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High-voltage and Switching Power transistors

Philips Components



PHILIPS

HIGH-VOLTAGE AND SWITCHING POWER TRANSISTORS

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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
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TIP47	350	250	1	40	TO-220AB
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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
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SELECTION GUIDE

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
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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

SELECTION GUIDE

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

SELECTION GUIDE

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

SELECTION GUIDE

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 NUMBER SURVEY

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

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

$V_{CBmax} (I_E = 0)$ 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 $\frac{R_B}{R_E} \leq y$ which are equivalent conditions under which the device may be cut-off.

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

TRANSISTOR RATINGS

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.

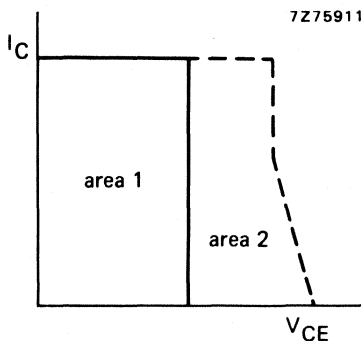


Fig. 1 Permissible operation areas.

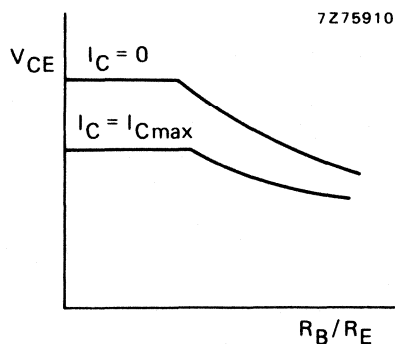


Fig. 2 Effect of collector current on permissible operation areas.

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.

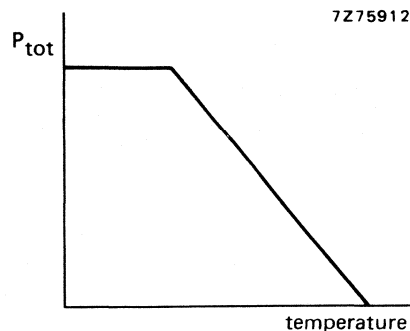


Fig. 3 Permissible total power dissipation.

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.

TRANSISTOR RATINGS

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

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

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

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

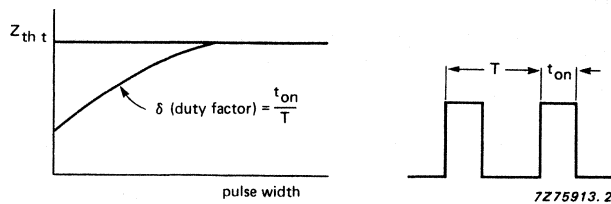


Fig. 4 Pulse power operation.

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

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

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

Temperature ratings

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

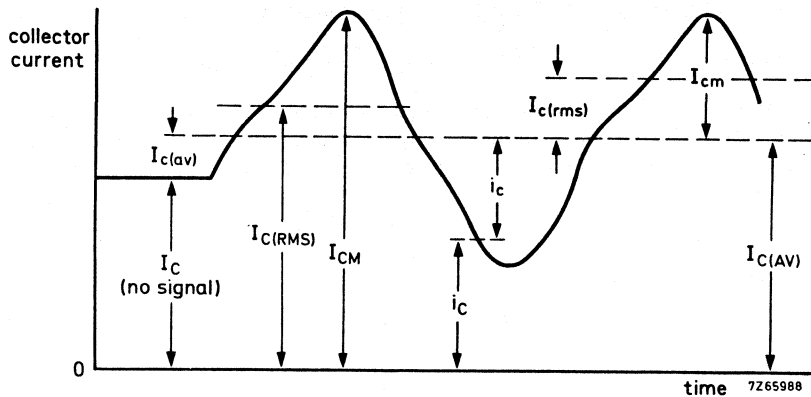
For multiple unit devices, the subscripts are modified by a number preceding the letter subscript; in the case of multiple subscripts, hyphens may be necessary to avoid misunderstanding.

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

Definition

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

Basic letters

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

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

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

- a) electrical parameters of external circuits and of circuits in which the device forms only a part;
- b) all inductances and capacitances.

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

Subscripts

General subscripts

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

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

Examples: Z_S , h_I , 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: $\text{Re}(h_{ib})$ etc. for the real part of h_{ib}
 $\text{Im}(h_{ib})$ etc. for the imaginary part of h_{ib}

TRANSISTOR SAFE OPERATING AREA (SOAR)

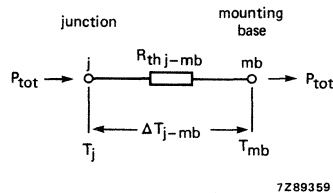
There are two main limiting factors which affect the power handling ability of a transistor; the average junction temperature and the second-breakdown.

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 $R_{th\ j-mb}$ between junction and mounting base, see Fig. 1.



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

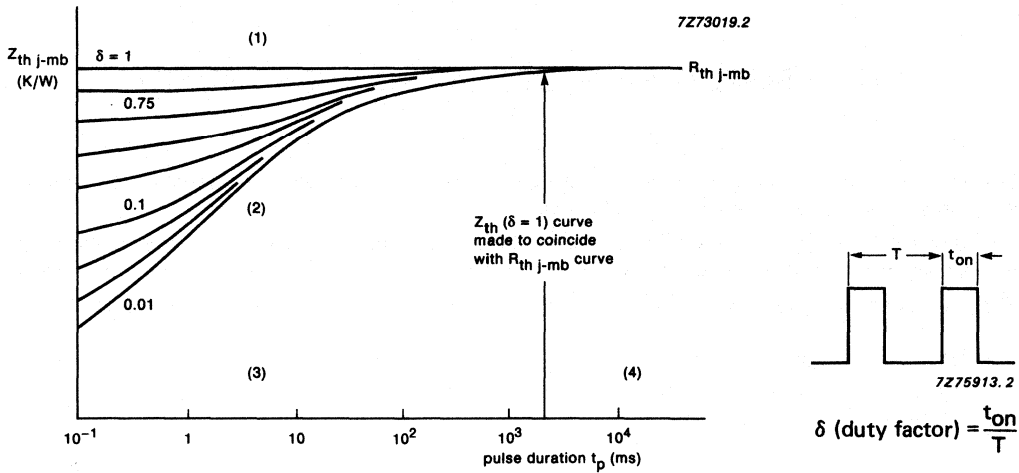
For steady-state (DC) operation the junction temperature will increase to:

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

For pulse operation the junction temperature will be:

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

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 $Z_{th\ j-mb}$ curves for a power transistor.

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

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

Maximum allowable dissipation

Total power dissipation in a transistor is given by:

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

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);

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

For pulsed conditions;

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

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

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

For pulsed conditions

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

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

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 $V_{\text{CE}} > V_{\text{CEO max}}$
- 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.

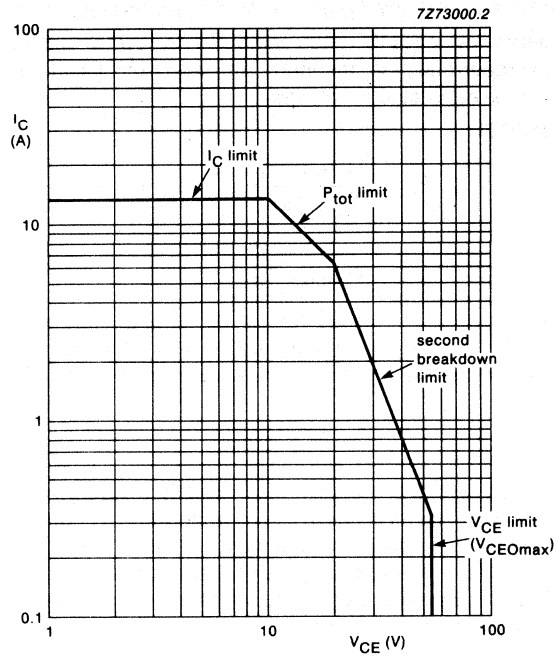
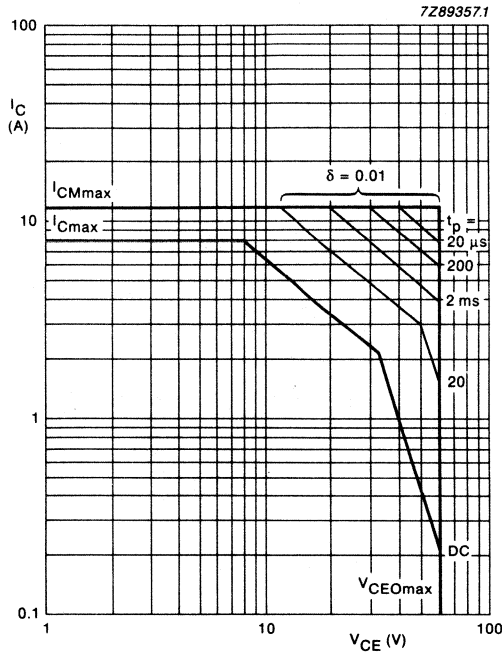


Fig. 3 A typical DC SOAR graph with boundaries defined.

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.

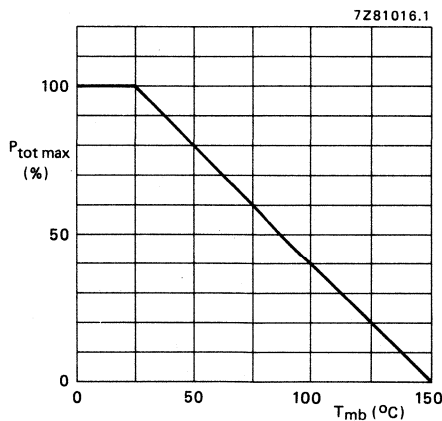
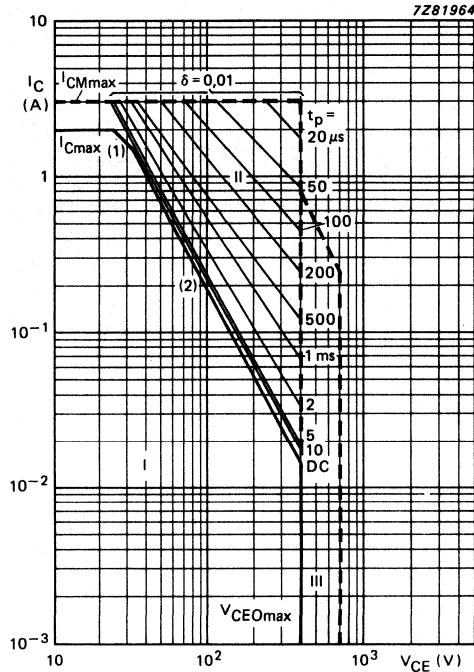


Fig. 5 Power derating curve, maximum permissible dissipation as a function of mounting base temperature.

FORWARD BIASED SAFE OPERATING AREA WITH $V_{CE} > V_{CE0max}$



- 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 $R_{BE} \leq 100 \Omega$ and $t_p \leq 6.0 \mu s$.

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

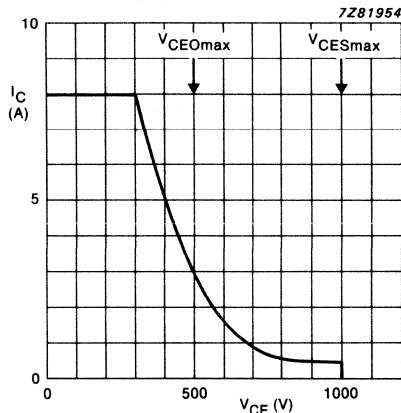
For switching power transistors in inductive load applications such as flyback converters, the collector-emitter voltage normally exceeds the rated V_{CE0max} limit in the non-inductive stage. The collector current will rise steeply at turn on while the collector-emitter voltage is still greater than V_{CE0max} . Under these conditions the collector current must be held 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 $T_{mb} \leq 100$ °C; $V_{BE\ off} = 5$ V; $I_C/I_B \geq 5$.

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 t_T |

Now determine the following parameters for the intended application.

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

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

For direct mounted devices:

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

For fully isolated devices:

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

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

For direct mounted devices:

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

For fully isolated devices:

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

SOAR

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 preferred transistor does not fit, select the nearest suitable device or modify the circuitry.

TRANSISTOR DATA

DEVELOPMENT DATA

This data sheet contains advance information and specifications are subject to change without notice.

BU306F
BU307F

SILICON DIFFUSED POWER TRANSISTORS

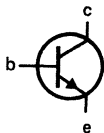
High-voltage, high-speed, glass-passivated npn power transistor in a SOT186 envelope with electrically isolated mounting base, intended for use in switching regulators, inverters, motor controls, solenoid/relay drivers and deflection circuits.

QUICK REFERENCE DATA

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

MECHANICAL DATA

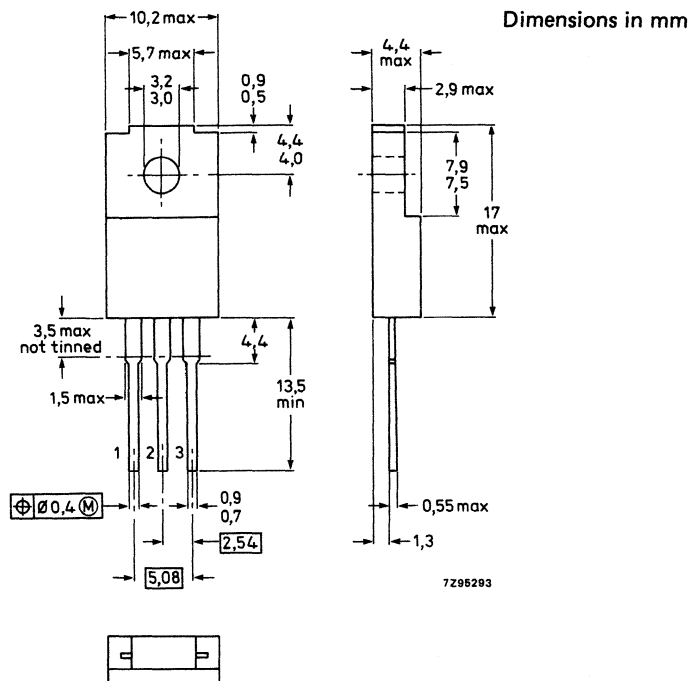
Fig. 1 SOT186.



Pinning:

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

Mounting base is electrically isolated from all terminals.



RATINGS

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

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

THERMAL RESISTANCE

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

ISOLATION

Isolation voltage from all terminals to external heatsink (peak value)	V_{isol}	max.	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

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

Collector cut-off current

$V_{CE} = V_{CESmax}; V_{BE} = -1.5\text{ V}$

$V_{CE} = V_{CESmax}; V_{BE} = -1.5\text{ V}; T_j = 100\text{ }^\circ\text{C}$

I_{CES}	max.	1.0	mA
I_{CES}	max.	5.0	mA

Emitter cut-off current

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

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

Current gain

$I_C = 0.5\text{ A}; V_{CE} = 5\text{ V}$

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

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

h_{FE}		15 to 50	
h_{FE}		8 to 40	
h_{FE}		6 to 30	

Collector-emitter saturation voltage

$I_C = 2\text{ A}; I_B = 0.4\text{ A}$

$I_C = 5\text{ A}; I_B = 1.0\text{ A}$

$I_C = 8\text{ A}; I_B = 2.0\text{ A}$

$I_C = 5\text{ A}; I_B = 1.0\text{ A}; T_j = 100\text{ }^\circ\text{C}$

V_{CEsat}	max.	1.0	V
V_{CEsat}	max.	1.5	V
V_{CEsat}	max.	3.0	V
V_{CEsat}	max.	2.0	V

Base-emitter saturation voltage

$I_C = 2\text{ A}; I_B = 0.4\text{ A}$

$I_C = 5\text{ A}; I_B = 1.0\text{ A}$

$I_C = 5\text{ A}; I_B = 1.0\text{ A}; T_j = 100\text{ }^\circ\text{C}$

V_{BEsat}	max.	1.2	V
V_{BEsat}	max.	1.6	V
V_{BEsat}	max.	1.5	V

Transition frequency

$I_C = 0.5\text{ A}; V_{CE} = 10\text{ V}; f = 1\text{ MHz}$

f_T	typ.	4.0	MHz
-------	------	-----	-----

Collector capacitance

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

C_{cb}	typ.	80	pF
----------	------	----	----

Collector-emitter sustaining voltage
(Figs 2 and 3)

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

		BU306F 307F		
$V_{CEO\text{sust}}$	min.	300	400	V

Switching times resistive load
(Figs 4 and 5)

$V_{CC} = 125\text{ V}; I_C = 5\text{ A}; t_p = 25\text{ }\mu\text{s}$

$\delta = 0.01; I_{B\text{ on}} = I_{B\text{ off}} = 1.0\text{ A}$

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)

$I_C = 5\text{ A}; I_{B\text{ on}} = 1.0\text{ A};$

$V_{\text{clamp}} = 300\text{ V}; V_{BE} = -5\text{ V};$

$T_C = 100\text{ }^\circ\text{C}; L_B = 1\text{ }\mu\text{H}$

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

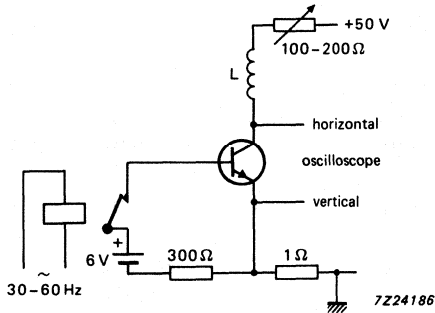


Fig. 2 Test circuit for $V_{CE0sust}$.

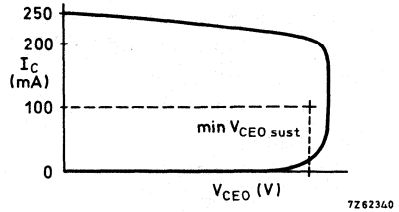


Fig. 3 Oscilloscope display for sustaining voltage.

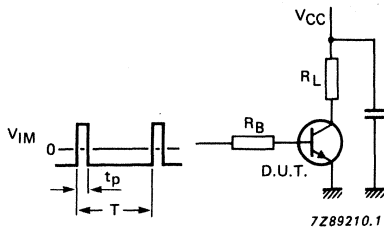


Fig. 4 Test circuit resistive load.

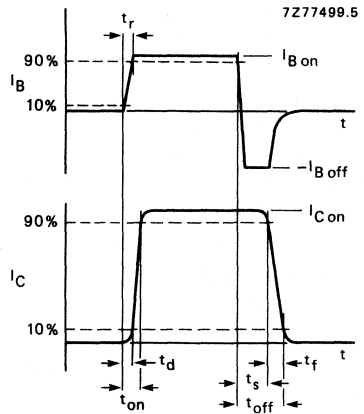


Fig. 5 Switching times waveforms with resistive load; $t_r \leq 30$ ns.

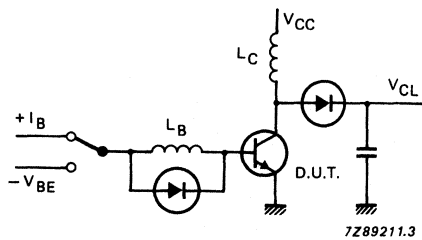


Fig. 6 Test circuit inductive load.

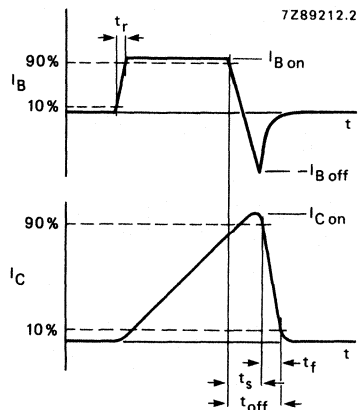


Fig. 7 Switching times waveforms with inductive load.

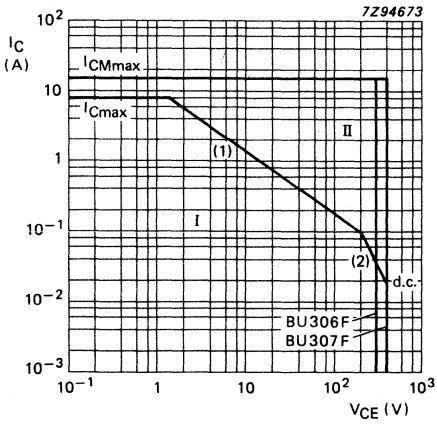


Fig. 8 Safe operating area; mounted *without* heatsink compound.

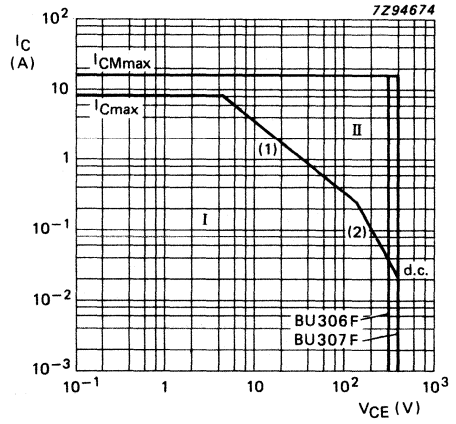


Fig. 9 Safe operating area; mounted *with* heatsink compound.

DEVELOPMENT DATA

Conditions for Figs 8 and 9:

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

(1) = $P_{tot\ max}$ line

(2) = second-breakdown limits

I = region of permissible DC operation

II = permissible extension for repetitive pulse operation

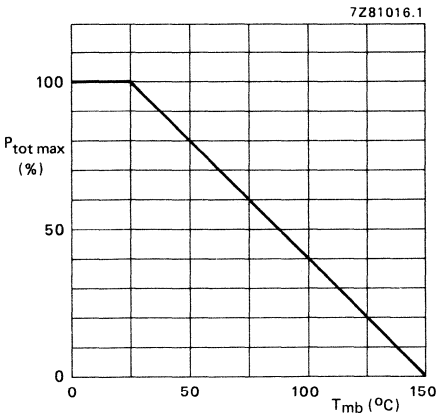


Fig. 10 Power derating curve.

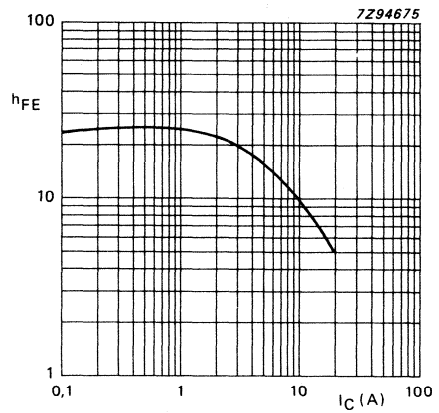


Fig. 11 DC current gain; $V_{CE} = 5\text{ V}$; $T_j = 25\text{ }^{\circ}\text{C}$.

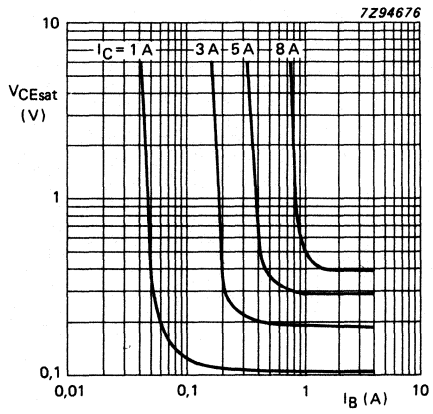


Fig. 12 Collector-emitter saturation voltage; $T_j = 25$ °C.

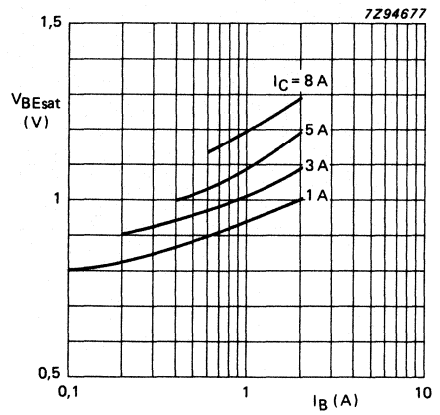


Fig. 13 Base-emitter saturation voltage; $T_j = 25$ °C.

DEVELOPMENT DATA

This data sheet contains advance information and specifications are subject to change without notice.

BU406F
BU407F

SILICON DIFFUSED POWER TRANSISTORS

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

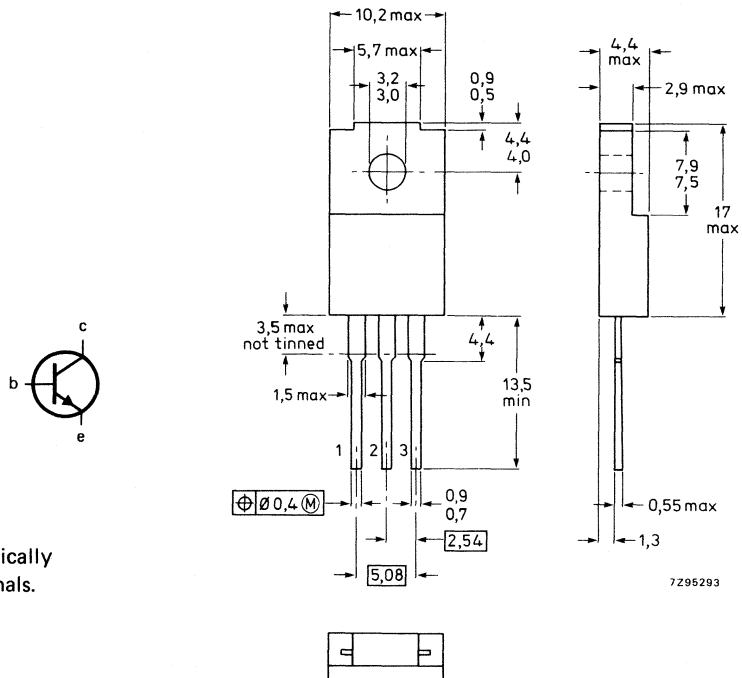
QUICK REFERENCE DATA

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

MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT186 .



Pinning:

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

Mounting base is electrically isolated from all terminals.

7295293

RATINGS

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

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

THERMAL RESISTANCE

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

ISOLATION

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

Notes

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

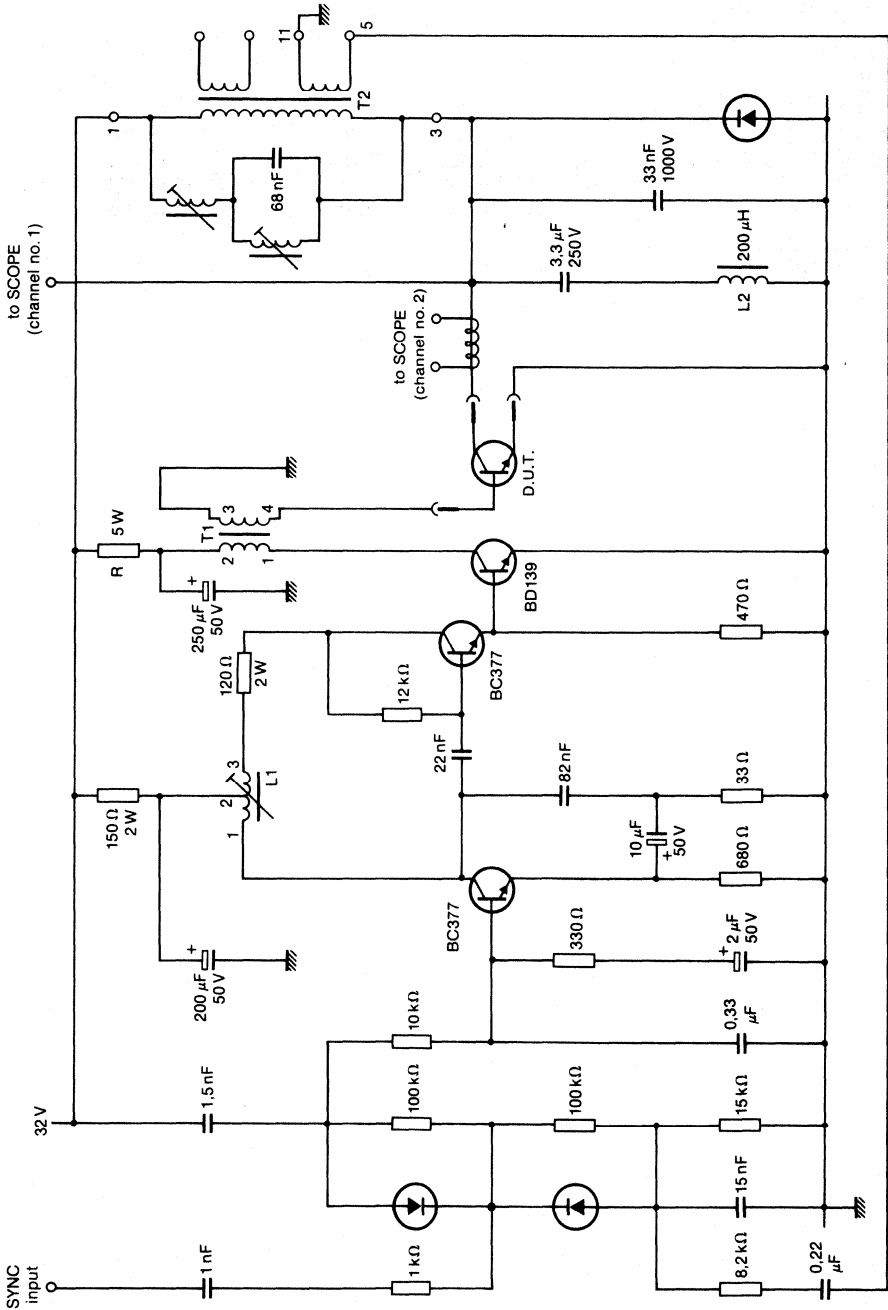
CHARACTERISTICS

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

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

DEVELOPMENT DATA

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



7281031.1

- L1 = horizontal hold coils: pins 1-2 = 75 turns (0.2 mm); pins 2-3 = 293 turns (0.2 mm); core = Si-ferrite B62120 (25 x 4 x 2 mm)
- L2 = horizontal yoke = 200 μH
- T1 = driver transformer: pins 2-1 = 125 turns (0.2 mm); pins 3-4 = 25 turns (0.4 mm); gap = 0.12 mm; core = 3E3 double E (19 x 15 x 5 mm)
- T2 = EHT transformer (ARCO type 249.065/035)
- R = 330 Ω for BU406F; 180 Ω for BU407F

Fig. 2 Test circuit inductive load.

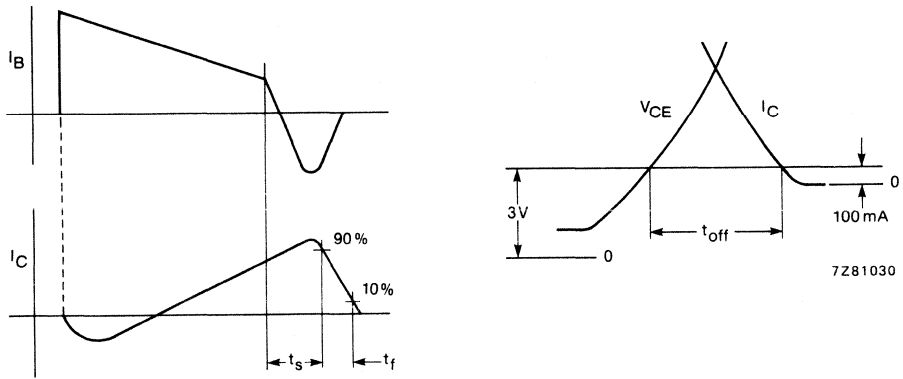


Fig. 3 Waveforms fall and storage time and turn-off time: turn-off time is the time for I_C to decrease to 100 mA after V_{CE} has risen 3 V into its flyback excursion.

DEVELOPMENT DATA

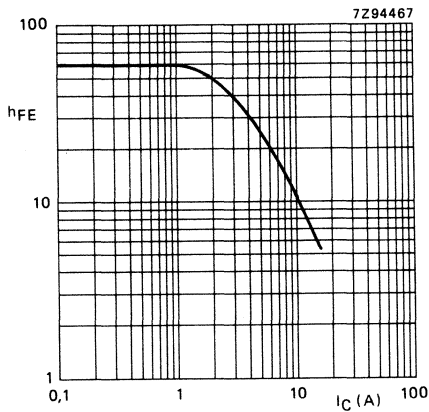


Fig. 4 BU406F: $V_{CE} = 5$ V;
 $T_j = 25$ °C; typical values.

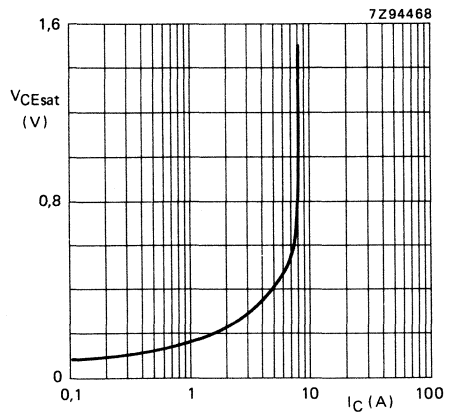


Fig. 5 BU406F: $I_C/I_B = 10$;
 $T_j = 25$ °C; typical values.

BU406F
BU407F

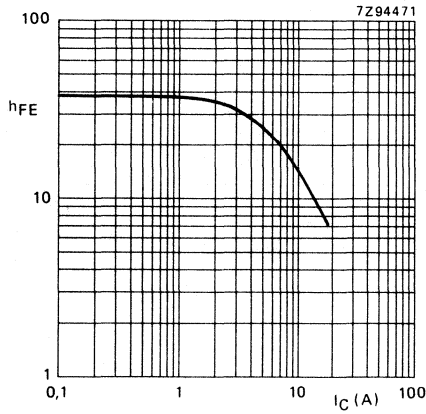


Fig. 6 BU407F: $V_{CE} = 5\text{ V}$;
 $T_j = 25\text{ }^\circ\text{C}$; typical values.

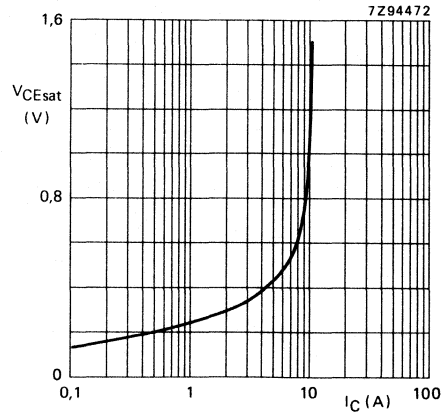


Fig. 7 BU407F: $I_C/I_B = 10$;
 $T_j = 25\text{ }^\circ\text{C}$; typical values.

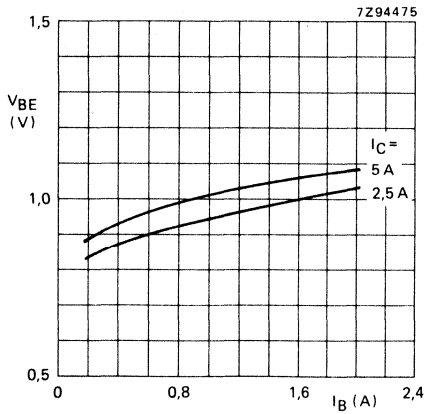


Fig. 8 BU406F/BU407F: $T_j = 25\text{ }^\circ\text{C}$;
typical values.

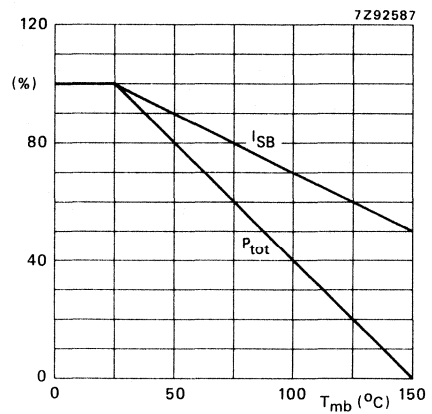
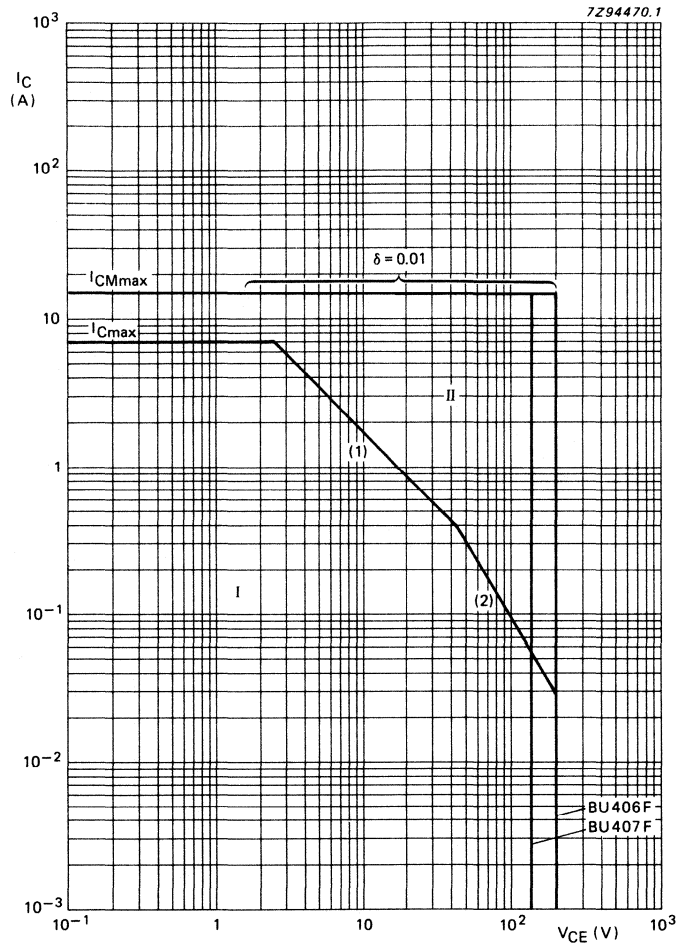


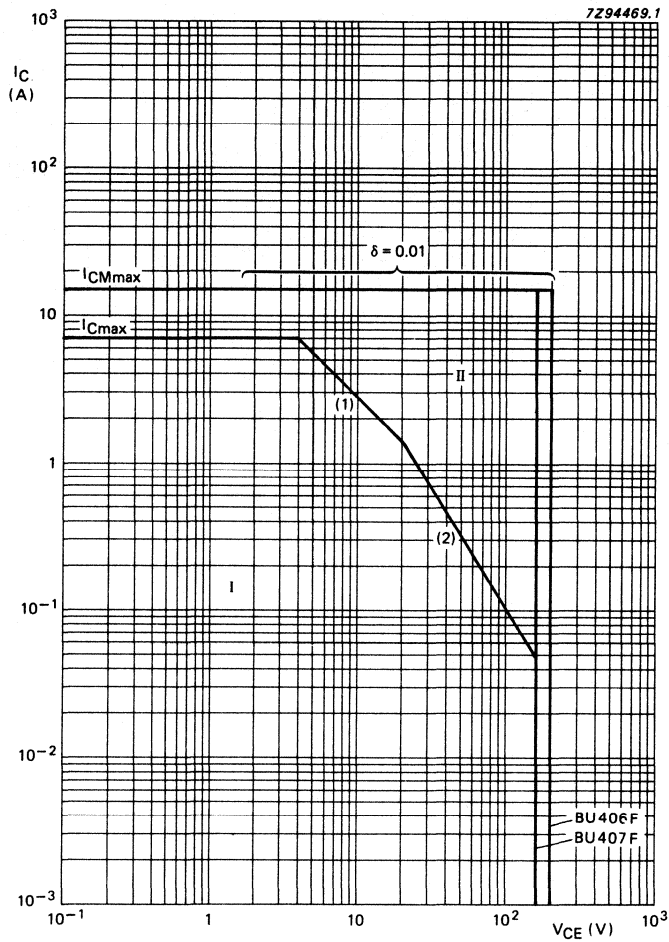
Fig. 9 BU406F/BU407F: total
power dissipation and second-
breakdown current derating curve.

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



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

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

SILICON DIFFUSED POWER TRANSISTOR

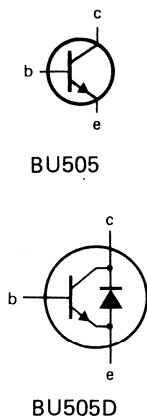
High-voltage, high-speed switching npn power transistor in a TO-220 envelope intended for use in horizontal deflection circuits of colour television receivers. The BU505D has an integrated efficiency diode.

QUICK REFERENCE DATA

Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM} V_{CEO}	max.	1500 V 700 V
Collector-emitter saturation voltage	V_{CEsat}	max.	5.0 V
Collector current saturation DC	I_{Csat} I_C	max.	2.0 A 2.5 A
peak value	I_{CM}	max.	4.0 A
Diode forward voltage (BU505D)	V_F	max.	1.8 V
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	75 W
Fall time; inductive load	t_f	typ.	0.9 μs

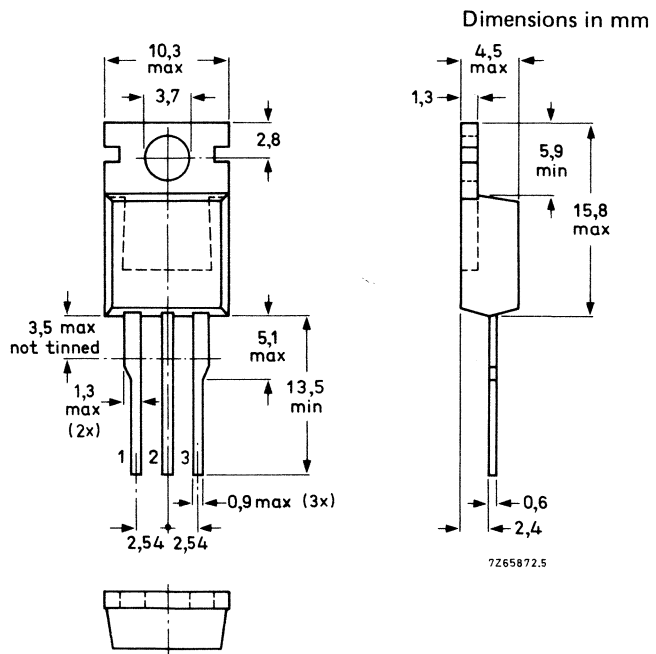
MECHANICAL DATA

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

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

Collector cut-off current*

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

Emitter cut-off current

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

Emitter-base voltage

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

Saturation voltage

 $I_C = 2.0\text{ A}; I_B = 0.9\text{ mA}$ $V_{CE_{sat}}$ max. 5.0 V $V_{BE_{sat}}$ max. 1.3 V

Diode forward voltage (BU505D)

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

Second breakdown current

 $V_{CE} = 120\text{ V}; t = 200\text{ }\mu\text{s}$ I_{SB} min. 2.0 ATransition frequency at $f = 5\text{ MHz}$ $I_C = 0.1\text{ A}; V_{CE} = 5\text{ V}$ f_T typ. 7.0 MHzCollector capacitance at $f = 1\text{ MHz}$ $I_E = I_e = 0; V_{CB} = 10\text{ V}$ C_C typ. 65 pFSwitching times (in horizontal deflection circuit)
(Fig. 4) $I_{CM} = 2\text{ V}; I_{B(end)} = 0.9\text{ A}; V_{dr} = -4\text{ V};$
 $T_{mb} = 85\text{ }^\circ\text{C}$ $L_B = 10\text{ }\mu\text{H}$ t_s typ. 6.5 μs t_f typ. 0.9 μs $L_B = 15\text{ }\mu\text{H}$ t_s typ. 7.5 μs t_f typ. 0.9 μs $L_B = 25\text{ }\mu\text{H}$ t_s typ. 9.5 μs t_f typ. 0.85 μs

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

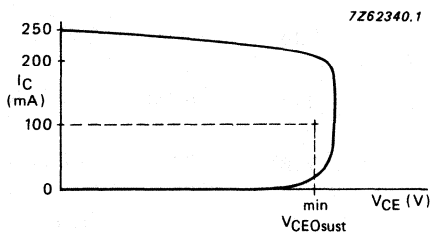


Fig. 2 Oscilloscope display for sustaining voltage.

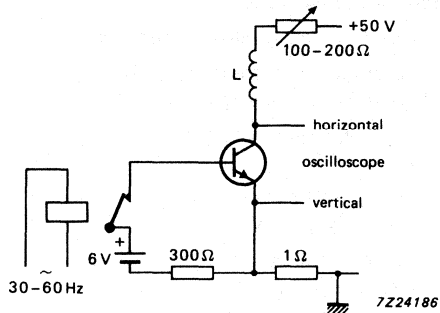


Fig. 3 Test circuit for V_{CEOsat} .

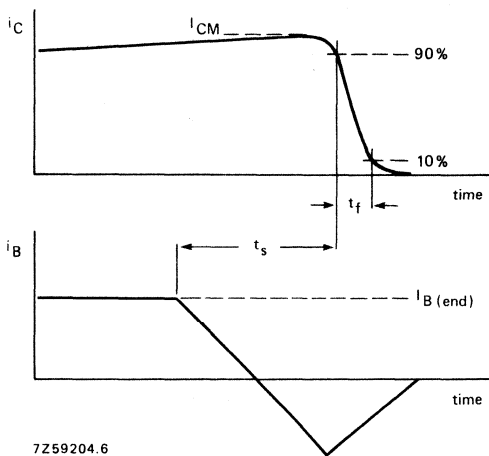


Fig. 4 Switching times waveforms.

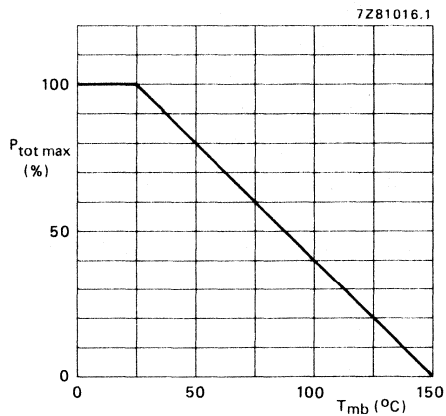
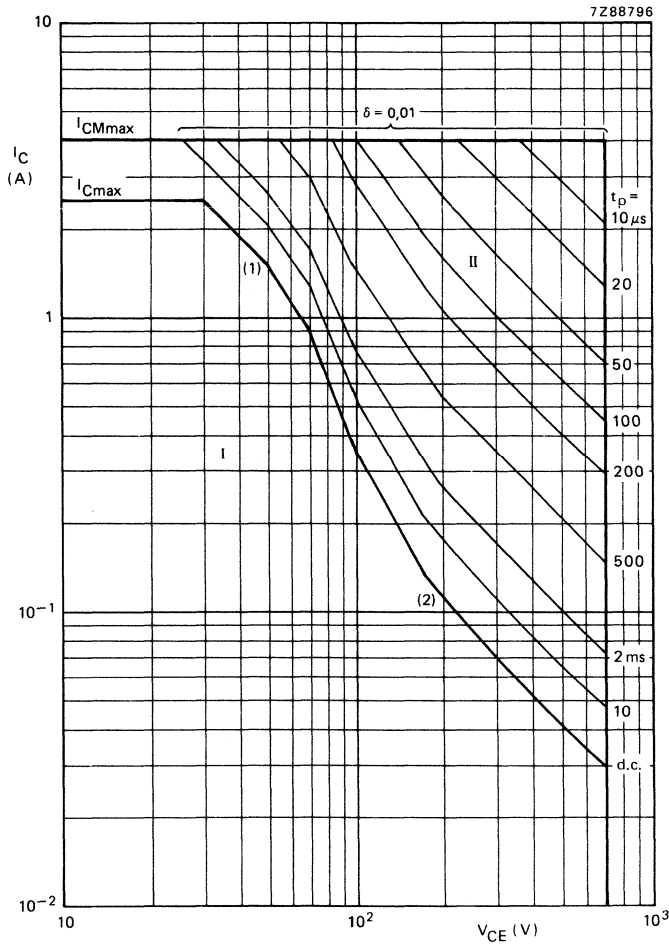


Fig. 5 Power derating curve.



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

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

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

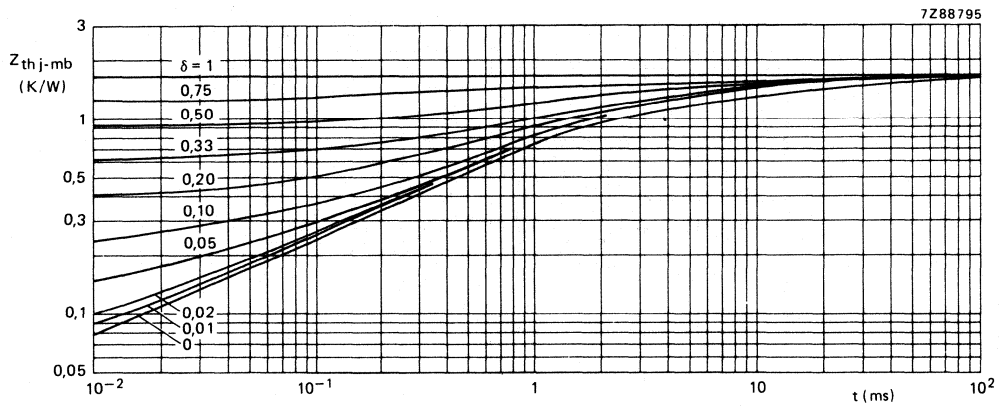


Fig. 7 Pulse power rating chart.

DEVELOPMENT DATA

This data sheet contains advance information and specifications are subject to change without notice.

BU505F
BU505DF

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.

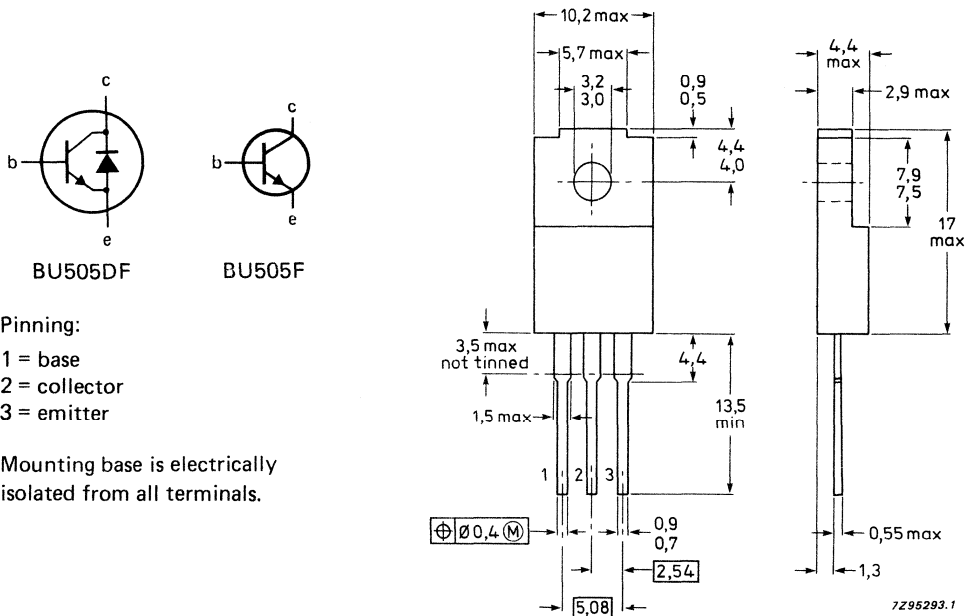
QUICK REFERENCE DATA

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 $T_h = 25^\circ C$	P_{tot}	max.	20 W
Fall time inductive load	t_f	typ.	0.7 μs

MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT186.



7295293.1

RATINGS

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

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

THERMAL RESISTANCE

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

ISOLATION

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

Notes

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

CHARACTERISTICS

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

Collector cut-off current*

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

Emitter cut-off current

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

Second-breakdown current

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

Collector-emitter sustaining voltage

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

Saturation voltage

 $I_C = 2.0\text{ A}; I_B = 0.9\text{ A}$ V_{CEsat} max. 5.0 V V_{BEsat} max. 1.3 V

Diode forward voltage (BU505DF)

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

DC current gain

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

Switching times (in horizontal deflection circuit)

(Fig. 4)

 $I_{CB} = 2\text{ V}; I_{B(end)} = 0.9\text{ A}; V_{dr} = -4\text{ V};$
 $T_{mb} = 85\text{ }^\circ\text{C}$ $L_B = 10\text{ }\mu\text{H}$ t_s typ. 6.5 μs t_f typ. 0.9 μs $L_B = 15\text{ }\mu\text{H}$ t_s typ. 7.5 μs t_f typ. 0.9 μs $L_B = 25\text{ }\mu\text{H}$ t_s typ. 9.5 μs t_f typ. 0.85 μs

DEVELOPMENT DATA

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

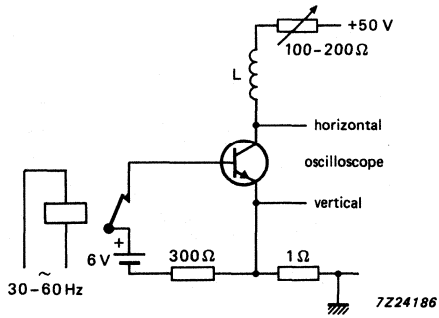


Fig. 2 Test circuit for $V_{CE0sust}$.

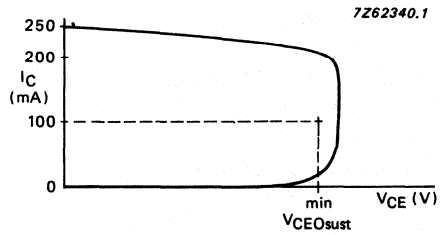


Fig. 3 Oscilloscope display for sustaining voltage.

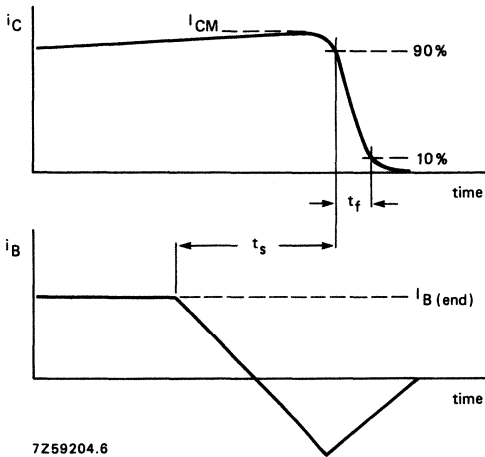


Fig. 4 Switching times waveforms.

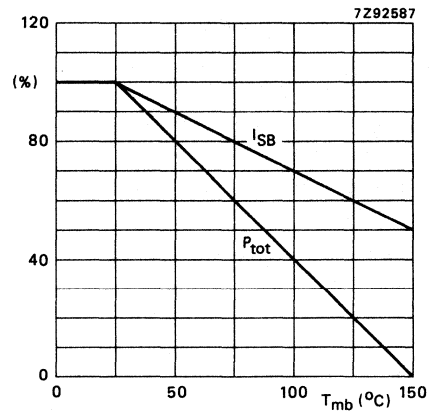
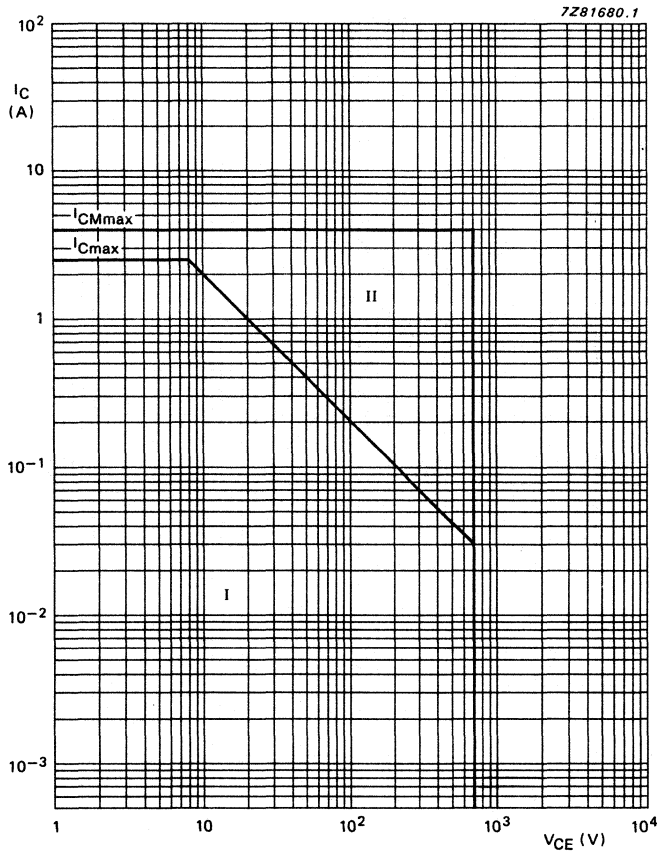


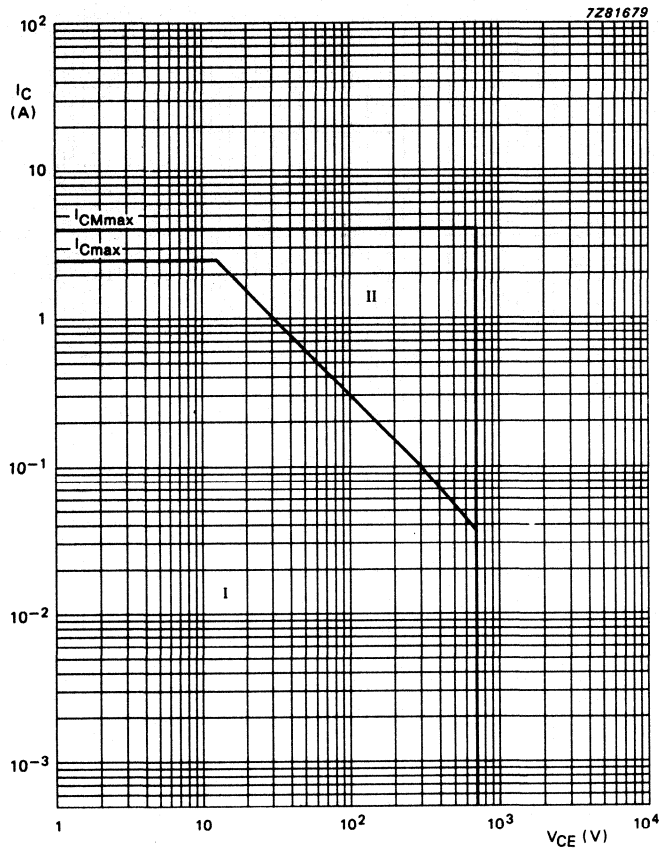
Fig. 5 Total power dissipation and second-breakdown current derating curve.

DEVELOPMENT DATA



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

Fig. 6 Safe operating area; $T_h = 25\text{ }^\circ\text{C}$; 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; $T_h = 25^\circ\text{C}$; mounted with heatsink compound and 30 ± 5 newtons pressure on the centre of the envelope.

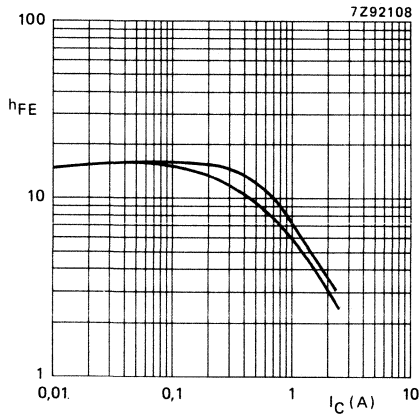


Fig. 8 Typical DC current gain.

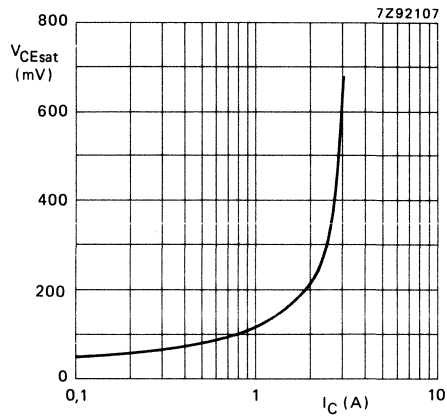


Fig. 9 Collector-emitter saturation voltage; $I_C/I_B = 2$; $T_j = 25^\circ C$.

DEVELOPMENT DATA

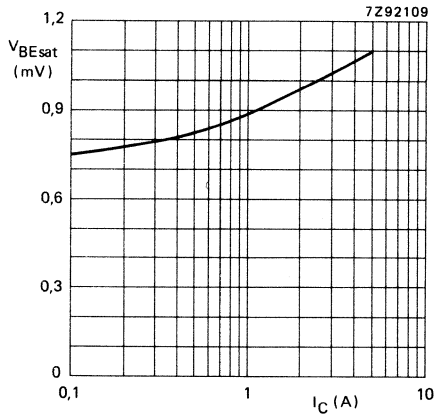


Fig. 10 Base-emitter saturation voltage; $I_C/I_B = 2$; $T_j = 25^\circ C$.

SILICON DIFFUSED POWER TRANSISTORS

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

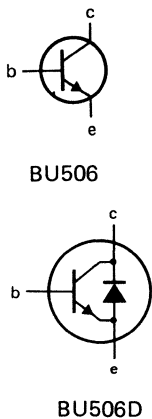
The BU506D has an integrated efficiency diode.

QUICK REFERENCE DATA

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

MECHANICAL DATA

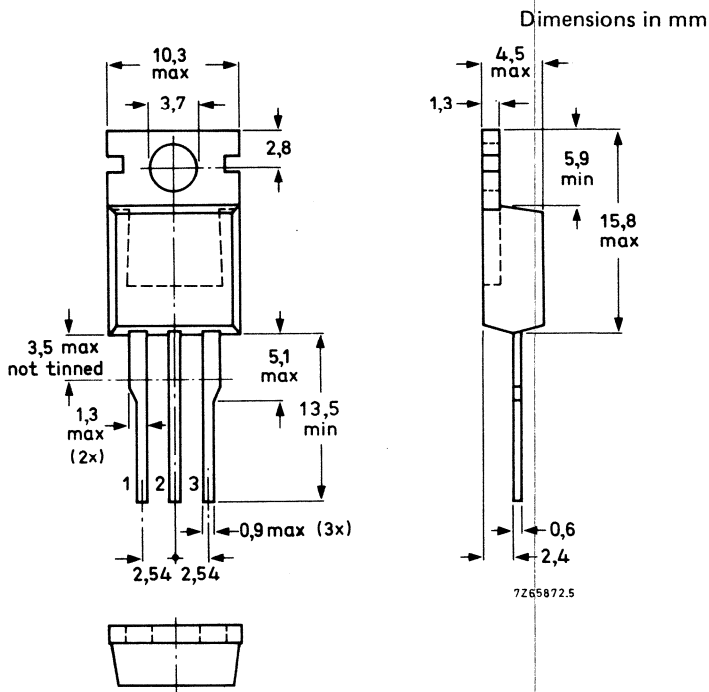
Fig. 1 TO-220AB.



Pinning:

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

Collector connected to case.



RATINGS

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

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

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

Collector cut-off current*

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

Emitter cut-off current

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

Collector-emitter sustaining voltage (Figs 2 and 3)

 $V_{CEO_{sust}}$ min. 700 V

Saturation voltage

 $I_C = 3\text{ A}; I_B = 1.33\text{ A}$ $V_{CE_{sat}}$ max. 5.0 V $V_{BE_{sat}}$ max. 1.3 V

Diode forward voltage (BU506D)

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

Second breakdown current

 $V_{CE} = 120\text{ V}; t = 100\text{ }\mu\text{s}$ I_{SB} min. 1.0 ASwitching times (in line deflection circuit)
(Fig. 4) $I_{CM} = 3\text{ A}; I_{B(end)} = 1\text{ A};$ $L_B = 12\text{ }\mu\text{H}$ t_f typ. 0.7 μs t_s typ. 6.5 μs

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

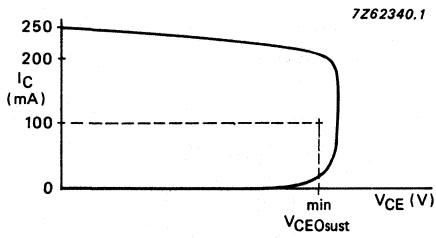


Fig. 2 Oscilloscope display for $V_{CEOsust}$.

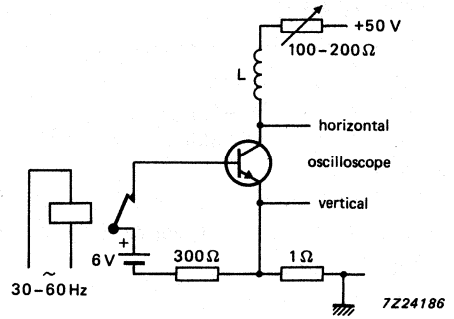


Fig. 3 Test circuit for $V_{CEOsust}$.

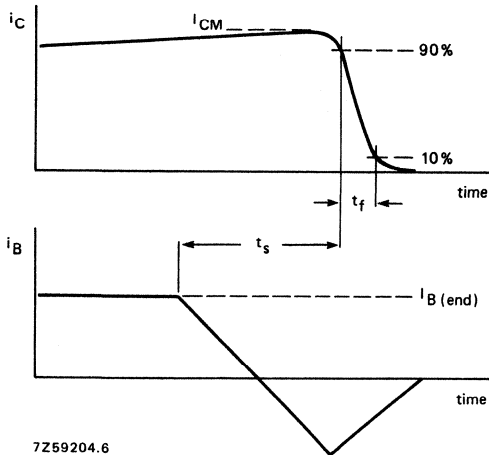


Fig. 4 Switching times waveforms.

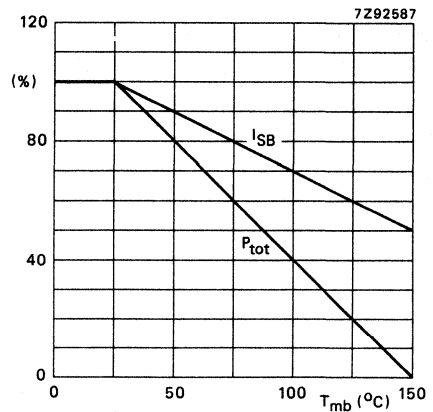
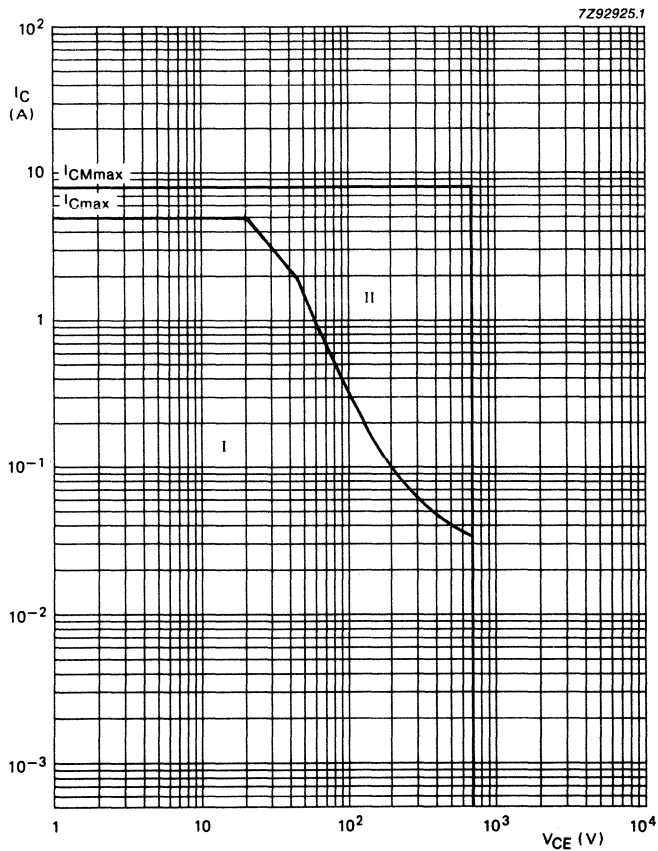


Fig. 5 Total power dissipation and second-current breakdown curve.



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

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

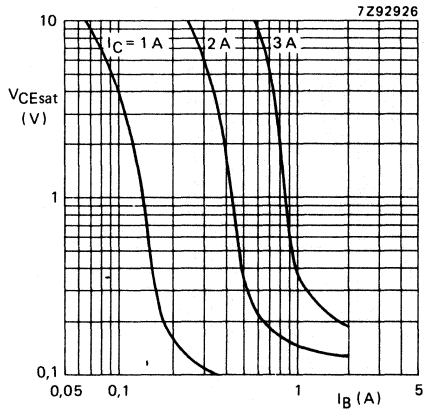


Fig. 7 Typical collector-emitter saturation voltage; $T_{mb} = 25\text{ }^{\circ}\text{C}$.

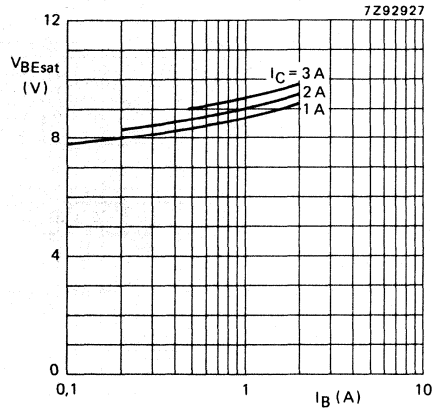


Fig. 8 Typical base-emitter saturation voltage; $T_{mb} = 25\text{ }^{\circ}\text{C}$.

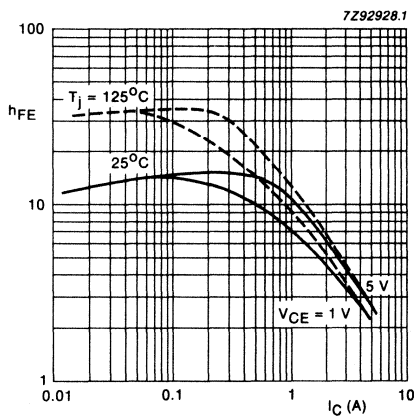


Fig. 9 Typical DC current gain.

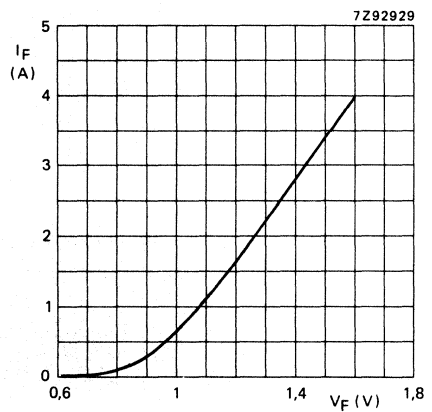


Fig. 10 Diode forward voltage; $T_{mb} = 25\text{ }^{\circ}\text{C}$.

DEVELOPMENT DATA

This data sheet contains advance information and specifications are subject to change without notice.

BU506F
BU506DF

SILICON DIFFUSED POWER TRANSISTORS

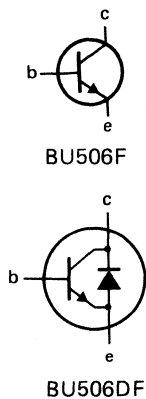
High-voltage, high-speed switching npn transistor in a SOT186 envelope, intended for use in horizontal deflection circuits of colour television receivers and in line-operated switch-mode applications. The BU506DF has an integrated efficiency diode.

QUICK REFERENCE DATA

Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM}	max.	1500 V
	V_{CEO}	max.	700 V
Collector-emitter saturation voltage	V_{CEsat}	max.	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 $T_h = 25^\circ\text{C}$	P_{tot}	max.	20 W
Diode forward voltage at $I_F = 3\text{ A}$ (BU506DF)	V_F	typ.	1.5 V
Fall time; inductive load	t_f	typ.	0.7 μs

MECHANICAL DATA

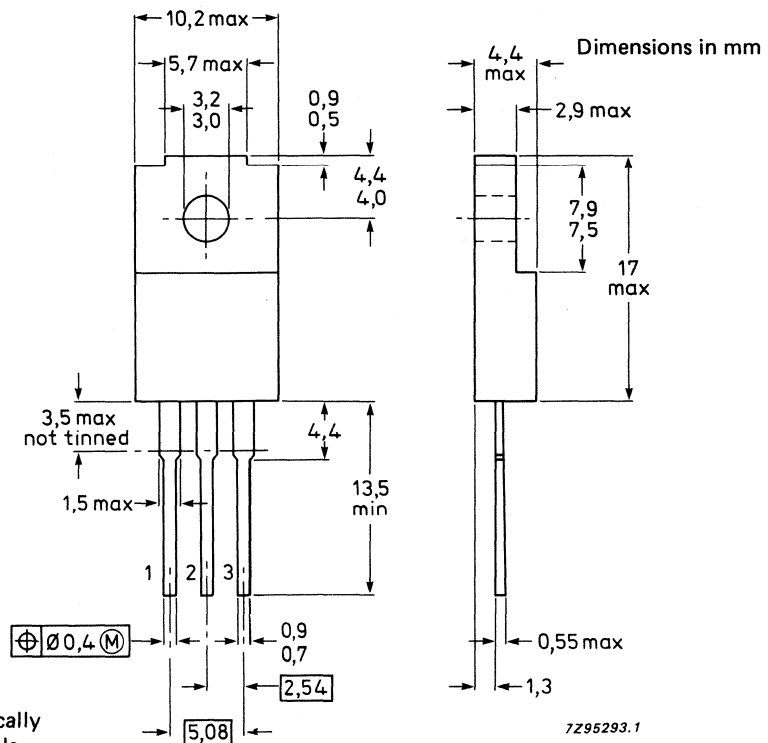
Fig. 1 SOT186.



Pinning:

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

Mounting base is electrically isolated from all terminals.



BU506F BU506DF

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 $T_h = 25^\circ\text{C}$	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)	$R_{th\ j-h}$	=	6.35 K/W
From junction to external heatsink (note 2)	$R_{th\ j-h}$	=	3.85 K/W
From junction to ambient	R_{th-a}	=	55 K/W

ISOLATION

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

Notes

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

CHARACTERISTICS

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

Collector cut-off current

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

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

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

Emitter cut-off current

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

I_{EBO}	max.	10 mA
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Saturation voltage

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

V_{CEsat}	max.	5.0 V
V_{BEsat}	max.	1.3 V

Collector saturation current

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

I_C	typ.	3.0 A
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DC current gain

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

h_{FE}	min.	2.25
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Second breakdown current

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

I_{SB}	min.	1.0 A
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Collector emitter sustaining voltage (Figs 2 and 3)

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

$V_{CEOsust}$	min.	700 V
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Diode forward voltage

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

V_F	typ.	1.5 V
V_F	max.	2.2 V

Switching times in horizontal deflection circuit

(Fig. 4)

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

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

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

t_f	typ.	0.7 μs
t_s	typ.	6.5 μs

DEVELOPMENT DATA

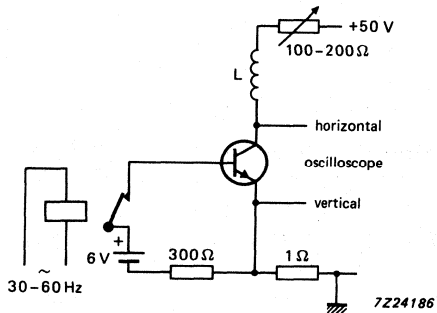


Fig. 2 Test circuit for $V_{CE0sust}$.

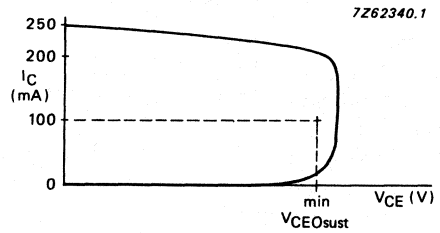


Fig. 3 Oscilloscope display for sustaining voltage.

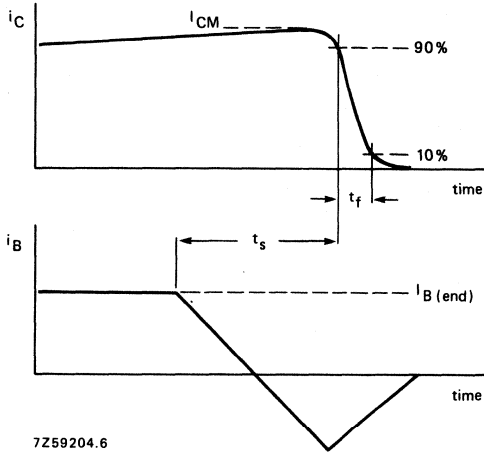


Fig. 4 Switching times waveforms.

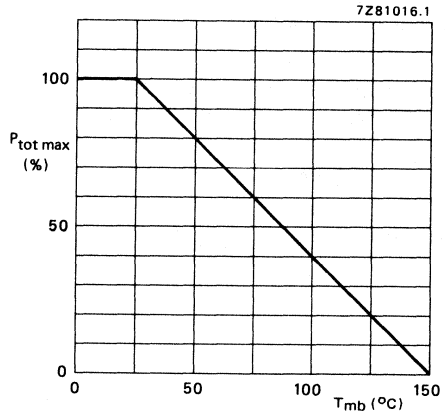


Fig. 5 Power derating curve.

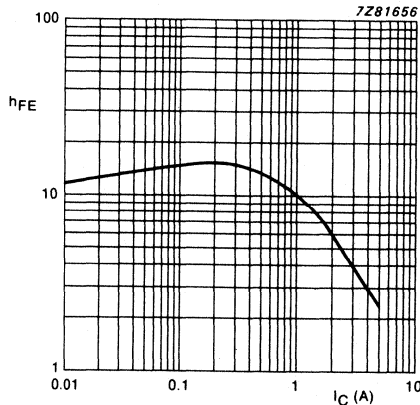
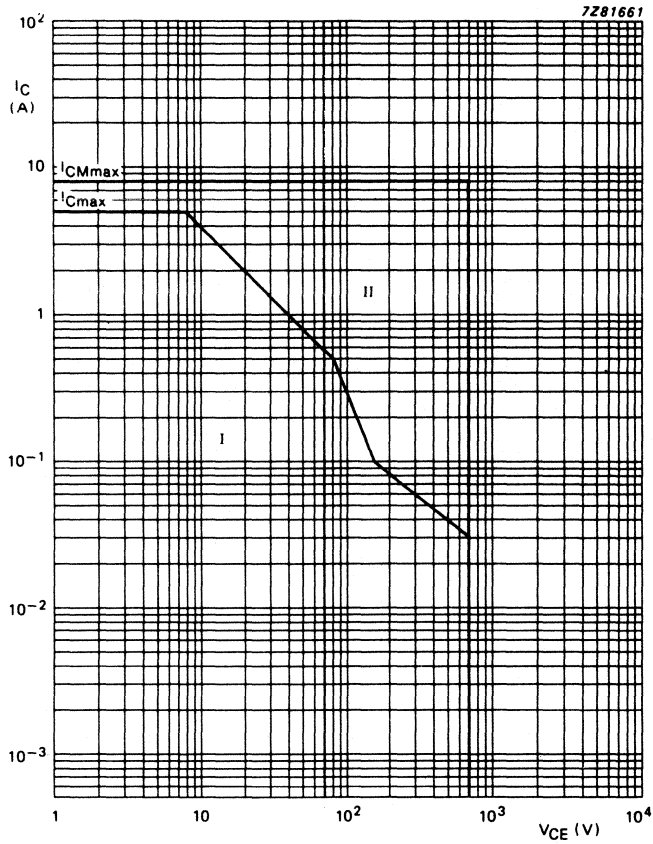


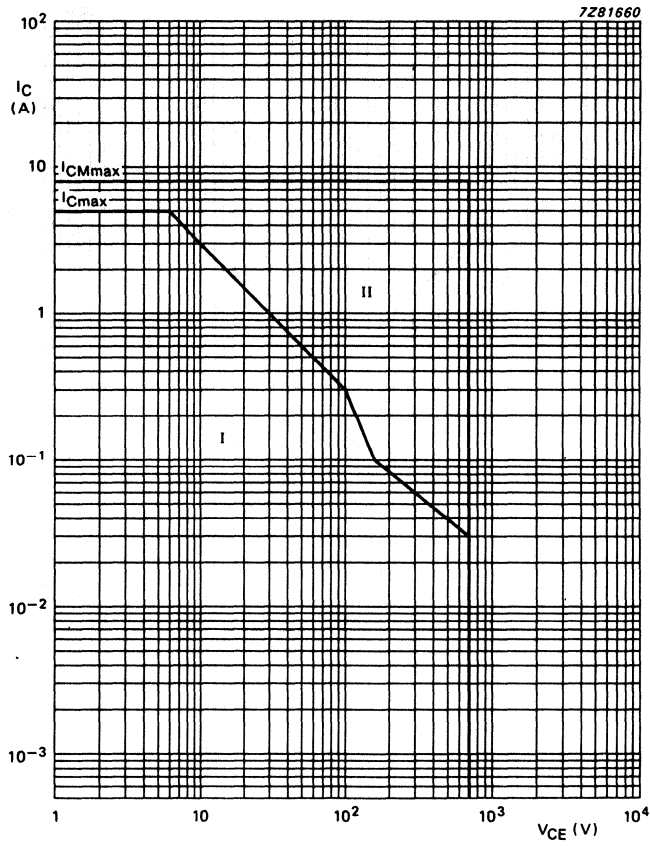
Fig. 6 Typical DC current gain; $V_{CE} = 5\text{ V}$; $T_j = 25\text{ }^\circ\text{C}$.

DEVELOPMENT DATA



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

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



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

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

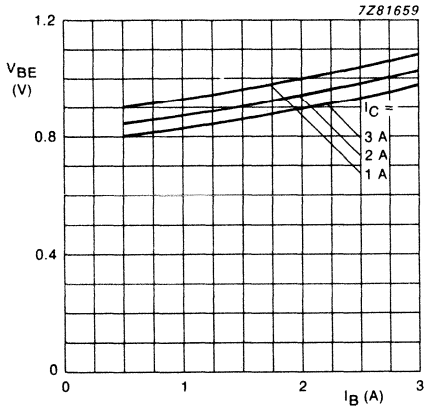


Fig. 9 Typical values V_{BE} ; $T_j = 25\text{ }^\circ\text{C}$.

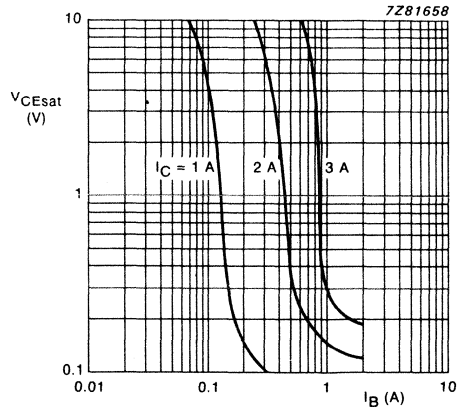


Fig. 10 Typical collector-emitter saturation voltage; $T_j = 25\text{ }^\circ\text{C}$.

DEVELOPMENT DATA

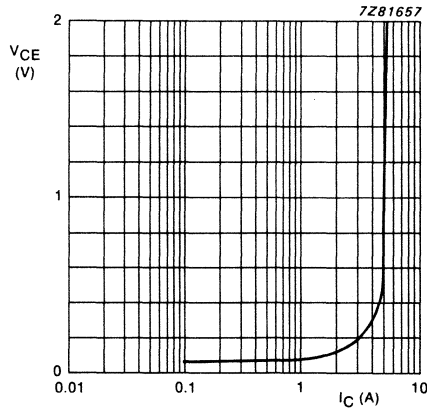


Fig. 11 Typical values V_{CE} ; $I_C/I_B = 2$; $T_j = 25\text{ }^\circ\text{C}$.

SILICON DIFFUSED POWER TRANSISTOR

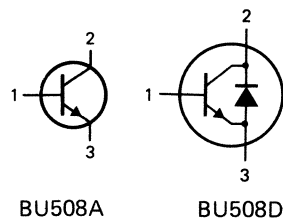
High-voltage, high-speed switching npn transistor in SOT93A envelope intended for use in horizontal deflection circuits of colour television receivers. The BU508D has an integrated efficiency diode.

QUICK REFERENCE DATA

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

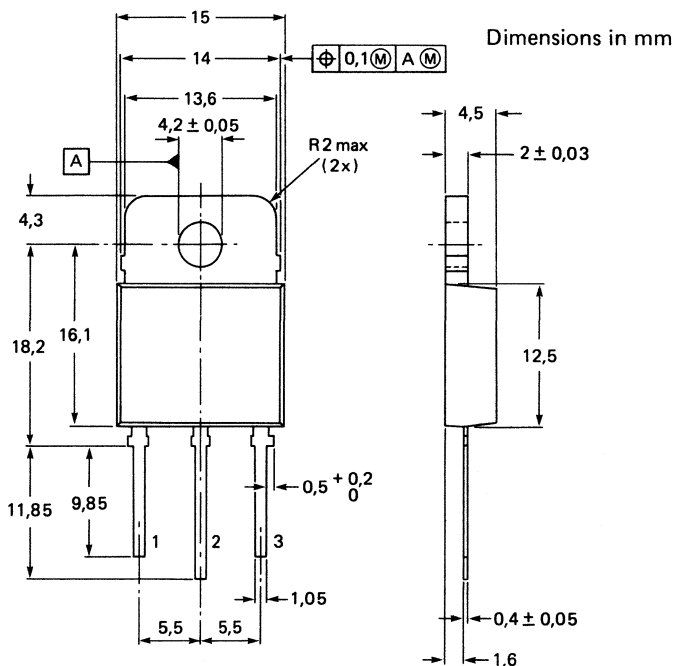
MECHANICAL DATA

Fig. 1 SOT93A.



1 = base
2 = collector
3 = emitter

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 $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	125 W
Storage temperature range	T_{stg}		-65 to + 150 $^\circ\text{C}$
Junction temperature	T_j	max.	150 $^\circ\text{C}$

THERMAL RESISTANCE

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

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

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

* Turn-off current.

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

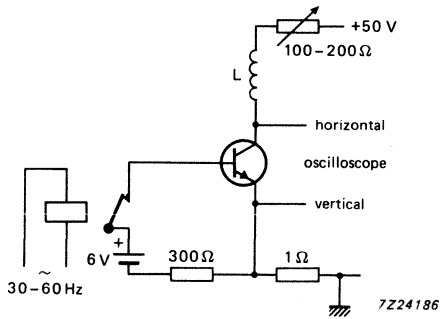


Fig. 2 Test circuit for $V_{CE0sust}$.

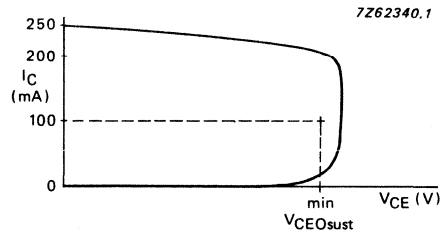


Fig. 3 Oscilloscope display for $V_{CE0sust}$.

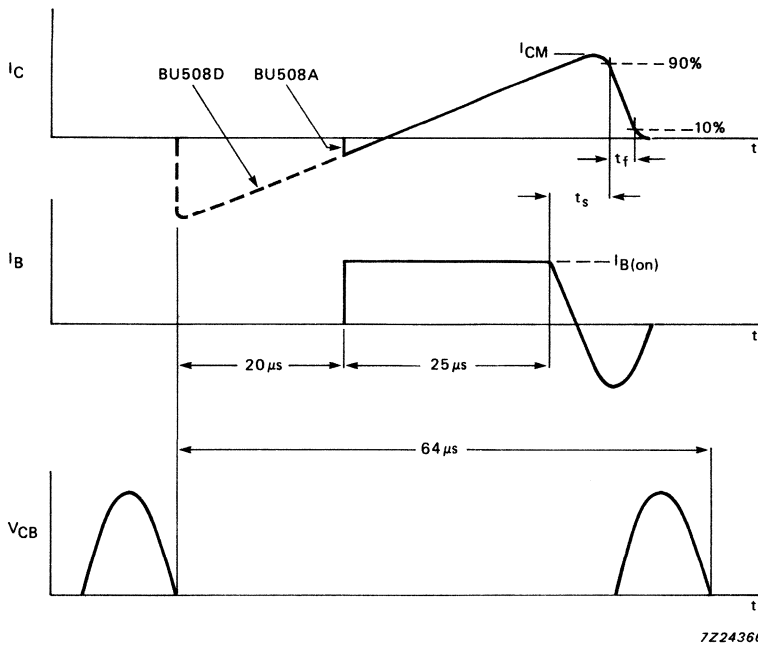


Fig. 4 Switching times waveforms; $I_{CM} = 4.5 \text{ A}$; $I_{B(on)} = 1.4 \text{ A}$; $L_B = 6 \mu\text{H}$;
 $-V_{BB} = 4 \text{ V}$; $-di_B/dt = 0.6 \text{ A}/\mu\text{s}$; typical value of $t_s = 6.5 \mu\text{s}$;
typical value of $t_f = 0.7 \mu\text{s}$.

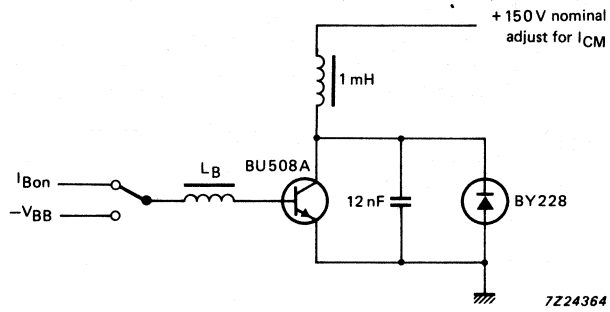


Fig. 5 Switching times test circuit (BU508A).

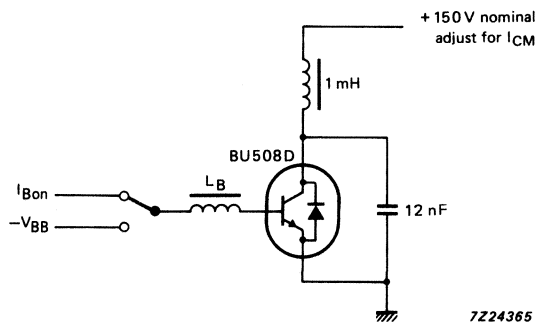
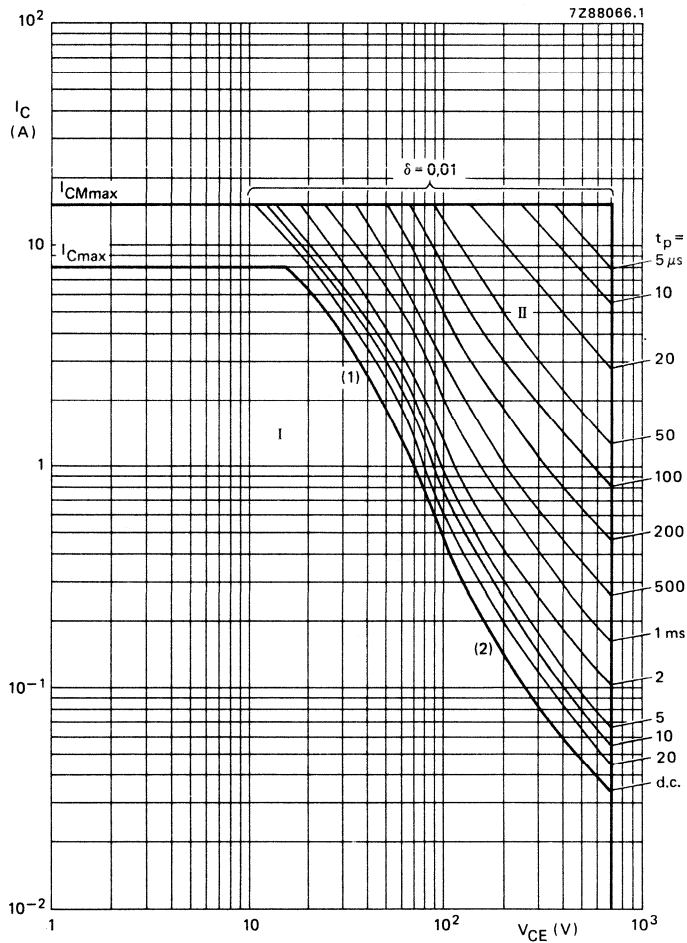


Fig. 6 Switching times test circuit (BU508D).



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

Fig. 7 Safe operating area; $T_{mb} < 25\text{ }^{\circ}\text{C}$.

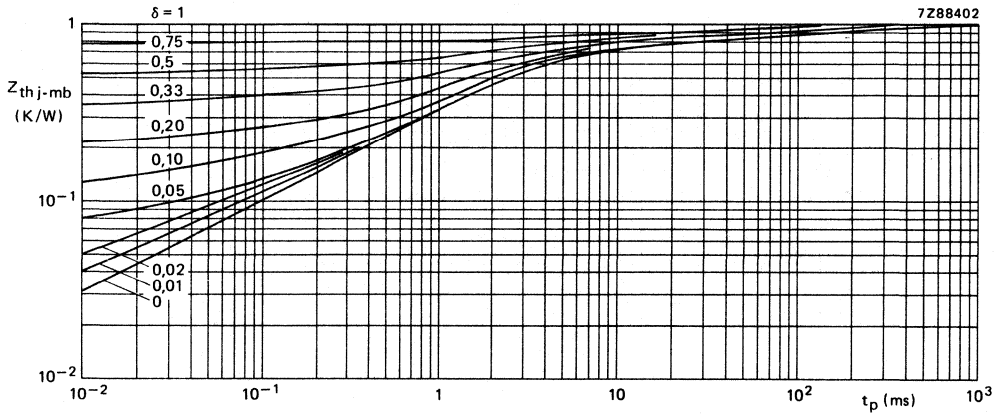


Fig. 8 Pulse power rating chart.

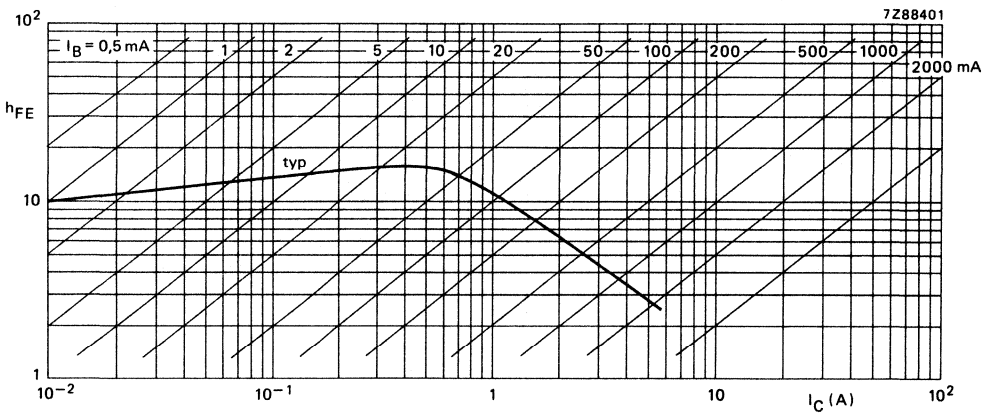


Fig. 9 Typical values DC current gain at $V_{CE} = 5 \text{ V}$; $T_{mb} = 25 \text{ }^\circ\text{C}$.

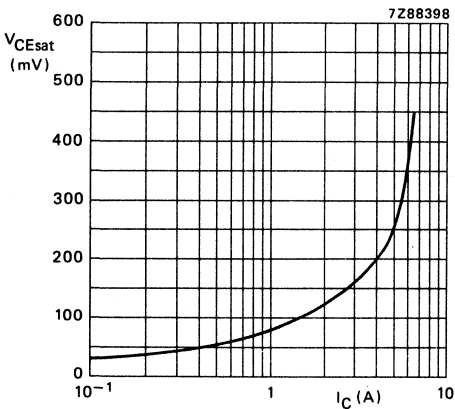


Fig. 10 Typical values $I_C/I_B = 2$; $T_j = 25 \text{ }^\circ\text{C}$.

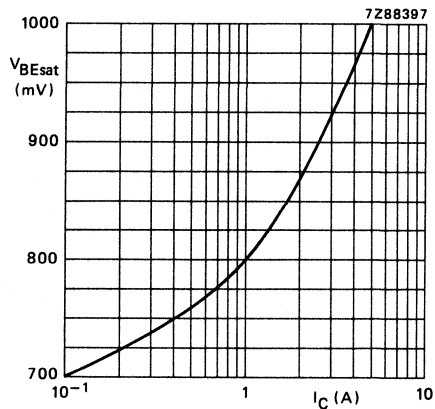


Fig. 11 Typical values $I_C/I_B = 2$; $T_j = 25 \text{ }^\circ\text{C}$.

DEVELOPMENT DATA

This data sheet contains advance information and specifications are subject to change without notice.

BU508AF
BU508DF

SILICON DIFFUSED POWER TRANSISTORS

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

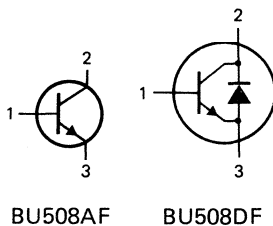
QUICK REFERENCE DATA

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

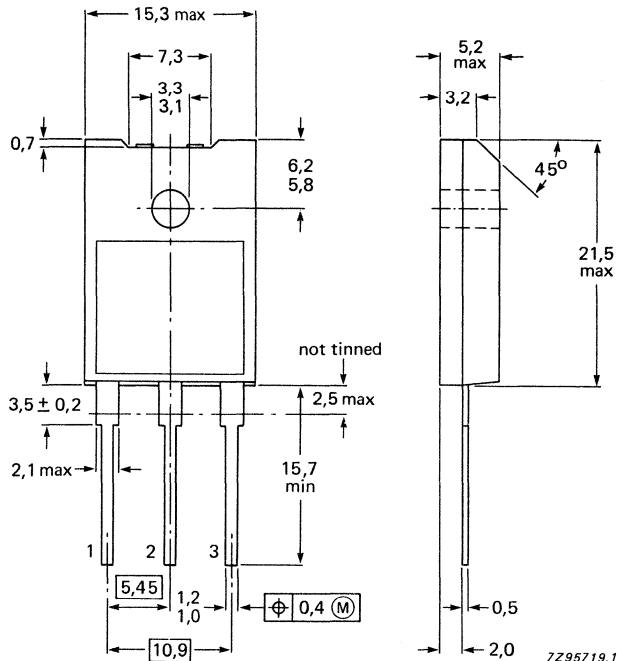
MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT199.



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 $T_h = 25\text{ }^\circ\text{C}^*$

P_{tot}	max.	34 W
-----------	------	------

Storage temperature

T_{stg}	-65 to + 150 $^\circ\text{C}$
-----------	-------------------------------

Junction temperature

T_j	max.	150 $^\circ\text{C}$
-------	------	----------------------

THERMAL RESISTANCE

From junction to mounting base

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

From junction to external heatsink *

$R_{th\ j-h}$	=	3,7 K/W
---------------	---	---------

From junction to external heatsink **

$R_{th\ j-h}$	=	2,8 K/W
---------------	---	---------

From junction to ambient

$R_{th\ j-a}$	=	35 K/W
---------------	---	--------

ISOLATION

Isolation voltage from all terminals to
external heatsink (peak value)

V_{isol}	max.	1500 V
------------	------	--------

Isolation capacitance from collector
to external heatsink

C_{isol}	typ.	21 pF
------------	------	-------

CHARACTERISTICS

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

Collector cut-off current

$V_{CE} = V_{CESmax}; V_{BE} = 0$	I_{CES}	max.	1 mA
$V_{CE} = V_{CESmax}; V_{BE} = 0; T_j = 125\text{ }^\circ\text{C}$	I_{CES}	max.	2 mA

Emitter cut-off current

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

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

** Mounted with heatsink compound and 30 ± 5 newtons pressure on centre of envelope.

Saturation voltages

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

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

Diode forward voltage

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

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

Collector-emitter sustaining voltage

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

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

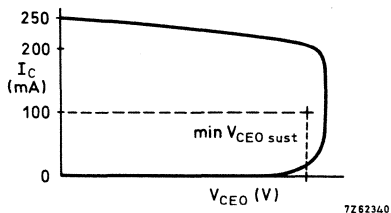


Fig. 2 Oscilloscope display for $V_{CE0\text{sust}}$.

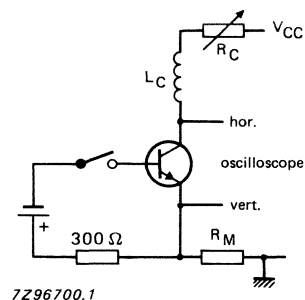


Fig. 3 Test circuit for $V_{CE0\text{sust}}$.

DEVELOPMENT DATA

Second-breakdown current

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

I_{SB}	min.	11 A
----------	------	------

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

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

f_T	typ.	7 MHz
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Collector capacitance at $f = 1 \text{ MHz}$

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

C_c	typ.	125 pF
-------	------	--------

Switching times in horizontal deflection circuit

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

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

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

t_f	typ.	0,7 μs
t_s	typ.	6,5 μs

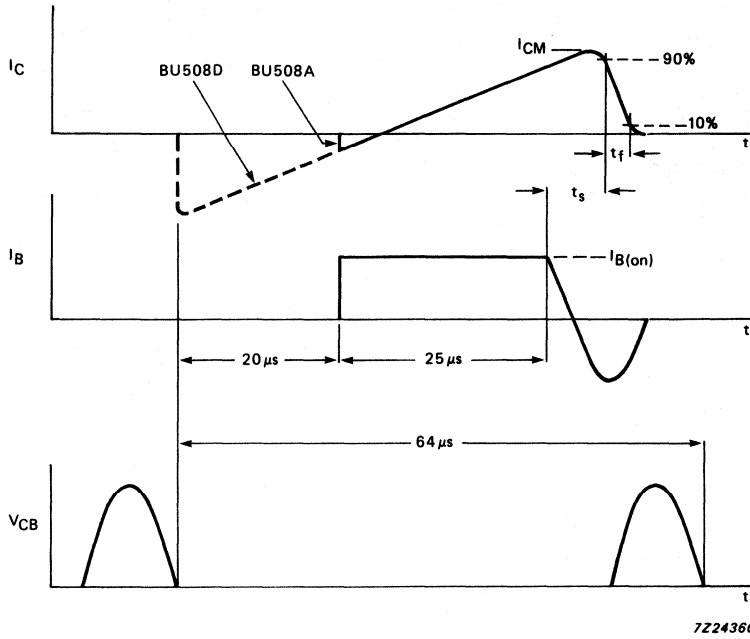


Fig. 4 Switching times waveforms.

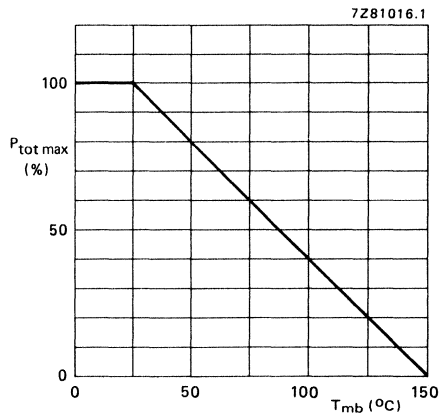


Fig. 5 Power derating curve.

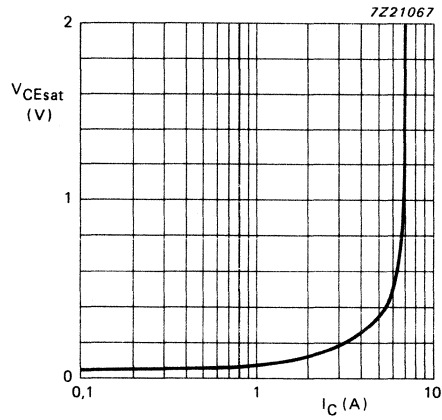


Fig. 6 Typical values $I_C/I_B = 2$; $T_j = 25$ °C.

DEVELOPMENT DATA

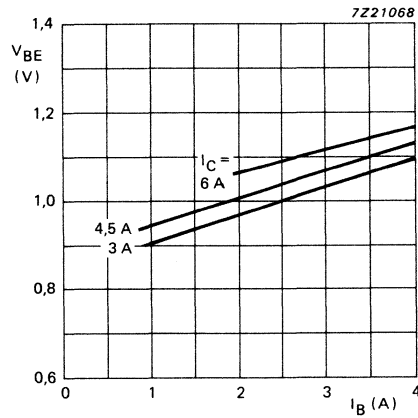


Fig. 7 Typical values base-emitter voltage at $T_j = 25$ °C.

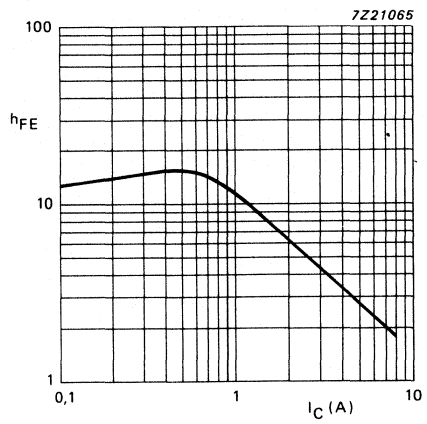


Fig. 8 Typical values DC current gain at V_{CE} = 5 V; T_j = 25 °C.

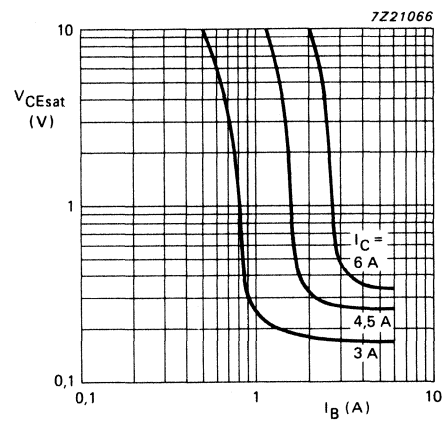
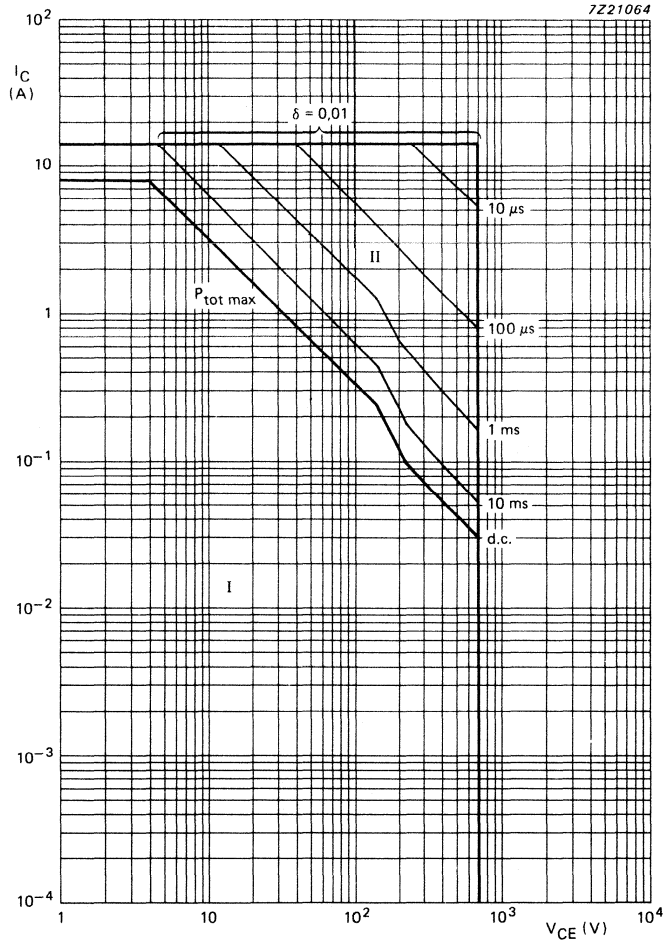


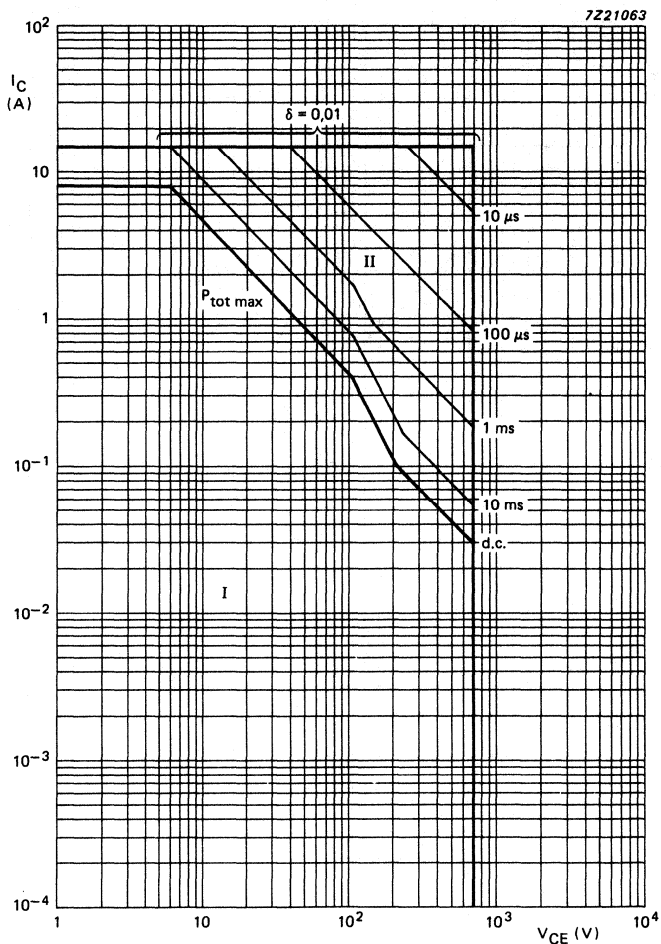
Fig. 9 Typical values collector-emitter voltage at T_j = 25 °C.

DEVELOPMENT DATA



I Region of permissible DC operation.
 II Permissible extension for repetitive pulse operation.
 Note: Mounted without heatsink compound and 30 ± 5 newtons pressure on the centre of the envelope.

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



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

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

SILICON DIFFUSED POWER TRANSISTORS

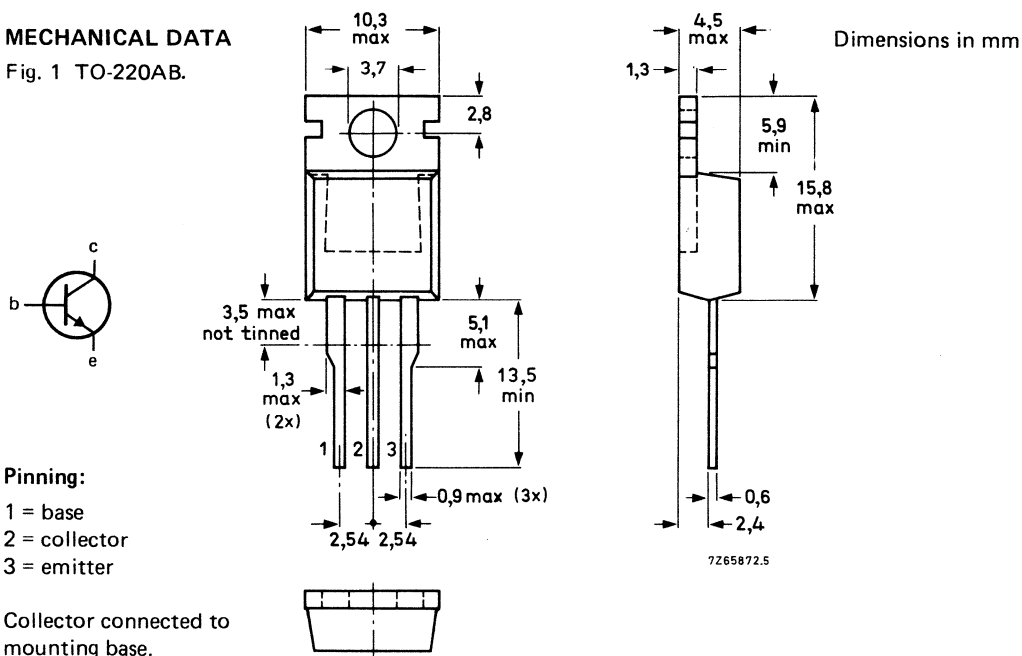
High-voltage, high-speed, glass-passivated npn power transistors in a TO-220 envelope intended for use in power supplies and deflection circuits for colour receivers and monitors.

QUICK REFERENCE DATA

Collector-emitter voltage			
peak value; $V_{BE} = 0$	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 $T_{mb} = 25^\circ C$	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

Fig. 1 TO-220AB.



RATINGS

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

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

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

Collector cut-off current

 $V_{BE} = 0; V_{CE} = V_{CESmax}$ I_{CES} max. 1.0 mA $V_{BE} = 0; V_{CE} = V_{CESmax}; T_j = 125\text{ }^\circ\text{C}$ I_{CES} max. 2.0 mA

Emitter cut-off current

 $I_C = 0; V_{EB} = 6\text{ V}$ I_{EBO} max. 1.0 mA

Collector-emitter breakdown voltage

 $I_C = 100\text{ mA}; I_B = 0$ V_{CEO} min. 550 V

Saturation voltage

 $I_C = 2.0\text{ A}; I_B = 0.33\text{ A}$ V_{CEsat} max. 2.0 V $I_C = 4.0\text{ A}; I_B = 1.33\text{ A}$ V_{CEsat} max. 3.0 V

DC current gain

 $I_C = 10\text{ mA}; V_{CE} = 5\text{ V}$ h_{FE} min. 6.0 $I_C = 1.0\text{ A}; V_{CE} = 5\text{ V}$ h_{FE} min. 8.0 $I_C = 2.0\text{ A}; V_{CE} = 2\text{ V}$ h_{FE} min. 6.0 $I_C = 4.0\text{ A}; V_{CE} = 3\text{ V}$ h_{FE} min. 3.0

Switching times; resistive load (Figs 2 and 3)

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

turn-on

 t_{on} max. 0.5 μs

turn-off; storage time

 t_s max. 6.0 μs

fall time

 t_f max. 0.7 μs

Switching times; inductive load (Figs 4 and 5)

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

turn-off; storage time

 t_s max. 2.5 μs

fall time

 t_f max. 0.8 μs

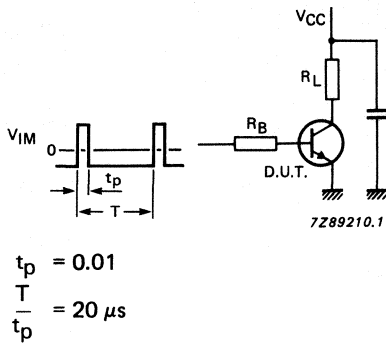


Fig. 2 Test circuit resistive load; $V_{CC} = 250 \text{ V}$; $V_{IM} = -6 \text{ to } +8 \text{ V}$.

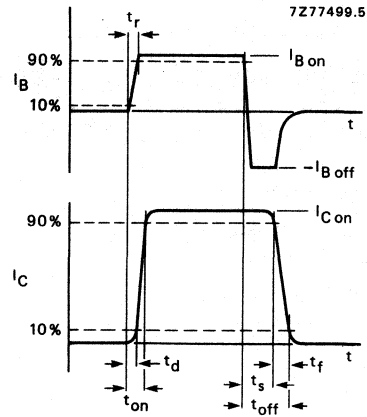
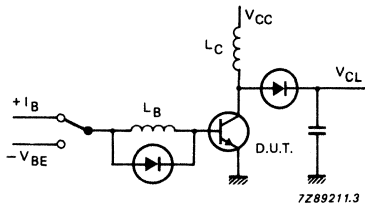


Fig. 3 Switching times waveforms with resistive load; $t_r < 50 \text{ ns}$.



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

Fig. 4 Test circuit inductive load.

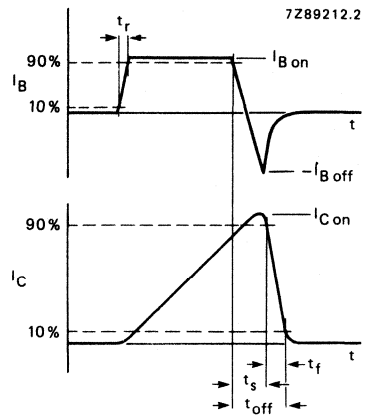


Fig. 5 Switching times waveforms with inductive load.

SILICON DIFFUSED POWER TRANSISTOR

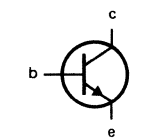
High-voltage, high-speed switching, glass passivated npn power transistor in a SOT93A envelope, intended for use in horizontal deflection circuits of television receivers. The BU705D has an integrated efficiency diode

QUICK REFERENCE DATA

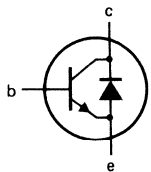
Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM} V_{CEO}	max. max.	1500 V 700 V
Collector-emitter saturation voltage	V_{CEsat}	max.	5 V
Collector current saturation DC peak value	I_{Csat} I_C I_{CM}	max. max. max.	2 A 2.5 A 4 A
Diode forward voltage (BU705D)	V_F	typ.	1.8 V
Total power dissipation up to $T_{mb} = 25^\circ C$	P_{tot}	max.	75 W
Fall time inductive load	t_f	typ.	0.7 μs

MECHANICAL DATA

Fig. 1 SOT93A.



BU705

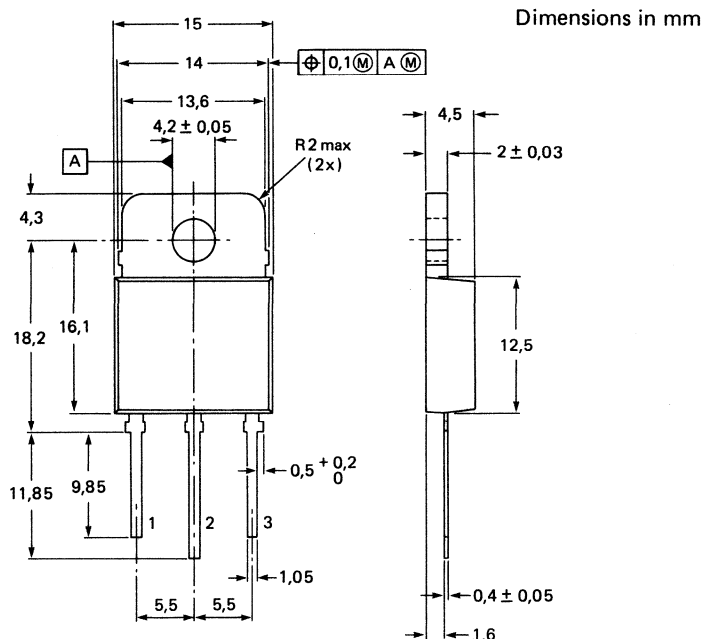


BU705D

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 $T_{mb} = 25$ °C	P_{tot}	max.	75 W
Storage temperature range	T_{stg}		-65 to +150 °C
Junction temperature	T_j	max.	150 °C

THERMAL RESISTANCE

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

$T_j = 25$ °C unless otherwise specified

Collector cut-off current*

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

$V_{CE} = V_{CESMmax}; V_{BE} = 0; T_j = 125$ °C

I_{CES}	max.	0,15 mA
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

$V_{CEO_{sust}}$	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; $t = 200$ μ s

I_{SB}	max.	2,0 A
----------	------	-------

Transition frequency at $f = 5$ MHz

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

f_T	typ.	7 MHz
-------	------	-------

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).

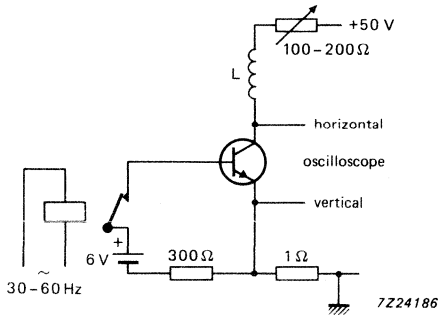


Fig. 2 Test circuit for sustaining voltage.

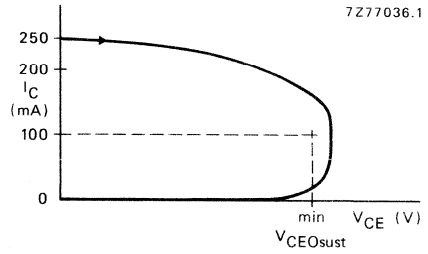


Fig. 3 Oscilloscope display for sustaining voltage.

Switching times (in horizontal deflection circuit)

$-V_{IM} = 4 \text{ V}$; $L_B = 25 \mu\text{H}$; $I_{CM} = 2 \text{ A}$

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

fall time

storage time

t_f	typ.	0,7 μs
t_s	typ.	10 μs

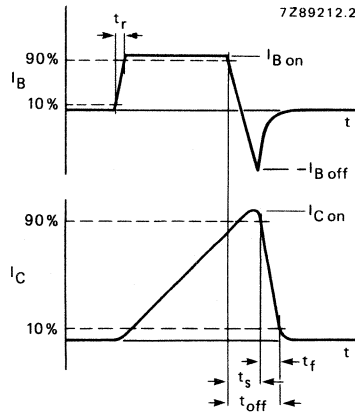
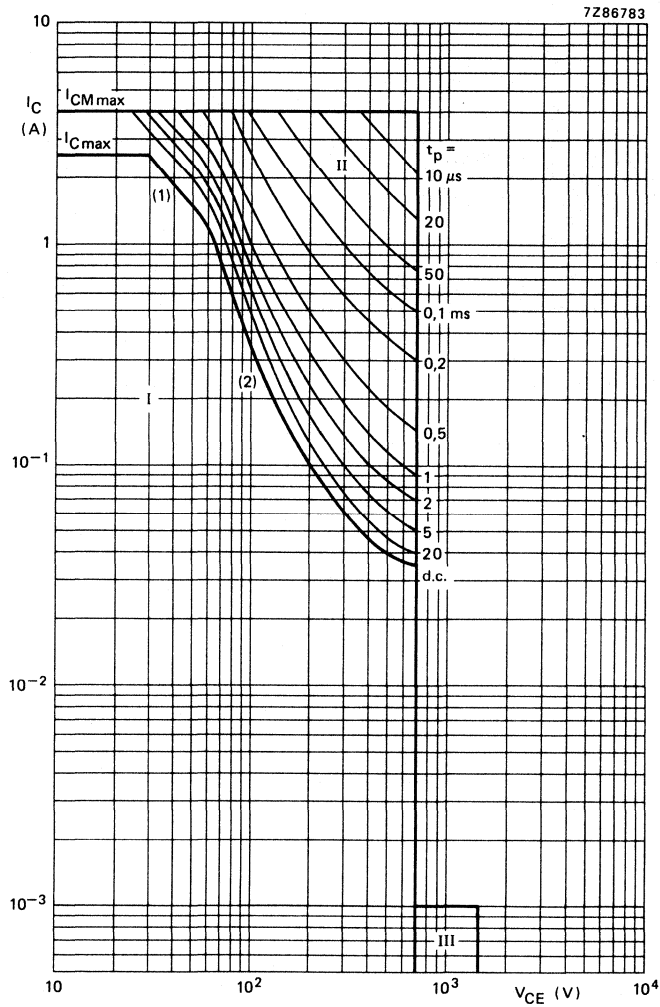


Fig. 4 Switching times waveform.



- (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; $T_{mb} = 25\ ^\circ C$.

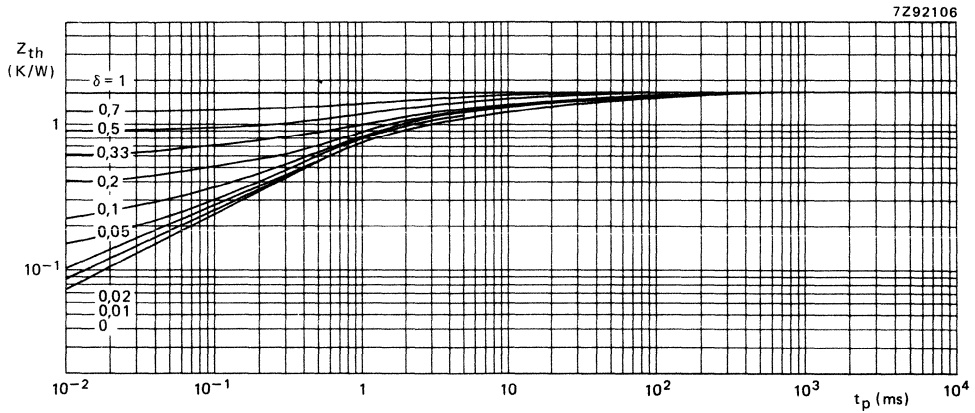


Fig. 6 Pulse power rating chart.

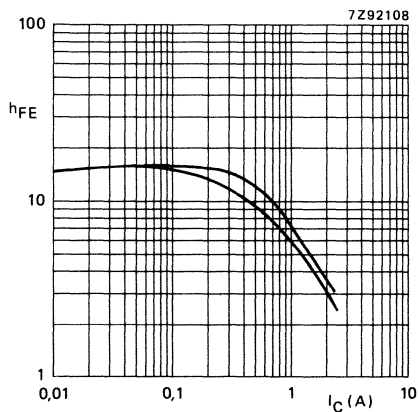


Fig. 7 Typical DC current gain.

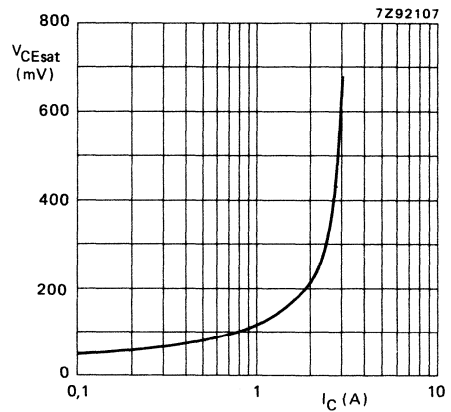


Fig. 8 Typical values V_{CEsat}
 $I_C/I_B = 2$; $T_j = 25^\circ C$.

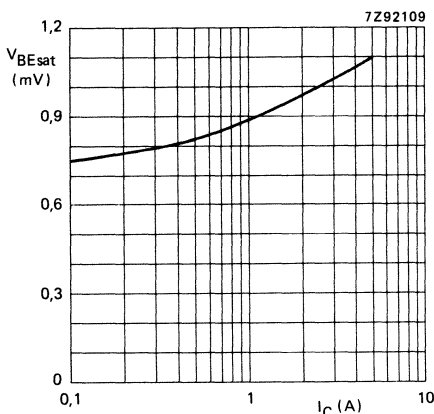


Fig. 9 Typical values V_{BEsat} ; $I_C/I_B = 2$; $T_j = 25^\circ C$.

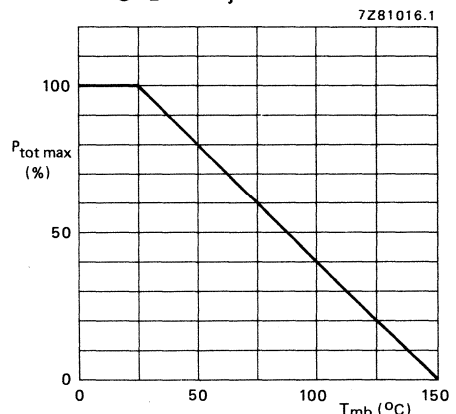


Fig. 10 Power derating curve.

DEVELOPMENT DATA

This data sheet contains advance information and specifications are subject to change without notice.

BU705F
BU705DF

SILICON DIFFUSED POWER TRANSISTORS

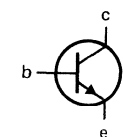
High-voltage, high-speed switching npn power transistors in a SOT199 envelope intended for use in horizontal deflection circuits of television receivers. The BU705DF has an integrated efficiency diode.

QUICK REFERENCE DATA

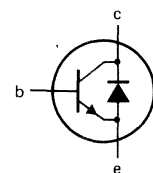
Collector-emitter voltage				
peak value; $V_{BE} = 0$	V_{CESM}	max.	1500	V
open base	V_{CEO}	max.	700	V
Collector-emitter saturation voltage	V_{CEsat}	max.	5.0	V
Collector current				
saturation	I_{Csat}	max.	2.0	A
DC	I_C	max.	2.5	A
peak value	I_{CM}	max.	4.0	A
Diode Forward voltage (BU705DF)	V_F	max.	1.8	V
Total power dissipation				
up to $T_{mb} = 25^\circ\text{C}$	P_{tot}	max.	29	W
Fall time; inductive load	t_f	typ.	0.9	μs

MECHANICAL DATA

Fig. 1 SOT199.



BU705F

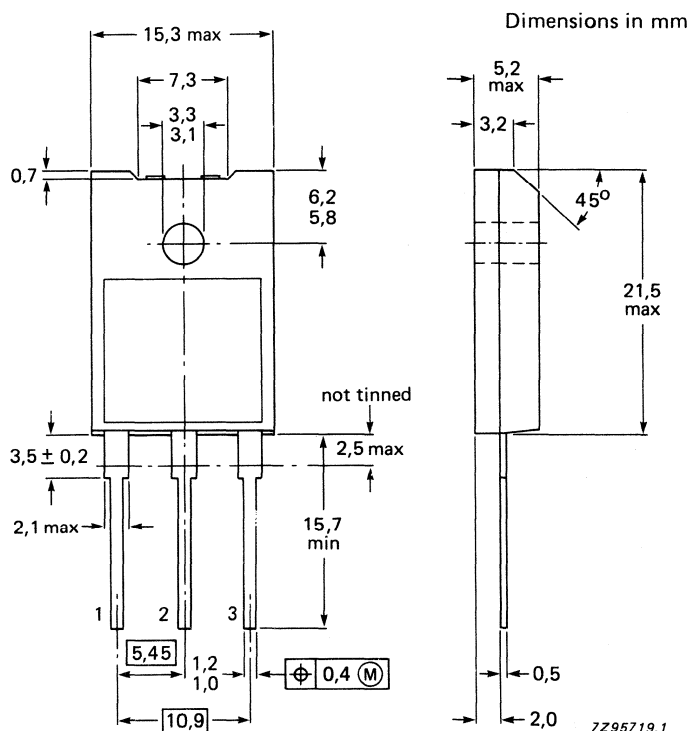


BU705DF

Pinning:

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

Mounting base is electrically isolated from all terminals



BU705F BU705DF

RATINGS

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

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

THERMAL RESISTANCE

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

ISOLATION

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

Notes

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

CHARACTERISTICS

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

Collector cut-off current

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

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

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

Emitter cut-off current

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

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

Saturation voltage

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

V_{CEsat}	max.	5.0 V
V_{BEsat}	max.	1.3 V

Diode forward voltage

$I_F = 2.0\text{ A}$

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

Collector saturation current

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

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

DC current gain

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

h_{FE}	min.	2.2
----------	------	-----

Second breakdown current

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

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

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

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

f_T	typ.	7.0 MHz
-------	------	---------

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

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

C_C	typ.	65 pF
-------	------	-------

Collector emitter sustaining voltage
(Figs 2 and 3)

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

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

Switching times in horizontal
deflection circuit (Fig. 4)

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

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

t_f	typ.	0.9 μs
t_s	typ.	7.5 μs

DEVELOPMENT DATA

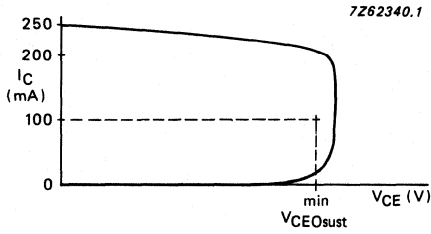


Fig. 2 Oscilloscope display for sustaining voltage.

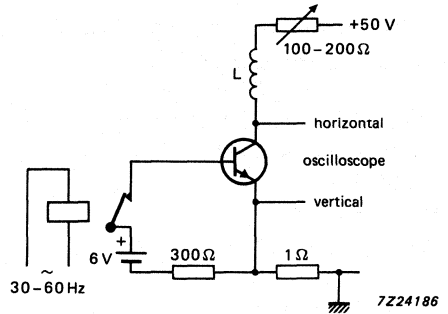


Fig. 3 Test circuit for V_{CEsust} .

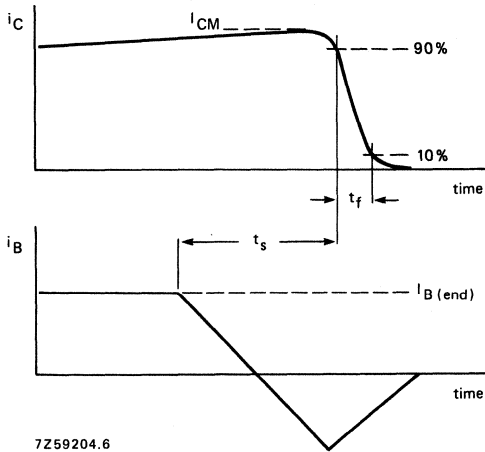


Fig. 4 Switching times waveforms.

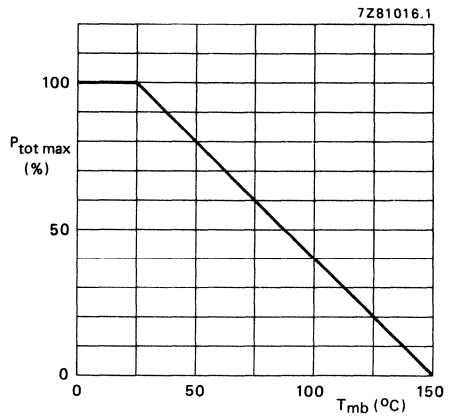
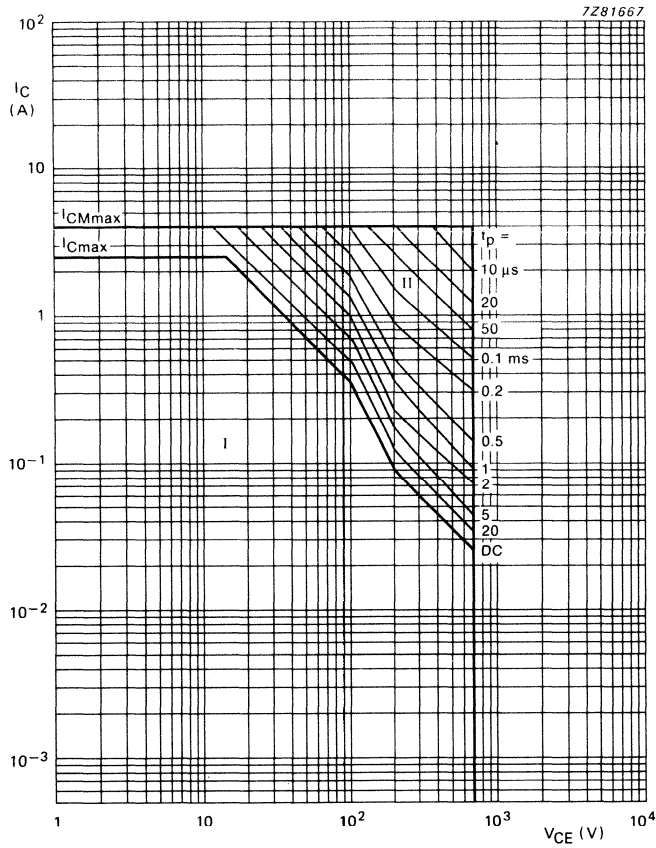


Fig. 5 Power derating curve.

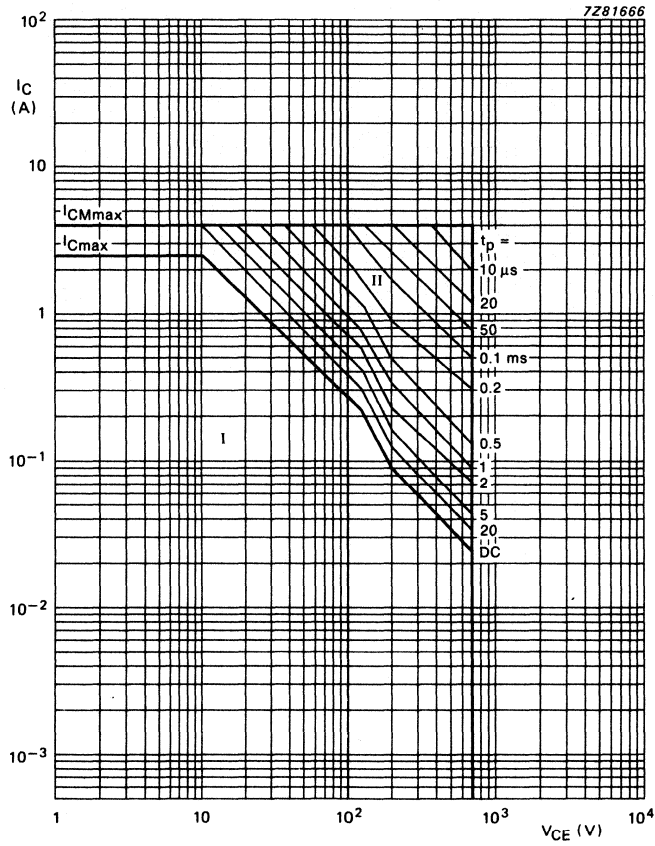
DEVELOPMENT DATA



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

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

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



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

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

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

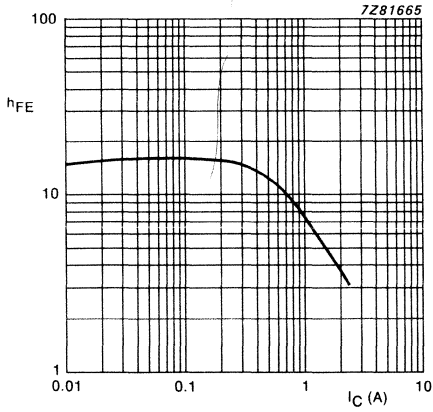


Fig. 8 Typical DC current gain;
 $V_{CE} = 5 \text{ V}$; $T_j = 25 \text{ }^\circ\text{C}$.

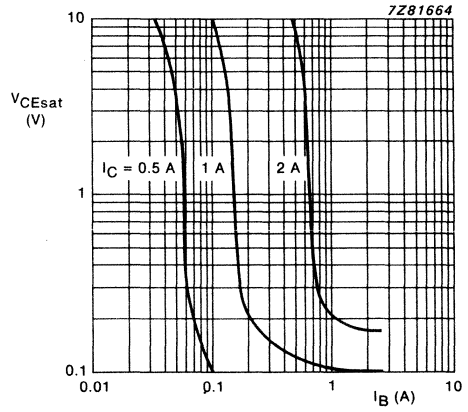


Fig. 9 Typical collector-emitter
saturation voltage; $T_j = 25 \text{ }^\circ\text{C}$.

DEVELOPMENT DATA

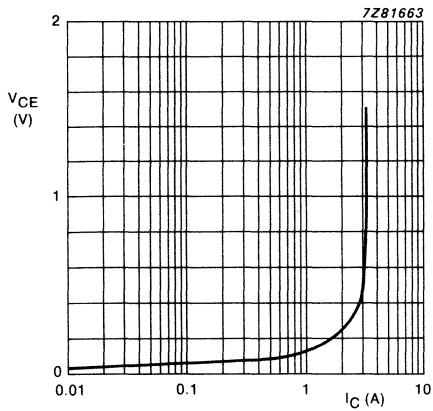


Fig. 10 Typical values V_{CE} ;
 $I_C/I_B = 2$; $T_j = 25 \text{ }^\circ\text{C}$.

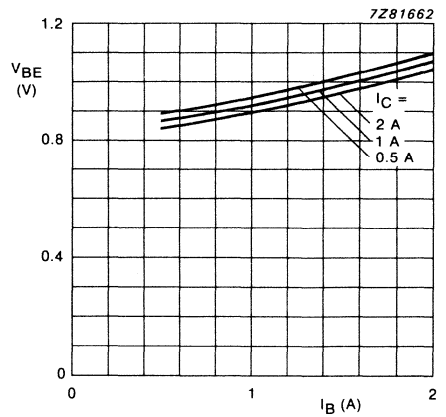


Fig. 11 Typical values V_{BE} ;
 $T_j = 25 \text{ }^\circ\text{C}$.

SILICON DIFFUSED POWER TRANSISTORS

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

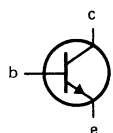
QUICK REFERENCE DATA

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

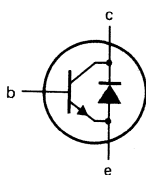
MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT93A.



BU706

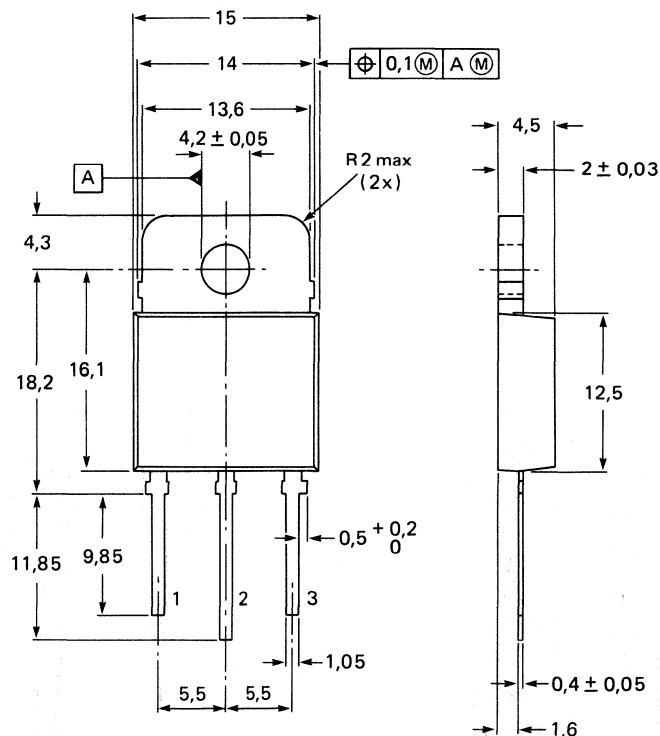


BU706D

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 $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	100 W
Storage temperature range	T_{stg}		-65 to + 150 $^\circ\text{C}$
Junction temperature	T_j	max.	150 $^\circ\text{C}$
THERMAL RESISTANCE			
From junction to mounting base	R_{thj-mb}	=	1.25 K/W

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

Collector cut-off current*

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

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

Emitter cut-off current

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

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

Second breakdown current

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

I_{SB}	min.	1.0 A
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Collector-emitter sustaining voltage

 $I_C = 0.1\text{ A}; I_B = 0;$ $L = 25\text{ mH}$ (Figs 2 and 3)

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

Saturation voltage

 $I_C = 3.0\text{ A}; I_B = 1.33\text{ mA}$

V_{CEsat}	max.	5.0 V
V_{BEsat}	max.	1.3 V

Diode forward voltage (BU706D)

 $I_F = 3\text{ A}$

V_F	typ.	1.5 V
V_F	max.	2.2 V

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

 $I_{CM} = 3.0\text{ A}; I_{B(end)} = 1.0\text{ A};$ $L_B = 12\text{ }\mu\text{H}$ $-di_B/dt = 0.33\text{ A}/\mu\text{s}$

t_f	typ.	0.7 μs
t_s	typ.	6.5 μs

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

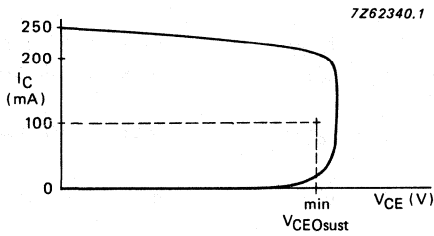


Fig. 2 Oscilloscope display for sustaining voltage.

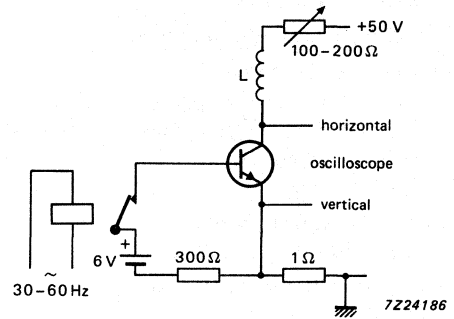


Fig. 3 Test circuit for $V_{CEOsust}$.

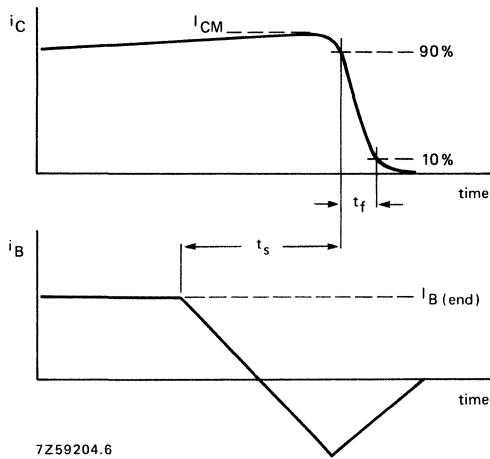


Fig. 4 Switching times waveforms.

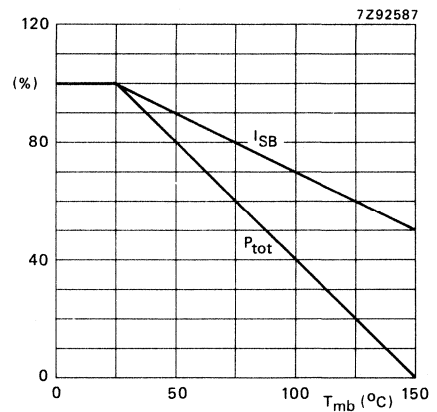
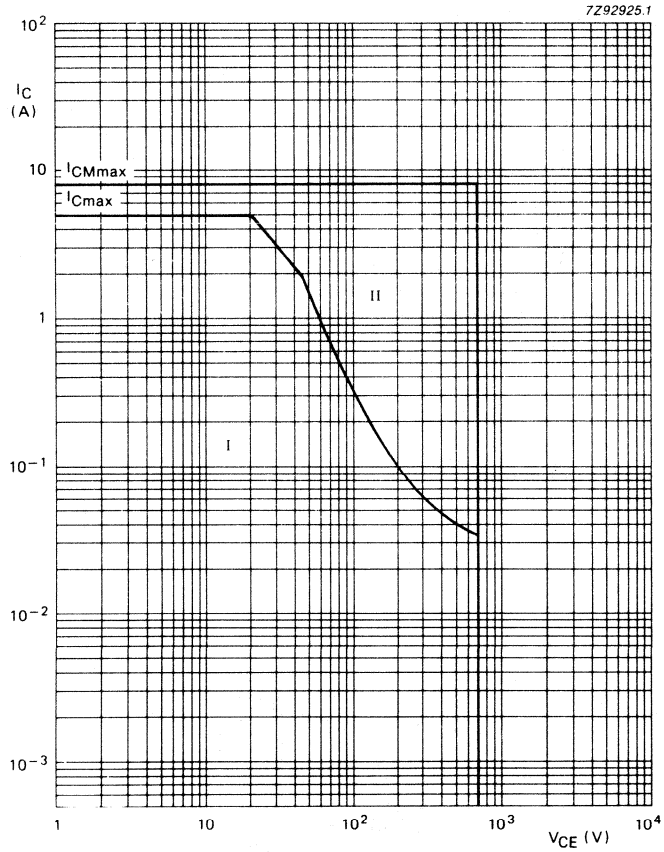


Fig. 5 Total power dissipation and second-breakdown current derating curve.



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

Fig. 6 Safe operating area.

BU706 BU706D

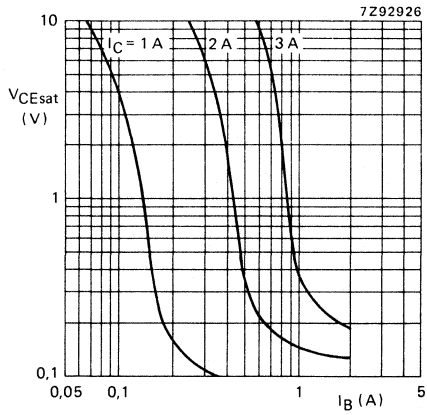


Fig. 7 Typical collector emitter saturation voltage; $T_{mb} = 25\text{ }^\circ\text{C}$.

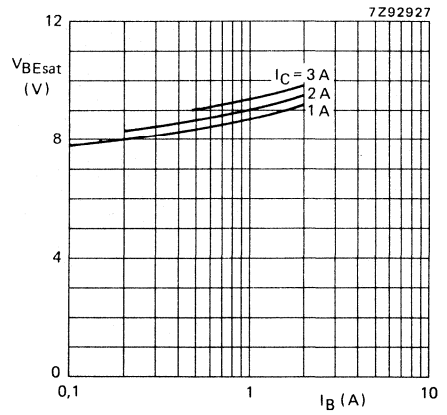


Fig. 8 Typical base-emitter saturation voltage; $T_{mb} = 25\text{ }^\circ\text{C}$.

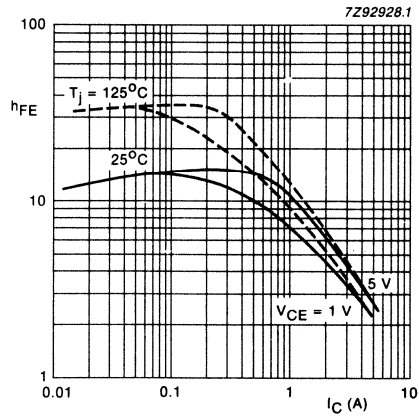


Fig. 9 Typical DC current gain.

DEVELOPMENT DATA

This data sheet contains advance information and specifications are subject to change without notice.

BU706F
BU706DF

SILICON DIFFUSED POWER TRANSISTORS

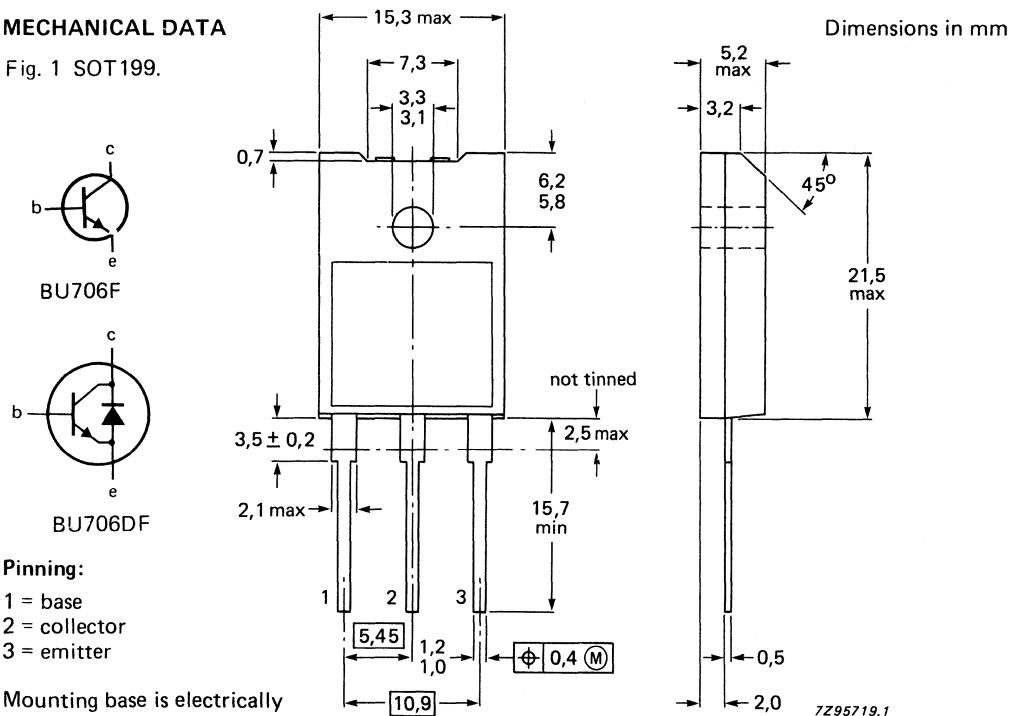
High-voltage, high-speed switching npn transistor in a SOT199 envelope, intended for use in horizontal deflection circuits of colour television receivers and in line-operated switch-mode applications. The BU706DF has an integrated efficiency diode.

QUICK REFERENCE DATA

Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM}	max.	1500 V
	V_{CEO}	max.	700 V
Collector-emitter saturation voltage	V_{CEsat}	max.	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 $T_H = 25^\circ C$	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

Fig. 1 SOT199.



RATINGS

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

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

THERMAL RESISTANCE

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

ISOLATION

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

Notes

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

CHARACTERISTICS

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

Collector cut-off current

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

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

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

Emitter cut-off current

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

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

Saturation voltage

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

V_{CEsat}	max.	5.0 V
V_{BEsat}	max.	1.3 V

Collector saturation current

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

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

DC current gain

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

h_{FE}	min.	2.25
----------	------	------

Second breakdown current

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

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

Collector emitter sustaining voltage (Figs 2 and 3)

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

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

Diode forward voltage

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

V_F	typ.	1.5 V
V_F	max.	2.2 V

Switching times in horizontal deflection circuit

(Fig. 4)

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

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

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

t_f	typ.	0.7 μs
t_s	typ.	6.5 μs

DEVELOPMENT DATA

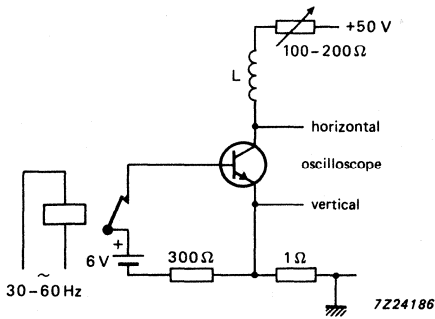


Fig. 2 Test circuit for $V_{CEOsust}$.

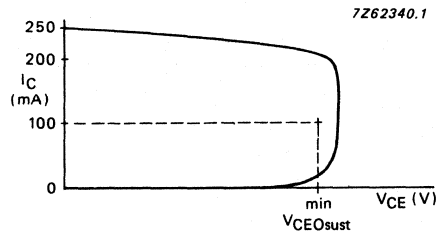
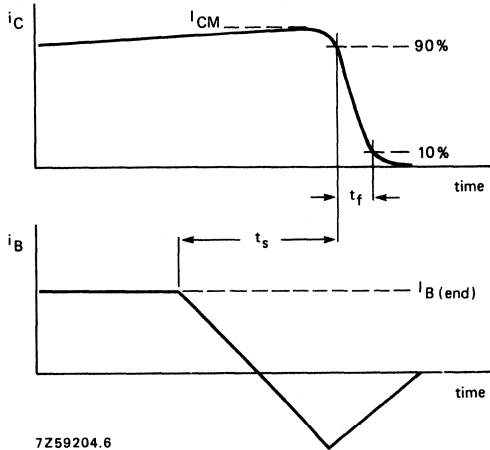


Fig. 3 Oscilloscope display for sustaining voltage.



7Z59204.6

Fig. 4 Switching times waveforms.

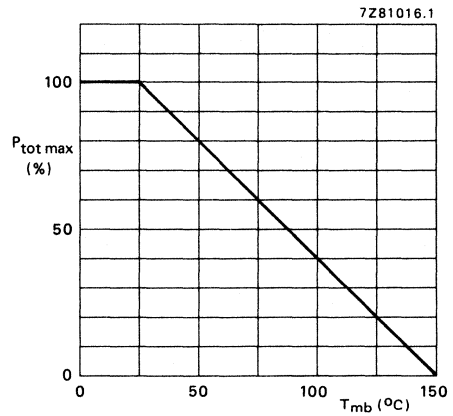


Fig. 5 Power derating curve.

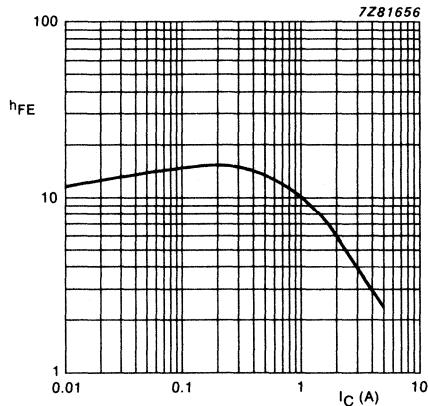
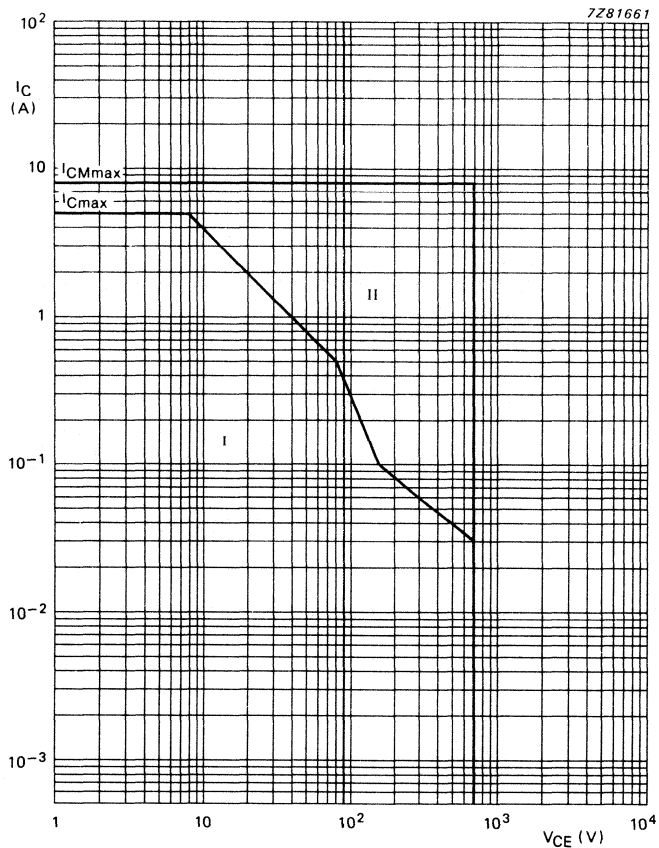


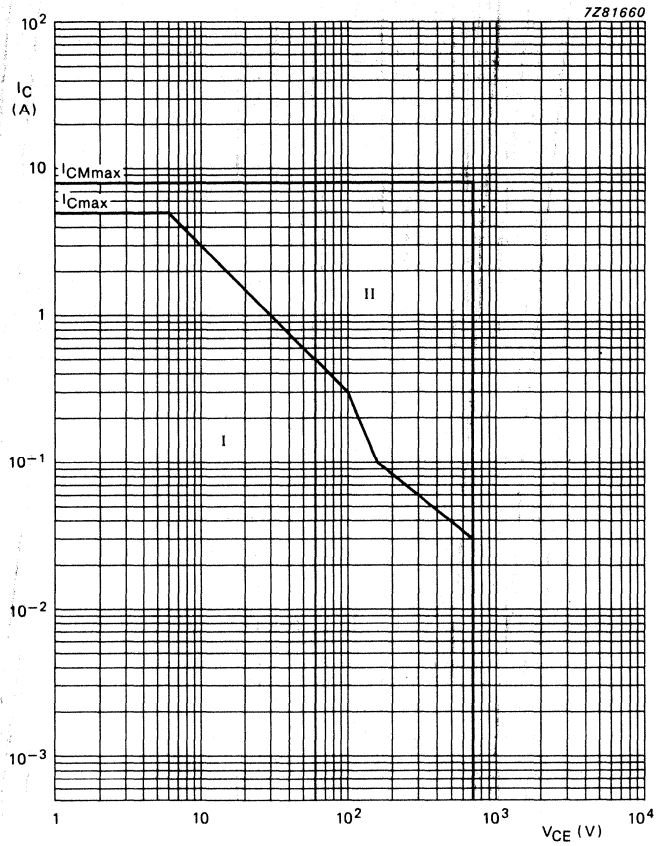
Fig. 6 Typical DC current gain; $V_{CE} = 5\text{ V}$; $T_j = 25\text{ }^\circ\text{C}$.

DEVELOPMENT DATA



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

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



I Region of permissible DC operation.

II Permissible extension for repetitive pulse operation.

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

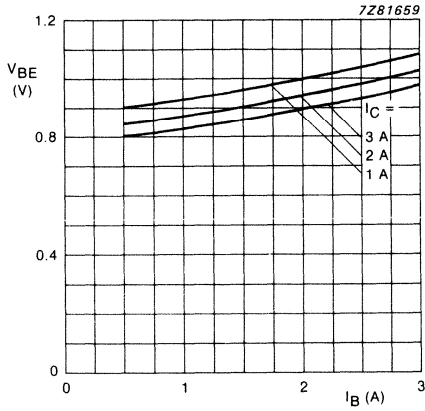


Fig. 9 Typical values V_{BE} ; $T_j = 25^\circ\text{C}$.

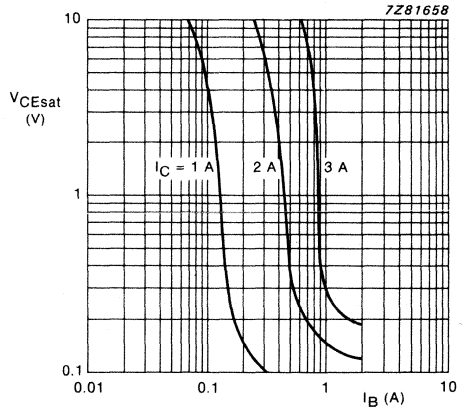


Fig. 10 Typical collector-emitter saturation voltage; $T_j = 25^\circ\text{C}$.

DEVELOPMENT DATA

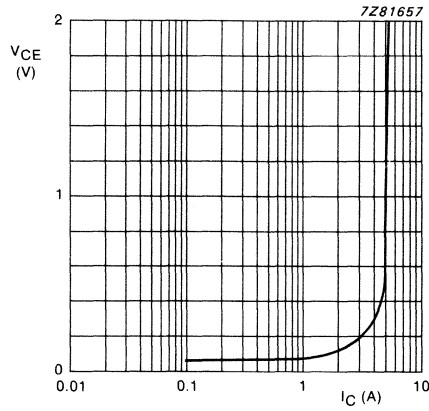


Fig. 11 Typical values V_{CE} ; $I_C/I_B = 2$; $T_j = 25^\circ\text{C}$.

DEVELOPMENT DATA

This data sheet contains advance information and specifications are subject to change without notice.

BU724
BU724A

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).

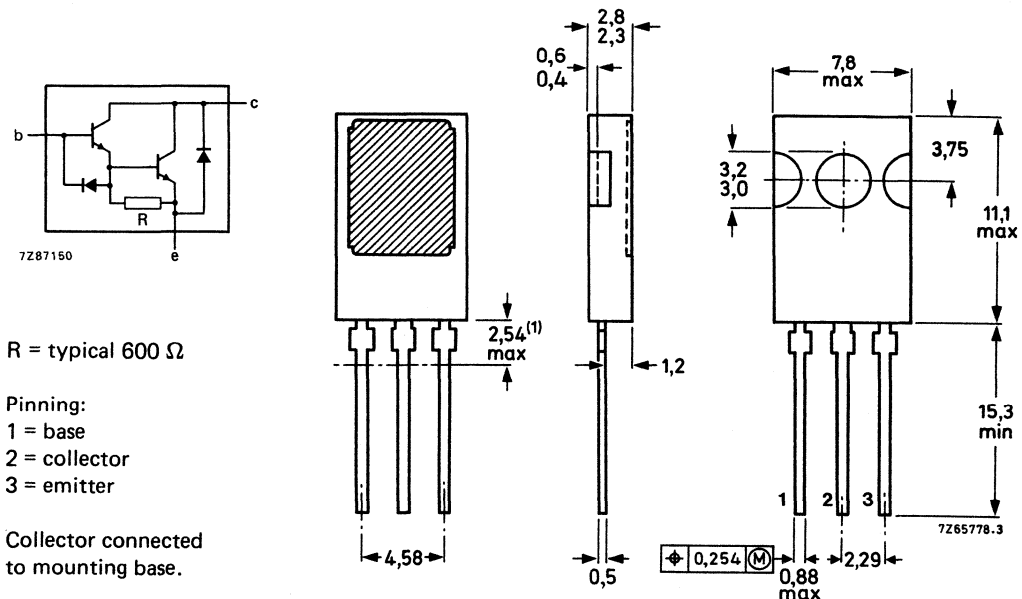
QUICK REFERENCE DATA

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

MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT82.



