

BENCHTOP INSTRUMENT

MYWAVE[®]

MFG-2000 Series
DDS Function Generator
Operation Manual

Part No. FGOM-020010E



Use of Operation Manual

Please read through and understand this Operation Manual before operating the product. After reading, always keep the manual nearby so that you may refer to it as needed. When moving the product to another location, be sure to bring the manual as well.

Calibration Notification

We notify that the instruments included in this manual are in compliance with the features and specifications as stated in this manual. Before shipment, the instrument has been calibrated in factory. The calibration procedures and standards are compliant to the national regulations and standards for electronic calibration.

Warranty

We guarantee that the instrument has been passed strict quality check. We warrant our instrument's mainframe and accessories in materials within the warranty period of one year. We guarantee the free spare parts for products which are approved defective in this period. To get repair service, please contact with your nearest sales and service office. We do not provide any other warranty items except the one being provided by this summary and the warranty statement. The warranty items include but not being subjected to the hinted guarantee items related to tradable characteristics and any particular purpose. We will not take any responsibility in cases regarding to indirect, particular and ensuing damage, such as modifications to the circuit and functions by the users, repairing or component replacement by the users, or damage during transportation.

For product improvement, the specifications are subject to change without prior notice. This manual is meant to be an operation guide to users and has been prepared with the utmost care. However, if you have any questions or note any errors or omissions, please contact your local distributor.

Safety Instruction

This chapter contains important safety instructions that you must follow when operating the instrument and when keeping it in storage. Read the following before any operation to insure your safety and to keep the best condition for the instrument.

1. Safety Terms and Symbols

The following safety symbols may appear in this manual or on the instrument:



WARNING Identifies conditions or practices that could result in injury or loss of life.



CAUTION Identifies conditions or practices that could result in damage to the instrument or to other properties.



DANGER High voltage



ATTENTION Refer to the manual



Earth (ground) terminal

2. Safety Guidelines



- Before plugging into local AC mains, check and make sure that the output voltage is compatible to the load. (It is suggested to disconnect a load before plugging into local AC mains.
- Do not use this instrument near water.
- Do not operate or touch this instrument with wet hands.
- Do not open the casing of the instrument when it is connected to AC mains.
- Do not use the instrument in an atmosphere which contains sulfuric acid mist or other substances which cause corrosion to metal.
- Do not use the instrument in a dusty place or a highly humid place as such will cause instrument reliability degradation and instrument failures.
- Install the instrument in a place where is free from vibration.
- Install the instrument in a place where the ambient temperature is in range of -10~70°C. Note that the instrument operation may become unstable if it is operated in an ambient temperature exceeding the range of 0~40°C

3. Power Supply



AC Input voltage: 110V~120V/220~240V $\pm 10\%$, 50/60Hz

Connect the protective grounding conductor of the AC power cord to an earth ground to avoid electrical shock.

4. Fuse



- Fuse type: 110~120V: T2A/250V, or 220~240V: T1A/250V.
- Make sure the correct type of fuse is installed before power up.
- Replace the AC fuse with the same type and rating as the original fuse.
- Disconnect the power cord before fuse replacement.
- Make sure the cause of fuse blowout is fixed before fuse replacement.

5. Maintenance Inspection

- Inspect the instrument at regular intervals so that it maintains its initial performance for a long time.
 - Check the input power cord for damage of the vinyl cover and overheating of the plug and cord stopper. Check the terminal screws and binding posts for loosening.
 - Remove dust from the inside of the casing and ventilation holes of the cover by using a compressed air or the exhaust air of a vacuum cleaner.
-

6. Cleaning

- Before cleaning, disconnect the AC mains.
 - To clean the power supply, use a soft cloth dampened in a solution of mild detergent and water. Do not spray cleaner directly onto the instrument, since it may leak into the cabinet and cause damage.
 - Do not use chemicals containing benzene, toluene, xylene, acetone, or similar solvents.
 - Do not use abrasive cleaners on any portion of the instrument.
-

Introduction

This operation manual is used for all models of this series of DDS function generator. The last two digits in the model number represent the maximum frequency of the channel A. There are four models to choose from this series, with max.frequency range of 10MHz, 20MHz, 40MHz and 60MHz.

