Programmer Guide

Synthesized Signal Generator

Content

Chapter 1 Summary

Computer applications is now quite popular, and traditional T&M instruments have been gradually replaced by digital ones, and continuous manual measurements are upgrading the grounds of the computer-controlled automatic test system, which is the inevitable trend of development in the field of electronic measuring. For middle-to-high-end measuring instruments, at home and abroad, almost all of them are equipped with programmable interface. Regardless of any type, any model of instrument, as long as with this interface, you can connect them with computer using a cable to form an automatic test system. During measuring process, each instrument in the system exchange and transfer data through interface and cable. According to pre-programmed test procedures, computer control instruments to work coordinately. For example, firstly command signal generator to provide an appropriate signal to the measured object, and then command the frequency meter, voltage meter to measure the frequency and voltage, and then computer to do data processing, and which finally sent to the printer to print test report. So the complex testing tasks are all done automatically by the test system, as long as you program the test program then you can get the test results. Not only saves manpower, improve efficiency, and test results are accurate and reliable, reducing manual errors and mistakes, or even complete some measurement which could not be done by manual.

The programmable commands are written referring to SCPI standards. The instrument comes with RS232 interface and USB Device interface, IEEE488 programmable interface is optional. The programmable commands are expressed by ASCII character, and the data returned by the instrument to the computer are all expressed by the ASCII characters.

Chapter 2 Programmable Interface

This chapter will introduce how to use the programmable interface and data format of download and upload in detail.

2.1 RS232 interface

The RS232 interface of this instrument complies with the provisions of the EIA-RS232 standard. This is an asynchronous serial communication interface with the features of distant transmission, less transmission line and simple interface. All micro-computers are equipped with this interface, and it's no necessary to configure the additional interface card. It applies to common test system of university, mining enterprises and other.

The rear panel of instrument has a 9-wire interface socket, which plug RS232 interface cable into, and plug the other end of the cable into computer serial interface socket or transfer bus distributor outlet.

Interface setting: Baud rate：19200bit/s (default)

Start bits: 1 bit

Checking bits: None

Data bits: 8 bits

Stop bits: 1 bit

Flow control: None

Programmable address: 19 (default)

The baud rate is variable, and 7 types are optional, separately is 115200, 57600, 38400, 19200, 9600, 4800 and 2400. When the electromagnetic interference is less or RS232 interface cable is short, you should select higher baud rate, which can increase the transmission speed of the remote command; when the electromagnetic interference is more or RS232 interface cable is long, you should select lower baud rate to reduce the error rate in the transmission of remote command.

In automatic test system, each device must be set to one number, which is programmed address, exclusive in the automatic test system, the setting range from 01 to 31.

2.2 USB Device interface

The USB Device Programmable interfaces comply with USB V1.1 standard. This is a universal interface, and all micro-computers are equipped with this interface, and it's no necessary to

configure the additional interface card. It applies to common test system of university, mining enterprises and other.

Plug one end of supplied USB cable into the USB socket on PC, and the other end into the USB socket in rear panel of instrument. Turn on the generator. The computer will prompt “discovering the new hardware”. Install the USB driver according to the prompt of “new hardware installation wizard” one by one and set the search path as the folder “CH372DRV” to complete the installation of USB driver which applies to instruments. The driver just needs to be installed once and it will be used normally after that.

Identification code of USB programmable interface is set to 0. If the instrument using multiple USB interface is composed of automatic test systems, identification code should be changed, please contact us.

2.3 GPIB interface

GPIB is optional standard interface for the instrument, also named as IEEE-488 interface, which complies with the requirements of IEEE-488-1978 standard. This is a parallel asynchronous communication interface with features of fast transmission speed, high reliability and fully functional, but a GPIB interface card is needed to configure in the computer, and use a 24-core shielded cable. It applies to more complex automatic test system in the research and measurement testing departments.

The instrument rear panel has a 24-pin interface socket, plug GPIB cable into the interface socket, and the other end of the cable into the socket of the computer GPIB interface card, or transfer bus distributor outlet. Then the GPIB interface is available to use.

Programmable address of the GPIB system is 01 to 15, listening address and speaking address of each device is same.

2.4 Download data format

A programmed command string that computer download to instrument is called a data frame. There are 4 bytes is unique in the data frame of RS232 programmable interface, the first two bytes are frame header, which are fixed to ASCII encoding of 127 and 254. The last two bytes are the ASCII code of the programmed address. If programmed address is 19, the ASCII code is "1" and "9", header and address are used to identify beginning of programmed command string. Only to

receive the correct header and programmable address code, following programmed command will be received, otherwise, the instrument will not respond. If missing out the header and address code, the instrument will not receive any data. Other programmable interfaces don't have these four bytes. Then the followings are programmed command ASCII character strings, and finally are the terminator of frame end (ASCII code is 10). As the length of programmable command string is not fixed, the terminator is required at the end of the string. Only receive end character, the instrument will stop receiving. After receiving command character string, the instrument will check the correctness of the string, and instrument will execute continuously until meeting with end character, even when instrument executes next commands. If miss the end character, instrument may be out of work.

