MODEL 325

FUNCTION GENERATOR

OPERATING MANUAL

Model 325

15 MHz Function Generator

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P/N 032-5501-01

Warranty

OR-X warrants only to the original purchaser that this product, as purchased from OR-X or an OR-X distributor or dealer, will conform to the written specifications for a period of one year from the date of purchase. If the product fails to conform to these warranties, OR-X, as its sole and exclusive liability hereunder, will repair or replace the product and/or its components within a reasonable period of time if the product is returned to OR-X's facility, within the warranty period as expressed above. These warranties are made upon the express condition that:

a. The purchaser promptly notify OR-X in writing of any non-conformity with the above warranty including a detailed explanation of the alleged deficiencies.

b. The product is returned to OR-X at the buyer's expense only after obtaining the proper authorization from OR-X.

c. When the product is returned for repair, a copy of the original bill of sale or invoice is sent with the product .

d. OR-X will not be liable for any incidental or consequential damages.

e. In the opinion of OR-X upon inspection, the product has not been misused, altered, or damaged due to abnormal handling and/or operation.

f. Repairs to the product and/or its components have not been made by anyone other than OR-X or one of its authorized repair agents.

g. The product has not been modified, altered, or changed in any manner by anyone other than OR-X or one of its authorized repair agents.

THIS WARRANTY EXCLUDES ALL OTHER WARRANTIES, WHETHER EXPRESSED OR IMPLIED, ORAL OR WRITTEN, INCLUDING WITHOUT LIMITATION WARRANTIES OF MERCHANTABILITY AND/OR FITNESS FOR A PARTICULAR PURPOSE.

No term, condition, understanding or agreement purporting to modify the terms of this warranty shall have any legal effect unless made in writing and signed by an authorized officer of OR-X and the purchaser.

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. 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. OR-X assumes no liability for a customer's failure to comply with these requirements. This is a Safety Class I instrument.

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 TEXIO 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 all of the 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.***

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.***

Contents

Section 1

Introduction

1.1 Introduction

This manual contains information required to operate, program and test the MODEL 325 - DDS Function Generator. This section covers the instrument general description, instrument specifications and characteristics.

1.2 Description

The MODEL 325 is a versatile high performance Function generator that generates Sine, Square and Triangle signals. Waveforms can be output in continuous, triggered, gated or burst mode. AM and FM modulation combined with versatile Sweep capabilities make the unit suitable for a wide range of applications.
The instrument can be remotely operated via the RS232 interface bus and it is SCPI compatible.

1.3 MODEL 325 - SPECIFICATIONS

FREQUENCY CHARACTERISTICS (STANDARD WAVEFORMS)

Sine	-	0.01 Hz to 15 MHz
Square	-	0.01 Hz to 15 MHz
Triangle , Ramp	-	0.01 Hz to 2 MHz
Accuracy	-	0.005 % (50 ppm)
Resolution	-	6 digits or 10 mHz

OUTPUT CHARACTERISTICS

Amplitude Range	-	10mV to 10Vp-p into 50 ohms
Resolution	-	3 digits (1000 counts)
Amplitude Accuracy	-	± 2% ± 20mV of the programmed output from 1.01V- 10V
Flatness	-	0.5 dB at 1MHz
	-	1 dB to 15 MHz
Offset Range	-	± 4.5V into 50 ohms, depending on the Amplitude setting
Offset Resolution	-	10 mV with 3 digits resolution
Offset Accuracy	-	± 2% ± 10mV into 50 ohms
Output Impedance	-	50 ohms
Output Protection	-	The instrument output is protected against short circuit or accidental voltage practically available in electronic laboratories, applied to the main output connector

WAVEFORM CHARACTERISTICS

Harmonic Distortion	-	0-20 KHz -50 dBc
	-	20 KHz-100 KHz -45 dBc
	-	100 KHz-1 MHz -40 dBc
	-	1 MHz-15 MHz -30 dBc
Spurious	-	DC-1MHz <-55 dBc
Square Rise/Fall Time	-	< 25 ns (10% to 90%) at full amplitude into 50 ohms
Variable Duty Cycle	-	20% to 80% to 2 MHz for Square and 10%-90% for Triangle
Symmetry at 50%	-	< 1 %

OPERATING MODES

Continuous	-	Output continuous at programmed parameters.
Triggered	-	Output quiescent until triggered by an internal or external trigger, then one waveform cycle is generated to programmed parameters, up to 2 MHz
Gate	-	Same as triggered mode, except waveform is executed for the duration of the gate signal. The last cycle started is completed.
Trigger Source	-	Trigger source may be internal, external or manual. Internal trigger rate 10us to 10.

MODULATION CHARACTERISTICS

Amplitude Modulation

- Internal:	Selectable sine signal of 400 Hz, 800 Hz, 1000 Hz or 3000 Hz Variable modulation from 0% to 100% in 1% steps.
- External:	5 Vp-p for 100% modulation, 10 Kohms input impedance, DC to 20 KHz bandwidth.

Frequency Modulation

- Internal:	Selectable sine signal of 400 Hz, 800 Hz, 1000 Hz or 3000 Hz
- External:	5 Vp-p for 100% deviation, 10 Kohms input impedance, DC to 20 KHz bandwidth.

SWEEP CHARACTERISTICS

Sweep Shape:	Linear and Logarithmic, up or down
Sweep Time:	10 ms to 50 s.

