

GP1665H

Programmable Waveform Synthesizer

User's Guide

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GEOTEST

MARVIN TEST SYSTEMS, INC.

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Chapter 1 - Overview

Introduction

This manual contains information required to operate, program and test the GP1665H Programmable Waveform Synthesizer. This section covers the instrument general description, instrument specifications and characteristics.

Features

- Fully compatible with the Wavetek 178
- Generates sine, square, triangle waveforms
- Synthesized waveforms with 8 digits of frequency resolution in all modes
- Frequency range from 1 μ Hz to 50 MHz
- Phase locking allows GP1665H to operate with high precision/ accuracy
- Trigger, gate, or burst modes of operation
- Logarithmic or linear sweep generation
- Phase- or amplitude-modulation

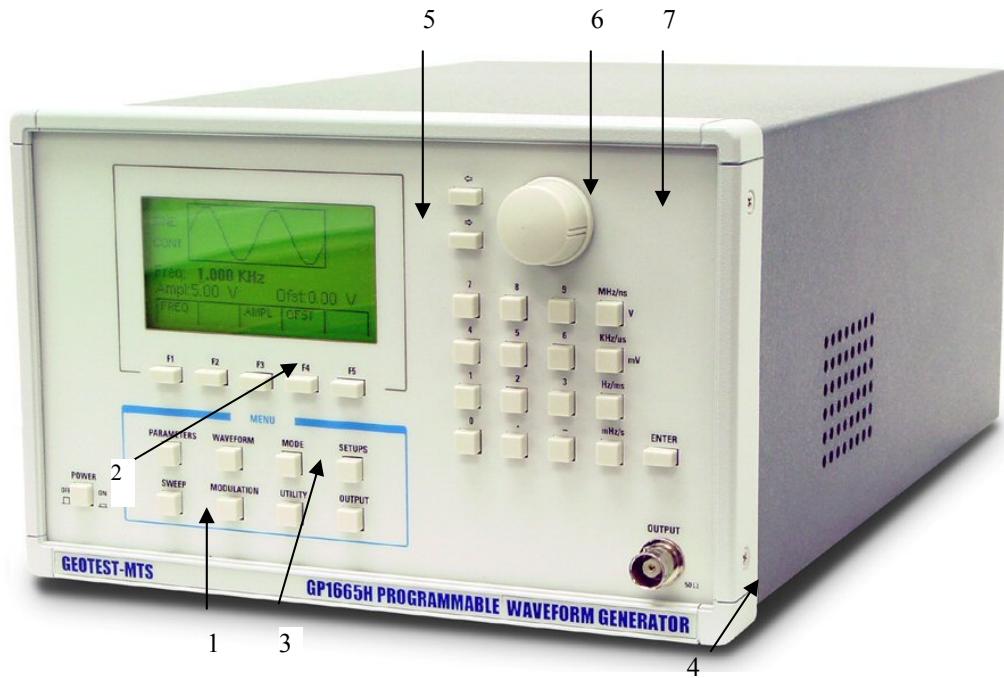


Figure 1-1: GP1665H Front Panel

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

The Rear Panel

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

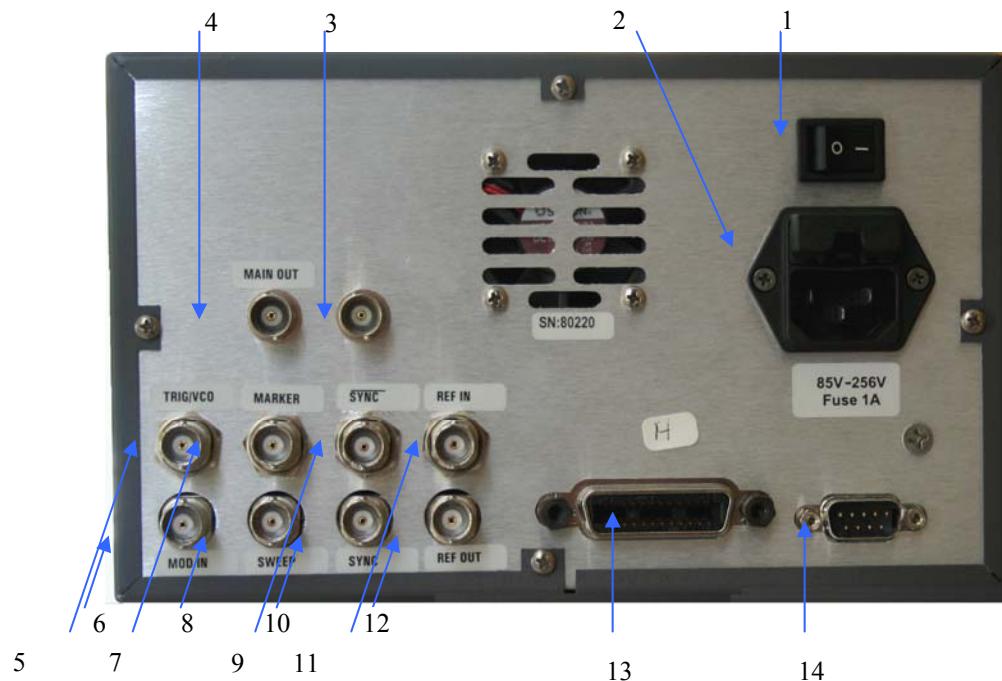


Figure 1-3: Rear Panel

Location	Function	Location	Function
1	Power Switch	8	Sweep Output Reference Input
2	Power Cord Receptacle	9	Inverted Sync Output
3	Phase Modulation Input	10	Sync Output
4	Function Output	11	Reference Input
5	Trigger Input	12	Reference Output
6	AM Input	13	GPIB Connector
7	Marker Output	14	RS-232 Connector

Safety Information

The GP1665H 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.



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



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



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.



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.

Chapter 2 - Specifications

General Information

The GP1665H is a Programmable Waveform Synthesizer that can generate the following waveforms: Sine, Square, Triangle, Ramps, Haversine, Havertriangles, AM and DC.

Operating Modes

Continuous	Continuous waveform is generated, phase locked to internal 10 MHz crystal reference
VCO	External voltage (1 kHz max) from 10 mV to 10 linearly sweeps 3 decades up to top of decade in which function generator is set. Twelve overlapping ranges cover 1 μ Hz to 50 MHz.
Trigger	Pos. ext input pulse > 10 ns wide generates one output cycle. Upper level > + 250 mV, lower level < 0V.
Gate	Oscillator enabled when ext input \geq 250 mV, disabled when \leq 0 V. First and last output cycles are always complete
Burst	A preprogrammed number of output cycles is generated. Min time between bursts 50 ns Burst length 0 to 9,999 cycles. Min trigger pulse width 10 ns.
FM	0 to \pm 1 V modulates with \pm 1 % deviation.
AM	0 to 2.5V _{pk-pk} modulates 0 to 100 % modulation depth.
Sweep	Provides logarithmic up/down sweep of up to three decades between limits set on the function generator. Eleven overlapping ranges cover 1 μ Hz to 50 MHz.

Timing Parameters

Frequency	0.001 Hz – 50 MHz, sine and square
Resolution	4 digits
Accuracy	\pm 0.001%
Jitter	0.1 % for FRQ > 1 KHz, 0.02% for FRQ < 999 Hz
Stability	1 ppm
Duty Cycle	20%-50%-80%

Amplitude Characteristics

Range	10 mV – 10 Vpk-pk into 50 Ω
Resolution	3 digits
Accuracy	\pm 3% to 5 MHZ, \pm 8% to 20 MHZ, \pm 5%/-20% to 50 MHZ for sine waveform

Offset Characteristics

Range	0 to ± 5 V into $50\ \Omega$
Resolution	3 digits
Accuracy	$\pm 1\%$ setting, $\pm 1\%$ AMP, ± 20 mV

Waveform Performance

Sine THD	< -40 dB to 5 MHz, < -30 dB to > 5 MHz
Square Transition	< 5 ns, 10% to 90%
Square Aberrations	< $\pm 5\%$
Waveforms	Sine, square, triangle, sawtooth, and DC

VCO

Band	3 decades max.
Ranges	$\pm 1\ \mu\text{Hz} - 50$ MHz
Mod Bandwidth	DC-100 KHz

Modulation

FM	1 Max deviation for ± 1 V input
Mod Bandwidth	DC-20 KHz
AM Depth	100 % for ± 2.5 V input
AM Bandwidth	DC-100 KHz

Sweep Mode

Log Sweep	Up-down, full frequency range available
Sweep Time	0.01/0.1/1/10/100/1,000 a per decade selectable
Repetition	Continuous or triggered
output	0 V – 2.99 V triangle, $50\ \Omega$ impedance

Inputs and Outputs

SYNC Output	1.5 V into $50\ \Omega$, 50% duty cycle, $50\ \Omega$ impedance
External Trigger	High > 250 mV, positive slope 10 nA min pulse, 10 k IN impedance
VCO Input	10 mV – 10 V, 10 Kohms IN impedance
Modulation Input	Max ± 20 V, 10 Kohms IN impedance

General

Interface	Fully compatible with HP8165A
Memory	10 setups
Power Requirements	100-240V selectable, 50 VA max
Weight	5 kg
Dimensions	13.0 cm (5.25") H x 21.2 cm (8.3") W x 40 cm (15.75") L
Operating Temperature	00 C to 500 C
Humidity	To 95% RH, 00 C to 400 C
Connectors	Rear panel connectors optional
Rack Mount	Optional

Note: Specifications are Subject to Change without notice

GPIB Interface

Conforms to IEEE 488.2-1987.

