Model 395

100 MHz Synthesized Arbitrary Waveform Generator

- *A Universal Signal Source*
- *High-speed Performance at a Low Price*
- *100 MHz Sampling Clock Rate Arb*
- *12 Bit Vertical Resolution*
- *Pulse Train Generator*
- *Noise Generator*
- *Function Generator Including*
  - *Sine Waves to 40 MHz*
  - *Square Waves to 50 MHz*
  - *Triangle Waves to 10 MHz*
- *Internal/External AM and FM Modulation*
- *Sweep, Trigger, and Gate Operation*
- *Waveform Linking and Summing*

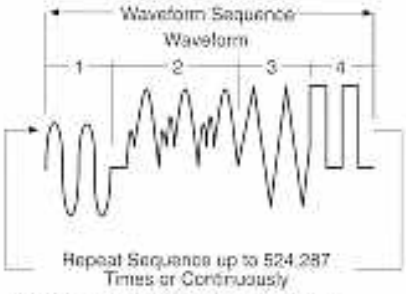
Wavetek's Model 395 arbitrary waveform generator (arb) is the first of a new generation of value priced *universal signal sources*. You can use it as an arb, pulse generator, function generator, noise generator, sweep generator, trigger generator, or modulation source. Whatever the mix of your applications, Model 395 is the best price/performance choice.

Current digital technology, coupled with Wavetek's innovative design, means that Model 395 can provide the functionality of seven instruments for the price of one. The 100 MHz Model 395 has the power and flexibility to provide the right signals for applications ranging from in-circuit testing of semiconductors to the complex pulse patterns required in communication testing. And no other waveform generator provides such an easy and low-cost solution to performance characterization testing of all kinds of electronic devices.

Arbitrary Waveform Generator

Model 395 takes its place in the impressive Wavetek family of synthesized arbitrary waveform generators as the worldwide price/performance leader among single-channel arbs. There simply isn't another 100 MHz arb on the market that can match its price, especially when you consider the supporting features. User-defined (arbitrary) waveforms can be generated at clock rates from 100 mHz to 100 MHz with 12 bits of vertical resolution and 64k (256k optional) points of horizontal memory. Direct digital synthesis (DDS) techniques are used to provide accuracies comparable to those available in expensive frequency synthesizers.

A waveform sequencing feature allows up to four waveforms to be linked in a sequence for creating long waveforms.

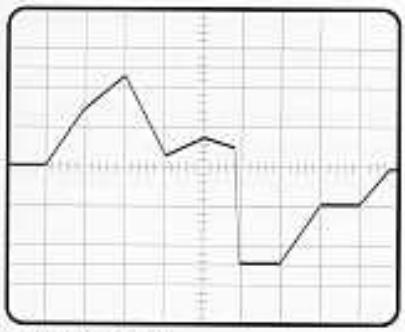


Up to 4 waveforms can be linked. Each waveform can have a repeat count of up to 65,535 or run continuously, conditional upon an external trigger event (repeat until event

Arbitrary waveforms can be created from the front panel or remotely downloaded via the RS-232 interface (an RS-232 cable is included with the 395) or optional GPIB. The GPIB option includes direct DSO waveform transfer, which allows you to upload waveforms directly into Model 395 that have been captured with any of 25 different digital storage oscilloscopes from a variety of vendors. Wavetek also offers WaveForm DSP, a software tool that makes waveform creation, modification, and downloading easy over either interface.

These are the kinds of high-performance specifications that make Model 395 the arb of choice for a variety of applications that require complex, nonstandard waveforms — from simulating power line disturbances such as drop out and spiked signals to providing complex signals for pressure sensors used in mechanical testing.

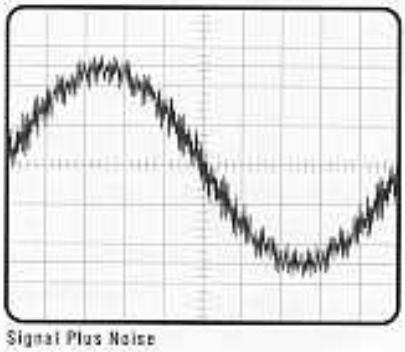
Function Generator. With the introduction of the versatile and low-cost Model 395, there's no longer any reason to buy an ordinary function-only generator. The 395 generates 16 standard waveforms: square, sine, positive and negative ramps, pulse, pulse train, five different noise functions, triangle, positive and negative haversines, (sin x)/x, and DC. And the performance specifications are first rate, providing square



