GP1650W

User's Guide

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GEOTEST

MARVIN TEST SYSTEMS, INC.

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Table of Contents

Chapter 1 - Overview

Introduction

This manual contains information required to operate, program and test the GP1650W ARBITRARY WAVEFORM GENERATOR. This section covers the instrument general description, instrument specifications and characteristics.

Features

- Generates sine, square, triangle, ramp and arbitrary waveforms

- Up to 10 Vpp amplitude into 50Ω

- Sample route range from 200 ns to 999.9 s

- 3 digit resolution

- Trigger and burst modes

- Form, fit and function compatibility with Wavetek 175 for ATE applications
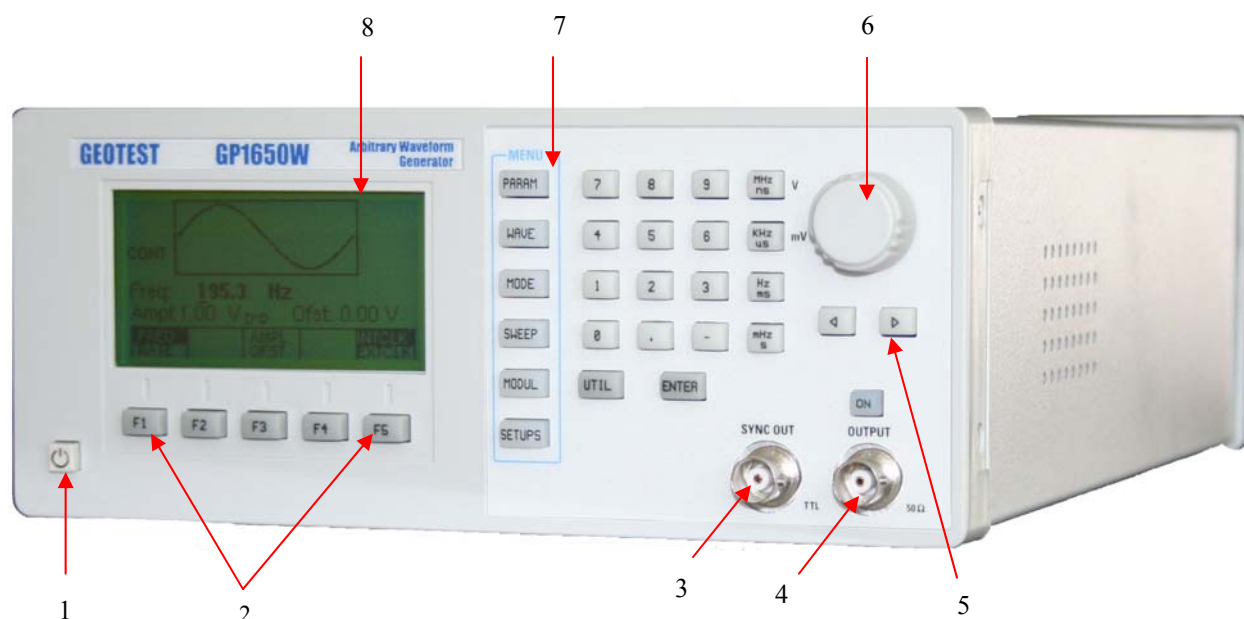
Figure 1-1: Front Panel

Location	Function	Location	Function
1	Power On-Off	5	Cursor Keys
2	Select menu options: F1- F5 Keys	6	Rotary Input Knob
3	SYNC Out	7	Menu Keys
4	Output Connector	8	Display Window

Instrument Description

The Arbitrary Waveform Generator (Arb), generates any waveform that can be expressed as a function of time. The working Random Access Memory (RAM) has four sets of 256 addresses and each address accepts an 8 bit word. This corresponds to a 1024 (time) by 255 (amplitude) matrix in which to draw waveforms. These storage addresses can be manually loaded by front panel controls or remotely loaded via the GPIB interface. The stored waveform, or any portion thereof, then can be generated at selectable clock rates and amplitudes.

In addition to the four working Random Access Memories (RAMs), four pre designed waveform are available: Sine, triangle, square and ramp.

Operation can be continuous or triggered. Triggering can be for a preset number of cycles or the number of cycles triggered can be monitored and displayed. Start and stop addresses are selectable for partial waveform output. Output may be held at any level, or amplitude and offset can be slowly ramped to zero when a ramp to zero command is given.

Front panel operation is by keyboard and display which gives immediate verification of parameter and value in memory.

The GP1650W is fully compatible with the requirements of IEEE Standard 488-1975 for integration into a General Purpose Interface Bus (GPIB).

The Rear Panel

The rear panel connectors are shown in Figure 1-2:
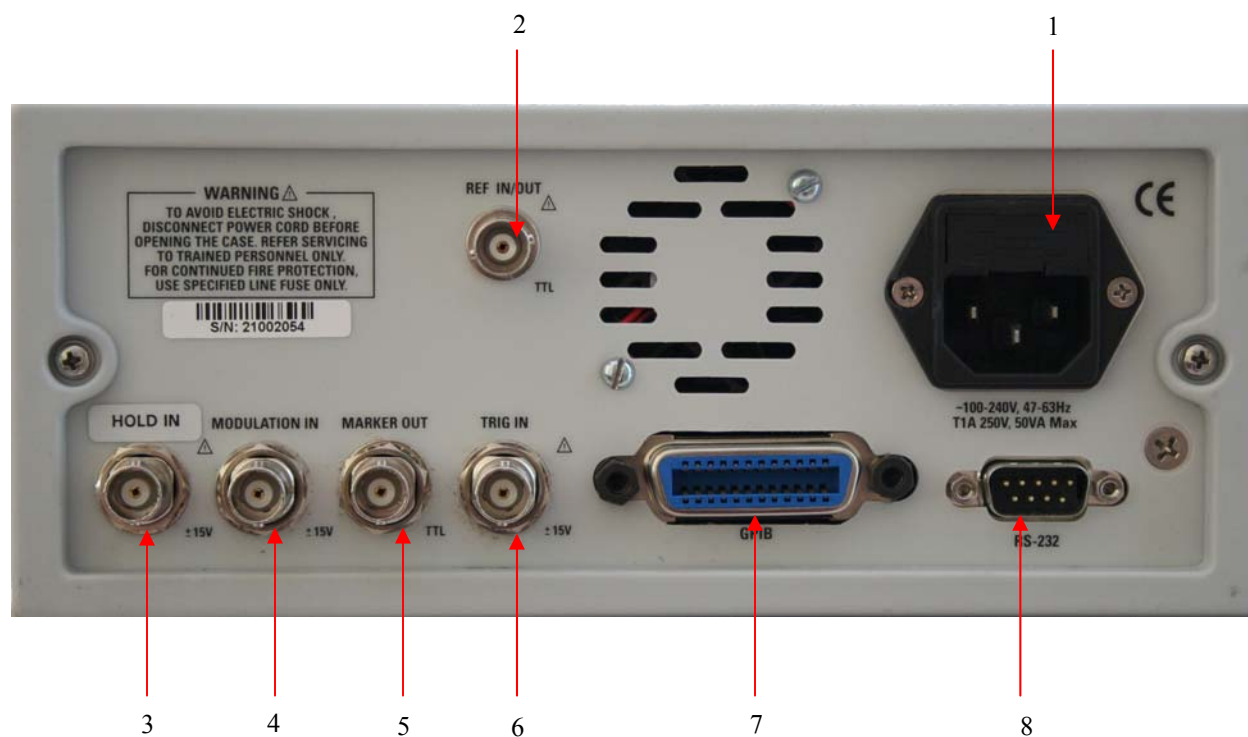
Figure 1-2: GP1650W Rear Panel

Location	Function
1	Power Cord Receptacle
2	Ref In/Out
3	Hold In
4	Modulation Input
5	Marker Output
6	Trigger Input
7	GPIB Connector
8	RS-232 Connector

Rack Mount

The instrument can provided with a rack mount kit for standard 19" rack as shown in Figure 1-4 and Figure 1-3:

Figure 1-3: GP1650W in a Rack Mount Kit – Front

In the rack mount kit the main and Sync outputs are routed to the back.

Figure 1-4: GP1650W in a Rack Mount Kit - Back

Safety Information

The instrument is wired for earth grounding via the facility power wiring. Do not bypass earth grounding with two wire extension cords, plug adapters, etc.

BEFORE PLUGGING IN the instrument complies with installation instructions.