INPUTS AND OUTPUTS

Trigger In	-	TTL compatible.
	-	Max. rate 2MHz.
	-	Minimum width 50ns.
Sync Out	-	TTL pulse at programmed frequency, 50 ohms source impedance.
Modulation IN	-	5 Vp-p for 100% modulation .
	-	10 KΩ input impedance. Dc to >20 KHz minimum bandwidth.

GENERAL

Store memory	20 full panel settings at power-off
Dimensions	- 8.4 inch (213 mm) wide - 3.5 inch (88 mm) high - 8.3 inch (210 mm) deep
Weight	- Aprox 2.5 Kg.
Power	- 90V-264V, 30 VA max
Temperature	- Operating - 0ºC to +50ºC, Non-operating - -10ºC to +70ºC
Humidity	- 95 % RH , 0ºC to 30ºC
EMC	- According to EN55011 for radiated and conducted emissions.
Electrical Discharge Immunity	- According to EN55082
Safety Specifications	- According to EN61010

NOTE

Specifications are verified according to the performance check procedures in the technical manual.
Specifications not verified in the manual are either explanatory notes or general performance characteristics only.

Section 2

Installation

2.1 Introduction

This section contains installation information, power requirements, initial inspection and signal connections for MODEL 325 - Function Generator.

2.2 Mechanical Inspection

This instrument was carefully inspected before shipment. 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. Use packing material around all sides of the container and seal it with tape bands. Mark the box "FRAGILE".

2.3 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 service center.

2.4 Instrument Mounting

The MODEL 325 - Function Generator is intended for bench use. The instrument includes a front feet tilt mechanism for optimum panel viewing angle. The instrument does not require special cooling when operated within conventional temperature limits. The unit can be installed in a closed rack or test station if proper air flow is assured for removing about 15 W of power dissipation.

2.5 Power Requirements

The MODEL 325 can be operated from any source of 90V to 264V AC, frequency from 48Hz to 66Hz. The maximum power consumption is 30 VA. Use a slow blow fuse UL/CSA approved of 1A as indicated on the rear panel of the instrument.

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

2.6 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.

2.7 Signal Connections

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

2.8 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
1	-	-
2	TXD	Transmit Data
3	RXD	Receive Data
4	-	-
5	GND	Signal ground
6	-	-
7	RTS	Request to Send
8	CRS	Clear to send
9	-	-

2.9 RS-232 Configuration

The instrument use 8 data bits, 1 stop bit, no parity and baud rate of 19200.

Section 3

Operating Instructions

3.1 General Description

This section describes the displays, controls and connectors of the MODEL 325 - Function Generator.
All controls for the instrument local operation are located on the front panel. The connectors are located on both front and rear panels.

Figure 3.1 - MODEL 325 Front Panel

1. Power ON-OFF -Applies and removes AC power to the unit.

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

3. FI-F4 Keys -Select the menu options that appear on the second line of the LCD display. Menus differ depending on the selected parameter, function or mode.

4. Function Keys -Select the output waveform, Sine, Square, Triangle or Arbitrary.

5. Rotary Knob -Used to increment/decrement numerical values or to scan through the possible selections.

6. Modify Keys -Used to move the cursor (when visible) to either left or right.

3.2 Display Window

The MODEL 325 has a graphic LCD display that can display up to 124 x 32 dots. When you power-on the unit the SINE is selected and its current settings appear in the display. The bottom displays a menu that corresponds to the function, parameter or mode displayed selected.

3.3 Front Panel Controls

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

To change a setting:
1. Press the key that leads to a required item.
2. Move cursor using cursor keys to the appropriate position in the numeric field (if applicable).
3. 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.

3.4 Connectors

The function generator has all BNC connectors on the front panel where you can connect coaxial cables. These coaxial cables serve as carrier lines for input and output signals delivered to and from the function generator.

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

Trig In Connector
Use this connector to apply an external trigger or gate signal, depending on the waveform generator setting, to the generator. This connector is also the input to the build-in counter, activated by pressing the COUNT pushbutton.

Sync Out Connector
Use this connector to output a positive TTL sync pulse generated at each waveform cycle.

Modulation In Connector
5V p-p signal for 100% modulation, 10Kohms input impedance with DC - >20 KHz bandwidth.

3.5 Output Connections

The waveform generator output circuits operate as a 50 ohms voltage source working into a 50 ohms load. At higher frequencies, non terminated or improperly terminated output 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.

Impedance Matching

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

3.6 MENU Keys

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

3.6.1 WAVEFORM Keys

The keys select the waveform output and displays the waveform parameter menu (frequency, amplitude and offset).

Sine Menu

F1: FREQ **-** (Frequency) Selects and displays the frequency. Change the frequency setting using the cursor keys and the rotary knob.

F2: AMPL **-** Selects the Amplitude parameter.

F3:OFST **-**Selects the Offset parameter. Change the offset by using the cursor keys and rotary knob. If a certain setting cannot be produced, the waveform generator will display a "Setting Conflict" message.

