Arbitrary Function Generator

AFG-4000 Series

Programming Manual

GW INSTEK PART NO.

ISO-9001 CERTIFIED MANUFACTURER

GW INSTEK

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Table of Contents

SAFETY INSTRUCTIONS 5
Safety Precaution before Operation 10
Electro-static Discharge (ESD) Protection 12
First Time to Power on 13

GETTING STARTED 14
Main Features 15
Panel Overview 17
Boot Up 23

REMOTE INTERFACE 27
Establishing a Remote Connection 28
Command Syntax 31
Command List 36
System Commands 41
Status Register Commands 43
System Remote Commands 46
DISPlay Commands 49
HCOPy Commands 51
MEMory Commamds 52
Apply Commands 53
Output Commands 59
Pulse Configuration Commands 68
Harmonic Commands 72
Amplitude Modulation (AM) Commands 75
Double-sideband amplitude Modulation (DSBAM) Commands 80
Amplitude Shift Keying (ASK) Commands 85
Frequency Modulation (FM) Commands 88
Frequency-Shift Keying (FSK) Commands 93
3Frequency-Shift Keying (3FSK) Commands 96

4Frequency-Shift Keying (4FSK) Commands 98
Phase Modulation (PM)Commands 101
Phase Shift Keying (PSK)Commands 105
Binary Phase Shift Keying (BPSK)Commands..... 108
Quadrature Phase Shift Keying (QPSK)Commands 111
Output Shift Keying (OSK)Commands 114
SUM Modulation (SUM) Commands..... 117
Pulse Width Modulation (PWM)Commands..... 121
Frequency Sweep Commands..... 125
Burst Mode Commands..... 132
Arbitrary Waveform Commands 139
COUNTER 147
COUPLE 152
Save and Recall Commands 154
Error Messages..... 155
SCPI Status Register 158
EC Declaration of Conformity 165

INDEX 166

SAFETY INSTRUCTIONS

This chapter contains important safety instructions that you must follow during operation and storage. Read the following before any operation to insure your safety and to keep the instrument in the best possible condition.

Safety Symbols

These safety symbols may appear in this manual or on the instrument.

WARNING	Warning: Identifies conditions or practices that could result in injury or loss of life.
CAUTION	Caution: Identifies conditions or practices that could result in damage to the AFG-4000 or to other properties.
	DANGER High Voltage
	Attention Refer to the Manual
	Protective Conductor Terminal
	Earth (ground) Terminal

Do not dispose electronic equipment as unsorted municipal waste. Please use a separate collection facility or contact the supplier from which this instrument was purchased.

Safety Guidelines

General Guideline

CAUTION

- Do not place any heavy object on the AFG-4000.
- Avoid severe impact or rough handling that may damaging the AFG-4000.
- Avoid discharges of static electricity on or near the AFG-4000.
- Do not block the cooling fan opening.
- Use only mating connectors, not bare wires, for the terminals.
- The instrument should only be disassembled by a qualified technician..

(Measurement categories) EN 61010 specifies the measurement categories and their requirements as follows. The AFG-4000 falls under category I.

- Measurement category IV is for measurement performed at the source of a low-voltage installation.
- Measurement category III is for measurement performed in a building installation.
- Measurement category II is for measurement performed on circuits directly connected to a low voltage installation.
- Measurement category I is for measurements performed on circuits not directly connected to Mains.

Power Supply

WARNING

- AC Input voltage rating: 100Vac-240Vac (+/-10%)
- Frequency: 50Hz/60Hz
- Connect the protective grounding conductor of the AC power cord to an earth ground to prevent electric shock..

Fuse WARNING	• Fuse type: F2A/250V. • Only qualified technicians should replace the fuse. • To ensure fire protection, replace the fuse only with the specified type and rating. • Disconnect the power cord and all test leads before replacing the fuse. • Make sure the cause of fuse blowout is fixed before replacing the fuse.
Cleaning the AFG-4000	• Disconnect the power cord before cleaning the AFG-4000. • Use a soft cloth dampened in a solution of mild detergent and water. Do not spray any liquid into the AFG-4000. • Do not use chemicals containing harsh material such as benzene, toluene, xylene, and acetone.
Operation Environment	• Location: Indoor, no direct sunlight, dust free, almost non-conductive pollution (Note below) • Relative Humidity: <80% • Altitude: < 2000m • Temperature: 0°C to 40°C

	(Pollution Degree) EN 61010-1 specify the pollution degrees and their requirements as follows. The AFG-4000 falls under degree 2. Pollution refers to "addition of foreign matter, solid, liquid, or gaseous (ionized gases), that may produce a reduction of dielectric strength or surface resistivity". • Pollution degree 1: No pollution or only dry, non-conductive pollution occurs. The pollution has no influence. • Pollution degree 2: Normally only non-conductive pollution occurs. Occasionally, however, a temporary conductivity caused by condensation must be expected. • Pollution degree 3: Conductive pollution occurs, or dry, non-conductive pollution occurs which becomes conductive due to condensation which is expected. In such conditions, equipment is normally protected against exposure to direct sunlight, precipitation, and full wind pressure, but neither temperature nor humidity is controlled.
Storage environment	• Location: Indoor • Relative Humidity: <70% • Temperature: -20°C to 60°C
Disposal	Do not dispose this instrument as unsorted municipal waste. Please use a separate collection facility or contact the supplier from which this instrument was purchased. Please make sure discarded electrical waste is properly recycled to reduce environmental impact.

Power cord for the United Kingdom

When using the function generator in the United Kingdom, make sure the power cord meets the following safety instructions.

NOTE: This lead/appliance must only be wired by competent persons

WARNING: THIS APPLIANCE MUST BE EARTHED

IMPORTANT: The wires in this lead are coloured in accordance with the following code:

Green/ Yellow:	Earth
Blue:	Neutral
Brown:	Live (Phase)

As the colours of the wires in main leads may not correspond with the coloured marking identified in your plug/appliance, proceed as follows:

The wire which is coloured Green & Yellow must be connected to the Earth terminal marked with either the letter E, the earth symbol ⏚ or coloured Green/Green & Yellow.

The wire which is coloured Blue must be connected to the terminal which is marked with the letter N or coloured Blue or Black.

The wire which is coloured Brown must be connected to the terminal marked with the letter L or P or coloured Brown or Red.

If in doubt, consult the instructions provided with the equipment or contact the supplier.

This cable/appliance should be protected by a suitably rated and approved HBC mains fuse: refer to the rating information on the equipment and/or user instructions for details. As a guide, a cable of 0.75mm² should be protected by a 3A or 5A fuse. Larger conductors would normally require 13A types, depending on the connection method used.

Any exposed wiring from a cable, plug or connection that is engaged in a live socket is extremely hazardous. If a cable or plug is deemed hazardous, turn off the mains power and remove the cable, any fuses and fuse assemblies. All hazardous wiring must be immediately destroyed and replaced in accordance to the above standard.

Safety Precaution before Operation

Check Power Supply

The analyzer is equipped with a three-wire power cord in accordance with international safety standards. The product must be grounded properly before being powered on, as floating or improper ground may cause damage to the instrument or personal injury.

Make sure the grounding conductor of the function generator is grounded before turning on the instrument. After which the AC power cord can be connected. Do not use a non-ground power cord.

Allowed Variation Range of Supply Power Parameters

The function generator is compatible with 100V~240V, 50Hz-60Hz AC power. The table below lists the power requirement to run the function generator.

Power Supply Parameter	Compatible Range
Voltage	100 - 240 VAC
Frequency	50 - 60 Hz ±10%
Power	<50VA

To prevent or lower the risk of damage to the function generator from power interference between instruments, especially from peak pulses produced by large power consumption instruments, a 220V/110V AC regulated power supply is recommended.

Power Cord Selection

The analyzer is equipped with a three-wire power cord in accordance with international safety standards. This cable grounds the analyzer cabinet when connected to an appropriate power line outlet. The cable must be rated greater than 250Vac and 2A.

⚠ WARNING	Improper grounding may cause damage to the instrument, or result in personal injury. Make sure the grounding conductor of the function generator is grounded before turning on the instrument. Always use a well-grounded power source. Do not use an external power cable, power cord or an auto transformer without grounded protection. If this product is to be powered via an external auto transformer for voltage reduction, ensure that its common terminal is connected to a neutral (earthed pole) of the power supply. Make sure the supply power is stable before turning on the analyzer to protect it from damage. Refer to "First Time to Power on" on page 12.

Electro-static Discharge (ESD) Protection

ESD is an issue often ignored by users. Damage from ESD on the instrument is unlikely to occur immediately but will significantly reduce the reliability of it. Therefore, ESD precautions should be implemented in the work environment, and applied daily.

Generally, there are two steps to manage ESD protection:

1. Conductive table mats to connect hands via wrist bands
2. Conductive ground mat to connect feet via ankle straps

Implement both protection methods will provide a good level of anti-static protection. If used alone, the protection will not be as reliable. To ensure user's safety, anti-static components should offer at least 1MΩ isolation resistance.

⚠ WARNING The above ESD protections measures cannot be used when working with over 500V!

Make good use of anti-static technology to protect components from damage:

1. Quickly ground the internal and external conductor of the coaxial cable before it is connected with the function generator.
2. Staff must wear anti-static gloves before touching the connector cord or doing any assemble work.
3. Assure all the instruments are grounded properly to avoid static storage.

First Time to Power on

Connect the three-pin AC power cord into the instrument. Insert the plug into a power socket provided with a protective ground.

⚠ WARNING	Check the power source before turning on the function generator, to protect the device from damage.

Steps

1. Press the power switch on the bottom left of the front panel.
2. Self-initialization takes about 30 seconds, after the boot screen the function generator will default to the scanning curve.
3. After power on, let the function generator warm up for 60 minutes for stabilization to obtain the most accurate results.

GETTING STARTED

The Getting started chapter introduces the function generator's main features, appearance, set up procedure and power-up.

Main Features 15
Panel Overview 17
AFG-4125E Front Panel 17
AFG-4125AE Front Panel 17
AFG-4225E/4235/4260/4280/4210H/4225H Front Panel 18
AFG-4125E/4125AE/4225E Rear Panel 21
AFG-4235/4260/4280/4210H/4225H Rear Panel 21
Boot Up 23
Display 24

Main Features

- Provide single-channel or dual-channel output
  - AFG-4125E/ 4125AE: single channel
  - AFG-4225E/ 4235/ 4260/ 4280/ 4210H/ 4225H: dual-channel
- Built-in Sine, Square, Triangle, Ramp, Pulse, Noise, Harmonic wave, Arbitrary wave
- Min. resolution is 1uHz
- Arbitrary function
- Sampling Range
  - AFG-4225H: 1.25GSa/s
  - AFG-4235/ 4260/ 4280/ 4210H: 500MSa/s
  - AFG-4125E/ 4125AE/ 4225E: 125MSa/s
- Amplitude Resolution
  - AFG-4235/ 4260/ 4280/ 4210H/ 4225H: 16 bits
  - AFG-4125E/ 4125AE/ 4225E: 14bits
- Memory Length
  - AFG-4225E / 4235/ 4260/ 4280/ 4210H/ 4225H: 10M/per channel
  - AFG-4125E/ 4125AE: 16k/per channel
- Provide modulation: AM, DSB-AM, FM, PM, PWM, ASK, PSK, BPSK, QPSK, FSK, 3FSK, 4FSK, OSK, SUM
- Built-in sweep, burst, counter function
- Built-in Power Amplifier function (AFG-4125AE)
- Communication interface
  - AFG-4235/ 4260/ 4280/ 4210H/ 4225H provide USB, LAN interface

- AFG-4125E/ 4125AE/ 4225E provide USB interface

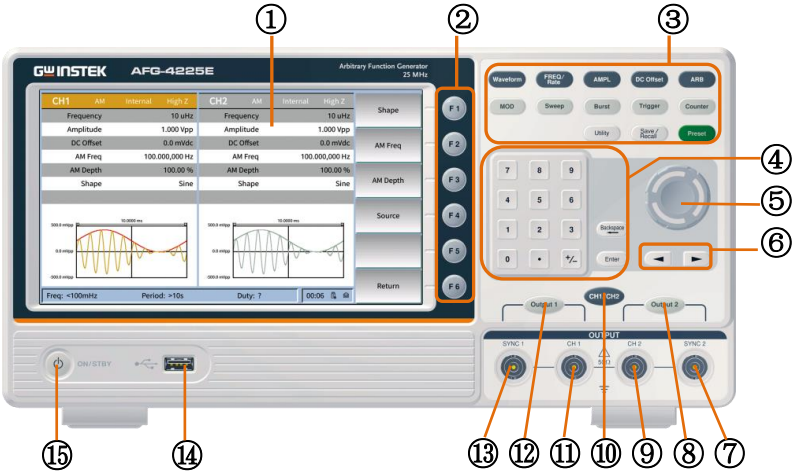
- 8″ TFT LCD Display, 800*480 resolution
  - Multi-Touch Display: AFG-4235/ 4260/ 4280/ 4210H/ 4225H
  - Without Touch Display: AFG-4125E/ 4125AE/ 4225E

Panel Overview

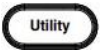
AFG-4125E Front Panel

AFG-4125AE Front Panel

AFG-4225E/4235/4260/4280/4210H/4225H Front Panel



1	LCD		Display the user interface.
2	Menu soft keys	① ~ ⑥	The F1 to F6 function keys directly correspond to the soft keys on the right-hand side of display.
3	Function keys	Waveform	**Waveform** Basic waveform buttons, including sine waves, square waves, triangle waves, pulse waves, noise waves, and harmonics;
		FREQ/Rate	**FREQ/Rate** The FREQ/Rate key is used to set the frequency or sample rate.
		AMPL	**AMPL** AMPL sets the waveform amplitude.
		DC Offset	**DC Offset** Sets the DC offset.
		ARB	**ARB** ARB is used to set the arbitrary waveform parameters.

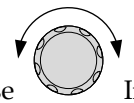
	MOD	Output modulation waveform;
	Sweep	Sweep sine, square, triangle or arbitrary waves;
	Burst	Generate pulse trains of sine waves, square waves, triangle waves, pulse waves, noise waves or arbitrary waves;
	Trigger	Manual trigger button;
	Counter	Frequency counter button;
	**Utility**	Auxiliary function button;
	Save/Recall	Save/recall function button;
	Preset	Restore factory settings button.

4 Numeric keyboard

Parameter input.

5 Scroll Wheel

)uring parameter editing, turn the knob lockwise to increase, or counter lockwise to decrease the parameter alues at specified steps.



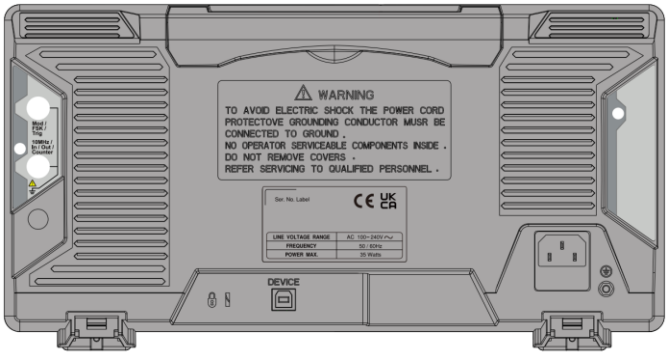
Decrease Increase

6 Arrow Keys

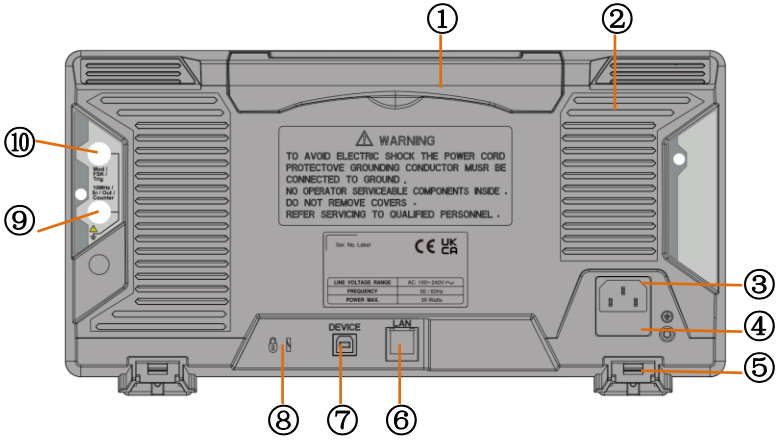
Move the cursor of the selected parameter.

7	CH2 Synchronous output terminal		When **Utility** → CH1/2 Settings → CH2 Synchronization is set to On, this terminal outputs a synchronization signal that matches the current configuration of CH2.
8	CH2 Signal output button		Turn on or off the output of CH2 channel waveform or synchronization signal. When the output is turned on, the button backlight lights up.
9	CH2 Output		Output CH2 channel signal.
10	CH1/CH2		CH1 and CH2 channel display interface switching button.
11	CH1 Output		Output CH1 channel signal.
12	CH1 Signal output button		Turn on or off the output of CH1 channel waveform or synchronization signal. When the output is turned on, the button backlight lights up.
13	CH1 Synchronous output terminal		When **Utility** → CH1/2 Settings → CH2 Synchronization is set to On, this terminal outputs a synchronization signal that matches the current configuration of CH1.
14	USB interface		Connect to an external USB Host device, such as inserting a USB flash drive.
15	Power button		Turn the power on or off.
16	Power Amplifier out		Power Amplifier output port
17	Power Amplifier in		Power Amplifier input port

AFG-4125E/4125AE/4225E Rear Panel



AFG-4235/4260/4280/4210H/4225H Rear Panel



1. Handle
2. Heat sink fan
3. AC Power Input Socket

Power input: 100-240V±10% AC 50-60Hz.

4. Fuse box — F2A/250V
5. Stool — To adjust the angle of the device.

6. LAN Port

LAN interface for remote control.

7. USB Device Port

USB type-B device port is used to connect the function generator to a PC for remote control.

8. Security Lock Hole
Users can use the security lock (buy it by themselves) to lock the instrument at a fixed location.

9. 10MHz In/Out/Counter Connector
Default is used to receive frequency meter input signal. When the instrument is set to the internal clock source and **Utility** → System Settings → Clock Output is set to on, it is used to output a 10MHz clock signal; when the instrument is set to an external clock source, it is used to receive an external 10MHz clock signal.

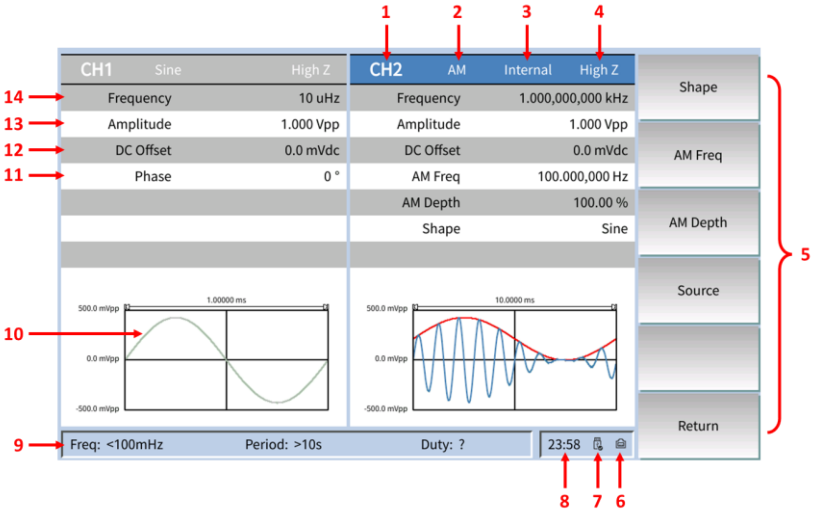
10. Mod/FSK/Trig Connector
When modulating waveform, output scanning frequency, or output pulse train, the signal connected here can be used as an external signal source.

Note: If one channel turns on AM, FM, PM, PWM or OSK, and another channel turns on ASK, FSK, PSK, frequency sweep or pulse train, and both channels are set to external trigger, the channel where the trigger source is set later can When using an external trigger, the other channel will automatically cancel the external trigger due to a different type of external modulation signal.

Boot Up

Confirm AC voltage	Before turning on the power, confirm that the input power meets the conditions of 100-240 V (±10%), 50/60 Hz.
Connect the AC power cord	The fuse is a 250 V, F2AL slow-blow type, and connects the AC power cord to the rear panel receptacle.
⚠ Waring	To prevent electric shock, please make sure the instrument is properly grounded.
Power on	Press the power switch to turn on the power.
Power off	Press the power switch again, the status light will show blue, and turn off the power of the whole machine.

Display



NO	Description	
1	Channel Status	Display areas of CH1 and CH2. Indicate whether the corresponding channel is selected and turned on (ON/OFF).The area of the channel currently selected is highlighted and the on/off state of the channel currently turned on is "ON".
2	Current waveform or Current Modulation	
3	Trigger Source	Internal: internal modulation or internal trigger source; External: external modulation or external trigger source; Manual: Manual trigger source.
4	Output impedance	50Ω or high impedance

5	Menu	Display the operation menu corresponding to the function currently selected. For example, the "Sine" function menu is displayed in the above figure.
6	LAN status light	When the instrument is correctly connected to the LAN, this indicator will light.
7	USB status light	When the generator detects a USB storage device, this indicator will light.
8	Time	Display the current time.
9	Counter	The brief information of the counter will only be displayed when the frequency counter function is turned on and the interface currently displayed is not the frequency counter interface. When the statistic function is turned off: only display the frequency and period. When the statistic function is turned on: display the measurement parameters currently selected, the on/off status of the statistic function, the measurement values and the number of measurements.
10	Waveform	Display the currently selected waveform shape in each channel.
11	Phase	Display the current waveform phase in each channel. Press the corresponding softkey **Start Phase** and use the numeric keyboard or direction keys and knob to modify this parameter. The parameter that can be modified currently will be highlighted and the lightspot above the number indicates current cursor location.

12	Offset	Display the current waveform DC offset in each channel. Press the corresponding softkey **Offset** and use the numeric keyboard or direction keys and knob to modify this parameter. The parameter that can be modified currently will be highlighted and the lightspot above the number indicates current cursor location.
13	Amplitude	Display the current waveform amplitude in each channel. Press the corresponding softkey **Ampl** and use the numeric keyboard or direction keys and knob to modify this parameter. The parameter that can be modified currently will be highlighted and the lightspot above the number indicates current cursor location.
14	Frequency	Display the current waveform frequency in each channel. Press the corresponding softkey **Freq** and use the numeric keyboard or direction keys and knob to modify this parameter. The parameter that can be modified currently will be highlighted and the lightspot above the number indicates current cursor location.

