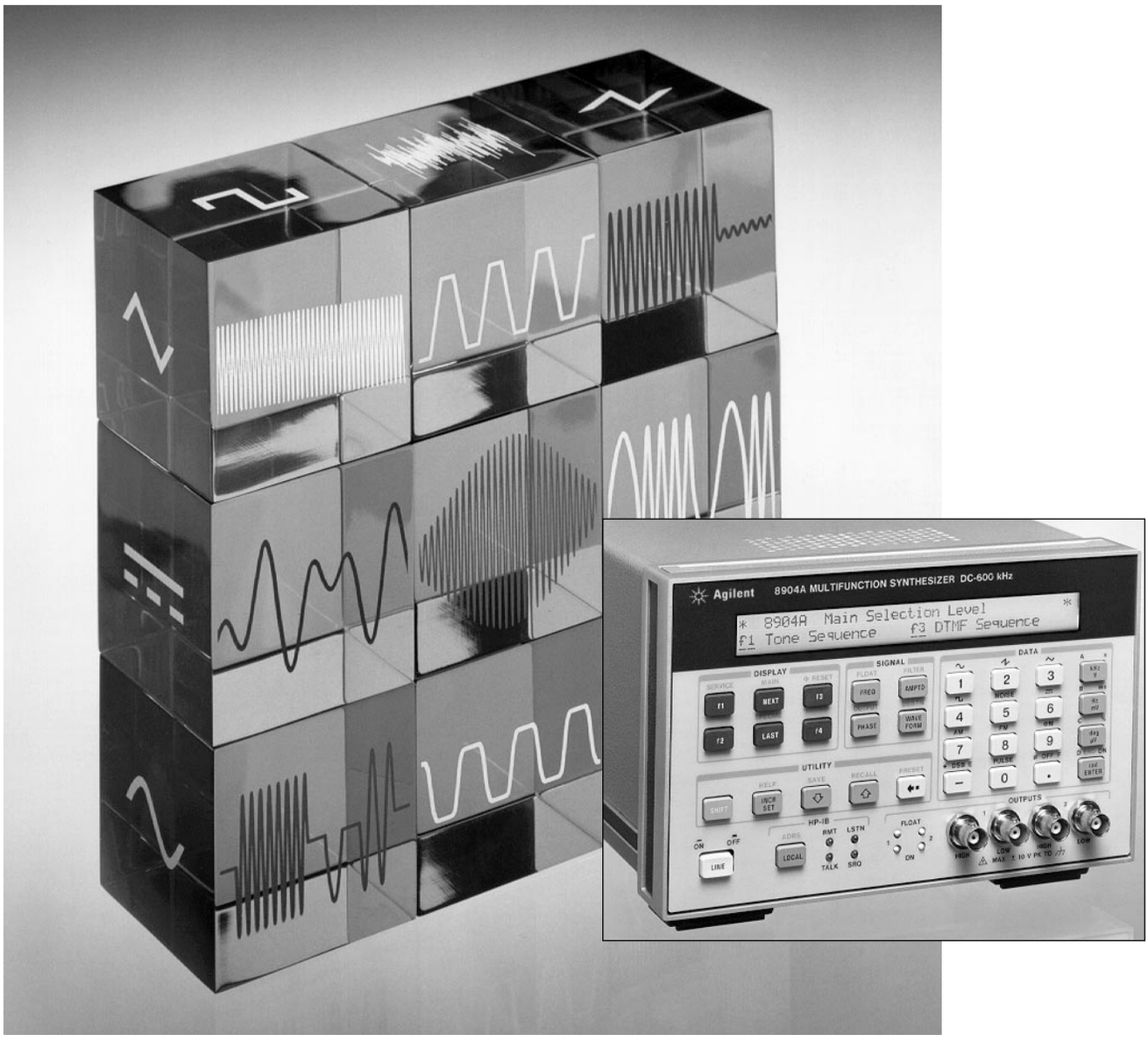
Agilent 8904A

Multifunction Synthesizer
dc to 600 kHz



Build complex waveforms from common signals

Agilent Technologies
Innovating the HP Way

The Agilent 8904A Multifunction Synthesizer . . .

The Agilent Technologies 8904A Multifunction Synthesizer uses the latest VLSIC technology to create complex signals from six fundamental waveforms. The standard 8904A digitally synthesizes precise sine, square, triangle, ramp, white noise, and dc waveforms and routes these signals to a single output. Option 001 adds three more identical internal synthesizers (channels) which can either modulate the first synthesizer or be summed to the output. Frequency, amplitude, waveform, phase, and destination can be independently set for each synthesizer. Available modulation types for channel A include AM, FM, F M, DSBSC, and pulse modulation. Option 002 adds a second 50 Ω output, providing a second separate signal for two channel applications. Option 003 adds fast hop and digital modulation capability to the 8904A. Option 005 allows multiple 8904As to be phase synchronized for applications which require the use of more than one 8904A. Option 006 changes output 1 of the 8904A from a 50 Ω floating output to a 600 Ω, high-power balanced output. With this option, the 8904A can deliver 10 volts rms into a 600 Ω load from 30 Hz to over 100 kHz. All this unique capability makes the 8904A a powerful tool for demanding applications like VOR, ILS, FM Stereo, and communications signaling.

. . . Begins with . . .