RATINGS

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

		BU724	724A	
Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM}	max. 650	850	V
	V_{CEO}	max. 375	400	V
Collector current saturation DC peak value	I_{Csat}	max. 0.4	0.3	A
	I_C	max. 2.0		A
	I_{CM}	max. 3.0		A
Base current DC peak value	I_B	max. 0.2		A
	I_{BM}	max. 1.0		A
Total power dissipation up to $T_{amb} = 25\text{ }^\circ\text{C}$	P_{tot}	max. 1.5		W
	P_{tot}	max. 25		W
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$				
Storage temperature range	T_{stg}		-65 to + 150	$^\circ\text{C}$
Junction temperature	T_j	max. 150		$^\circ\text{C}$
THERMAL RESISTANCE				
From junction to mounting base	$R_{th\ j-mb}$	=	5.0	K/W
From junction to ambient	$R_{th\ j-amb}$	=	83	K/W

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

Collector cut-off currents*

$V_{CE} = V_{CESM\text{ max}}; V_{BE} = 0.3\text{ V}$

$V_{CE} = V_{CES\text{ max}}; V_{BE} = 0.3\text{ V}; T_j = 125\text{ }^\circ\text{C}$

I_{CES}	max.	0.1	mA
I_{CES}	max.	0.2	mA

Emitter cut-off current

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

I_{EBO}	max.	2.0	mA
I_{EBO}	min.	3.3	mA

Collector-emitter sustaining voltage

$I_B = 0; I_C = 10\text{ mA}$

		BU724	724A
V_{CEO}	min.	375	400 V

Saturation voltages

$I_C = 400\text{ mA}; I_B = 1.0\text{ mA}$

$I_C = 300\text{ mA}; I_B = 1.0\text{ mA}$

V_{CEsat}	max.	5.0	— V
V_{CEsat}	max.	—	3.0 V
V_{BEsat}	max.	2.0	V

Parasitic collector current

$V_{CE} = 10\text{ V}; -I_B = 250\text{ mA}$

I_{cp}	max.	100	μA
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Switching times resistive load

$I_{C\text{ on}} = 0.4\text{ A}; I_{BM} = 9\text{ mA}$

$-V_{EE} = 1\text{ V}; V_{CC} = 250\text{ V}$

$I_B = 1\text{ mA}; T_{mb} = 100\text{ }^\circ\text{C}$

rise time

t_{on}	max.	1.0	μs
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storage time

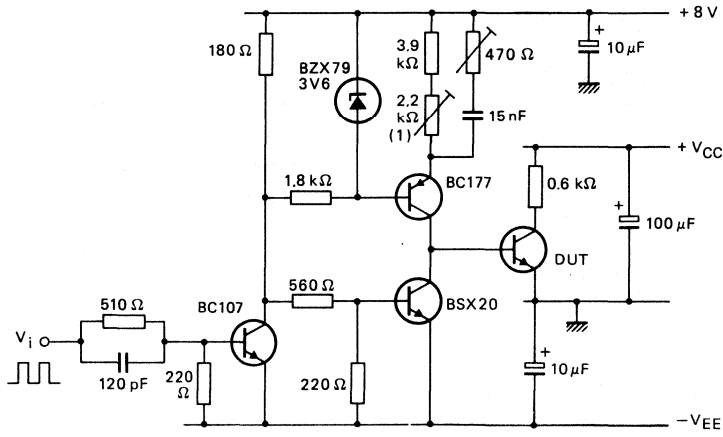
t_s	max.	1.5	μs
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fall time

t_f	max.	1.5	μs
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DEVELOPMENT DATA

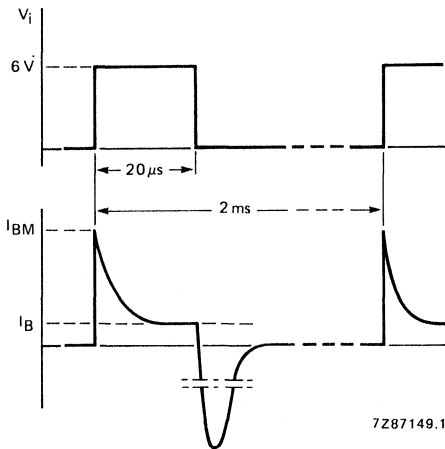
* Measured with a half-sinewave voltage (curve tracer).



7281940

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

Fig. 2 Switching times test circuit.



7287149.1

Fig. 3 Input current and current waveforms.

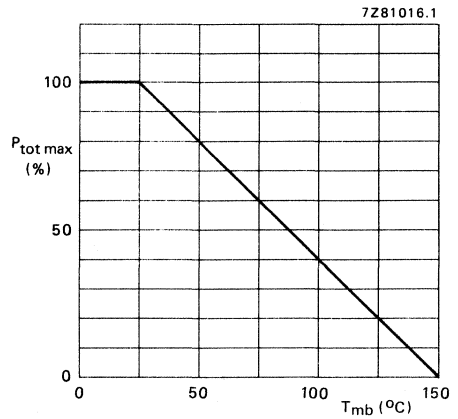
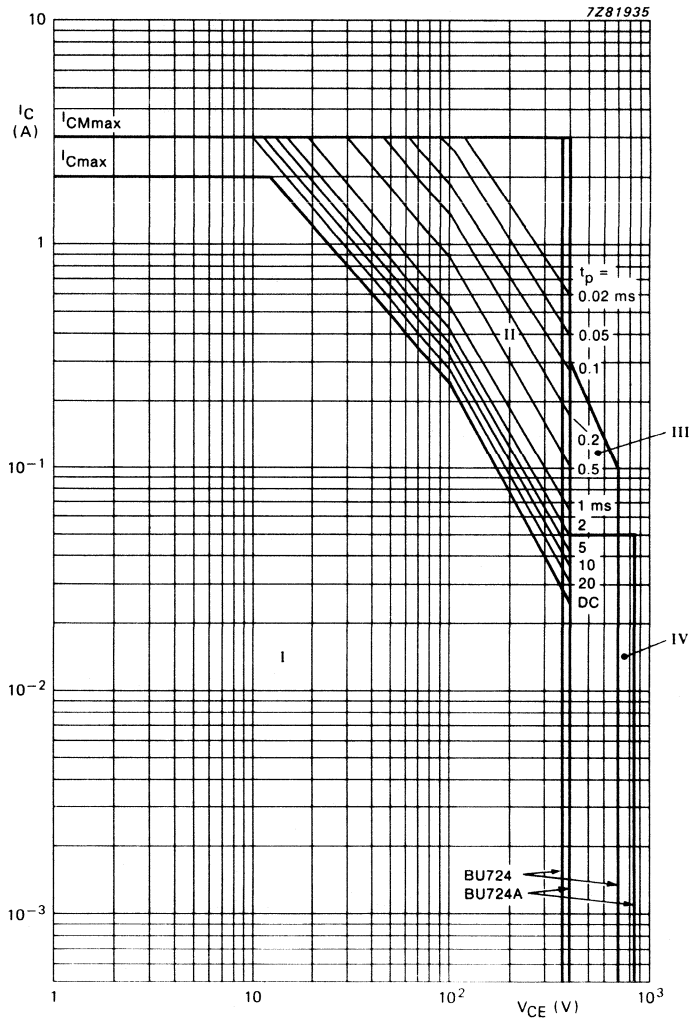


Fig. 4 Power derating curve.

DEVELOPMENT DATA



- 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 $dV_{CB}/dt \leq 5000 V/\mu s$.

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

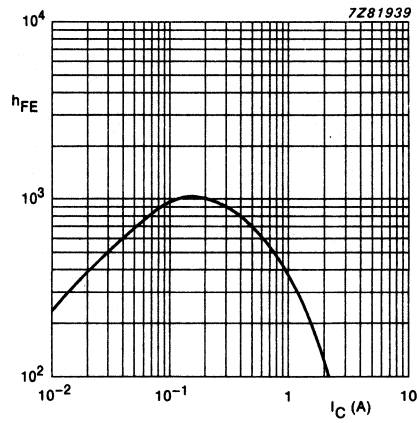


Fig. 6 Typical DC current gain; $V_{CE} = 5$ V; $T_{mb} = 25$ °C.

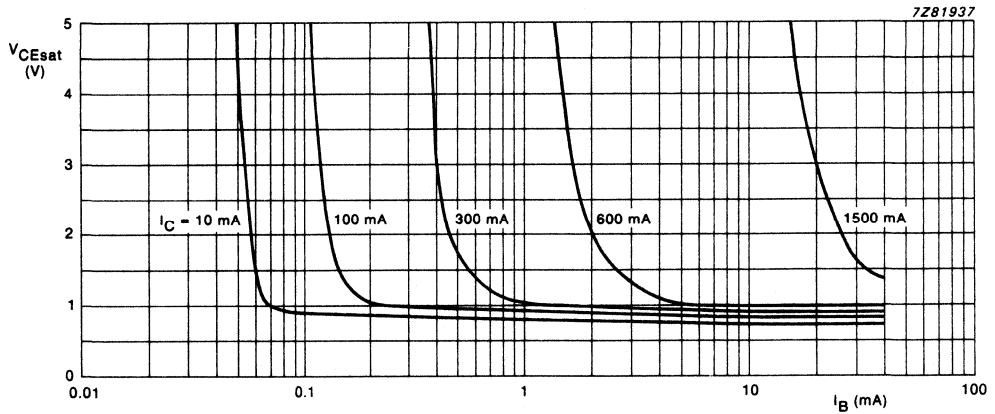


Fig. 7 Typical collector-emitter saturation voltage as a function of base current; $T_{mb} = 25$ °C.

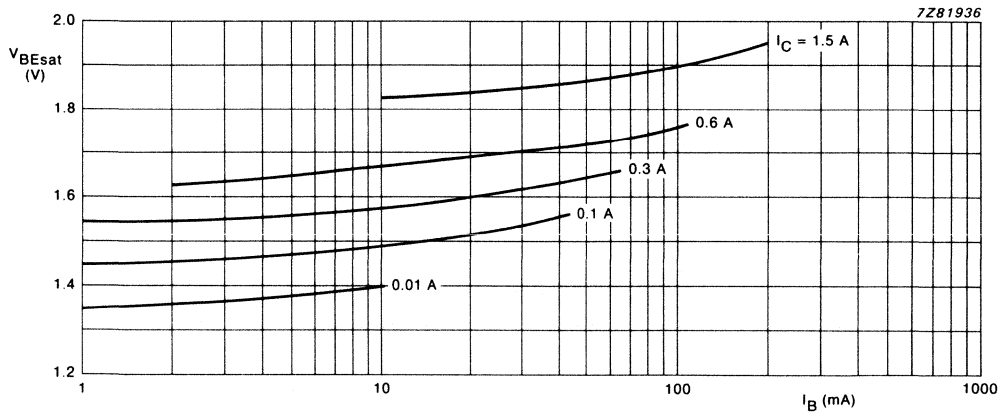


Fig. 8 Typical base-emitter saturation voltage as a function of base current.

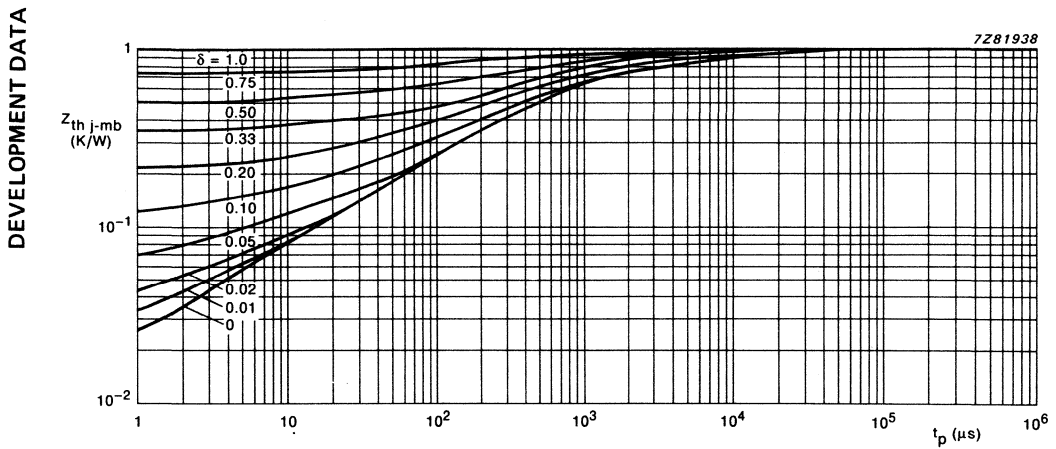


Fig. 9 Normalized thermal response at pulse power conditions.

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.

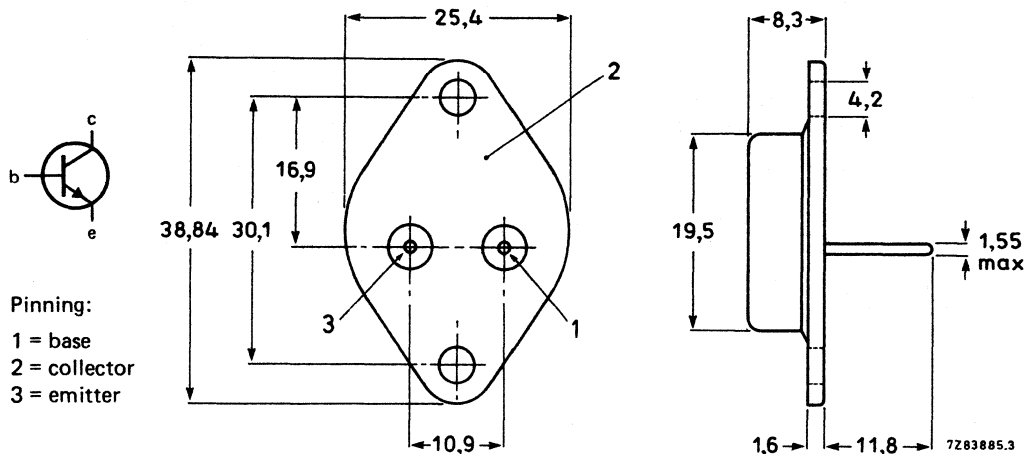
QUICK REFERENCE DATA

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 $T_{mb} = 25\text{ }^\circ\text{C}$	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.



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 $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	160 W
Storage temperature range	T_{stg}		-65 to + 150 $^\circ\text{C}$
Junction temperature	T_j	max.	150 $^\circ\text{C}$

THERMAL RESISTANCE

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

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

Collector cut-off current*

$V_{CE} = V_{CESMmax}; V_{BE} = 0$	I_{CES}	max.	1 mA
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$V_{CE} = V_{CESMmax}; V_{BE} = 0; T_j = 125\text{ }^\circ\text{C}$	I_{CES}	max.	4 mA
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Emitter cut-off current

$I_C = 0; V_{EB} = 5\text{ V}$	I_{EBO}	max.	10 mA
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Saturation voltages

$I_C = 9\text{ A}; I_B = 4\text{ A}$	V_{CEsat}	max.	1 V
--------------------------------------	-------------	------	-----

	V_{BEsat}	max.	1,5 V
--	-------------	------	-------

$I_C = 12\text{ A}; I_B = 6\text{ A}$	V_{CEsat}	max.	3 V
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Collector-emitter sustaining voltage

$I_C = 200\text{ mA}; I_B = 0; L = 25\text{ mH}$	$V_{CEO\text{sust}}$	min.	700 V
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Second breakdown collector current

$V_{CE} = 100\text{ V}; t_p = 1\text{ s}$	$I_{(SB)C}$	min.	0,4 A
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Transition frequency at $f = 5\text{ MHz}$

$I_C = 0,1\text{ A}; V_{CE} = 5\text{ V}$	f_T	typ.	7 MHz
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Collector capacitance at $f = 1\text{ MHz}$

$I_E = I_e = 0; V_{CB} = 10\text{ V}$	C_C	typ.	200 pF
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* Measured with a half-sinewave voltage (curve tracer).

Switching times resistive load (Figs 2 and 3)

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

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

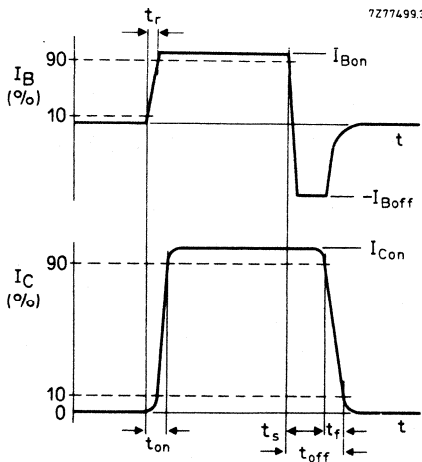
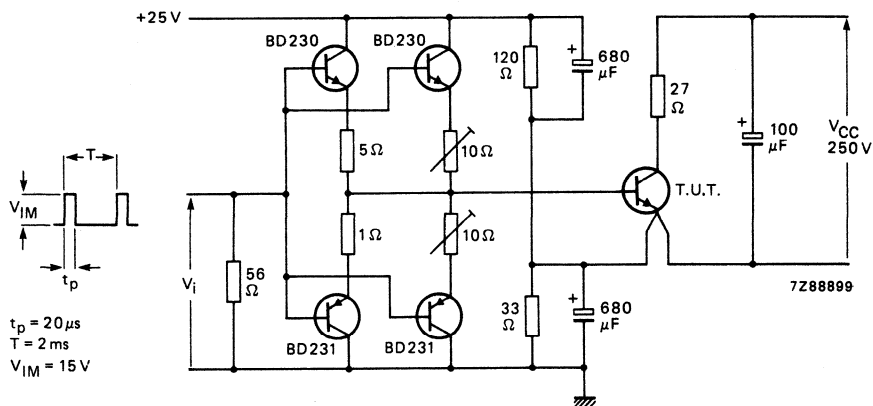
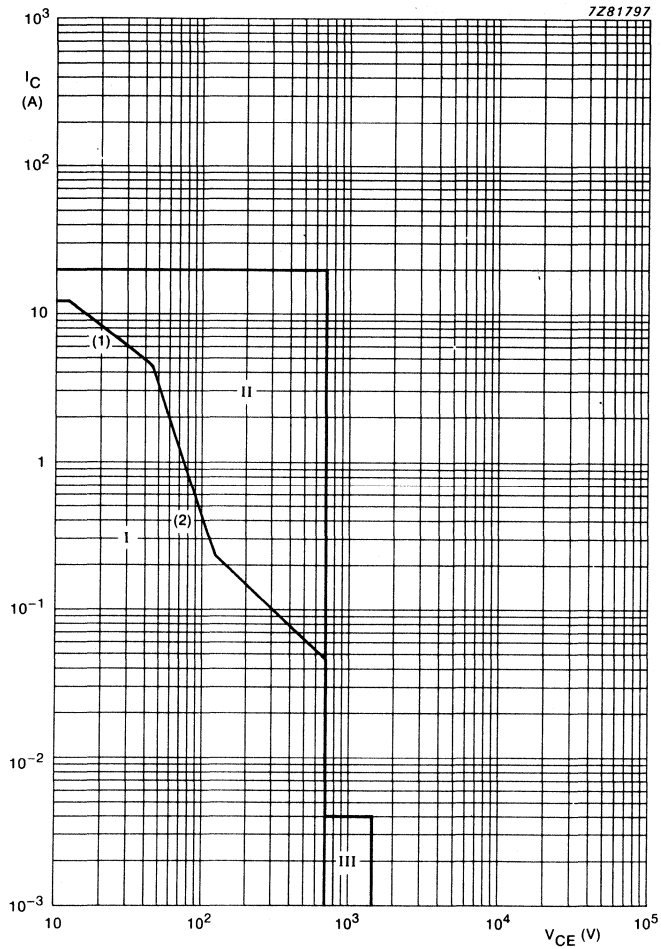


Fig. 2 Switching times waveforms with resistive load.



$t_p = 20 \mu\text{s}$
 $T = 2 \text{ ms}$
 $V_{IM} = 15 \text{ V}$

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 $V_{BE} \leq 0$ and $t_p \leq 5$ ms.

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

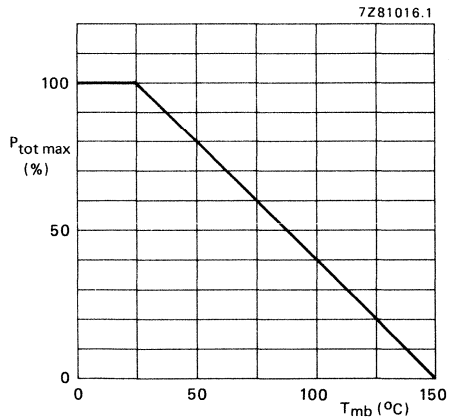


Fig. 5 Power derating curve.

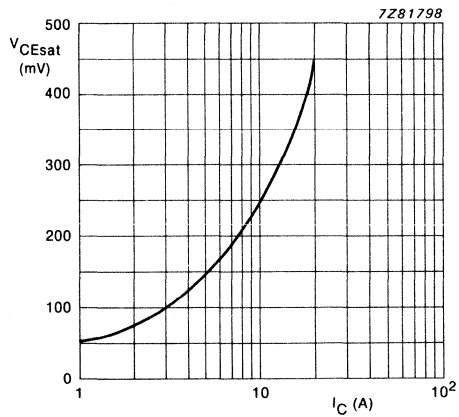


Fig. 6 Typical values $I_C/I_B = 2$; $T_j = 25$ °C.

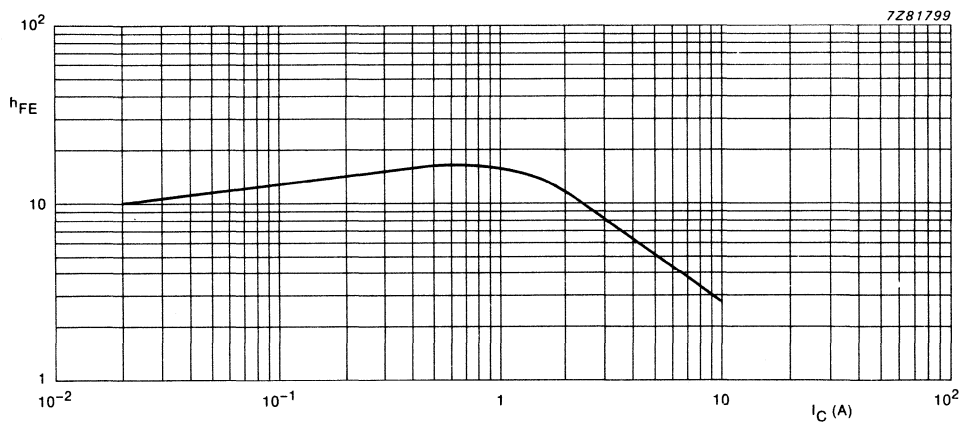


Fig. 7 Typical values DC current gain at $V_{CE} = 5$ V; $T_{mb} = 25$ °C.

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.

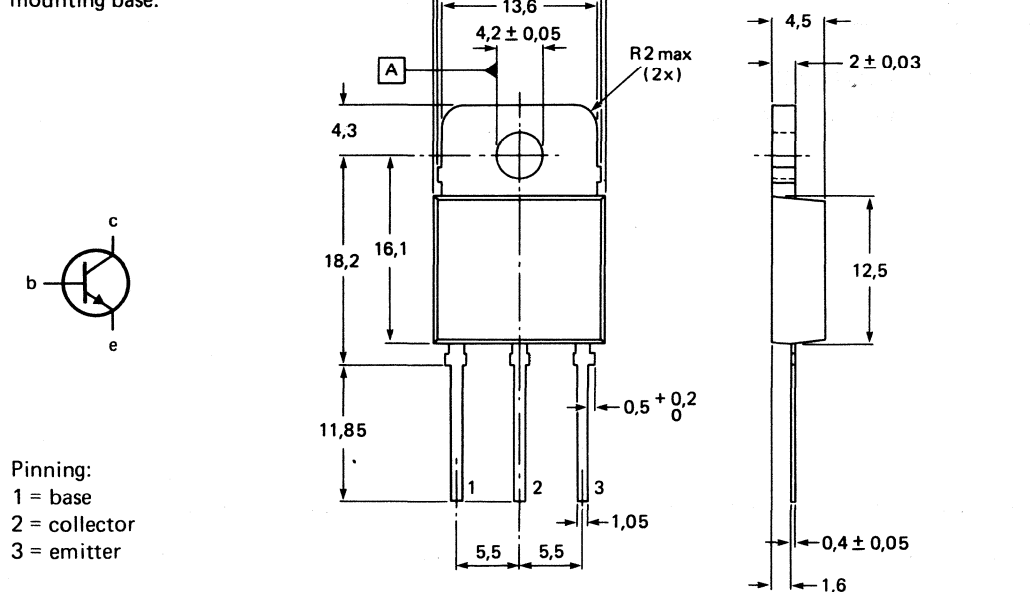
QUICK REFERENCE DATA

		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 $T_{mb} = 25^\circ C$	P_{tot}	max. 125	W
Collector saturation current	I_{Csat}	max. 2,5	A
Fall time	t_f	typ. 0,2	μs

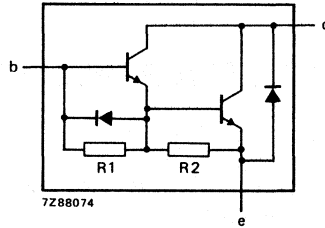
MECHANICAL DATA

Fig. 1 SOT93.

Collector connected to mounting base.



7296696



R1 typ. 200 Ω
R2 typ. 100 Ω

Fig. 2 Circuit diagram.

RATINGS

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

		BU826	BU826A
Collector-emitter voltage (peak value; $V_{BE} = 0$)	V_{CESM}	max. 800	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 $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max. 125	W
Storage temperature range	T_{stg}	-65 to + 150	$^\circ\text{C}$
Junction temperature*	T_j	max. 150	$^\circ\text{C}$

THERMAL RESISTANCE*

From junction to mounting base	$R_{th\ j-mb}$	=	1,0	K/W
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* Based on maximum average junction temperature in line with common industrial practice. The resulting higher junction temperature of the output transistor part is taken into account.

CHARACTERISTICS

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

Collector cut-off current*

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

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

Emitter cut-off current

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

Collector-emitter sustaining voltage

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

Saturation voltages

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

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

I_{CES} max. 1 mA

I_{CES} max. 2 mA

I_{EBO} max. 150 mA
min. 50 mA

$V_{CEOsust}$ min. 375 V

V_{CEsat} max. 2,0 V

V_{BEsat} max. 2,2 V

V_{CEsat} max. 2,5 V

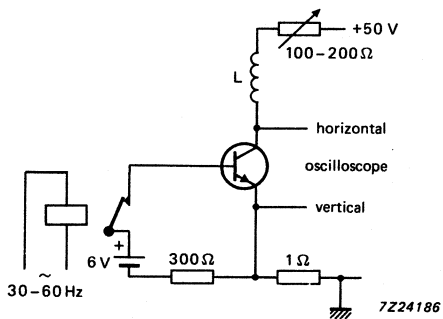


Fig. 3 Test circuit for $V_{CEOsust}$.

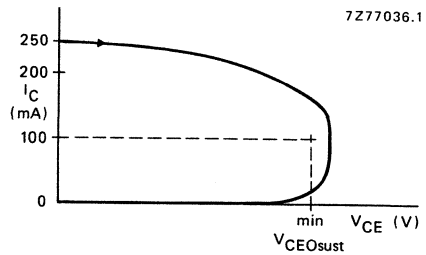


Fig. 4 Oscilloscope display for $V_{CEOsust}$.

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

CHARACTERISTICS (continued)

Switching times (between 10% and 90% levels)

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

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

Turn-on time

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

Turn-off time: Storage time

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

Fall time

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

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

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

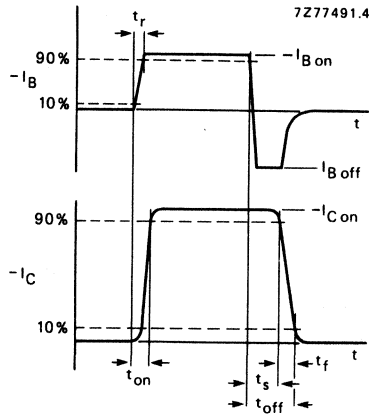


Fig. 5 Waveforms.

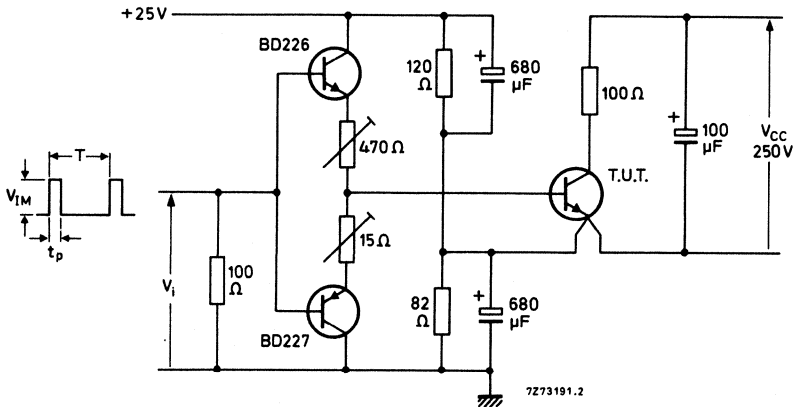
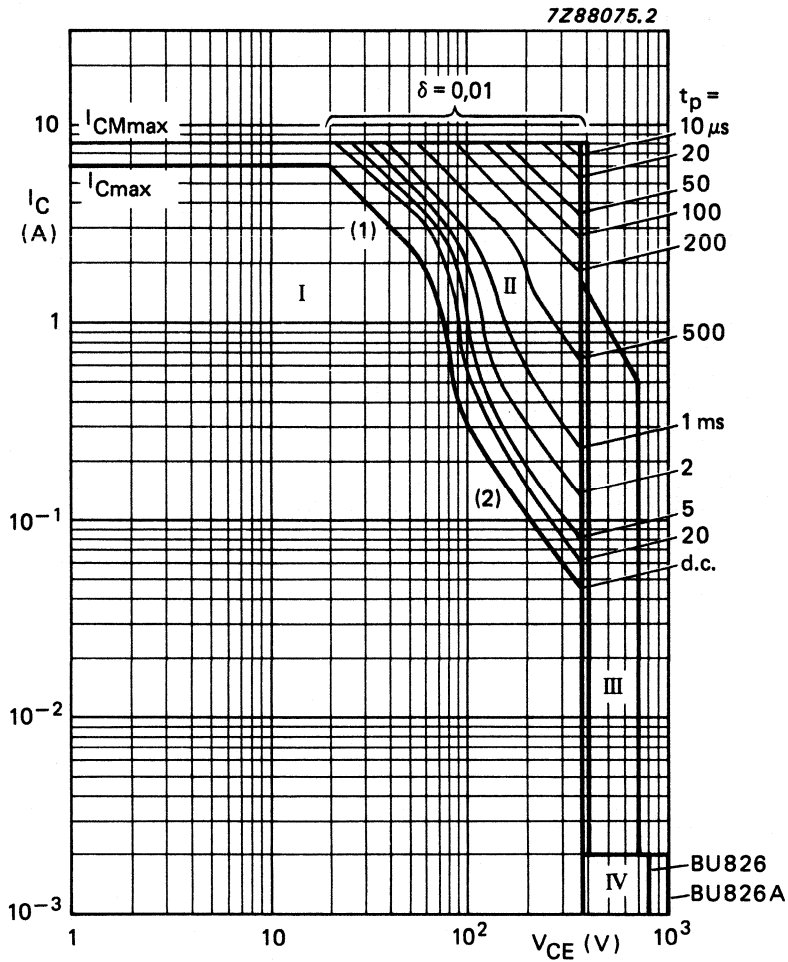
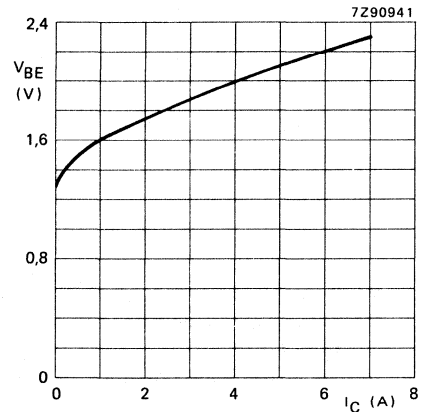
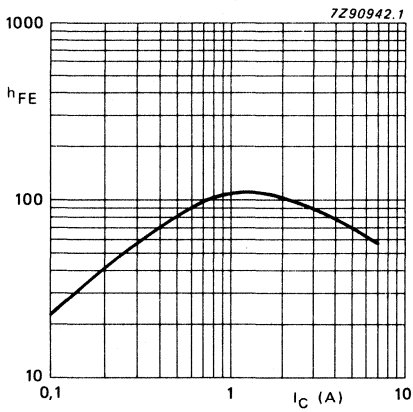
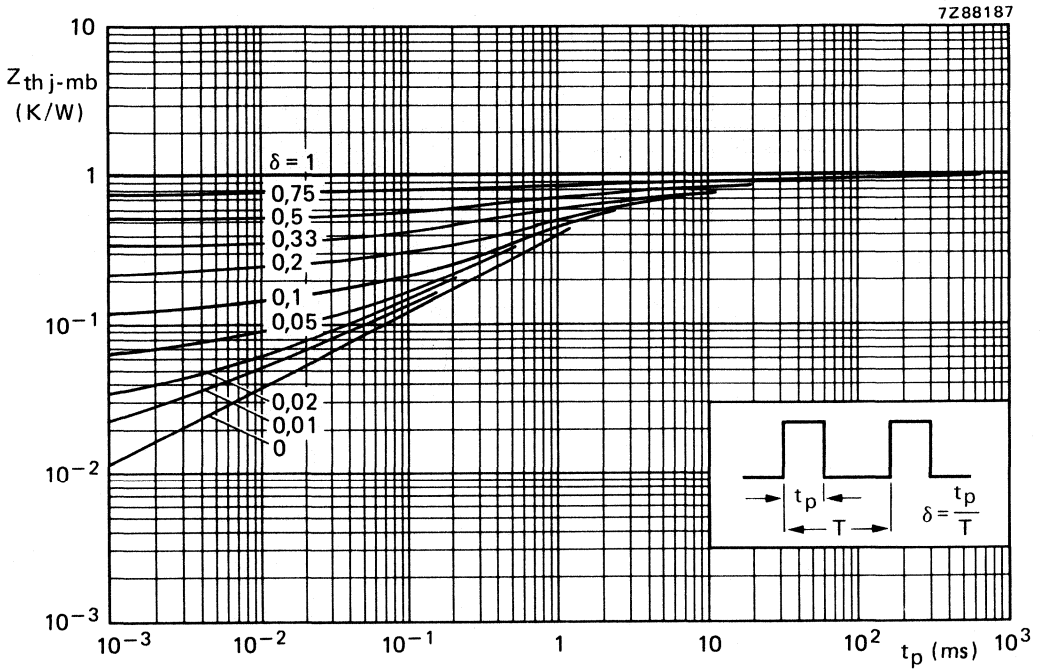


Fig. 6 Test circuit. $T = 2 \text{ ms}$; $t_p = 20 \mu\text{s}$; $V_{IM} = 15 \text{ V}$.



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

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



SILICON DIFFUSED POWER TRANSISTORS

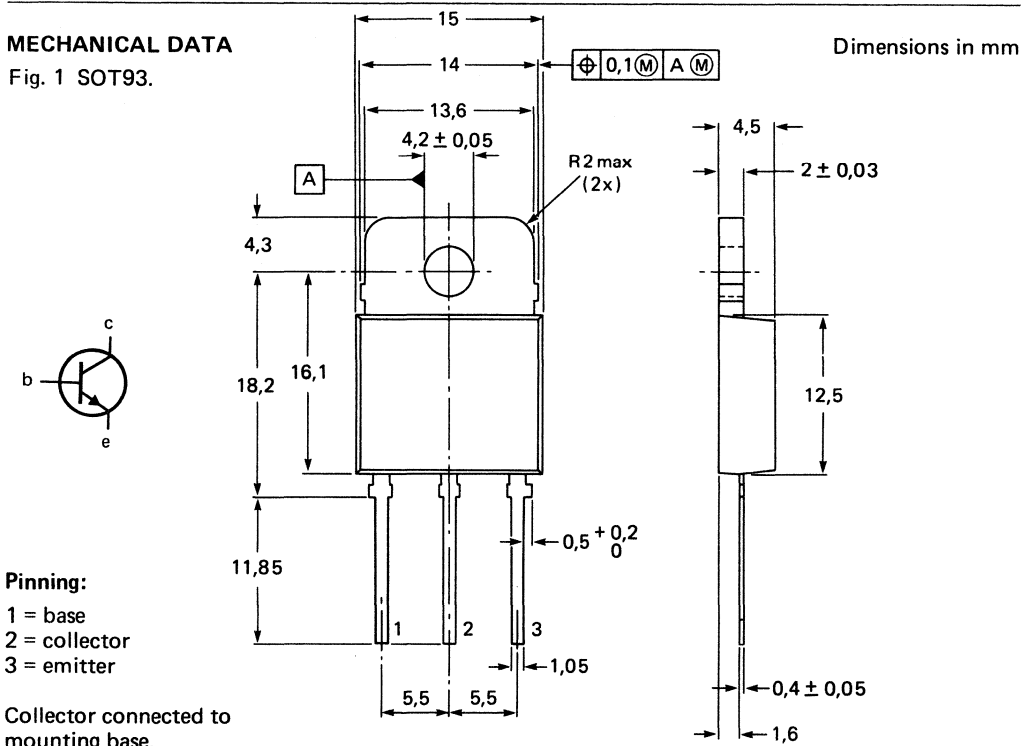
High-voltage, high-speed, glass-passivated npn power transistors in a SOT93 envelope intended for use in power supplies and deflection circuits for colour receivers and monitors.

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 $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	125 W
DC current gain			
$I_C = 3.2\text{ A}; V_{CE} = 2\text{ V}$	h_{FE}	min.	6.0
Switching times; resistive load			
fall time	t_f	max.	0.7 μs

MECHANICAL DATA

Fig. 1 SOT93.



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 $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	125 W
Storage temperature range	T_{stg}		-65 to + 150 $^\circ\text{C}$
Junction temperature	T_j	max.	150 $^\circ\text{C}$

THERMAL RESISTANCE

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

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

Collector cut-off current

$V_{BE} = 0; V_{CE} = V_{CESmax}$	I_{CES}	max.	1.0 mA
$V_{BE} = 0; V_{CE} = V_{CESmax}; T_j = 125\text{ }^\circ\text{C}$	I_{CES}	max.	2.0 mA

Emitter cut-off current

$I_C = 0; V_{EB} = 6\text{ V}$	I_{EBO}	max.	1.0 mA
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Collector-emitter breakdown voltage

$I_C = 100\text{ mA}; I_B = 0$	V_{CEO}	min.	550 V
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Saturation voltage

$I_C = 3.2\text{ A}; I_B = 0.53\text{ A}$	V_{CEsat}	max.	2.0 V
$I_C = 6.0\text{ A}; I_B = 2.0\text{ A}$	V_{CEsat}	max.	1.8 V

DC current gain

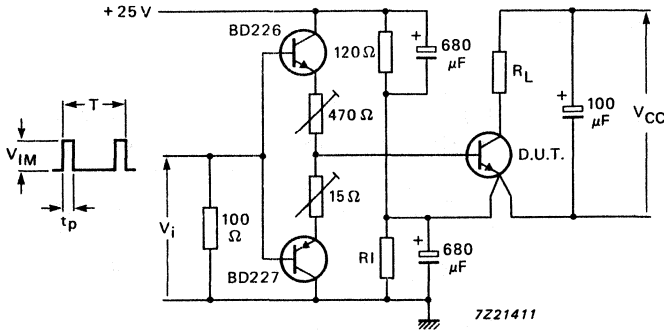
$I_C = 10\text{ mA}; V_{CE} = 5\text{ V}$	h_{FE}	min.	6.0
$I_C = 1.5\text{ A}; V_{CE} = 5\text{ V}$	h_{FE}	min.	8.0
$I_C = 3.2\text{ A}; V_{CE} = 2\text{ V}$	h_{FE}	min.	6.0
$I_C = 4.0\text{ A}; V_{CE} = 3\text{ V}$	h_{FE}	min.	5.5

Switching times; resistive load (Figs 2 and 3)

$I_{Con} = 3.2\text{ A}; I_{Bon} = 0.53\text{ A}$			
turn-on	t_{on}	max.	0.5 μs
turn-off; storage time	t_s	max.	6.0 μs
fall time	t_f	max.	0.7 μs

Switching times; inductive load (Figs 4 and 5)

$I_{Con} = 3.2\text{ A}; I_{Bon} = 0.53\text{ A}$			
turn-off; storage time	t_s	max.	2.5 μs
fall time	t_f	max.	0.8 μs



$t_p = 20 \mu s$
 $T = 2 ms$
 $V_{IM} = 15 V$

Fig. 2 Test circuit resistive load;
 $V_{CC} = 240 V$; $R_L = 75 \Omega$; $R_1 = 82 \Omega$.

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

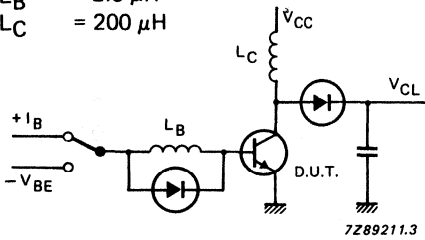


Fig. 4 Test circuit inductive load.

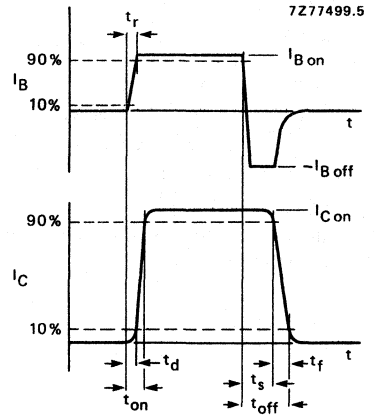


Fig. 3 Switching times waveforms with resistive load; $t_r \leq 30 ns$.

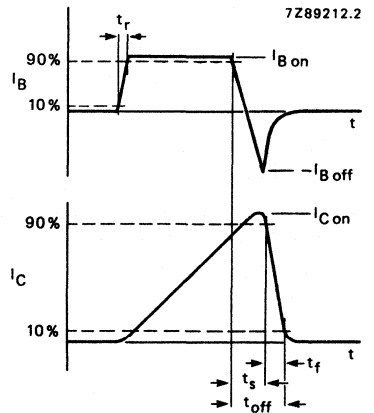


Fig. 5 Switching times waveforms with inductive load.

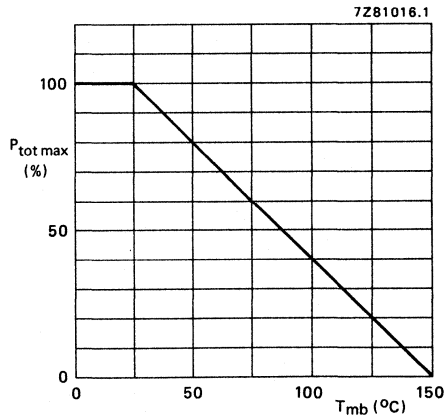
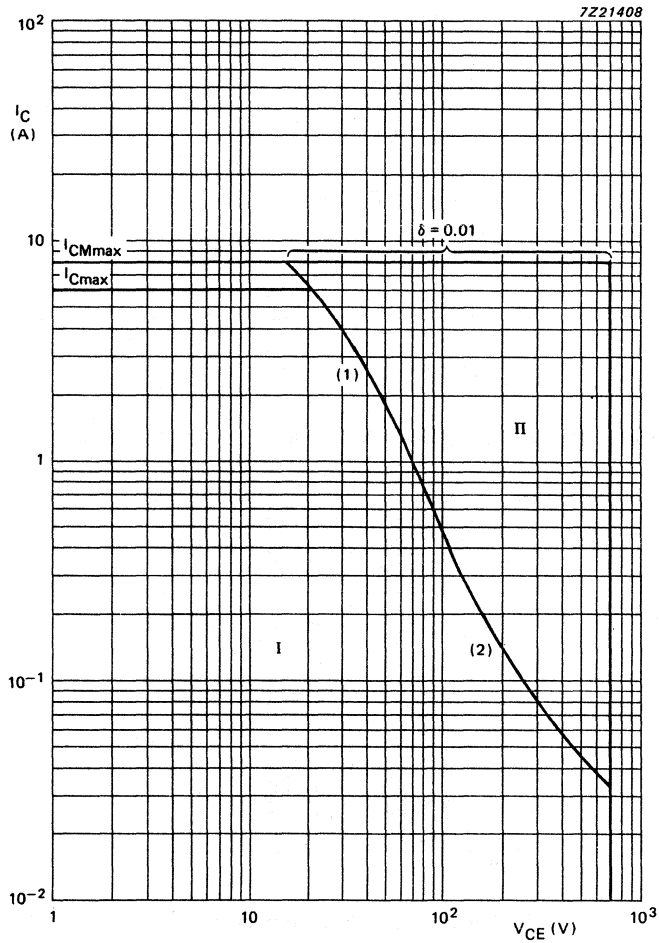


Fig. 6 Power derating curve.



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

Fig. 7 Forward bias SOAR.

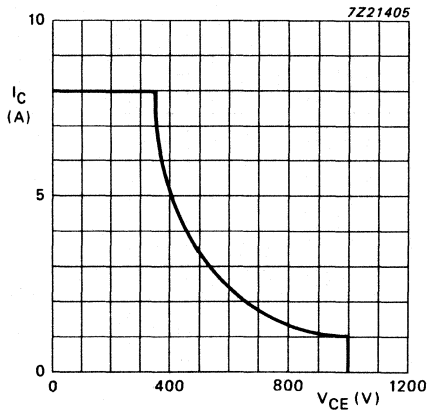


Fig. 8 Reverse bias SOAR; $-V_{BE} = 5 \text{ V}$; $\beta_F \leq 4$; $T_j \leq 100 \text{ }^\circ\text{C}$.

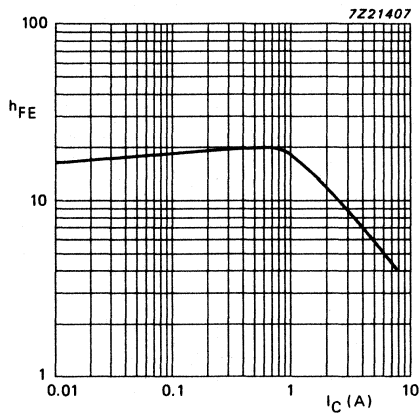


Fig. 9 Typical values DC current gain; $V_{CE} = 5 \text{ V}$.

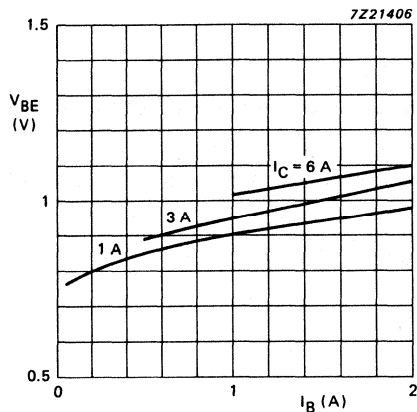


Fig. 10 Base-emitter voltage as a function of base current.

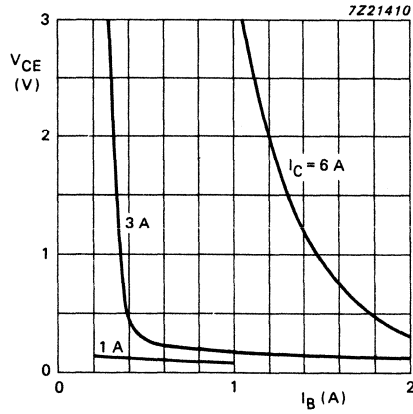


Fig. 11 Collector-emitter voltage as a function of base current.

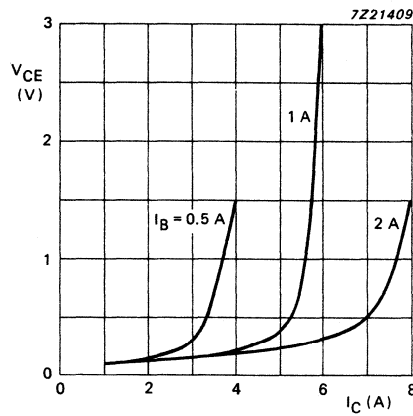


Fig. 12 Collector-emitter voltage as a function of collector current.

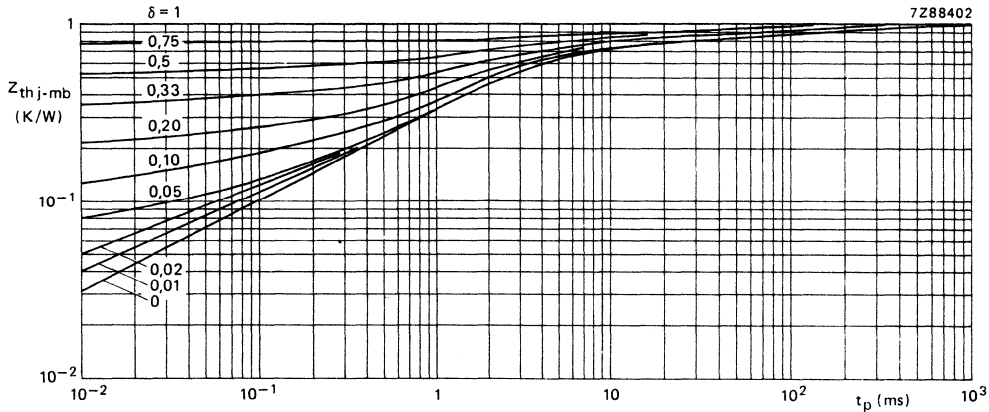


Fig. 13 Pulse power rating chart.

SILICON DIFFUSED POWER 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.

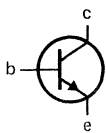
QUICK REFERENCE DATA

			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 $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	125	W

MECHANICAL DATA

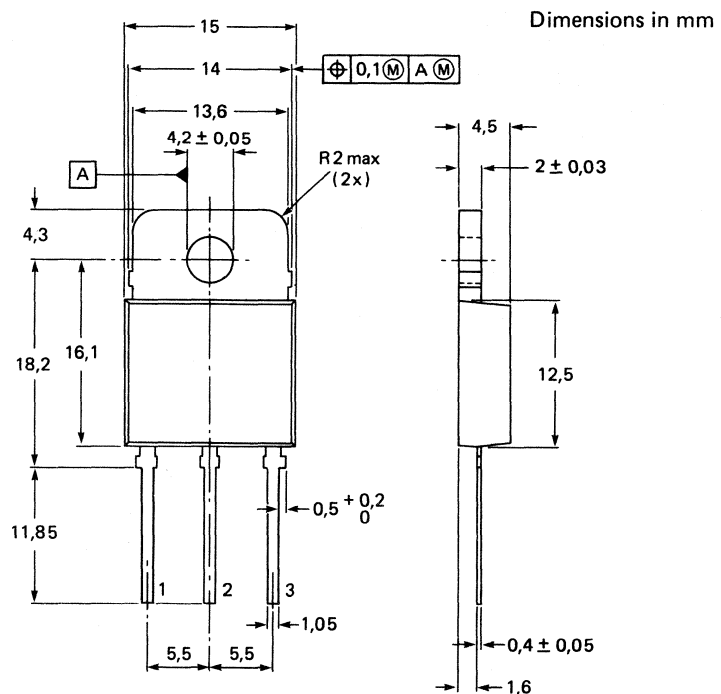
Fig. 1 SOT93.

Collector connected to mounting base.



Pinning:

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



7296696

BUP22 SERIES

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 $T_{mb} = 25^\circ\text{C}$	P_{tot} max.	125	W
Storage temperature range	T_{stg}	-65 to + 150	$^\circ\text{C}$
Junction temperature	T_j max.	150	$^\circ\text{C}$

THERMAL RESISTANCE

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

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

Collector cut-off current*

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

I_{CES} max.	1	mA
----------------	---	----

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

$T_j = 125^\circ\text{C}$

I_{CES} max.	2	mA
----------------	---	----

Emitter cut-off current

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

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

DC current gain

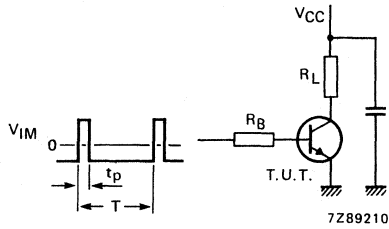
$I_C = 1\text{ A}; V_{CE} = 5\text{ V}$

h_{FE} typ.	25	
---------------	----	--

		BUP22B	BUP22C
Collector-emitter sustaining voltage $I_B = 0; I_C = 0.1\text{ A}; L = 25\text{ mH}$	$V_{CEO_{sust}}$ min.	400	450 V
Saturation voltages $I_C = 6\text{ A}; I_B = 0.8\text{ A}$	V_{CEsat} max.	1.5	- V
	V_{BEsat} max.	1.5	- V
$I_C = 6\text{ A}; I_B = 1\text{ A}$	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
	t_s	typ.	—	1.1 μs
$I_{C\ on} = 6\ A; I_{B\ on} = 1\ A$	t_f	typ.	—	40 ns



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

Fig. 2 Test circuit resistive load.

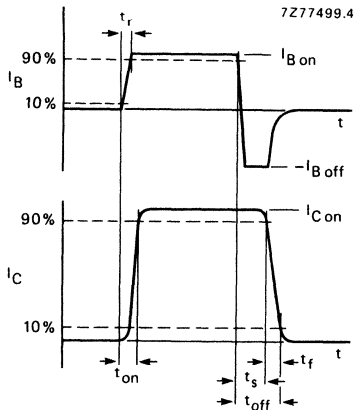


Fig. 3 Switching times waveforms with resistive load.

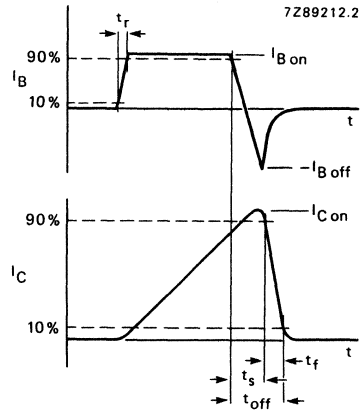
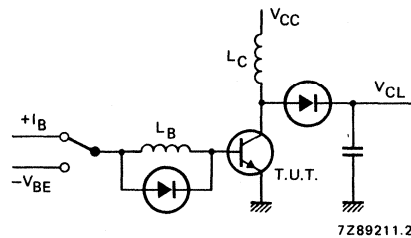
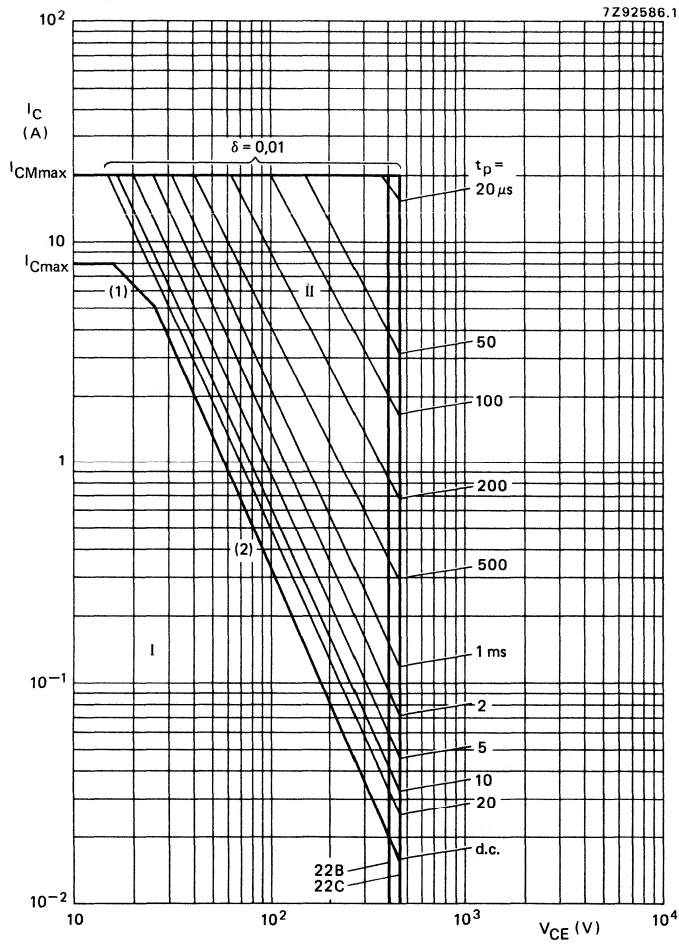


Fig. 4 Switching times waveforms with inductive load.



$V_{CL} = 250 \text{ V}$
 $V_{CC} = 30 \text{ V}$
 $-V_{BE} = 5 \text{ V}$
 $L_B = 1 \mu\text{H}$
 $L_C = 200 \mu\text{H}$

Fig. 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 $T_{mb} \leq 250$ °C.

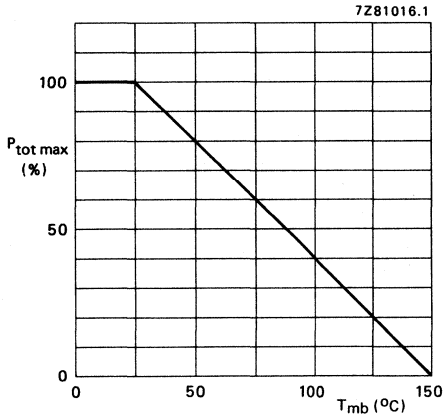


Fig. 7 Total power derating curve.

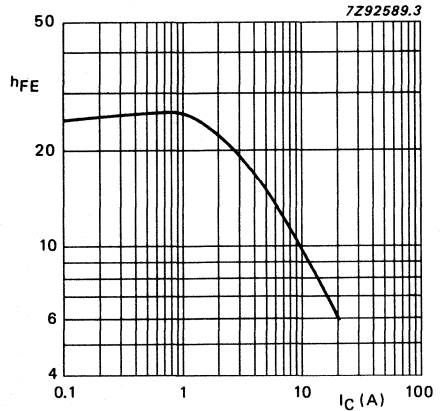


Fig. 8 Typical values DC current gain at $T_{mb} = 25\text{ }^{\circ}\text{C}$.

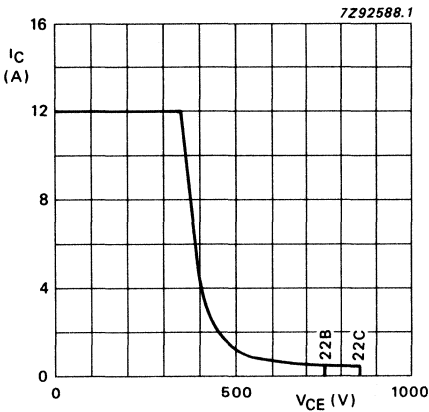


Fig. 9 Reverse bias SOAR; $T_{mb} = 100\text{ }^{\circ}\text{C}$;
 $V_{BE(off)} = 1\text{ to }5\text{ V}$; $L_B = 0\text{ to }3\text{ }\mu\text{H}$.

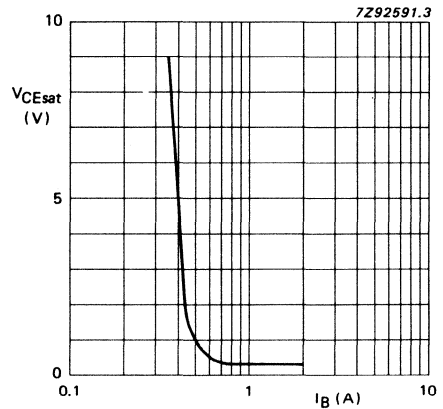


Fig. 10 Typical values V_{CEsat} at $T_j = 25\text{ }^{\circ}\text{C}$;
 $I_C = 6\text{ A}$.

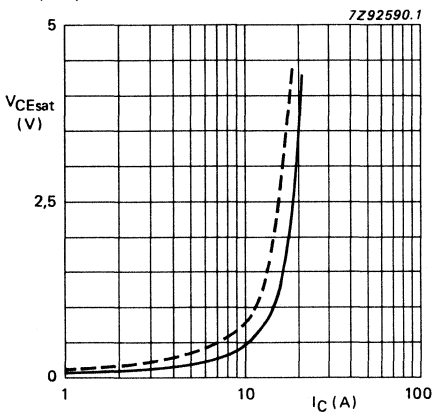


Fig. 11 Typical values collector voltage at $T_j = 25\text{ }^{\circ}\text{C}$;
 $I_C/I_B = 7, 5\text{ and }6$ for BUP22B and BUP22C resp;
(—) = BUP22B; (---) = BUP22C.

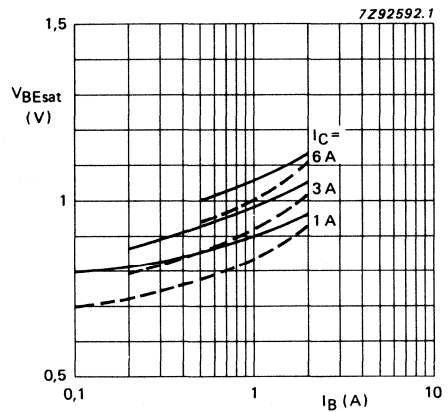


Fig. 12 Typical values V_{BE} at $T_j = 25\text{ }^{\circ}\text{C}$;
(—) = BUP22B; (---) = BUP22C.

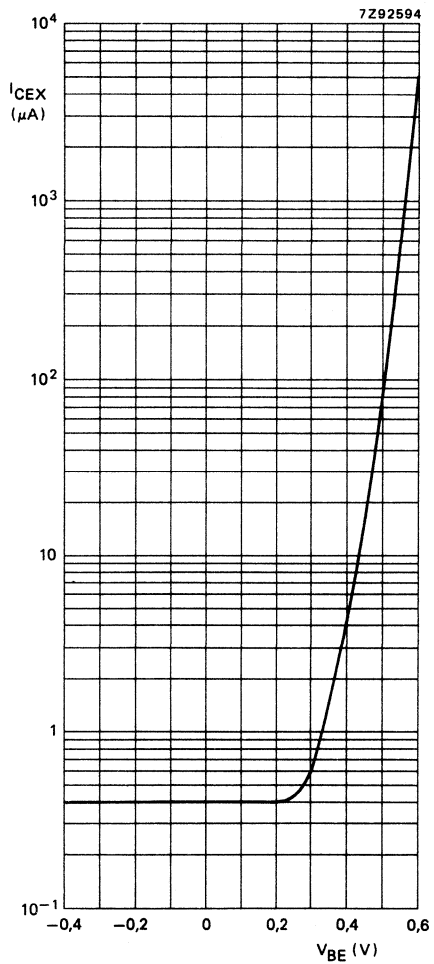


Fig. 13 Typical values collector cut-off current at $T_j = 25\text{ }^\circ\text{C}$; $V_{CE} = 250\text{ V}$.

DEVELOPMENT DATA

This data sheet contains advance information and specifications are subject to change without notice.

BUP22BF
BUP22CF

SILICON DIFFUSED POWER TRANSISTORS

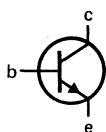
High-voltage, high-speed, glass-passivated npn power transistor in a SOT199 envelope intended for use in converters, inverters, switching regulators, motor control systems, etc.

QUICK REFERENCE DATA

			BUP22BF	BUP22CF
Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM}	max.	750	850 V
	V_{CEO}	max.	400	450 V
Collector-emitter saturation voltage	V_{CEsat}	max.	1.5	V
Collector current saturation DC peak value; $t_p \leq 20$ ms	I_{Csat}	max.	6.0	A
	I_C	max.	8.0	A
	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

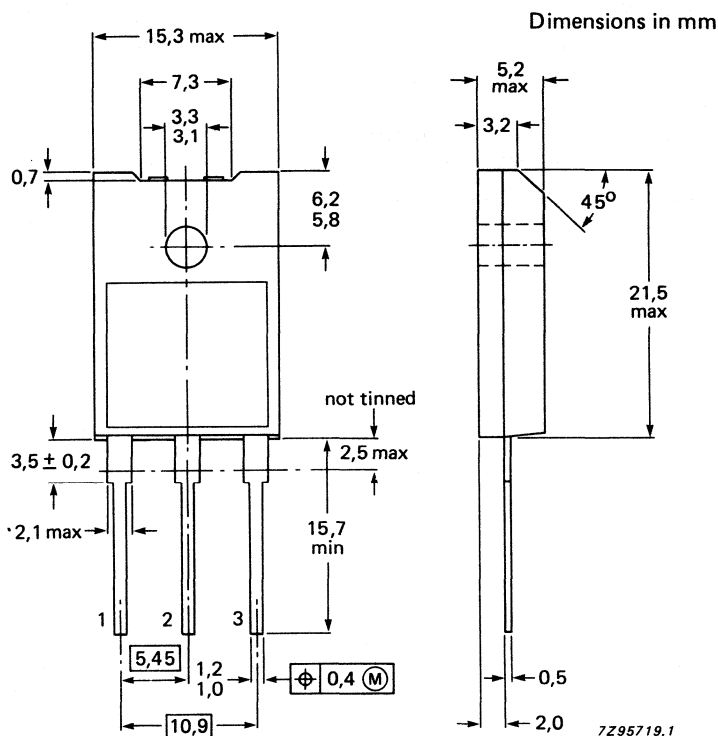
Fig. 1 SOT199.



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; $V_{BE} = 0$ open base	V_{CESM}	max.	750	850	V
	V_{CEO}	max.	400	450	V
Collector current saturation DC	I_{Csat}		6.0		A
	I_C	max.	8.0		A
	I_{CM}	max.	20		A
Base current DC	I_B	max.	4.0		A
	I_{BM}	max.	6.0		A
Total power dissipation up to $T_h = 25\text{ }^\circ\text{C}$ (note 1)	P_{tot}	max.	34		W
	P_{tot}	max.	45		W
Storage temperature range	T_{stg}		-65 to + 150		$^\circ\text{C}$
	T_j	max.	150		$^\circ\text{C}$

THERMAL RESISTANCE

From junction to external heatsink (note 1)	$R_{th\ j-h}$	=	3.7		K/W
	$R_{th\ j-h}$	=	2.8		K/W
From junction to ambient	$R_{th\ j-a}$	=	35		K/W

ISOLATION

Isolation voltage from all terminals to external heatsink (peak value)	V_{isol}	max.	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.

CHARACTERISTICS

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

Collector cut-off currents*

 $V_{CE} = V_{CESMmax}; V_{BE} = 0$ I_{CES} max. 1.0 mA $V_{CE} = V_{CESMmax}; V_{BE} = 0; T_j = 125\text{ }^\circ\text{C}$ I_{CES} max. 2.0 mA

Emitter cut-off current

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

DC current gain

 $I_C = 1.0\text{ A}; V_{CE} = 5\text{ V}$ h_{FE} typ. 25

Saturation voltages

 $I_C = 6\text{ A}; I_B = 0.8\text{ A}$ V_{CEsat} max. 1.5 V V_{BEsat} max. 1.5 V $I_C = 6\text{ A}; I_B = 1.0\text{ A}$ V_{CEsat} max. 1.5 V V_{BEsat} max. 1.5 V

Collector-emitter sustaining voltage (Figs 2 and 3)

 $I_C = 100\text{ mA}; I_B\text{ off} = 0; L = 25\text{ mH}$ $V_{CEOsust}$ min. 400 V

Collector saturation current

 $V_{CE} = 1.5\text{ V}$ I_{Csat} 6.0 A

Switching times resistive load (Figs 4 and 5)

 $I_C\text{ on} = 6\text{ A}; I_B\text{ on} = I_B\text{ off} = 0.8\text{ A}$

Turn-on time

 t_{on} max. 1.0 μs

Turn-off; storage time

 t_s max. 4.5 μs

fall time

 t_f max. 0.7 μs $I_C\text{ on} = 6\text{ A}; I_B\text{ on} = I_B\text{ off} = 1\text{ A}$

Turn-on time

 t_{on} max. 1.0 μs

Turn-off; storage time

 t_s max. 4.5 μs

fall time

 t_f max. 0.7 μs

Switching times inductive load (Figs 6 and 7)

 $I_C\text{ on} = 6\text{ A}; I_B = 0.8\text{ A};$ $V_{CL} = 250\text{ V}; T_c = 100\text{ }^\circ\text{C}$

Turn-off; storage time

 t_s typ. 2.0 μs t_s max. 2.5 μs

fall time

 t_f typ. 100 ns t_f max. 250 ns $I_C\text{ on} = 6\text{ A}; I_B = 1\text{ A};$ $V_{CL} = 250\text{ V}; T_c = 100\text{ }^\circ\text{C}$

Turn-off; storage time

 t_s typ. 2.0 μs t_s max. 2.5 μs

fall time

 t_f typ. 100 ns t_f max. 250 ns

DEVELOPMENT DATA

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

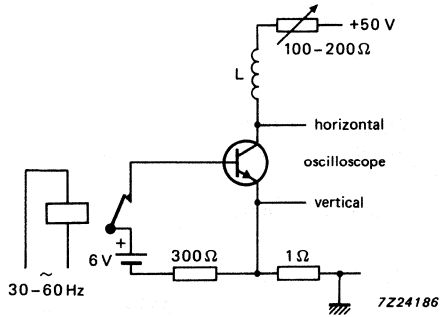


Fig. 2 Test circuit for $V_{CE0sust}$.

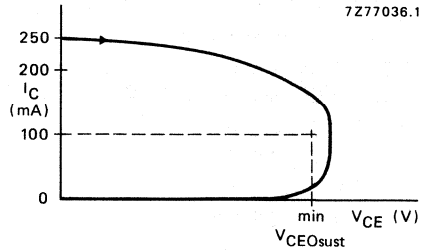
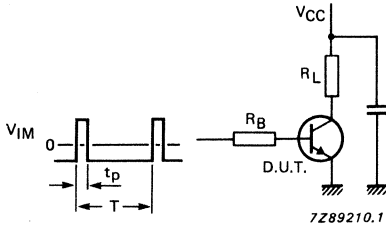


Fig. 3 Oscilloscope display for sustaining voltage.



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

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

Fig. 4 Test circuit resistive load.

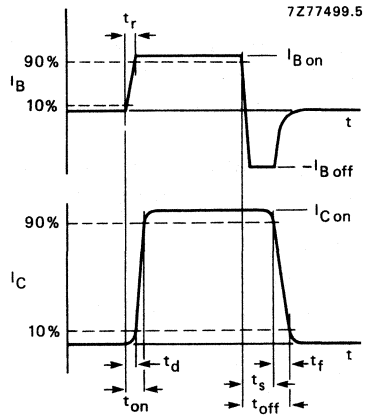
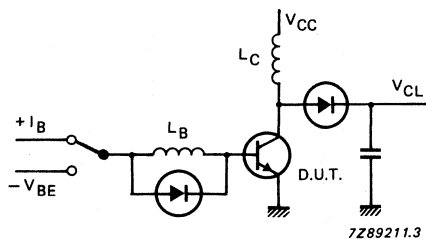


Fig. 5 Switching times waveforms with resistive load; $t_r \leq 20 \text{ ns}$.



$V_{CL} = \text{up to } 850 \text{ V}$
 $V_{CC} = 30 \text{ V}$
 $-V_{BE} = 5 \text{ V}$
 $L_B = 1.0 \mu\text{H}$
 $L_C = 200 \mu\text{H}$

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

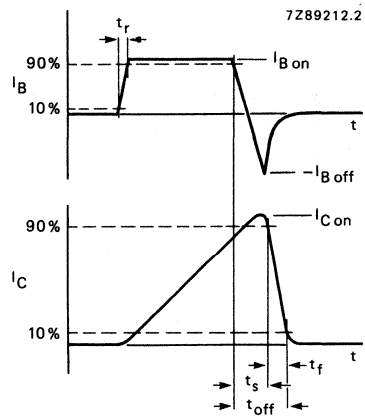
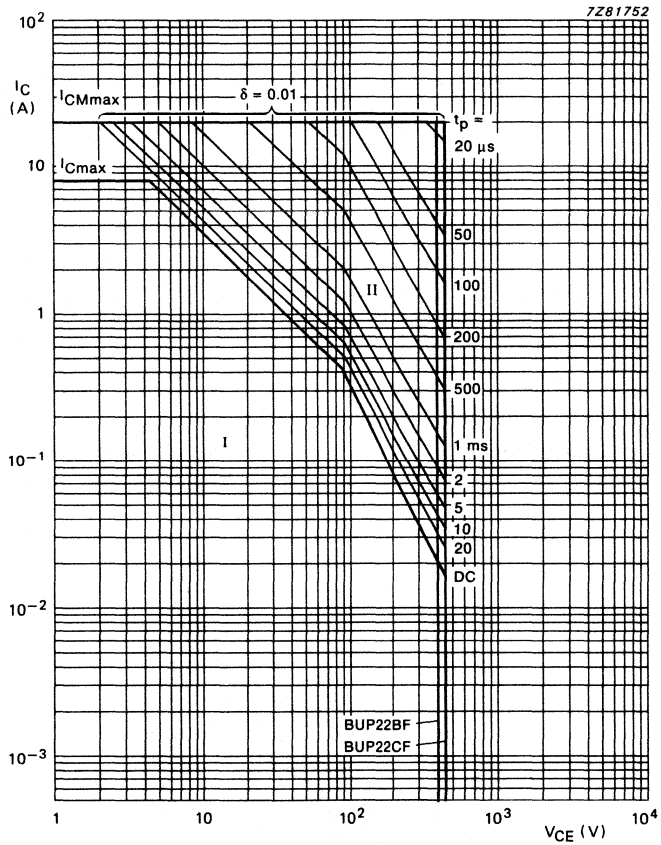


Fig. 7 Switching times waveforms with inductive load.

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 $T_{mb} < 25^\circ\text{C}$.

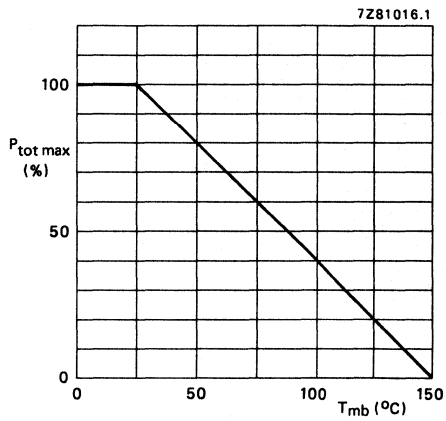


Fig. 9 Power dissipation curve.

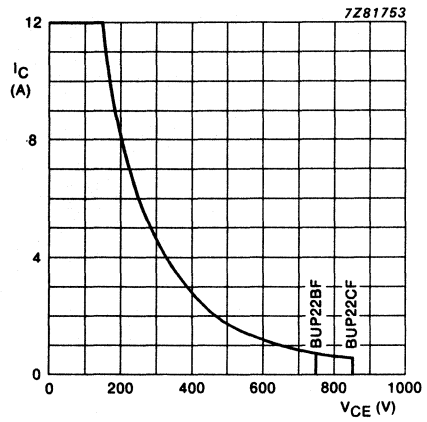


Fig. 10 Reverse bias SOAR;
 $V_{BE} = -1\text{ V to }-5\text{ V}$; $T_j < 100\text{ }^\circ\text{C}$.

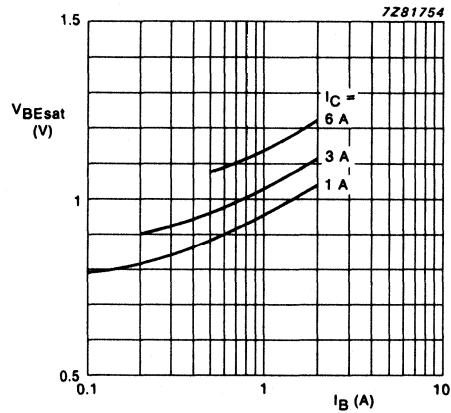
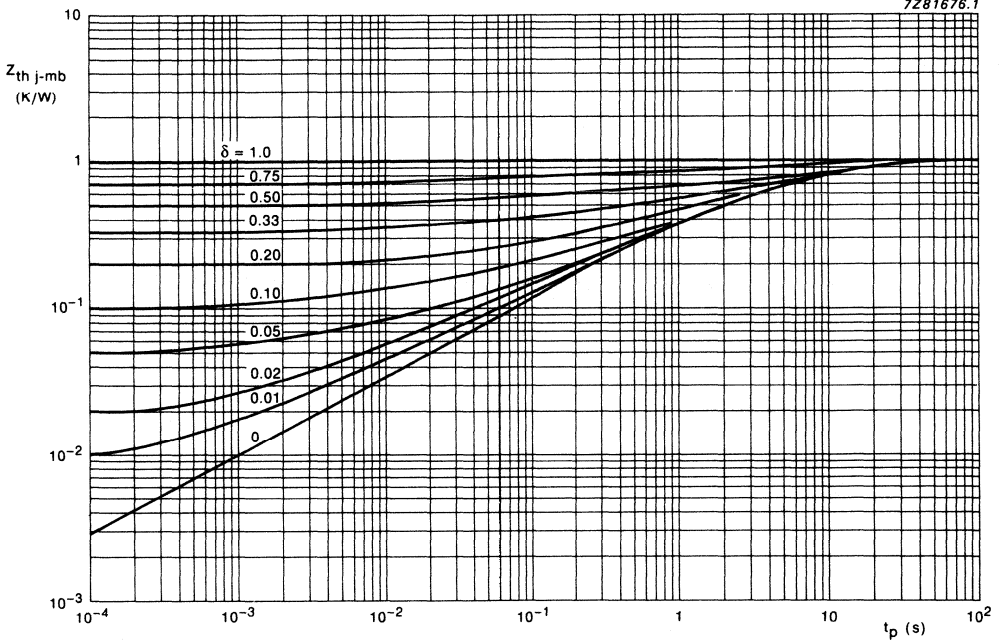


Fig. 11 Base-emitter saturation voltages as a function of base current; $T_j = 25\text{ }^\circ\text{C}$.

7Z81676.1



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

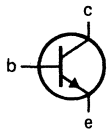
			BUP23B	BUP23C
Collector-emitter voltage peak value; $V_{BE} = 0$	V_{CESM}	max.	750	850 V
Collector-emitter voltage open base	V_{CEO}	max.	400	450 V
Collector-emitter saturation voltage	V_{CEsat}	max.	1.5	V
Collector saturation current	I_{Csat}	max.	10	A
Collector current (DC)	I_C	max.	15	A
Collector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

MECHANICAL DATA

Dimensions in mm

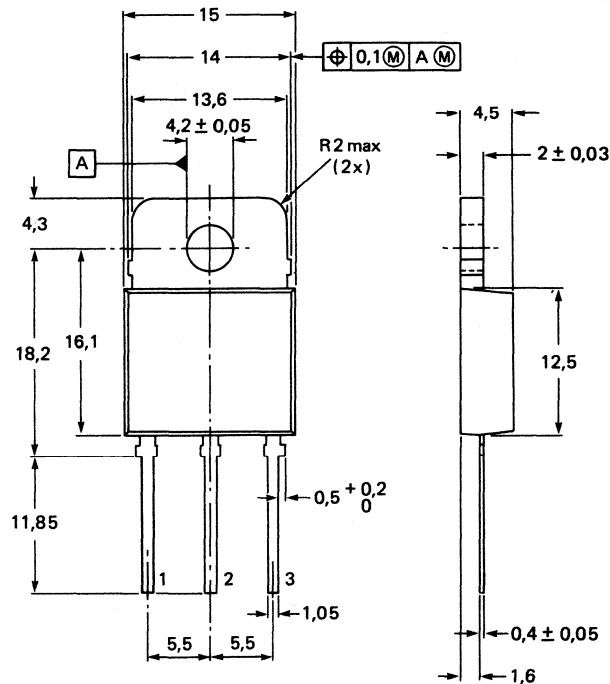
Fig. 1 SOT93.

Collector connected to
mounting base.



Pinning:

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



7296696

BUP23B BUP23C

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 $T_{mb} = 25^\circ\text{C}$	P_{tot}	max.	125	W
Storage temperature range	T_{stg}		-65 to +150	$^\circ\text{C}$
Junction temperature	T_j	max.	150	$^\circ\text{C}$

THERMAL RESISTANCE

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

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

Collector cut-off current*

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

I_{CES}	max.	1	mA
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Emitter cut-off current

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

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

DC current gain

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

h_{FE}	typ.	25	
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			BUP23B	BUP23C
Collector-emitter sustaining voltage $I_B = 0; I_C = 0.1\text{ A}; L = 25\text{ mH}$	$V_{CEO_{sust}}$	min.	400	450 V
Saturation voltages $I_C = 10\text{ A}; I_B = 1.33\text{ A}$	V_{CEsat}	max.	1.5	- V
	V_{BEsat}	max.	1.5	- V
$I_C = 10\text{ A}; I_B = 1.67\text{ A}$	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}	—	0.7 μs
	t_s	—	2.0 μs
	t_f	—	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	—	2.1 μs
	t_f	—	40 ns

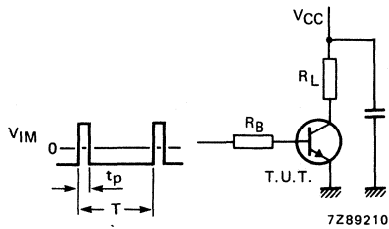


Fig. 2 Test circuit resistive load.

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

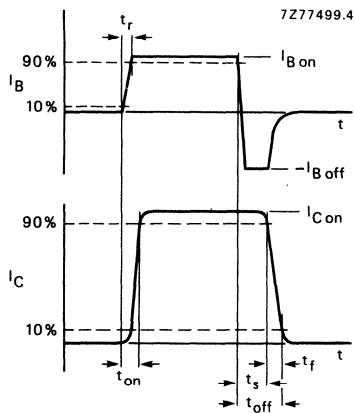


Fig. 3 Switching times waveforms with resistive load.

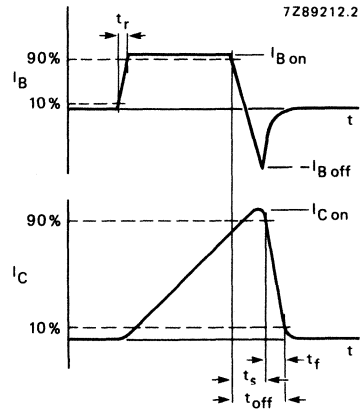
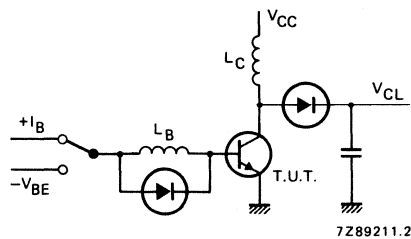
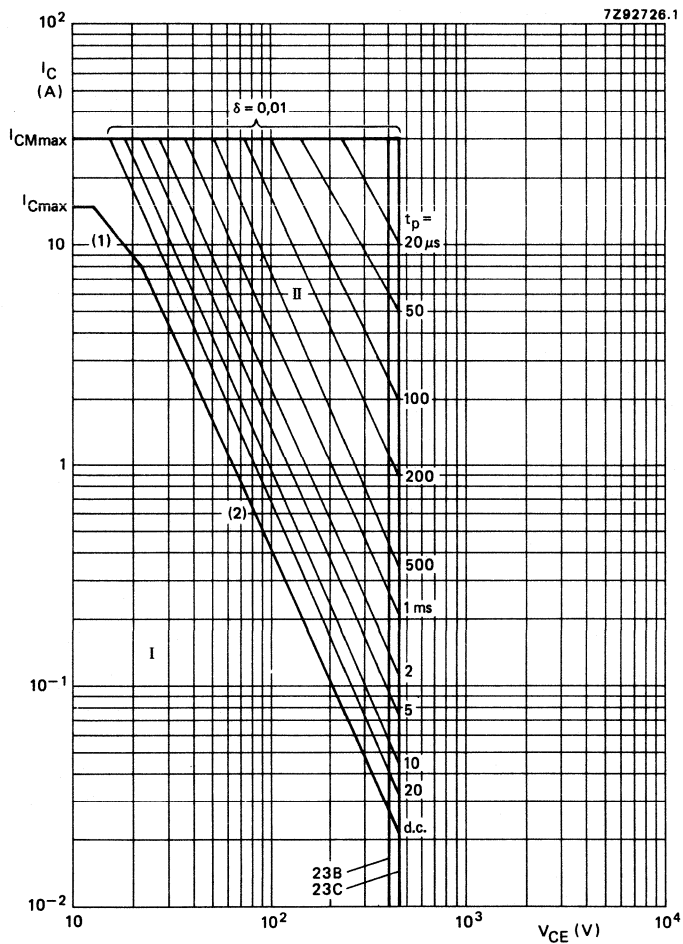


Fig. 4 Switching times waveforms with inductive load.



$V_{CL} = 250 \text{ V}$
 $V_{CC} = 30 \text{ V}$
 $-V_{BE} = 5 \text{ V}$
 $L_B = 1 \mu\text{H}$
 $L_C = 200 \mu\text{H}$

Fig. 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 $T_{mb} \leq 25\ ^\circ\text{C}$.

BUP23B
BUP23C

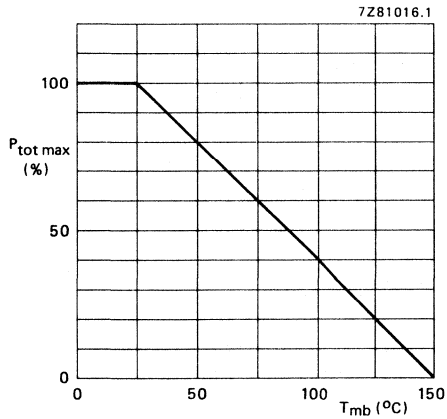


Fig. 7 Total power dissipation derating curve.

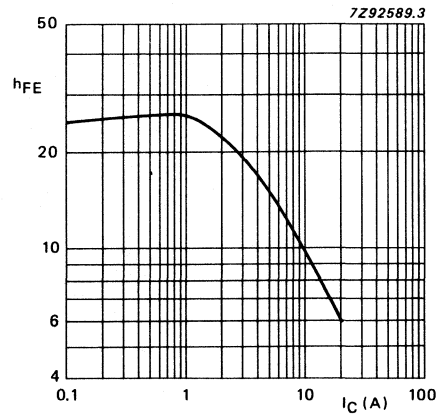


Fig. 8 Typical values DC current gain at $T_{mb} = 25^\circ\text{C}$.

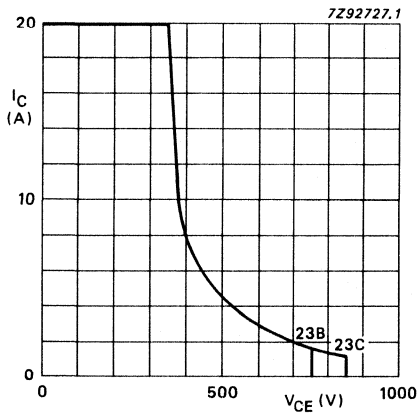


Fig. 9 Reverse bias SOAR; $T_{mb} = 100^\circ\text{C}$; $V_{BE}(\text{off}) = 1$ to 5V ; $L_B = 0$ to $3\ \mu\text{H}$.

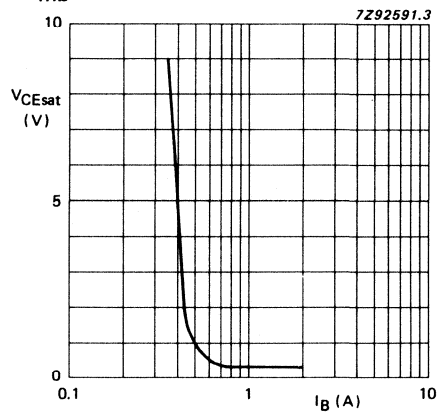


Fig. 10 Typical values $V_{CE\text{sat}}$ at $T_j = 25^\circ\text{C}$; $I_C = 10\text{A}$.

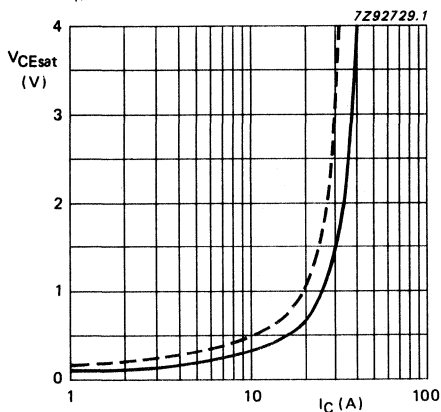


Fig. 11 Typical values collector voltage at $T_j = 25^\circ\text{C}$; $I_C/I_B = 7, 5$ and 6 for BUP22B and BUP23C resp; (—) = BUP23B; (---) = BUP23C.

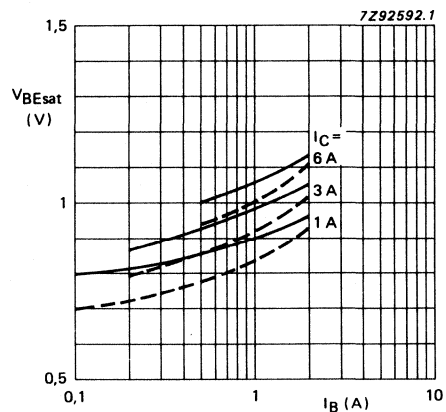


Fig. 12 Typical values V_{BE} at $T_j = 25^\circ\text{C}$; (—) = BUP23B; (---) = BUP23C.

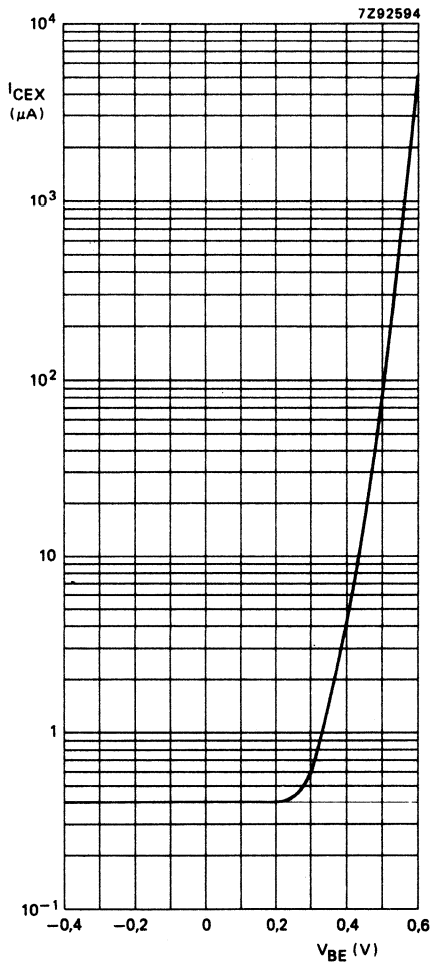


Fig. 13 Typical values collector cut-off current at $T_j = 25^\circ C$; $V_{CE} = 250 V$.

DEVELOPMENT DATA

This data sheet contains advance information and specifications are subject to change without notice.

BUP23BF
BUP23CF

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.

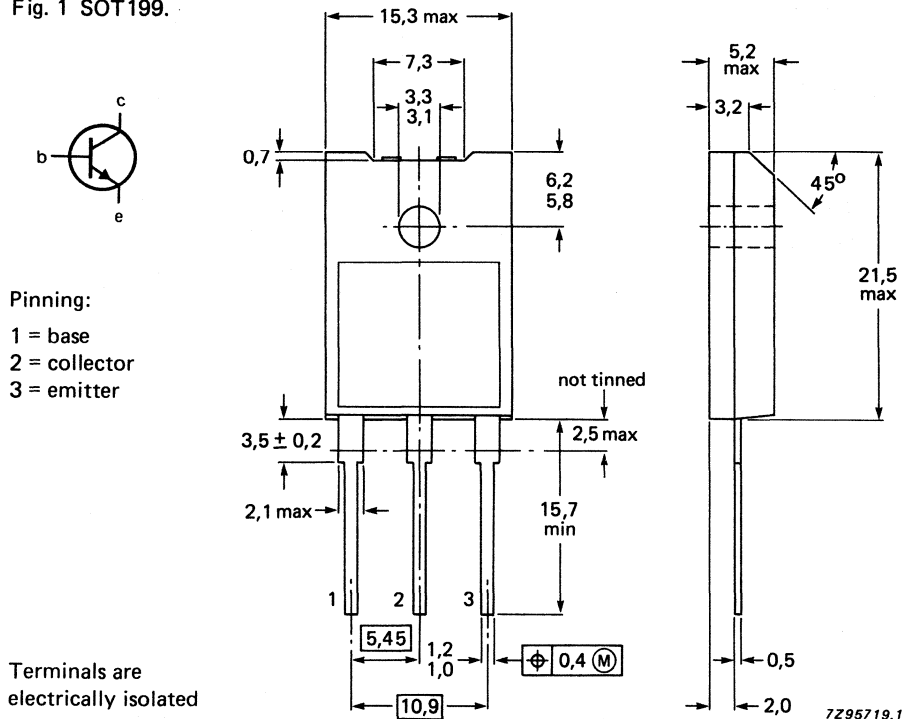
QUICK REFERENCE DATA

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

MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT199.



BUP23BF BUP23CF

RATINGS

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

			BUP23BF	23CF
Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM}	max.	750	850 V
	V_{CEO}	max.	400	450 V
Collector current saturation DC peak value; $t_p < 20$ ms	I_{Csat}		10	A
	I_C	max.	15	A
	I_{CM}	max.	30	A
Base current DC peak value; $t_p < 20$ ms	I_B	max.	6.0	A
	I_{BM}	max.	9.0	A
Total power dissipation up to $T_h = 25$ °C (note 1)	P_{tot}	max.	37	W
	P_{tot}	max.	50	W
Total power dissipation up to $T_h = 25$ °C (note 2)				
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_{thj-h}	=	3.4	K/W
	R_{thj-h}	=	2.5	K/W
From junction to ambient	R_{thj-a}	=	35	K/W

ISOLATION

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

Notes

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

CHARACTERISTICS

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

Collector cut-off currents *

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

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

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

Emitter cut-off current

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

I_{EBO}	max.	10	mA
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DC current gain

$I_C = 1.5\text{ V}; V_{CE} = 5\text{ V}$

h_{FE}	typ.	25	
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BUP23BF | 23CF

Saturation voltages

$I_C = 10\text{ A}; I_B = 1.33\text{ A}$

V_{CEsat}	max.	1.5	—	V
-------------	------	-----	---	---

V_{BEsat}	max.	1.5	—	V
-------------	------	-----	---	---

$I_C = 10\text{ A}; I_B = 1.67\text{ A}$

V_{CEsat}	max.	—	1.5	V
-------------	------	---	-----	---

V_{BEsat}	max.	—	1.5	V
-------------	------	---	-----	---

Collector-emitter sustaining voltage

(Figs 2 and 3)

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

$V_{CEOsust}$	min.	400	450	V
---------------	------	-----	-----	---

Collector saturation current

$V_{CE} = 1.5\text{ V}$

I_{Csat}	max.	10	10	A
------------	------	----	----	---

Switching times; resistive load

(Figs 4 and 5)

$I_{C\text{on}} = 10\text{ A}; I_{B\text{on}} = I_{B\text{off}} = 1.33\text{ A}$

Turn-on time

t_{on}	max.	1.0	—	μs
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Turn-off; storage time

t_s	max.	4.5	—	μs
-------	------	-----	---	---------------

fall time

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

$I_{C\text{on}} = 10\text{ A}; I_{B\text{on}} = I_{B\text{off}} = 1.67\text{ A}$

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)

$I_{C\text{on}} = 10\text{ A}; I_B = 1.33\text{ A}$

$V_{CL} = 250\text{ V}; T_{mb} = 100\text{ }^\circ\text{C}$

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

$I_{C\text{on}} = 10\text{ A}; I_B = 1.67\text{ A}$

$V_{CL} = 250\text{ V}; T_{mb} = 100\text{ }^\circ\text{C}$

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
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DEVELOPMENT DATA

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

BUP23BF BUP23CF

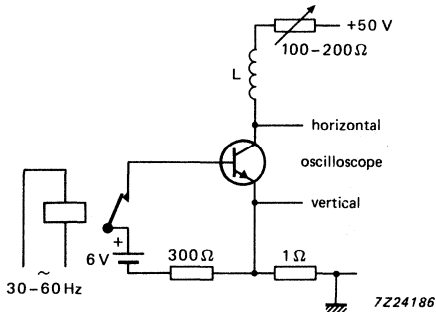


Fig. 2 Test circuit for $V_{CEOsust}$.

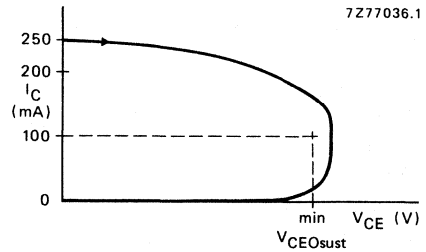


Fig. 3 Oscilloscope display for sustaining voltage.

$$V_{CC} = 250 \text{ V}$$

$$t_p = 20 \mu\text{s}$$

$$V_{IM} = -6 \text{ to } +8 \text{ V}$$

$$\frac{t_p}{T} = 0.01$$

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

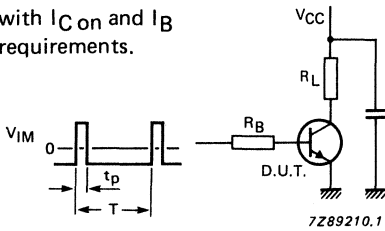


Fig. 4 Test circuit resistive load.

$$V_{CL} \leq 850 \text{ V}$$

$$V_{CC} = 30 \text{ V}$$

$$-V_{BE} = 5 \text{ V}$$

$$L_B = 1.0 \mu\text{H}$$

$$L_C = 200 \mu\text{H}$$

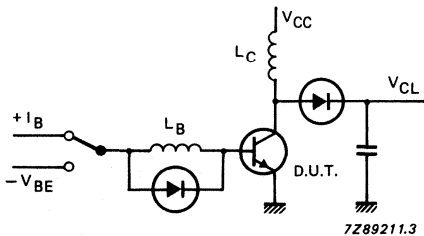


Fig. 6 Test circuit inductive load and reverse bias SOAR.

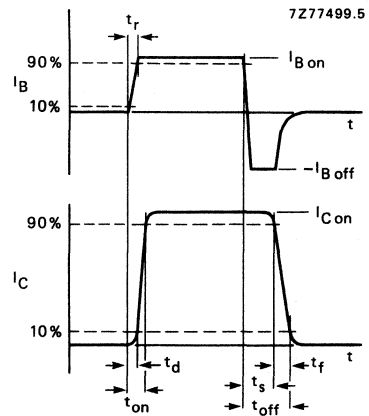


Fig. 5 Switching times waveforms with resistive load; $t_r \leq 20 \text{ ns}$.

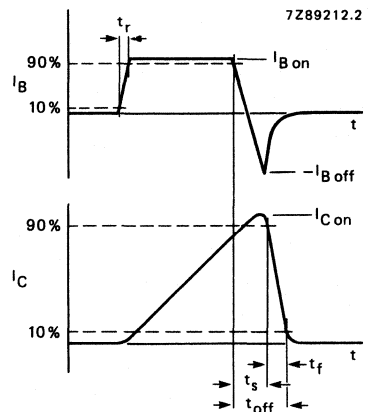
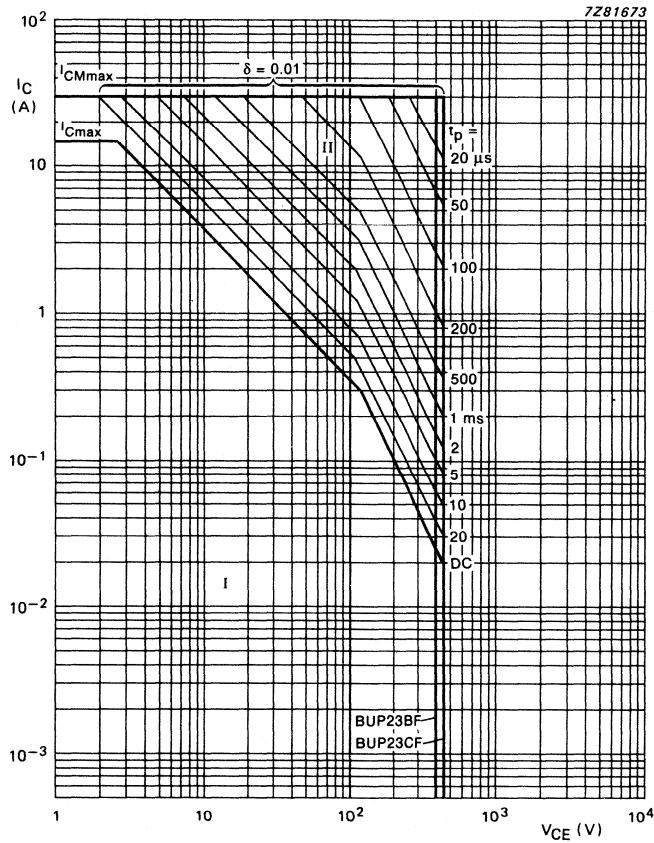


Fig. 7 Switching times waveforms with inductive load.

DEVELOPMENT DATA



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 $T_{mb} < 25$ °C.

BUP23BF
BUP23CF

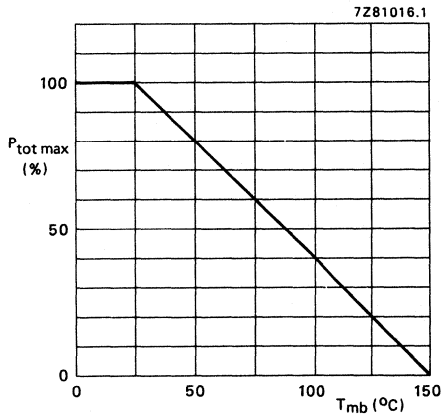


Fig. 9 Power dissipation curve.

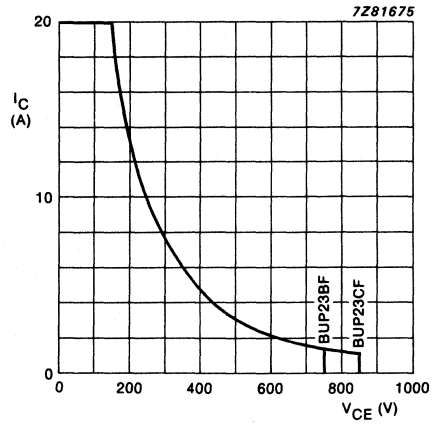


Fig. 10 Reverse bias SOAR;
 $V_{BE} = -1\ V\ to\ -5\ V; T_{mb} \leq 100\ ^\circ C.$

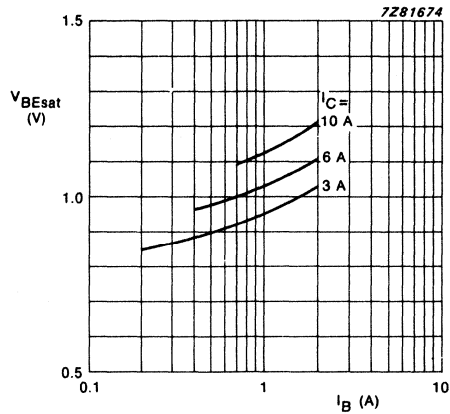
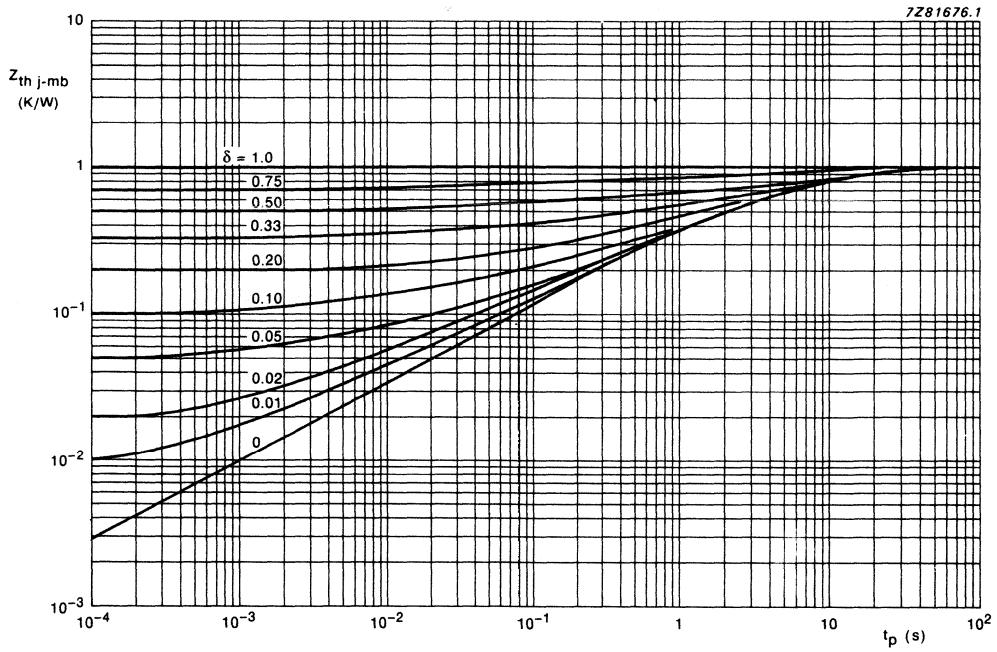


Fig. 11 Base-emitter saturation voltages
as a function of base current; $T_j = 25\ ^\circ C.$

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 TO-3 envelope, intended for use in converters, inverters, switching regulators, motor control systems etc.

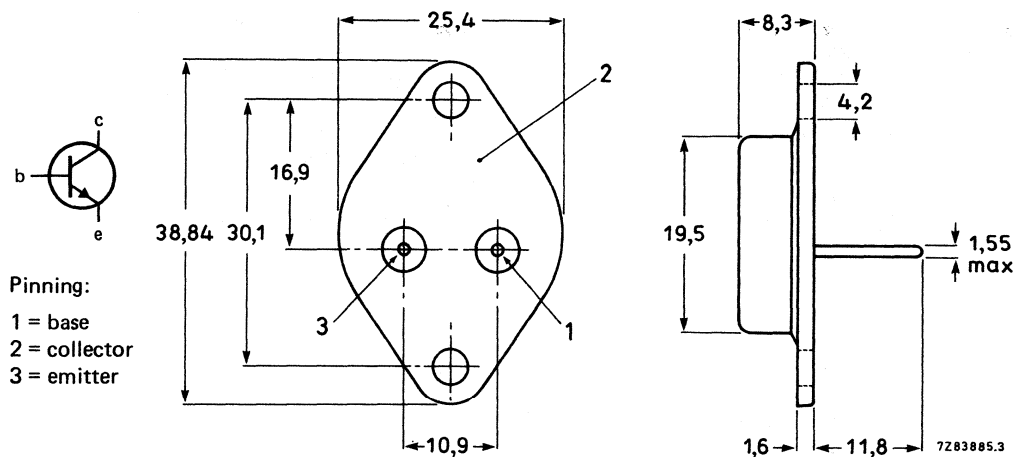
QUICK REFERENCE DATA

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

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-3.



Collector connected to case.

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 $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot} max.	100	W
Storage temperature range	T_{stg}	-65 to +200	$^\circ\text{C}$
Junction temperature	T_j max.	200	$^\circ\text{C}$

THERMAL RESISTANCE

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

CHARACTERISTICS

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

Collector cut-off current *

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

I_{CES} max.	1	mA
----------------	---	----

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

I_{CES} max.	2	mA
----------------	---	----

Emitter cut-off current

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

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

Saturation voltages

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

	BUS11	BUS11A
V_{CEsat} max.	1,5	- V
V_{CEsat} max.	-	1,5 V
V_{BEsat} max.	1,4	- V
V_{BEsat} max.	-	1,4 V

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

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

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

Collector-emitter sustaining voltage

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

$V_{CEO_{sust}}$ min.	400	450 V
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* Measured with a half-sinewave voltage (curve tracer).

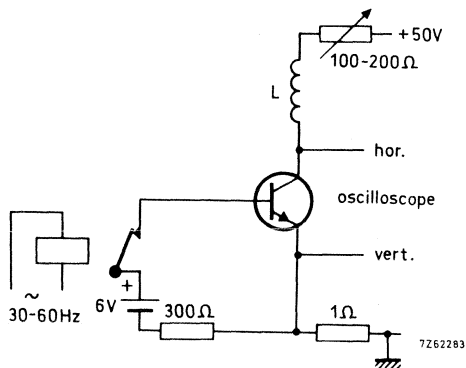


Fig. 2 Test circuit for $V_{CEOsust}$.

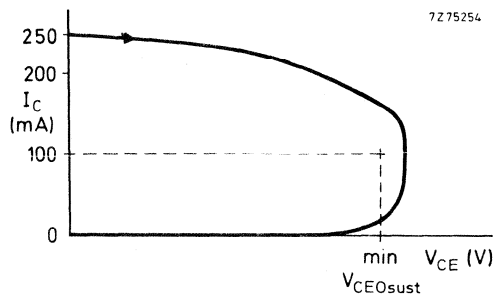


Fig. 3 Oscilloscope display for sustaining voltage.

Switching times resistive load (Figs 4 and 5)

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

Turn-on time

Turn-off: Storage time

Fall time

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

Turn-on time

Turn-off: Storage time

Fall time

Switching times inductive load (Figs 6 and 7)

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

Turn-off: Storage time

Fall time

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

Turn-off: Storage time

Fall time

Switching times inductive load (Figs 6 and 7)

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

Turn-off: Storage time

Fall time

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

Turn-off: Storage time

Fall time

		BUS11	BUS11A	
t_{on}	max.	1	—	μs
t_s	max.	4	—	μs
t_f	max.	0,8	—	μs
t_{on}	max.	—	1	μs
t_s	max.	—	4	μs
t_f	max.	—	0,8	μs
t_s	typ.	1,1	—	μs
	max.	1,4	—	μs
t_f	typ.	80	—	ns
	max.	150	—	ns
t_s	typ.	1,2	—	μs
	max.	1,5	—	μs
t_f	typ.	140	—	ns
	max.	300	—	ns
t_s	typ.	—	1,1	μs
	max.	—	1,4	μs
t_f	typ.	—	80	ns
	max.	—	150	ns
t_s	typ.	—	1,2	μs
	max.	—	1,5	μs
t_f	typ.	—	140	ns
	max.	—	300	ns

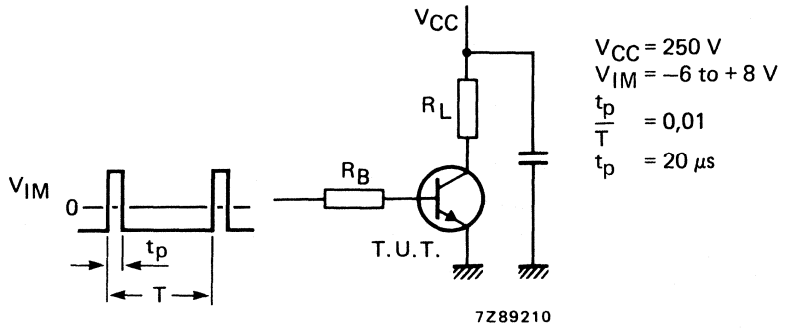


Fig. 4 Test circuit resistive load.

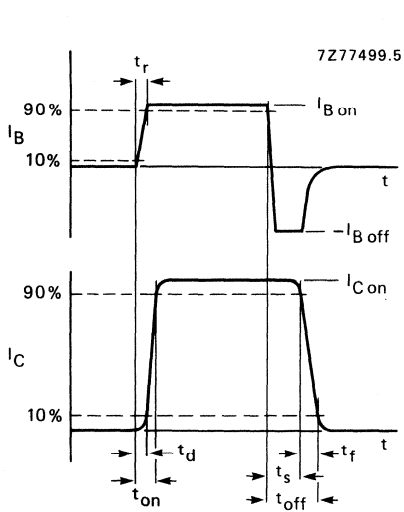


Fig. 5 Switching times waveforms with resistive load.

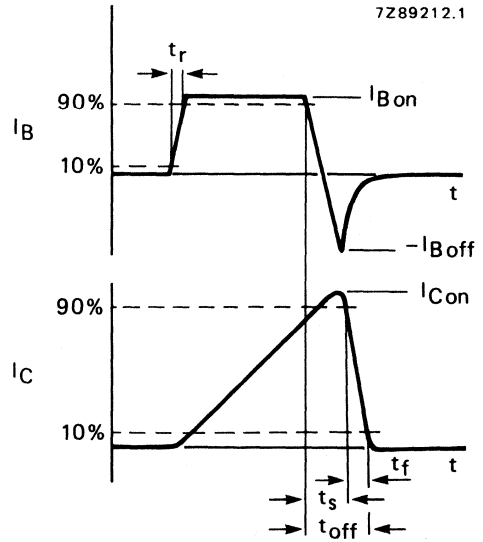


Fig. 6 Switching times waveforms with inductive load.

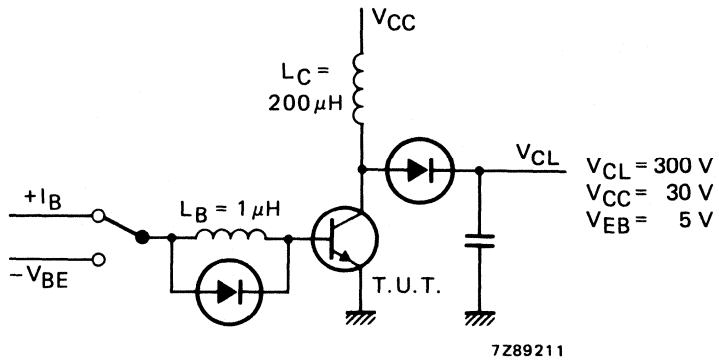
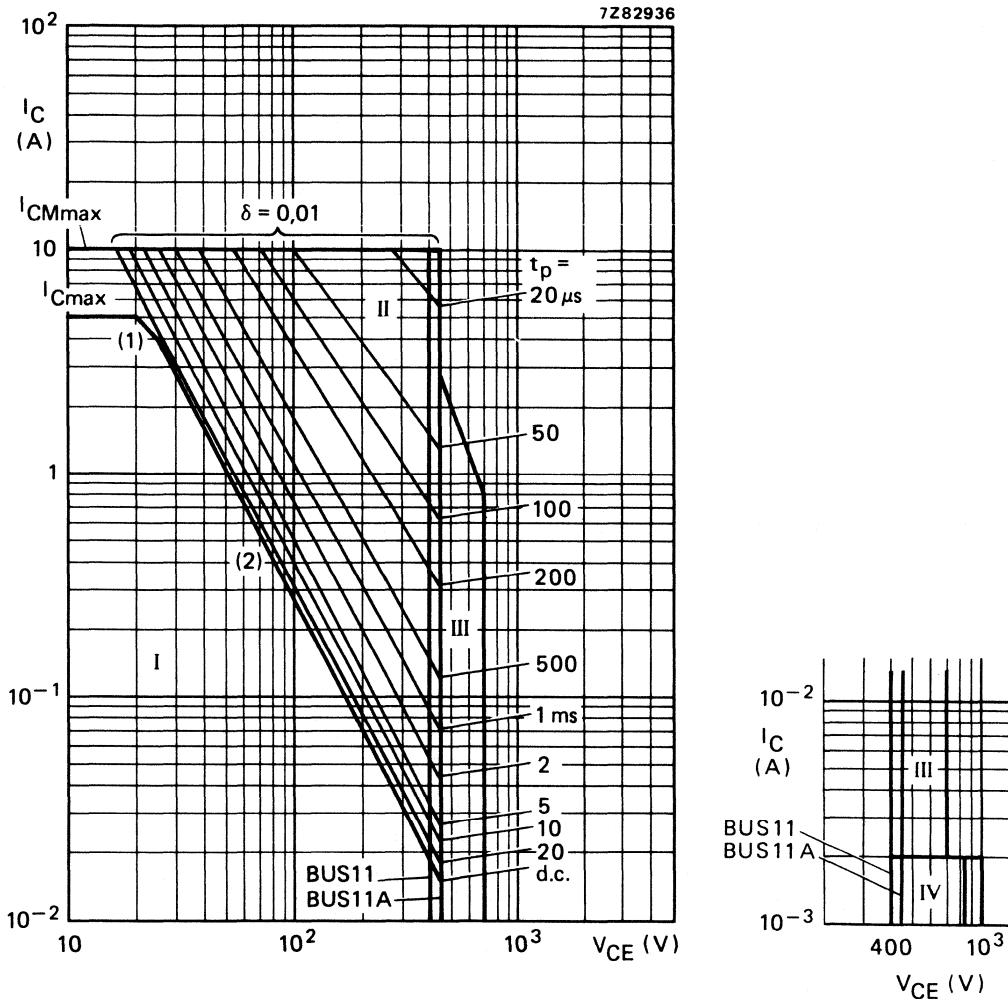


Fig. 7 Test circuit inductive load.



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

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

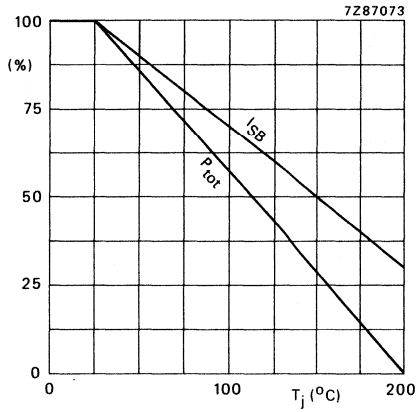


Fig. 9 Total power dissipation and second-breakdown current derating curve.

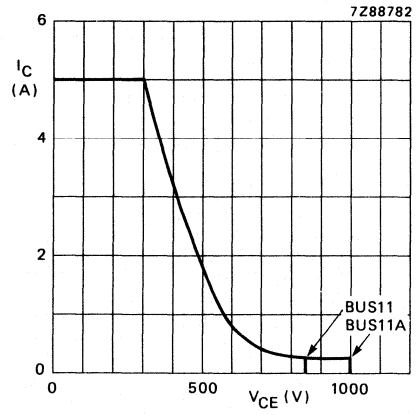


Fig. 10 Reverse bias SOAR.

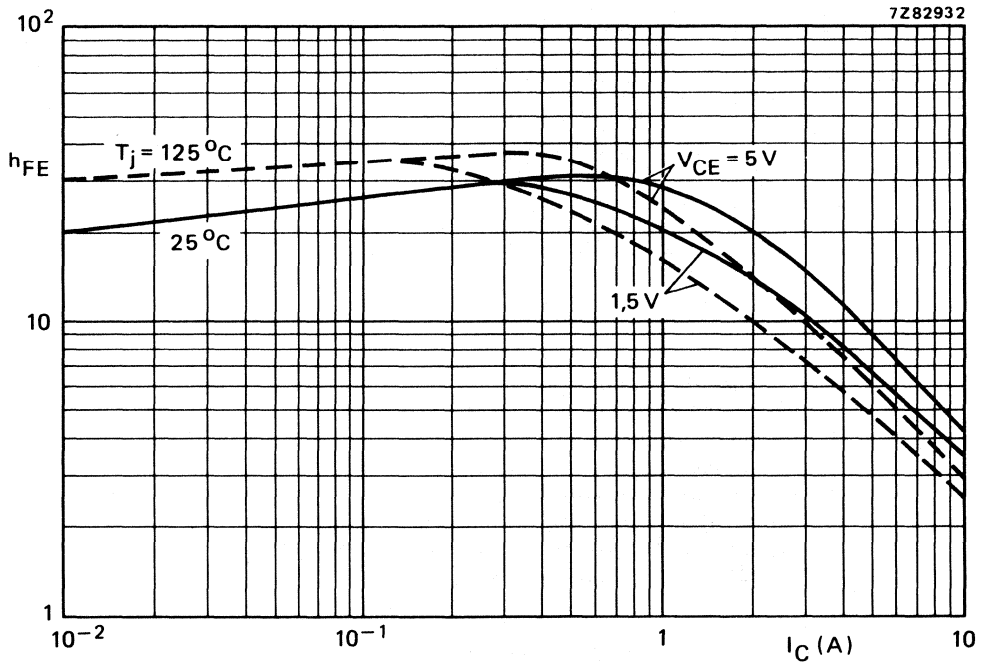


Fig. 11 DC current gain.

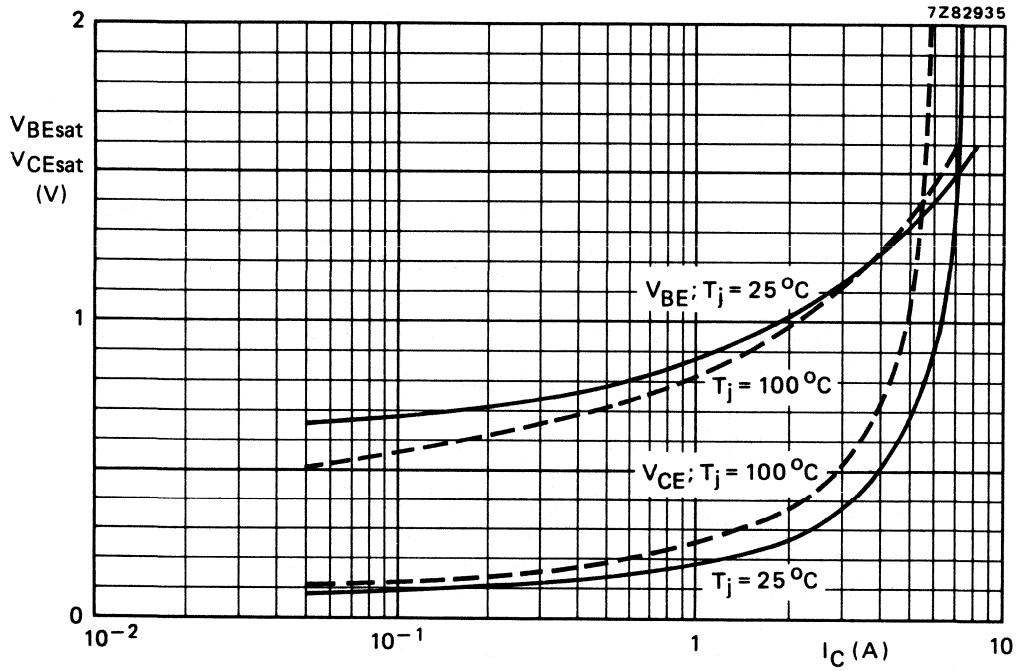


Fig. 12 Typical values base-emitter and collector-emitter voltage, $I_C/I_B = 5$.

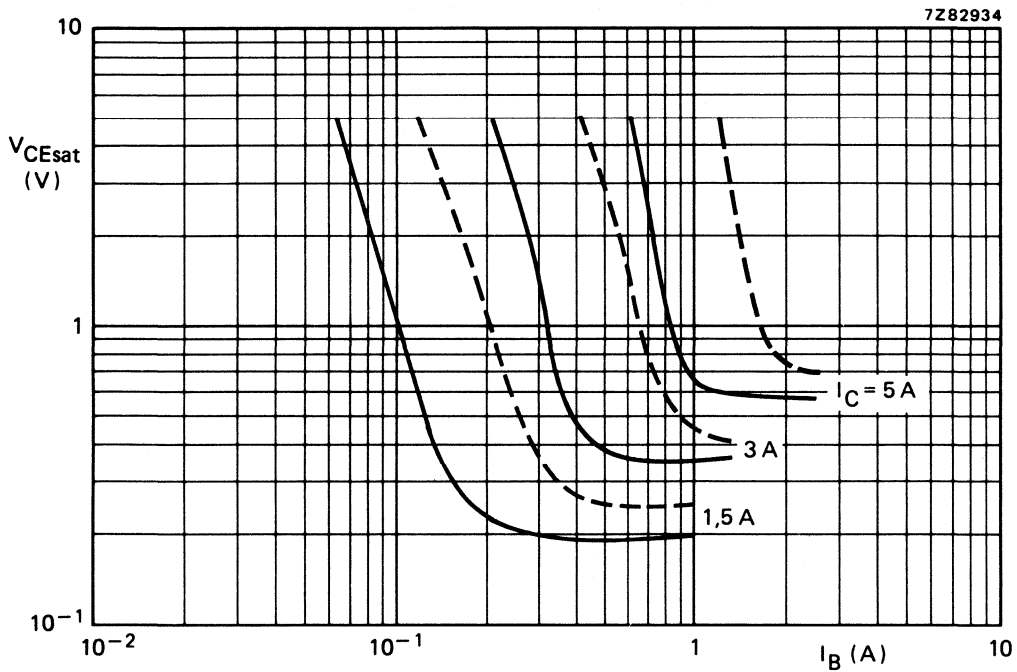


Fig. 13 Typ. (—) and max. (---) values collector-emitter saturation voltage at $T_j = 25^\circ C$.

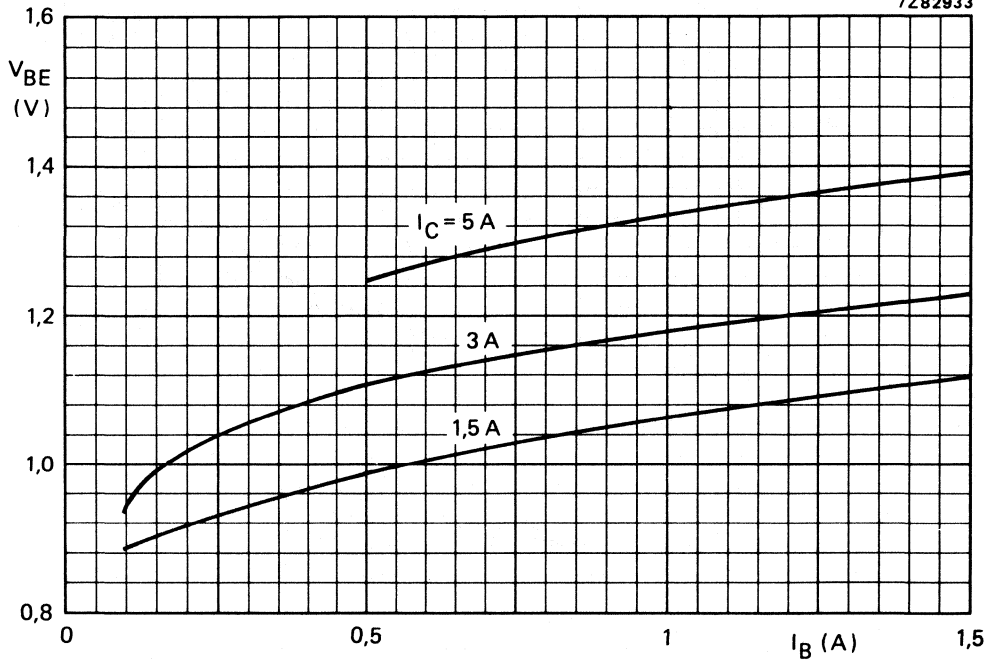


Fig. 14 Typical values at $T_j = 25$ °C.

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.

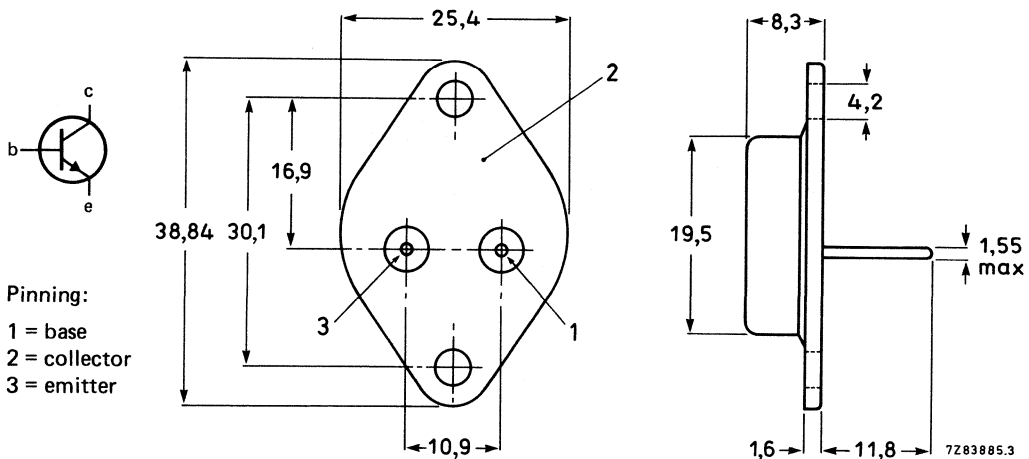
QUICK REFERENCE DATA

		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 $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot} max.	125	W
Fall time; resistive load	t_f max.	0,8	μs

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-3.



Collector connected to case.

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	8	A
Collector current (peak value); $t_p < 2$ ms	I_{CM}	max.	20	20	A
Base current (DC)	I_B	max.	4	4	A
Base current (peak value); $t_p \leq 2$ ms	I_{BM}	max.	6	6	A
Total power dissipation up to $T_{mb} = 25$ °C	P_{tot}	max.	125	125	W
Storage temperature range	T_{stg}		-65 to +200		°C
Junction temperature	T_j	max.	200	200	°C

THERMAL RESISTANCE

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

$T_j = 25$ °C unless otherwise specified

Collector cut-off current *

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

$V_{CE} = V_{CESMmax}; V_{BE} = 0; T_j = 125$ °C

I_{CES}	max.	1	mA
I_{CES}	max.	3	mA

Emitter cut-off current

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

I_{EBO}	max.	10	mA
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		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	$V_{CEO_{sust}}$	min.	400	450	V

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

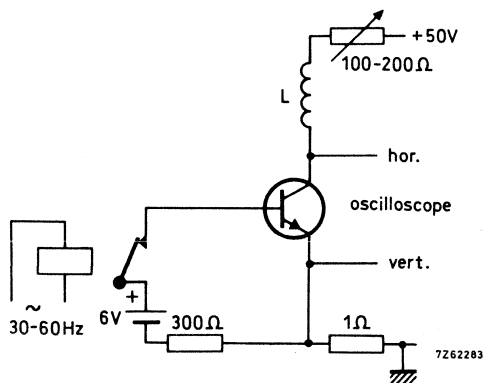


Fig. 2 Test circuit for $V_{CEOsust}$

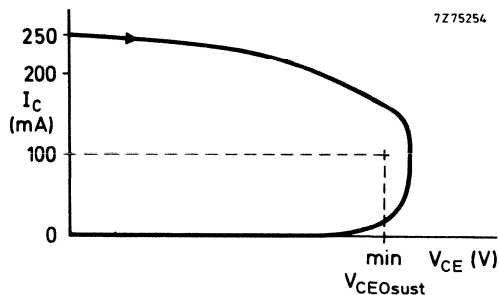


Fig. 3 Oscilloscope display for sustaining voltage.

Switching times resistive load (Figs 4 and 5)

$I_{Con} = 6 \text{ A}; I_{Bon} = -I_{Boff} = 1,2 \text{ A}$

Turn-on time

Turn-off: Storage time

Fall time

$I_{Con} = 5 \text{ A}; I_{Bon} = -I_{Boff} = 1 \text{ A}$

Turn-on time

Turn-off: Storage time

Fall time

Switching times inductive load (Figs 6 and 7)

$I_{Con} = 6 \text{ A}; I_B = 1,2 \text{ A}$

Turn-off: Storage time

Fall time

$I_{Con} = 6 \text{ A}; I_B = 1,2 \text{ A}; T_j = 100 \text{ }^\circ\text{C}$

Turn-off: Storage time

Fall time

Switching times inductive load (Figs 6 and 7)

$I_{Con} = 5 \text{ A}; I_B = 1 \text{ A}$

Turn-off: Storage time

Fall time

$I_{Con} = 5 \text{ A}; I_B = 1 \text{ A}; T_j = 100 \text{ }^\circ\text{C}$

Turn-off: Storage time

Fall time

		BUS12	BUS12A
t_{on}	max.	1	— μs
t_s	max.	4	— μs
t_f	max.	0,8	— μs
t_{on}	max.	—	1 μs
t_s	max.	—	4 μs
t_f	max.	—	0,8 μs
t_s	typ.	1,6	— μs
	max.	2,1	— μs
t_f	typ.	80	— ns
	max.	150	— ns
t_s	typ.	1,8	— μs
	max.	2,3	— μs
t_f	typ.	140	— ns
	max.	300	— ns
t_s	typ.	—	1,6 μs
	max.	—	2,1 μs
t_f	typ.	—	80 ns
	max.	—	150 ns
t_s	typ.	—	1,8 μs
	max.	—	2,3 μs
t_f	typ.	—	140 ns
	max.	—	300 ns

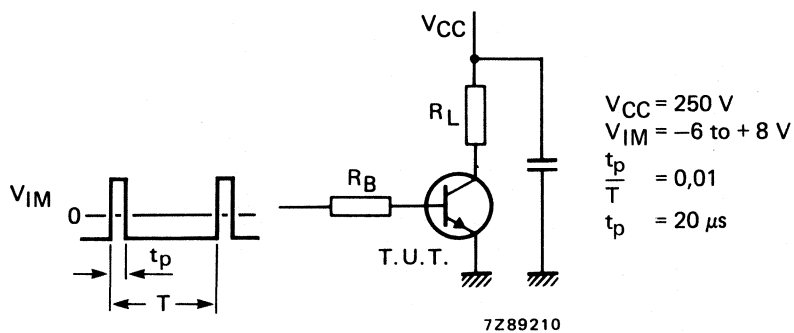


Fig. 4 Test circuit resistive load.

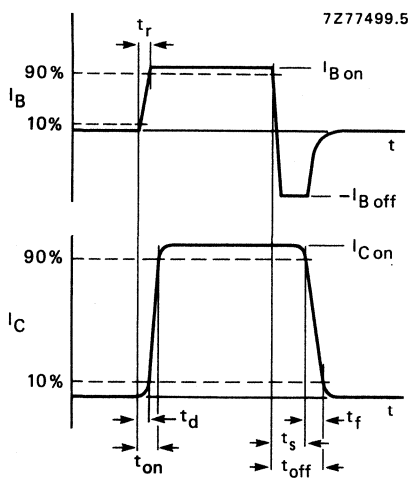


Fig. 5 Switching times waveforms with resistive load.

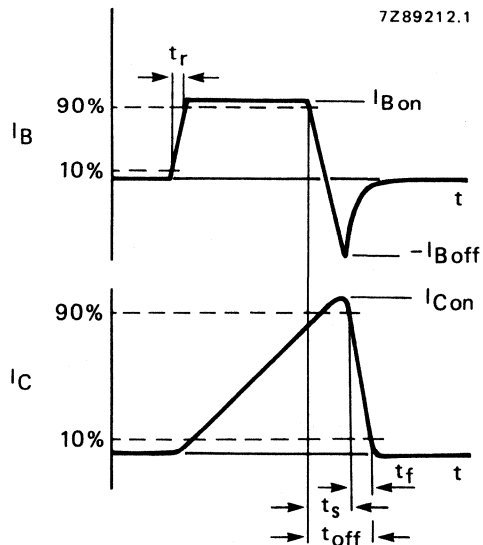


Fig. 6 Switching times waveforms with inductive load.

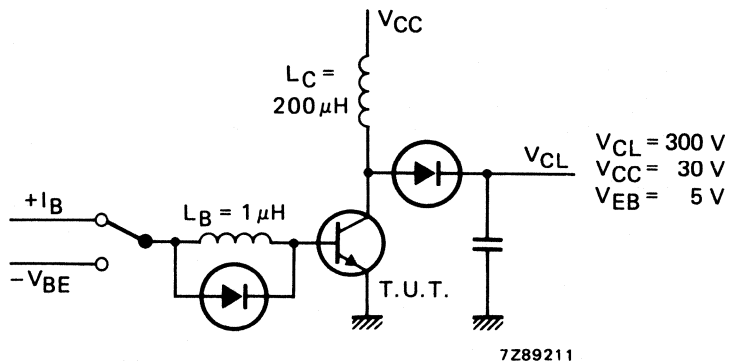
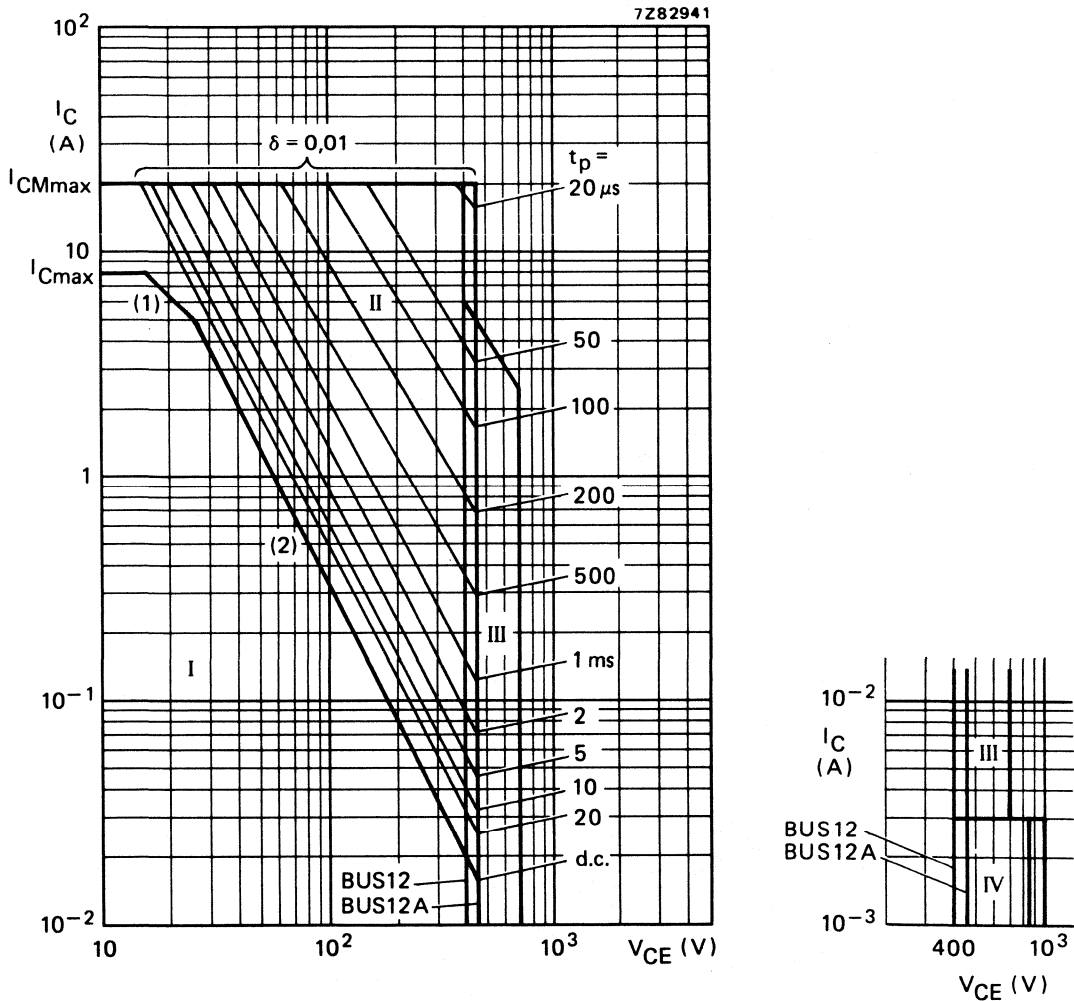


Fig. 7 Test circuit inductive load.



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

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

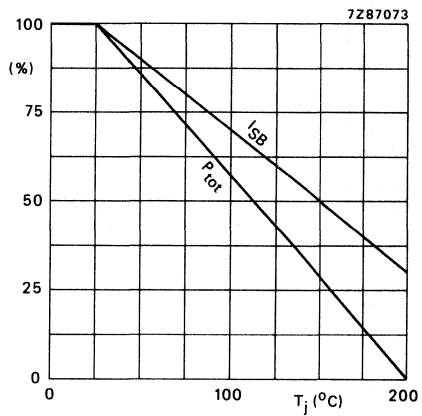


Fig. 9 Total power dissipation and second-breakdown current derating curve.

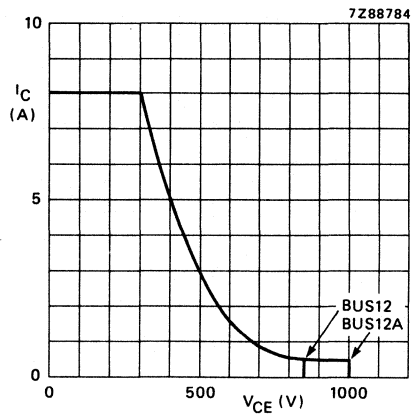


Fig. 10 Reverse bias SOAR.

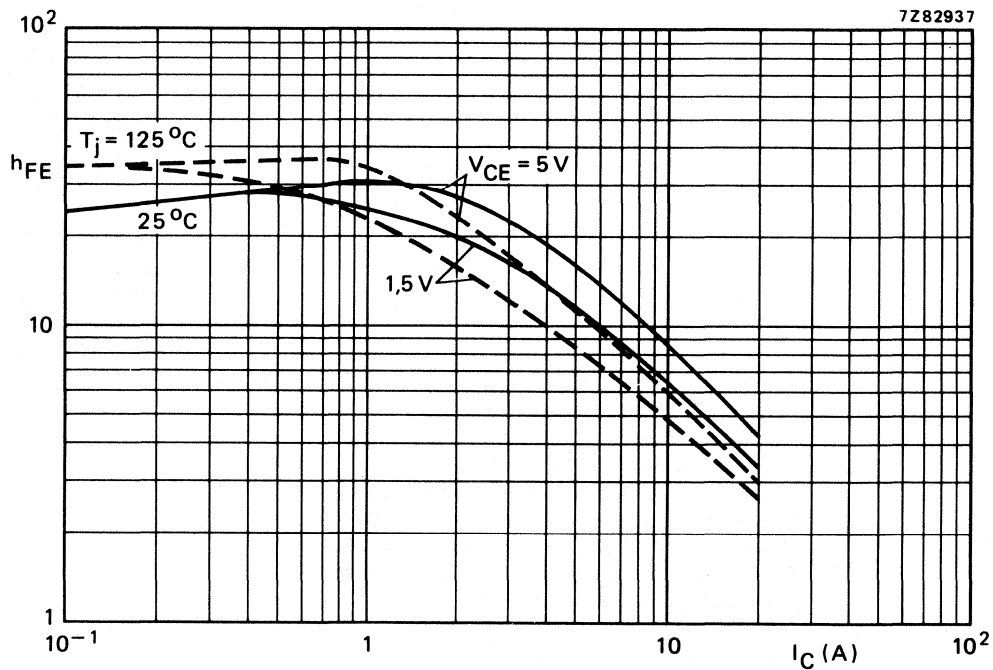


Fig. 11 Typical values DC current gain.

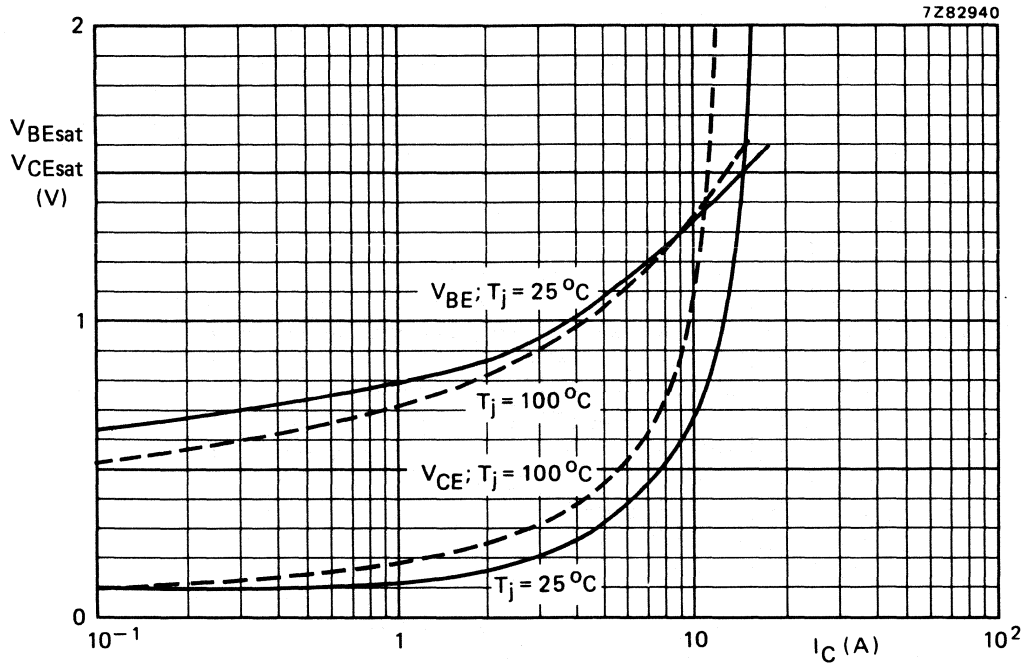


Fig. 12 Typical values base and collector voltage at $I_C/I_B = 5$.

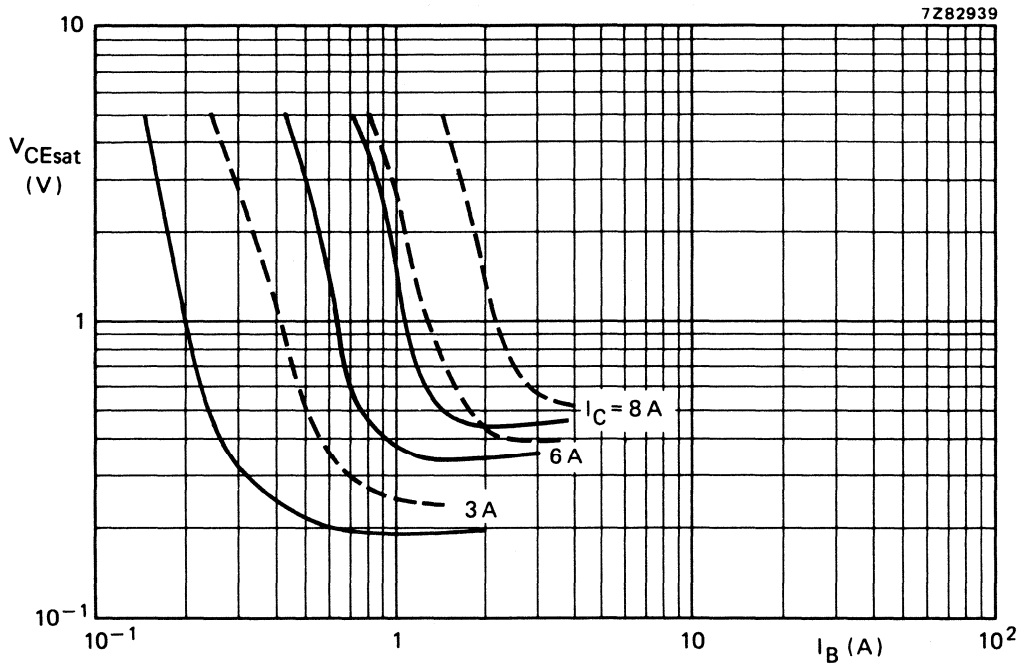


Fig. 13 Typ. (—) and max. (---) values collector-emitter saturation voltage at $T_j = 25^\circ\text{C}$.

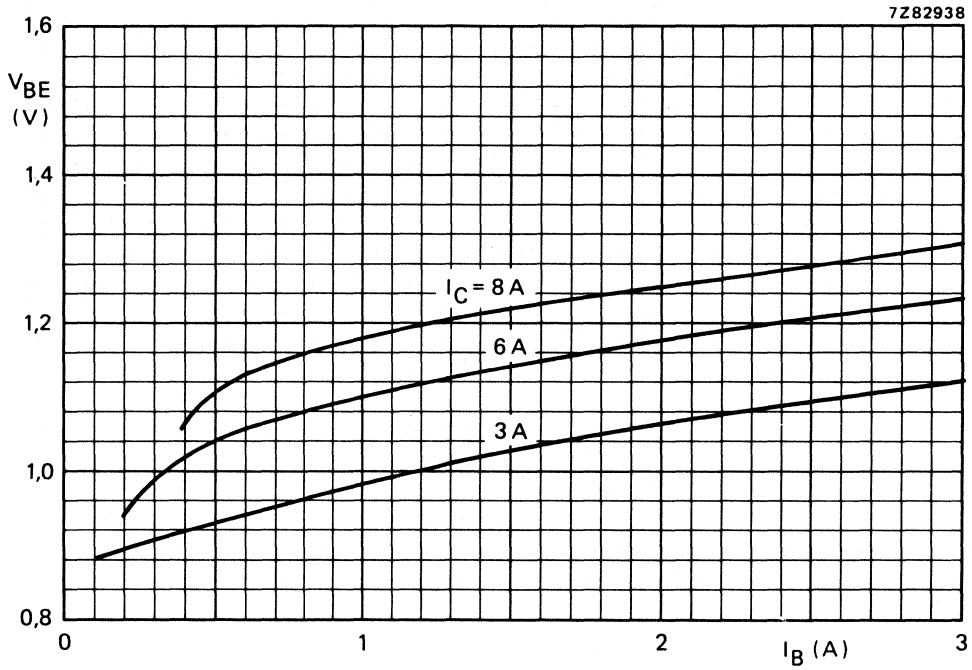


Fig. 14 Typical values base-emitter voltage at $T_j = 25$ °C.

SILICON DIFFUSED POWER TRANSISTORS



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

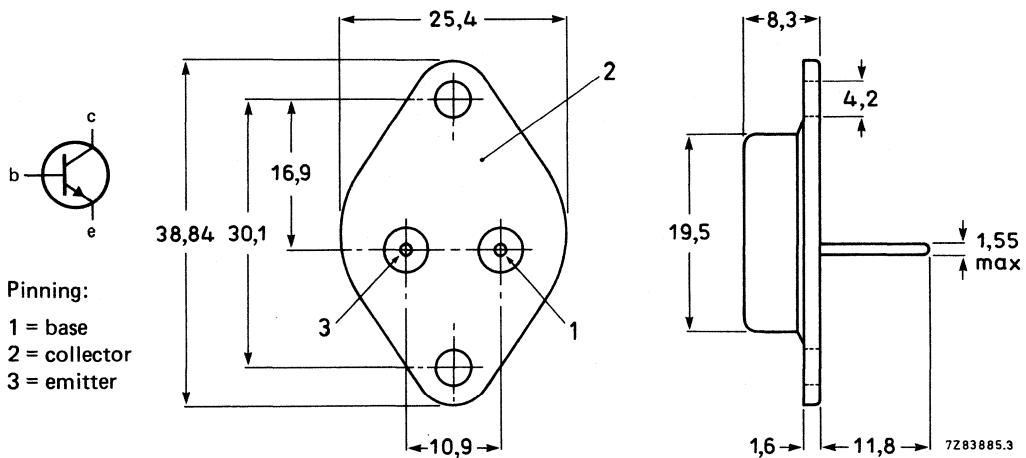
QUICK REFERENCE DATA

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

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)

		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	$R_{th\ j-mb}$	=	1,0	K/W
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CHARACTERISTICS

$T_j = 25$ °C unless otherwise specified

Collector cut-off current *

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

$V_{CE} = V_{CESMmax}; V_{BE} = 0; T_j = 125$ °C

I_{CES}	max.	1	mA
I_{CES}	max.	4	mA

Emitter cut-off current

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

I_{EBO}	max.	10	mA
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		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	$V_{CEO_{sust}}$	min. 400	450 V

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

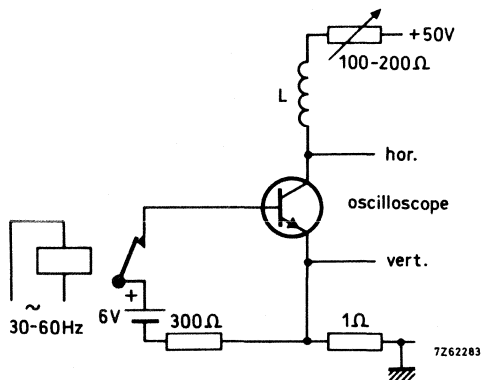


Fig. 2 Test circuit for $V_{CEOsust}$.

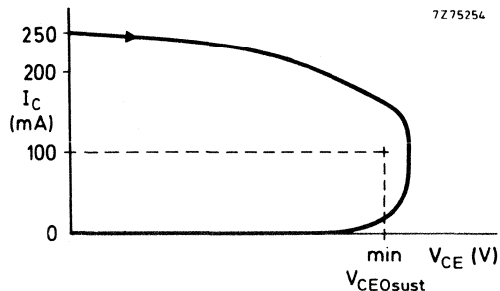


Fig. 3 Oscilloscope display for sustaining voltage.

Switching times resistive load (Figs 4 and 5)

$I_{Con} = 10\text{ A}; I_B\text{ on} = -I_B\text{ off} = 2\text{ A}$

Turn-on time

Turn-off: Storage time

Fall time

$I_{Con} = 8\text{ A}; I_B\text{ on} = -I_B\text{ off} = 1,6\text{ A}$

Turn-on time

Turn-off: Storage time

Fall time

Switching times inductive load (Figs 6 and 7)

$I_{Con} = 10\text{ A}; I_B = 2\text{ A}$

Turn-off: Storage time

Fall time

$I_{Con} = 10\text{ A}; I_B = 2\text{ A}; T_j = 100\text{ }^\circ\text{C}$

Turn-off: Storage time

Fall time

Switching times inductive load (Figs 6 and 7)

$I_{Con} = 8\text{ A}; I_B = 1,6\text{ A}$

Turn-off: Storage time

Fall time

$I_{Con} = 8\text{ A}; I_B = 1,6\text{ A}; T_j = 100\text{ }^\circ\text{C}$

Turn-off: Storage time

Fall time

		BUS13	BUS13A		
t_{on}	max.	1	—	μs	
t_s	max.	4	—	μs	
t_f	max.	0,8	—	μs	
t_{on}	max.	—	1	μs	
t_s	max.	—	4	μs	
t_f	max.	—	0,8	μs	
t_s	typ.	2,3	—	μs	
	max.	3,0	—	μs	
t_f	typ.	80	—	ns	
	max.	150	—	ns	
t_s	typ.	2,5	—	μs	
	max.	3,2	—	μs	
t_f	typ.	140	—	ns	
	max.	300	—	ns	
t_s	typ.	—	2,3	μs	
	max.	—	3,0	μs	
t_f	typ.	—	80	ns	
	max.	—	150	ns	
t_s	typ.	—	2,5	μs	
	max.	—	3,2	μs	
t_f	typ.	—	140	ns	
	max.	—	300	ns	

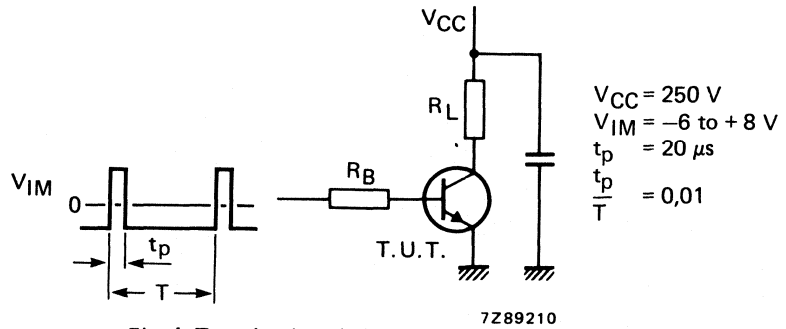


Fig. 4 Test circuit resistive load.

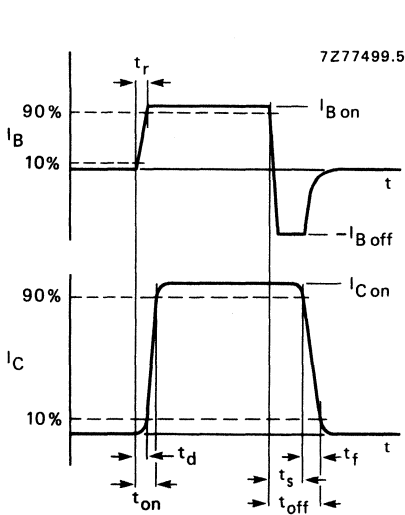


Fig. 5 Switching times waveforms with resistive load.

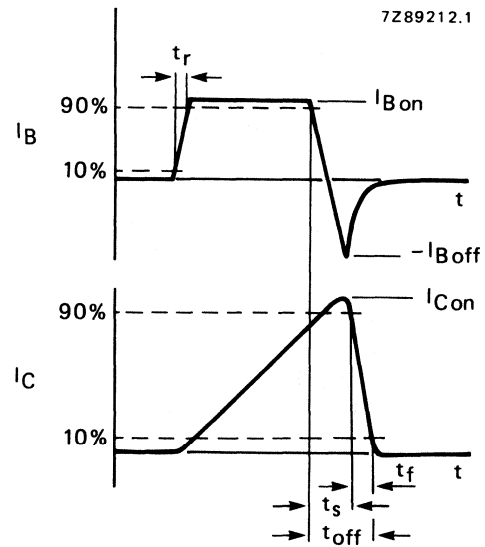


Fig. 6 Switching times waveforms with inductive load.

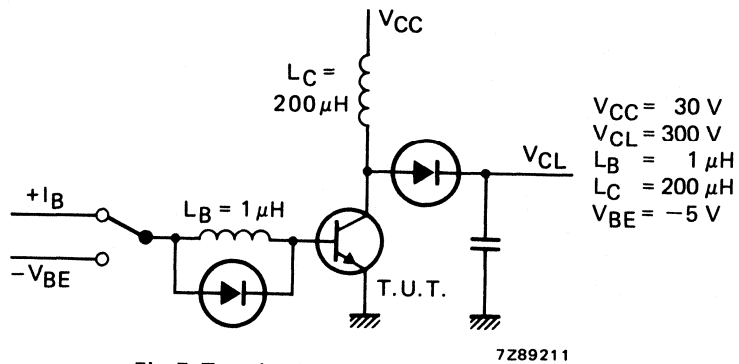
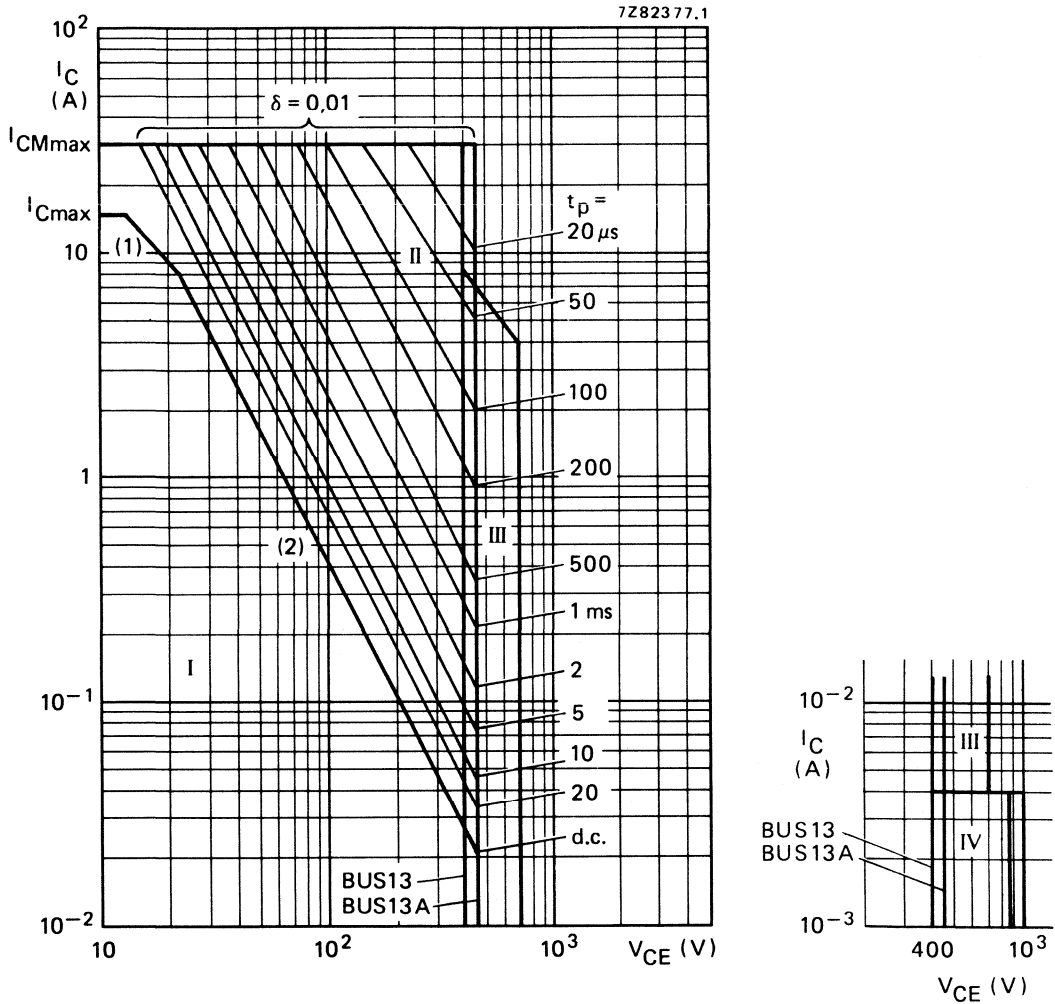


Fig. 7 Test circuit inductive load.



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

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

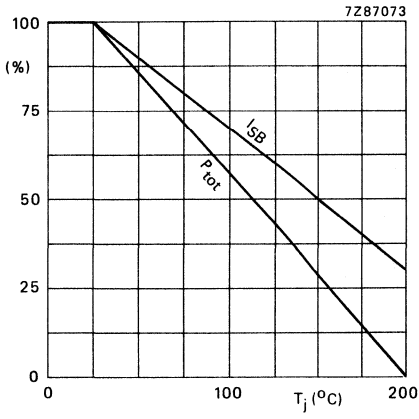


Fig. 9 Total power dissipation and second-breakdown current derating curve.

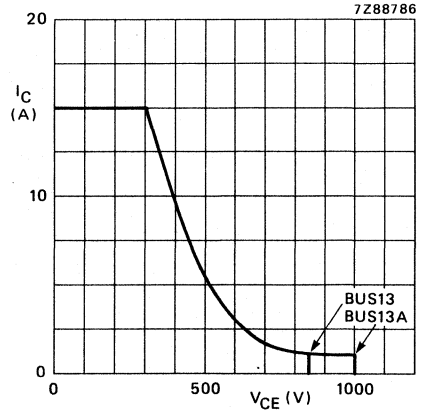


Fig. 10 Reverse bias SOAR.

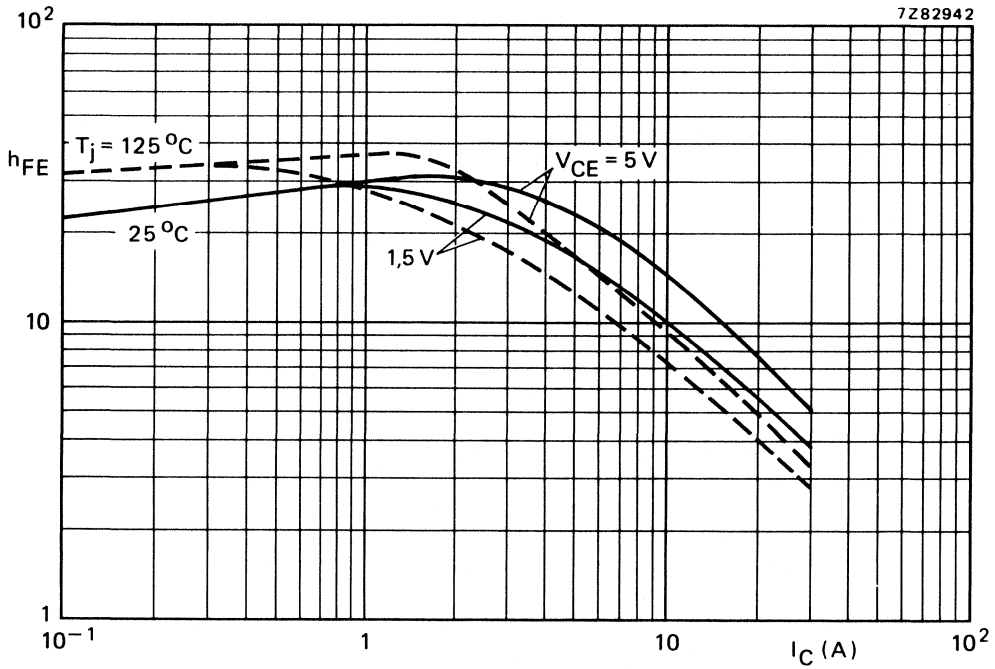


Fig. 11 Typical values DC current gain.

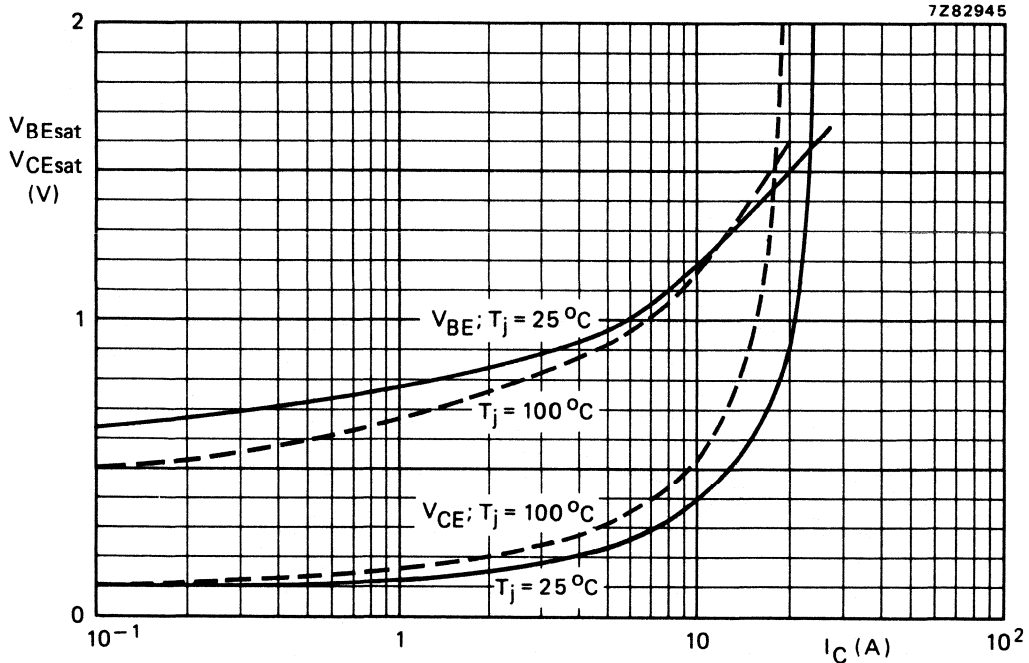


Fig. 12 Typical values base and collector voltage at $I_C/I_B = 5$.

