

# **GP1616H**

## **Programmable Function Generator**

### ***User's Guide***

Last Updated: December 7, 2007

***GEOTEST***

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*MARVIN TEST SYSTEMS, INC.*



## Safety and Handling

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Each product shipped by Geotest is carefully inspected and tested prior to shipping. The shipping box provides protection during shipment, and can be used for storage of both the hardware and the software when they are not in use.

## Warranty

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Geotest products are warranted against defects in materials and workmanship for a period of 12 months. Unless covered by software support or maintenance agreement. Geotest shall repair or replace (at its discretion) any defective product during the stated warranty period. The software warranty includes any revisions or new versions released during the warranty period. Revisions and new versions may be covered by a software support agreement. If you need to return a board, please contact Geotest Customer Technical Services department via <http://www.geotestinc.com/magic> the Geotest on-line support system.

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You can also use Geotest technical support phone line (949) 263-2222. This service is available between 7:30 AM and 5:30 PM Pacific Standard Time.

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# Chapter 1 - Overview

## Introduction

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This manual contains information required to operate, program and test the GP1616H Programmable Waveform Synthesizer. This section covers the instrument general description, instrument specifications and characteristics.

## Features

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- Generates sine, square, triangle and pulse waveforms
- Up to 32 Vpp amplitude
- Frequency range from 1 mHz to 50 MHz
- 3 digit resolution
- Trigger and modulation modes
- Logarithmic sweep and burst modes
- FM, AM, and PWM modes

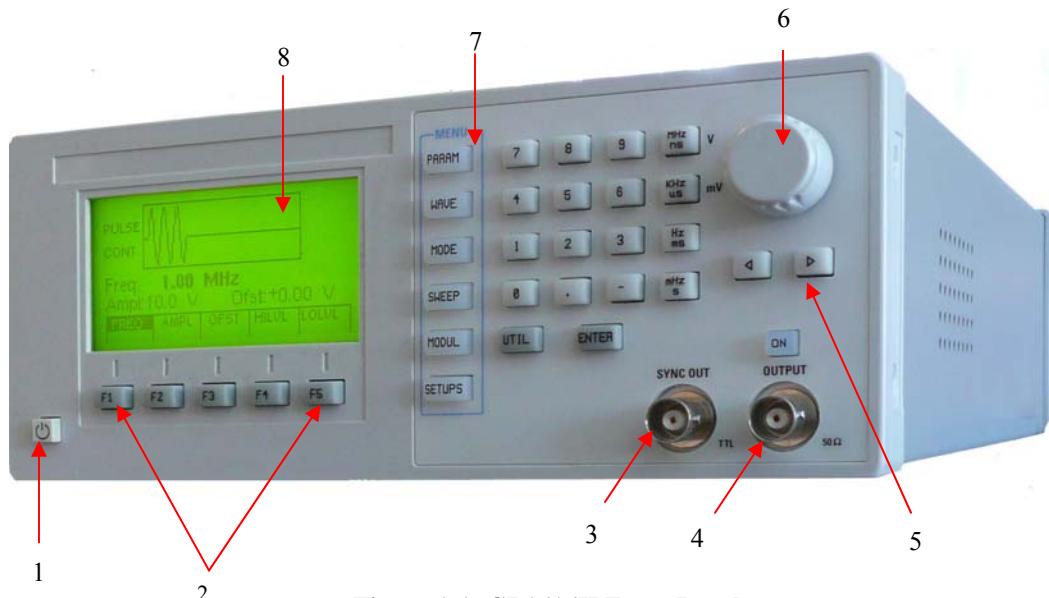


Figure 1-1: GP1616H Front Panel

Location	Function	Location	Function
1	Power On-Off	5	Cursor Keys
2	Select menu options: F1- F6 Keys	6	Rotary Input Knob
3	SYNC Out	7	Menu Keys
4	Output Connector	8	Display Window

## The Rear Panel

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

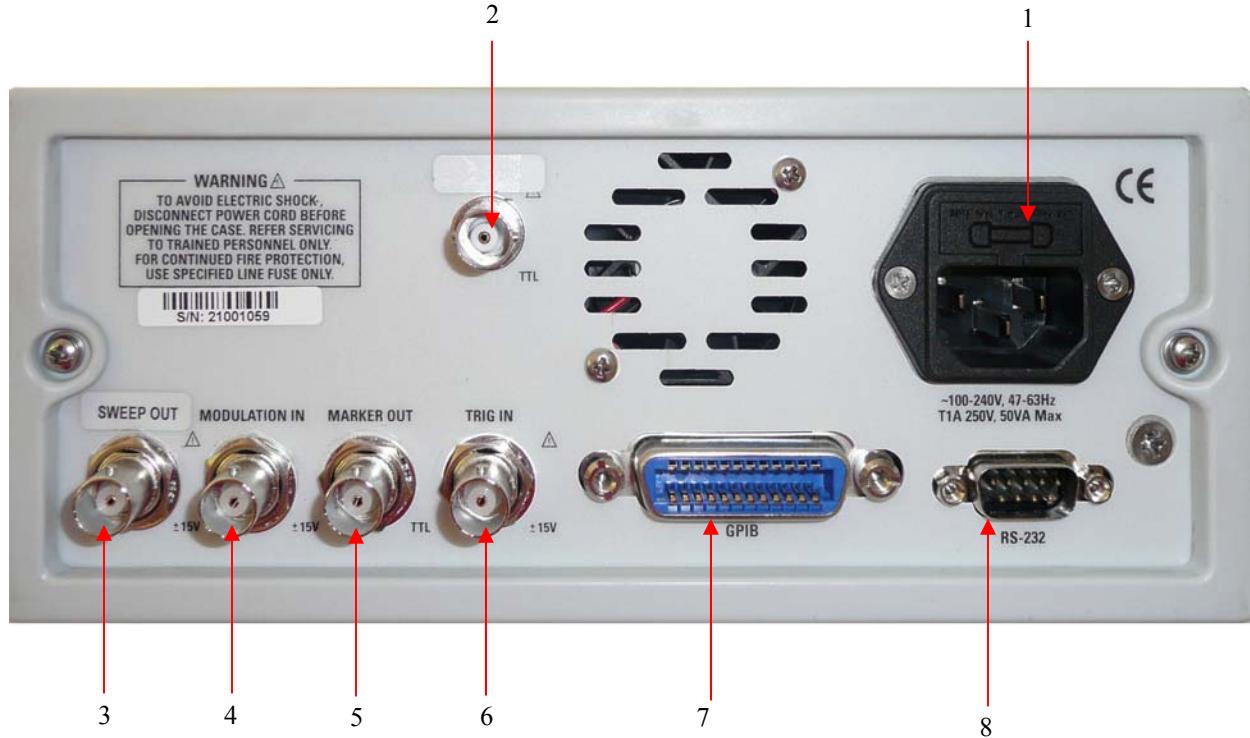


Figure 1-2: GP1616H – Rear Panel

Location	Function
1	Power Cord Receptacle
2	Not Used
3	Sweep Output
4	Modulation Input
5	Marker Output
6	Trigger Input
7	GPIB Connector
8	RS-232 Connector

## Safety Information

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The GP1616H is a Safety Class 1 instrument. Before operation, review the Safety Summary.