Chapter 3 - Installation

Introduction

This section contains installation information, power requirements, initial inspection and signal connections for the GP1665H Programmable Waveform Synthesizer.

Mechanical Inspection

The GP1665H 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

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

The GP1665H 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

The GP1665H requires a power source of 100V, 120V, 220V or 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).

Caution – The line power voltage of the instrument is noted on the AC input plug. To prevent damage to the instrument, check for proper match of line voltage and proper fuse type and rating.

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:

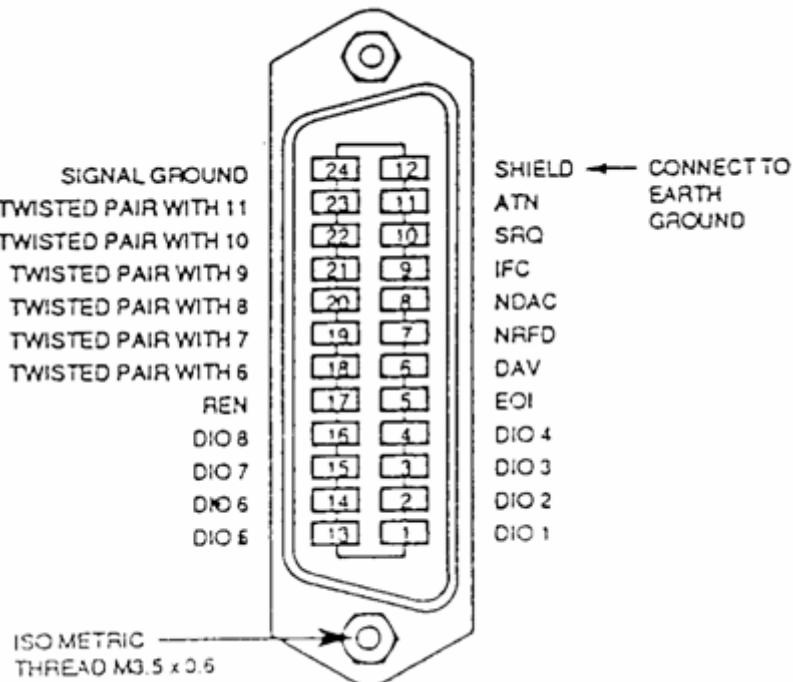


Figure 3-1: GPIB Connector

RS-232 Connection

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

This section describes the displays, controls, and connectors on the front panel of the GP1665 Series Programmable Waveform Synthesizer. All controls you use for local operation of the GP1665 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 GP1665H front panel.

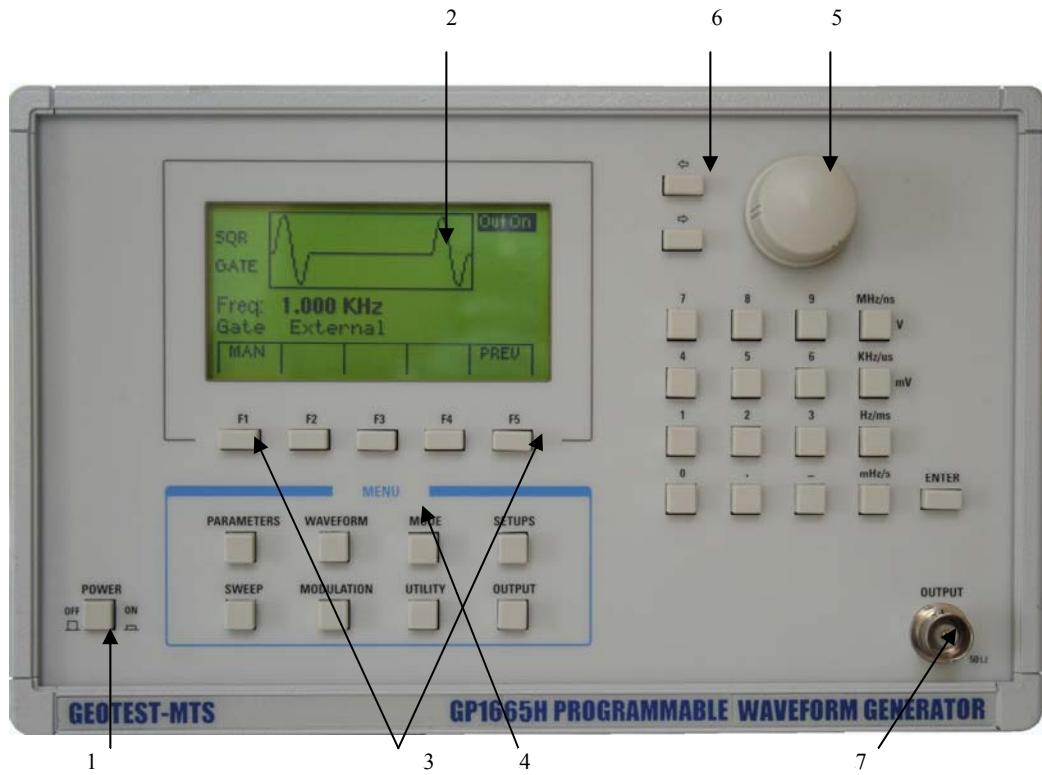


Figure 4-1: GP1665H Front Panel

Power On-OFF: Applies and removes AC power to the unit.

Display Window: Displays all instrument data and settings on a LCD.

F1 through F5 keys: Select menu options that appear on the second line of the display window. Menus differ depending on the selected parameter, function or mode.

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 line of the display.

ROTARY INPUT knob: Used to increment/decrement numeric values or to scan through the possible values of non-numeric values.

Cursor Keys: Used to move the cursor (when visible) to either left or right.

Output Connector: Function output. The output status is displayed on the LCD.

Front Panel Displays

The GP1665H uses a LCD display window to display information.

Display Window

The GP1665H has graphical LCD display window. When you power-on the GP1665H 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, Amplitude and Offset, and allows changing the settings.

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

- | | |
|----------|--|
| F1: FREQ | (Frequency) Selects and displays the frequency. Change the frequency setting using the data keys or the rotary input knob. |
| F3: 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. |
| F4: OFST | (Offset) Selects and displays the Offset. Change the offset setting using the data keys or the rotary input knob. |

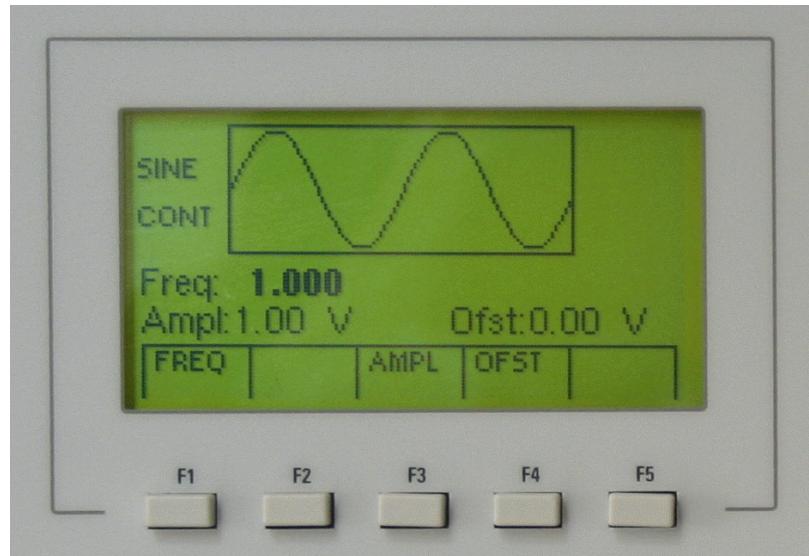


Figure 4-2: Parameter Menu

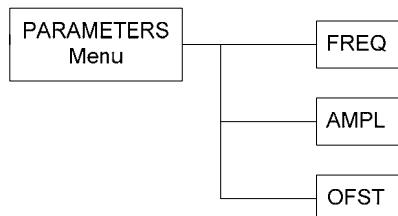


Figure 4-3: Parameters Menu Options

Waveform Menu

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

To select the output waveform, press WAVEFORM, then press the function key that corresponds to the desired Waveform menu option (Figure 4-4)

