Effects of Cable Length on SCR Drive Waveforms

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The current rise time and peak pulse current are critical parameters for effective and efficient turn on of SCR power devices. As the length of the SCR gate drive cables increases, the performance of the gate drive pulses degrades. Oztek recommends using gate drive cables which are as short as possible to ensure the best performance. The OZSCR1x00 boards have been rated for operation with gate drive cables which are 18 inches long. Certain applications may require longer cables; in these cases it is important to evaluate the final system performance in order to ensure proper SCR operation. Several different cables were tested to compare and document the effect of cable length on the gate pulse waveforms.

Properly triggering an SCR in order to achieve expected performance under dynamic conditions requires a gate current several times greater than the gate trigger current, I_{GT}, specified in the manufacturer's datasheet. Figure 1 illustrates the OZSCR1x00 gate-pulse waveforms and the recommended drive parameters [1].

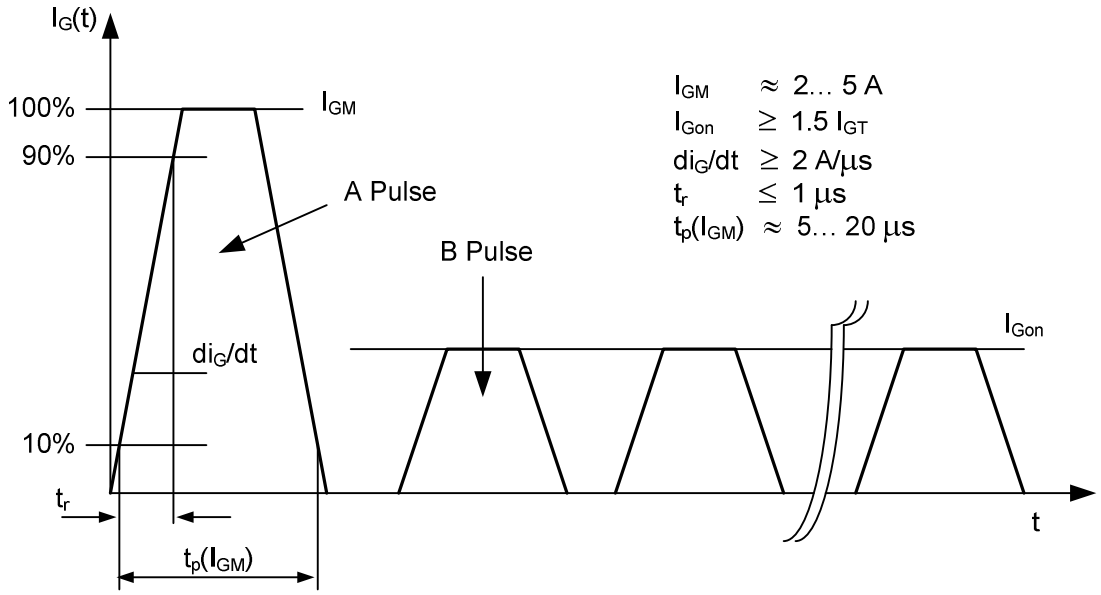

Figure 1 - Recommended SCR Gate-Pulse Waveform

The initial part of the gate pulse, characterized by the parameters I_{GM}, di_G/dt, tr and $t_p(I_{GM})$, strongly affects the following SCR characteristics and ratings. A high I_{GM} and a low t_r, i.e. a high di_G/dt, enhance all of the following ratings and characteristics [1]:

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- Turn-on delay time
- Turn-on fall time of the anode voltage
- Turn-on switching energy loss
- Critical di/dt of the anode current at turn-on.

As cable length increases, two important parameters are degraded. First is the current rise time. All gate drive cables should be constructed to tightly couple, preferably with a twisted pair, the gate and cathode connections. This helps to minimize inductance in the cable. As the cable length is increased, the cable inductance is also increased. Increased inductance slows the rise time, di/dt, of the current pulses. The second concern when lengthening cables is an increase in series resistance. Additional series resistance reduces the peak current, I_{GM}, delivered to the SCR gate.

The performance of the OZSCR1x00 gate drive circuit was measured while firing into a 1Ω load with seven different cables. The cables were constructed from 22 gauge wire, in both twisted pair and jacketed pair styles, and ranged in length from 13.5 inches to 150 inches. In our testing, increasing the cable length from 13.5 inches to 150 inches increased the rise time from 450ns to 1500ns. The same increase in cable length decreased the peak current from 2.7A to 2.4A. The following table presents the test results.

Table 1 - A and B Pulse Characteristics for Different Cables

Cable #	Cable Type	Length (in.)	A Pulse I_{PEAK} (A)	A Pulse Rise Time (ns)	B Pulse I_{PEAK} (A)	B Pulse Rise Time (ns)
1	Twisted Pair	13.5	2.7	450	0.687	140
2	Twisted Pair	19.5	2.7	550	0.707	160
3	Twisted Pair	44	2.6	800	0.693	250
4	Twisted Pair	150	2.4	1500	0.687	450
5	Jacketed	18	2.7	450	0.720	180
6	Jacketed	36.5	2.7	550	0.700	180
7	Jacketed	121	2.6	1100	0.693	275

The following figures illustrate respectively the OZSCR1000 A-Pulse drive waveform when using a 13.5”cable as compared to a 150” cable.