The following safety precautions apply to both operating and maintenance personnel and must be observed during all phases of operation, service, and repair of this instrument. Specific warnings and cautions are found throughout the manual where they apply. Before applying power, follow the installation instructions and become familiar with the operating instructions for this instrument.

Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the instrument. Geotest assumes no liability for a customer's failure to comply with these requirements.

### Ground the Instrument

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. 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.

### Do not operate in an explosive atmosphere

Do not operate the instrument in the presence of flammable gases or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.

### Keep away from live circuits

Instrument covers must not be removed by operating personnel. Component replacement and internal adjustments must be made by qualified maintenance personnel. Disconnect the power cord before removing the instrument covers and replacing components. Under certain conditions, even with the power cable removed, dangerous voltages may exist. To avoid injuries, always disconnect power and discharge circuits before touching them.

### Do not service or adjust alone

Do not attempt any internal service or adjustment unless another person, capable of rendering first aid and resuscitation, is present.

### Do not substitute parts or modify the instrument

Do not install substitute parts or perform any unauthorized modifications to this instrument. Return the instrument to Geotest for service and repair to ensure that safety features are maintained.

### Warnings and cautions

**WARNING** and **CAUTION** statements, such as the following examples, denote a hazard and appear throughout this manual. Follow all instructions contained in these statements.

A **WARNING** statement calls attention to an operating procedure, practice, or condition, which, if not followed correctly, could result in injury or death to personnel.

A **CAUTION** statement calls attention to an operating procedure, practice, or condition, which, if not followed correctly, could result in damage to or destruction of part or the entire product.



**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.

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**Warning** – To avoid electrical shock hazard, disconnect power cord before removing covers. Refer servicing to qualified personnel.

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**Warning** – To avoid electrical shock hazard, disconnect power cord before removing covers. Refer servicing to qualified personnel.

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**Caution** – Before connecting the line cord to the AC mains, check the rear panel AC line voltage indicator. Applying a line voltage other than the indicated voltage can destroy the AC line fuses. For continued fire protection, replace fuses only with those of the specified voltage and current ratings.

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**Caution** – This product uses components which can be damaged by electro-static discharge (ESD). To avoid damage, be sure to follow proper procedures for handling, storing and transporting parts and subassemblies which contain ESD-sensitive components.

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# Chapter 2 - Specifications

## General Information

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The GP1616H function generator is a programmable instrument capable of generating predefined Sine, Square, Triangle, Ramp, Haversine, Haver triangle and Pulse waveforms as well as a programmable DC output.

## Operating Modes

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Continuous	Continuous waveform is generated, phase locked to an internal crystal reference
Trigger	Active input edge generates one output cycle. Trigger slope: Positive or negative Minimum pulse width: 10 ns Minimum amplitude: 500 mV (p-p) Input impedance: 10 K ohms
Gate	Active level enables output cycles. First and last output cycles are always completed.
Counted Burst	A preprogrammed number of output cycles (1 to 1999) are generated. Min time between bursts is 100ns when triggered by an external trigger.
Logarithmic Sweep	Provides logarithmic up/down sweep between start and stop frequencies. Sweep time per decade is selectable between 10 ms and 500 s.

## Timing Parameters

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Frequency	0.001 Hz - 50 MHz
Resolution	3 digits
Accuracy	50 ppm
Jitter	<0.1% + 100 ps
Stability	50 ppm
Duty Cycle	10% to 90% in 1% steps, <1 MHz 20% to 80% in 1% steps, 1 MHz to 10 MHz 50% fixed, 10 MHz to 50 MHz

## Output Characteristics

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Range	10 mV - 16 Vpk-pk into 50 Ω	
Resolution	3 digits	
Accuracy:		
Level Window:	±800 mV	±8.00 V
Amplitude	±5% [0.45dB]	±5% [0.45dB]
Offset	± 1% of setting ± 1% of amplitude ± 4 mV	± 0.5% of setting ± 1% of amplitude ± 40 mV
Waveforms	Sine, Triangle, Pulse, Square	
Output Modes	Complement, disable, output limit	

## Waveform Performance

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Sine THD	40 dB to 5 MHz, <-30 dB to >5 MHz
Triangle and Ramp Non-Linearity	<±3% (10% to 90% of amplitude, 100mHZ to 1MHz)
Square and Pulse Transition Time	<7 ns, 10% to 90%
Pulse Aberrations	<±5% of amplitude

## VCO

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Band	3 decades max.
Ranges	± 1 μHz – 50 MHz
Pulse BandwidthTH	DC-100 HKz

## Modulation

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FM	Deviation: >+/-5% max for ±6 V input Mod bw: DC to 20 KHz
AM	Modulation: 100%, +/- 2.5 V input Mod bw: DC to 20KHz
Pulse BandwidthTH	Range: Max of one decade with +/- 6.5 volt input Pulse width range: 10 ns to 1 s, in eight decade ranges

## Sweep Mode

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Log Sweep	1 mHz to 50MHz
Sweep Time	10mSec 500Sec
output	0-10V 1.5V/decade

## Inputs and Outputs

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Trigger Output	>2 V into 50 Ω impedance
External Trigger	Threshold level: TTL levels Trigger slope: pos or neg Min pulse width: 10 ns Input impedance: 10 K ohm
Modulation Input	Max ± 20 V, 10 Kohms impedance
Main Output	Range: +/- 8 volts into 50 ohms
Marker Output	High level: >2 volts into 50 ohms Low level: 0 volts Edges: Positive at marker frequency Negative at start of sweep
X-Output	Levels: 0 volts to 10 volts, 1.5 volt per sweep decade into Hi Z.

## General

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Power Requirements	100-240 V selectable, 50 VA max
Weight	3.5 Kg
Dimensions	89 mm (3.5") H x 213 mm (8.4") W x 30 cm (12 ")L
Operating Temperature	0° C to 50° C
Humidity	To 95% RH, 0° C to 40° C

**Note:** Specifications are Subject to Change without notice

## GPIB Interface

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Conforms to IEEE 488.2-1987.



