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Wavetek 95 Synthesized Arbitrary Waveform Generator

SECTION 1 GENERAL

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1.1 ABOUT THIS MANUAL

The Model 95, 20 MHz Synthesized Arbitrary/Function Generator Instruction Manual provides information on how to use and maintain the Model 95.

Section 1, General, lists and describes the Model 95 specifications.

Section 2, Preparation, provides preliminary unit setup instructions. This section includes instrument receiving and inspection, return for repair, initial checkout including fuse and voltage selection and turn on, error messages, and functional check.

Section 3, Operation, describes instrument operation – local (front panel) and remote (GPIB).

1.2 MODEL 95

The Model 95 is a rugged 1mHz to 20 MHz programmable, synthesized Arbitrary/Function Generator. The function generator produces predefined sine, triangle, and square waveforms. While the arbitrary waveform generator (Arb) supplies user-defined waveforms. Function generator and Arb waveforms can be continuous, triggered, gated, burst, AM (amplitude modulation), SCM (suppressed carrier modulation), FM (frequency modulation), or sweep. The two main outputs (balanced and unbalanced) supply the selected waveform at levels from 1mVpp to 30 Vpp.

The Arb generator lets the user to define up to four functions (waveforms). The unit stores these waveforms in its battery-backed memory (RAM). Each of the four Arb waveforms may be 2 words to 8K words horizontal by 12 bits (4096 points) vertical; also see Option 002. Edit the Arb waveforms using point, line, or three point edit methods. Plus, the Model 95 can insert dc, triangle, square, ramp up, ramp down, sine, cosine, inverse sine, or inverse cosine within a waveform.

At frequencies above 20 Hz (all functions in continuous, AM, and SCM modes) the Model 95 phase locks its function generator to its own internal frequency synthesizer (internal phase lock). The internal synthesizer improves the frequency accuracy to ±(10ppm + 1.5 ppm/°C); also see Option 001. This internal frequency synthesizer also acts as an internal trigger source for the trigger, gate, or bust modes. Also the Model 95 can phase lock to an external source (same conditions as internal phase lock). When external phase locked, the Model 95 allows the phase of the output to be shifted ±180°.

1.3 SPECIFICATIONS

1.3.1 Waveforms (Functions)

Programmable sine, triangle, and square; variable symmetry for pulse and ramp waveforms; arbitrary waveforms; and dc.

Sine Distortion

Sine function at all outputs (10 Vpp, 50Ω):
<1% (-40 dB) THD 1 mHz to 20 Hz;
<0.5% (-46 dB) THD 20 Hz to 100 kHz.

Arb Sine Waveform at 200 kHz sample frequency and 1000 data points for sine wave, 50 mVrms amplitude:
<0.18% (-55 dB) THD to 100 kHz.

Unbalanced Output, 50Ω and 75Ω, no harmonics above:
-40 dBc, 100 kHz to 2MHz,
-30 dBc, 2MHz to 6MHz,
-25 dBc, 6MHz to 20 MHz.

Time Symmetry

With fixed at 50%, time symmetry the accuracy is <±(0.2%+5ns).

Time symmetry is variable from 5% to 95% in 1% steps to 2MHz. Between 2MHz and 20 MHz the time symmetry limits linearly decrease to a fixed 50% at 20 MHz. Accuracy is <±(1%+5ns).

Minimum width is 25 ns

Square Transition Time

The transition time (rise/fall) is <9 ns, 10% to 90%, full Unbalanced Output into 50 Ω impedance.

Aberrations

Overshoot and ringing is <(5%+20 mV) of the peak to peak amplitude.

Triangle Linearity

10% to 90% nonlinearity:
±1%, 1mHz to 100 kHz;
±2%, 100 kHz to 2 MHz;
±10%, 2MHz to 5 MHz.

1.3.2 Operational Modes

Continuous

In this mode, the Model 95 supplies a continuous waveform at the selected frequency. The unit automatically selects its internal synthesizer at frequencies above 20 Hz.

Triggered

In this mode, the Model 95 remains quiescent at trigger baseline of selected function until a trigger event occurs. The Trig/Freq In signal, Manual Trigger, GPIB trigger command, or internal trigger starts the trigger event. This event initiates a single waveform at the programmed frequency and, after completing the waveform, returns the generator to the quiescent baseline. The Model 95 provides an internal trigger frequency between 1mHz and 15 MHz. Accuracy of triggered waveform period is <±3%.