2.5 Upload data format

After receiving and executing the commands when connecting RS232 interface, the character string that instrument upload to computer is called data frame, which doesn't have frame header and address character, neither does end character. After receiving commands, firstly the instrument will check the validity of the string, then upload character string 'OK' (validity) or 'Error' (illegal). Only commands are validity, the instrument will execute. If receiving query commands, the instrument will post back a character string as requests. After finishing execute, the instrument will upload 'OK' (normal execute) or 'Data out of range' (the setting value beyond the limitation of the max. and min, the instrument will alarm)

The instrument will not upload data when connecting USB and GPIB interface. Only receiving query commands, it will return data.

2.6 Data length

Available length of programmed commands instrument process is 64 ASCII code, please pay attention to the commands length when programming.

2.7 Enter or exit program

The initialization of remote interface has been finished after powering on the instrument. The instrument will enter into remote state automatically and keyboard will be locked at the same time. Green prompt 'R' will show in display. Input commands '*LOC' to exit remote state and the keyboard will be unlocked and meantime green prompt 'R' will disappear.

Chapter 3 SCPI commands summary

This chapter will introduce the code rules of SCPI commands in detail.

3.1 SCPI command language

SCPI (Standard Commands for Programmable Instruments) is a standardized set of commands and based on ASCII code with hierarchical structure, through the remote interface to programmer control the instruments. Take the following for examples,

SOURce:
VOLTage
:HIGH {< Amplitude value >|MINimum|MAXimum}
:HIGH?
FSK
:SOURce {INTernal|EXTernal}
:SOURce?
AM
:DEPTh {<Depth percentage>|MINimum|MAXimum}
:DEPTh?
BURSt
:PHASe {<Phase>|MINimum|MAXimum}
:PHASe?

SOURce is the root keywords of above command, VOLTage, FSK, AM and BURSt are subnode keywords, but HIGH, SOURce, DEPTh and PHASe are endnode keywords. Using colon ":" to separate the keywords.

3.2 Command format

The SCPI adopt the following format:

VOLTage {< amplitude value >|MINimum|MAXimum}

According to command syntax, most of command and some parameter are expressed by mixture of uppercase and lowercase letters, and uppercase stands for the abbreviation of command. The command allows abbreviation command (short format), or full words command (full format). Full format commands will be suggested if you want to get better readable codes. VOLT and VOLTAGE in above commands are both acceptable. Just because uppercase and lowercase are allowed, VOLTAGE, volt and Volt are acceptable format, but VOL and VOLTAG will resulted in mistake, because they are not the abbreviation format and not a full word.

Brace { } contains the parameter options of command string, which will not be sent with command string.

Separating character|: separate several parameter options of the command string.

Angular bracket < > indicates this option is a parameter value. For example, the parameter in angular bracket of above mentioned commands is amplitude. The angular bracket isn't sent with command string and you must specify a value for this parameter.

Square bracket [ ]: parameters contains in this character is optional and could be omitted. The square bracket isn't sent with command string. If you don't specify a value for optional parameter, the instrument will select default value.

3.3 Command separator

Using colon ":" to separate the keywords, and separate command keyword and parameters with space, if the command contains many parameters, you can use comma "," to separate. As follows:

APPL:CHA:SIN 5 KHZ, 3.0 VPP, 0 Vdc

Use semicolon ";" to link several commands with same scale and under one subsystem, in this case the higher scale command could be omitted and the program becomes simpler. For example, **FREQ:STARt 10;STOP 1000** equals to the following two commands:

FREQ:STARt 10

FREQ:STOP 1000

Use a semicolon and a colon ";:" to link several commands under different subsystems, or it will results in mistakes taking the follow for example,

SWE:SPACE LIN ;:TRIG:SOUR EXT

3.4 MIN and MAX

Use 'MINimum' or 'MAXimum' to replace of parameters in command. For example, refer to following commands,

FREQuency：CHA {< Frequency>|MINimum|MAXimum}

You don't need to specify frequency, and use MIN parameter to set the minimum range of frequency or use MAX parameter to set the maximum range of frequency.

3.5 Enquiry parameter setting

Users can add interrogation “?” in the end of commands, so you can query the current value of most parameters. For example, set the amplitude output of following commands to be 2Vpp,

VOLT:CHA 2 Vpp

Send query **VOLT:CHA?** to return amplitude value.

3.6 Command end character

Each end of character string should be added an end character (shift character). The command string end always reset the SCPI commands path to root level.

3.7 Universal commands of IEEE-488.2

IEEE-488.2 standard defines a group of common commands, which can execute reset/self-checking, state operating and so on. Universal commands start with *, with length of three characters, and could have parameters. Take the following example,

***RST**

***RCL**

3.8 SCPI parameter type

SCPI language defines program message and response message by different data format.