Maintenance may require power on with the instrument covers removed. This should be done only by qualified personnel aware of the electrical hazards.

Warning – notes call attention to possible injury or death hazards in subsequent operation.

Caution – notes call attention to possible equipment damage in subsequent operations.

Chapter 2 - Specifications

General Information

The function generator is a programmable instrument capable of generating predefined Sine, Square, Triangle, Ramp, Arbitrary waveforms and TTL sync as well as a programmable DC output.

Waveforms

The waveforms are: Sine, Square, Triangle, Arbitrary and TTL sync.

Arbitrary Waveforms

Arbitrary waveforms are stored on four 256 X 255 point RAM matrices. Each RAM block can be addressed individually or they can be addressed in sequence. This feature allows additional address resolution of custom waveforms. Block length can be from 2 to 256 address points, or when blocks are stacked, up to 1024 address points.

Sync Output

TTL level pulse with a trailing edge coincident with the start address. Pulse width is one sample time.

Marker Output

TTL level output coincident with a selected data address. Available at rear panel BNC.

Operating Modes

Continuous	Generator operates continuously at selected frequency.
Preset Triggered	Generator quiescent until triggered via front panel key, GPIB program or TTL pulse at rear panel BNC; then a preset number of cycles to 9999 are generated at a selected frequency.
Monitor Triggered	As for Preset Triggered, except the cycles are output continuously after triggering, until a hold command (via front panel key, GPIB program or TTL low at rear panel BNC) is given. The number of cycles generated up to 9999 can be displayed.
Hold Control	GPI B program or TTL low at rear panel BNC can stop the waveform asynchronously to the reference clock.

Sample Time

The stepping time from data point to adjacent data point is selectable as 200 ns to 999.9s for fixed waveforms and Sample time accuracy is ±0.03% of setting. Resolution is 100 ns. Output frequency is 19.5 kHz to 3.90 µHz (71 hr/cycle) rate for a 256 word block. Sample time can be displayed and programmed in seconds, or block rate in hertz.

Reference Clock

Internal 10 MHz crystal controlled oscillator or external TTL compatible frequency source input at rear panel BNC. TTL compatible reference clock output provided.

External Clock

TTL compatible signal applied at rear panel BNC. Permissible external clock frequency is dc to 11 MHz for continuous modes.

Main Output

Sine, square, triangle, ramp and arbitrary waveform selectable. Full block amplitude variable from 2 mV to 20V peak-to-peak into open circuit (10V peak-to-peak into 50m with 3 digit resolution. Amplitude accuracy with 0 Vdc offset between 2 and 20V Pop is ±2% of setting plus 2 digits. Signal offset is from 0 to ±10V into open circuit (0 ±5V into 50 ohm with 3 digit resolution. Offset accuracy is ±2% of setting plus 2 digits.

Output Amplifier Rise/Fail Time

Less than 50 ns, 50 ohm termination, main output.

Display

 All status, modes and functions are shown by LCD graphical display.

External Program Interface

IEEE Standard 488 compatible General Purpose Interface Bus (GPIB). Connector on rear panel. Address setting is via front panel. The interface provides listener (AH1 and L4), talker (SH1 and T6), service request (SR1), remote local (RL1), device clear (DC1) and device trigger (DT1) capabilities.

Amplitude and DC Offset

Measured at full output and 25 ±1° DC.

Timing Parameters

Frequency	0.001 Hz - 5 MHz, sine, square, triangle
Resolution	3 digits
Accuracy	50 ppm
Jitter	<0.1% + 100 ps
Stability	50 ppm

Chapter 3 - Installation

Introduction

This section contains installation information, power requirements, initial inspection and signal connections for the GP1650W Programmable Arbitrary Waveform Generator.

Mechanical Inspection

The GP1650W is a calibrated and ready for use when received. Upon receipt inspect the instrument for damage that might have occurred in transit. If there is damage due to shipping, file a claim with the carrier who transported the unit. The shipping and packing material should be saved if reshipment is required. If the original container is not to be used, then use a heavy carton box. Wrap the unit with plastic and place cardboard strips across the face for protection. Mark the box "FRAGILE". Cushion the instrument with urethane foam between the carton and instrument on all sides. Seal the carton with shipping tape and mark the box "FRAGILE".

Initial Inspection

After the mechanical inspection, verify the contents of the shipment (accessories and installed options). If the contents are incomplete, or if the instrument does not pass the acceptance checks, notify Geotest Customer Support.

Instrument Mounting

The GP1650W can be installed in a rack or used on a bench. The instrument does not require special cooling when operated within conventional temperature limits. A 5 cm minimum clearance must be provided at the rear of the unit for proper operation of the blower. The unit can be installed in a closed rack or test station if proper air flow is assured for removing about 50 W of power dissipation.

Power Requirements

The GP1650W can operate from 100 – 240 Vac, 50/60Hz. The maximum power consumption is 50 VA.

No voltage selection is required.

Use only T 1A, 250 V, 5 x 20 mm fuses. The ac line fuses are located in the fuse holder Assembly next to power cord receptacle. To access the fuse, first disconnect the power cord and then remove the fuse cartridge.

Grounding Requirements

To minimize shock hazard, the instrument chassis and cabinet must be connected to an electrical ground. This instrument is grounded through the ground conductor of the supplied, three-conductor ac power cable. The power cable must be plugged into an approved three-conductor electrical outlet.

Warning - Do not alter the ground connection. Without the protective ground connection, all accessible conductive parts (including control knobs) can render an electric shock. The power jack and mating plug of the power cable meet IEC safety standards.

Signal Connections

Use RG58U 50 Ohm or equivalent coaxial cables for all input and output signals to and from the instrument.

GPIB Connections

The rear panel GPIB connector (Figure 3-1) is an AMPHENOL 57-10240 or equivalent, and connects to a standard IEEE-488 bus cable connector. The GPIB line screens are not isolated from chassis and signal ground.

GPIB Address

The instrument is shipped with the address set to decimal 9. The address can be changed from the front panel by using the "UTIL" menu, refer to "UTILITY FUNCTIONS".
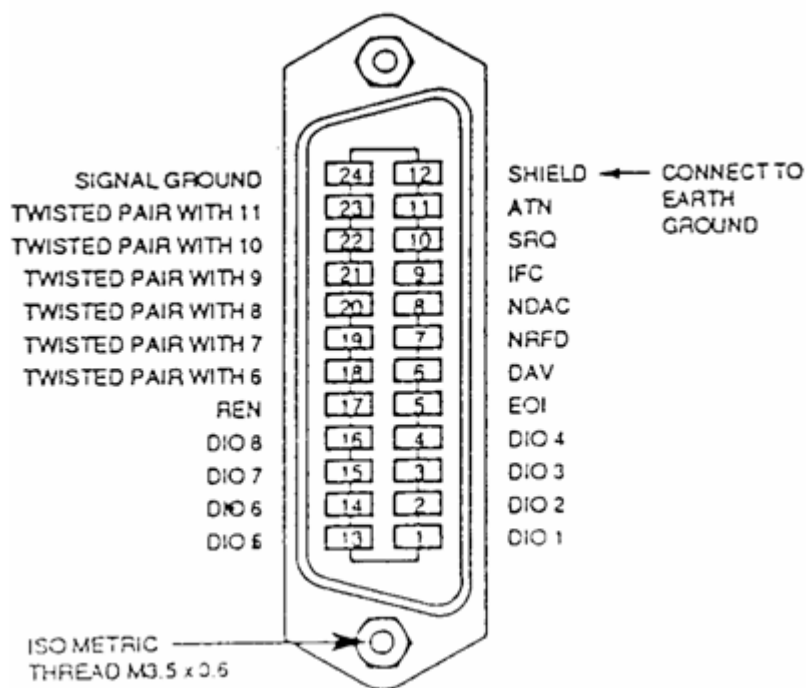

