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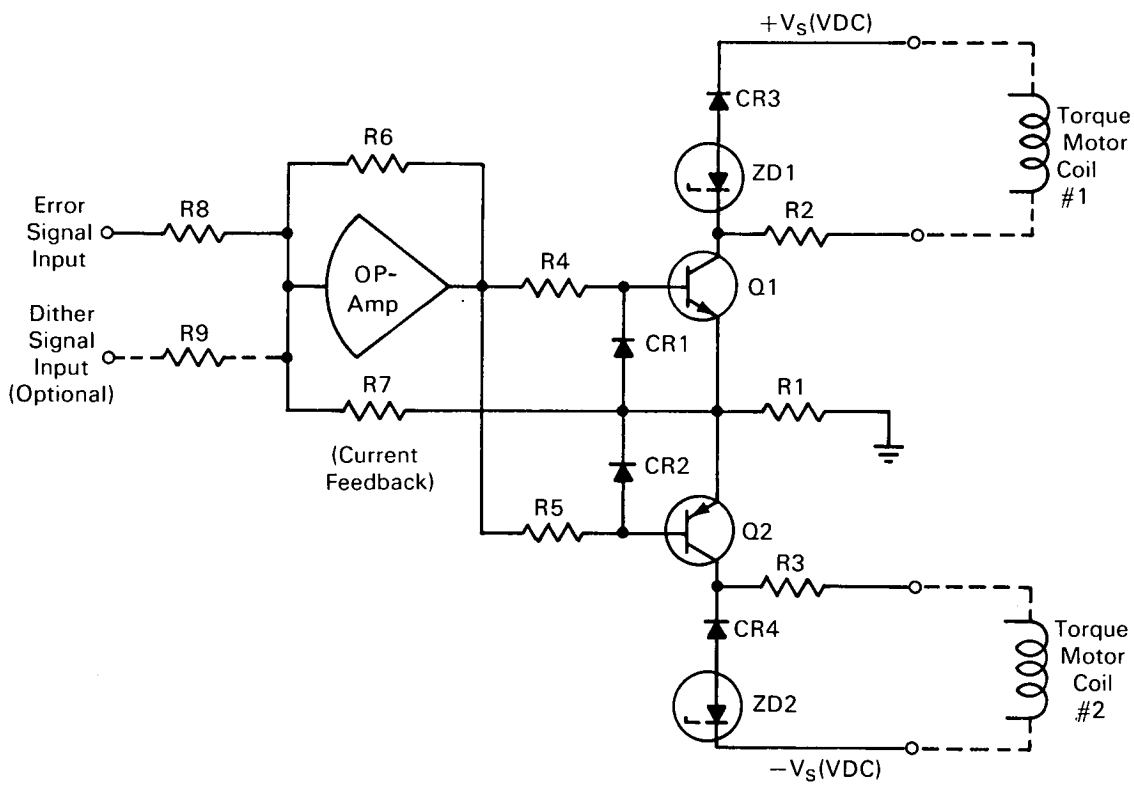
Low-Cost, Fast-Response Drive Circuit for Electromagnetic Torque Motors



Fast response (150-200 Hz) electrohydraulic servo systems are used as research tools in experimental dynamics and controls studies. These systems normally include a fast-response electrohydraulic servovalve device which has an electromagnetic torque motor as the initial stage. This input device consists of two mutually-coupled coils driven by the output of an electronic servoamplifier device. The response of the torque motor coils when driven by zero source impedance is, however, quite low (40-50 Hz); consideration must therefore be given to insuring that the driving amplifier output appears as a very high impedance to eliminate the dynamics of the torque motor device.

Conventional high output impedance coil driving circuits are undesirably complex. The coil drive circuit described herein accomplishes significant reduction of the inductive coil time constant with a minimum of circuit sophistication. This circuit has been developed

(continued overleaf)

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into a low-cost modular servoamplifier output stage. It is to be used with a compatible preamplifier stage, which will provide the other servo-loop functions of summing, adjustable gain, and compensation. The response improvement of the torque motor coils with this particular arrangement of output circuit elements (see diagram) is greater than 25:1 for small signals, and 5:1 at full output current amplitude.

The above improvement is accomplished in the following manner. The output configuration alternately energizes the torque motor coils in a push–pull configuration. These coils, which are mutually coupled have the response degrading effects of this coupling eliminated by the push–pull arrangement and by the zener diodes (ZD1 and ZD2) connected across the coils in series with the conventional "free-wheeling" rectifiers (CR3 and CR4). Response is further improved (a) by the fact that the output transistors function as current amplifiers, and (b) by the use of negative differential current feedback (R1 and R7). This latter feature also provides (a) minimization of the output dead-zone nonlinearity, caused by the output transistor (Q1 and Q2) base-to-emitter junction voltage drops, and (b) stabilization of the output gain for variations of the current gain of the output transistors. The magnitude of this improvement eliminates torque motor response influence on the overall control system dynamic performance.

Notes:

1. It should be noted that no new components or concepts have been generated (in fact, similar circuits have been used in computer designs), but this innovation combines components and concepts into a novel servovalve drive circuit application. Advantages are simplicity and reduced cost compared to other approaches to obtain the same results.
2. Inquiries concerning this innovation may be directed to:

   Technology Utilization Officer
   Lewis Research Center
   21000 Brookpark Road
   Cleveland, Ohio 44135
   Reference: B68-10386

Patent status:

No patent action is contemplated by NASA.

Source John R. Zeller
(LEW-10143)