Numeric value parameter: numeric value parameter is presented by decimal number, but don’t support scientific notation. You also can use two special values Minimum and Maximum to instead parameter value of command. If there is no unit in the end of value parameter, the present unit will be default. Take the following for example,

FREQuency {< Frequency>|MINimum|MAXimum}

Discrete parameter: it’s used to set finite number parameter value (for example, BUS, IMMediate and EXTernal), and be same as commands, you can use full or abbreviation format, or mixing uppercase and lowercase is also allowed. Query response will always return short format with uppercase. The following command use the discrete parameter,

SWEep:SPACing {LINear|LOGarithmic}

Boolean parameter: a Boolean parameter specifies a single binary condition which is either true or false. For “True”, the parameter value is “ON”, and for “False”, the parameter value is “OFF”. Take the following for example,

SYSTem:BEEPer:STATe {OFF|ON}

Chapter 4 Programmable commands

This chapter will introduce each piece of command in command set which synthesized signal generator support, including command format, function description and notice.

4.1 Subsystem command

The subsystem commands that instrument include are:

APPLy
FUNCtion
FREQuency
VOLTage
OUTPut
PULSe
AM
FM
FSK
PSK
SWEep
BURSt
TRIGger
SYSTem
DISPlay
MEMory
IEEE 488.2

4.2 APPLY command

APPLy:CHA:SINusoid [< Frequency > [,< Amplitude > [,< Offset >1]]]
APPLy:CHA:SQUare [< Frequency > [,<Amplitude> [,< Offset >1]]]
APPLy:CHA?

APPLy:CHB:SINusoid [< Frequency > [,<Amplitude> [,< Offset >]]]
APPLy:CHB:SQUare [< Frequency > [,<Amplitude> [,< Offset >]]]
APPLy:CHB:RAMP [< Frequency > [,<Amplitude> [,< Offset >]]]
APPLy:CHB:PULSe [< Frequency > [,<Amplitude> [,< Offset >]]]
APPLy:CHB:EXP [< Frequency > [,<Amplitude> [,< Offset >]]]
APPLy:CHB:SINC [< Frequency> [,<Amplitude> [,< Offset >]]]
APPLy:CHB:NOISe [< Frequency>2 [,<Amplitude> [,< Offset >]]]
APPLy:CHB:DC [< Frequency >2 [,<Amplitude>2 [,< Offset >]]]
APPLy:CHB?

[1] this parameter doesn't work for CHA and user can select not input.

[2] this parameter doesn't work for the command but a value must be specified.

APPLy commands provide direct way to program through programmable interface. User can select frequency, amplitude and offset in a command, shown as the following

APPLy:CHA:< Function > [< Frequency > [,< Amplitude > [,< Offset >]]]

For example, output a 1Vpp Sine on CHA via frequency 2kHz,

APPL:CHA:SIN 5 KHZ, 1.0 VPP

APPLy commands execute following operation:

- When setting CHA, make the modulation, sweep or burst mode of CHA disable and set the instrument to be continuous mode. When setting CHB, make the modulation, sweep or burst mode of CHA enable.
- Make output enabled.
- Set the duty cycle of Square and select automatically 50%.
- Set the symmetry of Ramp and select automatically 100%.

Output frequency

The output frequency range depends on the appointed function, you can select MINimum and MAXimum to replace the specific frequency value. MIN means the allowed minimum frequency of appointed function and MAX means the allowed maximum frequency of appointed function.

Function limitation

Frequency limitation depends on the appointed function of APPLy commands. For example, if output a 100MHz Sine at present, then use APPLy commands to modify the function to be Square, thus the instrument will adjust the output frequency to be 80MHz, and default warning of 'Data out of range' will pop up in remote interface.

Output amplitude

The output amplitude range depends on the appointed function and output terminal, MINimum and MAXimum can be used to replace the specific amplitude value.

Because optional parameter is used in APPLy commands (included in square bracket), only frequency is set well that amplitude can be used, and only frequency and amplitude are set that the offset can be used. When setting parameter, the allowed input unit is same as keyboard operation, or don't input unit and the instrument will process as following steps:

Frequency, modulated offset: Hz

Amplitude: Vpp

Offset, high level, low level: Vdc

Period, pulse width, time: s

Duty cycle, symmetry, modulated depth: %

Phase: °

NCYC: N

When inquiry the present parameter, the above mentioned unit are default unit of returned value.

Explanation of APPLy commands

APPLy:CHA:SINusoid [< Frequency > [,< Amplitude > [,< Offset >]]]

CHA outputs a Sine with assigned frequency and amplitude after executing commands. Offset parameter doesn't work for this command and is allowed not to input.

APPLy:CHA:SQUare [< Frequency > [,< Amplitude > [,< Offset >]]]

CHA outputs a Square with assigned frequency and amplitude after executing commands. Offset parameter doesn't work for this command and is allowed not to input.

APPLy:CHA?

