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# Specifications

Specifications apply at 18°-28°C after one hour warm-up, at maximum output into 50Ω

## WAVEFORMS

### STANDARD

Sine, square, positive pulse, negative pulse, multi-level squarewave, triangle, ramp up, ramp down, DC and pseudo-random noise.

### ARBITRARY

Sampling Frequency:	27.48MHz
Waveform Length::	1024 points maximum
Vertical Resolution:	10 bits

### FREQUENCY

Frequency ranges for standard waveform are listed below. In Arbitrary mode all waveform points are output up to approximately 27 kHz beyond which they are sampled.

Sine:	100 μHz to 10 MHz
Square:	100 μHz to 10 MHz
Positive/Negative Pulse:	100 μHz to 10 MHz
Triangle:	100 μHz to 100 kHz
Positive/Negative Ramp:	100 μHz to 100 kHz
Multi-level square:	100 μHz to 100 kHz
Pseudo-random noise:	30 mHz to 700 kHz
Resolution:	7 digits (limited by 100 μHz)
Accuracy:	Typically 10 ppm for 1 year, 18°C to 28°C
Stability:	Typically 1ppm per °C outside 18°C to 28°C

### WAVEFORM CHARACTERISTICS

Sine Distortion:	<0.3% to 500 kHz <-50 dBc to 1 MHz <-35 dB to 10 MHz
Non-harmonic spurs:	typically -50 dBc to 10 MHz
Square Rise/Fall Time:	<25 ns
Square Aberrations:	<5% + 2 mV
Square Symmetry Control:	1 to 99% (0.1% resolution) 100 μHz to 30 kHz 20 to 80% (0.1% resolution) 30 kHz to 10 MHz
Triangle Linearity Error:	<0.5% to 30 kHz
Triangle Symmetry Control:	1 to 99% (0.1% resolution) 100 μHz to 100 kHz
Pulse Rise/Fall Time:	<25 ns
Pulse Aberrations:	<5% + 2 mV
Pulse Symmetry Control:	1 to 99% (0.1% resolution) 100 μHz to 30 kHz 20 to 80% (0.1% resolution) 30 kHz to 10 MHz
Multi-level Square:	Maximum of 16 steps of discrete amplitude and duration (1 to 1,024 points). Allows generating 3 level square, staircase, multiplexed LCD driver signals, etc.

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## OUTPUT CHARACTERISTICS

Output Impedance:	50 $\Omega$ or 600 $\Omega$ switchable
Amplitude:	2.5 mVpp to 10 Vpp into 50 $\Omega$ /600 $\Omega$ 5 mVpp to 20 Vpp into open circuit
DC Offset:	$\pm 5$ V (limited by offset plus signal peak) into 50 $\Omega$ /600 $\Omega$ $\pm 10$ V (limited by offset plus signal peak) into open circuit
Resolution:	3 digits (limited by 1 mV)
Accuracy:	3% + 1 mV at 1 kHz into 50 $\Omega$ /600 $\Omega$
Flatness:	$\pm 0.2$ dB to 500 kHz, $\pm 1$ dB to 5 MHz, $\pm 2.5$ dB to 10 MHz

## OPERATING MODES

### CONTINUOUS

Continuous cycles of the selected waveform are output at the programmed frequency.

### TRIGGER/BURST

Phase coherent triggering of the programmed number of cycles of the selected waveform. Waveforms start and stop at the phase angle specified in the Start/Stop phase parameter.

Trigger Sources:	External signal, manual (front panel key), internal trigger generator or remote command.
Burst Count:	1 to 1023 cycles
Trigger Repetition Rate:	dc to 50 kHz (internal trigger generator) dc to 1 MHz (external trigger signal)

### GATE

Cycles of the selected waveform are continuously output while the trigger signal is present.

Trigger Sources:	External signal, manual (front panel key), internal trigger generator or remote command
Trigger Repetition Rate:	dc to 50 kHz (internal trigger generator) dc to 1 MHz (external trigger signal)

### SWEEP

Sweep Mode:	Linear or logarithmic, single triggered cycle or continuous
Frequency Range:	100 $\mu$ Hz to the maximum frequency for selected waveform
Markers:	Two variable markers during sweep
Trigger Sources:	External signal, manual (front panel key), or remote command

### FREQUENCY HOP

Up to 16 different hop waveforms, each with independently settable frequency, amplitude, offset, waveform (except noise), and duration for each waveform. Phase continuous switching between frequencies can be executed via software or manually (front panel key). Waveform duration can be set from 2 ms to 65 s in 1 ms increments. HOP can be externally triggered from the EXT TRIG input.

