PHILIPS

Data handbook



Electronic components and materials

Semiconductors

Book S2b

1987

Thyristors

Triacs

Accessories

S2b 1987

THYRISTORS AND TRIACS

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DATA HANDBOOK SYSTEM

Our Data Handbook System comprises more than 60 books with specifications on electronic components, subassemblies and materials. It is made up of four series of handbooks:

ELECTRON TUBES	BLUE
SEMICONDUCTORS	RED
INTEGRATED CIRCUITS	PURPLE
COMPONENTS AND MATERIALS	GREEN
The contents of each series are listed on pages iv to vii.	and each is revised

The data handbooks contain all pertinent data available at the time of publication, and each is revised and reissued periodically.

When ratings or specifications differ from those published in the preceding edition they are indicated with arrows in the page margin. Where application information is given it is advisory and does not form part of the product specification.

Condensed data on the preferred products of Philips Electronic Components and Materials Division is given in our Preferred Type Range catalogue (issued annually).

Information on current Data Handbooks and on how to obtain a subscription for future issues is available from any of the Organizations listed on the back cover.

Product specialists are at your service and enquiries will be answered promptly.

ELECTRON TUBES (BLUE SERIES)

The blue series of data handbooks comprises:

T1	Tubes for r.f. heating
T2a	Transmitting tubes for communications, glass types
T2b	Transmitting tubes for communications, ceramic types
ТЗ	Klystrons
Т4	Magnetrons for microwave heating
Т5	Cathode-ray tubes Instrument tubes, monitor and display tubes, C.R. tubes for special applications
Т6	Geiger-Müller tubes
Т8	Colour display systems Colour TV picture tubes, colour data graphic display tube assemblies, deflection units
Т9	Photo and electron multipliers
Т10	Plumbicon camera tubes and accessories
т11	Microwave semiconductors and components
T12	Vidicon and Newvicon camera tubes
Т13	Image intensifiers and infrared detectors
Т15	Dry reed switches

T16 Monochrome tubes and deflection units Black and white TV picture tubes, monochrome data graphic display tubes, deflection units

SEMICONDUCTORS (RED SERIES)

The red series of data handbooks comprises:

S1 Diodes Small-signal silicon diodes, voltage regulator diodes (< 1,5 W), voltage reference diodes, tuner diodes, rectifier diodes

- S2a Power diodes
- S2b Thyristors and triacs
- S3 Small-signal transistors
- S4a Low-frequency power transistors and hybrid modules
- S4b High-voltage and switching power transistors
- S5 Field-effect transistors
- S6 R.F. power transistors and modules
- S7 Surface mounted semiconductors
- S8a Light-emitting diodes

S8b Devices for optoelectronics Optocouplers, photosensitive diodes and transistors, infrared light-emitting diodes and infrared sensitive devices, laser and fibre-optic components

- S9 Power MOS transistors
- S10 Wideband transistors and wideband hybrid IC modules
- S11 Microwave transistors
- S12 Surface acoustic wave devices
- S13 Semiconductor sensors
- *S14 Liquid Crystal Displays

*To be issued shortly.

INTEGRATED CIRCUITS (PURPLE SERIES)

The NEW SERIES of handbooks is now completed. With effect from the publication date of this handbook the "N" in the handbook code number will be deleted. Handbooks to be replaced during 1986 are shown below.

The purple series of handbooks comprises:

IC01	Radio, audio and associated systems Bipolar, MOS	new issue 1986 IC01N 1985
IC02a/b	Video and associated systems Bipolar, MOS	new issue 1986 ICO2Na/b 1985
IC03	Integrated circuits for telephony Bipolar, MOS	new issue 1987 ICO3N 1985
IC04	HE4000B logic family CMOS	new issue 1986 IC4 1983
IC05N	HE4000B logic family – uncased ICs CMOS	published 1984
IC06N	High-speed CMOS; PC74HC/HCT/HCU Logic family	published 1986
IC08	ECL 10K and 100K logic families	New issue 1986 IC08N 1984
IC09N	TTL logic series	published 1986
IC10	Memories MOS, TTL, ECL	new issue 1986 IC7 1982
IC11N	Linear LSI	published 1985
Supplement to IC11N	Linear LSI	published 1986
IC12	I ² C-bus compatible ICs	not yet issued
IC13	Semi-custom Programmable Logic Devices (PLD)	new issue 1986 IC13N 1985
IC14	Microcontrollers and peripherals Bipolar, MOS	published 1986
IC15	FAST TTL logic series	new issue 1986 IC15N 1985
IC16	CMOS integrated circuits for clocks and watches	first issue 1986
IC17	Integrated Services Digital Networks (ISDN)	not yet issued
IC18	Microprocessors and peripherals	new issue 1986

COMPONENTS AND MATERIALS (GREEN SERIES)

The green series of data handbooks comprises:

- C2 Television tuners, coaxial aerial input assemblies, surface acoustic wave filters
- C3 Loudspeakers
- C4 Ferroxcube potcores, square cores and cross cores
- C5 Ferroxcube for power, audio/video and accelerators
- C6 Synchronous motors and gearboxes
- C7 Variable capacitors
- C8 Variable mains transformers
- C9 Piezoelectric quartz devices
- C11 Varistors, thermistors and sensors
- C12 Potentiometers, encoders and switches
- C13 Fixed resistors
- C14 Electrolytic and solid capacitors
- C15 Ceramic capacitors
- C16 Permanent magnet materials
- C17 Stepping motors and associated electronics
- C18 Direct current motors
- C19 Piezoelectric ceramics
- C20 Wire-wound components for TVs and monitors
- C22 Film capacitors



SELECTION GUIDE

SELECTION GUIDE

GATE TURN-OFF THYRISTORS

IT(AV)			Outline	VDR	Mmax	(V)					Page
(A)	(A)			600	800	850	1000	1200	1300	1500	
3.2	12	BT157	TO-220AB	+							39
6.5	25	BTW58	TO-220AB	-							163
10	25	BTV58	TO-220AB								75
10	50	BTR59	SOT-93	+-							51
15	50	BTS59	SOT-93								63
15	50	BTV59	TO-238AA	-							87
15	50	BTV59D	TO-238AA								99
15	50	BTV70	TO-238AA								137
15	50	BTV70D	TO-238AA								149
25	120	BTV60	TO-238AA	+-							113
25	120	BTV60D	TO-238AA								123

THYRISTORS

General purpose thyristors

IT(RMS)max		Outline	VRR	Mmax	(V)						Pag
(A)			200	400	500	600	650	800	1000	1200	
0.8	BT169	TO-92	-+								23
4	BT150	TO-220AB									18
9	BT151F	SOT-186									20
12	BT151	TO-220AB	_								19
16	BTY79	TO-64	-+								29
16	BTW38	TO-64				·					24
16	BTW42	TO-64									25
20	BT152	TO-220AB									21
25	BT145	TO-220AB									17
25	BTW45	TO-48	-+								26
25	BTY91	TO-48	-+								30
32	BTW40	TO-48									25

THYRISTORS (Cont.)

Fast turn-off thyristors

IT(RMS)max		Outline	V _{DRMmax} (V)	Page
(A)			500 600 800 1000	
6	BT153	TO-220AB	♦ −−− −−− −	225
28	BTW62	TO-238AA	++	267 (ASCR construction)
28	BTW62D	TO-238AA		275 (ASCR construction)
40	BTW63	TO-48	_	287 (ASCR construction)

TRIACS

IT(RMS)max		Outline	VDRM	lmax (V)				Page
(A)			500	600	800	1000	1200	
4	BT136	TO-220AB	-+					315
4	BT136F	SOT-186	-+					327
8	BT 137	TO-220AB	-+					339
8	BT137F	SOT-186	-+					351
12	BT138	TO-220AB	-+					363
12	BT138F	SOT-186	-+					375
15	BTW43	TO-64						421
.16	BT139	TO-220AB	-+					387
16	BT139F	SOT-186	-+					399
25	BTA140	TO-220AB	-			L	L	411
								_
								Page

Bi-directional trigger device BR100/03: V(BO) = 28 to 36 V; IFRMmax = 2 A ----- 177



GENERAL SECTION

Type Designation Rating Systems Letter Symbols Quality Conformance and Reliability General Explanatory Notes Heatsinks



PRO ELECTRON TYPE DESIGNATION CODE FOR SEMICONDUCTOR DEVICES

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

"Although not all type numbers accord with the Pro Electron system, the following explanation is given for the ones that do."

A basic type number consists of: TWO LETTERS FOLLOWED BY A SERIAL NUMBER

FIRST LETTER

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

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

SECOND LETTER

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

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

The remainder of the type number is a **serial number** indicating a particular design or development and is in one of the following two groups:

- (a) A serial number consisting of three figures from 100 to 999.
- (b) A serial number consisting of one letter (Z, Y, X, W, etc.) followed by two figures.

RANGE NUMBERS

DESIGNATION

Where there is a range of variants of a basic type of rectifier diode, thyristor or voltage regulator diode the type number as defined above is often used to identify the range; further letters and figures are added after a hyphen to identify associated types within the range. These additions are as follows:

RECTIFIER DIODES, THYRISTORS AND TRIACS

A group of figures indicating the rated repetitive peak reverse voltage, V_{RRM}, or the rated repetitive peak off-state voltage, V_{DRM}, whichever value is lower, in volts for each type.

The final letter R is used to denote a reverse polarity version (stud-anode) where applicable. The normal polarity version (stud cathode) has no special final letter.

REGULATOR DIODES

A first letter indicating the nominal percentage tolerance in the operating voltage VZ.

- A. 1% (according to IEC 63: series E96)
- B. 2% (according to IEC 63: series E48)
- C. 5% (according to IEC 63: series E24)
- D. 10% (according to IEC 63: series E12)
- E. 20% (according to IEC 63: series E6)

A group of figures indicating the typical operating voltage V_Z for each type at the nominal operating current I_7 rating of the range.

The letter V is used to denote a decimal sign.

The final letter R is used to denote a reverse polarity version (stud anode) where applicable. The normal polarity version (stud cathode) has no special final letter.

Example:

BTW23-800R Silicon thyristor in the BTW23 range with 800 V maximum repetitive peak voltage, reverse polarity, stud connected to anode.

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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 (As used throughout this book)

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

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

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

DESIGN MAXIMUM RATING SYSTEM

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

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

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

DESIGN CENTRE RATING SYSTEM

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

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

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

LETTER SYMBOLS FOR RECTIFIER DIODES, THYRISTORS, TRIACS AND BREAKOVER DIODES

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 letters shall be used.

Subscripts

amb	Ambient
(AV), (av)	Average value
(BO)	Breakover
(BR)	Breakdown
case	Case
С	Controllable
D,d	Forward off-state ¹), non-triggered (gate voltage or current)
F,f	Forward ¹), fall
G,g	Gate terminal
Н	Holding
l,i	Input
J,j	Junction
L	Latching
M,m	Peak or crest value
min	Minimum
0,0	Output, open circuit
(OV)	Overload
Р,р	Pulse
Q,q	Turn-off
R,r	As first subscript: reverse, rise
	As second subscript: repetitive, recovery
(RMS), (rms)	R.M.S. value
S,s	As first subscript: storage, stray, series, source, switching
	As second subscript: non-repetitive
stg	Storage
T,t	Forward on-state 1), triggered (gate voltage or current)
th	Thermal
(TO)	Threshold
tot	Total
W	Working
Z	Reference or regulator (i.e. zener)

For power rectifier diodes, thyristors and triacs, the terminals are **not** indicated in the subscript, except for the gate-terminal of thyristors and triacs.

For the anode-cathode voltage of thyristors and triacs, F is replaced either by D or T, to distinguish between 'off-state' (non-triggered) and 'on-state' (triggered).

LETTER SYMBOLS

Example of the use of letter symbols



Simplified thyristor characteristic together with an anodecathode voltage as a function of time (no gate signal).

QUALITY CONFORMANCE AND RELIABILITY

In addition to 100% testing of all major device parameters in the production department, independently controlled statistical sampling for conformance and reliability takes place using BS6001 'Sampling Procedures and Tables'. BS6001 is consistent with MIL-STD-105D. DEF131A, IS02859, CA-C-115.

The market demand for a continuously improving product quality is being met by the annual updating of formal quality improvement plans.

The 'Defect free' and 'Right first time' concepts are applied regularly as part of an overall quality programme covering all aspects of device quality from initial design to final production. These concepts, together with the quality assurance requirements, embrace all the principles outlined in DEF STAN 05–21, AQAP–1, and BS5750 Pt1.

CONFORMANCE

The Company actively promote a policy of customer cooperation to determine their quality problems and future requirements. This cooperation is often in the form of a 'ppm' activity. The 'ppm' is a measure of conformance of the outgoing product, and is expressed as the number of reject devices found per million of products delivered (e.g. a process average of 0.01% = 100 ppm). Mutually agreed ppm targets are set, and a programme of quality improvement work initiated.

In addition to the above, special inspection and/or test procedures are available, following consultation with the customer and the agreement of a special specification.

RELIABILITY

'Screening', or 'Burn-in' procedures are also available, based on the requirements of CECC 50 000.

CECC 50 000 offers a choice of four screening sequences: 'A', 'B', 'C', 'D'. The Company's standard 'Hi-rel' procedure offers a combination of 'C' and 'D' sequences.

Sequence 'C'

- 1. High temperature storage 24 hours minimum.
- 2. Rapid change of temperature as detailed in agreed specification.
- 3. Sealing fine leak test.
 - gross leak test.
- 4. Functional electrical characteristics within group 'A' limits.

Sequence 'D'

1. 'Burn-in' – high-voltage reverse bias, 48 hours duration. Conditions as specified in CECC 50 000.

2. Post 'Burn-in' measurements - functional electrical characteristics, within group 'A' limits.

Other 'Hi-rel', 'Burn-in', or 'Screening' procedures may be available on request.



GATE TURN-OFF THYRISTORS

INTRODUCTION

The gate turn-off thyristor (GTO) is a three-junction bistable semiconductor switch for controlling current flow (the circuit symbol for the GTO is shown in Fig.1). Like a conventional thyristor, it can block a high-level forward voltage while in the off-state, and can pass a peak current far in excess of its rated average current when in the on-state. Unlike an ordinary thyristor, however, it can be turned off by the extraction of reverse current from the gate. In this respect it is similar to a high-voltage transistor, and combines the most desirable properties of both types of device.



Fig.1 GTO circuit symbol.

FORWARD CHARACTERISTICS

Forward blocking

When the gate is held at or below the potential of the cathode, the GTO is in its forward blocking (off) state, with a low leakage current flowing between anode and cathode. Four different anode to cathode voltage ratings are given in each GTO data sheet, and are defined as follows:

V_{DSM} the non-repetitive transient voltage.

- VDRM the repetitive peak voltage, with a short duty cycle (less than 5%).
- V_{DW} the crest working voltage, which is the repetitive peak voltage with a duty cycle of up to 50%.
- V_D the continuous d.c. anode to cathode voltage for the required life at maximum junction temperature.

These ratings are interpreted in Fig.2 for two different types of application:

GENERAL EXPLANATORY NOTES Forward blocking (cont)

GENERAL EXPLANATORY NOTES



- a) A resonant circuit such as a CRT line deflection stage or series resonant power supply.
- b) A square wave circuit such as a d.c. chopper or pulse-width modulated a.c. motor control.

Forward conduction

In forward conduction the GTO has two stable states, as indicated in Fig.3. When the anode current is below the latching current I_L , the device behaves as a high-voltage transistor, with a gate-anode current amplification factor I_A/I_G which increases with increasing anode current and with increasing junction temperature. When the anode current is equal to or greater than the latching current (i.e. when the gate current has been increased above the level required to trigger the device), the GTO is in its on-state with a small potential difference between the anode and cathode. Provided the anode current does not fall below the holding level, the device will remain in the on-state even when the gate current is removed, as in a conventional thyristor. Unlike most normal thyristors, however, the on-state voltage drop (V_T) can be reduced to some extent by maintaining a forward gate current and this is indicated in data graphs of V_T versus I_T. Since the latching currents of GTOs can be relatively high (typically 10–20% of the rated average current) it may be desirable in most applications to keep forward gate current flowing at a low level while the GTO is conducting, to prevent spurious unlatching of the device.





Fig.3 On-state current as a function of the on-state voltage with gate current as a parameter for the BTV59 GTO.

REVERSE CHARACTERISTICS

The reverse characteristic of the GTO is equivalent to that of a resistance which is incapable of blocking voltage or conducting significant current. For d.c. switching, this does not present any problems. However, if reverse voltage blocking is required for a.c. switching, a diode must be connected in series with the GTO as shown in Fig.4. If reverse current must be allowed to flow, a diode must be connected in anti-parallel with the GTO.





SWITCHING CHARACTERISTICS

Turn-on

During turn-on, care should be taken to ensure that adequate gate current is available whenever the anode current is likely to be less than the latching level. For example, Fig.5a shows that, if turn-on is achieved by discharging a capacitor into the gate of a GTO with an inductive load, too brief a time constant may cause the gate current to fall below I_{GT} before sufficient time has elapsed for the anode current to rise above the latching level. This could cause uncertain triggering. Also, if the anode current is only slightly higher than the latching level, a steep trailing edge of a positive gate pulse may cause the GTO to unlatch as shown in Fig.5b.



Fig.5a To ensure good triggering the anode current must rise above the latching level before the gate current falls below the minimum level required to ensure triggering. Fig.5b Unlatching can occur if the anode current is only slightly higher than the latching level during a rapid fall in gate current.

Although the value of gate current stated in data for a given junction temperature will always cause a GTO to turn on, the turn-on process may be very slow if the gate current supplied is only just greater than the trigger current of a particular device. Therefore it is usually desirable to apply an initial gate current pulse of 2–5 times the I_{GT} value given in data, to ensure fast turn-on. All turn-on times in data are defined under these conditions.

dI_T/dt limitation

Provided that sufficient gate over-drive is given at turn-on to ensure fast switching, rapid rise of anode current at turn-on (due, for instance, to the discharge of a capacitor or the reverse recovery current of a flywheel diode) will not cause any problems. This is due to the interdigitated gate-cathode structure of the device and to the fact that the rate of rise of current at turn-on is low and self-limiting until a large proportion of the device has come into conduction. The GTO can typically withstand values of turn-on dl_T/dt up to 2000A/ μ s.

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Turn-off

As mentioned above, a major characteristic of the GTO is its ability to be turned off from the conducting state by the reverse biasing of the gate-cathode junction. However, there are several limitations which must be taken into account when designing a GTO circuit:

Controllable Anode Current, Rate of rise of Anode Voltage, and Snubber Network design.

There is a limit to the magnitude of anode current which may be interrupted, and this is dependent on the behaviour of the anode voltage during turn-off (if this current is exceeded a failure occurs which is analagous to reverse-biased second breakdown in bipolar transistors, and may result in the destruction of the device). More particularly, the controllable anode current (I_{TC}) is a function of the rate of rise of reapplied voltage (dV_D/dt). In order to take advantage of the high peak current handling capabilities of the GTO, it is normally necessary to use a form of dV_D/dt limiting network (snubber network) connected across the anode-cathode of the device. This may take the form of a capacitor connected directly across the device, or a polarised (RCD) network. However, it should be noted that the standard RC snubber as used in thyristor or ASCR circuits is not suitable for use with the GTO, because the GTO current is interrupted internally rather than by an external commutating circuit.



Fig.6 Snubber networks.

Fig.6 shows some examples of snubber networks which may be used in practice:

(a) Polarised (RCD) snubber for a single GTO.

(b) and (c) Simple capacitor and RCD snubbers used in a bridge configuration. Note that when using an RCD network in this circuit it is necessary to decouple the d.c. supply with an inductor to prevent the top snubber capacitor (C_S) from charging up through the bottom GTO, and vice versa.

Turn-off (cont)

In all cases, the applied dV_{D}/dt is defined by the equation:

 $I_T = C_S \times dV_D/dt$

and the minimum permissible value of snubber capacitance which may be used in a particular circuit should be determined by consulting the relevant data graph of I_{TC} versus dV_D/dt . In resonant circuits, of course, dV_D/dt may be fixed by other circuit requirements.

If a simple capacitive snubber is used, the largest value of capacitance which may be connected directly across the GTO is limited by the energy dissipated in the GTO and the peak GTO anode current caused by its discharge at turn-on. Suggested maximum values (for a supply voltage equal to V_{Dmax} .) are as follows:

GTO	max. C _S
BT157	25 nF
BTV58, BTW58	50 nF
BTV59, BTW59	100 nF
BTV60	200 nF

If snubber capacitances greater than these values are required, a polarised (RCD) network should be used.

For any snubber network to be effective, the inductance in series with it (including stray inductance) must be minimised. The presence of series inductance in the snubber gives rise to an uncontrolled voltage across the device during the fall time (see the waveforms given in Fig.8). Since this is the equivalent of allowing a higher dV_D/dt , excessive inductance will reduce the value of I_{TC} below that which might be expected from a given value of snubber capacitance. Fig.7 indicates the effect this may have on controllable current for a typical device.



Fig.7 Typical anode current which can be turned off, as a function of snubber loop inductance for the BTV59 (C_S = 20 nF, T_{mb} = 25 °C)

May 1984



When using an RCD snubber network, in which the current transferred from the GTO to the snubber capacitor must pass through the diode, care should be taken in the selection of the diode used, since (particularly in 'fast-recovery' gold-doped diodes) a high transient forward voltage can appear when the forward current through the diode is increased rapidly from zero. This voltage will have exactly the same effect as that due to stray inductance, and must be minimised. In general, the effect of snubber inductance will increase with increasing anode current and reducing dV_D/dt . Another factor which should be taken into account when designing an RCD snubber network is the need for the snubber capacitor to be fully discharged before the device is turned off. When the GTO is

turned on, the capacitor is, of course, charged up to the d.c. supply voltage, and must discharge through the snubber resistance R_S . For a supply voltage equal to the V_{Dmax} rating of the GTO, a safe period to ensure adequate discharge of the capacitor is given by:

$$t_{on} = 5 \times R_S \times C_S$$

where t_{on} is in microseconds, R_S is in ohms and C_S is in microfarads.



Fig.8 Typical turn-off waveforms.

Gate circuit design

The amount of current a GTO can turn off is dependent on the performance of the gate drive circuit used, as well as the factors mentioned above. Essentially, the gate drive circuit consists of two distinct parts: a forward current source which provides gate current while the device is on, and a negative voltage source which is connected across the gate-cathode through a low impedance at turn-off. An idealised version of this is shown in Fig.9.

Gate circuit design (cont)

GENERAL EXPLANATORY NOTES



Fig.9 Idealised gate circuit.

The gate-cathode junction of a GTO may be regarded as a zener diode with a reverse breakdown voltage greater than that specified in the data sheet, so that, provided the negative voltage source does not exceed this voltage, no significant current will flow once the turn-off process is completed and the device is in the off state. During turn-off (see Fig.8) however, a current with a peak value of I_{GR} will flow. The ratio I_A/I_{GR} is known as the 'turn-off gain' of the device, and may vary from <1 to 3–4, depending on the current being turned off (each data sheet gives the maximum value of I_{GR} which might be expected, as a function of anode current). The rate at which the negative gate current rises during the storage period of turn-off ($-dI_G/dt$) is controlled by the impedance in the gate circuit. In practice this should be kept to a minimum, but a certain amount of wiring inductance is unavoidable, and is not detrimental to turn-off performance provided it is kept below the maximum limit given in each data sheet. Series resistance in the negative gate current path should be minimised, and this generally implies the use of a low-voltage fast-switching bipolar or power MOS device to switch the gate to a negative voltage. An example of a practical gate drive circuit (for the BTV/BTW59) is shown in Fig.10.



Fig. 10 Practical drive circuit suitable for a BTV59. The turn-off loop (shaded) should have minimum inductance, and the small decoupling capacitor (shown in dashed lines), should be wired as close as possible to the electrolytic capacitor.

Forward gate drive is provided by TR3, with an initial gate pulse being supplied via R5/C2. The discrete Darlington pair TR1/TR2 switches the gate to the -12 V rail, resulting in a negative gate voltage (V_{GR}) of approx. 10 V when the V_{CEsat} of TR2 is taken into account.

For smaller devices, such as the BT157 and the BTV/BTW58, a simpler gate circuit (as shown in Fig.11) may be adequate.



Fig.11 Simple gate circuit

The capacitor C1 is charged during the GTO on-time, and can then be used to supply the negative gate voltage to turn off the GTO. The capacitor must be large enough to ensure that the negative gate current pulse which occurs at turn-off does not discharge the capacitor by more than about 1 V, and must also be charged up adequately the first time the GTO is switched on.

It is recommended that wherever possible, full advantage should be taken of the guaranteed reverse breakdown voltage of the gate-cathode junction so that the maximum possible negative drive voltage is used. However, if this voltage is limited by other considerations to a lower value, due attention should be paid to the relevant data graph to ensure the maximum controllable current is not exceeded, since I_{TC} falls with reducing V_{GR} .

It should be noted that in most practical gate drives the gate-cathode junction is normally driven into reverse avalanche conduction for a short time while the negative gate current falls from its peak value back to zero (see Fig.8). Because of its interdigitated structure, the junction is capable of withstanding high avalanche currents for short periods without sustaining damage, so this does not cause a problem.

SAFE OPERATING AREA (SOAR)

Forward-biased SOAR

Since the GTO is a regenerative device it does not have forward-biased SOAR limitations in the same way as a bipolar transistor. Peak on-state current is limited by the capabilities of the connecting wires and the thermal capacity of the crystal, and is stated in data as a maximum non-repetive surge current limit in the same way as an ordinary thyristor.

Reversed-biased SOAR

For any particular applied dV_D/dt the GTO is capable of turning off the current given by the data graph of I_{TC} versus dV_D/dt up to the full rated V_{DRM} of the device. The RB SOAR curve is therefore a rectangle bounded by I_{TC} and V_{DRM} .

SWITCHING LOSSES

When the GTO is switched from the off- to the on-state and vice versa, there is a loss of energy resulting from the simultaneous presence of high voltage and high current during switching. The average power loss resulting from this may or may not be significant, depending on the frequency of operation. The switching losses are dependent on the operating conditions and must be considered when a circuit is being designed.

Turn-on Losses

The energy loss at turn-on can be estimated from the equation:

$$E_{on} = V_D \times I_T \times t_r \times 1/6$$

 where E_{on} is in microjoules, V_D is the voltage from which the GTO is being turned on, I_T is the current being turned on to, and t_r is the rise time in microseconds. These losses can clearly be minimised by ensuring fast turn-on with an initial high gate current pulse.

Turn-off Losses

At turn-off, switching losses are almost completely due to the small 'tail current' which flows after the anode voltage has begun to rise (see Fig.8). Turn-off losses are a function of anode current, applied dV_D/dt , and junction temperature. Each data sheet includes graphs which can be used to calculate losses given these conditions.

GENERAL EXPLANATORY NOTES

THYRISTORS AND TRIACS

SWITCHING CHARACTERISTICS

Thyristors and triacs are not perfect switches. They take a finite time to go from the off to the on-state and vice-versa. At frequencies up to about 400 Hz these effects can often be ignored, but in many applications involving fast switching action the departure from the ideal is important.

Gate-controlled turn-on time

Anode current does not commence flowing at the instant the gate current is applied. There is a period which elapses between the application of gate current and the onset of anode current known as delay time (t_d) . The rise time of anode current is known as t_r and is measured as the time taken for the anode voltage to fall from 90% to 10% of its initial value.

The conditions which need to be specified are:

- a) Off-state voltage (VD).
- b) On-state current (IT).

c) Gate trigger current (I_G) – high gate currents reduce turn-on time.

d) Rate of rise of gate trigger current (dl_G/dt) - high values reduce turn-on time.

e) Junction temperature (T_i) - high temperatures reduce turn-on time.

The waveforms are shown in the following diagram:



THYRISTORS

CIRCUIT-COMMUTATED TURN-OFF TIME

GENERAL EXPLANATORY NOTES

When a thyristor has been conducting and is reverse biased it cannot go immediately into the forward blocking state. Thyristors exhibit a stored charge in a similar fashion to rectifiers; it is only after this charge has been recombined or been swept out that the device can block reapplied off-state voltage. The turn-off time (t_q) is measured from the instant the anode current passes through zero to the instant the thyristor is capable of blocking reapplied off-state voltage.

The conditions which need to be specified are:

- a) On-state current (I_T) high peak currents mean longer turn-off times.
- b) Reverse voltage (V_R) low reverse voltages mean longer turn-off times. An example of this is when the thyristor is in anti-parallel with a diode, limiting the reverse voltage to a volt or so.
- c) Rate of fall of anode current (dl/dt) high rates mean shorter turn-off times.
- d) Rate of rise of reapplied off-state voltage (dV_D/dt) high rates mean longer turn-off times.
- e) Temperature (Ti or Tmb) high temperatures mean longer turn-off times.
- f) Gate conditions (-V_{GG}, R_{tot}) the application of a negative gate voltage during reverse recovery can be used to reduce the turn-off time. Care must be taken not to exceed the reverse gate voltage rating (V_{RGMmax}).

The waveforms are shown in the following diagram:





TRIACS

COMMUTATION dVcom/dt

When a triac has been conducting current in one direction and is then required to block voltage in the other, it is faced with a difficult task. Reverse recovery current adds to the capacitive current from the reapplied dV_D/dt in such a fashion that the device's ability to withstand high rates of reapplication of voltage is impaired. For this reason the commutation dV_D/dt is invariably worse than the static dV_D/dt.

The conditions which need to be specified are:

- a) R.M.S. current (I_{T(RMS)}) high currents make commutation harder.
- b) Re-applied off-state voltage (V_D), normally V_DRM max. high voltage will make commutation harder.
- c) Temperature (T_i or T_{mb}) high temperatures make commutation harder.
- d) -dI/dt high rates of change make commutation harder.

The waveforms are shown in the following diagram:


THYRISTORS

OPERATING NOTES

GENERAL EXPLANATORY NOTES

When there is a possibility that transients, due to the energy stored in the transformer, will exceed the maximum permissible non-repetitive peak reverse voltage, a damping circuit should be connected across the transformer.

Either a series RC circuit or a voltage dependent resistor may be used. Suitable component values for an RC circuit across the transformer primary or secondary may be calculated as follows:

V _{RSM} V _{RWM}	RC across of trans	RC across primary of transformer		RC across primary RC across of transformer of transformer		secondary former
	C (μF)	R (Ω)	C (μF)	R (Ω)		
2.0	200 ^I mag V ₁	<u>150</u> C	$225 \frac{l_{mag}T^2}{V_1}$	<u>200</u> C		
1.5	400 $\frac{I_{mag}}{V_1}$	225 C	$450 \frac{I_{mag}T^2}{V_1}$	275 C		
1.25	$550 rac{l_{mag}}{V_1}$	260 C	$620 \frac{l_{mag}T^2}{V_1}$	310 C		
1.0	800 ^I mag V1	<u>300</u> C	$900 \frac{I_{mag}T^2}{V_1}$	350 C		

where Imag = magnetising primary r.m.s. current (A)

V₁ = transformer primary r.m.s. voltage (V)

V₂ = transformer secondary r.m.s. voltage (V)

 $T = V_1/V_2$

V_{RSM} = the transient voltage peak produced by the transformer

V_{RWM} = the actually applied crest working reverse voltage

The capacitance values calculated from the above table are minimum values; to allow for circuit variations and component tolerances, larger values should be used.

Heatsinks are used where a semiconductor device is unable of itself to dissipate the heat generated by its internal power losses without the junction temperature exceeding its maximum. The simplest form of heatsink is a flat metal plate, but for economy in weight, size, and cost, more complex shapes are usually used.

Apart from information on heat transfer and the construction of assemblies, this Section shows how to take advantage of reverse polarity types, describes three types of heatsink, and gives calculation examples.

HEAT TRANSFER PATH

In, for example, a silicon rectifier the heat is generated inside the wafer and flows mainly by way of the base, through a heatsink to the ambient air.

The heat flow can be likened to the flow of electric current, with thermal resistance (R_{th} in $^{O}C/W$)analogous to the electric resistance (R in Ω).

Fig. 1 shows the heat path from junction to ambient as three thermal resistances in series:

- $R_{th j-mb}$ The thermal resistance from junction to mounting base. Its value is given in the data sheets of a device.
- R_{th mb-h} The thermal resistance from mounting base to heatsink (contact thermal resistance). It is caused by the imperfect nature and limited size of the contact between the two. Its value is also given in the data sheets.
- $R_{th\ h-a}$ The thermal resistance between the contact surface mentioned above and the ambient air.

For thermal balance air warmed by the heatsink must be replaced by cool, i.e., there must be an air flow.

From Fig. 1: $T_j - T_{amb} = P \times (R_{th j-mb} + R_{th mb-h} + R_{th h-a})$



Fig.1

IMPROVING HEAT TRANSFER

Heat transfer can be improved by reducing the thermal resistance of the contact and the thermal resistance of the heatsink.

Contact thermal resistance

- Make the contact area large
- Make the contact surfaces plane parallel by attention to drilling an punching, and make them burr-free.
- Apply sufficient pressure. Use a torque spanner adjusted to at least the rated minimum torque.
- Use metal oxide-loaded compound to fill air pockets.

Heatsink thermal resistance

- Paint or anodise the surface to improve radiation
- Increase the flow of cooling air
- Use a larger heatsink

The simplest form of air flow is natural convection. Mount the fins vertically, make intake and outlet apertures large, avoid obstructions, create a draught (chimney effect). A blower or fan must be used where free convection is not enough or where a smaller heatsink is wanted.

INSULATED MOUNTING

Where a semiconductor must be insulated from its heatsink (e.g., in bridge rectifiers) by a mica or teflon washer, the contact thermal resistance will be about ten times higher than without insulation. This must be compensated by a reduction in $R_{th\,h-a}$ to keep the total thermal resistance below the maximum given for P and T_{amb} . A larger heatsink may be necessary.



Fig. 2 Creepage distances with an insulated diode

Note: care must be taken that the creepage distances, see Fig. 2, are sufficient for the voltage involved. While A and B can be made large enough, C and D are likely to be the critical ones.

CONSTRUCTIONS

Good thermal coupling is essential to semiconductors connected in parallel to ensure good current sharing in view of the forward characteristics, and semiconductors in series in view of the reverse characteristics.

Mounting the semiconductors on the same heatsink not only saves mounting costs but also provides the needed thermal coupling.

Fig. 3 shows the construction for a plain heatsink, and Fig. 4 the construction for an extruded heatsink. The electrical connection is made with a copper strip at least 1 mm thick. For two diodes a plain heatsink should be twice the area, and an extruded heatsink twice the length needed for a single diode.

Reverse polarity devices are covenient for series connection of two diodes on a common heatsink. Figs. 5, 6 and 7 show how the use of normal polarity and reverse polarity diodes simplifies the construction of single-phase and three-phase bridge rectifiers.



Fig. 3 Plain cooling fin with two diodes



Fig. 5 Single phase full wave rectifier with diodes of different polarity on extruded aluminium heatsinks



Fig. 4 Extruded aluminium heatsink with two diodes



Fig. 6 Single phase full wave rectifier with diodes of different polarity on plain cooling fins (top view)

CONSTRUCTIONS (continued)



Fig. 7 Three phase full wave rectifier with diodes of different polarity on extruded aluminium heatsinks



EXAMPLES OF HEATSINK CALCULATION

1. Devices without controlled avalanche properties.

Assume that the diode of which the outlines are shown, is used in a three phase 50 Hz rectifier circuit at $T_{amb} = 50$ °C. Further assume: average forward current per diode $I_{F(AV)} = 65$ A; contact thermal resistance $R_{th mb}-h=0,1$ °C/W.



Stud: M12 Mounting base, across the flats: max. 27 mm



From the data of the diode the graph to be used is shown below.

From the lefthand graph it follows that $P_{tot} = 90$ W per diode (point A). From the righthand graph it follows that $R_{th} m_{b-a} \approx 1, 2 \ ^{O}C/W$. Thus $R_{th} h_{-a} = R_{th} m_{b-a} - R_{th} m_{b-h} = (1, 2 - 0, 1) \ ^{O}C/W = 1, 1 \ ^{O}C/W$. This may be achieved by different types of heatsinks as shown below.

Туре	Free convection	Forced cooling
flat, blackened bright		125 cm ² ; 2 m/s or 300 cm ² ; 1 m/s 175 cm ² ; 2 m/s
diecast 56280	applicable	
extrusion		
56230 bright blackened 56231 bri gh t blackened	l = 12 cm l = 8 cm l = 7 cm $l = 5 \text{ cm}^{-1}$	$\ell = 5 \text{ cm}^{1}$; 1 m/s $\ell = 5 \text{ cm}^{1}$; 1 m/s

¹) Practical minimum length

EXAMPLES OF HEATSINK CALCULATION (continued)

2. Devices with controlled avalanche properties

Assume that the diode of which the outlines are shown, is used in a three phase 50 Hz rectifier circuit at $T_{amb} = 40$ °C. Further assume: average forward current per diode $I_{F(AV)} = 10$ A; contact thermal resistance:

 $R_{th\ mb-h} = 0.5 \text{ }^{O}C/W$; repetitive peak reverse power in the avalanche region (t = 40 µs) $P_{RRM} = 2 \text{ } kW$ (per diode).



Stud: M12 Mounting base, across the flats: max. 27 mm



From the data of this diode the graph to be used is shown below.

From the lefthand graph it follows that $P_{tot} = 19.5$ W per diode (point A). The average reverse power in the avalanche region, averaged over any cycle, follows from

 $P_{R(AV)} = \delta \times P_{RRM}$, where the duty cycle $\delta = \frac{40 \ \mu s}{20 \ ms} = 0,002$. Thus $P_{R(AV)} = 0,002 \times 2 \ kW = 4 \ W$.

Therefore the total device power dissipation $P_{tot} = 19.5 + 4 = 23.5$ W (point B). From the righthand graph it follows that $R_{th\ mb-a} = 4 \ ^{o}C/W$. Hence the heatsink thermal resistance should be:

 $R_{\text{th h-a}} = R_{\text{th mb-a}} - R_{\text{th mb-h}} = (4 - 0.5) \circ C/W = 3.5 \circ C/W.$

A table of applicable heatsinks, similar to that on the foregoing page, can de derived for this case.

Thermal resistance of flat heatsinks of 2 mm copper or 3 mm aluminium. The graphs are valid for the combination of device and heatsink.



Studs: 10-32UNF Mounting bases, across the flats: max. 11,0 mm



Thermal resistance of flat heatsinks of 2 mm copper or 3 mm aluminium. The graphs are valid for the combination of device and heatsink.



Stud: ¼" x 28 UNF Mounting base, across the flats: max. 17 mm



Stud: M6 Stud: $\frac{1}{4}$ " x 28 UNF Mounting base, across the flats: max.14,0 mm



GATE TURN-OFF THYRISTORS

: :



Dimensions in mm

FAST GATE TURN-OFF THYRISTORS

Thyristors in TO-220AB envelopes capable of being turned both on and off via the gate. They are suitable for use in high-frequency inverters, resonant power supplies, horizontal deflection systems etc. The devices have no reverse blocking capability. For reverse blocking operation use with a series diode, for reverse conducting operation use with an anti parallel diode.

QUICK REFERENCE DATA

			BT157-1300R	1500R	
Repetitive peak off-state voltage	V _{DRM}	max.	1300	1500	v
Non-repetitive peak on-state current	ITSM	max.	2	20	А
Controllable anode current	ITCRM	max.	1	2	А
Average on-state current	IT(AV)	max.	3.	.2	Α
Fall time	tf	max.	20	0	ns

MECHANICAL DATA

Fig.1 TO-220AB 10,3 4,5 max max 3,7 1.3 2.8 5.9 min mounting a base ¥ 15,8 (see note) máx M0954 3,5 max 5,1 not tinned máx 13,5 1,3mín max (2x)0,9 max (3 x) 0.6 2.4 2,54 2,54 M0993

Net mass: 2 g

Note: The exposed metal mounting base is directly connected to the anode.

Accessories supplied on request: see data sheets Mounting instructions and accessories for TO-220 envelopes.

RATINGS

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

Anode to cathode			BT157-1300R 1500	DR
Transient off-state voltage	VDSM	max.	1500 1650) V*
Repetitive peak off-state voltage	V _{DRM}	max.	1300 1500) V*
Working off-state voltage	V _{DW}	max.	1200 1300) V*
Continuous off-state voltage	VD	max.	750 800) V*
Average on-state current (averaged over any 20 ms period) up to T _{mb} = 80 °C	I _{T(AV)}	max.	3.2	- A
Controllable anode current	TCRM	max.	12	А
Non-repetitive peak on-state current t = 10 ms; half-sinewave; T = 120 °C prior to surge	ITEM	max.	20	А
$I_j^2 = 120^{\circ}$ C prior to surge	1 5 IVI 12 t	max	2	A ² s
Total power dissipation up to $T_{mb} = 25 ^{\circ}\text{C}$	P _{tot}	max.	47.5	w
Gate to cathode				
Repetitive peak on-state current $T_j = 120$ °C prior to surge gate-cathode forward: $t = 1$ ms:				
half-sinewave	GFM	max.	25	A
gate-cathode reverse; t = 20 μ s	GRM	max.	15	А
Average power dissipation (averaged over any 20 ms period)	P _G (AV)	max.	2.5	W
Temperatures				
Storage temperature	Т _{stg}		-40 to +150	°C
Operating junction temperature	Тј	max.	120	٥C
THERMAL RESISTANCE				
From junction to mounting base	R _{th} j-mb	=	2.0	K/W
From mounting base to heatsink with heatsink compound	R _{th mb-h}	=	0.3	K/W
with 56367 alumina insulator and heatsink compound (clip-mounted)	R _{th mb-h}	=	0.8	K/W
From junction to ambient in free air, mounted on a printed circuit board	R _{th j-a}	=	60	K/W

* Measured with gate-cathode connected together.

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CHARACTE	RISTICS
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Anode to cathode

On-state voltage $I_T = 2.5 \text{ A}$; $I_G = 0.2 \text{ A}$; $T_j = 120 ^{\text{O}}\text{C}$	V _T	<	3.4	V*
Rate of rise of off-state voltage that will not trigger any off-state device; exponential method $V_D = 2/3 V_{Dmax}$; $V_{GR} = 5 V$; $T_j = 120 °C$ Rate of rise of off-state voltage that will not trigger any device following conduction: linear method:	dV _D /dt	<	10	kV/µs
$I_T = 1.8 \text{ A}; V_D = V_{DRMmax}; V_{GR} = 10 \text{ V}; T_j = 120 \text{ °C}$	dV_{D}/dt	<	1.5	kV/µs
Off-state current $V_D = V_{Dmax}$; $T_j = 120 \text{ °C}$	۱ _D	<	2.0	mA
Latching current; $T_j = 25 ^{O}\text{C}$	۱L	typ.	0.75	A**
Gate to cathode				
Voltage that will trigger all devices $V_D = 12 V; T_j = 25 °C$	V _{GT}	>	1.5	v
Current that will trigger all devices $V_D = 12 \text{ V}; \text{T}_j = 25 \text{ °C}$	I _{GT}	>	200	mA
Minimum reverse breakdown voltage I _{GRM} = 1.0 mA	V(BR)GR	>	10	v
Switching characteristics (resistive load)				
Turn-on when switched to $I_T = 2.5 \text{ A from } V_D = 250 \text{ V}$				
with $I_{GF} = 0.4 \text{ A}; I_j = 25 \text{ GC}$ delay time rise time	t _d t _r	< <	0.25 1.0	μs μs
IGF	M143	3		
		_		
90%	tim	e		
			54 0.00	,
	tim	e	Fig.2 Way	/etorms

- * Measured under pulse conditions to avoid excessive dissipation.
- ** Below latching level the device behaves like a transistor with a gain dependent on current.

Switching characteristics (inductive load)

Turn-off when switched from I _T = 2.5 A to V _D = V _{DRM max} . V _{GR} = 10 V; L _G \leq 1.5 µH; L _S \leq 0.25 µH, T _j = 25 °C		
storage time	ts	<
fall time	tf	<
peak reverse gate current	IGR	<



Fig.3 Waveforms

0.5

0.20

2.8

μs

μs

А



Fig.4 Inductive load test circuit

*Indicates stray series inductance only.

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Fig.5 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.

 $a = \text{form factor} = \frac{|T(RMS)|}{|T(AV)|}$

P = Power excluding switching losses



Fig.6 Anode current which can be turned off versus anode voltage; inductive load, V_{GR} = 10 V; L_G \leq 1.5 μ H; L_S \leq 0.25 μ H; T_j = 85 °C ^{*}dV_D/dt is calculated from I_T/C_S.

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Fig.13 Peak reverse gate current versus applied gate voltage; inductive load; I_T = 2.5 A; I_G = 0.2 A; L_G = 0.8 μ H; T_j = 120 °C; maximum values.







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Fig.16 Storage and fall times versus applied reverse gate voltage; inductive load; I_T = 2.5 A; L_G = 0.8 μ H; I_G = 0.2 A; T_j = 25 °C; maximum values.



Fig.17 Maximum energy loss at turn-off (per cycle) as a function of anode current and applied dV_D/dt (calculated from I_T/C_S); reapplied voltage sinsusoidal up to V_{DRM} = 1200 V; V_{GR} = 10 V; I_G = 0.2 A; $L_G \le 1.5 \ \mu\text{H}$; $L_S \le 0.25 \ \mu\text{H}$; T_j = 120 °C.



Fig.18 Energy loss at turn off as a function of junction temperature; $I_G = 0.2 \text{ A}$; $V_{GR} = 10 \text{ V}$. Normalised to $T_j = 120 \text{ }^{\circ}\text{C}$.

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

FAST GATE TURN-OFF THYRISTORS

Thyristors in SOT-93 envelopes which are capable of being turned both on and off via the gate, and may be used with gate-assisted turn-off in anode-commutated circuits. They are suitable for use in resonant power supplies, high-frequency inverters, motor control etc. The devices have no reverse blocking capability; for reverse blocking operation use with a series diode, for reverse conducting operation use with an anti-parallel diode. The anode is connected to the mounting base.

QUICK REFERENCE DATA

		BTR59	9—800R	1300R	
Repetitive peak off-state voltage	V _{DRM}	max.	800	1300	V
Controllable anode current	ITCRM	max.	5	0	А
Average on-state current	IT(AV)	max.	1	0	А
Circuit commutated turn-off time	tq	<	1.	.0	μs

MECHANICAL DATA

Fig.1 SOT93; anode connected to mounting base.

Dimensions in mm





Accessories supplied on request; see data sheets Mounting instructions and accessories for SOT-93 envelopes.

RATINGS

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

Anode to cathode		BTR59	-800R	1300R	
Transient off-state voltage	V _{DSM}	max.	800	1300	۷*
Repetitive peak off-state voltage	VDRM	max.	800	1300	V*
Working off-state voltage	V _{DW}	max.	600	1000	۷*
Continuous off-state voltage	VD	max.	400	750	۷*
Average on-state current (averaged over any 20 ms period) up to T_{mb} = 85 ^{o}C	IT(AV)	max.	1	0	А
R.M.S. on-state current	IT(RMS)	max.	16.	5	А
Controllable anode current	^I TCRM	max.	5	0	А
Non-repetitive peak on-state current t = 10 ms; half-sinewave; T _i = 120 ^o C prior to surge	ITSM	max.	10	0	A
I ² t for fusing; t = 10 ms	l²t	max.	5	0	A ² s
Total power dissipation up to T_{mb} = 25 °C	P _{tot}	max.	10	5	W
Gate to cathode					
Repetitive peak current $T_j = 120$ °C prior to surge gate-cathode forward; t = 10 ms; half-sinewave gate-cathode reverse; t = 20 µs	IGFM IGBM	max. max.	2	5	A A
Average power dissipation (averaged over any 20 ms period)	P _G (AV)	max.	5.	0	w
Temperatures					
Storage temperature	т _{stg}	-	-40 to +12	5	οС
Operating junction temperature	Тј	max.	12	0	oC
THERMAL RESISTANCE					
From mounting base to heatsink; with heatsink compound	R _{th mb-h}	=	0.	2	K/W
From junction to mounting base	R _{th} j-mb	-	0.	9	K/W

*Measured with gate-cathode connected together.

