GP1612H

Programmable
Pulse Generator

User's Guide

Last updated November 14, 2008

GEOTEST

MARVIN TEST SYSTEMS, INC.

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Table of Contents

Chapter 1 - Overview

Introduction

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

Features

- 50 MHZ frequency range with 16Vp-p into 50 Ω

- Variable width and delay with variable transitions

- IEEE 488.2 and SCPI compatible

- Compatible with the Hewlett Packard 8112A Pulse Generator
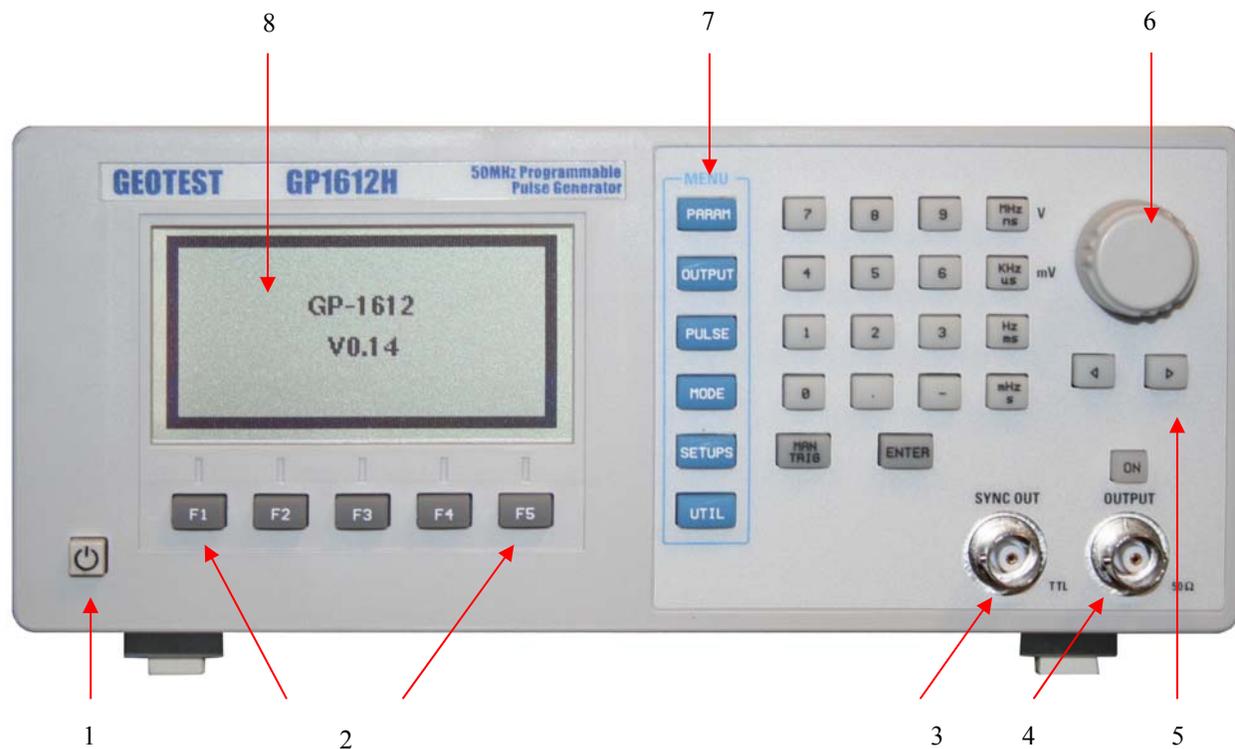
Figure 1-1: GP1612H Front Panel

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

The Rear Panel

The rear panel connectors are shown in Figure 1-2:
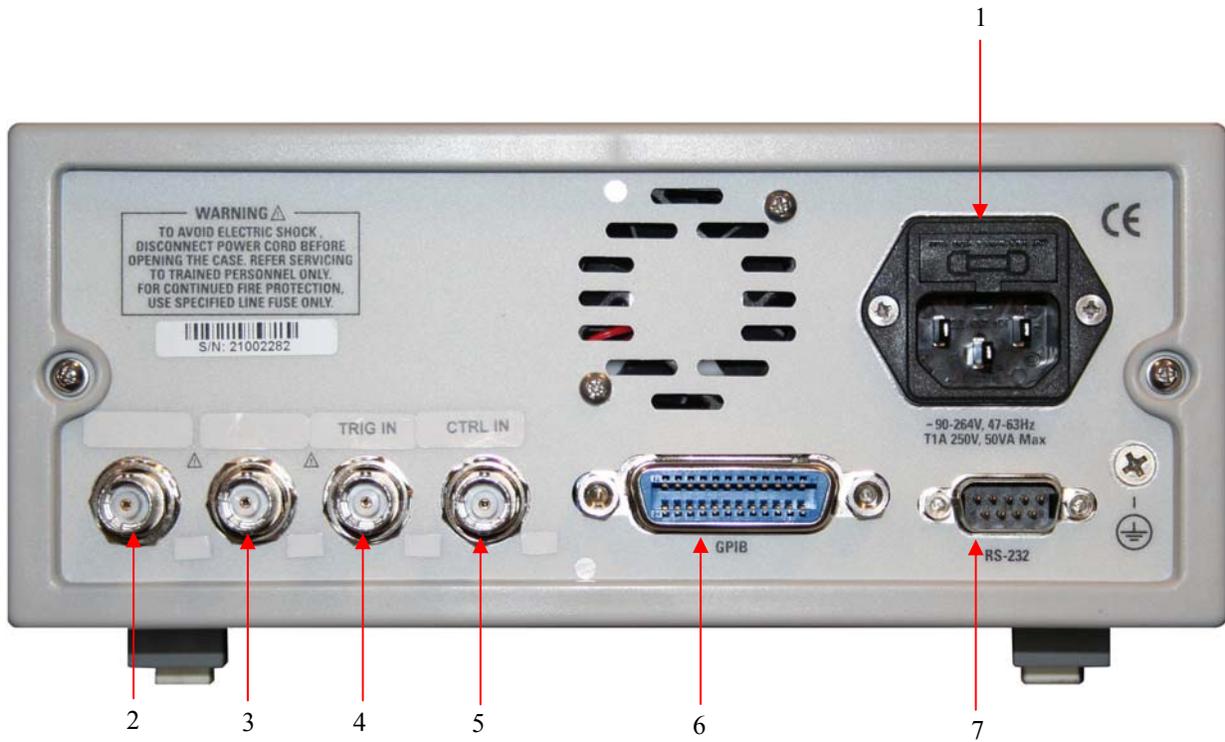
Figure 1-2: GP1612H Rear Panel

Location	Function	Location	Function
1	Power Cord Receptacle and Fuse holder	5	Control In Input (Reserved)
2	Reserved	6	GPIB Connector
3	Reserved	7	RS-232 Connector
4	Trigger Input		

Safety Information

The GP1612H 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 safely standards.

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

Caution –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

All specifications apply with a 50 ohm load, after a 30 minute warm-up period, and are valid for ambient temperature in the range 15°C to 35°C.

Timing Parameters

Unless otherwise stated, specifications are quoted for 50% amplitude in normal mode, fastest transitions.

