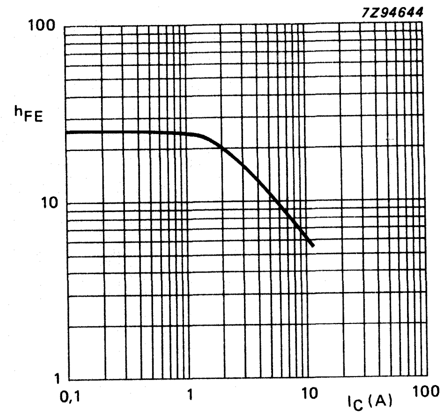


Fig. 10 Typical values DC current gain; $V_C = 5$ V; $T_j = 25$ °C.

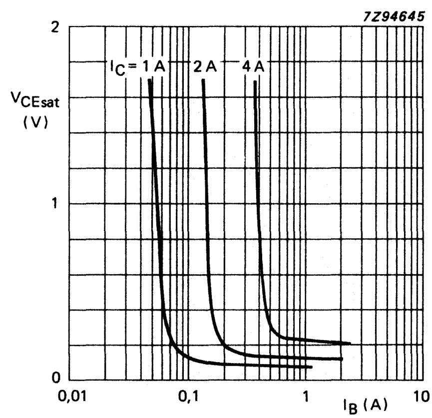


Fig. 11 Collector-emitter saturation voltage as a function of base current; $T_j = 25$ °C.

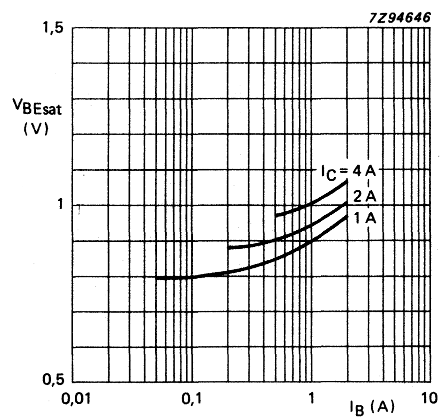


Fig. 12 Base-emitter saturation voltage as a function of base current; $T_j = 25$ °C

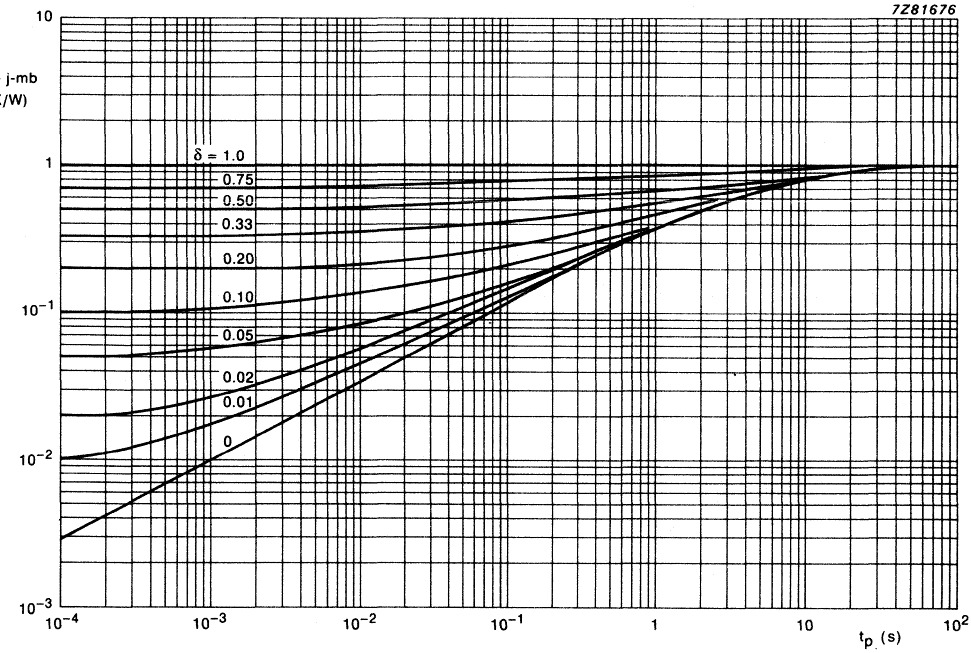


Fig. 13 Normalized thermal resistance.

DEVELOPMENT DATA

SILICON DIFFUSED POWER TRANSISTORS

High-voltage, high-speed, glass-passivated npn power transistor in a TO-220 envelope with electrically isolated seating plane, intended for use in converters, inverters, switching regulators, motor control systems etc.

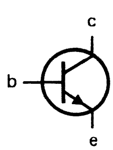
QUICK REFERENCE DATA

			BUT21B	21C	
Collector-emitter voltage					
peak value; $V_{BE} = 0$	V_{CESM}	max.	750	850	V
open base	V_{CEO}	max.	400	450	V
Collector-emitter saturation voltage					
$I_C = 3$ mA	V_{CEsat}	max.	1.5		V
Collector current					
saturation	I_{Csat}	max.	3.0		A
DC	I_C	max.	5.0		A
peak value	I_{CM}	max.	10		A
Total power dissipation up to $T_{mb} = 25\ ^oC$	P_{tot}	max.	100		W
Fall time	t_f	max.	0.7		μs

MECHANICAL DATA

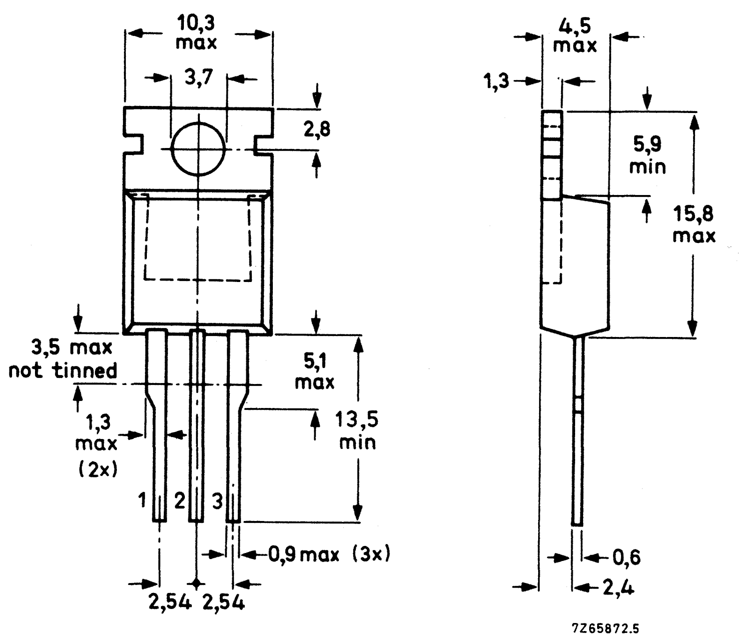
Dimensions in mm

Fig.1 TO-220AB.



Pinning

1 = base
2 = collector
3 = emitter



RATINGS

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

			BUT21B	21C	
Collector-emitter voltage					
Peak value; $V_{BE} = 0$	V_{CESM}	max.	750	850	V
open base	V_{CEO}	max.	400	450	V
Collector current					
saturation	I_{Csat}	max.	3.0		A
DC	I_C	max.	5.0		A
peak value	I_{CM}	max.	10		A
Base current					
DC	I_B	max.	2.0		A
peak value	I_{BM}	max.	4.0		A
Total power dissipation up to $T_{mb} = 25\ ^oC$	P_{tot}	max.	100		W
Storage temperature	T_{stg}		−65 to + 150		^oC
Junction temperature	T_j	max.	150		^oC

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	1.25	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off currents $V_{CE} = V_{CESmax}$; $V_{BE} = 0$	I_{CES}	max.	1.0	mA
Emitter cut-off current V_{EB} = 9 V; $I_C = 0$	I_{EBO}	max.	10	mA
Current gain I_C = 0.5 A; V_{CE} = 10 V	h_{FE}	typ.	25	

			BUT21B	21C	
Saturation voltages					
I_C = 3 A; I_B = 0.4 A	V_{CEsat}	max.	1.5	–	V
	V_{BEsat}	max.	1.5	–	V
I_C = 3 A; I_B = 0.5 A	V_{CEsat}	max.	–	1.5	V
	V_{BEsat}	max.	–	1.5	V
Collector-emitter sustaining voltage (Figs 2 and 3) I_C = 100 mA; I_B = 0; L = 25 mH	$V_{CEOsust}$	min.	400	450	V
Switching times resistive load (Figs 4 and 5) $I_{C\,on}$ = 3 A; $I_{B\,on} = I_{B\,off}$ = 0.4 A V_{CC} = 250 V; t_p = 20 µs; T = 2 ms					
Turn-on time	t_{on}	max.	1.0	–	µs
Turn-off					
storage time	t_s	max.	4.5	–	µs
fall time	t_f	max.	0.7	–	µs
$I_{C\,on}$ = 3 A; $I_{B\,on} = I_{B\,off}$ = 0.5 A					
Turn-on time	t_{on}	max.	–	1.0	µs
Turn-off					
storage time	t_s	max.	–	4.5	µs
fall time	t_f	max.	–	0.7	µs
Switching times inductive load (Figs 6 and 7) $I_{C\,on}$ = 3 A; $I_{B\,on} = I_{B\,on}$ as resistive load; V_{CL} = 250 V; $-V_{BE}$ = –5 V; L_B = 1 µH; T_c = 100 °C					
Turn-off					
storage time	t_s	typ.	2.0	–	µs
	t_s	max.	2.5	–	µs
fall time	t_f	typ.	100	–	µs
	t_f	max.	250	–	µs
$I_{C\,on}$ = 3 A; $I_B = I_{B\,on}$ as resistive load; V_{CL} = 250 V; T_c = 100 °C					
Turn-off					
storage time	t_s	typ.	–	2.0	µs
	t_s	max.	–	2.5	µs
fall time	t_f	typ.	–	100	µs
	t_f	max.	–	250	µs

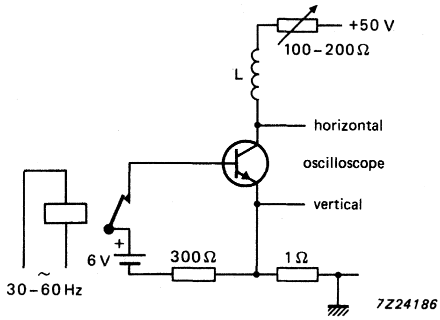


Fig.2 Test circuit for $V_{CEOsust}$.

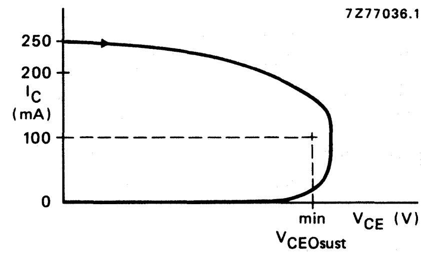


Fig.3 Oscilloscope display for sustaining voltage.

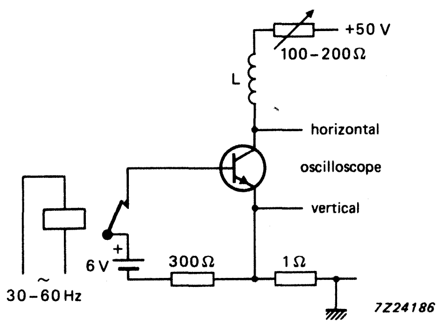


Fig.4 Test circuit resistive load.

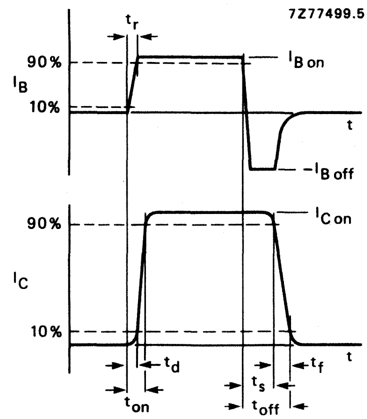


Fig.5 Switching times waveforms with resistive load; t_r max. 30 ns.

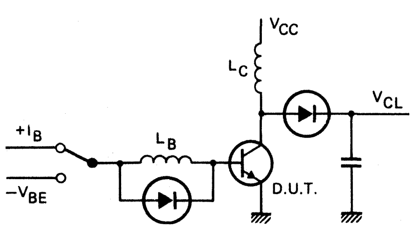


Fig.6 Test circuit inductive load.

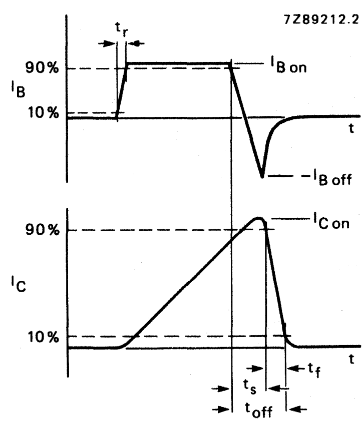
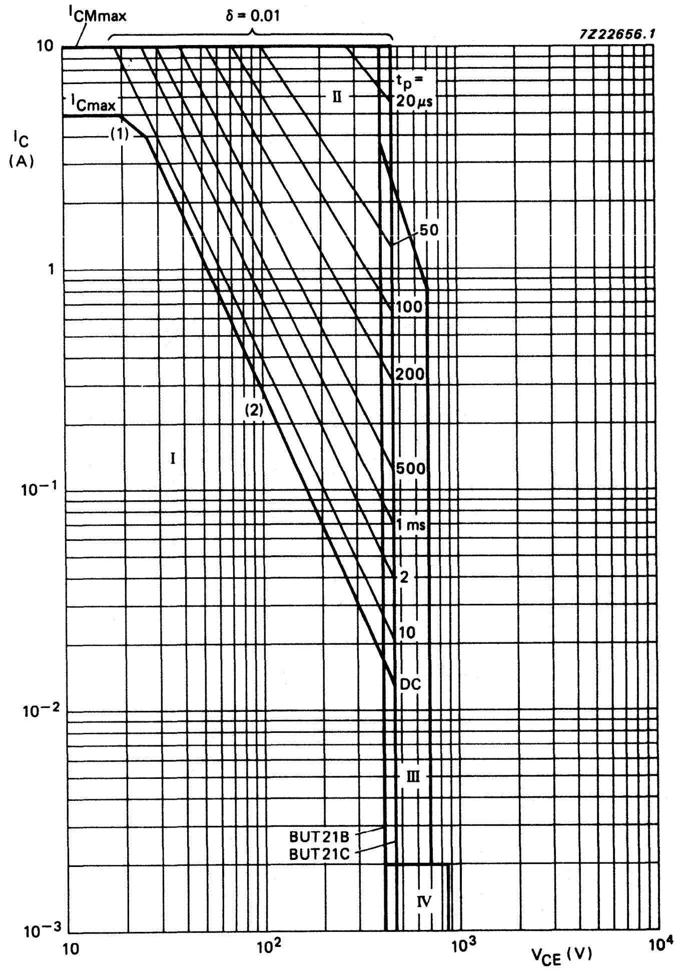


Fig.7 Switching times waveforms with inductive load.



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

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

Fig.8 Safe operating area at $T_{mb} < 25\ ^oC$.

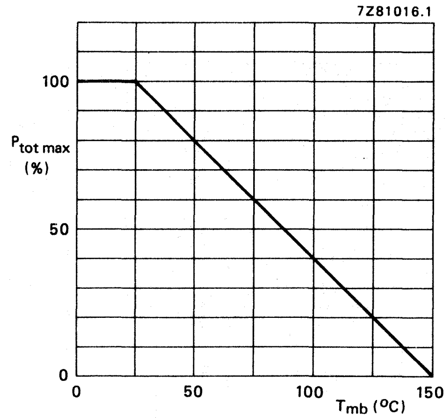


Fig.9 Power derating curve.

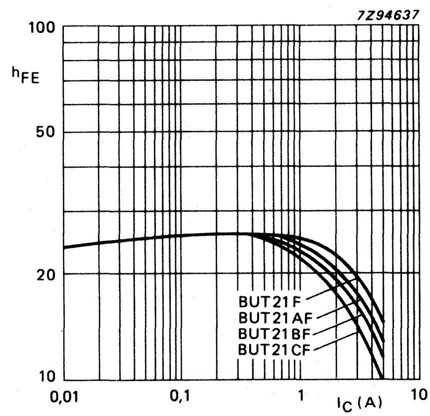


Fig.10 Typical DC current gain at V_{CE} = 5 V; T_j = 25 °C.

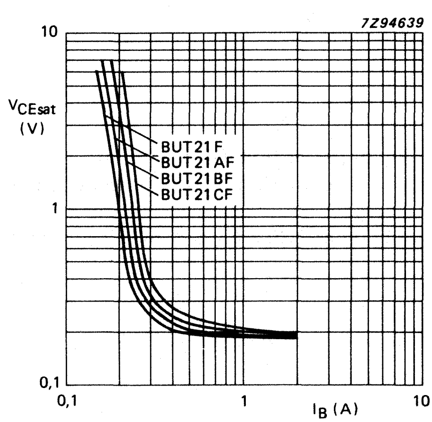


Fig.11 Collector-emitter saturation voltage as a function of base current; I_C = 3 A; T_j = 25 °C.

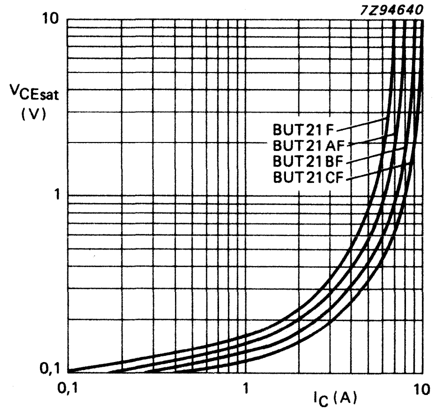


Fig.12 Collector-emitter saturation voltage as a function of collector current; I_C/I_B = 7.6 A (BUT21B), 6.0 A (BUT21C); T_j = 25 °C.

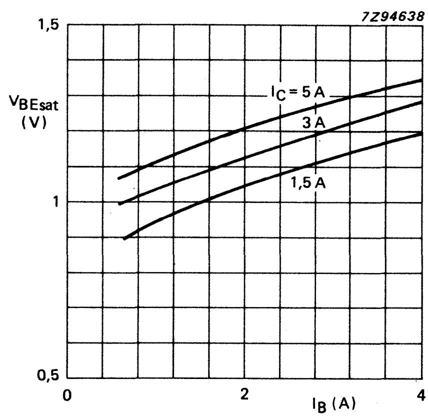


Fig.13 Base-emitter saturation voltage as a function of base current; T_j = 25 °C.

SILICON DIFFUSED POWER TRANSISTORS

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

QUICK REFERENCE DATA

			BUT21BF	21CF	
Collector-emitter voltage					
peak value; $V_{BE} = 0$	V_{CESM}	max.	750	850	V
open base	V_{CEO}	max.	400	450	V
Collector-emitter saturation voltage					
$I_C = 3$ mA	V_{CEsat}	max.	1.5		V
Collector current					
saturation	I_{Csat}	max.	3.0		A
DC	I_C	max.	5.0		A
peak value	I_{CM}	max.	10		A
Total power dissipation up to $T_h = 25\ ^oC$	P_{tot}	max.	20		W
Fall time	t_f	max.	0.7		μs

MECHANICAL DATA

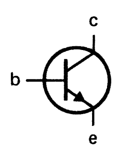
Dimensions in mm

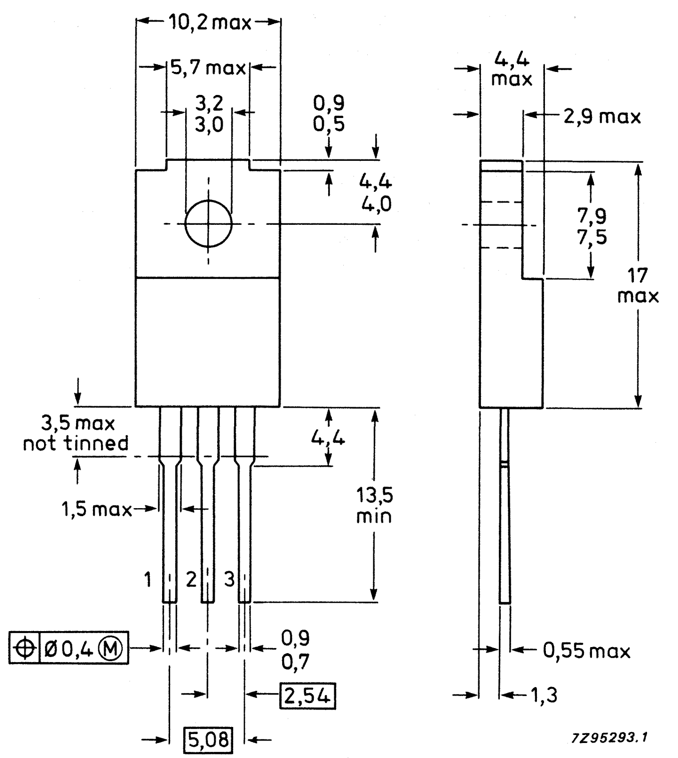
Fig.1 SOT186.

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)

			BUT21BF	21CF	
Collector-emitter voltage					
peak value; $V_{BE} = 0$	V_{CESM}	max.	750	850	V
open base	V_{CEO}	max.	400	450	V
Collector current					
saturation	I_{Csat}	max.	3.0		A
DC	I_C	max.	5.0		A
peak value	I_{CM}	max.	10		A
Base current					
DC	I_B	max.	2.0		A
peak value	I_{BM}	max.	4.0		A
Total power dissipation					
up to $T_h = 25\ ^oC$	P_{tot}	max.	20		W
Storage temperature	T_{stg}		–65 to + 150		^oC
Junction temperature	T_j	max.	150		^oC

THERMAL RESISTANCE

From junction to internal header	$R_{th\ j\text{-}mb}$	=	1.46	K/W
From junction to external heatsink (note 1)	$R_{th\ j\text{-}h}$	=	6.46	K/W
From junction to external heatsink (note 2)	$R_{th\ j\text{-}h}$	=	3.96	K/W
From junction to ambient	$R_{th\ j\text{-}a}$	=	55	K/W

ISOLATION

Isolation voltage from all terminals to external heatsink (peak value)	V_{isol}	max.	1000	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 °C unless otherwise specified

			BUT21BF	21CF	
Collector cut-off currents					
$V_{CE} = V_{CESmax}$; $V_{BE} = 0$	I_{CES}	max.	1.0		mA
Emitter cut-off current					
V_{EB} = 9 V; $I_C = 0$	I_{EBO}	max.	10		mA
Current gain					
I_C = 0.5 A; V_{CE} = 10 V	h_{FE}	typ.	25		
Saturation voltages					
I_C = 3 A; I_B = 0.4 A	V_{CEsat}	max.	1.5	–	V
	V_{BEsat}	max.	1.5	–	V
I_C = 3 A; I_B = 0.5 A	V_{CEsat}	max.	–	1.5	V
	V_{BEsat}	max.	–	1.5	V
Collector-emitter sustaining voltage (Figs 2 and 3)					
I_C = 100 mA; I_B = 0; L = 25 mH	$V_{CEOsust}$	min.	400	450	V
Switching times resistive load (Figs 4 and 5)					
$I_{C\,on}$ = 3 A; $I_{B\,on} = I_{B\,off}$ = 0.4 A; V_{CC} = 250 V; t_p = 20 µs; T = 2 ms					
Turn-on time	t_{on}	max.	1.0	–	µs
Turn-off storage time	t_s	max.	4.5	–	µs
fall time	t_f	max.	0.7	–	µs
$I_{C\,on}$ = 3 A; $I_{B\,on} = I_{B\,off}$ = 0.5 A					
Turn-on time	t_{on}	max.	–	1.0	µs
Turn-off storage time	t_s	max.	–	4.5	µs
fall time	t_f	max.	–	0.7	µs
Switching times inductive load (Figs 6 and 7)					
$I_{C\,on}$ = 3 A; $I_{B\,on} = I_{B\,on}$ as resistive load; V_{CL} = 250 V; $-V_{BE}$ = –5 V; L_B = 1 µH; T_c = 100 °C					
Turn-off storage time	t_s	typ.	2.0	–	µs
	t_s	max.	2.5	–	µs
fall time	t_f	typ.	100	–	µs
	t_f	max.	250	–	µs
$I_{C\,on}$ = 3 A; $I_B = I_{B\,on}$ as resistive load; V_{CL} = 250 V; T_c = 100 °C.					
Turn-off storage time	t_s	typ.	–	2.0	µs
	t_s	max.	–	2.5	µs
fall time	t_f	typ.	–	100	µs
	t_f	max.	–	250	µs

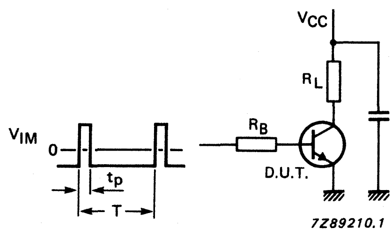


Fig.2 Test circuit for $V_{CEOsust}$.

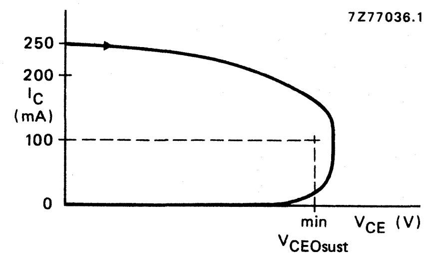


Fig.3 Oscilloscope display for sustaining voltage.

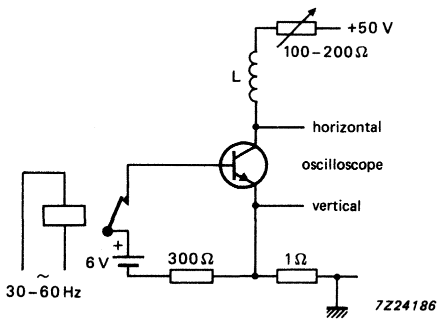


Fig.4 Test circuit resistive load.

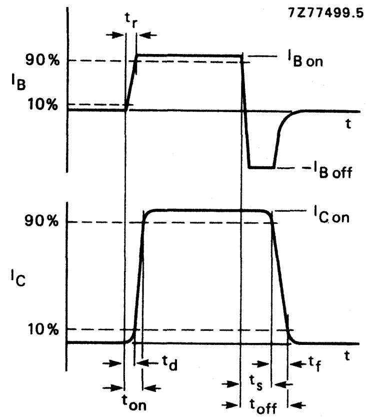


Fig.5 Switching times waveforms with resistive load; t_r max. 30 ns.

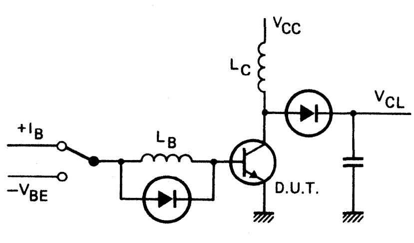


Fig.6 Test circuit inductive load.

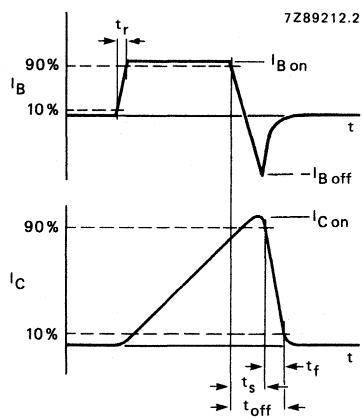
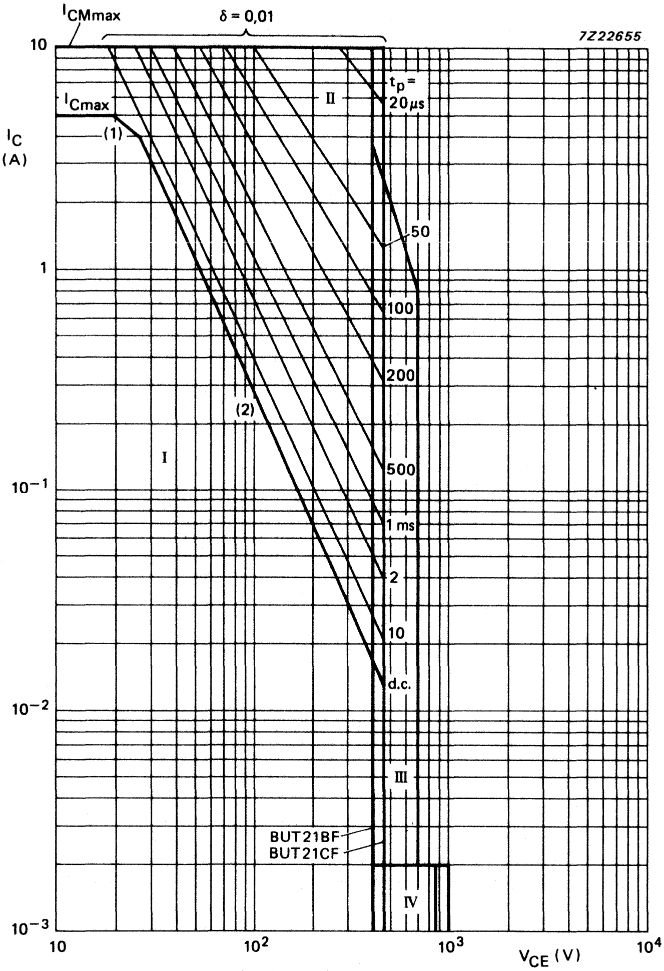


Fig.7 Switching times waveforms with inductive load.



(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.

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

Fig. 8 Safe operating area at $T_{mb} < 25\ ^oC$.

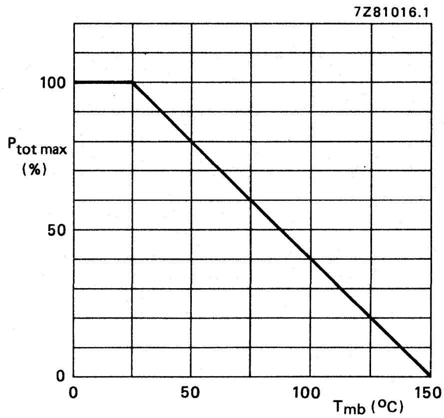


Fig.9 Power derating curve.

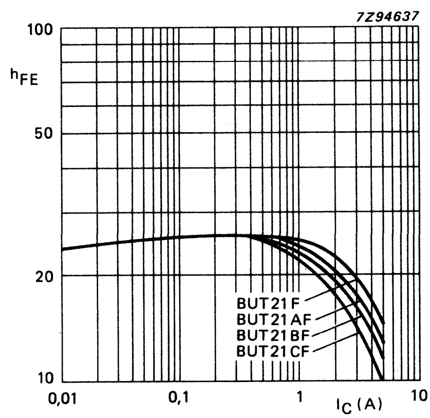


Fig.10 Typical DC current gain at V_{CE} = 5 V; T_j = 25 °C.

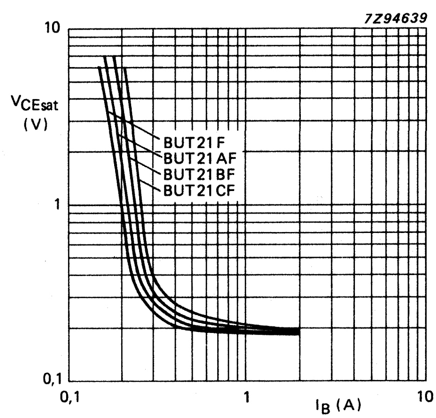


Fig.11 Collector-emitter saturation voltage as a function of base current; I_C = 3 A; T_j = 25 °C.

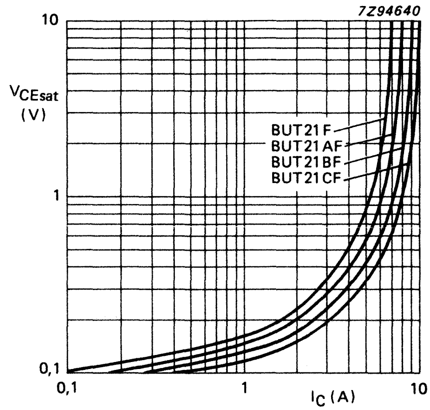


Fig.12 Collector-emitter saturation voltage as a function of collector current; I_C/I_B = 7.6 A (BUT21BF), 6.0 A (BUT21CF); T_j = 25 °C.

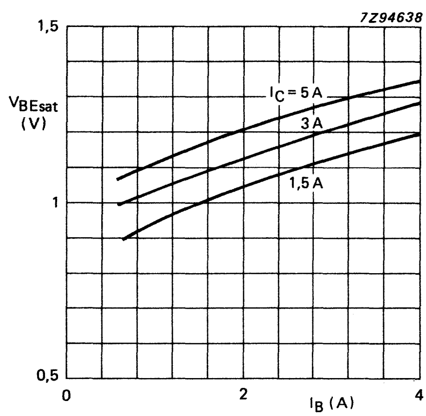


Fig.13 Base-emitter saturation voltage as a function of base current; T_j = 25 °C.

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.

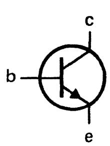
QUICK REFERENCE DATA

			BUT22B	22C	
Collector-emitter voltage					
peak value; $V_{BE} = 0$	V_{CESM}	max.	750	850	V
open base	V_{CEO}	max.	400	450	V
Collector-emitter saturation voltage	V_{CEsat}	max.	1,5		V
Collector current					
saturation	I_{Csat}		6,0		A
DC	I_C	max.	8,0		A
peak value	I_{CM}	max.	20		A
Total power dissipation					
up to $T_{mb} = 25\ ^oC$	P_{tot}	max.	125		W
Fall time	t_f	max.	0,7		μs

MECHANICAL DATA

Dimensions in mm

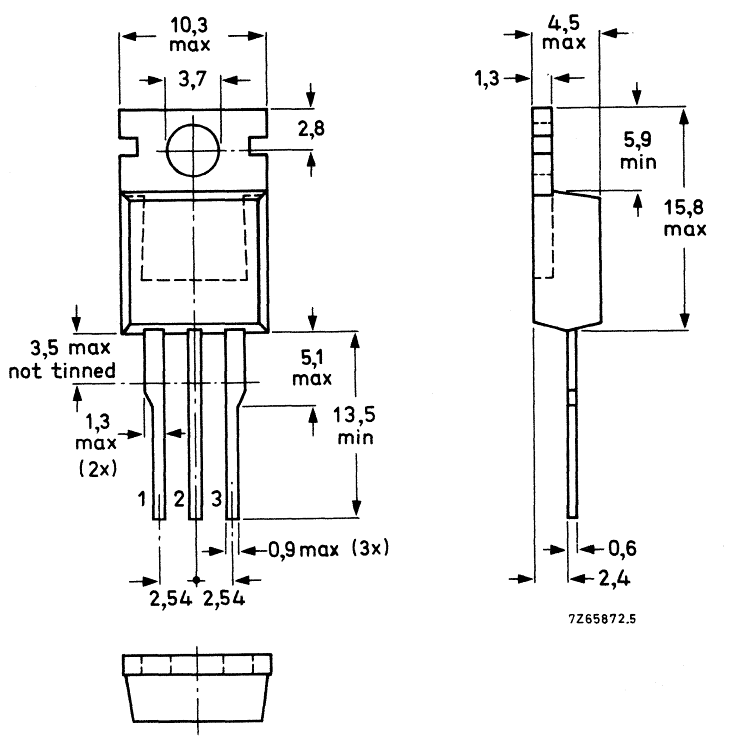
Fig. 1 TO-220AB.



Pinning:

1 = base
2 = collector
3 = emitter

Collector connected to mounting base.



RATINGS

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

			BUT22B	22C	
Collector-emitter voltage					
peak value; $V_{BE} = 0$	V_{CESM}	max.	750	850	V
open base	V_{CEO}	max.	400	450	V
Collector current					
saturation	I_{Csat}	max.	6,0		A
DC	I_C	max.	8,0		A
peak value	I_{CM}	max.	20		A
Base current					
DC	I_B	max.	4,0		A
peak value	I_{BM}	max.	6,0		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	$R_{th\ j\text{-}mb}$	=	1,0	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			BUT22B	22C	
Collector-cut-off currents*					
$V_{CE} = V_{CESmax}$; $V_{BE} = 0$	I_{CES}	max.	1,0		mA
Emitter cut-off current					
V_{EB} = 9 V; $I_C = 0$	I_{EBO}	max.	10		mA
Current gain					
I_C = 1,0 A; V_{CE} = 5 V	h_{FE}	typ.	25		
Collector-emitter sustaining voltage (Figs 2 and 3)					
$I_B = 0$; I_C = 0,1 A; L = 25 mH	$V_{CEOsust}$	min.	400	450	V
$I_{B\ off} = 0$; I_C = 100 mA; L = 25 mH	$V_{CEOsust}$	min.	400	450	V
Saturation voltages					
I_C = 6 A; I_B = 0,8 A	V_{CEsat}	max.	1,5	–	V
	V_{BEsat}	max.	1,5	–	V
I_C = 6 A; I_B = 1,0 A	V_{CEsat}	max.	–	1,5	V
	V_{BEsat}	max.	–	1,5	V
Collector saturation current					
V_{CE} = 1,5 V	I_{Csat}		6,0	6,0	A
Switching times resistive load (Figs 4 and 5)					
$I_{C\ on}$ = 6 A; $I_{B\ on} = I_{B\ off}$ = 0,8 A					
Turn-on time	t_{on}	max.	1,0	–	μs
Turn-off					
storage time	t_s	max.	4,5	–	μs
fall time	t_f	max.	0,7	–	μs
$I_{C\ on}$ = 5 A; $I_{B\ on} = I_{B\ off}$ = 1,0 A					
Turn-on time	t_{on}	max.	–	1,0	μs
Turn-off					
storage time	t_s	max.	–	4,5	μs
fall time	t_f	max.	–	0,7	μs
Switching times inductive load (Figs 6 and 7)					
$I_{C\ on}$ = 6 A; $I_{B\ on}$ = 0,8 A; V_{CL} = 250 V; T_c = 100 °C					
Turn-off					
storage time	t_s	typ.	2,0	–	μs
	t_s	max.	2,5	–	μs
fall time	t_f	typ.	100	–	ns
	t_f	max.	250	–	ns
$I_{C\ on}$ = 6 A; I_B = 1,0 A; V_{CL} = 250 V; T_c = 100 °C					
Turn-off					
storage time	t_s	typ.	–	2,0	μs
	t_s	max.	–	2,5	μs
fall time	t_f	typ.	–	100	ns
	t_f	max.	–	250	ns

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

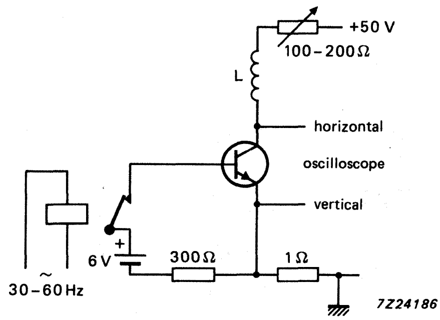


Fig. 2 Test circuit for $V_{CEOsust}$.

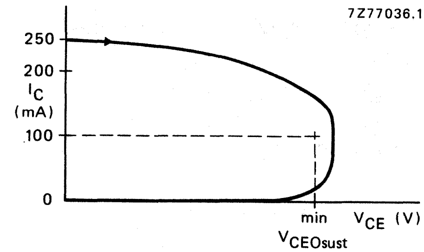


Fig. 3 Oscilloscope display for sustaining voltage.

V_{CC} = 250 V
t_p = 20 μs
V_{IN} = −6 to + 8 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.

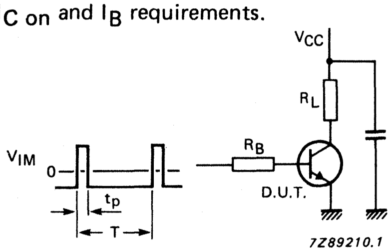


Fig. 4 Test circuit resistive load.

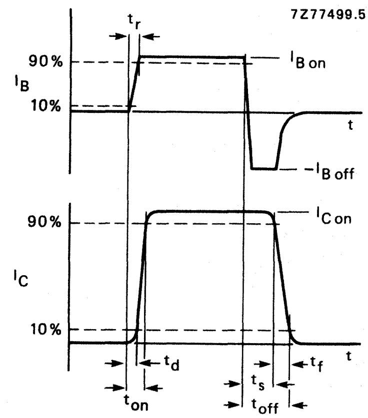


Fig. 5 Switching times waveforms with resistive load; $t_r \leqslant 30$ ns.

V_{CL} = up to 850 V
V_{CC} = 30 V
$-V_{BE}$ = 1 to 5 V
L_B = 1 μH
L_C = 200 μH

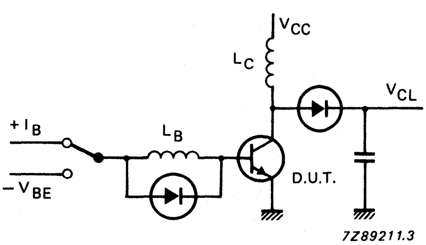


Fig. 6 Test circuit inductive load.

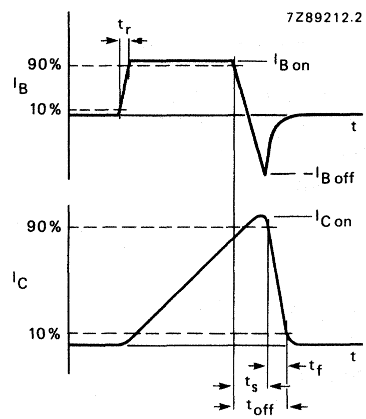
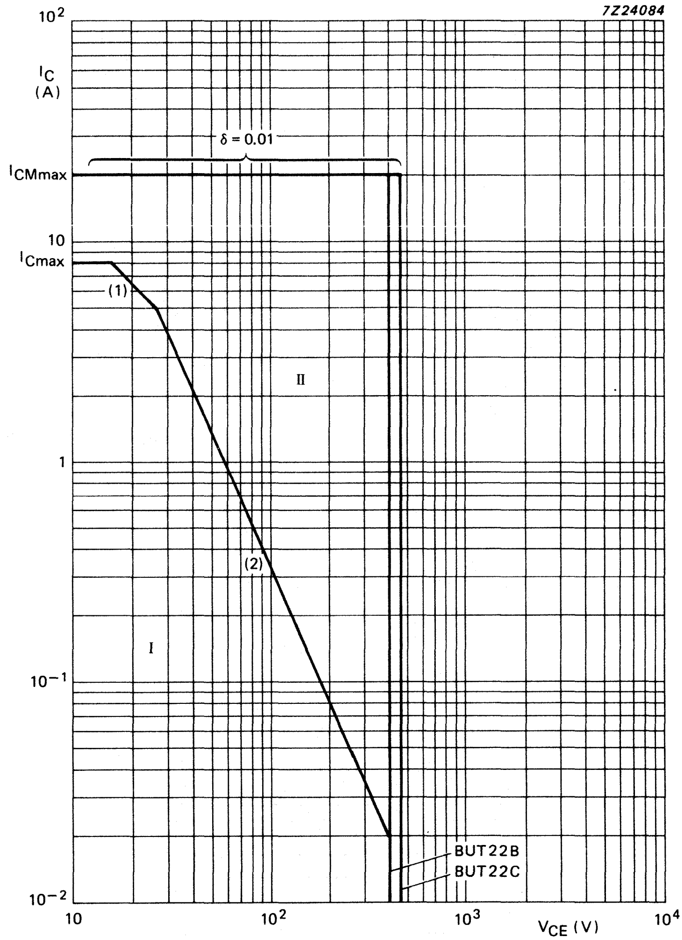


Fig. 7 Switching times waveforms with inductive load.



(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 $T_{mb} < 25\ ^{o}C$.

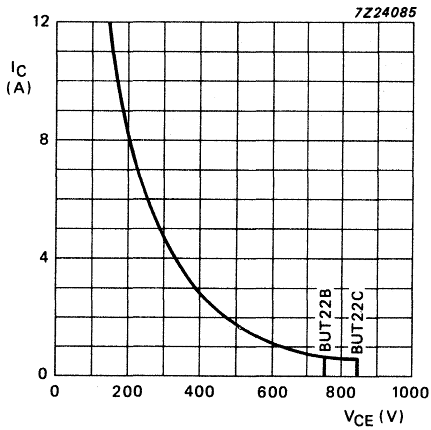


Fig. 9 Reverse bias SOAR.

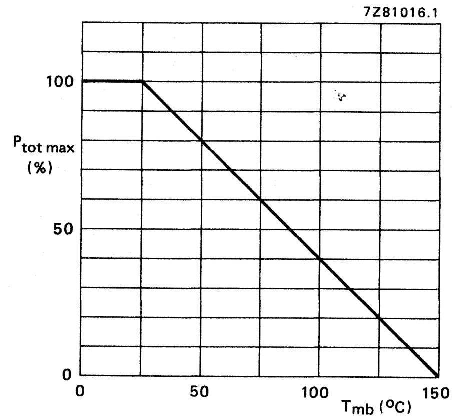


Fig. 10 Power derating curve.

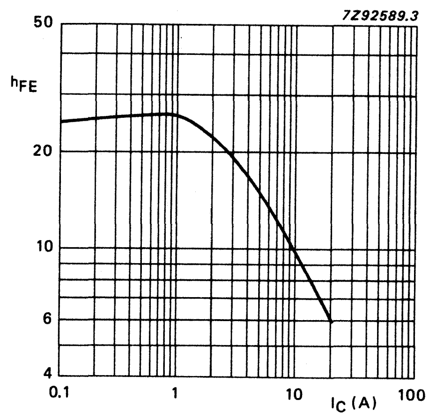


Fig. 11 Typical values DC current gain.

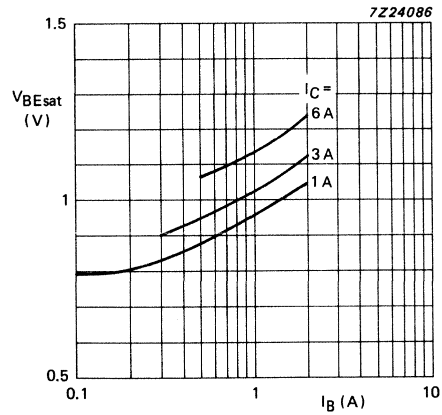


Fig. 12 Base-emitter saturation voltage as a function of base current; T_j = 25 °C.

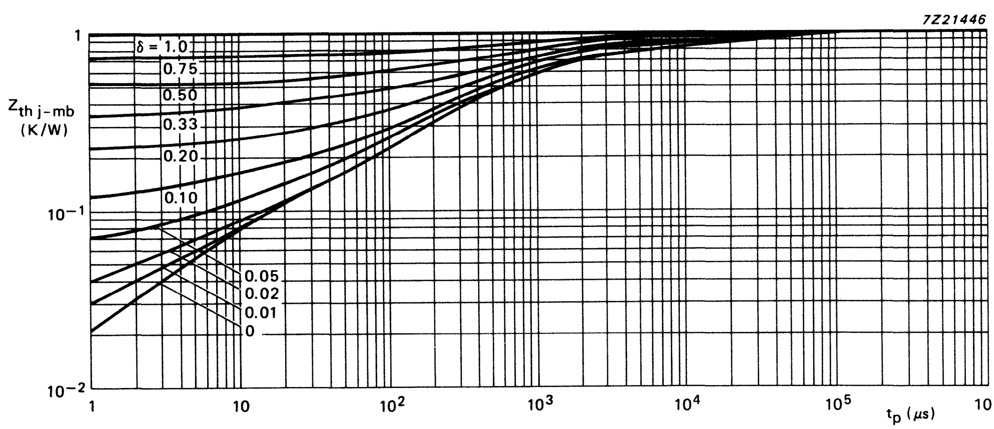


Fig. 13 Thermal response at pulse power conditions.

SILICON DIFFUSED POWER TRANSISTORS

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

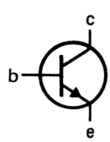
QUICK REFERENCE DATA

			BUT22BF	BUT22CF	
Collector-emitter voltage					
peak value; $V_{BE} = 0$	V_{CESM}	max.	750	850	V
open base	V_{CEO}	max.	400	450	V
Collector-emitter saturation voltage	V_{CEsat}	max.	1.5		V
Collector current					
saturation	I_{Csat}	max.	6.0		A
DC	I_C	max.	8.0		A
peak value; $t_p \leq 20$ ms	I_{CM}	max.	20		A
Total power dissipation					
up to $T_h = 25\,^oC$	P_{tot}	max.	23		W
Fall time; inductive load	t_f	max.	250		ns

MECHANICAL DATA

Dimensions in mm

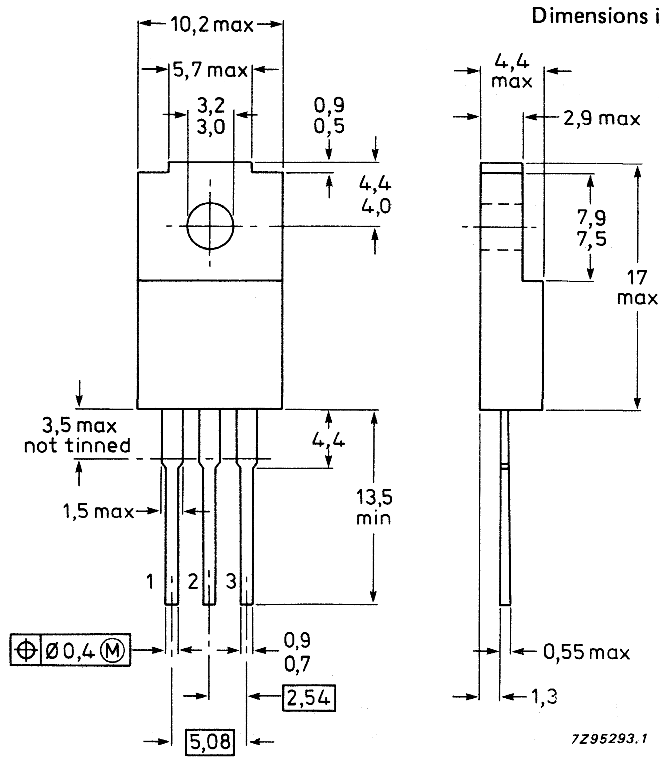
Fig. 1 SOT186.



Pinning:

1 = base
2 = collector
3 = emitter

Terminals are electrically isolated.



RATINGS

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

			BUT22BF	BUT22CF	
Collector-emitter voltage					
peak value; $V_{BE} = 0$	V_{CESM}	max.	750	850	V
open base	V_{CEO}	max.	400	450	V
Collector current					
saturation	I_{Csat}		6.0		A
DC	I_C	max.	8.0		A
peak value; $t_p < 20$ ms	I_{CM}	max.	20		A
Base current					
DC	I_B	max.	4.0		A
peak value; $t_p < 20$ ms	I_{BM}	max.	6.0		A
Total power dissipation up to $T_h = 25$ °C (note 1)	P_{tot}	max.	23		W
Total power dissipation up to $T_h = 25$ °C (note 2)	P_{tot}	max.	32		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)	$R_{th\ j\text{-}h}$	=	5.5	K/W
(note 2)	$R_{th\ j\text{-}h}$	=	3.9	K/W
From junction to ambient	$R_{th\ j\text{-}a}$	=	55	K/W

ISOLATION

Isolation voltage from all terminals to external heatsink (peak value)	V_{isol}	max.	2000	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 the envelope.
2. Mounted with heatsink compound and 30 ± 5 newtons pressure on centre of the envelope.

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			BUT22BF	BUT22CF	
Collector cut-off currents*					
$V_{CE} = V_{CESMmax}$; $V_{BE} = 0$	I_{CES}	max.	1.0		mA
$V_{CE} = V_{CESMmax}$; $V_{BE} = 0$; T_j = 125 °C	I_{CES}	max.	2.0		mA
Emitter cut-off current					
V_{EB} = 9 V; I_C = 0	I_{EBO}	max.	10		mA
DC current gain					
I_C = 1.0 A; V_{CE} = 5 V	h_{FE}	typ.	25		
Saturation voltages					
I_C = 6 A; I_B = 0.8 A	V_{CEsat}	max.	1.5	–	V
	V_{BEsat}	max.	1.5	–	V
I_C = 6 A; I_B = 1.0 A	V_{CEsat}	max.	–	1.5	V
	V_{BEsat}	max.	–	1.5	V
Collector-emitter sustaining voltage (Figs 2 and 3)					
I_C = 100 mA; $I_{B\,off}$ = 0; L = 25 mH	$V_{CEOsust}$	min.	400	450	V
Collector saturation current					
V_{CE} = 1.5 V	I_{Csat}		6.0	6.0	A
Switching times resistive load (Figs 4 and 5)					
$I_{C\,on}$ = 6 A; $I_{B\,on} = I_{B\,off}$ = 0.8 A					
Turn-on time	t_{on}	max.	1.0	–	μs
Turn-off; storage time	t_s	max.	4.5	–	μs
fall time	t_f	max.	0.7	–	μs
$I_{C\,on}$ = 6 A; $I_{B\,on} = I_{B\,off}$ = 1 A					
Turn-on time	t_{on}	max.	–	1.0	μs
Turn-off; storage time	t_s	max.	–	4.5	μs
fall time	t_f	max.	–	0.7	μs
Switching times inductive load (Figs 6 and 7)					
$I_{C\,on}$ = 6 A; I_B = 0.8 A; V_{CL} = 250 V; T_c = 100 °C					
Turn-off; storage time	t_s	typ.	2.0	–	μs
	t_s	max.	2.5	–	μs
fall time	t_f	typ.	100	–	ns
	t_f	max.	250	–	ns
$I_{C\,on}$ = 6 A; I_B = 1 A; V_{CL} = 250 V; T_c = 100 °C					
Turn-off; storage time	t_s	typ.	–	2.0	μs
	t_s	max.	–	2.5	μs
fall time	t_f	typ.	–	100	ns
	t_f	max.	–	250	ns

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

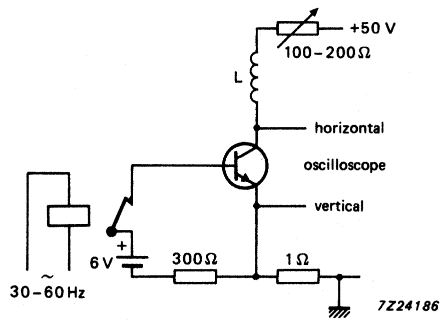


Fig. 2 Test circuit for $V_{CEOsust}$.

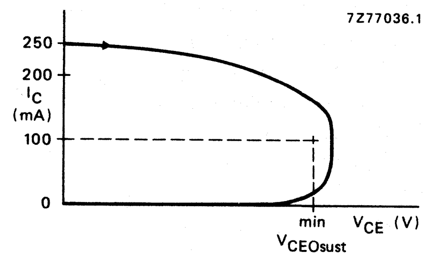
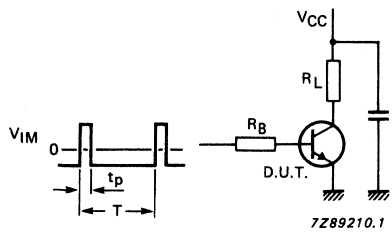


Fig. 3 Oscilloscope display for sustaining voltage.



V_{CC} = 250 V
t_p = 20 μs
V_{IM} = −6 to +8 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.

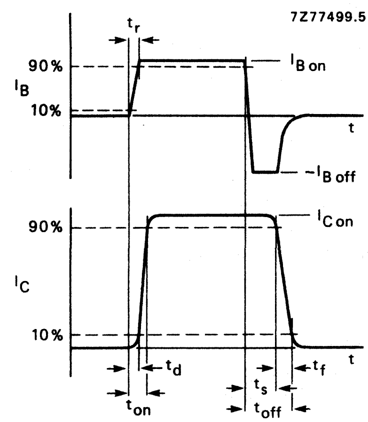
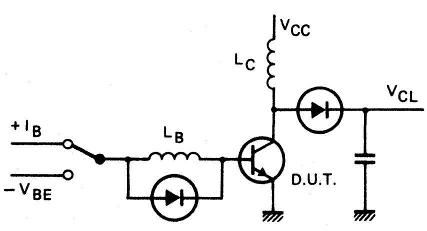


Fig. 5 Switching times waveforms with resistive load; $t_r \leq 20$ ns.



V_{CL} = up to 850 V
V_{CC} = 30 V
$-V_{BE}$ = 5 V
L_B = 1.0 μH
L_C = 200 μH

Fig. 6 Test circuit inductive load and reverse bias SOAR.

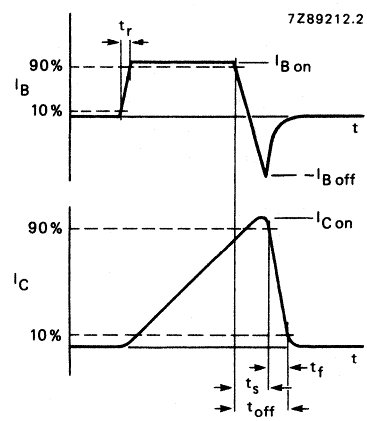
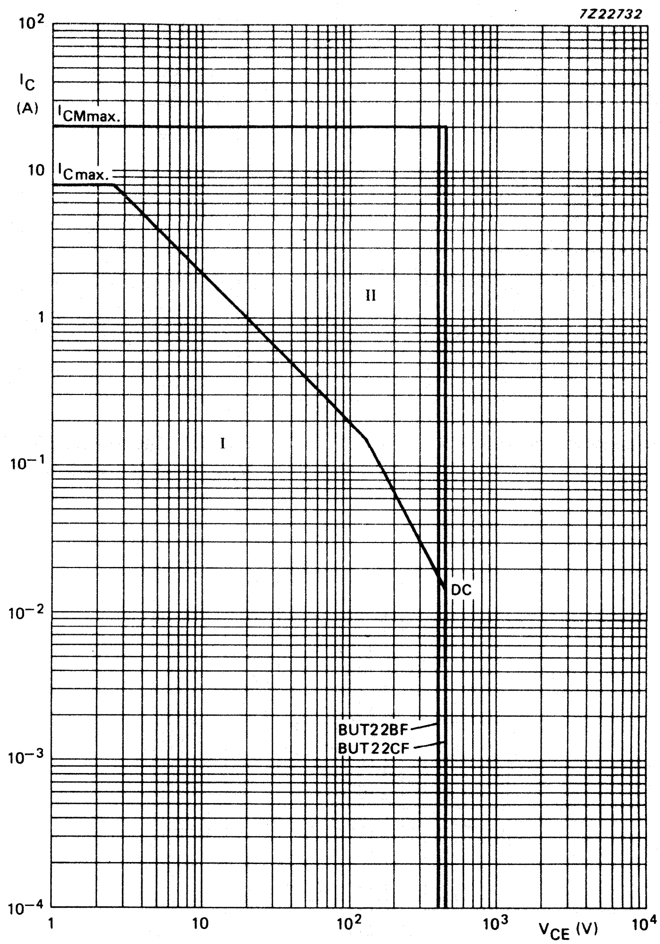


Fig. 7 Switching times waveforms with inductive load.



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 $T_{mb} < 25\ ^oC$.

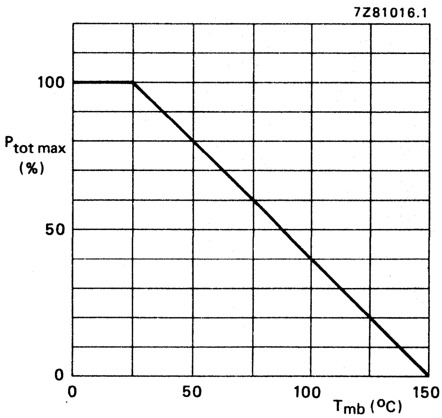


Fig. 9 Power dissipation curve.

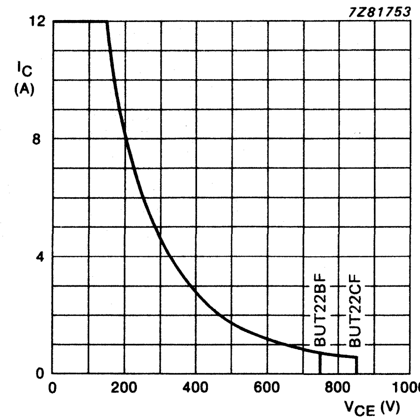


Fig. 10 Reverse bias SOAR;
V_{BE} = −1 V to −5 V; $T_j < 100$ °C.

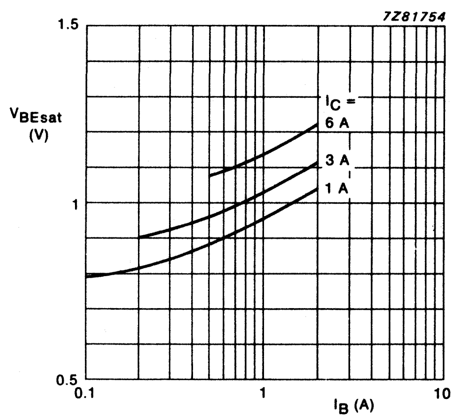
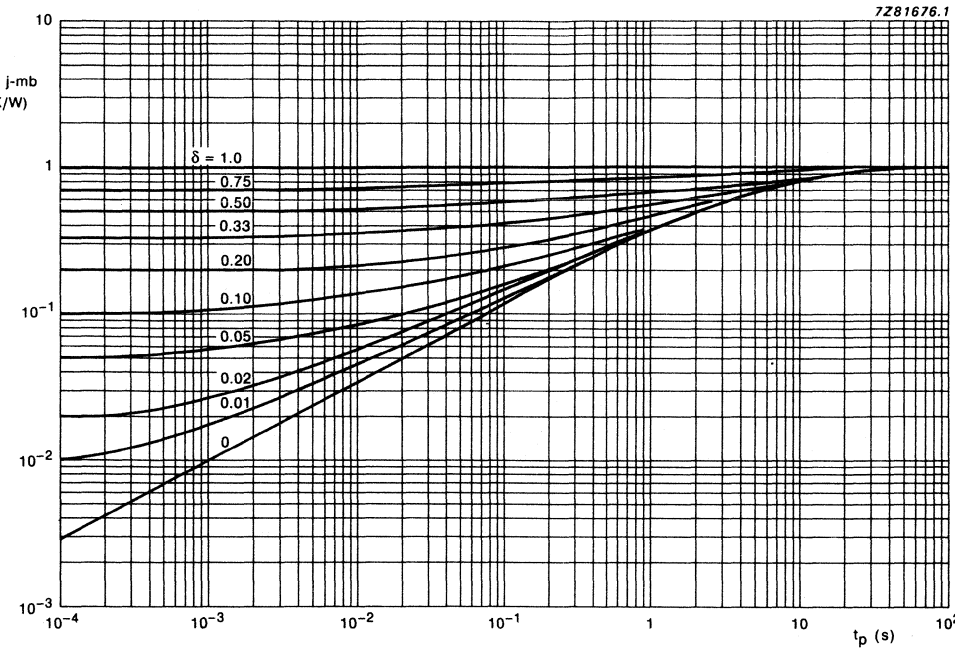


Fig. 11 Base-emitter saturation voltages as a function of base current; T_j = 25 °C.



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

Fig. 12 Normalized thermal response at pulse power conditions.

DEVELOPMENT DATA

SILICON DIFFUSED POWER TRANSISTORS

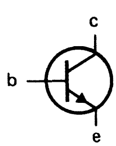
High-voltage, high-speed, glass-passivated npn power transistors in a TO-220 envelope intended for use in converters, inverters, switching regulators, motor control systems, etc.

QUICK REFERENCE DATA

			BUT131	131A	131H	
Collector-emitter voltage						
peak value; $V_{BE} = 0$	V_{CESM}	max.	850	1000	850	V
open base	V_{CEO}	max.	450	500	450	V
Collector-emitter saturation voltage	V_{CEsat}	max.		2.5		V
Collector current						
saturation	I_{Csat}	max.		3.0		A
DC	I_C	max.		5.0		A
peak value	I_{CM}	max.		10		A
Total power dissipation						
up to $T_{mb} = 25\ ^{o}C$	P_{tot}	max.		80		W
Fall time (resistive load)	t_f	typ.	0.07	0.07	0.12	μs

Fig. 1 TO-220AB.

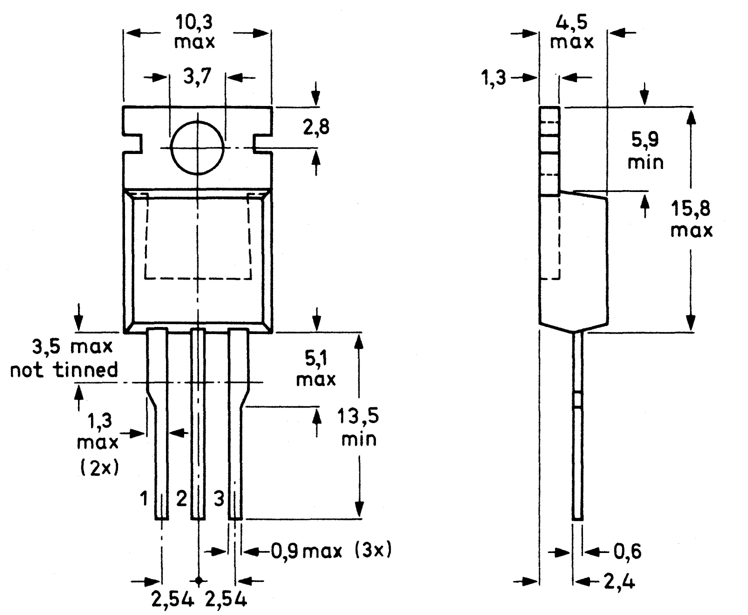
Dimensions in mm



Pinning:

1 = base
2 = collector
3 = emitter

Collector connected to mounting base.



RATINGS

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

			BUT131	131A	131H	
Collector-emitter voltage						
peak value; $V_{BE} = 0$	V_{CESM}	max.	850	1000	850	V
open base	V_{CEO}	max.	450	500	450	V
Collector current						
DC	I_C	max.		5.0		A
peak value; $t_p = 5$ ms; d = 10%	I_{CM}	max.		10		A
Base current						
DC	I_B	max.		4.0		A
peak value; $t_p = 5$ ms; d = 10%	I_{BM}	max.		8.0		A
Total power dissipation						
up to $T_{mb} = 25\ ^oC$	P_{tot}	max.		80		W
Storage temperature range	T_{stg}			−65 to +150		^oC
Junction temperature	T_j	max.		150		^oC

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	1.56	K/W

DEVELOPMENT DATA

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			BUT131	131A	131H	
Collector cut-off current*						
$V_{CE} = V_{CESMmax}$; $V_{BE} = -1.5$ V	I_{CEV}	max.		0.25		mA
$V_{CE} = V_{CESMmax}$; $V_{BE} = -1.5$ V; T_j = 100 °C	I_{CEV}	max.		1.5		mA
Emitter cut-off current						
V_{EB} = 6.0 V; I_C = 0	I_{EBO}	max.		1.0		mA
Collector-emitter sustaining voltage						
I_C = 100 mA; I_B = 0; L = 10 mH (see Figs 2 and 3)	$V_{CEOsust}$	min.	450	500	450	V
Saturation voltage						
T_{mb} = 25 °C and 100 °C						
I_C = 1.5 A; I_B = 0.2 A (BUT131) I_C = 1.5 A; I_B = 0.2 A (BUT131A) I_C = 1.5 A; I_B = 0.15 A (BUT131H)	V_{CEsat}	max.		1.0		V
I_C = 3 A; I_B = 0.4 A (BUT131) I_C = 3 A; I_B = 0.4 A (BUT131A) I_C = 3 A; I_B = 0.3 A (BUT131H)	V_{CEsat}	max.		2.5		V
	V_{BEsat}	max.		1.5		V
DC current gain						
I_C = 5 A; V_{CE} = 5 V	h_{FE}	min.	5	5	7	
Switching times resistive load (see Figs 4 and 5)						
$I_{C\,on}$ = 3 A; $I_{B\,on}$ = 0.4 A; $I_{B\,off}$ = 0.8 A						
Turn-on time	t_{on}	typ.	0.35	0.35	–	μs
Turn-off; storage time	t_s	typ.	1.2	1.2	–	μs
fall time	t_f	typ.	0.07	0.07	–	μs
$I_{C\,on}$ = 3 A; $I_{B\,on}$ = 0.3 A; $I_{B\,off}$ = 0.6 A						
Turn-on time	t_{on}	typ.	–	–	0.40	μs
Turn-off; storage time	t_s	typ.	–	–	1.2	μs
fall time	t_f	typ.	–	–	0.12	μs
Switching times inductive load (see Figs 6 and 7)						
$I_{C\,on}$ = 3 A; $I_{B\,on}$ = 0.4 A	t_{sv}	typ.	0.60	0.60	–	μs
$V_{BE\,off}$ = 5 V; $V_{CE(pk)}$ = 400 V;	t_{fi}	typ.	0.07	0.07	–	μs
T_j = 100 °C	t_c	typ.	0.20	0.20	–	μs
$I_{C\,on}$ = 3 A; $I_{B\,on}$ = 0.3 A	t_{sv}	typ.	–	–	0.50	μs
$V_{BE\,off}$ = 5 V; $V_{CE(pk)}$ = 400 V;	t_{fi}	typ.	–	–	0.07	μs
T_j = 100 °C	t_c	typ.	–	–	0.18	μs
Output capacitance						
V_{CB} = 10 V; I_E = 0; f_{test} = 1 kHz	C_{ob}	max.		200		pF

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

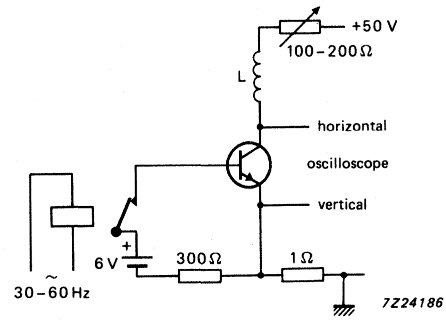


Fig. 2 Test circuit for $V_{CEOsust}$.

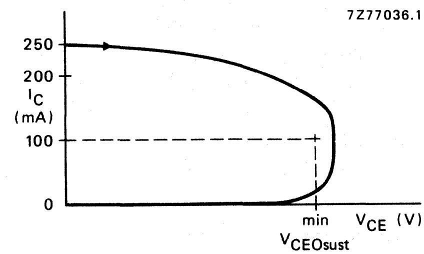
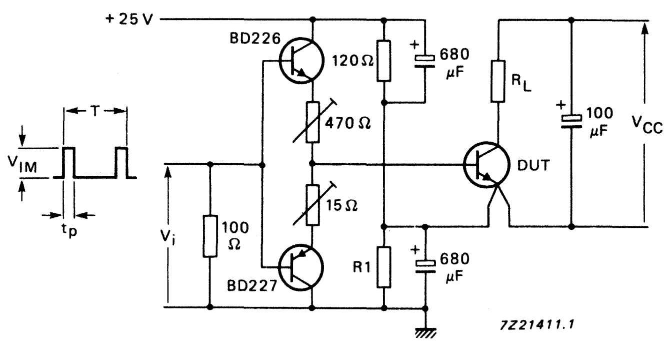


Fig. 3 Oscilloscope display for sustaining voltage.



t_p = 20 μs
T = 2 ms
V_{IM} = 15 V

Fig. 4 Test circuit resistive load; V_{CC} = 240 V; R_L = 82 Ω; R1 = 39 Ω.

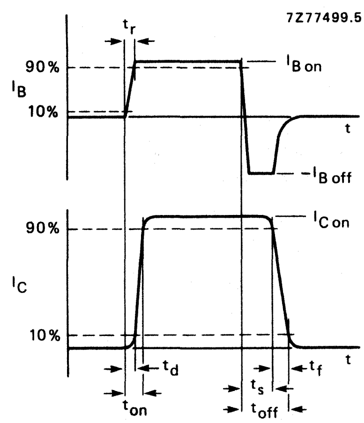
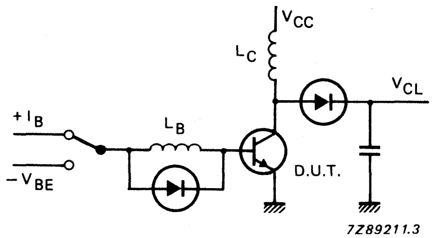


Fig. 5 Switching times waveforms with resistive load; $t_r \leqslant 30$ ns.



For inductive load;
V_{CL} = 400 V
$-V_{BE}$ = 5 V
For RB SOAR;
V_{CL} up to 1000 V
$-V_{BEoff}$ to be adjusted

Fig. 6 Test circuit inductive load and RB SOAR; V_{CC} = 20 V; L_C = 200 μH.

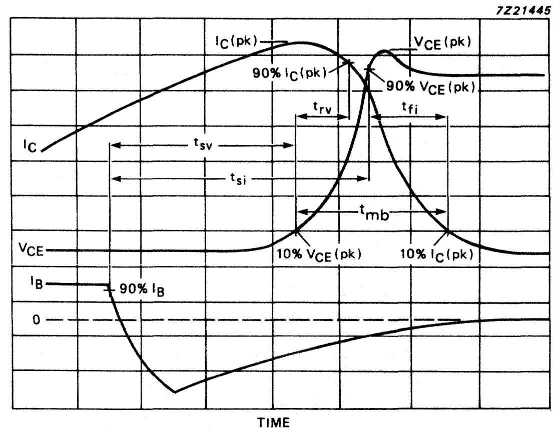


Fig. 7 Switching times waveforms with inductive load.

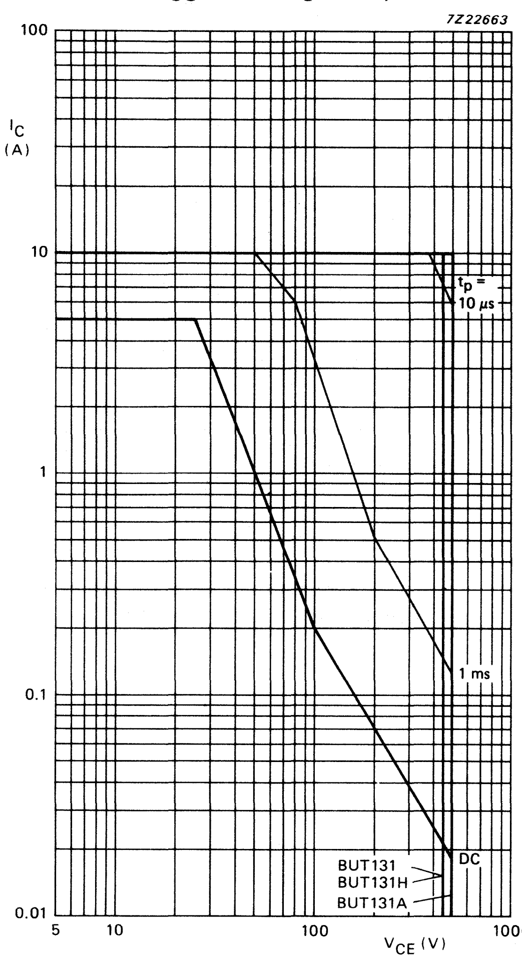


Fig. 8 Forward biased SOAR; T_{mb} = 25 °C.

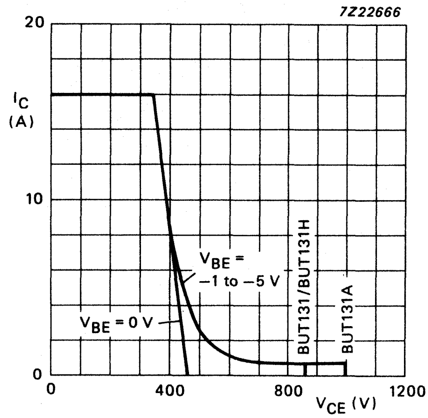


Fig. 9 Reverse bias SOAR; $I_C/I_B = 4$; $T_{mb} \leqslant 100\ ^oC$.

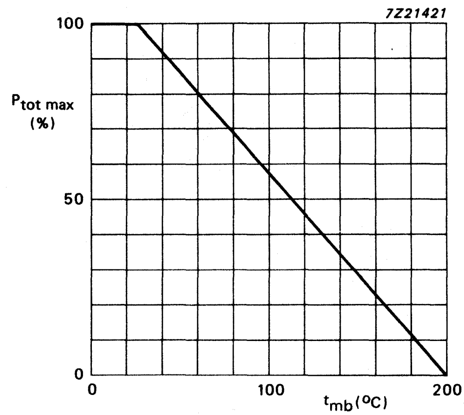


Fig. 10 Power derating curve.

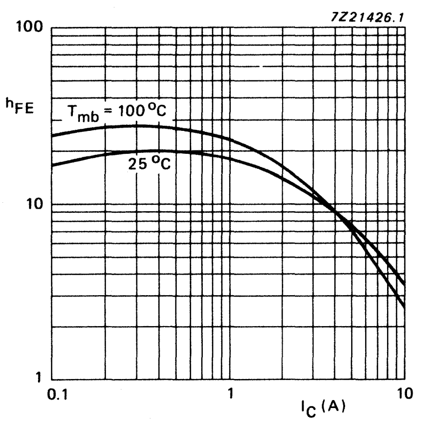


Fig. 11 Typical DC current gain; $V_{CE} = 5$ V.

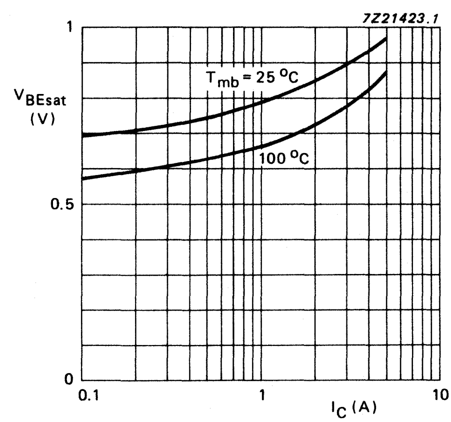


Fig. 12 Base-emitter saturation voltage as a function of collector current; $I_C/I_B = 10$.

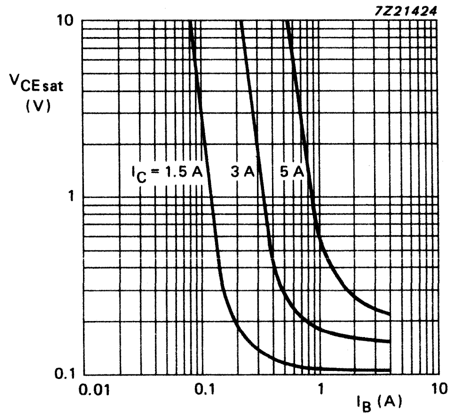


Fig. 13 Collector-emitter voltage as a function of base current; T_{mb} = 25 °C.

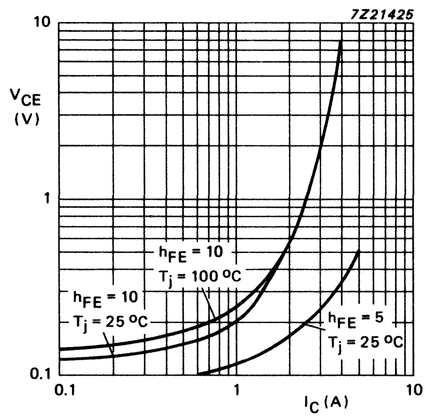


Fig. 14 Collector-emitter voltage as a function of collector current.

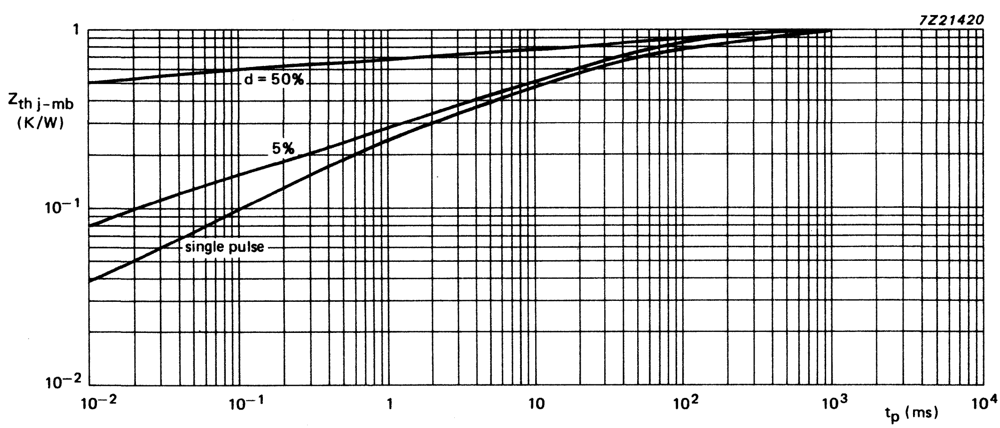


Fig. 15 Transient thermal impedance; (normalized).

DEVELOPMENT DATA

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.

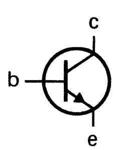
QUICK REFERENCE DATA

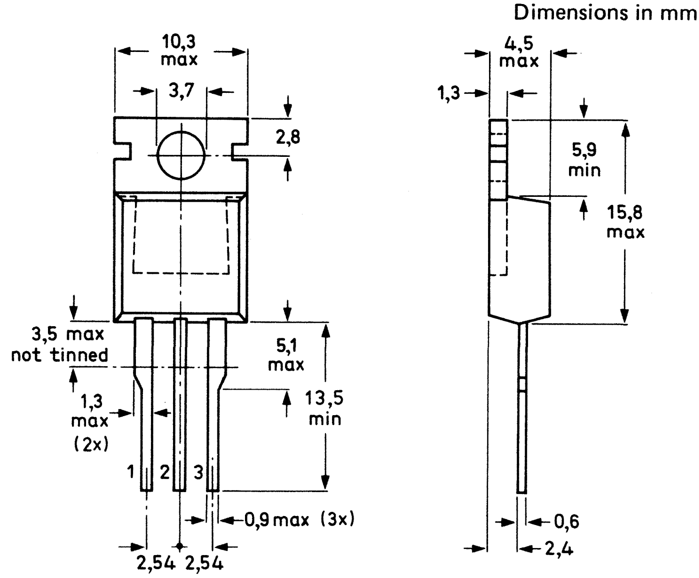
			BUV26	26A	
Collector-emitter voltage					
peak value; $V_{BE} = 0$	V_{CESM}	max.	180	200	V
open base	V_{CEO}	max.	90	100	V
Collector-emitter saturation voltage	V_{CEsat}	max.	1,5	1,0	V
Collector current					
saturation	I_{Csat}	max.	12	10	A
DC	I_C	max.	14		A
peak value	I_{CM}	max.	25		A
Total power dissipation					
up to $T_{mb} = 25\ ^oC$	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)

			BUV26	26A	
Collector-emitter voltage					
peak value; $V_{BE} = 0$	V_{CESM}	max.	180	200	V
open base	V_{CEO}	max.	90	100	V
Collector current					
saturation	I_{Csat}	max.	12	10	A
DC	I_C	max.	14		A
peak value	I_{CM}	max.	25		A
Base current					
DC	I_B	max.	4,0		A
peak value	I_{BM}	max.	6,0		A
Total power dissipation					
up to $T_{mb} = 25\ ^{o}C$	P_{tot}	max.	65		W
Storage temperature range	T_{stg}		–65 to + 150		^{o}C
Junction temperature	T_j	max.	150		^{o}C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	1,92	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off currents*					
$V_{CE} = V_{CESmax}$; V_{BE} = −1,5 V; T_j = 125 °C	I_{CES}	max.	1,0		mA
$V_{CE} = V_{CESmax}$; R_{BE} = 50 Ω; T_j = 125 °C	I_{CES}	max.	3,0		mA
Emitter cut-off current					
V_{EB} = 5 V; I_C = 0	I_{EBO}	max.	1,0		mA
			BUV26	26A	
Collector-emitter sustaining voltage (Figs 2 and 3)					
I_B = 0; I_C = 0,2 A; L = 25 mH	$V_{CEOsust}$	min.	90	100	V
Saturation voltages					
$I_C = I_{Csat}$; $I_B = I_{Csat}/10$	V_{CEsat}	max.	1,5	1,0	V
	V_{BEsat}	max.	2,0	1,5	V
$I_C = I_{Csat}/2$; $I_B = I_{Csat}/20$	V_{CEsat}	max.	0,6	0,5	V
	V_{BEsat}	max.	1,2	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 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)					
$I_{C\,on} = I_{Csat}$; $I_{B\,on} = I_{Csat}/10$; $V_{CE} = V_{clamp}$ = 50 V; L_B = 0,5 μH; $-V_B$ = 5 V					
Turn-off;					
storage time at T_j = 25 °C	t_s	typ.	0,5		μs
	t_f	typ.	40		ns
fall time at T_j = 125 °C	t_s	max.	2,0		μs
	t_f	max.	150		ns

DEVELOPMENT DATA

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

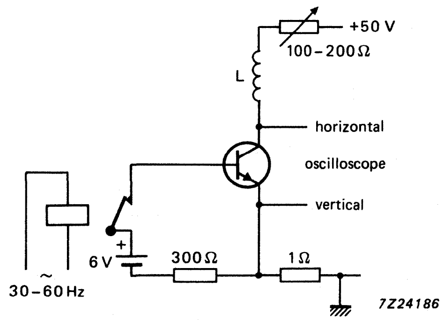


Fig. 2 Test circuit for V_{CEsust}.

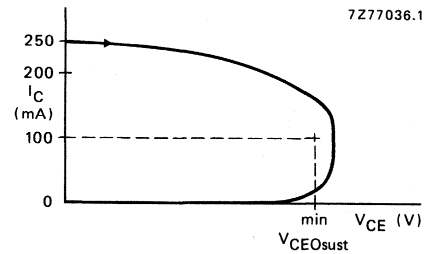


Fig. 3 Oscilloscope display for sustaining voltage.

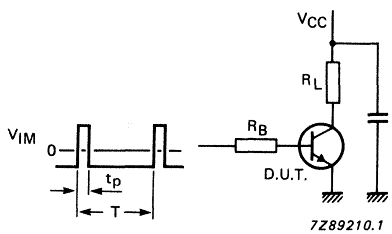


Fig. 4 Test circuit resistive load.

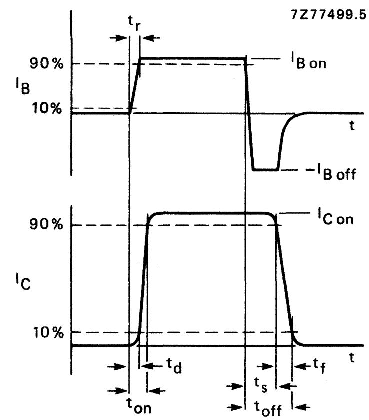
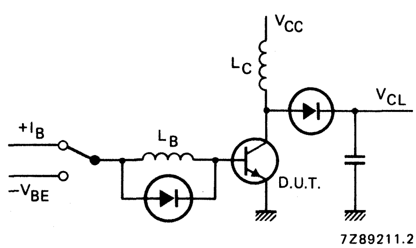


Fig. 5 Switching times waveforms with resistive load; $t_r \leqslant 30$ ns.



L_B = 0,5 μH
L_C = 200 μH
V_{CC} = 50 V
$-V_{BE}$ = 5 V
V_{CL} = 50 V

Fig. 6 Test circuit inductive load.

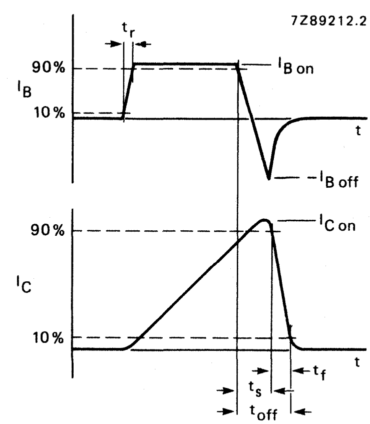


Fig. 7 Switching times waveforms with inductive load.

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.

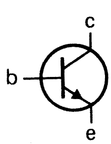
QUICK REFERENCE DATA

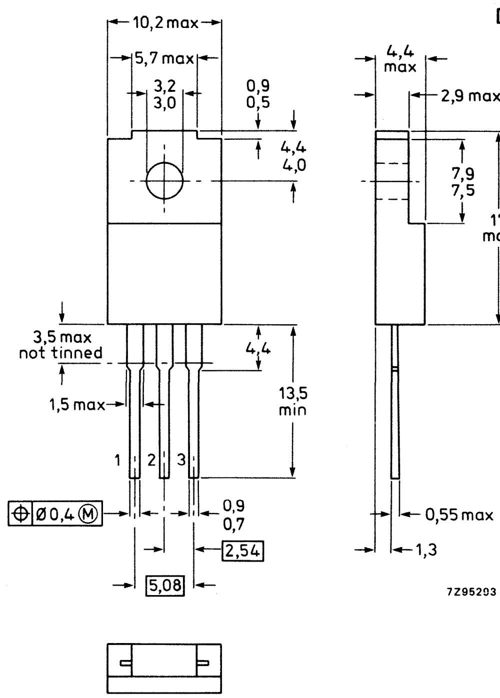
			BUV26F	26AF	
Collector-emitter voltage					
peak value; $V_{BE} = 0$	V_{CESM}	max.	180	200	V
open base	V_{CEO}	max.	90	100	V
Collector-emitter saturation voltage	V_{CEsat}	max.	1,5	1,0	V
Collector current					
saturation	I_{Csat}	max.	12	10	A
DC	I_C	max.	14		A
peak value	I_{CM}	max.	25		A
Total power dissipation					
up to $T_h = 25\ ^oC$	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.

