

### 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.

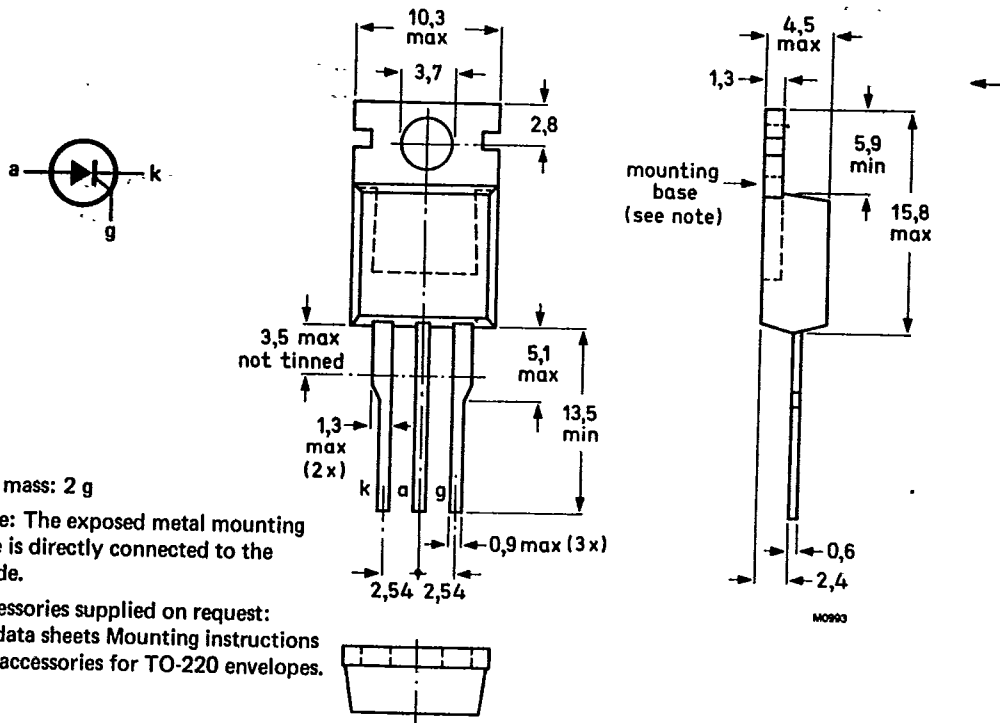
#### QUICK REFERENCE DATA

Repetitive peak off-state voltage	$V_{DRM}$	max.	500 V
Average on-state current	$I_T(AV)$	max.	4 A
R.M.S. on-state current	$I_T(RMS)$	max.	6 A
Repetitive peak on-state current	$I_{TRM}$	max.	30 A
Circuit-commutated turn-off time	$t_q$	<	20 $\mu s$

#### 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.

BT153

T-25-13

**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 $T_{mb} = 95$ °C	$I_T(AV)$	max.	4 A
R.M.S. on-state current	$I_T(RMS)$	max.	6 A
Working peak on-state current	$I_{TWM}$	max.	10 A
Repetitive peak on-state current	$I_{TRM}$	max.	30 A
Non-repetitive peak on-state current; $t = 10$ ms; half sine-wave; $T_j = 110$ °C prior to surge; with reapplied $V_{RWMmax}$	$I_{TSM}$	max.	40 A
$I^2t$ for fusing; $t = 10$ ms; $T_j = 25$ °C	$I^2t$	max.	10 A <sup>2</sup> s
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/ $\mu$ s

**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.	25 W

**Temperatures**

Storage temperature	$T_{stg}$	-40 to +125 °C
Operating junction temperature	$T_j$	max. 110 °C

\* Voltage shapes as occurring in the intended application.

Fast turn-off thyristor

BT153

T-25-13

**THERMAL RESISTANCE**

From junction to mounting base

$R_{th\ j-mb} = 1,5\ ^\circ C/W$

Transient thermal impedance;  $t = 1\ ms$ 

$Z_{th\ j-mb} = 0,2\ ^\circ C/W$

**Influence of mounting method**

1. Heatsink mounted with clip (see mounting instructions)

Thermal resistance from mounting base to heatsink

a. with heatsink compound

$R_{th\ mb-h} = 0,3\ ^\circ C/W$

b. with heatsink compound and 0,06 mm maximum mica insulator

$R_{th\ mb-h} = 1,4\ ^\circ C/W$

c. with heatsink compound and 0,1 mm maximum mica insulator (56369)