Gated

In this mode the Model 95 functions the same as the Triggered mode, except the generator runs continuously while the trigger event is true. The generator starts and stops in the quiescent state, and the Model 95 always completes its last cycle. Gate outputs initiated by the internal synthesizer have an approximate 1:1 on/off cycle.

Burst

In this mode, the Model 95 functions like the Triggered mode, except that the number of cycles generated, when triggered, is programmable from 1 to 1,000,000. The generator starts and stops in its quiescent state.

Amplitude Modulation (AM)

In this mode the Model 95 functions like the continuous mode except an external signal modulates the amplitude of the Model 95's output (carrier). The external signal can modulate the Model 95 from 0 to 100%. In this mode, the Model 95 displays the average amplitude; the Amplitude must be <7.5 Vpp in order to select the AM mode.

Suppressed Carrier Modulation (SCM)

In this mode, the Model 95 functions like the AM mode, except the Model 95 suppresses the output level to 0V with no external signal supplied. Three scale factors (Vout/Vin) aid in determining the input to output signal level. SCM can only be selected when the Continuous signal level is <7.5 Vpp.

Frequency Modulation (FM and VCG)

In the FM mode, an external signal controls the frequency of the generator. Connecting a dc level to the Trig/Freq In connector shifts the generator to a frequency based on the magnitude of the level. Connecting an ac signal to the Mod In deviates the frequency of the generator about its programmed frequency. The Model 95 only can be frequency modulated a maximum of three decades on a fixed range. Internal or external phase lock is not selectable in this mode.

Sweep

In this mode, the Model 95's frequency varies between start and stop frequencies. The unit linearly or logarithmically sweeps the frequency (Up and Up/Down) up to three decades on a selected range. The Model 95 provides five sweep modes: sweep start, sweep stop, continuous sweep, triggered sweep, or manually sweep. Sweep time is programmed from 100 ms to 3600s. Start/Stop frequency accuracies are <±3% on the top decade of the sweep and ±5% on the lower two decades of the sweep. All 50% symmetrical waveforms can be swept.

1.3.3 Frequency

Range

1mHz to 20 MHz, unsynthesized;
20 Hz to 20 MHz, synthesized;
1mHz to 1MHz, 600Ω or balanced output.

Frequency Modulation and Sweep Ranges

Internally, the Model 95 operates using ten frequency rangs. In the FM and Sweep modes, the frequency limits must be kept withnin one of these ranges. The following table lists the ten ranges and the maximum, frequency deviation (1000:1 or three decades) allowed for that range.

FM/Sweep Range	
Normal Range	**Minimum Frequency**
20 - 2.001 MHz	20k
2 - 0.2001 MHz	2kHz
200 - 20.01 kHz	200 Hz
20 - 2.001 kHz	20 Hz
2 - 0.2001 kHz	2Hz
200 - 20.01 Hz	0.2 Hz
20 - 2.001 Hz	0.02 Hz
2 - 0.2001 Hz	0.002 Hz
200 - 20.01 mHz [1]	2mHz
20 - 2.001 mHz [2]	2mHz

[1] *100:1 or two decades only.*
[2] *10:1 or one decade only.*

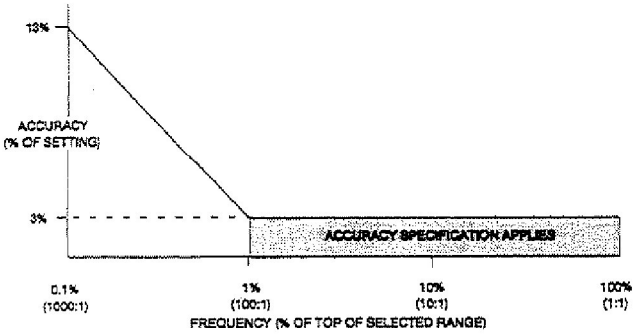
Resolution

4 digits

Accuracy

±10 ppm synthesized:
20 Hz to 20 MHz Continuous, AM, or SCM modes.

Non-Synthesized Accuracy



Stability

VS temperature:

±2 ppm/°C for synthesized (0°C to 50°C);
<100 ppm/°C for non-synthesized.

