

# TYPES TIC44, TIC45, TIC46, TIC47 P-N-P-N PLANAR SILICON REVERSE-BLOCKING TRIODE THYRISTORS

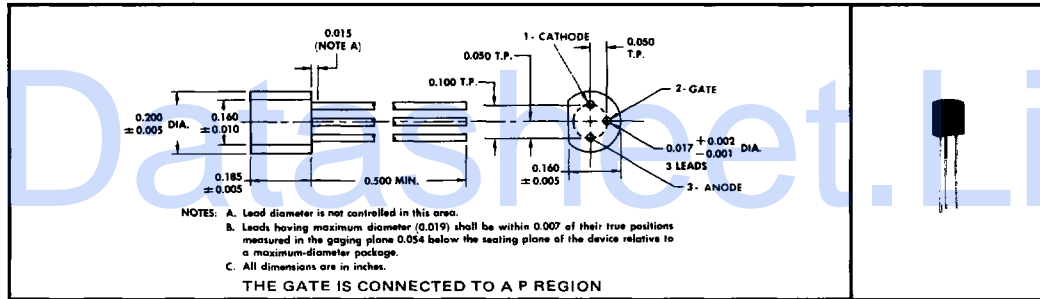
**SELECT† THYRISTORS‡**  
600 mA DC • 30 thru 200 VOLTS

Rugged, One-Piece Construction with Standard TO-18 100-mil Pin-Circle Configuration

TYPES TIC44, TIC45, TIC46, TIC47  
BULLETIN NO. DL-S-7111669, DECEMBER 1971  
REPLACES BULLETIN NO. DL-S-669051, SEPTEMBER 1966

## mechanical data

These thyristors are encapsulated in a plastic compound specifically designed for this purpose, using a highly mechanized process developed by Texas Instruments. The case will withstand soldering temperatures without deformation. These devices exhibit stable characteristics under high-humidity conditions and are capable of meeting MIL-STD-202C method 106B. The thyristors are insensitive to light.



## absolute maximum ratings over operating free-air temperature range (unless otherwise noted)

	TIC44	TIC45	TIC46	TIC47	UNIT
Static Off-State Voltage, $V_D$ (See Note 1)	30	60	100	200	V
Repetitive Peak Off-State Voltage, $V_{DRM}$ (See Note 1)	30	60	100	200	V
Static Reverse Voltage, $V_R$ (See Note 1)	30	60	100	200	V
Repetitive Peak Reverse Voltage, $V_{RRM}$ (See Note 1)	30	60	100	200	V
Continuous or RMS On-State Current at (or below) 55°C Case Temperature (See Note 2)	600				mA
Continuous or RMS On-State Current at (or below) 25°C Free-Air Temperature (See Note 3)	300				mA
Average On-State Current (180° Conduction Angle) at (or below) 55°C Case Temperature (See Note 4)	430				mA
Surge On-State Current (See Note 5)	6				A
Peak Negative Gate Voltage	8				V
Peak Positive Gate Current (Pulse Width $\leq 300 \mu s$ )	1				A
Peak Gate Power Dissipation (Pulse Width $\leq 300 \mu s$ )	4				W
Operating Free-Air Temperature Range	-55 to 125				°C
Storage Temperature Range	-55 to 150				°C
Lead Temperature 1/16 Inch from Case for 10 Seconds	260				°C

- NOTES: 1. These values apply when the gate-cathode resistance  $R_{GK} \leq 1 \text{ k}\Omega$ .  
2. These values apply for continuous d-c operation with resistive load. Above 55°C derate according to Figure 5.  
3. These values apply for continuous d-c operation with resistive load. Above 25°C derate according to Figure 6.  
4. This value may be applied continuously under single-phase, 60-Hz, half-sine-wave operation with resistive load. Above 55°C derate according to Figure 5.  
5. This value applies for one 60-Hz half sine wave when the device is operating at (or below) rated values of peak reverse voltage and on-state current. Surge may be repeated after the device has returned to original thermal equilibrium.