Common Specifications	Resolution	3 digits, best case 100 ps
	Accuracy	± 5% of programmed value ±2 ns
	Repeatability	Factor 4 better than accuracy
	Jitter	Max 0.2% of programmed value + 100 ps
Period (PER)	Range	20.0 ns to 950 ms
Delay (DEL) (after SYNC Out)	Range	75.0 ns to 950 ms (max:PER+55 ns)
	Accuracy	±5% of programmed value ±5 ns
Double Pulse (DBL) (interval between leading edges)	Range	20.0 ns to 950 ms (max: PER-WID) DEL and DBL are mutually exclusive
Pulse Width (WID)	Range	10.0 ns to 950 ms (max: PER-10 ns)
Duty Cycle (DTY)	Range	1% to 99%, subject to Width specification
	Resolution	1%
	Accuracy	±10% of programmed number
		WID and DTY are mutually exclusive
Linear Transitions (between 10% and 90% amplitude)	Range	6.5 ns to 95 ms, leading edge (LEE) and trailing edge (TRE) independently programmable within 1:20 ratio

Note: Delay, Width, and Transitions are under-programmable to ensure that the specified minimum values can always be obtained.

Output Parameters

Note: Output voltages are specified for a 50 ohm load. Output voltages double when driving a high impedance load.

High Level (HIL):	-7.90 V to +8.00 V
Low Level (LOL):	-8.00 V to +7.90 V
Resolution	3 digits (10 mV)
Level accuracy	1% of programmed value ±3% of amplitude ±40 mV
Repeatability	Factor 4 better than accuracy
Settling time	100 ns +LEE
Preshoot, Overshoot, Ringing:	±5% ±10 mV (variable transitions)
	±10% ±10 mV (fixed transitions)

Trigger Modes

The external trigger signal referred to in this section is applied to the **TRIG IN** BNC connector on the instrument rear panel. The trigger level and sense are adjustable. An external trigger can be simulated by pressing the MAN key.

Normal	A continuous pulse train is generated.
Trigger	Each active input edge triggers a single pulse (or double pulse if DBL is selected)
Gate	Active input level enables pulse train, last pulse always complete. Width and period of first pulse may deviate 10% from subsequent pulses.
External Width	Pulse recovery, input edges toggle output.
External Burst	Each active input edge triggers a burst of pulses [BUR] (1 to 1999 pulses). Width and period of first pulse may deviate 10% from subsequent pulses.

Output Modes

Complement	Selectable on/off
Disable	Disconnects output, default at switching on.
Limit	Implements present output levels as output limits.
Fixed transitions	5 ns from 10% and 90% amplitude, 3.5 ns from 20% to 80% amplitude
Cosine transitions	Up to 25% faster between 10% and 90% of amplitude than linear transitions
Linear transitions	±3% linearity

Inputs and Outputs

External Input	Threshold level	±10 V adjustable
	Minimum amplitude	500 mV (p-p)
	Maximum Input voltage	±20 V
	Minimum pulse width	10 ns
	Input impedance	10 kΩ
	Trig slope	off, pos, neg, both (Trigger and Ext Width only)
Trigger Output	High level	+ 2.4 V into 50 ft
		+ 4.8 V into high impedance
	Low level	0 V
	Duty cycle	50 %
	Output impedance	50 Ω
	Propagation Delay (EXT INPUT to RIG OUTPUT)	25 ns
	External Voltage limits	-0V, +5V
Main Output	Amplitude	100 mV to 16 V (200mV to 32V)pp
	Reflections	<10%
	Source Impedance	50 Ω
	Short circuit capability	Maximum peak current 150 mA for up to 1 hour (15°C to 35°C)
	External voltage limits	+5 V

Additional Features

Non-Volatile Memory	Power down location	saves current settings
	9 programmable locations	each stores a complete setup
	Standard settings location	100 μs, 1 V pulse at 1 kHz
Self-test	The instrument performs a self-test when switched on, and by GPIB command.	
Error detection	Visual and Status Byte indication of incompatible settings, under-range control voltage, and clipped amplitude (excessive transition time).	
GPIB Capability	The GP1612H is fully programmable except for the External Input trigger level.	
Capability codes	S H1, AH1, T6, L4, SR1, RL1, PPO, DC1, DT1, CO	
Learn modes	All or individual parameters can be programmed and uploaded	
Service request	Initiated by syntax and operating errors, returns error number	
Status byte	Returns text of operating-error message	
Message Times	Time to receive and execute a message	5 ms (Offset 30 ms)
	Time to send a message: Status byte Learn String	15 ms 1 ms per character, Status byte: 15 ms

General Characteristics

Environmental	Storage temperature range	-40° C to 70° C
	Operating temperature range	0° C to 55° C
	Humidity range	Up to 95% RH between 0° C and 40° C
Power supply	100/120/220/240 V rms (selectable) +5%, -10% 48-440Hz 120 VA maximum	
Weight	Net 5.9 kg (13 lbs) Shipping 8.0 kg (18 lbs)	
Dimensions	Height: 89 mm (3.5 in) Width: 213 mm (8.4 in) Depth: 445 mm (17.5 in)	
Recalibration	1 year recommended	

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 GP1612H Programmable Pulse Generator.

Mechanical Inspection

The GP1612H Programmable Pulse Generator 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

Warning – To avoid hazardous electric shock, do not perform electrical tests when there are signs of shipping damage to any part of the outer covers or panels.

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.

Power Requirements

The instrument requires a power source of 90 to 250 V rms (+5%, -10%) at a frequency of 48-440 Hz single phase. The maximum power consumption is 120 VA.

The instrument power fuse is located on the rear panel.

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 Connector

The rear panel GPIB connector (Figure 3-3), is compatible with the connector on Cable Assemblies 10833A, B, C and D. If a cable is to be locally manufactured, use male connector.
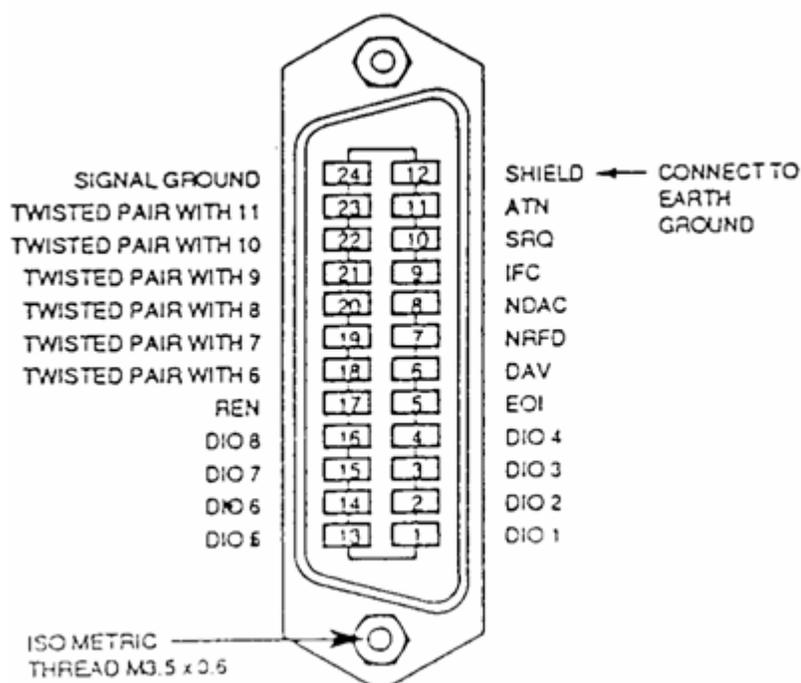
Figure 3-1: GPIB Connector

GPIB Logic Levels

The GP1612H lines use standard TTL logic, the levels being as follows:

- True = Low = digital ground or 0 Vdc to 0.4 Vdc,

- False = High = open or 2.5 Vdc to 5 Vdc.

