40 GHz, Agile, Phase-Coherent, Multi-Output Vector Signal Source

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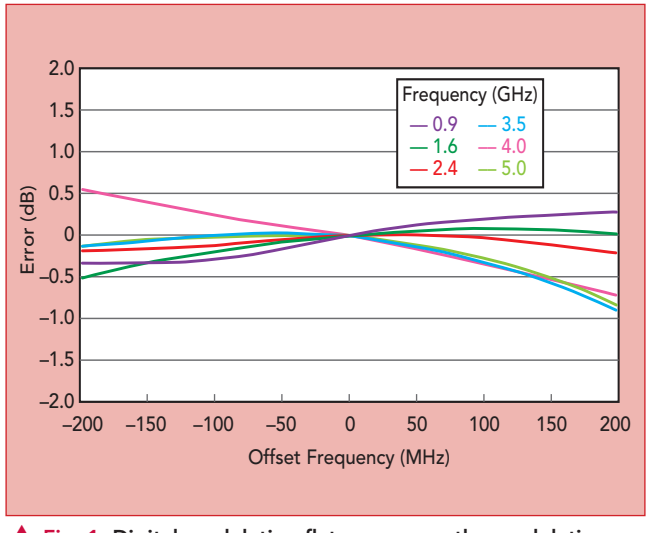
Today, digital modulation schemes are widely used in communication systems, and the increasing need for data bandwidth has pushed the signal purity and modulation bandwidth requirements for modern vector signal sources. Other applications with similar performance requirements include radio surveillance, interference analysis, radar signal analysis and electronic warfare.



▲ **Fig. 1 Digital modulation flatness across the modulation bandwidth at several carrier frequencies.**

Addressing these demanding requirements, AnaPico's recently introduced APVSG series of vector signal generators (VSGs) provide frequency coverage to 40 GHz and are available as single output desktop units or rack-mount instruments with multiple phase-coherent outputs. The APVSG series offers a cost-effective and flexible tool for generating high-quality, complex, wideband, digitally modulated signals. Each output channel has:

- Internal waveform memory up to 512 MS, at 32 bits per sample, for storage of several thousands of I/Q data segments
- Internal dual-channel arbitrary waveform generator with integrated asynchronous re-sampler that outputs 16-bit samples to 500 MSPS
- Proprietary mixed digital/analog self-calibrated I/Q modulator with flat frequency response over the ±200 MHz instantaneous modulation bandwidth (see ***Figure 1***) and good image rejection and local oscillator suppression
- Pulse modulator with a minimum pulse

width of 10 ns, 2 ns rise/fall times and >80 dB on/off ratio
- Single sideband phase noise of -150 dBc/Hz at 100 kHz offset from a 1 GHz carrier (see ***Figure 2***)
- Excellent harmonic and spurious rejection
- Sub-µs switching speed
- Options for relative phase stability and phase-coherent switching for beamforming and quantum computing applications

The instrument has a modular and scalable architecture, controlled from a Linux kernel that runs the device firmware. Multiple instruments, each with up to four channels, can be operated in a high performance clocking system, providing outstanding phase coherence among dozens of channels. The instruments can be operated in various modes to support different applications (see ***Figure 3***).

I/Q DATA PLAYBACK

User-defined I/Q data files in different formats can be uploaded into the instrument's internal memory using the supplied graphical software (see ***Figure 4***). The internal data format supports up to four markers for signal synchronization using TTL outputs. In addition to AnaPico proprietary data format, the graphical interface supports other file formats—CSV, Matlab and I/Q

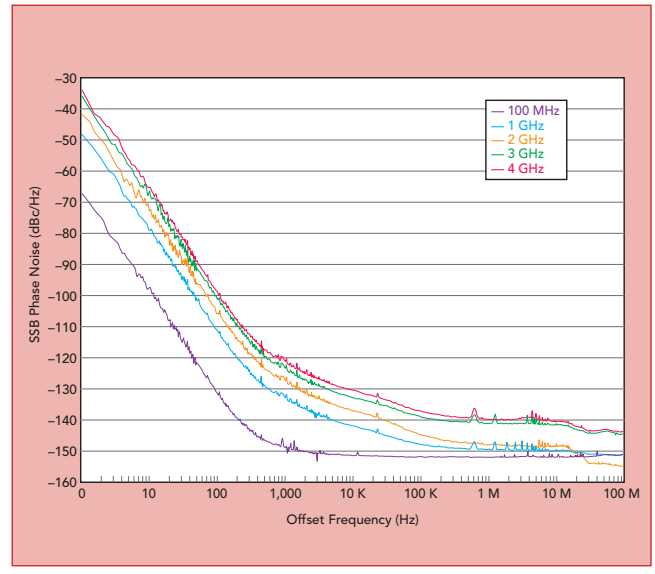


Fig. 2 **Single sideband phase noise with I/Q on.**

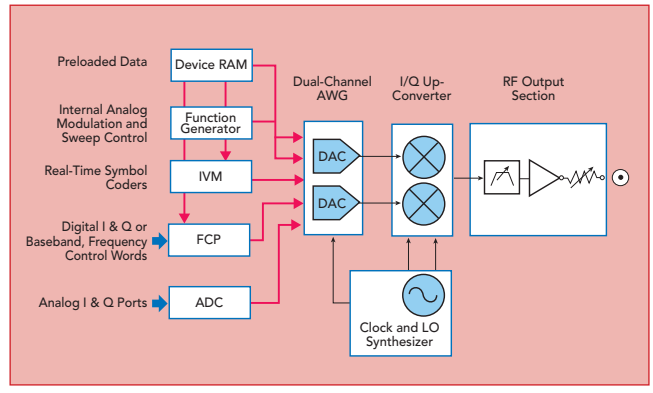


Fig. 3 **APVSG block diagram.**

formats from third-party suppliers—to maximize flexibility. Preloaded waveforms can be played back in a user-defined sequence and at a sampling rate set by the user.