Function synthesizer

The Agilent 8904A Multifunction Synthesizer delivers synthesizer accuracy, along with six waveforms in a compact, economical package. Broad sinewave frequency coverage from 0.1 Hz to 600 kHz with 0.1 Hz resolution make the 8904A ideal for a number of low-frequency applications. In addition to sinewave generation, the 8904A has five other standard functions: square, triangle, ramp, dc, and Gaussian white noise. Of these five, square, ramp, and triangle functions are available from 0.1 Hz to 50 kHz. All waveform values in the 8904A are DIGITALLY calculated in real time by Agilent's Digital Waveform Synthesis IC. The use of this chip results in signals with very well-defined accuracy and exact repeatability. This means unprecedented performance at an unexpectedly low price. Compared with analog technologies, drift is eliminated, accuracy is improved, and the number of required adjustments is greatly reduced.

Modulation source

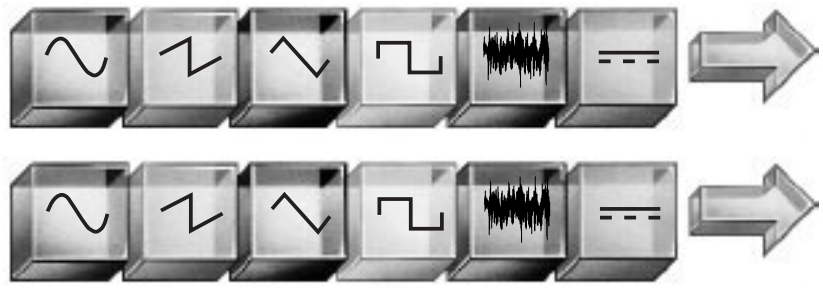
For demanding modulation requirements, where internal modulation sources of signal generators don't measure up, use the Agilent 8904A Multifunction Synthesizer. With its digitally synthesized accuracy and resolution, the 8904A is an ideal, yet low cost, external modulation source for signal generators. Besides common sinewave modulation, the functions of the 8904A can be used to create more complex modulating signals. For example, use the 8904A to externally modulate a signal generator with the noise function while at the same time using internal modulation. Using this technique accurate degradation of the modulation signal-to-noise ratio can be achieved. To accommodate applications requiring remote operation for system use, the 8904A comes with GPIB as a standard feature.

. . . And . . .

Stimulus for audio circuits

The 8904A has many characteristics and features which make it well suited as a stimulus for audio circuits. The output of the 8904A is characterized by low spurious and harmonic content. Total harmonic distortion plus noise (including all spurs) can be as low as –78 dBc. With low distortion, the 8904A can be used to test many high performance audio devices. Another unique characteristic of the 8904A is its exceptional level flatness. From 0.1 Hz to 100 kHz, the 8904A offers ±0.009 dB level flatness relative to 1 kHz. This state-of-the-art performance is a real plus for high performance audio test applications. Ground loops can be one of the most difficult problems to correct in audio tests. The 8904A is equipped with an electronically floating, 50 Ω output amplifier which makes overcoming ground loops easy.

Then add another . . .



Two outputs

Option 002 adds a second, identical synthesizer and floating output section to make the 8904A TWO synthesizers in one half-rack width instrument. Frequency, amplitude, waveform, and phase can be independently set for each of the two synthesizers. The flexibility provided by two sources is needed in a variety of applications. When simultaneous external modulation of a signal generator is required, the 8904A Option 002 provides an accurate, low-cost method of generating two independent modulating signals. Many two-input applications, such as differential amplifier testing, can benefit from the ability of the 8904A Option 002 to generate two independent test signals at the same time. Modern ATE systems designed to test complex systems or products require a number of sources to fully stimulate the device being tested. In these cases one or more 8904A Option 002 Multifunction Synthesizers can be used to provide multiple test signals. Two instruments provide four synthesizers and occupy only one 5.25-inch full rack space.

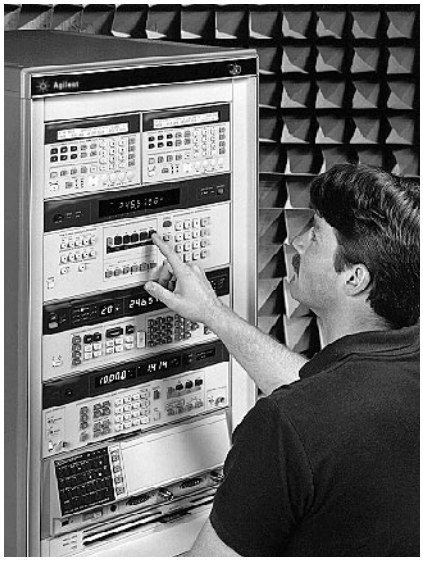
Phase offset

Although both synthesizers are independent, the relative phase between the two outputs can be precisely controlled. Either synthesizer can be varied in phase from 0 degrees to 359.9 degrees with a resolution of 0.1 degree. Direct digital synthesis ensures accurate, repeatable phase differentials. Phase accuracy between outputs is specified to be better than ±0.1 degree or 30 ns (whichever is greater) up to 100 kHz. Testing phase detectors, servo systems, shaft encoders, sonar, and other phase-sensitive two-port devices is easy and accurate with the 8904A Option 002. One unique application of the 8904A's phase capabilities is in driving balanced loads or lines. By operating the two synthesizers 180 degrees out of phase, the 8904A can function as a balanced source with much higher voltage output capability. In this configuration, the 8904A can deliver +23.8 dBm (12 volts rms) into a balanced 600 Ω load with a 100 Ω effective source impedance.