This series of DDS function generator uses Direct Digital Synthesis (DDS) technology. Its outstanding performance and system features make this function generator a perfect solution for your testing requirement. The simplified and optimized design of the front panel and dual-language (English/Chinese) LCD display interface make your testing much easier for operation and observation. Additionally, the extendable optional functions can also improve your system characteristics.

Technical characteristics and system features:

- High-accurate Frequency: up to the 10^{-5} order of magnitude
- High Frequency Resolution: full-range resolution is 40 mHz (extendable to 40 μ Hz)
- No Range Limitation: no frequency level switch, frequency set directly by digit keypad
- No Frequency Transition: momentarily switch to the stable value on phase and amplitude without transition and distortion
- Precise Output Waveform: output waveform is synthesized by the preset function calculation values, very accurate and less distortion
- Multiple Waveforms: output 32 kinds of the pre-stored waveforms
- Pulse Characteristics: set accurate pulse duty cycle
- Harmonic Wave Characteristics: output the fundamental and harmonic waves with adjustable phase
- Sweep Characteristics: frequency sweep and amplitude sweep, free to set the start and stop points
- Modulation Characteristics: output FM and AM signals
- Shift Keying Characteristics: output FSK, ASK, and PSK signals
- Burst Characteristics: output pulse waveform with burst count
- Store Characteristics: store 40 sets of the user parameters and recall
- Counter Characteristics: count the frequency, period, amplitude RMS value or peak-to-peak value
- Operation Mode: key operation for all functions, English/Chinese menu selectable, parameters settings by numeric keypad or rotary dial
- High Reliability: use VLSI components and surface mount technology
- Protection: over voltage protection, over current protection, output short circuit protection, reverse voltage protection
- Frequency Testing: optional frequency counter, capable of external frequency signal testing
- Power Amplifier: optional part, maximum output power up to 7W
- Remote Control: optional USB and RS232 interface

Check List

● DDS function generator	1	● USB software CD (optional)	1
● Power cord	1	● RS232 software CD (optional)	1
● Q9 test lead	1	● USB cable (optional)	1
● Q9 BNC-clip test lead	1	● RS232 cable (optional)	1
● Operation manual	1		

Optional Parts

- USB interface
- RS232 interface
- Frequency counter
- Power amplifier

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Chapter 1 Quick Starting

This chapter describes the front and rear panels of the DDS function generator. The brief introduction of the function generator helps you get familiar with the fundamental operations and functions. The main contents in this chapter are as the following:

1.1 Preparation

1.1.1 Check the Function Generator and Accessories

Check the function generator and accessory parts and verify all items in the good shape. If the box is broken, please keep the box until the function generator passes function test.

1.1.2 Connect the Function Generator to Power

Only under the conditions below, you can connect power cable and turn on the power switch.

Voltage: AC220V \pm 10%

AC110V \pm 10% (Pay attention to the position of voltage selection switch)

