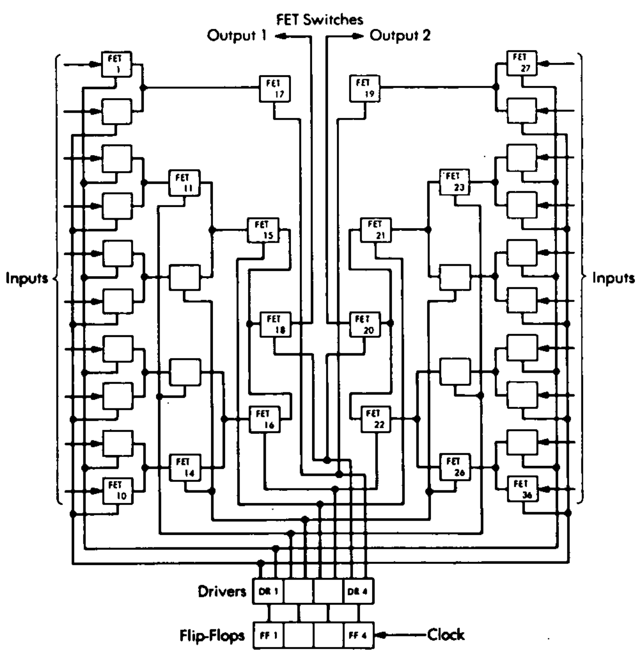
NASA TECH BRIEF

NASA Pasadena Office

Data Multiplexer Using a Tree Switch

The problem:

To provide a telemetry commutator system which will be highly reliable in missions lasting more than 12 years.



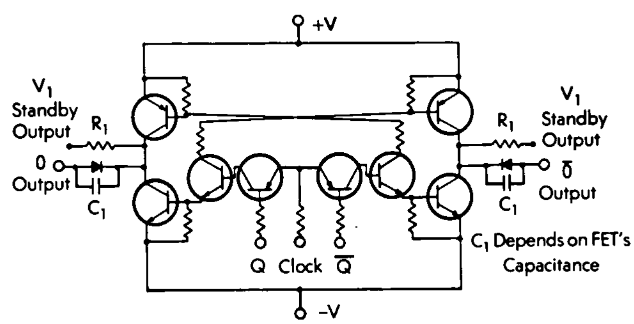
The solution:

A self-decoding FET-hybrid or integrated-circuit tree configuration that uses a minimum number of components and can be sequenced by a clock or by a computer.

How it's done:

Ordinarily, multiplexers are used in a block-type configuration with a driver for each commutator and a series of decoding gates. In the configuration developed for improved reliability, field-effect transistors (FET's) are connected in a self-decoding tree structure so that fewer drivers and no decoding gates are required; additionally, in the new configuration a single component failure will affect considerably fewer sensors. The clocked-tree configuration generates its own fixed sequence and requires only a clock for a driver. The diagram illustrates two decks of a typical high-reliability tree-type commutator.

Redundancy features can readliy be incorporated into the self-decoding tree configuration; in fact, as the tree grows in size and more sensors are included, the percentage of parts that will affect a given percentage of sensors steadily decreases because only *n* drivers are required for 2^n sensors and a fixed percentage of switches affects a fixed number of sensors. Therefore, if the number of sensors doubles, the percentage is halved .



A basic bipolar driver circuit, shown in the second diagram, includes all decoding and clocking gates necessary to decode parallel redundant control registers, and also has the low impedance output required for switching hundreds of FET's in a tree structure. The flip-flop outputs from the sensor address register

(continued overleaf)

are attached to Q and $\overline{Q}$. While the clock input is low, the entire circuit is off. When the clock input is high (5V) one side of the driver switches to +V and the other side to −V, depending on the states of Q and $\overline{Q}$. The switching rise and fall times are approximately 1 μs even for capacitative loads of several thousands of picofarads. The driver outputs O and $\overline{O}$ remain in the selected states as long as the clock pulse is high, and when the clock pulse ends, the high output falls to any selected V_1 with a time constant determined by the capacitative load and resistor R_1. Similarly, the low output rises to V_1. Thus, when the tree is not being switched, all FET's can be off if V_1 is made equal to −V.

Reliability of the system is improved by isolating each FET from the driver lines by resistors ($\approx$20 kilohms); thus, FET failures resulting from a short between gate and source or gate and drain cannot affect driver control of the rest of the FET's and fast switching is maintained. Even higher reliability can be obtained by combining two sets of two units each of the basic circuit made redundant for protection against shorted output.

Notes:

1. The use of the tree commutator in a computer-accessed telemetry system is described in Tech Brief B73-10290.
2. Requests for further information may be directed to:

   Technology Utilization Officer
   NASA Pasadena Office
   4800 Oak Grove Drive
   Pasadena, California 91103
   Reference: TSP 73-10289

Patent status:

This invention has been patented by NASA (U.S. Patent No. 3,614,327). Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to:

NASA Patent Counsel
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