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Module delivers DDS benefits to 40 GHz

SPEEDY SYNTHESIZER Switches to 20 GHz

p. 97

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COVER story

High-Speed Synthesizer Switches 0.01 To 20 GHz

An innovative VCO architecture arms this low-noise frequency synthesizer with the switching speed needed for high-volume device and component testing.

JACK BROWNE/ Technical Director

In an automatic-test-equipment (ATE) application, speed is money. Faster measurement times translate into higher throughput and more devices or components approved for shipping at the end of the day. Measurements, of course, require fast analysis equipment but also high-speed stimulus instruments to generate test signals. At microwave frequencies, the choice in fast-switching frequency synthesizers has been limited to a handful of suppliers. With the addition of the MG37020A fast-switching frequency synthesizer from Anritsu Co. (Morgan Hill, CA), however, a new source is available with the low noise and frequency switching speed to support commercial and military ATE applications. The MG37020A synthesizer tunes from 10 MHz to 20 GHz with frequency switching speed of 100 µs/point.

As with many suppliers of high-performance frequency synthesizers for test applications, Anritsu has generally designed its microwave signal generators around yttrium-indium-garnet (YIG) oscillators. Based on the resonant properties of a small YIG sphere within an electromagnetic (EM) field, with resonances altered by means of current applied to the coils that form the EM field around the YIG sphere, YIG oscillators are renowned for their wide frequency coverage, excellent tuning linearity, and low phase noise. However, they are limited in tuning speed, typically to the millisecond range.

1. Model MG37020A is a frequency synthesizer that can tune to 20 GHz with frequency switching speed of 100 µs/point.

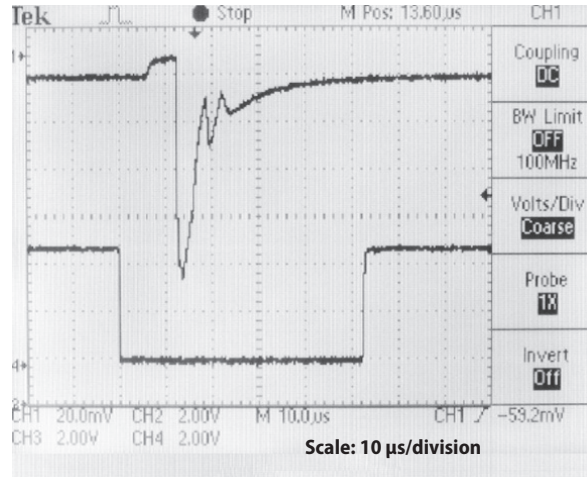
To achieve faster frequency tuning speed in the MG37020A frequency synthesizer ***(Fig. 1)***, the firm's engineers created a frequency synthesis architecture based on a low-noise voltage-controlled oscillator (VCO) rather than a YIG oscillator as the signal generator's internal microwave frequency source. The result is a test signal source that is approximately

an order of magnitude faster than a conventional YIG-based microwave signal generator, while maintaining the superb phase-noise performance associated with YIG sources.

The MG37020A fast-switching microwave signal generator is available in several versions and with a handful of options that enhance output power, frequency range, and synchronization when using multiple signal generators in an application. The standard MS37020A covers a frequency range of 2 to 20 GHz. Option 4 includes digital downconversion (DDC) circuitry that synthesizes added bandwidth from 10 MHz to 2.2 GHz for total frequency coverage of 10 MHz to 20 GHz. The use of the DDC circuitry is particularly effective of shaving the phase noise in this lower band of coverage. The typical phase noise through 2.2 GHz is -70 dBc/Hz offset 10 Hz from the carrier, -105 dBc/Hz offset 1 kHz from the carrier, and -114 dBc/Hz offset 1 MHz from the carrier. At higher microwave frequencies, the phase noise is still more than respectable, at typically -55 dBc/Hz offset 10 Hz from a 10-GHz carrier, -102 dBc/Hz offset 1 kHz from the same carrier, and -115 dBc/Hz offset 1 MHz from the same carrier ***(see table)***. Harmonic-related output content is no worse than -40 dBc below 2 GHz and better than -50 dBc from 2 to 20 GHz. Subharmonic content is no worse than -30 dBc, while nonharmonic spurious content is better than -40 dBc.

The MG37020A signal generator derives its accuracy from an internal 10-MHz frequency reference source with better than 2 x 10-9/day aging rate and better than 2 x 10-8/°C frequency stability with temperature from 0 to +50°C. When even better stability is required, the MG37020A can work with an external 10-MHz reference source at 0 to +20 dBm.

The MS37020A tunes to different frequencies with resolution as fine as 0.001 Hz. It can tune to a new frequency in less than 100 µs, unless the new frequency switches frequency bands within the synthesizer's total coverage (with a switch in filters) and then requires 500 µs or less frequency switching speed. The frequency synthesizer offers a variety of different sweep modes for changing frequencies, including selecting a manual sweep between two limits with a user-defined number of steps or step size as well as a list sweep mode that allows switching among as many as 10,000 different frequency steps. The dwell times between frequency steps can be adjusted from 50 µs to 30 s. The synthesizer provides numerous markers that can be set with the instrument's basic 0.001-Hz frequency resolution.



2. These oscilloscope traces show a MG37020A frequency step of 100 MHz occurring in less than 55 µs. The top trace shows a 10-GHz output signal and the bottom trace is the lock indicator signal.

The fast switching speed applies not only to frequency but to output power levels as well. The standard MG37020A provides maximum output power of +18 dBm through 10 GHz and as much as +15 dBm through 20 GHz. An MG37020A with the high-power option (Option 15) delivers output-power levels as high as +23 dBm through 20 GHz. An optional step attenuator provides amplitude control over these output levels over a total range of 130 dB, for adjusting levels as far down as -115 dBm through 20 GHz in standard models and -107 dBm through 20 GHz in models with Option 15. Power-level switching speed ranges from less than 100 µs for level changes that don't involve a step attenuator to typically 20 ms or less for level changes that involve a step attenuator. Output levels for the MG37020A can be set with 0.01-dB resolution.