Amplitude and Offset Interaction:

Amplitude and offset settings interact and are bound by hardware restrictions. In order to obtain the desired waveform the following amplitude and offset hardware limitations must be considered:

The offset voltage has three ranges as follows:

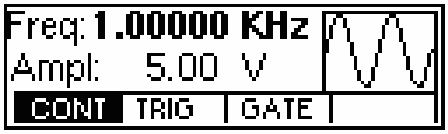
Output Voltage Range	Constraints of Amplitude + Offset
1.01 volt to 10.00 volts	(Vp-p)/2 + |offset| <= 5 volts
0.101 volt to 1 volt	(Vp-p)/2 + |offset| <= 0.5 volts
0.010 volt to 0.100 volt	(Vp-p)/2 + |offset| <= 0.05 volts

F4:SYM - When the Square or Triangle waveforms are selected, the SYMMETRY is available. Change the symmetry by using the cursor keys and rotary knob. If a certain setting cannot be produced, the waveform generator will display a warning message.

Triangle Menu

3.6.2 MODE Key

Selects the output mode: CONT (Continuous), TRIG (Triggered) and GATE (Gated).
To select the output mode, press MODE, then press the function key that corresponds to the desired Mode menu option, as shown:



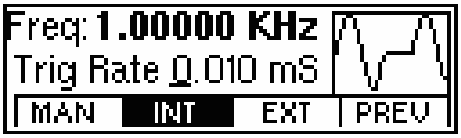
Mode Menu

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.

After selecting the TRIG , GATE or BURST menu, the trigger source menu is available:



Trigger Menu

F1: MAN - Selects manual as the trigger source. To trigger the waveform generator, press this MAN TRIG again.

F2: INT - Selects the internal trigger generator as the trigger source. Change the internal trigger rate displayed with 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.

F4: PREV - Returns to the previous menu.

3.6.3 UTILITY Key

Utility Menu

F1: RECALL - Recalls a previously stored front-panel setup from the selected buffer. Change the buffer number by using the rotary input knob. Valid storage buffer numbers are from 1 to 19. Buffer 0 is the factory default setup.

F2: STORE - Stores the current front-panel setup to the specified storage buffer. Change the buffer number by using the rotary input knob. Valid storage buffer numbers range from 1 to 19.

F3: EXEC - Performs the execution of the RECALL or STORE selected by the previous selection. A DONE message is displayed after the execution of the store operation.

F4: INTEN - Change the intensity and contrast of the LCD display, for optimal viewing angle.

3.6.4 SWEEP Key

Selects the Sweep Mode and allows the entering of sweep parameters as Sweep Start, Stop and Rate.
To select the sweep mode, press SWEEP, then press the function key that corresponds to the desired Sweep menu option, as shown:

Sweep Menu

F1: ON/OFF - Operates the sweep function, selecting between Sweep On or Off.

F2: LIN - Selects the LINEAR sweep shape.

F3: LOG - Selects the LOG sweep shape.

F4: SET - Selects the Sweep setting parameters (Start, Stop and Rate).

3.6.5 MODULATION Key

Selects the Modulation mode **AM** or **FM** .
To select the output mode, press MODUL key, then press the function key that corresponds to the desired menu option, as shown:

Modulation Menu

If the **AM** is selected, the following menu is available:

AM Menu

F1: % **-** Selects the modulation depth (from 0 to 100%).

F2: FREQ **-** Selects the modulation frequency, from the available list of 400 Hz, 800 HZ, 1000 Hz or 3000 Hz.

F3-F4: INT/EXT - Selects and enables the external modulation by an external signal applied to the Modulation In connector.

If the **FM** is selected, the following menu is available:

FM Menu

F2: DEV **-** Selects the FM deviation frequency.

F3: FREQ **- -** Selects the modulation frequency, from the available list of 400 Hz, 800 HZ, 1000 Hz or 3000 Hz.

F3-F4: INT/EXT - Selects and enables the external modulation by an external signal applied to the Modulation In connector.

3.6.6 COUNTER Key

By pressing this key, the build-in Frequency counter is enabled and the frequency of the signal connected to the TRIG IN connector is displayed. The counter is auto ranging with up to 8 digits resolution.

Counter Menu

3.7 Cursor Movement Keys

Use these keys to move the cursor (when visible) either left or right. They are used in conjunction with the rotary input knob to set the step size of the rotary input knob.

3.8 Rotary Input Knob

Use this knob to increase and decrease numeric values or to scroll through a list. The cursor indicates the low-order position of the displayed value which changes when you rotate the knob (for straight numeric entries only). For other types of data, the whole value changes when you rotate the knob.

3.9 Power-On Settings

At power-on, the waveform generator performs a diagnostic self-test procedure to check itself for errors. If it find an error, and error code and text appear in the display window. Other error codes appear when you enter and invalid front-panel setting.
When the waveform generator finishes the diagnostic self-test routine, it enters the local state (LOGS) and assumes power-on default settings. Table 3-2 lists the factory default settings.

Table 3-2
Power-on Default Settings

Key Function		**Comments**
FREQUENCY	1000 Hz	Wave frequency
AMPLITUDE	5.00V	Peak to peak output amplitude
FUNCTION	SINE	Output waveform
OFFSET	0.00V	Zero offset
REPETITION	10ms	Internal trigger rate
MODE	CONT	Waveform mode
TRIG SOURCE	EXT	External trigger source
SWEEP	OFF	Sweep execution
MODULATION	OFF	Modulation execution

3.10 Memory

The waveform generator uses a Nonvolatile FLASH for storing the front panel settings.
Up to 20 front panel settings are stored. Recall 0 is the factory default settings.
Because it is impossible to 100% guarantee against loss of stored data, you should maintain a record of the data stored in memory so that you can manually restore such data, if necessary.