All GPIB lines have LOW assertion states. High states are held at 3.0 Vdc by pull-ups within the instrument. When a line functions as an input, approximately 3.2 mA of current is required to pull it low through a closure to digital ground. When a line functions as an output, it will sink up to 48 mA in the low state and approximately 0.6 mA in the high state.

⚠️ **Caution –** The GPIB line screens are isolated from ground.

Operating Environment

Warning – The GP1612H is not designed for outdoor use. To prevent potential fire or shock hazard, do not expose the GP1612H to rain or other excessive moisture.

Temperature The GP1612H may be operated in temperatures from 0°C to 55°C.

Humidity The GP1612H may be operated in environments with humidity up to 95% (0°C to +40°C). However, the GP1612H should be protected from temperatures or temperature changes which cause condensation within the instrument.

Instrument Cooling

The GPIB is equipped with a cooling fan mounted inside the rear panel. The instrument should be mounted so that air can freely circulate through it. When operating the GP1612H, choose a location that provides at least 75 mm (3 inches) of clearance at the rear, and at least 25 mm (1 inch) of clearance at each side. Failure to provide adequate air clearance will result in excessive internal temperature, reducing instrument reliability.

Claims and Repackaging

If physical damage is evident or if the instrument does not meet specification when received, notify the carrier and the nearest Hewlett-Packard Service Office. The Sales/Service Office will arrange for repair or replacement of the unit without waiting for settlement of the claim against the carrier.

Storage and Shipment

The instrument can be stored or shipped at temperatures between —40°C and +75°C. The instrument should be protected from temperature extremes which may cause condensation within it.

Return Shipment to Geotest

If the instrument is to be shipped to Geotest, attach a tag showing owner, return address, model number and full serial number and the type of service required.

The original shipping carton and packing material may be re-usable, but the Hewlett-Packard Sales/Service Office will also provide information and recommendations on materials to be used if the original packing is no longer available or reusable. General instructions for repacking are as follows:

1. Wrap instrument in heavy paper or plastic.
2. Use strong shipping container. A double wall carton made of 350-pound test material is adequate.
3. Use enough shock-absorbing material (3 to 4 inch layer) around all sides of the instrument to provide a firm cushion and prevent movement inside container. Protect control panel with cardboard.
4. Seal shipping container securely.
5. Mark shipping container FRAGILE to encourage careful handling.
6. In any correspondence, refer to instrument by model number and serial number.

Chapter 4 - Operating

Introduction

This section describes the displays, controls, and connectors on the front panel of the GP1612H Programmable Pulse Generator. All controls you use for local operation of the GP1612H are on the front panel. Connections are available on the front and rear panels. The main function output is available on 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 GP1612H front panel.
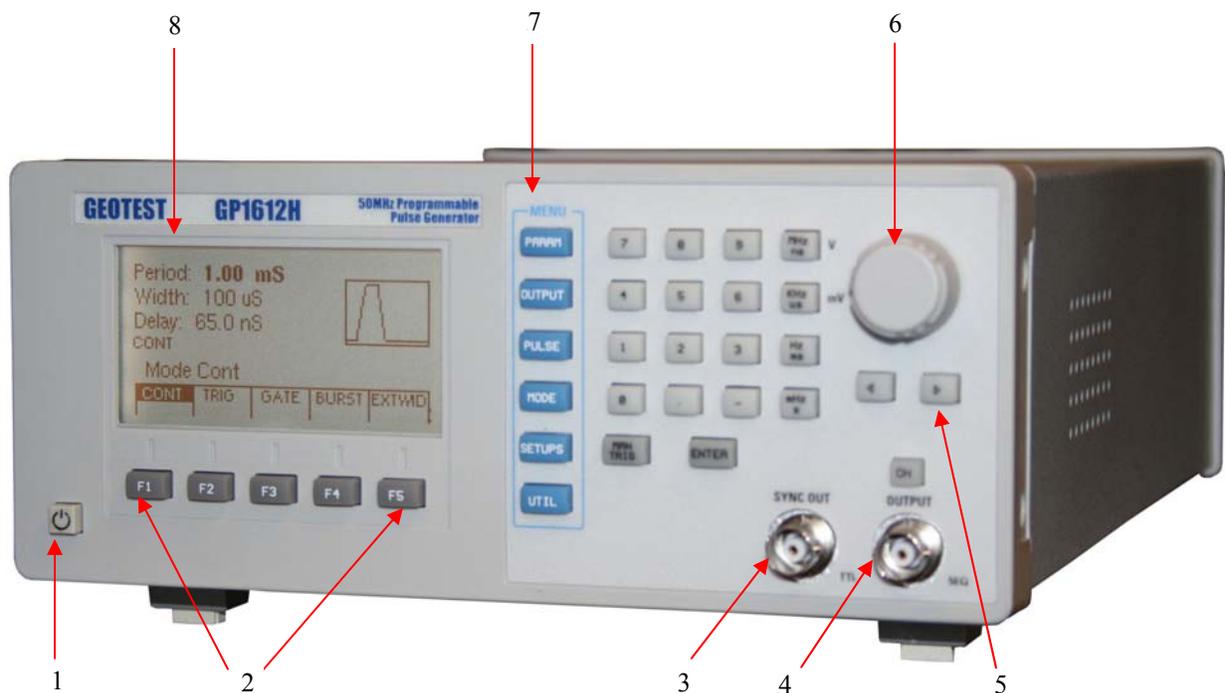
Figure 4-1: GP1612H Front Panel

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

The GP1612H has graphical LCD display window. When you power-on the GP1612H 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 sections 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: PERIOD/FREQ   Selects between Frequency and Period for setting and display.

F2: WIDTH/DUTY   (Width) Selects pulse width setting; (Duty) Pulse duty cycle is variable from 1% to 99%. Percentage values are shown on the display.

F3: DELAY   Enables the operator to set the desired delay

F5: SINGLE/DOUBLE   Toggles between single or double pulse modes.
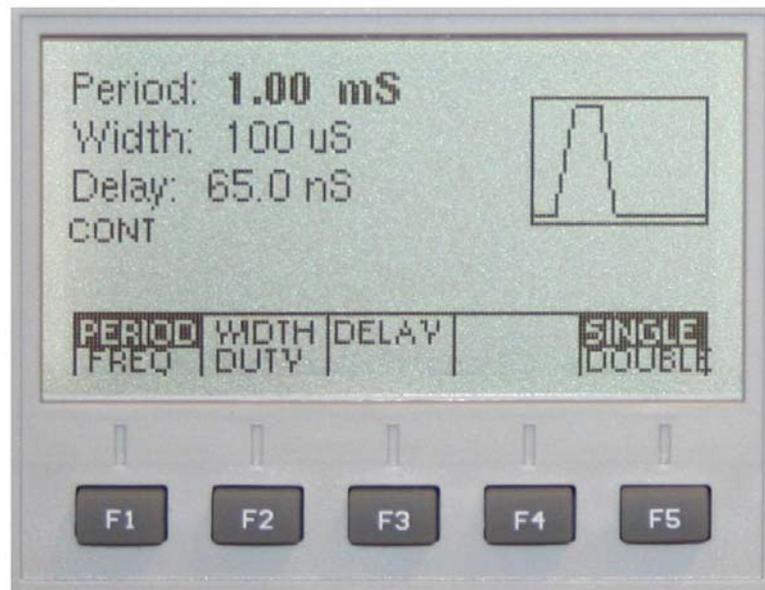
Figure 4-2: Parameter Menu
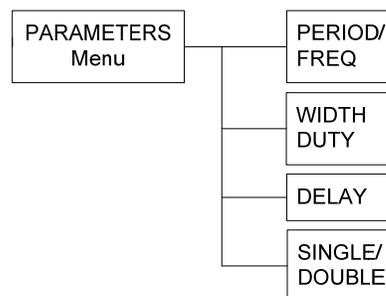
Figure 4-3: Parameters Menu Options

Output 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: HI-LVL/LO-LVL   Toggles between Hi Level setting and Lo level setting. To set the level uses the key pad or the knob.