REMOTE INTERFACE

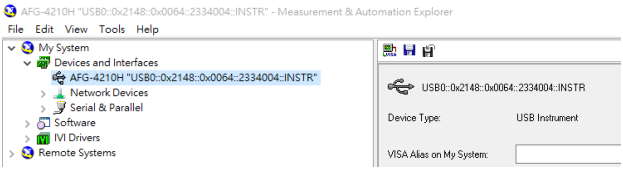
Establishing a Remote Connection 28
Configure USB interface 28
Configure LAN interface 30
Command Syntax 31
Command List 36
Error Messages 155
Command Error Codes 155
Query Errors 157
Arbitrary Waveform Errors 157
SCPI Status Register 158
Register types 158
AFG-4000 Status System 160
Questionable Status Register 161
Standard Event Status Registers 161
The Status Byte Register 163
Output Queue 164
Error Queue 164

Establishing a Remote Connection

AFG-4000 has 2 remote communication interfaces which are USB and LAN. These two communication modes can be used simultaneously.

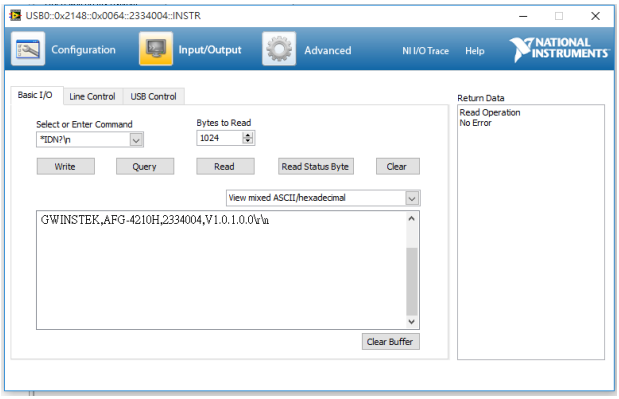
Configure USB interface

Description	Communication via USB interface, using USB Device TMC mode.
Interface	Connect the USB cable to the rear panel USB B (slave) port.
Connection and operation	1. Use the USB cable to connect the **USB Device Interface** on the rear panel of the signal generator to the USB interface of the PC. 2. To use USB communication, you need to use the "NI Visa" software of NI (National Instruments Corporation); 3. After connecting to the host computer through the USB slave interface on the rear panel, open the "NI Visa" software, as shown in the figure above, select View -> Refresh in the menu bar of Measurement & Automation Explorer, when the connection is successful, click on the drop-down arrow of "Devices and Interfaces" in “My System” menu , the serial number of AFG-4000 and the USB Interface number will be displayed on the right side of the page.



Function Measurement

Click the "Open VISA Test Panel" key on the page to pop up the VISA Test Panel, click the Input/Output key in the VISA Test Panel, in the Select or Enter Command box, you can execute all statements including query, setting, measurement, reading and etc. When requiring to query, enter the corresponding query Command and then click the "Query" key to run the Command. Enter the corresponding Command when requiring to operate setting and measurement action and then click the "Write" key. Enter the corresponding Command when requiring to operate reading action and then click the "Read" key. Refer to Command List.



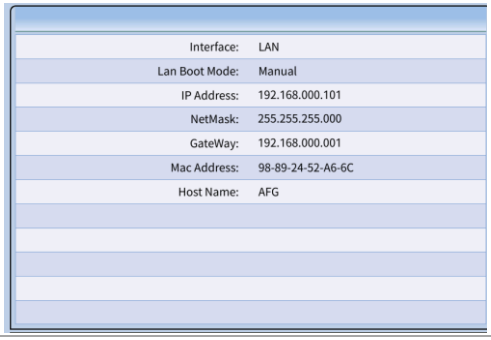
Enter the query Command "*IDN?" as shown above, and the instrument identification information such as manufacturer, model, serial number and software version will be returned. The message "Read Operation No Error" is displayed in the Return Data window.

Exit remote control mode

.Send System:Loacl Command from PC.

NOTE: USB is a hot-swap device, which can be disconnected or connected at any time.

Configure LAN interface

Description	When using the LAN interface, set the relevant parameters on the front panel.
Interface	Connect the LAN cable to the rear panel LAN port.
Parameter settings	
Parameter description	Mode：Choose DHCP (obtain IP address automatically) or Manual (set IP address manually); IP Address: ranging from 1.0.0.0 to 223.255.255.255; (excluding 127.nnn.nnn.nnn); Subnet Mask: ranging from 1.0.0.0 to 255.255.255.255; Gateway: ranging from 1.0.0.0 to 223.255.255.255 (excluding 127.nnn.nnn.nnn);
Exit remote control mode	.Send System:Local Command from PC **WARNING：LAN is a hot-swap device, which can be disconnected or connected at any time.**

Command Syntax

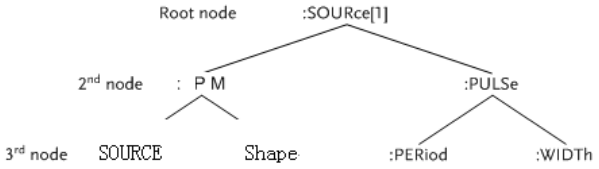
Compatible standard	• IEEE488.2, 1992 (fully compatible) • SCPI, 1994 (partially compatible)

Command Tree

The SCPI standard is an ASCII based standard that defines the command syntax and structure for programmable instruments.

Commands are based on a hierarchical tree structure. Each command keyword is a node on the command tree with the first keyword as the root node. Each sub node is separated with a colon.

Shown below is a section of the SOURce[1|2|3|4] root node and the :PM and :PULSe sub nodes.



Command types

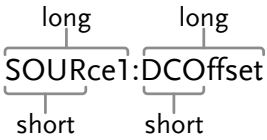
Commands can be separated in to three distinc types, simple commands, compound commands and queries.

Simple	A single command with/without a parameter
Example	*OPC
Compound	Two or more commands separated by a colon (:) with/without a parameter
Example	SOURce1:PULSe:WIDTh

	Query	A query is a simple or compound command followed by a question mark (?). A parameter (data) is returned. The maximum or minimum value for a parameter can also be queried where applicable.
	Example	SOURce1:FREQuency? SOURce1:FREQuency? MIN

Command forms

Commands and queries have two different forms, long and short. The command syntax is written with the short form of the command in capitals and the remainder (long form) in lower case.



The commands can be written in capitals or lower-case, just so long as the short or long forms are complete. An incomplete command will not be recognized.

Below are examples of correctly written commands:

LONG	SOURce1:DCOffset
	SOURCE1:DCOFFSET
	source1:dcoffset
SHORT	SOUR1:DCO
	sour1:dco

Command Format		1: command header 2: single space 3: parameter 4: message terminator
Square Brackets []	Commands that contain squares brackets indicate that the contents are optional. The function of the command is the same with or without the square bracketed items. Brackets are not sent with the command. For example, the frequency query below can use any of the following 3 forms: SOURce1:FREQuency? [MINimum|MAXimum] SOURce1:FREQuency? MAXimum SOURce1:FREQuency? MINimum SOURce1:FREQuency?	
Braces {}	Commands that contain braces indicate one item within the braces must be chosen. Braces are not sent with the command.	
Angled Brackets <>	Angle brackets are used to indicate that a value must be specified for the parameter. See the parameter description below for details. Angled brackets are not sent with the command.	
Bars |	Bars are used to separate multiple parameter choices in the command format.	

Parameters

Type	Description	Example
<Boolean>	Boolean logic	0, 1/ON,OFF
<NR1>	integers	0, 1, 2, 3
<NR2>	decimal numbers	0.1, 3.14, 8.5
<NR3>	floating point	4.5e-1, 8.25e+1
<NRf>	any of NR1, 2, 3	1, 1.5, 4.5e-1

	<NRf+> <Numeric>	NRf type with a suffix including MINimum, MAXimum or DEFault parameters.	1, 1.5, 4.5e-1 MAX, MIN,
	<aard>	Arbitrary ASCII characters.	
	<discrete>	Discrete ASCII character parameters	IMM, EXT, MAN
	<frequency> <peak deviation in Hz> <rate in Hz>	NRf+ type including frequency unit suffixes.	1 KHZ, 1.0 HZ, MHZ
	<amplitude>	NRf+ type including voltage peak to peak.	VPP
	<offset>	NRf+ type including volt unit suffixes.	V
	<seconds>	NRf+ type including time unit suffixes.	NS, S MS US
	<percent> <depth in percent>	NRf type	N/A
Message terminators	LF CR	line feed code (new line) and carriage return.	
	LF	line feed code (new line)	
	EOI	IEEE-488 *EOI* (End-Or-Identify)	
Note	∧j or ∧m should be used when using a terminal program.		

Command Separators	Space	A space is used to separate a parameter from a keyword/command header.
	Colon (:)	A colon is used to separate keywords on each node.
	Semicolon (;)	A semi colon is used to separate subcommands that have the same node level. For example: SOURce[1|2]:DCOffset? SOURce[1|2]:OUTPut? →SOURce1:DCOffset?;OUTPut?
	Colon + Semicolon (:;)	A colon and semicolon can be used to combine commands from different node levels. For example: SOURce1:PM:SOURce? SOURce1:PULSe:WIDTh? →SOURce1:PM:SOURce?:;SOURce:PULSe:WIDTh?
	Comma (,)	When a command uses multiple parameters, a comma is used to separate the parameters. For example: SOURce:APPLy:SQUare 10KHZ, 2.0 VPP, -1V

Command List

System Commands 41
*IDN? 41
*RST 41
*TST? 41
*OPC 42
*OPC? 42
*TRG 42
Status Register Commands 43
*CLS 43
*ESE 43
*ESR? 44
*STB? 44
*SRE 45
System Remote Commands 46
SYSTem:LOCal 46
SYSTem:REMote 46
SYSTem:ERRor? 46
SYSTem:VERSion? 46
SYSTem:LANguage 47
SYSTem:BEEPer:STATe 47
SYSTem:BEEPer:STATe? 48
SYSTem:BEEPer[:IMMediate] 48
SYSTem:RESTART 48
DISPlay Commands 49
DISPlay:BRIGhtness 49
DISPlay:BRIGhtness? 49
DISPlay:SAVer:DELay 49
DISPlay:SAVer:DELay? 49
DISPlay:SAVer[:STATe] 50
DISPlay:SAVer[:STATe]? 50
DISPlay:SAVer:IMMediate 50
HCOPy Commands 51
HCOPy:SDUMp[:IMMeddiate] 51
HCOPy:SDUMp:DATA? 51
MEMory Commamds 52
MEMory:CATalog? 52
MEMory:DELete 52
Apply Commands 53
SOURce[1|2]:APPLy:SINusoid 55
SOURce[1|2]:APPLy:SQUare 55
SOURce[1|2]:APPLy:RAMP 56

SOURce[1|2]:APPLy:PULSe 56
SOURce[1|2]:APPLy:NOISe 57
SOURce[1|2]:APPLy:HARMonic 57
SOURce[1|2]:APPLy:USER 58
SOURce[1|2]:APPLy? 58
Output Commands 59
SOURce[1|2]:FUNCtion 59
SOURce[1|2]:FREQuency 61
SOURce[1|2]:AMPLitude 63
SOURce[1|2]:DCOffset 64
SOURce[1|2]:RAMP:SYMMetry 65
OUTPut[1|2] 66
OUTPut[1|2]:LOAD 66
SOURCE[1|2]:PHASe 67
SOURce[1|2]:PHASe:SYNChronize 68
Pulse Configuration Commands 68
SOURCE[1|2]:PULSe:WIDTh 68
SOURCE[1|2]:PULSe:DCYCLe 69
SOURCE[1|2]:PULSe:TRANsition:LEADing 70
SOURCE[1|2]:PULSe:TRANsition:TRAIling 71
Harmonic Commands 72
SOURce[1|2]:HARMonic:TOTAl 72
SOURce[1|2]:HARMonic:TYPE 73
SOURce[1|2]:HARMonic:ORDEr 73
Amplitude Modulation (AM) Commands 75
AM Overview 75
SOURce[1|2]:AM:STATe 76
SOURce[1|2]:AM:SOURce 76
SOURce[1|2]:AM:INTernal:FUNCtion 77
SOURce[1|2]]:AM:INTernal:FREQuency 78
SOURce[1|2]:AM:DEPTh 78
Double-sideband amplitude Modulation (DSBAM) Commands 80
DSBAM Overview 80
SOURce[1|2]:DSBAm:STATe 81
SOURce[1|2]:DSBAm:SOURce 81
SOURce[1|2]:DSBAm:INTernal:FUNCtion 82
SOURce[1|2]]:DSBAm:INTernal:FREQuency 83
SOURce[1|2]:DSBAm:DEPTh 83
Amplitude Shift Keying (ASK) Commands 85
ASK Overview 85
SOURce[1|2]:ASKey:STATe 85
SOURce[1|2]:ASKey:SOURce 86
SOURce[1|2]:ASK:AMPlitude 86

SOURce[1|2]:ASKey:INTernal RATE 87
Frequency Modulation (FM) Commands 88
FM Overview 88
SOURce[1|2]:FM:STATe 89
SOURce[1|2]:FM:SOURce 89
SOURce[1|2]:FM:INTernal:FUNCtion 90
SOURce[1|2]:FM:INTernal:FREQuency 91
SOURce[1|2]:FM:DEViation 91
Frequency-Shift Keying (FSK) Commands 93
FSK Overview 93
SOURce[1|2]:FSKey:STATe 93
SOURce[1|2]:FSKey:SOURce 94
SOURce[1|2]:FSKey:FREQuency 94
SOURce[1|2]:FSKey:INTernal:RATE 95
3Frequency-Shift Keying (3FSK) Commands 96
3FSK Overview 96
SOURce[1|2]:3FSKey:STATe 96
SOURce[1|2]:3FSKey:FREQuency 97
SOURce[1|2]:3FSKey:INTernal:RATE 97
4Frequency-Shift Keying (4FSK) Commands 98
4FSK Overview 98
SOURce[1|2]:4FSKey:STATe 99
SOURce[1|2]:4FSKey:FREQuency 99
SOURce[1|2]:4FSKey:INTernal:RATE 100
Phase Modulation (PM)Commands 101
PM Overview 101
SOURce[1|2]:PM:STATe 102
SOURce[1|2]:PM:SOURce 102
SOURce[1|2]:PM:INTernal:FUNction 103
SOURce[1|2]:PM:INTernal:FREQuency 103
SOURce[1|2]:PM:DEViation 104
Phase Shift Keying (PSK)Commands 105
PSK Overview 105
SOURce[1|2]:PSKey:STATe 105
SOURce[1|2]:PSKey:SOURce 106
SOURce[1|2]:PSKey:DEViation 106
SOURce[1|2]:PSKey:INTernal RATE 107
Binary Phase Shift Keying (BPSK)Commands 108
BPSK Overview 108
SOURce[1|2]:BPSKey:STATe 108
SOURce[1|2]:BPSKey:DATA 109
SOURce[1|2]:BPSKey:PHASE 109
SOURce[1|2]:BPSKey:INTernal RATE 110

Quadrature Phase Shift Keying (QPSK)Commands 111
QPSK Overview 111
SOURce[1|2]:QPSKey:STATe 111
SOURce[1|2]:QPSKey:PHASE 112
SOURce[1|2]:QPSKey:INTernal RATE 112
Output Shift Keying (OSK)Commands.....114
OSK Overview 114
SOURce[1|2]:OSKey:STATe 114
SOURce[1|2]:OSKey:TIME 115
SOURce[1|2]:OSKey:INTernal RATE 115
SUM Modulation (SUM) Commands.....117
SUM Overview 117
SOURce[1|2]:SUM:STATe 118
SOURce[1|2]:SUM:SOURce 118
SOURce[1|2]:SUM:INTernal:FUNction 119
SOURce[1|2]:SUM:INTernal:FREQuency 119
SOURce[1|2]:SUM:AMPL 120
Pulse Width Modulation (PWM)Commands.....121
PWM Overview 121
SOURce[1|2]:PWM:STATe 121
SOURce[1|2]:PWM:SOURce 122
SOURce[1|2]:PWM:INTernal:FUNction 123
SOURce[1|2]:PWM:INTernal:FREQuency 123
SOURce[1|2]:PWM:DUTY 124
Frequency Sweep Commands.....125
Sweep Overview 125
SOURce[1|2]:SWEep:STATe 126
SOURce[1|2]:FREQuency:STARt 126
SOURce[1|2]:FREQuency:STOP 127
SOURce[1|2]:FREQuency:CENTer 128
SOURce[1|2]:FREQuency:SPAN 128
SOURce[1|2]:SWEep:SPACing 129
SOURce[1|2]:SWEep:TIME 129
SOURce[1|2]:SWEep:SOURce 130
Burst Mode Commands.....132
Burst Mode Overview 132
SOURce[1|2]:BURSt:STATe 134
SOURce[1|2]:BURSt:MODE 134
SOURce[1|2]:BURSt:NCYCles 135
SOURce[1|2]:BURSt:INTernal:PERiod 136
SOURce[1|2]:BURSt:TRIGger:SOURce 137
SOURce[1|2]:BURSt:GATE:POLarity 138
Arbitrary Waveform Commands 139
Arbitrary Waveform Overview 139

SOURce[1|2]:FUNCtion USER 140
SOURce[1|2]:DATA:DAC 141
SOURce[1|2]:ARB:EDIT:COPY 142
SOURce[1|2]:ARB:EDIT:DELete 142
SOURce[1|2]:ARB:EDIT:DELete:ALL 143
SOURce[1|2]:ARB:EDIT:POINt 143
SOURce[1|2]:ARB:EDIT:LINE 144
SOURce[1|2]:ARB:EDIT:PROTect 144
SOURce[1|2]:ARB:EDIT:PROTect:ALL 145
SOURce[1|2]:ARB:EDIT:UNProtect 145
SOURce[1|2]:ARB:OUTPut 145
COUNTER 147
COUNTER:STATE 147
COUNter:COUPling 147
COUNter:HFR 148
COUNter:SENSitivity 148
COUNter:TRIGger 149
COUNter:DUTYcycle? 150
COUNter:FREQ? 150
COUNter:PERiod 150
COUNter:PULSewidth 151
COUPLE 152
SOURce[1|2]:FREQuency:COUPle 152
SOURce[1|2]:AMPlitude:COUPle 152
SOURce[1|2]:TRACk:STATe 153
Save and Recall Commands 154
*SAV 154
*RCL 154

System Commands

*IDN? System Query

Description	Returns the function generator manufacturer, model number, serial number and firmware version number in the following format: Manufacturer, Model,SN:XXXXXXXX,Vm.mm
Query Syntax	***IDN?**
Return parameter	<string>
Example	***IDN?** Manufacturer, Model,SN:XXXXXXXX,Vm.mm Returns the identification of the function generator.

*RST System Command

Description	Reset the function generator to its factory default state.
Note	Note the *RST command will not delete instrument save states in memory.
Syntax	***RST**

*TST? System Query

Description	Performs a system self-test and returns a pass or fail judgment. An error message will be generated if the self test fails.
Note	The error message can be read with the SYST:ERR? query.
Query Syntax	***TST?**
Return parameter	+0 Pass judgment

	+1 Fail judgment
Example	***TST?**
	+0
	The function generator passed the self-test.

*OPC System Command

Description	This command sets the Operation Complete Bit (bit 0) of the Standard Event Status Register after the function generator has completed all pending operations. For the AFG-4000, the *OPC command is used to indicate when a sweep or burst has completed.
Note	Before the OPC bit is set, other commands may be executed.
Syntax	***OPC**

*OPC? System Query

Description	Returns the OPC bit to the output buffer when all pending operations have completed. I.e. when the OPC bit is set.
Note	Commands cannot be executed until the *OPC? query has completed.
Query Syntax	***OPC?**
Return parameter	1
Example	***OPC?**
	1
	Returns a "1" when all pending operations are complete.

*TRG System Command

Description	Generate a trigger event for both CH1 and CH2.
Note	Before the OPC bit is set, other commands may be executed.
Syntax	***TRG**

Status Register Commands

*CLS

System Command

Description	The *CLS command clears all the event registers, the error queue and cancels an *OPC command.
Syntax	***CLS**

*ESE

System Command

Description	The Standard Event Status Enable command determines which events in the Standard Event Status Event register can set the Event Summary Bit (ESB) of the Status Byte register. Any bit positions set to 1 enable the corresponding event. Any enabled events set bit 5 (ESB) of the Status Byte register.
Note	The *CLS command clears the event register, but not the enable register.
Syntax	***ESE <enable value>**
Parameter	<enable value> 0~255
Example	***ESE 20** Sets a bit weight of 20 (bits 2 and 4).
Query Syntax	***ESE?**

Return Parameter	Bit	Register	Bit	Register
	0	Not used	4	Message Available
	1	Not used	5	Standard Event

	2	Error Queue	6	Master Summary
	3	Questionable Data	7	Not used

Example ***ESE?**

4

Bit 2 is set.

*ESR? System Command

Description	Reads and clears the Standard Event Status Register. The bit weight of the standard event status register is returned.
Note	The *CLS will also clear the standard event status register.
Query Syntax	***ESR?**

Return Parameter

Bit	Register	Bit	Register
0	Operation Complete	4	Execution Error
1	Not Used	5	Command Error
2	Query Error	6	Not Used
3	Device Error	7	Power On

Query Example ***ESR?**

5

Returns the bit weight of the standard event status register (bit 0 and 2).

*STB? System Command

Description	Reads the Status byte condition register.
Note	Bit 6, the master summary bit, is not cleared.
Syntax	***STB?**

*SRE System Command

Description	The Service Request Enable Command determines which events in the Status Byte Register are allowed to set the MSS (Master summary bit). Any bit that is set to "1" can cause the MSS bit to be set.
Note	The *CLS command clears the status byte event register, but not the enable register.
Syntax	***SRE <enable value>**
Parameter	<enable value> 0~255
Example	***SRE 12** Sets a bit weight of 12 (bits 2 and 3) for the service request enable register.
Query Syntax	***SRE?**

Return Parameter

Bit	Register	Bit	Register
0	Not used	4	Message Available
1	Not used	5	Standard Event
2	Error Queue	6	Master Summary
3	Questionable Data	7	Not used

Query Example	***SRE? 12** Returns the bit weight of the status byte enable register.

