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NASA TECH BRIEF

Goddard Space Flight Center

Isosceles Detector Provides Maximum Resolution in Expanded Range

A dynamic range expansion system for radio frequency (rf) signal detection equipment contains a range expander which consists of a unique combination of standard electronic circuitry; i.e., rf amplifiers, rf amplitude modulated detectors, and an operational (summing) amplifier. The analog detector is comprised of a trigger circuit, dual amplitude detectors, and an analog summation circuit.

The device is called an isosceles detector because its output waveform (curve A, Figure 2) resembles an isosceles triangle. The analog output gives maximum resolution over a fixed voltage range, without switching.

The heart of the detector is the summing amplifier (see Fig. 1), which combines the negative and positive detector outputs and introduces a fixed gain as a scaling factor to determine the output voltage range. A Schmitt trigger circuit senses when the negative detector overcomes its threshold. When the negative detector reaches −20 mV over background, the Schmitt trigger fires, giving a range flag output. This indicates that the analog voltage being sampled on curve A is on the negative slope.

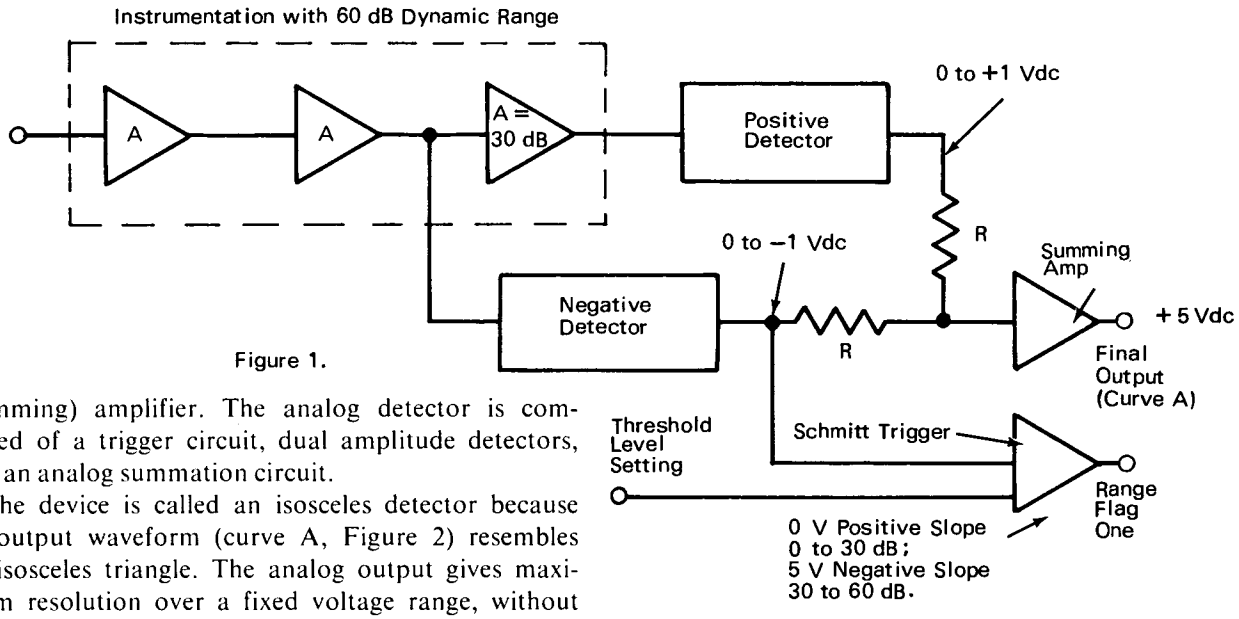

Figure 1.

In a system containing a receiver with 60 dB of dynamic range, the analog output, which uses a standard AM diode detector, can be modified to provide more resolution within the 0 to 5 Vdc range.

Incorporating the isosceles detector into this system requires only minor changes and provides twice the resolution now available. The block diagram of the modified system is also shown in Figure 1.