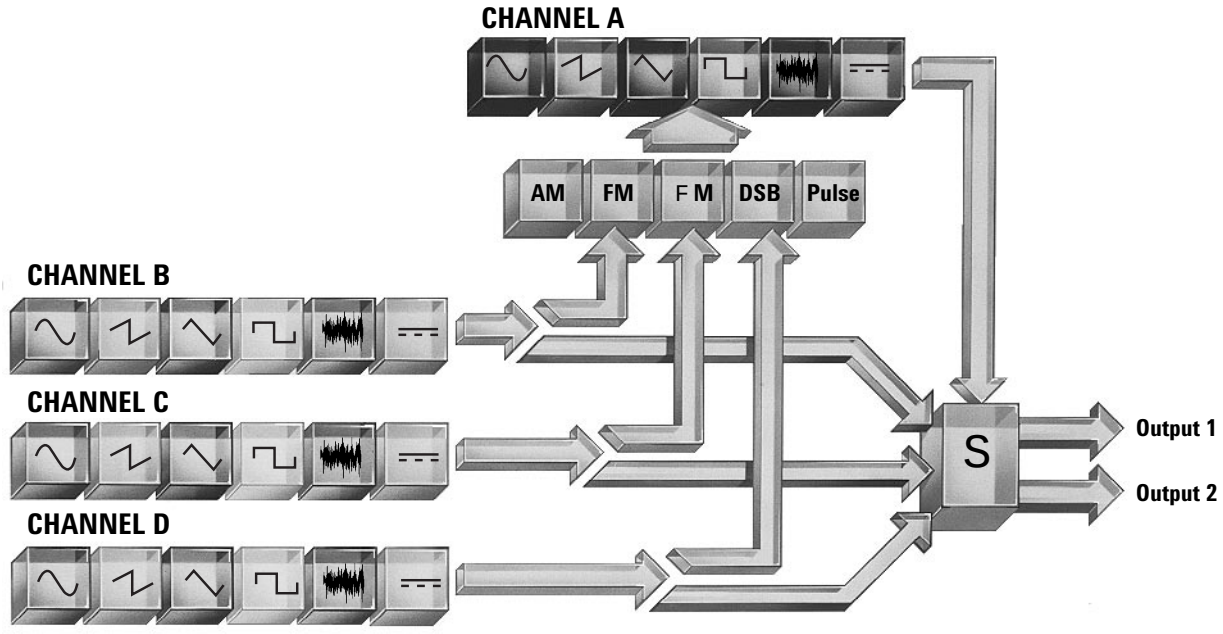
Then add two more . . . and sum . . . and modulate . . .

Complex signal generation

By adding three more internal synthesizers (two with Option 002) which can modulate or be summed with synthesizer A (channel A), Option 001 is the key to complex signal generation for the Agilent 8904A Multifunction Synthesizer. All four internal synthesizers can be set to generate different waveforms, frequencies, amplitudes, and phases at the same time. These signals can then be DIGITALLY summed before routing to the output. If Option 002 is present, channels may be routed to either of the two outputs. In addition to summing, Option 001 allows channels B, C, and D to be used as modulation sources for channel A. The allowable modulation types for channel A are: AM, FM, ƒM, DSBSC (Double Sideband Suppressed Carrier), and pulse modulation. Channels B, C, and D can be used to generate up to three independent forms of modulation at the same time, or can be summed prior to channel A modulation. Using summation and modulation, the 8904A Option 001 can generate many complex waveforms.



With Option 002, two units provide four independent outputs in one full width rack space.



Option 001 adds three internal synthesizers (two in conjunction with Option 002) which can modulate or be summed with channel A.

. . . And you get complex signal generation . . .

VOR/ILS

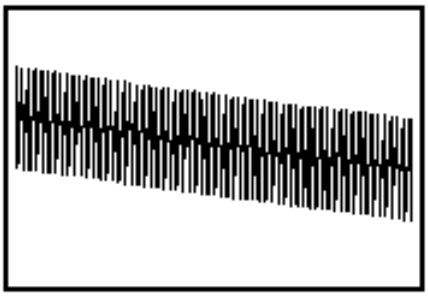
VOR (VHF Omni Range) signals are used by modern aircraft for navigation. To create accurate VOR composite signals, a generator must have precise frequency modulation and extremely accurate phase settability. Agilent 8904A Option 001 meets these needs easily with mathematically calculated frequency modulation and the repeatability of digital phase offset control. For VOR, channel B is used to frequency modulate channel A, while channel C is summed with the modulated channel A. The bearing angle can then be changed by altering the relative phase of channel C. The minimum bearing angle resolution is 0.1 degree. Since the entire VOR composite waveform is "calculated" in real time by the Digital Waveform Synthesis IC, the 8904A Option 001 can deliver typical bearing accuracy on the order of ±0.05 degrees. This state-of-the-art performance is repeatable and drift free unlike older technology analog VOR generators. ILS (Instrument Landing System) composite signals can also be generated with digital accuracy with the 8904A Option 001.