# Chapter 3 - Installation

## Introduction

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This section contains installation information, power requirements, initial inspection and signal connections for the GP1616H Programmable Waveform Synthesizer.

## Mechanical Inspection

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The GP1616H Programmable Waveform Synthesizer is 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

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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 specification acceptance tests, notify the local GEOTEST service center.

## Instrument Mounting

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The GP1616H is intended for rack mount or bench use. The instrument does not require special cooling when operated within conventional temperature limits. A 2" 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 80 W of power dissipation.

The generator can be used as a bench instrument or rack mounted. In either use, ensure that there is no impedance to air flow at any surface of the instrument. Before rack mounting, it may be desirable to perform the initial checkout to verify operation of all functions.

## Power Requirements

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The GP1616H requires a power source of 100V to 240 V (+5%, -10%) at a frequency of 48Hz to 66Hz. The maximum power consumption is 200 VA. Use a slow blow fuse UL/CSA approved of 1A as indicated on the rear panel of the instrument).

The instrument power fuse is located on the AC input plug. To access the fuse, first disconnect the power cord and then remove the fuse cartridge.

## Grounding Requirements

For the safety of operating personnel, the instrument must be grounded. The central pin on the AC plug grounds the instrument when properly connected to the ground wire and plugged into proper receptacle.

**Warning** – To avoid personal injury due to shock, the third wire earth ground must be continuous to the power outlet. Before connection to the power outlet, examine all cables and connections between the unit and the facility power. For a continuous earth ground path, the power cable must 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 Address

For instruments on the General Purpose Interface Bus (GPIB), ensure that the GPIB address is correct. The GPIB address can be changed by using the Utility menu.

## GPIB Connections

The rear panel GPIB connector is a 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 as shown in Figure 3-1:

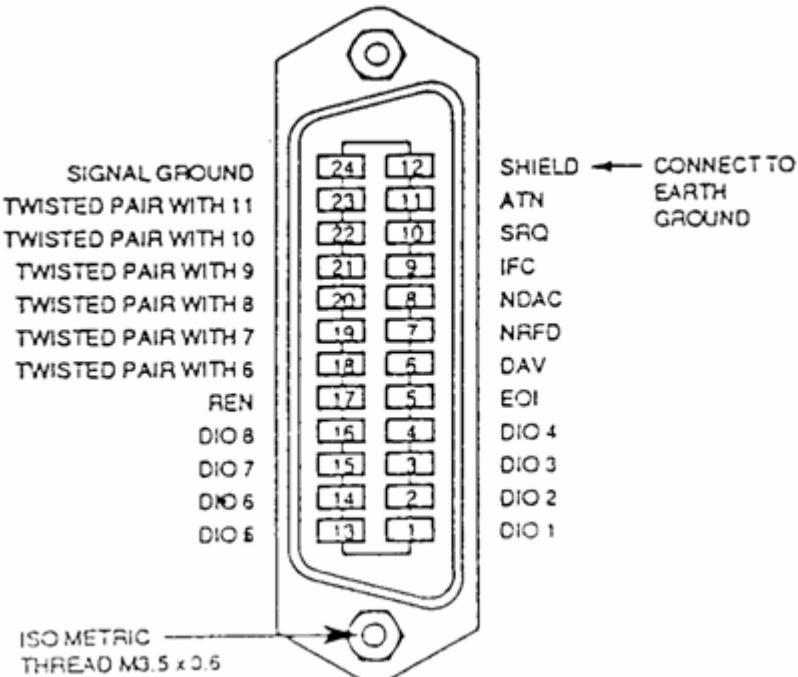


Figure 3-1: GPIB Connector

## RS-232 Connection

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The rear panel RS-232 connector is a standard DB-9 male connector configured as a DCE:

DB-9 pin	Name	Note	Computer DB25 pin	Direction
1	N/C	-	8	In
2	RXD	Receive Data	3	In
3	TXD	Transmit Data	2	Out
4	N/C	-	-	Out
5	GND	Signal Ground	7	-
6	N/C	-	6	In
7	RTS	Request to Send	4	Out
8	CRS	Clear to Send	5	In
9	N/C	-	-	-



# Chapter 4 - Operating Instructions

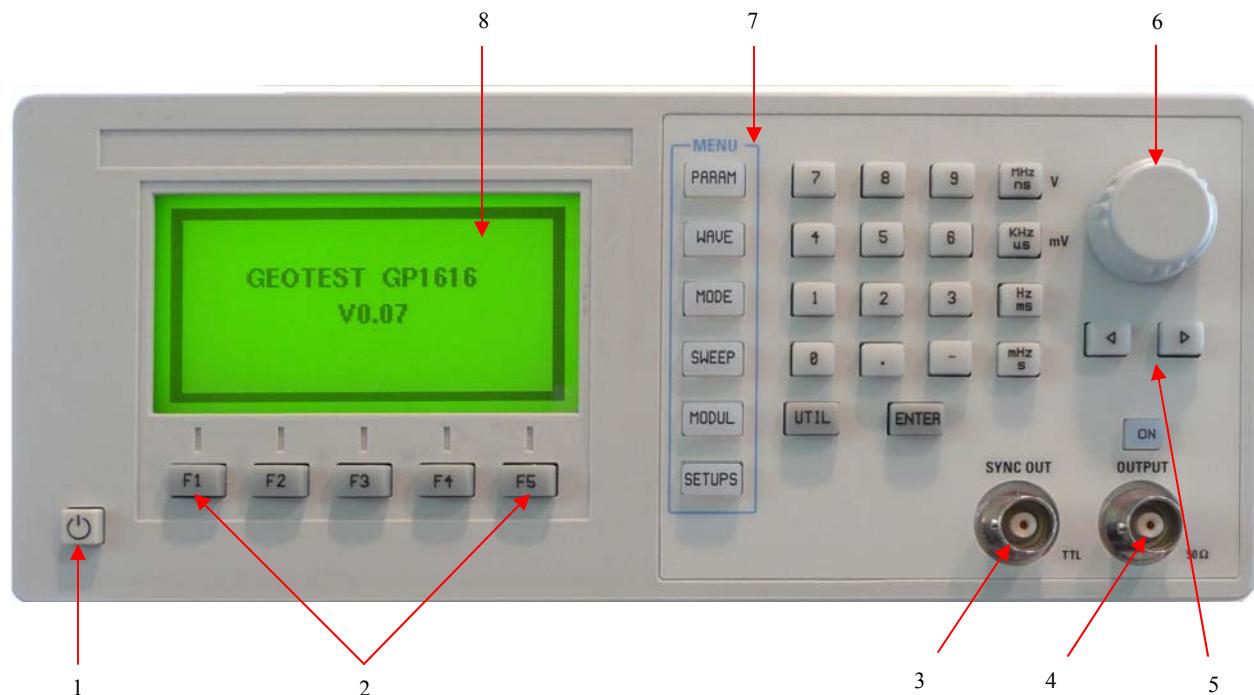
## Introduction

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This section describes the displays, controls, and connectors on the front panel of the GP1616H Series Programmable Waveform Synthesizer. All controls you use for local operation of the GP1616H series are on the front panel. All of the connections are available on the rear panel. The main function output is also available in the front.