RATINGS

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

			BUV26F	26AF	
Collector-emitter voltage					
peak value; $V_{BE} = 0$	V_{CESM}	max.	180	200	V
open base	V_{CEO}	max.	90	100	V
Collector current					
saturation	I_{Csat}		12	10	A
DC	I_C	max.	14		A
peak value	I_{CM}	max.	25		A
Base current					
DC	I_B	max.	4,0		A
peak value	I_{BM}	max.	6,0		A
Total power dissipation					
up to $T_h = 25\ ^oC$	P_{tot}	max.	18		W
Storage temperature range	T_{stg}		−65 to + 150		^oC
Junction temperature	T_j	max.	150		^oC

THERMAL RESISTANCE

From junction to external heatsink (1)	$R_{th\ j\text{-}h}$	=	7,0	K/W
From junction to external heatsink (2)	$R_{th\ j\text{-}h}$	=	4,5	K/W
From junction to ambient	$R_{th\ j\text{-}a}$	=	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 °C unless otherwise specified

Collector cut-off currents				
$V_{CE} = V_{CESmax}$; V_{BE} = −1,5 V; T_j = 125 °C	I_{CEX}	max.	1,0	mA
$V_{CE} = V_{CESmax}$; V_{BE} = 0; T_j = 125 °C	I_{CES}	max.	3,0	mA
Emitter cut-off current				
V_{EB} = 5 V; I_C = 0	I_{EBO}	max.	1,0	mA

			BUV26F	26AF	
Saturation voltages					
$I_C = I_{Csat}$; $I_B = I_{Csat}/10$	V_{CEsat}	max.	1,5	1,0	V
	V_{BEsat}	max.	2,0	1,5	V
I_C = 6 A; $I_B = I_{Csat}/20$	V_{CEsat}	max.	0,6	–	V
	V_{BEsat}	max.	1,2	–	V
I_C = 5 A; $I_B = I_{Csat}/20$	V_{CEsat}	max.	–	0,5	V
	V_{BEsat}	max.	–	1,2	V
Collector-emitter sustaining voltage (Figs 2 and 3)					
I_C = 200 mA; I_B = 0; L = 25 mH	$V_{CEOsust}$	min.	90	100	V

DEVELOPMENT DATA

Switching times resistive load (Figs 4 and 5)				
$I_{C\,on} = I_{Csat}$; $I_{B\,on} = I_{Csat}/10$				
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
$I_{C\,on} = I_{Csat}$; $I_{B\,off} = 2\,I_{B\,on}$				
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)				
$I_{C\,on} = I_{Csat}$; $I_{B\,on} = I_{Csat}/10$ at T_j = 25 °C				
Turn-off;				
storage time	t_s	typ.	0,5	μs
fall time	t_f	typ.	40	ns
Turn off; T_j = 125 °C				
storage time	t_s	max.	2,0	μs
fall time	t_f	max.	150	ns

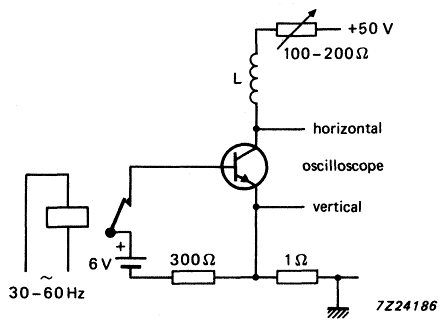


Fig. 2 Test circuit for $V_{CEOsust}$.

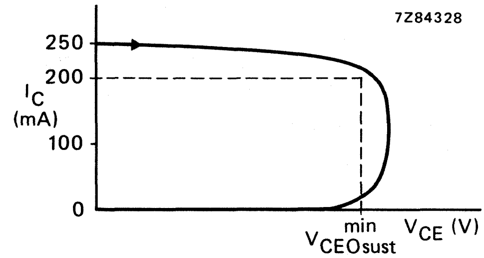


Fig. 3 Oscilloscope display for sustaining voltage.

$V_{CC} = 50$ V
$t_p = 20\ \mu s$
$V_{IM} = -6$ to $+4{,}5$ 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.

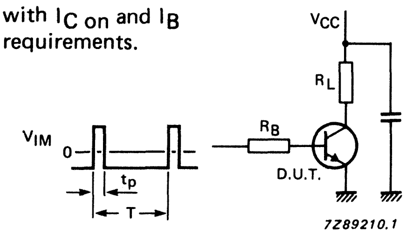


Fig. 4 Test circuit resistive load.

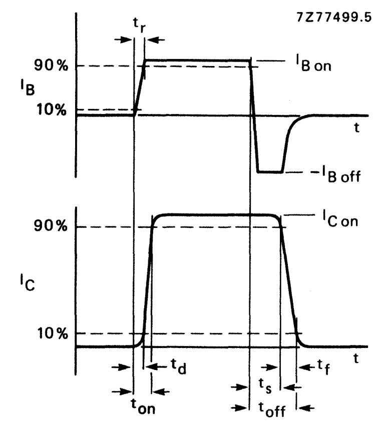


Fig. 5 Switching times waveforms with resistive load; $t_r \leqslant 30$ ns.

V_{CL} = up to 50 V
V_{CC} = 30 V
$-V_{BE}$ = 5 V
$L_B = 0{,}5\ \mu H$
$L_C = 200\ \mu H$

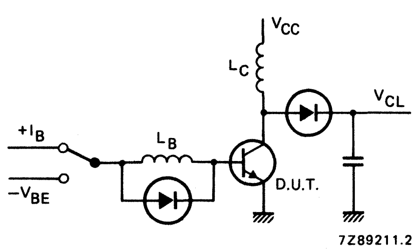


Fig. 6 Test circuit inductive load.

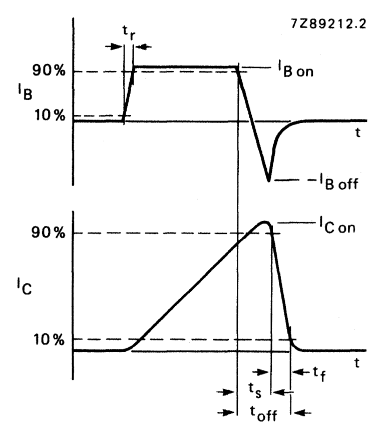
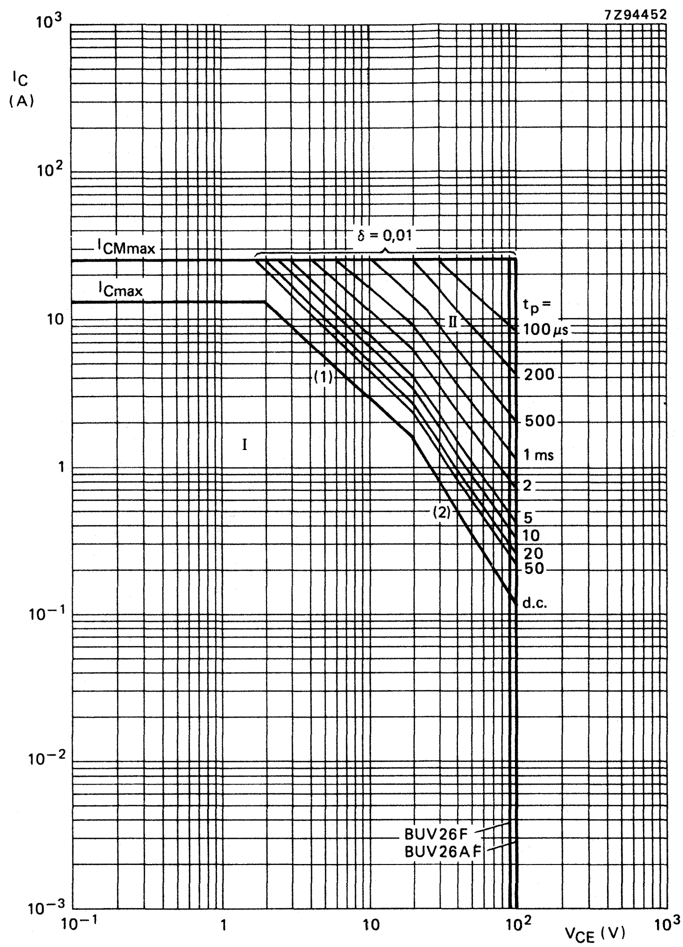
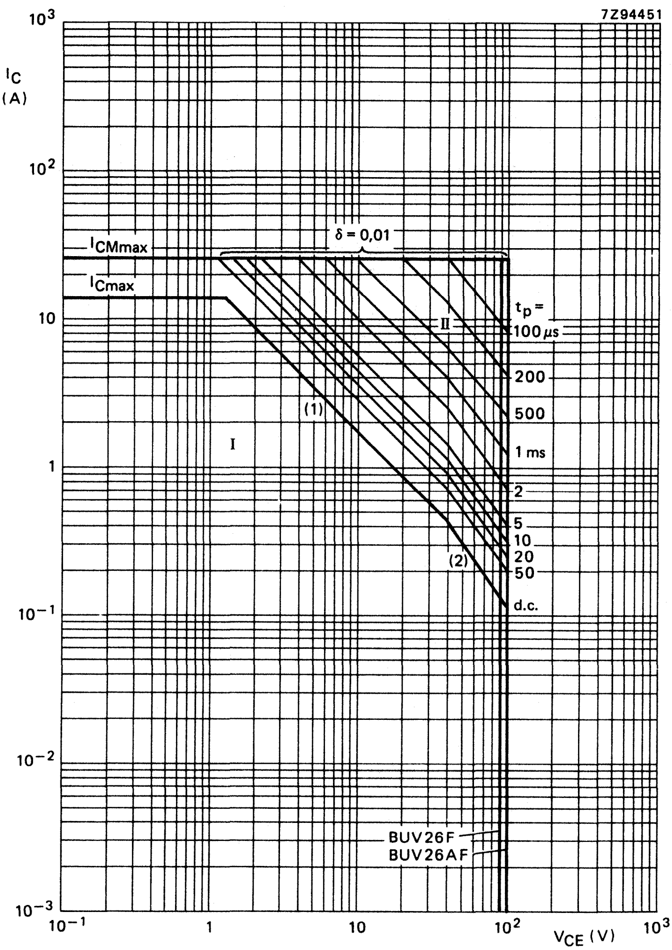


Fig. 7 Switching times waveforms with inductive load.



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 $T_{mb} < 25$ °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 $T_{mb} < 25\ ^oC$; mounted without heatsink compound and 30 ± 5 newtons pressure on the centre of the envelope.

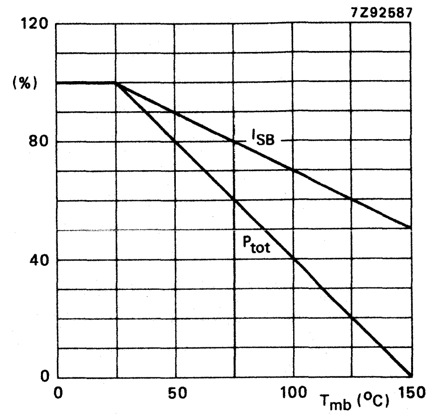


Fig. 10 Total power dissipation and second-breakdown current derating curve.

DEVELOPMENT DATA

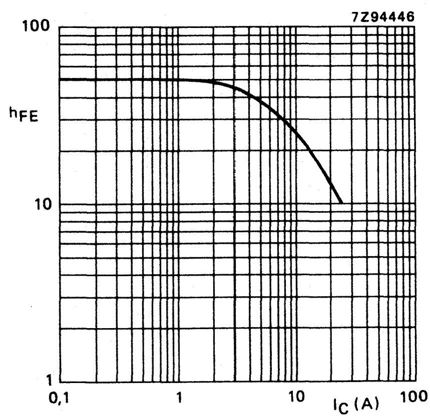


Fig. 11 Typical DC current gain (BUV26F); V_{CE} = 5 V; T_j = 25 °C.

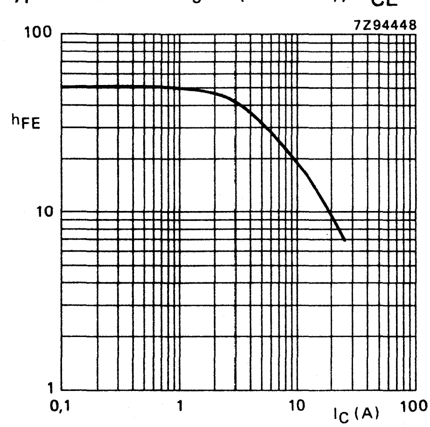


Fig. 12 Typical DC current gain (BUV26AF); V_{CE} = 5 V; T_j = 25 °C.

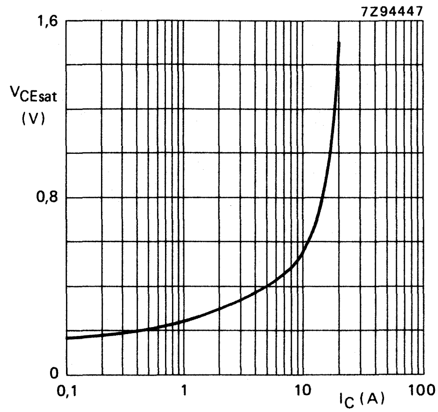


Fig. 13 Collector-emitter saturation voltage as a function of collector current (BUV26F); $I_C/I_B = 10$.

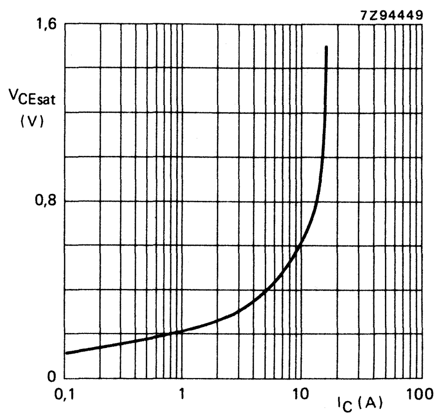


Fig. 14 Collector-emitter saturation voltage as a function of collector current (BUV26AF); $I_C/I_B = 10$.

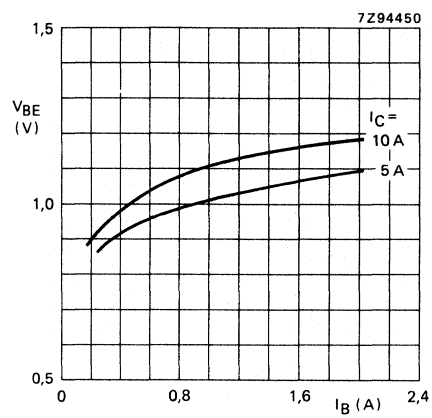


Fig. 15 Base-emitter voltage as a function of base current; $T_j = 25\ ^oC$.

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.

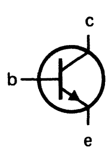
QUICK REFERENCE DATA

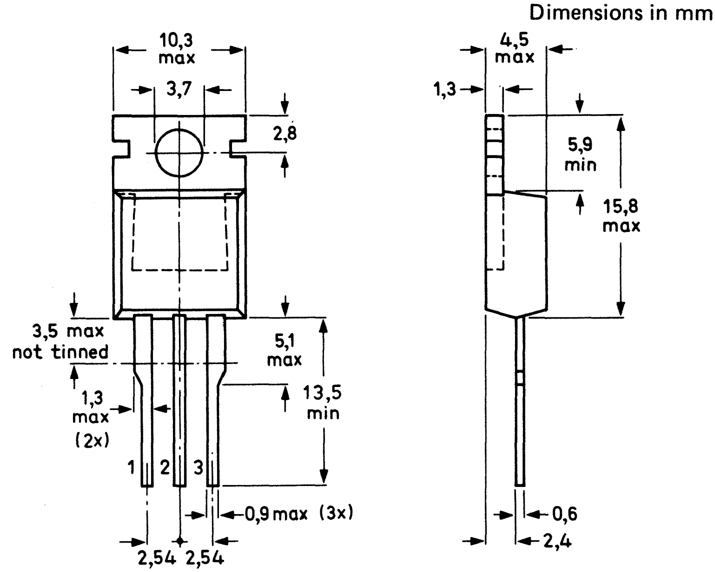
			BUV27	27A	
Collector-emitter voltage					
peak value; $V_{BE} = 0$	V_{CESM}	max.	240	300	V
open base	V_{CEO}	max.	120	150	V
Collector-emitter saturation voltage	V_{CEsat}	max.	1,5	1,0	V
Collector current					
saturation	I_{Csat}		8,0	7,0	A
DC	I_C	max.	15		A
peak value	I_{CM}	max.	25		A
Total power dissipation					
up to $T_{mb} = 25\ ^oC$	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; $V_{BE} = 0$	V_{CESM}	max.	240	300	V
open base	V_{CEO}	max.	120	150	V
Collector current					
saturation	I_{Csat}		8,0	7,0	A
DC	I_C	max.	15		A
peak value	I_{CM}	max.	25		A
Base current					
DC	I_B	max.	4,0		A
peak value	I_{BM}	max.	6,0		A
Total power dissipation					
up to T_{mb} = 25 °C	P_{tot}	max.	65		W
Storage temperature	T_{stg}		−65 to + 150		°C
Junction temperature	T_j	max.	150		°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	1,92	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off currents*					
$V_{CE} = V_{CESmax}$; $V_{BE} = -1{,}5$ V; T_j = 125 °C	I_{CEX}	max.	1,0		mA
$V_{CE} = V_{CESmax}$; $R_{BE} = 50\ \Omega$; T_j = 125 °C	I_{CER}	max.	3,0		mA
Emitter cut-off current					
V_{EB} = 5 V; I_C = 0	I_{EBO}	max.	1,0		mA
			BUV27	27A	
Collector-emitter sustaining voltage (Figs 2 and 3)					
I_B = 0; I_C = 0,2 A; L = 25 mH	$V_{CEOsust}$	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		V
Switching times resistive load (Figs 4 and 5)					
$I_{Con} = I_{Csat}$; $I_{Bon} = I_{Csat}/10$; $I_{Boff} = 2I_{Bon}$; V_{CE} = 50 V					
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)					
$I_{Con} = I_{Csat}$; $I_{Bon} = I_{Csat}/10$; $V_{CC} = V_{CL}$ = 50 V; L_B = 1 μH; $-V_B$ = 5 V					
Turn-off; storage time at T_j = 25 °C	t_s	typ.	0,6		μs
	t_f	typ.	40		ns
fall time at T_j = 125 °C	t_s	max.	2,0		μs
	t_f	max.	150		ns

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

DEVELOPMENT DATA

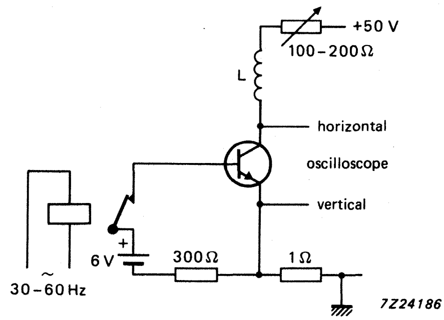


Fig. 2 Test circuit for V_{CEsust}.

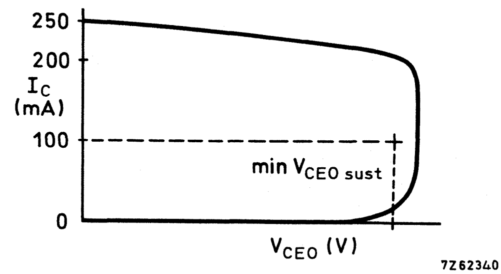


Fig. 3 Oscilloscope display for sustaining voltage.

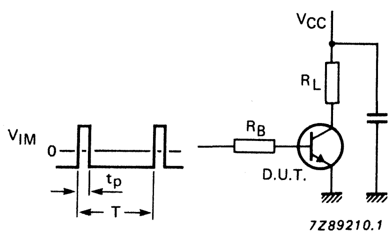


Fig. 4 Test circuit resistive load.

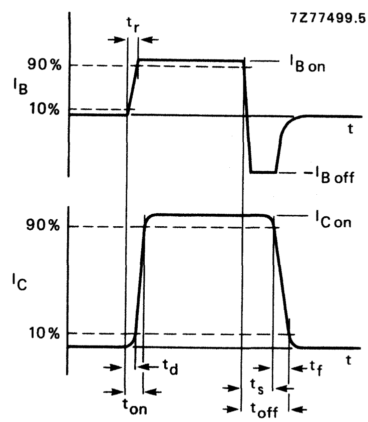


Fig. 5 Switching times waveforms with restrictive load; $t_r \leqslant 30$ ns.

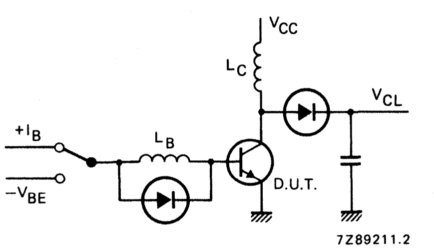


Fig. 6 Test circuit inductive load.
V_{CC} = 50 V; V_{CL} = 50 V.

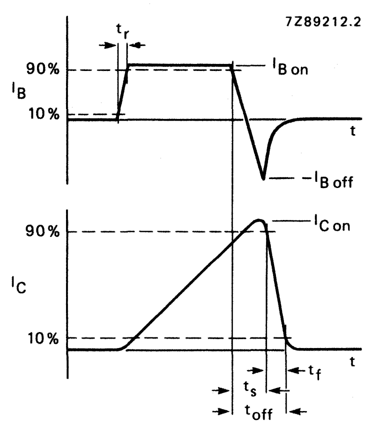


Fig. 7 Switching times waveforms with inductive load.

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.

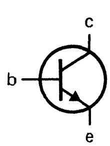
QUICK REFERENCE DATA

			BUV27F	27AF	
Collector-emitter voltage					
peak value; $V_{BE} = 0$	V_{CESM}	max.	240	300	V
open base	V_{CEO}	max.	120	150	V
Collector-emitter saturation voltage	V_{CEsat}	max.	1.0	1.5	V
Collector current					
saturation	I_{Csat}	max.	8.0	7.0	A
DC	I_C	max.	15		A
peak value	I_{CM}	max.	25		A
Total power dissipation					
up to $T_h = 25\ ^oC$	P_{tot}	max.	18		W
Fall time; inductive load	t_f	typ.	40		ns

MECHANICAL DATA

Dimensions in mm

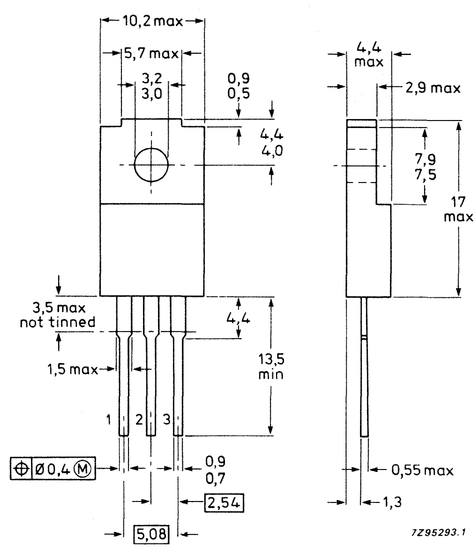
Fig. 1 SOT186.



Pinning:

1 = base
2 = collector
3 = emitter

Mounting base is electrically isolated from all terminals.



RATINGS

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

			BUV27F	27AF	
Collector-emitter voltage					
peak value; $V_{BE} = 0$	V_{CESM}	max.	240	300	V
open base	V_{CEO}	max.	120	150	V
Collector current					
saturation	I_{Csat}	max.	8.0	7.0	A
DC	I_C	max.	15		A
peak value	I_{CM}	max.	20		A
Base current					
DC	I_B	max.	4.0		A
peak value	I_{BM}	max.	6.0		A
Total power dissipation					
up to $T_h = 25\ ^oC$	P_{tot}	max.	18		W
Storage temperature range	T_{stg}		−65 to + 150		^oC
Junction temperature	T_j	max.	150		^oC

THERMAL RESISTANCE

From junction to mounting base (note 1)	$R_{th\ j\text{-}mb}$	=	7.0	K/W
From junction to mounting base (note 2)	$R_{th\ j\text{-}mb}$	=	4.5	K/W
From junction to ambient	$R_{th\ j\text{-}a}$	=	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 °C unless otherwise specified

			BUV27F	27AF	
Collector cut-off currents					
$V_{CE} = V_{CESmax}$; V_{BE} = −1.5 V; T_j = 125 °C	I_{CEX}	max.		1.0	mA
$V_{CE} = V_{CESmax}$; V_{BE} = 0 V; T_j = 125 °C	I_{CES}	max.		3.0	mA
Emitter cut-off current					
V_{EB} = 5 V; I_C = 0	I_{EBO}	max.		1.0	mA
Saturation voltages					
$I_C = I_{Csat}$; $I_B = I_{Csat}/10$	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 mA; I_B = 0; L = 25 mH	$V_{CEOsust}$	min.	120	150	V
Switching times resistive load (Figs 4 and 5)					
$I_C = I_{Csat}$; $I_{B\,on} = I_{Csat}/10$; $I_{Boff} = 2I_{Bon}$					
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)					
$I_C = I_{Csat}$; $I_{B\,on} = I_{Csat}/10$; $V_{BE\,off}$ = −5 V					
Turn-off; storage time at T_j = 25 °C	t_s	typ.		0.6	µs
fall time	t_f	typ.		40	ns
Turn-off; storage time at T_j = 125 °C	t_s	max.		2.0	µs
fall time	t_f	max.		150	ns

DEVELOPMENT DATA

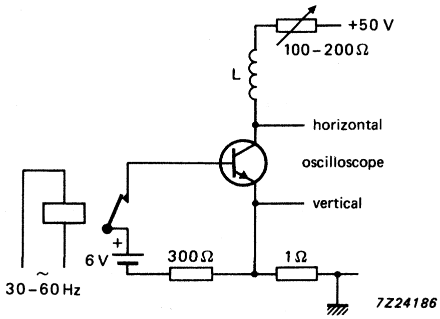


Fig. 2 Test circuit for $V_{CEOsust}$.

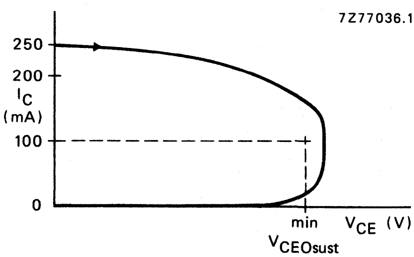
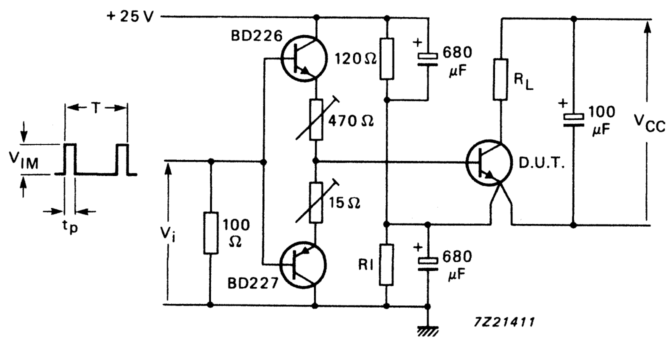


Fig. 3 Oscilloscope display for sustaining voltage.



t_p = 20 µs
T = 2 ms
V_{IM} = 15 V

Fig. 4 Test circuit resistive load; V_{CC} = 50 V; R_L = 100 Ω; R1 = 82 Ω.

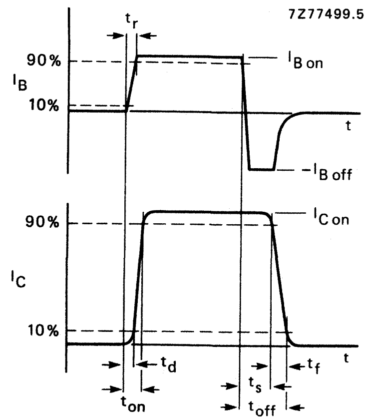
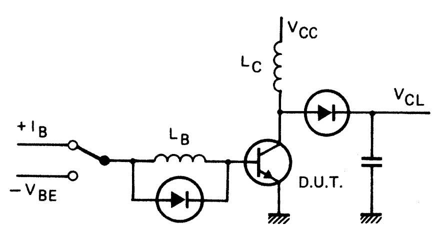


Fig. 5 Switching time waveforms with resistive load; $t_r \leqslant$ 30 ns.



V_{clamp} = 40 V
$-V_{BE}$ = −5 V

Fig. 6 Test circuit inductive load; V_{CC} = 50 V; L_C = 200 µH.

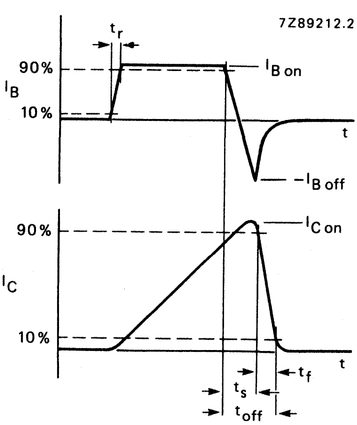
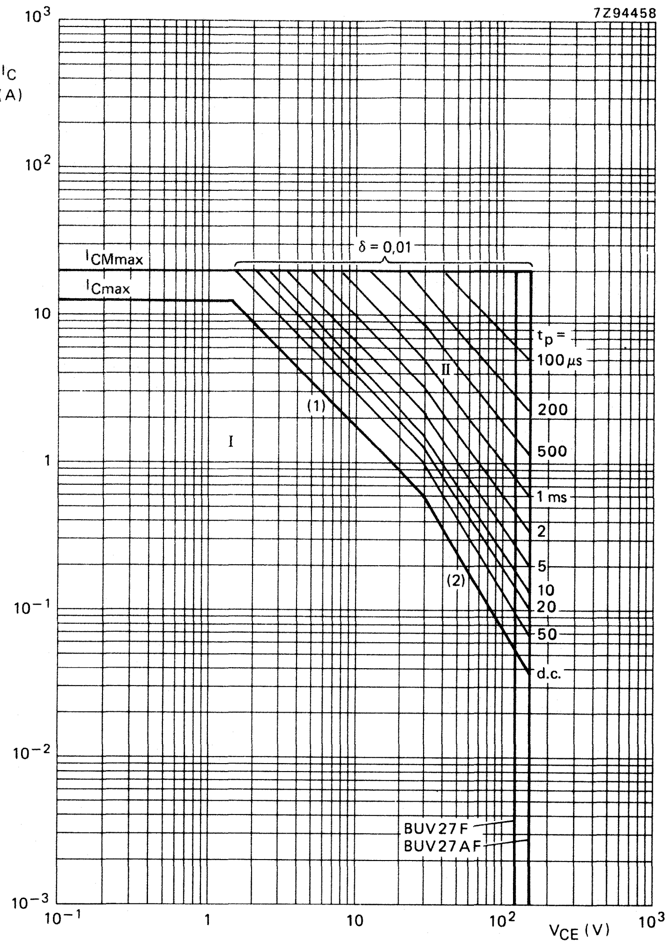


Fig. 7 Switching times waveforms with inductive load.



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 $T_{mb} < 25\ ^{o}C$; mounted without heatsink compound and 30 ± 5 newtons pressure on the centre of the envelope.

DEVELOPMENT DATA

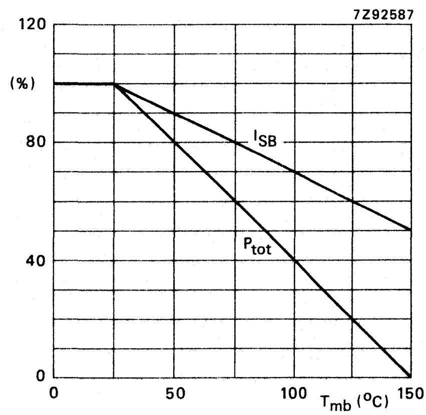


Fig. 9 Power dissipation and second-breakdown current derating curve.

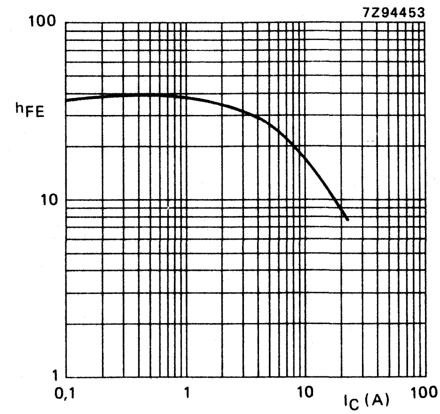


Fig. 10 Typical DC current gain; V_{CE} = 5 V; T_j = 25 °C.

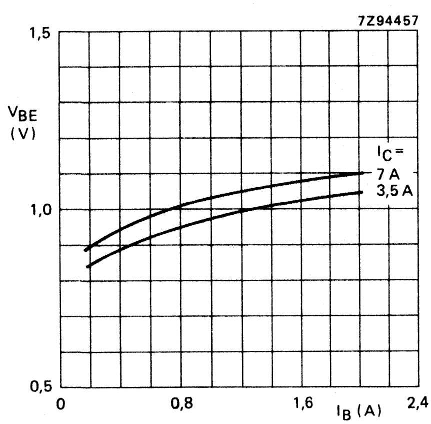


Fig. 11 Base-emitter voltage as a function of base current.

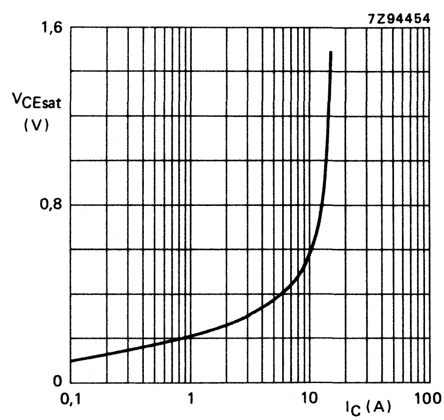


Fig. 12 Collector-emitter saturation voltage as a function of collector current; I_C/I_B = 10.

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.

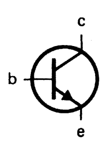
QUICK REFERENCE DATA

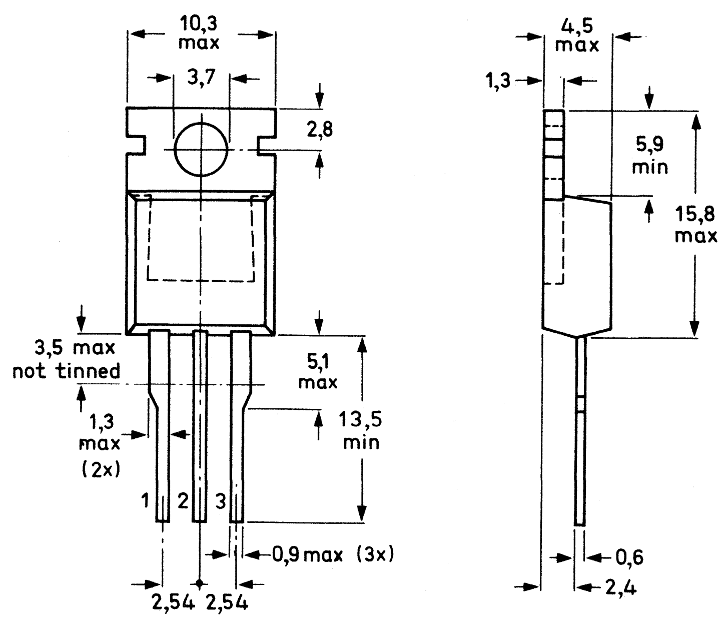
			BUV28	28A	
Collector-emitter voltage					
peak value; $V_{BE} = 0$	V_{CESM}	max.	400	450	V
open base	V_{CEO}	max.	200	225	V
Collector-emitter saturation voltage					
$I_C = I_{Csat}$	V_{CEsat}	max.	1,5		V
Collector current					
saturation	I_{Csat}	max.	6,0	4,0	A
DC	I_C	max.	12		A
peak value	I_{CM}	max.	20		A
Total power dissipation					
up to $T_{mb} = 25\ ^oC$	P_{tot}	max.	65		W
Fall time inductive load	t_f	typ.	40		ns

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-220AB.





7Z65872.5

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; $V_{BE} = 0$	V_{CESM}	max.	400	450	V
open base	V_{CEO}	max.	200	225	V
Collector current					
saturation	I_{Csat}	max.	6,0	4,0	A
DC	I_C	max.	12		A
peak value	I_{CM}	max.	20		A
Base current					
DC	I_B	max.	2,0		A
peak value	I_{BM}	max.	4,0		A
Total power dissipation					
up to $T_{mb} = 25\ ^oC$	P_{tot}	max.	65		W
Storage temperature range	T_{stg}		−65 to + 150		^oC
Junction temperature	T_j	max.	150		^oC

THERMAL RESISTANCE

From junction to mounting base	$R_{th\,j\text{-}mb}$	=	1,92	K/W

DEVELOPMENT DATA

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off currents*					
$V_{CE} = V_{CESMmax}$; V_{BE} = −1,5 V; T_j = 125 °C	I_{CEX}	max.	1,0		mA
$V_{CE} = V_{CESMmax}$; R_{BE} = 50 Ω; T_j = 125 °C	I_{CER}	max.	3,0		mA
Emitter cut-off current					
V_{EB} = 5 V; I_C = 0	I_{EBO}	max.	1,0		mA
			BUV28	28A	
Saturation voltages					
$I_C = I_{Csat}$; $I_B = I_{Csat}/10$	V_{CEsat}	max.	1,5	1,5	V
	V_{BEsat}	max.	2,0	2,0	V
$I_C = I_{Csat}/2$; $I_B = I_{Csat}/20$	V_{CEsat}	max.	0,7	0,7	V
Collector-emitter sustaining voltage (Figs 2 and 3)					
I_C = 0,2 A; I_B = 0; L = 25 mH	$V_{CEOsust}$	min.	200	225	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 V					
Turn-on time	t_{on}	typ.	0,3		μs
Turn-off; storage time	t_s	typ.	0,5		μs
fall time	t_f	typ.	0,1		μs
Turn-on time	t_{on}	max.	1,0		μs
Turn-off; storage time	t_s	max.	1,5		μs
fall time	t_f	max.	0,25		μs
Switching times inductive load (Figs 6 and 7)					
$I_{C\,on} = I_{Csat}$; $I_{B\,on} = I_{Csat}/10$; L_B = 3 μH; $-V_B$ = 5 V; $V_{CC} = V_{CL}$ = 50 V					
Turn-off; storage time at T_j = 25 °C	t_s	typ.	1,0		μs
fall time	t_f	typ.	40		ns
Turn-off; storage time at T_j = 125 °C	t_s	max.	3,0		μs
fall time	t_f	max.	200		ns

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

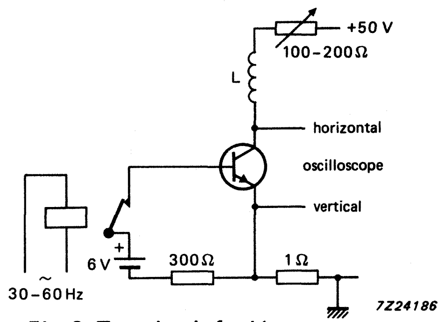


Fig. 2 Test circuit for $V_{CEOsust}$.

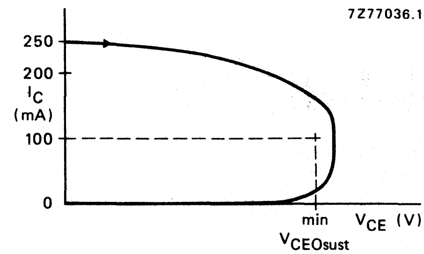
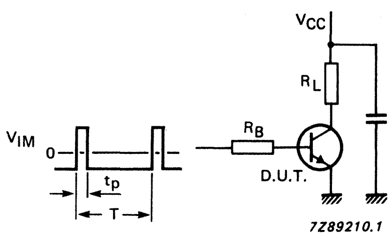


Fig. 3 Oscilloscope display for sustaining voltage.



V_{CC} = 50 V
t_p = 20 μs
V_{IM} = −6 to + 4,5 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.

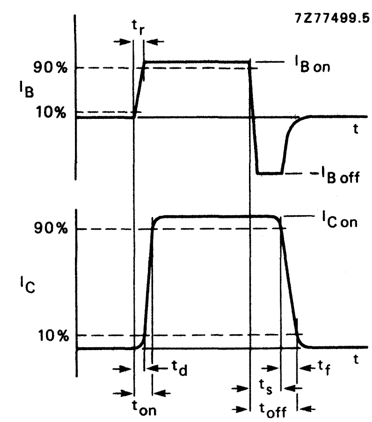
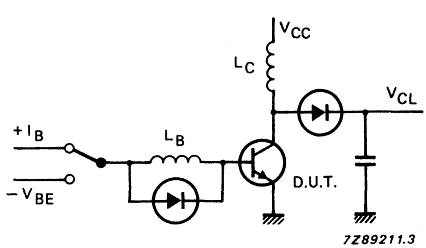


Fig. 5 Switching times waveforms with resistive load; $t_r \leqslant 30$ ns.



V_{CL} = up to 50 V
V_{CC} = 30 V
$-V_{BE}$ = 5 V
L_B = 0,5 μH
L_C = 200 μH

Fig. 6 Test circuit inductive load.

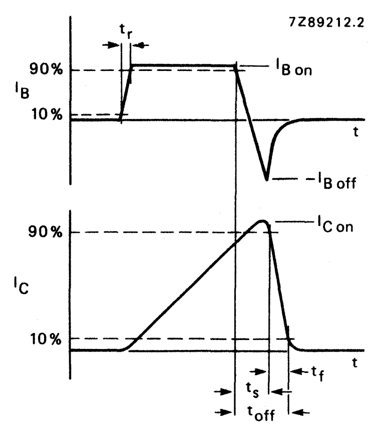


Fig. 7 Switching times waveforms with inductive load.

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.

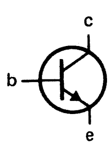
QUICK REFERENCE DATA

			BUV28F	28AF	
Collector-emitter voltage					
peak value; $V_{BE} = 0$	V_{CESM}	max.	400	450	V
open base	V_{CEO}	max.	200	225	V
Collector-emitter saturation voltage	V_{CEsat}	max.	1.5	1.5	V
Collector current					
saturation	I_{Csat}	max.	6.0	4.0	A
DC	I_C	max.	12		A
peak value	I_{CM}	max.	20		A
Total power dissipation					
up to $T_h = 25\ ^oC$	P_{tot}	max.	18		W
Fall time; inductive load	t_f	typ.	40		ns

MECHANICAL DATA

Dimensions in mm

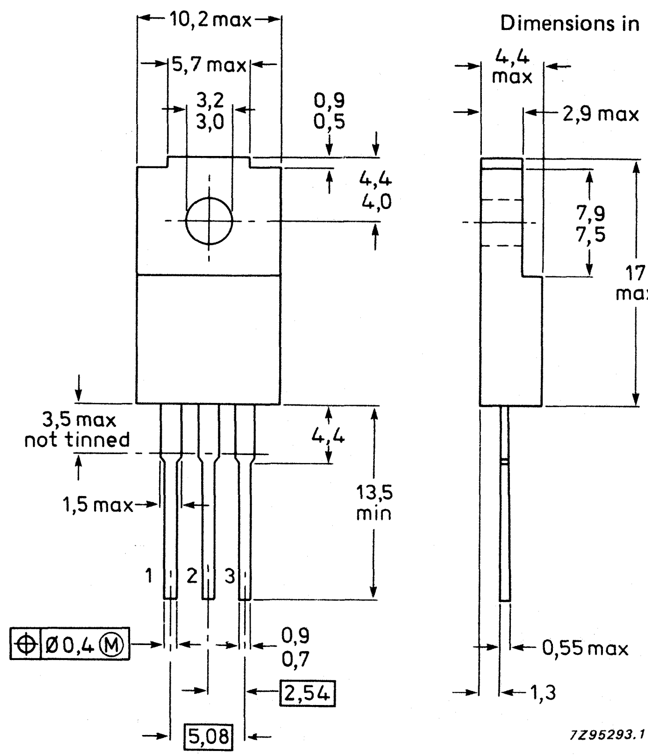
Fig. 1 SOT186.



Pinning:

1 = base
2 = collector
3 = emitter

Mounting base is electrically isolated from all terminals.



RATINGS

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

			BUV28F	28AF	
Collector-emitter voltage					
peak value; $V_{BE} = 0$	V_{CESM}	max.	400	450	V
open base	V_{CEO}	max.	200	225	V
Collector current					
saturation	I_{Csat}	max.	6.0	4.0	A
DC	I_C	max.	12		A
peak value	I_{CM}	max.	20		A
Base current					
DC	I_B	max.	2.0		A
peak value	I_{BM}	max.	4.0		A
Total power dissipation					
up to $T_h = 25\ ^oC$	P_{tot}	max.	18		W
Storage temperature range	T_{stg}		−65 to + 150		^oC
Junction temperature	T_j	max.	150		^oC

THERMAL RESISTANCE

From junction to heatsink (note 1)	$R_{th\ j\text{-}h}$	=	7.0	K/W
From junction to heatsink (note 2)	$R_{th\ j\text{-}h}$	=	4.5	K/W
From junction to ambient	$R_{th\ j\text{-}a}$	=	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 °C unless otherwise specified

			BUV28F	28AF	
Collector cut-off currents					
$V_{CE} = V_{CESmax}$; V_{BE} = −1.5 V; T_j = 125 °C	I_{CEX}	max.	1.0		mA
$V_{CE} = V_{CESmax}$; V_{BE} = 0 V; T_j = 125 °C	I_{CES}	max.	3.0		mA
Emitter cut-off current					
V_{EB} = 5 V; I_C = 0	I_{EBO}	max.	1.0		mA
Saturation voltages					
$I_C = I_{Csat}$; $I_B = I_{Csat}/10$	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 mA; I_B = 0; L = 25 mH	$V_{CEOsust}$	min.	200	225	V
Switching times resistive load (Figs 4 and 5)					
$I_{C\,on} = I_{Csat}$; $I_{B\,on} = I_{Csat}/10$; $I_{Boff} = 2I_{Bon}$					
Turn-on time	t_{on}	typ.	0.3		μs
Turn-off; storage time	t_s	typ.	0.5		μs
fall time	t_f	typ.	0.1		μs
Turn-on time	t_{on}	max.	1.0		μs
Turn-off; storage time	t_s	max.	1.5		μs
fall time	t_f	max.	0.25		μs
Switching times inductive load (Figs 6 and 7)					
$I_C = I_{Csat}$; $I_{B\,on} = I_{Csat}/10$ at T_j = 25 °C					
Turn-off; storage time at T_j = 25 °C	t_s	typ.	1.0		μs
fall time	t_f	typ.	40		ns
Turn-off; storage time at T_j = 125 °C	t_s	typ.	3.0		μs
fall time	t_f	max.	200		ns

DEVELOPMENT DATA

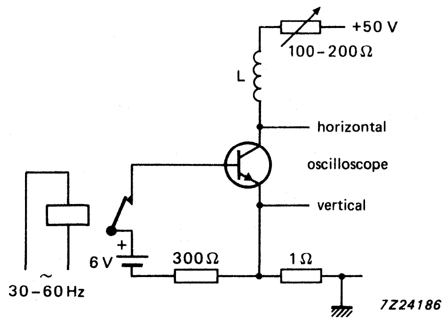


Fig. 2 Test circuit for $V_{CEOsust}$.

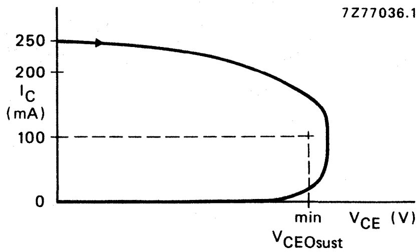
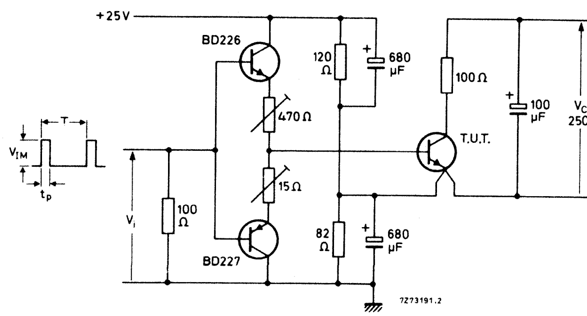


Fig. 3 Oscilloscope display for sustaining voltage.



t_p = 20 µs
T = 2 ms
V_{IM} = 15 V

Fig. 4 Test circuit resistive load; V_{CC} = 50 V; R_L = 4 Ω; R1 = 82 Ω.

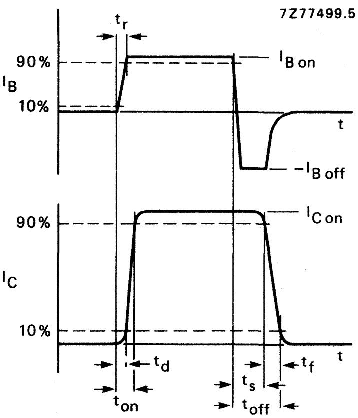


Fig. 5 Switching times waveforms with resistive load; $t_r \leqslant 30$ ns.

V_{clamp} = 40 V
$-V_{BE}$ = –5 V
L_B = 0.5 µH

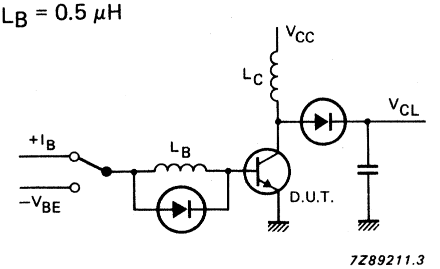


Fig. 6 Test circuit inductive load; V_{CC} = 30 V; L_C = 200 µH.

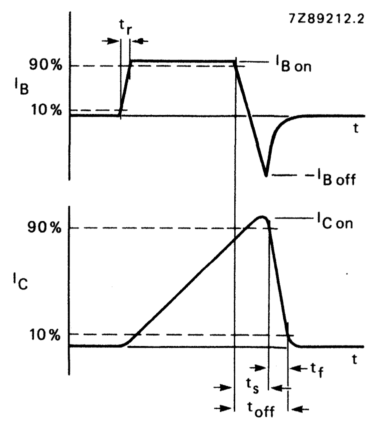
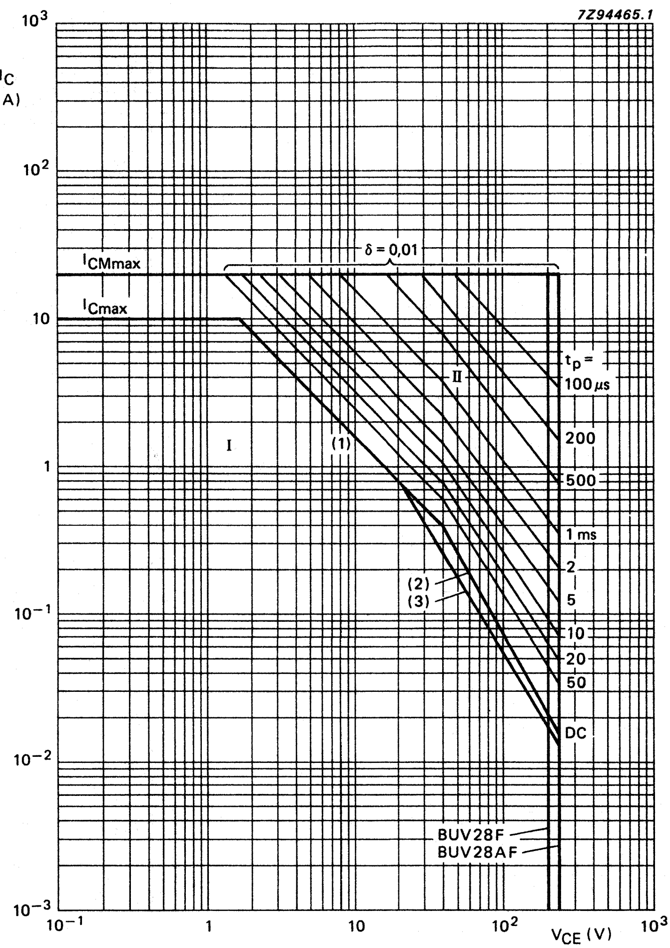


Fig. 7 Switching times waveforms with inductive load.



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 $T_{mb} < 25\ ^oC$.

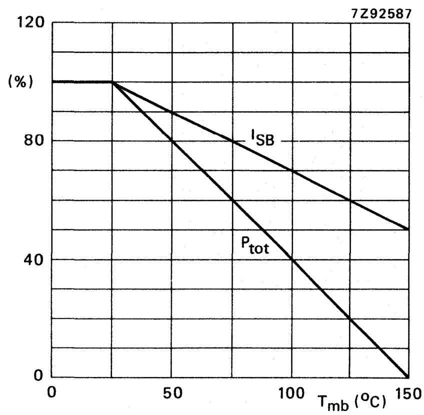


Fig. 9 Power dissipation and second-breakdown current derating curve.

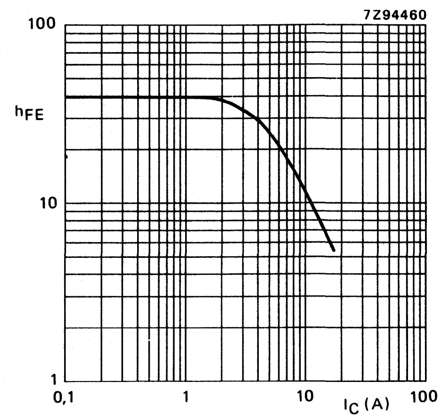


Fig. 10 Typical DC current gain; V_{CE} = 5 V; T_j = 25 °C.

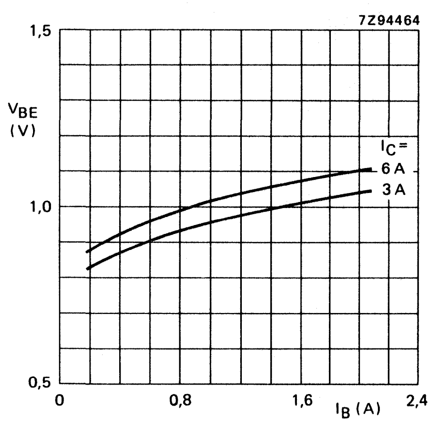


Fig. 11 Base-emitter voltage as a function of base current.

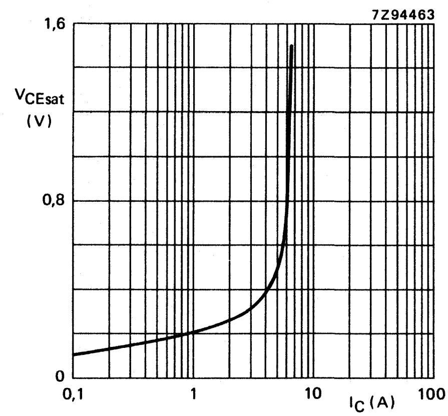


Fig. 12 Collector-emitter saturation voltage as a function of collector current; I_C/I_B = 10.

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

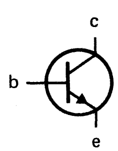
			BUV47	47A	
Collector-emitter voltage (peak value; $V_{BE} = 0$)	V_{CESM}	max.	850	1000	V
Collector-emitter voltage (open base)	V_{CEO}	max.	400	450	V
Collector current (DC)	I_C	max.	9		A
Collector current (peak value)	I_{CM}	max.	15		A
Total power dissipation up to $T_{mb} = 25\ ^oC$	P_{tot}	max.	120		W
Collector-emitter saturation voltage					
$I_C = 6$ A; $I_B = 1,2$ A	V_{CEsat}	max.	—	—	V
$I_C = 5$ A; $I_B = 1,0$ A	V_{CEsat}	max.	1,5	1,5	V
Fall time (resistive load)					
$I_{Con} = 6$ A; $I_{Bon} = -I_{Boff} = 1,2$ A	t_f	max.	—	—	μs
$I_{Con} = 5$ A; $I_{Bon} = -I_{Boff} = 1,0$ A	t_f	max.	0,8	0,8	μs

MECHANICAL DATA

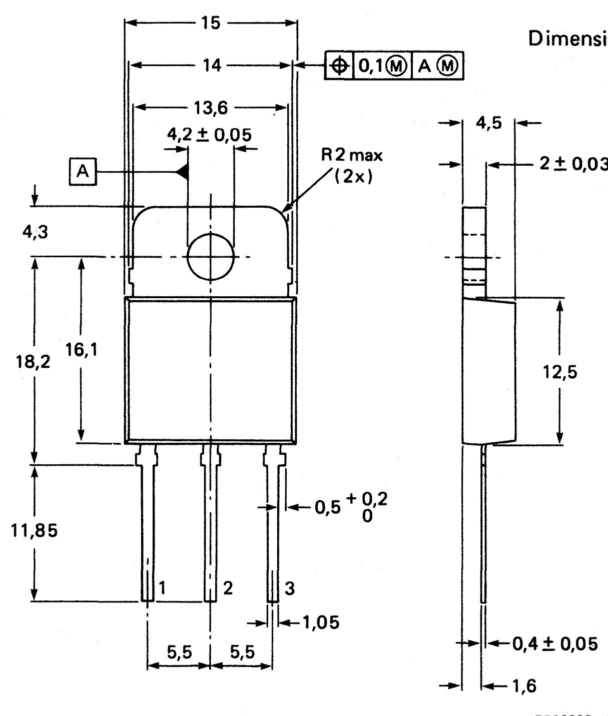
Dimensions in mm

Fig. 1 SOT93.

Collector connected to mounting base.



Pinning:
1 = base
2 = collector
3 = emitter



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 $T_{mb} = 25\ ^oC$	P_{tot}	max.	120		W
Storage temperature	T_{stg}		−65 to + 175		^oC
Junction temperature	T_j	max.	175		^oC

THERMAL RESISTANCE

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

CHARACTERISTICS

$T_j = 25\ ^oC$ unless otherwise specified

			BUV47	47A	
Collector cut-off current*					
$V_{CE} = V_{CEXmax}$; $V_{BE} = -2{,}5$ V	I_{CES}	max.	0,15		mA
$V_{CE} = V_{CEXmax}$; $V_{BE} = -2{,}5$ V; $T_j = 125\ ^oC$	I_{CES}	max.	1,5		mA
$V_{CE} = V_{CEXmax}$; $R_{BE} = 10\ \Omega$	I_{CER}	max.	0,4		mA
$V_{CE} = V_{CEXmax}$; $R_{BE} = 10\ \Omega$; $T_j = 125\ ^oC$	I_{CER}	max.	3,0		mA
Emitter cut-off current					
$I_C = 0$; $-V_{BE} = 5$ V	I_{EBO}	max.	1,0		mA
Collector-emitter sustaining voltage					
$I_C = 100$ mA; $I_B = 0$; L = 25 mH	$V_{CEOsust}$	min.	400	450	V

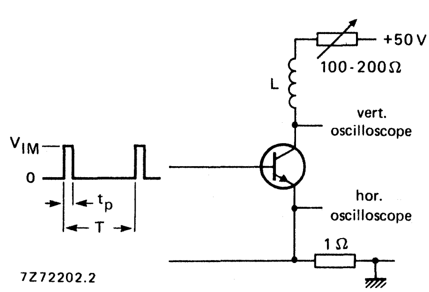


Fig. 2 Test circuit for $V_{CEOsust}$.
$V_{IM} = 6$ V; $t_p = 40$ ms; $\delta = 0{,}5$; $R_B = 300\ \Omega$.

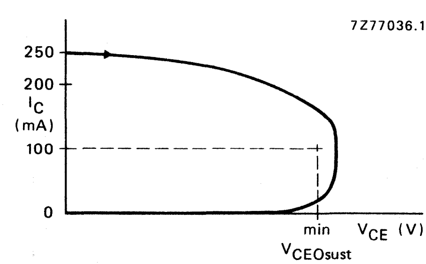


Fig. 3 Oscilloscope display for sustaining voltage.

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

			BUV47	47A	
Saturation voltages					
I_C = 9 A; I_B = 3 A	V_{CEsat}	max.	–	–	V
I_C = 6 A; I_B = 1,2 A	V_{CEsat}	typ.	–	–	V
		max.	–	–	V
	V_{BEsat}	max.	–	–	V
I_C = 8 A; I_B = 2,5 A	V_{CEsat}	max.	3	3	V
I_C = 5 A; I_B = 1 A	V_{CEsat}	typ.	0,6	0,6	V
		max.	1,5	1,5	V
	V_{BEsat}	max.	1,6	1,6	V
Switching times resistive load (Figs 4 and 5)					
I_{Con} = 6 A; I_{Bon} = $-I_{Boff}$ = 1,2 A					
Turn-on time	t_{on}	typ.	–	–	μs
		max.	–	–	μs
Turn-off: Storage time	t_s	typ.	–	–	μs
		max.	–	–	μs
Fall time	t_f	typ.	–	–	μs
		max.	–	–	μs
I_{Con} = 5 A; I_{Bon} = $-I_{Boff}$ = 1 A					
Turn-on time	t_{on}	typ.	0,34	0,34	μs
		max.	1,0	1,0	μs
Turn-off: Storage time	t_s	typ.	1,75	1,75	μs
		max.	3,0	3,0	μs
Fall time	t_f	typ.	0,36	0,36	μs
		max.	0,8	0,8	μs

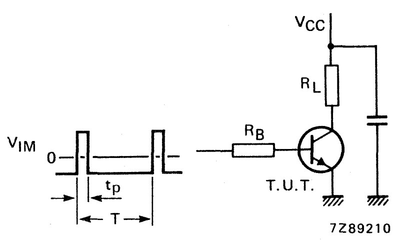


Fig. 4 Test circuit resistive load.
V_{CC} = 150 V; V_{IM} = –6 to + 8 V;
t_p/T = 0,01; t_p = 20 μs.
The values of R_B and R_L are selected in accordance with I_{Con} and I_B requirements.

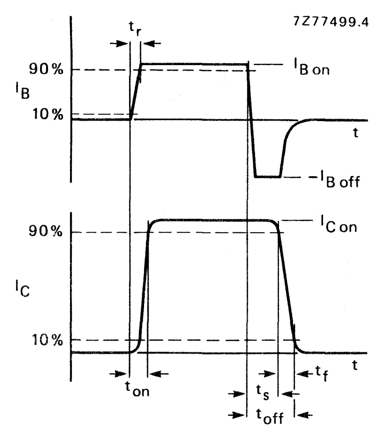


Fig. 5 Switching times waveforms with resistive load.

CHARACTERISTICS (continued)

			BUV47	47A	
Switching times inductive load (Figs 6 and 7)					
I_{Con} = 6 A; I_{Bon} = 1,2 A					
Turn-off: Storage time	t_s	typ.			
Fall time	t_f	typ.	—	—	ns
I_{Con} = 6 A; I_{Bon} = 1,2 A; T_j = 100 °C					
Turn-off: Storage time	t_s	max.			
Fall time	t_f	max.	—	—	μs
I_{Con} = 5 A; I_{Bon} = 1,0 A					
Turn-off: Storage time	t_s	typ.			
Fall time	t_f	typ.	90	90	ns
I_{Con} = 5 A; I_{Bon} = 1,0 A; T_j = 100 °C					
Turn-off: Storage time	t_s	max.			
Fall time	t_f	max.	0,4	0,4	μs

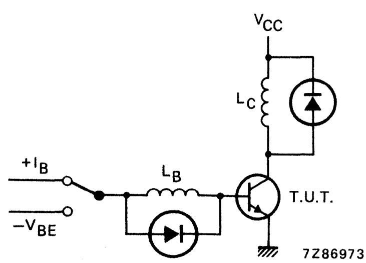


Fig. 6 Test circuit inductive load.
V_{CC} = 300 V; $-V_{BE}$ = 5 V;
L_B = 3 μH; L_C = 1 mH.

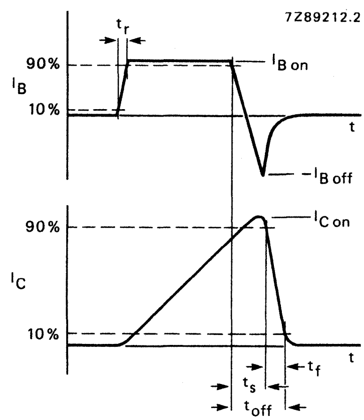
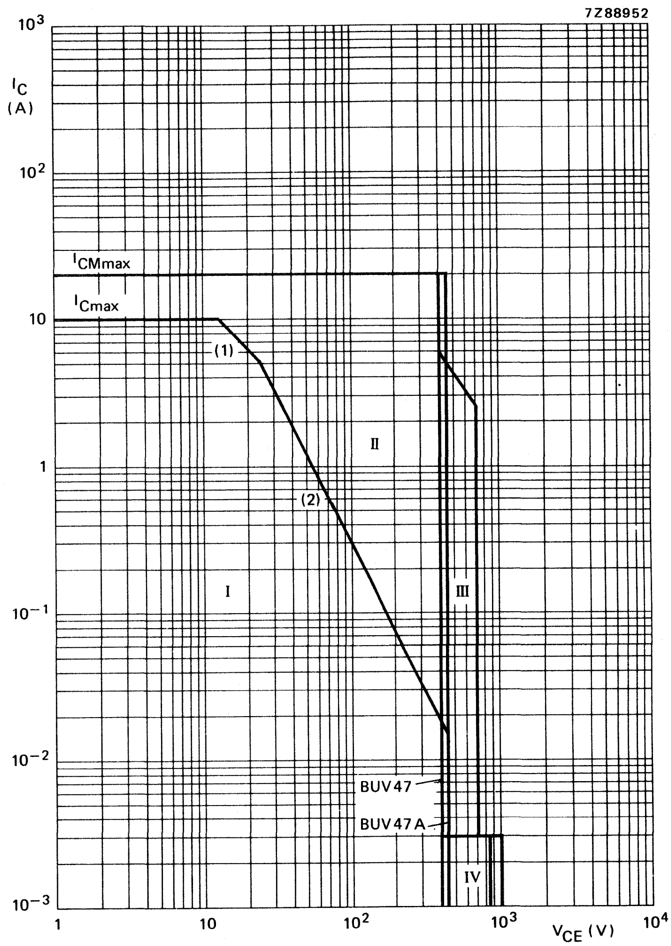


Fig. 7 Switching times waveforms with inductive load.



(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 $R_{BE} \leqslant 100\ \Omega$ and $t_p \leqslant 0{,}6\ \mu s$.
IV Repetitive pulse operation in this region is permissible provided $V_{BE} \leqslant 0$ and $t_p \leqslant 2$ ms.

Fig. 8 Safe Operating Area at $T_{mb} \leqslant 25\ ^oC$.

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

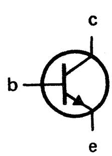
			BUV48	BUV48A	
Collector-emitter voltage (peak value; $V_{BE} = 0$)	V_{CESM}	max.	850	1000	V
Collector-emitter voltage (open base)	V_{CEO}	max.	400	450	V
Collector current (DC)	I_C	max.	15		A
Collector current (peak value)	I_{CM}	max.	30		A
Total power dissipation up to $T_{mb} = 25\ ^oC$	P_{tot}	max.	150		W
Collector-emitter saturation voltage					
$I_C = 10$ A; $I_B = 2$ A	V_{CEsat}	max.	1.5	—	V
$I_C = 8$ A; $I_B = 1.8$ A	V_{CEsat}	max.	—	1.5	V
Fall time (resistive load)					
$I_{Con} = 10$ A; $I_{Bon} = -I_{Boff} = 2$ A	t_f	max.	0.8	—	μs
$I_{Con} = 8$ A; $I_{Bon} = -I_{Boff} = 1.6$ A	t_f	max.	—	0.8	μs

MECHANICAL DATA

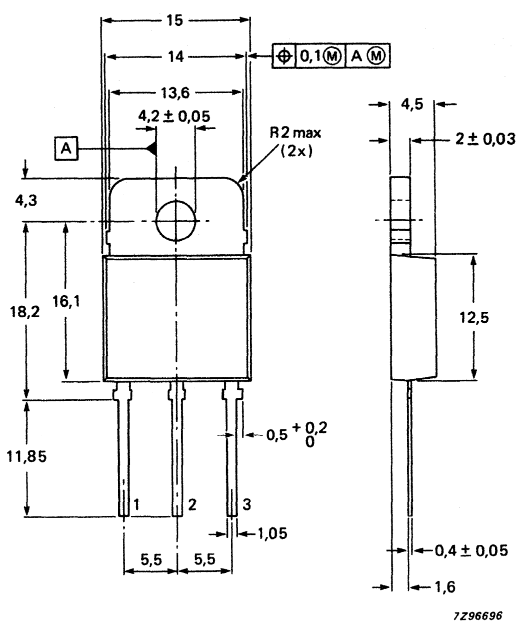
Dimensions in mm

Fig.1 SOT93.

Collector connected to mounting base.



Pinning:
1 = base
2 = collector
3 = emitter



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 °C	P_{tot}	max.	150		W
Storage temperature	T_{stg}		−65 to + 175		°C
Junction temperature	T_j	max.	175		°C

THERMAL RESISTANCE

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

CHARACTERISTICS

T_{mb} = 25 °C unless otherwise specified

Collector cut-off current*				
$V_{CE} = V_{CBOmax}$; $V_{BE} = 0$	I_{CES}	max.	0,2	mA
$V_{CE} = V_{CBOmax}$; $V_{BE} = 0$; T_{mb} = 125 °C	I_{CES}	max.	2	mA
$V_{CE} = V_{CBOmax}$; $R_{BE} \leqslant 10\ \Omega$	I_{CER}	max.	0,5	mA
$V_{CE} = V_{CBOmax}$; $R_{BE} \leqslant 10\ \Omega$; T_{mb} = 125 °C	I_{CER}	max.	4	mA
Emitter cut-off current				
$I_C = 0$; $V_{EB} = 5$ V	I_{EBO}	max.	1	mA
Emitter-base breakdown voltage				
$I_C = 0$; $I_B = 50$ mA	$V_{(BR)EBO}$		7 to 30	V

Saturation voltages			BUV48	BUV48A	
I_C = 15 A; I_B = 3 A	V_{CEsat}	max.	5	–	V
I_C = 10 A; I_B = 2 A	V_{CEsat}	max.	1,5	–	V
	V_{BEsat}	max.	1,6	–	V
I_C = 12 A; I_B = 2,4 A	V_{CEsat}	max.	–	5	V
I_C = 8 A; I_B = 1,6 A	V_{CEsat}	max.	–	1,5	V
	V_{BEsat}	max.	–	1,6	V

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

DEVELOPMENT SAMPLE DATA

Collector-emitter sustaining voltage
I_C = 200 mA; I_{Boff} = 0; L = 25 mH

		BUV48	BUV48A	
$V_{CEOsust}$	min.	400	450	V

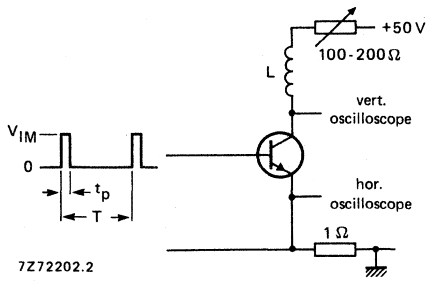


Fig. 2 Test circuit for $V_{CEOsust}$.
V_{IM} = 6 V; t_p = 40 ms; δ = 0,5; R_B = 300 Ω.

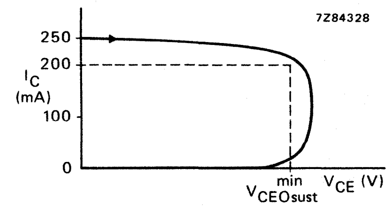


Fig. 3 Oscilloscope display for sustaining voltage.

Switching times resistive load (Figs 4 and 5)

			BUV48	BUV48A	
I_{Con} = 10 A; I_{Bon} = $-I_{Boff}$ = 2 A					
Turn-on time	t_{on}	typ.	0,55	–	μs
		max.	1,0	–	μs
Turn-off: Storage time	t_s	typ.	1,5	–	μs
		max.	3,0	–	μs
Fall time	t_f	typ.	0,3	–	μs
		max.	0,8	–	μs
I_{Con} = 8 A; I_{Bon} = $-I_{Boff}$ = 1,6 A					
Turn-on time	t_{on}	typ.	–	0,55	μs
		max.	–	1,0	μs
Turn-off: Storage time	t_s	typ.	–	1,5	μs
		max.	–	3,0	μs
Fall time	t_f	typ.	–	0,3	μs
		max.	–	0,8	μs

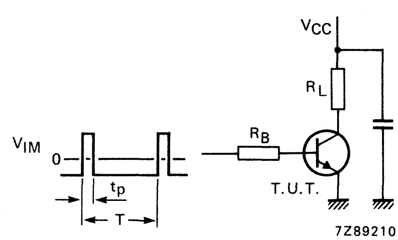


Fig. 4 Test circuit resistive load.
V_{CC} = 150 V; V_{IM} = −6 to + 8 V;
t_p = 20 μs; δ = t_p/T = 0,01.
The values of R_B and R_L are selected in accordance with I_{Con} and I_B requirements.

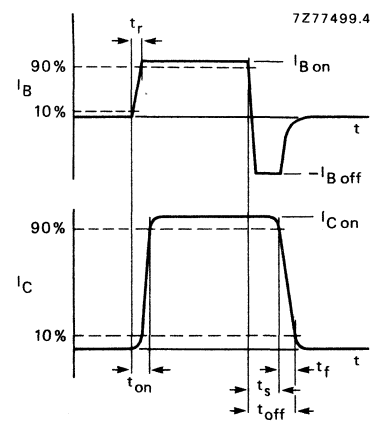


Fig. 5 Switching times waveforms with resistive load.

Switching times inductive load (Figs 6 and 7)

			BUV48	BUV48A	
I_{Con} = 10 A; I_{Bon} = 2 A;					
Turn-off: Storage time	t_s	typ.	3,5	–	μs
Fall time	t_f	typ.	0,08	–	μs
I_{Con} = 10 A; I_{Bon} = 2 A; T_j = 100 °C					
Turn-off: Storage time	t_s	max.	5,0	–	μs
Fall time	t_f	max.	0,4	–	μs
I_{Con} = 8 A; I_{Bon} = 1,6 A;					
Turn-off: Storage time	t_s	typ.	–	3,5	μs
Fall time	t_f	typ.	–	0,08	μs
I_{Con} = 8 A; I_{Bon} = 1,6 A; T_j = 100 °C					
Turn-off: Storage time	t_s	max.	–	5,0	μs
Fall time	t_f	max.	–	0,4	μs

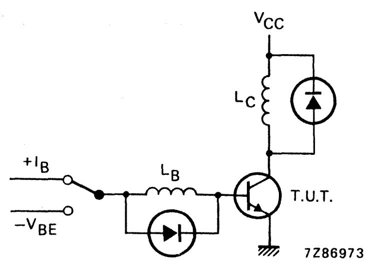


Fig. 6 Test circuit inductive load.

V_{CC} = 300 V; $-V_{BE}$ = 5 V; L_B = 3 μH; L_C = 1 mH

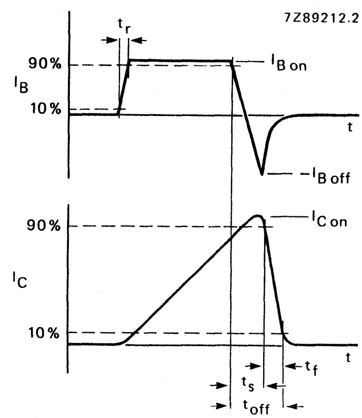
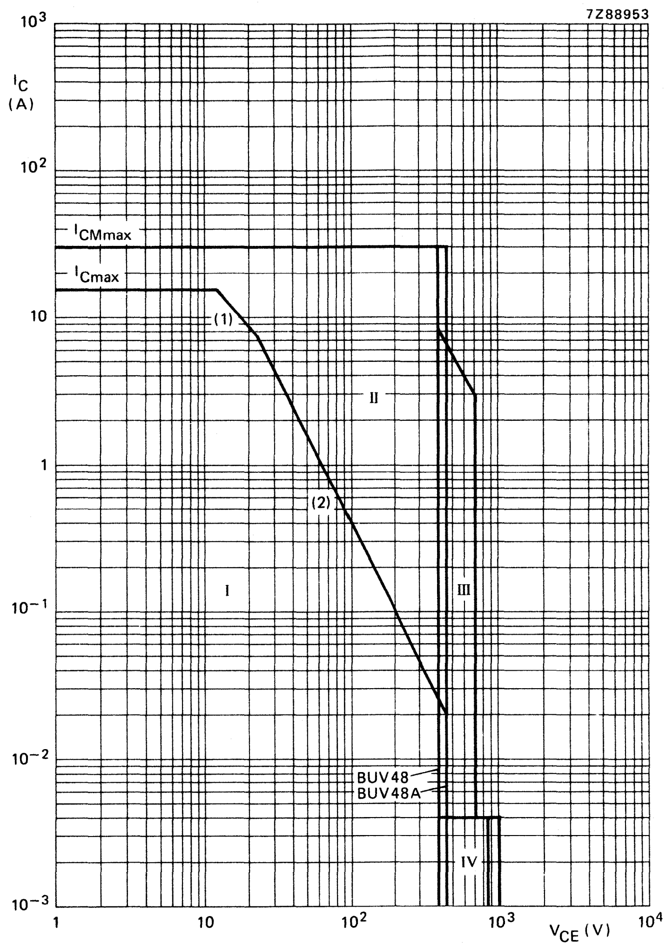


Fig. 7 Switching times waveforms with inductive load.

DEVELOPMENT SAMPLE DATA



(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 $R_{BE} \leqslant 100\ \Omega$ and $t_p \leqslant 0,6\ \mu s$.
IV Repetitive pulse operation in this region is permissible provided $V_{BE} \leqslant 0$ and $t_p \leqslant 2$ ms.

Fig. 8 Safe Operating Area at $T_{mb} \leqslant 25\ ^{\circ}C$.

SILICON DIFFUSED POWER TRANSISTORS

High voltage, high speed switching npn power transistor in plastic SOT93 envelope, intended for use in converters, inverters, switching regulators, motor control systems and switching applications.

QUICK REFERENCE DATA

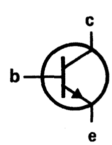
			BUV82	BUV83	
Collector-emitter voltage (peak value; V_{BE} = 0)	V_{CESM}	max.	850	1000	V
Collector-emitter voltage (R_{BE} = 100 Ω)	V_{CER}	max.	500	500	V
Collector-emitter voltage (open base)	V_{CEO}	max.	400	450	V
Collector-emitter saturation voltage	V_{CEsat}	max.	1,5		V
Collector current (DC)	I_C	max.	6		A
Collector current (peak value)	I_{CM}	max.	10		A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	100		W
Fall time	t_f	typ.	0,3		μs

MECHANICAL DATA

Dimensions in mm

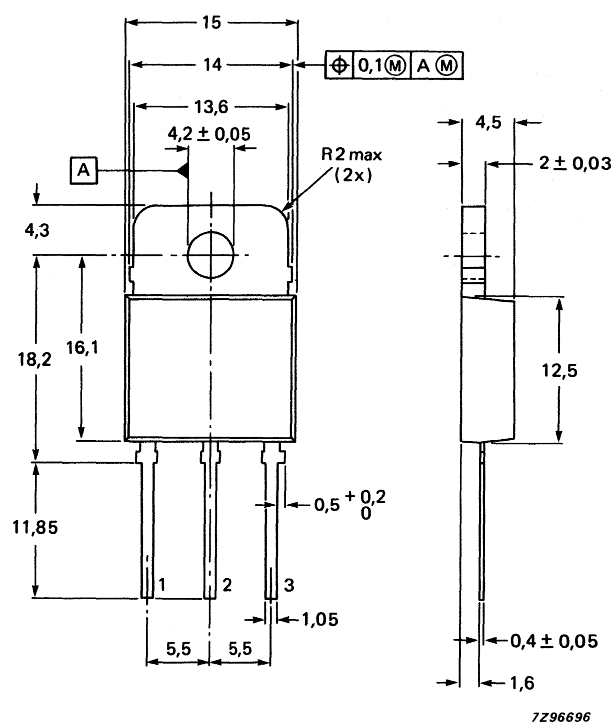
Fig. 1 SOT93.

Collector connected to mounting base.



Pinning:

1 = base
2 = collector
3 = emitter



RATINGS

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

			BUV82	BUV83	
Collector-emitter voltage peak value; $V_{BE} = 0$	V_{CESM}	max.	850	1000	V
Collector-emitter voltage ($R_{BE} = 100\ \Omega$)	V_{CER}	max.	500	500	V
Collector-emitter voltage (open base)	V_{CEO}	max.	400	450	V
Collector current (DC)	I_C	max.	6		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)	I_{BM}	max.	3		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.	3		A
Total power dissipation up to $T_{mb} = 25\ ^oC$	P_{tot}	max.	100		W
Storage temperature range	T_{stg}		−65 to + 150		^oC
Junction temperature	T_j	max.	150		^oC

THERMAL RESISTANCE

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

CHARACTERISTICS

$T_j = 25\ ^oC$ unless otherwise specified

Collector cut-off current**				
$V_{CE} = V_{CESMmax}$; $V_{BE} = 0$	I_{CES}	max.	1	mA
$V_{CE} = V_{CESMmax}$; $V_{BE} = 0$; $T_j = 125\ ^oC$	I_{CES}	max.	2	mA
DC current gain				
$I_C = 0,6$ A; $V_{CE} = 5$ V	h_{FE}	typ.	22	

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

T_j = 25 °C unless otherwise specified

Emitter cut-off current				
I_C = 0; V_{EB} = 10 V	I_{EBO}	max.	10	mA
Saturation voltages				
I_C = 2,5 A; I_B = 0,5 A	V_{CEsat}	max.	1,5	V
	V_{BEsat}	max.	1,4	V
I_C = 4 A; I_B = 1,25 A	V_{CEsat}	max.	3	V
	V_{BEsat}	max.	1,6	V

			BUV82	BUV83	
Collector-emitter sustaining voltages					
I_C = 100 mA; I_{Boff} = 0; L = 25 mH	$V_{CEOsust}$	min.	400	450	V
I_C = 100 mA; R_{BE} = 100 Ω; L = 15 mH	$V_{CERsust}$	min.	500	500	V

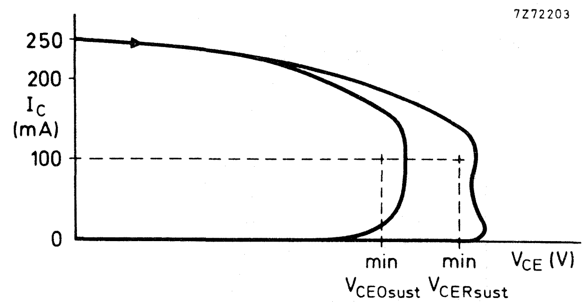


Fig. 2 Oscilloscope display for sustaining voltages.

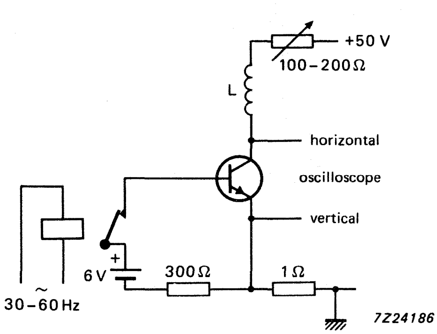


Fig. 3 Test circuit for $V_{CEOsust}$.

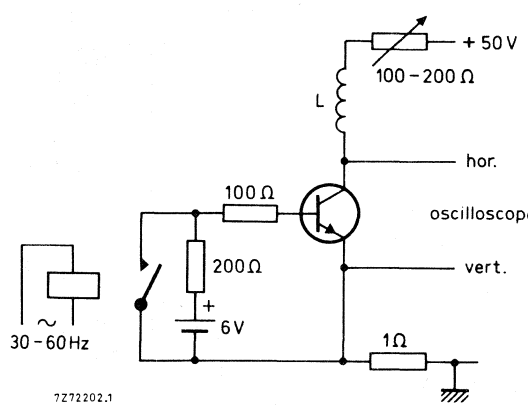


Fig. 4 Test circuit for $V_{CERsust}$.

CHARACTERISTICS (continued)

T_j = 25 °C unless otherwise specified

Transition frequency at f = 1 MHz I_C = 0,2 A; V_{CE} = 10 V	f_T	typ.	6 MHz
Switching times I_{Con} = 2,5 A; V_{CC} = 250 V I_{Bon} = 0,5 A; $-I_{Boff}$ = 1 A Turn-on time	t_{on}	typ. min.	0,3 μs 0,6 μs
Turn-off: Storage time	t_s	typ. min.	2 μs 3,5 μs
Fall time	t_f	typ.	0,3 μs
Fall time, T_{mb} = 95 °C	t_f	min.	0,75 μs

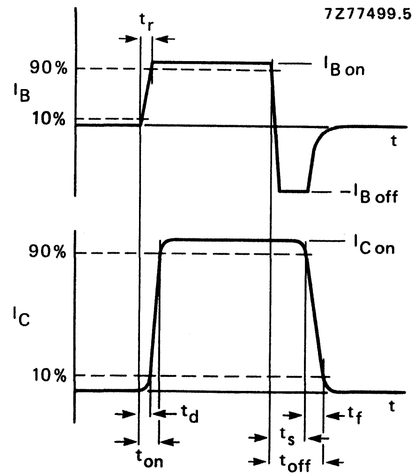
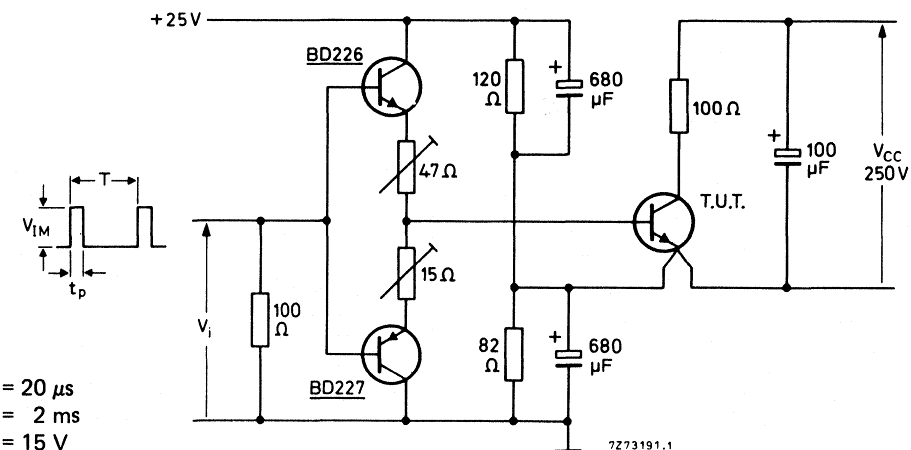
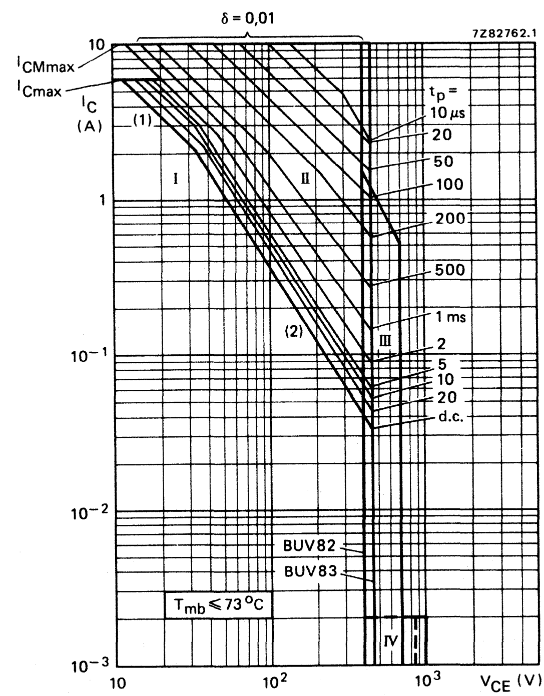


Fig. 5 Switching times waveform.



t_p = 20 μs
T = 2 ms
V_{IM} = 15 V

Fig. 6 Switching times test circuit.



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 $R_{BE} \leqslant 100\ \Omega$ and $t_p \leqslant 0{,}6\ \mu s$.

IV Repetitive pulse operation in this region is permissible, provided $V_{BE} \leqslant 0$ and $t_p \leqslant 5$ ms.

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

(2) Second-breakdown limits.

Fig. 7 Safe operating area.

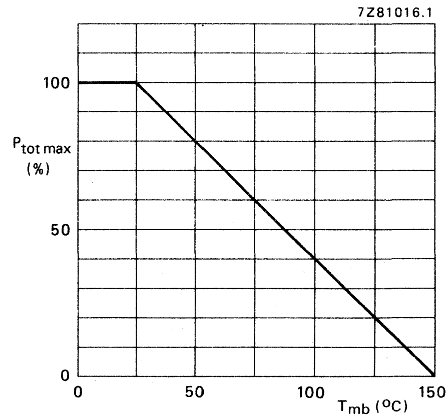


Fig. 8 Power derating curve.

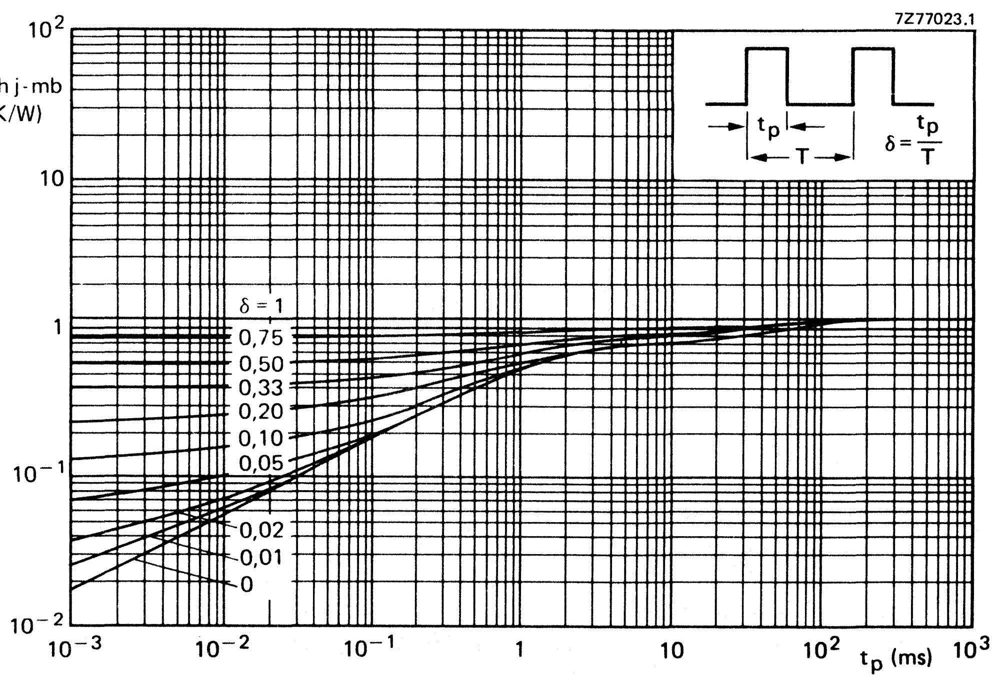


Fig. 9 Pulse power rating chart.

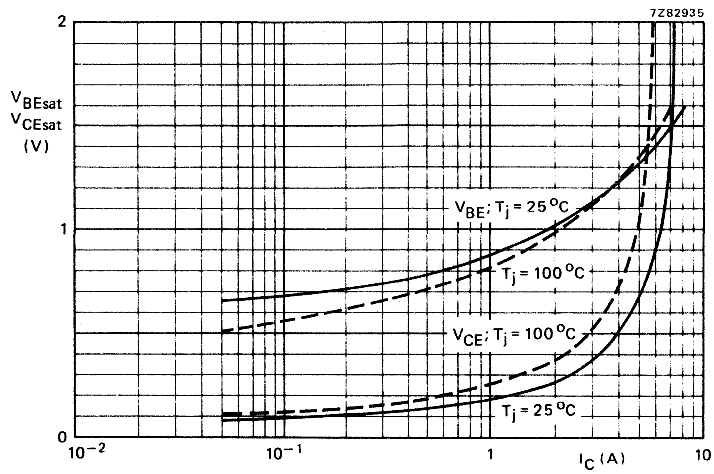


Fig. 10 Typical values base-emitter and collector-emitter voltage, I_C/I_B = 5.