System Remote Commands

SYSTem:LOCal — System Command

Description	Sets the function generator to local mode. In local mode, all front panel keys are operational.
Syntax	**SYSTem:LOCal**
Example	**SYST:LOC**

SYSTem:REMote — System Command

Description	Disables the front panel keys and puts the function generator into remote mode
Syntax	**SYSTem:REMote**
Example	**SYST:REM**

SYSTem:ERRor? — System Query

Description	Reads an error from the error queue.	
Query Syntax	**SYSTem:ERRor?**	
Return parameter	<string>	Returns an error string, <256 ASCII characters.
Example	**SYSTem:ERRor?** **-138 Suffix not allowed** Returns an error string.	

SYSTem:VERSion? — System Query

Description	Performs a system version query. Returns a string with the instrument, firmware version, FPGA revision and bootloader.
Query Syntax	**SYSTem:VERSion?**

Return parameter	<string>
Example	**SYST:VERS?** VX.XXX_XXXX Returns the version infmation.

SYSTem:LANguage System Command

Description	Sets the language that the instrument uses to display information on the screen . Different languages may support different types of languages .
Note	SCHinese | ENGLish specifies which language will be used to display instrument information on the screen.
Syntax	**SYSTem:LANguage {SCHinese|ENGLish}**
Example	**SYSTEM:LANGUAGE ENGLish** Specify that the instrument displays information in English.
Query Syntax	**SYSTem:LANguage ?**
Return parameter	SCHinese|ENGLish
Example	**SYSTem:LANguage?** **ENGLish** The current language is English.

SYSTem:BEEPer:STATe System Command

Description	Sets the beeper ON or OFF. When the beeper is set to ON, the instrument will beep when an error message or a warning message is displayed on the screen. The instrument does not beep when an error or warning caused by remote command execution.

Syntax	SYSTem:BEEPer:STATe {ON|OFF}
Example	**SYSTEM:BEEPER:STATE ON** Enable the beeper function.

SYSTem:BEEPer:STATe? System Query

Description	Queries the status of the beeper.	
Query Syntax	**SYSTem:BEEPer:STATe?**	
Return parameter	OFF	OFF
	ON	ON
Example	**SYSTem:BEEPer:STATe?** **OFF** Queries the on/off status of the beeper and the query returns OFF.	

SYSTem:BEEPer[:IMMediate] System Command

Description	Cause the instrument to beep immediately. This command is only available when the beeper is enabled.
Syntax	**SYSTem:BEEPer[:IMMediate]**
Example	**SYSTEM:BEEPER** Cause a beep.

SYSTem:RESTART System Command

Description	Restart the instrument.
Syntax	**SYSTem:RESTART**
Example	**SYSTem:RESTART** Restarts the instrument:

DISPlay Commands

DISPlay:BRIGhtness — Display Command

Description	Sets the screen brightness.
Syntax	**DISPlay:BRIGhtness {<brightness>|MINimum|MAXimum}**
Example	**DISP:BRIG 51** Sets the screen brightness to 51%.

DISPlay:BRIGhtness? — Display Query

Description	Queries the screen brightness.
Syntax	**DISPlay:BRIGhtness?**
Example	**DISP:BRIG?** Queries the screen brightness and the query returns 5.100000E+01

DISPlay:SAVer:DELay — Display Command

Description	Sets delay time for the screen saver function. The setting range is 1 minute to 999 minutes.
Syntax	**DISPlay:SAVer:DELay {<minutes>|MINimum|MAXimum}**
Example	**DISPlay:SAVer:DELay 30** Sets the delay time for the screen saver function to 30 minutes.

DISPlay:SAVer:DELay? — Display Query

Description	Queries delay time for the screen saver function.
Syntax	**DISPlay:SAVer:DELay? {MINimum|MAXimum}**

Example	**DISPlay:SAVer:DELay?** **10** Queries delay time for the screen saver function and the query returns 10 minutes.

DISPlay:SAVer[:STATe] Display Command

Description	Enables or disables the screen saver function.
Syntax	**DISPlay:SAVer[:STATe] {ON|OFF}**
Example	**DISPLAY:SAVER:STATE OFF** Disables the screen saver function:.

DISPlay:SAVer[:STATe]? Display Query

Description	Queries the on/off status of the screen saver function.
Syntax	**DISPlay:SAVer[:STATe] ?**
Example	**DISPLAY:SAVER?** **1** Queries the on/off status of the screen saver function and the query returns ON.

DISPlay:SAVer:IMMediate Display Command

Description	Enables the screen saver immediately without waiting.
Syntax	**DISPlay:SAVer:IMMediate**
Example	**DISPLAY:SAVER:IMMEDIATE** Sets the screen saver state to ON

HCOPy Commands

HCOPy:SDUMp[:IMMeddiate] Hcopy Command

Description	Copy a screen image and saves the image file to a USB memory. The default file name is n.BMP, where n is a consecutive number from 0. The image files are saved in a folder named Model/IMAGE (Model is the instrument model) in the USB memory.
Syntax	**HCOPy:SDUMp[:IMMediate]**
Example	**HCOPY:SDUMP:IMMEDIATE** Copy the screen image and may create a file 1.BMP in a USB memory.

HCOPy:SDUMp:DATA? Hcopy Query

Description	This query-only command returns a specified length of binary data which consist a BMP screen image.
Syntax	**HCOPy:SDUMp:DATA?**
Example	**HCOPy:SDUMp:DATA?** might return the following response: #6377512xxxxx . . . where 6 indicates that the following 6 digits (377512) specify the length of the data in bytes; xxxxx ... indicates the BMP image data.

MEMory Commamds

MEMory:CATalog? Memory Query

Description	This query-only command returns the current state of the mass storage system (USB memory).
Syntax	**MEMory:CATalog?**
Example	**MEMory:CATalog?** 21973685,16851047,"Test_folder,DIR,0",”Firmware.upp,,7791”,”memo.txt,,2566” The USB memory includes the Test_folder folder, a Firmware.upp file, and a memo.txt file.

MEMory:DELete Memory Command

Description	Delete a file or directory from the mass storage system. If a specified file in the mass storage is not allowed to overwrite or delete, this command causes an error. You can delete a directory if it is empty.
Syntax	**MEMory:DELete <file_name>**
Example	**MEMory:DELete ”/Test_folder/Case/Firmware.upp”** Delete the Firmware.upp file from the /Test_folder/Case directory:

Apply Commands

The APPLy command has 7 different types of outputs (Sine, Square, Ramp, Pulse, Noise,Harmonic,User). The command is the quickest, easiest way to output waveforms remotely. Frequency, amplitude and offset can be specified for each function.

As only basic parameters can be set with the Apply command, other parameters use the instrument default values.

As the frequency, amplitude and offset parameters are in nested square brackets, amplitude can only be specified if the frequency has been specified and offset can only be specified if amplitude has been set. For the example:

SOURce[1|2]:APPLy:SINusoid [<frequency> [,<amplitude> [,<offset>]]]

Output Frequency For the output frequency, MINimum, MAXimum and DEFault can be used. The default frequency for all functions is set to 1 kHz. The maximum and minimum frequency depends on the function used. If a frequency output that is out of range is specified, the max/min frequency will be used instead. A "Data out range error will be generated" from the remote terminal.

Output Amplitude

When setting the amplitude, MINimum, MAXimum and DEFault can be used. The range depends on the function being used and the output termination (50Ω or high impedance). The default amplitude for all functions is 100 mVpp (50Ω).

If the amplitude has been set and the output termination is changed from 50Ω to high impedance, the amplitude will double. Changing the output termination from high impedance to 50Ω will half the amplitude.

Vrms, dBm or Vpp units can be used to specify the output unit to use with the current command. If the output termination is set to high impedance, dBm units cannot be used. The units will default to Vpp.

The output amplitude can be affected by the function and unit chosen. Vpp and Vrms or dBm values may have different maximum values due to differences such as crest factor. For example, a 5Vrms square wave must be adjusted to 3.536 Vrms for a sine wave.

DC Offset voltage

The offset parameter can be set to MINimum, MAXimum or DEFault. The default offset is 0 volts. The offset is limited by the output amplitude as shown below.

$|V_{offset}| < V_{max} - Vpp/2$

If the output specified is out of range, the maximum offset will be set.

The offset is also determined by the output termination (50Ω or high impedance). If the offset

has been set and the output termination has changed from 50Ω to high impedance, the offset will double. Changing the output termination from high impedance to 50Ω will half the offset.

SOURce[1|2]:APPLy:SINusoid

Source Specific Command

Description	Outputs a sine wave from the selected channel when the command has executed. Frequency, amplitude and offset can also be set.	
Syntax	SOURce[1|2]:APPLy:SINusoid [<frequency> [,<amplitude> [,<offset>]]]	
Parameter	<frequency>	1μHz~250MHz
	<amplitude>	1mVpp~10Vpp (50 Ω)
	<offset>	±5 Vpk ac +dc (50 Ω)
Example	**SOUR1:APPL:SIN 2KHZ,MAX,MAX** Sets frequency to 2kHz and sets the amplitude and offset to the maximum.	

SOURce[1|2]:APPLy:SQUare

Source Specific Command

Description	Outputs a square wave from the selected channel when the command has executed. Frequency, amplitude and offset can also be set. The duty cycle is set to 50%.	
Syntax	SOURce[1|2]:APPLy:SQUare [<frequency> [,<amplitude> [,<offset>]]]	
Parameter	<frequency>	1μHz~50MHz
	<amplitude>	1mVpp~10Vpp (50Ω)
	<offset>	±5 Vpk ac +dc (50Ω)
Example	**SOUR1:APPL:SQU 2KHZ,MAX,MAX** Sets frequency to 2kHz and sets the amplitude and offset to the maximum.	

SOURce[1|2]:APPLy:RAMP

Source Specific Command

Description	Outputs a ramp wave from the selected channel when the command has executed. Frequency, amplitude and offset can also be set. The symmetry is set to 100%.	
Syntax	**SOURce[1|2]:APPLy:RAMP [<frequency> [,<amplitude> [,<offset>]]]**	
Parameter	<frequency>	1μHz~5MHz
	<amplitude>	1mVpp~10Vpp (50Ω)
	<offset>	±5 Vpk ac +dc (50Ω)
Example	**SOUR1:APPL:RAMP 2KHZ,MAX,MAX** Sets frequency to 2kHz and sets the amplitude and offset to the maximum.	

SOURce[1|2]:APPLy:PULSe

Source Specific Command

Description	Outputs a pulse waveform from the selected channel when the command has executed. Frequency, amplitude and offset can also be set.	
Note	The PW settings from the SOURce[1|2]:PULS: WIDT command are preserved. Edge and pulse width may be adjusted to supported levels. Repetition rates will be approximated from the frequency.	
Syntax	**SOUR[1|2]:APPLy:PULSe [<frequency> [,<amplitude> [,<offset>]]]**	
Parameter	<frequency>	1μHz~25MHz
	<amplitude>	1mV~10V (50Ω)
	<offset>	±5 Vpk ac +dc (50Ω)
Example	**SOUR1:APPL:PULS 1KHZ,MIN,MAX**	

Sets frequency to 1kHz and sets the amplitude to minimum and the and offset to the maximum.

SOURce[1|2]:APPLy:NOISe

Source Specific Command

Description	Outputs Gaussian noise (no set bandwidth). Amplitude and offset can also be set.	
Note	Frequency cannot be used with the noise function; however a value (or DEFault) must be specified. The frequency is remembered for the next function used.	
Syntax	**SOURce[1|2]:APPLy:NOISe [<frequency|DEFault> [,<amplitude> [,<offset>]]]**	
Parameter	<frequency>	Not applicable
	<amplitude>	1mV~10V (50Ω)
	<offset>	±5 Vpk ac +dc (50Ω)
Example	**SOUR1:APPL:NOIS DEF, 3.0, 1.0** Sets the amplitude to 3 volts with an offset of 1 volt.	

SOURce[1|2]:APPLy:HARMonic

Source Specific Command

Description	Outputs a sine wave with harmonic components from the selected channel when the command has executed. Frequency, amplitude and offset can also be set. The maximum frequency is limited by the highest order. Highest order n: maximum frequency is sine wave bandwidth/n.
Syntax	**SOURce[1|2]:APPLy:HARMonic [<frequency> [,<amplitude> [,<offset>]]]**

Parameter	<frequency>	1μHz~125MHz
	<amplitude>	1mV~10V (50Ω)
	<offset>	±5 Vpk ac +dc (50Ω)
Example	**SOUR1:APPL:HARM 2KHZ,MAX,MAX** Sets the frequency to 2kHz and sets the amplitude and offset to the maximum.	

SOURce[1|2]:APPLy:USER

Source Specific Command

Description	Outputs an arbitrary waveform from the selected channel. The output is that specified from the FUNC:USER command.	
Note	Frequency and amplitude cannot be used with the DC function; however a value (or DEFault) must be specified. The values are remembered for the next function used.	
Syntax	**SOURce[1|2]:APPLy:USER [<frequency> [,<amplitude> [,<offset>]]]**	
Parameter	<frequency>	1μHz~30MHz (15MHz AFG-4125E/ 4125AE/ 4225E)
	<amplitude>	1mV~10V (50Ω)
	<offset>	±5 Vpk ac +dc (50Ω)
Example	**SOUR1:APPL:USER 1KHZ,5.0,1.0**	

SOURce[1|2]:APPLy?

Source Specific Command

Description	Outputs a string with the current settings.	
Note	The string can be passed back appended to the Apply Command.	
Syntax	**SOURce[1|2]:APPLy?**	
Return Parameter	<string>	Function, frequency, amplitude, offset

Example	**SOUR1:APPL?** SIN +5.0000000000000E+03 +3.0000E+00 -2.50E+00 Returns a string with the current function and parameters, Sine, 5kHz 3 Vpp -2.5V offset.

Output Commands

Unlike the Apply commands, the Output commands are low level commands to program the function generator.

This section describes the low-level commands used to program the function generator. Although the APPLy command provides the most straightforward method to program the function generator, the low-level commands give you more flexibility to change individual parameters.

SOURce[1|2]:FUNCtion

Source Specific Command

Description	The FUNCtion command selects and outputs the selected output. The User parameter outputs an arbitrary waveform previously set by the SOURce[1|2]:FUNC:USER command.
Note	If the function mode is changed and the current frequency setting is not supported by the new mode, the frequency setting will be altered to next highest value. Vpp and Vrms or dBm amplitude values may have different maximum values due to differences such as crest factor. For example, if a 5Vrms square wave is changed to a sinewave, then the Vrms is automatically adjusted to 3.536. The modulation, burst and sweep modes can only be used with some of the basic waveforms. If a mode is not supported, the conflicting mode will be disabled. See the table below.

	Sine	Squ	Ramp	Pulse	Noise	Harm	ARB
AM	✓	✓	✓	×	×	×	✓
DSBAM	✓	✓	✓	×	×	×	×
FM	✓	✓	✓	×	×	×	✓
PM	✓	✓	✓	×	×	×	✓
SUM	✓	✓	✓	×	×	×	×
PWM	×	×	×	✓	×	×	×
ASK	✓	✓	✓	×	×	×	✓
FSK	✓	✓	✓	×	×	×	✓
3FSK	✓	✓	✓	×	×	×	✓
4FSK	✓	✓	✓	×	×	×	✓
PSK	✓	✓	✓	×	×	×	✓
BPSK	✓	✓	✓	×	×	×	✓
QPSK	✓	✓	✓	×	×	×	✓
OSK	✓	×	×	×	×	×	×
SWEEP	✓	✓	✓	×	×	×	✓
BURST	✓	✓	✓	✓	✓	×	✓

Syntax	**SOURce[1|2]:FUNCtion {SINusoid|SQUare|RAMP| PULSe|NOISe| USER| HARMonic }**	
Example	**SOUR1:FUNC SIN** Sets the output as a sine function.	
Query Syntax	**SOURce[1|2]:FUNCtion?**	
Return Parameter	SIN, SQU, RAMP, PULS, NOIS, USER, HARMonic	Returns the current output type.
Example	**SOUR1:FUNC?** SIN Current output is sine.	

SOURce[1|2]:FREQuency

Source Specific Command

Description	Sets the output frequency for the the SOURce[1|2] :FUNCtion command. The query command returns the current frequency setting.
Note	The maximum and minimum frequency depends on the function mode.

Sine	1μHz~25MHz (35MHz AFG-4235 60MHz AFG-4260 80MHz AFG-4280 100MHz AFG-4210H 250MHz AFG-4225H)
Square	1uHz~5MHz (15MHz AFG-4235 30MHz AFG-4260/4280/4210H 50MHz AFG-4225H)
Ramp	1μHz~1MHz (3MHz AFG-4235/4260/4280/4210H 5MHz AFG-4225H)
Pulse	1μHz~5MHz (15MHz AFG-4235 25MHz AFG-4260/4280/4210H/4225H)
Noise	Not applicable
Harmonic	1μHz~12.5MHz (17.5MHz AFG-4235 30MHz AFG-4260 40MHz AFG-4280 50MHz AFG-4210H 125MHz AFG-4225H)
User	1μHz~15MHz (30MHz AFG-4235/4260/4280/4210H/4225H)

	If the function mode is changed and the current frequency setting is not supported by the new mode, the frequency setting will be altered to next highest value.	
Syntax	**SOURce[1|2]:FREQuency {<frequency>|MINimum|MAXimum}**	
Example	**SOUR1:FREQ MAX** Sets the frequency to the maximum for the current mode.	
Query Syntax	**SOURce[1|2]:FREQuency?**	
Return Parameter	<NR3>	Returns the frequency for the current mode.
Example	**SOUR1:FREQ? MAX** **+5.0000000000000E+07** The maximum frequency that can be set for the current function is 50MHz.	

SOURce[1|2]:AMPLitude

Source Specific Command

Description	The SOURce[1|2]:AMPLitude command sets the output amplitude for the selected channel. The query command returns the current amplitude settings.
Note	The maximum and minimum amplitude depends on the output termination. The default amplitude for all functions is 1 Vpp (High z). If the amplitude has been set and the output termination is changed from 50Ω to high impedance, the amplitude will double. Changing the output termination from high impedance to 50Ω will half the amplitude. The offset and amplitude are related by the following equation. $\|V_{offset}\| < V_{max} - Vpp/2$

If the output termination is set to high impedance, dBm units cannot be used. The units will default to Vpp.

The output amplitude can be affected by the function and unit chosen. Vpp and Vrms or dBm values may have different maximum values due to differences such as crest factor. For example, a 5Vrms square wave must be adjusted to 3.536 Vrms for a sine wave.

The amplitude units can be explicitly used each time the SOURce[1|2]:AMPlitude command is used.

Syntax	**SOURce[1|2]:AMPLitude {< amplitude> |MINimum|MAXimum}**
Example	**SOUR1:AMPL MAX** Sets the amplitude to the maximum for the current mode.
Query Syntax	**SOURce[1|2]:AMPLitude? {MINimum|MAXimum}**
Return Parameter	<NR3> Returns the amplitude for the current mode.
Example	**SOUR1:AMPL? MAX** +8.000E+00 The maximum amplitude that can be set for the current function is 8 volts.

SOURce[1|2]:DCOffset

Source Specific Command

Description	Sets or queries the DC offset for the current mode.
Note	The offset parameter can be set to MINimum, MAXimum or DEFault. The default offset is 0 volts. The offset is limited by the output amplitude as shown below.

	|V*offset*| < V*max* – Vpp/2 If the output specified is out of range, the maximum offset will be set. The offset is also determined by the output termination (50Ω or high impedance). If the offset has been set and the output termination has changed from 50Ω to high impedance, the offset will double. Changing the output termination from high impedance to 50Ω will half the offset.
Syntax	**SOURce[1|2]:DCOffset {< offset> |MINimum|MAXimum}**
Example	**SOUR1:DCO MAX** Sets the offset to the maximum for the current mode.
Query Syntax	**SOURce[1|2]:DCOffset? {MINimum|MAXimum}**
Return Parameter	<NR3> Returns the offset for the current mode.
Example	**SOUR1:DCO?** +1.00E+00 The offset for the current mode is set to +1volts.

SOURce[1|2]:RAMP:SYMMetry

Source Specific Command

Description	Sets or queries the symmetry for ramp waves only. The setting is remembered if the function mode is changed. The default symmetry is 50%.
Syntax	**SOURce[1|2]:RAMP:SYMMetry {< percent> |MINimum|MAXimum}**
Example	**SOUR1:RAMP:SYMM +5.00E+01** Sets the symmetry to the 50%.
Query Syntax	**SOURce[1|2]:RAMP:SYMMetry? {MINimum|MAXimum}**

Return Parameter	<NR3>	Returns the symmetry as a percentage.
Example	SOUR1:RAMP:SYMMetry? +5.00E+01 Sets the symmetry to the 50%.	

OUTPut[1|2]

Source Specific Command

Description	Enables/Disables or queries the front panel output. The default is set to off.	
Note	If the output is overloaded by an external voltage, the output will turn off. The overload must first be removed before the output can be turned on again with output command. Using the Apply command automatically sets the front panel output to on.	
Syntax	OUTPut[1|2] {OFF|ON}	
Example	OUTP1 ON Turns the output on.	
Query Syntax	OUTPut[1|2]?	
Return Parameter	1	ON
	0	OFF
Example	OUTP1? 1 The channel 1 output is currently on.	

OUTPut[1|2]:LOAD

Source Specific Command

Description	Sets or queries the output termination. Two impedance settings can be chosen, DEFault (50Ω) and INFinity (high impedance >10 kΩ). The output termination is to be used as a reference only. If the output termination is set 50Ω but the actual load impedance is not 50Ω, then the amplitude and offset will not be correct.
Note	If the amplitude has been set and the output termination is changed from 50Ω to high impedance, the amplitude will double. Changing the output termination from high impedance to 50Ω will half the amplitude. If the output termination is set to high impedance, dBm units cannot be used. The units will default to Vpp.
Syntax	**OUTPut[1|2]:LOAD {DEFault|INFinity}**
Example	**OUTP1:LOAD DEF** Sets the output termination to 50Ω.
Query Syntax	**OUTPut[1|2]PULSe]:LOAD?**

Return Parameter		
	DEF	Default
	INF	INFinity

Example	**OUTP1:LOAD?** **DEF** The output is set to the default of 50Ω.

