

A Low-Cost Cross-Correlation Residual Noise Measurement System & Efficient Digital Signal Processing Techniques

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This paper describes a residual phase noise measurement system using cross-correlation techniques¹ that is built from relatively low-cost and readily available components and exhibits a system noise floor of around -177 dBc/Hz when measuring a device operating at 0 dBm output power. The system has been used to measure the noise performance of amplifiers operating at 100 MHz.

The block diagram of the system is shown in Fig 1 and is based on previous work done at York². Here, components are selected to operate at 100 MHz and low-level mixers are used to ensure inputs to the mixer are as close to saturation as possible to minimise the noise floor when measuring low-level signals, however each component in the system is SMA connectorised to enable the system to be easily modified to perform measurements at different frequencies and power levels.

A 16-bit PicoScope 4262 oscilloscope connected to a PC is used as a dual-channel FFT spectrum analyser and a software library has been written that enables the raw capture data to be processed efficiently such that residual noise data can be calculated in real-time without significantly increasing the measurement time even on inexpensive hardware. Included in this is the ability to vary the resolution bandwidth for different frequency bands, so that a large number of cross-correlations can be performed to suppress far-out noise, whilst still maintaining a small resolution bandwidth close-to-carrier. This technique has been used to perform a measurement with sub-Hz close-to-carrier resolution bandwidth and over 8,000,000 correlations at a 100 kHz offset in around 40 minutes. The signal processing techniques will be described in detail at the conference and the software library provided open-source. Sponsors:- Keysight & EPSRC.

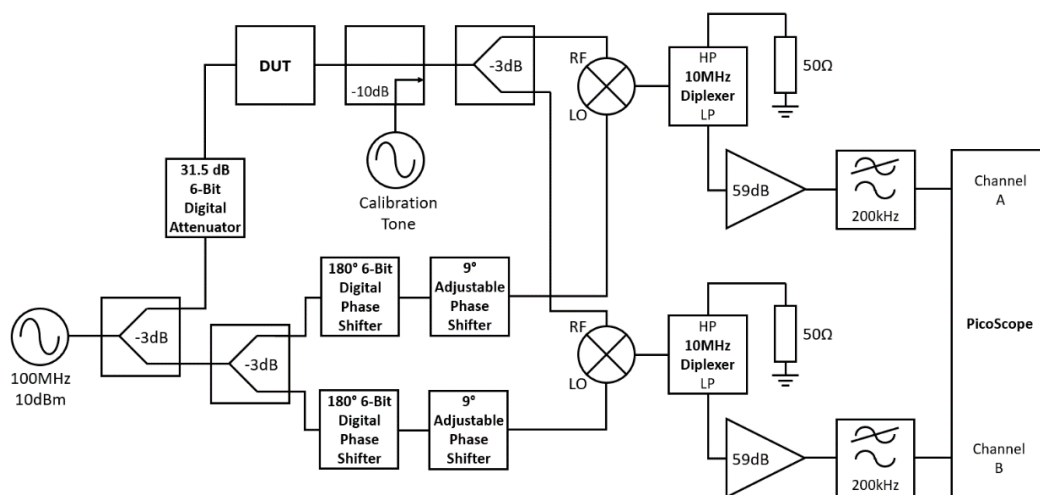


Fig 1: Residual noise measurement system block diagram

¹ W. F. Walls, "Cross-correlation phase noise measurements", Proc. IEEE Frequency Control Symposium, 1992, pp. 257–261.

² S. J. Bale, D. Adamson, B. Wakley, J. Everard, "Cross Correlation Residual Phase Noise Measurements using Two HP3048A Systems and a PC Based Dual Channel FFT Spectrum Analyser", 24th European Frequency and Time Forum, 13-16 April 2010