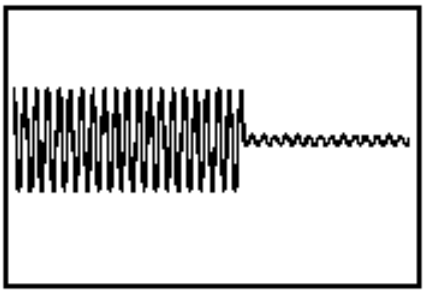
Audio testing

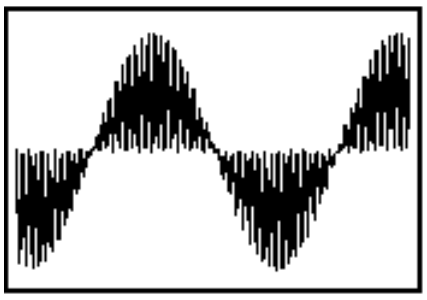
With Option 001, the 8904A can generate many different types of test signals used in audio applications. By summing or modulating with the four internal channels, the 8904A can generate intermodulation test signals which conform to international standards. CCIF twin-tone, DIN, and SMPTE intermodulation test signals can be created with the 8904A. Typical residual intermodulation distortion is less than –70 dB. With independent control of all four internal synthesizers, almost any type of IM test signal can be generated. Another complex signal often used to test amplifier power reserves is the IHF Dynamic Headroom test signal. The 8904A can generate this signal with synthesizer precision, low distortion, and exact timing. In fact, any sinewave burst signal can be created which will be glitch free with phase continuous transitions within the frequency resolution of the 8904A (0.1 Hz). Another useful signal is a phase-continuous linear sweep. By using a ramp waveform to frequency modulate channel A, a linear phase continuous sweep can be created. Sweep time can be varied from 10 seconds (ramp at 0.1 Hz) to 20 microseconds (ramp at 50 kHz). Special functions can be set which will reverse the modulating ramp waveform to produce sweeps which change the sweep direction.

FM stereo mode

In conjunction with an RF signal generator, the 8904A Option 001 can generate the signals required to test commercial FM broadcast stereo receivers. The FM stereo mode included with Option 001 transforms the 8904A into a dedicated FM stereo encoder. Single keystrokes control the audio test tone frequency, composite signal level, test signal mode, pilot on/off, and pilot level in terms of % of composite level. Test signal modes include Left=Right, Left=– Right, Left Only, and Right Only. The pilot tone amplitude, frequency and phase, as well as subcarrier frequency are fully adjustable. Audio test tone frequency can be set from 20 Hz to 15 kHz in 0.1 Hz increments. Three pre-emphasis curves ensure compliance with all international standards: 25 µsec, 50 µsec, and 75 µsec. Digital synthesis combined with superb analog performance yields typical stereo separation of greater than 65 dB over the full 20 Hz to 15 kHz audio bandwidth. The digital nature of the stereo test signals generated by the 8904A eliminates such signal by-products as subcarrier leakage and pilot tone/subcarrier phase error found in analog stereo encoders.



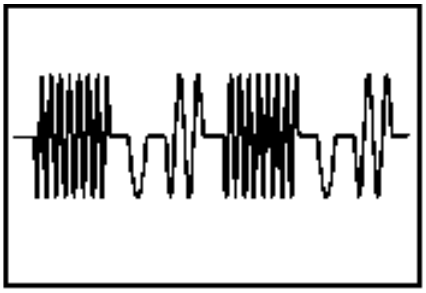




Communication signaling

In addition to the extra channels, Option 001 also adds four sequence modes to the 8904A: tone sequence mode, DTMF sequence mode, digital sequence mode, and Hop Ram sequence mode. These modes make the 8904A a powerful tool for generating sequences used in communications signaling. Tone sequence mode allows entry of 16 unique sine wave tones, each with an "on-time" and "off-time." From these 16 tones, sequences can be built up to a length of 750 tones. The minimum on and off time duration is 800 µs with 10 µs resolution, while the maximum value is 655.35 ms. Timing accuracy is better than ±20 µs. When no off-time is specified, tone sequence mode will switch to the next tone frequency in a phase continuous manner **without** discontinuities.

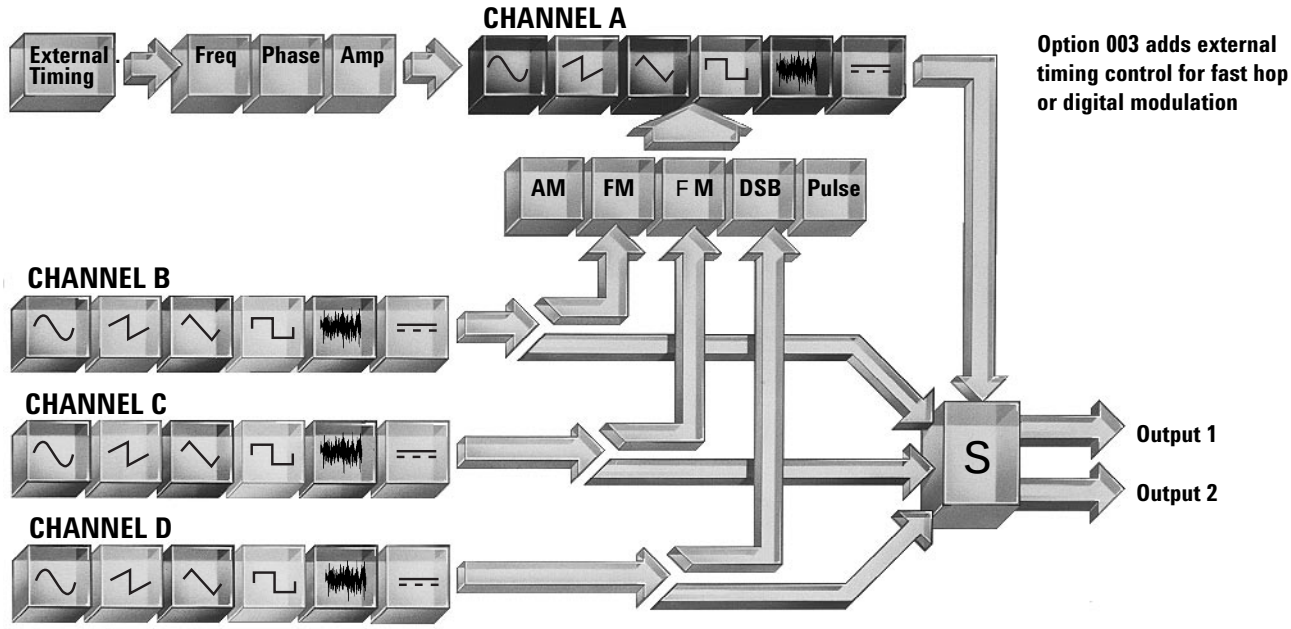
DTMF (Dual Tone Multi Frequency) mode allows generation of sequences up to 750 telephone type signals in length. In DTMF mode, the 8904A can generate the 16 standard frequency pairs as defined by Bell Telephone (Bell technical reference publication No. 48005). Minimum timing periods for DTMF are 1 ms, with 10 µs resolution.