SOURCE[1|2]:PHASe

Instrument Command

Description	Sets the phase.	
Syntax	**SOURce[1|2]:PHASe {<phase>|<MIN>|<MAX>}**	
Parameter	phase	0~360
	min	Sets the phase to the minimum value.

	max	Sets the phase to the maxium value.
Example	**SOURce1:PHASe 25**	
	Sets the phase of channel 1 to 25°.	
Query Syntax	**SOURce[1|2]:PHASe? {MAX|MIN}**	
Return Parameter	<NRf>	Returns the current phase in degrees.
Example	**SOURce1:PHASe?**	
	+2.500E+01	
	Returns the phase of channel 1 as 25°.	

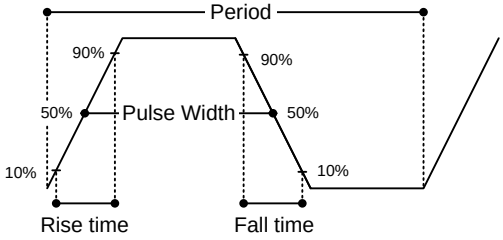
SOURce[1|2]:PHASe:SYNChronize

Instrument Command

Description	Sychronizes the phase of channel 1 and channel 2.
Syntax	**SOURce[1|2]:PHASe:SYNChronize**
Example	**SOURce1:PHASe:SYNChronize**
	Synchronizes the phase of channel 1

Pulse Configuration Commands

The pulse chapter is used to control and output pulse waveforms. Unlike the APPLy command, low level control is possible including setting the leading edge time, trailingedge time, period and pulse width.



SOURCE[1|2]:PULSe:WIDTh

Source Specific Command

Description	Sets or queries the pulse width. The default pulse width is 500us. Pulse width is defined as the time from the rising to falling edges (at a threshold of 50%).	
Note	The pulse width is restricted to the following limitations: Pulse Width ≥ Minimum Pulse Width Pulse Width < Pulse Period - Minimum Pulse Width	
Syntax	**SOURCE[1|2]:PULSe:WIDTh {<seconds>|MINimum|MAXimum}**	
Example	**SOURCE1:PULS:WIDT MAX** Sets the pulse width to the maximum allowed.	
Query Syntax	**SOURCE[1|2]:PULSe:WIDTh? [MINimum|MAXimum]**	
Return Parameter	<seconds>	≧48 ns (≧18ns AFG-4235, ≧12ns AFG-4260/4280/4210H, ≧7ns AFG-4225H. limited by the current frequency setting)
Example	**SOURCE1:PULS:WIDT?** +2.000000000000E-08 The pulse width is set to 20 nanoseconds.	

SOURCE[1|2]:PULSe:DCYCLe

Source Specific Command

Description	Sets or queries the pulse duty cycle.
Note	The duty cycle is restricted to the following limitations: Pulse Duty Cycle ≥ 100% × Minimum Pulse Width ÷ Pulse Period

	Pulse Duty Cycle < 100%×(1-2*Minimum Pulse Width÷Pulse Period)	
Syntax	**SOURCE[1|2]:PULSe:DCYCle{<percent>|MINimum|MAXimum}**	
Example	**SOURCE1:PULS:DCYC MAX** Sets the duty to the maximum allowed.	
Query Syntax	**SOURCE1:PULSe:DCYCle? [MINimum|MAXimum]**	
Return Parameter	<NR3>	0.01%~99.99%(limited by the current frequency setting)
Example	**SOURCE1:PULS:DCYC?** +1.0000E+01 The duty cycle is set to 10%	

SOURCE[1|2]:PULSe:TRANsition:LEADing

Source Specific Command

Description	Sets or queries the pulse leading edge time. The default rise time is 1.953us. The leading and trailing edge time can be different.
Note	The leading edge time is limited by the pulse width as noted below: Leading/Trailing Edge Time ≤ 0.625 × Pulse Width
Syntax	**SOURCE[1|2]:PULSe:TRANsition:LEADing {<seconds>|MINimum|MAXimum}**
Example	**SOURCE1:PULS:TRANsition:LEADing MAX** Sets the pulse transition trailing to the maximum allowed.
Query Syntax	**SOURCE[1|2]:PULSe:TRANsition:LEADing? [MINimum|MAXimum]**

Return Parameter	<seconds>	≧32ns(8ns AFG-4235/4260/4280/4210H, 7ns AFG-4225H. limited by the current frequency and pulse width settings)
Example	**SOURCE1:PULS:TRANsition:LEADing?** +8.0000E-08 The pulse transition trailing is set to 80 nanoseconds.	

SOURCE[1|2]:PULSe:TRANsition:TRAIling

Source Specific Command

Description	Sets or queries the pulse trailing edge time. The default rise time is 10ns. The leading and trailing edge time can be different.
Note	The trailing edge time is limited by the pulse width as noted below: Leading/Trailing Edge Time ≤ 0.625 × Pulse Width
Syntax	**SOURCE[1|2]:PULSe:TRANsition:TRAIling {<seconds>|MINimum|MAXimum}**
Example	**SOURCE1:PULS:TRANsition:TRAIling MAX** Sets the pulse transition trailing to the maximum allowed.
Query Syntax	**SOURCE[1|2]:PULSe:TRANsition:TRAIling? [MINimum|MAXimum]**

Return Parameter	<seconds>	≧32ns(8ns AFG-4235/4260/4280/4210H, 7ns AFG-4225H. limited by the current frequency and pulse width settings)
Example	**SOURCE1:PULS:TRANsition:TRAIling?** +8.0000E-08 The pulse transition trailing is set to 80 nanoseconds.	

Harmonic Commands

SOURce[1|2]:HARMonic:TOTAl

Source Specific Command

Description	Sets the highest order harmonic fortheharmonic output. By default this is set to 2.
Note	SOURce[1|2]:HARMonic:TOTAl{<id>|MINimum|MAXimum}
Syntax	**SOURce[1|2]:HARMonic:TOTAl{<id>|MINimum|MAXimum}**
Example	**SOUR1:HARMonic:TOTAl MAX** Sets the highest order harmonic to the maximum allowed.
Query Syntax	**SOURce[1|2]:HARMonic:TOTAl? [MINimum|MAXimum]**
Return Parameter	<NR1> 2-16
Example	**SOUR1:HARM:TOTAl? MIN** 2 Returns the minimum harmonic.

SOURce[1|2]:HARMonic:TYPE

Source Specific Command

Description	Specifies which harmonics are output; odd, even, allor user specified.	
Syntax	**SOURce[1|2]:HARMonic:TYPE {EVEN|ODD|ALL|USER,10000001}**	
Example	**SOURce1:HARMonic:TYPE USER,11000001** Outputs only the 2nd and 8th harmonic.(1st harmonic is the fundamental frequency)	
Query Syntax	**SOURce[1|2]:HARMonic:TYPE?**	
Parameter /Return Parameter	<EVEN>	Output all even orders
	<ODD>	Output all odd orders
	<ALL>	Output all orders, subject to the number specified in "SOURce[1|2]:HARMonic:TOTAl" command.
	<USER $X_1X_2X_3X_4X_5X_6X_7X_8$>	Outputs only the specified orders, where X = Boolean (0, 1) X_x= order number.
Example	**SOUR1:HARM:TYPE?** **EVEN** Returns EVEN harmonic.	

SOURce[1|2]:HARMonic:ORDEr

Source Specific Command

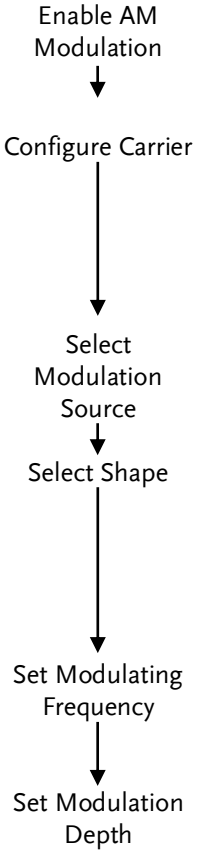
Description	Sets or queries the amplitude and phase of each order. By default, each order is set to 1Vpp, with a phase of 0°.
Syntax	**SOURce[1|2]:HARMonic:ORDEr {<id>,<amplitude>,<phase>}**
Example	**SOURce1:HARMonic:ORDEr 2,3.0,180**

	Sets the 2nd harmonic to 3.0Vpp and a phase of 180°.	
Query Syntax	**SOURce[1|2]:HARMonic:ORDEr? <id>** **Returns the <id>:,<amplitude>,<phase>.**	
Parameter /Return Parameter	<id>	<NR1> Order number: 2 -16
	<amplitude>	<NR2> Amplitude of the selected order: 1mV ~ 10V (50ohm impedance)
	<phase>	<NR3> Phase: 0 ~ 360°
Example	**SOUR1:HARM:ORDE? 2** Order 2 :3.000E+00,1.800E+02 Returns the 2nd harmonic settings as 3Vpp with a phase of 180°.	

Amplitude Modulation (AM) Commands

AM Overview

To successfully create an AM waveform, the following commands must be executed in order.



1. Turn on AM modulation using the SOURce[1|2]:AM:STAT ON command
2. Use the APPLy command to select a carrier waveform. Alternatively the equivalent FUNC, FREQ, AMPl, and DCOffs commands can be used to create a carrier waveform with a designated frequency, amplitude and offset.
3. Select an internal or external modulation source using the SOURce[1|2]: AM:SOUR command.
4. Use the SOURce[1|2]: AM:INT:FUNC command to select a sine, square, ramp, noise or ARB modulating waveshape. For internal sources only.
5. Set the modulating frequency using the SOURce[1|2]: AM:INT:FREQ command. For internal sources only.
6. Set the modulation depth using the SOURce[1|2]: AM:DEPT command.

SOURce[1|2]:AM:STATe

Source Specific Command

Description	Sets or disables AM modulation. By default AM modulation is disabled. AM modulation must be enabled before setting other parameters.	
Note	Burst or sweep mode will be disabled if AM modulation is enabled. As only one modulation is allowed at any one time, other modulation modes will be disabled when AM modulation is enabled.	
Syntax	**SOURce[1|2]:AM:STATe {OFF|ON}**	
Example	**SOUR1:AM:STAT ON** Enables AM modulation.	
Query Syntax	**SOURce[1|2]:AM:STATe?**	
Return Parameter	0	Disabled (OFF)
	1	Enabled (ON)
Example	**SOUR1:AM:STAT?** **1** AM modulation mode is currently enabled.	

SOURce[1|2]:AM:SOURce

Source Specific Command

Description	Sets or queries the modulation source as internal or external. Internal is the default modulation source.
Note	If an external modulation source is selected, modulation depth is limited to ± 1V from the MOD INPUT terminal on the rear panel. For example, if modulation depth is set to 100%, then the maximum amplitude is +1V, and the minimum amplitude is -1V.
Syntax	**SOURce[1|2]:AM:SOURce {INTernal|EXTernal}**
Example	**SOUR1:AM:SOUR EXT**

	Sets the modulation source to external.			
Query Syntax	**SOURce[1|2]:AM:SOURce?**			
Return Parameter	INT	Internal		
	EXT	External		
Example	**SOUR1:AM:SOUR?**			
	INT			
	The modulation source is set to internal.			

SOURce[1|2]:AM:INTernal:FUNCtion

Source Specific Command

Description	Sets the shape of the modulating waveform from sine, square, ramp, noise and ARB. The default shape is sine.			
Note	Square and ramp waveforms have a 50% duty cycle.			
Syntax	**SOURce[1|2]:AM:INTernal:FUNCtion {SINusoid|SQUare|Ramp|Noise|ARB}**			
Example	**SOUR1:AM:INT:FUNC SIN**			
	Sets the AM modulating wave shape to sine.			
Query Syntax	**SOURce[1|2]:AM:INTernal:FUNCtion?**			
Return Parameter	SIN	Sine	NOISE	Noise
	SQU	Square	ARB	ARB
	RAMP	Ramp		
Example	**SOUR1:AM:INT:FUNC?**			
	SIN			
	The shape for the modulating waveform is Sine.			

SOURce[1|2|]:AM:INTernal:FREQuency

Source Specific Command

Description	Sets the frequency of the internal modulating waveform only. The default frequency is 100Hz.	
Syntax	**SOURce[1|2]:AM:INTernal:FREQuency {<frequency>|MINimum|MAXimum}**	
Parameter	<frequency>	2 mHz~ 1MHz
Example	**SOUR1:AM:INT:FREQ +1.0000E+02** Sets the modulating frequency to 100Hz.	
Query Syntax	**SOURce[1|2]:AM:INTernal:FREQuency? [MINimum|MAXimum]**	
Return Parameter	<NR3>	Returns the frequency in Hz.
Example	**SOUR1:AM:INT:FREQ?** **+1.0000000E+02** Returns the frequency to 100Hz.	

SOURce[1|2]:AM:DEPTh

Source Specific Command

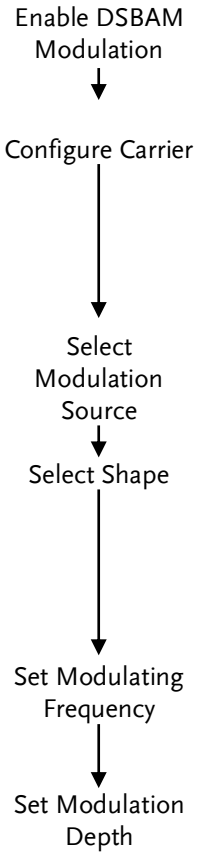
Description	Sets or queries the modulation depth for internal sources only. The default is 100%.	
Note	The function generator will not output more than ±5V, regardless of the modulation depth. The modulation depth of an external source is controlled using the ±1V MOD INPUT terminal on the rear panel, and not the SOURce[1|2]:AM:DEPTh command.	
Syntax	**SOURce[1|2]:AM:DEPTh {<depth in percent>|MINimum|MAXimum}**	
Parameter	<depth in percent>	0~120%
Example	**SOUR1:AM:DEPT 50** Sets the modulation depth to 50%.	

Query Syntax	**SOURce[1|2]:AM:DEPTh? [MINimum|MAXimum]**	
Return Parameter	<NR3>	Return the modulation depth as a percentage.
Example	**SOUR1:AM:DEPT?**	
	+5.0000E+01	
	The modulation depth is 50%.	

Double-sideband amplitude Modulation (DSBAM) Commands

DSBAM Overview

To successfully create an DSBAM waveform, the following commands must be executed in order.



7. Turn on DSBAM modulation using the SOURce[1|2]:DSBAm:STAT ON command
8. Use the APPLy command to select a carrier waveform. Alternatively the equivalent FUNC, FREQ, AMPl, and DCOffs commands can be used to create a carrier waveform with a designated frequency, amplitude and offset.
9. Select an internal or external modulation source using the SOURce[1|2]: DSBAm:SOUR command.
10. Use the SOURce[1|2]: DSBAm:INT:FUNC command to select a sine, square or ramp modulating waveshape. For internal sources only.
11. Set the modulating frequency using the SOURce[1|2]: DSBAm:INT:FREQ command. For internal sources only.
12. Set the modulation depth using the SOURce[1|2]: DSBAm:DEPT command.

SOURce[1|2]:DSBAm:STATe

Source Specific Command

Description	Sets or disables DSBAM modulation. By default DSBAM modulation is disabled. DSBAM modulation must be enabled before setting other parameters.
Note	Burst or sweep mode will be disabled if DSBAM modulation is enabled. As only one modulation is allowed at any one time, other modulation modes will be disabled when DSBAM modulation is enabled.
Syntax	**SOURce[1|2]:DSBAm:STATe {OFF|ON}**
Example	**SOUR1:DSBA:STAT ON** Enables DSBAM modulation.
Query Syntax	**SOURce[1|2]:DSBAm:STATe?**
Return Parameter	0 Disabled (OFF) 1 Enabled (ON)
Example	**SOUR1:DSBA:STAT?** **1** DSBAM modulation mode is currently enabled.

SOURce[1|2]:DSBAm:SOURce

Source Specific Command

Description	Sets or queries the modulation source as internal or external. Internal is the default modulation source.
Note	If an external modulation source is selected, modulation depth is limited to ± 1V from the MOD INPUT terminal on the rear panel. For example, if modulation depth is set to 100%, then the maximum amplitude is +1V, and the minimum amplitude is -1V.
Syntax	**SOURce[1|2]:DSBAm:SOURce {INTernal|EXTernal}**

Example	**SOUR1:DSBA:SOUR EXT** Sets the modulation source to external.	
Query Syntax	**SOURce[1|2]:DSBAm:SOURce?**	
Return Parameter	INT	Internal
	EXT	External
Example	**SOUR1:DSBA:SOUR?** **INT** The modulation source is set to internal.	

SOURce[1|2]:DSBAm:INTernal:FUNCtion

Source Specific Command

Description	Sets the shape of the modulating waveform from sine, square and ramp. The default shape is sine.		
Note	Square and ramp waveforms have a 50% duty cycle.		
Syntax	**SOURce[1|2]:DSBAm:INTernal:FUNCtion {SINusoid|SQUare|Ramp}**		
Example	**SOUR1:DSBA:INT:FUNC SIN** Sets the AM modulating wave shape to sine.		
Query Syntax	**SOURce[1|2]:DSBAm:INTernal:FUNCtion?**		
Return Parameter	SIN	Sine	
	SQU	Square	
	RAMP	Ramp	
Example	**SOUR1:DSBA:INT:FUNC?** **SIN** The shape for the modulating waveform is Sine.		

SOURce[1|2|]:DSBAm:INTernal:FREQuency

Source Specific Command

Description	Sets the frequency of the internal modulating waveform only. The default frequency is 100Hz.	
Syntax	**SOURce[1|2]:DSBAm:INTernal:FREQuency {<frequency>|MINimum|MAXimum}**	
Parameter	<frequency>	2 mHz~ 1MHz
Example	**SOUR1:DSBA:INT:FREQ +1.0000E+02** Sets the modulating frequency to 100Hz.	
Query Syntax	**SOURce[1|2]:DSBAm:INTernal:FREQuency? [MINimum|MAXimum]**	
Return Parameter	<NR3>	Returns the frequency in Hz.
Example	**SOUR1:DSBA:INT:FREQ?** **+1.0000000E+02** Returns the frequency to 100Hz.	

SOURce[1|2]:DSBAm:DEPTh

Source Specific Command

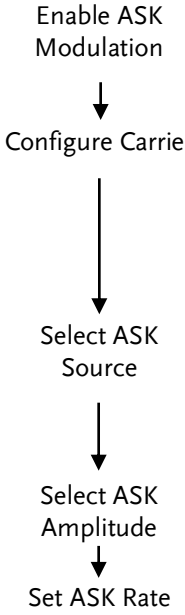
Description	Sets or queries the modulation depth for internal sources only. The default is 100%.	
Note	The function generator will not output more than ±5V, regardless of the modulation depth. The modulation depth of an external source is controlled using the ±1V MOD INPUT terminal on the rear panel, and not the SOURce[1|2]:DSBAm:DEPTh command.	
Syntax	**SOURce[1|2]:DSBAm:DEPTh {<depth in percent>|MINimum|MAXimum}**	
Parameter	<depth in percent>	0~100%
Example	**SOUR1:DSBAm:DEPT 50** Sets the modulation depth to 50%.	

Query Syntax	**SOURce[1|2]:DSBAm:DEPTh? [MINimum|MAXimum]**	
Return Parameter	<NR3>	Return the modulation depth as a percentage.
Example	**SOUR1:DSBAm:DEPT?**	
	+5.0000E+01	
	The modulation depth is 50%.	

Amplitude Shift Keying (ASK) Commands

ASK Overview

The following is an overview of the steps required to generate an ASK modulated waveform.



1. Turn on ASK modulation using the SOURce[1|2]: ASK:STAT ON command.
2. Use the APPLy command to select a carrier waveform. Alternatively, the FREQ, AMPl, and DCOffs commands can be used to create a carrier waveform with a designated frequency, amplitude and offset.
3. Select an internal or external modulation source using the SOURce[1|2]:ASK:SOUR INT command.
4. Set the modulation amplitude using the SOURce[1|2]:ASK:AMPL command.
5. Use the SOURce[1|2]: ASK:INT:RATE command to set the ASK rate. The ASK rate can only be set for internal sources.

SOURce[1|2]:ASKey:STATe

Source Specific Command

Description	Turn on or off the ASK modulation function of the specified channel. Query the on/off status of the ASK modulation function of the specified channel.
Note	Burst or sweep mode will be disabled if ASK modulation is enabled. As only one modulation is allowed at any one time, other modulation modes will be disabled when ASK modulation is enabled.

Syntax	**SOUR[1|2]:ASK:STATe {OFF|ON}**	
Example	**SOUR1:ASK:STAT ON** Enables ASK modulation.	
Query Syntax	**SOUR1:ASK:STATe?**	
Return Parameter	OFF	Disabled (OFF)
	ON	Enabled (ON)
Example	**SOUR1:ASK:STAT?** **ON** ASK modulation mode is currently enabled.	

SOURce[1|2]:ASKey:SOURce

Source Specific Command

Description	Sets or queries the ASK source as internal or external. Internal is the default source.	
Syntax	**SOURce[1|2]:ASKey:SOURce {INTernal|EXTernal}**	
Example	**SOUR1:ASK:SOUR EXT** Sets the ASK source to external.	
Query Syntax	**SOURce[1|2]:ASKey:SOURce?**	
Return Parameter	INTernal	Internal
	EXTernal	External
Example	**SOUR1:ASK:SOUR?** **EXTernal** The ASK source is set to external.	

SOURce[1|2]:ASK:AMPlitude

Source Specific Command

Description	Sets or queries the ASK amplitude. The default modultaion amplitude is set to 1V.
Note	For ASK, the modulating waveform is a square wave with a duty cycle of 50%.