Section 4

Programming

4.1 Overview

This section provides detailed information on programming the MODEL 325 via the RS-232 interface.

4.2 Device States

The device may be in one of the two possible states described below.

4.2.1 Local State (LOCS)

In the LOCS the device may be operated from the front panel.

4.2.2 Remote State (REMS)

In the REMS the device may be operated from the RS232 interface. Actuating any front panel key will cause the device state to revert to the LOCS.

4.3 Message Exchange Protocol

The device decodes messages using the Message Exchange Protocol similar to the one defined in IEEE 488.2. The following functions implemented in the MEP must be considered:

4.3.1 The Input Buffer

The device has a 128-byte long cyclic input buffer. Decoding of remote messages is begun as soon as the input buffer is not empty, that is, as soon as the controller has sent at least one byte to the device. Should the input buffer be filled up by the controller faster than the device can remove the bytes and decode them, the bus handshake (CTS/RTS) is used to pause data transfer until room has been made for more bytes in the buffer. This prevents the controller from overrunning the device with data.

4.3.2 The Output Queue

The device has a 100-byte long output queue in which it stores response messages for the controller to read. If at the time a response message is formatted the queue contains previously formatted response messages, such that there is not enough place in the queue for the new message, the device will put off putting the message in the queue until there is place for it.

4.3.3 Response Messages

The device sends a Response Message in response to a valid query. All queries return a single Response Message Unit. In only one case is the Response Message generated when the response is read (as opposed to when the response is parsed), and this is when querying Arbitrary Waveform data. All other queries generate the Response Message when they are parsed.

4.4 Instrument Identification

The *IDN? common query is used to read the instrument's identification string. The string returned is as follows:

OR-X,MODEL 325,0,V0.1

The “V0.1” reflects the firmware version number and will change accordingly.

4.5 Instrument Reset

The *RST common command effects an instrument reset to the factory default power up state.

4.6 Command Syntax

A Program Message is defined as a string containing one Program Message Units, which is an instrument command or query. The Program Message is terminated by the Program Message Terminator.

The Program Message Terminator consists of optional white space characters, followed by the Linefeed (LF) character (ASCII 0A);

The Program Message Unit can be divided into three sections as follows:

a) Program Header

The Program Header represents the operation to be performed, and consists of ASCII character mnemonics. Two types of Program Headers are used in the MODEL 325: Instrument-control headers and Common Command and Query headers. Common Command and Query Program Headers consist of a single mnemonic prefixed by an asterisk ('*').

The mnemonics consist of upper - or lower-case alpha characters.

Example: The command to set the frequency to 1KHZ may be written in the following ways:

FREQ 1KHZ
FREQ 1000HZ
FREQ 1000
FREQ 1E3
freq 1khz
freq 1000hz
freq 1000
freq 1e3

b) Program Header Separator

The Program Header Separator is used to separate the program header from the program data. It consists of one or more white space characters, denoted as <ws>. Typically, it is a space.

c) Program Data

The Program Data represent the values of the parameters being set, for example, the '1KHZ' in the above examples. Different forms of program data are accepted, depending on the command. The Program Data types used in the instrument are:

i) Character program data

This form of data is comprised of a mnemonic made up of lower - or upper-case alpha characters. As with Program Header mnemonics, some Character Data mnemonics have short and long forms. Only the short or the long form may be used.

ii) Boolean data

Boolean data indicate that the parameter can take one of two states, ON or OFF. The parameter may be character type
ON or OFF

or numeric. A numeric value is rounded to an integer. A non-zero result is interpreted as 1 (ON), and a zero result as 0 (OFF).
Queries return the values 0 or 1.

iii) NRf

This is a decimal numeric data type, where
NR1 indicates an integer number,
NR2 indicates a fixed point real number, and
NR3 indicates a floating point real number.

iv) Numeric value program data

This data type defines numeric values, as well as special cases of Character Data. Numeric values may be specified in any of Integer, Fixed Point or Floating Point format. All parameters which have associated units accept a suffix, which may be specified using upper or lower-case characters. When the suffix is not specified, the numeric value is accepted in the default units, which are Hertz for frequency, Seconds for time, and Volts for voltage. To set the frequency to 1KHz we can send one of the following commands:

FREQ 1000
FREQ 1E3

The special forms of character data accepted as numbers are

MAXimum: sets the parameter to its maximum value.
MINimum: sets the parameter to its minimum value.

For example, to set the frequency to it's maximum value we can send the command

FREQ MAX

Some Program Message Units either require, or can accept, more than one data element. Program data elements are separated from each other by the Program Data Separator. It is defined as optional white space characters followed by a comma (','), which in turn is followed by optional white space characters.

There are two types of Program Message Units: Command Message Units and Query Message Units. A Query differs from a Command in that the Program Header is terminated with a question mark ('?'). For example, the frequency might be queried with the following query:

FREQ?

Some Query Message Units accept data, giving the device more specific information about what is being queried. In many cases the Query Message Unit may optionally be supplied with the MIN or MAX mnemonics as data. This tells the device to return the minimum or maximum value to which the parameter may currently be set. For example,

FREQ? MAX

will return the maximum value to which the frequency may currently be set.

