

## 290 Series Waveform Generators



1, 2, or 4 channel 100 MS/s waveform generators

- 100 MS/s 12-bit arbitrary waveform capability
- 1 M point waveform memory
- 40 MHz function generator capabilities using DDS (50 MHz for square waves)
- 10 ns pulse pattern generator
- Waveform sequencing with up to 1024 segments
- Unlimited waveform storage using CF® memory card
- Waveform Manager Plus for Windows software
- USB interface in addition to RS-232 and GPIB

These universal waveform generators combine many generators in one instrument. Their extensive signal simulation capabilities include arbitrary waveforms, function generator, pulse/pulse train generator, sweep generator, trigger generator, tone generator, and amplitude modulation source.

## 290 Series Waveform Generators

Arbitrary Waveforms	
<b>Waveforms</b>	The maximum arbitrary waveform size is 1 M points. Up to 500 user-defined waveforms may be stored on the removable memory card. Arbitrary waveforms can be defined by front panel editing controls, by downloading of waveform data via RS-232, USB or GPIB, or by writing directly to the removable memory card using the USB card reader/writer connected to a PC.
<b>Waveform memory</b>	1 M points. Minimum waveform size is 8 points.
<b>Vertical resolution</b>	12 bits
<b>Sample clock range</b>	100 mHz to 100 MHz
<b>Resolution</b>	4 digits
<b>Accuracy</b>	± 1 digit of setting
<b>Output filter</b>	Selectable between 40 MHz Elliptic, 20 MHz Bessel or none
<b>Sequence</b>	Up to 1024 waveforms may be linked. Each waveform can have a loop count of up to 32,768. A sequence of waveforms can be looped up to 1,048,575 times or run continuously.
<b>Noise function</b>	Digital noise generated by a 35-bit linear feedback register clocked at 100 MHz. User's external filter defines bandwidth and response

<b>Standard Waveforms</b>	
<b>Waveforms</b>	Sine, square, triangle, DC, positive ramp, negative ramp, sin(x)/x, pulse, pulse train, cosine, haversine and havercosine
<b>Sine, Cosine, Haversine, Havercosine</b>	
<b>Range</b>	0.1 mHz to 40 MHz
<b>Resolution</b>	0.1 mHz or 10 digits
<b>Accuracy</b>	Better than 10 ppm for 1 year
<b>Temperature stability</b>	Typically < 1 ppm/°C
<b>Output level</b>	5 mV to 20 V p-p from 50 Ω
<b>Harmonic distortion</b>	< 0.15 % THD to 100 kHz; < -60 dBc to 20 kHz, < -50 dBc to 1 MHz, < -40 dBc to 10 MHz, < -30 dBc to 40 MHz
<b>Non-harmonic spuri</b>	< -60 dBc to 1 MHz, < -60 dBc + 6 dB/octave 1 MHz to 40 MHz
<b>Square</b>	
<b>Range</b>	1 mHz to 50 MHz
<b>Resolution</b>	1 mHz (4 digits)
<b>Accuracy</b>	± 1 digit of setting
<b>Output level</b>	5 mV to 20 V p-p from 50 Ω
<b>Rise and fall times</b>	< 8 ns
<b>Triangle</b>	
<b>Range</b>	0.1 mHz to 500 kHz
<b>Resolution</b>	0.1 mHz or 10 digits
<b>Accuracy</b>	Better than 10 ppm for 1 year
<b>Output level</b>	5 mV to 20 V p-p from 50 Ω, linearity error: < 0.1 % to 30 kHz
<b>Ramps and Sin(x)/x</b>	
<b>Range</b>	0.1 mHz to 500 kHz
<b>Resolution</b>	0.1 mHz or 10 digits
<b>Accuracy</b>	Better than 10 ppm for 1 year
<b>Output level</b>	5 mV to 20 V p-p from 50 Ω
<b>Linearity error</b>	< 0.1 % to 30 kHz
<b>Pulse and Pulse Train</b>	
<b>Output level</b>	5 mV to 20 V p-p from 50 Ω
<b>Rise and fall times</b>	< 8 ns
<b>Period</b>	Range: 40 ns to 100 s; Resolution: 4-digits; Accuracy: ± 1 digit of setting
<b>Delay</b>	Range: -99.9 s to + 99.99 s; Resolution: 0.001 % of period or 10 ns
<b>Width</b>	Range: 10 ns to 99.99 s; Resolution: 0.001 % of period or 10 ns

Trains of up to 10 pulses may be specified, each having independently defined width, delay and level. The baseline voltage is separately defined and the sequence repetition rate is set by the pulse train period.

