PANEL: NOISE IN MICROWAVE TRANSMISSION APPLICATIONS OF GUNN AND IMPATT DIODES

# IMPATT and Gunn Diode Noise Diagnostics

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In a communications system, the noise performance answer of most significance is the signal to noise ratio at the baseband output from a receiver. This is reflected in the form of the noise specification for components used in communications service. This is a ratio of noise in a 3 kHz bandwidth to the power in a test tone which causes 200 kHz deviation in the transmitter. This 3 kHz bandwidth is swept through the baseband region--typically 50 kHz to 5 mHz.

The recently developed Hewlett Packard mini-computer or calculator spectrum analyzer equipment can be used to good advantage in checking the base band signal to noise performance. The analyzer can be swept from 20 Hz to 13 MHz which more than covers the base band. It does have a 3 kHz bandwidth although other bandwidths can be used and correction factors written into the control program. (These programs can be written in the computing language BASIC.) Much calculating and other data processing can be done between measurements and the plotted results become available in finished form at a rate which competes with storage CRT display on a conventional spectrum analyzer.

If the baseband signal is not satisfactory, we must diagnose the cause of the troubles. We expect the cause might be excessive FM noise in the transmitter or receiving local oscillator, wideband noise from the transmission path, or noise in other parts of the receiver. To sort out the cause, each of these must be measured independently.

I still recommend measurement of the transmitter and receiving local oscillator FM noise by the cavity discriminator [1]. This discriminator rejects AM on the input signal, has an easily checked noise threshold, and uses as a frequency reference a microwave cavity whose noise problems are caused by acoustic vibration which is below the frequency of interest in communications systems. The most tedious portion of the noise measurement is recording, processing, and ploting the data. Again, the calculator controlled spectrum analyzer takes the pain out of this chore [2]. The data can be taken in a bandwidth appropriate to the measurement and processed in the calculator or mini-computer to be plotted in the desired 3 kHz bandwidth and with reference to the standard test tone.

The cavity discriminator is usually limited to an upper frequency (in the baseband output) of 100 to 200 kHz. Data for the FM noise up to this limit is usually sufficient to imply the performance, via well known oscillator noise theory, through the rest of the baseband region. I will present some typical data for IMPATT and TEO FM and AM noise to serve as a basis for system noise evaluations.

If the noise coming out of the receiver discriminator has a rising slope of 20 dB per decade, the cause is additive wide band noise somewhere in the system. The places to look for this noise include TWTs used in the transmitter, defective receiver front end amplifiers or mixers, and inadequate power at the receiving antenna.

## REFERENCES

[1] J. R. Ashley, C. B. Searles, and F. M. Palka, "The Measurement of Oscillator Noise at Microwave Frequencies," IEEE Trans MTT Special Issue on noise, Vol MTT-16 No 9 pp 753-760, Sept 1968.

[2] J. R. Ashley, C. Reynolds, T. A. Barley, and G. J. Rast, "Calculator Controlled Spectral Analysis of Microwave Oscillator Noise," Instrument Society of America, Huntsville, Alabama Meeting, April 16, 1975.