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20 GHz Fast-Tuning Signal Generator

PXIe-5654



- 250 kHz to 20 GHz frequency range
- 100 μ s frequency switching speed
- -133 dBc/Hz phase noise at 1 GHz, 10 kHz offset
- Output power up to +27 dBm
- ± 0.35 dB amplitude accuracy from -10 dBm to +13 dBm
- >130 dB of RF output power range
- AM, FM, phase, and pulse modulation
- Tunable oscillator, interference injection, IMD measurements

Overview

The PXIe-5654 microwave signal generator features an ideal combination of exceptional phase noise and frequency tuning time as low as 100 μ s. These features address applications such as blocker testing/receiver desensitization, high-performance intermodulation distortion (IMD) measurements and various electronic warfare applications.

With up to 20 GHz of frequency coverage, 130 dB of RF output power range and low harmonics, this signal generator is designed to meet the challenging requirements of RFIC characterization, satellite test, and radar applications. The microwave signal generator is a continuous-wave (CW) source that also supports analog modulation like AM, FM, PM, and pulse modulation.

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Application and Technology

Exceptionally Low Phase Noise

The PXIe-5654 signal generator offers the benefit of a very low single sideband (SSB) phase noise of -133 dBc/Hz (typical) at 10 kHz carrier offset and 1 GHz carrier frequency. The low-phase noise of the PXIe-5654 makes it highly suitable in phase-noise test systems, in mixed-signals IC testing, in phase-noise measurements on free-running voltage-controlled oscillators, and as a tunable local oscillator (LO) or clock source. Figure 1 shows the typical phase noise of the PXIe-5654, measured at different carrier frequencies and offsets.

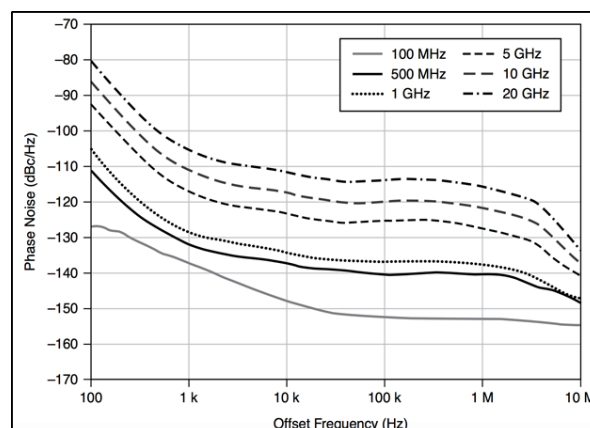


Figure 1. Typical Phase Noise on the PXIe-5654

Fast Switching

The PXIe-5654 architecture allows for extremely fast frequency switching speeds as low as 100 μ s. In automated and production test, fast frequency switching speeds improve test times and throughput. Furthermore, switching time and exceptionally low phase noise, makes this an ideal LO component for electronic devices like an RF mixer or vector signal analyzer.

Amplitude Power

When paired with the PXIe-5696, amplitude extender module (AEM), the PXIe-5654 supports up to +27 dBm output power with a typical amplitude accuracy of ± 0.60 dBm. Such a high output power with accurate amplitude control, makes the PXIe-5654 a cost-effective and modular CW source solution for interference injection, LO substitution, and wireless component test. The PXIe-5654 paired with the AEM can provide output power as low as -110 dBm, thereby offering an RF output power range of more than 130 dB.