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 GP1616H front panel.



**Figure 4-1: GP1616H 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
4	Output Connector: Function output. The output status is displayed on the LCD.
5	Cursor Keys: Used to move the cursor (when visible) to either left or right.
6	ROTARY INPUT knob: Used to increment/decrement numeric values or to scan through the possible values of non-numeric values.
7	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.
8	Display Window: Displays all instrument data and settings on a LCD.

## Display Window

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The GP1616H has graphical LCD display window. When you power-on the GP1616H 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

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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.

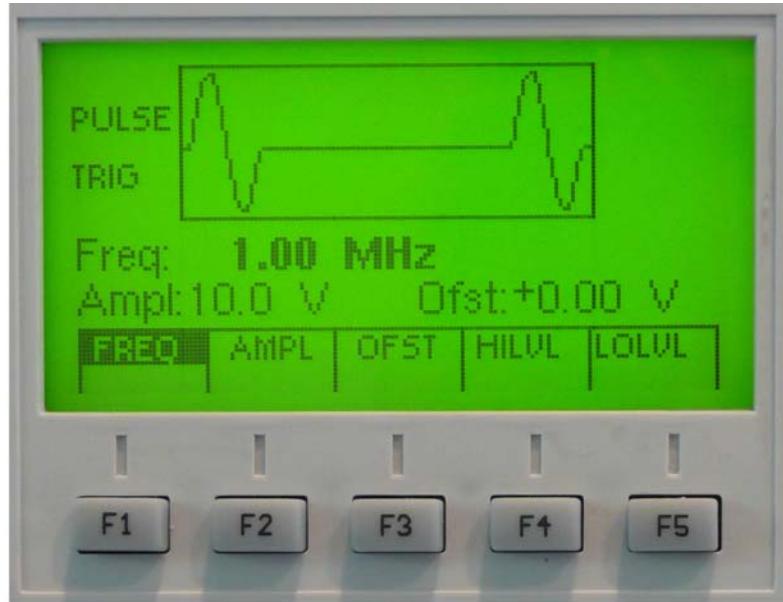
#### Parameters Menu

This key selects and displays the waveform parameters Frequency, Amplitude and Offset, High Level and Low Level.

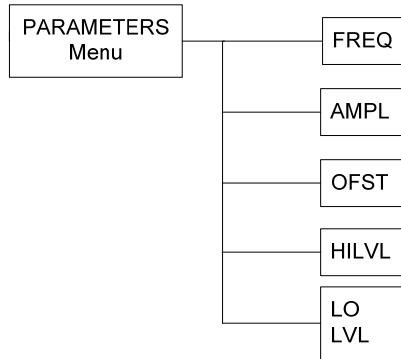
To display a parameter, press PARAMETERS, then press the F1, F2, F3, F4 or F5 key that corresponds to the desired Parameter menu option (see Figure 4-2).

- |          |  |
|----------|--|
| F1: FREQ | (Frequency) Selects and displays the frequency. Change the frequency setting using the data keys or the rotary input knob.   |
| F2: AMPL | (Amplitude) Selects and displays Amplitude. Change amplitude using data keys or the rotary input knob. This setting defines amplitude of the waveform in units selected by F2. |
| F3: OFST | (Offset) Selects and displays the Offset. Change the offset setting using the data keys or the rotary input knob.  |

- F4: HILVL      High Level  
 F5: LOVLV      Low Level



**Figure 4-3: Parameter Menu**



**Figure 4-4: Parameters Menu Options**

#### Waveform Menu

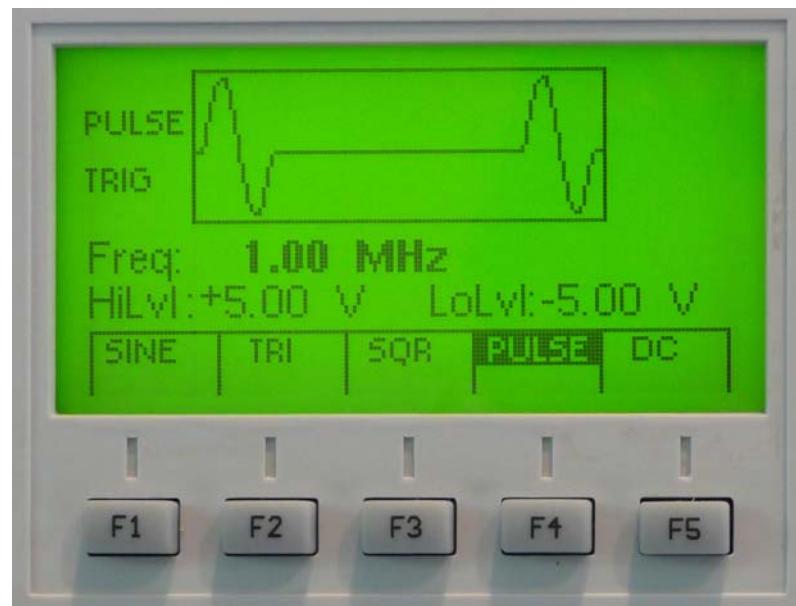
Displays the waveforms available: SINE, TRI (Triangle), and SQR (Square), Pulse and DC.

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

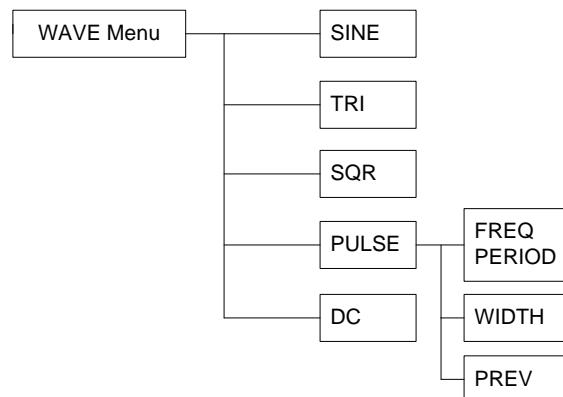
- F1: SINE      Selects the Sine waveform.  
 F2: TRI      (Triangle) selects the triangle waveform and displays the waveform duty cycle.  
 F3: SQR      (Square) selects the square waveform and displays the waveform duty cycle.