F4: LIM ON/LIM OF   Toggles between level limits on or off.

F5: HILIM/LOLIM   Toggles between Hi level Limit setting and Lo level Limit setting. To set the limit use the key pad or the knob.
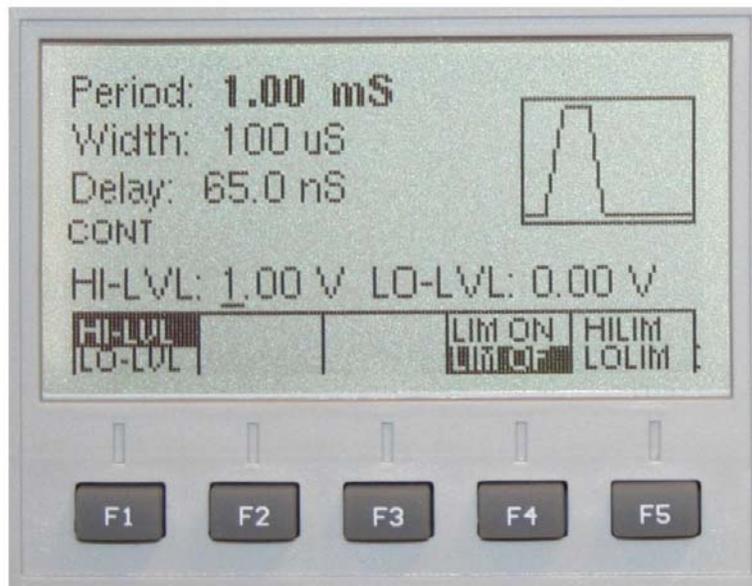
Figure 4-4: Output Menu
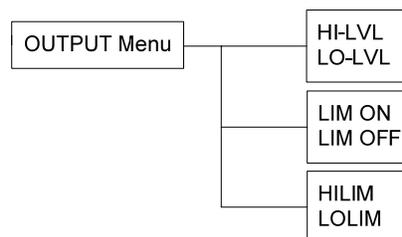
Figure 4-5: Output Menu Options

Pulse Menu

Displays the programmable pulse attributes: Rise, Fall, Equal, Comp and Norm.

To modify a pulse attribute, press PULSE, then press the function key that corresponds to the desired Pulse attribute.

F1: RISE   Sets the pulse rise time.

F2: FALL   Sets the pulse fall time.

F3: EQUAL Sets the pulse fall time to be the same as the rise time.

F4: COMP   Sets the output to complement (inverted) mode

F5: NORM   Sets the output to normal (not inverted) mode
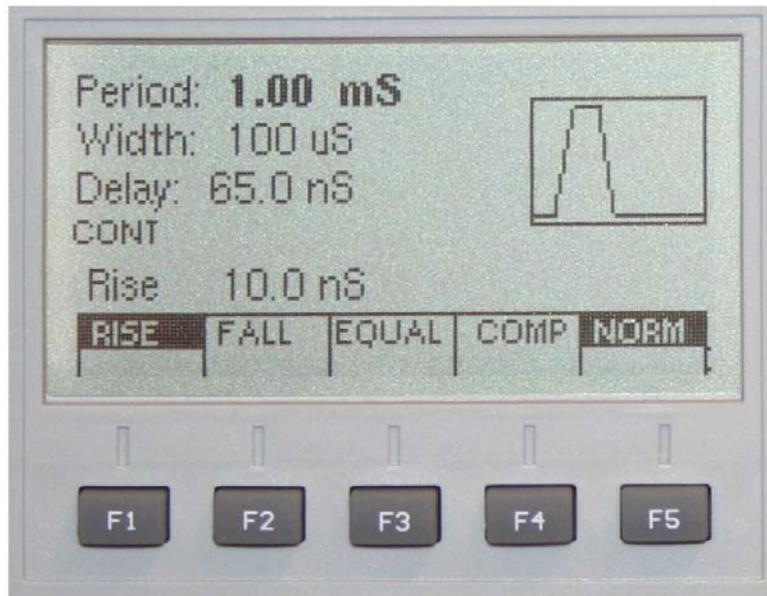
Figure 4-6: Pulse Menu
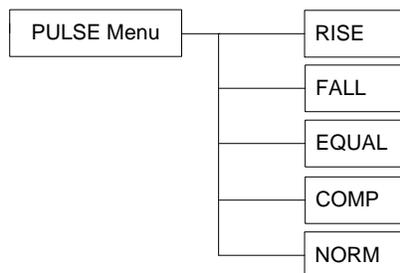
Figure 4-7: Pulse Menu Options

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:
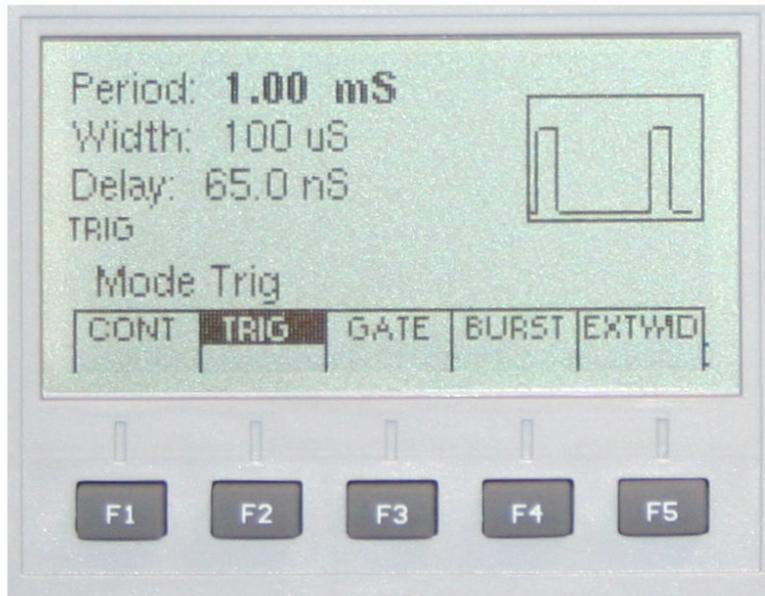
Figure 4-8: Mode Menu

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 1999. Change N by using either the data keys or the rotary input knob.