Figure 3-1 : 24-Pin Micro-Ribbon (Series 57) Connector

GPIB Address Codes

Device	Address					
	ASCII		Binary*	Hexadecimal		
	Listen	Talk	5 4 3 2 1	Listen	Talk	
0	SP	@	0 0 0 0 0	20	40	
1	!	A	0 0 0 0 1	21	41	
2	"	B	0 0 0 1 0	22	42	
3	#	C	0 0 0 1 1	23	43	
4	$	D	0 0 1 0 0	24	44	
5	%	E	0 0 1 0 1	25	45	
6	&	F	0 0 1 1 0	26	46	
7	'	G	0 0 1 1 1	27	47	
8	(	H	0 1 0 0 0	28	48	
9	)	I	0 1 0 0 1	29	49	
10	*	J	0 1 0 1 0	2A	4A	
11	+	K	0 1 0 1 1	2B	4B	
12	,	L	0 1 1 0 0	2C	4C	
13	-	M	0 1 1 0 1	2D	4D	
14	.	N	0 1 1 1 0	2E	4E	
15	/	O	0 1 1 1 1	2F	4F	
16	0	P	1 0 0 0 0	30	50	
17	1	Q	1 0 0 0 1	31	51	
18	2	R	1 0 0 1 0	32	52	
19	3	S	1 0 0 1 1	33	53	
20	4	T	1 0 1 0 0	34	54	
21	5	U	1 0 1 0 1	35	55	
22	6	V	1 0 1 1 0	36	56	
23	7	W	1 0 1 1 1	37	57	
24	8	X	1 1 0 0 0	38	58	
25	9	Y	1 1 0 0 1	39	59	
26	:	Z	1 1 0 1 0	3A	5A	
27	;	[	1 1 0 1 1	3B	5B	
28	<	\	1 1 1 0 0	3C	5C	
29	=	]	1 1 1 0 1	3D	5D	
30	>	↑	1 1 1 1 0	3E	5E	

*The 6th and 7th bits which define the ASCII codes are not needed in this application, since device uniqueness is assured with digits 1 thru 5 only. It is desireable for a device to have the same 'binary' listen and talk address.

Chapter 4 - Operating Instructions

Introduction

This section describes the displays, controls, and connectors on the front panel of the GP1650W Arbitrary Waveform Generator. All controls you use for local operation of the GP1650W is on the front panel. The connections are available on the front and the rear panel.

Several front panel controls (keys) select parameters or functions for the waveform output, display the current settings of parameters or functions, and change those settings. Other keys program and generate the waveform output.

Figure 4-1 shows the display, controls, and connectors on the GP1650W front panel.
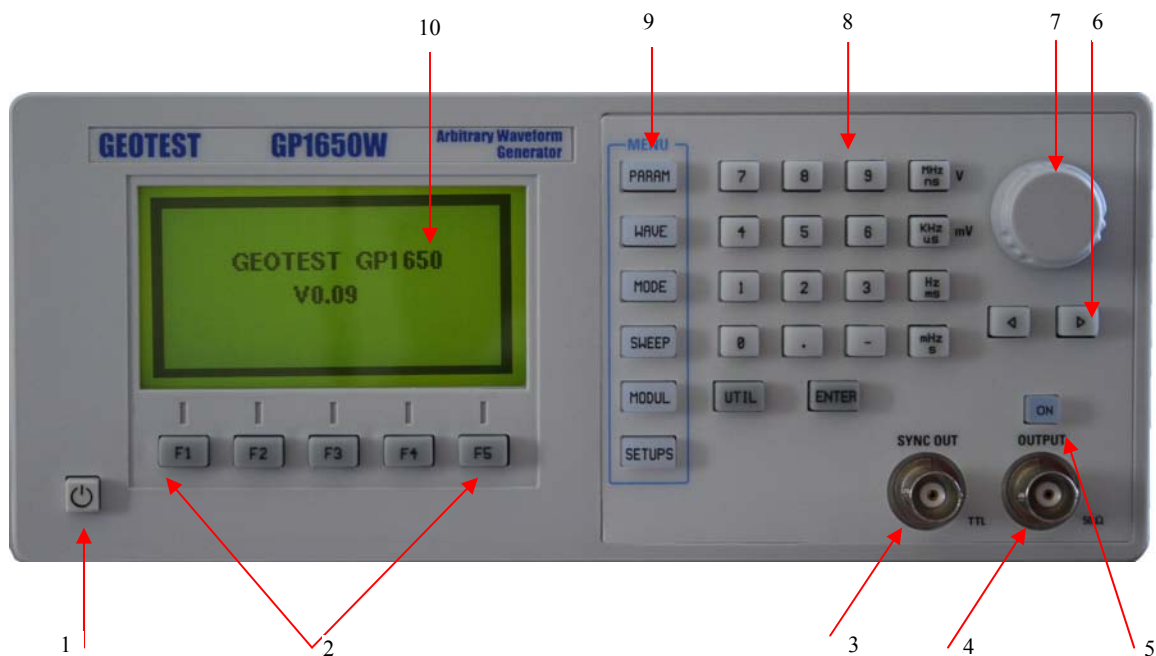
Figure 4-1: GP1650W Front Panel

1	Power On-OFF: Applies and removes power to the unit.
2	F1 through F5 keys: Select menu options that appear on the display window. Menus differ depending on the selected parameter, function or mode.
3	SYNC Out Output
4	Output Connector: Function output. The output status is displayed on the LCD.
5	Output On: Turn output on and off.
6	Cursor Keys: Used to move the cursor (when visible) to either left or right to select which digit the knob will change.
7	ROTARY knob: Used to increment/decrement numeric values above the cursor or to scan through the possible values of non-numeric values.
8	Numeric keypad
9	MENU keys: Select parameters, functions or modes whose settings you want to display or change. Each key causes a different menu to appear on the lower part of the display.
10	Display Window: Displays all instrument data and settings on a LCD.

Display Window

The GP1650W has graphical LCD display window. When you power-on the GP1650W the parameter menu is displayed on the bottom portion of the window. The top portion of the windows shows a graphical representation of the selected waveform and mode.

Changing Settings

When you press the data (numeric or units) keys, the value is entered and displayed at the selected parameter field. To complete a setting change, press ENTER. You can also use the cursor keys and the rotary input knob to change settings.

Front Panel Controls

The front-panel controls select, display, and change parameter, function, and mode settings. Use the data keys, the rotary input knob, and the cursor movement keys to enter data into the waveform generator.

To change a setting:

Press the MENU key that leads to the required item.

Press a F1 to F5 key to select a specific item or a submenu leading to it. Repeat as needed.

Enter the new setting using the numeric keys.

Enter the units for the numeric value.

Press ENTER.

Alternatively:

Press the MENU key that leads to the required item.

Press a F1 to F5 key to select a specific item or a submenu leading to it. Repeat as needed.

Move the cursor to the appropriate position in the numeric field (if applicable).

Use the rotary input to change the value of the displayed item. Changes take effect immediately.

The following subsections describe the function of each front panel key and connector.

Menu Keys

These keys select the main menus for displaying or changing a parameter, function or mode.

Parameters Menu

This key selects and displays the waveform parameters Frequency, Rate, Amplitude and Offset, INTCLK and EXTCLK.

To display a parameter, press PARAMETERS, then press the F1, F3 or F5 key that corresponds to the desired Parameter menu option (see Figure 4-2).

F1: FREQ   (Frequency) Selects and displays the frequency. Change the frequency setting using the data keys or the rotary input knob.

RATE   Selects and displays the Rate. Change the rate setting using the data keys or the rotary input knob. The Rate parameter governs the rate at which waveform points are executed, and thus the frequency of the waveform output. When you set this parameter, the waveform generator will keep that execution rate for all waveform lengths until it is changed.

F3: AMPL   (Amplitude) Selects and displays Amplitude. Change amplitude using data keys or the rotary input knob.

   OFST   (Offset) Selects and displays the Offset. Change the offset setting using the data keys or the rotary input knob.

F5: INTCLK   Selects internal clock as reference clock.

F5: EXTCLK   Selects external clock as reference clock.
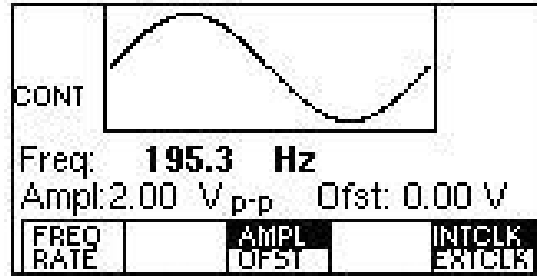
Figure 4-2: Parameter Menu
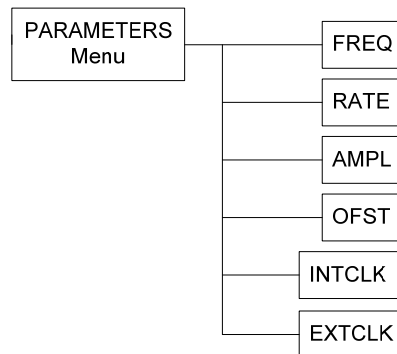
Figure 4-3: Parameters Menu Options

Waveform Menu

Displays the waveforms available: SINE, SQR (Square), TRI (Triangle), RAMP and ARBitrary.