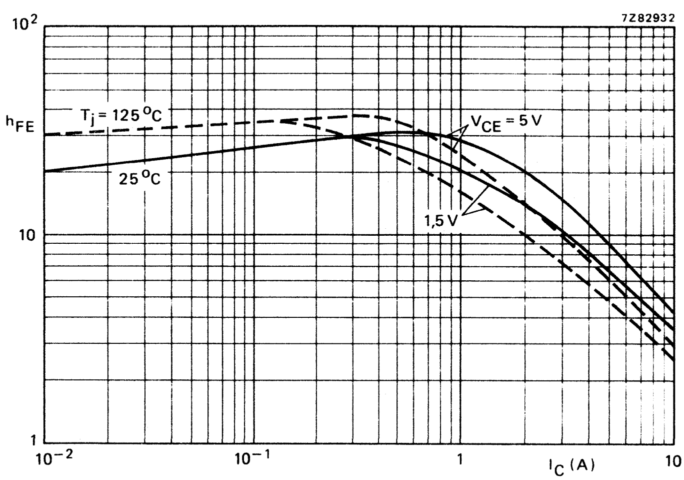


Fig. 11 Typical values DC current gain.

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.

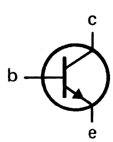
QUICK REFERENCE DATA

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 $T_{mb} = 25\ ^oC$	P_{tot}	max.	125	W
Turn-off fall time	t_f	typ.	0.5	μs

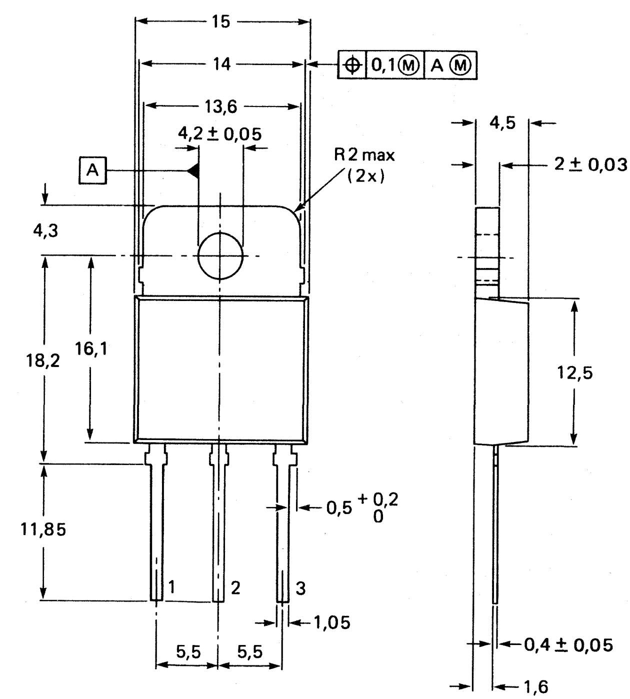
MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT93.



Pinning:
1 = base
2 = collector
3 = emitter



Collector connected to the mounting base.

7Z96696

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 $T_{mb} = 25\ ^oC$	P_{tot}	max.	125	W
Storage temperature range	T_{stg}		−65 to + 150	^oC
Junction temperature	T_j	max.	150	^oC

THERMAL RESISTANCE

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

CHARACTERISTICS

$T_j = 25\ ^oC$ unless otherwise specified

Collector cut-off current*				
$V_{BE} = 0$; $V_{CE} = V_{CESMmax}$	I_{CES}	max.	1,0	mA
$V_{BE} = 0$; $V_{CE} = V_{CESMmax}$; $T_j = 125\ ^oC$	I_{CES}	max.	2,0	mA
Emitter cut-off current				
$V_{EB} = 5$ V; $I_C = 0$	I_{EBO}	max.	10	mA
Collector-emitter sustaining voltage				
$I_B = 0$; $I_C = 100$ mA; L = 25 mH	$V_{CEOsust}$	min.	800	V
Saturation voltage				
$I_C = 4,5$ A; $I_B = 2$ A	V_{CEsat}	max.	1	V
$I_C = 6$ A; $I_B = 3$ A	V_{BEsat}	max.	1,3	V
	V_{CEsat}	typ.	1	V
Transition frequency at f = 5 MHz				
$I_C = 0,1$ A; $V_{CE} = 5$ V	f_T	typ.	7	MHz
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; $V_{CB} = 10$ V	C_c	typ.	125	pF
Switching times in resistive switching circuit (Fig. 5)				
$I_{Con} = 4,5$ A; $I_{Bon} = -I_{Boff} = 2$ 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				
$V_{CE} = 100$ V; $t_p = 1$ s	I_{SB}	min.	0,3	A

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

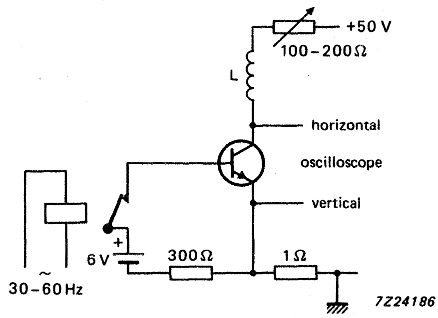


Fig. 2 Test circuit for $V_{CEOsust}$

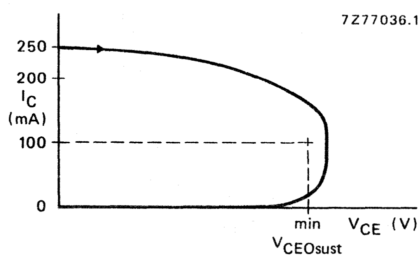


Fig. 3 Oscilloscope display for $V_{CEOsust}$.

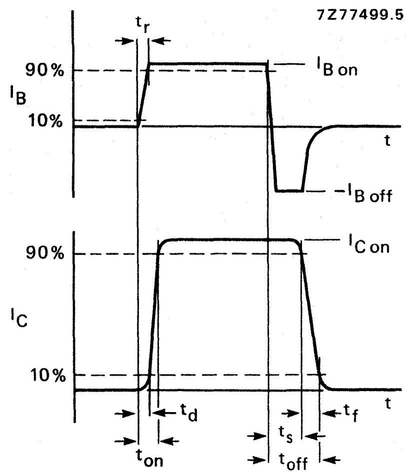


Fig. 4 Waveforms.

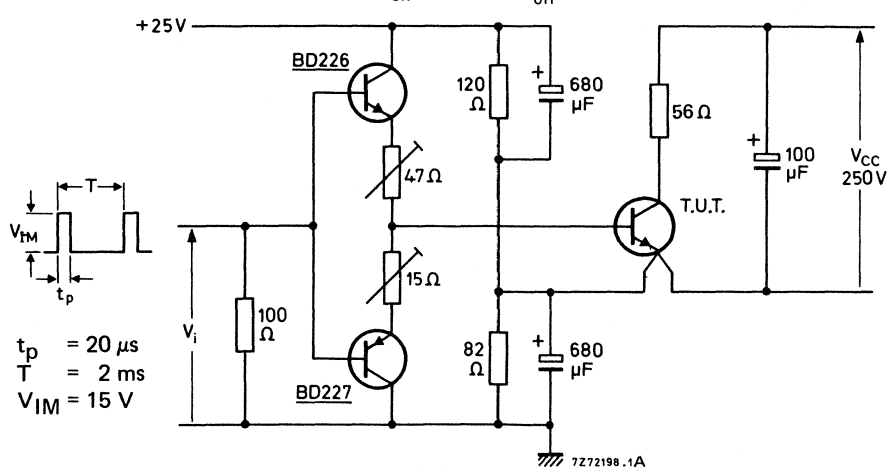
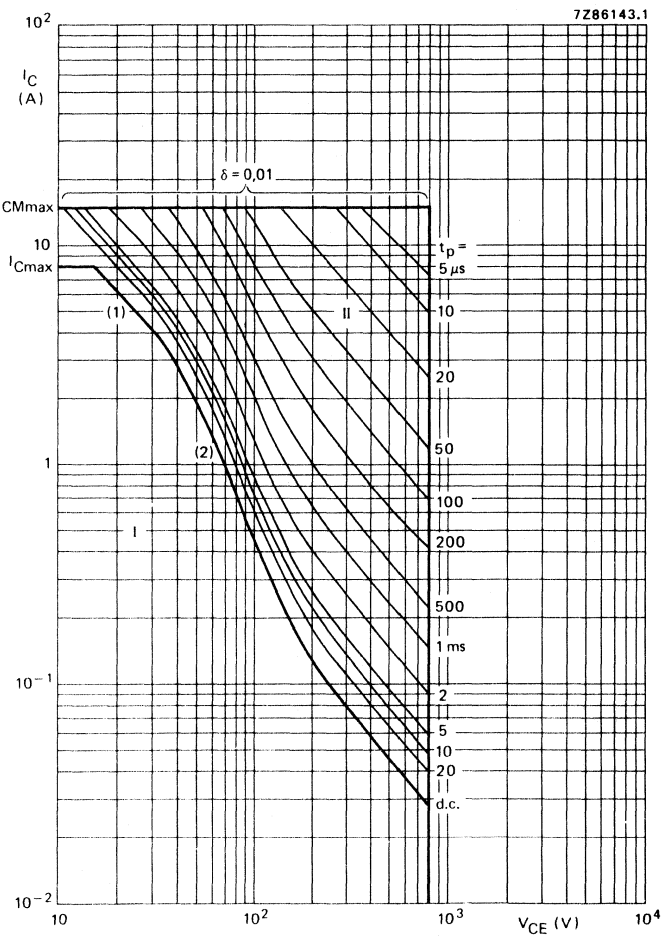


Fig. 5 Switching times test circuit.



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; $T_{mb} \leqslant 25\ ^{o}C$.

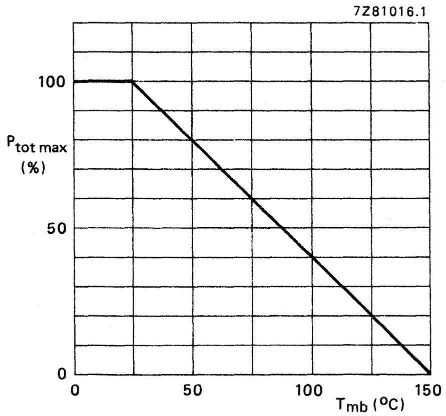


Fig. 7 Power derating curve.

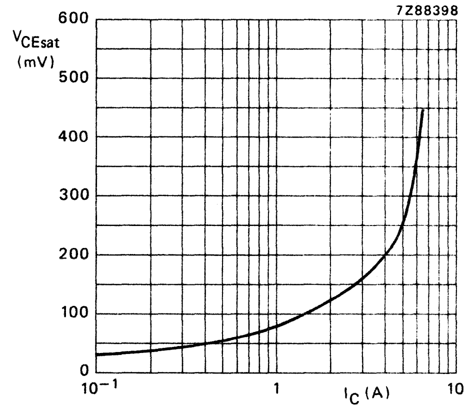


Fig. 8 Typical values $I_C/I_B = 2$; $T_j = 25\ ^oC$.

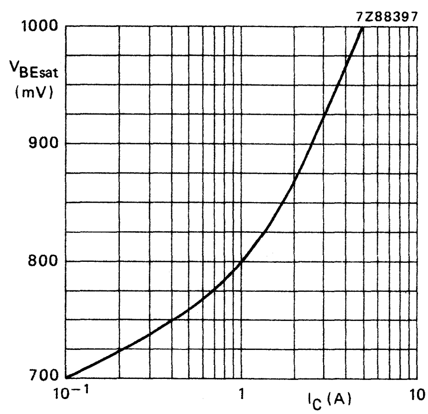


Fig. 9 Typical values $I_C/I_B = 2$; $T_j = 25\ ^oC$.

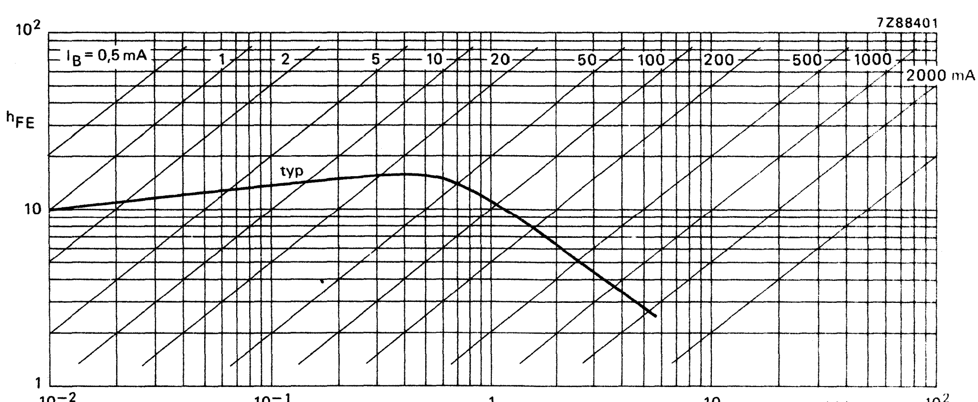


Fig. 10 Typical values DC current gain at $V_{CE} = 5$ V; $T_{mb} = 25\ ^oC$.

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.

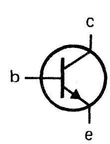
QUICK REFERENCE DATA

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 $T_{mb} = 25\ ^{o}C$	P_{tot}	max.	125	W
Fall time (inductive switching)	t_f	typ.	1	μs

MECHANICAL DATA

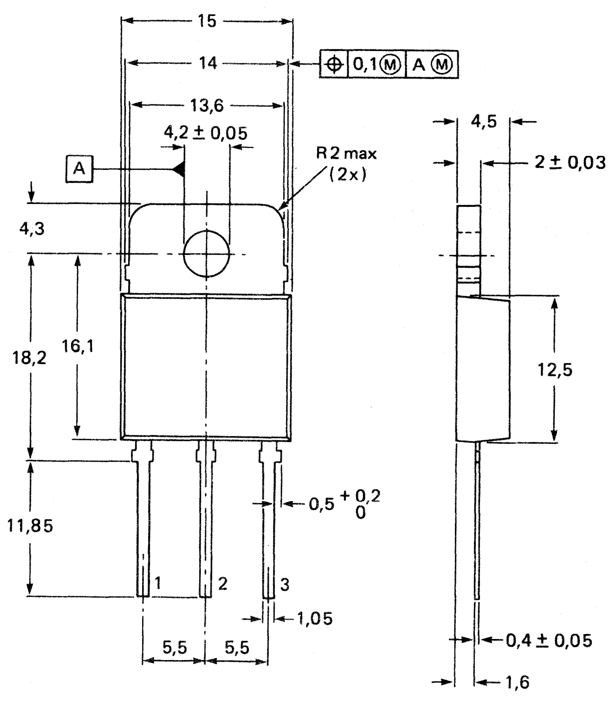
Dimensions in mm

Fig. 1 SOT-93.



Pinning:
1 = base
2 = collector
3 = emitter

Collector connected to mounting base.



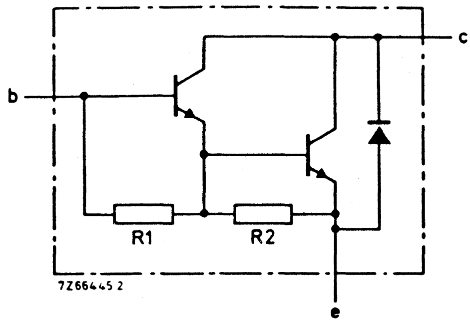


Fig. 2 Darlington circuit diagram
R1 typical 500 Ω
R2 typical 300 Ω

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 $T_{mb} = 25\ ^oC$	P_{tot}	max.	125	W
Storage temperature range	T_{stg}		−65 to +150	^oC
Junction temperature	T_j	max.	150	^oC

THERMAL RESISTANCE

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

CHARACTERISTICS

$T_j = 25\ ^oC$ unless otherwise specified

Collector cut-off current*				
$V_{CE} = V_{CESMmax}$; $V_{BE} = 0$	I_{CES}	max.	1	mA
$V_{CE} = V_{CESMmax}$; $V_{BE} = 0$; $T_j = 125\ ^oC$	I_{CES}	max.	3	mA
Emitter cut-off current				
$I_C = 0$; $V_{EB} = 6$ V	I_{EBO}	max.	20	mA
Collector-emitter sustaining voltage				
$I_C = 5$ A; $I_B = 0$; L = 8 mH	$V_{CEOsust}$	min.	400	V
Diode forward voltage				
$I_F = 8$ A; $I_B = 0$	V_F	max.	3	V

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

Saturation voltages			
$I_C = 5$ A; $I_B = 50$ mA	V_{CEsat}	max.	1.5 V
	V_{BEsat}	max.	2 V
$I_C = 5$ A; $I_B = 60$ mA; $T_j = -40$ °C	V_{CEsat}	max.	1.5 V
	V_{BEsat}	max.	2 V
$I_C = 6$ A; $I_B = 100$ mA; $T_j = 150$ °C	V_{CEsat}	max.	1.5 V
	V_{BEsat}	max.	2 V
$I_C = 10$ A; $I_B = 300$ mA	V_{CEsat}	max.	2 V
	V_{BEsat}	max.	2.5 V
Turn-off breakdown energy, with inductive load (Fig. 3) $I_C = 10$ A; $I_B = 300$ mA $L_C = 8$ mH; $V_{CL} = 400$ V	$E_{(BR)}$	min.	400 mJ
Turn-on test (Fig. 4)	V_{CEon}	min.	400 V
Fall time; inductive switching (Fig. 5)			
$I_{Con} = 5$ A; $I_{Bon} = 50$ mA; $L_C = 200$ µH	t_f	typ.	0.7 µs
$I_{Con} = 10$ A; $I_{Bon} = 300$ mA; $L_C = 200$ µH	t_f	typ.	1 µs

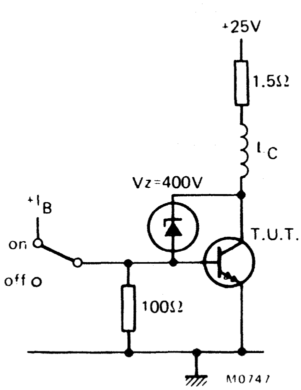


Fig. 3 Energy test.

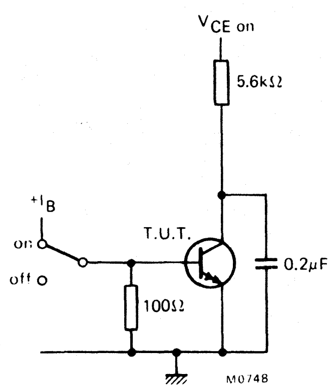


Fig. 4 Turn-on test.

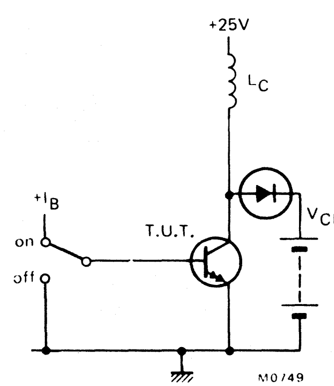
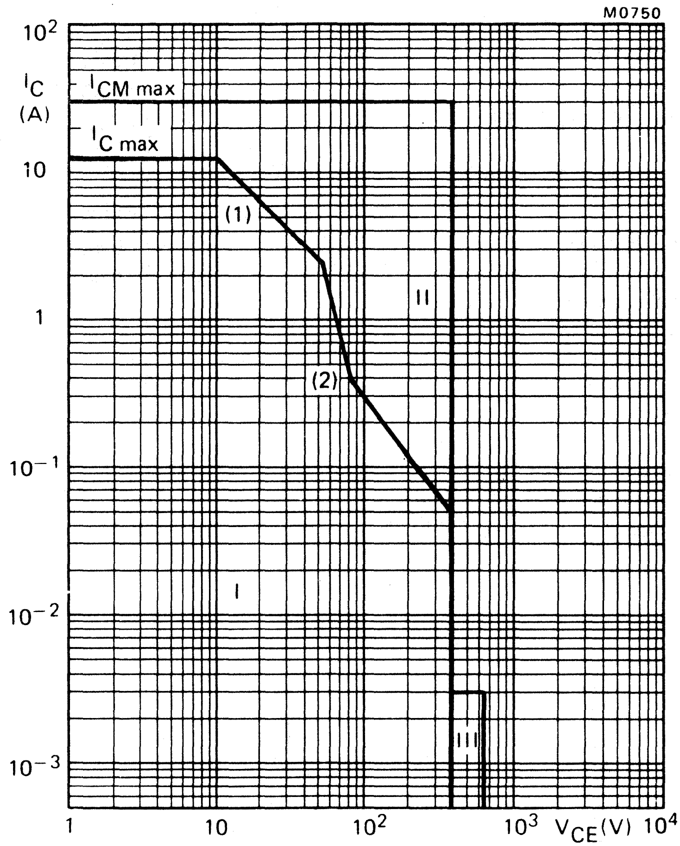


Fig. 5 Inductive switching.



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; $T_{mb} \leqslant 25\ ^oC$.

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.

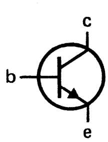
QUICK REFERENCE DATA

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 $T_{mb} = 25\ ^\circ C$	P_{tot}	max.	34	W
Collector-emitter saturation voltage				
$I_C = 5$ A; $I_B = 0.05$ A	V_{CEsat}	max.	1.5	V
$I_C = 10$ A; $I_B = 0.3$ A	V_{CEsat}	max.	2	V
Fall time (inductive switching)				
$I_{Con} = 5$ A; $I_{Bon} = 50$ mA; $L_C = 200\ \mu H$	t_f	typ.	0.7	μs
$I_{Con} = 10$ A; $I_{Bon} = 300$ mA; $L_C = 200\ \mu H$	t_f	typ.	1	μs

MECHANICAL DATA

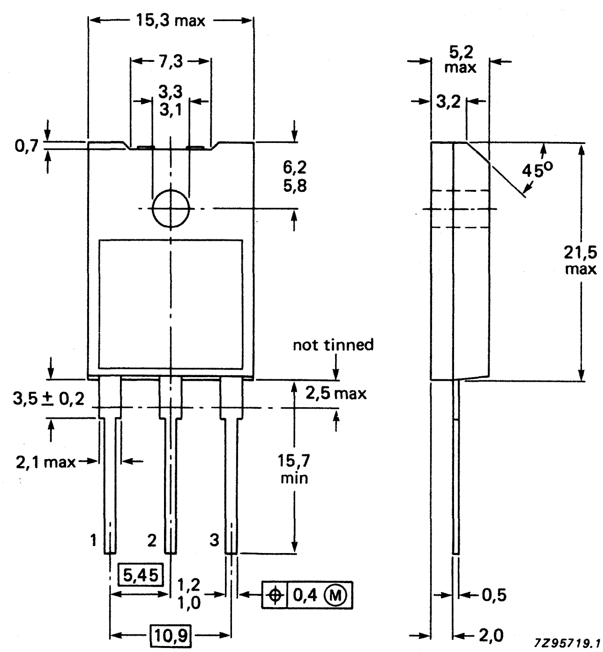
Dimensions in mm

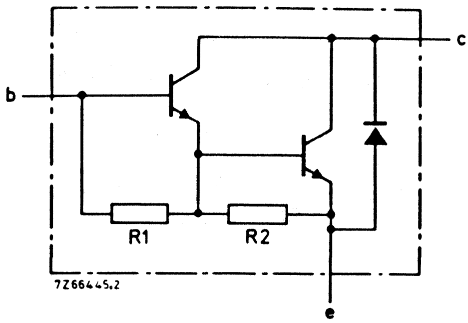
Fig. 1 SOT199.



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 $T_{mb} = 25$ °C	P_{tot}	max.	34	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)	Rth_{j-h}	=	3.7	K/W
From junction to external heatsink (note 2)	Rth_{j-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 °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 °C	I_{CES}	max.	3	mA
Emitter cut-off current				
$I_C = 0$; V_{EB} = 6 V	I_{EBO}	max.	20	mA
Collector-emitter sustaining voltage				
I_C = 5 A; $I_B = 0$; L = 8 mH	$V_{CEOsust}$	min.	400	V
Diode forward voltage				
I_F = 8 A; $I_B = 0$	V_F	max.	3	V
Saturation voltages				
I_C = 5 A; I_B = 0.05 A	V_{CEsat}	max.	1.5	V
	V_{BEsat}	max.	2.0	V
I_C = 5 A; I_B = 0.06 A; T_j = –40 °C	V_{CEsat}	max.	1.5	V
	V_{BEsat}	max.	2.0	V
I_C = 6 A; I_B = 0.1 A; T_j = 150 °C	V_{CEsat}	max.	1.5	V
	V_{BEsat}	max.	2.0	V
I_C = 10 A; I_B = 0.3 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 A; I_B = 0.3 A; L_C = 8 mH; V_{CL} = 400 V	$E_{(BR)}$	min.	400	mJ
Turn-on test (see Fig. 4)	V_{CEon}	min.	400	V
Fall-time, inductive switching				
I_{Con} = 5 A; I_{Bon} = 50 mA; L_C = 200 μH	t_f	typ.	0.7	μs
I_{Con} = 10 A; I_{Bon} = 300 mA; L_C = 200 μH	t_f	typ.	1	μs

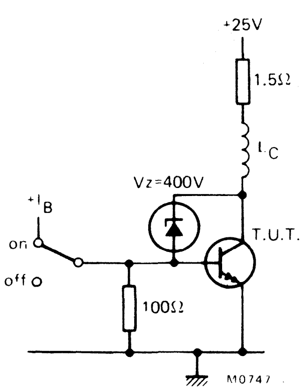


Fig.3 Energy test.

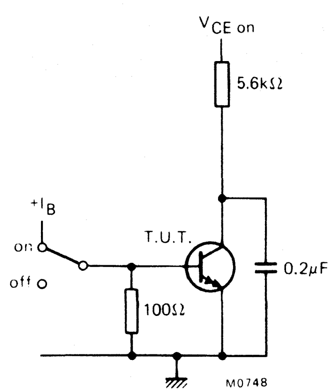


Fig.4 Turn-on test.

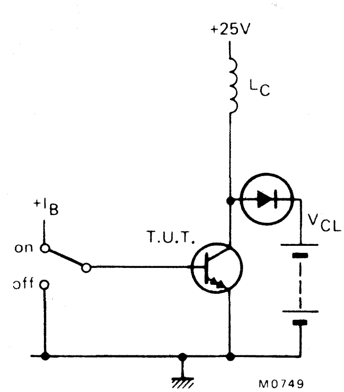
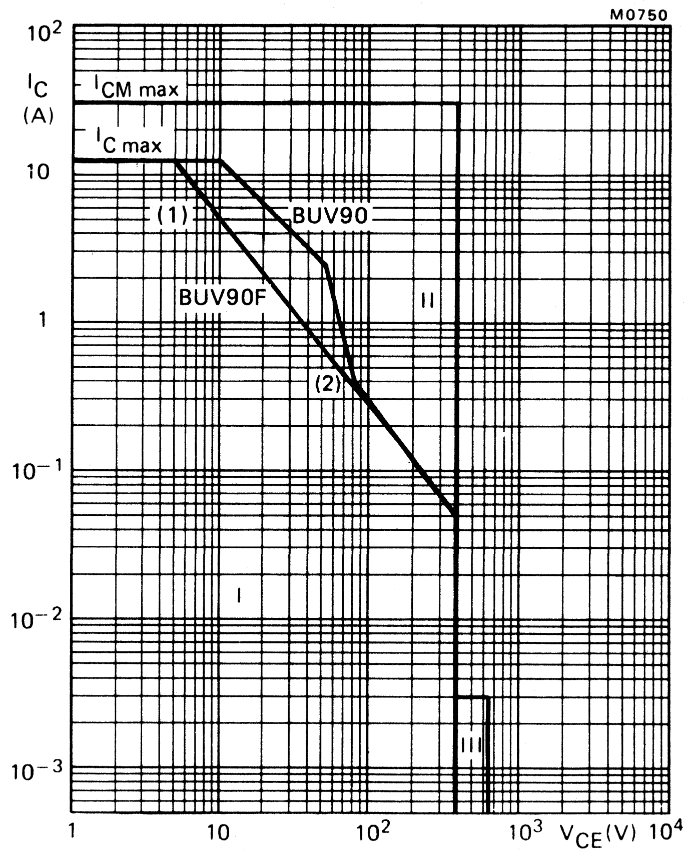


Fig.5 Inductive switching.

* 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; $T_{mb} \leqslant 25\ ^{o}C$; 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.

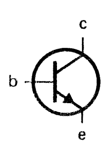
QUICK REFERENCE DATA

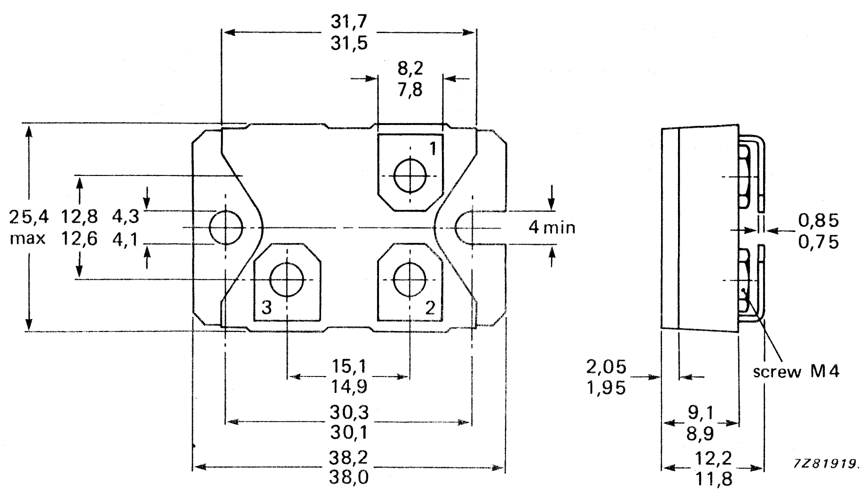
			BUV98(V)	98A(V)	
Collector-emitter					
peak value; $V_{BE} = 0$	V_{CESM}	max.	850	1000	V
open base	V_{CEO}	max.	450	450	V
Collector-emitter saturation voltage	V_{CEsat}	max.	1.5		V
Collector current					
saturation	I_{Csat}	max.	20	16	A
DC	I_C	max.	30		A
peak value	I_{CM}	max.	60		A
Total power dissipation					
up to $T_{mb} = 25\ ^oC$	P_{tot}	max.	150		W
Fall time	t_f	typ.	80		ns

MECHANICAL DATA

Dimensions in mm

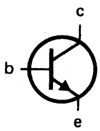
Fig. 1 SOT227B (BUV98V and BUV98AV).

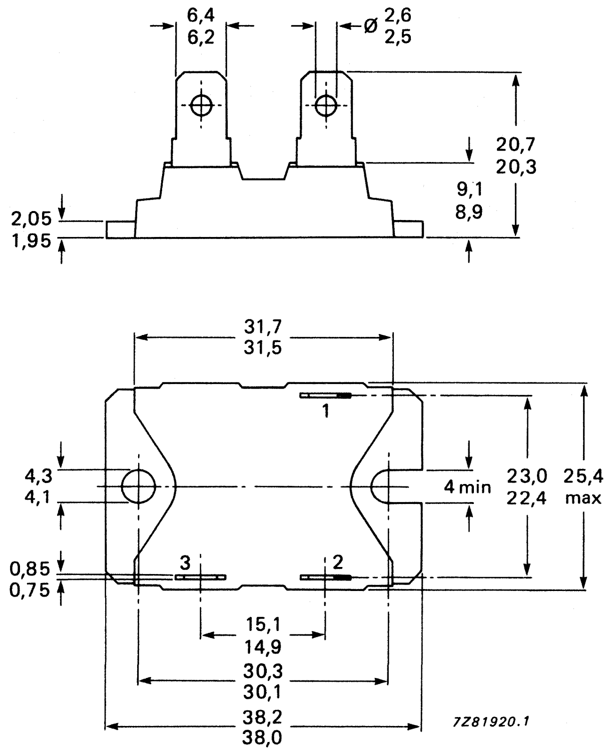




Pinning

1 = collector
2 = base
3 = emitter





Pinning

1 = collector
2 = base
3 = emitter

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; $V_{BE} = 0$	V_{CESM}	max.	850	1000	V
open base	V_{CEO}	max.	450	450	V
Collector current					
saturation	I_{Csat}		20	16	A
DC	I_C	max.	30		A
peak value	I_{CM}	max.	60		A
Base current					
DC	I_B	max.	8.0		A
peak value	I_{BM}	max.	30		A
Total power dissipation					
up to T_{mb} = 25 °C	P_{tot}	max.	150		W
Storage temperature range	T_{stg}		−65 to +150		°C
Junction temperature	T_j	max.	150		°C

DEVELOPMENT DATA

THERMAL RESISTANCE

From junction to mounting base with heatsink compound	$R_{th\ j\text{-}mb}$	=	0.83 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 °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 = 125 °C	I_{CES}	max.	4.0 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.	1.5 V
	V_{BEsat}	max.	1.6 V
Collector-emitter sustaining voltage (Figs 2 and 3)			
I_C = 200 mA; I_B = 0; L = 25 mH	$V_{CEOsust}$	min.	450 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}	typ.	0.55 µs
		max.	1.0 µs
turn-off; storage time	t_s	typ.	1.5 µs
		max.	3.0 µs
fall time	t_f	typ.	0.3 µs
		max.	0.8 µs
Switching times inductive load (Figs 6 and 7)			
$I_C = I_{Csat}$; $I_{B\ on} = I_{Csat}/5$; V_{BE} = –5 V			
turn-off; storage time	t_s	typ.	3.5 µs
fall time	t_f	typ.	80 ns
T_j = 100 °C			
turn-off; storage time	t_s	max.	5.0 µs
fall time	t_f	max.	400 ns

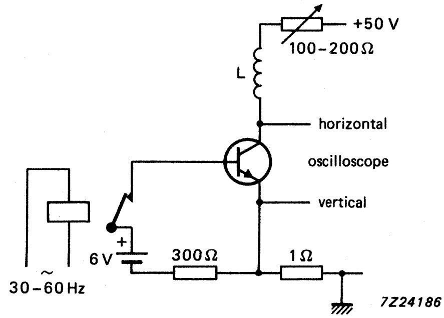


Fig. 3 Test circuit for $V_{CEOsust}$.

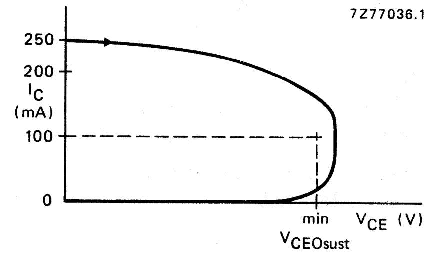


Fig. 4 Oscilloscope display for sustaining voltage.

t_p = 20 µs
T = 2 ms
V_{IM} = 15 V

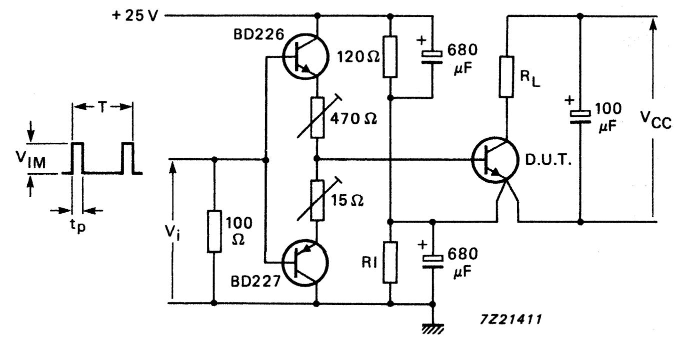


Fig. 5 Test circuit resistive load; V_{CC} = 150 V; R_L = 83 Ω; R1 = 82 Ω.

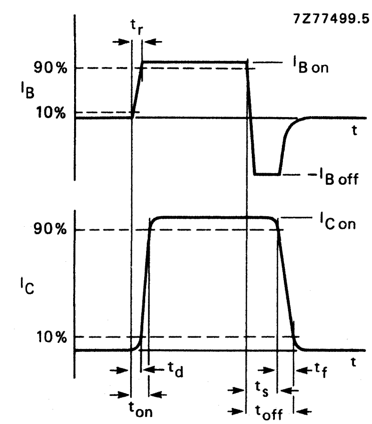


Fig. 6 Switching times waveforms with resistive load; $t_r \leqslant 30$ ns.

For inductive load:
V_{clamp} = 300 V
$-V_{BE}$ = −5 V
L_B = 1.5 μH
For RB SOAR:
V_{clamp} up to 1000 V
$-V_{BE}$ to be adjusted

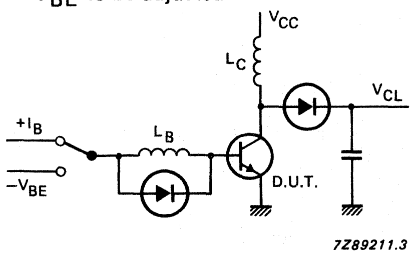


Fig. 7 Test circuit inductive load and RB SOAR; V_{CC} = 30 V; L_C = 200 μH.

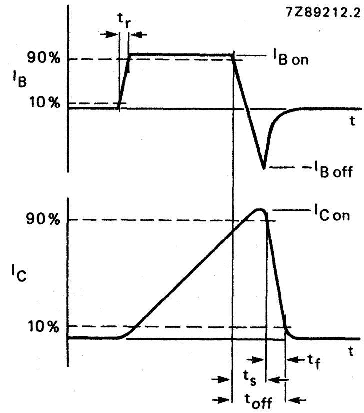
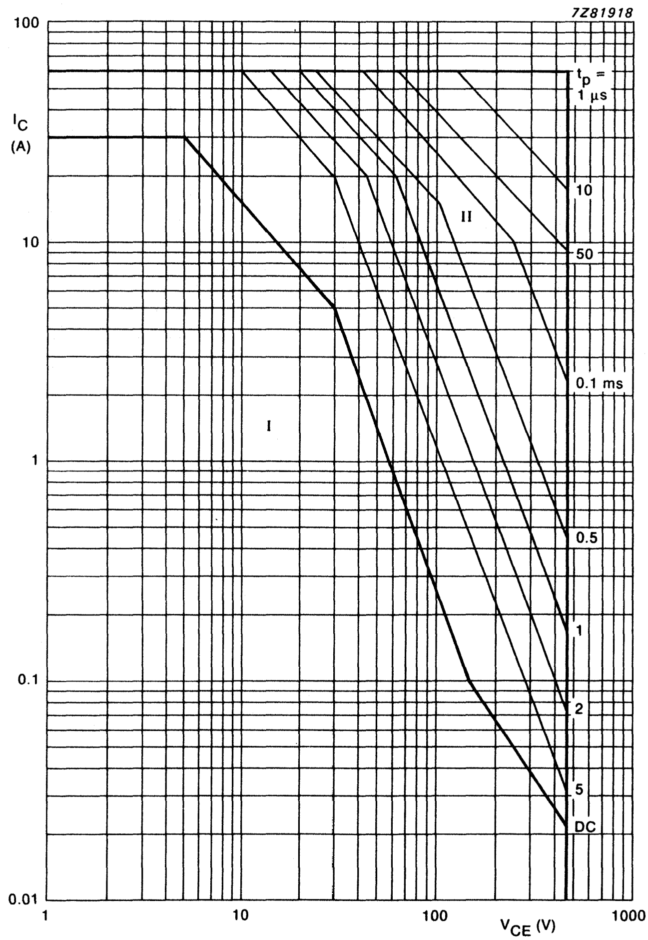


Fig. 8 Switching times waveforms with inductive load.

DEVELOPMENT DATA



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

Fig. 9 Safe operating area at $T_{mb} < 25$ °C.

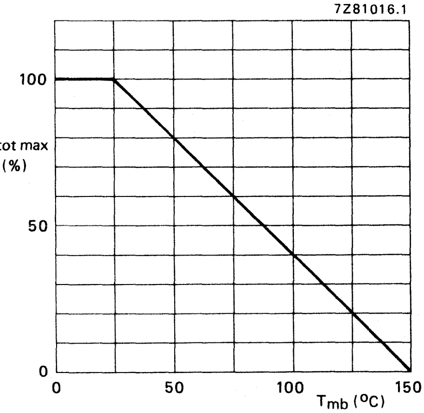


Fig. 10 Total power dissipation.

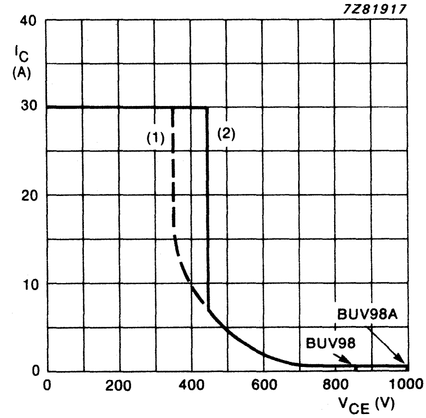


Fig. 11 Reverse bias SOAR; $V_{BE} = -5$ V; $I_C/I_B \geq 5$; $T_j \leq 125$ °C.
(1) Hard saturation.
(2) With anti-saturation network.

DEVELOPMENT DATA

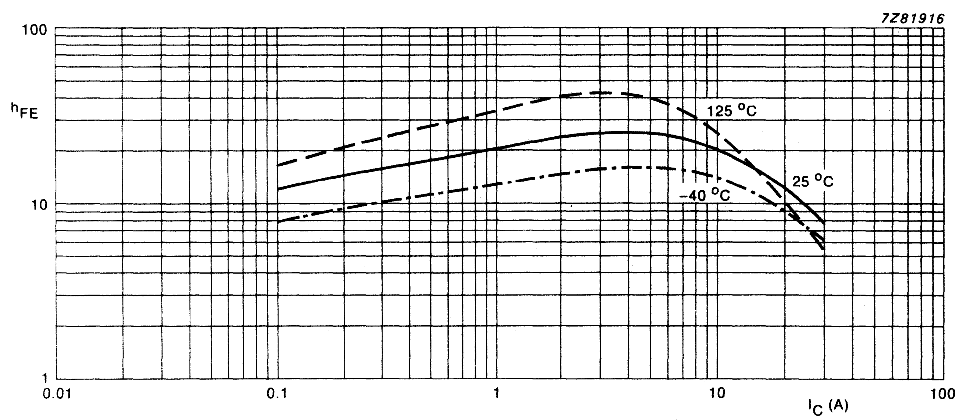


Fig. 12 Typical DC current gain at V_{CE} = 5 V.

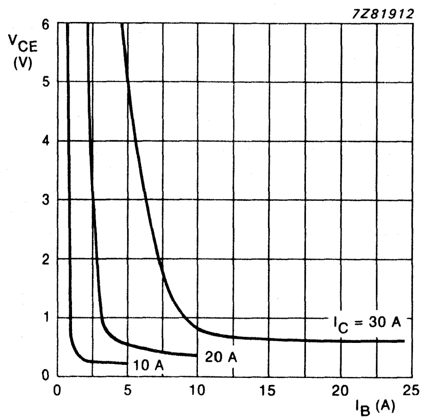


Fig. 13 Collector-emitter voltage as a function of base current; T_j = 25 °C.

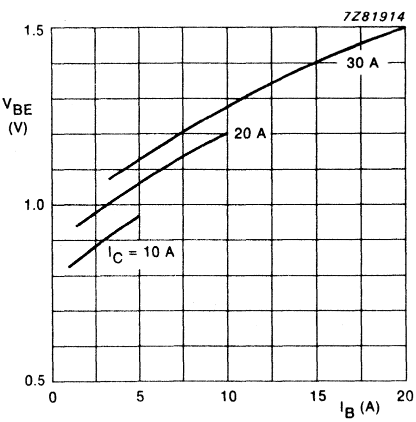


Fig. 14 Base-emitter saturation voltage as a function of base current; T_j = 25 °C.

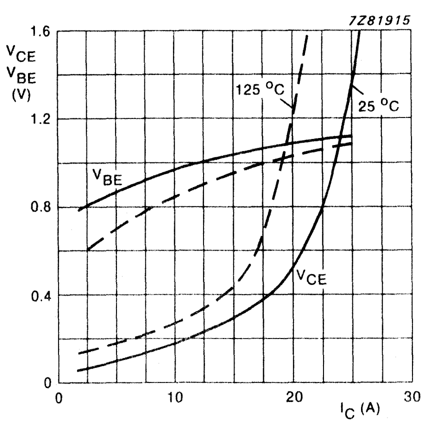


Fig. 15 Typical V_{CEsat} and V_{BEsat} as a function of collector current; I_C/I_B = 5.

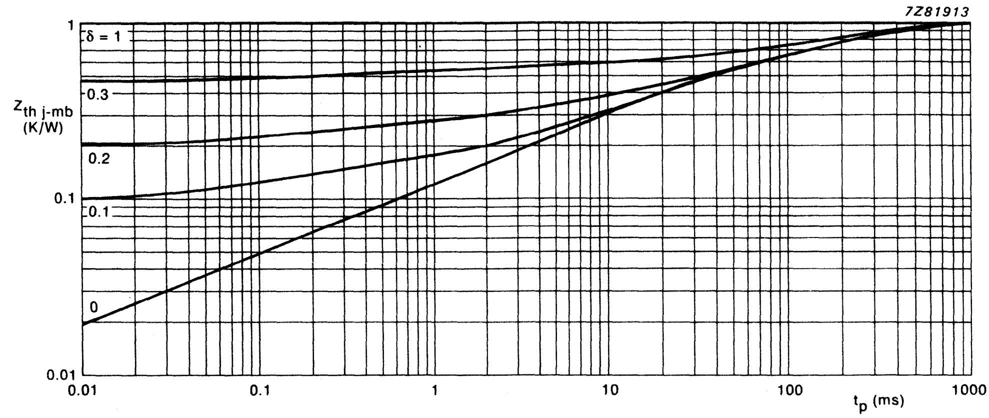


Fig. 16 Thermal response at pulse power conditions.

DEVELOPMENT DATA

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.

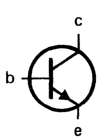
QUICK REFERENCE DATA

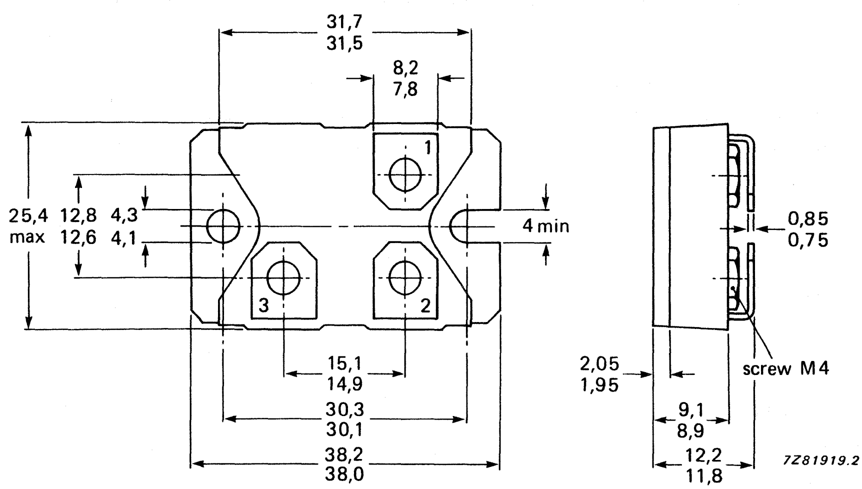
			BUV298(V)	298A(V)	
Collector-emitter voltage					
peak value; $V_{BE} = 0$	V_{CESM}	max.	850	1000	V
open base	V_{CEO}	max.	450	450	V
Collector-emitter saturation voltage	V_{CEsat}	max.	1.2	1.2	V
Collector current					
saturation	I_{Csat}	max.	40	32	A
DC	I_C	max.	60		A
peak value	I_{CM}	max.	90		A
Total power dissipation					
up to $T_{mb} = 25\ ^oC$	P_{tot}	max.	250		W
Fall time inductive load at 100 ^oC	t_f	max.	0.4		μs

MECHANICAL DATA

Dimensions in mm

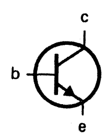
Fig. 1 SOT227B (BUV298V and BUV298AV).

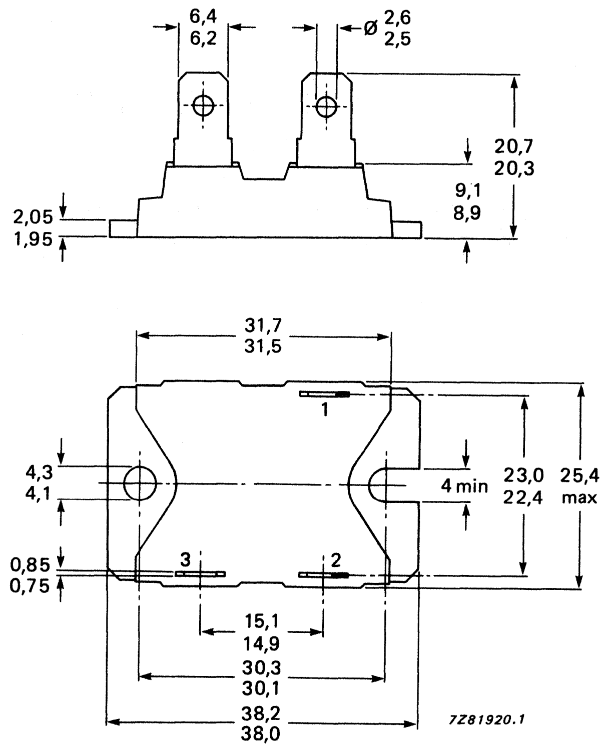




Pinning

1 = collector
2 = base
3 = emitter





Pinning

1 = collector
2 = base
3 = emitter

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; $V_{BE} = 0$	V_{CESM}	max.	850	1000	V
open base	V_{CEO}	max.	450	450	V
Collector current					
saturation	I_{Csat}		40	32	A
DC	I_C	max.	60	60	A
peak value	I_{CM}	max.	90	90	A
Base current					
DC	I_B	max.	12	10	A
peak value	I_{BM}	max.	20	16	A
Total power dissipation					
up to $T_{mb} = 25\ ^oC$	P_{tot}	max.	250	250	W
Storage temperature range	T_{stg}		−65 to +150		^oC
Junction temperature	T_j	max.	150		^oC

THERMAL RESISTANCE

From junction to mounting base with heatsink compound	$R_{th\ j\text{-}mb}$	=	0.5 K/W

ISOLATION

Isolation 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 °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 °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	$V_{CEOsust}$	min.	450 V
Switching times inductive load			
T_j = 100 °C			
turn-off; storage time	t_s	max.	4.5 μs
fall time	t_f	max.	0.4 μs

DEVELOPMENT DATA

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.

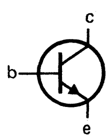
QUICK REFERENCE DATA

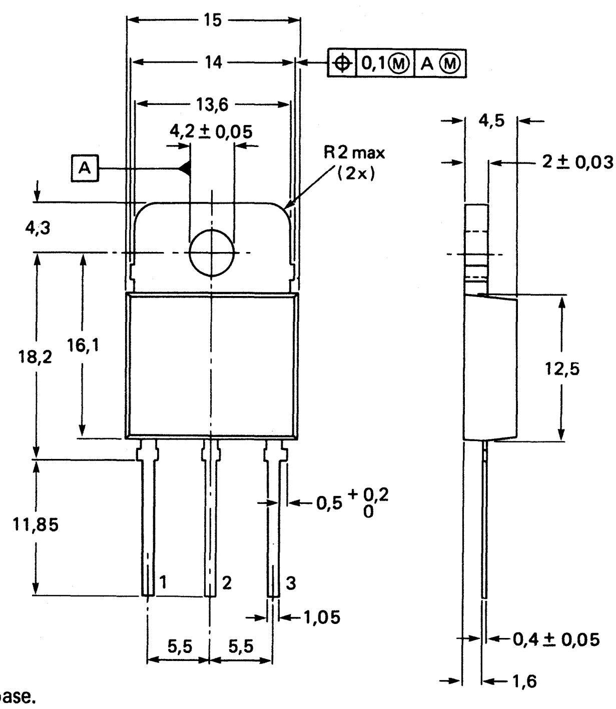
			BUW11	BUW11A	
Collector-emitter voltage (peak value; $V_{BE} = 0$)	V_{CESM}	max.	850	1000	V
Collector-emitter voltage (open base)	V_{CEO}	max.	400	450	V
Collector-emitter saturation voltage	V_{CEsat}	max.	1.5		V
Collector current (DC)	I_C	max.	5		A
Collector current (peak value)	I_{CM}	max.	10		A
Total power dissipation up to $T_{mb} = 25\ ^oC$	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.

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	$R_{th\ j\text{-}mb}$	=	1,25	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			BUW11	BUW11A	
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 °C	I_{CES}	max.	2		mA
Emitter cut-off current					
$I_C = 0$; V_{EB} = 9 V	I_{EBO}	max.	10		mA
Saturation voltages					
I_C = 3 A; I_B = 0,6 A	V_{CEsat}	max.	1,5	–	V
	V_{BEsat}	max.	1,4	–	V
I_C = 2,5 A; I_B = 0,5 A	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	$V_{CEOsust}$	min.	400	450	V
Collector saturation current					
V_{CE} = 1,5 V	I_{Csat}	max.	3	2,5	A

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

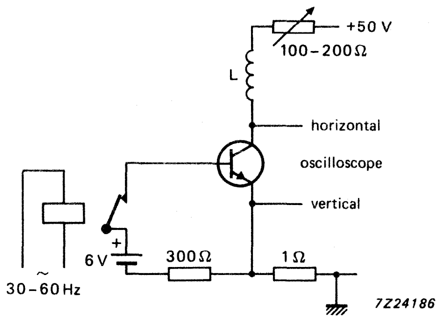


Fig. 2 Test circuit for $V_{CEOsust}$.

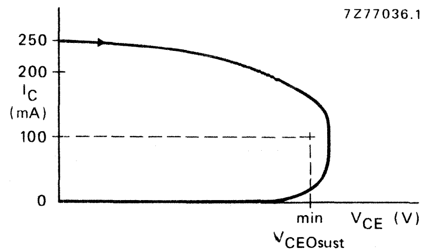
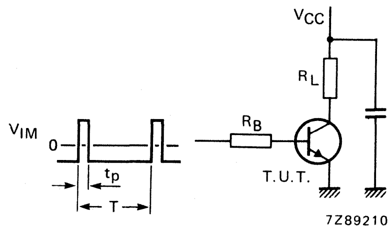


Fig. 3 Oscilloscope display for sustaining voltage.

			BUW11	BUW11A	
Switching times resistive load (Figs 4 and 5)					
I_{Con} = 3 A; I_{Bon} = I_{Boff} = 0,6 A					
Turn-on time	t_{on}	max.	1	–	μs
Turn-off: Storage time	t_s	max.	4	–	μs
Fall time	t_f	max.	0,8	–	μs
I_{Con} = 2,5 A; I_{Bon} = $-I_{Boff}$ = 0,5 A					
Turn-on time	t_{on}	max.	–	1	μs
Turn-off: Storage time	t_s	max.	–	4	μs
Fall time	t_f	max.	–	0,8	μs
Switching times inductive load (Figs 6 and 7)					
I_{Con} = 3 A; I_B = 0,6 A					
Turn-off: Storage time	t_s	typ.	1,1	–	μs
		max.	1,4	–	μs
Fall time	t_f	typ.	80	–	ns
		max.	150	–	ns
I_{Con} = 3 A; I_B = 0,6 A; T_j = 100 °C					
Turn-off: Storage time	t_s	typ.	1,2	–	μs
		max.	1,5	–	μs
Fall time	t_f	typ.	140	–	ns
		max.	300	–	ns
Switching times inductive load (Figs 6 and 7)					
I_{Con} = 2,5 A; I_B = 0,5 A					
Turn-off: Storage time	t_s	typ.	–	1,1	μs
		max.	–	1,4	μs
Fall time	t_f	typ.	–	80	ns
		max.	–	150	ns
I_{Con} = 2,5 A; I_B = 0,5 A; T_j = 100 °C					
Turn-off: Storage time	t_s	typ.	–	1,2	μs
		max.	–	1,5	μs
Fall time		typ.	–	140	ns
		max.	–	300	ns



V_{CC} = 250 V
V_{IM} = −6 to + 8 V
$\frac{t_p}{T}$ = 0,01
t_p = 20 μs
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.

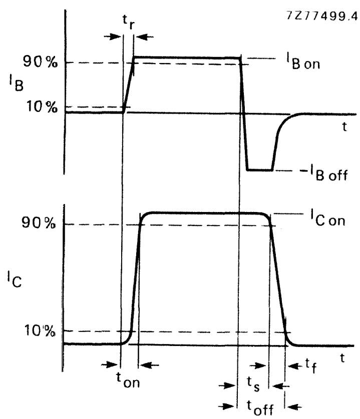


Fig. 5 Switching times waveforms with resistive load.

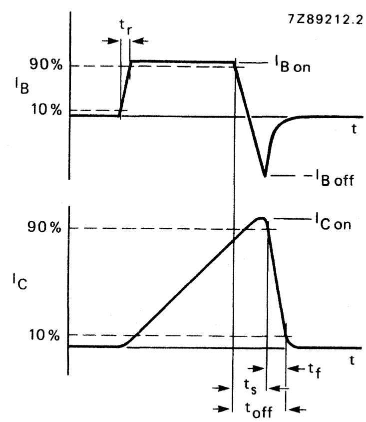
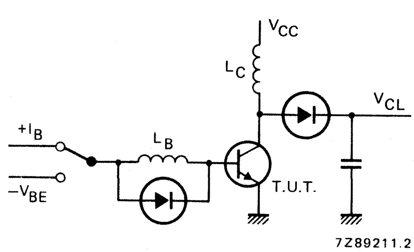
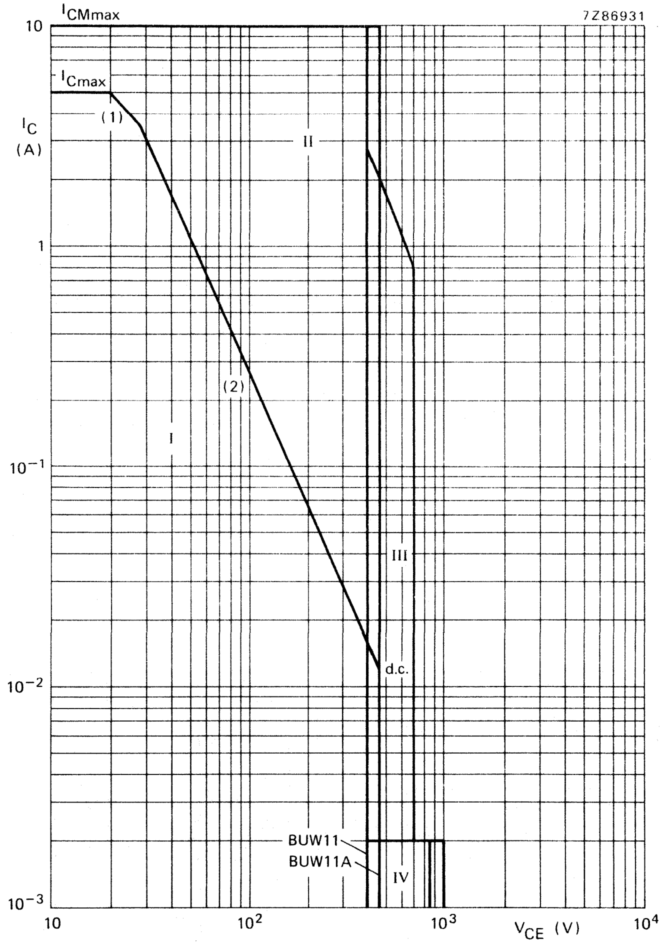


Fig. 6 Switching times waveforms with inductive load.



V_{CL} = 300 V
V_{CC} = 30 V
$-V_{BE}$ = 5 V
L_B = 1 μH
L_C = 200 μH

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 $R_{BE} \leqslant 100\ \Omega$ and $t_p \leqslant 0,6\ \mu s$.
IV Repetitive pulse operation in this region is permissible provided $V_{BE} \leqslant 0$ and $t_p \leqslant 5$ ms.

Fig. 8 Safe operating area at $T_{mb} \leqslant 25\ ^oC$.

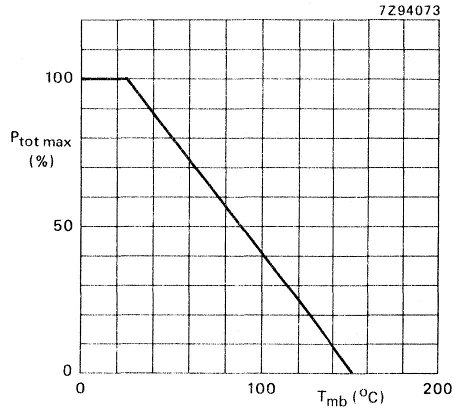


Fig. 9 Total power dissipation derating curve.

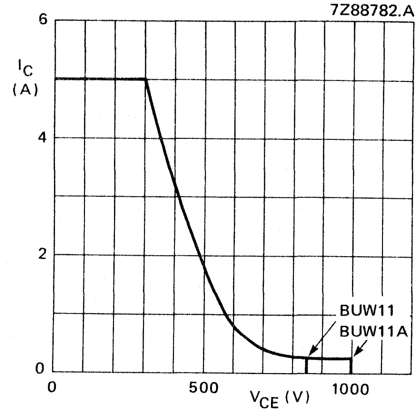


Fig. 10 Reverse bias SOAR.

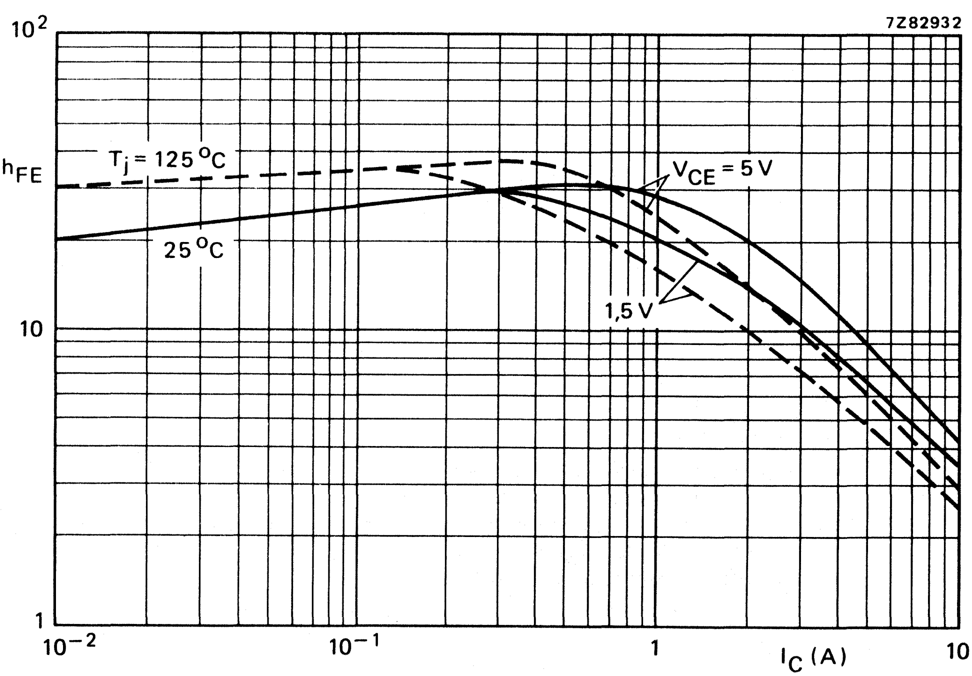


Fig. 11 Typical values DC current gain.

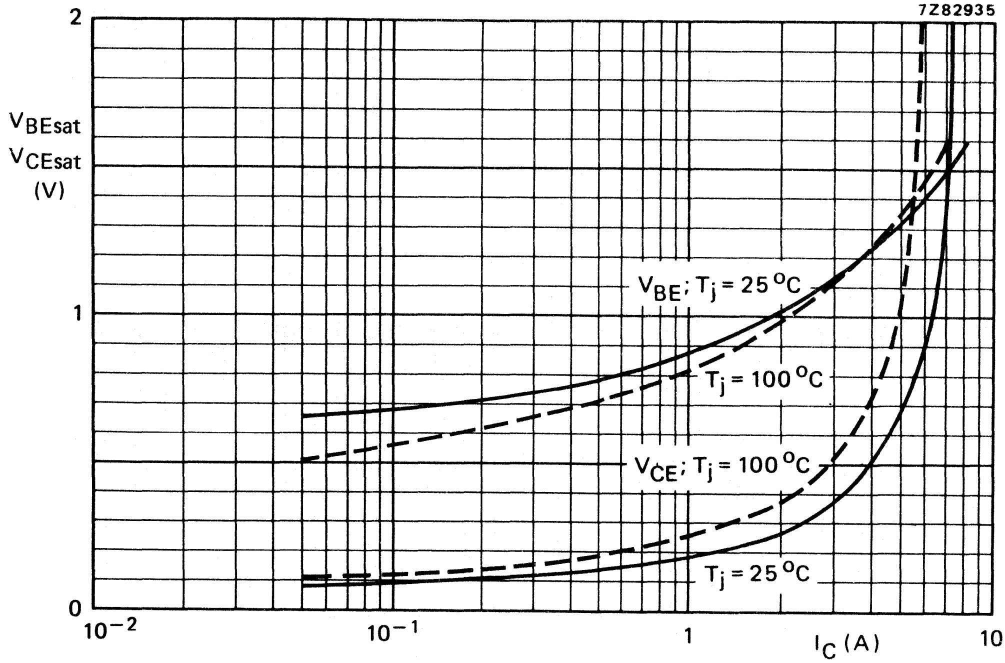


Fig. 12 Typical values base-emitter and collector-emitter voltage, I_C/I_B = 5.

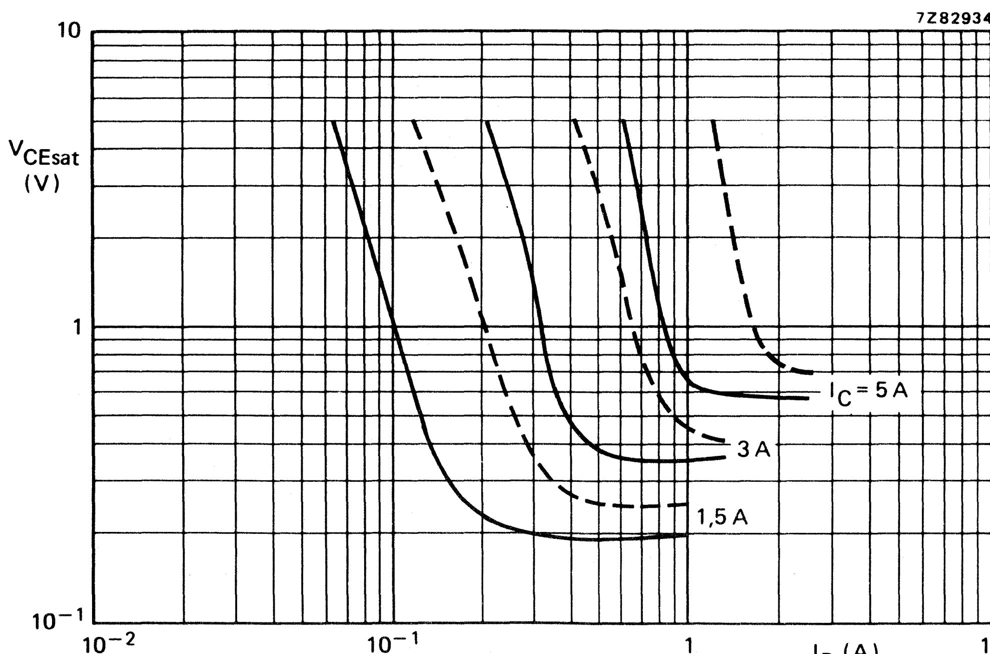


Fig. 13 Typ. (———) and max. (– – –) values collector-emitter saturation voltage at T_j = 25 °C.

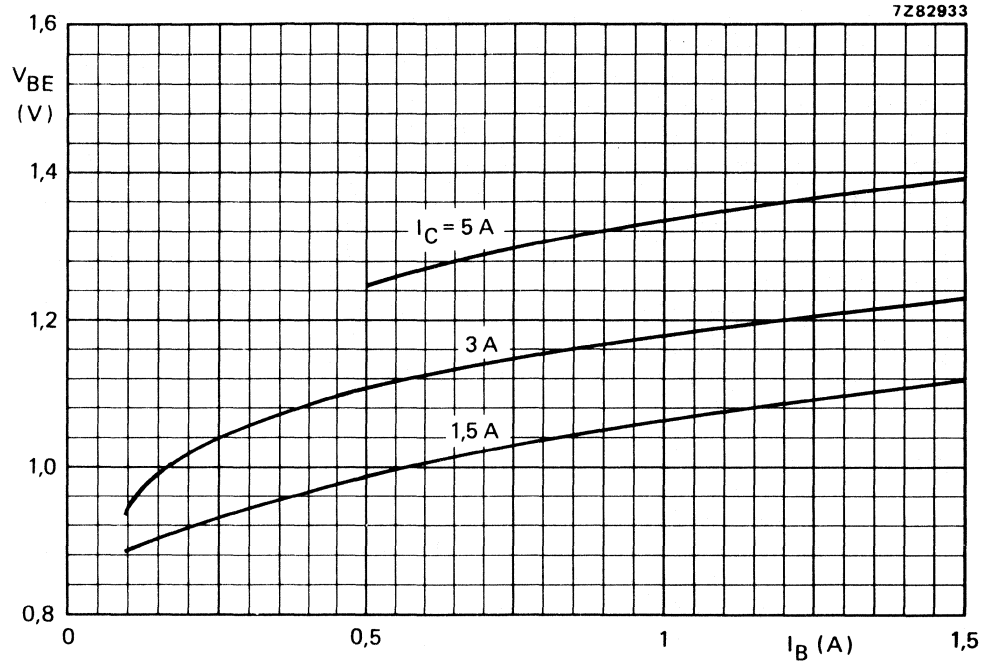


Fig. 14 Typical values at T_j = 25 °C.

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.

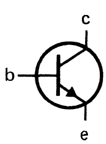
QUICK REFERENCE DATA

			BUW11F	BUW11AF	
Collector-emitter voltage					
peak value; $V_{BE} = 0$	V_{CESM}	max.	850	1000	V
open base	V_{CEO}	max.	400	450	V
Collector-emitter saturation voltage	V_{CEsat}	max.	1.5	1.5	V
Collector current					
saturation	I_{Csat}	max.	3.0	2.5	A
DC	I_C	max.	5.0		A
peak value; $t_p < 20$ ms	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

Dimensions in mm

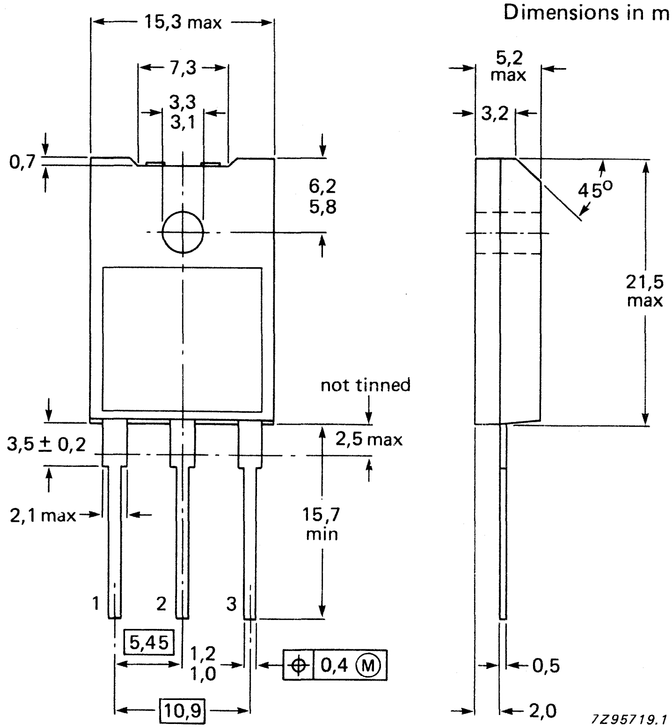
Fig. 1 SOT199.



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; $V_{BE} = 0$	V_{CESM}	max.	850	1000	V
open base	V_{CEO}	max.	400	450	V
Collector current					
saturation	I_{Csat}		3.0	2.5	
DC	I_C	max.	5.0		A
peak value; $t_p < 20$ ms	I_{CM}	max.	10		A
Base current					
DC	I_B	max.	2.0		A
peak value; $t_p < 20$ ms	I_{BM}	max.	4.0		A
Total power dissipation up to $T_{mb} = 25$ °C (note 1)	P_{tot}	max.	32		W
Total power dissipation up to $T_{mb} = 25$ °C (note 2)	P_{tot}	max.	41		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)	$R_{th\ j\text{-}h}$	=	3.95	K/W
From junction to external heatsink (note 2)	$R_{th\ j\text{-}h}$	=	3.05	K/W
From junction to ambient	$R_{th\ j\text{-}a}$	=	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

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 °C unless otherwise specified

Collector cut-off currents*					
$V_{CE} = V_{CESMmax}$; $V_{BE} = 0$	I_{CES}	max.	1.0		mA
$V_{CE} = V_{CESMmax}$; $V_{BE} = 0$; T_j = 125 °C	I_{CES}	max.	2.0		mA
Emitter cut-off current					
V_{EB} = 9 V; $I_C = 0$	I_{EBO}	max.	10		mA

			BUW11F	BUW11AF	
Saturation voltages					
I_C = 3 A; I_B = 0.6 A	V_{CEsat}	max.	1.5	–	V
	V_{BEsat}	max.	1.4	–	V
I_C = 2.5 A; I_B = 0.5 A	V_{CEsat}	max.	–	1.5	V
	V_{BEsat}	max.	–	1.4	V
Collector-emitter sustaining voltage (Figs 2 and 3)					
I_C = 100 mA; $I_{B\,off} = 0$; L = 25 mH	$V_{CEOsust}$	min.	400	450	V
Collector saturation current					
V_{CE} = 1.5 V	I_{Csat}	max.	3.0	2.5	A
Switching times resistive load (Figs 4 and 5)					
$I_{C\,on}$ = 3 A; $I_{B\,on} = I_{B\,off}$ = 0.6 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
$I_{C\,on}$ = 2.5 A; $I_{B\,on} = I_{B\,off}$ = 0.5 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)					
$I_{C\,on}$ = 3 A; I_B = 0.6 A; V_{CL} = 250 V; T_c = 100 °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
$I_{C\,on}$ = 2.5 A; I_B = 0.5 A; V_{CL} = 300 V; T_c = 100 °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

DEVELOPMENT DATA

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

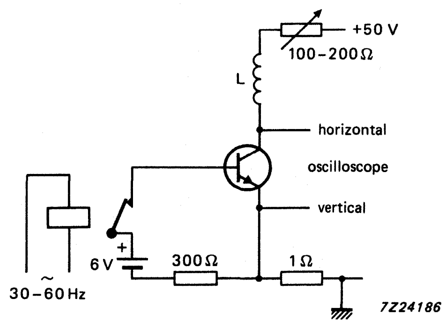


Fig. 2 Test circuit for $V_{CEOsust}$.

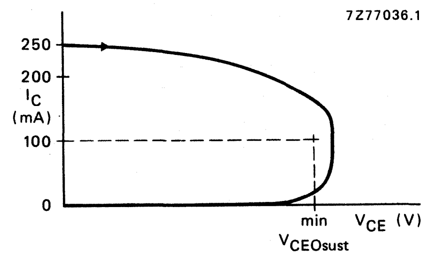


Fig. 3 Oscilloscope display for sustaining voltage.

V_{CC} = 250 V
t_p = 20 μs
V_{IM} = −6 to + 8 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.

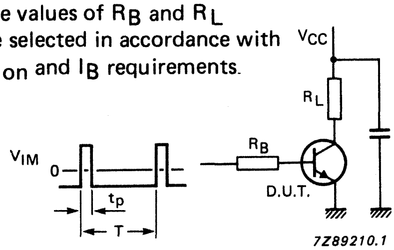


Fig. 4 Test circuit resistive load.

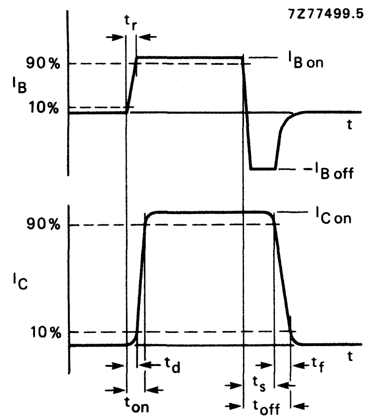


Fig. 5 Switching times waveforms with resistive load; $t_r \leqslant 20$ ns.

V_{CL} = up to 1000 V
V_{CC} = 30 V
$-V_{BE}$= 1 V to 5 V
L_B = 1.0 μH
L_C = 200 μH

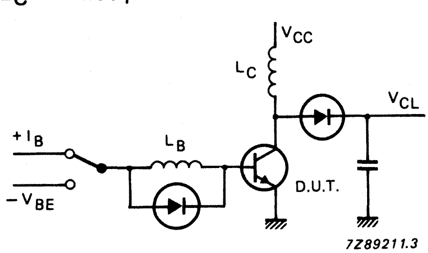


Fig. 6 Test circuit inductive load and reverse bias SOAR.

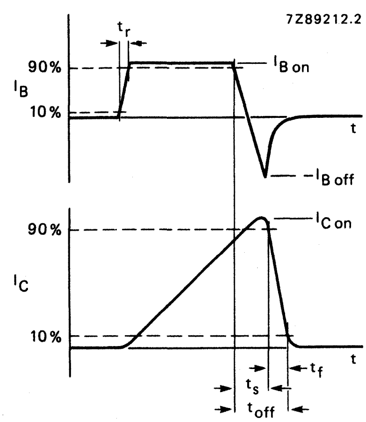
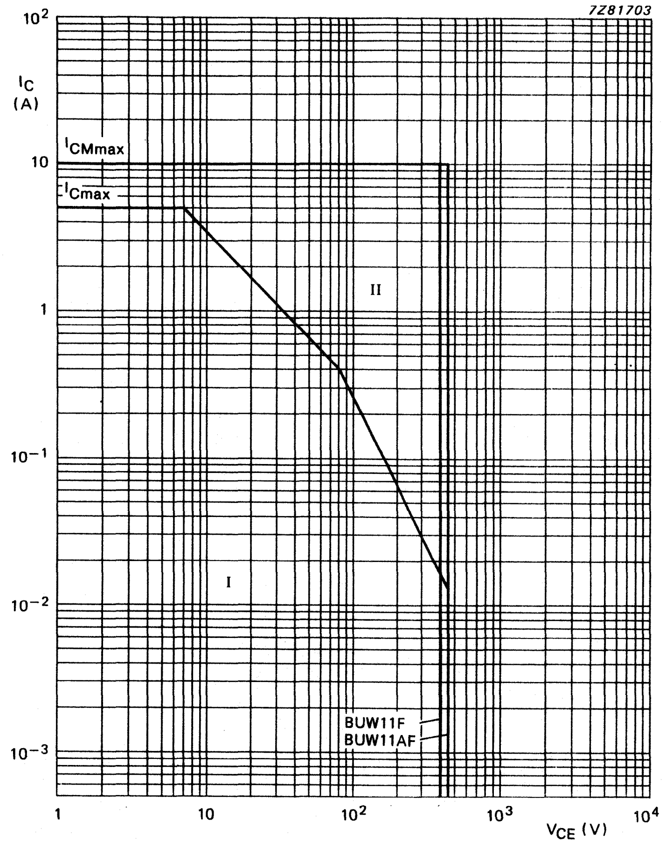


Fig. 7 Switching times waveforms with inductive load.

DEVELOPMENT DATA



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 $T_{mb} < 25\ ^oC$.

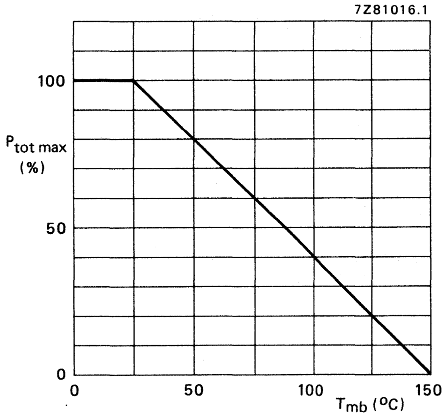


Fig. 9 Power dissipation curve.

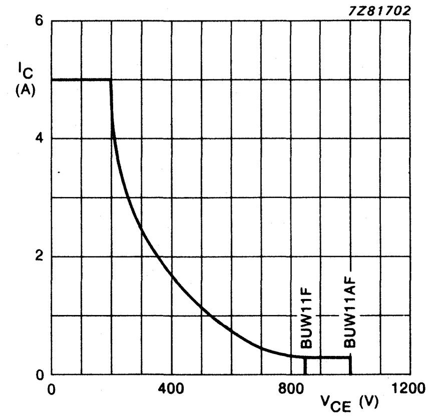


Fig. 10 RB SOAR; $T_c \leq 100$ °C; $V_{BE} = -1$ V to -5 V.

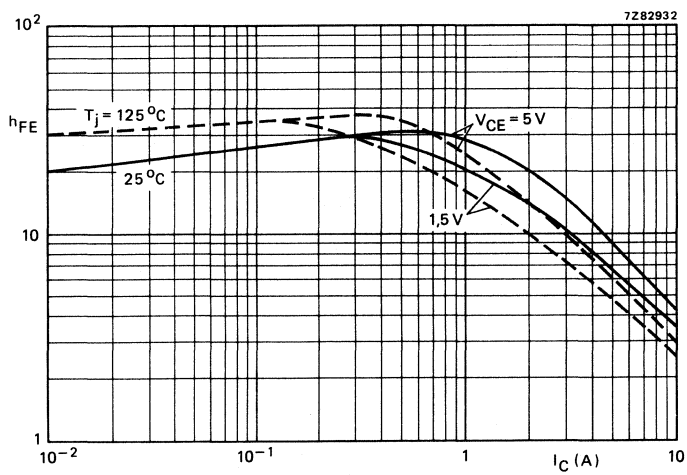


Fig. 11 Typical values DC current gain; T_j = 125 °C.

DEVELOPMENT DATA

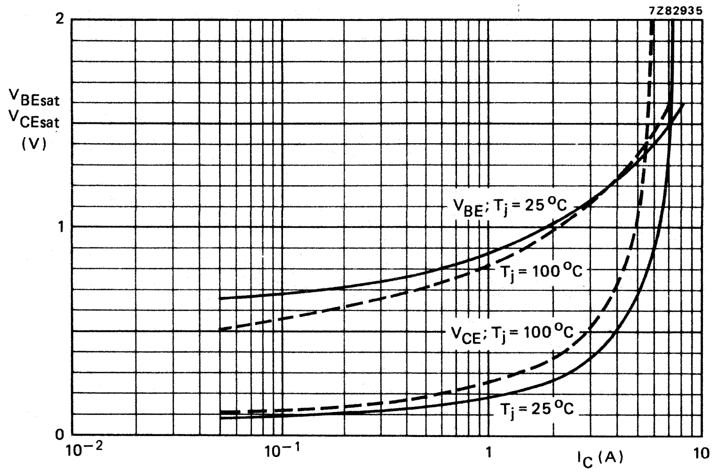


Fig. 12 Typical values base and collector voltages at I_C/I_B = 5.

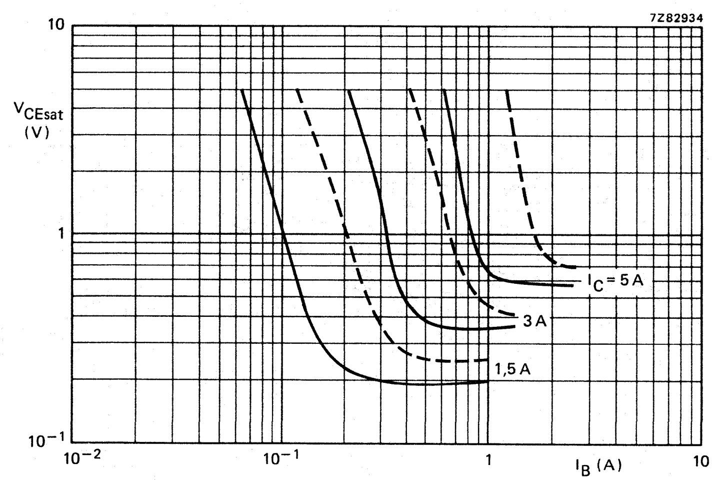


Fig. 13 Typical (———) and maximum (— — —) values saturation voltage; T_j = 25 °C.

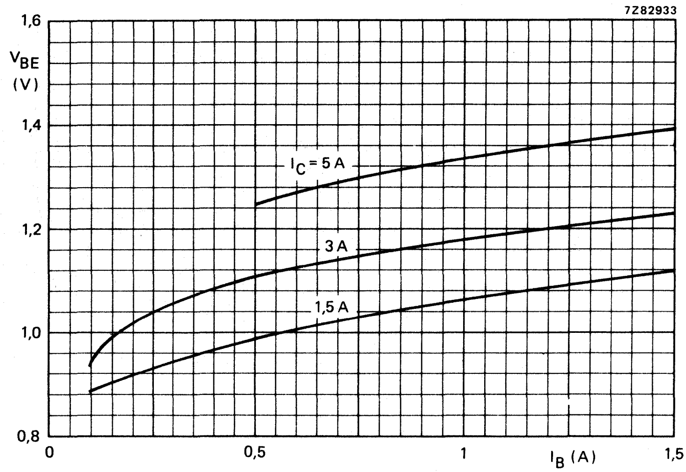


Fig. 14 Typical values base-emitter voltage at T_j = 25 °C.

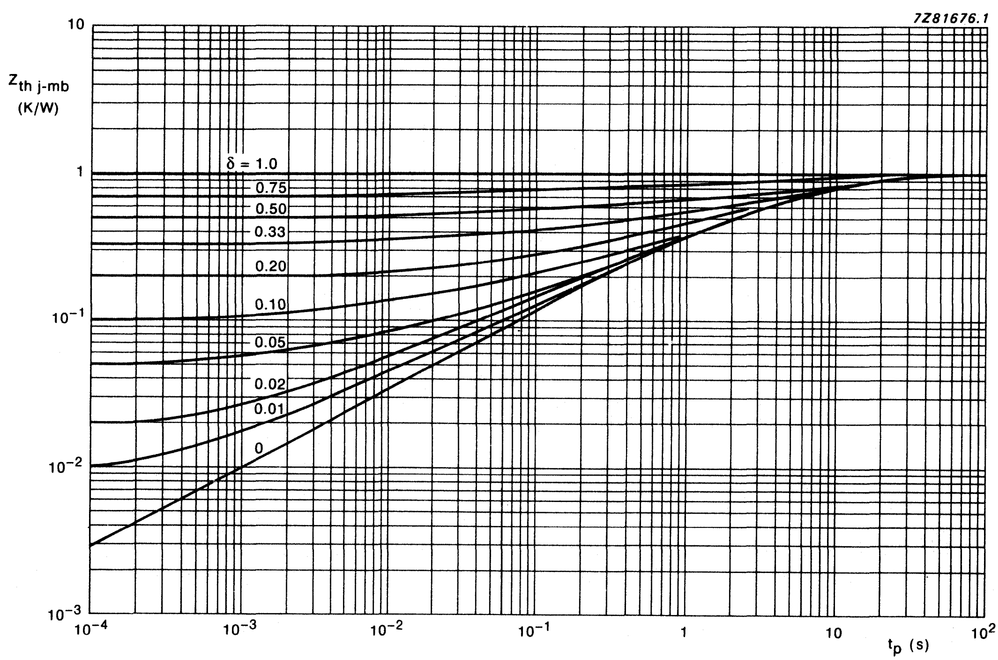


Fig. 15 Normalized thermal response at pulse power conditions.

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.

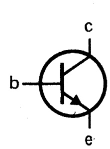
QUICK REFERENCE DATA

			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 $T_{mb} = 25\ ^oC$	P_{tot}	max.	125		W
Fall time (resistive load)	t_f	max.	0.8		μs

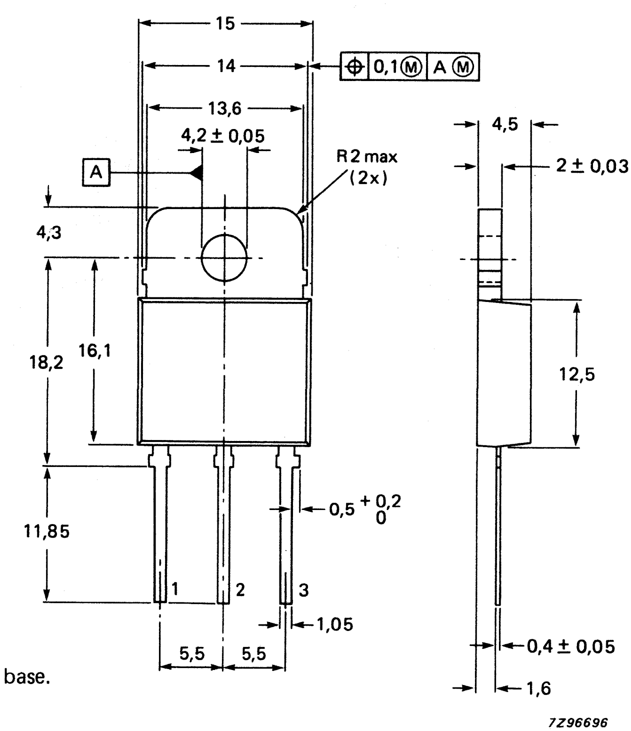
MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT93.



Pinning:
1 = base
2 = collector
3 = emitter



Collector connected to mounting base.