Syntax	**SOURce[1|2]:ASKey:AMPlitude {<voltage>|MINimum|MAXimum}**	
Parameter	<amplitude>	0V～ current amplitude of the carrier waveform
Example	**SOUR1:ASK:AMPlitude 0.5V** Sets the ASK amplitude to 0.5V.	
Query Syntax	**SOURce[1|2]:ASKey: AMPlitude? [MINimum|MAXimum]**	
Return Parameter	<NR3>	Returns the modulation amplitude in mV.
Example	**SOUR1:ASK:AMPlitude?** **5.000E+02** Returns depth to 0.5V.	

SOURce[1|2]:ASKey:INTernal RATE

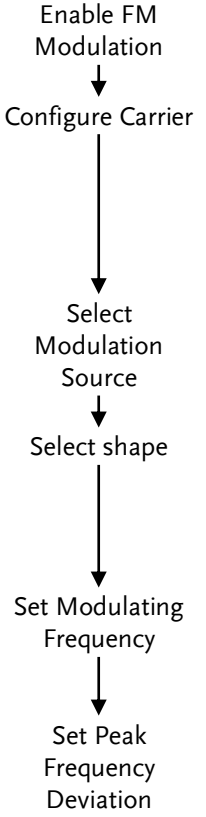
Source Specific Command

Description	Sets or queries the ASK rate for internal sources only.	
Note	External sources will ignore this command.	
Syntax	**SOURce[1|2]:ASKey:INTernal:RATE {<rate in Hz> |MINimum|MAXimum}**	
Parameter	<rate in Hz>	2 mHz~1MHz
Example	**SOUR1:ASK:INT:RATE MAX** Sets the rate to the maximum (1MHz).	
Query Syntax	SOURce[1|2]:ASKey:INTernal:RATE? [MINimum|MAXimum]	
Return Parameter	<NR3>	Returns the ASK rate in Hz.
Example	**SOUR1:ASK:INT:RATE?** **+1.0000E+06** Returns the maximum ASK rate allowed.	

Frequency Modulation (FM) Commands

FM Overview

The following is an overview of the steps required to generate an FM waveform.



1. Turn on FM modulation using the SOURce[1|2]: FM:STAT ON command.
2. Use the APPLy command to select a carrier waveform. Alternatively, the FUNC, FREQ, AMPl, and DCOffs commands can be used to create a carrier waveform with a designated frequency, amplitude and offset.
3. Select an internal or external modulation source using the SOURce[1|2]:FM:SOUR command.
4. Use the SOURce[1|2]:FM:INT:FUNC command to select a sine, square, upramp, dnramp or triangle modulating waveshape. For internal sources only.
5. Set the modulating frequency using the SOURce[1|2]: FM:INT:FREQ command. For internal sources only.
6. Use the SOURce[1|2]:FM:DEV command to set the frequency deviation.

SOURce[1|2]:FM:STATe

Source Specific Command

Description	Sets or disables FM modulation. By default FM modulation is disabled. FM modulation must be enabled before setting other parameters.	
Note	Burst or sweep mode will be disabled if FM modulation is enabled. As only one modulation is allowed at any one time, other modulation modes will be disabled when FM modulation is enabled.	
Syntax	**SOUR[1|2]:FM:STATe {OFF|ON}**	
Example	**SOUR1:FM:STAT ON** Enables FM modulation.	
Query Syntax	**SOURce[1|2]:FM:STATe?**	
Return Parameter	OFF	Disabled (OFF)
	ON	Enabled (ON)
Example	**SOUR1:FM:STAT?** **ON** FM modulation mode is currently enabled.	

SOURce[1|2]:FM:SOURce

Source Specific Command

Description	Sets or queries the modulation source as internal or external. Internal is the default modulation source.
Note	If an external modulation source is selected, modulation depth is limited to ± 1V from the MOD INPUT terminal on the rear panel. For example, if modulation depth is set to 100%, then the maximum amplitude is +1V, and the minimum amplitude is -1V.
Syntax	**SOURce[1|2]:FM:SOURce {INTernal|EXTernal}**

Example	**SOUR1:FM:SOUR EXT** Sets the modulation source to external.			
Query Syntax	**SOURce[1|2]:FM:SOURce?**			
Return Parameter	INTernal	Internal		
	EXTernal	External		
Example	**SOUR1:FM:SOUR?** **INTernal** The modulation source is set to internal.			

SOURce[1|2]:FM:INTernal:FUNCtion

Source Specific Command

Description	Sets the shape of the modulating waveform from sine, square, ramp, noise and ARB. The default shape is sine.			
Note	Square and Ramp waveforms have a 50% duty cycle.			
Syntax	**SOURce[1|2]:FM:INTernal:FUNCtion {SINusoid|SQUare|RAMP|NOISe|USER}**			
Example	**SOUR1:FM:INT:FUNC SIN** Sets the FM modulating wave shape to sine.			
Query Syntax	**SOURce[1|2]:FM:INTernal:FUNCtion?**			
Return Parameter	SIN	Sine	NOISe	Noise
	SQUare	Square	ARB	ARB
	RAMP	Ramp		
Example	**SOUR1:FM:INT:FUNC?** **SIN** The shape for the modulating waveform is Sine.			

SOURce[1|2]:FM:INTernal:FREQuency

Source Specific Command

Description	Sets the frequency of the internal modulating waveform only. The default frequency is 100Hz.	
Syntax	**SOURce[1|2]:FM:INTernal:FREQuency {<frequency>|MINimum|MAXimum}**	
Parameter	<frequency>	2 mHz~ 1 MHz
Example	**SOUR1:FM:INT:FREQ 100** Sets the modulating frequency to 100Hz.	
Query Syntax	**SOURce[1|2]:FM:INTernal:FREQuency? [MINimum|MAXimum]**	
Return Parameter	<NR3>	Returns the frequency in Hz.
Example	**SOUR1:FM:INT:FREQ?** **+1.0000E+02** Returns the frequency to 100Hz.	

SOURce[1|2]:FM:DEViation

Source Specific Command

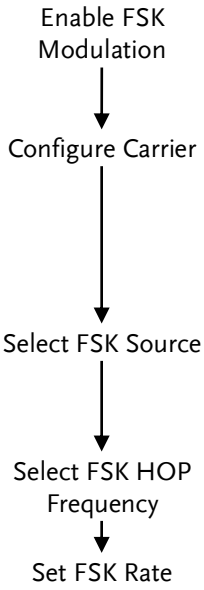
Description	Sets or queries the peak frequency deviation of the modulating waveform from the carrier waveform. The default peak deviation is 100Hz. The frequency deviation of external sources is controlled using the ±1V MOD INPUT terminal on the rear panel. A positive signal (>0~+1V) will increase the deviation (up to the set frequency deviation), whilst a negative voltage will reduce the deviation.
Note	The relationship of peak deviation to modulating frequency and carrier frequency is shown below. Peak deviation = modulating frequency – carrier frequency. The carrier frequency must be greater than or

	equal to the peak deviation frequency. The sum of the deviation and carrier frequency must not exceed the maximum frequency for a specific carrier shape. If an out of range deviation is set for any of the above conditions, the deviation will be automatically adjusted to the maximum value allowed and an "out of range" error will be generated. For square wave carrier waveforms, the deviation may cause the duty cycle frequency boundary to be exceeded. In these conditions the duty cycle will be adjusted to the maximum allowed and a "settings conflict" error will be generated.	
Syntax	**SOURce[1|2]:FM:DEViation {<peak deviation in Hz>|MINimum|MAXimum}**	
Parameter	<peak deviation in Hz>	DC to Max Frequency
Example	**SOUR1:FM:DEV MAX** Sets the frequency deviation to the maximum value allowed.	
Query Syntax	**SOURce[1|2]:FM:DEViation? [MINimum|MAXimum]**	
Return Parameter	<NR3>	Returns the frequency deviation in Hz.
Example	**SOURce1:FM:DEViation? MAX** **+1.0000E+01** Returns the maximum frequency deviation allowed.	

Frequency-Shift Keying (FSK) Commands

FSK Overview

The following is an overview of the steps required to generate an FSK modulated waveform.



1. Turn on FSK modulation using the SOURce[1|2]:FSK:STAT ON command.
2. Use the APPLy command to select a carrier waveform. Alternatively, the FUNC, FREQ, AMPl, and DCOffs commands can be used to create a carrier waveform with a designated frequency, amplitude and offset.
3. Select an internal or external modulation source using the SOURce[1|2]:FSK:SOUR command.
4. Set the hop frequency using the SOURce[1|2]:FSK:FREQ command.
5. Use the SOURce[1|2]: FSK:INT:RATE command to set the FSK rate. The FSK rate can only be set for internal sources.

SOURce[1|2]:FSKey:STATe

Source Specific Command

Description	Turns FSK Modulation on or off. By default FSK modulation is off.
Note	Burst or sweep mode will be disabled if FSK modulation is enabled. As only one modulation is allowed at any one time, other modulation modes will be disabled when FSK modulation is enabled.
Syntax	**SOURce[1|2]:FSKey:STATe {OFF|ON}**
Example	**SOUR1:FSK:STAT ON**

	Enables FSK modulation	
Query Syntax	**SOURce[1|2]:FSKey:STATe?**	
Return Parameter	OFF	Disabled (OFF)
	ON	Enabled (ON)
Example	**SOUR1:FSK:STAT?**	
	ON	
	FSK modulation is currently enabled.	

SOURce[1|2]:FSKey:SOURce

Source Specific Command

Description	Sets or queries the FSK source as internal or external. Internal is the default source.
Note	If an external FSK source is selected, FSK rate is controlled by the Trigger INPUT terminal on the rear panel.
Syntax	**SOURce[1|2]:FSKey:SOURce {INTernal|EXTernal}**
Example	**SOUR1:FSK:SOUR INT** Sets the FSK source to internal.
Query Syntax	**SOURce[1|2]:FSKey:SOURce?**

Return Parameter		
	INTernal	Internal
	EXTernal	External

Example	
	SOUR1:FSK:SOUR?
	INTernal
	The FSK source is set to internal.

SOURce[1|2]:FSKey:FREQuency

Source Specific Command

Description	Sets the FSK hop frequency. The default hop frequency is set to 100Hz.
Note	For FSK, the modulating waveform is a square wave with a duty cycle of 50%.

Syntax	**SOURce[1|2]:FSKey:FREQuency {<frequency>|MINimum|MAXimum}**	
Parameter	<frequency>	1 μHz to Max Frequency
Example	**SOUR1:FSK:FREQ +1.0000E+02** Sets the FSK hop frequency to to 100Hz.	
Query Syntax	**SOURce[1|2]:FSKey:FREQuency? [MINimum|MAXimum]**	
Return Parameter	<NR3>	Returns the frequency in Hz.
Example	**SOUR1:FSK:FREQ? +1.0000000000000E+02** Returns the frequency to 100Hz.	

SOURce[1|2]:FSKey:INTernal:RATE

Source Specific Command

Description	Sets or queries the FSK rate for internal sources only.	
Note	External sources will ignore this command.	
Syntax	**SOURce[1|2]:FSKey:INTernal:RATE {<rate in Hz>|MINimum|MAXimum}**	
Parameter	<rate in Hz>	2 mHz~1MHz
Example	**SOUR1:FSK:INT:RATE MAX** Sets the rate to the maximum (1MHz).	
Query Syntax	**SOURce[1|2]:FSKey:INTernal:RATE? [MINimum|MAXimum]**	
Return Parameter	<NR3>	Returns the FSK rate in Hz.

Example **SOUR1:FSK:INT:RATE? MAX**

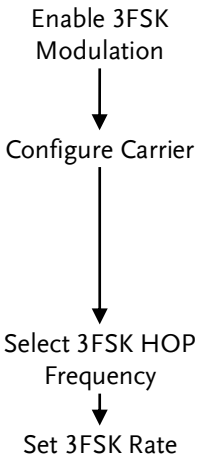
+1.000000000E+06

Returns the maximum FSK rate allowed.

3Frequency-Shift Keying (3FSK) Commands

3FSK Overview

The following is an overview of the steps required to generate an 3FSK modulated waveform.



6. Turn on 3FSK modulation using the SOURce[1|2]:3FSK:STAT ON command.
7. Use the APPLy command to select a carrier waveform. Alternatively, the FUNC, FREQ, AMPl, and DCOffs commands can be used to create a carrier waveform with a designated frequency, amplitude and offset.
8. Set the hop frequency using the SOURce[1|2]:3FSK:FREQ command.
9. Use the SOURce[1|2]: 3FSK:INT:RATE command to set the 3FSK rate. The 3FSK rate can only be set for internal sources.

SOURce[1|2]:3FSKey:STATe

Source Specific Command

Description	Turns 3FSK Modulation on or off. By default 3FSK modulation is off.
Note	Burst or sweep mode will be disabled if 3FSK modulation is enabled. As only one modulation is allowed at any one time, other modulation modes will be disabled when 3FSK modulation is enabled.

Syntax	**SOURce[1|2]:3FSKey:STATe {OFF|ON}**	
Example	**SOUR1:3FSK:STAT ON** Enables 3FSK modulation	
Query Syntax	**SOURce[1|2]:3FSKey:STATe?**	
Return Parameter	OFF	Disabled (OFF)
	ON	Enabled (ON)
Example	**SOUR1:3FSK:STAT?** **ON** 3FSK modulation is currently enabled.	

SOURce[1|2]:3FSKey:FREQuency

Source Specific Command

Description	Sets the 3FSK hop frequency. The default hop frequency is set to 100Hz.	
Note	For 3FSK, the modulating waveform is a square wave with a duty cycle of 50%.	
Syntax	**SOURce[1|2]:3FSKey:FREQuency <n>,{<frequency>|MINimum|MAXimum}**	
Parameter	<frequency>	1 μHz to Max Frequency
Example	**SOUR1:3FSK:FREQ 1,+1.0000E+02** Sets the 3FSK hop1 frequency to 100Hz.	
Query Syntax	**SOURce[1|2]:3FSKey:FREQuency? <n>, [MINimum|MAXimum]**	
Return Parameter	<NR3>	Returns the frequency in Hz.
Example	**SOUR1:3FSK:FREQ? 1** **+1.0000000000000E+02** Returns the hop1 frequency to 100Hz.	

SOURce[1|2]:3FSKey:INTernal:RATE

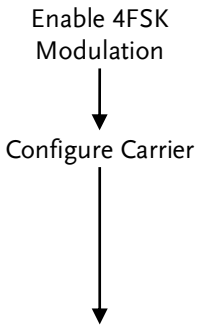
Source Specific Command

Description	Sets or queries the 3FSK rate for internal sources only.	
Syntax	**SOURce[1|2]:3FSKey:INTernal:RATE {<rate in Hz> |MINimum|MAXimum}**	
Parameter	<rate in Hz>	2 mHz~1MHz
Example	**SOUR1:3FSK:INT:RATE MAX** Sets the rate to the maximum (1MHz).	
Query Syntax	**SOURce[1|2]:3FSKey:INTernal:RATE? [MINimum|MAXimum]**	
Return Parameter	<NR3>	Returns the 3FSK rate in Hz.
Example	**SOUR1:3FSK:INT:RATE? MAX** **+1.000000000E+06** Returns the maximum 3FSK rate allowed.	

4Frequency-Shift Keying (4FSK) Commands

4FSK Overview

The following is an overview of the steps required to generate an 4FSK modulated waveform.



10. Turn on 4FSK modulation using the SOURce[1|2]:4FSK:STAT ON command.
11. Use the APPLy command to select a carrier waveform. Alternatively, the FUNC, FREQ, AMPl, and DCOffs commands can be used to create a carrier waveform with a designated frequency, amplitude and offset.
12. Set the hop frequency using the SOURce[1|2]:4FSK:FREQ command.

Frequency
↓
Set 4FSK Rate

13. Use the SOURce[1|2]: 4FSK:INT:RATE command to set the 4FSK rate. The 4FSK rate can only be set for internal sources.

SOURce[1|2]:4FSKey:STATe

Source Specific Command

Description	Turns 4FSK Modulation on or off. By default 4FSK modulation is off.	
Note	Burst or sweep mode will be disabled if 4FSK modulation is enabled. As only one modulation is allowed at any one time, other modulation modes will be disabled when 4FSK modulation is enabled.	
Syntax	**SOURce[1|2]:4FSKey:STATe {OFF|ON}**	
Example	**SOUR1:4FSK:STAT ON** Enables 4FSK modulation	
Query Syntax	**SOURce[1|2]:4FSKey:STATe?**	
Return Parameter	OFF	Disabled (OFF)
	ON	Enabled (ON)
Example	**SOUR1:4FSK:STAT?** **ON** 4FSK modulation is currently enabled.	

SOURce[1|2]:4FSKey:FREQuency

Source Specific Command

Description	Sets the 4FSK hop frequency. The default hop frequency is set to 100Hz.	
Note	For 4FSK, the modulating waveform is a square wave with a duty cycle of 50%.	
Syntax	**SOURce[1|2]:4FSKey:FREQuency <n>,{<frequency>|MINimum|MAXimum}**	
Parameter	<frequency>	1 µHz to Max Frequency

Example	**SOUR1:4FSK:FREQ 1,+1.0000E+02** Sets the 4FSK hop1 frequency to to 100Hz.	
Query Syntax	**SOURce[1|2]:4FSKey:FREQuency? <n> [MINimum|MAXimum]**	
Return Parameter	<NR3>	Returns the frequency in Hz.
Example	**SOUR1:4FSK:FREQ? 1** **+1.0000000000000E+02** Returns the hop1 frequency to 100Hz.	

SOURce[1|2]:4FSKey:INTernal:RATE

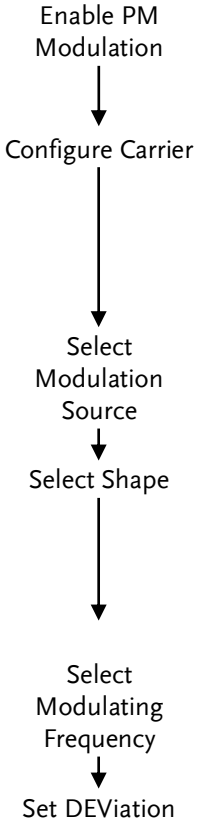
Source Specific Command

Description	Sets or queries the 4FSK rate for internal sources only.	
Syntax	**SOURce[1|2]:4FSKey:INTernal:RATE {<rate in Hz> |MINimum|MAXimum}**	
Parameter	<rate in Hz>	2 mHz~1MHz
Example	**SOUR1:4FSK:INT:RATE MAX** Sets the rate to the maximum (1MHz).	
Query Syntax	**SOURce[1|2]:4FSKey:INTernal:RATE? [MINimum|MAXimum]**	
Return Parameter	<NR3>	Returns the 4FSK rate in Hz.
Example	**SOUR1:4FSK:INT:RATE? MAX** **+1.000000000E+06** Returns the maximum 4FSK rate allowed.	

Phase Modulation (PM)Commands

PM Overview

The following is an overview of the steps required to generate a PM modulated waveform.



1. Turn on PM modulation using the SOURce[1|2]: PM:STATe ON command.
2. Use the APPLy command to select a carrier waveform. Alternatively, the FUNC, FREQ, AMPl, and DCOffs commands can be used to create a carrier waveform with a designated frequency, amplitude and offset.
3. Select an internal or external modulation source using the SOURce[1|2]:PM:SOUR command.
4. Use the SOURce[1|2]: PM:INT:FUNC command to select a sine, square, ramp, noise or ARB modulating waveshape. For internal sources only.
5. Set the modulating frequency using the SOURce[1|2]:PM:INT:FREQ command. For internal sources only.
6. Use the SOURce[1|2]:PM:DEV command to set the phase DEViation.

SOURce[1|2]:PM:STATe

Source Specific Command

Description	Turns PM Modulation on or off. By default PM modulation is off.	
Note	Burst or sweep mode will be disabled if PM modulation is enabled. As only one modulation is allowed at any one time, other modulation modes will be disabled when PM modulation is enabled.	
Syntax	**SOURce[1|2]:PM:STATe {OFF|ON}**	
Example	**SOUR1:PM:STAT ON** Enables PM modulation	
Query Syntax	**SOURce[1|2]:PM:STATe?**	
Return Parameter	OFF	Disabled (OFF)
	ON	Enabled (ON)
Example	**SOUR1:PM:STAT?** **ON** PM modulation is currently enabled.	

SOURce[1|2]:PM:SOURce

Source Specific Command

Description	Sets or queries the PM source as internal or external. Internal is the default source.
Note	If an external PM source is selected, the phase modulation is controlled by the MOD INPUT terminal on the rear panel. .
Syntax	**SOURce[1|2]:PM:SOURce {INTernal|EXTernal}**
Example	**SOUR1:PM:SOUR INT** Sets the PM source to internal.
Query Syntax	**SOURce[1|2]:PM:SOURce?**

Return Parameter	INTernal	Internal
	EXTernal	External

Example **SOUR1:PM:SOUR?**

INTernal

The PM source is set to internal.

SOURce[1|2]:PM:INTernal:FUNction

Source Specific Command

Description: Sets the shape of the modulating waveform from sine, square, ramp, noise and ARB. The default shape is sine.

Note: Square and ramp waveforms have a 50% duty cycle.

Syntax: **SOURce[1|2]:PM:INTernal:FUNCtion {SINusoid|SQUare|RAMP|NOISe|USER}**

Example: **SOUR1:PM:INT:FUNC SIN**

Sets the PM modulating wave shape to sine. .

Query Syntax: **SOURce[1|2]:PM:INTernal:FUNCtion?**

Return Parameter	SIN	Sine	NOISe	Noise
	SQUare	Square	ARB	ARB
	RAMP	Ramp		

Example **SOUR1:PM:INT:FUNC?**

SIN

The shape for the modulating waveform is Sine.

SOURce[1|2]:PM:INTernal:FREQuency

Source Specific Command

Description: Sets the modulating waveform frequency for internal sources. The default frequency is set to 100Hz.

