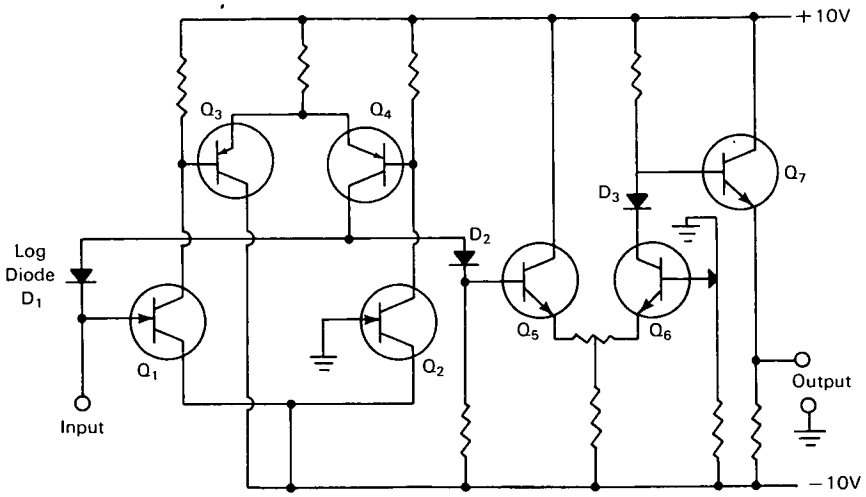
NASA TECH BRIEF

Logarithmic Amplifier Uses Field Effect Transistors



The problem: Some instrumentation and recording applications require a logarithmic response to an input signal having a range of current variation from 10^{-12} to 10^{-4} ampere. Temperature compensation also is required.

The solution: A solid-state amplifier that utilizes field-effect transistors and planar junction diodes. This circuit has a logarithmic response to signals ranging from 10^{-12} to 10^{-4} ampere.

How it's done: The basic circuit is a temperature-stabilized amplifier composed of three differential amplifier stages, an emitter-follower output stage, and a planar-junction logarithmic diode.

The required response to an unusually large range of input current variation is achieved by using two n-channel field-effect transistors, Q_1 and Q_2, for the first differential amplifier stage. Because of the very high input impedance exhibited by these transistors, they are also sensitive to very small currents.

The two field effect transistors, Q_1 and Q_2, drive the second differential amplifier stage, Q_3 and Q_4. The output of Q_3 is applied to the final differential amplifier stage, Q_5 and Q_6, and to the planar-junction logarithmic diode, D_1. By inserting D_1 in the feedback path to the first differential amplifier stage, the logarithmic output of the circuit is achieved.

The output of Q_6 is applied to Q_7, which is operated as an emitter-follower. This configuration provides a high output impedance for the amplifier. The differential amplifier structure of the circuit provides temperature compensation.

Notes:

1. For optimum overall characteristics, the components should be matched.
2. The final output voltage, E_o, taken between the emitter of Q_7 and ground, will be

$$E_o = K_1 \log (5 \times 10^{11} I_{in} + 1) + K_2$$

(continued overleaf)

3. Inquiries concerning this innovation may be directed to:

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Patent status: NASA encourages commercial use of this innovation. No patent action is contemplated.

Source: J.L. Stewart
(JPL-509)