†Trademark of Texas Instruments  
‡U. S. Patent No. 3,439,238

# TYPES TIC44, TIC45, TIC46, TIC47

## P-N-P-N PLANAR SILICON REVERSE-BLOCKING TRIODE THYRISTORS

electrical characteristics at 25°C free-air temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	MAX	UNIT
$I_D$	Static Off-State Current	$V_D = \text{Rated } V_D, R_{GK} = 1 \text{ k}\Omega, T_A = 125^\circ\text{C}$	50		$\mu\text{A}$
$I_R$	Static Reverse Current	$V_R = \text{Rated } V_R, R_{GK} = 1 \text{ k}\Omega, T_A = 125^\circ\text{C}$	50		$\mu\text{A}$
$I_{GT}$	Gate Trigger Current (See Note 6)	$V_{AA} = 6 \text{ V}, R_L = 100 \Omega, t_{p(g)} > 20 \mu\text{s}$	200		$\mu\text{A}$
$V_{GT}$	Gate Trigger Voltage (See Note 6)	$V_{AA} = 6 \text{ V}, R_L = 100 \Omega, t_{p(g)} > 20 \mu\text{s}$	0.8		V
		$V_{AA} = 6 \text{ V}, R_L = 100 \Omega, t_{p(g)} > 20 \mu\text{s}, T_A = 125^\circ\text{C}$	0.2		
$I_H$	Holding Current	$R_L = 100 \Omega, R_{GK} = 1 \text{ k}\Omega$	5		mA
$V_T$	On-State Voltage	$I_T = 300 \text{ mA}, R_{GK} > 1 \text{ k}\Omega, \text{ See Note 7}$	1.4		V

NOTES: 6. When measuring these parameters, a 1-k $\Omega$  resistor should be used between gate and cathode to prevent triggering by random noise.

7. This parameter is measured using pulse techniques.  $t_w = 1 \text{ ms}$ , duty cycle  $< 1\%$ .

switching characteristics at 25°C free-air temperature

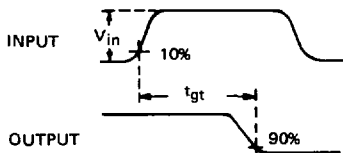
PARAMETER		TEST CONDITIONS	TYP	UNIT
$t_{gt}$	Gate-Controlled Turn-On Time	$V_{AA} = 30 \text{ V}, R_L = 50 \Omega, R_G = 20 \text{ k}\Omega, V_{in} = 20 \text{ V}, \text{ See Figure 1}$	3.5	$\mu\text{s}$
$t_q$	Circuit-Commutated Turn-Off Time	$V_{AA} = 30 \text{ V}, R_L = 50 \Omega, I_{RM} = 1 \text{ A}, \text{ See Figure 2}$	6.8	$\mu\text{s}$

thermal characteristics

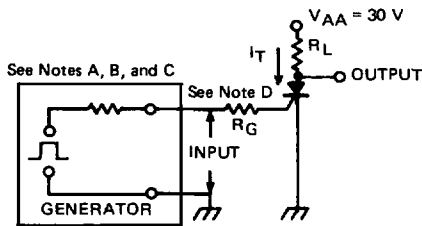
PARAMETER		MAX	UNIT
$R_{\theta JC}$	Junction-to-Case Thermal Resistance	75	$^\circ\text{C/W}$
$R_{\theta JA}$	Junction-to-Free-Air Thermal Resistance	275	

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## PARAMETER MEASUREMENT INFORMATION



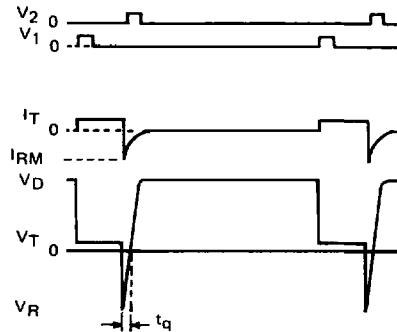
VOLTAGE WAVEFORMS



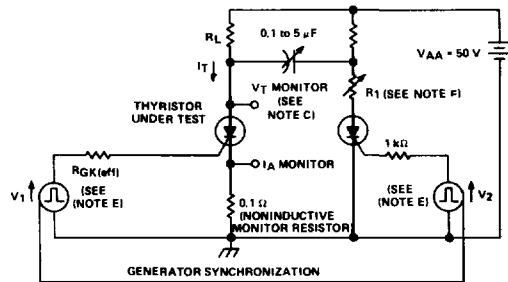
TEST CIRCUIT

FIGURE 1—TURN-ON TIME

- NOTES:
- A.  $V_{in}$  is measured with gate and cathode terminals connected as shown and anode terminal open.
  - B. The input waveform of Figure 1 has the following characteristics:  $t_r \leq 40$  ns,  $t_w \geq 20$   $\mu$ s.
  - C. Waveforms are monitored on an oscilloscope with the following characteristics:  $t_r \leq 14$  ns,  $R_{in} \geq 10$  M $\Omega$ ,  $C_{in} \leq 12$  pF.
  - D.  $R_G$  includes the total resistance of the generator and the external resistor.