Syntax: **SOURce[1|2]:PM:INTernal:FREQuency {<frequency>|MINimum|MAXimum}**

Parameter	<frequency>	2 mHz~ 1MHz
Example	**SOUR1:PM:INT:FREQ MAX**	
	Sets the frequency to the maximum value.	
Query Syntax	**SOURce[1|2]:PM:INTernal:FREQuency?**	
Return Parameter	<NR3>	Returns the frequency in Hz.
Example	**SOUR1:PM:INT:FREQ?** **+2.0000000E+04** Returns the modulating frequency. (20kHz)	

SOURce[1|2]:PM:DEViation

Source Specific Command

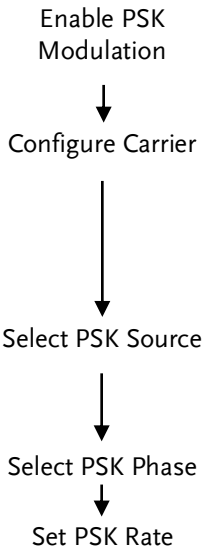
Description	Sets or queries the phase deviation of the modulating waveform from the carrier waveform. The default phase deviation is 0°.
Note	For external sources, the phase deviation is controlled by the ±1V MOD Input terminal on the rear panel. If the phase deviation is set to 180 degrees, then +1V represents a deviation of 180 degrees. A lower input voltage will decrease the set phase deviation.
Syntax	**SOURce[1|2]:PM:DEViation {< phase>|minimum |maximum}**

Parameter	<percent>	0°~180°
Example	**SOUR1:PM:DEViation +3.0000E+01** Sets the deviation to 30°.	
Query Syntax	**SOURce[1|2]:PM:DEViation?**	
Return Parameter	<NR1>	Returns the deviation .
Example	**SOUR1:PM:DEViation?** **30** The current deviation is 30°.	

Phase Shift Keying (PSK)Commands

PSK Overview

The following is an overview of the steps required to generate an PSK modulated waveform.



1. Turn on PSK modulation using the SOURce[1|2]: PSK:STAT ON command.
2. Use the APPLy command to select a carrier waveform. Alternatively, the FREQ, AMPl, and DCOffs commands can be used to create a carrier waveform with a designated frequency, amplitude and offset.
3. Select an internal or external modulation source using the SOURce[1|2]:PSK:SOUR command.
4. Set the hop frequency using the SOURce[1|2]:PSK:PHASE command.
5. Use the SOURce[1|2]: PSK:INT:RATE command to set the PSK rate. The PSK rate can only be set for internal sources.

SOURce[1|2]:PSKey:STATe

Source Specific Command

Description	Turns PSK Modulation on or off. By default PSK modulation is off.
Note	Burst or sweep mode will be disabled if PSK modulation is enabled. As only one modulation is allowed at any one time, other modulation modes will be disabled when PSK modulation is enabled.
Syntax	**SOURce[1|2]:PSKey:STATe {OFF|ON}**
Example	**SOUR1:PSK:STAT ON**

	Enables PSK modulation	
Query Syntax	**SOURce[1|2]:PSKey:STATe?**	
Return Parameter	OFF	Disabled (OFF)
	ON	Enabled (ON)
Example	**SOUR1:PSK:STAT?**	
	ON	
	PSK modulation is currently enabled.	

SOURce[1|2]:PSKey:SOURce

Source Specific Command

Description	Sets or queries the PSK source as internal or external. Internal is the default source.
Note	If an external PSK source is selected, PSK rate is controlled by the Trigger INPUT terminal on the rear panel.
Syntax	**SOURce[1|2]:PSKey:SOURce {INTernal|EXTernal}**
Example	**SOUR1:PSK:SOUR EXT**
	Sets the PSK source to external.
Query Syntax	**SOURce[1|2]:PSKey:SOURce?**

Return Parameter	INTernal	Internal
	EXTernal	External
Example	**SOUR1:PSK:SOUR?**	
	INTernal	
	The PSK source is set to internal.	

SOURce[1|2]:PSKey:DEViation

Source Specific Command

Description	Sets the PSK phase deviation. The default hop frequency is set to 0°.
Note	For PSK, the modulating waveform is a square wave with a duty cycle of 50%.

Syntax	SOURce[1|2]:PSKey:DEVitaion {<phase>|MINimum|MAXimum}	
Parameter	<phase>	0～360°.
Example	**SOUR1:PSK:DEV 180** Sets the PSK phase deviation to to 180°.	
Query Syntax	**SOURce[1|2]:PSKey:DEViation? [MINimum|MAXimum]**	
Return Parameter	<DEG>	0～360°.
Example	**SOUR1:PSK:DEV? MAX** **360°** Returns the maximum phase deviation allowed.	

SOURce[1|2]:PSKey:INTernal RATE

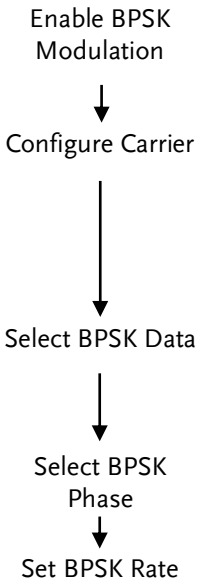
Source Specific Command

Description	Sets or queries the PSK rate for internal sources only.	
Note	External sources will ignore this command.	
Syntax	**SOURce[1|2]:PSKey:INTernal:RATE {<rate in Hz>|MINimum|MAXimum}**	
Parameter	<rate in Hz>	2 mHz~1MHz
Example	**SOUR1:PSK:INT:RATE MAX** Sets the rate to the maximum (1MHz).	
Query Syntax	**SOURce[1|2]:PSKey:INTernal:RATE? [MINimum|MAXimum]**	
Return Parameter	<NR3>	Returns the PSK rate in Hz.
Example	**SOUR1:PSK:INT:RATE? MAX** **+1.0000E+06** Returns the maximum PSK rate allowed.	

Binary Phase Shift Keying (BPSK)Commands

BPSK Overview

The following is an overview of the steps required to generate an PSK modulated waveform.



6. Turn on BPSK modulation using the SOURce[1|2]: BPSK:STAT ON command.
7. Use the APPLy command to select a carrier waveform. Alternatively, the FREQ, AMPl, and DCOffs commands can be used to create a carrier waveform with a designated frequency, amplitude and offset.
8. Select an data modulation source using the SOURce[1|2]:BPSK:DATA command.
9. Set the phase deviation using the SOURce[1|2]:BPSK:PHASE command.
10. Use the SOURce[1|2]: BPSK:INT:RATE command to set the BPSK rate. The BPSK rate can only be set for internal sources.

SOURce[1|2]:BPSKey:STATe

Source Specific Command

Description	Turns BPSK Modulation on or off. By default BPSK modulation is off.
Note	Burst or sweep mode will be disabled if BPSK modulation is enabled. As only one modulation is allowed at any one time, other modulation modes will be disabled when BPSK modulation is enabled.
Syntax	**SOURce[1|2]:BPSKey:STATe {OFF|ON}**

Example	**SOUR1:BPSK:STAT ON**	
	Enables BPSK modulation	
Query Syntax	**SOURce[1|2]:BPSKey:STATe?**	
Return Parameter	OFF	Disabled (OFF)
	ON	Enabled (ON)
Example	**SOUR1:BPSK:STAT?**	
	ON	
	BPSK modulation is currently enabled.	

SOURce[1|2]:BPSKey:DATA

Source Specific Command

Description	Sets or queries the data source of modulation signal of BPSK modulation. PN15 is the default data source.	
Syntax	**SOURce[1|2]:BPSKey:DATA {01|10|PN15|PN21}**	
Example	**SOUR1:BPSK:DATA 01**	
	Sets the BPSK source to 01 pattern.	
Query Syntax	**SOURce[1|2]:BPSKey:SOURce?**	
Return Parameter	01	01
	10	10
	PN15	PN15
	PN21	PN21
Example	**SOUR1:BPSK:DATA?**	
	01	
	The BPSK source is set to 01 pattern.	

SOURce[1|2]:BPSKey:PHASE

Source Specific Command

Description	Sets the BPSK hop frequency. The default hop frequency is set to 180°.

Note	For BPSK, the modulating waveform is a square wave with a duty cycle of 50%.	
Syntax	**SOURce[1|2]:BPSKey:PHASe** {<phase>|MINimum|MAXimum}	
Parameter	<phase>	0～360°.
Example	**SOUR1:BPSK:PHAS 180** Sets the BPSK phase deviation to to 180°.	
Query Syntax	**SOURce[1|2]:BPSKey:PHASe? [MINimum|MAXimum]**	
Return Parameter	<NR1>	0～360°.
Example	**SOUR1:BPSK:PHAS? MAX** **360** Returns the maximum phase deviation allowed.	

SOURce[1|2]:BPSKey:INTernal RATE

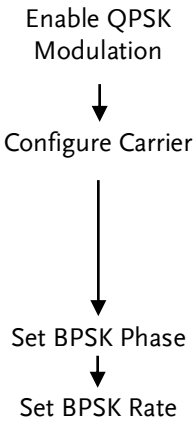
Source Specific Command

Description	Sets or queries the BPSK rate for internal sources only.	
Syntax	**SOURce[1|2]:BPSKey:INTernal:RATE {<rate in Hz>|MINimum|MAXimum}**	
Parameter	<rate in Hz>	2 mHz~1MHz
Example	**SOUR1:BPSK:INT:RATE MAX** Sets the rate to the maximum (1MHz).	
Query Syntax	**SOURce[1|2]:BPSKey:INTernal:RATE? [MINimum|MAXimum]**	
Return Parameter	<NR3>	Returns the BPSK rate in Hz.
Example	**SOUR1:BPSK:INT:RATE? MAX** **+1.0000E+06** Returns the maximum BPSK rate allowed.	

Quadrature Phase Shift Keying (QPSK)Commands

QPSK Overview

The following is an overview of the steps required to generate an QPSK modulated waveform.



11. Turn on QPSK modulation using the SOURce[1|2]: QPSK:STAT ON command.
12. Use the APPLy command to select a carrier waveform. Alternatively, the FREQ, AMPl, and DCOffs commands can be used to create a carrier waveform with a designated frequency, amplitude and offset.
13. Set the phase devitaion using the SOURce[1|2]:QPSK:PHASE command.
14. Use the SOURce[1|2]: QPSK:INT:RATE command to set the QPSK rate. The QPSK rate can only be set for internal sources.

SOURce[1|2]:QPSKey:STATe

Source Specific Command

Description	Turns QPSK Modulation on or off. By default QPSK modulation is off.
Note	Burst or sweep mode will be disabled if QPSK modulation is enabled. As only one modulation is allowed at any one time, other modulation modes will be disabled when QPSK modulation is enabled.
Syntax	**SOURce[1|2]:QPSKey:STATe {OFF|ON}**

Example	**SOUR1:QPSK:STAT ON**	
	Enables QPSK modulation	
Query Syntax	**SOURce[1|2]:QPSKey:STATe?**	
Return Parameter	OFF	Disabled (OFF)
	ON	Enabled (ON)
Example	**SOUR1:QPSK:STAT?**	
	ON	
	QPSK modulation is currently enabled.	

SOURce[1|2]:QPSKey:PHASE

Source Specific Command

Description	Sets the QPSK phase deviation. The default phase deviation is set to 0°.	
Note	For QPSK, the modulating waveform is a square wave with a duty cycle of 50%.	
Syntax	**SOURce[1|2]:QPSKey:PHASe <n>,**{<phase>|MINimum|MAXimum}	
Parameter	<phase>	0～360°.
Example	**SOUR1:QPSK:PHAS 1,180**	
	Sets the QPSK phase1 deviation 180°.	
Query Syntax	**SOURce[1|2]:QPSKey:PHASe? <n> ,[MINimum|MAXimum]**	
Return Parameter	<NR1>	0～360°.
Example	**SOUR1:QPSK:PHAS1? MAX**	
	360°	
	Returns the maximum modulating phase 1 allowed.	

SOURce[1|2]:QPSKey:INTernal RATE

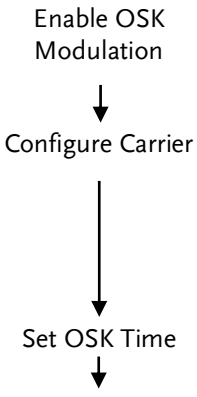
Source Specific Command

Description	Sets or queries the QPSK rate for internal sources only.	
Syntax	**SOURce[1|2]:QPSKey:INTernal:RATE {<rate in Hz> |MINimum|MAXimum}**	
Parameter	<rate in Hz>	2 mHz~1MHz
Example	**SOUR1:QPSK:INT:RATE MAX** Sets the rate to the maximum (1MHz).	
Query Syntax	**SOURce[1|2]:QPSKey:INTernal:RATE? [MINimum|MAXimum]**	
Return Parameter	<NR3>	Returns the BPSK rate in Hz.
Example	**SOUR1:QPSK:INT:RATE? MAX** **+1.0000E+06** Returns the maximum QPSK rate allowed.	

Output Shift Keying (OSK)Commands

OSK Overview

The following is an overview of the steps required to generate an OSK modulated waveform.



15. Turn on OSK modulation using the SOURce[1|2]: OSK:STAT ON command.
16. Use the APPLy command to select a carrier waveform. Alternatively, the FREQ, AMPl, and DCOffs commands can be used to create a carrier waveform with a designated frequency, amplitude and offset.
17. Set the oscillate period using the SOURce[1|2]:OSK:TIME command.
18. Use the SOURce[1|2]: OSK:INT:RATE command to set the OSK rate. The OSK rate can only be set for internal sources.

SOURce[1|2]:OSKey:STATe

Source Specific Command

Description	Turns OSK Modulation on or off. By default OSK modulation is off.
Note	Burst or sweep mode will be disabled if OSK modulation is enabled. As only one modulation is allowed at any one time, other modulation modes will be disabled when OSK modulation is enabled.
Syntax	**SOURce[1|2]:OSKey:STATe {OFF|ON}**
Example	**SOUR1:OSK:STAT ON** **Enables OSK modulation**

Query Syntax	**SOURce[1|2]:OSKey:STATe?**	
Return Parameter	OFF	Disabled (OFF)
	ON	Enabled (ON)
Example	**SOUR1:OSK:STAT?**	
	ON	
	OSK modulation is currently enabled.	

SOURce[1|2]:OSKey:TIME

Source Specific Command

Description	Sets or queries the OSK oscillate period. The default oscillate period is set to 100us.	
Syntax	**SOURce[1|2]:OSKey:TIME** {<time>|MINimum|MAXimum}	
Parameter	< seconds >	8ns～249.75s.
Example	**SOUR1:OSK:TIME 100 us**	
	Sets the OSK oscillate period to to 100us.	
Query Syntax	**SOURce[1|2]:OSKey:TIME? [MINimum|MAXimum]**	
Return Parameter	<NR3 >	8ns～249.75s.
Example	**SOUR1:OSK:TIME? MAX**	
	4.75e-06	
	Returns the maximum oscillate period allowed.	

SOURce[1|2]:OSKey:INTernal RATE

Source Specific Command

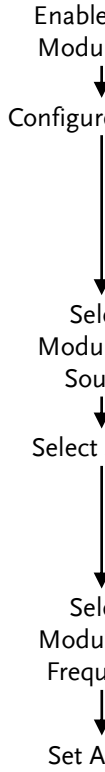
Description	Sets or queries the OSK rate for internal sources only.	
Syntax	**SOURce[1|2]:OSKey:INTernal:RATE {<rate in Hz> |MINimum|MAXimum}**	
Parameter	<rate in Hz>	2 mHz~1MHz
Example	**SOUR1:OSK:INT:RATE MAX**	
	Sets the rate to the maximum (1MHz).	

Query Syntax	SOURce[1|2]:OSKey:INTernal:RATE? [MINimum|MAXimum]	
Return Parameter	<NR3>	Returns the OSK rate in Hz.
Example	SOUR1:OSK:INT:RATE? MAX +1.0000E+06	
	Returns the maximum OSK rate allowed.	

SUM Modulation (SUM) Commands

SUM Overview

The following is an overview of the steps required to generate a SUM modulated waveform.



1. Turn on SUM modulation using the SOURce[1|2]: SUM:STATe ON command.
2. Use the APPLy command to select a carrier waveform. Alternatively, the FUNC, FREQ, AMPl, and DCOffs commands can be used to create a carrier waveform with a designated frequency, amplitude and offset.
3. Select an internal or external modulation source using the SOURce[1|2]:SUM:SOUR command.
4. Use the SOURce[1|2]: SUM:INT:FUNC command to select a sine, square, ramp, noise or ARB modulating waveshape. For internal sources only.
5. Set the modulating frequency using the SOURce[1|2]:SUM:INT:FREQ command. For internal sources only.
6. Use the SOURce[1|2]:SUM:AMPL command to set the SUM amplitude.

SOURce[1|2]:SUM:STATe

Source Specific Command

Description	Turns SUM Modulation on or off. By default SUM modulation is off.	
Note	Burst or sweep mode will be disabled if SUM modulation is enabled. As only one modulation is allowed at any one time, other modulation modes will be disabled when SUM modulation is enabled.	
Syntax	**SOURce[1|2]:SUM:STATe {OFF|ON}**	
Example	**SOUR1:SUM:STAT ON** Enables SUM modulation	
Query Syntax	**SOURce[1|2]:SUM:STATe?**	
Return Parameter	OFF	Disabled (OFF)
	ON	Enabled (ON)
Example	**SOUR1:SUM:STAT?** **ON** SUM modulation is currently enabled.	

SOURce[1|2]:SUM:SOURce

Source Specific Command

Description	Sets or queries the SUM source as internal or external. Internal is the default source.
Note	If an external modulation source is selected, the SUM amplitude is limited to ± 5V from the MOD INPUT terminal on the rear panel. For example, if SUM amplitude is set to 100%, then the maximum amplitude is +5V, and the minimum amplitude is -5V.
Syntax	**SOURce[1|2]:SUM:SOURce {INTernal|EXTernal}**
Example	**SOUR1:SUM:SOUR INT** Sets the SUM source to internal.

Query Syntax	**SOURce[1|2]:SUM:SOURce?**	
Return Parameter	INTernal	Internal
	EXTernal	External
Example	**SOUR1:SUM:SOUR?**	
	INTernal	
	The SUM source is set to internal.	

SOURce[1|2]:SUM:INTernal:FUNction

Source Specific Command

Description	Sets the shape of the modulating waveform from sine, square, ramp, noise and ARB. The default shape is sine.			
Syntax	**SOURce[1|2]:SUM:INTernal:FUNCtion {SINusoid|SQUare|RAMP|NOISe|USER}**			
Example	**SOUR1:SUM:INT:FUNC SIN**			
	Sets the SUM modulating wave shape to sine.			
Query Syntax	**SOURce[1|2]:SUM:INTernal:FUNCtion?**			
Return Parameter	SIN	Sine	NOISe	Noise
	SQUare	Square	ARB	ARB
	RAMP	Ramp		
Example	**SOUR1:SUM:INT:FUNC?**			
	SIN			
	The shape for the modulating waveform is Sine.			

SOURce[1|2]:SUM:INTernal:FREQuency

Source Specific Command

Description	Sets the modulating waveform frequency for internal sources. The default frequency is set to 100Hz.	
Syntax	**SOURce[1|2]:SUM:INTernal:FREQuency {<frequency>|MINimum|MAXimum}**	
Parameter	<frequency>	2 mHz~ 1MHz

Example	SOUR1:SUM:INT:FREQ MAX Sets the frequency to the maximum value.	
Query Syntax	SOURce[1|2]:SUM:INTernal:FREQuency?	
Return Parameter	<NR3>	Returns the frequency in Hz.
Example	SOUR1:SUM:INT:FREQ? +2.0000000e+04 Returns the modulating frequency (20kHz).	

SOURce[1|2]:SUM:AMPL

Source Specific Command

Description	The SUM amplitude command sets or queries the amplitude of the modulating waveform as a percentage of the carrier amplitude.	
Syntax	SOURce[1|2]:SUM:AMPL{< percent>|minimum |maximum}	
Parameter	<percent>	0%~100%
Example	SOUR1:SUM:AMPLitude +3.0000E+01 Sets the amplitude to 30%.	
Query Syntax	SOURce[1|2]:SUM:AMPLitude?	
Return Parameter	<NR3>	Returns the amplitude in % .
Example	SOUR1:SUM:AMPLitude? +3.000E+01 The current amplitude is 30%.	

Pulse Width Modulation (PWM)Commands

PWM Overview

The following is an overview of the steps required to generate a PWM modulated waveform.

1. Turn on PWM modulation using the SOURce[1|2]: PWM:STATe ON command.
2. Use the APPLy command to select a pulse waveform. Alternatively, the FUNC, FREQ, AMPl, and DCOffs commands can be used to create a pulse waveform with a designated frequency, amplitude and offset.
3. Select an internal or external modulation source using the SOURce[1|2]:PWM:SOUR command.
4. Use the SOURce[1|2]: PWM:INT:FUNC command to select a sine, square, ramp, noise or ARB modulating waveshape. For internal sources only.
5. Set the modulating frequency using the SOURce[1|2]:PWM:INT:FREQ command. For internal sources only.
6. Use the SOURce[1|2]:PWM:DUTY command to set the duty cycle or Pulse Width.

SOURce[1|2]:PWM:STATe

Source Specific Command

Description	Turns pulse width modulation on or off. By default PWM is off.

Note	Burst or sweep mode will be disabled if PWM modulation is enabled. As only one modulation is allowed at any one time, other modulation modes will be disabled when PWM modulation is enabled.
Syntax	**SOURce[1|2]:PWM:STATe {OFF|ON}**
Example	**SOUR1:PWM:STAT ON** Enables PWM modulation
Query Syntax	**SOURce[1|2]:PWM:STATe?**
Return Parameter	OFF Disabled (OFF) ON Enabled (ON)
Example	**SOUR1:PWM:STAT?** **ON** PWM modulation is currently enabled.

SOURce[1|2]:PWM:SOURce

Source Specific Command

Description	Sets or queries the PWM source as internal or external. Internal is the default source.
Note	If an external PWM source is selected, the duty cycle/pulse width is controlled by the MOD INPUT terminal on the rear panel.
Syntax	**SOURce[1|2]:PWM:SOURce {INTernal|EXTernal}**
Example	**SOUR1:PWM:SOUR EXT** Sets the PWM source to external.
Query Syntax	**SOURce[1|2]:PWM:SOURce?**
Return Parameter	INTernal Internal EXTernal External
Example	**SOUR1:PWM:SOUR?** **INTernal** The PWM source is set to internal.