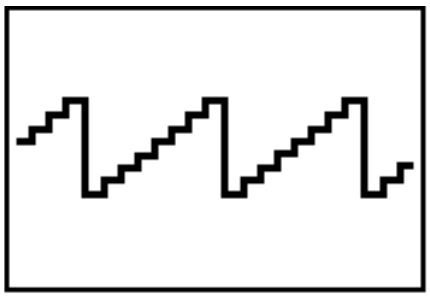


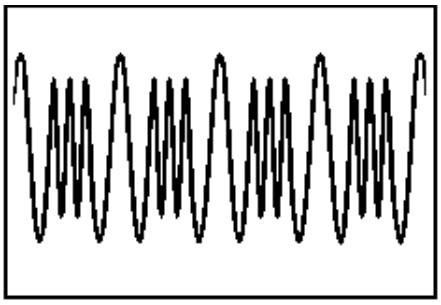
Digital sequence mode can generate digital bit streams up to 3,000 bits in length. Minimum period in the digital mode is 100 µs with 10 µs resolution. On and off "levels" in the digital mode can be set to any value for simulating different logic families and asserted "high" or asserted "low" logic conventions. For ease of entry, data may be entered in binary, octal, or hexadecimal formats. All three modes contain extensive sequence-editing features, and three control modes: single sequence, continuously repeat sequence, and manual step-through sequence.

Hop Ram sequence mode offers a mix of the capabilities of the tone and digital sequence modes. This mode allows entry of 16 signal states, each with an associated amplitude, frequency, and phase value. Sequences of up to 750 tones can be built if all 16 states are used, or up to 3,000 tones if only two of the states are used. A unique burst function allows the pattern to be repeated a specified number of times from 1 to 127. Unlike the other sequence modes, Hop Ram sequence mode allows you to use any of the six standard waveforms available in the 8904A: sine, square, ramp, triangle, dc or white Gaussian noise. Instead of selecting the timing in terms of milliseconds, Hop Ram sequence mode sets timing in terms of frequency. This allows the generation of patterns which have precise baud rates such as 1200, 2400, 4800, or 9600.

Add external timing control to get . . .







. . . Fast hop

Option 003 adds the ability to hop the 8904A in frequency, phase, and/or amplitude. Up to 16 frequency/phase/amplitude states can be entered into the "Hop Ram" memory. To hop, an external device must address the four-bit TTL-level address bus provided on the digital port connector on the rear panel. As the address supplied to the bus is varied, the 8904A will hop to the frequency/phase/amplitude state that corresponds to that address of the Hop Ram memory. Fast hop can only be performed on channel A. Phase continuous frequency switching can be done in as little as 8 µs. Since the signals are digitally created, there is no settling time like traditional PLL synthesizers. Only the cycle time of the Digital Waveform Synthesis IC determines the switching speed. Control functions allow you to enable or disable any one of the three hop parameters. For example, phase and amplitude hop can be disabled to produce only frequency hopping without having to remove the phase and amplitude hop data from the Hop Ram. If Option 001 and 003 are installed, the other three channels can be used while hopping. Channel B, for example, could be set to phase modulate channel A with noise while channel A is hopping. This setup allows controlled amounts of "phase noise" to be added to the hopping signal.

. . . Digital modulation

One application for Option 003 is the creation of digital modulation formats. By hopping frequency, FSK and other frequency switching type modulation formats with up to 16 frequencies can be generated. BPSK, QPSK, and other phase shifting formats can be made by hopping just phase. With a combination of amplitude and phase hopping, the 8904A Option 003 can generate QAM signals with up to 16 phase amplitude states. The digital data must be supplied to the digital control port in a four-bit wide parallel word to control the timing.

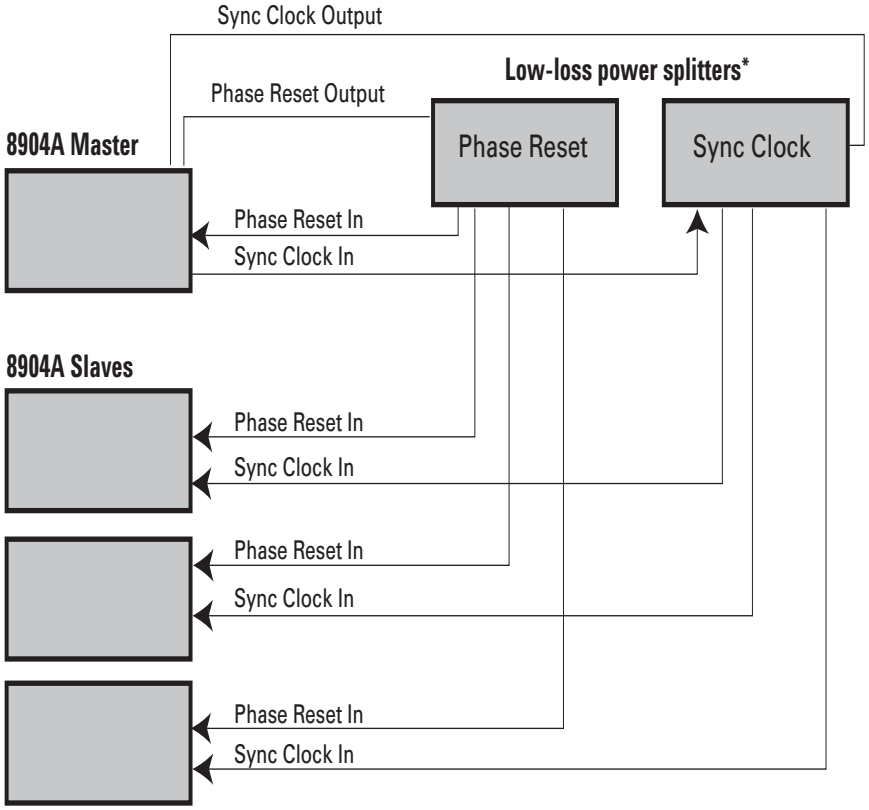
Phase synchronization or add 600 Ω output

