AN 6196

Gate Power Calculations

Application Note

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When designing a gate drive to control thyristors it is necessary, to verify that the peak gate power and the average gate power will not degrade the thyristor, as well as assuring that the current pulse is of the right shape and magnitude to achieve the turn-on performance required [see Application Note AN4840 "Gate Triggering and the Use of Gate Characteristics"],

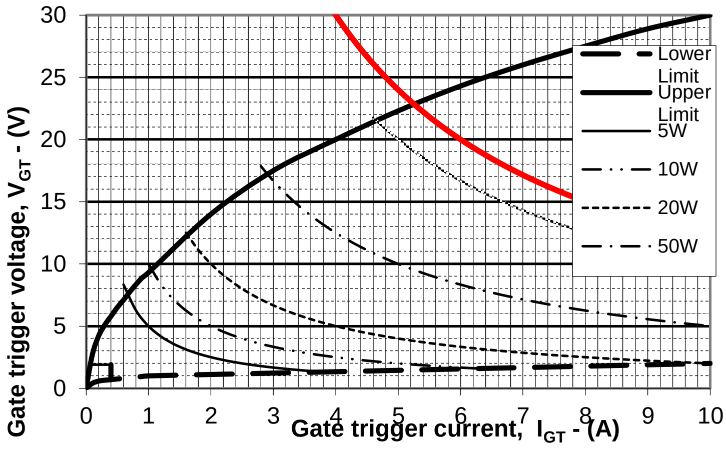
Figure 14 of Dynex i^2 thyristor datasheets contains the following table embedded in the graph.

Pulse Power P_{GM} (Watts)			
Pulse Width (µs)	Frequency (Hz)		
	50	100	400
100	150	150	150
200	150	150	125
500	150	150	50
1000	150	100	25
10000	20	-	-

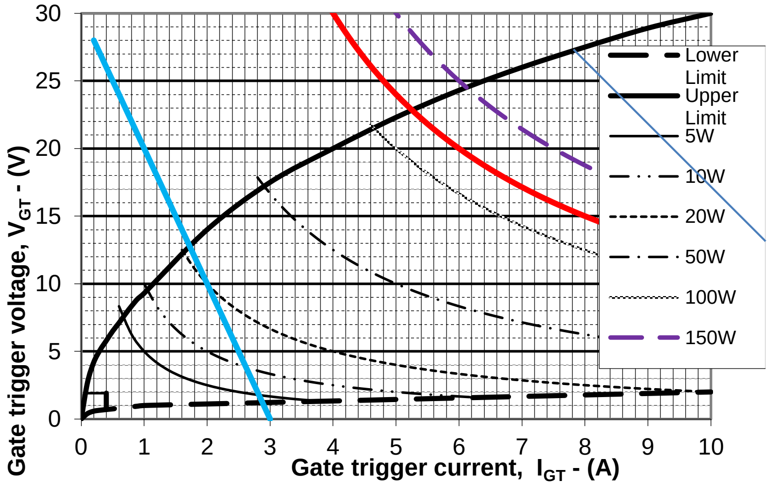
This assumes for simplicity that the pulses are rectangular. The table states that the **maximum peak pulse power is 150 watts and the average power, which is Pulse Width x frequency x Pulse Power, is limited to 10 watts.**

Suppose that we have a gate drive of 12.5µs pulses with a frequency of 20kHz. This means that the maximum allowable peak gate power is 10W/(12.5E-6 x 20E3) or 40W. This would be true if the thyristor was continuously triggered by the picket fence train of pulse, but in our example the gate drive only supplies pulse for 120 electrical degrees, so our equation becomes Pulse Width x frequency x Pulse Power x duty cycle ≤ 10W. Our maximum allowable peak (pulse) power is now 120W instead of 40W.

We can plot this on figure 15 of the datasheet

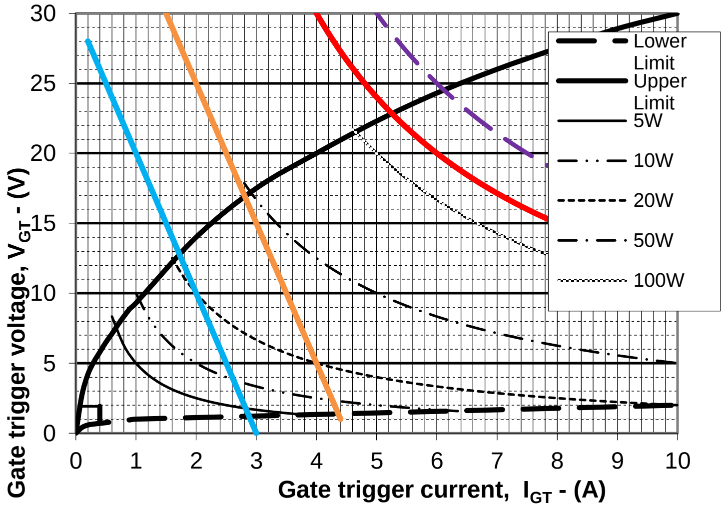


The load line of our gate drive is given by the open circuit voltage of 30V and a short circuit current of 3A. If this is plotted on the above graph it should lie to the left of the 120W peak power limit line.



Therefore our gate drive complies with the limit of 120W when connected to our thyristor.

Because of the way our gate drive operates, the first pulse in the train is larger than the subsequent pulses because the energy reservoir capacitor does not have time to fully re-charge after the first pulse. Therefore we must just check that the peak gate power for this initial pulse does not exceed the 150W limit. The initial open circuit voltage on the reservoir capacitor is 45V, the internal resistance is 10Ω as before so we can plot this load line too.



The load line is then compared to the 150W curve or the power calculated from the values of current and voltage where the load line intercepts the upper gate characteristic at 2.8A and 17 i.e. 48W. Either way our initial gate pulse is less than 150W and our gate drive is fully acceptable from a gate power point of view.

Finally, a check on the magnitude of the gate current. Say the datasheet upper limit for IGT in the "Gate Trigger Characteristics and Ratings" table is 350mA, then we recommend 5x IGT to 10x IGT as a design, or in this case 1.75A to 3.5A. From the blue load line above we see that the intercept with the upper limit gate characteristic is just over 1.75A, so satisfactory for a reasonable di/dt performance.

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