Frequency: 50Hz \pm 5%

Watts: <45VA

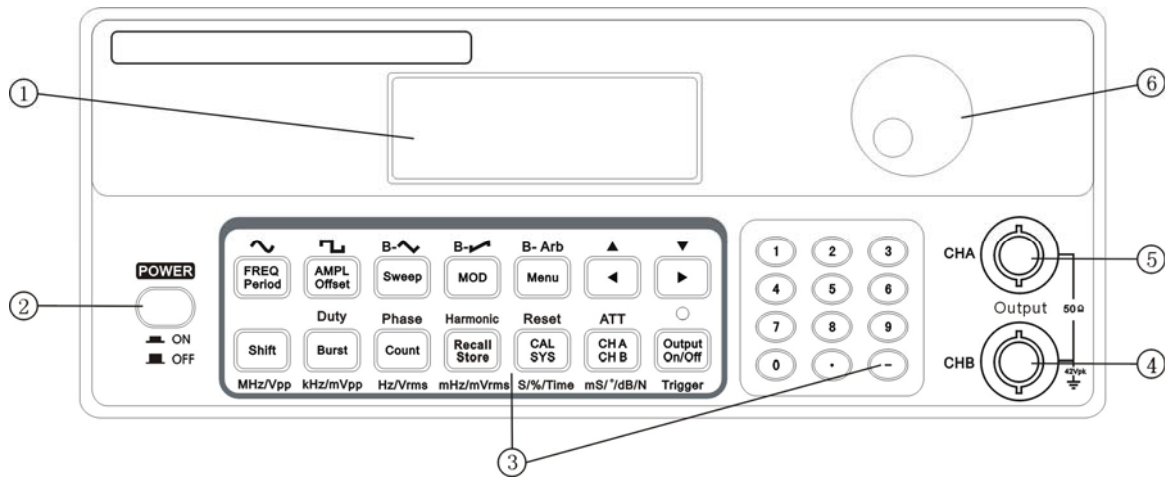
Temperature: 0~40°C Humidity: <80%

Plug the power cord into an 110V/220V power outlet with ground connection and turn on the function generator. The function generator starts to initialize - display the instrument name, load the default parameters, display menu of Channel A frequency, start channel A and B output signal. After initialization, the function generator is in the normal working mode.

WARNING: For protection from electrical shock, the three-hole power cord with protective earth ground has to be used.

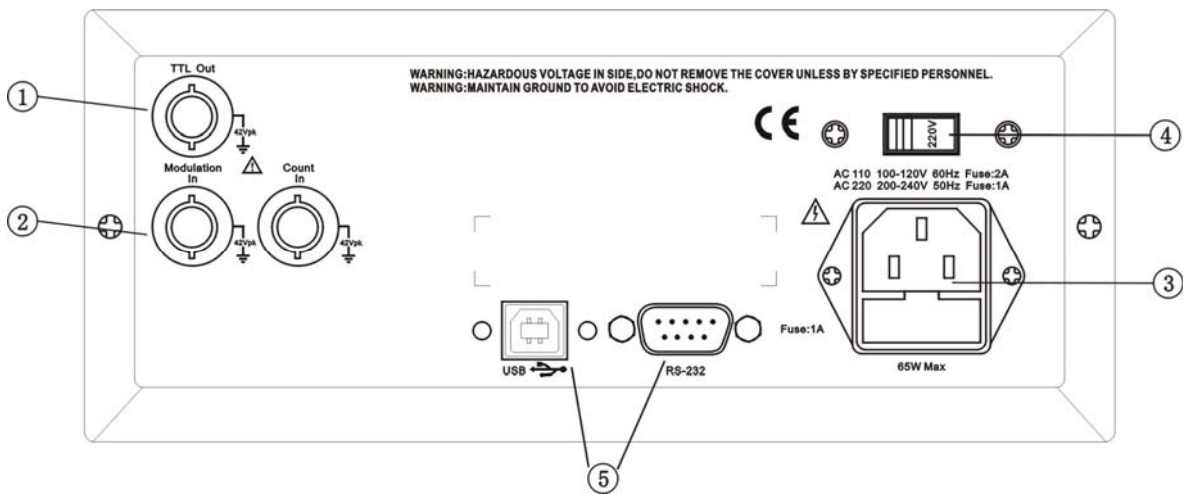
1.2 Front and Rear Panel

Front panel



- | | | |
|---------------------|---------------------|----------------|
| 1. LCD display | 2. Power switch | 3. Keypad |
| 4. Channel B output | 5. Channel A output | 6. Rotary knob |

Rear Panel



- | | |
|------------------------------|---|
| 1. TTL output (BNC) | 2. Modulation/External signal input (BNC) |
| 3. Power connector with fuse | 4. AC110V/220V power selection switch |
| 5. RS232/USB connector | |

1.3 Description of LCD Display

On the top line of the LCD display, the function and operation option are displayed. In the “CHA Alone” and “CHB Alone” mode, the current function or the output waveform is shown on the left side and the current option is shown on the right side. Under each function, there are variety options shown in the table below. The options with shadow are frequently-used which can be selected by using the shortcut function keys on the front panel. However, the options without shadow are not common. So first select the corresponding function, then use the key [Menu] to select them. At the bottom line of the LCD display, the parameters of the current option are displayed.