<b>Operating Modes</b>	
<b>Continuous</b>	Waveform runs continuously
<b>Triggered Burst</b>	<b>Each active edge of the trigger signal will produce one burst of the waveform</b>
<b>Carrier waveforms</b>	All standard and arbitrary
<b>Max. carrier frequency</b>	The smaller of 2.5 MHz or the maximum for the selected waveform. 100 Msamples/s for ARB or Sequence.
<b>Number of Cycles</b>	1 to 1048575
<b>Trigger rep. rate</b>	0.005 Hz to 100 kHz internal, dc to 1 MHz external
<b>Trigger source</b>	Internal from keyboard or trigger generator. External from TRIG IN or remote interface.
<b>Start/stop phase</b>	$\pm 360^\circ$ settable with $0.1^\circ$ resolution, subject to waveform frequency and type
<b>Gated</b>	<b>Waveform will run while the Gate signal is true and stop while false</b>
<b>Carrier waveforms</b>	All standard and arbitrary
<b>Max. carrier frequency</b>	The smaller of 2.5 MHz or the maximum for the selected waveform. 80 Msamples/s for ARB or Sequence.
<b>Trigger rate</b>	0.005 Hz to 100 kHz internal, dc to 1 MHz external
<b>Gate signal source</b>	Internal from keyboard or trigger generator. External from TRIG IN or remote interface.
<b>Start/stop phase</b>	$\pm 360^\circ$ settable with $0.1^\circ$ resolution, subject to waveform frequency and type
<b>Sweep</b>	<b>Capability provided for both standard and arbitrary waveforms. Arbitrary waveforms are expanded or condensed to exactly 4096 points and DDS techniques are used to perform the sweep.</b>
<b>Carrier waveforms</b>	All standard and arbitrary except pulse, pulse train and sequence. Sweep mode: Linear or logarithmic, continuous or triggered.
<b>Sweep direction</b>	Up, down, up/down or down/up
<b>Sweep range</b>	1 MHz to 40 MHz in one range. Phase continuous. Independent setting of start/stop frequency.
<b>Sweep time</b>	1 ms to 999 s (3 digit resolution)
<b>Marker</b>	Variable during sweep.
<b>Sweep trig. Source</b>	The sweep may be free run or triggered from the following sources: Manually from keyboard. Externally from TRIG IN input or remote interface.
<b>Sweep hold</b>	Sweep can be held and restarted by HOLD key
<b>Tone Switching</b>	<b>Capability provided for both standard and arbitrary waveforms. Arbitrary waveforms are expanded or condensed to exactly 4096 points and DDS techniques used to allow instantaneous frequency switching.</b>
<b>Carrier waveforms</b>	All waveforms bar pulse, pulse train, sequence
<b>Frequency list</b>	Up to 16 frequencies from 1 MHz to 40 MHz
<b>Trigger rep. rate</b>	0.005 Hz to 100 kHz internal, dc to 1 MHz external. Usable repetition rate and waveform frequency depend on the tone switching mode.

<b>Source</b>	Internal from keyboard or trigger generator. External from TRIG IN or remote interface.
<b>Tone switching modes</b>	
<b>Gated</b>	The tone is output while the trigger signal is true and stopped, at the end of the current waveform cycle, while the trigger signal is false. The next tone is output when the trigger signal is true again.
<b>Triggered</b>	The tone is output when the trigger signal goes true and the next tone is output, at the end of the current waveform cycle, when the trigger signal goes true again.
<b>FSK</b>	The tone is output when the trigger signal goes true and the next tone is output, immediately, when the trigger signal goes true again.

### **External Amplitude Modulation**

<b>Carrier frequency</b>	Entire range for selected waveform
<b>Carrier waveforms</b>	All standard and arbitrary waveforms
<b>Modulation source</b>	Modulation socket
<b>Frequency range</b>	DC to 500 kHz
<b>Signal range</b>	Approx. 1 V pk-pk for 100 % level change at maximum output

### **External Signal Summing**

<b>Carrier frequency</b>	Entire range for selected waveform
<b>Carrier waveforms</b>	All standard and arbitrary waveforms
<b>Sum source</b>	Sum socket
<b>Frequency range</b>	DC to 16 MHz
<b>Signal range</b>	Approximately 2 Vpk-pk input for 20 Vpk-pk output.