Not all Program Message units have query forms (for example, SAV), and some Program Message Units might have only the query form (for example IDN?).

The instrument puts the response to the query into the output queue, from where it may be read by the controller.

4.7 Status Reporting

The instrument is capable of reporting status events and errors to the controller.

4.7.1 The Error Queue

The error queue is used to store codes of errors detected in the device. It is implemented as a cyclic buffer of length 10. The error queue is read with the following query:

ERR?

The first error in the queue is returned, and the queue is advanced.

4.7.2 Error Codes

The negative error codes are defined by SCPI. Positive codes are specific to the instrument.

The error message is returned in the form

<error number>,"<error description>"

A table of error numbers and their descriptions is presented here.

No error reported

0 - No error

Command Errors

A command error is in the range -199 to -100, and indicates that a syntax error was detected. This includes the case of an unrecognized header.

-100	Command Error
-101	Invalid character
-102	Syntax error
-103	Invalid separator
-104	Data type error
-108	Parameter not allowed More parameters than allowed were received
-109	Missing parameter Fewer parameters than necessary were received
-110	Command header error
-111	Header separator error
-112	Program mnemonic too long The mnemonic must contain no more than 12 characters.
-113	Undefined header
-120	Numeric data error
-121	Invalid character in number
-123	Exponent too large
-124	Too many digits
-128	Numeric data not allowed A different data type was expected
-131	Invalid suffix
-134	Suffix too long
-138	Suffix not allowed
-140	Character data error.
-141	Invalid character data. Incorrect character data were received.
-144	Character data too long Character data may contain no more than 12 characters.
-148	Character data not allowed
-158	String data not allowed
-178	Expression data not allowed

Execution Errors

An execution error indicates that the device could not execute a syntactically correct command, either since the data were out of the instrument's range, or due to a device condition.

-200	Execution error An attempt was made to RECALL the contents of an uninitialized stored setting buffer.
-211	Trigger ignored. The *TRG common command was ignored due to the device not being in the correct state to execute the trigger.
-220	Parameter error. A parameter is in the correct range, but conflicts with other parameters.
-221	Settings conflict. The parameter is out of range due to the current instrument state.
-222	Data out of range.
-224	Illegal parameter value. The parameter value must be selected from a finite list of possibilities.

Device-Specific Errors

An error specific to the device occurred.

-315	Configuration memory lost. Device memory has been lost.
-330	Self-test failed.
-325	Queue overflow. Error codes have been lost due to more than 10 errors being reported without being read.

Query Errors

A query error indicates that the output queue control has detected a problem. This could occur if either an attempt was made to read data from the instrument if none was available, or when data were lost. Data could be lost when a query causes data to be formatted for the controller to be read, and the controller sends more commands without reading the data.

-410	Query INTERRUPTED. Data were sent before the entire response of a previous query was read.
-420	Query UNTERMINATED. An attempt was made to read a response before the complete program message meant to generate that response was sent.

Warnings

The execution of some commands might cause an undesirable instrument state. The commands are executed, but a warning is issued.

500	Trigger rate short
510	Output overload

"Trigger rate short" means that the period of the waveform is larger than the value of the internal trigger rate. Thus not every trigger will generate a cycle (or burst) of the waveform.

4.8 COMMON COMMANDS

4.8.1 System Data Commands

a) ***IDN?** - Identification query

The identification query enables unique identification of the device over the GPIB. This query should always be the last in a program message. It returns a string with four fields:

Manufacturer name
Model name
Serial number (0 if not relevant)
Version number

Command
Type: Common Query
Syntax: *IDN?
Response: OR-X, MODEL 325,0,V1.1

4.8.2 Internal Operation Commands

a) ***RST** - Reset command

The Reset command performs a device reset. It causes the device to return to the factory default power up state.

Type: Common Command
Syntax: *RST

4.8.3 Device Trigger Commands

a) ***TRG** - Trigger command

This command is analogous to the IEEE 488.1 Group Execute Trigger interface message, and has the same effect. It is used to trigger the device to output a wave, and is accepted only when the trigger mode is set to Trigger, Gate or Burst, and the trigger source is set to BUS.

Type: Common Command
Syntax: *TRG

4.8.4 Stored Settings Commands

a) ***RCL** - Recall instrument state

This command is used to restore the state of the device to that stored in the specified memory location.

Arguments
Type <NRf>
Range 0 to 19. Non integer values are rounded before execution

Type: Common Command
Syntax: *RCL<ws><NRf>
Example: *RCL 0 (Recall default state)
*RCL 19

b) ***SAV** - Save instrument state

This command is used to store the current instrument state in the specified memory location.

Arguments
Type: <NRf>
Range: 1 to 19. Non integer values are rounded before execution
Type: Common Command
Syntax: *SAV<ws><NRf>
Example: *SAV 11

Stored setting location 0 stores the factory defaults, and is a read-only location.

4.9 INSTRUMENT CONTROL COMMANDS

Instrument control commands are grouped into logical subsystems according to the SCPI instrument model. The commands are comprised of mnemonics indicating the subsystem to which the command belongs, and the hierarchy within that subsystem. When the command is to be referred to the Root node, it should be prefixed with a colon (:). Mnemonics appearing in square brackets [...] are optional. The '|' character is used to denote a choice of specifications. The '<ws>' is used to denote a white space character.