. . . Phase synchronization

With Option 005, multiple 8904As can be phase synchronized to provide more than two channels of phase related outputs. In the synchronous mode, one unit is specified to be the "master" and all others are designated "slaves." Two signals from the master unit (sync clock and phase reset) are routed to external power splitters which divide the signals to the slave units. When a phase reset command is issued from the master, via the front panel or GPIB, all units reset to their specified phase relationships. In this mode all connected units are phase locked and will not drift relative to each other. Whenever the frequency, destination, or angle modulation amplitude are changed on any of the units, a phase reset must be issued on the master unit to restore proper phase. In the synchronous mode, the phase accuracy from unit to unit is specified as an additional 30 ns error for frequencies from 0.1 Hz to 100 kHz. This yields a total specification of the larger of ±0.1 degree or 60 nsec for the same frequency range. Using low-loss power splitters, up to eight units can be synchronized for a total of 16 phase related outputs if the units have Option 002. If more signals are desired, amplifiers can be inserted before the power splitters to increase the number of synchronized units. Because the extra cables required for synchronous operation use the mounting holes normally reserved for rear panel outputs, Option 004 (rear panel outputs) cannot be ordered with Option 005. Option 005 solves many tough testing problems by providing a high performance yet low cost solution to generating many phase related signals. For example, testing three phase power line devices requires the generation of three voltage and three current waveforms which are phase related. With Option 005, three 8904As with Option 002 and 005 can be used to generate the required signals. Acoustics and sonar work also require large numbers of phase related signals. With Option 005, the 8904A can be used to provide a cost effective solution for these demanding applications.

Or add 600 Ω balanced output

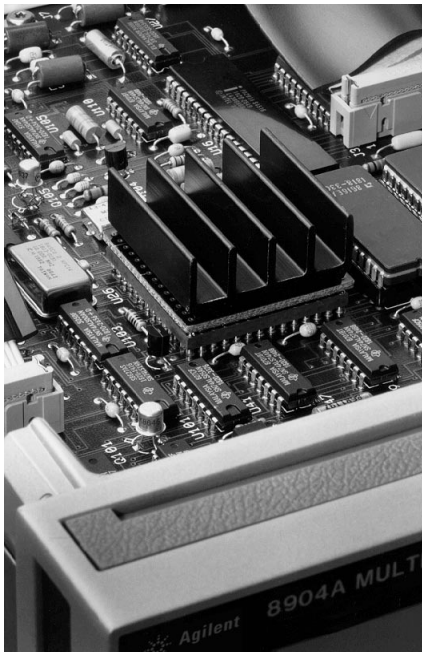
Option 006 replaces the standard 50 Ω electronic floating output (output one only) with a transformer coupled 600 Ω output, This balanced, fully floating output delivers higher power into 600 Ω loads than the standard 50 Ω output. The maximum signal level is a full 10 volts rms into a 600 Ω load (20 volts rms open circuit). The Option 006 output is specified for sinewaves only and covers the frequency range of 30 Hz to 100 kHz. Output frequencies above 100 kHz are available up to 200 kHz with a typical rolloff of –4 dB at 200 kHz. Option 006 is ideal for applications requiring true balanced operation or the higher signal levels commonly required in 600 Ω audio systems. Because of the band-limited nature of a transformer coupled output, Option 006 cannot pass dc or low frequency signals, and causes waveform distortion when passing square or ramp waveforms. The transformer adds little distortion above 300 Hz preserving the excellent spectral purity of the standard 8904A. The Option 006 output also has degraded phase linearity compared to the excellent phase linearity of the standard 50 Ω output. Option 004, rear panel outputs is not available when Option 006 is ordered.



Abbreviated specifications

Agilent digital technology: Unparalleled performance at an unprecedented price

The Agilent 8904A's Digital Waveform Synthesis IC uses Agilent's proprietary CMOS high-density VLSI process. With 100,000 transistors, this IC realizes four complete waveform synthesizers, plus a host of support functions, on a single chip. The Digital Waveform Synthesis IC allows the 8904A to generate complex waveforms with accuracy and repeatability not found in traditional analog function generators or multi-phase-lock-loop synthesizers. In addition, drift and power consumption are reduced while reliability is increased (over 400 MSI TTL chips would be required to emulate the function of the Digital Waveform Synthesis IC).