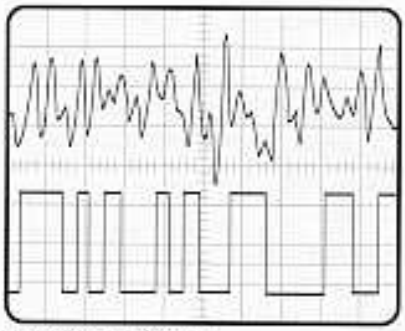
Mechanical Testing

waves to 50 MHz, sine waves to 40 MHz, and triangles to 10 MHz, with synthesized accuracy and outputs up to 10 Vp-p (into 50 Ω). Direct digital synthesis (DDS) enables 10-digit frequency resolution for sine waves to 20 MHz and for most other standard waveforms to 100 kHz. Waveforms can be output continuously or in triggered, gated, or swept modes for applications like simulating input signals to sensors. Other capabilities give you the flexibility of the very best function generators including frequency and amplitude modulation, and summing Model 395's waveform with an external signal.

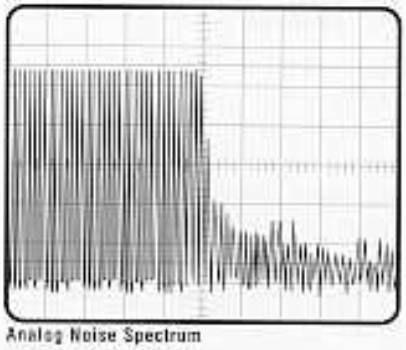
Noise Generator. The built-in noise generator is ideal for applications where precise noise is required, such as testing electronic engine module noise susceptibility in automobiles. Extensive noise generation capabilities are provided by 5 programmable noise functions: analog (white) noise, digital noise, comb function, signal-plus-noise, and signal-plus-comb.



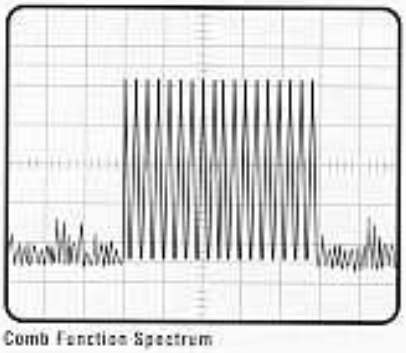
Signal Plus Noise



Analog and Digital Noise



Analog Noise Spectrum



Comb Function Spectrum

Other programmable features include sequence length for white and digital noise, bandwidths to 10 MHz for comb and white noise, bandwidths to 50 MHz for digital noise, and noise-to-signal ratios from 1% to 99%.

Pulse Generator. Model 395 has a built-in pulse generator that offers a greater degree of control over pulse shape and amplitude than many other pulse generators. Simple pulses up to 10 MHz can be generated. You can create complex pulse trains of up to 10 pulses with *individually programmable* rise time, fall time, width, level, and negative or positive (in respect to the sync pulse) delay. This versatility makes Model 395 suitable in pulse applications as diverse as measuring the baseband frequency response in a microwave system, measuring the real-time impedance of biological cells, and testing propagation delay in electronic circuits.

Trigger Generator. Model 395 makes a great trigger generator for devices under test, whether you are using standard functions or user-defined waveforms.

Triggered Pulse Train

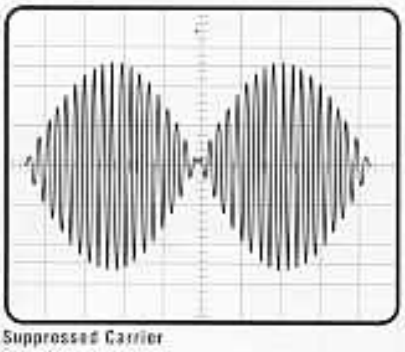
Burst count is programmable from 1 to 1,048,575 cycles. Gated mode provides continuous output of the waveform for the duration of the gating signal. Four different trigger sources are available for maximum versatility: internal trigger generator with programmable trigger period, external signal with programmable trigger level and slope, remote trigger command, and manual trigger key.

Sweep Generator. Use Model 395 as a sweep generator for performance characterization and frequency response testing, such as testing amplifier response or rapid cycling of a mechanical servo. Standard or arbitrary waveforms can be swept in one continuous range from 1 mHz to 20 MHz. Triggered and manual sweep operations also can be performed. Seven sweep modes, with

Model 395

linear and logarithmic sweep spacing, a TTL level sweep marker, and a ramp output give you the flexibility you need. There's even a pen lift function for use with chart recorders.

Modulation Source. If you do communication or audio design and test, Model 395 offers internally generated amplitude modulation and frequency modulation, as well as externally controlled amplitude modulation in two modes.



Suppressed Carrier

Convenience and Versatility. Wavetek designed Model 395 for user convenience. The user screens are tailored to the particular jobs you want to perform, such as setting up a pulse generator or a noise function.

From any screen, you can access help screens that guide you in using the instrument's extensive capabilities. And you can store at least 10 instrument set-ups so you don't have to spend valuable time duplicating past effort.

