fundamentals of the gate triggering process, gate triggering devices and simple gate triggering circuits.

3.2 FIRING OF THYRISTORS

The basic requirements for the successful firing of a thyristor are that the current supplied to the gate should:

(i) be of adequate amplitude and sufficiently short rise time.
(ii) be of adequate duration.
(iii) occur at a time when the main circuit conditions are favourable to conduction.

3.2.1 Gate-Current Amplitude and Rise Time

The quoted firing current $I_{g(min)}$ in Chapter 2 expresses the minimum gate current required to fire all thyristors of a given type at a standard temperature. This is not

The gate drive chosen must trigger the thyristor under the most adverse conditions, and, in particular, at the lowest thyristor junction temperature that is likely to occur. Both $V_{g(min)}$ and $I_{g(min)}$ exhibit a negative variation with temperature.

A specification of the gate current amplitude is incomplete unless the rise time of the pulse is also specified. To be useful, an adequate level of gate-current must be reached before the thyristor has turned ON—that is, within the turn-on delay time—and even given that this condition has met, the effectiveness of the pulse still increases somewhat as the rise time is further reduced. On the other hand, there is no particular advantage in a very short rise time if the amplitude is not sufficient to give a commensurately short turn-ON time. Hence, amplitude and rise time must be considered together in designing a firing circuit in accordance with any stipulated di/dt capability and switching performance.

The design of circuit for very short gate pulse rise times has to allow for the finite response time of the gate-cathode junction itself, which makes it necessary [illegible] higher voltage than is apparent from the static gate characteristics. [illegible] an open-circuit source voltage of 15–20 Volt is specified in order to

3.2.2 Gate Pulse Duration

Under favourable conditions, a thyristor may be triggered successfully by a gate-pulse of a duration approximately equal to the turn-on time of the cell. However, a considerably longer pulse duration is desirable for one or more of the following reasons:

(a) A relatively long period may be required for the anode current, to rise to the latching current level.
(b) Oscillations, reflections or other disturbances may conspire to turn-off the thyristor shortly after it is first triggered.
(c) There may be uncertainty as to whether the anode circuit conditions are favourable to conduction when the firing pulse is initiated.

The relative importance of these factors, and possibly the ease with which they can be modified, determine the pulse duration required in a particular [illegible] ensuring that the pulse is of adequate duration is to

The relative importance of these factors, and possibly the ease with which they can be modified, determine the pulse duration required in a particular application. A certain way of ensuring that the pulse is of adequate duration is to extend it to the whole period for which the thyristor is intended to conduct; this is often done in cases where the moment, when the thyristor becomes forward-biased, is more or less unpredictable (as in many type of forced-commutation inverter with reactive load). Alternatively, the pulse is made to cover at least the period of uncertainty. Since, however, the generation of a very long pulse, particularly if high amplitude and a short-rise time are required, usually entails an unwelcome degree of complexity and cost, pulses of short duration are more often used where possible. An incidental advantage of a short-pulse is that if it coincides with the reverse anode voltage the resulting reverse loss reduces to insignificant.

In general, a pulse-duration of less than about 10 μs requires considerable c[illegible] anode circuit, while a duration of 30–60 μs is

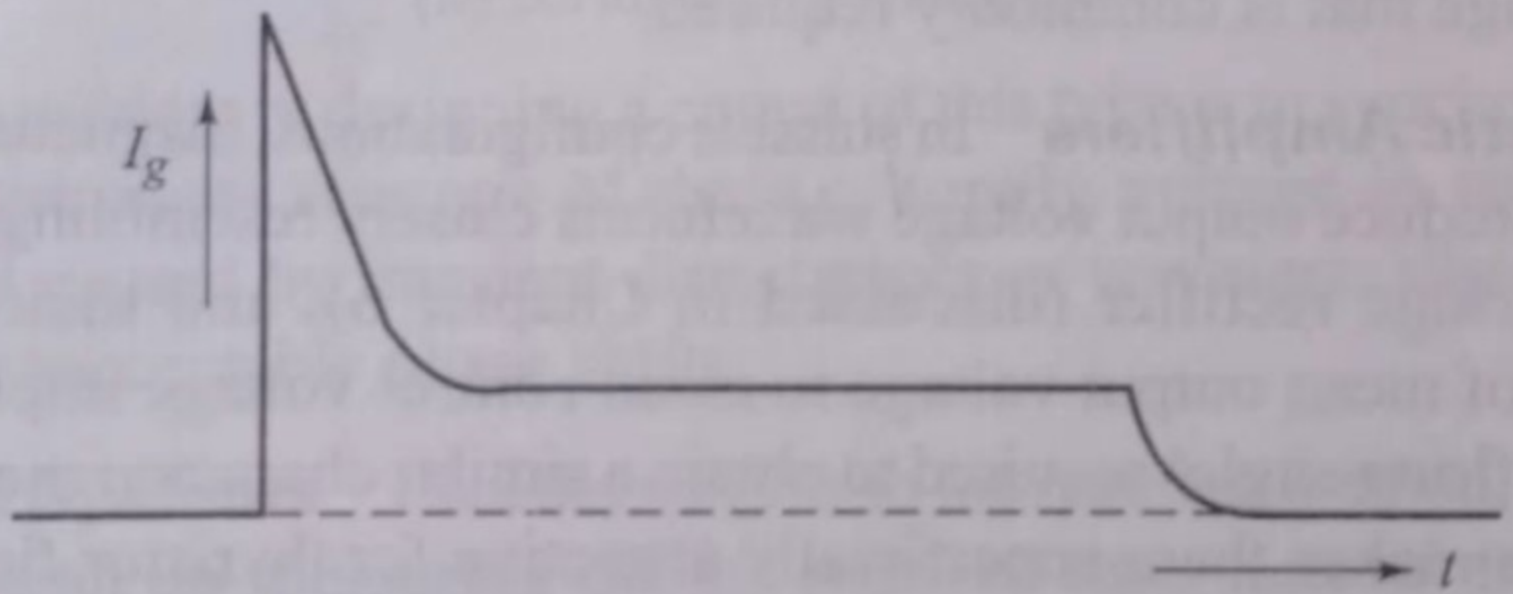

Fig. 3.1 *Extended gate firing pulse with high initial amplitude*

egative overshoot at the end of the gate pulse is generally to be avoided
n some circumstances it may tend to turn-off the anode current that has