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

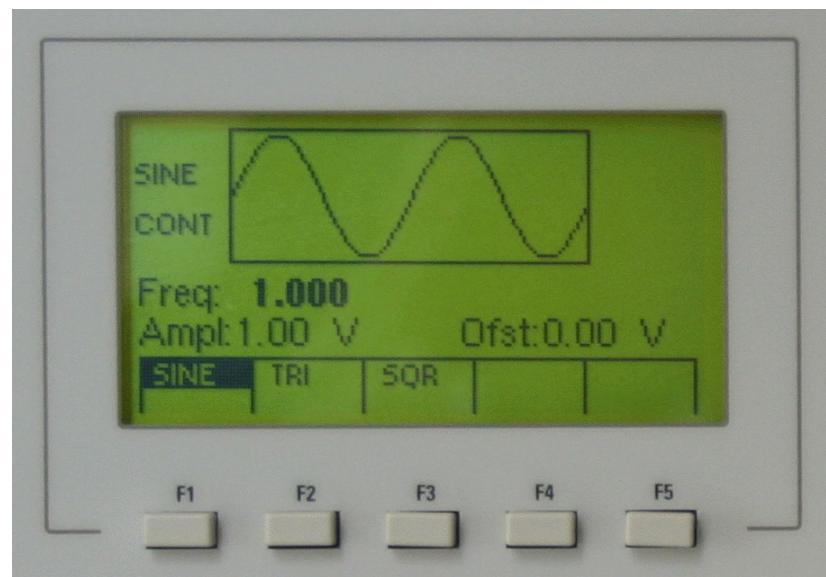


Figure 4-4: Waveform Menu

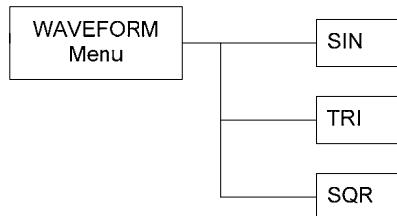


Figure 4-5: Waveform Menu Options

Mode Menu

Selects the output mode: CONT (Continuous), TRIG (Triggered), GATE (Gated), or BURST. To select the output mode, press MODE, then press the function key that corresponds to the desired Mode menu option (Figure 4-6):

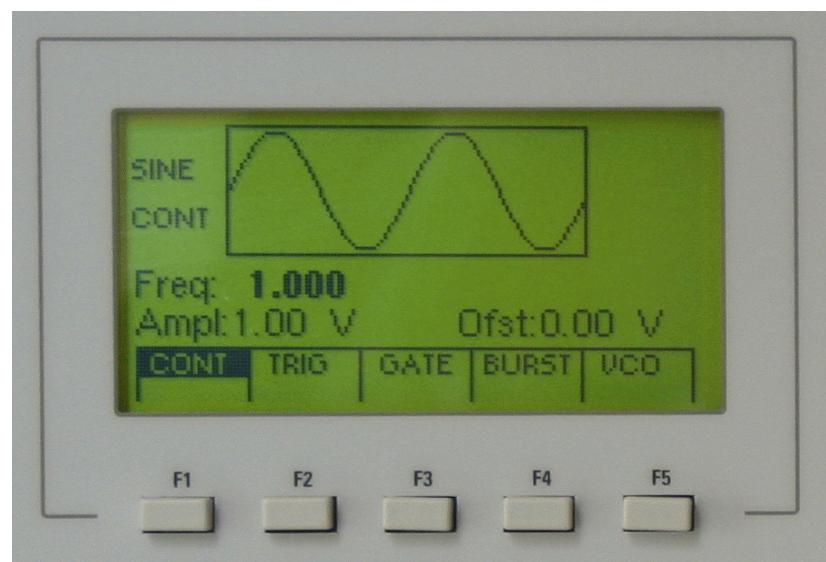


Figure 4-6: Mode Menu

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.

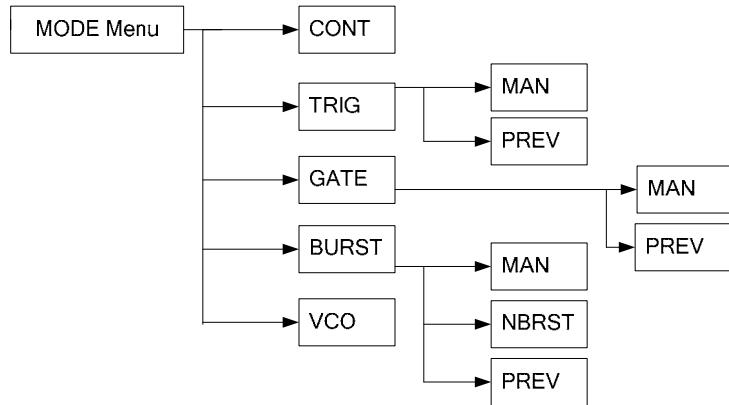


Figure 4-7: Mode Menu Options

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: VCO External voltage (1 kHz max) from 10 mV to 10 linearly sweeps 3 decades up to top of decade in which function generator is set.

Mode Sub Menu

After selecting the TRIG, GATE or BURST in the Mode menu, the Mode sub menu is available:

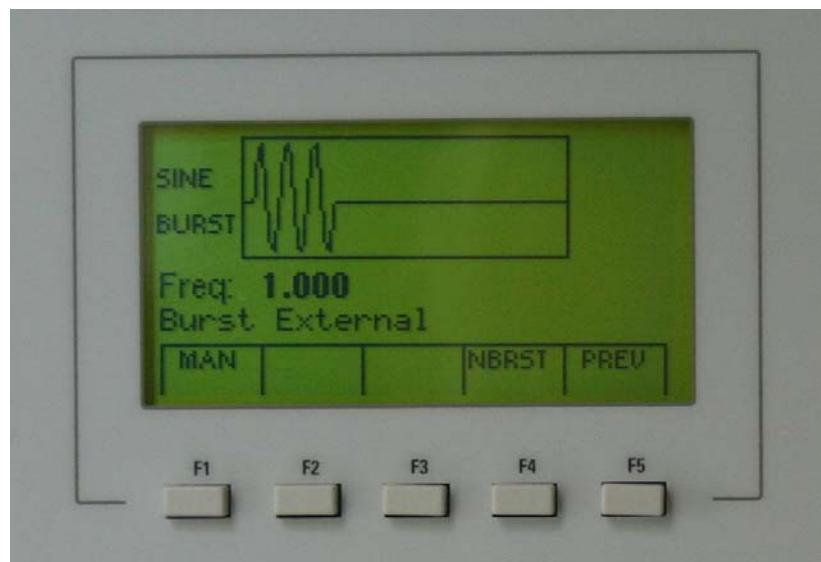


Figure 4-8: Mode sub Menu

F1: MAN Generates a manual trigger. To trigger the waveform generator, press this F1.

F4: NBRST Selects the number of burst pulses to be output with each trigger. The N can be changed from 1 to 999,999. Change N by using either the data keys or the rotary input knob. This option is available only after F4:BURST was selected in the main Mode Menu.

F5: PREV Returns to the previous Menu selection.

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.

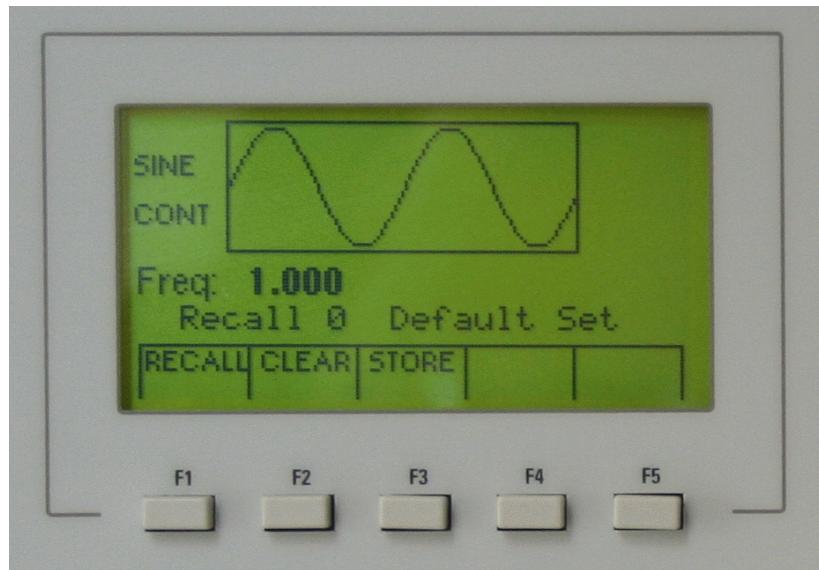


Figure 4-9: Setups Menu

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.

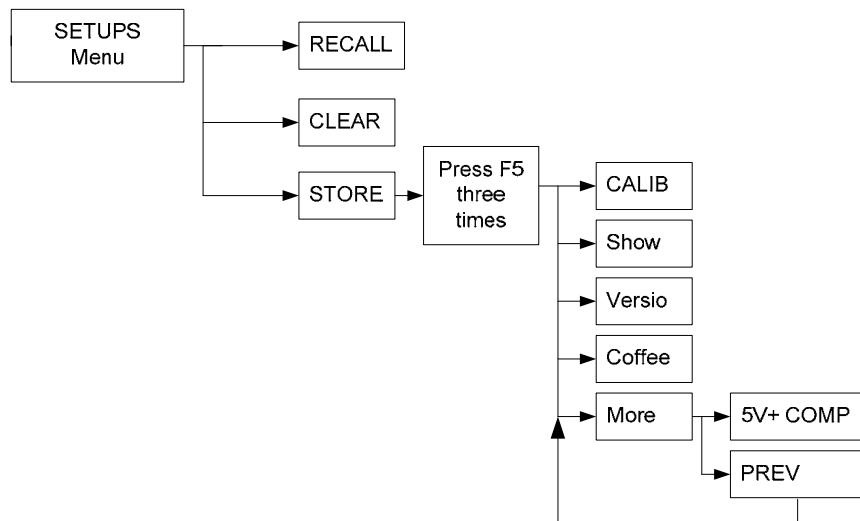
Buffer 0 is the factory default setup; buffer 50 is the last front panel setup before power-off.