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 $T_{mb} = 25\ ^oC$	P_{tot}	max.	125		W
Storage temperature range	T_{stg}		−65 to + 150		^oC
Junction temperature	T_j	max.	150		^oC

THERMAL RESISTANCE

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

CHARACTERISTICS

$T_j = 25\ ^oC$ unless otherwise specified

Collector cut-off current*					
$V_{CE} = V_{CESMmax}$; $V_{BE} = 0$	I_{CES}	max.	1		mA
$V_{CE} = V_{CESMmax}$; $V_{BE} = 0$; $T_j = 125\ ^oC$	I_{CES}	max.	3		mA
Emitter cut-off current					
$I_C = 0$; $V_{EB} = 9$ V	I_{EBO}	max.	10		mA

			BUW12	BUW12A	
Saturation voltages					
$I_C = 6$ A; $I_B = 1,2$ A	V_{CEsat}	max.	1,5	–	V
	V_{BEsat}	max.	1,5	–	V
$I_C = 5$ A; $I_B = 1,0$ A	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	$V_{CEOsust}$	min.	400	450	V

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

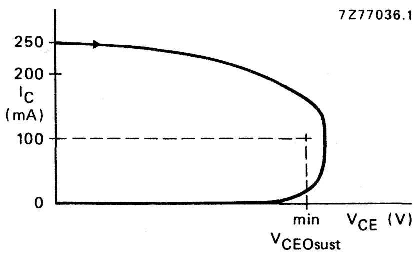


Fig. 2 Oscilloscope display for sustaining voltage.

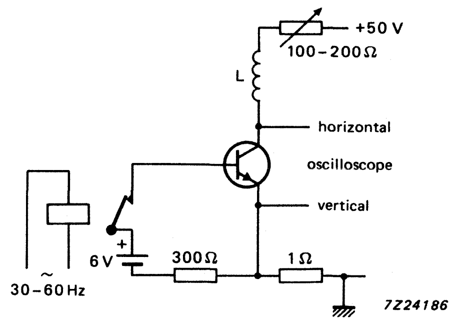
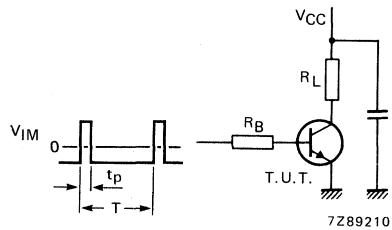


Fig. 3 Test circuit for $V_{CEOsust}$.

			BUW12	BUW12A	
Switching times resistive load (Figs 4 and 5)					
I_{Con} = 6 A; I_{Bon} = $-I_{Boff}$ = 1,2 A					
Turn-on time	t_{on}	max.	1	—	μs
Turn-off: Storage time	t_s	max.	4	—	μs
Fall time	t_f	max.	0,8	—	μs
I_{Con} = 5 A; I_{Bon} = $-I_{Boff}$ = 1 A					
Turn-on time	t_{on}	max.	—	1	μs
Turn-off: Storage time	t_s	max.	—	4	μs
Fall time	t_f	max.	—	0,8	μs
Switching times inductive load (Figs 6 and 7)					
I_{Con} = 6 A; I_B = 1,2 A					
Turn-off: Storage time	t_s	typ.	1,6	—	μs
		max.	2,1	—	μs
Fall time	t_f	typ.	80	—	ns
		max.	150	—	ns
I_{Con} = 6 A; I_B = 1,2 A; T_j = 100 °C					
Turn-off: Storage time	t_s	typ.	1,8	—	μs
		max.	2,3	—	μs
Fall time	t_f	typ.	140	—	ns
		max.	300	—	ns
Switching times inductive load (Figs 6 and 7)					
I_{Con} = 5 A; I_B = 1 A					
Turn-off: Storage time	t_s	typ.	—	1,6	μs
		max.	—	2,1	μs
Fall time	t_f	typ.	—	80	ns
		max.	—	150	ns
I_{Con} = 5 A; I_B = 1 A; T_j = 100 °C					
Turn-off: Storage time	t_s	typ.	—	1,8	μs
		max.	—	2,3	μs
Fall time	t_f	typ.	—	140	ns
		max.	—	300	ns



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

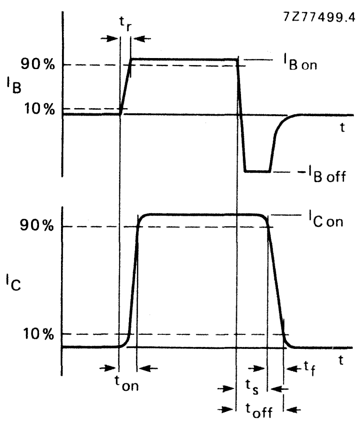


Fig. 5 Switching times waveforms. with resistive load.

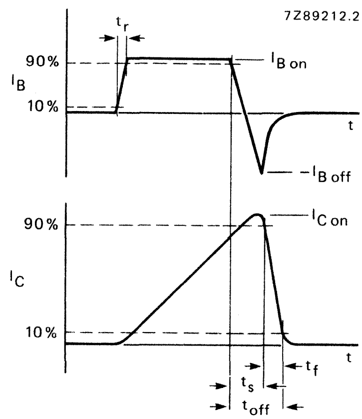
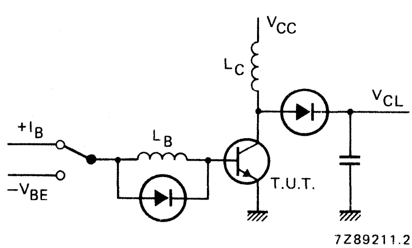
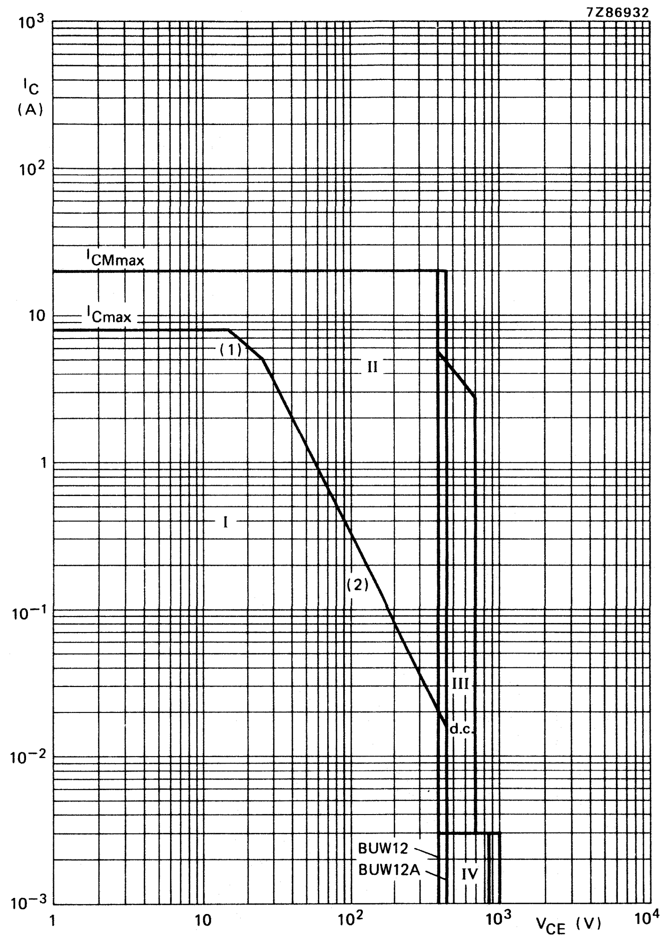


Fig. 6 Switching times waveforms with inductive load.



$V_{CL} = 300$ V
$V_{CC} = 30$ V
$-V_{BE} = 5$ V
$L_B = 1\ \mu H$
$L_C = 200\ \mu H$

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 $R_{BE} \leqslant 100\ \Omega$ and $t_p \leqslant 0,6\ \mu s$.
IV Repetitive pulse operation in this region is permissible provided $V_{BE} \leqslant 0$ and $t_p \leqslant 2$ ms.

Fig. 8 Safe operating area at $T_{mb} \leqslant 25\ ^oC$.

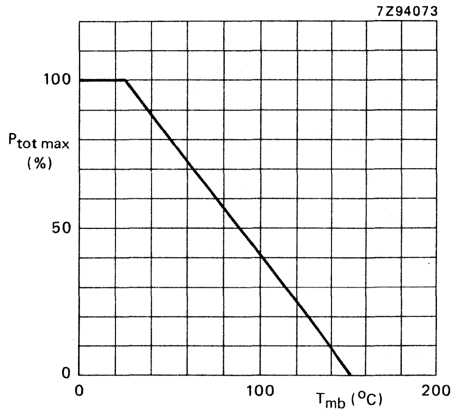


Fig. 9 Total power dissipation derating curve.

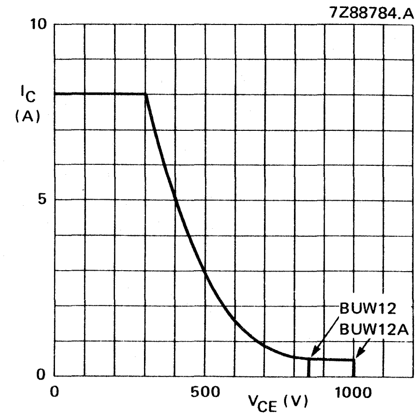


Fig. 10 Reverse bias SOAR.

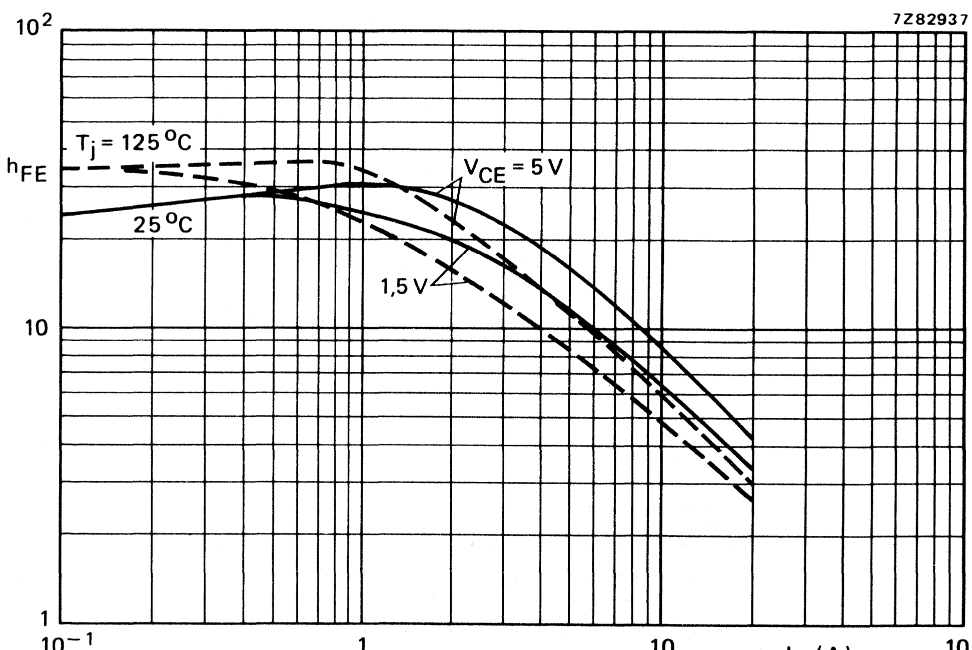


Fig. 11 Typical values DC current gain.

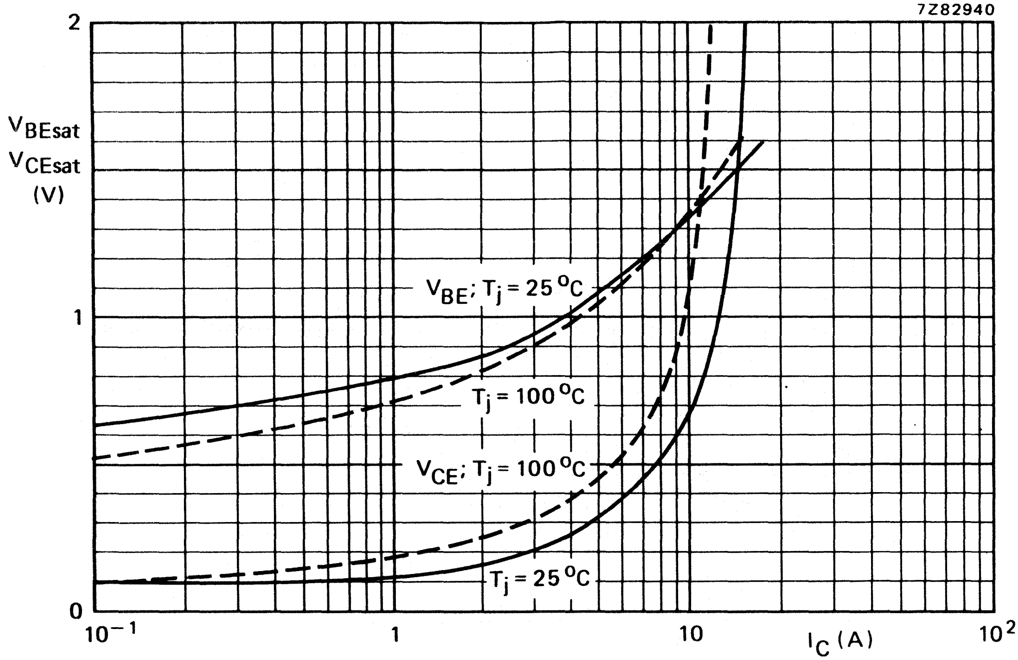


Fig. 12 Typical values base and collector voltage at $I_C/I_B = 5$.

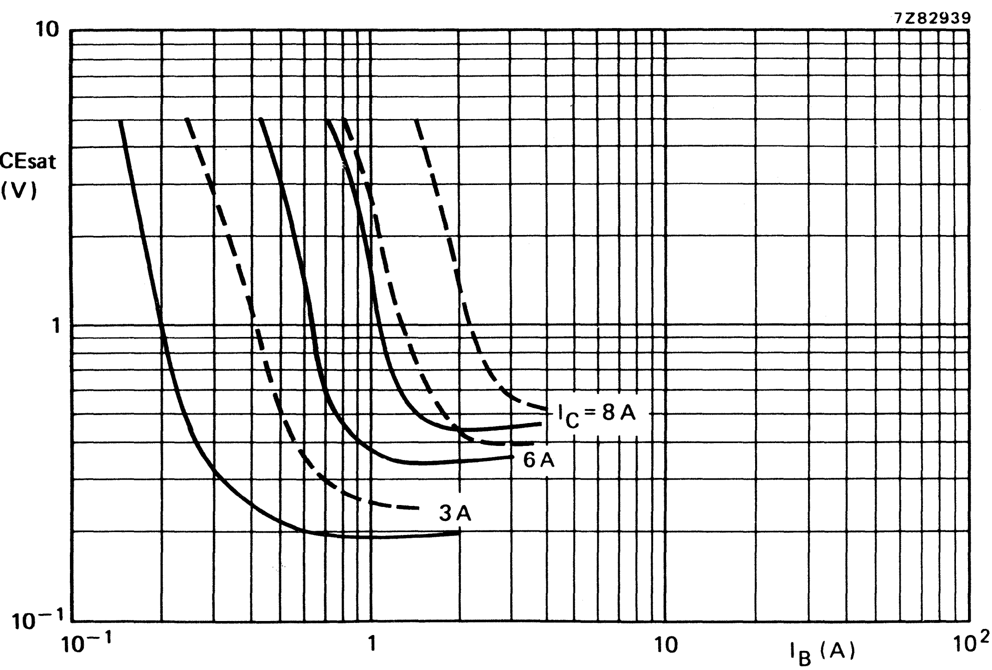


Fig. 13 Typ. (——) and max. (– – –) values collector-emitter saturation voltage at T_j = 25 °C.

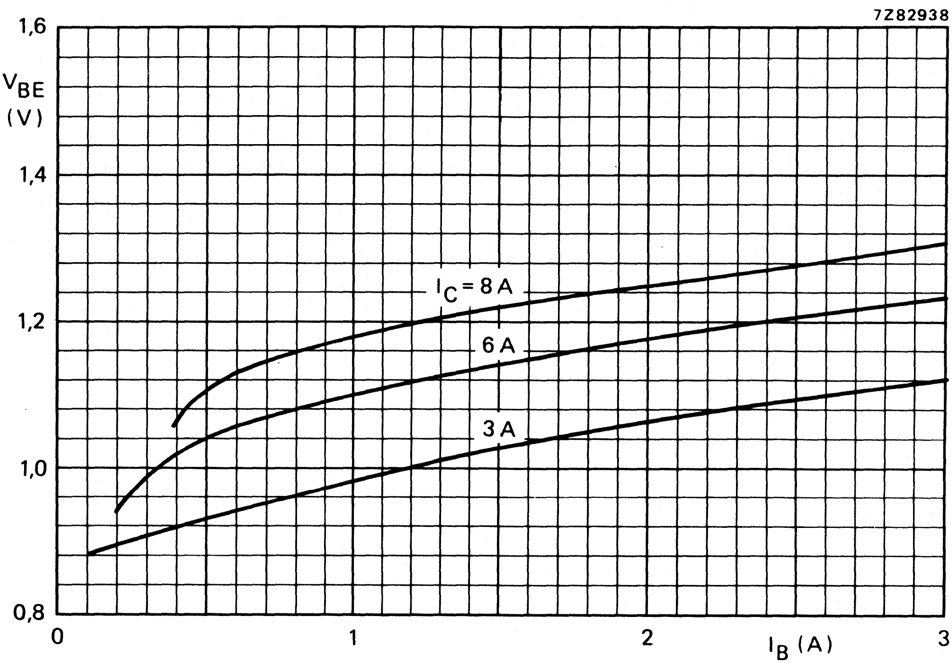


Fig. 14 Typical values base-emitter voltage at T_j = 25 °C.

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.

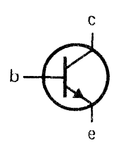
QUICK REFERENCE DATA

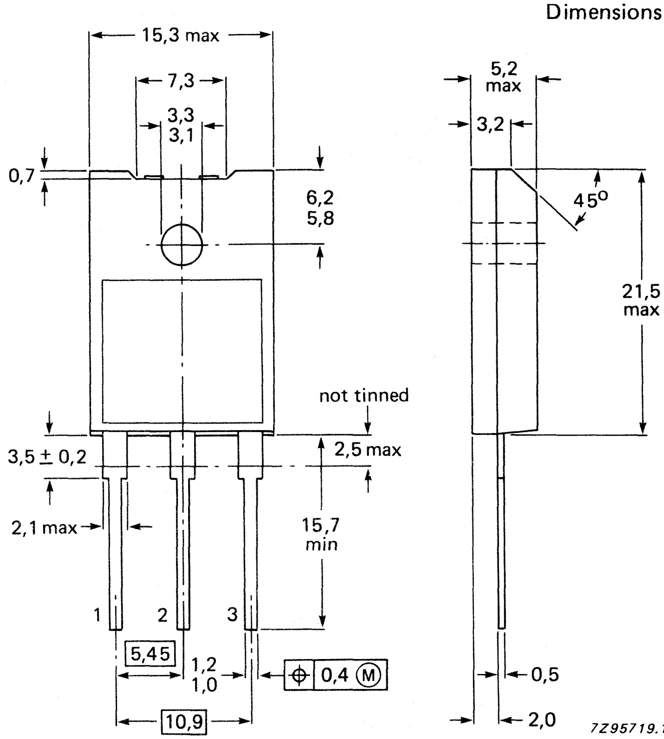
			BUW12F	BUW12AF	
Collector-emitter voltage					
peak value; $V_{BE} = 0$	V_{CESM}	max.	850	1000	V
open base	V_{CEO}	max.	400	450	V
Collector-emitter saturation voltage	V_{CEsat}	max.	1.5	1.5	V
Collector current					
saturation	I_{Csat}	max.	6.0	5.0	A
DC	I_C	max.	8.0		A
peak value	I_{CM}	max.	20		A
Total power dissipation					
up to $T_{mb} = 25\ ^oC$	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.

RATINGS

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

			BUW12F	BUW12AF	
Collector-emitter voltage					
peak value; $V_{BE} = 0$	V_{CESM}	max.	850	1000	V
open base	V_{CEO}	max.	400	450	V
Collector current					
saturation	I_{Csat}		6.0	5.0	A
DC	I_C	max.	8.0		A
peak value	I_{CM}	max.	20		A
Base current					
DC	I_B	max.	4.0		A
peak value	I_{BM}	max.	6.0		A
Total power dissipation up to $T_h = 25\ ^oC$ (note 1)	P_{tot}	max.	34		W
Total power dissipation up to $T_h = 25\ ^oC$ (note 2)	P_{tot}	max.	45		W
Storage temperature range	T_{stg}		–65 to + 150		^oC
Junction temperature	T_j	max.	150		^oC

THERMAL RESISTANCE

From junction to external heatsink (note 1)	$R_{th\ j\text{-}h}$	=	3.7	K/W
From junction to external heatsink (note 2)	$R_{th\ j\text{-}h}$	=	2.8	K/W
From junction to ambient	$R_{th\ j\text{-}a}$	=	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

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 °C unless otherwise specified

Collector cut-off currents*				
$V_{CE} = V_{CESMmax}$; $V_{BE} = 0$	I_{CES}	max.	1.0	mA
$V_{CE} = V_{CESMmax}$; $V_{BE} = 0$; T_j = 125 °C	I_{CES}	max.	3.0	mA
Emitter cut-off current				
V_{EB} = 9 V; $I_C = 0$	I_{EBO}	max.	10	mA

			BUW12F	BUW12AF
Saturation voltages				
I_C = 6 A; I_B = 1.2 A	V_{CEsat}	max.	1.5	– V
	V_{BEsat}	max.	1.5	– V
I_C = 5 A; I_B = 1.0 A	V_{CEsat}	max.	–	1.5 V
	V_{BEsat}	max.	–	1.5 V
Collector-emitter sustaining voltage (Figs 2 and 3)				
I_C = 100 mA; $I_{B\ off}$ = 0; L = 25 mH	$V_{CEOsust}$	min.	400	450 V
Collector saturation current				
V_{CE} = 1.5 V	I_{Csat}	max.	6.0	5.0 A
Switching times resistive load (Figs 4 and 5)				
$I_{C\ on}$ = 6 A; $I_{B\ on} = I_{B\ off}$ = 1.2 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
$I_{C\ on}$ = 5 A; $I_{B\ on} = I_{B\ off}$ = 1 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)				
$I_{C\ on}$ = 6 A; I_B = 1.2 A; V_{CL} = 250 V; T_c = 100 °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
$I_{C\ on}$ = 5 A; I_B = 1 A; V_{CL} = 300 V; T_c = 100 °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

DEVELOPMENT DATA

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

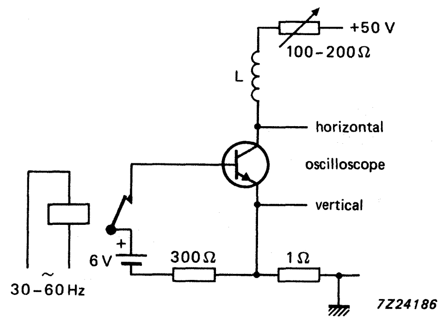


Fig. 2 Test circuit for $V_{CEOsust}$.

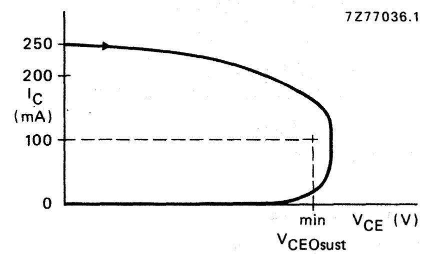


Fig. 3 Oscilloscope display for sustaining voltage.

V_{CC} = 250 V
t_p = 20 μs
V_{IM} = −6 to + 8 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

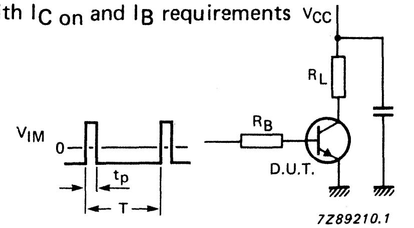


Fig. 4 Test circuit resistive load.

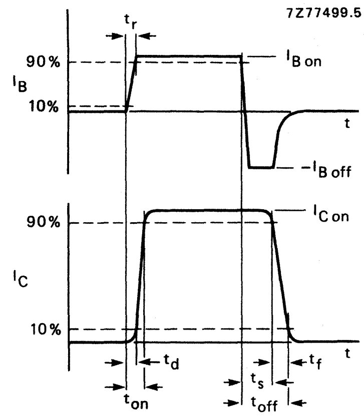


Fig. 5 Switching waveforms with resistive load; $t_r \leqslant 20$ ns.

V_{CL} = up to 1000 V
V_{CC} = 30 V
$-V_{BE}$= 1 V to 5 V
L_B = 1.0 μH
L_C = 200 μH

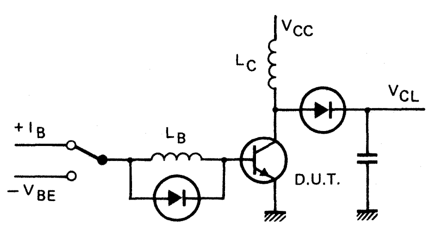


Fig. 6 Test circuit inductive load and reverse bias SOAR.

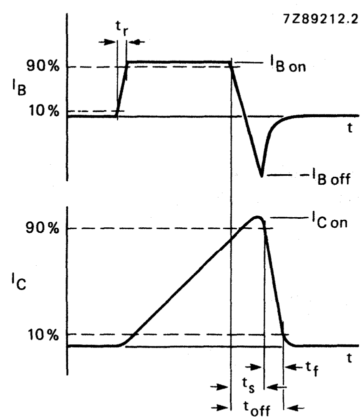
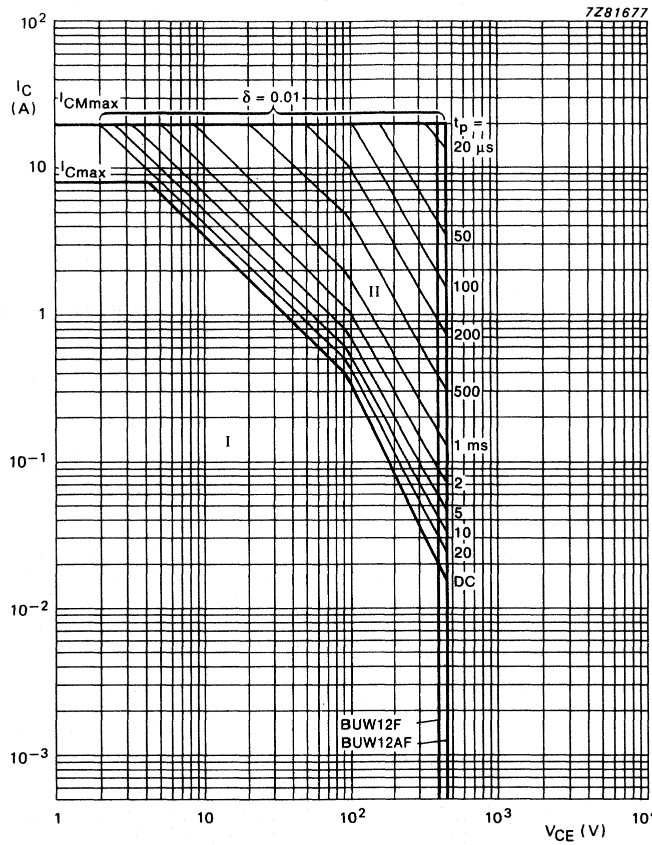


Fig. 7 Switching times waveforms with inductive load.



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.

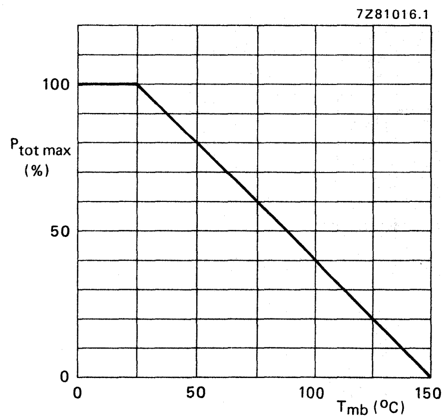


Fig. 9 Power dissipation curve.

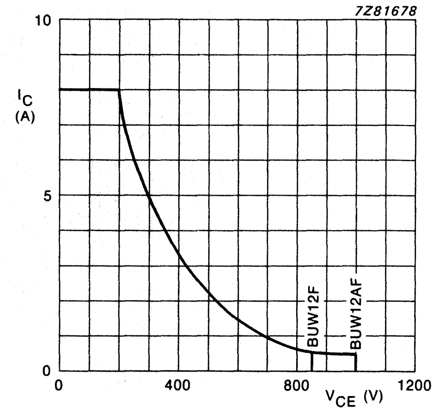


Fig. 10 RB SOAR; $T_c \leqslant 100\,^{o}C$; $V_{BE} = -1$ V to -5 V.

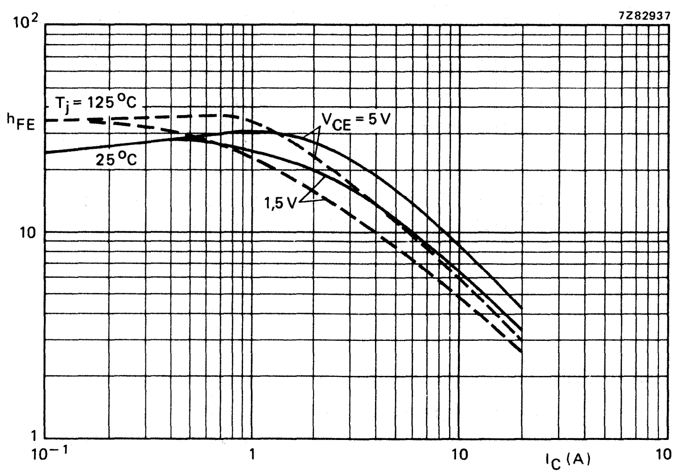


Fig. 11 Typical values DC current gain; $T_j = 125\,^{o}C$.

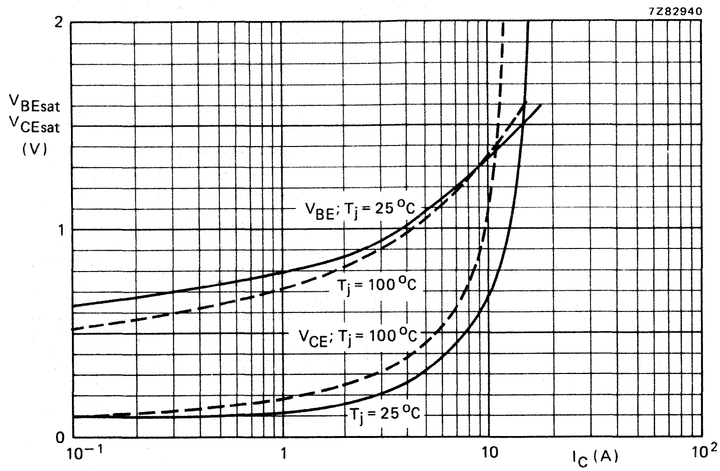


Fig. 12 Typical values base and collector voltages at $I_C/I_B = 5$.

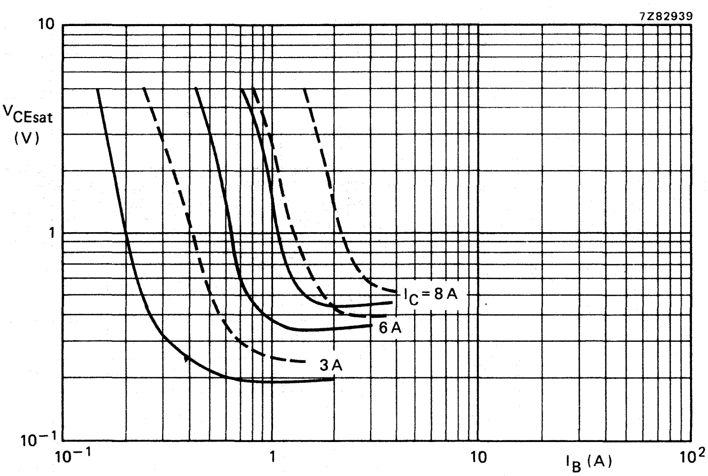


Fig. 13 Typical (——) and maximum (– – –) values saturation voltage; $T_j = 25$ °C.

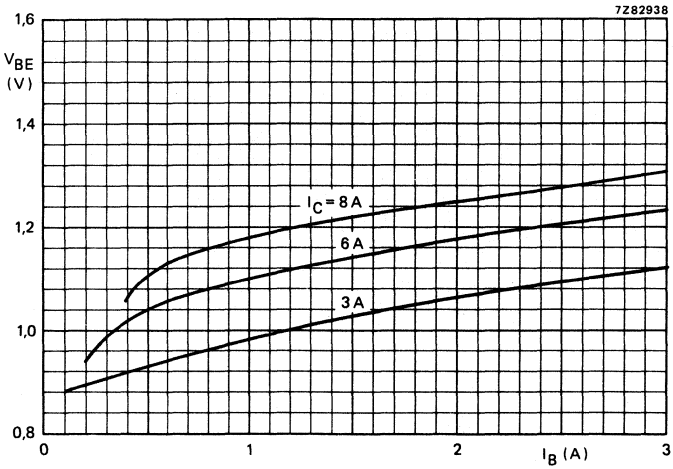


Fig. 14 Typical values base-emitter voltage at T_j = 25 °C.

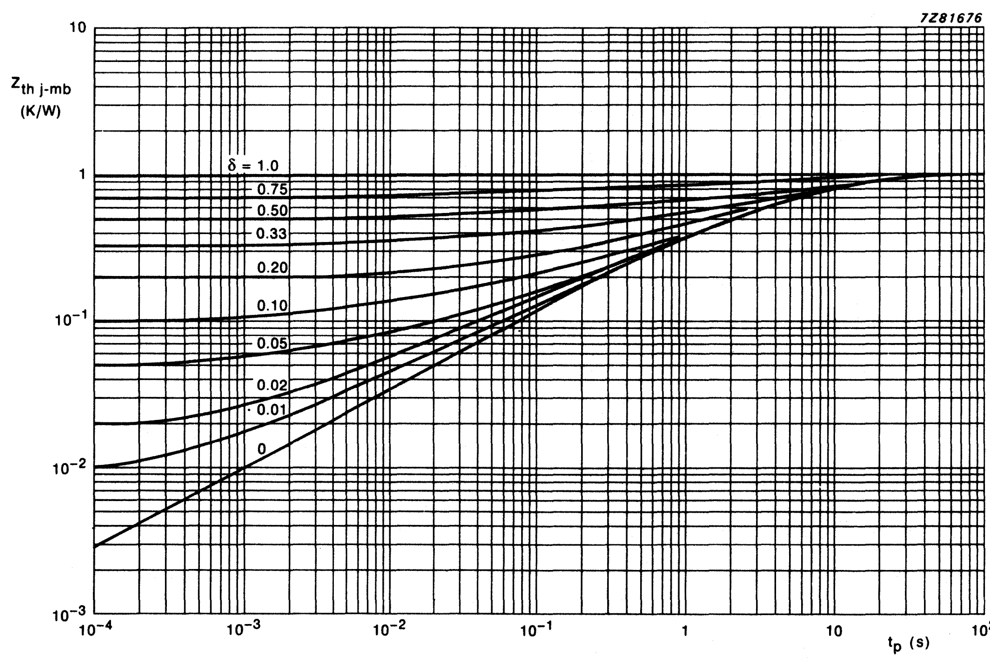


Fig. 15 Normalized thermal response at pulse power conditions.

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.

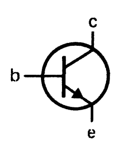
QUICK REFERENCE DATA

			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 °C	P_{tot}	max.	175		W
Fall time	t_f	max.	0.8		μs

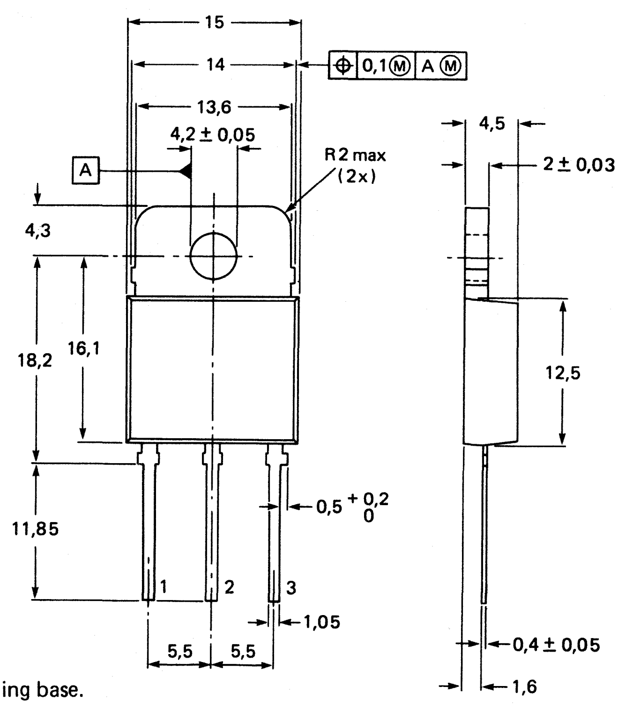
MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT93.



Pinning:
1 = base
2 = collector
3 = emitter



Collector connected to mounting base.

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	$R_{th\ j\text{-}mb}$	=	0,7	K/W

CHARACTERISTICS

T_j = 25 °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 °C	I_{CES}	max.	4	mA
Emitter cut-off current				
$I_C = 0$; V_{EB} = 9 V	I_{EBO}	max.	10	mA

			BUW13	BUW13A	
Saturation voltages					
I_C = 10 A; I_B = 2 A	V_{CEsat}	max.	1,5	–	V
	V_{BEsat}	max.	1,6	–	V
I_C = 8 A; I_B = 1,6 A	V_{CEsat}	max.	–	1,5	V
	V_{BEsat}	max.	–	1,6	V
Collector-emitter sustaining voltage					
I_C = 100 mA; I_{Boff} = 0; L = 25 mH	$V_{CEOsust}$	min.	400	450	V

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

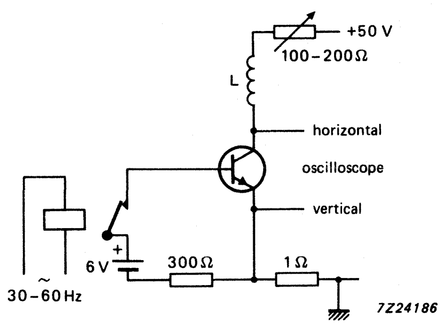


Fig. 2 Test circuit for $V_{CEOsust}$.

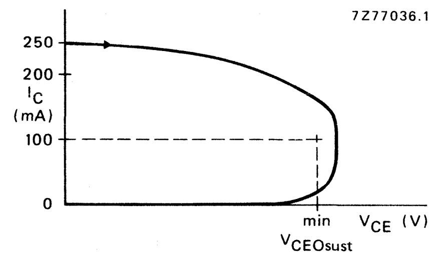
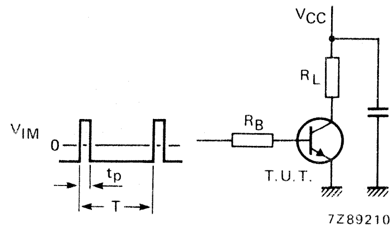


Fig. 3 Oscilloscope display for sustaining voltage.

			BUW13	BUW13A	
Switching times resistive load (Figs 4 and 5)					
I_{Con} = 10 A; I_{Bon} = $-I_{Boff}$ = 2 A					
Turn-on time	t_{on}	max.	1	–	μs
Turn-off: Storage time	t_s	max.	4	–	μs
Fall time	t_f	max.	0,8	–	μs
I_{Con} = 8 A; I_{Bon} = $-I_{Boff}$ = 1,6 A					
Turn-on time	t_{on}	max.	–	1	μs
Turn-off: Storage time	t_s	max.	–	4	μs
Fall time	t_f	max.	–	0,8	μs
Switching times inductive load (Figs 6 and 7)					
I_{Con} = 10 A; I_B = 2 A					
Turn-off: Storage time	t_s	typ.	2,3	–	μs
		max.	3,0	–	μs
Fall time	t_f	typ.	80	–	ns
		max.	150	–	ns
I_{Con} = 10 A; I_B = 2 A; T_j = 100 °C					
Turn-off: Storage time	t_s	typ.	2,5	–	μs
		max.	3,2	–	μs
Fall time	t_f	typ.	140	–	ns
		max.	300	–	ns
Switching times inductive load (Figs 6 and 7)					
I_{Con} = 8 A; I_B = 1,6 A					
Turn-off: Storage time	t_s	typ.	–	2,3	μs
		max.	–	3,0	μs
Fall time	t_f	typ.	–	80	ns
		max.	–	150	ns
I_{Con} = 8 A; I_B = 1,6 A; T_j = 100 °C					
Turn-off: Storage time	t_s	typ.	–	2,5	μs
		max.	–	3,2	μs
Fall time	t_f	typ.	–	140	ns
		max.	–	300	ns



V_{CC} = 250 V
V_{IM} = −6 to + 8 V
t_p = 20 μs
$\frac{t_p}{T}$ = 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.

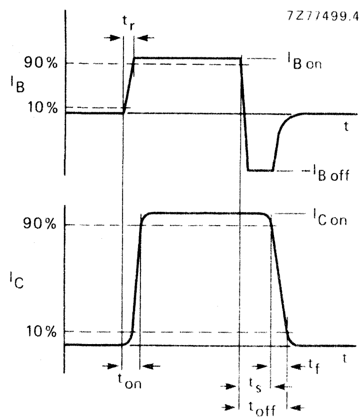


Fig. 5 Switching times waveforms with resistive load.

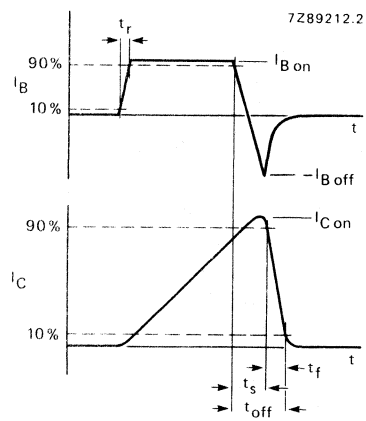
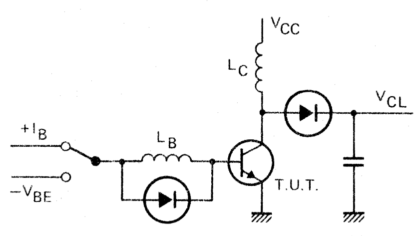
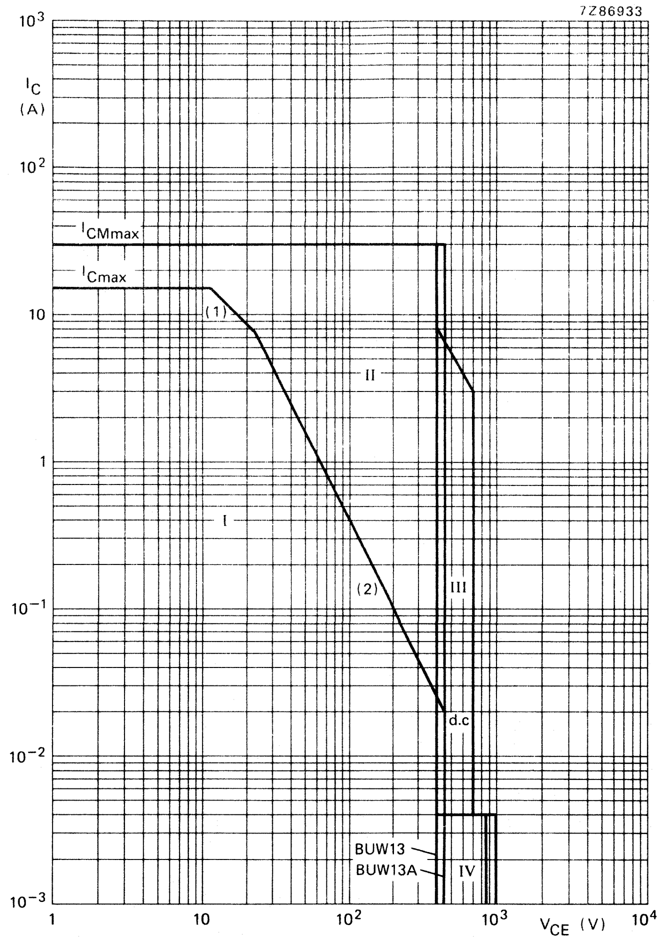


Fig. 6 Switching times waveforms with inductive load.



V_{CL} = 300 V
V_{CC} = 30 V
$-V_{BE}$ = 5 V
L_B = 1 μH
L_C = 200 μH

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 $R_{BE} \leqslant 100\ \Omega$ and $t_p \leqslant 0,6\ \mu s$.
IV Repetitive pulse operation in this region is permissible provided $V_{BE} \leqslant 0$ and $t_p \leqslant 5$ ms.

Fig. 8 Safe operating area at $T_{mb} \leqslant 25\ ^oC$.

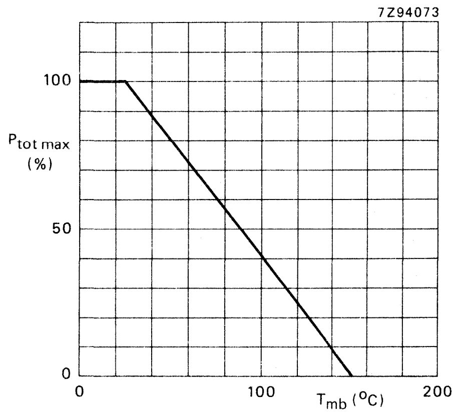


Fig. 9 Total power dissipation derating curve.

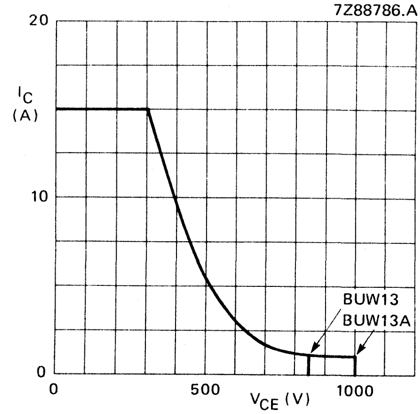


Fig. 10 Reverse bias SOAR.

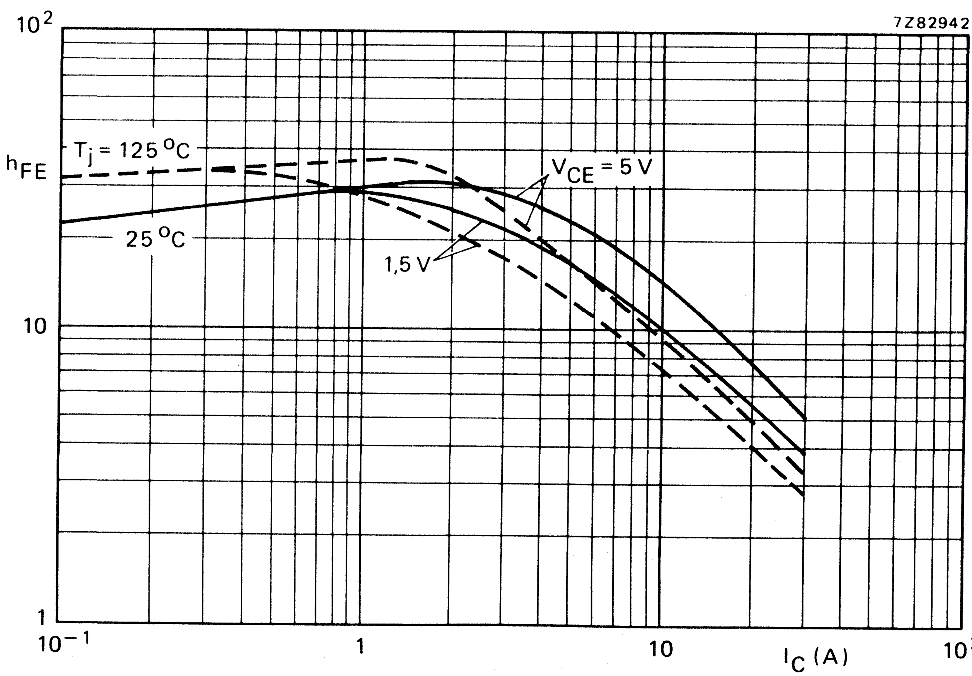


Fig. 11 Typical values DC current gain.

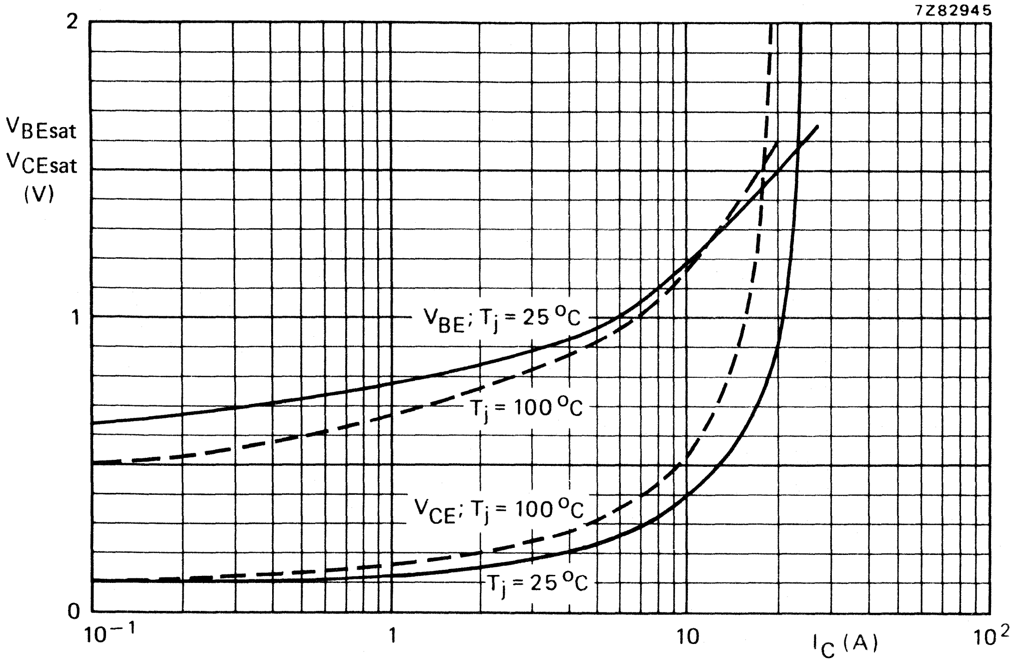


Fig. 12 Typical values base and collector voltage at $I_C/I_B = 5$.

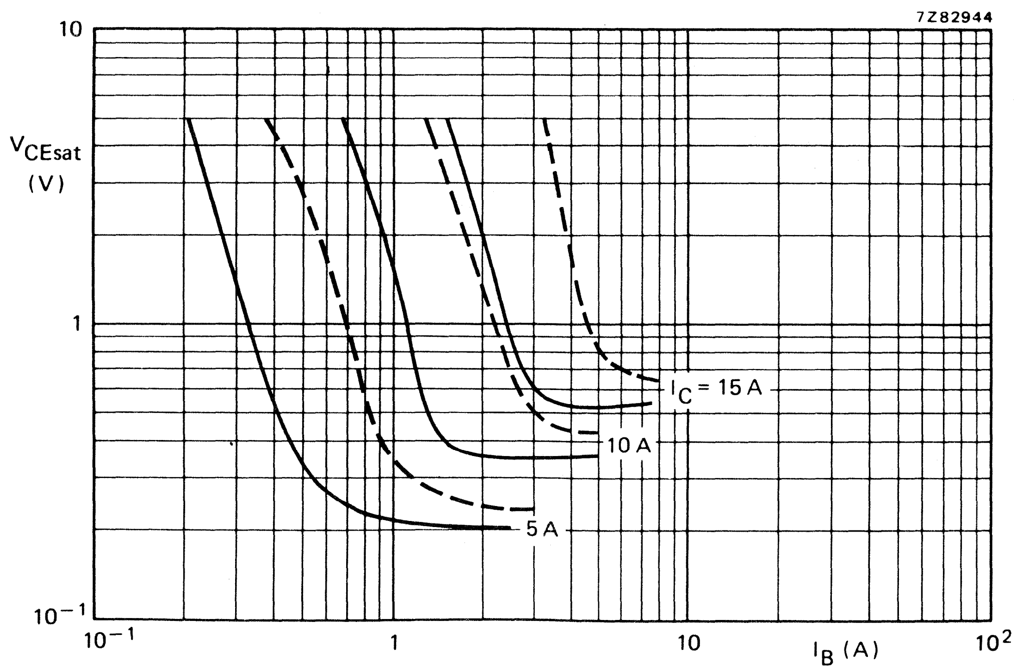


Fig. 13 Typical (——) and maximum (– – –) values saturation voltage. T_j = 25 °C.

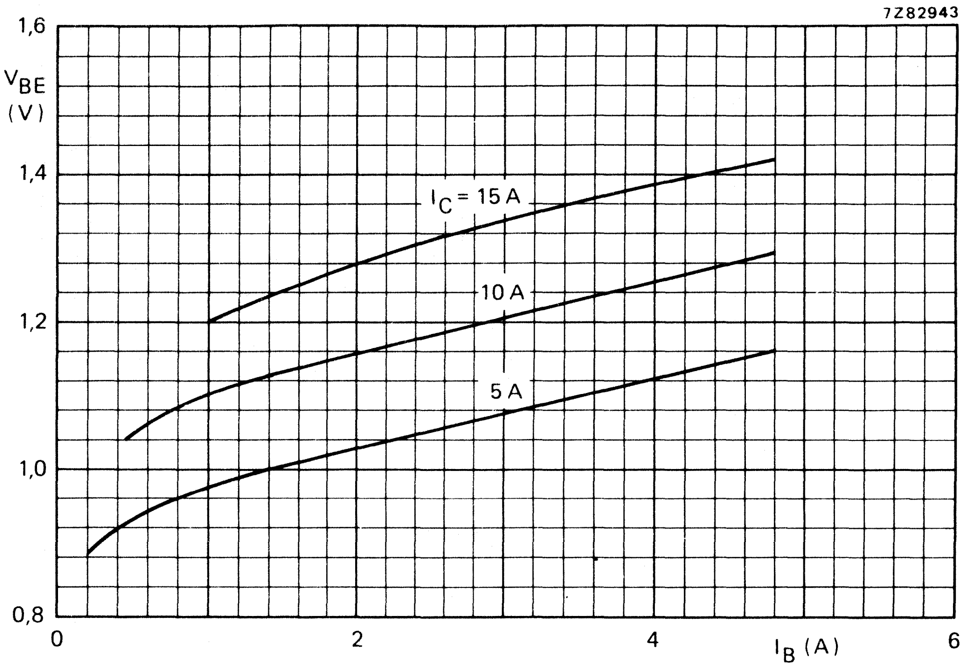


Fig. 14 Typical values base-emitter voltage at T_j = 25 °C.

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.

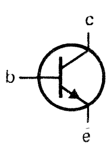
QUICK REFERENCE DATA

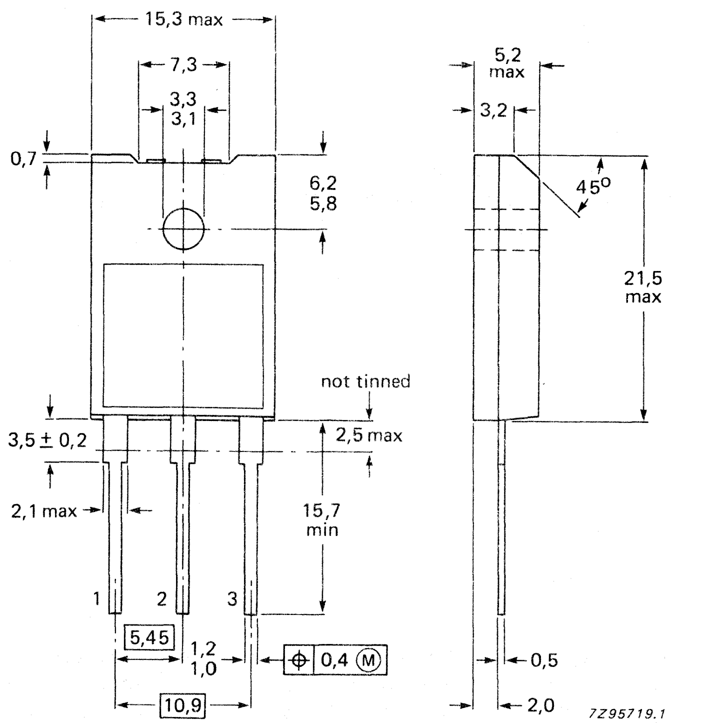
			BUW13F	BUW13AF	
Collector-emitter voltage					
peak value; $V_{BE} = 0$	V_{CESM}	max.	850	1000	V
open base	V_{CEO}	max.	400	450	V
Collector-emitter saturation voltage	V_{CEsat}	max.	1.5	1.5	V
Collector current					
saturation	I_{Csat}		10.0	8.0	A
DC	I_C	max.	15		A
peak value; $t_p < 20$ ms	I_{CM}	max.	30		A
Total power dissipation					
up to $T_h = 25\ ^oC$	P_{tot}	max.	37		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.

RATINGS

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

			BUW13F	BUW13AF	
Collector-emitter voltage					
peak value; $V_{BE} = 0$	V_{CESM}	max.	850	1000	V
open base	V_{CEO}	max.	400	450	V
Collector current					
saturation	I_{Csat}		10.0	8.0	A
DC	I_C	max.	15		A
peak value; $t_p < 20$ ms	I_{CM}	max.	30		A
Base current					
DC	I_B	max.	6.0		A
peak value; $t_p = -20$ ms	I_{BM}	max.	9.0		A
Total power dissipation up to $T_h = 25$ °C (note 1)	P_{tot}	max.	37		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)	$R_{th\ j\text{-}h}$	=	3.4	K/W
From junction to external heatsink (note 2)	$R_{th\ j\text{-}h}$	=	2.5	K/W
From junction to ambient	$R_{th\ j\text{-}a}$	=	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 ⩽ 65% under clean and dustfree conditions.

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			BUW13F	BUW13AF	
Collector cut-off currents*					
$V_{CE} = V_{CESMmax}$; $V_{BE} = 0$	I_{CES}	max.	1.0		mA
$V_{CE} = V_{CESMmax}$; $V_{BE} = 0$; T_j = 125 °C	I_{CES}	max.	4.0		mA
Emitter cut-off current					
V_{EB} = 9 V; $I_C = 0$	I_{EBO}	max.	10		mA
Saturation voltages					
I_C = 10 A; I_B = 2 A	V_{CEsat}	max.	1.5	–	V
	V_{BEsat}	max.	1.6	–	V
I_C = 8 A; I_B = 1.6 A	V_{CEsat}	max.	–	1.5	V
	V_{BEsat}	max.	–	1.6	V
Collector-emitter sustaining voltage (Figs 2 and 3)					
I_C = 100 mA; $I_{B\ off} = 0$; L = 25 mH	$V_{CEOsust}$	min.	400	450	V
Collector saturation current					
V_{CE} = 1.5 V	I_{Csat}		10	8.0	A
Switching times resistive load (Figs 4 and 5)					
$I_{C\ on}$ = 10 A; $I_{B\ on} = I_{B\ off}$ = 2 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
$I_{C\ on}$ = 8 A; $I_{B\ on} = I_{B\ off}$ = 1.6 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	μ
Switching times inductive load (Figs 6 and 7)					
$I_{C\ on}$ = 10 A; I_B = 2 A; V_{CL} = 250 V; T_c = 100 °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
$I_{C\ on}$ = 8 A; I_B = 1.6 A; V_{CL} = 300 V; T_c = 100 °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

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

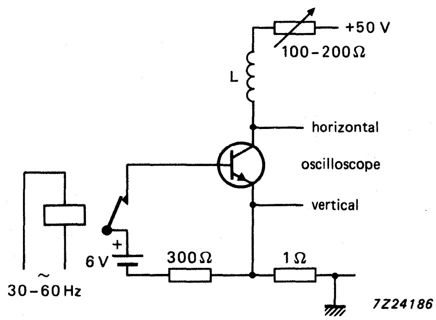


Fig. 2 Test circuit for $V_{CEOsust}$.

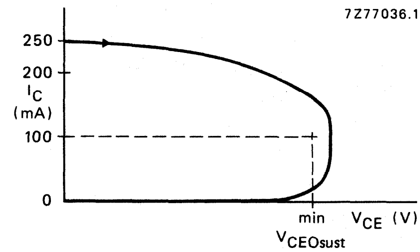
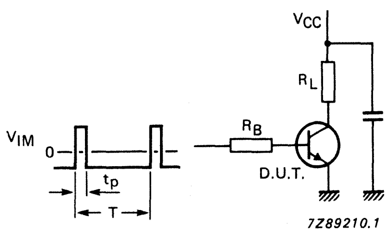


Fig. 3 Oscilloscope display for sustaining voltage.



V_{CC} = 250 V
t_p = 20 μs
V_{IM} = −6 to +8 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.

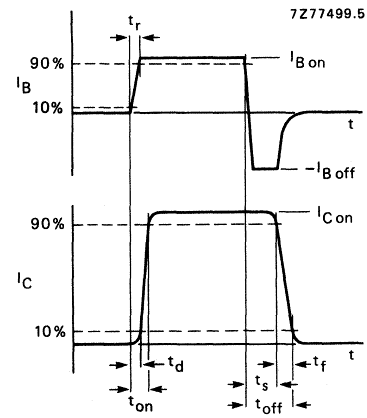
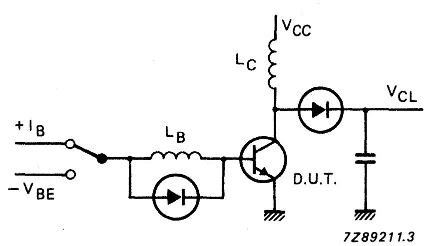


Fig. 5 Switching times waveforms with resistive load; $t_r \leqslant 20$ ns.



V_{CL} = up to 1000 V
V_{CC} = 30 V
$-V_{BE}$ = 5 V
L_B = 1.0 μH
L_C = 200 μH

Fig. 6 Test circuit inductive load and reverse bias SOAR.

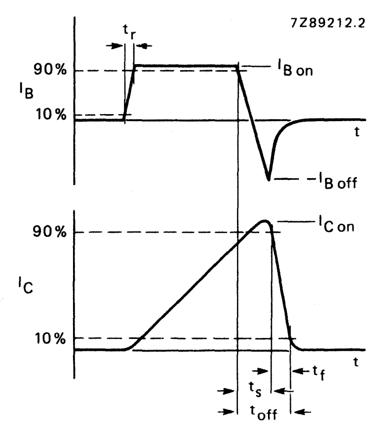
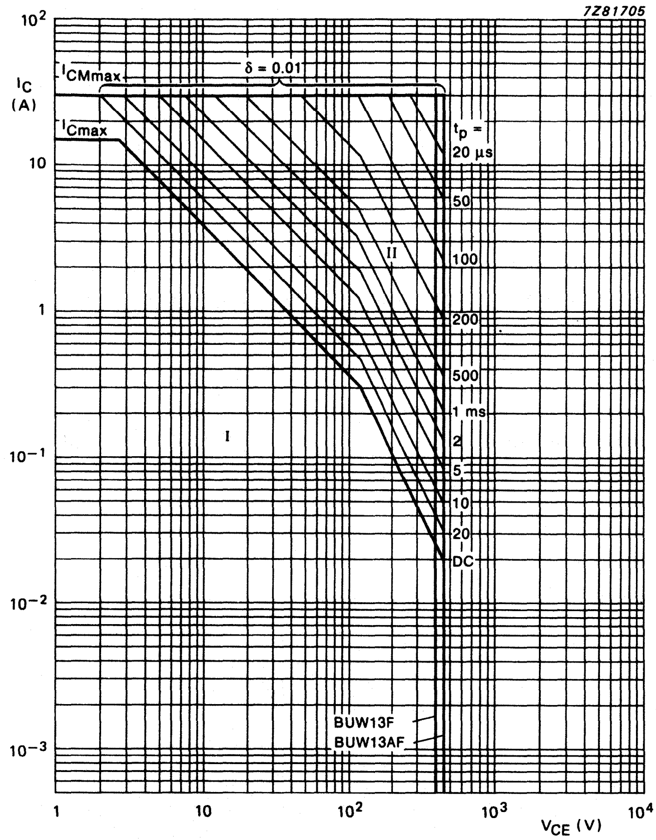


Fig. 7 Switching times waveforms with inductive load.



(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 $T_{mb} < 25\ ^oC$.

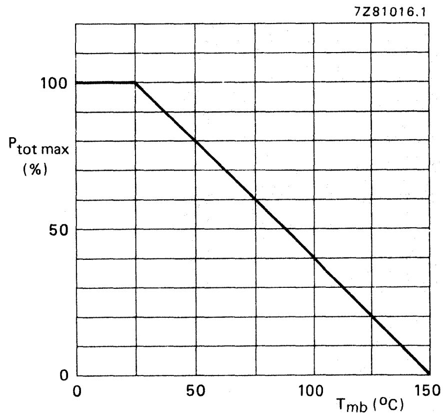


Fig. 9 Power dissipation curve.

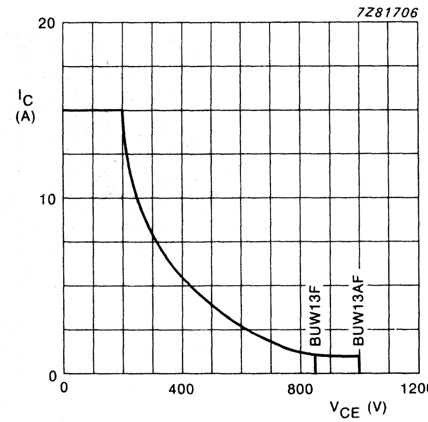


Fig. 10 RB SOAR; $T_c \leq 100$ °C; $V_{BE} = -1$ V to -5 V.

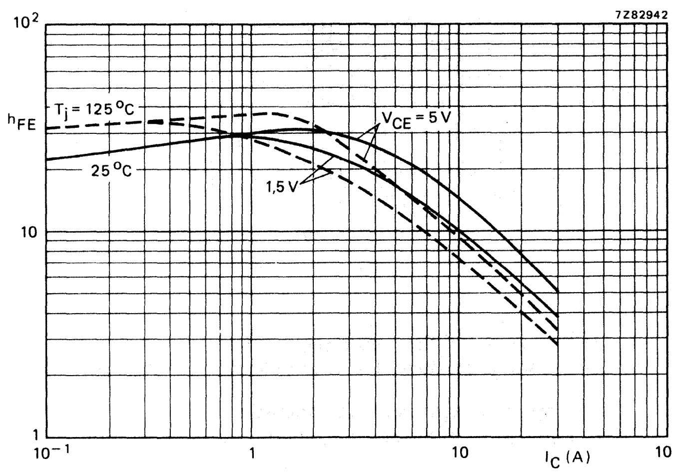


Fig. 11 Typical values DC current gain; $T_j = 125$ °C.

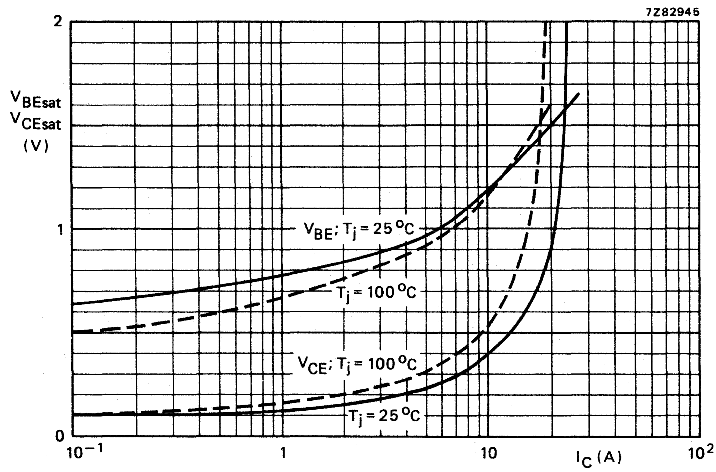


Fig. 12 Typical values base and collector voltages at $I_C/I_B = 5$.

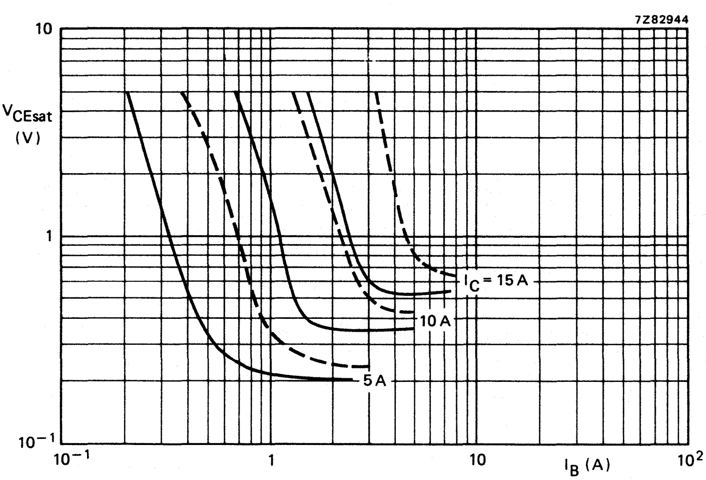


Fig. 13 Typical (——) and maximum (– – –) values saturation voltage; T_j = 25 °C.

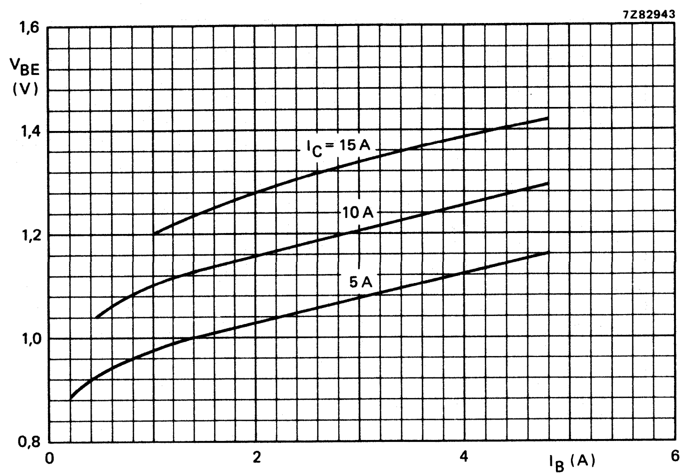


Fig. 14 Typical values base-emitter voltage at T_j = 25 °C.

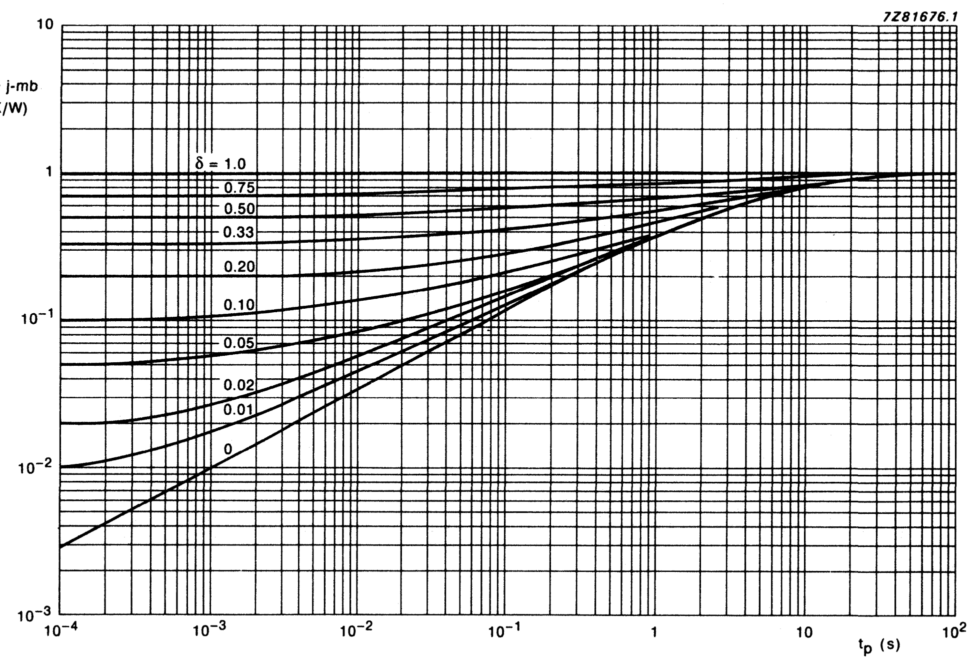


Fig. 15 Normalized thermal response at pulse power conditions.

SILICON DIFFUSED POWER TRANSISTORS

High-voltage, high-speed, glass-passivated npn power transistors in SOT82 envelopes, intended for use in converters, inverters, switching regulators, motor control systems and switching applications.

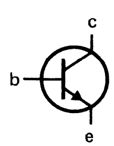
QUICK REFERENCE DATA

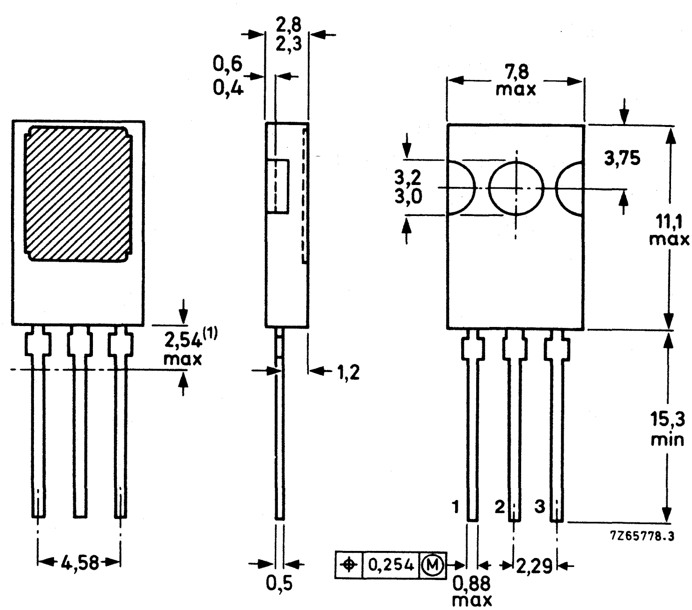
			BUW84	BUW85	
Collector-emitter voltage (peak value; $V_{BE} = 0$)	V_{CESM}	max.	800	1000	V
Collector-emitter voltage (open base)	V_{CEO}	max.	400	450	V
Collector-emitter saturation voltage	V_{CEsat}	max.	1		V
Collector current (DC)	I_C	max.	2		A
Collector current (peak value)	I_{CM}	max.	3		A
Total power dissipation up to $T_{mb} = 45\ ^{o}C$	P_{tot}	max.	50		W
Fall time	t_f	typ.	0.4		μs

MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT82.





Pinning;

1 = base
2 = collector
3 = emitter

Collector connected to mounting base.

(1) Within this region the cross-section of the leads is uncontrolled.

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	$R_{th\ j\text{-}mb}$	=	2.1	K/W
From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	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	μA
$V_{CEM} = V_{CESMmax}$; V_{BE} = 0; T_j = 125 °C	I_{CES}	max.	1.5	mA
DC current gain				
I_C = 0,1 A; V_{CE} = 5 V	h_{FE}	typ.	50	
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

			BUW84	BUW85	
Collector-emitter sustaining voltage I_C = 100 mA; I_{Boff} = 0; L = 25 mH	$V_{CEOsust}$	min.	400	450	V

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

CHARACTERISTICS (continued)

T_j = 25 °C unless otherwise specified

Transition frequency at f = 1 MHz			
I_C = 0,2 A; V_{CE} = 10 V	f_T	typ.	20 MHz
Switching times			
I_{Con} = 1 A; V_{CC} = 250 V			
I_{Bon} = 0,2 A; $-I_{Boff}$ = 0,4 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 °C	t_f	max.	1.4 μs

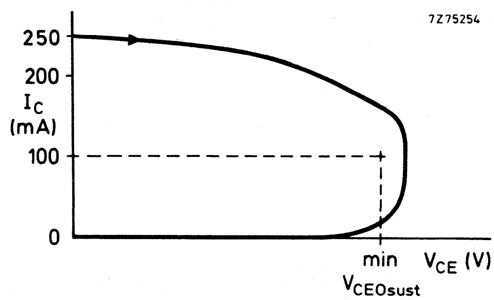


Fig. 2 Oscilloscope display for sustaining voltage.

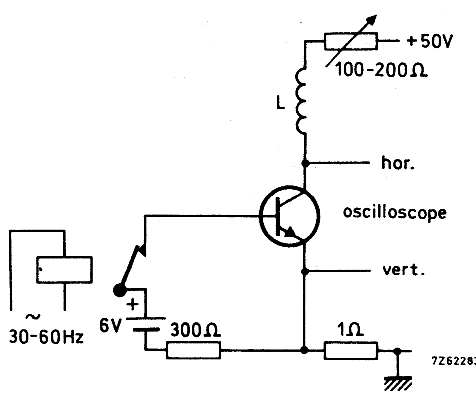


Fig. 3 Test circuit for $V_{CEOsust}$.

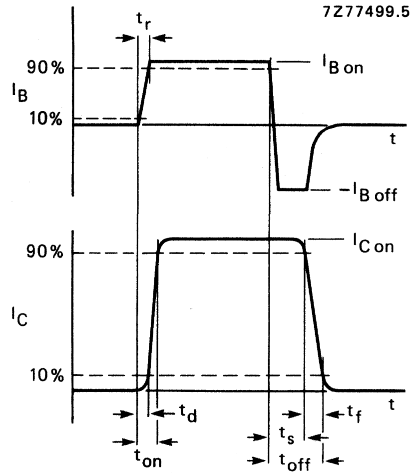


Fig. 4 Switching times waveforms with resistive load.

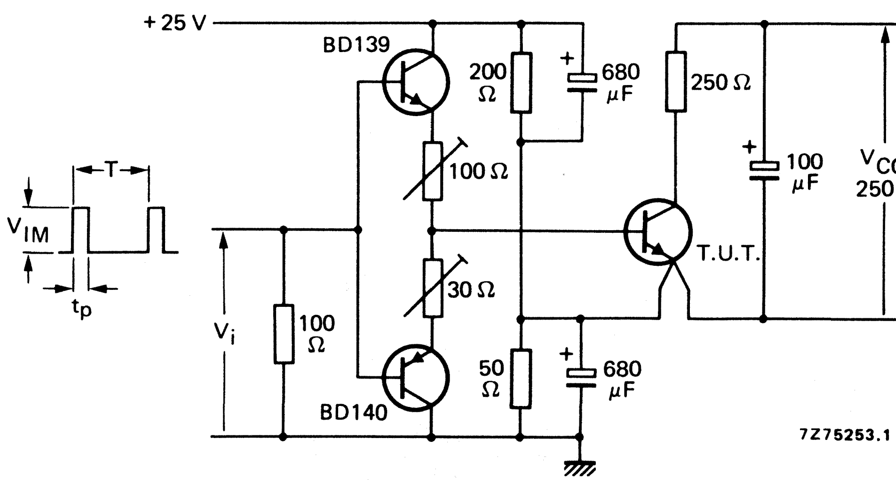
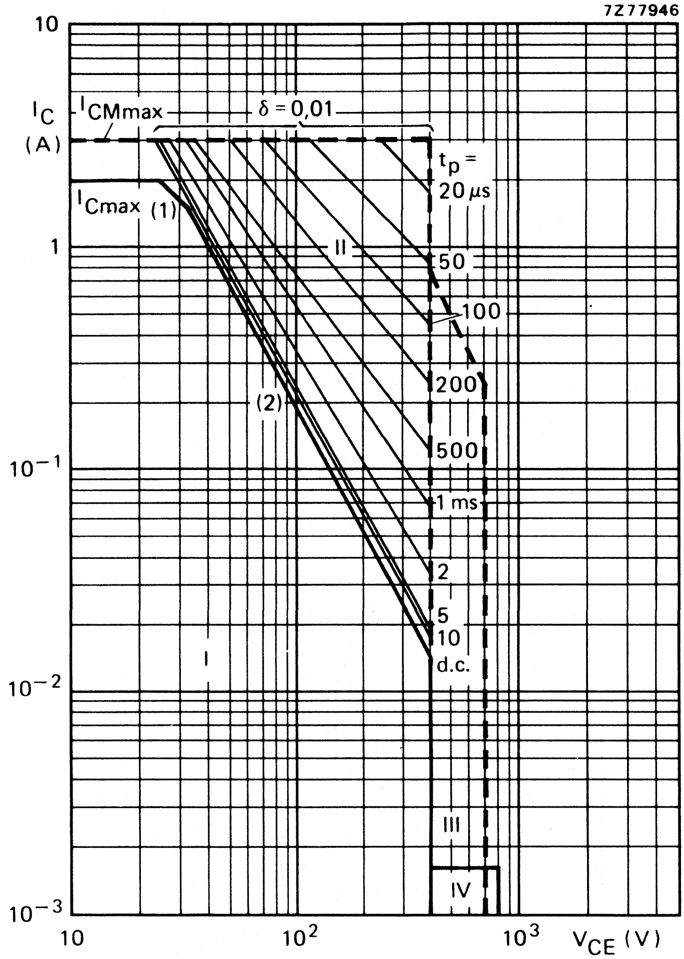
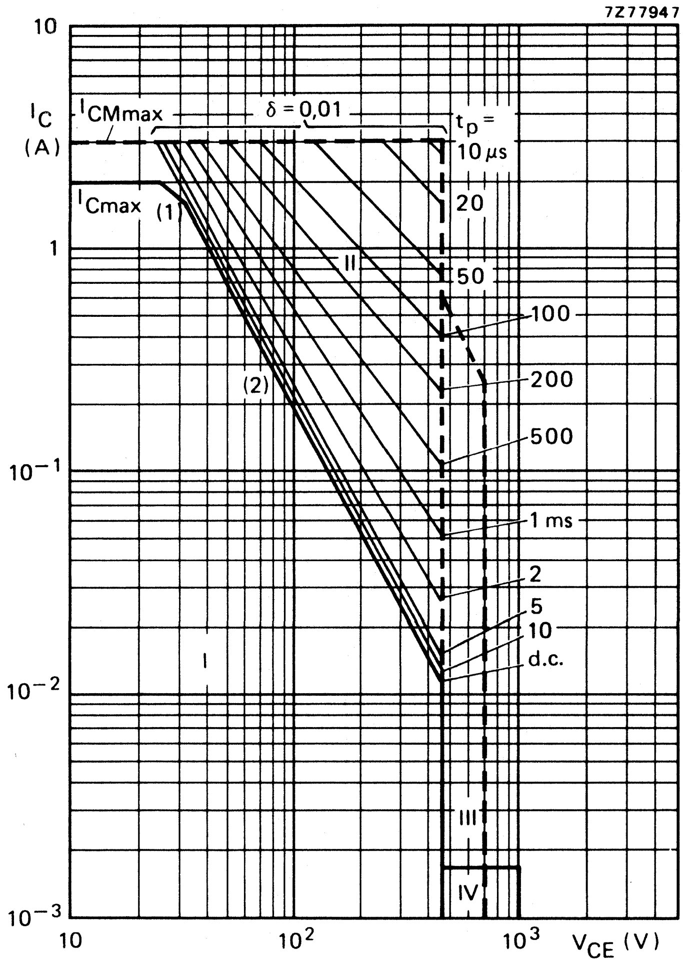


Fig. 5 Test circuit resistive load.



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 $R_{BE} \leqslant 100\ \Omega$ and $t_p \leqslant 0,6\ \mu s$
IV Repetitive pulse operation in this region is permissible, provided $V_{BE} \leqslant 0$ and $t_p \leqslant 2$ ms
(1) $P_{tot\ max}$ line.
(2) Second-breakdown limits.

Fig. 6 Safe operating area at $T_{mb} \leqslant 25\ ^oC$ of BUW84.



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 $R_{BE} \leqslant 100\ \Omega$ and $t_p \leqslant 0{,}6\ \mu s$
IV Repetitive pulse operation in this region is permissible, provided $V_{BE} \leqslant 0$ and $t_p \leqslant 2$ ms
(1) $P_{tot\ max}$ line.
(2) Second-breakdown limits.

Fig. 7 Safe operating area $T_{mb} \leqslant 25\ ^oC$ of BUW85.

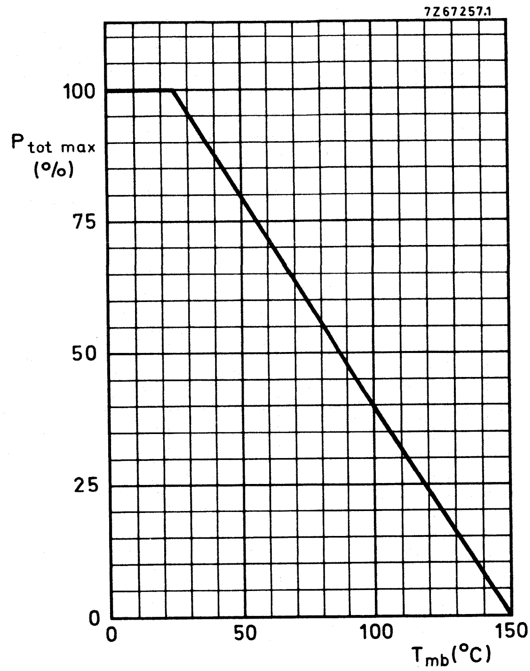


Fig. 8 Power derating curve.

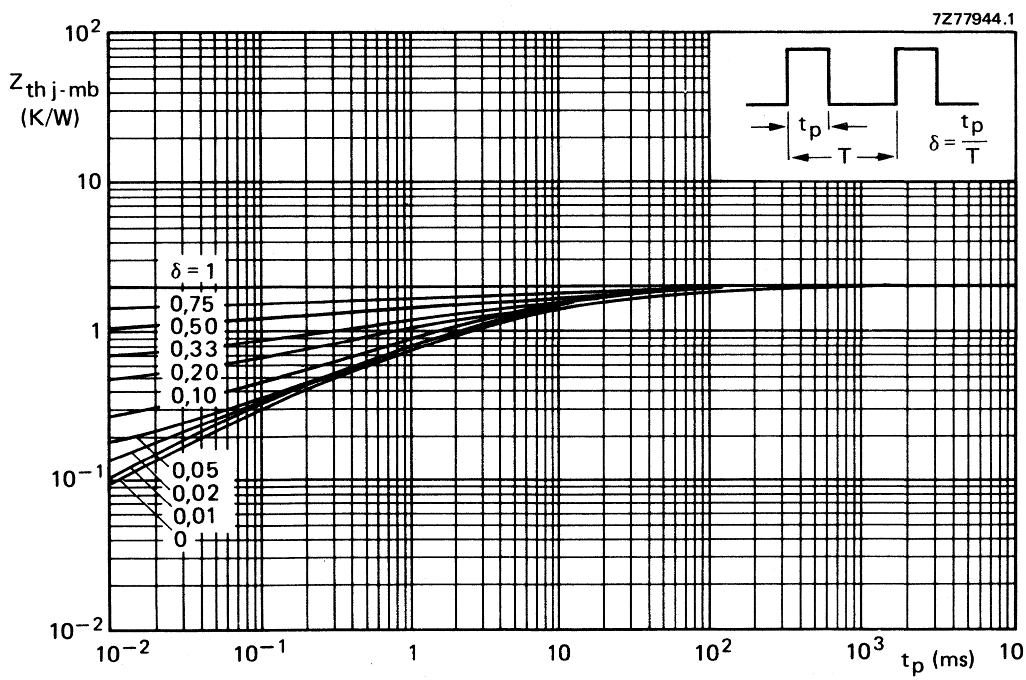


Fig. 9 Pulse power rating chart.

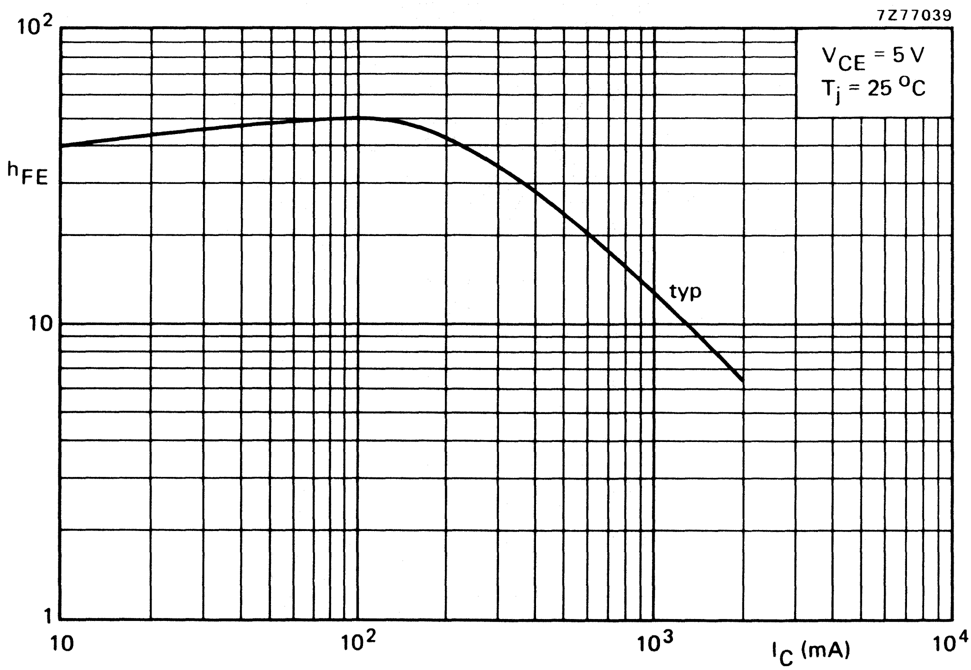


Fig. 10 Typical DC current gain.

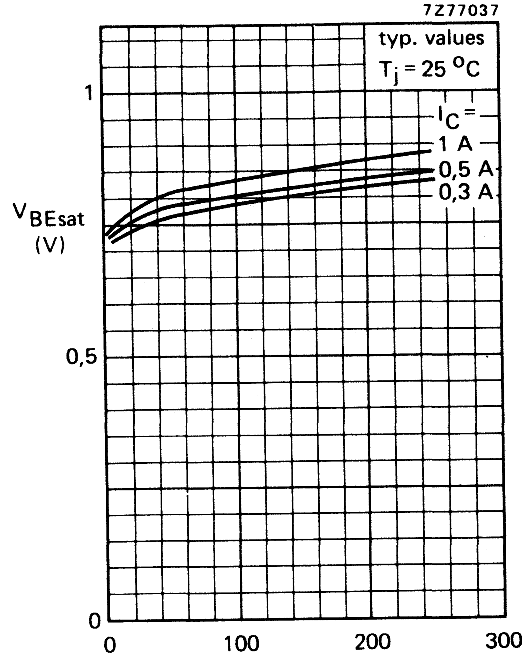


Fig. 11 Typical base-emitter saturation voltage.

