Dynamic Range Extension of Schottky Detectors

Application Note 956-5

Introduction

Detectors are essentially low sensitivity receivers which function on the basis of direct rectification of the RF signal through the use of a non-linear resistive element – a diode. Generally detectors can be classified into two distinct types: the small-signal type, also known as square-law detectors; and the large-signal type, also known as linear or peak detectors.

Small-Signal Detectors

The small-signal detector operation is dependent on the slope and curvature of the VI characteristic of the diode in the neighborhood of the bias point. The output of the detector is proportional to the power input to the diode, that is, the output voltage (or current) is proportional to the square of the input voltage (or current), hence the term "square law" (see Figure 1).

Large-Signal Detectors

The large-signal detector operation is dependent on the slope of the VI characteristic in the linear portion, consequently the diode functions essentially as a switch. In large-signal detection, the diode conducts over a portion of the input cycle and the output current of the diode follows the peaks of the input signal waveform with a linear relationship between the output current and the input voltage.

The square law dynamic range may be defined as the difference between the power input for 1 dB deviation from the ideal square law response (compression point) and the power input corresponding to the tangential signal sensitivity (TSS).

Normal operating conditions for the Schottky detector call for a large load resistance (100 KΩ) and a small bias current (20 µA). These normal conditions assure the minimum value of TTS input level, but not the maximum value of compression level.

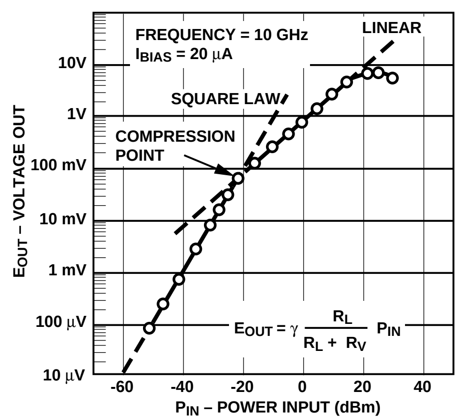

Figure 1. Typical Detector Output Voltage vs. Input Power

The compression level can be raised by reducing the value of R_L, the load resistance. However, the sensitivity degrades by the factor

$$R_L / (R_L + R_V) ,$$

where R_V is the diode's video resistance. This degradation in TSS exceeds the improvement in compression, so there is no improvement in square law dynamic range.

Another technique for raising the compression level is to increase the bias current. This also degrades the sensitivity, but the improvement in compression exceeds this degradation so square law dynamic range is increased.

Figure 2 illustrates the effect of bias current level on a Hewlett-Packard 5082-2751 detector, measured at 10 GHz. The diode impedance was matched to the 50 ohm system at each bias level. The tuner was adjusted at an input level of -30 dBm.

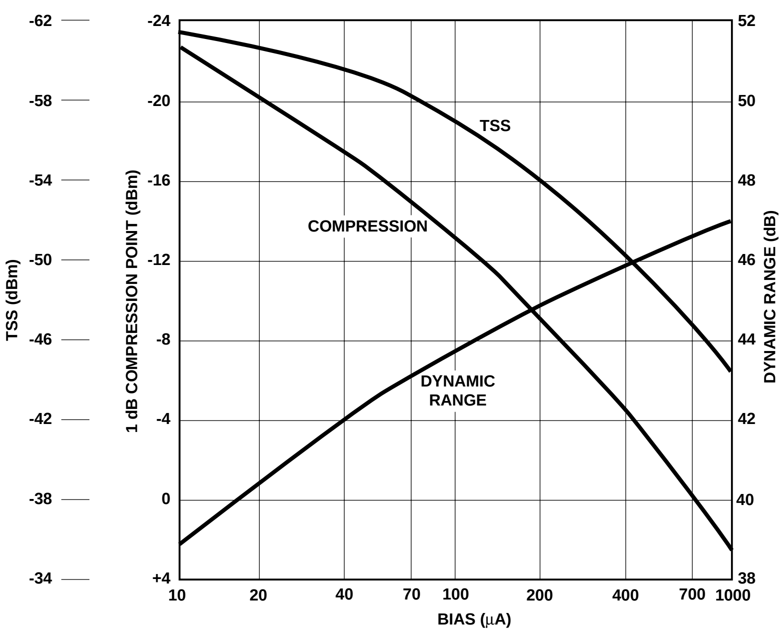

Figure 2. Dynamic Range Improvement with Bias

Conclusion

The improvement in dynamic range is evident by the increased spacing between the TSS and compression curves.

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