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

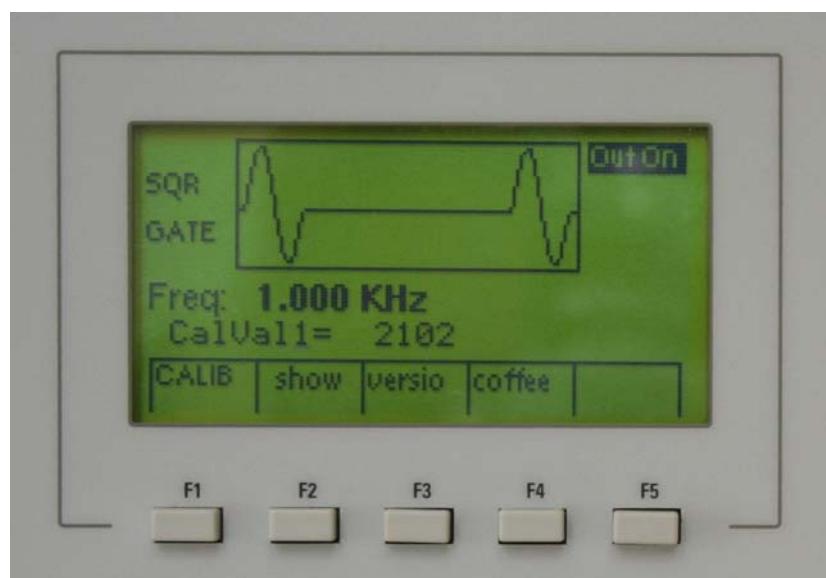
keys or the rotary input knob. Valid storage buffer numbers range from 1 to 49.

F5: Press F5 three times to access the Special Setups sub menu.

**Figure 4-10: Setups Menu Options****Special Setup Menu**

After pressing F5 three times in the Setup menu, the Special Setups sub menu is available. See Figure 4-11.

- | | |
|------------|---|
| F1: CALIB | Perform instrument calibration. See Chapter 6 – Maintenance0. |
| F2: Show | Shows calibration values |
| F3: Versio | Shows firmware version |
| F4: Coffee | Coffee break |
| F3: More | Shows more menu options as follows (Figure 4-11): |

**Figure 4-11: Special Setups Menu**

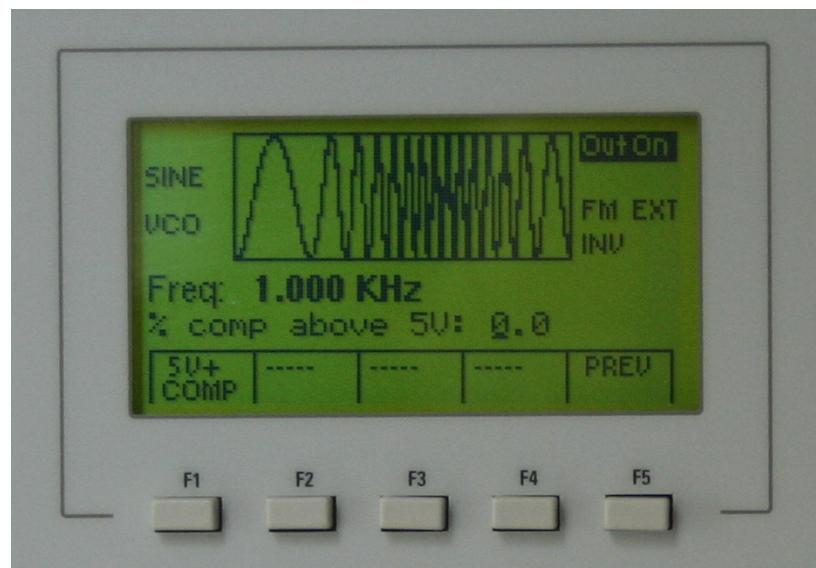


Figure 4-12: Special Setups-More

F1: 5V+
COMP

Compensation value for output levels >5V.

When the output level is greater than 5V or less than -5V the internal 50ohm output resistor is disconnected. The use of this COMP value allows the user to compensate for conditions where the output load may not be 50 ohms, allowing amplitude and offset accuracies of the instrument to be maintained. To set the compensation value use the numeric keys and enter a value in percents.

F5: PREV

Returns to the previous Menu selection.

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 4-13.

F1: ON/ OFF

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.

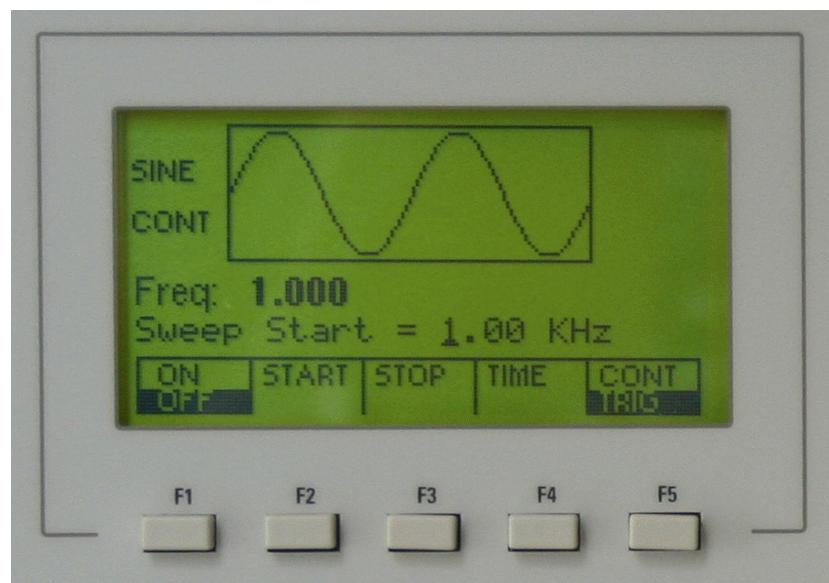


Figure 4-13: Sweep Menu

- F2: START Defines the Sweep Start frequency. Change the start frequency by using the rotary input knob or data keys.
- F3: 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: CONT/ TRIG Generates a manual trigger event for Sweep.

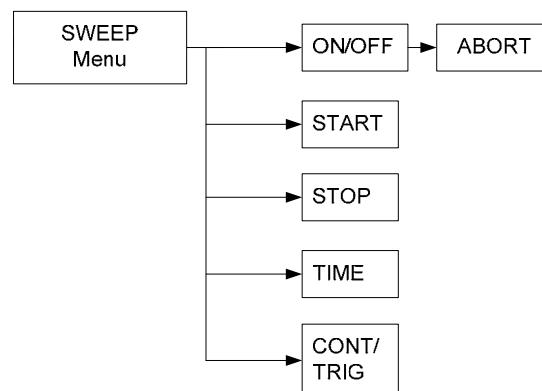


Figure 4-14: Sweep Menu Options

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 Figure 4-15.

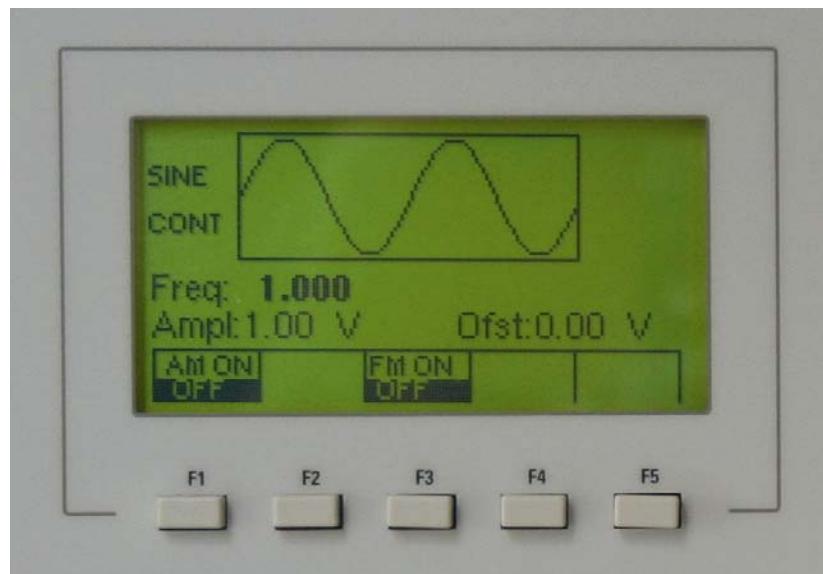


Figure 4-15: Modulation Menu

F1: AM ON/OFF Selects the Modulation ON operating mode.

F2: FM ON/OFF Selects the Modulation OFF operating mode.

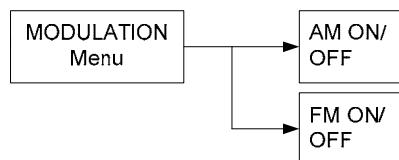


Figure 4-16: Modulation Menu Options

Utility Menu

Selects and sets the GPIB address, display Intensity and Phase functions.

