Introduction

This Synthesized Programmable Arbitrary Waveform Generator uses a combination of direct digital synthesis and phase lock loop techniques to provide high performance and extensive facilities in a compact instrument. It can generate a wide variety of waveforms between 0·1mHz and 15MHz with high resolution and accuracy.

Arbitrary waveforms may be defined with 12 bit vertical resolution and from 4 to 65536 horizontal points. In addition a number of standard waveforms are available including sine, square, triangle, ramp and pulse.

Arbitrary waveforms may be replayed at a user specified waveform frequency or period, or the sample rate may be defined in terms of period or frequency.

Extensive waveform editing features between defined start and end points are incorporated, including waveform insert, point edit, line draw, amplitude adjust and invert. The Model 39 is also supported by Wavetek's WaveForm DSP2 arbitrary waveform creation software, which can download waveforms via the RS232 or GPIB interfaces.

Up to 50 waveforms may be stored with the length and name specified by the user. Waveforms may be strung together to form a sequence of up to four steps. Each waveform may have a user defined repeat count from 1 to 32768.

All waveforms can be swept over their full frequency range at a rate variable between 30 milliseconds and 15 minutes. Sweep can be linear or logarithmic, single or continuous. Single sweeps can be triggered from the front panel, the trigger input, or the digital interfaces. A sweep marker is provided.

Amplitude Modulation is available for all waveforms and is controlled from an external generator via the Ext VCA input.

All waveforms are available as a Triggered Burst whereby each active edge of the trigger signal will produce one burst of the carrier. The number of cycles in the burst can be set between 1 and 1048575. The Gated mode turns the output signal On when the gating signal is true and Off when it is false. Both Triggered and Gated modes can be operated from the internal Trigger Generator (0.005Hz to 50kHz), from an external source (dc to 1MHz) or by a key press or remote command.

The signals from the REF IN/OUT socket and the SYNC OUT socket can be used to phase lock two or more generators. This can be used to generate multi-phase waveforms or locked waveforms of different frequencies.

The generator parameters are clearly displayed on a backlit LCD with 4 rows of 20 characters. Soft-keys and sub menus are used to guide the user through even the most complex functions.

All parameters can be entered directly from the numeric keypad. Alternatively most parameters can be incremented or decremented using the rotary control. This system combines quick and easy numeric data entry with quasi-analog adjustment when required.

The generator has, as standard, both RS-232 and GPIB interfaces which can be used for remote control of all of the instrument functions or for the down-loading of arbitrary waveforms; the GPIB interface conforms to IEEE-488.2.

Specifications

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

WAVEFORMS

Standard Waveforms

Sine, square, triangle, DC, positive ramp, negative ramp, sin(x)/x, pulse, pulse train, cosine, haversine and havercosine.

Sine, Cosine, Haversine, Havercosine

Range:	0·1 mHz to 10 MHz.
Resolution:	0·1mHz (7 digits)
Accuracy:	10 ppm for 1 year.
Temperature Stability:	Typically <1 ppm/°C
Output Level:	5mV to 20V pk-pk from 50Ω.
Harmonic Distortion:	<0.1% THD to 100kHz; <-65dBc to 20kHz,
	<-50dBc to 1MHz, <-35dBc to 10MHz.
Non-harmonic Spurii:	<-65dBc to 1MHz, <-65dBc + 6dB/octave 1MHz to 10MHz.

Square

Range:	1 mHz to 15MHz.
Resolution:	1mHz (4 digits)
Accuracy:	± 1 digit of setting.
Output Level:	5mV to 20V pk-pk from 50Ω.
Rise and Fall Times:	<25ns

Triangle

Range:	0.1 mHz to 100kHz.
Resolution:	0.1mHz (7 digits)
Accuracy:	10 ppm for 1 year.
Output Level:	5mV to 20V pk-pk from 50Ω.
Linearity Error:	<0.1% to 30 kHz

Ramps and Sin(x)/x

Range:	0.1 mHz to 100kHz.
Resolution:	0.1mHz (7 digits)
Accuracy:	10 ppm for 1 year.
Output Level:	5mV to 20V pk-pk from 50Ω.
Linearity Error:	<0.1% to 30 kHz

Pulse and Pulse Train

Output Level:	5mV to 20V pk-pk from 50Ω.
Rise and Fall Times:	<25ns

Period:

Range:	133·3ns to 100s.
Resolution:	4-digit.
Accuracy:	± 1 digit of setting.