As part of its low cost of ownership, Model 395 is extremely reliable, having a mean time between failure of 10,000 hours. And with a simple calibration procedure that can be performed entirely from the front panel without removing the instrument cover, calibration takes less than 15 minutes.

Specification

Specifications apply within the specified environmental conditions after a 30 minute warm-up.

Amplitude

Range: 10 mVp-p to 10 Vp-p into 50 Ω.
Resolution: 3.0 digits.
Accuracy:
25 ± 10° C: ±(1% + 2 mVp-p).

Offset

Range: ±5 V into 50 Ω.
Resolution: 3 digits.
Accuracy:
25 ± 10° C: ±(1% + 20 mV).

Standard Waveforms

Sine, square, triangle, pulse, pulse trains, DC, positive/negative ramp, positive/negative haversine, (sin x)/x, and five noise functions.

Frequency (Sine and Haversine)

Range: 1 μHz to 40 MHz.
Resolution: (Resolution limited by 1 μHz.)
≤ 20 MHz: 10 digits; ±30 ppm.
> 20 MHz: 4 digits; ±100 ppm.

Frequency (Square)

Range: 1 mHz to 50 MHz.
Resolution: 4 digits; ±100 ppm.

Frequency (Triangle)

Range: 1 μHz to 10 MHz.
Resolution:
≤ 100 kHz: 10 digits; ±30 ppm.
> 100 kHz: 4 digits; ±100 ppm.

Frequency (Ramp)

Range: 1 μHz to 2 MHz.
Resolution:
≤ 100 kHz: 10 digits; ±30 ppm.
> 100 kHz: 4 digits; ±100 ppm.

Frequency (Sin (x)/x)

Range: 1 μHz to 1 MHz.
Resolution:
≤ 100 kHz: 10 digits; ±30 ppm.
> 100 kHz: 4 digits; ±100 ppm.

Waveform Quality

Square Transition Time: < 8 ns.
Square Aberrations: < (5% + 20 mV).
Sine Distortion:
< 100 kHz: 0.15% (-56 dBc)
< 5 MHz: No harmonic > -35 dBc.

Arbitrary Waveforms

Sampling Frequency

Range: 100 mHz to 100 MHz.
Resolution: 4 digits.
Accuracy: ±100 ppm.

Waveform Memory Size

64 k points; 256 k points optional.
Minimum Waveform Size: 10 points.
Vertical Resolution: 12 bits.
Output Filters (Selectable): 20 MHz Elliptic (8 pole), 40 MHz Elliptic (8 pole), 10 MHz Bessel (2 pole), no filter.
Waveform Sequencing: Up to 4 waveforms can be linked. Each waveform can have a repeat (loop) count of up to 65,535 or run continuously, conditional upon an external trigger event (repeat until event true). Additionally, a sequence of waveforms can be repeated up to 524,287 times or run continuously.

Pulse Waveforms

Up to 10 pulses may be independently programmed in a pulse pattern. Parameters that can be independently programmed for each pulse are rise time, fall time, width, delay, and amplitude.

For Periods ≤ 655 μs:

Range: 100 ns to 655 μs.
Resolution: 20 ns.
Accuracy: ±100 ppm.
Rise/Fall:
Fixed: 8 ns.
Variable: 50 ns to 500 μs.
Resolution: 8 ns.
Accuracy: ±0.1% ±5 ns
(< 8 ns for fixed rise/fall).
Delay:
Range: -600 to +600 μs.
Resolution: 10 ns.
Accuracy: ±0.1% ±5 ns.
Width:
Range: 10 ns to 655 μs.
Resolution: 10 ns.
Accuracy: ±0.1% ±5 ns.

For Periods > 655 μs:

Range: 655 μs to 10 s.
Resolution: 4 digits.
Accuracy: ±100 ppm.
Rise/Fall: 0.1% to 79% of period (or < 8 ns).
Delay: -99.9% to +99.9% of period.
Width: 0.002% to 99.9% of period.

Noise

White (Analog) Noise: Uniform frequency distribution with programmable noise bandwidth.
Noise BW Range: 10 mHz to 10 MHz.

Sequence Length:
Standard: $2^n - 1$, n = 6 - 16.
With Option 002: $2^n - 1$, n = 6 - 17.
Digital Noise: Digital noise provides a random 0,1 pattern with programmable sequence length.
Clock Range: 10 mHz to 100 MHz.
Sequence Length:
Standard: $2^n - 1$, n = 6 - 16.
With Option 002: $2^n - 1$, n = 6 - 17.
Comb: Uniformly distributed frequency spectra within a well-defined frequency band.
Start/Stop Range: 1 Hz to 10 MHz.
Number of Lobes: 3 to 256.
Signal-Plus-Noise, Signal-Plus-Comb: Adds analog noise or comb to any standard or arbitrary waveform with precise, controlled noise-to-signal ratio.
N/S Ratio: 1% to 99% Vp-p.
Resolution: 1%.

