

X-BAND SOLID-STATE OSCILLATOR AND MIXER

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An oscillator/mixer assembly has been developed which employs an avalanche transit-time oscillator (ATTO) as the local oscillator for a wide band mixer. The oscillator is electrically tunable from 7.5 to 11.5 GHz, with a yttrium-iron-garnet toroid as the principal tuning element, and the overall single side-band noise figure of the assembly varies from 9 db (at center of band) to 11 db at the band edges. When used with a klystron local oscillator the mixer displays a noise figure of less than 9 db over this frequency range.

The design of the ATTO housing was based upon theoretical, computer-aided analyses. In the configuration chosen, the diode is mounted within a small radial-line cavity which also encloses a yttrium-iron-garnet (YIG) toroid. An electromagnet varies the magnetic field strength within which the toroid is immersed, thereby changing the resonant frequency of the composite structure. The oscillation frequency is determined by the diode parameters and the equivalent susceptance of the YIG-loaded cavity. A coaxial line, aperture coupled to the cavity through an annular opening in the top, serves as the load. A wide band multistep transformer permits the energy to be transferred to a 50 ohm transmission line system.

The characteristics of the ATTO which are important in the present application include the output power level, the variation in power across the frequency range, the a.m. and f.m. noise modulation levels, and the avoidance of spurious oscillations. In addition, the maximum tuning rates and repeatability of the frequency at a given current may be significant, as well as the performance under environmental conditions. At the present stage of the development program, the following values have been measured.

Frequency Range	7.45 to 11.5 GHz
Output power level	30 mW minimum
Power level variation	3 db
Noise output in 1 KHz band 10 KHz from carrier	115 db below carrier.

NOTES

The configuration of the experimental model is shown in Figure 1.

The mixer utilizes a three-layer strip transmission line to perform the coupling, filtering, and biasing functions. Each dielectric layer is .020 thick, and the center layer supports etched stripline circuitry on each side. Tandem overlay coupling sections of the type described by Shelton¹ are used to obtain the broadband 3 db power split required. Bias and i.f. connections to the diodes and bias to the ATTO are built into the mixer circuitry, as well as the necessary attenuating structures and low pass filters. Characteristics of the mixer which are significant to the present system are described below:

Frequency Range	7.0 to 11.5 GHz
Noise figure (30 MHz I F)	7 to 8.5 db
L.O. noise suppression	20 db
VSWR	1.5 - maximum
Output impedance	50 ohms nominal

Although double-prong pill package diodes are presently employed, the use of beam-lead diodes will be investigated and reported in the final paper. The configuration of the balanced mixer is shown in Figure 2.

Preliminary data on the combined ATTO/mixer assembly are shown in Figure 3, in which the noise figure is recorded as a function of frequency. It will be noted that the noise figure rises rapidly at each end of the band. This is partly due to the local oscillator noise suppression of the mixer, which is dependent upon the power splitting characteristics of the hybrid, and partly due to the increased noise content of the ATTO as it nears the limits of its tuning range. From 8.0 to 10.5 GHz the noise figure remains below 10 db.

This development program is being conducted under a contract from the Naval Research Laboratories, Washington, D.C.

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1. J. P. Shelton, Jr., "Impedances of Offset Parallel-Coupled Strip Transmission Lines," IEEE Trans. on Microwave Theory and Techniques, Vol. MTT-14 pp 7-15, January 1966.

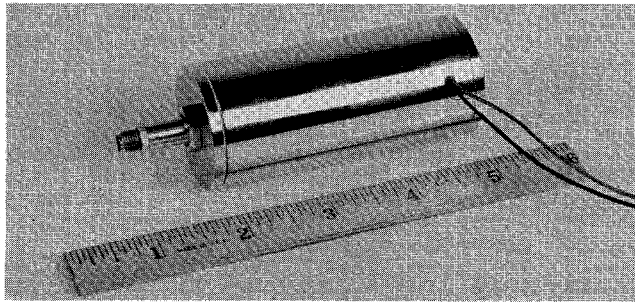


Figure 1. Magnetically Tuned ATTO.

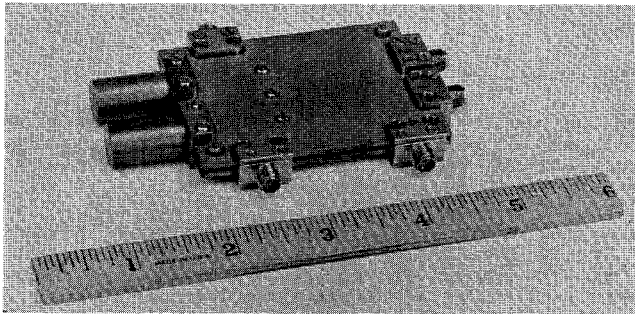


Figure 2. X Band Balanced Mixer.

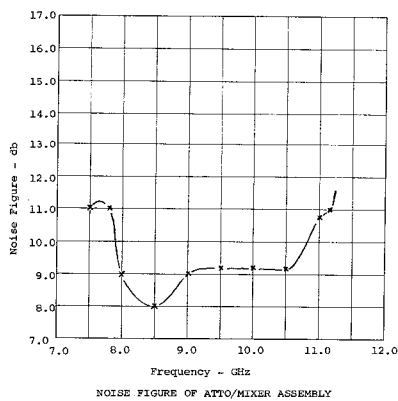


FIGURE 3