$R_{th\ mb-h} = 2,2\ ^\circ C/W$

d. with heatsink compound and 0,25 mm max. alumina insulator (56367)

$R_{th\ mb-h} = 0,8\ ^\circ C/W$

e. without heatsink compound

$R_{th\ mb-h} = 1,4\ ^\circ C/W$

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

$R_{th\ j-a} = 60\ ^\circ C/W$

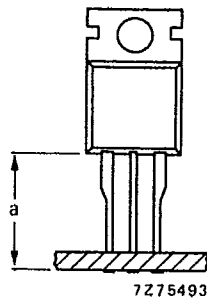


Fig. 2.

**CHARACTERISTICS**

**Anode to cathode**

On-state voltage

$I_T = 10 \text{ A}; T_j = 25 \text{ }^\circ\text{C}$

$V_T < 2,5 \text{ V}^*$

Rate of rise of off-state voltage that will not trigger any device;  $T_j \leq 110 \text{ }^\circ\text{C}$

$dV_D/dt < 200 \text{ V}/\mu\text{s}$

Off-state current

$V_D = V_{DRMmax}; T_j = 110 \text{ }^\circ\text{C}$

$I_D < 1,5 \text{ mA}$

Holding current;  $T_j = 25 \text{ }^\circ\text{C}$

$I_H < 100 \text{ mA}$

**Gate to cathode**

Voltage that will trigger all devices

$V_D = 6 \text{ V}; T_j = 25 \text{ }^\circ\text{C}; t_p \geq 5 \mu\text{s}$

$V_{GT} > 2,5 \text{ V}$

Current that will trigger all devices

$V_D = 6 \text{ V}; T_j = 25 \text{ }^\circ\text{C}; t_p \geq 5 \mu\text{s}$

$I_{GT} > 40 \text{ mA}$

**Switching characteristics**

Circuit-commutated turn-off time (in regulating circuits)

when switched from  $I_T = 10 \text{ A}$  to  $V_R \geq 50 \text{ V}$  with  
 $-dI_T/dt = 10 \text{ A}/\mu\text{s}; dV_D/dt = 200 \text{ V}/\mu\text{s}; V_{DM} = 500 \text{ V};$   
 $R_{GK} = 68 \Omega; T_{mb} = 80 \text{ }^\circ\text{C}; t_p \leq 50 \mu\text{s}$

$t_q < 20 \mu\text{s}$

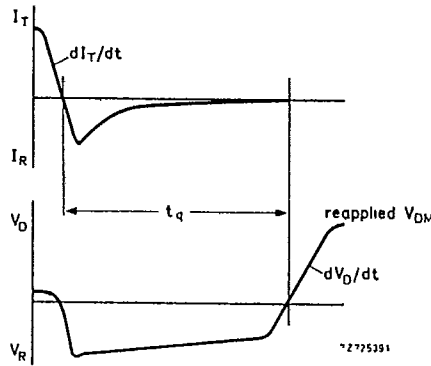


Fig. 3 Circuit-commutated turn-off time definition.

\* Measured under pulse conditions to avoid excessive dissipation.

**MOUNTING INSTRUCTIONS**

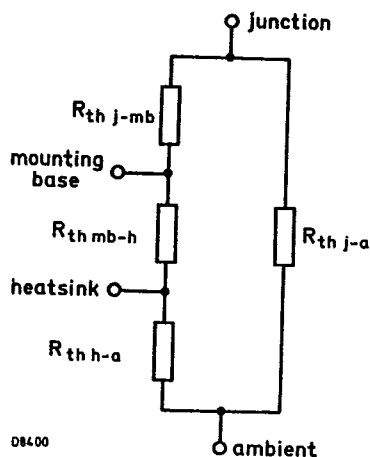
1. The device may be soldered directly into the circuit, but the maximum permissible temperature of the soldering iron or bath is 275 °C; it must not be in contact with the joint for more than 5 seconds. Soldered joints must be at least 4.7 mm from the seal.
2. The leads should not be bent less than 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  $R_{th\ mb-h}$  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.
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.