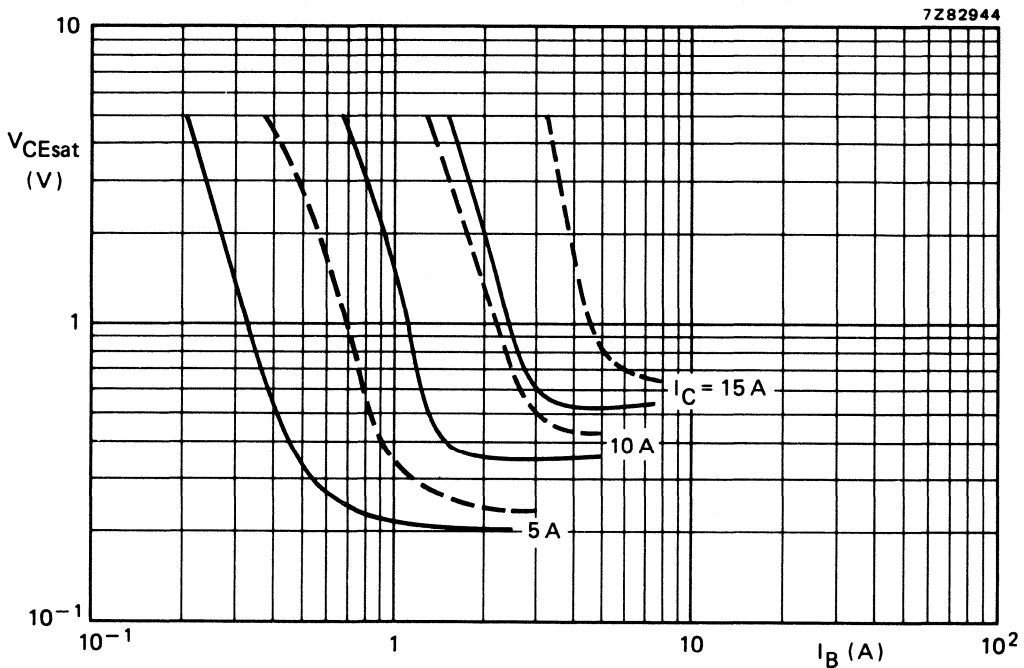


Fig. 13 Typical (—) and maximum (---) values saturation voltage. $T_j = 25^\circ\text{C}$.

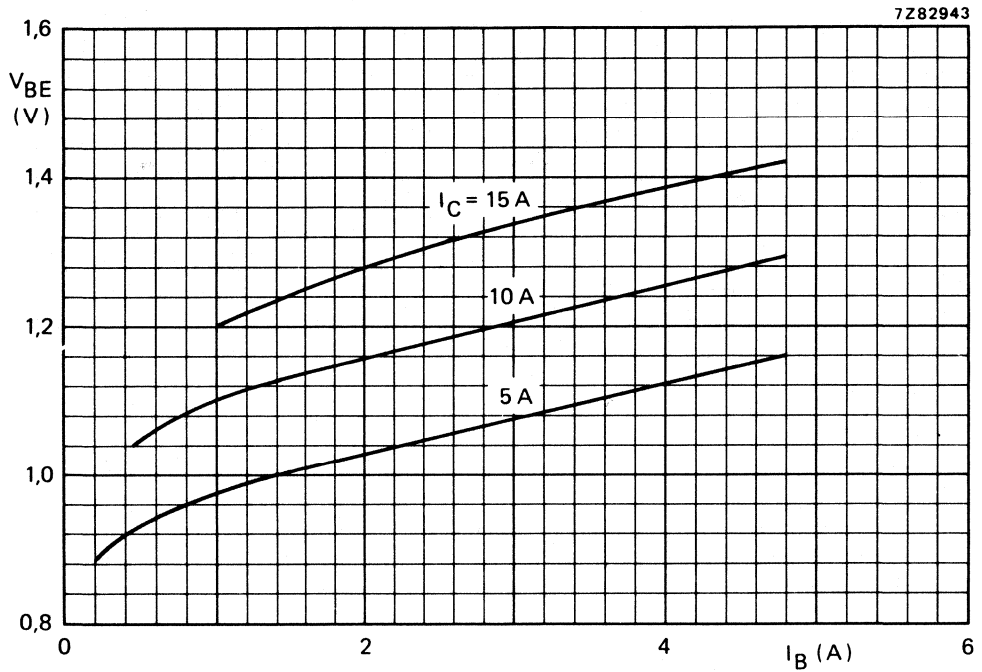


Fig. 14 Typical values base-emitter voltage at $T_j = 25$ °C.

SILICON DIFFUSED POWER TRANSISTORS

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

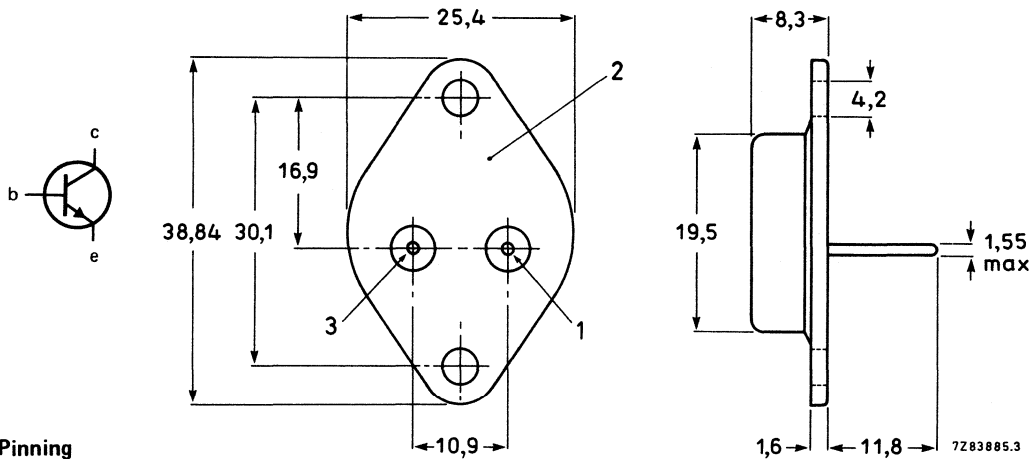
QUICK REFERENCE DATA

		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 $T_{mb} = 25\text{ }^\circ\text{C}$	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 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	$R_{th\ j-mb}$	=	0,7	K/W
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CHARACTERISTICS

$T_j = 25$ °C unless otherwise specified

Collector cut-off current*

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

$V_{CE} = V_{CESMmax}; V_{BE} = 0; T_j = 125$ °C

I_{CES}	max.	1	mA
I_{CES}	max.	5	mA

Emitter cut-off current

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

I_{EBO}	max.	10	mA
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		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	$V_{CEO_{sust}}$	min. 400	450 V
$I_C = 100$ mA; $I_{B_{off}} = 0; I = 25$ mH			

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

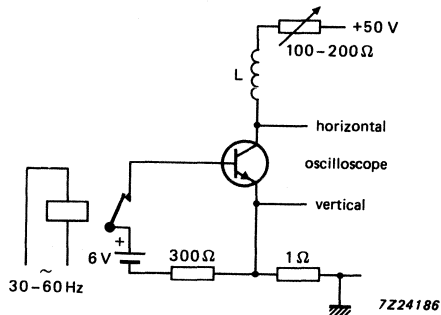


Fig. 2 Test circuit for $V_{CEOsust}$.

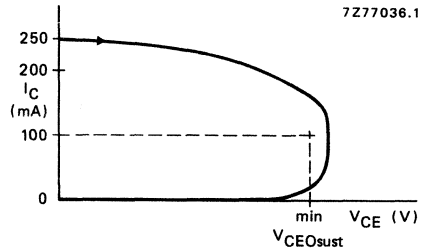


Fig. 3 Oscilloscope display for sustaining voltage.

Switching times resistive load (Figs 4 and 5)

$I_{Con} = 20\text{ A}$; $I_{Bon} = -I_{Boff} = 4\text{ A}$

Turn-on time

Turn-off: Storage time

Fall time

$I_{Con} = 16\text{ A}$; $I_{Bon} = -I_{Boff} = 3,2\text{ A}$

Turn-on time

Turn-off: Storage time

Fall time

Switching times inductive load (Figs 6 and 7)

$I_{Con} = 20\text{ A}$; $I_B = 4\text{ A}$

Turn-off: Storage time

Fall time

$I_{Con} = 20\text{ A}$; $I_B = 4\text{ A}$; $T_j = 100\text{ }^\circ\text{C}$

Turn-off: Storage time

Fall time

Switching times inductive load (Figs 6 and 7)

$I_{Con} = 16\text{ A}$; $I_B = 3,2\text{ A}$

Turn-off: Storage time

Fall time

$I_{Con} = 16\text{ A}$; $I_B = 3,2\text{ A}$; $T_j = 100\text{ }^\circ\text{C}$

Turn-off: Storage time

Fall time

		BUS14	BUS14A	
t_{on}	max.	1	—	μs
t_s	max.	4	—	μs
t_f	max.	0,8	—	μs
t_{on}	max.	—	1	μs
t_s	max.	—	4	μs
t_f	max.	—	0,8	μs
t_s	typ.	2,8	—	μs
	max.	3,6	—	μs
t_f	typ.	80	—	ns
	max.	150	—	ns
t_s	typ.	3,1	—	μs
	max.	4,0	—	μs
t_f	typ.	140	—	ns
	max.	300	—	ns
t_s	typ.	—	28	μs
	max.	—	3,6	μs
t_f	typ.	—	80	ns
	max.	—	150	ns
t_s	typ.	—	3,1	μs
	max.	—	4,0	μs
t_f	typ.	—	140	ns
	max.	—	300	ns

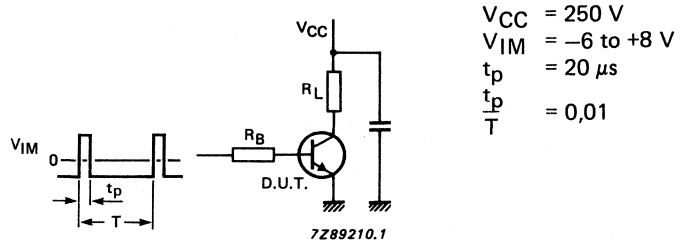


Fig. 4 Test circuit resistive load.

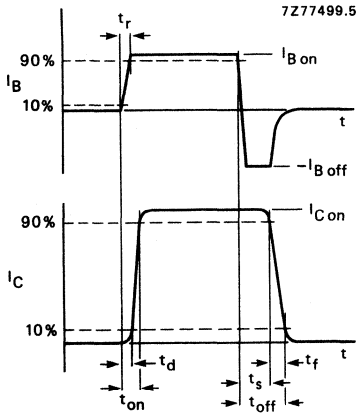


Fig. 5 Switching times waveforms with resistive load.

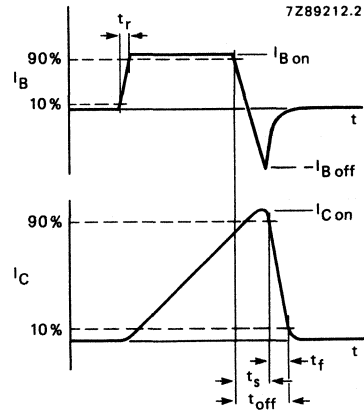


Fig. 6 Switching times waveforms with inductive load.

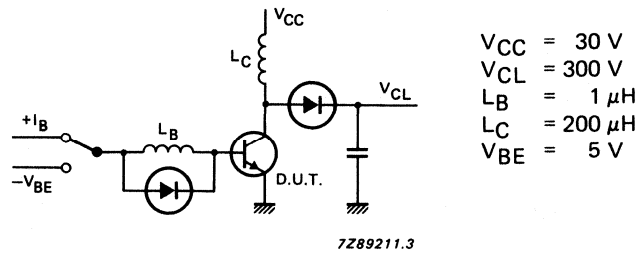
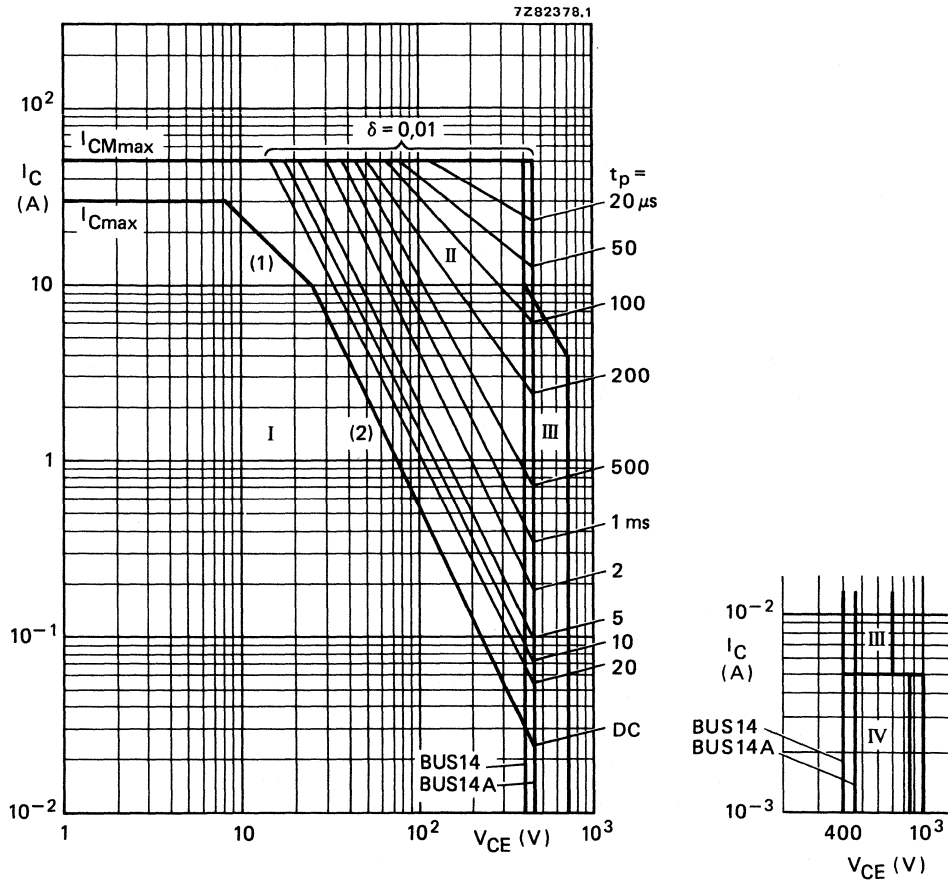


Fig. 7 Test circuit inductive load.



- (1) P_{tot} max and P_{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 $T_{mb} \leq 25^\circ C$.

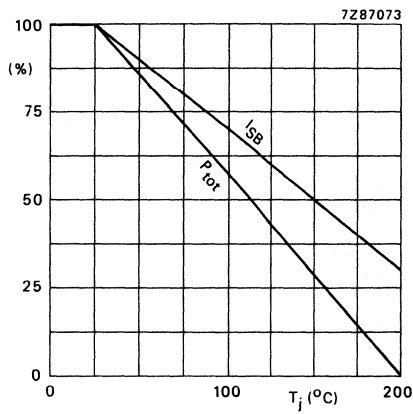


Fig. 9 Total power dissipation and second-breakdown current derating curve.

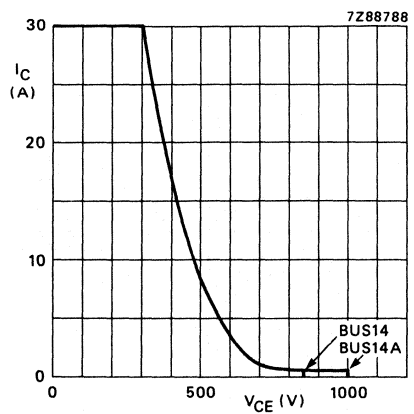


Fig. 10 Reverse bias SOAR.

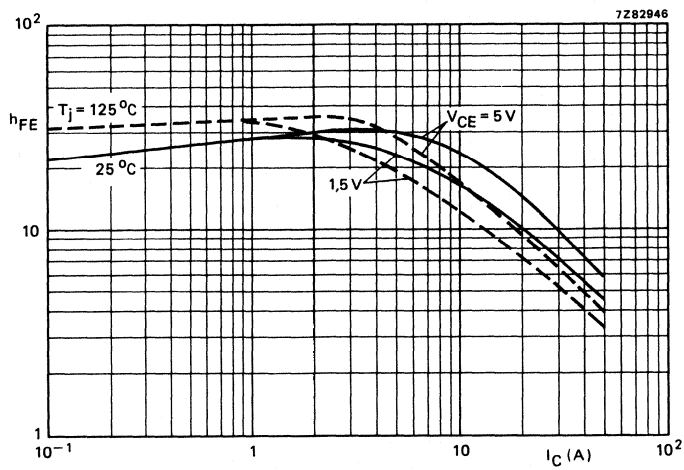


Fig. 11 Typical values DC current gain.

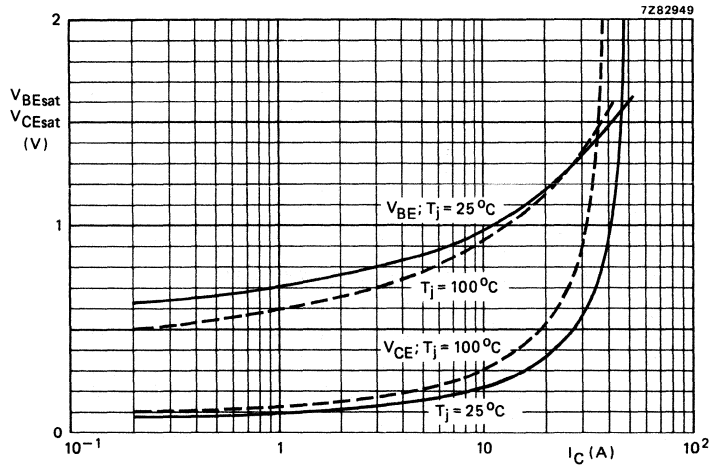


Fig. 12 Typical values base and collector voltage. $I_C/I_B = 5$.

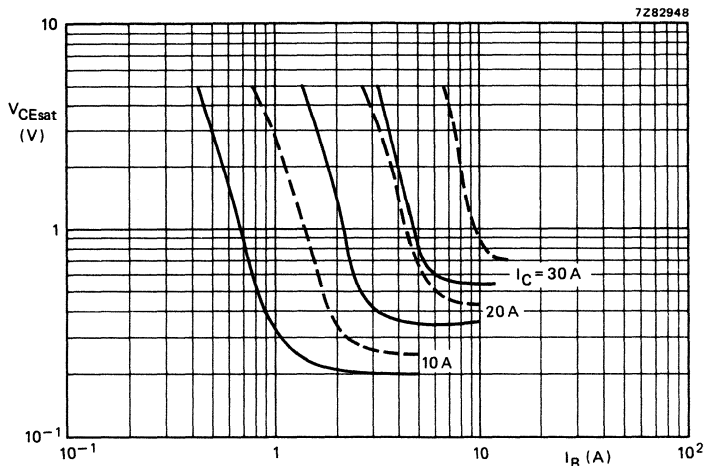


Fig. 13 Typical (—) and maximum (---) values saturation voltage. $T_j = 25^\circ\text{C}$.

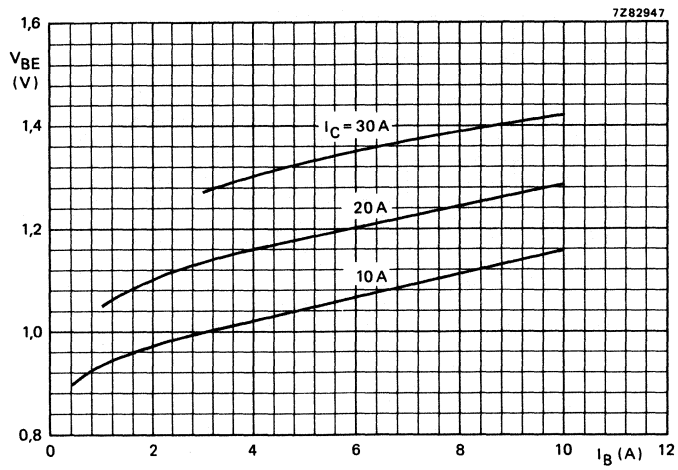


Fig. 14 Typical values at $T_j = 25$ °C.

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.

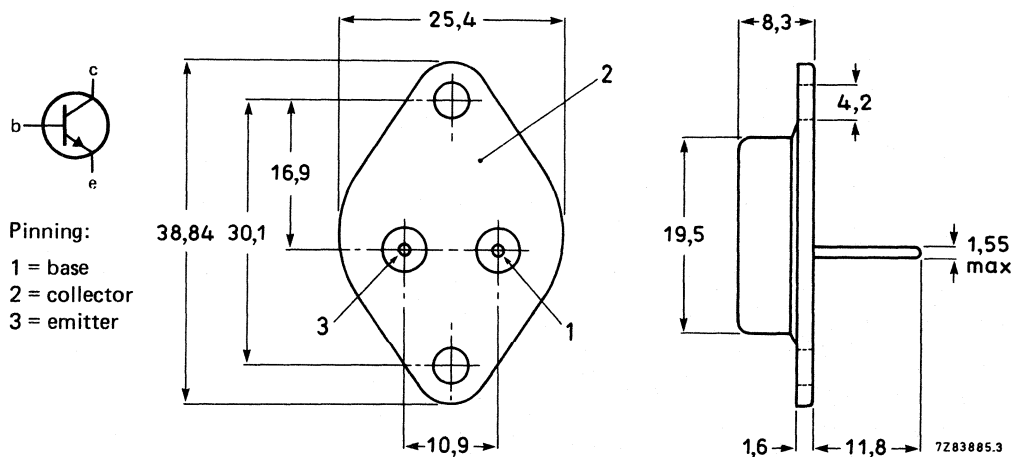
QUICK REFERENCE DATA

		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 $T_{mb} \leq 25^\circ\text{C}$	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 $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot} max.	100	W
Storage temperature range	T_{stg}	-65 to +200	$^\circ\text{C}$
Junction temperature	T_j max.	200	$^\circ\text{C}$

THERMAL RESISTANCE

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

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

Collector cut-off current* $V_{CE} = V_{CESMmax}; V_{BE} = 0$	I_{CES} max.	1	mA
Emitter cut-off current $I_C = 0; V_{EB} = 9\text{ V}$	I_{EBO} max.	10	mA
		BUS21B	BUS21C
DC current gain $I_C = 0,5\text{ A}; V_{CE} = 10\text{ V}$ $I_C = 3\text{ A}; V_{CE} = 1,5\text{ V}$	h_{FE} typ. min.	25 7,5	25 6
Collector-emitter sustaining voltage $I_B = 0; I_C = 0,1\text{ A}; L = 25\text{ mH}$	$V_{CEO_{sust}}$ min.	400	450 V
Saturation voltages $I_C = 3\text{ A}; I_B = 0,4\text{ A}$	V_{CEsat} max.	1,5	V
	V_{BEsat} max.	1,5	V
$I_C = 3\text{ A}; I_B = 0,5\text{ A}$	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.

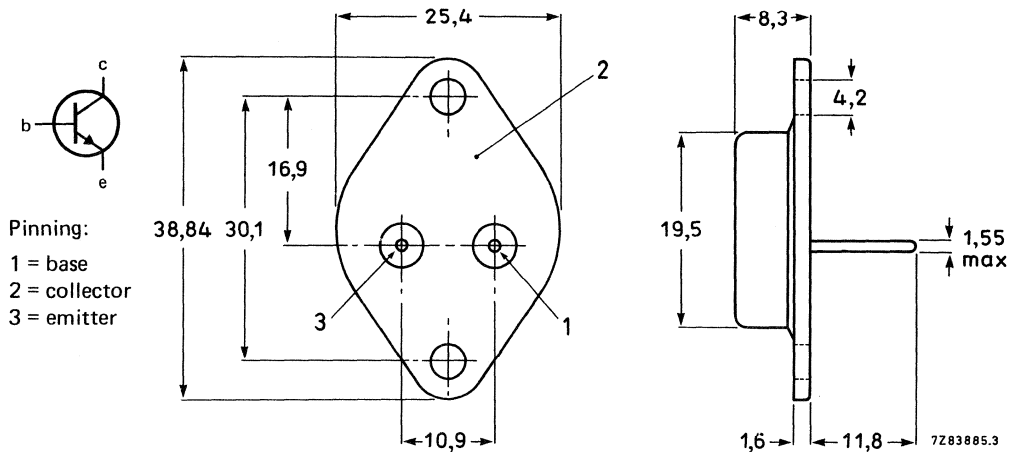
QUICK REFERENCE DATA

		RUS22B		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 $T_{mb} \leq 25\text{ }^\circ\text{C}$	P_{tot}	max.	125		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)

		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 $T_{mb} = 25^\circ\text{C}$	P_{tot}	max.		125	W
Storage temperature range	T_{stg}		-65 to +200		$^\circ\text{C}$
Junction temperature	T_j	max.		200	$^\circ\text{C}$

THERMAL RESISTANCE

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

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

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

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

Switching times inductive load (Figs 4 and 5)

$I_{Con} = 6 \text{ A}; I_{Bon} = 0,8 \text{ A}$

t_s

typ.

1,1

— μs

t_f

typ.

80

— μs

$I_{Con} = 6 \text{ A}; I_{Bon} = 1 \text{ A}$

t_s

typ.

—

1,1 μs

t_f

typ.

—

80 μs

BUS22B

BUS22C

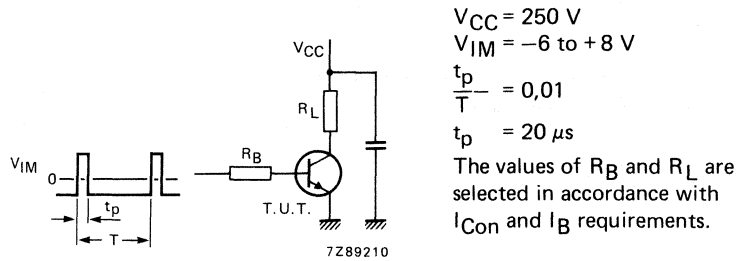


Fig. 2 Test circuit resistive load.

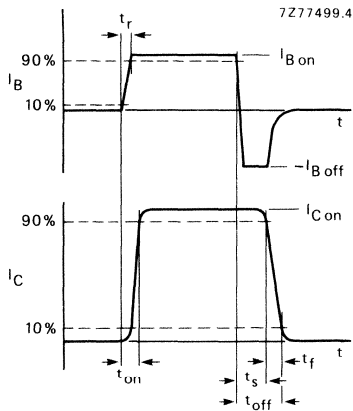


Fig. 3 Switching times waveforms with resistive load.

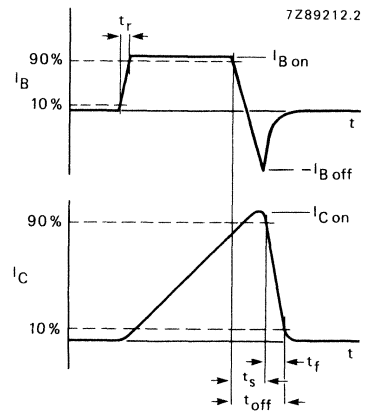


Fig. 4 Switching times waveforms with inductive load.

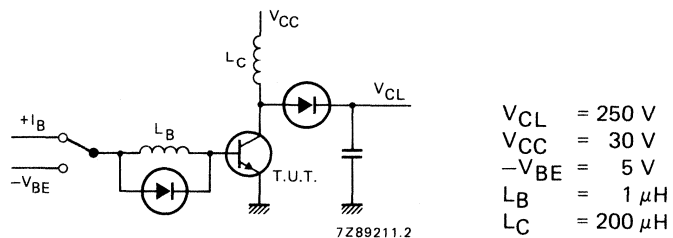
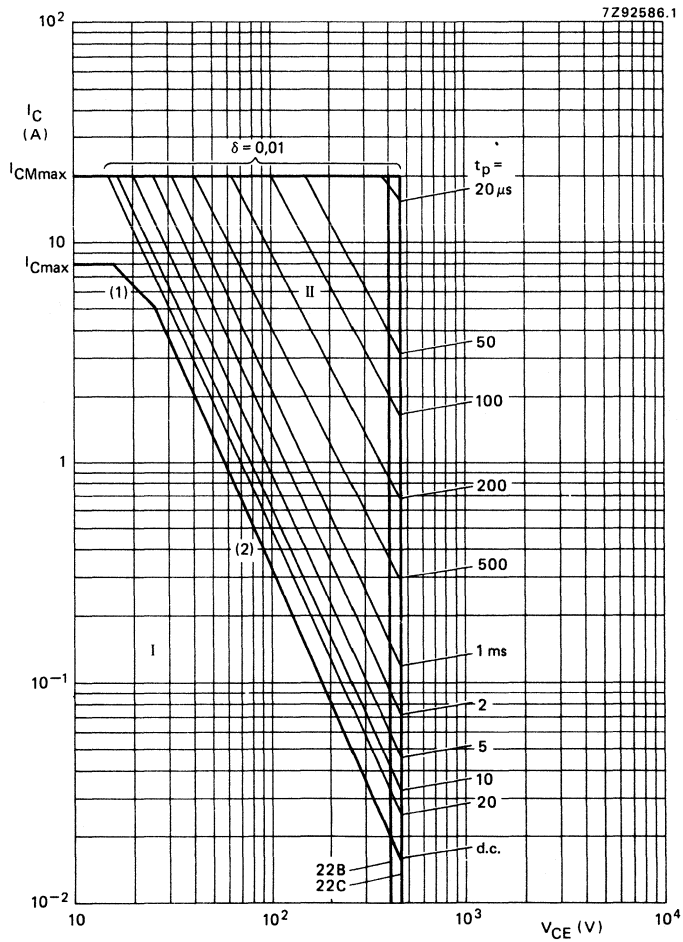


Fig. 5 Test circuit inductive load.



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

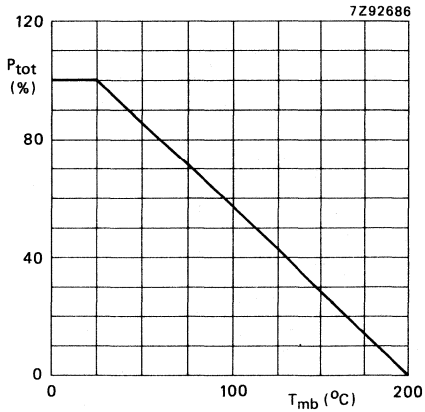


Fig. 7 Total power dissipation.

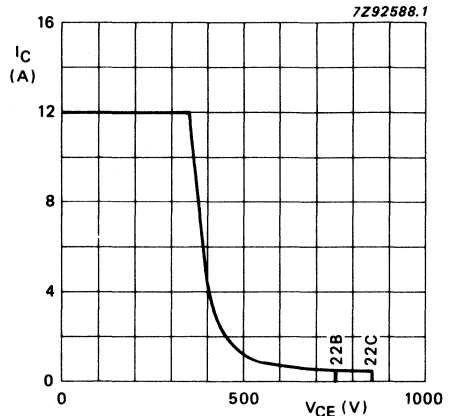


Fig. 8 Reverse bias SOAR; $T_{mb} = 100$ °C; $V_{BE(off)} = 1$ to 5 V; $L_B = 0$ to 3 μ H.

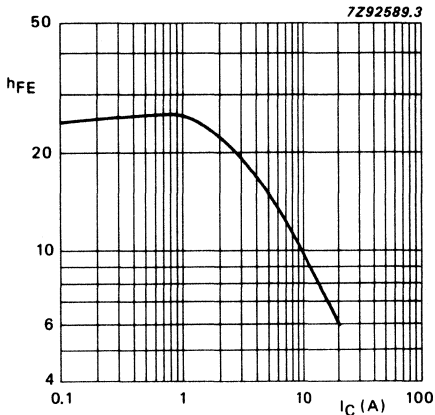


Fig. 9 Typical values DC current gain at $T_{mb} = 25$ °C.

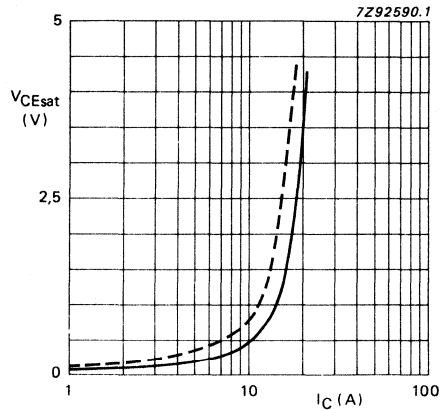


Fig. 10 Typical values collector voltage at $T_j = 25$ °C; $I_C/I_B = 7, 5$ and 6 for BUS22B and BUS22C respectively.

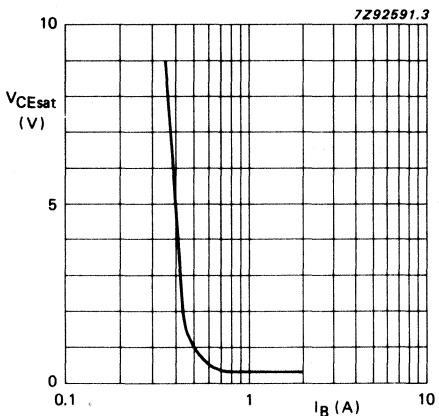


Fig. 11 Typical values V_{CEsat} at $T_j = 25$ °C; $I_C = 6$ A.

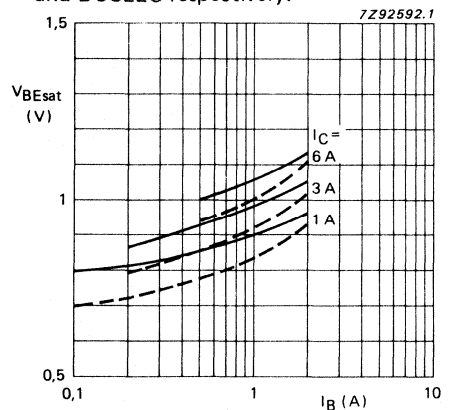


Fig. 12 Typical values V_{BEsat} at $T_j = 25$ °C; (—) = BUS22B; (- - -) = BUS22C.

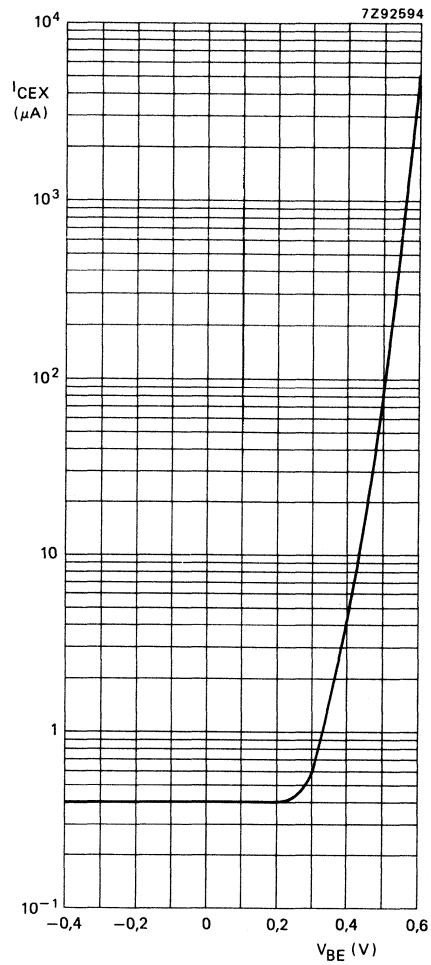


Fig. 13 Typical values collector cut-off current at $T_j = 25^\circ C$; $V_{CE} = 250$ V.

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.

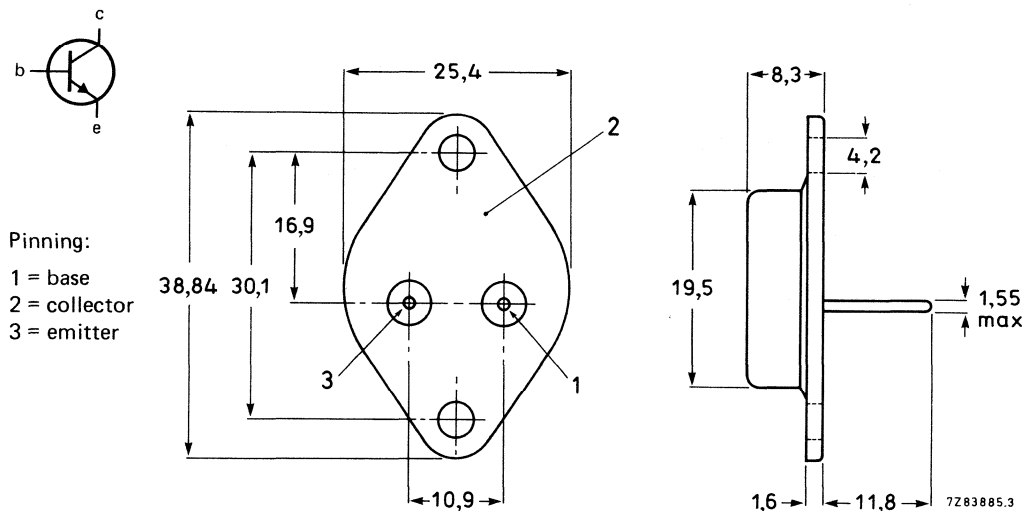
QUICK REFERENCE DATA

		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 $T_{mb} = 25\text{ }^\circ\text{C}$	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 $T_{mb} = 25^\circ\text{C}$	P_{tot}	max. 175	W
Storage temperature range	T_{stg}	-65 to +150 $^\circ\text{C}$	
Junction temperature	T_j	max. 150	$^\circ\text{C}$

THERMAL RESISTANCE

From junction to mounting base	R_{thj-mb}	=	0.7	K/W
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CHARACTERISTICS

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

Collector cut-off current*

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

I_{CES}	max.	1	mA
-----------	------	---	----

Emitter cut-off current

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

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

DC current gain

$$I_C = 1.5\text{ A}; V_{CE} = 5\text{ V}$$

h_{FE}	typ.	25	
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Collector-emitter sustaining voltage

$$I_B = 0; I_C = 0.1\text{ A}; L = 25\text{ mH}$$

		BUS23B	C
$V_{CEO_{sust}}$	min.	400	450 V

Saturation voltages

$$I_C = 10\text{ A}; I_B = 1.33\text{ A}$$

V_{CEsat}	max.	1.5	- V
V_{BEsat}	max.	1.5	- V

$$I_C = 10\text{ A}; I_B = 1.67\text{ A}$$

V_{CEsat}	max.	-	1.5 V
V_{BEsat}	max.	-	1.5 V

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

Switching times resistive load (Figs 2 and 3)

$I_{Con} = 10 \text{ A};$

$I_{Bon} = -I_{Boff} = 1.33 \text{ A}$

$I_{Con} = 10 \text{ A};$

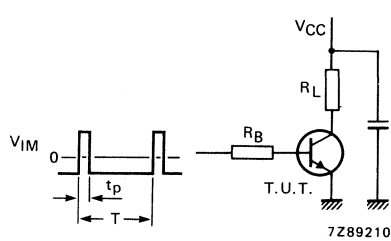
$I_{Bon} = -I_{Boff} = 1.67 \text{ A}$

Switching times inductance load (Figs 4 and 5)

$I_{Con} = 10 \text{ A}; I_{Bon} = 1.33 \text{ A}$

$I_{Con} = 10 \text{ A}; I_{Bon} = 1.67 \text{ A}$

		BUS23B	C
t_{on}	typ.	0.7	— μs
t_s	typ.	2.0	— μs
t_f	typ.	0.27	— μs
t_{on}	typ.	—	0.7 μs
t_s	typ.	—	2.0 μs
t_f	typ.	—	0.27 μs
t_s	typ.	2.1	— μs
t_f	typ.	40	— ns
t_s	typ.	—	2.1 μs
t_f	typ.	—	40 ns



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

Fig. 2 Test circuit resistive load.

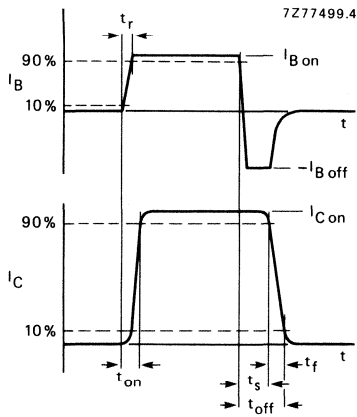


Fig. 3 Switching times waveforms with resistive load.

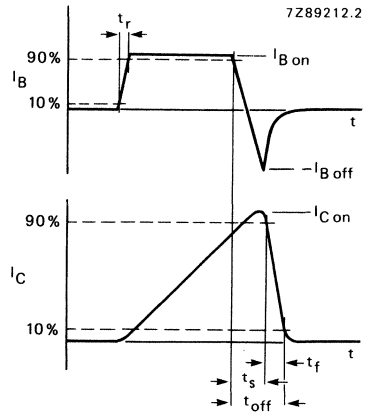
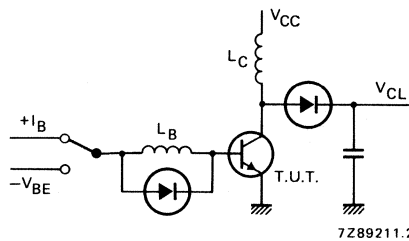
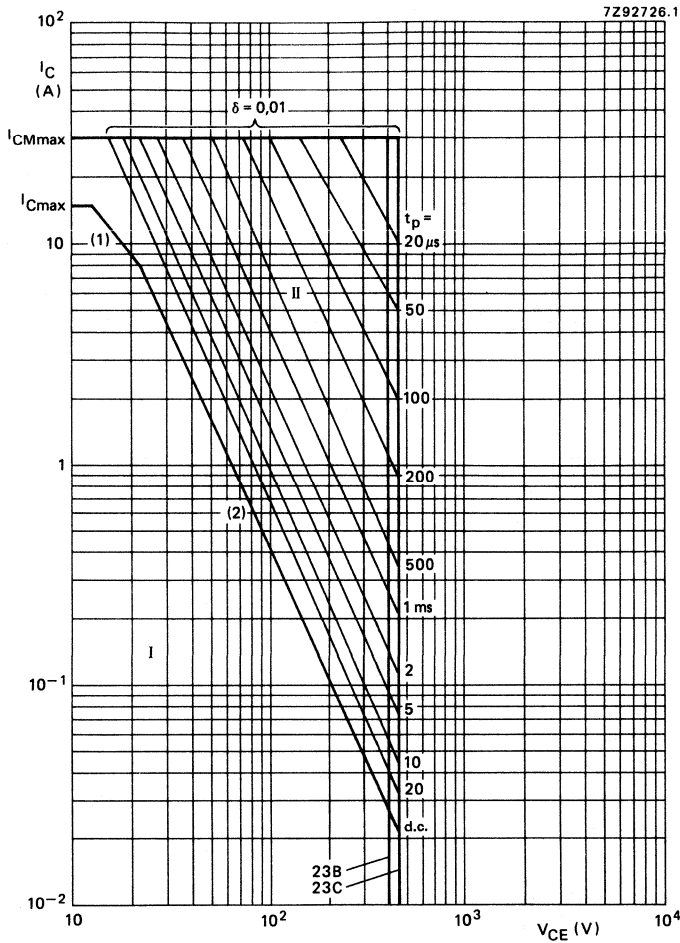


Fig. 4 Switching times waveforms with inductive load.



$V_{CL} = 250 \text{ V}$
 $V_{CC} = 30 \text{ V}$
 $-V_{BE} = 5 \text{ V}$
 $L_B = 1 \mu\text{H}$
 $L_C = 200 \mu\text{H}$

Fig. 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 $T_{mb} \leq 25\ ^\circ\text{C}$.

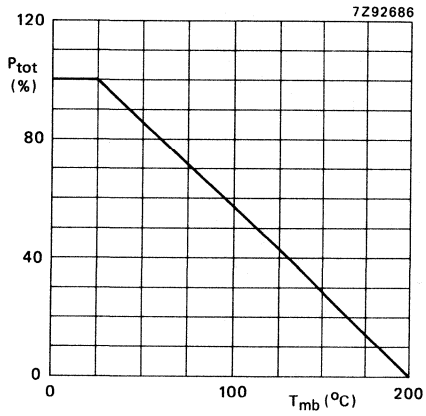


Fig. 7 Total power dissipation.

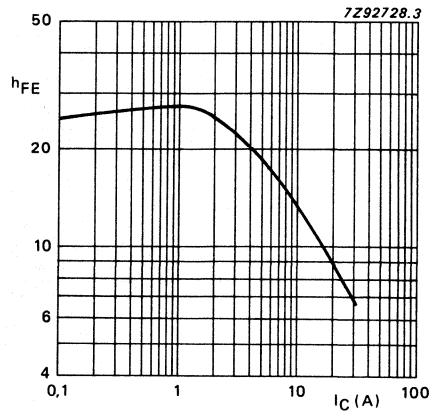


Fig. 8 Typical values DC current gain at $T_j = 25^\circ\text{C}$.

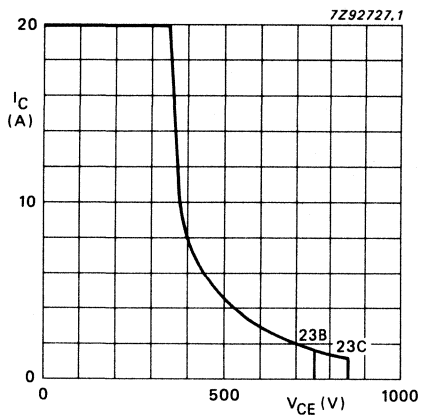


Fig. 9 Reverse bias SOAR; $T_{mb} = 100^\circ\text{C}$; $V_{BE(off)} = 1$ to 5 V; $L_B = 0$ to 3 μH .

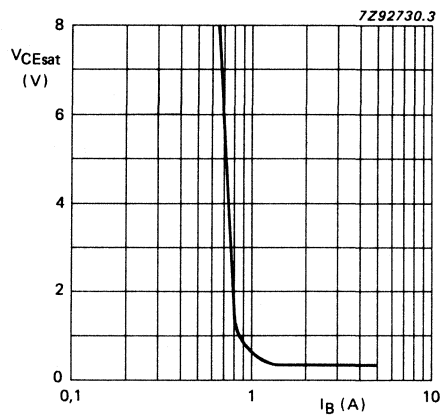


Fig. 10 Typical values V_{CEsat} at $T_j = 25^\circ\text{C}$; $I_C = 10$ A.

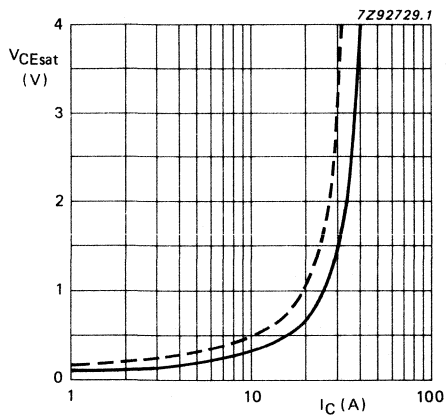


Fig. 11 Typical values collector voltage at $T_j = 25\text{ }^\circ\text{C}$; $I_C/I_B = 7,5$ and 6 for BUS23B and BUS23C respectively; (—) = BUS23B; (---) = BUS23C.

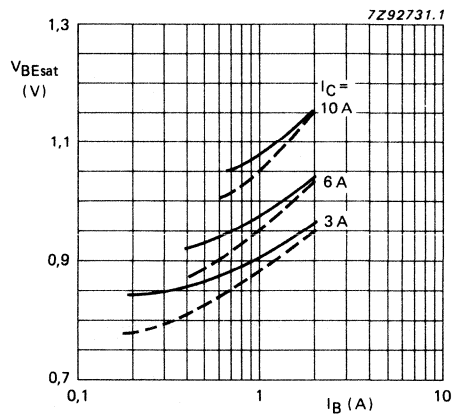


Fig. 12 Typical values V_{BE} at $T_j = 25\text{ }^\circ\text{C}$; (—) = BUS23B; (---) = BUS23C.

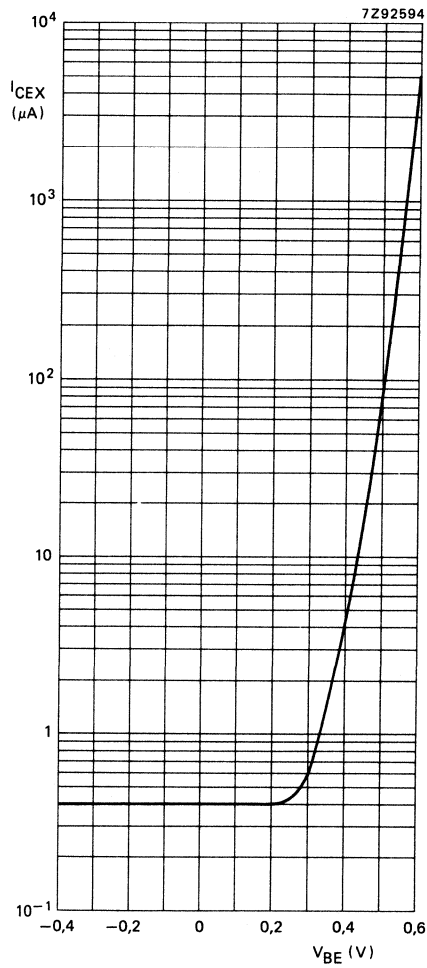


Fig. 13 Typical values collector cut-off current at $T_j = 25\text{ }^\circ\text{C}$; $V_{CE} = 250\text{ V}$.

DEVELOPMENT DATA

This data sheet contains advance information and specifications are subject to change without notice.

BUS24 SERIES

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.

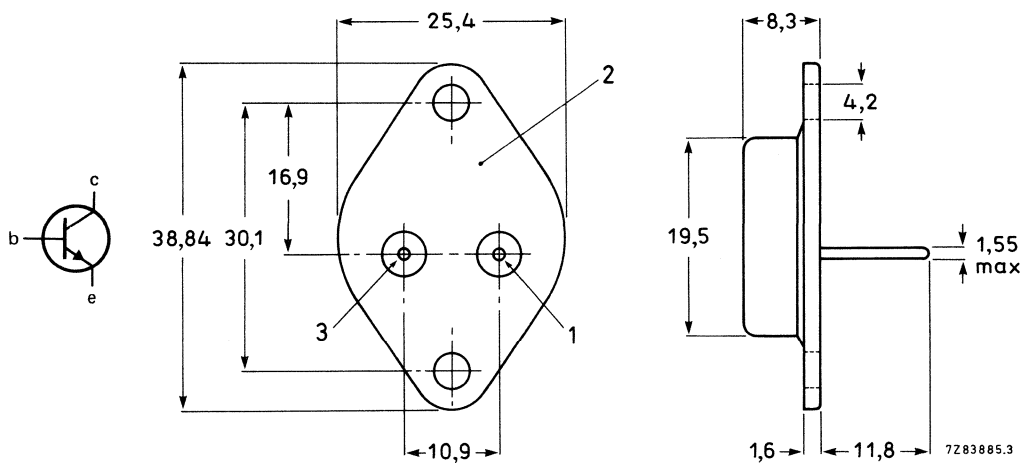
QUICK REFERENCE DATA

			BUS24B	24C
Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM}	max.	750	850 V
	V_{CEO}	max.	400	450 V
Collector-emitter saturation voltage $I_C = 20$ A	V_{CEsat}	max.	1.5	V
Collector current saturation DC peak value	I_{Csat}	max.	20	A
	I_C	max.	30	A
	I_{CM}	max.	50	A
Total power dissipation up to $T_{mb} = 25$ °C	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.

BUS24 SERIES

RATINGS

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

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

THERMAL RESISTANCE

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

CHARACTERISTICS

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

Collector cut-off current*

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

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

Emitter cut-off current

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

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

Collector-emitter sustaining voltage (Figs 2 and 3)

$I_B = 0; I_C = 0.1\text{ A}; L = 25\text{ mH}$

$V_{CEOsust}$	min.	400	450	V
---------------	------	-----	-----	---

Saturation voltages

$I_C = 20\text{ A}; I_B = 2.66\text{ A}$

BUS24B

V_{CEsat}	max.	1.5	V
-------------	------	-----	---

V_{BEsat}	max.	1.5	V
-------------	------	-----	---

$I_B = 3.34\text{ A}$

BUS24C

V_{CEsat}	max.	1.5	V
-------------	------	-----	---

V_{BEsat}	max.	1.5	V
-------------	------	-----	---

Current gain

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

h_{FE}	typ.	25	
----------	------	----	--

Switching times resistive load (Figs 4 and 5)

$I_{C\text{ on}} = 20\text{ A}; V_{CC} = 250\text{ V}$

$I_{B\text{ on}} = I_{B\text{ off}} = 2.66\text{ A}$

BUS24B

t_{on}	max.	1.0	μs
----------	------	-----	---------------

t_s	max.	4.5	μs
-------	------	-----	---------------

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

$I_{B\text{ on}} = I_{B\text{ off}} = 3.34\text{ A}$

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)

$I_{C\text{ on}} = 20\text{ A}$

$I_{B\text{ on}} = I_{B\text{ off}}$ as resistive load

$V_{BE} = -5\text{ V}; L_B = 1\text{ }\mu\text{H};$

$V_{CL} = 250\text{ V}; T_{mb} = 100\text{ }^\circ\text{C}.$

t_s	typ.	2.5	μs
-------	------	-----	---------------

t_s	max.	3.0	μs
-------	------	-----	---------------

t_f	typ.	0.1	μs
-------	------	-----	---------------

t_f	max.	0.25	μs
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DEVELOPMENT DATA

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

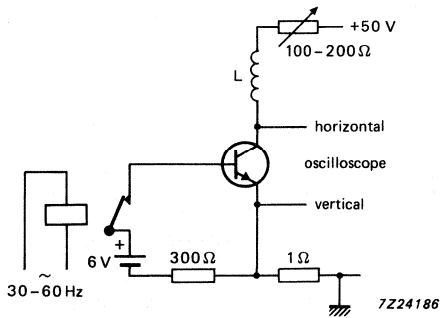


Fig. 2 Test circuit for $V_{CEOsust}$.

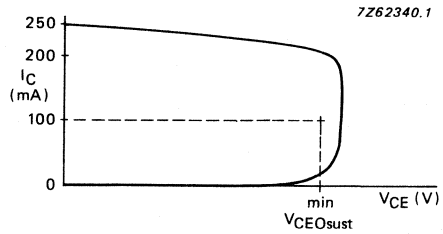


Fig. 3 Oscilloscope display for sustaining voltage.

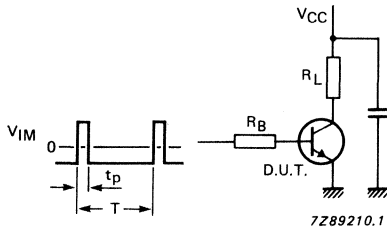


Fig. 4 Test circuit resistive load.

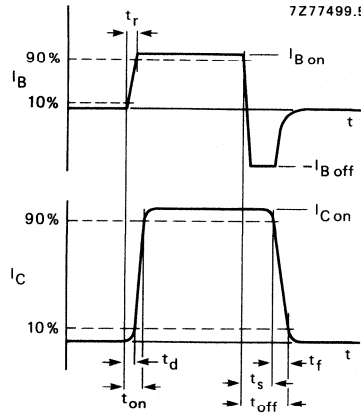


Fig. 5 Switching times waveforms with resistive load; $t_r \leq 20$ ns.

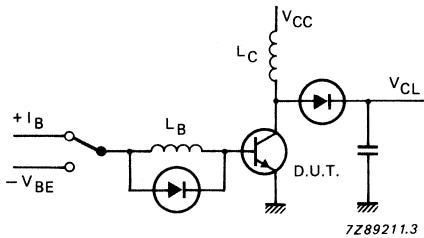


Fig. 6 Test circuit inductive load.

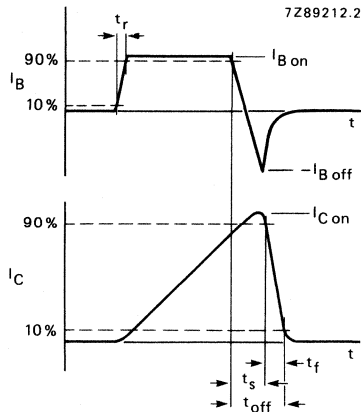
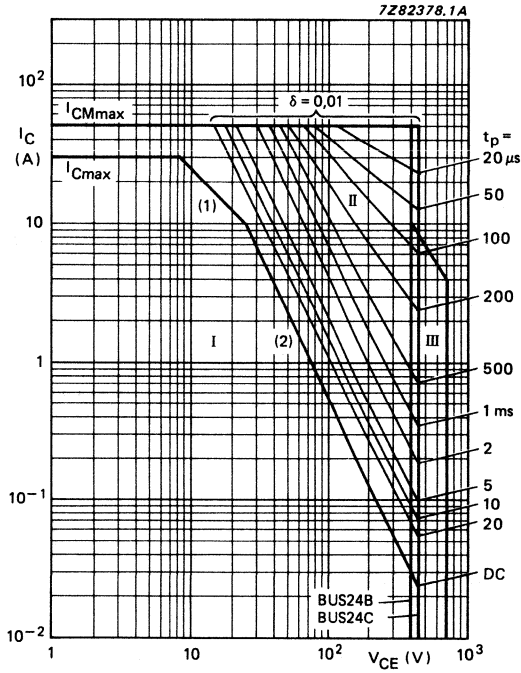


Fig. 7 Switching times waveforms with inductive load.

DEVELOPMENT DATA



- (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 $t_p \leq 0.6 \mu s$.

Fig. 8 Forward biased Safe Operating area at $T_{mb} = 25^\circ C$.

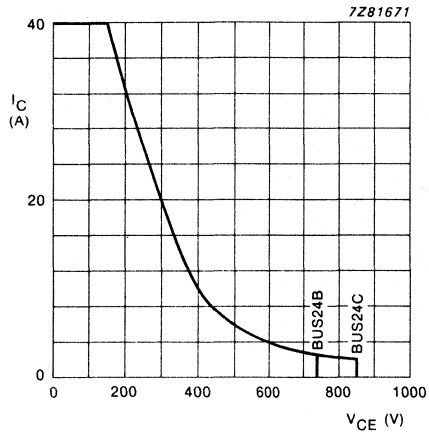


Fig. 9 Reverse bias SOAR; $T_{mb} \leq 100^\circ\text{C}$; $V_{BE} = -1\text{ V to } -5\text{ V}$.

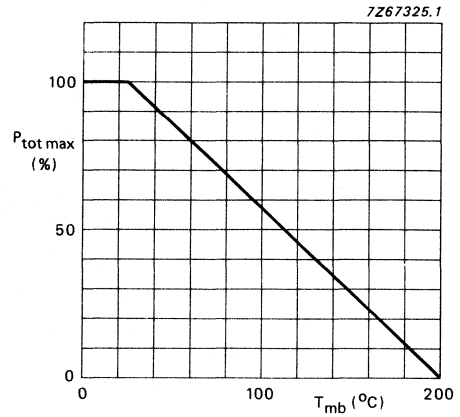


Fig. 10 Power derating curve.

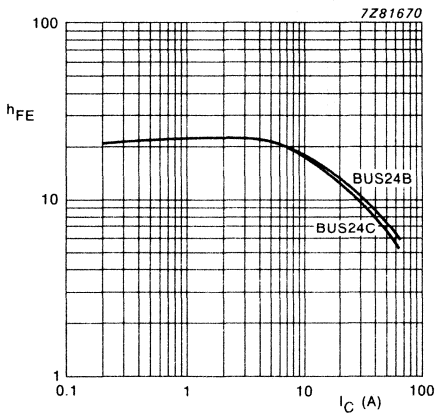


Fig. 11 DC current gain; $V_{CE} = 1.5\text{ V}$; $T_j = 25^\circ\text{C}$.

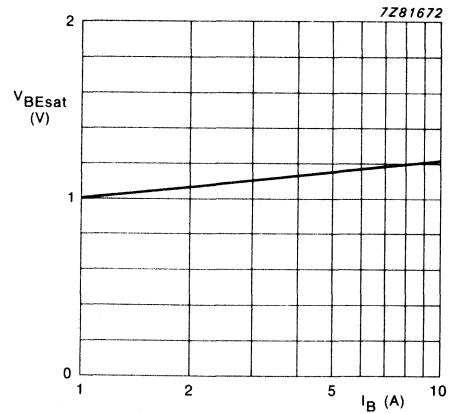


Fig. 12 Base-emitter saturation voltage as a function of base current; $I_C = 20\text{ mA}$; $T_{mb} = 25^\circ\text{C}$.

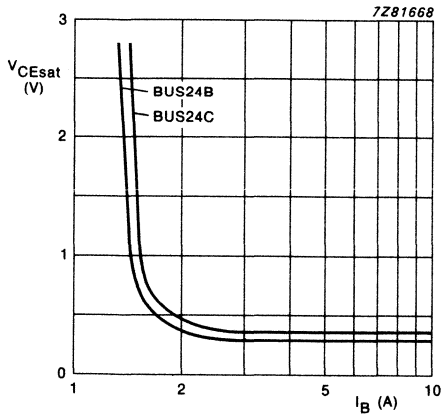


Fig. 13 Collector-emitter saturation voltage as a function of base current; $I_C = 20$ A; $T_j = 25$ °C.

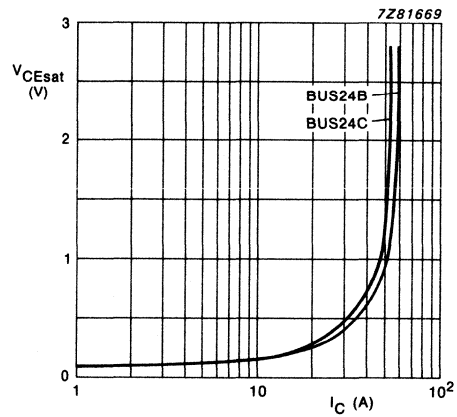


Fig. 14 Collector-emitter saturation voltage as a function of collector current: $I_C/I_B = 7.5$ for BUS24B; $I_C/I_B = 6.0$ for BUS24C.

DEVELOPMENT DATA

DEVELOPMENT DATA

This data sheet contains advance information and specifications are subject to change without notice.

BUS131 SERIES

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.

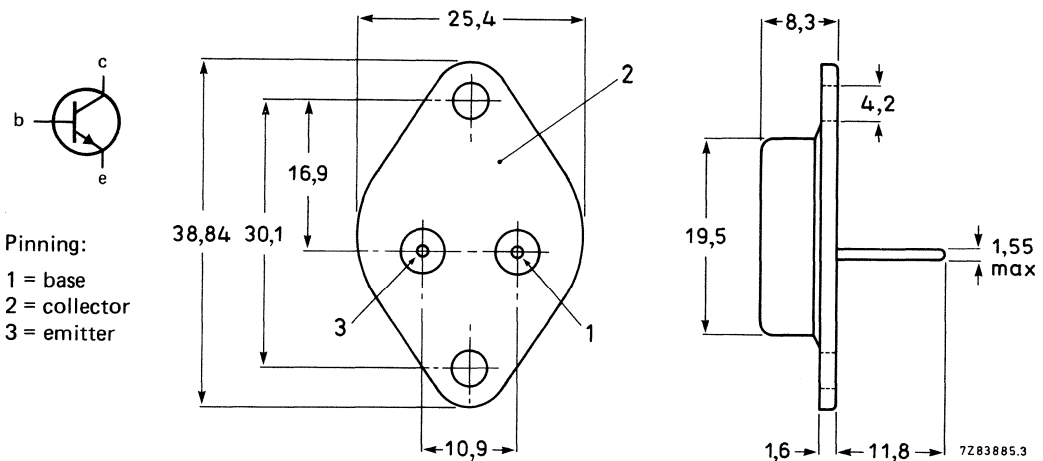
QUICK REFERENCE DATA

			BUS131	131A	131H
Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM}	max.	850	1000	850 V
	V_{CEO}	max.	450	500	450 V
Collector-emitter saturation voltage	V_{CEsat}	max.		2.5	V
Collector current saturation DC peak value	I_{Csat}	max.		3.0	A
	I_C	max.		5.0	A
	I_{CM}	max.		10	A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	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.



Collector connected to case.

BUS131 SERIES

RATINGS

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

			BUS131	131A	131H
Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM}	max.	850	1000	850 V
	V_{CEO}	max.	450	500	450 V
Collector current DC peak value; $t_p = 5$ ms; $d = 10\%$	I_C	max.		5.0	A
	I_{CM}	max.		10	A
Base current DC peak value; $t_p = 5$ ms; $d = 10\%$	I_B	max.		4.0	A
	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

CHARACTERISTICS

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

Collector cut-off current*

$V_{CE} = V_{CESMmax}; V_{BE} = -1.5\text{ V}$

$V_{CE} = V_{CESMmax}; V_{BE} = -1.5\text{ V}$

$T_j = 100\text{ }^\circ\text{C}$

I_{CEV} max. 0.25 mA

I_{CEV} max. 1.5 mA

Emitter cut-off current

$V_{EB} = 6.0\text{ V}; I_C = 0$

I_{EBO} max. 1.0 mA

	BUS131	131A	131H
--	--------	------	------

Collector-emitter sustaining voltage

$I_C = 100\text{ mA}; I_B = 0; L = 10\text{ mH}$

(see Figs 2 and 3)

$V_{CEOsust}$ min. 450 500 450 V

Saturation voltage

$T_C = 25\text{ }^\circ\text{C}$ and $100\text{ }^\circ\text{C}$

$I_C = 1.5\text{ A}; I_B = 0.2\text{ A}$ (BUS131)

$I_C = 1.5\text{ A}; I_B = 0.2\text{ A}$ (BUS131A)

$I_C = 1.5\text{ A}; I_B = 0.15\text{ A}$ (BUS131H)

V_{CEsat} max. 1.0 V

$I_C = 3\text{ A}; I_B = 0.4\text{ A}$ (BUS131)

$I_C = 3\text{ A}; I_B = 0.4\text{ A}$ (BUS131A)

$I_C = 3\text{ A}; I_B = 0.3\text{ A}$ (BUS131H)

V_{CEsat} max. 2.5 V

V_{BEsat} max. 1.5 V

DC current gain

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

h_{FE} min. 5 5 7

Switching times resistive load

(see Figs 4 and 5)

$I_{C\text{ on}} = 3\text{ A}; I_{B\text{ on}} = 0.4\text{ A}; I_{B\text{ off}} = 0.8\text{ A}$

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

$I_{C\text{ on}} = 3\text{ A}; I_{B\text{ on}} = 0.3\text{ A}; I_{B\text{ off}} = 0.6\text{ A}$

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)

$I_{C\text{ on}} = 3\text{ A}; I_{B\text{ on}} = 0.4\text{ A}$

t_{sv} typ. 0.60 0.60 — μs

$V_{BE\text{ off}} = 5\text{ V}; V_{CE(pk)} = 400\text{ V};$

$T_j = 100\text{ }^\circ\text{C}$

t_{fi} typ. 0.07 0.07 — μs

t_c typ. 0.20 0.20 — μs

$I_{C\text{ on}} = 3\text{ A}; I_{B\text{ on}} = 0.3\text{ A}$

t_{sv} typ. — — 0.50 μs

$V_{BE\text{ off}} = 5\text{ V}; V_{CE(pk)} = 400\text{ V};$

$T_j = 100\text{ }^\circ\text{C}$

t_{fi} typ. — — 0.07 μs

t_c typ. — — 0.18 μs

Output capacitance

$V_{CB} = 10\text{ V}; I_E = 0; f_{test} = 1\text{ kHz}$

C_{ob} max. 200 pF

DEVELOPMENT DATA

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

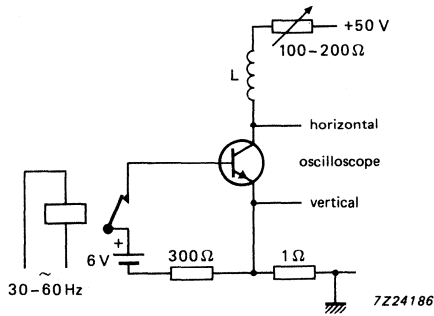


Fig. 2 Test circuit for $V_{CE(sust)}$.

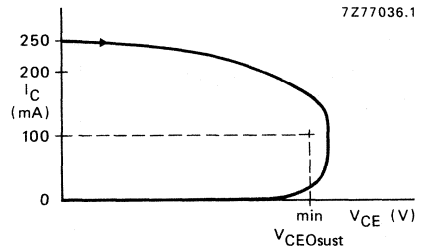
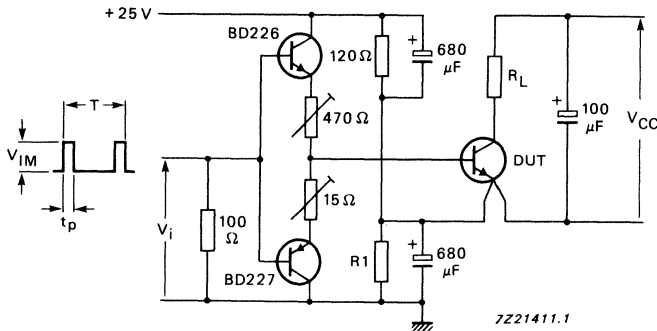


Fig. 3 Oscilloscope display for sustaining voltage.



$t_p = 20 \mu s$
 $T = 2 ms$
 $V_{iM} = 15 V$

Fig. 4 Test circuit resistive load; $V_{CC} = 240 V$;
 $R_L = 82 \Omega$; $R_1 = 39 \Omega$.

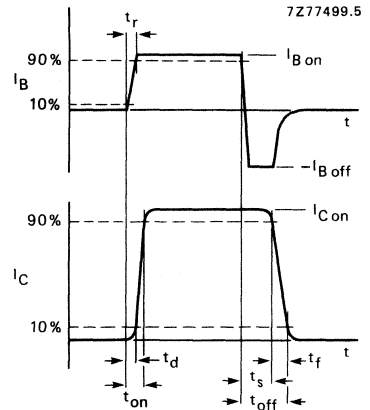
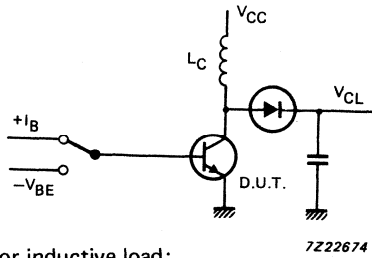


Fig. 5 Switching times waveforms with resistive load; $t_r \leq 30 ns$.



7Z22674

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

Fig. 6 Test circuit inductive load and RB SOAR; $V_{CC} = 20 \text{ V}$; $L_C = 200 \mu\text{H}$.

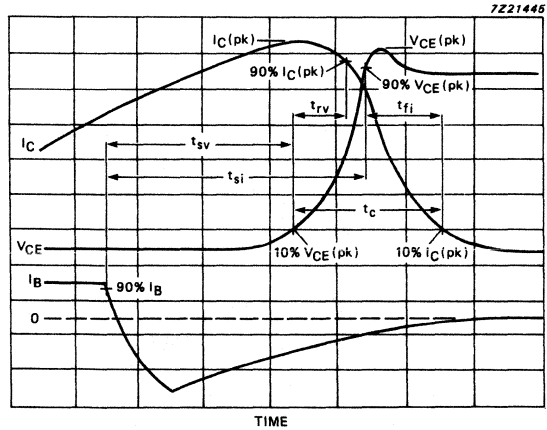


Fig. 7 Switching times waveforms with inductive load.

DEVELOPMENT DATA

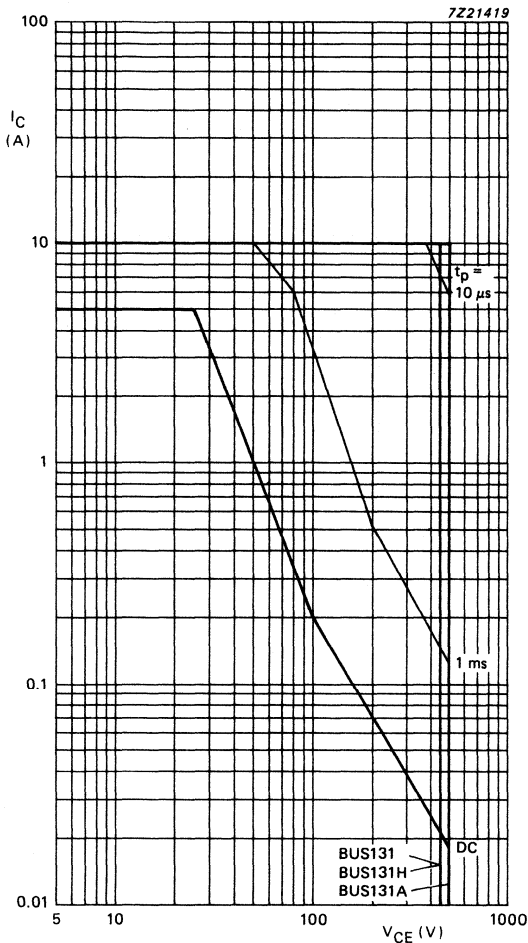


Fig. 8 Forward biased SOAR; $T_{mb} = 25 \text{ }^\circ\text{C}$.

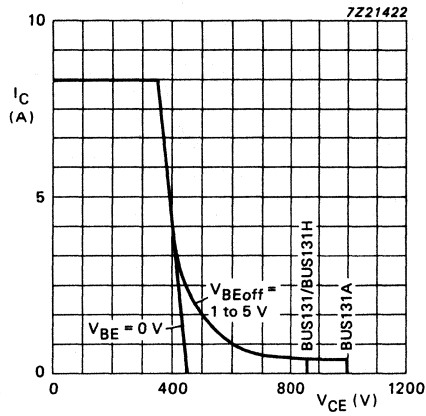


Fig. 9 Reverse bias SOAR; $I_C/I_B = 4$; $T_{mb} \leq 100^\circ\text{C}$.

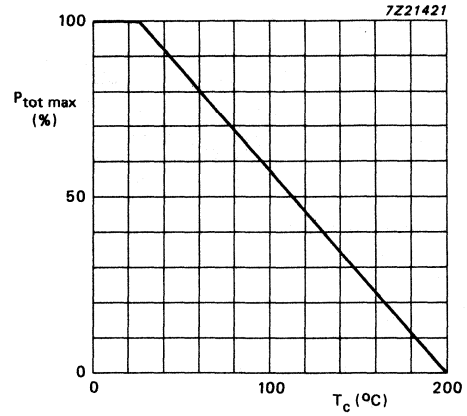


Fig. 10 Power derating curve.

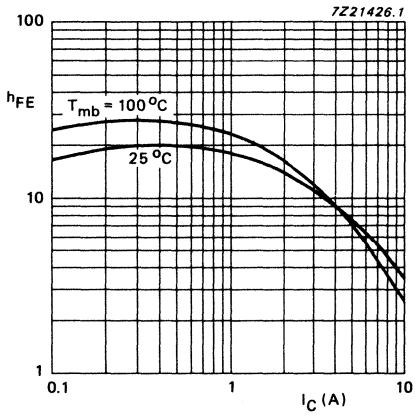


Fig. 11 Typical DC current gain; $V_{CE} = 5\text{ V}$.

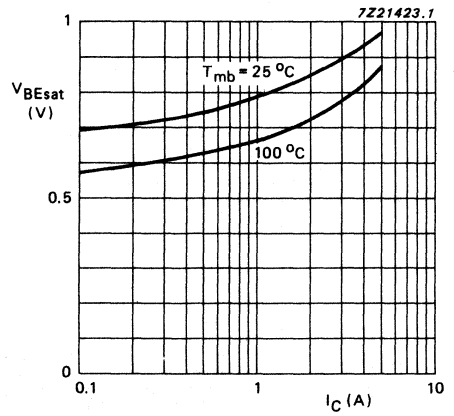


Fig. 12 Base-emitter saturation voltage as a function of collector current; $I_C/I_B = 10$.

DEVELOPMENT DATA

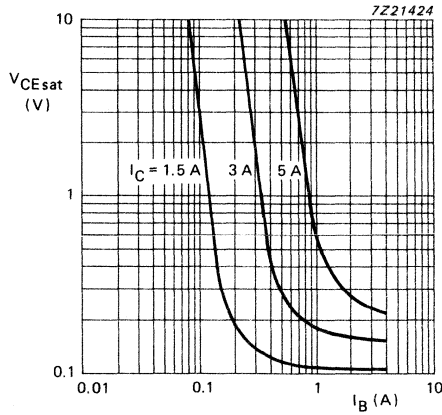


Fig. 13 Collector-emitter voltage as a function of base current; $T_C = 25\text{ }^\circ\text{C}$.

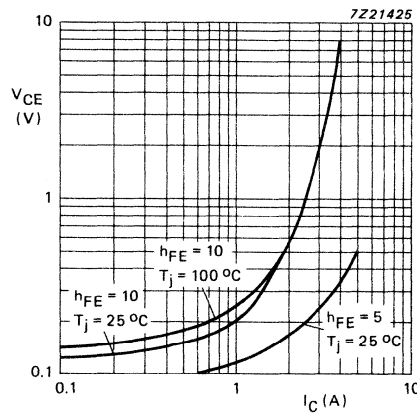


Fig. 14 Collector-emitter voltage as a function of collector current.

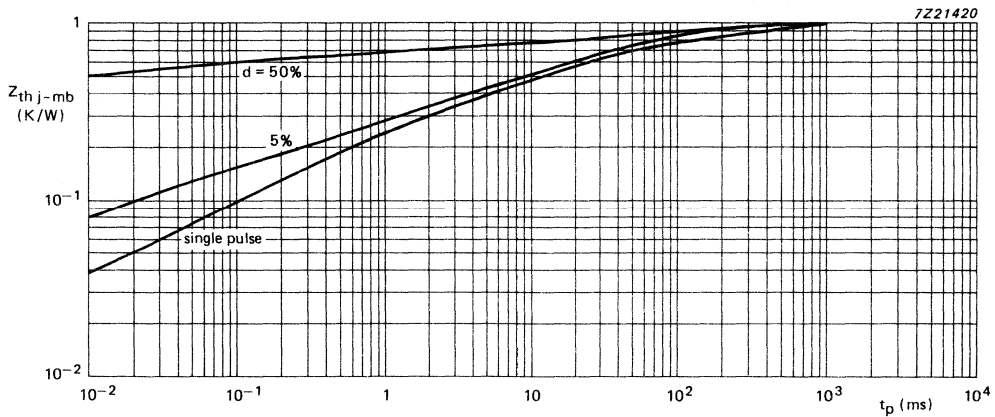


Fig. 15 Transient thermal impedance; (normalized).

DEVELOPMENT DATA

This data sheet contains advance information and specifications are subject to change without notice.

BUS132 SERIES

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.

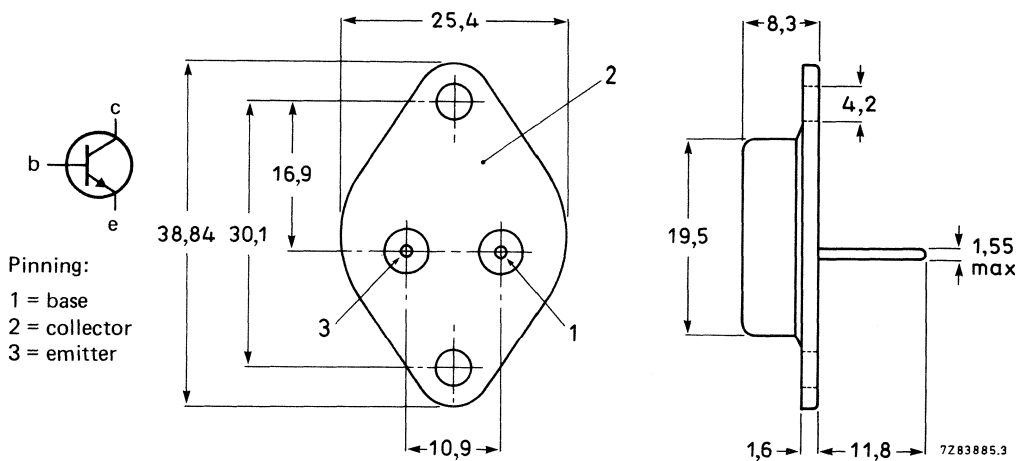
QUICK REFERENCE DATA

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

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)

			BUS132	132A	132H
Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM}	max.	850	1000	850 V
	V_{CEO}	max.	450	500	450 V
Collector current DC peak value; $t_p = 5$ ms; $d = 10\%$	I_C	max.		8.0	A
	I_{CM}	max.		16	A
Base current DC peak value; $t_p = 5$ ms; $d = 10\%$	I_B	max.		6.0	A
	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	$R_{th\ j-mb}$	=		1.17	K/W

CHARACTERISTICS

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

Collector cut-off current*

$V_{CE} = V_{CESMmax}; V_{BE} = -1.5\text{ V}$

I_{CEV} max. 0.25 mA

$V_{CE} = V_{CESMmax}; V_{BE} = -1.5\text{ V}$

$T_j = 100\text{ }^\circ\text{C}$

I_{CEV} max. 1.5 mA

Emitter cut-off current

$V_{EB} = 6.0\text{ V}; I_C = 0$

I_{EBO} max. 1.0 mA

BUS132 | 132A | 132H

Collector-emitter sustaining voltage
(see Figs 2 and 3)

$I_C = 100\text{ mA}; I_B = 0; L = 10\text{ mH}$

$V_{CEOsust}$ min. 450 500 450 V

Saturation voltage

$T_{mb} = 25\text{ }^\circ\text{C}$ and $100\text{ }^\circ\text{C}$

$I_C = 3\text{ A}; I_B = 0.4\text{ A}$ (BUS132)

$I_C = 3\text{ A}; I_B = 0.6\text{ A}$ (BUS132A)

$I_C = 3\text{ A}; I_B = 0.3\text{ A}$ (BUS132H)

V_{CEsat} max. 2.5 1.0 2.5 V

$I_C = 5\text{ A}; I_B = 0.66\text{ A}$ (BUS132)

$I_C = 5\text{ A}; I_B = 1.0\text{ A}$ (BUS132A)

$I_C = 5\text{ A}; I_B = 0.5\text{ A}$ (BUS132H)

V_{CEsat} max. 3.0 1.5 3.0 V

V_{BEsat} max. 1.5 1.5 1.5 V

DC current gain

$I_C = 8\text{ A}; V_{CE} = 5\text{ V}$

h_{FE} min. 5 5 7

Switching times resistive load
(see Figs 4 and 5)

$I_{C\ on} = 5\text{ A}; I_{B\ on} = 0.66\text{ A}; I_{B\ off} = 1.3\text{ A}$

Turn-on time

t_{on} typ. 0.35 0.35 — μs

Turn-off; storage time
fall time

t_s typ. 1.5 1.5 — μs
 t_f typ. 0.1 0.1 — μs

$I_{C\ on} = 5\text{ A}; I_{B\ on} = 0.5\text{ A}; I_{B\ off} = 1.0\text{ A}$

Turn-on time

t_{on} typ. — — 0.4 μs

Turn-off; storage time
fall time

t_s typ. — — 1.5 μs
 t_f typ. — — 0.1 μs

Switching times inductive load
(see Figs 6 and 7)

$I_{C\ on} = 5\text{ A}; I_{B\ on} = 0.66\text{ A}$

t_{sv} typ. 0.8 0.8 — μs

$V_{BE\ off} = 5\text{ V}; V_{CE(pk)} = 400\text{ V};$
 $T_j = 100\text{ }^\circ\text{C}$

t_{fi} typ. 0.08 0.08 — μs

t_c typ. 0.25 0.25 — μs

$I_{C\ on} = 5\text{ A}; I_{B\ on} = 0.5\text{ A}$

t_{sv} typ. — — 0.6 μs

$V_{BE\ off} = 5\text{ V}; V_{CE(pk)} = 400\text{ V};$
 $T_j = 100\text{ }^\circ\text{C}$

t_{fi} typ. — — 0.07 μs

t_c typ. — — 0.2 μs

Output capacitance

$V_{CB} = 10\text{ V}; I_E = 0; f_{test} = 1\text{ kHz}$

C_{ob} max. 350 pF

DEVELOPMENT DATA

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

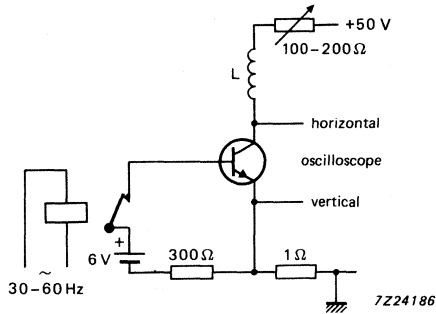


Fig. 2 Test circuit for $V_{CEOsust}$.

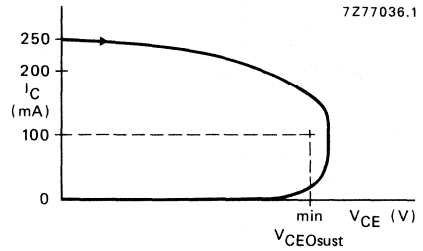
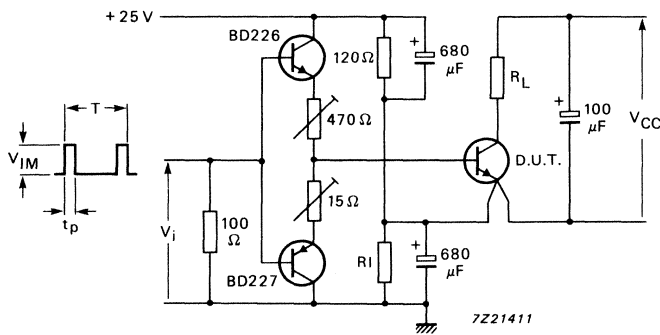


Fig. 3 Oscilloscope display for sustaining voltage.



$t_p = 20 \mu s$
 $T = 2 ms$
 $V_{IM} = 15 V$

Fig. 4 Test circuit resistive load; $V_{CC} = 250 V$;
 $R_L = 50 \Omega$; $R_1 = 39 \Omega$.

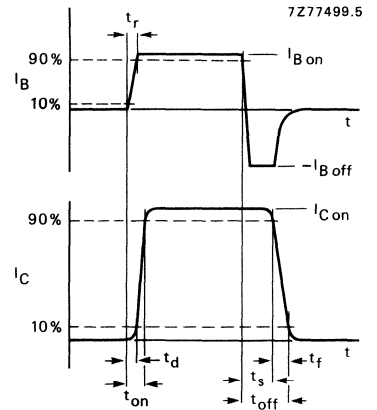


Fig. 5 Switching times waveforms with resistive load; $t_r \leq 30 ns$.

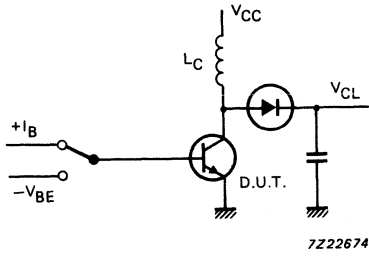


Fig. 6 Test circuit inductive load and RB SOAR; $V_{CC} = 20\text{ V}$; $L_C = 200\ \mu\text{H}$.

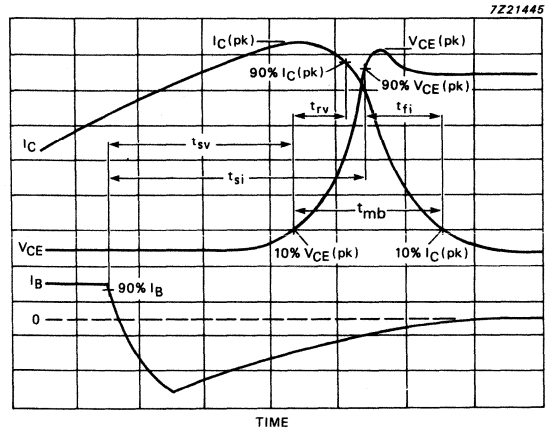


Fig. 7 Switching times waveforms with inductive load.

DEVELOPMENT DATA

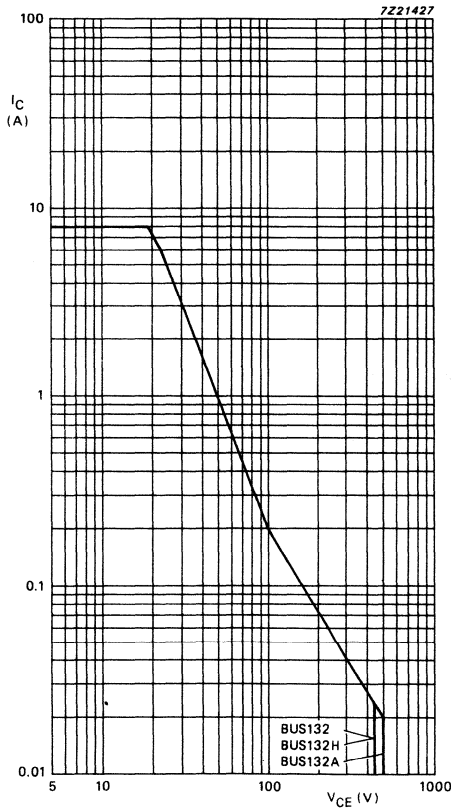


Fig. 8 Forward biased SOAR; $T_{mb} = 25\ ^\circ\text{C}$.

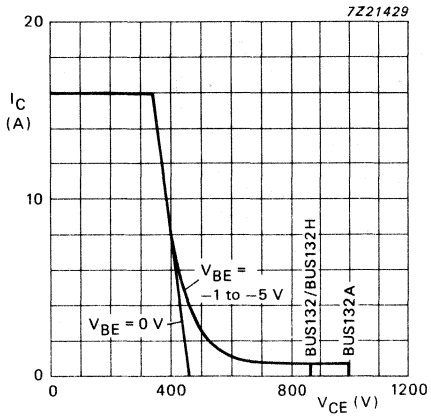


Fig. 9 Reverse bias SOAR;
 $I_C/I_B = 4$; $T_{mb} \leq 25^\circ\text{C}$.

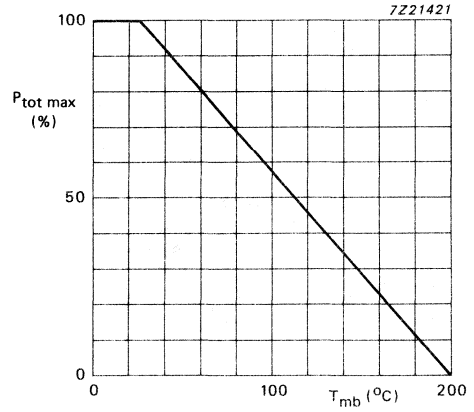


Fig. 10 Power derating curve.

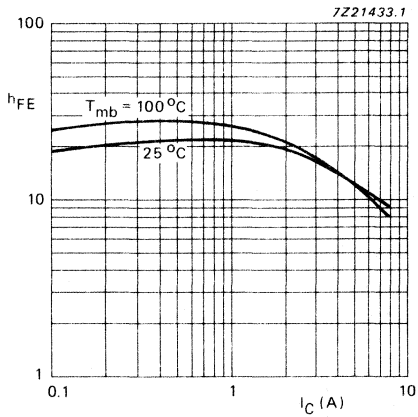


Fig. 11 Typical DC current gain; $V_{CE} = 5\text{ V}$.

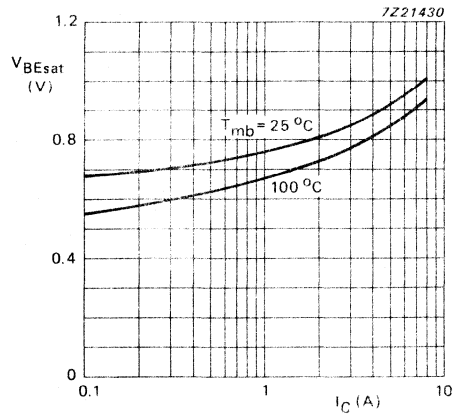


Fig. 12 Base-emitter saturation voltage
 as a function of collector
 current; $I_C/I_B = 10$.

DEVELOPMENT DATA

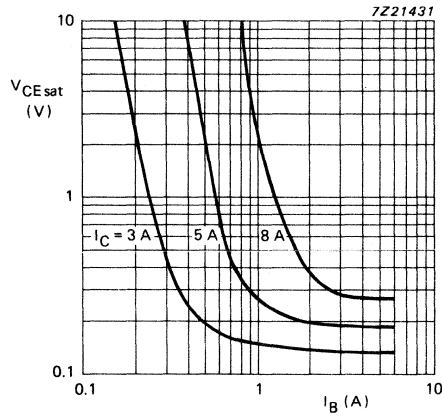


Fig. 13 Collector-emitter voltage as a function of base current; $T_{mb} = 25^\circ\text{C}$.

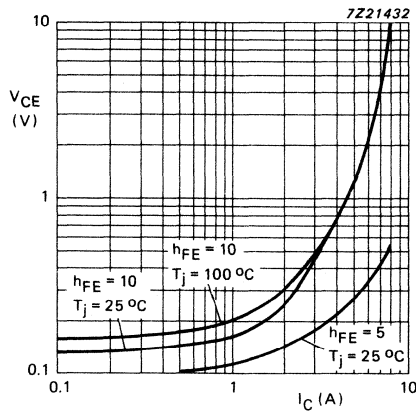


Fig. 14 Collector-emitter voltage as a function of collector current.

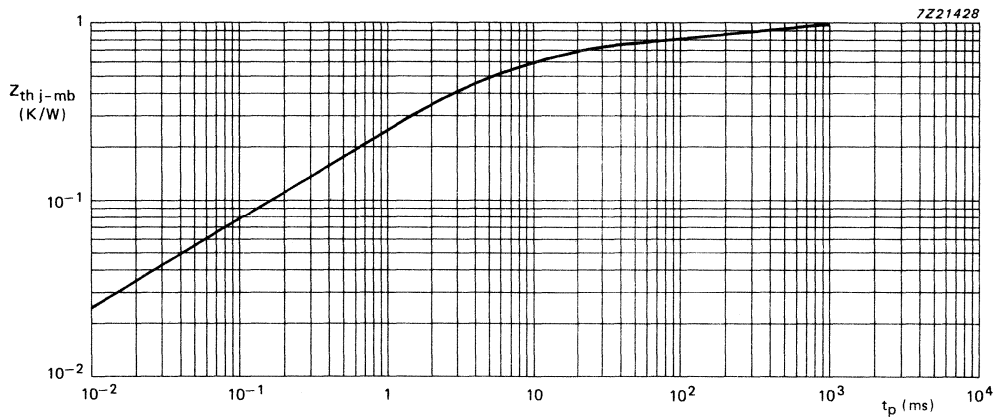


Fig. 15 Transient thermal impedance; (normalized).

DEVELOPMENT DATA

This data sheet contains advance information and specifications are subject to change without notice.

BUS133 SERIES

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.

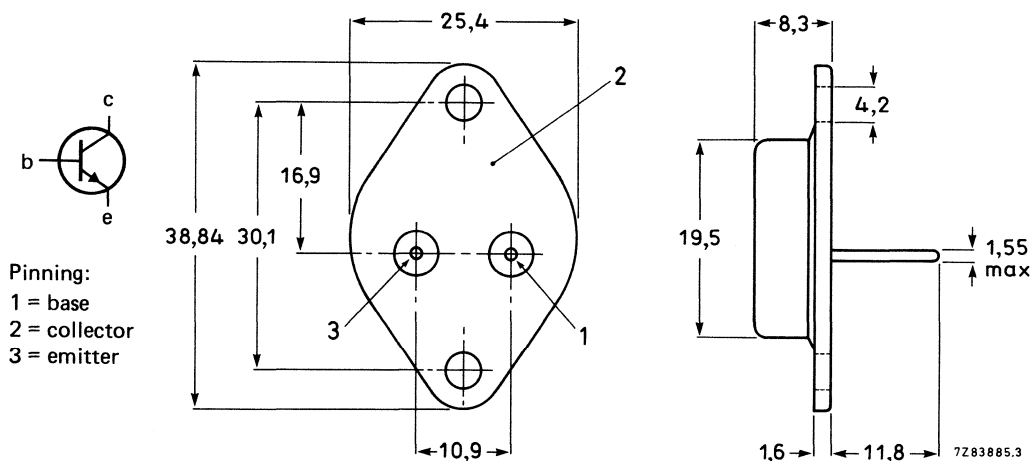
QUICK REFERENCE DATA

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

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)

			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	$R_{th\ j-mb}$	=		1.0	K/W

CHARACTERISTICS

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

Collector cut-off current*

 $V_{CE} = V_{CESMmax}; V_{BE} = -1.5\text{ V}$ $V_{CE} = V_{CESMmax}; V_{BE} = -1.5\text{ V}$ $T_j = 100\text{ }^\circ\text{C}$

ICEV max. 0.25 mA

ICEV max. 1.5 mA

Emitter cut-off current

 $V_{EB} = 6.0\text{ V}; I_C = 0$

IEBO max. 1.0 mA

Collector-emitter sustaining voltage

 $I_C = 100\text{ mA}; I_B = 0; L = 10\text{ mH}$

VCEOsust min. 450 500 450 V

Saturation voltage

 $T_{mb} = 25\text{ }^\circ\text{C}$ and $100\text{ }^\circ\text{C}$ $I_C = 5\text{ A}; I_B = 0.7\text{ A}$ (BUS133) $I_C = 5\text{ A}; I_B = 1.0\text{ A}$ (BUS133A) $I_C = 5\text{ A}; I_B = 0.5\text{ A}$ (BUS133H)

VCEsat max. 2.5 1.0 2.5 V

 $I_C = 10\text{ A}; I_B = 1.3\text{ A}$ (BUS133) $I_C = 10\text{ A}; I_B = 2.0\text{ A}$ (BUS133A) $I_C = 10\text{ A}; I_B = 1.0\text{ A}$ (BUS133H)

VCEsat max. 3.0 1.5 3.0 V

VBEsat max. 1.5 1.5 1.5 V

DC current gain

 $I_C = 15\text{ A}; V_{CE} = 5\text{ V}$

hFE min. 5 5 7

Switching times resistive load

(see Figs 4 and 5)

 $I_{C\text{ on}} = 10\text{ A}; I_{B\text{ on}} = 1.3\text{ A}; I_{B\text{ off}} = 2.6\text{ A}$

Turn-on time

ton typ. 0.4 0.45 — μs

Turn-off; storage time

ts typ. 1.3 1.3 — μs

fall time

tf typ. 0.15 0.15 — μs $I_{C\text{ on}} = 10\text{ A}; I_{B\text{ on}} = 1\text{ A}; I_{B\text{ off}} = 2.0\text{ A}$

Turn-on time

ton typ. — — 0.4 μs

Turn-off; storage time

ts typ. — — 1.3 μs

fall time

tf typ. — — 0.15 μs

Switching times inductive load

(see Figs 6 and 7)

 $I_{C\text{ on}} = 10\text{ A}; I_{B\text{ on}} = 1.3\text{ A};$ tsv typ. 0.9 0.9 — μs $V_{BE\text{ off}} = 5\text{ V}; V_{CE(pk)} = 400\text{ V};$ $T_C = 100\text{ }^\circ\text{C}$ tfj typ. 0.05 0.05 — μs tc typ. 0.16 0.16 — μs $I_{C\text{ on}} = 10\text{ A}; I_{B\text{ on}} = 1\text{ A};$ tsv typ. — — 0.65 μs $V_{BE\text{ off}} = 5\text{ V}; V_{CE(pk)} = 400\text{ V};$ $T_C = 100\text{ }^\circ\text{C}$ tfj typ. — — 0.03 μs tc typ. — — 0.15 μs

Output capacitance

 $V_{CB} = 10\text{ V}; I_E = 0; f_{\text{test}} = 1\text{ kHz}$

Cob max. 400 pF

DEVELOPMENT DATA

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

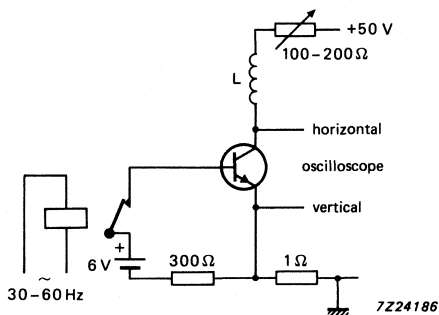


Fig. 2 Test circuit for $V_{CEOsust}$.

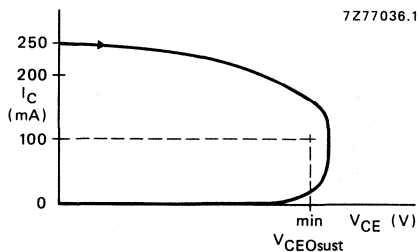


Fig. 3 Oscilloscope display for sustaining voltage.

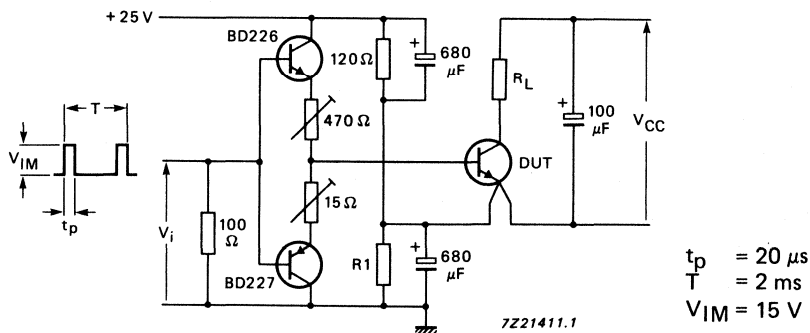
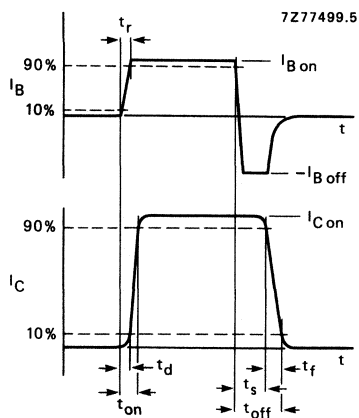


Fig. 4 Test circuit resistive load; $V_{CC} = 250 \text{ V}$;
 $R_L = 25 \Omega$; $R_1 = 39 \Omega$.



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

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

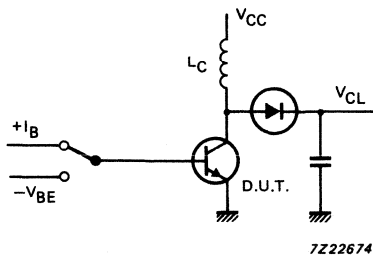


Fig. 6 Test circuit inductive load and RB SOAR; $V_{CC} = 20\text{ V}$; $L_C = 200\ \mu\text{H}$.

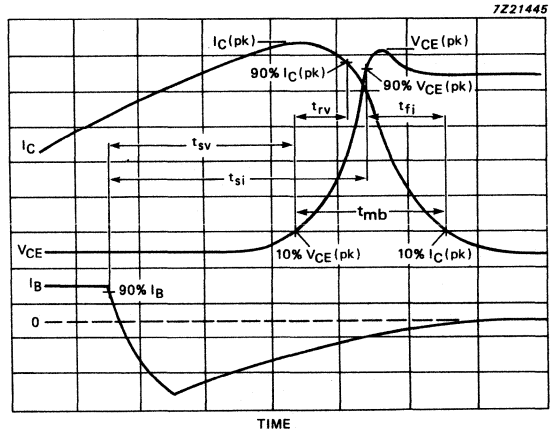


Fig. 7 Switching times waveforms with inductive load.

DEVELOPMENT DATA

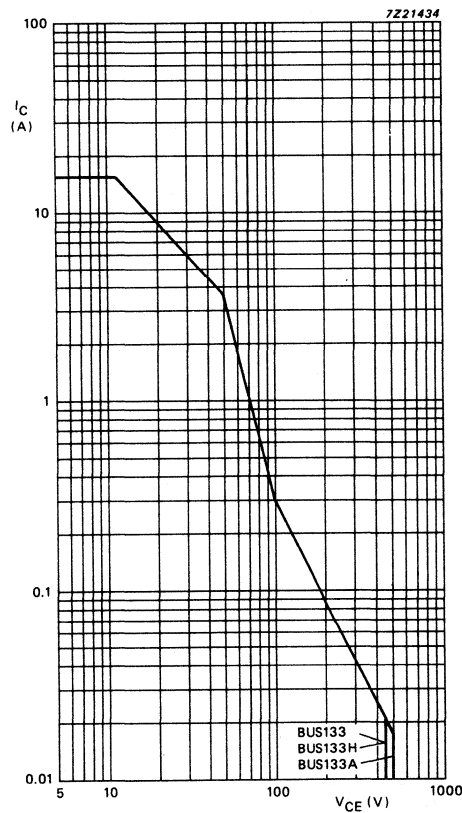


Fig. 8 Forward biased SOAR; $T_{mb} = 25\text{ }^\circ\text{C}$.

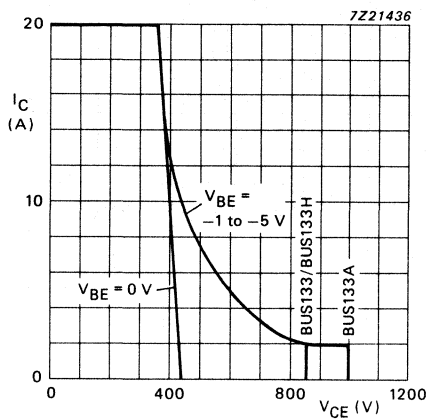


Fig. 9 Reverse bias SOAR; $I_C/I_B = 4$; $T_{mb} = 25\text{ }^\circ\text{C}$.

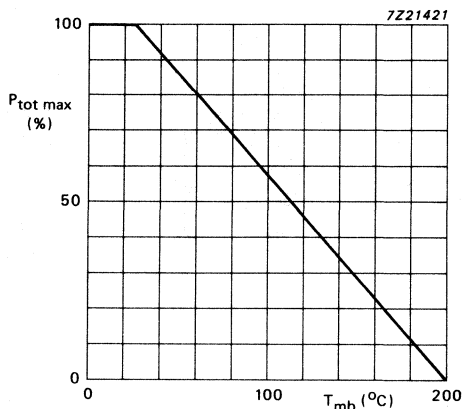


Fig. 10 Power derating curve.

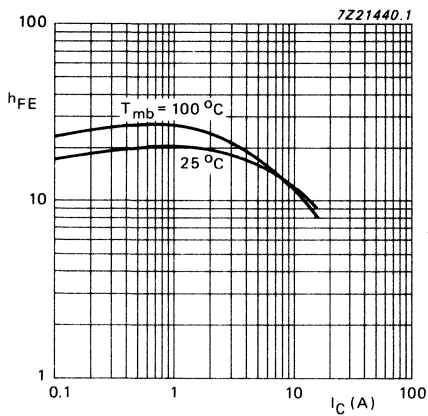


Fig. 11 Typical DC current gain; $V_{CE} = 5\text{ V}$.

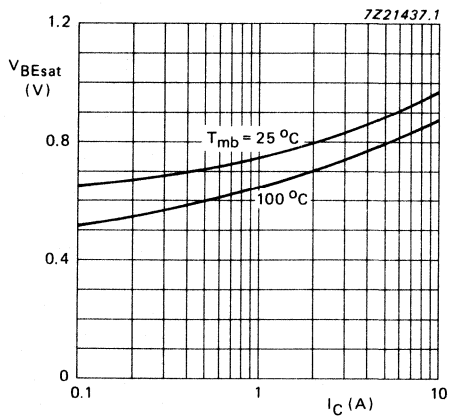


Fig. 12 Base-emitter saturation voltage as a function of collector current; $I_C/I_B = 10$.

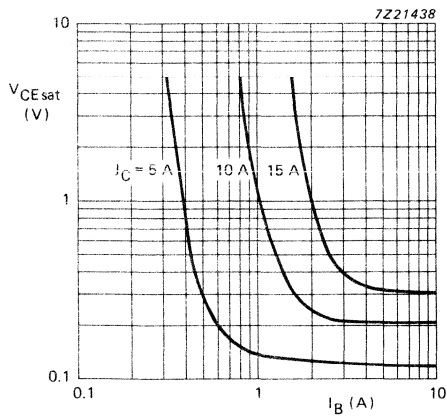


Fig. 13 Collector-emitter saturation voltage as a function of base current; $T_{mb} = 25^\circ\text{C}$.

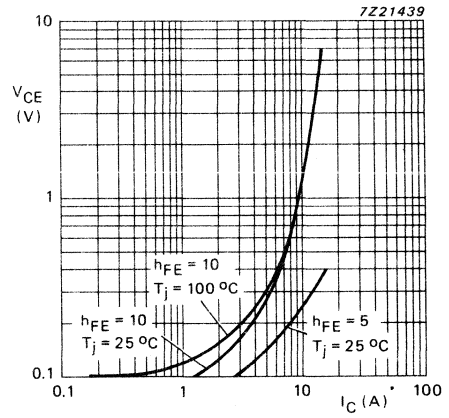


Fig. 14 Collector-emitter voltage as a function of collector current.

DEVELOPMENT DATA

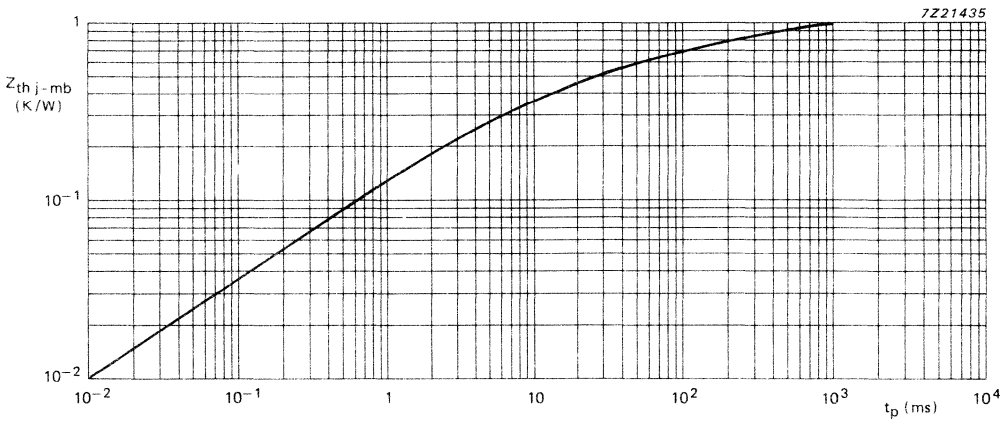


Fig. 15 Transient thermal impedance; (normalized).

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.

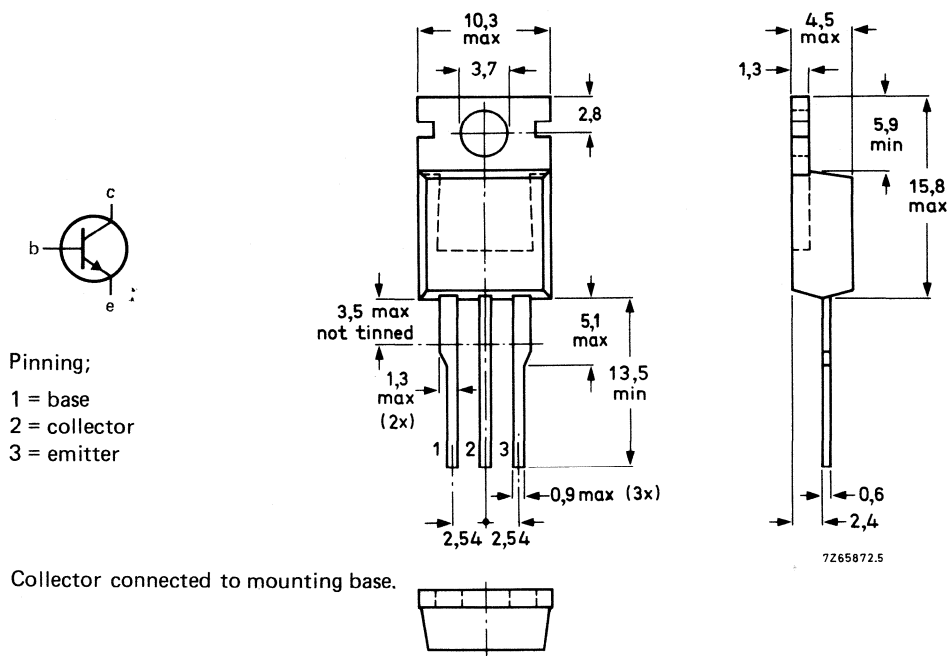
QUICK REFERENCE DATA

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

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-220AB.



RATINGS

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

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

THERMAL RESISTANCE

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

$T_j = 25$ °C unless otherwise specified

Collector cut-off current *

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

Emitter cut-off current

$I_C = 0; V_{EB} = 9$ V	I_{EBO} max.	10	mA
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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	$V_{CEO_{sust}min.}$	400	450 V
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* Measured with a half-sinewave voltage (curve tracer).

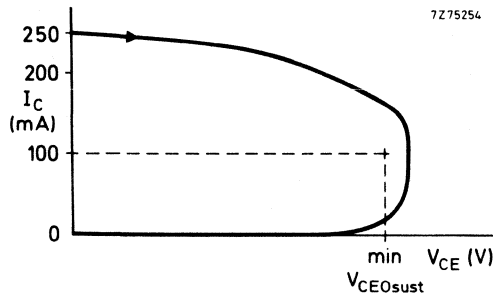


Fig. 2 Oscilloscope display for sustaining voltage.

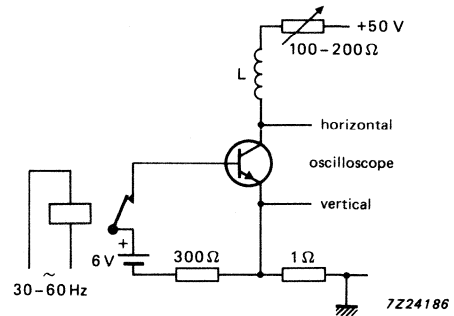


Fig. 3 Test circuit for $V_{CE0sust}$.

Switching times resistive load (Figs 4 and 5)

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

Turn-on time

Turn-off: Storage time

Fall time

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

Turn-on time

Turn-off: Storage time

Fall time

Switching times inductive load (Figs 6 and 7)

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

Turn-off: Storage time

Fall time

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

Turn-off: Storage time

Fall time

Switching times inductive load (Figs 6 and 7)

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

Turn-off: Storage time

Fall time

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

Turn-off: Storage time

Fall time

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

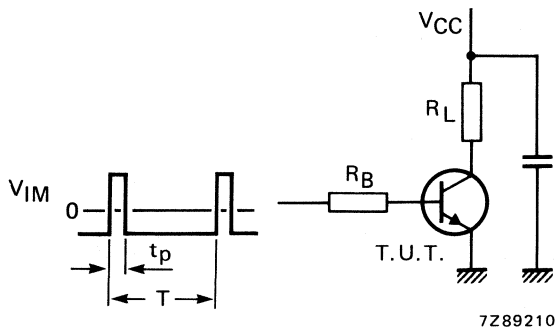


Fig. 4 Test circuit resistive load.

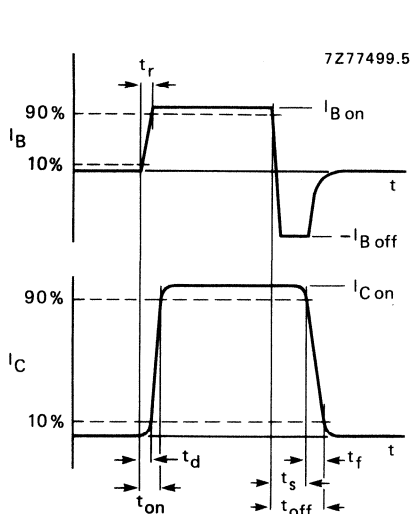


Fig. 5 Switching times waveforms with resistive load.

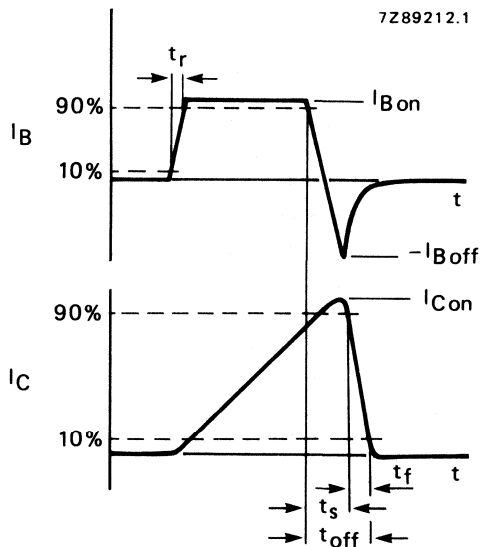


Fig. 6 Switching times waveforms with inductive load.

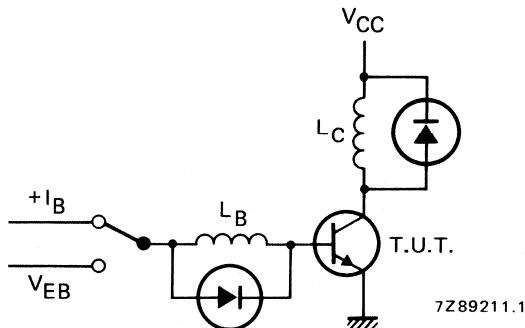
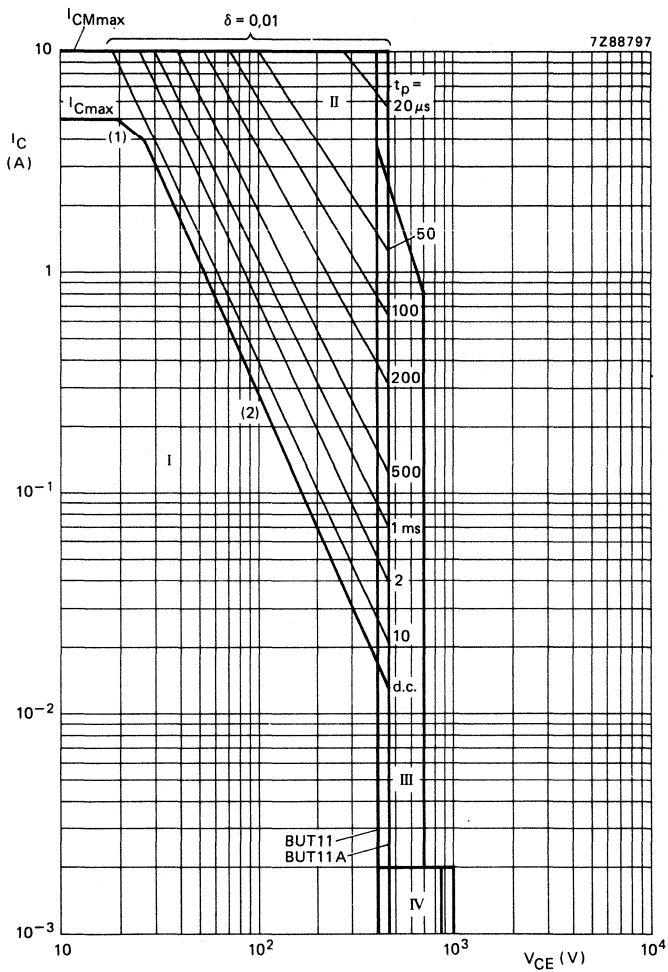


Fig. 7 Test circuit inductive load.



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

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

BUT11
BUT11A

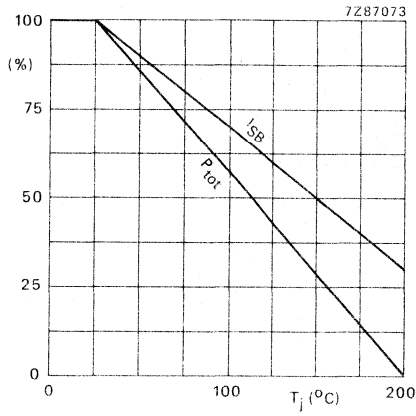


Fig. 9 Total power dissipation and second-breakdown current derating curve.

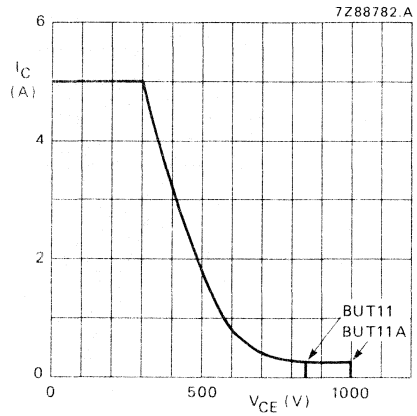


Fig. 10 Reverse bias SOAR.

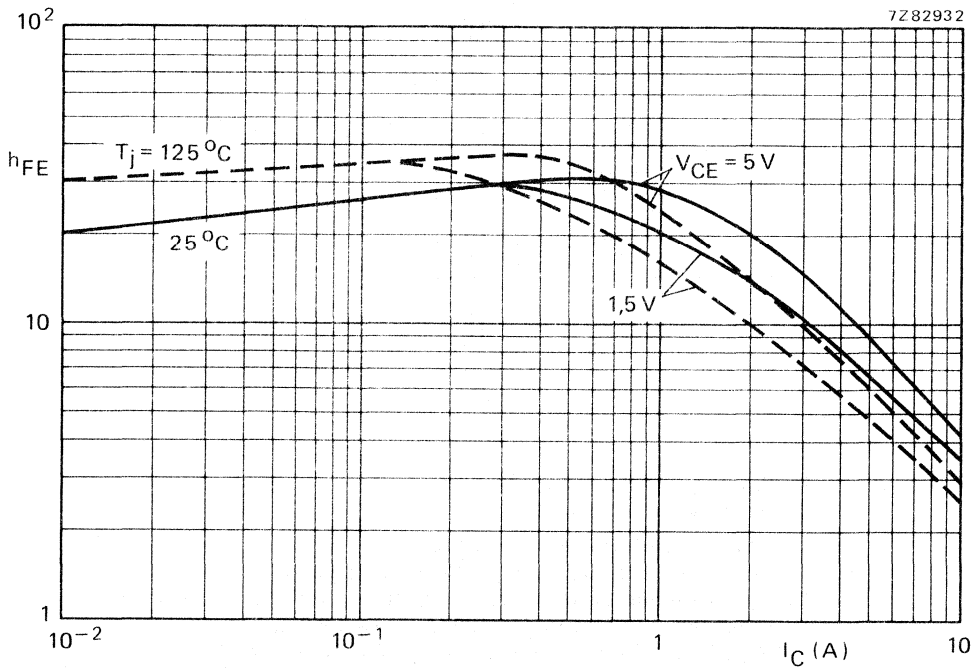


Fig. 11 Typical DC current gain.

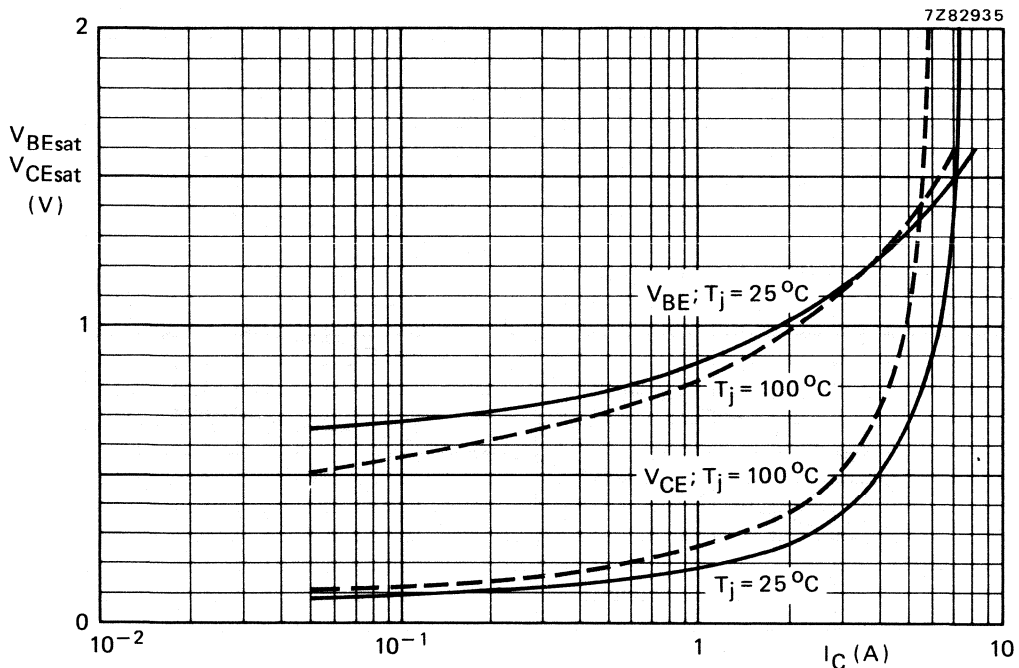


Fig. 12 Typical values base-emitter and collector-emitter voltage, $I_C/I_B = 5$.

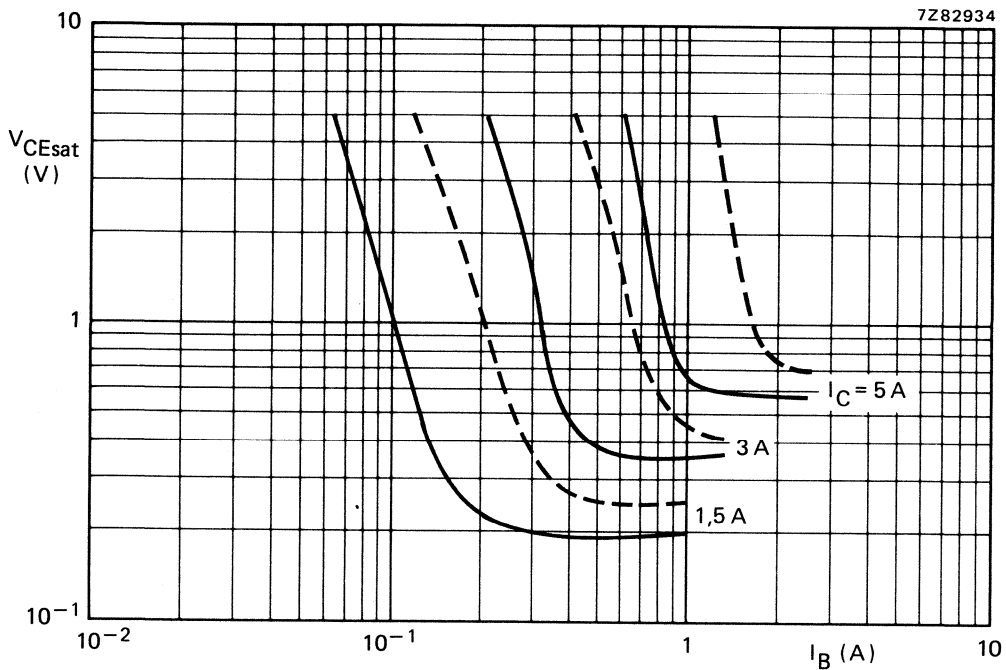


Fig. 13 Typ. (—) and max. (---) values collector-emitter saturation voltage at $T_j = 25^\circ C$.

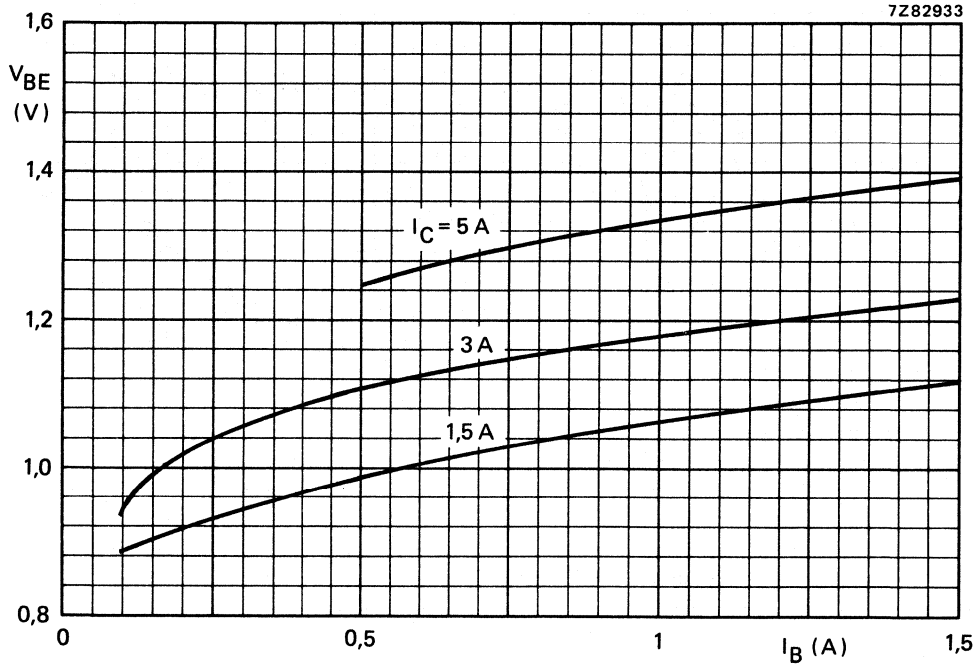


Fig. 14 Typical values at $T_j = 25$ °C.

SILICON DIFFUSED POWER TRANSISTOR

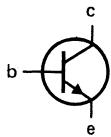
High-voltage, high-speed, glass-passivated npn power transistor in a SOT186 envelope with an electrically insulated mounting base. The device is intended for use in converters, inverters, switching regulators, motor control systems, etc.

QUICK REFERENCE DATA

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

MECHANICAL DATA

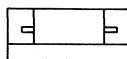
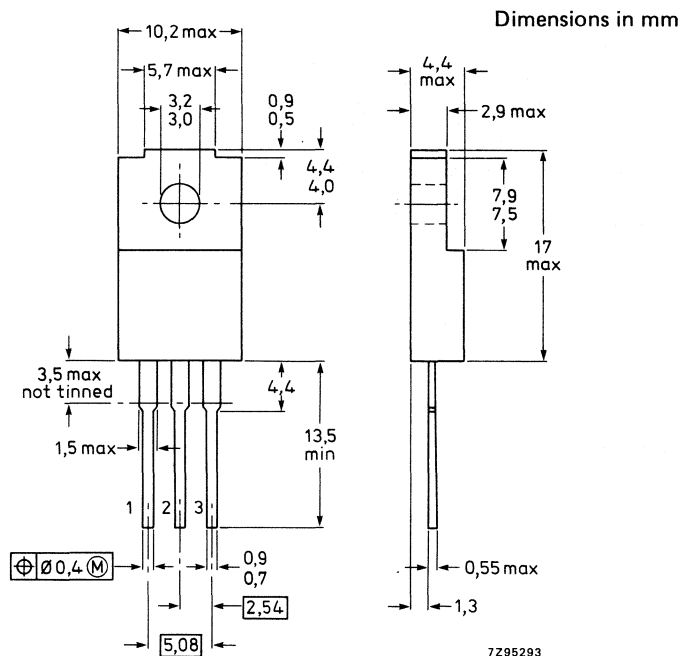
Fig. 1 SOT186.



Pinning;

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

Mounting base is electrically 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
	V_{CESM}	max.	850	1000 V
Collector current DC	I_C	max.	5	A
	I_{CM}	max.	10	A
Base current DC	I_B	max.	2	A
	I_{BM}	max.	4	A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$ (note 1)	P_{tot}	max.	20	W
Storage temperature range	T_{stg}		-65 to +150	$^\circ\text{C}$
Junction temperature	T_j	max.	150	$^\circ\text{C}$

THERMAL RESISTANCE

From junction to internal heatsink	R_{thj-mb}	=	1,45	K/W
From junction to external heatsink (note 1)	R_{thj-h}	=	6,45	K/W
From junction to external heatsink (note 2)	R_{thj-h}	=	3,95	K/W
From junction to ambient	R_{thj-a}	=	55	K/W

ISOLATION

Voltage allowed between all terminals and external heatsink, peak value	V_{isol}	max.	1500	V
Isolation capacitance between collector and external heatsink	C_{isol}	typ.	12	pF

CHARACTERISTICS

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

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

Collector-emitter sustaining voltage

$I_C = 0,1 \text{ A}; I_B = 0; L = 25 \mu\text{H}$
(see Figs 2 and 3)

Saturation voltages

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

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

Switching times resistive load (Figs 4 and 5)

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

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

Switching times inductive load (Figs 6 and 7)

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

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

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

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

		BUT11A	BUT11AF	
$V_{CEOsust}$	min.	400	450	V
V_{CEsat}	max.	1,5	—	V
V_{BEsat}	max.	1,3	—	V
V_{CEsat}	max.	—	1,5	V
V_{BEsat}	max.	—	1,3	V
t_{on}	max.	1	—	μs
t_s	max.	4	—	μs
t_f	max.	0,8	—	μs
t_{on}	max.	—	1	μs
t_s	max.	—	4	μs
t_f	max.	—	0,8	μs
t_s	typ.	1,1	—	μs
	max.	1,4	—	μs
t_f	typ.	80	—	ns
	max.	150	—	ns
t_s	typ.	1,2	—	μs
	max.	1,5	—	μs
t_f	typ.	140	—	ns
	max.	300	—	ns
t_s	typ.	—	1,1	μs
	max.	—	1,4	μs
t_f	typ.	—	80	ns
	max.	—	150	ns
t_s	typ.	—	1,2	μs
	max.	—	1,5	μs
t_f	typ.	—	140	ns
	max.	—	300	ns

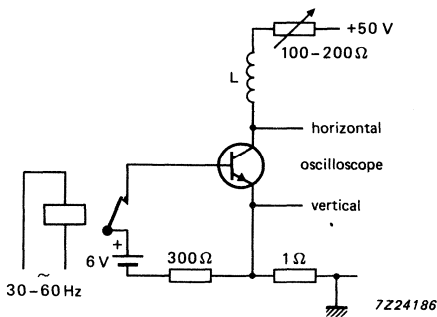


Fig. 2 Test circuit for $V_{CEOsust}$.

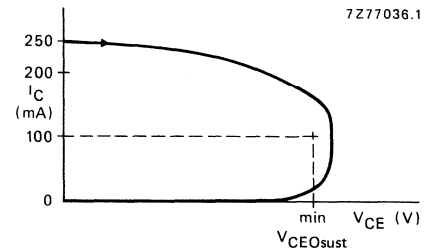


Fig. 3 Oscilloscope display for sustaining voltage.

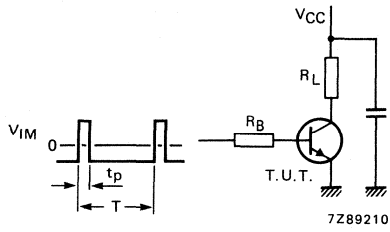


Fig. 4 Test circuit resistive load.

$$V_{CC} = 250 \text{ V}$$

$$V_{IM} = -6 \text{ to } +8 \text{ V}$$

$$t_p = 20 \mu\text{s}$$

$$\frac{t_p}{T} = 0,01$$

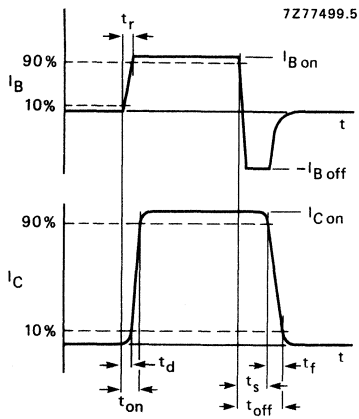


Fig. 5 Switching times waveforms with resistive load.

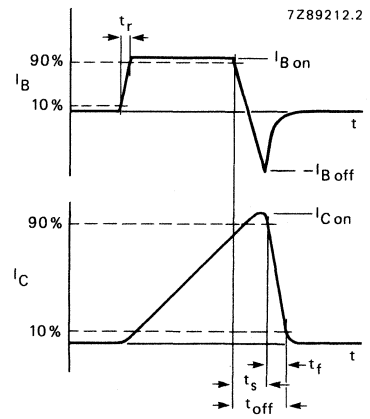


Fig. 6 Switching times waveforms with inductive load.

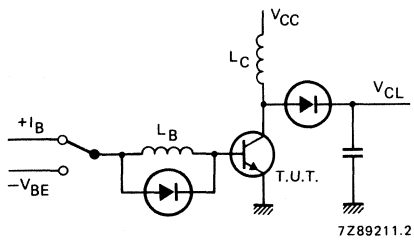


Fig. 7 Test circuit inductive load.

$$V_{CL} = 300 \text{ V}$$

$$V_{CC} = 30 \text{ V}$$

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

$$L_B = 1 \mu\text{H}$$

$$L_C = 200 \mu\text{H}$$

DEVELOPMENT DATA

This data sheet contains advance information and specifications are subject to change without notice.

BUT12
BUT12A

SILICON DIFFUSED POWER TRANSISTORS

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

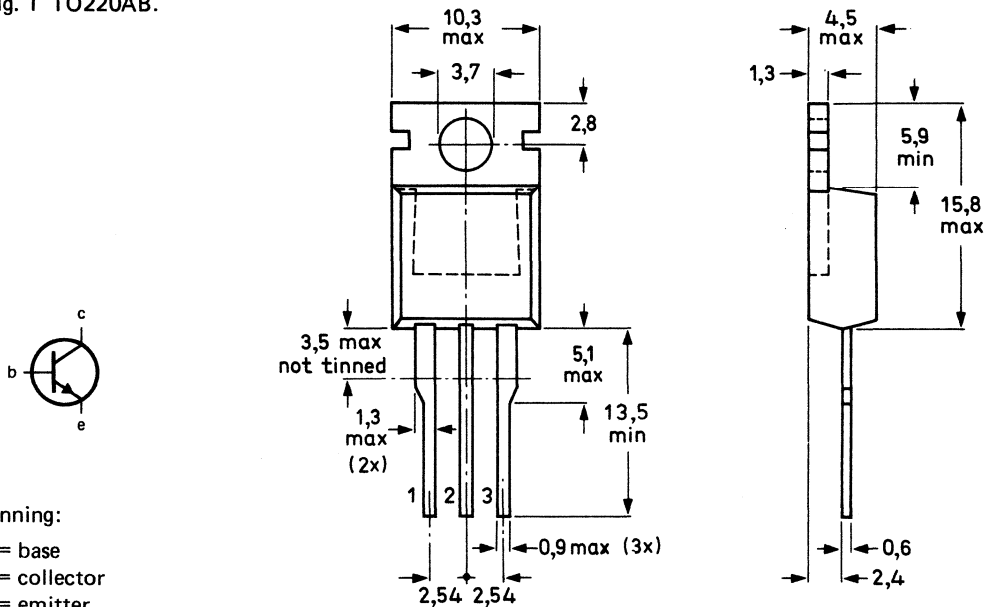
QUICK REFERENCE DATA

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

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO220AB.



Collector connected to mounting base.

BUT12 BUT12A

RATINGS

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

		BUT12	BUT12A
Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM}	max. 850	1000 V
	V_{CEO}	max. 400	450 V
Collector current saturation DC peak value	I_{Csat}	6.0	5.0 A
	I_C	max. 8	A
	I_{CM}	max. 20	A
Base current DC peak value	I_B	max. 4.0	A
	I_{BM}	max. 6.0	A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max. 125	W
Storage temperature range	T_{stg}	-65 to +150	$^\circ\text{C}$
Junction temperature	T_j	max. 150	$^\circ\text{C}$
THERMAL RESISTANCE			
From junction to mounting base	$R_{th\ j-mb}$	=	1.0 K/W

CHARACTERISTICS

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

Collector cut-off currents*

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

 I_{CES} max. 1.0 mA

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

 I_{CES} max. 3.0 mA

Emitter cut-off current

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

 I_{EBO} max. 10 mA

Saturation voltages

$I_C = 6\text{ A}; I_B = 1.2\text{ A}$

 V_{CEsat} max. 1.5 V_{BEsat} max. 1.5

$I_C = 5\text{ A}; I_B = 1.0\text{ A}$

 V_{CEsat} max. — V_{BEsat} max. 1.5 V

Collector-emitter sustaining voltage

(Figs 2 and 3)

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

 $V_{CEOsust}$ min. 400

Switching times resistive load

(Figs 4 and 5)

$I_{C\text{ on}} = 6\text{ A}; I_{B\text{ on}} = -I_{B\text{ off}} = 1.2\text{ A}$

Turn-on time t_{on} max. 1.0 — μs

Turn-off;

storage time

 t_s max. 4.0 — μs

fall time

 t_f max. 0.8 — μs

$I_{C\text{ on}} = 5\text{ A}; I_{B\text{ on}} = -I_{B\text{ off}} = 1.0\text{ A}$

Turn-on time

 t_{on} max. — 1.0 μs

Turn-off;

storage time

 t_s max. — 4.0 μs

fall time

 t_f max. — 0.8 μs

Switching times inductive load

(Figs 5 and 6)

$I_{C\text{ on}} = 6\text{ A}; I_{B\text{ on}} = 1.2\text{ A}$

$V_{CL} = 250\text{ V}; T_c = 100\text{ }^\circ\text{C}$

Turn-off;

storage time

 t_s typ. 1.9 — μs t_s max. 2.5 — μs

fall time

 t_f typ. 200 — ns t_f max. 300 — ns

$I_{C\text{ on}} = 5\text{ A}; I_{B\text{ on}} = 1.0\text{ A}$

$V_{CL} = 300\text{ V}; T_c = 100\text{ }^\circ\text{C}$

Turn-off;

storage time

 t_s typ. — 1.9 μs t_s max. — 2.5 μs

fall time

 t_f typ. — 200 ns t_f max. — 300 ns

DEVELOPMENT DATA

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

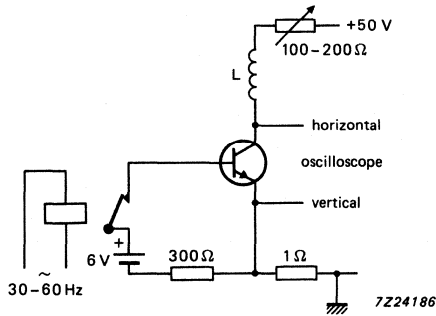


Fig. 2 Test circuit for $V_{CEOsust}$.

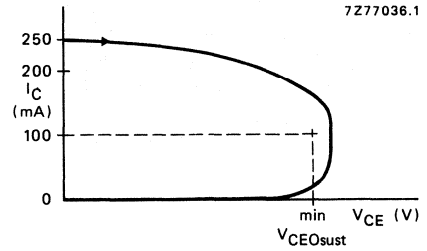
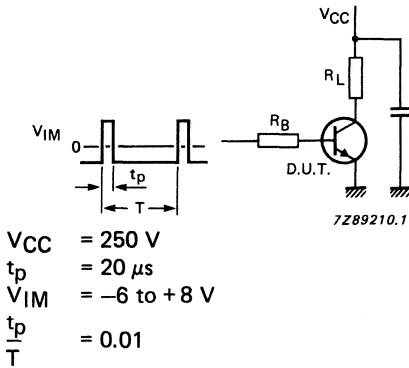


Fig. 3 Oscilloscope display for sustaining voltage.



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

Fig. 4 Test circuit resistive load.

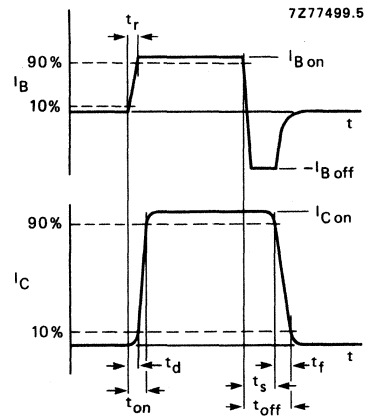
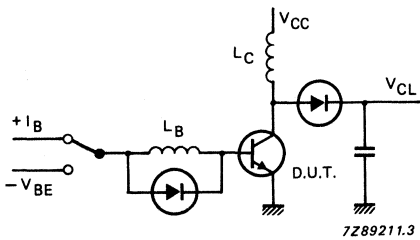


Fig. 5 Switching times waveforms with resistive load; $t_r \leq 20 \text{ ns}$.



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

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

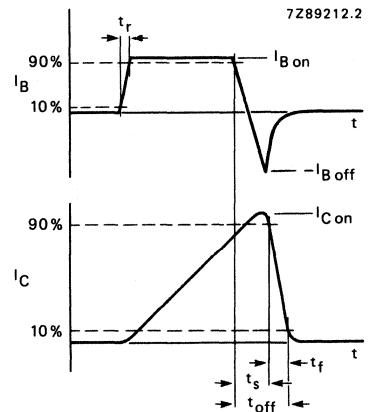
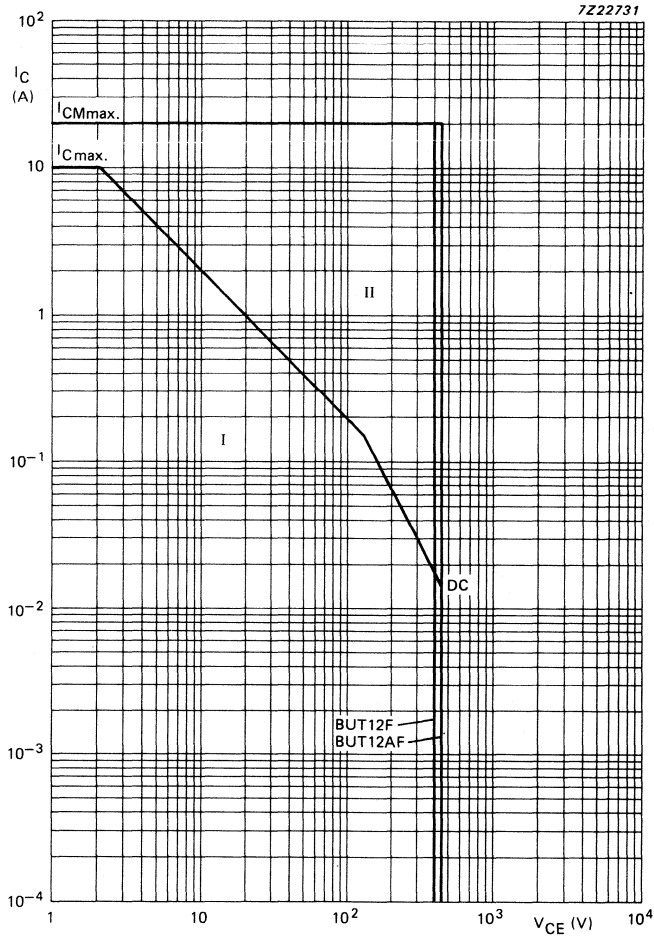


Fig. 7 Switching times waveforms with inductive load.

DEVELOPMENT DATA



- (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 $T_{mb} < 25^\circ\text{C}$.

BUT12
BUT12A

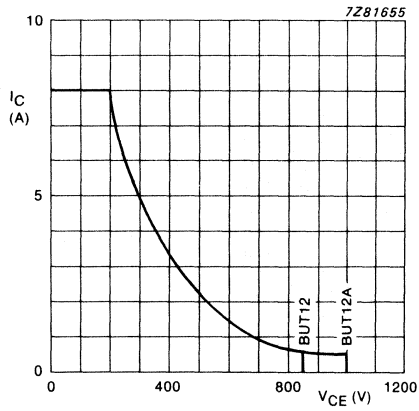


Fig. 9 Reverse bias SOAR; $T_C = 100^\circ\text{C}$;
 $V_{BE} = -1\text{ V to } -5\text{ V}$.

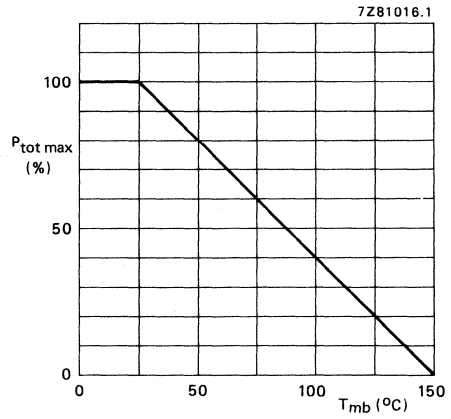


Fig. 10 Power derating curve.

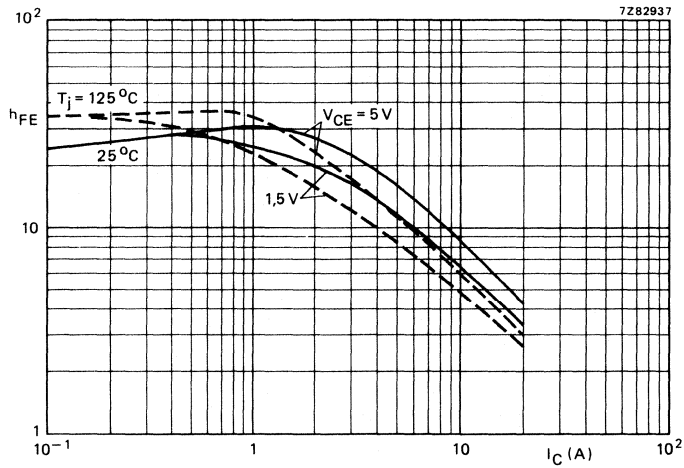


Fig. 11 Typical values DC current gain.

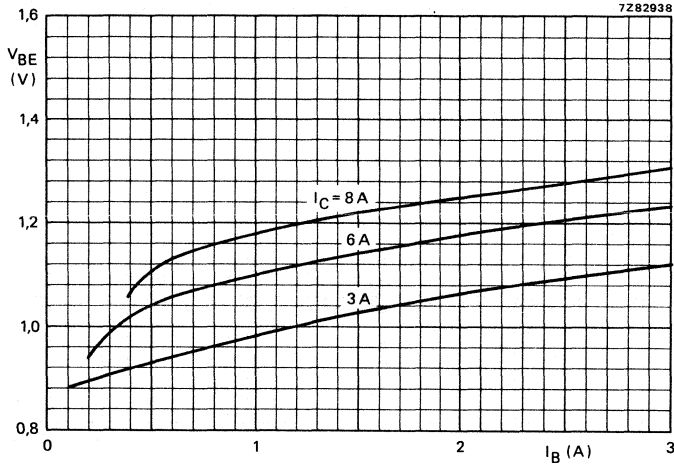


Fig. 12 Base-emitter voltage as a function of base current at $T_j = 25^\circ C$.

DEVELOPMENT DATA

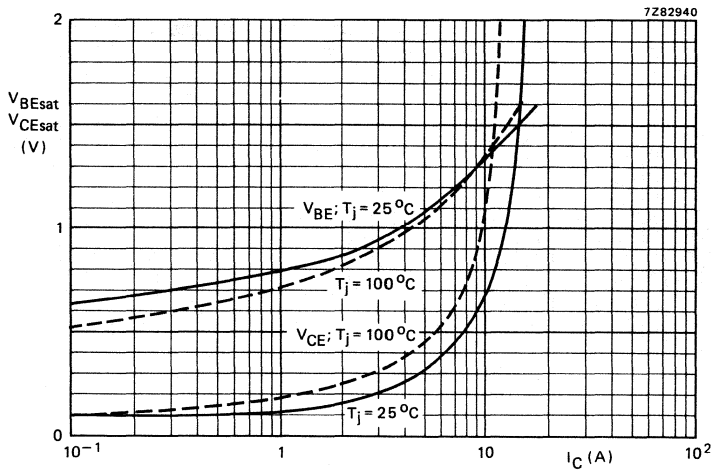


Fig. 13 Typical values base and collector voltage at $I_C/I_B = 5$.

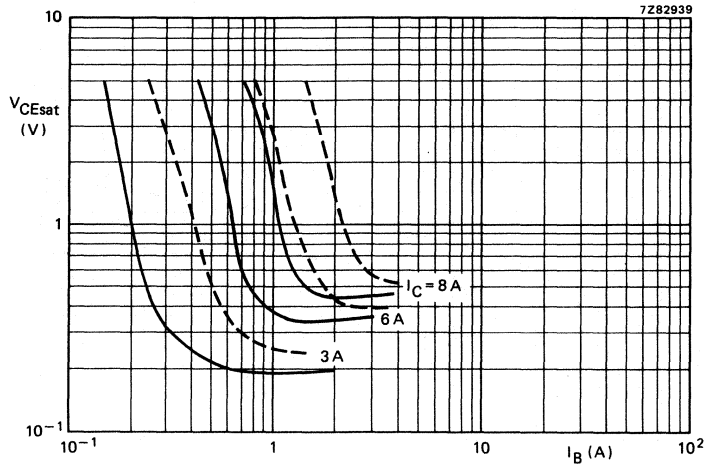


Fig. 14 Typical (—) and max. (---) values collector emitter saturation voltage at $T_j = 25^\circ C$.

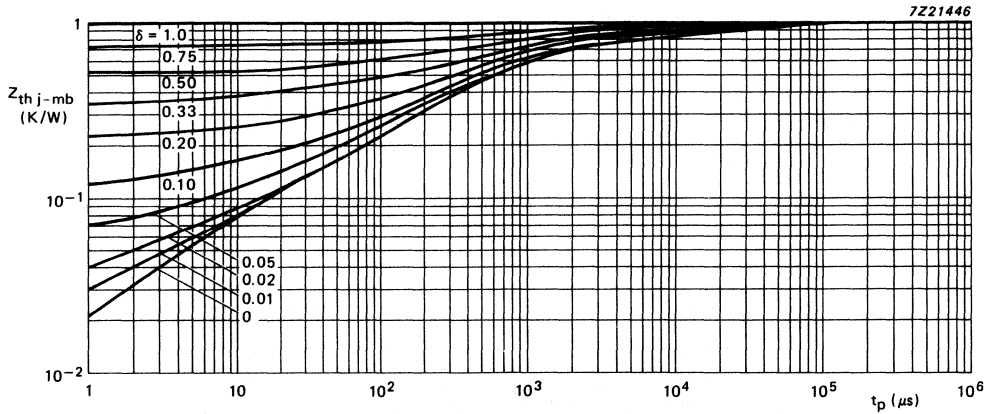


Fig. 15 Thermal response at pulse power conditions.

DEVELOPMENT DATA

This data sheet contains advance information and specifications are subject to change without notice.

BUT12F BUT12AF

SILICON DIFFUSED POWER TRANSISTORS

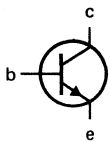
High-voltage, high-speed, glass-passivated npn power transistors in a SOT186 envelope intended for use in converters, inverters, switching regulators, motor control systems, etc.

QUICK REFERENCE DATA

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

MECHANICAL DATA

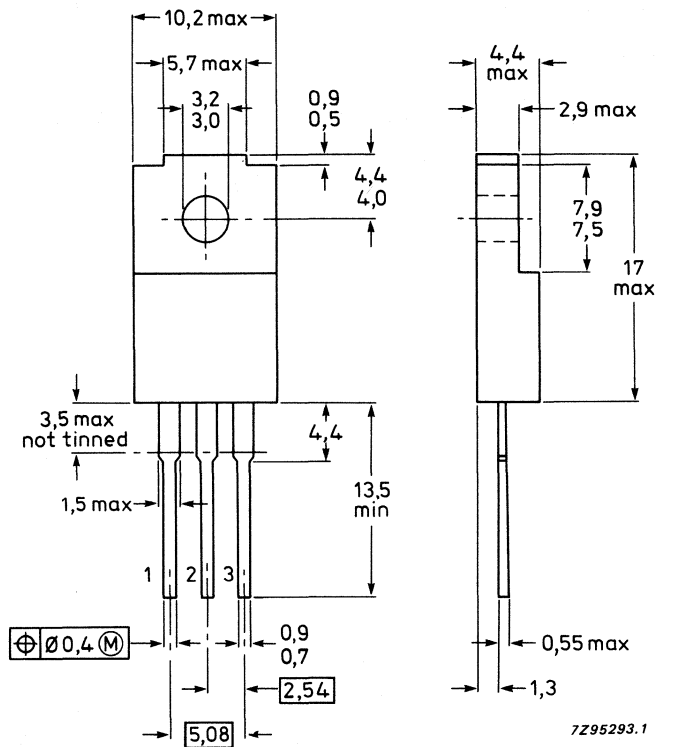
Fig. 1 SOT186.



Pinning:

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

Mounting base is electrically isolated from all terminals.



BUT12F BUT12AF

RATINGS

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

			BUT12F	BUT12AF
Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM}	max.	850	1000 V
	V_{CEO}	max.	400	450 V
Collector current saturation DC peak value	I_{Csat}		6.0	5.0 A
	I_C	max.	8	A
	I_{CM}	max.	20	A
Base current DC peak value	I_B	max.	4.0	A
	I_{BM}	max.	6.0	A
Total power dissipation up to $T_h = 25\text{ }^\circ\text{C}$ (note 1)	P_{tot}	max.	23	W
Storage temperature range	T_{stg}		-65 to +150	$^\circ\text{C}$
Junction temperature	T_j	max.	150	$^\circ\text{C}$
THERMAL RESISTANCE				
From junction to external heatsink (note 1)	$R_{th\ j-h}$	=	5.5	K/W
From junction to external heatsink (note 2)	$R_{th\ j-h}$	=	3.9	K/W
From junction to ambient	$R_{th\ j-a}$	=	55	K/W
ISOLATION				
Isolation voltage from all terminals to external heatsink (peak value)	V_{isol}	max.	1500	V
Isolation capacitance from collector to external heatsink	C_{isol}	max.	12	pF

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

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

Collector cut-off currents*

$V_{CE} = V_{CEs\max}; V_{BE} = 0$

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

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

Emitter cut-off current

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

I_{EBO}	max.	10	mA
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Saturation voltages

$I_C = 6\text{ A}; I_B = 1.2\text{ A}$

		BUT12F	BUT12AF
V_{CEsat}	max.	1.5	— V
V_{BEsat}	max.	1.5	— V

$I_C = 5\text{ A}; I_B = 1.0\text{ A}$

V_{CEsat}	max.	—	1.5 V
V_{BEsat}	max.	—	1.5 V

Collector-emitter sustaining voltage

(Figs 2 and 3)

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

$V_{CEOsust}$	min.	400	450 V
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Switching times resistive load

(Figs 4 and 5)

$I_{C\text{ on}} = 6\text{ A}; I_{B\text{ on}} = -I_{B\text{ off}} = 1.2\text{ A}$

Turn-on time

t_{on}	max.	1.0	— μs
----------	------	-----	-----------------

Turn-off;

storage time

fall time

t_s	max.	4.0	— μs
t_f	max.	0.8	— μs

$I_{C\text{ on}} = 5\text{ A}; I_{B\text{ on}} = -I_{B\text{ off}} = 1.0\text{ A}$

Turn-on time

t_{on}	max.	—	1.0 μs
----------	------	---	-------------------

Turn-off;

storage time

fall time

t_s	max.	—	4.0 μs
t_f	max.	—	0.8 μs

Switching times inductive load

(Figs 5 and 6)

$I_{C\text{ on}} = 6\text{ A}; I_{B\text{ on}} = 1.2\text{ A}$

$V_{CL} = 250\text{ V}; T_c = 100\text{ }^\circ\text{C}$

Turn-off;

storage time

fall time

t_s	typ.	1.9	— μs
t_s	max.	2.5	— μs
t_f	typ.	200	— ns
t_f	max.	300	— ns

$I_{C\text{ on}} = 5\text{ A}; I_{B\text{ on}} = 1.0\text{ A}$

$V_{CL} = 300\text{ V}; T_c = 100\text{ }^\circ\text{C}$

Turn-off;

storage time

fall time

t_s	typ.	—	1.9 μs
t_s	max.	—	2.5 μs
t_f	typ.	—	200 ns
t_f	max.	—	300 ns

DEVELOPMENT DATA

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

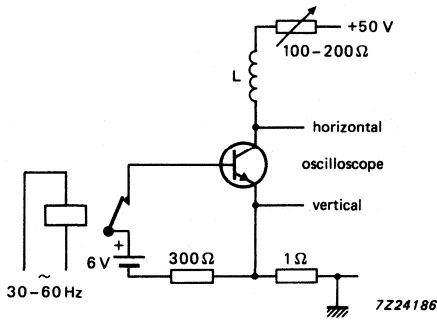


Fig. 2 Test circuit for $V_{CEOsust}$.

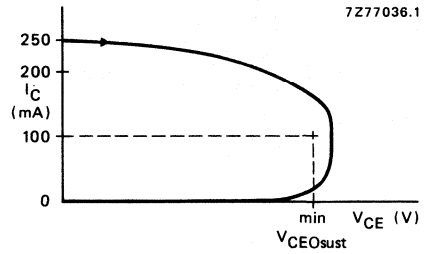
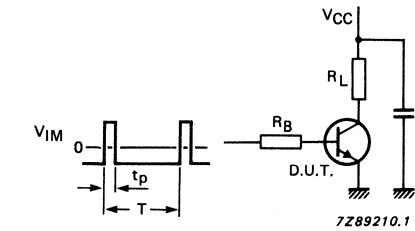


Fig. 3 Oscilloscope display for sustaining voltage.



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

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

Fig. 4 Test circuit resistive load.

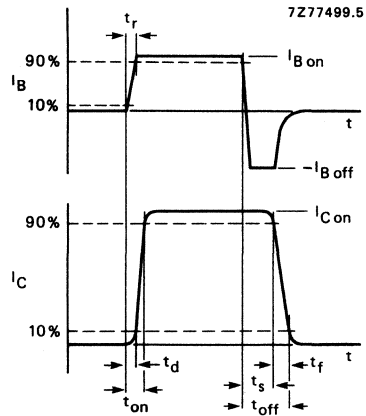
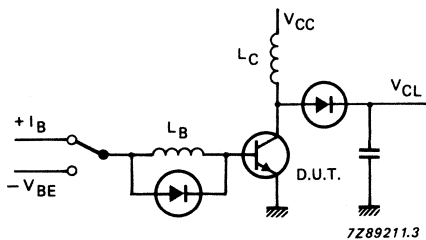


Fig. 5 Switching times waveforms with resistive load; $t_r \leq 20 \text{ ns}$.



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

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

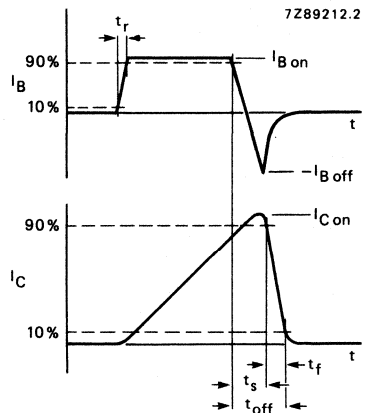
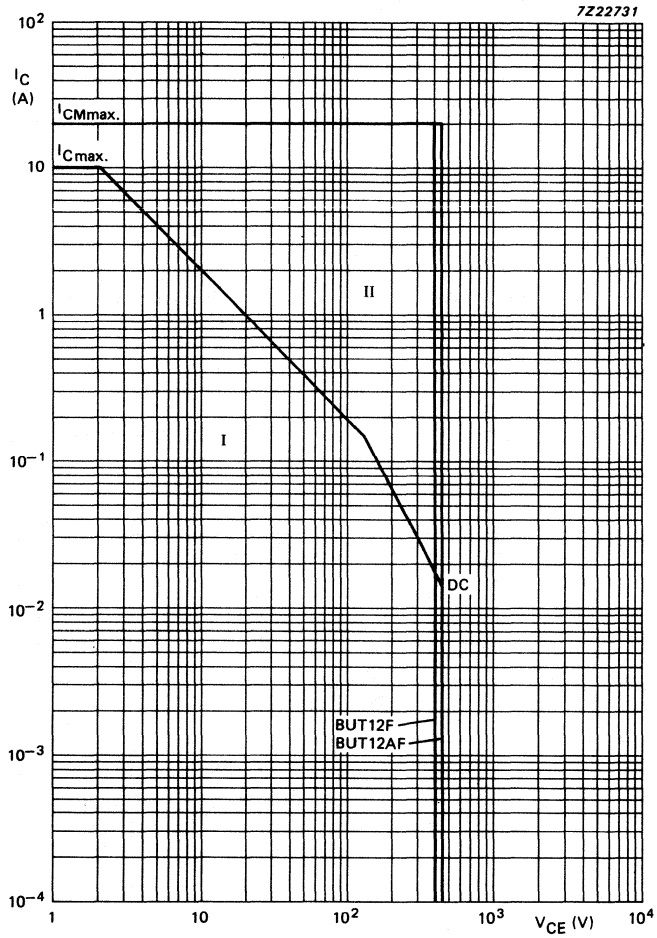


Fig. 7 Switching times waveforms with inductive load.

DEVELOPMENT DATA



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

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

BUT12F BUT12AF

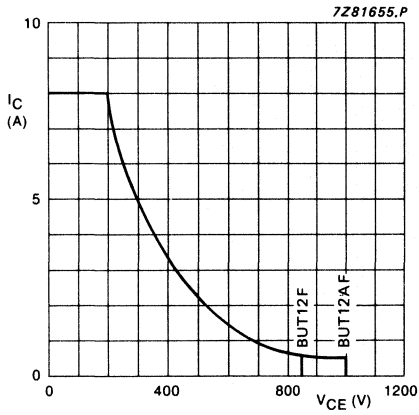


Fig. 9 Reverse bias SOAR; $T_{mb} = 100\text{ }^{\circ}\text{C}$;
 $V_{BE} = -1\text{ V to } -5\text{ V}$.

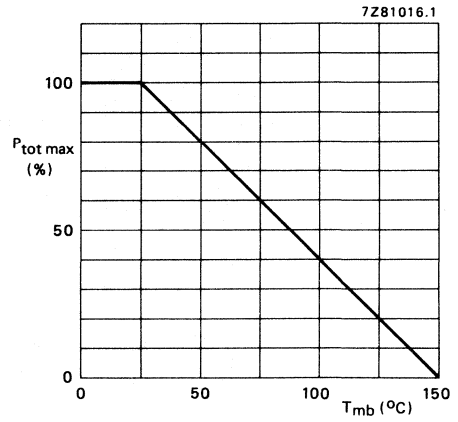


Fig. 10 Power derating curve.