Enquiry the present configuration of CHA, and return a character string with quotation marks. The purpose of this command is to attach inquiry response on APPL: command and put the synthesized signal generator in appointed state using inquiry result. As the following example shown, return the amplitude and offset of function, together with quotation marks. For the returned parameter, the frequency unit is Hz, amplitude unit is Vpp and offset unit is Vdc. There is no DC offset for CHA output function, so the returned offset parameter is always 0.

"CHA:SIN,+1.0000000000e+03,+1.0000e+00,+0.0000e+00"

APPLy:CHB:SINusoid [<Frequency > [,<Amplitude > [,<Offset >]]]

CHB outputs a Sine with specific frequency, amplitude and DC offset. The above command covers present symmetry setting and selects 100% automatically and output the waveform immediately after executing commands.

APPLy:CHB:SQUare [<Frequency > [,<Amplitude > [,<Offset >]]]

CHB outputs a Square with specific frequency, amplitude and DC offset. The commands covers present setting of duty cycle and select 50% automatically and output the waveform immediately after executing commands.

APPLy:CHB:RAMP [<Frequency > [,<Amplitude > [,<Offset >]]]

CHB outputs a Ramp with specific frequency, amplitude and DC offset. The above command covers present symmetry setting and selects 100% automatically and output the waveform immediately after executing commands.

APPLy:CHB:PULSe [<Frequency > [,<Amplitude > [,<Offset >]]]

CHB outputs a Pulse with specific frequency, amplitude and DC offset and output the waveform immediately after executing commands. In most applications, the repeat frequency of Pulse is specified by waveform period but not frequency. In some case, the APPLy commands will output a pulse as per appointed frequency. Therefore, FUNC:CHB:PULS:PER commands are suggested to use on setting repeat frequency of pulse.

APPLy:CHB:EXP [<Frequency > [,<Amplitude > [,<Offset >]]]

CHB output an exponential wave with specific frequency, amplitude and DC offset and output the waveform immediately after executing commands.

APPLy:CHB:SINC [<Frequency > [,<Amplitude > [,<Offset >]]]

CHB output a SINC wave with specific frequency, amplitude and DC offset and output the waveform immediately after executing commands.

APPLy:CHB:NOISe [<Frequency > [,<Amplitude > [,<Offset >]]]

CHB output a noise with specific amplitude and DC offset and output the waveform immediately after executing commands. Frequency parameters doesn't work for the command but a value must be appointed.

APPLy:CHB:DC [<Frequency > [,<Amplitude >> [,<Offset >]]]

CHB output DC with specific offset, and output DC immediately after executing commands. Frequency and amplitude don't work for the command but specific value must be appointed.

APPLy:CHB?

"CHB:SIN,+1.0000000000e+03,+1.0000e+00,+0.0000e+00"

The command will be used to enquiry CHB present configuration, and return a character string with quotation mark. The purpose of this command is to attach enquiry response on APPL: command and put the synthesized signal generator to appointed state with the enquiry result. As the following commands shown, amplitude and offset together with quotation mark will be returned. In returned parameter, the frequency unit is Hz, amplitude unit is VPP and offset unit is Vdc.

"CHB:SIN,+1.0000000000e+03,+1.0000e+00,+0.0000e+00"

4.3 Output configuration commands

FUNCtion:CHA {SINusoid|SQUare}
FUNCtion:CHA?

FUNCtion:CHB {SINusoid|SQUare|RAMP|PULSe|EXP|SINC|NOISe|DC}
FUNCtion:CHB?
FUNCtion:CHB:SQUare:DCYCle {< Percentage>|MINimum|MAXimum}
FUNCtion:CHB:SQUare:DCYCle?
FUNCtion:CHB:RAMP:SYMMetry {< Percentage>|MINimum|MAXimum}
FUNCtion:CHB:RAMP:SYMMetry?
FUNCtion:CHB:PULSe:PERiod {< Second>|MINimum|MAXimum}
FUNCtion:CHB:PULSe:PERiod?
FUNCtion:CHB:PULSe:WIDTh {< Second>|MINimum|MAXimum}
FUNCtion:CHB:PULSe:WIDTh?

FREQuency:CHA {< Frequency >|MINimum|MAXimum}
FREQuency:CHA?

FREQuency:CHB {< Frequency >|MINimum|MAXimum}
FREQuency:CHB?

VOLTage:CHA {< Amplitude >|MINimum|MAXimum}
VOLTage:CHA? [MINimum | MAXimum]

VOLTage:CHB {< Amplitude >|MINimum|MAXimum}
VOLTage:CHB?
VOLTage:CHB:OFFSet {< Offset >|MINimum|MAXimum}
VOLTage:CHB:OFFSet?
VOLTage:CHB:HIGH {< Voltage >|MINimum|MAXimum}
VOLTage:CHB:HIGH?
VOLTage:CHB:LOW {< Voltage >|MINimum|MAXimum}
VOLTage:CHB:LOW?

OUTPut:CHA {OFF|ON}

OUTPut:CHA?

OUTPut:CHA:LOAD {LOW|HIGH}

OUTPut:CHA:LOAD?