F5: EXTWID (External Width) Output toggles with each trigger edge.
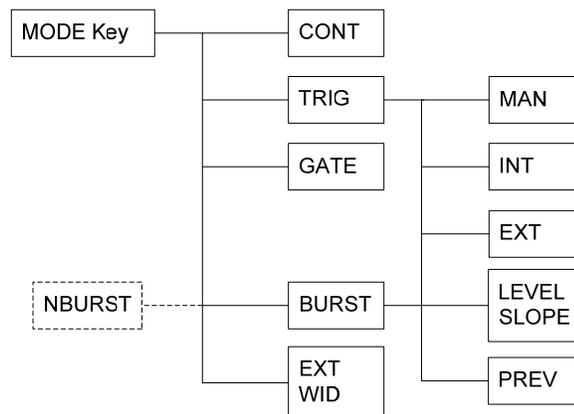
[1] Burst only

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:
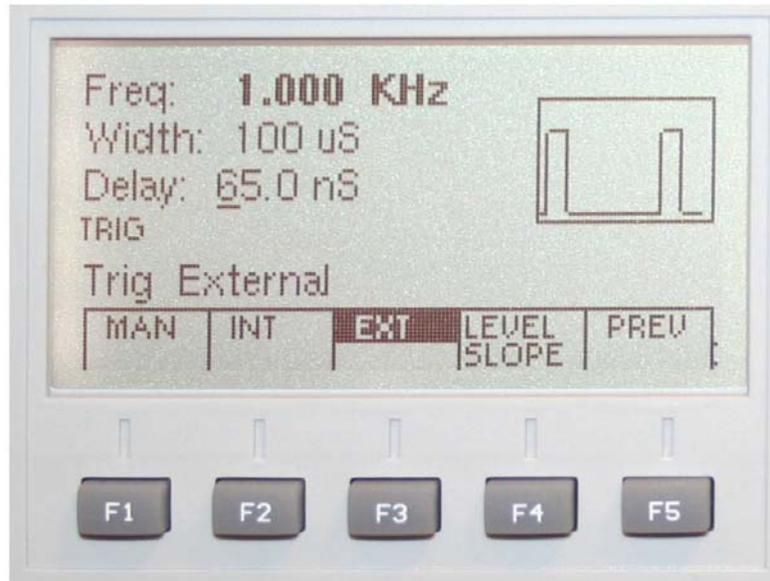
Figure 4-10: Mode sub Menu

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   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: LEVEL SLOPE   Toggles between trigger level settings or trigger slope settings

F5: PREV   Returns to Mode menu

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

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

F4: CLEAR   Clears all stored locations and sets the GP1612H to the default parameters.
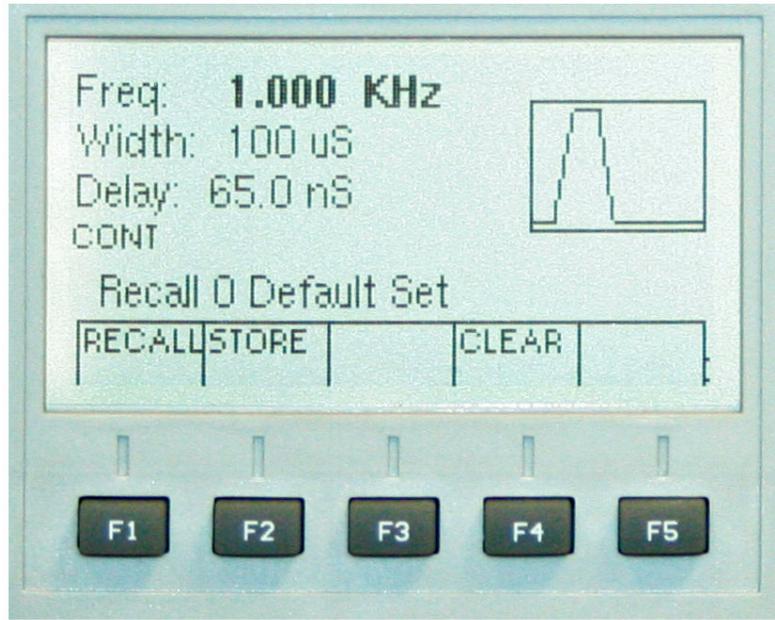
Figure 4-11: Setups Menu
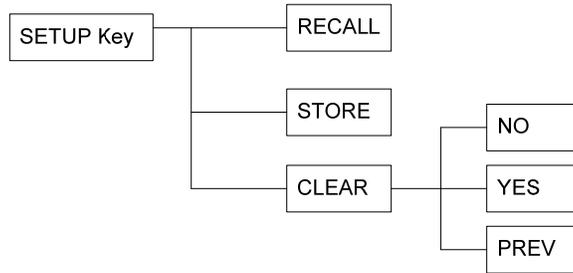
Figure 4-12: Setups Menu Options

F5:   Press F5 three times to access the Special Setups sub menu.
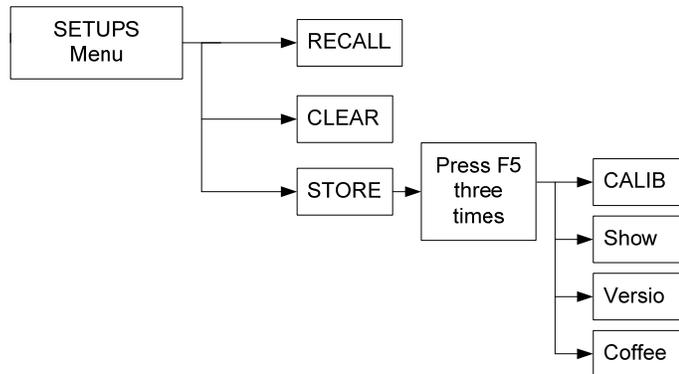
Figure 4-13: Special Setups Sub Menu Options

Special Setups Sub Menu

After pressing F5 three times in the Setup menu, the Special Setups sub menu is available. See Figure 4-14:

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

F2: SHOW   Shows calibration values

F3: VERSIO   Shows firmware version

F4: COFFEE   Coffee break ☺
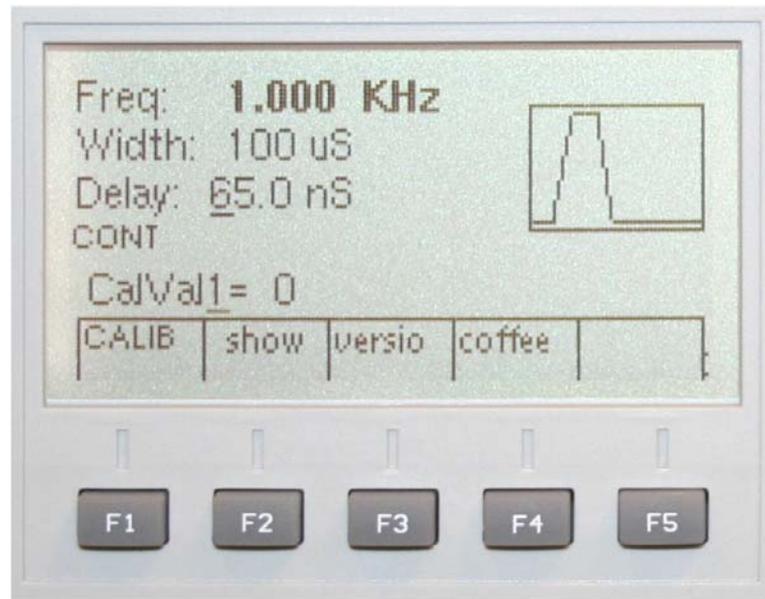
Figure 4-14: Special Setups Menu

Util Menu

Allows setting of the instrument's GPIB address and to adjust the LCD intensity.

To set GPIB address, press UTIL and select GPIB. To adjust LCD intensify, press UTIL and select INTEN.