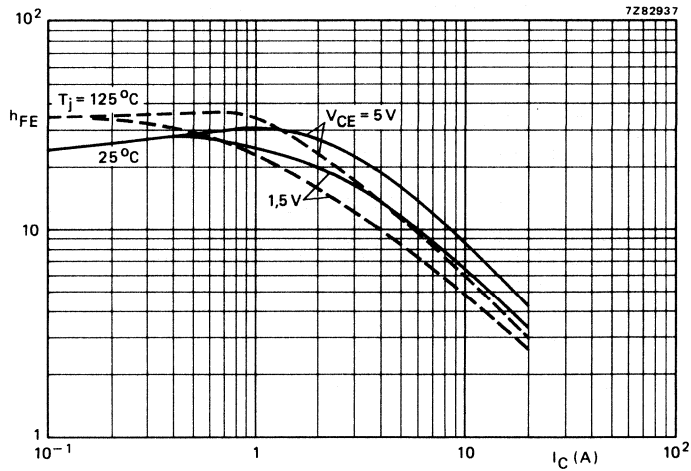


Fig. 11 Typical values DC current gain.

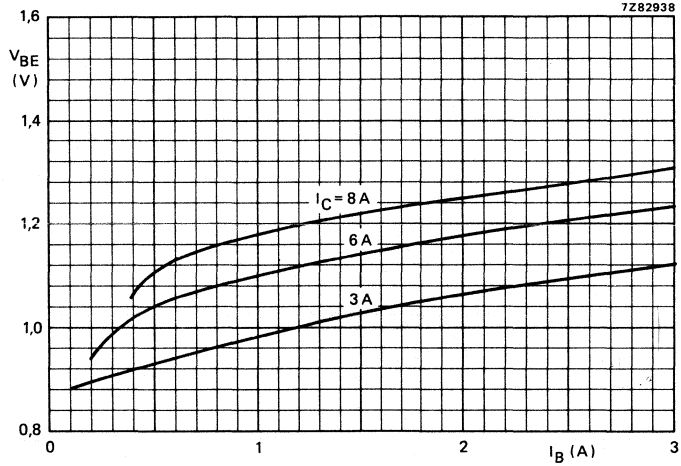


Fig. 12 Base-emitter voltage as a function of base current at $T_j = 25^\circ\text{C}$.

DEVELOPMENT DATA

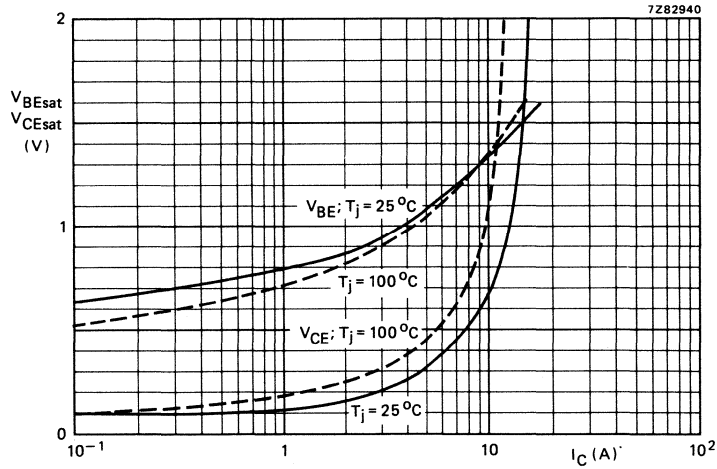


Fig. 13 Typical values base and collector voltage at $I_C/I_B = 5$.

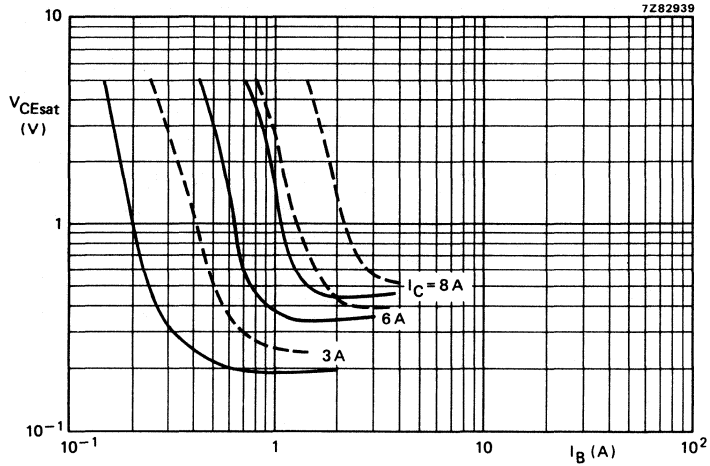


Fig. 14 Typical (—) and max. (---) values collector emitter saturation voltage at $T_j = 25^\circ\text{C}$.

DEVELOPMENT DATA

This data sheet contains advance information and specifications are subject to change without notice.

**BUT18
BUT18A**

SILICON DIFFUSED POWER TRANSISTORS

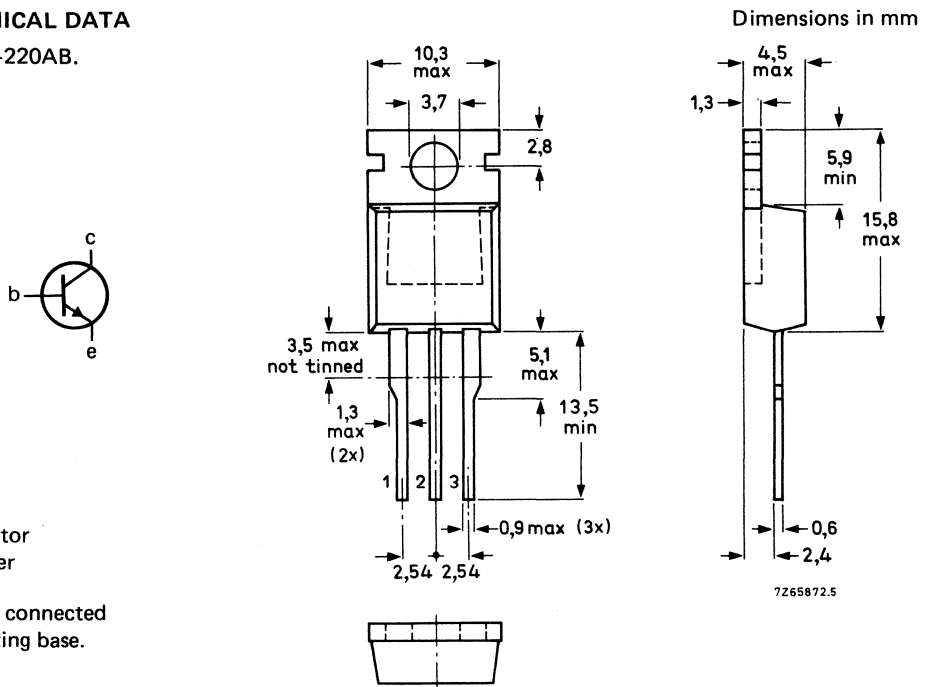
High-voltage, high-speed, glass-passivated npn power transistors in a TO-220 envelope, intended for use in converters, inverters, switching regulators, motor control systems, etc.

QUICK REFERENCE DATA

			BUT18	BUT18A
Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM}	max.	850	1000 V
	V_{CEO}	max.	400	450 V
Collector-emitter saturation voltage	V_{CEsat}	max.	1.5	V
Collector current saturation DC peak value	I_{Csat}		4.0	A
	I_C	max.	6.0	A
	I_{CM}	max.	12	A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	110	W
Fall time	t_f	max.	0.8	μs

MECHANICAL DATA

Fig. 1 TO-220AB.



Pinning:

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

Collector connected
to mounting base.

BUT18 BUT18A

RATINGS

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

		BUT18	BUT18A
Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM}	max. 850	1000 V
	V_{CEO}	max. 400	450 V
Collector current	saturation		4.0 A
	DC	I_C max.	6.0 A
	peak value	I_{CM} max.	12 A
Base current	DC	I_B max.	3.0 A
	peak value	I_{BM} max.	6.0 A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot} max.	110	W
Storage temperature range	T_{stg}	-65 to + 150 $^\circ\text{C}$	
Junction temperature	T_j max.	150	$^\circ\text{C}$
THERMAL RESISTANCE			
From junction to mounting base	$R_{th\ j-mb}$	=	1.15 K/W

CHARACTERISTICS

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

Collector cut-off currents*

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

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

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

Emitter cut-off current

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

I_{EBO}	max.	10	mA
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Collector-emitter sustaining voltage

$I_C = 0.1\text{ A}; I_{B\text{ off}} = 0; L = 25\text{ mH}$ (Figs 2 and 3)

		BUT18	BUT18A
$V_{CEOsust}$	min.	400	450 V

Saturation voltages

$I_C = 4\text{ A}; I_B = 0.8\text{ A}$

V_{CEsat}	max.	1.5	V
V_{BEsat}	max.	1.3	V

Current gain

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

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

h_{FE}	min.	10	
h_{FE}	typ.	25	

Switching times resistive load (Figs 4 and 5)

$I_{C\text{ on}} = 4\text{ A}; I_{B\text{ on}} = -I_{B\text{ off}} = 0.8\text{ A}$

Turn-on time

t_{on}	max.	1.0	μs
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Turn-off; storage time

t_s	max.	4.0	μs
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fall time

t_f	max.	0.8	μs
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Switching times inductive load (Figs 6 and 7)

$I_{C\text{ on}} = 4\text{ A}; I_{B\text{ on}} = 0.8\text{ A}; V_{CL} = 250\text{ V}$

Turn-off; storage time

t_s	typ.	1.6	μs
t_s	max.	2.5	μs

fall time

t_f	typ.	150	ns
t_f	max.	400	ns

DEVELOPMENT DATA

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

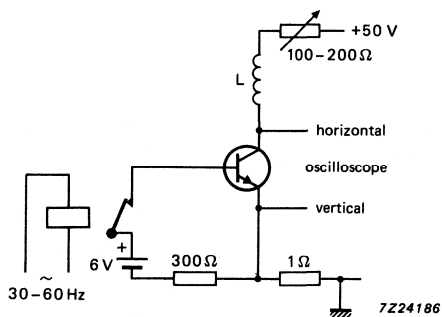


Fig. 2 Test circuit for $V_{CEOsust}$.

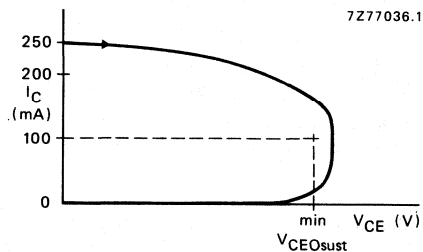
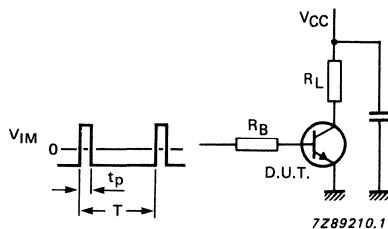


Fig. 3 Oscilloscope display for sustaining voltage.



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

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

Fig. 4 Test circuit resistive load.

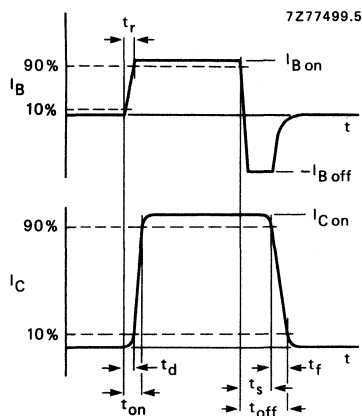
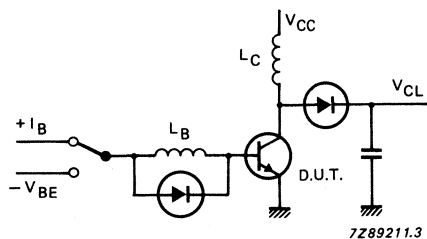


Fig. 5 Switching times waveforms with resistive load; $t_r \leq 30 \text{ ns}$.



$V_{CL} = \text{up to } 1000 \text{ V}$
 $V_{CC} = 30 \text{ V}$
 $-V_{BE} = 5 \text{ V}$
 $L_B = 1 \mu\text{H}$ (0 for R_B SOAR)
 $L_C = 200 \mu\text{H}$

Fig. 6 Test circuit inductive load and R_B SOAR.

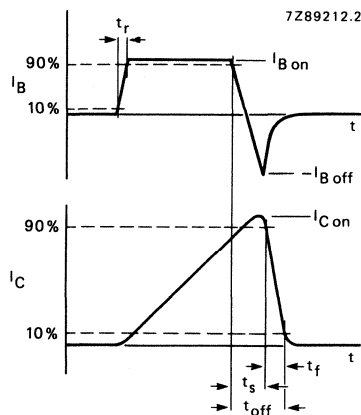
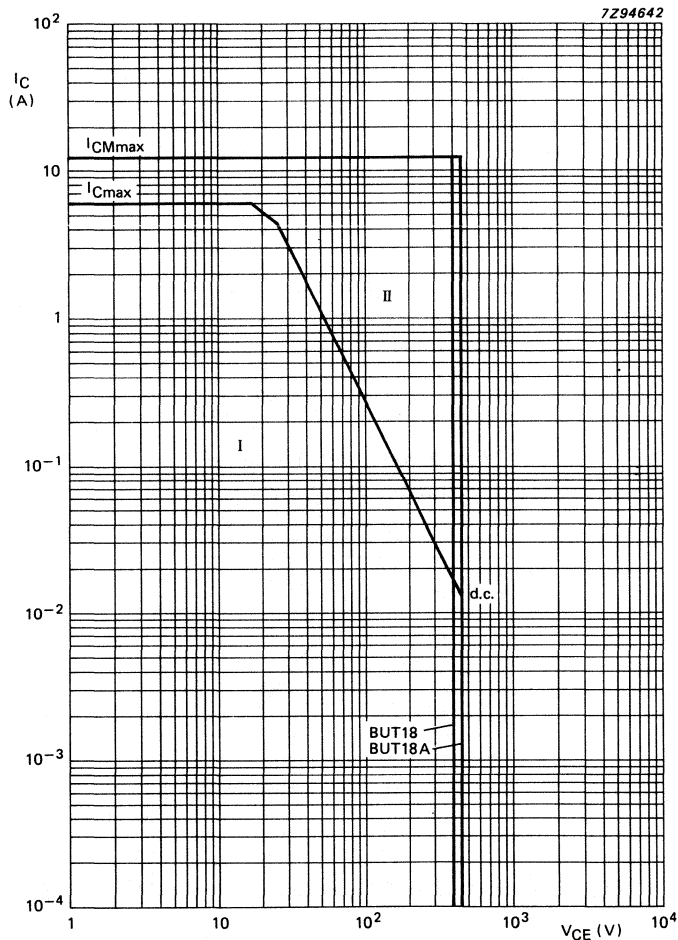


Fig. 7 Switching times waveforms with inductive load.

DEVELOPMENT DATA



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

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

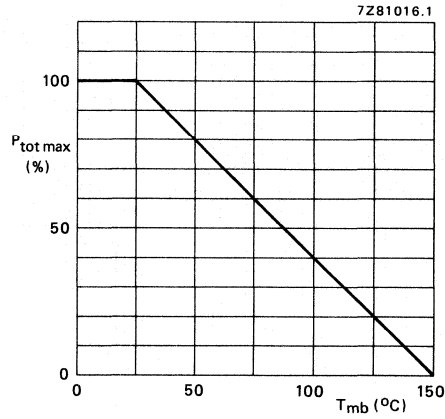


Fig. 9 Power derating curve.

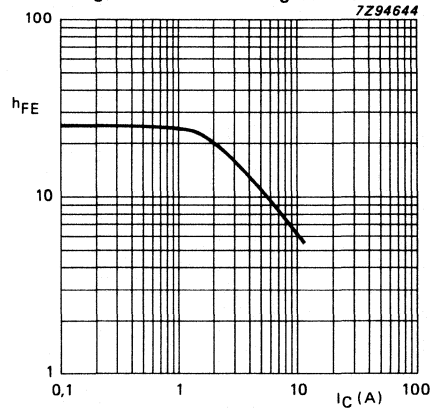


Fig. 10 Typical values DC current gain; $V_{CE} = 5\ V$; $T_j = 25\ ^\circ C$.

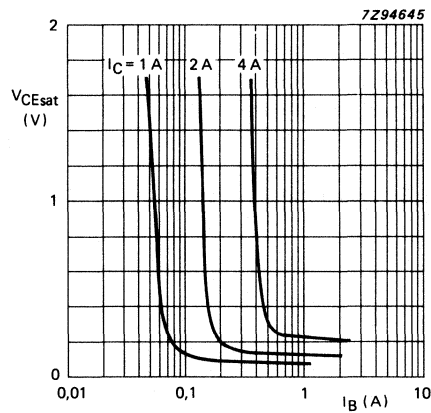


Fig. 11 Collector-emitter saturation voltage as a function of base current; $T_j = 25\ ^\circ C$.

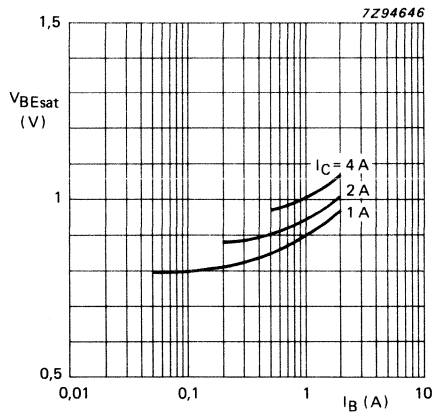


Fig. 12 Base-emitter saturation voltage as a function of base current; $T_j = 25^\circ\text{C}$.

DEVELOPMENT DATA

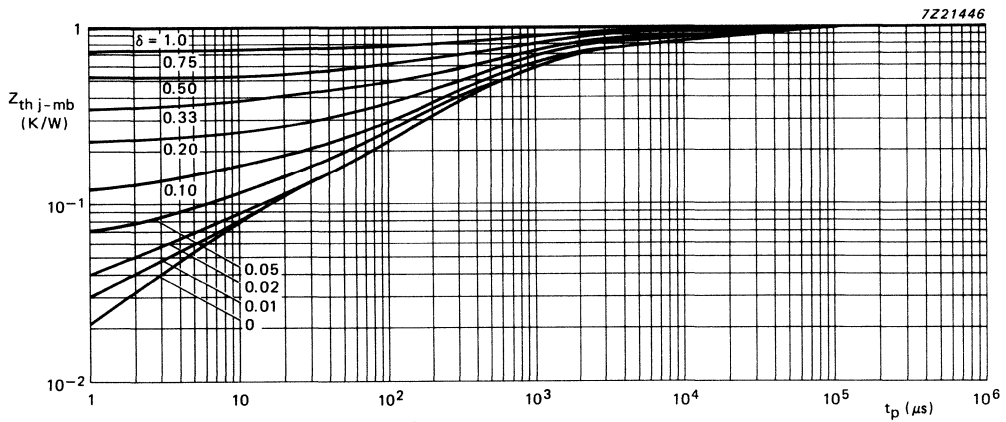


Fig. 13 Thermal response at pulse power conditions.

DEVELOPMENT DATA

This data sheet contains advance information and specifications are subject to change without notice.

BUT18F
BUT18AF

SILICON DIFFUSED POWER TRANSISTORS

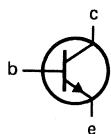
High-voltage, high-speed, glass-passivated npn power transistors in a SOT186 envelope with electrically isolated mounting base, intended for use in converters, inverters, switching regulators, motor control systems etc.

QUICK REFERENCE DATA

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

MECHANICAL DATA

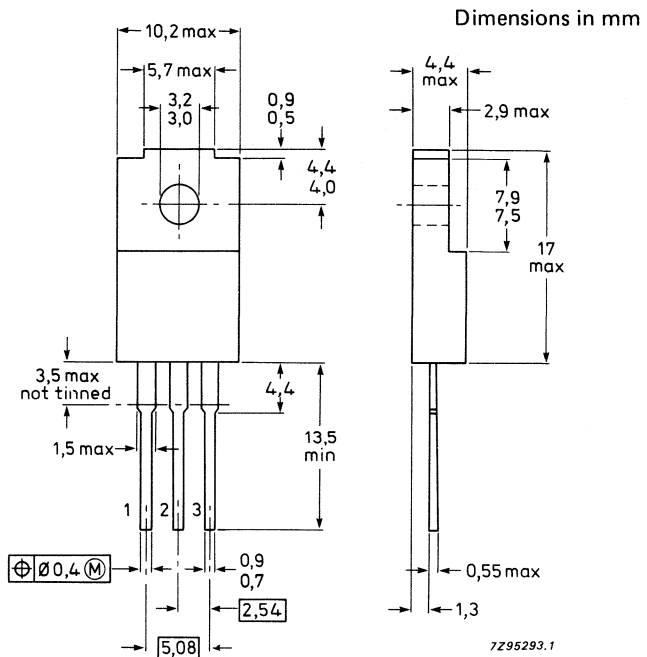
Fig. 1 SOT186.



Pinning:

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

Mounting base is electrically isolated from all terminals.



BUT18F BUT18AF

RATINGS

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

		BUT18F	18AF
Collector-emitter voltage			
peak value; $V_{BE} = 0$	V_{CESM}	max.	850
open base	V_{CEO}	max.	400
Collector current			
saturation	I_{Csat}		4.0
DC	I_C	max.	6.0
peak value	I_{CM}	max.	12
Base current			
DC	I_B	max.	3.0
peak value	I_{BM}	max.	6.0
Total power dissipation			
up to $T_{mb} = 25\text{ }^\circ\text{C}$			
without heatsink compound	P_{tot}	max.	20
with heatsink compound	P_{tot}	max.	33
Storage temperature range	T_{stg}		-65 to + 150
Junction temperature	T_j	max.	150

THERMAL RESISTANCE

From junction to external heatsink (note 1)

 without heatsink compound
 with heatsink compound

$R_{th\ j-h}$	=	6.15	K/W
$R_{th\ j-h}$	=	3.65	K/W

ISOLATION

Isolation voltage from all terminals
 to external heatsink (peak value)

V_{isol}	max.	1500	V
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Isolation capacitance from collector
 to external heatsink

C_{isol}	typ.	12	pF
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Note

1. 30 ± 5 newtons pressure on the centre of the envelope.

CHARACTERISTICS

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

Collector cut-off currents*

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

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

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

Emitter cut-off current

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

I_{EBO}	max.	10	mA
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BUT18F	18AF
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Collector-emitter sustaining voltage (Figs 2 and 3)

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

$V_{CEO\text{ sust}}$	min.	400	450	V
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Saturation voltages

$I_C = 4\text{ A}; I_B = 0.8\text{ A}$

$V_{CE\text{ sat}}$	max.	1.5	V
$V_{BE\text{ sat}}$	max.	1.3	V

Current gain

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

$I_C = 0.4\text{ mA}; V_{CE} = 5\text{ V}$

h_{FE}	min.	10
h_{FE}	typ.	25

Switching times resistive load (Figs 4 and 5)

$I_{C\text{ on}} = 4\text{ A}; I_{B\text{ on}} = -I_{B\text{ off}} = 0.8\text{ A}$

turn-on time

t_{on}	max.	1.0	μs
----------	------	-----	---------------

turn-off; storage time

t_s	max.	4.0	μs
-------	------	-----	---------------

fall time

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

Switching times inductive load (Figs 6 and 7)

$I_{C\text{ on}} = 4\text{ A}; I_{B\text{ on}} = 0.8\text{ A}$

turn-off; storage time

t_s	typ.	1.6	μs
t_s	max.	2.5	μs

fall time

t_f	typ.	150	ns
t_f	max.	400	ns

DEVELOPMENT DATA

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

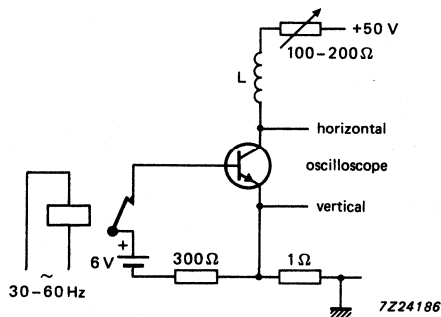


Fig. 2 Test circuit for $V_{CEOsust}$.

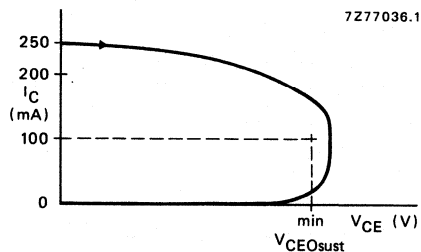
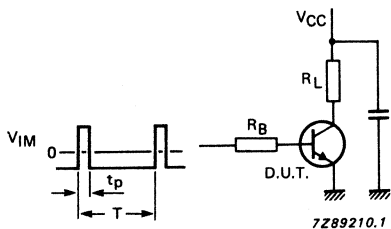


Fig. 3 Oscilloscope display for sustaining voltage.



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

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

Fig. 4 Test circuit resistive load.

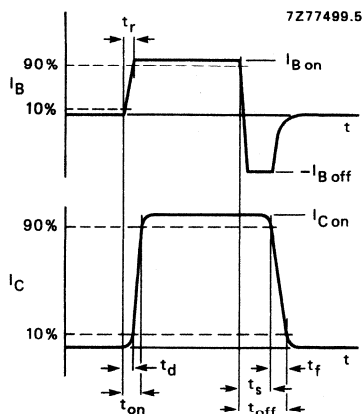
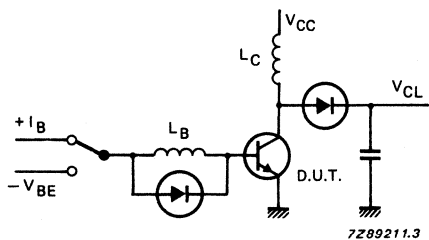


Fig. 5 Switching times waveforms with resistive load; $t_r \leq 20 \text{ ns}$.



$V_{CL} = 300 \text{ V}$
 $V_{CC} = 30 \text{ V}$
 $-V_{BE} = 5 \text{ V}$
 $L_B = 1 \mu\text{H}$
 $L_C = 200 \mu\text{H}$

Fig. 6 Test circuit inductive load.

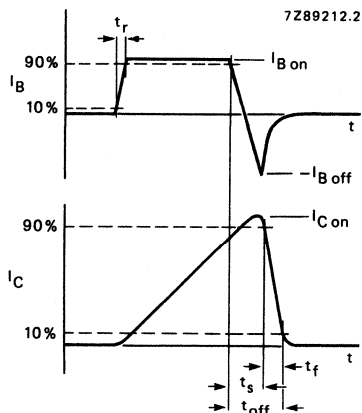
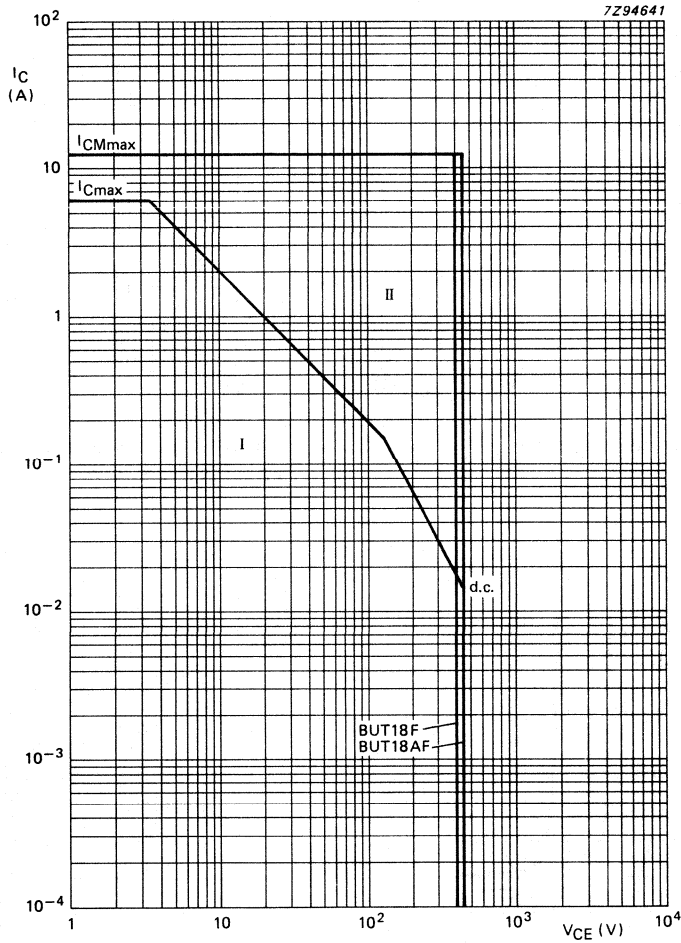


Fig. 7 Switching times waveforms with inductive load.

DEVELOPMENT DATA



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

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

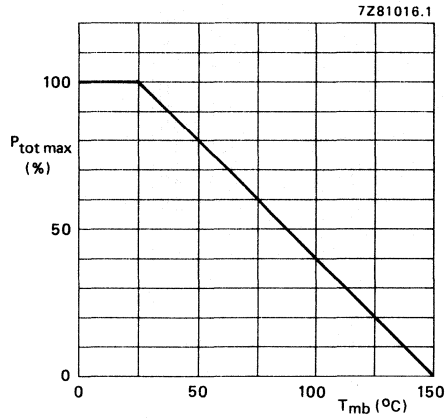


Fig. 9 Power derating curve.

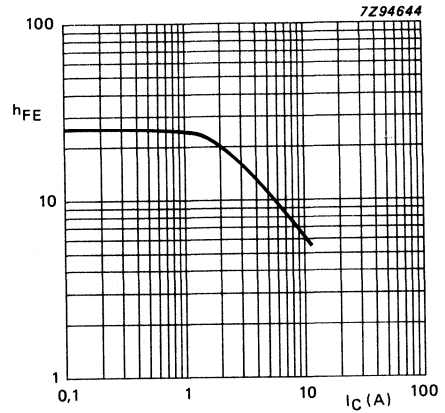


Fig. 10 Typical values DC current gain;
 $V_C = 5\ V$; $T_j = 25\ ^\circ C$.

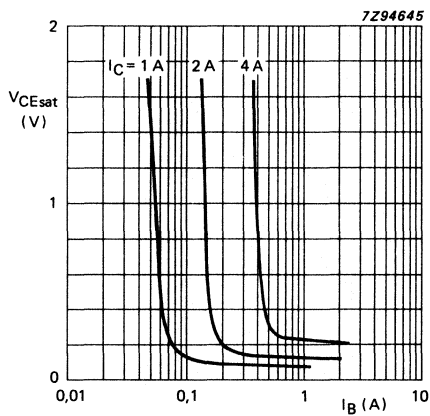


Fig. 11 Collector-emitter saturation voltage as a function of base current;
 $T_j = 25\ ^\circ C$.

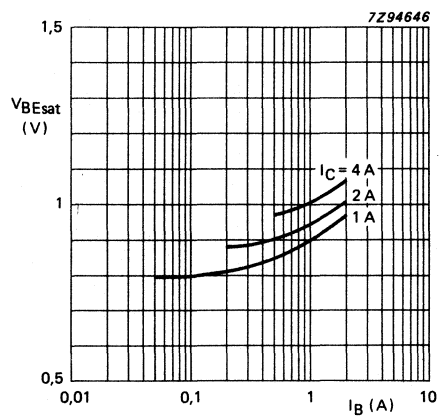


Fig. 12 Base-emitter saturation voltage as a function of base current; $T_j = 25\ ^\circ C$

DEVELOPMENT DATA

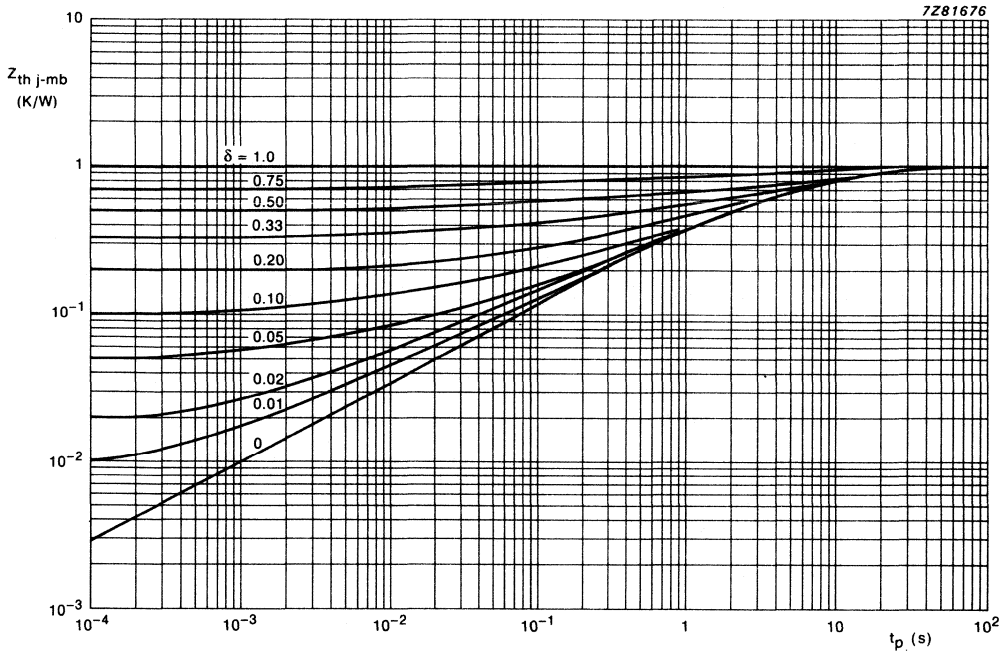


Fig. 13 Normalized thermal resistance.

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.

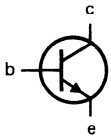
QUICK REFERENCE DATA

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

MECHANICAL DATA

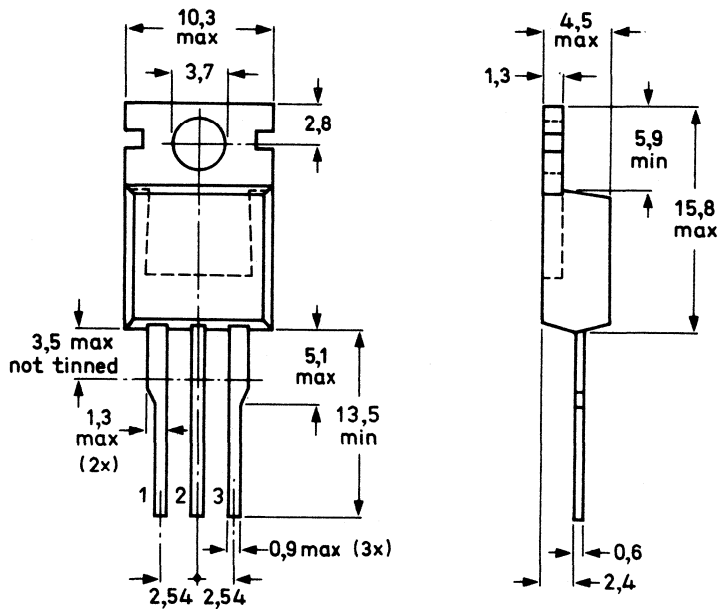
Dimensions in mm

Fig.1 TO-220AB.



Pinning

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



7265872.5

BUT21B BUT21C

RATINGS

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

		BUT21B	21C
Collector-emitter voltage Peak value; $V_{BE} = 0$ open base	V_{CESM}	max. 750	850 V
	V_{CEO}	max. 400	450 V
Collector current saturation DC peak value	I_{Csat}	max. 3.0	A
	I_C	max. 5.0	A
	I_{CM}	max. 10	A
Base current DC peak value	I_B	max. 2.0	A
	I_{BM}	max. 4.0	A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max. 100	W
Storage temperature	T_{stg}	-65 to +150 $^\circ\text{C}$	
Junction temperature	T_j	max. 150	$^\circ\text{C}$
THERMAL RESISTANCE			
From junction to mounting base	R_{thj-mb}	=	1.25 K/W

CHARACTERISTICS

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

Collector cut-off currents

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

 I_{CES} max. 1.0 mA

Emitter cut-off current

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

 I_{EBO} max. 10 mA

Current gain

$I_C = 0.5\text{ A}; V_{CE} = 10\text{ V}$

 h_{FE} typ. 25

Saturation voltages

$I_C = 3\text{ A}; I_B = 0.4\text{ A}$

 V_{CEsat} max. 1.5 V V_{BEsat} max. 1.5 V

$I_C = 3\text{ A}; I_B = 0.5\text{ A}$

 V_{CEsat} max. 1.5 V V_{BEsat} max. 1.5 V

Collector-emitter sustaining voltage

(Figs 2 and 3)

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

 $V_{CEO_{sust}}$ min. 400 450 V

Switching times resistive load

(Figs 4 and 5)

$I_{C\text{ on}} = 3\text{ A}; I_{B\text{ on}} = I_{B\text{ off}} = 0.4\text{ A}$

$V_{CC} = 250\text{ V}; t_p = 20\text{ }\mu\text{s}; T = 2\text{ ms}$

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

$I_{C\text{ on}} = 3\text{ A}; I_{B\text{ on}} = I_{B\text{ off}} = 0.5\text{ A}$

Turn-on time

 t_{on} max. 1.0 μs

Turn-off

storage time

 t_s max. 4.5 μs

fall time

 t_f max. 0.7 μs

Switching times inductive load

(Figs 6 and 7)

$I_{C\text{ on}} = 3\text{ A}; I_{B\text{ on}} = I_{B\text{ on}}$ as resistive

load; $V_{CL} = 250\text{ V}; -V_{BE} = -5\text{ V};$

$L_B = 1\text{ }\mu\text{H}; T_c = 100\text{ }^\circ\text{C}$

Turn-off

storage time

 t_s typ. 2.0 μs t_s max. 2.5 μs

fall time

 t_f typ. 100 μs t_f max. 250 μs

$I_{C\text{ on}} = 3\text{ A}; I_B = I_{B\text{ on}}$ as resistive

load; $V_{CL} = 250\text{ V}; T_c = 100\text{ }^\circ\text{C}$

Turn-off

storage time

 t_s typ. 2.0 μs t_s max. 2.5 μs

fall time

 t_f typ. 100 μs t_f max. 250 μs

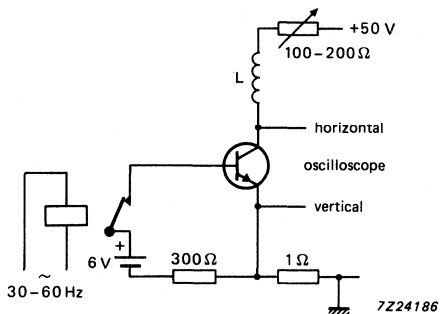


Fig.2 Test circuit for $V_{CE0sust}$.

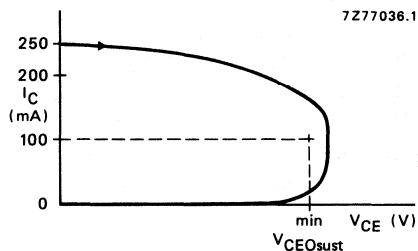


Fig.3 Oscilloscope display for sustaining voltage.

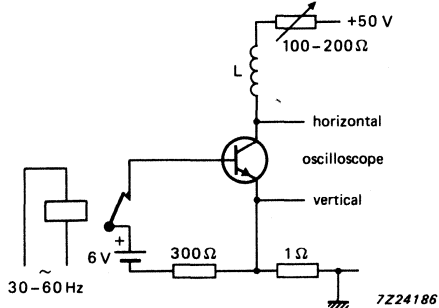


Fig.4 Test circuit resistive load.

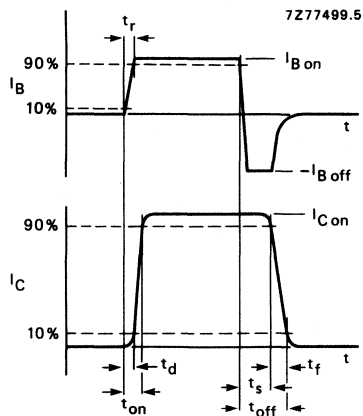


Fig.5 Switching times waveforms with resistive load; t_r max. 30 ns.

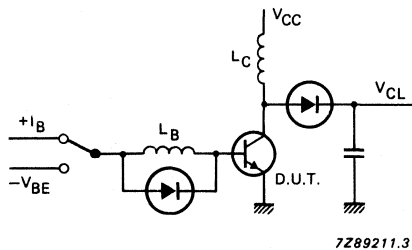


Fig.6 Test circuit inductive load.

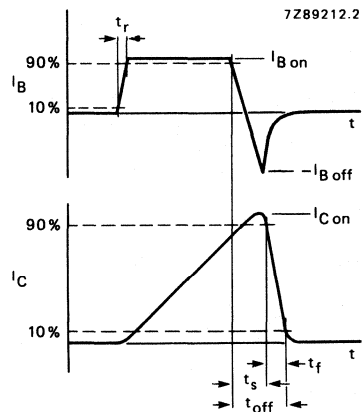
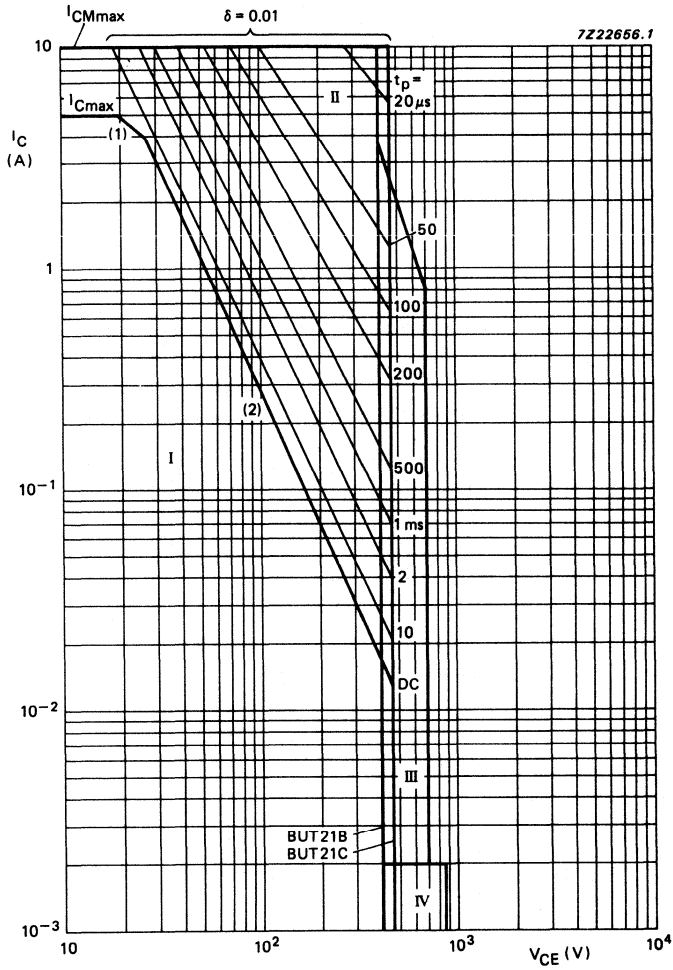


Fig.7 Switching times waveforms with inductive load.



- 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 $T_{mb} < 25 \text{ }^\circ\text{C}$.

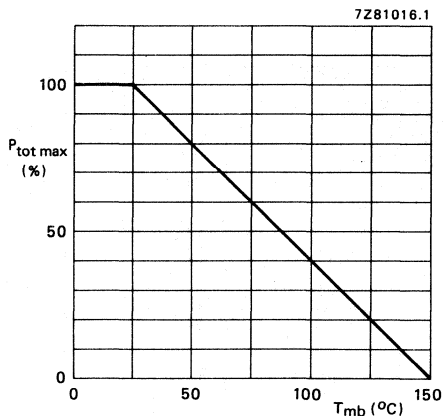


Fig.9 Power derating curve.

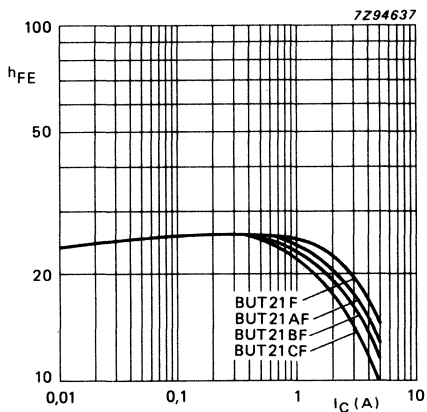


Fig.10 Typical DC current gain at $V_{CE} = 5\ V$; $T_j = 25\ ^\circ C$.

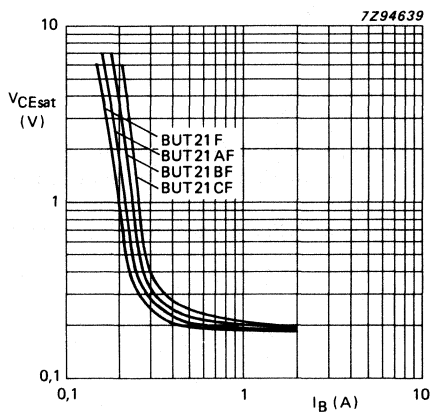


Fig.11 Collector-emitter saturation voltage as a function of base current; $I_C = 3\ A$; $T_j = 25\ ^\circ C$.

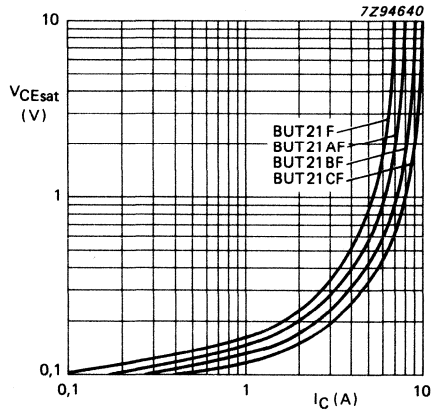


Fig.12 Collector-emitter saturation voltage as a function of collector current; $I_C/I_B = 7.6$ A (BUT21B), 6.0 A (BUT21C); $T_j = 25$ °C.

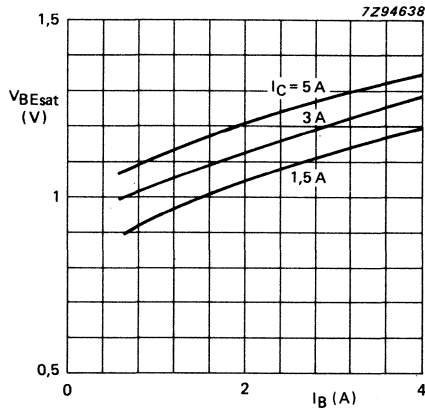


Fig.13 Base-emitter saturation voltage as a function of base current; $T_j = 25$ °C.

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

MECHANICAL DATA

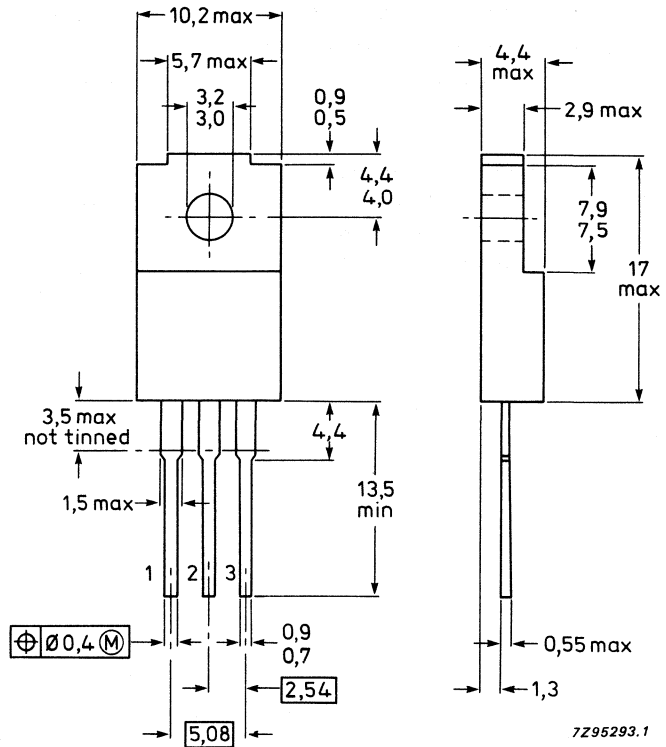
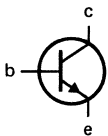
Dimensions in mm

Fig.1 SOT186.

Pinning

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

Mounting base is electrically isolated from all terminals.



BUT21BF BUT21CF

RATINGS

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

		BUT21BF		21CF
Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM}	max.	750	850 V
	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 $T_h = 25\text{ }^\circ\text{C}$	P_{tot}	max.	20	W
Storage temperature	T_{stg}		-65 to + 150 $^\circ\text{C}$	
Junction temperature	T_j	max.	150	$^\circ\text{C}$

THERMAL RESISTANCE

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

ISOLATION

Isolation voltage from all terminals to external heatsink (peak value)	V_{isol}	max.	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

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

Collector cut-off currents

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

I_{CES}	max.	1.0	mA
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Emitter cut-off current

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

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

Current gain

$I_C = 0.5\text{ A}; V_{CE} = 10\text{ V}$

h_{FE}	typ.	25	
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Saturation voltages

$I_C = 3\text{ A}; I_B = 0.4\text{ A}$

		BUT21BF	21CF	
V_{CEsat}	max.	1.5	—	V
V_{BEsat}	max.	1.5	—	V

$I_C = 3\text{ A}; I_B = 0.5\text{ A}$

V_{CEsat}	max.	—	1.5	V
V_{BEsat}	max.	—	1.5	V

Collector-emitter sustaining voltage

(Figs 2 and 3)

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

$V_{CEO sust}$	min.	400	450	V
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Switching times resistive load

(Figs 4 and 5)

$I_{C on} = 3\text{ A}; I_{B on} = I_{B off} = 0.4\text{ A}$

$V_{CC} = 250\text{ V}; t_p = 20\text{ }\mu\text{s}; T = 2\text{ ms}$

Turn-on time

t_{on}	max.	1.0	—	μs
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Turn-off

storage time

t_s	max.	4.5	—	μs
-------	------	-----	---	---------------

fall time

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

$I_{C on} = 3\text{ A}; I_{B on} = I_{B off} = 0.5\text{ A}$

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)

$I_{C on} = 3\text{ A}; I_{B on} = I_{B on}$ as resistive

load; $V_{CL} = 250\text{ V}; -V_{BE} = -5\text{ V};$

$L_B = 1\text{ }\mu\text{H}; T_c = 100\text{ }^\circ\text{C}$

Turn-off

storage time

t_s	typ.	2.0	—	μs
-------	------	-----	---	---------------

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

fall time

t_f	typ.	100	—	μs
-------	------	-----	---	---------------

t_f	max.	250	—	μs
-------	------	-----	---	---------------

$I_{C on} = 3\text{ A}; I_B = I_{B on}$ as resistive

load; $V_{CL} = 250\text{ V}; T_c = 100\text{ }^\circ\text{C}$

Turn-off

storage time

t_s	typ.	—	2.0	μs
-------	------	---	-----	---------------

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

fall time

t_f	typ.	—	100	μs
-------	------	---	-----	---------------

t_f	max.	—	250	μs
-------	------	---	-----	---------------

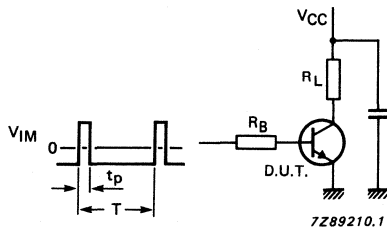


Fig. 2 Test circuit for $V_{CEOsust}$.

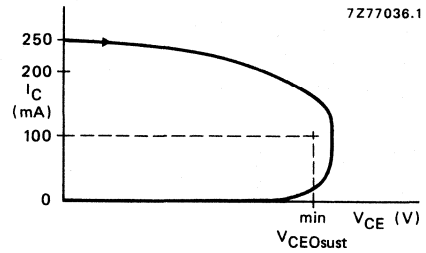


Fig. 3 Oscilloscope display for sustaining voltage.

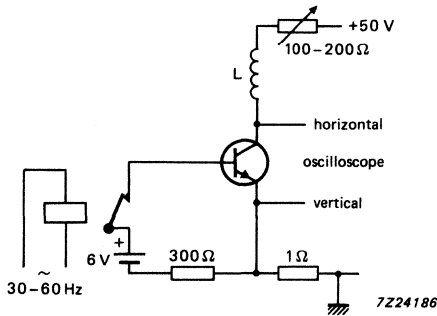


Fig. 4 Test circuit resistive load.

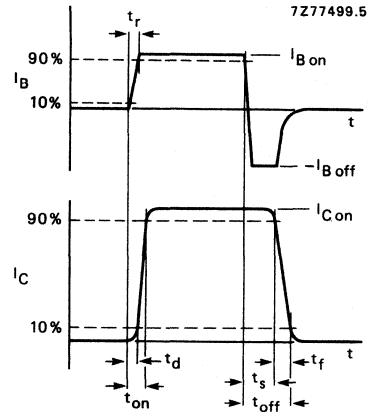


Fig. 5 Switching times waveforms with resistive load; t_r max. 30 ns.

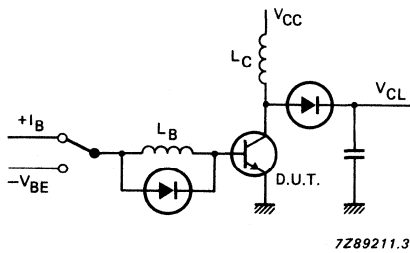


Fig. 6 Test circuit inductive load.

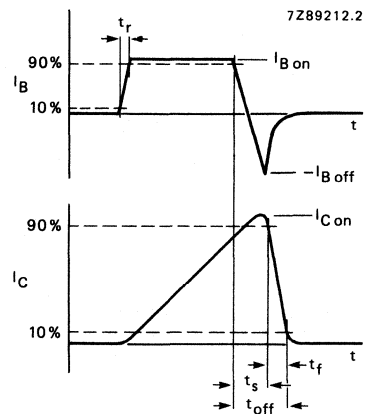
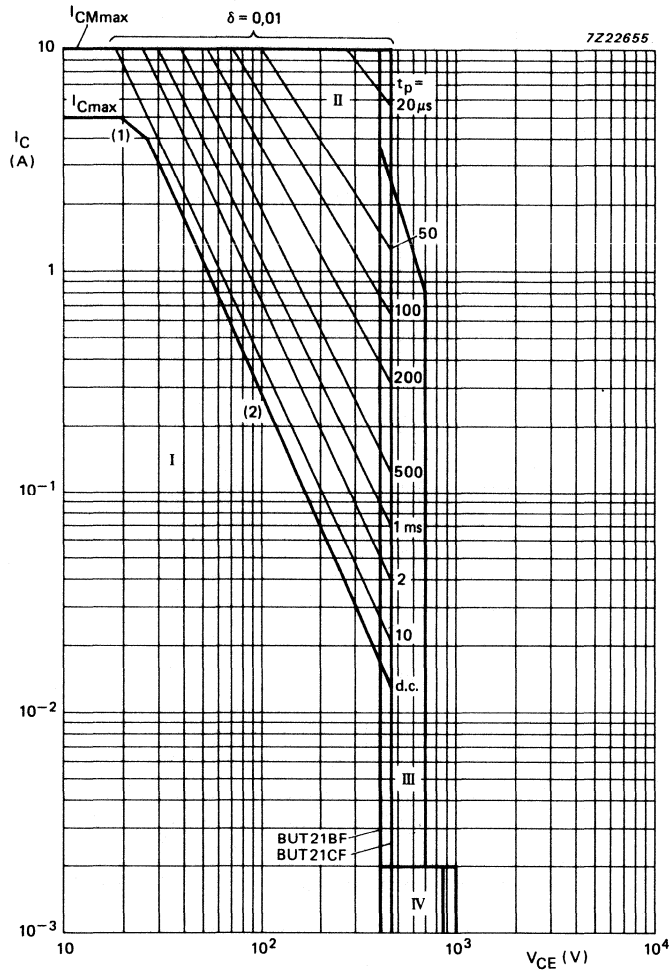


Fig. 7 Switching times waveforms with inductive load.



- (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 $T_{mb} < 25$ °C.

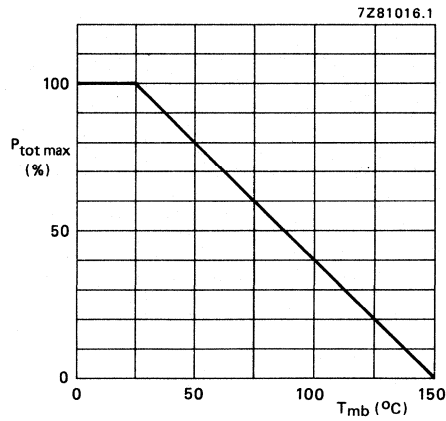


Fig.9 Power derating curve.

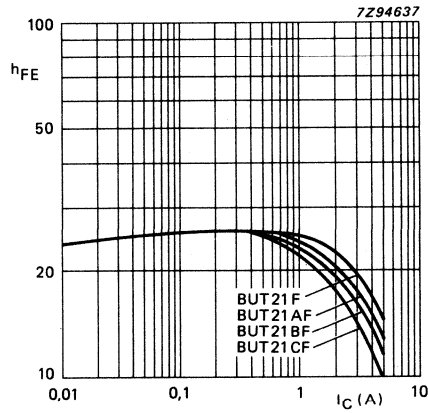


Fig.10 Typical DC current gain at $V_{CE} = 5\ V$; $T_j = 25\ ^\circ C$.

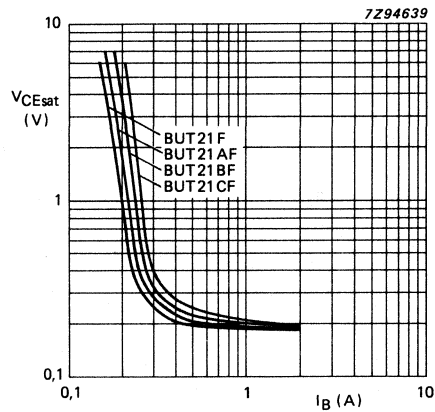


Fig.11 Collector-emitter saturation voltage as a function of base current; $I_C = 3\ A$; $T_j = 25\ ^\circ C$.

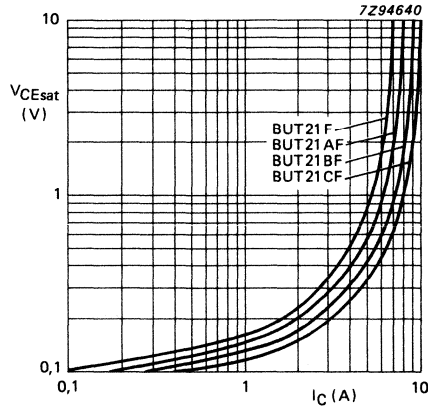


Fig.12 Collector-emitter saturation voltage as a function of collector current; $I_C/I_B = 7.6$ A (BUT21BF), 6.0 A (BUT21CF); $T_j = 25$ °C.

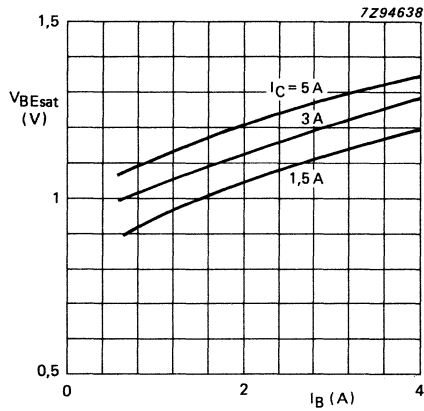


Fig.13 Base-emitter saturation voltage as a function of base current; $T_j = 25$ °C.

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.

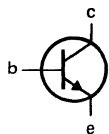
QUICK REFERENCE DATA

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

MECHANICAL DATA

Dimensions in mm

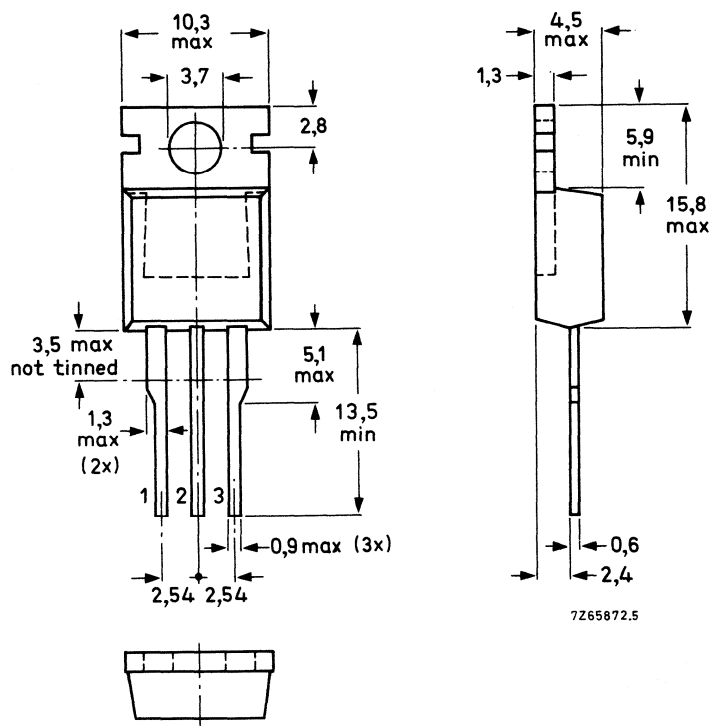
Fig. 1 TO-220AB.



Pinning:

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

Collector connected
to mounting base.



BUT22B BUT22C

RATINGS

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

		BUT22B	22C	
Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM}	max. 750	850	V
	V_{CEO}	max. 400	450	V
Collector current saturation DC peak value	I_{Csat}	max.	6,0	A
	I_C	max.	8,0	A
	I_{CM}	max.	20	A
Base current DC peak value	I_B	max.	4,0	A
	I_{BM}	max.	6,0	A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	125	W
Storage temperature range	T_{stg}		-65 to + 150	$^\circ\text{C}$
Junction temperature	T_j	max.	150	$^\circ\text{C}$
THERMAL RESISTANCE				
From junction to mounting base	$R_{th\ j-mb}$	=	1,0	K/W

CHARACTERISTICS

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

Collector-cut-off currents*

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

 I_{CES} max. 1,0 mA

Emitter cut-off current

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

 I_{EBO} max. 10 mA

Current gain

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

 h_{FE} typ. 25

BUT22B | 22C

Collector-emitter sustaining voltage

(Figs 2 and 3)

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

 $V_{CEOsust}$ min. 400 450 V

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

 $V_{CEOsust}$ min. 400 450 V

Saturation voltages

$I_C = 6\text{ A}; I_B = 0,8\text{ A}$

 V_{CEsat} max. 1,5 — V V_{BEsat} max. 1,5 — V

$I_C = 6\text{ A}; I_B = 1,0\text{ A}$

 V_{CEsat} max. — 1,5 V V_{BEsat} max. — 1,5 V

Collector saturation current

$V_{CE} = 1,5\text{ V}$

 I_{Csat} 6,0 6,0 A

Switching times resistive load

(Figs 4 and 5)

$I_{C\text{ on}} = 6\text{ A}; I_{B\text{ on}} = I_{B\text{ off}} = 0,8\text{ A}$

Turn-on time

 t_{on} max. 1,0 — μs

Turn-off

storage time

 t_s max. 4,5 — μs

fall time

 t_f max. 0,7 — μs

$I_{C\text{ on}} = 5\text{ A}; I_{B\text{ on}} = I_{B\text{ off}} = 1,0\text{ A}$

Turn-on time

 t_{on} max. — 1,0 μs

Turn-off

storage time

 t_s max. — 4,5 μs

fall time

 t_f max. — 0,7 μs

Switching times inductive load

(Figs 6 and 7)

$I_{C\text{ on}} = 6\text{ A}; I_{B\text{ on}} = 0,8\text{ A}$

$V_{CL} = 250\text{ V}; T_c = 100\text{ }^\circ\text{C}$

Turn-off

storage time

 t_s typ. 2,0 — μs t_s max. 2,5 — μs

fall time

 t_f typ. 100 — ns t_f max. 250 — ns

$I_{C\text{ on}} = 6\text{ A}; I_B = 1,0\text{ A}$

$V_{CL} = 250\text{ V}; T_c = 100\text{ }^\circ\text{C}$

Turn-off

storage time

 t_s typ. — 2,0 μs t_s max. — 2,5 μs

fall time

 t_f typ. — 100 ns t_f max. — 250 ns

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

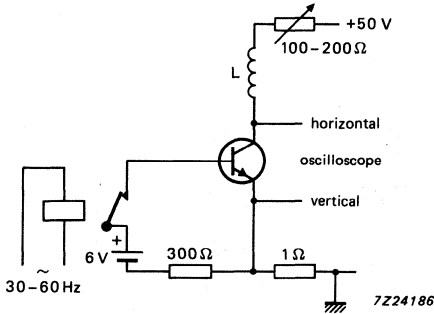


Fig. 2 Test circuit for $V_{CE0sust}$.

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

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

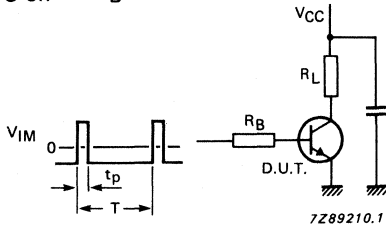


Fig. 4 Test circuit resistive load.

$V_{CL} = \text{up to } 850 \text{ V}$
 $V_{CC} = 30 \text{ V}$
 $-V_{BE} = 1 \text{ to } 5 \text{ V}$
 $L_B = 1 \mu\text{H}$
 $L_C = 200 \mu\text{H}$

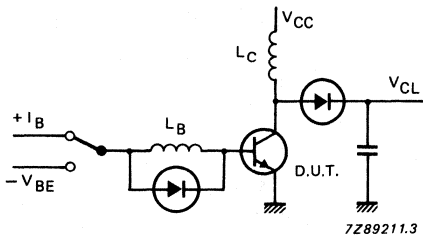


Fig. 6 Test circuit inductive load.

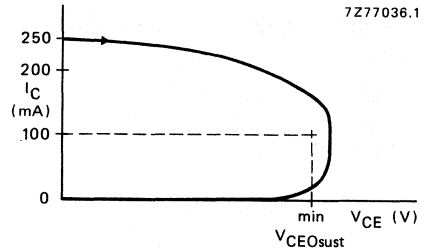


Fig. 3 Oscilloscope display for sustaining voltage.

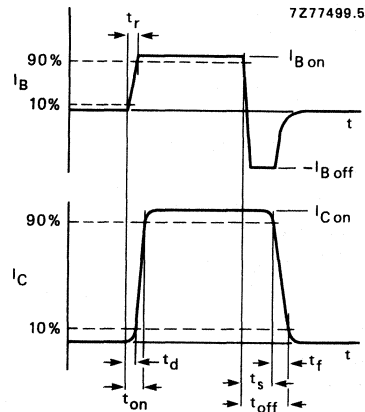


Fig. 5 Switching times waveforms with resistive load; $t_r \leq 30 \text{ ns}$.

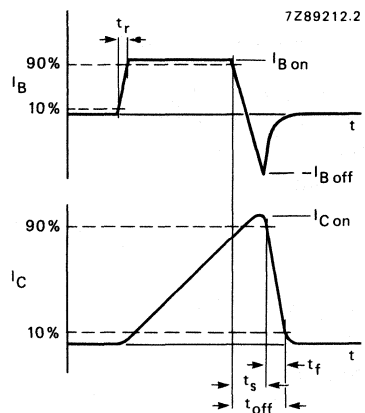
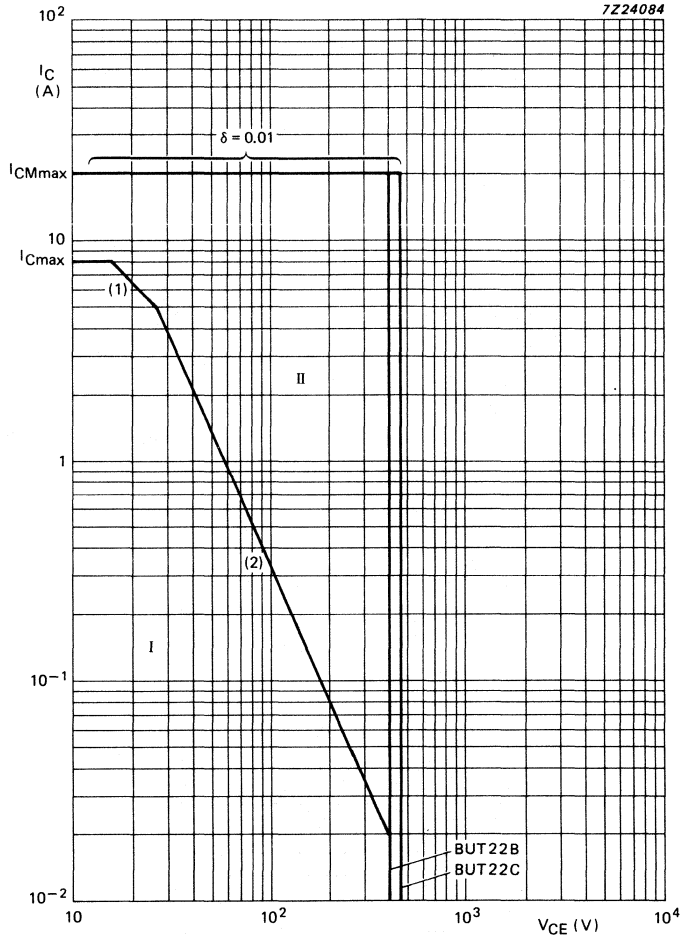


Fig. 7 Switching times waveforms with inductive load.



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

**BUT22B
BUT22C**

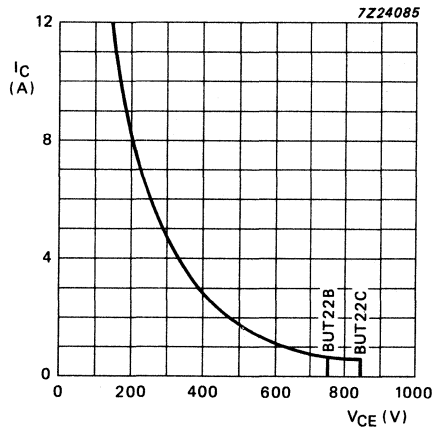


Fig. 9 Reverse bias SOAR.

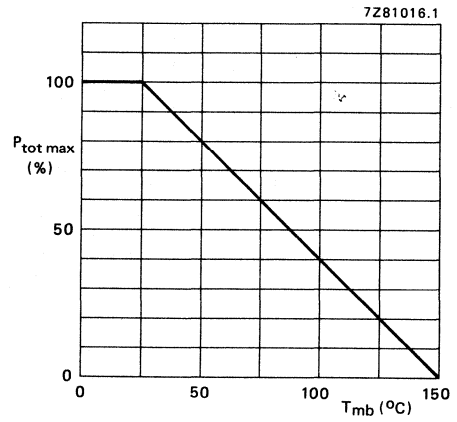


Fig. 10 Power derating curve.

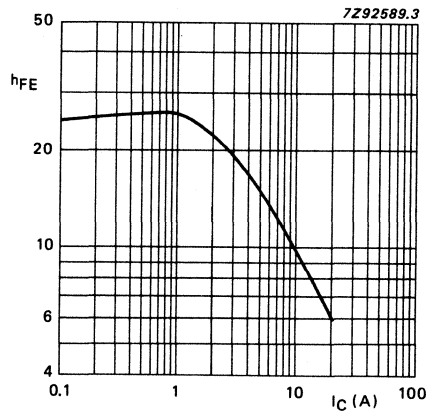


Fig. 11 Typical values DC current gain.

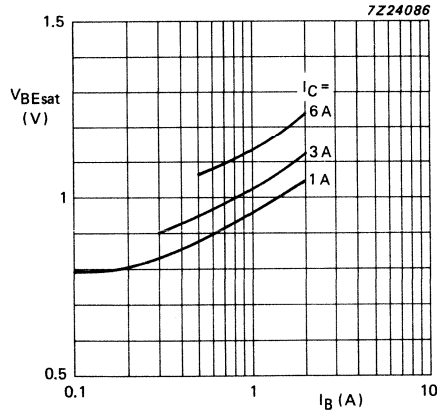


Fig. 12 Base-emitter saturation voltage as a function of base current; $T_j = 25^\circ\text{C}$.

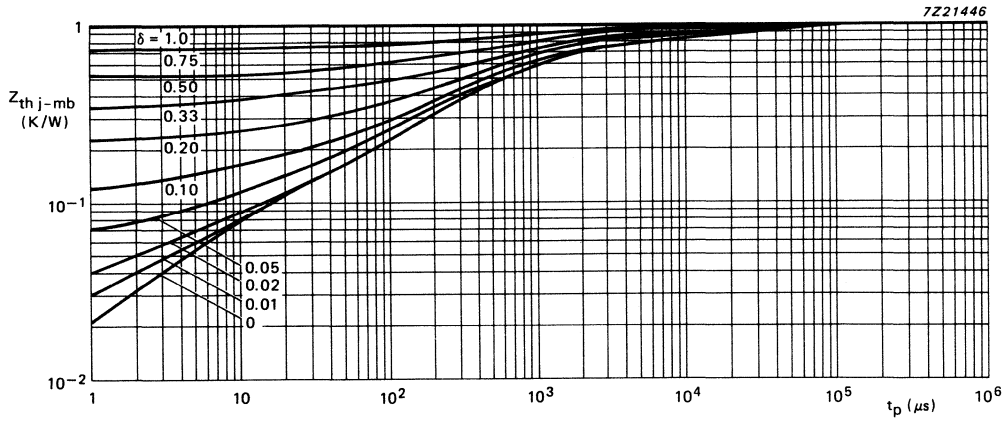


Fig. 13 Thermal response at pulse power conditions.

DEVELOPMENT DATA

This data sheet contains advance information and specifications are subject to change without notice.

BUT22BF
BUT22CF

SILICON DIFFUSED POWER TRANSISTORS

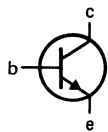
High-voltage, high-speed, glass-passivated npn power transistor in a SOT186 envelope intended for use in converters, inverters, switching regulators, motor control systems, etc.

QUICK REFERENCE DATA

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

MECHANICAL DATA

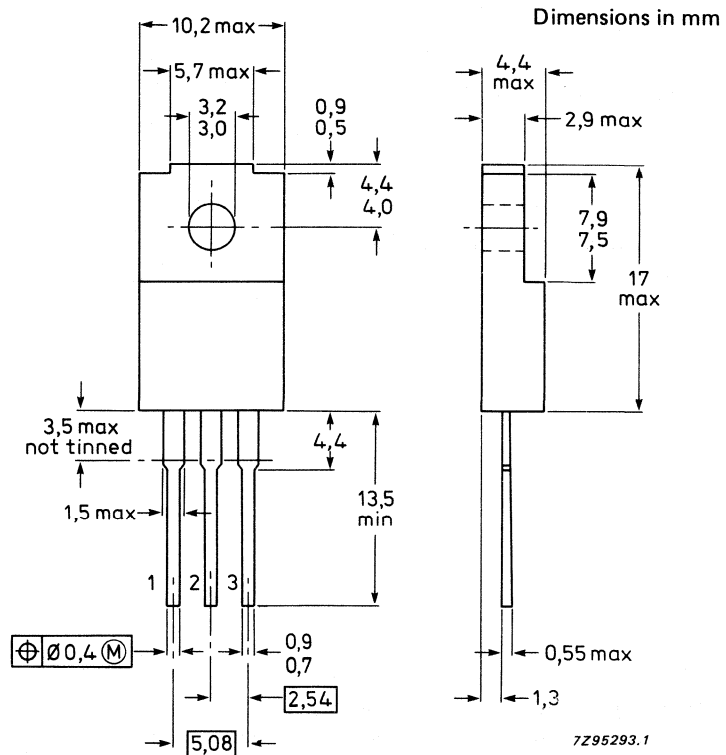
Fig. 1 SOT186.



Pinning:

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

Terminals are electrically isolated.



BUT22BF BUT22CF

RATINGS

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

		BUT22BF	BUT22CF
Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM}	max. 750	850 V
	V_{CEO}	max. 400	450 V
Collector current saturation DC peak value; $t_p < 20$ ms	I_{Csat}		6.0 A
	I_C	max.	8.0 A
	I_{CM}	max.	20 A
Base current DC peak value; $t_p < 20$ ms	I_B	max.	4.0 A
	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)	$R_{th j-h}$	=	5.5 K/W
	$R_{th j-h}$	=	3.9 K/W
From junction to ambient	$R_{th j-a}$	=	55 K/W
ISOLATION			
Isolation voltage from all terminals to external heatsink (peak value)	V_{isol}	max.	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

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

Collector cut-off currents*

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

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

Emitter cut-off current

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

I_{EBO}	max.	10	mA
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DC current gain

 $I_C = 1.0\text{ A}; V_{CE} = 5\text{ V}$

h_{FE}	typ.	25	
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Saturation voltages

 $I_C = 6\text{ A}; I_B = 0.8\text{ A}$

		BUT22BF	BUT22CF
V_{CEsat}	max.	1.5	— V
V_{BEsat}	max.	1.5	— V

 $I_C = 6\text{ A}; I_B = 1.0\text{ A}$

V_{CEsat}	max.	—	1.5 V
V_{BEsat}	max.	—	1.5 V

Collector-emitter sustaining voltage (Figs 2 and 3)

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

$V_{CEOsust}$	min.	400	450 V
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Collector saturation current

 $V_{CE} = 1.5\text{ V}$

I_{Csat}		6.0	6.0 A
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Switching times resistive load (Figs 4 and 5)

 $I_{C\text{ on}} = 6\text{ A}; I_{B\text{ on}} = I_{B\text{ off}} = 0.8\text{ A}$

Turn-on time

t_{on}	max.	1.0	— μs
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Turn-off; storage time

t_s	max.	4.5	— μs
-------	------	-----	-----------------

fall time

t_f	max.	0.7	— μs
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 $I_{C\text{ on}} = 6\text{ A}; I_{B\text{ on}} = I_{B\text{ off}} = 1\text{ A}$

Turn-on time

t_{on}	max.	—	1.0 μs
----------	------	---	-------------------

Turn-off; storage time

t_s	max.	—	4.5 μs
-------	------	---	-------------------

fall time

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

Switching times inductive load (Figs 6 and 7)

 $I_{C\text{ on}} = 6\text{ A}; I_B = 0.8\text{ A};$ $V_{CL} = 250\text{ V}; T_C = 100\text{ }^\circ\text{C}$

Turn-off; storage time

t_s	typ.	2.0	— μs
-------	------	-----	-----------------

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

fall time

t_f	typ.	100	— ns
-------	------	-----	------

t_f	max.	250	— ns
-------	------	-----	------

 $I_{C\text{ on}} = 6\text{ A}; I_B = 1\text{ A};$ $V_{CL} = 250\text{ V}; T_C = 100\text{ }^\circ\text{C}$

Turn-off; storage time

t_s	typ.	—	2.0 μs
-------	------	---	-------------------

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

fall time

t_f	typ.	—	100 ns
-------	------	---	--------

t_f	max.	—	250 ns
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DEVELOPMENT DATA

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

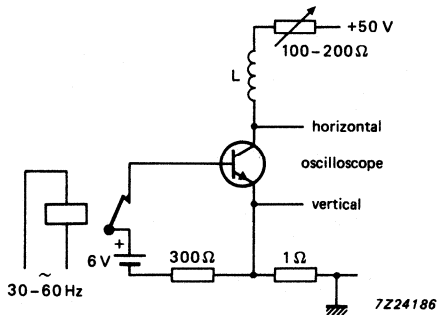


Fig. 2 Test circuit for $V_{CEOsust}$.

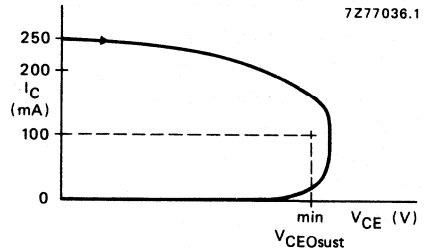
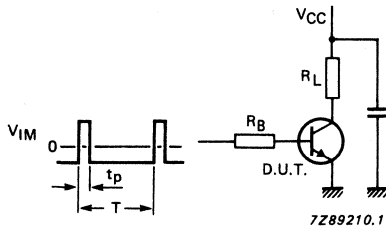


Fig. 3 Oscilloscope display for sustaining voltage.



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

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

Fig. 4 Test circuit resistive load.

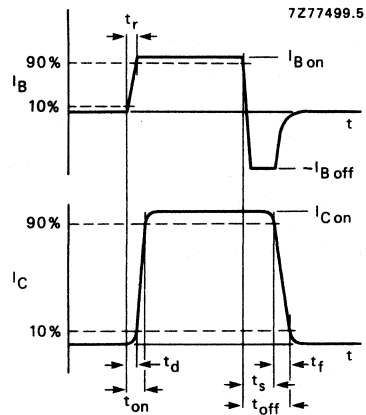
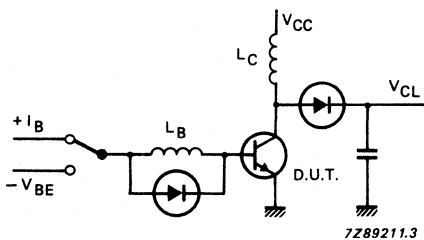


Fig. 5 Switching times waveforms with resistive load; $t_r \leq 20 \text{ ns}$.



$V_{CL} = \text{up to } 850 \text{ V}$
 $V_{CC} = 30 \text{ V}$
 $-V_{BE} = 5 \text{ V}$
 $L_B = 1.0 \mu\text{H}$
 $L_C = 200 \mu\text{H}$

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

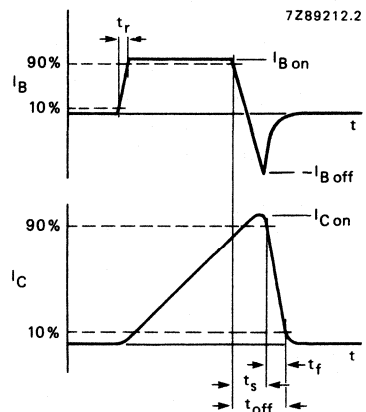
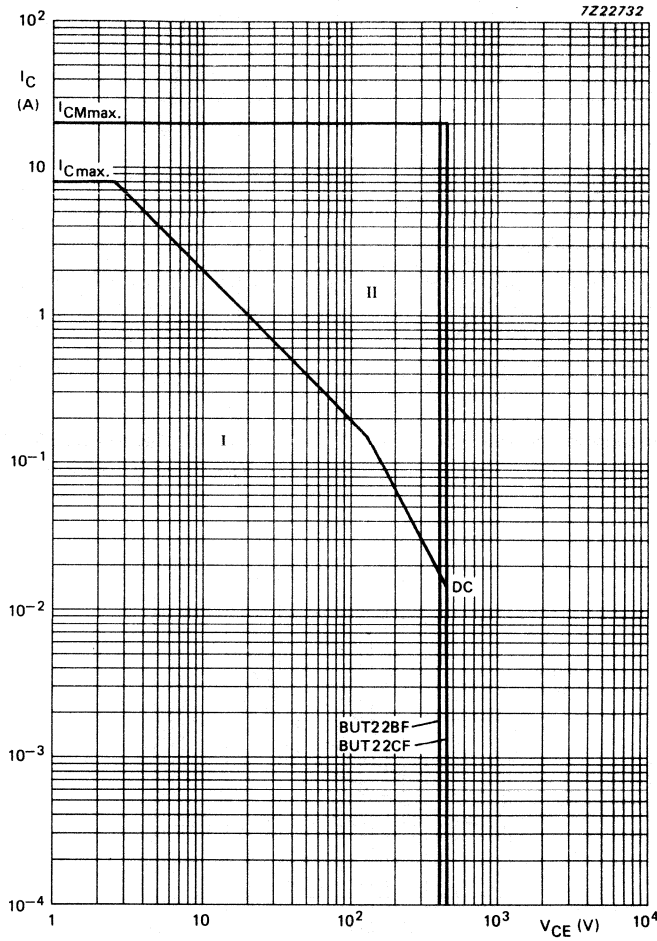


Fig. 7 Switching times waveforms with inductive load.

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 $T_{mb} < 25^\circ\text{C}$.

BUT22BF
BUT22CF

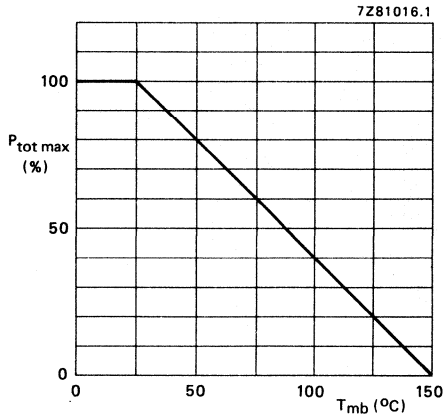


Fig. 9 Power dissipation curve.

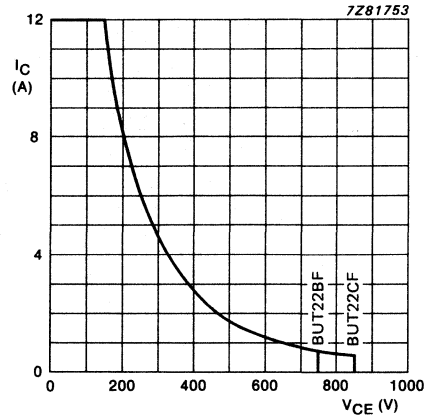


Fig. 10 Reverse bias SOAR;
 $V_{BE} = -1\ V\ to\ -5\ V$; $T_j < 100\ ^\circ C$.

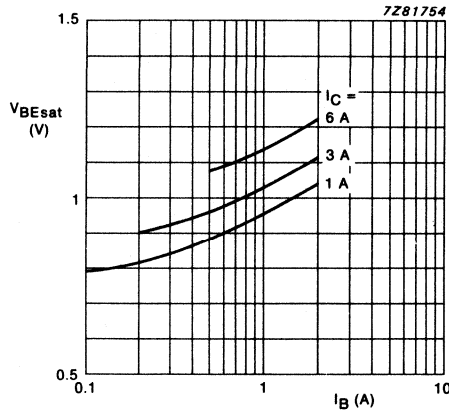


Fig. 11 Base-emitter saturation voltages as a function of base current; $T_j = 25\ ^\circ C$.

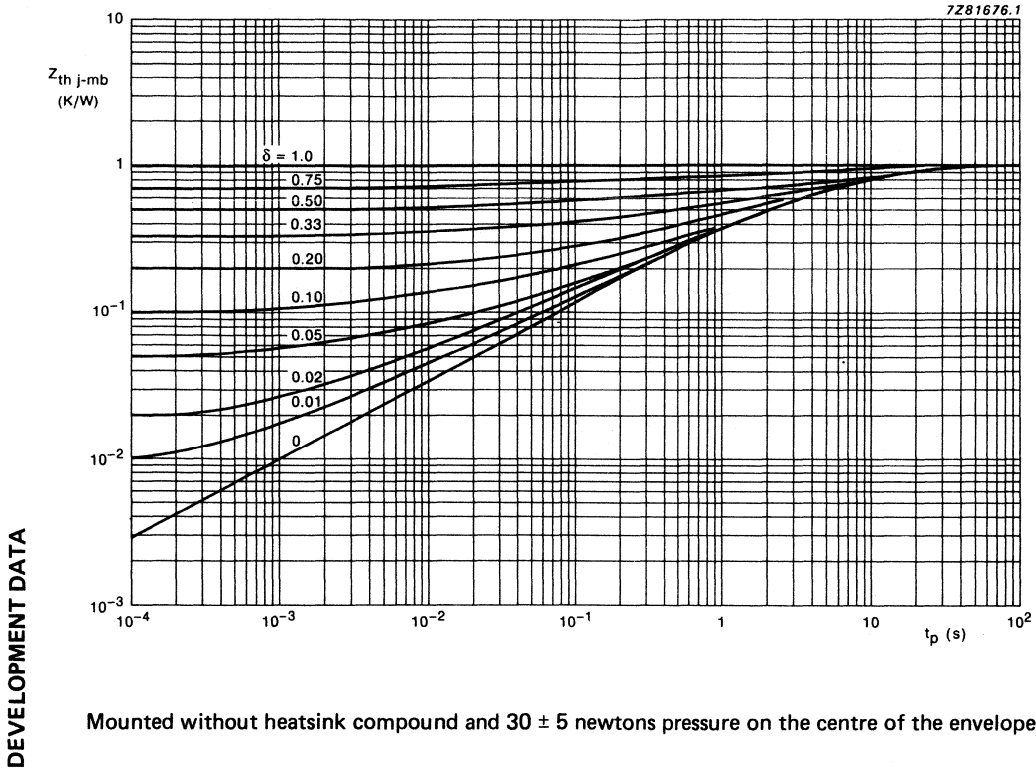


Fig. 12 Normalized thermal response at pulse power conditions.

DEVELOPMENT DATA

This data sheet contains advance information and specifications are subject to change without notice.

BUT131 SERIES

SILICON DIFFUSED POWER TRANSISTORS

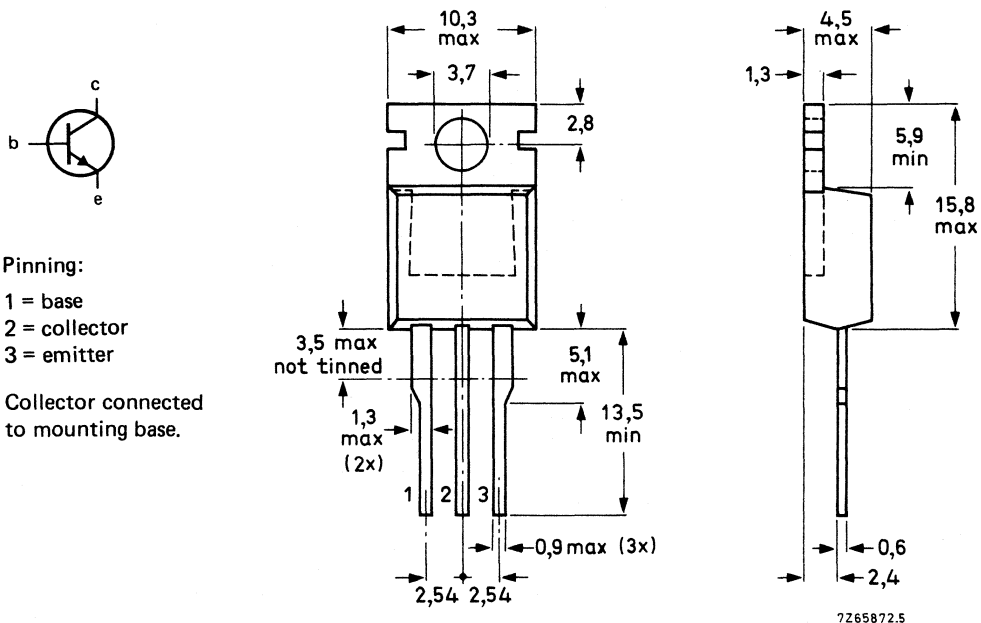
High-voltage, high-speed, glass-passivated npn power transistors in a TO-220 envelope intended for use in converters, inverters, switching regulators, motor control systems, etc.

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 $T_{mb} = 25^\circ C$	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.

BUT131 SERIES

RATINGS

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

			BUT131	131A	131H
Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM}	max.	850	1000	850 V
	V_{CEO}	max.	450	500	450 V
Collector current DC peak value; $t_p = 5$ ms; $d = 10\%$	I_C	max.		5.0	A
	I_{CM}	max.		10	A
Base current DC peak value; $t_p = 5$ ms; $d = 10\%$	I_B	max.		4.0	A
	I_{BM}	max.		8.0	A
Total power dissipation up to $T_{mb} = 25$ °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	$R_{th\ j-mb}$	=		1.56	K/W

CHARACTERISTICS

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

Collector cut-off current*

 $V_{CE} = V_{CESMmax}; V_{BE} = -1.5\text{ V}$ $V_{CE} = V_{CESMmax}; V_{BE} = -1.5\text{ V}$ $T_j = 100\text{ }^\circ\text{C}$ I_{CEV} max. 0.25 mA I_{CEV} max. 1.5 mA

Emitter cut-off current

 $V_{EB} = 6.0\text{ V}; I_C = 0$ I_{EBO} max. 1.0 mA

Collector-emitter sustaining voltage

 $I_C = 100\text{ mA}; I_B = 0; L = 10\text{ mH}$

(see Figs 2 and 3)

 $V_{CEOsust}$ min. BUT131 450 131A 500 131H 450 V

Saturation voltage

 $T_{mb} = 25\text{ }^\circ\text{C}$ and $100\text{ }^\circ\text{C}$ $I_C = 1.5\text{ A}; I_B = 0.2\text{ A}$ (BUT131) $I_C = 1.5\text{ A}; I_B = 0.2\text{ A}$ (BUT131A) $I_C = 1.5\text{ A}; I_B = 0.15\text{ A}$ (BUT131H) V_{CEsat} max. 1.0 V $I_C = 3\text{ A}; I_B = 0.4\text{ A}$ (BUT131) $I_C = 3\text{ A}; I_B = 0.4\text{ A}$ (BUT131A) $I_C = 3\text{ A}; I_B = 0.3\text{ A}$ (BUT131H) V_{CEsat} max. 2.5 V V_{BEsat} max. 1.5 V

DC current gain

 $I_C = 5\text{ A}; V_{CE} = 5\text{ V}$ h_{FE} min. 5 5 7

Switching times resistive load

(see Figs 4 and 5)

 $I_{C\ on} = 3\text{ A}; I_{B\ on} = 0.4\text{ A}; I_{B\ off} = 0.8\text{ A}$

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 $I_{C\ on} = 3\text{ A}; I_{B\ on} = 0.3\text{ A}; I_{B\ off} = 0.6\text{ A}$

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)

 $I_{C\ on} = 3\text{ A}; I_{B\ on} = 0.4\text{ A}$ t_{sv} typ. 0.60 0.60 — μs $V_{BE\ off} = 5\text{ V}; V_{CE(pk)} = 400\text{ V};$ $T_j = 100\text{ }^\circ\text{C}$ t_{fi} typ. 0.07 0.07 — μs t_c typ. 0.20 0.20 — μs $I_{C\ on} = 3\text{ A}; I_{B\ on} = 0.3\text{ A}$ t_{sv} typ. — — 0.50 μs $V_{BE\ off} = 5\text{ V}; V_{CE(pk)} = 400\text{ V};$ $T_j = 100\text{ }^\circ\text{C}$ t_{fi} typ. — — 0.07 μs t_c typ. — — 0.18 μs

Output capacitance

 $V_{CB} = 10\text{ V}; I_E = 0; f_{test} = 1\text{ kHz}$ C_{ob} max. 200 pF

DEVELOPMENT DATA

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

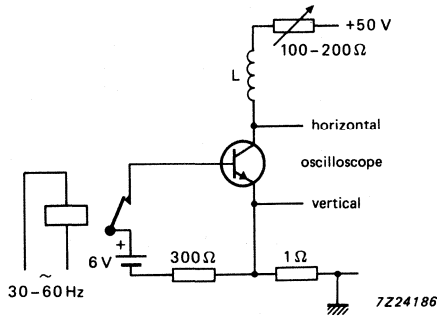


Fig. 2 Test circuit for $V_{CEOsust}$.

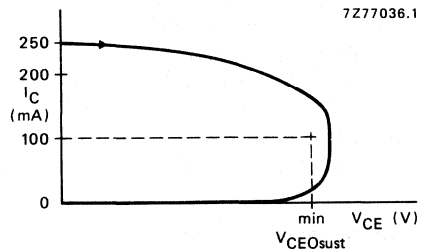
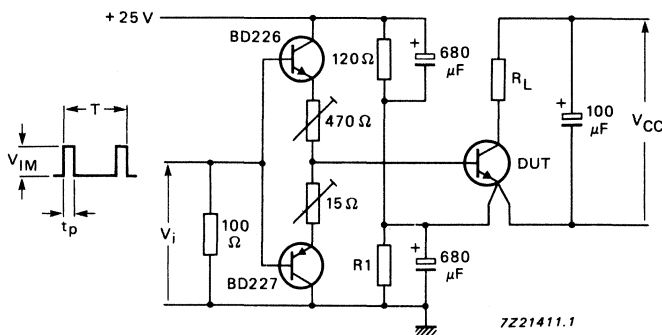


Fig. 3 Oscilloscope display for sustaining voltage.



$t_p = 20 \mu s$
 $T = 2 ms$
 $V_{IM} = 15 V$

Fig. 4 Test circuit resistive load; $V_{CC} = 240 V$;
 $R_L = 82 \Omega$; $R_1 = 39 \Omega$.

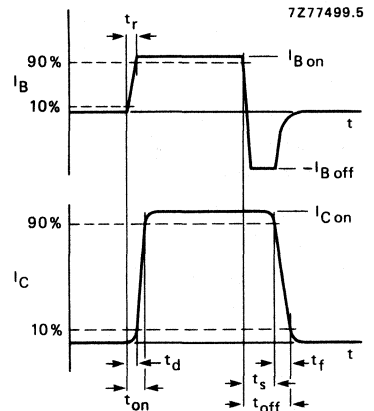
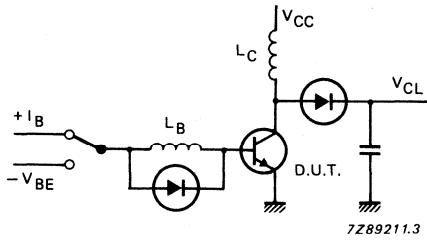


Fig. 5 Switching times waveforms with resistive load; $t_r \leq 30 ns$.



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

Fig. 6 Test circuit inductive load and RB SOAR; $V_{CC} = 20 \text{ V}$; $L_C = 200 \mu\text{H}$.

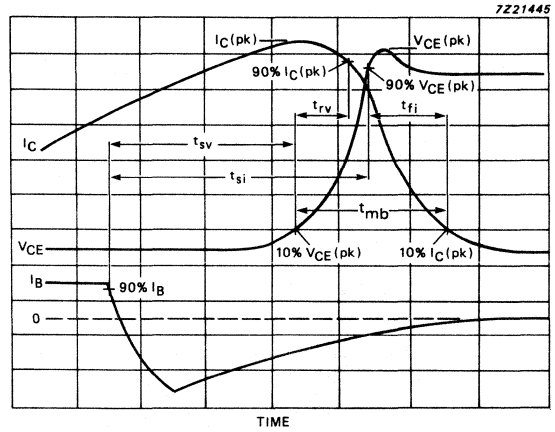


Fig. 7 Switching times waveforms with inductive load.

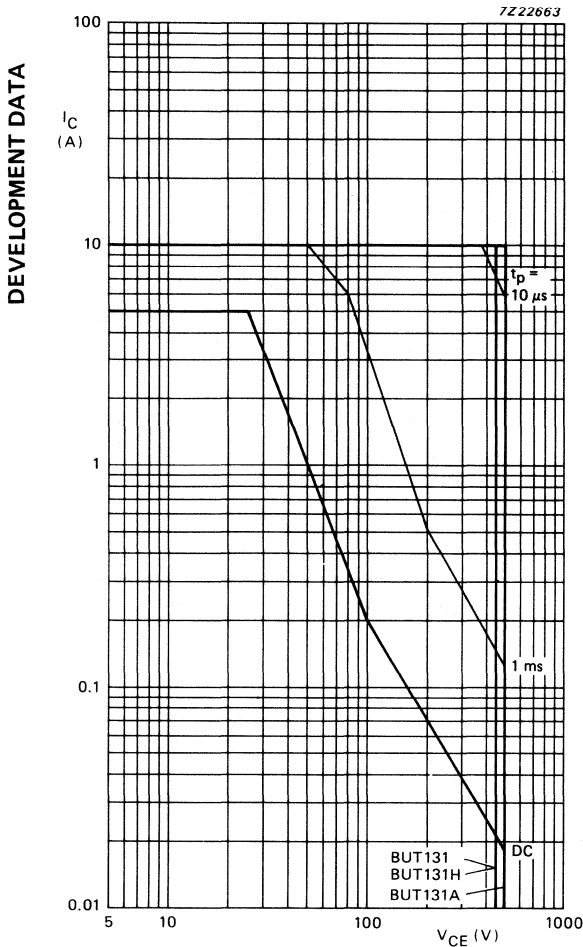


Fig. 8 Forward biased SOAR; $T_{mb} = 25 \text{ }^\circ\text{C}$.

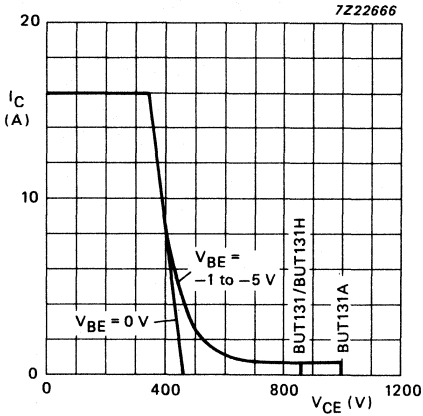


Fig. 9 Reverse bias SOAR; $I_C/I_B = 4$; $T_{mb} \leq 100^\circ\text{C}$.

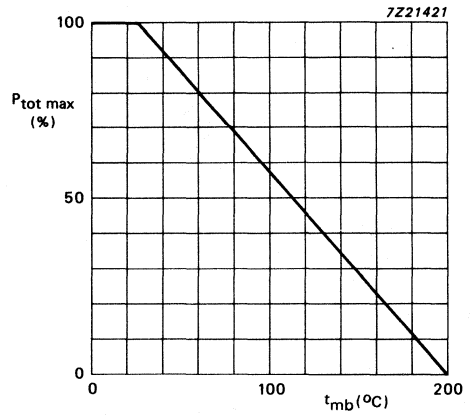


Fig. 10 Power derating curve.

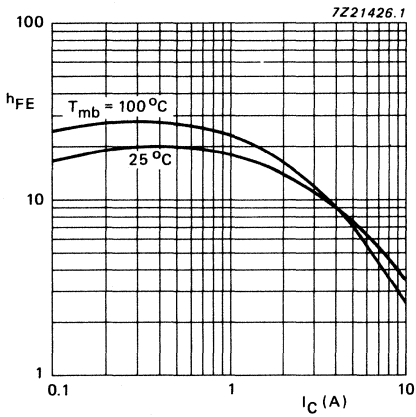


Fig. 11 Typical DC current gain; $V_{CE} = 5\text{ V}$.

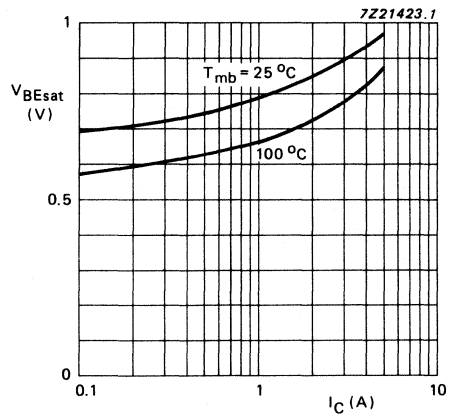


Fig. 12 Base-emitter saturation voltage as a function of collector current; $I_C/I_B = 10$.

DEVELOPMENT DATA

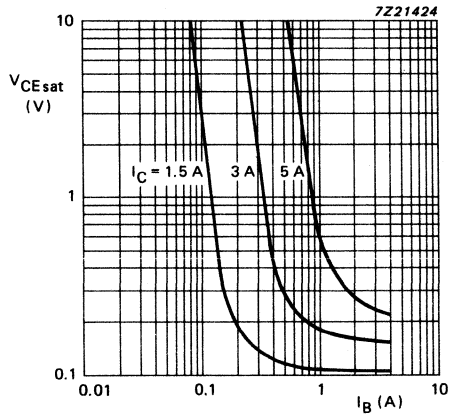


Fig. 13 Collector-emitter voltage as a function of base current; $T_{mb} = 25^\circ\text{C}$.

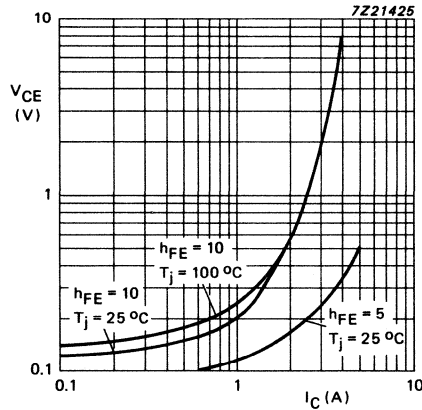


Fig. 14 Collector-emitter voltage as a function of collector current.

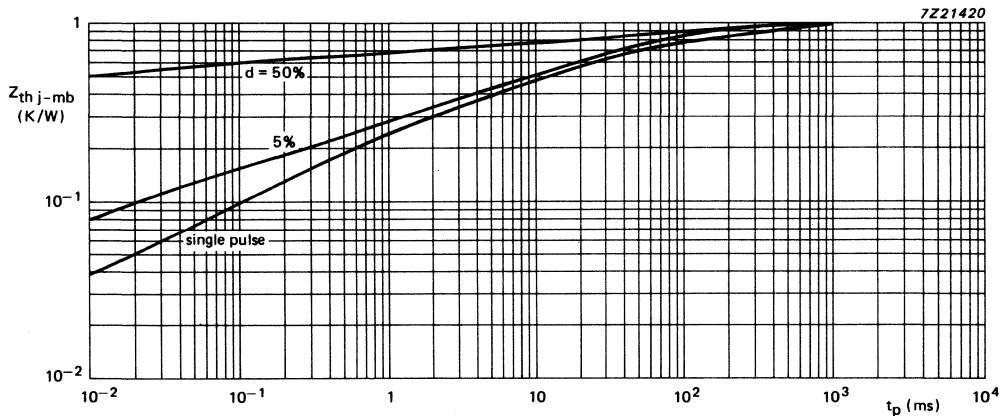


Fig. 15 Transient thermal impedance; (normalized).

DEVELOPMENT DATA

This data sheet contains advance information and specifications are subject to change without notice.

BUV26
BUV26A

SILICON POWER TRANSISTORS

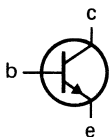
High-speed, glass-passivated npn power transistors in a TO-220 envelope intended for fast switching applications such as high frequency and efficiency converters, switching regulators and motor control.

QUICK REFERENCE DATA

			BUV26	26A
Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM}	max.	180	200 V
	V_{CEO}	max.	90	100 V
Collector-emitter saturation voltage	V_{CEsat}	max.	1,5	1,0 V
Collector current saturation	I_{Csat}	max.	12	10 A
DC	I_C	max.	14	A
peak value	I_{CM}	max.	25	A
Total power dissipation up to $T_{mb} = 25^\circ C$	P_{tot}	max.	65	W
Fall time; inductive load	t_f	typ.	40	ns

MECHANICAL DATA

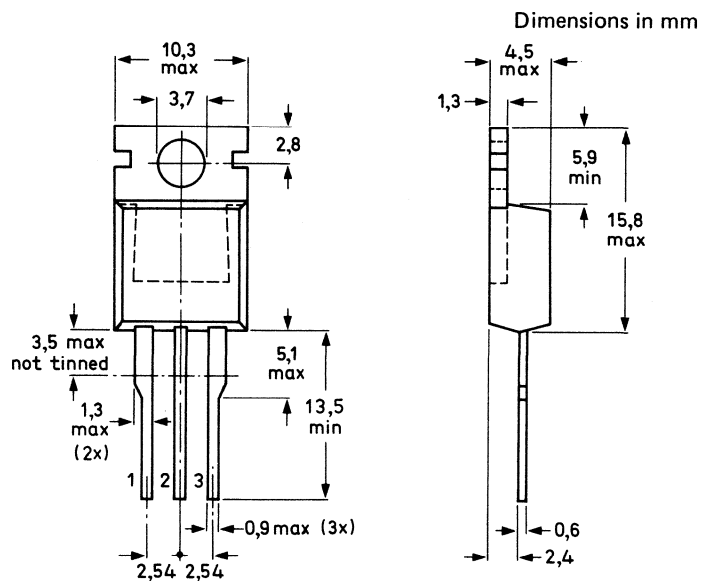
Fig. 1 TO-220AB.



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; $V_{BE} = 0$ open base	V_{CESM}	max. 180	200	V
	V_{CEO}	max. 90	100	V
Collector current saturation DC peak value	I_{Csat}	max. 12	10	A
	I_C	max.	14	A
	I_{CM}	max.	25	A
Base current DC peak value	I_B	max.	4,0	A
	I_{BM}	max.	6,0	A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	65	W
Storage temperature range	T_{stg}		-65 to + 150	$^\circ\text{C}$
Junction temperature	T_j	max.	150	$^\circ\text{C}$
THERMAL RESISTANCE				
From junction to mounting base	$R_{th\ j-mb}$	=	1,92	K/W

CHARACTERISTICS

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

Collector cut-off currents*

 $V_{CE} = V_{CESmax}; V_{BE} = -1,5\text{ V};$
 $T_j = 125\text{ }^\circ\text{C}$ I_{CES} max. 1,0 mA $V_{CE} = V_{CESmax}; R_{BE} = 50\ \Omega;$
 $T_j = 125\text{ }^\circ\text{C}$ I_{CES} max. 3,0 mA

Emitter cut-off current

 $V_{EB} = 5\text{ V}; I_C = 0$ I_{EBO} max. 1,0 mACollector-emitter sustaining voltage
(Figs 2 and 3) $I_B = 0; I_C = 0,2\text{ A}; L = 25\text{ mH}$ $V_{CEO_{sust}}$ 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

DEVELOPMENT DATA

Switching times resistive load
(Figs 4 and 5) $I_{C\ on} = I_{Csat}; I_{B\ on} = I_{Csat}/10;$ $I_{B\ off} = 2I_{B\ on}; V_{CE} = 50\text{ V}$

Turn-on time

 t_{on} typ. 0,4 μs

Turn-off;

storage time

 t_s typ. 0,45 μs

fall time

 t_f typ. 0,12 μs

Turn-on time

 t_{on} max. 0,6 μs

Turn-off;

storage time

 t_s max. 1,0 μs

fall time

 t_f max. 0,25 μs Switching times inductive load
(Figs 6 and 7) $I_{C\ on} = I_{Csat}; I_{B\ on} = I_{Csat}/10;$ $V_{CE} = V_{clamp} = 50\text{ V}; L_B = 0,5\ \mu\text{H};$ $-V_B = 5\text{ V}$

Turn-off;

storage time at $T_j = 25\text{ }^\circ\text{C}$ t_s typ. 0,5 μs t_f typ. 40 nsfall time at $T_j = 125\text{ }^\circ\text{C}$ t_s max. 2,0 μs t_f max. 150 ns

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

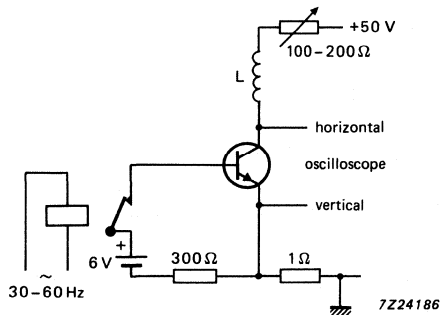


Fig. 2 Test circuit for V_{CEsust} .

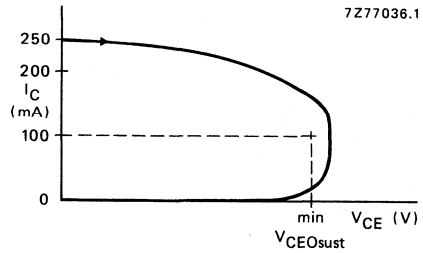


Fig. 3 Oscilloscope display for sustaining voltage.

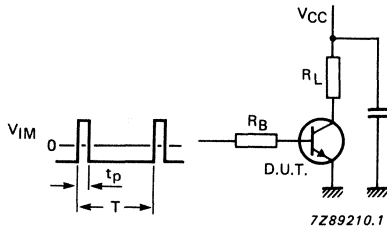


Fig. 4 Test circuit resistive load.

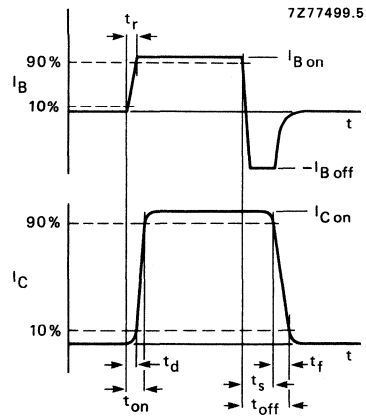
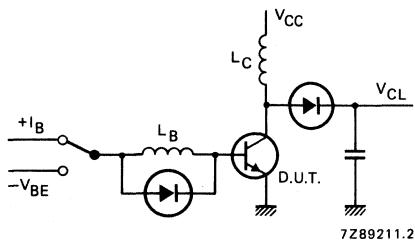


Fig. 5 Switching times waveforms with resistive load; $t_r \leq 30$ ns.



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

Fig. 6 Test circuit inductive load.

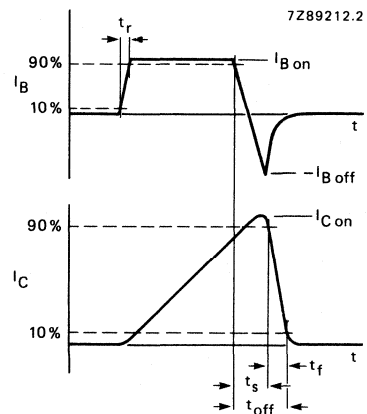


Fig. 7 Switching times waveforms with inductive load.

DEVELOPMENT DATA

This data sheet contains advance information and specifications are subject to change without notice.

BUV26F
BUV26AF

SILICON DIFFUSED POWER TRANSISTORS

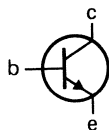
High-voltage, high-speed, glass-passivated npn power transistor in a SOT186 envelope with electrically isolated mounting base, intended for use in converters, inverters, switching regulators, motor control systems, etc.

QUICK REFERENCE DATA

		BUV26F	26AF
Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM}	max. 180	200 V
	V_{CEO}	max. 90	100 V
Collector-emitter saturation voltage	V_{CEsat}	max. 1,5	1,0 V
Collector current saturation DC peak value	I_{Csat}	max. 12	10 A
	I_C	max.	14 A
	I_{CM}	max.	25 A
Total power dissipation up to $T_h = 25\text{ }^\circ\text{C}$	P_{tot}	max. 18	W
Fall time; inductive load	t_f	typ. 40	ns

MECHANICAL DATA

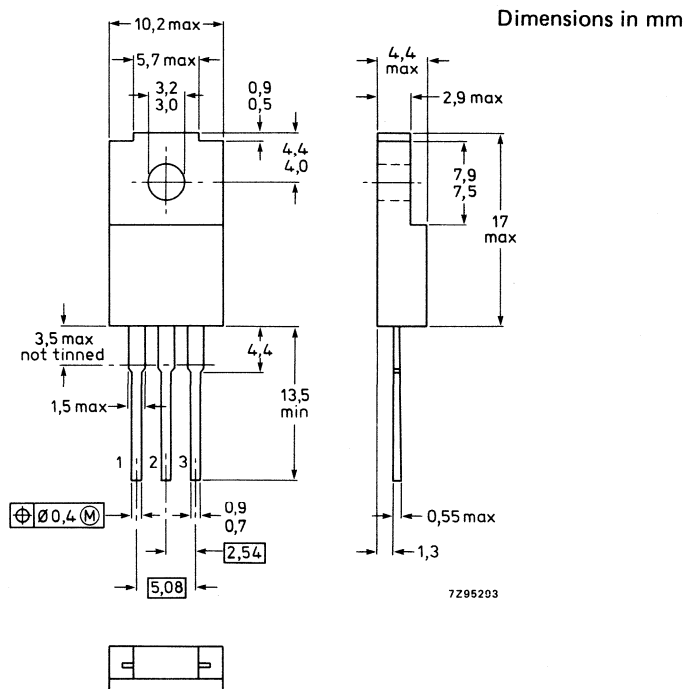
Fig. 1 SOT186.



Pinning:

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

Mounting base is electrically isolated from all terminals.



RATINGS

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

			BUV26F	26AF
Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM}	max.	180	200 V
	V_{CEO}	max.	90	100 V
Collector current saturation DC peak value	I_{Csat}		12	10 A
	I_C	max.	14	A
	I_{CM}	max.	25	A
Base current DC peak value	I_B	max.	4,0	A
	I_{BM}	max.	6,0	A
Total power dissipation up to $T_h = 25\text{ }^\circ\text{C}$	P_{tot}	max.	18	W
Storage temperature range	T_{stg}		-65 to + 150 $^\circ\text{C}$	
Junction temperature	T_j	max.	150	$^\circ\text{C}$
THERMAL RESISTANCE				
From junction to external heatsink (1)	$R_{th\ j-h}$	=	7,0	K/W
From junction to external heatsink (2)	$R_{th\ j-h}$	=	4,5	K/W
From junction to ambient	$R_{th\ j-a}$	=	55	K/W
ISOLATION				
Isolation voltage from all terminals to external heatsink (peak value)	V_{isol}	max.	1500	V
Isolation capacitance from collector to external heatsink	C_{isol}	typ.	12	pF

Notes

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

CHARACTERISTICS

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

Collector cut-off currents

 $V_{CE} = V_{CESmax}; V_{BE} = -1,5\text{ V}; T_j = 125\text{ }^\circ\text{C}$ $V_{CE} = V_{CESmax}; V_{BE} = 0; T_j = 125\text{ }^\circ\text{C}$

I_{CEX}	max.	1,0	mA
I_{CES}	max.	3,0	mA

Emitter cut-off current

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

I_{EBO}	max.	1,0	mA
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Saturation voltages

 $I_C = I_{Csat}; I_B = I_{Csat}/10$

		BUV26F	26AF
V_{CEsat}	max.	1,5	1,0 V
V_{BEsat}	max.	2,0	1,5 V

 $I_C = 6\text{ A}; I_B = I_{Csat}/20$

V_{CEsat}	max.	0,6	— V
V_{BEsat}	max.	1,2	— V

 $I_C = 5\text{ A}; I_B = I_{Csat}/20$

V_{CEsat}	max.	—	0,5 V
V_{BEsat}	max.	—	1,2 V

Collector-emitter sustaining voltage
(Figs 2 and 3) $I_C = 200\text{ mA}; I_B = 0; L = 25\text{ mH}$

$V_{CEO_{sust}}$	min.	90	100 V
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Switching times resistive load
(Figs 4 and 5) $I_{C\text{ on}} = I_{Csat}; I_{B\text{ on}} = I_{Csat}/10$

Turn-on time

t_{on}	typ.	0,4	μs
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Turn-off;

storage time

t_s	typ.	0,45	μs
-------	------	------	---------------

fall time

t_f	typ.	0,12	μs
-------	------	------	---------------

 $I_{C\text{ on}} = I_{Csat}; I_{B\text{ off}} = 2 I_{B\text{ on}}$

Turn-on time

t_{on}	max.	0,6	μs
----------	------	-----	---------------

Turn-off;

storage time

t_s	max.	1,0	μs
-------	------	-----	---------------

fall time

t_f	max.	0,25	μs
-------	------	------	---------------

Switching times inductive load
(Figs 6 and 7) $I_{C\text{ on}} = I_{Csat}; I_{B\text{ on}} = I_{Csat}/10$
at $T_j = 25\text{ }^\circ\text{C}$

Turn-off;

storage time

t_s	typ.	0,5	μs
-------	------	-----	---------------

fall time

t_f	typ.	40	ns
-------	------	----	----

Turn off;

 $T_j = 125\text{ }^\circ\text{C}$

storage time

t_s	max.	2,0	μs
-------	------	-----	---------------

fall time

t_f	max.	150	ns
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DEVELOPMENT DATA

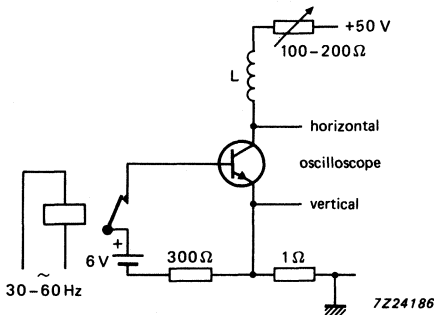


Fig. 2 Test circuit for $V_{CE(sust)}$.

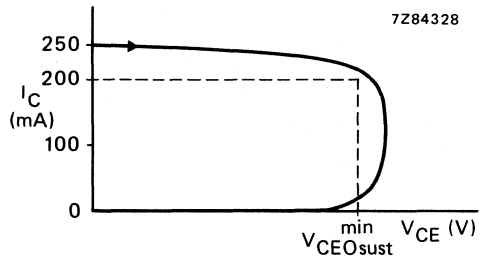


Fig. 3 Oscilloscope display for sustaining voltage.

$V_{CC} = 50\text{ V}$
 $t_p = 20\ \mu\text{s}$
 $V_{IM} = -6\text{ to } +4,5\text{ V}$
 $\frac{t_p}{T} = 0,01$

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

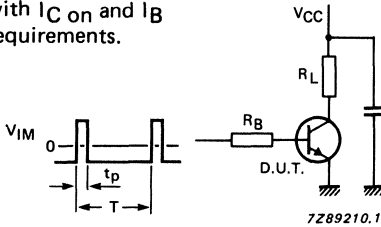


Fig. 4 Test circuit resistive load.

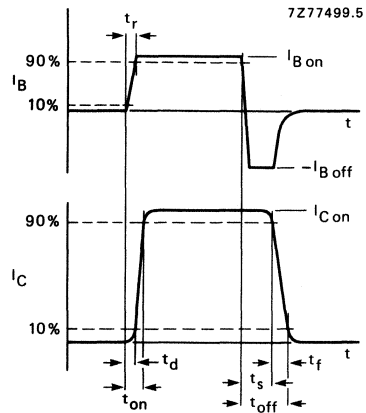


Fig. 5 Switching times waveforms with resistive load; $t_r \leq 30\text{ ns}$.

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

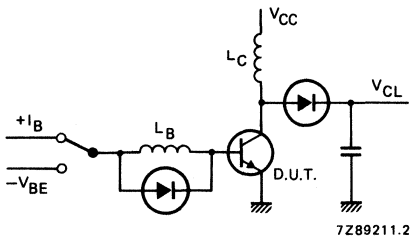


Fig. 6 Test circuit inductive load.

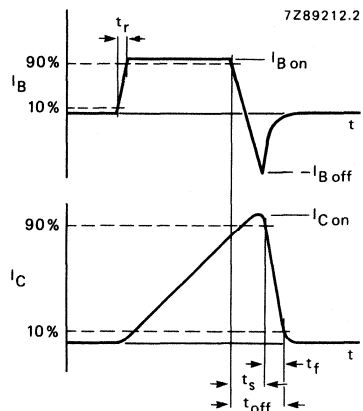
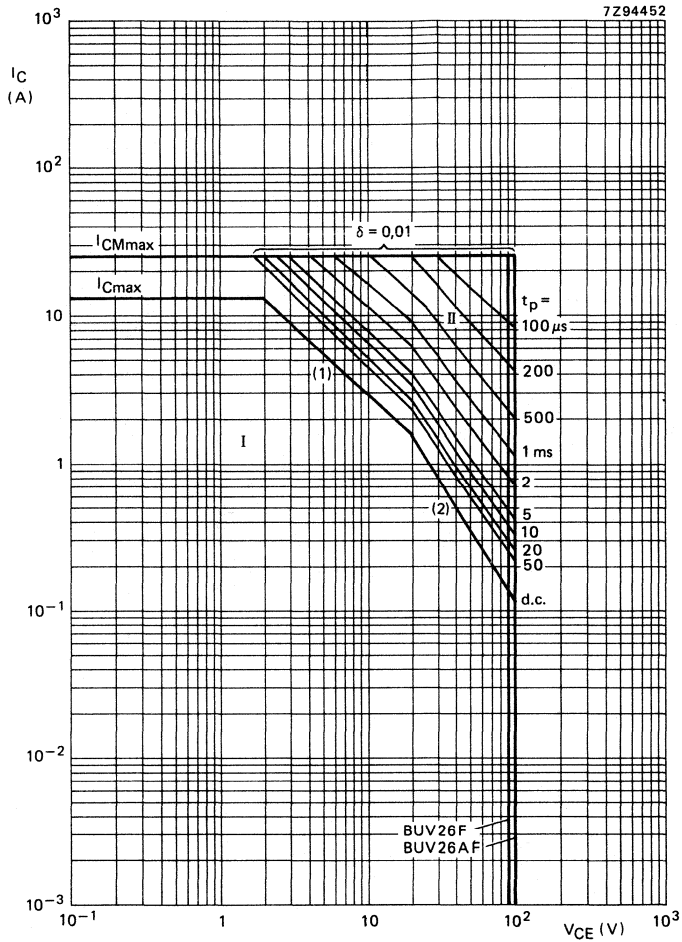


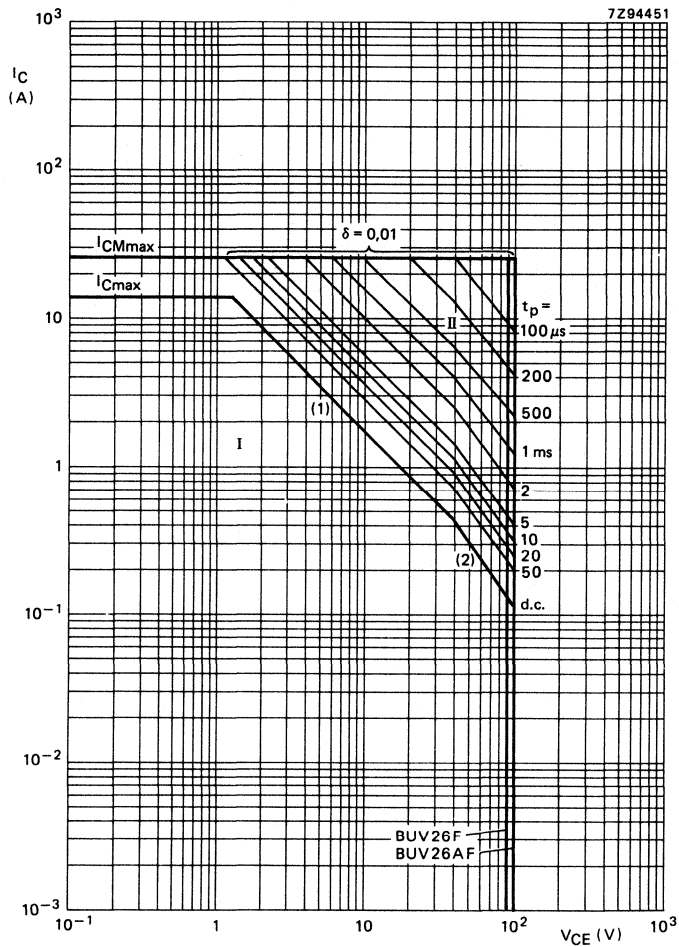
Fig. 7 Switching times waveforms with inductive load.

DEVELOPMENT DATA



- I Region of permissible DC operation
- II Permissible extension for repetitive pulse operation
- (1) $P_{tot\ max}$ and $P_{peak\ max}$ lines
- (2) Second-breakdown limits

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



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

Fig. 9 Safe operating area at $T_{mb} < 25^\circ C$; mounted without heatsink compound and 30 ± 5 newtons pressure on the centre of the envelope.

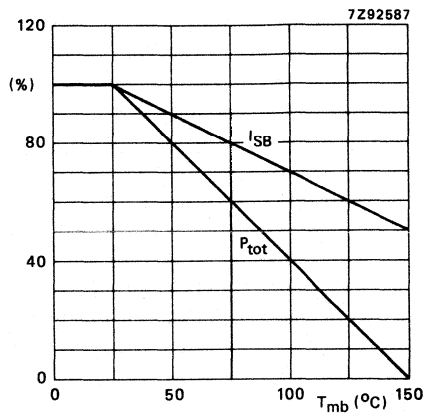


Fig. 10 Total power dissipation and second-breakdown current derating curve.

DEVELOPMENT DATA

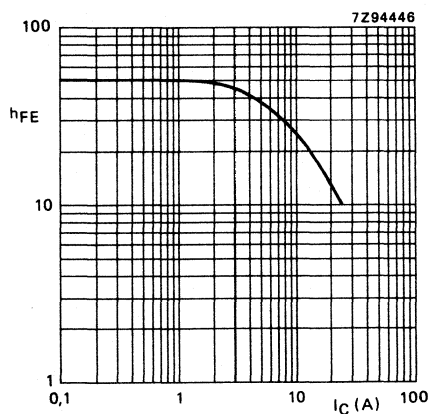


Fig. 11 Typical DC current gain (BUV26F); $V_{CE} = 5$ V; $T_j = 25$ °C.

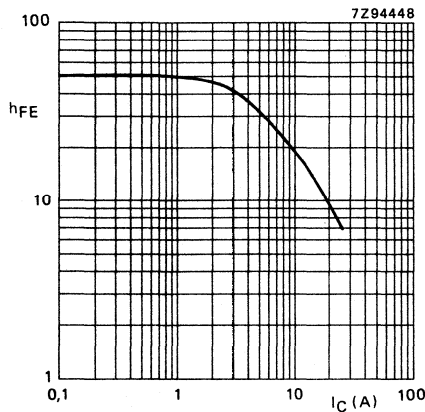


Fig. 12 Typical DC current gain (BUV26AF); $V_{CE} = 5$ V; $T_j = 25$ °C.

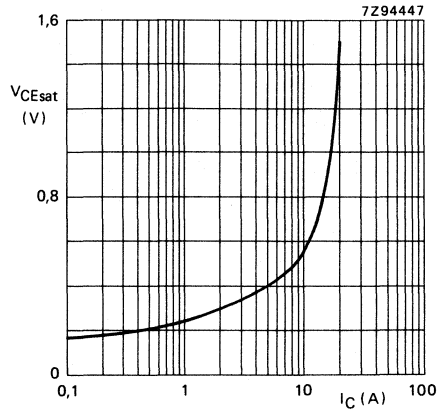


Fig. 13 Collector-emitter saturation voltage as a function of collector current (BUV26F); $I_C/I_B = 10$.

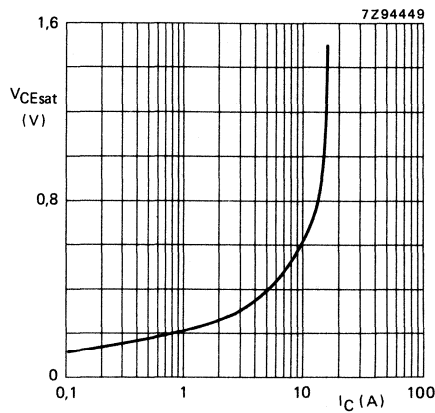


Fig. 14 Collector-emitter saturation voltage as a function of collector current (BUV26AF); $I_C/I_B = 10$.

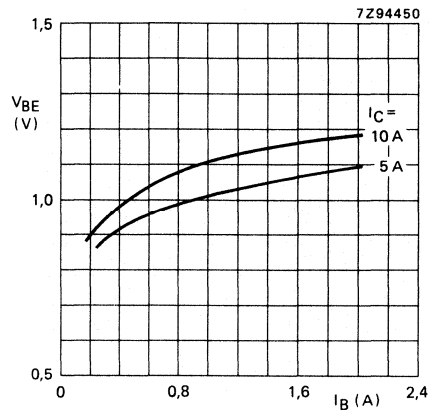


Fig. 15 Base-emitter voltage as a function of base current; $T_j = 25$ °C.

DEVELOPMENT DATA

This data sheet contains advance information and specifications are subject to change without notice.

BUV27
BUV27A

SILICON POWER TRANSISTORS

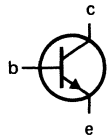
High-speed, glass-passivated npn power transistors in a TO-220 envelope intended for fast switching applications such as high frequency and efficiency converters, switching regulators and motor control.

QUICK REFERENCE DATA

		BUV27	27A
Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM}	max. 240	300 V
	V_{CEO}	max. 120	150 V
Collector-emitter saturation voltage	V_{CEsat}	max. 1,5	1,0 V
Collector current saturation DC peak value	I_{Csat}	8,0	7,0 A
	I_C	max. 15	A
	I_{CM}	max. 25	A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max. 65	W
Fall time; inductive load	t_f	typ. 40	ns

MECHANICAL DATA

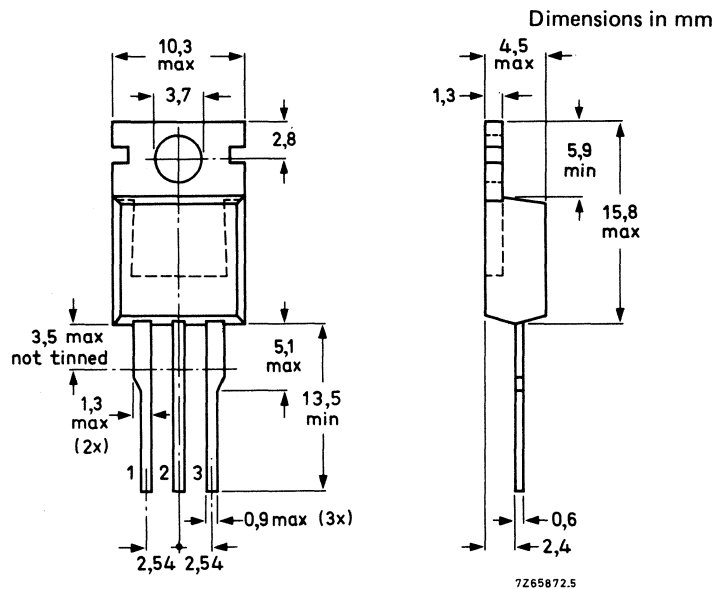
Fig. 1 TO-220AB.



Pinning:

b = base
c = collector
e = emitter

Collector connected to
mounting base.



RATINGS

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

		BUV27	27A	
Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM}	max. 240	300	V
	V_{CEO}	max. 120	150	V
Collector current saturation DC peak value	I_{Csat}	8,0	7,0	A
	I_C	max. 15	15	A
	I_{CM}	max. 25	25	A
Base current DC peak value	I_B	max. 4,0	4,0	A
	I_{BM}	max. 6,0	6,0	A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max. 65	65	W
Storage temperature	T_{stg}	-65 to + 150		$^\circ\text{C}$
Junction temperature	T_j	max. 150	150	$^\circ\text{C}$
THERMAL RESISTANCE				
From junction to mounting base	$R_{th\ j-mb}$	=	1,92	K/W

CHARACTERISTICS

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

Collector cut-off currents*

 $V_{CE} = V_{CEsmax}; V_{BE} = -1,5\text{ V};$
 $T_j = 125\text{ }^\circ\text{C}$ I_{CEX} max. 1,0 mA $V_{CE} = V_{CEsmax}; R_{BE} = 50\ \Omega;$
 $T_j = 125\text{ }^\circ\text{C}$ I_{CER} max. 3,0 mA

Emitter cut-off current

 $V_{EB} = 5\text{ V}; I_C = 0$ I_{EBO} max. 1,0 mACollector-emitter sustaining voltage
(Figs 2 and 3) $I_B = 0; I_C = 0,2\text{ A}; L = 25\text{ mH}$

		BUV27	27A	
$V_{CEO_{sust}}$	min.	120	150	V

Saturation voltages

 $I_C = I_{Csat}; I_B = I_{Csat}/10$ V_{CEsat} max. 1,5 V V_{BEsat} max. 2,0 V $I_C = I_{Csat}/2; I_B = I_{Csat}/20$ V_{CEsat} max. 0,7 VSwitching times resistive load
(Figs 4 and 5) $I_{Con} = I_{Csat}; I_{Bon} = I_{Csat}/10;$ $I_{Boff} = 2I_{Bon}; V_{CE} = 50\text{ V}$

Turn-on time

 t_{on} typ. 0,4 μs Turn-off; storage time
fall time t_s typ. 0,5 μs t_f typ. 0,12 μs

Turn-on time

 t_{on} max. 0,8 μs Turn-off; storage time
fall time t_s max. 1,2 μs t_f max. 0,4 μs Switching times inductive load
(Figs 6 and 7) $I_{Con} = I_{Csat}; I_{Bon} = I_{Csat}/10;$ $V_{CC} = V_{CL} = 50\text{ V}; L_B = 1\ \mu\text{H};$ $-V_B = 5\text{ V}$ Turn-off; storage time at $T_j = 25\text{ }^\circ\text{C}$ t_s typ. 0,6 μs t_f typ. 40 nsfall time at $T_j = 125\text{ }^\circ\text{C}$ t_s max. 2,0 μs t_f max. 150 ns

DEVELOPMENT DATA

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

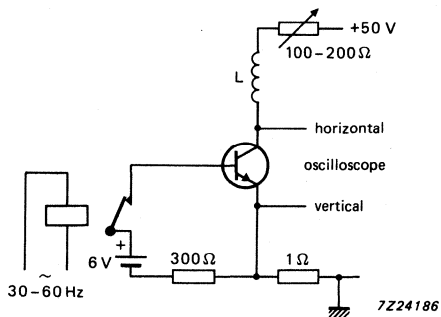


Fig. 2 Test circuit for V_{CEsust} .

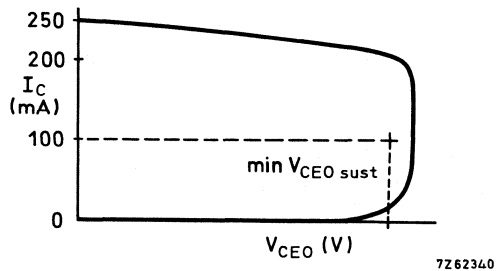


Fig. 3 Oscilloscope display for sustaining voltage.

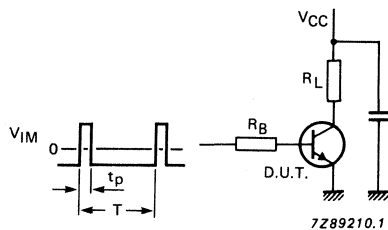


Fig. 4 Test circuit resistive load.

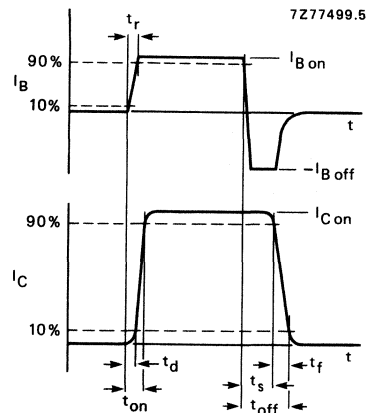


Fig. 5 Switching times waveforms with restrictive load; $t_r \leq 30$ ns.

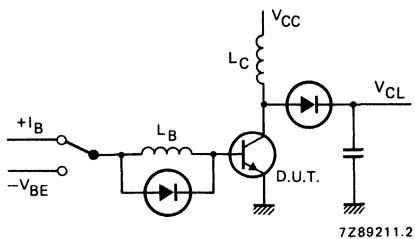


Fig. 6 Test circuit inductive load.
 $V_{CC} = 50$ V; $V_{CL} = 50$ V.

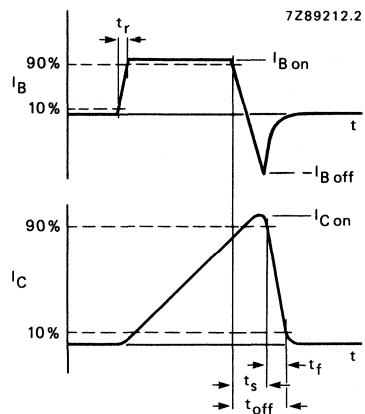


Fig. 7 Switching times waveforms with inductive load.

DEVELOPMENT DATA

This data sheet contains advance information and specifications are subject to change without notice.

BUV27F
BUV27AF

SILICON DIFFUSED POWER TRANSISTORS

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

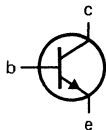
QUICK REFERENCE DATA

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

MECHANICAL DATA

Dimensions in mm

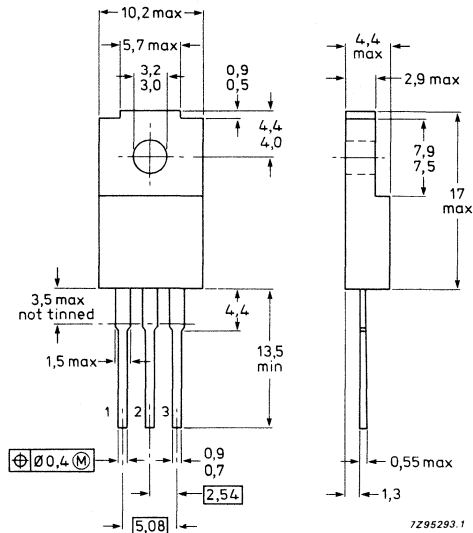
Fig. 1 SOT186.



Pinning:

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

Mounting base is electrically isolated from all terminals.



BUV27F BUV27AF

RATINGS

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

			BUV27F	27AF
Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM}	max.	240	300 V
	V_{CEO}	max.	120	150 V
Collector current saturation DC peak value	I_{Csat}	max.	8.0	7.0 A
	I_C	max.		15 A
	I_{CM}	max.		20 A
Base current DC peak value	I_B	max.		4.0 A
	I_{BM}	max.		6.0 A
Total power dissipation up to $T_H = 25\text{ }^\circ\text{C}$	P_{tot}	max.		18 W
Storage temperature range	T_{stg}		-65 to + 150 $^\circ\text{C}$	
Junction temperature	T_j	max.		150 $^\circ\text{C}$
THERMAL RESISTANCE				
From junction to mounting base (note 1)	$R_{th\ j-mb}$	=		7.0 K/W
From junction to mounting base (note 2)	$R_{th\ j-mb}$	=		4.5 K/W
From junction to ambient	$R_{th\ j-a}$	=		55 K/W
INSULATION				
Insulation voltage from all terminals to external heatsink (peak value)	V_{isol}	max.		1500 V
Insulation capacitance from collector to external heatsink	C_{isol}	typ.		12 pF

Notes

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

CHARACTERISTICS

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

Collector cut-off currents

$V_{CE} = V_{CESmax}; V_{BE} = -1.5\text{ V}; T_j = 125\text{ }^\circ\text{C}$
 $V_{CE} = V_{CESmax}; V_{BE} = 0\text{ V}; T_j = 125\text{ }^\circ\text{C}$

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

Emitter cut-off current

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

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

Saturation voltages

$I_C = I_{Csat}; I_B = I_{Csat}/10$

		BUV27F	27AF
V_{CEsat}	max.	1.5	1.0 V
V_{BEsat}	max.	2.0	2.0 V

Collector-emitter sustaining voltage (Figs 2 and 3)

$I_C = 200\text{ mA}; I_B = 0; L = 25\text{ mH}$

$V_{CEOsust}$	min.	120	150 V
---------------	------	-----	-------

Switching times resistive load (Figs 4 and 5)

$I_C = I_{Csat}; I_{B\text{ on}} = I_{Csat}/10; I_{B\text{ off}} = 2I_{B\text{ on}}$

Turn-on time

t_{on}	typ.	0.4	μs
----------	------	-----	---------------

Turn-off; storage time
fall time

t_s	typ.	0.5	μs
t_f	typ.	0.12	μs

Turn-on time

t_{on}	max.	0.8	μs
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Turn-off; storage time
fall time

t_s	max.	1.2	μs
t_f	max.	0.4	μs

Switching times inductive load (Figs 6 and 7)

$I_C = I_{Csat}; I_{B\text{ on}} = I_{Csat}/10$
 $V_{BE\text{ off}} = -5\text{ V}$

Turn-off; storage time at $T_j = 25\text{ }^\circ\text{C}$
fall time

t_s	typ.	0.6	μs
t_f	typ.	40	ns

Turn-off; storage time at $T_j = 125\text{ }^\circ\text{C}$
fall time

t_s	max.	2.0	μs
t_f	max.	150	ns

DEVELOPMENT DATA

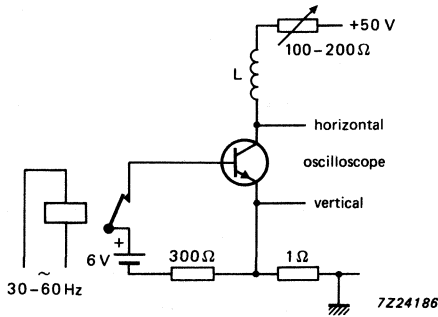


Fig. 2 Test circuit for $V_{CEOsust}$.

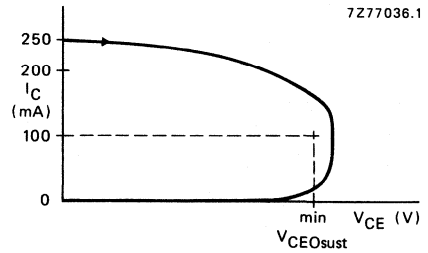
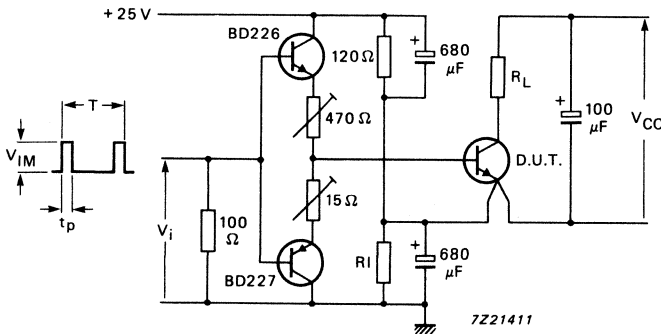


Fig. 3 Oscilloscope display for sustaining voltage.



$t_p = 20 \mu s$
 $T = 2 ms$
 $V_{IM} = 15 V$

Fig. 4 Test circuit resistive load; $V_{CC} = 50 V$;
 $R_L = 100 \Omega$; $R_1 = 82 \Omega$.

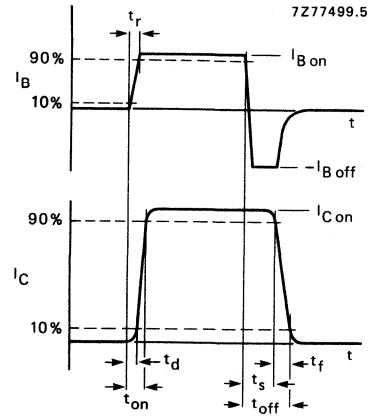
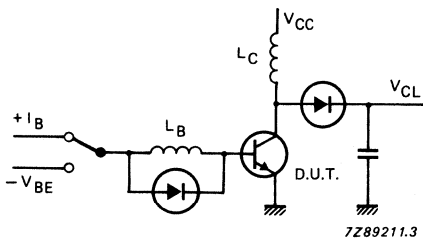


Fig. 5 Switching time waveforms with resistive load; $t_r \leq 30 ns$.



$V_{clamp} = 40 V$
 $-V_{BE} = -5 V$

Fig. 6 Test circuit inductive load; $V_{CC} = 50 V$;
 $L_C = 200 \mu H$.

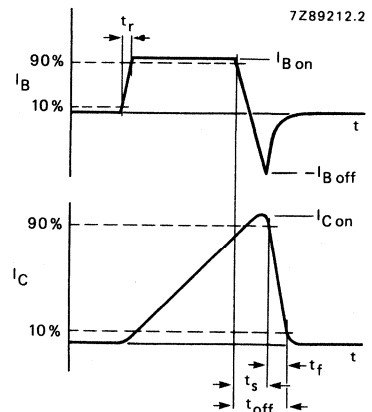
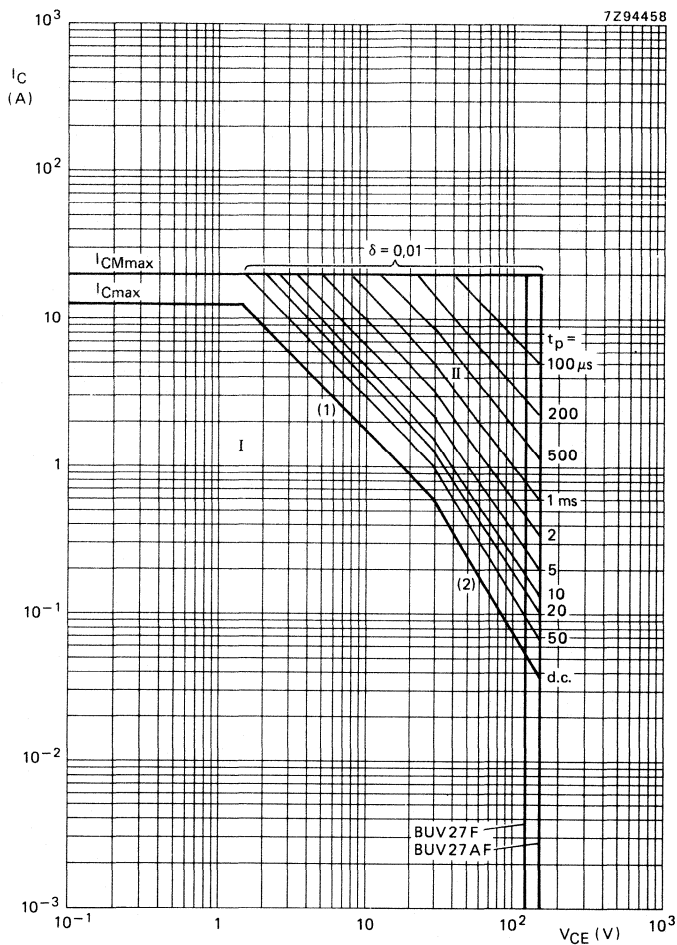


Fig. 7 Switching times waveforms with inductive load.

DEVELOPMENT DATA



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

- (1) P_{tot} and $P_{tot max}$ lines.
- (2) Second-breakdown limits (independent of temperature).

Fig. 8 Forward bias SOAR at $T_{mb} < 25^\circ C$; mounted without heatsink compound and 30 ± 5 newtons pressure on the centre of the envelope.

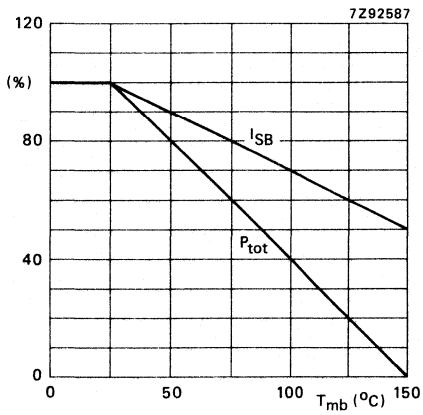


Fig. 9 Power dissipation and second-breakdown current derating curve.

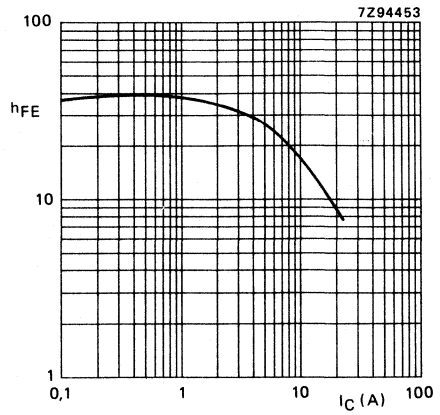


Fig. 10 Typical DC current gain; $V_{CE} = 5\text{ V}$; $T_j = 25\text{ }^\circ\text{C}$.

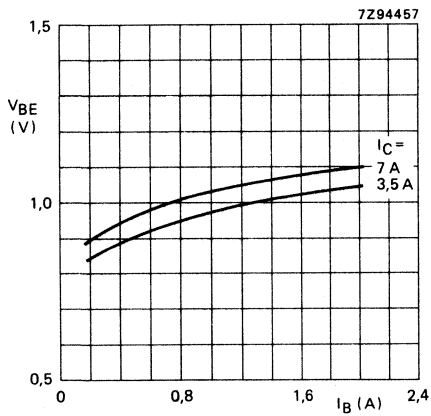


Fig. 11 Base-emitter voltage as a function of base current.

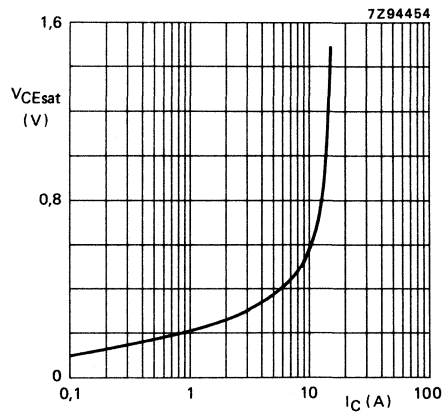


Fig. 12 Collector-emitter saturation voltage as a function of collector current; $I_C/I_B = 10$.

DEVELOPMENT DATA

This data sheet contains advance information and specifications are subject to change without notice.

BUV28
BUV28A

SILICON DIFFUSED POWER TRANSISTORS

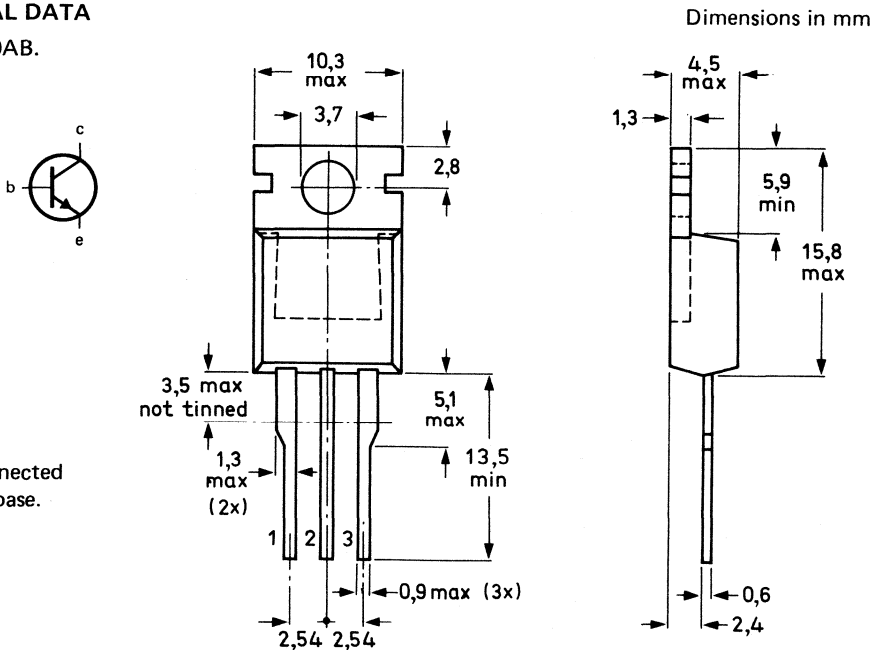
High-speed, glass-passivated npn transistors in a TO-220 envelope intended for fast switching applications such as high frequency and efficiency converters, switching regulators and motor controls.

QUICK REFERENCE DATA

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

MECHANICAL DATA

Fig. 1 TO-220AB.



Pinning:

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

Collector connected
to mounting base.

7Z65872.5

RATINGS

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

		BUV28	28A
Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM}	max. 400	450 V
	V_{CEO}	max. 200	225 V
Collector current	I_{Csat}	max. 6,0	4,0 A
	I_C	max.	12 A
	I_{CM}	max.	20 A
Base current	I_B	max.	2,0 A
	I_{BM}	max.	4,0 A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	65 W
Storage temperature range	T_{stg}		-65 to + 150 $^\circ\text{C}$
Junction temperature	T_j	max.	150 $^\circ\text{C}$
THERMAL RESISTANCE			
From junction to mounting base	R_{thj-mb}	=	1,92 K/W

CHARACTERISTICS

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

Collector cut-off currents*

$V_{CE} = V_{CESMmax}; V_{BE} = -1,5\text{ V}$
 $T_j = 125\text{ }^\circ\text{C}$

$V_{CE} = V_{CESMmax}; R_{BE} = 50\ \Omega;$
 $T_j = 125\text{ }^\circ\text{C}$

Emitter cut-off current

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

I_{CEX} max. 1,0 mA

I_{CER} max. 3,0 mA

I_{EBO} max. 1,0 mA

Saturation voltages

$I_C = I_{Csat}; I_B = I_{Csat}/10$

$I_C = I_{Csat}/2; I_B = I_{Csat}/20$

Collector-emitter sustaining voltage

(Figs 2 and 3)

$I_C = 0,2\text{ A}; I_B = 0; L = 25\text{ mH}$

Switching times resistive load

(Figs 4 and 5)

$I_{C\ on} = I_{Csat}; I_{B\ on} = I_{Csat}/10;$

$I_{B\ off} = 2I_{B\ on}; V_{CE} = 50\text{ V}$

Turn-on time

t_{on} typ. 0,3 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)

$I_{C\ on} = I_{Csat}; I_{B\ on} = I_{Csat}/10;$

$L_B = 3\ \mu\text{H}; -V_B = 5\text{ V};$

$V_{CC} = V_{CL} = 50\text{ V}$

Turn-off;

storage time at $T_j = 25\text{ }^\circ\text{C}$

t_s typ. 1,0 μs

fall time

t_f typ. 40 ns

Turn-off;

storage time at $T_j = 125\text{ }^\circ\text{C}$

t_s max. 3,0 μs

fall time

t_f max. 200 ns

DEVELOPMENT DATA

	BUV28	28A
V_{CEsat}	max. 1,5	1,5 V
V_{BEsat}	max. 2,0	2,0 V
V_{CEsat}	max. 0,7	0,7 V
$V_{CEO\ sust}$	min. 200	225 V

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

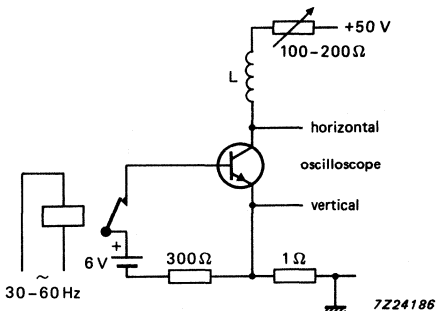


Fig. 2 Test circuit for $V_{CEOsust}$.

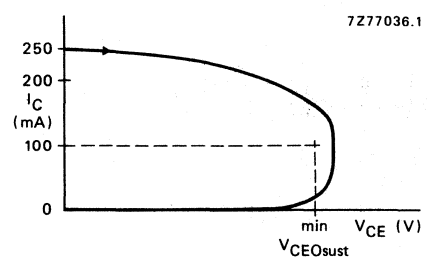
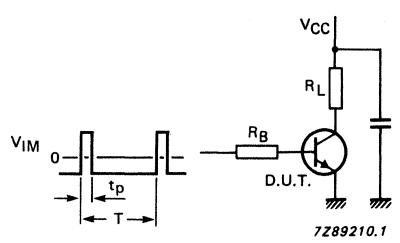


Fig. 3 Oscilloscope display for sustaining voltage.



$V_{CC} = 50\text{ V}$
 $t_p = 20\ \mu\text{s}$
 $V_{IM} = -6\text{ to } +4,5\text{ V}$
 $\frac{t_p}{T} = 0,01$

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

Fig. 4 Test circuit resistive load.

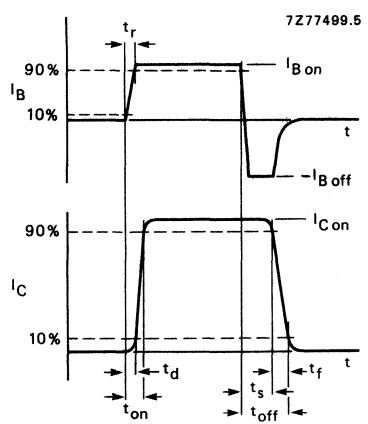
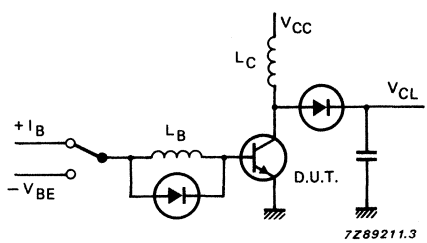


Fig. 5 Switching times waveforms with resistive load; $t_r \leq 30\text{ ns}$.



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

Fig. 6 Test circuit inductive load.

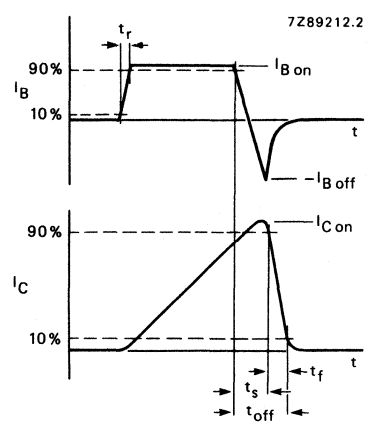


Fig. 7 Switching times waveforms with inductive load.

DEVELOPMENT DATA

This data sheet contains advance information and specifications are subject to change without notice.

BUV28F
BUV28AF

SILICON DIFFUSED POWER TRANSISTORS

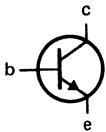
High-voltage, high-speed, glass-passivated npn power transistor in a SOT186 envelope with electrically isolated mounting base, intended for use in converters, inverters, switching regulators, motor control systems, etc.

QUICK REFERENCE DATA

		BUV28F	28AF
Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM}	max. 400	450 V
	V_{CEO}	max. 200	225 V
Collector-emitter saturation voltage	V_{CEsat}	max. 1.5	1.5 V
Collector current	saturation	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 $T_h = 25^\circ\text{C}$	P_{tot}	max. 18	W
Fall time; inductive load	t_f	typ. 40	ns

MECHANICAL DATA

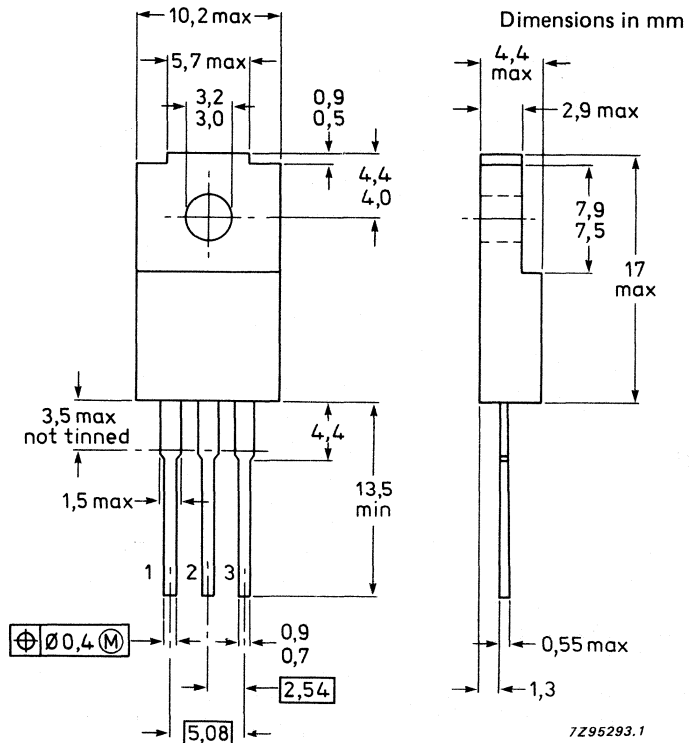
Fig. 1 SOT186.



Pinning:

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

Mounting base is electrically isolated from all terminals.



7Z95293.1

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 $T_h = 25\text{ }^\circ\text{C}$	P_{tot}	max.		18 W
Storage temperature range	T_{stg}		-65 to + 150 $^\circ\text{C}$	
Junction temperature	T_j	max.		150 $^\circ\text{C}$
THERMAL RESISTANCE				
From junction to heatsink (note 1)	$R_{th\ j-h}$	=		7.0 K/W
From junction to heatsink (note 2)	$R_{th\ j-h}$	=		4.5 K/W
From junction to ambient	$R_{th\ j-a}$	=		55 K/W
ISOLATION				
Isolation voltage from all terminals to external heatsink (peak value)	V_{isol}	max.		1500 V
Isolation capacitance from collector to external heatsink	C_{isol}	typ.		12 pF

Notes

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

CHARACTERISTICS

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

Collector cut-off currents

 $V_{CE} = V_{CESmax}; V_{BE} = -1.5\text{ V}; T_j = 125\text{ }^\circ\text{C}$ $V_{CE} = V_{CESmax}; V_{BE} = 0\text{ V}; T_j = 125\text{ }^\circ\text{C}$ I_{CEX} max. 1.0 mA I_{CES} max. 3.0 mA

Emitter cut-off current

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

Saturation voltages

 $I_C = I_{Csat}; I_B = I_{Csat}/10$ V_{CEsat} max. 1.5 V V_{BEsat} max. 2.0 V

Collector-emitter sustaining voltage (Figs 2 and 3)

 $I_C = 200\text{ mA}; I_B = 0; L = 25\text{ mH}$ $V_{CEO_{sust}}$ min. 200 V

Switching times resistive load (Figs 4 and 5)

 $I_{C\text{ on}} = I_{Csat}; I_{B\text{ on}} = I_{Csat}/10; I_{B\text{ off}} = 2I_{B\text{ on}}$

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)

 $I_C = I_{Csat}; I_{B\text{ on}} = I_{Csat}/10$ at $T_j = 25\text{ }^\circ\text{C}$ Turn-off; storage time at $T_j = 25\text{ }^\circ\text{C}$ t_s typ. 1.0 μs

fall time

 t_f typ. 40 nsTurn-off; storage time at $T_j = 125\text{ }^\circ\text{C}$ t_s typ. 3.0 μs

fall time

 t_f max. 200 ns

DEVELOPMENT DATA

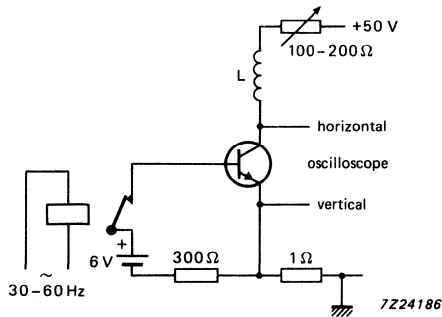


Fig. 2 Test circuit for $V_{CE0\text{sust}}$.