The table of function and option

Function key	CHA Alone (sine)		CHB Alone (sine)	CHA Frequency Sweep
option	CHA frequency	CHA offset	CHB frequency	Start frequency
	Peak-to-peak value	CHA attenuation	Peak-to-peak value	Stop frequency
	CHA period	CHA duty cycle	CHB period	Sweep type
	Root mean squared value		Root mean squared value	Sweep mode
	Phase		Phase	Interval time
			CHB harmonic wave	Single burst
			CHB waveform	CHA frequency
Function key	CHA Amplitude Sweep	FM	AM	CHB Burst
option	Start amplitude	Carrier frequency	Carrier frequency	CHB frequency
	Stop amplitude	Carrier amplitude	Carrier amplitude	CHB amplitude
	Sweep type	Modulation frequency	Modulation frequency	Burst count
	Sweep mode	FM deviation	AM depth	Burst frequency
	Interval time	Modulation wave	Modulation wave	
	Single burst	Signal source	Signal source	
	CHA amplitude			
Function key	FSK	ASK	PSK	
option	Carrier frequency	Carrier frequency	Carrier frequency	
	Carrier amplitude	Carrier amplitude	Carrier amplitude	
	Hop frequency	Hop amplitude	Hop phase	
	Interval time	Interval time	Interval time	
Function key	Count	Calibration	System	
option	CHA frequency	Calibration switch	Interface type	
	Gate time	CHA frequency	Remote address	
	Low pass filter	Carrier frequency	Language setup	
	Signal source	FM deviation	Beeper	
			Software version	

1.4 Key Description

There are 26 keys on the front panel. The black word on each key represents the basic function. Simply press the key to use the basic function. The green word at the upper of key represents the second function of the key. Press

key **[Shift]**, the sign “ ↑ ” will be displayed at the lower-right of the LCD. Then press the function key, you can select the second function. In order to select one of the eleven functions, sequentially press the function key and key **[Menu]**.

In this section, the basic functions of the 26 keys will be introduced. The selections of green second function and black function will be introduced in the following chapters.

Numeric keys

Key name	Main function	Second function	Key name	Main function	Second function
0	Input digit 0	Not available	7	Input digit 7	Not available
1	Input digit 1	Not available	8	Input digit 8	Not available
2	Input digit 2	Not available	9	Input digit 9	Not available
3	Input digit 3	Not available	•	Input decimal point	Not available
4	Input digit 4	Not available	—	Input negative sign	Not available
5	Input digit 5	Not available	◀	Flash digit left shift	Add digit
6	Input digit 6	Not available	▶	Flash digit right shift	Subtract digit

Function keys

Key name	Main function	Second function	Unit function
FREQ/Period	Frequency/period selection	Sine selection	Not available
AMPL/Offset	Amplitude/offset selection	Square selection	Not available
Sweep	Sweep selection	CHB triangle selection	Not available
MOD	Modulation selection	CHB ramp selection	Not available
Menu	Menu selection	CHB waveform selection	Not available
Burst	CHB burst selection	Duty cycle selection	kHz/mVpp
Count	Frequency counter selection	Phase selection	Hz/Vrms
Recall/store	Recall/store parameters	Harmonic wave selection	mHz/mVrms
CAL/SYS	Parameter calibration/system setup	Reset selection	s%/Time
CHA/CHB	CHA Alone/CHB Alone	Attenuation selection	ms/° /dB/N

Other keys

Key name	Main function	Others
Output On/Off	Signal output on/off	Single trigger for sweep and burst function
Shift	Shift to 2'nd function with other keys and exit remote control	Unit MHz/Vpp

Key functions: 26 keys are available on front panel and a “di” sound will be heard when pressed.

Key **[Menu]**: press key **[Menu]** without numeric input, users can select all options under the current function.

Most keys have second functions that are marked in green above the keys. To use the second function, key **[Shift]** should be pressed first before pressing the function key.

A few keys can also be used as unit keys that marked in black below the keys. To use the unit function, a digit key should be pressed first before the unit key is pressed.

Key **[Shift]**: its basic function is for second function shifting. Press key **[Shift]**, the sign “ ↑ ” lamp turns on. At this time, the second function of the function key is validated. Press key **[Shift]** again, the sign “ ↑ ” lamp turns off. At this time, the basic function of the function key is validated. Key **[Shift]** is also used as unit MHz/Vpp and has the function for exiting the remote control.

1.5 Fundamental Operation

This section introduces the fundamental operations on the general requirements through some examples. See **Chapter 3** in “Operation Manual” for more information if you have complex problems or need the complicated operations.

1.5.1 Function of Channel A

Press key [**CHA/CHB**] and select “CHA Alone” function.

