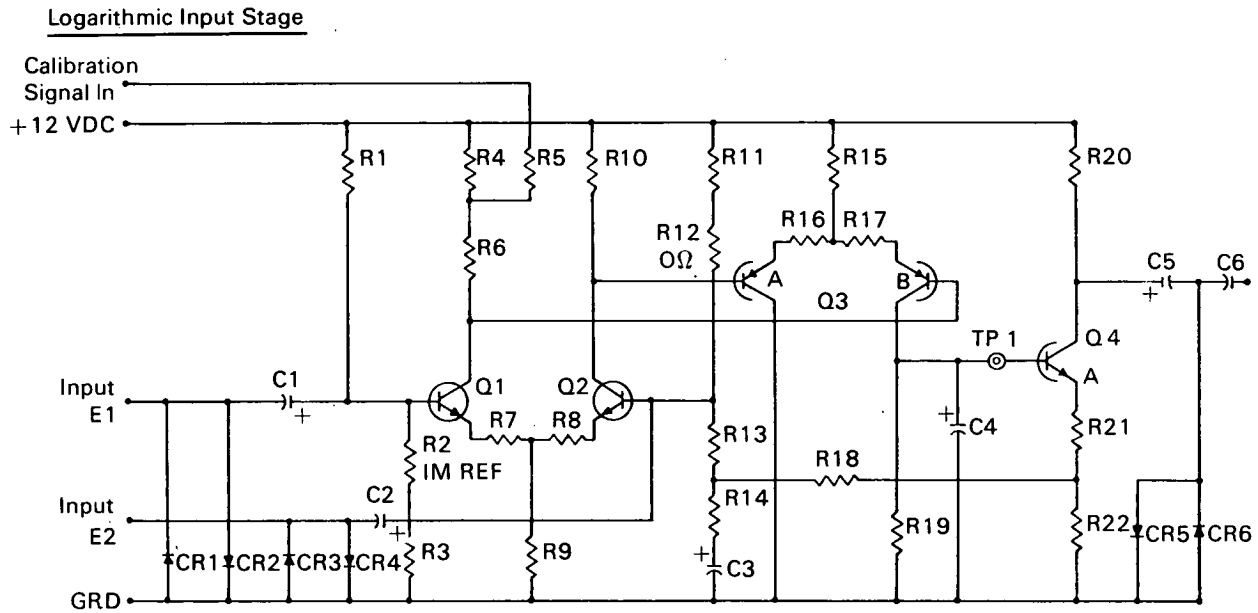
NASA TECH BRIEF

Log Amplifier Instrument Measures Physiological Biopotentials Over Wide Dynamic Range



Signal Conditioner: Schematic

The problem:

The recording of biopotentials is difficult because their extreme dynamic range usually exceeds the capability of most recording devices; for example, 25 to 1 variations in amplitude are often found between the EEG potentials of animals which are awake and those which are asleep. Since these amplitude variations also exceed the input signal capabilities of most telemetering systems, a method was required to compress signal amplitudes without loss of resolution so that EEG signals from animals (asleep or awake) could be transmitted.

The solution:

Biopotential inputs are capacitatively coupled to a miniature, low power, solid-state signal conditioner consisting of a two-stage differential preamplifier that has a low noise figure; the output of the preamplifier uses diodes to provide an overall gain which is nearly logarithmic.

How it's done:

The electronic circuitry developed for this application is shown in the figure. The differential input stage is a conventional circuit employing two low-noise npn transistors, Q1 and Q2, with capacitatively

(continued overleaf)

coupled inputs and appropriately placed diodes to suppress voltage overloads. The input resistance of the stage is 1 megohm. The input transistors are direct-coupled to a difference amplifier consisting of a matched pair of silicon pnp transistors, Q3. The output from the second differential stage, Q3B, is coupled directly to an npn amplifier, Q4A, which in turn provides dc feedback to the base of Q2 for Q-point stabilization of the overall amplifier, and feeds an amplified signal via a capacitor to the logarithmic diode signal compressors, CR5 and CR6.

Notes:

1. The response of the signal compressing diodes is not strictly logarithmic and is somewhat sensitive to changes in temperature. However, the preamplifier is intended for use where the absolute magnitude of a signal is not a critically important factor.
2. The use of low-noise npn transistors in complementary configuration with the matched pair pnp differential amplifier offers an improvement in noise and thermal stability over conventional circuits.
3. The upper limit of frequency response is determined by capacitor C4.
4. Requests for further information may be directed to:

   Technology Utilization Officer
   Ames Research Center
   Moffett Field, California 94035
   Reference: TSP70-10508

Patent status:

No patent action is contemplated by NASA.

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