Fig. 14.

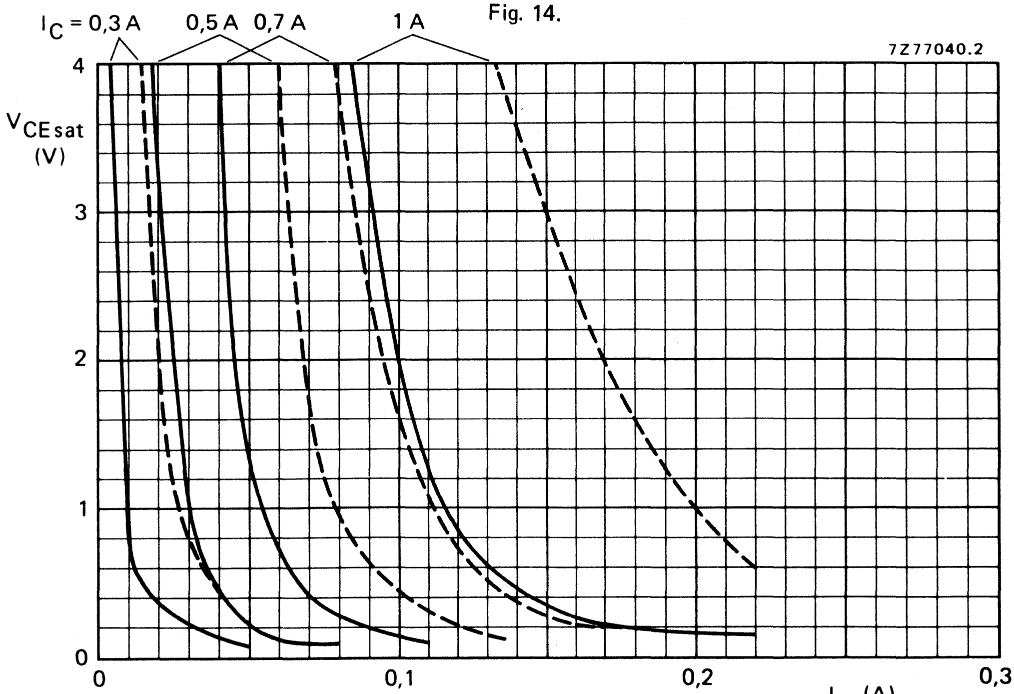


Fig. 12 Typical (——) and maximum (– – –) values saturation voltage at T_j = 25 °C.

SILICON DIFFUSED POWER TRANSISTORS

High-speed switching npn transistors in a metal envelope intended for use in converters, inverters, switching regulators and switching control amplifiers.

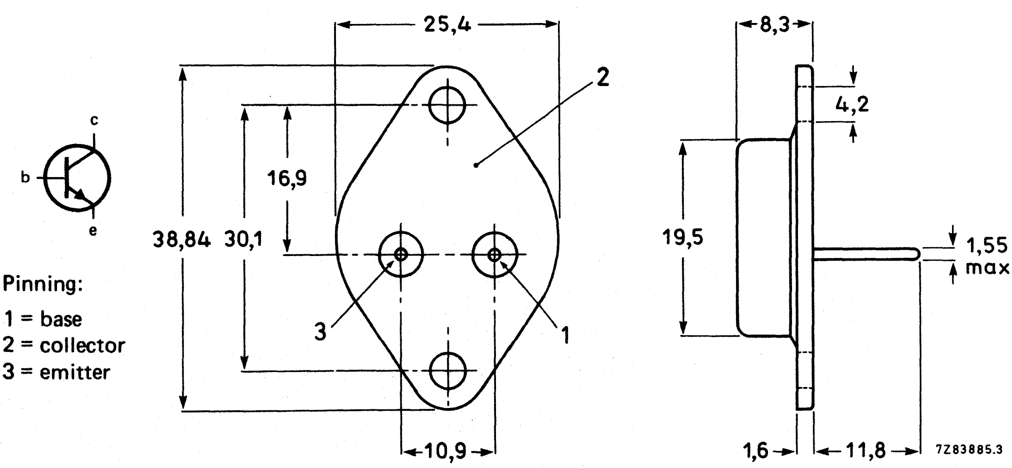
QUICK REFERENCE DATA

			BUW86	87	87A	
Collector-emitter voltage						
peak value; $V_{BE} = 0$	V_{CESM}	max.	240	300	400	V
open base	V_{CEO}	max.	120	150	200	V
Collector-emitter saturation voltage	V_{CEsat}	max.		1.0		V
Collector current						
saturation	I_{Csat}	max.	8.0	7.0	5.0	A
DC	I_C	max.		10		A
peak value	I_{CM}	max.		15		A
Total power dissipation						
up to $T_{mb} = 25\ ^oC$	P_{tot}	max.		62.5		W
Fall time resistive load	t_f	typ.		0.3		µs
Transition frequency at f = 5 MHz	f_T	typ.		50		MHz

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-3.



Pinning:

1 = base
2 = collector
3 = emitter

Collector connected to case.

RATINGS

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

			BUW86	87	87A	
Collector-base voltage						
open emitter	V_{CBO}	max.	240	300	400	V
Collector-emitter voltage						
peak value; $V_{BE} = 0$	V_{CESM}	max.	240	300	400	V
open base	V_{CEO}	max.	120	150	200	V
Emitter-base voltage	V_{EBO}	max.		6.0		V
Collector current						
saturation	I_{Csat}		8.0	7.0	5.0	A
DC	I_C	max.		10		A
peak value	I_{CM}	max.		15		A
Base current						
DC	I_B	max.		2.0		A
peak value	I_{BM}	max.		3.0		A
Emitter current						
DC	I_E	max.		11		A
peak value	I_{EM}	max.		15		A
Total power dissipation						
up to $T_{mb} = 25\ ^oC$	P_{tot}	max.		62.5		W
Storage temperature range	T_{stg}			−65 to + 200		^oC
Junction temperature	T_j	max.		200		^oC

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	2.8	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			BUW86	87	87A	
Collector cut-off current*						
$V_{CE} = V_{CBO}$; $V_{BE} = 0$	I_{CES}	max.		1.0		mA
$V_{CE} = V_{CBO}$; $V_{BE} = 0$; T_j = 150 °C	I_{CES}	max.		2.0		mA
Saturation voltages						
$I_C = I_{CEsat}$; $I_B = I_{CEsat}/10$	V_{CEsat}	max.		1.0		V
	V_{BEsat}	max.		1.6		V
I_C = 5 A; I_B = 0.5 A	V_{CEsat}	max.	0.65	–	–	V
I_C = 4 A; I_B = 0.4 A	V_{CEsat}	max.	–	0.65	–	V
I_C = 3 A; I_B = 0.3 A	V_{CEsat}	max.	–	–	0.65	V
DC current gain						
I_C = 5 A; V_{CE} = 5 V	h_{FE}	min.	20	–	–	
I_C = 4 A; V_{CE} = 5 V	h_{FE}	min.	–	20	–	
I_C = 3 A; V_{CE} = 5 V	h_{FE}	min.	–	–	20	
Transition frequency						
f = 5 MHz	f_T	typ.		50		MHz
Switching time resistive load (Figs 4 and 5)						
$I_C = I_{Csat}$; $I_B = -I_{BM} = I_{Csat}/10$						
V_{CC} = 60 V for BUW86	t_{on}	typ.	0.2	0.25	0.3	µs
V_{CC} = 75 V for BUW87	t_{on}	max.	0.35	0.4	0.4	µs
V_{CC} = 100 V for BUW87A	t_s	typ.	0.6	0.7	1.0	µs
	t_s	max.	1.3	1.3	1.5	µs
	t_f	typ.	0.12	0.15	0.15	µs
	t_f	max.	0.3	0.3	0.3	µs
Switching times inductive load (Figs 6 and 7)						
$I_C = I_{Csat}$; $I_B = I_{Csat}/10$; T_{mb} = 100 °C						
Fall time	t_f	typ.		60		ns

DEVELOPMENT DATA

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

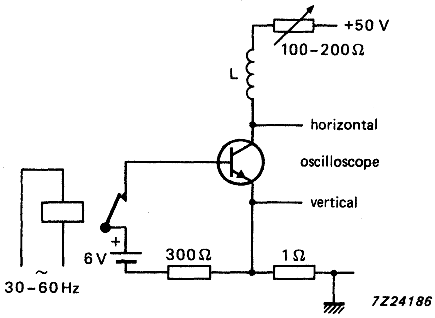


Fig. 2 Test circuit for $V_{CEOsust}$.

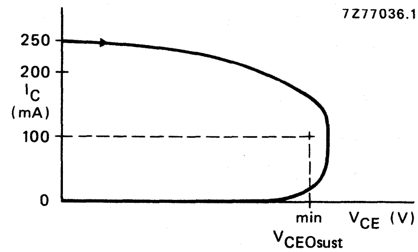


Fig. 3 Oscilloscope display for sustaining voltage.

t_p = 20 μs
V_{IM} = −6 to + 8 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.

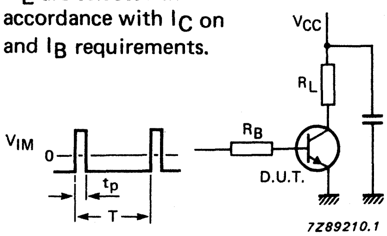


Fig. 4 Test circuit resistive load.

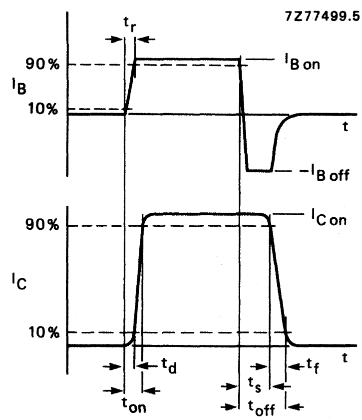
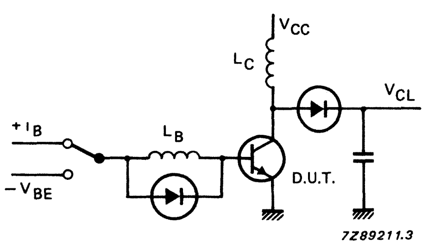


Fig. 5 Switching times waveforms with resistive load; $t_r \leq 20$ ns.



V_{CL} = up to 400 V
V_{CC} = 30 V
$-V_{BE}$ = 5 V
L_B = 1.0 μH
L_C = 200 μH

Fig. 6 Test circuit inductive load.

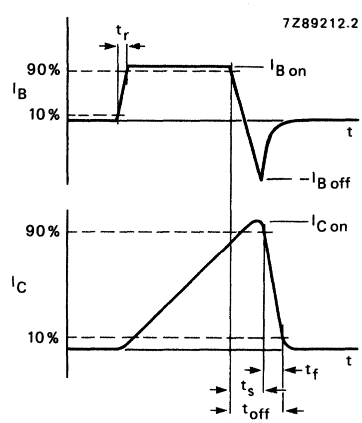


Fig. 7 Switching times waveforms with inductive load.

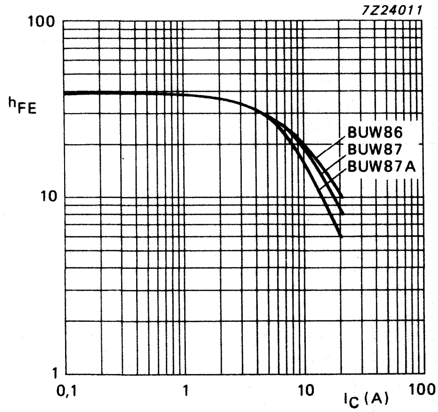


Fig. 8 DC current gain; V_{CE} = 5 V; T_j = 25 °C.

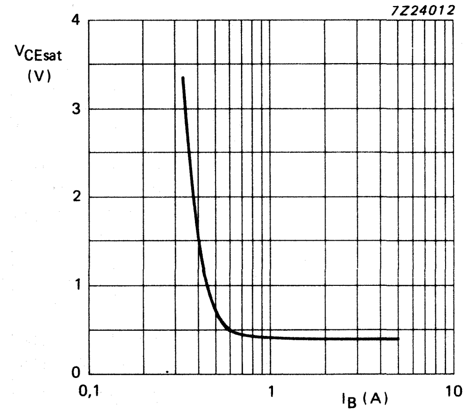


Fig. 9 Collector-emitter saturation voltage, BUW86; I_C = 8 A.

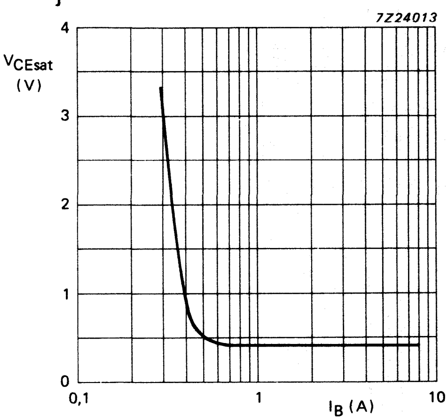


Fig. 10 Collector-emitter saturation voltage, BUW87; I_C = 7 A.

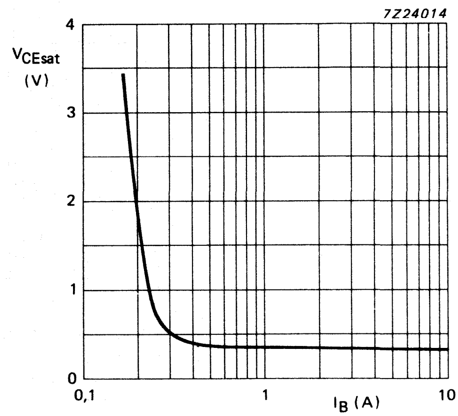


Fig. 11 Collector-emitter saturation voltage, BUW87A; I_C = 5 A.

DEVELOPMENT DATA

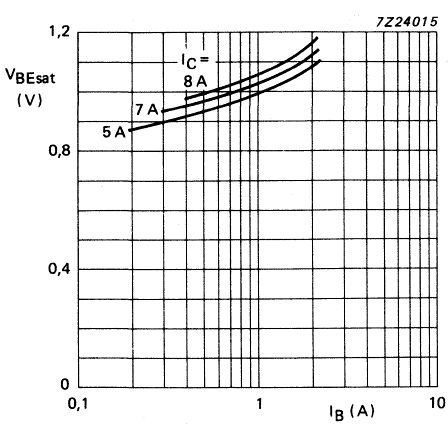


Fig. 12 Base-emitter saturation voltage; T_j = 25 °C.

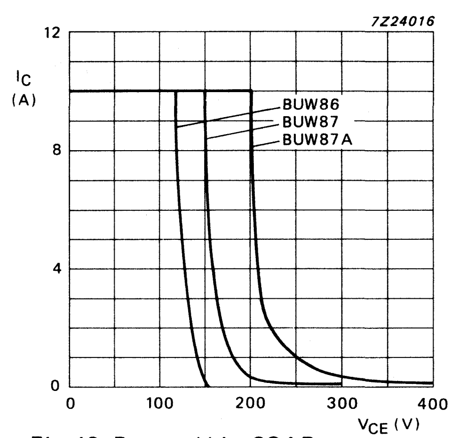


Fig. 13 Reversed bias SOAR.

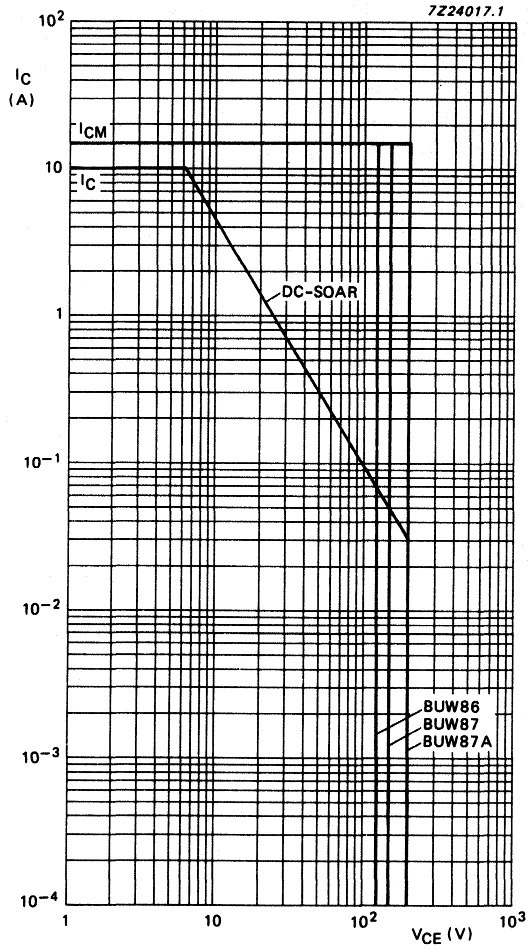


Fig. 14 Safe operating area; T_{mb} = 25 °C.

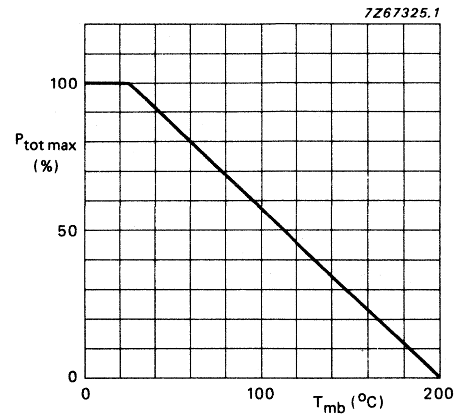


Fig. 15 Total power dissipation derating curve.

NPN SILICON POWER TRANSISTORS

High-voltage, glass-passivated power transistors in SOT93 envelope, intended for use in very fast switching applications in inductive circuits.

BUW131H is a high gain selection for applications where drive current is limited.

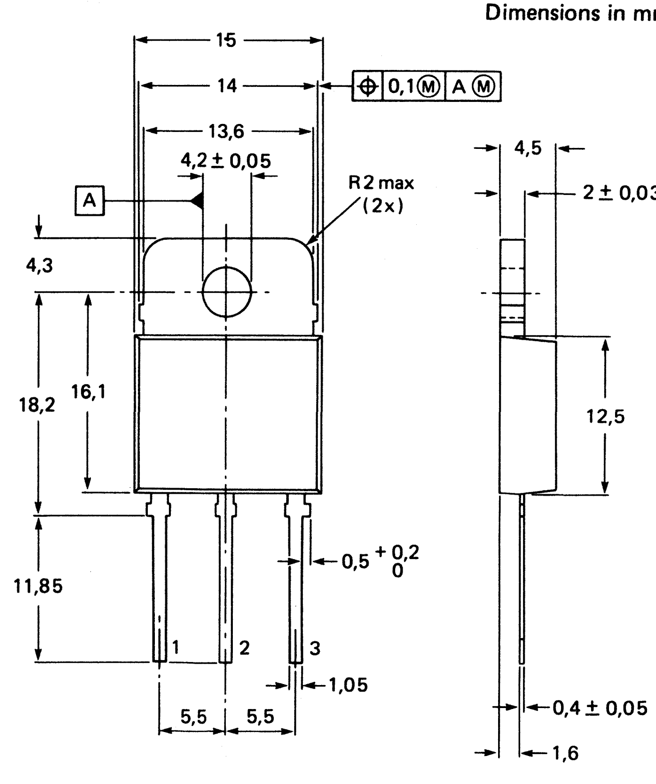
QUICK REFERENCE DATA

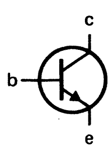
			BUW131	131A	131H	
Collector-emitter voltage						
peak value; $V_{BE} = 0$	V_{CESM}	max.	850	1000	850	V
open base	V_{CEO}	max.	450	500	450	V
Collector-emitter saturation voltage	V_{CEsat}	max.	3.0	2.5	3.0	V
Collector current						
saturation current	I_{Csat}	max.		3.0		A
DC	I_C	max.		5.0		A
peak value	I_{CM}	max.		10.0		A
Total power dissipation						
up to $T_{mb} = 25\ ^oC$	P_{tot}	max.		80		W
Fall time (resistive load)	t_f	typ.	0.07	0.07	0.12	μs

MECHANICAL DATA

Dimensions in mm

Fig.1 SOT93.





Pinning:

1 = base
2 = collector
3 = emitter

Collector connected to mounting base

RATINGS

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

			BUW131	131A	131H	
Collector-emitter voltage						
peak value; $V_{BE} = 0$	V_{CESM}	max.	850	1000	850	V
open base	V_{CEO}	max.	450	500	450	V
Collector current						
DC	I_C	max.		8.0		A
peak value						
t_p = 5 ms; d = 10%	I_{CM}	max.		16		A
Base current						
DC	I_B	max.		6.0		A
peak value						
t_p = 5 ms; d = 10%	I_{BM}	max.		12		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	$R_{th\ j\text{-}mb}$	=	1.0	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Parameter	Symbol		BUW131	131A	131H	Unit
Collector cut-off current*						
$V_{CE} = V_{CESMmax}$; $V_{BE} = -1.5$ V	I_{CEV}	max.		0.25		mA
$V_{CE} = V_{CESMmax}$; $V_{BE} = -1.5$ V; T_j = 100 °C	I_{CEV}	max.		1.5		mA
Emitter cut-off current						
V_{EB} = 6.0 V; I_C = 0	I_{EBO}	max.		1.0		mA
Collector-emitter sustaining voltage						
I_C = 100 mA; I_B = 0; L = 10 mH (see Figs 2 and 3)	$V_{CEOsust}$	min.	450	500	450	V
Saturation voltage						
T_C = 25 °C and 100 °C						
I_C = 3 A; I_B = 0.4 A (BUW131) I_C = 3 A; I_B = 0.6 A (BUW131A) I_C = 3 A; I_B = 0.3 A (BUW131H)	V_{CEsat}	max.		1.0		V
I_C = 5 A; I_B = 0.66 A (BUW131) I_C = 5 A; I_B = 1.0 A (BUW131A) I_C = 5 A; I_B = 0.5 A (BUW131H)	V_{CEsat}	max.		2.5		V
	V_{BEsat}	max.		1.5		V
DC current gain						
I_C = 5 A; V_{CE} = 5 V	h_{FE}	min.	5	5	7	V
Switching times resistive load (see Figs 4 and 5)						
$I_{C\,on}$ = 3 A; $I_{B\,on}$ = 0.4 A; $I_{B\,off}$ = 0.8 A						
Turn-on time	t_{on}	typ.	0.35	0.35	–	µs
Turn-off; storage time	t_s	typ.	1.2	1.2	–	µs
fall time	t_f	typ.	0.1	0.1	–	µs
$I_{C\,on}$ = 3 A; $I_{B\,on}$ = 0.3 A; $I_{B\,off}$ = 0.6 A						
Turn-on time	t_{on}	typ.	–	–	0.4	µs
Turn-off; storage time	t_s	typ.	–	–	1.5	µs
fall time	t_f	typ.	–	–	0.1	µs
Switching times inductive load (see Figs 6 and 7)						
$I_{C\,on}$ = 3 A; $I_{B\,on}$ = 0.4 A;	t_{sv}	typ.	0.6	0.6	–	µs
$V_{BE\,off} = -5$ V; $V_{CE(pk)}$ = 400 V;	t_{fi}	typ.	0.07	0.07	–	µs
T_j = 100 °C	t_c	typ.	0.2	0.2	–	µs
$I_{C\,on}$ = 3 A; $I_{B\,on}$ = 0.3 A;	t_{sv}	typ.			0.5	µs
$V_{BE\,off} = -5$ V; $V_{CE(pk)}$ = 400 V;	t_{fi}	typ.			0.07	µs
T_j = 100 °C	t_c	typ.			0.18	µs
Output capacitance						
V_{CB} = 10 V; I_E = 0; f_{test} = 1 kHz	C_{ob}	max.		200		pF

DEVELOPMENT DATA

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

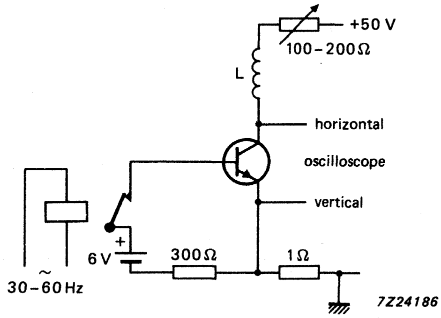


Fig. 2 Test circuit for $V_{CEOsust}$.

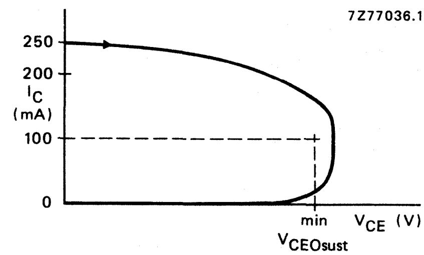
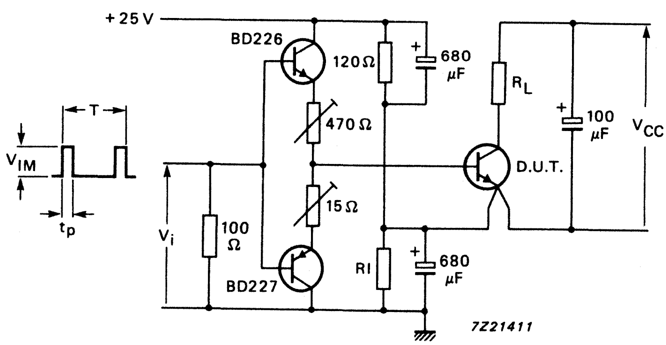


Fig. 3 Oscilloscope display for sustaining voltage.



t_p = 20 µs
T = 2 ms
V_{IM} = 15 V

Fig. 4 Test circuit resistive load;
V_{CC} = 250 V; R_L = 50 Ω; R1 = 39 Ω.

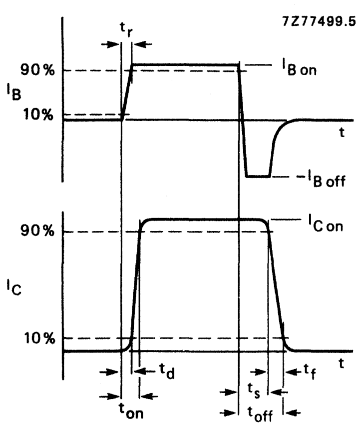


Fig. 5 Switching times waveforms with resistive load; t_r = ≤ 20 ns.

For inductive load;
V_{CL} = 400 V
V_{BE} = −5 V

For RB SOAR;
V_{CL} up to 1000 V
V_{BEoff} to be adjusted

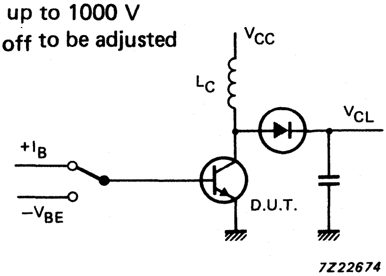


Fig. 6 Test circuit inductive load and RB SOAR; V_{CC} = 20 V; L_C = 200 µH.

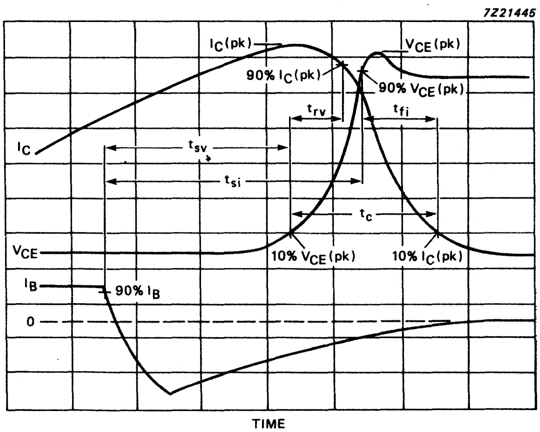


Fig.7 Switching times waveforms with inductive load.

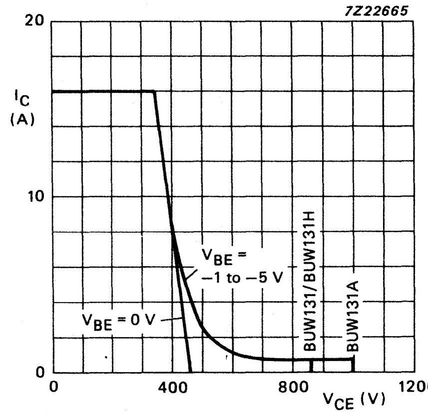


Fig.8 Reverse bias SOAR; $I_C/I_B = 4$; $T_{mb} = 25\ ^oC$.

DEVELOPMENT DATA

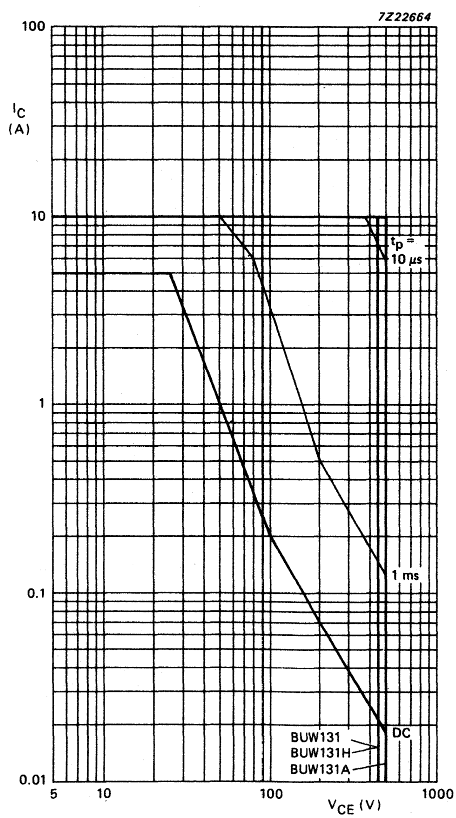


Fig.9 Forward biased SOART; $T_c = 25\ ^oC$.

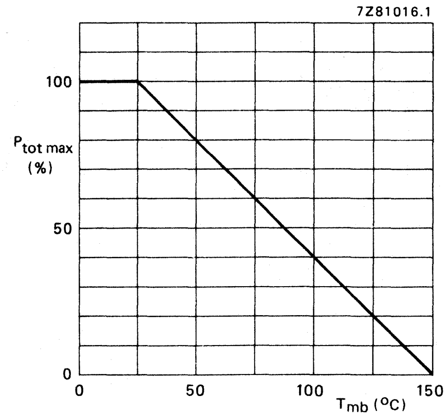


Fig. 10 Power derating curve.

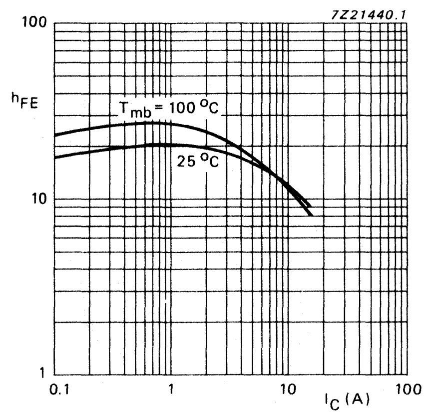


Fig. 11 Typical DC current gain; V_{CE} = 5 V.

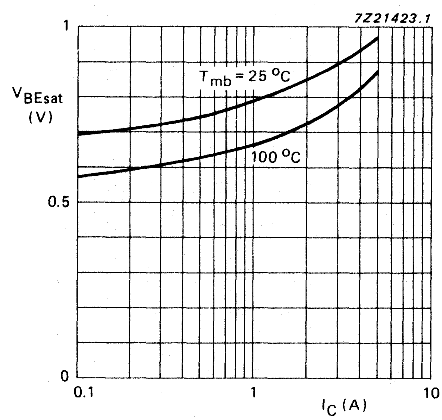


Fig. 12 Base-emitter saturation voltage as a function of collector current; I_C/I_B = 10.

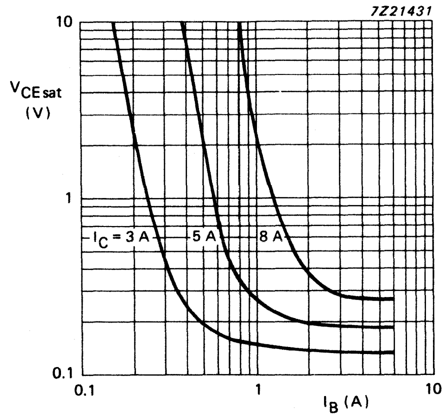


Fig. 13 Collector-emitter voltage as a function of base current; T_{mb} = 25 °C.

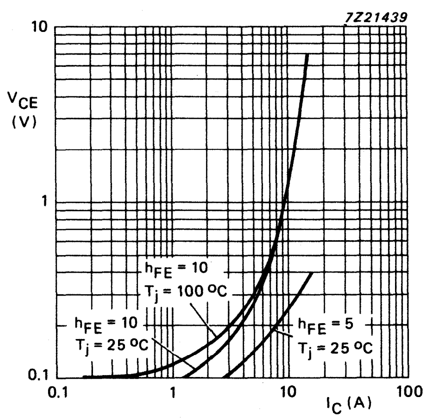


Fig. 14 Collector-emitter voltage as a function of collector current.

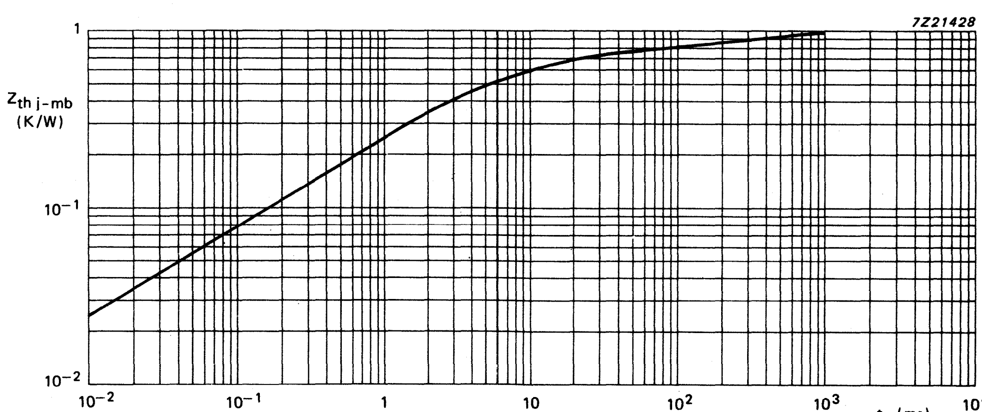


Fig. 15 Transient thermal impedance; (normalized).

DEVELOPMENT DATA

NPN SILICON POWER TRANSISTORS

High-voltage, glass-passivated power transistors in SOT93 envelope, intended for use in very fast switching applications in inductive circuits.

BUW132H is a high gain selection for applications where drive current is limited.

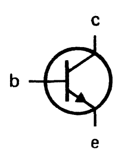
QUICK REFERENCE DATA

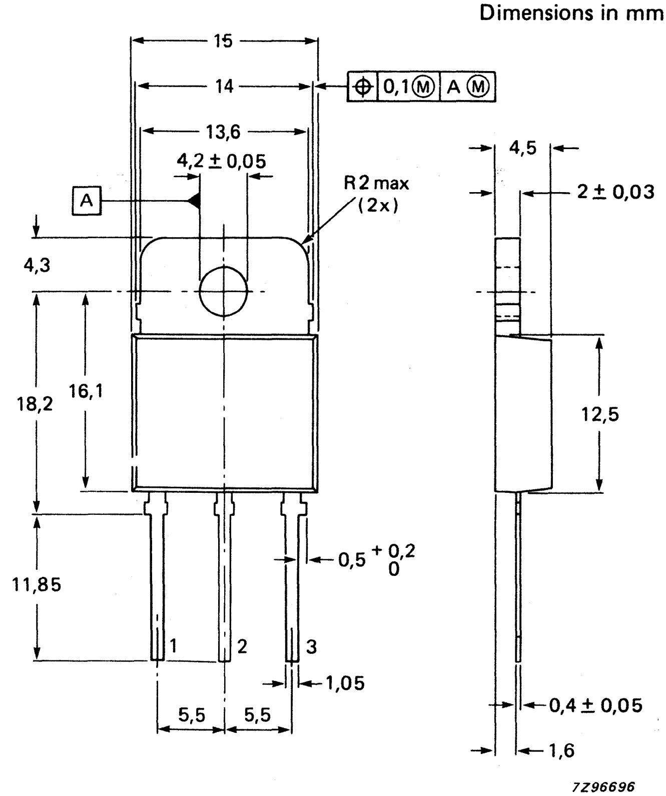
			BUW132	132A	132H	
Collector-emitter voltage						
peak value; $V_{BE} = 0$	V_{CESM}	max.	850	1000	850	V
open base	V_{CEO}	max.	450	500	450	V
Collector-emitter saturation voltage	V_{CEsat}	max.	3.0	1.5	3.0	V
Collector current						
saturation current	I_{Csat}	max.		5.0		A
DC	I_C	max.		8.0		A
peak value	I_{CM}	max.		16		A
Total power dissipation						
up to $T_{mb} = 25\ ^oC$	P_{tot}	max.		125		W
Fall time (resistive load)	t_f	typ.		0.1		μs

MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT93.





Pinning:

1 = base
2 = collector
3 = emitter

Collector connected to mounting base

RATINGS

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

			BUW132	132A	132H	
Collector-emitter voltage						
peak value; $V_{BE} = 0$	V_{CESM}	max.	850	1000	850	V
open base	V_{CEO}	max.	450	500	450	V
Collector current						
DC	I_C	max.		8.0		A
peak value $t_p = 5$ ms; d = 10%	I_{CM}	max.		16		A
Base current						
DC	I_B	max.		6.0		A
peak value $t_p = 5$ ms; d = 10%	I_{BM}	max.		12		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	$R_{th\ j\text{-}mb}$	=	1.0	K/W

DEVELOPMENT DATA

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current*						
$V_{CE} = V_{CESMmax}$; V_{BE} = −1.5 V	I_{CEV}	max.		0.25		mA
$V_{CE} = V_{CESMmax}$; V_{BE} = −1.5 V; T_j = 100 °C	I_{CEV}	max.		1.5		mA
Emitter cut-off current						
V_{EB} = 6.0 V; I_C = 0	I_{EBO}	max.		1.0		mA
			BUW132	132A	132H	
Collector-emitter sustaining voltage						
I_C = 100 mA; I_B = 0; L = 10 mH (see Figs 2 and 3)	$V_{CEOsust}$	min.	450	500	450	V
Saturation voltage						
T_C = 25 °C and 100 °C						
I_C = 3 A; I_B = 0.4 A (BUW132) I_C = 3 A; I_B = 0.6 A (BUW132A) I_C = 3 A; I_B = 0.3 A (BUW132H)	V_{CEsat}	max.	2.5	1.0	2.5	V
I_C = 5 A; I_B = 0.66 A (BUW132) I_C = 5 A; I_B = 1.0 A (BUW132A)	V_{CEsat}	max.	3.0	1.5	3.0	V
I_C = 5 A; I_B = 0.5 A (BUW132H)	V_{BEsat}	max.	1.5	1.5	1.5	V
DC current gain						
I_C = 8 A; V_{CE} = 5 V	h_{FE}	min.	5	5	7	V
Switching times resistive load (see Figs 4 and 5)						
$I_{C\,on}$ = 5 A; $I_{B\,on}$ = 0.66 A; $I_{B\,off}$ = 1.3 A						
Turn-on time	t_{on}	typ.	0.35	0.35	–	μs
Turn-off; storage time	t_s	typ.	1.5	1.5	–	μs
fall time	t_f	typ.	0.1	0.1	–	μs
$I_{C\,on}$ = 5 A; $I_{B\,on}$ = 0.5 A; $I_{B\,off}$ = 1.0 A						
Turn-on time	t_{on}	typ.	–	–	0.4	μs
Turn-off; storage time	t_s	typ.	–	–	1.5	μs
fall time	t_f	typ.	–	–	0.1	μs
Switching times inductive load (see Figs 6 and 7)						
$I_{C\,on}$ = 5 A; $I_{B\,on}$ = 0.66 A;	t_{sv}	typ.	0.8	0.8	–	μs
$V_{BE\,off}$ = −5 V; $V_{CE(pk)}$ = 400 V;	t_{fi}	typ.	0.08	0.08	–	μs
T_j = 100 °C	t_c	typ.	0.25	0.25	–	μs
$I_{C\,on}$ = 5 A; $I_{B\,on}$ = 0.5 A;	t_{sv}	typ.			0.6	μs
$V_{BE\,off}$ = −5 V; $V_{CE(pk)}$ = 400 V;	t_{fi}	typ.			0.07	μs
T_j = 100 °C	t_c	typ.			0.2	μs
Output capacitance						
V_{CB} = 10 V; I_E = 0; f_{test} = 1 kHz	C_{ob}	max.		350		pF

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

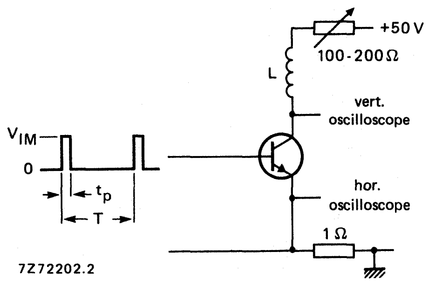


Fig. 2 Test circuit for $V_{CEOsust}$.

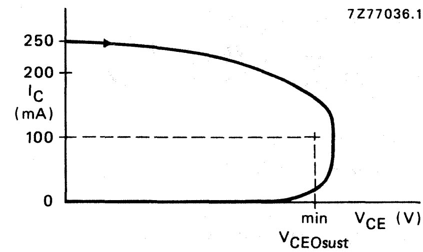
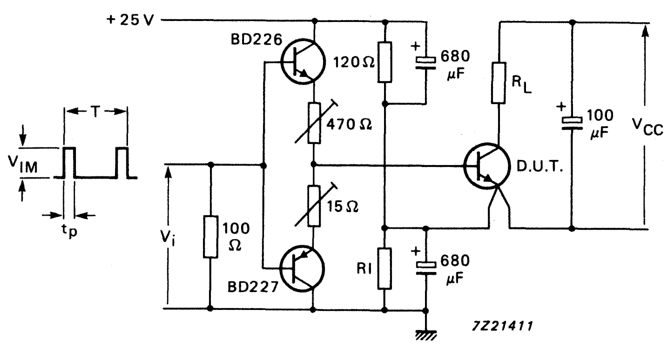


Fig. 3 Oscilloscope display for sustaining voltage.



t_p = 20 μs
T = 2 ms
V_{IM} = 15 V

Fig. 4 Test circuit resistive load;
V_{CC} = 250 V; R_L = 50 Ω; R1 = 39 Ω.

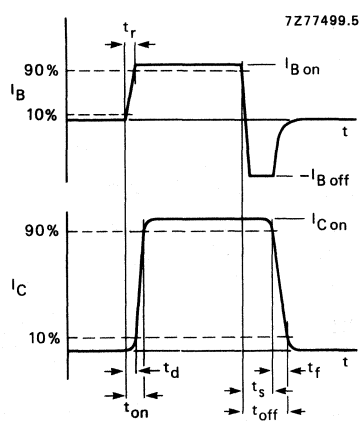


Fig. 5 Switching times waveforms with resistive load; $t_r \leqslant$ 20 ns.

For inductive load;
V_{CL} = 400 V
V_{BE} = −5 V

For RB SOAR;
V_{CL} up to 1000 V
V_{BEoff} to be adjusted

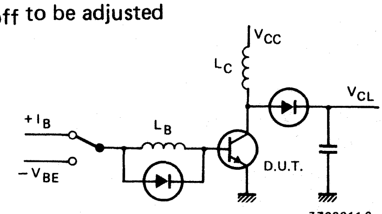


Fig. 6 Test circuit inductive load and RB SOAR; V_{CC} = 20 V; L_C = 200 μH.

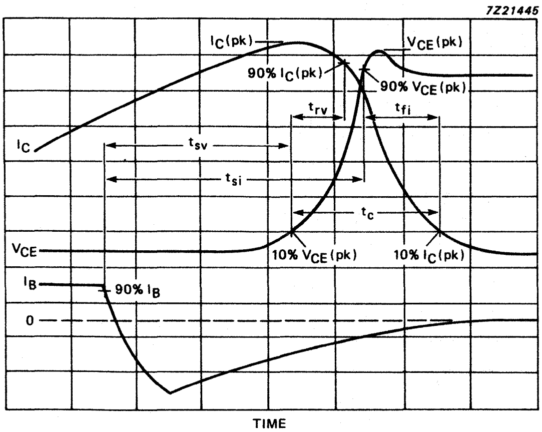


Fig. 7 Switching times waveforms with inductive load.

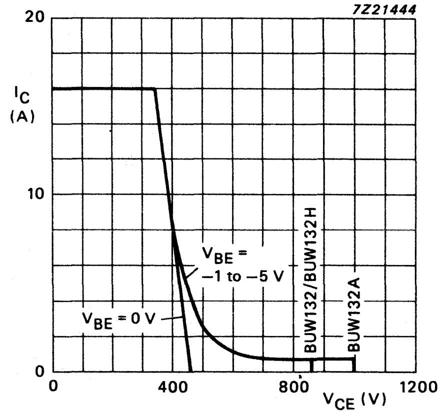


Fig. 8 Reverse bias SOAR; $I_C/I_B = 4$; $T_{mb} = 25\ ^oC$.

DEVELOPMENT DATA

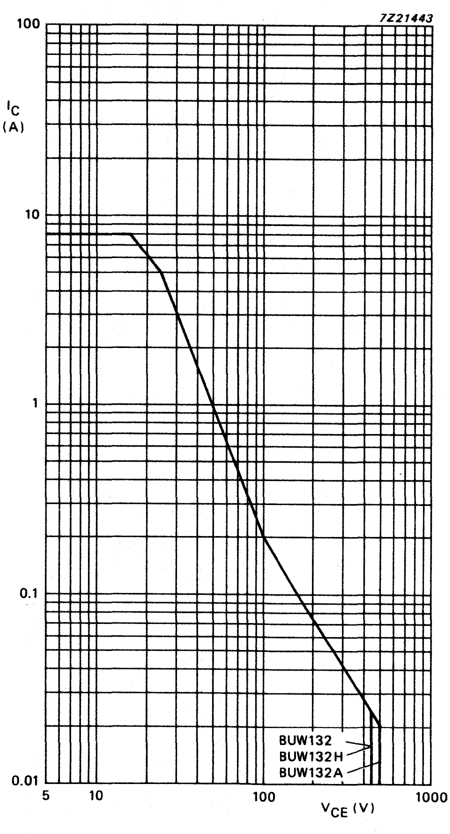


Fig. 9 Forward biased SOAR; $T_{mb} = 25\ ^oC$.

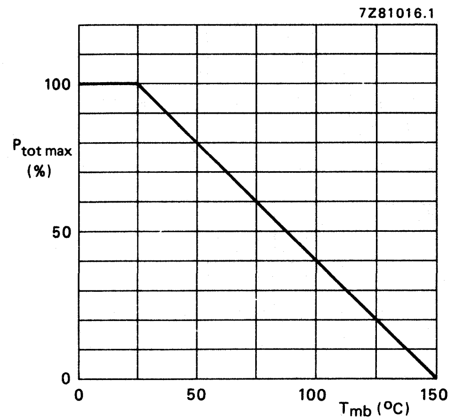


Fig. 10 Power derating curve.

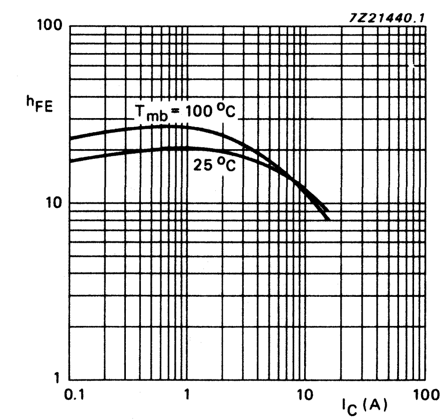


Fig. 11 Typical DC current gain; V_{CE} = 5 V.

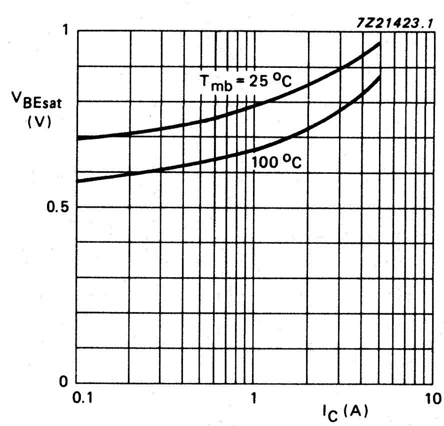


Fig. 12 Base-emitter saturation voltage as a function of collector current; I_C/I_B = 10.

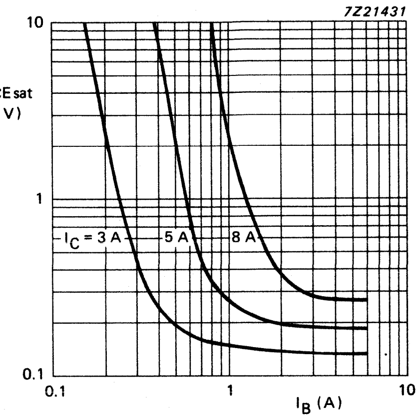


Fig. 13 Collector-emitter voltage as a function of base current; T_{mb} = 25 °C.

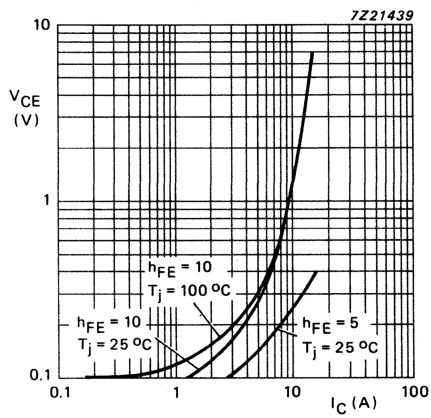


Fig. 14 Collector-emitter voltage as a function of collector current.

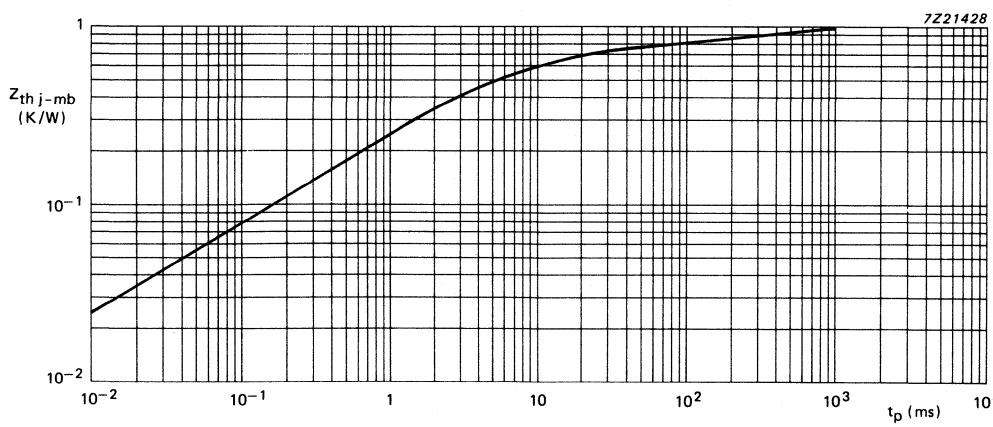


Fig. 15 Transient thermal impedance; (normalized).

DEVELOPMENT DATA

NPN SILICON POWER TRANSISTORS

High-voltage, glass-passivated power transistors in SOT93 envelope, intended for use in very fast switching applications in inductive circuits.

BUW133H is a high gain selection for applications where drive current is limited.

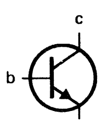
QUICK REFERENCE DATA

			BUW133	133A	133H	
Collector-emitter voltage						
$V_{BE} = 0$; peak value	V_{CESM}	max.	850	1000	850	V
open base	V_{CEO}	max.	450	500	450	V
Collector-emitter saturation voltage	V_{CEsat}	max.	3.0	1.5	3.0	V
Collector current						
saturation	I_{Csat}	max.		10		A
DC	I_C	max.		15		A
peak value	I_{CM}	max.		20		A
Total power dissipation up to $T_{mb} = 25\ ^oC$	P_{tot}	max.		135		W
Fall time (resistive load)	t_f	typ.		0.15		µs

MECHANICAL DATA

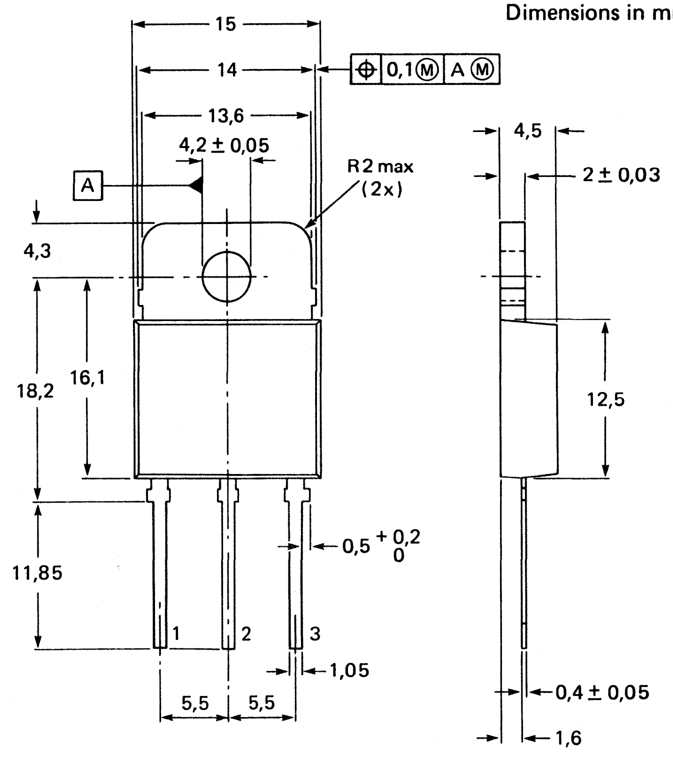
Dimensions in mm

Fig. 1 SOT93.



1 = base
2 = collector
3 = emitter

Collector connected to mounting base



RATINGS

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

			BUW133	133A	133H	
Collector-emitter voltage						
$V_{BE} = 0$; peak value	V_{CESM}	max.	850	1000	850	V
open base	V_{CEO}	max.	450	500	450	V
Collector current						
DC	I_C	max.		15		A
peak value ; $t_p = 5$ ms; d = 10%	I_{CM}	max.		20		A
Base current						
DC	I_B	max.		10		A
peak value; $t_p = 5$ ms; d = 10%	I_{BM}	max.		15		A
Total power dissipation						
up to $T_{mb} = 25$ °C	P_{tot}	max.		135		W
Storage temperature range	T_{stg}			−65 to + 150		°C
Junction temperature	T_j	max.		150		°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	0.93	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			BUW133	133A	133H	
Collector cut-off current*						
$V_{CE} = V_{CESMmax}$; $V_{BE} = -1.5$ V	I_{CESM}	max.		0.25		mA
$V_{CE} = V_{CESMmax}$; $V_{BE} = -1.5$ V; T_j = 100 °C	I_{CESM}	max.		1.5		mA
Emitter cut-off current						
V_{EB} = 6.0 V; I_C = 0	I_{EBO}	max.		1.0		mA
Collector-emitter sustaining voltage						
I_C = 100 mA; I_B = 0; L = 10 mH (see Figs 2 and 3)	$V_{CEOsust}$	min.	450	500	450	V
Saturation voltage						
T_C = 25 °C and 100 °C						
I_C = 5 A; I_B = 1.0 A (BUW133A); I_C = 5 A; I_B = 0.7 A (BUW133); I_C = 5 A; I_B = 0.5 A (BUW133H)	V_{CEsat}	max.	2.5	1.0	2.5	V
I_C = 10 A; I_B = 2.0 A (BUW133A); I_C = 10 A; I_B = 1.3 A (BUW133)	V_{CEsat}	max.	3.0	1.5	3.0	V
I_C = 10 A; I_B = 1.0 A (BUW133H)	V_{BEsat}	max.	1.5	1.5	1.5	V
DC current gain						
I_C = 15 A; V_{CE} = 5 V	h_{FE}	min.	5	5	7	
Switching times resistive load (see Figs 4 and 5)						
$I_{C\,on}$ = 10 A; $I_{B\,on}$ = 1.3 A; $I_{B\,off}$ = 2.6 A						
Turn-on time	t_{on}	typ.	0.4	0.4	–	µs
Turn-off; storage time	t_s	typ.	1.3	1.3	–	µs
fall time	t_f	typ.	0.15	0.15	–	µs
$I_{C\,on}$ = 10 A; $I_{B\,on}$ = 1 A; $I_{B\,off}$ = 2 A						
Turn-on time	t_{on}	typ.	–	–	0.4	µs
Turn-off; storage time	t_s	typ.	–	–	1.3	µs
fall time	t_f	typ.	–	–	0.15	µs
Switching times inductive load (see Figs 6 and 7)						
$I_{C\,on}$ = 10 A; $I_{B\,on}$ = 1.3 A;	t_{sv}	typ.	0.9	0.9	–	µs
$V_{BE\,off}$ = −5 V; $V_{CE(pk)}$ = 400 V;	t_{fi}	typ.	0.05	0.05	–	µs
T_j = 100 °C	t_c	typ.	0.16	0.16	–	µs
$I_{C\,on}$ = 10 A; $I_{B\,on}$ = 1 A;	t_{sv}	typ.	–	–	0.65	µs
$V_{BE\,off}$ = 5 V; $V_{CE(pk)}$ = 400 V;	t_{fi}	typ.	–	–	0.03	µs
T_j = 100 °C	t_c	typ.	–	–	0.15	µs
Output capacitance						
V_{CB} = 10 V; I_E = 0; f_{test} = 1 kHz	C_{ob}	max.		400		pF

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

DEVELOPMENT DATA

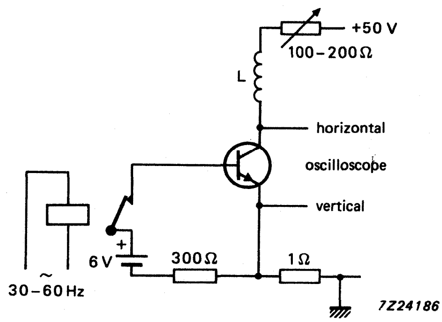


Fig. 2 Test circuit for $V_{CEOsust}$.

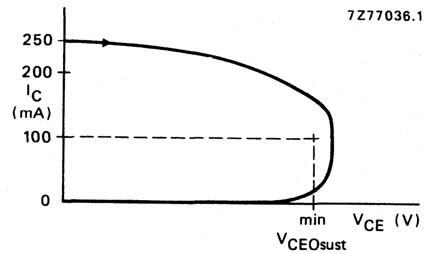
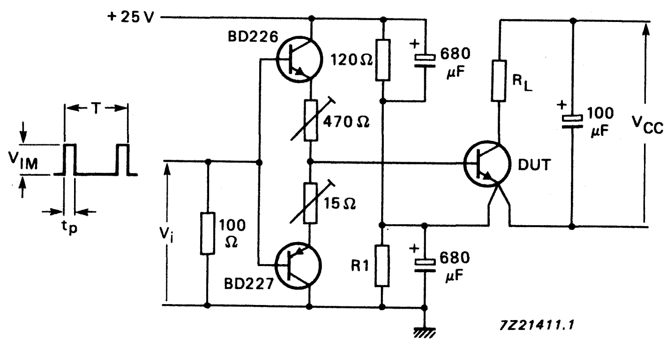


Fig. 3 Oscilloscope display for sustaining voltage.



t_p = 20 µs
T = 2 ms
V_{IM} = 15 V

Fig. 4 Test circuit resistive load; V_{CC} = 250 V; R_L = 25 Ω; R1 = 39 Ω.

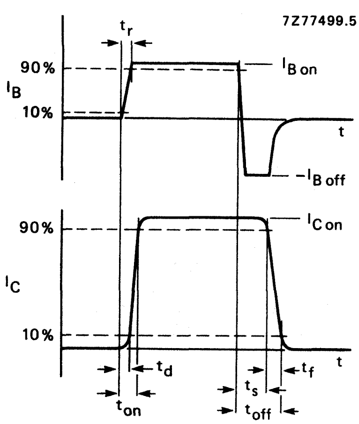
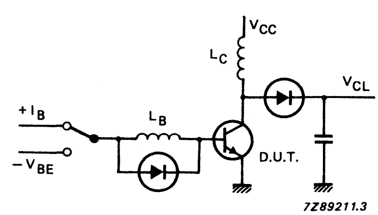


Fig. 5 Switching times waveforms with resistive load; $t_r \leqslant$ 30 ns.



For inductive load;
V_{clamp} = 400 V
V_{BE} = –5 V
For RB SOAR;
V_{clamp} up to 1000 V
$-V_{BE}$ to be adjusted

Fig. 6 Test circuit inductive load and RB SOAR; V_{CC} = 20 V; L_C = 200 µH.

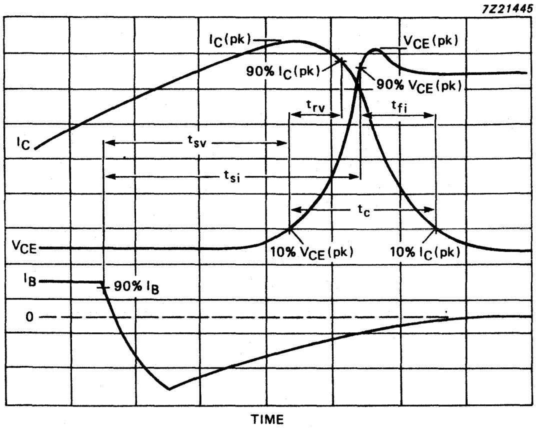


Fig. 7 Switching times waveforms with inductive load.

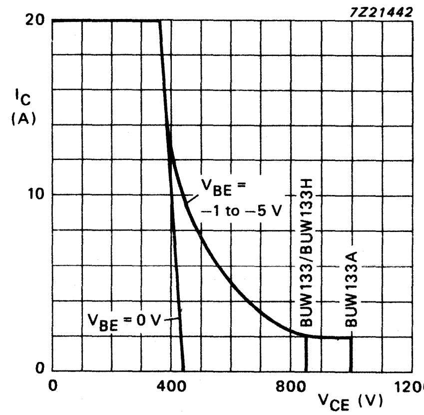


Fig. 8 Reverse bias SOAR; $I_C/I_B = 4$; $T_{mb} = 25\ ^{o}C$.

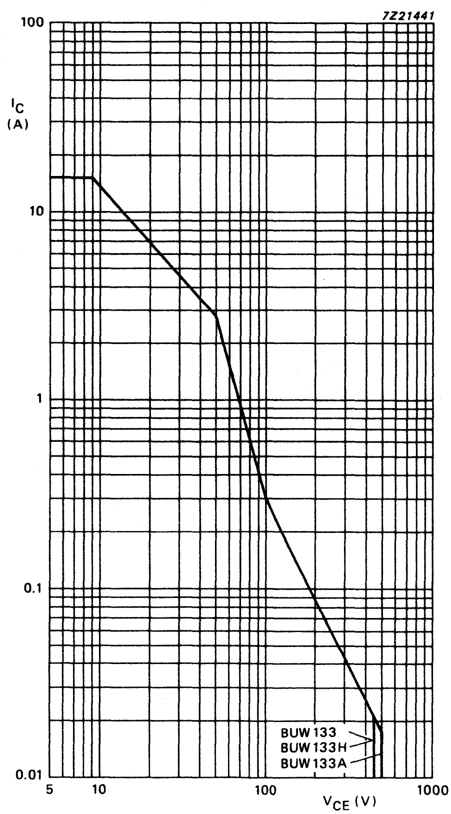


Fig. 9 Forward biased SOAR; $T_{mb} = 25\ ^{o}C$.

DEVELOPMENT DATA

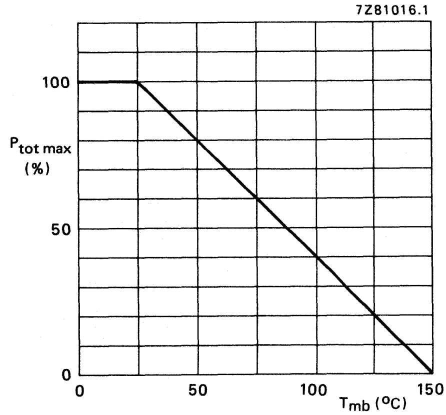


Fig. 10 Power derating curve.

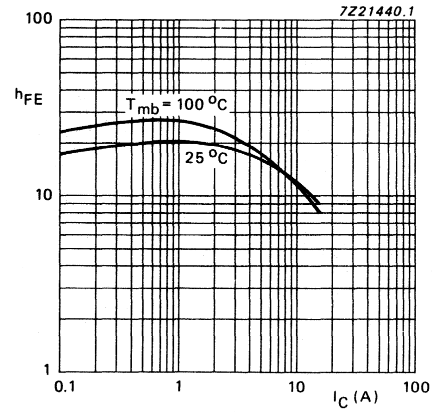


Fig. 11 Typical DC current gain; V_{CE} = 5 V.

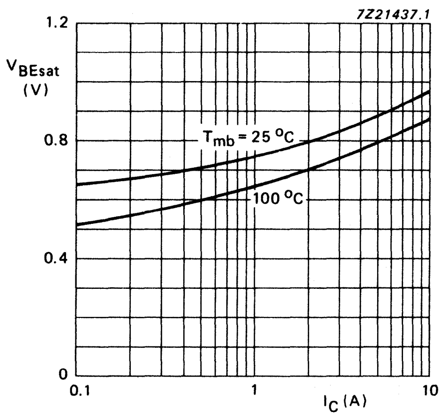


Fig. 12 Base-emitter saturation voltage as a function of collector current; I_C/I_B = 10.

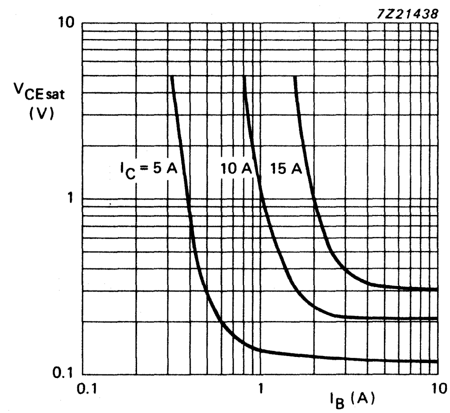


Fig. 13 Collector-emitter saturation voltage as a function of base current; T_{mb} = 25 °C.

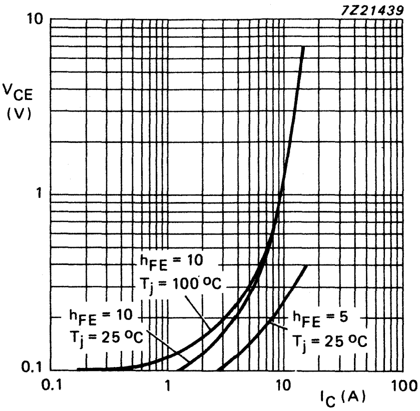


Fig. 14 Collector-emitter voltage as a function of collector current.

DEVELOPMENT DATA

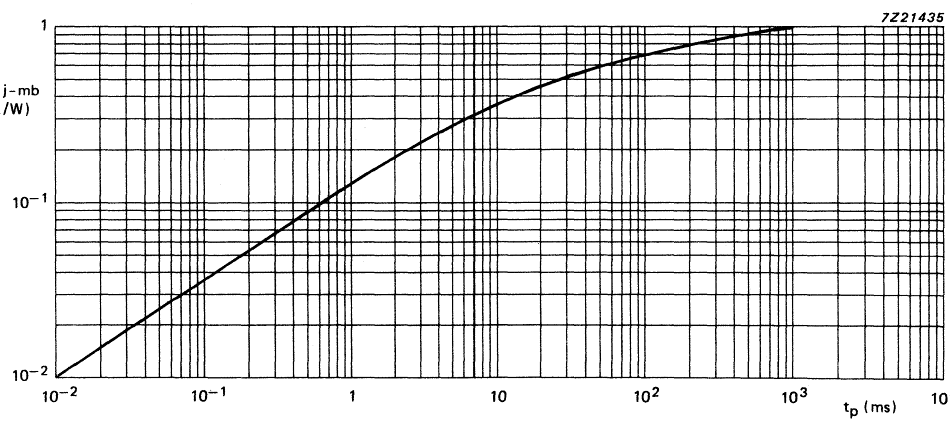


Fig. 15 Transient thermal impedance; (normalized).

SILICON DIFFUSED POWER TRANSISTORS

High-voltage, high-speed, glass-passivated npn power transistors in a TO-3 envelope, intended for use in converters, inverters, switching regulators, motor control systems etc.

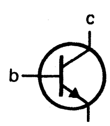
QUICK REFERENCE DATA

			BUX46	BUX46A	
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.	3,5		A
Collector current (peak value)	I_{CM}	max.	5		A
Total power dissipation up to $T_{mb} = 25\ °C$	P_{tot}	max.	85		W
Fall time (resistive load)	t_f	max.	0,8		μs

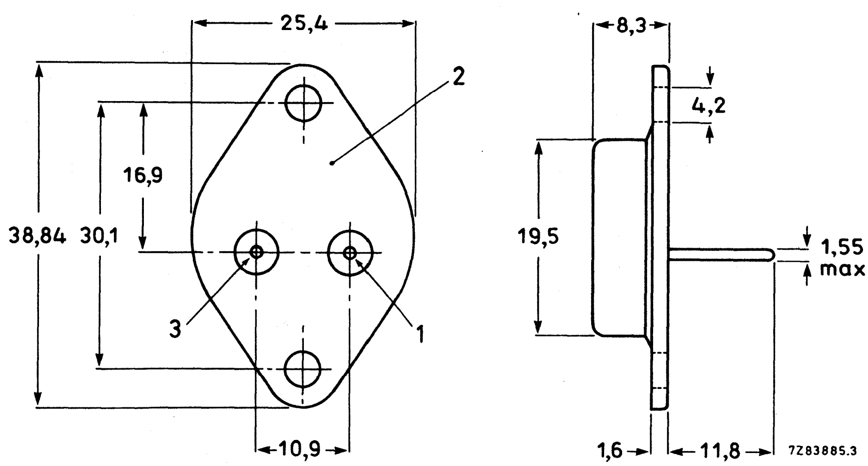
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-3.



Pinning;
1 = base
2 = collector
3 = emitter



Collector connected to case.

RATINGS

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

			BUX46	BUX46A	
Collector-emitter voltage (peak value; V_{BE} = 0)	V_{CESM}	max.	850	1000	V
Collector-emitter voltage ($R_{BE} \leqslant 10\ \Omega$)	V_{CER}	max.	850	1000	V
Collector-emitter voltage (open base)	V_{CEO}	max.	400	450	V
Collector current (DC)	I_C	max.	3,5		A
Collector current (peak value) $t_p < 2$ ms	I_{CM}	max.	5		A
Base current (DC)	I_B	max.	1,5		A
Base current (peak value); $t_p < 2$ ms	I_{BM}	max.	3		A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	85		W
Storage temperature range	T_{stg}		−65 to +175		°C
Junction temperature	T_j	max.	175		°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	1,75	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			BUX46	BUX46A	
Collector cut-off current*					
$V_{CE} = V_{CESMmax}$; $R_{BE} \leqslant 10\ \Omega$	I_{CER}	max.	0,3		mA
$V_{CE} = V_{CESMmax}$; $R_{BE} \leqslant 10\ \Omega$; T_j = 125 °C	I_{CER}	max.	2		mA
Emitter cut-off current					
I_C = 0; V_{EB} = 5 V	I_{EBO}	max.	1		mA
Saturation voltages					
I_C = 3,5 A; I_B = 0,7 A	V_{CEsat}	max.	5		V
I_C = 2,5 A; I_B = 0,5 A	V_{CEsat}	max.	1,5		V
	V_{BEsat}	max.	1,3		V
Collector-emitter sustaining voltage					
I_C = 200 mA; I_B = 0; L = 25 mH	$V_{CEOsust}$	min.	400	450	V
Collector-emitter cut-off current					
$V_{CE} = V_{CESMmax}$; V_{BE} = −2,5 V	I_{CEX}	max.	0,1		mA
$V_{CE} = V_{CESMmax}$; V_{BE} = −2,5 V; T_j = 124 °C	I_{CEX}	max.	1		mA
Emitter-base breakdown voltage					
I_C = 0; I_E = 0,5 A	$V_{(BR)EBO}$	max.	30		V
Second breakdown collector current					
V_{CE} = 70 V; t = 1 sec.	$I_{(SB)C}$	min.	0,5		A

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

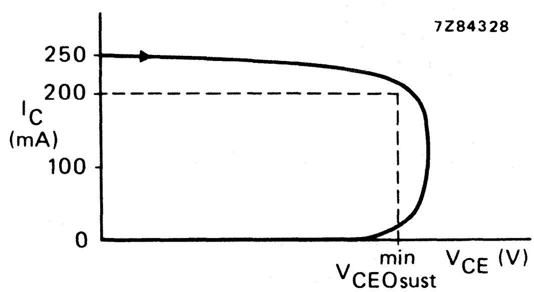


Fig. 2 Oscilloscope display for sustaining voltage.

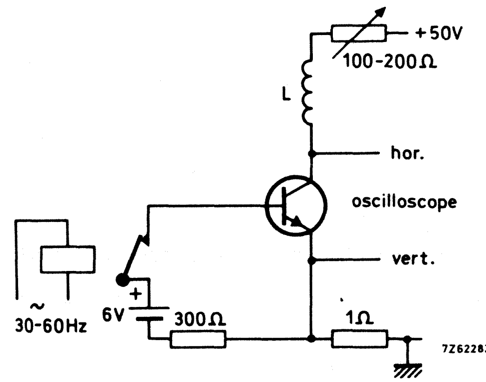


Fig. 3 Test circuit for $V_{CEOsust}$.

Switching times resistive load (Figs 4 and 5)

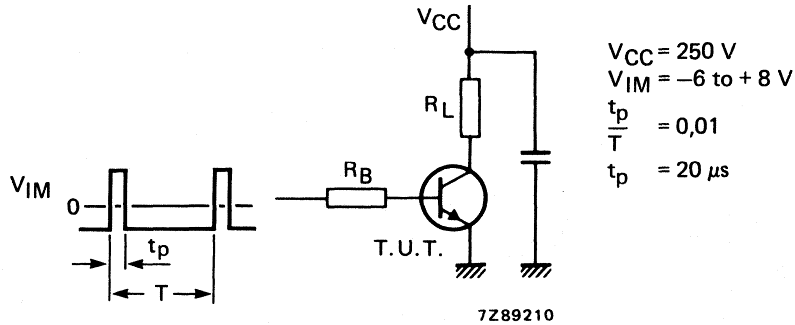
I_{Con} = 2,5 A; I_{Bon} = $-I_{Boff}$ = 0,5 A

Turn-on time	t_{on}	typ. max.	0,5 μs 1 μs
Turn-off: Storage time	t_s	typ. max.	1,5 μs 3 μs
Fall time	t_f	typ. max.	0,5 μs 0,8 μs

Switching times inductive load (Figs 6 and 7)

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

Fall time	t_f	max.	0,2 μs



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.

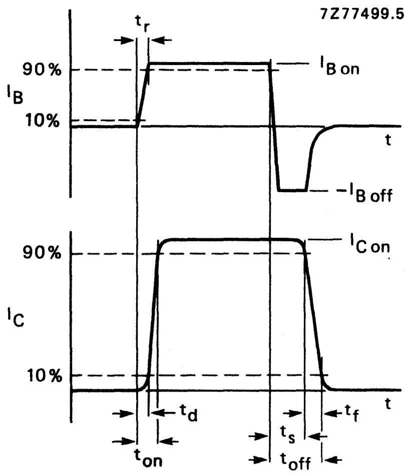


Fig. 5 Switching times waveforms with resistive load.

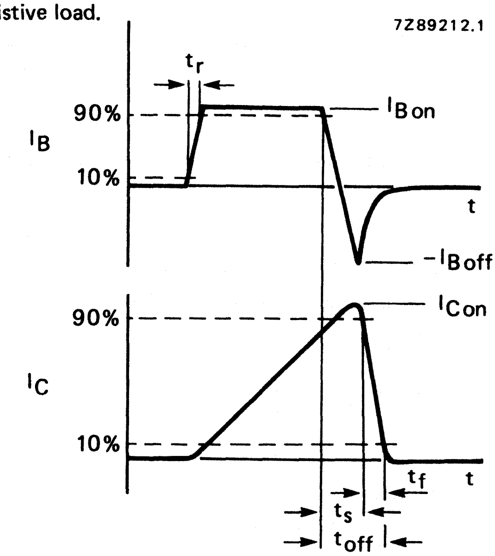


Fig. 6 Switching times waveforms with inductive load.

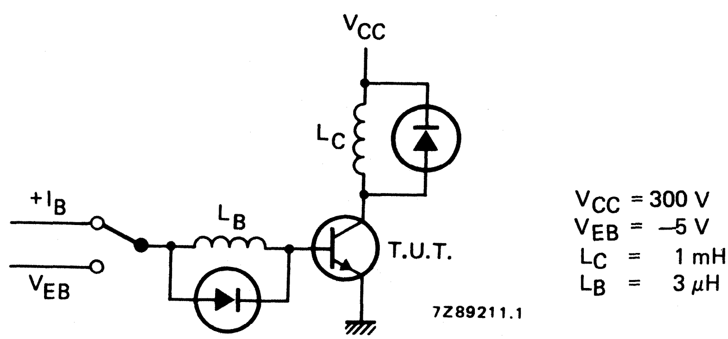
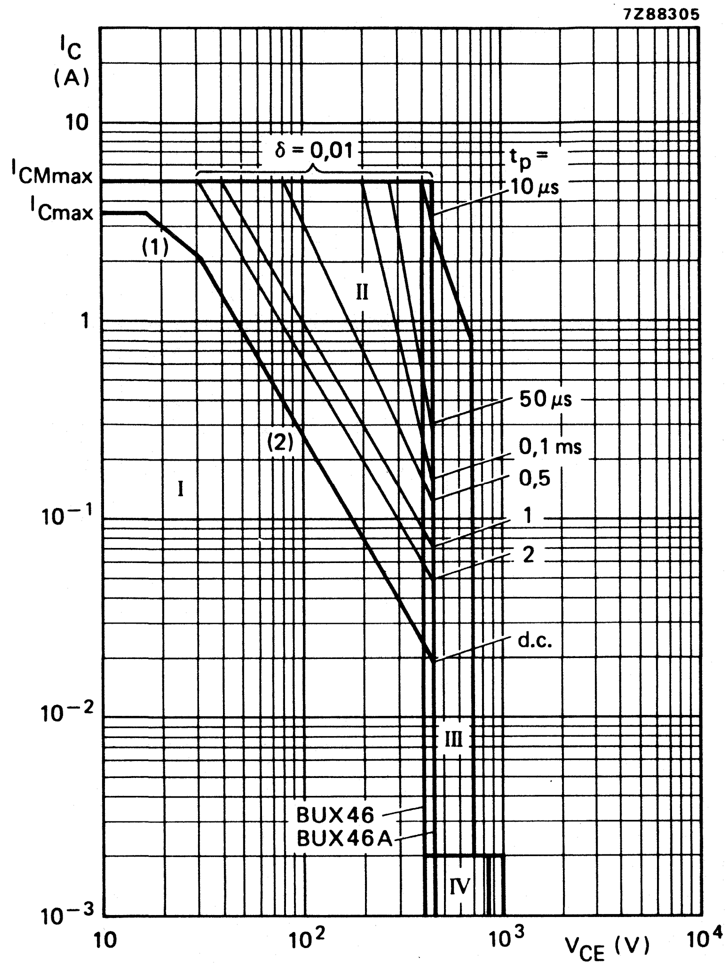
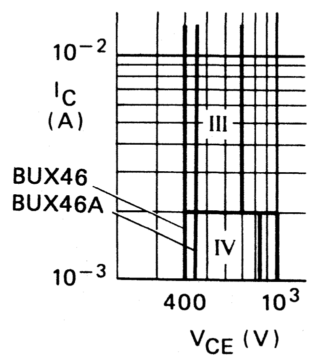


Fig. 7 Test circuit inductive load.





(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 $R_{BE} \leqslant 100\ \Omega$ and $t_p \leqslant 0,6\ \mu s$.
IV Repetitive pulse operation in this region is permissible, provided $V_{BE} \leqslant 0$ and $t_p \leqslant 2$ ms.

Fig. 8 Safe operating area at $T_{mb} \leqslant 60\ ^oC$.

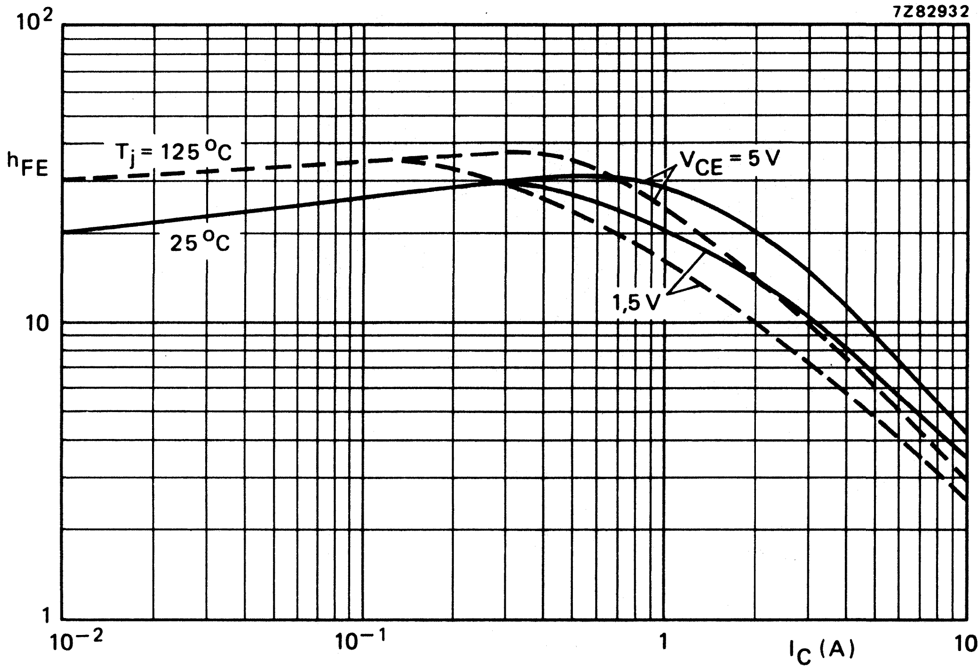


Fig. 9 DC current gain.

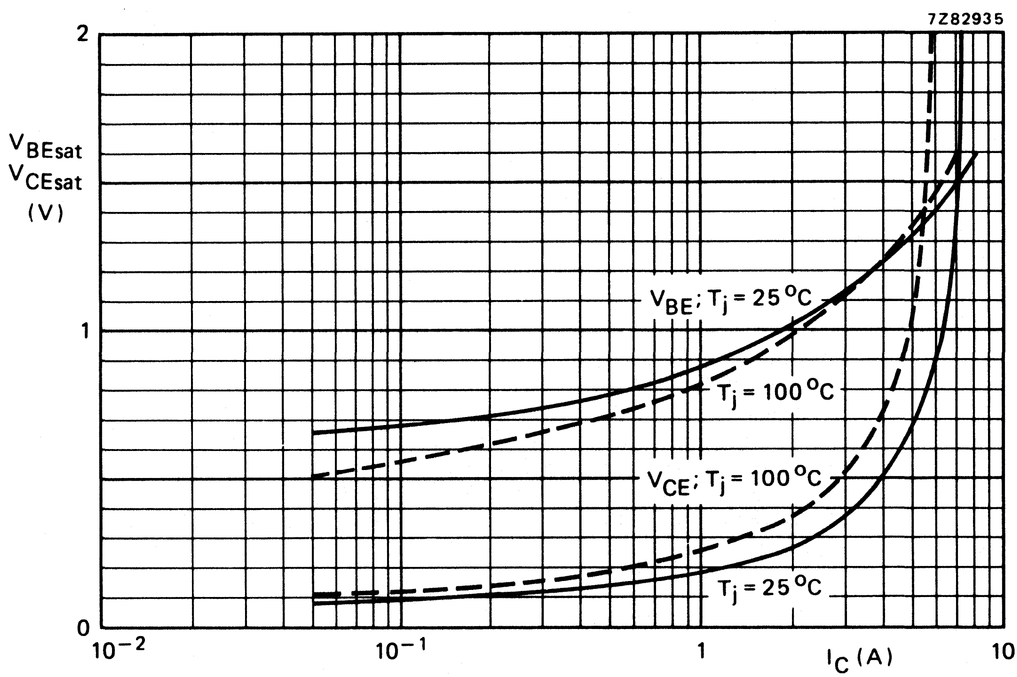


Fig. 10 Typical values base-emitter and collector-emitter voltage, $I_C/I_B = 5$.

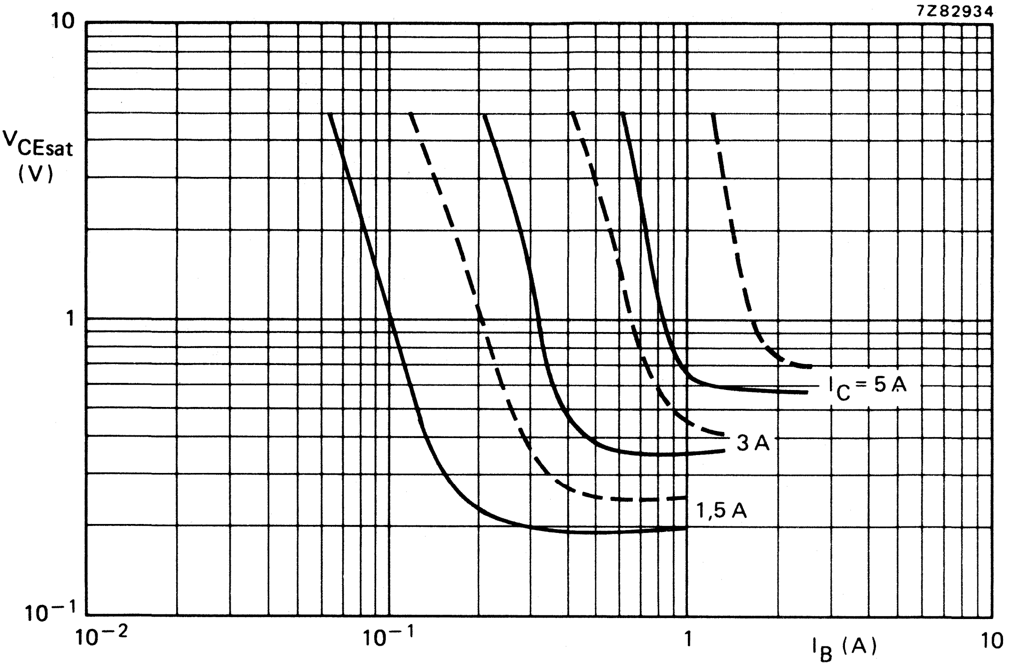


Fig. 11 Typ. (——) and max. (— — —) values collector-emitter saturation voltage at T_j = 25 °C.

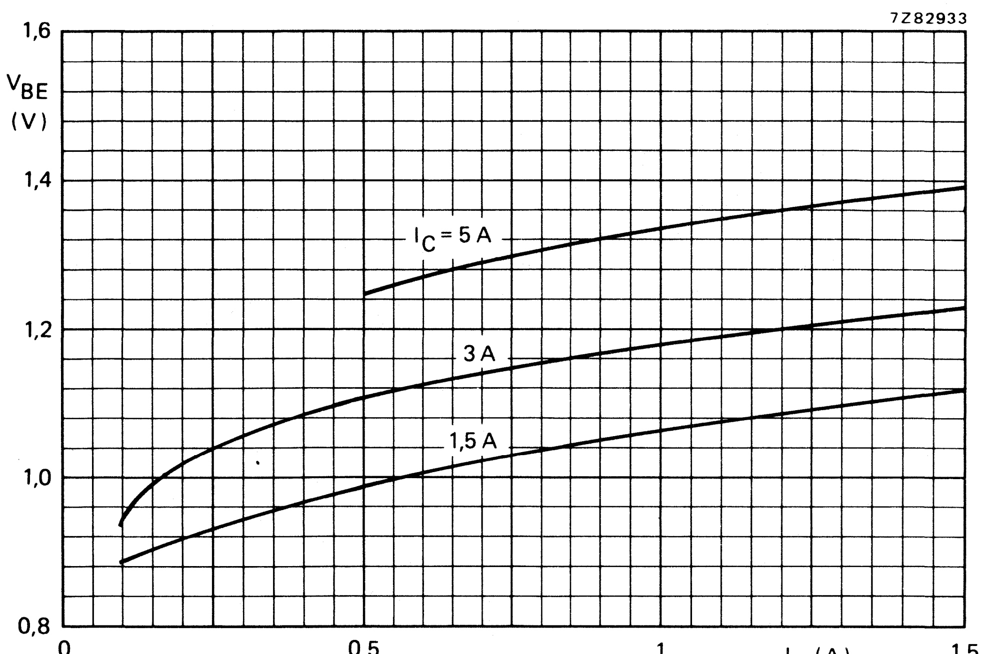


Fig. 12 Typical values at T_j = 25 °C.

SILICON DIFFUSED POWER TRANSISTORS

High-voltage, high-speed, glass-passivated npn power transistors in a TO-3 envelope, intended for use in converters, inverters, switching regulators, motor control systems etc.

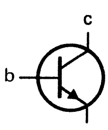
QUICK REFERENCE DATA

			BUX47	BUX47A	
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.	9		A
Collector current (peak value)	I_{CM}	max.	15		A
Total power dissipation up to $T_{mb} = 25\ °C$	P_{tot}	max.	125		W
Fall time (resistive load)	t_f	max.	0,8		µs

MECHANICAL DATA

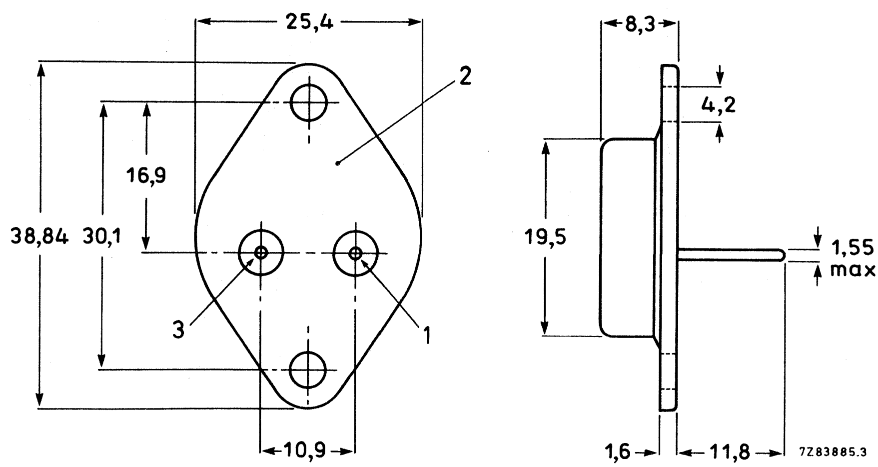
Dimensions in mm

Fig. 1 TO-3.