Set the frequency of the channel A: set frequency as 3.5 kHz.

Press [**FREQ**] and select “Frequency”, then press keys [**3**] [**.**] [**5**] and the soft key corresponding to [**kHz**]. Adjust the frequency of the channel A: press key [**◀**] or [**▶**] to move the cursor left or right, and tune the rotary knob left or right to add or subtract the digit on cursor, or to decrease or increase the digits continuously by steps, so as to make coarse or fine adjustment of the frequency. Apply the same procedures for other parameters adjustments.

Set the period of the channel A: set period at 2.5 ms.

Press key [**Period**] and select “Period”, then press keys [**2**] [**.**] [**5**] and the soft key corresponding to [**ms**].

Set the amplitude of the channel A: set amplitude at 3.2 Vpp.

Press key [**AMPL**] and select “Amplitude”, then press keys [**3**] [**.**] [**2**] and the soft key corresponding to [**Vpp**].

Set the amplitude format of the channel A: Vrms or Vpp

Press key [**AMPL**] and select “Amplitude”, then press key [**Vrms**] or [**Vpp**].

Select the channel A waveform: select the sine or square wave.

Press keys [**Shift**] [**~**] to select sine wave. Press keys [**Shift**] [**□**] to select square wave.

Set the channel A duty cycle: set the duty cycle at 65%.

Press keys [**Shift**] [**Duty**], then press keys [**6**] [**5**] and the soft key corresponding to [%].

Set the channel A attenuation: select the fixed attenuation 0dB (after power on or reset, the instrument is default as AUTO attenuation).

Press keys [**Shift**] [**ATT**], then press key [**1**] and the soft key corresponding to [**dB**].

Set the channel A offset: in the attenuation (0dB) mode, set DC offset as -1 Vdc

Press key [**Offset**] and select “Offset”, then press keys [**-**] [**1**] and the soft key corresponding to [**Vdc**].

Recall the stored parameters: recall the 15th stored parameters. (only for the keypad operations)

Press key [**Recall**] and select recall function, then press keys [**1**] [**5**] [**No.**].

1.5.2 Function of Channel B

Press key [**CHA/CHB**] and select “CHB Alone” function.

Set the channel B frequency and amplitude: apply the same setting method as explained in section 1.5.1.

Select the channel B common waveform: select the sine, square, triangle and ramp wave.

Press keys [**Shift**] [**~**] to select sine wave.

Press keys [**Shift**] [**□**] to select square wave.

Press keys [**Shift**] [**B-~**] to select triangle wave.

Press keys [**Shift**] [**B-✓**] to select ramp wave.

Select the channel B other waveform: select one of the 32 kinds of waveforms.

Press keys [**Shift**] [**B-Arb**] and select “Channel B waveform”. Rotate the knob to select one of the 32 kinds of waveforms. (For details, please refer to the table of the waveform index number and name in section 3.3.1)

Set the Channel B harmonic wave: set the frequency of channel B as a 3-time harmonic wave of channel A.

Press keys [CHB] [Menu] [Harmonic] [3] [TIME].

Set the phase of channel A and channel B: set the phase of channel A and channel B as 45° and 90° respectively.

Press keys [CHA] [Shift] [Phase] [4] [5] [°].

Press keys [CHB] [Shift] [Phase] [9] [0] [°].

1.5.3 Frequency Sweep of the Channel A

Press key [Sweep] and select “CHA Sw Fr” function. The instrument will output the frequency sweep signal with the default parameters at CHA output.

Set the sweep mode: set the Up-Down sweep mode.

Press key [Menu] and select “Sweep mode”, then press keys [2] [No.].

The setup of other sweep parameters will be introduced in section 3.4.

1.5.4 Amplitude Sweep of the Channel A

Press key [Sweep] and select “CHA Sw Am”. The instrument will output the amplitude sweep signal with the default parameters at CHA output.

Set the interval time: set the interval time as 0.5s.

Press key [Menu] and select “Interval time”, then press keys [0] [.] [5] [s].

The setup of other sweep parameters will be introduced in section 3.5.

1.5.5 Frequency Modulation (FM) of the Channel A

Press key [MOD] and select “CHA FM”. The instrument will output the FM signal with the default parameters at CHA output.