4.9.1 Default Subsystem

The Source Subsystem controls the frequency, voltage, amplitude modulation and clock source. The command structure is as follows:

FUNCtion SINusoid|SQUare|TRIangle||
FREQuency <numeric value>
AMPLitude <numeric value>
OFFSet <numeric value>
DCYCle **<**numeric value**>**

MODE CONT/ TRIG / GATE / BRST
TRIG INT / EXT
TRAte <numeric value>

MODULation OFF/AM/FM/INT/EXT
MODFRequency <numeric value>
MODSHape SIN/TRI/ SQU
DEViation <numeric value>
DEPTh <numeric value>

SWSTArt <numeric value>
SWSTOp <numeric value>
SWRAte <numeric value>
SWEep ON/OFF/LIN/LOG

4.9.1.1 Frequency

FREQuency <frequency>

The frequency command controls the frequency of the output waveform.

Arguments
Type: Numeric.
Units: MHz, KHz, Hz (default)
Range: For SIN and SQU - 10uHz to 31MHz,
For TRI – 10uHz to 500KHz,
Rounding: The value is rounded to 6 (DDS).
Command Type: Setting or Query
Setting
Syntax: FREQuency<ws><frequency>[units]
FREQuency<ws>MINimum|MAXimum
Examples: FREQ 5KHZ
FREQ 5E3
FREQ MAXIMUM

FREQ MIN
Query
Syntax: FREQuency?[<ws>MAXimum|MINimum]
Examples: FREQ?
FREQ? MAX
Response: NR3

Considerations:

1) The MIN and MAX arguments refer to currently settable minimum or maximum.
2) FIXed is alias for CW.

4.9.1.2 Amplitude

AMPLitude <p-p amplitude>

The amplitude command is used to set the peak-to-peak amplitude of the output waveform. Note that the amplitude and the offset are limited by the relation

Peak Amplitude + |Offset| <= 5V

Arguments
Type: Numeric
Units: V, mV, VPP, mVPP
Range: 10mV to 10V
Rounding: 1mV from 10mV to 999mV. 10mV from 1V to 10V.
Command Type: Setting or Query
Setting
Syntax: AMPLitude<ws><amplitude>[units]
AMPLitude<ws>MINimum|MAXimum
Examples: AMPL 2.5
AMPL 2.5V
AMPL MAX
Query
Syntax: AMPLitude? <ws>MINimum|MAXimum]
Examples: AMPL?
AMPL? MAX
Response: NR2
Considerations:

1) The MAXimum amplitude is dependent on the offset.
2) The MAX and MIN arguments should not be used in a program message containing an OFFSet command, since these values are evaluated during parsing, based on the current value of the offset.

4.9.1.3 Offset

OFFSet <offset>

The offset command is used to set the DC offset of the output waveform. Note that the amplitude and the offset are limited by the relation

Peak Amplitude + |Offset| ≤ 5V

Arguments
Type: Numeric

Units: V, mV
Range: 10mV to 4.5V
Rounding: to 10mV
Command Type: Setting or Query
Setting
Syntax: OFFSet<ws><offset>[units]
OFFSet<ws>MINimum|MAXimum
Examples: OFFS 2.5
OFFS 2.5V
OFFS MAX
Query
Syntax: OFFSet?[<ws>MINimum|MAXimum]
Examples: OFFS?
OFFS? MAX
Response: NR2
Considerations:

1) The MAXimum offset is dependent on the amplitude.
2) The MAX and MIN arguments should not be used in a program message containing an AMPLitude command, since these values are evaluated during parsing, based on the current value of the amplitude.

4.9.1.4 Function

FUNCtion

The function command is used to set the type of waveform to be generated by the instrument.

Command Type: Setting or Query
Setting Syntax: FUNCtion<WS><OPTION>
Examples: FUNC SIN
Query Syntax: FUNCtion?
Examples: FUNC?
Response: SIN|TRI|SQU|
Considerations:

The following functions are available:

SINusoid,SQUare, TRIangle,

4.9.1.5 Modulation

The following commands control the modulation:

MODULation

This command activates or deactivates modulation:
Command Type: Setting or Query
Setting
Syntax: MODULation OFF|AM|FM|INT|EXT
Examples: MODULation FM
MODULation OFF
Query
Syntax: MODULation?
Response: OFF |
AM INT |
AM EXT |

FM INT |
FM EXT

DEPTh

This command sets the AM modulation depth in %
Arguments
Type: Numeric
Units: none (implied %)
Range: 0 to 100
Rounding: To integer
Command Type: Setting or Query
Setting
Syntax: DEPTh<ws><percent depth>
DEPTh<ws>MINimum|MAXimum
Examples: DEPTh 50
Query
Syntax: DEPTh?[<ws>MINimum|MAXimum]
Response: NR3

MODFRequency

This command sets the AM and FM modulating waveform frequency
Arguments
Type: Numeric.
Units: MHz, KHz, Hz (default)
Range: 400 Hz, 800 Hz, 1000 Hz or 3000 Hz only
Command Type: Setting or Query
Setting
Syntax: MODFR<ws><frequency>[units]
Examples: MODFR 1KHZ
MODFR 1E3
Query
Examples: MODFR?
Response: 1000 Hz

DEViation

This command sets the FM modulation deviation
Arguments
Type: Numeric.
Units: MHz, KHz, Hz (default)
Range: Dependent on the carrier frequency, up to 1.56MHz.
Fmax = carrier frequency
Fmin = 10 uHz
Rounding: The value is rounded to 4 digits.
Command Type: Setting or Query
Setting
Syntax: DEViation<ws><frequency>[units]
DEViation<ws>MINimum|MAXimum
Examples: DEV 5KHZ
DEV 5E3
DEV MAXIMUM
DEV MIN
Query
Syntax: DEViation?[<ws>MAXimum|MINimum]
Examples: DEV?

