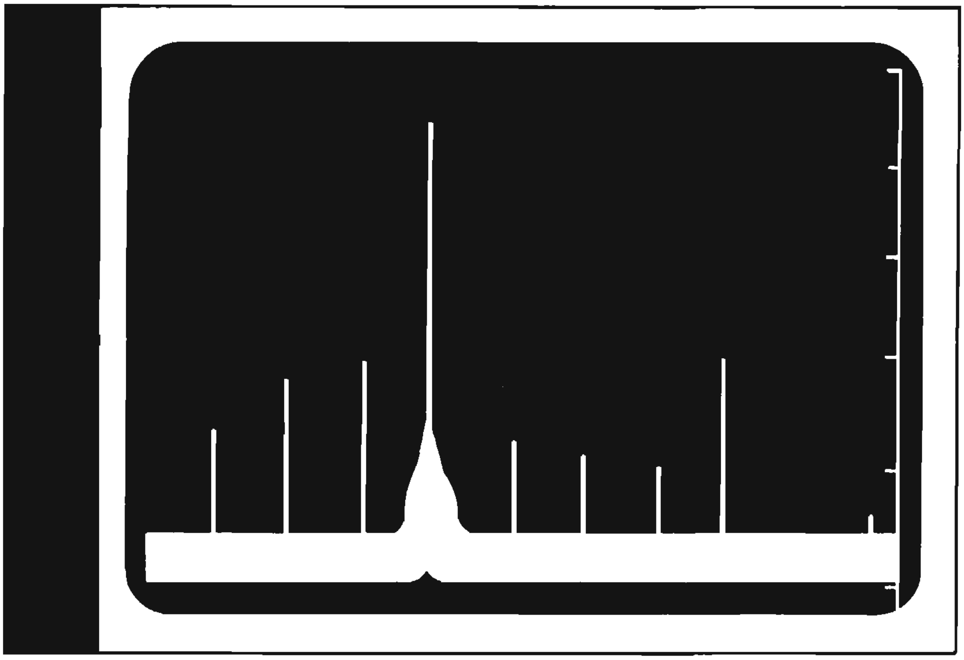

pseudo-logarithmic display

for the microwave spectrum analyzer

This pseudo-logarithmic circuit for your home-built microwave spectrum analyzer provides good resolution and 40 dB dynamic range

In a recent article I described a microwave spectrum analyzer which covered dc to 2.5 GHz with up to 2 GHz of dispersion, 2 MHz resolution, and 50 dB of dynamic range.[1] This analyzer was built almost completely from surplus materials and has been well received by the amateur microwave community. However, the instrument has one drawback: the display graduations are linear rather than logarithmic. This limitation was discussed in the original article, and reader suggestions were solicited.

Before my spectrum analyzer article appeared (but after the manuscript was finalized) *ham radio* published a very fine article by Jeff Walker, W3JW, on the design and construction of a high resolution high-frequency spectrum analyzer.[2] In that article Walker described a simple and effective circuit for providing his analyzer with a pseudo-logarithmic display which allowed him to view 40 dB dynamic range at one vertical deflection setting. It seemed to me that this circuit would, with suitable modification, greatly enhance the performance of my analyzer. I am pleased to report that it did just that.

circuit description

Walker's circuit, shown in **fig. 1**, consists of an audio-frequency detector, lowpass filter, and a unique nonlinear diode limiter arrangement. My analyzer already included an i-f detector diode, the out-

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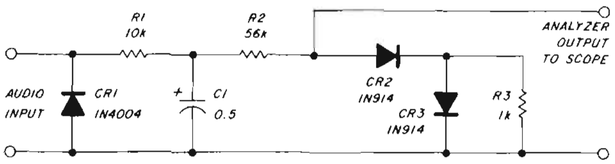


fig. 1. Pseudo-logarithmic signal-processing circuit developed by W3JW for use in a high-frequency spectrum analyzer.[2]