Set the FM deviation: set the FM deviation as 5%.

Press key [Menu] and select “FM Deviation”, then press keys [5] [%].

The setup of other FM parameters will be introduced in section 3.6.

1.5.6 Amplitude Modulation (AM) of the Channel A

Press key [MOD] and select “CHA AM”. The instrument will output the AM signal with the default parameters at CHA output.

Set the AM depth: set the AM depth at 50%

Press key [Menu] and select “AM Depth”, next press keys [5] [0] [%].

The setup of other AM parameters will be introduced in section 3.7.

1.5.7 Burst Output of the Channel B

Press key [Burst] and select “CHB Burst”. The instrument will output the burst count signal with the default parameters at CHB output.

Set the burst count: set the burst count as 5 cycles.

Press key [Menu] and select “Cycles”, next press keys [5] [CYCL].

The setup of other burst parameters will be introduced in section 3.8.

1.5.8 FSK Modulation of the Channel A

Press key **[MOD]** and select “CHA FSK”. The instrument will output the FSK signal with the default parameters at CHA output.

Set the hop frequency: set the hop frequency at 1 kHz.

Press key **[Menu]** and select “Hop Freq”, next press keys **[1] [kHz]**.

The setup of other FSK parameters will be introduced in section 3.9.

1.5.9 ASK Modulation of the Channel A

Press key **[MOD]** and select “CHA ASK”. The instrument will output the ASK signal with the default parameters at CHA output.

Set the carrier amplitude: set the carrier amplitude at 2 Vpp.

Press key **[Menu]** and select “Carrier Ampl”, next press keys **[2] [Vpp]**.

The setup of other ASK parameters will be introduced in section 3.10.

1.5.10 PSK Modulation of the Channel A

Press key **[MOD]** and select “CHA PSK”. The instrument will output the PSK signal with the default parameters at CHA output.

Set the hop phase: set the hop phase at 180° .

Press key **[Menu]** and select “Hop Phase”, next press keys **[1] [8] [0] [°]**.

The setup of other PSK parameters will be introduced in section 3.11.

1.5.11 CHA/CHB Output On/Off

Press key **[CHA]**, channel A is shown on the LCD display, press **[Output]**, the output lamp turns to green, the signal of channel A outputs. Press **[Output]** again, the output lamp turns off, the instrument closes the signal output of channel A.

Press key **[CHB]**, channel B is shown on the LCD display, press **[Output]**, the output lamp turns to red, the signal of channel B outputs. Press **[Output]** again, the output lamp turns off, the instrument closes the signal output of channel B.

After power on, the default state is not having signal output, with the lamp being off. When the output lamp turns to orange, there are signals output both in channel A and channel B.

1.5.12 System Initialization Status

At power on or pressing keys **[Shift] [Reset]**, the system initialization status of the instrument is as the followings:

Channel A:

Waveform: sine wave	Frequency: 1.0000000kHz	Amplitude: 2.000Vpp
Attenuation: AUTO	Period: 1ms	Offset: 0.000 Vdc
Pulse duty cycle: 50.0%	Square duty cycle: 50.0%	Time interval: 10ms
Carrier frequency: 50kHz	Start frequency: 500.00000Hz	Stop frequency: 50.000000kHz
Modulation frequency: 1.0000000kHz	Start amplitude: 10mVpp	Stop amplitude: 2.000Vpp
AM depth: 100%	Carrier amplitude: 2Vpp	Sweep mode: Up Sweep
Hop frequency: 5.0000000kHz	FM Deviation: 10%	Burst count: 3 CYCL

Hop phase: 180°
Phase: 0°

Hop amplitude: 1.000Vpp

Burst frequency: 100.0000000Hz

Channel B:

Waveform: sine wave

Frequency: 1.0000000kHz

Amplitude: 2.000Vpp

A harmonic: 1.00 TIME

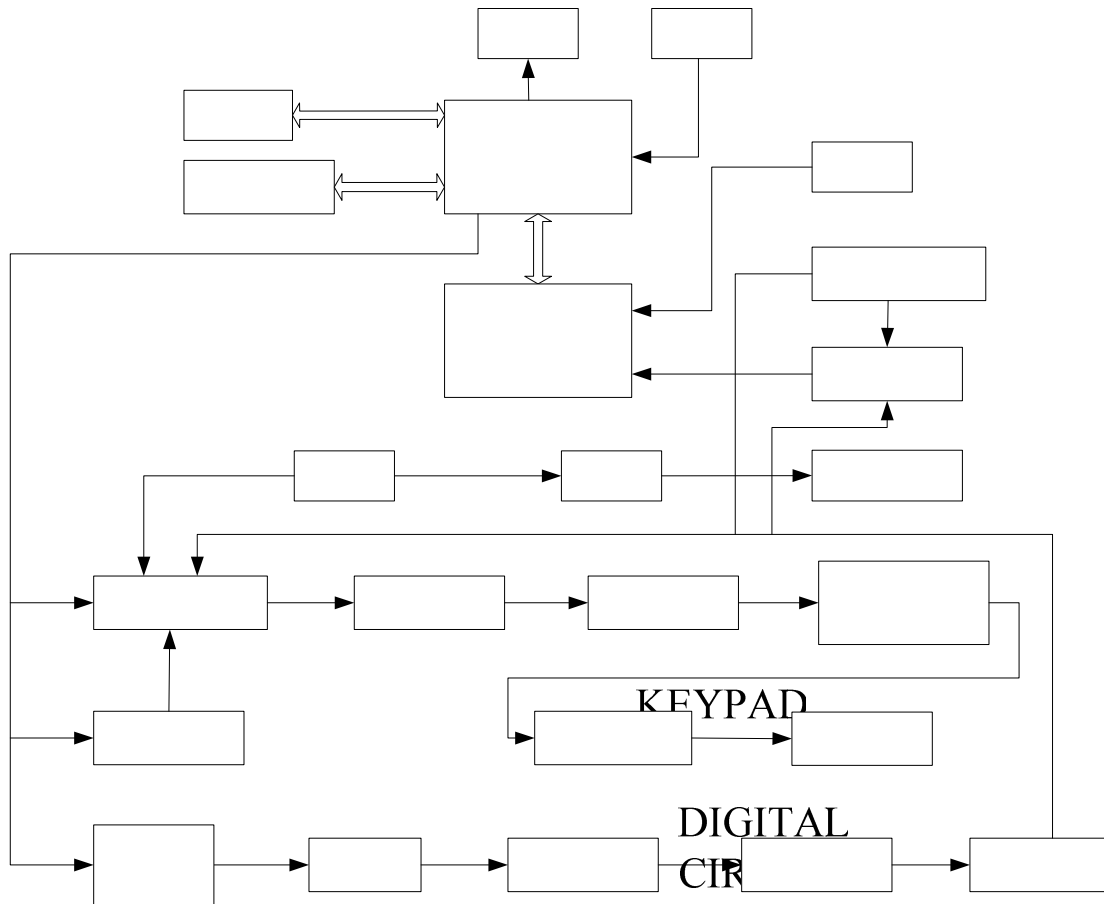
Period: 1ms

Phase: 0°

Chapter 2 Principle of the Function Generator

In order to help you better understand the internal operation of the instrument, this chapter describes the basic signal generator concepts and provides the specific details on the internal operations of the function generator.

2.1 Principle Diagram



2.2 Principle of Direct Digital Synthesis

In order to generate a voltage signal, the traditional analog signal source generally uses the discrete electronic components to build oscillation circuitries in variety ways. The accuracy of frequency is not only low but also very unstable. The production and testing procedures are very complicated and time-consuming. Moreover, it is not convenient for the frequency setting and computer programming. The Direct Digital Synthesis (DDS) technology is a new signal-generation technique. DDS does not consist of any oscillating components. It applies a stream of digital data which represents the desired waveform pre-stored in memory to the input of digital-to-analog converter (DAC). The DAC converts the data and outputs a series of voltage steps approximating the desired waveform.

For example, to synthesize a sine waveform, first, the function $y = \sin(x)$ is digitized, then the digitized value y is sequentially stored in the waveform memory by the address of x . DDS uses the phase accumulating technique to control the address of the waveform memory. In every single sampling period, a phase increment is added to the current content of the phase accumulator. The output frequency of DDS can be modified by changing this phase increment. The digitized waveform data is read from the waveform memory addressed by the phase accumulator

AMPLITUDE
CONTROL AM

VOLTAGE
AMPLIFIER

and converted into an analog voltage through D/A converter and amplifier circuitry. Because the waveform data are the interval samples, the output of DDS is a stepwise sine wave. Thus, the output waveform from DDS has to be filtered out the high harmonic components by a low-pass filter. The high accurate reference regulator in D/A converter assures the amplitude precision and stability of the output waveform.