WAVEFORMS



TEST CIRCUIT

FIGURE 2—COMMUTATING TURN-OFF TIME

- NOTES:
- E. Pulse generators for  $V_1$  and  $V_2$  are synchronized to provide an anode current waveform with the following characteristics:  $t_w = 50$  to  $300$   $\mu$ s, duty cycle = 1%. The pulse widths of  $V_1$  and  $V_2$  are  $\geq 10$   $\mu$ s.
  - F. Resistor  $R_1$  is adjusted for  $I_{RM} = 1$  A.

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## THERMAL INFORMATION

The minimum heat-sink requirements may be calculated for any on-state current, heat-sink combination by the following procedure:

1. Determine worst-case power dissipation from Figure 3.
2. Calculate maximum allowable case-to-free-air thermal resistance by use of the equation.

$$R_{\theta CA} = \frac{T_J - T_A}{P_{A(av)}} - R_{\theta JC}$$

where:  $T_J$  = Junction temperature

$T_A$  = Free-air temperature

$P_{A(av)}$  = Average anode power dissipation (see Figure 3 for worst-case values)

$R_{\theta JC}$  = Junction-to-case thermal resistance = 75°C/W maximum.

3. Determine area of heat sink from Figure 4.

### EXAMPLE

Determine: Minimum size of 1/16"-thick aluminum heat sink for safe operation of thyristor at an average current of 0.4 A with a conduction angle of 180°

Given: Maximum  $T_J = 125^\circ\text{C}$

$T_A = 35^\circ\text{C}$

$R_{\theta JC} = 75^\circ\text{C/W}$

Solution: From Figure 3,  $P_{A(av)} = 0.84\text{ W}$  for 0.4 A with 180° conduction angle. Using the equation of step 2 above:

$$R_{\theta CA} = \frac{125^\circ\text{C} - 35^\circ\text{C}}{0.84\text{ W}} - 75^\circ\text{C/W} = 32^\circ\text{C/W}$$

Figure 4 shows that for  $R_{\theta CA}$  of 32°C/W, the area is 18 sq. in. The minimum dimensions of the sides should be:

$$\sqrt{\frac{\text{area}}{2}} \times \sqrt{\frac{\text{area}}{2}} = \sqrt{\frac{18}{2}} \times \sqrt{\frac{18}{2}} = 3'' \times 3''$$

NOTES: 8. The thyristor is mounted in the center of a square heat sink vertically positioned in still free air with both sides exposed. The heat-sink area is twice the area of one side.

9.  $R_{\theta CA}$  includes the case-to-heat sink thermal resistance,  $R_{\theta CHS}$ , in addition to the heat-sink-to-free-air thermal resistance,  $R_{\theta HSA}$  and is defined by the equation,  $R_{\theta CA} = R_{\theta CHS} + R_{\theta HSA}$ .

