Low Power

Applications and Technical Data Book

POWEREX

■ **Helpful Hints**

10.0 Selection of Devices and Cautions for Use

10.0 Selections of Devices and Cautions for Use

10.1 Use of Thyristors

10.1.1 Determination of the Current

The permissible currents for thyristors is shown by the average value.

- When no rush current flows (heater, solenoid load) Load current x 1.3 to 1.5 ⩽ permissible current for thyristor

  Example:
  1A x 1.5 → Applicable to 2A type thyristors. Determine the size of heatsink fin from the catalog. See Figure 10.1.

- When the rush current flows (lamp, transformer, motor load), the rush current should be measured and a detailed heat calculation should be made. The current is roughly estimated to be twice the calculated value when no rush current flows.

Figure 10.1

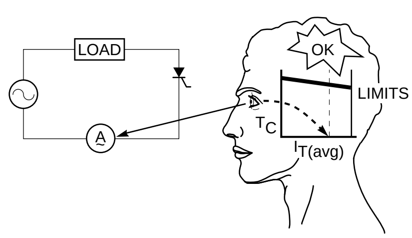
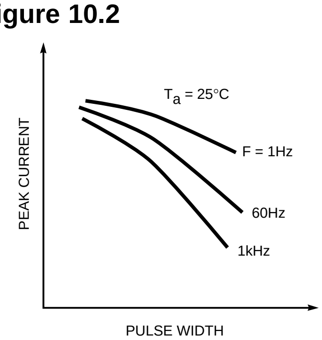


Figure 10.2



- When pulses are used (capacitor discharge, LC oscillation, short-duration application) (less than 10 seconds). See Figure 10.2.

10.1.2 Selection of Withstanding Voltage Class

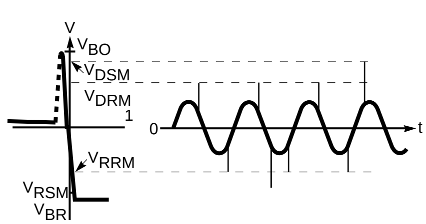
Withstanding voltage of thyristor (V_{DRM}) =
Supply Voltage x 2.5 to 3

See Figure 10.3.

10.1.3 Selection of Voltage Items

Supply Voltage	Location of Use	With-standing Voltage Class	V_{DRM} (V)	V_{DSM} (V)
100V Line	Japan (Home Use)	8	400	—
120V Line	USA			
100V Line	Earth Leakage Breaker	8	400	500
200V Line	Japan	12	600	—
230V, 240V Line	Europe			
200V Line (240V)	Leakage Protector	12	600	800

Figure 10.3



Measures for dv/dt

When large voltage dv/dt is applied to thyristors, CR absorbers should be connected in parallel to the thyristors to lighten the dv/dt applied to the device.

A capacitor of 0.047μF and a resistor of 33Ω are generally used for low power thyristors.

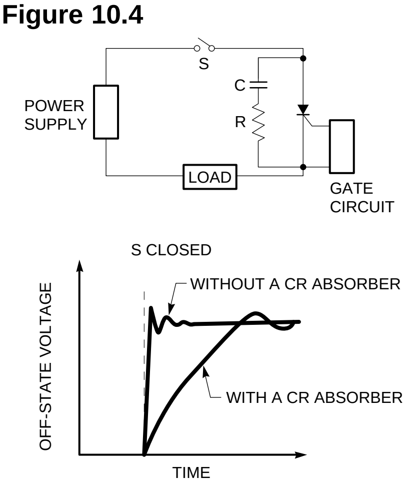
It is generally recommended to insert a resistor of 1kΩ between the gate and cathode for high-sensitivity low-current thyristors to lighten the dv/dt.

Figure 10.4 shows how to lighten the dv/dt with a CR absorber.

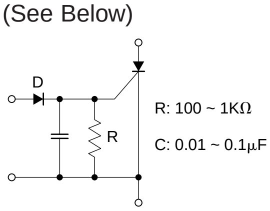
Cautions on the di/dt

If the current rate-of-rise di/dt exceeds the limit when a thyristor is turned on, the device may be damaged. In applications for inverters and choppers which discharge large currents when the thyristor is turned on, the di/dt causes a problem and, therefore, should be lightened by connecting an anode reactor.

Figure 10.4



Measures for Error Prevention
The cause and preventive measures of errors in the trigger circuit are shown in the following table.