To select the Utility menu, press UTILITY, and then press the function key that corresponds to the desired menu option, as shown in Figure 4-17.

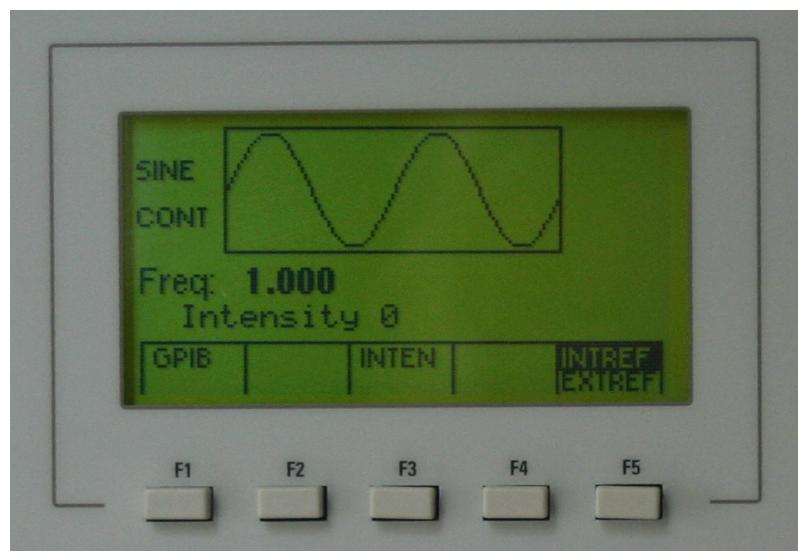


Figure 4-17: Utility Menu

- F1: GPIB Selects the GPIB remote address for the instrument. After selection the GPIB address can be set to any value from 0 to 31 using the rotary knob or the data keys. The value is kept in a nonvolatile memory and used at power-on. The factory default address is 9. Setting the address to 31 puts the device in the off-bus state (it will not respond to messages on the GPIB bus).
- F3: INTEN (Intensity) Selects the intensity of the LCD display. Select a value using the rotary input knob. Valid numeric values are from 0 to 30. The value is kept in the nonvolatile memory after a 20 seconds time-out.
- F5: INTERF/
EXTREF Internal Reference / External Reference. Reserved for future use.

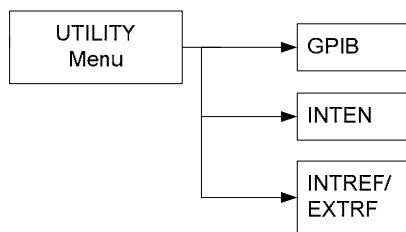
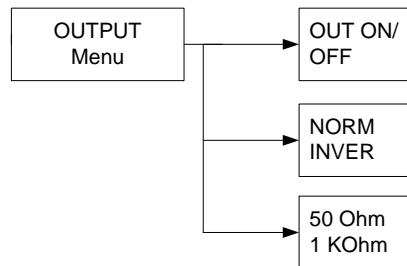


Figure 4-18: Utility Menu Options

Output Menu Key

Sets the output ON and OFF. Pushing the OUTPUT menu key will toggle the output between ON and OFF as indicated on the top right corner of the LCD window.

**Figure 4-19: Output Menu Options**

Connectors

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.
Function Out Connector	Use this connector to transfer the main output signal from the waveform generator back.
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.
Ref In Connector	Use this connector to input a 10MHz TTL signal to be used as a reference clock for the unit signal generation.
Ref Out Connector	Use this connector to output the 10MHz internal reference clock
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
Phase Mod Connector	Phase Modulation input. 5Vp signal deviates the output 360° for frequencies >500KHz. For slower frequencies phase modulation is reduced by 100 times.

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

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. 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 power-on default settings. Table 4-1 lists the factory default settings. You can program the waveform generator for any settings you want at power on, as described earlier in this section.

Key Function	Setting	Comments
FREQUENCY	1.000 KHz	Wave frequency
AMPLITUDE	1.00 V	Peak-to-peak output amplitude
OFFSET	0.00 V	Zero offset
REPETITION	10.00 mS	Internal trigger rate
MODE	CONT	Waveform mode
SLOPE	POS	External trigger slope
NBURST	2	Waves per burst
CLOCK SOURCE	INT	Internal clock source
TRIG SOURCE	EXT	External trigger source
AM	OFF	No AM
OUTPUT	ON	Output disabled
INT	5	LED intensity setting

Table 4-1: Power-On Default Settings

Using the GP1665H

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

This section provides detailed information on programming the GP1665H via the IEEE 488 bus (referred to as the GPIB - General Purpose Interface Bus). The GP1665H is programmable over the IEEE 488.1 bus, and its message protocol is compatible with IEEE 488.2. The device command set is compatible with the SCPI 1992.0 standard.

The command syntax as defined by the IEEE 488.2 and SCPI standards is briefly explained in the following sections. Users who have experience programming GPIB instruments may skip these paragraphs, and go directly to where the individual command syntax is given. Considering the relative newness ??? of these standards, it is recommended to all users to read the explanations given here. Users wishing to gain further insight should consult the standards.

Device State

The device may be in one of the four possible states which are described below. The transition between states is defined by IEEE 488.1.

Local State (LOCS)

In LOCS the device may be operated from the front panel only. Settings may be queried over the GPIB, but not changed. Commands that do not affect the instrument's signal output are accepted.

Local with Lockout State (LWLS)

In the LWLS mode, the device may be operated from the front panel only. Its settings may be queried over the GPIB, but not changed. Commands that do not affect the instrument's signal output are accepted. The difference between the LOCS and the LWLS is that when the instrument is in the LWLS state, the device may enter the Remote With Lockout State.

Remote State (REMS)

When in the REMS mode, the device may be operated from the GPIB. Actuating any front panel key will cause the device state to revert to the LOCS. The LCD window will show REMOTE CONTROLLED – GPIB.

Remote with Lockout State (RWLS)

In the RWLS mode, the device is operable only from the GPIB. Front panel operation may be returned by either sending an appropriate IEEE 488.1 command, or by cycling the device power.

Interface Function Subsets

The following interface function subsets are implemented in the GP1665H:

SH1, AH1, T6, L4, SR1, RL1, PP0, DC1, DT1, E2, C0

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

The "Z" string command initiates an instrument reset to the factory default power up state.

Basic Command Structure

The GP1665H is programmed by sending ASCII coded characters to the microprocessor via one of the two possible input ports (keyboard or GPIB). If input characters are present on more than one input port, they are read first from the GPIB and then from the keyboard. Thus, if the GPIB port is continuously supplied with characters, then no characters will ever be read from the keyboard.

Characters

Characters used to program the GP1665H are divided into classes:

1. **Alphabetic Characters** – The characters **A** through **Z** (except **E**) select actions or commands. The **X** character used in front of another alphabetic character to select an alternate set of actions or commands. The **X** must directly precede the alphabetic character without intervening characters of any kind. For example, **P** selects the output and off/on state and **XP** selects front/rear function output, but **X A P** (where **A** is a space character) selects output off/on, but not front/rear output because a space character, not **X**, was placed immediately before the **P**. Alphabetic characters generated by such keys are printed in a corner of the key.
2. **Numeric Characters** – The characters 0 through 9, E, -, and decimal point(.)
3. **Special Character** – Quote (').
4. **Terminator Character** – Initially the ASCII new line character (NL). This can be changed by programming.
5. **Nonprogramming Characters** – Any character not in one of the previously described classes. They have no effect on programming and may be interspersed freely among programming characters, except after X (refer to item 1).

Action Vs Parameter

The alphabetic characters are used to select either actions or parameters. An action is a sequence of events which happens when a programmed letter is selected or a key is pressed. There is no need for a numerical suffix. A programming parameter has one or two letters (and most have keys) plus a numeric value which controls some aspect of the instrument's operation.

To program an action, simply program the proper alphabetic character from either the front panel or GPIB port. The action will then take place, but only if the instrument is in the *enable* state at the moment when that character is read by the instrument's microprocessor.

To examine the current value of a parameter, simply program the proper alphabetic character from either the front panel or GPIB port. The current value is then displayed on the front panel. Display occurs whether or not the

instrument is enabled. If the character programmed does not correspond to a legal parameter in the instrument, nothing happens.

Programming Parameter Values

The numeric characters (0 through 9, E, -,.) are used to program new parameter values. To change a parameter value, first program the alphabetic character which selects the desired parameter (F= frequency, etc.). Next, program the new value using numeric characters. Any sequence of characters which gives the new value is acceptable. For example, all of the sequences in the table below cause the value 100 to be programmed.

ASCII	Standard Notation
100	100
0100	100 (leading zeros are ignored)
1E2	1 x 102
.01E4	.01 x 104
.01E304	.01 x 104 (last two exponent digits only are used)
1000E-1	1000 x 10-1
1-E-2-	1 x 102 (two minus signs cancel)
1E.2	1 x 102 (decimal points in exponent are ignored)

Table 5-1: Examples of Value Programming

The numbers to the left of the **E** are the mantissa; the digits to the right (only two are allowed) are the exponent power: for example 9.99 E2 = 9.99 x 10² = 999.

