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NASA TECH BRIEF

Goddard Space Flight Center

Fast Recharge Circuit for Q-Switched Lasers

The problem:

Q-switched, cavity-dumped lasers employ an electro-optic-effect cell, such as a Pockels cell, to alternately block and release the laser pulse. The Pockels cell requires a high-speed switching circuit that can apply and remove a high voltage. The circuit must switch at rates greater than 5 kHz, should be solid-state to eliminate warmup time, should provide a variable voltage waveform, and should allow polarity reversal.

The solution:

A new solid-state circuit employs complementary transistor switches and can meet all of the stated requirements.

How it's done:

A simplified schematic of the circuit is shown in Figure 1. A high voltage is applied to the input terminal by a dc supply (not shown), and controlling commands are applied to the Q-Switching (QS) and cavity-dumping (CD) terminals. The QS command is applied at a time t_o (see Figure 2) to the primary of the high-voltage isolating transformer T_1. A triggering pulse is produced at the secondary T_1 and applied directly to fast switch #1 (a series-connected chain of 2N5401 pnp transistors). Before the signal is applied, the full high voltage is across the fast switch. Upon receipt of the QS command at t_o, the switch shorts, connecting the anode of diode D_1, and hence point A, rapidly to the high-voltage source. The rise time at point B (t_{rB}) may be determined from the following equation (if C_1 is $\gg C_B$).

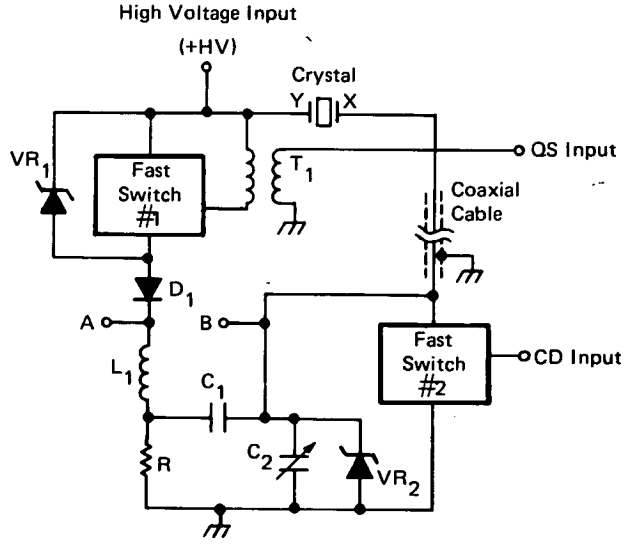

Figure 1. Switching Circuit

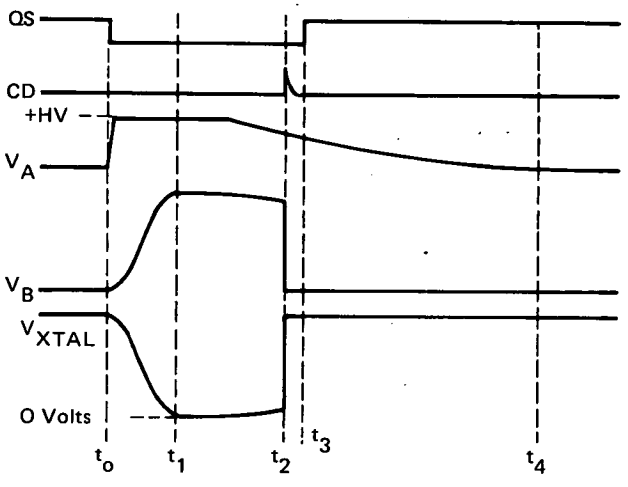

Figure 2. Timing Diagram

$$t_{rB} = \sqrt{\pi (L)(C_B)},$$

where $C_B = C_2 + C_{CRYSTAL} + C_{VR2} + C_{FAST\ SWITCH\ \#2}$

When the voltage level at B exceeds the voltage rating of zener diode VR2, further increase is clipped.

(continued overleaf)

At some later time t_2, a pulse, applied at terminal CD by a pulse generator (not shown), causes fast switch #2 to short point B to ground. (Fast switch #2 is a series-connected chain of avalanche MPSU04 npn transistors.) This switching completes the generation of a high-voltage pulse suitable for the Pockels Cell. The polarity of the waveform applied to the Pockels Cell may be reversed simply by returning electrode Y to ground instead of the high-voltage source as shown. Another high-voltage pulse may be generated once the voltage at point A has returned to zero. Capacitor C1 isolates and protects fast switch #1 from #2 should a fault develop in either.

Note:

No further documentation is available. Specific questions, however, may be directed to:

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NASA has decided not to apply for a patent.

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