Delay:

Range:	-99·9s to + 99·99s
Resolution:	0·002% of period or 33·33ns, whichever is greater.

Width:

Range:	33·3ns to 99·99s
Resolution:	0·002% of period or 33·33ns, whichever is greater.

Note that the pulse width and absolute value of the delay may not exceed the pulse period at any time.

Pulse trains of up to 10 pulses may be specified, each pulse 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.

Arbitrary

Up to 50 user defined waveforms may be stored in RAM. Waveforms can be defined by front panel editing controls or by downloading of waveform data via RS232 or GPIB.

Waveform Memory Size:	64k points. Maximum waveform size is 64k points, minimum waveform size is 4 points.
Vertical Resolution:	12 bits
Sample Clock Range:	100mHz to 30MHz
Resolution:	4 digits
Accuracy:	± 1 digit of setting.

Sequence

Up to 4 waveforms may be linked. Each waveform can have a loop count of up to 32768. A sequence of waveforms can be looped up to 1048575 times or run continuously.

Output Filter

Selectable between 10MHz Elliptic, 10MHz Bessel, or None.

OPERATING MODES

Triggered Burst

Each active edge of the trigger signal will produce one burst of the waveform, starting and stopping at the waveform position specified by the sync marker setting.

Carrier Waveforms:	All standard and arbitrary
Number of Cycles:	1 to 1048575
Trigger Repetition Rate:	dc to 50 kHz internal, dc to 1MHz external.
Source:	Internal from keyboard or trigger generator. External from TRIG IN or remote interface.

Gated

Waveform will run while the Gate signal is true and stop while false.

Carrier Waveforms:	All standard and arbitrary.
Trigger Repetition Rate:	dc to 50 kHz internal, dc to 1 MHz external.
Gate Signal Source:	Internal from keyboard or trigger generator. External from TRIG IN or remote interface.

Sweep

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.

Carrier Waveforms:	All standard and arbitrary except pulse, pulse train and sequence.
Sweep Mode:	Linear or logarithmic, up or down, triggered or continuous.
Sweep Range:	From 1mHz to 10 MHz in one range. Phase continuous. Independent setting of the start and stop frequency.
Sweep Time:	30ms to 999s (3 digit resolution).
Marker:	Variable during sweep.
Sweep Trigger Source:	The sweep may be free run or triggered from the following sources: Manually from keyboard. Externally from TRIG IN input or remote interface.
Sweep Hold:	Sweep can be held and restarted by the HOLD key.

Tone

Capability provided for both standard and arbitrary waveforms. Arbitrary waveforms are expanded or condensed to exactly 4096 points and DDS techniques are used to allow instantaneous frequency switching.

Carrier Waveforms:	All waveforms except pulse, pulse train and sequence.
Frequency List:	Up to 16 frequencies from 1mHz to 10MHz.
Switching Sources:	External trigger input. A true level will output the tone, a false level will stop the tone and switch to the next frequency on the list ready for the next true level.
Min. switch time:	20ms per tone.

Using 2 instruments with their outputs summed together it is possible to generate DTMF test signals.

External Amplitude Modulation

Carrier frequency:	Entire range for selected waveform.
Carrier waveforms:	All standard and arbitrary waveforms
Modulation source:	VCA/SUM IN socket.
Frequency Range:	DC - 100 kHz.
Signal Range:	Approximately 2·5V pk-pk for 100% level change at maximum output.

External Signal Summing

Carrier frequency:	Entire range for selected waveform.
Carrier waveforms:	All standard and arbitrary waveforms.
Sum source:	VCA/SUM IN socket.
Frequency Range:	DC to 10MHz.
Signal Range:	Approximately 5Vpk-pk input for 20Vpk-pk output.

Trigger Generator

Internal source 0.005 Hz to 50kHz squarewave adjustable in 20us steps. 3 digit resolution. Available for external use from the SYNC OUT socket.