F4: PULSE      Selects the pulse waveform and displays the Pulse sub menu

F5: DC      Selects the DC waveform



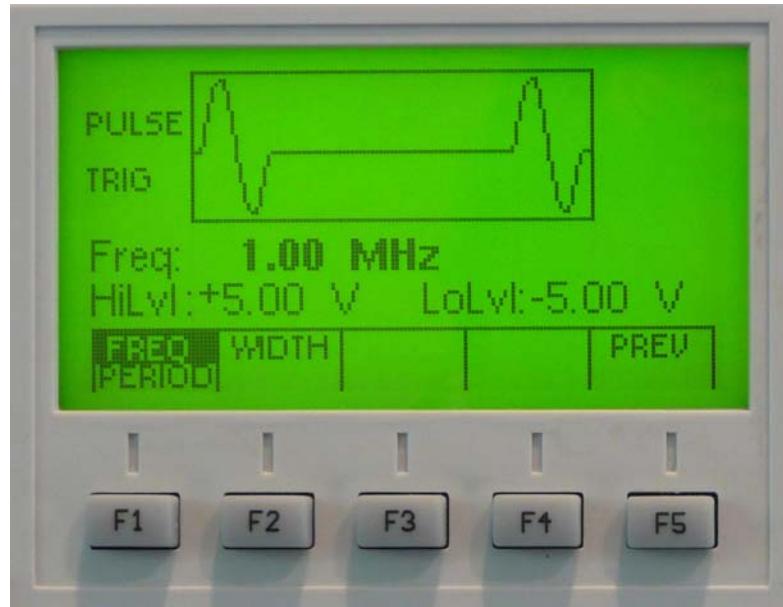
**Figure 4-5: Waveform Menu**



**Figure 4-6: Waveform Menu Options**

#### Pulse Sub Menu

After selecting the Pulse in the Wave menu, the Pulse sub menu is available:

**Figure 4-7: Pulse Sub Menu**

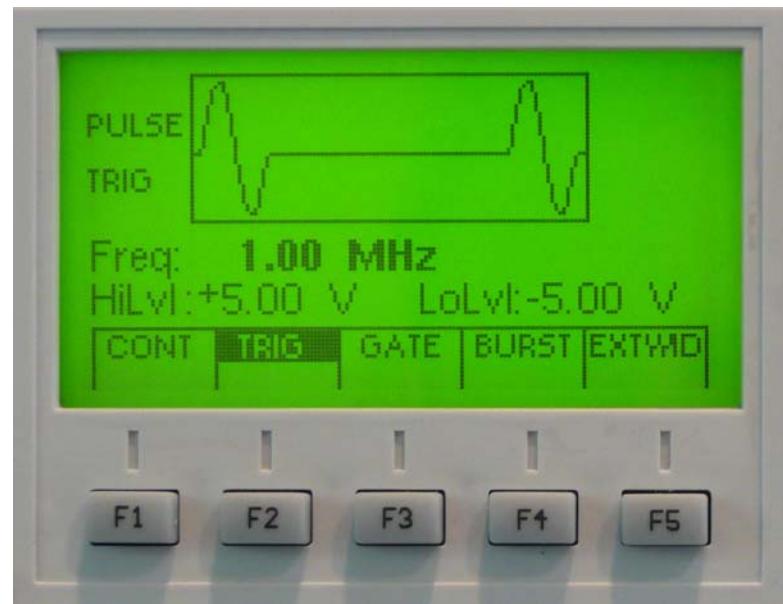
F1: FREQ PERIOD Selects between Frequency and Period for setting and display

F2: WIDTH Selects pulse width setting

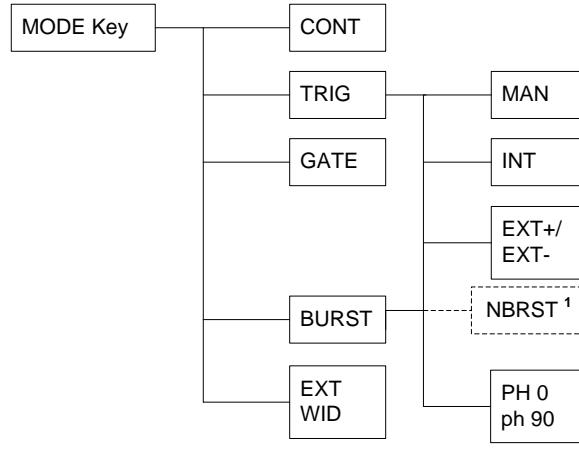
F5: PREV Returns to Waveform menu

#### **Mode Menu**

Selects the output mode: CONT (Continuous), TRIG (Triggered), GATE (Gated), BURST and EXT WIDTH. 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.
- F5: EXTWID Ext Width