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## AMPLITUDE MODULATION

Carrier Frequency Range 100  $\mu$ Hz to the maximum frequency for selected waveform.

Carrier Waveforms:	All
Depth:	Typically variable from 0% to 100% in 1% increments
Internal Source:	1 kHz fixed sinewave or 5 mHz to 50 kHz squarewave
External Source:	DC to 100 kHz (4 quadrant)
External Sensitivity:	Approximately 2 V <sub>pp</sub> for 50% modulation

## FREQUENCY SHIFT KEYING (FSK)

Phase coherent switching between two selected frequencies at a rate defined by the switching signal source.

Carrier Frequency:	100 $\mu$ Hz to the maximum frequency for selected waveform
Carrier Waveforms:	All
Switch Repetition Rate:	dc to 50 kHz (internal trigger generator) dc to 1 MHz (external trigger signal)
Switching Signal Source:	Internal from front panel key or internal trigger generator External from Trig/Gate input or remote interface

## START/STOP PHASE

Phase relationship between MAIN OUT and AUX OUT is determined by the START/STOP PHASE setting.

Carrier Frequency:	100 $\mu$ Hz to 1 MHz
Carrier Waveforms:	All
Range:	0 to 360 degrees
Resolution:	1 degree

## TRIGGER GENERATOR

Internal source 5 mHz to 50 kHz squarewave adjustable in 20  $\mu$ s steps with 3 digit resolution.  
Available for output at the sweep/marker connector (except during sweep or HOP operation).

## OUTPUTS/INPUTS

### FRONT PANEL CONNECTIONS

MAIN OUT	Waveform output at 50 $\Omega$ or 600 $\Omega$ (selectable) impedance. Short circuit protection for up to 60 seconds is provided.
AUX OUT:	CMOS/TTL level signal at the frequency and symmetry of main output. Phase relationship between MAIN OUT and AUX OUT is determined by the START/STOP PHASE setting.
EXT TRIG:	External trigger input for Trigger, Gate, Sweep and FSK operating modes. It is also used to synchronize one Model 29 (as a slave) to another Model 29 (as a master). Maximum input voltage is $\pm 10$ V.

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## REAR PANEL CONNECTIONS

CLOCK IN/OUT	The function of the CLOCK IN/OUT connector is set from the front panel SYS (system) menu as follows:
CLOCK IN	The connector serves as an input for an external clock
CLOCK OUT	This is the default setting. The internal clock is made available as an output. When two or more Model 29s are synchronized the CLOCK OUT is used as a master to drive the CLOCK IN of the slave units.
PHASE LOCK	For use as a slave unit phase locked to the master unit.
VCA IN	Input connector for externally controlled Amplitude Modulation (AM). Impedance is nominally 6 k $\Omega$ .
SYNC OUT	When two or more generators are synchronized the SYNC OUT connector on the master generator is connected to the EXT TRIG inputs of the slave generators. SYNC OUT logic levels are nominally 0V and 5V with 50 $\Omega$ output impedance.
TRIG/SWEEP OUT	The function of this output is automatically determined by the generator operating mode. Except in sweep and HOP modes the output is that of the internal trigger generator, a fixed amplitude squarewave whose frequency is set in the TRIG of GATE menus. The rising edge of the trigger generator initiate trigger, gate and burst modes. In sweep mode the output is a 3-level waveform, changing from high (4V) to low (0V) at the start of the sweep, with narrow 1V pulses at marker points. In HOP mode the output goes low on entry to each waveform step and high after the new frequency and waveshape of that step have been set. Output impedance is 1k $\Omega$ .

## INTERFACES

Full remote control facilities are provided through RS232 and IEEE-488 (GPIB) interfaces.

RS232:	Variable baud rate, 9600 baud max; 9-pin D connector.
IEEE-488:	Conforms with IEEE-488.1 and IEEE.488.2

## STORED SETTINGS

Up to 9 complete instrument set-ups may be stored and recalled from battery backed memory.

## GENERAL

Display:	20 character by 4 row alphanumeric display.
Size:	130 mm (height), 212 mm (width), 330 mm (depth)
Weight:	9 pounds (4.1 kg)
Power	115 V or 230 V nominal 50/60 Hz, adjustable internally, operating range $\pm 14\%$ of nominal, 30 VA maximum.
Operating Range:	5°C to 40°C, 20-80%RH
Storage Range:	-20°C to 60°C
Options:	19" Rack Mount Kit
Safety:	Complies with EN61010-1
EMC:	Complies with EN55011 and EN50082-1.