To select the output waveform, press WAVEFORM, then press the function key that corresponds to the desired Waveform menu option.

F1: SINE   Selects the Sine waveform.

F2: SQR   (Square) selects the square waveform and displays the waveform duty cycle.

F3: TRI   (Triangle) selects the triangle waveform and displays the waveform duty cycle.

F3: SQR   (Square) selects the square waveform and displays the waveform duty cycle.

F4: RAMP   (Ramp) selects the ramp waveform and displays the waveform duty cycle.

F5: ARB   (Arbitrary) selects the Arbitrary waveform and displays the waveform duty cycle and switches to

the ARB sub menu.
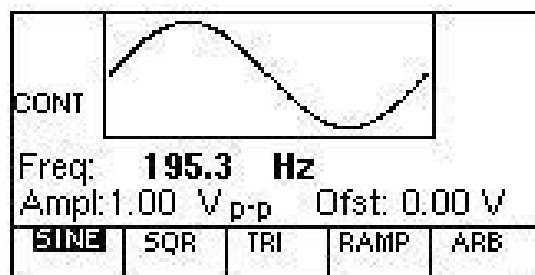
Figure 4-4: Waveform Menu
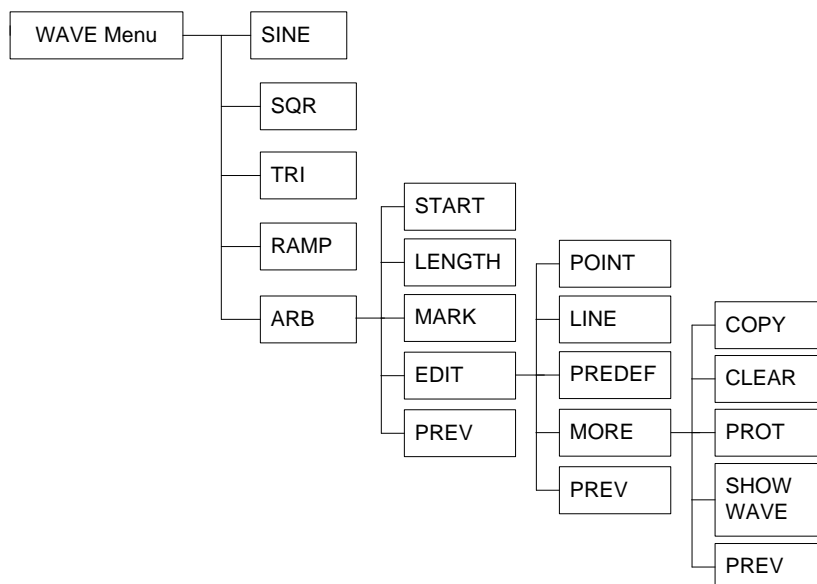
Figure 4-5: Waveform Menu Options

Waveform ARB Sub Menu

After selecting the Ramp in the Wave menu, the Waveform sub menu is available:
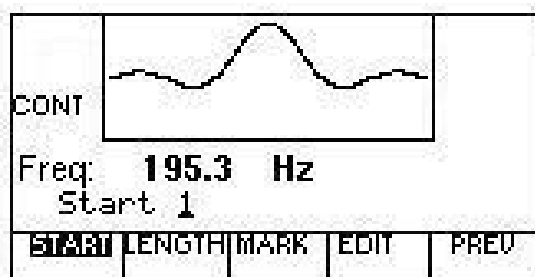
Figure 4-6: Waveform Sub Menu

F1: START	Selects between Frequency and Period for setting and display
F2: LENGTH	Display the length of the waveform
F3:MARK	Displays Marker/Sync menu
F4:EDIT	Edit Arbitrary waveform
F5: PREV	Returns to Waveform menu
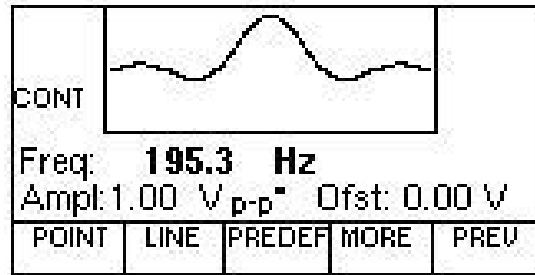
4-7: Waveform Edit Menu

Mode Menu

Selects the output mode: CONT (Continuous), TRIG (Triggered), GATE (Gated), and BURST. To select the output mode, press MODE, then press the function key that corresponds to the desired Mode menu option:
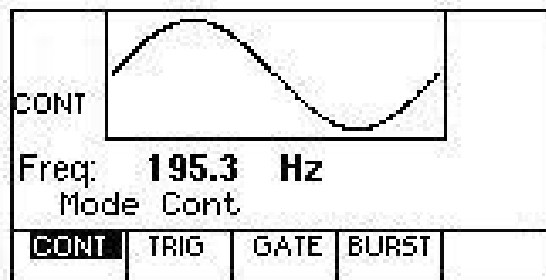
Figure 4-8: Mode Menu

F1: CONT   (Continuous) Selects continuous output.

F2: TRIG   (Triggered) Triggers one output cycle of the selected waveform for each trigger event.

F3: GATE   (Gated) Triggers output cycles as long as the trigger source asserts the gate signal.

F4: BURST   (Burst) Trigger outputs N cycles for each trigger event, where N ranges from 2 to 999999. Change N by using either the data keys or the rotary input knob.
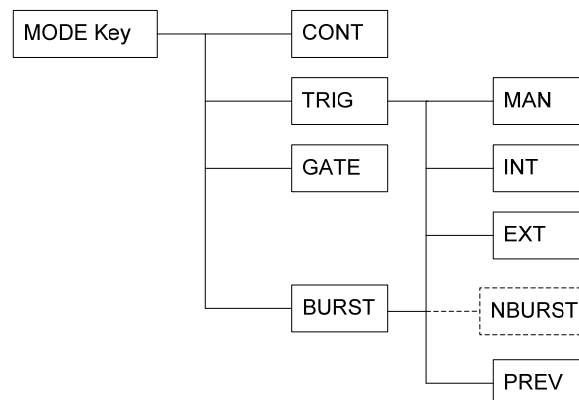
Figure 4-9: Mode Menu Options

Mode Sub Menu

After selecting the TRIG or BURST in the Mode menu, the Mode sub menu is available:
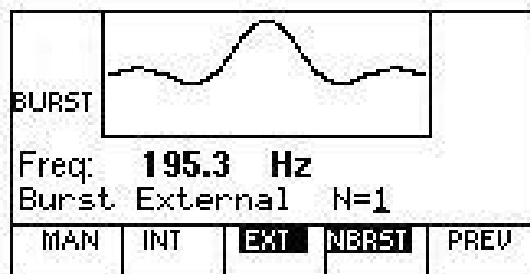
Figure 4-10: Mode sub Menu

F1: MANual	Selects manual as the trigger source. To trigger the waveform generator, press the MAN TRIG key on the front-panel.
F2: INTernal	Selects the internal trigger generator as the trigger source. Change the internal trigger rate with the data keys or the rotary input knob.
F3: EXTernal	Selects the external trigger signal as the trigger source. The trigger source is supplied through the TRIG IN connector for the appropriate channel. Pressing F3 (EXT), displays the External TRIGGER Submenu so you can set the external trigger qualifications.
F4: NBURST	Select number of cycles for burst available only when in burst mode.
F5: PREV	Returns to Mode menu

Sweep Menu

Sweep is Not Available

Modulation Menu

Sets the Modulation mode ON or OFF.