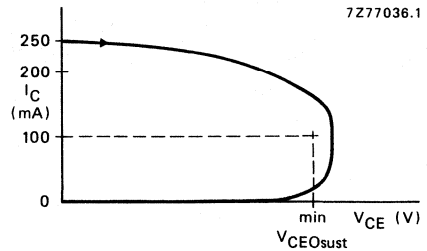
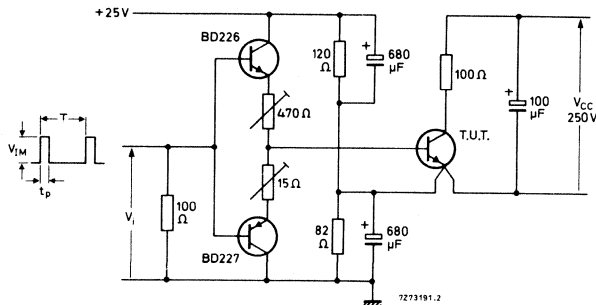


Fig. 3 Oscilloscope display for sustaining voltage.



$t_p = 20 \mu\text{s}$
 $T = 2 \text{ ms}$
 $V_{IM} = 15 \text{ V}$

Fig. 4 Test circuit resistive load; $V_{CC} = 50 \text{ V}$;
 $R_L = 4 \Omega$; $R_1 = 82 \Omega$.

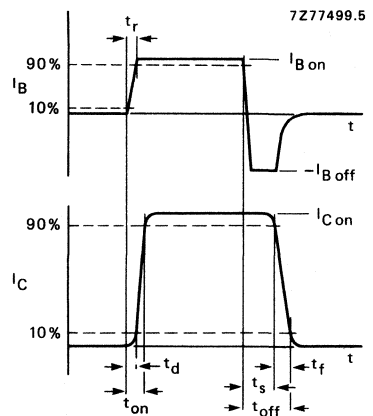


Fig. 5 Switching times waveforms with resistive load; $t_r \leq 30 \text{ ns}$.

$V_{\text{clamp}} = 40 \text{ V}$
 $-V_{BE} = -5 \text{ V}$
 $L_B = 0.5 \mu\text{H}$

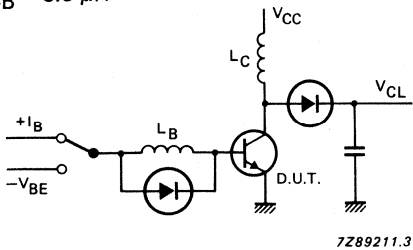


Fig. 6 Test circuit inductive load; $V_{CC} = 30 \text{ V}$;
 $L_C = 200 \mu\text{H}$.

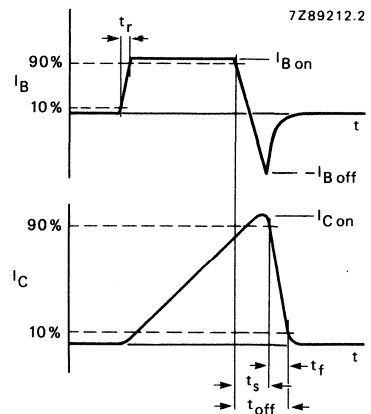
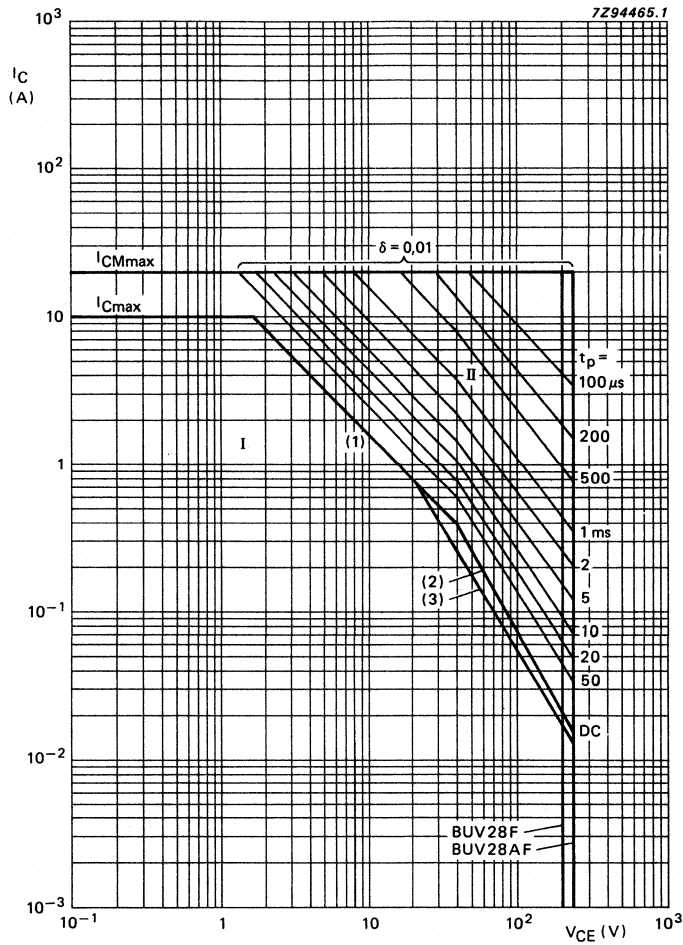


Fig. 7 Switching times waveforms with inductive load.

DEVELOPMENT DATA



- 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 $T_{mb} < 25$ °C.

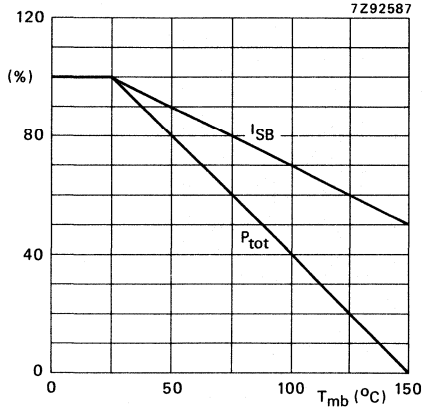


Fig. 9 Power dissipation and second-breakdown current derating curve.

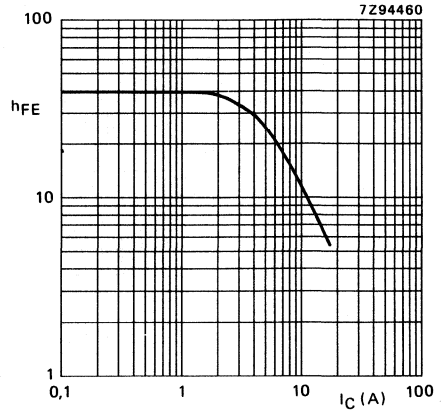


Fig. 10 Typical DC current gain; $V_{CE} = 5 \text{ V}$; $T_j = 25 \text{ }^\circ\text{C}$.

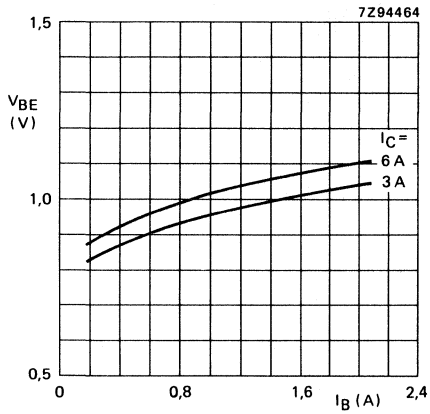


Fig. 11 Base-emitter voltage as a function of base current.

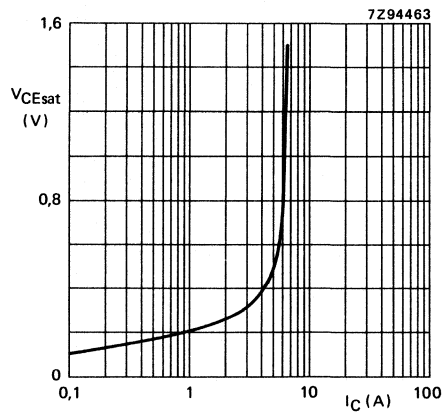


Fig. 12 Collector-emitter saturation voltage as a function of collector current; $I_C/I_B = 10$.

DEVELOPMENT DATA

This data sheet contains advance information and specifications are subject to change without notice.

BUV47
BUV47A

SILICON DIFFUSED POWER TRANSISTORS

High-voltage, high-speed, glass-passivated npn power transistors in a SOT93 envelope, intended for use in converters, inverters, switching regulators, motor control systems etc.

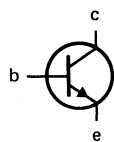
QUICK REFERENCE DATA

		BUV47	47A
Collector-emitter voltage (peak value; $V_{BE} = 0$)	V_{CESM} max.	850	1000 V
Collector-emitter voltage (open base)	V_{CEO} max.	400	450 V
Collector current (DC)	I_C max.	9	A
Collector current (peak value)	I_{CM} max.	15	A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot} max.	120	W
Collector-emitter saturation voltage	V_{CEsat} max.	—	— V
$I_C = 6\text{ A}; I_B = 1,2\text{ A}$	V_{CEsat} max.	1,5	1,5 V
$I_C = 5\text{ A}; I_B = 1,0\text{ A}$			
Fall time (resistive load)	t_f max.	—	— μs
$I_{Con} = 6\text{ A}; I_{Bon} = -I_{Boff} = 1,2\text{ A}$	t_f max.	0,8	0,8 μs
$I_{Con} = 5\text{ A}; I_{Bon} = -I_{Boff} = 1,0\text{ A}$			

MECHANICAL DATA

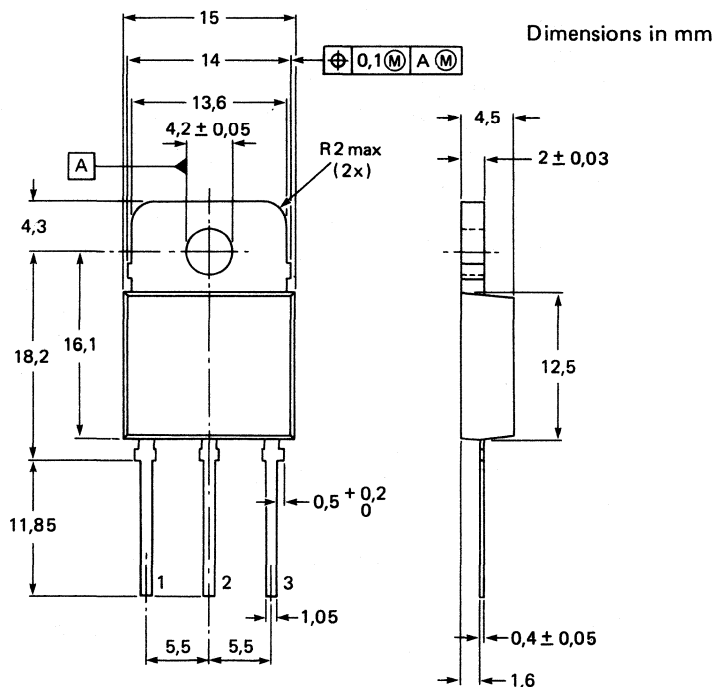
Fig. 1 SOT93.

Collector connected to mounting base.



Pinning:

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



7Z96696

RATINGS

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

		BUV47	47A
Collector-emitter voltage (peak value; $V_{BE} = 0$)	V_{CESM} max.	850	1000 V
Collector-emitter voltage (open base)	V_{CEO} max.	400	450 V
Emitter-base voltage	V_{EBO} max.	7	V
Collector current (DC)	I_C max.	9	A
Collector current (peak value)	I_{CM} max.	15	A
Base current (DC)	I_B max.	3	A
Base current (peak value)	I_{BM} max.	6	A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot} max.	120	W
Storage temperature	T_{stg}	-65 to + 175	$^\circ\text{C}$
Junction temperature	T_j max.	175	$^\circ\text{C}$

THERMAL RESISTANCE

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

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

Collector cut-off current*

$V_{CE} = V_{CEXmax}; V_{BE} = -2,5\text{ V}$

$V_{CE} = V_{CEXmax}; V_{BE} = -2,5\text{ V}; T_j = 125\text{ }^\circ\text{C}$

$V_{CE} = V_{CEXmax}; R_{BE} = 10\ \Omega$

$V_{CE} = V_{CEXmax}; R_{BE} = 10\ \Omega; T_j = 125\text{ }^\circ\text{C}$

Emitter cut-off current

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

Collector-emitter sustaining voltage

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

I_{CES} max.	0,15	mA
I_{CES} max.	1,5	mA
I_{CER} max.	0,4	mA
I_{CER} max.	3,0	mA
I_{EBO} max.	1,0	mA
$V_{CEO_{sust}}$ min.	400	450 V

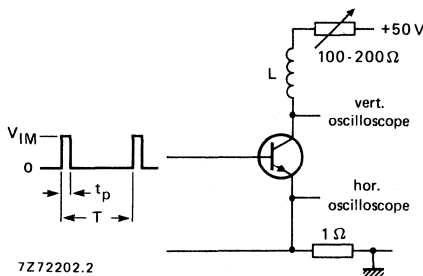


Fig. 2 Test circuit for $V_{CEO_{sust}}$.
 $V_{IM} = 6\text{ V}; t_p = 40\text{ ms}; \delta = 0,5; R_B = 300\ \Omega$.

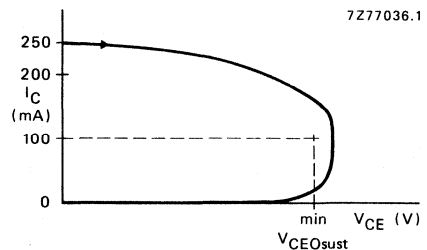


Fig. 3 Oscilloscope display for sustaining voltage.

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

DEVELOPMENT DATA

Saturation voltages

$I_C = 9 \text{ A}; I_B = 3 \text{ A}$

$I_C = 6 \text{ A}; I_B = 1,2 \text{ A}$

$I_C = 8 \text{ A}; I_B = 2,5 \text{ A}$

$I_C = 5 \text{ A}; I_B = 1 \text{ A}$

Switching times resistive load (Figs 4 and 5)

$I_{Con} = 6 \text{ A}; I_{Bon} = -I_{Boff} = 1,2 \text{ A}$

Turn-on time

Turn-off: Storage time

Fall time

$I_{Con} = 5 \text{ A}; I_{Bon} = -I_{Boff} = 1 \text{ A}$

Turn-on time

Turn-off: Storage time

Fall time

BUV47 | 47A

		BUV47	47A
V_{CEsat}	max.	—	— V
	typ.	—	— V
	max.	—	— V
V_{BEsat}	max.	—	— V
V_{CEsat}	max.	3	3 V
	typ.	0,6	0,6 V
V_{CEsat}	max.	1,5	1,5 V
	max.	1,6	1,6 V
t_{on}	typ.	—	— μs
	max.	—	— μs
t_s	typ.	—	— μs
	max.	—	— μs
t_f	typ.	—	— μs
	max.	—	— μs
t_{on}	typ.	0,34	0,34 μs
	max.	1,0	1,0 μs
t_s	typ.	1,75	1,75 μs
	max.	3,0	3,0 μs
t_f	typ.	0,36	0,36 μs
	max.	0,8	0,8 μs

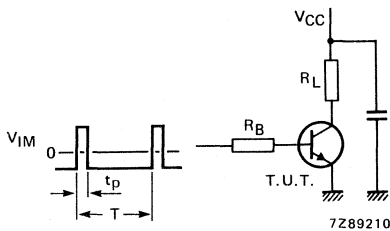


Fig. 4 Test circuit resistive load.
 $V_{CC} = 150 \text{ V}; V_{IM} = -6 \text{ to } +8 \text{ V};$
 $t_p/T = 0,01; t_p = 20 \mu\text{s}.$

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

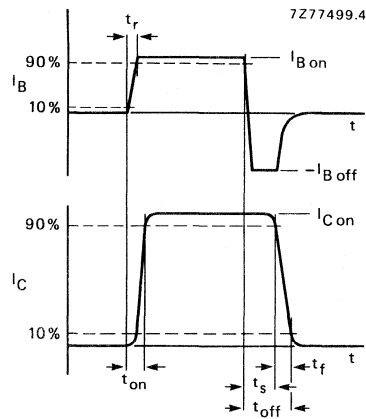


Fig. 5 Switching times waveforms with resistive load.

CHARACTERISTICS (continued)

Switching times inductive load (Figs 6 and 7)

$I_{Con} = 6 \text{ A}; I_{Bon} = 1,2 \text{ A}$

Turn-off: Storage time
Fall time

$I_{Con} = 6 \text{ A}; I_{Bon} = 1,2 \text{ A}; T_j = 100 \text{ }^\circ\text{C}$

Turn-off: Storage time
Fall time

$I_{Con} = 5 \text{ A}; I_{Bon} = 1,0 \text{ A}$

Turn-off: Storage time
Fall time

$I_{Con} = 5 \text{ A}; I_{Bon} = 1,0 \text{ A}; T_j = 100 \text{ }^\circ\text{C}$

Turn-off: Storage time
Fall time

		BUV47	47A
t_s	typ.		
t_f	typ.	—	— ns
t_s	max.		
t_f	max.	—	— μs
t_s	typ.		
t_f	typ.	90	90 ns
t_s	max.		
t_f	max.	0,4	0,4 μs

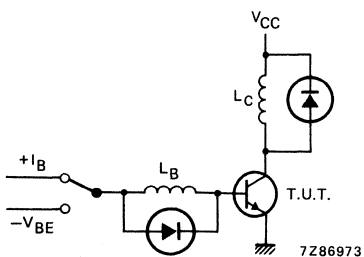


Fig. 6 Test circuit inductive load.
 $V_{CC} = 300 \text{ V}; -V_{BE} = 5 \text{ V};$
 $L_B = 3 \mu\text{H}; L_C = 1 \text{ mH}.$

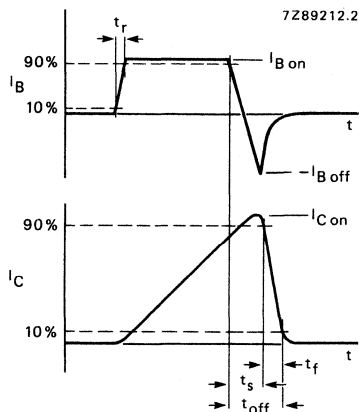
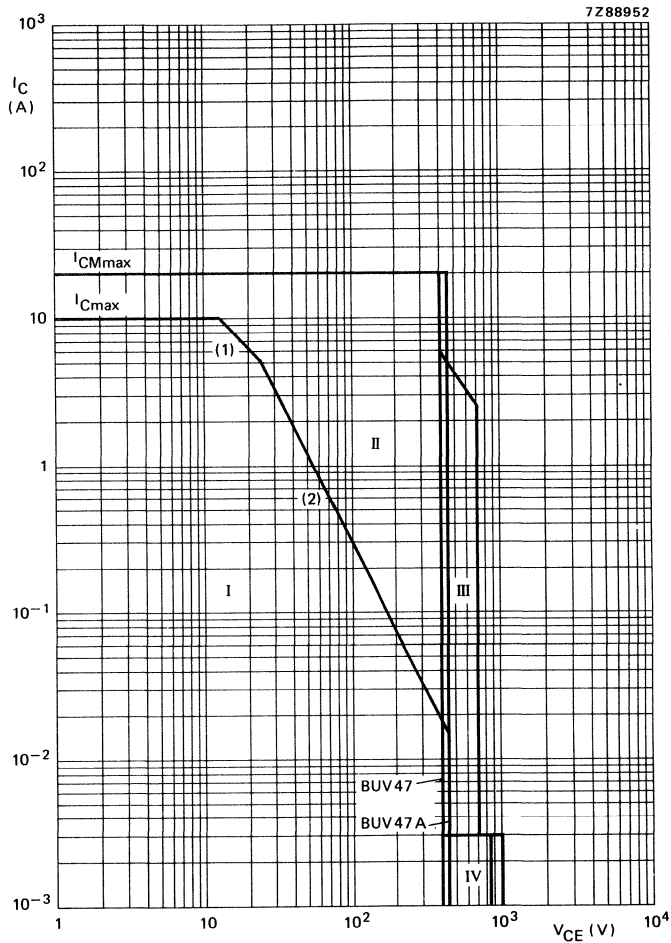


Fig. 7 Switching times waveforms with inductive load.



(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 $R_{BE} \leq 100 \Omega$ and $t_p \leq 0,6 \mu s$.

IV Repetitive pulse operation in this region is permissible provided $V_{BE} \leq 0$ and $t_p \leq 2 ms$.

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

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

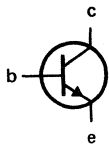
		BUV48		BUV48A	
Collector-emitter voltage (peak value; $V_{BE} = 0$)	V_{CESM}	max.	850	1000	V
Collector-emitter voltage (open base)	V_{CEO}	max.	400	450	V
Collector current (DC)	I_C	max.	15	15	A
Collector current (peak value)	I_{CM}	max.	30	30	A
Total power dissipation up to $T_{mb} = 25^\circ\text{C}$	P_{tot}	max.	150	150	W
Collector-emitter saturation voltage $I_C = 10\text{ A}; I_B = 2\text{ A}$ $I_C = 8\text{ A}; I_B = 1.8\text{ A}$	V_{CEsat}	max.	1.5	—	V
	V_{CEsat}	max.	—	1.5	V
Fall time (resistive load) $I_{Con} = 10\text{ A}; I_{Bon} = -I_{Boff} = 2\text{ A}$ $I_{Con} = 8\text{ A}; I_{Bon} = -I_{Boff} = 1.6\text{ A}$	t_f	max.	0.8	—	μs
	t_f	max.	—	0.8	μs

MECHANICAL DATA

Dimensions in mm

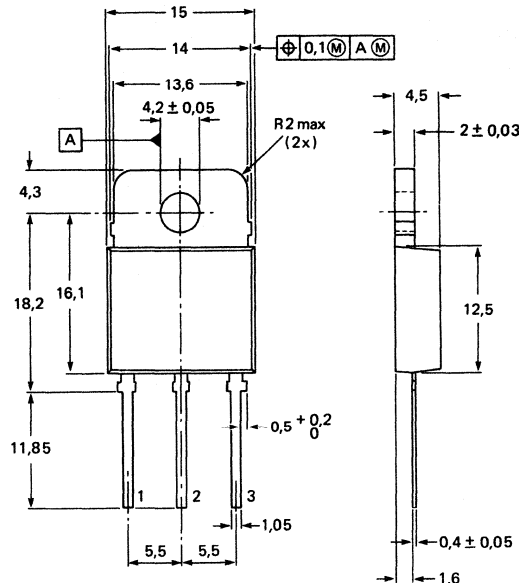
Fig.1 SOT93.

Collector connected to mounting base.



Pinning:

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



7296696

RATINGS

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

			BUV48	BUV48A	
Collector-emitter voltage (peak value; $V_{BE} = 0$)	V_{CESM}	max.	850	1000	V
Collector-emitter voltage (open base)	V_{CEO}	max.	400	450	V
Emitter-base voltage	V_{EBO}	max.	7		V
Collector current (DC)	I_C	max.	15		A
Collector current (peak value)	I_{CM}	max.	30		A
Base current (DC)	I_B	max.	4		A
Base current (peak value)	I_{BM}	max.	20		A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	150		W
Storage temperature	T_{stg}		-65 to + 175		$^\circ\text{C}$
Junction temperature	T_j	max.	175		$^\circ\text{C}$

THERMAL RESISTANCE

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

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

Collector cut-off current*

$V_{CE} = V_{CB0max}; V_{BE} = 0$	I_{CES}	max.	0,2		mA
$V_{CE} = V_{CB0max}; V_{BE} = 0; T_{mb} = 125\text{ }^\circ\text{C}$	I_{CES}	max.	2		mA
$V_{CE} = V_{CB0max}; R_{BE} \leq 10\ \Omega$	I_{CER}	max.	0,5		mA
$V_{CE} = V_{CB0max}; R_{BE} \leq 10\ \Omega; T_{mb} = 125\text{ }^\circ\text{C}$	I_{CER}	max.	4		mA

Emitter cut-off current

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

$I_C = 0; I_B = 50\text{ mA}$	$V_{(BR)EBO}$		7 to 30		V
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Saturation voltages

			BUV48	BUV48A	
$I_C = 15\text{ A}; I_B = 3\text{ A}$	V_{CEsat}	max.	5	—	V
$I_C = 10\text{ A}; I_B = 2\text{ A}$	V_{CEsat}	max.	1,5	—	V
	V_{BEsat}	max.	1,6	—	V
$I_C = 12\text{ A}; I_B = 2,4\text{ A}$	V_{CEsat}	max.	—	5	V
$I_C = 8\text{ A}; I_B = 1,6\text{ A}$	V_{CEsat}	max.	—	1,5	V
	V_{BEsat}	max.	—	1,6	V

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

Collector-emitter sustaining voltage
 $I_C = 200 \text{ mA}$; $I_{B\text{off}} = 0$; $L = 25 \text{ mH}$

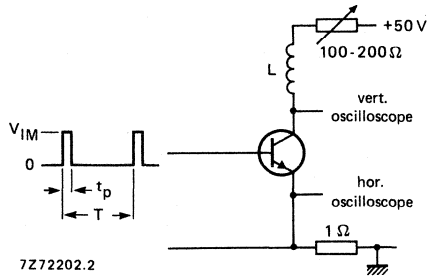


Fig. 2 Test circuit for $V_{CE0\text{sust}}$.
 $V_{IM} = 6 \text{ V}$; $t_p = 40 \text{ ms}$; $\delta = 0,5$; $R_B = 300 \Omega$.

	BUV48	BUV48A	
$V_{CE0\text{sust}}$ min.	400	450	V

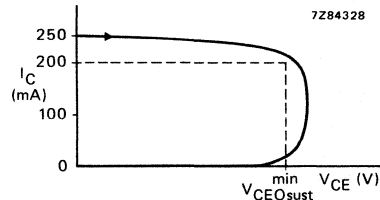


Fig. 3 Oscilloscope display for sustaining voltage.

DEVELOPMENT SAMPLE DATA

Switching times resistive load (Figs 4 and 5)

$I_{C\text{on}} = 10 \text{ A}$; $I_{B\text{on}} = -I_{B\text{off}} = 2 \text{ A}$
 Turn-on time

Turn-off: Storage time

Fall time

$I_{C\text{on}} = 8 \text{ A}$; $I_{B\text{on}} = -I_{B\text{off}} = 1,6 \text{ A}$
 Turn-on time

Turn-off: Storage time

Fall time

		BUV48	BUV48A	
t_{on}	typ.	0,55	—	μs
	max.	1,0	—	μs
t_s	typ.	1,5	—	μs
	max.	3,0	—	μs
t_f	typ.	0,3	—	μs
	max.	0,8	—	μs
t_{on}	typ.	—	0,55	μs
	max.	—	1,0	μs
t_s	typ.	—	1,5	μs
	max.	—	3,0	μs
t_f	typ.	—	0,3	μs
	max.	—	0,8	μs

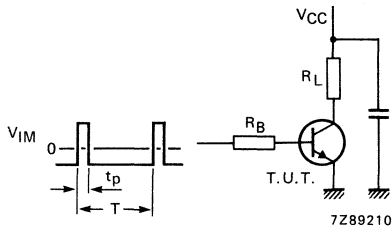


Fig. 4 Test circuit resistive load.
 $V_{CC} = 150 \text{ V}$; $V_{IM} = -6 \text{ to } +8 \text{ V}$;
 $t_p = 20 \mu\text{s}$; $\delta = t_p/T = 0,01$.

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

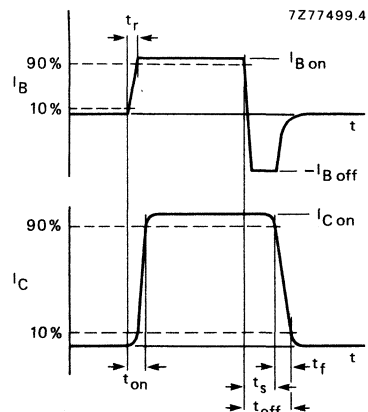


Fig. 5 Switching times waveforms with resistive load.

BUV48 BUV48A

Switching times inductive load (Figs 6 and 7)

$I_{Con} = 10 \text{ A}; I_{Bon} = 2 \text{ A};$

Turn-off: Storage time
Fall time

$I_{Con} = 10 \text{ A}; I_{Bon} = 2 \text{ A}; T_j = 100 \text{ }^\circ\text{C}$

Turn-off: Storage time
Fall time

$I_{Con} = 8 \text{ A}; I_{Bon} = 1,6 \text{ A};$

Turn-off: Storage time
Fall time

$I_{Con} = 8 \text{ A}; I_{Bon} = 1,6 \text{ A}; T_j = 100 \text{ }^\circ\text{C}$

Turn-off: Storage time
Fall time

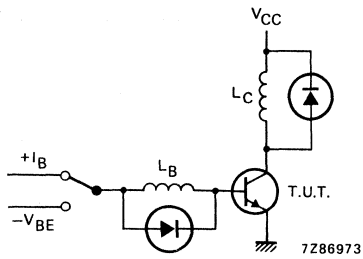


Fig. 6 Test circuit inductive load.

$V_{CC} = 300 \text{ V}; -V_{BE} = 5 \text{ V}; L_B = 3 \text{ } \mu\text{H};$
 $L_C = 1 \text{ mH}$

		BUV48	BUV48A	
t_s	typ.	3,5	—	μs
t_f	typ.	0,08	—	μs
t_s	max.	5,0	—	μs
t_f	max.	0,4	—	μs
t_s	typ.	—	3,5	μs
t_f	typ.	—	0,08	μs
t_s	max.	—	5,0	μs
t_f	max.	—	0,4	μs

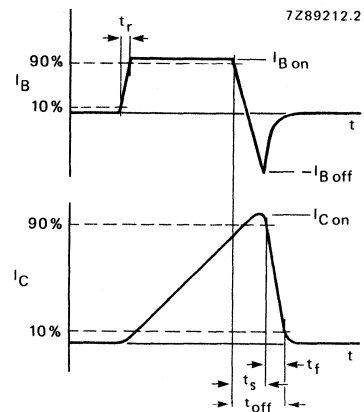
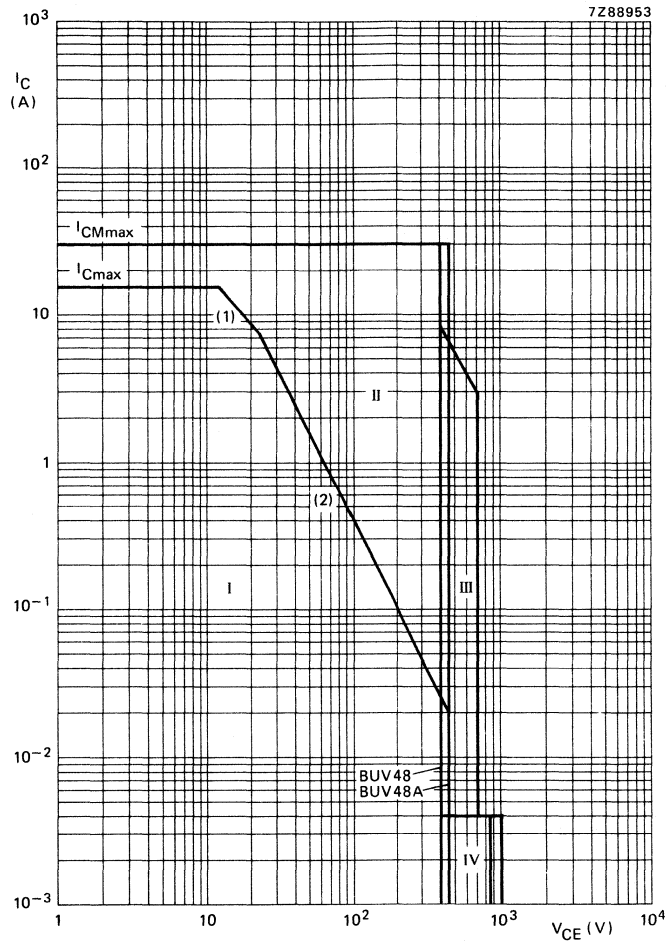


Fig. 7 Switching times waveforms with inductive load.



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

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

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

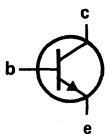
		BUV82	BUV83
Collector-emitter voltage (peak value; $V_{BE} = 0$)	V_{CESM} max.	850	1000 V
Collector-emitter voltage ($R_{BE} = 100 \Omega$)	V_{CER} max.	500	500 V
Collector-emitter voltage (open base)	V_{CEO} max.	400	450 V
Collector-emitter saturation voltage	V_{CEsat} max.	1,5	V
Collector current (DC)	I_C max.	6	A
Collector current (peak value)	I_{CM} max.	10	A
Total power dissipation up to $T_{mb} = 25 \text{ }^\circ\text{C}$	P_{tot} max.	100	W
Fall time	t_f typ.	0,3	μs

MECHANICAL DATA

Dimensions in mm

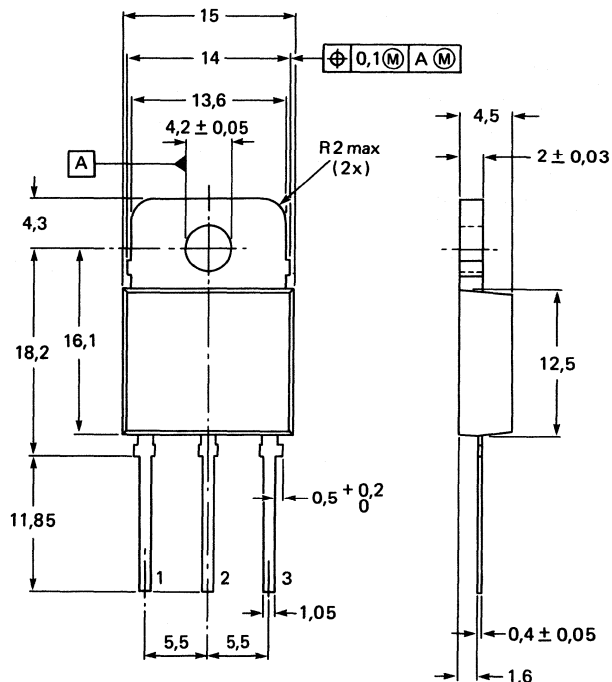
Fig. 1 SOT93.

Collector connected to mounting base.



Pinning:

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



7296696

BUV82 BUV83

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) $t_p = 2 \text{ ms}$	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 $T_{mb} = 25 \text{ }^\circ\text{C}$	P_{tot}	max.		100	W
Storage temperature range	T_{stg}		-65 to + 150		$^\circ\text{C}$
Junction temperature	T_j	max.		150	$^\circ\text{C}$

THERMAL RESISTANCE

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

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

Collector cut-off current**

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

I_{CES} max. 1 mA

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

I_{CES} max. 2 mA

DC current gain

$I_C = 0,6 \text{ A}; V_{CE} = 5 \text{ V}$

h_{FE} typ. 22

* Turn-off current.

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

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

Emitter cut-off current

$I_C = 0; V_{EB} = 10\text{ V}$

I_{EBO}	max.	10	mA
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Saturation voltages

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

V_{CEsat}	max.	1,5	V
-------------	------	-----	---

V_{BEsat}	max.	1,4	V
-------------	------	-----	---

$I_C = 4\text{ A}; I_B = 1,25\text{ A}$

V_{CEsat}	max.	3	V
-------------	------	---	---

V_{BEsat}	max.	1,6	V
-------------	------	-----	---

Collector-emitter sustaining voltages

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

$V_{CEOsust}$	min.	400	450	V
---------------	------	-----	-----	---

$I_C = 100\text{ mA}; R_{BE} = 100\text{ }\Omega; L = 15\text{ mH}$

$V_{CERsust}$	min.	500	500	V
---------------	------	-----	-----	---

BUV82 | BUV83

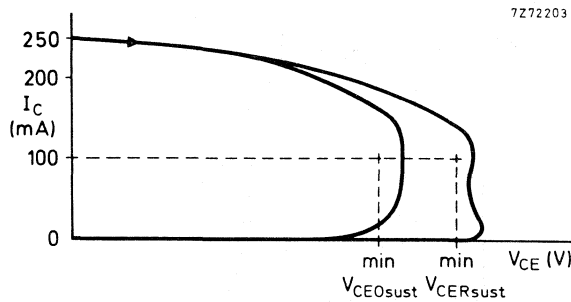


Fig. 2 Oscilloscope display for sustaining voltages.

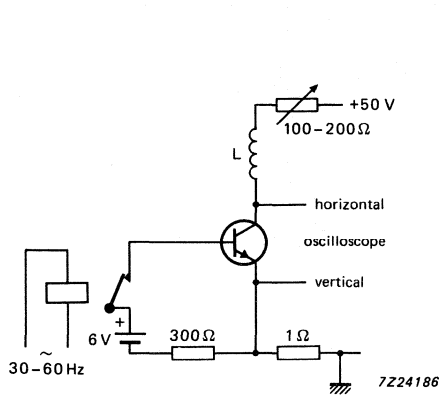


Fig. 3 Test circuit for $V_{CEOsust}$.

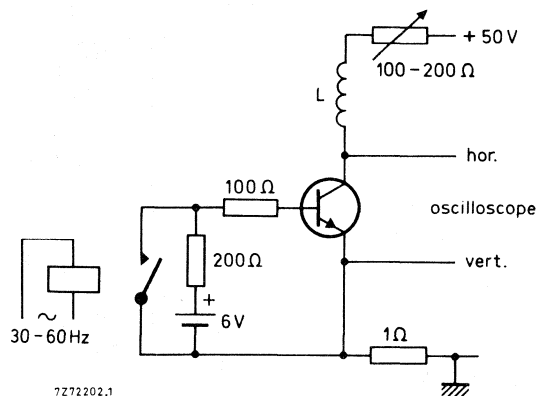


Fig. 4 Test circuit for $V_{CERsust}$.

CHARACTERISTICS (continued)

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

Transition frequency at $f = 1\text{ MHz}$

$I_C = 0,2\text{ A}$; $V_{CE} = 10\text{ V}$

f_T typ. 6 MHz

Switching times

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

$I_{Bon} = 0,5\text{ A}$; $-I_{Boff} = 1\text{ A}$

Turn-on time

t_{on} typ. 0,3 μs
min. 0,6 μs

Turn-off: Storage time

t_s typ. 2 μs
min. 3,5 μs

Fall time

t_f typ. 0,3 μs

Fall time, $T_{mb} = 95\text{ }^\circ\text{C}$

t_f min. 0,75 μs

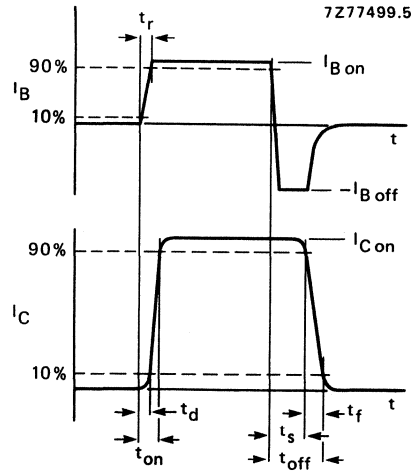
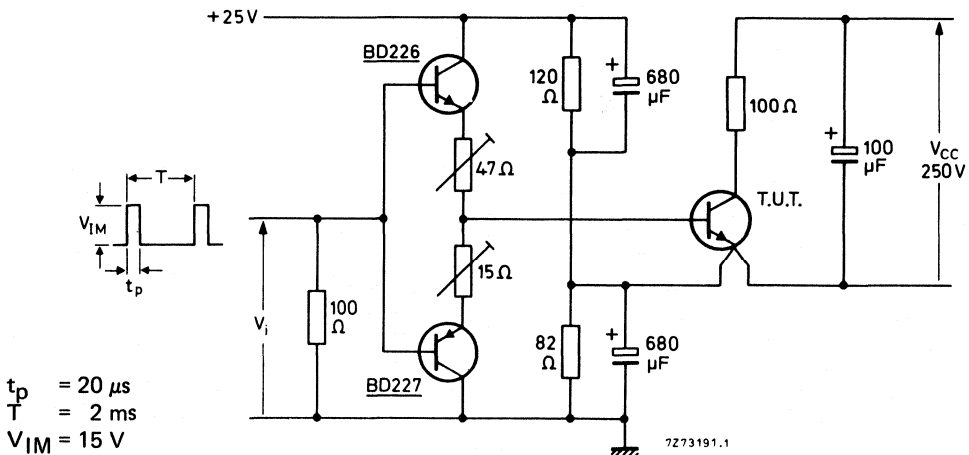
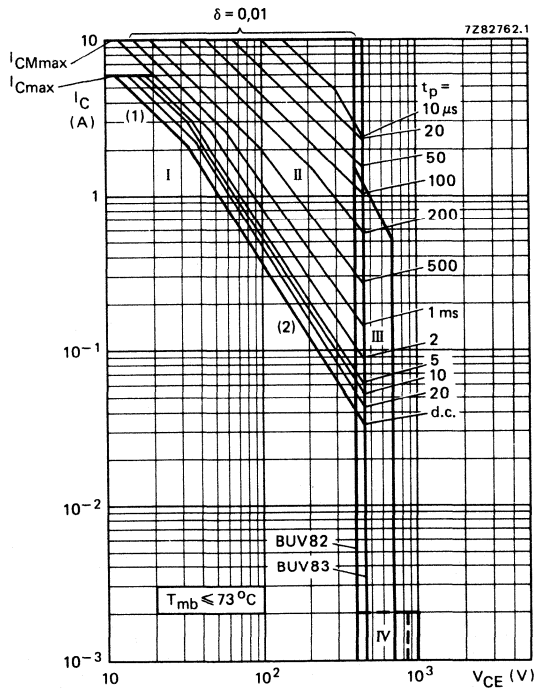


Fig. 5 Switching times waveform.



$t_p = 20\text{ }\mu\text{s}$
 $T = 2\text{ ms}$
 $V_{IM} = 15\text{ V}$

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 $R_{BE} \leq 100 \Omega$ and $t_p \leq 0,6 \mu s$.
 - IV Repetitive pulse operation in this region is permissible, provided $V_{BE} \leq 0$ and $t_p \leq 5 ms$.
- (1) $P_{tot} max$ and $P_{peak} max$ lines.
 (2) Second-breakdown limits.

Fig. 7 Safe operating area.

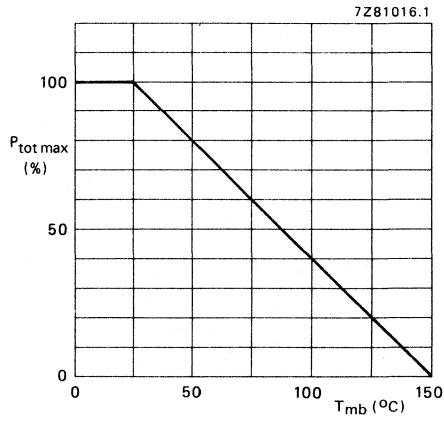


Fig. 8 Power derating curve.

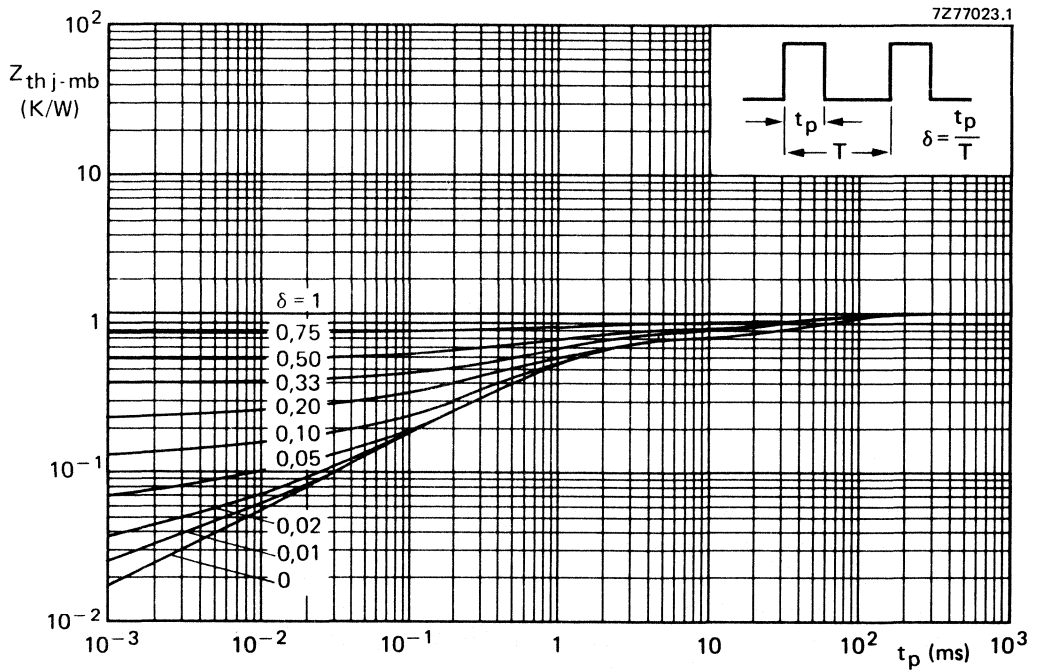


Fig. 9 Pulse power rating chart.

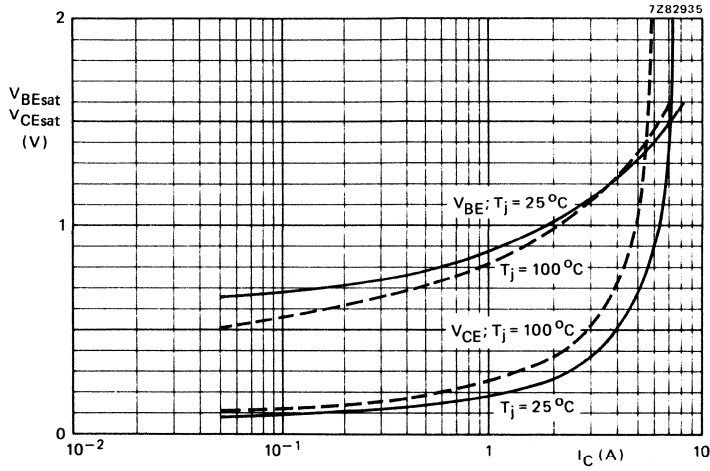


Fig. 10 Typical values base-emitter and collector-emitter voltage, $I_C/I_B = 5$.

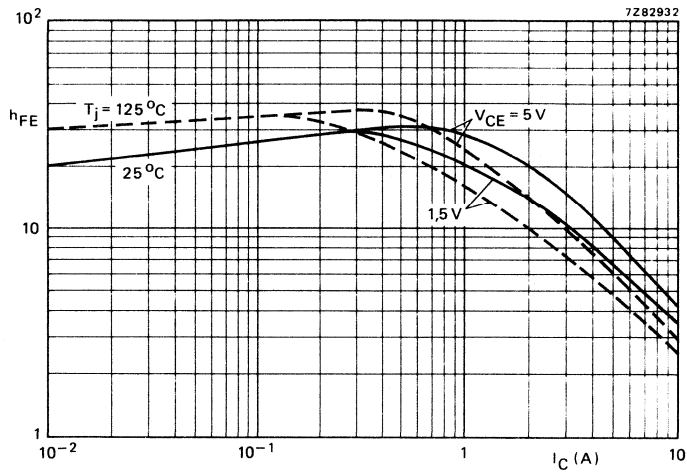


Fig. 11 Typical values DC current gain.

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.

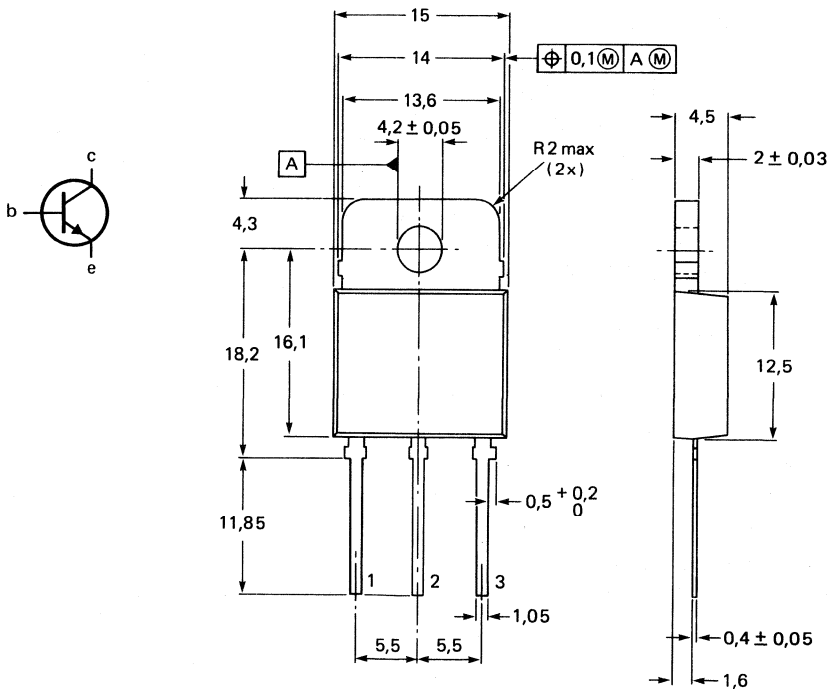
QUICK REFERENCE DATA

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 $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	125 W
Turn-off fall time	t_f	typ.	0.5 μs

MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT93.



Pinning:

1 = base

2 = collector

3 = emitter

Collector connected to the mounting base.

7296696

RATINGS

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

Collector-emitter voltage (peak value; $V_{BE} = 0$)	V_{CESM}	max.	1200 V
Collector-emitter voltage (open base)	V_{CEO}	max.	800 V
Collector current (DC)	I_C	max.	8 A
Collector current (peak value)	I_{CM}	max.	15 A
Base current (DC)	I_B	max.	4 A
Base current (peak value)	I_{BM}	max.	6 A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	125 W
Storage temperature range	T_{stg}		-65 to + 150 $^\circ\text{C}$
Junction temperature	T_j	max.	150 $^\circ\text{C}$

THERMAL RESISTANCE

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

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

Collector cut-off current*

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

$V_{EB} = 5\text{ V}; I_C = 0$	I_{EBO}	max.	10 mA
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Collector-emitter sustaining voltage

$I_B = 0; I_C = 100\text{ mA}; L = 25\text{ mH}$	$V_{CEO_{sust}}$	min.	800 V
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Saturation voltage

$I_C = 4,5\text{ A}; I_B = 2\text{ A}$	V_{CEsat}	max.	1 V
--	-------------	------	-----

$I_C = 6\text{ A}; I_B = 3\text{ A}$	V_{BEsat}	max.	1,3 V
--------------------------------------	-------------	------	-------

	V_{CEsat}	typ.	1 V
--	-------------	------	-----

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

$I_C = 0,1\text{ A}; V_{CE} = 5\text{ V}$	f_T	typ.	7 MHz
---	-------	------	-------

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

$I_E = I_e = 0; V_{CB} = 10\text{ V}$	C_c	typ.	125 pF
---------------------------------------	-------	------	--------

Switching times in resistive switching circuit (Fig. 5)

$I_{Con} = 4,5\text{ A}; I_{Bon} = -I_{Boff} = 2\text{ A}$

Turn-on time	t_{on}	typ.	0,2 μs
--------------	----------	------	-------------------

Storage time	t_s	typ.	3,5 μs
--------------	-------	------	-------------------

Fall time	t_f	typ.	0,5 μs
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Second-breakdown current

$V_{CE} = 100\text{ V}; t_p = 1\text{ s}$	I_{SB}	min.	0,3 A
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* Measured with a half-sinewave voltage (curve tracer).

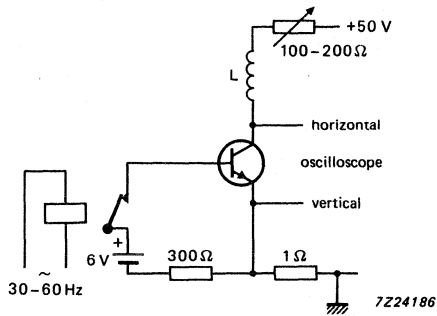


Fig. 2 Test circuit for $V_{CEOsust}$

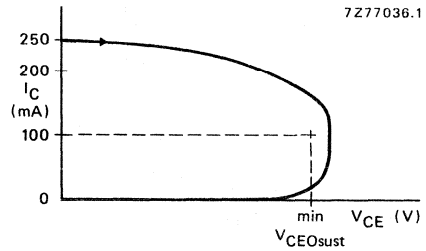


Fig. 3 Oscilloscope display for $V_{CEOsust}$.

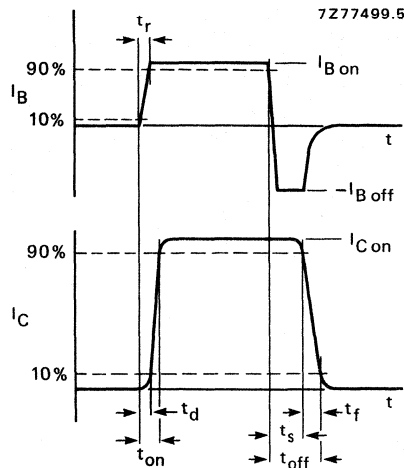


Fig. 4 Waveforms.

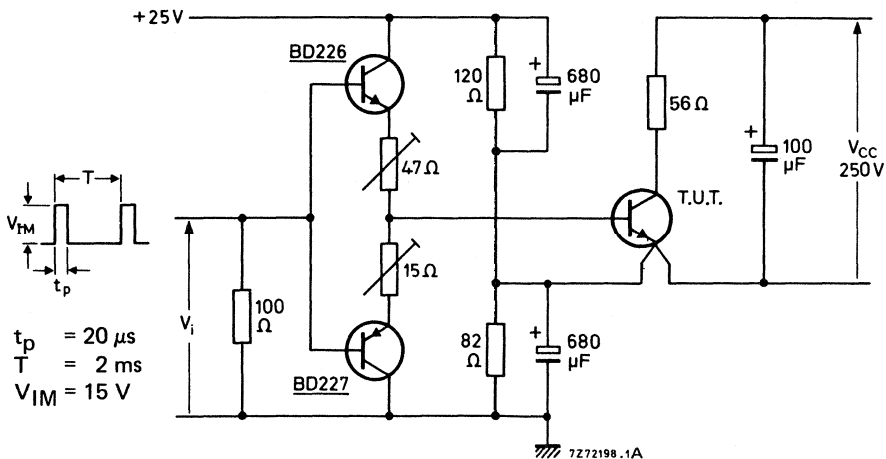
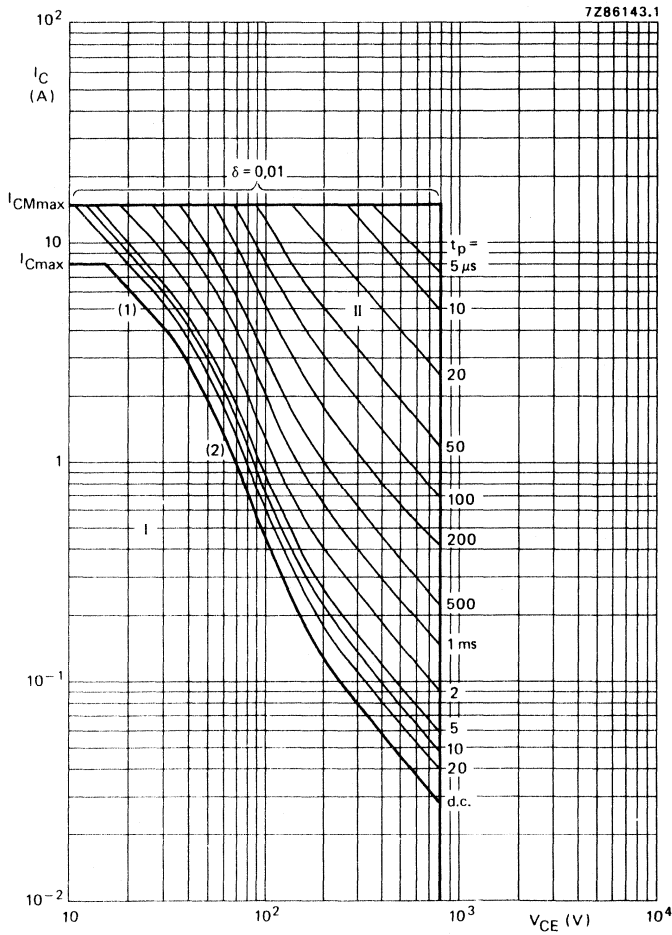


Fig. 5 Switching times test circuit.



1. $P_{tot\ max}$ and $P_{tot\ peak\ max}$ lines.
 2. Second-breakdown limits.
- I Region of permissible DC operation.
- II Permissible extension for repetitive pulse operation.

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

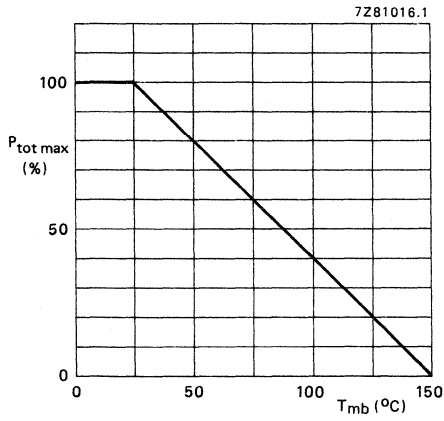


Fig. 7 Power derating curve.

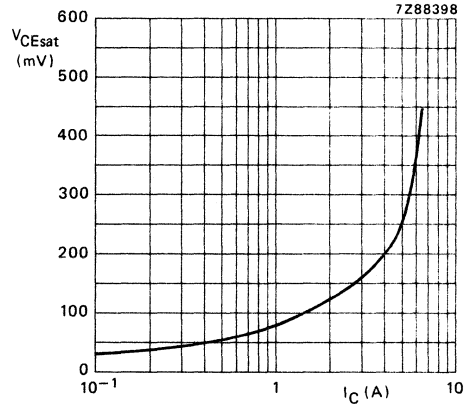


Fig. 8 Typical values $I_C/I_B = 2$; $T_j = 25^\circ\text{C}$.

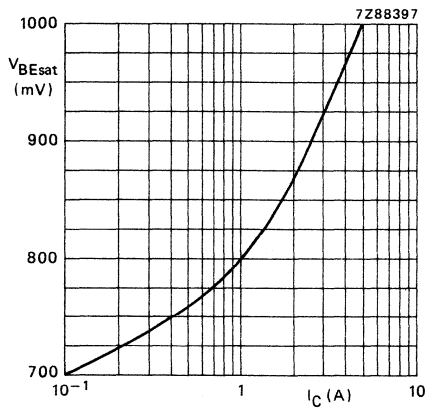


Fig. 9 Typical values $I_C/I_B = 2$; $T_j = 25^\circ\text{C}$.

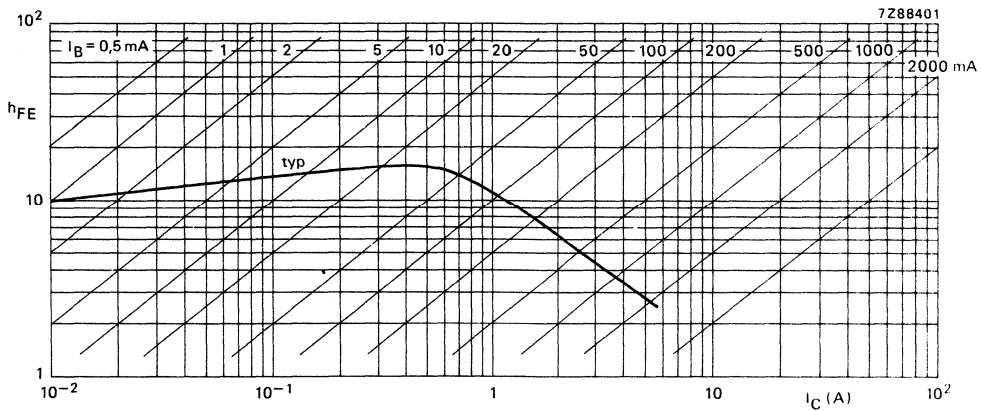


Fig. 10 Typical values DC current gain at $V_{CE} = 5\text{ V}$; $T_{mb} = 25^\circ\text{C}$.

SILICON DIFFUSED DARLINGTON POWER TRANSISTORS

High-voltage, monolithic npn power Darlington transistors in an SOT93 envelope, intended for use in car ignition systems, DC and AC motor controls, solenoid drivers, etc.

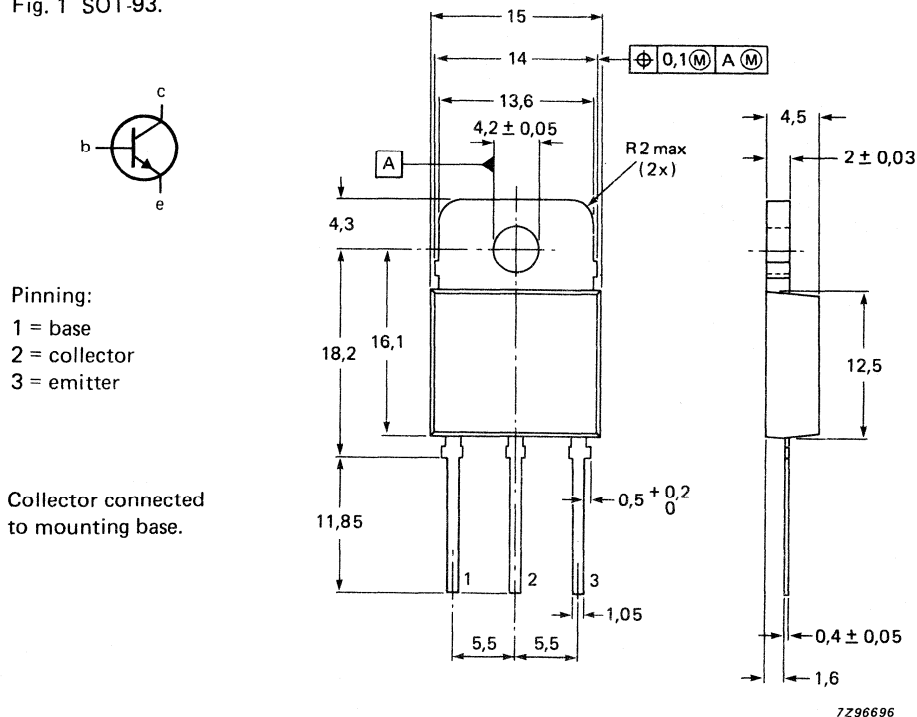
QUICK REFERENCE DATA

Collector-emitter voltage (peak value; $V_{BE} = 0$)	V_{CESM}	max.	650 V
Collector-emitter voltage (open base)	V_{CEO}	max.	400 V
Collector-emitter saturation voltage	V_{CEsat}	max.	2 V
Collector saturation current	I_{Csat}		10 A
Collector current (DC)	I_C	max.	12 A
Collector current (peak value)	I_{CM}	max.	30 A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	125 W
Fall time (inductive switching)	t_f	typ.	1 μs

MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT-93.



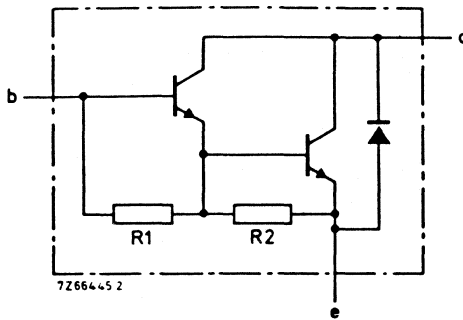


Fig. 2 Darlington circuit diagram
 R1 typical 500 Ω
 R2 typical 300 Ω

RATINGS

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

Collector-emitter voltage (peak value; $V_{BE} = 0$)	V_{CESM}	max.	650	V
Collector-emitter voltage (open base)	V_{CEO}	max.	400	V
Collector current (DC)	I_C	max.	12	A
Collector current (peak value)	I_{CM}	max.	30	A
Base current (DC)	I_B	max.	4	A
Base current (peak value)	I_{BM}	max.	6	A
Total power dissipation up to $T_{mb} = 25\text{ °C}$	P_{tot}	max.	125	W
Storage temperature range	T_{stg}		-65 to +150	°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

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

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

Collector cut-off current*				
$V_{CE} = V_{CESMmax}; V_{BE} = 0$	I_{CES}	max.	1	mA
$V_{CE} = V_{CESMmax}; V_{BE} = 0; T_j = 125\text{ °C}$	I_{CES}	max.	3	mA
Emitter cut-off current				
$I_C = 0; V_{EB} = 6\text{ V}$	I_{EBO}	max.	20	mA
Collector-emitter sustaining voltage				
$I_C = 5\text{ A}; I_B = 0; L = 8\text{ mH}$	$V_{CEO_{sust}}$	min.	400	V
Diode forward voltage				
$I_F = 8\text{ A}; I_B = 0$	V_F	max.	3	V

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

Saturation voltages

$I_C = 5 \text{ A}; I_B = 50 \text{ mA}$

$I_C = 5 \text{ A}; I_B = 60 \text{ mA}; T_j = -40 \text{ }^\circ\text{C}$

$I_C = 6 \text{ A}; I_B = 100 \text{ mA}; T_j = 150 \text{ }^\circ\text{C}$

$I_C = 10 \text{ A}; I_B = 300 \text{ mA}$

V_{CEsat}	max.	1.5 V
V_{BEsat}	max.	2 V
V_{CEsat}	max.	1.5 V
V_{BEsat}	max.	2 V
V_{CEsat}	max.	1.5 V
V_{BEsat}	max.	2 V
V_{CEsat}	max.	2 V
V_{BEsat}	max.	2.5 V

Turn-off breakdown energy, with inductive load (Fig. 3)

$I_{Con} = 10 \text{ A}; I_{Bon} = 300 \text{ mA}$

$L_C = 8 \text{ mH}; V_{CL} = 400 \text{ V}$

Turn-on test (Fig. 4)

$E(BR)$	min.	400 mJ
V_{CEon}	min.	400 V

Fall time; inductive switching (Fig. 5)

$I_{Con} = 5 \text{ A}; I_{Bon} = 50 \text{ mA}; L_C = 200 \text{ } \mu\text{H}$

$I_{Con} = 10 \text{ A}; I_{Bon} = 300 \text{ mA}; L_C = 200 \text{ } \mu\text{H}$

t_f	typ.	0.7 μs
t_f	typ.	1 μs

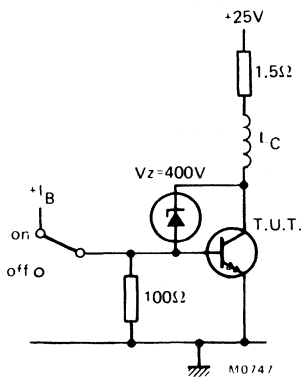


Fig. 3 Energy test.

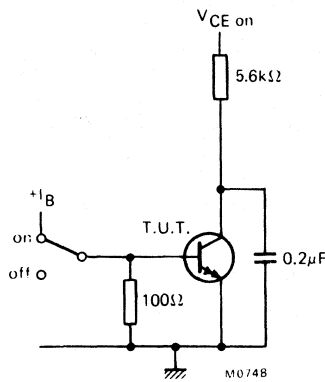


Fig. 4 Turn-on test.

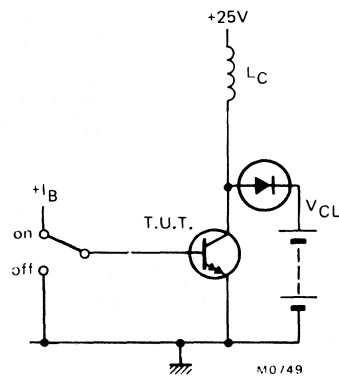
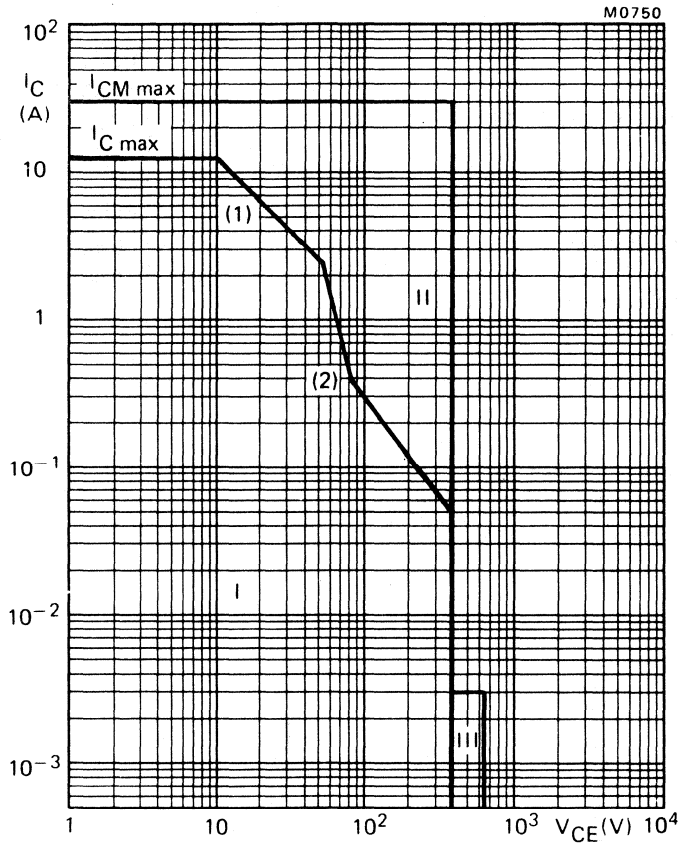


Fig. 5 Inductive switching.



- I Region of permissible DC operation
- II Permissible extension for repetitive pulse operation
- III Repetitive pulse operation in this region is permissible, provided $V_{BE} < 0$ and $t_p < 5\ ms$.
- (1) $P_{tot\ max}$ line.
- (2) Second-breakdown limits.

Fig. 6 Safe operating area; $T_{mb} \leq 25\ ^\circ C$.

SILICON DIFFUSED DARLINGTON POWER TRANSISTORS

High-voltage, monolithic npn power Darlington transistors in a SOT199 envelope intended for use in car ignition systems, DC and AC motor controls, solenoid drivers, etc.

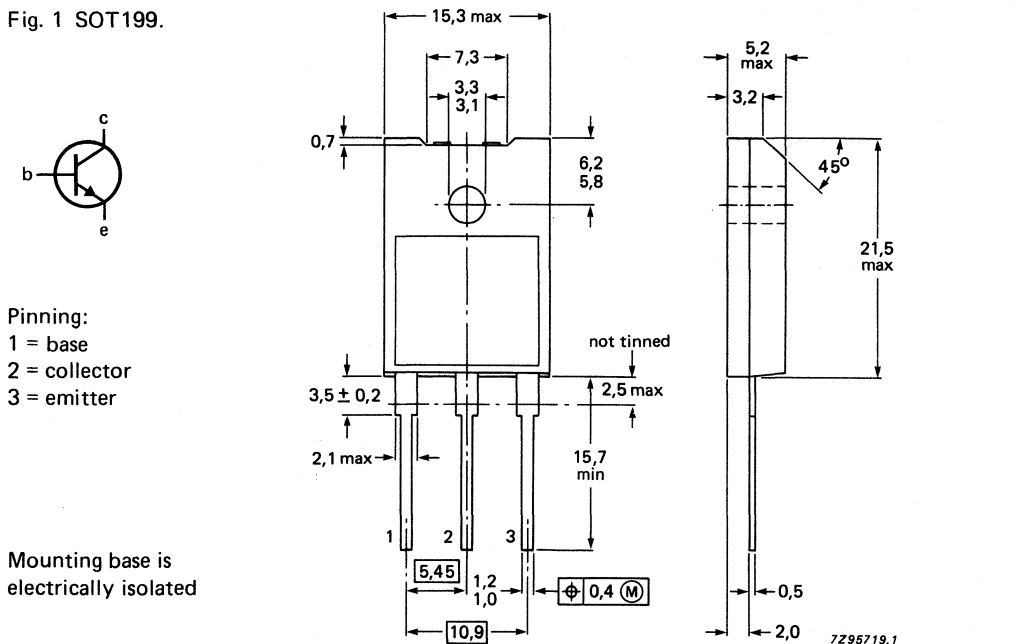
QUICK REFERENCE DATA

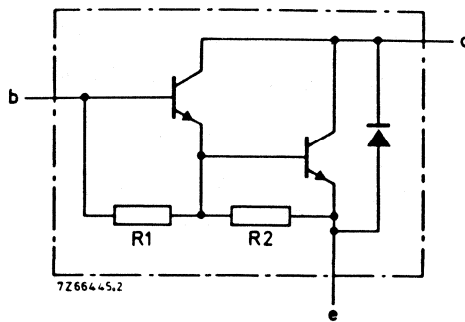
Collector-emitter voltage (peak value; $V_{BE} = 0$)	V_{CESM}	max.	650	V
Collector-emitter voltage (open base)	V_{CEO}	max.	400	V
Collector saturation current	I_{Csat}	max.	10	A
Collector current (DC)	I_C	max.	12	A
Collector current (peak value)	I_{CM}	max.	30	A
Total power dissipation up to $T_{mb} = 25^\circ\text{C}$	P_{tot}	max.	34	W
Collector-emitter saturation voltage				
$I_C = 5\text{ A}; I_B = 0.05\text{ A}$	V_{CEsat}	max.	1.5	V
$I_C = 10\text{ A}; I_B = 0.3\text{ A}$	V_{CEsat}	max.	2	V
Fall time (inductive switching)				
$I_{Con} = 5\text{ A}; I_{Bon} = 50\text{ mA}; L_C = 200\ \mu\text{H}$	t_f	typ.	0.7	μs
$I_{Con} = 10\text{ A}; I_{Bon} = 300\text{ mA}; L_C = 200\ \mu\text{H}$	t_f	typ.	1	μs

MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT199.





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 $T_{mb} = 25\text{ °C}$	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)	R_{thj-h}	=	3.7	K/W
From junction to external heatsink (note 2)	R_{thj-h}	=	2.8	K/W

ISOLATION

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

Notes

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

CHARACTERISTICS

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

Collector cut-off current *

$V_{CE} = V_{CESMmax}; V_{BE} = 0$	I_{CES}	max.	1	mA
$V_{CE} = V_{CESMmax}; V_{BE} = 0; T_j = 125\text{ }^\circ\text{C}$	I_{CES}	max.	3	mA

Emitter cut-off current

$I_C = 0; V_{EB} = 6\text{ V}$	I_{EBO}	max.	20	mA
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Collector-emitter sustaining voltage

$I_C = 5\text{ A}; I_B = 0; L = 8\text{ mH}$	$V_{CEO_{sust}}$	min.	400	V
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Diode forward voltage

$I_F = 8\text{ A}; I_B = 0$	V_F	max.	3	V
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Saturation voltages

$I_C = 5\text{ A}; I_B = 0.05\text{ A}$	V_{CEsat}	max.	1.5	V
	V_{BEsat}	max.	2.0	V
$I_C = 5\text{ A}; I_B = 0.06\text{ A}; T_j = -40\text{ }^\circ\text{C}$	V_{CEsat}	max.	1.5	V
	V_{BEsat}	max.	2.0	V
$I_C = 6\text{ A}; I_B = 0.1\text{ A}; T_j = 150\text{ }^\circ\text{C}$	V_{CEsat}	max.	1.5	V
	V_{BEsat}	max.	2.0	V
$I_C = 10\text{ A}; I_B = 0.3\text{ A}$	V_{CEsat}	max.	2.0	V
	V_{BEsat}	max.	2.5	V

Turn-off breakdown energy with inductive load (see Fig. 3)

$I_C = 10\text{ A}; I_B = 0.3\text{ A}; L_C = 8\text{ mH}; V_{CL} = 400\text{ V}$	$E(BR)$	min.	400	mJ
---	---------	------	-----	----

Turn-on test (see Fig. 4)

	V_{CEon}	min.	400	V
--	------------	------	-----	---

Fall-time, inductive switching

$I_{Con} = 5\text{ A}; I_{Bon} = 50\text{ mA}; L_C = 200\text{ }\mu\text{H}$	t_f	typ.	0.7	μs
$I_{Con} = 10\text{ A}; I_{Bon} = 300\text{ mA}; L_C = 200\text{ }\mu\text{H}$	t_f	typ.	1	μs

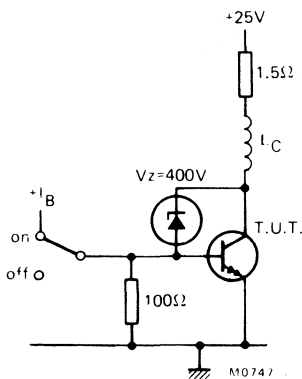


Fig.3 Energy test.

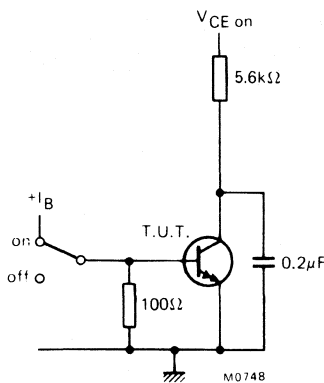


Fig.4 Turn-on test.

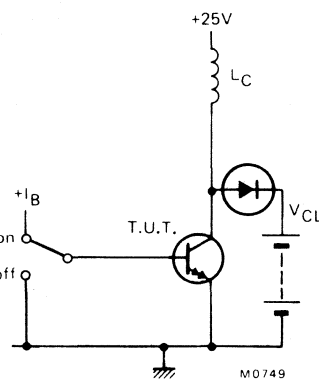
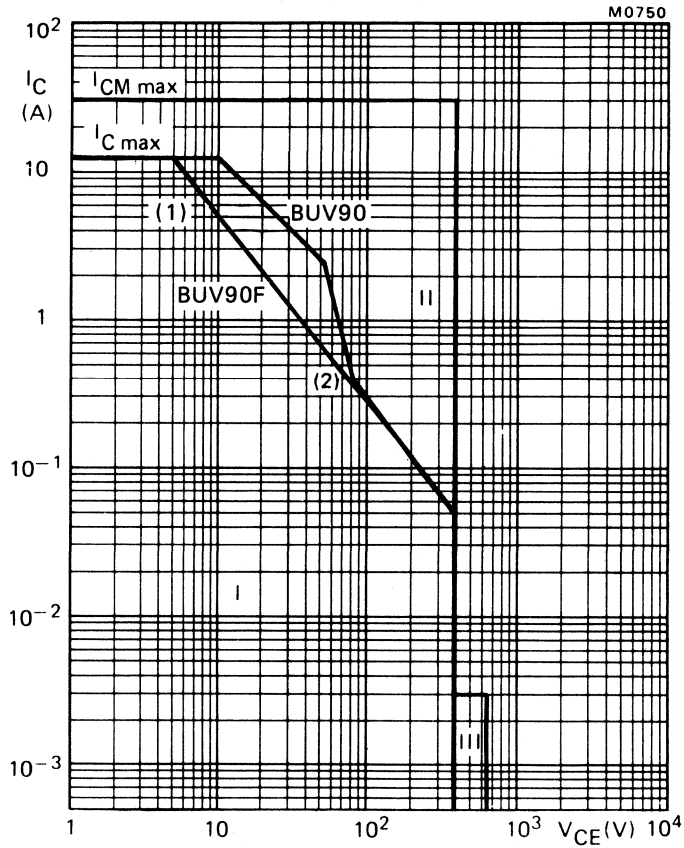


Fig.5 Inductive switching.

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



- I Region of permissible DC operation
- II Permissible extension for repetitive pulse operation
- III Repetitive pulse operation in this region is permissible, provided $V_{BE} < 0$ and $t_p < 5$ ms.
- (1) P_{tot} max line.
- (2) Second-breakdown limits (independent of temperature).

Fig. 6 Safe operating area; $T_{mb} \leq 25$ °C; mounted without heatsink compound and ± 30 newtons pressure on centre of envelope.

DEVELOPMENT DATA

This data sheet contains advance information and specifications are subject to change without notice.

BUV98(V)
BUV98A(V)

SILICON DIFFUSED POWER TRANSISTORS

High-voltage, high-current, high-speed transistors, assembled in the isolated ISOTOP package; intended for use in inverters, converters and motor control applications on 220 V to 380 V mains supplies.

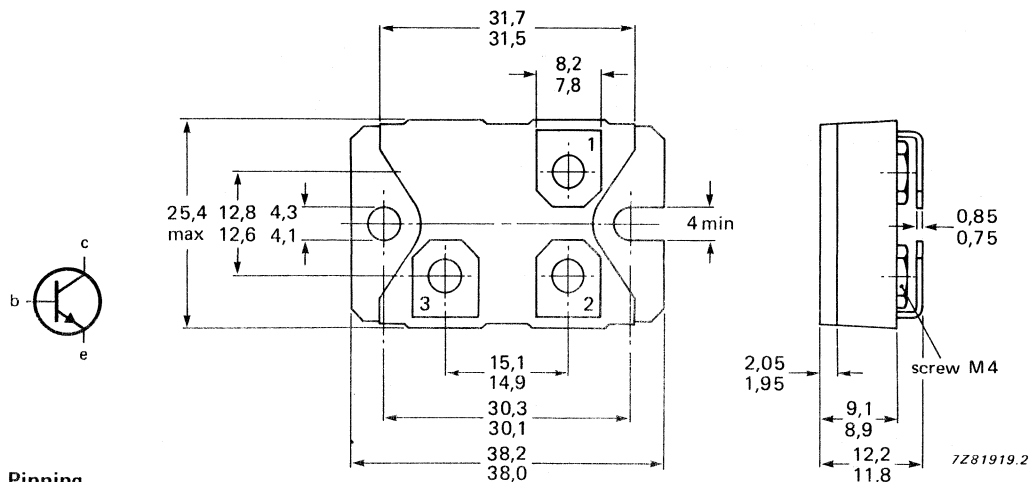
QUICK REFERENCE DATA

			BUV98(V)	98A(V)	
Collector-emitter peak value; $V_{BE} = 0$ open base	V_{CESM}	max.	850	1000	V
	V_{CEO}	max.	450	450	V
Collector-emitter saturation voltage	V_{CEsat}	max.	1.5		V
Collector current saturation DC peak value	I_{Csat}	max.	20	16	A
	I_C	max.	30		A
	I_{CM}	max.	60		A
Total power dissipation up to $T_{mb} = 25^\circ\text{C}$	P_{tot}	max.	150		W
Fall time	t_f	typ.	80		ns

MECHANICAL DATA

Dimensions in mm

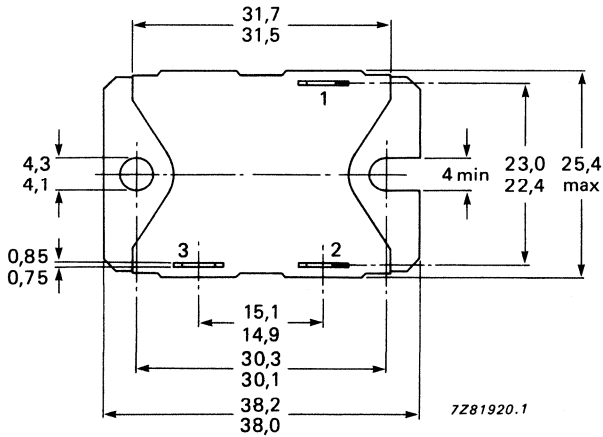
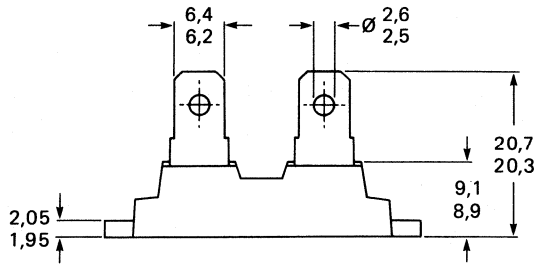
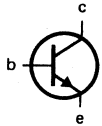
Fig. 1 SOT227B (BUV98V and BUV98AV).



Pinning

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

BUV98(V)
BUV98A(V)



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; $V_{BE} = 0$ open base	V_{CESM}	max.	850	1000	V
	V_{CEO}	max.	450	450	V
Collector current saturation DC peak value	I_{Csat}		20	16	A
	I_C	max.		30	A
	I_{CM}	max.		60	A
Base current DC peak value	I_B	max.		8.0	A
	I_{BM}	max.		30	A
Total power dissipation up to $T_{mb} = 25^\circ\text{C}$	P_{tot}	max.		150	W
Storage temperature range	T_{stg}			-65 to +150	$^\circ\text{C}$
Junction temperature	T_j	max.		150	$^\circ\text{C}$

THERMAL RESISTANCEFrom junction to mounting base
with heatsink compound

$R_{th\ j-mb}$	=	0.83 K/W
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ISOLATIONIsolation voltage from all terminals to
external heatsink (RMS value)

V_{isol}	max.	2500 V
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Isolation capacitance from collector
to external heatsink

C_{isol}	typ.	45 pF
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CHARACTERISTICS $T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified

Collector cut-off currents

$V_{CE} = V_{CESMmax}; V_{BE} = -0\text{ V}$

I_{CES}	max.	0.4 mA
-----------	------	--------

$V_{CE} = V_{CESMmax}; V_{BE} = -0\text{ V};$

$T_j = 125\text{ }^\circ\text{C}$

I_{CES}	max.	4.0 mA
-----------	------	--------

Emitter cut-off current

$V_{EB} = 5\text{ V}; I_C = 0$

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)

$I_C = 200\text{ mA}; I_B = 0; L = 25\text{ mH}$

$V_{CEO\text{sust}}$	min.	450 V
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Switching times resistive load
(Figs 4 and 5)

$I_C = I_{Csat}; I_{B\text{ on}} = I_{Csat}/5;$

$I_{B\text{ off}} = I_{B\text{ on}}$

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)

$I_C = I_{Csat}; I_{B\text{ on}} = I_{Csat}/5;$

$V_{BE} = -5\text{ V}$

turn-off; storage time

t_s	typ.	3.5 μs
-------	------	-------------------

fall time

t_f	typ.	80 ns
-------	------	-------

 $T_j = 100\text{ }^\circ\text{C}$

turn-off; storage time

t_s	max.	5.0 μs
-------	------	-------------------

fall time

t_f	max.	400 ns
-------	------	--------

DEVELOPMENT DATA

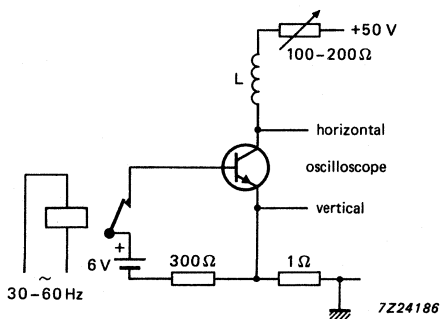


Fig. 3 Test circuit for $V_{CEOsust}$.

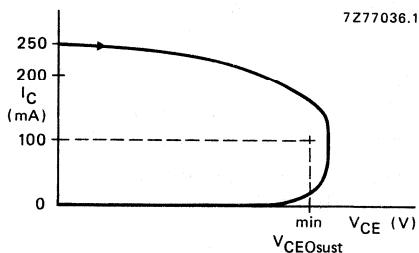


Fig. 4 Oscilloscope display for sustaining voltage.

$t_p = 20 \mu s$
 $T = 2 ms$
 $V_{IM} = 15 V$

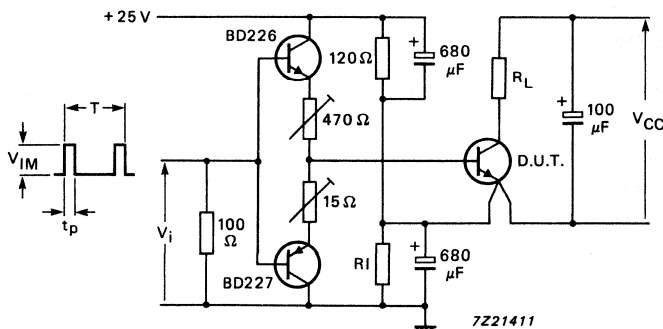


Fig. 5 Test circuit resistive load; $V_{CC} = 150 V$; $R_L = 83 \Omega$; $R_1 = 82 \Omega$.

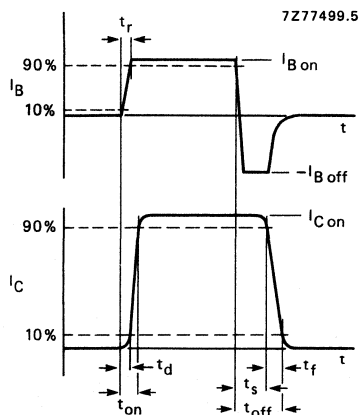


Fig. 6 Switching times waveforms with resistive load; $t_r \leq 30 ns$.

For inductive load:

$V_{\text{clamp}} = 300 \text{ V}$

$-V_{\text{BE}} = -5 \text{ V}$

$L_{\text{B}} = 1.5 \mu\text{H}$

For RB SOAR:

V_{clamp} up to 1000 V

$-V_{\text{BE}}$ to be adjusted

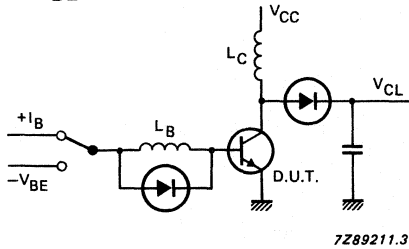


Fig. 7 Test circuit inductive load and RB SOAR; $V_{\text{CC}} = 30 \text{ V}$; $L_{\text{C}} = 200 \mu\text{H}$.

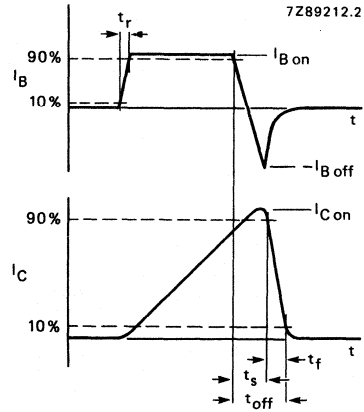
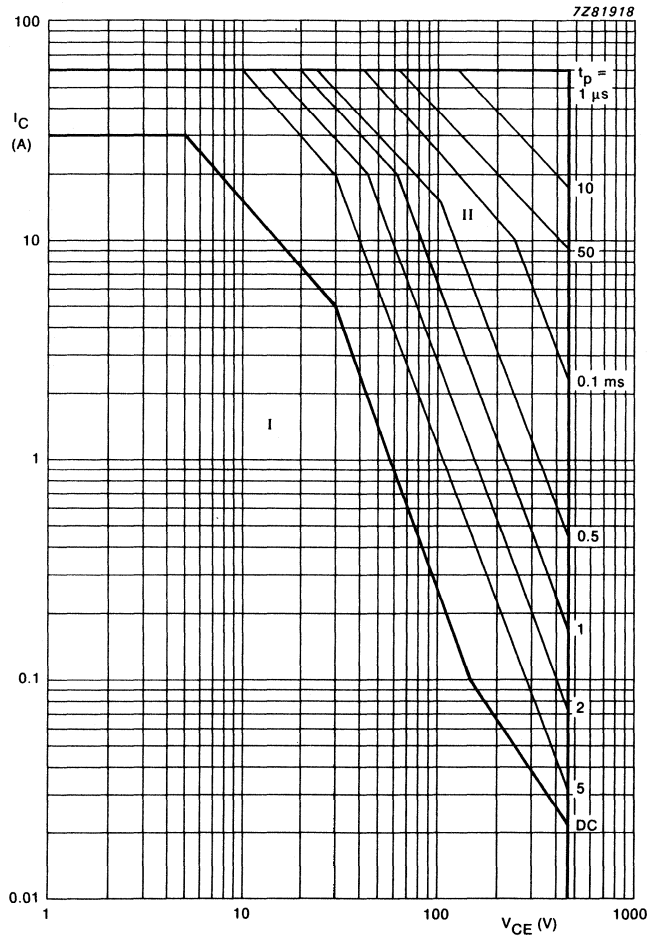


Fig. 8 Switching times waveforms with inductive load.

DEVELOPMENT DATA



- I Region of permissible DC operation.
- II Permissible extension for single pulse operation.

Fig. 9 Safe operating area at $T_{mb} < 25^\circ\text{C}$.

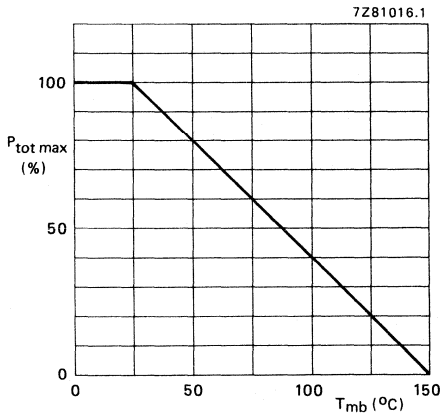


Fig. 10 Total power dissipation.

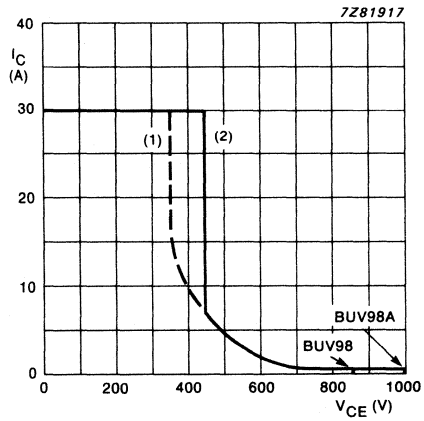


Fig. 11 Reverse bias SOAR; $V_{BE} = -5$ V;
 $I_C/I_B \geq 5$; $T_j \leq 125$ °C.
(1) Hard saturation.
(2) With anti-saturation network.

DEVELOPMENT DATA

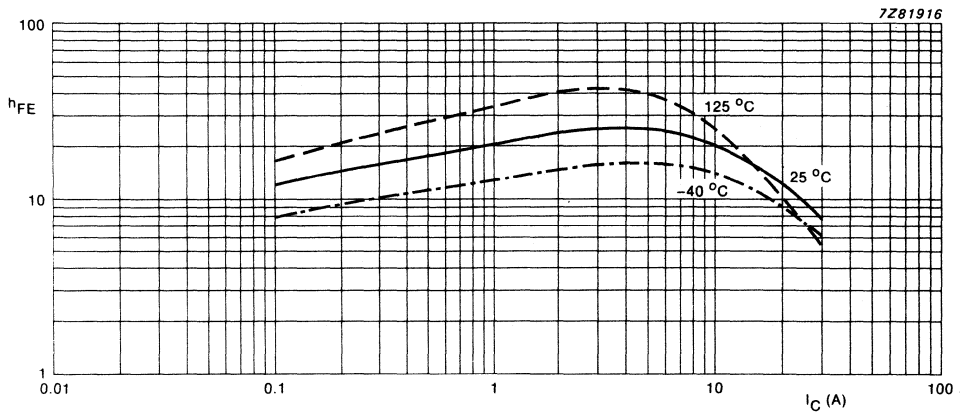


Fig. 12 Typical DC current gain at $V_{CE} = 5$ V.

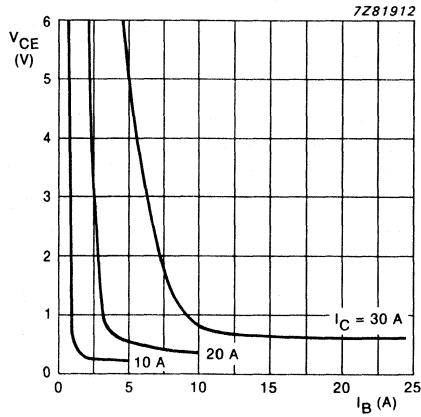


Fig. 13 Collector-emitter voltage as a function of base current; $T_j = 25^\circ\text{C}$.

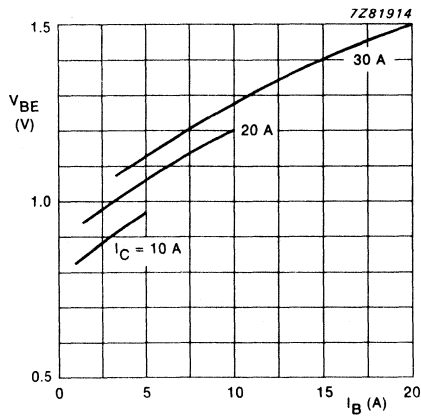


Fig. 14 Base-emitter saturation voltage as a function of base current; $T_j = 25^\circ\text{C}$.

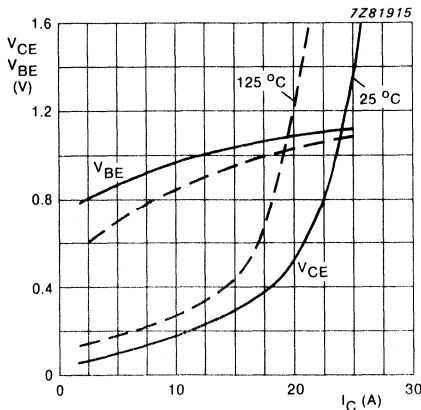


Fig. 15 Typical V_{CEsat} and V_{BEsat} as a function of collector current; $I_C/I_B = 5$.

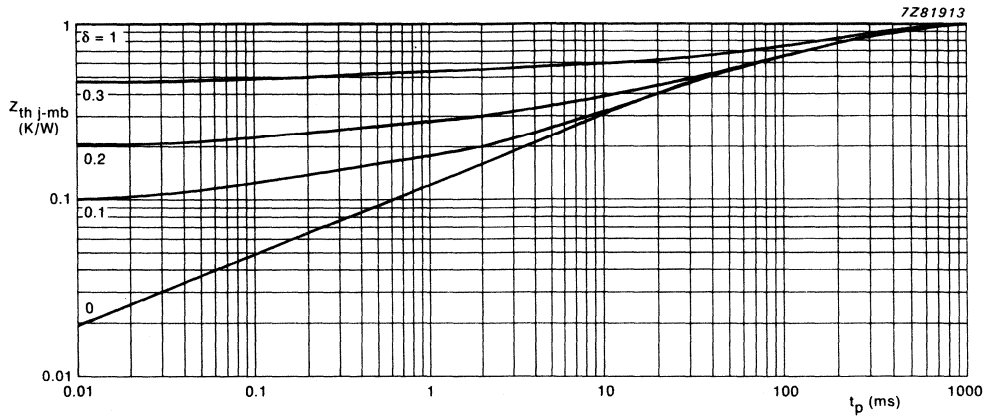


Fig. 16 Thermal response at pulse power conditions.

DEVELOPMENT DATA

DEVELOPMENT DATA

This data sheet contains advance information and specifications are subject to change without notice.

BUV298(V)
BUV298A(V)

SILICON DIFFUSED POWER TRANSISTORS

High-voltage, high-current, high-speed transistors, assembled in the isolated ISOTOP package; intended for use in inverters, converters and motor control applications on 220 V to 380 V mains supply.

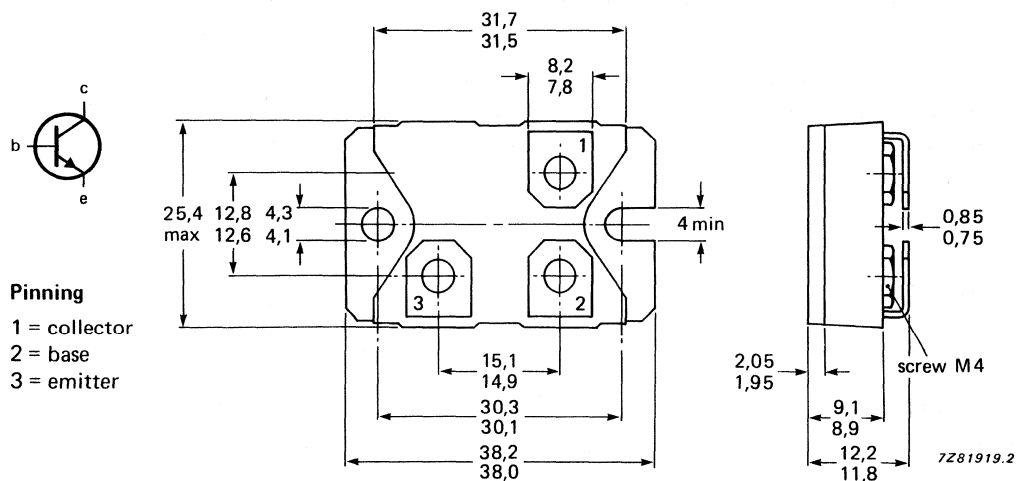
QUICK REFERENCE DATA

			BUV298(V)		298A(V)	
Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM}	max.	850	1000	V	
	V_{CEO}	max.	450	450	V	
Collector-emitter saturation voltage	V_{CEsat}	max.	1.2	1.2	V	
Collector current saturation DC peak value	I_{Csat}	max.	40	32	A	
	I_C	max.		60	A	
	I_{CM}	max.		90	A	
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.		250	W	
Fall time inductive load at $100\text{ }^\circ\text{C}$	t_f	max.		0.4	μs	

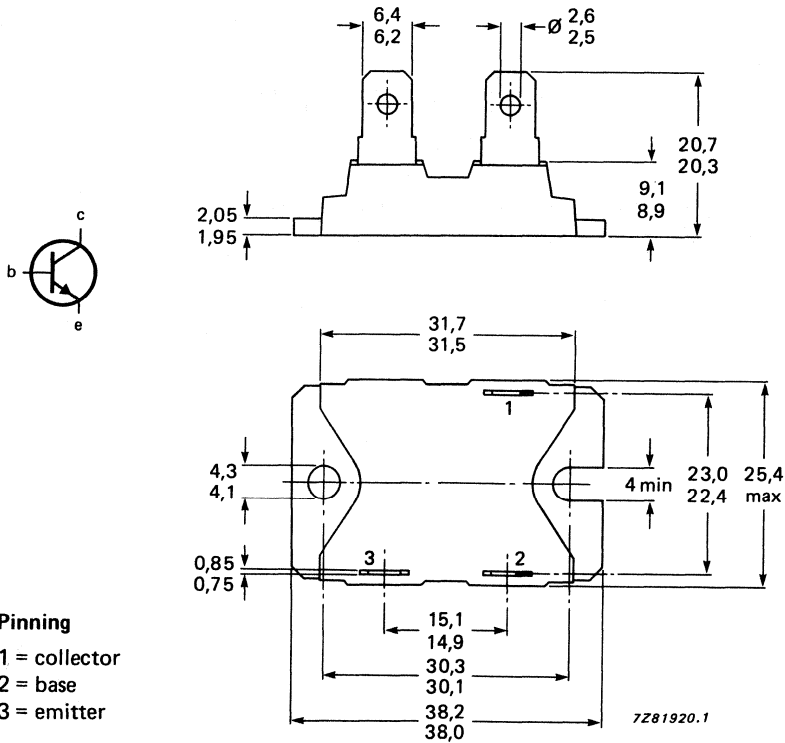
MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT227B (BUV298V and BUV298AV).



BUV298(V)
BUV298A(V)



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 $T_{mb} = 25^\circ C$	P_{tot}	max. 250	250	W
Storage temperature range		T_{stg}	-65 to +150		$^\circ C$
Junction temperature		T_j	max. 150		$^\circ C$

THERMAL RESISTANCEFrom junction to mounting base
with heatsink compound

$R_{th\ j-mb}$	=	0.5 K/W
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ISOLATIONIsolation voltage from all terminals to
external heatsink (RMS value)

$V_{isol(rms)}$	max.	2500 V
-----------------	------	--------

Isolation capacitance from collector
to external heatsink

C_{isol}	typ.	45 pF
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CHARACTERISTICS $T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified

Collector cut-off currents

$V_{CE} = V_{CESMmax}; V_{BE} = 0\text{ V}$

I_{CES}	max.	0.4 mA
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$V_{CE} = V_{CESMmax}; V_{BE} = 0\text{ V};$

$T_j = 100\text{ }^\circ\text{C}$

I_{CES}	max.	2.0 mA
-----------	------	--------

Emitter cut-off current

$V_{EB} = 5\text{ V}; I_C = 0$

I_{EBO}	max.	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

$I_C = 200\text{ mA}; I_B = 0; L = 25\text{ mH}$

$V_{CEO\text{sust}}$	min.	450 V
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Switching times inductive load

$T_j = 100\text{ }^\circ\text{C}$

turn-off; storage time
fall time

t_s	max.	4.5 μs
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t_f	max.	0.4 μs
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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.

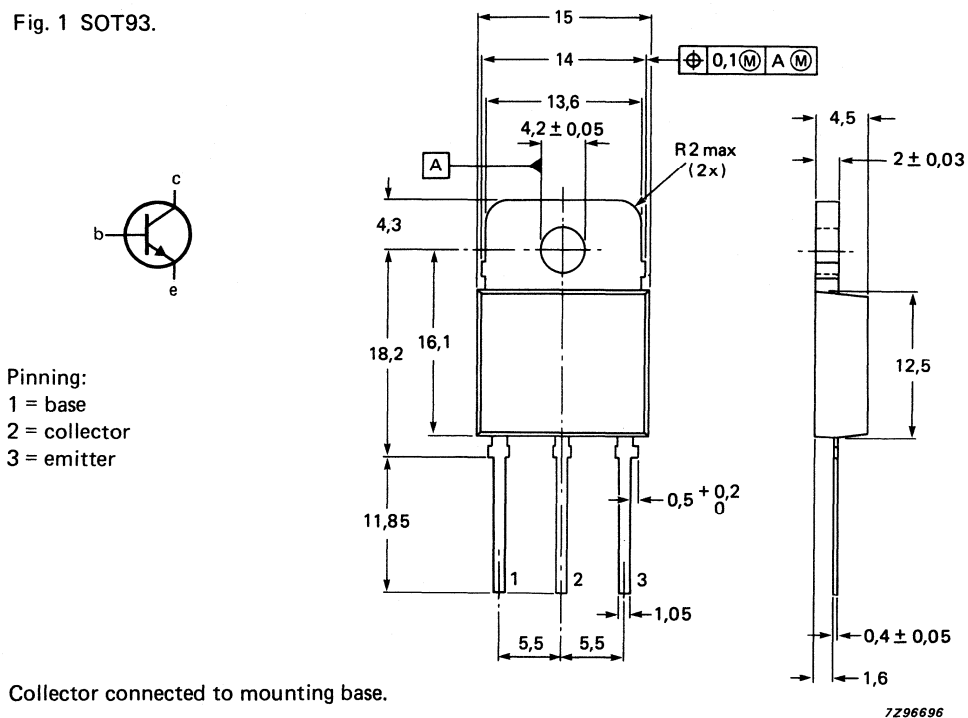
QUICK REFERENCE DATA

		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 $T_{mb} = 25^\circ\text{C}$	P_{tot} max.	100		W
Fall time (resistive load)	t_f max.	0.8		μs

MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT93.



RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BUW11	BUW11A	
Collector-emitter voltage (peak value; $V_{BE} = 0$)	V_{CESM}	max.	850	1000	V
Collector-emitter voltage (open base)	V_{CEO}	max.	400	450	V
Collector current (DC)	I_C	max.	5		A
Collector current (peak value) $t_p < 2$ ms	I_{CM}	max.	10		A
Base current (DC)	I_B	max.	2		A
Base current (peak value); $t_p < 2$ ms	I_{BM}	max.	4		A
Total power dissipation up to $T_{mb} = 25$ °C	P_{tot}	max.	100		W
Storage temperature range	T_{stg}		-65 to +150		°C
Junction temperature	T_j	max.	150		°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j-mb}$	=	1,25		K/W
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CHARACTERISTICS

$T_j = 25$ °C unless otherwise specified

Collector cut-off current*

$V_{CE} = V_{CESMmax}; V_{BE} = 0$

$V_{CE} = V_{CESMmax}; V_{BE} = 0; T_j = 125$ °C

I_{CES}	max.	1	mA
I_{CES}	max.	2	mA

Emitter cut-off current

$I_C = 0; V_{EB} = 9$ V

I_{EBO}	max.	10	mA
-----------	------	----	----

Saturation voltages

$I_C = 3$ A; $I_B = 0,6$ A

$I_C = 2,5$ A; $I_B = 0,5$ A

		BUW11	BUW11A	
V_{CEsat}	max.	1,5	—	V
V_{BEsat}	max.	1,4	—	V
V_{CEsat}	max.	—	1,5	V
V_{BEsat}	max.	—	1,4	V

Collector-emitter sustaining voltage

$I_C = 100$ mA; $I_{Boff} = 0$; $L = 25$ mH

$V_{CEO_{sust}}$	min.	400	450	V
------------------	------	-----	-----	---

Collector saturation current

$V_{CE} = 1,5$ V

I_{Csat}	max.	3	2,5	A
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* Measured with a half sinewave voltage (curve tracer).

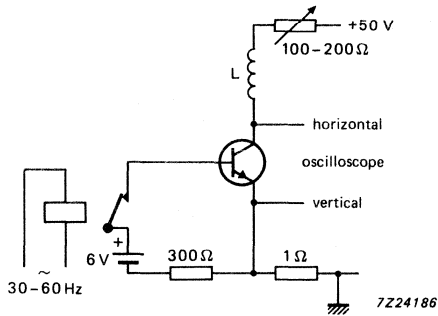


Fig. 2 Test circuit for $V_{CEOsust}$.

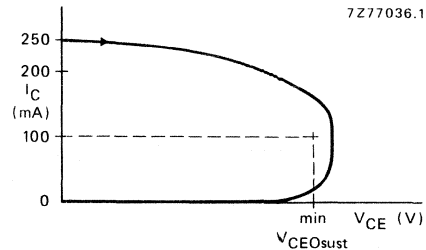


Fig. 3 Oscilloscope display for sustaining voltage.

Switching times resistive load (Figs 4 and 5)

$I_{Con} = 3 \text{ A}; I_{Bon} = I_{Boff} = 0,6 \text{ A}$

Turn-on time

Turn-off: Storage time

Fall time

$I_{Con} = 2,5 \text{ A}; I_{Bon} = -I_{Boff} = 0,5 \text{ A}$

Turn-on time

Turn-off: Storage time

Fall time

Switching times inductive load (Figs 6 and 7)

$I_{Con} = 3 \text{ A}; I_B = 0,6 \text{ A}$

Turn-off: Storage time

Fall time

$I_{Con} = 3 \text{ A}; I_B = 0,6 \text{ A}; T_j = 100 \text{ }^\circ\text{C}$

Turn-off: Storage time

Fall time

Switching times inductive load (Figs 6 and 7)

$I_{Con} = 2,5 \text{ A}; I_B = 0,5 \text{ A}$

Turn-off: Storage time

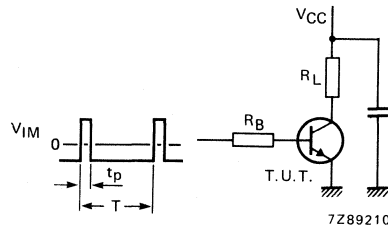
Fall time

$I_{Con} = 2,5 \text{ A}; I_B = 0,5 \text{ A}; T_j = 100 \text{ }^\circ\text{C}$

Turn-off: Storage time

Fall time

		BUW11	BUW11A	
t_{on}	max.	1	—	μs
t_s	max.	4	—	μs
t_f	max.	0,8	—	μs
t_{on}	max.	—	1	μs
t_s	max.	—	4	μs
t_f	max.	—	0,8	μs
t_s	typ.	1,1	—	μs
	max.	1,4	—	μs
t_f	typ.	80	—	ns
	max.	150	—	ns
t_s	typ.	1,2	—	μs
	max.	1,5	—	μs
t_f	typ.	140	—	ns
	max.	300	—	ns
t_s	typ.	—	1,1	μs
	max.	—	1,4	μs
t_f	typ.	—	80	ns
	max.	—	150	ns
t_s	typ.	—	1,2	μs
	max.	—	1,5	μs
	typ.	—	140	ns
	max.	—	300	ns



$V_{CC} = 250 \text{ V}$
 $V_{IM} = -6 \text{ to } +8 \text{ V}$
 $\frac{t_p}{T} = 0,01$
 $t_p = 20 \mu\text{s}$
 The values of R_B and R_L are selected in accordance with $I_{C\text{on}}$ and I_B requirements.

Fig. 4 Test circuit resistive load.

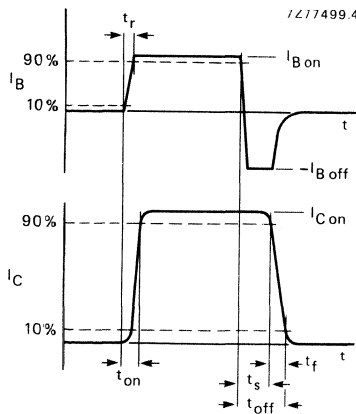


Fig. 5 Switching times waveforms with resistive load.

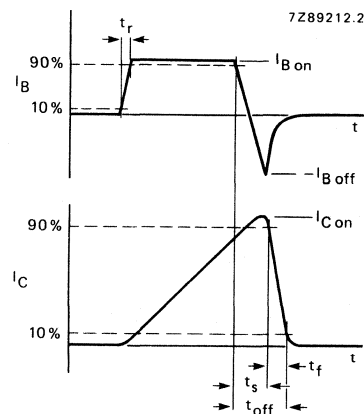
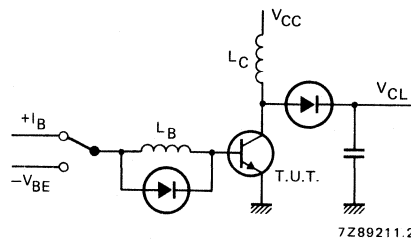
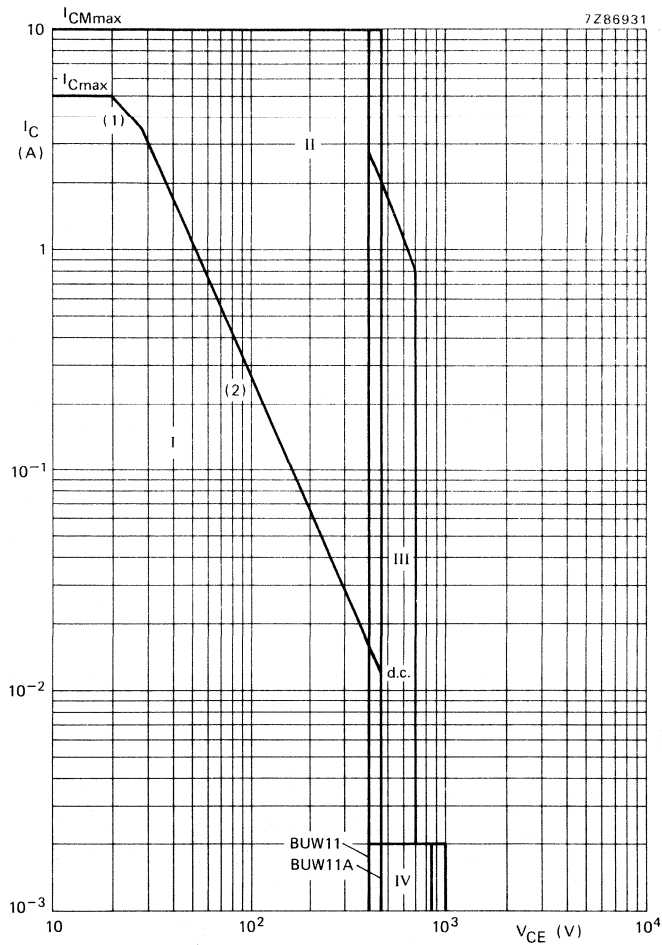


Fig. 6 Switching times waveforms with inductive load.



$V_{CL} = 300 \text{ V}$
 $V_{CC} = 30 \text{ V}$
 $-V_{BE} = 5 \text{ V}$
 $L_B = 1 \mu\text{H}$
 $L_C = 200 \mu\text{H}$

Fig. 7 Test circuit inductive load.



(1) P_{tot} max line.

(2) Second-breakdown limits.

I Region of permissible DC operation

II Permissible extension for repetitive pulse operation

III Area of permissible operation during turn-on in single transistor converters, provided $R_{BE} \leq 100 \Omega$ and $t_p \leq 0,6 \mu s$.

IV Repetitive pulse operation in this region is permissible provided $V_{BE} \leq 0$ and $t_p \leq 5$ ms.

Fig. 8 Safe operating area at $T_{mb} \leq 25^\circ C$.

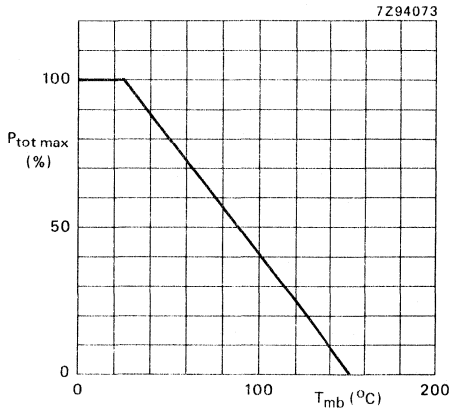


Fig. 9 Total power dissipation derating curve.

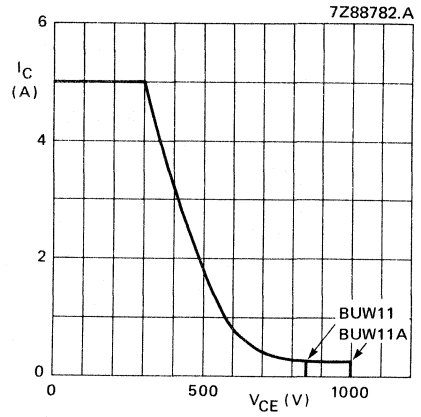


Fig. 10 Reverse bias SOAR.

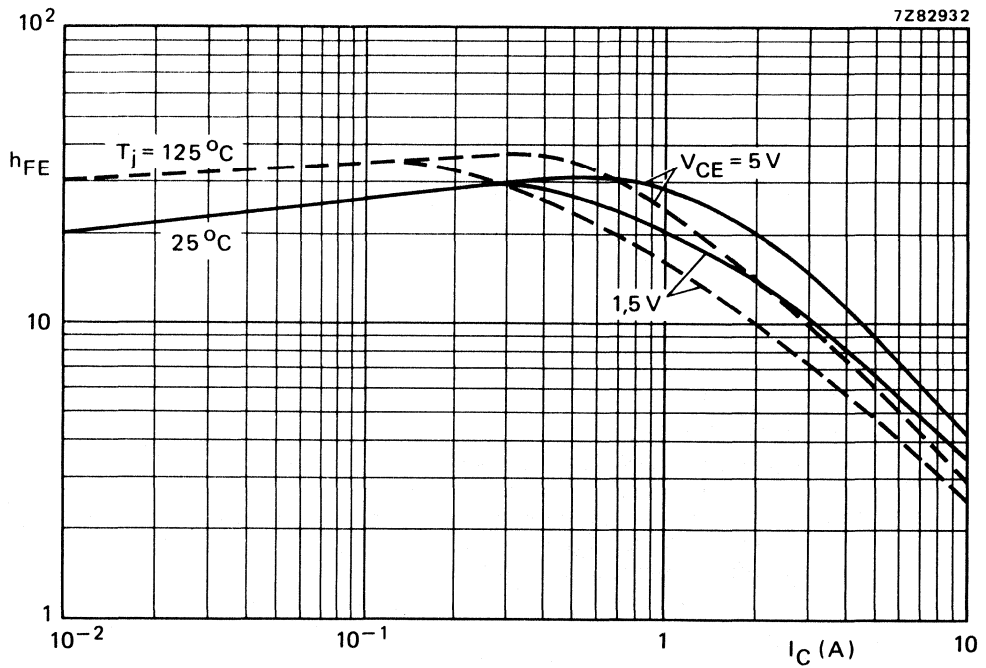


Fig. 11 Typical values DC current gain.

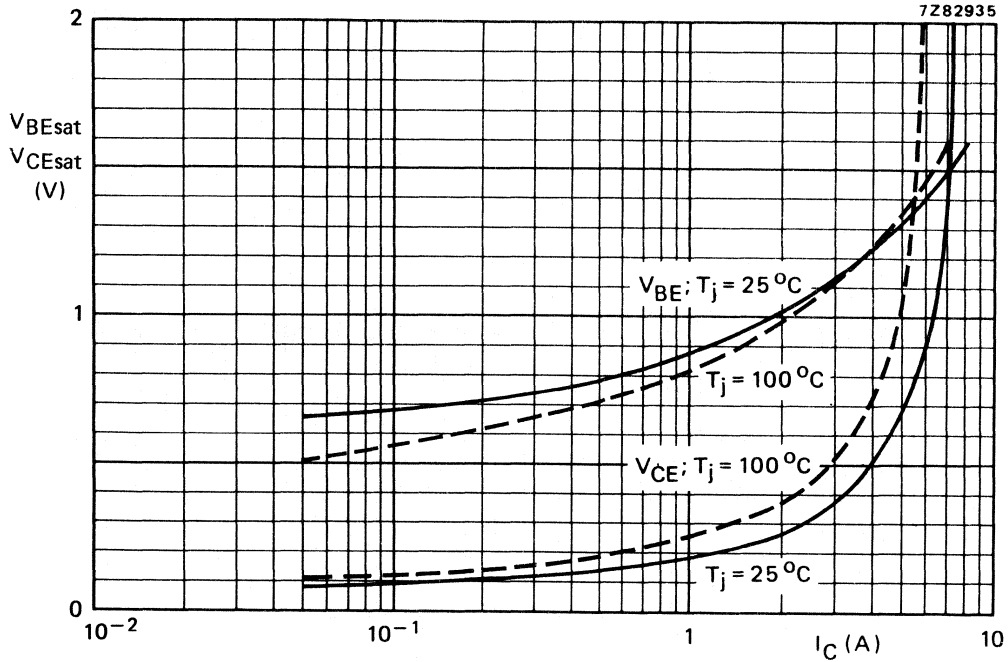


Fig. 12 Typical values base-emitter and collector-emitter voltage, $I_C/I_B = 5$.

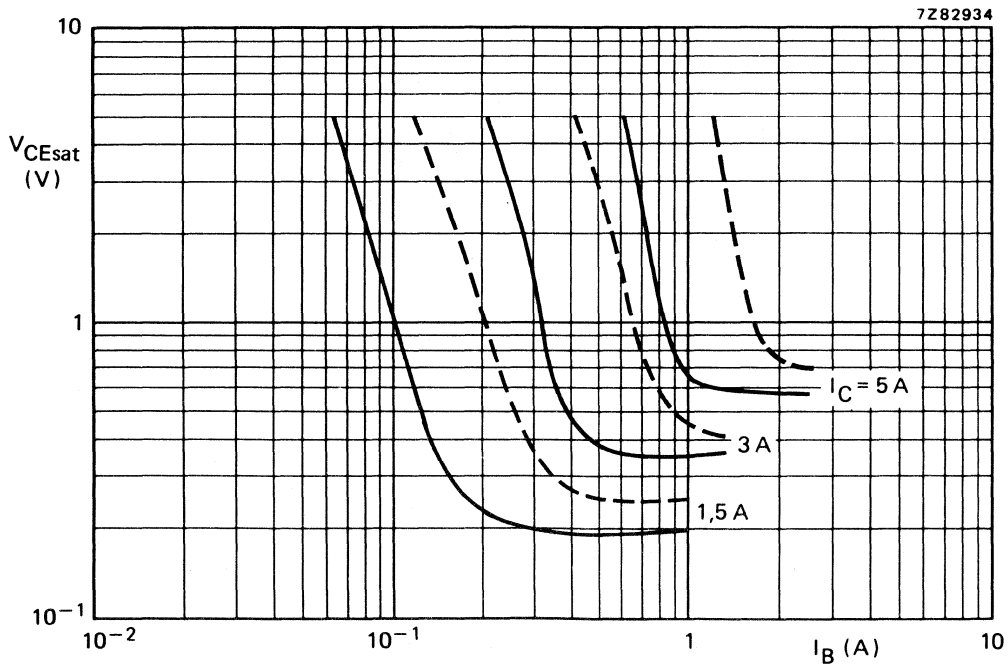


Fig. 13 Typ. (—) and max. (---) values collector-emitter saturation voltage at $T_j = 25^\circ\text{C}$.

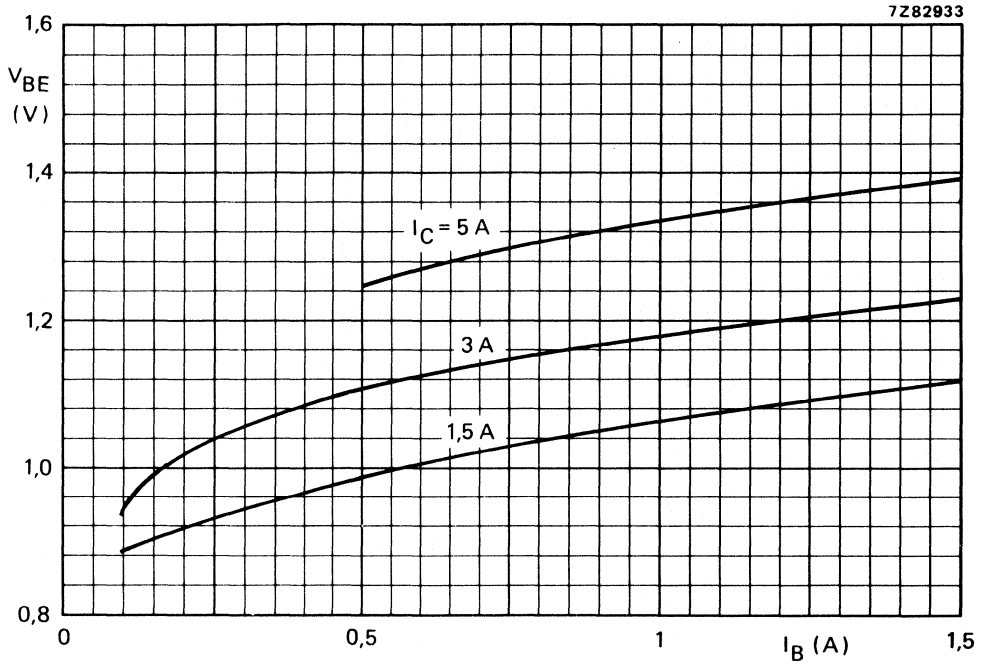


Fig. 14 Typical values at $T_j = 25$ °C.

DEVELOPMENT DATA

This data sheet contains advance information and specifications are subject to change without notice.

BUW11F
BUW11AF

SILICON DIFFUSED POWER TRANSISTORS

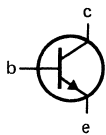
High-voltage, high-speed, glass-passivated npn power transistor in a SOT199 envelope intended for use in converters, inverters, switching regulators, motor control systems, etc.

QUICK REFERENCE DATA

			BUW11F	BUW11AF
Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM}	max.	850	1000 V
	V_{CEO}	max.	400	450 V
Collector-emitter saturation voltage	V_{CEsat}	max.	1.5	1.5 V
Collector current saturation DC	I_{Csat}	max.	3.0	2.5 A
	I_C	max.	5.0	A
	I_{CM}	max.	10	A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	32	W
Fall time	t_f	max.	0.8	μs

MECHANICAL DATA

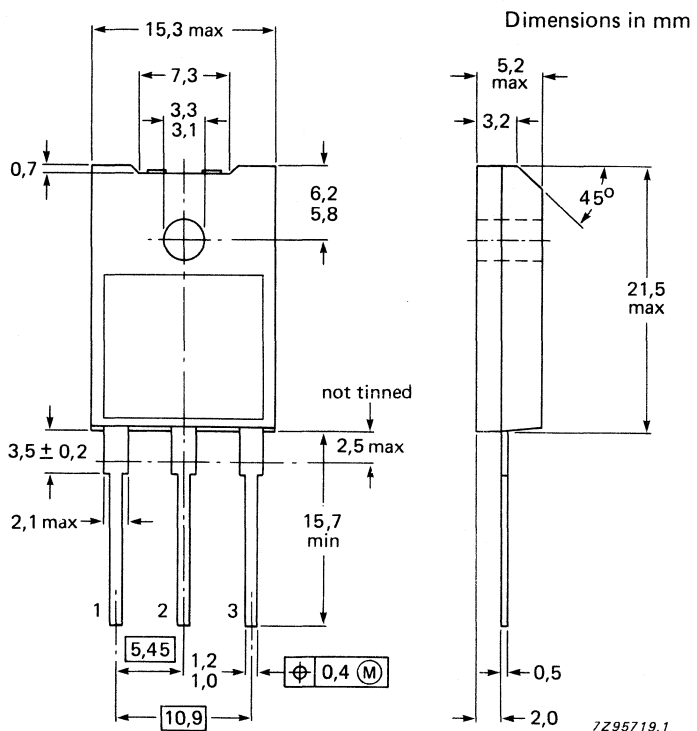
Fig. 1 SOT199.



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; $V_{BE} = 0$ open base	V_{CESM}	max.	850	1000 V
	V_{CEO}	max.	400	450 V
Collector current saturation DC	I_{Csat}		3.0	2.5
	I_C	max.	5.0	A
	I_{CM}	max.	10	A
Base current DC	I_B	max.	2.0	A
	I_{BM}	max.	4.0	A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$ (note 1)	P_{tot}	max.	32	W
	P_{tot}	max.	41	W
Storage temperature range	T_{stg}		-65 to + 150	$^\circ\text{C}$
Junction temperature	T_j	max.	150	$^\circ\text{C}$
THERMAL RESISTANCE				
From junction to external heatsink (note 1)	$R_{th\ j-h}$	=	3.95	K/W
From junction to external heatsink (note 2)	$R_{th\ j-h}$	=	3.05	K/W
From junction to ambient	$R_{th\ j-a}$	=	35	K/W
ISOLATION				
Isolation voltage from all terminals to external heatsink (peak value)	V_{isol}	max.	1500	V
Isolation capacitance from collector to external heatsink	C_{isol}	max.	21	pF

Notes

1. Mounted without heatsink compound and 30 ± 5 newtons pressure on centre of envelope.
2. Mounted with heatsink compound and 30 ± 5 newtons pressure on centre of envelope.

CHARACTERISTICS

 $T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified

Collector cut-off currents*

$V_{CE} = V_{CESMmax}; V_{BE} = 0$

 I_{CES} max. 1.0 mA

$V_{CE} = V_{CESMmax}; V_{BE} = 0; T_j = 125\text{ }^\circ\text{C}$

 I_{CES} max. 2.0 mA

Emitter cut-off current

$V_{EB} = 9\text{ V}; I_C = 0$

 I_{EBO} max. 10 mA

Saturation voltages

$I_C = 3\text{ A}; I_B = 0.6\text{ A}$

 V_{CEsat} max. 1.5 V V_{BEsat} max. 1.4 V

$I_C = 2.5\text{ A}; I_B = 0.5\text{ A}$

 V_{CEsat} max. 1.5 V V_{BEsat} max. 1.4 VCollector-emitter sustaining voltage
(Figs 2 and 3)

$I_C = 100\text{ mA}; I_{B\text{ off}} = 0; L = 25\text{ mH}$

 $V_{CEO\text{ sust}}$ min. 400 V

Collector saturation current

$V_{CE} = 1.5\text{ V}$

 $I_{C\text{ sat}}$ max. 3.0 ASwitching times resistive load
(Figs 4 and 5)

$I_{C\text{ on}} = 3\text{ A}; I_{B\text{ on}} = I_{B\text{ off}} = 0.6\text{ A}$

Turn-on time

 t_{on} max. 1.0 μs Turn-off; storage time
fall time t_s max. 4.0 μs t_f max. 0.8 μs

$I_{C\text{ on}} = 2.5\text{ A}; I_{B\text{ on}} = I_{B\text{ off}} = 0.5\text{ A}$

Turn-on time

 t_{on} max. 1.0 μs Turn-off; storage time
fall time t_s max. 4.0 μs t_f max. 0.8 μs Switching times inductive load
(Figs 6 and 7)

$I_{C\text{ on}} = 3\text{ A}; I_B = 0.6\text{ A};$

$V_{CL} = 250\text{ V}; T_c = 100\text{ }^\circ\text{C}$

Turn-off; storage time

 t_s typ. 2.0 μs t_s max. 2.5 μs

fall time

 t_f typ. 200 ns t_f max. 300 ns

$I_{C\text{ on}} = 2.5\text{ A}; I_B = 0.5\text{ A};$

$V_{CL} = 300\text{ V}; T_c = 100\text{ }^\circ\text{C}$

Turn-off; storage time

 t_s typ. 2.0 μs t_s max. 2.5 μs

fall time

 t_f typ. 200 ns t_f max. 300 ns

DEVELOPMENT DATA

* Measured with a half-sinewave voltage (curve tracer).

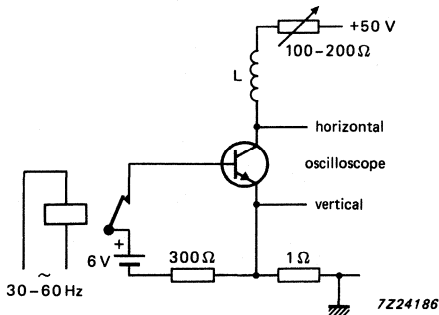


Fig. 2 Test circuit for $V_{CE0\text{sust}}$.

$V_{CC} = 250 \text{ V}$
 $t_p = 20 \mu\text{s}$
 $V_{IM} = -6 \text{ to } +8 \text{ V}$
 $\frac{t_p}{T} = 0.01$

The values of R_B and R_L are selected in accordance with I_C on and I_B requirements.

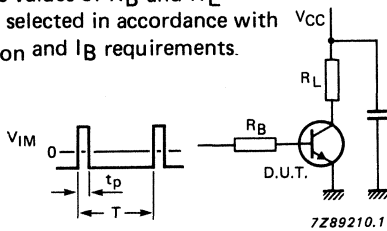


Fig. 4 Test circuit resistive load.

$V_{CL} = \text{up to } 1000 \text{ V}$
 $V_{CC} = 30 \text{ V}$
 $-V_{BE} = 1 \text{ V to } 5 \text{ V}$
 $L_B = 1.0 \mu\text{H}$
 $L_C = 200 \mu\text{H}$

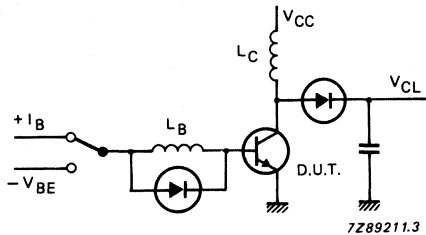


Fig. 6 Test circuit inductive load and reverse bias SOAR.

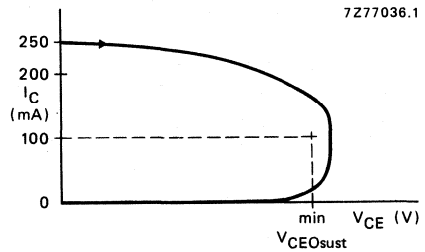


Fig. 3 Oscilloscope display for sustaining voltage.

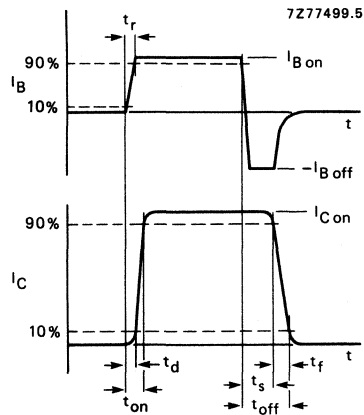


Fig. 5 Switching times waveforms with resistive load; $t_r \leq 20 \text{ ns}$.

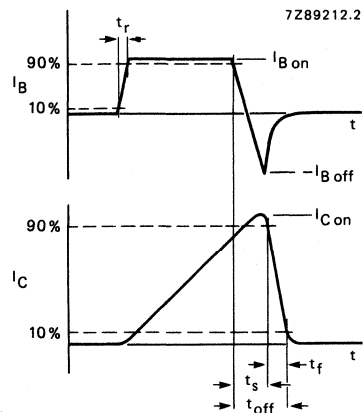
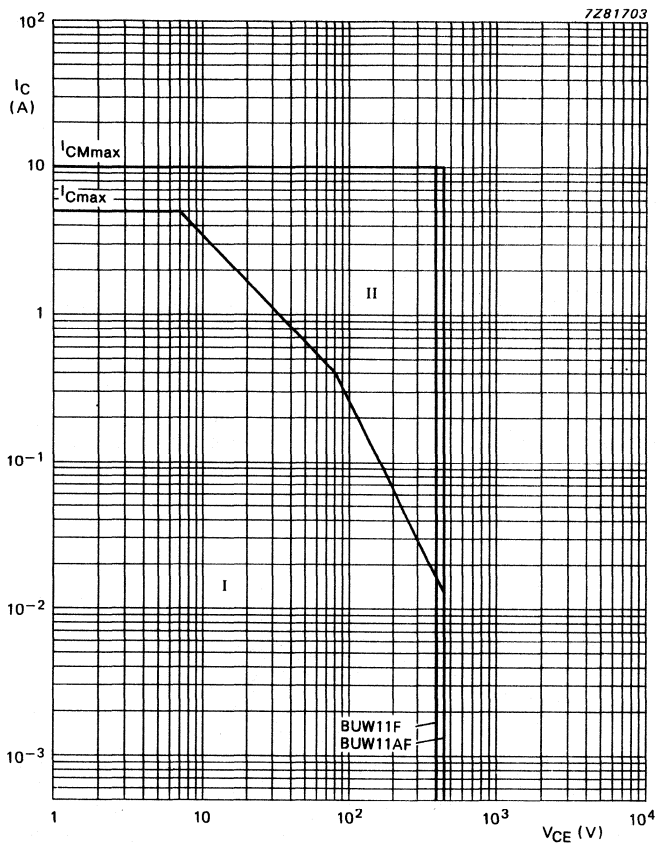


Fig. 7 Switching times waveforms with inductive load.

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 $T_{mb} < 25 \text{ }^\circ\text{C}$.

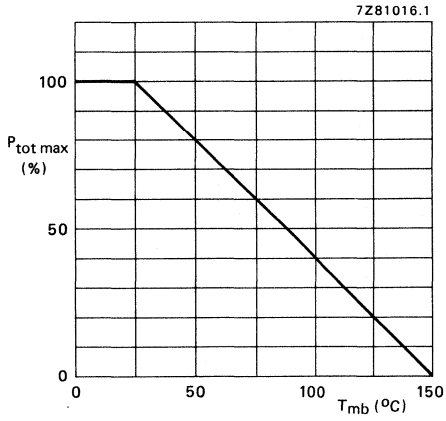


Fig. 9 Power dissipation curve.

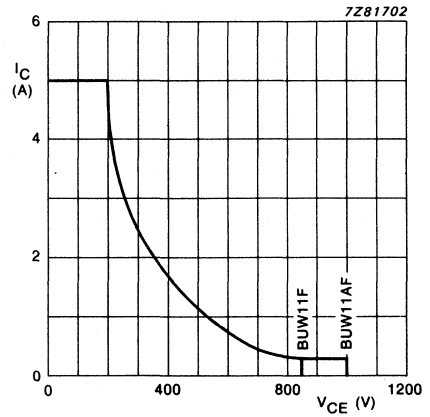


Fig. 10 RB SOAR; $T_c \leq 100 \text{ }^\circ\text{C}$;
 $V_{BE} = -1 \text{ V to } -5 \text{ V}$.

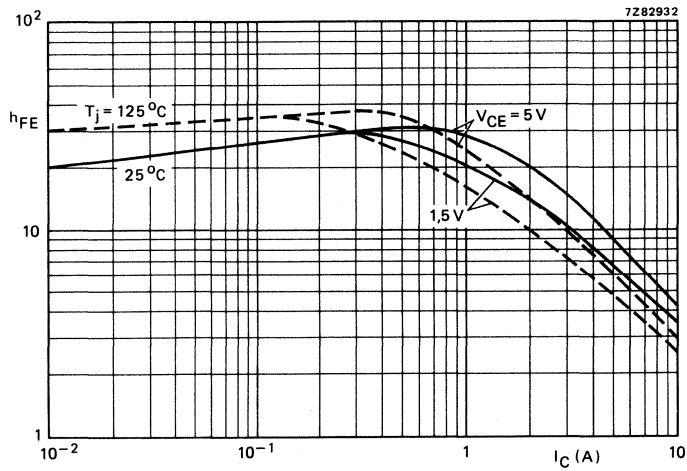


Fig. 11 Typical values DC current gain; $T_j = 125 \text{ }^\circ\text{C}$.

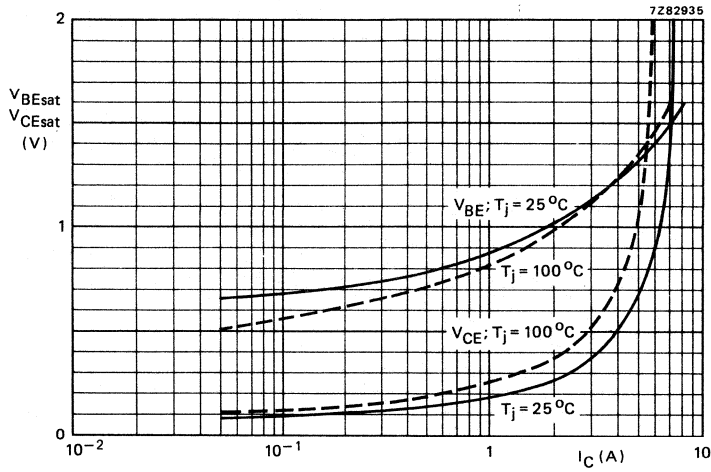


Fig. 12 Typical values base and collector voltages at $I_C/I_B = 5$.

DEVELOPMENT DATA

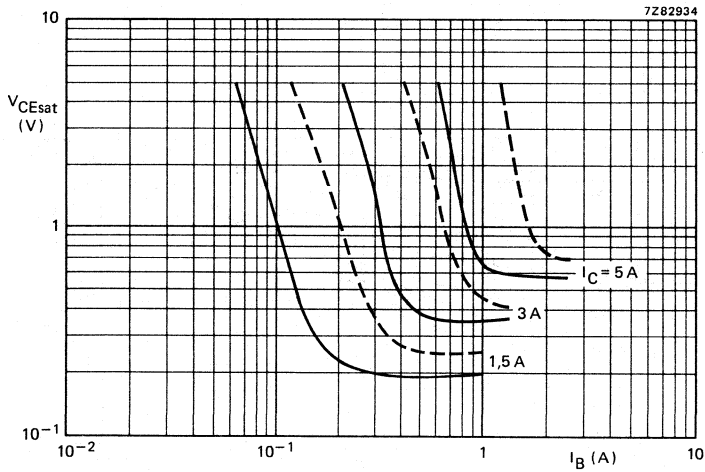


Fig. 13 Typical (—) and maximum (---) values saturation voltage; $T_j = 25^\circ\text{C}$.

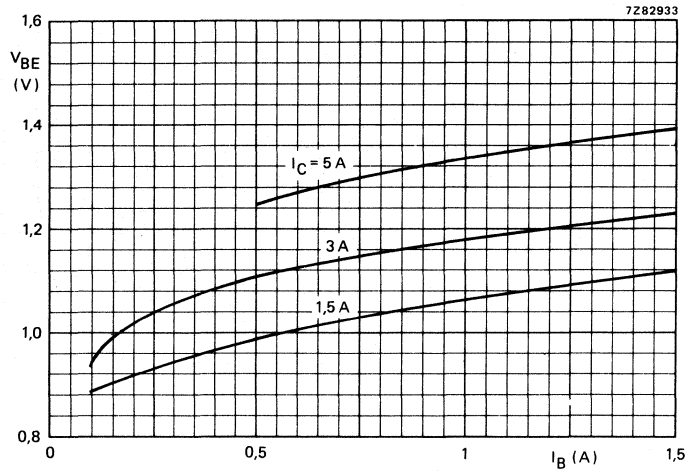


Fig. 14 Typical values base-emitter voltage at $T_j = 25 \text{ }^\circ\text{C}$.

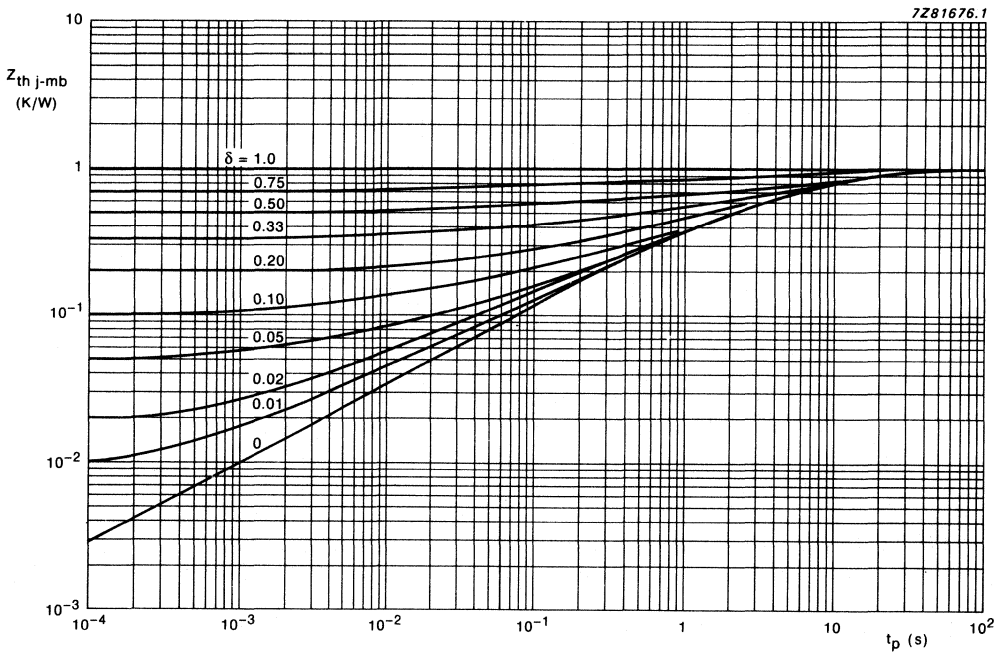


Fig. 15 Normalized thermal response at pulse power conditions.

SILICON DIFFUSED POWER TRANSISTORS

High-voltage, high-speed, glass-passivated npn power transistors in a SOT93 envelope, intended for use in converters, inverters, switching regulators, motor control systems etc.

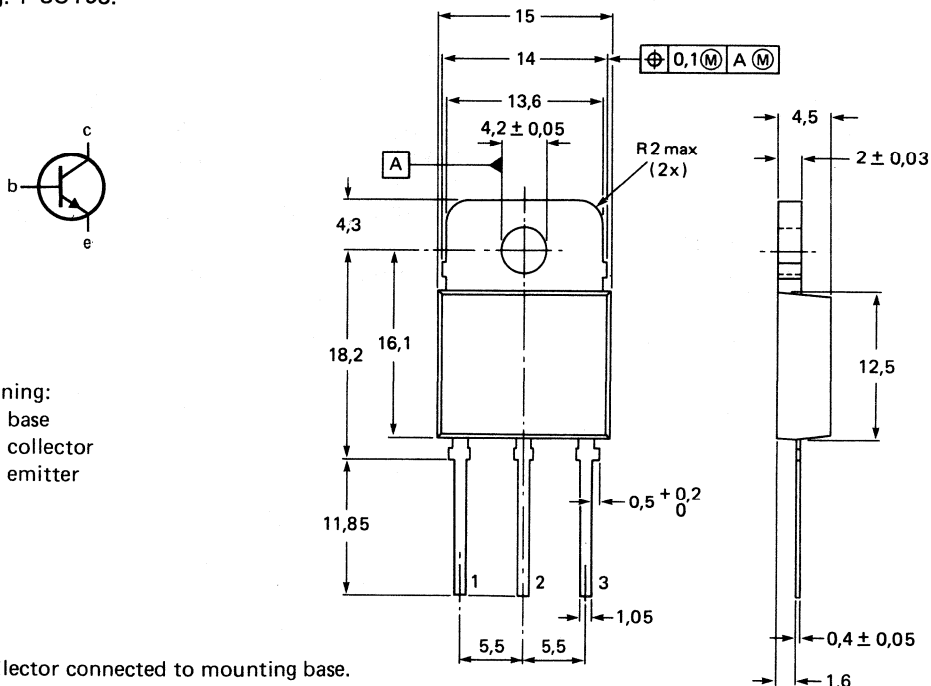
QUICK REFERENCE DATA

		BUW12	BUW12A	
Collector-emitter voltage (peak value; $V_{BE} = 0$)	V_{CESM} max.	850	1000	V
Collector-emitter voltage (open base)	V_{CEO} max.	400	450	V
Collector-emitter saturation voltage	V_{CEsat} max.	1.5		V
Collector current (DC)	I_C max.	8		A
Collector current (peak value)	I_{CM} max.	20		A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot} max.	125		W
Fall time (resistive load)	t_f max.	0.8		μs

MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT93.



7296696

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BUW12	BUW12A	
Collector-emitter voltage (peak value; $V_{BE} = 0$)	V_{CESM}	max.	850	1000	V
Collector-emitter voltage (open base)	V_{CEO}	max.	400	450	V
Collector current (DC)	I_C	max.	8		A
Collector current (peak value); $t_p < 2$ ms	I_{CM}	max.	20		A
Base current (DC)	I_B	max.	4		A
Base current (peak value); $t_p \leq 2$ ms	I_{BM}	max.	6		A
Total power dissipation up to $T_{mb} = 25$ °C	P_{tot}	max.	125		W
Storage temperature range	T_{stg}		-65 to + 150		°C
Junction temperature	T_j	max.	150		°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j-mb}$	=	1,0		K/W
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CHARACTERISTICS

$T_j = 25$ °C unless otherwise specified

Collector cut-off current*

$V_{CE} = V_{CESMmax}; V_{BE} = 0$

$V_{CE} = V_{CESMmax}; V_{BE} = 0; T_j = 125$ °C

I_{CES}	max.	1		mA
I_{CES}	max.	3		mA

Emitter cut-off current

$I_C = 0; V_{EB} = 9$ V

I_{EBO}	max.	10		mA
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Saturation voltages

$I_C = 6$ A; $I_B = 1,2$ A

$I_C = 5$ A; $I_B = 1,0$ A

			BUW12	BUW12A	
V_{CEsat}	max.	1,5	—	V	
V_{BEsat}	max.	1,5	—	V	
V_{CEsat}	max.	—	1,5	V	
V_{BEsat}	max.	—	1,5	V	

Collector-emitter sustaining voltage

$I_C = 100$ mA; $I_{Boff} = 0$; $L = 25$ mH

$V_{CEO sust}$	min.	400	450	V
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* Measured with a half-sinewave voltage (curve tracer).

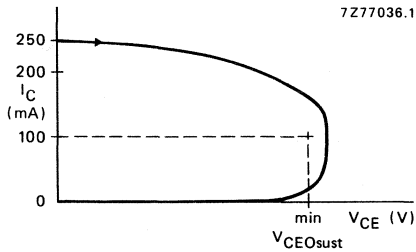


Fig. 2 Oscilloscope display for sustaining voltage.

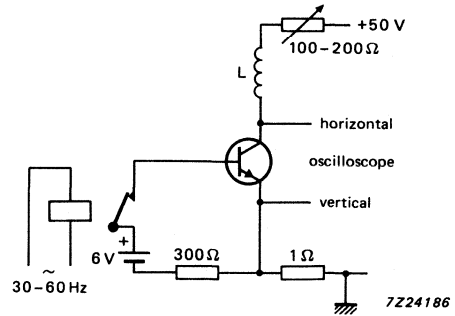


Fig. 3 Test circuit for $V_{CEOsust}$.

Switching times resistive load (Figs 4 and 5)

$I_{Con} = 6\text{ A}$; $I_{Bon} = -I_{Boff} = 1,2\text{ A}$

Turn-on time

Turn-off: Storage time

Fall time

$I_{Con} = 5\text{ A}$; $I_{Bon} = -I_{Boff} = 1\text{ A}$

Turn-on time

Turn-off: Storage time

Fall time

Switching times inductive load (Figs 6 and 7)

$I_{Con} = 6\text{ A}$; $I_B = 1,2\text{ A}$

Turn-off: Storage time

Fall time

$I_{Con} = 6\text{ A}$; $I_B = 1,2\text{ A}$; $T_j = 100\text{ }^\circ\text{C}$

Turn-off: Storage time

Fall time

Switching times inductive load (Figs 6 and 7)

$I_{Con} = 5\text{ A}$; $I_B = 1\text{ A}$

Turn-off: Storage time

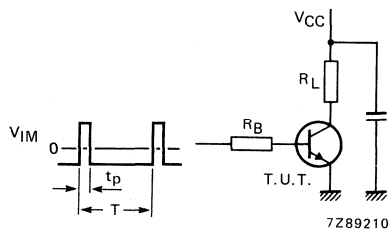
Fall time

$I_{Con} = 5\text{ A}$; $I_B = 1\text{ A}$; $T_j = 100\text{ }^\circ\text{C}$

Turn-off: Storage time

Fall time

		BUW12	BUW12A	
t_{on}	max.	1	—	μs
t_s	max.	4	—	μs
t_f	max.	0,8	—	μs
t_{on}	max.	—	1	μs
t_s	max.	—	4	μs
t_f	max.	—	0,8	μs
t_s	typ.	1,6	—	μs
	max.	2,1	—	μs
t_f	typ.	80	—	ns
	max.	150	—	ns
t_s	typ.	1,8	—	μs
	max.	2,3	—	μs
t_f	typ.	140	—	ns
	max.	300	—	ns
t_s	typ.	—	1,6	μs
	max.	—	2,1	μs
t_f	typ.	—	80	ns
	max.	—	150	ns
t_s	typ.	—	1,8	μs
	max.	—	2,3	μs
t_f	typ.	—	140	ns
	max.	—	300	ns



$V_{CC} = 250 \text{ V}$
 $V_{IM} = -6 \text{ to } +8 \text{ V}$
 $\frac{t_p}{T} = 0,01$
 $t_p = 20 \mu\text{s}$
 The values of R_B and R_L are selected in accordance with I_{Con} and I_B requirements.

Fig. 4 Test circuit resistive load.

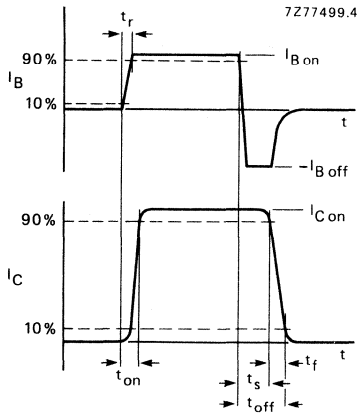


Fig. 5 Switching times waveforms with resistive load.

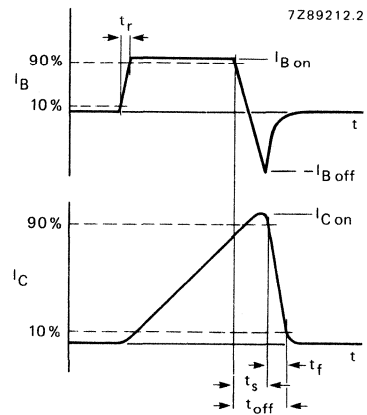
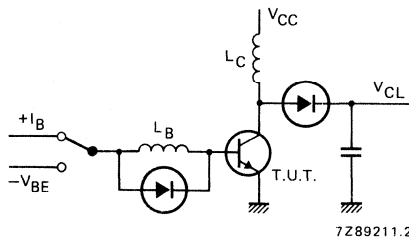
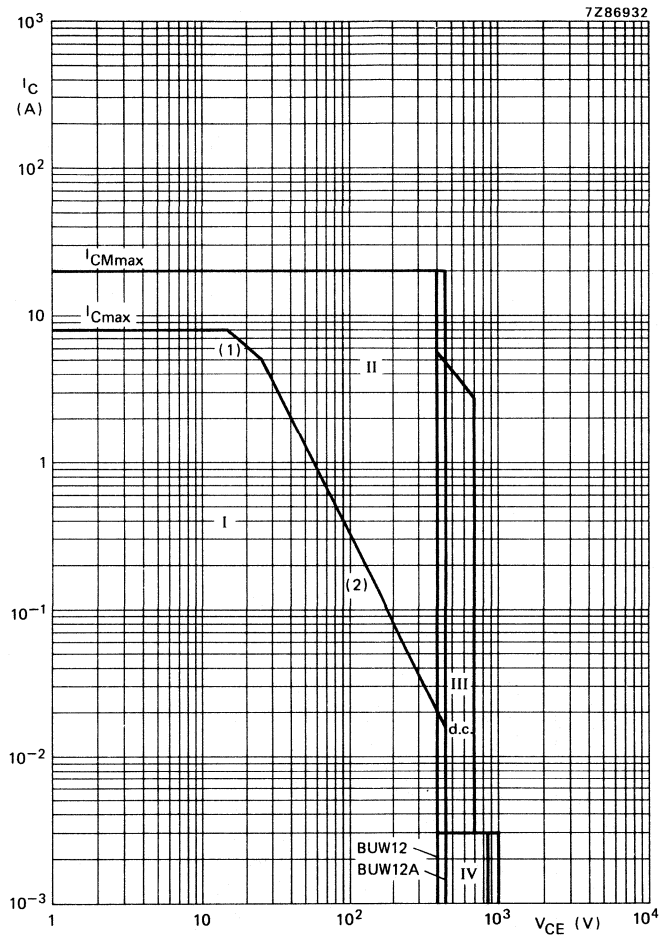


Fig. 6 Switching times waveforms with inductive load.



$V_{CL} = 300 \text{ V}$
 $V_{CC} = 30 \text{ V}$
 $-V_{BE} = 5 \text{ V}$
 $L_B = 1 \mu\text{H}$
 $L_C = 200 \mu\text{H}$

Fig. 7 Test circuit inductive load.



- (1) P_{tot} max line.
- (2) Second-breakdown limits.
- I Region of permissible DC operation.
- II Permissible extension for repetitive pulse operation.
- III Area of permissible operation during turn-on in single transistor converters, provided $R_{BE} \leq 100 \Omega$ and $t_p \leq 0,6 \mu s$.
- IV Repetitive pulse operation in this region is permissible provided $V_{BE} \leq 0$ and $t_p \leq 2$ ms.

Fig. 8 Safe operating area at $T_{mb} \leq 25^\circ C$.

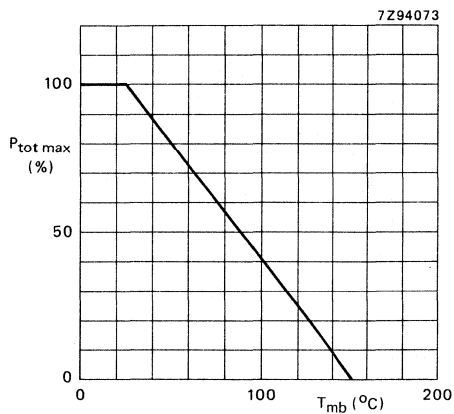


Fig. 9 Total power dissipation derating curve.

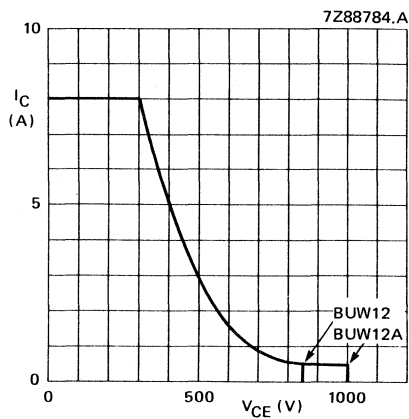


Fig. 10 Reverse bias SOAR.

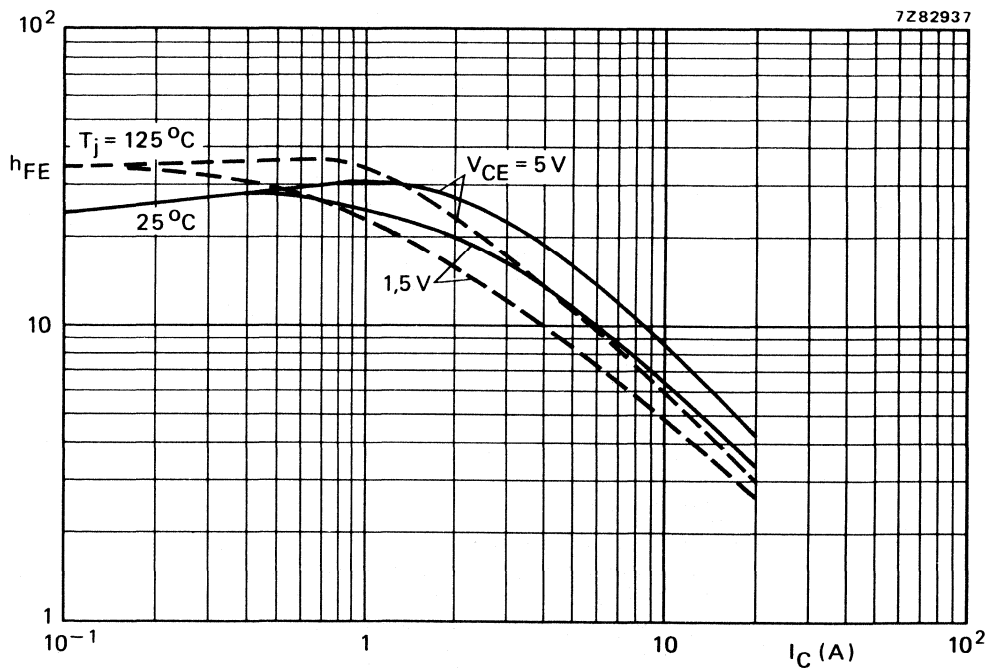


Fig. 11 Typical values DC current gain.

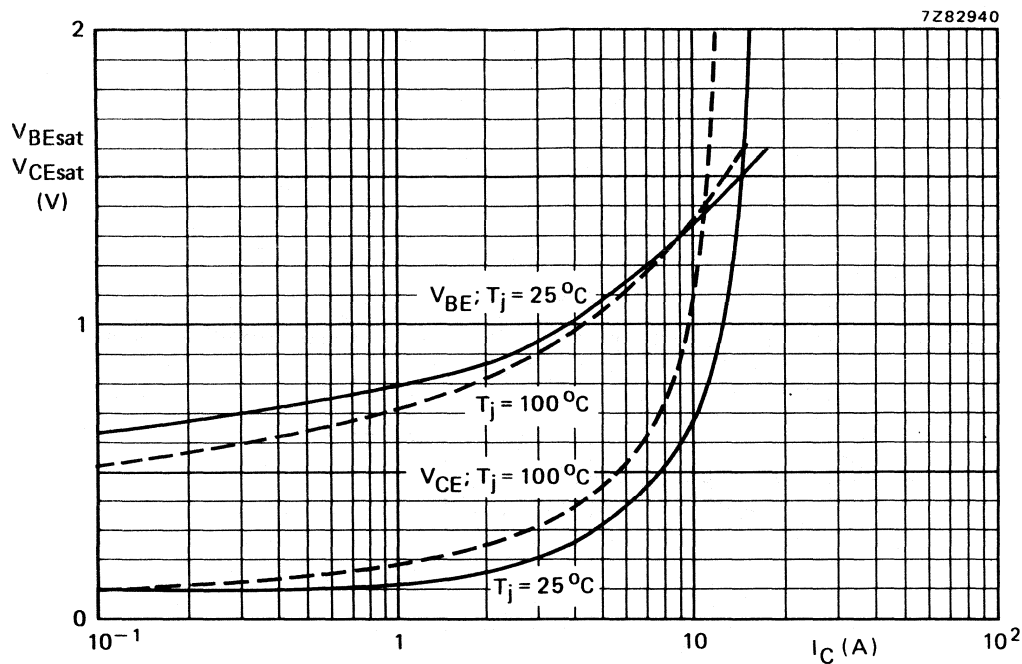


Fig. 12 Typical values base and collector voltage at $I_C/I_B = 5$.

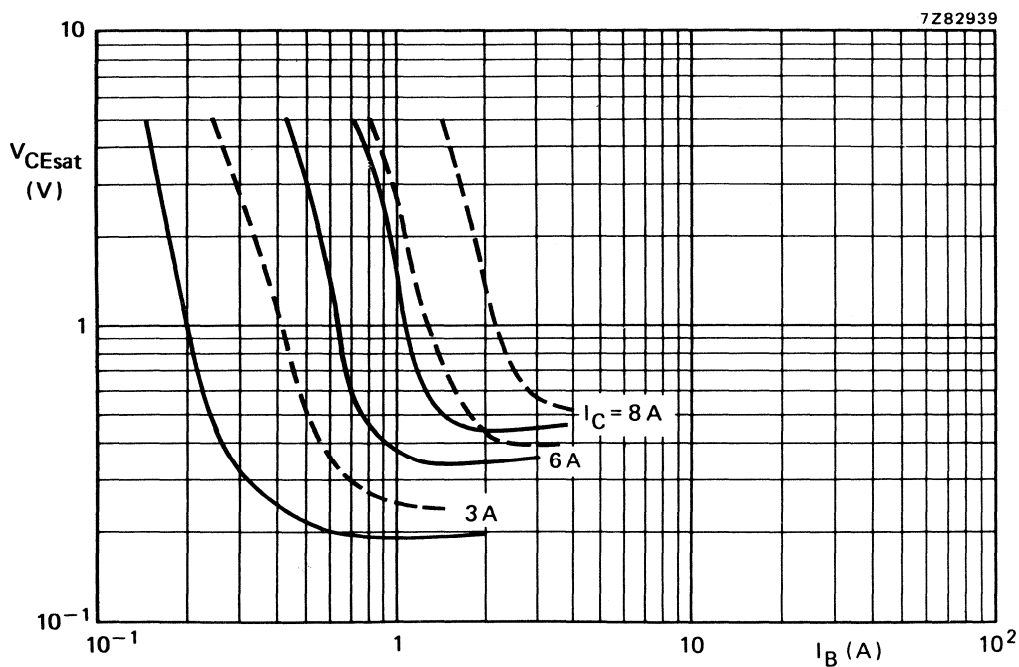


Fig. 13 Typ. (—) and max. (---) values collector-emitter saturation voltage at $T_j = 25^\circ\text{C}$.

