Microwave Journal

Ultra Low Phase Noise—Phase Coherent Synthesizers

Holzworth has released a product line of ultra low phase noise, multi-channel CW sources that incorporate up to eight independently tunable channels inside a single 1U high housing. One example is the HS3008A, 3 GHz RF synthesizer, which is capable of tuning frequencies from 8 MHz to 3 GHz in 0.001 Hz steps. Like all Holzworth synthesizers, the HS3008A demonstrates industry leading phase noise with excellent channel-to-channel phase stability. The non-PLL-based synthesis architecture is currently available with bandwidths up to 6 GHz while enabling tight stability, phase coherency and extremely fast tuning speeds. Holzworth's versatile multi-channel synthesizer products can be controlled directly by the proprietary application software, a shared library file (Linix™) or any standard control program/language capable of communicating with a DLL file. These USB instruments also offer an optional SPI interface.

DESIGN

Holzworth RF synthesizers are stand alone units with an integrated precision 100 MHz OCXO. An external 10 or 100 MHz precision reference may also be used with the standard auto-detection reference input/output ports. Holzworth synthesizers are unique in that they do not utilize a PLL-based architecture to achieve broadband, low phase noise frequency generation. The proprietary design approach enables industry leading phase noise, spectral purity and ultra fast switching speeds inside highly compact form factors. Multi-channel synthesizers benefit greatly from the elimination of phase-locked loops because the phase response is continuous and therefore the relationship between every reference locked channel is precisely coherent by design. In the multi-channel models, each synthesized channel operates independently, yet on the exact same reference clock cycle (instead of locking to a free running oscillator), thereby improving channel-to-channel phase stability. Up to 64 channels can be reference linked within a system to maintain a fully phase coherent relationship across all independently tunable channels. The non-PLL designs also offer valuable channel-to-channel phase drift performance, being less than 0.5 degrees between any two channels.

All Holzworth synthesizers are CE and RoHS certified, housed in precision machined aluminum bodies for maximum RF shielding in rugged and highly compact form factors. Single channel synthesizers are 1 x 4 x 6 inches in size while all multi-channel units are 1.75 (1U) x 17 x 15 inches. Power consumption is approximately 10 W per channel. The minimal heat dissipation accommodates a fan-less design, which eliminates problematic micro-phonics and electrical noise that are common with designs that require cooling fans.

HOLZWORTH INSTRUMENTATION
Boulder, CO

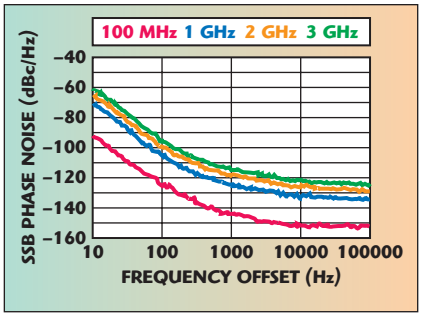


Fig. 1 SSB phase noise at 100 MHz, 1 GHz, 2 GHz and 3 GHz (P_{out}= +12 dBm).

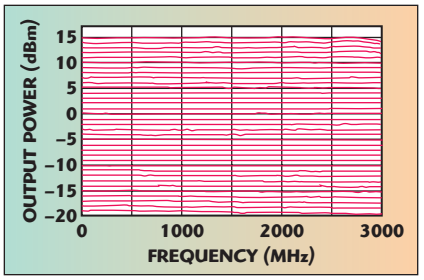


Fig. 2 Output power flatness vs. frequency.

PERFORMANCE

As an example, the HS3008A has typical phase noise of -151 dBc/Hz at 100 MHz (10 kHz offset). ***Figure 1*** shows the SSB phase noise performance versus frequency offset at 100 MHz, 1, 2 and 3 GHz with an output power of +12 dBm. The output power range is adjustable in 0.1 dB steps from -110 to +15 dBm (absolute limits are frequency dependent). ***Figure 2*** demonstrates the output power flatness performance from -19 to +15 dBm in 1 dB increments over the frequency range of 8 MHz to 3 GHz. The tuning speeds are extremely fast, being as low as 5 µs with settling times of approximately 100 ns (narrowband list mode). Custom options are available for external controlled SPI tuning speeds of <200 µs for frequency changes that span the full bandwidth of the instrument.

Spectral purity compliments the ultra low phase noise performance. ***Figure 3*** shows the spurious/harmonic performance of the synthesizer at 100 MHz, 1, 2 and 2.9 GHz at an output power of +10 dBm. ***Figure 4*** demonstrates the absolute performance of the second and third harmonics as they vary with the output power and the second and third harmonic levels relative to the fundamental. Holzworth synthesizers offer frequency tuning resolution of 0.001 Hz, amplitude tuning resolution of 0.1 dBm and phase offset tuning resolution of 0.1 degree (frequency dependent). ***Figure 5*** displays the channel-to-channel phase drift performance at