Only one decimal point and one **E** (keyboard EXP) are allowed per number; additional ones are ignored. The sign toggle character may appear any number of times and causes the sign of the mantissa (if **E** has not been programmed) or the exponent (if **E** has been programmed) to be reversed (if negative, then positive, and vice versa) each time it appears. Any number of nonprogramming characters may be interspersed with the numeric characters, as they have no effect. If an undesired value is entered, the CLEAR ENTRY key can be used to erase it.

Parameter	Round Offs
Frequency	Up to 8 digits, 1 µHz minimum.
Amplitude	To nearest 20 mV, 10.02 to 20.00V To nearest 10 mV, 1.01 to 10.00V To nearest 1 mV, 99 to 1000 mV To nearest 100µV 9.9 to 100.0 mV To nearest 10 µV, 1.00 to 10.00 mV
Offset	Up to 3 digits: To nearest 10 mV, 5.01 to 10.00V To nearest 5 mV, 1.005 to 5.00V To nearest 1 mV, 100.5 to 10.00mV To nearest 100 µV, 10.05 to 100.0 mV, To nearest 10 µV,

Parameter	Round Offs
	1.00 to 10.00mV
Phase	Up to 5 digits: ± 360.000 ±.010
Time (Sweep)	Up to 4 digits or 10µs to nearest .01s
Time (Sweep Off)	Up to 8 digits: 10 µs to 600.00s to nearest 10 µs
All Other Parameters	To nearest integer

Table 5-2: Round Off Values

Several parameters require codes for specific selections; for example, functions codes 0 through 3 select sine wave, triangle wave, square wave and ramp waveform.

Since the number input format is so general, the microprocessor must be told when the last numeric character has been entered so it can evaluate the number. This is done by programming either an alphabetic, special or terminator character. When this is done, the new value is rounded off (see Table 5-2) and tested to see if it is a legal value for the setting being changed (see the Errors section below). If it is legal, the new value is entered into the instrument's scratch pad memory; however, it is not yet sent to the waveform circuits. That is usually done by programming the **I** action (EXEC key on the front panel). Other methods of execution are GET and cursor, which are described later. An asterisk (*) on the display indicates that the new parameter value programmed has not been executed and resides in scratch pad memory only. All parameter values may be erased before execution by using the CLEAR ENTRY key, which will erase the value stored in scratch pad and display the original value.

Displaying Errors

At power-on, the waveform generator performs a diagnostic routine to check for problems. If the diagnostic routine finds an error, an error message is displayed. The waveform generator also displays error messages when front-panel settings are invalid or may produce unexpected results.

Message Text	Cause
Out of range	Attempt to set variable out of instrument limits.
Setting conflict	Can't have this parameter set with some other.
Trig rate short	Internal trigger rate too short for wave/burst.
Empty location	Attempt to restore non-existent setting.
SCALE too high	Attempt to set scale too high for current dot value.
Protected RAM	Attempt to write to protected RAM range.
RAM error	Error in testing RAM.
Save RAM	New firmware installed.

Table 5-3: Error Messages for GP1665H

Errors

When an illegal value is programmed or interdependent parameter errors are detected, an error signal is indicated on the front panel or via the GPIB interface. Keyboard errors only are indicated on the front panel display and by a double “beep” of the key tone. For errors made via the GPIB (but not the keyboard), a service request (SRQ) is made, providing the service request function has been enabled. The controller can then serial poll all instruments to verify that the GP1665H sent the SRQ and then subsequently inquire as to the nature of the error.

Class 1 Errors

Class 1 errors are caused by programming values out-side the limits of the parameter being programmed. For example, programming amplitude of 500 volts will cause a parameter error when the next alpha character is programmed.

At this time, the GP1665H disregards the new values and retains the previously programmed values in scratch pad memory.

Class 2 Errors

Class 2 errors are inter-parameter inconsistencies, such as a frequency greater than specified for a particular function. Tests are made every time an execute (**I**) command is issued for a stored setup (**M**) or a curser key is pressed. Resulting errors are displayed, and transfers of values are made to waveform circuits or storage regardless of the error indicated. Notice that upon receiving a Group Execute Trigger, the GP1665H programming is executed without error checking.

Class 3 Error

A Class 3 error occurs if an empty stored setting is retrieved. The error is displayed and the state of the GP1665H remains unchanged from the previously executed program.

Executing the Program

A program or setting can be executed, i.e., transferred to the waveform circuits, by the execute commands, GET (Group Execute Trigger) command, and the rotary knob.

GPIB and the front panel ENTER key initiate execute commands that cause parameter values and inter-parameter tests to be loaded and transfers these programmed values to the waveform generation circuits.

GET is a GPIB only command (no front panel key) that causes the GP1665H to execute and trigger, but without time consuming microprocessor error checking.

The Rotary Knob is exclusively a front panel function which performs an execute with error checks after each digit increment or decrement.

GPIB **Z** is a command which reset the GP1665H to the original power up conditions and perform an automatic execute.

Trigger Mode and Slope

Triggered and gated modes of the main generator are initiated either by external or internal triggers. External triggers are: external TTL level signal at front or rear panel BNCs, Manual trigger at MAN TRIG key on the front panel or GPIB **J** and **H** commands. Internal trigger is the sweep generator; that is, each sweep generator cycle triggers or gates the main generator.

The sweep generator is triggered by the above named external triggers only.

Note: “External/Internal” trigger mode (**G0** or **1**) has no effect on sweep generator triggering. If the sweep generator is in a trigger-mode, external triggers (TTL level signals at front or rear panel BNCs, manual trigger at MAN TRIG key on the front panel or **GPIB J** and **H** programming codes) will initiate a sweep generator output.

Both the main generator and sweep generator can be triggered by the same source, one may be triggered and the other not, or the external trigger may trigger the sweep generator which in turn triggers the main generator – trigger operation depends upon the generator modes.

G Followed by its code, selects either internal or external trigger (affects main generator only):

G0 Selects external trigger.

G1 Selects internal trigger.

J (pressing MAN TRIG) – Start trigger for the main and sweep generator. In main generator gated mode, the main generator is gated on.

H (releasing MAN TRIG) – In main generator gated mode, terminates the output of the main generator (the last cycle started is always completed).

Q Followed by its code, selects triggering either on the rising edge of the trigger signal or the falling edge:

Q0 Selects triggering on the rising edge (\nearrow) of the trigger signal. The main generator gates on at the high level.

Q1 Selects triggering on the falling edge (\searrow) of the trigger signal. The main generator gates on at the low level.

Main Generator

The following sections describe the keys and codes related to main generator operation. This block of keys is labeled MAIN on the front panel.

Frequency

Selecting **F** following a value (up to 8 digits) programs the main generator's frequency in hertz. See

Table 5-1 for programming values. At any time the frequency may be modified by the cursor. Upper frequency is limited by the operating mode and function.

Amplitude

V followed by its code selects the unit of measure for amplitude programming into a 50Ω load. (DC offset is always Vpeak):

V0 Selects peak-to-peak into 50Ω .

V1 Selects volts rms into 50Ω .

V2 Selects dBm into 50Ω .

An **A** followed by a value (up to 3 digits) programs the output amplitude. Amplitude may be programmed in volts peak-to-peak from mV to 20 Vp-p specified into a 50Ω load. See Table 5-1 for programming values, Table 5-2 for round off values and the Output section for function output and load operation.

Amplitude values may be modified by the cursor (see the topic: Cursor).

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 be necessary to decrease the number of digits of resolution of amplitude or offset in order to prevent clipping in the output amplifier or decrease the programmed value of offset (or amplitude) if a large amount of output attenuation has been programmed.

The sum of amplitude and offset control the output amplifier and attenuator. The output amplifier is limited to ± 10.00 volts peak and a 3 digit input (X.XX). The attenuator can operate at only $\times 10^0$, $\times 10^{-1}$, $\times 10^{-2}$ or $\times 10^{-3}$.

Offset

D followed by a value (up to 3 digits) offsets the function output from 0 to + 10V, specified into a 50Ω load. Offset is programmed in volts dc. See Table 5-1 for programming values, Table 5-2 specifies round off values and the Output section specifies function output and load operation. Offset value may be modified by the cursor (see the topic Cursor).

Note: When offset is used, 3 digit resolutions for offset or amplitude may be reduced in some cases (see the topic Amplitude).

Function

- C** Followed by a single digit parameter value selects function at the FUNCTION OUT BNC. Six function codes are used.
- C0** Selects sine wave. Frequency maximum is 50 MHz in continuous mode and 200 kHz is trigger, gated or burst mode.
- C1** Selects triangle wave. Frequency maximum is 500 kHz in continuous mode and 200 kHz is trigger, gated or burst mode.
- C2** Selects square wave. Frequency maximum is 50 MHz in continuous mode and 200 kHz is trigger, gated or burst mode.
- C3** Selects ramp. Frequency maximum is 20 kHz in continuous, trigger, gated burst mode.
- C4** Selects dc output voltage. The dc level is set by programming offset as described in the Offset section of this manual.
- C5** Selects amplitude modulation. When AM is selected the main out level is reduced to half the programmed amplitude. An ac voltage (± 2.5 Vp, typical, for 100% modulation; dc to 10 MHz minimum rate) applied at the AM IN BNC modulates the function generator's output.