The graphical interface can also be used to program waveforms such as multi-tone, user-defined chirps or broadband noise; it also enables control of the internal analog modulators, including the function generators for pulse trains, and the optional real-time coders.

OPTIONS

The APVSG can be ordered with several options:

Fast Sweeping and Chirping (Option FS)—APVSGs are optimized for very fast frequency hopping, sweeps and chirping. Frequency switching over the instrument's full frequency range is less than 1 µs. Pulse chirps, linear, polynomial, exponential and user-defined functions are supported (see ***Figure 5***).

Fast Control Port (Option FCP)—The APVSG can be controlled with the fast control port (FCP), a reconfigurable parallel port with LVDS signal inputs. Depending on the requirement, the FCP has four use cases:

- Frequency hopping or sweeping. Using the frequency, amplitude and phase words applied to the FCP interface, the user can implement very fast frequency hopping—above 1 MHz—over the entire frequency range with real-time input.
- Low latency playback control. Pre-stored waveforms can be addressed as memory segments and triggered for immediate play with low latency, typically 200 ns.
- Digital I/Q streaming. Digital I/Q data can be directly applied to the internal modulator at up to 250 MSPS.
- Real-time data streaming. User data can be read in real-time and coded on one of the built-in modulation schemes, like QAM or QPSK.

Built-in Analog Modulation (Option MOD)—The APVSG uses the internal function generator to generate high-quality amplitude, frequency and pulse modulation. Wideband, high rate, multi-tone FM, PM or AM can be combined with precise, phase synchronous pulse modulation, with pulse widths down to 10 ns and on-off ratios >80 dB.

Analog I and Q Data Inputs (Option AIQ)—External analog inputs for I and Q data are supported with more than 100 MHz signal bandwidth.

Internal I/Q Generator (Option IVM)—Using a novel architecture for I/Q modulation, the APVSG series provides quick, "user friendly" waveform generation (see Figure 3). The baseband generator supports the playback of pure digital data, mapping digital symbols into a selected I/Q constellation at symbol rates to 10 MHz in real-time, passing the result through the selected pulse-shaping filter to generate the final waveform, updated in real-time

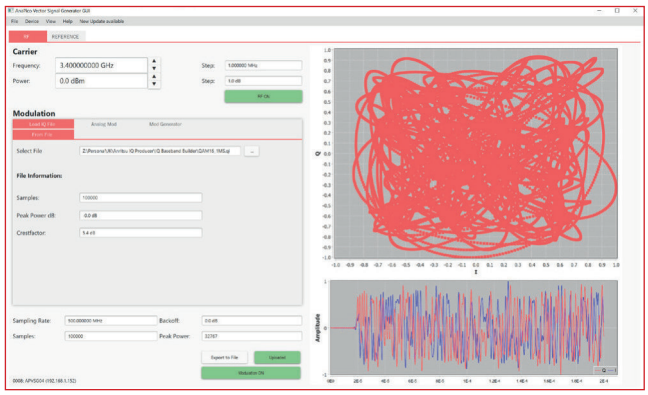


Fig. 4 Screenshot of the APVSG graphical interface.

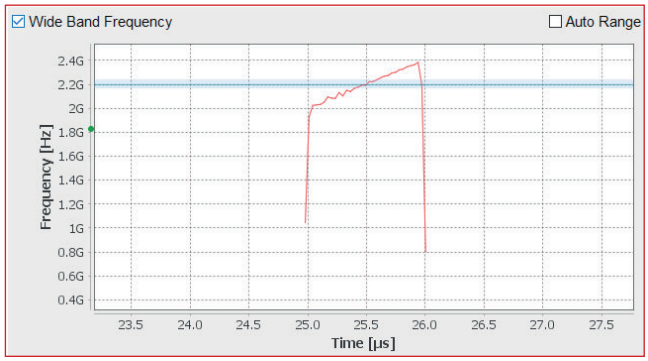


Fig. 5 Screenshot of a 1 µs linear chirp over the 400 MHz modulation bandwidth.

at the full sampling rate, to drive the 16-bit DACs. This baseband signal is then modulated onto an RF carrier using the internal I/Q vector modulator. The symbols can be a fixed pattern, PRBS data from an internal source, a downloaded user list or streamed real-time from the FCP data port. The constellation mapping can be user-defined and the digital filters include user-defined FIR.

SUMMARY

AnaPico's new APVSG series of VSGs are ultra agile, with wide modulation bandwidth and flexible operating modes. They are available in single (desktop) or multiple channel (rack-mount) forms, well-suited for applications such as quantum computing, radar, wireless communication, electronic warfare, beamforming and other applications where high-quality signals are needed.

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