VS time:

±20 ppm/year for synthesized,
±0.1% for non-synthesized within 10 minutes.
±0.5% for non-synthesized within 24 hours;

Internal Phase Lock

The Model 95 can be phase locked at frequencies >20 Hz (Continuous, AM or SCM mode) to an internal crystal referenced frequency synthesizer which improves the generator's frequency accuracy and stability.

External Phase Lock

The Model 95 phase locks (frequencies above 20 Hz: Continuous, AM, or SCM mode) to an external source. Model 95 measures the external signal, sets the generator's frequency, and locks the generator to the source. The external source controls the generator's frequency, stability, and purity.

Also, external phase lock permits programmable phase shift (±180° or ±π radians) with 1° resolution. Phase lock accuracy (50 Hz to 10 MHz) is ±(4°+20 ns) accuracy. If the external source has dc offset, the Model 95 ignores the offset.

1.3.4 Amplitude

Range

1mVpp to 15 Vpp terminated into selected output impedance;
2mVpp to 30 Vpp into an open circuit.

Resolution

4 Digits: 2mVpp to 20 Vpp Open Circuit (minimum 1mV),
1mVpp to 10 Vpp Terminated ;
4 1/2: 20 Vpp to 30 Vpp Open Circuit,
10 Vpp to 15 Vpp Terminated.
Offset waveforms may reduce amplitude resolution.

Accuracy

Percent of settings for all functions at 1kHz:
±(2%+1mV), to 100 mVpp terminated;
±(2%+2mV), to 1Vpp terminated;
±(2%+10 mV), to 15 Vpp terminated.

Flatness (50Ω or 75Ω)

Relative to 1 kHz:
Unbalanced 50Ω
<2 MHz
±0.3 dB, sine and square;
±0.5 dB, triangle.
2 MHz to 20 MHz
±0.75 dB, sine and square;
±1.5 dB, triangle.
Balanced 135Ω
<100 kHz
±0.3 dB, sine.
100 kHz to 1MHz
±0.75 dB, sine.

1.3.5 Offset

Range

1mV to ±7.5 V (terminated);
1mV to ±15 V open circuit.

Resolution

4 digits; programming both offset and amplitude may reduce resolution.

Accuracy

±(2%+ 1mV), to 9.99 mV terminated;
±(2%+2mV), to 999 mV terminated;
±(2%+10 mV), to 7.5V terminated.

3.6 Outputs

Sync Output

Sync Out is a female BNC connector which supplies a TTL compatible synchronizing pulse output. The sync signal is at programmed frequency and symmetry and in phase with the square function. Output level is >2Vpp to <0.4 Vpp into 50Ω termination. The 10% to 90% transition times are less than 13 ns. When using Arb functions, the Sync Address key sets an Arb Address.

Sweep Output

Sweep Out is a female BNC connector,which supplies a 0 to +5V ramp to indicate sweep position. Source impedance is 600Ω. Sweep Output is active only with the sweep modes.

Unbalanced Output

Unbalanced output is a female BNC connector which is the source of programmed waveform at selected frequency, amplitude, symmetry, and offset. Source impedance is 600Ω ±1% to 1MHz, 50Ω ±1%, or 75Ω ±1% to 20 MHz. The Unbalanced Output can not be used with the Balanced Output.

Balanced Output

Balanced outputs are dual "banana jack" connectors which provide differential outputs. A universal binding post provides a signal common "center tap" connection. Source impedance is programmable as 135Ω ±1% or 600Ω ±1% to 1MHz. The balanced output can not be used with the unbalanced output.

Z-Axis Output

Z-Axis Out is a rear panel BNC connector for scope Z-Axis (intensity) modulation during Arb editing. Select the Z-Axis characteristics to match the scope's Z-Axis input. The Model 95 produces an output of ±4Vp (50Ω termination) with positive pulse and selectable polarity (logic sense not amplitude).