Modes

- B** followed by its code (0 through 6) selects the operating mode. The selected mode is indicated on the front panel readout when the MODE key is pressed. In addition to the main generator mode selection, the output is affected by other variables. Many of the modes depend on a trigger.
- B0** Selects continuous operation of the main generator.
- B1** Selects triggered mode. The main generator is triggered by an external signal, internal sweep signal, or a manual trigger of GPIB commands. When triggered, one cycle is generated.
- B2** Selects gated mode. The onset of the trigger, regardless of its source (ref: mode **B1**), enables the main generator for the duration of the trigger signal plus the time required for the completion of the last cycle started.
- B3** Selects burst mode. Burst mode outputs a preprogrammed number of cycles each time the generator is triggered at a pre-selected rate.
R followed by its value (1 to 65,536) denotes the number of cycles generated for each triggered burst.
- B4** Selects a triggered haverwave. For ramp and square waveforms, Triggered haverwave is identical to mode B1, triggered waveforms. For sine and triangle, triggered haverwave is one cycle of the waveform starting and ending at a phase angle of -90° . Square wave starts and ends at its negative peak. If waveform amplitude is programmed negative, the waveform starts and ends at a $+ 90^\circ$ phase angle. Square wave starts and ends at its positive peak.
- B5** Selects a gated haverwave. For ramp and square waveforms, gated haverwave is identical to mode B2, gated waveforms. For sine and triangle waveforms, gated haverwave is one or more cycles of the selected

waveforms starting at a phase angle of -90^0 , if any. If waveform amplitude is programmed negative, the waveform starts at $+90^0$ phase angle. The onset of the trigger, regardless of its source (ref: mode **B1**), enables the main generator for the duration of the trigger signal plus the time required for the completion of the last cycle started.

- B6** Selects a burst haverwave. For ramp and square waveforms, burst haverwave is identical to mode **B3**, burst mode. For sine and triangle, burst is the output of a preprogrammed number of cycles of selected haverwave starting at a phase angle of -90^0 . If waveform amplitude is programmed negative, the waveform starts at $+90^0$ phase angle.
- R** followed by its value (1 to 65,536) denotes the number of cycles in the burst.

Phase

To shift output signal phase relative to some external signal, the basic 10 MHz reference must be locked to the reference clock of the external instrument. An external reference input can be a sine wave or pulse of 500 mV to 10 vp-p in amplitude at 1, 2, 3,... or 10 MHz ± 5 ppm. A message REFERENCE NOT LOCKED is displayed if the GP1665H internal reference and the external reference source are not synchronized or if the external reference has high jitter.

The frequencies of the two signals to be phase locked should be adjusted to be identical or integer multiples. The phase angle of these signals is not defined, but by programming **L** (PHASE REF) that phase angle becomes the reference phase "zero" for subsequent phase changes.

- K** followed by a value selects the phase shift (relative to phase "zero") measured in degrees. Phase value is programmed from ± 1000 revolutions ($\pm 360,000^0$) with 0.01^0 resolution steps to 500 kHz and 0.1^0 above 500 kHz. When executed, the phase shifts to the programmed angle relative to Phase Reference. Phase Reference may be redefined at any time by programming **L** (PHASE REF).

Note: When the function is a square wave, there may be a $\pm 3.6^0$ phase offset error after you have phase shifted the first time. The error is eliminated by programming **L** and noting the new phase reference angle from which to shift. Subsequent shifts will be to specified accuracy.

Applying an input to the \emptyset MOD IN BNC will phase modulate the GP1665H. A 5 Vp signal deviates the function output approximately 360^0 when output frequency is >500 kHz. For frequencies ≤ 500 kHz, phase modulation is reduced by 100 times. Phase modulation is relative to the reference source and at a deviation rate determined by the \emptyset Mode frequency (dc to 10 kHz minimum).

The Rear Panel REF OUT BNC is a source of the 10 MHz, 2Vp-p sine wave which is locked to the reference clock. Source impedance is 50Ω .

Sweep Generator

An internal generator sweeps the main generator either linearly or logarithmically from the start frequency to the stop frequency. Two overlapping sweep ranges are used: the low range 1 μ Hz to 500 kHz and the high range 5 kHz to 50 MHz.

A class 2 error occurs when start and stop frequencies are not in the same range.

In addition to sweeping the main generator, when trigger mode is "internal" and the main generator is in a trigger or gate mode, the sweep generator triggers the main generator.

The following sections discuss sweep generator controls and operation.

Start and Stop Frequency

The main generator sweeps from the start frequency to the stop frequency. For sweep up (increasing frequency) the start frequency is lower than the stop frequency. For sweep down (decreasing frequency), the start frequency is higher than the stop frequency.

N followed by its value (up to 8 digits or 1 μ Hz) programs the start frequency. The start frequency is programmed in hertz.

O followed by its value (up to 8 digits or 1 μ Hz) programs the stop frequency. The stop frequency is programmed in hertz.

Sweep Time

T followed by a value selects the time required to sweep between the start and stop frequency. The value is programmed in seconds (see Table 5-1 for programming values). Time can be programmed from 10 ms to 600.00s with 10 ms resolution in all sweep modes except “sweep off,” which can be programmed from 10 μ s to 600.00s with 10 μ s resolution.

When sweeping, altering sweep time, sweep frequency or stop frequency causes the generator to reset to the start frequency.

Sweep Width

Sweep width is the difference between the start and stop frequencies. Maximum sweep width is limited by the sweep range, either 5 μ Hz to 500 kHz or 5 kHz to 50 MHz.

Minimum sweep is dependent on the sweep range and time. Any start and stop frequencies may be used provided a minimum separation is maintained:

Low band: 20 mHz per 1s of sweep time.

High band: 2 Hz per 1s of sweep time.

Minimum width in logarithmic sweep mode is limited to the above restrictions and a start/stop frequency ratio of 2.

Sweep Mode

S Followed by its single numeric value selects the sweep operating mode. The selected mode is indicated on the front panel readout when the MODE key is pressed. In addition to the sweep generator mode selection, output mode is affected by other variables. Many of the modes depend on a trigger.

S0 Selects sweep off mode.

S1 Selects continuous ramp. Normally used with continuous main generator mode to give continuous linear sweep. SWEEP OUT is a continuous 0 to approximately +5V ramp.

S2 Selects triggered linear ramp. For each trigger, the main generator, in continuous mode, sweeps once and returns to the start frequency. SWEEP OUT outputs a 0V to approximately + 5V ramp starting with the trigger.

S3 Selects triggered linear ramp and triggered reset. Upon receiving a trigger, the main generator, in continuous mode, will sweep from the start frequency to the stop frequency and hold at the stop frequency. Upon receipt of a second trigger the main generator returns to the start frequency. SWEEP OUT outputs a 0 to approximately +5V ramp starting with the first trigger and then remains at 5 volts until the next trigger occurs.

S4 Selects continuous logarithmic ramp. Normally used with continuous main generator mode to give continuous logarithmic sweep. SWEEP OUT is a continuously recurring 0 to + 5V linear ramp.

- S5** Selects triggered logarithmic ramp. Logarithmic version of mode **S2**.
- S6** Selects triggered logarithmic ramp and triggered reset. Logarithmic version of mode **S3**.

Hold and Resume

HX (Hold) will stop the sweep and hold the main generator frequency until **XJ** (Resume) resumes the sweep. When held, the precise frequency is displayed as HOLD AT XX.XXXXXXX Hz. When resumed, SWEEP RESUME is displayed.

While the sweep is being held, the FUNCTION OUT frequency can be modified by the cursor keys. When RESUME is pressed, the frequency returns to the “hold” frequency and the sweep continues. However, the ramp voltage at SWP OUT is not modified by cursor action even if the frequency during hold is. To return the output to the start frequency rather than completing the sweep from the hold frequency, manual trigger or an external trigger is used. If the sweep generator is in triggered sweep/reset mode, two triggers will be necessary to restart the output at the start frequency.

Marker, Marker frequency and Marker Output

The frequencies of 10 markers can be preset but only one marker can be selected at a time. The marker output is a TTL-level low-to-high transition, which indicates that the frequency has swept through the programmed marker frequency. The marker output remains low for frequencies less than the marker frequency and at frequencies greater than the marker frequency the marker output remains high regardless of sweep direction.

At power on, all ten markers are preset to 1 kHz. If new marker frequencies are entered into each marker location, a reset, either from the keyboard or GPIB resets only marker #1 to 1 kHz. All other marker frequencies are unaltered. Marker frequencies can also be stored for convenience.

XN followed by a value (1 through 10) selects the marker number. Only the selected marker’s frequency is indicated by the marker output. After a marker has been selected, the marker’s frequency may be altered by programming **X0**, and the frequency (up to 8 digits) in hertz. The value replaces the former value upon the programming of the next alpha character.

Stored Settings

Up to 5 different sets of front panel settings can be stored and recalled from Random Access Memory (RAM). Option 001 provides nonvolatile memory for 40 additional stored settings. Optional memory is battery backed up (internally recharged) for a 60 day (minimum) retention of settings. Memory is expandable to 240 stored settings.