OUTPut:CHA:TTL {OFF|ON}

OUTPut:CHA:TTL?

OUTPut:CHB {OFF|ON}

OUTPut:CHB?

OUTPut:CHB:LOAD { LOW|HIGH}

OUTPut:CHB:LOAD?

Although APPLy command provide the direct way for programming, but low-level commands have more flexibility in changing several parameters.

The explanation of output configuration

FUNCtion:CHA {SINusoid|SQUare}

FUNCtion:CHA?

Select function of CHA output, and set it with selected frequency, amplitude and offset. Inquiry present function of CHA, character string format "CHA:WAVE:SIN" will be returned.

FUNCtion:CHB {SINusoid|SQUare|RAMP|PULSe|EXP|SINC|NOISe|DC}

FUNCtion:CHB?

Select function of CHB output, and set it with selected frequency, amplitude and offset. Inquiry present function of CHB, character string format "CHB:WAVE:SIN" will be returned.

FUNCtion:CHB:SQUare:DCYCle {< Percentage>|MINimum|MAXimum}

FUNCtion:CHB:SQUare:DCYCle?

Set Square duty cycle of CHB. When inquiry it, "+5.0000e-01" will be returned.

FUNCtion:CHB:RAMP:SYMMetry {< Percentage >|MINimum|MAXimum}

FUNCtion:CHB:RAMP:SYMMetry?[MINimum | MAXimum]

Set Ramp symmetry of CHB. Symmetry stands for the rising time quantum per period. When inquiry it, "+1.0000e+00" will be returned.

FUNCtion:CHB:PULSe:PERiod {< Second >|MINimum|MAXimum}

FUNCtion:CHB:PULSe:PERiod?

Set Pulse period of CHB. When inquiry it, "+1.0000000000e-03" will be returned.

FUNCtion:CHB:PULSe:WIDTh {< Second >|MINimum|MAXimum}

FUNCtion:CHB:PULSe:WIDTh?

Set Pulse width of CHB. When inquiry it, "+5.0000000000e-04" will be returned.

FREQuency:CHA {< Frequency >|MINimum|MAXimum}

FREQuency:CHA?[MINimum | MAXimum]

Set output frequency of CHA. When inquiry it, "+2.0000000000e+03" will be returned.

FREQuency:CHB {< Frequency >|MINimum|MAXimum}

FREQuency:CHB?[MINimum | MAXimum]

Set output frequency of CHB. When inquiry it, "+1.0000000000e+03" will be returned.

VOLTage:CHA {< Amplitude >|MINimum|MAXimum}

VOLTage:CHA?

Set output amplitude of CHA according to the present setting of load. When inquiry it, "+1.0000e+00" will be returned.

VOLTage:CHB {< Amplitude >|MINimum|MAXimum}

VOLTage:CHB?

Set output amplitude of CHB according to the present setting of load. When inquiry it, "+1.0000e+00" will be returned.

VOLTage:CHB:HIGH {< Voltage >|MINimum|MAXimum}

VOLTage:CHB:HIGH?

Set high level of CHB output according to the present setting of load. When inquiry it, "+5.0000e-01" will be returned.

VOLTage:CHB:LOW {< Voltage >|MINimum|MAXimum}

VOLTage:CHB:LOW?

Set low level of CHB output according to the present setting of load. When inquiry it, "+5.0000e-01" will be returned.

VOLTage:CHB:OFFSet {< Offset >|MINimum|MAXimum}

VOLTage:CHB:OFFSet?

Set DC offset of CHB output according to the present setting of load. When inquiry it, "+0.0000e+00" will be returned.

OUTPut:CHA {OFF|ON}

OUTPut:CHA?

Enable or disable the CHA output. When enquiry the output state of CHA, "CHA:OUT:ON" will be returned.

OUTPut:CHA:LOAD {HIGH|lOW}

OUTPut:CHA:LOAD?

Set CHA load to be high Z or 50Ω. When inquiry it, "CHA:LOAD:LOW" will be returned.

OUTPut:CHA:TTL {OFF|ON}

OUTPut:CHA:TTL?

Enable or disable TTL output of CHA. When inquiry it, "CHA:TTL:ON" will be returned.

OUTPut:CHB {OFF|ON}

OUTPut:CHB?

Enable or disable CHB output. When inquiry output state of CHB, "CHB:OUT:ON" will be returned.

OUTPut:CHB:LOAD {HIGH|lOW}

OUTPut:CHB:LOAD?

Set load impedance of CHB to be High Z or 50Ω. When inquiry it, "CHB:LOAD:LOW" will be returned.

4.4 AM commands

AM:INTernal:FUNCtion {SINusoid|SQUare|Ramp}

AM:INTernal:FUNCtion?

AM:INTernal:FREQuency {< Frequency >|MINimum|MAXimum}

AM:INTernal:FREQuency?

AM:DEPTh {< Depth percentage>|MINimum|MAXimum}

AM:DEPTh?

AM:SOURce {INTernal|EXTernal}

AM:SOURce?