DEV? MAX
Response: NR3

4.9.1.6 Sweep control

The following commands control the sweep functionality:

SWEep

This command activates or deactivates sweep:
Arguments
Type: Boolean
Command Type: Setting or Query
Setting
Syntax: SWE<ws>ON|OFF|LIN|LOG
Examples: SWE ON
SWE LIN
Query
Syntax: SWE?
Response: OFF|LIN|LOG
Note: Sweep cannot be activated if FM is active.

SWRAte

This command sets the time for one complete sweep:
Arguments
Type: Numeric
Units: S, mS, uS, nS
Range: 10mS to 50S
Rounding: to 4 digits
Command Type: Setting or Query
Setting
Syntax: SWRAte<ws><time>[units]
SWRAte<ws>MINimum|MAXimum
Examples: **SWRA**te 50MS
Query
Syntax: SWRAte?[<ws>MINimum|MAXimum]
Response: NR3

SWSTArt

This command sets the start frequency of the sweep:
Arguments
Type: Numeric.
Units: MHz, KHz, Hz (default)
Range: Dependent on the frequency range of the current function.
Rounding: The value is rounded to 4 digits.
Command Type: Setting or Query
Setting
Syntax: SWSTArt<ws><frequency>[units]
SWSTArt<ws>MINimum|MAXimum
Examples: SWSTArt 5KHZ
SWSTArt 5E3
SWSTArt MAXIMUM
SWSTArt MIN
Query
Syntax: SWSTArt?[<ws>MAXimum|MINimum]

Examples: SWSTArt ?
SWSTArt ? MAX
Response: NR3

SWSTOp

This command sets the stop frequency of the sweep:
Arguments
Type: Numeric.
Units: MHz, KHz, Hz (default)
Range: Dependent on the frequency range of the current function.
Rounding: The value is rounded to 4 digits.
Command Type: Setting or Query
Setting
Syntax: SWSTOp<ws><frequency>[units]
SWSTOp<ws>MINimum|MAXimum
Examples: SWSTOp 5KHZ
SWSTOp 5E3
SWSTOp MAXIMUM
SWSTOp MIN
Query
Syntax: SWSTOp?[<ws>MAXimum|MINimum]
Examples: SWSTOp ?
SWSTOp ? MAX
Response: NR3

4.9.1.7 Duty Cycle

DCYCle <duty cycle value>

This command is used to set the duty-cycle of the square wave or the symmetry of triangular wave. The value is given in percent .

Arguments Type: Numeric
Units: None (percent implied)
Range: 20 to 80 for Square and 10% to 90% for Triangle
Rounding: To integer
Command Type: Setting or Query
Syntax: DCYCle <ws><duty cycle value>
DCYCle <ws>MINimum|MAXimum
Query Syntax: DCYCle?[<ws>MINimum|MAXimum]
Response: NR3

4.9.1.8 Trigger Mode

MODE <trigger mode>

This command is used to set the trigger mode.

Arguments
Type: Character
Options: CONTinuous
TRIGger
GATE
Command Type: Setting or Query

Setting
Syntax: MODE<ws><option>
Examples: MODE CONT
MODE GATE
Query
Syntax: MODE?
Response: CONT|TRIG|GATE

4.9.1.9 Trigger Source

TRIGger<trigger source>

This command is used to select the trigger source, for use in the Trigger, Gate and Burst trigger modes.

Arguments
Type: Character
Options: INTernal - Internal trigger
EXTernal - External trigger
Command Type: Setting or Query
Setting
Syntax: TRIGger<ws><option>
Examples: TRIG EXT
TRIG INT
Query
Syntax: TRIGger?
Response: INT|EXT

4.9.1.10 Internal Trigger Rate

TRAte <trigger rate>

Sets the rate of the internal trigger.

Arguments
Type: Numeric
Units: S, mS, uS, nS
Range: 10E-6S to 10S
Rounding: to 4 digits
Command Type: Setting or Query
Setting
Syntax: TRAte<ws><value>[units]
TRAte<ws>MINimum|MAXimum
Examples: TRAte 10E-6
TRAte MIN
Query
Syntax: TRAte?[<ws>MINimum|MAXimum]
Response: NR3
Examples: TRAte?
TRAte? MIN

4.9.2 Error Queue Reading

ERRor?
This query returns the first entry in the error queue, and removes that entry from the queue.