### **Trigger Generator**

<b>Source</b>	Internal source 0.005 Hz to 100 kHz squarewave adjustable in 10 us steps. 3 digit resolution. Available for external use from the SYNC OUT socket.
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### **Main Outputs – One for each channel**

<b>Output impedance</b>	50 $\Omega$
<b>Amplitude</b>	5 mV to 20 V pk-pk open circuit (2.5 mV to 10 V pk-pk into 50 $\Omega$ . Amplitude can be specified open circuit (Hi Z) or into an assumed load of 50 $\Omega$ or 60 $\Omega$ , in Vpk-pk, Vrms or dBm.
<b>Ampl. accuracy</b>	Better than 2 % $\pm$ 1 mV at 1 kHz into 50 $\Omega$ .
<b>Ampl. flatness</b>	$\pm$ 0.2 dB to 1 MHz; $\pm$ 0.4 dB to 40 MHz
<b>DC offset range</b>	$\pm$ 10 V. DC offset plus signal peak limited to $\pm$ 10 V from 50 $\Omega$ .
<b>Offset accuracy</b>	Typically within $\pm$ 3 % $\pm$ 10 mV, unattenuated
<b>Resolution</b>	3 digits or 1 mV for both Amplitude and DC Offset
<b>Sync Out – One for each channel</b>	<b>Multifunction output user definable or automatically selected to be any of the following:</b>
<b>Waveform sync (All waveforms)</b>	A square wave with 50 % duty cycle at the main waveform frequency, or a pulse coincident with the first few points of an arbitrary waveform.

<b>Position markers (Arbitrary only)</b>	Any point(s) on the waveform may have associated marker bit(s) set high or low
<b>Burst done</b>	Produces a pulse coincident with the last cycle of a burst
<b>Sequence sync</b>	Produces a pulse coincident with the end of a waveform sequence
<b>Trigger</b>	Selects the current trigger signal. Useful for synchronising burst or gated signals.
<b>Sweep sync</b>	Outputs a pulse at the start of sweep to synchronise an oscilloscope or recorder. Can additionally output a sweep marker.
<b>Phase lock out</b>	Used to phase lock two generators. Produces a positive edge at the 0o phase point.
<b>Output signal level</b>	Logic level of < 0.8 V to > 3 V for all outputs except Sweep Sync. Sweep Sync is a 3-level waveform.

### Trig In

<b>Frequency range</b>	DC to 1 MHz
<b>Signal range</b>	Threshold nominally TTL level; max. input $\pm 10$ V
<b>Min. rulse width</b>	50 ns for Trigger and Gate modes; 50 $\mu$ s for Sweep mode
<b>Input impedance</b>	10 k $\Omega$

### Modulation In

<b>Frequency range</b>	DC to 500 kHz
<b>Signal range</b>	VCA: Approximately 1 Vpk-pk for 100 % level change at maximum output SCM: Approximately $\pm 1$ Vpk for maximum output
<b>Input impedance</b>	Typically 1 k $\Omega$

### Sum In

<b>Frequency range</b>	DC to 30 MHz (291) DC to 16 MHz (292/294)
<b>Signal range</b>	Approximately 2 Vpk-pk input for 20 Vpk-pk output
<b>Input impedance</b>	Typically 1 k $\Omega$
<b>Hold</b>	Holds an arbitrary waveform at its current position. A TTL low level or switch closure causes the waveform to stop at the current position and wait until a TTL high level or switch opening which allows the waveform to continue. The front panel MAN/HOLD key or remote command may also be used to control the Hold function.
<b>Input impedance</b>	10 k $\Omega$

### Ref Clock In/Out

<b>Set to input</b>	Input for an external 10 MHz reference clock. TTL/CMOS threshold level.
<b>Set to output</b>	Buffered version of the internal 10 MHz clock. Output levels nominally 1 V and 4 V from 50 $\Omega$ .
<b>Set to phase lock</b>	Used together with SYNC OUT on a master and the TRIG IN on a slave to synchronize (phase lock) two generators