To select the modulation mode, press MODULATION, then press the function key that corresponds to the desired menu option, as shown in Figure 4-11.
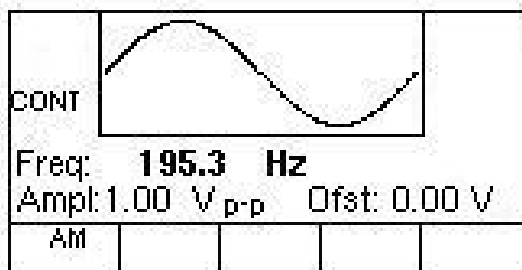
Figure 4-11: Modulation Menu

F1: AM   Displays the AM menu: Enable or Disables AM.
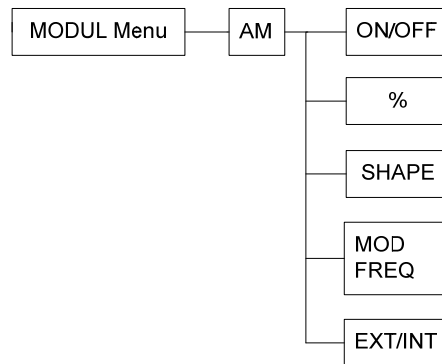
Figure 4-12: Modulation Menu Options

F1: ON/OFF   Sets the Modulation mode ON or OFF

F2: %   Sets modulation factor

F3: SHAPE   Select modulating waveform

F4: MOD FREQ Sets modulation frequency

F5: EXT/INT   Selects internal or external modulation source

Setups Menu

The waveform generator can store the current front-panel settings, called a setup, into one of 49 storage buffers. When you recall a setup, the waveform generator restores the front-panel settings to those that you stored in the selected buffer. All waveform data is stored in the setup.
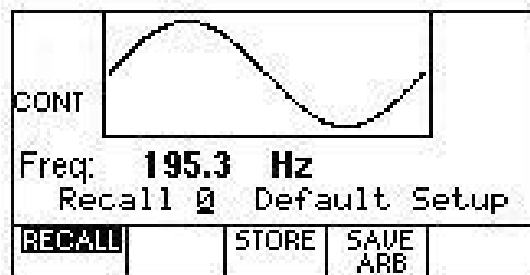
Figure 4-13: Setups Menu
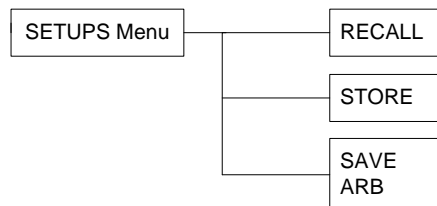
Figure 4-14: Setups Menu

F1: RECALL Recalls a previously stored front-panel setup from the selected buffer. Change the buffer number by using the rotary input knob or data keys. Valid storage buffer numbers are from 1 to 49.

Buffer 0 is the factory default setup; buffer 50 is the last front panel setup before power-off.

F3: STORE   Stores the current front-panel setup to the specified storage buffer. Change the buffer number by using the data keys or the rotary input knob. Valid storage buffer numbers range from 1 to 49.

F4: SAVE ARB

        Saves the current arbitrary waveform to flash memory

F5:   Press F5 three times to access the Special Setups sub menu.
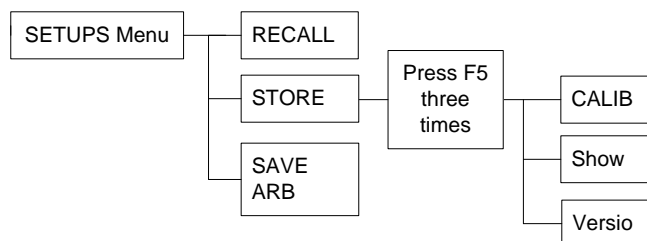
Figure 4-15: Setups Menu Options

Special Setup Menu

After pressing F5 three times in the Setup menu, the Special Setups sub menu is available.

F1: CALIB   Perform instrument calibration. See Chapter 6 – Maintenance.

F2: Show   Shows calibration values

F3: Versio   Shows firmware version
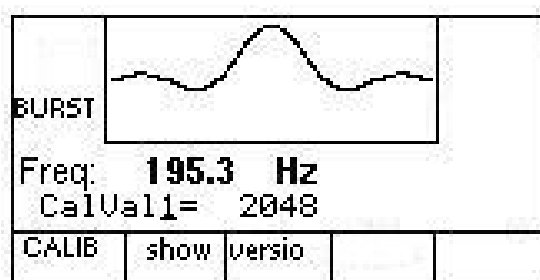
4-16: Special Setups Menu

Connectors

The waveform generator has two BNC connector on the front panel and five on the rear panel where you can connect coaxial cables. These coaxial cables provide input and output signals to and from the function generator.

Output Connector   Use this connector to transfer the main output signal from the waveform generator front.

Ref In/Out Connector   Use this connector to output the 10 MHz internal reference clock or to input a 10MHz TTL signal to be used as a reference clock for the unit generation.

Trig In Connector   Use this connector to transfer an external trigger or gate signal, depending on the waveform generator setting, to the waveform generator.

Hold In Connector   Use this connector to input a TTL signal that controls the arbitrary waveform output. When the input is high, the arbitrary waveform output stops and the output voltage remains at the level of the last point output. When the input is low, the arbitrary waveform output resumes. When not connected, a low level is assumed.

Modulation In Connector   Amplitude Modulation input. 5V p-p signal for 100% AM modulation, 10Kohms input impedance with DC - >50KHz bandwidth.

Marker Connector   Use this connector to output a positive TTL pulse that indicates the general passed the programmed marker address.

Output Connections

The waveform generator output circuits operate as a 50 ohm voltage source working into a 50 ohm load. At higher frequencies, un-terminated or improperly terminated output can cause aberrations on the output waveform. In addition, loads less than 50 ohms reduce the waveform amplitude, while loads more than 50 ohms increase waveform amplitude.

Excessive distortion or aberrations caused by improper termination are less noticeable at lower frequencies, especially with sine and triangle waveforms. To ensure waveform integrity, follow these precautions:

1.   Use good quality 50 ohms coaxial cable and connectors.

2.   Make all connections tight and as short as possible.

3.   Use good quality attenuators if it is necessary to reduce waveform amplitudes applied to sensitive circuits.

4.   Use termination or impedance-matching devices to avoid reflections.

5.   Ensure that attenuators and terminations have adequate power handling capabilities.

If there is a DC voltage across the output load, use a coupling capacitor in series with the load. The time constant of the coupling capacitor and load must be long enough to maintain pulse flatness.

Memory Data (Y) for Arbitrary Waveforms

This parameter is used to read and program data points in the waveform memory. The MEMORY DATA key provides access to the data point located at the address specified by the memory address parameter (X) in the memory block specified by the function parameter (C). Programming a value into this parameter changes the data point value if the memory block is a RAM block; otherwise, nothing happens.

This change occurs immediately without use of an execute. This parameter has an automatic increment feature. If the memory data key (Y) is pressed (or Y is programmed over the GPIB) twice without pressing any other alpha key, then the second pressing will increment the memory address parameter (X) value and display the Y data a t the

new address. Additional pressings will continue to increment the address until the sequence is broken by pressing another alpha key.

Note that it is possible to program a new Y value between pressings of the memory data key; this provides a convenient way to program successive data points using only the memory data key. For example, a ramp from 127 to -127 can be programmed as follows: Y 127Y 126Y 125Y . . . . . Y-126Y-127Y-127 (a total of 256 settings). This parameter also provides an alternate "interpolation mode" form of programming used to draw straight line segments. This mode is activated when two pairs of X,Y data point settings are programmed with no other keys pressed (or no other alphabetic characters programmed over the GPIB). After the second pair is programmed, a line is drawn between the first and second points, approximating a straight line as closely as possible. When composing waveforms by entering data only when a change in slope is required, the microprocessor automatically draws the line (step linearly) between the points entered. If the slope (Change in Y/Change in X) is not a whole number, the microprocessor plots two or more line segments that approximate a single line segment as nearly as possible. ("Line segment" referred to here is a set of linear steps.)

Additional X,Y pairs may be programmed and lines will then be drawn between the second and third, third and fourth, etc., points. To exit from interpolation mode, just press a key other than memory address or memory data. Table 3-1, step 8, shows an example of programming a complete block of RAM using the interpolation mode.

Important notes for the interpolation mode are:

1. Each parameter (X or Y) of the X,Y pairs must be programmed with a new value. Just pressing a memory address or data key is not sufficient.

2. The parameters must be entered in the order XYXY . . .(not YXYX).

3. No other alpha keys may be pressed during an XYXY . . . interpolation sequence.

    Example: XOYOX100Y100I will draw a straight line from (0,O) to (100,100), but XOYOAXlOOY100 will

    only set the data points a t memory locations 0 and 100 to 0 and 100, respectively, leaving the other 254

    data points untouched.