CHARACTERISTICS

Anode to cathode

On-state voltage $I_T = 10 A; I_G = 0.5 A; T_i = 120 {}^{O}C$	VT	<	3.0	V*
Rate of rise of off-state voltage that will not trigger any off-state device; exponential method $V_D = 2/3 V_{Dmax}; V_{GR} = 5 V; T_i = 120 \text{ °C}$	dV _D /dt	<	10	kV/µs
Rate of rise of off-state voltage that will not trigger any device following conduction, linear method $I_T = 20 A; V_D = V_{DRMmax}; V_{GR} = 10 V; T_i = 120 °C$	dV _D /dt	<	1.0	kV/μs
Off-state current	D.			
V _D = V _{Dmax} ; T _j = 120 °C	۱ _D	<	5.0	mA
Latching current; T _j = 25 ^o C	۱L	typ.	1.5	A**
Gate to cathode				
Voltage that will trigger all devices $V_D = 12 V$; $T_j = 25 \ ^{o}C$	V _{GT}	>	1.5	v
Current that will trigger all devices $V_D = 12 \text{ V}; \text{ T}_j = 25 ^{\text{O}}\text{C}$	IGT	>	500	mA
Minimum reverse breakdown voltage IGR = 1.0 mA	V _(BR) GR	>	10	v
Switching characteristics (resistive load)				
Turn-on when switched to $I_T = 10 \text{ A}$ from $V_D = 250 \text{ V}$ with $I_{GF} = 2.5 \text{ A}$; $T_j = 25 \text{ °C}$				
delay time rise time	^t d t _r	< <	0.3 1.5	μs μs
	M1433	- - -		
' Fig.2 Waveforms.				

- *Measured under pulse conditions to avoid excessive dissipation.
- **Below latching level the device behaves like a transistor with a gain dependent on current.

DEVELOPMENT DATA

Switching characteristics (inductive load)

Turn-off when switched from $I_T = 10 \text{ A to } V_D = V_{Dmax}$;

V_{GR} = 10 V; $L_G \le 0.5 \ \mu$ H; $L_S \le 0.25 \ \mu$ H; $C_S \ge$	≥ 20 nF; T _j = 85 ^o C			
storage time	ts	<	0.60	μs
fall time	t _f	<	0.25	μs
peak reverse gate current	IGR	<	10	А



Fig.3 Waveforms.



Fig.4 Inductive load test circuit.

*Indicates stray series inductance only.

μs

1.0

Switching characteristics (circuit-commutated)*

Turn-off time

 $I_T = 50 \text{ A}; -dI_T/dt = 10 \text{ A}/\mu s; dV_D/dt = 200 \text{ V}/\mu s;$ $V_{GR} = 5 \text{ V}; T_j = 120 \text{ °C}$



tq

<

Fig.5 Circuit-commutated turn-off time definition.

*Figs. 7, 11, 12, 13, 15, 16, 17 do not apply to commutated turn-off.



Fig.6 The right hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.

a = form factor = $\frac{|T(RMS)|}{|T(AV)|}$

P = power excluding switching losses.

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Fig.7 Anode current which can be turned off versus applied dV $_D/dt^*$; inductive load; LG \leq 0.5 μ H; LS \leq 0.25 μ H; Tj = 120 °C.

 $^{*}dV_{D}/dt$ is calculated from I_{T}/C_{S} .



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 $I_T = 10 \text{ A}$; $I_G = 0.5 \text{ A}$; $L_G = 0.4 \mu\text{H}$; $T_j = 120 \text{ °C}$; maximum values.







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Fig.15 Storage and fall times versus applied reverse gate voltage; inductive load, I_T = 10 A; I_G = 0.5 A; L_G = 0.4 μ H; T_j = 25 °C; maximum values.



Fig.16 Maximum energy loss at turn-off (per cycle) as a function of anode current and applied dV_D/dt (calculated from I_T/C_S); dV_D/dt linear up to $V_D = V_{DWmax}$; $V_{GR} = 10$ V; I_G = 0.5 A; $L_G < 0.5 \mu$ H; $L_S < 0.25 \mu$ H; $T_i = 120$ °C.



Fig.17 Energy loss at turn-off as a function of junction temperature; $I_G = 0.5 \text{ A}$; $V_{GR} = 10 \text{ V}$. Normalised to $T_j = 120 \text{ }^{\circ}\text{C}$.

FAST GATE TURN-OFF THYRISTORS

Thyristors in SOT-93 envelopes capable of being turned both on and off via the gate. They are suitable for use in high-frequency inverters, power supplies, motor control etc. The devices have no reverse blocking capability; for reverse blocking operation use with a series diode, for reverse conducting operation use with an anti-parallel diode. The anode is connected to the mounting base.

QUICK REFERENCE DATA

		BTS59-850	R 1000R	1200R
Repetitive peak off-state voltage	VDRM	max. 850	1000	1200 V
Non-repetitive peak on-state current	ITSM	max.	100	А
Controllable anode current	ITCRM	max.	50	А
Average on-state current	T(AV)	max.	15	А
Fall time	t _f	<	250	ns

MECHANICAL DATA

Fig.1 SOT-93; anode connected to mounting base

15.2 4.6 max. max. - 14 0.1 @ A @ 13.6 2 4.25 4.15 R. 2 max.(2x) 3 4.3 2 M2282 21 max 12.7 max. 1.3 2.2 max. 0.5 dimensions 13.6 min. within this min. zone are 11.85 uncontrolled. 2 1 3 1.15 -0.4 0.95 -5.5-5.5-1.6

Accessories supplied on request: see data sheets Mounting instructions and accessories for SOT-93 envelopes.

Dimensions in mm

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RATINGS

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

Anode to cathode		BTS59	9-850R	1000R	1200R	
Transient off-state voltage	VDSM	max.	1000	1100	1300	۷*
Repetitive peak off-state voltage	VDRM	max.	850	1000	1200	۷*
Working off-state voltage	V _{DW}	max.	600	800	1000	V*
Continuous off-state voltage	VD	max.	500	650	750	۷*
Average on-state current (averaged over any 20 ms period) up to T _{mb} = 85 ^o C	^I T(AV)	max.		15		A
Controllable anode current	TCRM	max.		50		А
Non-repetitive peak on-state current t = 10 ms; half-sinewave; T: = 120 °C prior to surre		may		100		٨
I_{j}^{2} for fusing: $t = 10$ ms		max.		50		A 2
Tatel serves distinction we to T	1-1 D	max.		50		A* s
Total power dissipation up to $T_{mb} = 25 {}^{\circ}C$	Ptot	max.		105		W
Gate to cathode						
Repetitive peak current $T_j = 120$ °C prior to surge gate-cathode forward; t = 10 ms; half singurate				05		
gate-cathode reverse; t = 20 μ s	GFM	max. max.		25 25		A
Average power dissipation (averaged over any 20 ms period)	P _G (AV)	max.		5.0		w
Temperatures						
Storage temperature	T _{stg}		-40 t	o +125		٥C
Operating junction temperature	тj	max.		120		٥C
THERMAL RESISTANCE						
From mounting base to heatsink;						
with heatsink compound	R _{th mb-h}	=		0.2		K/W
From junction to mounting base	R _{th} j-mb	=		0.9		K/W

Measured with gate-cathode connected together. ×

CHARACTERISTICS				
Anode to cathode				
On-state voltage I _T = 10 A; I _G = 0.5 A; T _j = 120 ^o C	VT	<	2.3	V*
Rate of rise of off-state voltage that will not trigger any off-state device; exponential method $V_D = 2/3 V_{Dmax}$; $V_{GR} = 5 V$; $T_j = 120 \text{ °C}$	dV _D /dt	<	10	kV/µs
Rate of rise of off-state voltage that will not trigger any device following conduction, linear method $I_T = 20 \text{ A}$; $V_D = V_{DRMmax}$; $V_{GR} = 10 \text{ V}$; $T_j = 120 ^{OC}$	dV _D /dt	<	1.0	kV/µs
Off-state current. V _D = V _{Dmax} ; T _j = 120 ^o C	۱ _D	<	5.0	mA
Latching current; T _j = 25 ^o C	۱L	typ.	1.5	A**
Gate to cathode Voltage that will trigger all devices $V_D = 12 V; T_i = 25 \ ^{\circ}C$	VGT	>	1.5	V
Current that will trigger all devices $V_D = 12 \text{ V}, T_j = 25 \text{ °C}$	IGT	>	300	mA
Minimum reverse breakdown voltage I _{GR} = 1.0 mA	V(BR)GR	>	10	v
Switching characteristics (resistive load) Turn-on when switched to $I_T = 10$ A from $V_D = 250$ V with $I_{GF} = 1.5$ A; $T_j = 25$ °C delay time rise time	t _d t _r	< <	0.3 1.5	μs μs
	time	Fig.2 V	Vaveforms	

* Measured under pulse conditions to avoid excessive dissipation.

** Below latching level the device behaves like a transistor with a gain dependent on current.

Switching characteristics (inductive load)

switched from $I_T = 10 \text{ A to } V_D$	= V _{Dmax} ;			
/; $L_{G} \le 0.5 \ \mu H$; $L_{S} \le 0.25 \ \mu H$; C	$C_{S} \ge 20 \text{ nF}; T_{j} = 25 ^{O}C$			
)	ts	<	0.60	μs
	t _f	<	0.25	μs
gate current	^I GR	<	10	А
	e switched from I _T = 10 A to V _D /; L _G \leq 0.5 μ H; L _S \leq 0.25 μ H; C e gate current	e switched from I _T = 10 A to V _D = V _{Dmax} ; /; L _G \leq 0.5 µH; L _S \leq 0.25 µH; C _S \geq 20 nF; T _j = 25 °C t _s t _f e gate current I _{GR}	e switched from I _T = 10 A to V _D = V _{Dmax} ; /; L _G \leq 0.5 µH; L _S \leq 0.25 µH; C _S \geq 20 nF; T _j = 25 °C t _s < t _f < e gate current I _{GR} <	e switched from I _T = 10 A to V _D = V _{Dmax} ; /; L _G \leq 0.5 µH; L _S \leq 0.25 µH; C _S \geq 20 nF; T _j = 25 °C t _s < 0.60 t _f < 0.25 e gate current I _{GR} < 10



Fig.3 Waveforms.



*Indicates stray series inductance only

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Fig.5 The right hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.

a = form factor = $\frac{IT(RMS)}{IT(AV)}$

P = power excluding switching losses.

M2279 10² $dV_D/dt^*=$ 50 70∨/μs 100∨/μs 200V/µs тс 500V/µs (A) -1kV/μs· 5kV/µs 10 BTS59--1200R -1000R - 850R 1 10² 10³ $v_D(v)$

Fig.6 Anode current which can be turned off versus anode voltage; inductive load; V_{GR} = 10 V; L_G \leq 0.5 µH; L_S \leq 0.25 µH; T_j = 120 °C. *dV_D/dt is calculated from I_T/C_S.



Fig.7 Anode current which can be turned off versus applied dV_D/dt*; inductive load; L_G \leq 0.5 μ H; L_S \leq 0.25 μ H; T_j = 120 °C. *dV_D/dt is calculated from I_T/C_S.



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Fig.15 Storage and fall times versus applied reverse gate voltage; inductive load; I_T = 10 A; I_G = 0.5 A; L_G = 0.4 μ H; T_j = 25 °C; maximum values.



Fig.16 Maximum energy loss at turn-off (per cycle) as a function of anode current and applied dV_D/dt (calculated from I_T/C_S); dV_D/dt linear up to V_{Dmax} = 600 V; V_{GR} = 10 V; I_G = 0.5 A; L_G \leq 0.5 μ H; L_S \leq 0.25 μ H; T_j = 120 °C.



Fig.17 Energy loss at turn off as a function of junction temperature; $I_G = 0.5 \text{ A}$; $V_{GR} = 10 \text{ V}$. Normalised to $T_j = 120 \text{ }^{\circ}\text{C}$.

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FAST GATE TURN-OFF THYRISTORS

Thyristors in TO-220AB envelopes capable of being turned both on and off via the gate. They are suitable for use in high-frequency inverters, power supplies, motor control etc. The devices have no reverse blocking capability. For reverse blocking operation use with a series diode, for reverse conducting operation use with an anti parallel diode.

QUICK REFERENCE DATA

			BTV58-	-600R	850R	1000R	
Repetitive peak off-state voltage	V _{DRM}	max.		600	850	1000	v
Non-repetitive peak on-state current	ITSM	max.			75		А
Controllable anode current	ITCRM	max.			25		А
Average on-state current	IT(AV)	max.			10		А
Fall time	t _f	max.			250		ns

MECHANICAL DATA

Fig.1 TO-220AB.



Dimensions in mm



Net mass: 2 g

Note: The exposed metal mounting base is directly connected to the anode. Accessories supplied on request: see data sheets Mounting instructions and accessories for TO-220 envelopes.

RATINGS

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

Anode to cathode		BTV58	8-600R	850R	1000R
Transient off-state voltage*	V _{DSM}	max.	750	1000	1100 V
Repetitive peak off-state voltage *	VDRM	max.	600	850	1000 V
Working off-state voltage *	V _{DW}	max.	400	600	800 V
Continuous off-state voltage *	VD	max.	400	500	650 V
Average on-state current (averaged over any 20 ms period) up to $T_{mb} = 80 \ ^{o}C$	I _{T(AV)}	max.		10	<u> </u>
Controllable anode current	ITCRM	max.		25	А
Non-repetitive peak on-state current t = 10 ms; half-sinewave; T: = 120 °C prior to surge	ITOM	max		75	Δ
I_j^2 for fusing: t = 10 ms	' 1 SIVI	max.		28	Δ^2 s
Total power dissipation up to $T_{\rm eff} = 25.00$	Р	max.		20 65	w
Total power dissipation up to Tmb = 25 °C	' tot	max.		05	
Gate to cathode					
Repetitive peak on-state current $T_i = 120$ °C prior to surge					
gate-cathode forward; t = 10 ms; half-sinewave gate-cathode reverse; t = 20 μ s	IGFM IGRM	max. max.		25 25	A
Average power dissipation (averaged over any 20 ms period)	P _G (AV)	max.		2,5	w
Temperatures					
Storage temperature	T _{stq}		-40 te	o + 150	°C
Operating junction temperature	т _ј	max.		120	oC
THERMAL RESISTANCE					
From junction to mounting base	R _{th j-mb}	1 <u></u>		1,5	K/M
From mounting base to heatsink with heatsink compound	R _{th mb-h}	=		0,3	K/W
with 56367 alumina insulator and heatsink compound (clip-mounted)	R _{th mb-h}	=		0,8	K/M

* Measured with gate connected to cathode.

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CHARACTERISTICS					
Anode to cathode					
On-state voltage I _T = 5 A; I _G = 0.2 A;	T _j = 120 °C	۷ _T	<	1.8	V*
Rate of rise of off-state trigger any off-state o V _D = 2/3 V _{Dmax} ; V	voltage that will not levice; exponential method GR = 5 V; Tj = 120 °C	dV _D /dt	<	10	kV/μs
Rate of rise of off-state any device following $I_T = 5 A$; $V_D = V_{DR}$	voltage that will not trigger conduction, linear method Mmax; V _{GR} = 10 V; T _j = 120 ^o C	dV _D /dt	<	1.5	kV/μs
Off-state current					
$V_D = V_{Dmax}; T_i = 12$	20 ºC	۱ _D	<	3.0	mA
Latching current; T _j = 2	5 °C	۱L	typ.	1.0	A**
Gate to cathode					
Voltage that will trigger	all devices				
$V_D = 12 \text{ V}; \text{ T}_j = 25 ^{\circ}$	C	V _{GT}	>	1.5	v
Current that will trigger V _D = 12 V; T _j = 25 °	all devices C	I _{GT}	>	200	mA
Minimum reverse break	town voltage				
I _{GR} = 1.0 mA		V _(BR) GR	>	10	v
Switching characteristic	s (resistive load)				
Turn-on when switched	to $I_T = 5 \text{ A from } V_D = 250 \text{ V}$				
with I _{GF} = 0.5 A; T _j	= 25 °C				
delay time		^t d	<	0.25	μs
rise time		۲r	<	1.0	μs
	IGF	M14	433		
		ti	me		
	90%				
	10%			Fig.2 Wave	forms
		ti	me		

- * Measured under pulse conditions to avoid excessive dissipation.
- ** Below latching level the device behaves like a transistor with a gain dependent on current.

Switching characteristics (inductive load)

Turn-off when switched from $I_T = 5 \text{ A to } V_D = V_{Dmax}$; $V_{GR} = 10 \text{ V}$; $L_G \leq 1.0 \mu\text{H}$; $L_S \leq 0.25 \mu\text{H}$; $T_j = 25 \text{ °C}$ storage time fall time

peak reverse gate current

t _s	<	0.5	μs
t _f	<	0.25	μs
GR	<	6	Α



Fig.3 Waveforms.

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*indicates stray series inductance only.

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Fig.5 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.

a = form factor = $\frac{IT(RMS)}{IT(AV)}$

P = power excluding switching losses.

*Mounting-base temperature scale is for comparison purposes and is correct only for R_{th mb-a} < 9.6 K/W.



Fig.6 Anode current which can be turned off versus anode voltage; inductive load; V_{GR} = 10 V; L_G \leq 1.0 µH; L_S \leq 0.25 µH; T_j = 85 °C. *dV_D/dt is calculated from I_T/C_S.

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Fig.7 Anode current which can be turned off versus applied dV_D/dt*; inductive load; V_{GR} = 10 V. L_G \leq 1.0 μ H; L_S \leq 0.25 μ H. *dV_D/dt is calculated from I_T/C_S.



 $L_G \leqslant$ 1.0 $\mu H; \, L_S \leqslant$ 0.25 $\mu H; \, ^* dV_D/dt$ is calculated from I_T/C_S.



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Fig.16 Storage and fall times versus applied reverse gate voltage; inductive load; I_T = 5 A; I_G = 0.2 A; L_G = 0.8 μ H; T_j = 25 °C; maximum values.



Fig.17 Maximum energy loss at turn-off (per cycle) as a function of anode current and applied dV_D/dt (calculated from I_T/C_S); dV_D/dt linear up to V_{Dmax} = 600 V; V_{GR} = 10 V; I_G = 0.2 A; L_G \leq 1.0 μ H; L_S \leq 0.25 μ H; T_j = 120 °C.



Fig.18 Energy loss at turn off as a function of junction temperature; $I_G = 0.2 \text{ A}$; $V_{GR} = 10 \text{ V}$. Normalised to $T_j = 120 \text{ °C}$.

FAST GATE TURN-OFF THYRISTORS

Thyristors in TO-238AA envelopes with electrically isolated metal baseplates capable of being turned both on and off via the gate. They are suitable for use in high-frequency inverters, power supplies, motor control etc. The devices have no reverse blocking capability. For reverse blocking operation use with a series diode, for reverse conducting operation use with an anti-parallel diode.

QUICK REFERENCE DATA

		BTV5	9-600R	850R	1000R	
Repetitive peak off-state voltage	VDRM	max.	600	850	1000	v
Non-repetitive peak on-state current	^I TSM	max.	<u></u>	100		А
Controllable anode current	ITCRM	max.		50		А
Average on-state current	IT(AV)	max.		15		Α
Fall time	tf	<		250		ns

MECHANICAL DATA

Fig. 1 TO-238AA

Dimensions in mm



Pin 1 = gate (AMP 187 series)

2 = cathode (AMP 250 series) 3 = anode (AMP 250 series)

Baseplate is electrically isolated.

RATINGS

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

Anode to cathode		BTV5	9-600R	850R	1000R	
Transient off-state voltage	V _{DSM}	max.	750	1000	1100	V*
Repetitive peak off-state voltage	VDRM	max.	600	850	1000	۷*
Working off-state voltage	V _{DW}	max.	400	600	800	V*
Continuous off-state voltage	VD	max.	400	500	650	V*
Average on-state current (averaged over any 20 ms period) up to T _{mb} = 60 ^o C	IT(AV)	max.	·	15		A
Controllable anode current	ITCRM	max.		50		А
Non-repetitive peak on-state current t = 10 ms; half-sinewave; T = 120 °C prior to surge	TOM	max		100		А
l_{1}^{2} t for fusing: t = 10 ms	151VI 12+	max		50		A ² s
Total power dissipation up to $T_{mb} = 25 \text{ °C}$	Ptot	max.		60		w
Gate to cathode	101					
Repetitive peak on-state current $T_j = 120$ °C prior to surge gate-cathode forward; t = 10 ms;						
half-sinewave	GFM	max.		25		Α
gate-cathode reverse; t = 20 μ s	GRM	max.		25		А
Average power dissipation (averaged over any 20 ms period)	^P G(AV)	max.		5.0		w
Temperatures						
Storage temperature	T _{stg}		-40 to	o +150		°C
Operating junction temperature	т _ј	max.		120		°C
ISOLATION**						
R.M.S. isolation voltage	V _{isol}	min.		2500		۷
THERMAL RESISTANCE						
From mounting base to heatsink ; with heatsink compound	R _{th mb-h}	=		0.5		K/W
From junction to mounting base	R _{th} j-mb	=		1.5		K/W

* Measured with gate-cathode connected together.

** From baseplate to all terminals strapped together.

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CHARACTERISTICS

Anode to cathode

On-state voltage I _T = 10 A; I _G = 0.5 A; T _j = 120 °C	VT	<	2.3	V*
Rate of rise of off-state voltage that will not trigger any off-state device; exponential method $V_D = 2/3 V_{Dmax}$; $V_{GR} = 5 V$; $T_j = 120 °C$	dV _D /dt	<	10	kV/μs
Rate of rise of off-state voltage that will not trigger any device following conduction, linear method $I_T = 10 \text{ A}$; $V_D = V_{DRMmax}$; $V_{GR} = 10 \text{ V}$; $T_j = 120 ^{\circ}\text{C}$	dV _D /dt	<	1.0	kV/μs
Off-state current V _D = V _{Dmax;} T _j = 120 °C	۱ _D	<	5.0	mA
Latching current; T _j = 25 ^O C	۱L	typ.	1.5	A**
Gate to cathode				
Voltage that will trigger all devices V _D = 12 V; T _j = 25 °C	V _{GT}	>	1.5	v
Current that will trigger all devices $V_D = 12 \text{ V}; \text{ T}_j = 25 \text{ °C}$	I _{GT}	>	200	mA
Minimum reverse breakdown voltage I _{GR} = 1.0 mA	V _(BR) GR	>	10	v
Switching characteristics (resistive load) Turn on when switched to I _T = 10 A from V _D = 250 V with I _{GF} = 1.0 A; T _j = 25 $^{\circ}$ C		,		
delay time rise time	^t d ^t r	<	0.3 1.5	μs μs
^{I}GF ^{I}G ^{I}G ^{I}T I	M1433	-	F ': 0.14	
	tim	e	Fig.2 Wa	veforms

* Measured under pulse conditions to avoid excessive dissipation.

**Below latching level the device behaves like a transistor with a gain dependent on current.

Switching characteristics (inductive load)

Turn-off when switched from $I_T = 10 \text{ A to } V_D = V_{Dmax}$;				
V_{GR} = 10 V; $L_{G} \le 0.5 \ \mu$ H; $L_{S} \le 0.25 \ \mu$ H; T_{j} = 25 °C				
storage time	t _s	<	0.60	
fall time	tf	<	0.25	
peak reverse gate current	IGR	<	10	



Fig.3 Waveforms.

μs μs A



Fig.4 Inductive load test circuit.

*Indicates stray series inductance only.

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Fig. 5 The right hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.

a = form factor = $\frac{I_T(RMS)}{I_T(AV)}$

P = power excluding switching losses.



Fig. 6 Anode current which can be turned off versus anode voltage; inductive load; V_{GR} = 10 V; L_G \leq 0.5 μ H; L_S \leq 0.25 μ H; T_j = 85 °C. *dV_D/dt is calculated from I_T/C_S.



Fig.7 Anode current which can be turned off versus applied dV_D/dt⁺; inductive load; V_{GR} = 10 V; $L_G \leq 0.5 \ \mu$ H; $L_S \leq 0.25 \ \mu$ H. *dV_D/dt is calculated from I_T/C_S.







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Fig.12 Peak reverse gate current versus anode current at turn-off; inductive load; $V_{G\,R}$ = 10 V; I_G = 0.5 A; L_G = 0.4 μ H; T_j = 120 °C; maximum values.



 $I_G = 0.5 \text{ A}$; $L_G = 0.4 \ \mu\text{H}$; $T_i = 120 \ ^{o}\text{C}$; maximum values.

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Fig.16 Storage and fall times versus applied reverse gate voltage; inductive load; I_T = 10 A; I_G = 0.5 A; L_G = 0.4 μ H; T_j = 25 °C; maximum values.

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Fig.17 Maximum energy loss at turn-off (per cycle) as a function of anode current and applied dV_D/dt (calculated from I_T/C_S); dV_D/dt linear up to V_{Dmax} = 600 V; V_{GR} = 10 V; I_G = 0.5 A; $L_{G} \le 0.5 \ \mu\text{H}; L_{S} \le 0.25 \ \mu\text{H}; T_{i} = 120 \ ^{\circ}\text{C}.$



Fig.18 Energy loss at turn off as a function of junction temperature; $I_G = 0.5 \text{ A}$; $V_{GR} = 10 \text{ V}$. Normalised to $T_j = 120 \text{ °C}$.

FAST GATE TURN-OFF THYRISTORS WITH ANTI-PARALLEL DIODE

Fast gate turn-off thyristors with anti-parallel connected fast soft-recovery diodes in TO-238AA. They are suitable for use in high frequency inverters, power supplies and motor control systems requiring a parallel connected flywheel or efficiency diode. The baseplate is electrically isolated.

QUICK REFERENCE DATA

GTO		BTV59D	D-850R	1000R	1200R	
Repetitive peak off-state voltage	V _{DRM}	max.	850	1000	1200	v
Non-repetitive peak on-state current	TSM	max.		100		А
Controllable anode current	ITCRM	max.		50		Α
Average on-state current	IT(AV)	max.		15		А
Fall time	t _f	<		250		ns
Diode						
Average forward current	F(AV)	max.		9.0		А
Non-repetitive peak forward current	I FSM	max.		60		А
Reverse recovery time	t _{rr}	<		600		ns

MECHANICAL DATA

Fig.1 TO-238AA

Dimensions in mm



Pin 1 = gate (AMP 187) series 2 = k(GTO) a(Diode); (AMP 250 series) 3 = a(GTO) k(Diode); (AMP 250 series) Baseplate is electrically isolated. For further information see data sheets BTV59 and BY359.
RATINGS

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

Anode to cathode		BTV59	D-850R	1000R	1200R	
Transient off-state voltage	V _{DSM}	max.	1000	1100	1300	۷*
Repetitive peak off-state voltage	VDRM	max.	850	1000	1200	۷*
Working off-state voltage	V _{DW}	max.	600	800	1000	۷*
Continuous off-state voltage	VD	max.	500	650	750	۷*
Average on-state current (averaged over any 20 ms period) up to T _{mb} = 60 ^o C	IT(AV)	max.		15	·	А
Controllable anode current	ITCRM	max.		50		A
Non-repetitive peak on-state current t = 10 ms; half-sinewave; T: = 120 9C prior to surre	1701	may		100		^
$I_j = 120$ - C prior to surge	11SM 12+	max.		50		A A ² a
Total power dissipation up to $T_{\rm eff} = 25.90$	Prot	max.		60 60		w
Gate to cathode	. 101	max.		00		
Repetitive peak on-state current $T_j = 120$ °C prior to surge gate-cathode forward; t = 10 ms; half-sinewave	ICT.M	max		25		Δ
gate-cathode reverse; t = 20 μ s		max.		25		Â
Average power dissipation (averaged over any 20 ms period)	P _G (AV)	max.		5.0		w
Diode						
Average forward current (averaged over any 20 ms period) up to T_{mb} = 70 °C	lF(AV)	max.		9.0		А
Non-repetitive peak on-state current t = 10 ms; half-sinewave T_j = 120 ^o C prior to surge	FSM	max.		60		А
Temperatures						
Storage temperature	T _{stg}		-40 te	o +125		oC
Operating junction temperature	Тј	max.		120		oC
ISOLATION**						
R.M.S. isolation voltage	V _{isol}	min.		2500		V

Measured with gate-cathode connected together.
** From baseplate to all terminals strapped together.

August 1985

THERMAL RESISTANCE

GTO

From junction to mounting base	R _{th} j-mb	=	1.5	K/W
From mounting base to heatsink with heatsink compound	R _{th mb-h}	=	0.3	K/W
Diode				
From junction to mounting base	R _{th i-mb}	=	3.6	K/W
From mounting base to heatsink with heatsink compound	R _{th mb-h}	=	0.3	K/W



Fig.2 Equivalent thermal network.

GTO CHARACTERISTICS

Anode to cathode

On-state voltage $I_T = 10 A; I_G = 0.5 A; T_j = 120 \text{ °C}$	VT	<	2.3	V*
Rate of rise of off-state voltage that will not trigger any off-state device; exponential method $V_D = 2/3 V_{Dmax}$; $V_{GR} = 5 V$; $T_j = 120 \text{ °C}$	dV _D /dt	<	10	kV/μs
Rate of rise of off-state voltage that will not trigger any device following conduction, linear method $I_T = 10 A$; $V_D = V_{DRMmax}$; $V_{GR} = 10 V$; $T_j = 120 ^{\circ}\text{C}$	dV _D /dt	<	1.0	kV/μs
Off-state current $V_D = V_{Dmax}$; $T_j = 120 \text{ °C}$	۱ _D	<	5.0	mA
Latching current; T _j = 25 ^o C	۱L	typ.	1.5	A**
Gate to cathode				
Voltage that will trigger all devices V _D = 12 V; T _j = 25 °C	V _{GT}	>	1.5	v
Current that will trigger all devices $V_D = 12 \text{ V}$; T _j = 25 °C	IGT	>	200	mA
Minimum reverse breakdown voltage IGR = 1.0 mA	V _(BR) GR	>	10	v
Switching characteristics (resistive load)				
Turn-on when switched to $I_T = 10 \text{ A}$ from $V_D = 250 \text{ V}$ with $I_{GF} = 1.0 \text{ A}$; $T_j = 25 \text{ °C}$ delay time rise time	^t d tr	< <	0.3 1.5	μs us
	time	3 		
$ \cdot _{t_r}$				

Fig.3 Waveforms.

time

* Measured under pulse conditions to avoid excessive dissipation.

10%

** Below latching level the device behaves like a transistor with a gain dependent on current.

GTO (cont.)

Switching characteristics (inductive load)

Turn-off when switched from $I_T = 10 \text{ A to } V_D = V_{Dmax}$;

 V_{GR} = 10 V; $L_{G} \le 0.5 \ \mu$ H; $L_{S} \le 0.25 \ \mu$ H; T_{i} = 25 °C

storage time	ts	<	0.60	μs
fall time	t _f	< .	0.25	μs
peak reverse gate current	^I GR	<	10	А



Fig.4 Waveforms.



*Indicates stray series inductance only

GTO (cont.)



Fig.6 The right hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.

a = form factor = $\frac{I_T(RMS)}{I_T(AV)}$

P = power excluding switching losses.

Values given on the right hand graph assume that the diode is not dissipating significant power.

GTO (cont.)











Fast gate turn-off thyristors

BTV59D SERIES





Fig.14 Maximum energy loss at turn-off (per cycle) as a function of anode current and applied dV_D/dt (calculated from I_T/C_S); dV_D/dt linear up to V_{Dmax} = 600 V; V_{GR} = 10 V; I_G = 0.5 A; L_G \leq 0.5 μ H; L_S \leq 0.25 μ H; T_j = 120 °C.



Fig.15 Energy loss at turn off as a function of junction temperature; $I_G = 0.5 \text{ A}$; $V_{GR} = 10 \text{ V}$. Normalised to $T_j = 120 \text{ }^{\circ}\text{C}$.

DIODE CHARACTERISTICS

Forward voltage I _F = 10 A; T _j = 25 ^o C	VF	<	2.0	V*
Reverse recovery when switched from IF = 2 A to VR \geq 30 V with $-dI_F/dt$ = 20 A/µs; Tj = 25 °C recovered charge recovery time	O _s t _{rr}	< <	2.0 0.6	μC μs
Forward recovery when switched to IF = 5 A with $t_r = 0.1 \ \mu s$; T _j = 25 °C recovery time	t _{fr}	<	1.0	μs



Fig.16 Definition of t_{rr} and Q_s .





*Measured under pulse conditions to avoid excessive dissipation



Fig.18 The right hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.

a = form factor = $\frac{|F(RMS)|}{|F(AV)|}$

Values given on the right hand graph assume that the GTO is not dissipating significant power.

Fast gate turn-off thyristors

BTV59D SERIES

DIODE (cont.)



Fig.19 Forward voltage as a function of forward current; maximum values.



Fig.20 Peak reverse recovery current versus $-dI_F/dt$; $T_j = 25 \text{ °C}$; maximum values.

DIODE (cont.)



Fig.21 Transient thermal impedance.

FAST GATE TURN-OFF THYRISTORS

Thyristors in TO-238AA envelopes with electrically isolated metal baseplates capable of being turned both on and off via the gate. They are suitable for use in high-frequency inverters, power supplies, motor control etc. The devices have no reverse blocking capability. For reverse blocking operation use with a series diode, for reverse conducting operation use with an anti-parallel diode.

QUICK REFERENCE DATA

		BTV60	—850R	1000R	1200R	
Repetitive peak off-state voltage	V _{DRM}	max.	850	1000	1200	ν
Non-repetitive peak on-state current	ITSM	max.		240		A 🛶
Controllable anode current	TCRM	max.		120		А
Average on-state current	IT(AV)	max.		25		А
Fall time	tf	<		300		ns

MECHANICAL DATA

Fig.1 TO-238AA

Dimensions in mm



Pin 1 = gate (AMP 187 series) 2 = cathode (AMP 250 series) 3 = anode (AMP 250 series)

Baseplate is electrically isolated.

RATINGS

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

V* V* V*
V* V*
V*
V*
А
А
A
A ² s
w
A/µs
Δ
A
w
oC
οС
v
K/W
K/W

*Measured with gate-cathode connected together.

**From baseplate to all terminals strapped together.

Anode to cathode

On-state voltage I _T = 20 A; I _G = 0.5 A; T _j = 120 $^{\circ}$ C	VT	<	2.2	۷*
Rate of rise of off-state voltage that will not trigger any off-state device; exponential method $V_D = 2/3 V_{Dmax}$; $V_{GR} = 5 V$; $T_j = 120 \text{ °C}$	dV _D /dt	<	10	kV/µs
Rate of rise of off-state voltage that will not trigger any device following conduction, linear method $I_T = 60 A$; $V_D = V_{DRMmax}$; $V_{GR} = 10 V$; $T_j = 120 ^{OC}$	dV _D /dt	<	1.0	kV/μs
Off-state current V _D = V _{Dmax} ; T _j = 120 °C	ID	<	5.0	mA
Latching current; $T_j = 25 \text{ °C}$	۱L	typ.	5.0	A**
Gate to cathode				
Voltage that will trigger all devices $V_D = 12 V$; T _j = 25 °C	V _{GT}	>	1.5	v
Current that will trigger all devices $V_D = 12 V; T_j = 25 {}^{o}C$	IGT	>	500	mA
Minimum reverse breakdown voltage I _{GR} = 1.0 mA	V _(BR) GR	>	10	v
Switching characteristics (resistive load)				
Turn-on when switched to $I_T = 50$ A from $V_D = 250$ V with $I_{GF} = 2.5$ A; $T_j = 25$ °C			0.5	
rise time	^t d t _r	<	0.5 2.0	μs μs
	time			
	time	Fig.2	2 Wavefor	ms.

*Measured under pulse conditions to avoid excessive dissipation.

**Below latching level the device behaves like a transistor with a gain dependent on current.

Switching characteristics (inductive load)

Turn-off when switched from $I_T = 50$ A to $V_D = V_{Dmax}$;

V_{GR} = 10 V; $L_G \le 0.5 \mu\text{H}$; $L_S \le 0.25 \mu\text{H}$; T_j	= 25 °C			
storage time	t _s	<	1.0	μs
fall time	t _f	<	0.3	μs
peak reverse gate current	IGR	<	25	Α





Fig.3 Waveforms.



Fig.4 Inductive load test circuit.

*Indicates stray series inductance only. **Minimum permissible GTO on-time (μ s) = R_S (Ω) x C_S (μ F) x 5.

April 1984



Fig.5 The right hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.

a = form factor = $\frac{I_T(RMS)}{I_T(AV)}$

P = power excluding switching losses.



Fig.6 Anode current which can be turned off versus anode voltage; inductive load; V_{GR} = 10 V; L_G \leq 0.5 μ H; L_S \leq 0.25 μ H; T_j = 120 °C. *dV_D/dt is calculated from I_T/C_S.









Fig.11 Maximum energy loss at turn-off (per cycle) as a function of anode current and applied dV_D/dt (calculated from I_T/C_S); dV_D/dt linear up to V_{Dmax} = 600 V; V_{GR} = 10 V; I_G = 0.5 A; L_G \leq 0.5 μ H; L_S \leq 0.25 μ H; T_j = 120 °C.



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Dimensions in mm

9.8

max

M1447

FAST GATE TURN-OFF THYRISTORS WITH ANTI-PARALLEL DIODE

Fast gate turn-off thyristors with anti-parallel connected fast soft-recovery diodes in TO-238AA. They are suitable for use in high-frequency inverters, power supplies and motor control systems requiring a parallel-connected flywheel or efficiency diode. The baseplate is electrically isolated.

QUICK REFERENCE DATA

GTO		BTV60	BTV60D-850R		1200R	
Repetitive peak off-state voltage	VDRM	max.	850	1000	1200	V
Non-repetitive peak on-state current	TSM	max.		240		А
Controllable anode current	^I TCRM	max.		120		А
Average on-state current	IT(AV)	max.		25		А
Fall time	tf	<		300		ns
Diode						
Average forward current	^I F(AV)	max.		14		А
Non-repetitive peak forward current	FSM	max.		100		А
Reverse recovery time	t _{rr}	<		600		ns

MECHANICAL DATA

2

3

Fig.1 TO-238AA

1

M2271

seating 38,6max plane 4.83 6.43 (2x) 12.1 4.67 6.27 max ф đ 2 17.6 21.7 max max 3 φ4.0 ſ t D ±0.1 20.8max -- 2.2max 30,1+0,1

Pin 1 = gate (AMP 187) series 2 = k(GTO) a(Diode); (AMP 250 series) 3 = a(GTO) k(Diode); (AMP 250 series) Baseplate is electrically isolated.

RATINGS

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

Anode to cathode		BTV60	D-850R	J 1000R	1200R	
Transient off-state voltage	V _{DSM}	max.	1000	1100	1300	V*
Repetitive peak off-state voltage	VDRM	max.	850	1000	1200	V*
Working off-state voltage	VDW	max.	600	800	1000	٧*
Continuous off-state voltage	VD	max.	500	650	750	۷*
Average on-state current (averaged over any 20 ms period) up to T_{mb} = 70 °C	IT(AV)	max.		25		A
Controllable anode current	TCRM	max.		120		А
Non-repetitive peak on-state current t = 10 ms; half-sinewave;				240		
$I_j = 120$ °C prior to surge	TSM	max.		240		A A
1° t for fusing; t = 10 ms	1*t	max.		290		A* s
Total power dissipation up to $T_{mb} = 25 \text{ °C}$	P _{tot}	max.		120		W
Maximum rate of rise of anode current at turn-on,V _D = V _{Dmax} ; I _{GF} = 2.5 A; I _T = 200 A	dl _T /dt	max.		1000		A/µs
Gate to cathode						
Repetitive peak on-state current gate-cathode forward; t = 1 ms; gate-cathode reverse; t = 20 μs	IGFM	max. max.		35 50		A A
Average power dissipation (averaged over any 20 ms period)	P _G (AV)	max.		10		w
Diode						
Average forward current (averaged over any 20 ms period) up to $T_{mb} = 70 \ ^{o}C$	IF(AV)	max.		14		A
Non-repetitive peak forward current t = 10 ms, half-sinewave T _j = 120 ^O C prior to surge	IFSM	max.		100		A
Temperatures						
Storage temperature	Teta		-40 to	o +125		°C
Operating junction temperature	Ti	max.		120		°C
ISOLATION**	,					
R.M.S. isolation voltage	V _{isol}	min.		2500		v

*Measured with gate-cathode connected together.

**From baseplate to all terminals strapped together.

THERMAL RESISTANCE

GТО

From junction to mounting base	R _{th} j-mb	=	0.8	K/W
From mounting base to heatsink with heatsink compound	R _{th mb-h}	=	0.2	K/W
Diode				
From junction to mounting base	R _{th} j-mb	=	1.4	K/W
From mounting base to heatsink with heatsink compound	R _{th mb-h}	=	0.2	K/W



Fig.2 Equivalent thermal network.

GTO CHARACTERISTICS

Anode to cathode

On-state voltage $I_T = 20 \text{ A}; I_G = 0.5 \text{ A}; T_i = 120 ^{\circ}\text{C}$	VT	<	2.2	V*
Rate of rise of off-state voltage that will not trigger any off-state device; exponential method $V_{2} = 2/2 V_{2}$	d\/_ /d+	_	10	k)//o
$v_D = 2/3 v_{Dmax}$; $v_{GR} = 5 v$; $i_j = 120 v_C$	av D/at		10	κv/μs
trigger any device following conduction, linear method $I_T = 60 \text{ A}; V_D = V_{DRMmax}; V_{GR} = 10 \text{ V}; T_j = 120 ^{\circ}\text{C}$	dV _D /dt	<	1.0	kV/µs
Off-state current				
V _D = V _{Dmax} ; T _j = 120 °C	۱ _D	<	5.0	mA
Latching current; T _j = 25 ^o C	۱L	typ.	5.0	A**
Gate to cathode				
Voltage that will trigger all devices $V_D = 12 V; T_j = 25 \circ C$	V _{GT}	>	1.5	v
Current that will trigger all devices $V_D = 12 V; T_j = 25 {}^{O}C$	IGT	>	500	mA
Minimum reverse breakdown voltage I _{GR} = 1.0 mA	V _(BR) GR	>	10	V
Switching characteristics (resistive load)				
Turn-on when switched to $I_T = 50$ A from $V_D > 250$ V				
with $I_{GF} = 2.5 \text{ A}$; $T_j = 25 \text{ °C}$	•	/	0.5	
rise time	^t d t _r	<	0.5 2.0	μs μs
	М1/	433		
	ti	me F	ig.3 Wave	forms.

*Measured under pulse conditions to avoid excessive dissipation.

**Below latching level the device behaves like a transistor with a gain dependent on current.

May 1986

GTO(cont.)

Switching characteristics (inductive load)

Furn-off when switched from I_T = 50A to	o V _D = V _{Dmax} ;			
V_{GR} = 10 V; $L_{G} \le 0.4 \mu$ H; $L_{S} \le 0.25$	μΗ, C _s ≫50nF, T _j = 25	oC		
storage time	t _s	<	1.0	μs
fall time	tf	<	0.3	μs
peak reverse gate current	^I GR	<	25	А



Fig.4 Waveforms.

Fig.5 Inductive load test circuit.

* Indicates stray series inductance only.

**Minimum permissible GTO on-time (μ s)= 5R_S (Ω)C_S (μ F).

 $-v_{GG}$

M2721



Fig.6b Diode.

10 15 I_{T(AV)} (A)

May 1986

5

0



Fig.7 Anode current which can be turned off versus anode voltage; inductive load; $V_{GR} = 10 \text{ V}$; $L_G \leq 0.5 \mu\text{H}$; $L_S \leq 0.25 \mu\text{H}$; $T_j = 120^{\circ}\text{C}$. *dV_D/dt is calculated from I_T/C_S.

GTO (cont.)









Fig.12 Maximum energy loss at turn-off (per cycle) as a function of anode current and applied dV_D/dt (calculated from I_T/C_S); dV_D/dt linear up to V_{Dmax} = 600 V; V_{GR} = 10 V; I_G = 0.5 A; $L_G \le 0.5 \mu$ H; $L_S \le 0.25 \mu$ H; T_i = 120 °C.



May 1986

DIODE CHARACTERISTICS

Forward voltage I _F = 20 A; T _j = 25 °C	VF	<	2.5	V*
Reverse recovery when switched from				
I_F = 2 A to \dot{V}_R \geqslant 30 V with $-dI_F/dt$ = 20 A/µs; T_j = 25 oC recovered charge recovery time	Q _s t _{rr}	< <	2.0 0.6	μC μs
Forward recovery when switched to $I_F = 5 \text{ A with } t_r = 0.1 \ \mu s; T_j = 25 \ ^{O}C$	+ <i>c</i>	_	1.0	
recovery time	^l tr		1.0	μ5



Fig.14 Definition of t_{rr} and Ω_s .



Fig.15 Definition of tfr.

*Measured under pulse conditions to avoid excessive dissipation.

May 1986





10² -dI_F/dt (A/µs)10³

134

1 L 10 DIODE (cont.)



Fig.18 Transient thermal impedance.


FAST GATE TURN-OFF THYRISTORS

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Thyristors in TO-238AA envelopes with electrically isolated metal baseplates capable of being turned both on and off via the gate. They are suitable for use in high-frequency inverters, power supplies, motor control etc. The devices have no reverse blocking capability. For reverse blocking operation use with a series diode, for reverse conducting operation use with an anti-parallel diode.

QUICK REFERENCE DATA

		BTV70-850R		1000R	1200R	
Repetitive peak off-state voltage	V _{DRM}	max.	850	1000	1200	v
Non-repetitive peak on-state current	ITSM	max.		100		А
Controllable anode current	ITCRM	max.		50		А
Average on-state current	IT(AV)	max.		15		Α
Fall time	t _f	<		250		ns

MECHANICAL DATA

Fig.1 TO-238AA

Dimensions in mm



Pin 1 = gate (AMP 187 series) 2 = cathode (AMP 250 series)

- 3 = anode (AMP 250 series)
- Baseplate is electrically isolated.

RATINGS

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

Anode to cathode		BTV7	0-850R	1000R	1200R	
Transient off-state voltage	V _{DSM}	max.	1000	1100	1300	۷*
Repetitive peak off-state voltage	VDRM	max.	850	1000	1200	۷*
Working off-state voltage	V _{DW}	max.	600	800	1000	٧*
Continuous off-state voltage	VD	max.	500	650	750	۷*
Average on-state current (averaged over any 20 ms period) up to $T_{mb} = 60 ^{\circ}\text{C}$	IT(AV)	max.		15		А
Controllable anode current	TCRM	max.		50		А
Non-repetitive peak on-state current t = 10 ms; half-sinewave;				100		·
$I_j = 120 \text{°C}$ prior to surge	ITSM	max.		100		A
1^{2} t for fusing; t = 10 ms	l²t	max.		50		A²s
Total power dissipation up to $1 \text{ mb} = 25 \text{ °C}$	Ptot	max.		60		w
Gate to cathode						
Repetitive peak current T _j = 120 ^o C prior to surge gate-cathode forward; t = 10 ms;						
half-sinewave	GFM	max.		25		Α
gate-cathode reverse; $t = 20 \ \mu s$	GRM	max.		25		A
Average power dissipation (averaged over any 20 ms period)	PG(AV)	max.		5.0		w
Temperatures						
Storage temperature	T _{stg}		-40	to +125		٥C
Operating junction temperature	Тј	max.		120		oC
ISOLATION**						
R.M.S. isolation voltage	V _{isol}	min.		2500		V
THERMAL RESISTANCE						
From mounting base to heatsink; with heatsink compound	R _{th mb-h}	-		0.3		K/W
From junction to mounting base	R _{th i-mb}	=		1.5		K/W

* Measured with gate-cathode connected together.

** From baseplate to all terminals strapped together.

August 1985

CHARACTERISTICS				
Anode to cathode				
On-state voltage I_T = 10 A; I_G = 0.5 A; T_j = 120 °C	۷ _T	<	2.3	V*
Rate of rise of off-state voltage that will not trigger any off-state device, exponential method $V_D = 2/3 V_{Dmax}$; $V_{GR} = 5 V$; $T_j = 120 \text{ °C}$	dV _D /dt	<	10	kV/μs
Rate of rise of off-state voltage that will not trigger any device following conduction, linear method I _T = 20 A; V _D = V _{DRMmax} ; V _{GR} = 10 V; T _j 120 °C	dV _D /dt	<	1.0	kV/μs
Off-state current $V_D = V_{Dmax}$; T _j = 120 °C	۱ _D	<	5.0	mA
Latching current; $T_j = 25 \ ^{o}C$	۱L	typ.	1.5	A**
Gate to cathode				
Voltage that will trigger all devices $V_D = 12 \text{ V}; \text{ T}_j = 25 ^{\circ}\text{C}$	V _{GT}	>	1.5	v
Current that will trigger all devices $V_D = 12 \text{ V}; \text{ T}_j = 25 ^{\circ}\text{C}$	IGT	>	300	mA
Minimum reverse breakdown voltage I _{GR} = 1.0 mA	V _{(BR)GR}	>	10	v
Switching characteristics (resistive load) Turn-on when switched to $I_T = 10$ A from $V_D = 250$ V with $I_{GF} = 1.5$ A; $T_j = 25$ °C				
delay time rise time	^t d ^t r	< <	0.3 1.5	μs μs
	M1433	-		
	time	.	Eig 2 Wei	oforma
	citric		rig.2 wav	retorms.

* Measured under pulse conditions to avoid excessive dissipation.

