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Fail-Safe Bidirectional Valve Driver

\[ R_L \text{ (Max.)} = 13 \text{ Ohms} \\
I_L \text{ (Min.)} = 1.0 \text{ Ampere} \]

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The problem:
Bidirectional valve driver circuits which operate from a single power supply are subject to damage when the load is shorted or shorted to ground.

The solution:
Cross-coupled diodes are added to a commonly used bidirectional valve driver circuit to protect the circuit and power supply.

How it's done:
When the set/reset command [+2.7 volts (peak), 20-millisecond duration] is received, the current limiter is turned on and applies power (+Vc) to the valve driver. The current limit is set to 1.3 amperes and protects the power supply (+Vcc) in the event of a short circuit (see figure). The cross-coupled diodes D3 and D4 prevent simultaneous execution of the set and reset commands.

Valve actuation is prevented in the event the actuator coil is shorted to ground; under normal operation, the coil is isolated from ground. Should the coil become grounded, cross-coupling diode D2 prevents valve actuation by clamping point A. In addition, when the coil is shorted, transistors Q2 and Q3 are protected by holding Q2 off. However, with R5 properly adjusted, Q3 will be turned on just enough to drive D3 and R1 (Q3 collector current) while maintaining Q2 in an off state.

Notes:
1. This circuit may be used in systems requiring fail-safe bidirectional valve operation, particularly in chemical- and petroleum-processing control systems and computer-controlled hydraulic or pneumatic systems.
2. Requests for further information may be directed to:
   Technology Utilization Officer
   NASA Pasadena Office
   4800 Oak Grove Drive
   Pasadena, California 91103
   Reference: TSP73-10450

Patent status:
NASA has decided not to apply for a patent.

Source: Hisashi Fujimoto of Caltech/JPL under contract to NASA Pasadena Office (NPO-11958)