Cause	Preventative Measures
Noise to Trigger Circuit	1. Stabilize the supply voltage. 2. Insert a surge voltage abosrber. 3. Avoid the use of a differentiation circuit which can be easily affected by the noise votltage resulting from the design of trigger circuits. 4. Provide electromagnetic shields to avoid external noise from the chassis.
Noise Voltage (Induced in relation to the trigger circuit to the gate of the thyristor.)	1. Use shielded wires to transmit the trigger signals. 2. Keep the wires as far apart as possible from the main circuit wires to avoid electromagnetic complications.
Feedback Noise from the Main Circuit	1. Insert an abosrber at the gate. (See Below) 2. Insert a diode (See Below) 

10.2 Use of Triacs

10.2.1 Determination of the Current

The permissible currents for triacs are shown by the effective values. See Figure 10.5.

The indicator values of AC ammeter are important.

- When no rush current flows (heater load) Load current x 1.3 to 1.5 ⩽ permissible current for triacs

  Example:
  6A x 1.5 → Applicable to 10A class thyristors

  Determine the size of heatsink fin from the catalog.

- When the rush current flows (lamp, transformer, motor load) The rush current should be measured and a detailed heat calculation should be made.

  Provide us with the following values and Powerex will do the calculation for you.

  Ambient Temperature:
  T_a = ____°C

  Peak Value of Rush Current:
  I_P = ____A
  Waveform if available.

  Constant Current Value:
  $I_{T(RMS)}$ = ____A

  Operation Sequence:
  ____ Seconds during ON
  ____ Seconds during OFF

  Heatsink fin Material, size, painting, heat resistance $R_{th(f-a)}$ if available.

The following triacs are applicable to the loads when the rush current flows (see following table).

Load	Rush Current	Applicable Triacs
Incadescent Lamp		
100V - 800W	80A	BCR16CM
100V - 600W	60A	BCR12CM
100V - 500W	50A	BCR10CM
Halogen Lamp		
100V - 600W	72A	BCR16CM
Microwave Oven		
100V - 600W	80A	BCR16CM
General Use – 3 Phase Induction Motor	40A-45A	
0.75kW - 200V		BCR16CM

Section of Withstanding Voltage Class as shown in Figure 10.6.

Withstanding voltage of triacs:

V_{DRM} = Two or three times the supply voltage

Figure 10.5

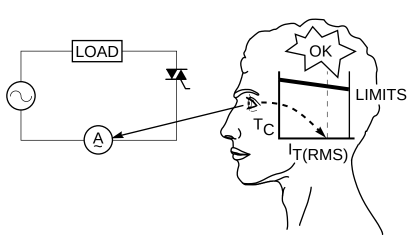
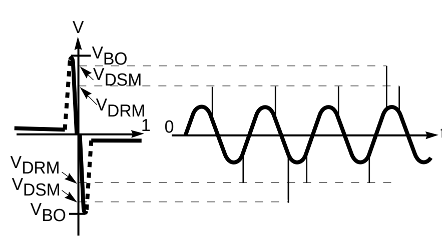


Figure 10.6



Section of Withstanding Voltage Items

100V to 120V Line System

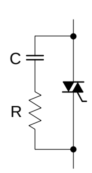
Supply Voltage	Location of Use	With-standing Voltage Item	V_{DRM} (V)	V_{DSM} (V)
100V Line	Japan (Home Use)	8	400	600
120V Line	USA	8	400	600
100V Line 120V Line	Reversing Operation of Capacitor Motor	8	400	600

200V to 240V Line System

Supply Voltage	Location of Use	With-standing Voltage Item	V_{DRM} (V)	V_{DSM} (V)
200V Line	Japan (Factory Use)	12	600	800
230V, 240V Line	Europe	12	600	800

Selection of CR Absorber

In general, CR absorbers should be connected to suppress the $(dv/dt)_C$ value applied to the device when controlling the inductive load by triacs as shown here.



The values for CR absorbers vary in accordance with the circuit conditions and sometimes they have to be determined by experimentation. In most cases, the $(dv/dt)_C$ value can be controlled to be less than 2.5V/μs (supply voltage 100V) and 5V/μs (supply voltage 200V) when C is 0.1μF and R is 100Ω.

