

Elektrotechnik-Elektronik-Informationstechnik

EEI KOLLOQUIUM

Low Noise Signal Generation and Verification Techniques

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Diskussionsleitung: Prof. Dr.-Ing. M. Vossiek

The need for improved signal detection capability in Communications and Radar System Performance has resulted in requirements for extremely low noise in the signal generation portion of the hardware. Depending on the complexity of the signal generator, the signal path circuitry often includes a cascade of a very large number of non-oscillator as well as oscillator-included components such as amplifiers, mixers, switches, filters, PLL ICs, etc. In addition to the spectral performance of the oscillator(s), the cumulative effect of the residual noise characteristics of the non-oscillator components on output signal noise level and jitter can be significant. Tradeoffs must often be made with regard to maintaining adequate inter-component signal level, linear device operation (to minimize multiplicative noise), and DC power consumption. The use of noise modelling and noise analysis spreadsheets has become a mandatory part of the design process.

Noteworthy strides have been made in order to enhance signal generator spectral purity by employing new technologies and circuit design techniques. These include the following:

1. Acoustic resonator design and processing optimization and screening for low self-noise
2. High Q microwave resonators
3. Noise enhancement, detection, and reduction using carrier nulling and feed-back or feed-forward techniques
4. Noise de-correlation via use of multiple devices

One result of these improvements, however, is that the output signal at-rest phase noise performance is now degraded by significantly lower levels of vibration and acoustic stress. For this reason, improving the vibration immunity of sensitive components represents a current challenging and important task facing the Frequency Control community. In addition to conventional, mechanical vibration isolation techniques, the successful use of accelerometer-sensed feedback for cancellation of vibration-induced FM in HF crystal oscillators has recently been reported. Here too, the effects of "non-oscillator" component vibration (including mechanical resonances) can be a source of unanticipated signal spectral degradation.

Accurate verification of phase noise performance (especially in the presence of vibration and acoustic stress) of low noise signal generator hardware represents an important, related issue. Measurement results obtained using phase noise measurement equipment can be misleading and lead to erroneous conclusions.

This lecture will cover the aforementioned topics with the goal of acquainting the attendees with both a historical and current perspective regarding the design, performance, and testing of low noise signal generation hardware.