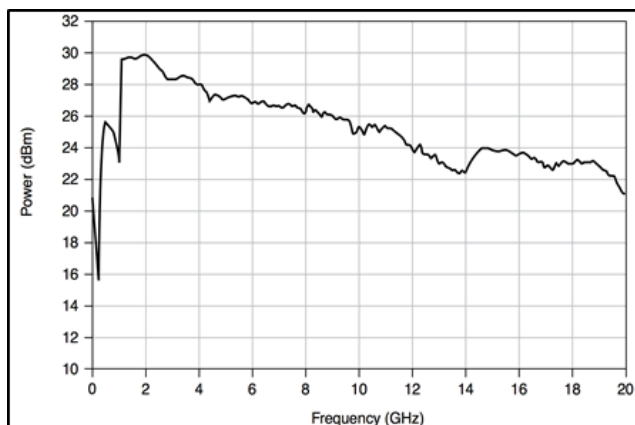


Figure 2 Typical Maximum Available Output Power of the PXIe-5654 with the PXIe-5696

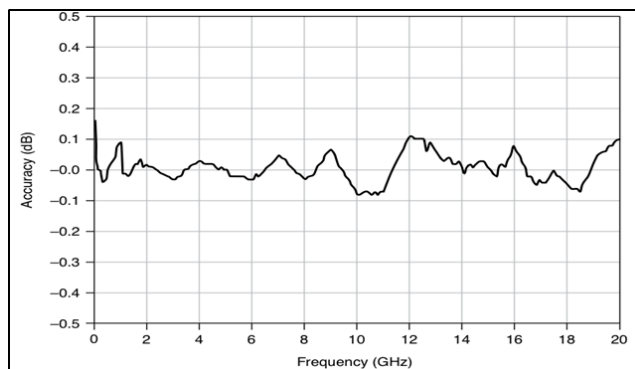


Figure 3. Typical Power Accuracy at -40 dBm for the PXIe-5654, with the PXIe-5696

Harmonics

Table 1 shows the typical harmonics of the PXIe-5654, with the AEM, for the frequency range from 250 kHz to 20 GHz. The combination of high output power and low harmonics is ideal for characterizing microwave components like filters and amplifiers. Having harmonics as low as -55 dBc eliminates the need for external filters.

Frequency	Harmonics (dBc)	
	PXIe-5654	PXIe-5654 with PXIe-5696
250 kHz to <250 MHz	≤ -20	≤ -20
250 MHz to <1 GHz	≤ -25	≤ -25
1 GHz to <2 GHz	≤ -30	≤ -30
2 GHz to <12 GHz	≤ -40	≤ -55
12 GHz to 20 GHz	≤ -40	≤ -50

Table 1. Typical PXIe-5654 Harmonics

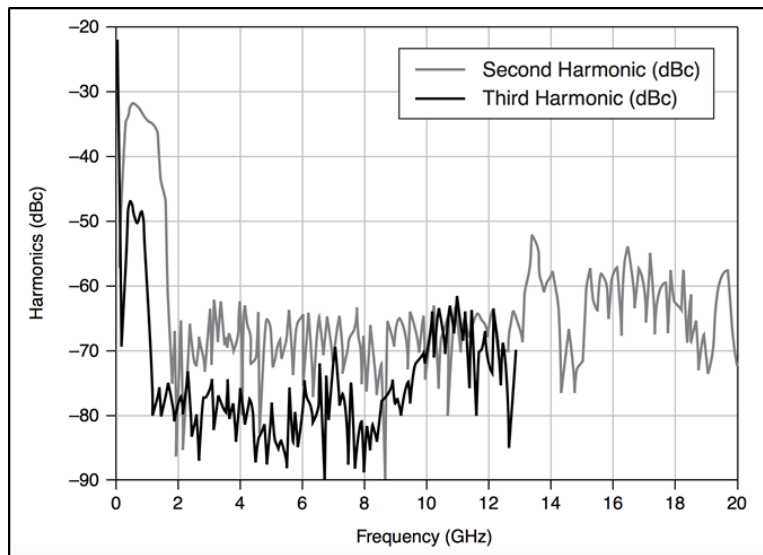


Figure 4. PXle-5654 with the PXle-5696 Typical Harmonics Level at +8 dBm Output Power

Modulation

The PXle-5654 offers additional capabilities including AM, FM, PM, and pulse modulation. The signal generator can generate pulses as narrow as 50 ns with 15 ns rise and fall time and 80 dB carrier on/off ratio. The PXle-5654 also offers wideband FM modulation, which, in combination with pulse modulation, can prove valuable in radar and electronic warfare applications. Figure 5 shows the wideband FM spectrum generated from the PXle-5654. Note that the generator can output 160MHz of modulation bandwidth at 20 GHz.