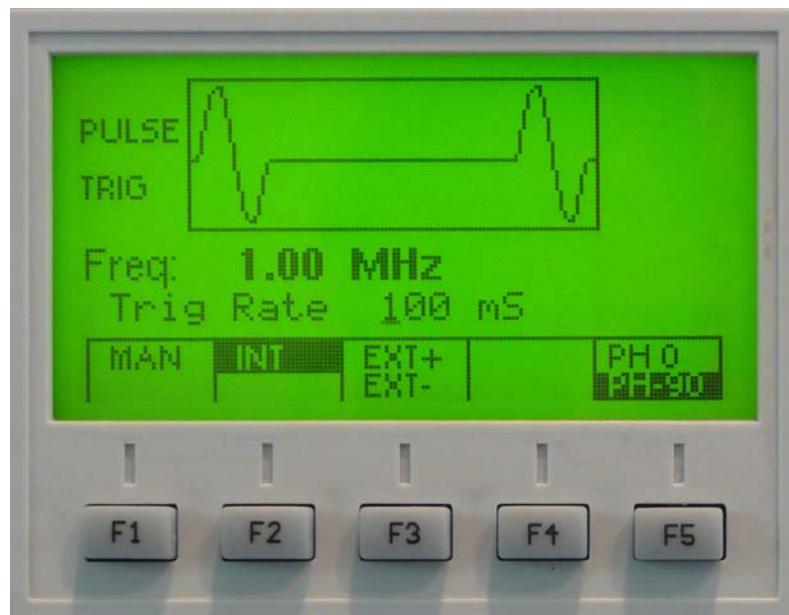


<sup>1)</sup>Burst only

**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**

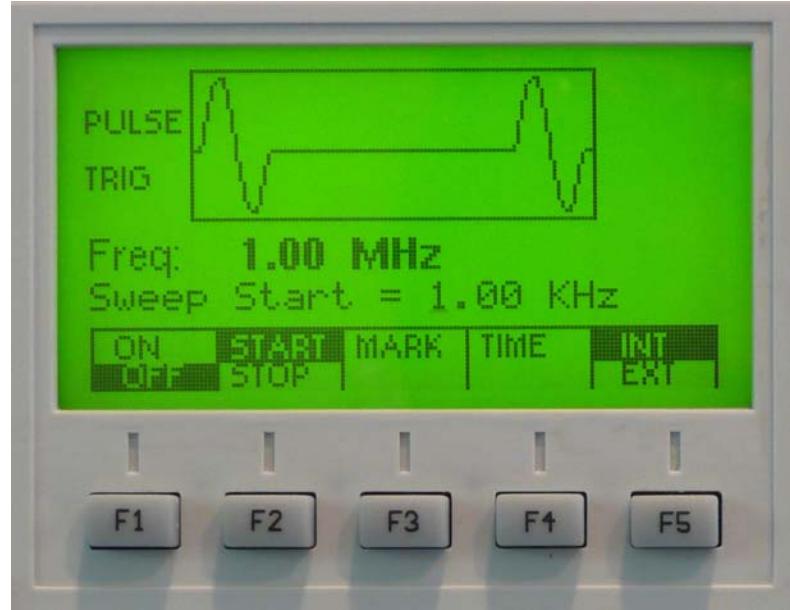
- F1: MAN Generates a manual trigger. To trigger the waveform generator, press this F1.
- F2: INT Selects the internal trigger generator as the trigger source. Change the internal trigger rate with the data keys or the rotary input knob.
- F3: EXT+/EXT- Selects the external trigger signal as the trigger 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: PH 0 PH -90 Changes the phase between 0 and -90 degrees (Haver function)

### Sweep Menu

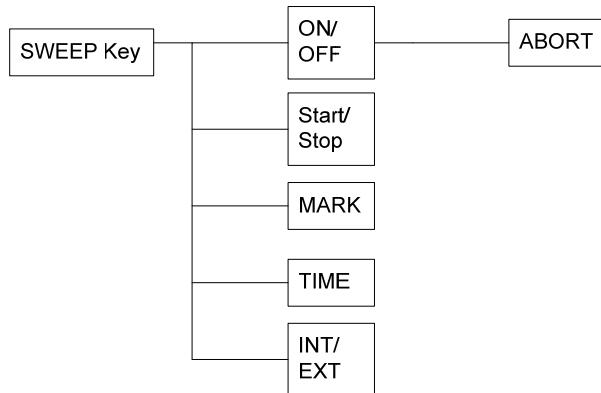
Selects the Sweep mode parameters

To select the Sweep mode, press SWEEP, then press the function key that corresponds to the desired Sweep menu option as shown in Figure 4.

- F1: ON/ Sets the sweep function On or Off.
- OFF Pressing F1 will toggle between Sweep On or Off. After turning sweep on it will take the instrument a few seconds to setup the waveform. During this time the menu will change to show F2:ABORT. Pressing F2 will abort the process.

**Figure 4: Sweep Menu**

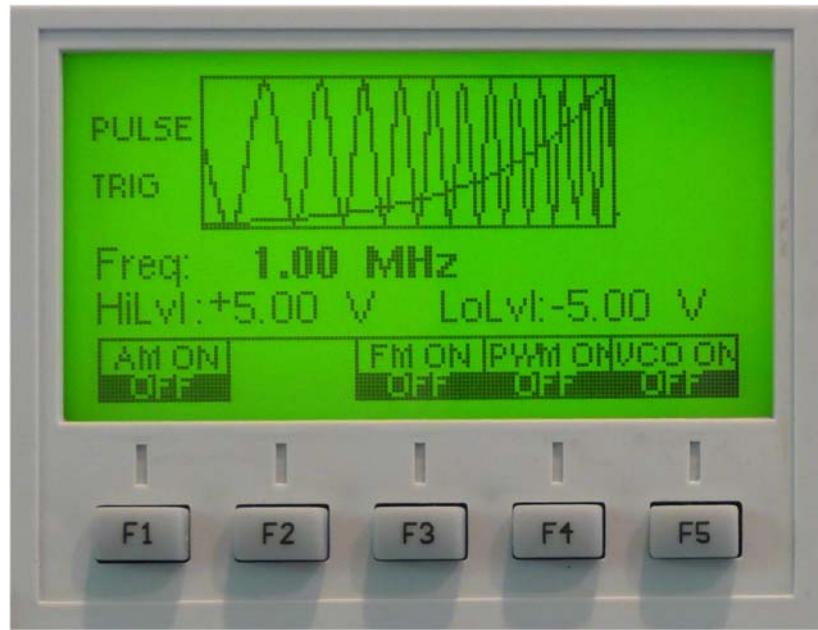
- F2: START Defines the Sweep Start frequency. Change the start frequency by using the rotary input knob or data keys.
- STOP Defines the Sweep Stop frequency. Change the stop frequency by using the rotary input knob or data keys.
- F4: TIME Defines the Sweep Time.
- F5: INT/  
EXT Selects internal or external modulation source.

**Figure 4-11: Sweep Menu Options**

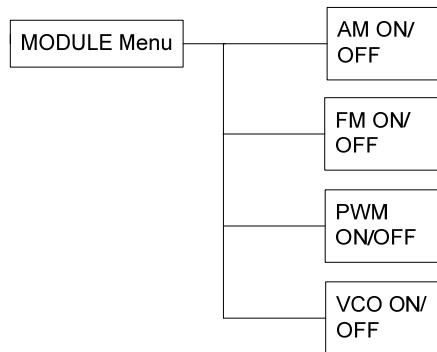
### Modulation Menu

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 4-12.