Recommended Values for C and R

	100V ~ 120V	200V ~ 240V
C	0.1μF, 400WV	0.1μF, 600WV
R	100Ω, 0.5W	100Ω, 1W

10.3 Gate Circuit and Gate Trigger Current

10.3.1 Gate Circuit

As stated earlier, triacs have four trigger modes and can be used in the combinations shown in Figure 10.7.

10.3.2 Inductive and Resistive Load

The commutation characteristics of triacs should be considered according to the load. Commutating characteristics $(di/dt)_C$ and $(dv/dt)_C$ shift to on-state without the gate signal and become uncontrollable as shown in Figure 10.8, if they exceed certain values during commutation through the effect of current delay when the inductive load (L load) is controlled by triacs (commutation failure). See Figure 10.9

To turn off the triacs, the appropriate device should be selected in accordance with the load. Also, C and R should be connected in series to the device to control the rise in voltage during commutation.

	Example of Load
L Load (Inductive Load)	Motors, Electromagnetic Valves, Transformers, Solenoids
R Load (Resistive Load)	Heaters, Lamps

Trigger Mode of Triacs

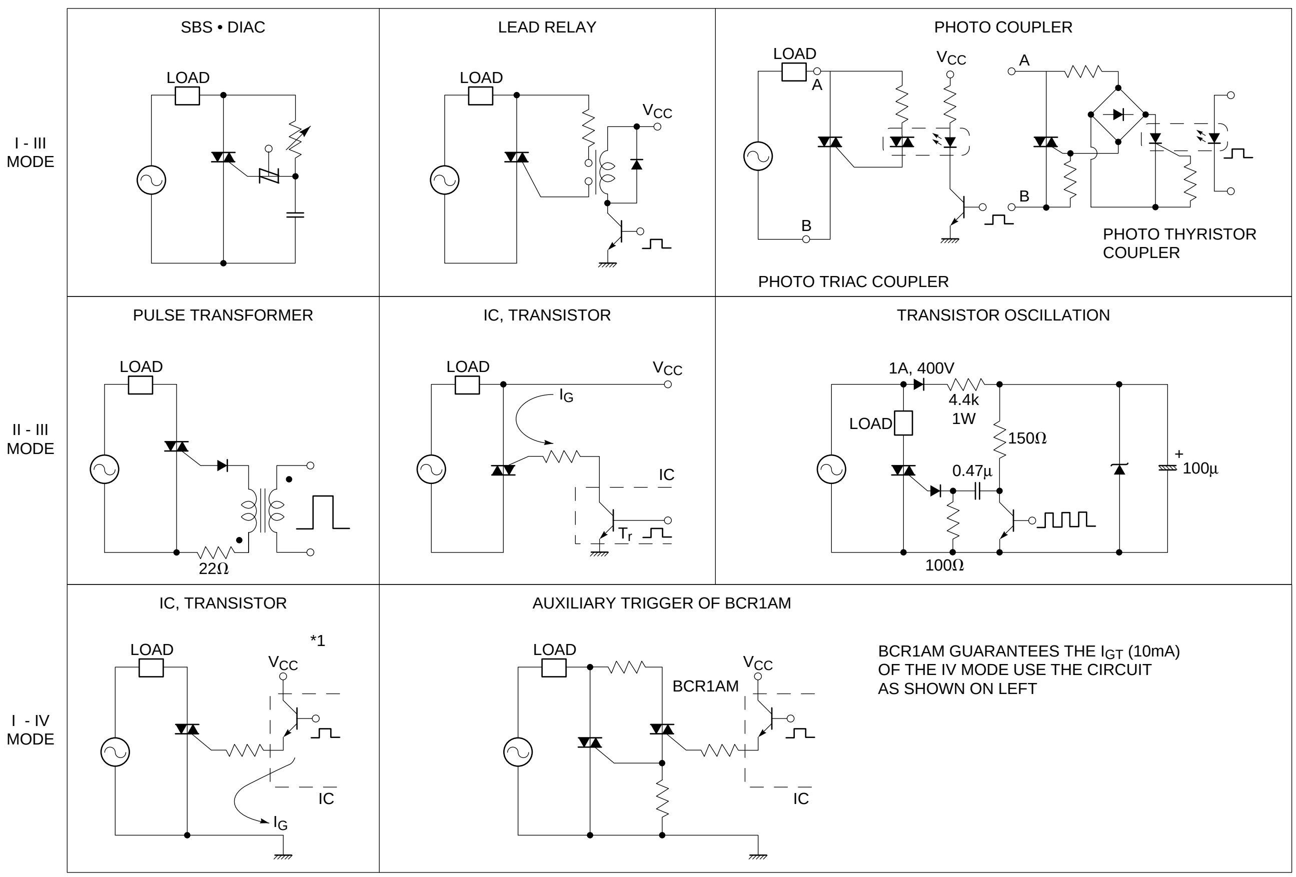
Triacs are turned on by applying either positive or negative gate signals. Thyristors are turned on by the gate signal when either forward or reverse voltages are applied. See Figure 10.10.