Command Type: Query only
Query
Syntax: ERRor?
Response: <Error number>, "<error description>"

ASCII & GPIB CODE CHART

B7 B6 B5 / BITS / B4 B3 B2 B1	0 0 0	0 0 1	0 1 0	0 1 1	1 0 0	1 0 1	1 1 0	1 1 1
	CONTROL		NUMBERS SYMBOLS		UPPER CASE		LOWER CASE	
0 0 0 0	0 NUL 0 0	20 DLE 10 16	40 SP 20 32	60 0 30 48	100 @ 40 64	120 P 50 80	140 ` 60 96	160 p 70 112
0 0 0 1	1 GTL SOH 1 1	21 LLO DC1 11 17	41 ! 21 33	61 1 31 49	101 A 41 65	121 Q 51 81	141 a 61 97	161 q 71 113
0 0 1 0	2 STX 2 2	22 DC2 12 18	42 " 22 34	62 2 32 50	102 B 42 66	122 R 52 82	142 b 62 98	162 r 72 114
0 0 1 1	3 ETX 3 3	23 DC3 13 19	43 # 23 35	63 3 33 51	103 C 43 67	123 S 53 83	143 c 63 99	163 s 73 115
0 1 0 0	4 SDC EOT 4 4	24 DCL DC4 14 20	44 $ 24 36	64 4 34 52	104 D 44 68	124 T 54 84	144 d 64 100	164 t 74 116
0 1 0 1	5 PPC ENQ 5 5	25 PPU NAK 15 21	45 % 25 37	65 5 35 53	105 E 45 69	125 U 55 85	145 e 65 101	165 u 75 117
0 1 1 0	6 ACK 6 6	26 SYN 16 22	46 & 26 38	66 6 36 54	106 F 46 70	126 V 56 86	146 f 66 102	166 v 76 118
0 1 1 1	7 BEL 7 7	27 ETB 17 23	47 ' 27 39	67 7 37 55	107 G 47 71	127 W 57 87	147 g 67 103	167 w 77 119
1 0 0 0	10 GET BS 8 8	30 SPE CAN 18 24	50 (28 40	70 8 38 56	110 H 48 72	130 X 58 88	150 h 68 104	170 x 78 120
1 0 0 1	11 TCT HT 9 9	31 SPD EM 19 25	51) 29 41	71 9 39 57	111 I 49 73	131 Y 59 89	151 i 69 105	171 y 79 121
1 0 1 0	12 LF A 10	32 SUB 1A 26	52 * 2A 42	72 : 3A 58	112 J 4A 74	132 Z 5A 90	152 j 6A 106	172 z 7A 122
1 0 1 1	13 VT B 11	33 ESC 1B 27	53 + 2B 43	73 ; 3B 59	113 K 4B 75	133 [5B 91	153 k 6B 107	173 { 7B 123
1 1 0 0	14 FF C 12	34 FS 1C 28	54 , 2C 44	74 < 3C 60	114 L 4C 76	134 \ 5C 92	154 l 6C 108	174 | 7C 124
1 1 0 1	15 CR D 13	35 GS 1D 29	55 - 2D 45	75 = 3D 61	115 M 4D 77	135] 5D 93	155 m 6D 109	175 } 7D 125
1 1 1 0	16 SO E 14	36 RS 1E 30	56 . 2E 46	76 > 3E 62	116 N 4E 78	136 ^ 5E 94	156 n 6E 110	176 ~ 7E 126
1 1 1 1	17 SI F 15	37 US 1F 31	57 / 2F 47	77 UNL ? 3F 63	117 O 4F 79	137 UNT — 5F 95	157 o 6F 111	177 DEL (RUBOUT) 7F 127
	ADDRESSED COMMANDS	UNIVERSAL COMMANDS	LISTEN ADDRESSES		TALK ADDRESSES		SECONDARY ADDRESSES OR COMMANDS (PPE)	(PPD)

octal 25 PPU — GPIB code
NAK — ASCII character
hex 15 21 — decimal

4.10 RS-232 Programming

4.10.1 General

The INSTALLATION section of this manual describes the RS-232-C connection for the instrument.

EIA standard RS-232-C specifies the electrical characteristics and pin out of a serial communication standard for connecting "data terminal equipment" (DTE) to "data communication equipment" (DCE). Data terminal equipment is usually devices such as terminals, computers, or printers that are the final destination for data. Data communication equipment, on the other hand, is usually a modem or other device that converts the data to another form and passes it through. The instrument can be configured only as a DCE, so in most cases it can be connected with a straight-through cable to a computer, but would require special cabling to connect to another DCE device.

The baud rate is the bit rate during the transmission of a word in bits per second. Different devices use many baud rates, but the baud rates of the two devices that are connected must be the same. The instrument is set to a fixed baud rates of 19200 as described in Section 3, Operating Instructions.

Data signals over the RS-232-C use a voltage of +3V to +25V to represent a zero (called a space) and a voltage of -3V to -25V to represent a one (called a mark). Handshake and control lines use +3V to +25V to indicate a true condition and -3V to -25V to indicate a false condition.
When no data is being transmitted, the idle state of the data lines will be the mark state. To transmit a byte, the transmitting device first sends a start bit to synchronize the receiver.

4.10.2 RS-232-C Operation

The RS-232-C standard is not very specific about many of the handshaking signals and it is therefore usually necessary to refer to the manuals for both of the devices being connected to determine the exact pin out, signal definition, and signal direction for the devices.

The instrument is programmed by sending ASCII coded characters to the instrument.
When the instrument is in the remote mode remote command input has priority over any front panel control. Therefore, as long as the serial interface is continuously supplied with data, the keyboard will appear to be inoperative to the user.

The instrument accepts a carriage return (CR) as an end of string (EOS) terminator and sends both a CR and LF as the EOS terminator.