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SOLID-STATE DEVICES FOR LOW-FREQUENCY DOPPLER DETECTORS*

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This paper describes doppler detector measurements for X-band IMPATT, Gunn and BARITT devices with doppler frequencies between 1 Hz and 1 kHz. Over this range of frequencies the BARITT is found to be superior as a self-oscillating doppler detector.

Introduction

The purpose of this paper is to describe the properties of solid-state devices as low-frequency (1 to 1000 Hz) self-mixing doppler detectors. Previous measurements at doppler frequencies between 200 Hz and 50 kHz have shown that the BARITT device is superior in terms of microwave power required, dc power required, path loss and minimum detectable signal.[1-3] This paper will show that the BARITT is also superior at very low doppler frequencies.

Solid-State Device Doppler Measurements

The minimum detectable signal (MDS) for doppler frequencies between 1 Hz and 1 kHz was measured for IMPATT, BARITT and Gunn devices used in a self-mixed mode of operation. A block diagram of the test circuit is shown in Fig. 1. In the RF circuit the oscillator power is attenuated and then fed through a pin modulator by means of a circulator. The signal is 100 percent square-wave modulated and returned to the diode after being further attenuated. At the oscillator the return signal is mixed with the oscillator signal by the nonlinearity of the device, and the low-frequency doppler signal appears across the device terminals. The low-frequency detection circuit for the IMPATT and BARITT is shown in Fig. 2a and for the Gunn device, in Fig. 2b. The ac doppler signal is separated from the bias by the coupling capacitor. The signal is then amplified by the low-noise amplifier and either displayed on the oscilloscope or the wave analyzer. For oscilloscope use the low-noise amplifier sets the noise bandwidth of the signal. With the wave analyzer the bandwidth is set using the bandpass nature of the analyzer. In the Gunn device circuit the doppler signal is an ac current. This current is converted to a voltage by the current sampling resistor. The MDS is the signal strength at unity signal to noise ratio in a 1-Hz bandwidth. The MDS vs. doppler frequency for various power levels for BARITT, IMPATT and Gunn devices is shown in Figs. 3 through 5. These figures show that the BARITT device is a very sensitive doppler detector even at low doppler frequencies. The BARITT is 15 to 25 dB more sensitive than an IMPATT and more than 30 dB more sensitive than the Gunn device, even though it is operating at a lower dc and microwave power level.

Conclusions

Self-oscillating doppler detector characteristics for IMPATT, Gunn and BARITT devices have been measured in the 1 Hz to 1 kHz frequency range. Over this range of operation the BARITT is a superior detector, with better MDS and lower dc and microwave power required.

List of References

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3. East, J. R., Nguyen-Ba, H., and Haddad, G. I., "BARITT devices for self-mixing doppler radar applications," 1976 Int. Microwave Symp. Digest, pp. 43-44, June 1976.

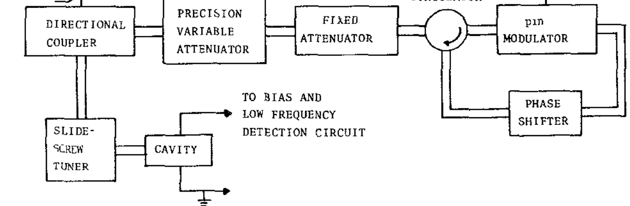

FIG. 1 RF CIRCUIT DIAGRAM.