SOURce[1|2]:PWM:INTernal:FUNction

Source Specific Command

Description	Sets the shape of the modulating waveform from sine, square, ramp, noise and ARB. The default shape is sine.
Note	Square and triangle waveforms have a 50% duty cycle. Carrier must be a pulse or PWM waveform.
Syntax	**SOURce[1|2]:PWM:INTernal:FUNCtion {SINusoid|SQUare|RAMP|NOISe|USER}**
Example	**SOUR1:PWM:INT:FUNC SIN** Sets the PWM modulating wave shape to sine.
Query Syntax	**SOURce[1|2]:PWM:INTernal:FUNction?**

Return Parameter				
	SIN	Sine	NOISe	Noise
	SQUare	Square	ARB	ARB
	RAMP	Ramp		

Example	**SOUR1:PWM:INT:FUNC?** **SIN** The shape for the modulating waveform is Sine.

SOURce[1|2]:PWM:INTernal:FREQuency

Source Specific Command

Description	Sets the modulating waveform frequency for internal sources. The default frequency is set to 100Hz.
Syntax	**SOURce[1|2]:PWM:INTernal:FREQuency {<frequency>|MINimum|MAXimum}**

Parameter		
	<frequency>	2 mHz~ 1MHz

Example	**SOUR1:PWM:INT:FREQ MAX** Sets the frequency to the maximum value.
Query Syntax	**SOURce[1|2]:PWM:INTernal:FREQuency?**

Return Parameter	<NR3>	Returns the frequency in Hz.
Example	SOUR1:PWM:INT:FREQ? MAX +1.0000e+06 Returns the modulating frequency. (1MHz)	

SOURce[1|2]:PWM:DUTY

Source Specific Command

Description	Sets or queries the duty cycle deviation. The default duty cycle is 0%.	
Note	The duty cycle is limited by period, edge time and minimum pulse width. The duty cycle deviation of an external source is controlled using the ±1V MOD INPUT terminal on the rear panel. A positive signal (>0~+1V) will increase the deviation (up to the set duty cycle deviation), whilst a negative voltage will reduce the deviation.	
Syntax	SOURce[1|2]:PWM:DUTY {< percent>|minimum |maximum}	
Parameter	<percent>	0%~100% (limited, see above)
Example	SOUR1:PWM:DUTY +3.0000E+01 Sets the duty cycle to 30%.	
Query Syntax	SOURce[1|2]:PWM:DUTY?	
Return Parameter	<NR3>	Returns the duty in %.
Example	SOUR1:PWM:DUTY? +3.0000e+01 The current duty cycle is 30%.	

Frequency Sweep Commands

Sweep Overview

Below shows the order in which commands must be executed to perform a sweep.

1. Turn on Sweep mode modulation using the SOURce[1|2]: SWE:STAT ON command.

2. Use the APPLy command to select the waveform shape. Alternatively, the FUNC, FREQ, AMPl, and DCOffs commands can be used to create a waveform with a designated frequency, amplitude and offset.

3. Set the frequency boundaries by setting start and stop frequencies or by setting a center frequency with a span.

   Start~Stop

   Use the SOURce[1|2]:FREQ:STAR and SOURce[1|2]:FREQ:STOP to set the start and stop frequencies. To sweep up or down, set the stop frequency higher or lower than the start frequency.

   Span

   Use the SOURce[1|2]:FREQ:CENT and SOURce[1|2]:FREQ:SPAN commands to set the center frequency and the frequency span. To sweep up or down, set the span as positive or negative.

4. Choose Linear or Logarithmic spacing using the SOURce[1|2]:SWE:SPAC command.

Select Sweep Time ↓

5. Choose the sweep time using the SOURce[1|2]:SWE:TIME command.

Select the sweep trigger source ↓

6. Select an internal or external sweep trigger source using the SOURce[1|2]:SOUR command.

SOURce[1|2]:SWEep:STATe

Source Specific Command

Description	Sets or disables Sweep mode. By default Sweep is disabled. Sweep modulation must be enabled before setting other parameters.	
Note	Any modulation modes or Burst mode will be disabled if sweep mode is enabled.	
Syntax	**SOURce[1|2]:SWEep:STATe {OFF|ON}**	
Example	**SOUR1:SWE:STAT ON** Enables sweep mode.	
Query Syntax	**SOURce[1|2]:SWEep:STATe?**	
Return Parameter	OFF	Disabled (OFF)
	ON	Enabled (ON)
Example	**SOUR1:SWE:STAT?** **ON** Sweep mode is currently enabled.	

SOURce[1|2]:FREQuency:STARt

Source Specific Command

Description	Sets the start frequency of the sweep. 100Hz is the default start frequency.
Note	To sweep up or down, set the stop frequency higher or lower than the start frequency.

Syntax	**SOURce[1|2]:FREQuency:STARt {<frequency>|MINimum|MAXimum}**	
Parameter	<frequency>	1uHz to Max Frequency
Example	**SOUR1:FREQ:STAR +2.0000E+03** Sets the start frequency to 2kHz.	
Query Syntax	**SOURce[1|2]:FREQuency:STARt? [MINimum|MAXimum]**	
Return Parameter	<NR3>	Returns the start frequency in Hz.
Example	**SOUR1:FREQ:STAR? MAX** +2.5000000000000e+07 Returns the maximum start frequency allowed.	

SOURce[1|2]:FREQuency:STOP

Source Specific Command

Description	Sets the stop frequency of the sweep. 1 kHz is the default start frequency.	
Note	To sweep up or down, set the stop frequency higher or lower than the start frequency.	
Syntax	**SOURce[1|2]:FREQuency:STOP {<frequency>|MINimum|MAXimum}**	
Parameter	<frequency>	1uHz to Max Frequency
Example	**SOUR1:FREQ:STOP +2.0000E+03** Sets the stop frequency to 2kHz.	
Query Syntax	**SOURce[1|2]:FREQuency:STOP? [MINimum|MAXimum]**	
Return Parameter	<NR3>	Returns the stop frequency in Hz.
Example	**SOUR1:FREQ:STOP? MAX** +2.5000000000000E+07 Returns the maximum stop frequency allowed.	

SOURce[1|2]:FREQuency:CENTer

Source Specific Command

Description	Sets and queries the center frequency of the sweep. 550 Hz is the default center frequency.	
Note	The maximum center frequency depends on the sweep span and maximum frequency: max center freq = max freq – span/2	
Syntax	**SOURce[1|2]:FREQuency:CENTer {<frequency>|MINimum|MAXimum}**	
Parameter	<frequency>	1uHz to Max Frequency
Example	**SOUR1:FREQ:CENT +2.0000E+03** Sets the center frequency to 2kHz.	
Query Syntax	**SOURce[1|2]:FREQuency:CENTer? [MINimum|MAXimum]**	
Return Parameter	<NR3>	Returns the stop frequency in Hz.
Example	**SOUR1:FREQ:CENT? MAX** +2.5000000000000E+07 Returns the maximum center frequency allowed, depending on the span.	

SOURce[1|2]:FREQuency:SPAN

Source Specific Command

Description	Sets and queries the frequency span of the sweep. 900 Hz is the default frequency span. The span frequency is equal to the stop-start frequencies.
Note	To sweep up or down, set the span as positive or negative. The maximum span frequency has a relationship to the center frequency and maximum frequency: max freq span= 2(max freq – center freq)

Syntax	**SOURce[1|2]:FREQuency:SPAN {<frequency>|MINimum|MAXimum}**	
Parameter	<frequency>	1uHz to Max Frequency
Example	**SOUR1:FREQ:SPAN +2.0000E+03** Sets the frequency span to 2kHz.	
Query Syntax	**SOURce[1|2]:FREQuency:SPAN? [MINimum|MAXimum]**	
Return Parameter	<NR3>	Returns the frequency span in Hz.
Example	**SOUR1:FREQ:SPAN?** +2.0000000000000e+03 Returns the frequency span for the current sweep.	

SOURce[1|2]:SWEep:SPACing

Source Specific Command

Description	Sets linear or logarithmic sweep spacing. The default spacing is linear.	
Syntax	**SOURce[1|2]:SWEep:SPACing {LINear|LOGarithmic}**	
Example	**SOUR1:SWE:SPAC LIN** Sets the spacing to linear.	
Query Syntax	**SOURce[1|2]:SWEep:SPACing?**	
Return Parameter	LINear LOGarithmic	Linear spacing Logarithmic spacing
Example	**SOUR1:SWE:SPAC?** **LINear** The spacing is currently set as linear.	

SOURce[1|2]:SWEep:TIME

Source Specific Command

Description	Sets or queries the sweep time. The default sweep time is 1 second.

Note	The function generator automatically determines the number of frequency points that are used for the sweep based on the sweep time.	
Syntax	**SOURce[1|2]:SWEep:TIME {<seconds>|MINimum|MAXimum}**	
Parameter	<seconds>	1 ms ~ 500 s
Example	**SOUR1:SWE:TIME +1.0000E+00** Sets the sweep time to 1 second.	
Query Syntax	**SOURce[1|2]:SWEep:TIME? {<seconds>|MINimum|MAXimum}**	
Return Parameter	<NR3>	Returns sweep time in seconds.
Example	**SOUR1:SWE:TIME?** +1.00000e+00 Returns the sweep time (1 seconds).	

SOURce[1|2]:SWEep:SOURce

Source Specific Command

Description	Sets or queries the trigger source as immediate (internal), external or manual. Immediate (internal) is the default trigger source. IMMediate will constantly output a swept waveform. EXTernal will output a swept waveform after each external trigger pulse. Manual will ouput a swept waveform after the trigger softkey is pressed.

Note	If the APPLy command was used to create the waveform shape, the source is automatically set to IMMediate. The *OPC/*OPC? command/query can be used to signal the end of the sweep. If the trigger source is set to manual, the function generator starts sweeping each time a trigger command is received. To trigger the function generate from remote interface, it is necessary to send a * TRG trigger command.	
Syntax	**SOURce[1|2]: SWEep:SOURce {IMMediate|EXTernal|MANual}**	
Example	**SOUR1:SWE:SOUR IMM** Sets the sweep source to internal.	
Query Syntax	**SOURce[1|2]: SWEep:SOURce?**	
Return Parameter	IMMediate	Immediate
	EXTernal	External
	MANual	Manual
Example	**SOUR1:SWE:SOUR?** **IMMediate** The sweep source is set to internal.	

Burst Mode Commands

Burst Mode Overview

Burst mode can be configured to use an internal trigger (N Cycle mode) or an external trigger (Gate mode) using the Trigger INPUT terminal on the rear panel. Using N Cycle mode, each time the function generator receives a trigger, the function generator will output a specified number of waveform cycles (burst). After the burst, the function generator will wait for the next trigger before outputting another burst. N Cycle is the default Burst mode.

The alternative to using a specified number of cycles, Gate mode uses the external trigger to turn on or off the output. When the Trigger INPUT signal is high*, waveforms are continuously output (creating a burst). When the Trigger INPUT signal goes low*, the waveforms will stop being output after the last waveform completes its period. The voltage level of the output will remain equal to the starting phase of the burst waveforms, ready for the signal to go high* again.

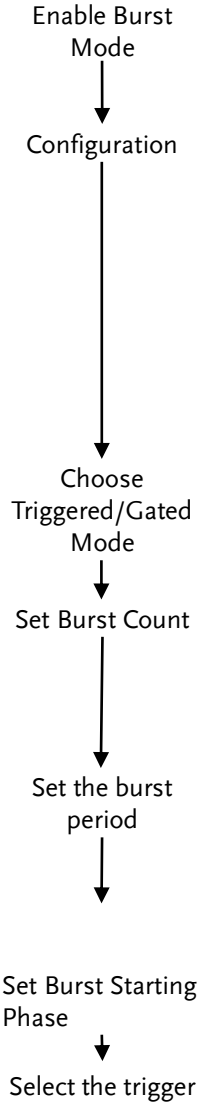
*assuming the Trigger polarity is not inverted.

Only one burst mode can be used at any one time. The burst mode depends on the source of the trigger (internal, external, manual) and the source of the burst.

	Function		
Burst Mode & Source	N Cycle*	Cycle	Phase
Triggered – IMMediate, BUS	Available	Available	Available
Triggered - EXTernal, MANual	Available	Unused	Available
Gated pulse - IMMediate	Unused	Unused	Available

*burst count

The following is an overview of the steps required to generate a burst waveform.



1. Turn on Burst mode using the SOURce[1|2]:BURS:STAT ON command.
2. Use the APPLy command to select a sine, square, ramp, pulse burst waveform*. Alternatively, the FUNC, FREQ, AMPl, and DCOffs commands can be used to create the burst waveform* with a designated frequency, amplitude and offset.
3. *2 mHz minimum for internally triggered bursts.
4. Use the SOURce[1|2]: BURS:MODE command to select from triggered or gated burst modes.
5. Use the SOURce[1|2]:BURS:NCYC command to set the burst count. This command is only for triggered burst mode only.
6. Use the SOURce[1|2]:BURS:INT:PER command to set the burst period/cycle. This command is only applicable for triggered burst mode (internal trigger).
7. Use the SOURce[1|2]:BURS:PHAS command to set the burst starting phase.
8. Use the SOURce[1|2]:BURS:TRIG:SOUR command to select the trigger source for triggered burst mode only.

SOURce[1|2]:BURSt:STATe

Source Specific Command

Description	Turns burst mode on or off. By default burst mode is turned off.	
Note	When burst mode is turned on, sweep and any modulation modes are disabled.	
Syntax	**SOURce[1|2]:BURSt:STATe {OFF|ON}**	
Example	**SOUR1:BURS:STAT ON** Turns burst mode on.	
Query Syntax	**SOURce[1|2]:BURSt:STATe?**	
Return Parameter	OFF	Disabled
	ON	Enabled
Example	**SOUR1:BURS:STAT?** **ON** Burst mode is off.	

SOURce[1|2]:BURSt:MODE

Source Specific Command

Description	Sets or queries the burst mode as gated or triggered. The default burst mode is triggered.	
Note	The burst count, period, trigger source and any manual trigger commands are ignored in gated burst mode.	
Syntax	**SOURce[1|2]:BURSt:MODE {TRIGgered|GATed}**	
Example	**SOUR1:BURS:MODE TRIG** Sets the burst mode to triggered.	
Query Syntax	**SOURce[1|2]:BURSt:MODE?**	
Return Parameter	TRIGgered	Triggered mode
	GATed	Gated mode

Example	**SOUR1:BURS:MODE?** **TRIGgered** The current burst mode is triggered.

SOURce[1|2]:BURSt:NCYCles

Source Specific Command

Description	Sets or queries the number of cycles (burst count) in triggered burst mode. The default number of cycles is 1. The burst count is ignored in gated mode.	
Note	If the trigger source is set to immediate, the product of the burst period and waveform frequency must be greater than the burst count: Burst Period X Waveform frequency > burst count If the burst count is too large, the burst period will automatically be increased and a "Settings conflict" error will be generated. Only sine and square waves are allowed infinite burst above BW/2.	
Syntax	**SOURce[1|2]:BURSt:NCYCles{< # cycles> |INFinity|MINimum |MAXimum}**	
Parameter	<# cycles>	1~1,000,000 cycles.
	INFinity	Sets the number to continuous.
	MINimum	Sets the number to minimum allowed.
	MAXimum	Sets the number to maximum allowed.
Example	**SOUR1:BURS:NCYC INF** Sets the number of burst cycles to continuous (infinite).	
Query Syntax	**SOURce[1|2]:BURSt:NCYCles? [MINimum|MAXimum]**	
Return Parameter	<NR3>	Returns the number of cycles.
	INF	INF is returned if the number of cycles is continuous.

Example	**SOUR1:BURS:NCYC?** +1.000000E+00 The burst cycles are set to 1.

SOURce[1|2]:BURSt:INTernal:PERiod

Source Specific Command

Description	Sets or queries the burst period. Burst period settings are only applicable when the trigger is set to immediate. The default burst period is 1 s. During manual triggering, external triggering or Gate burst mode, the burst period settings are ignored.	
Note	The burst period must be long enough to output the designated number of cycles for a selected frequency. Burst period > burst count/(waveform frequency + 200 ns) If the period is too short, it is automatically increased so that a burst can be continuously output. A "data out of range" error will also be generated.	
Syntax	**SOURce[1|2]:BURSt:INTernal:PERiod {<seconds>|MINimum|MAXimum}**	
Parameter	<seconds >	20 ns ~ 500 seconds
Example	**SOUR1:BURS:INT:PER +1.0000E+01** Sets the period to 10 seconds.	
Query Syntax	**SOURce[1|2]:BURSt:INTernal:PERiod? [MINimum|MAXimum]**	
Return Parameter	<NR3>	Returns the burst period in milliseconds.
Example	**SOUR1:BURS:INT:PER?** +1.00000000e+04 The burst period is 10 seconds.	

SOURce[1|2]:BURSt:TRIGger:SOURce

Source Specific Command

Description

Sets or queries the trigger source for triggered burst mode. In trigged burst mode, a waveform burst is output each time a trigger signal is received and the number of cycles is determined by the burst count.

There are three trigger sources for triggered burst mode:

Immediate	A burst is output at a set frequency determined by the burst period.
External	EXTernal will output a burst waveform after each external trigger pulse. Any additional trigger pulse signals before the end of the burst are ignored.
Manual	Manual triggering will output a burst waveform after the trigger softkey is pressed.

Note	If the APPLy command was used, the source is automatically set to IMMediate. The *OPC/*OPC? command/query can be used to signal the end of the burst. If the trigger source is set to manual, the function generator outputs a burst count waveform with the specified number of cycles each time the trigger signal * TRG is received. The function generator stops and waits for the next trigger after the specified number of cycles has been output. You can configure the function generator to use an internal trigger to start a burst or send a trigger signal from the rear panel port connector by pressing the front panel key and you can also send a trigger command * TRG through the remote interface to provide an external trigger source.
Syntax	**SOURce[1|2]:BURSt:TRIGger:SOURce {IMMediate|EXTernal|MANual}**
Example	**SOUR1:BURS:TRIG:SOUR IMM** Sets the burst trigger source to internal.
Query Syntax	**SOURce[1|2]:BURSt:TRIGger:SOURce?**

Return Parameter		
	IMMediate	Immediate
	EXTernal	External
	MANual	Manual

Example	**SOUR1:BURS:TRIG:SOUR?** **IMMediate** The burst trigger source is set to immediate.

SOURce[1|2]:BURSt:GATE:POLarity

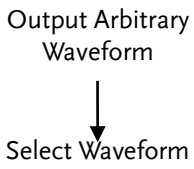
Source Specific Command

Description	In gated mode, the function generator will output a waveform continuously while the external trigger receives logically true signal from the Trigger INPUT terminal. Normally a signal is logically true when it is high. The logical level can be inverted so that a low signal is considered true.	
Syntax	**SOURce[1|2]:BURSt:GATE:POLarity {NORMal|INVertes}**	
Parameter	NORMal	Logically high
	INVertes	Logically low
Example	**SOUR1:BURS:GATE:POL INV** Sets the state to logically low (inverted).	
Query Syntax	**SOURce[1|2]:BURSt:GATE:POLarity?**	
Return Parameter	NORMal	Normal(High) logical level
	INVerted	Inverted (low) logical level
Example	**SOUR1:BURS:GATE:POL?** **INVerted** The true state is inverted(logically low).	

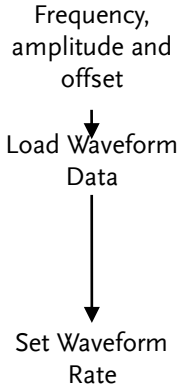
Arbitrary Waveform Commands

Arbitrary Waveform Overview

Use the steps below to output an arbitrary waveform over the remote interface.



1. Use the SOURce[1|2]:FUNCtion USER command to output the arbitrary waveform currently selected in memory.



2. Use the APPLy command to select frequency, amplitude and DC offset. Alternatively, the FUNC, FREQ, AMPl, and DCOffs commands can be used.

3. Waveform data (1 to 10240000 points per waveform) can be downloaded into volatile memory using the DATA:DAC command. Binary integer or decimal integer values in the range of ± 32767 can be used.

4. The waveform rate is the product of the number of points in the waveform and the waveform frequency.

Rate = Hz × # points

Range:	Rate:	1μHz ~ 62.5MHz
	Frequency:	1μHz ~ 30MHz (15MHz AFG-4125E/4125AE/4225E)
	# points:	1~10240000 (16384 AFG-4125E/4125AE/4225E)

SOURce[1|2]:FUNCtion USER

Source Specific Command

Description	Use the SOURce[1|2]:FUNCtion USER command to output the arbitrary waveform currently selected in memory. The waveform is output with the current frequency, amplitude and offset settings.
Syntax	**SOURce[1|2]:FUNCtion USER**
Example	**SOUR1:FUNC USER** Selects and outputs the current waveform in memory.

SOURce[1|2]:DATA:DAC

Source Specific Command

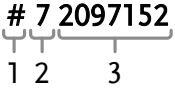
Description

The DATA:DAC command is used to download binary or decimal integer values into memory using the IEEE-488.2 binary block format or as an ordered list of values.

Note

The integer values (±32767) correspond to the maximum and minimum peak amplitudes of the waveform. For instance, for a waveform with an amplitude of 5Vpp (0 offset), the value 32767 is the equivalent of 2.5 Volts. If the integer values do not span the full output range, the peak amplitude will be limited.

The IEEE-488.2 binary block format is comprised of three parts:



1. Initialization character (#)
2. Digit length (in ASCII) of the number of bytes
3. Number of bytes

IEEE 488.2 uses two bytes to represent waveform data (16 bit integer). Therefore the number of bytes is always twice the number of data points.

Syntax

DATA:DAC VOLATILE, <start>,{<binary block>|<value>, <value>, . . . }

Parameter

<start>	Start address of the arbitrary waveform
<binary block>	Decimal or integer values ±32767 (±8191 AFG-4125E/4125AE/4225E)
<value>	

Example

DATA:DATA VOLATILE, #216 Binary Data

The command above downloads 5 data values (stored in 14 bytes) using the binary block format.

DATA:DAC VOLATILE,1000,511,1024,0,-1024,-511

Downloads the data values (511, 1024, 0, -1024, -511)to address 1000.