***The fast** switching speed of the M37020A applies not only to frequency but to output power levels as well.*

WINDOWS XP PRO CONTROL

The MG37020A synthesized signal generator is built into a compact, rack-mountable enclosure that makes efficient use of available ATE rack space. It incorporates a personal-computer (PC) type control architecture with familiar Windows(R) XP Professional operating system for use of programming. For local control, the MG37020A features a color touch-screen display with ports for a computer mouse and keyboard. For ease of use, the MG37020A supports the connection of an external display monitor and other Windows XP compliant peripheral devices. For security, the MG37020A also features a removable hard drive to protect sensitive data and instrument settings.

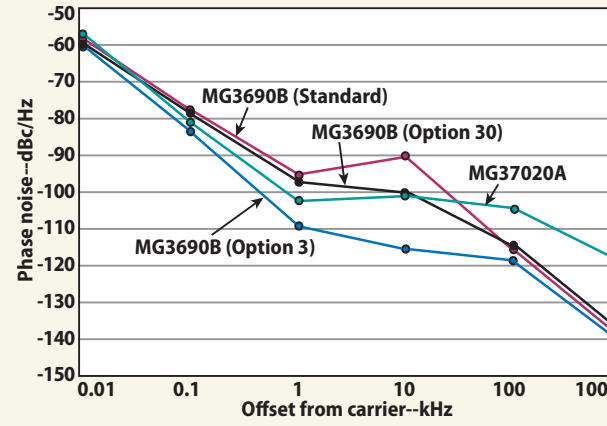
The easy-to-follow user interface has an intuitive menu flow, familiar icons, and on-screen function keys. For remote operation, the MG37020A boasts a variety of connectivity choices, with Universal Serial Bus (USB) 2.0 Device and Host capability, Ethernet local-area-network (LAN) connectivity, IEEE-488 General Purpose Interface Bus (GPIB), and RS-232 serial input/output (I/O) connectivity all standard.

PROLIFIC PULSE MODULATION

In addition to its frequency-extension and higher-power options, the MG37020A fast-switching frequency synthesizer also offers an option for those in need of comprehensive pulse-modulation capabilities. With the option, the MG37020A can be equipped with an internal pulse generator for producing single, double, triple, and quadruple pulses. The pulse generator features swept delay capability for performing moving-target-indication (MTI) signal simulations. The option includes pulse burst capability designed to address dynamic frequency selection (DFS) test applications without the need of an additional pulse generator. Such testing is critical when evaluating interference scenarios for civilian and military radar systems at Industrial-Scientific-Medical (ISM) band frequencies. The internal pulse generator in the MG37020A can produce leveled pulses with widths as narrow as 100 ns and unleveled pulses with widths as narrow as 10 ns. It can orchestrate pulse repetition frequencies (PRFs) from 100 Hz to 5 MHz. The modulation on/off ratio is typically greater than 80 dB.

Also, the MG37020A can be specified with an Ultra-Stable Phase Track option. It allows as many as four MG37020A frequency synthesizers to be interconnected and synchronized for applications requiring multiple test signals that accurately phase track each other, such as in radar system and EW system simulators. The multiple synthesizers synchronize to the low-noise internal 100-MHz frequency reference of one source (a master) to control the phase drift of the interconnected signal sources. The option results in minimizing phase wander to typically less than ±1 deg. in 100 s.

For many bench top measurement applications, a slower-tuning, YIG-based frequency synthesizer may do just fine. But for repetitive, high-throughput measurements, such as on military phased-array modules, for radar-cross-section (RCS) testing, for antenna testing, and for production testing of commercial radio-frequency integrated circuits (RFICs), assuming the analysis equipment can switch quickly, a fast-tuning frequency synthesizer can dramatically increase the test yield of an ATE system. The MG37020A allows test operators to boost their system throughput as well as make measurements at smaller step sizes and across a greater number of frequency points in the same test time as a conventional YIG-based frequency synthesizer. P&A: 12 wks. **Anritsu Co., 490 Jarvis Dr., Morgan Hill, CA 95037-2809; (408) 778-2000, FAX: (408) 776-1744, Internet: www.us.anritsu.com.**



3. The phase-noise performance of the MG37020A synthesizer compares favorable with other high-performance frequency synthesizers, including Anritsu's own MG3690B synthesizers with coaxial models covering 0.1 Hz to 70 GHz.

The MG37020A At A Glance

Frequency range Standard With Option 4	 2 to 20 GHz 10 MHz to 20 GHz
Frequency resolution	0.001 Hz
Sweep widths	0.001 Hz to full range
Number of sweep steps	1 to 10,000
Frequency switching speed	<100 µs/point <500 µs/point when crossing a filter band-switch point 50 µs to 30 s
Dwell time per step	50 µs to 30 s
Maximum output power	+18 dBm at 10 GHz, +15 dBm at 20 GHz
Output power range	-115 to +15 dBm at 20 GHz
Output power resolution	0.01 dB
Output power accuracy	±1.0 dB
Power level switching time	<100 µs without attenuator <20 ms with step attenuator
Harmonics 10 to 100 MHz 0.1 to 20.0 GHz	 < -40 dBc < -50 dBc
Spurious	< -40 dBc
Phase noise (at 10 GHz, typ.) Offset 10 Hz Offset 1 kHz Offset 10 kHz Offset 1 MHz	 -50 dBc/Hz -95 dBc/Hz -98 dBc/Hz -114 dBc/Hz

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