** Below latching level the device behaves like a transistor with a gain dependent on current.

Switching characteristics (inductive load)

t _s	<	0.60	μs
t _f	<	0.25	μs
IGR	· < ·	10	Α
	t _s t _f I _{GR}	t _s < t _f < I _{GR} <	$\begin{array}{llllllllllllllllllllllllllllllllllll$



Fig.3 Waveforms.



* Indicates stray series inductance only

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Fig.5 The right hand part shows the interrelationship between the power (derived from the left hand part) and the maximum permissible temperatures.

a = form factor = $\frac{I_T(RMS)}{I_T(AV)}$

P = power excluding switching losses.





 $^{*}dV_{D}/dt$ is calculated from I_{T}/C_{S} .

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Fig.7 Anode current which can be turned off versus applied dV_D/dt*; inductive load; L_G \leq 0.5 μ H, L_S \leq 0.25 μ H, T_j = 120 °C;

 $^{*}dV_{D}/dt$ is calculated from I_{T}/C_{S} .



August 1985





Fast gate turn-off thyristors

BTV70 SERIES







Fig.16 Maximum energy loss at turn-off (per cycle) as a function of anode current and applied dV_D/dt (calculated from I_T/C_S); dV_D/dt linear up to V_{Dmax} = 600 V; V_{GR} = 10 V; I_G = 0.5 A; L_G \leq 0.5 μ H; L_S \leq 0.25 μ H; T_i = 120 °C.



Fig.17 Energy loss at turn-off as a function of junction temperature; $I_G = 0.5 \text{ A}$; $V_{GR} = 10 \text{ V}$. Normalised to $T_j = 120 \text{ }^{9}\text{C}$.

FAST GATE TURN-OFF THYRISTORS WITH ANTI-PARALLEL DIODE

Fast gate turn-off thyristors with anti-parallel connected fast soft-recovery diodes in TO-238AA. They are suitable for use in high-frequency inverters, power supplies and motor control systems requiring a parallel connected flywheel or efficiency diode. The baseplate is electrically isolated.

QUICK REFERENCE DATA

GTO		BTV70D	850R	1000R	1200R	
Repetitive peak off-state voltage	VDRM	max.	850	1000	1200	V
Non-repetitive peak on-state current	ITSM	max.		100		А
Controllable anode current	^I TCRM	max.		50		А
Average on-state current	IT(AV)	max.		15		А
Fall time	tf	<		250		ns
Diode						
Average forward current	IF(AV)	max.		9.0		А
Non-repetitive peak forward current	FSM	max.		60		А
Reverse recovery time	t _{rr}	<		600		ns

MECHANICAL DATA

Fig.1 TO-238AA

1

M2271





Dimensions in mm

Pin 1 = gate (AMP 187 series) 2 = k (GTO), a (diode); AMP 250 series 3 = a (GTO), k (diode); AMP 250 series Baseplate is electrically isolated.

For further information see data sheets BTV70 and BY359.

RATINGS

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

Anode to cathode		BTV70D	850R	1000R	1200R	
Transient off-state voltage	VDSM	max.	1000	1100	1300	۷*
Repetitive peak off-state voltage	VDRM	max.	850	1000	1200	۷*
Working off-state voltage	V _{DW}	max.	600	800	1000	V*
Continuous off-state voltage	VD	max.	500	650	750	۷*
Average on-state current (averaged over any 20 ms period) up to T _{mb} = 60 ^o C	IT(AV)	max.	-	15		A
Controllable anode current	ITCRM	max.		50		А
Non-repetitive peak on-state current t = 10 ms; half-sinewave;	1			100		•
$I_j = 120 - C$ prior to surge		max.		50		A A ²
Tatal a succer dissingtion	1-1	max.		50		A-s
up to $T_{mb} = 25 \ ^{\circ}C$	P _{tot}	max.		60		w
Gate to cathode						
Repetitive peak on-state current $T_j = 120$ ^O C prior to surge gate-cathode forward; t = 10 ms;						
half-sinewave	GFM	max.		25		А
gate-cathode reverse; $t = 20 \ \mu s$	IGRM	max.		25		А
Average power dissipation (averaged over any 20 ms period)	PG(AV)	max.		5.0		w
Diode						
Average forward current (averaged over any 20 ms period) up to T_{mb} = 70 °C	IF(AV)	max.		9.0		А
Non-repetitive peak on-state current t = 10 ms; half-sinewave; T _j = 120 ^o C prior to surge	FSM	max.		60		A
Temperatures						
Storage temperature	т _{stq}		-40 t	to +125		oC
Operating junction temperature	тj	max.		120		oC
ISOLATION**						
R.M.S. isolation voltage	V _{isol}	min.		2500		v

* Measured with gate-cathode connected together.

** From baseplate to all terminals strapped together.

THERMAL RESISTANCE

GTO

From junction to mounting base	R _{th j-mb}	=	1.5	K/W
From mounting base to heatsink with heatsink compound	R _{th} mb-h	=	0.3	K/W
Diode				
From junction to mounting base	R _{th j-mb}	=	3.6	K/W
From mounting base to heatsink with heatsink compound	R _{th mb-h}	=	0.3	K/W



Fig.2 Equivalent thermal network.

GTO CHARACTERISTICS

Anode to cathode

On-state voltage $I_T = 10 \text{ A}$; $I_G = 0.5 \text{ A}$; $T_j = 120 ^{\circ}\text{C}$	v _T	<	2.3	V*
Rate of rise of off-state voltage that will not trigger any off-state device; exponential method $V_D = 2/3 V_{Dmax}$; $V_{GR} = 5 V$; $T_j = 120 \text{ °C}$	dV _D /dt	<	10	kV/μs
Rate of rise of off-state voltage that will not trigger any device following conduction, linear method $I_T = 20 \text{ A}$; $V_D = V_{DRMmax}$; $V_{GR} = 10 \text{ V}$; $T_j = 120 ^{O}\text{C}$	dV _D /dt	<	1.0	kV/μs
Off-state current $V_D = V_{Dmax}$; $T_j = 120 \text{ °C}$	۱D	<	5.0	mA
Latching current; T _j = 25 ^o C	١	typ.	1.5	A**
Gate to cathode				
Voltage that will trigger all devices $V_D = 12 \text{ V}$; $T_j = 25 \text{ °C}$	V _{GT}	>	1.5	v
Current that will trigger all devices $V_D = 12 \text{ V}$; $T_j = 25 \text{ °C}$	IGT	>	300	mA
Minimum reverse breakdown voltage I _{GR} = 1.0 mA	V(BR)GR	>	10	v
Switching characteristics (resistive load)				
Turn-on when switched to $I_T = 10 \text{ A}$ from $V_D = 250 \text{ V}$ with $I_{OT} = 1.5 \text{ A} \cdot \text{T} = 25.90$				
delay time rise time	^t d ^t r	< <	0.3 1.5	μs μs
	M14	133		
I_G I_T 90% I_T I_T I_T I_T I_T I_T I_T I_T I_T I_T I_T I_T I_T I_T I_T I_T I_T I_T	ti	me		
10%				

Fig.3 Waveforms.

time

Measured under pulse conditions to avoid excessive dissipation.
** Below latching level the device behaves like a transistor with a gain dependent on current.

GTO (cont.)

Switching characteristics (inductive load)

Turn-off when switched from $I_T = 10 \text{ A to } V_D = V_{Dmax}$;

 $V_{GB} = 10 \text{ V}; \text{ L}_{G} \le 0.5 \mu\text{H}; \text{ L}_{S} \le 0.25 \mu\text{H}; \text{ T}_{i} = 25 \text{ }^{O}\text{C}$

G.N. 6	,			
storage time	t _s	<	0.60	μs
fall time	tf	<	0.25	μs
peak reverse gate current	^I GF	< ج	10	А





Fig.4 Waveforms.



GTO (cont.)



Fig.6 The right hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.

a = form factor = $\frac{IT(RMS)}{IT(AV)}$

P = power excluding switching losses.

Values given on the right hand graph assume that the diode is not dissipating significant power.

Fast gate turn-off thyristors

BTV70D SERIES

GTO (cont.)



Fig.7 Anode current which can be turned off versus applied dVD/dt*; inductive load; $L_G \le 0.5 \ \mu$ H; $L_S \le 0.25 \ \mu$ H; $T_i = 120 \ ^{o}$ C.

 $^{*}dV_{D}/dt$ is calculated from I_{T}/C_{S} .



Fast gate turn-off thyristors

BTV70D SERIES



GTO (cont.)







Fig.14 Energy loss at turn off as a function of junction temperature; $I_G = 0.5 \text{ A}$; $V_{GR} = 10 \text{ V}$. 100 $T_i ({}^{0}\text{C})$ 150 Normalised to $T_j = 120 {}^{0}\text{C}$.

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DIODE CHARACTERISTICS

Forward voltage IF = 10 A; $T_j = 25 \text{ °C}$	٧F	<	2.0	V*
Reverse recovery when switched from IF = 2 A to VR \geq 30 V with $-dIF/dt$ = 20 A/µs; Tj = 25 °C recovered charge recovery time	O _s t _{rr}	< <	2.0 0.6	μC μs
Forward recovery when switched to $I_F = 5 \text{ A with } t_r = 0.1 \ \mu s; T_j = 25 \ ^{\text{o}}\text{C}$ recovery time	t _{fr}	<	1.0	μs









*Measured under pulse conditions to avoid excessive dissipation

DIODE (cont.)



Fig.17 The right hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.

a = form factor = $\frac{|F(RMS)|}{|F(AV)|}$

Values given on the right hand graph assume that the GTO is not dissipating significant power.

Fast gate turn-off thyristors

BTV70D SERIES

DIODE (cont.)







Fig.19 Peak reverse recovery current versus $-dI_F/dt$; $T_i = 25 \text{ }^{o}C$; maximum values.



Fig.20 Transient thermal impedance.

FAST GATE TURN-OFF THYRISTORS

Thyristors in TO-220AB envelopes capable of being turned both on and off via the gate. They are suitable for use in high-frequency inverters, resonant power supplies, motor control, horizontal deflection systems etc. The devices have no reverse blocking capability. For reverse blocking operation use with a series diode, for reverse conducting operation use with an anti parallel diode.

BTW58-1000R 1300R 1500R 1000 1300 1500 Repetitive peak off-state voltage VDRM max. v Non-repetitive peak on-state current ITSM max. 50 А 25 Controllable anode current max. А **ITCRM** 6.5 Average on-state current max. А T(AV) 250 Fall time < tf ns

MECHANICAL DATA

QUICK REFERENCE DATA

Fig.1 TO-220AB



Dimensions in mm



Net mass: 2 g

Note: The exposed metal mounting base is directly connected to the cathode.

Accessories supplied on request: see data sheets Mounting instructions and accessories for TO-220 envelopes.

RATINGS

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

Anode to cathode			BTW58-100	OR	1300R	1500R	
Transient off-state voltage	VDSM	max.	120	00	1500	1650	۷*
Repetitive peak off-state voltage	VDRM	max.	100	0	1300	1500	V*
Working off-state voltage	V _{DW}	max.	65	60	1200	1300	۷*
Continuous off-state voltage	VD	max.	65	i0	750	800	V*
Average on-state current (averaged 20 ms period) up to $T_{mb} = 85$ °C	over any C		IT(AV)	ma	×.	6.5	A
Controllable anode current			ITCRM	ma	x.	25	А
Non-repetitive peak on-state currer t = 10 ms; half-sinewave;	ıt		I			50	Δ
$I_j = 120$ °C prior to surge			TSM	ma	х.	50	A . 2
1^{2} t for fusing; t = 10 ms			I²t	ma	x.	12.5	A²s
Total power dissipation up to T_{mb}	= 25 °C		P _{tot}	ma	x.	65	w
Gate to cathode							
Repetitive peak on-state current T _j = 120 ^o C prior to surge							
gate-cathode forward; $t = 10 \text{ ms}$	half-sinev	vave	GFM	ma	x.	25 25	A A
gate-callide reverse, $t = 20 \mu s$	d over any		GRM	ma.	^ .	25	~
20 ms period)	u over any	/	P _G (AV)	ma	x.	2.5	Ŵ
Temperatures							
Storage temperature			Τ _{stq}		-40 te	o +150	oC
Operating junction temperature			тј	ma	х.	120	°C
THERMAL RESISTANCE							
From junction to mounting base			R _{th j-mb}	=		1.5	K/W
From mounting base to heatsink with heatsink compound			R _{th mb-h}	=		0.3	K/W
with 56367 alumina insulator an heatsink compound (clip-mount	id ed)		R _{th mb-h}	=		0.8	K/W

*Measured with gate-cathode connected together.

May 1984

CHARACTERISTICS

On-state voltage I _T = 5 A; I _G = 0.2 A; T _j = 120 °C	V _T	<	3.0	V*
Rate of rise of off-state voltage that will not trigger any off-state device; exponential method $V_D = 2/3 V_{Dmax}$; $V_{GR} = 5 V$; $T_j = 120 \text{ °C}$	dV _D /dt	<	10	kV/µs
Rate of rise of off-state voltage that will not trigger any device following conduction, linear method $I_T = 5 A$; $V_D = V_{DRMmax}$; $V_{GR} = 10 V$; $T_j = 120 ^{\circ}\text{C}$	dV _D /dt	<	1.5	kV/µs
Off-state current $V_D = V_{Dmax}$; $T_j = 120 \ ^{o}C$	۱ _D	<	3.0	mA
Latching current; T _j = 25 ^o C	۱L	typ.	1.0	A**
Gate to cathode				
Voltage that will trigger all devices $V_D = 12 \text{ V}$; T _j = 25 °C	V _{GT}	>	1.5	v
Current that will trigger all devices $V_D = 12 \text{ V}; \text{ T}_j = 25 ^{O}\text{C}$	I _{GT}	>	200	mA
Minimum reverse breakdown voltage $I_{GR} = 1.0 \text{ mA}$	V _(BR) GR	>	10	V
Switching characteristics (resistive load)				
Turn-on when switched to $I_T = 5 \text{ A}$ from $V_D = 250 \text{ V}$ with $I_{DC} = 0.5 \text{ A}$: T: = 25.90				
delay time rise time	^t d t _r	< <	0.25 1.0	μs μs
	M1433			
10%	time		Fig.2 Wave	forms

- * Measured under pulse conditions to avoid excessive dissipation.
- ** Below latching level the device behaves like a transistor with a gain dependent on current.

Switching characteristics (inductive load)

Turn-off when switched from I_T = 5 A to V_D = V_{DRMmax}. V_{GR} = 10 V; L_G \leq 1.0 μ H; L_S \leq 0.25 μ H; T_j = 25 °C

storage time	ts	<	0.5	μs
fall time	t _f	<	0.25	μs
peak reverse gate current	IGR	<	6	Α



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M1591



Fig.4 Inductive load test circuit

*Indicates stray series inductance only.

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May 1984



Fig.5 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.

a = form factor = $\frac{|T(RMS)|}{|T(AV)|}$

P = power excluding switching losses.

 $*T_{mb}$ scale is for comparison purposes and is correct only for $R_{th mb-a} < 9.6$ K/W.



Fig.6 Anode current which can be turned off versus anode voltage; inductive load; V_{GR} = 10 V; L_G \leq 1.0 μ H; L_S \leq 0.25 μ H; T_j = 85 °C. *dV_D/dt is calculated from I_T/C_S.

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Fast gate turn-off thyristors

BTW58 SERIES




















BTW58 SERIES





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Fast gate turn-off thyristors

BTW58 SERIES



Fig.16 Storage and fall times versus applied reverse gate voltage; inductive load; I_T = 5 A; I_G = 0.2 A; L_G = 0.8 μ H; T_j = 25 °C; maximum values.

BTW58 SERIES



Fig.17 Maximum energy loss at turn-off (per cycle) as a function of anode current and applied dV_D/dt (calculated from I_T/C_S); reapplied voltage sinsusoidal up to V_{DRM} = 1200 V; V_{GR} = 10 V; I_G = 0.2 A; L_G \leq 1.0 μ H; L_S \leq 0.25 μ H; T_j = 120 °C.



Fig.18 Energy loss at turn off as a function of junction temperature; $I_G = 0.2 \text{ A}$; $V_{GR} = 10 \text{ V}$. Normalised to $T_j = 120 \text{ }^{\circ}\text{C}$.

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THYRISTORS



Dimensions in mm

SILICON BI-DIRECTIONAL TRIGGER DEVICE

Silicon bi-directional trigger device intended for use in triac and thyristor trigger circuits.

QUICK REFERENCE DATA

Breakover voltage	V _(BO)		28 to 36	v
Output voltage	vo	>	5	V
Repetitive peak current	IFRM	max.	2	Α

MECHANICAL DATA

Fig. 1

RATINGS

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

Total power dissipation up to $T_{amb} = 50 ^{o}\text{C}$	Ptot	max.	150	mW
Repetitive peak current (t \leq 20 μ s)	^I FRM	max.	2	А
Storage temperature	T _{stg}	-55 to +125		٥C
Junction temperature	т _ј	max.	100	٥C
THERMAL RESISTANCE				
From junction to ambient in free air	R _{th j-a}	=	0.33	K/mW

BR100/03

CHARACTERISTICS

T_i = 25 ^oC

Breakover voltage at
$$\frac{dV}{dt}$$
 = 10 V/msV (BO)28 to 36VBreakover voltage symmetry $|V_{(BO)I} - V_{(BO)III}| < 3$ VOutput voltage at $\frac{dV}{dt}$ = 10 V/ms V_O >5VBreakover current at V = 0.98 V(BO) $I_{(BO)}$ <100 μA







Fig. 3 Test circuit for output voltage

THYRISTORS

Glass-passivated 25 ampere thyristors intended for use in applications involving high fatigue stress due to thermal cycling and repeated switching. These thyristors feature a high surge current capability. Typical applications include motor and heating control, regulators for transfomerless power supply circuits, relay and coil pulsing and power supply crowbar protection circuits.

QUICK REFERENCE DATA

		BT145-500R		5-500R 600R 8		
Repetitive peak voltages	V _{DRM} /V _{RRM}	max.	500	600	800	v
Average on-state current	IT(AV)	max.		16		А
R.M.S. on-state current	IT(RMS)	max.		25		А
Non-repetitive peak on-state current	ITSM	max.		300		А

MECHANICAL DATA

Fig.1 TO-220AB

4.5 10,3 max máx 1,3 3,7 2,8 5,9 min mounting base ¥ 15.8 (see note) máx 3,5 max 5,1 not tinned màx 13.5 ŧ 1,3min máx (2x) 🗕 0,9 max (3 x) 0,6 2,4 2,54 2,54 M0993

Net mass: 2 g

Note: The exposed metal mounting base is directly connected to the anode.

Accessories supplied on request: see data sheets Mounting instructions and accessories for TO-220 envelopes.

Dimensions in mm

RATINGS

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

Anode to cathode		BT145-	500R	6	00R	800R	
No-repetitive peak voltages	V _{DSM} /V _{RSM}	max.	500	6	00	800	V
Repetitive peak voltages	V _{DRM} /V _{RRM}	max.	500	6	00	800	V
Crest working voltages	V _{DWM} /V _{RWM}	max.	400	4	00	400	v
Average on-state current (averaged ove any 20 ms period) up to $T_{mb} = 93$ o	r C	IT(AV)	_	max.		16	А
R.M.S. on-state current		T(RMS	5)	max.		25	А
Repetitive peak on-state current		TRM		max.		300	А
Non-repetitive peak on-state current; t half sine-wave; T _j = 115 °C prior to s with reapplied Vouve	= 10 ms; surge;	TOM		max		300	А
l^2 t for fusing (t = 10 ms)		'151VI 1 ² t		max.		450	A ² s
Rate of rise of on-state current after tr with $I_G = 160$ mA to $I_T = 50$ A; dI _G	iggering /dt = 160 A/ms	dI _T /dt		max.		200	A/µs
Gate to cathode							
Reverse peak voltage		V _{RGM}		max.		5	V
Average power dissipation (averaged o	ver any 20 ms period)	PG(AV	')	max.	•	0.5	W
Peak power dissipation; t \leq 10 μ s		P _{GM}		max.		20	W
Temperature							
Storage temperature		т _{stg}		_4	l0 to	+ 150	°C
Juction temperature		тј		max.		110	°C
THERMAL RESISTANCE							
From junction to mounting base		R _{th j-m}	ıb	=		1.0	K/W
From mounting base to heatsink with heatsink compound		R _{th} mb)-h	=		0.3	K/W

Thyristors

THERMAL RESISTANCE				
From junction to mounting base	R _{th j-mb}	=	1.0	K/W
Transient thermal impedance; t = 1 ms	Z _{th j-mb}	=	0.09	K/W
Influence of mounting method				
1. Heatsink-mounted with clip (see mounting instructions)				
Thermal resistance from mounting base to heatsink				
a. with heatsink compound	R _{th mb-h}	=	0.3	K/W
b. with heatsink compound and 0.06 mm maximum mica insulator	R _{th mb-h}	=	1.4	K/W
c. with heatsink compound and 0.1 mm maximum mica insulator (56369)	R _{th mb-h}	=	2.2	K/W
 with heatsink compound and 0.25 mm maximum alumina insulator (56367) 	R _{th mb-h}	=	0.8	K/W
e. without heatsink compound	R _{th mb-h}	=	1.4	K/W
2. Free-air operation				
The quoted values of B_{+b} ; a should be used only when no leads of othe	r dissipating	comr	onents	run

The quoted values of $R_{th\ j-a}$ should be used only when no leads of other dissipating components run to the same tie-point.

Thermal resistance from junction to ambient in free air: mounted on a printed-circuit board at a = any lead length

R _{th j-a}	=	60	K/W
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Fig.2.

CHARACTERISTICS

Anode to cathode

On-state voltage (measured under pulse conditions)

I _T = 30 A; T _j = 25 ^o C	VT	<	1.5	v
Rate of rise of off-sate voltage that will not trigger any device				
T _j = 110 ^o C; R _{GK} = open circuit	dV _D /dt	<	200	V/µs
Reverse current				
V _R = V _{RWMmax} ; T _j = 110 ^o C	IR	<	1.0	mA
Off-state current				
V _D = V _{DWMmax} ; T _j = 110 °C	۱ _D	<	1.0	mA
Latching current; T _i = 25 ^o C	۱L	<	80	mA
Holding current; $T_i = 25 \text{ °C}$	ЧΗ	<	60	mA
Gate to cathode				
Voltage that will trigger all devices				
$V_{D} = 12 V; T_{i} = -40 °C$	V _{GT}	>	1.5	v
$V_{\rm D} = 12 \text{ V}; T_{\rm i} = 25 {}^{\rm o}\text{C}$	V _{GT}	>	1.0	v
Voltage that will not trigger any device				
V _D = V _{DRMmax} ; T _i = 110 °C	V _{GD}	<	0.25	v
Current that will trigger all devices				
V _D = 12V; T _i = -40 °C	^I GT	>	55	mA
V _D = 12 V; T _i = 25 °C	IGT	>	35	mA

Switching characteristics

Gate-controlled turn-on time $(t_{gt} = t_d + t_r)$ when switched from $V_D = V_{DRMmax}$ to $I_T = 40$ A; $I_{GT} = 100$ mA; $dI_G/dt = 5$ A/µs; $T_j = 25$ °C

typ.

2

μs



t_{gt}

Fig.3 Gate controlled turn-on time definition.

MOUNTING INSTRUCTIONS

- The device may be soldered directly into the circuit, but the maximum permissible temperature of the soldering iron or bath is 275 °C; it must not be in contact with the joint for more than 5 seconds. Soldered joints must be at least 4.7 mm from the seal.
- The leads should not be bent less than 2.4 mm from the seal, and should be supported during bending. The leads can be bent, twisted or straightened by 90^o maximum. The minimum bending radius is 1 mm.
- 3. It is recommended that the circuit connection be made to the anode tag, rather than direct to the heatsink.
- 4. Mounting by means of a spring clip is the best mounting method because it offers:
 - a. a good thermal contact under the crystal area and slightly lower $\rm R_{th}$ $\rm m_{b-h}$ values than screw mounting.
 - b. safe isolation for mains operation.

However, if a screw is used, it should be M3 cross-recess pan-head. Care should be taken to avoid damage to the plastic body.

- For good thermal contact, heatsink compound should be used between mounting base and heatsink. Values of 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.
- 6. Rivet mounting (only possible for non-insulated mounting).

Devices may be rivetted to flat heatsinks; such a process **must neither** deform the mounting tab, **nor** enlarge the mounting hole.

 The heatsink must have a flatness in the mounting area of 0.02 mm maximum per 10 mm. Mounting holes must be deburred.

OPERATING NOTES

Dissipation and heatsink considerations:

 The various components of junction temperature rise above ambient are illustrated in Fig.4.



b. The method of using Fig.5 is as follows:

Starting with the required current on the $I_{T(AV)}$ axis, trace upwards to meet the appropriate form factor curve. Trace right horizontally and upwards from the appropriate value on the T_{amb} scale. The intersection determines the $R_{th\ mb-a}$. The heatsink thermal resistance value ($R_{th\ h-a}$) can now be calculated from:

$R_{th h-a} = R_{th mb-a} - R_{th mb-h}$

c. Any measurement of heatsink temperature should be made immediately adjacent to the device.



Fig.5 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.

$$\begin{array}{c} & \alpha = \text{conduction angle per half cycle} \\ & a = \text{form factor} = \frac{I_{T} (RMS)}{I_{T}(AV)} \end{array} \end{array}$$

α	а
30o	4
60 ⁰	2.8
90 ⁰	2.2
120 ⁰	1.9
180 ⁰	1.57





Fig.6 Maximum permissible non-repetitive r.m.s. on-state current based on sinusoidal currents (f=50Hz) with re-applied V_{RWMmax}; $T_j = 110$ °C prior to surge.



May 1986



all devices as a function of junction temperature.



Fig.9 Maximum rate of rise of off-state voltage that will not trigger any device as a function of junction temperature.

10

 $Z_{\text{th } j-\text{mb}}$ (K/W) 10^{-1}

May 1986

186

Dimensions in mm

THYRISTORS

Fully-diffused thyristors in TO-92 package, with low gate current requirement suitable for driving from IC outputs. Applications include relay and coil pulsing, control of small d.c. motors, small lamps, etc.

QUICK REFERENCE DATA

		<u>BT149</u>	— F	Α	В	D	E	M	
Repetitive peak voltages	V _{DRM} /V _{RRM}	max.	50	100	200	400	500	600	v
Average on-state current	IT(AV)	max.			0	.5			А
R.M.S. on-state current	IT(RMS)	max.			0	.8			А
Non-repetitive peak on-state current	TSM	max.				8			А

MECHANICAL DATA

Fig.1 TO-92 variant





BT149-F,A,B,D,E

5.2 max







12.7 min

July 1984

RATINGS

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

Anode to cathode		BT14	19 — F	A	В	D	E	м	
Non-repetitive peak voltages (t ≤ 10 ms)	V _{DSM} /V _{RSM}	max.	50	100	200	400	500	600	V*
Repetitive peak voltages $(\delta \leqslant 0.01)$	V _{DRM} /V _{RRM}	max.	50	100	200	400	500	600	v
Average on-state current (average 20 ms period) up to T _{mb} = 55	ed over any 5 ^o C		T(AV)	1	max.		0.	5	A
R.M.S. on-state current				S)	max.		0.3	8	А
Repetitive peak on-state current			TRM	-,	max.		:	8	А
Non-repetitive peak on-state curr half sine-wave; T _j = 125 ^o C pr with reapplied V RWMmax	rent; t = 10 ms; ior to surge;		ITEM		max		;	R	Δ
l^2 t for fusing (t = 10 ms)			13101 1 ² t		max		0.3	2	Δ^2 s
Rate of rise of on-state current a $I_G = 1 \text{ mA to } I_T = 1.8 \text{ A; } dI_G$	fter triggering wit /dt = 4 mA/µs	h (dl _T /dt		max.		3	D	A/μs
Gate to cathode									
Peak reverse voltage		,	VRGM		max.		. · · · · ·	3	v
Average power dissipation (avera period)	ged over any 20 m	าร่	GIAV)	max.		0.	1	w
Peak power dissipation		I	GM	,	max.		:	2	w
Temperatures									
Storage temperature		-	T _{sta}			—40 t	o +150	D	οС
Operating junction temperature		-	г _і		max.		125	5	οС
THERMAL RESISTANCE									
From junction to mounting base		i	R _{th i-m}	b	=		100)	K/W
From junction to ambient in free mounted on a p.c.b. with any	e air, lead length	I	R _{th} j-a	-	=		200)	K/W

 $R_{GK} = 1 k\Omega$

THYRISTORS

Glass-passivated thyristor in TO-220AB envelope, featuring sensitive gate triggering as low as 200 μ A. Particularly suitable in applications where high fatigue stresses due to thermal cycling and repeated switching are present. Typical applications include temperature and motor control, relay and coil pulsing and power supply crowbar protection circuits and regulators in transformerless power supply systems.

QUICK REFERENCE DATA

Repetitive peak voltages	V _{DRM} /V _{RRM}	max.	500	v
Average on-state current	IT(AV)	max.	2.5	А
rms on-state current	IT(RMS)	max.	4	А
Non-repetitive on-state current	ITSM	max.	25	А

MECHANICAL DATA

Fig.1 TO-220AB

10,3 4,5 max max 3,7 1,3 2,8 5.9 min mounting base Ā 15,8 (see note) max 3,5 max 5,1 not tinned max 13,5 1,3min max (2x) -0,9 max (3 x) - 0,6 2.4 2.54 2.54 M0003

Net mass: 2 g

Note: The exposed metal mounting base is directly connected to the anode.

Accessories supplied on request, see data sheets Mounting instructions and accessories for TO-220 envelopes.

Dimensions in mm

RATINGS

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

Anode to cathode				
Non-repetitive peak voltages (t \leq 10 ms)	V _{DSM} /V _{RSM}	max.	500	۷*
Repetitive peak voltage ($\delta \leqslant$ 0.01)	VDRM/VRRM	max.	500	V
Crest working voltages	V _{DWM} /V _{RWM}	max.	400	V
Continuous voltages	V _D /V _R	max.	400	V
Average on-state current (averaged over any 20 ms period) up to T_{mb} = 98 °C	^I T(AV)	max.	2.5	А
R.M.S. on-state current	^I T(RMS)	max.	4	А
Repetitive peak on-state current	TRM	max.	25	А
Non-repetitive peak on-state current t = 10 ms; half sine-wave; $T_j = 110 \ ^{O}C$ prior to surge; with reapplied V RWMmax	Ітем	max.	25	А
I^2 t for fusing (t = 10 ms)	1 ² t	max.	3	A ² s
Rate of rise of on-state current after triggering with $I_G = 50 \text{ mA}$; to $I_T = 10 \text{ A}$; $dI_G/dt = 50 \text{ mA}/\mu \text{s}$	dl _T /dt	max.	50	A/μs
Gate to cathode				
Average power dissipation (averaged over any 20 ms.period)	^P G(AV)	max.	0.5	w
Peak power dissipation	PGM	max.	5	W
Temperatures				
Storage temperature	T _{stq}		-40 to +125	oC
Junction temperature	т _і	max.	110	٥C
	-			

*Although not recommended, higher off-state voltages may be applied without damage, but the thyristor may switch into the on-state. The rate of rise of on-state current should not exceed 15 A/µs.

ТΗ	ERMAL RESISTANCE				
Fre	om junction to mounting base	R _{th j-mb}	=	2.5	K/W
Tra	ansient thermal impedance; t = 1 ms	Z _{th j-mb}	=	0.2	K/W
Inf	luence of mounting method				
1.	Heatsink mounted with clip (see mounting instructions)				
Th	ermal resistance from mounting base to heatsink				
a.	with heatsink compound	R _{th mb-h}	=	0.3	K/W
b.	with heatsink compound and 0.06 mm maximum mica insulator	R _{th mb-h}	=	1.4	K/W
с.	with heatsink compound and 0.1 mm maximum mica insulator (56369)	R _{th mb-h}	=	2.2	K/W
d.	with heatsink compound and 0.25 mm maximum alumina insulator (56367)	R _{th mb-h}	=	0.8	K/W
e.	without heatsink compound	R _{th mb-h}	=	1.4	K/W
2.	Free air operation				

The quoted values of $\mathsf{R}_{th\;j\text{-}a}$ should be used only when no leads of other dissipating components run to the same tie-point.

Thermal resistance from junction to ambient in free air;

mounted on a	printed-circuit b	oard at a = any	lead length	Rth i-a	=



Fig.2

60

K/W

CHARACTERISTICS (T_j = 25 °C unless otherwise stated)

Anode to cathode

On-state voltage I _T = 5 A	ν _T	<	1.8	V*
Rate of rise of off-state voltage that will not trigger any device R _{GK} = 100 Ω; T _j = 110 ^o C	dV _D /dt	typ.	5	V/µs
Reverse current				
V _R = V _{RWMmax} ; T _j = 110 °C	R	< 1	0.5	mA
Off-state current				
V _D = V _{DWMmax} ; T _j = 110 ^o C	I _D	<	0.5	mA
Latching curent	١L	< 1	10	mA
Holding current	IН	<	6	mA
Gate to cathode				
Voltage that will trigger all devices $V_D = 12 V$ $V_D = 12 V$; $T_j = -40 \text{ °C}$	V _{GT} V _{GT}	> >	1.5 2.3	V
Voltage that will not trigger any device $V_D = 12 \text{ V}$; T _j = 110 °C	V _{GD}	<	250	mV
Current that will trigger all devices $V_D = 12 V$ $V_D = 12 V$; $T_j = -40 \ ^{o}C$	IGT IGT	> > ;	200 260	μΑ μΑ

Switching characteristics

Gate-controlled turn-on time $(t_{gt} = t_d + t_r)$ with switched from V_D = V_{DWMmax} to I_T = 10 A; I_{GT} = 5 mA; dI_G/dt = 0.2 A/µs

t_{gt}

typ.

2

μs



Fig.3 Gate-controlled turn-on time definition.

*Measured under pulse conditions to avoid excessive dissipation.

MOUNTING INSTRUCTIONS

- The device may be soldered directly into the circuit, but the maximum permissible temperature of the soldering iron or bath is 275 °C; it must not be in contact with the joint for more than 5 seconds. Soldered joints must be at least 4.7 mm from the seal.
- The leads should not be bent less than 2.4 mm from the seal, and should be supported during bending. The leads can be bent, twisted or straightened by 90^o maximum. The minimum bending radius is 1 mm.
- 3. It is recommended that the circuit connection be made to the anode tag, rather than direct to the heatsink.
- 4. Mounting by means of a spring clip is the best mounting method because it offers:
 - a. a good thermal contact under the crystal area and slightly lower $\rm R_{th\ mb-h}$ values than screw mounting.

b. safe isolation for mains operation.

However, if a screw is used, it should be M3 cross-recess pan-head. Care should be taken to avoid damage to the plastic body.

- For good thermal contact, heatsink compound should be used between mounting base and heatsink. Values of 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.
- 6. Rivet mounting (only possible for non-insulated mounting).

Devices may be rivetted to flat heatsinks; such a process **must neither** deform the mounting tab, **nor** enlarge the mounting hole.

7. The heatsink must have a flatness in the mounting area of 0.02 mm maximum per 10 mm. Mounting holes must be deburred.

OPERATING NOTES

Dissipation and heatsink considerations:

a. The various components of junction temperature rise above ambient are illustrated in Fig.4.



- b. The method of using Fig.5 is as follows:
 - Starting with the required current on the $I_{T(AV)}$ axis, trace upwards to meet the appropriate form factor curve. Trace right horizontally and upwards from the appropriate value on the T_{amb} scale. The intersection determines the $R_{th\ mb-a}$. The heatsink thermal resistance value ($R_{th\ h-a}$) can now be calculated from:

$$R_{th h-a} = R_{th mb-a} - R_{th mb-h}$$

c. Any measurement of heatsink temperature should be made immediately adjacent to the device.



Fig.5 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.

 $\alpha = \text{conduction angle per half cycle}$ $a = \text{form factor} = \frac{\text{IT(RMS)}}{\text{IT(AV)}}$

α	а
300	4
60 ⁰	2.8
90 ⁰	2.2
120 ⁰	1.9
180 ⁰	1.57





Fig.6 Maximum permissible non-repetitive r.m.s. on-state current based on sinusoidal currents (f = 50 Hz) with reapplied V_{RWMmax}. T_j = 110 ^oC prior to surge.





Fig.7 —
$$T_j = 25 \text{ °C}; - - T_j = 110 \text{ °C}.$$



Fig.8 Minimum gate voltage that will trigger all devices as a function of junction temperature.

Fig.9 Minimum gate current that will trigger all devices as a function of junction temperature.



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April 1986

THYRISTORS



Glass-passivated thyristors in TO-220AB envelopes, which are particularly suitable in situations creating high fatigue stresses involved in thermal cycling and repeated switching. Applications include temperature control, motor control, regulators in transformerless power supply applications, relay and coil pulsing and power supply crowbar protection circuits.

QUICK REFERENCE DATA

		BT151-500R 650R		650R	800R	
Repetitive peak voltages	V _{DRM} /V _{RRM}	max.	500	650	800	V
Average on-state current	T(AV)	max.		7.5		А
R.M.S. on-state current	IT(RMS)	max.		12		А
Non-repetitive peak on-state current	ITSM	max.		100		Α

MECHANICAL DATA



see data sheets Mounting instructions and accessories for TO-220 envelopes.

Products approved to CECC 50 011--003 available on request.

RATINGS

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

Anode to cathode		BT1514	500R	650R	800R	
Non-repetitive peak voltages (t \leq 10 ms)	V _{DSM} /V _{RSM}	max.	500	650	800	۷*
Repetitive peak voltages ($\delta \leqslant$ 0.01)	V _{DRM} /V _{RRM}	max.	500	650	800	V
Crest working voltages	V _{DWM} /V _{RWM}	max.	400	400	400	V
Continuous voltages	V _D /V _R	max.	400	400	400	V
Average on-state current (averaged over any 20 ms period) up to T_{mb} = 95 °C	IT(AV)	max.		7.5		A
R.M.S. on-state current	T(RMS)	max.		12		А
Repetitive peak on-state current	TRM	max.		65		А
Non-repetitive peak on-state current; t = 10 ms; half sine-wave; $T_j = 110$ °C prior to surge; with reapplied V purcharge;	TEM	max		100		Δ
l^2 t for fusing (t = 10 ms)	1 ² t	max.		50		A ² s
Rate of rise of on-state current after triggering with $I_G = 50 \text{ mA to}$ $I_T = 20 \text{ A}$; $dI_G/dt = 50 \text{ mA}/\mu s$	dl _T /dt	max.		50		A/μs
Gate to cathode						
Reverse peak voltage	V _{RGM}	max.		5		v
Average power dissipation (averaged over any 20 ms period)	P _G (AV)	max.		0.5		w
Peak power dissipation	PGM	max.		5		w
Temperatures						
Storage temperature	T _{sta}		40 t	o +125		οС
Operating junction temperature	Тj	max.		110		oC

*Although not recommended, higher off-state voltages may be applied without damage, but the thyristor may switch into the on-state. The rate of rise of on-state current should not exceed 15 A/ μ s.

THERMAL RESISTANCE				
From junction to mounting base	R _{th} j-mb	=	1.3	K/W
Transient thermal impedance; t = 1 ms	Z _{th j-mb}	=	0.2	K/W
Influence of mounting method				
1. Heatsink mounted with clip (see mounting instructions)				
Thermal resistance from mounting base to heatsink				
a. with heatsink compound	R _{th} mb-h	=	0.3	K/W
b. with heatsink compound and 0.06 mm maximum mica insulator	R _{th} mb-h	=	1.4	K/W
c. with heatsink compound and 0.1 mm maximum mica insulator (56369)	R _{th} mb-h	=	2.2	K/W
d. with heatsink compound and 0.25 mm max. alumina insulator (56367)	R _{th} mb-h	=	0.8	K/W
e. without heatsink compound	R _{th mb-h}	=	1.4	K/W
2. Free-air operation				

The quoted values of $R_{th\ j-a}$ should be used only when no leads of other dissipating components run to the same tie-point.

Thermal resistance from junction to ambient in free air: mounted on a printed-circuit board at a = any lead length and with copper laminate

R_{th j-a} = 60 K/W



Fig. 2.

CHARACTERISTICS

Anode to cathode				
On-state voltage				
$I_{T} = 23 \text{ A}; T_{j} = 25 \text{ °C}$	۷T	<	1,75	V*
Rate of rise of off-state voltage that will not trigger any device; T _j = 110 ^o C; see Fig.10				
R _{GK} = open circuit	dV _D /dt	<	50	V/µs
$R_{GK} = 100 \Omega$	dV _D /dt	<	200	V/µs
Reverse current				
V _R = V _{RWMmax} ; T _j = 110 °C	I _R	<	0,5	mA
Off-state current				
V _D = V _{DWMmax} ; T _i = 110 °C	ID	<	0,5	mA
Latching current; $T_i = 25 {}^{\circ}C$	1	<	40	mA
Holding current; $T_j = 25 ^{\circ}C$	ц Ц	<	20	mA
Gate to cathode				
Voltage that will trigger all devices				
V _D = 6 V; T _i = 25 °C	VGT	>	1,5	V
$V_{D} = 6 V; T_{j} = -40 °C$	VGT	>	2,3	V
Voltage that will not trigger any device				
$V_D = V_{DRMmax}$; T _i = 110 °C	V _{GD}	<	250	mV
Current that will trigger all devices				
$V_{D} = 6 V; T_{i} = 25 °C$	IGT	>	15	mA
$V_{\rm D}^{-} = 6 \text{ V}; \text{ T}_{\rm j}^{\prime} = -40 \text{ °C}$	IGT	>	20	mΑ
Switching characteristics				
Gate-controlled turn-on time $(t_{gt} = t_d + t_r)$ when				

typ.

tgt

2 μs

switched from $V_D = V_{DRMmax}$ to $I_T = 40 \text{ A}$; $I_{GT} = 100 \text{ mA}$; $dI_G/dt = 5A/\mu s$; $T_j = 25 \text{ °C}$



Fig.2a Gate controlled turn-on time definition.

*Measured under pulse conditions to avoid excessive dissipation.

MOUNTING INSTRUCTIONS

- The device may be soldered directly into the circuit, but the maximum permissible temperature of the soldering iron or bath is 275 °C; it must not be in contact with the joint for more than 5 seconds. Soldered joints must be at least 4.7 mm from the seal.
- The leads should not be bent less than 2.4 mm from the seal, and should be supported during bending. The leads can be bent, twisted or straightened by 90° maximum. The minimum bending radius is 1 mm.
- 3. It is recommended that the circuit connection be made to the anode tag, rather than direct to the heatsink.
- 4. Mounting by means of a spring clip is the best mounting method because it offers:
 - a. a good thermal contact under the crystal area and slightly lower $\mathsf{R}_{th\ mb-h}$ values than screw mounting.
 - b. safe isolation for mains operation.

However, if a screw is used, it should be M3 cross-recess pan-head. Care should be taken to avoid damage to the plastic body.

- For good thermal contact, heatsink compound should be used between mounting base and heatsink. Values of 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.
- 6. Rivet mounting (only possible for non-insulated mounting)

Devices may be rivetted to flat heatsinks; such a process **must neither** deform the mounting tab, **nor** enlarge the mounting hole.

7. The heatsink must have a flatness in the mounting area of 0.02 mm maximum per 10 mm. Mounting holes must be deburred.

OPERATING NOTES

Dissipation and heatsink considerations:

 The various components of junction temperature rise above ambient are illustrated in Fig.3.



- b. The method of using Fig.4 is as follows:
 - Starting with the required current on the $I_{T(AV)}$ axis, trace upwards to meet the appropriate form factor curve. Trace right horizontally and upwards from the appropriate value on the T_{amb} scale. The intersection determines the R_{th} mb-a. The heatsink thermal resistance value (R_{th} h-a) can now be calculated from:

$R_{th h-a} = R_{th mb-a} - R_{th mb-h}$

c. Any measurement of heatsink temperature should be made immediately adjacent to the device.



Fig.4 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.

α	а
30 ⁰	4
60 ⁰	2,8
90o	2,2
120 ⁰	1,9
180 ⁰	1,57

 α = conduction angle per half cycle

a = form factor =
$$\frac{IT(RMS)}{IT(AV)}$$

Thyristors

BT151 SERIES



Fig.5 Maximum permissible non-repetitive r.m.s. on-state current based on sinusoidal currents (f = 50 Hz); T_j = 110 °C prior to surge; with reapplied V_{RWMmax}.

I





Fig.6 Minimum gate voltage that will trigger all devices as a function of junction temperature.

Fig.7 Minimum gate current that will trigger all devices as a function of junction temperature.



March 1984

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Fig.9



Fig. 10 Maximum rate of rise of off-state voltage that will not trigger any device (exponential method) as a function of junction temperature.



FULL-PACK THYRISTORS

Glass-passivated thyristors in SOT-186 envelopes, incorporating electrical isolation between the seating plane and all three terminals. Applications include temperature control, motor control, regulators in transformerless power supply applications, relay and coil pulsing and power supply crowbar protection circuits.

QUICK REFERENCE DATA

		BT151F-500	650 800	
Repetitive peak voltages	V _{DRM} /V _{RRM}	max. 500	650 800	V
Average on-state current	IT(AV)	max.	5.7	А
R.M.S. on-state current	^I T(RMS)	max.	9	А
Non-repetitive peak on-state current	ITSM	max.	100	А

MECHANICAL DATA

Fig.1 SOT-186







The seating plane is electrically isolated from all three terminals.

Dimensions in mm
RATINGS

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

Anode to cathode		BT151	F-500	650	800	
Non-repetitive peak voltages (t \leq 10 ms)	V _{DSM} /V _{RSM}	max.	500	650	800	۷*
Repetitive peak voltages ($\delta \leqslant 0.01$)	V _{DRM} /V _{RRM}	max.	500	650	800	v
Crest working voltages	V _{DWM} /V _{RWM}	max.	400	400	400	v
Continuous voltages	V _D /V _R	max.	400	400	400	v
Average on-state current (averaged over any 20 ms period) up to T _h = 74 ^o C	IT(AV)	max.		5.7		А
R.M.S. on-state current	T(RMS)	max.		9		А
Repetitive peak on-state current	TRM	max.		65		А
Non-repetitive peak on-state current t = 10 ms; half-sinewave; $T_j = 110 \circ C$ prior to surge;	1			100		•
with reapplied v RWMmax l^{2} t for fusion (t = 10 me)	ITSM	max.		100		A
Rate of rise of on-state current after triggering with $I_G = 50$ mA to $I_T = 20$ A; dI _G /dt = 50 mA/ μ s	dl _T /dt	max.		50		A~s A/µs
Gate to cathode						
Reverse peak voltage	V _{BGM}	max.		5		v
Average power dissipation (averaged over any 20 ms period)	PG(AV)	max.		0.5		w
Peak power dissipation	PGM	max.		5		W
Temperatures						
Storage temperature	T _{sta}		-40 to	+125		οС
Operating junction temperature	T _i	max.		110		oC
ISOLATION	,					
From all three terminals to external heatsink (peak)	V _{isol}	min.		1000		v
Capacitance from anode to external heatsink	C _{isol}	typ.		12		pF

*Although not recommended, higher off-state voltages may be applied without damage, but the thyristor may switch into the on-state. The rate of rise of on-state current should not exceed 15 A/ μ s.

THERMAL RESISTANCE

1. Heatsink-mounted with clip (see mounting instructions)

Thermal resistance from junction to external heatsink

With heatsink compound	R _{th j-h}	==	4.5	K/W
Without heatsink compound	R _{th j-h}	=	6.5	K/W

2. Free-air operation

The quoted values of $R_{th\ j-a}$ should be used only when no leads of other dissipating components run to the same tie-point.

Thermal resistance from junction to ambient in free air; mounted on a printed-circuit board at a = any lead length and with copper laminate

 $R_{th j-a} = 55 K/W$



Fig.2.

CHARACTERISTICS

Anode to cathode

On-state voltage				
I _T = 23 A; T _j = 25 ^o C	VT	<	1.75	V*
Rate of rise of off-state voltage that will not trigger any device: $T_{1} = 110$ PC: see Fig 10				
$B_{CK} = open circuit$	dV⊳/dt	<	50	V/us
$R_{GK} = 100 \Omega$	dV _D /dt	<	200	V/μs
Reverse current				
V _R = V _{RWMmax} ; T _i = 110 ^o C	I _R	<	0.5	mA
Off-state current				
V _D = V _{DWMmax} ; T _j = 110 ^o C	۱D	<	0.5	mA
Latching current; T _j = 25 ^o C	١L	<	40	mA
Holding current; $T_j = 25 \text{ °C}$	ŀн	<	20	mA
Gate to cathode				
Voltage that will trigger all devices				
$V_{D} = 6 V; T_{i} = 25 °C$	VGT	>	1.5	v
$V_{D} = 6 V; T_{j} = -40 °C$	VGT	>	2.3	v
Voltage that will not trigger any device				
V _D = V _{DRMmax} ; T _j = 110 °C	V _{GD}	<	250	mν
Current that will trigger all devices				
V _D = 6 V; T _i = 25 ^o C	IGT	>	15	mΑ
V _D = 6 V; T _j = -40 °C	^I GT	>	20	mA

Switching characteristics

Gate-controlled turn-on time ($t_{gt} = t_d + t_r$) when switched from V_D = V_{DRMmax} to I_T = 40 A; I_{GT} = 100 mA; dI_G/dt = 5 A/µs; T_j = 25 °C

tat

typ.

