



FULLY AUTOMATED SIGNAL ANALYZER

The versatile APPH6000 signal analyzer from AnaPico enables the fast and accurate measurement of single-sideband phase noise and amplitude noise, which play an important role in many RF and microwave designs, especially when developing crystal and voltage-controlled oscillators (VCO), pre-scalers, frequency converters and synthesizer

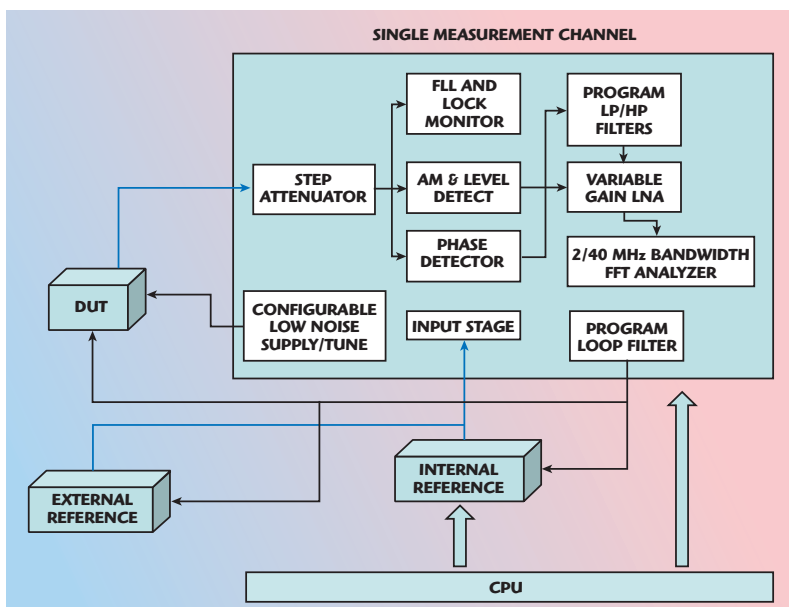
phase locked loops (PLL). It is capable of performing sensitive measurements of baseband and supply noise and has the capacity to conduct parameter extraction of VCOs and useful time-domain transient measurements such as the locking behavior of PLLs.

SYSTEM ARCHITECTURE

Figure 1 shows a block diagram of the APPH6000, which consists of one or two measurement channels (two when using phase noise cross-correlation). Each channel consists of a programmable step attenuator, a frequency counter, programmable phase and amplitude detectors, bandwidth-adjustable PLL and frequency acquisition loop, a gain and bandwidth programmable low noise amplifier and a high-resolution FFT analyzer. Each channel also includes programmable supply and control voltage for device under test (DUT) biasing.

MEASUREMENT CAPABILITY

The APPH6000 is a fully automated signal analyzer that provides reliable and fast noise measurements, is easily installed and config-



▲ Fig. 1 Block diagram of the APPH6000 signal analyzer.

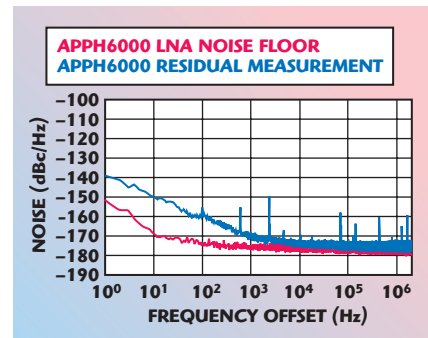
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ured, and is highly reconfigurable for a variety of applications. It also covers a wide frequency range from 10 MHz to 6.2 GHz (up to 7 GHz with an external source).

