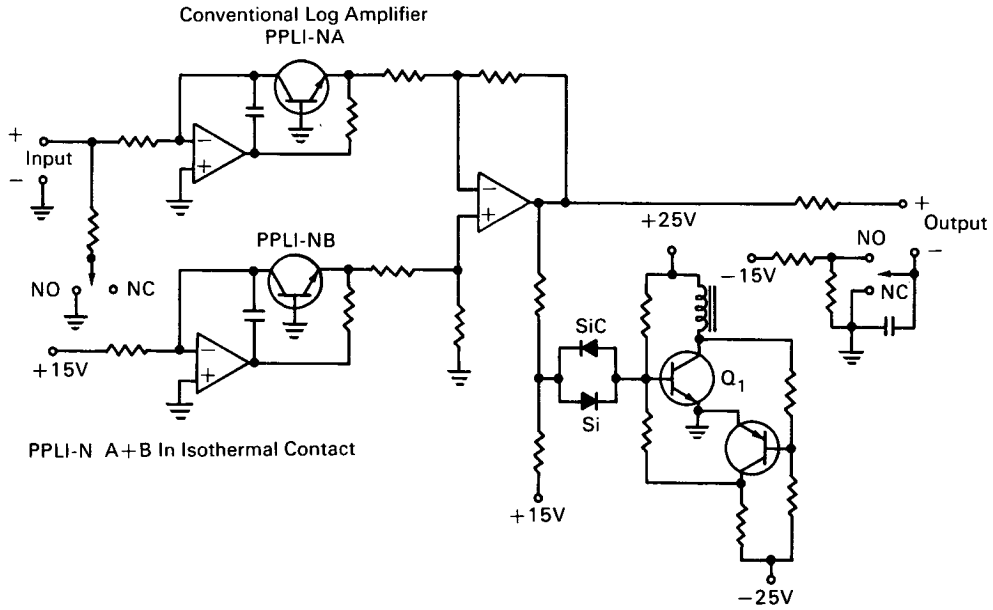
NASA TECH BRIEF

SiC/Si Diode Trigger Circuit Provides Automatic Range Switching for Log Amplifier



The problem:

To provide automatic range change to extend the operating range of a logarithmic amplifier–conversion circuit and to assure stability at or near the range switch-over point. It is required that the range extension circuit provide two more decades of operation to the logarithmic amplifier converter.

The solution:

A SiC/Si diode pair provides hysteresis for a trigger circuit that actuates a relay at the desired range extension point. The trigger circuit, consisting of a transistor driven relay, provides the range extension while the diode pair provides the hysteresis to assure stability in the system at or near the range crossover point.

How it's done:

The logarithmic amplifier–converter is a standard circuit utilizing operational amplifiers. The two transistors in transdiode configuration are in isothermal contact to provide temperature stability of 0.3 percent per degree C. The conventional difference amplifier, associated with the logarithmic amplifier–converter, provides a conversion accuracy of 1 percent over the entire operating range.

The automatic range extension circuit consists of two active portions: a hysteresis generator and a relay trigger circuit.

(continued overleaf)

The standard logarithmic amplifier-converter circuit will operate in the range of 5×10^{-10} to 1×10^{-3} amp, with one volt per decade of input current appearing at the output of the amplifier. When the input current reaches 1×10^{-3} amp (or in fact slightly higher, 8×10^{-2} amp), transistor Q_1 in the trigger circuit turns on, thereby energizing the relay. One set of contacts of the relay divides the input current by 100 (the addition of 1.01 ohms resistance to ground). The second set of contacts adds two volts to the output of the log amplifier. Since the output is one volt per decade of input current, when the input is divided by 100 (two decades), the output will drop two volts giving a step function in the X–Y plot of the output. By adding two volts to the output at the same time that the input is divided by 100, the graph of output voltage versus input current will appear as an uninterrupted straight line.

If no hysteresis were provided at the input to the trigger circuit, any noise associated with the input current at, or very near, the range switch-over point would cause the extender circuit to drop in and out on each noise spike. To avoid this instability, a SiC diode is placed in parallel with a Si diode to provide a hysteresis at the input to the trigger circuit. The SiC diode has a forward bias voltage drop of 1.6 volts, while the Si diode has a forward bias voltage of 0.6 volt. This offset of bias voltage (unbalanced hysteresis) assures that the trigger circuit will not energize and de-energize at precisely the same input current. More specifically, the trigger circuit is energized when the input current reaches 8×10^{-2} amp, but will not be de-energized until the input current drops below 6×10^{-2} amp. This allows a peak-to-peak noise level, at the input to the log amplifier, of nearly 2 ma before stability of the system is in jeopardy.

Notes:

1. Although this system provides a range extension of two decades, any desired decade extension can be obtained by selecting the division factor of the input circuit and adding the appropriate voltage at the output to cover the number of decades the system range has been extended.
2. By using other combinations of diodes, any hysteresis can be generated to provide the stability required to cover the noise level at the input to the system. The only limitation is that the trigger transistor is not biased beyond the point where it will turn on.
3. Inquiries concerning this invention may be directed to:

   Technology Utilization Officer
   Marshall Space Flight Center
   Huntsville, Alabama 35812
   Reference: B67-10314

Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to NASA, Code GP, Washington, D.C. 20546.

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