2

μs





Fig.3 Gate controlled turn-on time definition.

*Measured under pulse conditions to avoid excessive dissipation.

MOUNTING INSTRUCTIONS

- The device may be soldered directly into the circuit, but the maximum permissible temperature of the soldering iron or bath is 275 °C; it must not be in contact with the joint for more than 5 seconds. Soldered joints must be at least 4.7 mm from the seal.
- 2. The leads should not be bent less than 2.4 mm from the seal, and should be supported during bending.
- 3. Mounting by means of a spring clip is the best mounting method because it offers good thermal contact under the crystal and slightly lower R_{th} _{j-h} values than screw mounting. It is recommended that the force exerted on the top of the device by the clip should be at least 2 kgf (20 N).
- 4. However, if a screw is used it should be M3 cross-recess pan-head. Care should be taken to avoid damage to the plastic body.

For good thermal contact heatsink compound should be used between seating plane and heatsink. Values of $R_{th j-h}$ given for mounting with heatsink compound refer to the use of a metallic-oxide loaded compound. Ordinary silicone grease is not recommended.

5. Rivet mounting is not recommended.

OPERATING NOTES

Dissipation and heatsink considerations:

a. The various components of junction temperature rise above ambient are illustrated in Fig.4.



b. The method of using Fig.5 is as follows:

Starting with the required current on the $I_{T(AV)}$ axis of Fig.5a, trace upwards to meet the appropriate form factor curve and read off the power P on the left hand scale. Using this value of P, on either Fig.5b or c, trace right horizontally and upwards from the appropriate value on the T_{amb} scale. The intersection determines $R_{th h-a}$, the required heatsink thermal resistance value.

c. Any measurement of heatsink temperature should be made immediately adjacent to the device.



Fig.5b Without heatsink compound.

 α = conduction angle per half cycle

a = form factor =
$$\frac{|T(RMS)|}{|T(AV)}$$
$$\frac{\alpha}{\alpha} |_{+}$$
$$\frac{\alpha}{30^{\circ}} |_{+}$$
$$\frac{\alpha}{30^{\circ}} |_{+}$$
$$\frac{\alpha}{30^{\circ}} |_{+}$$
$$\frac{\alpha}{1.9}$$
$$\frac{120^{\circ}}{1.9}$$
$$\frac{1.57}{1.57}$$

Figs. 5a,b,c Interrelationship between power (derived from Fig.5a) and maximum permissible temperatures.







Fig.6 Maximum permissible non-repetitive r.m.s. on-state current based on sinusoidal currents (f = 50 Hz); T_i = 110 ^oC prior to surge; with reapplied V_{RWMmax}.

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Fig.7 Minimum gate voltage that will trigger all devices as a function of junction temperature.



Fig.8 Minimum gate current that will trigger all devices as a function of junction temperature.



Thyristors

BT151F SERIES



Fig. 10 Maximum rate of rise of off-state voltage that will not trigger any device (exponential method) as a function of junction temperature.







THYRISTORS



Glass-passivated thyristors in TO-220AB envelopes, which are particularly suitable in situations creating high fatigue stresses involved in thermal cycling and repeated switching. Applications include temperature control, motor control, regulators in transformerless power supply applications, relay and coil pulsing and power supply crowbar protection circuits.

BT152-400R 600R 800R 400 600 800 Repetitive peak voltages VDRM/VRRM v max. Average on-state current 13 T(AV) max. А 20 R.M.S. on-state current IT(RMS) max. А 200 Non-repetitive peak on-state current А **ITSM** max.

MECHANICAL DATA

QUICK REFERENCE DATA

Fig.1 TO-220AB







Net mass: 2 g

Note: The exposed metal mounting base is directly connected to the anode

Accessories supplied on request: see data sheets Mounting instructions and accessories for TO-220 envelopes.

Products approved to CECC 50 011-011 available on request.

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BT152 SERIES

RATINGS

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

Anode to cathode		BT152-	-400 R	6	600R	800R	
Non-repetitive peak voltages	V _{DSM} /V _{RSM}	max.	450	6	50	850	v
Repetitive peak voltages	V _{DRM} /V _{RRM}	max.	400	6	600	800	V
Crest working voltages	V _{DWM} /V _{RWM}	max.	400	4	00	400	V
Average on-state current (averaged over any 20 ms period) up to T _{mb} = 93 ^o C		IT(AV)	r	nax.	1:	3	A
R.M.S. on-state current		T(RMS	5) r	nax.	20)	А
Repetitive peak on-state current		ITRM	r	nax.	200)	А
Non-repetitive peak on-state current; t = 10 half sine-wave; $T_i = 115 ^{O}\text{C}$ prior to si	0 ms; urge;						
with reapplied V _{RWMmax}		ITSM	r	nax.	200)	А
I^2 t for fusing (t = 10 ms)		l² t	r	nax.	200)	A² s
Rate of rise of on-state current after trigge with I_G = 160 mA to I_T = 50 A; dI_G/dt	ring = 160 A/ms	dI _T /dt	r	nax.	200	D	A∕µs
Gate to cathode							
Reverse peak voltage		VRGM	r	nax.	Į	5	V
Average power dissipation (averaged over a	ny 20 ms period)	P _G (AV) r	nax.	0.9	5	W
Peak power dissipation; t \leq 10 μ s		PGM	r	nax.	20)	W
Temperature							
Storage temperature		т _{stq}	-	-40 1	to +150)	οС
Junction temperature		Тј	r	nax.	119	5	٥C

THERMAL RESISTANCE				
From junction to mounting base	R _{th j-mb}	=	1.1	K/W
Transient thermal impedance; t = 1 ms	Z _{th j-mb}	= 0).12	K/W
Influence of mounting method				
1. Heatsink mounted with clip (see mounting instructions)				
Thermal resistance from mounting base to heatsink				
a. with heatsink compound	R _{th mb-h}	=	0.3	K/W
b. with heatsink compound and 0.06 mm maximum mica insulator	R _{th mb-h}	=	1.4	K/W
c. with heatsink compound and 0.1 mm maximum mica insulator (56369)	R _{th mb-h}	=	2.2	K/W
d. with heatsink compound and 0.25 mm max. alumina insulator (56367)	R _{th mb-h}	=	8.0	K/W
e. without heatsink compound	R _{th mb-h}	=	1.4	K/W
2. Free-air operation				

The quoted values of ${\sf R}_{th\ j-a}$ should be used only when no leads of other dissipating components run to the same tie-point.

Thermal resistance from junction to ambient in free air: mounted on a printed-circuit board at a = any lead length and with copper laminate

R_{th j-a} = 60 K/W





CHARACTERISTICS

Anode to cathode

On-state voltage	(measured under	pulse conditions)
------------------	-----------------	-------------------

I _T = 40 A; T _i = 25 °C	ν _T	<	1.75	V
Rate of rise of off-state voltage				
$T_j = 115 \text{ °C}; R_{GK} = \text{ open circuit}$	dV _D /dt	<	200	V/µs
Reverse current				
$V_R = V_{RWMmax}$; $T_j = 115 {}^{\circ}C$	IR	<	1.0	mA
Off-state current		_	4.0	
$V_D = V_{DWMmax}$; $T_j = 115 \text{ °C}$	۱D	<	1.0	mA
Latching current; T _j = 25 ^o C	١Ľ	<	80	mA
Holding current; $T_j = 25 \ ^{O}C$	ιH	<	60	mA
Gate to cathode				
Voltage that will trigger all devices				
$V_D = 12 V; T_j = -40 °C$	VGT	>	1.5	V
$v_{\rm D} = 12 v; t_{\rm j} = 25 {}^{\circ}{\rm C}$	VGT	>	1.0	v
Voltage that will not trigger any device $V_{D} = V_{D} = V_{D}$	Von	1	0.25	v
$v_D = v_D RMmax$, $r_j = 115 °C$	▼GD		0.25	v
$V_D = 12 V \cdot T = -40 \text{ °C}$	ICT	>	50	mA
$V_{\rm D} = 12 \text{ V}; \text{T}_{\rm j} = 25 \text{ °C}$	IGT	>	32	mA

t_{gt}

tq

Switching characteristics

Gate-controlled turn-on time ($t_{gt} = t_d + t_r$) when switched from V_D = V_{DRMmax} to I_T = 40 A; I_{GT} = 100 mA; dI_G/dt = 5 A/µs; T_j = 25 °C

Circuit-commutated turn-off time when switched from I_T = 40 A to V_R > 50 V with $-dI_T/dt$ = 10 A/µs; dV_D/dt = 50 V/µs; T_j = 115 °C





2

35

typ.

typ.

μs

μs

MOUNTING INSTRUCTIONS

- The device may be soldered directly into the circuit, but the maximum permissible temperature of the soldering iron or bath is 275 °C; it must not be in contact with the joint for more than 5 seconds. Soldered joints must be at least 4.7 mm from the seal.
- The leads should not be bent less than 2.4 mm from the seal, and should be supported during bending. The leads can be bent, twisted or straightened by 90^o maximum. The minimum bending radius is 1 mm.
- 3. It is recommended that the circuit connection be made to the anode tag, rather than direct to the heatsink.
- 4. Mounting by means of a spring clip is the best mounting method because it offers:
 - a. a good thermal contact under the crystal area and slightly lower $R_{th\ mb-h}$ values than screw mounting.

b. safe isolation for mains operation.

However, if a screw is used, it should be M3 cross-recess pan-head. Care should be taken to avoid damage to the plastic body.

- For good thermal contact, heatsink compound should be used between mounting base and heatsink. Values of 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.
- 6. Rivet mounting (only possible for non-insulated mounting)

Devices may be rivetted to flat heatsinks; such a process **must neither** deform the mounting tab, **nor** enlarge the mounting hole.

7. The heatsink must have a flatness in the mounting area of 0.02 mm maximum per 10 mm. Mounting holes must be deburred.

OPERATING NOTES

Dissipation and heatsink considerations:

 The various components of junction temperature rise above ambient are illustrated in Fig.4.



- b. The method of using Fig.5 is as follows:
 - Starting with the required current on the $I_{T(AV)}$ axis, trace upwards to meet the appropriate form factor curve. Trace right horizontally and upwards from the appropriate value on the T_{amb} scale. The intersection determines the $R_{th\ mb}$ -a. The heatsink thermal resistance value ($R_{th\ h-a}$) can now be calculated from:

$$R_{th h-a} = R_{th mb-a} - R_{th mb-h}$$

c. Any measurement of heatsink temperature should be made immediately adjacent to the device.

BT152 SERIES



Fig.5 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.

$\left(\right)$	α =	conduction angle per half cycle
	. =	form forter - ^I T (RMS)
→ α ↓	a ~	IT(AV)

α	а
30 ⁰	4
60 ⁰	2.8
90 ⁰	2.2
120 ⁰	1.9
180 ⁰	1.57

Thyristors

BT152 SERIES



Fig.6 Maximum permissible non-repetitive r.m.s. on-state current based on sinusoidal currents (f = 50 Hz); T_j = 115 °C prior to surge; with reapplied V_{RWMmax} .



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FAST TURN-OFF THYRISTOR

Glass-passivated fast-turn-off thyristor in a TO-220AB envelope, intended for use in inverter, pulse and switching applications. Its characteristics make the device extremely suitable for use in regulator, vertical deflection, and east/west correction circuits of colour television receivers.

QUICK REFERENCE DATA

Repetitive peak off-state voltage	VDRM	max.	500	v
Average on-state current	IT(AV)	max.	4	А
R.M.S. on-state current	IT(RMS)	max.	6	А
Repetitive peak on-state current	ITRM	max.	30	А
Circuit-commutated turn-off time	tq	<	20	μs

MECHANICAL DATA

Fig. 1 TO-220AB.

10.3 4,5 max max 3,7 1,3ŧ 2.8 5,9 4 min mounting base ŧ 15,8 (see note) máx 3.5 max 5.1 not tinned máx 13,5 1,3min max (2x) Net mass: 2 g C Note: The exposed metal mounting -0,9 max (3 x) 0.6 base is directly connected to the -2.4 anode. 2,54 2,54 M0993 Accessories supplied on request: see data sheets Mounting instructions and accessories for TO-220 envelopes.

Dimensions in mm

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RATINGS

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

Anode to cathode				
Non-repetitive peak voltages (t \leq 10 ms)	V _{DSM} /V _{RSM}	max.	550	v
Repetitive peak voltages	V _{DRM} /V _{RRM}	max.	500	V
Working voltages	V _{DW} /V _{RW}	max.	400	V *
Average on-state current (averaged over any 20 ms period) up to $T_{mb} = 95 \ ^{o}C$	IT(AV)	max.	4	A
R.M.S. on-state current	IT(RMS)	max.	6	А
Working peak on-state current	Ттим	max.	10	А
Repetitive peak on-state current	ITRM	max.	30	А
Non-repetitive peak on-state current; t = 10 ms; half sine-wave; T _j = 110 ^o C prior to surge;				
with reapplied VRWMmax	TSM	max.	40	A
I ² t for fusing; t = 10 ms; T _j = 25 °C	l ² t	max.	10	A²s
Rate of rise of on-state current after triggering up to f = 20 kHz; V_{DM} = 300 V to I _{TM} = 6 A	dI _T /dt	max.	200	A∕µs
Gate to cathode				
Average power dissipation (averaged over any 20 ms period)	P _G (AV)	max.	1	w
Peak power dissipation; t = 10 μ s	P _{GM}	max.	25	W
Temperatures				
Storage temperature	T _{stg}	-40 to +	125	οС
Operating junction temperature	тj	max.	110	οС

* Voltage shapes as occurring in the intended application.

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the same tie-point.

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THERMAL RESISTANCE				
From junction to mounting base	R _{th} j-mb	=	1,5	oC/M
Transient thermal impedance; t = 1 ms	Z _{th j-mb}	=	0,2	oC/M
Influence of mounting method				
1. Heatsink mounted with clip (see mounting instructions)				
Thermal resistance from mounting base to heatsink				
a. with heatsink compound	R _{th} mb-h	=	0,3	oC/M
b. with heatsink compound and 0,06 mm maximum mica insulator	R _{th mb-h}	=	1,4	oC/M
c. with heatsink compound and 0,1 mm maximum mica insulator (56369)	R _{th} mb-h	=	2,2	oC/M
d. with heatsink compound and 0,25 mm max. alumina insulator (56367)	R _{th} mb-h	=	0,8	oC/M
e. without heatsink compound	R _{th mb-h}	=	1,4	oC/M
2. Free-air operation				
The quoted values of $R_{th\;j\text{-}a}$ should be used only when no leads of other dist	sipating com	oon	ents	run to

Thermal resistance from junction to ambient in free air: mounted on a printed-circuit board at a = any lead length and with copper laminate

 $R_{th j-a} = 60 \text{ °C/W}$



Fig. 2.

CHARACTERISTICS

Anode to cathode On-state voltage $I_T = 10 \text{ A}; T_i = 25 \text{ }^{\circ}\text{C}$ < 2,5 V * Vт Rate of rise of off-state voltage that will not trigger any device; $T_i \le 110 \text{ °C}$ dV_D/dt < 200 V/µs Off-state current V_D = V_{DRMmax}; T_i = 110 °C ID <1,5 mA Holding current; $T_i = 25 \text{ °C}$ < 100 mA IH. Gate to cathode Voltage that will trigger all devices $V_{D} = 6 V; T_{i} = 25 \text{ °C}; t_{D} \ge 5 \mu s$ VGT > 2,5 V Current that will trigger all devices $V_D = 6 V; T_i = 25 \circ C; t_p \ge 5 \mu s$ 40 mA IGT > Switching characteristics Circuit-commutated turn-off time (in regulating circuits)

when switched from I_T = 10 A to V_R \ge 50 V with -dI_T/dt = 10 A/µs; dV_D/dt = 200 V/µs; V_{DM} = 500 V; R_{GK} = 68 Ω ; T_{mb} = 80 °C; t_p \le 50 µs

< 20 μs

ta



Fig. 3 Circuit-commutated turn-off time definition.

* Measured under pulse conditions to avoid excessive dissipation.

MOUNTING INSTRUCTIONS

- 1. The device may be soldered directly into the circuit, but the maximum permissible temperature of the soldering iron or bath is 275 °C; it must not be in contact with the joint for more than 5 seconds. Soldered joints must be at least 4.7 mm from the seal.
- 2. The leads should not be bent less than 2.4 mm from the seal, and should be supported during bending. The leads can be bent, twisted or straightened by 90° maximum. The minimum bending radius is 1 mm.
- 3. It is recommended that the circuit connection be made to the anode tag, rather than direct to the heatsink.
- 4. Mounting by means of a spring clip is the best mounting method because it offers:
 - a. a good thermal contact under the crystal area and slightly lower Rth mb-h values than screw mounting.
 - b. safe isolation for mains operation.

However, if a screw is used, it should be M3 cross-recess pan-head. Care should be taken to avoid damage to the plastic body.

- 5. For good thermal contact, heatsink compound should be used between mounting base and heatsink. Values of Rth mb-h given for mounting with heatsink compound refer to the use of a metallic-oxide loaded compound. Ordinary silicone grease is not recommended.
- 6. Rivet mounting (only possible for non-insulated mounting)

Devices may be rivetted to flat heatsinks; such a process must neither deform the mounting tab, nor enlarge the mounting hole.

7. The heatsink must have a flatness in the mounting area of 0.02 mm maximum per 10 mm. Mounting holes must be deburred.

OPERATING NOTES

Dissipation and heatsink considerations:

a. The various components of junction temperature rise above ambient are illustrated in Fig.4.



Fig.4

b. The method of using Fig.5 is as follows:

Starting with the required current on the $I_{T(AV)}$ axis, trace upwards to meet the appropriate form factor curve. Trace right horizontally and upwards from the appropriate value on the Tamb scale. The intersection determines the Rth mb-a. The heatsink thermal resistance value (Rth h-a) can now be calculated from:

$R_{th h-a} = R_{th mb-a} - R_{th mb-h}$

Any measurement of heatsink temperature should be made immediately adjacent to the device.





Fig. 5 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.



α	а
30 ⁰	4
60 ⁰	2,8
90 ⁰	2,2
120 ⁰	1,9
180 ⁰	1,57

230



Fig. 6 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.

 P_{tot} = maximum power dissipation including gate and switching losses.

ITWM = maximum working peak on-state current.



BT153



Fig. 9 Maximum permissible non-repetitive r.m.s. on-state current based on sinusoidal currents (f = 50 Hz); $T_i = 110 \text{ }^{\circ}\text{C}$ prior to surge; with reapplied V_{RWMmax} .



Fast turn-off thyristor

BT153













BT153









Fig. 15.



THYRISTORS

Fully-diffused thyristors in TO-92 package, with low gate current requirement suitable for driving from IC outputs. Applications include relay and coil pulsing, control of small d.c. motors, small lamps, etc.

QUICK REFERENCE DATA

			BT169-B	D	M	
Repetitive peak voltages	V _{DRM} /V _{RRM}	max.	200	400	600	V
Average on-state current	IT(AV)	max.		0.5		А
R.M.S. on-state current	IT(RMS)	max.		0.8		А
Non-repetitive peak on-state current	ITSM	max.		8		А

MECHANICAL DATA

Fig.1 TO-92 variant

Dimensions in mm



BT169 SERIES

RATINGS

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

Anode to cathode			BT169	в	D	М	
Non-repetitive peak voltages (t \leq 10 ms)	VDSM/VRSM	max.	2	00	400	600	V*
Repetitive peak voltages $(\delta \leq 0.01)$	V _{DRM} /V _{RRM}	max.	2	00	400	600	v
Average on-state current (averaged over 20 ms period) up to $T_{mb} = 55 ^{\circ}\text{C}$	any	IT(AV)	max.		0.5		A
R.M.S. on-state current		T(BMS)	max.		0.8		A
Repetitive peak on-state current		TRM	max.		8		А
Non-repetitive peak on-state current; t = half sine-wave; $T_j = 125$ °C prior to su with respective V - wave	10 ms; urge;				0		Δ
with reapplied V RWMmax		'TSM	max.		8		A
1^{2} t for fusing (t = 10 ms)		I ² t	max.		0.32		A*s
Rate of rise of on-state current after trig I _G = 1 mA to I _T = 1.8 A; dI _G /dt = 4 m	gering with mA/μs	dl _T /dt	max.		30		A/µs
Gate to cathode							
Peak reverse voltage		V _{RGM}	max.		8		V
Average power dissipation (averaged over any 20 ms period)		P _{G(AV)}	max.		0.1		W
Peak power dissipation		PGM	max.		2		W
Temperatures							
Storage temperature		T _{sta}		40 to	+150		°C
Operating junction temperature		T _j	max.		125		oC
THERMAL RESISTANCE		•					
From junction to mounting base		R _{th i-mb}	=		100		K/W
From junction to ambient in free air, mounted on a p.c.b. with any lead len	igth	R _{th j-a}	=		200		K/W

*R_{GK} = 1 kΩ.

BT169 SERIES

CHARACTERISTICS

Anode to cathode

On-state voltage $I_{T} = 1 A \cdot T = 25 \ 9C$	\/ -	1	1 35	V/*
$I_1 = I A$, $I_2 = 25 \cdot 0$ Pate of rise of off state voltage that will not	v į		1.55	v
trigger any device: exponential method:				
$V_D = 2/3 V_{DRMmax}$; $R_{GK} = 1 k\Omega$; $T_j = 125 \text{ °C}$	dV _D /dt	<	100	V/µs
Reverse current				
V _R = V _{RRMmax} ; R _{GK} = 1 kΩ; T _j = 125 ^o C	I R	<	0.1	mΑ
Off-state current				
V _D = V _{DRMmax} ; R _{GK} = 1 kΩ; T _j = 125 ^o C	۱D	<	0.1	mA
Latching current				
$V_D = 6 V; R_{GK} = 1 k\Omega; T_j = 25 °C$	١L	<	6	mA
Holding current				
V _D = 6 V; R _{GK} = 1 kΩ; T _j = 25 ^o C	ΙH	<	5	mA
Gate to cathode				
Voltage that will trigger all devices				
V _D = 6 V; T _i = 25 ^o C	V _{GT}	>	0.8	V
Current that will trigger all devices				
$V_{D} = 6 V; T_{j} = 25 °C$	IGT	>	0.2	mA
Switching characteristics				
Gate-controlled delay time when switched				
from $V_D = V_{DRMmax}$ to $I_T = 1.5 A$;				
l _{GT} = 10 mA; dl _G /dt = 0.1 A/µs; T _j = 25 ^o C	td	<	1.0	μs
Circuit-commutated turn-off time when switched				
from I _T = 0.5 A to V _R $>$ 35 V with				
dI _T /dt = 110 A/μs; dV _D /dt = 50 V/μs; T _i = 125 °C	ta	<	100	μs

*Measured under pulse conditions to avoid excessive dissipation.



THYRISTORS

Silicon thyristors in metal envelopes, intended for general purpose single-phase or three-phase mains operation.

The series consists of reverse polarity types (anode to stud) identified by a suffix R:BTW23-600R to 1600R.

QUICK REFERENCE DATA

	BTW23-	600R	800R	1000R	1200R	1400R	1600R	_
Repetitive peak voltages V _{DRM} = V _{RRM}	max.	600	800	1000	1200	1400	1600	v
Average on-state current						/) max	x. 90	А
R.M.S. on-state current						/IS) max	k. 140	А
Non-repetitive peak on-state cur			ITSM	max	k. 2000	А		
Rate of rise of off-state voltage that will not trigger any devic	e				dV _D /d	dt <	200	V/µs
On request (see Ordering Note)					dV _D /o	tt <	1000	V/µs

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-94: with metric M12 stud (ϕ 12 mm).

Encapsulation may differ from that shown, but will conform to TO-94 major dimensions.



Net mass: 134 g Diameter of clearance hole: max. 13,0 mm Torque on nut: min. 9 Nm (90 kg cm) max. 17,5 Nm (175 kg cm) Supplied with device: 1 nut, 1 lock washer Nut dimensions across the flats: 19 mm.

BTW23 SERIES

RATINGS

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

Anode to cathode									
		BTW2	3-600 R	800R	1000R	1200R	1400R	1600F	1
Non-repetitive peak voltage (t ≤ 10 ms)	v _{DSM} /v _{RSM}	max.	600	800	1000	1200	1400	1600	v
Repetitive peak voltages	V _{DRM} /V _{RRM}	max.	600	800	1000	1200	1400	1600	v
Crest working voltages	V _{DWM} /V _{RWM}	max.	400	600	700	800	800	800	۷*
Average on-state current (a any 20 ms period) up to	veraged over T _{mb} = 85 ^o C				IT(A	(V)	max.	90	A
R.M.S. on-state current					IT(F	RMS)	max.	140	Α
Repetitive peak on-state cu	irrent				ITR	м	max.	1250	Α
Non-repetitive peak on-stat half sine-wave; T _j = 125 with reapplied Vouve	te current; t = 10 ^O C prior to surge	ms; ;			1=0	-	may	2000	۵
1^{2} t for fueing (t = 10 ms)	lax				1 SI 12+	И	max.	2000	Δ2 ε
Pata of sing (L = 10 ms)							max.	20 000	~ 3
with $I_G = 750$ mA to $I_T = 300$ A; $dI_G/dt = 1$ A/µs					dl _T /	dt	max.	300	A∕µs
Gate to cathode									
Reverse peak voltage					VRC	ЗM	max.	10	v
Average power dissipation any 20 ms period)	(averaged over				PGL	۵\/)	max.	2	w
Peak power dissipation					PGN	1	max.	10	w
Temperatures					*				
Storage temperature					Teta		-55 to	o + 125	оС
Junction temperature					T _j		max.	125	°C
THERMAL RESISTANCE									
From junction to mountin	g base				R _{th}	i-mb	=	0,3	°C/W
From mounting base to he	atsink				R _{th}	mb-h	=	0,1	°C/W
Transient thermal impedan	nce (t = 1 ms)				Zth	j-mb	=	0,015	°C/W

* To ensure thermal stability: $\rm R_{th\,j-a}\,{<}\,0,75$ °C/W (d.c. blocking) or ${<}\,1,5$ °C/W (a.c.). For smaller heatsinks $\rm T_{j\,max}$ should be derated.

April 1978

THYRISTORS



Dimensions in mm

Glass-passivated silicon thyristors in metal envelopes, intended for use in power control circuits (e.g. light and motor control) and power switching systems.

The series consists of reverse polarity types (anode to stud) identified by a suffix R: BTW38-600R to 1000R.

QUICK REFERENCE DATA

			BTW38-600R	800R	1000R	
Repetitive peak voltages	V _{DRM} /V _{RRM}	max.	600	800	1000	v
Average on-state current	IT(AV)	max.		10		A
R.M.S. on-state current	IT(RMS)	max.		16		А
Non-repetitive peak on-state current	ITSM	max.		150		Α

MECHANICAL DATA

Fig.1 TO-64: with metric M5 stud (ϕ 5 mm); e.g. BTW38–600R.





Net mass: 7 g Diameter of clearance hole: max. 5.2 mm Accessories supplied on request: see ACCESSORIES section Supplied with device: 1 nut, 1 lock washer Torque on nut: min. 0.9 Nm (9 kg cm) max. 1.7 Nm (17 kg cm) Nut dimensions across the flats: 8.0 mm.

Products approved to CECC 50 011-006 available on request.

March 1984
RATINGS

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

Anode to cathode			BTW38-600R	800R	1000R	
Non-repetitive peak voltages (t \leq 10 ms)	V _{DSM} /V _{RSM}	max.	600	800	1000	V
Repetitive peak voltages	V _{DRM} /V _{RRM}	max.	600	800	1000	V
Crest working voltages	V _{DWM} /V _{RWM}	max.	400	600	700	V*
Average on-state current (averaged over any 20 ms period) up to T _{mb} = 85	oC	IT(A	V) ma	ix.	10	A
R.M.S. on-state current		IT(RI	MS) ma	IX.	16	А
Repetitive peak on-state current			n ma	ix.	75	А
Non-repetitive peak on-state current; t half sine-wave; T _j = 125 ^O C prior to with reapplied V RWMmax	t = 10 ms; surge;	ITSM	ı ma	ıx.	150	A
l^2 t for fusing (t = 10 ms)		1 ² t	ma	x.	112	A ² s
Rate of rise of on-state current after t with $I_G = 250$ mA to $I_T = 25$ A; di	riggering _G /dt = 0.25 A/µs	dl _T /d	lt ma	ix.	50	A/µs
Gate to cathode						
Average power dissipation (averaged o period)	wer any 20 ms	P _G (A	V) ma	ix.	0.5	w
Peak power dissipation		PGM	ma	ax.	5	W
Temperatures						
Storage temperature		T _{stg}		55 t	o +125	°C
Junction temperature		т _ј	ma	ax.	125	°C
THERMAL RESISTANCE						
From junction to mounting base		R _{th} j	-mb =		1.8	K/W
From mounting base to heatsink with heatsink compound		R _{th}	mb-h =		0.5	κ/w
From junction to ambient in free air		R _{th} i	-a =		45	K/W
Transient thermal impedance (t = 1 m	is)	Z _{th}	j-mb =		0.1	K/W

OPERATING NOTE

The terminals should neither be bent nor twisted; they should be soldered into the circuit so that there is no strain on them.

During soldering the heat conduction to the junction should be kept to a minimum.

*To ensure thermal stability: $R_{th j-a} < 4$ K/W (d.c. blocking) or < 8 K/W (a.c.). For smaller heatsinks T_{j max} should be derated. For a.c. see Fig.3.

CHARACTERISTICS

Anode to cathode

On-state voltage (measured under pulse conditions) I_T = 20 A; T_j = 25 ^{o}C	ν _T	<	2	V
Rate of rise of off-state voltage that will not				
trigger any device; expontential method; $V_D = 2/3 V_{DDMmax}$, $T_i = 125 ^{O}C$	dVp/dt	<	200	V/us
Beverse current	a • D, a •		200	• , μ.ο
$V_{\rm R} = V_{\rm RWMmax}$; T _i = 125 °C	I _B	<	3	mA
Off-state current				
V _D = V _{DWMmax} ; T _i = 125 °C	۱ _D	<	3	mA
Latching current; $T_i = 25 \text{ °C}$	ιL	<	150	mA
Holding current; T _j = 25 ^o C	ι _Η	<	75	mA
Gate to cathode				
Voltage that will trigger all devices				
V _D = 6 V; T _j = 25 °C	V _{GT}	>	1.5	V
Voltage that will not trigger any device				
V _D = V _{DRMmax} ; T _j = 125 ^o C	V _{GD}	<	200	mV
Current that will trigger all devices				
V _D = 6 V; T _j = 25 °C	^I GT	>	50	mΑ
Switching characteristics				
Gate-controlled turn-on time $(t_{gt} = t_d + t_r)$ when switched from $V_D = V_{DRMmax}$ to $I_T = 40$ A;			0	
$I_{GT} = 100 \text{ mA}; dI_{G}/dt = 5 \text{ A}/\mu s; I_{j} = 25 \text{ °C}$	^t gt	typ.	2	μs
Circuit-commutated turn-off time when switched from $I_T = 40 \text{ A to } V_R > 50 \text{ V with}$				
_dI _T /dt = 10A/μs; dV _D /dt = 50 V/μs; T _j = 115 °C	tq	typ.	35	μs



Fig.2a Gate-controlled turn-on time definition.











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Thyristors

BTW38 SERIES



Fig. 5 Minimum gate voltage that will trigger all devices as a function of $\mathsf{T}_{i}.$





Fig. 6 Minimum gate current that will trigger all devices as a function of T_i .

Fig. 7.



Fig. 8 Maximum rate of rise of off-state voltage that will not trigger any device (exponential method) as a function of T_i .

Fig. 9 Maximum rate of rise of off-state voltage that will not trigger any device (exponential method) as a function of applied voltage.













March 1984

THYRISTORS

Also available to BS9341-F083

Dimensions in mm

Glass-passivated silicon thyristors in metal envelopes, intended for use in power control applications in general, and lighting control (in a.c. controller circuit) up to 2,5 kW in particular. A feature of the thyristors is their high surge rating.

The series consistos of reverse polarity types (anode to stud) identified by a suffix R: BTW40-400R to 800R.

QUICK REFERENCE DATA

		BTW40	-400R	600R	8001	F
Repetitive peak voltages	V _{DRM} /V _{RRM}	max.	400	600	800	V
Average on-state current		IT(AV)	m	ax.	20	А
R.M.S. on-state current		IT(RMS	S) m	ax.	32	А
Non-repetitive peak on-state current		ITSM	m	ax.	400	А

MECHANICAL DATA

Fig. 1 TO-48: with metric M6 stud (ϕ 6 mm); e.g. BTW40-400R.

Types with ½ in x 28 UNF stud (ϕ 6,35 mm) are available on request. These are indicated by the suffix U: e.g. BTW40-400RU.



Net mass: 14 g Diameter of clearance hole: max. 6,5 mm Accessories supplied on request: see ACCESSORIES section



Torque on nut: min. 1,7 Nm (17 kg cm) max. 3,5 Nm (35 kg cm) Supplied with the device: 1 nut, 1 lock washer Nut dimensions across the flats; M6: 10 mm ¼ in x 28 UNF: 11,1 mm

RATINGS

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

Anode to cathode

	BTW40-40		BTW40-400R		8001	8
Non-repetitive peak voltages (t \leq 10 ms)	V _{DSM} /V _{RSM}	max.	400	600	800	v
Repetitive peak voltages	V _{DRM} /V _{RRM}	max.	400	600	800	v
Crest working voltages	V _{DWM} /V _{RWM}	max.	300	400	600	v *
Average on-state current (averaged over any 20 ms period) up to T _{mb} = 85 °C		IT(AV)	m	ax.		А
R.M.S. on-state current		T(RM	s) m	ax.	32	Α
Repetitive peak on-state current		TRM	m	ax.	200	Α
Non-repetitive peak on-state current; t = 10 ms; half sine-wave; T _j = 125 ^o C prior to surge;					400	•
With reapplied V RWMmax		'TSM	m	ax.	400	A
If the fusing $(t = 10 \text{ ms})$		l*t	m	ax.	800	A's
Rate of rise of on-state current after triggering with $I_G = 400$ mA to $I_T = 60$ A; $dI_G/dt = 0.4$	A/µs	dl _T /dt	m	ax.	100	A/µs
Gate to cathode						
Reverse peak voltage		V _{RGM}	m	ax.	10	v
Average power dissipation (averaged over any 20 ms period)		P _{G(AV}) m	ax.	1	w
Peak power dissipation		PGM	m	ax.	5	w
Temperatures						
Storage temperature		T _{stg}	-	55 to +	125	°C
Junction temperature		т _ј	m	ax.	125	°C
THERMAL RESISTANCE						
From junction to mounting base		R _{th j-m}	nb =		1	°C/W
From mounting base to heatsink with heatsink compound		R _{th} mt	v.h =		0,2	°C/W
Transient thermal impedance (t = 1 ms)		Z _{th j-m}	ib =		0,1	°C/W

OPERATING NOTE

The terminals should neither be bent not twisted; they should be soldered into the circuit so that there is no strain on them.

During soldering the heat conduction to the junction should be kept to a minimum.

* To ensure thermal stability: R_{th j-a} < 6,5 °C/W (d.c. blocking) or < 13 °C/W (a.c.). For smaller heatsinks T_{j max} should be derated. For a.c. see Fig. 3.

CHARACTERISTICS

Anode to cathode

On-state voltage			
I _T = 50 A; T _j = 25 ^o C	٧T	<	2,1 V *
Rate of rise of off-state voltage that will not trigger any device; exponential method; $V_D = 2/3 V_{DRMmax}$; $T_i = 125 \ ^{o}C$	dV∩/dt	<	100 V/µs
Reverse current	U		
V _R = V _{RWMmax} ; T _j = 125 °C	I _R	<	3 mA
Off-state current			
V _D = V _{DWMmax} ; T _j = 125 °C	۱ _D	<	3 mA
Latching current; T _j = 25 ^o C	۱L	<	150 mA
Holding current; T _j = 25 °C	Ч	<	75 mA
Gate to cathode			
Voltage that will trigger all devices			
V _D = 6 V; T _j = 25 °C	V _{GT}	>	1,5 V
Voltage that will not trigger any device			
V _D = V _{DRMmax} ; T _j = 125 ^o C	V _{GD}	<	200 mV
Current that will trigger all devices			
V _D = 6 V; T _j = 25 °C	IGT	>	75 mA

Switching characteristics

Gate-controlled turn-on time $(t_{qt} = t_d + t_r)$ when
switched from $V_D = V_{DWMmax}$ to $I_T = 100 \text{ A}$
$I_{GT} = 400 \text{ mA}; dI_G/dt = 1 \text{ A}/\mu s; T_i = 25 \text{ °C}$



Gate-controlled turn-on time definition

*Measured under pulse conditions to avoid excessive dissipation.



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$\begin{array}{c} & & & & & \\ 1000 \\ & & & \\ \frac{dV_D}{dt} \\ & & \\ 500 \\ & & \\ 0 \\ & & \\ 0 \\ & & \\ 0 \\ & & \\ \end{array}$

Fig. 4 Maximum rate of rise of off-state voltage that will not trigger any device (exponential method) as a function of T_i .





BTW40 SERIES

Fig. 5 Maximum rate of rise of off-state voltage that will not trigger any device (exponential method) as a function of applied voltage.

Fig. 6.



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THYRISTORS



Glass-passivated silicon thyristors in metal envelopes with high dV_D/dt capabilities. They are intended for use in power control circuits and switching systems where high transients can occur (e.g. phase control in three-phase systems).

The series consists of reverse polarity types (anode to stud) identified by a suffix R: BTW42-600R to 1000R.

QUICK REFERENCE DATA

		BTW42	2—600 R	800R	1000 R	
Repetitive peak voltages	V _{DRM} /V _{RRM}	max.	600	800	1000	v
Average on-state current	IT(AV)	max.		10		А
R.M.S. on-state current	IT(RMS)	max.		16		А
Non-repetitive peak on-state current	ITSM	max.		150		А
Rate of rise of off-state voltage that will not trigger any device	dV _D /dt	<		500		V/µs
On request (see Ordering Note)	dV _D /dt	<		1000		V/µs

MECHANICAL DATA

Fig.1 TO-64: with metric M5 stud (ϕ 5 mm); e.g. BTW42-600R.



Net mass: 7 g Diameter of clearance hole: max. 5.2 mm Accessories supplied on request: see ACCESSORIES section



Dimensions in mm

Supplied with device: 1 nut, 1 lock washer. Torque on nut: min. 0.9 Nm (9 kg cm) max. 1.7 Nm (17 kg cm) Nut dimensions across the flats: 8.0 mm.

Products approved to CECC 50 011-006 available on request.

RATINGS

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

Anode to cathode						
Non-repetitive peak voltages		BTW4	2-600R	800R	1000	R
(t ≤ 10 ms)	V _{DSM} /V _{RSM}	max.	600	800	1000	v
Repetitive peak voltages	V _{DRM} /V _{RRM}	max.	600	800	1000	V
Crest working voltages	V _{DWM} /V _{RWM}	max.	400	600	700	V*
Average on-state current (averaged over any 20 ms period) up to $T_{mb} = 85 ^{\circ}\text{C}$		IT(A	v)	max.	 10	A
R.M.S. on-state current		IT(R	MS)	max.	16	А
Repetitive peak on-state current			1	max.	75	А
Non-repetitive peak on-state current; t = 10 m half sine-wave; T _j = 125 °C prior to surge; with reception Verward	ns;	I			150	•
l^{2} t for fusing (t = 10 ma)		ITSM		max.	110	A A2-
$P_{t} = 10 \text{ ms}$		1-1		max.	112	A-s
with $I_G = 250$ mA to $I_T = 25$ A; $dI_G/dt = 0$	g 0,25 Α/μs	dl _T /c	it	max.	50	A∕µs
Gate to cathode						
Average power dissipation (averaged over any 20 ms period)		PG(A	V)	max.	0,5	w
Peak power dissipation		PGM		max.	5	W
Temperatures						
Storage temperature		T _{sta}		—55 to	+ 125	°C
Junction temperature		тј		max.	125	oC
THERMAL RESISTANCE						
From junction to mounting base		R _{th i}	-mb	=	1,8	K/W
From mounting base to heatsink with heatsink compound		, Rthr	nh-h	=	0,5	к/w
From junction to ambient in free air		R _{th} i	-a	=	45	K/W
Transient thermal impedance (t = 1 ms)		Z _{th j}	-mb	=	0,1	K/W

OPERATING NOTE

The terminals should neither be bent nor twisted; they should be soldered into the circuit so that there is no strain on them.

During soldering the heat conduction to the junction should be kept to a minimum.

ORDERING NOTE

Types with dV_D/dt of 1000 V/ μ s are available on request. Add suffix C to the type number when ordering; e.g. BTW42-600RC.

*To ensure thermal stability: R_{th j-a} < 4 K/W (d.c. blocking) or < 8 K/W (a.c.). For smaller heatsinks T_{j max} should be derated. For a.c. see Fig.3 (BTW38 data).

CHARACTERISTICS

Anode to cathode

On-state voltage (measured under pulse conditions) $I_T = 20 \text{ A}$; $T_j = 25 ^{O}\text{C}$	۷ _T	<	2	v
Rate of rise of off-state voltage that will not trigger any device; expontential method; VD = 2/3 VDRMmax; Ti = 125 °C	dV _D /dt	<	500	V/µs
Reverse current	D.			
V _R = V _{RWMmax} ; T _j = 125 ^o C	۱ _R	<	3	mA
Off-state current				
V _D = V _{DWMmax} ; T _j = 125 ^o C	۱ _D	<	3	mA
Latching current; $T_i = 25 \text{ °C}$	۱	<	150	mA
Holding current; T _j = 25 ^o C	IН	<	75	mA
Gate to cathode				
Voltage that will trigger all devices $V_D = 6 V; T_i = 25 {}^{O}C$	V _{GT}	>	1.5	v
Voltage that will not trigger any device $V_D = V_{DRMmax}$; T _j = 125 °C	V _{GD}	<	200	mV
Current that will trigger all devices				
$V_{D} = 6 V; T_{j} = 25 °C$	I _{GT}	>	50	mA
Switching characteristics				
Gate-controlled turn-on time $(t_{gt} = t_d + t_r)$ when switched from V _D = V _{DRMmax} to I _T = 40 A; I _{GT} = 100 mA; dI _G /dt = 5 A/µs; T _j = 25 °C	^t gt	typ.	2	μs
Circuit-commutated turn-off time when switched from I_T = 40 A to V_R $>$ 50 V with				
_dI _T /dt = 10A/μs; dV _D /dt = 50 V/μs; T _j = 115 ^o C	ta	typ.	35	μs

 $-dI_T/dt = 10A/\mu s; dV_D/dt = 50 V/\mu s; T_j = 115$ °C



Fig.2a Gate-controlled turn-on time definition.









Fig.3 Maximum rate of rise of off-state voltage that will not trigger any device (exponential method) as a function of T_i .



Fig.4 Maximum rate of rise of off-state voltage that will not trigger any device (exponential method) as a function of applied voltage.

FOR FURTHER DETAILS REFER TO BTW38 DATA.

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THYRISTORS



Dimensions in mm

Glass-passivated silicon thyristors in metal envelopes, intended for power control applications.

The series consistos of reverse polarity types (anode to stud) identified by a suffix R: BTW45-400R to 1200R.

QUICK REFERENCE DATA

	BTW4	5-400R	600R	800R	1000R	1200R
Repetitive peak voltages VDRM ⁼ VRRM	max.	400	600	800	1000	1200 V
Average on-state current			I	T(AV)	max.	16 A
R.M.S. on-state current			I	T(RMS)	max.	25 A
Non-repetitive peak on-state current			1	тѕм	max.	300 A
Rate of rise of off-state voltage that will not trigger any device			c	dV _D /dt	<	200 V/µs
On request (see Ordering Note)				dV _D /dt	<	1000 V/μs

MECHANICAL DATA

Fig. 1 TO-48: with metric M6 stud (ϕ 6 mm); e.g. BTW45-400R.

Types with $\frac{1}{4}$ in x 28 UNF stud (ϕ 6,35 mm) are available on request. These are indicated by the suffix U: BTW45-400RU. 4.2

ŧ. 7.6 max



Net mass: 14 g Diameter of clearance hole: max. 6,5 mm Accessories supplied on request: see ACCESSORIES section



Torque on nut: min. 1,7 Nm (17 kg cm) max. 3,5 Nm (35 kg cm) Supplied with the device: 1 nut, 1 lock washer Nut dimensions across the flats; M6: 10 mm ¼ in x 28 UNF: 11,1 mm

Products approved to CECC 50 011-002, available on request

February 1984

RATINGS

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

Anode to cathode								
		BTW4	5-400R	600R	800R	1000R	1200	R
Non-repetitive peak voltages (t \leq 10 ms)	V _{DSM} /V _{RSM}	max.	400	600	800	1000	1200	- V
Repetitive peak voltages	V _{DRM} /V _{RRM}	max.	400	600	800	1000	1200	v
Crest working voltages	V _{DWM} /V _{RWM}	max.	300	400	600	700	800	۷*
Average on-state current (average any 20 ms period) up to ${\sf T}_{mb}$	ed over = 85 ^o C			^ا T(4V)	max.	16	A
R.M.S. on-state current				T(I	RMS)	max.	25	А
Repetitive peak on-state current				TR	M	max.	200	А
Non-repetitive peak on-state curr half sine-wave; T _j = 125 °C pr	rent; t = 10 ms; ior to surge;							
with reapplied VRWM max				ITS	М	max.	300	A
1^2 t for fusing (t = 10 ms)				l² t		max.	450	A ² s
Rate of rise of on-state current a with $I_G = 400 \text{ mA}$ to $I_T = 60$	fter triggering A; dI _G /dt = 0,4 A	A∕µs		dIT	/dt	max.	100	A/µs
Gate to cathode								
Reverse peak voltage				VR	ЗM	max.	10	V
Average power dissipation (avera any 20 ms period)	ged over			PG(AV)	max.	1	w
Peak power dissipation				PGN	Λ	max.	5	W
Temperatures								
Storage temperature				Tsto	1	—55 to	+ 125	oC
Junction temperature				Тj	,	max.	125	οС
THERMAL RESISTANCE								
From junction to mounting base				R _{th}	i-mb	=	1,33	°C/W
From mounting base to heatsink	; with heatsink co	ompoun	d	R _{th}	mb-h	=	0,2	°C/W
Transient thermal impedance(t =	• 1 ms)			Z _{th}	j-mb	=	0,1	oC/M

OPERATING NOTE

The terminals should neither be bent nor twisted; they should be soldered into the circuit so that there is no strain on them.

During soldering the heat conduction to the junction should be kept to a minimum.

* To ensure thermal stability: $\rm R_{th\,j-a}\,{<}\,6,5$ °C/W (d.c. blocking) or ${<}\,13$ °C/W (a.c.). For smaller heatsinks T $_{j\,max}$ should be derated. For a.c. see Fig. 2.

Thyristors

BTW45 SERIES

CHARACTERISTICS

Anode to cathode			
On-state voltage $I_T = 50$ A; $T_j = 25$ °C	VT	<	2 V*
Rate of rise of off-state voltage that will not trigger any device; exponential method; $V_D = 2/3 V_{DRM max}$; $T_j = 125 ^{O}\text{C}$	dV _D /dt	<	200 V/µs
Reverse current			
V _R = V _{RWM max} ; T _j = 125 °C	I _R	<	3 mA
Off-state current			
V _D = V _{DWM max} ; T _j = 125 °C	۱ _D	<	3 mA
Latching current; T _j = 25 ^o C	ار	<	150 mA
Holding current; $T_j = 25 \text{ °C}$	ΙΗ	<	75 mA
Gate to cathode			
Voltage that will trigger all devices $V_D = 6 V; T_j = 25 ^{O}C$	VGT	>	1,5 V
Voltage that will not trigger any device			
V _D = V _{DRM max} ; T _j = 125 ^o C	V _{GD}	<	200 mV
Current that will trigger all devices			
V _D = 6 V; T _j = 25 °C	IGT	>	75 mA

Switching characteristics

Gate-controlled turn-on time $(t_{gt} = t_d + t_r)$ when switched from V_D = V_{DWM} max to I_T = 100 A; I_{GT} = 400 mA; dI_G/dt = 1 A/µs; T_j = 25 °C



Gate-controlled turn-on time definition.

t_{gt} t_r < < 1 μs 0,5 μs

ORDERING NOTE

Types with dV_D/dt of 1000 V/ μ s are available on request. Add suffix C to the type number when ordering; e.g. BTW45-400RC.