MAXIMUM AVERAGE ANODE POWER DISSIPATED

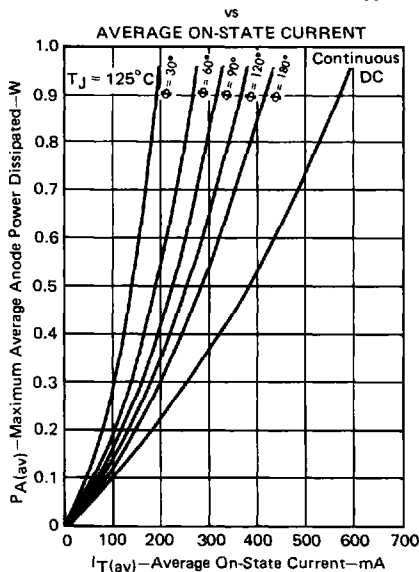


FIGURE 3

TYPICAL HEAT-SINK AREA  
vs  
CASE-TO-FREE-AIR THERMAL RESISTANCE  
1/16"-THICK ALUMINUM HEAT SINK

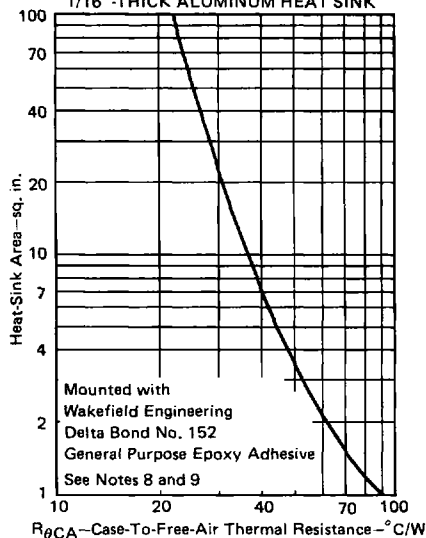


FIGURE 4

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## THERMAL INFORMATION

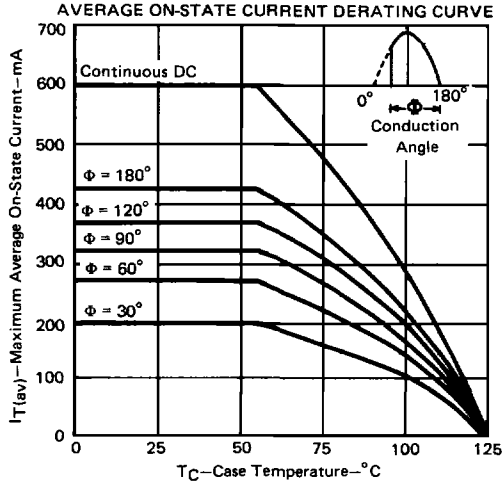


FIGURE 5

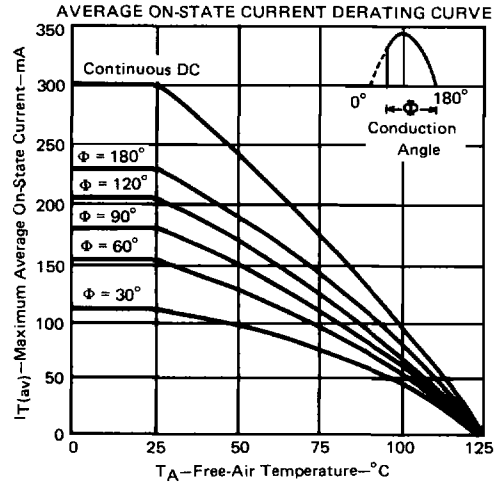


FIGURE 6

## TYPICAL CHARACTERISTICS

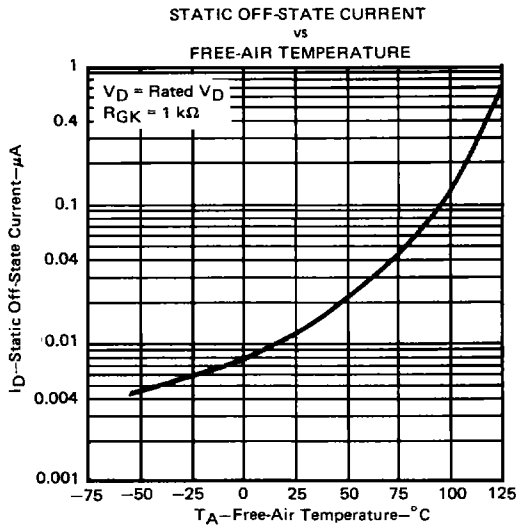


FIGURE 7

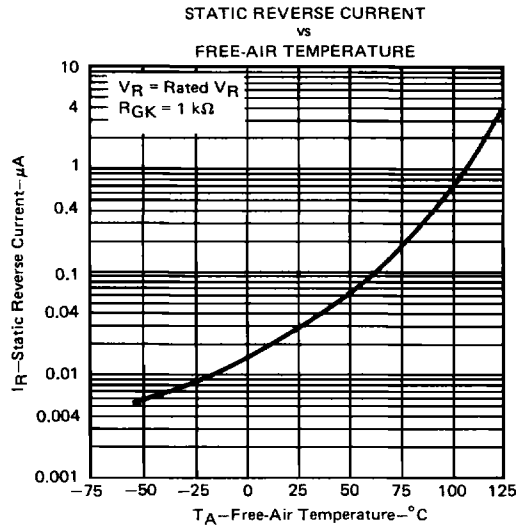


