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Real-Time Automated Residual Phase Noise Measurements to 50GHz

Phase Noise Analysis has traditionally been a smaller sector of the electronics test and measurement market, primarily being a parameter that was verified by defense RADAR systems providers. With the rapid growth of high-speed communications markets, everyone from chipset manufacturers to complete systems providers have been adopting phase noise as a key parameter for quantifying RF signal stability performance. Furthermore, phase noise can be quickly converted to jitter, enabling a reliable method for rapid jitter analysis in time domain applications.

Holzworth Instrumentation was founded in 2004 on the premise of *taking the mystery out of phase noise measurements*. This translates to Holzworth phase noise analysis products targeting ease of use, reliability, repeatability, traceability, and fast measurement speeds at reasonable price points.

Phase Noise Analysis breaks down into two categories: absolute measurements and residual measurements, also known as “additive” measurements.

Absolute phase noise is used to quantify the performance of signal sources such as clocks, oscillators, signal generators, etc., and can be applied to a single device or an entire system. The block diagram shown in Figure 1 illustrates a simplified heterodyne upconversion system. The absolute phase noise can be measured at any node in the system. However, the absolute data collected at any given node will provide the total phase noise performance of the system from the LO signal sources at the far left all the

way up to the specific measurement node. This absolute data will include any performance degradations caused by components and/or subsystems in that path. When comparing the absolute performance at a system node versus that directly at the output of an LO, chances are that the performance has been degraded by one of the subsystem components in the path. In order to quantify what each of the multi-port components are contributing to the overall absolute phase noise performance of the system, one must employ a different measurement method.

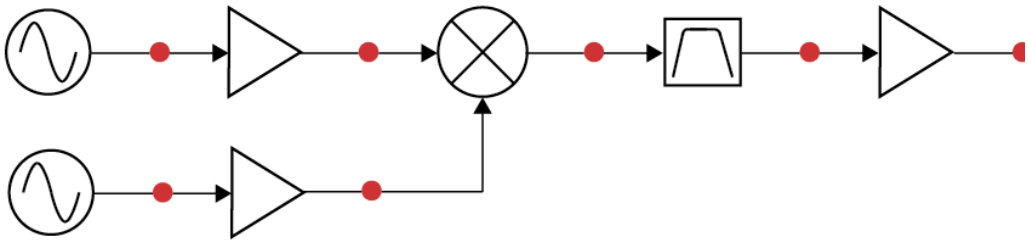

Figure 1: Heterodyne Upconverter showing measurement nodes.

Residual phase noise, now commonly referred to as “additive” phase noise, is a measurement that is devised to verify what a multi-port device such as an amplifier, PLL, frequency converter, mixer, etc., is contributing (or adding) to the system’s overall phase noise performance. As an example, more and more amplifier manufacturers are being required by their customers to measure the residual phase noise of their products as part of the manufacturing performance testing process so that the integrators are ensured that the amplifier will not degrade their system performance beyond a specified level.

Holzworth HA7062 Real Time Phase Noise Analyzers are designed to fully automate both absolute and residual phase noise measurements. Although these phase noise analyzers offer absolute measurement options to 6GHz, 26GHz, and 40GHz, their residual measurement capability is limited to a maximum of 6GHz. Like other phase noise analysis solutions, an external heterodyne downconversion system can be setup to extend this measurement to higher frequencies. However, the external heterodyne setup can be problematic and time consuming as it requires meticulous attention to every detail in order to acquire valid data.

The Holzworth HA7063A 50GHz Downconverter eliminates these labor-intensive heterodyne test setups and works in conjunction with an HA7062 Real Time Phase Noise Analyzer as a single unit. The HA7063A integrates the newest HSY Series RF Synthesizers from Holzworth as the test system LOs along with an analog heterodyne downconversion architecture to optimize both absolute and residual measurement noise floors to 50GHz.

In order to make a residual phase noise measurement, system quadrature must be achieved by adjusting the phase (delay) in each signal path of the cross-correlation phase noise test set. Setting system quadrature has traditionally been achieved manually via mechanical phase shifters (delay lines) or via the meticulous process of physically swapping out RF cable lengths. To accommodate automated residual measurements, Holzworth specifically manufactures the HX5100 Series Electronic Phase Shifters, which connect directly to and are automatically adjusted by the phase noise test system. The block diagram in Figure 2 shows the HA7063A 50GHz Downconverter residual measurement test setup.

Figure 2: Residual measurement test setup of the HA7063A 50GHz Downconverter.

As shown in Figure 2, the residual phase noise test setup requires 2x external phase shifters, a 3-way power divider and a signal source (internal to the HA7063A) set to the desired test frequency. The internal HSY Series LO outputs are available at the front panel of the HA7063A and can be independently controlled from the virtual front panel GUI. These LOs operate up to 24GHz and either one can be used as the residual test system signal source, to further simplify the test system equipment list.

With the measurement setup complete, the user need only make a few selections from driver free GUI. Note that for ATE manufacturing test, the phase noise analysis system can be fully automated via command line to eliminate the GUI interface.

From the GUI, the *Measurement Type* dropdown is set to “Additive” and *Phase Shifters* dropdown is set to “HX5100.” At this point, the system will

have already made any internal frequency and power level adjustments to match the RF signal coming from the DUT. With the number of cross correlations selected anywhere from 1x to infinite, the user selects “Acquire” and the real-time cross correlation test system will set quadrature via the HX5100 Electronic Phase Shifters and then make the residual measurement.

Holzworth engineering has responded to customer requests for a straightforward residual phase noise test system that addresses the needs of component and systems manufacturers serving everywhere from 10MHz, though the critical X-band RADAR range, and all the way up into the mmWave bands covering 5G, military communications, *etc.*

The HA7063A 50GHz Downconverter, coupled with an HA7062 Real Time Phase Noise Analyzer, simplifies the residual phase noise measurement process, which saves the user setup time, helps to eliminate potential setup error, and quickly provides accurate, NIST traceable data. All Holzworth phase noise analysis product calibrations are ISO 17025:2017 and ANSI z540.1 accredited.