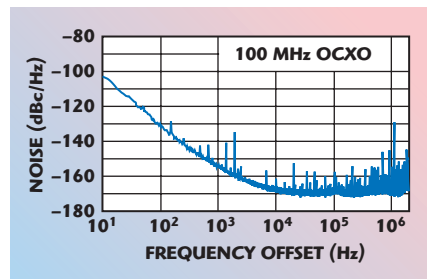
The signal analyzer features SSB phase noise measurement using the PLL method with internal or external reference and either the DUT or reference can be tuned. The offset range is 0.1 Hz to 2 MHz (optionally extendable to 40 MHz) and the noise floor is -174 dBc/Hz at 1 kHz, but can be

as low as -180 dBc/Hz with the high power option. A two-channel cross-correlation is available to further lower the instrument noise floor. **Figure 2** shows the instrument noise floor for the standard single channel operation; **Figure 3** shows a single-channel measurement of a low noise 100 MHz OCXO (16 averages).

Other features include: low RMS jitter or residual FM at a user-specified band of offset frequency, amplitude noise measurements with internal de-



▲ Fig. 2 The measurement noise floor of the APPH6000.



▲ Fig. 3 Single channel measurement of 100 MHz OCXO.

tectors, external detectors that can be used to cover higher frequency ranges, and two-port residual (additive) phase noise and AM noise measurements.

The APPH6000 offers VCO characterization: tuning characteristics such as frequency versus tuning voltage; tuning sensitivity, signal power level versus frequency or tuning voltage, and supply pushing figure. It also provides low noise internal DC sources that support automatic measurement of tuning and pushing figures. There is direct access to FFT analyzer input for the low noise measurement of trace noise and transients on supply and control signals, together with transient measurements of frequency and phase and PLL locking measurements.

SINGLE CHANNEL PHASE NOISE MEASUREMENT

For phase noise analysis, the instrument uses an enhanced version of the PLL method, whereby the DUT signal and a (tunable) low noise RF source are locked in phase quadrature. The resulting baseband voltage is directly related to phase noise of the DUT and reference, and is subsequently post-processed and visualized.

When the DUT and reference source are connected, the measurement starts detecting the signal power of the DUT and adjusting the input

step attenuator for optimum power level. Either the internal reference is auto-tuned near the DUT frequency or an externally applied reference is manually tuned by the user.

The remaining small frequency difference results in a beat signal at the phase detector output that is used to derive the demodulation calibration factor of the phase detector, taking into account possible nonlinear operation of the detector. After calibration, the optimum loop bandwidth with cor-

responding loop filter parameters are determined, depending on the desired frequency offset range, frequency tuning gain and DUT frequency agility.

The loop is closed and phase lock is achieved and maintained during measurement using proprietary frequency acquisition and lock monitoring circuitry. The loop bandwidth is adjusted depending on the stability and the expected noise performance of the DUT. To maintain locking during a long measurement, the frequency

drift of the DUT is checked periodically and, if necessary, the internal reference frequency is adjusted.

Once the PLL is in phase quadrature, the voltage fluctuations at the output are band-pass filtered and amplified with a gain-adjustable low noise amplifier. The adaptive gain and switchable high pass filters ensure that optimum dynamic range is presented to the consecutive FFT analyzer, depending on the DUT noise and offset to be measured. The FFT analyzer performs Fourier transformation and visualizes the results accordingly. For close-in phase noise, the noise suppression of the loop is fully compensated to derive accurate measurement results. There is also a two-channel cross-correlation option available, which further lowers the instrument noise floor.

INTERNAL LOW NOISE REFERENCE

Optionally, the APPH6000 can also be equipped with a low noise, DCFM capable signal source. Depending on the DUT stability and noise performance, the DCFM is automatically set to the appropriate sensitivity levels. Tracking ranges up to three percent of the carrier frequency allow measurements of heavily time-varying sources.

The complete system operates with speed and precision without requiring any additional test equipment and the instrument is remotely controlled via either a USB or LAN interface and supports SCPI syntax for control. Software drivers are also provided to simplify integration in other application software. A user friendly, powerful GUI runs on any Windows™ or Linux system and facilitates easy measurement set-up and data post-processing, with all kinds of memory and mathematical functions.

CONCLUSION

The APPH6000 signal analyzer is a versatile instrument capable of meeting most needs of the RF and microwave engineer. It is available in a compact and robust enclosure and will soon be offered as a 1U 19 inch rack system.

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