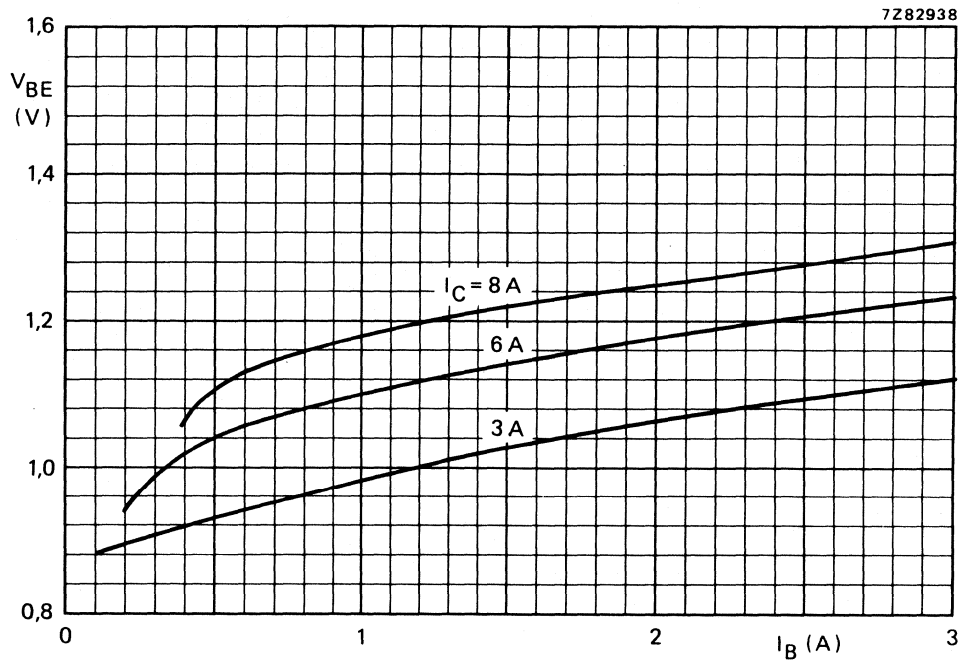


Fig. 14 Typical values base-emitter voltage at $T_j = 25^\circ\text{C}$.

DEVELOPMENT DATA

This data sheet contains advance information and specifications are subject to change without notice.

BUW12F
BUW12AF

SILICON DIFFUSED POWER TRANSISTORS

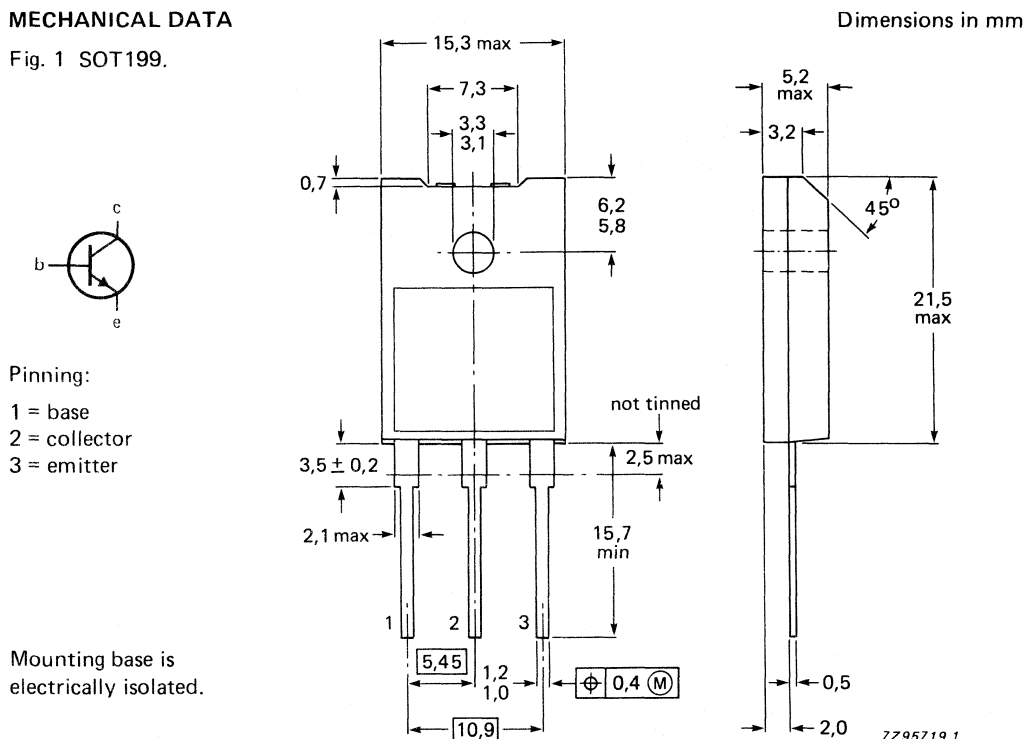
High-voltage, high-speed, glass-passivated npn power transistor in a SOT199 envelope intended for use in converters, inverters, switching regulators, motor control systems, etc.

QUICK REFERENCE DATA

			BUW12F	BUW12AF
Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM}	max.	850	1000 V
	V_{CEO}	max.	400	450 V
Collector-emitter saturation voltage	V_{CEsat}	max.	1.5	1.5 V
Collector current saturation DC peak value	I_{Csat}	max.	6.0	5.0 A
	I_C	max.	8.0	A
	I_{CM}	max.	20	A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	34	W
Fall time	t_f	max.	0.8	μs

MECHANICAL DATA

Fig. 1 SOT199.



RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BUW12F	BUW12AF
Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM}	max.	850	1000 V
	V_{CEO}	max.	400	450 V
Collector current saturation DC peak value	I_{Csat}		6.0	5.0 A
	I_C	max.	8.0	A
	I_{CM}	max.	20	A
Base current DC peak value	I_B	max.	4.0	A
	I_{BM}	max.	6.0	A
Total power dissipation up to $T_h = 25\text{ }^\circ\text{C}$ (note 1)	P_{tot}	max.	34	W
Total power dissipation up to $T_h = 25\text{ }^\circ\text{C}$ (note 2)	P_{tot}	max.	45	W
Storage temperature range	T_{stg}		-65 to + 150	$^\circ\text{C}$
Junction temperature	T_j	max.	150	$^\circ\text{C}$
THERMAL RESISTANCE				
From junction to external heatsink (note 1)	$R_{th\ j-h}$	=	3.7	K/W
From junction to external heatsink (note 2)	$R_{th\ j-h}$	=	2.8	K/W
From junction to ambient	$R_{th\ j-a}$	=	35	K/W
ISOLATION				
Isolation voltage from all terminals to external heatsink (peak value)	V_{isol}	max.	1500	V
Isolation capacitance from collector to external heatsink	C_{isol}	max.	21	pF

Notes

1. Mounted without heatsink compound and 30 ± 5 newtons pressure on centre of envelope.
2. Mounted with heatsink compound and 30 ± 5 newtons pressure on centre of envelope.

CHARACTERISTICS

 $T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified

Collector cut-off currents*

$V_{CE} = V_{CESMmax}; V_{BE} = 0$

$V_{CE} = V_{CESMmax}; V_{BE} = 0; T_j = 125\text{ }^\circ\text{C}$

I_{CES}	max.	1.0	mA
I_{CES}	max.	3.0	mA

Emitter cut-off current

$V_{EB} = 9\text{ V}; I_C = 0$

I_{EBO}	max.	10	mA
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Saturation voltages

$I_C = 6\text{ A}; I_B = 1.2\text{ A}$

V_{CEsat}	max.	1.5	— V
V_{BEsat}	max.	1.5	— V

$I_C = 5\text{ A}; I_B = 1.0\text{ A}$

V_{CEsat}	max.	—	1.5 V
V_{BEsat}	max.	—	1.5 V

Collector-emitter sustaining voltage

(Figs 2 and 3)

$I_C = 100\text{ mA}; I_{B\text{ off}} = 0; L = 25\text{ mH}$

$V_{CEO\text{ sust}}$	min.	400	450 V
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Collector saturation current

$V_{CE} = 1.5\text{ V}$

$I_{C\text{ sat}}$	max.	6.0	5.0 A
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Switching times resistive load

(Figs 4 and 5)

$I_{C\text{ on}} = 6\text{ A}; I_{B\text{ on}} = I_{B\text{ off}} = 1.2\text{ A}$

Turn-on time

t_{on}	max.	1.0	— μs
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Turn-off; storage time

t_s	max.	4.0	— μs
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fall time

t_f	max.	0.8	— μs
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$I_{C\text{ on}} = 5\text{ A}; I_{B\text{ on}} = I_{B\text{ off}} = 1\text{ A}$

Turn-on time

t_{on}	max.	—	1.0 μs
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Turn-off; storage time

t_s	max.	—	4.0 μs
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fall time

t_f	max.	—	0.8 μs
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Switching times inductive load

(Figs 6 and 7)

$I_{C\text{ on}} = 6\text{ A}; I_B = 1.2\text{ A};$

$V_{CL} = 250\text{ V}; T_c = 100\text{ }^\circ\text{C}$

Turn-off; storage time

t_s	typ.	1.9	— μs
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t_s	max.	2.5	— μs
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fall time

t_f	typ.	200	— ns
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t_f	max.	300	— ns
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$I_{C\text{ on}} = 5\text{ A}; I_B = 1\text{ A};$

$V_{CL} = 300\text{ V}; T_c = 100\text{ }^\circ\text{C}$

Turn-off; storage time

t_s	typ.	—	1.9 μs
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t_s	max.	—	2.5 μs
-------	------	---	-------------------

fall time

t_f	typ.	—	200 ns
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t_f	max.	—	300 ns
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DEVELOPMENT DATA

* Measured with a half-sinewave voltage (curve tracer).

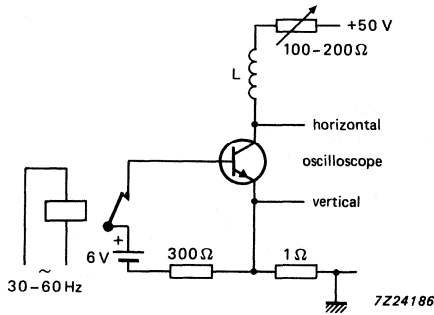


Fig. 2 Test circuit for $V_{CEOsust}$.

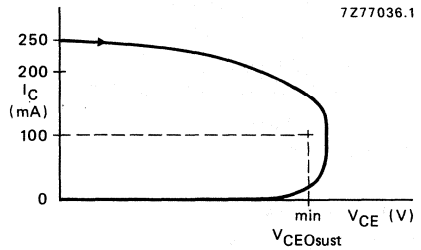


Fig. 3 Oscilloscope display for sustaining voltage.

$V_{CC} = 250 \text{ V}$
 $t_p = 20 \mu\text{s}$
 $V_{IM} = -6 \text{ to } +8 \text{ V}$
 $\frac{t_p}{T} = 0.01$

The values of R_B and R_L are selected in accordance with $I_{C on}$ and I_B requirements

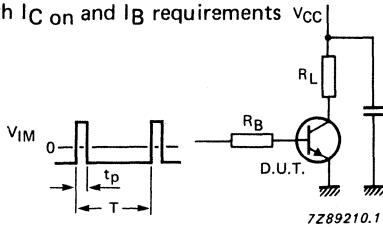


Fig. 4 Test circuit resistive load.

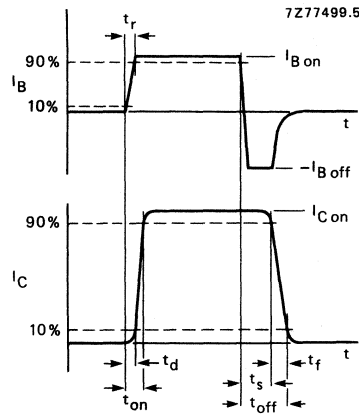


Fig. 5 Switching waveforms with resistive load; $t_r \leq 20 \text{ ns}$.

$V_{CL} = \text{up to } 1000 \text{ V}$
 $V_{CC} = 30 \text{ V}$
 $-V_{BE} = 1 \text{ V to } 5 \text{ V}$
 $L_B = 1.0 \mu\text{H}$
 $L_C = 200 \mu\text{H}$

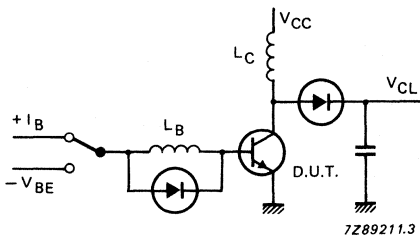


Fig. 6 Test circuit inductive load and reverse bias SOAR.

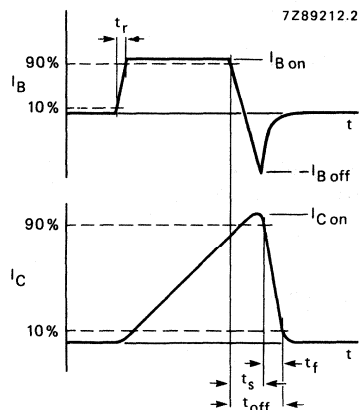
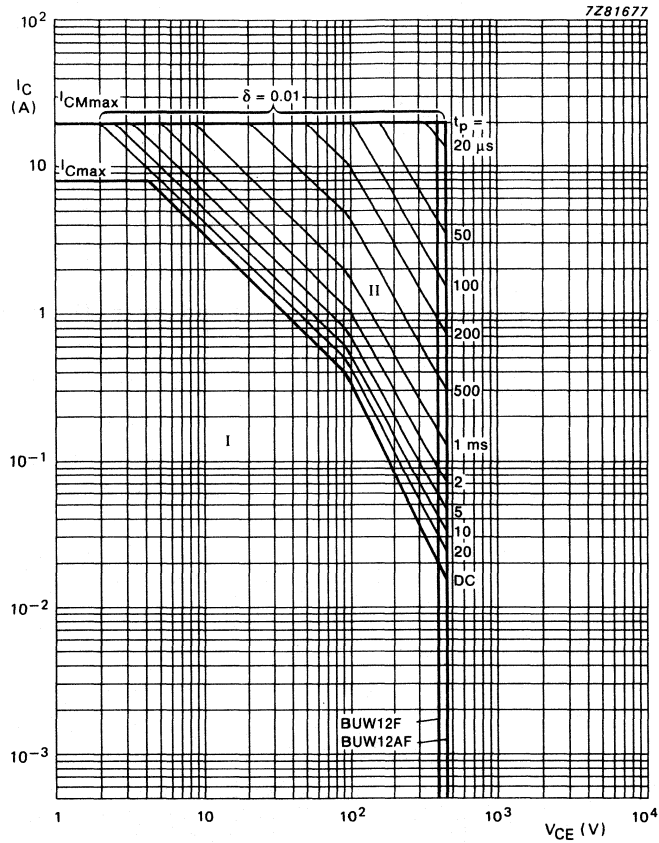


Fig. 7 Switching times waveforms with inductive load.

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 $T_{mb} < 25 \text{ }^\circ\text{C}$.

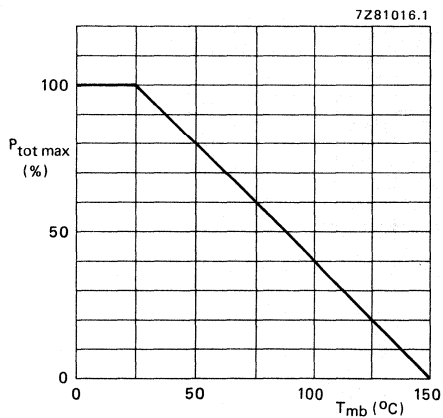


Fig. 9 Power dissipation curve.

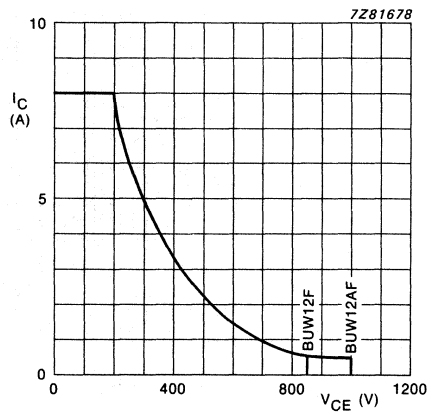


Fig. 10 RB SOAR; $T_c \leq 100^\circ\text{C}$;
 $V_{BE} = -1\text{ V to } -5\text{ V}$.

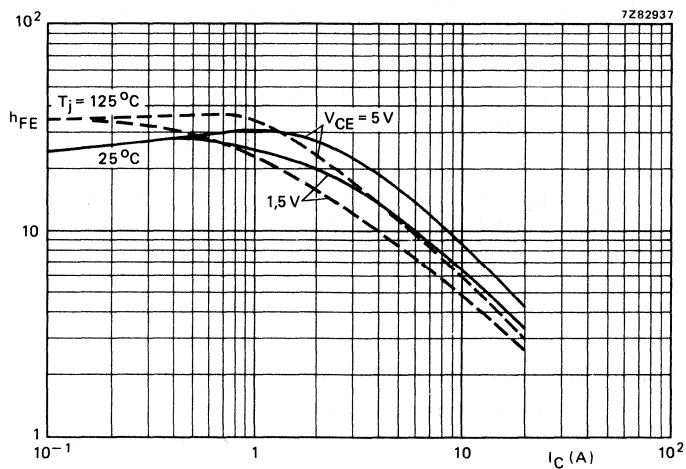


Fig. 11 Typical values DC current gain; $T_j = 125^\circ\text{C}$.

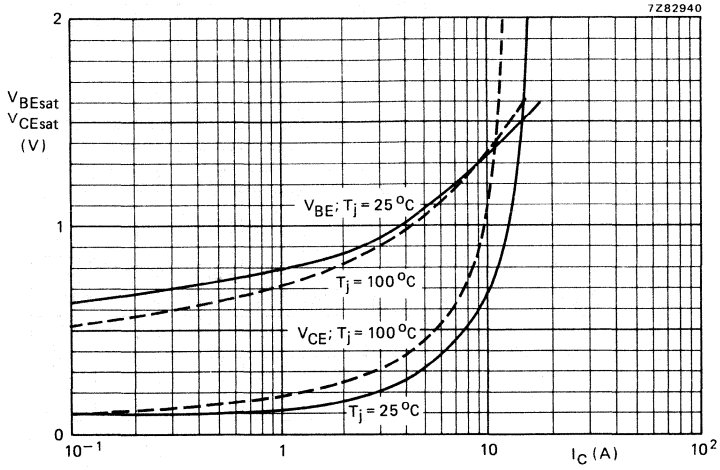


Fig. 12 Typical values base and collector voltages at $I_C/I_B = 5$.

DEVELOPMENT DATA

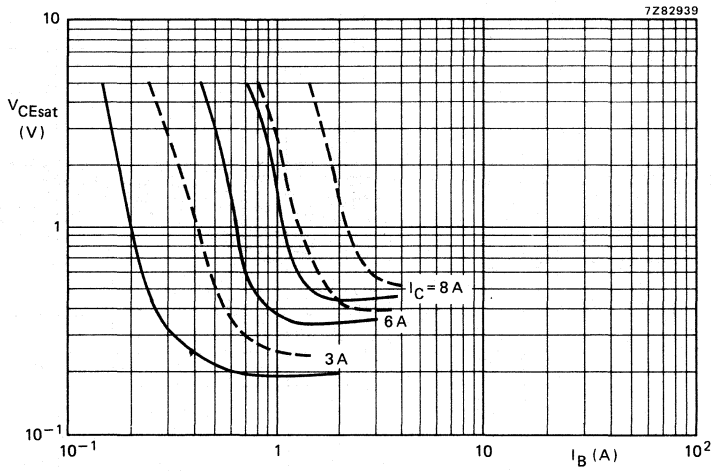


Fig. 13 Typical (—) and maximum (---) values saturation voltage; $T_j = 25^\circ\text{C}$.

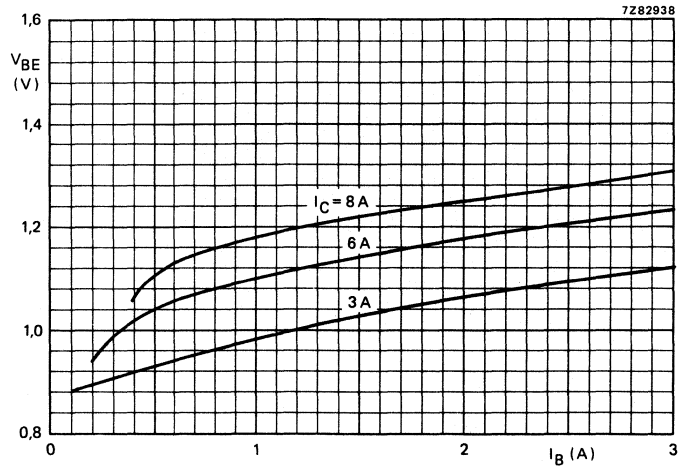


Fig. 14 Typical values base-emitter voltage at $T_j = 25\text{ }^\circ\text{C}$.

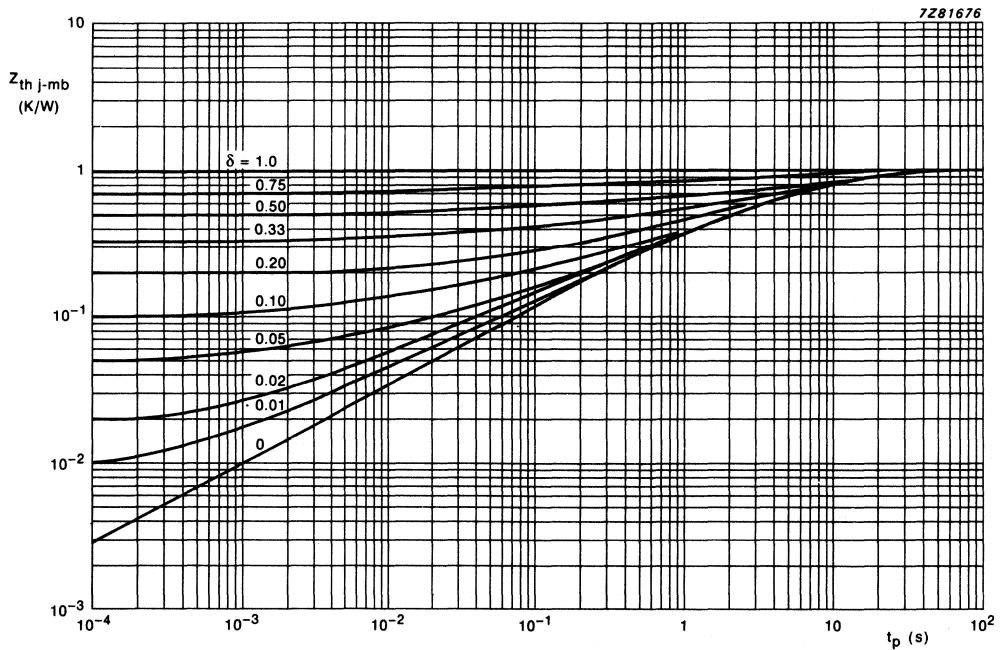


Fig. 15 Normalized thermal response at pulse power conditions.

SILICON DIFFUSED POWER TRANSISTORS

High-voltage, high-speed, glass-passivated npn power transistors in a SOT93 envelope, intended for use in converters, inverters, switching regulators, motor control systems etc.

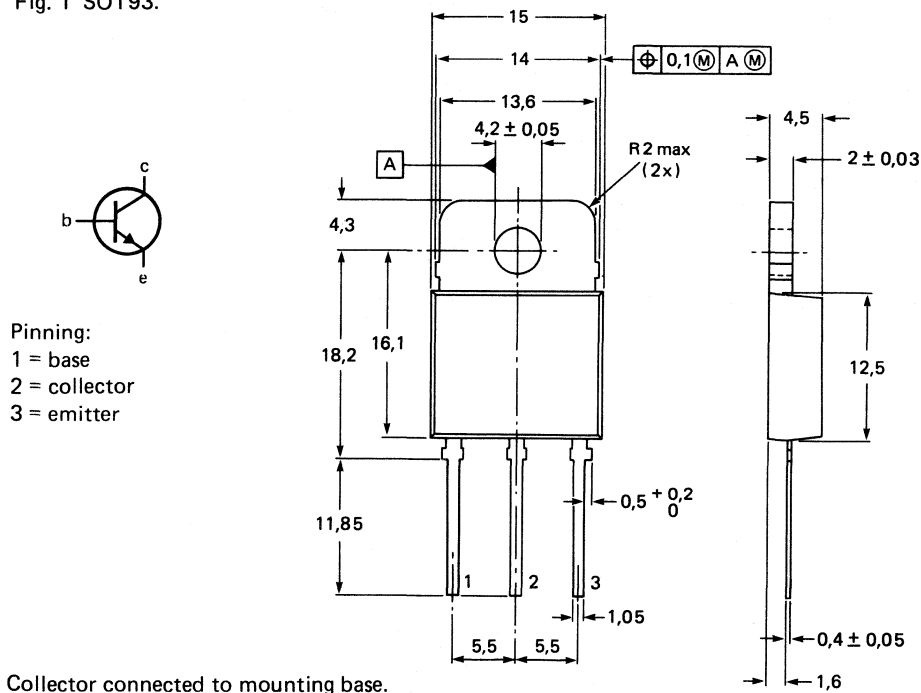
QUICK REFERENCE DATA

		BUW13	BUW13A	
Collector-emitter voltage (peak value; $V_{BE} = 0$)	V_{CESM} max.	850	1000	V
Collector-emitter voltage (open base)	V_{CEO} max.	400	450	V
Collector-emitter saturation voltage	V_{CEsat} max.	1.5		V
Collector current (DC)	I_C max.	15		A
Collector current (peak value)	I_{CM} max.	30		A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot} max.	175		W
Fall time	t_f max.	0.8		μs

MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT93.



7296696

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BUW13	BUW13A	
Collector-emitter voltage (peak value, $V_{BE} = 0$)	V_{CESM}	max.	850	1000	V
Collector-emitter voltage (open base)	V_{CEO}	max.	400	450	V
Collector current (DC)	I_C	max.	15		A
Collector current (peak value); $t_p < 2$ ms	I_{CM}	max.	30		A
Base current (DC)	I_B	max.	6		A
Base current (peak value); $t_p < 2$ ms	I_{BM}	max.	9		A
Total power dissipation up to $T_{mb} = 25$ °C	P_{tot}	max.	175		W
Storage temperature range	T_{stg}		-65 to +150		°C
Junction temperature	T_j	max.	150		°C

THERMAL RESISTANCE

From junction to mounting base	R_{thj-mb}	=	0,7		K/W
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CHARACTERISTICS

$T_j = 25$ °C unless otherwise specified

Collector cut-off current*

$V_{CE} = V_{CESMmax}; V_{BE} = 0$

$V_{CE} = V_{CESMmax}; V_{BE} = 0; T_j = 125$ °C

I_{CES}	max.	1	mA
I_{CES}	max.	4	mA

Emitter cut-off current

$I_C = 0; V_{EB} = 9$ V

I_{EBO}	max.	10	mA
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Saturation voltages

$I_C = 10$ A; $I_B = 2$ A

$I_C = 8$ A; $I_B = 1,6$ A

		BUW13	BUW13A	
V_{CEsat}	max.	1,5	—	V
V_{BEsat}	max.	1,6	—	V
V_{CEsat}	max.	—	1,5	V
V_{BEsat}	max.	—	1,6	V

Collector-emitter sustaining voltage

$I_C = 100$ mA; $I_{Boff} = 0$; $L = 25$ mH

$V_{CEO_{sust}}$	min.	400	450	V
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* Measured with a half-sinewave voltage (curve tracer).

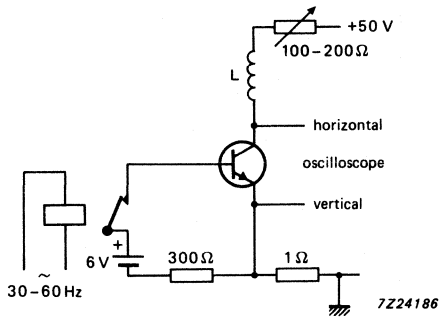


Fig. 2 Test circuit for $V_{CEOsust}$.

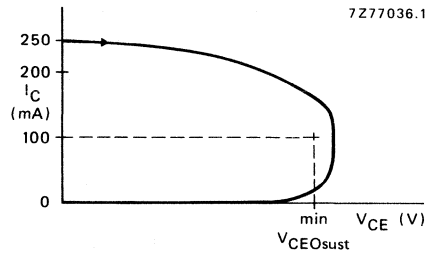


Fig. 3 Oscilloscope display for sustaining voltage.

Switching times resistive load (Figs 4 and 5)

$I_{Con} = 10 \text{ A}; I_{Bon} = -I_{Boff} = 2 \text{ A}$

Turn-on time

Turn-off: Storage time

Fall time

$I_{Con} = 8 \text{ A}; I_{Bon} = -I_{Boff} = 1,6 \text{ A}$

Turn-on time

Turn-off: Storage time

Fall time

Switching times inductive load (Figs 6 and 7)

$I_{Con} = 10 \text{ A}; I_B = 2 \text{ A}$

Turn-off: Storage time

Fall time

$I_{Con} = 10 \text{ A}; I_B = 2 \text{ A}; T_j = 100 \text{ }^\circ\text{C}$

Turn-off: Storage time

Fall time

Switching times inductive load (Figs 6 and 7)

$I_{Con} = 8 \text{ A}; I_B = 1,6 \text{ A}$

Turn-off: Storage time

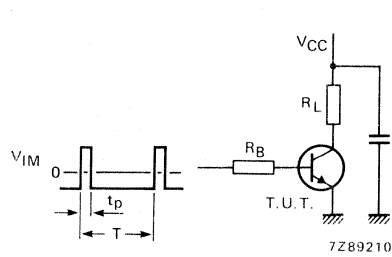
Fall time

$I_{Con} = 8 \text{ A}; I_B = 1,6 \text{ A}; T_j = 100 \text{ }^\circ\text{C}$

Turn-off: Storage time

Fall time

		BUW13	BUW13A
t_{on}	max.	1	— μs
t_s	max.	4	— μs
t_f	max.	0,8	— μs
t_{on}	max.	—	1 μs
t_s	max.	—	4 μs
t_f	max.	—	0,8 μs
t_s	typ.	2,3	— μs
	max.	3,0	— μs
t_f	typ.	80	— ns
	max.	150	— ns
t_s	typ.	2,5	— μs
	max.	3,2	— μs
t_f	typ.	140	— ns
	max.	300	— ns
t_s	typ.	—	2,3 μs
	max.	—	3,0 μs
t_f	typ.	—	80 ns
	max.	—	150 ns
t_s	typ.	—	2,5 μs
	max.	—	3,2 μs
t_f	typ.	—	140 ns
	max.	—	300 ns



$V_{CC} = 250 \text{ V}$
 $V_{IM} = -6 \text{ to } +8 \text{ V}$
 $t_p = 20 \mu\text{s}$
 $\frac{t_p}{T} = 0,01$
 The values of R_B and R_L are selected in accordance with $I_{C\text{on}}$ and I_B requirements.

Fig. 4 Test circuit resistive load.

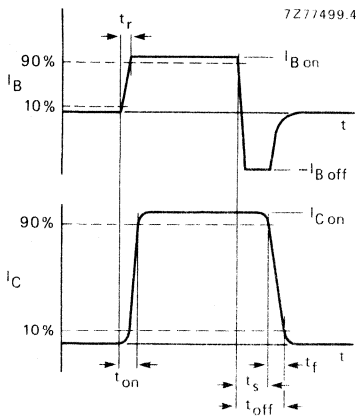


Fig. 5 Switching times waveforms with resistive load.

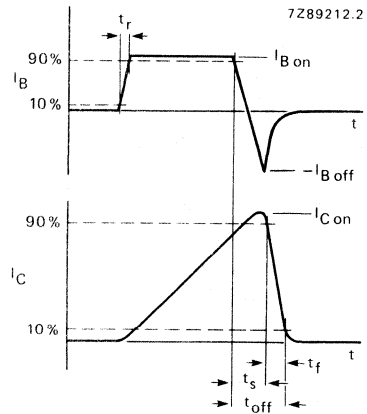
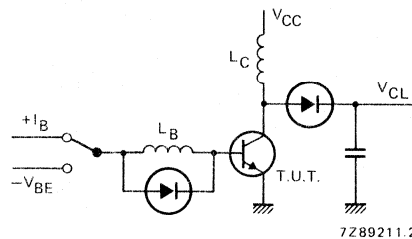
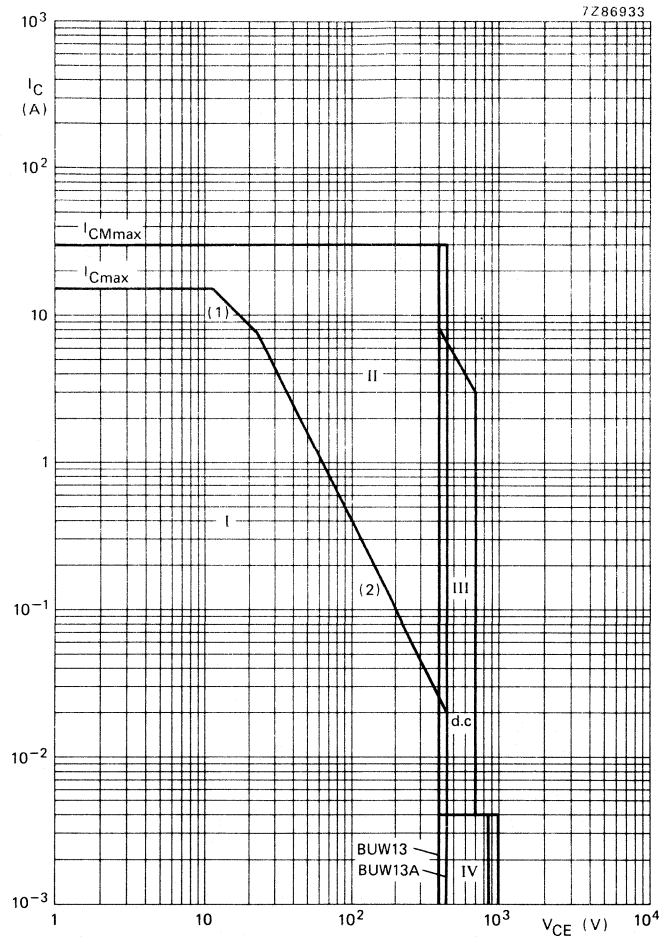


Fig. 6 Switching times waveforms with inductive load.



$V_{CL} = 300 \text{ V}$
 $V_{CC} = 30 \text{ V}$
 $-V_{BE} = 5 \text{ V}$
 $L_B = 1 \mu\text{H}$
 $L_C = 200 \mu\text{H}$

Fig. 7 Test circuit inductive load.



(1) P_{tot} max line.

(2) Second-breakdown limits.

I Region of permissible DC operation.

II Permissible extension for repetitive pulse operation.

III Area of permissible operation during turn-on in single transistor converters, provided $R_{BE} \leq 100 \Omega$ and $t_p \leq 0,6 \mu s$.

IV Repetitive pulse operation in this region is permissible provided $V_{BE} \leq 0$ and $t_p \leq 5 ms$.

Fig. 8 Safe operating area at $T_{mb} \leq 25^\circ C$.

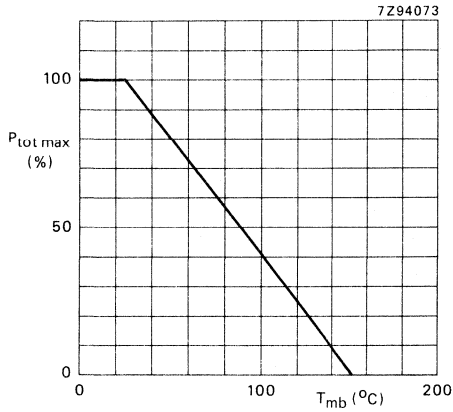


Fig. 9 Total power dissipation derating curve.

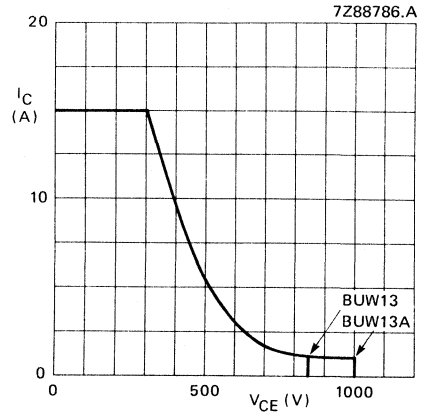


Fig. 10 Reverse bias SOAR.

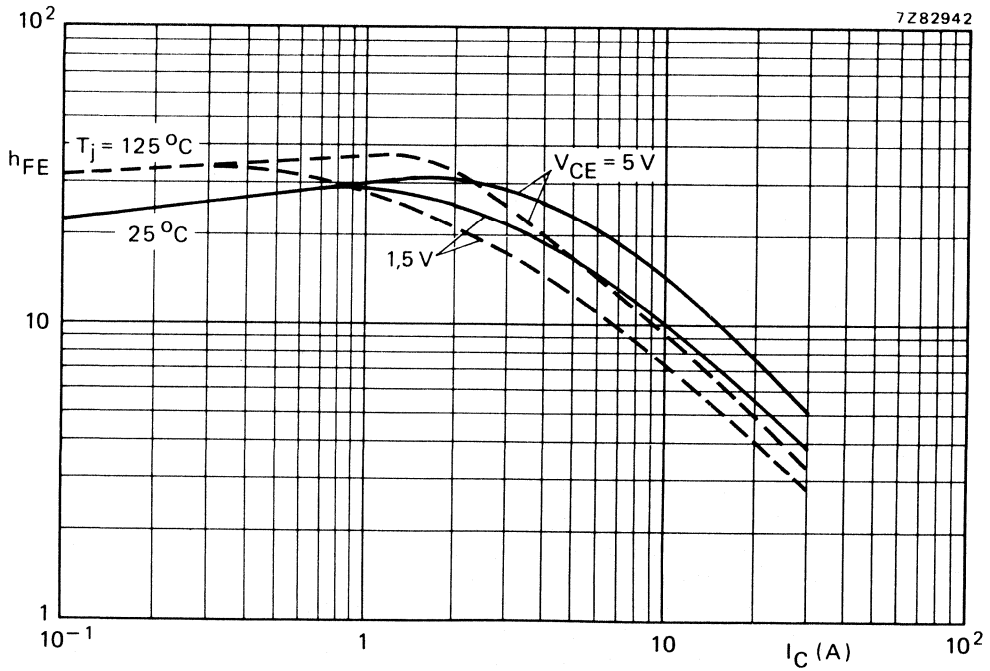


Fig. 11 Typical values DC current gain.

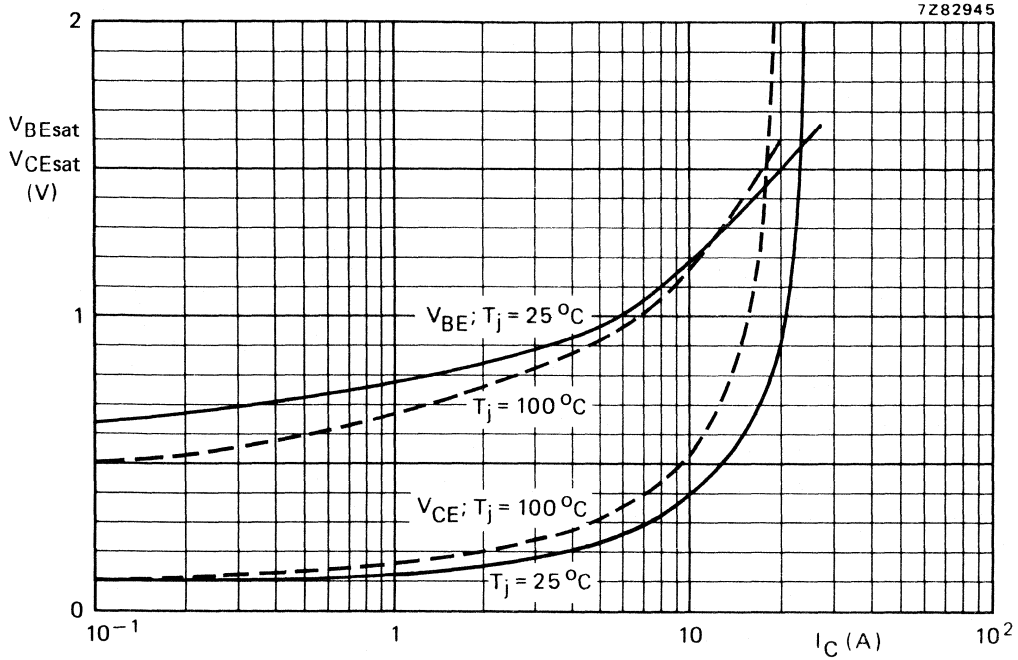


Fig. 12 Typical values base and collector voltage at $I_C/I_B = 5$.

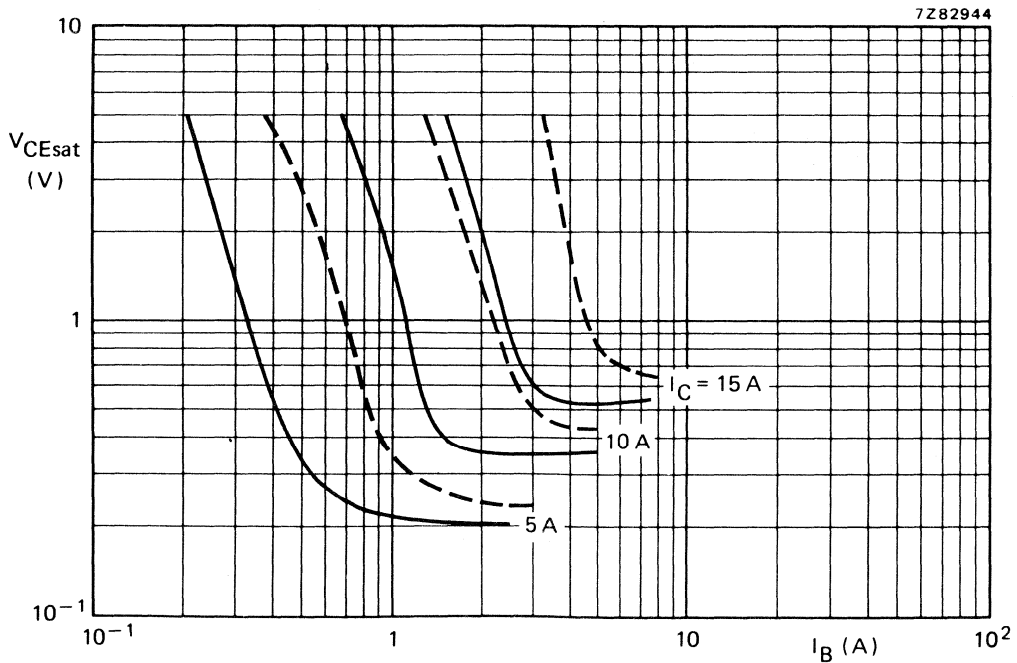


Fig. 13 Typical (—) and maximum (---) values saturation voltage. $T_j = 25^\circ\text{C}$.

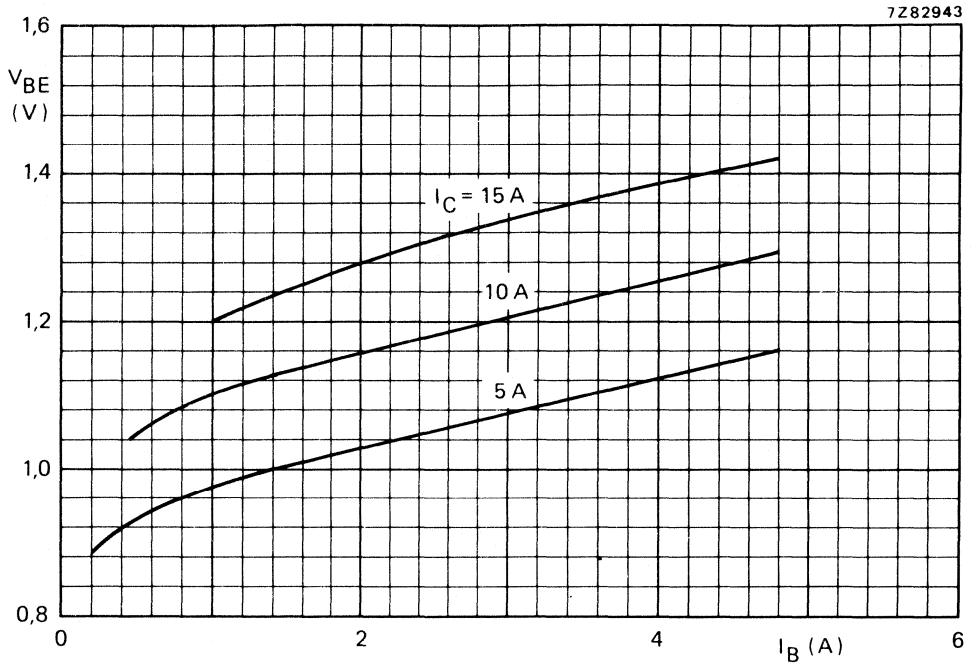


Fig. 14 Typical values base-emitter voltage at $T_j = 25$ °C.

SILICON DIFFUSED POWER TRANSISTORS

High-voltage, high-speed, glass-passivated npn power transistor in a SOT199 envelope intended for use in converters, inverters, switching regulators, motor control systems, etc.

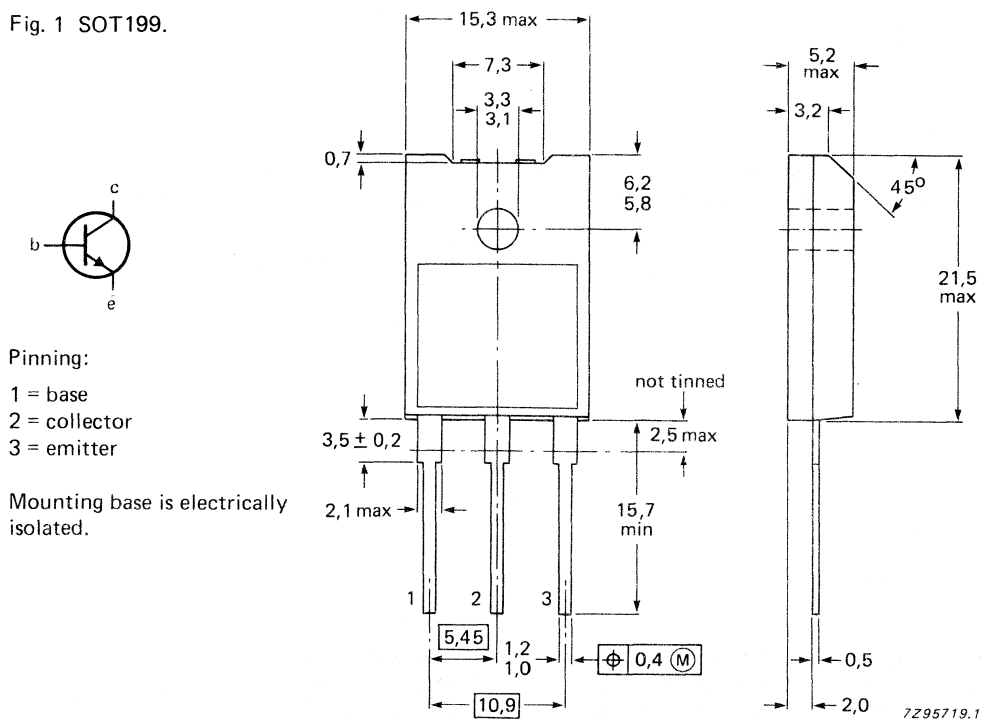
QUICK REFERENCE DATA

		BUW13F	BUW13AF
Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM}	max. 850	1000 V
	V_{CEO}	max. 400	450 V
Collector-emitter saturation voltage	V_{CEsat}	max. 1.5	1.5 V
Collector current saturation DC peak value; $t_p < 20$ ms	I_{Csat}	10.0	8.0 A
	I_C	max. 15	A
	I_{CM}	max. 30	A
Total power dissipation up to $T_H = 25$ °C	P_{tot}	max. 37	W
Fall time	t_f	max. 0.8	μs

MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT199.



RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

		BUW13F	BUW13AF
Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM} max.	850	1000 V
	V_{CEO} max.	400	450 V
Collector current saturation DC peak value; $t_p < 20$ ms	I_{Csat}	10.0	8.0 A
	I_C max.		A
	I_{CM} max.		A
Base current DC peak value; $t_p = -20$ ms	I_B max.	6.0	A
	I_{BM} max.	9.0	A
Total power dissipation up to $T_h = 25$ °C (note 1)	P_{tot} max.	37	W
Total power dissipation up to $T_h = 25$ °C (note 2)	P_{tot} max.	50	W
Storage temperature range	T_{stg}	-65 to + 150	°C
Junction temperature	T_j max.	150	°C

THERMAL RESISTANCE

From junction to external heatsink (note 1)	$R_{th\ j-h}$ =	3.4	K/W
From junction to external heatsink (note 2)	$R_{th\ j-h}$ =	2.5	K/W
From junction to ambient	$R_{th\ j-a}$ =	35	K/W

ISOLATION

Isolation voltage from all terminals to external heatsink (peak value) (note 3)	V_{isol} max.	2000	V
Isolation capacitance from collector to external heatsink	C_{isol} max.	21	pF

Notes

1. Mounted without heatsink compound and 30 ± 5 newtons pressure on centre of envelope.
2. Mounted with heatsink compound and 30 ± 5 newtons pressure on centre of envelope.
3. Repetitive peak operation with $RH \leq 65\%$ under clean and dustfree conditions.

CHARACTERISTICS

 $T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified

Collector cut-off currents*

 $V_{CE} = V_{CESMmax}; V_{BE} = 0$ $V_{CE} = V_{CESMmax}; V_{BE} = 0; T_j = 125\text{ }^\circ\text{C}$

I_{CES}	max.	1.0	mA
I_{CES}	max.	4.0	mA

Emitter cut-off current

 $V_{EB} = 9\text{ V}; I_C = 0$

I_{EBO}	max.	10	mA
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Saturation voltages

 $I_C = 10\text{ A}; I_B = 2\text{ A}$

		BUW13F	BUW13AF
V_{CEsat}	max.	1.5	— V
V_{BEsat}	max.	1.6	— V

 $I_C = 8\text{ A}; I_B = 1.6\text{ A}$

V_{CEsat}	max.	—	1.5 V
V_{BEsat}	max.	—	1.6 V

Collector-emitter sustaining voltage (Figs 2 and 3)

 $I_C = 100\text{ mA}; I_B\text{ off} = 0; L = 25\text{ mH}$

$V_{CEOsust}$	min.	400	450 V
---------------	------	-----	-------

Collector saturation current

 $V_{CE} = 1.5\text{ V}$

I_{Csat}		10	8.0 A
------------	--	----	-------

Switching times resistive load (Figs 4 and 5)

 $I_{C\text{ on}} = 10\text{ A}; I_{B\text{ on}} = I_{B\text{ off}} = 2\text{ A}$

Turn-on time

t_{on}	max.	1.0	— μs
----------	------	-----	-----------------

Turn-off; storage time

t_s	max.	4.0	— μs
-------	------	-----	-----------------

fall time

t_f	max.	0.8	— μs
-------	------	-----	-----------------

 $I_{C\text{ on}} = 8\text{ A}; I_{B\text{ on}} = I_{B\text{ off}} = 1.6\text{ A}$

Turn-on time

t_{on}	max.	—	1.0 μs
----------	------	---	-------------------

Turn-off; storage time

t_s	max.	—	4.0 μs
-------	------	---	-------------------

fall time

t_f	max.	—	0.8 μ
-------	------	---	-----------

Switching times inductive load (Figs 6 and 7)

 $I_{C\text{ on}} = 10\text{ A}; I_B = 2\text{ A};$ $V_{CL} = 250\text{ V}; T_C = 100\text{ }^\circ\text{C}$

Turn-off; storage time

t_s	typ.	2.8	— μs
-------	------	-----	-----------------

t_s	max.	3.5	— μs
-------	------	-----	-----------------

fall time

t_f	typ.	200	— ns
-------	------	-----	------

t_f	max.	300	— ns
-------	------	-----	------

 $I_{C\text{ on}} = 8\text{ A}; I_B = 1.6\text{ A};$ $V_{CL} = 300\text{ V}; T_C = 100\text{ }^\circ\text{C}$

Turn-off; storage time

t_s	typ.	—	2.8 μs
-------	------	---	-------------------

t_s	max.	—	3.5 μs
-------	------	---	-------------------

fall time

t_f	typ.	—	200 ns
-------	------	---	--------

t_f	max.	—	300 ns
-------	------	---	--------

* Measured with a half-sinewave voltage (curve tracer).

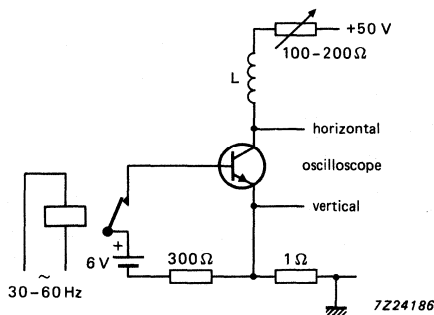


Fig. 2 Test circuit for $V_{CE(sust)}$.

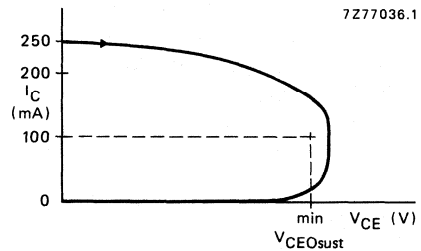
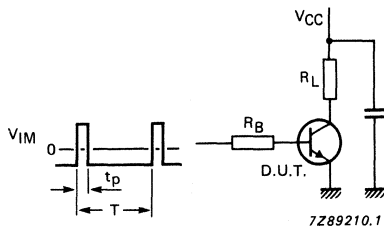


Fig. 3 Oscilloscope display for sustaining voltage.



$V_{CC} = 250 \text{ V}$
 $t_p = 20 \mu\text{s}$
 $V_{IM} = -6 \text{ to } +8 \text{ V}$
 $\frac{t_p}{T} = 0.01$

The values of R_B and R_L are selected in accordance with $I_{C(on)}$ and I_B requirements.

Fig. 4 Test circuit resistive load.

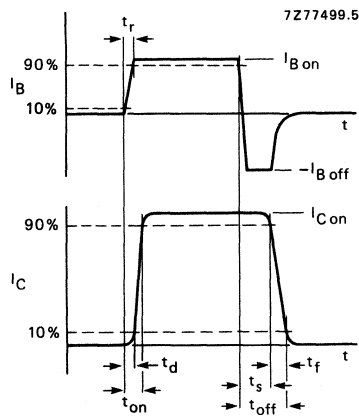
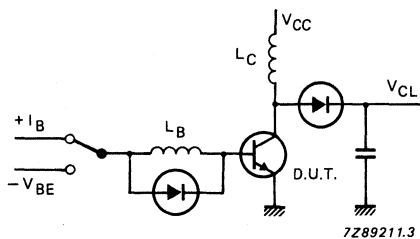


Fig. 5 Switching times waveforms with resistive load; $t_r \leq 20 \text{ ns}$.



$V_{CL} = \text{up to } 1000 \text{ V}$
 $V_{CC} = 30 \text{ V}$
 $-V_{BE} = 5 \text{ V}$
 $L_B = 1.0 \mu\text{H}$
 $L_C = 200 \mu\text{H}$

Fig. 6 Test circuit inductive load and reverse bias SOAR.

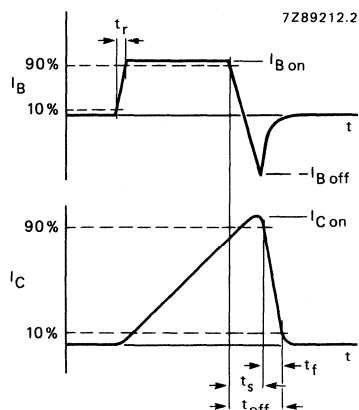
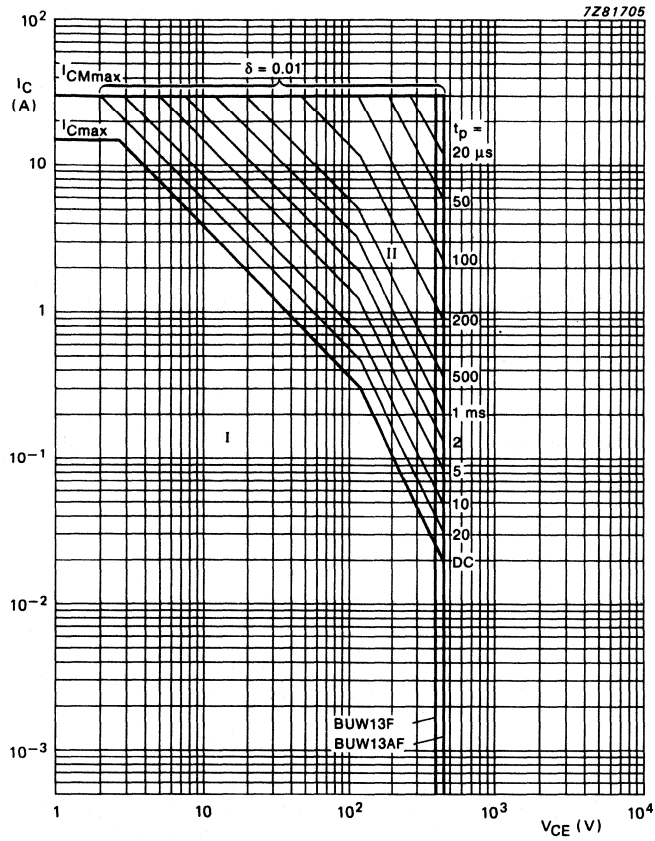


Fig. 7 Switching times waveforms with inductive load.



- (1) P_{tot} max and P_{tot} peak max lines.
 - (2) Second-breakdown limits (independent of temperature).
- I Region of permissible DC operation.
 II Permissible extension for repetitive pulse operation.

Fig. 8 Safe operating area at $T_{mb} < 25^\circ\text{C}$.

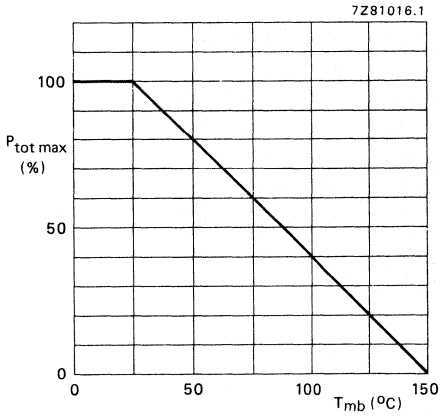


Fig. 9 Power dissipation curve.

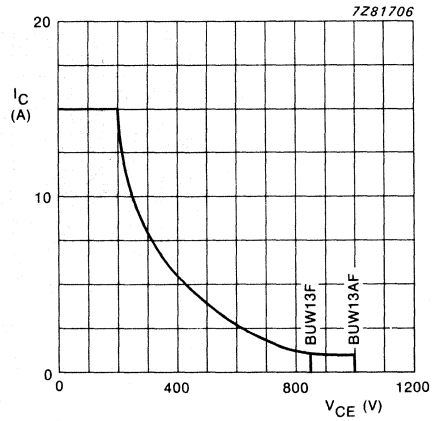


Fig. 10 RB SOAR; $T_c \leq 100^\circ\text{C}$;
 $V_{BE} = -1\text{ V to } -5\text{ V}$.

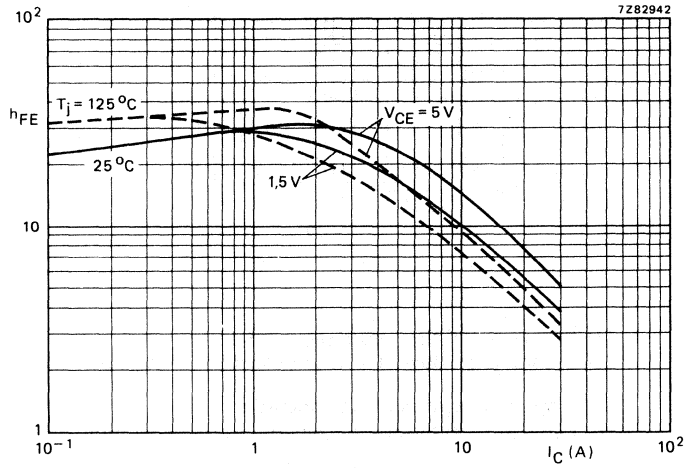


Fig. 11 Typical values DC current gain; $T_j = 125^\circ\text{C}$.

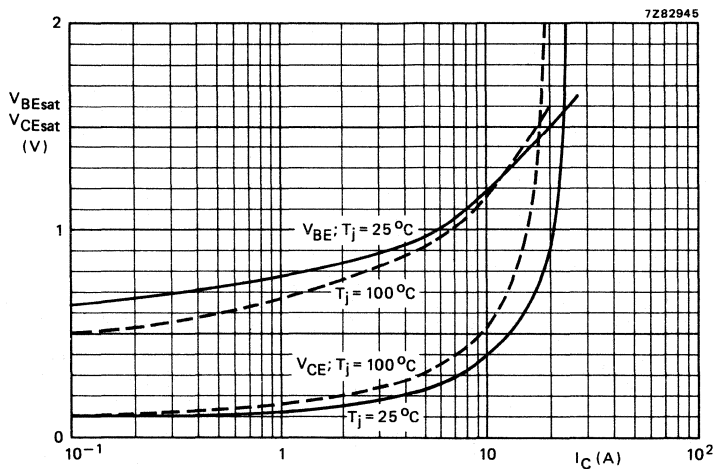


Fig. 12 Typical values base and collector voltages at $I_C/I_B = 5$.

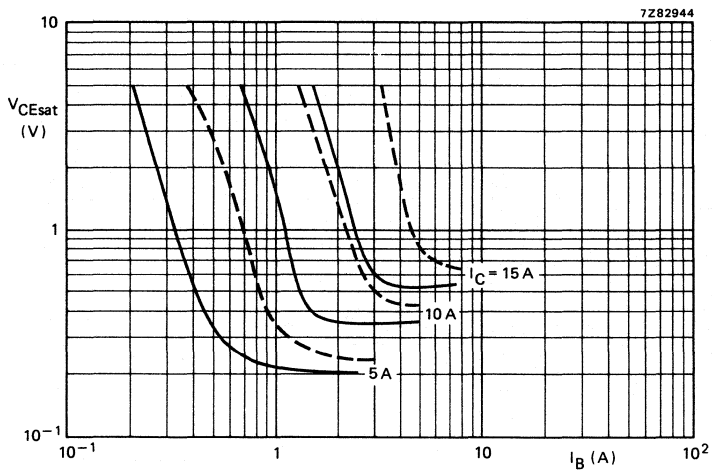


Fig. 13 Typical (—) and maximum (---) values saturation voltage; $T_j = 25^\circ C$.

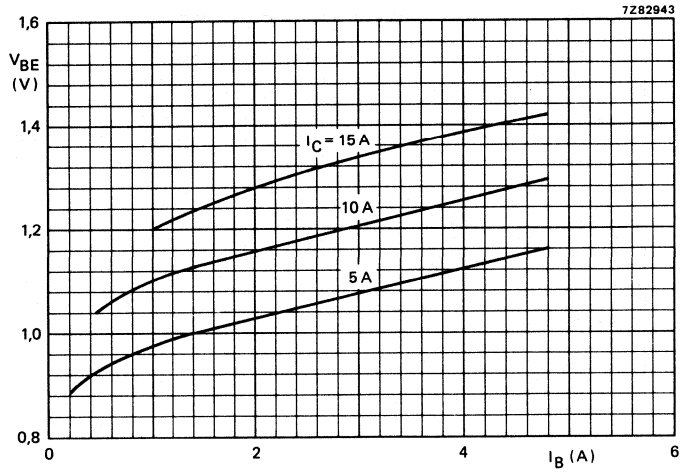


Fig. 14 Typical values base-emitter voltage at $T_j = 25$ °C.

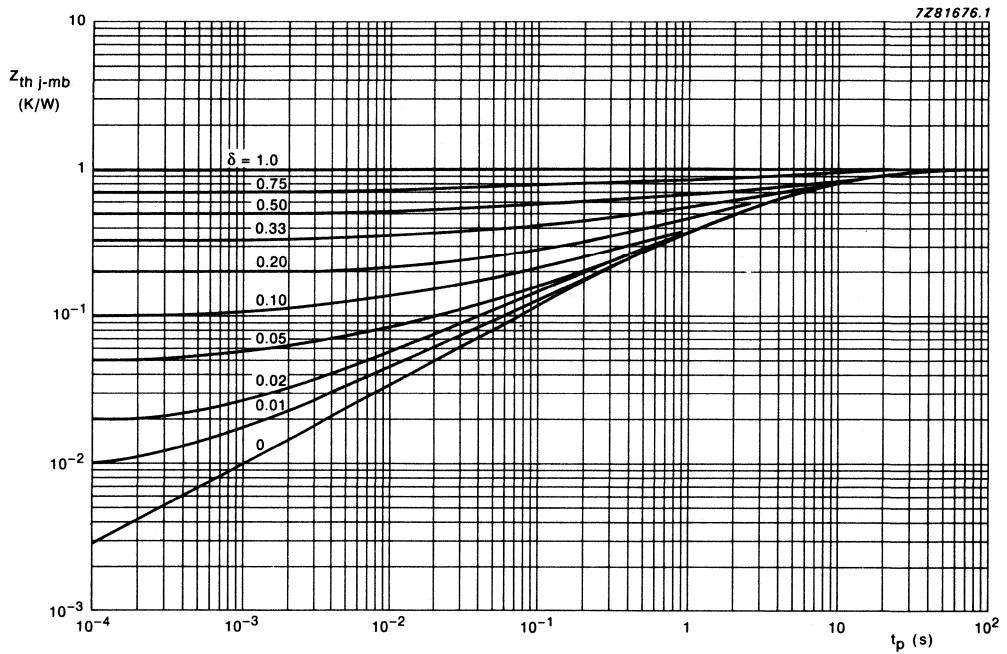


Fig. 15 Normalized thermal response at pulse power conditions.

SILICON DIFFUSED POWER TRANSISTORS

High-voltage, high-speed, glass-passivated npn power transistors in SOT82 envelopes, intended for use in converters, inverters, switching regulators, motor control systems and switching applications.

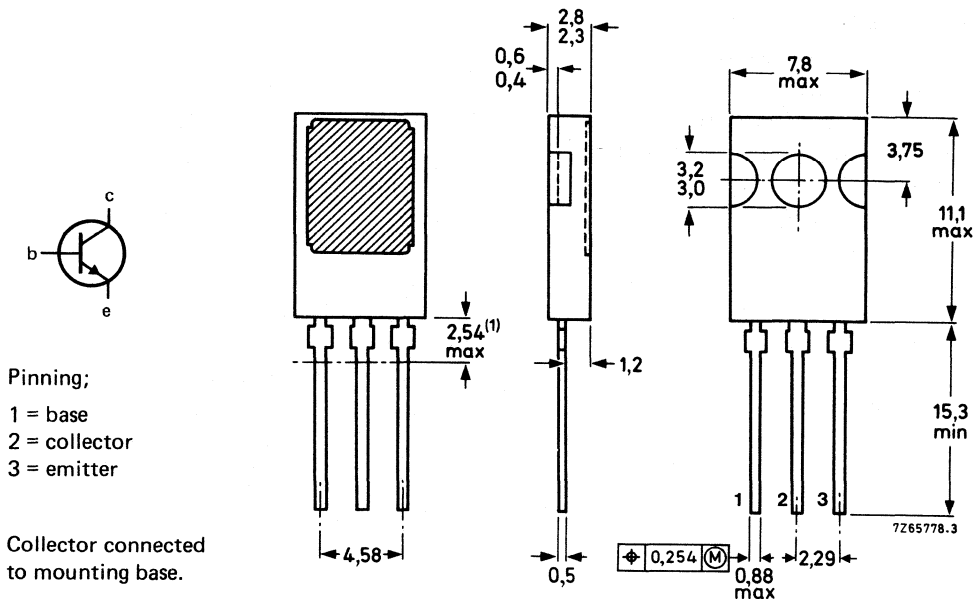
QUICK REFERENCE DATA

		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 $T_{mb} = 45\text{ }^\circ\text{C}$	P_{tot} max.	50	W
Fall time	t_f typ.	0.4	μs

MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT82.



(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	$R_{th\ j-mb}$	=	2.1	K/W
From junction to ambient in free air	$R_{th\ j-a}$	=	100	K/W

CHARACTERISTICS

$T_j = 25$ °C unless otherwise specified

Collector cut-off current **

$V_{CEM} = V_{CESMmax}; V_{BE} = 0$

I_{CES} max. 200 μ A

$V_{CEM} = V_{CESMmax}; V_{BE} = 0; T_j = 125$ °C

I_{CES} max. 1.5 mA

DC current gain

$I_C = 0,1$ 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

Collector-emitter sustaining voltage

$I_C = 100$ mA; $I_{Boff} = 0; L = 25$ mH

	BUW84	BUW85
$V_{CEO_{sust}}$ min.	400	450 V

* Turn-off current.

** Measured with a half-sinewave voltage (curve tracer).

CHARACTERISTICS (continued)

$T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified

Transition frequency at $f = 1\text{ MHz}$

$I_C = 0,2\text{ A}; V_{CE} = 10\text{ V}$

f_T typ. 20 MHz

Switching times

$I_{Con} = 1\text{ A}; V_{CC} = 250\text{ V}$

$I_{Bon} = 0,2\text{ A}; -I_{Boff} = 0,4\text{ A}$

Turn-on time

t_{on} typ. 0.2 μs
max. 0.5 μs

Turn-off: Storage time

t_s typ. 2 μs
max. 3.5 μs

Fall time

t_f typ. 0.4 μs

Fall time, $T_{mb} = 95\text{ }^\circ\text{C}$

t_f max. 1.4 μs

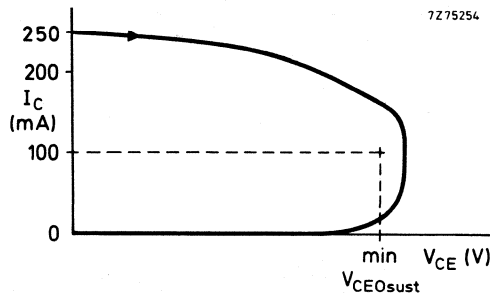


Fig. 2 Oscilloscope display for sustaining voltage.

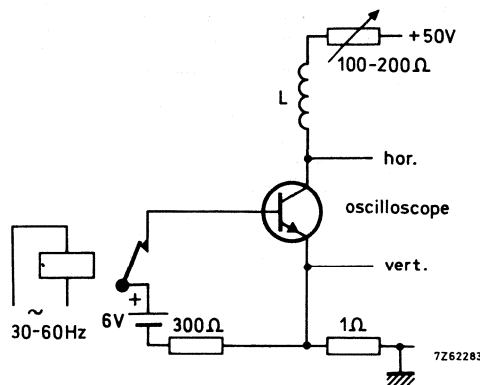


Fig. 3 Test circuit for $V_{CEOsust}$.

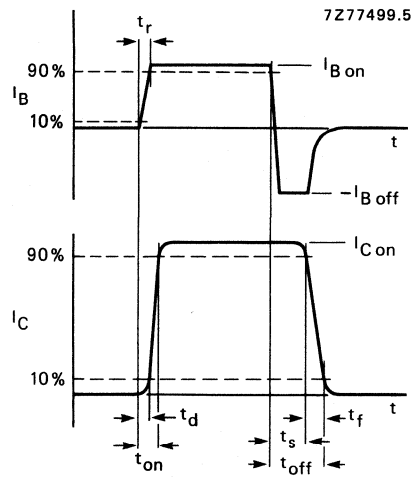


Fig. 4 Switching times waveforms with resistive load.

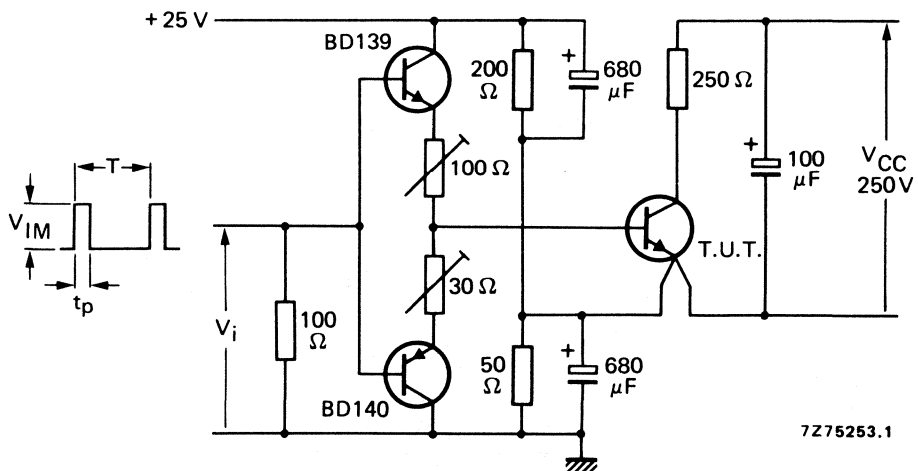
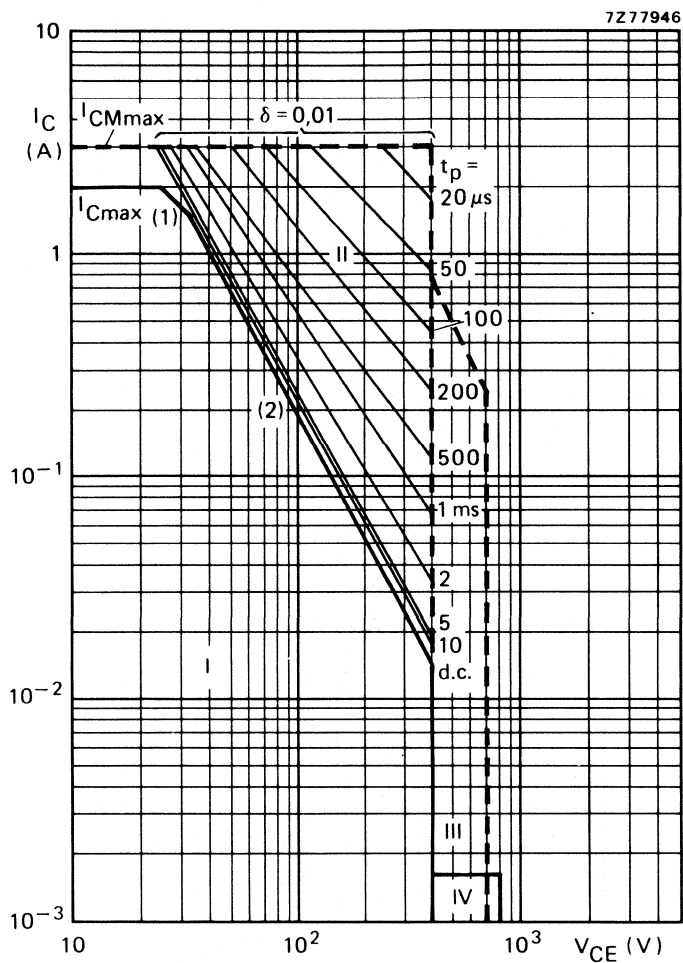
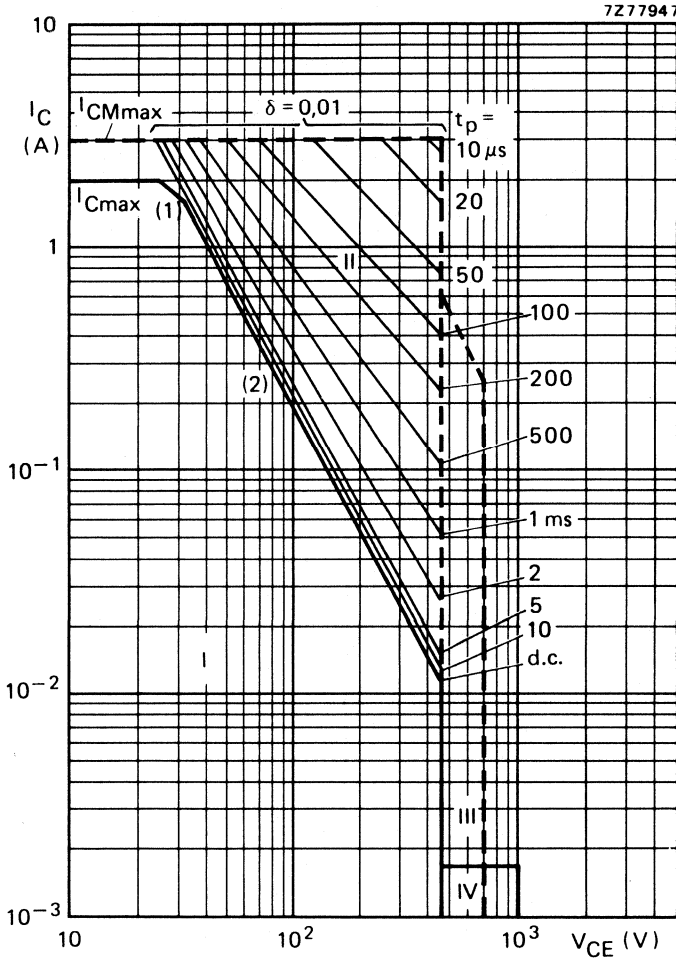


Fig. 5 Test circuit resistive load.



- 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 $R_{BE} \leq 100 \Omega$ and $t_p \leq 0,6 \mu s$
 - IV Repetitive pulse operation in this region is permissible, provided $V_{BE} \leq 0$ and $t_p \leq 2 ms$
- (1) P_{tot} max line.
 (2) Second-breakdown limits.

Fig. 6 Safe operating area at $T_{mb} \leq 25 ^\circ C$ 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 $R_{BE} \leq 100 \Omega$ and $t_p \leq 0,6 \mu s$
- IV Repetitive pulse operation in this region is permissible, provided $V_{BE} \leq 0$ and $t_p \leq 2 ms$
- (1) $P_{tot} max$ line.
- (2) Second-breakdown limits.

Fig. 7 Safe operating area $T_{mb} \leq 25 \text{ }^\circ\text{C}$ of BUW85.

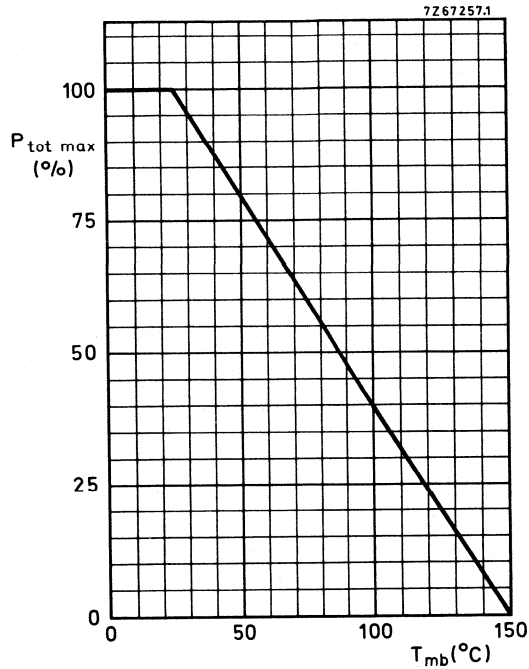


Fig. 8 Power derating curve.

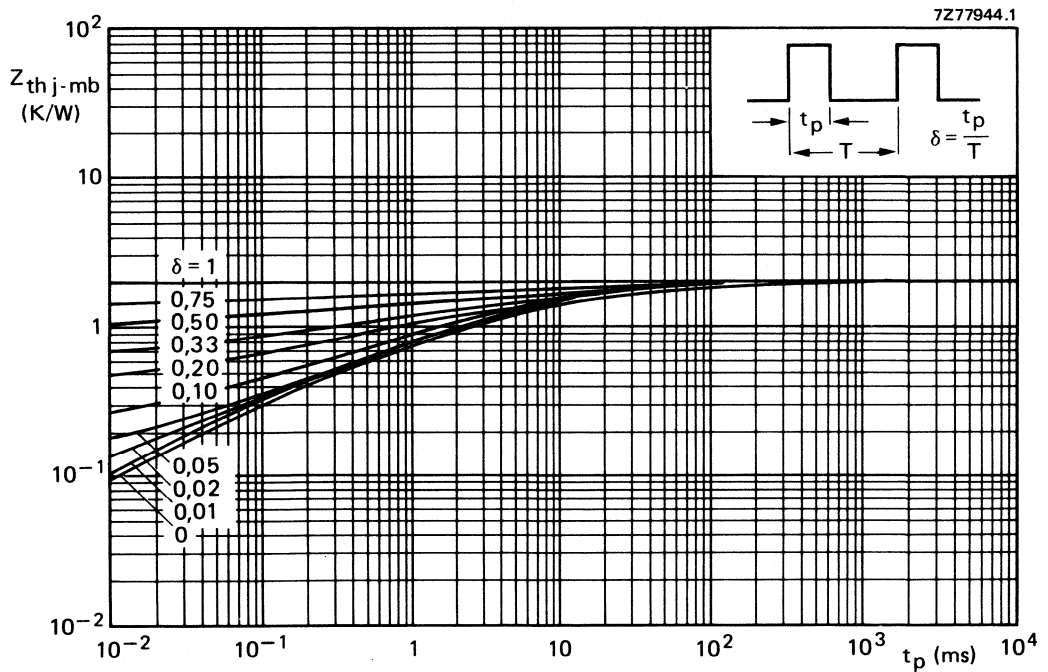


Fig. 9 Pulse power rating chart.

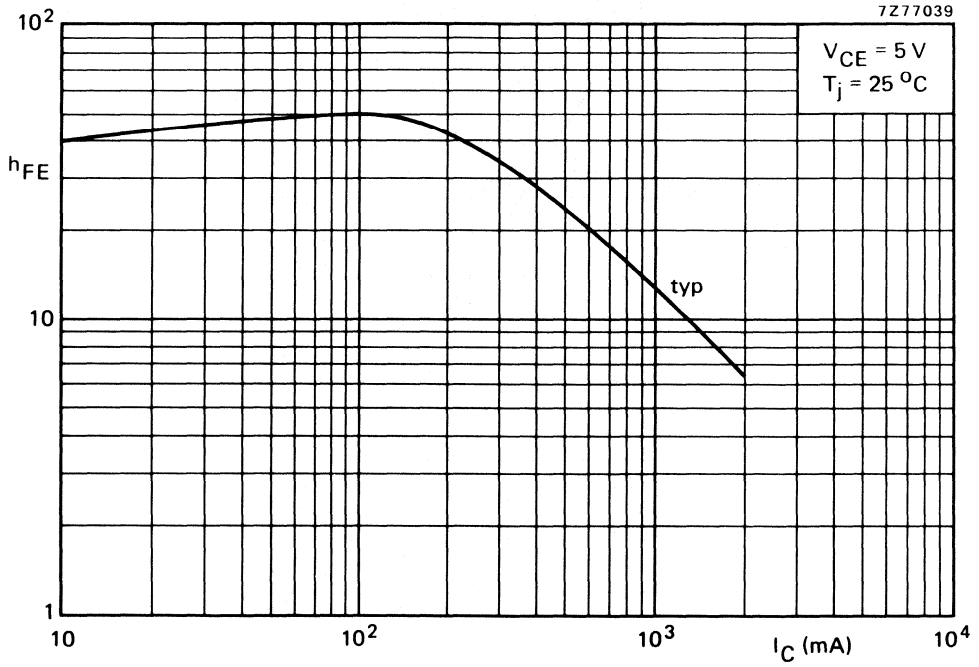


Fig. 10 Typical DC current gain.

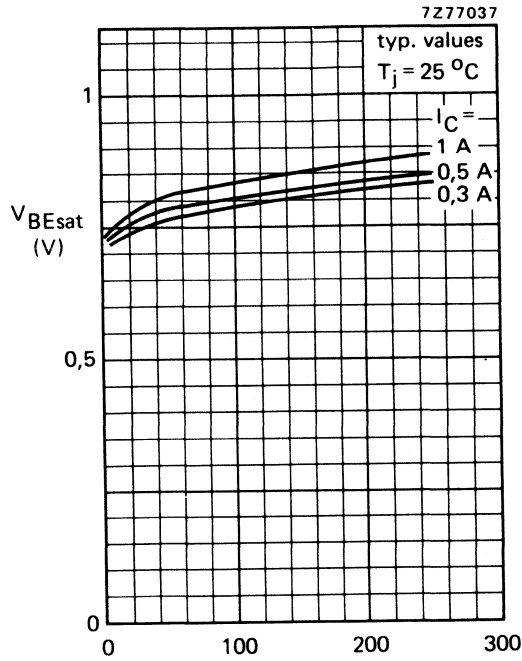


Fig. 11 Typical base-emitter saturation voltage.

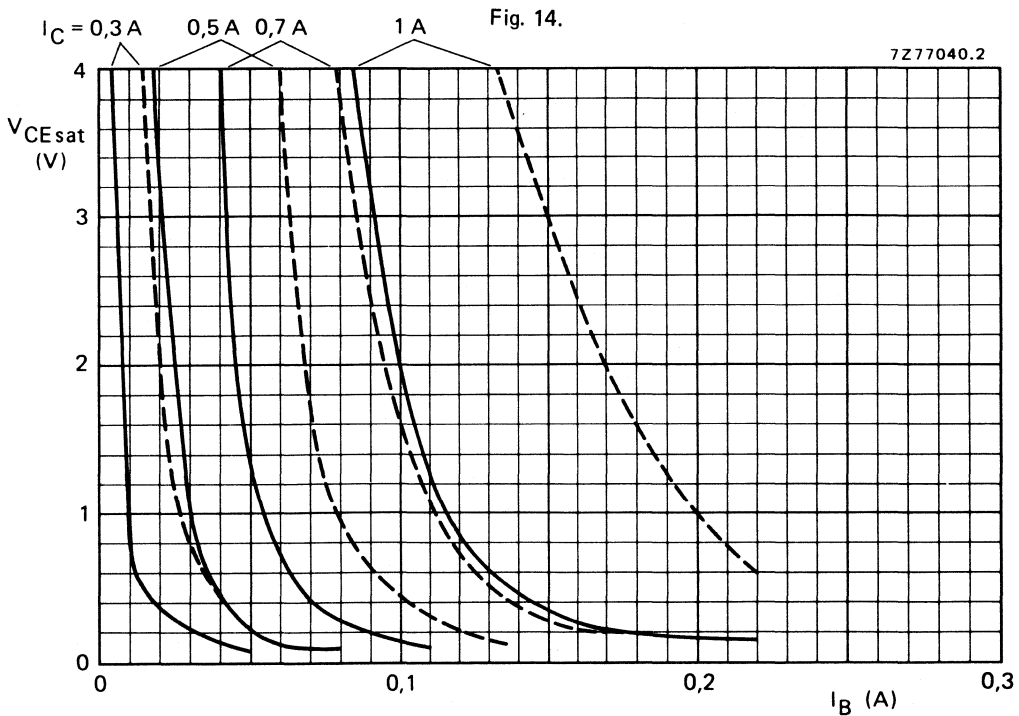


Fig. 12 Typical (—) and maximum (---) values saturation voltage at $T_j = 25^\circ\text{C}$.

DEVELOPMENT DATA

This data sheet contains advance information and specifications are subject to change without notice.

**BUW86
BUW87
BUW87A**

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.

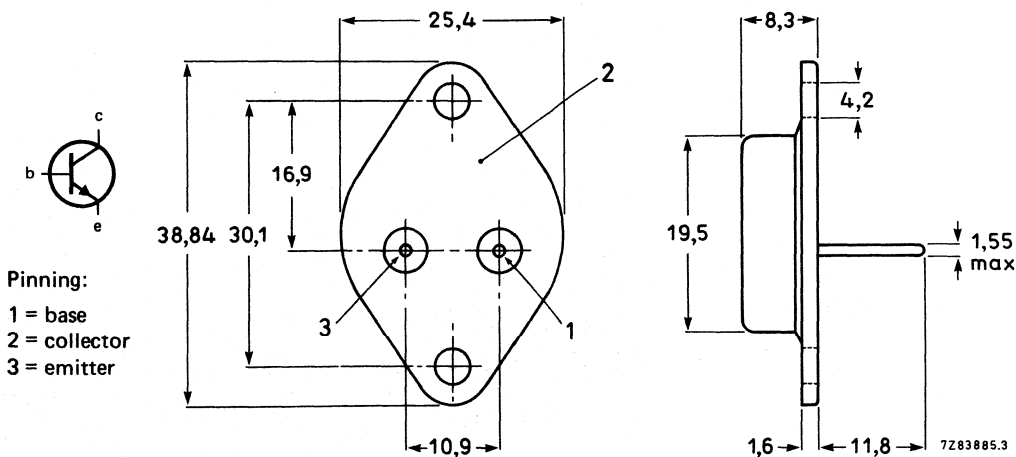
QUICK REFERENCE DATA

			BUW86	87	87A
Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM}	max.	240	300	400 V
	V_{CEO}	max.	120	150	200 V
Collector-emitter saturation voltage	V_{CEsat}	max.		1.0	V
Collector current saturation DC peak value	I_{Csat}	max.	8.0	7.0	5.0 A
	I_C	max.		10	A
	I_{CM}	max.		15	A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.		62.5	W
Fall time resistive load	t_f	typ.		0.3	μs
Transition frequency at $f = 5\text{ MHz}$	f_T	typ.		50	MHz

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)

			BUW86	87	87A
Collector-base voltage open emitter	V _{CB0}	max.	240	300	400 V
Collector-emitter voltage peak value; V _{BE} = 0 open base	V _{CESM}	max.	240	300	400 V
	V _{CEO}	max.	120	150	200 V
Emitter-base voltage	V _{EB0}	max.		6.0	V
Collector current saturation DC peak value	I _{Csat}		8.0	7.0	5.0 A
	I _C	max.		10	A
	I _{CM}	max.		15	A
Base current DC peak value	I _B	max.		2.0	A
	I _{BM}	max.		3.0	A
Emitter current DC peak value	I _E	max.		11	A
	I _{EM}	max.		15	A
Total power dissipation up to T _{mb} = 25 °C	P _{tot}	max.		62.5	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}	=		2.8	K/W

CHARACTERISTICS

 $T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified

Collector cut-off current*

$V_{CE} = V_{CBO}; V_{BE} = 0$

$V_{CE} = V_{CBO}; V_{BE} = 0;$

$T_j = 150\text{ }^\circ\text{C}$

 I_{CES} max. 1.0 mA 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

$I_C = 5\text{ A}; I_B = 0.5\text{ A}$

$I_C = 4\text{ A}; I_B = 0.4\text{ A}$

$I_C = 3\text{ A}; I_B = 0.3\text{ A}$

 V_{CEsat} max. 0.65 V V_{CEsat} max. 0.65 V V_{CEsat} max. 0.65 V

DC current gain

$I_C = 5\text{ A}; V_{CE} = 5\text{ V}$

$I_C = 4\text{ A}; V_{CE} = 5\text{ V}$

$I_C = 3\text{ A}; V_{CE} = 5\text{ V}$

hFE min. 20

hFE min. 20

hFE min. 20

Transition frequency

$f = 5\text{ MHz}$

 f_T typ. 50 MHzSwitching time resistive load
(Figs 4 and 5)

$I_C = I_{Csat};$

$I_B = -I_{BM} = I_{Csat}/10$

$V_{CC} = 60\text{ V}$ for BUW86

$V_{CC} = 75\text{ V}$ for BUW87

$V_{CC} = 100\text{ V}$ for BUW87A

 t_{on} typ. 0.2 μs t_{on} max. 0.35 μs t_s typ. 0.6 μs t_s max. 1.3 μs t_f typ. 0.12 μs t_f max. 0.3 μs Switching times inductive load
(Figs 6 and 7)

$I_C = I_{Csat}; I_B = I_{Csat}/10;$

$T_{mb} = 100\text{ }^\circ\text{C}$

Fall time

 t_f typ. 60 ns

DEVELOPMENT DATA

* Measured with a half-sinewave voltage (curve tracer).

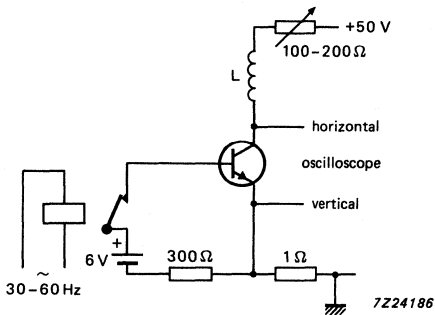


Fig. 2 Test circuit for $V_{CEOsust}$.

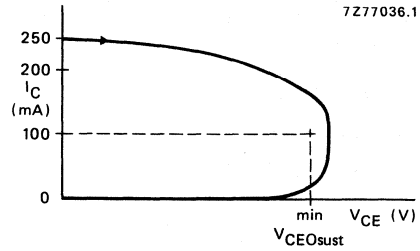


Fig. 3 Oscilloscope display for sustaining voltage.

$t_p = 20 \mu s$
 $V_{IM} = -6 \text{ to } +8 \text{ V}$
 $\frac{t_p}{T} = 0.01$

The values of R_B and R_L are selected in accordance with I_C on and I_B requirements.

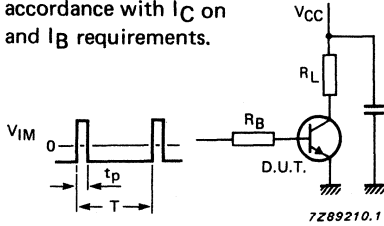


Fig. 4 Test circuit resistive load.

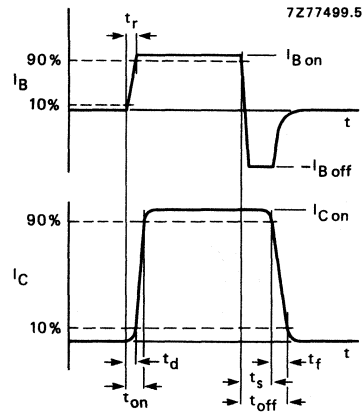
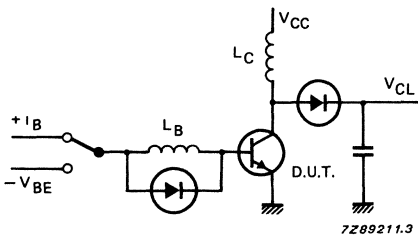


Fig. 5 Switching times waveforms with resistive load; $t_r \leq 20 \text{ ns}$.



$V_{CL} = \text{up to } 400 \text{ V}$
 $V_{CC} = 30 \text{ V}$
 $-V_{BE} = 5 \text{ V}$
 $L_B = 1.0 \mu H$
 $L_C = 200 \mu H$

Fig. 6 Test circuit inductive load.

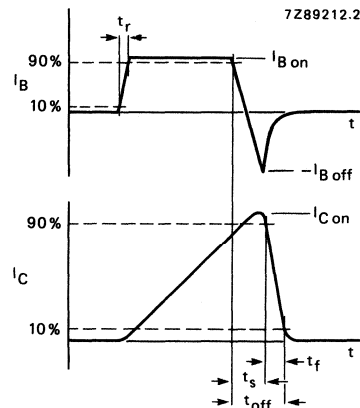


Fig. 7 Switching times waveforms with inductive load.

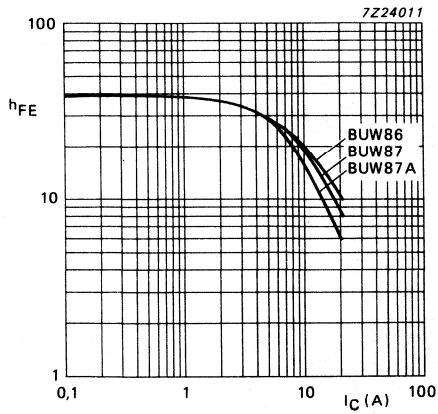


Fig. 8 DC current gain; $V_{CE} = 5 \text{ V}$;
 $T_j = 25 \text{ }^\circ\text{C}$.

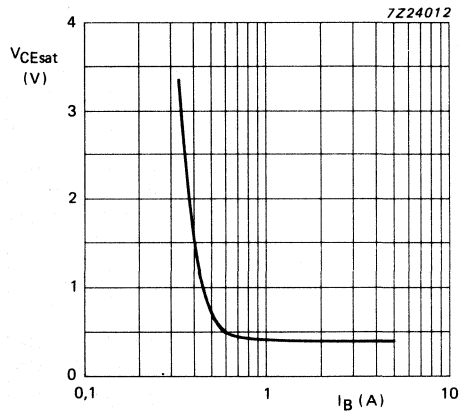


Fig. 9 Collector-emitter saturation voltage, BUW86; $I_C = 8 \text{ A}$.

DEVELOPMENT DATA

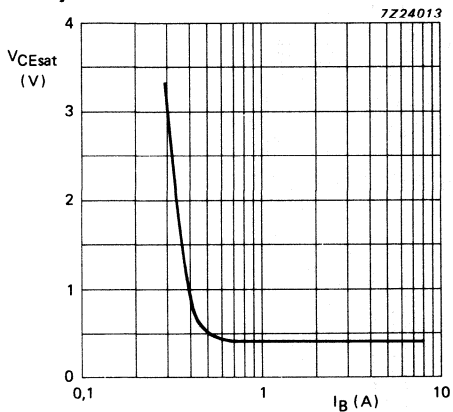


Fig. 10 Collector-emitter saturation voltage, BUW87; $I_C = 7 \text{ A}$.

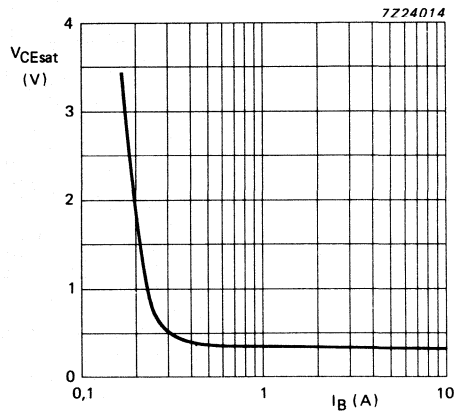


Fig. 11 Collector-emitter saturation voltage, BUW87A; $I_C = 5 \text{ A}$.

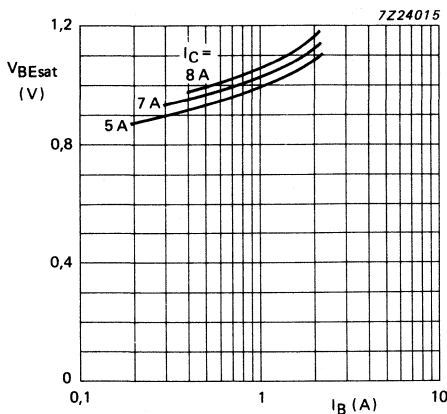


Fig. 12 Base-emitter saturation voltage;
 $T_j = 25 \text{ }^\circ\text{C}$.

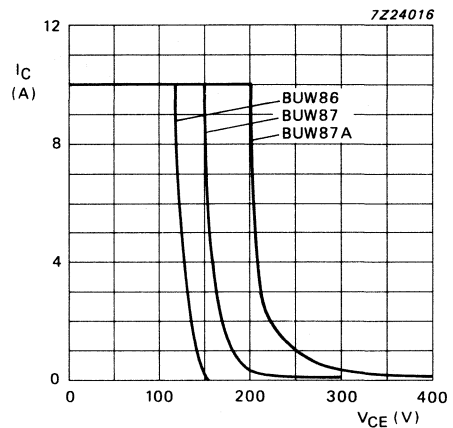


Fig. 13 Reversed bias SOAR.

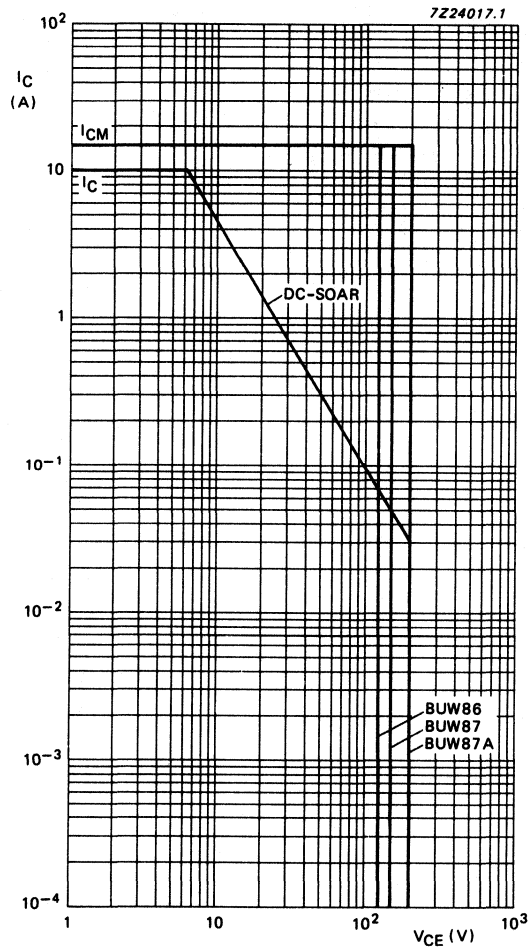


Fig. 14 Safe operating area; $T_{mb} = 25^\circ\text{C}$.

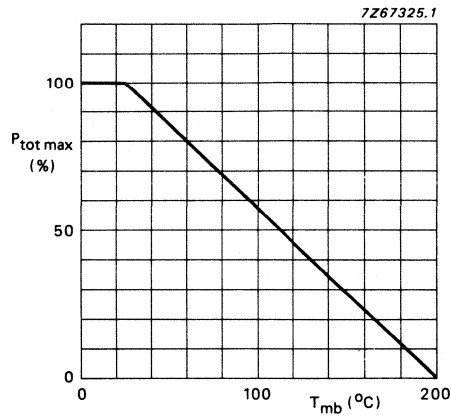


Fig. 15 Total power dissipation derating curve.

DEVELOPMENT DATA

DEVELOPMENT DATA

This data sheet contains advance information and specifications are subject to change without notice.

BUW131 SERIES

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.

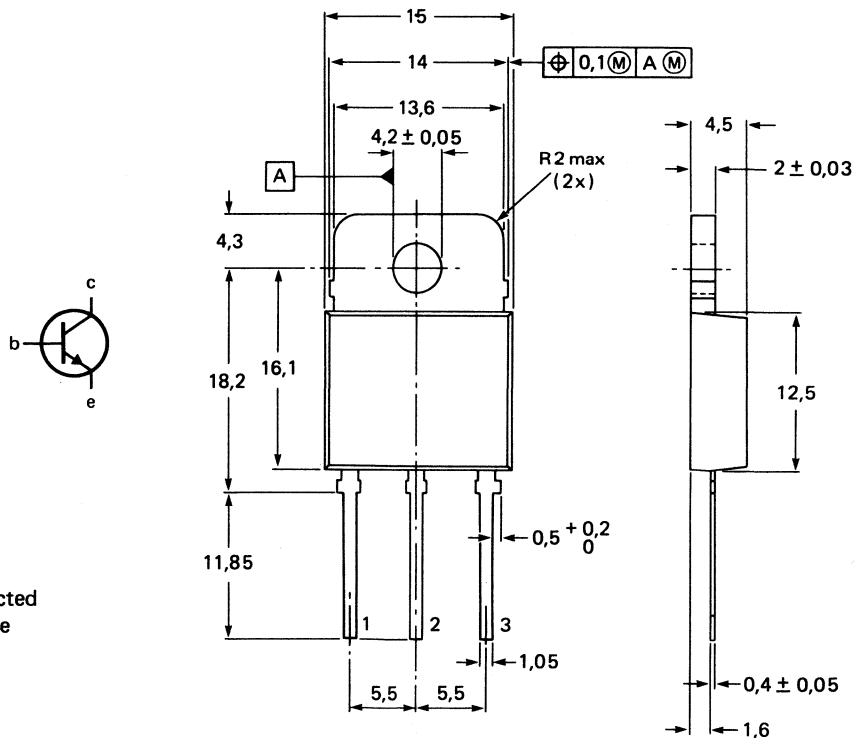
QUICK REFERENCE DATA

			BUW131	131A	131H
Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM}	max.	850	1000	850 V
	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 DC peak value	I_{Csat}	max.		3.0	A
	I_C	max.		5.0	A
	I_{CM}	max.		10.0	A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.		80	W
Fall time (resistive load)	t_f	typ.	0.07	0.07	0.12 μs

MECHANICAL DATA

Fig.1 SOT93.

Dimensions in mm



Pinning:

- 1 = base
- 2 = collector
- 3 = emitter

Collector connected to mounting base

7296696

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

		BUW131	131A	131H
Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM}	max. 850	1000	850 V
	V_{CEO}	max. 450	500	450 V
Collector current DC peak value $t_p = 5 \text{ ms}; d = 10\%$	I_C	max.	8.0	A
	I_{CM}	max.	16	A
Base current DC peak value $t_p = 5 \text{ ms}; d = 10\%$	I_B	max.	6.0	A
	I_{BM}	max.	12	A
Total power dissipation up to $T_{mb} = 25 \text{ }^\circ\text{C}$	P_{tot}	max.	125	W
Storage temperature range	T_{stg}		-65 to + 150	$^\circ\text{C}$
Junction temperature	T_j	max.	150	$^\circ\text{C}$
THERMAL RESISTANCE				
From junction to mounting base	$R_{th \text{ j-mb}}$	=	1.0	K/W

CHARACTERISTICS

$T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified

Collector cut-off current*

$V_{CE} = V_{CESMmax}; V_{BE} = -1.5\text{ V}$

I_{CEV} max. 0.25 mA

$V_{CE} = V_{CESMmax}; V_{BE} = -1.5\text{ V}$

$T_j = 100\text{ }^\circ\text{C}$

I_{CEV} max. 1.5 mA

Emitter cut-off current

$V_{EB} = 6.0\text{ V}; I_C = 0$

I_{EBO} max. 1.0 mA

Collector-emitter sustaining voltage

$I_C = 100\text{ mA}; I_B = 0; L = 10\text{ mH}$
(see Figs 2 and 3)

		BUW131	131A	131H
$V_{CEO_{sust}}$	min.	450	500	450 V

Saturation voltage

$T_C = 25\text{ }^\circ\text{C}$ and $100\text{ }^\circ\text{C}$

$I_C = 3\text{ A}; I_B = 0.4\text{ A}$ (BUW131)

$I_C = 3\text{ A}; I_B = 0.6\text{ A}$ (BUW131A)

$I_C = 3\text{ A}; I_B = 0.3\text{ A}$ (BUW131H)

$V_{CE_{sat}}$ max. 1.0 V

$I_C = 5\text{ A}; I_B = 0.66\text{ A}$ (BUW131)

$I_C = 5\text{ A}; I_B = 1.0\text{ A}$ (BUW131A)

$I_C = 5\text{ A}; I_B = 0.5\text{ A}$ (BUW131H)

$V_{CE_{sat}}$ max. 2.5 V

$V_{BE_{sat}}$ max. 1.5 V

DC current gain

$I_C = 5\text{ A}; V_{CE} = 5\text{ V}$

h_{FE} min. 5 5 7 V

Switching times resistive load

(see Figs 4 and 5)

$I_{C\text{ on}} = 3\text{ A}; I_{B\text{ on}} = 0.4\text{ A}; I_{B\text{ off}} = 0.8\text{ A}$

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

$I_{C\text{ on}} = 3\text{ A}; I_{B\text{ on}} = 0.3\text{ A}; I_{B\text{ off}} = 0.6\text{ A}$

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)

$I_{C\text{ on}} = 3\text{ A}; I_{B\text{ on}} = 0.4\text{ A};$

t_{sv} typ. 0.6 0.6 — μs

$V_{BE\text{ off}} = -5\text{ V}; V_{CE(pk)} = 400\text{ V};$

t_{fj} typ. 0.07 0.07 — μs

$T_j = 100\text{ }^\circ\text{C}$

t_c typ. 0.2 0.2 — μs

$I_{C\text{ on}} = 3\text{ A}; I_{B\text{ on}} = 0.3\text{ A};$

t_{sv} typ. — — 0.5 μs

$V_{BE\text{ off}} = -5\text{ V}; V_{CE(pk)} = 400\text{ V};$

t_{fj} typ. — — 0.07 μs

$T_j = 100\text{ }^\circ\text{C}$

t_c typ. — — 0.18 μs

Output capacitance

$V_{CB} = 10\text{ V}; I_E = 0; f_{test} = 1\text{ kHz}$

C_{ob} max. 200 pF

DEVELOPMENT DATA

* Measured with a half-sinewave voltage (curve tracer).

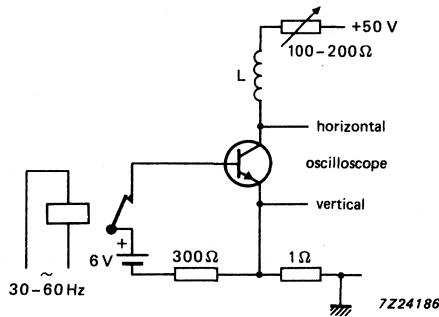


Fig. 2 Test circuit for $V_{CE0sust}$.

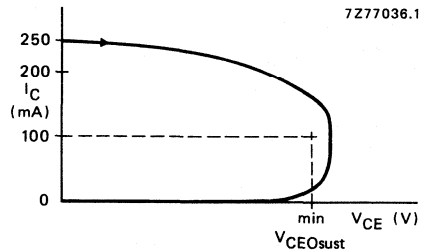


Fig. 3 Oscilloscope display for sustaining voltage.

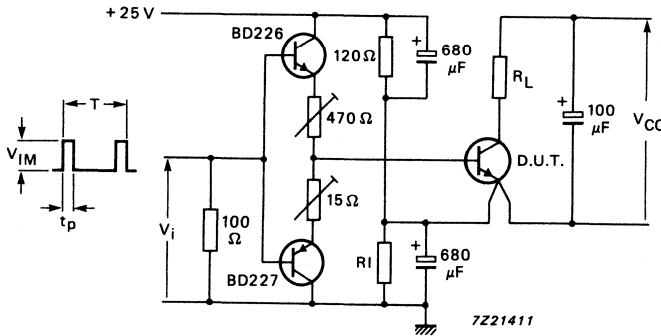


Fig. 4 Test circuit resistive load;
 $V_{CC} = 250\text{ V}$; $R_L = 50\ \Omega$; $R_1 = 39\ \Omega$.

$t_p = 20\ \mu\text{s}$
 $T = 2\ \text{ms}$
 $V_{iM} = 15\ \text{V}$

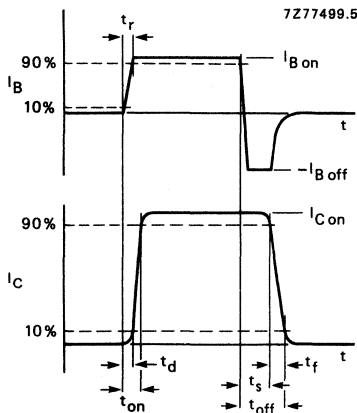


Fig. 5 Switching times waveforms with resistive load; $t_r \leq 20\ \text{ns}$.

For inductive load;
 $V_{CL} = 400\ \text{V}$
 $V_{BE} = -5\ \text{V}$

For RB SOAR;
 V_{CL} up to 1000 V
 V_{BEoff} to be adjusted

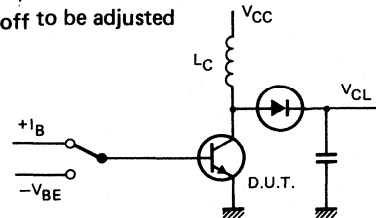


Fig. 6 Test circuit inductive load and RB SOAR; $V_{CC} = 20\ \text{V}$; $L_C = 200\ \mu\text{H}$.

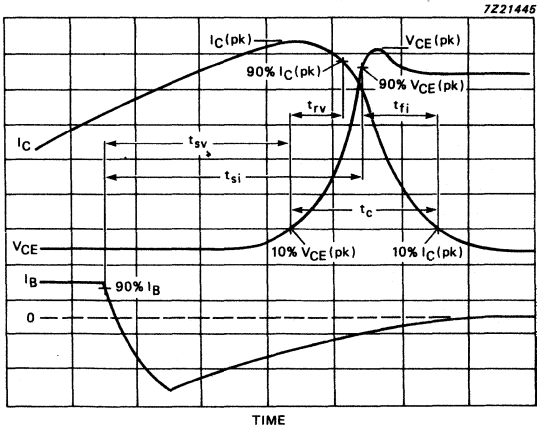


Fig.7 Switching times waveforms with inductive load.

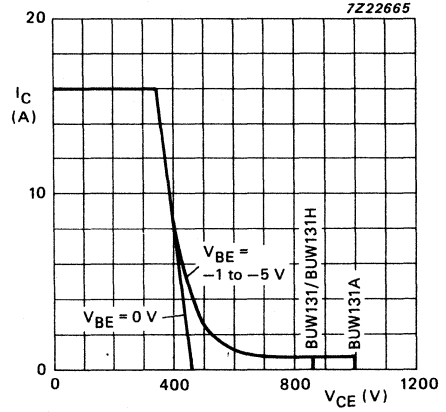


Fig.8 Reverse bias SOAR; $I_C/I_B = 4$; $T_{mb} = 25^\circ\text{C}$.

DEVELOPMENT DATA

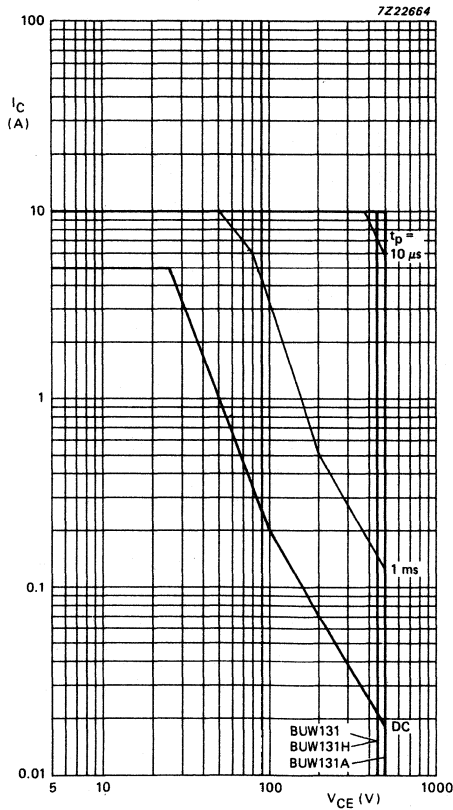


Fig.9 Forward biased SOAR; $T_c = 25^\circ\text{C}$.

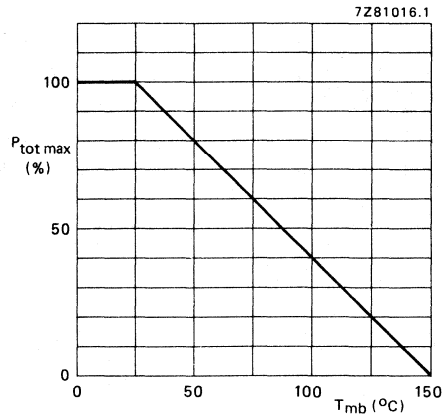


Fig. 10 Power derating curve.

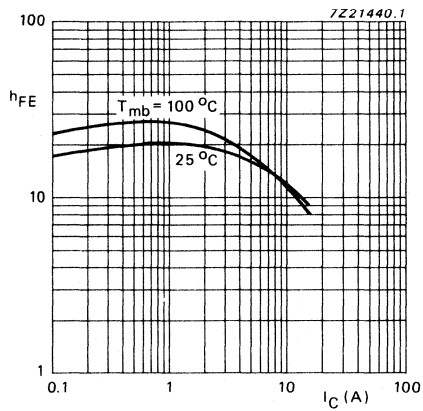


Fig. 11 Typical DC current gain; $V_{CE} = 5\ V$.

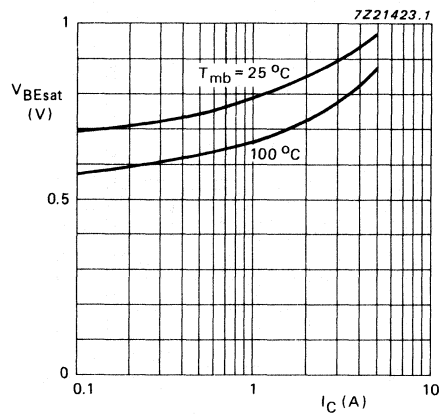


Fig. 12 Base-emitter saturation voltage as a function of collector current; $I_C/I_B = 10$.

DEVELOPMENT DATA

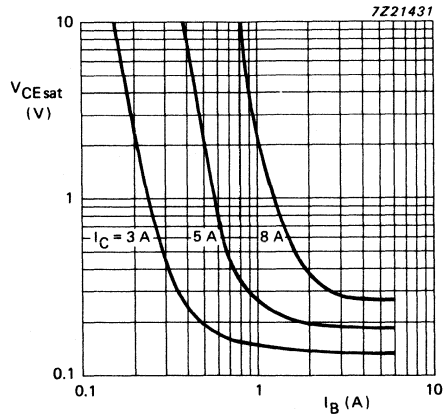


Fig. 13 Collector-emitter voltage as a function of base current; $T_{mb} = 25\text{ }^\circ\text{C}$.

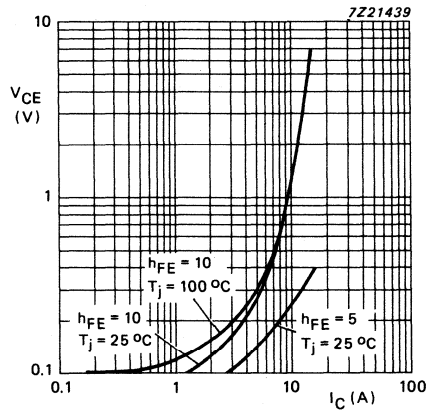


Fig. 14 Collector-emitter voltage as a function of collector current.

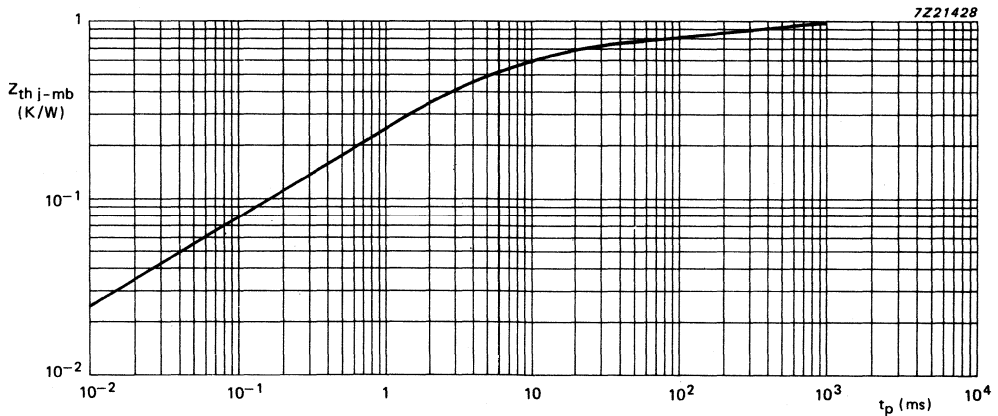


Fig. 15 Transient thermal impedance; (normalized).

DEVELOPMENT DATA

This data sheet contains advance information and specifications are subject to change without notice.

BUW132 SERIES

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.

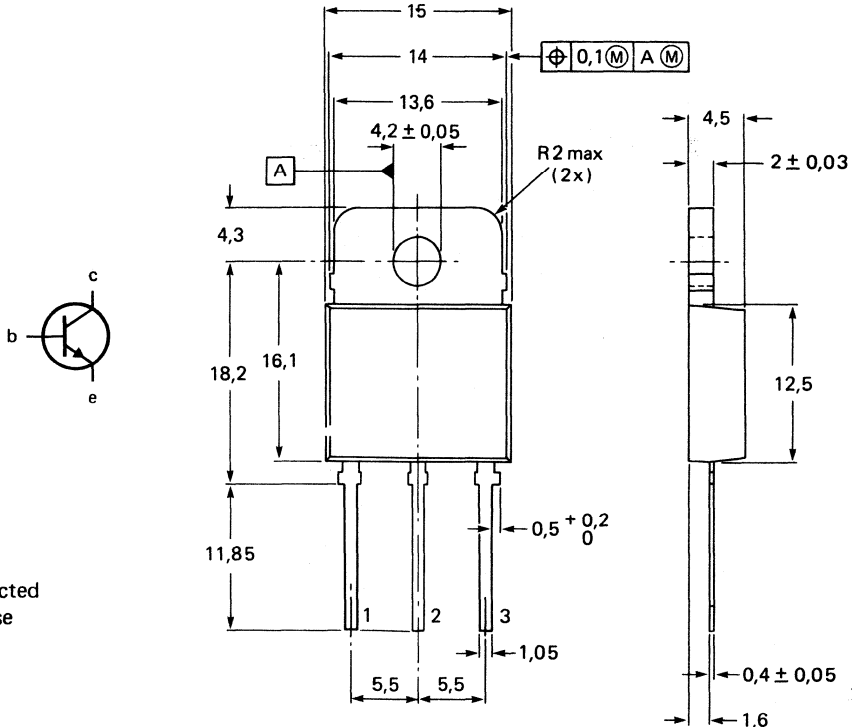
QUICK REFERENCE DATA

			BUW132	132A	132H
Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM}	max.	850	1000	850 V
	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}		5.0	A
	DC	I_C		8.0	A
	peak value	I_{CM}		16	A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	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

7296696

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BUW132	132A	132H
Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM}	max.	850	1000	850 V
	V_{CEO}	max.	450	500	450 V
Collector current DC peak value $t_p = 5 \text{ ms}; d = 10\%$	I_C	max.		8.0	A
	I_{CM}	max.		16	A
Base current DC peak value $t_p = 5 \text{ ms}; d = 10\%$	I_B	max.		6.0	A
	I_{BM}	max.		12	A
Total power dissipation up to $T_{mb} = 25 \text{ }^\circ\text{C}$	P_{tot}	max.		125	W
Storage temperature range	T_{stg}			-65 to + 150	$^\circ\text{C}$
Junction temperature	T_j	max.		150	$^\circ\text{C}$
THERMAL RESISTANCE					
From junction to mounting base	$R_{th \text{ j-mb}}$	=		1.0	K/W

CHARACTERISTICS

$T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified

Collector cut-off current*

$V_{CE} = V_{CESMmax}; V_{BE} = -1.5\text{ V}$

I_{CEV} max. 0.25 mA

$V_{CE} = V_{CESMmax}; V_{BE} = -1.5\text{ V}$

$T_j = 100\text{ }^\circ\text{C}$

I_{CEV} max. 1.5 mA

Emitter cut-off current

$V_{EB} = 6.0\text{ V}; I_C = 0$

I_{EBO} max. 1.0 mA

BUW132 132A 132H

Collector-emitter sustaining voltage

$I_C = 100\text{ mA}; I_B = 0; L = 10\text{ mH}$

(see Figs 2 and 3)

$V_{CEOsust}$ min. 450 500 450 V

Saturation voltage

$T_C = 25\text{ }^\circ\text{C}$ and $100\text{ }^\circ\text{C}$

$I_C = 3\text{ A}; I_B = 0.4\text{ A}$ (BUW132)

$I_C = 3\text{ A}; I_B = 0.6\text{ A}$ (BUW132A)

$I_C = 3\text{ A}; I_B = 0.3\text{ A}$ (BUW132H)

V_{CEsat} max. 2.5 1.0 2.5 V

$I_C = 5\text{ A}; I_B = 0.66\text{ A}$ (BUW132)

$I_C = 5\text{ A}; I_B = 1.0\text{ A}$ (BUW132A)

$I_C = 5\text{ A}; I_B = 0.5\text{ A}$ (BUW132H)

V_{CEsat} max. 3.0 1.5 3.0 V

V_{BEsat} max. 1.5 1.5 1.5 V

DC current gain

$I_C = 8\text{ A}; V_{CE} = 5\text{ V}$

h_{FE} min. 5 5 7 V

Switching times resistive load

(see Figs 4 and 5)

$I_{C\ on} = 5\text{ A}; I_{B\ on} = 0.66\text{ A}; I_{B\ off} = 1.3\text{ A}$

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

$I_{C\ on} = 5\text{ A}; I_{B\ on} = 0.5\text{ A}; I_{B\ off} = 1.0\text{ A}$

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)

$I_{C\ on} = 5\text{ A}; I_{B\ on} = 0.66\text{ A};$

$V_{BE\ off} = -5\text{ V}; V_{CE(pk)} = 400\text{ V};$

$T_j = 100\text{ }^\circ\text{C}$

t_{sv} typ. 0.8 0.8 — μs

t_{fi} typ. 0.08 0.08 — μs

t_c typ. 0.25 0.25 — μs

$I_{C\ on} = 5\text{ A}; I_{B\ on} = 0.5\text{ A};$

$V_{BE\ off} = -5\text{ V}; V_{CE(pk)} = 400\text{ V};$

$T_j = 100\text{ }^\circ\text{C}$

t_{sv} typ. — 0.6 μs

t_{fi} typ. — 0.07 μs

t_c typ. — 0.2 μs

Output capacitance

$V_{CB} = 10\text{ V}; I_E = 0; f_{test} = 1\text{ kHz}$

C_{ob} max. 350 pF

DEVELOPMENT DATA

* Measured with a half-sinewave voltage (curve tracer).

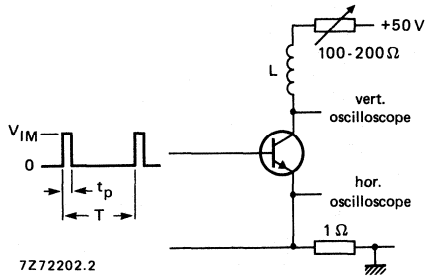


Fig. 2 Test circuit for $V_{CEOsust}$.

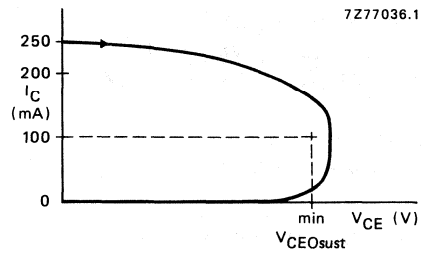


Fig. 3 Oscilloscope display for sustaining voltage.

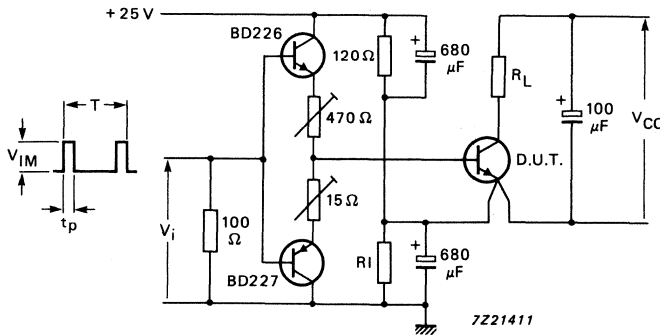


Fig. 4 Test circuit resistive load;
 $V_{CC} = 250\text{ V}$; $R_L = 50\ \Omega$; $R_1 = 39\ \Omega$.

$t_p = 20\ \mu\text{s}$
 $T = 2\ \text{ms}$
 $V_{IM} = 15\ \text{V}$

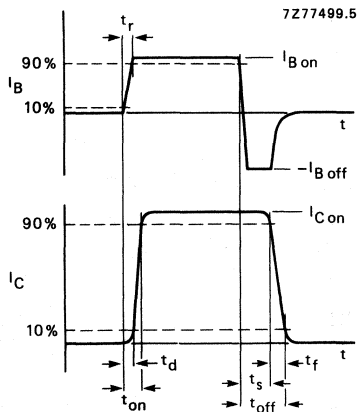


Fig. 5 Switching times waveforms with resistive load; $t_r \leq 20\ \text{ns}$.

For inductive load;
 $V_{CL} = 400\ \text{V}$
 $V_{BE} = -5\ \text{V}$

For RB SOAR;
 V_{CL} up to 1000 V
 V_{BEoff} to be adjusted

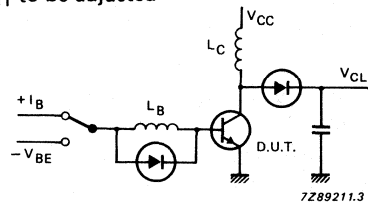


Fig. 6 Test circuit inductive load and RB SOAR; $V_{CC} = 20\ \text{V}$; $L_C = 200\ \mu\text{H}$.

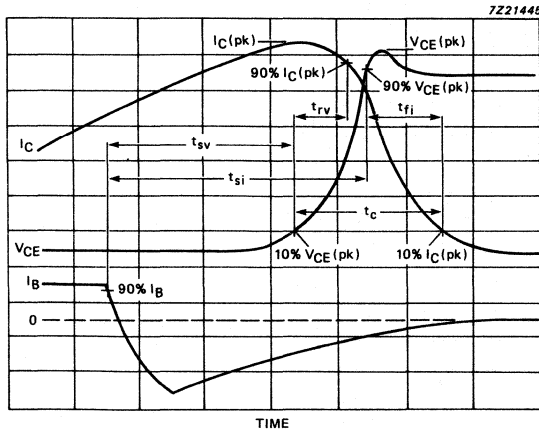


Fig. 7 Switching times waveforms with inductive load.

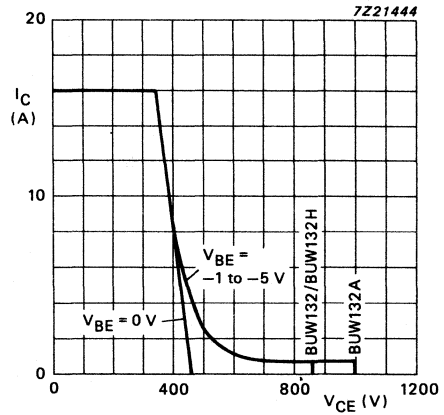


Fig. 8 Reverse bias SOAR; $I_C/I_B = 4$; $T_{mb} = 25^\circ\text{C}$.

DEVELOPMENT DATA

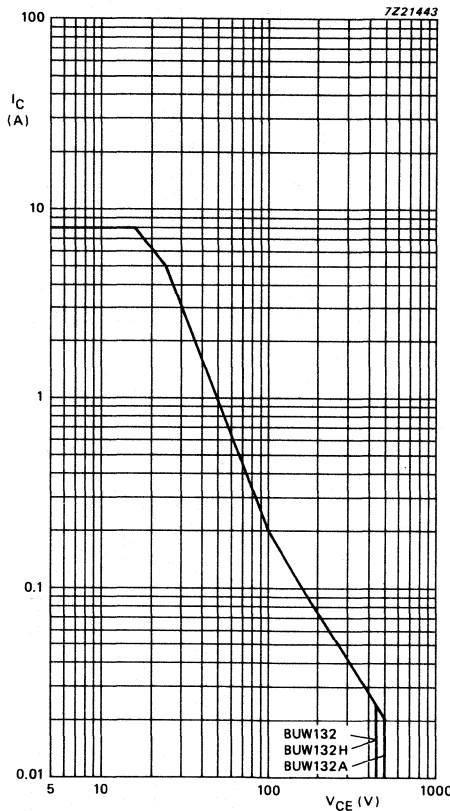


Fig. 9 Forward biased SOAR; $T_{mb} = 25^\circ\text{C}$.

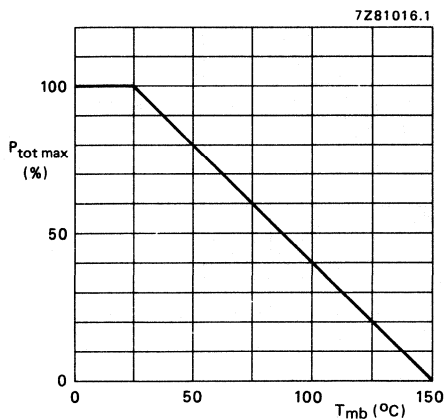


Fig. 10 Power derating curve.

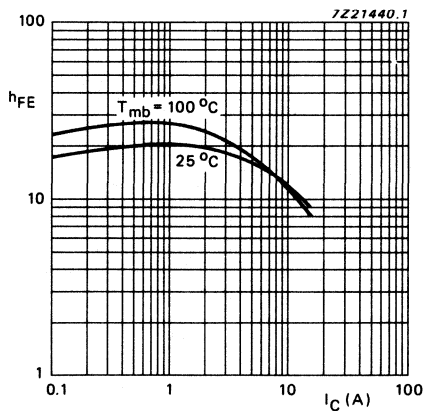


Fig. 11 Typical DC current gain; $V_{CE} = 5$ V.

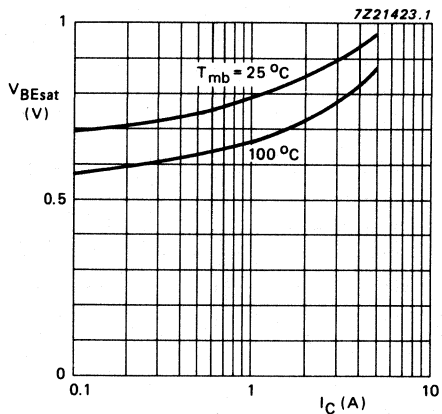


Fig. 12 Base-emitter saturation voltage as a function of collector current; $I_C/I_B = 10$.

DEVELOPMENT DATA

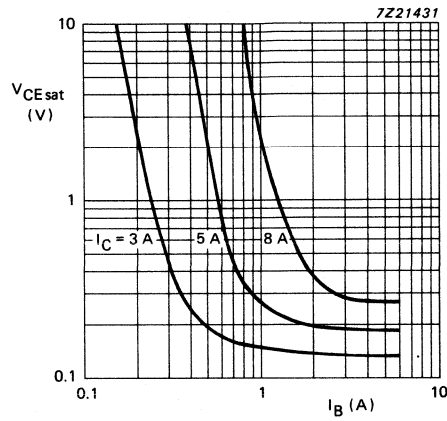


Fig. 13 Collector-emitter voltage as a function of base current; $T_{mb} = 25^\circ\text{C}$.

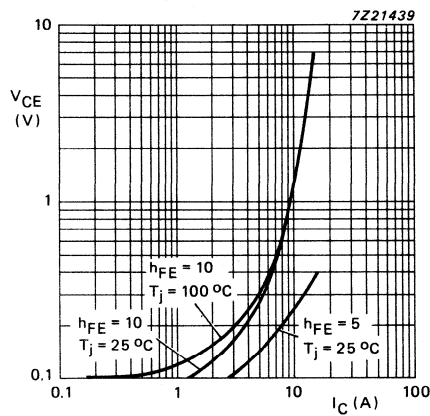


Fig. 14 Collector-emitter voltage as a function of collector current.

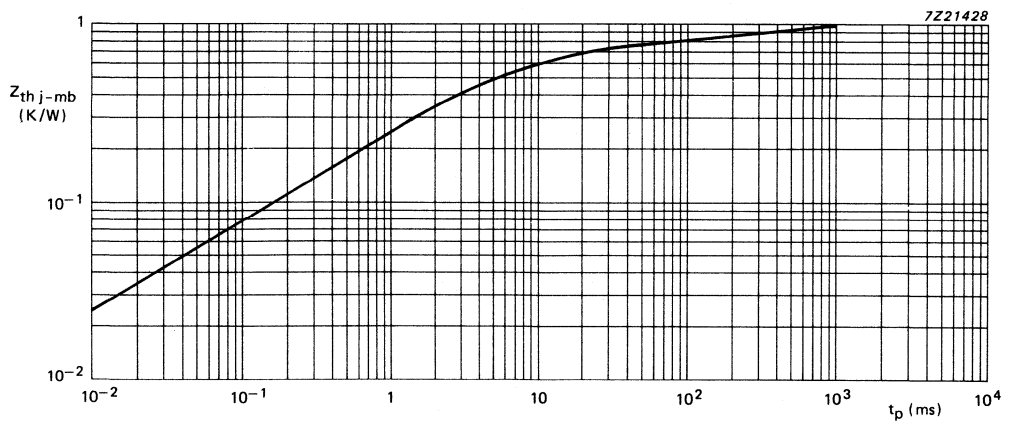


Fig. 15 Transient thermal impedance; (normalized).

DEVELOPMENT DATA

This data sheet contains advance information and specifications are subject to change without notice.

BUW133 SERIES

NPN SILICON POWER TRANSISTORS

High-voltage, glass-passivated power transistors in SOT93 envelope, intended for use in very fast switching applications in inductive circuits.

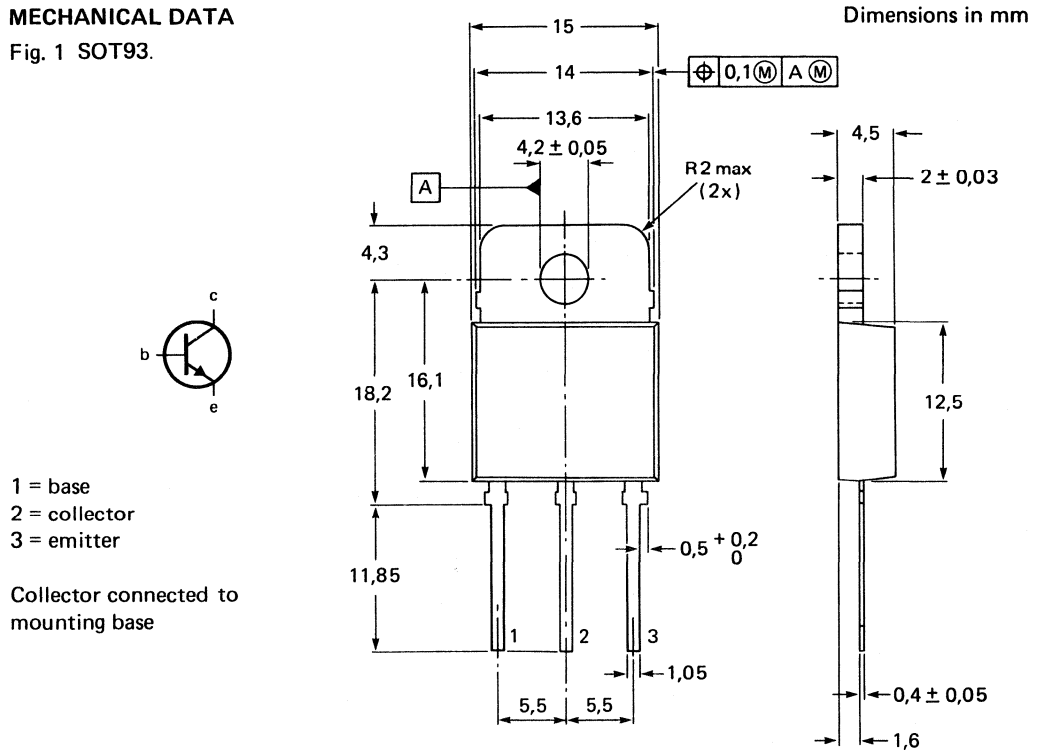
BUW133H is a high gain selection for applications where drive current is limited.

QUICK REFERENCE DATA

			BUW133	133A	133H
Collector-emitter voltage $V_{BE} = 0$; peak value open base	V_{CESM}	max.	850	1000	850 V
	V_{CEO}	max.	450	500	450 V
Collector-emitter saturation voltage	V_{CEsat}	max.	3.0	1.5	3.0 V
Collector current saturation DC peak value	I_{Csat}	max.		10	A
	I_C	max.		15	A
	I_{CM}	max.		20	A
Total power dissipation up to $T_{mb} = 25^\circ C$	P_{tot}	max.		135	W
Fall time (resistive load)	t_f	typ.		0.15	μs

MECHANICAL DATA

Fig. 1 SOT93.



7296696

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			$R_{th\ j-mb}$	=	0.93 K/W

CHARACTERISTICS

 $T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified

Collector cut-off current*

 $V_{CE} = V_{CESMmax}; V_{BE} = -1.5\text{ V}$ I_{CESM} max. 0.25 mA $V_{CE} = V_{CESMmax}; V_{BE} = -1.5\text{ V}$ $T_j = 100\text{ }^\circ\text{C}$ I_{CESM} max. 1.5 mA

Emitter cut-off current

 $V_{EB} = 6.0\text{ V}; I_C = 0$ I_{EBO} max. 1.0 mA

Collector-emitter sustaining voltage

 $I_C = 100\text{ mA}; I_B = 0; L = 10\text{ mH}$

(see Figs 2 and 3)

 $V_{CEO_{sust}}$ min. 450 500 450 V

Saturation voltage

 $T_C = 25\text{ }^\circ\text{C}$ and $100\text{ }^\circ\text{C}$ $I_C = 5\text{ A}; I_B = 1.0\text{ A}$ (BUW133A) $I_C = 5\text{ A}; I_B = 0.7\text{ A}$ (BUW133) $I_C = 5\text{ A}; I_B = 0.5\text{ A}$ (BUW133H) $V_{CE_{sat}}$ max. 2.5 1.0 2.5 V $I_C = 10\text{ A}; I_B = 2.0\text{ A}$ (BUW133A) $I_C = 10\text{ A}; I_B = 1.3\text{ A}$ (BUW133) $I_C = 10\text{ A}; I_B = 1.0\text{ A}$ (BUW133H) $V_{CE_{sat}}$ max. 3.0 1.5 3.0 V $V_{BE_{sat}}$ max. 1.5 1.5 1.5 V

DC current gain

 $I_C = 15\text{ A}; V_{CE} = 5\text{ V}$ h_{FE} min. 5 5 7

Switching times resistive load

(see Figs 4 and 5)

 $I_{C\text{ on}} = 10\text{ A}; I_{B\text{ on}} = 1.3\text{ A};$ $I_{B\text{ off}} = 2.6\text{ A}$

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 $I_{C\text{ on}} = 10\text{ A}; I_{B\text{ on}} = 1\text{ A};$ $I_{B\text{ off}} = 2\text{ A}$

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)

 $I_{C\text{ on}} = 10\text{ A}; I_{B\text{ on}} = 1.3\text{ A};$ $V_{BE\text{ off}} = -5\text{ V}; V_{CE(pk)} = 400\text{ V};$ $T_j = 100\text{ }^\circ\text{C}$ t_{sv} typ. 0.9 0.9 — μs t_{fi} typ. 0.05 0.05 — μs t_c typ. 0.16 0.16 — μs $I_{C\text{ on}} = 10\text{ A}; I_{B\text{ on}} = 1\text{ A};$ $V_{BE\text{ off}} = 5\text{ V}; V_{CE(pk)} = 400\text{ V};$ $T_j = 100\text{ }^\circ\text{C}$ t_{sv} typ. — — 0.65 μs t_{fi} typ. — — 0.03 μs t_c typ. — — 0.15 μs

Output capacitance

 $V_{CB} = 10\text{ V}; I_E = 0; f_{test} = 1\text{ kHz}$ C_{ob} max. 400 pF

* Measured with a half-sinewave voltage (curve tracer).

DEVELOPMENT DATA

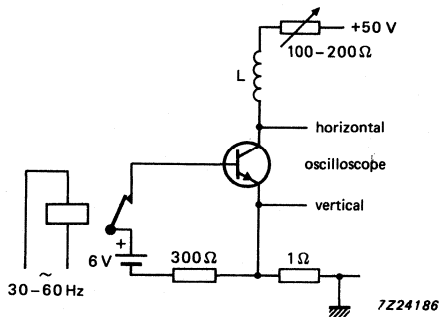


Fig. 2 Test circuit for $V_{CEOsust}$.

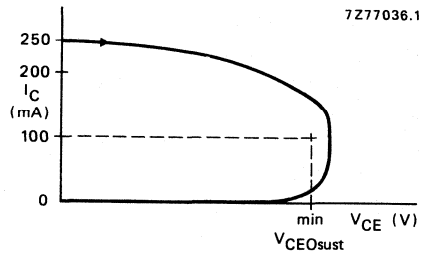


Fig. 3 Oscilloscope display for sustaining voltage.

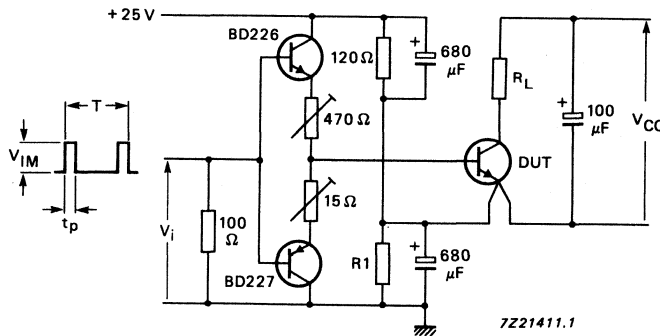


Fig. 4 Test circuit resistive load; $V_{CC} = 250\text{ V}$;
 $R_L = 25\ \Omega$; $R_1 = 39\ \Omega$.

$t_p = 20\ \mu\text{s}$
 $T = 2\ \text{ms}$
 $V_{IM} = 15\ \text{V}$

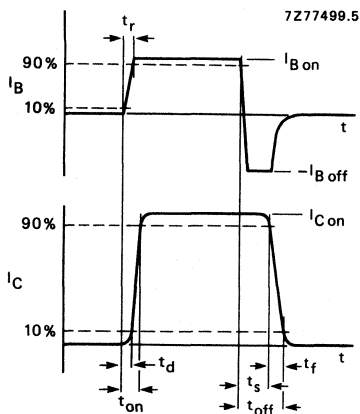
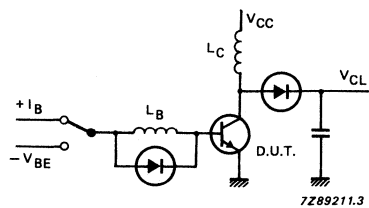


Fig. 5 Switching times waveforms with resistive load; $t_r \leq 30\ \text{ns}$.



For inductive load;
 $V_{clamp} = 400\ \text{V}$
 $V_{BE} = -5\ \text{V}$
For RB SOAR;
 V_{clamp} up to 1000 V
 $-V_{BE}$ to be adjusted

Fig. 6 Test circuit inductive load and RB SOAR; $V_{CC} = 20\ \text{V}$; $L_C = 200\ \mu\text{H}$.

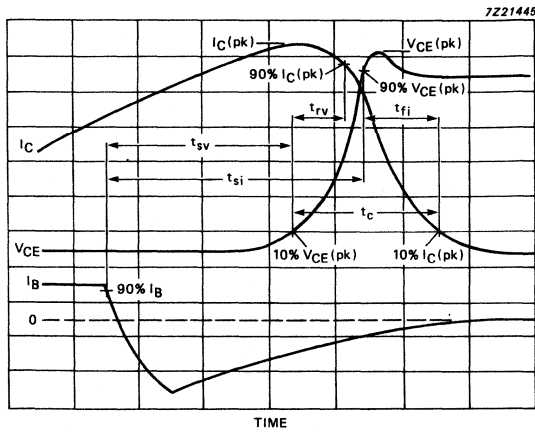


Fig. 7 Switching times waveforms with inductive load.

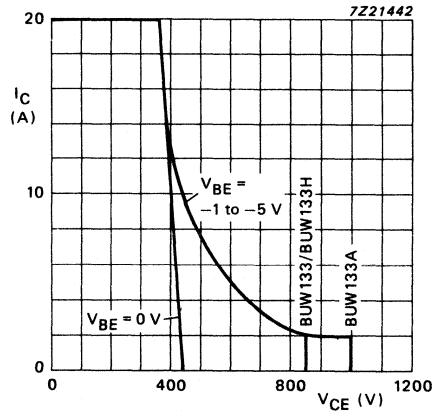


Fig. 8 Reverse bias SOAR; $I_C/I_B = 4$; $T_{mb} = 25^\circ\text{C}$.

DEVELOPMENT DATA

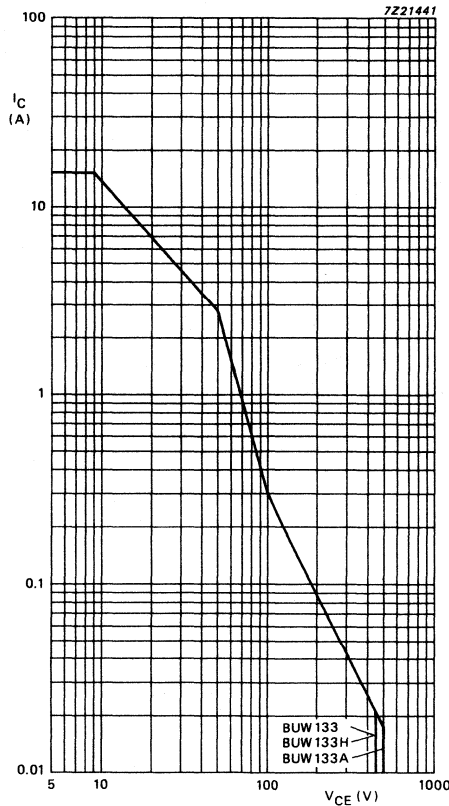


Fig. 9 Forward biased SOAR; $T_{mb} = 25^\circ\text{C}$.

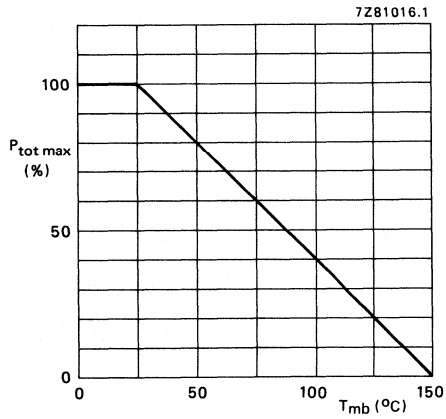


Fig. 10 Power derating curve.

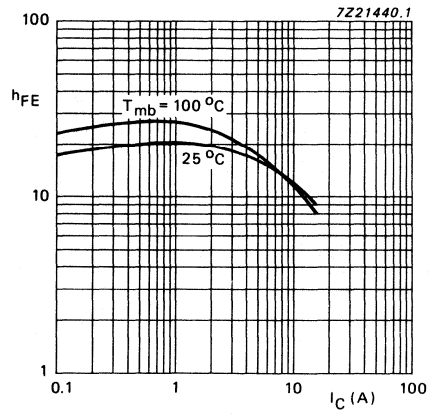


Fig. 11 Typical DC current gain; $V_{CE} = 5 \text{ V}$.

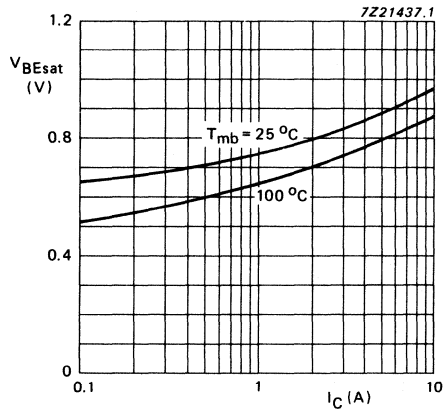


Fig. 12 Base-emitter saturation voltage as a function of collector current; $I_C/I_B = 10$.

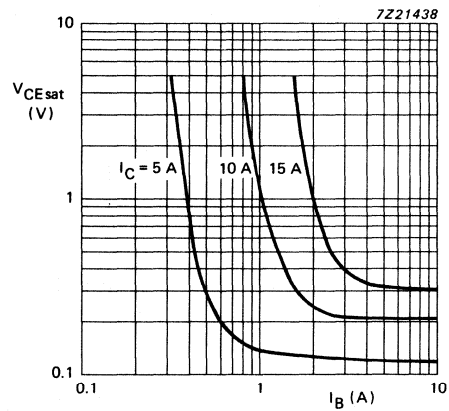


Fig. 13 Collector-emitter saturation voltage as a function of base current; $T_{mb} = 25 \text{ }^\circ\text{C}$.

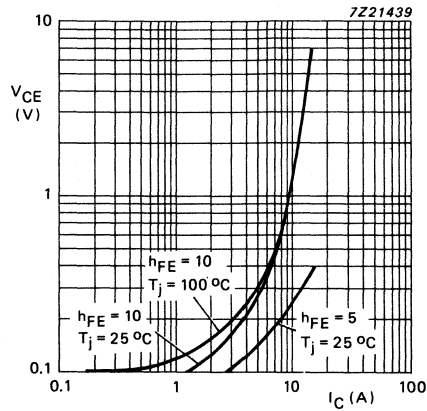


Fig. 14 Collector-emitter voltage as a function of collector current.

DEVELOPMENT DATA

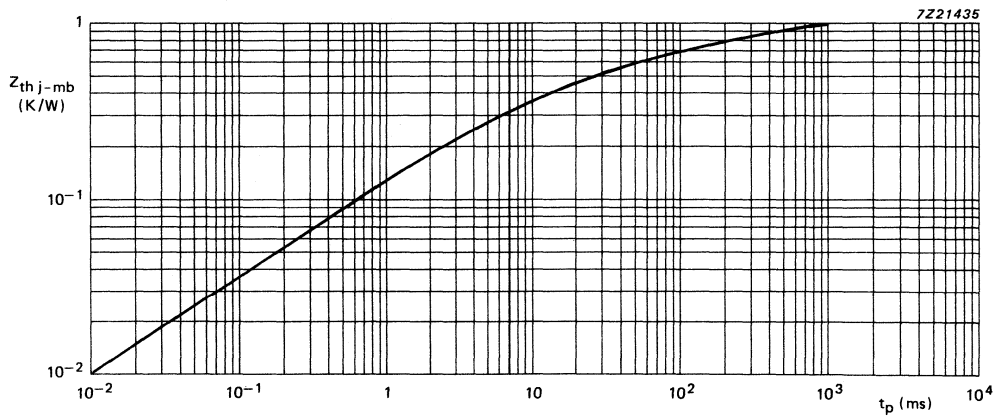


Fig. 15 Transient thermal impedance; (normalized).

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.

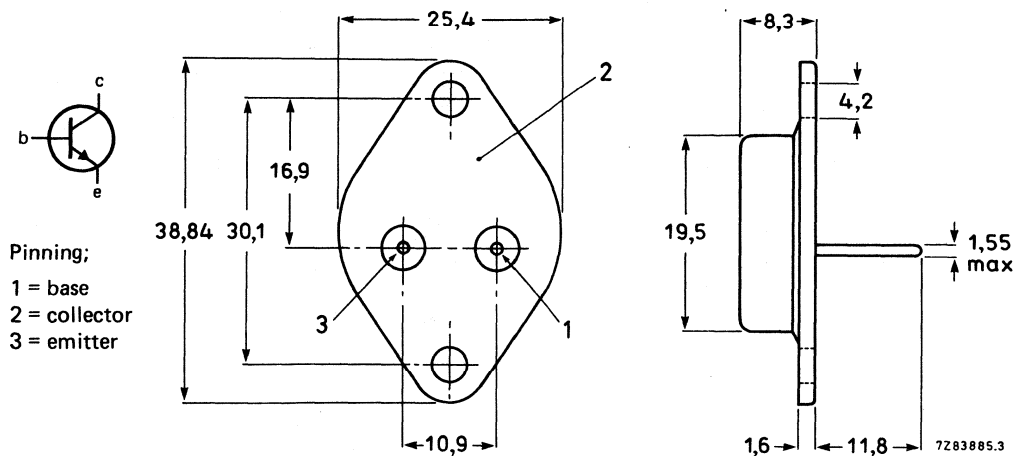
QUICK REFERENCE DATA

		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 $T_{mb} = 25^\circ\text{C}$	P_{tot} max.	85	W
Fall time (resistive load)	t_f max.	0,8	μs

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-3.



Collector connected to case.

BUX46 BUX46A

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 ($R_{BE} \leq 10 \Omega$)	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 $T_{mb} = 25^\circ\text{C}$	P_{tot}	max.	85		W
Storage temperature range	T_{stg}		-65 to +175		$^\circ\text{C}$
Junction temperature	T_j	max.	175		$^\circ\text{C}$

THERMAL RESISTANCE

From junction to mounting base	R_{thj-mb}	=	1,75		K/W
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CHARACTERISTICS

$T_j = 25^\circ\text{C}$ unless otherwise specified

Collector cut-off current*

$$V_{CE} = V_{CESMmax}; R_{BE} \leq 10 \Omega$$

$$V_{CE} = V_{CESMmax}; R_{BE} \leq 10 \Omega; T_j = 125^\circ\text{C}$$

I_{CER}	max.	0,3		mA
I_{CER}	max.	2		mA

Emitter cut-off current

$$I_C = 0; V_{EB} = 5 \text{ V}$$

I_{EBO}	max.	1		mA
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Saturation voltages

$$I_C = 3,5 \text{ A}; I_B = 0,7 \text{ A}$$

$$I_C = 2,5 \text{ A}; I_B = 0,5 \text{ A}$$

V_{CEsat}	max.	5		V
V_{CEsat}	max.	1,5		V
V_{BEsat}	max.	1,3		V

Collector-emitter sustaining voltage

$$I_C = 200 \text{ mA}; I_B = 0; L = 25 \text{ mH}$$

$V_{CEO_{sust}}$	min.	400		450	V
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Collector-emitter cut-off current

$$V_{CE} = V_{CESMmax}; V_{BE} = -2,5 \text{ V}$$

$$V_{CE} = V_{CESMmax}; V_{BE} = -2,5 \text{ V}; T_j = 124^\circ\text{C}$$

I_{CEX}	max.	0,1		mA
I_{CEX}	max.	1		mA

Emitter-base breakdown voltage

$$I_C = 0; I_E = 0,5 \text{ A}$$

$V_{(BR)EBO}$	max.	30		V
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Second breakdown collector current

$$V_{CE} = 70 \text{ V}; t = 1 \text{ sec.}$$

$I_{(SB)C}$	min.	0,5		A
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* Measured with a half-sinewave voltage (curve tracer).

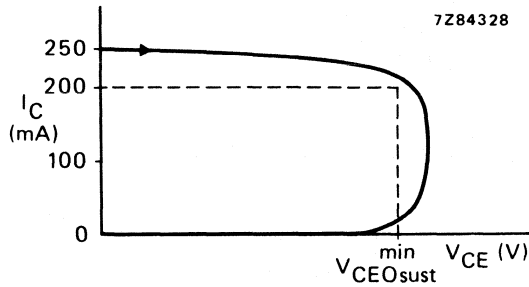


Fig. 2 Oscilloscope display for sustaining voltage.

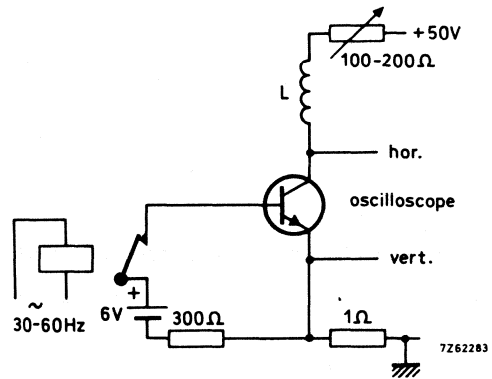


Fig. 3 Test circuit for $V_{CEOsust}$.

Switching times resistive load (Figs 4 and 5)

$I_{Con} = 2,5 \text{ A}; I_{Bon} = -I_{Boff} = 0,5 \text{ A}$

Turn-on time

t_{on}	typ.	0,5 μs
	max.	1 μs
t_s	typ.	1,5 μs
	max.	3 μs
t_f	typ.	0,5 μs
	max.	0,8 μs

Turn-off: Storage time

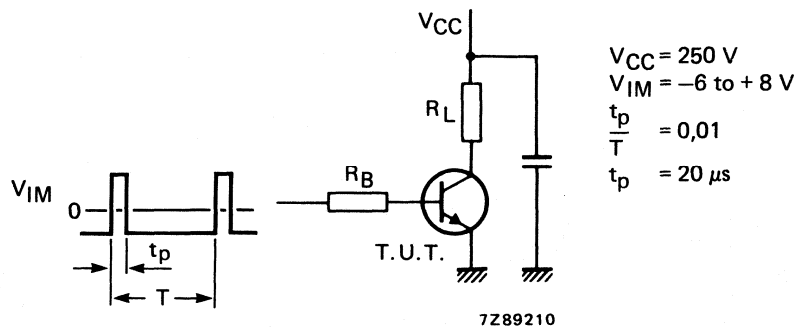
Fall time

Switching times inductive load (Figs 6 and 7)

$I_{Con} = 2,5 \text{ A}; I_B = 0,5 \text{ A}$

Fall time

t_f	max.	0,2 μs
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The values of R_B and R_L are selected in accordance with $I_{C\text{ on}}$ and I_B requirements.

Fig. 4 Test circuit resistive load.

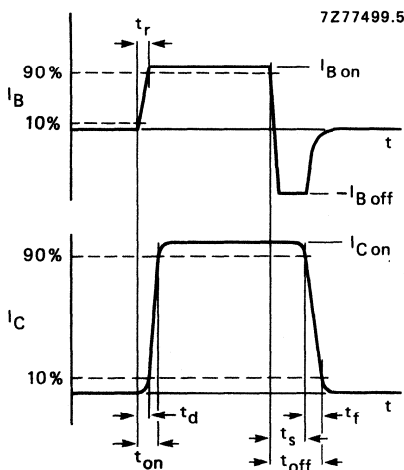


Fig. 5 Switching times waveforms with resistive load.

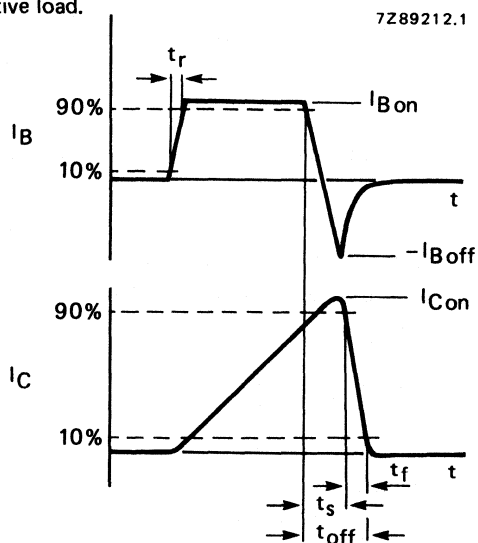


Fig. 6 Switching times waveforms with inductive load.

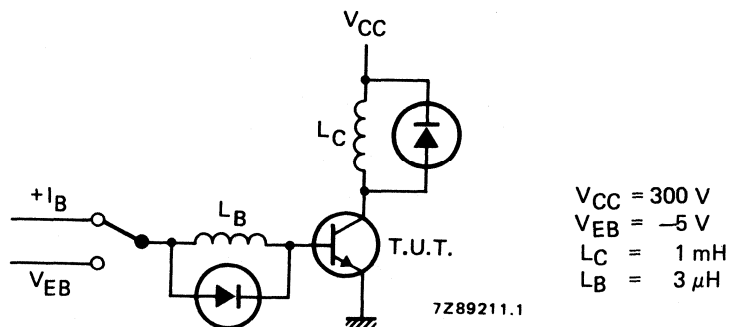
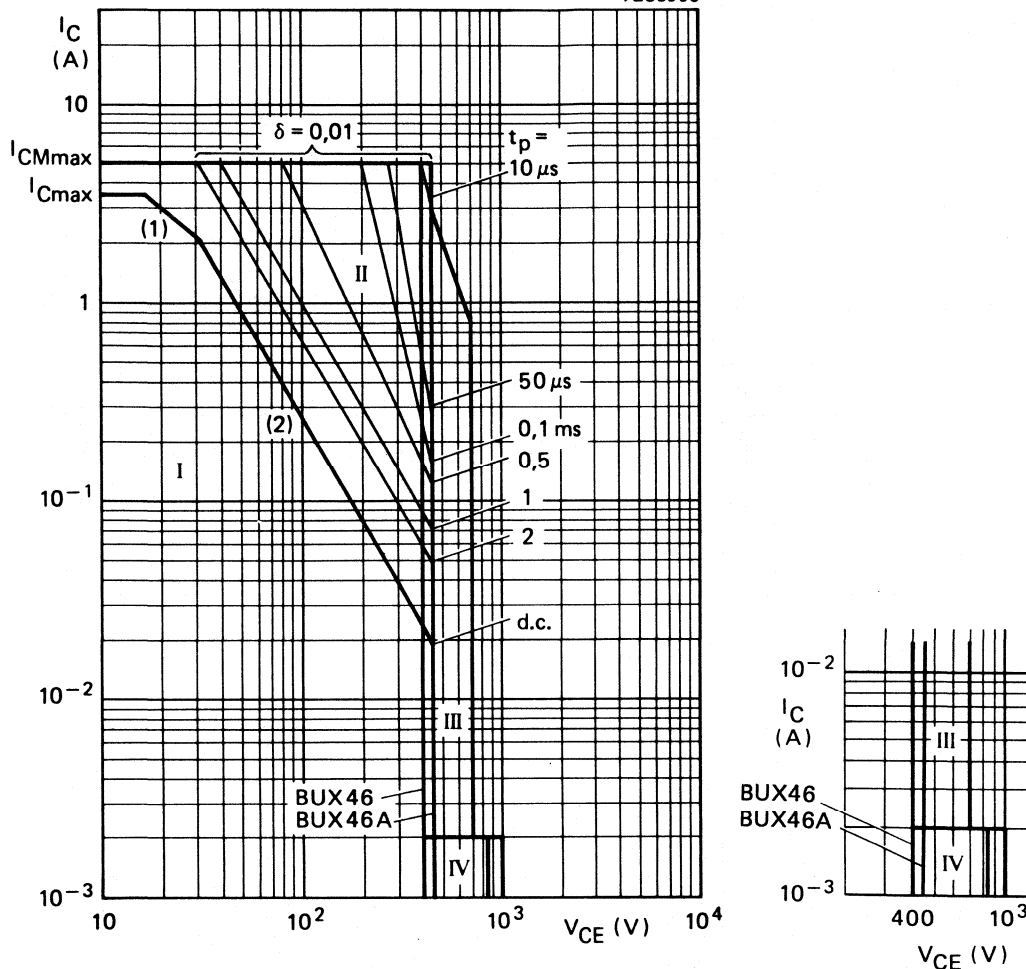


Fig. 7 Test circuit inductive load.