Storing Program Sets

Program sets may be stored by keyboard or GPIB command. To store the program set that is in scratch pad memory enter M followed by the storage location (1 through 49). The next alpha programmed is the terminator, which allows the storage to occur. If a program was previously stored in that location, it will be erased and replaced by the new set. When a program is stored, the settings are tested for class one errors in the same manner as with an execute command. The program is always stored, whether or not errors were detected. Programs can be stored without interrupting the output of the GP1665H if a terminator other than EXEC (**I**) is used: this is possible because it is the scratch pad memory that is stored rather than the actual settings of the waveform circuits. Note that during GP1665H operation, scratch pad memory can be changed and stored without affecting GP1665H output.

Recalling Stored Programs

The information stored in a program may be recovered either from the front panel or by a command over the GPIB. To recall, program a **Y** followed by the number of desired program. When the next alpha entry is made, the settings

stored in the selected program are transferred to display memory and the scratch pad memory. Data is then available which can be sent to the waveform circuitry of the instrument, or, if desired, it may be examined and altered by use of the front panel keys.

The identifying numbers of programs in RAM range from 1 through 49. If a program number does not exist or an illegal identifying number is programmed, an error will result.

Programming a **W** causes the program next in the sequence after the last program accessed to be recalled. This provides an automatic way to recall a sequence of programs. However, the programs need not be numbered consecutively. If there is no program following the last program accessed, an error occurs.

Programming **U** is similar to the **W** action previously described, except that programs are recalled in descending numeric order.

High Speed Recall of Stored Programs

The Group Execute Trigger (GET) allows a rapid GPIB recall of stored programs. In the GET mode of operation, the program is recalled and executed, and the waveform circuits are triggered, all within 2.5 ms of receiving the GET command. There are three possible modes of GET operation. There is no error checking.

Deleting Programs

To delete a program, program the letter M followed by a *minus* sign and the number of the program to be removed. When the number is terminated (by the next alpha character), the program is removed from storage; there is no other effect.

Outputs

Front/Rear Function Output

One function output BNC is located on the front panel and one on the rear panel. At power up the reset the signal is applied to the front panel BNC only, the rear panel output is safely turned off for ATE applications. After power is on, programming selects front or rear output.

- XP** followed by a numerical code selects the front or rear panel BNC:
- XP0** Selects front panel output and disconnects the signal from the rear panel.
- XP1** Selects rear panel output and disconnects the signal from the front panel.

Output On/Off

P followed by a code switches the output on or off.

- P0** Internally disconnects the signal from the selected function output BNC making the signal unavailable at the connector. In **P0**, the function output presents high source impedance at the BNC.
- P1** Internally connects the signal to the selected function output BNC.
- P2** Internally disconnects the signal from the selected function output making the signal unavailable. The function output source impedance is 50Ω.

Sync Outputs

Sync outputs of TTL and TTL square wave are provided, respectively, at the BNC's on the front and rear panels. The sync signal is 0V to approximately 3V (TTL) from a 50Ω source. Sync outputs are in phase with the main generator square wave output only.

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 GP1665H enters the remote state when it receives its listen address and REN is enabled. The GP1665H 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 Or Identify) indicates that the data on lines DIO1-DIO8 is the last byte of a data message. When the GP1665H receives a data byte with EOI true, the GP1665H automatically supplies a

terminator character following the data byte. When the GP1665H 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 GP1665H 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 GP1665H 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 GP1665H talk address are selected by the same rear panel switches used to select the listen address. Thus, if the GP1665H 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 GP1665H.

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 GP1665H are:

1. **Device Clear (DCL)** – Resets the GP1665H 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 GP1665H 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 GP1665H 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 GP1665H are:

1. **Go To Local (GTL)** – Commands GP1665H to go to local mode.
2. **Selective Device Clear (SDC)** – Resets the GP1665H 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 GP1665H 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 GP1665H 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 GP1665H, the currently programmed terminator character will be put into the input string following the character with the EOI

Talker

To read a message from the GP1665H, first send the talk address (with ATN on) over the bus. The instrument will then send the message currently selected by the Talk Message Select (**XT**) setting. Y=The last character of the GP1665H's message will be the currently programmed terminator character with the EOI line asserted.

XT0 Sweep Status.

XT1 List of programming errors. When read, message sets to null.

XT2 Serial poll byte message.

XT3 value of most recently programmed selector.

- XT4** Main generator settings.
- XT5** Sweep generator settings.
- XT6** Current marker frequency.
- XT7** Model and software version.

Service Request Enabling

XQ followed by its code selects the conditions under which the GPIB SRQ signal will be sent by the GP1665H.

The codes are:

- XQ0** SRQ off.
- XQ1** SRQ sent if a programming error occurred.

End of String or Terminator Specification

XV followed by its argument designates a new End Of String (EOS) or terminator character. The argument is the decimal value of the ASCII character and is the new terminator: an EOS character recognized by the GP1665H. Any ASCII character except NUL is accepted.

The terminator character has two uses. During output, it is appended to the end of every response to a GPIB talk request.. During input, it defines , the end of a group of programming characters. Since it is always recognized, even in a quoted string, it can be used to insure that the instrument is in a known state, so that following programming characters will be interpreted correctly.

At power on time, the EOS character is the line fed control character, ASCII character LF (10_{10}). When the GP1665H issues a talk message, the EOS character is the last byte sent. In addition, the End Or Identify (EOI) line is pulsed now (END message) during the EOS character transmission. If the GPIB controller does not look for the END message (EOI line low), and it does not recognize the Line Feed (LF) as a string terminator, a new EOS character will be needed. For example, to change the EOS character from an LF to a Carriage Return (CR), program **XV13**.

Get Mode

XG followed by its code selects what actions occur when a Group Execute Trigger (GET) command is sent to the GP1665H. The code may be **0**, **1** or **-1**.

- XG0** Upon receipt of GET, the programmed waveform values in the scratch pad memory are transferred to the waveform generator circuits, and then the microprocessor sends a trigger pulse if the mode is not continuous. This is the same sequence of events that would occur if in execute, then a trigger action (**IJ**) were programmed, except that no error checking is done.
- XG1** Upon receipt of GET, the stored setting next in sequence after the last stored setting accessed is recalled if it exists. This is the same sequence of events that would occur if a trigger action was programmed (**WIJ**) except no error checking is done.
- XG-1** Upon receipt of GET, the stored setting previous in sequence before the last stored setting accessed is recalled if it exists. Then the actions described for code 0 are performed. This is the same sequence of events that would occur if a previous setting, execute and a trigger action (**UIJ**) were programmed, except that no error checking is done.

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

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 feed through 50ohm terminator - 0.1%. If a feed through terminator is not available, it can be substituted with a regular terminator and a BNC T adaptor
2. BNC T adaptor
3. BNC cable, 6-18 inches long
4. BNC cable, 2-4 feet long
5. BNC to Banana Jack adapter
6. A calibrated 4½ digits or better DMM.

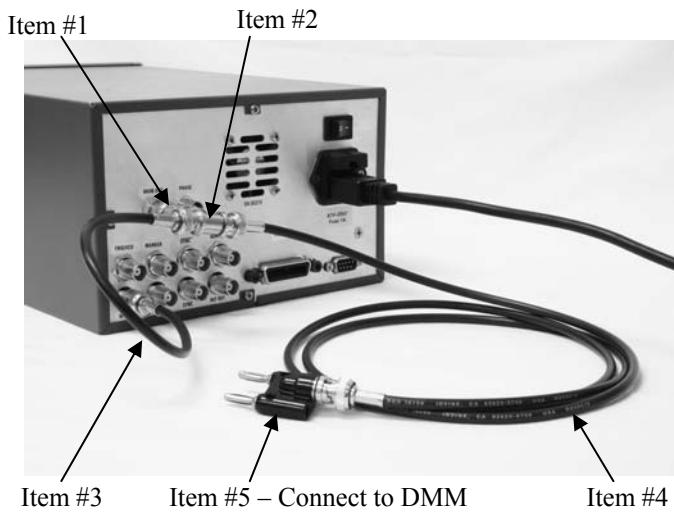


Figure 6-1: Calibration Setup

Connections

All connections are at the back of the GP1665H. See Figure 6-1.

1. Connect item #1 BNC terminator to the GP1665H Function output.
2. Connect item #2 BNC T to item #1 BNC terminator.
3. Connect item #3 BNC cable between one side of item #2 BNC T and the AM MOD IN input of the GP1665H.
4. Connect item #4 BNC cable between the other side of item #2 BNC T and item #5 BNC to Banana Jack adapter.
5. Plug item #5 BNC to Banana Jack adapter into Item 6 DMM voltage inputs.

Operation

1. Set DMM to measure VDC at Auto-Range.
2. Power up the GP1665H.
3. Let the GP1665H warm up 15 minutes before starting calibration.
4. Push the SETUP menu key on the GP1665H front panel and then push F5 quickly three times.
5. On the new menu select CALIB.

Follow the instructions on the GP1665H 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

From time to time a new firmware revision may be released to correct bugs and enhance features. The GP1665 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.

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 GP1665.

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 GP1665.
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.