Sample Time (T) and Waveform Smoothing

Hardware dictates a stepping time resolution of 100 ns. This results in sample time round off.

Both sample time steps and smoothing steps are clock controlled; RAM and counter waveforms have a minimum step time of 200 ns. Arb software detects sample times of less than 200 ns and returns ERROR readout when an attempt is made to place those times in scratch pad memory.

When the sample time is programmed, the unrounded value is retained. Rounding is done when the execute action takes place, allowing the precision of the programmed value to be the maximum possible. For example, assume that the sample time is programmed to be 23.45 µs. In this case, the sample time will be rounded to 3 digits (23.5ps) when execute occurs.

Clock Time Units(S)

This parameter selects whether the sample time parameter (T) is programmed and displayed in seconds.

The actual time programmed will be displayed when sample time (T) is selected.

Full or Partial Block (U)

The full or partial block parameter selects whether a block consists of either the entire 256 points available or a portion of them selected by the block start address (V) and block stop address (W) parameters. If a full block (UO) is selected, the waveform is output by sequentially reading the sample points from the selected block starting at address 0 and ending at address 255. If a partial block (U l) is selected, the sample points are sequentially read starting at the

block start address parameter value and ending at the block stop address parameter value. The start and stop address parameters should not be set to the same value if a partial block is selected, because no waveform will be generated. If an execute (Ii)s done in this case, an ERROR will be displayed, although the start and stop addresses will be programmed into the waveform generator circuits anyway. If two or more blocks are joined together and partial block (U 1) is selected, then the resulting waveform is composed of the selected portion of each block. The start address may be greater than the stop address; in this case, the block: "wraps around" from address 255 to address 0.

Block Rate (F)

The block rate parameter is not a separate parameter. Instead, it is an alternative means of setting the sample time parameter in terms of the repetition frequency of blocks. When a block rate is programmed, the sample time necessary to produce it is computed from the number of blocks stacked together; the programmed block rate and the current size of a block as selected by full/partial block parameter and the start and stop block address parameters.

Note: When partial is selected, the block rate is the rate of the partial block.

It is not possible, in general, to compute a sample time which will produce the desired frequency exactly. Consequently, when the block rate is displayed on the front panel, the number displayed is not the block rate that was programmed, but the block rate actually being produced.

If the full/partial block parameter code is zero,

$$\text{Sample Time} = \frac{1}{\text{Block Rate} * 256 * \text{No. of Blocks}}$$

If the full/partial block parameter code is one and the stop address is greater than the start address,

$$\text{Sample Time} = \frac{1}{\text{Block Rate} * (\text{Stop Adr} - \text{Start Adr} + 1) * \text{No. of Blocks}}$$

If the full/partial block parameter code is one and the stop address is less than the start address,

$$\text{Sample Time} = \frac{1}{\text{Block Rate} * (\text{Stop Adr} - \text{Start Adr} + 257) * \text{No. of Blocks}}$$

Amplitude (A) and Offset (D)

The amplitude parameter selects the amplitude generated by a waveform memory data point value of + 127 (or the negative amplitude generated by a value of - 127) at the ARB OUT (ATTEN) BNC connector. Smaller data point values will produce proportionately smaller amplitudes. Values from 1 mV p-p to 10 V p-p (and -1mVp-p to -10V p-p) into 50 Ω and 0 may be programmed with 3 digit resolution. Negative values of amplitude invert the waveform.

The offset parameter selects a dc offset to be added to the output waveform. Values from 1 mV to 5V (and -1mV to -5V) and 0 may be programmed with 3 digit accuracy into 50 Ω.

The amplitude and offset are not completely independent of one another, because they share a common output amplifier and attenuator. In certain cases it may become necessary to decrease the number of digits of resolution of amplitude or offset (or both) in order to either prevent clipping in the output amplifier or to make the programmed value of offset (or amplitude) appear at the output despite an unfavorable attenuator setting required by a larger value of amplitude (or offset). The sum of amplitude or offset controls the output amplifier and attenuator. The output amplifier is limited to 10V p-p (into 50 Ω). The attenuator operates at one of the values of $X\ 10^0$, $X\ 10^{-1}$, $X10^{-2}$, or $X\ 10^{-3}$ (0 dB, -20dB, -40dB, -60 dB).

If the absolute peak value at the amplifier input (which is the sum of the absolute values of the amplitude and offset mantissas, when amplitude and offset are expressed in scientific notation) exceeds 10V, then logic divides the values programmed into the amplitude and offset by 10 and, to maintain the desired output level, decreases attenuation by a factor of 10 also. If this must be done, then one digit of resolution is lost from both amplitude and offset. This

adjustment cannot be done if the sum of the absolute values of the programmed amplitude and offset (which is the X 10 multipliers as well as the mantissas) is greater than 10V;   in this case, the output will be clipped.

To determine if there is clipping or loss of resolution, perform the following calculations:

1. Add twice the absolute value of the desired offset to the absolute value of the desired amplitude. If the sum exceeds 10, clipping will occur. If not, go to step 2 to determine a trial attenuator setting.

2. Write the larger of the absolute amplitude or twice absolute offset in the form N.NN X 10^X,   where N.NN is between 1.00 and 9.99. Then X 10^x is the trial attenuator setting. Perform step 3 to determine if the amplifier output would be clipped for the trial attenuator setting.

3. Take the sum of amplitude and offset computed in step 1 and write it in the form MM.MM X 10^X,   where x is the exponent computed in step 2. If MM.MM is greater than 9.99, then one digit of resolution must be lost from both amplitude and offset in order to prevent the output amplifier from clipping. Perform step 4 if there was no loss of resolution to determine if the smallest amplifier input caused too many significant digits.

4. Write the amplitude or twice the offset, whichever is smaller in absolute value, in the form Y.YYZZZ X 10^X, where x is the exponent computed in step 2. If any of the digits ZZZ are not zero, then resolution is lost, because only Y.YY can be used to program the waveform generator circuits.

Errors

Programmed values are evaluated by the microprocessor when it receives a following alpha or terminator character.

This character acts as a terminator, indicating that the operator is through selecting the numerical value. If, after round off, the value is out of range for the selected parameter, an ERROR message is placed on the display and the scratch pad memory is not changed. If executed, output would be the current values in scratch pad memory.

When the execute key is pressed, two error tests are made: one for clipping (absolute value of amplitude plus absolute value of offset greater than 10V p-p into 503) and one for misprogramming of the block start and stop addresses (start (V) and stop (W) addresses equal and partial block mode enabled (U1)). If clipping error is detected, ERROR will be displayed on the front panel and the incorrect parameters will be sent unaltered to the waveform circuits. If start and stop addresses are equal, ERROR is displayed and the last legal addresses are retained.

Preset and Monitor Trigger (M)

In both modes the waveform may be stopped a t any time with a hold command (H), and then resumed from the place where stopped with a trigger (J). If the preset mode is selected, the trigger will reset the cycle counter before summing the waveform, thus restarting the process of generating a preset number of cycles. In this case, the preset length (L) parameter determines the number of cycles generated after the trigger, with the first cycle being composed of the remaining portion of the cycle that was interrupted by the hold command.

Operating Considerations

Caution - Observe the specified maximum input voltage ratings listed in the Electrical Specifications in this document; otherwise, instrument damage can occur if the maximum input ratings are exceeded.

Impedance Matching

If the waveform generator is driving a high impedance, such as the 1 mega Ohm input impedance (paralleled by a shunt capacitance) of an oscilloscope vertical input, connect the transmission line to a 50 ohm attenuator, a 50 ohm termination, and the oscilloscope input. The attenuator isolates the input capacitance of the device and terminates the waveform generator properly.

Error Check

At power-on, the waveform generator performs a diagnostic self-test procedure to check itself for errors. If it finds an error, an error code and text appear in the display window. Other error codes appear when you enter an invalid front-panel setting.

Power-On Settings

When the waveform generator finishes the diagnostic self-test routine, it enters the local state (LOCS) and assumes the last saved settings.

Using the GP1650W

This section explains how to generate various waveforms and modify the output waveform, including:

Selecting a waveform

Modifying waveform output

Storing and recalling a waveform generator setup

Selecting a Waveform

You can select several standard waveforms such as: sine, triangle and square. Creating a standard waveform requires selecting the waveform type, parameters, modes, etc., and other r settings that define the waveform.