BT153

T-25-13

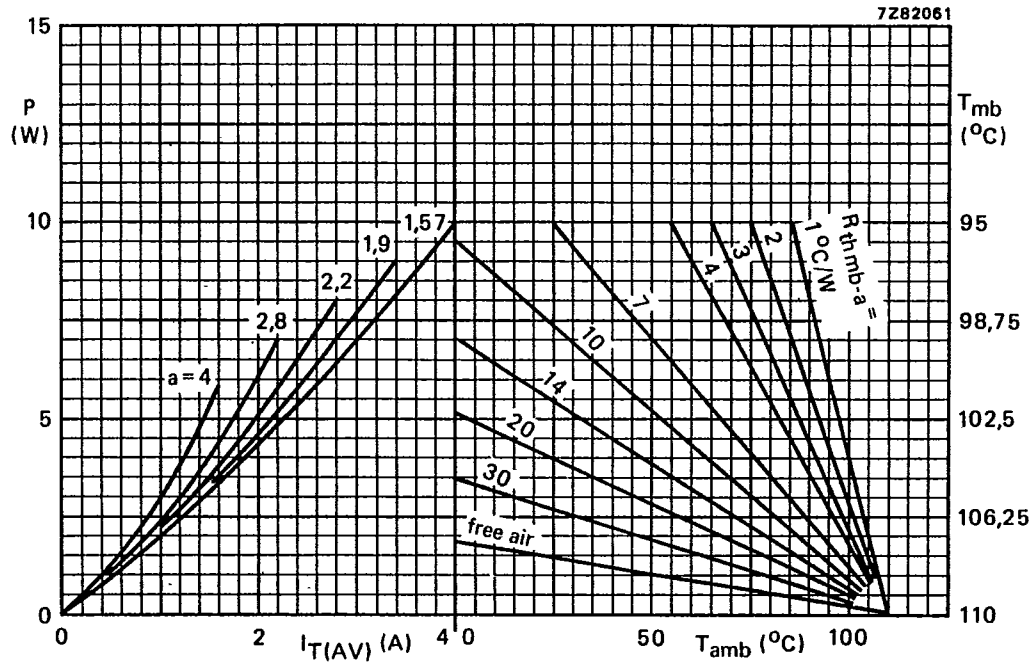


Fig. 5 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.



$\alpha$  = conduction angle per half cycle

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

$\alpha$	a
30°	4
60°	2,8
90°	2,2
120°	1,9
180°	1,57

T-25-13

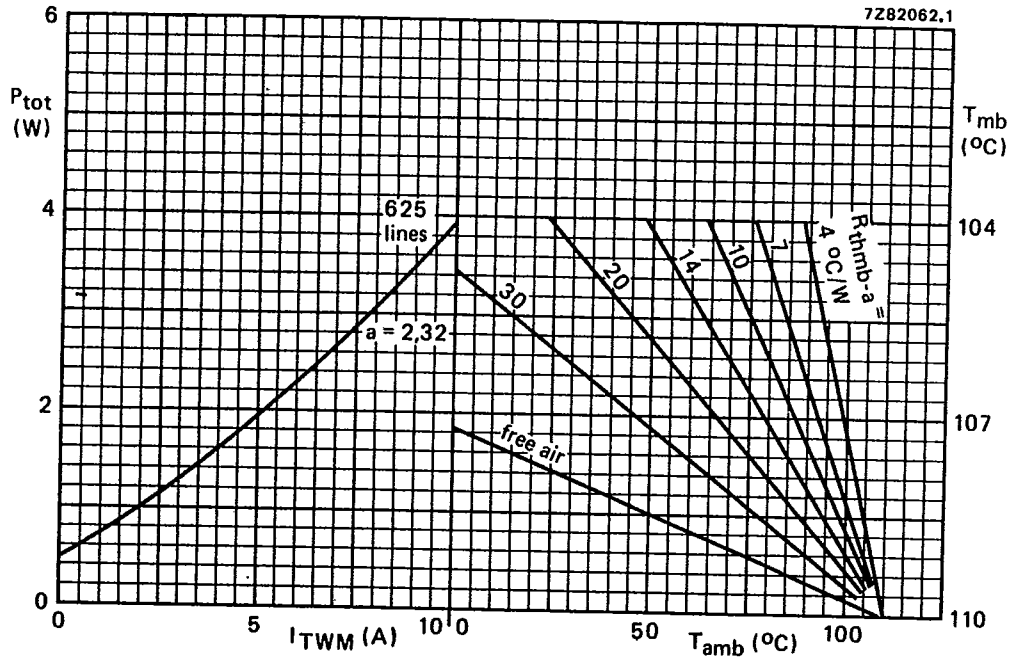


Fig. 6 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.

