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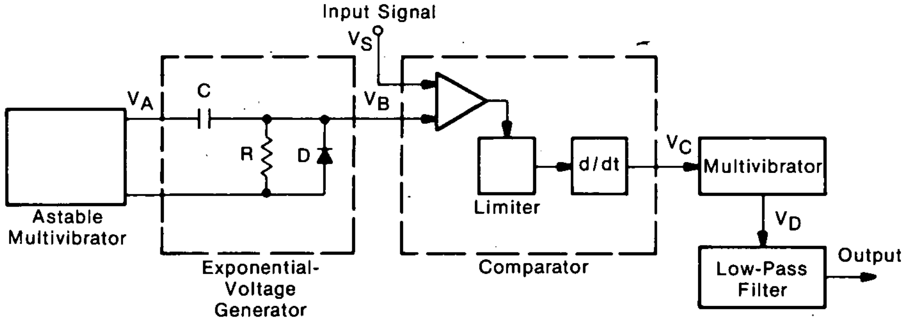
Logarithmic-Function Generator



The problem:

Typical logarithmic-function generators are either electromechanical or purely electronic. The electromechanical type utilizes a logarithmic potentiometer in combination with a servomechanism. Its disadvantages are large size, high power consumption, and poor frequency response. The purely electronic type using solid-state components, loses accuracy with expanded dynamic range.

The solution:

A new solid-state logarithmic-function generator is compact and provides improved accuracy.

How it's done:

The generator (Figure 1) includes an astable multivibrator feeding into an RC circuit. The resulting exponentially decaying voltage is compared with an input signal. The generator output is proportional to the time required for the exponential voltage to decay from the preset reference level to the level of the input signal.

The time constant of the RC differentiator circuit is selected according to the desired dynamic range of the converter. Diode limiter D ensures a zero voltage across the differentiator at the beginning of each cycle.

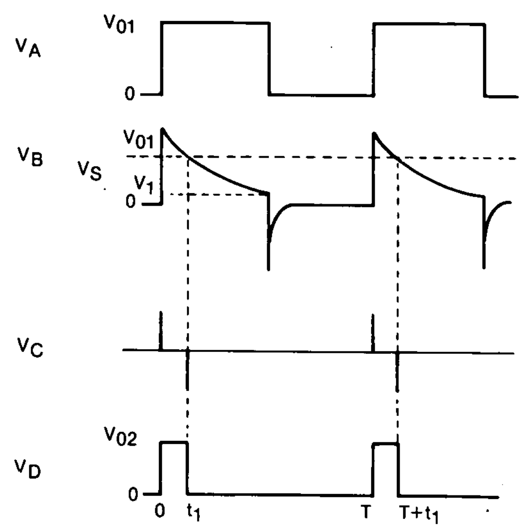


Figure 1. Logarithmic-Function Generator

Both V_B and a dc voltage V_S proportional to the input signal are fed to a differential comparator. The comparator has a differentiated output which triggers a bistable multivibrator. Positive pulses at times T = 0, T, etc. cause the multivibrator positive transition (leading edge). The negative pulses of V_C at times $t = t_1$, $T+t_1$, etc. are used to reset the multivibrator

(continued overleaf)

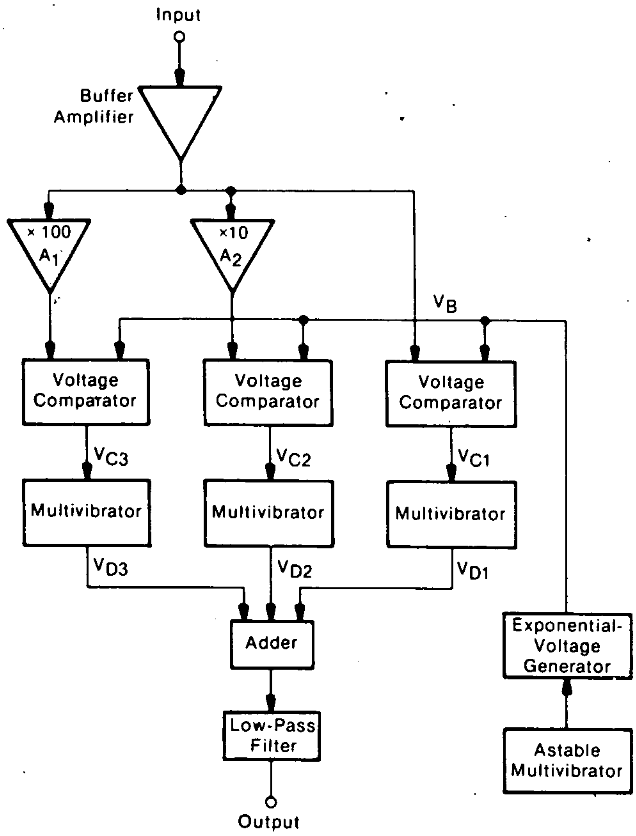


Figure 2. Logarithmic-Function Generator With Wider Dynamic Range

(negative edge). The resulting pulse width is proportional to t and is a measure of log (V_{01}/V_S).

A comparable circuit with a wider dynamic range is shown in Figure 2. Its principle is similar to that of Figure 1; however, it employs parallel branches (three are shown as an example). In addition, it uses an input buffer amplifier, two additional voltage comparators and multivibrators, and an adder.

In operation, the reference branch generates an output pulse V_{D1} as in Figure 1. The other two branches are amplified by 10 and 100, respectively. The system output is again proportional to log (V_{01}/V_S). However, in this case, the output voltage is obtained by averaging and adding output signals V_{D1} and V_{D2} from the last two branches. When the system input V_S falls in the range of

$$0.01\,V_{01} \leqslant V_S \leqslant 0.1\,V_{01}$$

the output of the channel which includes amplifier A_1 is greater than V_{01}. Thus voltage V_{D3} makes no contribution to the system output. The system output becomes proportional to

$$\log 10 + \log (V_{01}/10V_S) = \log (V_{01}/V_S)$$

On the other hand, when V_S falls in the range of

$$0.001\,V_{01} \leqslant V_S \leqslant 0.01\,V_{01}$$

the system output becomes proportional to

$$\log 10 + \log 10 + \log (V_{01}/100V_S) = \log (V_{01}/V_S)\,.$$

Note:

Requests for further information may be directed to:

Technology Utilization Officer
NASA Pasadena Office
4800 Oak Grove Drive
Pasadena, California 91103
Reference: TSP74-10285

Patent status:

This invention has been patented by NASA (U.S. Patent No. 3,648,043). Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to:

Patent Counsel
NASA Pasadena Office
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