Driving the Thyristor, and its Protection

The basic gate requirements to trigger a thyristor into the conduction state are that the current supplied to the gate is

(a) of adequate amplitude and sufficiently short rise time
(b) of sufficient duration.

The gate conditions are subject to the anode being forward-biased with respect to the cathode. Figure 8.1 illustrates a typical thyristor gate current waveform. The initial high and rapid current quickly turns on the device so as to increase the anode initial $di/dt$ capability. After a few microseconds the gate current can be decreased to a value in excess of the minimum gate requirement. After the thyristor has latched on, the gate drive may be removed in order to reduce gate power consumption, namely the losses. In some inductive load applications, where
the load current lags, a continuous train of gate pulses is usually applied to ensure turn-on.

Gate drives can be divided broadly into two types, either electrically isolated or non-isolated. To obtain electrical isolation usually involves the use of a pulse-transformer or an opto-coupler but above a few kilovolts fibre-optic techniques are applicable.

8.1 Gate drive circuits

Only low-power thyristors with amplifying gates can be triggered directly from ttl or cmos. Usually a power interface stage is employed to convert ttl current sink levels of a few milliamps up to the required gate power levels.

Figure 8.2 shows two power interface circuits for triggering a triac. The triac could equally be another thyristor device. An important safety feature of both these circuits is that no active device exists between the gate and M1. During the off state the gate is clamped by the resistor $R_g$ to a voltage well below the minimum voltage level for turn-on.

![Integrated circuit compatible triac gate drive circuits: (a) high ttl output activation; (b) low level ttl output activation using an interfacing pnp transistor.](image)

Bidirectional gate current can bring the triac into conduction. Figure 8.3 shows how negative gate turn-on current can be derived.

If electrical isolation between the control circuitry and the thyristor circuit is required, a simple triac opto-coupler can be employed as shown in figure 8.4. The phototriac is optically turned on which allows main triac gate current to flow, the magnitude of which is controlled by the resistor $R_g$. If the main device is an scr, an opto-coupled scr can be used for isolation and triggering.

When suitable voltage rails are not available, a pulse transformer drive circuit