Pinning:

1 = base
2 = collector
3 = emitter



Collector connected to case.

RATINGS

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

			BUX47	BUX47A	
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); $t_p < 5$ ms	I_{CM}	max.	15		A
Base current (DC)	I_B	max.	3		A
Base current (peak value); $t_p \leqslant 5$ 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 +200		°C
Junction temperature	T_j	max.	200		°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\,j\text{-}mb}$	=	1,4	K/W

CHARACTERISTICS

$T_j = 25$ °C unless otherwise specified

			BUX47	BUX47A	
Collector cut-off current*					
$V_{CE} = V_{CESMmax}$; $R_{BE} \leqslant 10\,\Omega$	I_{CER}	max.	0,4		mA
$V_{CE} = V_{CESMmax}$; $R_{BE} \leqslant 10\,\Omega$; $T_j = 125$ °C	I_{CER}	max.	3		mA
Emitter cut-off current					
$I_C = 0$; $V_{EB} = 5$ V	I_{EBO}	max.	1		mA
Saturation voltages					
$I_C = 6$ A; $I_B = 1{,}2$ A	V_{CEsat}	max.	1,5	–	V
$I_C = 9$A; $I_B = 1{,}8$ A	V_{CEsat}	max.	5	–	V
$I_C = 5$ A; $I_B = 1$ A	V_{CEsat}	max.	–	1,5	V
$I_C = 8$ A; $I_B = 1{,}6$ A	V_{CEsat}	max.	–	5	V
$I_C = 6$ A; $I_B = 1{,}2$ A	V_{BEsat}	max.	1,6	–	V
$I_C = 5$ A; $I_B = 1$ A	V_{BEsat}	max.	–	1,6	V
Collector-emitter sustaining voltage					
$I_C = 200$ mA; $I_B = 0$; $L = 25$ mH	$V_{CEOsust}$	min.	400	450	V
Emitter-base breakdown voltage					
$I_C = 0$; $I_B = 0{,}5$ A	$V_{(BR)EBO}$		7 to 30		V
Collector cut-off current					
$V_{CE} = V_{CESMmax}$; $V_{BE} = -2{,}5$ V	I_{CEX}	max.	0,15		mA
$V_{CE} = V_{CESMmax}$; $V_{BE} = -2{,}5$ V; $T_j = 125$ °C	I_{CEX}	max.	1,5		mA

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

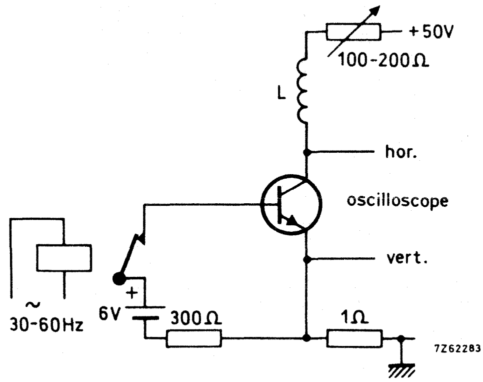


Fig. 2 Test circuit for $V_{CEOsust}$.

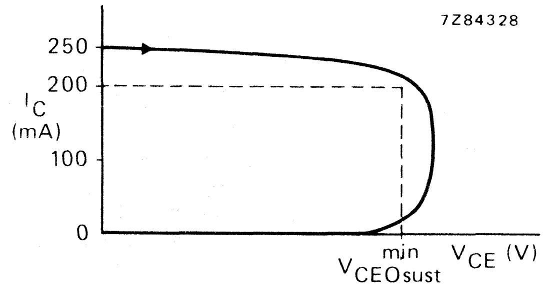


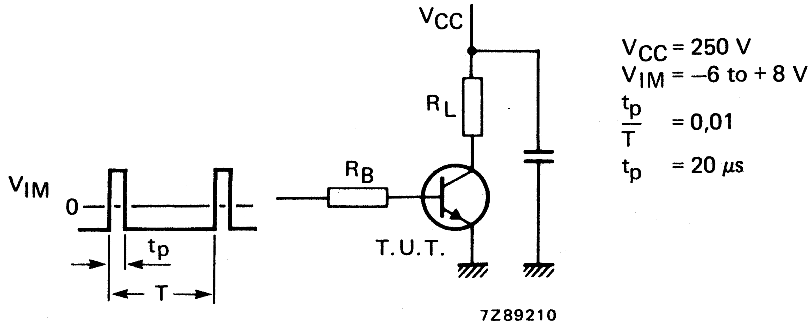
Fig. 3 Oscilloscope display for sustaining voltage.

Switching times resistive load (Figs 4 and 5)
BUX47: I_{Con} = 6 A; I_{Bon} = $-I_{Boff}$ = 1,2 A
BUX47A: I_{Con} = 5 A; I_{Bon} = $-I_{Boff}$ = 1 A

Turn-on time	t_{on}	typ.	0,6 μs
		max.	1,0 μs
Turn-off: Storage time	t_s	typ.	2,8 μs
		max.	3,0 μs
Fall time	t_f	typ.	0,45 μs
		max.	0,8 μs

Switching times inductive load (Figs 6 and 7)
BUX47: I_{Con} = 6 A; I_B = 1,2 A
BUX47A: I_{Con} = 5 A; I_B = 1 A

Turn-off: Storage time	t_s	typ.	2,5 μs
Storage time; T_j = 100 °C	t_s	max.	4 μs
Fall time	t_f	typ.	80 ns
Fall time; T_j = 100 °C	t_f	max.	400 ns



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.

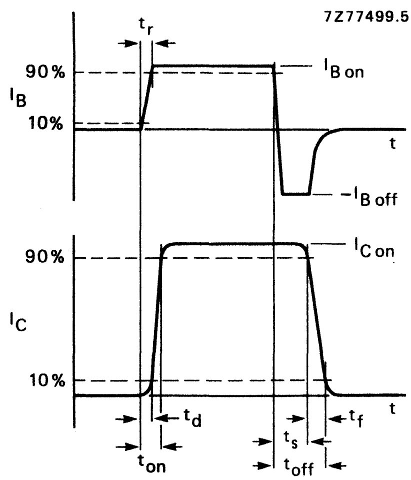


Fig. 5 Switching times waveforms with resistive load.

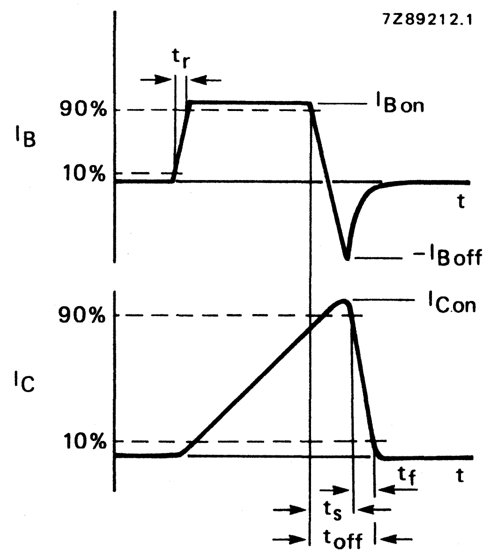


Fig. 6 Switching times waveforms with inductive load.

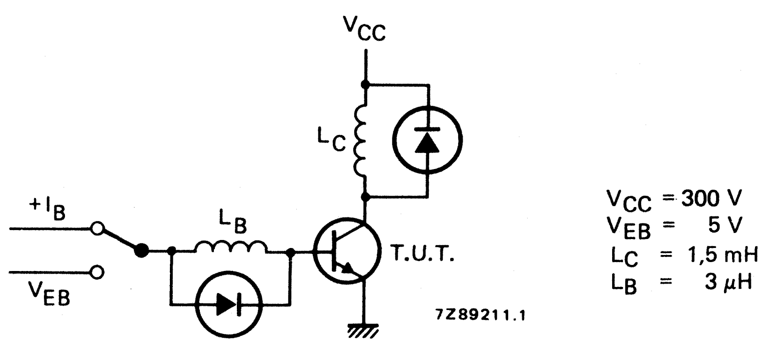
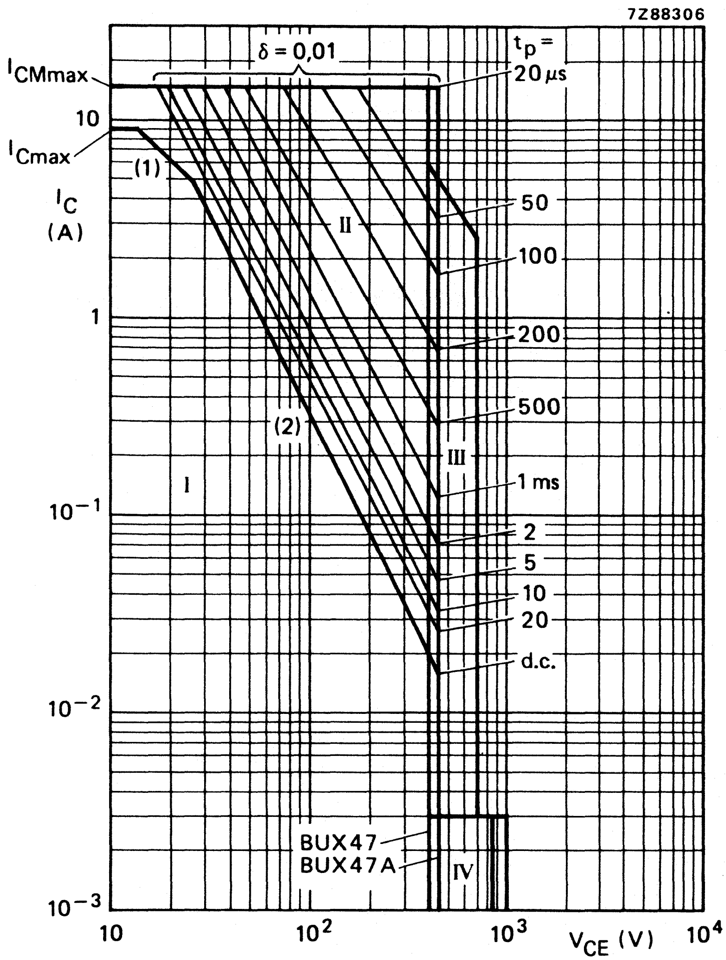
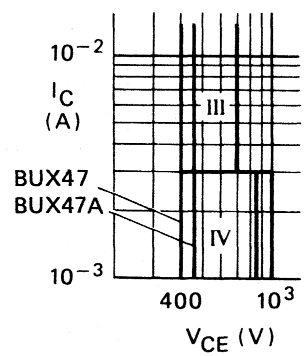


Fig. 7 Test circuit inductive load.





(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 $R_{BE} \leqslant 100\ \Omega$ and $t_p \leqslant 0,6\ \mu s$.
IV Repetitive pulse operation in this region is permissible, provided $V_{BE} \leqslant 0$ and $t_p \leqslant 2$ ms.

Fig. 8 Safe operating area at $T_{mb} \leqslant 25\ ^oC$.

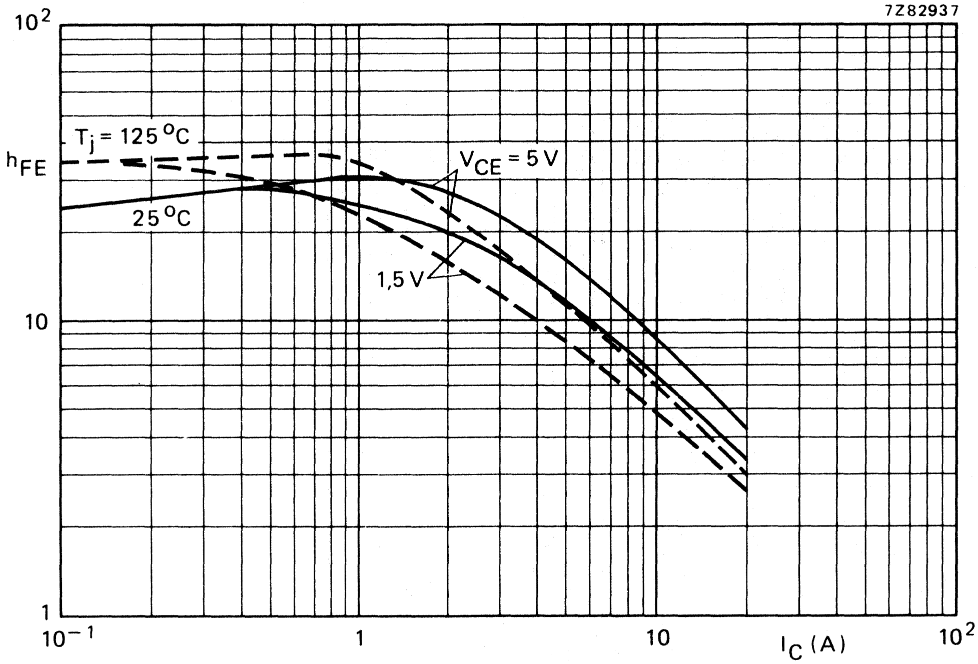


Fig. 9 Typical values DC current gain.

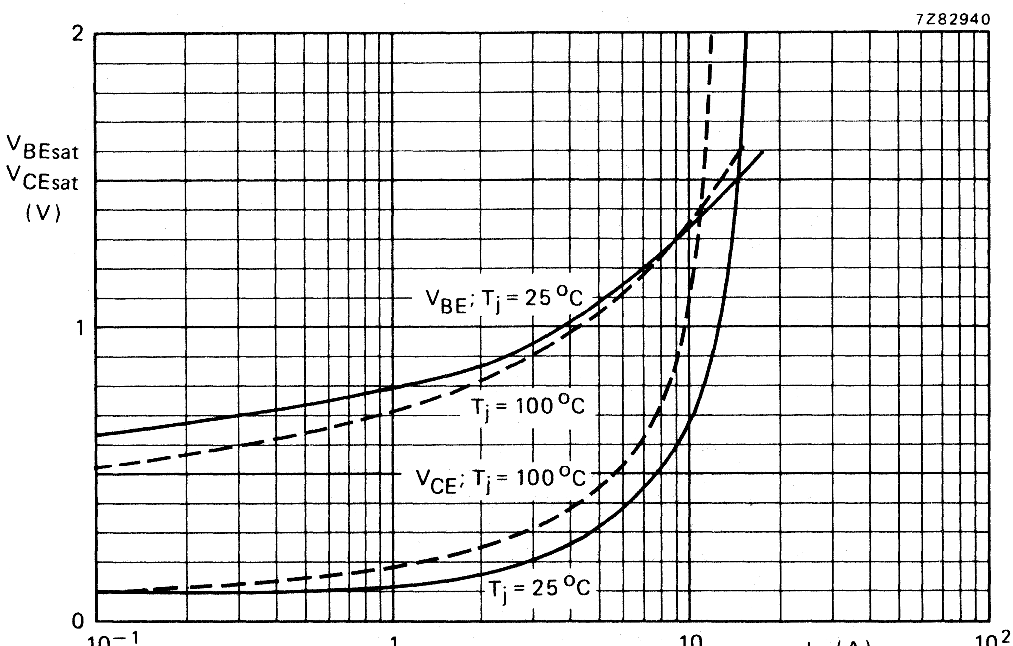


Fig. 10 Typical values base and collector voltage at I_C/I_B = 5.

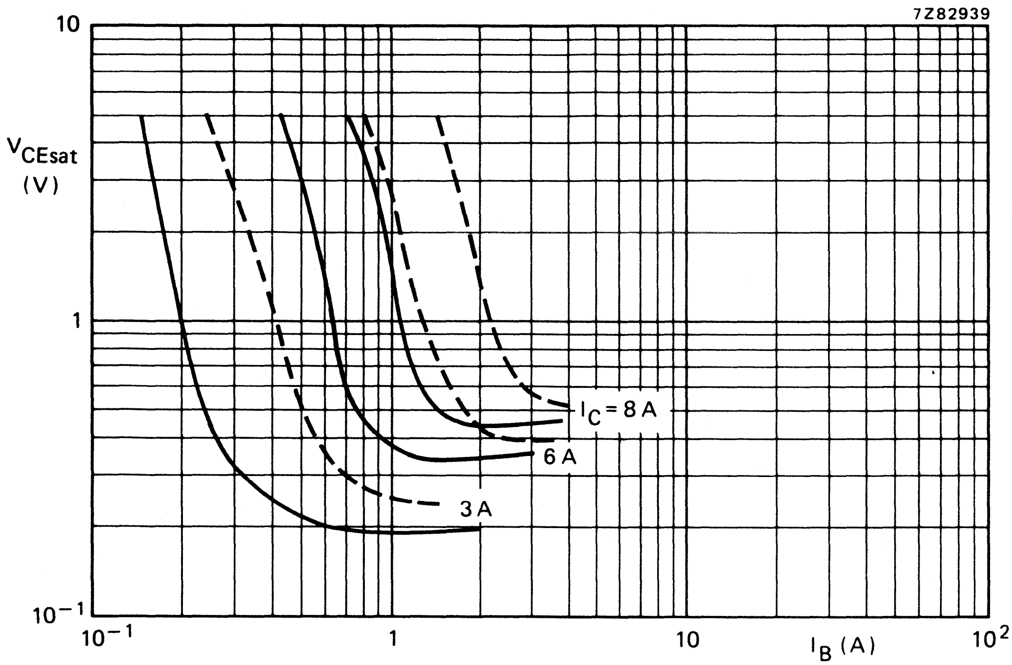


Fig. 11 Typ. (——) and max. (– – –) values collector-emitter saturation voltage at T_j = 25 °C.

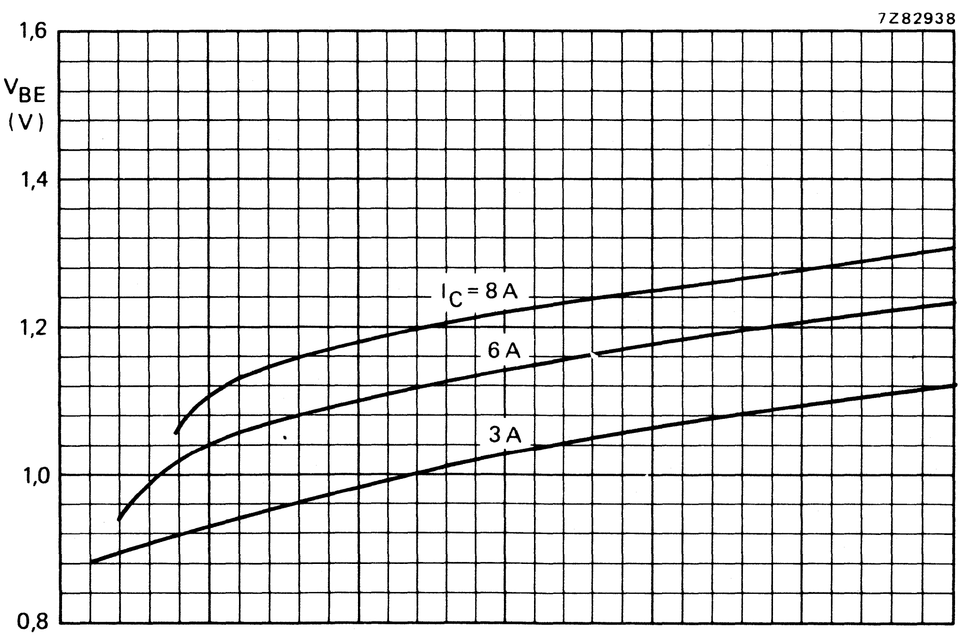


Fig. 12 Typical values base-emitter voltage at T_j = 25 °C.

SILICON DIFFUSED POWER TRANSISTORS

High-voltage, high-speed, glass-passivated npn power transistors in a TO-3 envelope, intended for use in converters, inverters, switching regulators, motor control systems etc.

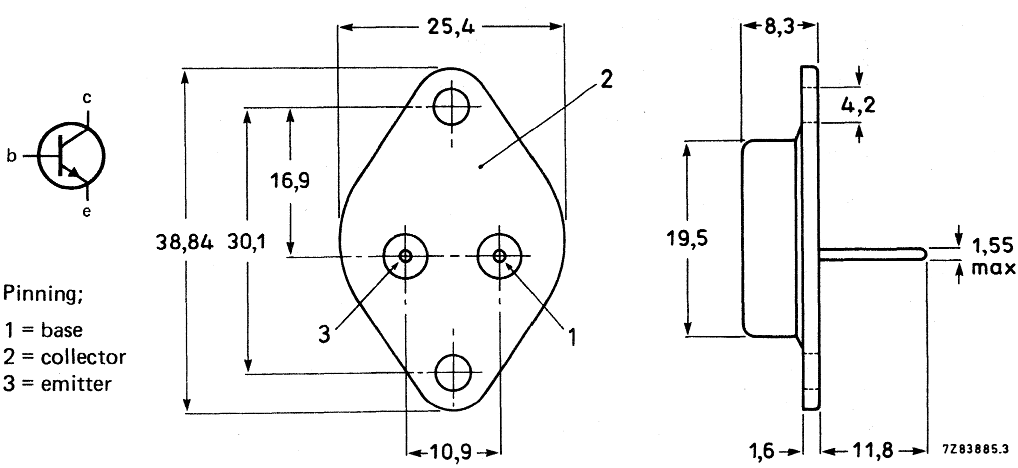
QUICK REFERENCE DATA

			BUX48	BUX48A	
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 $T_{mb} = 25\ ^oC$	P_{tot}	max.	175		W
Fall time (resistive load)	t_f	max.	0,8		μs

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-3.



Pinning;
1 = base
2 = collector
3 = emitter

Collector connected to case.

RATINGS

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

			BUX48	BUX48A	
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
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 °C	P_{tot}	max.	175		W
Storage temperature range	T_{stg}		−65 to +200		°C
Junction temperature	T_j	max.	200		°C

THERMAL RESISTANCE

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

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			BUX48	BUX48A	
Collector-emitter current *					
$V_{CE} = V_{CESM}$; $R_{BE} \leqslant 10\ \Omega$;	I_{CESM}	max.	0,5		mA
$V_{CE} = V_{CESM}$; $R_{BE} \leqslant 10\ \Omega$; Tj = 125 °C	I_{CESM}	max.	4		mA
Collector-emitter current					
$V_{CE} = V_{CEX}$; V_{BE} = −2,5 V	I_{CEV}	max.	0,2		mA
$V_{CE} = V_{CEX}$; V_{BE} = −2,5 V; T_j = 125 °C	I_{CEV}	max.	2		mA
Emitter cut-off current					
I_C = 0; V_{EB} = 5 V	I_{EBO}	max.	1		mA
Saturation voltages					
I_C = 10 A; I_B = 2 A	V_{CEsat}	max.	1,5	–	V
	V_{BEsat}	max.	1,6	–	V
I_C = 8 A; I_B = 1,6 A	V_{CEsat}	max.	–	1,5	V
	V_{BEsat}	max.	–	1,6	V
I_C = 15 A; I_B = 3 A	V_{CEsat}	max.	5	–	V
I_C = 12 A; I_B = 2,4 A	V_{CEsat}	max.	–	5	V
Collector-emitter sustaining voltage					
I_C = 200 mA; I_{Boff} = 0; L = 25 mH	$V_{CEOsust}$	min.	400	450	V
Emitter-base breakdown voltage					
I_C = 0; I_B = 50 mA;	$V_{(BR)EBO}$		7 to 30		V

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

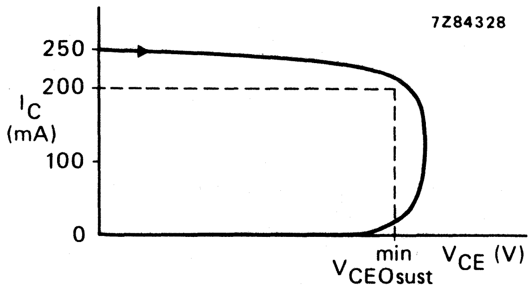


Fig. 2 Oscilloscope display for sustaining voltage.

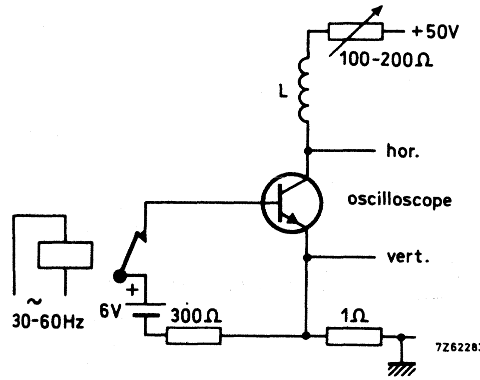
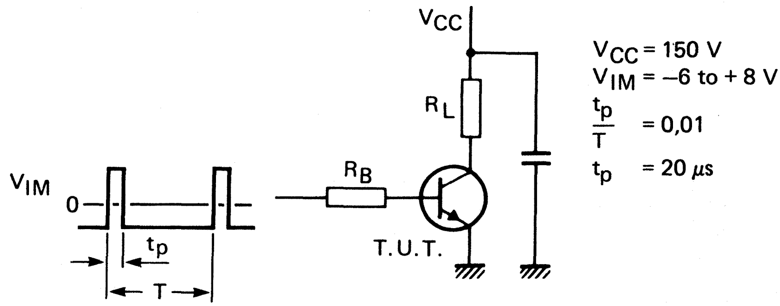


Fig. 3 Test circuit for $V_{CEOsust}$.

			BUX48	BUX48A	
Switching times resistive load (Fig. 4 and 5)					
I_{Con} = 10 A; I_{Bon} = $-I_{Boff}$ = 2 A					
Turn-on time	t_{on}	max.	1	–	μs
Turn-off: Storage time	t_s	max.	3	–	μs
Fall time	t_f	max.	0,8	–	μs
I_{Con} = 8 A; I_{Bon} = $-I_{Boff}$ = 1,6 A					
Turn-on time	t_{on}	max.	–	1	μs
Turn-off: Storage time	t_s	max.	–	3	μs
Fall time	t_f	max.	–	0,8	μs
Switching times inductive load (Fig. 6 and 7)					
I_{Con} = 10 A; I_{Bon} = 2 A; T_{mb} = 25 °C					
Turn-off: Storage time	t_s	typ.	3	–	μs
Fall time	t_f	typ.	80	–	ns
I_{Con} = 10 A; I_{Bon} = 2 A; T_{mb} = 100 °C					
Turn-off: Storage time	t_s	max.	5	–	μs
Fall time	t_f	max.	0,4	–	μs
I_{Con} = 8 A; I_{Bon} = 1,6 A; T_{mb} = 25 °C					
Turn-off: Storage time	t_s	typ.	–	3	μs
Fall time	t_f	typ.	–	80	ns
I_{Con} = 8 A; I_{Bon} = 1,6 A; T_{mb} = 100 °C					
Turn-off: Storage time	t_s	max.	–	5	μs
Fall time	t_f	max.	–	0,4	μs



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.

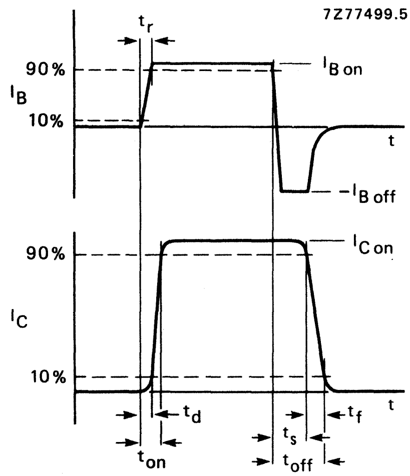


Fig. 5 Switching times waveforms with resistive load.

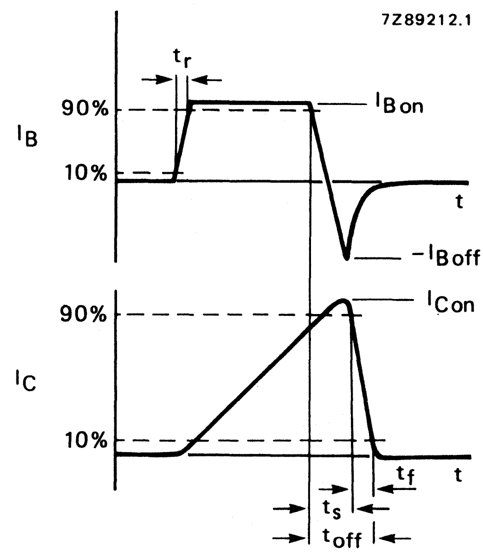


Fig. 6 Switching times waveforms with inductive load.

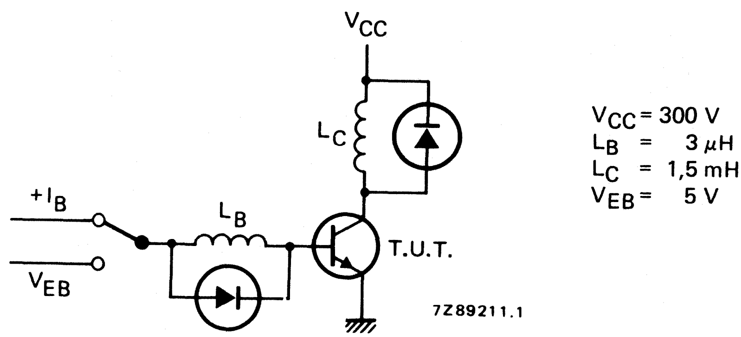
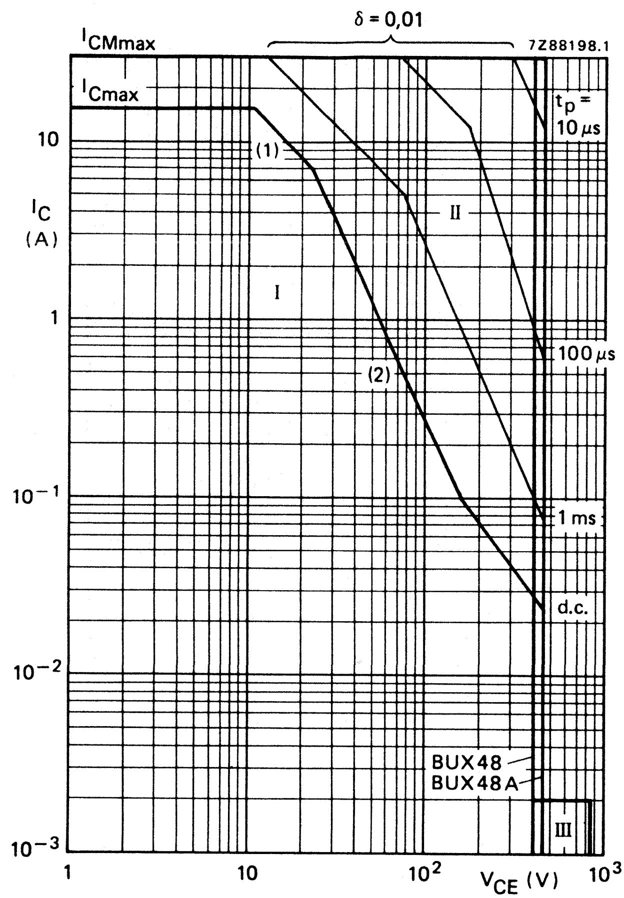


Fig. 7 Test circuit inductive load.



(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 Repetitive pulse operation in this region is permissible, provided $V_{BE} \leqslant 0$ and $t_p \leqslant 5$ ms.

Fig. 8 Safe operating area at $T_{mb} \leqslant 25$ °C.

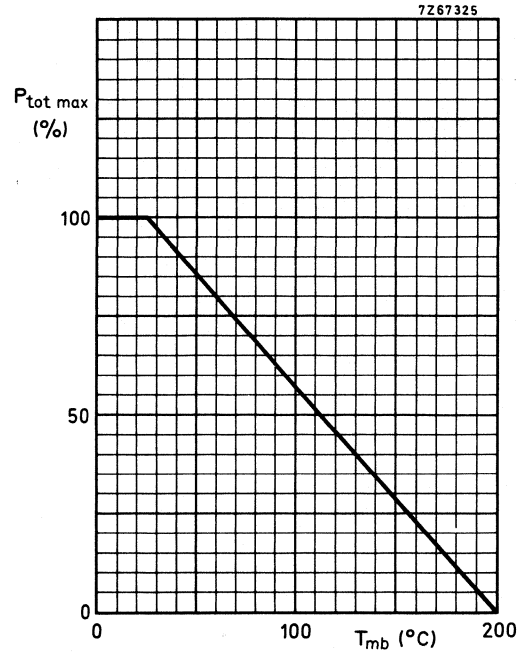


Fig. 9 Derating curve.

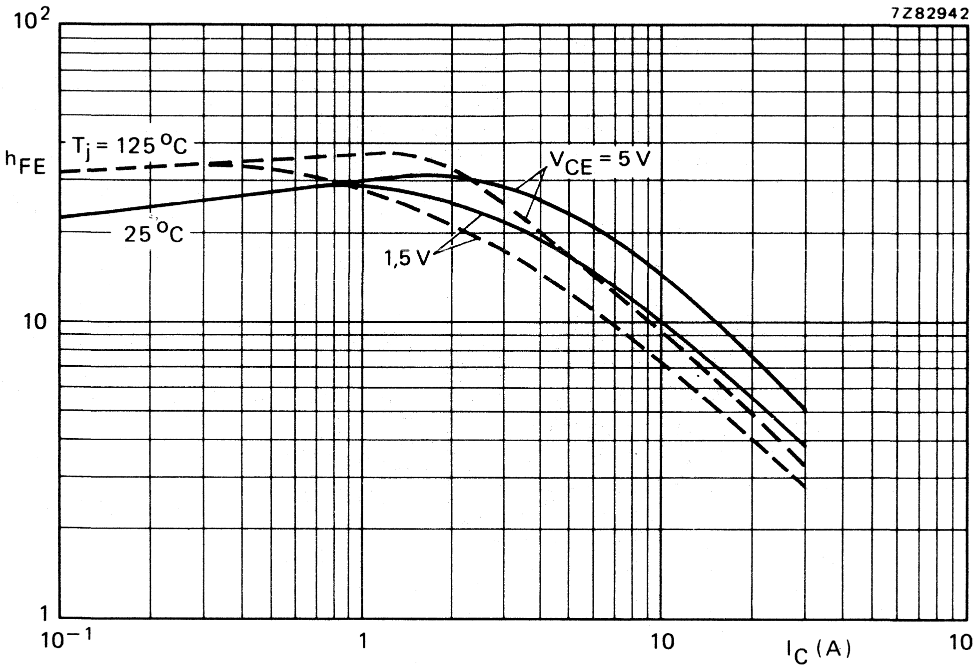


Fig. 10 Typical values DC current gain.

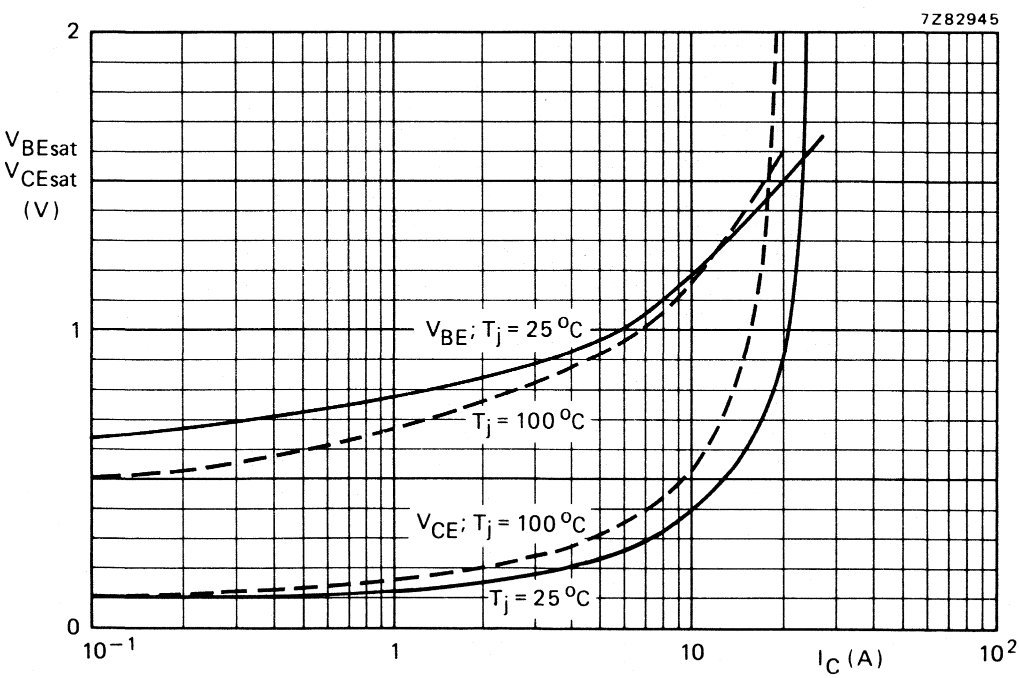


Fig. 11 Typical values base and collector voltage at $I_C/I_B = 5$.

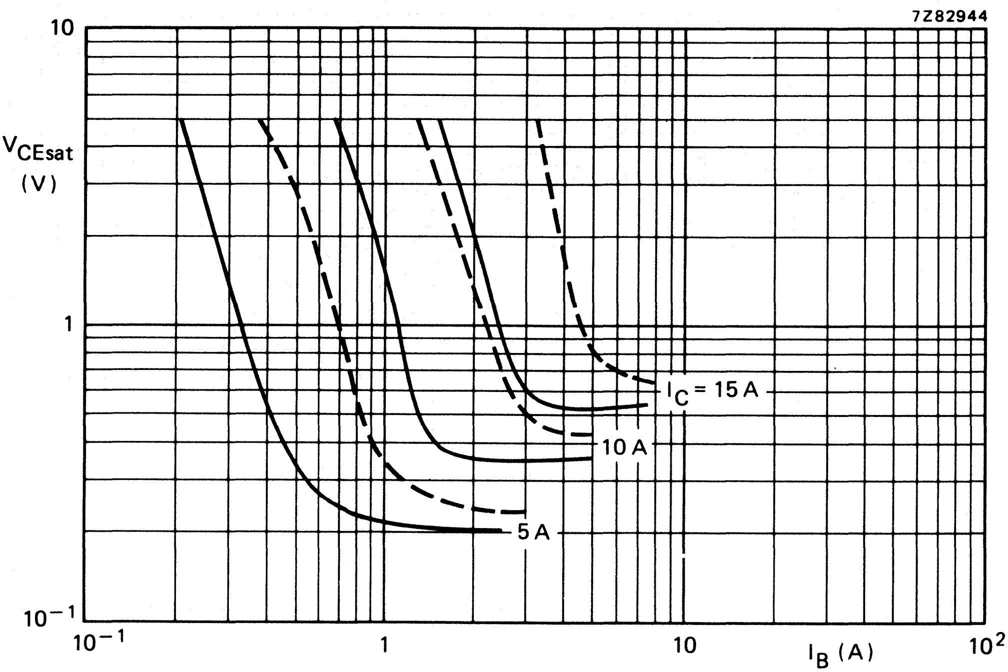


Fig. 12 Typical (——) and maximum (– – –) values saturation voltage. T_j = 25 °C.

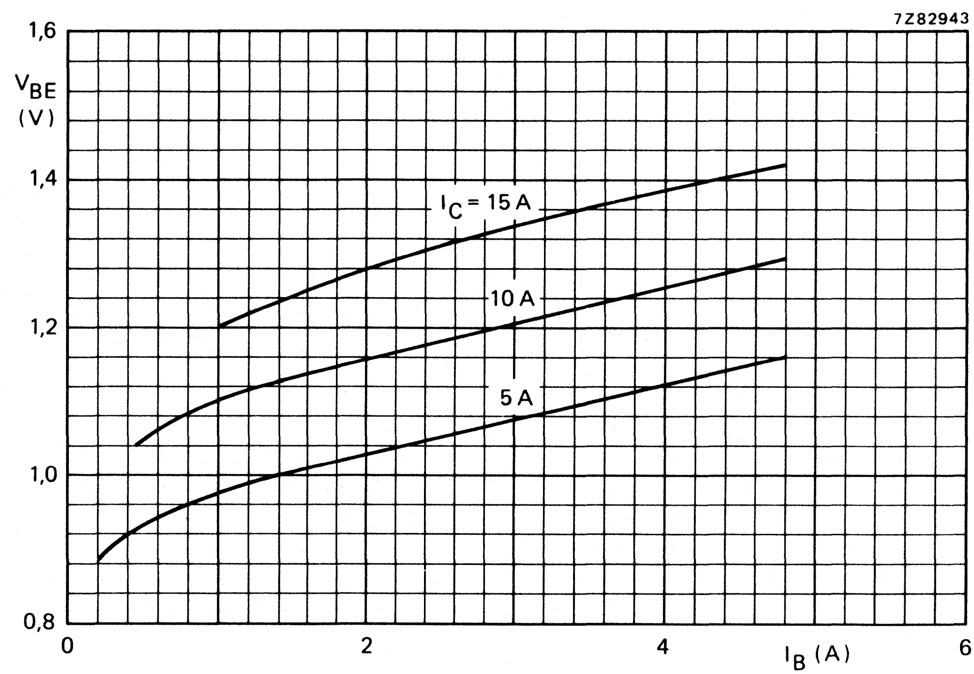


Fig. 13 Typical values base-emitter voltage at T_j = 25 °C.

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.

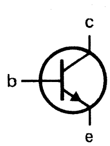
QUICK REFERENCE DATA

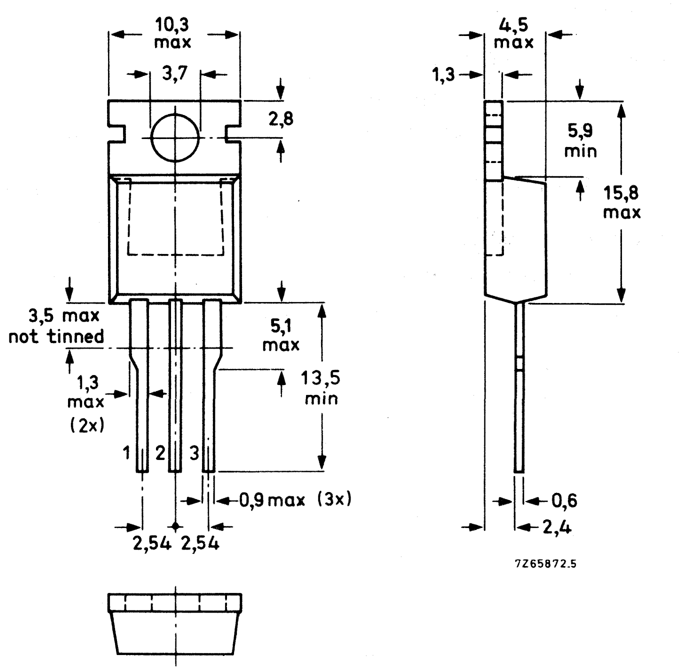
			BUX84	BUX85	
Collector-emitter voltage (peak value; $V_{BE} = 0$)	V_{CESM}	max.	800	1000	V
Collector-emitter voltage (open base)	V_{CEO}	max.	400	450	V
Collector-emitter saturation voltage	V_{CEsat}	max.	1		V
Collector current (DC)	I_C	max.	2		A
Collector current (peak value)	I_{CM}	max.	3		A
Total power dissipation up to $T_{mb} = 50\ ^oC$	P_{tot}	max.	40		W
Fall time	t_f	max.	0,4		μs

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-220AB.





Pinning;

1 = base
2 = collector
3 = emitter

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 $T_{mb} = 50\ ^oC$	P_{tot}	max	40	W
Storage temperature range	T_{stg}		−65 to +150	^oC
Junction temperature	T_j	max	150	^oC

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	2,5	K/W
From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	70	K/W

CHARACTERISTICS $T_j = 25\ ^oC$ unless otherwise specified

Collector cut-off current **

$V_{CEM} = V_{CESMmax}$; $V_{BE} = 0$	I_{CES}	max.	200	μA
$V_{CEM} = V_{CESMmax}$; $V_{BE} = 0$; $T_j = 125\ ^oC$	I_{CES}	max.	1,5	mA

DC current gain

$I_C = 0{,}1$ A; $V_{CE} = 5$ V	h_{FE}	typ	50	

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

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.	1,0		V
$I_C = 1$ A; $I_B = 0{,}2$ A	V_{BEsat}	max.	1,1		V
Collector-emitter sustaining voltage			BUX84	BUX85	
$I_C = 100$ mA; $I_{Boff} = 0$; L = 25 mH	$V_{CEOsust}$	min.	400	450	V

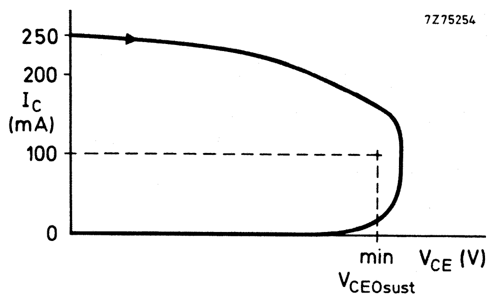


Fig. 2 Oscilloscope display for sustaining voltage.

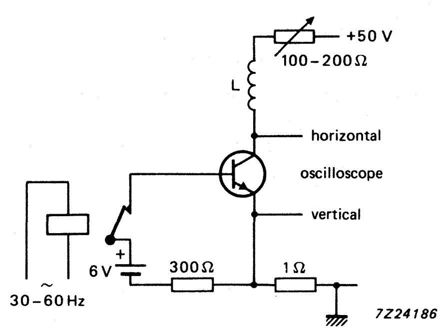


Fig. 3 Test circuit for $V_{CEOsust}$.

CHARACTERISTICS (continued) $T_j = 25\ ^oC$ unless otherwise specified

Transition frequency at f = 1 MHz

$I_C = 0,2$ A; $V_{CE} = 10$ V	f_T	typ	20	MHz

Switching times

$I_{Con} = 1$ A; $V_{CC} = 250$ V
$I_{Bon} = 0,2$ A; $-I_{Boff} = 0,4$ 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, $T_{mb} = 95\ ^oC$	t_f	max.	1,4	μs

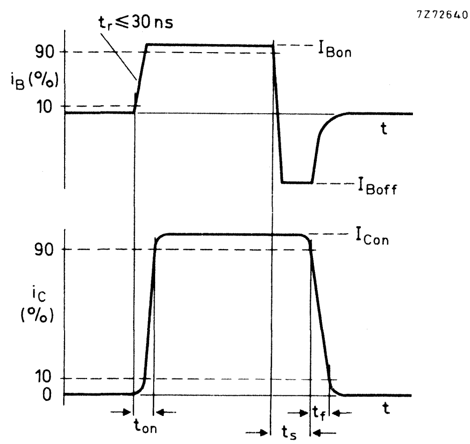


Fig. 4 Switching times waveforms with resistive load.

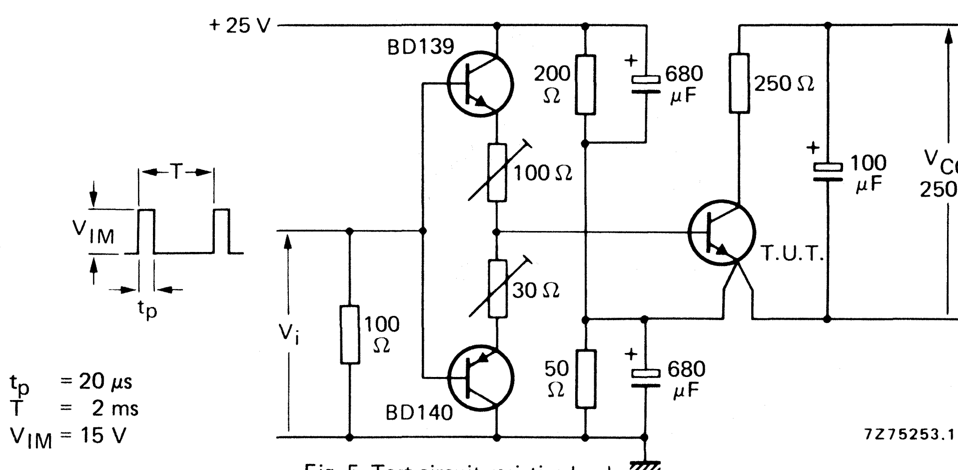
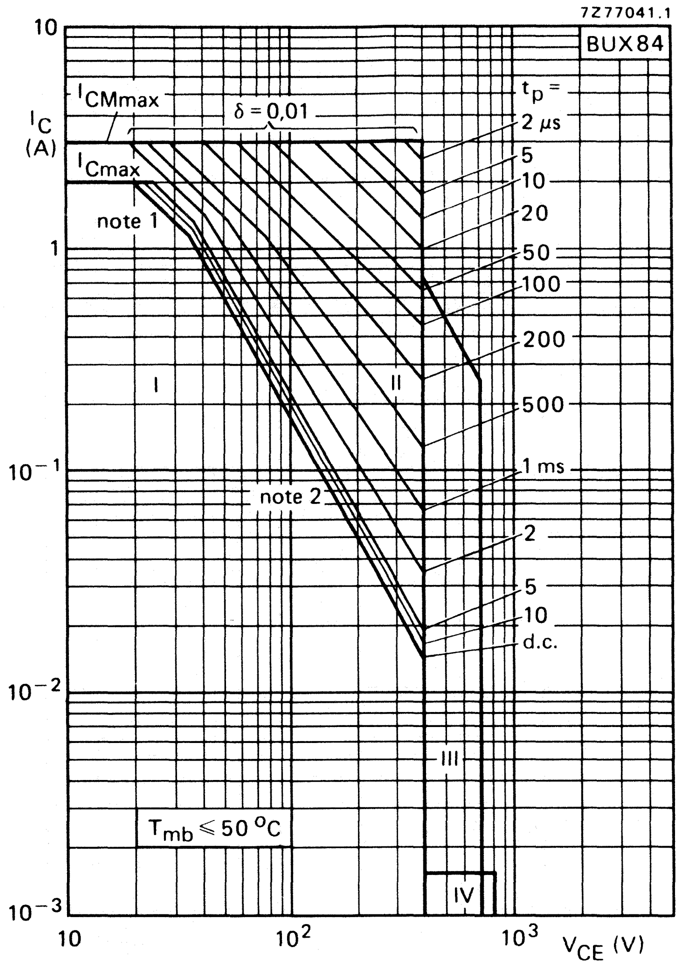


Fig. 5 Test circuit resistive load.



1. $P_{tot\ max}$ and $P_{peak\ max}$ lines.
2. Second-breakdown limits.

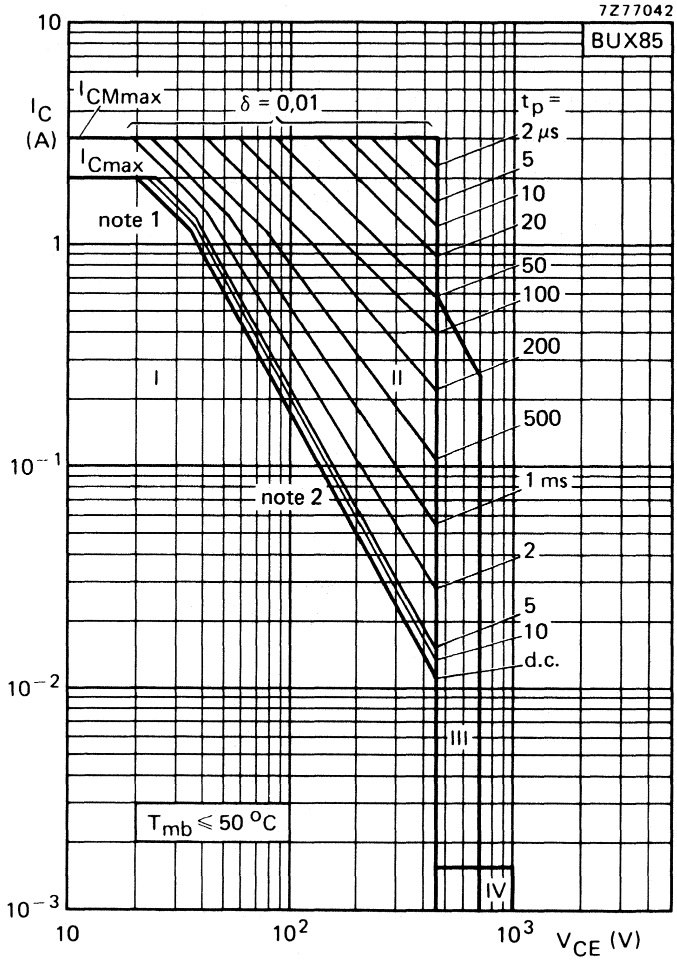
I Region of permissible DC operation

II Permissible extension for repetitive pulse operation

III Area of permissible operation during turn-on in single transistor converters, provided $R_{BE} \leqslant 100\ \Omega$ and $t_p \leqslant 0{,}6\ \mu s$

IV Repetitive pulse operation in this region is permissible, provided $V_{BE} \leqslant 0$ and $t_p \leqslant 2$ ms

Fig. 6 Safe operating area.



1. $P_{tot\ max}$ and $P_{peak\ max}$ lines.
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I Region of permissible DC operation

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Fig. 7 Safe operating area.

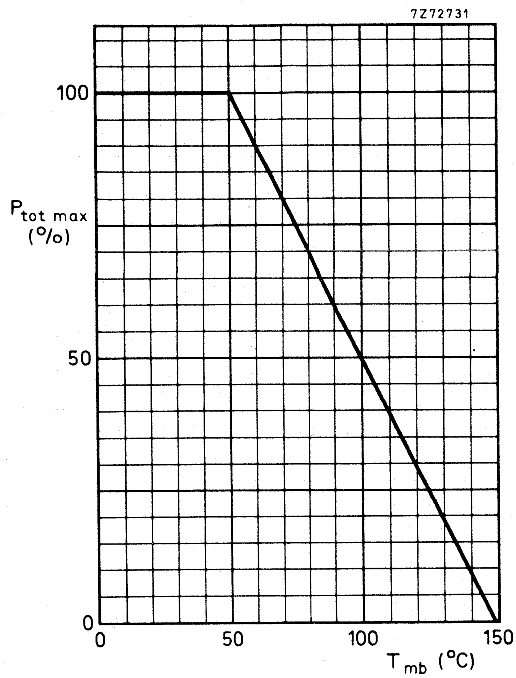


Fig. 8 Power derating curve.

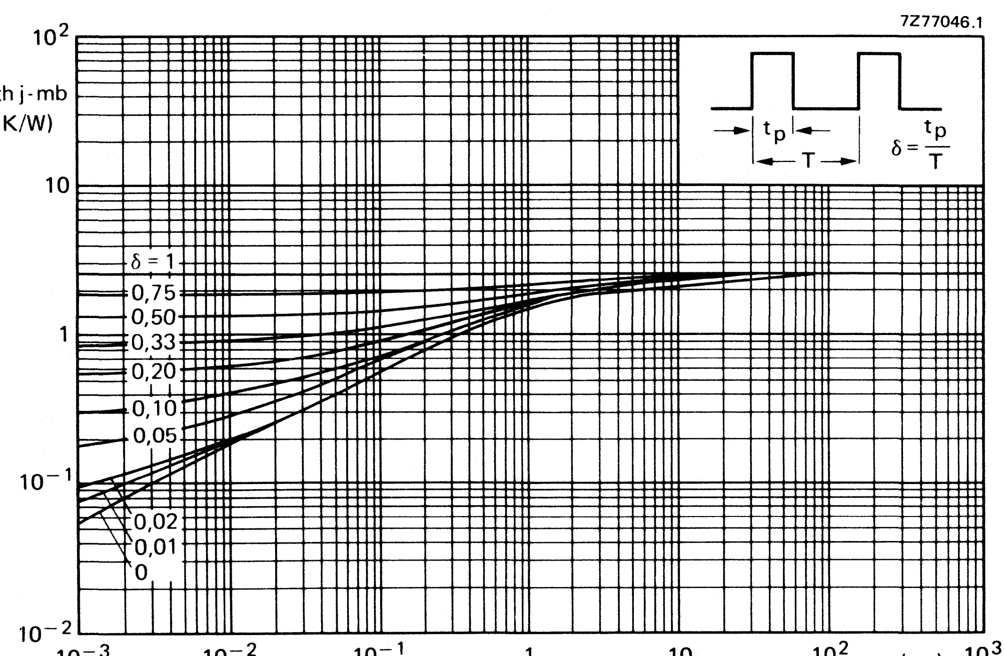


Fig. 9 Pulse power rating chart.

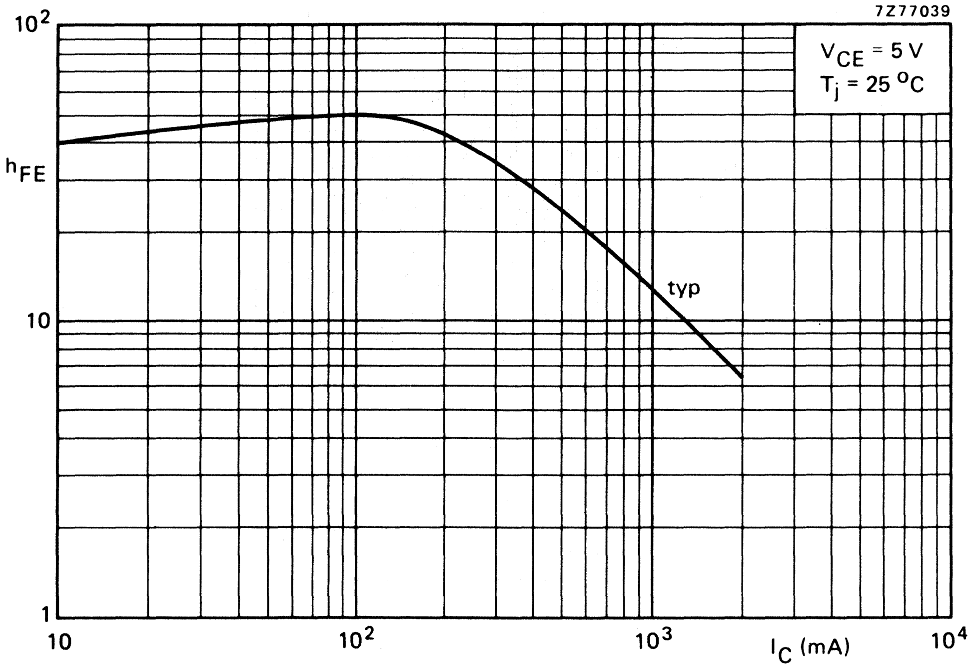


Fig. 10 Typical DC current gain.

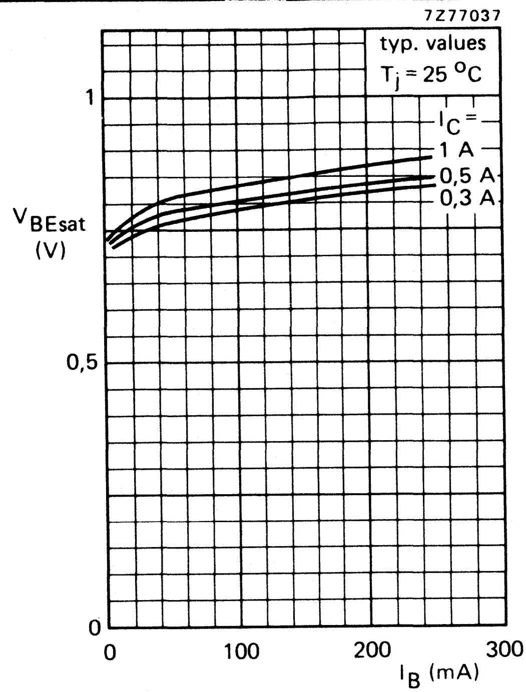


Fig. 11 Typical values saturation voltage, T_j = 25 °C.

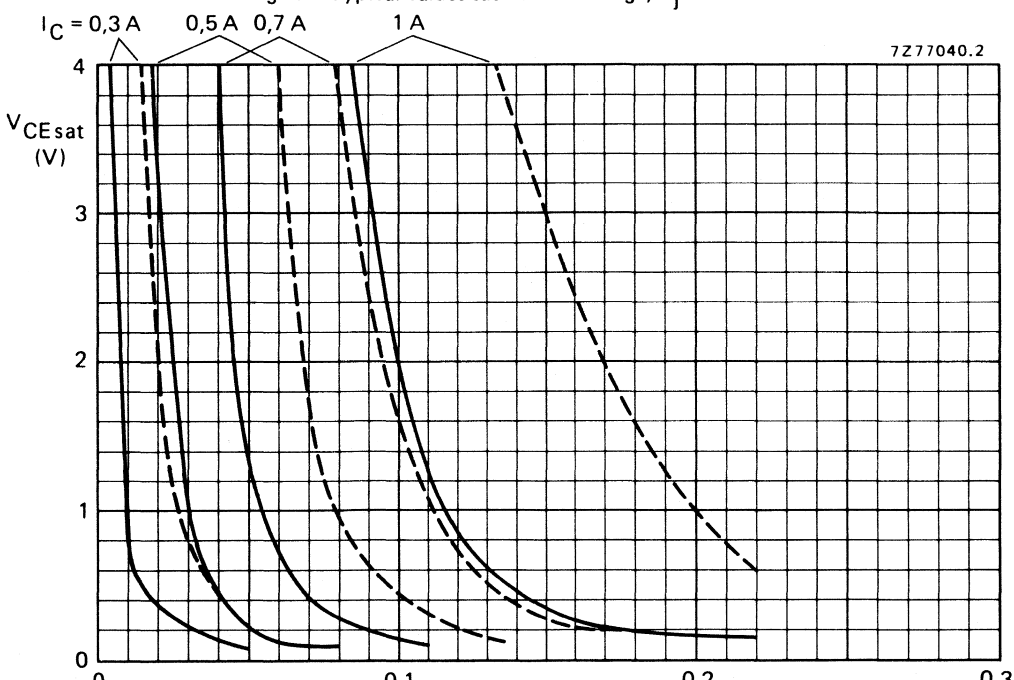


Fig. 12 Typical (——) and maximum (– – –) values saturation voltage at T_j = 25 °C.

SILICON DIFFUSED POWER TRANSISTORS

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

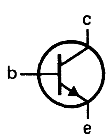
QUICK REFERENCE DATA

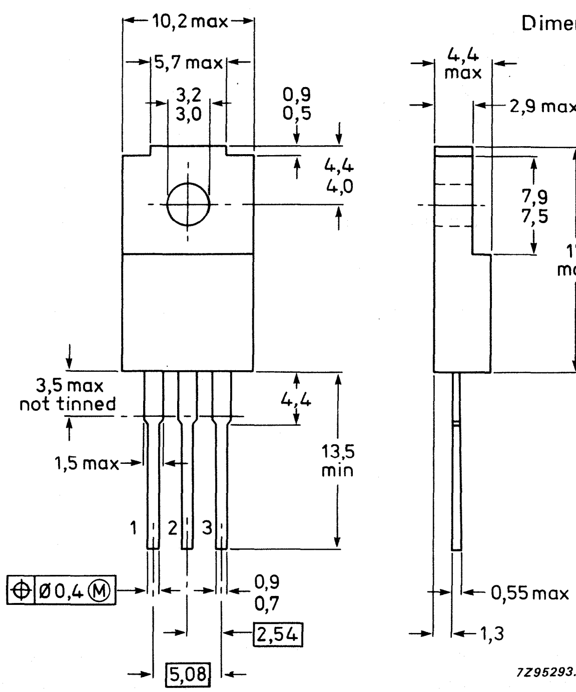
			BUX84F	BUX85F	
Collector-emitter voltage					
peak value; $V_{BE} = 0$	V_{CESM}	max.	800	1000	V
open base	V_{CEO}	max.	400	450	V
Collector-emitter saturation voltage	V_{CEsat}	max.	1,0		V
Collector saturation current	I_{Csat}	max.	1		A
Collector current					
DC	I_C	max.	2		A
peak value	I_{CM}	max.	3		A
Total power dissipation up to $T_h = 25\ ^oC$	P_{tot}	max.	18		W
Fall time	t_f	typ.	0,4		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)

			BUX84F	BUX85F	
Collector-emitter voltage					
open base	V_{CEO}	max.	400	450	V
peak value; $V_{BE} = 0$	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	I_B	max.	0,75		A
peak value	I_{BM}	max.	1		A
Total power dissipation					
up to $T_h = 25\ ^oC$ (note 1)	P_{tot}	max.	18		W
Storage temperature range	T_{stg}		−65 to +150		^oC
Junction temperature	T_j	max.	150		^oC

THERMAL RESISTANCE

From junction to external heatsink (note 1)	$R_{th\ j\text{-}h}$	=	7,2	K/W
From junction to external heatsink (note 2)	$R_{th\ j\text{-}h}$	=	4,7	K/W
From junction to ambient	$R_{th\ j\text{-}a}$	=	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

$T_j = 25\ ^oC$ unless otherwise specified

Collector cut-off currents				
$V_{CE} = V_{CESmax}$; $V_{BE} = 0$	I_{CES}	max.	0,2	mA
$V_{CE} = V_{CESmax}$; $V_{BE} = 0$; $T_j = 125\ ^oC$	I_{CES}	max.	1,5	mA
Emitter cut-off current				
$V_{EB} = 5$ V; $I_C = 0$	I_{EBO}	max.	1	mA
DC current gain				
$I_C = 0,1$ A; $V_{CE} = 5$ V	h_{FE}	typ.	50	
Transition frequency at f = 1 MHz				
$I_C = 0,2$ A; $V_{CE} = 10$ 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.

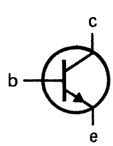
QUICK REFERENCE DATA

			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 $T_{mb} = 60\ ^{o}C$	P_{tot}	max.	20		W
Fall time	t_f	typ.	0,4		μs

MECHANICAL DATA

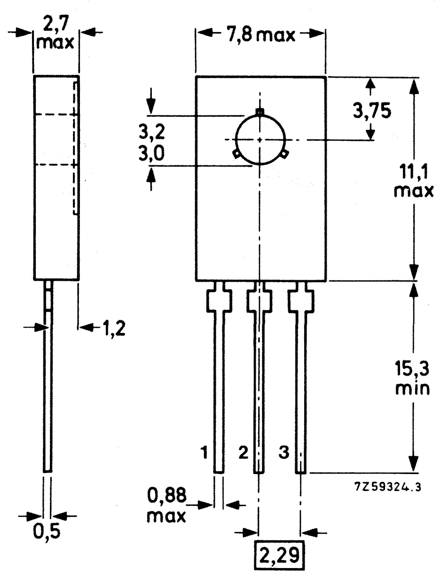
Dimensions in mm

Fig. 1 TO-126.



Pinning;

1 = base
2 = collector
3 = emitter



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	$R_{th\ j\text{-}mb}$	=	4,5	K/W
From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	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}	typ.	50	

Notes

1. Turn-off current.
2. Measured with a half-sinewave voltage (curve tracer).

Emitter cut-off current

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

Saturation voltage

$I_C = 0,1$ A; $I_B = 10$ mA	V_{CEsat}	max.	0,8		V
$I_C = 0,2$ A; $I_B = 20$ mA	V_{CEsat}	max.	1,0		V
$I_C = 0,2$ A; $I_B = 20$ mA	V_{BEsat}	max.	1,0		V

Collector-emitter sustaining voltages

			BUX86	BUX87	
$I_C = 100$ mA; $I_{Boff} = 0$; $L = 25$ mH	$V_{CEOsust}$	min.	400	450	V

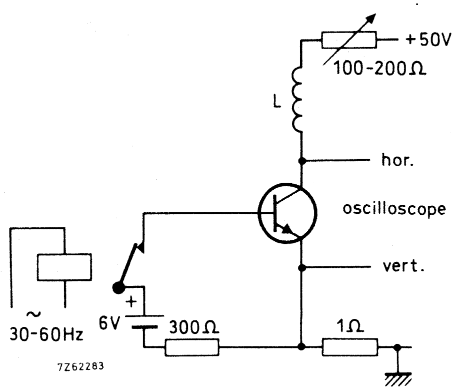


Fig. 2 Test circuit for $V_{CEOsust}$.

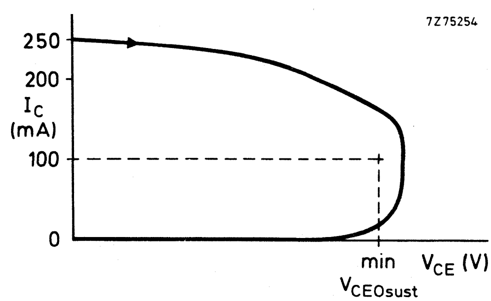


Fig. 3 Oscilloscope display for sustaining voltage.

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	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 °C	t_f	max.	1,3	μs

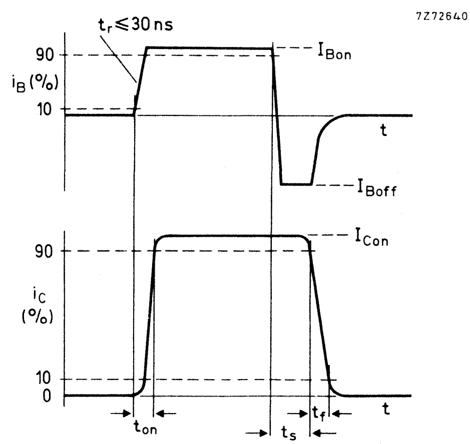
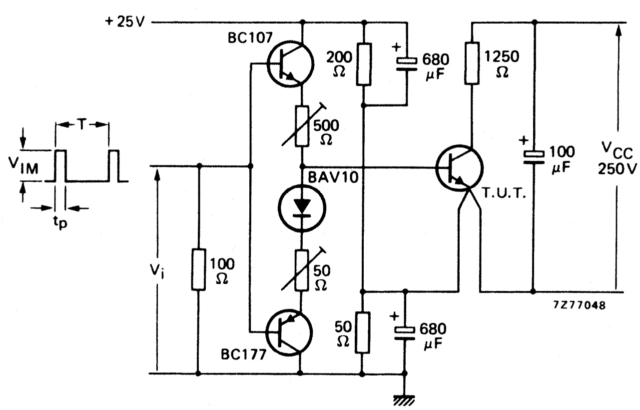
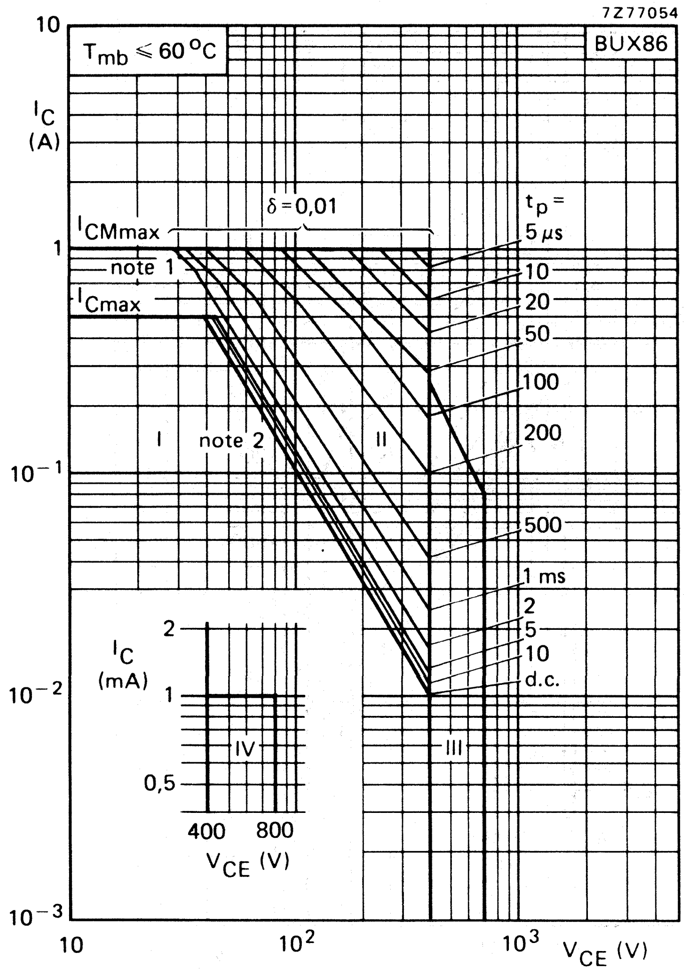


Fig. 4 Switching times waveforms with resistive load.



t_p = 20 μs
T = 2 ms
V_{IM} = 15 V

Fig. 5 Test circuit resistive load.



1. $P_{peak\ max}$ lines.
2. Second-breakdown limits.

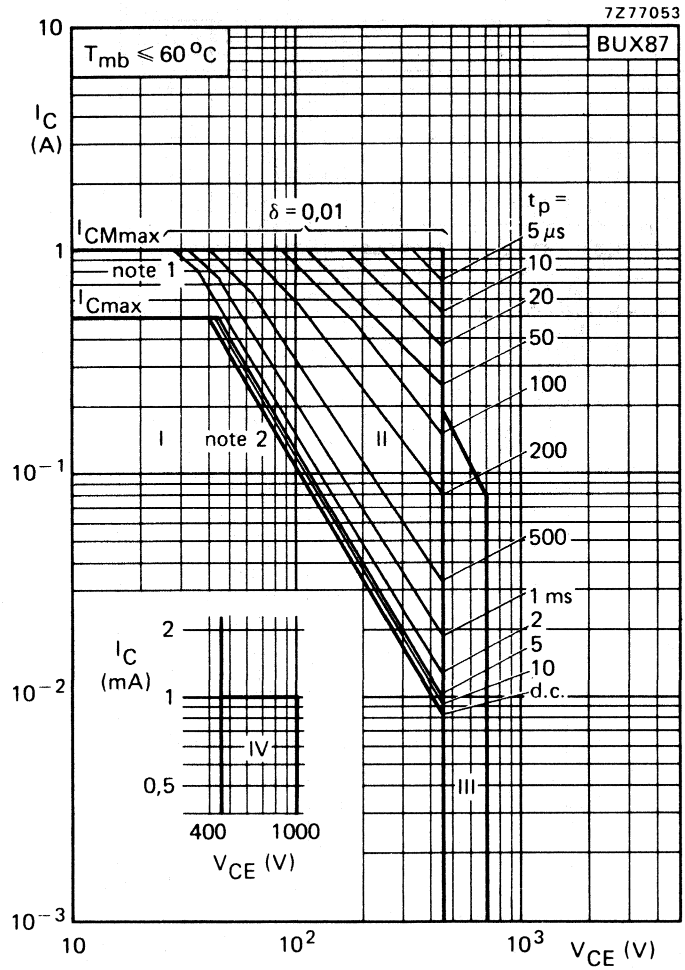
I Region of permissible DC operation

II Permissible extension for repetitive pulse operation

III Area of permissible operation during turn-on in single-transistor converters, provided $R_{BE} \leqslant 100\ \Omega$ and $t_p \leqslant 0{,}6\ \mu s$

IV Repetitive pulse operation in this region is permissible, provided $V_{BE} \leqslant 0$ and $t_p \leqslant 2$ 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 $R_{BE} \leqslant 100\ \Omega$ an $t_p \leqslant 0,6\ \mu s$

IV Repetitive pulse operation in this region is permissible provided $V_{BE} \leqslant 0$ and $t_p \leqslant 2$ ms

Fig. 7 Safe operating area.

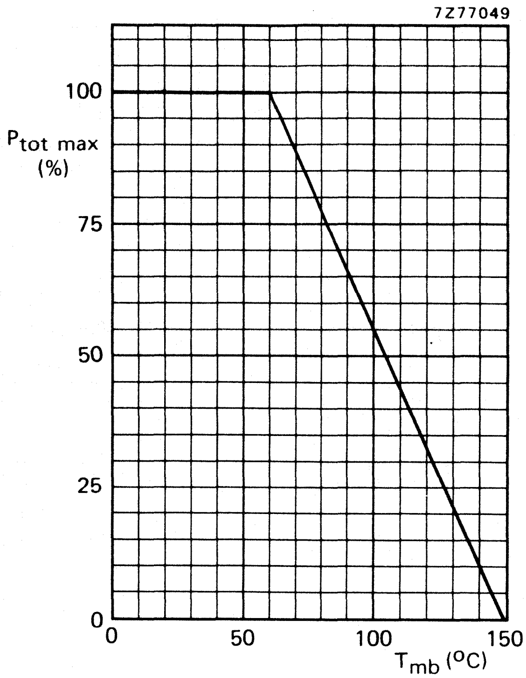


Fig. 8 Power derating curve.

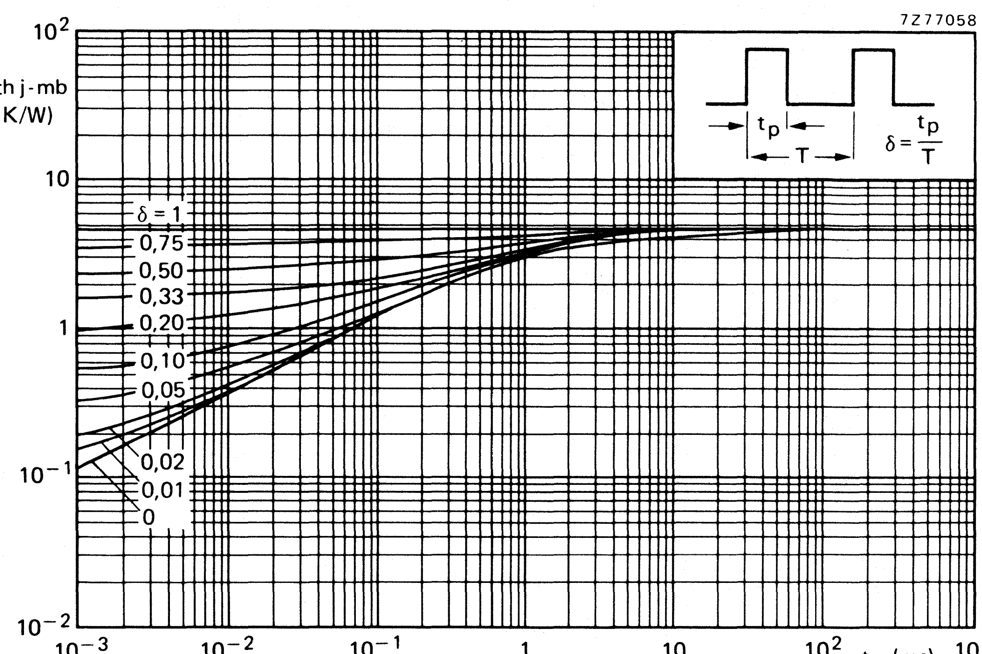


Fig. 9 Pulse power rating chart.

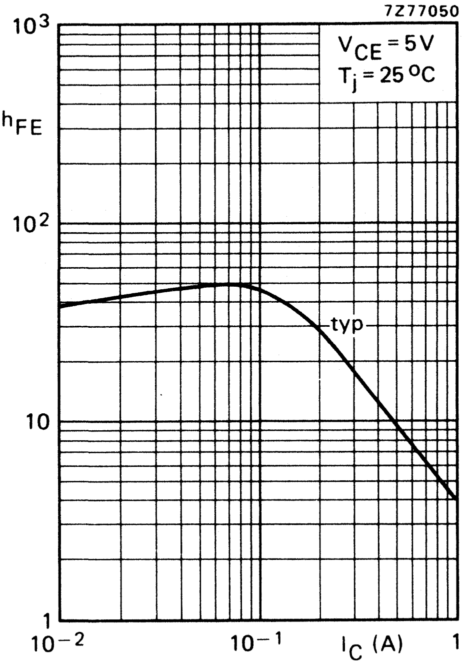


Fig. 10 Typical DC current gain.

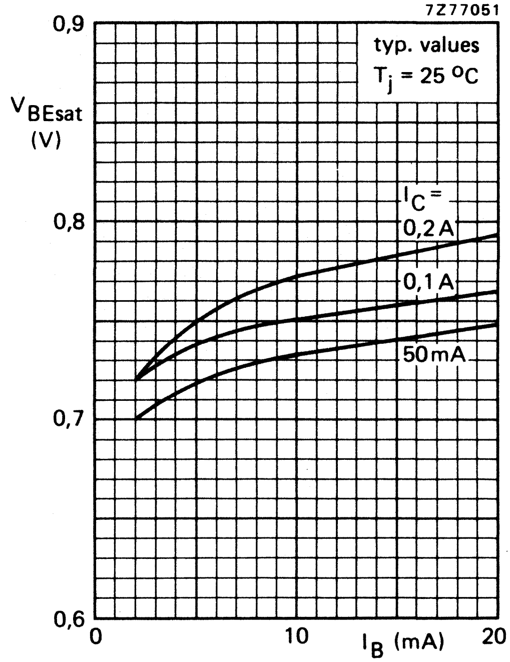


Fig. 11 Typical base-emitter voltage.

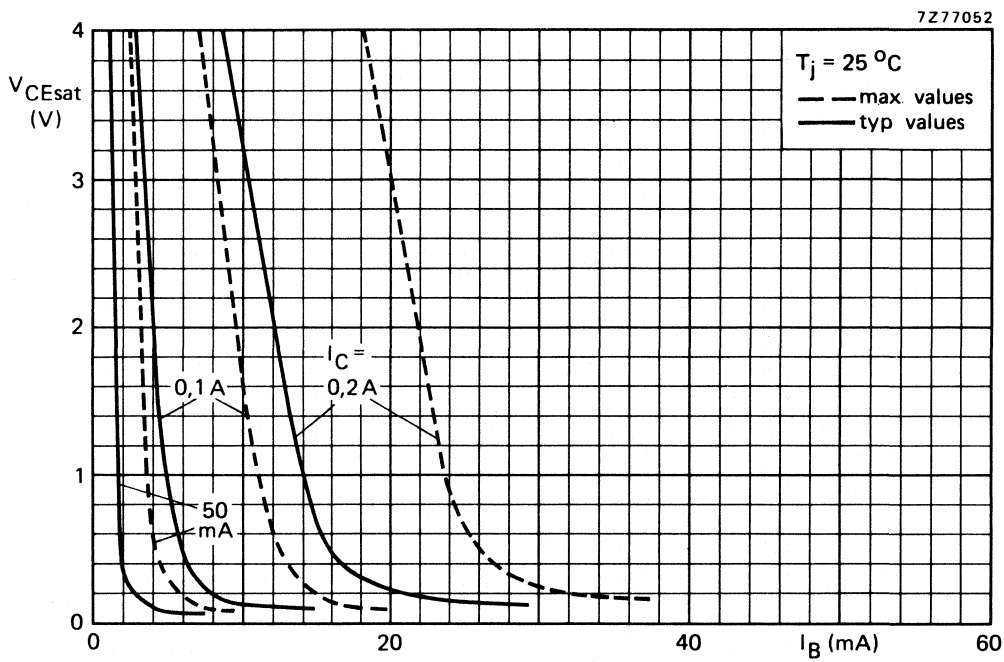


Fig. 12 Typical collector-emitter saturation voltage.

SILICON DIFFUSED POWER TRANSISTOR

High-voltage, high-speed, glass-passivated npn switching transistor in a TO-3 envelope, intended for use in three-phase AC motor control systems.

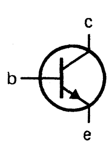
QUICK REFERENCE DATA

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.	12	A
Collector current (peak value)	I_{CM}	max.	20	A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	160	W
Collector saturation current	I_{Csat}	max.	9	A
Fall time	t_f	typ.	0,5	μs

MECHANICAL DATA

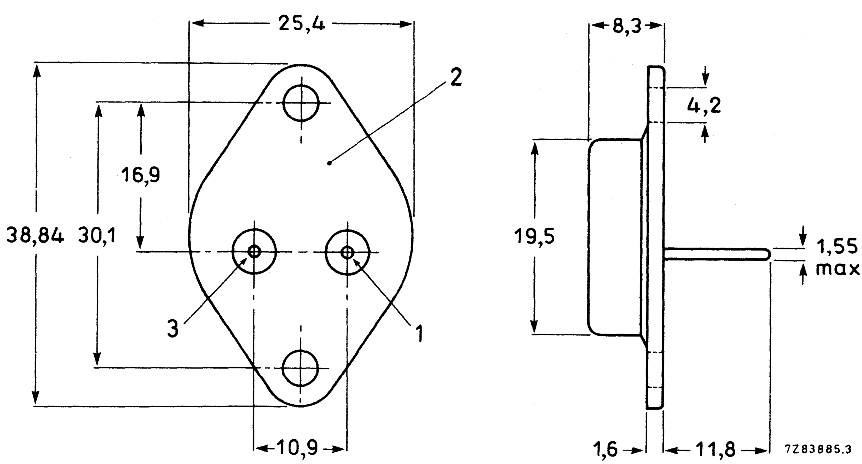
Dimensions in mm

Fig. 1 TO-3.



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.	1200	V
Collector-emitter voltage (open base)	V_{CEO}	max.	800	V
Collector current (DC)	I_C	max.	12	A
Collector current (peak value); $t_p < 2$ ms	I_{CM}	max.	20	A
Base current (DC)	I_B	max.	8	A
Base current (peak value); $t_p < 2$ ms	I_{BM}	max.	12	A
Total power dissipation up to $T_{mb} = 25\ ^oC$	P_{tot}	max.	160	W
Storage temperature range	T_{stg}		−65 to + 150	^oC
Junction temperature	T_j	max.	150	^oC

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	0,78	K/W

CHARACTERISTICS

$T_j = 25\ ^oC$ unless otherwise specified

Collector cut-off current*				
$V_{CE} = V_{CESMmax}$; $V_{BE} = 0$	I_{CES}	max.	1	mA
$V_{CE} = V_{CESMmax}$; $V_{BE} = 0$; $T_j = 125\ ^oC$	I_{CES}	max.	4	mA
Emitter cut-off current				
$I_C = 0$; $V_{EB} = 5$ V	I_{EBO}	max.	10	mA
Saturation voltages				
$I_C = 9$ A; $I_B = 4$ A	V_{CEsat}	max.	1	V
	V_{BEsat}	max.	1,5	V
$I_C = 12$ V; $I_B = 6$ A	V_{CEsat}	max.	3	V
Collector-emitter sustaining voltage				
$I_C = 200$ mA; $I_B = 0$; L = 25 mH	$V_{CEOsust}$	min.	800	V
Second breakdown collector current				
$V_{CE} = 100$ V; $t_p = 1$ s	$I_{(SB)C}$	min.	0,4	A
Transition frequency at f = 5 MHz				
$I_C = 0,1$ A; $V_{CE} = 5$ V	f_T	typ.	7	MHz
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; $V_{CB} = 10$ V	C_C	typ.	200	pF

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

Switching times resistive load (Figs 2 and 3)

$I_{Con} = 9$ A; $I_{Bon} = -I_{Boff} = 4$ A

Turn-on time	t_{on}	typ.	1,5	μs
Turn-off: Storage time	t_s	typ.	4,5	μs
Fall time	t_f	typ.	0,5	μs

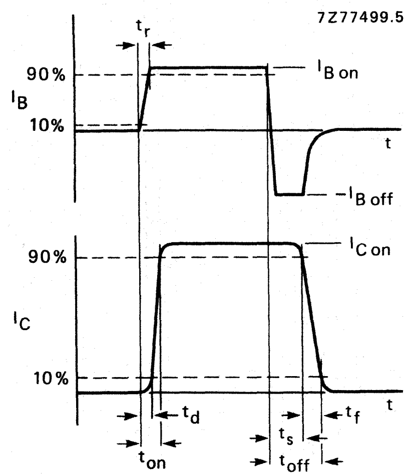


Fig. 2 Switching times waveforms with resistive load.

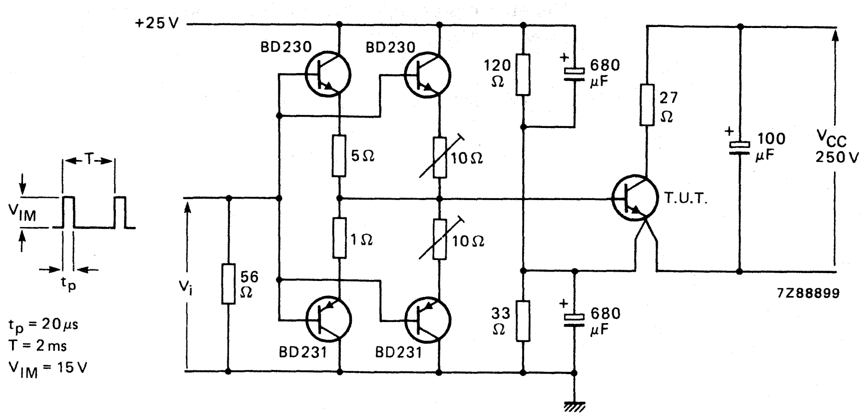
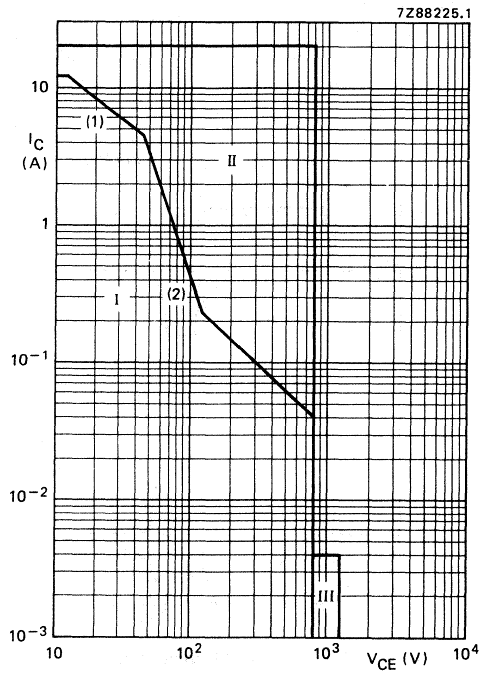


Fig. 3 Test circuit resistive load.



(1) $P_{tot\,max}$ line.
(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 permissible, provided $V_{BE} \leqslant 0$ and $t_p \leqslant 5$ ms.

Fig. 4 Safe operating area at $T_{mb} \leqslant 25\ ^oC$.

SILICON DIFFUSED POWER TRANSISTORS

High-voltage, high-speed, glass-passivated npn power transistors in a TO-3 envelope, intended for use in converters, inverters, switching regulators, motor control systems etc.