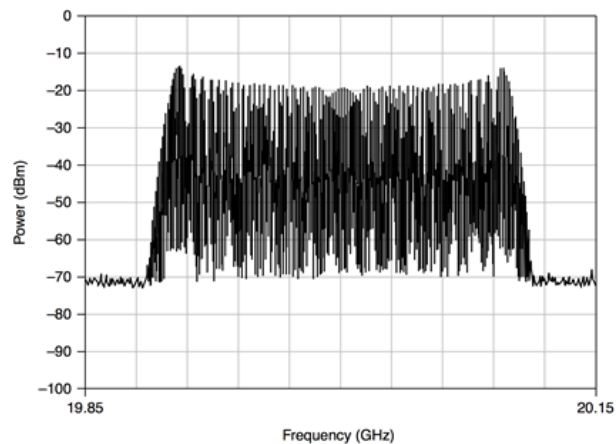


Figure 5. Wideband FM at 20 GHz

Connector name.....	PULSE IN
Repetition frequency.....	DC to 10 MHz
Input level	
RF on.....	TTL high
RF off.....	TTL low
Absolute maximum input level.....	+5.5 V
Absolute minimum input level.....	-0.5 V
Input impedance.....	>100 k Ω
Carrier on/off ratio (250 MHz to.....	80 dB
20 GHz) ¹⁹	
Minimum pulse width (250 MHz to.....	50 ns, typical
20 GHz)	
Rise/fall time (250 MHz to 20 GHz).....	15 ns
Maximum width compression ²⁰	15 ns, nominal
(250 MHz to 20 GHz)	
Delay time (250 MHz to 20 GHz).....	<35 ns, nominal
Pulse overshoot (250 MHz to.....	<10%
20 GHz)	

Table 2. PXIe-5654 Pulse Modulation Characteristics

PXIe-5654 Basic Architecture

The system block diagram of the PXIe-5654, in Figure 6, illustrates how the CPU manages the control signals and data transferred between the circuit blocks. The CPU controls all the internal registers and components necessary for frequency generation, modulation, and amplitude control. Additionally, the CPU monitors the temperature, health, and status of the module and flags any operation or temperature problems. The following list describes the individual blocks of the PXIe-5654:

- Clocking Circuitry contains the system clock reference and the direct digital synthesizer. The system clock is a 100 MHz oven-controlled crystal oscillator that can be configured to phase-lock to an external reference of 1 MHz to 20 MHz in 1 MHz intervals.
- The REF OUT connector provides a 10 MHz reference output signal and the REF OUT 2 provides a 100 MHz reference output signal.
- Signal generation occurs inside the Main Synthesizer circuit. The synthesizer is phase-locked to the reference clock. Following the main synthesizer are the Dividers to scale the frequency.
- The Amplitude Control circuit performs amplitude control.
- After the amplitude control circuit, a Switched Filter Bank ensures adequate harmonic suppression for each hardware band.
- The Pulse Modulation circuit performs the pulse modulation, the Main Synthesizer performs the FM and PM, and the Amplitude Control circuit performs the AM.
- The automatic leveling control (ALC) IN of the PXIe-5696 uses a temperature-stable voltage reference and digital-to-analog converter in the AEM to perform fine amplitude corrections in the Amplitude Control circuit of the PXIe-5654.