*Measured under pulse conditions to avoid excessive dissipation.



Thyristors









Fig. 5 Maximum rate of rise of off-state voltage that will not trigger any device (exponential method) as a function of applied voltage.

Fig. 6.

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BTW45 SERIES



April 1978

FAST TURN-OFF THYRISTORS

Asymmetrical thyristors (ASCR) in TO-238AA envelopes with electrically isolated metal baseplates, suitable for use in high-frequency inverters, power supplies, motor control systems etc. For reverse blocking operation use with a series diode, for reverse conducting operation use with an anti-parallel diode.

QUICK REFERENCE DATA

		BTW62	2—600R	800R	1000R	
Repetitive peak off-state voltage	VDRM	max.	600	800	1000	v
Average on-state current	IT(AV)	max.		18		А
Repetitive peak on-state current	^I TRM	max.		175		А
Circuit-commutated turn-off time suffix K suffix N	tq tq	< <		4 6		μs μs

MECHANICAL DATA

Fig.1 TO-238AA

Dimensions in mm



Pin 1 = gate (AMP 187 series)

- 2 = cathode (AMP 250 series)
- 3 = anode (AMP 250 series)
- Baseplate is electrically isolated.

RATINGS

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

Anode to cathode		BTW62	-600R	800R	1000R	
Transient off-state voltage	V _{DSM}	max.	800	1000	1000	V
Repetitive peak off-state voltage	VDRM	max.	600	800	1000	V
Continuous off-state voltage	VD	max.	500	650	700	V
Transient reverse voltage; t $_{\rm p}$ $<$ 5 μ s	V _{RSM}	max.		15		V
Average on-state current (averaged over any 20 ms period) up to $T_{res} = 85.90$		may		18		٨
B M S operate current		max.		28		Δ
Repetitive peak on-state current; $t_p = 50 \ \mu s; \ \delta = 0.05$		max.		175		A
Non-repetitive peak on-state current $T_j = 125 \ ^{O}C$ prior to surge;				200		
t = 10 ms; half sine-wave	TSM	max.		200		A
I ² t for fusing; t = 10 ms	l² t	max.		200		A ² s
Rate of rise of on-state current after triggering with $I_G = 1.25 \text{ A}$; $I_T = 80 \text{ A}$	dl _T /dt	max.		1000		A/µs
Gate to cathode						
Average power dissipation (averaged over any 20 ms period)	P _G (AV)	max.		1		w
Peak power dissipation; t = 10 μ s	PGM	max.		10		w
Temperatures						
Storage temperature	T _{stg}		-40 t	o +125		oC
Operating junction temperature	тј	max.		125		°C
ISOLATION*						
R.M.S. isolation voltage	V _{isol}	min.		2500		v
THERMAL RESISTANCE						
From junction to mounting base	R _{th} j-mb	=		1.1		K/W
From mounting base to heatsink with heatsink compound	R _{th mb-h}	=		0.2		K/W

*From baseplate to all three terminals connected together.

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CHARACTERISTICS

Anode to cathode				
On-state voltage $I_T = 50 \text{ A}; T_j = 25 ^{\text{O}}\text{C}$	ν _T	<	2.6	V*
Off-state current				
V _D = V _{Dmax} ; T _j = 125 °C	۱D	<	6.0	mA
Holding current; T _j = 25 ^o C	Ч	<	400	mA
Gate to cathode				
Voltage that will trigger all devices V_D = 12 V; T _j = 25 °C	V _{GT}	>	2.0	v
Current that will trigger all devices $V_D = 12 \text{ V}$; $T_j = 25 \text{ °C}$	^I GТ	>	250	mA
Switching characteristics (see Fig.2)				
Circuit commutated turn-off time $dV_D/dt = 500 V/\mu s$ (linear to V_{DRMmax}); $R_{GK} = 10 \Omega$; $V_G = 0$; $T_j = 125 $ °C; when switched from I _T = 100 A; $t_p = 150 \ \mu s$				
-dI _T /dt = 50 A/μs suffix K suffix N	^t q ^t q	< <	6 9	μs μs
-dI _T /dt = 10 A/μs suffix K suffix N	tq ta	<	4 6	μs μs



Fig.2 Circuit-commutated turn-off time definition.

*Measured under pulse conditions to avoid excessive dissipation.



Fig.3 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.

a = form factor = $\frac{|T(RMS)|}{|T(AV)|}$





Fig.4 Minimum gate voltage that will trigger all devices plotted against junction temperature.

Fig.5 Minimum gate current that will trigger all devices plotted against junction temperature.





Fig.7 Maximum total energy loss per pulse when switching a half-sinusoidal pulse from 600 V.

Device power (W) = Energy per pulse (J) x No. of pulses per second. For pulse widths $> 100 \ \mu s$ use Fig.3.



Fig.8 — $T_j = 25 \text{ °C};$ — $T_j = 125 \text{ °C};$ $t_p = 200 \ \mu s.$



Fig.9 Variation of t_q with T_j ; $-dI_T/dt = 50 \text{ A/}\mu$ s; $dV_D/dt = 500 \text{ V/}\mu$ s (linear to V_{DRMmax}); $I_T = 100 \text{ A}$; $t_p = 150 \mu$ s; $R_{GK} = 10 \Omega$; $V_G = 0$; maximum values.

Fig.10 Variation of t_q with negative bias; $-dI_T/dt = 50 \text{ A/}\mu$; $dV_D/dt = 500 \text{ V/}\mu$ s (linear to V_{DRMmax}); $I_T = 100 \text{ A}$; $t_p = 150 \mu$ s; $T_j = 125 \text{ }^{OC}$; maximum values.



FAST TURN-OFF THYRISTORS WITH ANTI-PARALLEL DIODES

Asymmetrical fast turn-off thyristors (ASCR) with anti-parallel-connected fast, soft-recovery diodes in TO-238AA envelopes. They are suitable for use in high-frequency inverters, power supplies and motor control systems requiring a parallel-connected flywheel or efficiency diode. The baseplate is electrically isolated.

QUICK REFERENCE DATA

Thyristor		BTW62D-600R		800R	1000R	
Repetitive peak off-state voltage	V _{DRM}	max.	600	800	1000	v
Average on-state current	IT(AV)	max.		18		А
Repetitive peak on-state current	^I TRM	max.		175		А
Circuit-commutated turn-off time suffix K suffix N	t _q t _q	< <		4 6		μs μs
Diode						
Average forward current	^I F(AV)	max.		8		А
Reverse recovery time	t _{rr}	<		600		ns

MECHANICAL DATA

Fig.1 TO-238AA



Pin 1 = gate (AMP187 series)

2 = k (thyristor), a(diode) ; (AMP250 series)

3 = a(thyristor), k(diode) ; (AMP250 series)

Baseplate is electrically isolated.

Dimensions in mm

RATINGS

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

THYRISTOR

Anode to cathode		BTW62D-	-600R	800R	1000R	
Transient off-state voltage	V _{DSM}	max.	800	1000	1000	v
Repetitive peak off-state voltage	V _{DRM}	max.	600	800	1000	V
Continuous off-state voltage	VD	max.	500	650	700	v
Average on-state current (averaged over any 20 ms period) up to T _{mb} = 85 ^o C	^I T(AV)	max.		18		A
R.M.S. on-state current	IT(RMS)	max.		28		А
Repetitive peak on-state current; $t_p = 50 \ \mu s; \delta = 0.05$	ITRM	max.		175		A
Non-repetitive peak on-state current $T_i = 125$ °C prior to surge;						
t = 10 ms; half sine-wave	ITSM	max.		200		A
I ² t for fusing; t = 10 ms	l² t	max.		200		A² s
Rate of rise of on-state current after triggering with I _G = 1.25 A; I _T = 80 A	dl _T /dt	max.		1000		A/µs
Gate to cathode						
Average power dissipation (averaged over any 20 ms period)	P _G (AV)	max.		1		w
Peak power dissipation; $t = 10 \mu s$	P _{GM}	max.		10		W
DIODE						
Average forward current (averaged over any 20 ms period) up to $T_{mb} = 85 ^{O}\text{C}$	I _{F(AV)}	max.		8		А
Non-repetitive peak on-state current t = 10 ms; half sine-wave $T_j = 125 ^{O}C$ prior to surge	I _{FSM}	max.		60		A
Temperatures						
Storage temperature	T _{stq}		-40 to	+125		°C
Operating junction temperature	т _ј	max.		125		°C
ISOLATION*						
R.M.S. isolation voltage	v _{isol}	min.		2500		v

*From baseplate to all three terminals connected together.

THERMAL RESISTANCE

Thyristor

From junction to mounting base	R _{th} j-mb	=	1.1	K/W
From mounting base to heatsink, with heatsink compound	Rth mb-h	=	0.2	K/W
Diode				
From junction to mounting base	R _{th} j-mb	=	2.8	K/W
From mounting base to heatsink, with heatsink compound	R _{th mb-h}	=	0.2	K/W



Fig.2 Equivalent thermal network.

THYRISTOR CHARACTERISTICS

Anode to cathode On-state voltage $I_T = 50 \text{ A}; T_i = 25 \text{ }^{0}\text{C}$ Vт < 2.6 V* Off-state current $V_{D} = V_{Dmax}; T_{i} = 125 {}^{O}C$ 6.0 In < mΑ Holding current; T_i = 25 ^oC 400 < Iн mA Gate to cathode Voltage that will trigger all devices $V_{D} = 12 V; T_{i} = 25 °C$ VGT > 2.0 v Current that will trigger all devices $V_{D} = 12 V; T_{i} = 25 °C$ 250 > mΑ IGT Switching characteristics (see Fig.6) Circuit-commutated turn-off time $dV_D/dt = 500 V/\mu s$ (linear to V_{DRMmax}); $R_{GK} = 10 \ \Omega$; $V_G = 0$; $T_j = 125 \ ^{o}C$; when switched from $I_T = 100 \ A$; $t_p = 150 \ \mu s$ $-dI_T/dt = 50 A/\mu s$ suffix K tq < 6 μs < suffix N 9 tq μs $-dI_T/dt = 10 A/\mu s$

suffix K suffix N



<

<

ťa

4

6

μs

μs



*Measured under pulse conditions to avoid excessive dissipation.

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Fast turn-off thyristors

BTW62D SERIES

THYRISTOR



Fig.4 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.

a = form factor = $\frac{I_T(RMS)}{I_T(AV)}$
THYRISTOR



(linear to V_{DRMmax}); $I_T = 100 \text{ A}$; $t_p = 150 \,\mu\text{s}$; $R_{GK} = 10 \,\Omega$; $V_G = 0$; maximum values.



Fig.5 —
$$T_j = 25 {}^{o}C; - - T_j = 125 {}^{o}C;$$

 $t_p = 200 \ \mu s.$



Fast turn-off thyristors

BTW62D SERIES

THYRISTOR



Fig.7 Maximum total energy loss per pulse when switching a halfsinusoidal pulse from 600 V. Device power (W) = Energy per pulse (J) x No. of pulses per second.

For pulse widths $> 100 \,\mu s$ use Fig.4.



Fig.8 Minimum gate voltage that will trigger all devices plotted against junction temperature.

Fig.9 Minimum gate current that will trigger all devices plotted against junction temperature.



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DIODE CHARACTERISTICS

Forward voltage				
$I_{F} = 10 \text{ A}; T_{j} = 25 ^{\circ}\text{C}$	V _F	< 1	2.0	V*
Reverse recovery when switched from				
$I_F = 2 A$ to $V_R \ge 30 V$ with				
$-dI_{E}/dt = 20 \text{ A}/\mu \text{s}; T_{i} = 25 ^{O}\text{C}$				
recovered charge	Q _c	<	2.0	μC
recovery time	trr	<	0.6	μs
Forward recovery when switched to				

t_{fr}

<

2.0

μs

 $I_F = 5$ A with $t_r = 0.1 \,\mu$ s; $T_j = 25 \,^{o}C$ recovery time



Fig.11 Definition of t_{rr} and Q_s .

Fig.12 Definition of tfr.

*Measured under pulse conditions to avoid excessive dissipation.

DIODE



Fig.13 The right hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.

a = form factor = $\frac{I_T(RMS)}{I_T(AV)}$

Fast turn-off thyristors

BTW62D SERIES



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FAST TURN-OFF THYRISTORS



Glass-passivated, asymmetrical, fast turn-off, forward blocking thyristors (ASCR) in TO-48 envelopes, suitable for operation in fast power inverters. For reverse-blocking operation use with a series diode, for reverse-conducting operation use with an anti-parallel diode.

QUICK REFERENCE DATA

		BTW63-600R		800R	1000R	
Repetitive peak off-state voltage	V _{DRM}	max.	600	800	1000	v
Average on-state current	IT(AV)	max.		25		А
Repetitive peak on-state current	TRM	max.		250		А
Circuit-commutated turn-off time						
suffix K	tq	<		4		μs
suffix N	tq	<		6		μs 🖛

MECHANICAL DATA

Fig.1 TO-48



Dimensions in mm



Net Mass: 14 g Diameter of clearance hole: max. 6.5 mm Accessories supplied on request: 56264a (mica washer); 56264b (insulating bush).

Torque on nut: min. 1.7 Nm (17 kg cm) max. 3.5 Nm (35 kg cm) Nut dimensions across the flats: 11.1 mm

Supplied with device: 1 nut, 1 lock washer.

Products approved to CECC 50 011-010 available on request.

BTW63 SERIES

RATINGS

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

Anode to cathode		BTW63	600R	800R	1000R	
Transient off-state voltage	V _{DSM}	max.	800	1000	1000	v
Repetitive peak off-state voltage	VDRM	max.	600	800	1000	v
Continuous off-state voltage	VD	max.	500	650	700	V
Transient reverse voltage (t $_{ m p}$ \leqslant 5 μ s)		VRSN	vi	max.	15	v
Average on-state current averaged over any 20 ms period ;						
• up to $T_{mb} = 85 {}^{o}C$		IT(A)	V)	max.	25	Α
R.M.S. on-state current		IT(BI	MS)	max.	40	А
Repetitive peak on-state current; $t_p = 50 \mu$	ιs; δ = 0.05	ITRM	1	max.	250	А
Non-repetitive peak on-state current						
t = 10 ms; half sine-wave		ITSM		max.	370	А
I^{2} t for fusing; t = 10 ms		l ² t		max.	700	A² s
Rate of rise of on-state current after trigger with I_G = 1.25 A; I_T = 80 A	ring	dIT/d	lt	max.	1000	A/µs
Gate to cathode						
Average power dissipation (averaged over any 20 ms period)		P _G (A	V)	max.	1	W
Peak power dissipation; t = 10 μ s		PGM		max.	10	W
Temperatures						
Storage temperature		T _{stg}		40 to	+125	°C
Operating junction temperature		Тј		max.	125	oC
THERMAL RESISTANCE						
 From junction to mounting base 		R _{th j}	-mb	=	0.8	K/W
From mounting base to heatsink						
with heatsink compound		R _{th} r	nb-h	=	0.2	K/W

OPERATING NOTE

The terminals should be neither bent nor twisted; they should be soldered into the circuit so that there is no strain on them.

During soldering the heat conduction to the junction should be kept to a minimum.

CHAR/	ACTER	STICS
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Anode to cathode				
On-state voltage				
I _T = 50 A; T _j = 25 °C	VT	<	2.6	۷*
Off-state current				
V _D = V _{Dmax} ; T _j = 125 °C	D	<	6.0	mA
Holding current; T _j = 25 °C	ЧН	<	400	mA
Gate to cathode				
Voltage that will trigger all devices				
V _D = 12 V; T _j = 25 °C	VGT	>	2.0	V
Current that will trigger all devices				
V _D = 12 V; T _j = 25 °C	IGT	>	250	mA
Switching characteristics (see Fig. 2)				-
Circuit commutated turn-off time				
$dV_D/dt = 500 V/\mu s$ (linear to V_{DRMmax});				
$R_{GK} = 10 \Omega$; $V_G = 0$; $T_j = 125 {}^{o}C$; when switched from $I_T = 100 A$; $t_p = 150 \mu$ s				
$-dI_T/dt = 50 A/\mu s$				
suffix K	ta	<	6	μs
suffix N	tq	<	9	μs
$-dI_T/dt = 10 A/\mu s$				
suffix K	ta	<	4	μs
suffix N	tq	<	6	μs



Fig.2 Circuit-commutated turn-off time definition.

*Measured under pulse conditions to avoid excessive dissipation.

BTW63 SERIES



Fig.3 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.



Fig.4 Maximum allowable peak on-state current versus pulse width; T_{mb} = 85 °C.

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Fast turn-off thyristors

BTW63 SERIES



Fig.6b Variation of t_q with negative bias; $-dI_T/dt = 50 A/\mu s; dV_D/dt = 500 V/\mu s$ (linear to V_{DRMmax}); $I_T = 100 A; t_p = 150 \mu s;$ $T_j = 125 \ ^{OC}$; maximum values.

Fig.5 —
$$T_j = 25 \text{ °C}; - - T_j = 125 \text{ °C};$$

 $t_p = 200 \ \mu s.$



Fig.6a Variation of t_q with T_j; $-dI_T/dt = 50 A/\mu s; dV_D/dt = 500 V/\mu s$ (linear to V_{DRMmax}); $I_T = 100 A; t_p = 150 \mu s;$ $R_{GK} = 10 \Omega; V_G = 0;$ maximum values.

BTW63 SERIES





Device power (W) = Energy per pulse (J) x No. of pulses per second. For pulse widths $> 100 \ \mu s$ use Fig.3.

Fast turn-off thyristors

v_{GT} (v) -50





Fig.9 Minimum gate current that will trigger all devices plotted against junction temperature.

BTW63 SERIES



THYRISTORS



Glass-passivated silicon thyristors in metal envelopes, intended for use in power control circuits (e.g. light and motor control) and power switching systems.

The series consistos of reverse polarity types (anode to stud) identified by a suffix R: BTY79-400R to 1000R.

QUICK REFERENCE DATA

	BTY79-400R		BTY79-400R 50		500R	600R	800 R	1000R	
Repetitive peak voltages V_{DRM}/V_{RRM}	max.	400	500	600	800	1000	v		
Average on-state current				IT(AV)	max.	10	А		
R.M.S. on-state current				IT(RMS	;) max.	16	А		
Non-repetitive peak on-state current				ITSM	max.	150	А		

MECHANICAL DATA

Fig. 1 TO-64: with 10-32 UNF stud (\$\phi\$ 4,83 mm).

Dimensions in mm





Net mass: 7 g Diameter of clearance hole: max. 5,2 mm Accessories supplied on request: see ACCESSORIES section

Supplied with device: 1 nut, 1 lock washer. Nut dimensions: across the flats: 9,5 mm. Products approved to CECC 50 011-006 available on request. Torque on nut: min. 0,9 Nm (9 kg cm) max. 1,7 Nm (17 kg cm)

BTY79 SERIES

RATINGS

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

Anode to cathode	E	3TY79-	400R	500R	600R	800R	1000R	
Non-repetitive peak off-state voltage $(t \le 10 \text{ ms})$	ge ⊸ VDSM**	max.	500	1100	1100	1100	1100	v
Non-repetitive peak reverse voltage $(t \leq 5 \text{ ms})$	VRSM	max.	500	600	720	960	1100	v
Repetitive peak voltages	VDRM/VRRM	max.	400	500	600	800	1000	v
Crest working voltages	V _{DWM} /V _{RWM}	max.	400	500	600	800	1000	۷*
Average on-state current (averaged any 20 ms period) up to T _{mb} =	over 85 ^o C			י ד	(AV)	max.	 . 10	А
R.M.S. on-state current				١T	(RMS)	max.	. 16	Α
Repetitive peak on-state current				١T	RM	max.	. 75	Α
Non-repetitive peak on-state currer half sine-wave; T _j = 125 °C prior with reapplied V pwmpay	nt; t = 10 ms; r to surge;			١т	SW	max.	. 150	А
l^2 t for fusing (t = 10 ms)				12	5 IVI	may	112	Δ2 ε
Rate of rise of on-state current after triggering with $I_G = 150 \text{ mA to } I_T = 30 \text{ A}; dI_G/dt = 0,25 \text{ A}/\mu s$				di	T/dt	max	. 50	Α/μs
Gate to cathode								
Average power dissipation (average	d over any 20 ms	period)		PC	G(AV)	max.	. 0,5	W
Peak power dissipation				PC	θM	max.	. 5	W
Temperatures								
Storage temperature				тs	tg	–55 t	o +125	°C
Junction temperature				т _ј		max	. 125	oC
THERMAL RESISTANCE								
From junction to mounting base				R ₁	th j-mb	=	1,8	°C/W
From mounting base to heatsink with heatsink compound				R	th mb-h	=	0,5	°C/W
From junction to ambient in free a	ir			R	th j-a	=	45	°C/W
Transient thermal impedance (t = '	l ms)			Zt	h j-mb	=	0,1	°C/W

 * To ensure thermal stability: R_{th j-a} < 4 °C/W (d.c. blocking) or < 8 °C/W (a.c.). For smaller heatsinks T_{j max} should be derated. For a.c. see Fig. 3.
 ** Although not recommended, higher off-state voltages may be applied without damage, but the thermal stability is a stability of the stability

** Although not recommended, higher off-state voltages may be applied without damage, but the thyristor may switch into the on-state. The rate of rise of on-state current should not exceed 100 A/μs.

Thyristors

BTY79 SERIES

CHARACTERISTICS

Anode to cathode

On-state voltage (measured under pulse conditions) $I_T = 20 \text{ A}$; $T_j = 25 ^{\text{O}}\text{C}$	VT	<	2	v
Rate of rise of off-state voltage that will not trigger any device; exponential method; $V_D = 2/3 V_{DRMmax}$; $T_j = 125 {}^{O}C$	dV _D /dt	<	200	V/µs
Reverse current				
V _R = V _{RWMmax} ; T _j = 125 ^o C	^I R	<	3	mΑ
Off-state current				
V _D = V _{DWMmax} ; T _j = 125 ^o C	۱D	<	3	mΑ
Latching current; $T_i = 25 ^{O}\text{C}$	۱L	<	150	mA
Holding current; $T_j = 25 \text{ °C}$	Η	<	75	mA
Gate to cathode				
Voltage that will trigger all devices $V_D = 6 V; T_j = 25 \text{ °C}$	V _{GT}	>	1.5	v
Voltage that will not trigger any device				
V _D = V _{DRMmax} ; T _j = 125 ^o C	V _{GD}	<	200	mV
Current that will trigger all devices $V_D = 6 V$; $T_i = 25 \ ^{o}C$	^I GT	>	30	mA
On request (see Ordering Note)	IGT	>	20	mA
Switching characteristics				
Gate-controlled turn-on time $(t_{gt} = t_d + t_r)$ when switched from VD = VDBMmax to $ t = 40 A$:				

 $I_{GT} = 100 \text{ mA}; dI_G/dt = 5 \text{ A}/\mu s; T_j = 25 \text{ °C}$

Circuit-commutated turn-off time when switched from I_T = 40 A to V_R > 50 V with $-dI_T/dt$ = 10 A/µs; dV_D/dt = 50 V/µs; T_j = 115,°C



Fig.2a Gate-controlled turn-on time definition.



typ.

typ.

tat

tα

2

35

μs

μs



OPERATING NOTE

The terminals should neither be bent nor twisted; they should be soldered into the circuit so that there is no strain on them.

During soldering the heat conduction to the junction should be kept to a minimum.

ORDERING NOTE

Types with low gate trigger current, $I_{GT} > 20$ mA, are available on request. Add suffix A to the type number when ordering: e.g. BTY79A-400R.



(1) T_{mb} -scale is for comparison purposes only and is correct only for $R_{th mb}$ -a $\leq 6 \text{ °C/W}$.

Thyristors

BTY79 SERIES



Fig. 4.



April 1978

BTY79 SERIES





Fig. 6 Minimum gate voltage that will trigger all devices as a function of ${\sf T}_{\rm j}.$

Fig. 7 Minimum gate current that will trigger all devices as a function of ${\rm T}_{\rm j}.$

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Thyristors

7Z67968.2 7Z67967.3 1500 1500 T_i = 125 °C dV dV_D dt dt (V/µs) (V/µs) 1000 1000 500 500 0 L 0 0∟ 25 V_{DM} V_{DRMmax} (%) 75 125 50 т_ј (°С) 100

Fig. 8 Maximum rate of rise of off-state voltage that will not trigger any device (exponential method) as a function of T_i .

Fig. 9 Maximum rate of rise of off-state voltage that will not trigger any device (exponential method) as a function of applied voltage.

BTY79 SERIES



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Thyristors

BTY79 SERIES





THYRISTORS

Glass-passivated silicon thyristors in metal envelopes, intended for power control and power switching applications.

The series consists of reverse polarity types (anode to stud) identified by a suffix R: BTY91-400R to 800R.

QUICK REFERENCE DATA

		BTY9	1-400R	500R	600R	800	R
Repetitive peak voltages	V _{DRM} /V _{RRM}	max.	400	500	600	800	v
Average on-state current		ŀ	T(AV)	m	ax.	16	А
R.M.S. on-state current		ŀ	T(RMS)	m	ax.	25	Α
Non-repetitive peak on-state current		ŀ	TSM	m	ax.	200	Α

7.6 max

MECHANICAL DATA

Fig. 1 TO-48: with ¼ in x 28 UNF stud (\$\$\phi 6,35 mm)\$.

3.1 2.9min min 2.0 12.4 min max 1/4 in x 28UNF a 1 6.35 max Ŧ 1.9 1.6 2.2 12.8 maxmax 22.2 max 11.5 30.3 max 10.72



Dimensions in mm

Torque on nut: min. 1,7 Nm (17 kg cm) max. 3,5 Nm (35 kg cm) Supplied with the device: 1 nut, 1 lock washer Nut dimensions across the flats: 11,1 mm

Net mass: 14 g Diameter of clearance hole: max. 6,5 mm Accessories supplied on request: see ACCESSORIES section

May 1984

BTY91 SERIES

RATINGS

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

Anode to cathode			BTY91	-400R	500R	600R	8001	2
Non-repetitive peak off-state voltage (t \leq 1	0 ms)	VDSM	max.	500	850	850	850	v
Non-repetitive peak reverse voltage (t \leq 5 m	ms)	V _{RSM}	max.	500	600	720	960	v
Repetitive peak voltages	VDRM	VRRM	max.	400	500	600	800	v
Crest working voltages	VDWN	I∕VRWM	max.	400	500	600	800	V *
Average on-state current (averaged over any 20 ms period) up to T_{mb} = 77 °C at T_{mb} = 85 °C			רו רו	-(AV) -(AV)	m	ax. ax.	16 14	A A
R.M.S. on-state current			רו	(RMS)	m	ax.	25	Α
Repetitive peak on-state current			۲I	RM	m	ax.	200	Α
Non-repetitive peak on-state current; t = 10 half sine-wave; $T_j = 125$ °C prior to surg with reapplied VRWMmax	0 ms; je;		۲I	SM	m	ax.	200	A
$I^{2}t$ for fusing (t = 10 ms)			1 ²	t	m	ax.	200	A ² s
Rate of rise of on-state current after trigger with I_G = 200 mA to I_T = 50 A	ring		dl	T/dt	m	ax.	20	A∕µs
Gate to cathode								
Reverse peak voltage			v	RGM	m	ax.	5	v
Average power dissipation (averaged over any 20 ms period)			P	G(AV)	m	ax.	0,5	w
Peak power dissipation			P	GM	m	ax.	5	w
Temperatures								
Storage temperature			Т,	stg	_!	55 to +	- 125	°C
Junction temperature			T	i	m	ax.	125	oC
THERMAL RESISTANCE								
From junction to mounting base			R	th j-mb	, =		1,6	°C/W
From mounting base to heatsink with heatsink compound			R	th mb-l	n =		0,2	°C/W
Transient thermal impedance (t = 1 ms)			Z	th j-mb	. =		0,09	°C/W

OPERATING NOTE

The terminals should neither be bent nor twisted; they should be soldered into the circuit so that there is no strain on them.

During soldering the heat conduction to the junction should be kept to a minimum.

* To ensure thermal stability: $R_{th j-a} < 4,5 \text{ °C/W}$ (d.c. blocking) or < 9 °C/W (a.c.). For smaller heatsinks $T_{j max}$ should be derated. For a.c. see Fig. 3.

Thyristors

BTY91 SERIES

CHARACTERISTICS

On-state voltage $I_T = 50 \text{ A}; T_i = 25 ^{\circ}\text{C}$	Vт	<	2 V *
Rate of rise of off-state voltage that will not trigger any device; exponential method; $V_D = 2/3 V_{DRMmax}$; $T_j = 125 \text{ °C}$	dV _D /dt	<	200 V/µs
Reverse current			
V _R = V _{RWMmax} ; T _j = 125 °C	I _R	<	3 mA
Off-state current			
V _D = V _{DWMmax} ; T _j = 125 °C	۱ _D	<	3 mA
Latching current; T _j = 25 ^o C	۱ _L	typ.	50 mA
Holding current; T _j = 25 ^o C	Ч	typ.	25 mA
Gate to cathode			
Voltage that will trigger all devices			
V _D = 6 V; T _j = 25 °C	V _{GT}	>	3 V
Voltage that will not trigger any device			
V _D = V _{DRMmax} ; T _j = 125 ^o C	V _{GD}	<	200 mV
Current that will trigger all devices			
V _D = 6 V; T _j = 25 °C	I _{GT}	>	40 mA

Switching characteristics

Gate-controlled turn on time ($t_{gt} = t_d + t_r$) when switched from V_D = 400 V to I_T = 10 A; I_{GT} = 200 mA; T_j = 25 °C

typ. 2 μs

t_{gt}



Fig. 2 Gate-controlled turn-on time definitions.

* Measured under pulse conditions to avoid excessive dissipation.

BTY91 SERIES



Fig. 3.



Fig. 4.

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Fig. 5.



Fig. 6.

BTY91 SERIES



Fig. 7.



Fig. 8.



Fig. 9.

BTY91 SERIES



Fig. 10.





TRIACS



TRIACS

Glass-passivated 4 ampere triacs intended for use in applications requiring high bidirectional transient and blocking voltage capability, and high thermal cycling performance with very low thermal resistances, e.g. a.c. power control applications such as lighting, industrial and domestic heating, motor control and switching systems.

QUICK REFERENCE DATA

			BT136-500	600	800	
Repetitive peak off-state voltage	V _{DRM}	max.	500	600	800	V
R.M.S. on-state current	^I T(RMS)	max.		4		А
Non-repetitive peak on-state current	TSM	max.		25		А

MECHANICAL DATA

Fig.1 TO-220AB

Dimensions in mm



Net mass: 2 g

Note: The exposed metal mounting base is directly connected to terminal T₂.

Supplied on request: accessories (see data sheets Mounting instructions and accessories for TO-220 envelopes).
RATINGS

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

		BT136	-500	600	800	
Voltages (in either direction)						
Non-repetitive peak off-state voltage (t \leq 10 ms)	V _{DSM}	max.	500*	600*	800	v
Repetitive peak off-state voltage ($\delta \leqslant 0.01$)	VDRM	max.	500	600	800	v
Crest working off-state voltage	VDWM	max.	400	400	400	V
Currents (in either direction)			<u> </u>			
B M S on state current (conduction angle 2600)						
up to $T_{mb} = 102 ^{\circ}C$	IT(RMS)	max.		4		А
Repetitive peak on-state current	ITRM	max.		25		А
Non-repetitive peak on-state current; T _i = 120 ^o C prior to surge;						
t = 20 ms; full sine-wave	ITSM	max.		25		А
I^2 t for fusing (t = 10 ms)	l² t	max.		4		$A^2 s$
Rate of rise of on-state current after triggering with $I_G = 200 \text{ mA to}$	dl ~ /dt	may		10		Δ /us
$17 - 0$ A, $01G/01 - 0.2$ A/ μ s	urr/ut	max.		10		<i>Α</i> /μ5
Gate to terminal 1						
POWER DISSIPATION						
Average power dissipation	_					
(averaged over any 20 ms period)	^P G(AV)	max.		0.5		W
Peak power dissipation	P _{GM}	max.		5		W
Temperatures						
Storage temperature	T _{stg}		-40 to	+125		oC
Operating junction temperature						• •
full-cycle operation	Ţj	max.		120		0C
nan-cycle operation	'j	max.		110		-0

*Although not recommended, off-state voltages up to 800 V may be applied without damage, but the triac may switch into the on-state. The rate of rise of on-state current should not exceed 3 A/ μ s.

THERMAL RESISTANCE

From junction to mounting base full-cycle operation half-cycle operation	R _{th} j-mb R _{th} j-mb	=	3.0 3.7	K/W K/W
Transient thermal impedance; $t = 1 ms$	Z _{th j-mb}	=	0.6	K/W
Influence of mounting method				
1. Heatsink mounted with clip (see mounting instructions)				
Thermal resistance from mounting base to heatsink				
a. with heatsink compound	R _{th mb-h}	=	0.3	K/W
b. with heatsink compound and 0.06 mm maximum mica insulator	R _{th mb-h}	=	1.4	K/W
c. with heatsink compound and 0.1 mm max. mica insulator (56369)	R _{th mb-h}	=	2.2	K/W
d. with heatsink compound and 0.25 mm max. alumina insulator (56367)	R _{th mb-h}		0.8	K/W
e. without heatsink compound	R _{th mb} -h	=	1.4	K/W

2. Free-air operation

The quoted value of $R_{\mbox{th}\mbox{ }j\mbox{-}a}$ should be used only when no leads of other dissipating components run to the same tie-point.

Thermal resistance from junction to ambient in free air: mounted on a printed circuit board at a = any lead length

 $R_{th j-a} = 60 \text{ K/W}$



CHAI	RACTERISTICS (T _i = 25 ^o C unless ot	herwise s	stated)						
Polari	ities, positive or negative, are identified	with resp	ect to	т ₁ .					
Volta	ges and currents (in either direction)								
On-sta	ate voltage (measured under pulse cond	itions to	prevent	t excess	ve dissip	oation)			
٦	r = 5 A				ν _T		<	1.70	V
Rate ar B B B B B B	of rise of off-state voltage that will not ny device; T _j = 120 ^o C; gate open circui T136 series T136 series G T136 series F T136 series E T136 – 500D	trigger t			dVD/0 dVD/0 dVD/0 dVD/0	dt dt dt dt dt	< < typ. typ.	100 200 50 50 50	V/μs V/μs V/μs V/μs V/μs
Rate o tr I _T B B B	of change of commutating voltage that igger any device when —dI _{com} /dt = 1.8 r(RMS) = 4 A; T _{mb} = 85 ^o C; gate open T136 series T136 series G T136 series F	will not A/ms; circuit ; `	V _D = V	′DWMm	ax dV _{cor} dV _{cor} dV _{cor}	n/dt n/dt n/dt	typ. < typ.	10 10 10	V/μs V/μs V/μs
Off-st	ate current								
V _D = V _{DWMmax} ; T _j = 120 °C				۱D		<	0.5	mA	
Gate	Gate voltage that will trigger all devices				V _{GT}		>	1.5	V
Gate	voltage that will not trigger any device								
V T	D = V _{DWMmax} ; T _j = 120 ^o C; ₂ and G positive or negative				V _{GD}		<	250	mV
Gate o	current that will trigger all devices (IGT); G to T	1						
Holdi	ng current (I _H)			T2+	T ₂ +	T2-	• 7	2-	
Latch	ing current (I _L); $V_D = 12 V$			G+	G—	G-		<u>;</u> +	
_		IGT	>	35	35	35		70	mA
В	1136 series	'H	<	15 20	15 30	15 20		15 30	mA mA
		· L			50		-		
B	T136 series G	'GT Iu	<	50 30	50 30	30		30 30	mA mA
		ι	<	30	45	30	4	15	mA
		IGT	>	25	25	25	7	70	mA
B	T136 series F	ļΗ.	<	15	15	15		15	mA
		<u>ال</u>	<	20	30	20		 .	mΑ
ь.	T126 parion E	GT	>	10 15	10	10		25	mA mA
D	TIJU Series L	тн Ц	$\stackrel{>}{<}$	15	20	15		20	mA
			>	5	5	5	+	0	mA
В	T136 – 500D	IH	<	10	10	10		0	mA
		۱۲	<	10	15	10		15	mΑ

MOUNTING INSTRUCTIONS

- The device may be soldered directly into the circuit, but the maximum permissible temperature of the soldering iron or bath is 275 °C; it must not be in contact with the joint for more than 5 seconds. Soldered joints must be at least 4.7 mm from the seal.
- The leads should not be bent less than 2.4 mm from the seal, and should be supported during bending. The leads can be bent, twisted or straightened by 90^o maximum. The minimum bending radius is 1 mm.
- It is recommended that the circuit connection be made to tag T₂, rather than direct to the heatsink.
- 4. Mounting by means of a spring clip is the best mounting method because it offers:
 - a. a good thermal contact under the crystal area and slightly lower $\rm R_{th\ mb-h}$ values than screw mounting. ,
 - b. safe isolation for mains operation.

However, if a screw is used, it should be M3 cross-recess pan-head. Care should be taken to avoid damage to the plastic body.

- For good thermal contact, heatsink compound should be used between mounting base and heatsink. Values of 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.
- 6. Rivet mounting (only possible for non-insulated mounting)

Devices may be rivetted to flat heatsinks; such a process **must neither** deform the mounting tab, **nor** enlarge the mounting hole.

 The heatsink must have a flatness in the mounting area of 0.02 mm maximum per 10 mm. Mounting holes must be deburred.

OPERATING NOTES

Dissipation and heatsink considerations:

 The various components of junction temperature rise above ambient are illustrated in Fig.3.



b. The method of using Fig.4 is as follows:

Starting with the required current on the $I_{T(RMS)}$ axis, trace upwards to meet the appropriate conduction angle curve. Trace right horizontally and upwards from the appropriate value on the T_{amb} scale. The intersection determines the $R_{th\ mb-a}$. The heatsink thermal resistance value ($R_{th\ h-a}$) can now be calculated from:

$R_{th h-a} = R_{th mb-a} - R_{th mb-h}$

c. Any measurement of heatsink temperature should be made immediately adjacent to the device.

FULL-CYCLE OPERATION



Fig.4 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.



= $\alpha_1 = \alpha_2$: conduction angle per half cycle

Note: For the type BT136–500D only, any operating point derived from Fig.4 should be derated by a further 10 $^{\circ}$ C.

Triacs

OVERLOAD OPERATION



Fig.5 Maximum permissible duration of steady overload (provided that T_{mb} does not exceed 120 °C during and after overload) expressed as a percentage of the steady state r.m.s. rated current. For high r.m.s. overload currents precautions should be taken so that the temperature of the terminals does not exceed 125 °C. During these overload conditions the triac may lose control. Therefore the overload should be terminated by a separate protection device.



Fig. 6

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Triacs

BT136 SERIES



Fig.7 Maximum permissible non-repetitive r.m.s. on-state current based on sinusoidal currents (f = 50 Hz); $T_j = 120$ °C prior to surge. The triac may temporarily lose control following the surge.



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Fig.9 Typical commutation dV/dt for BT136 series versus T_j . The triac should commutate when the dV/dt is below the value on the appropriate curve for pre-commutation dI_T/dt.





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Triacs

BT136 SERIES



Fig.11 Typical commutation dV/dt for BT136F series versus Ti. The triac should commutate when the dV/dt is below the value on the appropriate curve for pre-commutation dI_T/dt .





all devices; all conditions.



FULL-PACK TRIACS

Glass-passivated 4 ampere triacs in SOT-186 envelopes, which feature an electrically isolated seating plane. They are intended for use in applications requiring high bidirectional transient and blocking voltage capability. Typical applications include a.c. power control circuits such as lighting, industrial and domestic heating, motor control and switching systems.

QUICK REFERENCE DATA

		BT136	F-500	600	800	
Repetitive peak off-state voltage	VDRM	max.	500	600	800	v
R.M.S. on-state current	^I T(RMS)	max.		4		А
Non-repetitive peak on-state current	ITSM	max.		25		Α

0.9

4.4 4.0

10.2 max

5,7 max

3.2

3.0

MECHANICAL DATA

Fig.1 SOT-186



Dimensions in mm

4.4 max

2,9 max

7.9 7.5

17

max



top view

Net mass: 2 g.

The seating plane is electrically isolated from all terminals.

Accessories supplied on request (see data sheets Mounting instructions for F-pack devices and Accessories for SOT-186 envelopes).

BT136F SERIES

RATINGS

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

Voltages (in either direction)

		BT136	F-500	600	800	
Non-repetitive peak off-state voltage $(t \le 10 \text{ ms})$	V _{DSM}	max.	500*	600*	800	V
Repetitive peak off-state voltage ($\delta \leq 0.01$)	VDRM	max.	500	600	800	v
Crest working off-state voltage	VDWM	max.	400	400	400	v
Currents (in either direction)						
R.M.S. on-state current (conduction angle 36 up to $T_h = 86 ^{\circ}\text{C}$	0 ⁰) ^I T(BMS)	max.		4		A
Repetitive peak on-state current	TRM	max.		25		А
Non-repetitive peak on-state current; $T_j = 120$ °C prior to surge; t = 20 ms; full sine-wave		may		25		^
l^2 t for fusing (t = 10 ms)	1 5 M 1 ² +	max.		25 A		Λ^2
Rate of rise of on-state current after triggering with $I_G = 200 \text{ mA to } I_T = 6 \text{ A};$ $dI_G/dt = 0.2 \text{ A}/\mu \text{s}$	dl _T /dt	max.		10		Α/μs
Gate to terminal 1						
POWER DISSIPATION						
Average power dissipation (averaged over any 20 ms period)	P _{G(AV)}	max.		0.5		w
Peak power dissipation	PGM	max.		5		W
Temperatures						
Storage temperature	T _{stg}		-40 to	o +125		٥C
Operating junction temperature full-cycle operation half-cycle operation	Tj Tj	max. max.		120 110		oC oC
ISOLATION						
From all three terminals to external heatsink (peak)	V _{isol}	min.		1000		v
Capacitance from T ₂ to external heatsink	C _{isol}	typ.		12		рF

*Although not recommended, off-state voltages up to 800 V may be applied without damage, but the triac may switch into the on-state. The rate of rise of on-state current should not exceed $3 A/\mu s$.

THERMAL RESISTANCE

1.	Heatsink	mounted	with	clip	(see m	nounting	instructions)	
----	----------	---------	------	------	--------	----------	---------------	--

Thermal resistance from junction to external heatsink				
With heatsink compound	R _{th j-h}	=	5.5	K/W
Without heatsink compound	R _{th j-h}	=	7.2	K/W

2. Free-air operation

The quoted values of $R_{th\ j-a}$ should be used only when no leads of other dissipating components run to the same tie-point.

Thermal resistance from junction to ambient in free air: mounted on a printed-circuit board at a = any lead length

R _{th i-a}	=	55	K/W
· · [[]]-a		00	



Fig.2.

BT136F SERIES

herwise state	d)				
with respect	to T ₁ .				
tions to prev	ent exces	ssive dissipa V⊤	tion) <	1.70	v
trigger		·			
		dV _D /dt dV _D /dt dV _D /dt	< <	100 200	V/μs V/μs V/μs
		dV _D /dt dV _D /dt	typ. typ.	50 50 5	V/μs V/μs V/μs
vill not \/ms; :uit; V _D = V _I	DWMma×	(
		dV _{com} /dt dV _{com} /dt dV _{com} /dt	typ. < typ.	10 10 10	V/μs V/μs V/μs
		D	<	0.5	mA
		V _{GT}	>	1.5	v
		V _{GD}	<	250	mV
); G to T ₁					
	Т ₂ + G+	T ₂ + G–	T ₂ - G-	T ₂ G+	
I _{GT} > I _H < I _L <	35 15 20	35 15 30	35 15 20	70 15 30	mA mA mA
I _{GT} > I _H < I _L <	50 30 30	50 30 45	50 30 30	100 30 45	mA mA mA
I _{GT} > I _H < I _L <	25 15 20	25 15 30	25 15 20	70 15 30	mA mA mA
I _{GT} > I _H < I _L <	10 15 15	10 15 20	10 15 15	25 15 20	mA mA mA
IGT > IH <	5 10	5 10	5 10	10 10	mA mA
	herwise state with respect itions to prev trigger will not $\Delta/ms;$ cuit; $V_D = V_1$ $\Delta/ms;$ cuit; $V_D = V_1$ $\Delta/ms;$ $L < V_1 = V_1$ $\Delta/ms;$ $L < V_2 = V_1$ $\Delta/ms;$ $L < V_1 = V_1$ $\Delta/ms;$ $L < V_2 = V_1$ $L < V_2 = V_2$ $L < V_2 = V_2$ L < V	herwise stated) with respect to T ₁ . itions to prevent excess trigger will not A/ms; buit; VD = VDWMmax buit; VD = VDWMmax L^{T_2+} G^+ $I_{GT} > 35$ $I_{H} < 15$ $I_{L} < 20$ $I_{GT} > 50$ $I_{H} < 30$ $I_{L} < 30$ $I_{L} < 30$ $I_{GT} > 25$ $I_{H} < 15$ $I_{L} < 20$ $I_{GT} > 10$ $I_{H} < 15$ $I_{L} < 15$ $I_{L} < 15$ $I_{L} < 15$ $I_{L} < 15$ $I_{L} < 15$ $I_{L} < 10$ $I_{H} < 15$ $I_{L} < 15$ $I_{L} < 10$ $I_{H} < 15$ $I_{L} < 10$ $I_{H} < 15$ $I_{L} < 10$	herwise stated) with respect to T ₁ . itions to prevent excessive dissipa VT trigger $dV_D/dt dV_D/dt dV_D/dt dV_D/dt dV_D/dt dV_D/dt dV_D/dt dV_D/dt dV_D/dt dV_D/dt dV_Com/dt dV_com/dt dV_com/dt dV_com/dt dV_com/dt dV_com/dt iD VGT); G to T1 T2+ G+ T2+ G+ C iGT > 35 iH < 15 iL < 20 30 iGT > 50 50 iH < 30 iL < 30 iGT > 15 iL < 20 30 iGT > 15 iL < 20 30 iGT > 10 iGT > 50 50 iH < 15 iL < 20 30 iGT > 10 iGT > 10 iGT > 5 5 iH < 15 iL < 15 15 iL < 20 30 iGT > 10 iGT > 10 iGT > 5 5 iH < 15 iL < 15 15 iL < 15 15 10 10 iGT > 5 5 10 iGT > 10 iGT > 5 10 iGT > 5 10 iGT > 10 iGT > 10 iGT > 5 10 iGT > 5 10 iGT > 10 iGT > 5 10 iGT > 5 10 iGT > 10 iGT > 5 10 iGT > 5 10 iGT > 10 iGT > 5 10 iGT > 5 10 iGT > 10 iGT > 5 10 iGT > 10 i$	herwise stated) with respect to T ₁ . itions to prevent excessive dissipation) V_T < trigger $dV_D/dt < dV_D/dt <dV_D/dt <dV_D/dt <dV_D/dt <dV_D/dt <dV_D/dt <dV_D/dt <dV_D/dt <dV_D/dt <dV_Com/dt <dV_{com}/dt <$	herwise stated) with respect to T ₁ . itions to prevent excessive dissipation) $V_T < 1.70$ trigger $dV_D/dt < 100$ $dV_D/dt < 200$ $dV_D/dt < 50$ $dV_D/dt typ. 50$ $dV_D/dt typ. 50$ $dV_D/dt typ. 50$ $dV_D/dt typ. 10$ $dV_{com}/dt typ. 10$ $dV_{com}/dt typ. 10$ $dV_{com}/dt typ. 10$ $dV_{com}/dt typ. 10$ $dV_{com}/dt typ. 10$ $dV_{com}/dt typ. 10$ $I_D < 0.5$ $V_{GT} > 1.5$ $V_{GT} > 1.5$ $V_{GT} > 1.5$ $V_{GT} > 1.5$ $I_L < 20$ 30 20 30 $I_H < 15$ 15 15 15 $I_L < 20$ 30 45 30 45 $I_GT > 10$ 10 10 10 25 $I_H < 15$ 15 15 15 $I_L < 20$ 30 20 30 $I_GT > 10$ 10 10 10 25 $I_H < 15$ 15 15 15 $I_L < 20$ 30 20 30 $I_GT > 10$ 10 10 10 25 $I_H < 15$ 15 15 15 $I_L < 20$ 30 20 30 $I_GT > 10$ 10 10 10 25 $I_H < 15$ 15 15 15 $I_L < 15$ 20 15 20 $I_GT > 5$ 5 5 10 $I_H < 15$ 15 15 $I_L < 15$ 15 15 $I_L < 10$ 10 10 10 10

MOUNTING INSTRUCTIONS

- The triac may be soldered directly into the circuit, but the maximum permissible temperature of the soldering iron or bath is 275 °C; it must not be in contact with the joint for more than 5 seconds. Soldered joints must be at least 4.7 mm from the seal.
- 2. The leads should not be bent less than 2.4 mm from the seal, and should be supported during bending. The leads can be bent, twisted or straightened by 90^o maximum. The minimum bending radius is 1 mm.
- 3. Mounting by means of a spring clip is the best mounting method because it offers good thermal contact under the crystal area and slightly lower R_{th j-h} values than screw mounting. However, if a screw is used, it should be M3 cross-recess pan-head. Care should be taken to avoid damage to the plastic body.
- 4. For good thermal contact heatsink compound should be used between seating plane and heatsink. Values of R_{th j-h} given for mounting with heatsink compound refer to the use of a metallic-oxide loaded compound. Ordinary silicone grease is not recommended.
- 5. Rivet mounting is not recommended.
- The heatsink must have a flatness in the mounting area of 0.02 mm maximum per 10 mm. Mounting holes must be deburred.