Generating a standard waveform requires the following:

- Selecting the waveform
- Setting the output frequency
- Setting the output amplitude and offset

Selecting the Waveform

To select a waveform:

1. Press the WAVEFORM key.
2. Select the waveform from the menu available.

Setting the Output Frequency

To set the output frequency:

1. Press PARAMETER to select the Frequency parameter.
2. Use the rotary knob to set the frequency.

Setting the Output Amplitude

To set the output amplitude:

1. Press PARAMETER to display the Parameter menu.
2. Press F3:AMPL to select the Amplitude parameter.

3. Use the rotary knob to set the amplitude.

4. Press F:OFST again to select the Offset parameter.

Setting the Output Mode

 To set the output mode:

1.   Press MODE to display the Mode menu on the display window.

2. Press the function key (Fl to F5) that corresponds to the desired mode.

Setting the Output

To set the output channel, press the Output ON key.

Chapter 5 - Programming

Overview

This section provides detailed information on programming the GP1650W. The firmware is customized to be fully compatible with the Wavetek 175 GPIB (referred to General Purpose Interface Bus) command set. Software test procedures using the original Wavetek 175 instrument require no code modification when upgrading to the GP1650W.

The GP1650W uses all lines on the bus, terminations, logic levels and pinouts.

Address Assignment

The instrument's GPIB address can be set or checked by using the Utility menu. The address is then displayed in decimal form. The address can be modified using the keypad or the rotary knob.

Talk and listen addresses are transmitted by the system controller over the data bus with the ATN line true. When and instrument recognized its address, it will respond accordingly i.e. listen if listen address has been transmitted. When allocating addresses, make sure no two instruments have the same address.

Error Reporting

In general, whenever a program attempts to put the GP1650W into an error condition, the GP1650W responds by making a Service request i.e. set SRQ line true. Under these circumstances, the system controller will address the GP1650W as talker using a serial poll command (SPE), the GP1650W then responding by putting an error message on the data bus. This message consists of a single 8-bit byte in which SRQ bit 7 is set true ('1') and bits 1 to 3 comprise an error code.

Should a more detailed description of the error be required (e.g. duty cycle error or width error when TIMING ERROR is indicated by the status byte), this can be done via the "interrogate error" (IERR) command.

Device Address

The GPIB address of the device may be set to any value from 0 to 31. The address may be changed from the front panel using the numeric keypad or rotary encoder.

Setting the device to address 31 places the instrument in the 'off-bus' state. In this state it will not respond to messages on the GPIB. If the device is in the REMS when set to address 31, an internal 'return-to-local' command will be given, setting the device to the LOCS. If the device is in the RWLS, the 'return-to-local' command is ignored, and the device remains in the RWLS. The only way to then re-establish communication with the device over the GPIB is to cycle the power, and to then change the address to that required from the front panel.

Instrument Reset

Sending a 'Device Clear (DCL)' command initiates an instrument reset to the standard setup state. Table 5-1 lists the standard settings.

Key Function	Setting	Comments
FREQUENCY	193Hz	Wave frequency
AMPLITUDE	1.00 V	Peak-to-peak output amplitude
OFFSET	0.00 V	Zero offset
DTY	50 %	Duty Cycle
RPT	100 mS	repetition rate
MODE	CONT	Waveform mode
BUR	2	Waves per burst

Table 5-1: Standard Device Clear Settings

GPIB

The GPIB interface is an implementation of IEEE Standard 488-1978. It supports the following interface functions: Source Handshake (SH1), Acceptor Hand-shake (AH1), Talker (T6), Listener (L4), Service Request (SR1), Remote Local (RL1), Device Clear (DC1) and Device Trigger (DT1). The talk capability allows a device to send data (such as error message readings) out over the bus. The listen capability allows a device to receive data (such as device programming information) from the bus.

When the instrument is configured for remote mode by the GPIB controller the LCD window will not display any waveform information. It will only show REMOTE CONTROLLED – GPIB

Bus Lines Defined

The GPIB consists of 16 signal lines:

DIO1- DIO8	Data In/Out Lines
ATN	Attention
REN	Remote Enable
DAV	Data Available
NRFD	Not Ready For Data
NDAC	Not Data Accepted
EOI	End Or Identify
SRQ	Service Request
IFC	Interface Clear

1. **DIO1-DIO8 –** These eight lines (Data In/Out) are used to send commands from the controller and transfer data back and forth between instruments and the controller.

2. **ATN –** This line (Attention) is operated only by the controller. It specifies whether the information on lines DIO1-DIO8 is data (ATN false) or a command (ATN true). Whenever ATN is set true, no activity is allowed on the bus except for controller-originated messages; additionally, every device connected to the bus is required to receive and process every command sent by the controller.

3. **REN –** This line (Remote Enable) controls whether devices on the GPIB are in local or remote modes. In local mode, devices respond to front panel commands and do not respond to GPIB originated commands. In remote mode, the situation is reversed: GPIB originated commands are obeyed, while front panel commands are ignored. The GP1650W enters the remote state when it receives its listen address and REN is enabled. The GP1650W then stays in the remote mode until the REN line is put in the local state, a Go To Local (GTL) command is received or the LOCAL front panel key is pressed.

4. **DAV, NRFD, NDAC –** These are the "hand-shake" lines (Data Valid, Not Ready For Data and Not Data Accepted) which regulate the transmission of information over the lines DIO1-DIO8. For each command or data byte transferred, a complete handshake is designed to hold off the bus until the slowest device has accepted the information.

5. **EO1 –** When ATN is false, EOI (End Or Identify) indicates that the data on lines DIO1-DIO8 is the last byte of a data message. When the GP1650W receives a data byte with EOI true, the GP1650W automatically supplies a terminator character following the data byte. When the GP1650W transmits the last byte a message (which is always a terminator character), it also sets EOI true.

6. **SRQ –** This line (Service Request) is used by the GP1650W and other devices on the bus to signal to the controller that they request attention. Since the SRQ line is common to all devices, additional tests must be made to determine which devices are signaling. The controller performs a Serial Poll to accomplish this.

7. **IFC –** This line (Interface Clear) is used by the controller to reset the interface logic to a known state for all devices connected to the bus interface. Commands

Commands are sent over lines DIO1-DIO8 with ATN true. They are divided into five classes.

Listen Addresses

Talk Addresses

Secondary Addresses

Universal Commands:

     DCL – Device Clear

     SPE – Serial Poll Enable

     SPD – Serial Poll Disable

     LLO – Local Lockout

Addressed Commands:

     GTL – Go To Local

     SDC – Selective Device Clear

     GET – Group Execute Trigger

Listen Addresses

Listen addresses are used to command a device to read data bytes transmitted over lines DIO1-DIO8. There are 31 different available addresses (hexadecimal codes 20 through 3E, ASCII codes **SP** through >). A 32nd address, called unlisten (hexadecimal **3F**, ASCII **?**), is used to command all devices to not read data bytes. The GP1650W listen address is selected by the rear panel switches, which specify the lower 5 bits of the address. Pressing the front panel ADRS key displays the GPIB address as a decimal device number followed by the ASCII character listen and talk addresses.

Talk Address

Talk addresses are used to command a device to transmit data over lines DIO1-DIO8 whenever ATN is false. There are 31 different available addresses (hexadecimal codes **40** through **5E**, ASCII codes @ through ↑). A 32nd address, called untalk (hexadecimal **5F**, ASCII →) is used to command all devices to cease talking. The lower 5 bits of the GP1650W talk address are selected by the same rear panel switches used to select the listen address. Thus, if the GP1650W listen address is hexadecimal **21** (ASCII !), the talk address is hexadecimal **41** (ASCII **A**). Pressing the front ADRS key displays the GPIB address as a decimal device number followed by the ASCII character listen and talk addresses.

Secondary Address

Secondary addresses are used following a talk or listen address to provide the ability to address more than the 31 devices provided for by simple talk or listen addresses. Secondary addresses are ignored by the GP1650W.

Universal Commands

Universal commands are used to command a device to perform designated actions. Universal commands are recognized at all times. Universal commands performed by the GP1650W are:

1. **Device Clear (DCL) –** Resets the GP1650W to the initial power on settings, DCL affects all devices on the bus. The information is also set into the waveform generating circuitry.