$P_{tot}$  = maximum power dissipation including gate and switching losses.  
 $I_{TWM}$  = maximum working peak on-state current.

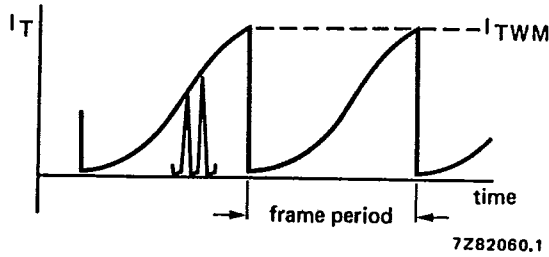


Fig. 7 Waveform defining  $I_{TWM}$ .

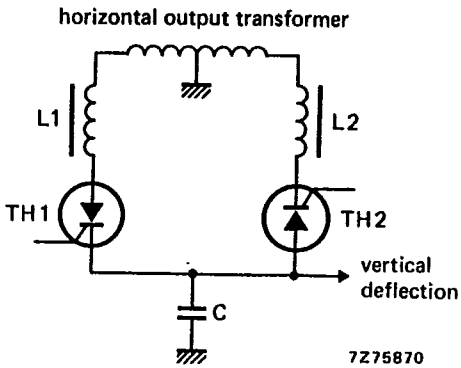


Fig. 8 Basic circuit of a vertical deflection system.

T-25-13

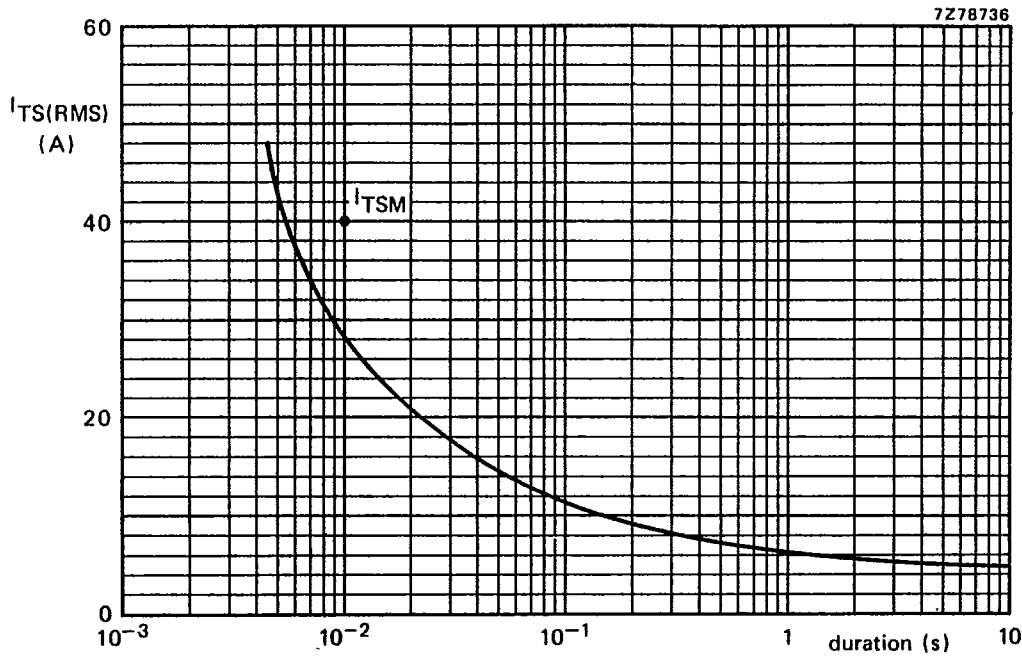
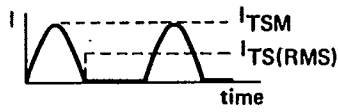


Fig. 9 Maximum permissible non-repetitive r.m.s. on-state current based on sinusoidal currents ( $f = 50$  Hz);  $T_j = 110$  °C prior to surge; with reapplied  $V_{RWMmax}$ .





