SESSION 11: NOISE AND FREQUENCY STABILIZATION OF FET OSCILLATORS

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This session addresses the topic of improving the noise and the frequency stability of FET oscillators. These are important characteristics directly affecting the performance of devices in practical systems. Over the last decade numerous studies have been reported on the design and the performance of FET oscillators, about their feedback implementation, the various circuit topologies, and the techniques for frequency stabilization, often employing dielectric resonators. The best design techniques also included non-linear modelling. Thus, the general design method for achieving oscillation at the required frequency and with required level of output power and efficiency is well established. Also, the reported performances have been excellent, with high levels of efficiency and operating frequencies well into the millimeter wave range. As a result FET oscillators have become attractive for application in many microwave systems, specifically in those having a limited amount of DC power available, or already built with FET technology.

Researchers, however, have reported noise levels for FET oscillators that are high compared to those, for instance, of low-noise Gunn or bipolar transistor oscillators. Although exact comparisons, even at identical values of circuit Q, are often difficult because of secondary effects due to differences in large-signal impedances and out-of-band characteristics, there is undoubtedly a strong need for developing noise-reduction techniques for FET oscillators. The first three papers of this session are devoted to this topic. The fourth paper, instead, deals with frequency stabilization.

The consensus among researchers is that the oscillator noise spectrum is generated not at microwave frequencies, but instead is a result of an up-conversion of low-frequency noise mixing with the carrier frequency in non-linear elements of the active device. Thus, non-linear phenomena, that are intrinsic in an oscillator that has achieved steady-state regime, also affect noise performance.

Three main topics will be covered in this session: 1) The origin of the low-frequency 1/f noise in FETs. 2) Techniques for improving the short-term stability of FET oscillators, thereby minimizing the FM noise. 3) A technique for improving the long-term stability, which is based on digital storage and control.

The paper by Rohdin et al. describes how the intrinsic low frequency noise of the FET is affected by physical parameters of the devices, and specifically how it can be improved by the use of a high purity buffer layer between the active channel and the substrate. Also, an analytical model is derived, that is useful for predicting oscillator noise performance.

Bianchini et al. describe a novel circuit that reduces the FM noise by a degeneration effect. The circuit includes a dielectric resonator which is both the frequency controlling element and the frequency discriminator within the noise feed-back loop.

The paper, by Riddle et al. also deals with a method for reducing the FM noise. It is based on terminating the gate circuit on a resistor of an appropriate value to minimize the up-conversion of the low-frequency noise. A parallel is drawn between the gate resistive loading for minimum oscillator noise and the gate impedance for minimum amplifier noise figure.

Finally, Lee et al. describe a digital compensation technique for achieving a very high frequency stability over a wide temperature range. It is a highly adaptable compensation technique based on A/D and D/A converters and an EPROM storing calibration data. Because of the present availability of inexpensive and easy to use A/D and D/A converters, it is expected that this easily automated digital compensation techniques will be highly favored over the time-consuming less-accurate analog techniques.