1.3.7 Inputs

Trigger/Frequency Input

Trig/Freq In serves two functions. In trigger modes, it accepts trigger source. The source can be TTL (dc to 20 MHz) or bipolar (0.6 Vpp to 30 Vpp, 20 Hz to 20 MHz (default)). Minimum pulse width is 50 ns. Trigger source is hardware selectable; refer to paragraph 2.4.6

In phase lock, Trig/Freq In accepts the signal that phase locks the Model 95 to the external source. The Model 95 measures the frequency, sets the unit to match the source frequency, and phase locks the generator to the source. Model 95 phase locks range from 20 Hz to 20 MHz in the Continuous, AM or SCM modes. The input signal must be a sine wave or bipolar signal (600 mVpp to 30 Vpp).

Input impedance is 10 kΩ ±2%.

Modulation In

Mod In, a female BNC connector, serves as the modulation input for FM (VCG), AM, and SCM. Input impedance is 10 kΩ ±2%. Bandwidth is dc to 1MHz. Maximum input level is ±20 Vpp (into 10 kΩ).

FM Mode: In FM an external signal provides linear control of waveform frequency around the programmed frequency. A ±10V input signal causes a 1000:1 (three decade) frequency change on the selected frequency range. An ac signal varies the frequency around the programmed frequency. A dc level shifts the generator to its new frequency. VCG bandwidth is dc to 100 kHz limited by 0.06 V/µs maximum slew rate. FM bandwidth is dc to 100 kHz deviation rate; with maximum envelope distortion of 1.78% (-35 dB). The Model 95's VCG circuit limits the bandwidth to 100 kHz. Envelope distortion is measured using 10 MHz carrier frequency, 1kHz modulation frequency and 1MHz (10%) depth (sine wave modulation).

AM Mode: In the AM mode an external signal provides linear control of waveform amplitude around the programmed amplitude value. Displayed amplitude dependent scale factor specifies approximate Vpp (into 10kΩ) required for 100% modulation. AM bandwidth is dc to 1MHz; with a maximum envelope distortion of 2% taken with 1MHz carrier frequency, 1kHz modulation frequency and 70% AM (sine wave modulation).

SCM (Suppressed Carrier Modulation): In the SCM mode, an external signal linearly controls the waveform's amplitude about the zero carrier level. The Model 95 displays a scale factor (2 V/V, 0.2 V/V, or 0.02 V/V) which defines the amount of Mod In signal level to produce a SCM output level. SCM bandwidth is dc to 1MHz. Maximum envelope distortion is 2% (1MHz carrier and 1kHz modulation).

1.3.8 Display

The Model 95 contains a 16 digit, Vacuum Florescent Display (VFD) with 14 segment, alphanumeric characters and 11 mm character height. The display shows all selectable parameters, parameter name, numeric value and the unit of measure. In addition, the display shows GPIB messages, various utilities, maintenance, and diagnostic information.

1.3.9 IEEE-488.1 Programming

Address

The Model 95 accepts GPIB addresses of 0 to 30 (default is 9). Addresses are front panel selectable and retained in battery backed memory.

Subsets

SH1, AH1, SR1, RL1, PP0, DC1, DT0, C0, T6, L4, TE0, LE0 and E1.

1.3.10 Arbitrary Waveform Generator

The Model 95's Arbitrary Waveform Generator (Arb) allows the user to create and store up to four unique waveforms. The Model 95 transfers the selected Arb waveform from storage RAM to the active RAM. The storage RAM contains four waveform blocks of up to 8K points with start and stop addresses, sync position and a Z-Axis marker. The Model 95 samples the Arb waveform in the active RAM using a clock derived from the function generator's frequency/period. The waveform may be from 2 samples to the full 8K samples in width. The RAM's battery allows the Model 95 to retain waveforms with the power off. The unit accepts Arb

waveforms via the GPIB which the unit stores in its active RAM. These waveforms can be edited and stored in memory.

Horizontal Resolution: four block of 8,191 points each; optionally four blocks of 32,766 points each.

Vertical Resolution: 12 bits (4096 points)

Sampling Frequency: 1mHz to 20 MHz.

Analog Filter: Two-pole active Bessel filter, programmable as no filter, 5MHz corner, and 50 kHz corner.

Digital Filter: A smoothing function that acts like a single pole, low pass filter which alters waveform data. Eight filter weights adjust the smoothing algorithm. The Model 95 displays the equivalent bandwidth.

Flatness: ±0.5 dB referenced to 1kHz sample waveform. Waveform: 10 point 2 MHz sine wave (20 MHz sample frequency), no filter or the 5 MHz cut-off filter .