F1: GPIB   Sets the instrument's GPIB address

F3: INTEN   Adjusts the LCD intensity
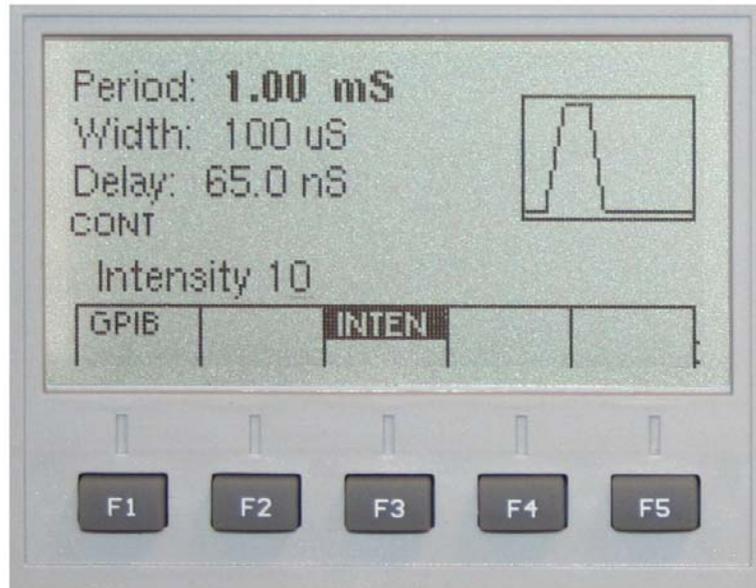
4: Util Menu
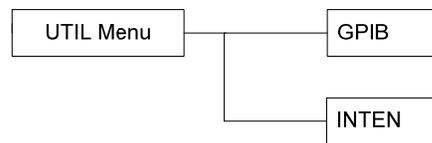
4: Util Menu Options

Connectors

The Pulse Generator has two BNC connectors on the front panel and four on the rear panel where you can connect coaxial cables. These coaxial cables provide input and output signals to and from the Pulse Generator.

Output Connector	Use this connector to transfer the main output signal from the waveform generator front.
Sync Out Connector	This output provides a TTL pulse at the beginning of each period. Use this output to synchronize with other instruments
Trig In Connector	Use this connector to transfer an external trigger or gate signal, depending on the setting, to the pulse generator.

Rest of connectors are reserved and currently not in use.

Output Connections

The Programmable Pulse 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 the last saved settings.

Chapter 5 - Programming

Overview

This section provides detailed information on programming the GP1612H. The firmware is customized to be fully compatible with the Hewlett Packard 8112A GPIB (referred to General Purpose Interface Bus) command set. Software test procedures using the original GP1612H instrument require no code modification when upgrading to the GP1612H.

The GP1612H uses all lines on the bus, terminations, logic levels and pinouts.

Error Reporting

In general, whenever a program attempts to put the GP1612H into an error condition, the GP1612H responds by making a Service request i.e. set SRQ line true. Under these circumstances, the system controller will address the GP1612H as talker using a serial poll command (SPE), the GP1612H then responding by putting an error message on the data bus. This message consists of a single 8-bit byte in which SRQ bit 7 is set true ('1') and bits 1 to 3 comprise an error code.

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

Device Address

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

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

Instrument Reset

Sending a 'Device Clear (DCL)' or RCL 0 commands initiates an instrument reset to the standard setup state.

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

Key Function	Setting	Comments
SLOPE	POS	External trigger slope
BUR	1	Waves per burst

Table 5-1: Standard Device Clear Settings

Setting the GPIB Address

The GP1612H's GPIB address is set at the factory to 12 decimal. The address stored in the Instrument's RAM, along with the current instrument setting.

Note: When allocating GPIB address make sure no instruments on the bus have the same address. The default GPIB address is 12.

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 GP1612H enters the remote state when it receives its listen address and REN is enabled. The GP1612H then stays in the remote mode until the REN line is put in the local state, a Go To Local (GTL) command is received or the LOCAL front panel key is pressed.

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

5. **EO1 –** When ATN is false, EOI (End Or Identify) indicates that the data on lines DIO1-DIO8 is the last byte of a data message. When the GP1612H receives a data byte with EOI true, the GP1612H automatically supplies a terminator character following the data byte. When the GP1612H 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 GP1612H 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:

1. Listen Addresses
2. Talk Addresses
3. Secondary Addresses
4. Universal Commands:

    DCL – Device Clear

    SPE – Serial Poll Enable

    SPD – Serial Poll Disable

    LLO – Local Lockout

5. 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 GP1612H 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.

Programming

To select an operating mode or to set a parameter to a specific value, the appropriate ASCII mnemonic must be sent to the GP1612H.

Example:

To set the Operating Mode to TRIG, the ASCII mnemonic M2 has to be sent to the GP1612H.

HP Basic Statement for this is: `OUTPUT "M2"`

When programming parameters, such as Period, Delay or Width, the ASCII mnemonic must be followed by the value and the appropriate unit. The ASCII mnemonic, the value and unit may be separated by a comma or space character. For better readability it is recommended to use a space character.

Example:

To set the Period to 2.2 ms, the ASCII mnemonic PER followed by the new value 2.2 and the unit MS must be sent to the GP1612H.

HP Basic Statement for this is:

`OUTPUT "PER 2.2 MS"` Or

`OUTPUT "PER2.2MS"`

Note: Program commands can be a combination of upper case or lower case ASCII characters, whereas the responses are always returned in uppercase.

Multiple Commands

You can send multiple programming commands on the same line. The commands may be separated by a comma or a space character. It is recommended to separate the commands with a comma, because this makes it easier to read such a programming message.

Examples:

`OUTPUT "Ml,T0 ,PER 1.25 MS"`   Commands separated with commas

`OUTPUT "Ml T0 PER 1.25 MS"`   Commands separated with space characters

`OUTPUT "M1T0PER 1.25 MS"`   Commands not separated

Commands which change modes are processed before commands which set parameters, irrespective of the command order within the programming message. If your application requires a parameter change to occur before a mode change, use separate programming messages for the two commands.

The GP1612H can be programmed into an error condition in just the same way as when using the front panel. For example, attempting to program a larger LOL than HIL:

`OUTPUT "HIL 1 V, LOL 2 V"`

Refer to "Error, Fault and Status Reporting" for details of error, fault and status reporting using the GPIB.

GPIB Command Messages

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

Action	Mnemonics	Value Delimiter
Selecting Trigger Modes:		
Standard Trigger Modes:		
Select NORM	M1	
Select TRIG	M2	
Select GATE	M3	
Select E.WID	M4	
Select E.BUR	M5	
Trigger Control:		
Select trigger off	T0	
Select positive trigger slope	T1	
Select negative trigger slope	T2	
Select both	T3	

Example: OUTPUT "M3, T1" Select GATE mode with a positive trigger slope.

Action	Mnemonics	Value Delimiter
Selecting Output Waveform Mode:		
Select fixed	W1	
Select liner	W2	
Select Gaussian	W3	
Select mode off	SM0	
Select mode on	SM1	

Example: OUTPUT "W2, SM1" Select linear output waveform transitions

Action	Mnemonics	Value Delimiter
Setting Parameters:		
Timing Parameters:		
Set period	PER	NS = namoseconds
Set delay	DEL	US = microsecounds
Set double pulse	DBL	MS = milliseconds
Set width	WID	
Set leading edge	LEE	
Set trailing edge	TRE	
Set duty cycle	DTY	%

Example: OUTPUT: ''Per 10 MS, DTY 30%" Set period to 10 ms, set duty cycle to 30%.