When a 0 dB signal level is present at the input to the string of amplifiers, the positive detector output is at 0 Vdc. Note that the negative detector input is down 30 dB from the positive one, and is at 0 Vdc until the amplifier input level is above 30 dB.

As the input level is increased from 0 to 30 dB, the positive detector output follows the input to

(continued overleaf)

provide a 0 to 1 Vdc output level. The summed output of both detectors is amplified by the summing amplifier to provide the positive slope of curve A. Therefore, a 0 to 5 Vdc output curve is detected for the 0 to 30 dB input levels. Up to this point, which corresponds to the peak of curve A, the range

Only 60 dB of range has been shown in the block diagram. However, the basic technique used in the single isosceles detector may be expanded to cover larger dynamic ranges, while keeping the same resolution. This is accomplished by cascading two or more isosceles detectors, in which case the analog

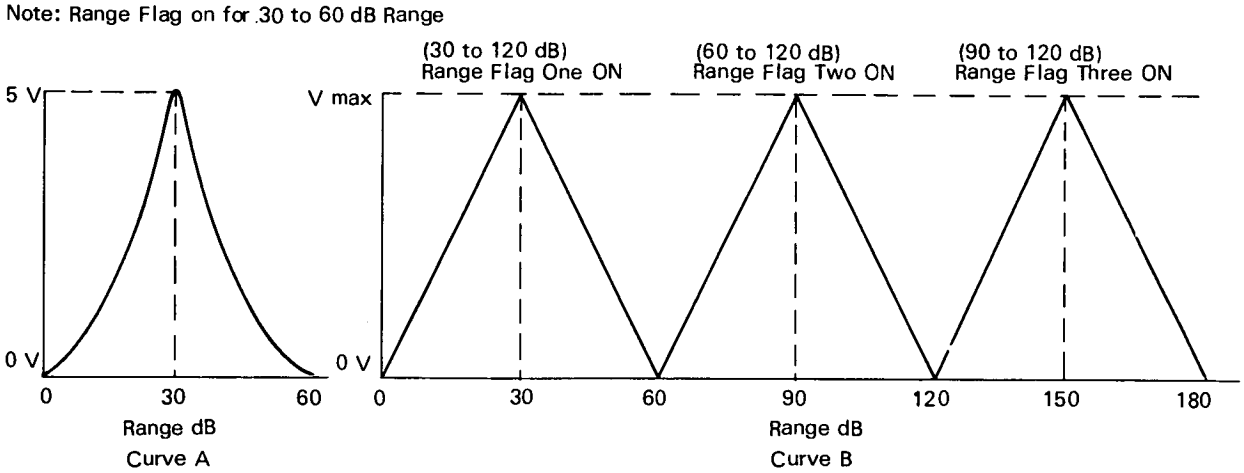

Figure 2.

flag output is at 0 Vdc. The positive detector goes into saturation at an input level of 30 dB. This is also the level at which the negative detector comes out of the background noise level. Over the next 30 to 60 dB, the negative detector goes from 0 to −1 Vdc. Meanwhile, the positive detector output sits at +1 Vdc. The negative detector output then subtracts from the positive detector and provides the negative slope of curve A from 5 to 0 Vdc for input levels from 30 to 60 dB. The range flag fires when the negative detector output reaches −20 mV. This flag gives a 5 Vdc level indicating that the negative slope of curve A is being used. Therefore, 60 dB of dynamic range is expanded over a 10 V curve (two 5 V ranges).

Two minor drawbacks of the circuit are: (1) the final output's symmetry depends upon how well the detectors and/or summing network are balanced; and (2) the range flag output must interpret the output voltage.

output and range flags shown in curve B would result. Different output voltages are possible; i.e., final analog output may be a positive or a negative voltage from 0 to −15 Vdc and range flags can be positive or negative, using conventional integrated circuitry.

Note:

No additional documentation is available. Specific questions, however, may be directed to:

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No patent action is contemplated by NASA.

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