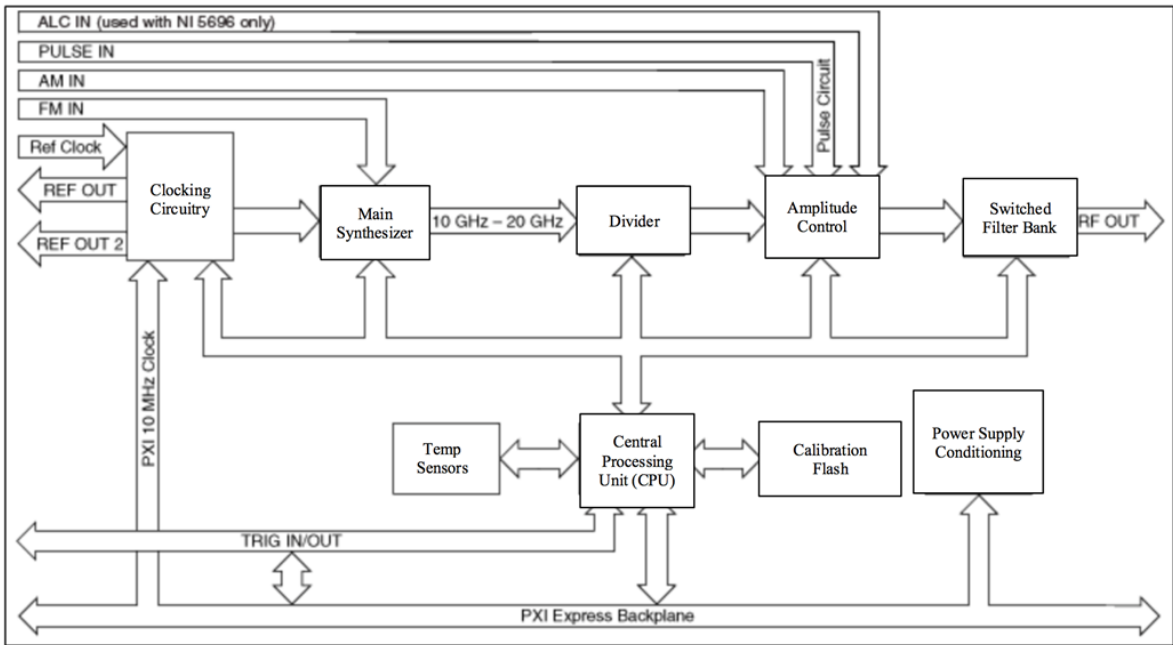


Figure 6. PXIe-5654 Block Diagram, Paired with the PXIe-5696

Comparison

Table 3 compares the PXIe-5654 and AEM with the other CW RF signal generators and vector signal generators (VSGs) in the NI PXI RF family. With an exceptionally low phase noise, faster tuning time, lower harmonics, higher output power, and higher accuracy, the NI PXIe-5654 keeps you at the forefront of measurement performance.

Measurement	5650/1/2	5673	5644R/45R/46R	5654 + 5696
Frequency Range	500 kHz to 1.1/3.3/6.6 GHz	85 MHz to 6.6 GHz	65 MHz to 6 GHz	250 kHz to 20 GHz
Bandwidth	N/A	100 MHz	80/200 MHz	N/A
Phase Noise (10 kHz offset) at 1 GHz	-112 dBc/Hz	-112 dBc/Hz	-112 dBc/Hz	-133 dBc/Hz
Modulation Capabilities	FM, 2-FSK, OOK	Vector Modulation	Vector Modulation	AM, FM, Phase, Pulse
Maximum Output Power (CW)	+10 dBm	+10 dBm	+10 dBm	+27 dBm
Amplitude Accuracy	±1 dB	±0.3 dB	±0.26 dB	±0.6 dB
RF List Mode Support	Yes	Yes	Yes	Yes
SFDR	-50 dBc	-52 dBc	-55 dBc	-60 dBc
Tuning Time	200 µs	200 µs	380 µs	100 µs

Table 3. Comparison of the PXIe-5654 and PXIe-5696 with Other PXI CW RF Signal Generators

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