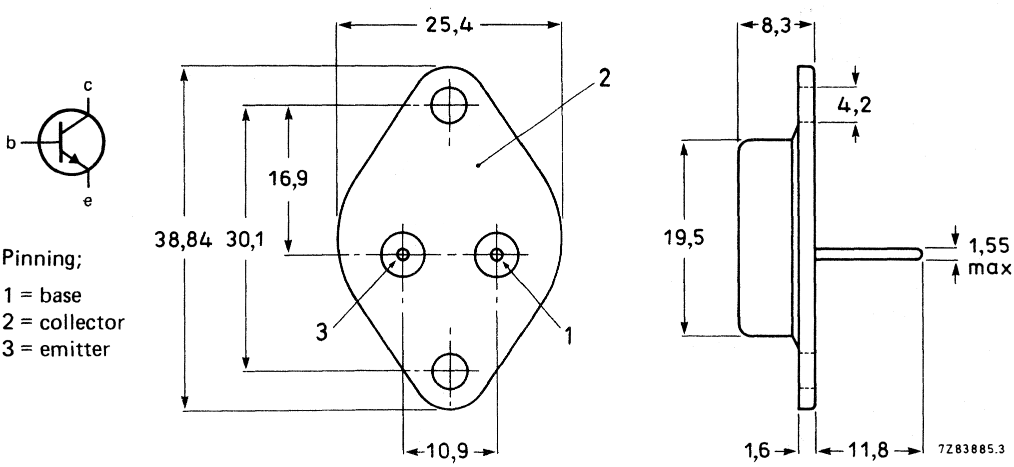
QUICK REFERENCE DATA

			BUX98	BUX98A	
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.	30		A
Collector current (peak value)	I_{CM}	max.	60		A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	250		W
Fall time (resistive load)	t_f	max.	0,8		μs

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-3.



Pinning;
1 = base
2 = collector
3 = emitter

Collector connected to case.

RATINGS

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

			BUX98	BUX98A	
Collector-emitter voltage (peak value; $V_B = 0$)	V_{CESM}	max.	850	1000	V
Collector-emitter voltage (open base)	V_{CEO}	max.	400	450	V
Collector current (DC)	I_C	max.	30		A
Collector current (peak value); $t_p < 5$ ms	I_{CM}	max.	60		A
Base current (DC)	I_B	max.	8		A
Base current (peak value); $t_p < 5$ ms	I_{BM}	max.	30		A
Total power dissipation up to $T_{mb} = 25\ ^oC$	P_{tot}	max.	250		W
Storage temperature range	T_{stg}		−65 to +200		^oC
Junction temperature	T_j	max.	200		^oC

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	0,7	K/W

CHARACTERISTICS

$T_j = 25\ ^oC$ unless otherwise specified

			BUX98	BUX98A	
Collector cut-off current*					
$V_{CE} = V_{CESMmax}$; $R_{BE} \leqslant 5\ \Omega$	I_{CER}	max.	1		mA
$V_{CE} = V_{CESMmax}$; $R_{BE} \leqslant 5\ \Omega$; $T_j = 125\ ^oC$	I_{CER}	max.	8		mA
Collector cut-off current					
$V_{CE} = V_{CESMmax}$; $V_{BE} = 2{,}5$ V	I_{CEX}	max.	0,4		mA
$V_{CE} = V_{CESMmax}$; $V_{BE} = 2{,}5$ V; $T_j = 125\ ^oC$	I_{CEX}	max.	4		mA
Emitter cut-off current					
$I_C = 0$; $V_{EB} = 5$ V	I_{EBO}	max.	2		mA
Saturation voltages					
$I_C = 20$ A; $I_B = 4$ A	V_{CEsat}	max.	1,5	−	V
	V_{BEsat}	max.	1,6	−	V
$I_C = 30$ A; $I_B = 8$ A	V_{CEsat}	max.	3,5	−	V
$I_C = 16$ A; $I_B = 3{,}2$ A	V_{CEsat}	max.	−	1,5	V
	V_{BEsat}	max.	−	1,6	V
$I_C = 24$ A; $I_B = 5$ A	V_{CEsat}	max.	−	5	V
Collector-emitter sustaining voltage					
$I_C = 200$ mA; $I_{Boff} = 0$; $L = 25$ mH	$V_{CEOsust}$	min.	400	450	V
Transition frequency at f = 1 MHz					
$I_C = 1$ A; $V_{CE} = 10$ V	f_T	typ.	5		MHz
Emitter-base breakdown voltage					
$I_C = 0$; $I_B = 0{,}1$ A	$V_{(BR)EBO}$		7 to 30		V
Collector capacitance at f = 1 MHz					
$V_{CE} = 10$ V	C_c	typ.	500		pF

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

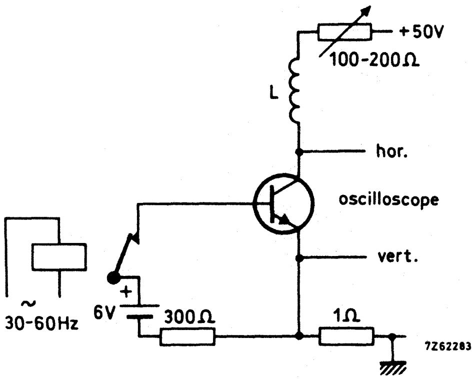


Fig. 2 Test circuit for $V_{CEOsust}$.

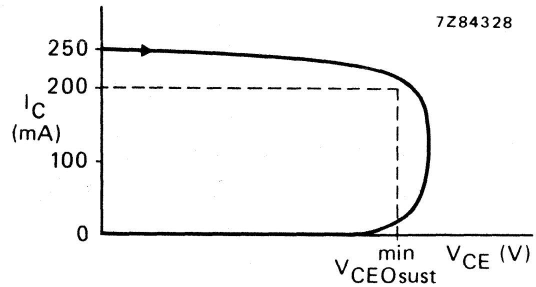
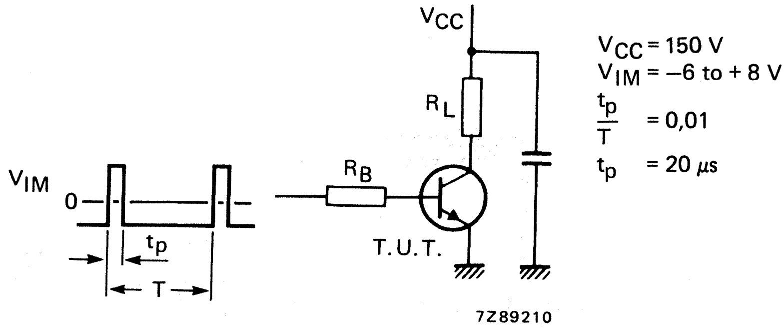


Fig. 3 Oscilloscope display for sustaining voltage.

			BUX98	BUX98A	
Switching times resistive load					
I_{Con} = 20 A; I_{Bon} = $-I_{Boff}$ = 4 A					
Turn-on time	t_{on}	typ.	0,55	–	μs
		max.	1	–	μs
Turn-off: Storage time	t_s	typ.	1,5	–	μs
		max.	3	–	μs
Fall time	t_f	typ.	0,3	–	μs
		max.	0,8	–	μs
I_{Con} = 16 A; I_{Bon} = $-I_{Boff}$ = 3,2 A					
Turn-on time	t_{on}	typ.	–	0,55	μs
		max.	–	1	μs
Turn-off: Storage time	t_s	typ.	–	1,5	μs
		max.	–	3	μs
Fall time	t_f	typ.	–	0,3	μs
		max.	–	0,8	μs
Switching times inductive load					
I_{Con} = 20 A; I_B = 4 A					
Turn-off: Storage time	t_s	typ.	3,5	–	μs
Fall time	t_f	typ.	80	–	ns
I_{Con} = 20 A; I_B = 4 A; T_j = 100 °C					
Storage time	t_s	max.	5	–	μs
Fall time	t_f	max.	400	–	ns
I_{Con} = 16 A; I_B = 3,2 A					
Turn-off: Storage time	t_s	typ.	–	3,5	μs
Fall time	t_f	typ.	–	80	ns
I_{Con} = 16 A; I_B = 3,2 A; T_j = 100 °C	t				
Turn-off: Storage time	t_s	max.	–	5	μs
Fall time	t_f	max.	–	400	ns



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.

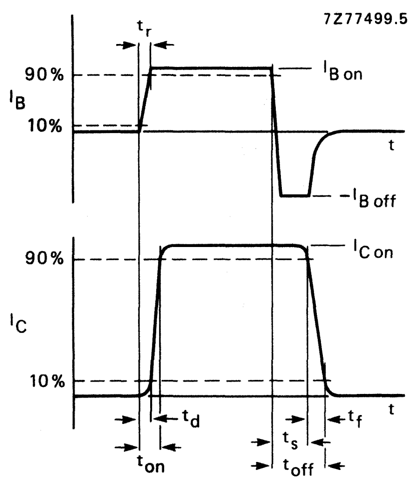


Fig. 5 Switching times waveforms with resistive load.

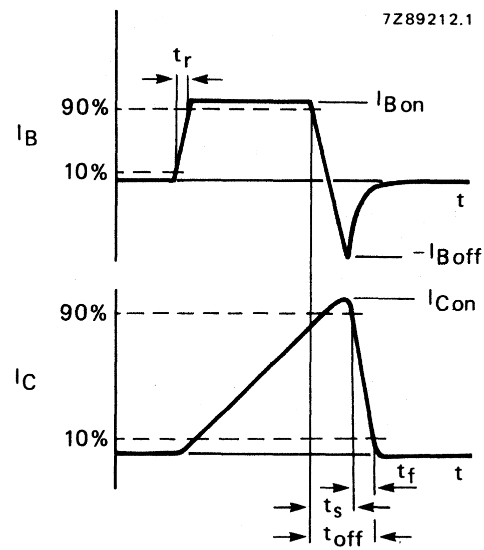


Fig. 6 Switching times waveforms with inductive load.

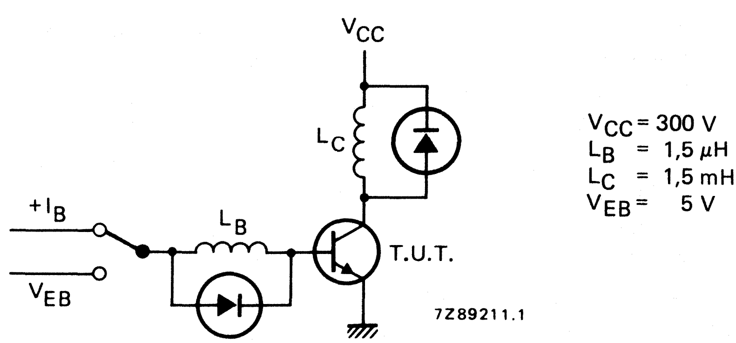
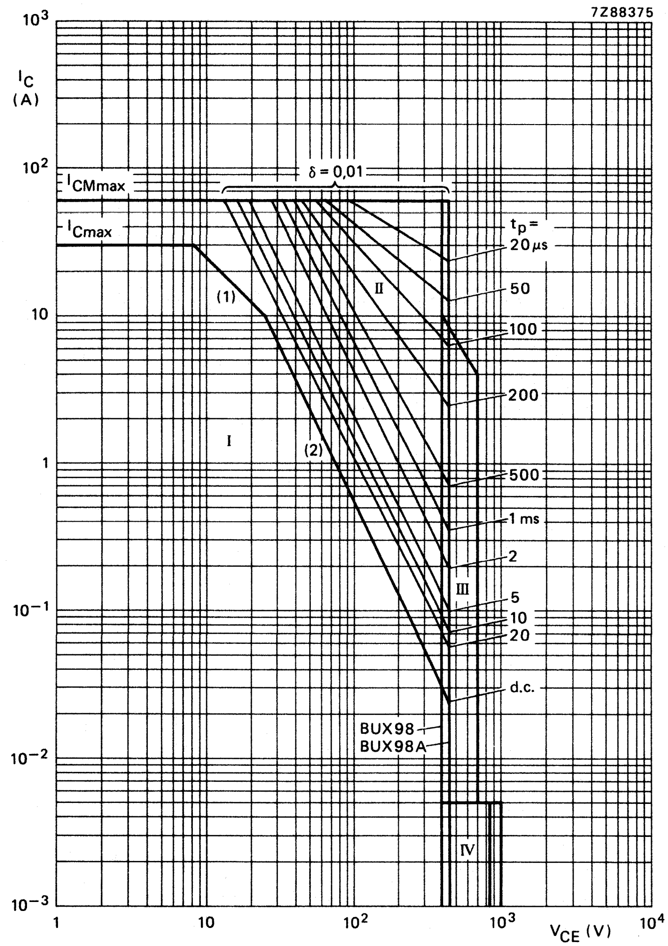


Fig. 7 Test circuit inductive load.



(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. 8 Safe operating area at $T_{mb} \leq 25\ ^oC$.

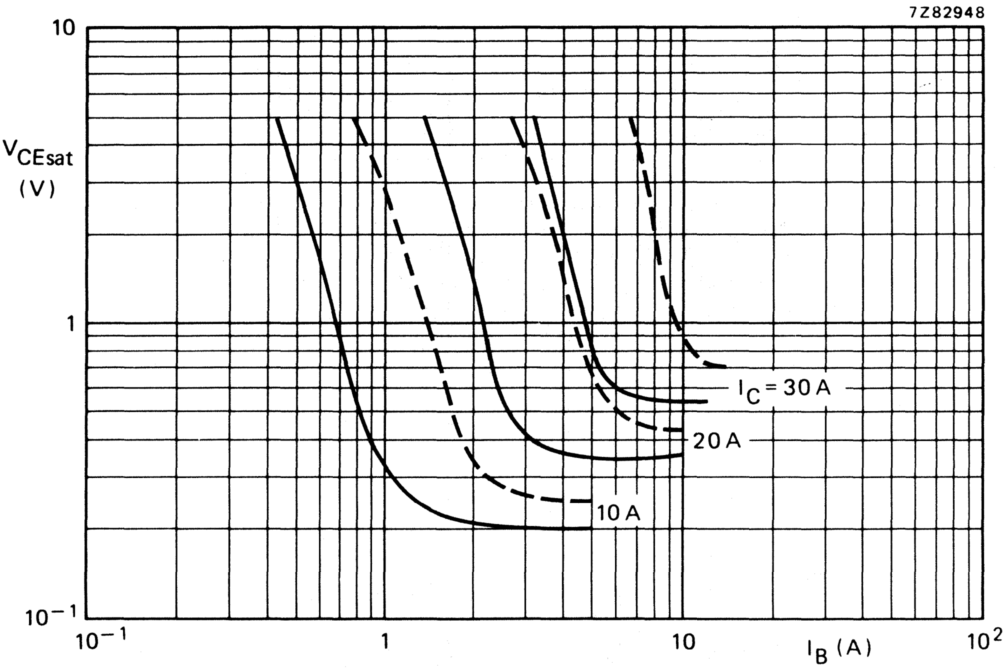


Fig. 9 Typical (——) and maximum (– – –) values saturation voltage. T_j = 25 °C.

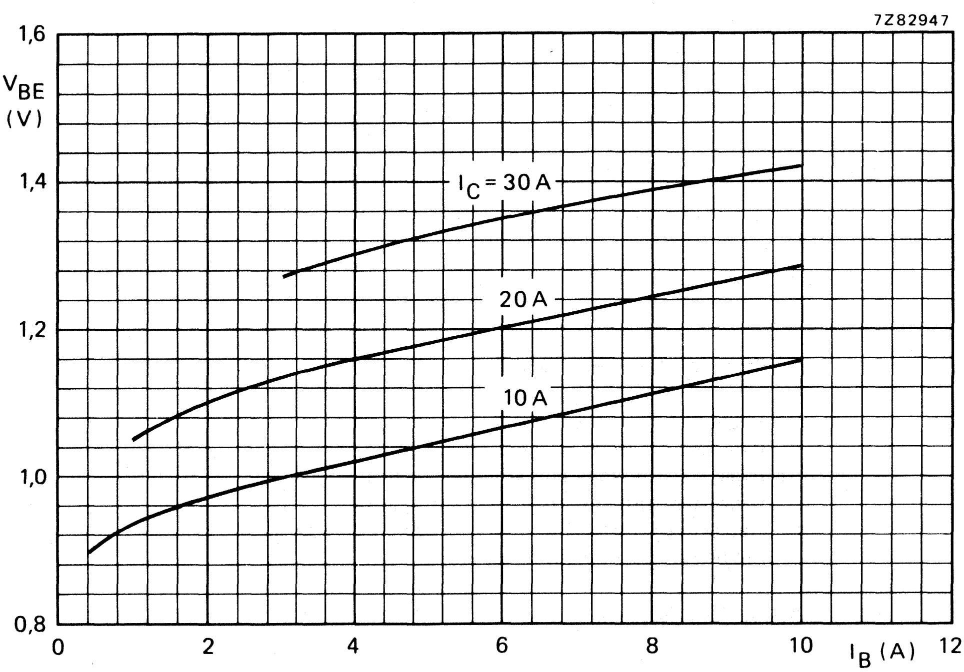


Fig. 10 Typical values at T_j = 25 °C.

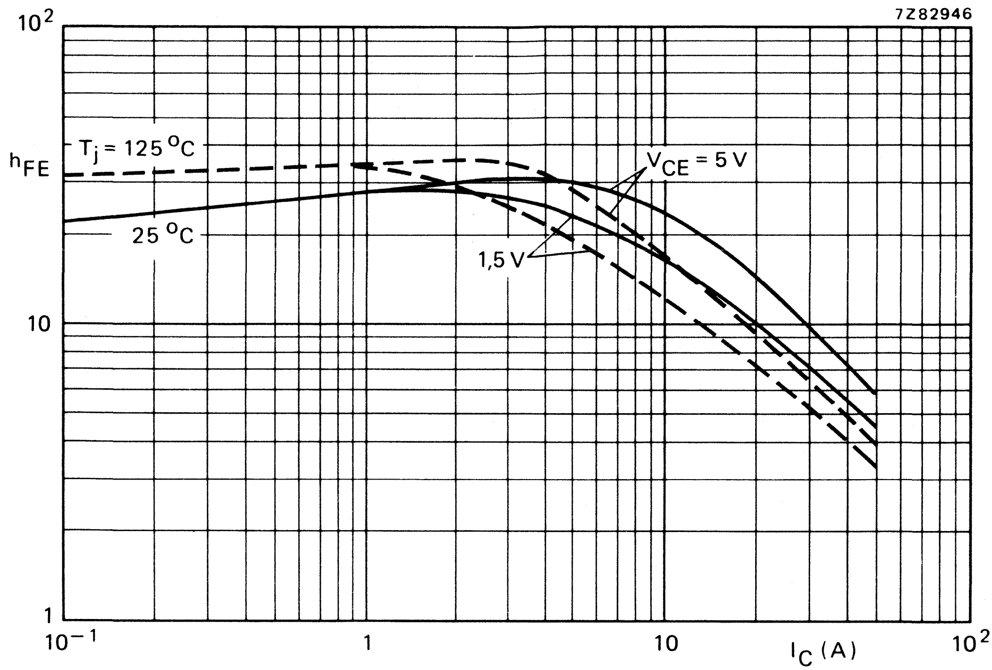


Fig. 11 Typical values DC current gain.

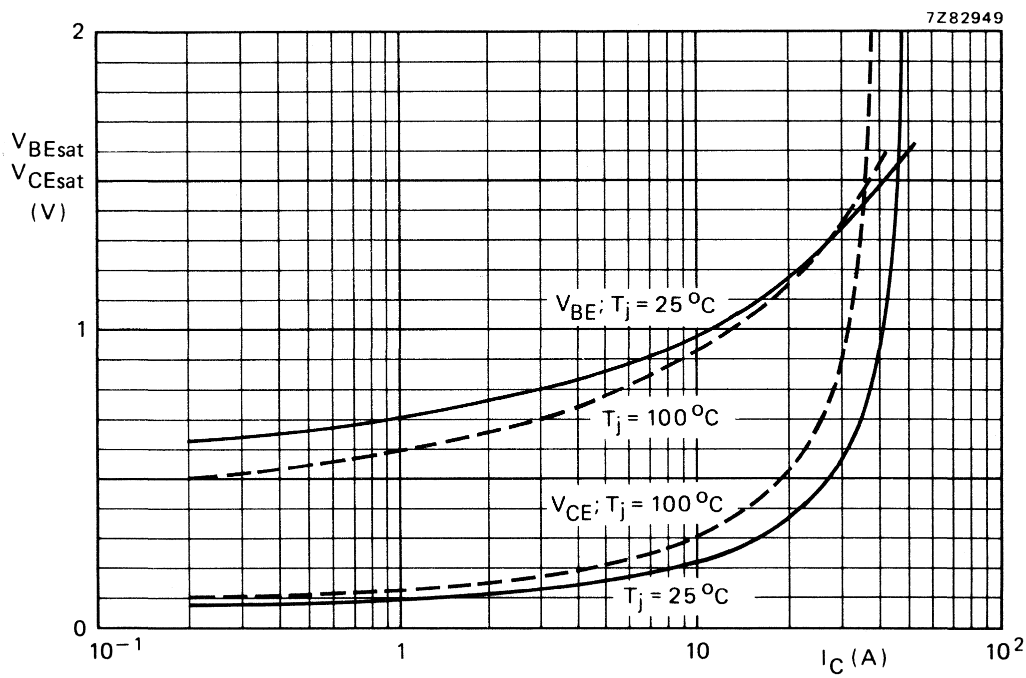


Fig. 12 Typical values base and collector voltage. $I_C/I_B = 5$.

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.

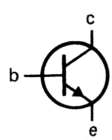
QUICK REFERENCE DATA

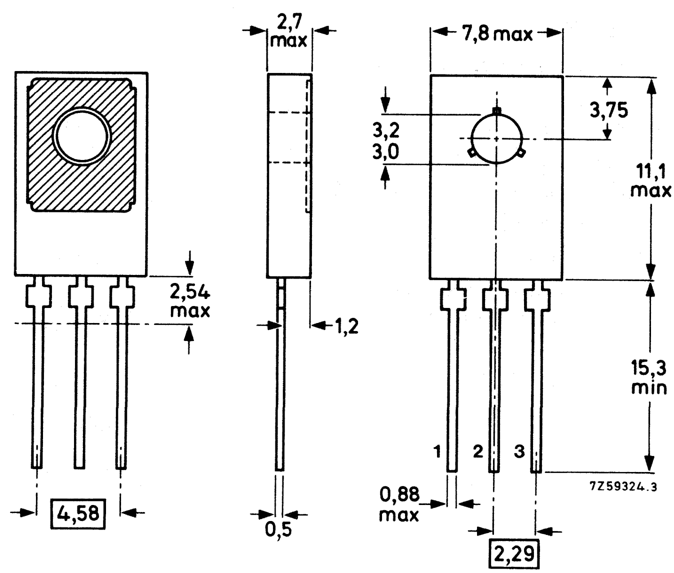
Collector-emitter voltage peak value; $V_{BE} = 0$	V_{CESM}	max.	730	V
Collector-emitter voltage, open base	V_{CEO}	max.	300	V
Collector-emitter saturation voltage	V_{CEsat}	max.	2	V
Collector current (DC)	I_C	max.	1,5	A
Total power dissipation up to $T_{mb} = 25\ ^oC$	P_{tot}	max.	28	W
Fall time	t_f	max.	0,8	μs

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-126.





Pinning;

1 = base
2 = collector
3 = emitter

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 $T_{mb} = 25\ ^oC$	P_{tot}	max.	28	W
Storage temperature range	T_{stg}		−65 to +150	^oC
Junction temperature	T_j	max.	150	^oC

THERMAL RESISTANCE

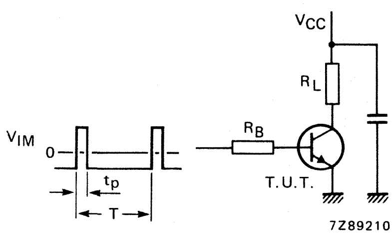
From junction to mounting base	$R_{th\ j\text{-}mb}$	=	4,5	K/W
From junction to ambient	$R_{th\ j\text{-}a}$	=	100	K/W

CHARACTERISTICS

$T_j = 25\ ^oC$ unless otherwise specified

Collector cut-off current $V_{CE} = 400$ V; $V_{BE} = 0$	I_{CES}	max.	5	μA
$V_{CE} = 730$ V; $V_{BE} = -1,5$ V	I_{CEX}	max.	50	μA
$V_{CE} = 730$ V; $V_{BE} = -1,5$ V; $T_j = 100\ ^oC$	I_{CEX}	max.	250	μA
Emitter cut-off current $I_C = 0$; $V_{EB} = 12$ V	I_{EBO}	max.	1	mA
Collector-emitter sustaining voltage $I_B = 0$; $I_C = 0,1$ A; L = 25 mH	$V_{CEOsust}$	min.	300	V
DC current gain $I_C = 10$ mA; $V_{CE} = 2$ V	h_{FE}	min.	10	
$I_C = 50$ mA; $V_{CE} = 5$ V	h_{FE}	min.	16	
		max.	42	

Transition frequency at f = 5 MHz I_C = 0,1 A; V_{CE} = 10 V	f_T	typ.	4 MHz
Saturation voltages I_C = 0,2 A; I_B = 20 mA	V_{CEsat} V_{BEsat}	max. max.	2 V 1 V
Collector capacitance at f = 1 MHz I_E = i_e = 0; V_{CB} = 10 V	C_c	typ.	12 pF
Switching times (resistive load) I_{Con} = 1 A; I_{Bon} = 20 mA; I_{Boff} = 40 mA	t_s t_f	max. max.	2 μs 0,8 μs



V_{CC} = 250 V
V_{IM} = −6 to +8 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.

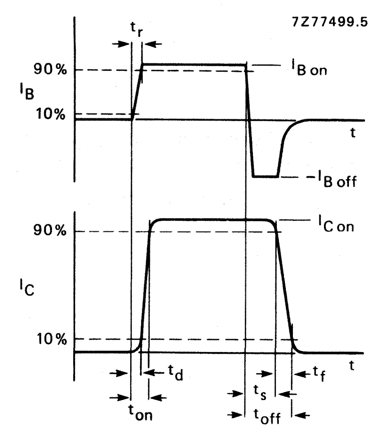
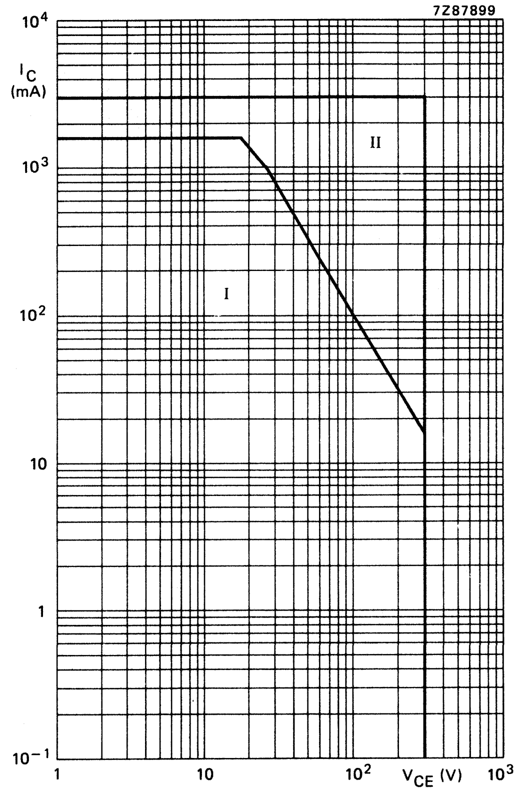


Fig. 3 Switching times waveforms with resistive load.



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

Fig. 4 Safe operating area.

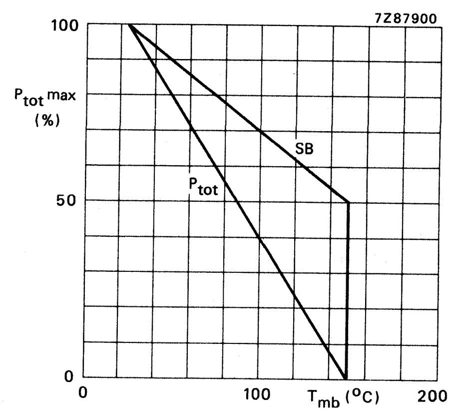


Fig. 5 Total power dissipation and second-breakdown current derating curve.

SILICON DIFFUSED POWER TRANSISTOR

High-voltage, high-speed switching npn transistor in a TO-3 envelope especially intended for use in AC motor control systems from three-phase mains.

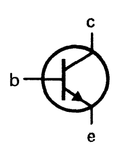
QUICK REFERENCE DATA

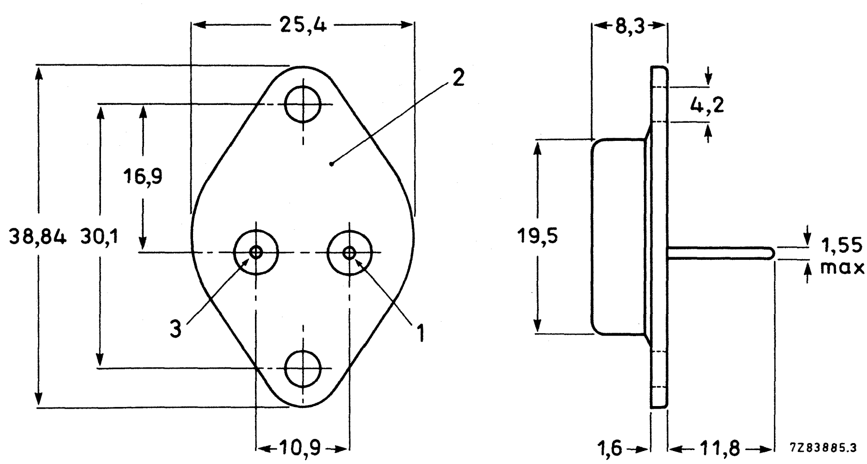
Collector-emitter voltage (peak value; $V_{BE} = 0$)	V_{CESM}	max.	1500	V
Collector-emitter voltage (open base)	V_{CEO}	max.	800	V
Collector-emitter saturation voltage	V_{CEsat}	max.	1	V
Collector current (DC)	I_C	max.	6	A
Total power dissipation up to $T_{mb} = 60\ ^oC$	P_{tot}	max.	80	W

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-3.





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 (V_{BE} = 0, peak value)	V_{CESM}	max.	1500	V
Collector-emitter voltage (open base)	V_{CEO}	max.	800	V
Collector current (DC)	I_C	max.	6	A
Collector current (peak value)	I_{CM}	max.	10	A
Collector current (non-repetitive peak)	I_{CSM}	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.	4	A
Total power dissipation up to T_{mb} = 60 °C	P_{tot}	max.	80	W
Storage temperature range	T_{stg}		−65 to + 150	°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	1,12	K/W

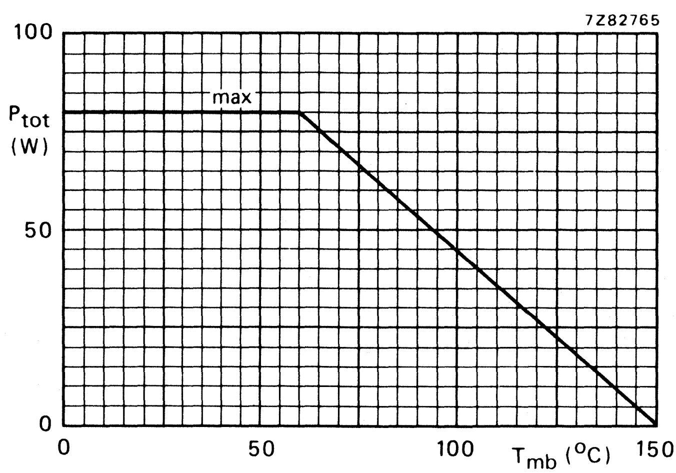


Fig. 2 Power derating curve.

* Turn-off current.

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current $V_{BE} = 0$; $V_{CE} = V_{CESMmax}$; T_j = 125 °C	I_{CES}	max.	1,0 mA
DC current gain I_C = 4,5 A; V_{CE} = 5 V	h_{FE}	min.	2,5
Emitter cut-off current $I_C = 0$; V_{EB} = 5 V	I_{EBO}	max.	10 mA
Saturation voltage I_C = 4,5 A; I_B = 2 A	V_{CEsat}	max.	1 V
I_C = 4,5 A; I_B = 2 A	V_{BEsat}	max.	1,5 V
Collector-emitter sustaining voltage $I_B = 0$; I_C = 100 mA; L = 25 mH	$V_{CEOsust}$	min.	800 V

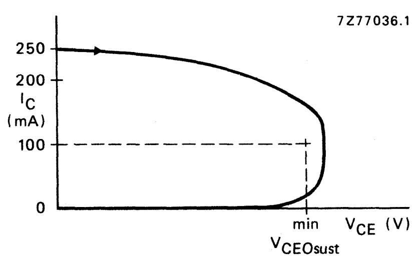


Fig. 3 Oscilloscope display for $V_{CEOsust}$.

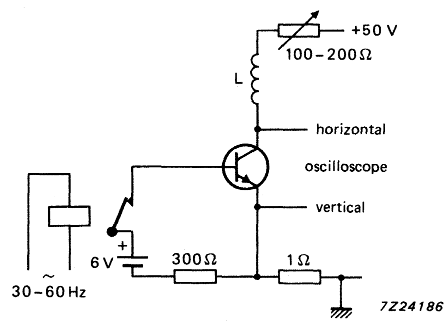


Fig. 4 Test circuit for $V_{CEOsust}$.

Second-breakdown collector current V_{CE} = 100 V; t_p = 1 s	$I_{(SB)}$	min.	0,3 A
Transition frequency at f = 5 MHz I_C = 0,1 A; V_{CE} = 5 V	f_T	typ.	7 MHz
Collector capacitance at f = 1 MHz $I_E = I_e = 0$; V_{CB} = 10 V	C_c	typ.	125 pF

CHARACTERISTICS (continued)

Switching times (between 10% and 90% levels)
in resistive switching circuit
I_{Con} = 4,5 A; V_{CC} = 250 V; R_L = 56 Ω
I_{Bon} = $-I_{Boff}$ = 2 A

Turn-on time	t_{on}	typ.	1,5	μs
Storage time ($t_s = t_{off} - t_f$)	t_s	typ.	4,5	μs
Fall time	t_f	typ.	0,5	μs

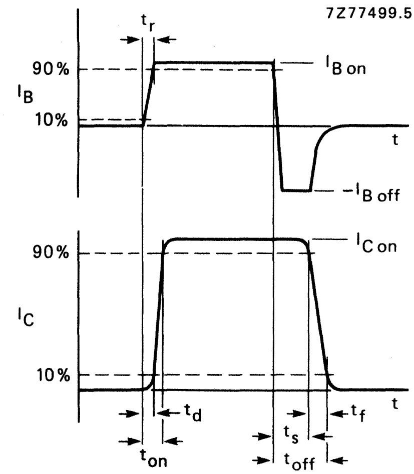


Fig. 5 Waveforms.

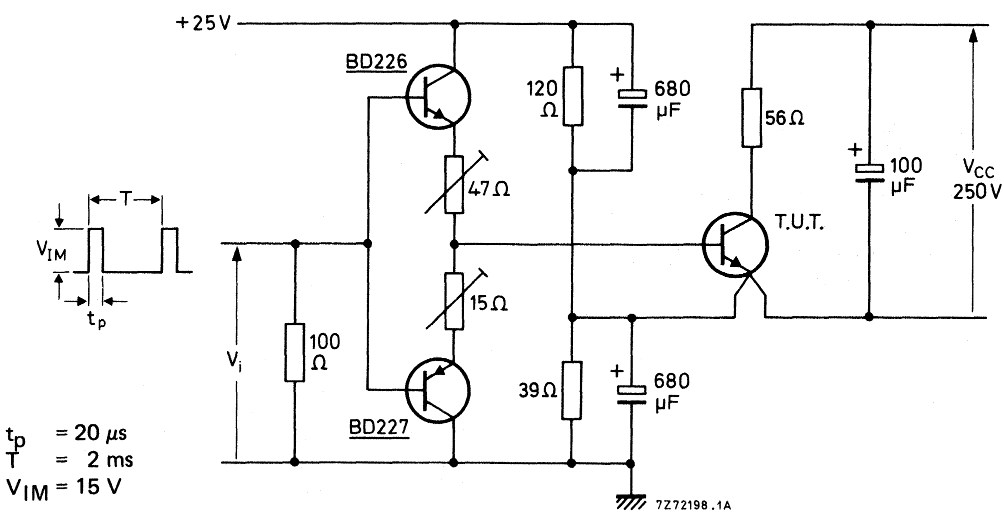
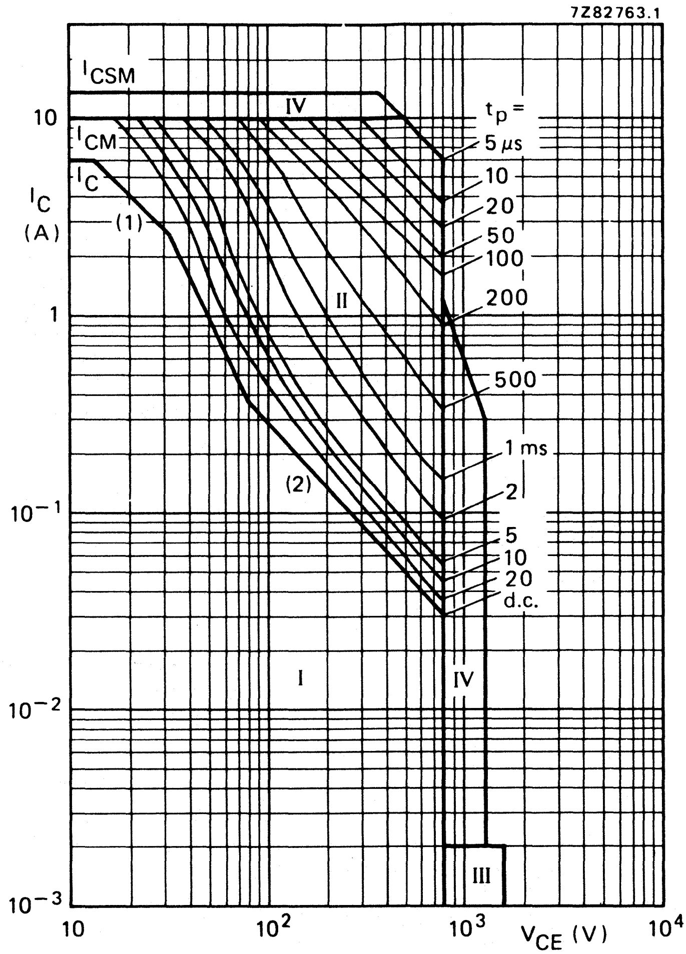


Fig. 6 Test circuit.



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 permissible, provided $V_{BE} \leqslant 0$ V; $t_p \leqslant 20\ \mu s$; $\delta \leqslant 0{,}25$.
IV Transient I_C/V_{CE} limit for V_{CE} less than 800 V provided $t_p < 5\ \mu s$.

Fig. 7 Safe operation area with the transistor forward biased. $T_{mb} \leqslant 60\ ^oC$; $\delta = 0.01$.

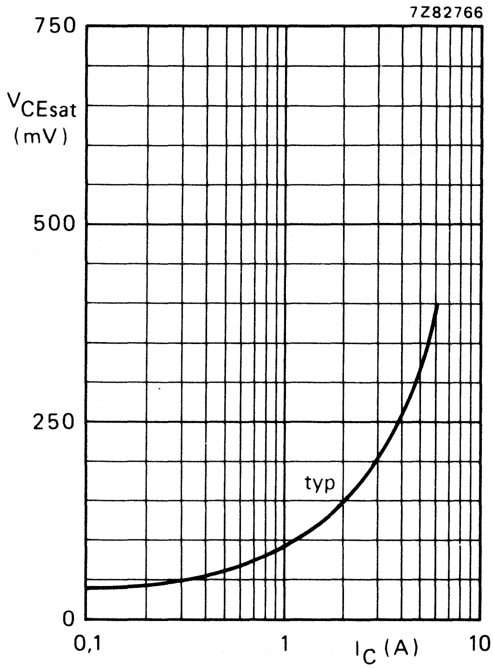


Fig. 8 Collector-emitter saturation voltage at I_C/I_B = 2; T_j = 25 °C.

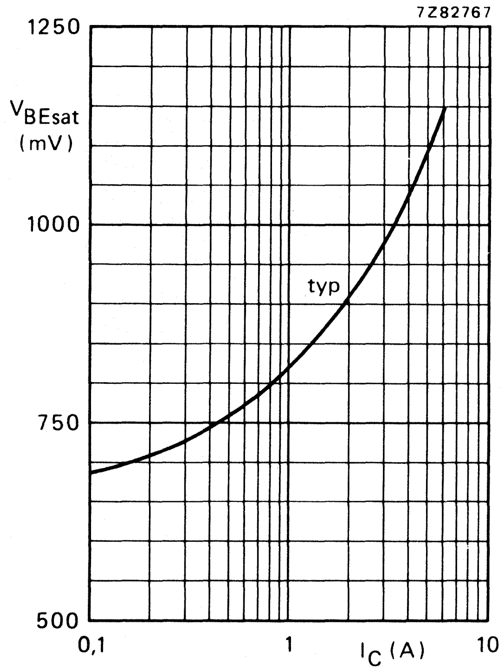


Fig. 9 Base-emitter saturation voltage at I_C/I_B = 2; T_j = 25 °C.

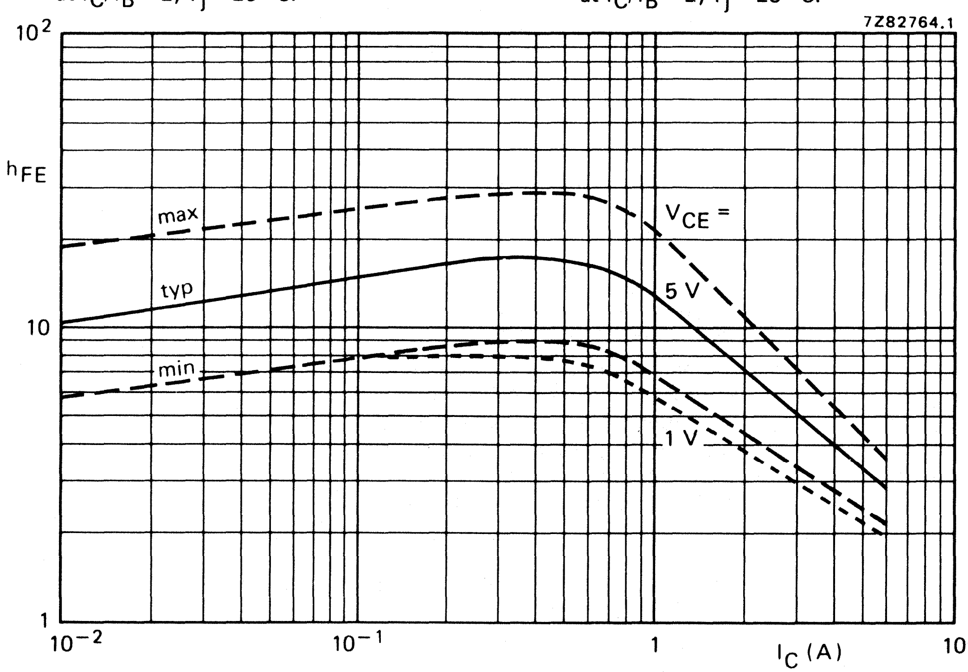


Fig. 10 DC current gain at V_{CE} = 5 V; T_j = 25 °C; . . . . at V_{CE} = 1 V.

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).

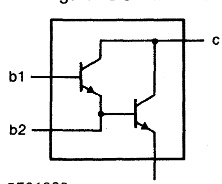
QUICK REFERENCE DATA

			ESM3045A(V)	3045D(V)	
Collector-emitter voltage					
peak value; $V_{BE} = 0$	V_{CESM}	max.	1000	600	V
open base	V_{CEO}	max.	450	450	V
Collector-emitter saturation voltage	V_{CEsat}	max.	2.0		V
Collector current					
saturation	I_{Csat}	max.	15		A
DC	I_C	max.	24		A
peak value	I_{CM}	max.	36		A
Total power dissipation					
up to $T_{mb} = 25\ ^oC$	P_{tot}	max.	125		W
Fall time inductive load	t_f	max.	0.5	0.4	μs

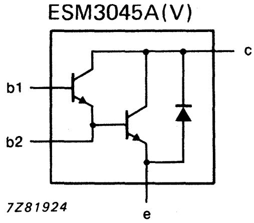
MECHANICAL DATA

Dimensions in mm

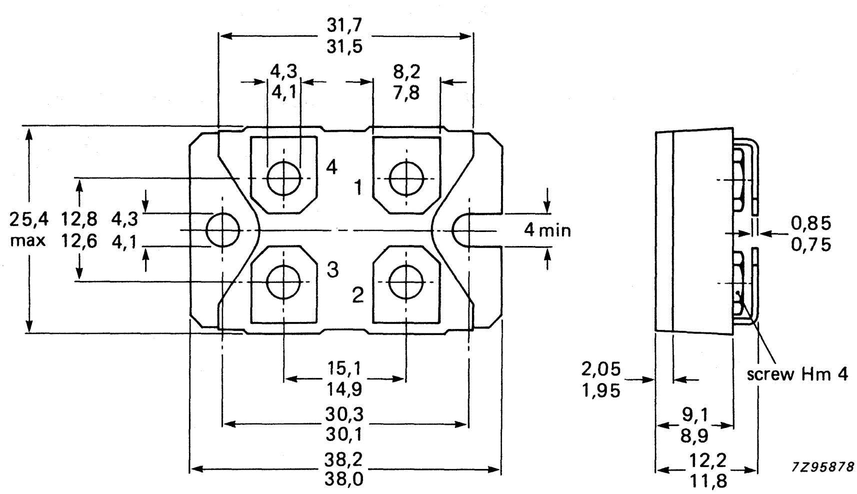
Fig. 1 SOT227B.



ESM3045A(V)

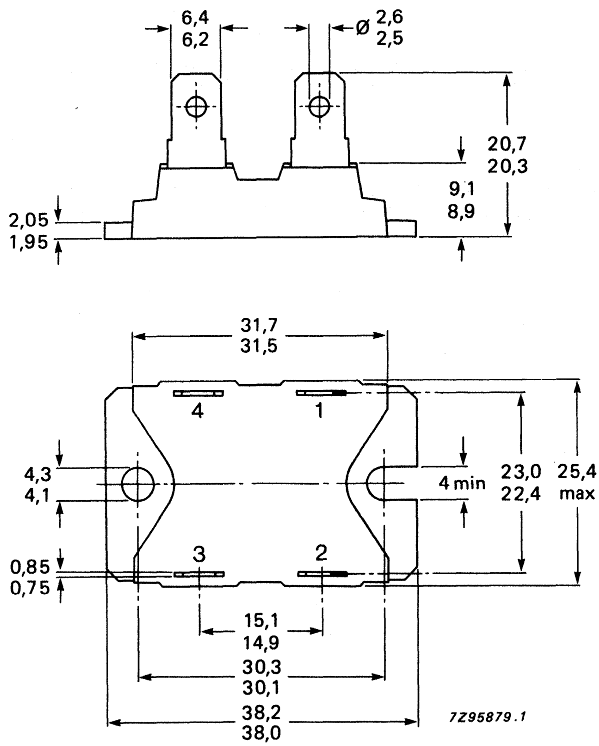


ESM3045D (V)



Pinning

1 = emitter
2 = base 1
3 = collector
4 = base 2



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)

			ESM3045A(V)	3045D(V)	
Collector-emitter voltage					
peak value; $V_{BE} = 0$	V_{CESM}	max.	1000	600	V
open base	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 $T_{mb} = 25\ ^oC$	P_{tot}	max.	125		W
Junction temperature	T_j	max.	150		^oC
Storage temperature range	T_{stg}		−40 to + 150		^oC

DEVELOPMENT DATA

THERMAL RESISTANCE

			ESM3045A(V)	3045D(V)	
From junction to mounting base transistor	$R_{th\ j\text{-}mb}$	=	1.0		K/W
From junction to mounting base diode	$R_{th\ j\text{-}mb}$	=	–	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 °C unless otherwise specified

			ESM3045A(V)	3045D(V)	
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 °C	I_{CES}	max.	1.5	4.0	mA
Emitter cut-off current V_{EB} = 5 V; $I_C = 0$	I_{EBO}	max.	1.0		mA
Saturation voltages $I_C = I_{Csat}$; $I_B = I_{Csat}/50$; T_j = 125 °C	V_{CEsat}	max.	2.0		V
	V_{BEsat}	max.	2.5		V
Collector-emitter sustaining voltage I_C = 200 mA; $I_B = 0$; L = 25 mH	$V_{CEOsust}$	min.	450		V
Diode forward voltage drop I_F = 20 A; T_j = 100 °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 V; T_j = 100 °C; R_{BB} = 0.6 Ω; V_{CL} = 450 V with anti-saturation network and spead-up diode	t_s	max.	4.0	4.0	μs
	t_s	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).

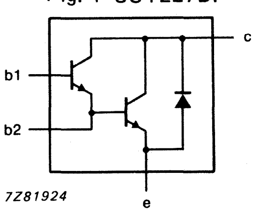
QUICK REFERENCE DATA

			ESM4045A(V)	4045D(V)	
Collector-emitter voltage					
peak value; $V_{BE} = 0$	V_{CESM}	max.	1000	600	V
open base	V_{CEO}	max.	450	450	V
Collector-emitter saturation voltage	V_{CEsat}	max.	2.0		V
Collector current					
saturation	I_{Csat}	max.	25		A
DC	I_C	max.	42		A
peak value	I_{CM}	max.	63		A
Total power dissipation					
up to $T_{mb} = 25\ ^{o}C$	P_{tot}	max.	150		W
Fall time inductive load	t_f	max.	0.5		μs

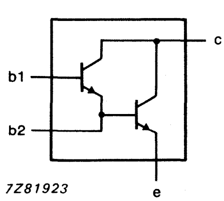
MECHANICAL DATA

Dimensions in mm

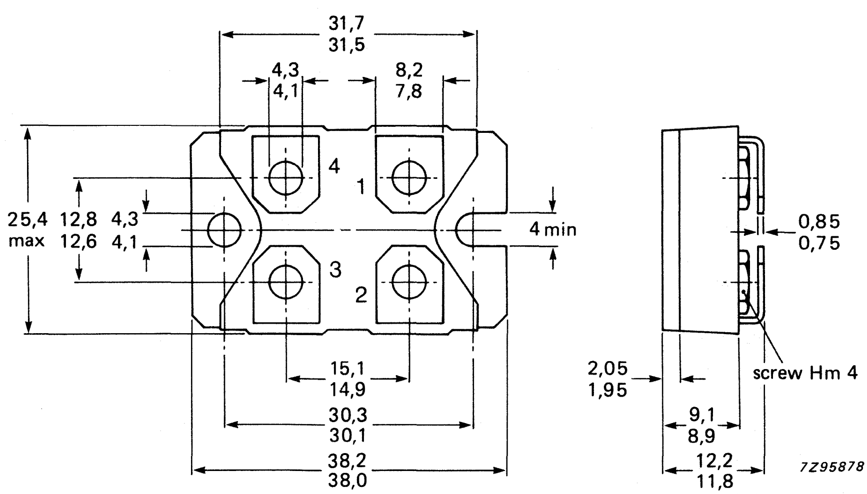
Fig. 1 SOT227B.



ESM4045D(V)

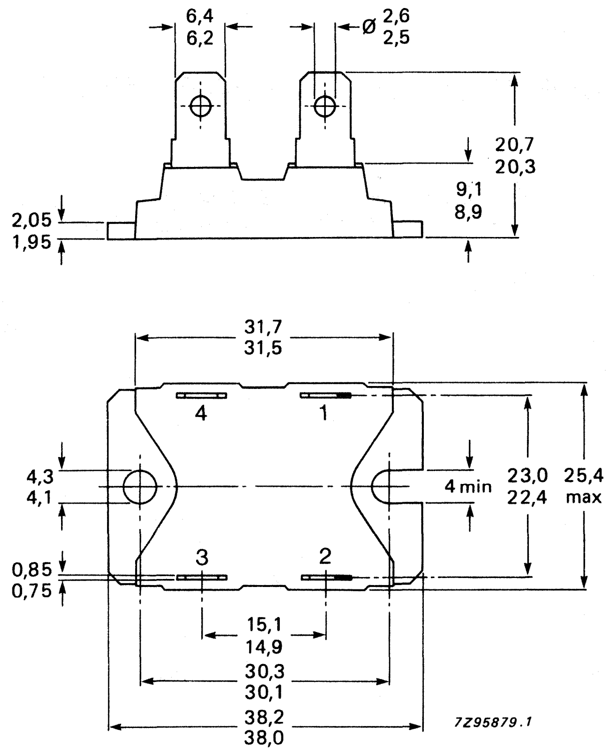


ESM4045A(V)



Pinning

1 = emitter
2 = base 1
3 = collector
4 = base 2



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; $V_{BE} = 0$	V_{CESM}	max.	1000	600	V
open base	V_{CEO}	max.	450		V
Collector current					
saturation	I_{Csat}	max.	25		A
DC	I_C	max.	42		A
peak value	I_{CM}	max.	63		A
Base current					
DC	I_B	max.	4.0		A
peak value	I_{BM}	max.	8.0		A
Total power dissipation					
up to $T_{mb} = 25\ ^oC$	P_{tot}	max.	150		W
Junction temperature	T_j	max.	150		^oC
Storage temperature range	T_{stg}		−40 to + 150		^oC

DEVELOPMENT DATA

THERMAL RESISTANCE

			ESM4045A(V)	4045D(V)	
From junction to mounting base transistor	$R_{th\ j\text{-}mb}$	=	0.83		K/W
From junction to mounting base diode	$R_{th\ j\text{-}mb}$	=	–	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 °C unless otherwise specified

			ESM4045A(V)	4045D(V)	
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 °C	I_{CES}	max.	2.0	7.0	mA
Emitter cut-off current V_{EB} = 5 V; $I_C = 0$	I_{EBO}	max.	1.0		mA
Saturation voltages $I_C = I_{Csat}$; $I_B = I_{Csat}/50$; T_j = 125 °C	V_{CEsat}	max.	2.0		V
	V_{BEsat}	max.	2.5		V
Collector-emitter sustaining voltage I_C = 200 mA; $I_B = 0$; L = 25 mH	$V_{CEOsust}$	min.	450		V
Diode forward voltage drop I_F = 35 A; T_j = 100 °C	V_F	max.	–	1.85	V
Switching times, inductive load $I_C = I_{Csat}$; $I_{B\ on} = I_{Csat}/50$; $V_{BE\ off}$ = −5 V; R_{BB} = 0.6 Ω; T_j = 100 °C; V_{CL} = 450 V with anti-saturation network and speed-up diode	t_s	max.	4.5	4.5	μs
	t_s	max.	0.6	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).

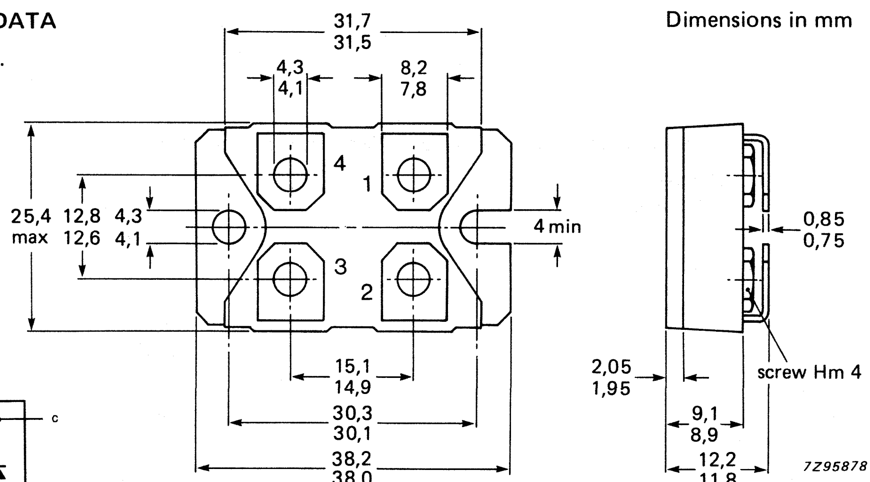
QUICK REFERENCE DATA

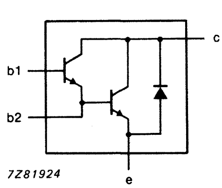
Collector-emitter voltage				
peak value; $V_{BE} = 0$	V_{CESM}	max.	600	V
open base	V_{CEO}	max.	450	V
Collector-emitter saturation voltage	V_{CEsat}	max.	2.0	V
Collector current				
saturation	I_{Csat}	max.	35	A
DC	I_C	max.	60	A
peak value	I_{CM}	max.	90	A
Total power dissipation				
up to $T_{mb} = 25\ ^{o}C$	P_{tot}	max.	175	W
Fall time inductive load	t_f	max.	0.5	μs

MECHANICAL DATA

Dimensions in mm

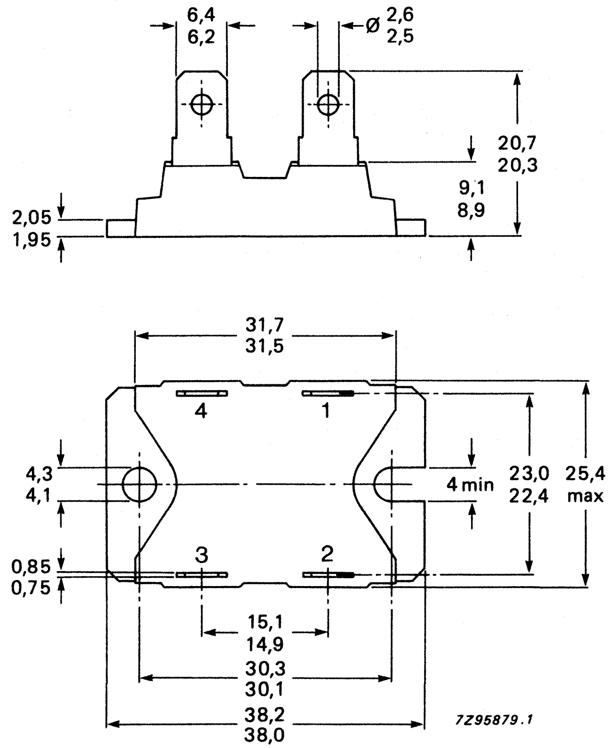
Fig. 1 SOT227B.





Pinning

1 = emitter
2 = base 1
3 = collector
4 = base 2



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 $T_{mb} = 25\ ^oC$	P_{tot}	max.	175	W
Junction temperature	T_j	max.	150	^oC
Storage temperature range	T_{stg}		−40 to +150	^oC

THERMAL RESISTANCE

From junction to mounting base transistor	$R_{th\ j\text{-}mb}$	=	0.71	K/W
From junction to mounting base diode	$R_{th\ j\text{-}mb}$	=	1.2	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 °C unless other 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 °C	I_{CES}	max.	13 mA
Emitter cut-off current			
V_{EB} = 5 V; $I_C = 0$	I_{EBO}	max.	1.0 mA
Saturation voltages			
$I_C = I_{Csat}$; $I_B = I_{Csat}/50$; T_j = 125 °C	V_{CEsat}	max.	2.0 V
	V_{BEsat}	max.	2.5 V
Collector-emitter sustaining voltage			
I_C = 200 mA; $I_B = 0$; L = 25 mH	$V_{CEOsust}$	min.	450 V
Diode forward voltage drop			
I_F = 50 A	V_F	max.	1.8 V
Switching times, inductive load			
$I_C = I_{Csat}$; $I_{B\,on} = I_{Csat}/50$; $V_{BE\,off}$ = −5 V; T_j = 100 °C; R_{BB} = 0.6 Ω; V_{CL} = 450 V with anti-saturation network and speed-up diode	t_s	max.	5.0 μs
	t_s	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).

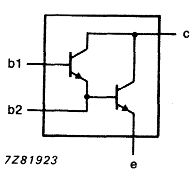
QUICK REFERENCE DATA

			ESM6045A(V)	6045D(V)	
Collector-emitter voltage					
peak value; $V_{BE} = 0$	V_{CESM}	max.	1000	600	V
open base	V_{CEO}	max.	450	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 $T_{mb} = 25\ ^oC$	P_{tot}	max	250		W
Fall time inductive load	t_f	max.	0.5		μs

MECHANICAL DATA

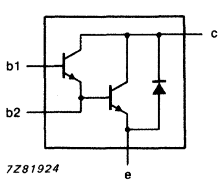
Dimensions in mm

Fig. 1 SOT227B.



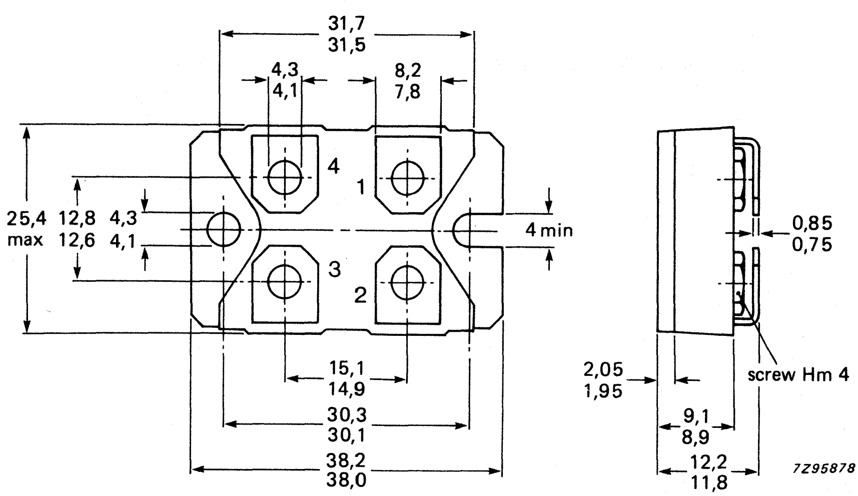
7Z81923

ESM6045A(V)



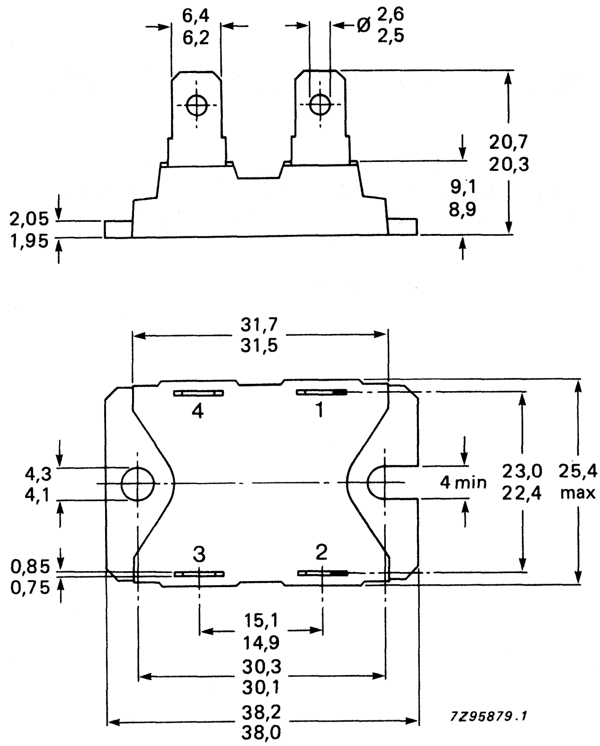
7Z81924

ESM6045D(V)



Pinning

1 = emitter
2 = base 1
3 = collector
4 = base 2



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)

			ESM6045A(V)	6045D(V)	
Collector-emitter voltage					
peak value; $V_{BE} = 0$	V_{CESM}	max.	1000	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 $T_{mb} = 25\ ^oC$	P_{tot}	max.	250		W
Junction temperature	T_j	max.	150		^oC
Storage temperature range	T_{stg}		−40 to +50		^oC

THERMAL RESISTANCE

			ESM6045A(V)	6045D(V)	
From junction to mounting base transistor	$R_{th\,j\text{-}mb}$	=	0.5		K/W
From junction to mounting base diode	$R_{th\,j\text{-}mb}$	=	–	1.2	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 °C unless otherwise specified

			ESM6045A(V)	6045D(V)	
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 °C	I_{CES}	max.	5.0	15	mA
Emitter cut-off current					
V_{EB} = 5 V; $I_C = 0$	I_{EBO}	max.	1.0		mA
Saturation voltages					
$I_C = I_{Csat}$; $I_B = I_{Csat}/50$; T_j = 125 °C	V_{CEsat}	max.	2.0		V
	V_{BEsat}	max.	2.5		V
Collector-emitter sustaining voltage					
I_C = 200 mA; $I_B = 0$; L = 25 mH	$V_{CEOsust}$	min.	450		V
Diode forward voltage drop					
I_F = 70 A; T_j = 100 °C	V_F	max.	–	1.9	V
Switching times, inductive load					
$I_C = I_{Csat}$; $I_{Bon} = I_{Csat}/50$; $V_{BE\,off}$ = −5V; T_j = 100 °C; R_{BB} = 0.6 Ω; V_{CL} = 450 V with anti-saturation network and speed-up diode	t_s	max.	5.5		μs
	t_s	max.	0.5		μs

DEVELOPMENT DATA

SILICON DIFFUSED POWER TRANSISTORS

High-voltage, high-speed glass passivated npn power transistor in a TO-220 envelope, intended for use in switching regulators, inverters, motor controls, solenoid/relay drivers and deflection circuits.

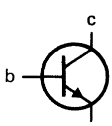
QUICK REFERENCE DATA

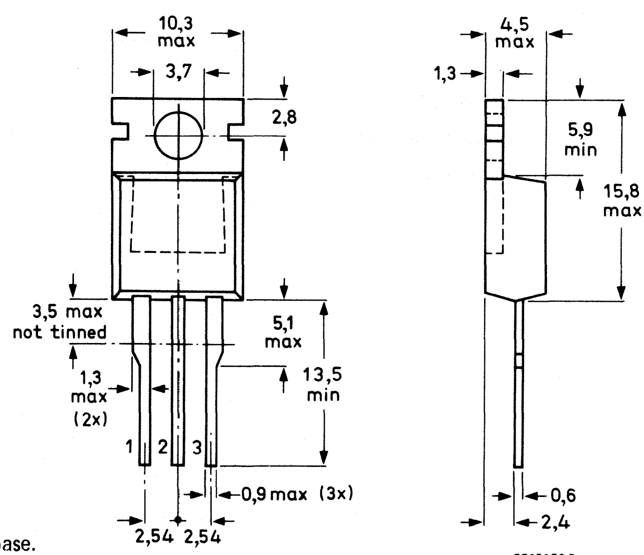
			MJE13004	13005	
Collector-emitter voltage					
peak value; $V_{BE} = 0$ V	V_{CESM}	max.	600	700	V
open base	V_{CEO}	max.	300	400	V
Collector-emitter saturation voltage	V_{CEsat}	max.	0.6		V
Collector current					
saturation	I_{Csat}	max.	2.0		A
DC	I_C	max.	4.0		A
peak value	I_{CM}	max.	8.0		A
Total power dissipation					
up to $T_{mb} = 25$ °C	P_{tot}	max.	75		W

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)

			MJE13004	13005	
Collector-emitter voltage					
peak value; $V_{BE} = 0$ V	V_{CESM}	max.	600	700	V
open base	V_{CEO}	max.	300	400	V
Emitter-base current	V_{EBO}	max.	9.0		V
Collector current					
saturation	I_{Csat}	max.	2.0		A
DC	I_C	max.	4.0		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.	6.0		A
peak value	I_{EM}	max.	12		A
Total power dissipation					
up to $T_{amb} = 25\ ^oC$	P_{tot}	max.	2		W
derate above 25 ^{o}C			16		mW/K
Total power dissipation					
up to $T_{mb} = 25\ ^oC$	P_{tot}	max.	75		W
derate above 25 ^{o}C			600		mW/K
Operating junction temperature range	T_j		–65 to + 150		^{o}C
Storage temperature range	T_{stg}		–65 to + 150		^{o}C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	1.67	K/W
From junction to ambient	$R_{th\ j\text{-}a}$	=	62.5	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			MJE13004	13005	
Collector-emitter sustaining voltage					
I_C = 10 mA; I_B = 0	$V_{CEOsust}$	min.	300	400	V
Collector cut-off current					
$V_{CE} = V_{CESMmax}$; V_{BE} = −1.5 V	I_{CEX}	max.	1.0		mA
$V_{CE} = V_{CESMmax}$; V_{BE} = −1.5 V; T_c = 100 °C	I_{CEX}	max.	5.0		mA
Emitter cut-off current					
V_{EB} = 9 V; I_C = 0	I_{EBO}	max.	1.0		mA
DC current gain					
I_C = 1 A; V_{CE} = 5 V	h_{FE}		10 to 60		
I_C = 2 A; V_{CE} = 5 V	h_{FE}		8 to 40		
Collector-emitter saturation voltage					
I_C = 1 A; I_B = 0.2 A	V_{CEsat}	max.	0.5		V
I_C = 2 A; I_B = 0.5 A	V_{CEsat}	max.	0.6		V
I_C = 4 A; I_B = 1.0 A	V_{CEsat}	max.	1.0		V
I_C = 2 A; I_B = 0.5 A; T_{mb} = 100 °C	V_{CEsat}	max.	1.0		V
Base-emitter saturation voltage					
I_C = 1 A; I_B = 0.2 A	V_{BEsat}	max.	1.2		V
I_C = 2 A; I_B = 0.5 A	V_{BEsat}	max.	1.6		V
I_C = 2 A; I_B = 0.5 A; T_{mb} = 100 °C	V_{BEsat}	max.	1.5		V
Transition frequency					
I_C = 0.5 A; V_{CE} = 10 V; f = 1 MHz	f_T	typ.	4.0		MHz
Collector capacitance					
V_{CB} = 10 V; I_E = 0	C_c	typ.	50		pF
Switching times, resistive load (Figs 2 and 3)					
V_{CC} = 125 V; I_C = 2 A; t_p = 25 μs; $I_{Bon} = I_{Boff}$ = 0.4 A	t_{on}	max.	0.8		μs
	t_s	max.	4.0		μs
	t_f	max.	0.9		μs
Switching times, inductive load (Figs 4 and 5)					
I_C = 2 A; V_{CL} = 300 V; T_{mb} = 100 °C; I_{Bon} = 0.4 A; V_{BEoff} = 5 V	t_s	typ.	0.9		μs
	t_s	max.	4.0		μs
	t_f	typ.	0.32		μs
	t_f	max.	0.9		μs

DEVELOPMENT DATA

V_{CC} = 125 V V_{IM} = 6 to 8 V

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

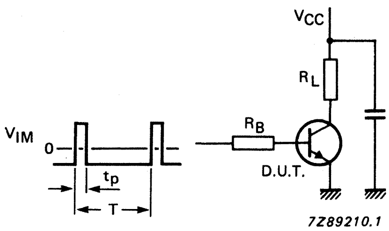


Fig. 2 Test circuit resistive load.

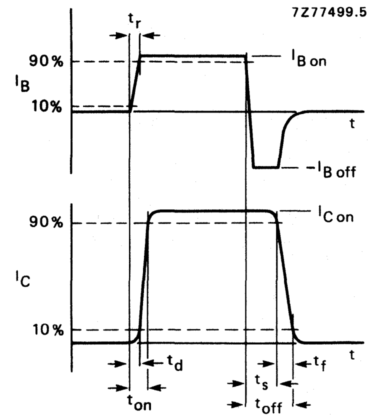


Fig. 3 Switching times waveforms with resistive load; $t_r \leqslant 30$ ns.

V_{CC} = 30 V
L_C = 200 μH
L_B = 1 μH

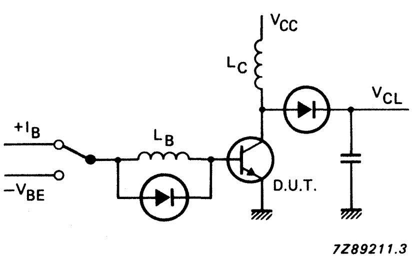


Fig. 4 Test circuit inductive load.

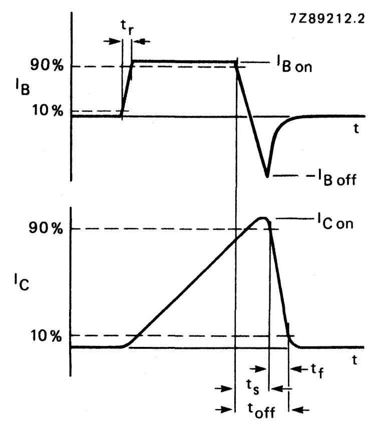


Fig. 5 Switching times waveforms with inductive load.

SILICON DIFFUSED POWER TRANSISTOR

High-voltage, high-speed glass-passivated npn power transistor in a TO-220 envelope, intended for use in switching regulators, inverters, motor controls, solenoid/relay drivers and deflection circuits.

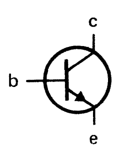
QUICK REFERENCE DATA

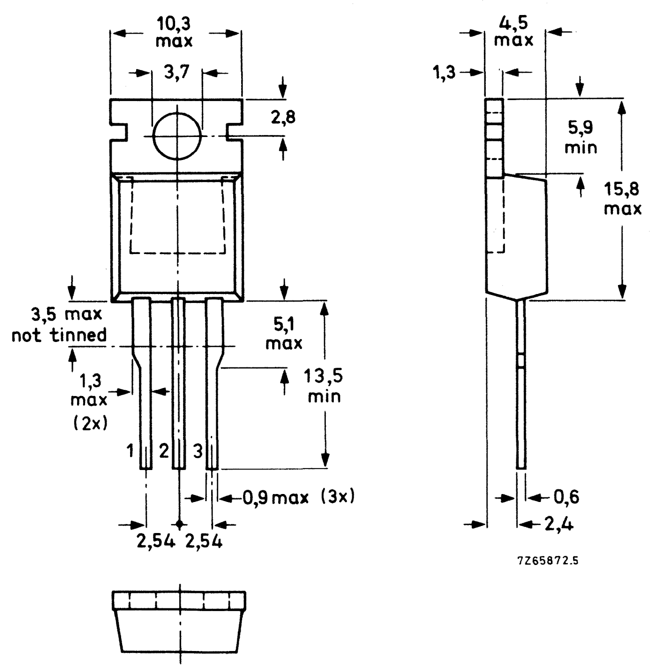
			MJE13006	MJE13007	
Collector-emitter voltage					
peak value; $V_{BE} = 0$	V_{CESM}	max.	600	700	V
open base	V_{CEO}	max.	300	400	V
Collector-emitter saturation voltage					
$I_C = I_{Csat}$	V_{CEsat}	max.	1.5		V
Collector current					
saturation	I_{Csat}	max.	5.0		A
DC	I_C	max.	8.0		A
peak value	I_{CM}	max.	16		A
Total power dissipation					
up to $T_{mb} = 25\ ^oC$	P_{tot}	max.	80		W

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)

			MJE13006	MJE13007	
Collector-emitter voltage					
peak value; $V_{BE} = 0$	V_{CESM}	max.	600	700	V
open base	V_{CEO}	max.	300	400	V
Emitter-base current	V_{EBO}	max.	9.0		V
Collector current					
saturation	I_{Csat}		5.0		A
DC	I_C	max.	8.0		A
peak value	I_{CM}	max.	16		A
Base current					
DC	I_B	max.	4.0		A
peak value	I_{BM}	max.	8.0		A
Emitter current					
DC	I_E	max.	12		A
peak value	I_{EM}	max.	24		A
Total power dissipation					
up to $T_{mb} = 25\,^{o}C$	P_{tot}	max.	65		W
derate above 25 ^{o}C			640		mW/^{o}C
Operating junction temperature range	T_j		−65 to + 150		^{o}C
Storage temperature range	T_{stg}		−65 to + 150		^{o}C

THERMAL RESISTANCE

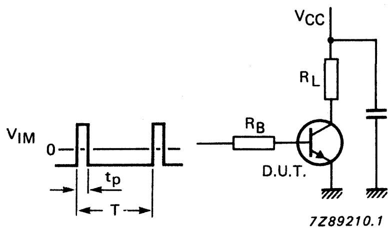
From junction to mounting base	$R_{th\,j\text{-}mb}$	=	1.56	K/W
From junction to ambient	$R_{th\,j\text{-}a}$	=	62.5	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			MJE13006	MJE13007	
Collector-emitter sustaining voltage					
I_C = 10 A; I_B = 0	$V_{CEOsust}$	min.	300	400	V
Collector cut-off current					
V_{CE} = $V_{CESMmax}$; V_{BE} = −1.5 V	I_{CEX}	max.	1.0		mA
V_{CE} = $V_{CESMmax}$; V_{BE} = −1.5 V; T_c = 100 °C	I_{CEX}	max.	5.0		mA
Emitter cut-off current					
V_{EB} = 9 V; I_C = 0	I_{EBO}	max.	1.0		mA
Current gain					
I_C = 0.5 A; V_{CE} = 5 V	h_{FE}		15 to 50		mA
I_C = 2.0 A; V_{CE} = 5 V	h_{FE}		8 to 40		mA
I_C = 5.0 A; V_{CE} = 5 V	h_{FE}		6 to 30		mA
Collector-emitter saturation voltage					
I_C = 2 A; I_B = 0.4 A	V_{CEsat}	max.	1.0		V
I_C = 5 A; I_B = 1.0 A	V_{CEsat}	max.	1.5		V
I_C = 8 A; I_B = 2.0 A	V_{CEsat}	max.	3.0		V
I_C = 5 A; I_B = 1.0 A; T_c = 100 °C	V_{CEsat}	max.	2.0		V
Base-emitter saturation voltage					
I_C = 2 A; I_B = 0.4 A	V_{BEsat}	max.	1.2		V
I_C = 5 A; I_B = 1.0 A	V_{BEsat}	max.	1.6		V
I_C = 5 A; I_B = 5.0 A	V_{BEsat}	max.	1.5		V
Transition frequency					
I_C = 0.5 A; V_{CE} = 10 V; f = 1 MHz	f_T	typ.	4.0		MHz
Collector capacitance					
V_{CB} = 10 V; I_E = 0	C_{ob}	typ.	80		pF
Switching times, resistive load (Figs 2 and 3)					
V_{CC} = 125 V; I_C = 5 A; t_p = 25 μs; $I_{B\,on}$ = $I_{B\,off}$ = 1.0 A	t_d	max.	0.1		μs
	t_r	max.	1.0		μs
	t_s	max.	3.0		μs
	t_f	max.	0.7		μs
Switching times, inductive load (Figs 4 and 5)					
I_C = 5 A; V_{CL} = 300 V; T_c = 100 °C; $I_{B\,on}$ = 1.0 A; $V_{BE\,off}$ = 5 V	t_s	typ.	0.86		μs
	t_s	max.	2.3		μs
	t_c	typ.	0.14		μs
	t_c	max.	0.7		μs

DEVELOPMENT DATA



V_{CC} = 125 V
V_{im} = −6 to 8 V
The values of R_B and R_L are selected in accordance with I_{Con} and I_B requirements.

Fig. 2 Test circuit resistive load.

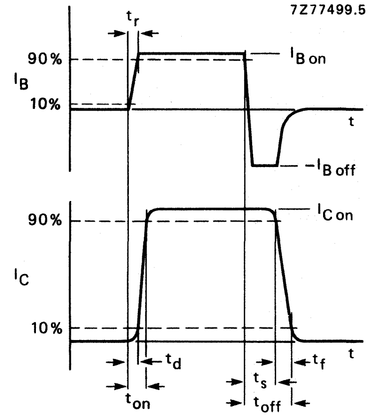
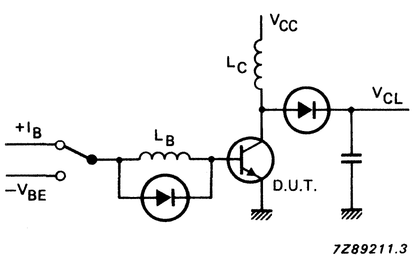


Fig. 3 Switching times waveforms with resistive load; $t_r \leqslant 30$ ns.



V_{CC} = 300 V
V_{CL} = 300 V
L_C = 250 μH
L_B = 1 μH

Fig. 4 Test circuit inductive load.

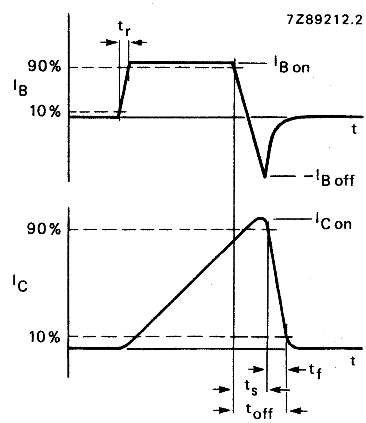
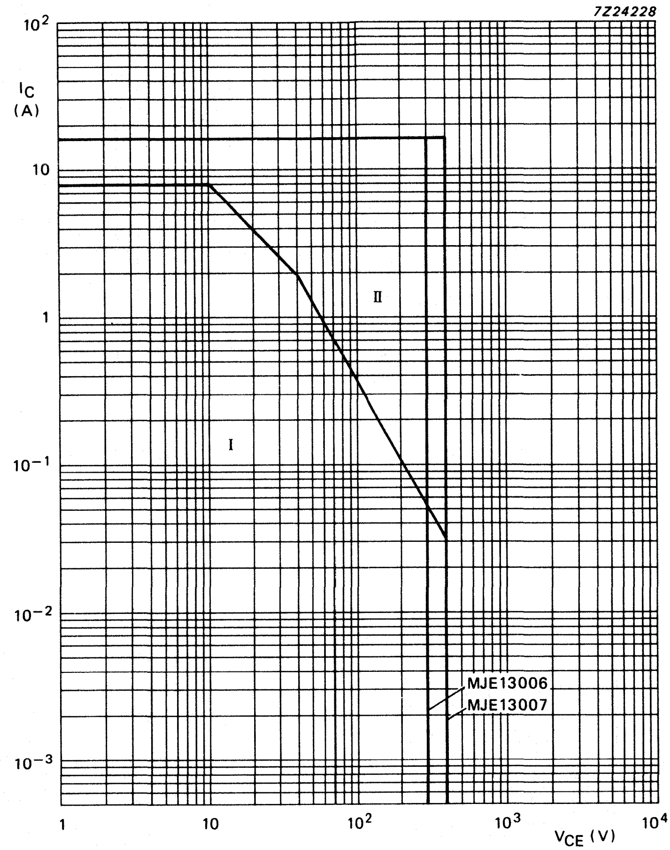


Fig. 5 Switching times waveforms with inductive load.



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

Fig. 6 Safe operating area.

DEVELOPMENT DATA

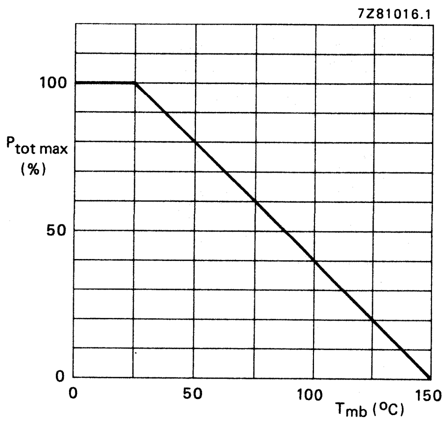


Fig. 7 Total power dissipation.

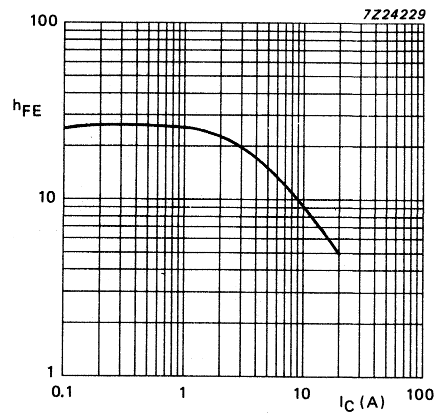


Fig. 8 DC current gain; V_{CE} = 5 V; T_j = 25 °C.

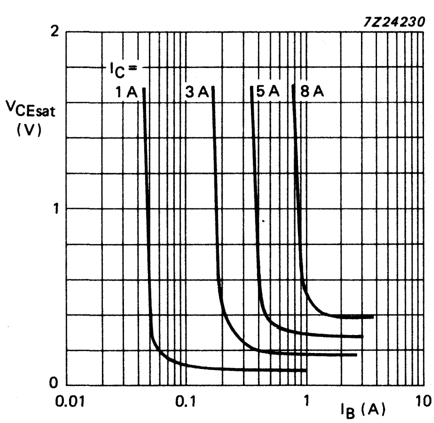


Fig. 9 Collector-emitter saturation voltage as a function of base current; T_j = 25 °C.

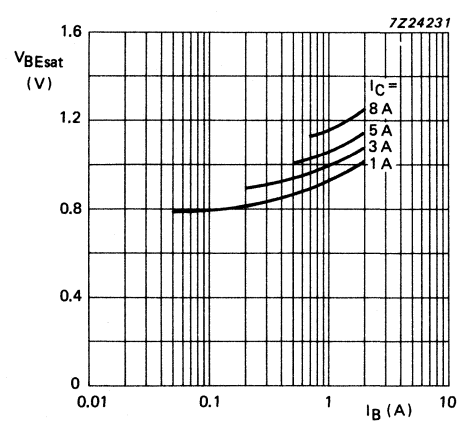


Fig. 10 Base-emitter saturation voltage as a function of base current; T_j = 25 °C.

SILICON DIFFUSED POWER TRANSISTORS

High-voltage, high-speed glass passivated npn power transistor in a TO-220 envelope, intended for use in switching regulators, inverters, motor controls, solenoid/relay drivers and deflection circuits.

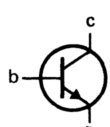
QUICK REFERENCE DATA

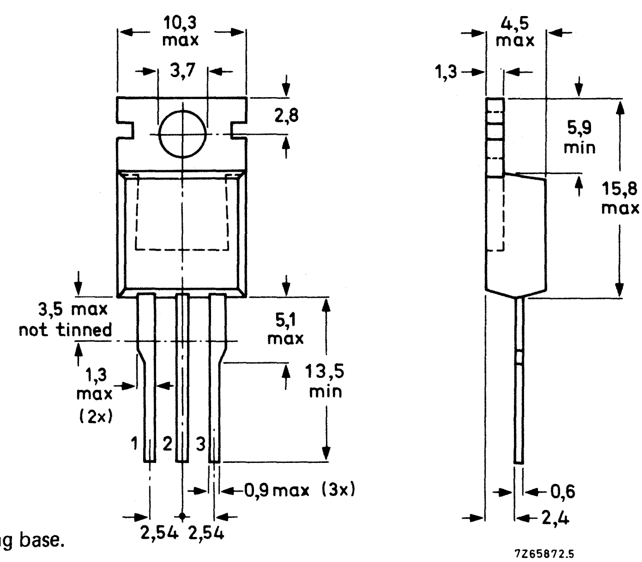
			MJE13008	13009	
Collector-emitter voltage					
peak value; $V_{BE} = 0$	V_{CESM}	max.	600	700	V
open base	V_{CEO}	max.	300	400	V
Collector-emitter saturation voltage	V_{CEsat}	max.	1.5		V
Collector current					
saturation	I_{Csat}	max.	8.0		A
DC	I_C	max.	12		A
peak value	I_{CM}	max.	24		A
Total power dissipation					
up to $T_{mb} = 25\ ^oC$	P_{tot}	max.	100		W

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)

			MJE13008	13009	
Collector-emitter voltage					
peak value; $V_{BE} = 0$	V_{CESM}	max.	600	700	V
open base	V_{CEO}	max.	300	400	V
Emitter-base current	V_{EBO}	max.	9.0		V
Collector current					
saturation	I_{Csat}		8.0		A
DC	I_C	max.	12		A
peak value	I_{CM}	max.	24		A
Base current					
DC	I_B	max.	6.0		A
peak value	I_{BM}	max.	12		A
Emitter current					
DC	I_E	max.	18		A
peak value	I_E	max.	36		A
Total power dissipation					
up to $T_a = 25\ ^oC$	P_{tot}	max.	2		W
derate above 25 ^oC			16		mW/K
Total power dissipation					
up to $T_{mb} = 25\ ^oC$	P_{tot}	max.	100		W
derate above 25 ^oC			800		mW/K
Operating junction temperature range	T_j		–65 to + 150		^oC
Storage temperature range	T_{stg}		–65 to + 150		^oC

THERMAL RESISTANCE

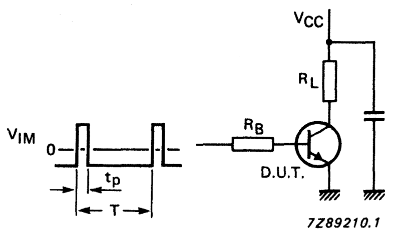
From junction to mounting base	$R_{th\ j\text{-}mb}$	=	1.25	K/W
From junction to ambient	$R_{th\ j\text{-}a}$	=	62.5	K/W

DEVELOPMENT DATA

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			MJE13008	13009	
Collector-emitter sustaining voltage					
I_C = 10 mA; I_B = 0	$V_{CEO\,sust}$	min.	300	400	V
Collector cut-off current					
$V_{CE} = V_{CESMmax}$; V_{BE} = −1.5 V	I_{CEX}	max.	1.0		mA
$V_{CE} = V_{CESMmax}$; V_{BE} = −1.5 V; T_c = 100 °C	I_{CEX}	max.	5.0		mA
Emitter cut-off current					
V_{EB} = 9 V; I_C = 0	I_{EBO}	max.	1.0		mA
Current gain					
I_C = 5 A; V_{CE} = 5 V	h_{FE}		8 to 40		
I_C = 8 A; V_{CE} = 5 V	h_{FE}		6 to 30		
Collector-emitter saturation voltage					
I_C = 5 A; I_B = 1.0 A	V_{CEsat}	max.	1.0		V
I_C = 8 A; I_B = 1.6 A	V_{CEsat}	max.	1.5		V
I_C = 12 A; I_B = 3.0 A	V_{CEsat}	max.	3.0		V
I_C = 8 A; I_B = 1.6 A; T_c = 100 °C	V_{CEsat}	max.	2.0		V
Base-emitter saturation voltage					
I_C = 5 A; I_B = 1.0 A	V_{BEsat}	max.	1.2		V
I_C = 8 A; I_B = 1.6 A	V_{BEsat}	max.	1.6		V
I_C = 8 A; I_B = 1.6 A; T_{mb} = 100 °C	V_{BEsat}	max.	1.5		V
Transition frequency					
I_C = 0.5 A; V_{CE} = 10 V; f = 1 MHz	f_T	typ.	4.0		MHz
Collector capacitance					
V_{CB} = 10 V; I_E = 0	C_{ob}	typ.	100		pF
Switching times, resistive load (Figs 2 and 3)					
V_{CC} = 125 V; I_C = 8 A; t_p = 25 μs; $I_{Bon} = I_{Boff}$ = 1.6 A	t_{on}	max.	1.1		μs
	t_s	max.	3.0		μs
	t_f	max.	0.7		μs
Switching times, inductive load (Figs 4 and 5)					
I_C = 8 A; V_{CL} = 300 V; T_c = 100 °C; I_{Bon} = 1.6 A; V_{BEoff} = 5 V	t_s	typ.	0.92		μs
	t_s	max.	2.3		μs
	t_f	typ.	0.12		μs
	t_f	max.	0.7		μs



V_{CC} = 125 V
V_{im} = −6 to 8 V
The value of R_B and R_L is selected in accordance with the I_C and I_B requirements.