Transition Times: <20 ns for a full amplitude step (no filter programmed).

Editing: The Model 95 offers four methods of editing the Arb waveforms: point, two-point, three-point, and block, plus undo edit.

Point editing allows the user to change a single point without affecting the other points.

Two-point editing allows the user to "draw a line" between two user-defined points (address/data). The Model 95 erases all previous data between the points.

Three-point allow the user to pick a point between left and right cursors and alter the waveform by "pulling" the point around.

Block edits allow the user to place a "standard" waveform (dc, triangle, square, ramp up, and ramp down, sine, cosine, inverse sine, and inverse cosine) between left and right cursors. Use any of the other edit methods to change the block waveform. In block edit mode, the amplitude and offset keys change the relative amplitude and offset. Also in the block edit mode, the Model 95 allows inversion of the selected part of the waveform.

Undo Edit allows the user to restore the original waveform when an error has been made.

Arb Sync: Sync Out (TTL) pulse marks a position within the Arb waveform block The Sync Address key selects the sync address. The Model 95 stores the sync address with the Arb waveform.

Z-Axis Out: Z-Axis Out, a rear panel BNC connector, provides a Z-Axis (intensity) output during Arb editing. The Model 95 allows selection of Z-Axis characteristics to match the scope's Z-Axis input: 100 mVpp to 4Vp (50Ω termination) positive pulse with selectable polarity (logic sense).

Trigger, Gate, and Burst of the Arb Waveform: Arb waveforms can be triggered, gated, and burst the same as the function generator. A single cycle of the Arb waveform is the time between the start and stop addresses.

1.4 OPTIONS

001: Frequency Reference — This option improves the accuracy and stability of the Model 95's reference oscillator. This option consists of an adjustable crystal (TCXO) with a ±1 ppm performance over the operating temperature range. The Option 001 also includes an external reference input connector and reference output connector. The reference input accepts a 10 MHz, TTL or Bipolar signal which overrides the internal reference. The reference output supplies 10 MHz, TTL pulses which can drive a 50Ω termination.

002: Extended Arb RAM — This option expands the Arb waveform RAM. It increases the active RAM from 8K to 32K (32,766 points). This option also enlarges the storage RAM.

003: Handles and Rack Adapter — This option consists of a pair of handles and rack adapters. Rack adapters allow mounting of the Model 95 in a standard 19 inch rack.

004: Extended Cards – This option supplies a set of extender cards which provide access to the daughter boards during maintenance.

1.5 STORED SETTINGS

The Model 95 stores up to 10 complete front panel setups in non-volatile memory. Last user setup also retained at power down.

1.6 GENERAL

1.6.1 Physical Specifications

Dimensions

35.6 cm (14 n.) wide, 13.3 cm (5.219 in.) high and 43.2 cm (17 in.) deep.

Weight

About 7.7 kg (17 lb.) net; 11.8 kg (26 b.) shipping.

Grounding

42V floating signal common.

Power

90 to 108, 108 to 126, 198 to 231, or 216 to 252 Vrms; 48 to 466 Hz; 1 phase; <100 VA.

1.6.2 Environmental Specifications

The Model 95 conforms to MIL-T-28800C, class 5 Enviornmental, safety, EMI/EMCV.

Temperature Range

0°C to +50°C for operation;
–40°C to +70°C for storage.

Warm Up Time

Allow 20 minutes for specified operation at temperature of last Auto Cal ±10°C. Auto Cal should be performed when the ambient temperature has changed.

Operational Humidity

11°C to 30°C at 95% relative humidity;
31°C to 40°C at 75% relative humidity;
41°C to 50°C at 45% relative humidity.

Altitude

To 10,000 ft. (3050m.) for operation;
To 15,000 ft. (4570m.) for non-operating.

Vibration (Operating)

Vibration level of 0.013 in. from 5 to 55 Hz (2g acceleration at 55 Hz.).

Shock (Non-operating)

40g, 9 ms half-sine wave.

Bench Handling (Operating)

4 in. or point of balance drop, any face, solid wooden surface.

Electromagnetic Compatibility

The Model 95 has been tested to MIL-STD-461A Notice 4 (EL) and meets the emission and susceptibility requirements of CE02, CE04, CS02, CS06, RE02, RE02.1, and RS03.