OPERATING NOTES

Dissipation and heatsink considerations:

a. The various components of junction temperature rise above ambient are illustrated in Fig.3.



Fig.3.

b. The method of using Figs.4 and 5 is as follows:

Starting with the required current on the $I_{T(RMS)}$ axis (l.h. graph) trace upwards to meet the appropriate conduction angle curve. Trace left from curve to obtain power P. Trace right from curve to obtain T_h (r.h. graph). Trace upwards from T_{amb}, intersect with T_h determines R_{th h-a}, required heatsink thermal resistance.

c. Any measurement of heatsink temperature should be made immediately adjacent to the device.

BT136F SERIES

FULL-WAVE CONDUCTION (with heatsink compound)



Fig.4 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.



Note: For the type BT136F-500D only, any operating point derived from Fig.4 should be derated by a further 10 °C.





Fig.5 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.



Note: For the type BT136F-500D only, any operating point derived from Fig.5 should be derated by a further 10 °C.

OVERLOAD OPERATION



Fig.6 Maximum permissible duration of steady overload (provided that T_h does not exceed 120 °C during and after overload) expressed as a percentage of the steady state r.m.s. rated current. For high r.m.s. overload currents precautions should be taken so that the temperature of the terminals does not exceed 125 °C. During these overload conditions the triac may lose control. Therefore the overload should be terminated by a separate protection device.

Triacs

BT136F SERIES



Fig.7 Maximum permissible non-repetitive r.m.s. on-state current based on sinusoidal currents (f = 50 Hz); T_j = 120 °C prior to surge. The triac may temporarily lose control following the surge.



BT136F SERIES



Fig.9 Typical commutation dV/dt for BT136F series versus T_j. The triac should commutate when the dV/dt is below the value on the appropriate curve for pre-commutation dI_T/dt .





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Triacs

BT136F SERIES



Fig.11 Typical commutation dV/dt or BT136F series F versus T_j. The triac should commutate when the dV/dt is below the value on the appropriate curve for pre-commutation dI_T/dt .



all devices; all conditions.

Fig.13 Normalised gate current that will trigger all devices; all conditions.

BT136F SERIES



Fig.14 Transient thermal impedance, - - with heatsink compound; —— without heatsink compound.

TRIACS

Glass-passivated 8 ampere triacs intended for use in applications requiring high bidirectional transient and blocking voltage capability, and high thermal cycling performance with very low thermal resistances, e.g. a.c. power control applications such as lighting, industrial and domestic heating, motor control and switching systems.

QUICK REFERENCE DATA

	BT137–5		-500	600	800	
Repetitive peak off-state voltage	V _{DRM}	max.	500	600	800	v
R.M.S. on-state current	IT(RMS)	max.		8		А
Non-repetitive peak on-state current	ITSM	max.		55		А

MECHANICAL DATA

Fig.1 TO-220AB.

Dimensions in mm



Net mass: 2 g

Note: The exposed metal mounting base is directly connected to terminal T₂.

Supplied on request: accessories (see data sheets Mounting instructions and accessories for TO-220 envelopes).

RATINGS

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

Voltages (in either direction)		BT137	-500	600	800	
Non-repetitive peak off-state voltage (t \leq 10 ms) Repetitive peak off-state voltage ($\delta \leq$ 0.01) Crest working off-state voltage	Vdsm Vdrm Vdwm	max. max. max.	500* 500 400	600* 600 400	800 800 400	V V V
Currents (in either direction)						
R.M.S. on-state current (conduction angle 360°) up to T_{mb} = 97 °C	I _{T(RMS)}	max.		8		A
Repetitive peak on-state current	ITRM	max.		55		Α
Non-repetitive peak on-state current; T _j = 120 ^o C prior to surge; t = 20 ms; full sine-wave	ITSM	max.		55		A
$I^2 t$ for fusing (t = 10 ms)	l² t	max.		15		$A^2 s$
Rate of rise of on-state current after triggering with $I_G = 200$ mA to $I_T = 12$ A; $dI_G/dt = 0.2$ A/µs	dI _T /dt	max.		20		A/μs
Gate to terminal 1						
POWER DISSIPATION						
Average power dissipation (averaged over any 20 ms period)	P _G (AV)	max.	0	.5		w
Peak power dissipation	PGM	max.		5		W
Temperatures						
Storage temperature	т _{stg}	-4	0 to +1:	25		oC
Operating junction temperature full-cycle operation half-cycle operation	Tj Tj	max. max.	1: 1	20 10		оС 0С

*Although not recommended, off-state voltages up to 800 V may be applied without damage, but the triac may switch into the on-state. The rate of rise of on-state current should not exceed 6 A/ μ s.

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THERMAL RESISTANCE

From junction to mounting base full-cycle operation half-cycle operation	R _{th} j-mb R _{th} j-mb	=	2.0 2.4	K/W K/W		
Transient thermal impedance; t = 1 ms	Z _{th j-mb}	=	0.3	K/W		
Influence of mounting method						
1. Heatsink mounted with clip (see mounting instructions)						
Thermal resistance from mounting base to heatsink						
a. with heatsink compound	R _{th mb-h}	=	0.3	K/W		
b. with heatsink compound and 0.06 mm maximum mica insulator	R _{th mb-h}	=	1.4	K/W		
c. with heatsink compound and 0.1 mm max. mica insulator (56369)	R _{th mb-h}	=	2.2	K/W		
d. with heatsink compound and $0.25\ \text{mm}$ max. alumina insulator (56367)	R _{th mb-h}	=	8.0	K/W		
e. without heatsink compound	Rth mb-h	=	1.4	K/W		
2. Free-air operation						
The quoted values of $R_{\mbox{th}j\mbox{-a}}$ should be used only when no leads of other dissipating components run to the same tie-point.						

Thermal resistance from junction to ambient in free air: mounted on a printed-circuit board at a = any lead length

R_{th j-a} = 60 K/W



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Fig.2

CHARACTERISTICS $(T_j = 25 \text{ °C unless})$	s otherwise	stated)	-,										
Voltages and currents (in either direction)													
On-state voltage (measured under pulse conditions to prevent excessive dissipation)													
$I_{T} = 10 \text{ A}$			V	T	,	<	1.65	v					
Rate of rise of off-state voltage that will no any device; T _j = 120 °C; gate open circ	ot trigger cuit						400						
B 13/ series BT137 series G			dV∩/dt			< <	200	V/μs V/μs					
BT137 series F			dV _D /dt			<	50	V/μs					
BT137 series E			dV _D /dt			typ.	50	V/µs					
B1137 = 500D			ď	VD/dt		typ.	5	V/µs					
trigger any device when -dl _{com} /dt = 3 IT(RMS) = 8 A; T _{mb} = 70 °C; gate op	at will not 3.6 A/ms; en circuit ;'	V _D = V _E) WMmax	¢									
BT137 series			dV _{com} /dt			typ.	10	V/µs					
BT137 series F			d'	v _{com/a} v _{com/d}	t	typ.	10	V/μs V/μs					
Off-state current				com									
$V_D = V_{DWMmax}; T_j = 120 {}^{\circ}C$			^I D			<	0.5	mA					
Gate voltage that will trigger all devices				VGT			1.5	v					
Gate voltage that will not trigger any device $V_D = V_{DWMmax}$; $T_j = 120$ °C; T_2 and G positive or negative			V _{GD}			<	250	mV					
Gate current that will trigger all devices (I	ст); G to T	1		00									
Holding current (IL)	31	•	T2+	T2+	T ₂	T2-	-						
Latching current (I_L); $V_D = 12 V$			G+	G—	G—	G+							
	IGT	>	35	35	35	70		mA					
BT137 series	IH I	<	20 30	20 45	20	20		mA mA					
	'L	<u> </u>											
BT137 series G	^I GT	> <	50 40	50 40	50 40	40		mA mA					
	ιL	<	45	60	45	60		mA					
	IGТ	>	25	25	25	70		mA					
BT137 series F	1H	<	20	20 45	20	20		mA mA					
	<u>ا'</u>	<u> </u>		+5		10		,					
BT137 series E	^I GT	>	10 20	10	20	25		mA m∆					
	IL.	<	25	35	25	35		mA					
·	IGT	>	5	5	5	10		mA					
BT137 — 500D	ļ.	<	15	15	15	15		mA					
	<u>ال</u>	<	15	20	15	20		mΑ					

MOUNTING INSTRUCTIONS

- The device may be soldered directly into the circuit, but the maximum permissible temperature of the soldering iron or bath is 275 °C; it must not be in contact with the joint for more than 5 seconds. Soldered joints must be at least 4.7 mm from the seal.
- The leads should not be bent less than 2.4 mm from the seal, and should be supported during bending. The leads can be bent, twisted or straightened by 90^o maximum. The minimum bending radius is 1 mm.
- It is recommended that the circuit connection be made to tag T₂, rather than direct to the heatsink.
- 4. Mounting by means of a spring clip is the best mounting method because it offers:
 - a. a good thermal contact under the crystal area and slightly lower $\rm R_{th\ mb-h}$ values than screw mounting.
 - b. safe isolation for mains operation.

However, if a screw is used, it should be M3 cross-recess pan-head. Care should be taken to avoid damage to the plastic body.

- 5. For good thermal contact, heatsink compound should be used between mounting base and heatsink. Values of 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.
- 6. Rivet mounting (only possible for non-insulated mounting)

Devices may be rivetted to flat heatsinks; such a process **must neither** deform the mounting tab, **nor** enlarge the mounting hole.

The heatsink must have a flatness in the mounting area of 0.02 mm maximum per 10 mm. Mounting holes must be deburred.

OPERATING NOTES

Dissipation and heatsink considerations:

 The various components of junction temperature rise above ambient are illustrated in Fig.3.



b. The method of using Fig.4 is as follows:

Starting with the required current on the $I_{T(RMS)}$ axis, trace upwards to meet the appropriate conduction angle curve. Trace right horizontally and upwards from the appropriate value on the T_{amb} scale. The intersection determines the $R_{th\ mb-a}$. The heatsink thermal resistance value $(R_{th\ h-a})$ can now be calculated from:

$R_{th h-a} = R_{th mb-a} - R_{th mb-h}$

c. Any measurement of heatsink temperature should be made immediately adjacent to the device.

FULL-CYCLE OPERATION



Fig.4 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.



Note: For the type BT137–500D only, any operating point derived from Fig.4 should be derated by a further 10 $^{\circ}$ C.

OVERLOAD OPERATION



Fig.5 Maximum permissible duration of steady overload (provided that T_{mb} does not exceed 120 °C during and after overload) expressed as a percentage of the steady state r.m.s. rated current. For high r.m.s. overload currents precautions should be taken so that the temperature of the terminals does not exceed 125 °C. During these overload conditions the triac may lose control. Therefore the overload should be terminated by a separate protection device.



Fig. 6

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Fig.7 Maximum permissible non-repetitive r.m.s. on-state current based on sinusoidal currents (f = 50 Hz); $T_j = 120 \text{ }^{\circ}\text{C}$ prior to surge. The triac may temporarily lose control following the surge.









Fig.9 Typical commutation dV/dt for BT137 series versus T_{j} . The triac should commutate when the dV/dt is below the value on the appropriate curve for pre-commutation dI_T/dt.





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Triacs

BT137 SERIES



Fig.11 Typical commutation dV/dt for BT137F series versus $T_{j\cdot}$ The triac should commutate when the dV/dt is below the value on the appropriate curve for pre-commutation dI_T/dt.





FULL-PACK TRIACS

Glass-passivated 8 Ampere triacs in SOT-186 envelopes, which feature an electrically isolated seating plan. They are intended for use in applications requiring high bidirectional transient and blocking voltage capability. Typical applications include a.c. power control circuits such as lighting, industrial and domestic heating, motor control and switching systems.

QUICK REFERENCE DATA

		BT137F-500		600	800	
Repetitive peak off-state voltage	VDRM	max.	500	600	800	v
R.M.S. on-state current	T(RMS)	max.		8		А
Non-repetitive peak on-state current	^I TSM	max.		55		Α



Net mass: 2 g.

The seating plane is electrically isolated from all terminals.

Accessories supplied on request (see data sheets Mounting instructions for F-pack devices and Accessories for SOT-186 envelopes).
BT137F SERIES

RATINGS

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

Voltages (in either direction)						
		BT1371	F-500	600	800	
Non-repetitive peak off-state voltage $(t \le 10 \text{ ms})$	V _{DSM}	max.	500*	600*	800	V
Repetitive peak off-state voltage ($\delta \leqslant 0.01$)	VDRM	max.	500	600	800	v
Crest working off-state voltage	VDWM	max.	400	400	400	V
Currents (in either direction)						
R.M.S. on-state current (conduction angle 36 up to T_h = 71 °C	0 ⁰) ^I T(RMS)	max.		8		A
Repetitive peak on-state current	TRM	max.		55		А
Non-repetitive peak on-state current; $T_j = 120 ^{O}\text{C}$ prior to surge; t = 20 ms; full sine-wave	ITCM	max		55		Δ
l^2 t for fusing (t = 10 ms)	$ ^{2}t$	max.		15		A^2s
Rate of rise of on-state current after triggering with $I_G = 200 \text{ mA to } I_T = 12 \text{ A};$ $dI_G/dt = 0.2 \text{ A}/\mu \text{s}$	dI _T /dt	max.		20		A/µs
Gate to terminal 1						
POWER DISSIPATION						
Average power dissipation (averaged over any 20 ms period)	P _{G(AV)}	max.		0.5		w
Peak power dissipation	PGM	max.		5		W
Temperatures						
Storage temperature	T _{stg}		-40 to	o +125		οС
Operating junction temperature full-cycle operation half-cycle operation	T _j Tj	max. max.		120 110		oC oC
ISOLATION						
From all three terminals to external heatsink (peak)	V _{isol}	min.		1000		v
Capacitance from T ₂ to external heatsink	C _{isol}	typ.	14. 1	12		рF

*Although not recommended, off-state voltages up to 800 V may be applied without damage, but the triac may switch into the on-state. The rate of rise of on-state current should not exceed 6 A/ μ s.

THERMAL RESISTANCE

1. Heatsink mounted with clip (see mounting instructions)

Thermal resistance from junction to external heatsink				
With heatsink compound	R _{th j-h}	=	4.5	K/W
Without heatsink compound	R _{th j-h}		6.5	K/W

2. Free-air operation

The quoted values of $R_{th\ j-a}$ should be used only when no leads of other dissipating components run to the same tie-point.

Thermal resistance from junction to ambient in free air: mounted on a printed-circuit board at a = any lead length

 $R_{th i-a} = 55 K/W$



Fig.2.

CHARACTERISTICS (T _i = 25 °C unless oth	nerwise stated)				
Polarities, positive or negative, are identified v	vith respect to	о Т ₁ .				
Voltages and currents (in either direction)						
On-state voltage (measured under pulse condit	tions to preve	nt exces	sive dissipa	tion)		
I _T = 10 A		`	√⊤	<	1.65	V
Rate of rise of off-state voltage that will not the	rigger					
any device; $I_j = 120$ °C; gate open circuit BT137E series			tV⊳/dt	/	100	1/100
BT137F series G			1Vp/dt	$\overline{\langle}$	200	V/µs
BT137F series F		Ċ	dV⊓/dt	<	50	V/µs
BT137F series E		c	dV _D /dt	typ.	50	V/µs
BT137F-500D		c	dV _D /dt	typ.	5	V/µs
Rate of change of commutating voltage that w	/ill not					
trigger any device when $-dI_{com}/dt = 3.6 \text{ A}$	/ms;					
$T(RMS) = 8 A; T_h = 54 °C; gate open circles and the set of the $	uit; $V_D = V_D$	WMmax	N / 11.		40	
BT137F series		C	^{dV} com/dt	typ.	10	V/µs
BT137F series F		((V com/dt	tvn	10	V/µs
Off-state current			Com, at	() p.	10	• , μο
$V_D = V_DWM_{max}$: T _i = 120 °C		1	D	<	0.5	mA
Gate voltage that will trigger all devices VG				>	15	V
Gate voltage that will not trigger any device			GI	-	1.0	•
$V_D = V_DWM_{max}$: Ti = 120 °C:						
T ₂ and G positive or negative		١	/GD	<	250	mV
Gate current that will trigger all devices (IGT)	; G to T ₁					
Holding current (L.)		T2+	T ₂ +	T2-	T2-	
Holding current (1H)		GŦ	G_	G-	G+	
Latching current (I _L); V _D = 12 V						
		35	35	35	70	mA
BT137F series	лы Ін <	20	20	20	20	mA
	ι <u>΄</u> <	30	45	30	45	mA
		50	50	50	100	mA
BT137F series G	иц / С	40	40	40	40	mA
	ι <u>΄</u> <	45	60	45	60	mA
						•
BT137E sories E		25	25	25	70	mΔ
	I _{GT} > Iн <	25 20	25 20	25 20	70 20	mA mA
	I _{GT} > I _H < I _L <	25 20 30	25 20 45	25 20 30	70 20 45	mA mA mA
	IGT > I _H < I _L <	25 20 30	25 20 45	25 20 30	70 20 45 25	mA mA mA
BT137F series E	IGT > I _H < I _L < IGT > I _H <	25 20 30 10 20	25 20 45 10 20	25 20 30 10 20	70 20 45 25 20	mA mA mA mA mA
BT137F series E	$\begin{array}{c c} I_{GT} & > \\ I_{H} & < \\ I_{L} & < \end{array}$ $\begin{array}{c c} I_{GT} & > \\ I_{H} & < \\ I_{L} & < \end{array}$	25 20 30 10 20 25	25 20 45 10 20 35	25 20 30 10 20 25	70 20 45 25 20 35	mA mA mA mA mA mA
BT137F series E	IGT > IH <	25 20 30 10 20 25 5	25 20 45 10 20 35 5	25 20 30 10 20 25 5	70 20 45 25 20 35	mA mA mA mA mA mA
BT137F series E BT137F-500D	IGT > IH <	25 20 30 10 20 25 5 15	25 20 45 10 20 35 5 15	25 20 30 10 20 25 5 15	70 20 45 25 20 35 10 15	mA mA mA mA mA mA mA mA
BT137F series E BT137F-500D	IGT > IH <	25 20 30 10 20 25 5 15 15	25 20 45 10 20 35 5 15 20	25 20 30 10 20 25 5 15 15	70 20 45 25 20 35 10 15 20	mA mA mA mA mA mA mA

MOUNTING INSTRUCTIONS

- The triac may be soldered directly into the circuit, but the maximum permissible temperature of the soldering iron or bath is 275 °C; it must not be in contact with the joint for more than 5 seconds. Soldered joints must be at least 4.7 mm from the seal.
- The leads should not be bent less than 2.4 mm from the seal, and should be supported during bending. The leads can be bent, twisted or straightened by 90^o maximum. The minimum bending radius is 1 mm.
- 3. Mounting by means of a spring clip is the best mounting method because it offers good thermal contact under the crystal area and slightly lower R_{th j-h} values than screw mounting. However, if a screw is used, it should be M3 cross-recess pan-head. Care should be taken to avoid damage to the plastic body.
- 4. For good thermal contact heatsink compound should be used between seating plane and heatsink. Values of R_{th j-h} given for mounting with heatsink compound refer to the use of a metallic-oxide loaded compound. Ordinary silicone grease is not recommended.
- 5. Rivet mounting is not recommended.
- The heatsink must have a flatness in the mounting area of 0.02 mm maximum per 10 mm. Mounting holes must be deburred.

OPERATING NOTES

Dissipation and heatsink considerations:

a. The various components of junction temperature rise above ambient are illustrated in Fig.3.



Fig.3.

- b. The method of using Figs.4 and 5 is as follows:
- Starting with the required current on the $I_{T(RMS)}$ axis (I.h. graph) trace upwards to meet the appropriate conduction angle curve. Trace left from curve to obtain power P. Trace right from curve to obtain T_h (r.h. graph). Trace upwards from T_{amb} , intersect with T_h determines $R_{th h-a}$, required heatsink thermal resistance.
- c. Any measurement of heatsink temperature should be made immediately adjacent to the device.

BT137F SERIES

FULL-WAVE CONDUCTION (with heatsink compound)



Fig.4 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.



Note: For the type BT137F-500D only, any operating point derived from Fig.4 should be derated by a further 10 °C.

FULL-WAVE CONDUCTION (without heatsink compound)



Fig.5 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.



Note: For the type BT137F-500D only, any operating point derived from Fig.5 should be derated by a further 10 $^{\rm O}$ C.

OVERLOAD OPERATION



Fig.6 Maximum permissible duration of steady overload (provided that T_h does not exceed 120 °C during and after overload) expressed as a percentage of the steady state r.m.s. rated current. For high r.m.s. overload currents precautions should be taken so that the temperature of the terminals does not exceed 125 °C. During these overload conditions the triac may lose control. Therefore the overload should be terminated by a separate protection device.

Triacs









Fig.8.



Fig.9 Typical commutation dV/dt for BT137F series versus T_j. The triac should commutate when the dV/dt is below the value on the appropriate curve for pre-commutation dl_T/dt.





Triacs









Fig.14 Transient thermal impedance, - - with heatsink compound; ---- without heatsink compound.

TRIACS

Glass-passivated 12 ampere triacs intended for use in applications requiring high bidirectional transient and blocking voltage capability, and high thermal cycling performance with very low thermal resistances, e.g. a.c. power control applications such as motor, industrial lighting, industrial and domestic heating control and static switching systems.

QUICK REFERENCE DATA

		BT138-500	600	800
Repetitive peak off-state voltage	VDRM	max. 500	600	800 V
R.M.S. on-state current	T(RMS)	max.	12	А
Non-repetitive peak on-state current	ITSM	max.	90	А

MECHANICAL DATA

Fig.1 TO-220AB

Dimensions in mm



Note: The exposed metal mounting base is directly connected to terminal T_2 .

Accessories supplied on request: see data sheet Mounting instructions and accessories for TO-220 envelopes.

BT138 SERIES

RATINGS

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

Voltages (in either direction)

		BT138	-500	600	800	
Non-repetitive peak off-state voltage (t \leq 10 ms)	V _{DSM}	max.	500*	600*	800	v
Repetitive peak off-state voltage ($\delta \leqslant 0.01$)	VDRM	max.	500	600	800	ν
Crest working off-state voltage	V _{DWM}	max.	400	400	400	v
Currents (in either direction)			_	~~~~		
R.M.S. on-state current (conduction angle 360°) up to $T_{mb} = 95$ °C		IT(RM	S)	max.	12	А
Repetitive peak on-state current		ITRM	1	max.	90	А
Non-repetitive peak on-state current; T _j = 120 ^o C prior to surge; t = 20 ms; full sine-wave		I _{TSM}		max.	90	А
I^2 t for fusing (t = 10 ms)		l²t	I	max.	40	A ² s
Rate of rise of on-state current after triggering wit $I_G = 200 \text{ mA to } I_T = 20 \text{ A};$ $dI_G/dt = 0.2 \text{ A}/\mu \text{s}$	h	dl⊤/dt		max.	30	A/μs
Gate to terminal 1						
Power dissipation						
Average power dissipation (averaged over any 20 r	ns period)	P _G (AV)	max.	0.5	W
Peak power dissipation		P _{GM}	I	max.	5.0	w
Temperatures						
Storage temperature		T _{stg}		-40 to +	125	oC
Operating junction temperature full-cycle operation half-cycle operation		Tj Tj	I	max. max.	120 110	oC ဝင

*Although not recommended, off-state voltages up to 800 V may be applied without damage, but the triac may switch into the on-state. The rate of rise of on-state current should not exceed 15 A/µs.

THERMAL RESISTANCE

From junction to mounting base full-cycle operation half-cycle operation	R _{th} j-mb R _{th} j-mb	=	1.5 2.0	K/W K/W
Transient thermal impedance; t = 1 ms	Z _{th j-mb}	=	0.1	K/W
Influence of mounting method				
1. Heatsink mounted with clip (see mounting instructions)				
Thermal resistance from mounting base to heatsink				
a. with heatsink compound	R _{th mb-h}	=	0.3	K/W
b. with heatsink compound and 0.06 mm maximum mica insulator	R _{th} mb-h	=	1.4	K/W
c. with heatsink compound and 0.1 mm maximum mica insulator (56369)	R _{th mb-h}	=	2.2	K/W
 d. with heatsink compound and 0.25 mm maximum alumina insulator (56367) 	R _{th mb-h}	=	0.8	K/W
e. without heatsink compound	R _{th mb-h}	=	1.4	K/W

2. Free-air operation

The quoted values of $R_{\mbox{th }j\mbox{-}a}$ should be used only when no leads of other dissipating components run to the same tie-point.

Thermal resistance from junction to ambient in free air: mounted on a printed-circuit board at a = any lead length

 $R_{\text{th i-a}} = 60 \text{ K/W}$



7**Z7549**3

Fig.2

BT138 SERIES

CHARACTERISTICS $(T_j = 25 ^{O}\text{C} \text{ unless oth})$	erwise st	ated)					
Polarities, positive or negative, are identified v	vith respe	ect to	о⊤ ₁ .				
Voltages and currents (in either direction)							
On-state voltage (measured under pulse condit	tions to p	reve	nt exces	sive dissipat	ion)		
I _T = 15 A				ν _T	<	1.65	V
Rate of rise of off-state voltage that will not the	rigger						
any device; T _j = 120 ^o C; gate open circuit BT138 series				dVp/dt	<	100	V/us
BT138 series G				dV _D /dt	<	200	V/μs
BT138 series F				dV _D /dt	<	50	V/µs
B1138 series E				av _D /at	typ	o. 50	V/μs
Rate of change of commutating voltage that w trigger any device when $-dl_{com}/dt = 5.4$, $l_{T(PMC)} = 12$ A: $T_{mb} = 70$ °C: gate open	vill not A/ms; circuit :	/n =		Imay			
BT138 series	,	. 0	- 0000	dV _{com} /	dt typ	o. 10	V/µs
BT138 series G				dV _{com} /	dt < dt tvr	10	V/µs
				u v com/	ու ւջբ	. 10	ν/μ5
Utf-state current						0.5	0
$V_D = V_DWMmax; T_j = 120 °C;$				D	<	0.5	mA
Gate voltage that will trigger all devices				V _{GT}	>	1.5	V
Gate voltage that will not trigger any device $V_D = V_{DWMmax}$; $T_j = 120$ °C; T_2 and G positive or negative				V _{GD}	<	250	mV
Gate current that will trigger all devices (IGT)	; G to T1						
Holding current (I _H)			T ₂ +	T2+	T2-	T ₂ -	
Latching current (I _L); $V_D = 12 V$			G+	6–	G	6+	
	^I GT	>	35	35	35	70	mA
BT138 series	ļΗ.	<	30	30	30	30	mA
· · · · · · · · · · · · · · · · · · ·	<u>יר</u>		40	00	40		mA
PT129 porion C	^I GT	>	50 60	50 60	50 60	100	mA mA
DT130 series d	чн Ц	\langle	60	90	60	90	mA
·		>	25	25	25	70	mΔ
BT138 series F	IH	<	30	30	30	30	mA
	ΙĽ	<	40	60	40	60	mA
	IGT	>	10	10	10	25	mA
BT138 series E	ΙΗ	<	30 20	30 40	30	30	mA mA
	١Ľ		30	40	30	40	ШA

MOUNTING INSTRUCTIONS

- The device may be soldered directly into the circuit, but the maximum permissible temperature of the soldering iron or bath is 275 °C; it must not be in contact with the joint for more than 5 seconds. Soldered joints must be at least 4.7 mm from the seal.
- The leads should not be bent less than 2.4 mm from the seal, and should be supported during bending. The leads can be bent, twisted or straightened by 90^o maximum. The minimum bending radius is 1 mm.
- It is recommended that the circuit connection be made to tag T₂, rather than direct to the heatsink.
- 4. Mounting by means of a spring clip is the best mounting method because it offers:
 - a. a good thermal contact under the crystal area and slightly lower $\rm R_{th\ mb-h}$ values than screw mounting.
 - b. safe isolation for mains operation.

However, if a screw is used, it should be M3 cross-recess pan-head. Care should be taken to avoid damage to the plastic body.

- For good thermal contact, heatsink compound should be used between mounting base and heatsink. Values of 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.
- 6. Rivet mounting (only possible for non-insulated mounting)

Devices may be rivetted to flat heatsinks; such a process **must neither** deform the mounting tab, **nor** enlarge the mounting hole.

7. The heatsink must have a flatness in the mounting area of 0.02 mm maximum per 10 mm. Mounting holes must be deburred.

OPERATING NOTES

Dissipation and heatsink considerations:

 The various components of junction temperature rise above ambient are illustrated in Fig.3.



b. The method of using Fig.4 is as follows:

Starting with the required current on the $I_{T(RMS)}$ axis, trace upwards to meet the appropriate conduction angle curve. Trace right horizontally and upwards from the appropriate value on the T_{amb} scale. The intersection determines the $R_{th\ mb-a}$. The heatsink thermal resistance value $(R_{th\ h-a})$ can now be calculated from:

$R_{th h-a} = R_{th mb-a} - R_{th mb-h}$

c. Any measurement of heatsink temperature should be made immediately adjacent to the device.

BT138 SERIES



Fig.4 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.

 $\alpha = \alpha_1 = \alpha_2: \text{ conduction angle per half cycle}$

OVERLOAD OPERATION



Fig.5 Maximum permissible duration of steady overload (provided that T_{mb} does exceed 120 °C during and after overload) expressed as a percentage of the steady state r.m.s. rated current. For high r.m.s. overload currents precautions should be taken so that the temperature of the terminals does not exceed 125 °C. During these overload conditions the triac may lose control. Therefore the overload should be terminated by a separate protection device.







Fig. 7

Triacs



BT138 SERIES



Fig.10 Typical commutation dV/dt for BT138 series versus T_j . The triac should commutate when dV/dt is below the value on the appropriate curve for pre-commutation dI_T/dt.





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Triacs

BT138 SERIES



Fig.12 Typical commutation dV/dt for BT138F series versus T_j . The triac should commutate when the dV/dt is below the value on the appropriate curve for pre-commutation dlT/dt.



trigger all devices; all conditions.



FULL-PACK TRIACS

Glass-passivated 12 ampere triacs in SOT-186 envelopes, which feature an electrically isolated seating plane. They are intended for use in applications requiring high bidirectional transient and blocking voltage capability. Typical applications include a.c. power control circuits such as lighting, industrial and domestic heating, motor control and switching systems.

QUICK REFERENCE DATA

		BT138	F-500	600	800		
Repetitive peak off-state voltage	VDRM	max.	500	600	800	V	
R.M.S. on-state current	IT(RMS)	max.		12		А	◄
Non-repetitive peak on-state current	TSM	max.		90		А	

MECHANICAL DATA Dimensions in mm Fig.1 SOT-186 10,2 max 4.4 5.7 max max 0.9 3.2 2,9 max 3.0 4.4 4.0 7.9 7.5 4 17 seating max 2 plane-(T₁) (T2) 3 (g) M2413 3.5 max 4.4 not tinned 13,5 1,5 maxmin 1 3 2 0.9 0.4 M 0.55 max 0.7 2,54 -1.3 м2295 5.08 top view

Net mass: 2 g.

The seating plane is electrically isolated from all terminals.

Accessories supplied on request (see data sheets Mounting instructions for F-pack devices and Accessories for SOT-186 envelopes).

RATINGS

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

Voltages (in either direction)				_		
		BT138	F-500	600	800	
Non-repetitive peak off-state voltage (t \leq 10 ms)	VDSM	max.	500*	600*	800	V
Repetitive peak off-state voltage ($\delta \leqslant 0.01$)	VDRM	max.	500	600	800	V
Crest working off-state voltage	VDWM	max.	400	400	400	v
Currents (in either direction)						
R.M.S. on-state current (conduction angle 36 up to T_h = 52 °C	0 ⁰) ^I T(RMS)	max.		12		A
Repetitive peak on-state current	TRM	max.		90		А
Non-repetitive peak on-state current; $T_j = 120$ °C prior to surge; t = 20 ms; full sine-wave	ITCM	max		90		Δ
l^2 t for fusing (t = 10 ms)	1 5 W	max.		40		A ² s
Rate of rise of on-state current after triggering with $I_G = 200 \text{ mA to } I_T = 20 \text{ A};$ $dI_G/dt = 0.2 \text{ A}/\mu \text{s}$	dIT/dt	max.		30		A/μs
Gate to terminal 1						
Power dissipation						
Average power dissipation (averaged over any 20 ms period)	P _G (AV)	max.		0.5		w
Peak power dissipation	PGM	max.		5.0		W
Temperatures						
Storage temperature	⊤ _{stg}		-40 to	o +125		οС
Operating junction temperature full-cycle operation half-cycle operation	Tj Tj	max. max.		120 110		oC oC
ISOLATION						
From all three terminals to external heatsink (peak)	V _{isol}	min.		1000		v
Capacitance from T ₂ to external heatsink	C _{isol}	typ.		12		pF

*Although not recommended, off-state voltages up to 800 V may be applied without damage, but the triac may switch into the on-state. The rate of rise of on-state current should not exceed 15 A/ μ s.

THERMAL RESISTANCE

1.	Heatsink mounted with clip (see mounting instructions)				
Th	ermal resistance from junction to external heatsink				
	With heatsink compound	R _{th i-h}	=	4.0	K/W
	Without heatsink compound	R _{th j-h}	=	5.5	K/W

2. Free-air operation

The quoted values of $R_{th\ j-a}$ should be used only when no leads of other dissipating components run to the same tie-point.

Thermal resistance from junction to ambient in free air: mounted on a printed-circuit board at a = any lead length

 $R_{th j-a} = 55 \text{ K/W}$



Fig.2.

CHARACTERISTICS ($T_i = 25 {}^{\text{O}}\text{C}$ unless ot	herwise stat	ted)				
Polarities, positive or negative, are identified	with respec	t to T ₁ .				
Voltage and currents (in either direction)						
On-state voltage (measured under pulse condi	tions to pre	vent exce	ssive dissipa	tion)		
I _T = 15 A			ν _T	<	1.65	V
Rate of rise of off-state voltage that will not t any device: $T_{1} = 120$ 9C; gate open circuit	rigger					
BT138F series			dV _D /dt	<	100	V/µs
BT138F series G			dVD/dt	<	200	V/µs
BT138F series F			dV _D /dt	<	50	V∕µs
BT138F series E			dV _D /dt	typ.	50	V/µs
Rate of change of commutating voltage that v	vill not					
trigger any device when $-dI_{com}/dt = 5.4 A$	v/ms; cuit: Vp =	Vouun				
BT138F series	cuit, VD	• Dwivim	ax dV.com/dt	tvp.	10	V/µs
BT138F series G			dV _{com} /dt	<	10	V/µs
BT138F series F			dV _{com} /dt	typ.	10	V∕µs
Off-state current						
V _D = V _{DWMmax} ; T _j = 120 °C;			۱D	<	0.5	mΑ
Gate voltage that will trigger all devices			V _{GT}	>	1.5	V
Gate voltage that will not trigger any device						
$V_D = V_{DWMmax}$; $T_j = 120 \text{ °C}$;						
T ₂ and G positive or negative			V _{GD}	<	250	mV
Gate current that will trigger all devices (IGT)	; G to T ₁					
Holding current (I _H)		T2+	T2+	T ₂ -	T2-	
		G+	G-	G-	G+	
Latching current (IL); VD = 12 V						-
	I _{GT} >	35	35	35	70	mΑ
BT138F series	<u>Ч</u> н <	30	30	30	30	mA
	<u>'L <</u>	40	60	40	60	mA
	I _{GT} >	50	50	50	100	mA
BT138F series G	<u>н <</u>	60	60	60	60	mA
	<u>ال</u> <	60	90	60	90	mA
	'gt >	25	25	25	70	mΑ
BT138F series F	<u>Ч</u> <	30	30	30	30	mA
	۱ <u>۲</u> <	40	60	40	60	mA
×	IGT >	10	10	10	25	mA
BT138F series E	I _Η <	30	30	30	30	mA
	۱_ <	30	40	30	40	mA

MOUNTING INSTRUCTIONS

- The triac may be soldered directly into the circuit, but the maximum permissible temperature of the soldering iron or bath is 275 °C; it must not be in contact with the joint for more than 5 seconds. Soldered joints must be at least 4.7 mm from the seal.
- 2. The leads should not be bent less than 2.4 mm from the seal, and should be supported during bending. The leads can be bent, twisted or straightened by 90° maximum. The minimum bending radius is 1 mm.
- 3. Mounting by means of a spring clip is the best mounting method because it offers good thermal contact under the crystal area and slightly lower R_{th} j-h values than screw mounting. However, if a screw is used, it should be M3 cross-recess pan-head. Care should be taken to avoid damage to the plastic body.
- 4. For good thermal contact heatsink compound should be used between seating plane and heatsink. Values of R_{th j-h} given for mounting with heatsink compound refer to the use of a metallic-oxide loaded compound. Ordinary silicone grease is not recommended.
- 5. Rivet mounting is not recommended.
- 6. The heatsink must have a flatness in the mounting area of 0.02 mm maximum per 10 mm. Mounting holes must be deburred.

OPERATING NOTES

Dissipation and heatsink considerations:

a. The various components of junction temperature rise above ambient are illustrated in Fig.3.



- b. The method of using Figs.4 and 5 is as follows:
- Starting with the required current on the $I_{T(RMS)}$ axis (l.h. graph) trace upwards to meet the appropriate conduction angle curve. Trace left from curve to obtain power P. Trace right from curve to obtain T_h (r.h. graph). Trace upwards from T_{amb} , intersect with T_h determines $R_{th h-a}$, required heatsink thermal resistance.
- c. Any measurement of heatsink temperature should be made immediately adjacent to the device.

BT138F SERIES

FULL-WAVE CONDUCTION (with heatsink compound)



Fig.4 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.



BT138F SERIES



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Fig.5 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.



 $\alpha = \alpha_1 = \alpha_2$: conduction angle per half cycle

OVERLOAD OPERATION



Fig.6 Maximum permissible duration of steady overload (provided that T_h does not exceed 120 °C during and after overload) expressed as a percentage of the steady state r.m.s. rated current. For high r.m.s. overload currents precautions should be taken so that the temperature of the terminals does not exceed 125 °C. During these overload conditions the triac may lose control. Therefore the overload should be terminated by a separate protection device.



Fig.7.



BT138F SERIES



Fig. 10 Typical commutation dV/dt for BT138F series versus T_j. The triac should commutate when dV/dt is below the value on the appropriate curve for pre-commutation dI_T/dt .





June 1986

Triacs



Fig. 12 Typical commutation dV/dt for BT138F series F versus T_j . The triac should commutate when the dV/dt is below the value on the appropriate curve for pre-commutation dI_T/dt.



BT138F SERIES



Fig.15

Dimensions in mm

TRIACS

Glass-passivated 16 ampere triacs intended for use in applications requiring high bidirectional transient and blocking voltage capability, and high thermal cycling performance with very low thermal resistances, e.g. a.c. power control applications such as motor, industrial lighting, industrial and domestic heating control and static switching systems.

QUICK REFERENCE DATA

		BT139-	-500	600	800		
Repetitive peak off-state voltage	VDRM	max.	500	600	800	v	
R.M.S. on-state current	IT(RMS)	max.		16		А	
Non-repetitive peak on-state current	ITSM	max.		140		А	4

MECHANICAL DATA

Fig.1 TO-220AB

10.3 4.5 max max 3.7 1.3 2.8 5.9 min ŧ mounting base (see note) 4 15.8 max 3.5 max 5.1 not tinned max 13.5 1.3 min max (2x)-0,9 max (3x) - 0.6 2.4 M1650 2.54 2.54 Net mass: 2 g Note: The exposed metal mounting base is directly connected

to terminal T₂.

Accessories supplied on request: see data sheet Mounting instructions and accessories for TO-220 envelopes.

April 1986
RATINGS

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

	Voltages (in either direction)		BT139	-500	600	800	
	Non-repetitive peak off-state voltage (t \leq 10 ms) Repetitive peak off-state voltage ($\delta \leq$ 0.01) Crest working off-state voltage	V _{DSM} V _{DRM} V _{DWM}	max. max. max.	500* 500 400	600* 600 400	800 800 400	V V V
	Currents (in either direction)						
	R.M.S. on-state current (conduction angle 360°) up to T _{mb} = 93 °C		IT(RM	S)	max.	16	А
•	Repetitive peak on-state current		ITRM		max.	140	Α
•	Non-repetitive peak on-state current; $T_j = 120 ^{O}\text{C} \text{ p}$ to surge; t = 20 ms; full sine-wave	rior	ITSM		max.	140	А
•	$I^{2}t$ for fusing (t = 10 ms)		l²t		max.	95	A ² s
	Rate of rise of on-state current after triggering with I_G = 200 mA to I_T = 20 A; dI_G/dt = 0.2 A/ μs		dI _T /dt		max.	30	A∕µs
	Gate to terminal 1						
	Power dissipation						
	Average power dissipation (averaged over any 20 ms	s period)	P _G (AV	')	max.	0.5	W
	Peak power dissipation		P _{GM}		max.	5	W
	Temperatures						
	Storage temperature		T _{stg}		-40 to	+125	oC
	Operating junction temperature full-cycle operation half-cycle operation		Т _ј Тј		max. max.	120 110	oC oC

*Although not recommended, off-state voltages up to 800 V may be applied without damage, but the triac may switch into the on-state. The rate of rise of on-state current should not exceed 15 A/µs.

THERMAL RESISTANCE

From junction to mounting base full-cycle operation half-cycle operation	R _{th} j-mb R _{th} j-mb	=	1.2 1.7	K/W K/W
Transient thermal impedance; $t = 1 ms$	Z _{th j-mb}	=	0.1	K/W
Influence of mounting method				
1. Heatsink mounted with clip (see mounting instructions)				
Thermal resistance from mounting base to heatsink				
a. with heatsink compound	R _{th} mb-h	=	0.3	K/W
b. with heatsink compound and 0.06 mm maximum mica insulator	R _{th mb-h}	=	1.4	K/W
c. with heatsink compound and 0.1 mm maximum mica insulator (56369)	R _{th} mb-h	=	2.2	K/W
 with heatsink compound and 0.25 mm maximum alumina insulator (56367) 	R _{th mb-h}	=	0.8	K/W
e. without heatsink compound	R _{th mb-h}	=	1.4	K/W

2. Free-air operation

The quoted values of $R_{th\;j\text{-}a}$ should be used only when no leads of other dissipating components run to the same tie-point.

Thermal resistance from junction to ambient in free air: mounted on a printed-circuit board at a = any lead length

 $R_{th j-a} = 60 \text{ K/W}$



Fig.2

CHARACTERISTICS $(T_j = 25 °C unless or Polarities, positive or negative, are identified of the second secon$	therwise s with respe	tated) ect to T	1۰				
Voltages and currents (in either direction)							
On-state voltage (measured under pulse condi	tions to p	revent	excessiv	e dissipati	on)		
I _T = 20 A				٧T	<	1.6	v
Rate of rise of off-state voltage that will not t any device; T _j = 120 ^o C; gate open circuit BT139 series BT139 series G BT139 series F BT139 series E	rigger			dV _D /dt dV _D /dt dV _D /dt dV _D /dt	< < < typ.	100 200 50 50	V/μs V/μs V/μs V/μs
Rate of change of commutating voltage that v trigger any device when $-dI_{com}/dt = 7.2$ $I_T(RMS) = 16 A; T_{mb} = 70 °C; gate operBT139 seriesBT139 series GBT139 series F$	vill not A/ms; n circuit ;\	^v D = V	DWMm	ax dV _{com} /dt dV _{com} /dt dV _{com} /dt	typ. < typ.	10 10 10	V/μs V/μs V/μs
Off-state current							
V _D = V _{DWMmax} ; T _j = 120 ^o C;				D	<	0.5	mA
Gate voltage that will trigger all devices				VGT	>	1.5	v
Gate voltage that will not trigger any device V _D = V _{DWMmax} ; T _j = 120 °C; T ₂ and G positive or negative				V _{GD}	<	250	mV
Gate current that will trigger all devices (IGT)	; G to T1						
Holding current (I _H)			T2+ G+	T2+ G-	т ₂ G	T ₂ - G+	-
Latching current (I_L); $V_D = 12 V$				_			
BT139 series	IGT IH IL	> < <	35 30 40	35 30 60	35 30 40	70 30 60	— mA mA mA
BT139 series G	IGT I _H IL	> < <	50 60 60	50 60 90	50 60 60	100 60 90	mA mA mA
BT139 series F	IGT I _H Iլ	> < <	25 30 40	25 30 60	25 30 40	70 30 60	mA mA mA
BT139 series E	^I GT I _Н IL	> < <	10 30 30	10 30 40	10 30 30	25 30 40	mA mA mA
······································	_			1		I	

MOUNTING INSTRUCTIONS

- The device may be soldered directly into the circuit, but the maximum permissible temperature of the soldering iron or bath is 275 °C; it must not be in contact with the joint for more than 5 seconds. Soldered joints must be at least 4.7 mm from the seal.
- The leads should not be bent less than 2.4 mm from the seal, and should be supported during bending. The leads can be bent, twisted or straightened by 90^o maximum. The minimum bending radius is 1 mm.
- It is recommended that the circuit connection be made to tag T₂, rather than direct to the heatsink.
- 4. Mounting by means of a spring clip is the best mounting method because it offers:
 - a. a good thermal contact under the crystal area and slightly lower R_{th mb-h} values than screw mounting.
 - b. safe isolation for mains operation.

However, if a screw is used, it should be M3 cross-recess pan-head. Care should be taken to avoid damage to the plastic body.

- For good thermal contact, heatsink compound should be used between mounting base and heatsink. Values of 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.
- 6. Rivet mounting (only possible for non-insulated mounting)

Devices may be rivetted to flat heatsinks; such a process must neither deform the mounting tab, nor enlarge the mounting hole.

 The heatsink must have a flatness in the mounting area of 0.02 mm maximum per 10 mm. Mounting holes must be deburred.

OPERATING NOTES

Dissipation and heatsink considerations:

 The various components of junction temperature rise above ambient are illustrated in Fig.3.



- b. The method of using Fig.4 is as follows:
- Starting with the required current on the $I_{T(RMS)}$ axis, trace upwards to meet the appropriate conduction angle curve. Trace right horizontally and upwards from the appropriate value on the T_{amb} scale. The intersection determines the $R_{th\ mb-a}$. The heatsink thermal resistance value ($R_{th\ h-a}$) can now be calculated from:

$R_{th h-a} = R_{th mb-a} - R_{th mb-h}$

c. Any measurement of heatsink temperature should be made immediately adjacent to the device.

FULL-CYCLE OPERATION



Fig. 4 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.

 $\alpha = \alpha_1 = \alpha_2$: conduction angle per half cycle

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Fig.6 Maximum permissible duration of steady overload (provided that T_{mb} does not exceed 120 °C during and after overload) expressed as a percentage of the steady state r.m.s. rated current. For high r.m.s. overload currents precautions should be taken so that the temperature of the terminals does not exceed 125 °C. During these overload conditions the triac may lose control. Therefore the overload should be terminated by a separate protection device.



Fig.7



Fig.15

Triacs

BT139 SERIES



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Fig.10 Typical commutation dV/dt for BT139 series versus T_j . The triac should commutate when the dV/dt is below the value on the appropriate curve for pre-commutation dI_T/dt.





Triacs

BT139 SERIES



Fig.12 Typical commutation dV/dt for BT139F series versus T_j . The triac should commutate when the dV/dt is below the value on the appropriate curve for pre-commutation dI_T/dt.





FULL-PACK TRIACS

Glass-passivated 16 ampere triacs in SOT-186 envelopes, which feature an electrically isolated seating plane. They are intended for use in applications requiring high bidirectional transient and blocking voltage capability. Typical applications include a.c. power control circuits such as lighting, industrial and domestic heating, motor control and switching systems.

QUICK REFERENCE DATA

		BT139F	- 500	600	800	
Repetitive peak off-state voltage	V _{DRM}	max.	500	600	800	v
R.M.S. on-state current	IT(RMS)	max.		16		А
Non-repetitive peak on-state current	ITSM	max.		140		А

MECHANICAL DATA

Fig.1 SOT-186





Net mass: 2g

The seating plane is electrically isolated from all terminals.