Fig. 2 Test circuit resistive load.

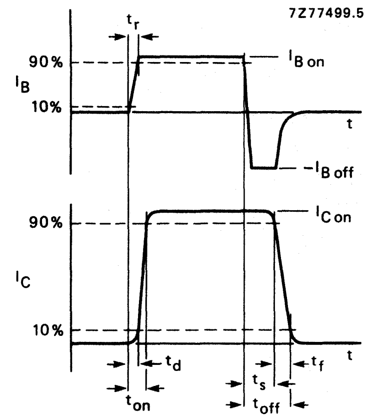
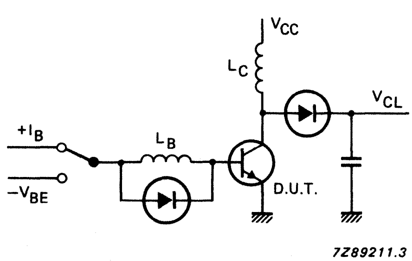


Fig. 3 Switching times waveforms with resistive load; $t_r \leqslant 30$ ns.



V_{CL} = 300 V
V_{CC} = 30 V
L_C = 200 μH
L_B = 1 μH

Fig. 4 Test circuit inductive load.

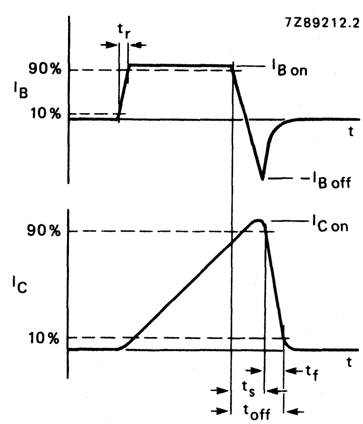


Fig. 5 Switching times waveforms with inductive load.

SILICON DIFFUSED POWER TRANSISTORS

High-voltage, high-speed, glass-passivated npn power transistors in a TO-126 envelope, intended for use in switching regulators, inverters, motor control, solenoid/relay drivers and deflection circuits.

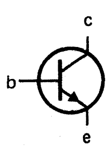
QUICK REFERENCE DATA

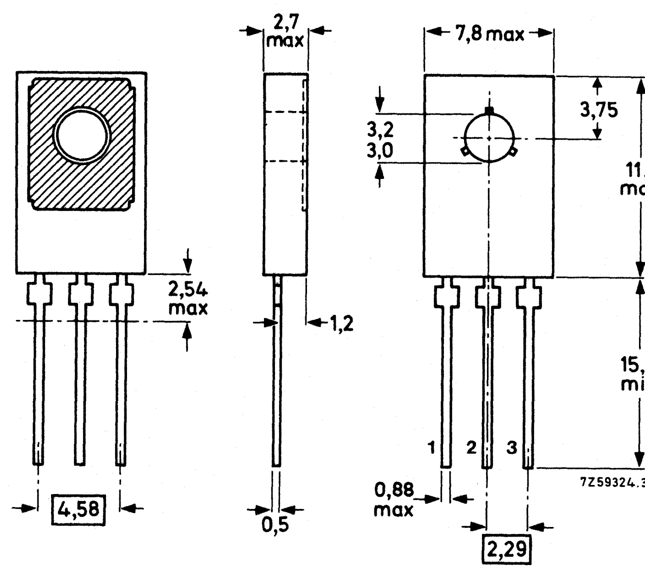
			PH13002	PH13003	
Collector-emitter voltage peak value; $V_{BE} = 0$	V_{CESM}	max.	600	700	V
Collector-emitter voltage, open base	V_{CEO}	max.	300	400	V
Collector-emitter saturation voltage	V_{CEsat}	max.	1,0		V
Collector current (DC)	I_C	max.	1,5		A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	28		W

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-126.





Pinning;

1 = base
2 = collector
3 = emitter

Collector connected to mounting base.

RATINGS

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

			PH13002	PH13003	
Collector-emitter voltage peak value; $V_{BE} = 0$	V_{CESM}	max.	600	700	V
Collector-emitter voltage, open base	V_{CEO}	max.	300	400	V
Emitter-base voltage	V_{EBO}	max.	9		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 $T_{amb} = 25\ ^oC$	P_{tot}	max.	1,25		W
Derate above 25 °C		=	10		mW/K
Total power dissipation up to $T_c = 25\ ^oC$	P_{tot}	max.	28		W
Derate above 25 °C		=	224		mW/K
Storage temperature range	T_{stg}		−65 to +150		°C
Junction temperature	T_j	max.	150		°C

THERMAL RESISTANCE

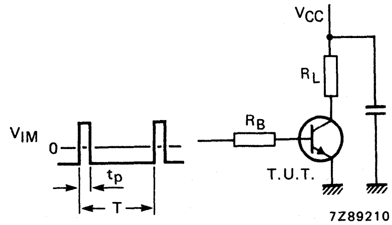
From junction to mounting base	$R_{th\ j\text{-}mb}$	=	4,5	K/W
From junction to ambient	$R_{th\ j\text{-}a}$	=	100	K/W

CHARACTERISTICS

$T_j = 25\ ^oC$ unless otherwise specified

			PH13002	PH13003	
Collector-emitter sustaining voltage $I_B = 0$; $I_C = 10$ mA	$V_{CEOsust}$	min.	300	400	V
Collector cut-off current $V_{CE} = V_{CESMmax}$; $V_{BE} = -1,5$ V	I_{CEX}	max.	1,0		mA
$V_{CE} = V_{CESMmax}$; $V_{BE} = -1,5$ V; $T_c = 100\ ^oC$	I_{CEX}	max.	5,0		mA
Emitter cut-off current $I_C = 0$; $V_{EB} = 9$ V	I_{EBO}	max.	1,0		mA
DC current gain $I_C = 0,5$ A; $V_{CE} = 2$ V	h_{FE}	min.	8		
		max.	40		
$I_C = 1$ A; $V_{CE} = 2$ V	h_{FE}	min.	5		
		max.	25		

Transition frequency at f = 1 MHz			
I_C = 0,1 A; V_{CE} = 10 V	f_T	min.	4 MHz
Saturation voltages			
I_C = 0,5 A; I_B = 0,1 A	V_{CEsat}	max.	0,5 V
	V_{BEsat}	max.	1,0 V
I_C = 1,0 A; I_B = 0,25 A	V_{CEsat}	max.	1,0 V
	V_{BEsat}	max.	1,2 V
I_C = 1,0 A; I_B = 0,25 A; T_c = 100 °C	V_{CEsat}	max.	1,0 V
	V_{BEsat}	max.	1,1 V
I_C = 1,5 A; I_B = 0,5 A	V_{CEsat}	max.	3 V
Collector capacitance at f = 1 MHz			
$I_E = i_e = 0$; V_{CB} = 10 V	C_c	typ.	12 pF
Switching times (resistive load)			
I_{Con} = 1 A; t_p = 25 μs;	t_d	max.	0,1 μs
$I_{Bon} = -I_{Boff}$ = 0,2 A	t_r	max.	1,0 μs
(see Figs 2 and 3)	t_s	max.	4,0 μs
	t_f	max.	0,7 μs
Switching times (inductive load)			
I_{Con} = 1 A; I_{Bon} = 0,2 A;	t_s	typ.	1,7 μs
V_{BEoff} = 5 V; T_c = 100 °C		max.	4,0 μs
(see Figs 4 and 5)	t_c	typ.	0,29 μs
		max.	0,75 μs
	t_f	typ.	0,15 μs



V_{CC} = 125 V
V_{IM} = –6 to 8 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.

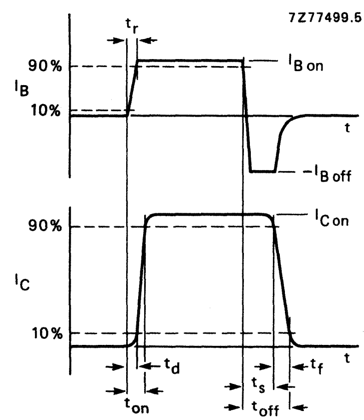


Fig. 3 Switching times waveforms with resistive load.

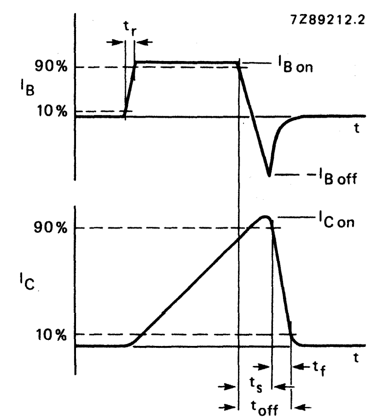
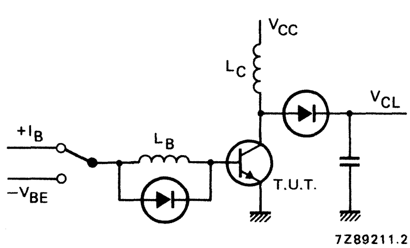
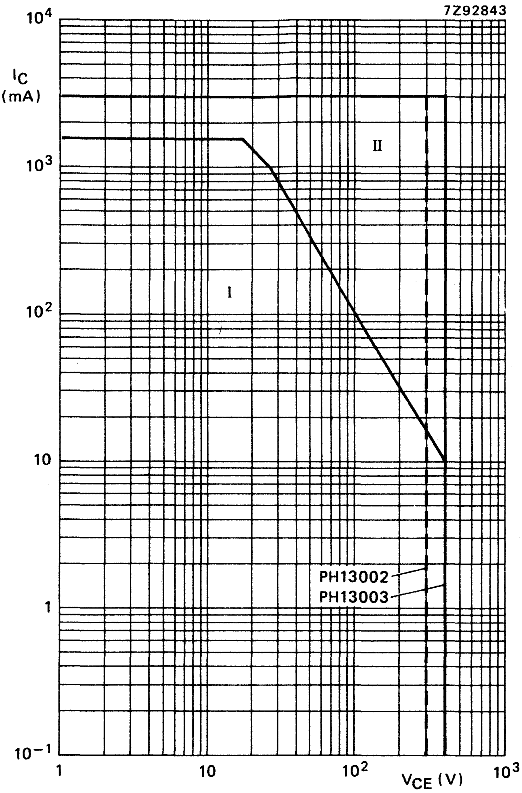


Fig. 4 Switching times waveforms with inductive load.



V_{CC} = 30 V
V_{CL} = 300 V
L_C = 200 μH
L_B = 1 μH

Fig. 5 Test circuit inductive load.



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

Fig. 6 Safe operating area.

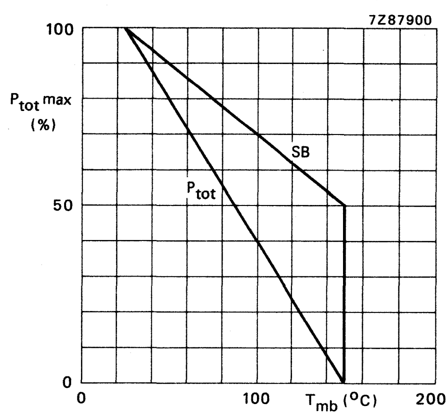


Fig. 7 Total power dissipation and second-breakdown current derating curve.

SILICON DIFFUSED POWER TRANSISTORS

Medium-voltage, high-speed, glass-passivated NPN power transistors in TO-220 envelope for amplifier and switching applications.

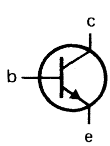
QUICK REFERENCE DATA

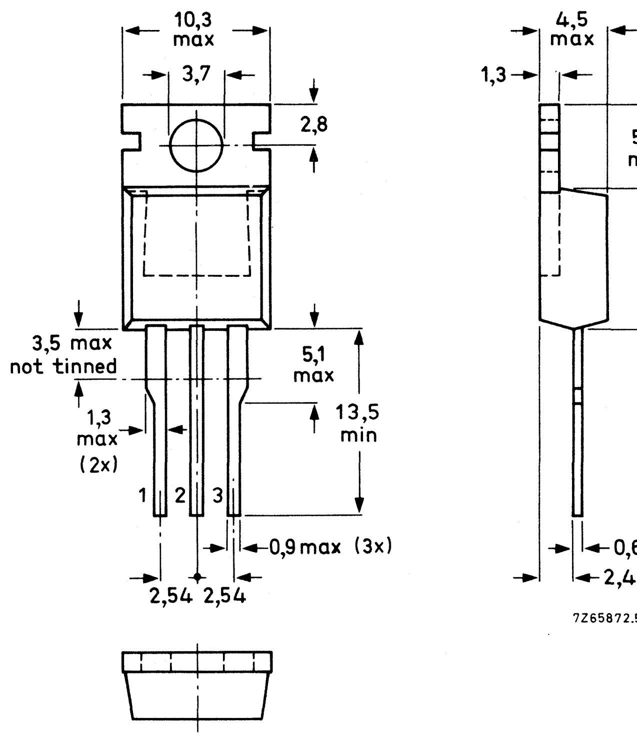
			TIP47	48	49	50	
Collector-base voltage (open emitter)	V_{CBO}	max.	350	400	450	500	V
Collector-emitter voltage (open base)	V_{CEO}	max.	250	300	350	400	V
Collector-emitter saturation voltage	V_{CEsat}	max.		1			V
Collector current (DC)	I_C	max.		1			A
Collector current (peak value)	I_{CM}	max.		2			A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.		40			W
Turn-off time	t_{off}	typ.		2			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)

			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	$R_{th\ j\text{-}mb}$	=	3,12	K/W
From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	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					
$L = 100$ mH; $I_C = 0{,}63$ A		$E_{(BR)}$	max.	20	mJ
Collector-emitter sustaining voltage					
$I_C = 30$ mA; $I_B = 0$;	TIP47	$V_{CEOsust}$	max.	250	V
$L = 25$ mH	TIP48	$V_{CEOsust}$	max.	300	V
	TIP49	$V_{CEOsust}$	max.	350	V
	TIP50	$V_{CEOsust}$	max.	400	V
Switching times					
$I_C = 1$ A; $I_{B\,on} = -I_{B\,off} = 100$ mA;					
$V_{CC} = 200$ V					
turn-on time		t_{on}	typ.	0,2	μs
turn-off time		t_{off}	typ.	2,0	μs

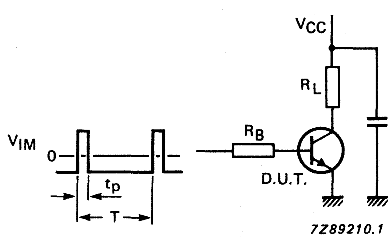


Fig. 2 Switching times test circuit with resistive load; $V_{IM} = -5$ to $+8$ V; $V_{CC} = 200$ V; $t_p = 20$ μs; $\delta = t_p/T = 1\%$.
The values of R_B and R_L are selected in accordance with $I_{C\,on}$ and I_B requirements.

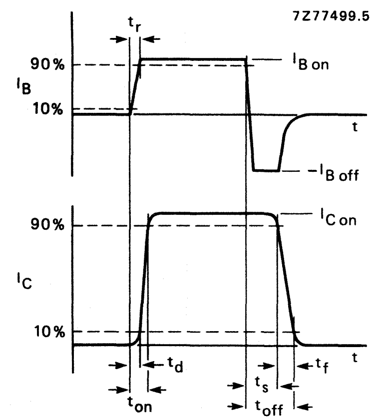
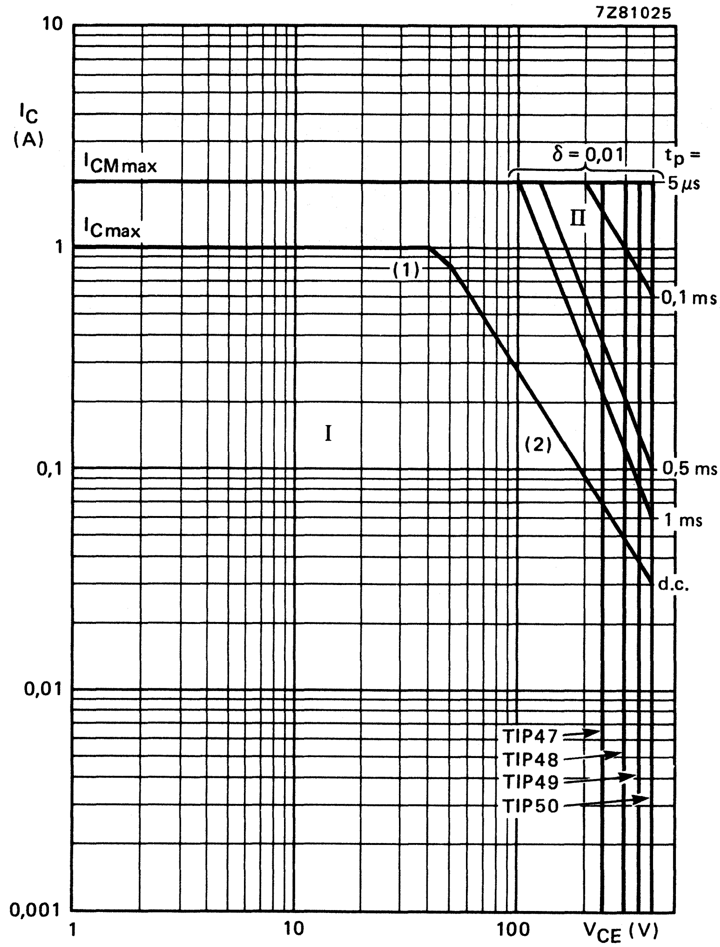


Fig. 3 Switching times waveforms.



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 $T_{mb} \leqslant 25\ ^{o}C$.

ACCESSORIES

SELECTION GUIDE

CLIP MOUNTING

envelope	direct mounting		insulated mounting		
	clip		mica	alumina	clip
TO-126 (SOT32)	56353		56354		56353
SOT82	56353		56354		56353
TO-220 (SOT78)	56363		56369	56367	56364
SOT186	56363				
SOT93	56379		56378		56379
SOT199	56379				

SCREW MOUNTING

envelope	direct mounting		insulated mounting			
	metal washer	mounting size	mica washer	insulated bush	metal washer	mounting size
TO-126 (SOT32)	56326	M3				
up to 300 V			56387a	56387b	56326	M2,5
TO-220 (SOT78)	56360a	M3				
up to 800 V			56359b	56359c	56360a	M3
up to 1000 V			56359b	56359d	56360a	M3
SOT186	56360a	M3				
SOT93	–	M4	56368a	56368b		M3
SOT199	–	M				
TO-3 (SOT3)	–	M4				
up to 500 V			56201d	56201j or 56261a		M3
up to 2000 V			56339	56352		M3

The accessories included in this section can be supplied on request. Details of their use can be found in the Mounting Instructions section.

TYPE NUMBER SURVEY ACCESSORIES

type number	description	envelope
56201d	mica washer (up to 500 V)	TO-3
56201j	insulating bushes (up to 500 V)	TO-3
56261a	insulating bushes (up to 500 V)	TO-3
56326	metal washer	TO-126
56339	mica washer (500 to 2000 V)	TO-3
56352	insulating mounting support	TO-3
56353	spring clip	TO-126/SOT82
56354	mica insulator	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 (brass)	TO-220
56363	spring clip (direct mounting)	TO-220
56364	spring clip (insulated mounting)	TO-220
56367	alumina insulator (up to 2000 V)	TO-220
56368a	mica insulator (up to 800 V)	SOT93
56368b	insulating bush (up to 800 V)	SOT93
56369	mica insulator (up to 2 kV)	TO-220
56378	mica insulator (up to 1500 V)	SOT93
56379	spring clip	SOT93
56387a	mica insulator (up to 300 V)	TO-126
56387b	insulating bush (up to 300 V)	TO-126

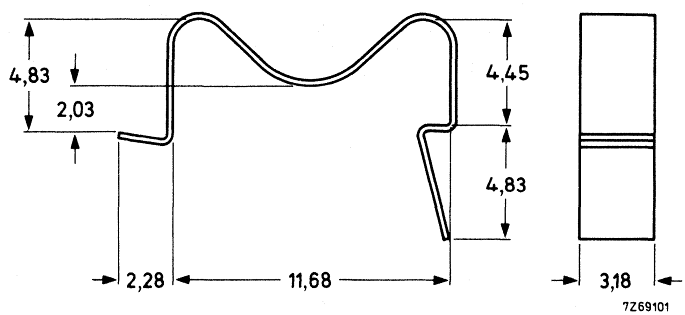
Mounting TO-126 and SOT82 envelopes.

56353 CLIP
for TO-126 and SOT82 envelopes

MECHANICAL DATA

Material: high carbon spring steel

Dimensions in mm

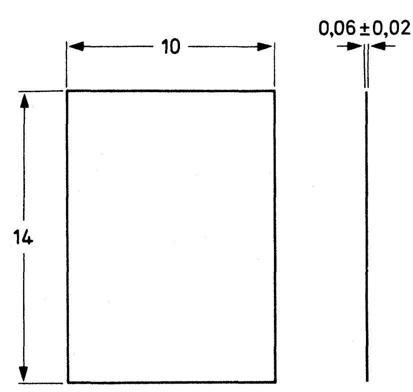


Spring clip suitable for heatsink of 1,5 to 2 mm.

56354 MICA INSULATOR
for TO-126 and SOT82 envelopes

MECHANICAL DATA

Dimensions in mm



Mounting of TO-126 envelopes

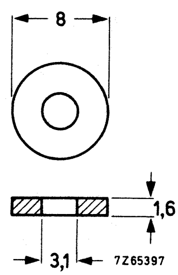
56326 WASHER

for direct mounting of TO-126 envelopes

MECHANICAL DATA

Dimensions in mm

Material: brass, nickel plated

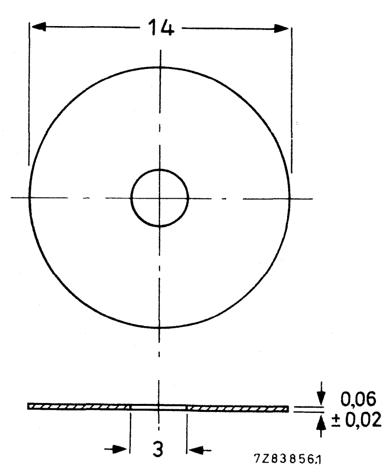


56387a MICA WASHER

for insulated screw mounting of TO-126 envelopes (up to 300 V)

MECHANICAL DATA

Dimensions in mm



Mounting of TO-126 envelopes

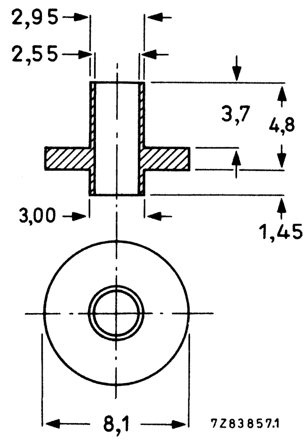
56387b INSULATING BUSH

for insulated screw mounting of TO-126 envelopes (up to 300 V)

MECHANICAL DATA

Dimensions in mm

Material: polyester



TEMPERATURE

Maximum permissible temperature T_{max} 150 °C

Clip mounting TO-220 envelopes

56363 SPRING CLIP

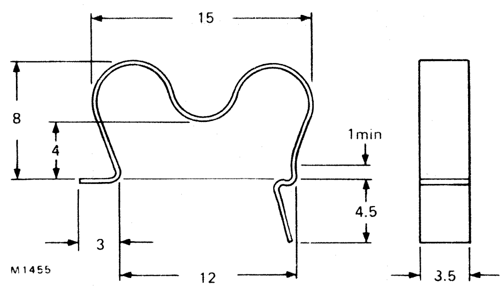
for direct mounting of TO-220 envelopes

MECHANICAL DATA

Dimensions in mm

Material: stainless steel; for mounting on heatsink of 1.0 to 2.0 mm.

Recommended force of clip on device is 20 N (2 kgf).



56364 SPRING CLIP

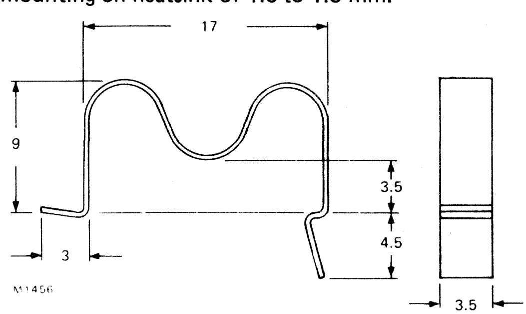
for insulated mounting of TO-220 envelopes

MECHANICAL DATA

Dimensions in mm

Material: stainless steel; for mounting on heatsink of 1.0 to 1.5 mm.

Recommended force of clip on device is 20 N (2 kgf).



To be used in conjunction with insulators **56367** or **56369**

Clip mounting TO-220 envelopes

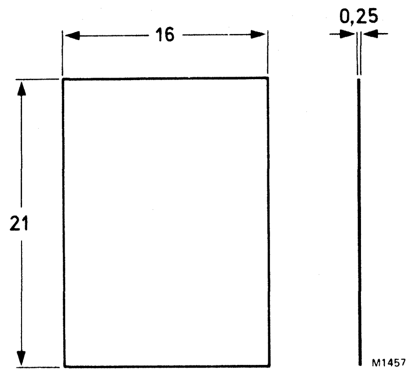
56367 ALUMINA INSULATOR

for insulated clip mounting of TO-220 envelopes (up to 2 kV)

MECHANICAL DATA

Dimensions in mm

Material: 96-alumina.



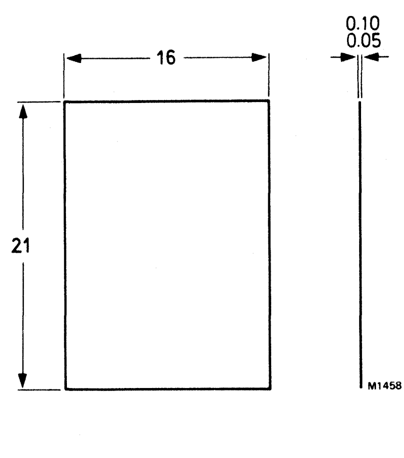
*Because alumina is brittle, extreme care must be taken when mounting devices not to crack the alumina, particularly when used without heatsink compound.

56369 MICA INSULATOR

for insulated clip mounting of TO-220 envelopes (up to 2 kV)

MECHANICAL DATA

Dimensions in mm

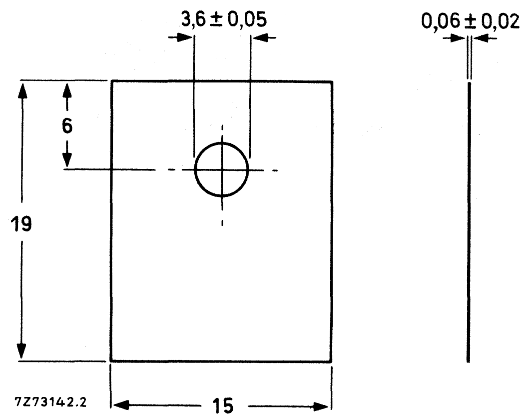


Mounting TO-220 envelopes

56359b MICAWASHER

for TO-220 envelopes (up to 1000 V)

Dimensions in mm



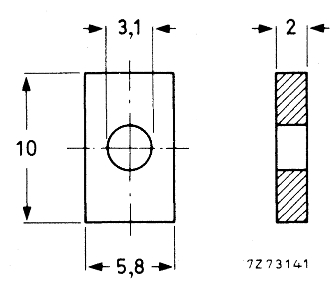
56360a RECTANGULAR WASHER

for direct and insulated mounting of TO-220 envelopes

MECHANICAL DATA

Material: brass; nickel plated.

Dimensions in mm



Mounting TO-220 envelopes

56359c INSULATING BUSH

for TO-220 envelopes (up to 800 V)

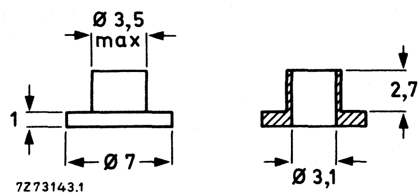
MECHANICAL DATA

Dimensions in mm

Material: polyester

TEMPERATURE

Maximum permissible temperature $T_{max} = 150\ ^{o}C$



56359d RECTANGULAR INSULATING BUSH

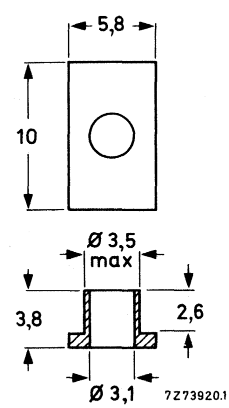
for TO-220 envelopes (up to 1000 V)

MECHANICAL DATA

Dimensions in mm

TEMPERATURE

Maximum permissible temperature $T_{max} = 150\ ^{o}C$



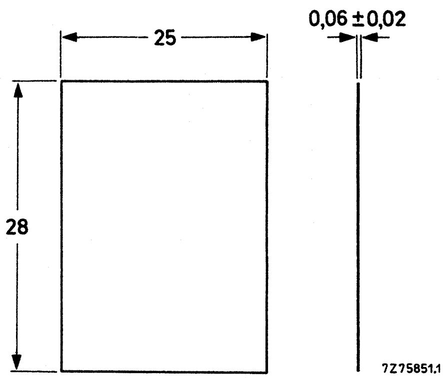
Clip mounting of SOT93 envelopes.

56378 MICA INSULATOR

for SOT93 clip mounting (up to 1500 V)

MECHANICAL DATA

Dimensions in mm



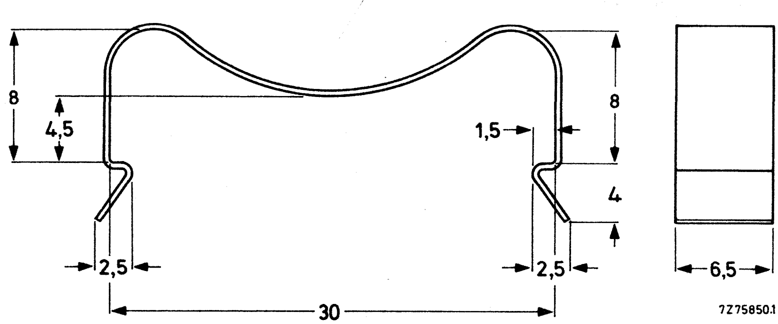
56379 SPRING CLIP

for direct and insulated mounting of SOT93 envelopes

MECHANICAL DATA

Dimensions in mm

Material:
CrNi steel NLN-939;
thickness 0,4 ± 0,04.



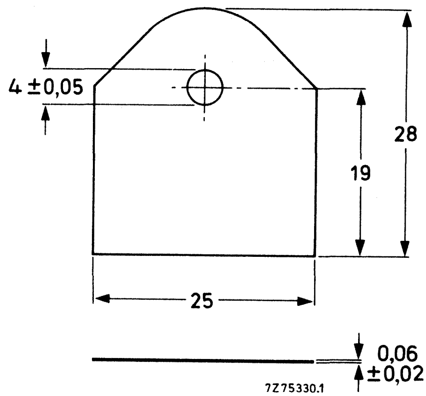
Screw mounting of SOT93 envelopes.

56368a MICA INSULATOR

for insulated screw mounting of SOT93 envelopes (up to 800 V)

MECHANICAL DATA

Dimensions in mm



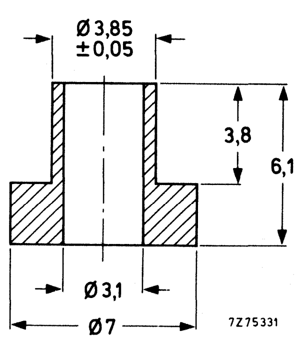
56368b INSULATING BUSH

for insulated screw mounting of SOT93 envelopes (up to 800 V)

MECHANICAL DATA

Dimensions in mm

Material: polyester



TEMPERATURE

Maximum permissible temperature T_{max} = 150 °C

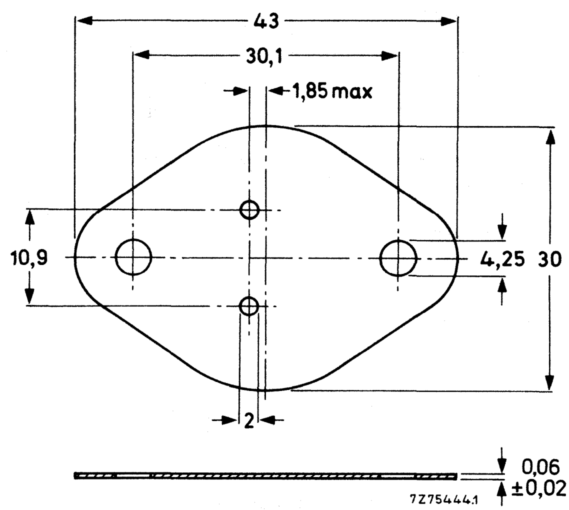
Mounting TO-3 envelopes

56201d MICA WASHER

Mica washer for up to 500 V insulation of TO-3 envelopes.

MECHANICAL DATA

Dimensions in mm



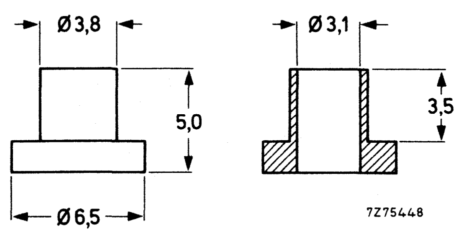
56201j 2 INSULATING BUSHES

Two insulating bushes for up to 500 V insulation of TO-3 envelopes.

MECHANICAL DATA

Dimensions in mm

material: polyester



TEMPERATURE

Maximum permissible temperature T_{max} = 150 °C

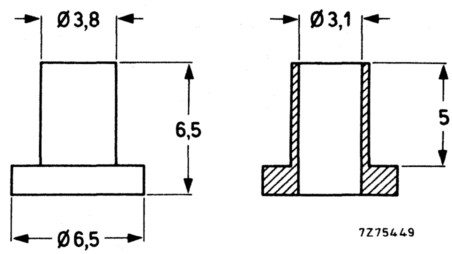
Mounting TO-3 envelopes

56261a 2 INSULATING BUSHES

Two insulating bushes for up to 500 V insulation of TO-3 envelopes.

MECHANICAL DATA Dimensions in mm

Material: polyester



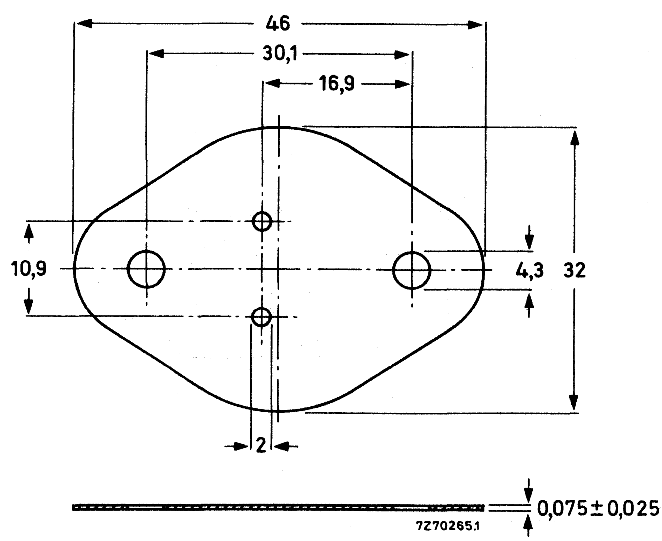
TEMPERATURE

Maximum permissible temperature T_{max} = 150 °C

56339 MICA WASHER

Mica washer for 500 to 2000 V insulation of TO-3 envelopes, for which it should be combined with mounting support 56352.

MECHANICAL DATA Dimensions in mm



Mounting TO-3 envelopes

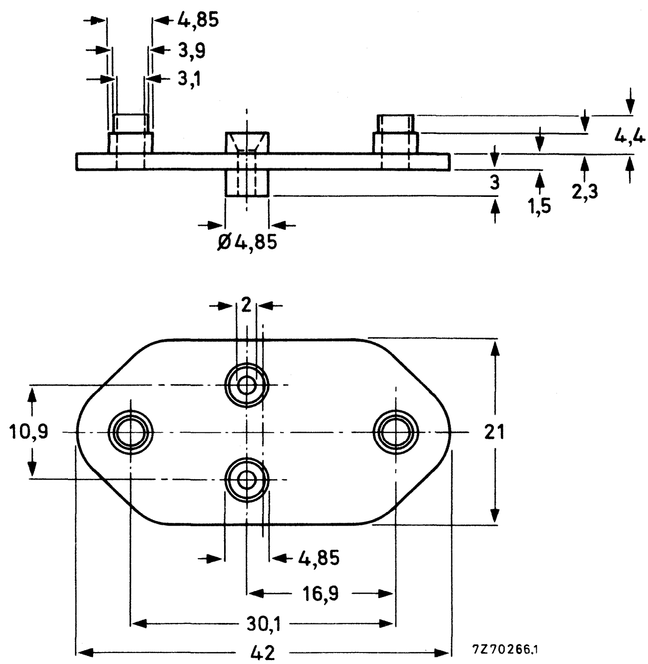
56352 MOUNTING SUPPORT

Mounting support for 500 to 2000 V insulation of TO-3 envelopes, for which it should be combined with mica washer 56339.

MECHANICAL DATA

Dimensions in mm

Material: polyester



TEMPERATURE

Maximum permissible temperature $T_{max} = 125\ ^{o}C$

MOUNTING INSTRUCTIONS

Flat heatsinks

All information on thermal resistances of the accessories combined with flat heatsinks is valid for *square* heatsinks of *1,5 mm blackened aluminium.*

For a few variations the thermal resistance may be derived as follows:

- Rectangular heatsinks (sides a and 2a)
  When mounted with long side horizontal, multiply by 0,95.
  When mounted with short side horizontal, multiply by 1,10.
- Unblackened or thinner heatsinks
  Multiply by the factor given in Fig. 1 as a function of the heatsink size A.

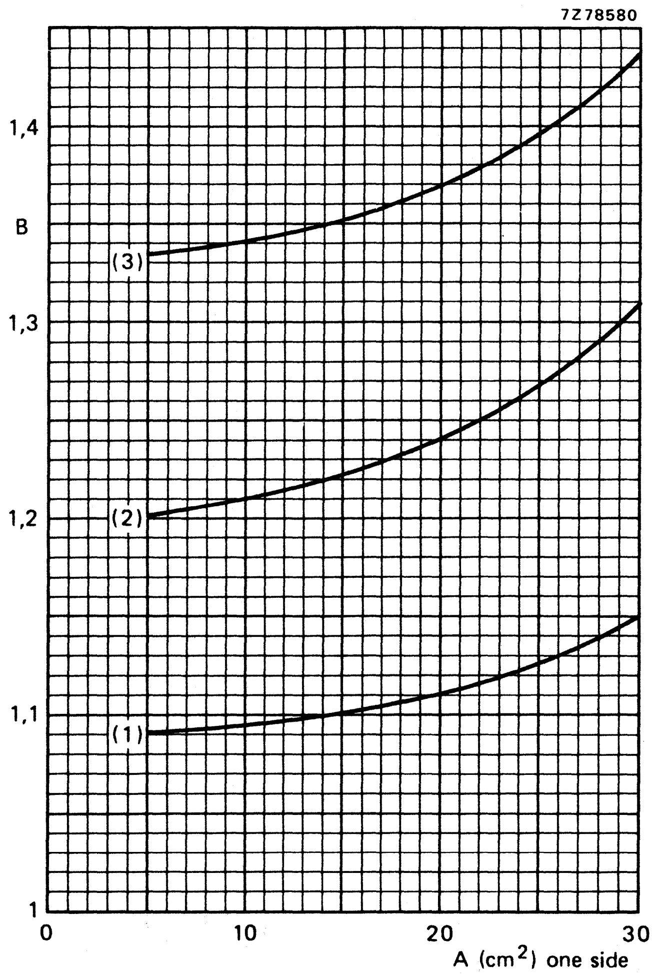


Fig. 1 Multiplication factor (B) as a function of heatsink area (A).
(1) 1 mm blackened aluminium.
(2) 1,5 mm unblackened aluminium.
(3) 1 mm unblackened aluminium.

MOUNTING INSTRUCTIONS FOR TO-3 ENVELOPES

GENERAL DATA AND INSTRUCTIONS

Instructions for direct mounting.

Mounting instructions for up to 500 V insulation.
Using insulating bushes 56201j or 56261a and mica washer 56201d.

Mounting instructions for 500 to 2000 V insulation.
Using mounting support 56352 and mica washer 56339.

Heatsink requirements

Flatness in the mounting area: 0,05 mm per 40 mm

Mounting holes must be deburred.

Mounting torques

Minimum torque (for good heat transfer)	0,4 Nm (4 kgcm)
Maximum torque (to avoid damaging the transistor)	0,6 Nm (6 kgcm)

N.B.: When the driven nut or screw is in direct contact with a toothed lock washer (e.g. Fig. 10), the torques are as follows:

Minimum torque	0,55 Nm (5,5 kgcm)
Maximum torque	0,8 Nm (8 kgcm)

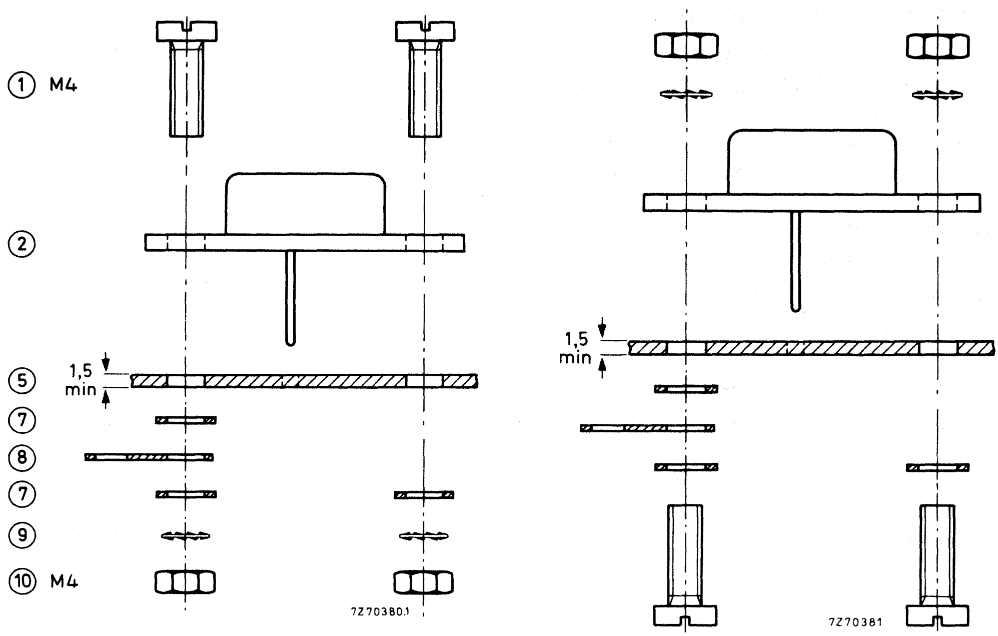
Thermal data

The thermal resistance from mounting base to heatsink ($R_{th\ mb-h}$) can be reduced by applying a heat conducting compound between transistor and heatsink. For insulated mounting the compound should be applied to the bottom of both device and insulator.

		Direct mounting	Insulated mounting		
			500 V mica	2000 V mica	
From mounting base to heatsink					
without heatsink compound	$R_{th\ mb-h}$	0,6	1,0	1,25	K/W
with heatsink compound	$R_{th\ mb-h}$	0,1	0,3	0,5	K/W

INSTRUCTIONS FOR DIRECT MOUNTING

The transistors should be mounted with M4 screws, see Figs 1 and 2. Minimum heatsink thickness (for good heat transfer) 1,5 mm. Hole pattern: Fig. 3.
A heatsink with tapped holes or insert nuts can also be used, but a torque washer is necessary between metal washer and transistor. See Fig. 4.



Figs 1 and 2. Direct mounting with nuts.

Legend for TO-3 mounting figures
(1) = screw
(2) = TO-3
(4) = mica
(5) = heatsink
(6) = insulating bush
(7) = metal washer
(8) = soldering tag
(9) = lock washer
(10) = nut
(11) = tapped hole
(12) = insert nut
Dimensions in mm

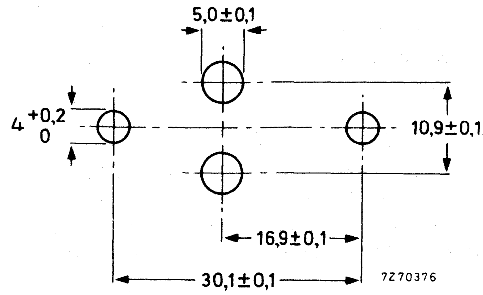


Fig. 3 Hole pattern for direct mounting with nuts.

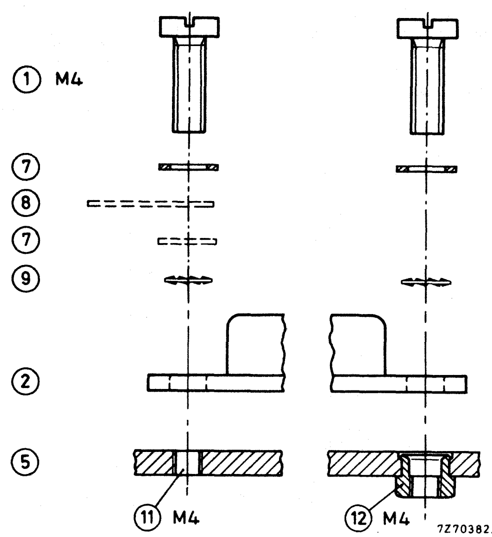


Fig. 4 Direct mounting with tapped holes or insert nuts.

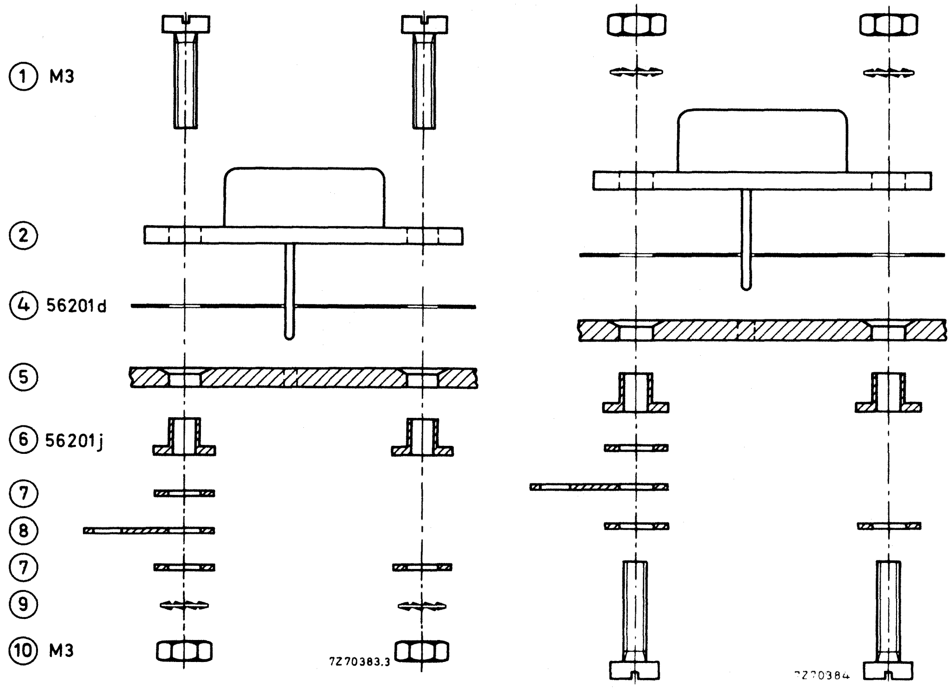
MOUNTING INSTRUCTIONS FOR UP TO 500 V INSULATION

Using insulating bushes 56201j and mica washer 56201d

For the component arrangement with minimum heatsink thickness see Figs 5 and 6. For hole pattern and shape of holes see Figs 7 and 8.

Using insulating bush 56261a and mica washer 56201d

For an arrangement with M3 screws and nuts see Fig. 9, mounting holes are given in Figs 7 and 8. The accessories can also be used in combination with M3 screws and heatsinks provided with tapped holes or insert nuts. Lock washers are necessary between screw-head and metal washer, see Fig. 10. For an assembly drawing with tapped holes see Fig. 11, with insert nuts see Fig. 12.



Figs 5 and 6. Insulated mounting (500 V) with 56201j and 56201d. Heatsink thickness: 1,5 to 2,5 mm.

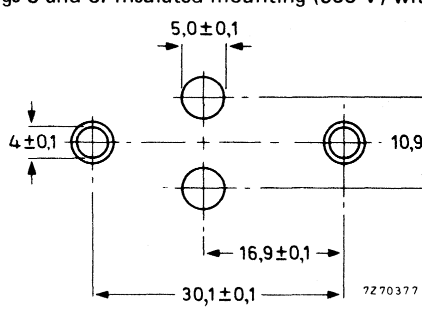


Fig. 7 Hole pattern for 500 V insulation, nut fastening.

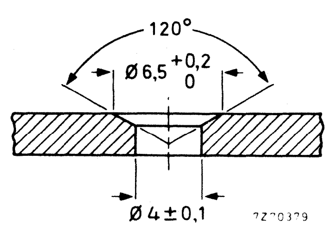


Fig. 8 Shape of hole for 500 V insulation, nut fastening.

For legend see page 652.

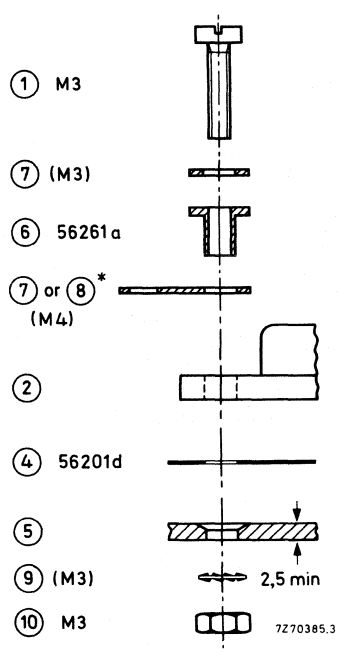


Fig. 9 Insulated mounting (500 V) with nuts.

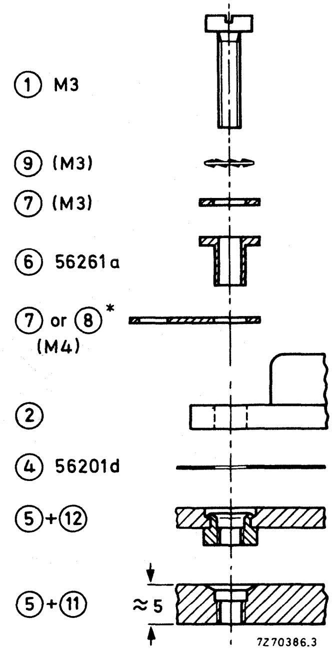


Fig. 10 Insulated mounting (500 V) with tapped holes or insert nuts.

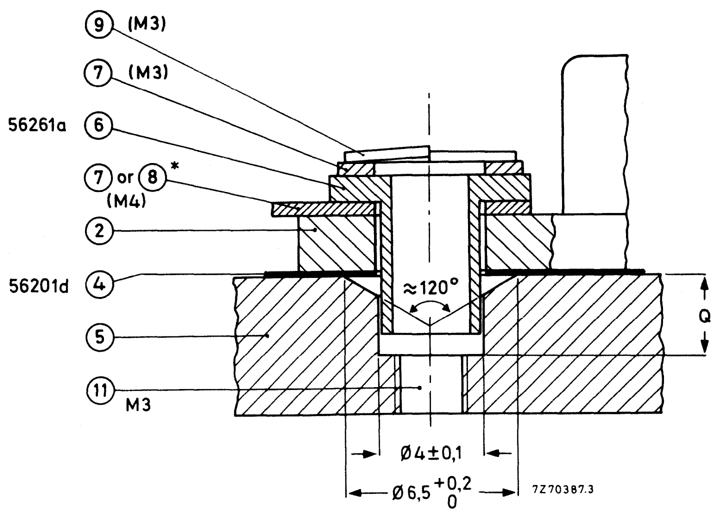


Fig. 11 Assembly (partial) for Fig. 10 - tapped holes.
Q minimum 2,5 mm.

For legend see page 652.

* Thickness approximately 0,6 mm, outer diameter 7,5 mm.

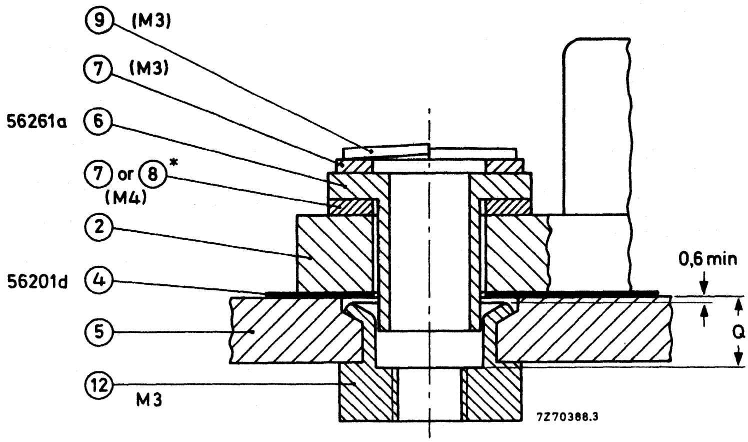


Fig. 12 Assembly (partial) for Fig. 10 - insert nuts Q minimum 2,5 mm.

For legend see page 652.

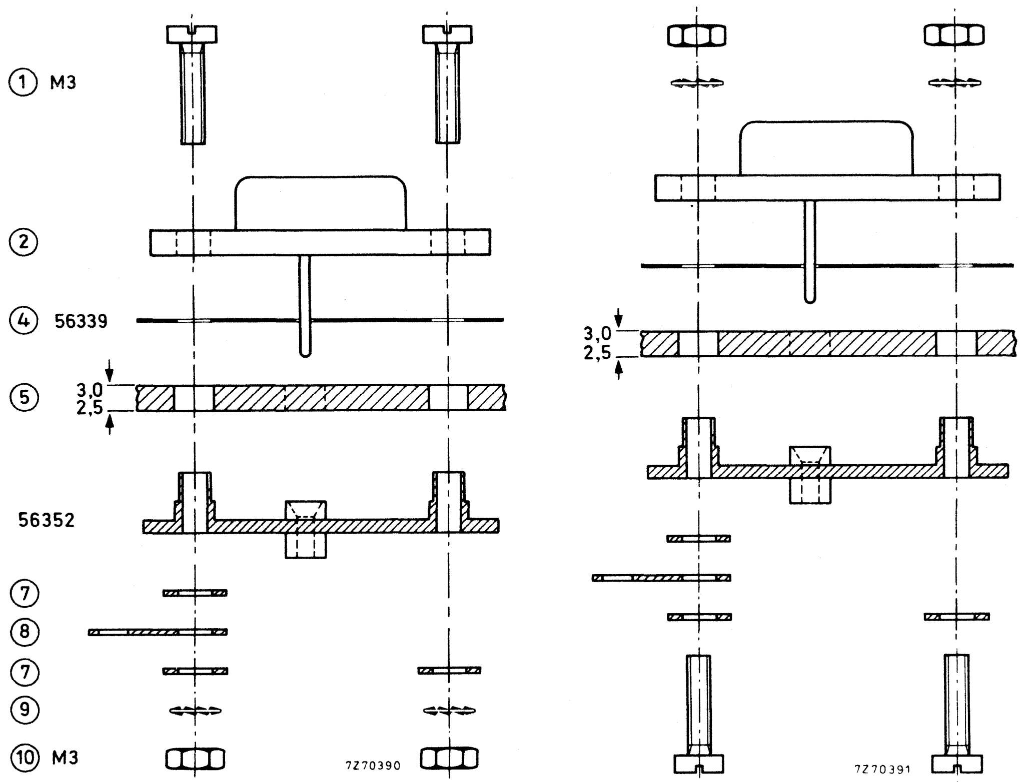
Dimensions in mm

* Thickness approximately 0,6 mm, outer diameter 7,5 mm.

MOUNTING INSTRUCTIONS FOR 500 V TO 2000 V INSULATION

Using mounting support 56352 and mica washer 56339

The transistor should be mounted with M3 screws. For component arrangement see Figs 13 and 14. For hole pattern see Fig. 15. Thickness of heatsink 2,5 mm to 3 mm.



Figs 13 and 14. Insulated mounting (500 V—2000 V).

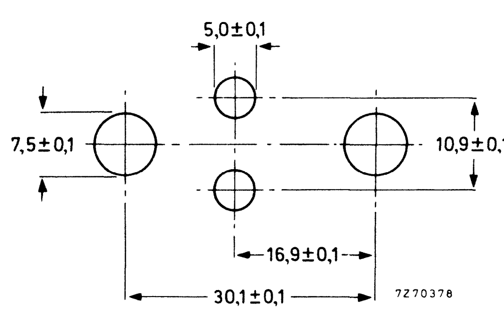


Fig. 15 Hole pattern for Figs 13 and 14.

For legend see page 652.

MOUNTING INSTRUCTIONS
FOR TO-126 AND SOT82 ENVELOPES

GENERAL DATA AND INSTRUCTIONS

General rules

1. First fasten the devices to the heatsink before soldering the leads.
2. Avoid axial stress to the leads.
3. Keep mounting tool (e.g. screwdriver) clear of the plastic body.

Heatsink requirements

Minimum thickness: 2 mm.
Flatness in the mounting area: 0,02 mm maximum deviation per 10 mm.
Mounting holes must be deburred and should also be perpendicular to the plane of the heatsink, within 10^{o} tolerance for M2,5 thread and within 2^{o} tolerance for M3 thread. If the hole in the heatsink is threaded, it should be counter-sunk and free of burrs.

Heatsink compound

Values of the thermal resistance from mounting base to heatsink ($R_{th\ mb\text{-}h}$) given for mounting with heatsink compound refer to the use of a metallic oxide-loaded compound. Ordinary silicone grease is not recommended.

For insulated mounting, the compound should be applied to the bottom of both device and insulator.

Mounting methods for power transistors

1. Clip mounting (TO-126 and SOT82)

   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

2. M2,5 and M3 screw mounting. (TO-126 only).

   The spacing washer should be inserted between screw head and body.

   Mounting torque for screw mounting:

Minimum torque (for good heat transfer)	0,4 Nm (4 kgcm)
Maximum torque (to avoid damaging the device)	0,6 Nm (6 kgcm)

   N.B. 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)	0,55 Nm (5,5 kgcm)
Maximum torque (to avoid damaging the device)	0,80 Nm (8,0 kgcm)

3. Body mounting (SOT82).

   A SOT82 envelope can be adhesive mounted or soldered into a hybrid circuit.
   For soldering a copper plate or an anodized aluminium plate with copper layer is recommended.
   When adhesive mounting is applied also a ceramic substrate may be used.

Thermal data

From mounting base to heatsink

	$R_{th\ mb\text{-}h}$ (K/W)			
	clip mounting		screw mounting	
	direct	insulated	direct	insulated
TO-126, with heatsink compound	1,0	3,0	0,5	3,0
TO-126, without heatsink compound	3,0	6,0	1,0	6,0
SOT82, with heatsink compound	0,4	2,0	–	–
SOT82, without heatsink compound	2,0	5,0	–	–

Lead bending

Maximum permissible tensile force on the body, for 5 seconds is 20 N (2 kgf).

The leads can be bent through 90° maximum, twisted or straightened. To keep forces within the above-mentioned limits, the leads are generally clamped near the body, using pliers. The leads should neither be bent nor twisted less than 2,4 mm from the body.

Lead soldering

For devices with a maximum junction temperature ⩽ 150 °C.

a. Dip or wave soldering
   Temperature ⩽ 260 °C at a distance from the body > 5 mm and for a total contact time with soldering bath or waves < 7 s.
b. Hand soldering
   Temperature at a distance from the body > 3 mm for a total contact time < 5 s is < 275 °C or < 250 °C for a total contact time of < 10 s.

The body of the device must be kept clear of 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 Sm/36 Pb/2 Ag or 60 Sn/40 Pb.
Maximum soldering temperature ⩽ 200 °C (tab-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.

INSTRUCTIONS FOR CLIP MOUNTING

Direct mounting with clip 56353

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^o to 30^o to the vertical (see Figs 1 and 2).
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 Fig. 3).

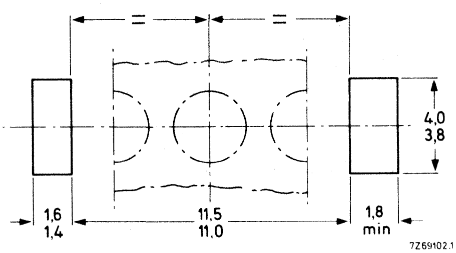


Fig. 1 Heatsink requirements.

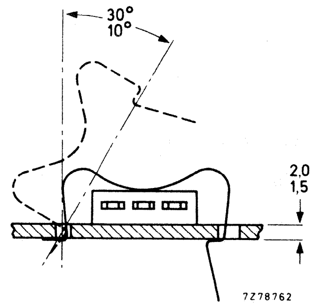


Fig. 2 Mounting spring clip.

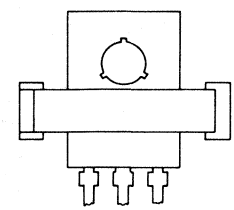


Fig. 3 Position of transistor (top view).

Insulated mounting with clip 56353 and mica 56354 (up to 1000 V insulation)

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^o to 30^o to the vertical (see Figs 4 and 5).
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 (Fig. 6). Ensure that the device is centred on the mica insulator to prevent creepage.

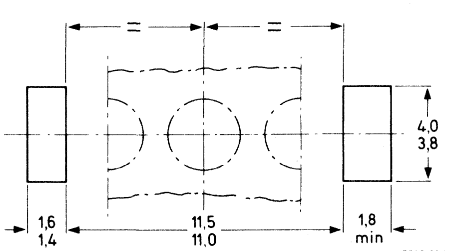
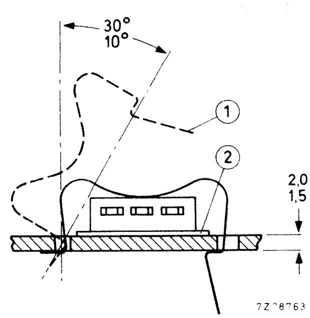


Fig. 4 Heatsink requirements.



(1) spring clip 56353.
(2) insulator 56354.
Fig. 5 Mounting.

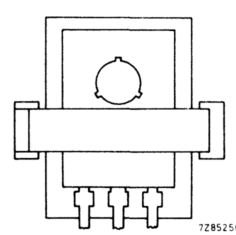


Fig. 6 Position of transistor (top view).

INSTRUCTIONS FOR SCREW MOUNTING

Dimensions in mm

Direct mounting with screw and spacing washer

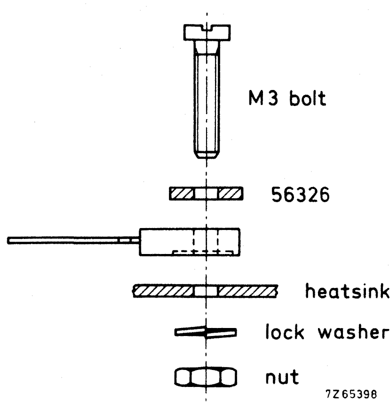


Fig. 7 Assembly through heatsink with nut.

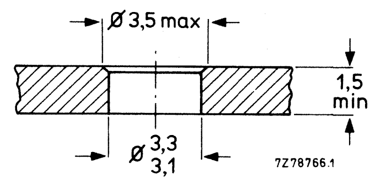


Fig. 8 Heatsink requirements.

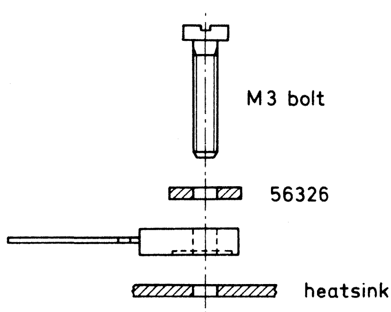


Fig. 9 Assembly into tapped heatsink.

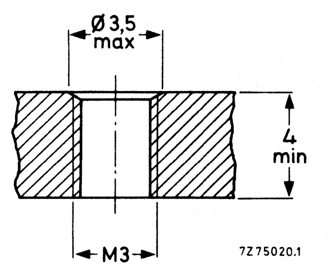
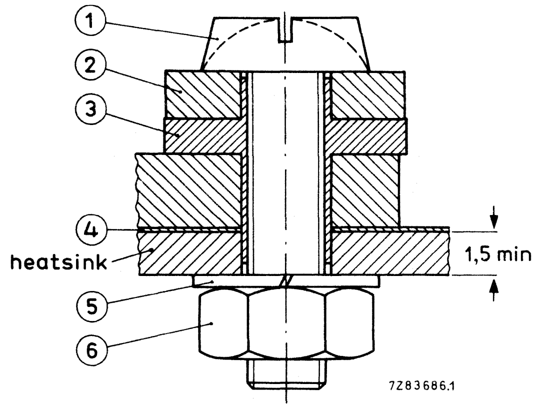


Fig. 10 Heatsink requirements.

INSTRUCTIONS FOR SCREW MOUNTING

Insulated mounting with 56326, 56387a and 56387b (up to 300 V)



(1) M2,5 screw
(2) metal washer 56326
(3) insulating bush 56387b
(4) mica washer 56387a
(5) lock washer
(6) M2,5 nut

Fig. 15 Assembly through heatsink with nut.

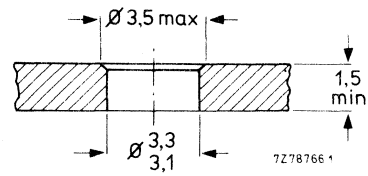
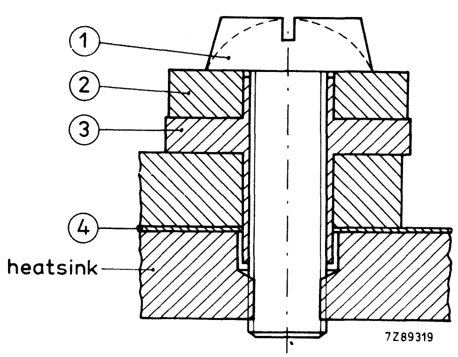


Fig. 16 Heatsink requirements.



(1) M2,5 screw
(2) metal washer 56326
(3) insulating bush 56387b
(4) mica washer 56387a

Fig. 17 Assembly with tapped heatsink.

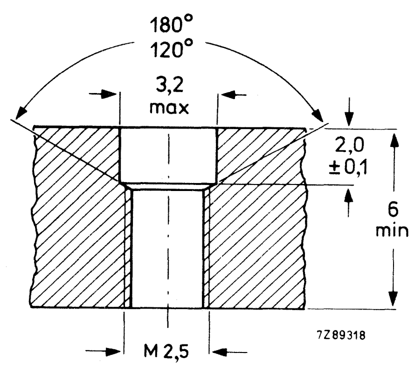


Fig. 18 Heatsink requirements.

MOUNTING INSTRUCTIONS FOR TO-220 AND SOT186 ENVELOPES

GENERAL DATA AND INSTRUCTIONS

General rules

1. First fasten the device to the heatsink before soldering the leads.
2. Avoid axial 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).

Heatsink requirements

Flatness in the mounting area: 0,02 mm maximum per 10 mm.
Mounting holes must be deburred, see further mounting instructions.

Heatsink compound

Values of the thermal resistance from mounting base to heatsink ($R_{th\ mb\text{-}h}$) given for mounting with heatsink compound refer to the use of a metallic oxide-loaded compound. Ordinary silicone grease is not recommended.

For insulated mounting, the compound should be applied to the bottom of both device and insulator.

Mounting methods for power transistors

1. Clip mounting

   Mounting with a spring clip gives:

   a. A good thermal contact under the crystal area, and slightly lower $R_{th\ mb\text{-}h}$ values than screw mounting.
   b. Safe insulation for mains operation.

2. M3 screw mounting

   It is recommended that the rectangular spacing washer is inserted between screw head and mounting tab.

   Mounting torque for screw mounting:

   (For thread-forming screws these are final values. Do not use self-tapping screws.)

Minimum torque (for good heat transfer)	0,55 Nm (5,5 kgcm)
Maximum torque (to avoid damaging the device)	0,80 Nm (8,0 kgcm)

N.B.: When a nut or screw is not driven direct against a curved spring washer or lock washer (not for thread-forming screw), the torques are as follows:

Minimum torque (for good heat transfer)	0,4 Nm (4 kgcm)
Maximum torque (to avoid damaging the device)	0,6 Nm (6 kgcm)

N.B. Data on accessories are given in separate data sheets.

3. Rivet mounting non-insulated

The device should not be pop-rivetted to the heatsink. It is permissible to press-rivet providing that eyelet rivets of soft material are used, and the press forces are slowly and carefully controlled so as to avoid shock and deformation of either heatsink or mounting tab.

Thermal data

			clip mounting	screw mounting	
From mounting base to heatsink					
with heatsink compound, direct mounting	$R_{th\ mb\text{-}h}$	=	0,3	0,5	K/W
without heatsink compound, direct mounting	$R_{th\ mb\text{-}h}$	=	1,4	1,4	K/W
with heatsink compound and 0,1 mm maximum mica washer	$R_{th\ mb\text{-}h}$	=	2,2	–	K/W
with heatsink compound and 0,25 mm maximum alumina insulator	$R_{th\ mb\text{-}h}$	=	0,8	–	K/W
with heatsink compound and 0,05 mm mica washer					
insulated up to 500 V	$R_{th\ mb\text{-}h}$	=	–	1,4	K/W
insulated up to 800 V/1000 V	$R_{th\ mb\text{-}h}$	=	–	1,6	K/W
without heatsink compound and 0,05 mm mica washer					
insulated up to 500 V	$R_{th\ mb\text{-}h}$	=	–	3,0	K/W
insulated up to 800 V/1000 V	$R_{th\ mb\text{-}h}$	=	–	4,5	K/W

Lead bending

Maximum permissible tensile force on the body, for 5 seconds is 20 N (2 kgf).

The leads can be bent through 90^{o} maximum, twisted or straightened. To keep forces within the above-mentioned limits, the leads are generally clamped near the body, using pliers. The leads should neither be bent nor twisted less than 2,4 mm from the body.

Soldering

Lead soldering temperature at > 3 mm from the body; t_{sld} < 5 s:

Devices with $T_{j\ max} \leqslant 175\ ^{o}C$, soldering temperature $T_{sld\ max} = 275\ ^{o}C$.
Devices with $T_{j\ max} \leqslant 110\ ^{o}C$, soldering temperature $T_{sld\ max} = 240\ ^{o}C$.

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.

It is not permitted to solder the metal tab of the device to a heatsink, otherwise its junction temperature rating will be exceeded.

Mounting base soldering

Recommended metal-alloy of solder paste (85% metal weight)
62 Sm/36 Pb/2 Ag or 60 Sn/40 Pb.
Maximum soldering temperature $\leqslant 200\ ^{o}C$ (tab-temperature).
Soldering cycle duration including pre-heating $\leqslant$ 30 sec.

For good soldering and avoiding damage to the encapsulation pre-heating is recommended to a temperature $\leqslant 165\ ^{o}C$ at a duration $\leqslant$ 10 s.

INSTRUCTIONS FOR CLIP MOUNTING

Direct mounting with clip 56363

1. Apply heatsink compound to the mounting base, then place the transistor 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 Figs 1 and 2).
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 Fig. 2a).

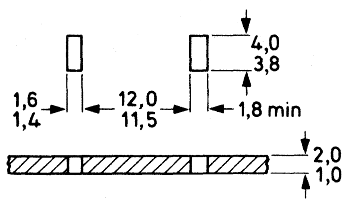
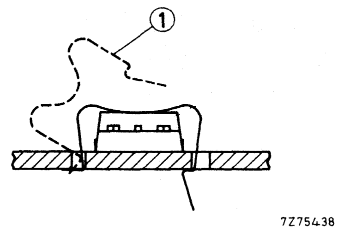


Fig. 1 Heatsink requirements.



(1) spring clip 56363.
Fig. 2 Mounting.

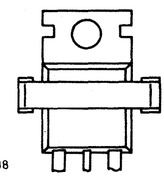


Fig. 2a Position of transistor (top view).

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 transistor and insulator, then place the transistor 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 Figs 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. Ensure that the device is centred on the mica insulator to prevent unwanted movement.

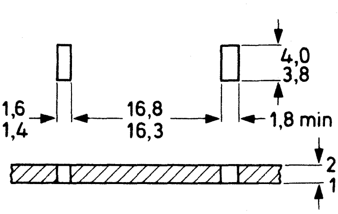
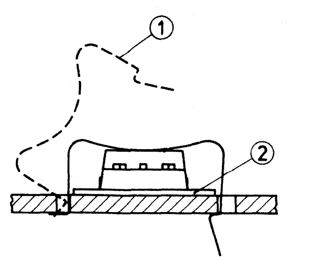


Fig. 3 Heatsink requirements.



(1) spring clip 56364.
(2) insulator 56369 or 56367.
Fig. 4 Mounting.

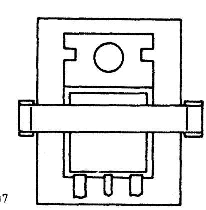


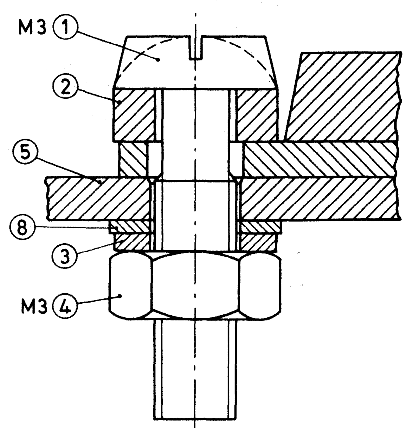
Fig. 4a Position of transistor (top view).

INSTRUCTIONS FOR SCREW MOUNTING

Dimensions in mm

Direct mounting with screw and spacing washer

- *through heatsink with nut*



(1) M3 screw.
(2) rectangular washer (56360a).
(3) lock washer.
(4) M3 nut.
(5) heatsink.
(8) plain washer.

Fig. 5 Assembly.

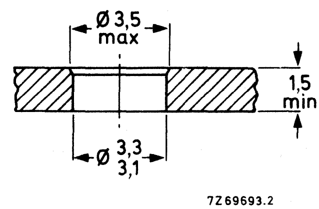
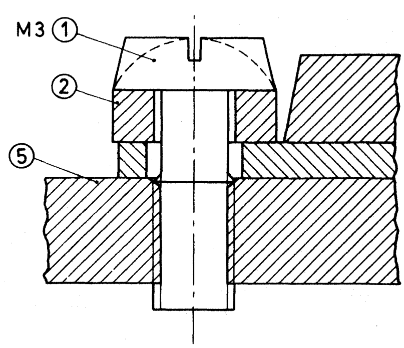


Fig. 6 Heatsink requirements.

- *into tapped heatsink*



(1) M3 screw.
(2) rectangular washer 56360a.
(5) heatsink.

Fig. 7 Assembly.

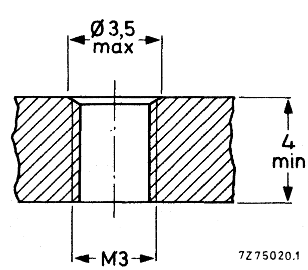


Fig. 8 Heatsink requirements.

Insulated mounting with screw and spacing washer
(not recommended where mounting tab is on mains voltage)

Dimensions in mm

- *through heatsink with nut*

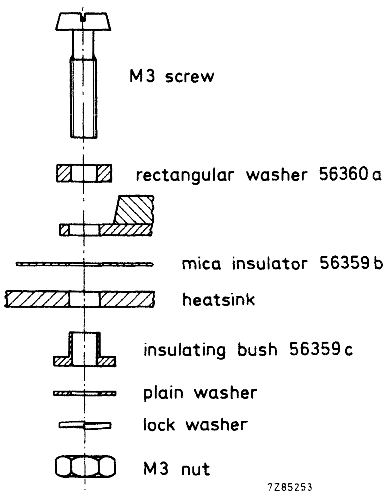


Fig. 9 Insulated screw mounting with rectangular washer. Known as a "bottom mounting".

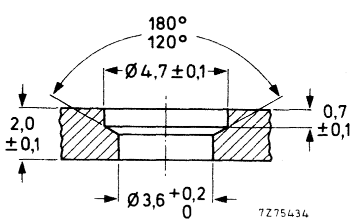


Fig. 10 Heatsink requirements for 500 V insulation.

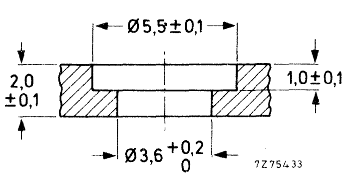


Fig. 11 Heatsink requirements for 800 V insulation.

- *into tapped heatsink*

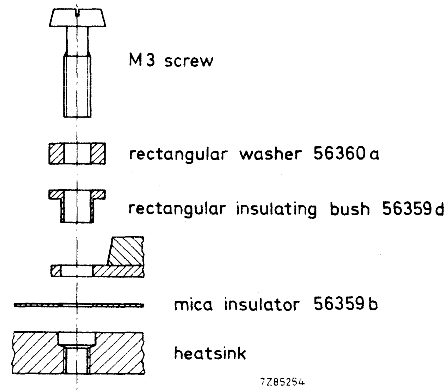


Fig. 12 Insulated screw mounting with rectangular washer into tapped heatsink. Known as a "top mounting".

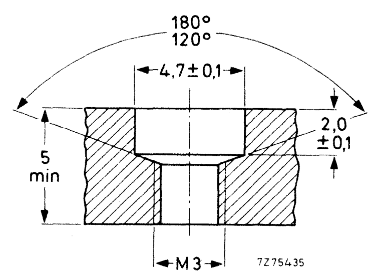


Fig. 13 Heatsink requirements for 500 V insulation.

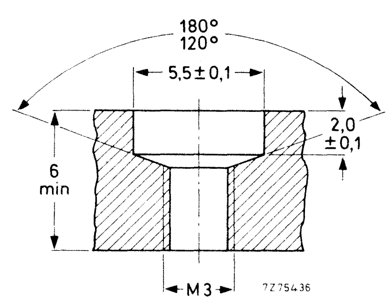


Fig. 14 Heatsink requirements for 1000 V insulation.

MOUNTING INSTRUCTIONS FOR SOT93 ENVELOPES

GENERAL DATA AND INSTRUCTIONS

General rule

Avoid any sudden forces on leads and body; these forces, such as those caused from falling on a hard surface, are easily underestimated. The direct screw mounting uses an M4 screw and the insulating mounting uses an M3 screw.

Heatsink requirements

Flatness in the mounting area: 0,02 mm maximum deviation per 10 mm.
The mounting hole must be deburred.

Heatsink compound

The thermal resistance from mounting base to heatsink ($R_{th\ mb\text{-}h}$) can be reduced by applying a metallic-oxide heatsink compound between the contact surfaces. For insulated mounting the compound should be applied to the bottom of both device and insulator.

Maximum play

The bush or the washer may only just touch the plastic part of the body, but should not exert any force on that part. Keep mounting tool (e.g. screwdriver) clear of the plastic body.

Mounting torques

For M3 screw (insulated mounting):	
Minimum torque (for good heat transfer)	0,4 Nm (4 kgcm)
Maximum torque (to avoid damaging the device)	0,6 Nm (6 kgcm)
For M4 screw (direct mounting only):	
Minimum torque (for good heat transfer)	0,4 Nm (4 kgcm)
Maximum torque (to avoid damaging the device)	1,0 Nm (10 kgcm)

Note: The M4 screw head should not touch the plastic part of the envelope.

Lead bending

Maximum permissible tensile force on the body for 5 s — 20 N (2 kgf)

No torsion is permitted at the emergence of the leads.

Bending or twisting is not permitted within a lead length of 0,3 mm.

The leads can be bent through 90° maximum, twisted or straightened; to keep forces within the above-mentioned limits, the leads are generally clamped near the body.

N.B. Data on accessories are given in chapter Accessories.

Soldering

Recommendations for devices with a maximum junction temperature rating ⩽ 175 °C:

a. 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.

b. 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.

Thermal data

			clip mounting	screw mounting
Thermal resistance from mounting base to heatsink				
direct mounting				
with heatsink compound	$R_{th\ mb-h}$	=	0,3	0,3 K/W
without heatsink compound	$R_{th\ mb-h}$	=	1,5	0,8 K/W
with 0,05 mm mica washer				
with heatsink compound	$R_{th\ mb-h}$	=	0,8	0,8 K/W
without heatsink compound	$R_{th\ mb-h}$	=	3,0	2,2 K/W

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 20° to the vertical (see Fig. 1b).
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 Fig. 1(c)).

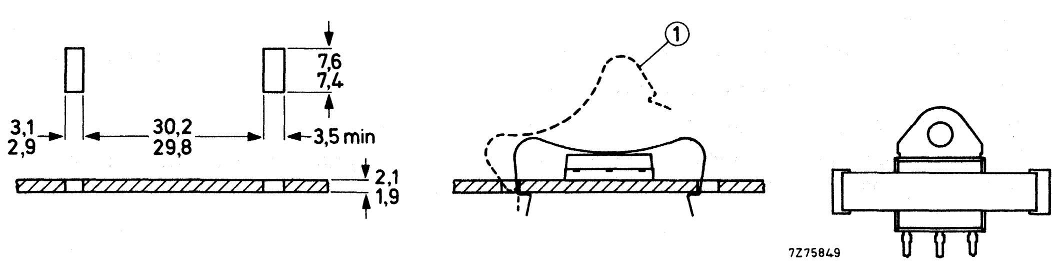


Fig. 1a Heatsink requirements.

(1) spring clip 56379.
Fig. 1b Mounting.

Fig. 1c Position of the device.

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 20° to the vertical (see Figs 2a and 2b).
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 Fig. 2c). There should be minimum 3 mm distance between the device and the edge of the insulator for adequate creepage.

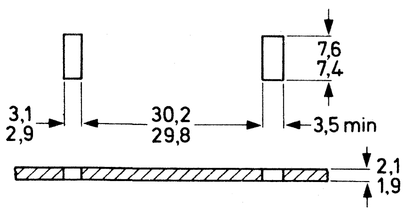
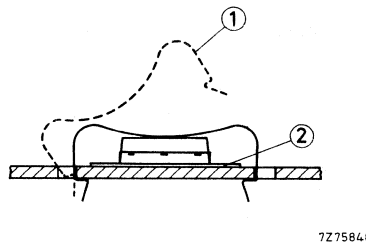


Fig. 2a Heatsink requirements.



(1) spring clip 56379
(2) insulator 56378
Fig. 2b Mounting

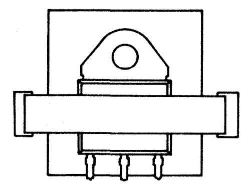
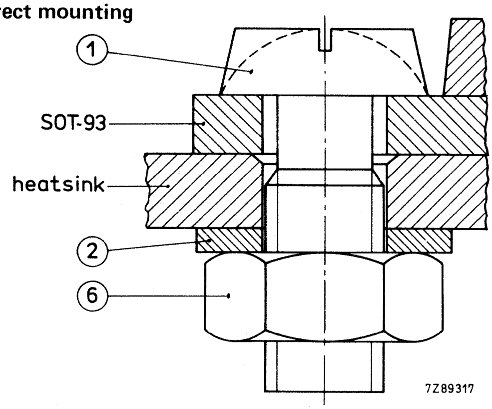


Fig. 2c Position of the device.

INSTRUCTIONS FOR SCREW MOUNTING

Direct mounting



(1) M4 screw; (2) plain washer; (6) M4 nut.
Fig. 3a Assembly through heatsink with nut.

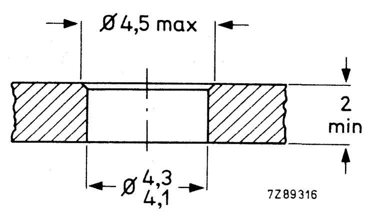
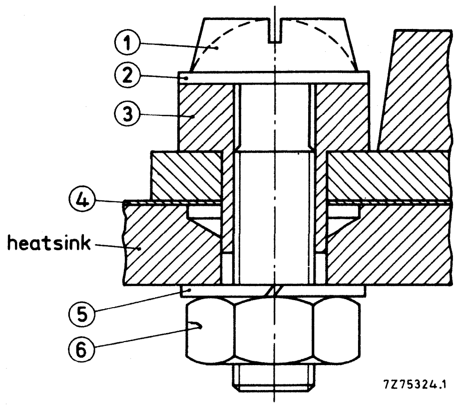


Fig. 3b Heatsink requirements.

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.

Insulated screw mounting with nut; up to 800 V.



(1) M3 screw
(2) plain washer
(3) insulating bush (56368b)
(4) mica insulator (56368a)
(5) lock washer
(6) M3 nut

Fig. 4 Assembly.
See also Fig. 9.

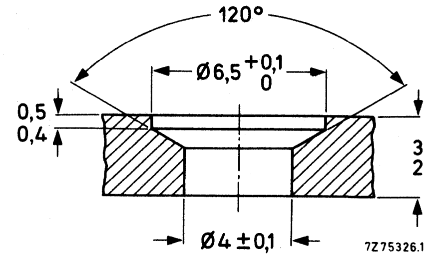


Fig. 5 Heatsink requirements
up to 800 V insulation.

Insulated screw mounting with tapped hole; up to 800 V.

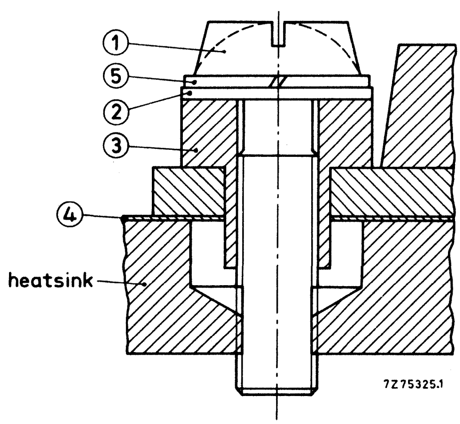
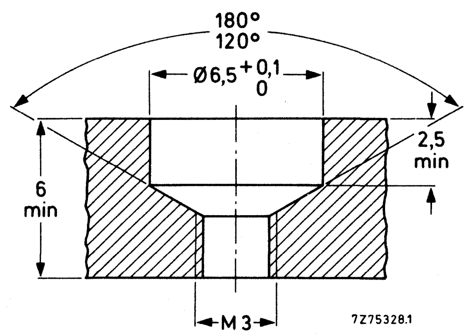


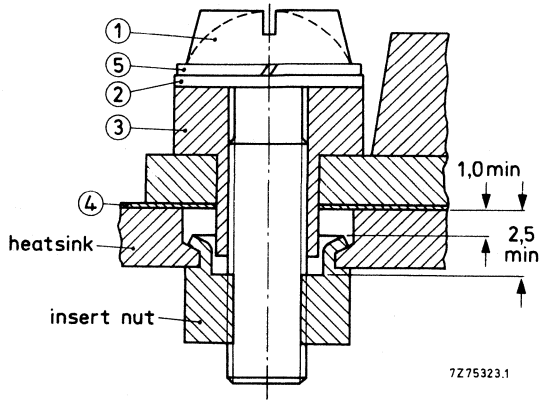
Fig. 6 Assembly.
See also Fig. 9.



(1) M3 screw
(2) plain washer
(3) insulating bush (56368b)
(4) mica insulator (56368a)
(5) lock washer

Fig. 7 Heatsink requirements
up to 800 V insulation.

Insulated screw mounting with insert nut; up to 500 V



(1) M3 screw
(2) plain washer
(3) insulating bush (56368b)
(4) mica insulator (56368a)
(5) lock washer

Fig. 8 Assembly and heatsink requirements for 500 V insulation. See also Fig. 3.

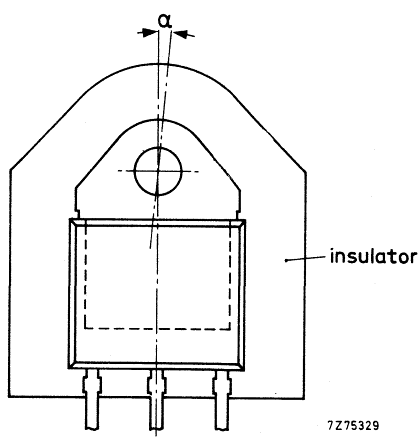


Fig. 9 Mica insulator.

The axial deviation (α) between SOT93 and mica should not exceed 5°.

INDEX OF TYPE NUMBERS

The inclusion of a type number in this publication does not necessarily imply its availability.

Key to handbook sections

A = Accessories
FET = Field-effect transistors
I = Infrared devices
LED = Light-emitting diodes
LCD = Liquid crystal displays
Mm = Surface-mounted devices
M = Microwave transistors
P = Low-frequency power transistors and modules
PDT = Photodiodes or transistors
Ph = Photoconductive devices
PhC = Photocouplers
PM = PowerMOS transistors
R = Rectifier diodes
RFP = RF power transistors and modules
RT = Triplers
SEN = Semiconductor sensors
SD = Small-signal diodes
Sm = Small-signal transistors
Sp = Special diodes
SP = Low-frequency switching power diodes
St = Rectifier stacks
T = Tuner diodes
Th = Thyristors
Tri = Triacs
TS = Transient suppressor diodes
Vrf = Voltage reference diodes
Vrg = Voltage regulator diodes
WBT = Wideband hybrid IC transistors
WBM = Wideband hybrid IC modules

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