### ARB Clock In

<b>Frequency Range</b>	DC to 50 MHz
<b>Max. input voltage</b>	+ 5 V, -1 V

<b>Inter-Channel Operation</b>	
<b>Inter-Channel Modulation</b>	The waveform from any channel may be used to Amplitude Modulate (AM) or Suppressed Carrier Modulate (SCM) the next channel. Alternatively any number of channels may be Modulated (AM or SCM) with the signal at the MODULATION input socket.
<b>Carrier frequency</b>	Entire range for selected waveform
<b>Carrier waveforms</b>	All standard and arbitrary waveforms
<b>Modulation types</b>	AM: Double sideband with carrier SCM: Double sideband suppressed carrier
<b>Modulation source</b>	Internal from the previous channel. External from Modulation input socket. The external modulation signal may be applied to any number of channels simultaneously
<b>Frequency range</b>	DC to > 100 kHz
<b>Internal AM depth</b>	0 % to 105 %
<b>Internal AM resolution</b>	1 %
<b>Carrier Suppression (SCM)</b>	> 40 dB
<b>External modulation signal range</b>	VCA: Approximately 1 V pk-pk for 100 % level change at maximum output SCM: Approximately $\pm 1$ Vpk for max. output
<b>Inter-Channel Analogue Summing</b>	<b>Waveform Summing sums the waveform from any channel into the next channel. Alternatively any number of channels may be summed with the signal at the SUM input socket.</b>
<b>Carrier frequency</b>	Entire range for selected waveform
<b>Carrier waveforms</b>	All standard and arbitrary waveforms
<b>Sum source</b>	Internal from the previous channel. External from SUM IN socket.
<b>Frequency range</b>	DC to > 16 MHz
<b>Ext. signal range</b>	Approx. 5 Vpk-pk input for 20 Vpk-pk output
<b>Inter-Channel Phase Locking</b>	<b>Two or more channels may be phase locked together. Each locked channel may be assigned a phase angle relative to the other locked channels. Arbitrary waveforms and waveform sequences may be phase locked but certain constraints apply to waveform lengths and clock frequency ratios.</b> <b>With one channel assigned as the Master and other channels as Slaves a frequency change on the master will be repeated on each slave thus allowing multiphase waveforms at the same frequency to be easily generated. DDS waveforms are those with 7 digits of frequency setting resolution, while Non-DDS waveforms have 4 digits.</b>
<b>Phase resolution</b>	DDS waveforms: 0.1 degree
<b>Non-DDS waveforms</b>	0.1 degree or 360 degrees/number of points whichever is the greater
<b>Phase error</b>	< $\pm 10$ ns all waveforms.
<b>Inter-Channel Triggering</b>	<b>Any channel can be triggered by the previous or next channel. The previous/next connections can be used to 'daisy chain' a trigger signal from a 'start' channel, through a number of channels in the 'chain' to an 'end' channel.</b> <b>Each channel receives the trigger out signal from the previous (or next) channel, and drives its selected trigger out to the next (or previous) channel. The 'end' channel trigger out can be set up to drive</b>

	<p>the 'start' channel, closing the loop.</p> <p>In this way, complex and versatile interchannel trigger schemes may be set up. Each channel can have its trigger out and its output waveform set up independently. Trigger out may be selected from Waveform End, Position Markers, Sequence Sync or Burst Done. Using the scheme above it is possible to create a sequence of up to 64 waveform segments, each channel producing up to 16 segments and all channels being summed to produce the complete waveform at the output of channel 4.</p> <p>The signals from the REF IN/OUT socket and the SYNC OUT socket can be used to phase lock two instruments where more than 4 channels are required.</p>
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### Interfaces

RS-232	Variable Baud rate, 9600 Baud maximum
IEEE488	Conforms with IEEE488.2
USB	Conforms with USB 1.1

### General Specifications

Display	20 character x 4 row alphanumeric LCD
Data entry	Keyboard selection of mode, waveform etc.; value entry by numeric keys or by rotary control.
Memory card	Removable memory card conforming to the Compact Flash memory card standard. Sizes from 32 MB to 1 GB can be used.
Stored settings	Up to 500 complete instrument set-ups may be stored and recalled from the memory card. Up to 500 arbitrary waveforms can also be stored independent of the instrument settings.
Size	130 mm (3U) high; 335 mm long; 350 mm wide (292/294), 212 mm wide (291)
Weight	292/294: 7.2 kg (16 lb); 291: 4.1 kg (9 lb)
Power	110 to 120 V or 100 V nominal 50/60/400 Hz; 220 to 240 V nominal, 50/60 Hz. Voltage adjustable internally; operating range $\pm 10\%$ of nominal; 60 VA max. Installation Category II.

### Compliance

Operating range	+5 °C to 40 °C, 20 to 80 % RH
Storage range	-20 °C to +60 °C
Environmental	Indoor use at altitudes to 200 m, Pollution Degree 2
Safety	Complies with EN61010-1
EMC	Complies with EN61326
Instrument drivers	Labview and LabWindows CVI drivers are either supplied with the instrument or are available via your local Fluke Office
Supplied Items	IEC Mains Lead. Printed manual (partly multi-language), multi-language manual on CD, Waveform Manager Plus software, compact Flash memory card, compact Flash card reader/writer (USB connection to PC)
Options	19-inch rack mounting kit