Operational Modes

Continuous: The selected waveform is output continuously at the programmed frequency.
Gated: The selected waveform is output continuously at the programmed frequency while the selected trigger signal is true.
Triggered: Upon transition of the selected trigger from false to true, the number of cycles specified by the count is output at the specified frequency. Burst count is programmable from 1 to 1,048,575. (One to 524,287 for waveform sequence operation.)
Sweep: Frequency sweep.

Triggering

Trigger Sources: 4 trigger sources: External TRIG IN BNC, internal trigger generator, front panel manual trigger key, and remote trigger command.
Trigger Level: The trigger level at the TRIG IN BNC is programmable.
Range: -10 V to +10 V.
Trigger Slope: Positive or negative.
Internal Trigger Source
Range: 200 ns to 1000 s.
Resolution: 100 ns limited by 6 digits.

Sync Output

Sync output can be selected from among the following 7 sources: waveform sync, trigger signal, burst done, loop done, sweep marker, position marker, pen lift.

Modulation

For both standard and arbitrary waveforms.

Internal Frequency Modulation

Carrier Signal
Source: Sine Wave
Center Frequency Range: 0.01 Hz to 40 MHz.
Deviation Frequency Range: 0.01 Hz to 40 MHz. Note: Center frequency plus deviation frequency must be ≤ 40 MHz.
Modulating Signal
Source: Any waveform except noise, AM, FM, or pulse.
Modulation Frequency Range: 0.01 Hz to 40 MHz.

Internal Amplitude Modulation

Modes
AM: 0 to 200% modulation
SCM: 200% modulation
Carrier Signal
Source: Sine wave
Carrier Frequency Range: 0.01 Hz to 40 MHz.
Modulating Signal
Source: Any waveform except noise, AM, FM, or pulse.
Modulation Frequency Range: 0.01 Hz to 40 MHz.

External Amplitude Modulation

Normal AM: 0 to 100% modulation.
Suppressed Carrier Modulation (SCM): ±100% modulation.

Signal Summing

External signals can be summed directly to the Model 395 output through the SUM IN BNC.

Sweep

Standard and arbitrary waveforms can be swept.
Sweep Start/Stop
Range: 1 mHz to 20 MHz.
Resolution: 4 digits limited by 1 mHz.
Sweep Time
Range: 30 ms to 1000 s.
Resolution: 1 ms.
Sweep Types: Sweep off, continuous, continuous w/ reverse, triggered, triggered w/ reverse, triggered w/ hold, triggered w/ hold and reverse, and manual.
Sweep Spacing: Linear and logarithmic.

Outputs

Reference Output (50 Ω): TTL level into open circuit; > 1.2 Vp-p.

Main Output (50 Ω): Output may be selected on or off.

AM Input (2.5 kΩ): ±2.5 V.
Sweep Output (1 kΩ): 0 to 10 V ramp proportional to completion of sweep.
Sync Output (50 Ω)
Low Level: < 0.4 V into 50 Ω.
High Level: > 2.0 V into 50 Ω.
Rise/Fall Time: < 7 ns.

Inputs

Trigger Input (2 kΩ)
Level: ±10 V (programmable).
Maximum Frequency: 10 MHz.
Sum Input (600 Ω)
Level: ±5 Vp-p max.
Bandwidth: > 30 MHz.
Protection: Over-voltage to ±10 V.
Reference Input (5 kΩ)
Level: 1 Vp-p minimum, 10 Vp-p maximum; 50 Vdc maximum.
Frequency: 10 MHz ±5%.

General

Remote Operation
RS-232 interface is standard. IEEE-488.2 (SCPI compatible) GPIB interface is optional.
Environment
Designed to MIL-T-28800C Class 5.
Temperature Range: Operates from 0° to +50° C; -20° to +70° C for storage.
Dimensions: 35.6 cm (14.00 in) wide, 13.3 cm (5.22 in) high, and 39.4 cm (15.5 in) deep.
Weight: Approximately 7.7 kg (17 lb) net; 10.0 kg (22 lb) shipping.
Power: 90 to 132, 188 to 252 volts rms; 48 to 440 Hz; 1 phase; < 80 VA.

Options

001: IEEE-488 Interface/Direct DSO Waveform Transfer
002: 256 k Extended Memory
004: Rack Mount Kit
Waveform DSP: Arbitrary Waveform Creation Software (DOS)

Factory/FOB

San Diego, California

For more information, contact your Aeroflex Wavetek representative (pp 97-99).