7Z88305



- (1) P_{tot} max and P_{tot} peak max. lines.
- (2) Second-breakdown limits.
- I Region of permissible DC operation.
- II Permissible extension for repetitive pulse operation.
- III Area of permissible operation during turn-on in single transistor converters, provided $R_{BE} \leq 100 \Omega$ and $t_p \leq 0,6 \mu s$.
- IV Repetitive pulse operation in this region is permissible, provided $V_{BE} \leq 0$ and $t_p \leq 2$ ms.

Fig. 8 Safe operating area at $T_{mb} \leq 60 \text{ }^\circ\text{C}$.

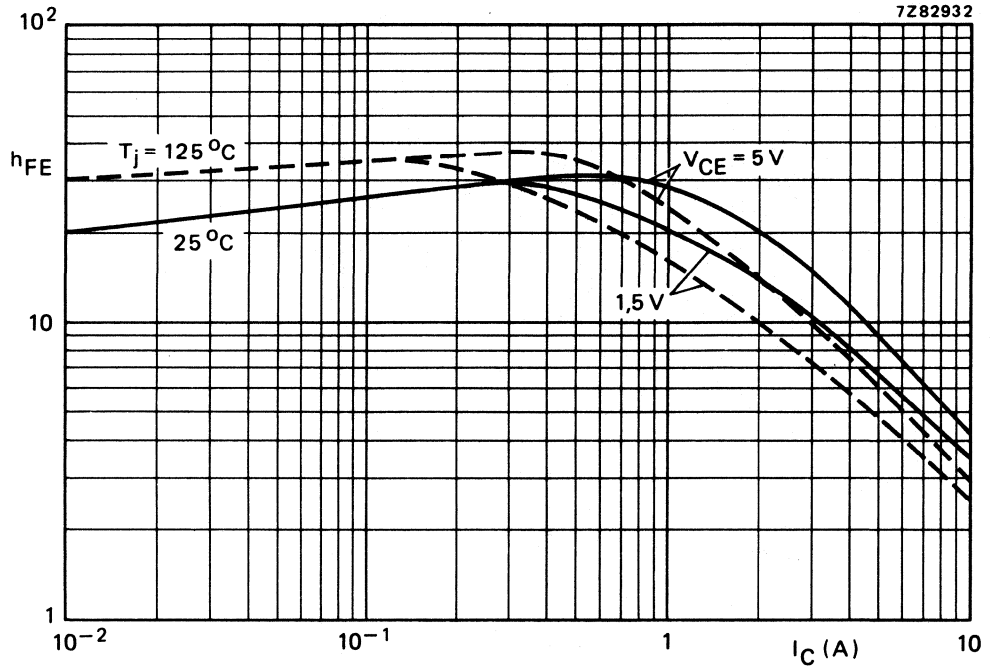


Fig. 9 DC current gain.

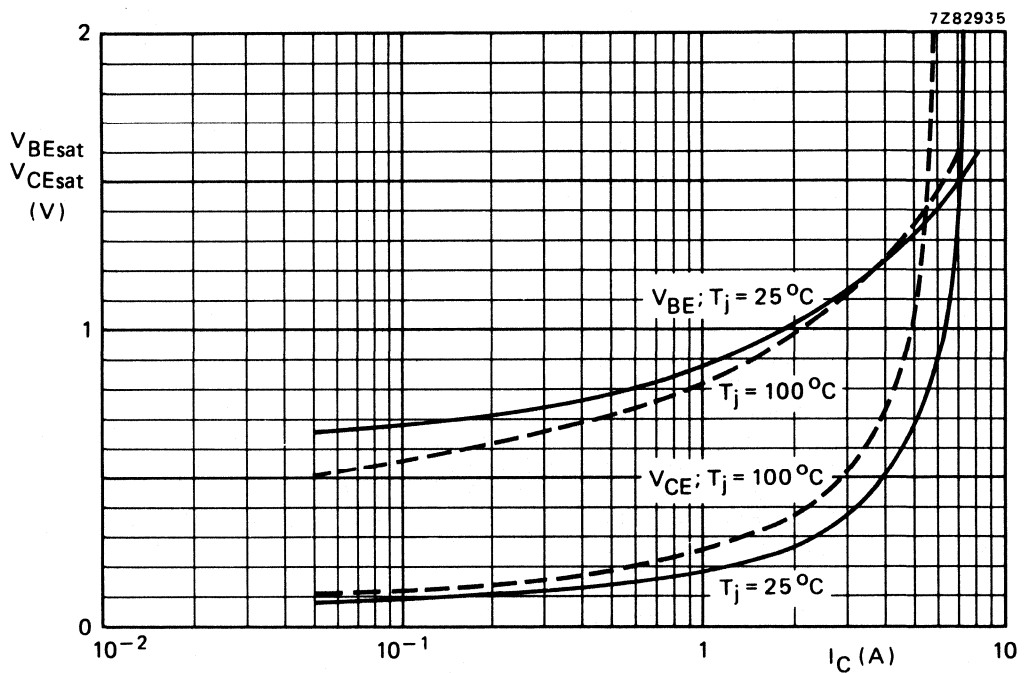


Fig. 10 Typical values base-emitter and collector-emitter voltage, $I_C/I_B = 5$.

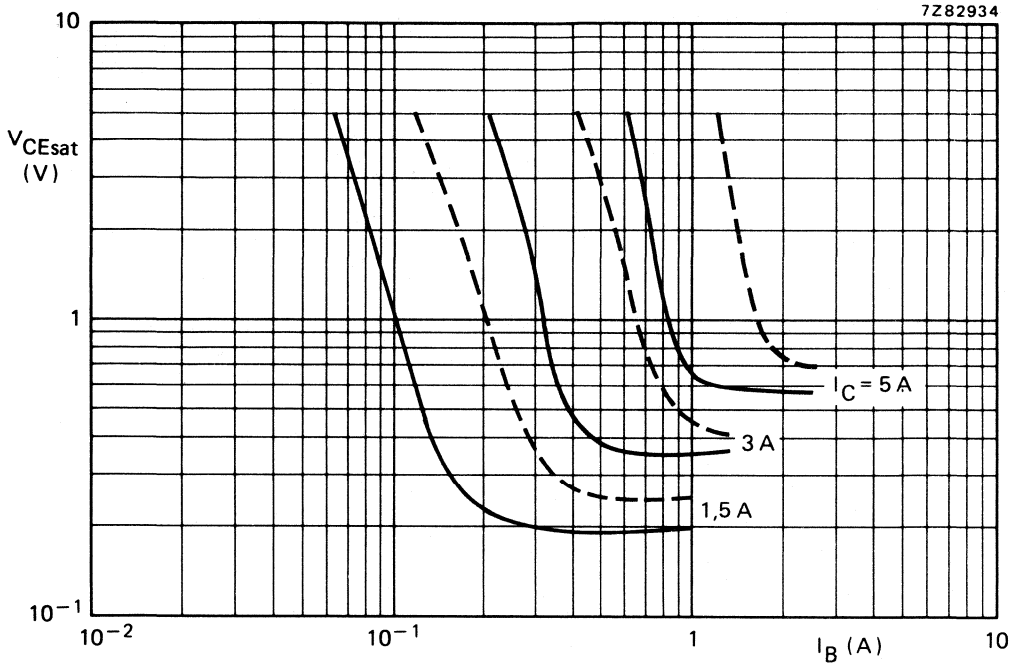


Fig. 11 Typ. (—) and max. (---) values collector-emitter saturation voltage at $T_j = 25\text{ }^\circ\text{C}$.

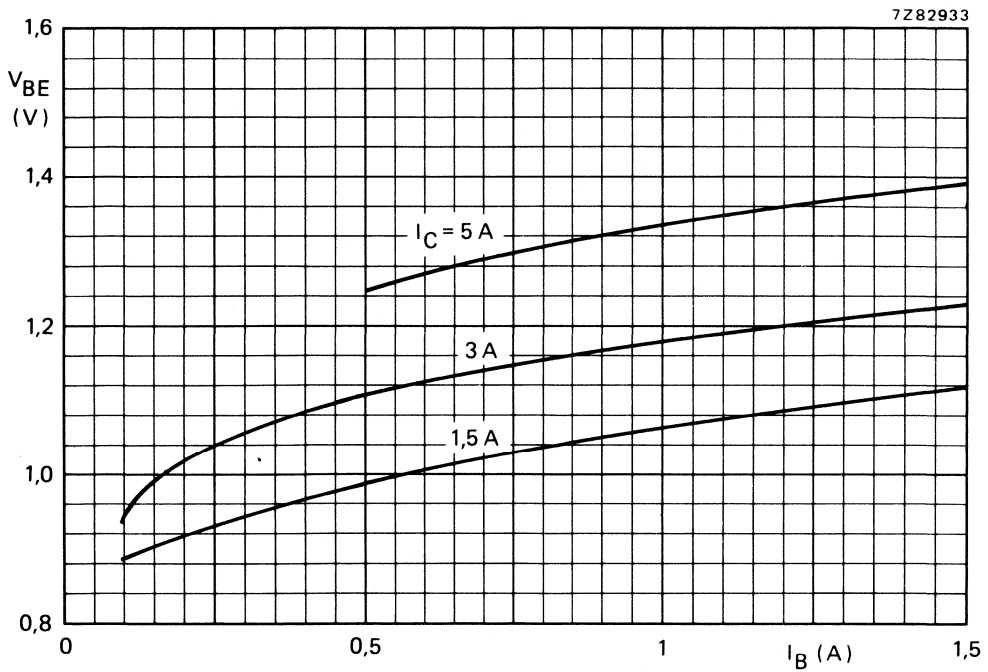


Fig. 12 Typical values at $T_j = 25\text{ }^\circ\text{C}$.

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.

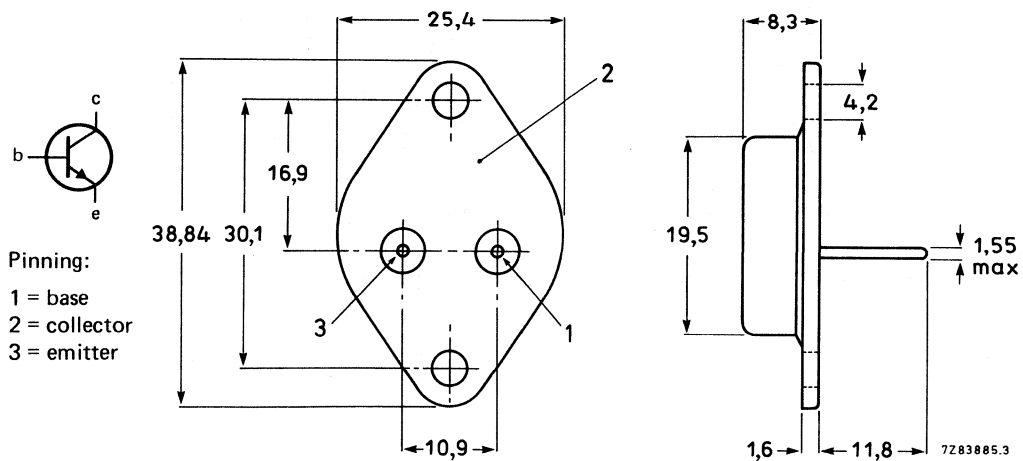
QUICK REFERENCE DATA

		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 $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot} , max.	125	W
Fall time (resistive load)	t_f , max.	0,8	μs

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-3.



Collector connected to case.

BUX47 BUX47A

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); $t_p \leq 5$ 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	$R_{th j-mb}$	=	1,4	K/W
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CHARACTERISTICS

$T_j = 25$ °C unless otherwise specified

Collector cut-off current*

$$V_{CE} = V_{CESMmax}; R_{BE} \leq 10 \Omega$$

$$V_{CE} = V_{CESMmax}; R_{BE} \leq 10 \Omega; T_j = 125$$
 °C

I_{CER}	max.	0,4	mA
I_{CER}	max.	3	mA

Emitter cut-off current

$$I_C = 0; V_{EB} = 5$$
 V

I_{EBO}	max.	1	mA
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Saturation voltages

$$I_C = 6$$
 A; $I_B = 1,2$ A

$$I_C = 9$$
 A; $I_B = 1,8$ A

$$I_C = 5$$
 A; $I_B = 1$ A

$$I_C = 8$$
 A; $I_B = 1,6$ A

$$I_C = 6$$
 A; $I_B = 1,2$ A

$$I_C = 5$$
 A; $I_B = 1$ A

V_{CEsat}	max.	1,5	—	V
V_{CEsat}	max.	5	—	V
V_{CEsat}	max.	—	1,5	V
V_{CEsat}	max.	—	5	V
V_{BEsat}	max.	1,6	—	V
V_{BEsat}	max.	—	1,6	V

Collector-emitter sustaining voltage

$$I_C = 200$$
 mA; $I_B = 0$; $L = 25$ mH

$V_{CEO_{sust}}$	min.	400	450	V
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Emitter-base breakdown voltage

$$I_C = 0; I_B = 0,5$$
 A

$V_{(BR)EBO}$		7 to 30		V
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Collector cut-off current

$$V_{CE} = V_{CESMmax}; V_{BE} = -2,5$$
 V

$$V_{CE} = V_{CESMmax}; V_{BE} = -2,5$$
 V; $T_j = 125$ °C

I_{CEX}	max.	0,15	mA
I_{CEX}	max.	1,5	mA

* Measured with a half-sinewave voltage (curve tracer).

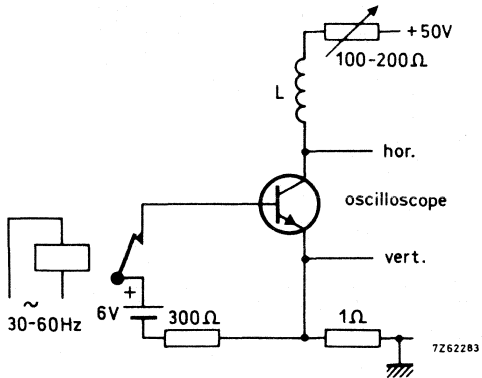


Fig. 2 Test circuit for $V_{CEOsust}$.

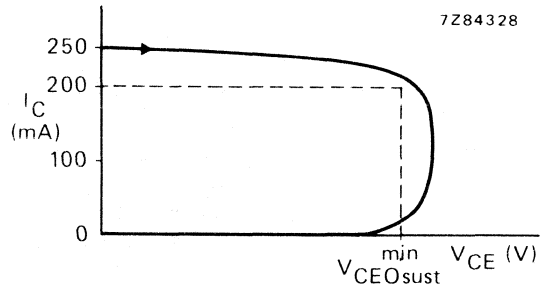


Fig. 3 Oscilloscope display for sustaining voltage.

Switching times resistive load (Figs 4 and 5)

BUX47: $I_{Con} = 6 \text{ A}$; $I_{Bon} = -I_{Boff} = 1,2 \text{ A}$

BUX47A: $I_{Con} = 5 \text{ A}$; $I_{Bon} = -I_{Boff} = 1 \text{ A}$

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: $I_{Con} = 6 \text{ A}$; $I_B = 1,2 \text{ A}$

BUX47A: $I_{Con} = 5 \text{ A}$; $I_B = 1 \text{ A}$

Turn-off: Storage time

t_s	typ.	2,5 μs
	max.	4 μs

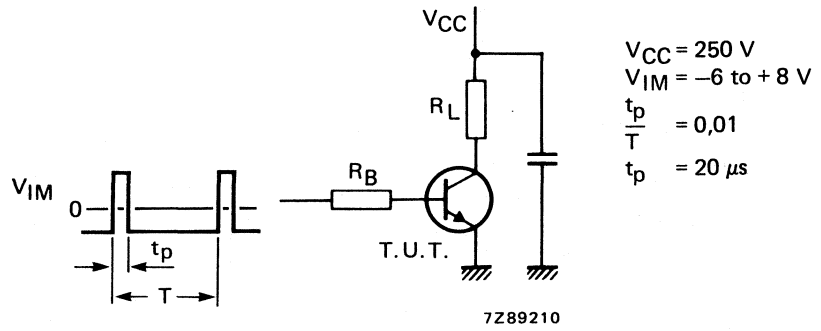
Storage time; $T_j = 100 \text{ }^\circ\text{C}$

Fall time

t_f	typ.	80 ns
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Fall time; $T_j = 100 \text{ }^\circ\text{C}$

t_f	max.	400 ns
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The values of R_B and R_L are selected in accordance with $I_{C \text{ on}}$ and I_B requirements.

Fig. 4 Test circuit resistive load.

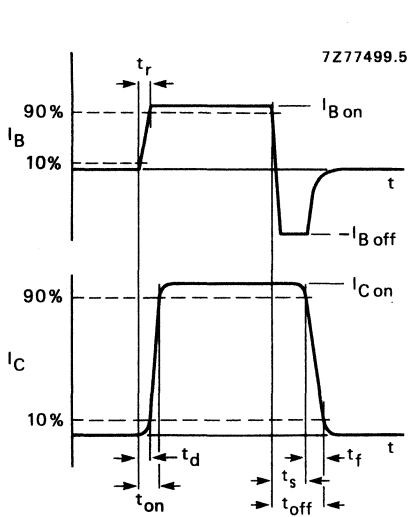


Fig. 5 Switching times waveforms with resistive load.

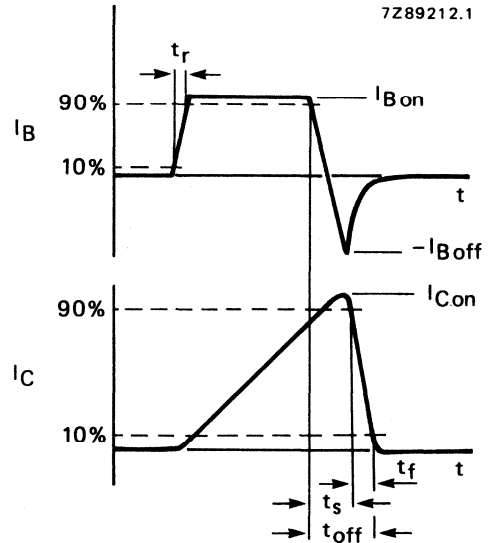


Fig. 6 Switching times waveforms with inductive load.

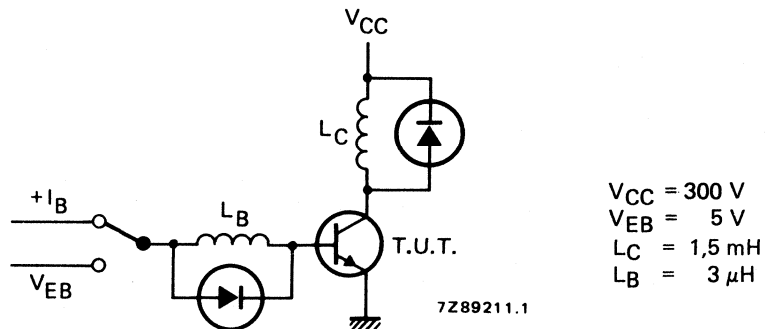
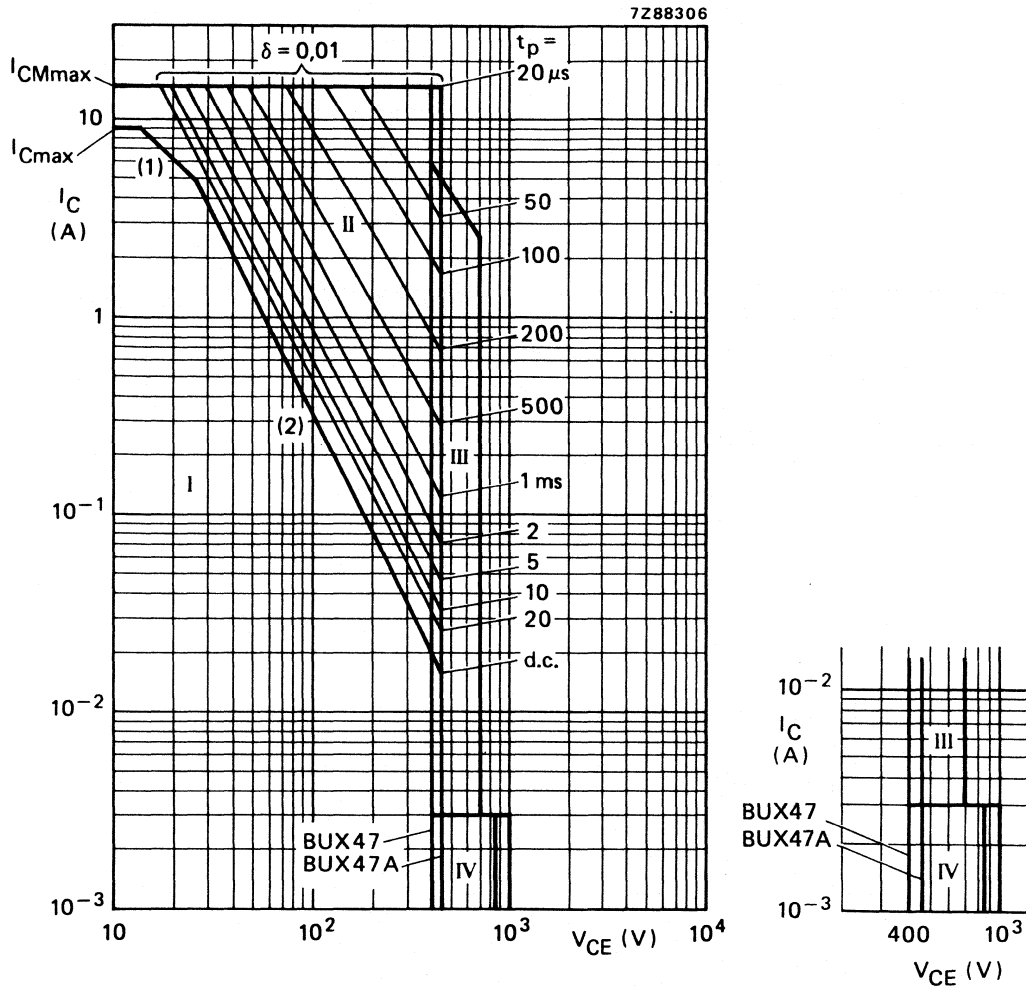


Fig. 7 Test circuit inductive load.



- (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 $R_{BE} \leq 100 \Omega$ and $t_p \leq 0,6 \mu$ s.
- IV Repetitive pulse operation in this region is permissible, provided $V_{BE} \leq 0$ and $t_p \leq 2$ ms.

Fig. 8 Safe operating area at $T_{mb} \leq 25^\circ\text{C}$.

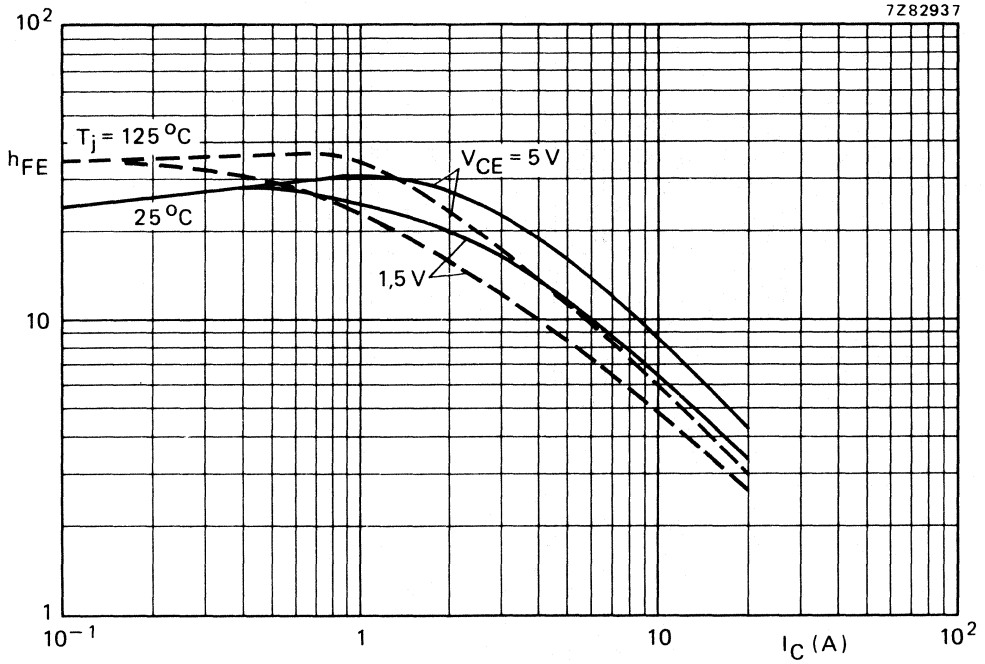


Fig. 9 Typical values DC current gain.

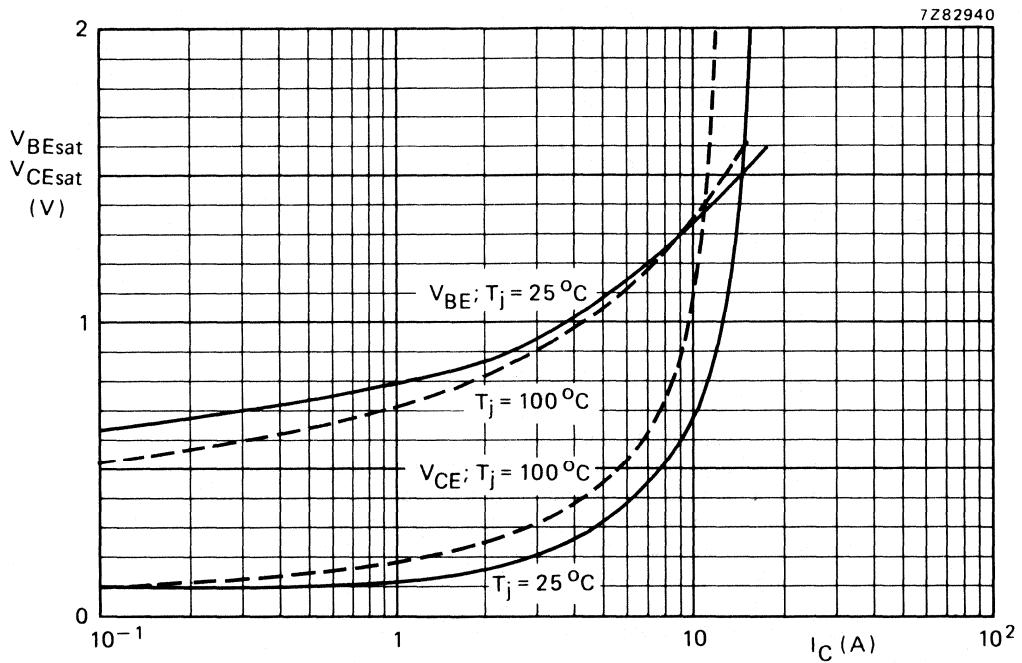


Fig. 10 Typical values base and collector voltage at $I_C/I_B = 5$.

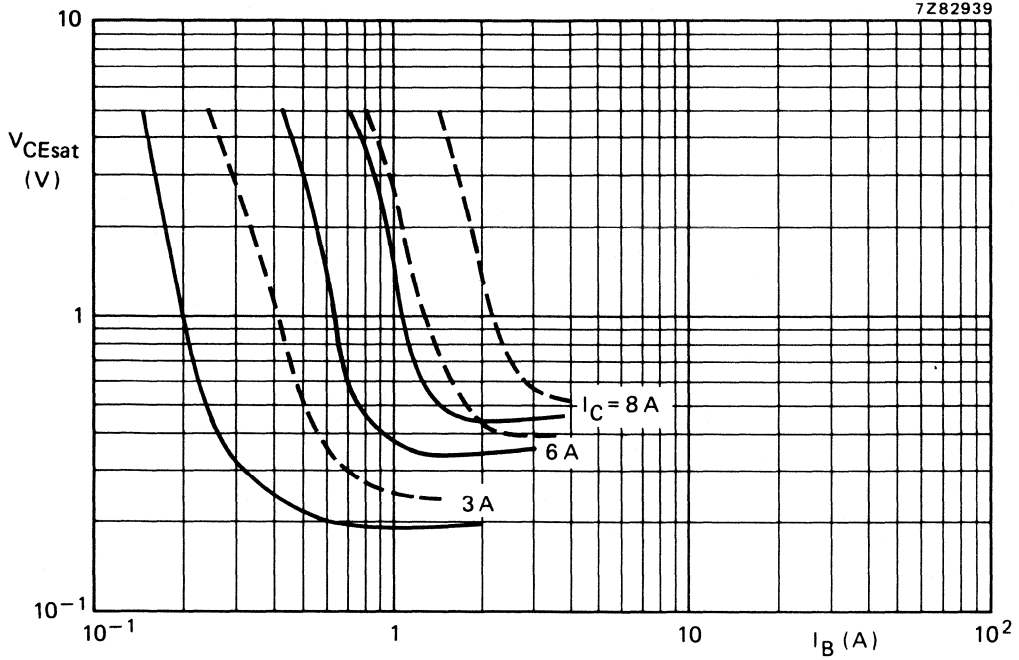


Fig. 11 Typ. (—) and max. (---) values collector-emitter saturation voltage at $T_j = 25^\circ C$.

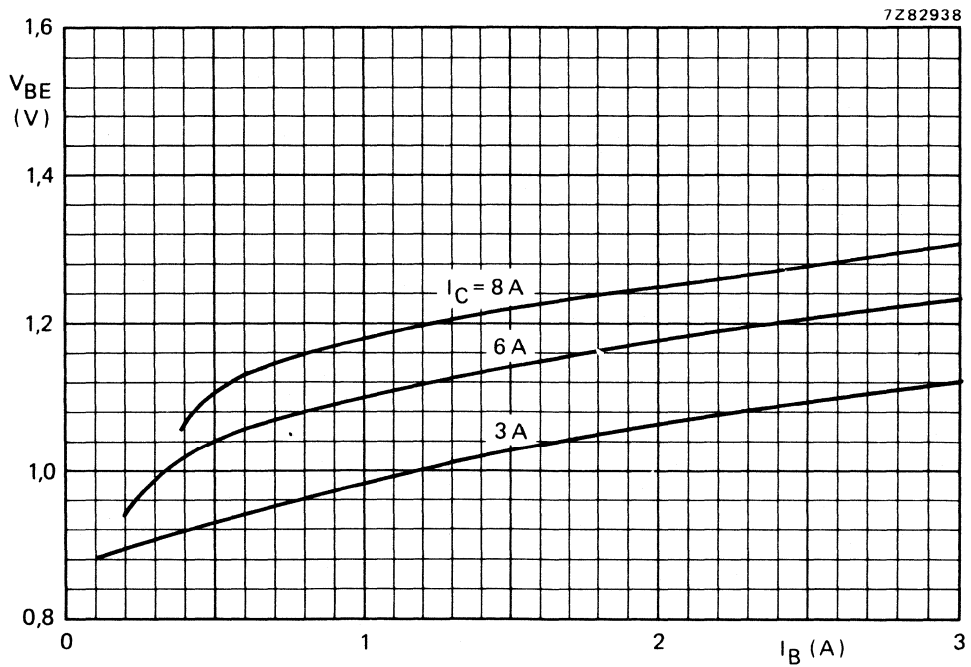


Fig. 12 Typical values base-emitter voltage at $T_j = 25^\circ C$.

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.

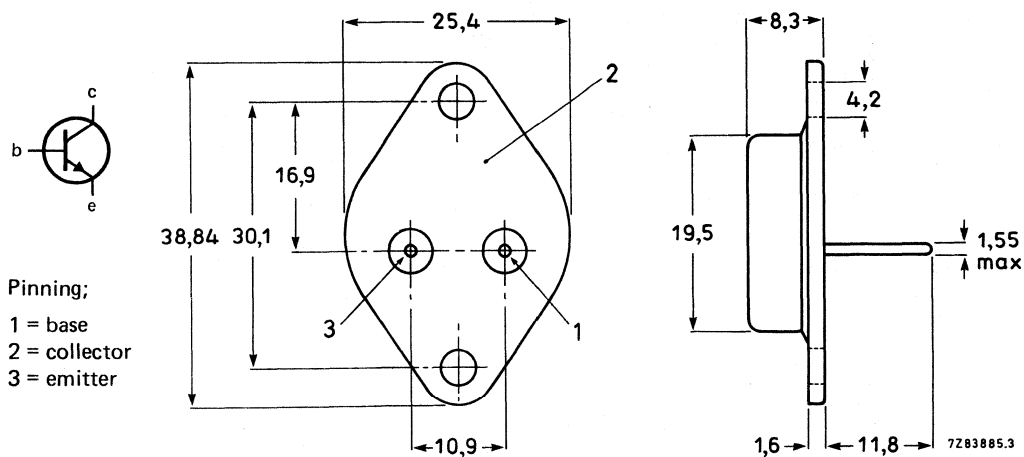
QUICK REFERENCE DATA

		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 $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot} max.	175	W
Fall time (resistive load)	t_f max.	0,8	μs

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-3.



Collector connected to case.

BUX48 BUX48A

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 $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	175	W
Storage temperature range	T_{stg}		-65 to +200	$^\circ\text{C}$
Junction temperature	T_j	max.	200	$^\circ\text{C}$

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j-mb}$	=	1,0	K/W
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CHARACTERISTICS

$T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified

Collector-emitter current *

$$V_{CE} = V_{CESM}; R_{BE} \leq 10\ \Omega;$$

I_{CESM}	max.	0,5	mA
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$$V_{CE} = V_{CESM}; R_{BE} \leq 10\ \Omega; T_j = 125\text{ }^\circ\text{C}$$

I_{CESM}	max.	4	mA
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Collector-emitter current

$$V_{CE} = V_{CEX}; V_{BE} = -2,5\text{ V}$$

I_{CEV}	max.	0,2	mA
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$$V_{CE} = V_{CEX}; V_{BE} = -2,5\text{ V}; T_j = 125\text{ }^\circ\text{C}$$

I_{CEV}	max.	2	mA
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Emitter cut-off current

$$I_C = 0; V_{EB} = 5\text{ V}$$

I_{EBO}	max.	1	mA
-----------	------	---	----

Saturation voltages

$$I_C = 10\text{ A}; I_B = 2\text{ A}$$

V_{CEsat}	max.	1,5	- V
-------------	------	-----	-----

V_{BEsat}	max.	1,6	- V
-------------	------	-----	-----

$$I_C = 8\text{ A}; I_B = 1,6\text{ A}$$

V_{CEsat}	max.	-	1,5 V
-------------	------	---	-------

V_{BEsat}	max.	-	1,6 V
-------------	------	---	-------

$$I_C = 15\text{ A}; I_B = 3\text{ A}$$

V_{CEsat}	max.	5	- V
-------------	------	---	-----

$$I_C = 12\text{ A}; I_B = 2,4\text{ A}$$

V_{CEsat}	max.	-	5 V
-------------	------	---	-----

Collector-emitter sustaining voltage

$$I_C = 200\text{ mA}; I_{Boff} = 0; L = 25\text{ mH}$$

$V_{CEO\text{sust}}$	min.	400	450 V
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Emitter-base breakdown voltage

$$I_C = 0; I_B = 50\text{ mA};$$

$V(BR)EBO$		7 to 30	V
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* Measured with a half sinewave voltage (curve tracer).

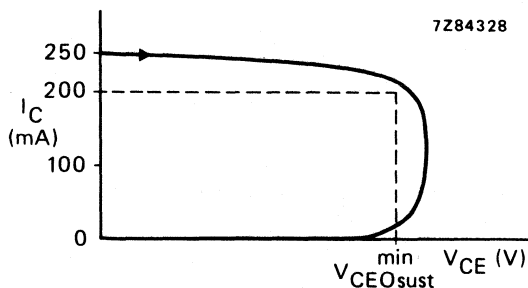


Fig. 2 Oscilloscope display for sustaining voltage.

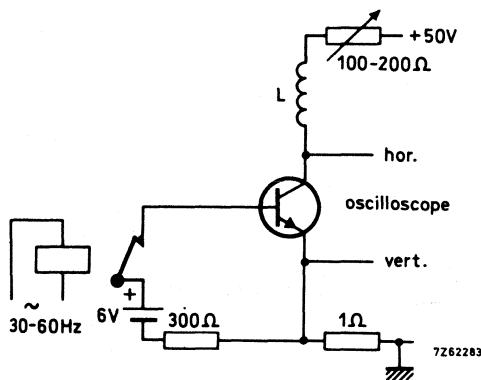


Fig. 3 Test circuit for $V_{CE(sust)}$.

Switching times resistive load (Fig. 4 and 5)

$I_{Con} = 10 \text{ A}; I_{Bon} = -I_{Boff} = 2 \text{ A}$

Turn-on time

Turn-off: Storage time
Fall time

$I_{Con} = 8 \text{ A}; I_{Bon} = -I_{Boff} = 1,6 \text{ A}$

Turn-on time

Turn-off: Storage time
Fall time

Switching times inductive load (Fig. 6 and 7)

$I_{Con} = 10 \text{ A}; I_{Bon} = 2 \text{ A}; T_{mb} = 25 \text{ }^\circ\text{C}$

Turn-off: Storage time
Fall time

$I_{Con} = 10 \text{ A}; I_{Bon} = 2 \text{ A}; T_{mb} = 100 \text{ }^\circ\text{C}$

Turn-off: Storage time
Fall time

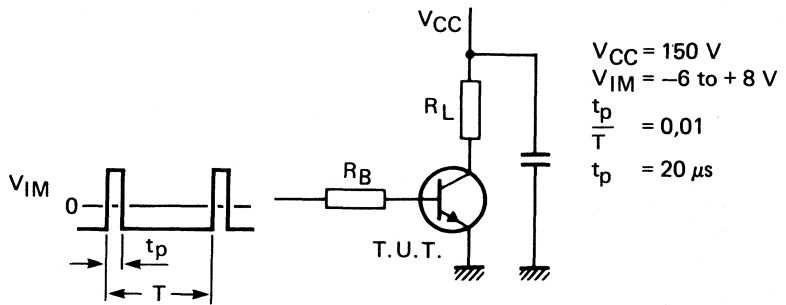
$I_{Con} = 8 \text{ A}; I_{Bon} = 1,6 \text{ A}; T_{mb} = 25 \text{ }^\circ\text{C}$

Turn-off: Storage time
Fall time

$I_{Con} = 8 \text{ A}; I_{Bon} = 1,6 \text{ A}; T_{mb} = 100 \text{ }^\circ\text{C}$

Turn-off: Storage time
Fall time

		BUX48	BUX48A	
t_{on}	max.	1	—	μs
t_s	max.	3	—	μs
t_f	max.	0,8	—	μs
t_{on}	max.	—	1	μs
t_s	max.	—	3	μs
t_f	max.	—	0,8	μs
t_s	typ.	3	—	μs
t_f	typ.	80	—	ns
t_s	max.	5	—	μs
t_f	max.	0,4	—	μs
t_s	typ.	—	3	μs
t_f	typ.	—	80	ns
t_s	max.	—	5	μs
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.

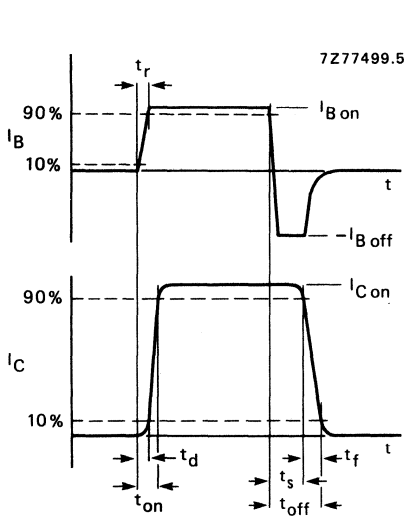


Fig. 5 Switching times waveforms with resistive load.

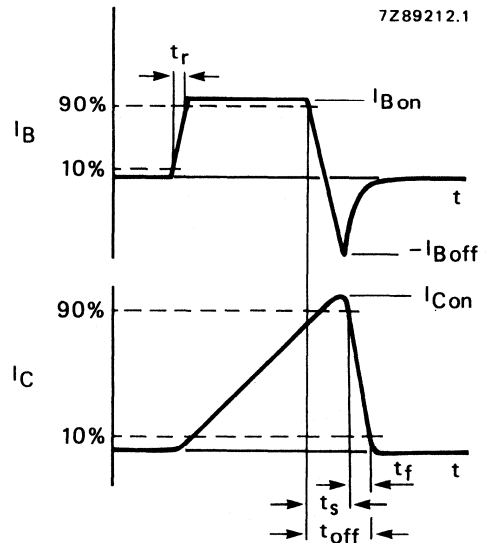


Fig. 6 Switching times waveforms with inductive load.

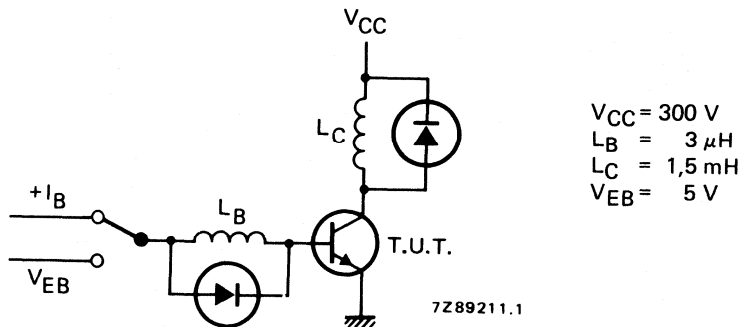
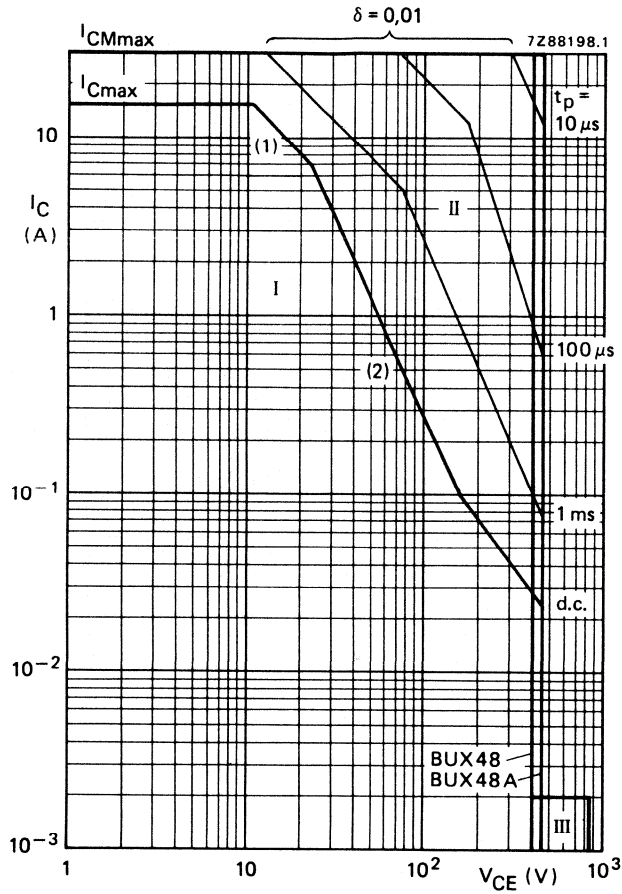


Fig. 7 Test circuit inductive load.



- (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 $V_{BE} \leq 0$ and $t_p \leq 5 \mu s$.

Fig. 8 Safe operating area at $T_{mb} \leq 25 \text{ }^\circ\text{C}$.

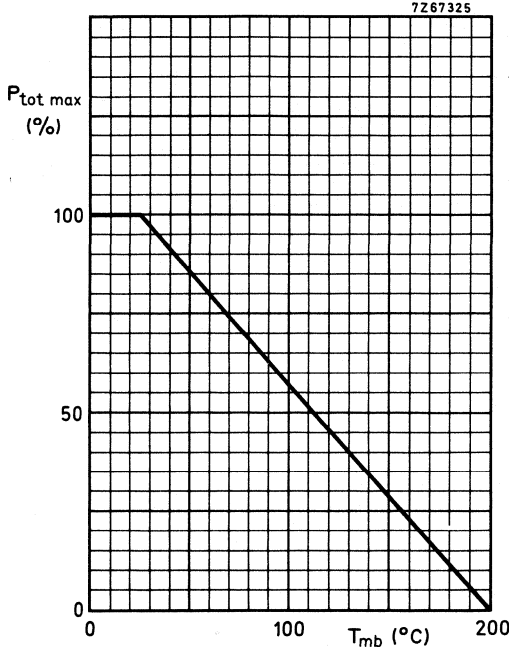


Fig. 9 Derating curve.

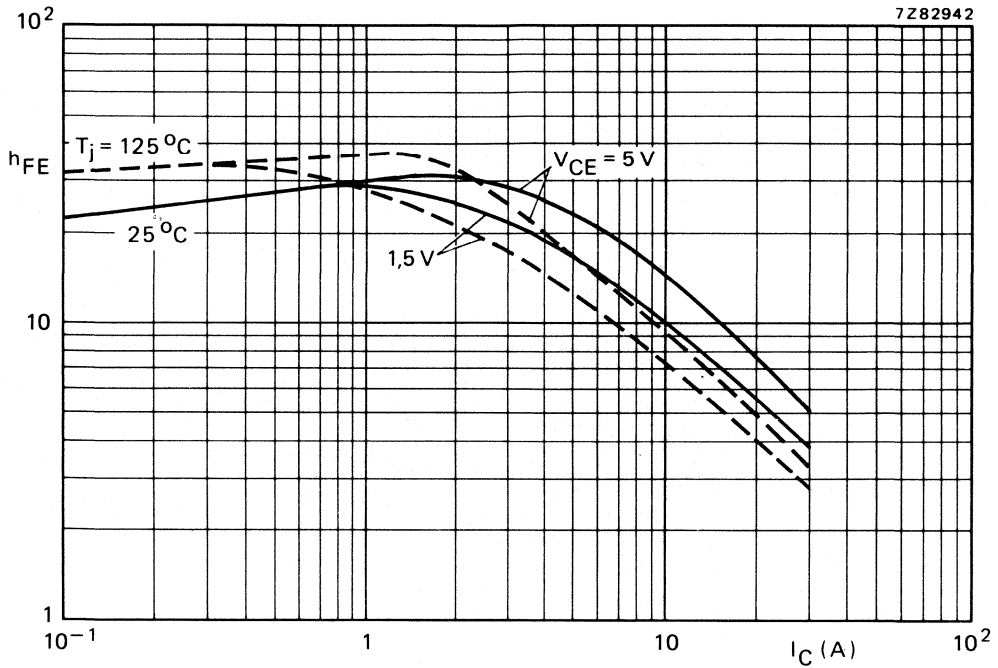


Fig. 10 Typical values DC current gain.

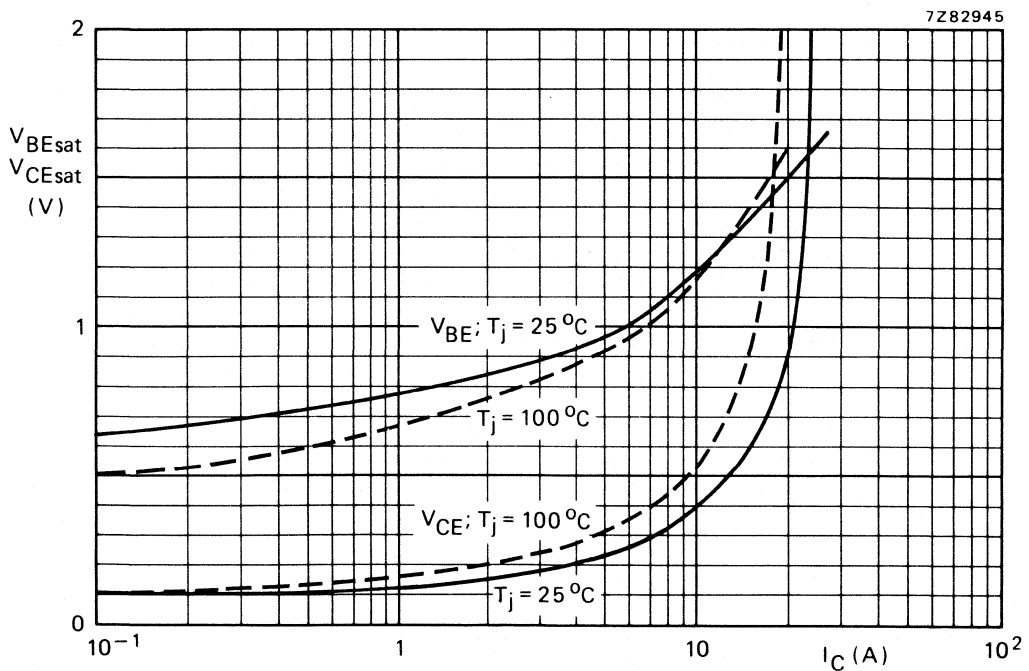


Fig. 11 Typical values base and collector voltage at $I_C/I_B = 5$.

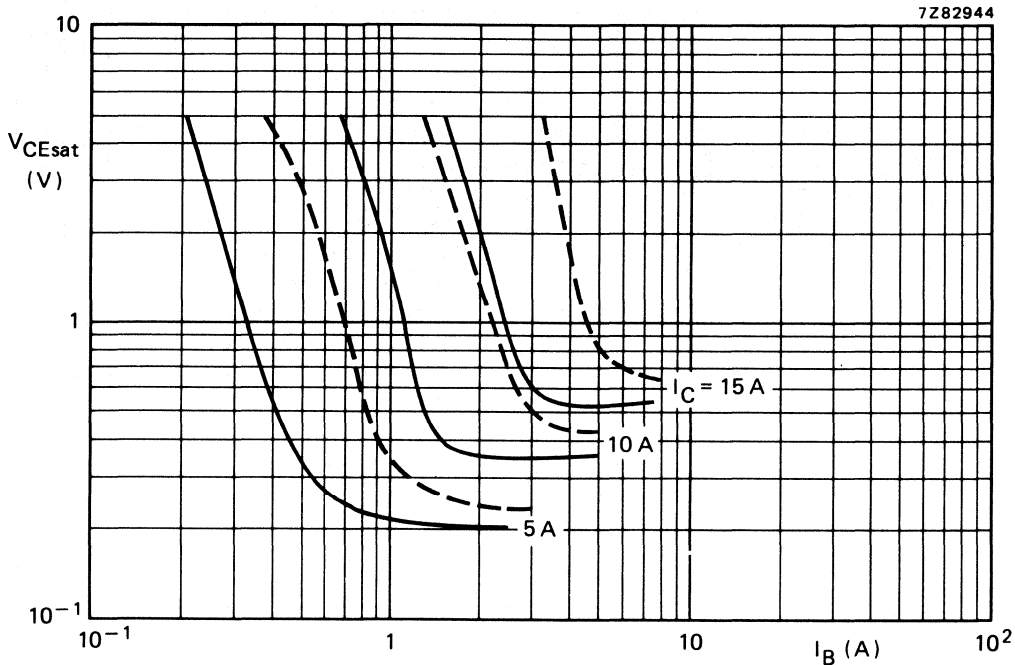


Fig. 12 Typical (—) and maximum (---) values saturation voltage. $T_j = 25^\circ C$.

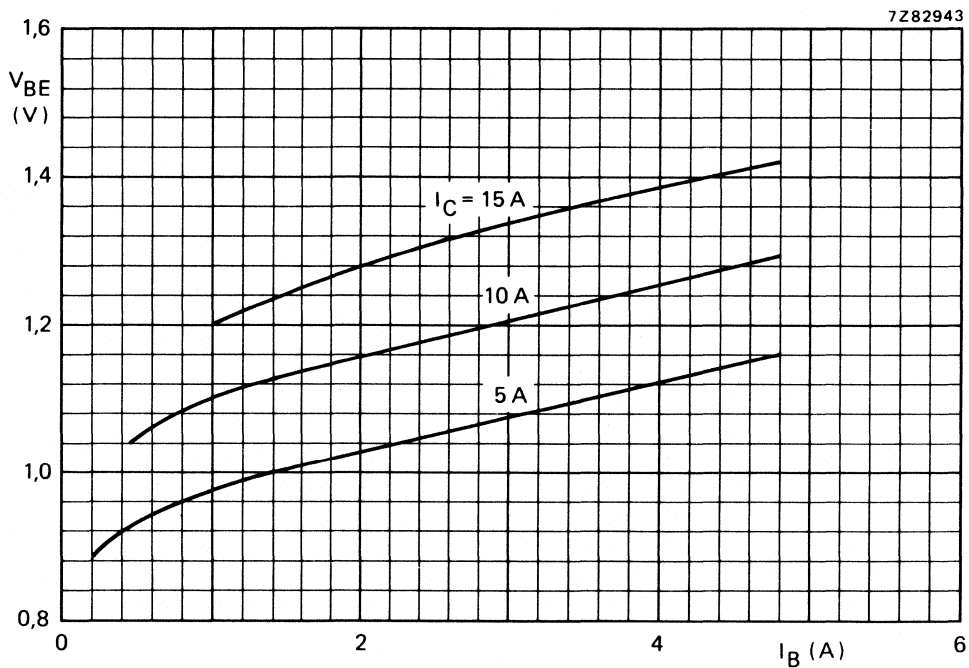


Fig. 13 Typical values base-emitter voltage at $T_j = 25^\circ C$.

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.

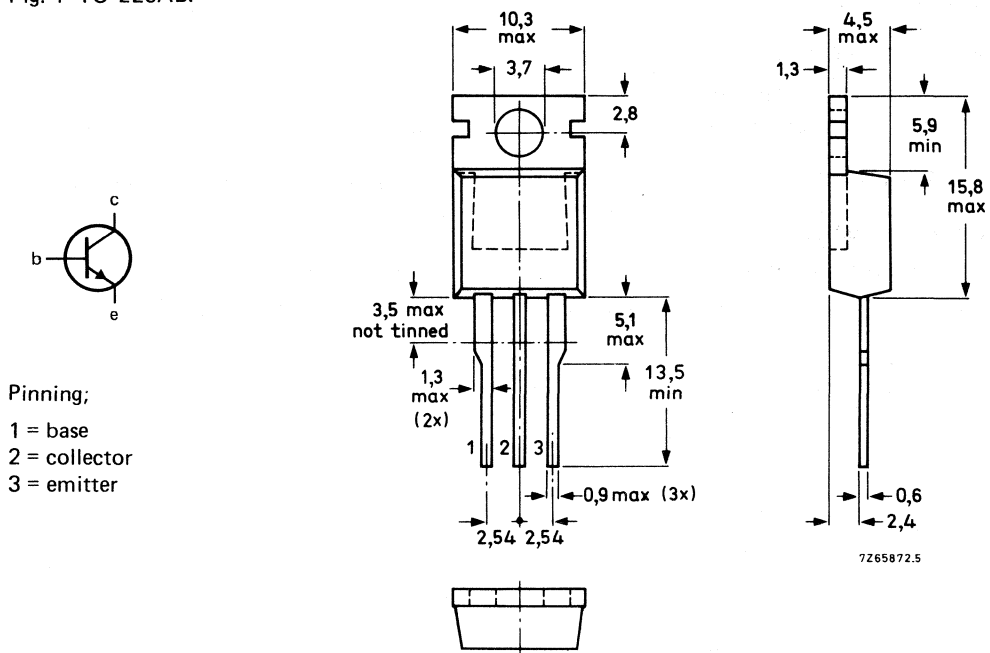
QUICK REFERENCE DATA

		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 $T_{mb} = 50^\circ C$	P_{tot} max.	40	W
Fall time	t_f max.	0,4	μs

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-220AB.



Collector connected to tab

BUX84 BUX85

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC134)

		BUX84	BUX85	
Collector-emitter voltage (peak value; $V_{BE} = 0$)	V_{CESM}	max 800	1000	V
Collector-emitter voltage (open base)	V_{CEO}	max 400	450	V

Collector current (DC)	I_C	max	2	A
Collector current (peak value) $t_p = 2$ ms	I_{CM}	max	3	A
Base current (DC)	I_B	max	0,75	A
Base current (peak value)	I_{BM}	max	1	A
Reverse base current (peak value) *	$-I_{BM}$	max	1	A

Total power dissipation up to $T_{mb} = 50$ °C	P_{tot}	max	40	W
--	-----------	-----	----	---

Storage temperature range	T_{stg}	-65 to +150		°C
Junction temperature	T_j	max	150	°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j-mb}$	=	2,5	K/W
From junction to ambient in free air	$R_{th\ j-a}$	=	70	K/W

CHARACTERISTICS

$T_j = 25$ °C unless otherwise specified

Collector cut-off current **

$V_{CEM} = V_{CESMmax}; V_{BE} = 0$	I_{CES}	max.	200	μA
$V_{CEM} = V_{CESMmax}; V_{BE} = 0; T_j = 125$ °C	I_{CES}	max.	1,5	mA

DC current gain

$I_C = 0,1$ A; $V_{CE} = 5$ V	h_{FE}	typ	50	
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* Turn-off current.

** Measured with a half-sinewave voltage (curve tracer).

Emitter cut-off current

$I_C = 0; V_{EB} = 5 \text{ V}$

I_{EBO}	max.	1	mA
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Saturation voltages

$I_C = 0,3 \text{ A}; I_B = 30 \text{ mA}$

V_{CEsat}	max.	0,8	V
-------------	------	-----	---

$I_C = 1 \text{ A}; I_B = 0,2 \text{ A}$

V_{CEsat}	max.	1,0	V
-------------	------	-----	---

$I_C = 1 \text{ A}; I_B = 0,2 \text{ A}$

V_{BEsat}	max.	1,1	V
-------------	------	-----	---

Collector-emitter sustaining voltage

$I_C = 100 \text{ mA}; I_{Boff} = 0; L = 25 \text{ mH}$

	BUX84	BUX85	
$V_{CEOsust}$	min. 400	450	V

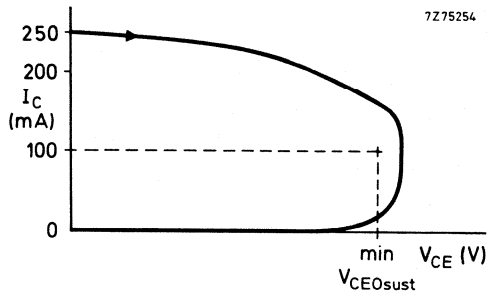


Fig. 2 Oscilloscope display for sustaining voltage.

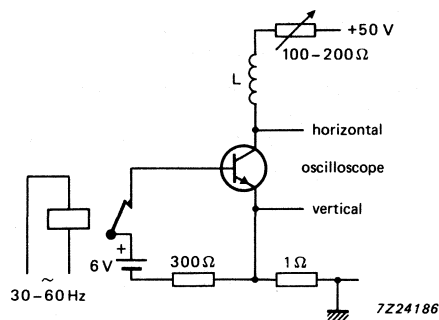


Fig. 3 Test circuit for $V_{CEOsust}$.

CHARACTERISTICS (continued)

$T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified

Transition frequency at $f = 1\text{ MHz}$

$I_C = 0,2\text{ A}$; $V_{CE} = 10\text{ V}$

f_T typ 20 MHz

Switching times

$I_{Con} = 1\text{ A}$; $V_{CC} = 250\text{ V}$

$I_{Bon} = 0,2\text{ A}$; $-I_{Boff} = 0,4\text{ A}$

Turn-on time

t_{on} typ 0,2 μs
max. 0,5 μs

Turn-off: Storage time

t_s typ 2 μs
max. 3,5 μs

Fall time

t_f typ 0,4 μs

Fall time, $T_{mb} = 95\text{ }^\circ\text{C}$

t_f max. 1,4 μs

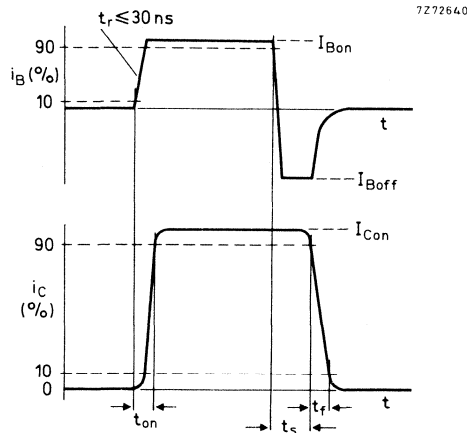


Fig. 4 Switching times waveforms with resistive load.

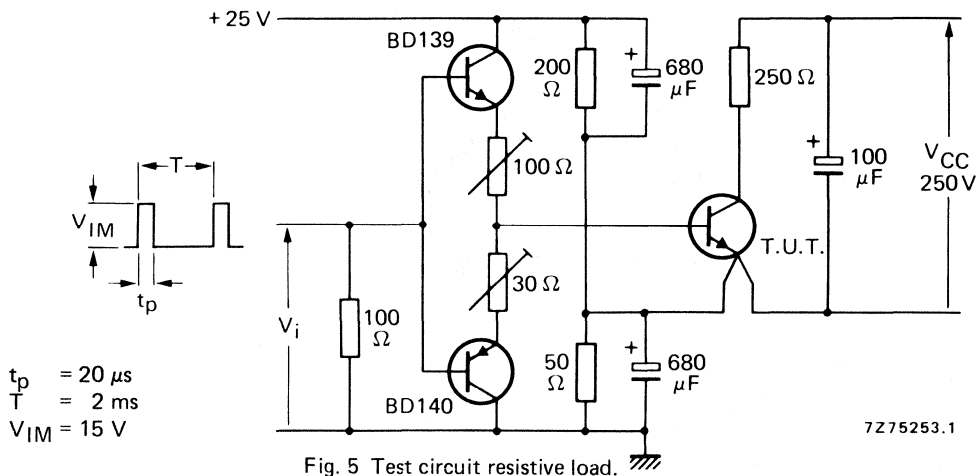
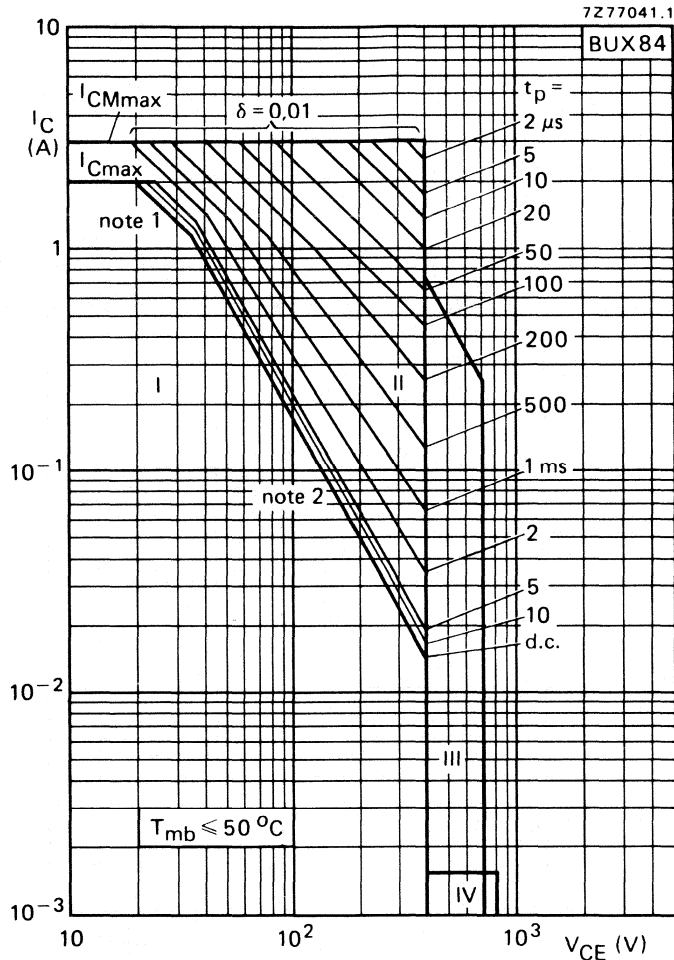


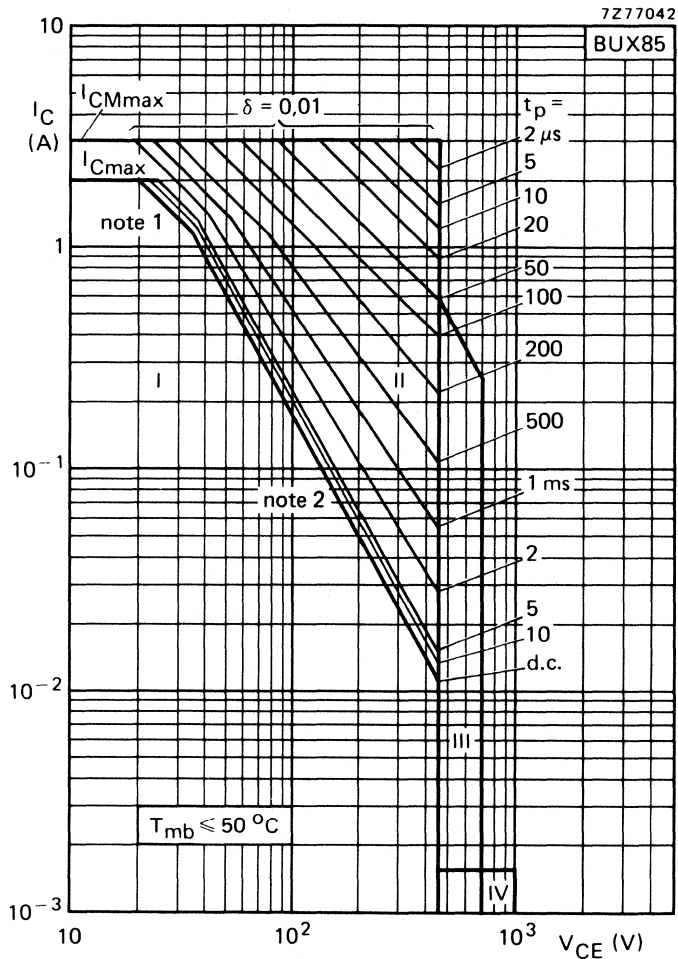
Fig. 5 Test circuit resistive load.



1. P_{tot} max and P_{peak} max lines.
2. Second-breakdown limits.

- I Region of permissible DC operation
- II Permissible extension for repetitive pulse operation
- III Area of permissible operation during turn-on in single transistor converters, provided $R_{BE} \leq 100 \Omega$ and $t_p \leq 0,6 \mu s$
- IV Repetitive pulse operation in this region is permissible, provided $V_{BE} \leq 0$ and $t_p \leq 2 ms$

Fig. 6 Safe operating area.



1. $P_{tot\ max}$ and $P_{peak\ max}$ lines.
 2. Second-breakdown limits.
- I Region of permissible DC operation
- II Permissible extension for repetitive pulse operation
- III Area of permissible operation during turn-on in single transistor converters, provided $R_{BE} \leq 100\ \Omega$ and $t_p \leq 0,6\ \mu s$
- IV Repetitive pulse operation in this region is permissible, provided $V_{BE} \leq 0$ and $t_p \leq 2\ ms$

Fig. 7 Safe operating area.

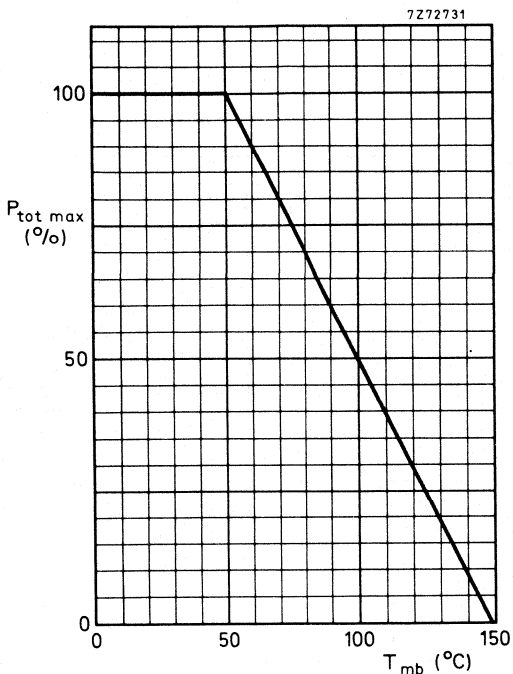


Fig. 8 Power derating curve.

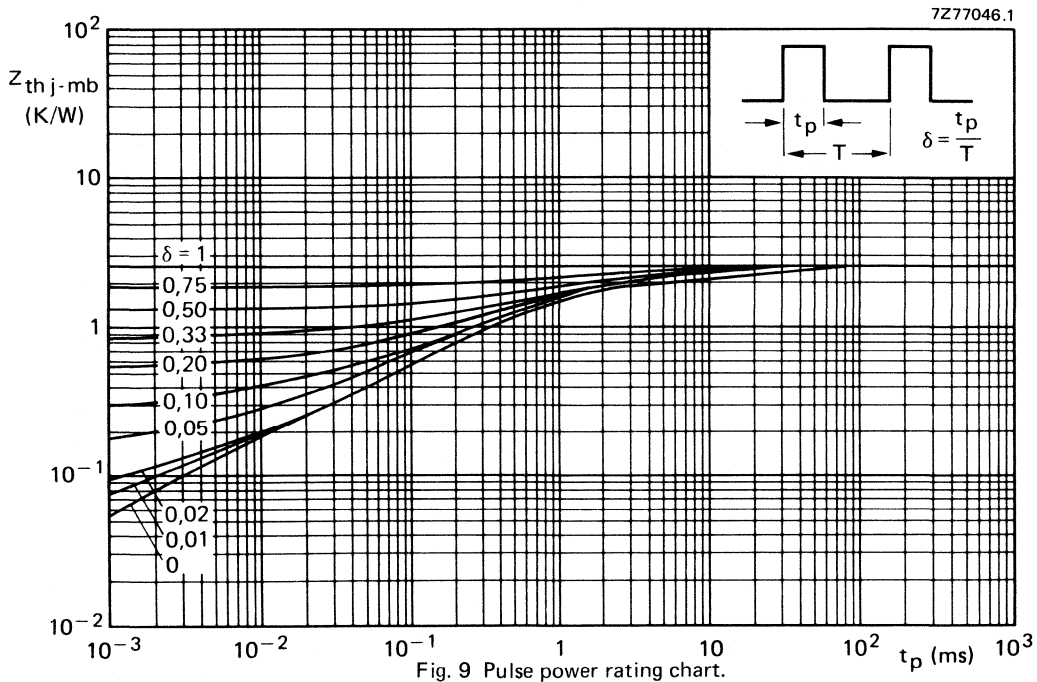


Fig. 9 Pulse power rating chart.

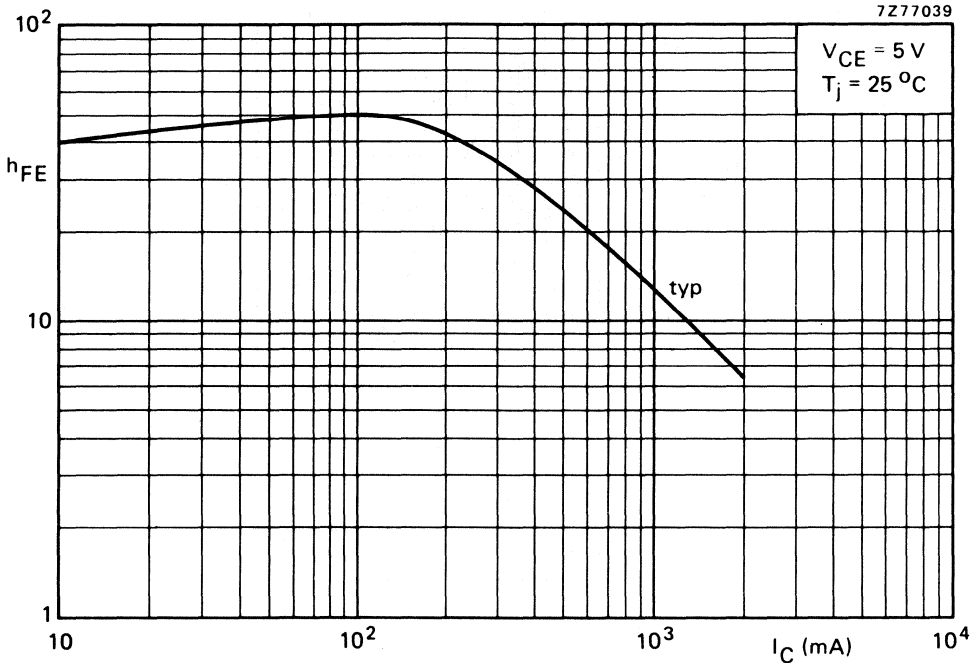


Fig. 10 Typical DC current gain.

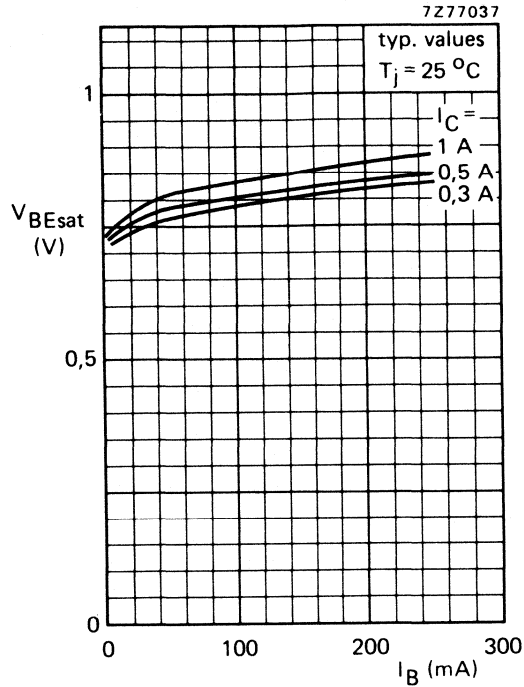


Fig. 11 Typical values saturation voltage, $T_j = 25\text{ }^\circ\text{C}$.

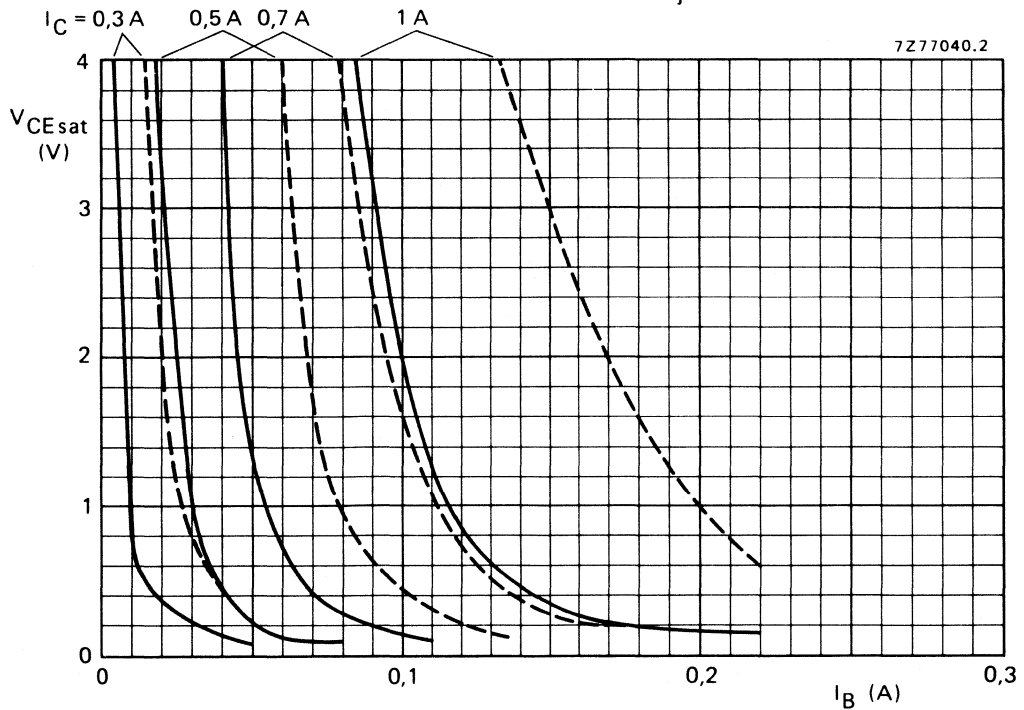


Fig. 12 Typical (—) and maximum (----) values saturation voltage at $T_j = 25\text{ }^\circ\text{C}$.

SILICON DIFFUSED POWER TRANSISTORS

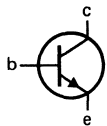
High-voltage, high-speed, glass-passivated npn power transistor in a SOT186 envelope with an electrically isolated mounting base. The device is intended for use in converters, inverters, switching regulators, motor control systems, etc.

QUICK REFERENCE DATA

			BUX84F	BUX85F
Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM}	max.	800	1000 V
	V_{CEO}	max.	400	450 V
Collector-emitter saturation voltage	V_{CEsat}	max.	1,0	V
Collector saturation current	I_{Csat}	max.	1	A
Collector current DC peak value	I_C	max.	2	A
	I_{CM}	max.	3	A
Total power dissipation up to $T_h = 25^\circ\text{C}$	P_{tot}	max.	18	W
Fall time	t_f	typ.	0,4	μs

MECHANICAL DATA

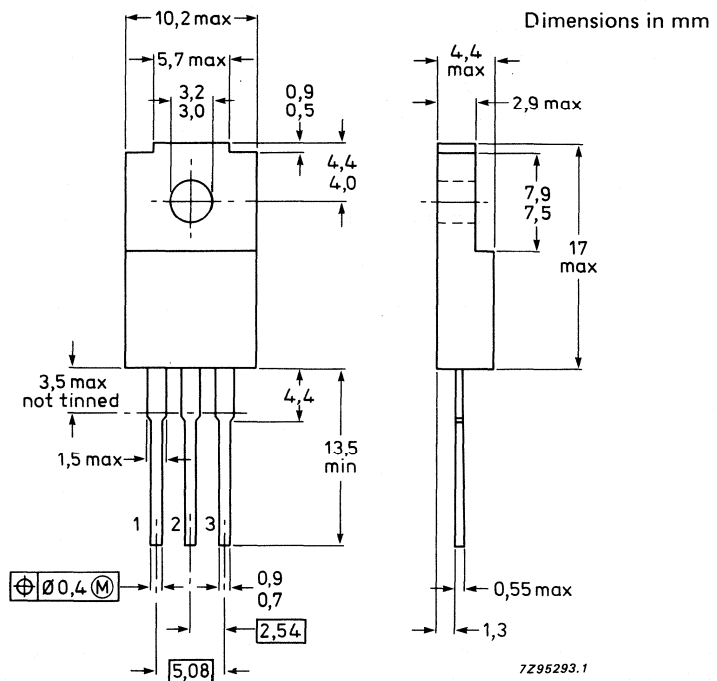
Fig. 1 SOT186.



Pinning

- 1 = base
- 2 = collector
- 3 = emitter

Mounting base is electrically isolated from all terminals.



RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

		BUX84F	BUX85F
Collector-emitter voltage open base	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 $T_h = 25\text{ }^\circ\text{C}$ (note 1)	P_{tot}	max. 18	W
Storage temperature range	T_{stg}	-65 to +150 $^\circ\text{C}$	
Junction temperature	T_j	max. 150	$^\circ\text{C}$

THERMAL RESISTANCE

From junction to external heatsink (note 1)	$R_{th\ j-h}$	=	7,2	K/W
From junction to external heatsink (note 2)	$R_{th\ j-h}$	=	4,7	K/W
From junction to ambient	$R_{th\ j-a}$	=	55	K/W

ISOLATION

Voltage allowed between all terminals and external heatsink, peak value	V_{isol}	max.	1500	V
Isolation capacitance between collector and external heatsink	C_{isol}	typ.	12	pF

CHARACTERISTICS

$T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified

Collector cut-off currents

$$V_{CE} = V_{CESmax}; V_{BE} = 0$$

$$V_{CE} = V_{CESmax}; V_{BE} = 0; T_j = 125\text{ }^\circ\text{C}$$

I_{CES}	max.	0,2	mA
	max.	1,5	mA

Emitter cut-off current

$$V_{EB} = 5\text{ V}; I_C = 0$$

I_{EBO}	max.	1	mA
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DC current gain

$$I_C = 0,1\text{ A}; V_{CE} = 5\text{ V}$$

h_{FE}	typ.	50	
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Transition frequency at $f = 1\text{ MHz}$

$$I_C = 0,2\text{ A}; V_{CE} = 10\text{ V}$$

f_T	typ.	20	MHz
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Notes

1. Mounted without heatsink compound and 30 ± 5 newtons pressure on centre of envelope.
2. Mounted with heatsink compound and 30 ± 5 newtons pressure on centre of envelope.

SILICON DIFFUSED POWER TRANSISTORS

High-voltage, high-speed, glass-passivated npn power transistors in TO-126 envelopes, for use in converters, inverters, switching regulators, motor control systems and switching applications.

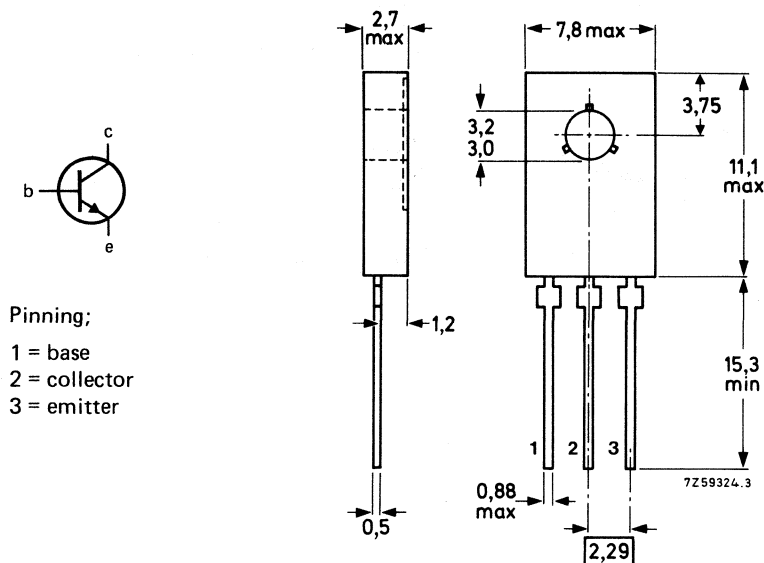
QUICK REFERENCE DATA

		BUX86	BUX87
Collector-emitter voltage (peak value; $V_B = 0$)	V_{CESM}	max. 800	1000 V
Collector-emitter voltage (open base)	V_{CEO}	max. 400	450 V
Collector-emitter saturation voltage	V_{CEsat}	max. 1	V
Collector current (DC)	I_C	max. 0,5	A
Collector current (peak value)	I_{CM}	max. 1	A
Total power dissipation up to $T_{mb} = 60\text{ }^\circ\text{C}$	P_{tot}	max. 20	W
Fall time	t_f	typ. 0,4	μs

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-126.



Pinning;

- 1 = base
- 2 = collector
- 3 = emitter

Collector connected to metal part of mounting surface.

BUX86
BUX87

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	$R_{thj-mb} =$	4,5		K/W
From junction to ambient in free air	$R_{thj-a} =$	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

$I_C = 0; V_{EB} = 5 \text{ V}$

I_{EBO}	max.	1	mA
-----------	------	---	----

Saturation voltage

$I_C = 0,1 \text{ A}; I_B = 10 \text{ mA}$

V_{CEsat}	max.	0,8	V
-------------	------	-----	---

$I_C = 0,2 \text{ A}; I_B = 20 \text{ mA}$

V_{CEsat}	max.	1,0	V
-------------	------	-----	---

$I_C = 0,2 \text{ A}; I_B = 20 \text{ mA}$

V_{BEsat}	max.	1,0	V
-------------	------	-----	---

Collector-emitter sustaining voltages

$I_C = 100 \text{ mA}; I_{Boff} = 0; L = 25 \text{ mH}$

$V_{CEOsust}$	min.	BUX86	BUX87	V
		400	450	

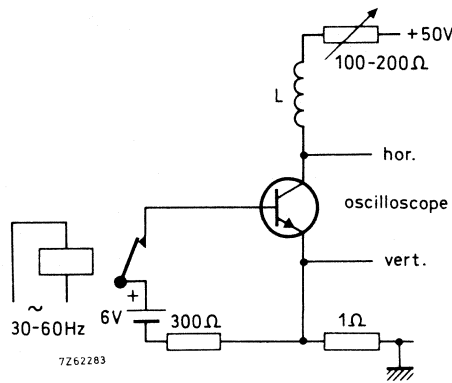


Fig. 2 Test circuit for $V_{CEOsust}$.

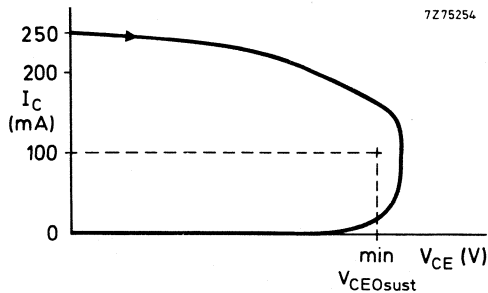


Fig. 3 Oscilloscope display for sustaining voltage.

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 μ s
max. 0,5 μ s

Turn-off: Storage time

t_s typ 2 μ s
max. 3,5 μ s

Fall time

t_f typ 0,4 μ s

Fall time, $T_{mb} = 95$ °C

t_f max. 1,3 μ s

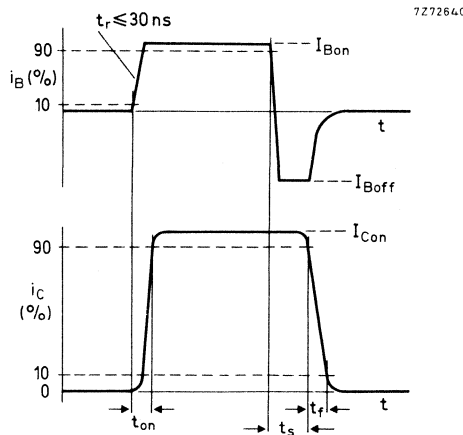
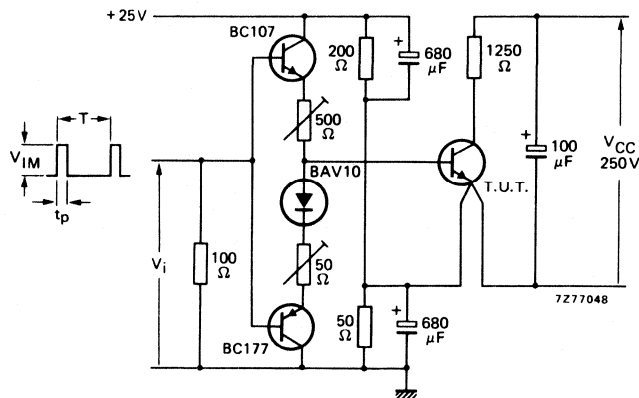
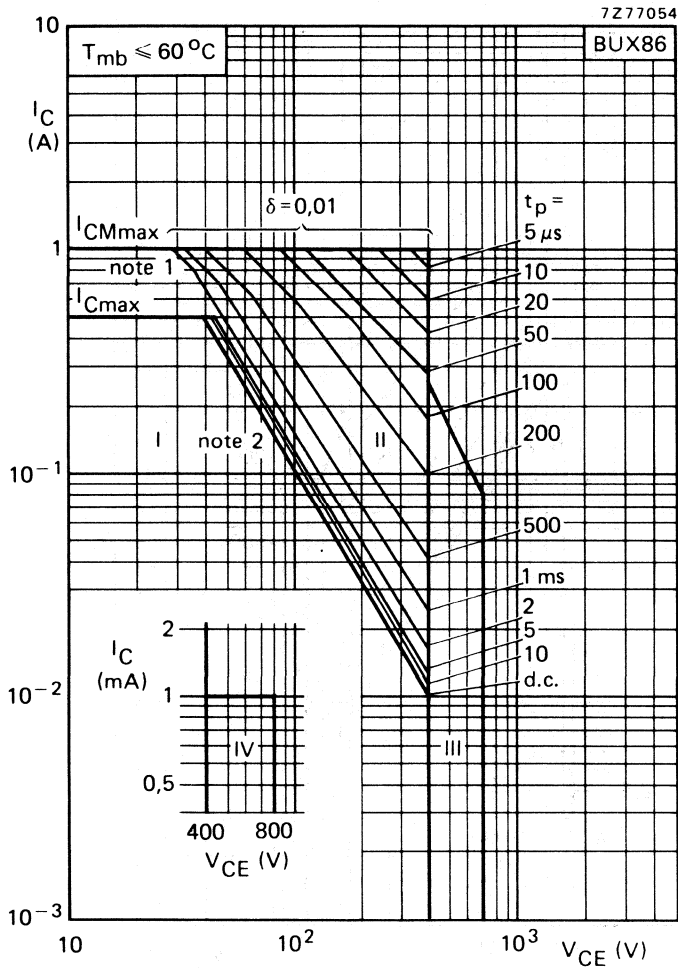


Fig. 4 Switching times waveforms with resistive load.



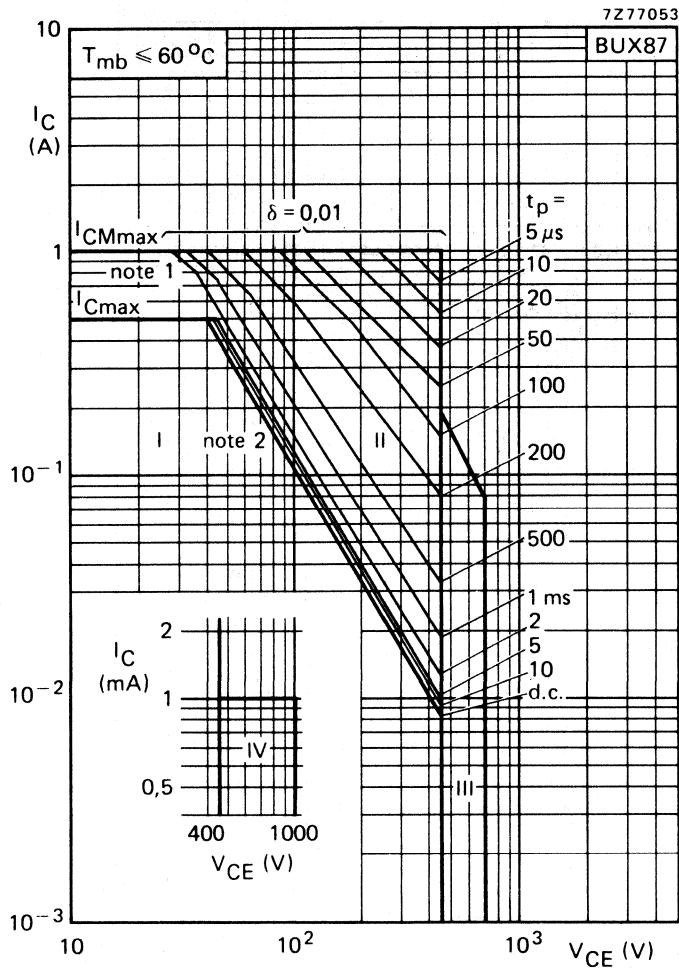
$t_p = 20$ μ s
 $T = 2$ ms
 $V_{IM} = 15$ V

Fig. 5 Test circuit resistive load.



1. P_{peak} max lines.
 2. Second-breakdown limits.
- I Region of permissible DC operation
- II Permissible extension for repetitive pulse operation
- III Area of permissible operation during turn-on in single-transistor converters, provided $R_{BE} \leq 100 \Omega$ and $t_p \leq 0,6 \mu s$
- IV Repetitive pulse operation in this region is permissible, provided $V_{BE} \leq 0$ and $t_p \leq 2 ms$

Fig. 6 Safe operating area.



1. P_{peak} max lines.
 2. Second-breakdown limits.
- I Region of permissible DC operation
- II Permissible extension for repetitive pulse operation
- III Area of permissible operation during turn-on in single-transistor converters, provided $R_{BE} \leq 100 \Omega$ and $t_p \leq 0,6 \mu s$
- IV Repetitive pulse operation in this region is permissible provided $V_{BE} \leq 0$ and $t_p \leq 2 ms$

Fig. 7 Safe operating area.

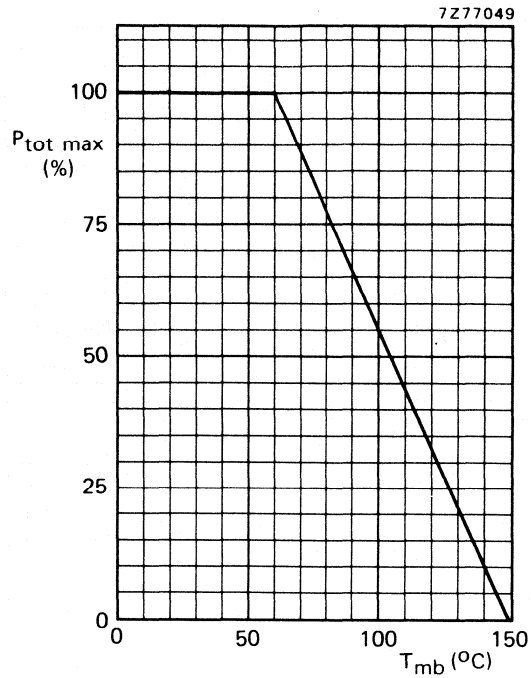


Fig. 8 Power derating curve.

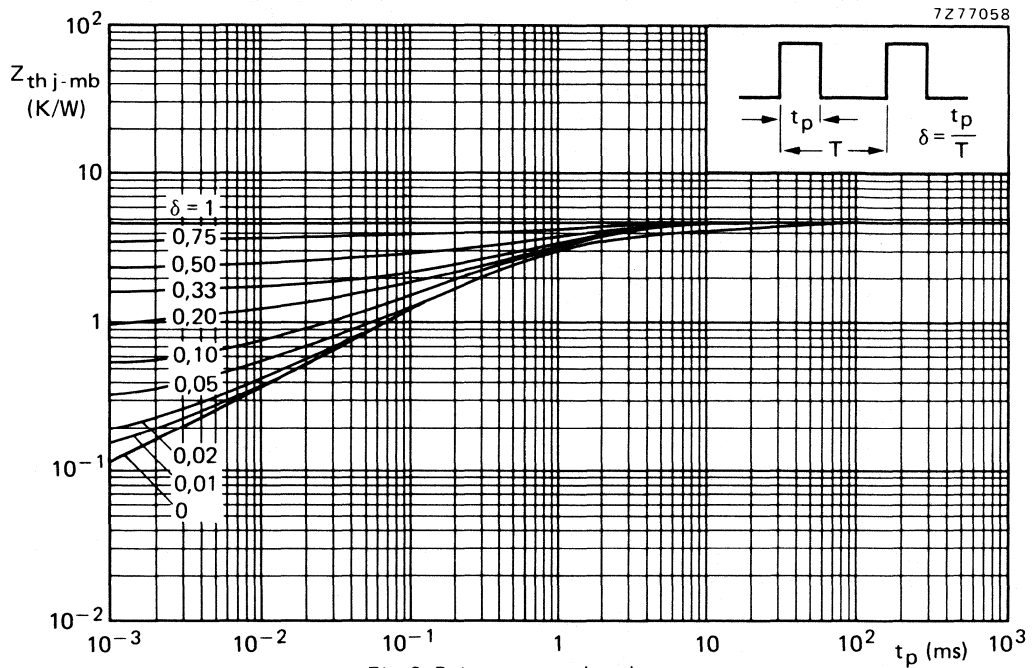


Fig. 9 Pulse power rating chart.

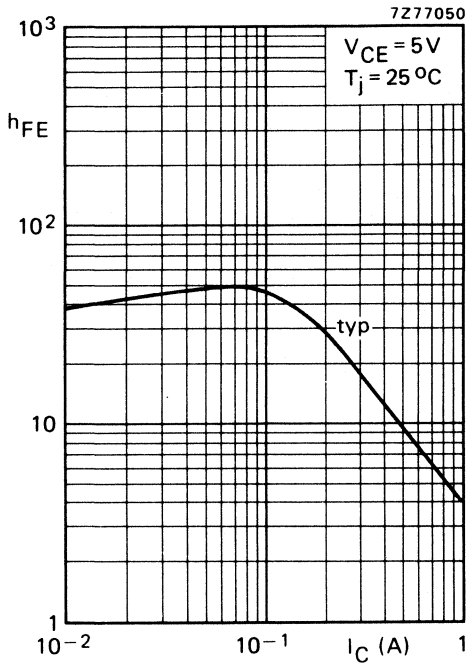


Fig. 10 Typical DC current gain.

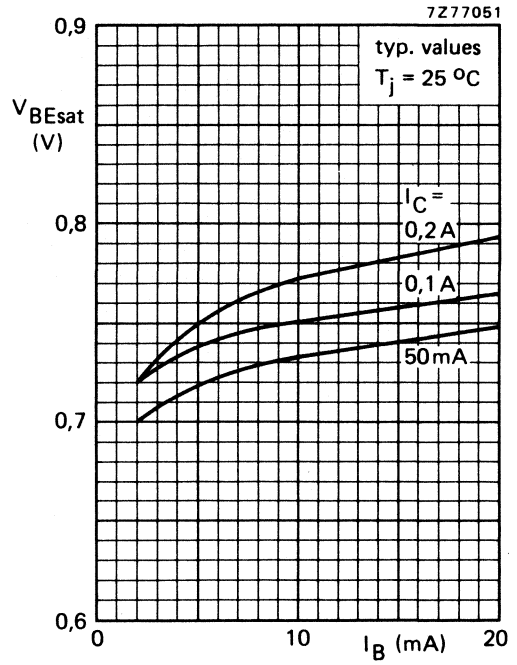


Fig. 11 Typical base-emitter voltage.

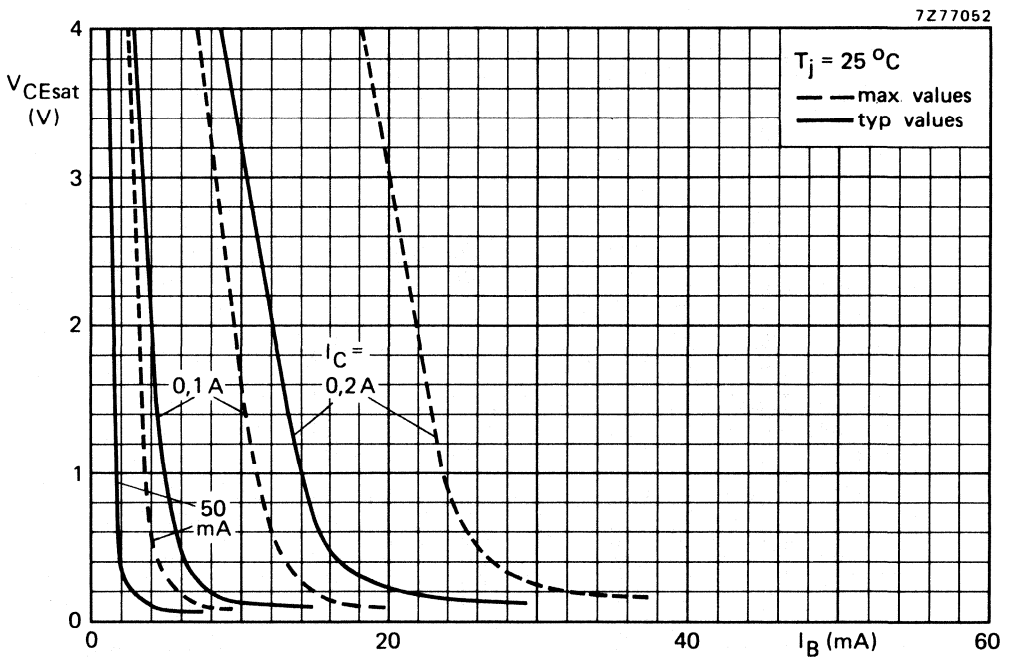


Fig. 12 Typical collector-emitter saturation voltage.

SILICON 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.

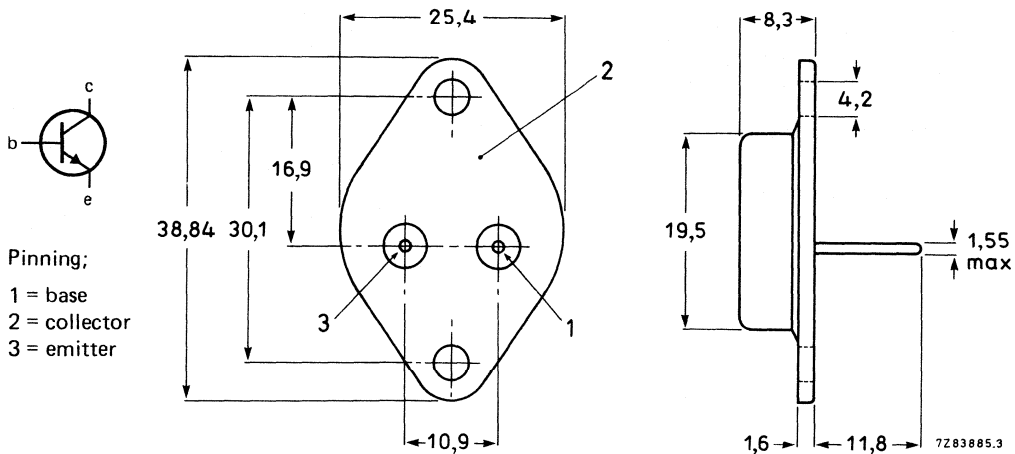
QUICK REFERENCE DATA

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 $T_{mb} = 25\text{ }^\circ\text{C}$	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.



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 $T_{mb} = 25$ °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	$R_{th\ j-mb}$	=	0,78 K/W
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CHARACTERISTICS

$T_j = 25$ °C unless otherwise specified

Collector cut-off current*

$$V_{CE} = V_{CESMmax}; V_{BE} = 0$$

I_{CES}	max.	1 mA
-----------	------	------

$$V_{CE} = V_{CESMmax}; V_{BE} = 0; T_j = 125$$
 °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
-------------	------	-------

$$I_C = 12$$
 V; $I_B = 6$ A

V_{CEsat}	max.	3 V
-------------	------	-----

Collector-emitter sustaining voltage

$$I_C = 200$$
 mA; $I_B = 0$; $L = 25$ mH

$V_{CEO\text{sust}}$	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)

$I_{Con} = 9\text{ A}$; $I_{Bon} = -I_{Boff} = 4\text{ A}$

Turn-on time

Turn-off: Storage time

Fall time

t_{on}	typ.	1,5	μs
t_s	typ.	4,5	μs
t_f	typ.	0,5	μs

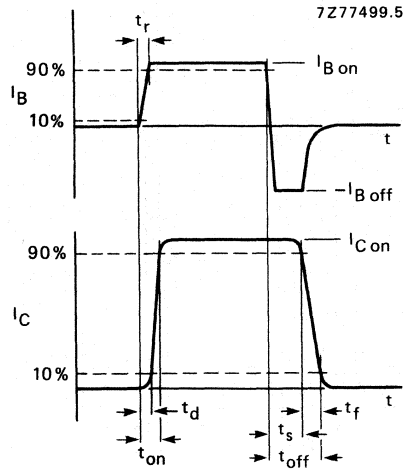


Fig. 2 Switching times waveforms with resistive load.

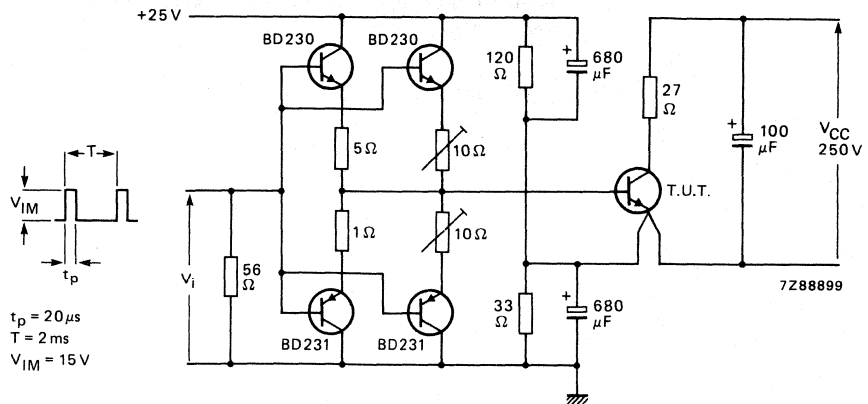
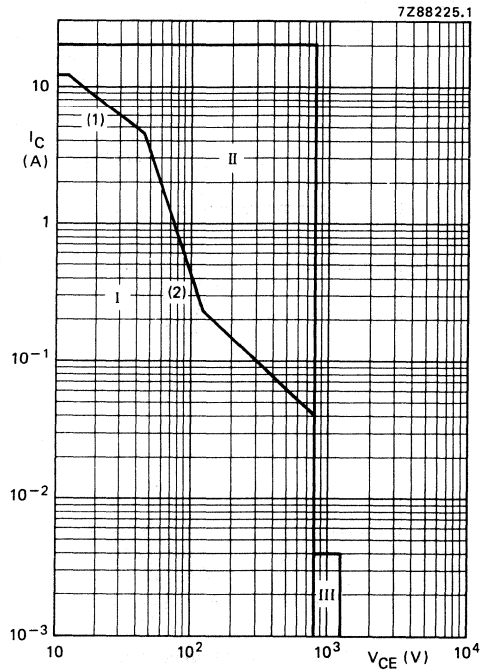


Fig. 3 Test circuit resistive load.



- (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 $V_{BE} \leq 0$ and $t_p \leq 5$ ms.

Fig. 4 Safe operating area at $T_{mb} \leq 25$ °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.

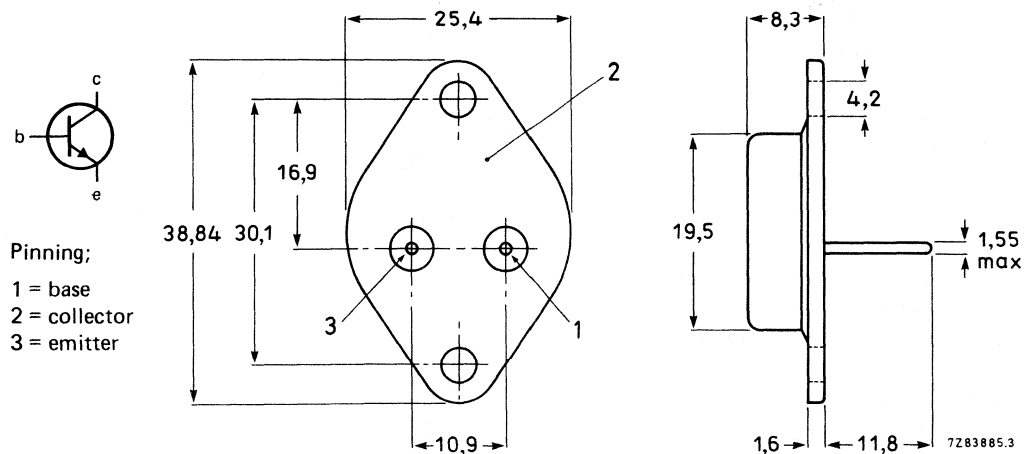
QUICK REFERENCE DATA

		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 $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot} max.	250	W
Fall time (resistive load)	t_f max.	0,8	μs

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-3.



Collector connected to case.

BUX98 BUX98A

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 $T_{mb} = 25$ °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	$R_{th\ j-mb}$	=	0,7		K/W
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CHARACTERISTICS

$T_j = 25$ °C unless otherwise specified

Collector cut-off current*

$$V_{CE} = V_{CESMmax}; R_{BE} \leq 5 \Omega$$

I_{CER}	max.	1	mA
-----------	------	---	----

$$V_{CE} = V_{CESMmax}; R_{BE} \leq 5 \Omega; T_j = 125$$
 °C

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; $T_j = 125$ °C

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

$V_{CEO\ sust}$	min.	400	450 V
-----------------	------	-----	-------

Transition frequency at $f = 1$ MHz

$$I_C = 1$$
 A; $V_{CE} = 10$ V

f_T	typ.	5	MHz
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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).

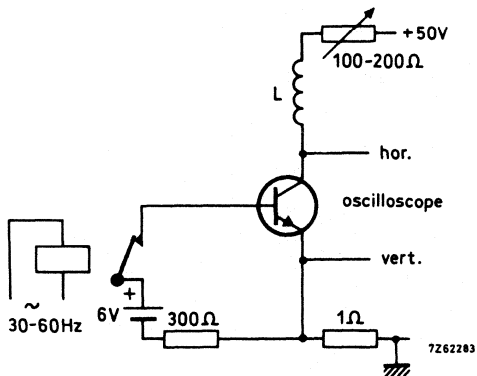


Fig. 2 Test circuit for $V_{CEOsust}$.

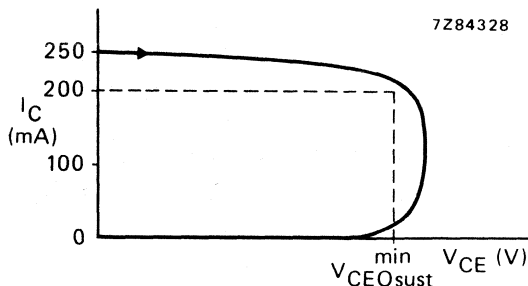


Fig. 3 Oscilloscope display for sustaining voltage.

Switching times resistive load

$I_{Con} = 20\text{ A}; I_{Bon} = -I_{Boff} = 4\text{ A}$
Turn-on time

Turn-off: Storage time

Fall time

$I_{Con} = 16\text{ A}; I_{Bon} = -I_{Boff} = 3,2\text{ A}$
Turn-on time

Turn-off: Storage time

Fall time

Switching times inductive load

$I_{Con} = 20\text{ A}; I_B = 4\text{ A}$

Turn-off: Storage time

Fall time

$I_{Con} = 20\text{ A}; I_B = 4\text{ A}; T_j = 100\text{ }^\circ\text{C}$

Storage time

Fall time

$I_{Con} = 16\text{ A}; I_B = 3,2\text{ A}$

Turn-off: Storage time

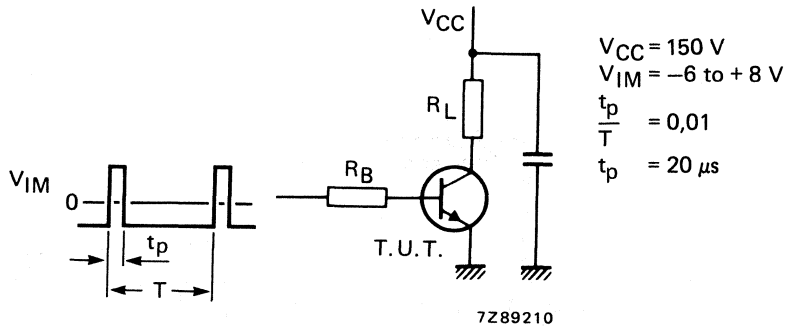
Fall time

$I_{Con} = 16\text{ A}; I_B = 3,2\text{ A}; T_j = 100\text{ }^\circ\text{C}$

Turn-off: Storage time

Fall time

		BUX98	BUX98A
t_{on}	typ.	0,55	— μs
	max.	1	— μs
t_s	typ.	1,5	— μs
	max.	3	— μs
t_f	typ.	0,3	— μs
	max.	0,8	— μs
t_{on}	typ.	—	0,55 μs
	max.	—	1 μs
t_s	typ.	—	1,5 μs
	max.	—	3 μs
t_f	typ.	—	0,3 μs
	max.	—	0,8 μs
t_s	typ.	3,5	— μs
	typ.	80	— ns
t_s	max.	5	— μs
	max.	400	— ns
t_s	typ.	—	3,5 μs
	typ.	—	80 ns
t_s	max.	—	5 μs
	max.	—	400 ns



The values of R_B and R_L are selected in accordance with $I_{C \text{ on}}$ and I_B requirements.

Fig. 4 Test circuit resistive load.

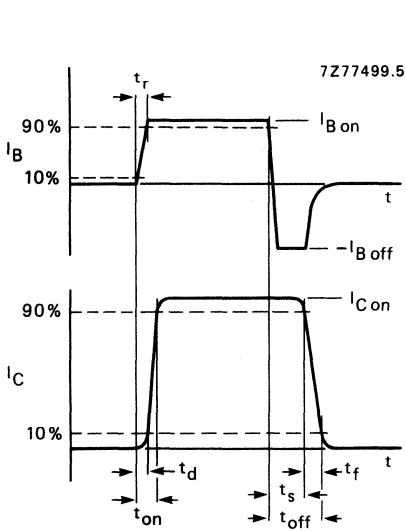


Fig. 5 Switching times waveforms with resistive load.

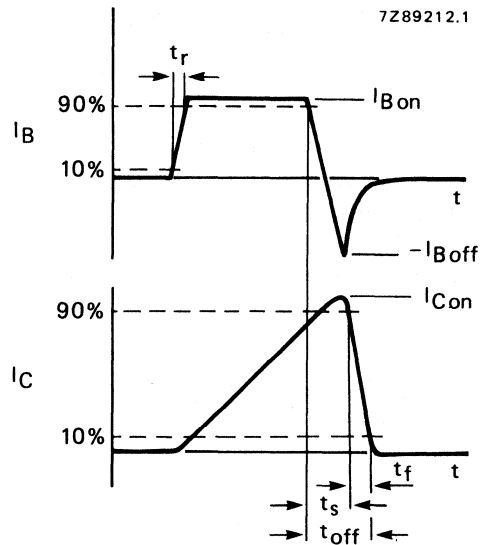


Fig. 6 Switching times waveforms with inductive load.

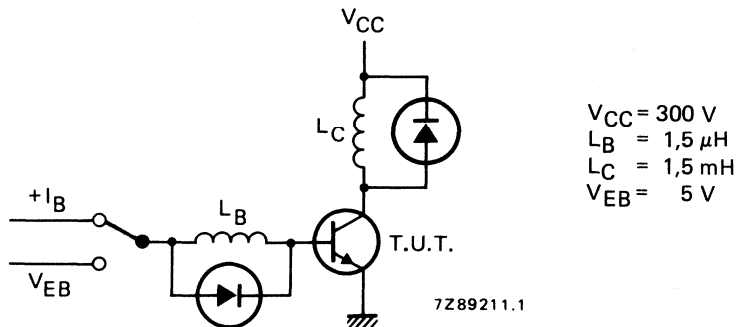
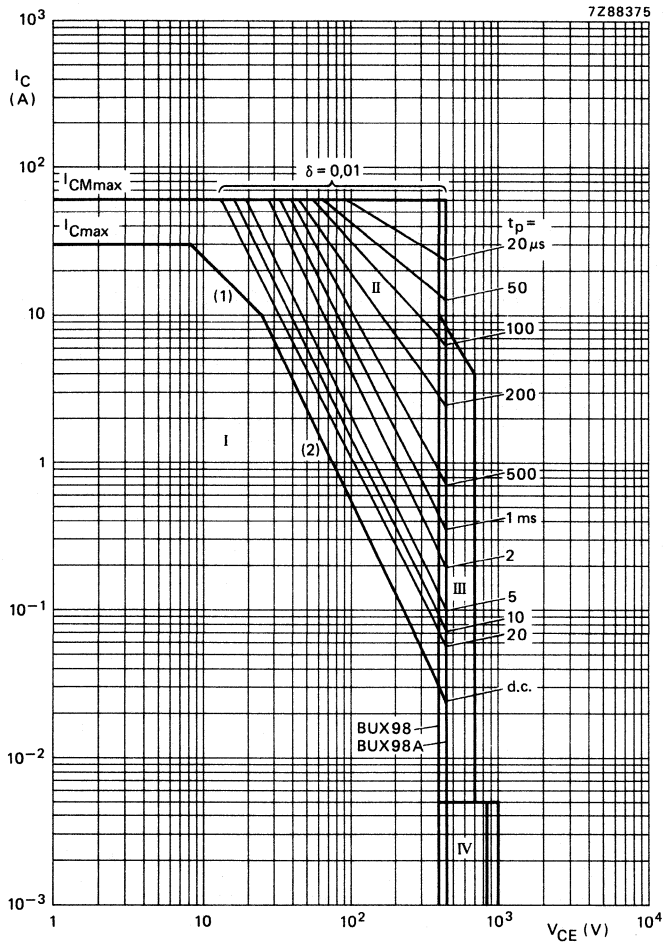


Fig. 7 Test circuit inductive load.



- (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 $T_{mb} \leq 25^\circ C$.

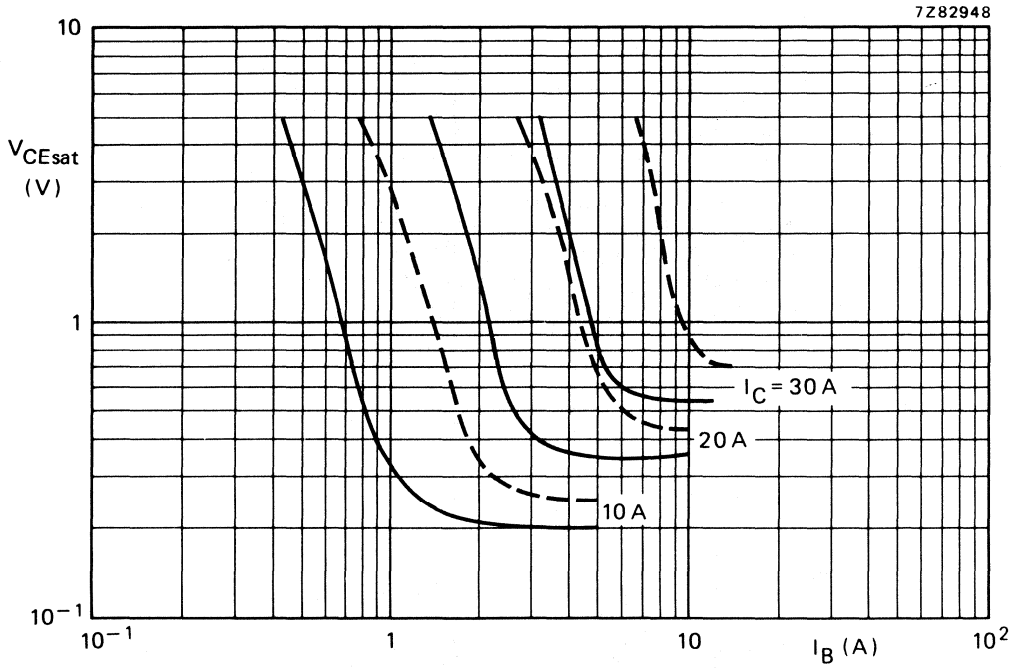


Fig. 9 Typical (—) and maximum (---) values saturation voltage. $T_j = 25\text{ }^\circ\text{C}$.

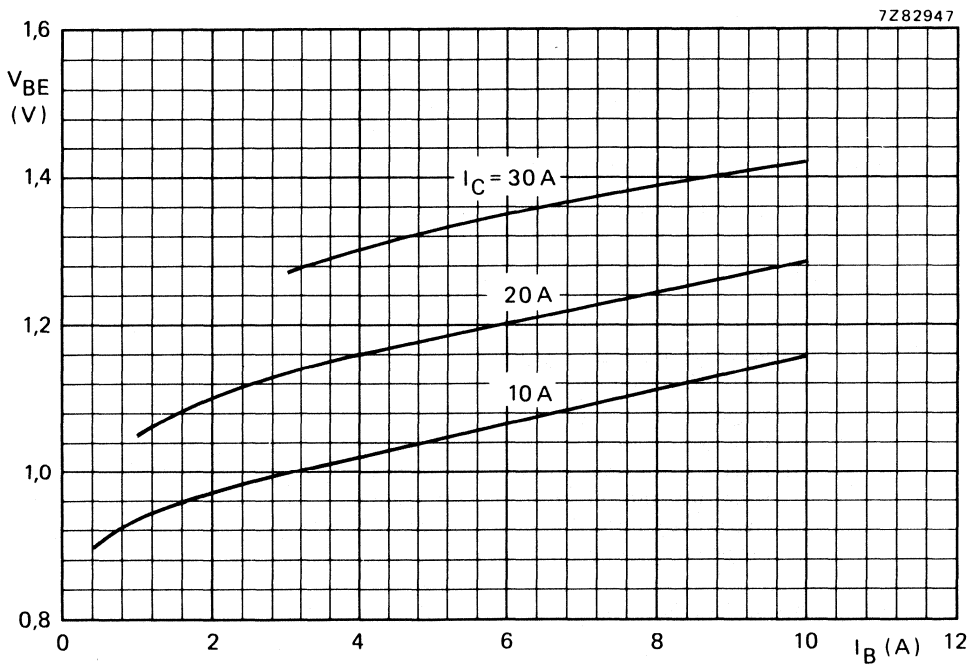


Fig. 10 Typical values at $T_j = 25\text{ }^\circ\text{C}$.

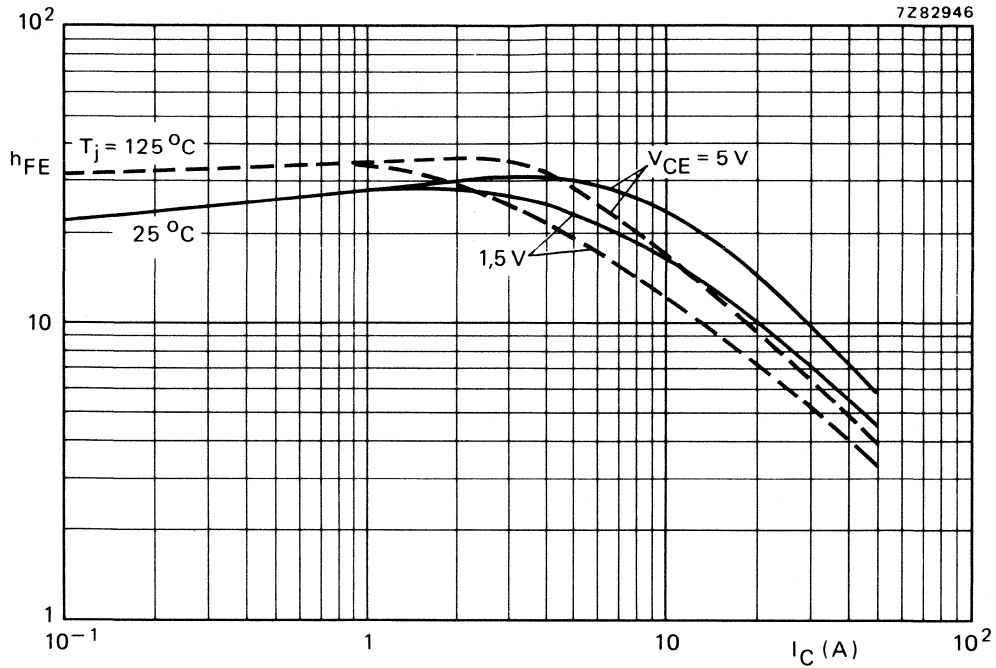


Fig. 11 Typical values DC current gain.

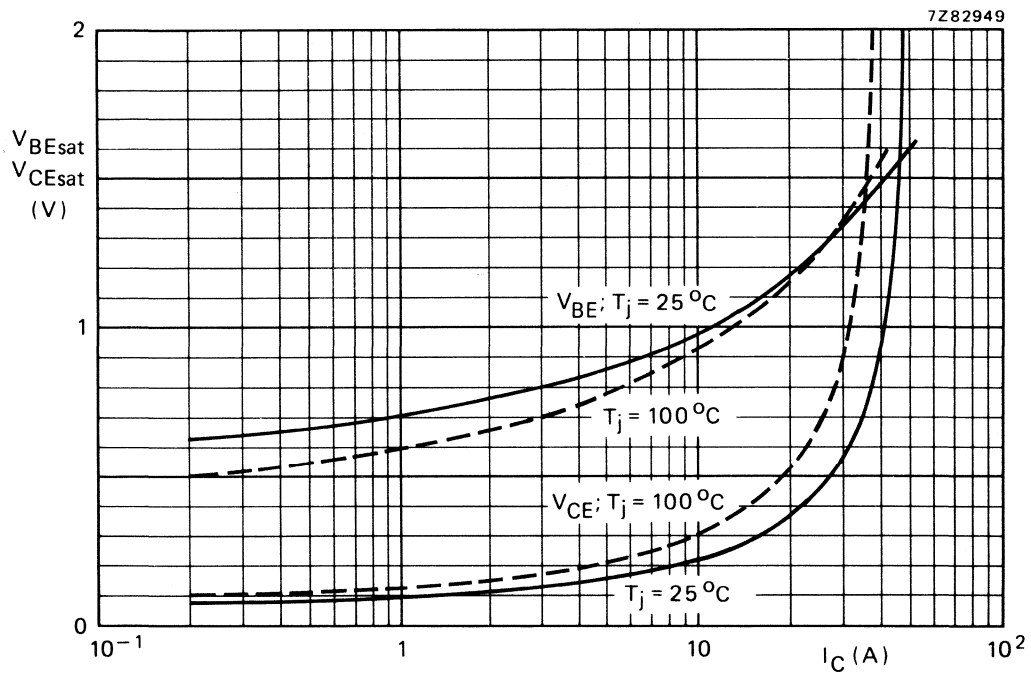


Fig. 12 Typical values base and collector voltage. $I_C/I_B = 5$.

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.

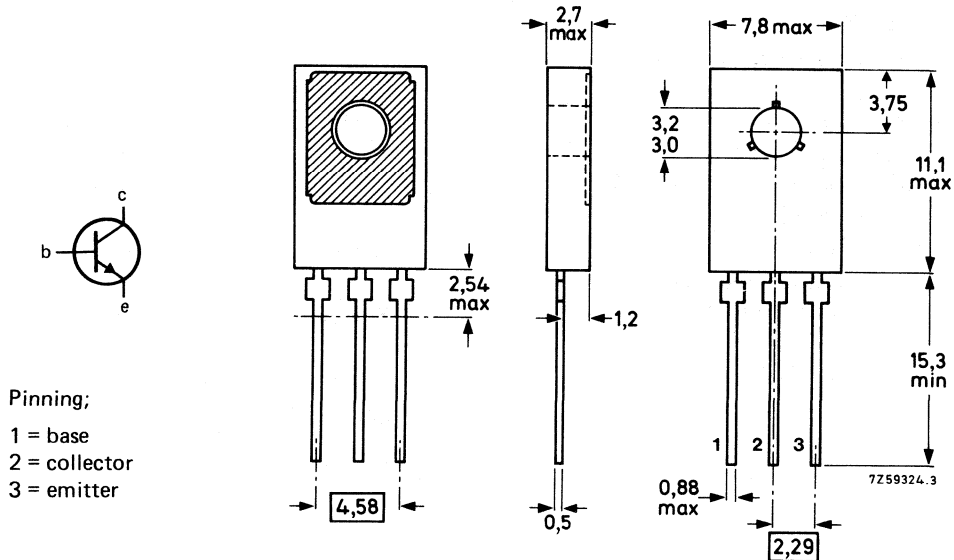
QUICK REFERENCE DATA

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 $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	28 W
Fall time	t_f	max.	0,8 μs

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-126.



Collector connected to metal part of mounting base.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

Collector-emitter voltage peak value; $V_{BE} = 0$	V_{CESM}	max.	730 V
Collector-emitter voltage, open base	V_{CEO}	max.	300 V
Emitter-base voltage, open collector	V_{EBO}	max.	12 V
Collector current (DC)	I_C	max.	1,5 A
Collector current (peak value)	I_{CM}	max.	3 A
Base current (DC)	I_B	max.	0,75 A
Base current (peak value)	I_{BM}	max.	1,5 A
Emitter current (DC)	I_E	max.	2,25 A
Emitter current (peak value)	I_{EM}	max.	4,5 A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	28 W
Storage temperature range	T_{stg}		-65 to +150 $^\circ\text{C}$
Junction temperature	T_j	max.	150 $^\circ\text{C}$

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j-mb}$	=	4,5 K/W
From junction to ambient	$R_{th\ j-a}$	=	100 K/W

CHARACTERISTICS

$T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified

Collector cut-off current $V_{CE} = 400\text{ V}; V_{BE} = 0$	I_{CES}	max.	5 μA
$V_{CE} = 730\text{ V}; V_{BE} = -1,5\text{ V}$	I_{CEX}	max.	50 μA
$V_{CE} = 730\text{ V}; V_{BE} = -1,5\text{ V}; T_j = 100\text{ }^\circ\text{C}$		max.	250 μA
Emitter cut-off current $I_C = 0; V_{EB} = 12\text{ V}$	I_{EBO}	max.	1 mA
Collector-emitter sustaining voltage $I_B = 0; I_C = 0,1\text{ A}; L = 25\text{ mH}$	$V_{CEO\text{sust}}$	min.	300 V
DC current gain $I_C = 10\text{ mA}; V_{CE} = 2\text{ V}$	h_{FE}	min.	10
$I_C = 50\text{ mA}; V_{CE} = 5\text{ V}$	h_{FE}	min.	16
		max.	42

Transition frequency at $f = 5 \text{ MHz}$
 $I_C = 0,1 \text{ A}; V_{CE} = 10 \text{ V}$

f_T typ. 4 MHz

Saturation voltages
 $I_C = 0,2 \text{ A}; I_B = 20 \text{ mA}$

V_{CEsat} max. 2 V
 V_{BEsat} max. 1 V

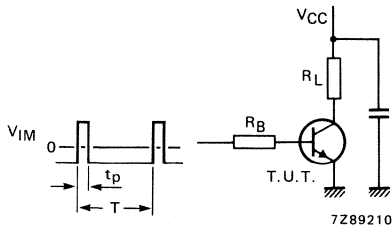
Collector capacitance at $f = 1 \text{ MHz}$
 $I_E = i_e = 0; V_{CB} = 10 \text{ V}$

C_C typ. 12 pF

Switching times (resistive load)

$I_{Con} = 1 \text{ A}; I_{Bon} = 20 \text{ mA}; I_{Boff} = 40 \text{ mA}$

t_s max. 2 μs
 t_f max. 0,8 μs



$V_{CC} = 250 \text{ V}$
 $V_{IM} = -6 \text{ to } +8 \text{ V}$
 The values of R_B and R_L are selected in accordance with the I_{Con} and I_B requirements.

Fig. 2 Test circuit resistive load.

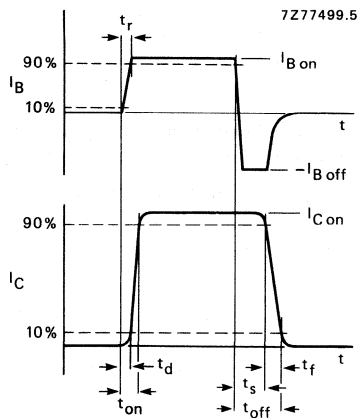
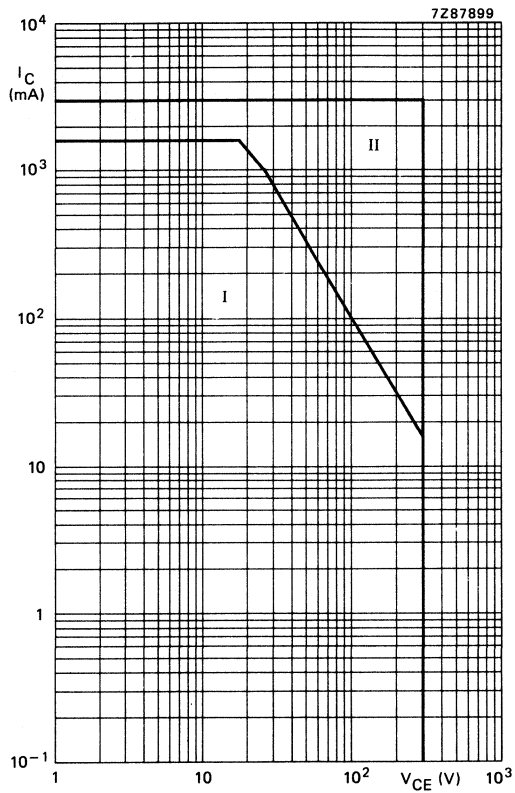


Fig. 3 Switching times waveforms with resistive load.



I Region of permissible DC operation
 II Permissible extension for repetitive pulse operation.

Fig. 4 Safe operating area.

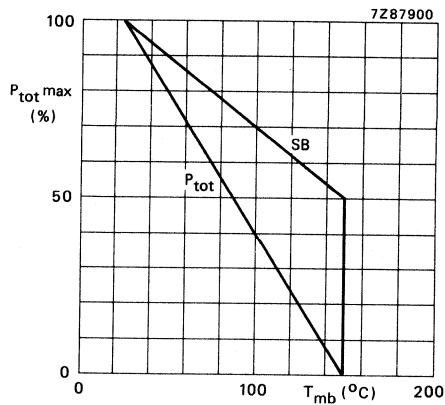


Fig. 5 Total power dissipation and second-breakdown current derating curve.

SILICON 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.

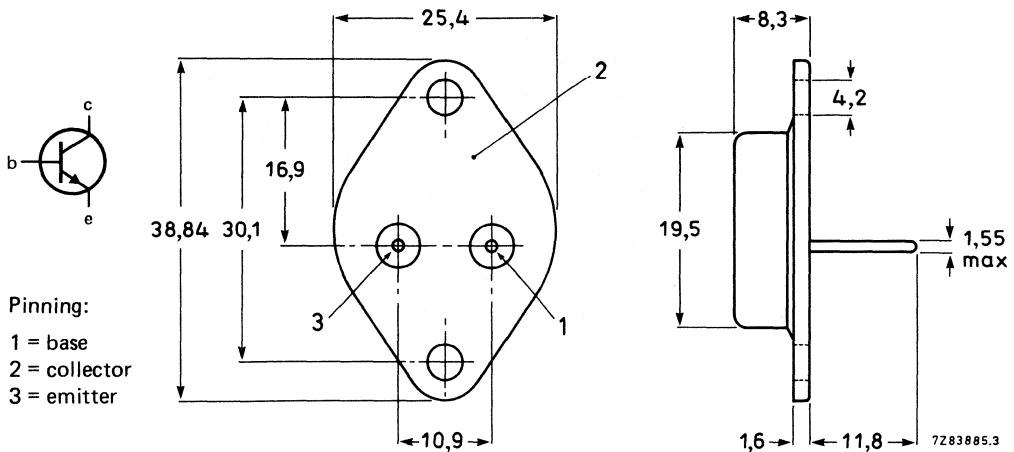
QUICK REFERENCE DATA

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 $T_{mb} = 60\text{ }^\circ\text{C}$	P_{tot}	max.	80 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)

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 $T_{mb} = 60\text{ }^\circ\text{C}$	P_{tot}	max.	80 W
Storage temperature range	T_{stg}		-65 to $+150\text{ }^\circ\text{C}$
Junction temperature	T_j	max.	$150\text{ }^\circ\text{C}$

THERMAL RESISTANCE

From junction to mounting base $R_{th\ j-mb} = 1,12\text{ K/W}$

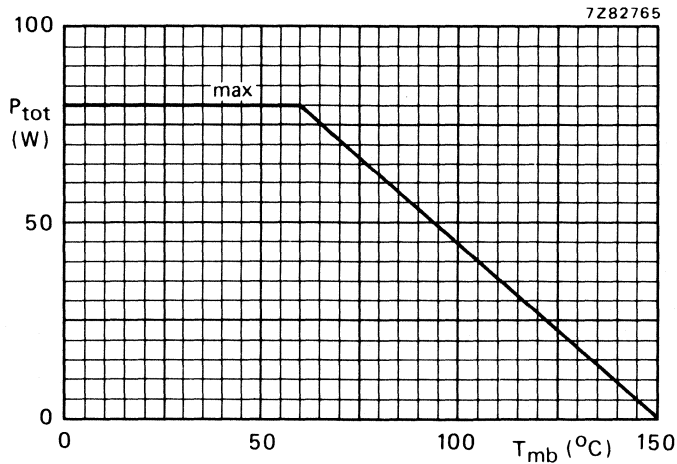


Fig. 2 Power derating curve.

* Turn-off current.

CHARACTERISTICS

$T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified

Collector cut-off current

$V_{BE} = 0; V_{CE} = V_{CESMmax}; T_j = 125\text{ }^\circ\text{C}$

I_{CES} max. 1,0 mA

DC current gain

$I_C = 4,5\text{ A}; V_{CE} = 5\text{ V}$

h_{FE} min. 2,5

Emitter cut-off current

$I_C = 0; V_{EB} = 5\text{ V}$

I_{EBO} max. 10 mA

Saturation voltage

$I_C = 4,5\text{ A}; I_B = 2\text{ A}$

V_{CEsat} max. 1 V

$I_C = 4,5\text{ A}; I_B = 2\text{ A}$

V_{BEsat} max. 1,5 V

Collector-emitter sustaining voltage

$I_B = 0; I_C = 100\text{ mA}; L = 25\text{ mH}$

$V_{CEO_{sust}}$ min. 800 V

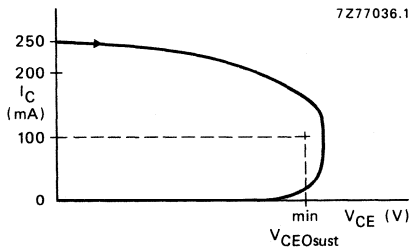


Fig. 3 Oscilloscope display for $V_{CEO_{sust}}$:

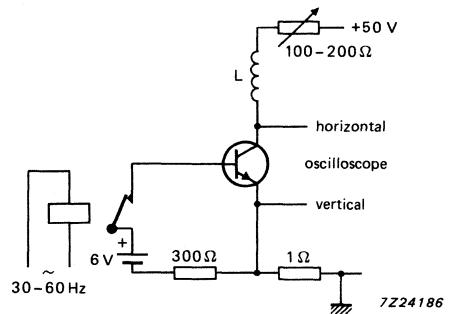


Fig. 4 Test circuit for $V_{CEO_{sust}}$:

Second-breakdown collector current

$V_{CE} = 100\text{ V}; t_p = 1\text{ s}$

$I_{(SB)}$ min. 0,3 A

Transition frequency at $f = 5\text{ MHz}$

$I_C = 0,1\text{ A}; V_{CE} = 5\text{ V}$

f_T typ. 7 MHz

Collector capacitance at $f = 1\text{ MHz}$

$I_E = I_e = 0; V_{CB} = 10\text{ V}$

C_c typ. 125 pF

CHARACTERISTICS (continued)

Switching times (between 10% and 90% levels)

in resistive switching circuit

$I_{Con} = 4,5 \text{ A}$; $V_{CC} = 250 \text{ V}$; $R_L = 56 \Omega$

$I_{Bon} = -I_{Boff} = 2 \text{ A}$

Turn-on time

t_{on} typ. $1,5 \mu\text{s}$

Storage time ($t_s = t_{off} - t_f$)

t_s typ. $4,5 \mu\text{s}$

Fall time

t_f typ. $0,5 \mu\text{s}$

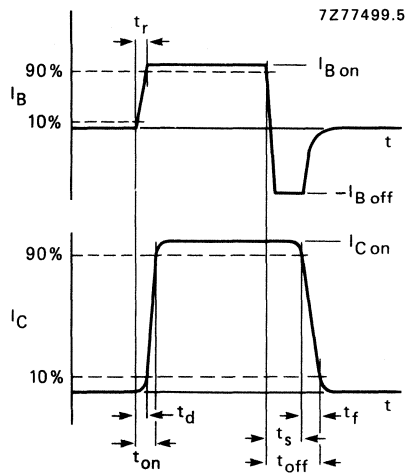


Fig. 5 Waveforms.

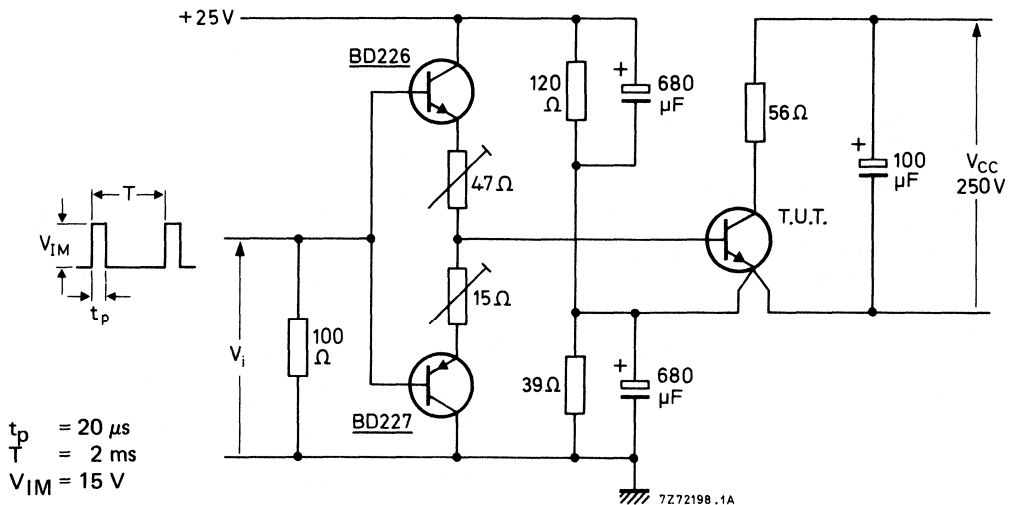
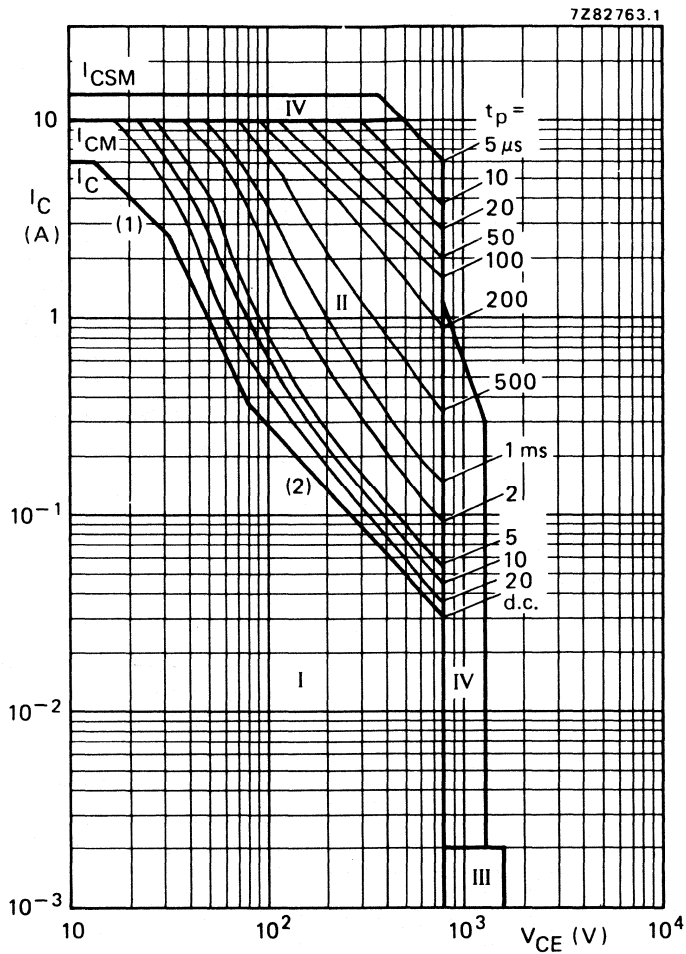


Fig. 6 Test circuit.



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 $V_{BE} \leq 0$ V; $t_p \leq 20 \mu s$; $\delta \leq 0,25$.
- 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.
 $T_{mb} \leq 60$ °C; $\delta = 0.01$.

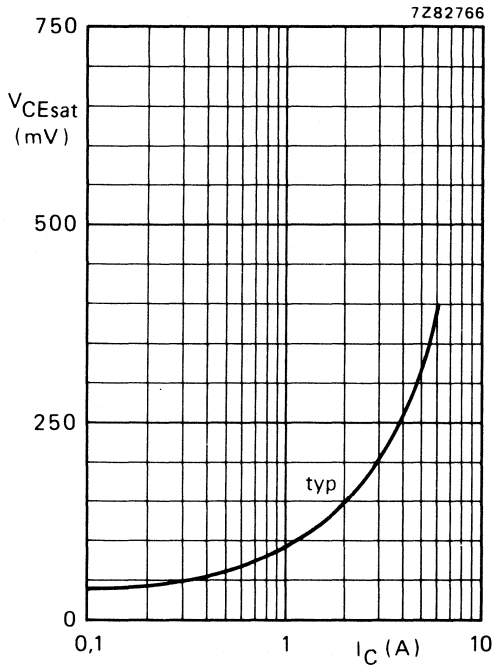


Fig. 8 Collector-emitter saturation voltage at $I_C/I_B = 2$; $T_j = 25$ °C.

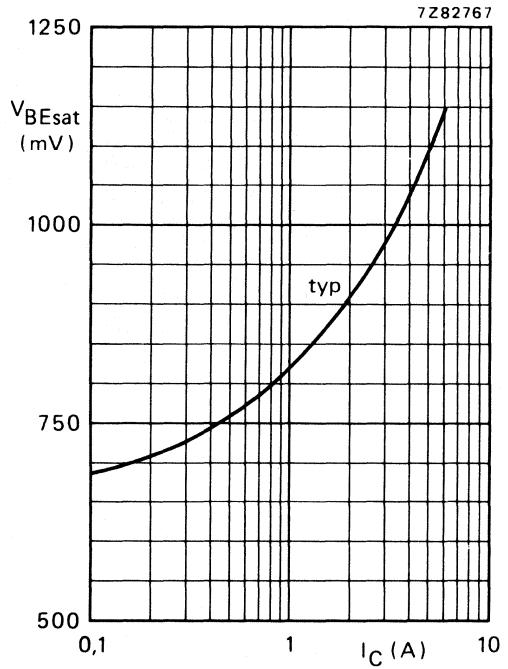


Fig. 9 Base-emitter saturation voltage at $I_C/I_B = 2$; $T_j = 25$ °C.

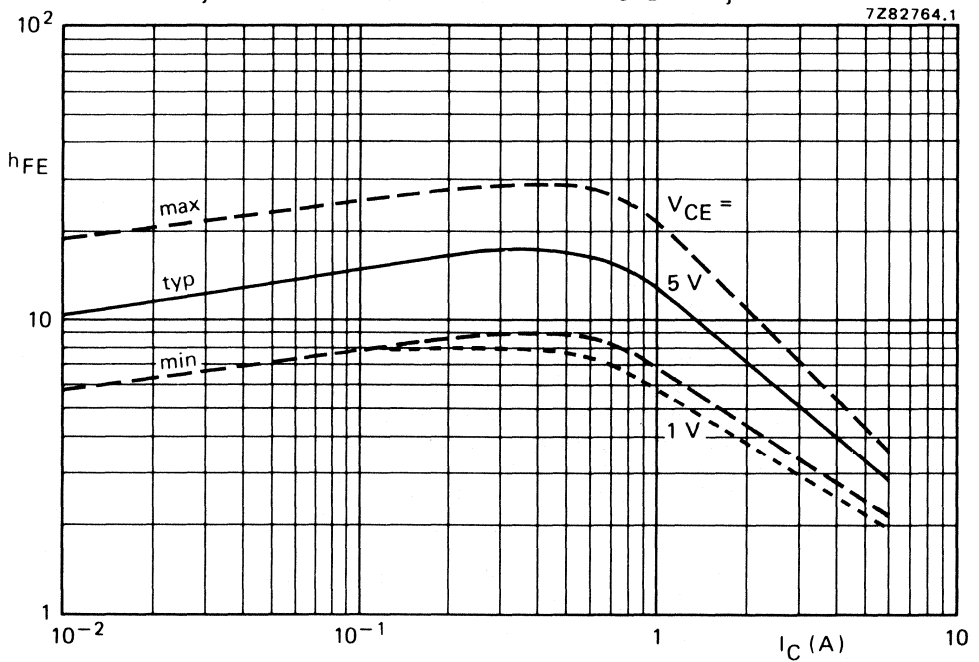


Fig. 10 DC current gain at $V_{CE} = 5$ V; $T_j = 25$ °C; at $V_{CE} = 1$ V.

DEVELOPMENT DATA

This data sheet contains advance information and specifications are subject to change without notice.

ESM3045A(V)
ESM3045D(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).

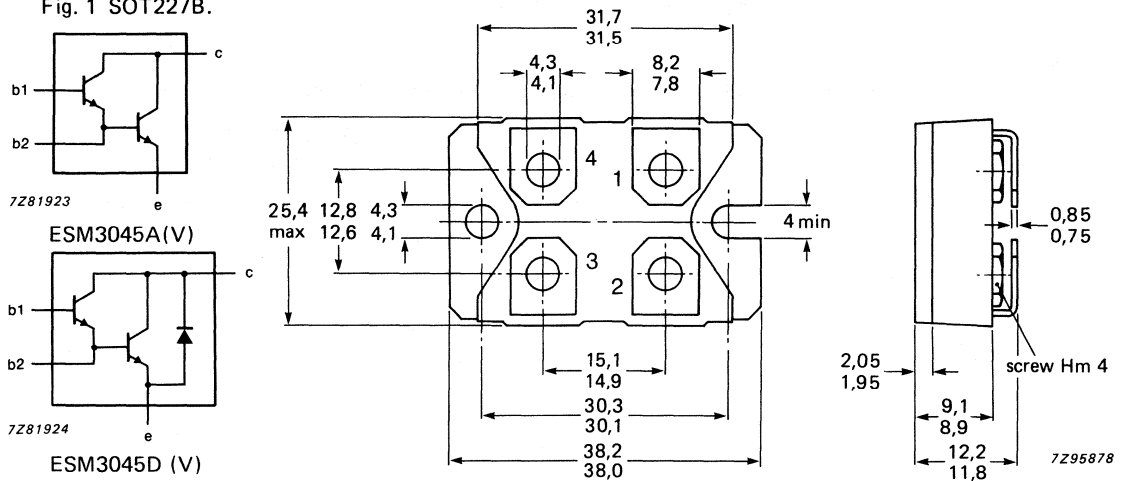
QUICK REFERENCE DATA

			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 $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	125	W
Fall time inductive load	t_f	max.	0.5	$0.4\text{ }\mu\text{s}$

MECHANICAL DATA

Dimensions in mm

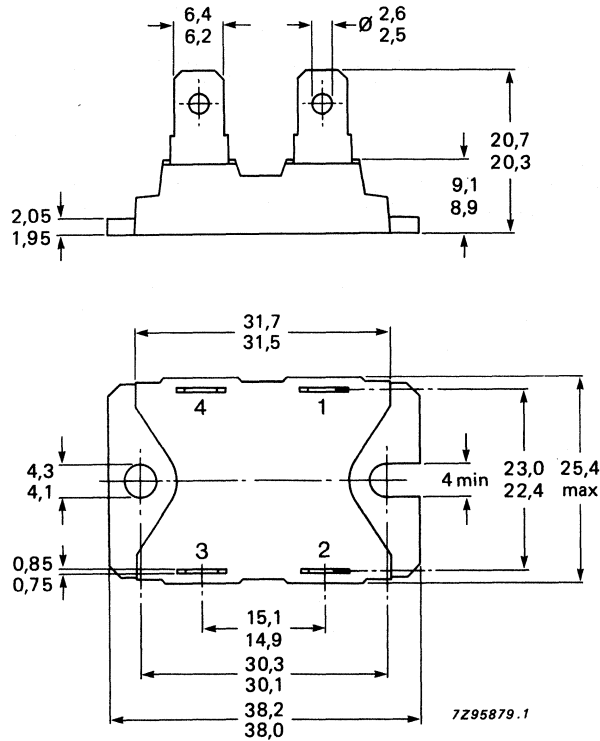
Fig. 1 SOT227B.



Pinning

- 1 = emitter
- 2 = base 1
- 3 = collector
- 4 = base 2

ESM3045A(V)
ESM3045D(V)



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; $V_{BE} = 0$ open base	V_{CESM}	max.	1000	450	600	V
	V_{CEO}	max.				V
Collector current saturation DC peak value	I_{Csat}	max.		15		A
	I_C	max.		24		A
	I_{CM}	max.		36		A
Base current DC peak value	I_B	max.		2.5		A
	I_{BM}	max.		5.0		A
Total power dissipation up to $T_{mb} = 25^\circ\text{C}$	P_{tot}	max.	125			W
Junction temperature	T_j	max.		150		$^\circ\text{C}$
Storage temperature range	T_{stg}			-40 to + 150		$^\circ\text{C}$

THERMAL RESISTANCE

		ESM3045A(V)	3045D(V)
From junction to mounting base transistor	$R_{th\ j-mb}$	=	1.0 K/W
From junction to mounting base diode	$R_{th\ j-mb}$	=	2.0 K/W

ISOLATION

Isolation voltage from all terminals to external heatsink (RMS value)	V_{isol}	max.	2500 V
Isolation capacitance from collector to external heatsink	C_{isol}	typ.	45 pF

CHARACTERISTICS

$T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified

Collector cut-off current

$V_{CE} = V_{CESMmax}; V_{BE} = 0$
 $V_{CE} = V_{CESMmax}; V_{BE} = 0$
 $T_j = 100\text{ }^\circ\text{C}$

I_{CES}	max.	1.0 mA
I_{CES}	max.	4.0 mA

Emitter cut-off current

$V_{EB} = 5\text{ V}; I_C = 0$

I_{EBO}	max.	1.0 mA
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Saturation voltages

$I_C = I_{Csat}; I_B = I_{Csat}/50; T_j = 125\text{ }^\circ\text{C}$

V_{CEsat}	max.	2.0 V
V_{BEsat}	max.	2.5 V

Collector-emitter sustaining voltage

$I_C = 200\text{ mA}; I_B = 0; L = 25\text{ mH}$

$V_{CEOsust}$	min.	450 V
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Diode forward voltage drop

$I_F = 20\text{ A}; T_j = 100\text{ }^\circ\text{C}$

V_F	max.	2.0 V
-------	------	-------

Switching times, inductive load

$I_C = I_{Csat}; I_{B\ on} = I_{Csat}/50$;
 $V_{BE\ off} = -5\text{ V}; T_j = 100\text{ }^\circ\text{C}$;
 $R_{BB} = 0.6\ \Omega; V_{CL} = 450\text{ V}$
 with anti-saturation network
 and speed-up diode

t_s	max.	4.0 μs
t_s	max.	0.4 μs

DEVELOPMENT DATA

DEVELOPMENT DATA

This data sheet contains advance information and specifications are subject to change without notice.

ESM4045A(V)
ESM4045D(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).

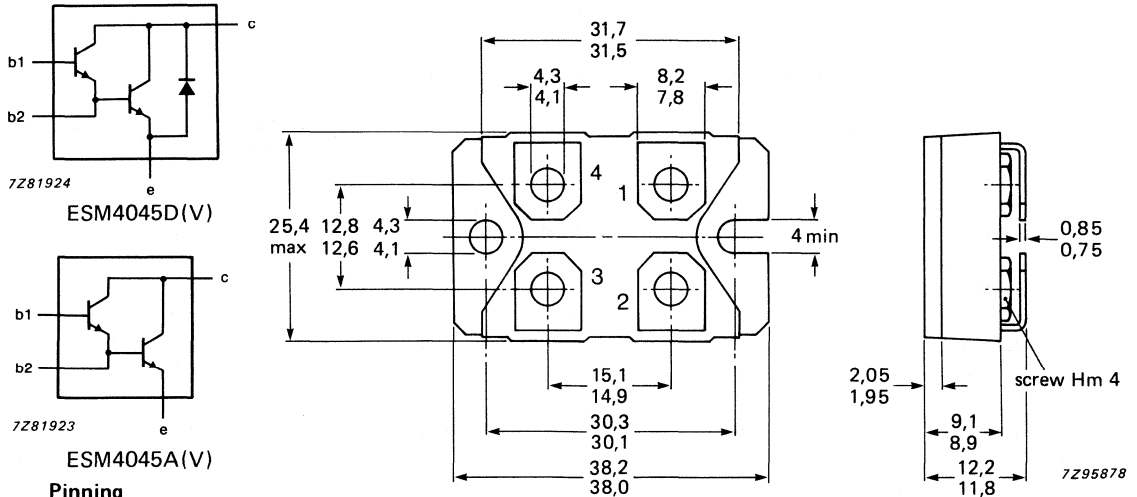
QUICK REFERENCE DATA

			ESM4045A(V)	4045D(V)
Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM}	max.	1000	600 V
	V_{CEO}	max.	450	450 V
Collector-emitter saturation voltage	V_{CEsat}	max.	2.0	V
Collector current saturation DC peak value	I_{Csat}	max.	25	A
	I_C	max.	42	A
	I_{CM}	max.	63	A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	150	W
Fall time inductive load	t_f	max.	0.5	μs

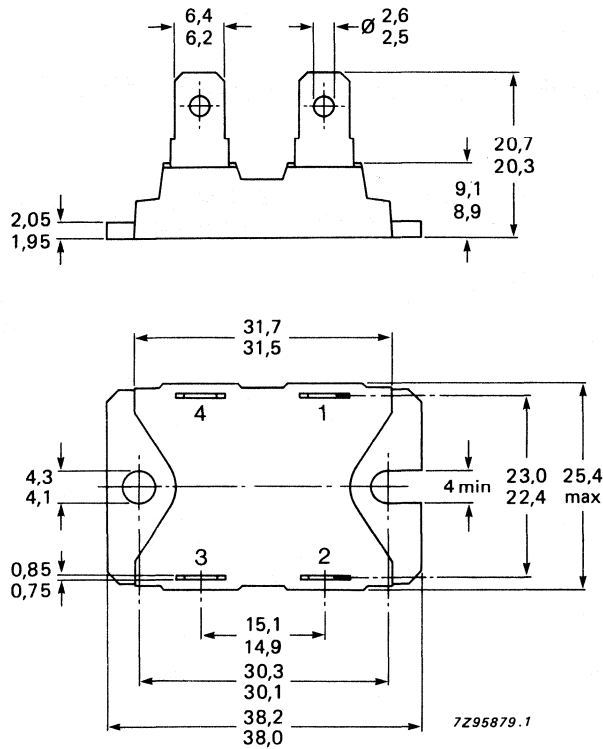
MECHANICAL DATA

Fig. 1 SOT227B.

Dimensions in mm



ESM4045A(V)
ESM4045D(V)



Pinning

- 1 = emitter
- 2 = base 1
- 3 = collector
- 4 = base 2

Fig. 2 SOT227A, with Faston terminals.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			ESM4045A(V)	4045D(V)
Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM}	max.	1000	600 V
	V_{CEO}	max.	450	V
Collector current	I_{Csat}	max.	25	A
	I_C	max.	42	A
	I_{CM}	max.	63	A
Base current	I_B	max.	4.0	A
	I_{BM}	max.	8.0	A
Total power dissipation up to $T_{mb} = 25^\circ C$	P_{tot}	max.	150	W
Junction temperature	T_j	max.	150	$^\circ C$
Storage temperature range	T_{stg}		-40 to + 150	$^\circ C$

THERMAL RESISTANCE

		ESM4045A(V)	4045D(V)
From junction to mounting base transistor	$R_{th\ j-mb} =$	0.83	K/W
From junction to mounting base diode	$R_{th\ j-mb} =$	—	1.5

ISOLATION

Isolation voltage from all terminals to external heatsink (RMS value)	V_{isol} max.	2500	V
Isolation capacitance from collector to external heatsink	C_{isol} typ.	45	pF

CHARACTERISTICS

$T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified

Collector cut-off current

$V_{CE} = V_{CESMmax}; V_{BE} = 0$ I_{CES} max. 1.0 mA

$V_{CE} = V_{CESMmax}; V_{BE} = 0$
 $T_j = 100\text{ }^\circ\text{C}$ I_{CES} max. 2.0 | 7.0 mA

Emitter cut-off current

$V_{EB} = 5\text{ V}; I_C = 0$ I_{EBO} max. 1.0 mA

Saturation voltages

$I_C = I_{Csat}; I_B = I_{Csat}/50; T_j = 125\text{ }^\circ\text{C}$ V_{CEsat} max. 2.0 V

V_{BEsat} max. 2.5 V

Collector-emitter sustaining voltage

$I_C = 200\text{ mA}; I_B = 0; L = 25\text{ mH}$ $V_{CEO sust}$ min. 450 V

Diode forward voltage drop

$I_F = 35\text{ A}; T_j = 100\text{ }^\circ\text{C}$ V_F max. — | 1.85 V

Switching times, inductive load

$I_C = I_{Csat}; I_{B\ on} = I_{Csat}/50;$ t_s max. 4.5 | 4.5 μs

$V_{BE\ off} = -5\text{ V}; R_{BB} = 0.6\ \Omega;$ t_s max. 0.6 | 0.5 μs

$T_j = 100\text{ }^\circ\text{C}; V_{CL} = 450\text{ V}$

with anti-saturation network

and speed-up diode

DEVELOPMENT DATA

DEVELOPMENT DATA

This data sheet contains advance information and specifications are subject to change without notice.

ESM5045D(V)

SILICON DARLINGTON POWER TRANSISTORS

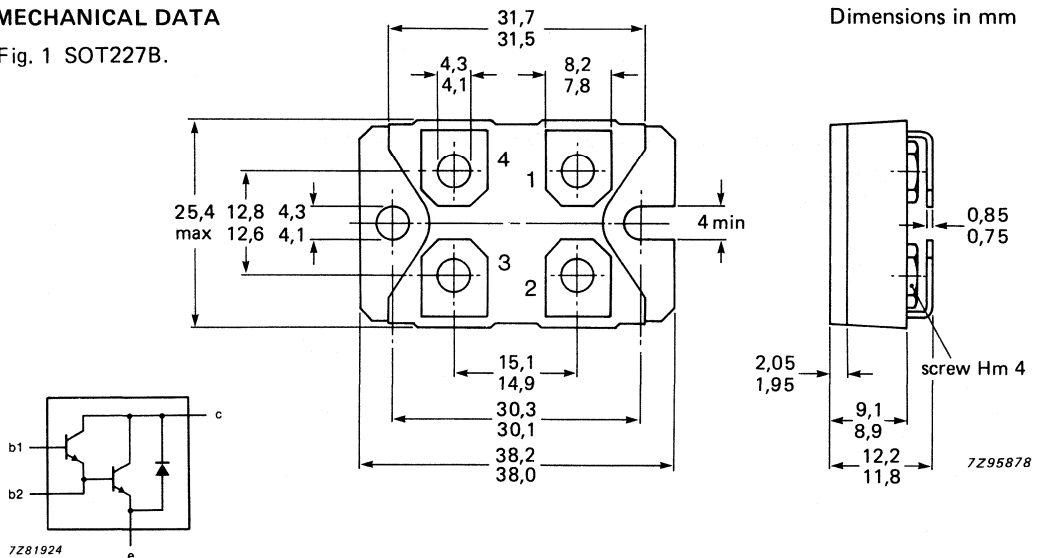
NPN high-current switching Darlington transistor in ISOTOP package, intended for use in motor drives, converters, switch mode power supplies (SMPS) and uninterruptable power supplies (UPS).

QUICK REFERENCE DATA

Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM}	max.	600 V
	V_{CEO}	max.	450 V
Collector-emitter saturation voltage	V_{CEsat}	max.	2.0 V
Collector current saturation	I_{Csat}	max.	35 A
DC	I_C	max.	60 A
peak value	I_{CM}	max.	90 A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	175 W
Fall time inductive load	t_f	max.	0.5 μs

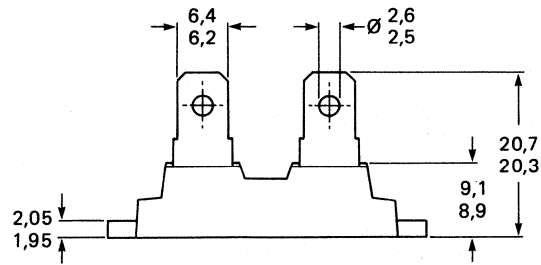
MECHANICAL DATA

Fig. 1 SOT227B.