Accessories supplied on request (see data sheets Mounting instructions for F-pack devices and Accessories for SOT-186 envelopes).

Dimensions in mm

RATINGS

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

Voltages (in either direction)		BT 1391	500	600	800	
Non-repetitive peak off-state voltage (t \leq 10 ms)	V _{DSM}	max.	500*	600*	800	v
Repetitive peak off-state voltage ($\delta \le 0.01$)	VDRM	max.	500	600	800	v
Crest working off-state voltage	V _{DWM}	max.	400	400	400	v
Currents (in either direction)						
R.M.S. on-state current (conduction angle 360 °) up to $T_h = 67$ °C	I _{T(RMS)}	max.		16		A
Repetitive peak on-state current	^I TRM	max.		140		А
Non-repetitive peak on-state current; T _i = 120 ^O C prior to surge;						
t = 20 ms; full sine-wave	^I тѕм	max.		140		А
I ² t for fusing (t = 10 ms)	l² t	max.		95		A² s
Rate of rise of on-state current after triggering with $I_G = 200 \text{ mA to } I_T = 20 \text{ A};$						
$dI_{G}/dt = 0.2 \text{ A}/\mu \text{s}$	dl _T /dt	max.		30		A/μs
Gate to terminal 1						
Power dissipation						
Average power dissipation (averaged over any 20 ms period)	P _G (AV)	max.		0.5		w
Peak power dissipation	P _{GM}	max.		5.0		W
Temperatures						
Storage temperature Full-cycle operating temperature	T _{stg} T _j	max.	40 to	+125 120		°C °C
ISOLATION						
From all three terminals to external heatsink (peak)	V _{isol}	min.		1000		v
Capacitance from T ₂ to external heatsink	C _{isol}	typ.		12		pF

*Although not recommended, off-state voltages up to 800 V may be applied without damage, but the triac may switch into the on-state. The rate of rise of on-state current should not exceed 15 A/ μ s.

June 1986

THERMAL RESISTANCE

1. Heatsink-mounted with clip (see mounting instructions)

Thermal resistance from junction to external heatsink				
With heatsink compound	R _{th j-h}	=	3.5	K/W
Without heatsink compound	R _{th j-h}	=	4.5	K/W

2. Free-air operation

The quoted values of $R_{th\ j\text{-}a}$ should be used only when no leads of other dissipating components run to the same tie-point.

Thermal resistance from junction to ambient in free air: mounted on a printed-circuit board at a = any lead length

R _{thi-a}	=	55	K/W



Fig.2

CHARACTERISTICS ($T_j = 25 {}^{O}C$ unless other Polarities positive or porative are identified a	erwise stat	ed)					
Voltages and currents (in either direction)	with respe		1.				
On-state voltage (measured under pulse condi	tions to n	rovent	avcassiv	a dissinat	ion)		
$I_T = 20 \text{ A}$		event	V	e uissipat T	<	1.6	v
Rate of rise of off-state voltage that will not t any device; T _j = 120 ^o C; gate open circuit BT139E series	rigger		ď	d dt	, · ·	100	Mus
BT 139F series G			ď	VD/dt	<	200	V/μs V/μs
BT139F series F			ď	V _D /dt	<	50	V/μs
BT139F series E			ď	V _D /dt	typ.	50	V/µs
Rate of change of commutating voltage that w trigger any device when -dl _{com} /dt = 7.2 A	vill not /ms;						
^I T(RMS) ⁼ 16 A; T _h = 70 ^o C; gate open cir V _D ^{= V} DWMmax	cuit;						
BT139F series			ď	V _{com} /dt	typ.	10	V/µs
BT139F series G			ď	V _{com} /dt	<	10	V/µs
BT139F series F			ď	v _{com/dt}	typ.	10	V/µs
Off-state current $V_D = V_{DWMmax}$; $T_j = 120 \ ^{o}$ C;)	<	0.5	mA
Gate voltage that will trigger all devices			v	эт	>	1.5	v
Gate voltage that will not trigger any device $V_D = V_{DWMmax}$; $T_j = 120 \text{ °C}$							
T ₂ and G positive or negative			v	GD	<	250	mV
Gate current that will trigger all devices (I_GT)	; G to T ₁		- .	- . 1			
Holding current (I _H)			2+	2+	T2	2	
Latching current (I _L); V _D = 12 V			GŦ	u	G	GT	
BT139F series	I _{GT} I _H I _L	> < <	35 30 40	35 30 60	35 30 40	70 30 60	mA mA mA
BT139F series G	I _{GT} I _H I _L	> < <	50 60 60	50 60 90	50 60 60	100 60 90	mA mA mA
BT139F series F	IGT I _H I _L	> < < <	25 30 40	25 30 60	25 30 40	70 30 60	mA mA mA
BT139F series E	I _{GT} I _H I _L	> < <	10 30 30	10 30 40	10 30 30	25 30 40	mA mA mA

MOUNTING INSTRUCTIONS

- The triac may be soldered directly into the circuit, but the maximum permissible temperature of the soldering iron or bath is 275 °C; it must not be in contact with the joint for more than 5 seconds. Soldered joints must be at least 4.7 mm from the seal.
- The leads should not be bent less than 2.4 mm from the seal, and should be supported during bending. The leads can be bent, twisted or straightened by 90° maximum. The minimum bending radius is 1 mm.
- 3. Mounting by means of a spring clip is the best mounting method because it offers good thermal contact under the crystal area and slightly lower R_{th j-h} values than screw mounting. However, if a screw is used, it should be M3 cross-recess pan-head. Care should be taken to avoid damage to the plastic body.
- 4. For good thermal contact heatsink compound should be used between seating plane and heatsink. Values of R_{th j-h} given for mounting with heatsink compound refer to the use of a metallic-oxide loaded compound. Ordinary silicone grease is not recommended.
- 5. Rivet mounting is not recommended.
- 6. The heatsink must have a flatness in the mounting area of 0.02 mm maximum per 10 mm. Mounting holes must be deburred.

OPERATING NOTES

Dissipation and heatsink considerations:

a. The various components of junction temperature rise above ambient are illustrated in Fig.3.



- b. The method of using Figs.4 and 5 is as follows:
- Starting with the required current on the $I_{T(RMS)}$ axis (I.h. graph) trace upwards to meet the appropriate conduction angle curve. Trace left from curve to obtain power P. Trace right from curve to obtain T_h (r.h. graph). Trace upwards from T_{amb} , intersect with T_h determines $R_{th h-a}$, required heatsink thermal resistance.
- c. Any measurement of heatsink temperature should be made immediately adjacent to the device.

FULL-CYCLE OPERATION (with heatsink compound)



Fig. 4 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.

 $\alpha = \alpha_1 = \alpha_2$: conduction angle per half cycle





Fig.5 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.





Fig.6 Maximum permissible duration of steady overload (provided that T_{mb} does not exceed 120 °C during and after overload) expressed as a percentage of the steady state r.m.s. rated current. For high r.m.s. overload currents precautions should be taken so that the temperature of the terminals does not exceed 125 °C. During these overload conditions the triac may lose control. Therefore the overload should be terminated by a separate protection device.



Triacs

BT139F SERIES





Fig. 10 Typical commutation dV/dt for BT139F series versus T_j . The triac should commutate when the dV/dt is below the value on the appropriate curve for pre-commutation dI_T/dt.





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Triacs

BT139F SERIES



Fig.12 Typical commutation dV/dt for BT139F series F versus T_j . The triac should commutate when the dV/dt is below the value on the appropriate curve for pre-commutation dI_T/dt.





LIMITS FOR STARTING OR INRUSH CURRENTS - FULL-CYCLE OPERATION

Fig.15.

TRIACS

Glass-passivated 25 ampere triacs intended for use in applications requiring high bidirectional transient and blocking voltage capability and high thermal cycling performance with very low thermal resistances. These triacs feature a high surge current capability. Typical applications include a.c. power control applications such as motor, industrial lighting, industrial and domestic heating control and static switching systems.

QUICK REFERENCE DATA

		BTA14	10-500	600	800	
Repetitive peak off-state voltage	V _{DRM}	max.	500	600	800	V
R.M.S. on-state current	IT(RMS)	max.		25		А
Non-repetitive peak on-state current (50Hz)	ITSM	max.		180		А
Non-repetitive peak on-state current (60Hz)	ITSM	max.		200		А

MECHANICAL DATA

Dimensions in mm

Fig.1 TO-220AB



Net mass- 2 g Note: The exposed metal mounting base is directly connected to terminal T_2 .

Accessories supplied on request: see data sheet Mounting instructions and accessories for TO-220 envelopes.

RATINGS

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

Voltages (in either direction)		BTA140	- 500	600	800	
Non-repetitive peak off-state voltage (t \leq 10 ms)	VDSM	max.	500*	600*	800	V
Repetitive peak off-state voltage ($\delta \leqslant$ 0.01)	VDRM	max.	500	600	800	V
Crest working off-state voltage	VDWM	max.	400	400	400	V
Currents (in either direction)						
R.M.S. on-state current (conduction angle 360°) up to T _{mb} = 89 °C		T(RMS)	m	iax.	25	A
Average on-state current for half-cycle operation (averaged over any 20 ms period) up to T _{mb} = 85 ^o C		^I T(AV)	m	iax.	18	A
Repetitive peak on-state current		ITRM	m	nax.	180	А
Non-repetitive peak on-state current; $T_j = 120$ °C prior to surge; full sine-wave						
t = 20 ms t = 16.7 ms		ITSM ITSM	m m	nax. nax.	180 200	A A
I^2 t for fusing (t = 10 ms)		l ² t	m	nax.	160	A² s
Rate of rise of on-state current after triggering with $I_G = 200 \text{ mA}$ to $I_T = 30 \text{ A}$; $dI_G/dt = 0.2 \text{ A}/\mu s$		dI _T /dt	n	nax.	30	A∕µs
Gate to terminal 1						
Power dissipation						
Average power dissipation (averaged over any 20 ms period)		PG(AV)	n	nax.	0.5	W
Peak power dissipation		PGM	n	nax.	5	W
Temperatures						
Storage temperature		⊤ _{stg}	-	-40 to	+125	٥C
Operating junction temperature full-cycle operation half-cycle operation		Tj Tj	n n	nax. nax.	120 110	٥C ٥C

* Although not recommended, off-state voltages up to 800 V may be applied without damage, but the triac may switch into the on-state. The rate of rise of on-state current should not exceed 15 A/ μ s.

THERMAL RESISTANCE

From junction to mounting base full-cycle operation half-cycle operation	R _{th j-mb} = 1.0 R _{th j-mb} = 1.4	K/W K/W
Transient thermal impedance; t = 1 ms	Z _{th j-mb} = 0.1	K/W
Influence of mounting method		
1. Heatsink mounted with clip (see mounting instructions)		
Thermal resistance from mounting base to heatsink		
a. with heatsink compound	$R_{th mb-h} = 0.3$	K/W
b. with heatsink compound and 0.06 mm maximum mica insulator	$R_{th mb-h} = 1.4$	K/W
c. with heatsink compound and 0.1 mm maximum mica insulator (56369)	$R_{th mb-h} = 2.2$	K/W
 d. with heatsink compound and 0.25 mm maximum alumina insulator (56367) 	$R_{th mb-h} = 0.8$	K/W
e, without heatsink compound	$R_{th mb-h} = 1.4$	K/W
2. Free-air operation		

The quoted values of $R_{th\ j-a}$ should be used only when no leads of other dissipating components run to the same tie-point.

Thermal resistance from junction to ambient in free air:

mounted on a printed-circuit board at a = any lead length

 $R_{th j-a} = 60 \text{ K/W}$



Fig.2

CHARACTERISTICS $(T_j = 25 \text{ °C unless c})$	otherwise	e statec	i)					
Polarities, positive or negative, are identified with respect to T_1 .								
Voltages and currents (in either direction)								
On-state voltage (measured under pulse con	ditions t	o preve	ent exces	sive dissi	oation)			
I _T = 30 A			٧T		<	1.55	V	
Rate of rise of off-state voltage that will not trigger any device; $T_i = 120 ^{\circ}\text{C}$; gate open circuit			dV	o/dt	<	100	V/µs	
Rate of change of commutating voltage that trigger any device when $-dl_{com}/dt = 9$ $I_{T}(RMS) = 25 A; T_{mb} = 75 {}^{\rm OC}$; gate op	t will no).0 A/ms en circu	t it;						
$V_D = V_{DWMmax}$		dVc	om/dt	typ.	10	V/µs		
Off-state current								
V _D = V _{DWMmax} ; T _j = 120 ^o C			۱D		<	0.5	mΑ	
Gate voltage that will trigger all devices			V _{GT} >			1.5	V	
Gate voltage that will not trigger any device	•							
$V_D = V_{DWMmax}$; $T_j = 120 \text{ oC}$; T_2 and G positive or negative			V _{GI}	D	<	250	mV	
			T2+ G+	T2+ G-	⊤2 G	T2- G+		
Gate current that will trigger all devices;								
G to T ₁	^I GT	>	35	35	35	70	mA	
Holding Current	ŀн	<	30	30	30	30	mA	
Latching current; V_D = 12 V; T_j = 25 ^o C	١L	<	40	60	40	60	mA	

MOUNTING INSTRUCTIONS

- The device may be soldered directly into the circuit, but the maximum permissible temperature of the soldering iron or bath is 275 °C; it must not be in contact with the joint for more than 5 seconds. Soldered joints must be at least 4.7 mm from the seal.
- The leads should not be bent less than 2.4 mm from the seal, and should be supported during bending. The leads can be bent, twisted or straightened by 90^o maximum. The minimum bending radius is 1 mm.
- It is recommended that the circuit connection be made to tag T₂, rather than direct to the heatsink.
- 4. Mounting by means of a spring clip is the best mounting method because it offers:
 - a. a good thermal contact under the crystal area and slightly lower $\rm R_{th}$ $\rm m_{b-h}$ values than screw mounting.
 - b. safe isolation for mains operation.

However, if a screw is used, it should be M3 cross-recess pan-head. Care should be taken to avoid damage to the plastic body.

- For good thermal contact, heatsink compound should be used between mounting base and heatsink. Values of 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.
- 6. Rivet mounting (only possible for non-insulated mounting)

Devices may be rivetted to flat heatsinks; such a process **must neither** deform the mounting tab, **nor** enlarge the mounting hole.

7. The heatsink must have a flatness in the mounting area of 0.02 mm maximum per 10 mm. Mounting holes must be deburred.

OPERATING NOTES

Dissipation and heatsink considerations:

 The various components of junction temperature rise above ambient are illustrated in Fig.3.



F ig.3.

- b. The method of using Fig.4 is as follows:
 - Starting with the required current on the $I_T(RMS)$ axis, trace upwards to meet the appropriate conduction angle curve. Trace right horizontally and upwards from the appropriate value on the T_{amb} scale. The intersection determines the $R_{th\ mb-a}$. The heatsink thermal resistance value $(R_{th\ h-a})$ can now be calculated from:

$R_{th h-a} = R_{th mb-a} - R_{th mb-h}$

c. Any measurement of heatsink temperature should be made immediately adjacent to the device.

FULL-CYCLE OPERATION



Fig.4 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.







Fig.5 Maximum permissible duration of steady overload (provided that T_{mb} does not exceed 120 °C during and after overload) expressed as a percentage of the steady state r.m.s. rated current. For high r.m.s. overload currents precautions should be taken so that the temperature of the terminals does not exceed 125 °C. During these overload conditions the triac may lose control. Therefore the overload should be terminated by a separate protection device.



Fig.6 Minimum gate voltage that will trigger all devices; all conditions.



Fig.7 Normalised gate current that will trigger all devices; all conditions.



Fig.8 Maximum permissible non-repetitive r.m.s. on-state current based on sinusoidal currents (f = 50 Hz); $T_i = 120$ °C prior to surge. The triac may temporarily lose control following the surge.



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TRIACS

Glass-passivated silicon triacs in metal envelopes, intended for industrial a.c. power control and particularly suitable for static switching of 3-phase induction motors. They may also be used for furnace control, lighting control and other static switching applications up to an r.m.s. on-state current of 15 A.

Two grades of commutation performance are available, 10 V/ μ s at 5 A/ms (suffix G) and 10 V/ μ s at 12 A/ms (suffix H).

QUICK REFERENCE DATA

		BTW43-600		800	1000	1200	
Repetitive peak off-state voltage VDR	м	max.	600	800	1000	1200	v
R.M.S. on-state current				MS)	max.	15	А
Non-repetitive peak on-state current			ITSM		max.	120	А
Rate of rise of commutating voltage that will not trigger any device (see Characteristics)			dV _{co}	m/dt	<	10	V∕µs

MECHANICAL DATA

Fig. 1 TO-64: with metric M5 stud (ϕ 5 mm).



Net mass: 7 g

Diameter of clearance hole: max. 5,2 mm Accessories supplied on request: 56295a (mica washer); 56295b (PTFE ring); 56295c (insulating bush).

Supplied with the device: 1 nut, 1 lock washer Nut dimensions across the flats: 8,0 mm





Torque on nut: min. 0,9 Nm (9 kg cm) max. 1,7 Nm (17 kg cm)

Dimensions in mm

BTW43 SERIES

RATINGS

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

Voltages (in either direction)*		DTWAR	600	000	1000	1200	
Non-repetitive peak off-state voltage		D1 W43	-000	800	1000	1200	
(t ≤ 10 ms)	VDSM	max.	600	800	1000	1200	V
Repetitive peak off-state voltage	VDRM	max.	600	800	1000	1200	V
Crest working off-state voltage	V _{DWM}	max.	400	600	700	800	V
Currents (in either direction)							
R.M.S. on-state current (conduction angle 360°)							
up to $T_{mb} = 75 ^{\circ}C$			T(RMS)		max.	15	A A
at $T_{mb} = 65 \text{°C}$			11	יד(RMS)		50	<u>,</u>
Repetitive peak on-state current			ΙT!	RM	max.	50	A
Non-repetitive peak on-state current T _i = 125 ^o C prior to surge; t = 20 ms; full sine-wave			١тs	SM	max.	120	A
I^2 t for fusing (t = 10 ms)			l² t		max.	72	$A^2 s$
Rate of rise of on-state current after triggering with $I_G = 0.5 A$ to $I_T = 25 A$; $dI_G/dt = 0.5 A/\mu s$			dI _T /dt		max.	50	A∕µs
Gate to terminal 1							
Power dissipation							
Average power dissipation (averaged over any 20 ms period)			PG	(AV)	max.	1	W
Peak power dissipation			PG	М	max.	10	W
Temperatures							
Storage temperature			T _{s1}	tg	- 55 to	+ 125	oC
Junction temperature			т _ј		max.	125	oC
THERMAL RESISTANCE							
From junction to mounting base							
full-cycle operation			Rti	h j-mb	=	2,0	K/W
half-cycle operation			Rt C	h j-mb	=	4,0	r∖/W
From mounting base to heatsink with heatsink compound			R _t	h mb-h	=	0,5	K/W
Transient thermal impedance; t = 1 ms			Ztl	n j-mb	=	0,2	K/W

* To ensure thermal stability: $R_{th\ j-a}$ < 6 K/W (full-cycle or half-cycle operation). For smalller heat-sinks T_j should be derated (see Fig.2).

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CHARACTERISTICS	$(T_{i} = 25 ^{\circ}\text{C} \text{ unless otherwise states})$	ted)
		acou,

Polarities positive or negative, are identified with respect to T1.

Voltages (in either direction)

On-state voltage $I_T = 20 \text{ A}$	٧T		< :	2,2 V*		
Rate of rise of off-state voltage that will not trigger any device; exponential method; $V_D = 2/3 V_{DRMmax}$; $T_j = 125 ^{o}\text{C}$	dV _D /dt		< 2	200 V/µs		
Rate of rise of commutating voltage that will not trigger any devi $T(RMS) = 12 A; V_D = V_{DWMmax}; T_{mb} = 85 ^{\circ}C$	ice; _dV _{co}	m/dt (V/μs)	-dl_/d	dt (A/ms)		
BTW43-600G to 1200G BTW43-600H to 1200H		< 10 < 10		5 12		
Currents (in either direction)						
Off-state current						
V _D = V _{DWMmax} ; T _j = 125 °C	۱D		<	5 mA		
	-	T ₂ pos.	T ₂	neg.		
Latching current	-		-			
G positive	L	< 200	2	200 mA		
G negative	۱L	< 200	2	200 mA		
Holding current		< 100				
G positive or negative	ιΗ	< 100		00 mA		
Gate to terminal 1						
Voltage and current that will trigger all devices $V_D = 12 V$						
G positive	{VGT IGT	> 2,5 > 100	2	5,0 V 200 mA		
G negative	(−V _G	T > 2,5 - > 100	1	2,5 V 00 mA		
Voltage that will not trigger any device	51					
V _D = V _{DRMmax} ; T _j = 125 ^o C; G positive or negative	V _{GD}	< 0,2		0,2 V		

* Measured under pulse conditions to avoid excessive dissipation.
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BTW43 SERIES





BTW43 SERIES



Fig. 6 Minimum gate voltage that will trigger all devices as a function of ${\rm T}_{\rm j}.$

Fig. 7 Minimum gate current that will trigger all devices as a function of T_i .

Conditions for Figs 6 and 7:

Triacs



Fig. 8 Maximum rate of rise of commutating voltage that will not trigger any device as a function of rate of fall of on-state current; $I_T(RMS) = 12 \text{ A}$; $V_D = V_{DWMmax}$.





ACCESSORIES



TYPE NUMBER SUMMARY

type number	e number description	
56264a	mica washer (up to 2000 V)	DO-5, TO-48
56264b	insulating bush	DO-5, TO-48
56295a	mica washer (up to 2000 V)	DO-4, TO-64
56295b	PTFE ring	DO-4, TO-64
56295c	insulating bush	DO-4, TO-64
56359b	mica washer (up to 1000 V)	TO-220
56359c	insulating bush (up to 800 V)	TO-220
56359d	rectangular insulating bush (up to 1000 V)	TO-220
56360a	rectangular washer	TO-220
56363	spring clip (direct mounting)	TO-220, SOT-186 🟼 🖛
56364	spring clip (insulated mounting)	TO-220
56367	alumina insulator (up to 2000 V)	TO-220
56368b	insulating bush (up to 800 V)	SOT-93
56368c	mica insulator (up to 800 V)	SOT-93 🔶
56369	mica insulator (up to 2000 V)	TO-220
56378	mica insulator (up to 1500 V)	SOT- 93
56379	spring clip	SOT-93, SOT-112

56264a

MICA WASHER

Insulator up to 2000 V

MECHANICAL DATA

Dimensions in mm



56264b

INSULATING BUSH

MECHANICAL DATA

Dimensions in mm



THERMAL RESISTANCE	0.8			
From mounting base to heatsink	M1452			
with mica washer, without heatsink compound	R _{th} mb-h	=	5	K/W
with mica washer, with heatsink compound	R _{th mb-h}	=	2.5	K/W
TEMPERATURE				
Maximum allowable temperature	т _{тах}	=	175	٥C

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56295a

MICA WASHER

Insulator up to 2 kV.

MECHANICAL DATA

Dimensions in mm



56295b PTFE RING

MECHANICAL DATA

Dimensions in mm



THERMAL RESISTANCE

From mounting base to heatsink without heatsink compound with heatsink compound TEMPERATURE Maximum allowable temperature max

56295c INSULATING BUSH

MECHANICAL DATA



R _{th} mb-h	=	5	K/W
R _{th} mb-h		2.5	K/W
Tmax	=	175	٥C

56359b

MICA WASHER

Insulator up to 1000 V.

MECHANICAL DATA



Insulator up to 1000 V.



Dimensions in mm

ACCESSORIES for TO-220 and SOT-186

56360a

RECTANGULAR WASHER (For TO-220)

SPRING CLIP (For TO-220 and SOT-186)

For direct and insulated mounting.

MECHANICAL DATA

Material: brass; nickel plated.



Dimensions in mm

56363

For direct mounting.

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).



SPRING CLIP (For TO-220)

For insulated mounting.

MECHANICAL DATA

56364

Material: stainless steel; for mounting on heatsink of 1.0 to 1.5 mm.



Dimensions in mm

56367

ALUMINA INSULATOR

For insulated clip mounting 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 up to 2 kV.

MECHANICAL DATA



Dimensions in mm

436

56368b

INSULATING BUSH

For insulated screw mounting up to 800 V.

MECHANICAL DATA

Material: polyester



TEMPERATURE

Maximum permissible temperature

56368c

MICA INSULATOR

For insulated screw mounting up to 800 V.

MECHANICAL DATA



56369: see preceding page.

Dimensions in mm

T_{max} = 150 °C

56378

MICA INSULATOR

For clip mounting up to 1500 V.

MECHANICAL DATA

25 0,06±0,02 28 28 28 28 28 28 275#51.1

56379

SPRING CLIP

For direct and insulated mounting of SOT-93 and SOT-112 envelopes.

MECHANICAL DATA

Dimensions in mm

Dimensions in mm

Material: CrNi steel NLN-939; thickness 0.4 ± 0.04.



MOUNTING INSTRUCTIONS



MOUNTING INSTRUCTIONS FOR TO-220 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 devices

1. Clip mounting

Mounting with a spring clip gives:

- 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 N	m (5	5,5 kg	jcm))				
Maximum	torque (to a	void da	imaging	the d	evice)			(),80 N	m (8	8,0 kg	jcm)
													,	

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)

3. Rivet mounting non-insulated

The device should not be pop-rivetted to the heatsink. However, 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

(Typical figures, for exact figures see data for each device type). From mounting base to beatsink					
R _{th mb-h}		0,3	0,5	K/W	
R _{th mb-h}	=	1,4	1,4	K/W	
R _{th mb-h}	н	2,2	_	K/W	
R _{th mb-h}	=	0,8	_	K/W	
R _{th} mb-h R _{th} mb-h	=		1,4 1,6	K/W K/W	
R _{th mb-h} R _{th mb-h}	=		3,0 4,5	K/W K/W	
	type). Rth mb-h Rth mb-h Rth mb-h Rth mb-h Rth mb-h Rth mb-h Rth mb-h Rth mb-h	type).c moiR th mb-h=R th mb-h=	type).clip mounting R_{th} mb-h=0,3 R_{th} mb-h=1,4 R_{th} mb-h=2,2 R_{th} mb-h=0,8 R_{th} mb-h=-	type).clip mountingscrew mountingRth mb-h=0,30,5Rth mb-h=1,41,4Rth mb-h=2,2-Rth mb-h=0,8-Rth mb-h=-1,4Rth mb-h=-1,6Rth mb-h=-3,0Rth mb-h=-4,5	

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 abovementioned 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 Sm/36 Pb/2 Ag or 60 Sn/40 Pb.

Maximum soldering temperature $\leq 200 \text{ °C}$ (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 $\leq 165 \text{ °C}$ at a duration $\leq 10 \text{ s}$.

INSTRUCTIONS FOR CLIP MOUNTING

Direct mounting with clip 56363

- 1. Apply heatsink compound to the mounting base, then place the device on the heatsink.
- 2. Push the short end of the clip into the narrow slot in the heatsink with 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). Do not insert more than 1 mm beyond final position.



Fig. 1 Heatsink requirements.

Fig. 2 Mounting. (1) spring clip 56363. Fig. 2a Position of device (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 device and insulator, then place the device with the insulator on the heatsink.
- 2. Push the short end of the clip into the narrow slot in the heatsink with the clip at an angle of 10° to 30° to the vertical (see 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 creepage.

Do not insert more than 1 mm beyond final position.



Fig. 3 Heatsink requirements.

Fig. 4 Mounting. (1) spring clip 56364. (2) insulator 56369 or 56367. Fig.4a Position of device (top view).

INSTRUCTIONS FOR SCREW MOUNTING

Dimensions in mm

Direct mounting with screw and spacing washer

• through heatsink with nut





Fig. 5 Assembly.

- (1) M3 screw.
- (2) rectangular washer (56360a).
- (3) lock washer.
- (4) M3 nut.
- (5) heatsink.
- (8) plain washer.
- into tapped heatsink







Fig. 8 Heatsink requirements.

Fig. 7 Assembly. (1) M3 screw.

- (2) rectangular washer 56360a.

(5) heatsink.

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Dimensions in mm

Insulated mounting with screw and spacing washer

(not recommended where mounting tab is on mains voltage)

• through heatsink with nut







Fig. 10 Heatsink requirements for 500 V insulation.



Fig. 11 Heatsink requirements for 800 V insulation.



Fig. 12 Insulated screw mounting with rectangular washer into tapped heatsink. Known as a "top mounting".



Fig. 13 Heatsink requirements for 500 V insulation.







MOUNTING INSTRUCTIONS FOR TO-220 FULL-PACK (SOT-186) DEVICES

Use of full-pack (SOT-186 envelope) devices allows an insulated mounting with up to 1kV isolation. These devices require the assembly of less components than TO-220 devices with insulating washers.

GENERAL DATA AND INSTRUCTIONS

General rules

1. Mounting instructions for voltage isolation are given for guidance. Users should aquaint themselves with the relevant statutory and mandatory regulations if the heatsink is earthed or may be touched.

2.Fasten device to heatsink before soldering the leads.

3. Avoid axial stress to the leads.

4.Be careful to avoid damaging plastic with mounting tool (e.g. screwdriver).

5.If a rectangular washer (part no. 56360a) is used in screw mounting it may only touch the main part of the body, it should not exert any force on this part.

Heatsink requirements

Flatness in the mounting area: 0.02mm maximum per 10mm.

Mounting holes must be deburred.

Heatsink compound

Values of thermal resistance given using heatsink compound refer to the use of a metallic oxideloaded compound. Ordinary silicone grease is not recommended.

Mounting methods for power devices

1.Clip mounting:

This gives better thermal contact under the crystal area than screw mounting.

For details of mounting force for spring clip mounting see data sheet "Accesories for TO-220".

2.M3 screw mounting:

It is recommended that a rectangular spacing washer (part no. 56360a) is inserted between the screw head and plastic mounting tab.

N.B. Data on accessories are given in separate data sheet "Accesories for TO-220".

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 against a curved spring washer or lock washer (not for thread-forming screws) the torques are as follows:				
Minimum torque (for good heat transfer)	0.40 Nm (4.0 kgcm)			
Maximum torque (to avoid damaging device)	0.60 Nm (6.0 kgcm)			

3.Rivet mounting:

This method is **NOT** recommended because it will damage the plastic encapsulation.

MOUNTING INSTRUCTIONS F-PACK

Lead bending

(Maximum permissible tensile force on the body, for 5 seconds is 20N (2kgf).

The leads should not be bent less than 2.4mm from the seal, and should be supported during bending.

The leads can be bent, twisted or straightened by 90 ^o maximum. The minimum bending radius is 1mm.



Fig.1 Lead bending of devices.

Soldering

Lead soldering temperature at >3mm from body for t_{sld} <5 seconds:

Devices with T_i max. ≤175 °C, T_{sld} max. = 275 °C.

Devices with T_i max. \leq 110 °C, T_{sld} max. = 240 °C.

Avoid any force on body and leads during or after soldering. Do not correct the position of the devices or of its leads after soldering.

INSTRUCTIONS FOR CLIP MOUNTING

1.Apply heatsink compound to the mounting base, then place device on heatsink.

- 2. Push the short end of clip (part no. 56363) into the narrow slot in the heatsink with the clip at an angle of between 10° to 30° to the vertical (see Figs.2 & 3).
- 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 down on the main part of the body, not on the tab (see Fig.3a).



INSTRUCTIONS FOR SCREW MOUNTING

Screw through heatsink with nut

Dimensions in mm



- Fig.4 Assembly.
- (1) M3 screw
- (2) plain washer
- (3) lock washer
- (4) M3 nut
- (5) heatsink

Into tapped heatsink



Fig.6 Assembly.

(5) heatsink



V

- Ø3,3 +

Fig.5 Heatsink requirements.

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Fig.7 Heatsink requirements.



MOUNTING REQUIREMENTS FOR VOLTAGE ISOLATION

Full-pack devices may be used to maintain voltage isolation between the heatsink and the electrical circuit. However, users must ensure that there is a sufficient creepage distance between the exposed metal of the device (at both the lead and tab ends) and the heatsink. The distance required will vary according to the application and the regulations that may apply.

To increase the creepage distances the heatsink may be formed with slots or holes around the lead and tab ends of the device. The dimensions of the holes will vary according to the creepage distances required. For detail see Fig.8.





MOUNTING INSTRUCTIONS FOR SOT-93 ENVELOPES

GENERAL DATA AND INSTRUCTIONS

General rule

Avoid any sudden forces on leads and body; these forces, such as from falling on a hard surface, are easily underestimated. In the direct screw mounting an M4 screw must be used; an M3 screw in the insulating mounting.

Heatsink requirements

Flatness in the mounting area: 0,02 mm maximum 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

1)
i)
1)
1)

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

No torsion is permitted at the emergence of the leads.

Bending or twisting is not permitted within a lead length of 0,3 mm from the body of the device.

The leads can be bent through 90° maximum, twisted or straightened; to keep forces within the abovementioned limits, the leads should be clamped near the body.

20 N (2 kgf)

Soldering

Recommendations for devices with a maximum junction temperature rating ≤ 175 °C:

a. Dip or wave soldering

Maximum permissible solder temperature is 260 $^{\circ}$ 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 $^{\circ}$ 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

•	(Typical figures, for exact figures see data for each device type).		mo	clip unting	scro mour	ew ntir	ng
	Thermal resistance from mounting base to heatsink direct mounting with heatsink compound without heatsink compound	R _{th mb-h} R _{th mb-h}		0,3 1,5	0, 0,	3 8	K/W K/W
	with 0,05 mm mica washer with heatsink compound without heatsink compound	R _{th mb-h} R _{th mb-h}	И	0,8 3,0	0, 2,	8 2	K/W K/W

INSTRUCTIONS FOR CLIP MOUNTING

Direct mounting with clip 56379

- 1. Place the device on the heatsink, applying heatsink compound to the mounting base.
- Push the short end of the clip into the narrow slot in the heatsink with the clip at an angle of 10° to 20° to the vertical (see Fig. 1b).
- 3. Push down the clip over the device until the long end of the clip snaps into the wide slot in the heatsink. The clip should bear on the plastic body, not on the tab (see Fig. 1(c)).







Fig. 1a Heatsink requirements.

Fig. 1b Mounting. (1) = spring clip 56379.



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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^o 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.



INSTRUCTIONS FOR SCREW MOUNTING

Direct mounting 1 SOT-93 heatsink (2 (6 7289317

Fig. 3a Assembly through heatsink with nut.



Fig. 3b Heatsink requirements.

When screw mounting the SOT-93 envelope, it is particularly important to apply a thin, even layer of heatsink compound to the mounting base, and to apply torgue to the screw slowly so that the compound has time to flow and the mounting base is not deformed. Most SOT-93 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.

Legend: (1) M4 screw; (2) plain washer; (6) M4 nut.

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 (56368c)
- (5) lock washer
- (6) M3 nut





Fig. 5 Heatsink requirements up to 800 V insulation.



Fig. 6 Assembly. See also Fig. 9.



Fig. 7 Heatsink requirements up to 800 V insulation.

- (1) M3 screw
- (2) plain washer
- (3) insulating bush (56368b)
- (4) mica insulator (56368c)
- (5) lock washer

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Insulated screw mounting with insert nut; up to 500 V



Fig. 8 Assembly and heatsink requirements for 500 V insulation. See also Fig. 3.

(1)	M3 screw
(2)	plain washer

- (3) insulating bush
- (56368b) (4) mica insulator (56368c)
- (5) lock washer



Fig. 9 Mica insulator.

The axial deviation (α) between SOT-93 and mica should not exceed 5°.

MOUNTING CONSIDERATIONS FOR STUD-MOUNTED DEVICES

Losses generated in a silicon device must flow through the case and to a lesser extent the leads. The greatest proportion of the losses flow out through the case into a heat exchanger which can be either free convection cooled, forced convection or even liquid cooled. For the majority of devices in our range natural convection is generally adequate, however, where other considerations such as space saving must be taken into account then methods such as forced convection etc. can be considered. The thermal path from junction to ambient may be considered as a number of resistances in series. The first thermal resistance will be that of junction to mounting base, usually denoted by $R_{\rm th}$ j-mb. The second is the contact thermal resistance $R_{\rm th}$ mb-h and finally there is the thermal resistance of the heatsink $R_{\rm th}$ h-a

In the rating curves, the contact thermal resistance and heatsink thermal resistances are combined as a single figure - Rth mb-a-

In addition to the steady state thermal conditions of the system, consideration should also be given to the possibility of any transient thermal excursions. These can be caused for example by starting conditions or overloads and in order to calculate the effect on the device, a graph of transient thermal resistance $Z_{th \ i-mb}$ as a function of time is given in each data sheet.



When mounting the device on the heatsink, care should be taken that the contact surfaces are free from burrs or projections of any kind and must be thoroughly clean.

In the case where an anodised heatsink is used, the anodising should be removed from the contact surface ensuring good electrical and thermal contact.

The contact surfaces should be smeared with a metallic oxide-loaded grease to ensure good heat transfer. Where the device is mounted in a tapped hole, care should be taken that the hole is perpendicular to the surface of the heatsink. When mounting the device to the heatsink, it is essential that a proper torque wrench is used, applying the correct amount of torque as specified in the published data.

Excessive torque can distort the threads of the device and may even cause mechanical stress on the wafer, leading to the possible failure.

Where isolation of the device from the heatsink is required, it is common practice to use a mica washer between contact surfaces, and where a clearance hole is used, a p.t.f.e. insulating bush is inserted. A metallic oxide-loaded heatsink compound should be smeared on all contact surfaces, including the mica washer, to ensure optimum heat transfer. The use of ordinary silicone grease is not recommended.

MOUNTING INSTRUCTIONS FOR DO-4 AND TO-64 ENVELOPES

GENERAL DATA AND INSTRUCTIONS

Mounting instructions for up to 2000 V insulation using 56295c insulating bush and 56295a mica washer.

Mounting instructions for up to 2000 V insulation using 56295b insulating ring and two 56295a mica washers.

HEATSINK REQUIREMENTS

Mounting holes must be deburred.

MOUNTING TORQUES

Minimum torque (for good heat transfer)	0.9 Nm (9 kg cm)
Maximum torque (to avoid damaging device)	1.7 Nm (17 kg cm)

THERMAL DATA

The thermal resistance from mounting base to heatsink (R_{th} mb-h) can be reduced by applying a heat conducting compound between device and heatsink. For insulated mounting the compound should be applied to the bottom of both device and insulator.

Thermal resistance from mounting base to heatsink (insulated mounting using 56295a mica washer) without heatsink compound with heatsink compound

R _{th} mb-h	=	5	K/W
R _{th} mb-h	=	2.5	K/W

MOUNTING INSTRUCTIONS DO-4: TO-64

MOUNTING INSTRUCTIONS FOR UP TO 2000 V INSULATION

Using 56295c insulating bush and 56295a mica washer.



Using insulating ring 56295b and two mica washers 56295a.



Fig. 2

MOUNTING INSTRUCTIONS DO-4; TO-64

(1a); (1b)	tag — alternative positions
(2)	mica washer 56295a
(3)	insulating ring 56295b
(4)	mica washer 56295a
(5)	plain washer (may be omitted
	if tag used in position 1b)
(6)	toothed lock washer (supplied with dev
(7)	10-32 nut (supplied with device)

MOUNTING INSTRUCTIONS FOR DO-5 AND TO-48 ENVELOPES

GENERAL DATA AND INSTRUCTIONS

Mounting instructions for up to 2000 V insulation using 56264b insulating bush and 56264a mica washer.

HEATSINK REQUIREMENTS

Mounting holes must be deburred.

MOUNTING TORQUES

Minimum torque (for good heat transfer)	1.7 Nm (17 kg cm)
Maximum torque (to avoid damaging device)	3.5 Nm (35 kg cm)

THERMAL DATA

The thermal resistance from mounting base to heatsink (R_{th} mb-h) can be reduced by applying a heat conducting compound between device and heatsink. For insulated mounting the compound should be applied to the bottom of both device and insulator.

Thermal resistance from mounting base

to heatsink (insulated mounting using 56264a mica washer)				
without heatsink compound	R _{th} mb-h	=	5	K/W
with heatsink compound	R _{th} mb-h	22	2.5	K/W

MOUNTING INSTRUCTIONS FOR UP TO 2000 V INSULATION

Using insulating bush 56264b and mica washer 56264a.






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BA221	S1	SD	BAS31	S7/S1	Mm/SD	BAV100	S7/S1	Mm/SD
BA223	S1	Т	BAS32	S7/S1	Mm/SD	BAV101	S7/S1	Mm/SD
BA281	S1	SD	BAS35	57/S1	Mm/SD	BAV102	S7/S1	Mm/SD
BA314	S1	Vrg	BAS45	S1	SD	BAV103	S7/S1	Mm/SD
BA315	S1	Vrq	BAS56	S1/S7	SD/Mm	BAW56	S7/S1	Mm / SD
BA316	S1	SD	BAT17	\$7/\$1	Mm/T	BAW62	S1	SD
BA317	S1	SD	BAT18	S7/S1	Mm/T	BAX12	S1	SD
BA318	S1	SD	BAT54	S1/S7	SD/Mm	BAX14	S1	SD
BA423	S1	т	BAT74	S1/S7	SD/Mm	BAX18	S1	SD
BA480	S1	Т	BAT81	S1	Т	BAY80	S1	SD
BA481	S1	Т	BAT82	S1	Т	BB112	S1	T
BA482	S1	Т	BAT83	S1	Т	BB119	S1	Т
BA483	S1	Т	BAT85	S1	Т	BB130	S1	Т
BA484	S1	Т	BAT86	S1	Т	BB204B	S1	Т
BA682	G1/G7	T/Mm	BAV10	G1	SD	BB204G	G1	т
BA683	51/57	T/Mm	BAV18	S1	SD	BB212	S1	Ť
BAC11	G1	5D	BAV19	51	SD	BB215	\$7/\$1	Mm/SD
BAS15	G1	SD	BAV20	51	SD	BB219	\$7/\$1	Mm/SD
BASIS	G7/G1	Mm /SD	BAV21	51	SD	BB405B	S1/51	T T
DASTO	57751	1111/50	DAVE	51	50	DD403D	51	1
BAS17	S7/S1	Mm/Vrg	BAV23	S7/S1	Mm/SD	BB417	S1	Т
BAS19	S7/S1	Mm/SD	BAV45	S1	Sp	BB809	S1	Т
BAS20	S7/S1	Mm/SD	BAV45A	S1	Sp	BB909A	S1	Т
BAS21	S7/S1	Mm/SD	BAV70	S7/S1	Mm/SD	BB909B	S1	Т
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Mm = Microminiature semiconductors

for hybrid circuits SD = Small-signal diodes Sp = Special diodes

T = Tuner diodes

Vrg = Voltage regulator diodes

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BBY40	S7/S1	Mm / T	BC640	S3	Sm	BCW81:R	S7	Mm
BC 107	S3	Sm	BC807	57	Mm	BCW89:R	S7	Mm
BC108	\$3	Sm	BC808	57	Mm	BCX17:R	57	Mm
BC109	S 3	Sm	BC817	S7	Mm	BCX18:R	S7	Mm
				-				
BC140	S 3	Sm	BC818	S7	Mm	BCX19:R	S7	Mm
BC141	S 3	Sm	BC846	S7	Mm	BCX20:R	S7	Mm
BC146	S 3	Sm	BC847	S7	Mm	BCX51	S7	Mm
BC160	S3	Sm	BC848	S7	Mm	BCX52	S7	Mm
BC161	S3	Sm	BC849	S7	Mm	BCX53	S7	Mm
BC177	S3	Sm	BC850	S7	Mm	BCX54	S7	Mm
BC178	S 3	Sm	BC856	S7	Mm	BCX55	S7	Mm
BC179	S3	Sm	BC857	S7	Mm	BCX56	S7	Mm
BC200	S3	Sm	BC858	S7	Mm	BCX68	S7	Mm
BC264A	S5	FET	BC859	S7	Mm	BCX69	S7	mm
								}
BC264B	S5	FET	BC860	S7	Mm	BCX70*	S7	Mm
BC264C	S5	FET	BC868	S7	Mm	BCX71*	S7	Mm
BC264D	S5	FET	BC869	S 7	Mm	BCY56	S3	Sm
BC327;A	S3	Sm	BCF29;R	S7	Mm	BCY57	S 3	Sm .
BC328	S 3	Sm	BCF30;R	S 7	Mm	BCY58	S3	Sm
BC337;A	S3	Sm	BCF32;R	S7	Mm	BCY59	S3	Sm
BC338	S3	Sm	BCF33;R	S7	Mm	BCY70	S3	Sm
BC368	S3	Sm	BCF70;R	S7	Mm	BCY71	S3	Sm
BC369	S 3	Sm	BCF81;R	S7	Mm	BCY72	53	Sm
BC375	S3	Sm	BCV26	s7	Mm	BCY78	S3	Sm
BC376	S3	Sm	BCV27	S7	Mm	BCY79	S3	Sm
BC546	S 3	Sm	BCV61	S7	Mm	BCY87	S3	Sm
BC547	S 3	Sm	BCV62	S7	Mm	BCY88	S3	Sm
BC548	53	Sm	BCV71;R	S7	Mm	BCY89	S3	Sm
BC549	53	Sm	BCV72;R	S7	Mm	BD131	S4a	P
BC550	53	Sm	BCW29;R	S7	Mm	BD132	S4a	Р
BC556	S 3	Sm	BCW30; R	S7	Mm	BD135	S4a	P
BC557	S 3	Sm	BCW31;R	S7	Mm	BD136	S4a	P
BC558	S 3	Sm	BCW32;R	S7	Mm	BD137	S4a	P
BC559	S 3	Sm	BCW33;R	S7	Mm	BD138	S4a	P
				_				
BC560	S 3	Sm	BCW60*	s7	Mm	BD139	S4a	P
BC635	S 3	Sm	BCW61*	S7	Mm	BD140	S4a	Р
BC636	S 3	Sm	BCW69;R	S7	Mm	BD201	S4a	P
BC637	S 3	Sm	BCW70; R	S7	Mm	BD202	S4a	Р
BC638	S 3	Sm	BCW71;R	S7	Mm	BD203	S4a	P

* = series

- FET = Field-effect transistors
- Mm = Microminiature semiconductors for hybrid circuits
- P = Low-frequency power transistors
- Sm = Small-signal transistors
- T = Tuner diodes

type no.	book	section	type no.	book	section	type no.	book	section
BD204	S4a	р	BD332	S4a	Р	BD828	S4a	Р
BD226	S4a	P	BD333	S4a	P	BD829	S4a	P
BD227	S4a	P	BD334	S4a	Р	BD830	S4a	Р
BD228	S4a	P	BD335	S4a	P	BD839	S4a	P
BD229	54a	P	BD336	S4a	P	BD840	S4a	Р
00000	Dia	-			-			-
BD230	S4a	P	BD337	S4a	P	BD841	S4a	Р
BD231	S4a	Р	BD338	S4a	Р	BD842	S4a	P
BD233	S4a	P	BD433	S4a	P	BD843	S4a	P
BD234	S4a	Р	BD434	S4a	Р	BD844	S4a	P
BD235	S4a	Р	BD435	S4a	Р	BD845	S4a	P
BD236	S4a	Р	BD436	S4a	Р	BD846	S4a	P
BD237	S4a	Р	BD437	S4a	P	BD847	S4a	P
BD238	S4a	Р	BD438	S4a	Р	BD848	S4a	P
BD239	S4a	Р	BD645	S4a	Р	BD849	S4a	P
BD239A	S4a	P	BD646	S4a	Р	BD850	S4a	Р
BD239B	S4a	Р	BD647	S4a	P	BD933	S4a	P
BD239C	S4a	Р	BD648	S4a	Р	BD934	S4a	P
BD240	S4a	Р	BD649	S4a	P	BD935	S4a	P
BD240A	S4a	Р	BD650	S4a	Р	BD936	S4a	P
BD240B	S4a	Р	BD651	S4a	Р	BD937	S4a	Р
								_
BD240C	S4a	Р	BD652	S4a	P	BD938	S4a	Р
BD241	S4a	P	BD675	S4a	Р	BD939	S4a	Р
BD241A	S4a	Р	BD676	S4a	P	BD940	S4a	Р
BD241B	S4a	Р	BD677	S4a	P	BD941	S4a	P
BD241C	S4a	Р	BD678	S4a	Р	BD942	S4a	P
DD 242	.		DDC 70	644	D	0042	640	п
BD242	54a	P	BD679	54a	P	DD343	54a Clo	P
BD242A	54a	P	BD680	54a	P	BD944	54d 64a	P
BD242B	54a	P	BD601	54a	P	DD345	54a 64-	P
BD242C	S4a	P	BD682	54a	P	BD946	54a	P
BD243	S4a	Р	BD683	54a	Р	BD947	54a	Р
BD243A	5 4 a	P	BD684	54a	P	BD948	S4a	р
BD243R	542	Þ	BD813	54a	P	BD949	54a	p
2430	SJa S/a	D	BD914	S1a	D	BD950	54a	p
BD245C	C/a	r D	80915	STa Sda	r D	BD951	542	p
DU244 DD244	54d C/~	r ·	BD015	C/~	r D	80957	542	p
DUZ44A	54d	r	01000	24d	r	00332	J-1a	-
BD244B	S4a	Р	BD817	S4a	Р	BD953	S4a	Р
BD244C	S4a	P	BD818	S4a	Р	BD954	S4a	P
BD329	S4a	P	BD825	S4a	P	BD955	S4a	Р
BD330	54a	P	BD826	54a	P	BD956	S4a	P
BD331	54a	P	BD827	54a	P	BDT20	S4a	P
20000		•	55021	014	-			-