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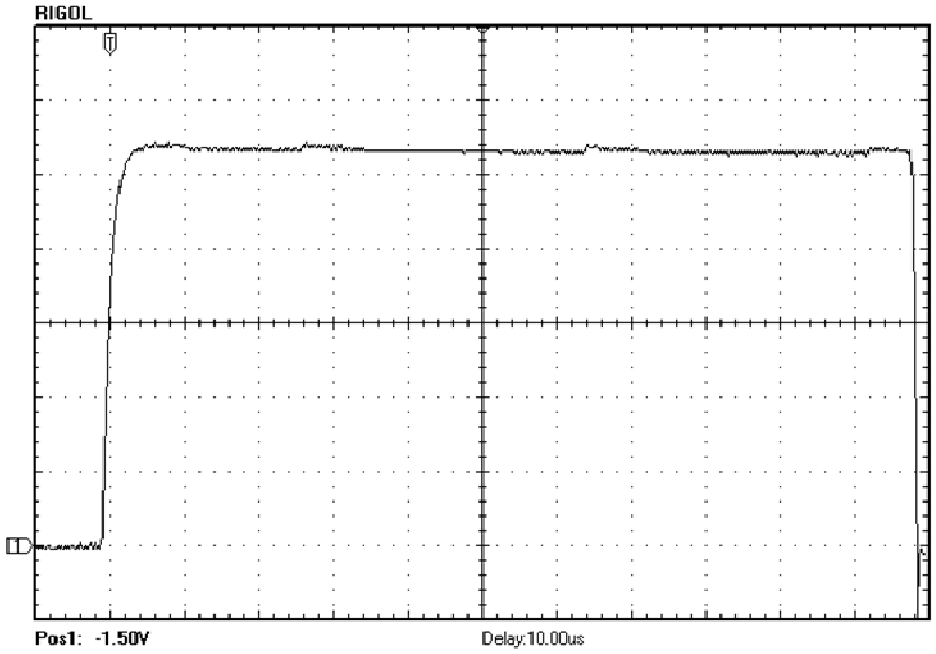

Figure 2 - OZSCR1000 A Pulse Waveform, 13.5" cable, 500mA/div, 2µs/div

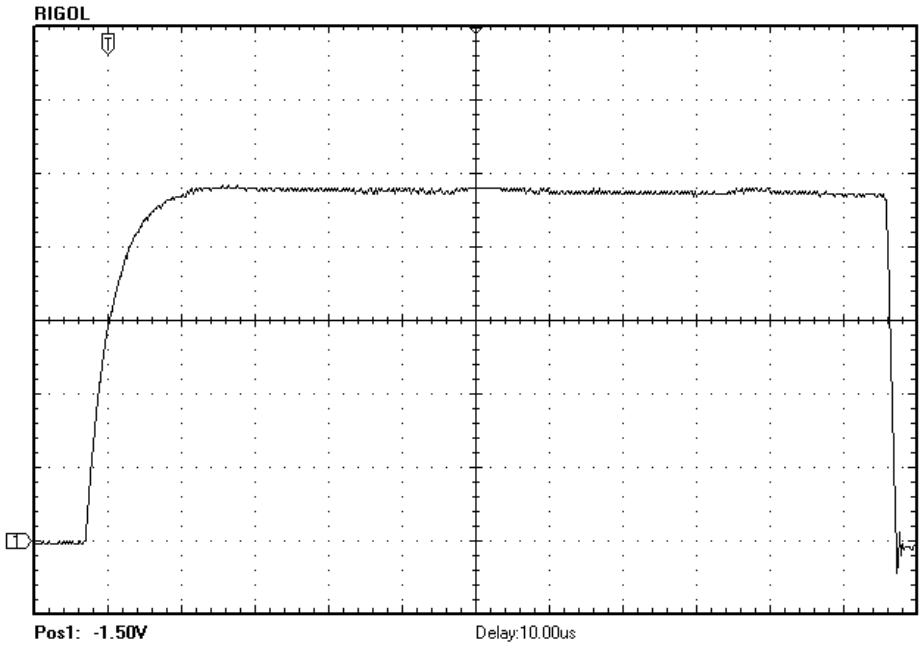

Figure 3 - OZSCR1000 A Pulse Waveform, 150" cable, 500mA/div, 2µs/div

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References:

[1] 5SYA2034-02 “Gate-drive Recommendations for Phase Control and Bi-directionally Controlled Thyristors”, Backlund B., Setz T.,Waldmeyer J., and Carroll E., ABB Switzerland Ltd, June 2007.

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