The explanation of AM commands

Following steps show how to form a AM waveform:

Configure carrier waveform (use APPLy commands or FUNC FREQ VOLT commands to select function, frequency and amplitude of carrier. You can select Sine or Square as carrier), select modulation source, select shape of modulated waveform, set modulating frequency, set modulating depth.

AM:INTernal:FUNCtion {SINusoid|SQUare|Ramp}

AM:INTernal:FUNCtion?

Select the shape of modulating waveform, which only is available for internal source. When inquiry modulating waveform shape, "AM:FUNC:SIN" will be returned.

AM:INTernal:FREQuency {< Frequency >|MINimum|MAXimum}

AM:INTernal:FREQuency?

Set the frequency of modulating waveform, which only be available for internal source. When inquiry it, "+1.0000000000e+02" will be returned.

AM:DEPTh {< Depth percentage >|MINimum|MAXimum}

AM:DEPTh?

Set modulating depth. When inquiry it, "+1.0000e+02" will be returned.

AM:SOURce {INTernal|EXTernal}

AM:SOURce?

Set the modulating source to be internal or external. When inquiry it, "AM:SOUR:INT" will be returned.

4.5 FM commands

FM:INTernal:FUNCtion {SINusoid|SQUare|Ramp}

FM:INTernal:FUNCtion?

FM:INTernal:FREQuency {< Frequency >|MINimum|MAXimum}

FM:INTernal:FREQuency?

FM:DEViation {< Deviation >|MINimum|MAXimum}

FM:DEViation?

FM:SOURce {INTernal|EXTernal}

FM:SOURce?

The explanation of FM commands

Following steps show how to form a FM waveform:

Configure carrier waveform (use APPLy commands or FUNC FREQ VOLT commands to select function, frequency and amplitude of carrier. You can select Sine or Square as carrier), select modulation source, select shape of modulated waveform, set modulating frequency, set modulating depth.

FM:INTernal:FUNCtion {SINusoid|SQUare|Ramp}

FM:INTernal:FUNCtion?

Set the shape of modulating waveform, which only be available for internal source. When inquiry it, "FM:FUNC:SIN" will be returned.

FM:INTernal:FREQuency {< Frequency >|MINimum|MAXimum}

FM:INTernal:FREQuency?

Set the frequency of modulating waveform, which only be available for internal source. When inquiry it, "+1.0000000000e+02" will be returned.

FM:DEViation {< Deviation >|MINimum|MAXimum}

FM:DEViation?

Set modulating deviation. When inquiry it, "+5.0000000000e+02" will be returned.

FM:SOURce {INTernal|EXTernal}

FM:SOURce?

Set the modulating source to be internal or external. When inquiry it, "FM:SOUR:INT" will be returned.

4.6 FSK commands

FSKey:FREQuency {< Frequency >|MINimum|MAXimum}

FSKey:FREQuency?

FSKey:INTernal:RATE {< Frequency >|MINimum|MAXimum}

FSKey:INTernal:RATE?

FSKey:SOURce {INTernal|EXTernal}

FSKey:SOURce?

The explanation of FSK commands

Following steps show how to form a FSK waveform:

Configure carrier (use APPLy commands or FUNC FREQ VOLT commands to select function, frequency and amplitude of carrier. You can select Sine or Square as carrier), select modulating source, select hop frequency and set FSK shifting frequency.

FSKey:FREQuency {< Frequency >|MINimum|MAXimum}

FSKey:FREQuency?

Set hopping frequency. When inquiry it, "+3.0000000000e+03" will be returned.

FSKey:INTernal:RATE {< Frequency >|MINimum|MAXimum}

FSKey:INTernal:RATE?

Set the shift frequency. When inquiry it, "+1.0000000000e+02" will be returned.

FSKey:SOURce {INTernal|EXTernal}

FSKey:SOURce?

Set the modulating source to be internal or external. When inquiry it, "FSK:SOUR:INT" will be returned.

4.7 PSK commands

PSKey:PHASe1 {< Angle>|MINimum|MAXimum}

PSKey:PHASe1?

PSKey:PHASe2 {< Angle>|MINimum|MAXimum}

PSKey:PHASe2?

PSKey:INTernal:RATE {< Frequency >|MINimum|MAXimum}

PSKey:INTernal:RATE?

PSKey:SOURce {INTernal|EXTernal}

PSKey:SOURce?

The explanation of PSK commands

Following steps show how to form a PSK waveform:

Configure carrier (use APPLy commands or FUNC FREQ VOLT commands to select function, frequency and amplitude of carrier. You can select Sine or Square as carrier), select modulating source, set starting phase1, set starting phase 2 and set the PSK shifting frequency.

PSKey:PHASe1 {< Angle >|MINimum|MAXimum}

PSKey:PHASe1?

Set the starting phase 1. When inquiry it, "+6.0000e+01" will be returned.

PSKey:PHASe2 {< Angle >|MINimum|MAXimum}

PSKey:PHASe2?

