SESSION 16: MILLIMETER-WAVE APPLICATIONS

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A broad range of subjects is included, indicative of the breadth of recent progress and current interest. Active diode circuit applications include efficient broadband IMPATT power amplifiers, and two very useful new Gunn oscillator applications: fundamental injection harmonic Gunn oscillators and frequency agile active phase shifters. A 35 GHz high power switch comprised of a monolithic array of silicon diodes will also be described. The final paper in the session describes the development of an algebraic treatment of the distortion in nonlinear devices under large signal conditions.

Looking ahead, significant advances are expected during the next year in the area of broadband IMPATT power amplifiers. Although increased output power available from IMPATT diodes is a factor, the main thrust and advances will occur in the circuits area. This includes both power combining and diode stabilization and embedding techniques. The latter is very important in achieving good operating circuit efficiency: this subject is presented in Paper 2 in this session. Incorporating all of these aspects will result in stable broadband solid state power amplifiers with 5-10W output power in the 43-45 GHz frequency range.

Specifically, the papers in this session present and discuss:

- An injection locked Gunn oscillator with significant output power at the second harmonic frequency (H. Barth, AEG-Telefunken). Clearly useful for a pulsed 94 GHz radar system application, the Gunn oscillator, functioning as the low power driver stage for a high power IMPATT amplifier, is driven by a stable 47 GHz source at its fundamental frequency and provides a +15 dBm output at its second harmonic frequency.

- A technique to evaluate and optimize the operating circuit efficiency of IMPATT diode amplifiers and oscillators (D.F. Peterson Steinbrecher Corporation). The approach is described for establishing the efficiency of diode embedding circuits and gives guidelines for its maximazation. Experimental results are presented for a single-diode Q-band amplifier with 1.5 watts output power from 43.5 - 45.5 GHz.

- Frequency agile active phase shifter (L.D. Cohen, Eaton Corporation). This phase shifter provides *in situ* power generation and electronically controlled phase shift of the generated energy. The active phase shifter is basically a widely tunable Gunn VCO that utilizes the same injection locking mechanism previously reported with FET type active microwave phase shifters: a change in phase occurs when the resonant frequency of an oscillator circuit is changed, but the frequency of oscillation is constrained from changing by injection locking the oscillator to a stable frequency source. A compact varactor-tuned 47 GHz Gunn VCO and frequency/phase doubler are described, with 320° of phase shift and 40 mW of output power at 94 GHz.

- A monolithic 35 GHz high power single throw switch (A. Armstrong, *et al*, M/A-COM). The switch control element is an array of PIN diodes fabricated into a window of silicon placed across the waveguide. The switch handles over 400W peak and 20W average power with 60 nsec switching speed and provides 23 dB isolation, 1 dB insertion loss and a 1.6:1 VSWR over the K_a waveguide band.

- A large signal analysis of nonlinear microwave systems (M. Steer and P. Khan, NCSU). An algebraic treatment of the distortion in nonlinear devices is presented which enables the large signal performance of these devices to be determined qualitatively without the complication of performing a numerical nonlinear analysis. For the case of a resistive mixer, for example, the optimum pump level for good gain compression performance can be determined.

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