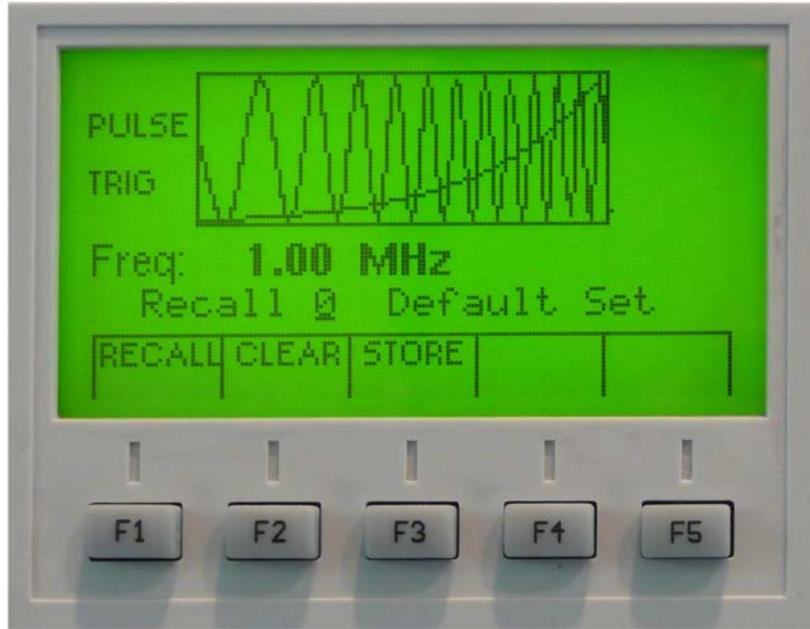
**4-13: Modulation Menu**

- F1: AM ON/OFF Sets the Amplitude Modulation ON and OFF.
- F3: FM ON/OFF Sets the Frequency Modulation ON and OFF.
- F4: PWM ON/OFF Sets the Pulse Width Modulation ON and OFF.
- F5: VCO ON/OFF Sets the Voltage Controlled Oscillator ON and OFF.

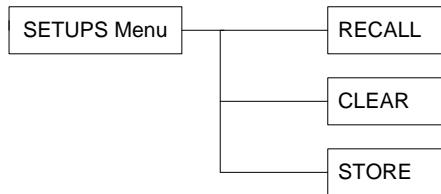
**4-14: Modulation Menu Options**

### **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.

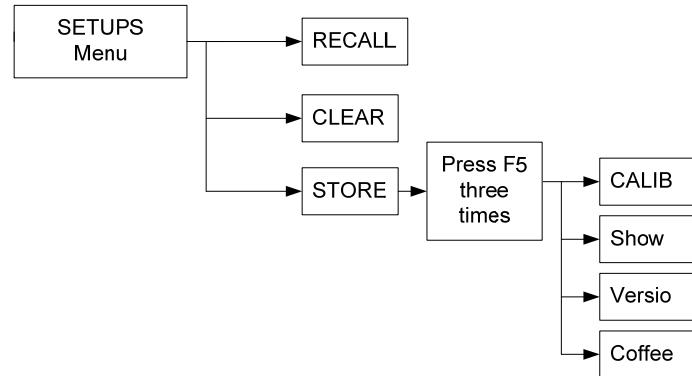


**Figure 4-15: Setups Menu**



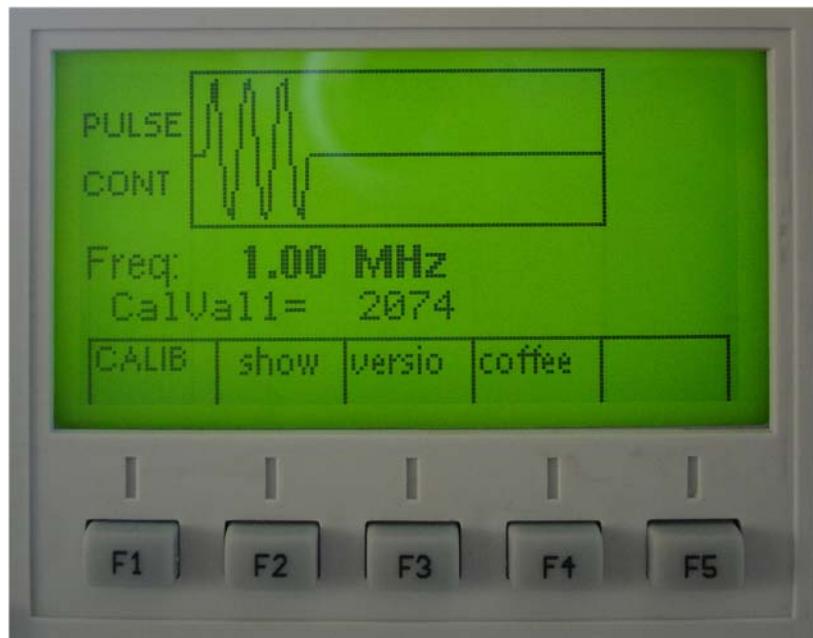
**Figure 4-16: Setups Menu**

- 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.
- F2: CLEAR If an undesired value is entered, the CLEAR ENTRY key can be used to erase it.
- 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.
- F5: Press F5 three times to access the Special Setups sub menu.

**Figure 4-17: Setups Menu Options****Special Setup Menu**

After pressing F5 three times in the Setup menu, the Special Setups sub menu is available. See 4-18:.

- |            |  |
|------------|--|
| F1: CALIB  | Perform instrument calibration. See Chapter 6 – Maintenance. |
| F2: Show   | Shows calibration values                                     |
| F3: Versio | Shows firmware version                                       |
| F4: Coffee | Coffee break   |

**4-18: Special Setups Menu**

## Connectors

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The waveform generator has one BNC connector on the front panel and ten 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.
Trig In Connector	Use this connector to transfer an external trigger or gate signal, depending on the waveform generator setting, to the waveform generator.
Sync Out Connectors	Use these connectors to output a TTL sync pulse generated at the specified location of each waveform cycle.
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 sweep passed the programmed marker frequency.
Sweep Connector	Provides a linear ramp output that starts at 0V with the sweep start frequency and ends at +5V with the sweep stop frequency

## Output Connections

---

The waveform generator output circuits operate as a 50 ohm voltage source working into a 50 ohm load. At higher frequencies, unterminated 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.

## Operating Considerations

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**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

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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. For more information on error codes, see the topic **Displaying Errors** in Chapter 4 – Operating Instruction.

## 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 GP1616H

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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 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 (F1 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

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This section provides detailed information on programming the GP1616H. The firmware is customized to be fully compatible with the Hewlett Packard 8116A GPIB (referred to General Purpose Interface Bus) command set. Software test procedures using the original HP8116A instrument require no code modification when upgrading to the GP1616H.

The GP1616H uses all lines on the bus, terminations, logic levels and pinouts.

## Address Assignment

---

The GP1616H's GPIB address is determined by an internal storage register. This register is initialized upon power turn-on by reading the address bits A1 to A5 from the GPIB ADDRESS switch on the rear panel. Note that this switch is factory preset to decimal 16. To change the address, first change the bit settings on the rear panel switch, then press the LCL key to read the new address into the register (alternatively, switch power off and on).

The current GPIB address can be checked by pressing the LCL key. The address is then displayed in decimal form. Talk and listen addresses are transmitted by the system controller over the data bus with the ATN line true. When an 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

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In general, whenever a program attempts to put the GP1616H into an error condition, the GP1616H responds by making a Service request i.e. set SRQ line true. Under these circumstances, the system controller will address the GP1616H as talker using a serial poll command (SPE), the GP1616H 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 puts 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. **Error!**  
**Reference source not found.** lists the standard settings.