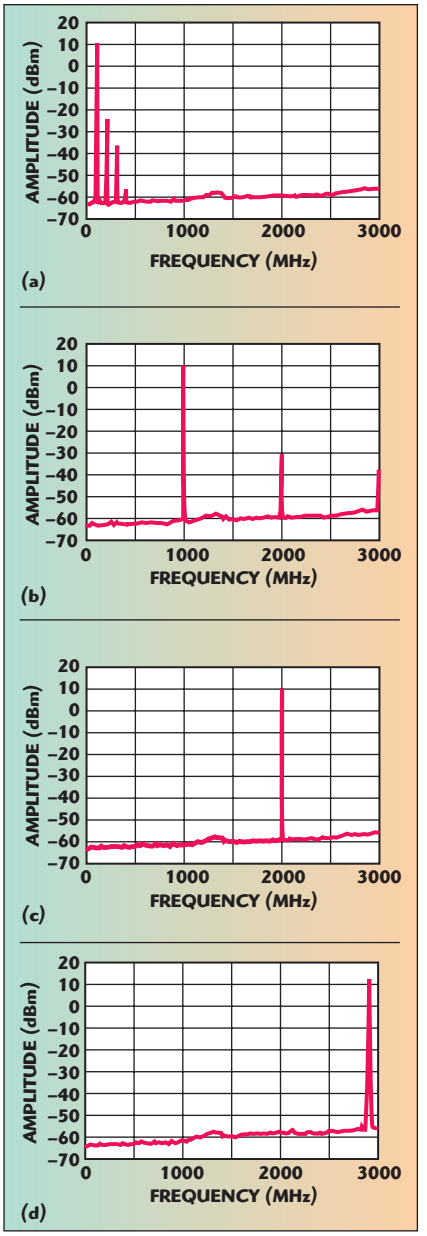


Fig. 3 Spectral data at 100 MHz (a), 1 GHz (b), 2 GHz (c) and 2.9 GHz (d) (P_{out} = +10 dBm).

3 GHz, over a period of one hour at 20 ± 2°C.

OPTIONS

Holzworth multi-channel synthesizer units are available with both standard and custom options.

- OPT-FIX10 Fixed 10 MHz (+5 dBm) reference output port
- OPT-FIX100 Fixed 100 MHz (+5 dBm) reference output port
- OPT-MOD xN modulation inputs - channel dedicated control
- OPT-MOD1 Single modulation input - global control
- OPT-TEMP Channel dedicated temperature sensors
- OPT-RACK 19 inch rack-mount hardware kit

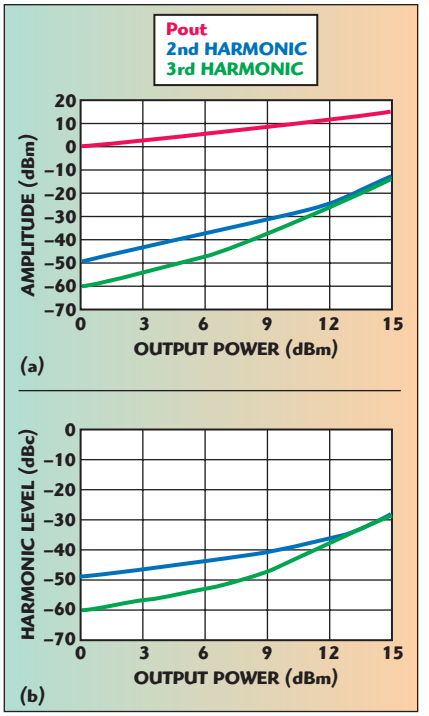


Fig. 4 Absolute (a) and relative (b) harmonic data (F_0 = 1 GHz).

- OPT-FIRM Application specific, custom firmware

Non-standard, application specific options are available.

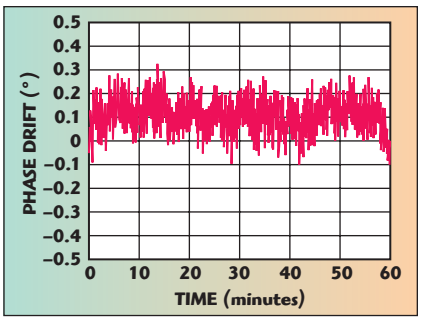
SYNTHESIZER CONTROL

Holzworth synthesizers offer both USB and SPI control interfaces as Virtual Instruments that have been designed to be highly versatile for integration into existing systems. All models can be controlled by the proprietary GUI application, LabVIEW™, MATLAB™, a shared library file (Linix), or any application capable of sending/receiving commands through a DLL file. Under the USB interface, the synthesizers utilize the HID (Human Interface Device) transfer protocol. The HID protocol requires no installation of hardware drivers while providing the highest level of stability.

The provided GUI application is Java™-based, making for a robust platform that is accepted as an industry standard. Operating on a minimal amount of memory (<2 MB), users can run the application directly from a USB memory stick. Full DLL access is provided to the user for absolute control over the instrument, allowing for ease of integration with proprietary programs.

CONCLUSION

The attractive performance-to-price ratio, with models operating to 6 GHz, makes Holzworth RF synthe-



▲ *Fig. 5 Channel to channel phase drift performance (3 GHz, 20 ± 2°C)*

sizers optimal solutions for precision measurement and phased-array systems where maintaining the phase relationship across multiple channels is imperative. These designs have been optimized to maintain best in class channel-to-channel phase drift over both temperature and time.

Holzworth synthesizers have been integrated into the most demanding and precise applications by world renowned companies and laboratories since its inception in 2004. Originally recognized for broadband performance inside compact form factors, the evolution of the multi-channel synthesizer products has gained recognition for exceptional phase coherency and phase stability. The relative channel density of these multi-channel synthesizers is remarkable when considering an example where a 64 channel array of fully phase coherent, independently tunable synthesizers will now integrate to within 16 inches of vertical rack space. Holzworth also designs application specific synthesis and phase noise measurement products.

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