SOURce[1|2]:ARB:EDIT:COPY

Source Specific Command

Description	Copies a segment of a waveform to a specific starting address.	
Syntax	**SOURce[1|2]:ARB:EDIT:COPY [<start>[,<length>[,<paste>]]]**	
Parameter	<start>	Start address: 0~10240000 (16384 AFG-4125E/4125AE/4225E)
	<length>	0 ~ 10240000 (16384 AFG-4125E/4125AE/4225E)
	<paste>	Paste address: 0~10240000 (16384 AFG-4125E/4125AE/4225E)
Example	**SOUR1:ARB:EDIT:COPY 1000, 256, 1257** Copies 256 data values starting at address 1000 and copies them to address 1257.	

SOURce[1|2]:ARB:EDIT:DELete

Source Specific Command

Description	Deletes a segment of a waveform from memory. The segment is defined by a starting address and length.
Note	A waveform/waveform segment cannot be deleted when output.

Syntax	**SOURce[1|2]:ARB:EDIT:DELete [<STARt>[,<LENGth>]]**	
Parameter	<STARt>	Start address: 0~10240000(16384 AFG-4125E/4125AE/4225E)
	<LENGth>	0 ~ 10240000(16384 AFG-4125E/4125AE/4225E)
Example	**SOURce1:ARB:EDIT:DEL 1000, 256**	
	Deletes a section of 256 data points from the waveform starting at address 1000.	

SOURce[1|2]:ARB:EDIT:DELete:ALL

Source Specific Command

Description	Deletes all user-defined waveforms from non-volatile memory and the current waveform in volatile memory.
Note	A waveform cannot be deleted when output.
Syntax	**SOURce[1|2]:ARB:EDIT:DELete:ALL**
Example	**SOUR1:ARB:EDIT:DEL:ALL**
	Deletes all user waveforms from memory.

SOURce[1|2]:ARB:EDIT:POINt

Source Specific Command

Description	Edit a point on the arbitrary waveform.	
Note	A waveform/waveform segment cannot be deleted when output.	
Syntax	**SOURce[1|2]:ARB:EDIT:POINt [<address> [, <data>]]**	
Parameter	<address>	Address of data point: 0~10240000(16384 AFG-4125E/4125AE/4225E)
	<data>	Value data: ± 32767 (±8191 AFG-4125E/4125AE/4225E)
Example	**SOUR1:ARB:EDIT:POIN 1000, 511**	

Creates a point on the arbitrary waveform at address 1000 with the highest amplitude.

SOURce[1|2]:ARB:EDIT:LINE

Source Specific Command

Description	Edit a line on the arbitrary waveform. The line is created with a starting address and data point and a finishing address and data point.	
Note	A waveform/waveform segment cannot be deleted when output.	
Syntax	**SOURce[1|2]:ARB:EDIT:LINE [<address1>[,<data>[,<address2>[,<data2>]]]]**	
Parameter	<addrress1>	Address of data point1: 0~10240000(16384 AFG-4125E/4125AE/4225E)
	<data1>	Value data1: ±32767(±8191 AFG-4125E/4125AE/4225E)
	<address2>	Address of data point2: 0~10240000(16384 AFG-4125E/4125AE/4225E)
	<data2>	Value data2: ± 32767(±8191 AFG-4125E/4125AE/4225E)
Example	**SOUR1:ARB:EDIT:LINE 40, 50, 100, 50** Creates a line on the arbitrary waveform at 40,50 to 100,50.	

SOURce[1|2]:ARB:EDIT:PROTect

Source Specific Command

Description	Protects a segment of the arbitrary waveform from deletion or editing.
Syntax	**SOURce[1|2]:ARB:EDIT:PROTect [<STARt>[,<LENGth>]**

Parameter	<STARt>	Start address: 0~10240000(16384 AFG-4125E/4125AE/4225E)
	<LENGth>	0 ~ 10240000(16384 AFG-4125E/4125AE/4225E)
Example	**SOUR1:ARB:EDIT:PROT 40, 50** Protects a segment of the waveform from address 40 for 50 data points.	

SOURce[1|2]:ARB:EDIT:PROTect:ALL

Source Specific Command

Description	Protects the arbitrary waveform currently in non-volatile memory/currently being output.
Syntax	**SOURce[1|2]:ARB:EDIT:PROTect:ALL**
Example	**SOUR1:ARB:EDIT:PROT:ALL**

SOURce[1|2]:ARB:EDIT:UNProtect

Source Specific Command

Description	Uprotects the arbitrary waveform currently in non-volatile memory/currently being output.
Syntax	**SOURce[1|2]:ARB:EDIT:UNProtect**
Example	**SOUR1:ARB:EDIT:UNP**

SOURce[1|2]:ARB:OUTPut

Source Specific Command

Description	Output the current arbitrary waveform in volatile memory. A specified start and length can also be designated.	
Syntax	**SOURce[1|2]:ARB:OUTPut [<STARt>[,<LENGth>]]**	
Parameter	<STARt>	Start address*: 0~10240000(16384 AFG-4125E/4125AE/4225E)

	<LENGth>	Length*: 0 ~ 10240000(16384 AFG-4125E/4125AE/4225E)

* Start + Length ≤ currently output arbitrary waveform

Example **SOUR1:ARB:OUTP 20,200**

Outputs the current arbitrary waveform in memory.

COUNTER

The frequency counter function can be turned on remotely to control the frequency counter.

COUNTER:STATE

Instrument Command

Description	Turns the frequency counter function on or off.	
Syntax	**COUNter:STATe {ON|OFF}**	
Parameter/ Return Parameter	ON	ON
	OFF	OFF
Example	**COUNter:STATe**	
	ON	
	Turns the frequency counter on	
Query Syntax	**COUNter:STATe?**	
Example	**COUNter:STATe?**	
	ON	
	Turns on the frequency counter.	

COUNter:COUPling

Instrument Command

Description	Sets the coupling mode of the input signal to AC or DC. Queries the coupling mode of the input signal.	
Syntax	**COUNter:COUPling {AC|DC}**	
Parameter /Return Parameter	DC	
	AC	
Example	**COUN:COUP DC**	
	Sets the coupling mode of the input signal to DC.	
Syntax	**COUNter:COUPling?**	

Example	**COUN:COUP?** DC Queries the coupling mode of the input signal and the query returns DC.

COUNter:HFR

Instrument Command

Description	Enable or disable the high-frequency reject of the counter. The query returns the state of high-frequency reject of the counter.	
Syntax	**COUNter:HFR {ON|OFF}**	
Parameter /Return Parameter	OFF	OFF
	ON	ON
Example	**COUNter:HFR ON** Enables the high frequency rejection function of the frequency counter.	
Syntax	**COUNter:HFR?**	
Example	**COUNter:HFR?** ON Queries the on/off status of the high frequency rejection function of the frequency counter and the query returns ON.	

COUNter:SENSitivity

Instrument Command

Description	Sets the trigger sensitivity of the frequency counter. Queries the trigger sensitivity of the frequency counter.
Syntax	**COUNter:SENSitivity [LOW|MIDDle|HIGH]**

Parameter /Return Parameter	LOW	Low is selected for the trigger sensitivity of the counter.
	MIDDle	Middle is selected for the trigger sensitivity of the counter.
	HIGH	High is selected for the trigger sensitivity of the counter.

Example **COUN:SENS LOW**

Sets the trigger sensitivity of the frequency counter to LOW.

Syntax **COUNter:SENSitivity?**

Example **COUN:SENS?**

LOW

Queries the trigger sensitivity of the frequency counter and the query returns LOW.

COUNter:TRIGger

Instrument Command

Description Sets or queries the trigger level of the counter.

Syntax **COUNter:TRIGger {<value>|MINimum|MAXimum}]**

Parameter /Return Parameter	<NR3>	The trigger level of the counter.
	<unit>	[mV|V]

Example **COUNter:TRIGger 500mV**

Sets the trigger level of the counter to 500 mV:

Syntax **COUNter:TRIGger?**

Example **COUNter:TRIGger? {MINimum|MAXimum}**

1.500000e+00

Queries the trigger level of the frequency counter and the query returns 1.500000E+00.

COUNter:DUTYcycle?

Instrument Command

Description	This query-only command returns the measurement results for duty cycle of the counter.
Syntax	**COUNter:DUTYcycle?**
Example	**COUNter:DUTYcycle?** +5.00e+01 Returns the Dutycycle as 50%.

COUNter:FREQ?

Instrument Command

Description	This query-only command returns the measurement results for frequency of the counter.
Syntax	**COUNter:FREQ?**
Example	**COUNter:FREQ?** +2.00e+03 Returns the Frequency as 2KHz.

COUNter:PERiod?

Instrument Command

Description	This query-only command returns the measurement results for period of the counter.
Syntax	**COUNter:PERiod?**
Example	**COUNter:PER?** +2.00E-07 Returns the Period as 200nS.

COUNter:PULSewidth?

Instrument Command

Description	This query-only command returns the measurement results for pulse width of the counter.
Syntax	**COUNter:PULSewidth?**
Example	**COUNter:PULS?** +1.04E-07 Returns the Pulse Width as 104nS.

COUPLE

The Couple commands can be used to remotely set the frequency coupling and amplitude coupling.

SOURce[1|2]:FREQuency:COUPle	Instrument Command

Description	Enables or disables the frequency coupling.	
Syntax	**SOURce[1|2]:FREQuency:COUPle {ON|Off}**	
Return/ Return parameter	1	ON
	0	Off
Example	**SOURce1:FREQuency:COUPle ON** Turns amplitude coupling on.	
Query Syntax	**SOURce[1|2]:FREQuency:COUPle?**	
Example	**SOURce1:FREQuency:COUPle?** 1 Frequency coupling has been enabled.	

SOURce[1|2]:AMPlitude:COUPle	Instrument Command

Description	Enables or disables the amplitude coupling.	
Syntax	**SOURce[1|2]:AMPlitude:COUPle {ON|Off}**	
Example	**SOURce1:AMPlitude:COUPle on** Turns amplitude coupling on.	
Query Syntax	**SOURce[1|2]:AMPlitude:COUPle?**	
Return Parameter	1	ON
	0	Off
Example	**SOURce1:AMPlitude:COUPle?** 1	

Amplitude coupling has been enabled.

SOURce[1|2]:TRACk:STATe

Instrument Command

Description	Turns tracking on or off.	
Syntax	**SOURce[1|2]:TRACk:STATe {ON|OFF|INVerted}**	
Parameter/ Return Parameter	ON	ON
	OFF	OFF
	INVerted	INVerted
Example	**SOURce1:TRACk:STATe ON** Turns tracking on. Channel 2 will "track" the changes of channel 1.	
Query Syntax	**SOURce[1|2]:TRACk:STATe?**	
Example	**SOURce1:TRACk:STATe?** ON Channel tracking is turned on.	

Save and Recall Commands

Up to 16 different instrument states can be stored to non-volatile memory (memory locations 0~15).

*SAV	Instrument Command
Description	Saves the current instrument state to a specified save slot. When a state is saved, all the current instrument settings, functions and waveforms are also saved.
Note	The *SAV command doesn't save waveforms in non-volatile memory, only the instrument state. The *RST command will not delete saved instrument states from memory.
Syntax	***SAV {0|1|2|3|4|5|6|7|8|9|10|11|12|13|14|15}**
Example	***SAV 0** Save the instrument state to memory location 0.

*RCL	Instrument Command
Description	Recall previously saved instrument states from memory locations 0~16.
Syntax	***RCL {0|1|2|3|4|5|6|7|8|9|10|11|12|13|14|15}**
Example	***RCL 0** Recall instrument state from memory location 0.

Error Messages

The AFG-4000 has a number of specific error codes. Use the SYSTem:ERRor command to recall the error codes. For more information regarding the error queue.

Command Error Codes

-101 Invalid character

An invalid character was used in the command string. Example: #, $, %.

SOURce1:AM:DEPTh MIN%

-102 Syntax error

Invalid syntax was used in the command string. Example: An unexpected character may have been encountered, like an unexpected space.

SOURce1:APPL:SQUare , 1

-103 Invalid separator

An invalid separator was used in the command string. Example: a space, comma or colon was incorrectly used.

APPL:SIN 1 1000 OR SOURce1:APPL:SQUare

-108 Parameter not allowed

The command received more parameters than were expected. Example: An extra (not needed) parameter was added to a command

SOURce1:APPL? 10

-109 Missing parameter

The command received less parameters than expected. Example: A required parameter was omitted.

SOURce1:APPL:SQUare

-113 Undefined header

An undefined header was encountered. The header is syntactically correct. Example: the header contains a character mistake.

SOUR1:AMM:DEPT MIN

-131 Invalid suffix

An invalid suffix was used. Example: An unknown or incorrect suffix may have been used with a parameter.

SOURce1:SWEep:TIME 0.5 SECS

-138 Suffix not allowed

A suffix was used where none were expected. Example: Using a suffix when not allowed.

SOURce1:BURSt: NCYCles 12 CYC

-158 String data not allowed

An unexpected character string was used where none were expected. Example: A character string is used instead of a valid parameter.

SOURce1:SWEep:SPACing 'TEN'

-170~178 expression errors

Example: The mathematical expression used was not valid.

Query Errors

-410 Query INTERRUPTED

Indicates that a command was received but the data in the output buffer from a previous command was lost.

-420 Query UNTERMINATED

The function generator is ready to return data, however there was no data in the output buffer. For example: Using the APPLy command.

-430 Query DEADLOCKED

Indicates that a command generates more data than the output buffer can receive and the input buffer is full. The command will finish execution, though all the data won't be kept.

Arbitrary Waveform Errors

-770 Nonvolatile arb waveform memory corruption detected

Indicates that a fault (check sum error) has occurred with the non-volatile memory that stores the arbitrary waveform data.

-781 Not enough memory to store new arb waveform; bad sectors

Indicates that a fault (bad sectors) has occurred with the non-volatile memory that stores the arbitrary waveform data. Resulting in not enough memory to store arbitrary data.

-787 Not able to delete the currently selected active arb waveform

Example: The currently selected waveform is being output and cannot be deleted.

800 Block length must be even	
	Example: As block data (DATA:DAC VOLATILE) uses two bytes to store each data point, there must be an even number or bytes for a data block.

SCPI Status Register

The status registers are used to record and determine the status of the function generator.

The function generator has a number of register groups:

Questionable Status Registers

Standard Event Status Registers

Status Byte Register

As well as the output and error queues.

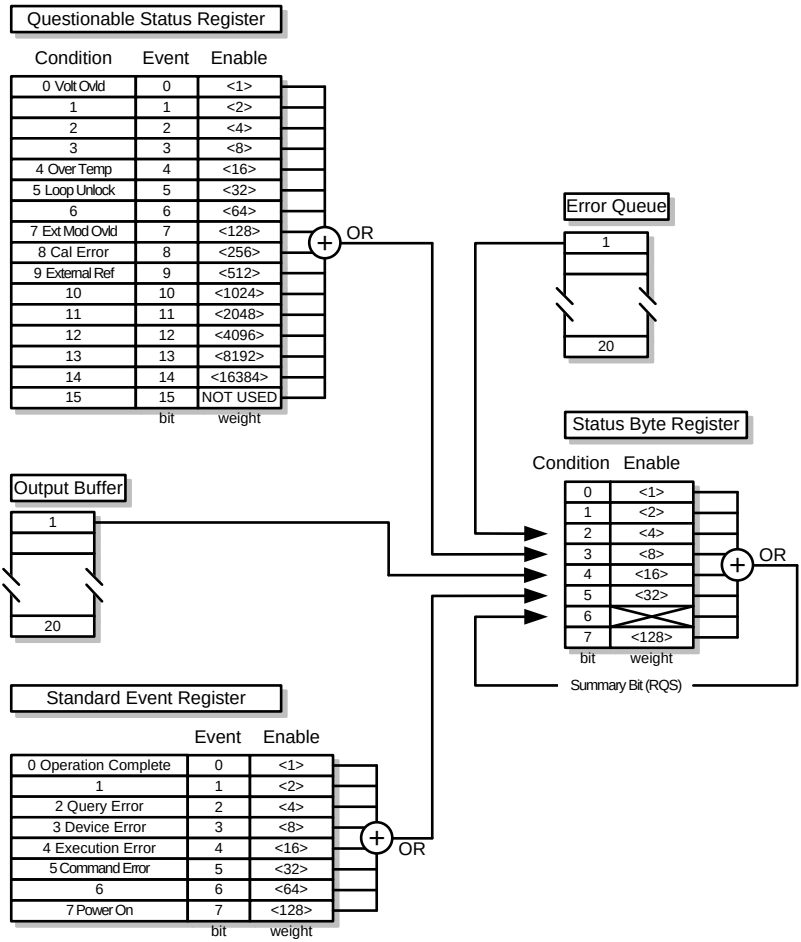
Each register group is divided into three types of registers: condition registers, event registers and enable registers.

Register types

Condition Register	The condition registers indicate the state of the function generator in real time. The condition registers are not triggered. I.e., the bits in the condition register change in real time with the instrument status. Reading a condition register will not clear it. The condition registers cannot be cleared or set.
Event Register	The Event Registers indicate if an event has been triggered in the condition registers. The event registers are latched and will remain set unless the *CLS command is used. Reading an event register will not clear it.

Enable Register	The Enable register determines which status event(s) are enabled. Any status events that are not enabled are ignored. Enabled events are used to summarize the status of that register group.

AFG-4000 Status System



Questionable Status Register

Description	The Questionable Status Registers will show if any faults or errors have occurred.

Bit Summary

Register	Bit	Bit Weight
Voltage overload	0	1
Over temperature	4	16
Loop unlock	5	32
Ext Mod Overload	7	128
Cal Error	8	256
External Reference	9	512

Standard Event Status Registers

Description	The Standard Event Status Registers indicate when the *OPC command has been executed or whether any programming errors have occurred.
Notes	The Standard Event Status Enable register is cleared when the *ESE 0 command is used. The Standard Event Status Event register is cleared when the *CLS command or the *ESR? command is used.

Bit Summary	Register	Bit	Bit Weight
	Operation complete bit	0	1
	Query Error	2	4
	Device Error	3	8
	Execution Error	4	16
	Command Error	5	32
	Power On	7	128

Error Bits		
	Operation complete	The operation complete bit is set when all selected pending operations are complete. This bit is set in response to the *OPC command.
	Query Error	The Query Error bit is set when there is an error reading the Output Queue. This can be caused by trying to read the Output Queue when there is no data present.
	Device Error	The Device Dependent Error indicates a failure of the self-test, calibration, memory or other device dependent error.
	Execution Error	The Execution bit indicates an execution error has occurred.
	Command Error	The Command Error bit is set when a syntax error has occurred.
	Power On	Power has been reset.

The Status Byte Register

Description

The Status Byte register consolidates the status events of all the status registers. The Status Byte register can be read with the *STB? query or a serial poll and can be cleared with the *CLS command.

Clearing the events in any of the status registers will clear the corresponding bit in the Status Byte register.

Notes

The Status byte enable register is cleared when the *SRE 0 command is used.

The Status Byte Condition register is cleared when the *CLS command is used.

Bit Summary

Register	Bit	Bit Weight
Error Queue	2	4
Questionable Data	3	8
Message Available	4	16
Standard Event	5	32
Master Summary / Request Service	6	64

Status Bits

Error Queue	There are error message(s) waiting in the error queue.
Questionable data	The Questionable bit is set when an “enabled” questionable event has occurred.
Message Available	The Message Available bit is set when there is outstanding data in the Output Queue. Reading all messages in the output queue will clear the message available bit.

	Standard Event	The Event Status bit is set if an "enabled" event in the Standard Event Status Event Register has occurred.
	Master Summary/ Service Request bit	The Master Summary Status is used with the *STB? query. When the *STB? query is read the MSS bit is not cleared. The Request Service bit is cleared when it is polled during a serial poll.

Output Queue

Description	The Output queue stores output messages in a FIFO buffer until read. If the Output Queue has data, the MAV bit in the Status Byte Register is set.

Error Queue

Description	The error queue is queried using the SYSTem:ERRor? command. The Error queue will set the "Error Queue" bit in the status byte register if there are any error messages in the error queue. If the error queue is full the last message will generate a "Queue overflow" error and additional errors will not be stored. If the error queue is empty, "No error" will be returned. Error messages are stored in the error queue in a first-in-first-out order. The errors messages are character strings that can contain up to 255 characters.

EC Declaration of Conformity

We

GOOD WILL INSTRUMENT CO., LTD.

declare that the CE marking mentioned product

satisfies all the technical relations application to the product within the scope of council:

Directive: EMC; LVD; WEEE; RoHS

The product is in conformity with the following standards or other normative documents:

◎ **EMC**	
EN 61326-1	Electrical equipment for measurement, control and laboratory use -- EMC requirements
Conducted & Radiated Emission EN 55011 / EN 55032	Electrical Fast Transients EN 61000-4-4
Current Harmonics EN 61000-3-2 / EN 61000-3-12	Surge Immunity EN 61000-4-5
Voltage Fluctuations EN 61000-3-3 / EN 61000-3-11	Conducted Susceptibility EN 61000-4-6
Electrostatic Discharge EN 61000-4-2	Power Frequency Magnetic Field EN 61000-4-8
Radiated Immunity EN 61000-4-3	Voltage Dip/ Interruption EN 61000-4-11 / EN 61000-4-34
◎ Safety	
EN 61010-1 :	Safety requirements for electrical equipment for measurement, control, and laboratory use - Part 1: General requirements

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INDEX

AM commands.....77, 82
Apply commands.....55
ARB commands.....141
ARB error messages.....159
Burst commands 134
Caution symbol.....5
Cleaning the instrument.....7
Command error codes 157
Command list.....38
Coupling commands.....154
Declaration of conformity.....167
Display
  diagram.....25
Disposal instructions 8
EN61010
  measurement category 6
  pollution degree.....8
Environment
  safety instruction 7
Error messages 157
FM commands.....90
Frequency counter commands149
Front panel diagram 17
FSK commands 95, 98, 100
Function keys
  key overview 18
Fuse replacement 157
  safety instruction 7
Ground
  symbol 5
List of features.....15
Operation keys
  key overview.....18
Output commands 61
Overview
  Display Overview 24
PM commands 103
Power on/off
  safety instruction.....6
Pulse configuration commands70, 74
Query Errors.....159
Remote control 28
  interface configuration.....29
Remote interface
  Error messages 157
  SCPI registers.....160
  Syntax 33
Save and Recall commands 156
SCPI registers 160
Service operation
  about disassembly 6
Status register commands.....45
SUM commands.....119
Sweep commands 127
System commands 43
UK power cord.....9
Warning symbol.....5