Pinning

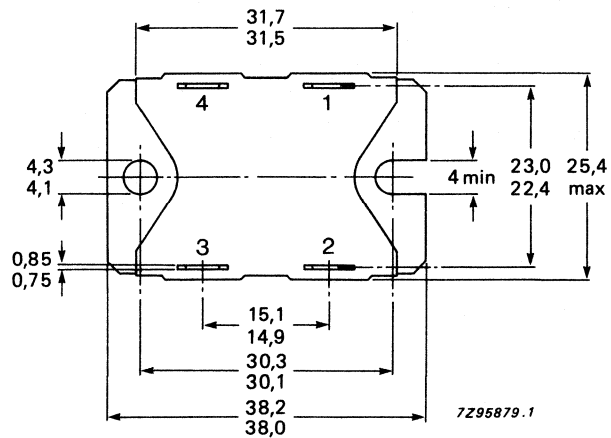
- 1 = emitter
- 2 = base 1
- 3 = collector
- 4 = base 2



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
open base

V_{CESM}	max.	600 V
V_{CEO}	max.	450 V

Collector current

saturation
DC
peak value

I_{Csat}		35 A
I_C	max.	60 A
I_{CM}	max.	90 A

Base current

DC
peak value

I_B	max.	6.0 A
I_{BM}	max.	12 A

Total power dissipation

up to $T_{mb} = 25\text{ }^\circ\text{C}$

P_{tot}	max.	175 W
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Junction temperature

T_j	max.	150 $^\circ\text{C}$
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Storage temperature range

T_{stg}		-40 to +150 $^\circ\text{C}$
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THERMAL RESISTANCE

From junction to mounting base
transistor

$R_{th\ j-mb}$	=	0.71 K/W
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From junction to mounting base
diode

$R_{th\ j-mb}$	=	1.2 K/W
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ISOLATION

Isolation voltage from all terminals to external heatsink (RMS value)

 V_{isol} max. 2500 V

Isolation capacitance from collector to external heatsink

 C_{isol} typ. 45 pF**CHARACTERISTICS** $T_j = 25\text{ }^\circ\text{C}$ unless other specified

Collector cut-off current

 $V_{CE} = V_{CESMmax}; V_{BE} = 0$ $V_{CE} = V_{CESMmax}; V_{BE} = 0; T_j = 100\text{ }^\circ\text{C}$ I_{CES} max. 1.0 mA I_{CES} max. 13 mA

Emitter cut-off current

 $V_{EB} = 5\text{ V}; I_C = 0$ I_{EBO} max. 1.0 mA

Saturation voltages

 $I_C = I_{Csat}; I_B = I_{Csat}/50; T_j = 125\text{ }^\circ\text{C}$ V_{CEsat} max. 2.0 V V_{BEsat} max. 2.5 V

Collector-emitter sustaining voltage

 $I_C = 200\text{ mA}; I_B = 0; L = 25\text{ mH}$ $V_{CEOsust}$ min. 450 V

Diode forward voltage drop

 $I_F = 50\text{ A}$ V_F max. 1.8 V

Switching times, inductive load

 $I_C = I_{Csat}; I_{B\text{ on}} = I_{Csat}/50;$ $V_{BE\text{ off}} = -5\text{ V}; T_j = 100\text{ }^\circ\text{C};$ $R_{BB} = 0.6\text{ }\Omega; V_{CL} = 450\text{ V}$

with anti-saturation network

and speed-up diode

 t_s max. 5.0 μs t_s max. 0.5 μs

DEVELOPMENT DATA

DEVELOPMENT DATA

This data sheet contains advance information and specifications are subject to change without notice.

ESM6045A(V)
ESM6045D(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).

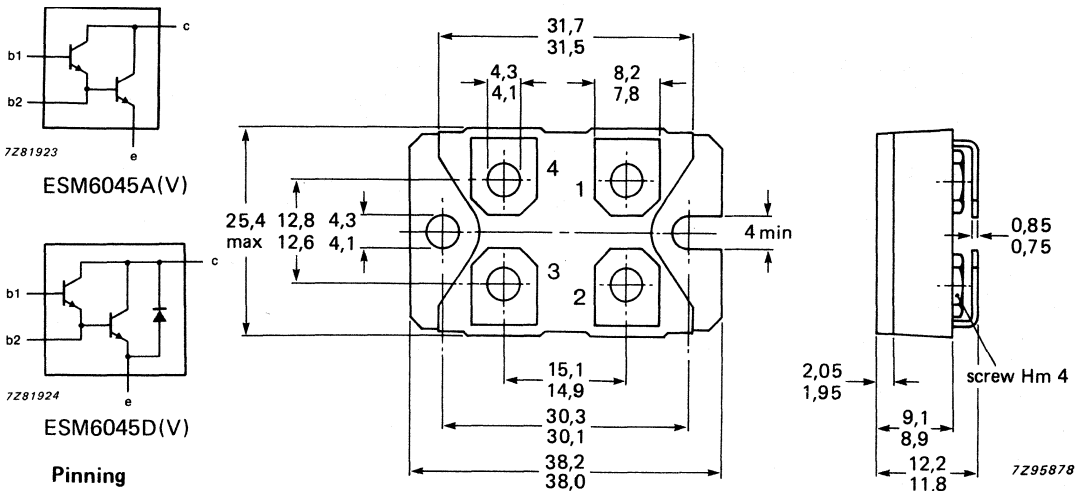
QUICK REFERENCE DATA

			ESM6045A(V)	6045D(V)
Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM}	max.	1000	600 V
	V_{CEO}	max.	450	450 V
Collector-emitter saturation voltage	V_{CEsat}	max.	2.0	V
Collector current saturation DC peak value	I_{Csat}	max.	50	A
	I_C	max.	84	A
	I_{CM}	max.	126	A
Total power dissipation up to $T_{mb} = 25^\circ C$	P_{tot}	max	250	W
Fall time inductive load	t_f	max.	0.5	μs

MECHANICAL DATA

Dimensions in mm

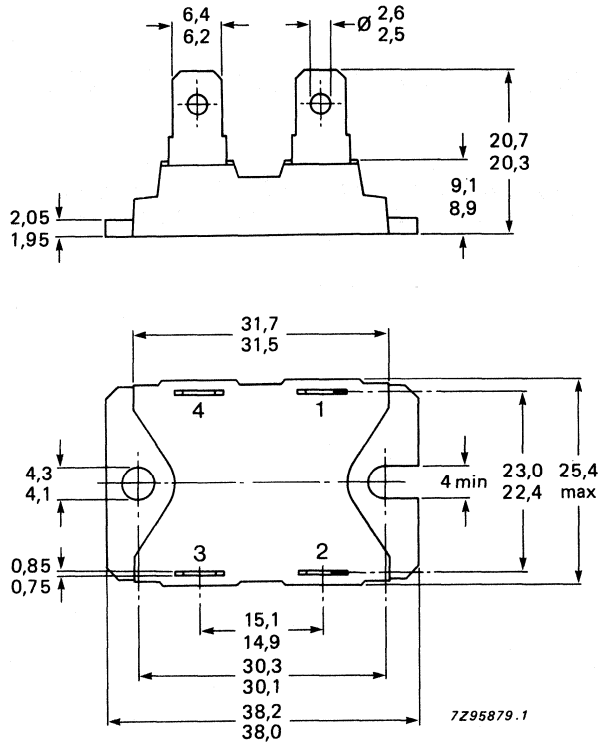
Fig. 1 SOT227B.



Pinning

- 1 = emitter
- 2 = base 1
- 3 = collector
- 4 = base 2

ESM6045A(V)
ESM6045D(V)



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; $V_{BE} = 0$ open base	V_{CESM}	max.	1000	600	V
	V_{CEO}	max.	450		V
Collector current saturation DC peak value	I_{Csat}	max.	50		A
	I_C	max.	84		A
	I_{CM}	max.	126		A
Base current DC peak value	I_B	max.	8.0		A
	I_{BM}	max.	16		A
Total power dissipation up to $T_{mb} = 25^\circ C$	P_{tot}	max.	250		W
Junction temperature	T_j	max.	150		$^\circ C$
Storage temperature range	T_{stg}		-40 to +50		$^\circ C$

THERMAL RESISTANCE

		ESM6045A(V)	6045D(V)
From junction to mounting base transistor	$R_{th\ j-mb} =$	0.5	K/W
From junction to mounting base diode	$R_{th\ j-mb} =$	—	1.2 K/W

ISOLATION

Isolation voltage from all terminals to external heatsink (rms value)	V_{isol} max.	2500	V
Isolation capacitance from collector to external heatsink	C_{isol} typ.	45	pF

CHARACTERISTICS

$T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified

		ESM6045A(V)	6045D(V)
Collector cut-off current $V_{CE} = V_{CESMmax}; V_{BE} = 0$ $V_{CE} = V_{CESMmax}; V_{BE} = 0$ $T_j = 100\text{ }^\circ\text{C}$	I_{CES} max.	1.0	mA
Emitter cut-off current $V_{EB} = 5\text{ V}; I_C = 0$	I_{EBO} max.	1.0	mA
Saturation voltages $I_C = I_{Csat}; I_B = I_{Csat}/50; T_j = 125\text{ }^\circ\text{C}$	V_{CEsat} max. V_{BEsat} max.	2.0 2.5	V V
Collector-emitter sustaining voltage $I_C = 200\text{ mA}; I_B = 0; L = 25\text{ mH}$	$V_{CEOsust}$ min.	450	V
Diode forward voltage drop $I_F = 70\text{ A}; T_j = 100\text{ }^\circ\text{C}$	V_F max.	—	1.9 V
Switching times, inductive load $I_C = I_{Csat}; I_{Bon} = I_{Csat}/50;$ $V_{BE\ off} = -5\text{ V}; T_j = 100\text{ }^\circ\text{C};$ $R_{BB} = 0.6\ \Omega; V_{CL} = 450\text{ V}$ with anti-saturation network and speed-up diode	t_s max. t_s max.	5.5 0.5	μs μs

DEVELOPMENT DATA

DEVELOPMENT DATA

This data sheet contains advance information and specifications are subject to change without notice.

MJE 13004
MJE 13005

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.

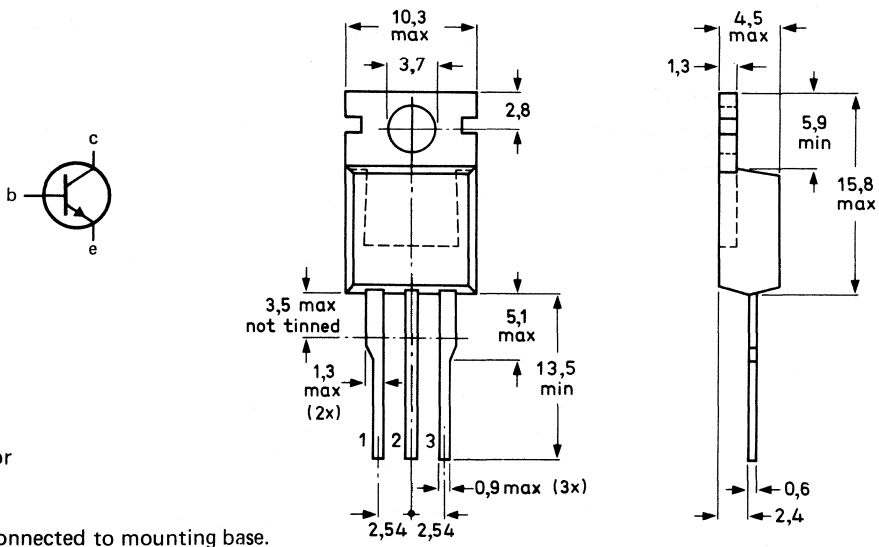
QUICK REFERENCE DATA

			MJE13004	13005
Collector-emitter voltage peak value; $V_{BE} = 0$ V open base	V_{CESM}	max.	600	700 V
	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

Fig. 1 TO-220AB.

Dimensions in mm



Pinning:

- 1 = base
- 2 = collector
- 3 = emitter

Collector connected to mounting base.

7265872.5

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

		MJE13004	13005
Collector-emitter voltage peak value; $V_{BE} = 0$ V open base	V_{CESM} max. V_{CEO} max.	600 300	700 V 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 $T_{amb} = 25$ °C	P_{tot} max.	2	W
derate above 25 °C		16	mW/K
Total power dissipation up to $T_{mb} = 25$ °C	P_{tot} max.	75	W
derate above 25 °C		600	mW/K
Operating junction temperature range	T_j	-65 to + 150	°C
Storage temperature range	T_{stg}	-65 to + 150	°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j-mb}$ =	1.67	K/W
From junction to ambient	$R_{th\ j-a}$ =	62.5	K/W

CHARACTERISTICS

 $T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified

DEVELOPMENT DATA

		MJE13004	13005
Collector-emitter sustaining voltage $I_C = 10\text{ mA}; I_B = 0$	$V_{CE0sust}$ min.	300	400 V
Collector cut-off current $V_{CE} = V_{CESMmax}; V_{BE} = -1.5\text{ V}$ $V_{CE} = V_{CESMmax}; V_{BE} = -1.5\text{ V};$ $T_C = 100\text{ }^\circ\text{C}$	I_{CEX} max.		1.0 mA
	I_{CEX} max.		5.0 mA
Emitter cut-off current $V_{EB} = 9\text{ V}; I_C = 0$	I_{EBO} max.		1.0 mA
DC current gain $I_C = 1\text{ A}; V_{CE} = 5\text{ V}$ $I_C = 2\text{ A}; V_{CE} = 5\text{ V}$	h_{FE}	10 to 60	
	h_{FE}	8 to 40	
Collector-emitter saturation voltage $I_C = 1\text{ A}; I_B = 0.2\text{ A}$ $I_C = 2\text{ A}; I_B = 0.5\text{ A}$ $I_C = 4\text{ A}; I_B = 1.0\text{ A}$ $I_C = 2\text{ A}; I_B = 0.5\text{ A}; T_{mb} = 100\text{ }^\circ\text{C}$	V_{CEsat} max.		0.5 V
	V_{CEsat} max.		0.6 V
	V_{CEsat} max.		1.0 V
	V_{CEsat} max.		1.0 V
Base-emitter saturation voltage $I_C = 1\text{ A}; I_B = 0.2\text{ A}$ $I_C = 2\text{ A}; I_B = 0.5\text{ A}$ $I_C = 2\text{ A}; I_B = 0.5\text{ A}; T_{mb} = 100\text{ }^\circ\text{C}$	V_{BEsat} max.		1.2 V
	V_{BEsat} max.		1.6 V
	V_{BEsat} max.		1.5 V
Transition frequency $I_C = 0.5\text{ A}; V_{CE} = 10\text{ V}; f = 1\text{ MHz}$	f_T typ.	4.0	MHz
Collector capacitance $V_{CB} = 10\text{ V}; I_E = 0$	C_c typ.	50	pF
Switching times, resistive load (Figs 2 and 3) $V_{CC} = 125\text{ V}; I_C = 2\text{ A}; t_p = 25\text{ } \mu\text{s};$ $I_{Bon} = I_{Boff} = 0.4\text{ A}$	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) $I_C = 2\text{ A}; V_{CL} = 300\text{ V}; T_{mb} = 100\text{ }^\circ\text{C};$ $I_{Bon} = 0.4\text{ A}; V_{BEoff} = 5\text{ V}$	t_s typ.	0.9	μs
	t_s max.	4.0	μs
	t_f typ.	0.32	μs
	t_f max.	0.9	μs

$V_{CC} = 125\text{ V}$ $V_{IM} = 6\text{ to }8\text{ V}$
The values of R_B and R_L are selected in accordance with the $I_{C\text{on}}$ and $I_{B\text{on}}$ requirements.

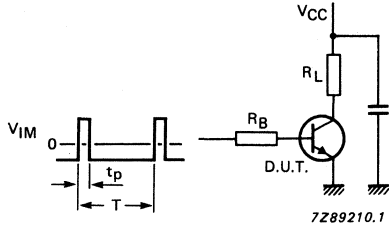


Fig. 2 Test circuit resistive load.

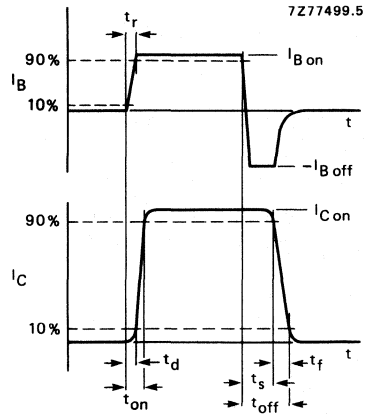


Fig. 3 Switching times waveforms with resistive load; $t_r \leq 30\text{ ns}$.

$V_{CC} = 30\text{ V}$
 $L_C = 200\ \mu\text{H}$
 $L_B = 1\ \mu\text{H}$

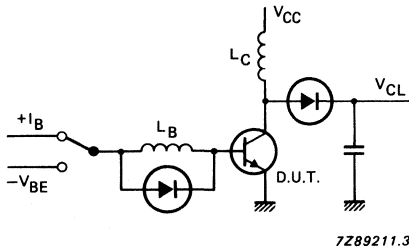


Fig. 4 Test circuit inductive load.

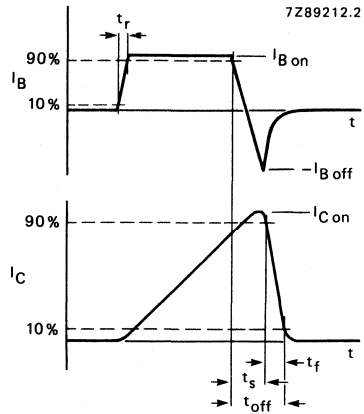


Fig. 5 Switching times waveforms with inductive load.

DEVELOPMENT DATA

This data sheet contains advance information and specifications are subject to change without notice.

MJE13006
MJE13007

SILICON DIFFUSED POWER TRANSISTOR

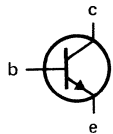
High-voltage, high-speed glass-passivated npn power transistor in a TO-220 envelope, intended for use in switching regulators, inverters, motor controls, solenoid/relay drivers and deflection circuits.

QUICK REFERENCE DATA

			MJE 13006	MJE 13007	
Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM}	max.	600	700	V
	V_{CEO}	max.	300	400	V
Collector-emitter saturation voltage $I_C = I_{Csat}$	V_{CEsat}	max.	1.5		V
Collector current saturation DC peak value	I_{Csat}	max.	5.0		A
	I_C	max.	8.0		A
	I_{CM}	max.	16		A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	80		W

MECHANICAL DATA

Fig. 1 TO-220AB.



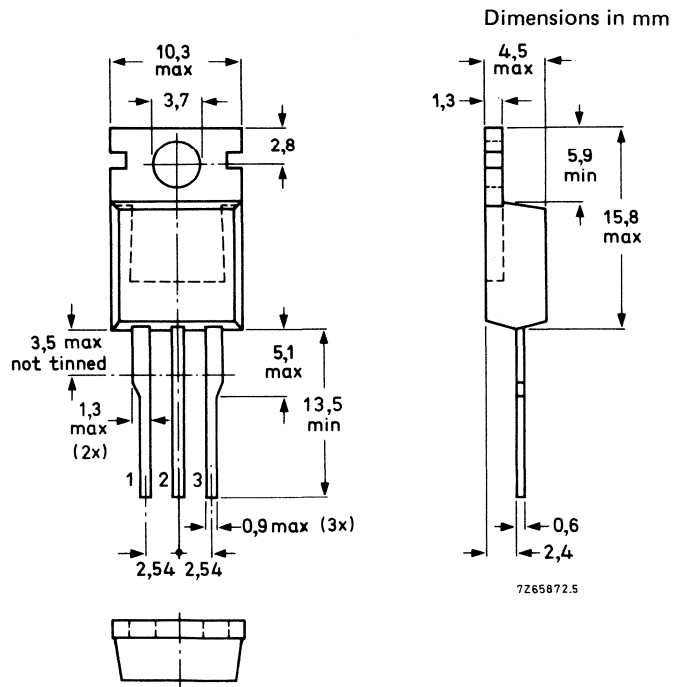
Pinning:

1 = base

2 = collector

3 = emitter

Collector connected to mounting base.



RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

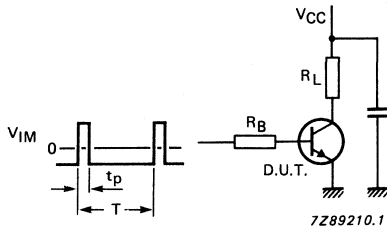
		MJE 13006	MJE 13007	
Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM} max.	600	700	V
	V_{CEO} max.	300	400	V
Emitter-base current	V_{EBO} max.	9.0		V
Collector current saturation DC peak value	I_{Csat}	5.0		A
	I_C max.	8.0		A
	I_{CM} max.	16		A
Base current DC peak value	I_B max.	4.0		A
	I_{BM} max.	8.0		A
Emitter current DC peak value	I_E max.	12		A
	I_{EM} max.	24		A
Total power dissipation up to $T_{mb} = 25^\circ\text{C}$ derate above 25°C	P_{tot} max.	65		W
		640		mW/ $^\circ\text{C}$
Operating junction temperature range	T_j	-65 to + 150		$^\circ\text{C}$
Storage temperature range	T_{stg}	-65 to + 150		$^\circ\text{C}$
THERMAL RESISTANCE				
From junction to mounting base	$R_{th\ j-mb}$ =	1.56		K/W
From junction to ambient	$R_{th\ j-a}$ =	62.5		K/W

CHARACTERISTICS

 $T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified

DEVELOPMENT DATA

		MJE13006	MJE13007
Collector-emitter sustaining voltage $I_C = 10\text{ A}; I_B = 0$	$V_{CEOsust}$ min.	300	400 V
Collector cut-off current $V_{CE} = V_{CESMmax}; V_{BE} = -1.5\text{ V}$ $V_{CE} = V_{CESMmax}; V_{BE} = -1.5\text{ V};$ $T_c = 100\text{ }^\circ\text{C}$	I_{CEX} max.	1.0	mA
	I_{CEX} max.	5.0	mA
Emitter cut-off current $V_{EB} = 9\text{ V}; I_C = 0$	I_{EBO} max.	1.0	mA
Current gain $I_C = 0.5\text{ A}; V_{CE} = 5\text{ V}$	h_{FE}	15 to 50	mA
$I_C = 2.0\text{ A}; V_{CE} = 5\text{ V}$	h_{FE}	8 to 40	mA
$I_C = 5.0\text{ A}; V_{CE} = 5\text{ V}$	h_{FE}	6 to 30	mA
Collector-emitter saturation voltage $I_C = 2\text{ A}; I_B = 0.4\text{ A}$	V_{CEsat} max.	1.0	V
$I_C = 5\text{ A}; I_B = 1.0\text{ A}$	V_{CEsat} max.	1.5	V
$I_C = 8\text{ A}; I_B = 2.0\text{ A}$	V_{CEsat} max.	3.0	V
$I_C = 5\text{ A}; I_B = 1.0\text{ A}; T_c = 100\text{ }^\circ\text{C}$	V_{CEsat} max.	2.0	V
Base-emitter saturation voltage $I_C = 2\text{ A}; I_B = 0.4\text{ A}$	V_{BEsat} max.	1.2	V
$I_C = 5\text{ A}; I_B = 1.0\text{ A}$	V_{BEsat} max.	1.6	V
$I_C = 5\text{ A}; I_B = 5.0\text{ A}$	V_{BEsat} max.	1.5	V
Transition frequency $I_C = 0.5\text{ A}; V_{CE} = 10\text{ V}; f = 1\text{ MHz}$	f_T typ.	4.0	MHz
Collector capacitance $V_{CB} = 10\text{ V}; I_E = 0$	C_{ob} typ.	80	pF
Switching times, resistive load (Figs 2 and 3) $V_{CC} = 125\text{ V}; I_C = 5\text{ A}; t_p = 25\text{ } \mu\text{s};$ $I_{B\text{ on}} = I_{B\text{ off}} = 1.0\text{ A}$	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) $I_C = 5\text{ A}; V_{CL} = 300\text{ V}; T_c = 100\text{ }^\circ\text{C};$ $I_{B\text{ on}} = 1.0\text{ A}; V_{BE\text{ off}} = 5\text{ V}$	t_s typ.	0.86	μs
	t_s max.	2.3	μs
	t_c typ.	0.14	μs
	t_c max.	0.7	μs



$V_{CC} = 125 \text{ V}$
 $V_{im} = -6 \text{ to } 8 \text{ V}$
 The values of R_B and R_L are selected in accordance with $I_{C\text{on}}$ and I_B requirements.

Fig. 2 Test circuit resistive load.

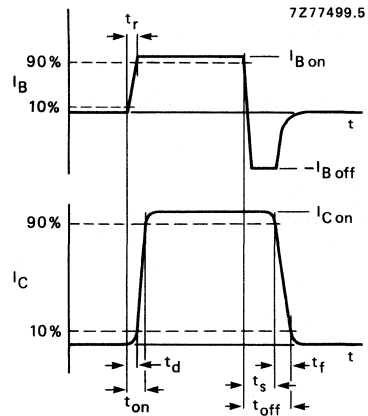
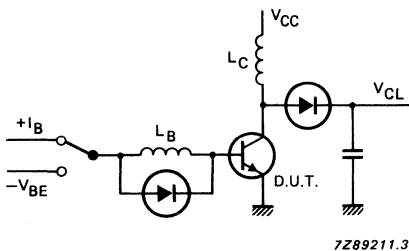


Fig. 3 Switching times waveforms with resistive load; $t_r \leq 30 \text{ ns}$.



$V_{CC} = 300 \text{ V}$
 $V_{CL} = 300 \text{ V}$
 $L_C = 250 \mu\text{H}$
 $L_B = 1 \mu\text{H}$

Fig. 4 Test circuit inductive load.

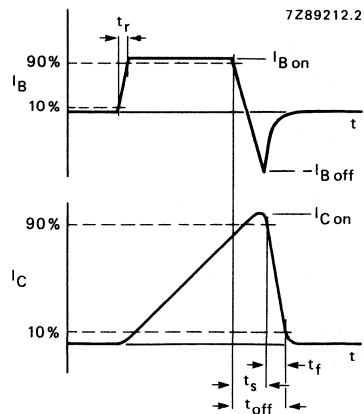
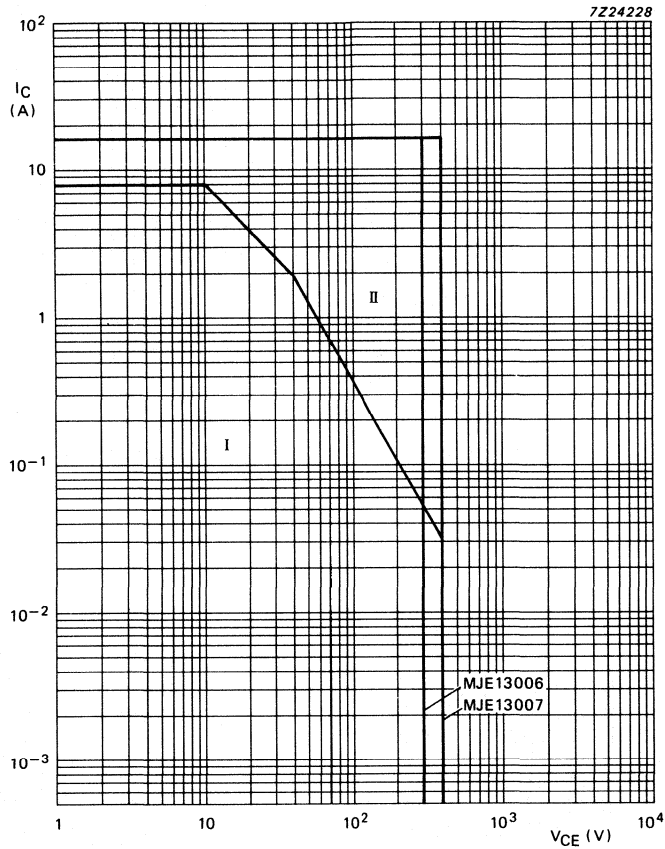


Fig. 5 Switching times waveforms with inductive load.

DEVELOPMENT DATA



- I Region of permissible DC operation.
- II Permissible extension for repetitive pulse operation.

Fig. 6 Safe operating area.

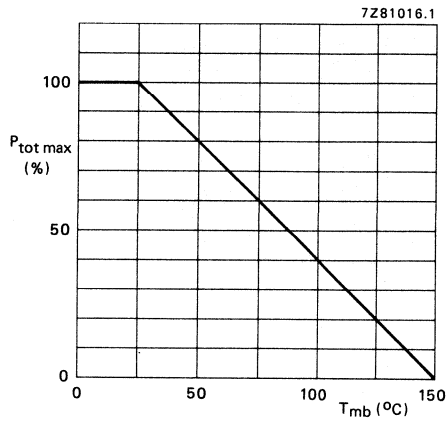


Fig. 7 Total power dissipation.

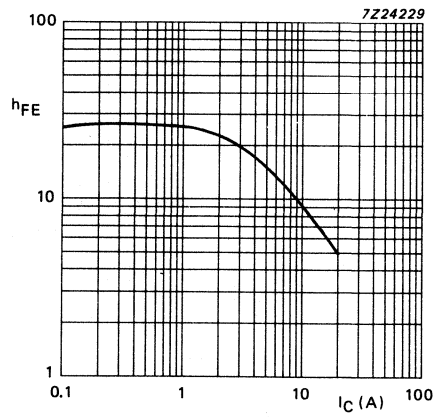


Fig. 8 DC current gain; $V_{CE} = 5$ V;
 $T_j = 25$ °C.

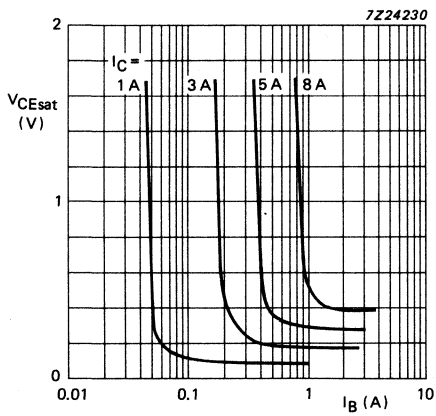


Fig. 9 Collector-emitter saturation voltage
as a function of base current; $T_j = 25$ °C.

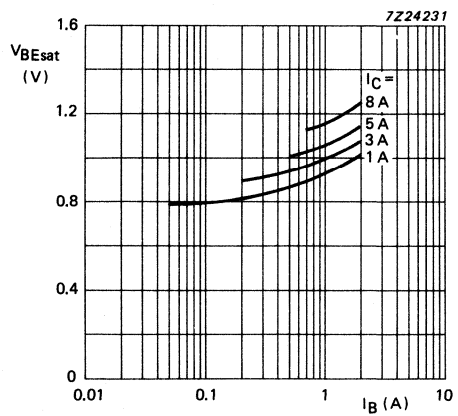


Fig. 10 Base-emitter saturation voltage as a
function of base current; $T_j = 25$ °C.

DEVELOPMENT DATA

This data sheet contains advance information and specifications are subject to change without notice.

MJE 13008
MJE 13009

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.

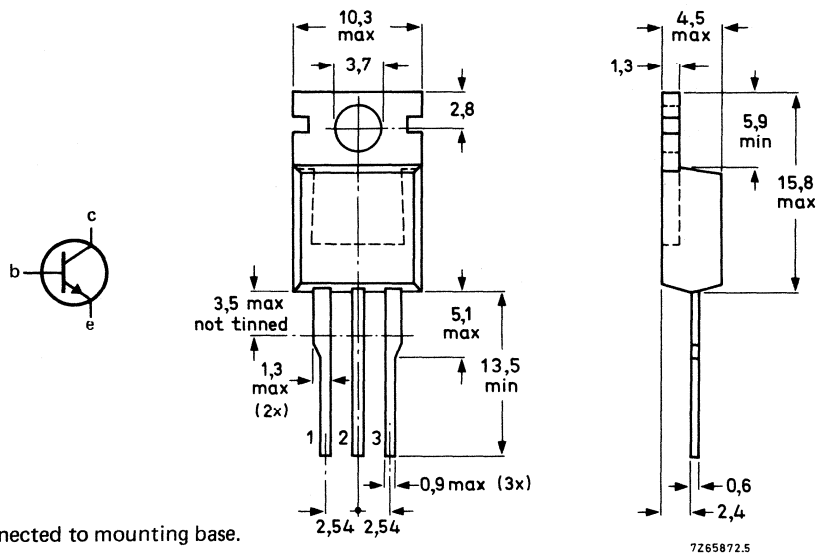
QUICK REFERENCE DATA

			MJE13008	13009
Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM}	max.	600	700 V
	V_{CEO}	max.	300	400 V
Collector-emitter saturation voltage	V_{CEsat}	max.	1.5 V	
Collector current saturation DC peak value	I_{Csat}	max.	8.0	A
	I_C	max.	12	A
	I_{CM}	max.	24	A
Total power dissipation up to $T_{mb} = 25^\circ\text{C}$	P_{tot}	max.	100	W

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-220AB.



RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

		MJE13008	13009
Collector-emitter voltage peak value; $V_{BE} = 0$ open base	V_{CESM} max.	600	700 V
	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 $T_a = 25^\circ\text{C}$ derate above 25°C	P_{tot} max.	2	W
			16 mW/K
Total power dissipation up to $T_{mb} = 25^\circ\text{C}$ derate above 25°C	P_{tot} max.	100	W
			800 mW/K
Operating junction temperature range	T_j	-65 to +150	$^\circ\text{C}$
Storage temperature range	T_{stg}	-65 to +150	$^\circ\text{C}$

THERMAL RESISTANCE

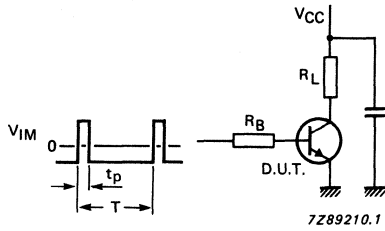
From junction to mounting base	$R_{th\ j-mb}$ =	1.25	K/W
From junction to ambient	$R_{th\ j-a}$ =	62.5	K/W

CHARACTERISTICS

 $T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified

DEVELOPMENT DATA

		MJE13008	13009
Collector-emitter sustaining voltage $I_C = 10\text{ mA}; I_B = 0$	$V_{CE0\text{ sust}}$ min.	300	400 V
Collector cut-off current $V_{CE} = V_{CESM\text{max}}; V_{BE} = -1.5\text{ V}$ $V_{CE} = V_{CESM\text{max}}; V_{BE} = -1.5\text{ V};$ $T_C = 100\text{ }^\circ\text{C}$	I_{CEX} max.	1.0	mA
	I_{CEX} max.	5.0	mA
Emitter cut-off current $V_{EB} = 9\text{ V}; I_C = 0$	I_{EBO} max.	1.0	mA
Current gain $I_C = 5\text{ A}; V_{CE} = 5\text{ V}$ $I_C = 8\text{ A}; V_{CE} = 5\text{ V}$	h_{FE}	8 to 40	
	h_{FE}	6 to 30	
Collector-emitter saturation voltage $I_C = 5\text{ A}; I_B = 1.0\text{ A}$ $I_C = 8\text{ A}; I_B = 1.6\text{ A}$ $I_C = 12\text{ A}; I_B = 3.0\text{ A}$ $I_C = 8\text{ A}; I_B = 1.6\text{ A}; T_C = 100\text{ }^\circ\text{C}$	$V_{CE\text{sat}}$ max.	1.0	V
	$V_{CE\text{sat}}$ max.	1.5	V
	$V_{CE\text{sat}}$ max.	3.0	V
	$V_{CE\text{sat}}$ max.	2.0	V
Base-emitter saturation voltage $I_C = 5\text{ A}; I_B = 1.0\text{ A}$ $I_C = 8\text{ A}; I_B = 1.6\text{ A}$ $I_C = 8\text{ A}; I_B = 1.6\text{ A}; T_{mb} = 100\text{ }^\circ\text{C}$	$V_{BE\text{sat}}$ max.	1.2	V
	$V_{BE\text{sat}}$ max.	1.6	V
	$V_{BE\text{sat}}$ max.	1.5	V
Transition frequency $I_C = 0.5\text{ A}; V_{CE} = 10\text{ V}; f = 1\text{ MHz}$	f_T typ.	4.0	MHz
Collector capacitance $V_{CB} = 10\text{ V}; I_E = 0$	C_{ob} typ.	100	pF
Switching times, resistive load (Figs 2 and 3) $V_{CC} = 125\text{ V}; I_C = 8\text{ A}; t_p = 25\text{ } \mu\text{s};$ $I_{Bon} = I_{Boff} = 1.6\text{ A}$	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) $I_C = 8\text{ A}; V_{CL} = 300\text{ V}; T_C = 100\text{ }^\circ\text{C};$ $I_{Bon} = 1.6\text{ A}; V_{BE\text{off}} = 5\text{ V}$	t_s typ.	0.92	μs
	t_s max.	2.3	μs
	t_f typ.	0.12	μs
	t_f max.	0.7	μs



$V_{CC} = 125 \text{ V}$
 $V_{im} = -6 \text{ to } 8 \text{ V}$
 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.

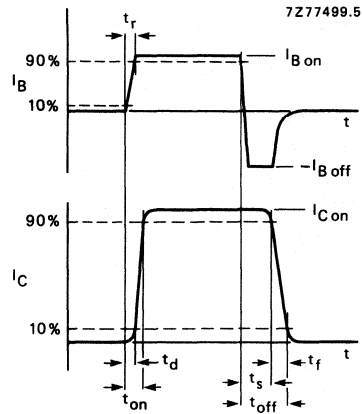
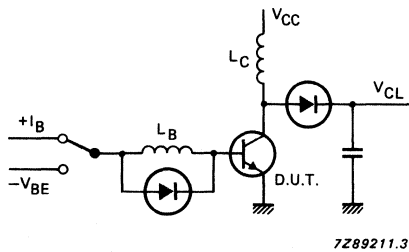


Fig. 3 Switching times waveforms with resistive load; $t_r \leq 30 \text{ ns}$.



$V_{CL} = 300 \text{ V}$
 $V_{CC} = 30 \text{ V}$
 $L_C = 200 \mu\text{H}$
 $L_B = 1 \mu\text{H}$

Fig. 4 Test circuit inductive load.

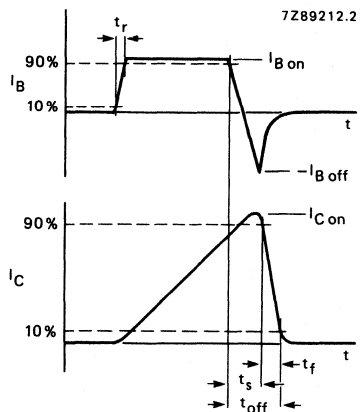


Fig. 5 Switching times waveforms with inductive load.

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.

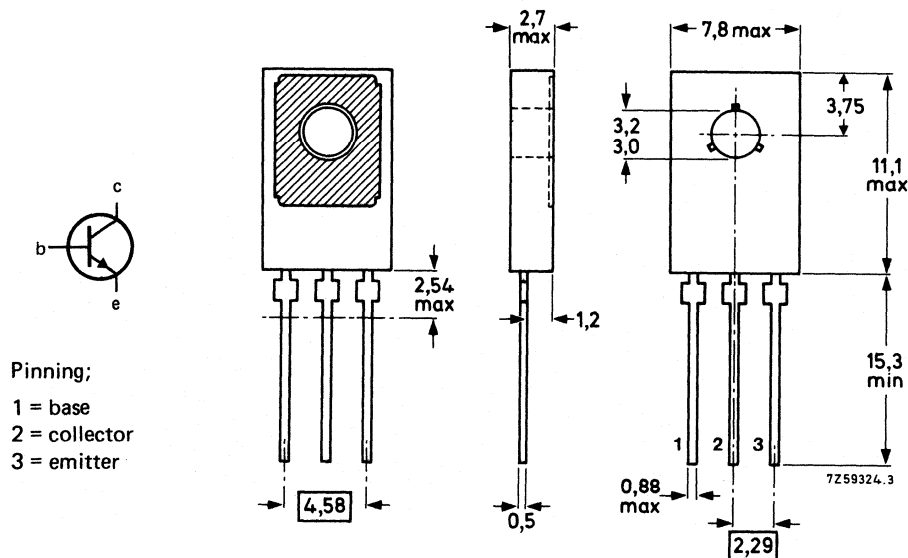
QUICK REFERENCE DATA

		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 $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot} max.		28 W

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-126.



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 $T_{amb} = 25\text{ }^\circ\text{C}$ Derate above $25\text{ }^\circ\text{C}$	P_{tot} max. =	1,25 10	W mW/K
Total power dissipation up to $T_c = 25\text{ }^\circ\text{C}$ Derate above $25\text{ }^\circ\text{C}$	P_{tot} max. =	28 224	W mW/K
Storage temperature range	T_{stg}	-65 to +150	$^\circ\text{C}$
Junction temperature	T_j max.	150	$^\circ\text{C}$

THERMAL RESISTANCE

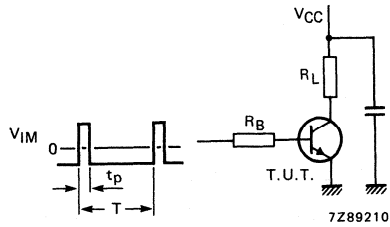
From junction to mounting base	$R_{th\ j-mb}$ =	4,5	K/W
From junction to ambient	$R_{th\ j-a}$ =	100	K/W

CHARACTERISTICS

$T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified

Collector-emitter sustaining voltage $I_B = 0$; $I_C = 10\text{ mA}$	$V_{CEOsust}$ min.	300	400 V
Collector cut-off current $V_{CE} = V_{CESMmax}$; $V_{BE} = -1,5\text{ V}$ $V_{CE} = V_{CESMmax}$; $V_{BE} = -1,5\text{ V}$; $T_c = 100\text{ }^\circ\text{C}$	I_{CEX} max. max.	1,0 5,0	mA mA
Emitter cut-off current $I_C = 0$; $V_{EB} = 9\text{ V}$	I_{EBO} max.	1,0	mA
DC current gain $I_C = 0,5\text{ A}$; $V_{CE} = 2\text{ V}$	h_{FE} min. max.	8 40	
$I_C = 1\text{ A}$; $V_{CE} = 2\text{ V}$	h_{FE} min. max.	5 25	

Transition frequency at $f = 1 \text{ MHz}$ $I_C = 0,1 \text{ A}; V_{CE} = 10 \text{ V}$	f_T	min.	4 MHz
Saturation voltages $I_C = 0,5 \text{ A}; I_B = 0,1 \text{ A}$	V_{CEsat}	max.	0,5 V
	V_{BEsat}	max.	1,0 V
$I_C = 1,0 \text{ A}; I_B = 0,25 \text{ A}$	V_{CEsat}	max.	1,0 V
	V_{BEsat}	max.	1,2 V
$I_C = 1,0 \text{ A}; I_B = 0,25 \text{ A}; T_C = 100 \text{ }^\circ\text{C}$	V_{CEsat}	max.	1,0 V
	V_{BEsat}	max.	1,1 V
$I_C = 1,5 \text{ A}; I_B = 0,5 \text{ A}$	V_{CEsat}	max.	3 V
Collector capacitance at $f = 1 \text{ MHz}$ $I_E = i_e = 0; V_{CB} = 10 \text{ V}$	C_C	typ.	12 pF
Switching times (resistive load) $I_{Con} = 1 \text{ A}; t_p = 25 \text{ } \mu\text{s};$ $I_{Bon} = -I_{Boff} = 0,2 \text{ A}$ (see Figs 2 and 3)	t_d	max.	0,1 μs
	t_r	max.	1,0 μs
	t_s	max.	4,0 μs
	t_f	max.	0,7 μs
Switching times (inductive load) $I_{Con} = 1 \text{ A}; I_{Bon} = 0,2 \text{ A};$ $V_{BEoff} = 5 \text{ V}; T_C = 100 \text{ }^\circ\text{C}$ (see Figs 4 and 5)	t_s	typ.	1,7 μs
		max.	4,0 μs
	t_c	typ.	0,29 μs
		max.	0,75 μs
	t_f	typ.	0,15 μs



$V_{CC} = 125 \text{ V}$
 $V_{IM} = -6 \text{ to } 8 \text{ V}$
 The values of R_B and R_L are selected in accordance with the $I_{C\text{on}}$ and I_B requirements.

Fig. 2 Test circuit resistive load.

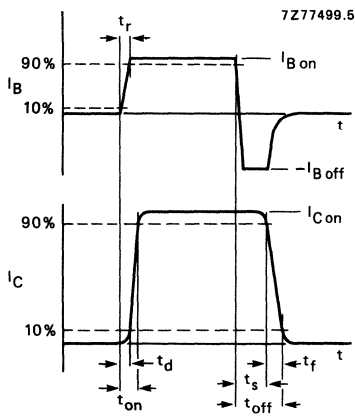


Fig. 3 Switching times waveforms with resistive load.

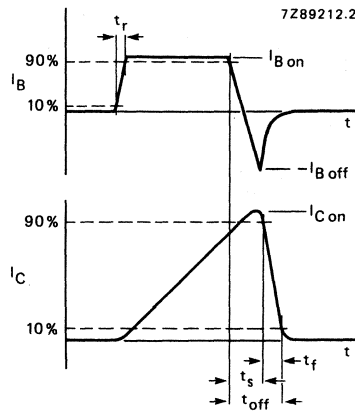
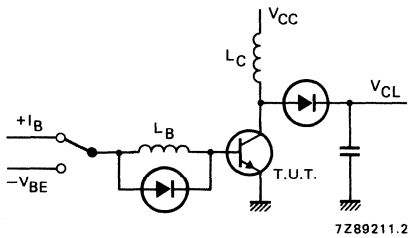
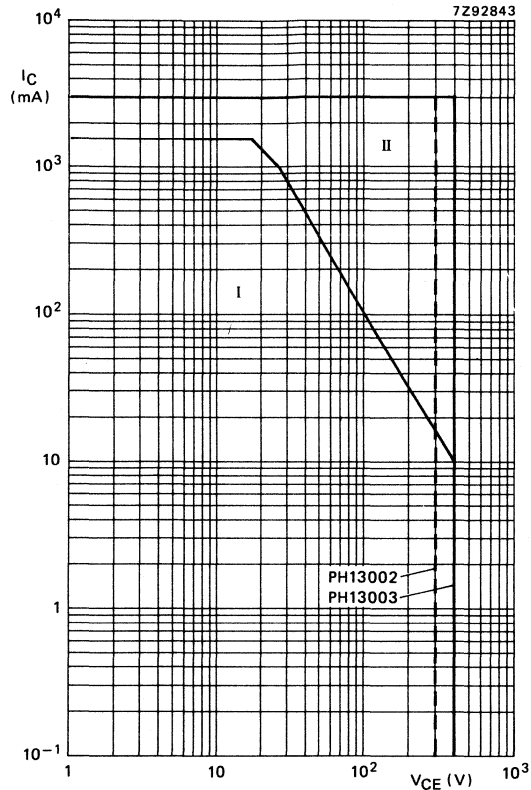


Fig. 4 Switching times waveforms with inductive load.



$V_{CC} = 30 \text{ V}$
 $V_{CL} = 300 \text{ V}$
 $L_C = 200 \mu\text{H}$
 $L_B = 1 \mu\text{H}$

Fig. 5 Test circuit inductive load.



- I Region of permissible DC operation
- II Permissible extension for repetitive pulse operation.

Fig. 6 Safe operating area.

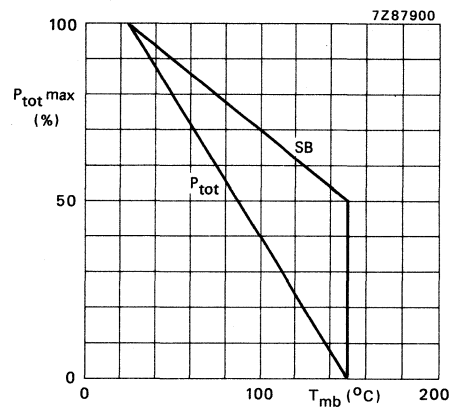


Fig. 7 Total power dissipation and second-breakdown current derating curve.

SILICON DIFFUSED POWER TRANSISTORS

Medium-voltage, high-speed, glass-passivated NPN power transistors in TO-220 envelope for amplifier and switching applications.

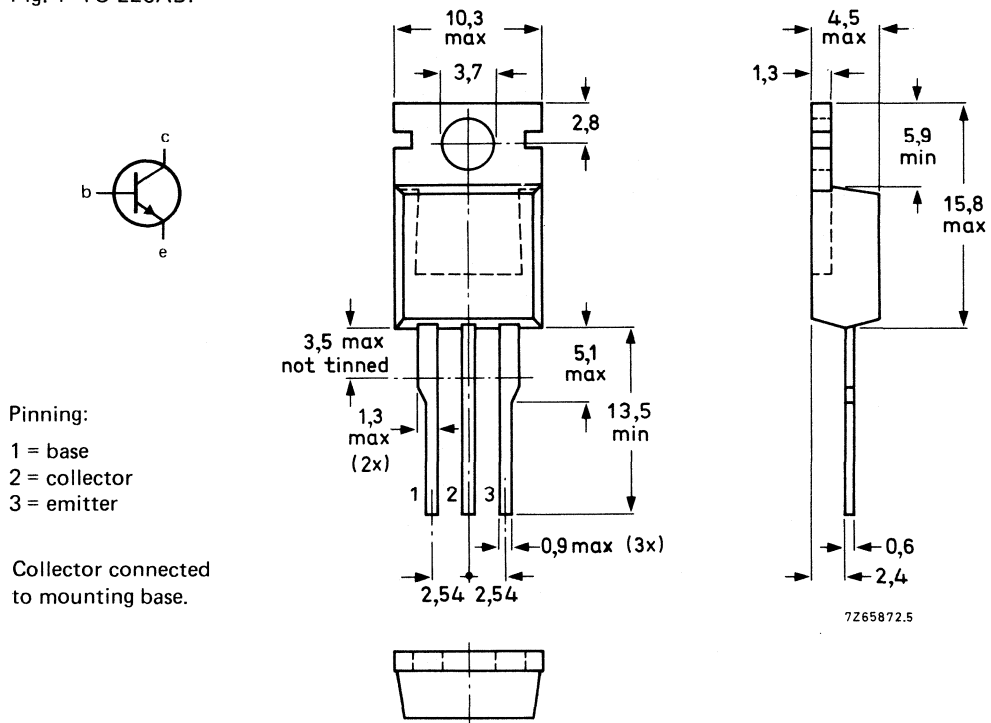
QUICK REFERENCE DATA

			TIP47	48	49	50	
Collector-base voltage (open emitter)	V_{CB0}	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 $T_{mb} = 25\text{ }^{\circ}\text{C}$	P_{tot}	max.			40		W
Turn-off time	t_{off}	typ.			2		μs

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-220AB.



TIP47; TIP48 TIP49; TIP50

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	$R_{th\ j-mb}$	=			3,12		K/W
From junction to ambient in free air	$R_{th\ j-a}$	=			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
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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
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Base-emitter voltage

$V_{CE} = 10$ V; $I_C = 1$ A	V_{BE}	max.			1,5		V
------------------------------	----------	------	--	--	-----	--	---

Transition frequency

$V_{CE} = 10$ V; $I_C = 0,2$ A; $f = 2$ MHz	f_T	min.			5		MHz
---	-------	------	--	--	---	--	-----

Small-signal current gain

$V_{CE} = 10$ V; $I_C = 0,2$ A; $f = 1$ kHz	h_{fe}	min.			25		
---	----------	------	--	--	----	--	--

Turn-off breakdown energy

$L = 100 \text{ mH}; I_C = 0,63 \text{ A}$

$E_{(BR)}$	max.	20	mJ
------------	------	----	----

Collector-emitter sustaining voltage

$I_C = 30 \text{ mA}; I_B = 0;$

$L = 25 \text{ mH}$

TIP47	$V_{CEOsust}$	max.	250	V
TIP48	$V_{CEOsust}$	max.	300	V
TIP49	$V_{CEOsust}$	max.	350	V
TIP50	$V_{CEOsust}$	max.	400	V

Switching times

$I_C = 1 \text{ A}; I_{B \text{ on}} = -I_{B \text{ off}} = 100 \text{ mA};$

$V_{CC} = 200 \text{ V}$

turn-on time

t_{on}	typ.	0,2	μs
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turn-off time

t_{off}	typ.	2,0	μs
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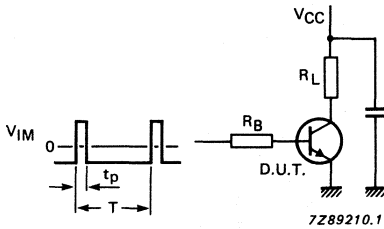


Fig. 2 Switching times test circuit with resistive load;
 $V_{IM} = -5 \text{ to } +8 \text{ V}; V_{CC} = 200 \text{ V};$
 $t_p = 20 \mu\text{s}; \delta = t_p/T = 1\%.$
The values of R_B and R_L are selected in accordance with $I_{C \text{ on}}$ and I_B requirements.

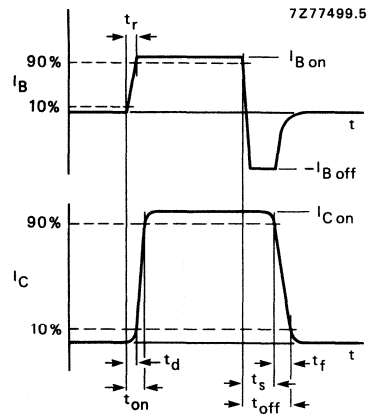
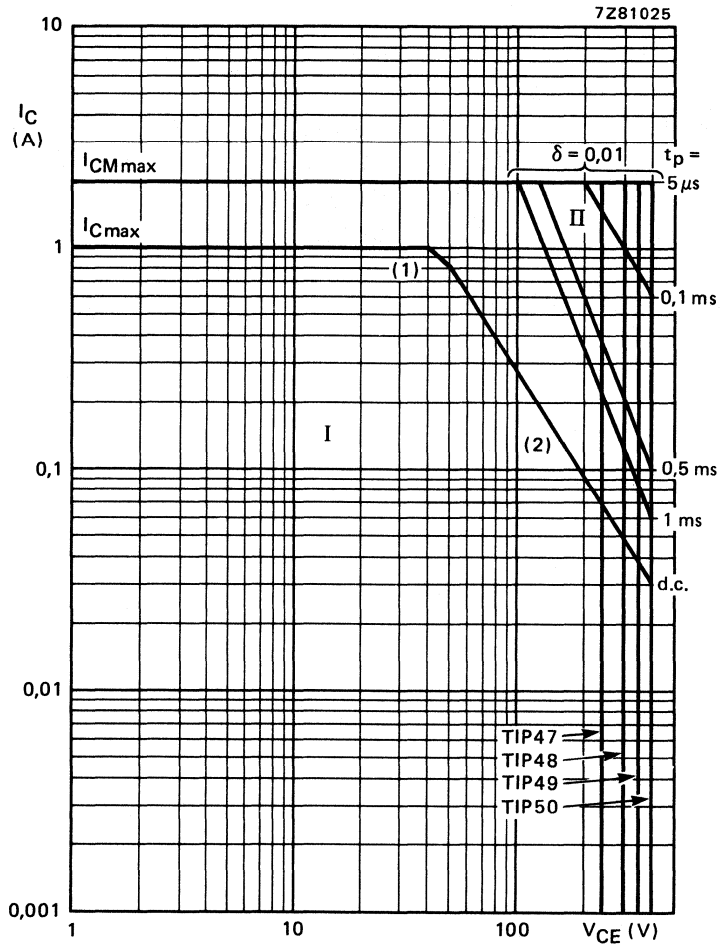


Fig. 3 Switching times waveforms.



- I Region of permissible DC operation.
- II Permissible extension for repetitive pulse operation.
- (1) $P_{tot\ max}$ and $P_{tot\ peak\ max}$ lines.
- (2) Second-breakdown limits.

Fig. 4 Safe operating area at $T_{mb} \leq 25\ ^\circ\text{C}$.

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) up to 300 V	56326	M3	56387a	56387b	56326	M2,5
TO-220 (SOT78) up to 800 V up to 1000 V	56360a	M3	56359b 56359b	56359c 56359d	56360a 56360a	M3 M3
SOT186	56360a	M3				
SOT93	—	M4	56368a	56368b		M3
SOT199	—	M				
TO-3 (SOT3) up to 500 V	—	M4	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

ACCESSORIES

Mounting TO-126 and SOT82 envelopes.

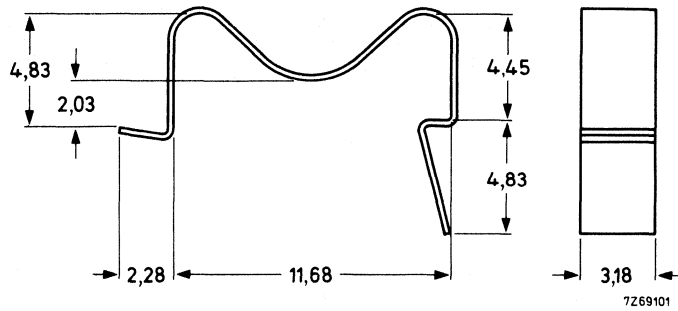
56353

CLIP for TO-126 and SOT82 envelopes

MECHANICAL DATA

Material: high carbon spring steel

Dimensions in mm



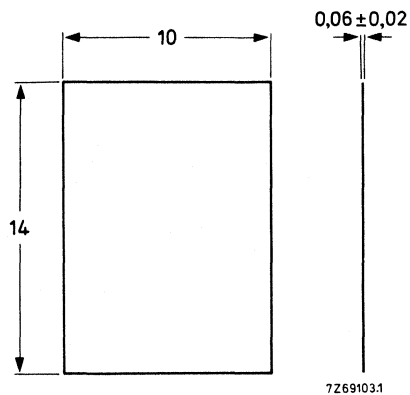
Spring clip suitable for heatsink of 1,5 to 2 mm.

56354

MICA INSULATOR for TO-126 and SOT82 envelopes

MECHANICAL DATA

Dimensions in mm



Mounting of TO-126 envelopes

56326

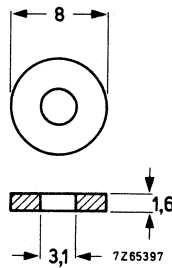
WASHER

for direct mounting of TO-126 envelopes

MECHANICAL DATA

Material: brass, nickel plated

Dimensions in mm



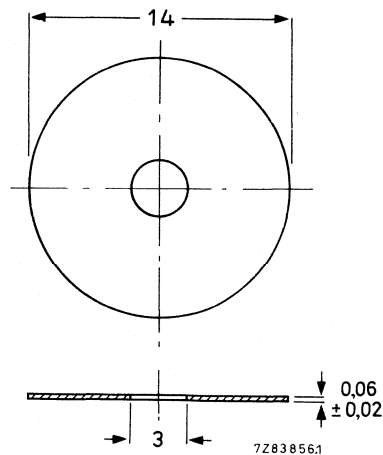
56387a

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

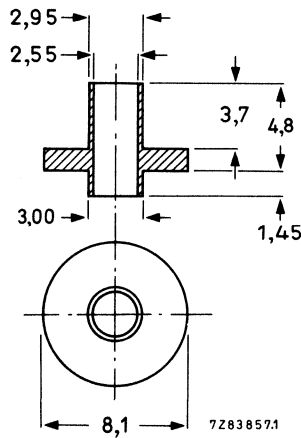
INSULATING BUSH

for insulated screw mounting of TO-126 envelopes (up to 300 V)

MECHANICAL DATA

Material: polyester

Dimensions in mm



TEMPERATURE

Maximum permissible temperature

T_{\max} 150 °C

Clip mounting TO-220 envelopes

56363

SPRING CLIP

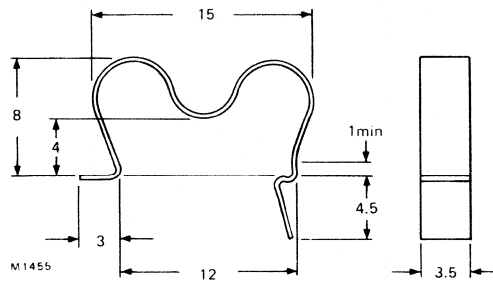
for direct mounting of TO-220 envelopes

MECHANICAL DATA

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).

Dimensions in mm



56364

SPRING CLIP

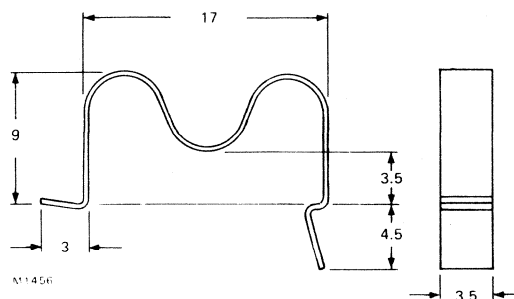
for insulated mounting of TO-220 envelopes

MECHANICAL DATA

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).

Dimensions in mm

To be used in
conjunction with
insulators 56367
or 56369

Clip mounting TO-220 envelopes

56367

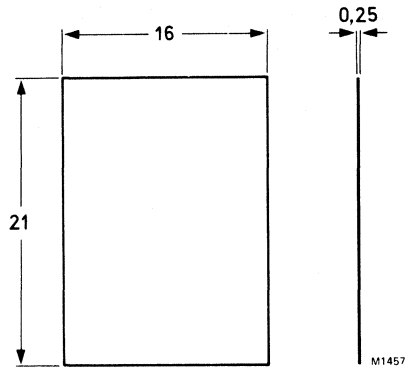
ALUMINA INSULATOR

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.

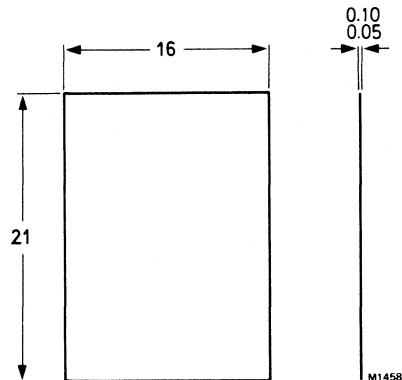
56369

MICA INSULATOR

for insulated clip mounting of TO-220 envelopes (up to 2 kV)

MECHANICAL DATA

Dimensions in mm



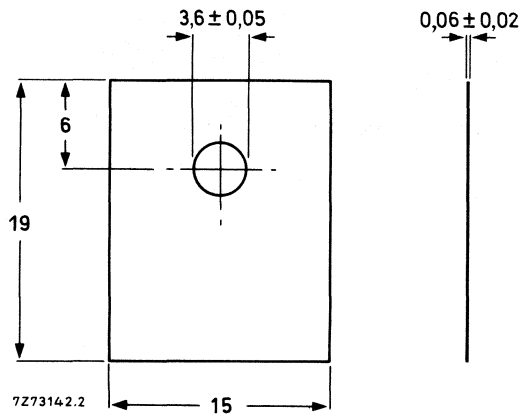
Mounting TO-220 envelopes

56359b

MICAWASHER

for TO-220 envelopes (up to 1000 V)

Dimensions in mm



56360a

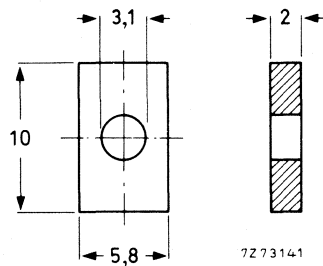
RECTANGULAR WASHER

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

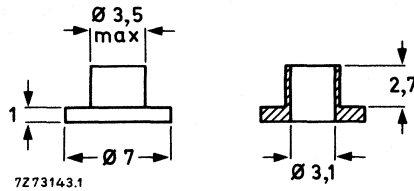
Material: polyester

TEMPERATURE

Maximum permissible temperature

$T_{max} = 150\text{ }^{\circ}\text{C}$

Dimensions in mm



56359d

RECTANGULAR INSULATING BUSH

for TO-220 envelopes (up to 1000 V)

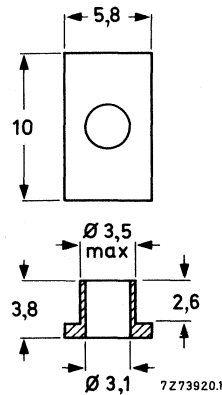
MECHANICAL DATA

TEMPERATURE

Maximum permissible temperature

$T_{max} = 150\text{ }^{\circ}\text{C}$

Dimensions in mm



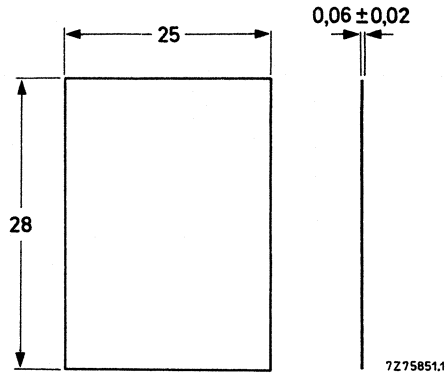
Clip mounting of SOT93 envelopes.

56378

MICA INSULATOR
for SOT93 clip mounting (up to 1500 V)

MECHANICAL DATA

Dimensions in mm



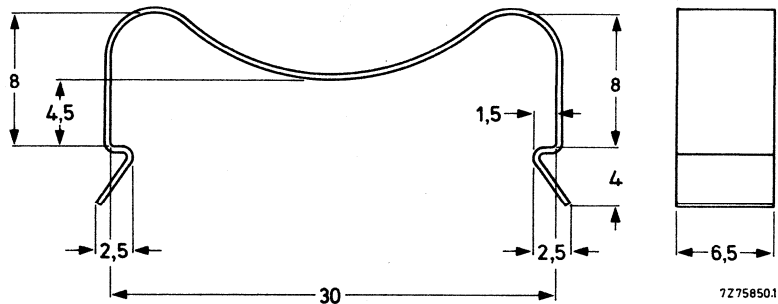
56379

SPRING CLIP
for direct and insulated mounting of SOT93 envelopes

MECHANICAL DATA

Dimensions in mm

Material:
CrNi steel NLN-939;
thickness $0,4 \pm 0,04$.

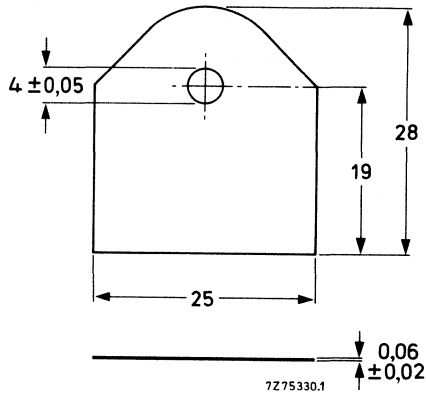


Screw mounting of SOT93 envelopes.

56368a MICA INSULATOR
for insulated screw mounting of SOT93 envelopes (up to 800 V)

MECHANICAL DATA

Dimensions in mm

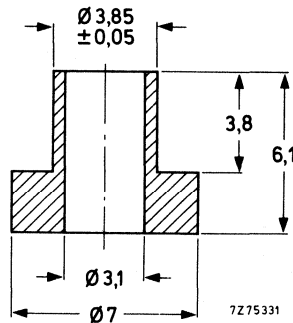


56368b INSULATING BUSH
for insulated screw mounting of SOT93 envelopes (up to 800 V)

MECHANICAL DATA

Dimensions in mm

Material: polyester



TEMPERATURE

Maximum permissible temperature

$T_{max} = 150\text{ }^{\circ}\text{C}$

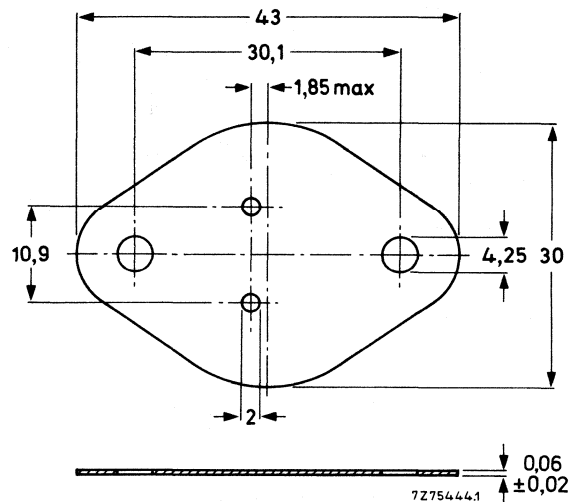
Mounting TO-3 envelopes

56201d MICA WASHER

Mica washer for up to 500 V insulation of TO-3 envelopes.

MECHANICAL DATA

Dimensions in mm



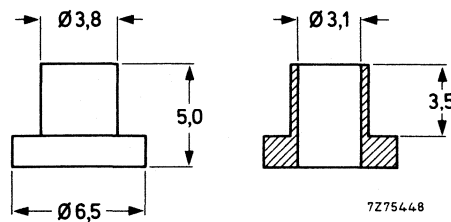
56201j 2 INSULATING BUSHES

Two insulating bushes for up to 500 V insulation of TO-3 envelopes.

MECHANICAL DATA

Dimensions in mm

material: polyester



TEMPERATURE

Maximum permissible temperature

$T_{max} = 150\text{ }^{\circ}\text{C}$

Mounting TO-3 envelopes

56261a

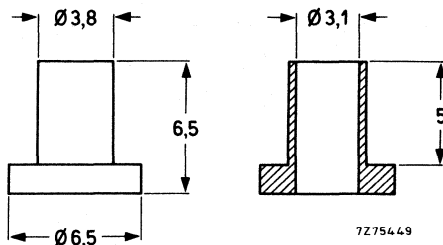
2 INSULATING BUSHES

Two insulating bushes for up to 500 V insulation of TO-3 envelopes.

MECHANICAL DATA

Material: polyester

Dimensions in mm



TEMPERATURE

Maximum permissible temperature

$T_{max} = 150\text{ }^{\circ}\text{C}$

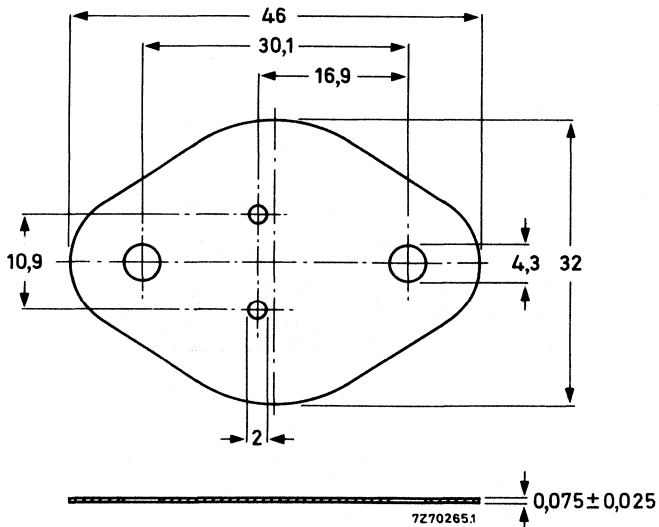
56339

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

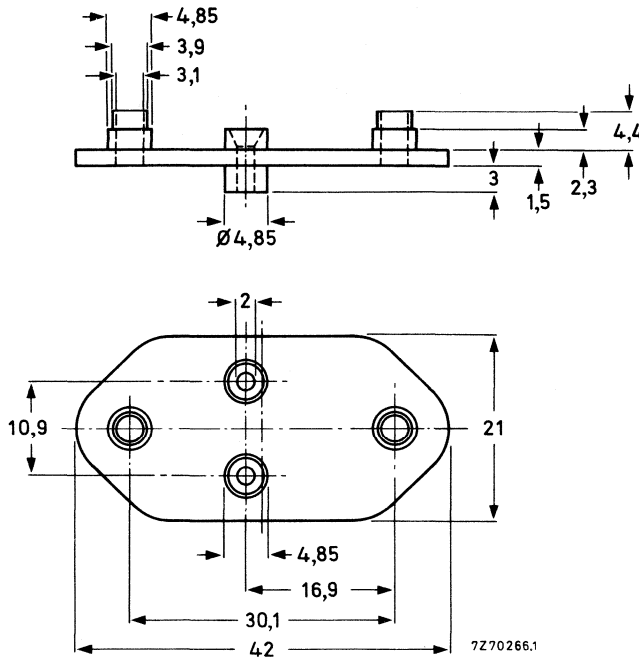
MOUNTING SUPPORT

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 °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 .

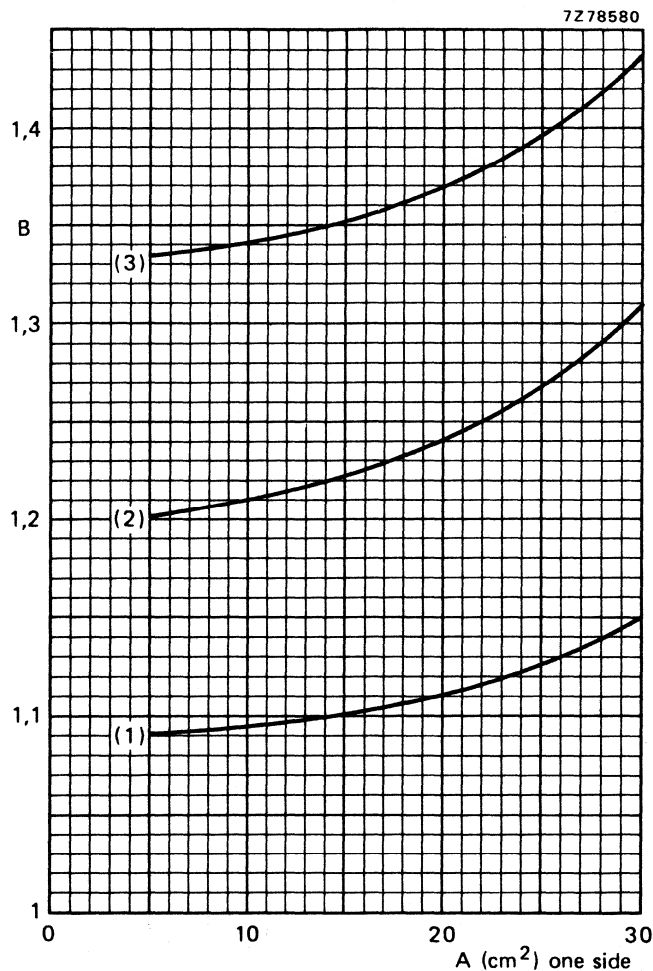


Fig. 1 Multiplication factor (B) as a function of heatsink area (A).

- (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.

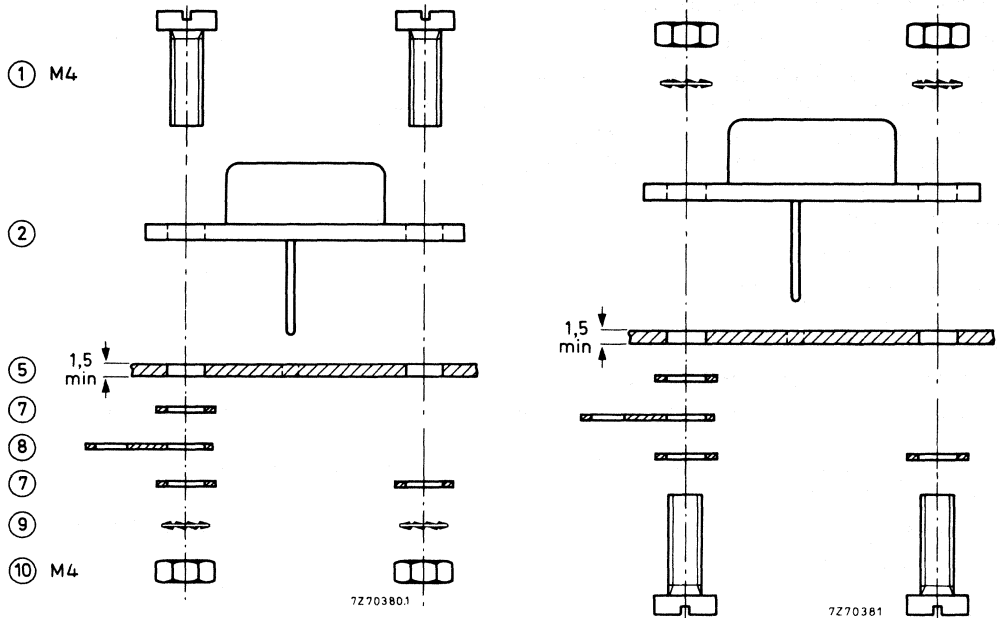
		Direct mounting	Insulated mounting		
			500 V mica	2000 V mica	
From mounting base to heatsink					
without heatsink compound	$R_{th\ mb-h}$	0,6	1,0	1,25	K/W
with heatsink compound	$R_{th\ mb-h}$	0,1	0,3	0,5	K/W

MOUNTING INSTRUCTIONS TO-3

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

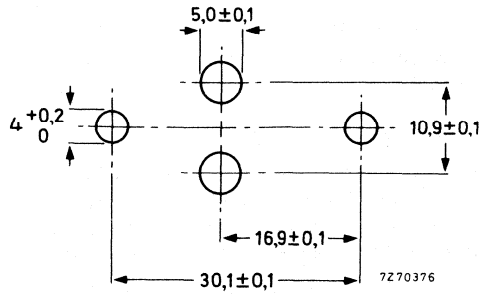


Fig. 3 Hole pattern for direct mounting with nuts.

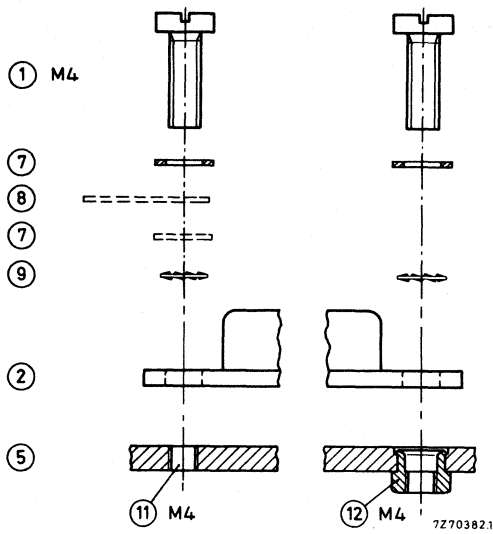


Fig. 4 Direct mounting with tapped holes or insert nuts.

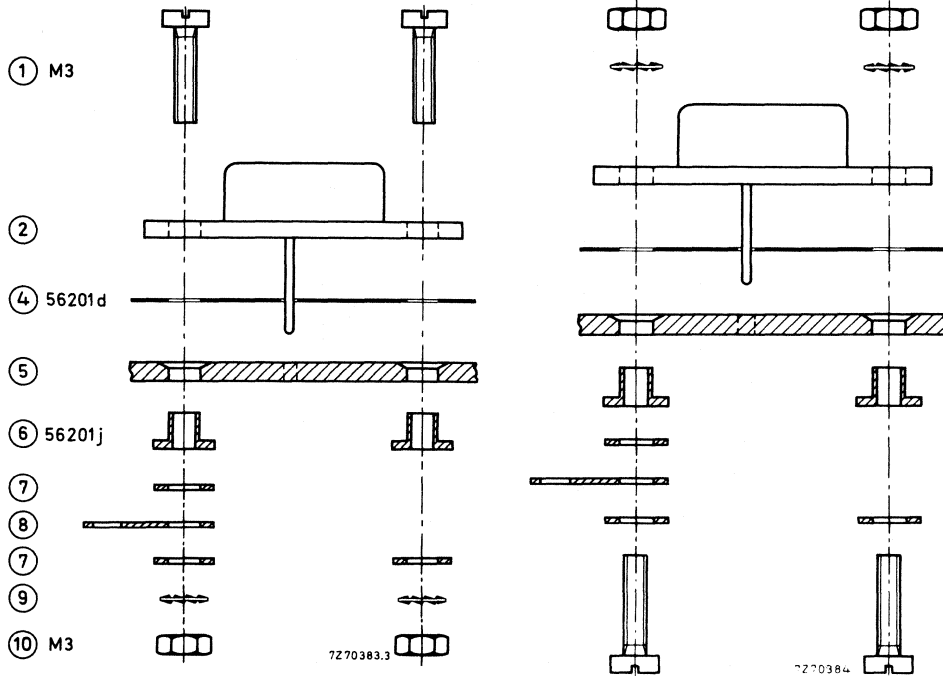
MOUNTING INSTRUCTIONS FOR UP TO 500 V INSULATION

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.

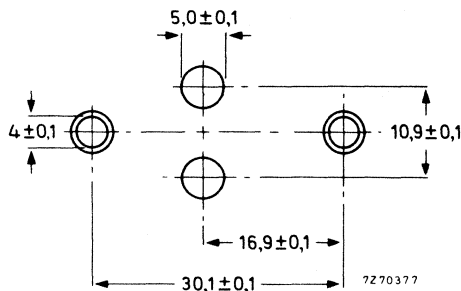


Fig. 7 Hole pattern for 500 V insulation, nut fastening.

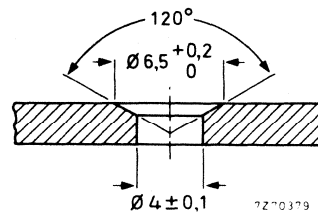


Fig. 8 Shape of hole for 500 V insulation, nut fastening.

For legend see page 652.

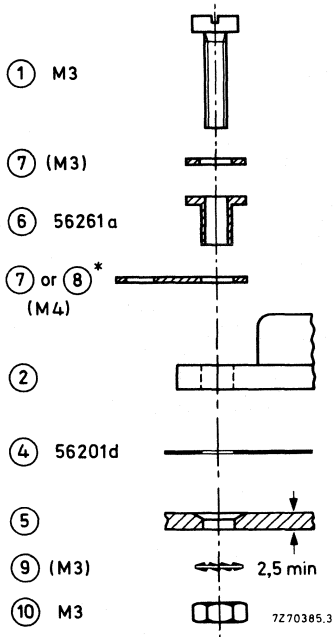


Fig. 9 Insulated mounting (500 V) with nuts.

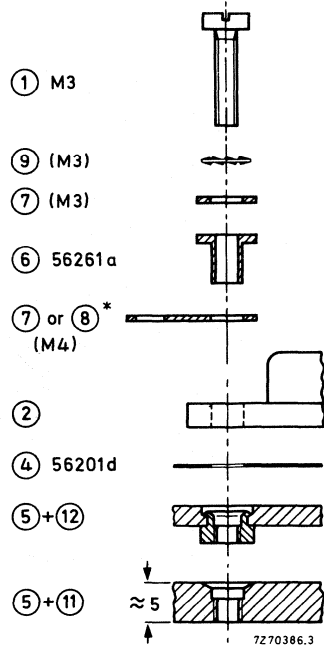


Fig. 10 Insulated mounting (500 V) with tapped holes or insert nuts.

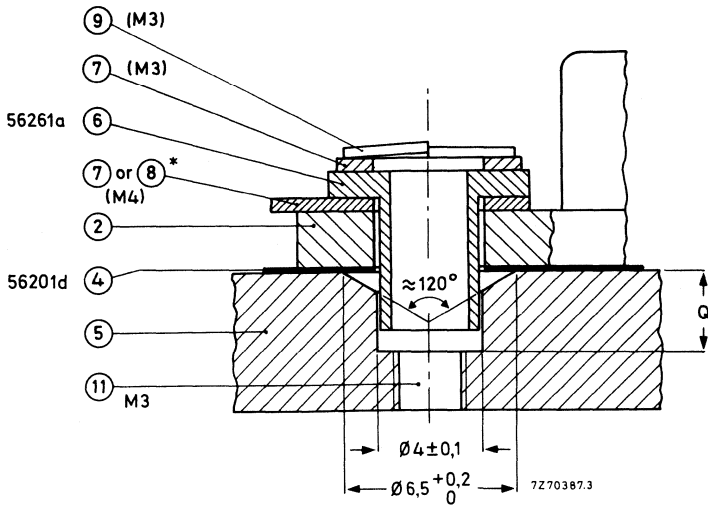


Fig. 11 Assembly (partial) for Fig. 10 - tapped holes.
Q minimum 2,5 mm.

For legend see page 652.

* Thickness approximately 0,6 mm, outer diameter 7,5 mm.

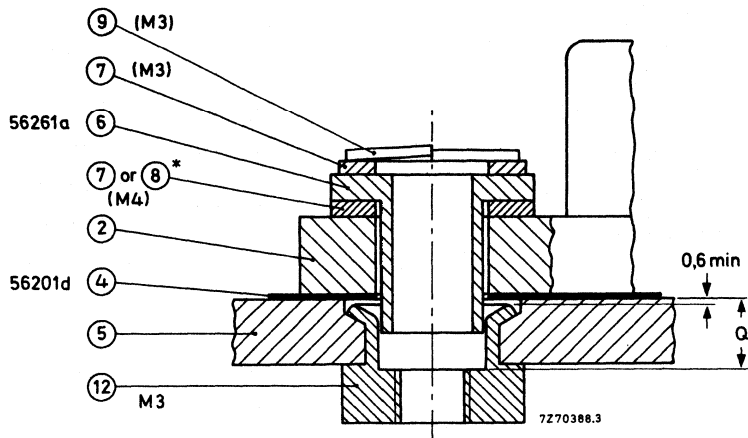


Fig. 12 Assembly (partial) for Fig. 10 - insert nuts Q minimum 2,5 mm.

For legend see page 652.

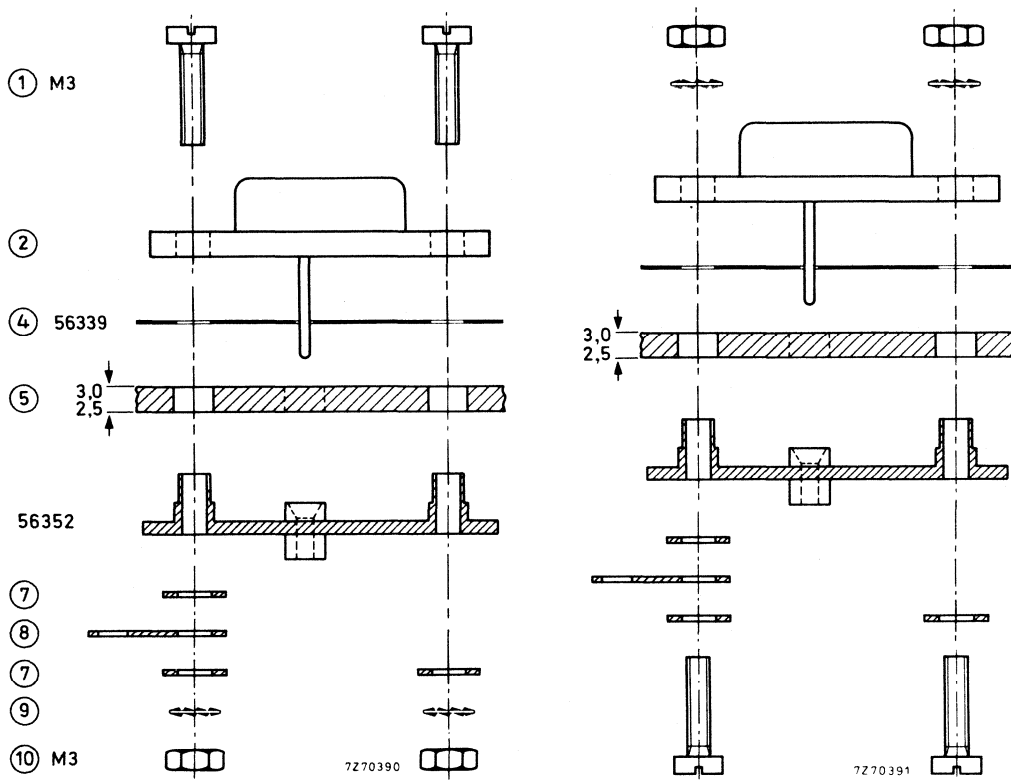
Dimensions in mm

* 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).

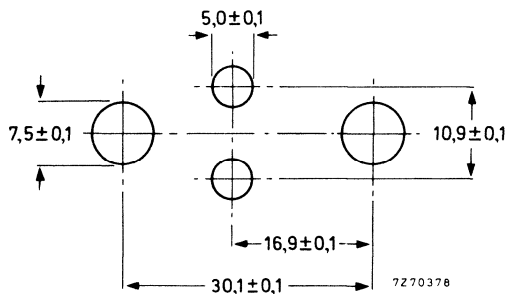


Fig. 15 Hole pattern for Figs 13 and 14.

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° tolerance for M2,5 thread and within 2° 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 ($R_{th\ mb-h}$) 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.

MOUNTING INSTRUCTIONS TO-126/SOT 82

Thermal data

From mounting base to heatsink

	$R_{th\ mb-h}$ (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 Sn/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° 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 (see Fig. 3).

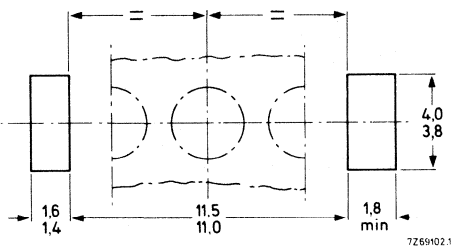


Fig. 1 Heatsink requirements.

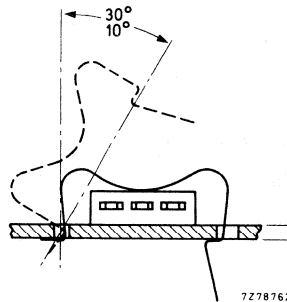


Fig. 2 Mounting spring clip.

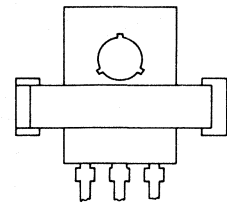


Fig. 3 Position of transistor (top view).

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° to 30° 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.

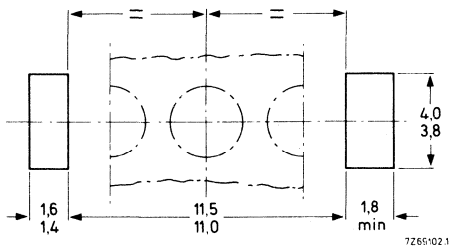
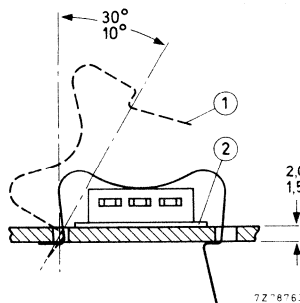


Fig. 4 Heatsink requirements.



(1) spring clip 56353.
(2) insulator 56354.
Fig. 5 Mounting.

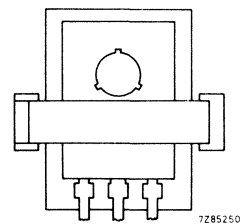


Fig. 6 Position of transistor (top view).

INSTRUCTIONS FOR SCREW MOUNTING
Direct mounting with screw and spacing washer

Dimensions in mm

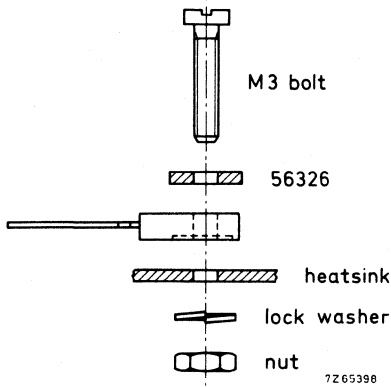


Fig. 7 Assembly through heatsink with nut.

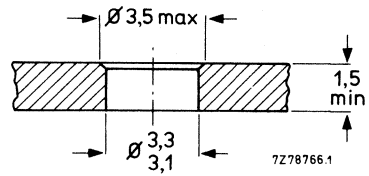


Fig. 8 Heatsink requirements.

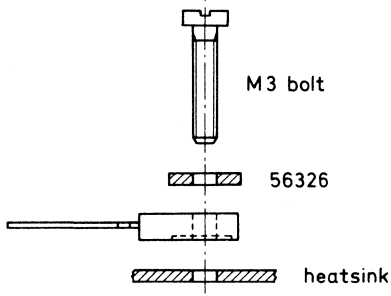


Fig. 9 Assembly into tapped heatsink.

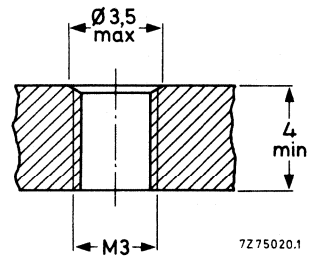
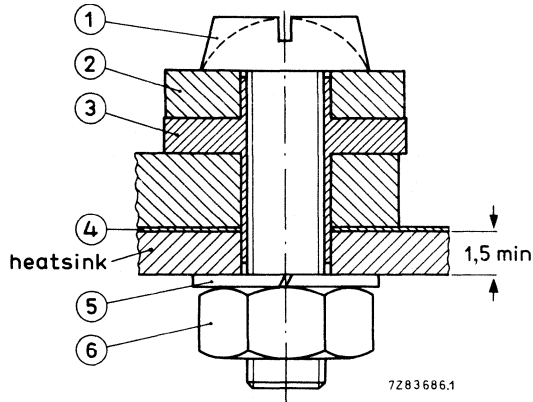


Fig. 10 Heatsink requirements.

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.

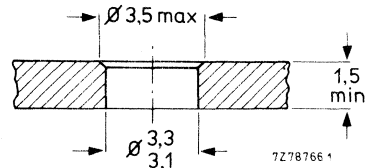
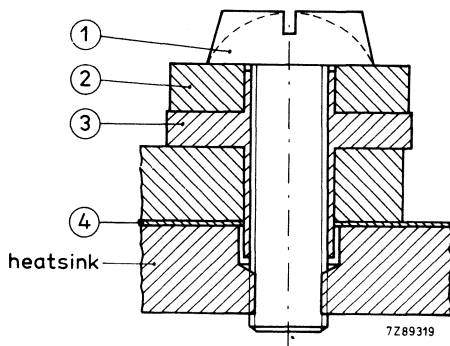


Fig. 16 Heatsink requirements.



- (1) M2,5 screw
- (2) metal washer 56326
- (3) insulating bush 56387b
- (4) mica washer 56387a

Fig. 17 Assembly with tapped heatsink.

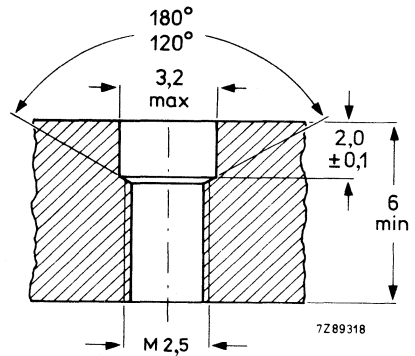


Fig. 18 Heatsink requirements.

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 ($R_{th\ mb-h}$) 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 $R_{th\ mb-h}$ 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-riveted 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	$R_{th\ mb-h}$	= 0,3	0,5	K/W
without heatsink compound, direct mounting	$R_{th\ mb-h}$	= 1,4	1,4	K/W
with heatsink compound and 0,1 mm maximum mica washer	$R_{th\ mb-h}$	= 2,2	—	K/W
with heatsink compound and 0,25 mm maximum alumina insulator	$R_{th\ mb-h}$	= 0,8	—	K/W
with heatsink compound and 0,05 mm mica washer insulated up to 500 V	$R_{th\ mb-h}$	= —	1,4	K/W
insulated up to 800 V/1000 V	$R_{th\ mb-h}$	= —	1,6	K/W
without heatsink compound and 0,05 mm mica washer insulated up to 500 V	$R_{th\ mb-h}$	= —	3,0	K/W
insulated up to 800 V/1000 V	$R_{th\ mb-h}$	= —	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° 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 $T_{j\ max} \leq 175$ °C, soldering temperature $T_{sld\ max} = 275$ °C.

Devices with $T_{j\ max} \leq 110$ °C, soldering temperature $T_{sld\ max} = 240$ °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 Sn/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 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).

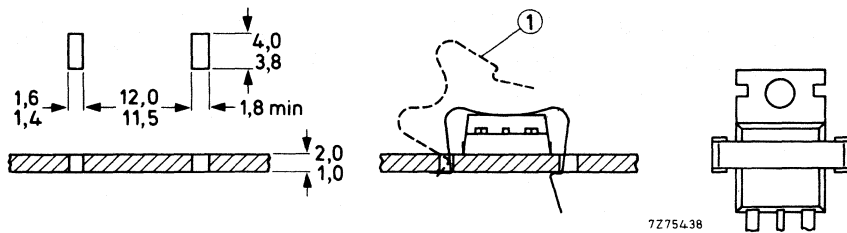


Fig. 1 Heatsink requirements.

(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.

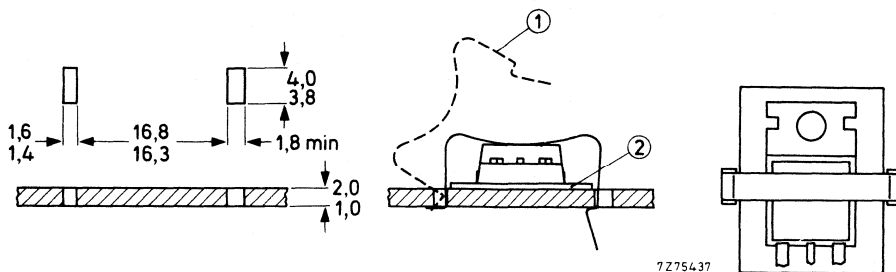


Fig. 3 Heatsink requirements.

(1) spring clip 56364.
(2) insulator 56369 or 56367.
Fig. 4 Mounting.

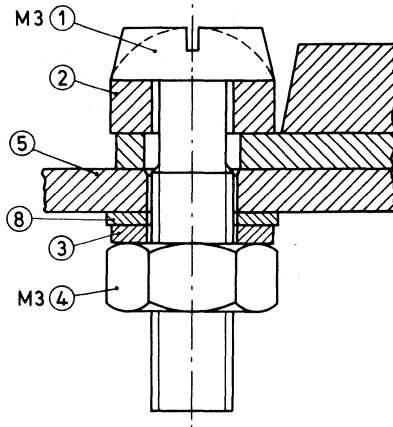
Fig. 4a Position of transistor (top view).

INSTRUCTIONS FOR SCREW MOUNTING

Dimensions in mm

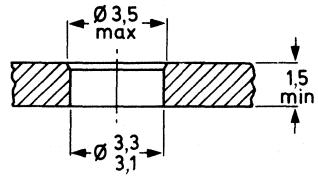
Direct mounting with screw and spacing washer

- *through heatsink with nut*



- (1) M3 screw.
- (2) rectangular washer (56360a).
- (3) lock washer.
- (4) M3 nut.
- (5) heatsink.
- (8) plain washer.

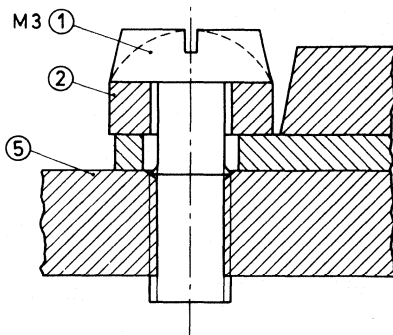
Fig. 5 Assembly.



7Z 69693.2

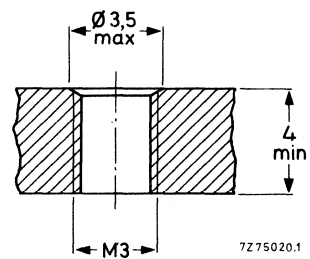
Fig. 6 Heatsink requirements.

- *into tapped heatsink*



- (1) M3 screw.
- (2) rectangular washer 56360a.
- (5) heatsink.

Fig. 7 Assembly.



7Z 75020.1

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*

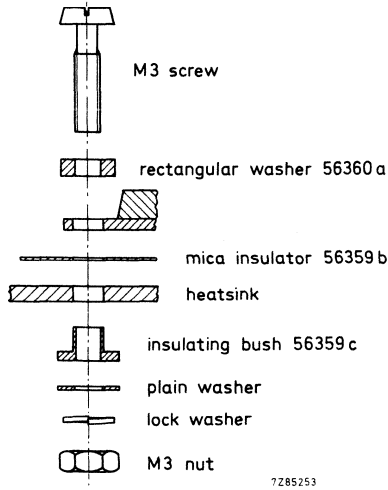


Fig. 9 Insulated screw mounting with rectangular washer. Known as a "bottom mounting".

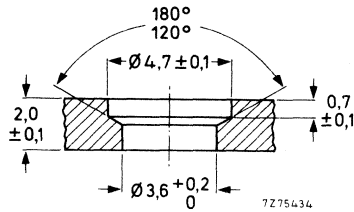


Fig. 10 Heatsink requirements for 500 V insulation.

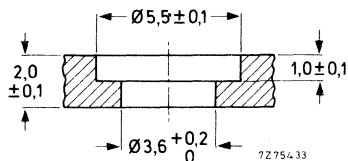


Fig. 11 Heatsink requirements for 800 V insulation.

● *into tapped heatsink*

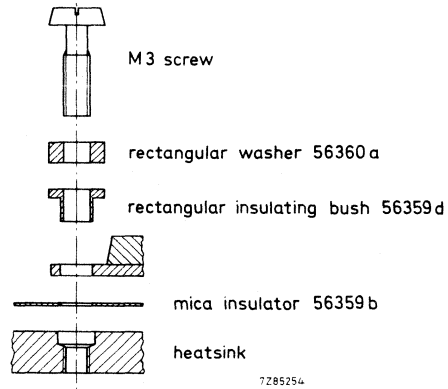


Fig. 12 Insulated screw mounting with rectangular washer into tapped heatsink. Known as a "top mounting".

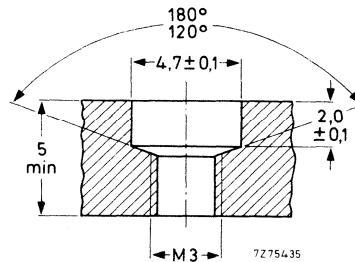


Fig. 13 Heatsink requirements for 500 V insulation.

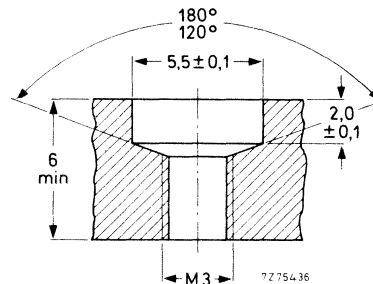


Fig. 14 Heatsink requirements for 1000 V insulation.

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 ($R_{th\ mb-h}$) 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.

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

Thermal resistance from mounting base to heatsink

direct mounting

with heatsink compound

without heatsink compound

with 0,05 mm mica washer

with heatsink compound

without heatsink compound

	clip mounting	screw mounting
$R_{th\ mb-h}$ =	0,3	0,3 K/W
$R_{th\ mb-h}$ =	1,5	0,8 K/W
$R_{th\ mb-h}$ =	0,8	0,8 K/W
$R_{th\ mb-h}$ =	3,0	2,2 K/W

INSTRUCTIONS FOR CLIP MOUNTING

Direct mounting with clip 56379

- Place the device on the heatsink, applying heatsink compound to the mounting base.
- 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).
- 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)).

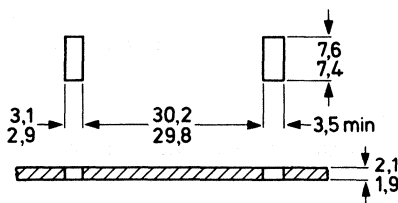
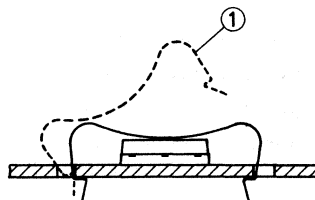


Fig. 1a Heatsink requirements.



(1) spring clip 56379.
Fig. 1b Mounting.

7275849

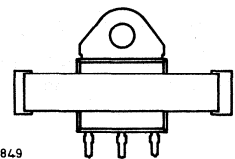


Fig. 1c Position
of the device.

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.

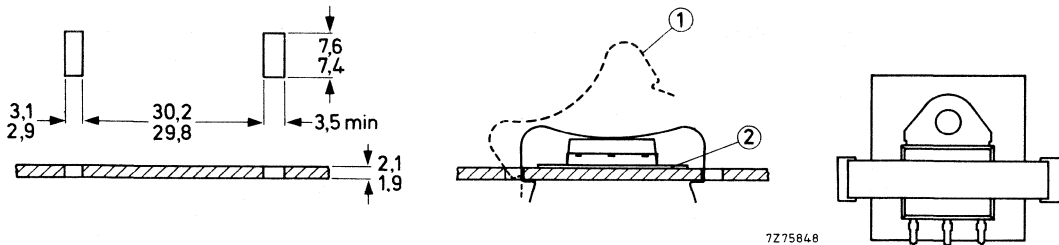


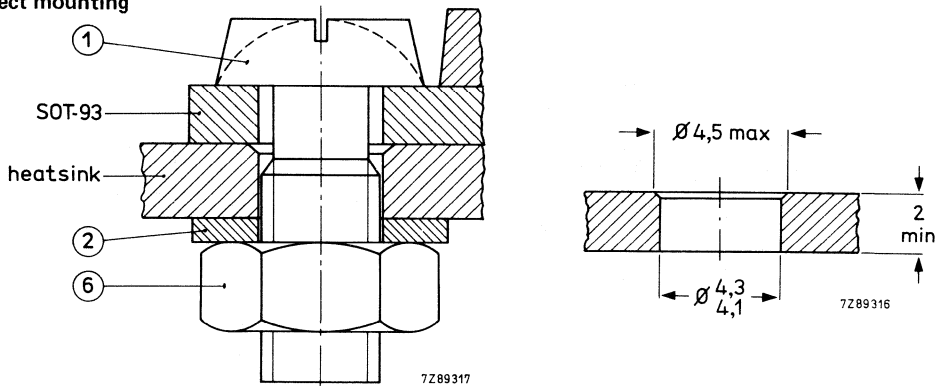
Fig. 2a Heatsink requirements.

(1) spring clip 56379
(2) insulator 56378
Fig. 2b Mounting

Fig. 2c Position of the device.

INSTRUCTIONS FOR SCREW MOUNTING

Direct mounting



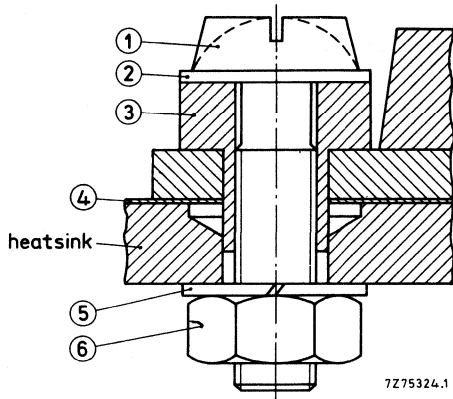
(1) M4 screw; (2) plain washer; (6) M4 nut.
Fig. 3a Assembly through heatsink with nut.

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.

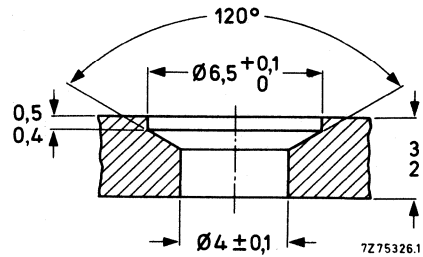


Fig. 5 Heatsink requirements
up to 800 V insulation.

Insulated screw mounting with tapped hole; up to 800 V.

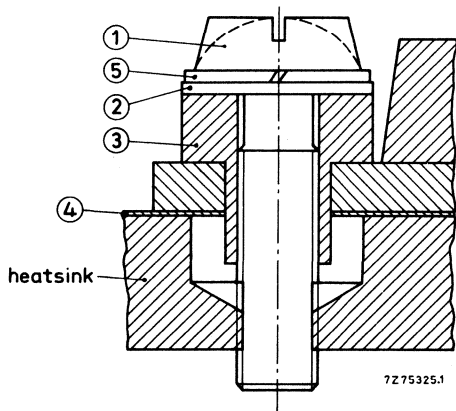
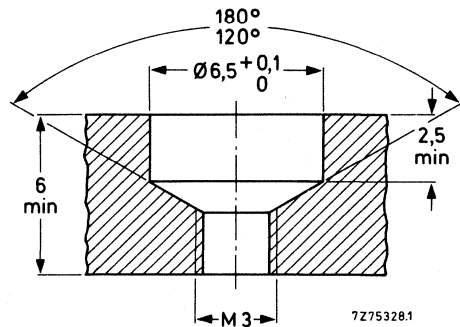


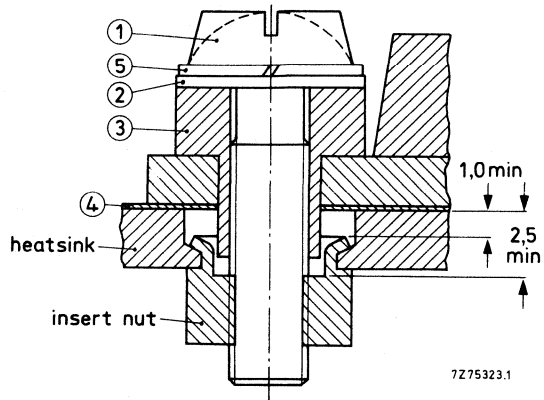
Fig. 6 Assembly.
See also Fig. 9.



- (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.

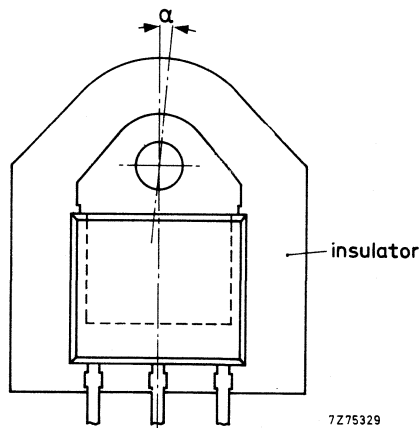


Fig. 9 Mica insulator.

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.

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BA221	S1	SD	BAS29	S1/S7	SD/Mm	BAV70	S7/S1	Mm/SD
BA223	S1	T	BAS31	S1/S7	SD/Mm	BAV74	S1	SD
BA281	S1	SD	BAS32	S1/S7	SD/Mm	BAV99	S1/S7	SD/Mm
BA314	S1	Vrg	BAS32L	S1/S7	SD/Mm	BAV100	S1/S7	SD/Mm
BA315	S1	Vrg	BAS35	S1/S7	SD/Mm	BAV101	S1/S7	SD/Mm
BA316	S1	SD	BAS45	S1	SD	BAV102	S1/S7	SD/Mm
BA317	S1	SD	BAS45L	S1/S7	SD	BAV103	S1/S7	SD/Mm
BA318	S1	SD	BAS56	S1/S7	SD/Mm	BAV105	S1/S7	SD
BA423	S1	T	BAS85	S1	SD	BAW56	S1/S7	SD/Mm
BA423L	S1	T	BAT17	S1/S7	T/Mm	BAW62	S1	SD
BA480	S1	T	BAT18	S7/S1	T/Mm	BAX12	S1	SD
BA481	S1	T	BAT54	S1/S7	SD/Mm	BAX14	S1	SD
BA482	S1	T	BAT74	S1/S7	SD/Mm	BAX18	S1	SD
BA483	S1	T	BAT81	S1	T	BAY80	S1	SD
BA484	S1	T	BAT82	S1	T	BB112	S1	T
BA682	S1/S7	T/Mm	BAT83	S1	T	BB119	S1	T
BA683	S1/S7	T/Mm	BAT85	S1	T	BB130	S1	T
BAS11	S1	SD	BAT86	S1	T	BB204B	S1	T
BAS15	S1	SD	BAV10	S1	SD	BB204G	S1	T
BAS16	S1/S7	SD/Mm	BAV18	S1	SD	BB212	S1	T
BAS17	S1/S7	Vrg/Mm	BAV19	S1	SD	BB215	S1/S7	SD/Mm
BAS19	S1/S7	SD/Mm	BAV20	S1	SD	BB219	S1/S7	SD/Mm
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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

* series.

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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BB804	S1/S7	T	BC556	S3	Sm	BCP69	S7	Mm
BB809	S1	T	BC557	S3	Sm	BCV26	S7	Mm
BB909A	S1	T	BC558	S3	Sm	BCV27	S7	Mm
BB909B	S1	T	BC559	S3	Sm	BCV28	S7	Mm
BB910	S1	T	BC560	S3	Sm	BCV29	S7	Mm
BB911	S1	T	BC635	S3	Sm	BCV46	S7	Mm
BBY31	S1/S7	T/Mm	BC636	S3	Sm	BCV47	S7	Mm
BBY39	S1	T	BC637	S3	Sm	BCV48	S7	Mm
BBY40	S1/S7	T/Mm	BC638	S3	Sm	BCV49	S7	Mm
BBY42	S1	T	BC639	S3	Sm	BCV61	S7	Mm
BBY62	S1	T	BC640	S3	Sm	BCV62	S7	Mm
BC107	S3	Sm	BC807	S7	Mm	BCV63	S7	Mm
BC108	S3	Sm	BC808	S7	Mm	BCV64	S7	Mm
BC109	S3	Sm	BC817	S7	Mm	BCV65	S7	Mm
BC140	S3	Sm	BC818	S7	Mm	BCV71;R	S7	Mm
BC141	S3	Sm	BC846	S7	Mm	BCV72;R	S7	Mm
BC160	S3	Sm	BC847	S7	Mm	BCW29;R	S7	Mm
BC161	S3	Sm	BC848	S7	Mm	BCW30;R	S7	Mm
BC177	S3	Sm	BC849	S7	Mm	BCW31;R	S7	Mm
BC178	S3	Sm	BC850	S7	Mm	BCW32;R	S7	Mm
BC179	S3	Sm	BC856	S7	Mm	BCW33;R	S7	Mm
BC264A	S5	FET	BC857	S7	Mm	BCW60*	S7	Mm
BC264B	S5	FET	BC858	S7	Mm	BCW61*	S7	Mm
BC264C	S5	FET	BC859	S7	Mm	BCW69;R	S7	Mm
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BC368	S3	Sm	BCF32;R	S7	Mm	BCX17;R	S7	Mm
BC369	S3	Sm	BCF33;R	S7	Mm	BCX18;R	S7	Mm
BC375	S3	Sm	BCF70;R	S7	Mm	BCX19;R	S7	Mm
BC376	S3	Sm	BCF81;R	S7	Mm	BCX20;R	S7	Mm
BC516	S3	Sm	BCP51	S7	Mm	BCX51	S7	Mm
BC517	S3	Sm	BCP52	S7	Mm	BCX52	S7	Mm
BC546	S3	Sm	BCP53	S7	Mm	BCX53	S7	Mm
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BCX70*	S7	Mm	BD238	S4a	P	BD438	S4a	P
BCX71*	S7	Mm	BD239	S4a	P	BD645	S4a	P
BCX78	S3	Sm	BD239A	S4a	P	BD646	S4a	P
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BD136	S4a	P	BD243C	S4a	P	BD814	S4a	P
BD137	S4a	P	BD244	S4a	P	BD815	S4a	P
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BD201	S4a	P	BD329	S4a	P	BD825	S4a	P
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BD226	S4a	P	BD333	S4a	P	BD829	S4a	P
BD227	S4a	P	BD334	S4a	P	BD830	S4a	P
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BD229	S4a	P	BD336	S4a	P	BD840	S4a	P
BD230	S4a	P	BD337	S4a	P	BD841	S4a	P
BD231	S4a	P	BD338	S4a	P	BD842	S4a	P
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BD847	S4a	P	BDT31B	S4a	P	BDT64B	S4a	P
BD848	S4a	P	BDT31C	S4a	P	BDT64C	S4a	P
BD849	S4a	P	BDT32	S4a	P	BDT65	S4a	P
BD850	S4a	P	BDT32A	S4a	P	BDT65A	S4a	P
BD933	S4a	P	BDT32B	S4a	P	BDT65B	S4a	P
BD934	S4a	P	BDT32C	S4a	P	BDT65C	S4a	P
BD935	S4a	P	BDT41	S4a	P	BDT81	S4a	P
BD936	S4a	P	BDT41A	S4a	P	BDT82	S4a	P
BD937	S4a	P	BDT41B	S4a	P	BDT83	S4a	P
BD938	S4a	P	BDT41C	S4a	P	BDT84	S4a	P
BD939	S4a	P	BDT42	S4a	P	BDT85	S4a	P
BD940	S4a	P	BDT42A	S4a	P	BDT86	S4a	P
BD941	S4a	P	BDT42B	S4a	P	BDT87	S4a	P
BD942	S4a	P	BDT42C	S4a	P	BDT88	S4a	P
BD943	S4a	P	BDT51	S4a	P	BDT91	S4a	P
BD944	S4a	P	BDT52	S4a	P	BDT92	S4a	P
BD945	S4a	P	BDT53	S4a	P	BDT93	S4a	P
BD946	S4a	P	BDT54	S4a	P	BDT94	S4a	P
BD947	S4a	P	BDT55	S4a	P	BDT95	S4a	P
BD948	S4a	P	BDT56	S4a	P	BDT96	S4a	P
BD949	S4a	P	BDT57	S4a	P	BDV64	S4a	P
BD950	S4a	P	BDT58	S4a	P	BDV64A	S4a	P
BD951	S4a	P	BDT60	S4a	P	BDV64B	S4a	P
BD952	S4a	P	BDT60A	S4a	P	BDV64C	S4a	P
BD953	S4a	P	BDT60B	S4a	P	BDV65	S4a	P
BD954	S4a	P	BDT60C	S4a	P	BDV65A	S4a	P
BD955	S4a	P	BDT61	S4a	P	BDV65B	S4a	P
BD956	S4a	P	BDT61A	S4a	P	BDV65C	S4a	P
BDT20	S4a	P	BDT61B	S4a	P	BDV66A	S4a	P
BDT21	S4a	P	BDT61C	S4a	P	BDV66B	S4a	P
BDT29	S4a	P	BDT62	S4a	P	BDV66C	S4a	P
BDT29A	S4a	P	BDT62A	S4a	P	BDV66D	S4a	P
BDT29B	S4a	P	BDT62B	S4a	P	BDV67A	S4a	P
BDT29C	S4a	P	BDT62C	S4a	P	BDV67B	S4a	P
BDT30	S4a	P	BDT63	S4a	P	BDV67C	S4a	P
BDT30A	S4a	P	BDT63A	S4a	P	BDV67D	S4a	P
BDT30B	S4a	P	BDT63B	S4a	P	BDV91	S4a	P
BDT30C	S4a	P	BDT63C	S4a	P	BDV92	S4a	P

type no.	book	section	type no.	book	section	type no.	book	section
BDV93	S4a	P	BDX67A	S4a	P	BF410C	S5	FET
BDV94	S4a	P	BDX67B	S4a	P	BF410D	S5	FET
BDV95	S4a	P	BDX67C	S4a	P	BF420	S3	Sm
BDV96	S4a	P	BDX68	S4a	P	BF421	S3	Sm
BDW55	S4a	P	BDX68A	S4a	P	BF422	S3	Sm
BDW56	S4a	P	BDX68B	S4a	P	BF423	S3	Sm
BDW57	S4a	P	BDX68C	S4a	P	BF450	S3	Sm
BDW58	S4a	P	BDX69	S4a	P	BF451	S3	Sm
BDW59	S4a	P	BDX69A	S4a	P	BF483	S3	Sm
BDW60	S4a	P	BDX69B	S4a	P	BF485	S3	Sm
BDX35	S4a	P	BDX69C	S4a	P	BF487	S3	Sm
BDX36	S4a	P	BDX77	S4a	P	BF494	S3	Sm
BDX37	S4a	P	BDX78	S4a	P	BF495	S3	Sm
BDX42	S4a	P	BDX91	S4a	P	BF496	S3	Sm
BDX43	S4a	P	BDX92	S4a	P	BF510	S5/S7	FET/Mm
BDX44	S4a	P	BDX93	S4a	P	BF511	S5/S7	FET/Mm
BDX45	S4a	P	BDX94	S4a	P	BF512	S5/S7	FET/Mm
BDX46	S4a	P	BDX95	S4a	P	BF513	S5/S7	FET/Mm
BDX47	S4a	P	BDX96	S4a	P	BF550;R	S7	Mm
BDX62	S4a	P	BDY90	S4a	P	BF569	S7	Mm
BDX62A	S4a	P	BDY90A	S4a	P	BF570	S7	Mm
BDX62B	S4a	P	BDY91	S4a	P	BF579	S7	Mm
BDX62C	S4a	P	BDY92	S4a	P	BF620	S7	Mm
BDX63	S4a	P	BF198	S3	Sm	BF621	S7	Mm
BDX63A	S4a	P	BF199	S3	Sm	BF622	S7	Mm
BDX63B	S4a	P	BF240	S3	Sm	BF623	S7	Mm
BDX63C	S4a	P	BF241	S3	Sm	BF660;R	S7	Mm
BDX64	S4a	P	BF245A	S5	FET	BF689K	S10	WBT
BDX64A	S4a	P	BF245B	S5	FET	BF720	S7	Mm
BDX64B	S4a	P	BF245C	S5	FET	BF721	S7	Mm
BDX64C	S4a	P	BF247A	S5	FET	BF722	S7	Mm
BDX65	S4a	P	BF247B	S5	FET	BF723	S7	Mm
BDX65A	S4a	P	BF247C	S5	FET	BF763	S10	WBT
BDX65B	S4a	P	BF256A	S5	FET	BF820	S7	Mm
BDX65C	S4a	P	BF256B	S5	FET	BF821	S7	Mm
BDX66	S4a	P	BF256C	S5	FET	BF822	S7	Mm
BDX66A	S4a	P	BF324	S3	Sm	BF823	S7	Mm
BDX66B	S4a	P	BF370	S3	Sm	BF824	S7	Mm
BDX66C	S4a	P	BF410A	S5	FET	BF840	S7	Mm
BDX67	S4a	P	BF410B	S5	FET	BF841	S7	Mm

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BF926	S3	Sm	BFP91A	S10	WBT	BFR49	S10	WBT
BF936	S3	Sm	BFP96	S10	WBT	BFR53	S10/S7	WBT/Mm
BF939	S3	Sm	BFQ10	S5	FET	BFR54	S3	Sm
BF960	S5	FET	BFQ11	S5	FET	BFR64	S10	WBT
BF964	S5	FET	BFQ12	S5	FET	BFR65	S10	WBT
BF964S	S5	FET	BFQ13	S5	FET	BFR84	S5	FET
BF965	S5	FET	BFQ14	S5	FET	BFR90	S10	WBT
BF966	S5	FET	BFQ15	S5	FET	BFR90A	S10	WBT
BF966S	S5	FET	BFQ16	S5	FET	BFR91	S10	WBT
BF967	S3	Sm	BFQ17	S10/S7	WBT/Mm	BFR91A	S10	WBT
BF970	S3	Sm	BFQ18A	S10/S7	WBT/Mm	BFR92	S10/S7	WBT/Mm
BF970A	S3	Sm	BFQ19	S10/S7	WBT/Mm	BFR92A	S10/S7	WBT/Mm
BF979	S3	Sm	BFQ22S	S10	WBT	BFR93	S10/S7	WBT/Mm
BF980	S5	FET	BFQ23	S10	WBT	BFR93A	S10/S7	WBT/Mm
BF981	S5	FET	BFQ23C	S10	WBT	BFR94	S10	WBT
BF982	S5	FET	BFQ24	S10	WBT	BFR95	S10	WBT
BF989	S5/S7	FET/Mm	BFQ32	S10	WBT	BFR96	S10	WBT
BF990A	S5/S7	FET/Mm	BFQ32C	S10	WBT	BFR96S	S10	WBT
BF991	S5/S7	FET/Mm	BFQ32M	S10	WBT	BFR101A;B	S5/S7	FET/Mm
BF992	S5/S7	FET/Mm	BFQ32S	S10	WBT	BFS17	S10/S7	WBT/Mm
BF994S	S5/S7	FET/Mm	BFQ33	S10	WBT	BFS17A	S10	WBT
BF996S	S5/S7	FET/Mm	BFQ33C	S10	WBT	BFS18;R	S7	Mm
BF997	S5/S7	FET/Mm	BFQ34	S10	WBT	BFS19;R	S7	Mm
BFG23	S10	WBT	BFQ34T	S10	WBT	BFS20;R	S7	Mm
BFG32	S10	WBT	BFQ42	S6	RFP	BFS21	S5	FET
BFG34	S10	WBT	BFQ43	S6	RFP	BFS21A	S5	FET
BFG35	S7	WBT/Mm	BFQ43S	S6	RFP	BFS22A	S6	RFP
BFG51	S10	WBT	BFQ51	S10	WBT	BFS23A	S6	RFP
BFG65	S10	WBT	BFQ51C	S10	WBT	BFT24	S10	WBT
BFG67	S10/S7	WBT/Mm	BFQ52	S10	WBT	BFT25	S10/S7	WBT/Mm
BFG90A	S10	WBT	BFQ53	S10	WBT	BFT44	S3	Sm
BFG91A	S10	WBT	BFQ63	S10	WBT	BFT45	S3	Sm
BFG92A	S10	WBT	BFQ65	S10	WBT	BFT46	S5/S7	FET/Mm
BFG93A	S10	WBT	BFQ66	S10	WBT	BFT92	S10/S7	WBT/Mm
BFG96	S10	WBT	BFQ67	S10/S7	WBT/Mm	BFT93	S10/S7	WBT/Mm
BFG97	S7	WBT/Mm	BFQ68	S10	WBT	BFW10	S5	FET
BFG135	S7	WBT/Mm	BFQ136	S10	WBT	BFW11	S5	FET
BFG195	S10	WBT	BFR29	S5	FET	BFW12	S5	FET
BFG198	S7	WBT/Mm	BFR30	S5/S7	FET/Mm	BFW13	S5	FET
BFP90A	S10	WBT	BFR31	S5/S7	FET/Mm	BFW16A	S10	WBT

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BFW17A	S10	WBT	BGY48 *	S6	RFP	BGY587	S10	WBM
BFW30	S10	WBT	BGY50	S10	WBM	BLF146	S6	RFP/FET
BFW61	S5	FET	BGY51	S10	WBM	BLF242	S6	RFP/FET
BFW92	S10	WBT	BGY52	S10	WBM	BLF244	S6	RFP/FET
BFW92A	S10	WBT	BGY53	S10	WBM	BLF245	S6	RFP/FET
BFW93	S10	WBT	BGY54	S10	WBM	BLT90/SL	S6	RFP
BFX34	S3	Sm	BGY55	S10	WBM	BLT91/SL	S6	RFP
BFX89	S10	WBT	BGY56	S10	WBM	BLT92/SL	S6	RFP
BFY50	S3	Sm	BGY57	S10	WBM	BLU20/12	S6	RFP
BFY51	S3	Sm	BGY58	S10	WBM	BLU30/12	S6	RFP
BFY52	S3	Sm	BGY58A	S10	WBM	BLU45/12	S6	RFP
BFY55	S3	Sm	BGY59	S10	WBM	BLU50	S6	RFP
BFY90	S10	WBT	BGY60	S10	WBM	BLU51	S6	RFP
BG2000	S1	RT	BGY61	S10	WBM	BLU52	S6	RFP
BG2097	S1	RT	BGY65	S10	WBM	BLU53	S6	RFP
BGD102	S10	WBM	BGY67	S10	WBM	BLU60/12	S6	RFP
BGD102E	S10	WBM	BGY67A	S10	WBM	BLU97	S6	RFP
BGD104	S10	WBM	BGY70	S10	WBM	BLU98	S6	RFP
BGD104E	S10	WBM	BGY71	S10	WBM	BLU99	S6	RFP
BGD502	S10	WBM	BGY74	S10	WBM	BLV10	S6	RFP
BGD504	S10	WBM	BGY75	S10	WBM	BLV11	S6	RFP
BGX885	S10	WBM	BGY78	S10	WBM	BLV20	S6	RFP
BGY22	S6	RFP	BGY84	S10	WBM	BLV21	S6	RFP
BGY22A	S6	RFP	BGY84A	S10	WBM	BLV25	S6	RFP
BGY23	S6	RFP	BGY85	S10	WBM	BLV30	S6	RFP
BGY23A	S6	RFP	BGY85A	S10	WBM	BLV30/12	S6	RFP
BGY32	S6	RFP	BGY86	S10	WBM	BLV31	S6	RFP
BGY33	S6	RFP	BGY87	S10	WBM	BLV32F	S6	RFP
BGY35	S6	RFP	BGY88	S10	WBM	BLV33	S6	RFP
BGY36	S6	RFP	BGY90A	S6	RFP	BLV33F	S6	RFP
BGY40A	S6	RFP	BGY90B	S6	RFP	BLV36	S6	RFP
BGY40B	S6	RFP	BGY93 *	S6	RFP	BLV45/12	S6	RFP
BGY41A	S6	RFP	BGY94 *	S6	RFP	BLV57	S6	RFP
BGY41B	S6	RFP	BGY95A	S6	RFP	BLV59	S6	RFP
BGY43	S6	RFP	BGY95B	S6	RFP	BLV75/12	S6	RFP
BGY45A	S6	RFP	BGY96A	S6	RFP	BLV80/28	S6	RFP
BGY45B	S6	RFP	BGY96B	S6	RFP	BLV90	S6	RFP
BGY46A	S6	RFP	BGY584A	S10	WBM	BLV90/SL	S6	RFP
BGY46B	S6	RFP	BGY585A	S10	WBM	BLV91	S6	RFP
BGY47 *	S6	RFP	BGY586	S10	WBM	BLV91/SL	S6	RFP

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type no.	book	section	type no.	book	section	type no.	book	section
BLV92	S6	RFP	BLX65E	S6	RFP	BPX71	S8b	PDT
BLV93	S6	RFP	BLX65ES	S6	RFP	BPX72	S8b	PDT
BLV94	S6	RFP	BLX67	S6	RFP	BR100/03	S2b	Th
BLV95	S6	RFP	BLX68	S6	RFP	BR101	S3	Sm
BLV97	S6	RFP	BLX69A	S6	RFP	BR210*	S2a	Th
BLV98	S6	RFP	BLX91A	S6	RFP	BR216*	S2a	Th
BLV99	S6	RFP	BLX91CB	S6	RFP	BR220*	S2a	Th
BLW29	S6	RFP	BLX92A	S6	RFP	BR220*	S2a	Th
BLW31	S6	RFP	BLX93A	S6	RFP	BRY39	S3	Sm
BLW32	S6	RFP	BLX94A	S6	RFP	BRY56	S3	Sm
						BRY61	S7	Mm
BLW33	S6	RFP	BLX94C	S6	RFP	BRY62	S7	Mm
BLW34	S6	RFP	BLX95	S6	RFP	BS107	S5	FET
BLW50F	S6	RFP	BLX96	S6	RFP	BS170	S5	FET
BLW60	S6	RFP	BLX97	S6	RFP	BS250	S5	FET
BLW60C	S6	RFP	BLX98	S6	RFP	BSD10	S5	FET
BLW76	S6	RFP	BLY87A	S6	RFP	BSD12	S5	FET
BLW77	S6	RFP	BLY87C	S6	RFP	BSD20	S5/S7	FET/Mm
BLW78	S6	RFP	BLY88A	S6	RFP	BSD22	S5/S7	FET/Mm
BLW79	S6	RFP	BLY88C	S6	RFP	BSD212	S5	FET
BLW80	S6	RFP	BLY89A	S6	RFP	BSD213	S5	FET
BLW81	S6	RFP	BLY89C	S6	RFP	BSD214	S5	FET
BLW83	S6	RFP	BLY90	S6	RFP	BSD215	S5	FET
BLW84	S6	RFP	BLY91A	S6	RFP	BSJ174	S5	FET
BLW85	S6	RFP	BLY91C	S6	RFP	BSJ175	S5	FET
BLW86	S6	RFP	BLY92A	S6	RFP	BSJ176	S5	FET
BLW87	S6	RFP	BLY92C	S6	RFP	BSJ177	S5	FET
BLW89	S6	RFP	BLY93A	S6	RFP	BSP15	S7	Mm
BLW90	S6	RFP	BLY93C	S6	RFP	BSP16	S7	Mm
BLW91	S6	RFP	BLY94	S6	RFP	BSP19	S7	Mm
BLW95	S6	RFP	BPF24	S8b	PDT	BSP20	S7	Mm
BLW96	S6	RFP	BPW22A	S8a/b	PDT	BSP30	S7	Mm
BLW97	S6	RFP	BPW50	S8a/b	PDT	BSP31	S7	Mm
BLW98	S6	RFP	BPW71	S8b	PDT	BSP32	S7	Mm
BLW99	S6	RFP	BPX25	S8b	PDT	BSP33	S7	Mm
BLX13	S6	RFP	BPX29	S8b	PDT	BSP40	S7	Mm
BLX13C	S6	RFP	BPX40	S8b	PDT	BSP41	S7	Mm
BLX14	S6	RFP	BPX41	S8b	PDT	BSP42	S7	Mm
BLX15	S6	RFP	BPX42	S8b	PDT	BSP43	S7	Mm
BLX39	S6	RFP	BPX61	S8b	PDT	BSP50	S7	Mm
BLX65	S6	RFP	BPX61P	S8b	PDT	BSP51	S7	Mm

type no.	book	section	type no.	book	section	type no.	book	section
BSP52	S7	Mm	BSS51	S3	Sm	BSV79	S5	FET
BSP60	S7	Mm	BSS52	S3	Sm	BSV80	S5	FET
BSP61	S7	Mm	BSS60	S3	Sm	BSV81	S5	FET
BSP62	S7	Mm	BSS61	S3	Sm	BSW66A	S3	Sm
BSR12;R	S7	Mm	BSS62	S3	Sm	BSW67A	S3	Sm
BSR13;R	S7	Mm	BSS63;R	S7	Mm	BSW68A	S3	Sm
BSR14;R	S7	Mm	BSS64;R	S7	Mm	BSX19	S3	Sm
BSR15;R	S7	Mm	BSS68	S3	Sm	BSX20	S3	Sm
BSR16;R	S7	Mm	BSS83	S5/S7	FET/Mm	BSX32	S3	Sm
BSR17;R	S7	Mm	BST15	S7	Mm	BSX45	S3	Sm
BSR17A;R	S7	Mm	BST16	S7	Mm	BSX46	S3	Sm
BSR18;R	S7	Mm	BST39	S7	Mm	BSX47	S3	Sm
BSR18A;R	S7	Mm	BST40	S7	Mm	BSX59	S3	Sm
BSR19	S7	Mm	BST50	S7	Mm	BSX60	S3	Sm
BSR19A	S7	Mm	BST51	S7	Mm	BSX61	S3	Sm
BSR20	S7	Mm	BST52	S7	Mm	BT136*	S2b	Tri
BSR20A	S7	Mm	BST60	S7	Mm	BT136F*	S2b	Tri
BSR30	S7	Mm	BST61	S7	Mm	BT137*	S2b	Tri
BSR31	S7	Mm	BST62	S7	Mm	BT137F*	S2b	Tri
BSR32	S7	Mm	BST70A	S5	FET	BT138*	S2b	Tri
BSR33	S7	Mm	BST72A	S5	FET	BT138F*	S2b	Tri
BSR40	S7	Mm	BST74A	S5	FET	BT139*	S2b	Tri
BSR41	S7	Mm	BST76A	S5	FET	BT139F*	S2b	Tri
BSR42	S7	Mm	BST78	S5	FET	BT145*	S2b	Tri
BSR43	S7	Mm	BST80	S5/S7	FET/Mm	BT149*	S2b	Th
BSR50	S3	Sm	BST82	S5/S7	FET/Mm	BT150	S2b	Th
BSR51	S3	Sm	BST84	S5/S7	FET/Mm	BT151*	S2b	Th
BSR52	S3	Sm	BST86	S5/S7	FET/Mm	BT151F*	S2b	Th
BSR56	S5/S7	FET/Mm	BST95	S5	FET	BT152*	S2b	Th
BSR57	S5/S7	FET/Mm	BST97	S5	FET	BT153	S2b	Th
BSR58	S5/S7	FET/Mm	BST100	S5	FET	BT157*	S2b	Th
BSR60	S3	Sm	BST110	S5	FET	BT169*	S2b	Th
BSR61	S3	Sm	BST120	S5/S7	FET/Mm	BTA140*	S2b	Tri
BSR62	S3	Sm	BST122	S5/S7	FET/Mm	BTR59*	S2b	Tri
BSR174	S5/S7	FET	BSV15	S3	Sm	BTS59*	S2b	Tri
BSR175	S5/S7	FET	BSV16	S3	Sm	BTV58*	S2b	Th
BSR176	S5/S7	FET	BSV17	S3	Sm	BTV59*	S2b	Th
BSR177	S5/S7	FET	BSV52;R	S7	Mm	BTV59D*	S2b	Th
BSS38	S3	Sm	BSV64	S3	Sm	BTV60*	S2b	Th
BSS50	S3	Sm	BSV78	S5	FET	BTV60D*	S2b	Th

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BTV70*	S2b	Th	BUS132*	S4b	SP	BUX46;A	S4b	SP
BTV70D*	S2b	Th	BUS133*	S4b	SP	BUX47;A	S4b	SP
BTW23*	S2b	Th	BUT11;A	S4b	SP	BUX48;A	S4b	SP
BTW38*	S2b	Th	BUT11F;AF	S4b	SP	BUX84	S4b	SP
BTW40*	S2b	Th	BUT12;A	S4b	SP	BUX84F	S4b	SP
BTW42*	S2b	Th	BUT12F;AF	S4b	SP	BUX85	S4b	SP
BTW43*	S2b	Tri	BUT18;A	S4b	SP	BUX85F	S4b	SP
BTW45*	S2b	Th	BUT18F;AF	S4b	SP	BUX86	S4b	SP
BTW58*	S2b	Th	BUT21B;C	S4b	SP	BUX87	S4b	SP
BTW62*	S2b	Th	BUT21BF;CF	S4b	SP	BUX88	S4b	SP
BTW62D*	S2b	Th	BUT22B;C	S4b	SP	BUX98;A	S4b	SP
BTW63*	S2b	Th	BUT22BF;CF	S4b	SP	BUX99	S4b	SP
BTY79*	S2b	Th	BUT131	S4b	SP	BUY89	S4b	SP
BTY91*	S2b	Th	BUV26;A	S4b	SP	BUZ10	S9	PM
BU306	S4b	SP	BUV26F;AF	S4b	SP	BUZ11	S9	PM
BU306F	S4b	SP	BUV27;A	S4b	SP	BUZ11A	S9	PM
BU505	S4b	SP	BUV27F;AF	S4b	SP	BUZ14	S9	PM
BU506	S4b	SP	BUV28;A	S4b	SP	BUZ15	S9	PM
BU506D	S4b	SP	BUV28F;AF	S4b	SP	BUZ20	S9	PM
BU508A	S4b	SP	BUV47;A	S4b	SP	BUZ21	S9	PM
BU508D	S4b	SP	BUV48;A	S4b	SP	BUZ23	S9	PM
BU705	S4b	SP	BUV82	S4b	SP	BUZ24	S9	PM
BU706	S4b	SP	BUV83	S4b	SP	BUZ25	S9	PM
BU706D	S4b	SP	BUV89	S4b	SP	BUZ31	S9	PM
BU806	S4b	SP	BUV90	S4b	SP	BUZ32	S9	PM
BU807	S4b	SP	BUV90F	S4b	SP	BUZ34	S9	PM
BU808	S4b	SP	BUV98(V);A	S4b	SP	BUZ35	S9	PM
BU824	S4b	SP	BUV298(V);A	S4b	SP	BUZ36	S9	PM
BU826	S4b	SP	BUW11;A	S4b	SP	BUZ41A	S9	PM
BUP22*	S4b	SP	BUW12;A	S4b	SP	BUZ42	S9	PM
BUP23*	S4b	SP	BUW12F;AF	S4b	SP	BUZ45	S9	PM
BUS11;A	S4b	SP	BUW13;A	S4b	SP	BUZ45A	S9	PM
BUS12;A	S4b	SP	BUW13F;AF	S4b	SP	BUZ45B	S9	PM
BUS13;A	S4b	SP	BUW84	S4b	SP	BUZ50A	S9	PM
BUS14;A	S4b	SP	BUW85	S4b	SP	BUZ50B	S9	PM
BUS21*	S4b	SP	BUW86	S4b	SP	BUZ50C	S9	PM
BUS22*	S4b	SP	BUW87;A	S4b	SP	BUZ53A	S9	PM
BUS23*	S4b	SP	BUW131*	S4b	SP	BUZ54	S9	PM
BUS24*	S4b	SP	BUW132*	S4b	SP	BUZ54A	S9	PM
BUS131*	S4b	SP	BUW133*	S4b	SP	BUZ60	S9	PM

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BUZ63	S9	PM	BUZ385	S9	PM	BY719	S1	R
BUZ64	S9	PM	BY224*	S2a	R	BY720	S1	R
BUZ71	S9	PM	BY225*	S2a	R	BY721	S1	R
BUZ71A	S9	PM	BY228	S1	R	BY722	S1	R
BUZ72	S9	PM	BY229*	S2a	R	BY723	S1	R
BUZ72A	S9	PM	BY229F*	S2a	R	BY724	S1	R
BUZ73	S9	PM	BY249*	S2a	R	BYD11 *	S1	R
BUZ73A	S9	PM	BY260*	S2a	R	BYD13 *	S1	R
BUZ74	S9	PM	BY261*	S2a	R	BYD14 *	S1	R
BUZ74A	S9	PM	BY328	S1	SD	BYD17 *	S1/S7	R/Mm
BUZ76	S9	PM	BY329*	S2a	R	BYD31 *	S1	R
BUZ76A	S9	PM	BY359*	S2a	R	BYD33 *	S†	R
BUZ78	S9	PM	BY438	S1	R	BYD34 *	S1	R
BUZ80	S9	PM	BY448	S1	R	BYD37 *	S1/S7	R/Mm
BUZ80A	S9	PM	BY458	S1	R	BYD73 *	S1	R
BUZ83	S9	PM	BY505	S1	R	BYD74 *	S1	R
BUZ83A	S9	PM	BY509	S1	R	BYD77 *	S1	R
BUZ84	S9	PM	BY527	S1	R	BYM26 *	S1	R
BUZ84A	S9	PM	BY584	S1	R	BYM36 *	S1	R
BUZ90	S9	PM	BY588	S1	R	BYM56 *	S1	R
BUZ90A	S9	PM	BY609	S1	R	BYP21*	S2a	R
BUZ94	S9	PM	BY610	S1	R	BYP22*	S2a	R
BUZ211	S9	PM	BY614	S1	R	BYP59*	S2a	R
BUZ307	S9	PM	BY619	S1	R	BYQ27*	S1	R
BUZ308	S9	PM	BY620	S1	R	BYQ28*	S2a	R
BUZ310	S9	PM	BY627	S1	R	BYR29*	S2a	R
BUZ311	S9	PM	BY705	S1	R	BYR29F*	S2a	R
BUZ326	S9	PM	BY706	S1	R	BYR30*	S1	R
BUZ330	S9	PM	BY707	S1	R	BYR79*	S1	R
BUZ331	S9	PM	BY708	S1	R	BYT28*	S2a	R
BUZ347	S9	PM	BY709	S1	R	BYT79*	S2a	R
BUZ348	S9	PM	BY710	S1	R	BYT230PIV	S1	R
BUZ349	S9	PM	BY711	S1	R	BYV10*	S1	R
BUZ350	S9	PM	BY712	S1	R	BYV18*	S2a	R
BUZ351	S9	PM	BY713	S1	R	BYV19*	S2a	R
BUZ355	S9	PM	BY714	S1	R	BYV20*	S2a	R
BUZ356	S9	PM	BY715	S1	R	BYV21*	S2a	R
BUZ357	S9	PM	BY716	S1	R	BYV22*	S2a	R
BUZ358	S9	PM	BY717	S1	R	BYV23*	S2a	R
BUZ384	S9	PM	BY718	S1	R	BYV24*	S2a	R

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BYV26 *	S1/S2a	R	BYW95A	S1	R	BZX55*	S1	Vrg
BYV27*	S1/S2a	R	BYW95B	S1	R	BZX70*	S2a	Vrg
BYV28*	S1/S2a	R	BYW95C	S1	R	BZX75*	S1	Vrg
BYV29*	S2a	R	BYW96D	S1	R	BZX79*	S1	Vrg
BYV29F*	S2a	R	BYW96E	S1	R	BZX84*	S1/S7	Vrg/Mm
BYV30*	S2a	R	BYX10G	S1	R	BZY91*	S2a	Vrg
BYV31*	S2a	R	BYX25*	S2a	R	BZY93*	S2a	Vrg
BYV32*	S2a	R	BYX30*	S2a	R	CNG35	SC12	PhC
BYV32F*	S2a	R	BYX32*	S2a	R	CNG36	SC12	PhC
BYV33*	S2a	R	BYX38*	S2a	R	CNG40	SC12	PhC
BYV33F*	S2a	R	BYX39*	S2a	R	CNG82	SC12	PhC
BYV34*	S2a	R	BYX42*	S2a	R	CNG83	SC12	PhC
BYV36 *	S1	R	BYX46*	S2a	R	CNR36	SC12	PhC
BYV39*	S2a	R	BYX50*	S2a	R	CNS35	SC12	PhC
BYV42*	S2a	R	BYX52*	S2a	R	CNW82	SC12	PhC
BYV43*	S2a	R	BYX56*	S2a	R	CNW83	SC12	PhC
BYV43F*	S2a	R	BYX90G	S1	R	CNX21	SC12	PhC
BYV44*	S2a	R	BYX96*	S2a	R	CNX35	SC12	PhC
BYV54V	S1	R	BYX97*	S2a	R	CNX35U	SC12	PhC
BYV60*	S2a	R	BYX98*	S2a	R	CNX36	SC12	PhC
BYV72*	S2a	R	BYX99*	S2a	R	CNX36U	SC12	PhC
BYV73*	S2a	R	BZD23	S1	Vrg	CNX38	SC12	PhC
BYV74*	S2a	R	BZD27	S1/S7	Vrg/Mm	CNX38U	SC12	PhC
BYV79*	S2a	R	BZT03	S1	Vrg	CNX39	SC12	PhC
BYV92*	S2a	R	BZV10	S1	Vrf	CNX39U	SC12	PhC
BYV95A	S1	R	BZV11	S1	Vrf	CNX48	SC12	PhC
BYV95B	S1	R	BZV12	S1	Vrf	CNX48U	SC12	PhC
BYV95C	S1	R	BZV13	S1	Vrf	CNX62	SC12	PhC
BYV96D	S1	R	BZV14	S1	Vrf	CNX62A	SC12	PhC
BYV96E	S1	R	BZV37	S1	Vrf	CNX71	SC12	PhC
BYW25*	S2a	R	BZV49*	S1/S7	Vrg/Mm	CNX72A	SC12	PhC
BYW29*	S2a	R	BZV55*	S7	Mm	CNX82A	SC12	PhC
BYW29F*	S2a	R	BZV60	S1	Vrg	CNX83A	SC12	PhC
BYW30*	S2a	R	BZV80	S1	Vrf	CNY17-1	SC12	PhC
BYW31*	S2a	R	BZV81	S1	Vrf	CNY17-2	SC12	PhC
BYW54	S1	R	BZV85*	S1	Vrg	CNY17-3	SC12	PhC
BYW55	S1	R	BZV86	S1	SD	CNY17-4	SC12	PhC
BYW56	S1	R	BZW03*	S1	Vrg	CQW58A	S8a	I
BYW92*	S2a	R	BZW14	S1	Vrg	CQW89A	S8a	I
BYW93*	S2a	R	BZW86*	S2a	TS	CQW89B	S8a	I

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CQY58A	S8a	I	LBE2003S	S11	M	LZ1418E100R	S11	M
CQY89A	S8a	I	LBE2005Q	S11	M	MCA230	SC12	PhC
CQY89F	S8a	I	LBE2008T	S11	M	MCA231	SC12	PhC
ESM3045A(V)	S4b	SP	LBE2009S	S11	M	MCA255	SC12	PhC
ESM3045D(V)	S4b	SP	LCE1004R	S11	M	MCT2	SC12	PhC
ESM4045A(V)	S4b	SP	LCE1010R	S11	M	MCT26	SC12	PhC
ESM4045D(V)	S4b	SP	LCE2003S	S11	M	MJE13004	S4b	SP
ESM5045D(V)	S4b	SP	LCE2005Q	S11	M	MJE13005	S4b	SP
ESM6045A(V)	S4b	SP	LCE2008T	S11	M	MJE13006	S4b	SP
ESM6045D(V)	S4b	SP	LCE2009S	S11	M	MJE13007	S4b	SP
Fresnel- lens	S8b	A	LJE42002T	S11	M	MJE13008	S4b	SP
H11A1	SC12	PhC	LKE1004R	S11	M	MJE13009	S4b	SP
H11A2	SC12	PhC	LKE2002T	S11	M	MKB12040WS	S11	M
H11A3	SC12	PhC	LKE2004T	S11	M	MKB12100WS	S11	M
H11A4	SC12	PhC	LKE2015T	S11	M	MKB12140W	S11	M
H11A5	SC12	PhC	LKE21004R	S11	M	MO6075B200Z	S11	M
H11B1	SC12	PhC	LKE21015T	S11	M	MO6075B400Z	S11	M
H11B2	SC12	PhC	LKE21050T	S11	M	MPS6513	S3	Sm
H11B3	SC12	PhC	LKE27010R	S11	M	MPS6514	S3	Sm
H11B255	SC12	PhC	LKE27025R	S11	M	MPS6515	S3	Sm
KMZ10A	S13	SEN	LKE32002T	S11	M	MPS6517	S3	Sm
KMZ10B	S13	SEN	LKE32004T	S11	M	MPS6518	S3	Sm
KMZ10C	S13	SEN	LTE21009R	S11	M	MPS6519	S3	Sm
KP100A	S13	SEN	LTE21015R	S11	M	MPS6520	S3	Sm
KP101A	S13	SEN	LTE21025R	S11	M	MPS6521	S3	Sm
KPZ20G	S13	SEN	LTE4002S	S11	M	MPS6522	S3	Sm
KPZ21G	S13	SEN	LTE42005S	S11	M	MPS6523	S3	Sm
KTY81-100*	S13	SEN	LTE42008R	S11	M	MPSA05	S3	Sm
KTY81-200*	S13	SEN	LTE42012R	S11	M	MPSA06	S3	Sm
KTY83-100*	S13	SEN	LUE2003S	S11	M	MPSA13	S3	Sm
KTY84-100*	S13	SEN	LUE2009S	S11	M	MPSA14	S3	Sm
KTY85-100*	S7	SEN	LV1721E50R	S11	M	MPSA42	S3	Sm
LAE2001R	S11	M	LV2024E45R	S11	M	MPSA43	S3	Sm
LAE4000Q	S11	M	LV2327E40R	S11	M	MPSA55	S3	Sm
LAE4001R	S11	M	LV2931E50S	S11	M	MPSA56	S3	Sm
LAE4002S	S11	M	LV3742E16R	S11	M	MPSA63	S3	Sm
LAE6000Q	S11	M	LV3742E24R	S11	M	MPSA64	S3	Sm
LBE1004R	S11	M	LVE21050R	S11	M	MPSA92	S3	Sm
LBE1010R	S11	M	LWE2015R	S11	M	MPSA93	S3	Sm
			LWE2025R	S11	M	MRB11080Y	S11	M

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MRB11175Y	S11	M	OSM9415	S2a	St	PKB23005U	S11	M
MRB11350Y	S11	M	OSM9510	S2a	St	PKB25006T	S11	M
MRB12175YR	S11	M	OSM9511	S2a	St	PKB32001U	S11	M
MRB12350YR	S11	M	OSM9512	S2a	St	PKB32003U	S11	M
MS1011B700Y	S11	M	OSS9115	S2a	St	PKB32005U	S11	M
MS6075B800Z	S11	M	OSS9215	S2a	St	PLED-G313A	S8a	LED
MSB11900Y	S11	M	OSS9415	S2a	St	PLED-G313N	S8a	LED
MSB12900Y	S11	M	P2105	S8b	I	PLED-G314A	S8a	LED
MZ0912B75Y	S11	M	PBMF4391	S5	FET	PLED-G314N	S8a	LED
MZ0912B150Y	S11	M	PBMF4392	S5	FET	PLED-G511C	S8a	LED
OM286; M	S13	SEN	PBMF4393	S5	FET	PLED-G513C	S8a	LED
OM287; M	S13	SEN	PDE1001U	S11	M	PLED-G513M	S8a	LED
OM320	S10	WBM	PDE1003U	S11	M	PLED-G514B	S8a	LED
OM321	S10	WBM	PDE1005U	S11	M	PLED-G514M	S8a	LED
OM322	S10	WBM	PDE1010U	S11	M	PLED-G544KL	S8a	LED
OM323	S10	WBM	PEE1001U	S11	M	PLED-G544LL	S8a	LED
OM323A	S10	WBM	PEE1003U	S11	M	PLED-GR14E	S8a	LED
OM335	S10	WBM	PEE1005U	S11	M	PLED-GR14F	S8a	LED
OM336	S10	WBM	PEE1010U	S11	M	PLED-GR14G	S8a	LED
OM337	S10	WBM	PH2222/A	S3	Sm	PLED-GR44DL	S8a	LED
OM337A	S10	WBM	PH2369	S3	Sm	PLED-H313A	S8a	LED
OM339	S10	WBM	PH2907	S3	Sm	PLED-H314A	S8a	LED
OM345	S10	WBM	PH2907A	S3	Sm	PLED-H511C	S8a	LED
OM350	S10	WBM	PH2955T	S4a	P	PLED-H514B	S8a	LED
OM360	S10	WBM	PH3055T	S4a	P	PLED-H544KL	S8a	LED
OM361	S10	WBM	PH5415	S3	Sm	PLED-H544LL	S8a	LED
OM370	S10	WBM	PH5416	S3	Sm	PLED-HR14E	S8a	LED
OM386B	S13	SEN	PH6659	S5	FET	PLED-HR14F	S8a	LED
OM386M	S13	SEN	PH6660	S5	FET	PLED-HR14G	S8a	LED
OM387B	S13	SEN	PH6661	S5	FET	PLED-HR44DL	S8a	LED
OM387M	S13	SEN	PH13002	S4b	SP	PLED-O313N	S8a	LED
OM388B	S13	SEN	PH13003	S4b	SP	PLED-O314N	S8a	LED
OM389B	S13	SEN	PHSD51	S2a	R	PLED-O513M	S8a	LED
OM931	S4a	P	PKB3001U	S11	M	PLED-O514M	S8a	LED
OM961	S4a	P	PKB3003U	S11	M	PLED-P313N	S8a	LED
OSB9115	S2a	St	PKB3005U	S11	M	PLED-P314N	S8a	LED
OSB9215	S2a	St	PKB12005U	S11	M	PLED-P513M	S8a	LED
OSB9415	S2a	St	PKB20010U	S11	M	PLED-P514M	S8a	LED
OSM9115	S2a	St	PKB23001U	S11	M	PLED-T512B	S8a	LED
OSM9215	S2a	St	PKB23003U	S11	M	PLED-TR12E	S8a	LED

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PLED-TR12F	S8a	LED	PMBT3906	S7	Mm	PN5416	S3	Sm
PLED-TR12G	S8a	LED	PMBT4401	S7	Mm	PO44	SC12	PhC
PLED-TR42DL	S8a	LED	PMBT4403	S7	Mm	PO44A	SC12	PhC
PLED-Y313A	S8a	LED	PMBT5088	S7	Mm	PPC5001T	S11	M
PLED-Y313N	S8a	LED	PMBT5401	S7	Mm	PQC5001T	S11	M
PLED-Y314A	S8a	LED	PMBT5550	S7	Mm	PTB23001X	S11	M
PLED-Y314N	S8a	LED	PMBT5551	S7	Mm	PTB23003X	S11	M
PLED-Y511C	S8a	LED	PMBT6428	S7	Mm	PTB23005X	S11	M
PLED-Y513C	S8a	LED	PMBT6429	S7	Mm	PTB32001X	S11	M
PLED-Y513M	S8a	LED	PMBTA05	S7	Mm	PTB32003X	S11	M
PLED-Y514B	S8a	LED	PMBTA06	S7	Mm	PTB32005X	S11	M
PLED-Y514M	S8a	LED	PMBTA13	S7	Mm	PTB42001X	S11	M
PLED-Y544KL	S8a	LED	PMBTA14	S7	Mm	PTB42002X	S11	M
PLED-Y544LL	S8a	LED	PMBTA42	S7	Mm	PTB42003X	S11	M
PLED-YR14E	S8a	LED	PMBTA43	S7	Mm	PV3742B4X	S11	M
PLED-YR14F	S8a	LED	PMBTA55	S7	Mm	PVB42004X	S11	M
PLED-YR14G	S8a	LED	PMBTA56	S7	Mm	PXT2222	S7	Mm
PLED-YR44DL	S8a	LED	PMBTA63	S7	Mm	PXT2222A	S7	Mm
PMBD914	S1	SD	PMBTA64	S7	Mm	PXT2907	S7	Mm
PMBD2835	S1	SD	PMBTA92	S7	Mm	PXT2907A	S7	Mm
PMBD2836	S1	SD	PMBTA93	S7	Mm	PXT3904	S7	Mm
PMBD2837	S1	SD	PMB25226	S1	SD	PXT3906	S7	Mm
PMBD2838	S1	SD	PMLL4148	S1/S7	SD	PXT4401	S7	Mm
PMBD6050	S1	SD	PMLL4150	S1/S7	SD	PXT4403	S7	Mm
PMBD6100	S1	SD	PMLL4151	S1/S7	SD	PXTA14	S7	Mm
PMBD7000	S1	SD	PMLL4153	S1/S7	SD	PXTA27	S7	Mm
PMBF4391	S5/S7	FET/Mm	PMLL4446	S1/S7	SD	PXTA64	S7	Mm
PMBF4392	S5/S7	FET/Mm	PMLL4448	S1/S7	SD	PXTA77	S7	Mm
PMBF4393	S5/S7	FET/Mm	PMLL5225B			PZ1418B15U	S11	M
PMBFJ174	S7	FET/Mm	to	S1/S7	SD	PZ1418B30U	S11	M
PMBFJ175	S7	FET/Mm	PMLL5267B			PZ1721B12U	S11	M
PMBFJ176	S7	FET/Mm	PN2222	S3	Sm	PZ1721B25U	S11	M
PMBFJ177	S7	FET/Mm	PN2222A	S3	Sm	PZ2024B10U	S11	M
PMBT2222	S7	Mm	PN2369	S3	Sm	PZ2024B20U	S11	M
PMBT2222A	S7	Mm	PN2369A	S3	Sm	PZ2327B15U	S11	M
PMBT2369	S7	Mm	PN2907	S3	Sm	PZB16035U	S11	M
PMBT2907	S7	Mm	PN2907A	S3	Sm	PZB16040U	S11	M
PMBT2907A	S7	Mm	PN3439	S3	Sm	PZB27020U	S11	M
PMBT3903	S7	Mm	PN3440	S3	Sm	PZT2222	S7	Mm
PMBT3904	S7	Mm	PN5415	S3	Sm	PZT2222A	S7	Mm

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PZT2907	S7	Mm	RZ3135B40W	S11	M	TIP140	S4a	P
PZT2907A	S7	Mm	RZ3135B50W	S11	M	TIP141	S4a	P
PZT3904	S7	Mm	RZB12050Y	S11	M	TIP145	S4a	P
PZT3906	S7	Mm	RZB12100Y	S11	M	TIP146	S4a	P
PZTA13	S7	Mm	RZB12250Y	S11	M	TIP147	S4a	P
PZTA14	S7	Mm	SL5500	SC12	PhC	TIP2955	S4a	P
PZTA42	S7	Mm	SL5501	SC12	PhC	TIP3055	S4a	P
PZTA43	S7	Mm	SL5504	SC12	PhC	1N821;A	S1	Vrf
PZTA63	S7	Mm	SL5511	SC12	PhC	1N823;A	S1	Vrf
PZTA64	S7	Mm	SL5505S	SC12	PhC	1N825;A	S1	Vrf
PZTA92	S7	Mm	TIP29*	S4a	P	1N827;A	S1	Vrf
PZTA93	S7	Mm	TIP30*	S4a	P	1N829;A	S1	Vrf
RPY97	S8b	I	TIP31*	S4a	P	1N914	S1	SD
RPY100	S8b	I	TIP32*	S4a	P	1N916	S1	SD
RPY101	S8b	I	TIP33*	S4a	P	1N3879	S2a	R
RPY102	S8b	I	TIP34*	S4a	P	1N3880	S2a	R
RPY103	S8b	I	TIP41*	S4a	P	1N3881	S2a	R
RPY107	S8b	I	TIP42*	S4a	P	1N3882	S2a	R
RPY109	S8b	I	TIP47	S4b	P	1N3883	S2a	R
RV2833B5X	S11	M	TIP48	S4b	P	1N3889	S2a	R
RV3135B5X	S11	M	TIP49	S4b	P	1N3890	S2a	R
RX1011B250Y	S11	M	TIP50	S4b	P	1N3891	S2a	R
RX1011B350Y	S11	M	TIP110	S4a	P	1N3892	S2a	R
RX1214B150Y	S11	M	TIP111	S4a	P	1N3893	S2a	R
RX1214B300Y	S11	M	TIP112	S4a	P	1N3909	S2a	R
RX2731B90W	S11	M	TIP115	S4a	P	1N3910	S2a	R
RX3034B70W	S11	M	TIP116	S4a	P	1N3911	S2a	R
RXB12350Y	S11	M	TIP117	S4a	P	1N3912	S2a	R
RZ1214B35Y	S11	M	TIP120	S4a	P	1N3913	S2a	R
RZ1214B65Y	S11	M	TIP121	S4a	P	1N4001D	S1	R
RZ1214B125Y	S11	M	TIP122	S4a	P	1N4002D	S1	R
RZ1214B150Y	S11	M	TIP125	S4a	P	1N4003D	S1	R
RZ2731B45W	S11	M	TIP126	S4a	P	1N4004D	S1	R
RZ2731B60W	S11	M	TIP127	S4a	P	1N4005D	S1	R
RZ2833B15W	S11	M	TIP130	S4a	P	1N4006D	S1	R
RZ2833B30W	S11	M	TIP131	S4a	P	1N4007D	S1	R
RZ2833B45W	S11	M	TIP132	S4a	P	1N4001G	S1	R
RZ2833B60W	S11	M	TIP135	S4a	P	1N4002G	S1	R
RZ3135B15W	S11	M	TIP136	S4a	P	1N4003G	S1	R
RZ3135B30W	S11	M	TIP137	S4a	P	1N4004G	S1	R

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1N4005G	S1	R	2N2907A	S3	Sm	2N4859	S5	FET
1N4006G	S1	R	2N3019	S3	Sm	2N4860	S5	FET
1N4007G	S1	R	2N3020	S3	Sm	2N4861	S5	FET
1N4148	S1	SD	2N3053	S3	Sm	2N5086	S3	Sm
1N4150	S1	SD	2N3375	S6	RFP	2N5087	S3	Sm
1N4151	S1	SD	2N3553	S6	RFP	2N5088	S3	Sm
1N4153	S1	SD	2N3632	S6	RFP	2N5089	S3	Sm
1N4446	S1	SD	2N3822	S5	FET	2N5400	S3	Sm
1N4448	S1	SD	2N3823	S5	FET	2N5401	S3	Sm
1N4531	S1	SD	2N3866	S6	RFP	2N5415	S3	Sm
1N4532	S1	SD	2N3903	S3	Sm	2N5416	S3	Sm
1N4933	S1	R	2N3904	S3	Sm	2N5550	S3	Sm
1N5059	S1	R	2N3905	S3	Sm	2N5551	S3	Sm
1N5060	S1	R	2N3906	S3	Sm	2N6659	S5	FET
1N5061	S1	R	2N3924	S6	RFP	2N6660	S5	FET
1N5062	S1	R	2N3926	S6	RFP	2N6661	S5	FET
1N5225B			2N3927	S6	RFP	4N25	SC12	PhC
to	S1	R	2N3966	S5	FET	4N25A	SC12	PhC
1N5267B			2N4030	S3	Sm	4N26	SC12	PhC
2N918	S10	WBT	2N4031	S3	Sm	4N27	SC12	PhC
2N930	S3	Sm	2N4032	S3	Sm	4N28	SC12	PhC
2N1613	S3	Sm	2N4033	S3	Sm	4N29	SC12	PhC
2N1711	S3	Sm	2N4091	S5	FET	4N30	SC12	PhC
2N1893	S3	Sm	2N4092	S5	FET	4N31	SC12	PhC
2N2219	S3	Sm	2N4093	S5	FET	4N32	SC12	PhC
2N2219A	S3	Sm	2N4123	S3	Sm	4N33	SC12	PhC
2N2222	S3	Sm	2N4124	S3	Sm	4N35	SC12	PhC
2N2222A	S3	Sm	2N4125	S3	Sm	4N36	SC12	PhC
2N2297	S3	Sm	2N4126	S3	Sm	4N37	SC12	PhC
2N2369	S3	Sm	2N4391	S5	FET	4N38	SC12	PhC
2N2369A	S3	Sm	2N4392	S5	FET	4N38A	SC12	PhC
2N2483	S3	Sm	2N4393	S5	FET	4N46	SC12	PhC
2N2484	S3	Sm	2N4400	S3	Sm	56201d	S4b	A
2N2904	S3	Sm	2N4401	S3	Sm	56201j	S4b	A
2N2904A	S3	Sm	2N4402	S3	Sm	56245	S3, 10	A
2N2905	S3	Sm	2N4403	S3	Sm	56246	S3, 10	A
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56369	S2/4	A
56378	S2/4	A
56379	S2/4	A
56387a, b	S4b	A
56397	S1	A
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6N136	SC12	PhC

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DATA HANDBOOK SYSTEM

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Supplement to IC11	Linear Products
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	SC09*	RF power modules
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C22	PA05*	Film capacitors
C15	PA06*	Ceramic capacitors
C9	PA07*	Piezoelectric quartz devices
C13	PA08*	Fixed resistors

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T2b	*	Transmitting tubes for communications, ceramic types
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T4	*	Magnetrons for microwave heating
T5	PC02**	Cathode-ray tubes
T6	PC03**	Geiger-Müller tubes
T9	PC04**	Photo and electron multipliers
T10	PC05**	Plumbicon camera tubes and accessories
T11	PC06**	Microwave diodes and sub-assemblies
T12	PC07**	Vidicon and Newvicon camera tubes and deflection units
T13	PC08**	Image intensifiers and infrared detectors
T15	PC09**	Dry reed switches
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