OUTPUTS

Main Output

Output Impedance:	50Ω
Amplitude:	5mV to 20V pk-pk open circuit (2.5mV to 10V pk-pk into 50Ω). Amplitude can be specified open circuit (hi Z) or into an assumed load of 50Ω or 600Ω in Vpk-pk, Vrms or dBm.
Amplitude Accuracy:	2% +/-1mV at 1kHz into 50Ω.
Amplitude Flatness:	+/-0.2dB to 200 kHz; +/-1dB to 5 MHz; +/-2dB to 10 MHz.
DC Offset Range:	+/-10V. DC offset plus signal peak limited to +/-10V from 50Ω.
DC Offset Accuracy:	Typically 3% +/-10mV, unattenuated.
Resolution:	3 digits or 1mV for both Amplitude and DC Offset.

Sync Out

Multifunction output user definable or automatically selected to be any of the following:

Waveform Sync: (all waveforms)	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.
Position Markers: (Arbitrary only)	Any point(s) on the waveform may have associated marker bit(s) set high or low.
Burst Done:	Produces a pulse coincident with the last cycle of a burst.
Sequence Sync:	Produces a pulse coincident with the end of a waveform sequence.
Trigger:	Selects the current trigger signal. Useful for synchronizing burst or gated signals.
Sweep Sync:	Outputs a pulse at the start of sweep to synchronize an oscilloscope or recorder.
Phase Lock Out:	Used to phase lock two or more generators. Produces a positive edge at the 0° phase point.
Output Signal Level:	TTL/CMOS logic levels from typically 50Ω.

Cursor/Marker Out

Adjustable output pulse for use as a marker in sweep mode or as a cursor in arbitrary waveform editing mode. Can be used to modulate the Z-axis of an oscilloscope or be displayed on a second 'scope channel.

Output Signal Level:	Adjustable from nominally 2V to 14V, normal or inverted; adjustable width as a cursor.
Output Impedance:	600Ω typical

INPUTS

Trig In

Frequency Range:	DC - 1MHz.
Signal Range:	Threshold nominally TTL level; maximum input +/-10V.
Minimum Pulse Width:	50ns, for Trigger and Gate modes; 50us for Sweep mode; 20ms for Tone mode.
Input Impedance:	10kΩ

VCA In

Frequency Range:	DC - 100kHz.
Signal Range:	2.5V for 100% level change at maximum output.
Input Impedance:	Typically 6kΩ.

Sum In

Frequency Range:	DC - 10MHz.
Signal Range:	Approximately 5Vpk-pk input for 20Vpk-pk output.
Input Impedance:	Typically 1k2Ω.

Hold

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 HOLD key or remote command may also be used to control the Hold function. While held a rising edge at TRIG IN will return the waveform to the start. The front panel MAN/SYNC key or remote command may also be used to return the waveform to the start.

Input Impedance:	10kΩ

Ref Clock In/Out

Set to Input:	Input for an external 10MHz reference clock. TTL/CMOS threshold level.
Set to Output:	Buffered version of the internal 10MHz clock. Output levels nominally 1V and 4V from 50Ω.
Set to Phase Lock:	Used together with SYNC OUT on a master and the TRIG IN on a slave to synchronize (phase lock) multiple instruments.

INTERFACES

Full remote control facilities are available through the RS232 and GPIB interfaces.

RS232:	Variable Baud rate, 9600 Baud maximum. 9-pin D-connector.
IEEE-488:	Conforms with IEEE488.1 and IEEE488.2

GENERAL

Display:	20 character x 4 row alphanumeric LCD.
Data Entry:	Keyboard selection of mode, waveform etc.; value entry direct by numeric keys or by rotary control.
Stored Settings:	Up to 9 complete instrument set-ups may be stored and recalled from battery-backed memory. Up to 50 arbitrary waveforms can also be stored independent of the instrument settings.
Size:	3U (130mm) height; half-rack (212mm) width; 330mm long.
Weight:	4.1kg. (9lb.)
Power:	230V, 115V or 100V nominal 50/60Hz, adjustable internally; operating range +/-14% of nominal; 40VA max. Installation Category II.
Operating Range:	+5°C to 40°C, 20-80% RH.
Storage Range:	-20°C to + 60°C.
Environmental:	Indoor use at altitudes up to 2000m, Pollution Degree 1.
Options:	19 inch rack mounting kit.
Safety:	Complies with EN61010-1.
EMC:	Complies with EN50081-1 and EN50082-1.