Set the starting phase 2. When inquiry it, "+9.0000e+01" will be returned.

PSKey:INTernal:RATE {< Frequency >|MINimum|MAXimum}

PSKey:INTernal:RATE?

Set the shifting frequency. When inquiry it, "+1.0000000000e+02" will be returned.

PSKey:SOURce {INTernal|EXTernal}

Set the modulating source to be internal or external. When inquiry it, "PSK:SOUR:INT" will be returned.

4.8 Sweep commands

FREQuency:STARt {< Frequency >|MINimum|MAXimum}

FREQuency:STARt?

FREQuency:STOP {< Frequency >|MINimum|MAXimum}

FREQuency:STOP?

FREQuency:STEP {< Frequency >|MINimum|MAXimum}

FREQuency:STEP?

SWEep:SPACing {LINear|LOGarithmic}

SWEep:SPACing?

SWEep:TIME {< Second >|MINimum|MAXimum}

SWEep:TIME?

SWEep:SOURce { INTernal |EXTernal|BUS}

SWEep:SOURce?

TRIGger:SLOPe {POSitive|NEGative}

TRIGger:SLOPe?

TRIGger:TRIGger

The explanation of sweep commands

Following steps show how to form sweep waveform

When sweep frequency lies in low frequency

Configure carrier (use APPLy commands or FREQ VOLT commands to select function and amplitude of carrier. You can select Sine or Square as carrier), set the sweep frequency limitation (starting frequency, ending frequency), select sweep mode, set sweeping time, select trigger source, set the trigger signal polarity when external trigger.

When sweep frequency lies in high frequency

Configure carrier (use APPLy commands or FREQ VOLT commands to select function and amplitude of carrier. You can select Sine or Square as carrier), set the sweep frequency limitation (starting frequency, ending frequency), set step frequency, set step time, select sweep trigger source, select the trigger signal polarity when external trigger.

FREQuency:STARt {< Frequency >|MINimum|MAXimum}
FREQuency:STARt?

Set the starting frequency. When inquiry it, "+1.0000000000e+03" will be returned.

FREQuency:STOP {< Frequency >|MINimum|MAXimum}
FREQuency:STOP?

Set the stopping frequency. When inquiry it, "+1.0000000000e+04" will be returned.

FREQuency:STEP {< Frequency >|MINimum|MAXimum}
FREQuency:STEP?

Set step frequency. When inquiry it, "+1.0000000000e+03" will be returned.

SWEep:SPACing {LINear|LOGarithmic}
SWEep:SPACing?

Set the sweep mode to be linearity or logarithm. When inquiry it, "SWE:SPAC:LIN" will be returned.

SWEep:TIME {< Second >|MINimum|MAXimum}
SWEep:TIME?

Set sweep time when lies in low frequency and set step time when lies in high frequency. When inquiry it, "+1.0000000000e-01" will be returned.

SWEep:SOURce { INTernal |EXTernal|BUS}
SWEep:SOURce?

Set the trigger source to be internal, external or manual. When inquiry it, "PSK:SOUR:INT" will be returned.

TRIGger:SLOPe {POSitive|NEGative}
TRIGger:SLOPe?

Set the polarity of trigger signal to be rising edge or falling edge. When inquiry it, "TRIG:SLOP:POS" will be returned.

TRIGger:TRIGger

When set the trigger mode to be manual, enable once trigger.

4.9 Burst commands

BURSt:NCYCles {<N cycles >|MINimum|MAXimum}

BURSt:NCYCles?

BURSt:INTernal:PERiod {< Second>|MINimum|MAXimum}

BURSt:INTernal:PERiod?

BURSt:PHASe {< Angle >|MINimum|MAXimum}

BURSt:PHASe? [MINimum | MAXimum]

BURSt:SOURce { INTernal |EXTernal|BUS|GATed}

BURSt:SOURce?

TRIGger:TRIGger

The explanation of sweep commands

Following steps show how to form a burst waveform

Configure carrier (use APPLy commands or FREQ VOLT commands to select function and amplitude of carrier. You can select Sine or Square as carrier), set the burst count, set the burst period, set the starting phase, select sweep trigger source.

BURSt:NCYCles {<N cycles >|MINimum|MAXimum}

BURSt:NCYCles?

Set the burst count. When inquiry it, "+5.00000e+00" will be returned.

BURSt:INTernal:PERiod {< Second >|MINimum|MAXimum}

BURSt:INTernal:PERiod?

Set the burst period. When inquiry it, "+1.0000000000e-01" will be returned.

BURSt:PHASe {< Angle >|MINimum|MAXimum}

BURSt:PHASe?

Set the starting phase of burst. When inquiry it, "+9.0000e+01" will be returned.

BURSt:SOURce { INTernal |EXTernal|BUS|GATed}

BURSt:SOURce?

Set the trigger source to be internal, external, manual or gated. When inquiry it, "BURS:SOUR:INT" will be returned.

TRIGger:TRIGger

Set the trigger mode to be manual, enable once trigger.