FIGURE 8

# TYPES TIC44, TIC45, TIC46, TIC47

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### TYPICAL CHARACTERISTICS

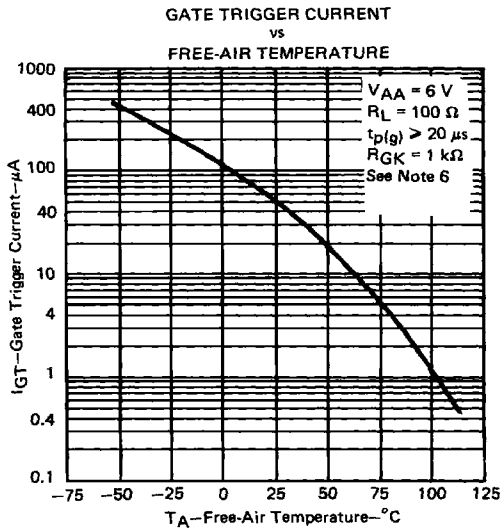


FIGURE 9

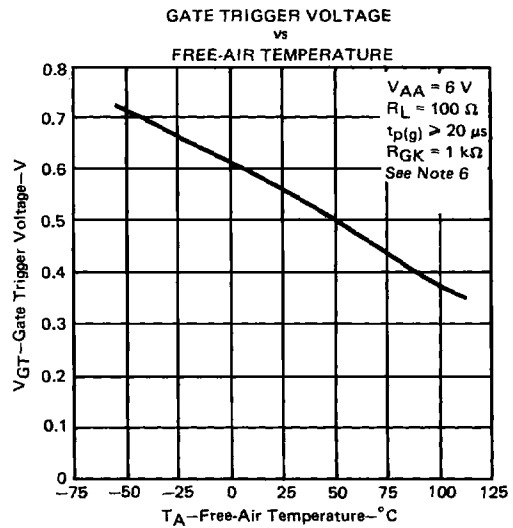


FIGURE 10

NOTE 6: When measuring these parameters, a 1-k $\Omega$  resistor should be used between gate and cathode to prevent triggering by random noise.

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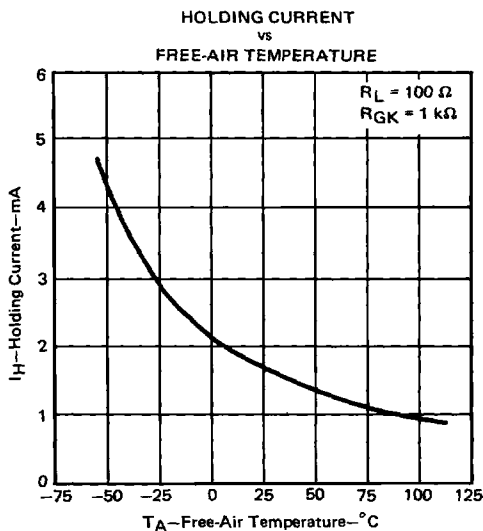


FIGURE 11

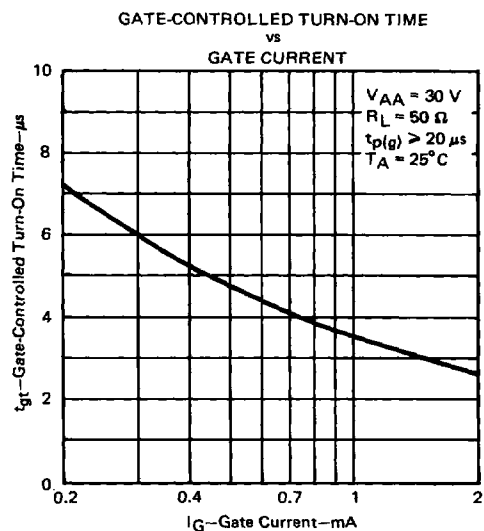


FIGURE 12