Action	Mnemonics	Value Delimiter
Level Parameters:		
Set high level	HIL	V = volts
Set low level	LVL	V = volts
Example: OUTPUT "HIL 2 V, LOL -1.25 V"		
Burst Parameter:		
Set burst number	BUR	#
Example: OUTPUT "BUR 375" Provides a burst of 375 output pulses		
Stored Parameters:		
Store parameter set	STO	1….9 set ident
Recall parameters set	RCL	0 = standard
		1….9 stored set
Example: OUTPUT "STO 5" Store current parameters set on instrument as setting number 5 OUTPUT "RCL 0" Revert instrument to standard parameter settings		
Excessive Slope Calculation:		
Recall slope calculation off	SR0	
Recall slope calculation on	SR1	
Example: OUTPUT "SRO" Switches off calculation of excessive slope (speeds up program execution)		

Table 5-2: Mode/Parameters Messages – Listen Function

Reading Parameters

The GP1612H provides special commands with which information can be read by the computer. These commands are called Talker Function Commands. After Sending a Talker Function Command the GP1612H will return a response message. A response message remains in the GP1612H output queue until it is read or another command is issued.

For example, to read the current value of the Period, the following commands are necessary:

```
OUTPUT "IPER"
ENTER ;A$
PRINT "GP1612H PER= ";A$
```

Note: After the Interrogate Parameter commands (IPER, IDEL, IDBL, etc.) the GP1612H does not return only the numeric values, instead it returns an ASCII-response that contains the command to set the interrogated parameter to its present value. If the current period is set to 1 ms, the variable A$ will contain the string "PER 1.00 MS" after conducting the example above.

It is possible to read the current setting of a parameter using the interrogation mnemonics listed here:

- IPER

- IDEL

- IDBL

- IDTY

- IWID

- ILEE

- ITRE

- IHIL

- ILOL

- IBUR

The GP1612H reply has the same format as that used when setting the parameter, for example:

```
PER 10MS
```

The reply length is always 12 characters.

It is also possible to read all the instrument settings in one go using the CST mnemonic. Refer to "Reading the Current Settings"

Example:

```
DIM B$ [12]
OUTPUT 712;"IDEL" ENTER 712;B$
PRINT "8112A DEL= ";B$
```

Dimension string allocates 12 characters of memory for reply.

Request current delay setting.

Read reply into allocated memory. Print the reply.

Selecting Output Modes

Action	Mnemonics
Switch off output limits	L0
Switch on output limits	L1
Switch off complementary output	C0
Complement output	C1
Enable output	D0
Disable output	D1

Example:

OUTPUT "L1, D0" Switch on output limits and enable the output signal

Reading the Current Settings

The Current Setting interrogate command CST tells the HP 8112A to send a response that contains all necessary commands to set the device to its present state. The response message called (ASCII) learns string, can be retransmitted as a program message without alteration.

The learn string may be altered in the computer before retransmitting it. Since the learn string is made up of the several independent commands, it is possible to send parts of the learn string (complete commands) to the instrument.

When the GP1612H replies with a string containing all current settings, the data is always in the same order:

M1,CTO,T1,W1,SMO,L0,CO3D1,BUR 001 #,PER 1.00 MS,DBL 200 US,DEL 65.0 NS, DTY 50%,WID 100 US,LEE 10.0 NS,TRE 10.0 NS,HIL 0.30 V,LOL -0.70 V

Example:

```
DIM B$ [153]
OUTPUT "CST"
ENTER ;B$
PRINT "GP1612H settings are: ";B$
```

Allocate memory for maximum reply length Request current settings of instrument.

Read reply into allocated memory Print the reply.

Error, Fault and Status Reporting

GPIB Status Byte

The GP1612H is provided with the capabilities of requesting service from the controller (the computer) whenever the instrument detects an error.

To be able to determine if an error was caused, Status Reporting Structures are required. For this purpose the instrument contains the Status Byte register:

The Status Byte Register (STB) is composed of seven single-bit "summary-messages". Each of the bits 0 thru 5 summarizes a specific type of error. For example, bit 0 represents all types of Limit errors. (See the operating manual of the GP1612H) Bit 6 of the STB is the Request Service (RQS) Bit and is set whenever a service request is caused. Bit 7 indicates whether the Buffer is empty or not.

After a Serial Poll (SPOLL) the complete Status Byte is cleard. The Status Byte is updated after every command received by the GP1612H.

The GP1612H status byte can be read using a serial poll

```
A = SPOLL
PRINT "GP1612H Status Byte= ";A
```

Read instrument status byte into variable A

The meaning of each bit in the status byte is given below. In all cases, the bit is set to 1 to indicate that the condition described is true.

Bit	Meaning
0	LIMIT ERROR (Causes SRQ)
1	TIMING ERROR (Causes SRQ)
2	SYNTAX ERROR (Causes SRQ)
3	SLOPE ERROR (Causes SRQ)
4	DUTY CYCLE ERROR (Causes SRQ)
5	INPUT ERROR (Causes SRQ)
6	SERVICE REQUEST (=SRQ)
7	BUFFER NOT EMPTY

The SRQ bit generates an interrupt at the system controller to indicate that the instrument requires attention. You can use this facility as the basis of interrupt driven error handling in your programming application.

The SRQ, Programming Error, Syntax Error and System Error bits are latched until the status byte is polled by the system controller. The other status bits represent the current condition at the time the status byte is read.

You can obtain more detailed information about timing and programming errors using the interrogate error (IERR) mnemonic. The HP 8112A responds with a string describing the current error conditions. The descriptions are covered in subsequent parts of this section.

```
DIM E$[45]
OUTPUT ;"IERR"
ENTER ;E$
PRINT "GP1612H Error= ";E$
```

Allocate memory for error string Request error information Read reply into allocated string

Limit Error (Bit 0)

There are two types of error which set the limit error bit in the status byte. The conditions which cause them and the description used by the GP1612H when replying to an IERR command are listed below. The limit error bit is not latched; therefore a transient error is only recorded by generating an SRQ.

Note: More than one error condition can occur at one time. When using the IERR command ensure that you allow for a reply containing t more than one error description.

IERR Description	Comments
Limit Error	This error appears only when the limit is on and: the programmed High-level is greater than the limited High-level the programmed Low-level is lower than the limited Low-level
Limit-HILC	This error appears only when the limit is on and: High-level control has been selected no High-level limit is possible as HILC is an external control voltage

Timing Error (Bit 1)

There are two types of error (shown for NORM mode only) which set the timing error bit in the status byte. The conditions which cause them and the description used by the GP1612H when replying to an IERR command are listed below. The timing error bit is not latched; therefore a transient error is only recorded by generating an SRQ.

Note: More than one error condition can occur at one time. When using the IERR command ensure that you allow for a reply containing more than one error description.

IERR Description	Comments
Delay Error	Delay value is greater than Period value. i.e. PER 1 ms, DEL 1.1 ms The front panel LEDs flash to indicate the invalid settings. The ERROR LED is on.
Width Error	Width value is greater than Period value, i.e. PER 1 ms, WID 1.1 ms The front panel LEDs flash to indicate the invalid settings. The ERROR LED is on.

Syntax Error (Bit 2)

This error occurs when the GP1612H cannot understand a programming message. e.g. DDY 50% instead of DTY 50%. The bit is latched until cleared by reading the status byte.

Slope Error (Bit 3)

This error is caused by excessive slope. The conditions which caused it and the description used by the HP 8112A when replying to an IERR command are listed below. The slope error bit is not latched, therefore a transient error is only recorded by generating an SRQ.

Note: More than one error condition can occur at one time. When using the IERR command ensure that you allow for a reply containing more than one error description.