Frequency range
Sine wave: 0.1 Hz to 600 kHz
Square, triangle, ramp: 0.1 Hz to 50 kHz

AC amplitude
Range: 0 to 10V_{p-p} into a 50 Ω load
Accuracy (sine wave): 1%, 0.1 Hz to 100 kHz
Flatness (>630 mV_{p-p}, 1 kHz reference): ±0.009 dB, 0.1 Hz to 100 kHz

DC amplitude
Range: 0 to ±10V open circuit

THD+N (amplitude >50 mV rms, 80 kHz BW, sine wave)
– 66 dBc rms, 20 Hz to 20 kHz (30 kHz BW to 7.5 kHz)

Phase (sine wave)
Range: 0 degrees to 359.9 degrees

Gaussian noise
Spectral characteristic: Equal energy per unit bandwidth ("white")

Option 001 specifications

Modulation (with Option 001)

Modulation for channel A ONLY, and specified for sine wave carrier and modulation. External modulation is NOT possible.

Modulation types: AM, FM, ƒM, Pulse, and DSBSC

Summation (with Option 001)
Two, three, or four channels may be summed into a single output. Two or three channels may be summed for modulation of channel A.

Sequence
Sequence modes: Tone, DTMF, and Digital sequence modes
Sequence length: 250 tones for Tone and DTMF modes; 1,000 bits for Digital mode
Timing resolution: 10 µs

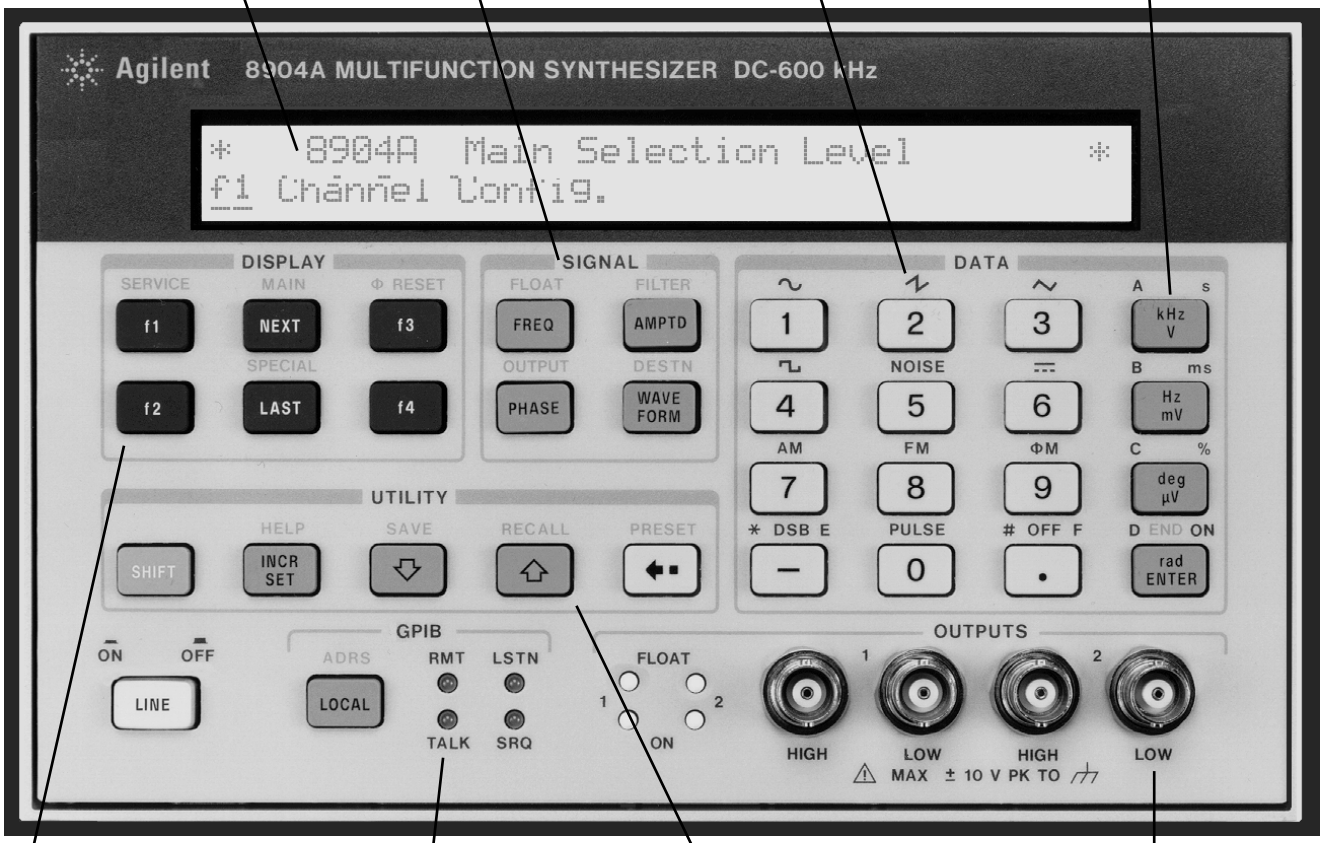
Front panel features

Backlit liquid crystal display presents all information in easy-to-understand alphanumeric screens. Tone, DTMF, Digital, and Hop Ram sequence modes available with Option 001 are ideal for generating signalling sequences used in communication systems.

All waveforms, phase offsets, frequencies, fine level settings, and modulation types are created by ***direct digital synthesis*** which yields outstanding accuracy and repeatability.

Six standard digitally created waveforms: sine, ramp, triangle, square, white Gaussian noise, and dc. Calibration quality AM, FM, ϕM, DSBSC, and Pulse Modulation on channel A.

Keypad for entering parameters and signalling sequences.



Softkeys provide simple control of operating modes and sequence functions. Step through all display screens with NEXT/LAST keys.