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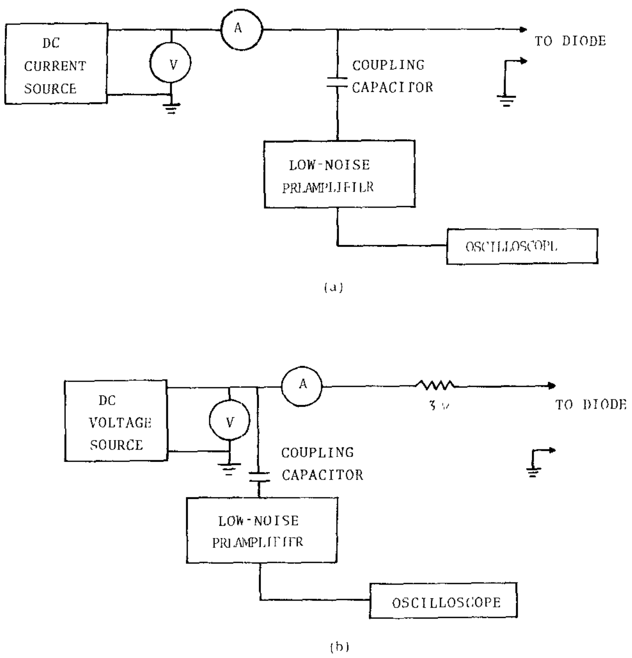

FIG. 2 BIAS AND DETECTION CIRCUITS FOR (a) BARITT AND IMPATT DEVICES AND (b) THE GUNN DEVICE.

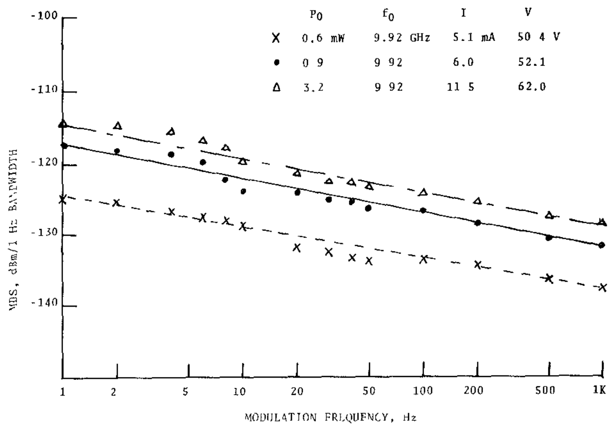

FIG. 3 MDS VS. MODULATION FREQUENCY FOR A BARITT DEVICE.

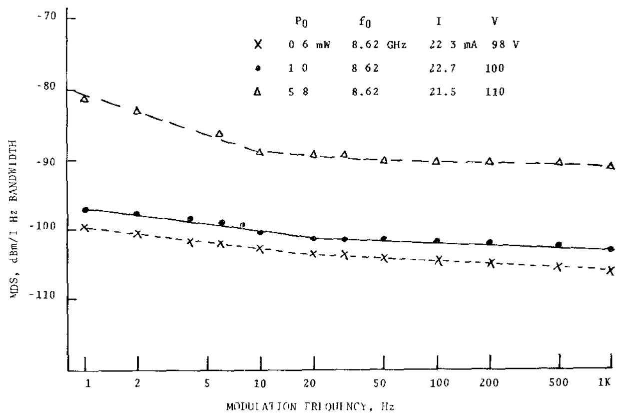

FIG. 4 MDS VS. MODULATION FREQUENCY FOR AN IMPATT DEVICE.

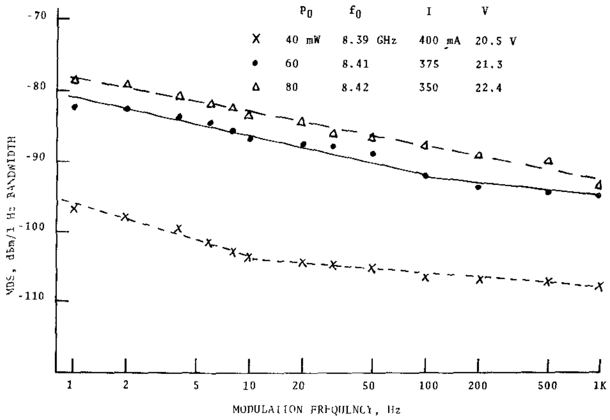

FIG. 5 MDS VS. MODULATION FREQUENCY FOR A GUNN DEVICE.