IERR Description	Comments
Excessive Slope	No Valid waveform at the output: LEE > WID x0.8 or (PERxDTY/100)x0.8 TRE > (PER-WID)x0.8 or PER -(PERxDTY/100))x0.8 TRE > (DBL-WID)x0.8 or DBL-(PERxDTY/200))x0.8 TRE > (PER-DBL-WID)x0.8 or PER-DBL-(PERxDTY/200))x0.8 No calculation with "SR1".

The "EXCESSIVE SLOPE" error message and calculation can be suppressed with the SRO command. This will reduce programming time.

Example:

```
OUTPUT ; "SRO"
```

This is particularly useful for character strings where a multiple of the same timing parameter is programmed such as

```
OUTPUT ; "SRO"
FOR A = 1 to 100
OUTPUT ; "PER (CHR$ A) MS" NEXT A
```

Immediately upon receiving the new PERIOD value, the GP1612H would calculate the excessive slope error for each period time interval. By suppressing "EXCESSIVE SLOPE", new settings for Period are accepted by the instrument without any calculation, and a reduction in programming time of typically 30 ms may be achieved.

Note: In the permanently stored Mode/Parameter settings in the GP1612H ROMs, "SR" is set to "0" (zero). If these settings are recalled as current settings, the Service Request function can be re-activated by programming "SR" to "1".

```
Output ; "SR1"
```

Duty Cycle Error (Bit 4)

There are three types of error which set the duty cycle error bit in the status byte. The conditions which cause them and the description used by the HP 8112A when replying to an IERR command are listed below. The timing error bit is not latched, therefore a transient error is only recorded by generating an SRQ.

Note: More than one error condition can occur at one time. When using the IERR command ensure that you allow for a reply containing more than one error description.

IERR Description	Comments
DTY-PERC	Duty cycle not available in PERC. An external voltage controls the Period and NOT the Duty Cycle
DTY-WIDC	As above. External voltage controls the Width and NOT the Duty Cycle
DTY-TRIG	An external trigger signal generates the Period. The displayed Duty Cycle is calculated from the internal Period. DTY is not confirmed with the external period

Input Error (Bit 5)

There are four types of error which set the input error bit in the status byte. The conditions which cause them and the description used by the HP 8112A when replying to an IERR command are listed below. The timing error bit is not latched, therefore a transient error is only recorded by generating an SRQ.

Note: More than one error condition can occur at one time. When using the IERR command ensure that you allow for a reply containing more than one error description.

IERR Description	Comments
EWID-PERC	The external trigger input signal is passed through to the output. A Control input cannot alter period, delay, or width. Identical returns are EWID-DELC and EWID-WIDC
TRIG-WIDC	Both inputs will attempt to control the period. This is not possible
GATE-TRIG slope	Both EXT INPUT slopes selected. Either leading edge or trailing edge may be specified but not both
EWID-TRIG slope	As above. Either leading edge or trailing edge may be specified but not both

Service Request (Bit 6)

This bit indicates that a service request has occurred. The bit is latched until cleared by reading the status byte.

Buffer not Empty (Bit 7)

This bit is set when there is data in the GP1612H input buffer. You can monitor this bit to determine if the instrument has finished interpreting a long programming message.

GPIB Universal Commands

The HP 8112A supports the following GPIB Universal commands:

Note: These are GPIB commands, Not instrument programming commands. They are not used in programming massages.

GPIB Mnemonic	Description	Basic 5.0/5.1 Equivalent
DCL	Device Clear	CLEAR 7
SDC	Selected Device Clear	CLEAR 712
LLO	Local Lockout	LOCAL LOCKOUT 7
GTL	Go to Local	LOCAL 712/LOCAL T
GET	Group Execute Trigger	TRIGGER 712/TRIGGER 7
UNL	Unlisten	SEND 712; UNL
UNT	Untalk	SEND 712; UNT
SPE	Serial Poll Enable	SPOLL (712)
SPD	Serial Poll Disable	
MLA	My Listen Address	Selectable
MTA	My Talk Address	Selectable

DCL

An GPIB DCL command causes the HP 8112A to load its standard parameter set. The instrument remains in its current mode (local or remote).

SDC

An GPIB SDC command causes the HP 8112A to load its standard parameter set and enter remote mode.

GET

An GPIB GET command simulates an external trigger to the HP 8112A in TRIG, E.BUR and E.SWP modes.

Hints for solving Problems that might Occur

Reading the Status Byte

When programming the HP 8112A it must be considered that the instrument needs some time to:

* Receive the commands
* Interpret the commands
* Update the Status Byte.

The hardware settling time must also be considered. (See Chapter 2" Specifications" for more details).

When a command is sent to the GP1612H, the device places all received characters into a buffer. Interpretation of the command(s) starts as soon as a valid terminator is received.

To determine if the buffer is empty or not, read the Status Byte by conducting a SPOLL. If bit 7 is set (decimal value of the STB is bigger than 127) then the buffer is not yet empty.

Whenever the status byte is read directly after sending a command, the HP 8112A should be given sufficient time to update the status byte. The time needed, varies with the type and number of the commands sent. For single commands 100 to 200 ms should be adequate.

Example:

```
10 CLEAR
20 A = SPOLL
30 !
40 OUTPUT "WID 10 MS"    !   causes error
50 WAIT .2               !   give GP1612H time to update the STB
60 PRINT "Status Byte:" ;A
70 END
```

If the wait period in line 50 is too low, the value of the Status Byte printed in line 60 will be 128. This indicates that the buffer is not yet empty. An adequate wait period (here 200 ms) will give the GP1612H enough time to process the command and update the status byte. As expected, the value of the status byte printed in line 60 will therefore be 74.

Possible Problem with SPOLL

If the GP1612H is the only instrument on the bus, the SPOLL statement may cause the instrument to "hang up".

Either of the following will clear the fault:

1.   Use a GPIB cable of not less than 2m length. Or:

2.   Use a user-defined function to interrogate the status byte instead of the usual SPOLL statement.

In the following program, line 20 causes a syntax error so that a SRQ is generated. Lines 40 to 130 show how the status byte can be interrogated with a user-defined function:

```
10 A=712
20 OUTPUT A;"XYZ" 30 WAIT .05
40 PRINT "Status byte:",FNSpoll(A)
50 END
60 DEF FNSpoll(A)
70 S_code=A DIV 100 80 H_addr=A MOD 100
90 SEND S_code;UNL MLA TALK H_addr CMD 24
100 ENTER S_code USING "#,B";Stb
110 SEND S_code;CMD 25 UNT
120 RETURN Stb
130 FNEND
```

Chapter 6 - Maintenance

Calibration

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. A BNC cable, 2-4 feet long
2. BNC to Banana Jack adapter
3. A calibrated 4½ digits or better DMM.

Connections

1. Connect item #1 BNC cable between the GP1612H Main Output and item #4 BNC to Banana Jack adapter.
2. Plug item #2 BNC to Banana Jack adapter into Item #3 DMM voltage inputs.

Operation

1. Set DMM to measure VDC at Auto-Range.
2. Power up the GP1612H.
3. Let the GP1612H warm up 15 minutes before starting calibration.
4. Push the SETUP menu key on the GP1612H front panel and then push F5 quickly three times.
5. On the new menu select CALIB.

Follow the instructions on the GP1612H display:
6. Adjust the knob on the front panel to get a reading of 0.000V±0.001 on the DMM and push Enter.
7. Adjust the knob on the front panel to get a reading of 4.500V±0.001 on the DMM and push Enter.
8. Wait for the 'Calibration Completed' message and push Enter.

Firmware Upgrade

Overview

From time to time a new firmware revision may be released to correct bugs and enhance features. The GP1612H 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 GP1612H.

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 GP1612H.
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.