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June 1968 Brief 68-10224

NASA TECH BRIEF

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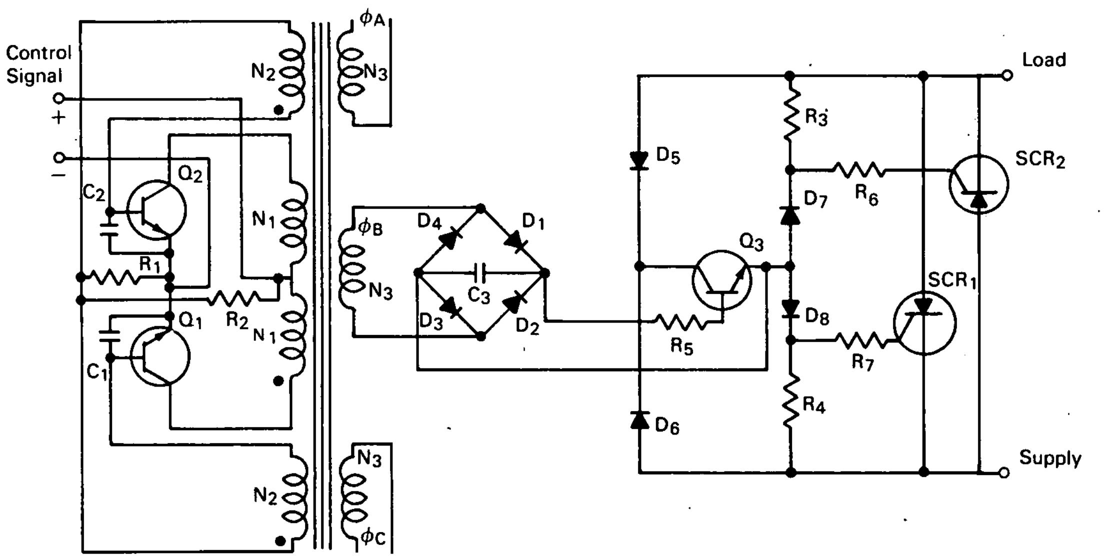
Semiconductor AC Static Power Switch



The problem:

Switches for aerospace power systems must have long life and high reliability and must operate satisfactorily in severe environments, including high vibration and shock conditions. Conventional electromechanical switches and relays often have undesirable characteristics for these applications; contact bounce, contact pitting, arcing, slow switching speed, etc.

The solution:

The construction of an AC (400 cps) static switch using semiconductors such as transistors and silicon controlled rectifiers (SCR's) which are reliable, capable of long life, and contain no moving parts.

How it's done:

Minimum power drain from the control signal is achieved by having the control signal turn on a small switch which in turn supplies turn-on power to the main SCR's. Since the control signal may or may not be grounded, an oscillator–transformer–rectifier circuit provides isolation between the control signal and the switch, and permits the use of a single control signal to operate all three phases of the switch.

The four main sections of the switch are the oscillator circuit, rectifier and filter, drive circuit, and power-handling circuit.

The oscillator is an astable multivibrator using two signal transistors (Q_1 and Q_2) that alternately conduct

(continued overleaf)

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and cut off. The input is 10 volts DC at 10 milliamperes (100 mW) and the output power is 60 milliwatts. The switch will operate with control signal input as low as 5 volts at 5 milliamperes over its temperature operating range of −40° to 80°C. The oscillator transformer has three output windings, designed for 3.5 volts at 6 milliamperes each. Each winding feeds a full-wave bridge rectifier and filter, the output of which is 2 volts. This voltage is applied to the drive transistor (Q_3) which saturates and in turn supplies power from the power line to the power handling SCR's through D_5 to D_6, D_7 to D_8, and R_6 to R_7.

The switch has positive turn-on over its temperature operating range when the power line voltage is at least 8 volts. Under normal conditions, the drive transistor dissipates less than 0.1 watt. However, if the switch is turned on when the AC supply voltage is at its maximum, the base drive will not be sufficient to hold the transistor in saturation. For this particular application, as much as 225 watts peak power may be dissipated in the drive transistor; thus, a high power transistor is used. The switch has a design rating of 4 amperes and has a continuous overload capability of 14 amperes for a range of heat-sink temperatures from −40° to 80°C.

Notes:

1. The desirable characteristics of this static switch are the absence of moving parts (and the associated wear), and the high gain possibilities between the control power and the power transferred.
2. Due to their capacity for a large number of operations, static switches are particularly suited to applications such as on–off type regulation, position controls for the orientation of solar panels, radio antennas, flashing lights, etc. They are also useful in applications which require fast response time such as the interconnection of alternators for parallel operation. Due to their relatively high resistance to shock and vibration, static switches are well suited to applications where accidental switching caused by mechanical vibration or shock cannot be tolerated.
3. Inquiries concerning this innovation may be directed to:

   Technology Utilization Officer
   Lewis Research Center
   21000 Brookpark Road
   Cleveland, Ohio 44135
   Reference: B68-10224

Patent status:

No patent action is contemplated by NASA.

Source: James Vrancik
(LEW-10344)