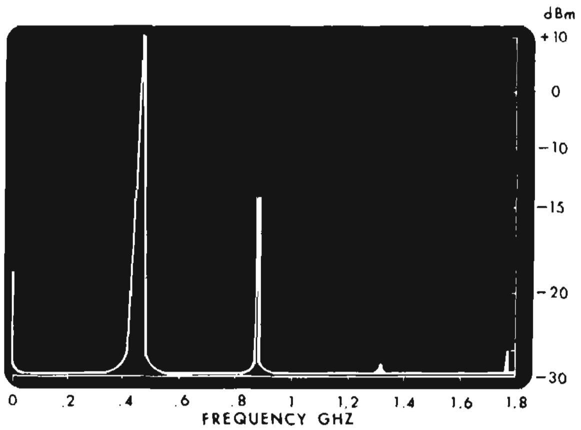
put of which I applied to Walker's filter/limiter circuit. However, I found it necessary to change the value of C1 to achieve the desired video frequency response at high sweep speeds (a value of 1000 pF is acceptable for sweep speeds of up to 60 Hz). For the logarithmic shaper circuit I replaced the 1N914 switch diodes with general-purpose Hewlett-Packard hot-carrier diodes. The final circuit values are shown in **fig. 2**.

Note that the detector circuit I used in my original analyzer provides a positive-going video output. If one of the more common negative-output detectors were used, it would be necessary to reverse the polarity of the Schottky diodes in the logarithmic shaper circuit.

performance

This shaper circuit enabled me to easily view 40 dB dynamic range (+10 to −40 dBm), with an unusual response which is very nearly logarithmic at 10 dB/cm at very low (−20 to −30 dBm) and very high (−10 to +10 dBm) signal levels. Intermediate amplitudes are "stretched" somewhat, as seen in the scope photograph. However, it is possible to measure signal amplitudes to within one or two dB over the entire 40 dB range, once you get the hang of it. It is possible to view spectral components as far down as −40 dBm, but scale compression at the low end is so great that you can only guess at the actual amplitude.

Spectrum display of a 450-MHz signal source, as viewed on the microwave spectrum analyzer with logarithmic video processing. The desired signal is at +10 dBm; second harmonic is down 23 dB at −13 dBm. Fourth harmonic is clearly visible at 40 dB down (−30 dBm). Also visible is a third harmonic component at approximately −35 dBm. Total display dynamic range easily exceeds 40 dB. Note the non-uniform vertical deflection graduations, discussed in the text.



calibration

The display response indicated in the photograph was achieved on my analyzer with i-f attenuation set at a minimum and video sensitivity at 50 mV/cm. The display was calibrated with the aid of a stable 10 mW signal source and a calibrated step-attenuator, by observing changes in the display amplitude as various amounts of attenuation were switched in. Since every analyzer is likely to exhibit its own transfer characteristics, it's a good idea to perform a similar calibration yourself if you duplicate this project.

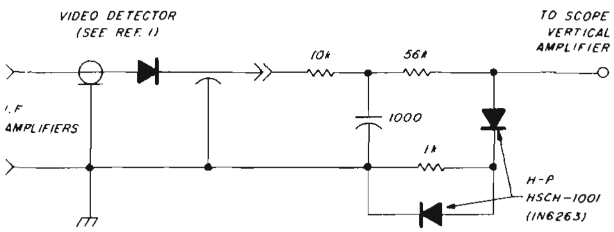


fig. 2. Signal-processor circuit as modified by N6TX for use with his microwave spectrum analyzer.[1]

One further point: When I change from low-band (dc to 2 GHz) to high-band (500 MHz to 2.5 GHz) coverage, the vertical scale calibration changes *considerably*. This is due to the difference in i-f gain with the i-f amplifiers operating at 2 and 1.5 GHz, respectively. Once the analyzer is recalibrated, however, I find it possible to easily resolve signal amplitudes over at least a 40 dB range, with the analyzer operating in either band.

Any feedback from readers who attempt to apply this or other signal-processor circuits would be greatly appreciated. All correspondence which includes a stamped, self-addressed envelope will be answered.

references

1. H. Paul Shuch, WA6UAM, "Low-Cost Microwave Spectrum Analyzer," *ham radio*, August, 1977, page 54.
2. Jeff Walker, W3JW, "High-Resolution Spectrum Analyzer for Single Sideband," *ham radio*, July, 1977, page 24.

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