THE SILICON CONTROLLED RECTIFIER AS A SWITCHING DEVICE IN OPERANT-CONDITIONING EXPERIMENTS^{1,2}

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One of the newer semiconductor devices, the silicon-controlled rectifier (SCR) shows potential as a switching device in operant conditioning equipment. The SCR is particularly applicable where large voltages or currents must be controlled by low-voltage programming equipment. Since ac power has many applications in certain operant conditioning circumstances (stimulus lights without "flicker", feeder operation, motors, *etc.*), a feasible, economical, safe, and reliable switching method would be of value. The apparatus described was constructed for use in pigeon visual discrimination experiments (Blough, 1956), but the principles can be extended to almost any circumstances requiring ac power control. A series of stimulus lights, a house light, and a solenoid-operated feeder are operated by 117 v ac which is in turn controlled by 24 v dc programming equipment.

The silicon-controlled rectifier is a bistable device, consisting of four alternate layers of *n* and *p* type silicon. Three leads are connected to these layers as shown in Fig. 1-a. Figure 1-b shows the corresponding symbolic representation of an SCR. When connected in a dc circuit so that the anode is positive and the cathode is negative, the SCR will block the flow of current until a small (approximately 3 v at 20-40 ma) positive potential is applied to the gate lead. In dc circuits the device will continue to conduct even if the initial gate potential is removed, thus requiring an external interruption of current to turn off the SCR.

In ac circuits, only the positive half-cycle is conducted and the device turns off when the voltage falls to zero, subsequently blocking the negative half-cycle as would an ordinary diode.

Half-wave dc is supplied to the lamps RL_1 , RL_2 , and RL_n in Fig. 2-a. The trigger voltage for SCR_1 , SCR_2 , and SCR_n is derived from the ac line through diode CR_1 , being reduced through appropriate resistors R_1 , R_2 , and R_n , and is controlled by dry-reed relays S_1 , S_2 , and S_n .

When at the beginning of each positive half-cycle in line A, the voltage at the gate of the SCR reaches the minimum trigger voltage of that SCR, the device fires and conducts until the end of the half-cycle, when the voltage falls to zero. The diode CR_1 protects the SCR by preventing the presence of negative potential at the gate when the cathode is positive during the next half-cycle.

Full-wave ac is utilized in the feeder solenoid by placing the coil T_1 in series with one side of the ac supply line and connecting SCR_x across the terminals of a bridge-rectifier as shown in Fig. 2-a. Trigger voltage is supplied through resistor R_x from the positive terminal of the rectifier bridge, and is switched

Fig. 1. (A) Diagram of an SCR showing four alternate layers of *n*- and *p*-type silicon with the attachment of the three leads.

(B) Symbolic representation of an SCR.

(C) Symbolic representation of a triac.

¹This work was done under contract number DA-18-108-AMC-108 (A) from the U. S. Army Chemical Research and Development Laboratories, Edgewood, Arsenal, Edgewood, Maryland, to FMC Corporation, Princeton, New Jersey, with Abbott Laboratories as subcontractor.

²In conducting this research, the investigators adhered to "Principles of Laboratory Animal Care" as established by the National Society for Medical Research.