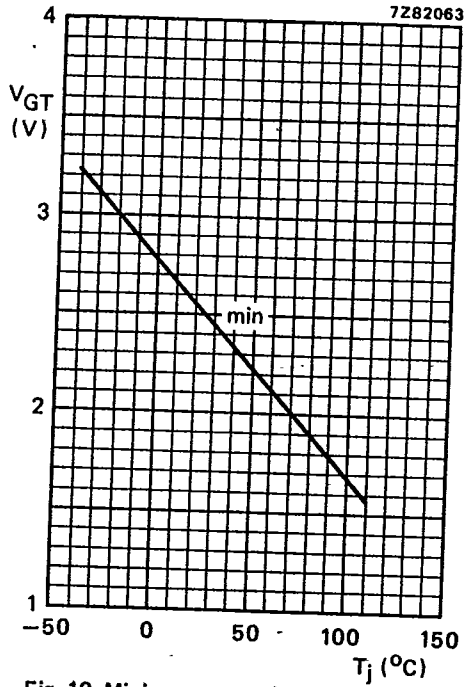


Fig. 10 Minimum gate voltage that will trigger all devices as a function of junction temperature.

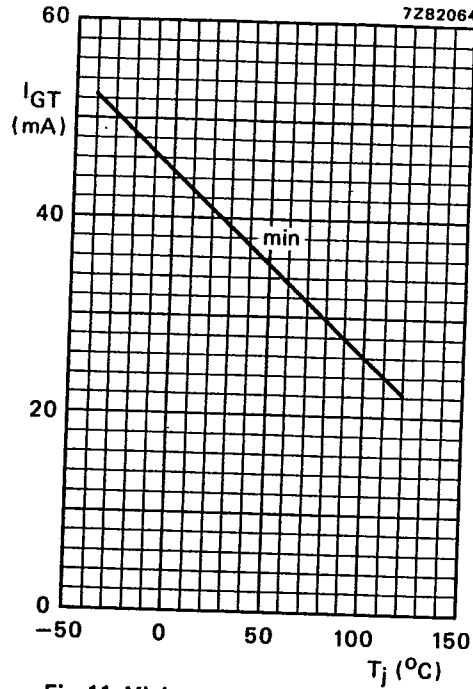


Fig. 11 Minimum gate current that will trigger all devices as a function of junction temperature.

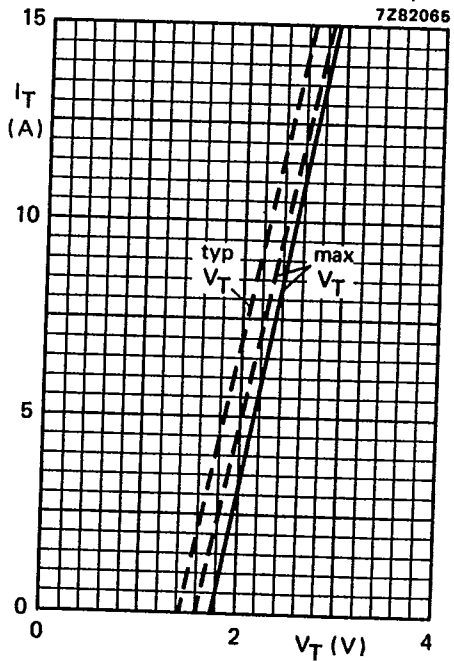


Fig. 12 —  $T_j = 25^{\circ}C$ ; ---  $T_j = 110^{\circ}C$ .

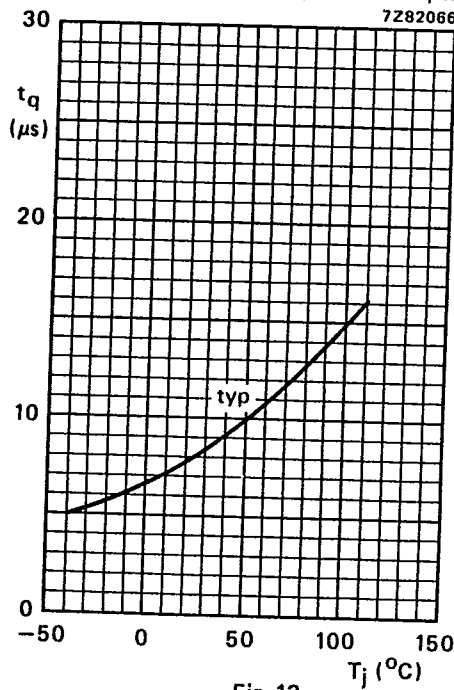


Fig. 13.