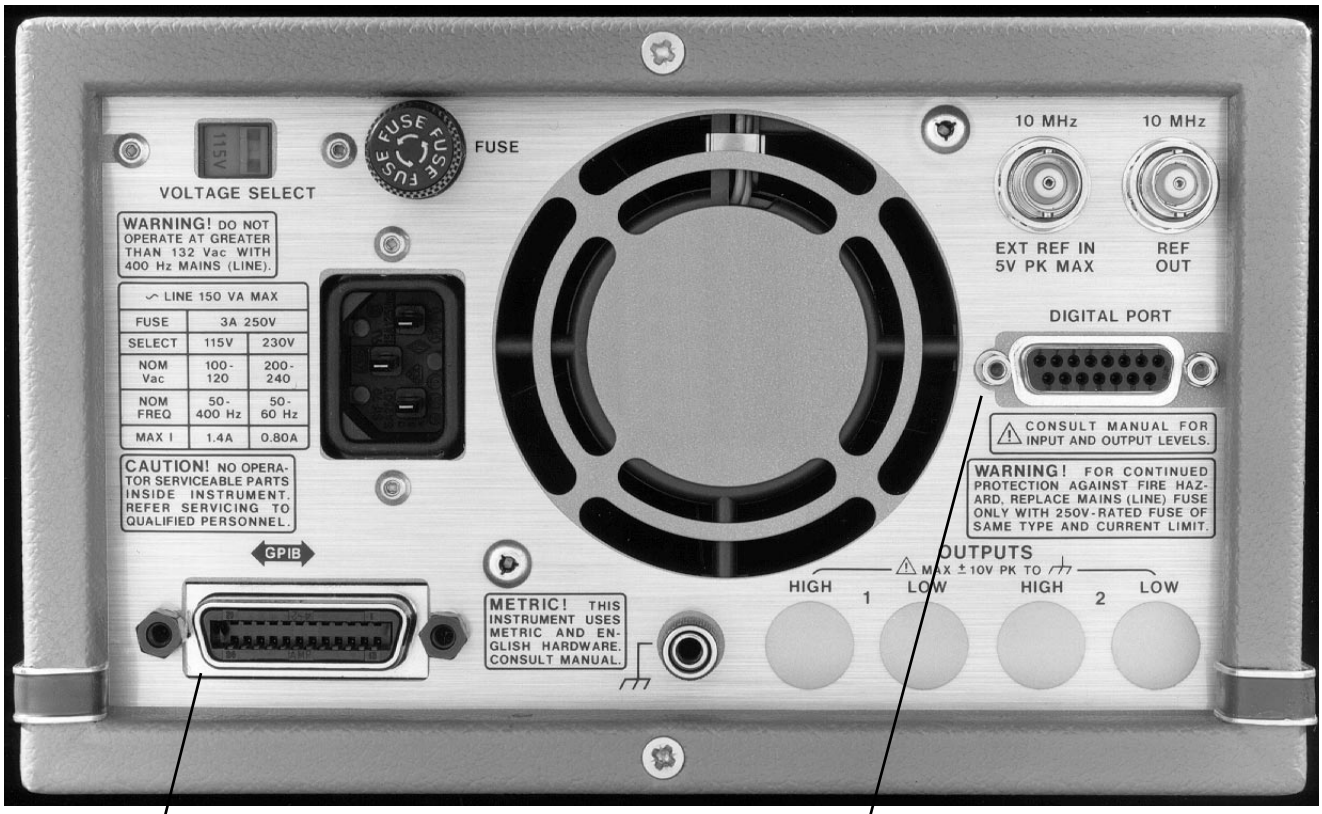
Full GPIB* control for ATE and automated production test.

Thirty-five storage registers save data for a given configuration, making repetitive tasks easy.

One electronic floating 50 Ω output is standard. Option 002 adds a second identical 50 Ω output; Option 006 converts output 1 into a high power 600 Ω balanced output (30 Hz to 100 kHz).

* GPIB: Not just IEEE-488, but the hardware, documentation and support that delivers the shortest path ot a measurement system.

Rear panel features



GPIB implementation includes powerful querry modes to determine instrument settings.

Digital port provides zero-crossing pulse and polarity squarewave outputs for all four internal channels.

With Option 001, a TTL-level line on the digital port can be sued to start Tone, DTMF, Digital, or Hop Ram sequences.

Option 003 adds the capability to fast hop frequency, phase, and amplitude by addressing the four-bit address bus on the digital port.

Agilent Technologies' Test and Measurement Support, Services, and Assistance
Agilent Technologies aims to maximize the value you receive, while minimizing your risk and problems. We strive to ensure that you get the test and measurement capabilities you paid for and obtain the support you need. Our extensive support resources and services can help you choose the right Agilent products for your applications and apply them successfully. Every instrument and system we sell has a global warranty. Support is available for at least five years beyond the production life of the product. Two concepts underlie Agilent's overall support policy: "Our Promise" and "Your Advantage."

Our Promise
"Our Promise" means your Agilent test and measurement equipment will meet its advertised performance and functionality. When you are choosing new equipment, we will help you with product information, including realistic performance specifications and practical recommendations from experienced test engineers. When you use Agilent equipment, we can verify that it works properly, help with product operation, and provide basic measurement assistance for the use of specified capabilities, at no extra cost upon request. Many self-help tools are available.

Your Advantage
"Your Advantage" means that Agilent offers a wide range of additional expert test and measurement services, which you can purchase according to your unique technical and business needs. Solve problems efficiently and gain a competitive edge by contracting with us for calibration, extra-cost upgrades, out-of-warranty repairs, and on-site education and training, as well as design, system integration, project management, and other professional services. Experienced Agilent engineers and technicians worldwide can help you maximize your productivity, optimize the return on investment of your Agilent instruments and systems, and obtain dependable measurement accuracy for the life of those products.

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