Key Function	Setting	Comments
FREQUENCY	1.00 KHz	Wave frequency
AMPLITUDE	1.00 V	Peak-to-peak output amplitude
OFFSET	0.00 V	Zero offset
DTY	50 %	Duty Cycle
STA	1 kHz	Sweep start frequency
STP	100 kHz	Sweep stop frequency
SWT	50 mS	Sweep time
MRK	1.00 kHz	Marker frequency
RPT	100 mS	repetition rate
MODE	CONT	Waveform mode
SLOPE	POS	External trigger slope
BUR	1	Waves per burst

**Table 5-1: Standard Device Clear Settings**

## GPIB

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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 GP1616H enters the remote state when it receives its listen address and REN is enabled. The GP1616H 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. **EOI** – When ATN is false, EOI (End Of Identify) indicates that the data on lines DIO1-DIO8 is the last byte of a data message. When the GP1616H receives a data byte with EOI true, the GP1616H automatically supplies a terminator character following the data byte. When the GP1616H 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 GP1616H 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 32<sup>nd</sup> address, called unlisten (hexadecimal 3F, ASCII ?), is used to command all devices to not read data bytes. The GP1616H 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.

**GPIB Command Messages**

The following command messages are available to control the instruments using GPIB.

<b>Message</b>	<b>Mnemonics ASCII Code</b>	<b>ASCII Code Delimiters</b>
Operating Modes:		
select NORM	M1	
select TRIG	M2	
select GATE	M3	
select E.WID	M4	
select I.SWP	M5	
select E.SWP	M6	
select I.BUR	M7	
select E.BUR	M8	
Control Modes:		
off	CT0	
select FM	CT1	
select AM	CT2	
select PWM	CT3	
select VCO	CT4	
Trigger Slope:		
off	T0	
select positive slope	T1	
select negative slope	T2	
Haversine (-90°):		
off	H0	
on	H1	
Waveform:		
off(dc)	W0	
select sine	W1	
select triangle	W2	
select square	W3	
select pulse	W4	
Parameters:		
set frequency	FRQ	MZ = Millihertz HZ= Hertz KHZ= Kilohertz MHZ=Megahertz

<b>Message</b>	<b>Mnemonics ASCII Code</b>	<b>ASCII Code Delimiters</b>
set duty cycle	DTY	%
set width	WID	NS=Nanoseconds US=Microseconds MS=Milliseconds
set amplitude	AMP	MV=Millivolts V=Volts
set offset	OFS	MV=Millivolts V=Volts
set high level	HIL	V=Volts
set low level	LOL	V=Volts
set burst number	BUR	#
set repetition rate for internet burst	RPT	NS=Nanoseconds US=Microseconds MS=Milliseconds
set sweep start frequency	STA	MZ=Millihertz HZ=Hertz KHZ=Kilohertz MHZ=Megahertz
set sweep stop frequency	STP	Opt.001 MZ=Millihertz HZ=Hertz KHZ=Kilohertz MHZ=Megahertz
set sweep marker frequency	MRK	MZ=Millihertz HZ=Hertz KHZ=Kilohertz MHZ=Megahertz
set sweep time	SWT	S=Seconds MS=Milliseconds
Sign:		
+	+	
+	-	
Decimal point:	.	

Message	Mnemonics ASCII Code	ASCII Code Delimiters
Limit: off on	LO LI	
Complement: off (normal output) on	C0 C1	
Disable: off (output enabled) on	D0 D1	
Execute Self-Test	EST	

**Table 5-2: Mode/Parameters Messages – Listen Function****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 32<sup>nd</sup> address, called untalk (hexadecimal **5F**, ASCII →) is used to command all devices to cease talking. The lower 5 bits of the GP1616H talk address are selected by the same rear panel switches used to select the listen address. Thus, if the GP1616H 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.

Message	ASCII Mnemonics	Sample Statements	
Current Parameter Setting	CST	HPL (HP9826) dim A \$ [89] or [161] wrt 716, "CST" red 716 A\$	BASIC (HP85) Dim A\$ [89] or [161] OUTPUT 716; "CST" ENTER 716; A\$
	IERR		
Interrogate Parameter	IFRQ IDTY IWID IHIL ILOL IAMP IOFS IBUR IRPT ISTA ISTP IMRK ISWT	dim B \$ [12] wrt 716, "IFRQ" red 716; B \$	Dim B \$ [12] OUTPUT 716; :IFRQ" ENTER 716; B\$

Message	ASCII Mnemonics	Sample Statements	
Status Byte (Serial Poll Enable/Serial Pool Disable)		Rds {716} →A	A=SPOLL {716}

**Table 5-3: Mode/Parameters Messages – Talker Function****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 GP1616H.

**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 GP1616H are:

1. **Device Clear (DCL)** – Resets the GP1616H 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 GP1616H 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 GP1616H 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 GP1616H are:

1. **Go To Local (GTL)** – Commands GP1616H to go to local mode.
2. **Selective Device Clear (SDC)** – Resets the GP1616H 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 GP1616H micro-processor is idle ((i.e., not processing a previously sent programming string), a GET command will be completed within 2.5 ms of receipt. Otherwise, it will not be done until current programming is processed.

## **Data Transfer**

In addition to accepting programming characters, the GP1616H 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 GP1616H, 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.

# Chapter 6 - Maintenance

## Calibration

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### Overview

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.

### Equipment

The equipment required to perform the calibration procedure is:

1. BNC 50ohm terminator - 0.1%, 6W 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 GP1616H Function Output.
2. Connect one item #2 BNC T to the GP1616H Modulation Input
3. Connect item #1 BNC terminator to one side item #2 BNC T that's on the Function 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 GP1616H.
3. Let the GP1616H warm up 15 minutes before starting calibration.
4. Push the SETUP menu key on the GP1616H front panel and then push F5 quickly three times.
5. On the new menu select CALIB.

Follow the instructions on the GP1616H display:

6. Adjust the knob on the front panel to get a reading of  $0.000V \pm 0.001$  on the DMM and push Enter.
7. Adjust the knob on the front panel to get a reading of  $4.500V \pm 0.001$  on the DMM and push Enter.
8. Wait for the ‘Calibration Completed’ message and push Enter.

## Firmware Upgrade

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### Overview

From time to time a new firmware revision may be released to correct bugs and enhance features. The GP1616 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](http://www.geotestinc.com).

### 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 GP1616.

### 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 GP1616.
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.