T-25-13

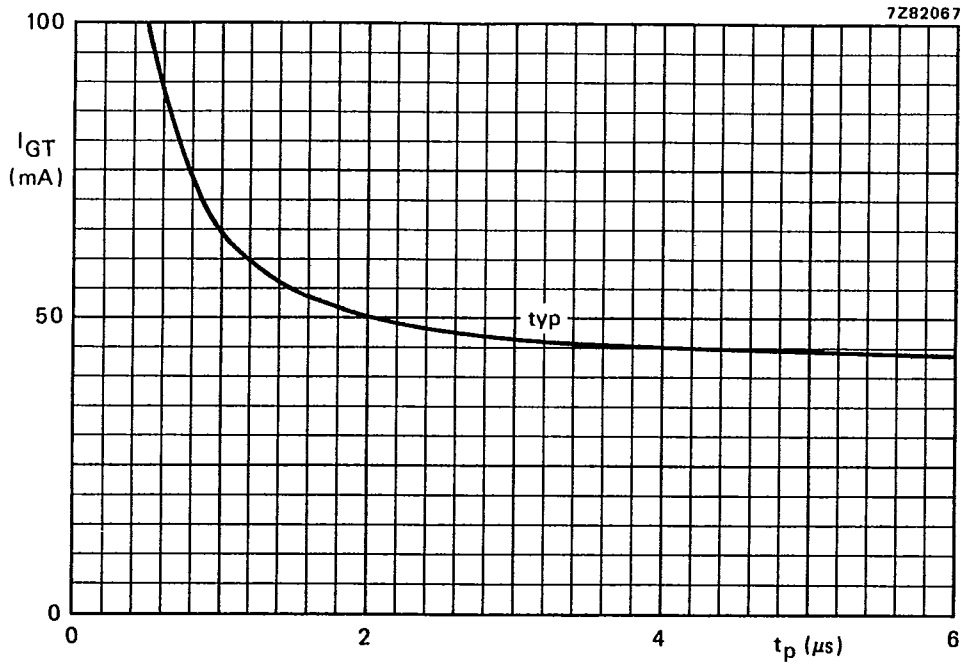
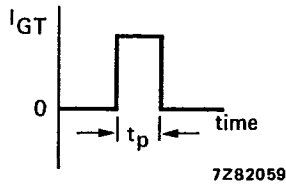


Fig. 14 Gate current that will trigger all devices as a function of rectangular pulse width;  $T_j = 25^\circ C$ .



T-25-13

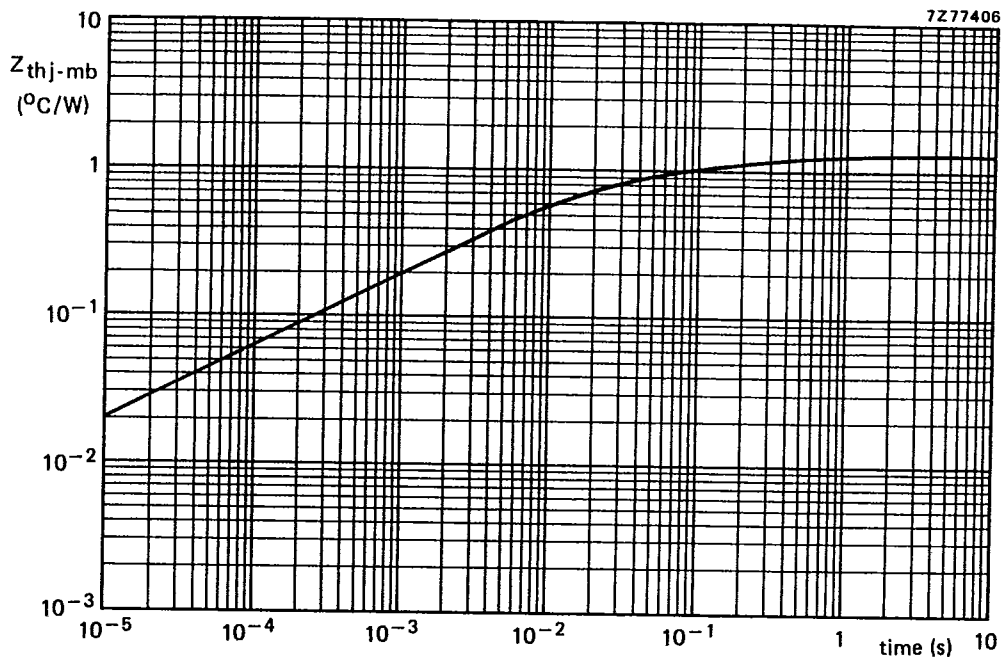


Fig. 15.