2. **Serial Poll Enable (SPE) –** Causes the instrument to engage in a serial poll by responding with the serial poll status byte when addressed as a talker. Data line DIO7 will be on, if service is being requested on the SRQ line. When the status byte is read, it is reset to an ASCII blank, and the SRQ line is released (of course, it may still be held down by other devices). The status byte is also available by reading the GP1650W talk message number 2. When this message is read, the status byte is reset and SRQ released as for the serial poll.

3. **Serial Poll Disable (SPD) –** Discontinues serial poll. Returns instruments to normal talk modes.

4. **Local Lockout (LLO) –** Causes the GPIB interface to enter a state where the front panel LOCAL key is inoperative. Once in this state, the only way to take the interface out of this state is to put the REN line in the local state. Local lockout must be sent to the GP1650W to totally disable front panel modification of the state of the instrument.

Addressed Commands

Addressed commands are used to command a device to perform designated actions. Addressed commands are recognized only when the instrument is addressed as a *listener*. Addressed commands performed by the GP1650W are:

1. **Go To Local (GTL) –** Commands GP1650W to go to local mode.

2. **Selective Device Clear (SDC) –** Resets the GP1650W to initial power on conditions. SDC affects only the selected unit.

3. **Group Execute Trigger (GET) –** Causes the actions as specified by the GET mode (**XG**) code. If the GP1650W micro-processor is idle ((i.e., not processing a previously sent programming string), a GET command will be completed within 2.5 ms 0f receipt. Otherwise, it will not be done until current programming is processed.

Data Transfer

In addition to accepting programming characters, the GP1650W will transmit status information over the bus. To program the instrument, first send the listen address (with ATN on), followed by the programming data (in ASCII, with ATN off). The instrument microprocessor accepts the data as fast as possible, until either 64 characters are received or there is a pause during the transfer of data. At that time, the entire string of received characters is scanned by the microprocessor, which carries out the scan and accepts the next 64 character string; it puts a display on the front panel which reflects the state of input processing at that point. If the EOI line is asserted while sending a character to the GP1650W, the currently programmed terminator character will be put into the input string following the character with the EOI.

Local

Any key in the front panel switches the GPIB interface to the local mode if it is not locked out.

GPIB Talk Message and Terminator Character (R)

One key (or "R" on GPIB) controls two parameters: the terminator character and the type of talk message sent when the Arb is addressed to talk over the GPIB. The terminator character is selected by programming a minus and the decimal value of the ASCII character that is to be the new terminator. Any ASCII character is acceptable except NUL (decimal code 0), so allowed values for programming the terminator range from -1 to -127.The terminator character has two uses. During output from the Arb over the GPIB, it is appended to every talk response. During input, it signals the end of a group of programming characters; in particular, it indicates the end of a number. At power on time, the terminator character is the line feed control character, decimal code 10. When the Arb sends a talk message, the terminator character is the last byte sent. In addition, the End Or Identify (EOI) line is pulled low (GPIB END message) during the terminator character transmission. If the device receiving the talk message requires a terminating character, but does not recognize either the line feed character or the END message, then a new terminator character must be programmed. For example, to change the terminator character to a carriage returns (decimal code 13), program "R-13".

Commands Summary

Command	Description
Q - GPIB Service Request Enable:	
Q 0	Suppresses all service requests.
Q 1	Enables service request for errors.
Q 2	Enables service request when the waveform generation circuits make a transition from not holding to holding.
Q 3	Enables service request for errors and transition to holding.
R - GPIB Talk:	
R 0	State of hold status.
R 1	List of first nine errors since this message was last read.
R 2	Reason why this instrument is requesting service.
R 3	Current value of the setting.
G - Ramp to Zero	
Z - Reset	
B - Mode, Continuous or Triggered:	
B 0	Continuous
B 1	Triggered
N - Clock, Internal or External:	
N 0	Internal 10 MHz clock.
N 1	External clock.
S - Clock, Time Unit:	
S 0	Seconds
S 1	Minutes
S 2	Hours
T - Clock, Sample Time	

Command	Description
F - Clock, Block Rate	
M - Trigger Cycle, Preset or Monitor:	
M 0	Preset Mode.
M 1	Monitor Mode.
L - Trigger Cycle, Preset Length.	
K - Trigger Cycle, Monitor Count.	
U - Block, Full or Partial:	
U 0	A full 256 address block.
U 1	Partial block forms one cycle.
V – Block, Start Address	
W – Block, Stop Address	
C – Function:	
C 0	Sine
C 1	Triangle
C 2	Square
C 3	Ramp
C 4	Prom block 1
C 5	Prom block 2
C 6	Prom block 3
C 7	Prom block 4
C 8	RAM block 1
C 9	RAM block 2
C 10	RAM block 3
C 11	RAM block 4
C 14	PROM block 1
C 15	PROM blocks 1 & 2
C 16	PROM blocks 1.2 & 3
C 17	PROM blocks 1, 2,3&4
C 18	RAM block 1
C 19	RAM blocks 1 & 2
C 20	RAM blocks 1, 2 & 3
C 21	RAM blocks 1, 2, 3 & 4
X – Memory Address	
Y – Memory, Data	
P – Output, Off or On:	
P 0	Output to ARB OUT
P 1	Output to ARB OUT
A – Output, Amplitude	
D – Output, Offset	
O – Smoothing, Off or On:	
O 0	Smoothing Off

Command	Description
O 1	Steps of data making up the waveform are smoothed for a more continuous waveform.
H – Manual, Hold	
J – Manual, Trigger	
E - Exponent	
I – Execute: This key causes an execute cycle which transfers from the display memory to the waveform generator circuits the values of the following parameters:	
Z - Reset	

Chapter 6 - Calibration and Firmware Upgrade

Calibration

Periodic calibration of all boards is needed because of component aging, which depends on instrument, time and environment. Use six months as an initial calibration period. If possible keep records of the parameter values, and modify the time between calibrations if the records indicate.

Required Equipment

The equipment required to perform the calibration procedure is:

1. BNC 50ohm terminator - 0.1%, 2W or higher
2. Two BNC T adaptors
3. Two BNC cable, 2-4 feet long
4. BNC to Banana Jack adapter
5. A calibrated 4½ digits or better DMM.

Connections

1. Connect one item #2 BNC T to the GP1650W Output.
2. Connect one item #2 BNC T to the GP1650W Modulation Input
3. Connect item #1 BNC terminator to one side item #2 BNC T that's on the output
4. Connect one item #3 BNC cable between the two BNC T
5. Connect one item #3 BNC cable between the other side of item #2 BNC T that's on the Modulation Input and item #4 BNC to Banana Jack adapter.
6. Plug item #4 BNC to Banana Jack adapter into Item #5 DMM voltage inputs.

Operation

1. Set DMM to measure VDC at Auto-Range.
2. Power up the GP1650W.
3. Let the GP1650W warm up 15 minutes before starting calibration.
4. Push the SETUP menu key on the GP1650W front panel and then push F5 quickly three times.
5. On the new menu select CALIB.
Follow the instructions on the GP1650W display:
6. Adjust the knob on the front panel to get a reading of 0.000V±0.001 on the DMM and push Enter.
7. Adjust the knob on the front panel to get a reading of 4.500V±0.001 on the DMM and push Enter.
8. Wait for the 'Calibration Completed' message and push Enter.
9. Turn OFF the unit.

Firmware Upgrade

Overview

From time to time a new firmware revision may be released to correct bugs and enhance features. The GP1650W supports field upgrade of the firmware.

The upgrade process requires a special loader software application. To obtain this application contact Geotest - Marvin Test Systems, Inc. at +1-949-263-2222 or on the web at www.geotestinc.com.

Required Equipment

The equipment required to perform the upgrade procedure is:

1. Computer with RS232 COM port and the loader software application installed
2. NULL modem cable

Connections

1. Connect null modem cable between the computer COM port and the RS232 connector in the back of the GP1650W.

Operation

1. Set the COM port to 9600 baud rate, 8 data bits, no parity, 1 stop bit and no flow control. On most Windows operating systems this can be done from the Windows Control panel by opening the Windows Device Manager from the System applet. Please refer to Windows Help for more details.
2. Run the special loader software application
3. In the loader dialog box select the text file to load for the new revision, which you received from Geotest.
4. In the loader dialog box select the correct computer COM port that is connected to the GP1650W.
5. In the loader dialog box click the Load button
6. Turn on instrument.
7. The loading process should start and should take about 5 minutes (about 9000 lines).
8. If you get an error message that appears in the status bar, click Abort, turn off instrument, and go back to step 5.