P = Low-frequency power transistors

type no.	book	section	type no.	book	section	type no.	book	section
BDT21	S4a	P	BDT61C	S4a	Р	BDV66B	S4a	р
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	р	BDV67C	S4a	Р
BDT 30A	S4a	Р	BDT63A	S4a	Р	BDV67D	S4a	Р
BDT 30B	S4a	P	BDT63B	S4a	P	BDV91	S4a	Р
BDT30C	S4a	P	PDT63C	S4a	Р	BDV92	S4a	Р
BDT31	S4a	P	BDT64	S4a	P	BDV93	S4a	Р
BDT31A	S4a	P	BDT64A	S4a	Р	BDV94	S4a	Р
BDT31B	S4a	Р	BDT64B	S4a	Р	BDV95	S4a	Р
BDT31C	S4a	Р	BDT64C	S4a	Р	BDV96	S4a	Р
BDT32	S4a	P	BDT65	S4a	Р	BDW55	S4a	Р
BDT32A	S4a	P	BDT65A	S4a	Р	BDW56	S4a	Р
BDT32B	S4a	P	BDT65B	S4a	Р	BDW57	S4a	Р
BDT32C	S4a	Р	BDT65C	S4a	Р	BDW58	S4a	Р
BDT41	S4a	P	BDT81	S4a	P	BDW59	S4a	P
BDT41A	S4a	Р	BDT82	S4a	P	BDW60	S4a	Р
BDT41B	S4a	P	BDT83	S4a	P	BDX35	S4a	P
BDT41C	S4a	Р	BDT84	S4a	Р	BDX36	S4a	Р
BDT42	S4a	P	BDT85	S4a	Р	BDX37	S4a	Р
BDT42A	S4a	Р	BDT86	S4a	Р	BDX42	S4a	P
BDT42B	S4a	Р	BDT87	S4a	Р	BDX43	S4a	P
BDT42C	S4a	Р	BDT88	S4a	Р	BDX44	S4a	Р
BDT51	S4a	P	BDT91	S4a	Р	BDX45	S4a	P
BDT52	S4a	Р	BDT92	S4a	Р	BDX46	S4a	Р
BDT53	S4a	P	BDT93	S4a	Р	BDX47	S4a	P
BDT54	S4a	Р	BDT94	S4a	Р	BDX62	S4a	Р
BDT55	S4a	P	BDT95	S4a	P	BDX62A	S4a	P
BDT56	S4a	Р	BDT96	S4a	P	BDX62B	S4a	P
BDT57	S4a	P	BDV64	S4a	Р	BDX62C	S4a	P
BDT58	S4a	Р	BDV64A	S4a	Р	BDX63	S4a	Р
BDT60	S4a	Р	BDV64B	S4a	Р	BDX63A	S4a	Р
BDT60A	S4a	Р	BDV64C	S4a	Р	BDX63B	S4a	P
BDT60B	S4a	P	BDV65	S4a	Р	BDX63C	S4a	P
BDT60C	S4a	Р	BDV65A	S4a	P	BDX64	S4a	P
BDT61	S4a	Р	BDV65B	S4a	P	BDX64A	S4a	P
BDT61A	S4a	P	BDV65C	S4a	P	BDX64B	S4a	Р
BDT61B	S4a	P	BDV66A	S4a	P	BDX64C	S4a	Р

P = Low-frequency power transistors

type no.	book	section	type no.	book	section	type no.	book	section
BDX65	S4a	Р	BF247B	S 5	FET	BF585	S4b	HVP
BDX65A	S4a	Р	BF247C	S5	FET	BF587	S4b	HVP
BDX65B	S4a	Р	BF256A	S5	FET	BF591	S4b	HVP
BDX65C	S4a	Р	BF256B	S 5	FET	BF593	S4b	HVP
BDX66	S4a	Р	BF256C	S 5	FET	BF620	S7	Mm
BDX66A	S4a	P	BF324	S 3	Sm	BF621	S7	Mm
BDX66B	S4a	Р	BF370	S3	Sm	BF622	S7	Mm
BDX66C	S4a	Р	BF410A	S 5	FET	BF623	S7	Mm
BDX67	S4a	Р	BF410B	S5	FET	BF660;R	S7	Mm
BDX67A	S4a	Р	BF410C	S 5	FET	BF689K	S10	WBT
BDX67B	S4a	Р	BF410D	S5	FET	BF763	S10	WBT
BDX67C	S4a	P	BF419	S4b	HVP	BF767	S7	Mm
BDX68	S4a	Р	BF420	S 3	Sm	BF819	S4b	HVP
BDX68A	S4a	Р	BF421	S3	Sm	BF820	S7	Mm
BDX68B	S4a	Р	BF422	S 3	Sm	BF821	S 7	Mm
BDX68C	S4a	P	BF423	S 3	Sm	BF822	s7	Mm
BDX69	S4a	Р	BF450	S3	Sm	BF823	S7	Mm
BDX69A	S4a	Р	BF451	S3	Sm	BF824	S7	Mm
BDX69B	S4a	P	BF457	S4b	HVP	BF840	S7	Mm
BDX69C	S4a	P	BF458	S4b	HVP	BF841	S7	Mm
BDX77	S4a	Р	BF459	S4b	HVP	BF857	S4b	HVP
BDX78	S4a	Р	BF469	S4b	HVP	BF858	S4b	HVP
BDX91	S4a	Р	BF470	S4b	HVP	BF859	S4b	HVP
BDX92	S4a	Р	BF471	S4b	HVP	BF869	S4b	HVP
BDX93	S4a	Р	BF472	S4b	HVP	BF870	S4b	HVP
BDX94	S4a	р	BF483	S 3	Sm	BF871	S4b	HVP
BDX95	S4a	P	BF485	S 3	Sm	BF872	S4b	HVP
BDX96	S4a	P	BF487	S 3	Sm	BF926	S 3	Sm
BDY90	S4a	Р	BF494	S 3	Sm	BF936	S 3	Sm
BDY90A	S4a	P	BF495	S 3	Sm	BF939	S 3	Sm
BDY91	S4a	P	BF496	S 3	Sm	BF960	S 5	FET
BDY92	S4a	p	BF510	S7/S5	Mm/FET	BF964	S5	FET
BF198	53	Sm	BF511	S7/S5	Mm/FET	BF966	S5	FET
BF199	S 3	Sm	BF512	\$7/\$5	Mm/FET	BF967	S3	Sm
BF240	\$3	Sm	BF513	\$7/\$5	Mm/FET	BF970	S3	Sm
BF241	53	Sm	BF536	S 7	Mm	BF979	S 3	Sm
BF245A	S5	FET	BF550:R	S7	Mm	BF980	S5	FET
BF245B	S5	FET	BF569	S7	Mm	BF981	S5	FET
BF245C	S5	FET	BF579	s7	Mm	BF982	S5	FET
BF247A	S 5	FET	BF583	S4b	HVP	BF989	S7/S5	Mm/FET
						1	•	

FET = Field-effect transistors

= Low-frequency power transistors

- HVP = High-voltage power transistors
- Sm = Small-signal transistors
- Mm = Microminiature semiconductors for hybrid circuits
- WBT = Wideband transistors

Ρ

t	ype no.	book	section	type no.	book	section	type no.	book	section
P	F990	57/55	Mm/FFT	BF051	\$10	WRT	BFT24	S10	WBT
5	F991	67/65	Mm/FFT	DFQ51 PF051C	S10	WDT	BFT25.P	\$7	Mm
	E007	67/65	Mm/FET	DFQJIC DFQ52	g10	WDT	BETAA	57 63	Cm
2	E001	67/65	Mm/FET	DFQ52 PF053	S10	WDT	BFT45	63	Sm
a a	E006	57/55	Mm/FET	BEQ13	S10 S10	WDT	BFT46	57/55	Mm/FFT
	12330	57755	rim/rE1	BrQ05	510	# D1	DI 140	57755	1.111/1.121
В	FG23	S10	WBT	BFQ65	S10	WBT	BFT92;R	s7	Mm
В	FG32	S10	WBT	BFQ66	S10	WBT	BFT93;R	S7	Mm
В	FG34	S10	WBT	BFQ67	S7	Mm	BFW10	S5	FET
В	FG51	S10	WBT	BFQ68	S10	WBT	BFW11	S5	FET
В	FG65	S10	WBT	BFQ136	S10	WBT	BFW12	S 5	FET
В	FG67	S 7	Mm	BFR29	S5	FET	BFW13	S 5	FET
Ē	FG90A	S10	WBT	BFR30	S7/S5	Mm/FET	BFW16A	S10	WBT
P	FG91A	S10	WBT	BFR31	\$7/\$5	Mm/FET	BFW17A	S10	WBT
В	FG96	S10	WBT	BFR49	510	WBT	BFW30	510	WBT
B	FP90A	S10	WBT	BFR53.R	57	Mm	BFW61	S5	FET
-				21 100 /11	0,	• •••	22.001	50	
В	FP91A	S10	WBT	BFR54	S3	Sm	BFW92	S10	WBT
В	FP96	S10	WBT	BFR64	S10	WBT	BFW92A	S10	WBT
В	FQ10	S5	FET	BFR65	S10	WBT	BFW93	S10	WBT
В	FQ11	S5	FET	BFR84	S5	FET	BFX29	\$3	Sm
В	FQ12	S5	FET	BFR90	S10	WBT	BFX30	S 3	Sm
в	F013	55	FFT	BEDGUY	S10	WRT	BFY34	c 3	Sm
B	F014	55	FET	DFRJOA DFDQ1	S10 S10	WDI	BFY84	63	Sm
B	F015	55	FFT	DEED 91 A	g10	WBT	BFX85	c3	Sm
B	F016	55	FFT	BED92.P	\$7	Mm	BFX86	53	Sm
R	F017	s7	Mm	DFR92,R	57 67	Mm	BFX87	e 3	Sm
D	1211	57		DFKJ2A;K	57	rim	DIAG	55	51
В	FQ18A	S7	Mm	BFR93;R	S7	Mm	BFX88	S 3	Sm
В	FQ19	S7	Mm	BFR93A;R	S7	Mm	BFX89	s10	WBT
В	FQ22S	S10	WBT	BFR94	S10	WBT	BFY50	S 3	Sm
В	FQ23	S10	WBT	BFR95	S10	WBT	BFY51	S 3	Sm
В	FQ23C	S10	WBT	BFR96	S10	WBT	BFY52	S 3	Sm
в	F024	S10	WBT	BFR96S	S10	WBT	BFY55	S 3	Sm
B	F032	S10	WBT	BFR101A	B S7/S5	Mm/FET	BFY90	s10	WBT
В	F032C	S10	WBT	BFS17:R	S7	Mm	BG2000	S1	RT
B	F032S	S10	WBT	BFS18:R	S7	Mm	BG2097	S1	RT
В	FQ33	S10	WBT	BFS19;R	s7	Mm	BGD102	S10	WBM
-	F034	C10	ND M	D.000 F	67	Max	DCD4032	C 10	WDM
B	ry34	510	WBT	BF520;R	5/ CF	MW Fra	BGD102E	510	WBM
B	ry34T	510	WBT	BF521	50	FET	BGD104	510	WDM
В	r042	50	RFP DED	BESZIA	50	FET	BGD104E	510	WBM
B	1043	50	REP	BFSZZA	50	RFP	DGI22	50	RFP DED
В	10435	50	KFP	BESZJA	56	RFP	BGIZZA	50	RFP

FET = Field-effect transistors

- Mm = Microminiature semiconductors
 - for hybrid circuits
- RFP = R.F. power transistors and modules
- RT = Tripler

Sm = Small-signal transistors

WBM = Wideband hybrid IC modules

WBT = Wideband transistors

type no.	book	section	type no.	book	section	type no.	book	section
DCV22	66	DED	DCV953	c10	WDM	DT V5 7	C C	DED
DOI23	50	DED	DOTOJA	510	PED		20	RFF RFD
DGIZJA	50	RFP DFD	DCV00D	50	DED	DLV37 DLV375/13	50	RFP
BGISZ	50	RFP	BGI90B	50		BPA 12/15	50	RFP
BGY33	56	RFP	BGY93	50	RFP	BLV80/28	56	RFP
BGY35	56	RFP	BGY94	56	RFP	BLA30	56	RFP
BGY36	S6	RFP	BGY95A	S6	RFP	BLV90/SL	S 6	RFP
BGY40A	S6	RFP	BGY95B	S6	RFP	BLV91	S6	RFP
BGY40B	S 6	RFP	BGY96A	S6	RFP	BLV91/SL	S6	RFP
BGY41A	S6	RFP	BGY96B	S6	RFP	BLV92	S6	RFP
BGY41B	S6	RFP	BLF146	S6	RFP/FET	BLV93	S6	RFP
BGY43	56	RFP	BLF242	S 6	RFP/FET	BLV94	56	RFP
BGY45A	56	RFP	BLF244	56	RFP/FET	BLV95	56	RFP
BGY45B	56	RFP	BLE245	56	REP/FET	BLV97	56	BED
BCY46A	56	RED	BLT90/SL	56	RFP	BLV98	56	PFD
BCV/6B	56	DED	BLT91/SL	56	RFD	DI 100	50	DED
001400	50	KFF		50	KI I		20	KFF
BGY47 [*]	S6	RFP	BLT92/SL	S6	RFP	BLW29	S6	RFP
BGY48 [*]	S6	RFP	BLU20/12	S 6	RFP	BLW31	S6	RFP
BGY50	S10	WBM	BLU30/12	S6	RFP	BLW32	S6	RFP
BGY51	S10	WBM	BLU45/12	S6	RFP	BLW33	S6	RFP
BGY52	S10	WBM	BLU50	S6	RFP	BLW34	S6	RFP
BCV53	c10	WDM	DT 115 1	66	PFD	DIWEOF	C C	חדת
DOIDD DCV54	c10	WDM	BL051	50	DED	DIWCO	50	RFP DED
DOIJA	c10	WDM	BL032	50	DED	DIWGOC	50	RFF DED
DGIJJ	C10	WDM		50	DED	DIWOOL	50	RFF
BGI JO	510	WDM		50	RFP DED	DLW/0	50	RFP
BGIS/	510	WBM	BLUST	50	RFP	BLW//	50	RFP
BGY58	S10	WBM	BLU98	S6	RFP	BLW78	S6	RFP
BGY58A	S10	WBM	BLU99	S6	RFP	BLW79	S6	RFP
BGY59	S10	WBM	BLV10	56	RFP	BLW80	S6	RFP
BGY60	S10	WBM	BLV11	S6	RFP	BLW81	S6	RFP
BGY61	S10	WBM	BLV20	S6	RFP	BLW83	S6	RFP
BGY65	S10	WBM	BLV21	56	RFP	BLW84	S 6	RFP
BGY67	510	WBM	BLV25	56	RFP	BLW85	56	RFP
BGY67A	510	WBM	BLV30	56	RFP	BLW86	56	RFP
BGY70	S10	WBM	BLV30/12	56	RFP	BLW87	56	RFP
BGY71	S10	WBM	BLV31	56	REP	BLW89	56	RFP
50171	5.0	w Dri		50		59403	50	NI I
BGY74	S10	WBM	BLV32F	S6	RFP	BLW90	S6	RFP
BGY75	S10	WBM	BLV33	S6	RFP	BLW91	S 6	RFP
BGY84	S10	WBM	BLV33F	S6	RFP	BLW95	S 6	RFP
BGY84A	s10	WBM	BLV36	S6	RFP	BLW96	S6	RFP
BGY85	S10	WBM	BLV45/12	S 6	RFP	BLW97	S6	RFP

- * = series
- FET = Field-effect transistors

RFP = R.F. power transistors and modules

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WMB = Wideband hybrid IC modules

type no.	book	section	type no.	book	section	type no.	book	section
BLW98	S 6	RFP	BPW71	58b	PDT	BSR30	S7	Mm
BLW99	S6	RFP	BPX25	S8b	PDT	BSR31	S7	Mm
BLX13	S6	RFP	BPX29	S8b	PDT	BSR32	S7	Mm
BLX13C	S6	RFP	BPX40	S8b	PDT	BSR33	S7	Mm
BLX14	S6	RFP	BPX41	S8b	PDT	BSR40	S7	Mm
BLX15	S6	RFP	BPX42	S8b	PDT	BSR41	S7	Mm
BLX39	S6	RFP	BPX61	S8b	PDT	BSR42	S7	Mm
BLX65	S6	RFP	BPX61P	S8b	PDT	BSR43	S7	Mm
BLX65E	S6	RFP	BPX71	S8b	PDT	BSR50	S3	Sm
BLX65ES	S6	RFP	BPX72	S8b	PDT	BSR51	S 3	Sm
BLX67	S 6	RFP	BR100/03	S2b	Th	BSR52	S 3	Sm
BLX68	S6	RFP	BR101	S3	Sm	BSR56	S7/S5	Mm/FET
BLX69A	S6	RFP	BR210*	S2a	Th	BSR57	S7/S5	Mm/FET
BLX91A	S6	RFP	BR216*	S2a	Th	BSR58	S7/S5	Mm/FET
BLX91CB	S6	RFP	BR220*	S2a	Th	BSR60	\$3	Sm
BLX92A	S6	RFP	BRY39	53	Sm	BSR61	S 3	Sm
BLX93A	56	RFP	BRY56	S3	Sm	BSR62	S 3	Sm
BLX94A	S6	RFP	BRY61	S7	Mm	BSS38	\$3	Sm
BLX94C	S6	RFP	BRY62	S7	Mm	BSS50	S 3	Sm
BLX95	S6	RFP	BS107	S5	FET	BSS51	53	Sm
BLX96	S6	RFP	BS170	S5	FET	BSS52	S 3	Sm
BLX97	S6	RFP	BSD10	S5	FET	BSS60	\$3	Sm
BLX98	S6	RFP	BSD12	S5	FET	BSS61	53	Sm
BLY87A	S6	RFP	BSD20	S5/7	FET	BSS62	S3	Sm
BLY87C	S6	RFP	BSD22	S5/7	FET	BSS63;R	S7	Mm
BLY88A	S6	RFP	BSD212	S5	FET	BSS64;R	S7	Mm
BLY88C	S6	RFP	BSD213	S5	FET	BSS68	S3	Sm
BLY89A	S6	RFP	BSD214	S5	FET	BSS83	S5/7	FET/Mm
BLY89C	S6	RFP	BSD215	S5	FET	BST15	s7	Mm
BLY90	S6	RFP	BSR12;R	S7	Mm	BST16	S7	Mm
BLY91A	S 6	RFP	BSR13;R	S7	Mm	BST39	S7	Mm
BLY91C	S6	RFP	BSR14;R	S 7	Mm	BST40	S7	Mm
BLY92A	S6	RFP	BSR15:R	S7	Mm	BST50	S7	Mm
BLY92C	S6	RFP	BSR16;R	S7	Mm	BST51	S7	Mm
BLY93A	S6	RFP	BSR17;R	S7	Mm	BST52	S7	Mm
BLY93C	S6	RFP	BSR17A:R	S 7	Mm	BST60	S7	Mm
BLY94	S 6	RFP	BSR18:R	S7	Mm	BST61	s7	Mm
BPF24	S8b	PDT	BSR18A:R	S 7	Mm	BST62	S7	Mm
BPW22A	S8a/b	PDT	BSR19; A	S 7	Mm	BST70A	S5	FET
BPW50	S8a/b	PDT	BSR20; A	S7	Mm	BST72A	\$5	FET

FET = Field-effect transistors

RFP = R.F. power transistors and modules

Sm = Small-signal transistors

- Mm = Microminiature semiconductors for hybrid circuits
- PDT = Photodiodes or transistors

Th = Thyristors

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type no.	book	section	type no.	book	section	type no.	book	section
BST74A	S5	FET	BT139*	S2b	Tri	BU508D	S4b	SP
BST76A	S5	FET	BT139F*	S2b	Tri	BU705	S4b	SP
BST78	S5	FET	BT145*	S2b	Tri	BU706	S4b	SP
BST80	S5/S7	FET/Mm	BT149*	S2b	Th	BU706D	S4b	SP
BST82	s5/s7	FET/Mm	BT150	S2b	Th	BU806	S4b	SP
BST84	S5/S7	FET/Mm	BT151*	S2b	Th	BU807	S4b	SP
BST86	S5/S7	FET/Mm	BT151F*	S2b	Th	BU808	S4b	SP
BST90	S5	FET	BT152*	S2b	Th	BU824	S4b	SP
BST97	S5	FET	BT153	S2b	Th	BU826	S4b	SP
BST100	S5	FET	BT157*	S2b	Th	BUP22*	S4b	SP
BST110	55	FET	BT169*	52b	Th	BIIP23*	54b	SP
BST120	\$5/\$7	FFT/Mm	BTA 140*	52b	Tri	BUS11.A	54h	SP
BST122	55/57	FFT/Mm	BTR59*	525 52b	Tri		S4b	SP
BGV15	63	Cm Cm	BTC59*	525 525	Tri	DUC12,A	C/h	CD CD
DOV15 DCV16	23 23	Cm	D1555	52.0 C2h	ть ть	DUC14.A	54D C/h	
DJVIO	20	510	BIV00"	320	111	BUS14;A	540	SP
BSV17	S3	Sm	BTV59*	S2b	Th	BUS21*	S4b	SP
BSV52;R	S7	Mm	BTV59D*	S2b	Th	BUS22*	S4b	SP
BSV64	\$3	Sm	BTV60*	S2b	Th	BUS23*	S4b	SP
BSV78	S5	FET	BTV60D*	S2b	Th	BUT11:A	S4b	SP
BSV79	S 5	FET	BTV70*	S2b	Th	BUT11A	S4b	SP
BSV80	55	FET	BTV70D*	s2h	Th	BUT11AF	S4b	SP
BSV81	55	FET	BTW23*	52b	Th	BUV82	54b	SP
BSW66A	53	Sm	BTW38*	52b	Th	BUV83	54b	SP
BSW67A	53	Sm	BTW40*	52b	Th	BUV89	54h	SP
BSW68A	53	Sm	BTW42*	52b	Th	BUV90.A	54h	SP
0.540001	55	Dim	01#14	57.5	111	D0000,R	545	51
BSX19	S 3	Sm	BTW43*	S2b	Tri	BUW11;A	S4b	SP
BSX20	S3	Sm	BTW45*	S2b	Th	BUW12;A	S4b	SP
BSX45	\$3	Sm	BTW58*	S2b	Th	BUW13;A	S4b	SP
BSX46	S3	Sm	BTW62*	S2b	Th	BUW84	S4b	SP
BSX47	S 3	Sm	BTW62D*	52b	Th	BUW85	S4b	SP
BSX59	S3	Sm	BTW63*	S2b	Th	BUX46:A	S4b	SP
BSX60	S 3	Sm	BTY79*	S2b	Th	BUX47:A	S4b	SP
BSX61	S 3	Sm	BTY91*	S2b	Th	BUX48 A	S4b	SP
BSY95A	S3	Sm	BU426	S4b	SP	BUX80	S4b	SP
BT136*	S2b	Tri	BU426A	S4b	SP	BUX81	S4b	SP
BT136F*	S2b	Tri	BU433	54b	SP	BUX82	S4b	SP
BT137*	52b	Tri	BU505	S4b	SP	BUX83	54h	SP
BT137F*	52b	Tri	BU506	54b	SP	BIIX84	S4h	SP
BT138*	525 52b	Tri	BU506D	54b	SP	BILYSAE	S4b	SD SD
BT138F*	52b	Tri	BU508A	54b	SP	BIIX85	54h	SP
511501	565	***	DUJUUR	J 1 D	NI	DOVOD	JID	51

* = series

FET = Field-effect transistors

Mm = Microminiature semiconductors

for hybrid circuits Sm = Small-signal transistors SP = Low-frequency switching power transistors

- Th = Thyristors
- Tri = Triacs

type no.	book	section	type no.	book	section	type no.	book	section
BUX85F	S4b	SP	BUZ54	S 9	PM	BY609	S1	R
BUX86	S4b	SP	BUZ54A	59	PM	BY610	S1	R
BUX87	S4b	SP	BUZ60	59	PM	BY614	51	R
BUX88	S4b	SP	BUZ 60B	59	PM	BY619	S1	R
BUX90	S4b	SP	BUZ63	S 9	PM	BY620	S1	R
BUX98	S4b	SP	BUZ63B	59	PM	BY627	S1	R
BUX98A	S4b	SP	BUZ64	59	PM	BY707	S1	R
BIIX99	S4b	SP	BU271	59	PM	BY708	S1	R
BUY89	54h	SP	BUZ71A	59	PM	BY709	51	R
BUZ 10	S 10 S 9	PM	BUZ72	S 9	PM	BY710	S1	R
DU7 101	C Q	DM	BI1772A	59	PM	BV711	51	P
D0210A	C 9	DM	BU773A	C 9	DM	BY712	C1	D
00211	CQ	DM	D0273A	C0	DM	D1712	C1	D
50211A	5) CQ	TPI DM	01274	CQ	DM	D1713	01 C1	n n
BU214 BU715	37 CQ	DM	BU274A	29. CQ	DM		51 C1	R D
D0712	.5.9	. rei	00270	55	r n	BIDIS	51	K
BUZ20	S9	PM	BUZ76A	S9	PM	BYD14 [*]	S1	R
BUZ21	59	PM	BUZ8O	59	PM	BYD17	S1	R
BUZ23	S9	PM	BUZ8OA	S9	PM	BYD33 [*]	S1	R
BUZ24	S9	PM	BUZ83	S9	PM	BYD37 [*]	S1	R
BUZ25	S9	PM	BUZ83A	S9	PM	BYD73*	S1	R
BUZ30	59	PM	BUZ84	S 9	PM	BYD74*	S1	R
BUZ31	59	PM	BUZ84A	S9	PM	BYD77*	S1	R
BUZ32	59	PM	BY224*	S2a	R	BYM26*	51	R
BUZ33	59	PM	BY225*	S2a	R	BYM36*	S1	R
BUZ34	59	PM	BY228	S1	R	BYM56*	S1	R
BUZ35	59	PM	BY229*	52a	R	BYD21*	52a	R
BU736	59	PM	BY229F*	52a 52a	R	BVD22*	52a 52a	R
BUZ 40	59	DM	BV249*	52a 52a	R	BYD59*	52a 52a	p
BU741A	59	PM	BY260*	52a	R	BY028*	52u 52a	R
BUZ42	59	PM	BY261*	S2a	R	BYR29*	S2a	R
0117/2	59	DM	BV320*	622	p	BVD20F*	622	p
DU243	57 CQ	DM	DI323*	52a 62a	л а	DIK47F*	52d 62a	л
	37 C0	PPI DM	BI303*	52d .	л р	BI120*	52a	к р
DU440	27	E'M DM	BI4JO DVAAO	ວ I ຕ 1	к р	BIT/9*	52a	к р
BUZ45A BUZ45B	59 59	PM PM	B1440 BY458	S1	R	BYV18*	S2a	R
	G 0	DM	DWEAF	C1	n	DWMAAA	6 2 -	
BUX45C	59	PM	BY505	51	ĸ	BYV19*	sza	ĸ
80246	59	PM	BY509	S1	ĸ	BYV20*	S2a	R
BUZ5OA	59	PM	BY527	51	ĸ	BYV21*	s2a	R
BUZSOB	59	PM	BY584	S1	R	BYV22*	S2a	R
BUZ53A	59	PM	BX288	S1	R	BYV23*	SZa	R

* = series

PM = Power MOS transistors

R = Rectifier diodes

SP = Low-frequency switching power transistors

type no.	book	section	type no.	book	section	type no.	book	section
BYV24*	S2a	R	BYW95A	S1	R	BZX70*	S2a	Vra
BYV26 [*]	S1/S2a	R	BYW95B	S1	R	BZX75*	S1	Vrg
BYV27*	S1/S2a	R	BYW95C	S1	R	BZX79*	S1	Vrg
BYV28*	S1/S2a	R	BYW96D	S1	R	B7X84*	\$7/\$1	Mm/Vrg
BYV29*	S2a	R	BYW96E	S1	R	BZY91*	S2a	Vrg
BYV29F*	S2a	R	BYX 10G	S1	R	BZY93*	52a	Vrg
BYV30*	S2a	R	BYX25*	S2a	R	CFX13	S11	м
BYV31*	S2a	R	BYX30*	S2a	R	CFX21	S11	M
BYV32*	S2a	R	BYX32*	S2a	R	CFX30	S11	M
BYV32F*	S2a	R	BYX38*	S2a	R	CFX31	S11	м
BYV33*	S2a	R	BYX39*	S2a	R	CFX32	S11	м
BYV33F*	S2a	R	BYX42*	S2a	R	CFX33	S11	м
BYV34*	S2a	R	BYX46*	S2a	R	CNG35	S8b	PhC
BYV36 [*]	S1	R	BYX50*	S2a	R	CNG36	S8b	PhC
BYV39*	S2a	R	BYX52*	S2a	R	CNR36	S8b	PhC
BYV42*	S2a	R	BYX56*	S2a	R	CNX21	S8b	PhC
BYV43*	S2a	R	BYX90G	S1	R	CNX35	58b	PhC
BYV43F*	S2a	R	BYX96*	S2a	R	CNX35U	58b	PhC
BYV44*	S2a	R	BYX97*	S2a	R	CNX36	58b	PhC
BYV60*	S2a	R	BYX98*	S2a	R	CNX36U	S8b	PhC
BYV72*	52a	R	BAXAd*	52a	R	CNX38	58h	PhC
BYV73*	52a	R	B7D23	C1	Wra	CNV38U	505 585	PhC
BYV74*	524	R	B2D23	C1	Vrg	CNV20	50D C9h	PhC
BY079*	52a 52a	R	D2D27	C1	Vrg	CNV39II	505 68h	PhC
BYV92*	52a 52a	R	B7V10	S1	Vrf	CNV44	505 68h	PhC
DIVJZ	520	ĸ	82410	51	VII	CNA44	300	FIIC
BYV95A	S1	R	BZV11	S1	Vrf	CNX44A	S8b	PhC
BYV95B	S1	R	BZV12	S1	Vrf	CNX46	S8b	PhC
BYV95C	S1	R	BZV13	S1	Vrf	CNX48	S8b	PhC
BYV96D	S1	R	BZV14	S1	Vrf	CNX48U	S8b	PhC
BYV96E	S1	R	BZV37	S1	Vrf	CNX62	S8b	PhC
BYW25*	S2a	R	BZV46	S1	Vrg	CNX72	S8b	PhC
BYW29*	S2a	R	BZV49*	S1/S7	Vrg/Mm	CNX82	S8b	PhC
BYW29F*	S2a	R	B2V55*	s7	Mm	CNX83	S8b	PhC
BYW30*	S2a	R	BZV80	S1	Vrf	CNX91	S8b	PhC
BYW31*	S2a	R	BZV81	S1	Vrf	CNX92	S8b	PhC
BYW54	S1	R	BZV85 [*]	S1	Vrg	CNY17-1	S8b	PhC
BYW55	S1	R	BZW03*	S1	Vrg	CNY17-2	S8b	PhC
BYW56	S1	R	BZW14	S1	Vrg	CNY17-3	S8b	PhC
BYW92*	S2a	R	BZW86*	S2a	TS	CNY50	58b	PhC
BYW93*	S2a	R	BZX55 [*]	S1	Vrg	CNY57	S8b	PhC
						1		

* = series

M = Microwave transistors

Mm = Microminiature semiconductors

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for hybrid circuits

- R = Rectifier diodes
- TS = Transient suppressor diodes
- Vrf = Voltage reference diodes

PhC = Photocouplers

Vrg = Voltage regulator diodes

type no.	book	section	type no.	book	section	type no.	book	section
CNY57A	S8b	PhC	COW10B(L)58a	LED	COY97A	S8a	LED
CNY57AU	S8b	PhC	COW1OU(L)58a	LED	Fresnel-	S8b	Α
CNY57U	S8b	PhC	COW11B(L)58a	LED	lens		
CNY62	S8b	PhC	COW12B(L)S8a	LED	H11A1	S8b	PhC
CNY63	S8b	PhC	CQW2OA	S8a	LED	H11A2	S8b	PhC
CQF24	S8b	Ph	CQW21	S8a	LED	H11A3	S8b	PhC
CQL10A	S8b	Ph	CQW22	S8a	LED	H11A4	S8b	PhC
CQL13A	S8b	Ph	CQW24(L)	S8a	LED	H11A5	S8b	PhC
CQL16	S8b	Ph	CQW54	S8a	LED	H11B1	S8b	PhC
CQS51L	S8a	LED	CQW60(L)	58a	LED	H11B2	S8b	PhC
C0554	58a	LED	COW60A (T)58a	LED	H11B3	S8b	PhC
C0582T	58a	LED	COWFOLL)58a	LED	H11B255	S8b	PhC
COS82AL	S8a	LED	COW61(L)	58a	LED	KMZ 10A	S13	SEN
C0584T.	58a	LED	COW62(L)	58a	LED	KM210B	S13	SEN
COSSEL	58a	LED	COW893	50a 58a/h	т	KMZ 10C	513	SEN
C72001	504	BLD	CQWOJA	50075	1	in in ite	W 10	0.210
CQS93	S8a	I'ED	CQW93	58a	LED	KP100A	S13	SEN
CQS93E	S8a	LED	CQW95	S8a	LED	KP101A	S13	SEN
CQS93L	S8a	LED	COW97	S8a	LED	KPZ20G	S13	SEN
CQS95	S8a	LED	COX24(L)	S8a	LED	KPZ21G	S13	SEN
CQS95E	S8a	LED	CQX51(L)	58a	LED	KTY81*	S13	SEN
COCOST	69.2	TED	COVEALE	69.	TED	Kurv83*	C13	CEN
CQ535L	50d	LED		50a 60a		VTV9/*	010 013	CEN
CQ597	50d	LED		50d	LED	TAE2001D	010	M
COCOTE	50d	LED		50a		LAE2001R	G11	1"I M
CQ597L	50d	LED	CQX64D	58a 69-		LAE40010	011	M
CQTIOB	58a	LED	CQX/4(L)	58a	LED	LAC4001R	511	INI
CQT24	S8a	LED	COX74D	S8a	LED	LAE4002S	S11	М
CÕT60	S8a	LED	COY 11B	S8b	LED	LAE60000	S11	М
COT70	S8a	LED	CÕY11C	S8b	LED	LBE1004R	S11	М
CQT8OL	58a	LED	COY24B(L)S8a	LED	LBE1010R	S11	М
CQV70(L)) S8a	LED	CQY49B	S8b	LED	LBE2003S	S11	М
			201140-5	-		TRESOUSS	C11	
CQV/UA(I	.)58a	LED	CQY49C	580	LED	LBE20030	511	M
COV/00(I	L)S8a	LED	CQY50	58b	LED	LBE2008T	511	M
COV/1A(I	5)S8a	LED	CQY52	58b	LED	LBEZUU9S	511	M
CQV72(L)) S8a	LED	CQY53S	S8b	LED	LCETUTOR	511	M
COASOL	58a	LED	CQY54A	58a	LED	LCE2003S	511	[v]
COV80AT	S8a	LED	COY58A	S8a/b	I	LCE20050	S11	М
COV80UL	S8a	LED	COY89A	S8a/b	T	LCE2008T	S11	M
COV81T	S8a	LED	COY94B(I)58a	LED	LCE20095	S11	M
0011001	58a	LED	COVOSB	582		LTE42002T	S11	M
COVAZI					145.17	1 101120021		

- * = series
- A = Accessories
- I = Infrared devices
- LED = Light-emitting diodes
- M = Microwave transistors

Ph = Photoconductive devices PhC = Photocouplers

SEN = Sensors

type no.	book	section	type no.	book	section	type no.	book	section
LKE2002T	S11	м	OM320	S10	WBM	PDE1003U	S11	м
LKE2004T	S11	М	OM321	S10	WBM	PDE 1005U	S11	М
LKE2015T	S11	М	OM322	S10	WBM	PDE1010U	S11	М
LKE21004R	S11	м	OM323	\$10	WBM	PEE 100 1U	S11	M
LKE21015T	S11	М	OM323A	510	WBM	PEE1003U	S11	м
LKE21050T	S11	м	OM335	S10	WBM	PEE 1005U	S11	M
LKE2701OR	S11	М	OM336	S10	WBM	PEE1010U	S11	М
LKE27025R	S11	М	OM337	S10	WBM	PH2222;R	S3	Sm
LKE32002T	S11	М	OM337A	S10	WBM	PH2222A;R	S 3	Sm
LKE32004T	S11	М	0М339	S10	WBM	PH2369	S 3	Sm
1 7 7 4 2005 9	C11	м	01245	C10	WDM	DU2907.D	63	Sm
LIE420005	011	I*I M	01345	510	WDM	DU20073.D	3J C2	Sm Cm
LIE42000R	511	[*] NG	01350	510	WBM	PH2907A;K	55	อแ
LTE42012R	511	ivi	OM360	510	WBM	PH29551	54a	Р Г
LV1/21E50R	511	M	OM361	S10	WBM	PH3055T	54a	P
LV2024E45R	S11	М	OM370	S10	WBM	PH5415	53	Sm
LV2327E40R	S11	м	OM386B	S13	SEN	PH5416	53	Sm
LV3742E16R	S11	M	OM386M	S13	SEN	PH13002	S4b	SP
LV3742E24R	S11	M	OM387B	513	SEN	PH13003	S4b	SP
LWF2015R	511	M	OM387M	513	SEN	PHSD51	52a	R
LWE2075R	S11	M	OM388B	\$13	SEN	PKB300111	511	M
DWL2025K			ONJOOD	515	SER	TRESCOTO	011	
I.Z 1418E100R	IS11	Μ	0М389В	S13	SEN	PKB3003U	S11	м
MCA230	S8b	PhC	OM931	S4a	Р	PKB3005U	S11	М
MCA231	S8b	PhC	OM961	S4a	P	PKB12005U	S11	М
MCA255	S8b	PhC	OSB9115	S2a	St	PKB20010U	S11	М
MCT2	S8b	PhC	OSB9215	S2a	St	PKB23001U	S11	м
MCT26	CBh	PhC	0000415	c2-	C+	1150055939	C11	м
	C11	M	0389415	52a	5C C+	DVD230050	C11	M
MEDIZO40WS	011 C11	M	0549115	52d	51	PKB250050	011	M
MKD 12 100W5	011	M	0519215	52d	5L Ch	PKB230001	011	M
MACOZEDOOO	511	[v]	05M9415	5Za	St	PKB320010	511	[4] M
M06075B2002	511	Ini	05M9510	SZa	St	PKB320030	511	191
M06075B4002	IS11	М	05M9511	S2a	St	PKB32005U	S11	м
MRB12175YR	S11	М	OSM9512	S2a	St	PMBF4391	S7	Mm
MRB12350YR	S11	М	0559115	S2a	St	PMBF4392	S7	Mm
MS1011B700Y	S11	M	0559215	S2a	St	PMBF4392	\$ 7	Mm
MS6075B8002	S11	M	0559415	S2a	St	PMLL4148	S1	SD
				-				
MSB12900Y	S11	М	P2105	S8b	I	PMLL4150	S1	SD
MZ0912B75Y	S11	М	PBMF4391	ន5	FET	PMLL4151	S1	SD
MZ0912B150Y	S11	М	PBMF4392	S5	FET	PMLL4153	S1	SD
OM286; M	S13	SEN	PBMF4393	S5	FET	PMLL4446	S1	SD
OM287; M	S13	SEN	PDE 100 1U	S11	м	PMLL4448	S1	SD
FET = Field-eff	ect tra	insistors		R	= Rectifier di	odes		
= Infrared	device	s		SD	= Small-signa	l diodes		
M = Microwa	ve tra	reistore		SEN	= Sensors			
Vm – Mieromi		anniaard	atora	Scill	- Small sizes	Itransistors		
fan hata			1015	011	- oman-signa	n u ansistors	OWC7 **	aneistor
ior nybr	iu circ	uits	• .	51	- Low-freque	ency switching p	ower ti	ansistor
- 1 Out trop		I DOWOR trop	auntora	C.+	- Hootitior of	001/0		

= Low-frequency power transistors Р PhC = Photocouplers

St = Rectifier stacks

WBM = Wideband hybrid IC modules

type no.	book	section	type no.	book	section	type no.	book	section
PMLL5225B			RZ1214B12	5YS11	М	TIP127	S4a	Р
to	S 1	SD	RZ1214B15	OYS11	м	TTP130	S4a	p
PMLL5267B			RZ2833B45	W S11	M	TTP131	S4a	P
P044	S8b	PhC	RZ3135B15	U S11	M	TIP132	S4a	p
PO44A	S8b	PhC	RZ3135B15	W S11	M	TIP135	S4a	Р
PPC5001T	S11	М	RZ3135B25	U S11	м	TIP136	S4a	Р
PQC5001T	S11	М	RZ3135B30	W S11	М	TIP137	S4a	P
PTB23001X	S11	М	RZB12100Y	S11	М	TIP140	S4a	P
PTB23003X	S11	М	RZB12350Y	S11	М	TIP141	S4a	P
PTB23005X	S11	М	RZZ1214B3	00YS11	М	TIP145	S4a	Р
PTB32001X	S11	м	SL5500	S8b	PhC	TIP146	S4a	Р
PTB32003X	S11	М	SL5501	S8b	PhC	TIP147	S4a	P
PTB32005X	S11	М	SL5502R	S8b	PhC	TIP2955	S4a	P
PTB42001X	S11	М	SL5504	S8b	PhC	TIP3055	S4a	Р
PTB42002X	S11	М	SL5504S	S8b	PhC	1N821;A	S1	Vrf
PTB42003X	S11	м	SL5505S	S8b	PhC	1N823;A	S1	Vrf
PV3742B4X	S11	М	SL5511	S8b	PhC	1N825;A	S1	Vrf
PVB42004X	S11	M	TIP29*	S4a	Р	1N827;A	S1	Vrf
PZ1418B15U	S11	М	TIP30*	S4a	Ρ	1N829;A	S1	Vrf
PZ1418B30U	S11	М	TIP31*	S4a	P	1N914	S1	SD
PZ1721B12U	S11	м	TIP32*	S4a	P	1N916	S1	SD
PZ1721B25U	S11	М	TIP33*	S4a	Р	1N3879	S2a	R
PZ2024B100	S11	М	TIP34*	S4a	Р	1N3880	S2a	R
PZ2024B20U	S11	M	TIP41*	S4a	P	1N3881	S2a	R
PZB16035U	S11	М	TIP42*	S4a	P	1N3882	S2a	R
PZB27020U	S11	М	TIP47	S4a	P	1N3883	S2a	R
RPY97	S8b	I	TIP48	S4a	Р	1N3889	S2a	R
RPY100	S8b	I	TIP49	S4a	Р	1N3890	S2a	R
RPY 101	S8b	I	TIP50	S4a	Р	1N3891	S2a	R
RPY102	S8b	I	TIP110	S4a	Ρ	1N3892	S2a	R
RPY 103	S8b	I	TIP111	S4a	P	1N3893	S2a	R
RPY107	S8b	I	TIP112	S4a	Р	1N3909	S2a	R
RPY 109	S8b	I	TIP115	S4a	Р	1N3910	S2a	R
RV3135B5X	S11	М	TIP116	S4a	Р	1N3911	S2a	R
RX1214B300	YS11	М	TIP117	S4a	Р	1N3912	S2a	R
RXB12350Y	S11	м	TIP120	S4a	P	1N3913	S2a	R
RZ1214B35Y	S11	М	TIP121	S4a	P	1N4001G	S1	R
RZ1214B60W	I S11	М	TIP122	S4a	P	1N4002G	S1	R
RZ1214B65Y	S11	М	TIP125	S4a	Р	1N4003G	S1	R
RZ1214B125	WS11	М	TIP126	S4a	Р	1N4004G	S1	R

- × = series
- = Infrared devices L
- М = Microwave transistors
- Ρ = Low-frequency power transistors

PhC = Photocouplers

- R = Rectifier diodes
- SD = Small-signal diodes
- Vrf = Voltage reference diodes

type no.	book	section	type no.	book	section	type no.	book	section
1N4005G	S1	R	2N2907	S 3	Sm	2N5400	S 3	Sm
1N4006G	S1	R	2N2907A	S3	Sm	2N5401	S 3	Sm
1N4007G	51	R	2N3019	S 3	Sm	2N5415	S 3	Sm
1N4148	S1	SD	2N3020	S3	Sm	2N5416	\$3	Sm
1N4150	S1	SD	2N3053	S 3	Sm	2N5550	S 3	Sm
1N4151	S1	SD	2N3375	S6	RFP	2N5551	53	Sm
1N4153	51	SD	2N3553	S6	RFP	2N6659	S5	FET
1N4446	S1	SD	2N3632	S6	RFP	2N6660	S5	FET
1N4448	S1	SD	2N3822	S5	FET	2N6661	S5	FET
1N4531	S1	SD	2N3823	S5	FET	4N25	S8b	PhC
1N4532	S1	SD	2N3866	S6	RFP	4N25A	S8b	PhC
1N5059	S1	R	2N39O3	\$3	Sm	4N26	S8b	PhC
1N5060	S1	R	2N3904	S 3	Sm	4N27	S8b	PhC
1N5061	S1	R	2N3905	\$3	Sm	4N28	S8b	PhC
1N5062	51	R	2N3906	\$3	Sm	4N35	S8b	PhC
1N5225B			2N3924	S6	RFP	4N36	S8b	PhC
to	S1	SD	2N3926	S6	RFP	4N37	S8b	PhC
1N5267B			2N3927	56	RFP	4N38	S8b	PhC
2N918	S10	WBT	2N3966	55	FET	4N38A	S8b	PhC
2N929	53	Sm	2N4030	53	Sm	502COF	S8b	Ph
LINES	00							
2N930	53	Sm	2N4031	53	Sm	503C0F	S8b	Ph
2N1613	53	Sm	2N4032	\$3	Sm	504COL	S8b	Ph
2N1711	53	Sm	2N4033	53	Sm	516COF-B	S8b	Ph
2N1893	53	Sm	2N4091	55	FET	56201d	S4b	A
2N2219	53	Sm	2N4092	55	FET	56201i	S4b	A
2112215	0.0	Dim	2111072	00				
2N2219A	53	Sm	2N4093	S5	FET	56245	S3,10	A
2N2222	53	Sm	2N4123	S3	Sm	56246	\$3.10	A
2N2222A	53	Sm	2N4124	S 3	Sm	56261a	S4b	A
2N2297	53	Sm	2N4125	\$3	Sm	56264	S2a/b	A
2N2368	53	Sm	2N4126	\$3	Sm	56295	S2a/b	A
2112500	00			20			,	
2N2369	53	Sm	2N4391	S5	FET	56326	S4b	A
2N2369A	53	Sm	2N4392	S5	FET	56339	S4b	A
2N2483	G 3	Sm	2N4393	55	FET	56352	S4b	A
2N2483	53	Sm	2N4427	56	RFP	56353	S4b	A
2N2904	53	Sm	2N4856	S5	FET	56354	S4b	A
2112303	00		1 20000			1		
2129042	53	Sm	2N4857	S5	FET	56359b	S2.41	A
202905	53	Sm	2N4858	\$5	FET	563590	S2.41	A
2N2905A	53	Sm	2N4859	S5	FET	563590	52.41	A
2N2906	53	Sm	2N4860	55	FET	56360a	52,4h	A
2029067	G 3	Sm	2N4861	55	FET	56363	52,41	
202300A	55	Ju	2111001			30303	02141	

A = Accessories

FET = Field-effect transistors

Ph = Photoconductive devices

PhC = Photocouplers R = Rectifier diodes RFP = R.F. power transistors and modules

SD = Small-signal diodes

Sm = Small-signal transistors

WBT = Wideband transistors

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type no.	book	section
56364	S2,4b	A
56367	S2a/b	Α
56368b	S2,4b	Α
56368c	S2,4b	Α
56369	S2,4b	Α.
56378	S2,4b	Α
56379	S2,4b	Α
56387a,b	S4b	Α
56397	S8b	A

A = Accessories

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