4.10 Trigger commands

TRIGger:SLOPe {POSitive|NEGative}

TRIGger:SLOPe?

TRIGger:TRIGger

The explanation of trigger commands

TRIGger:SLOPe {POSitive|NEGative}

TRIGger:SLOPe?

Set the polarity of trigger signal to be rising edge or falling edge. When inquiry it, "TRIG:SLOP:POS" will be returned.

TRIGger:TRIGger

Set the trigger mode to be manual, enable once trigger.

4.11 Relative commands with systems

DISPlay {OFF|ON}

DISPlay?

Turn on or off the display. When inquiry display state, "DISP:ON" will be returned.

SYSTem:VERSion?

Inquiry hardware/software version of instrument, the present version number of hardware and software will be returned.

SYSTem:BEEPer:STATe {OFF|ON}

SYSTem:BEEPer:STATe?

Set the beeper to be On or Off state. When inquiry it, "BEEP:STAT:ON" will be returned.

4.12 Interface configuration commands

SYSTem:LOCal

Set the instrument to be local state, the keys in front panel will work.

4.13 IEEE 488.2 common commands

IEEE standards define some common commands regarding to inquiry basic information or execute basic operation, which begin with * and the length of keywords is 3 characters.

***SAV {1|2|3|4}**

Store the present state in appointed memory location, and the instrument has 4 locations.

***RCL {1|2|3|4}**

Recall the instrument state from appointed location, and the instrument has 4 memory locations.

***RST**

Suspend present operating, and reset system.

MEMory:STATe:RECall:AUTO{OFF|ON}

MEMory:STATe:RECall:AUTO?

Set instrument connected with power, recall automatically when enable or disable status before shutdown. When inquiry it, "MEM:STAT:REC:OFF" will be returned.

Chapter 5 Application examples

This chapter provides some programmable interface command examples, to help users learn more about programmable commands.

5.1 CHA outputs sine

CHA outputs a sine with 10kHz frequency and 0.5Vpp amplitude.

Using **APPLy subsystem command,** below programmable commands realize same function

APPL:CHA:SIN 10000,0.5

APPL:CHA:SIN 10 kHz,0.5 Vpp

APPLy:CHA:SINusoid 10 kHz,500 mVpp

Use low-level command

FREQ:CHA 10000

VOLT:CHA:0.5 Vpp

OUTP:CHA ON

5.2 CHB outputs square

CHB outputs a square wave with 3kHz frequency, 2Vrms amplitude, 1Vdc DC offset and 50% duty cycle

Using **APPLy subsystem command,** below programmable commands realize same function

APPL:CHB:SQU 3000,2 Vrms,1

APPL:CHB:SQU 3 kHz,2 Vrms,1 Vdc

APPLy:CHB:SQUARE 3 kHz,2000 mVrms,1000 mVdc

Use low-level command

FREQ:CHB 3000

VOLT:CHB:2 Vrms

VOLT:CHB:OFFS 1 Vdc

OUTP:CHB ON

5.3 CHA outputs PSK modulation wave

CHA outputs an internally modulated PSK modulation wave with sine as carrier wave, of which the frequency is 100kHz frequency, amplitude is 1Vpp, start phase 1 is 45°, start phase 2 is 135° and mobile frequency is 200Hz.

FUNC:CHA SIN

FREQ:CHA 100 kHz

VOLT:CHA:1 Vpp

PSK:PHAS1 45

PSK:PHAS2 135

PSK:INT:RATE 200

PSK:SOUR INT

OUTP:CHA ON

5.4 CHA outputs pulse string

CHA outputs an internally modulated pulse string with sine as carrier wave, of which the frequency is 30kHz, amplitude is 1Vpp, start phase is 180°, burst period is 1s and pulse cycle is 5.

FUNC:CHA SIN

FREQ:CHA 30000

VOLT:CHA: 1

BURS:PHAS 180

BURS:INT:PER 1

BURS:NCYC 5 N

BURS:SOUR INT

OUTP:CHA ON

5.5 CHA outputs sweep wave

CHA outputs a sweep waveform triggered by the rising edge of external trigger signal, with square wave as carrier wave, of which the amplitude is 1Vpp, start frequency is 2kHz, end frequency is 20kHz, sweep time is 0.1s and sweep mode is linearity.

FUNC:CHA SQU

VOLT:CHA: 1

FREQ:STAR 2000

FREQ:STOP 20000

SWE:TIME 0.1

SWE:SPAC LIN

SWE:SOUR EXT

TRIG:SLOP POS

OUTP:CHA ON

5.6 CHA outputs AM modulation wave

CHA outputs an internally modulated AM modulation wave with sine as carrier wave, of which the frequency is 10MHz, amplitude is 3dBm, modulation frequency is 100Hz, modulation depth is

100% and modulation waveform is RAMP.

APPL:CHA:SIN 10 MHz,3 dBm

AM:DEPT 100%

AM:INT:FREQ 100

AM:INT:FUNC RAMP

AM:SOUR INT