Triacs can be triggered by the gate signal in the following four modes as shown in Figure 10.10. However, the IV mode is guaranteed only by the BCR1AM.

10.4 Determination of Gate Current (See Figure 10.11)

Figure 10.7

EXAMPLES OF GATE TRIGGER CIRCUIT



*1 THE IV MODE (G + T_2 –) IS NOT GENERALLY GUARANTEED EXCEPT THOSE OF BCR1AM. IF THIS TRIGGER MODE IS USED, SELECTION MUST BE MADE. SET THE SELECTION VALUS AT MORE THAN 80 ~ 100mA. (BCR3AM, BCR16HM)

Figure 10.8 Waveforms During Commutation

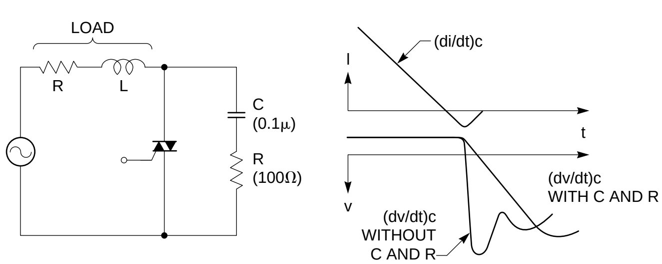
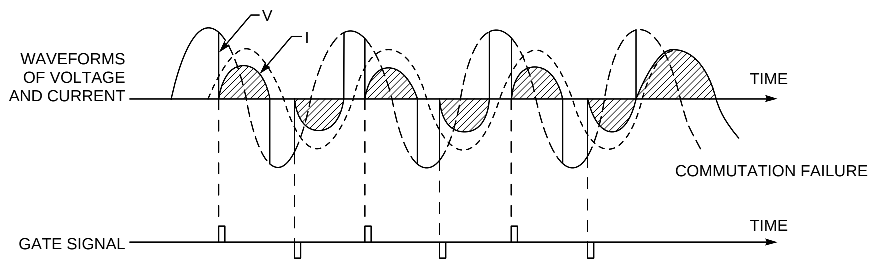


Figure 10.9 Waveforms of Voltage and Current Applied to Triacs During L Load



WAVEFORMS OF VOLTAGE AND CURRENT APPLIED TO TRIACS WHEN L LOAD IS USED AND WHEN COMMUTATION FAILS.

Figure 10.10 Trigger Mode for Triacs

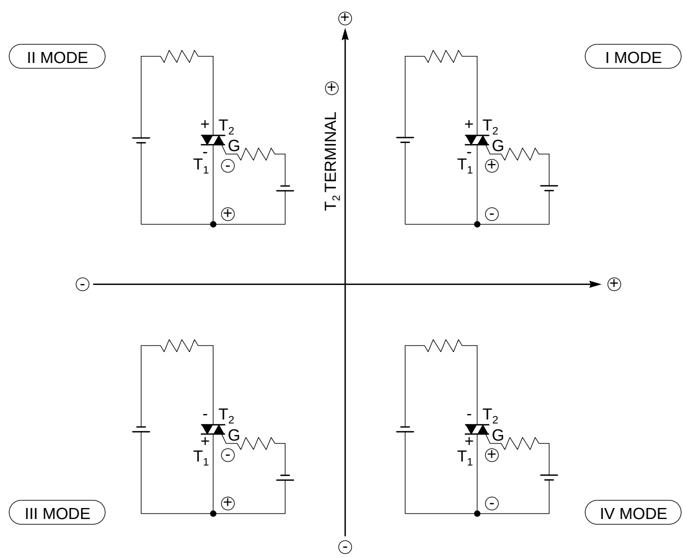


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Figure 10.11 Determination of Gate Current