The amplitude controller is a D/A converter. According to the preset amplitude value, this converter generates a corresponding analog voltage which multiplies with the output signal and produces a final output signal whose amplitude is equal to the preset value. The offset controller is also a D/A converter. According to the preset offset value, this converter generates a corresponding analog voltage which adds with the output signal and produces a final output signal whose offset is equal to the preset value. The output signal is output at the channel A.

2.3 Principle of Operation and Control

The MCU controls keypad and LCD display through the interface circuitry. When the key is pressed, the MCU detects the action, finds the code of key, and executes the corresponding program. The LCD display circuit adopts menu characters to display the working status and parameters of the instrument.

The knob on the front panel can be used to adjust the numeric digit on the cursor position. Every 15-degree rotation will generate a trigger pulse. Based on the pulse, the MCU can determine the knob left-rotation or right-rotation. If the rotation is left, the digit on the cursor is subtracted by one. If the rotation is right, the digit is added by one.

Chapter 3 Operation Instruction

In this chapter, you will learn more information about the functions and operations.

3.1 Operation Common Rules

3.1.1 Numeric Keypad Input

If an option is selected, you can input the parameters by using the numeric keys. There are ten numeric keys for data input. The input method is the shift input from left to right. The data can have only one decimal point. If one data input has more than one decimal point, only the first one is valid. In the offset mode, the negative sign can be input too. After input a new value, press unit key to validate it. If the input data has error, there are two ways to correct it.

Method 1: If the destination side of output signal can receive the wrong signal, press any unit key to terminate the current operation. Input the correct data, and press the unit key to validate the input.

Method 2: If the destination side of output signal can not receive the wrong signal, the wrong input is not validated because of no any wrong signal at the output. Reselect the operation, input correct data, and press the unit key to validate the input.

Although there are a variety of combinations of the decimal point and the unit key for data input, the instrument always displays the input data in a fixed format. For example, input either 1.5kHz or 1500Hz, after validation, the instrument will display as 1.500000kHz.

Different physics value has different unit, such as “Hz” for frequency, “V” for amplitude, “s” for time, and “° ” for phase. However, when using numeric keys to enter data, the input data will not be effective without the entry of unit. The instrument will display the corresponding unit when the physics value is selected.

3.1.2 Step Key Input

In practices, a set of frequency or amplitude value with same interval is commonly used. It is complicated and time consuming to input this kind of data by repeatedly pressing the numeric keypad and unit key. It is very convenient to use the step input method. Every pressing the corresponding soft key can make the frequency or amplitude increase or decrease by a step value. The modified data is validated automatically without pressing the unit key.

For example, to generate a series of frequency with interval 12.5 kHz, press the keys sequentially as following:

Press key [**Menu**] and select “Step Freq”;

Press keys [**1**] [**2**] [**.**] [**5**] and the soft key corresponding to [**kHz**];

Press key [**CHA**] and select “CHA Frequency”;

Press keys [**Shift**] [**▲**] to increase the frequency by 12.5 kHz or press keys [**Shift**] [**▼**] to decrease the frequency by 12.5 kHz. Repeat this operation, a series of waveform with equal interval frequency difference can be generated. The same procedure can be used for the amplitude operation. This method is only used on the frequency and amplitude of channel A.

3.1.3 Knob Adjustment

In some applications, it requires to adjust the output signal continuously. Using the rotary knob can complete this

task. On the top of the displayed parameter, there is a triangle-shape cursor. Press key [◀] or [▶] to move the cursor left or right. Rotate the knob to the right to continuously increase the cursor-located digit by 1 and make the carry to a higher unit position. Rotate the knob to the left to continuously decrease the cursor-located digit by 1 and make the carry to a lower unit position. When you use the knob to modify a specified data, the modified data is validated instantaneously without pressing the unit key. A coarse adjustment is made by moving the cursor to the left; and a fine adjustment is made by moving the cursor to the right.

3.1.4 Input Mode Selection

It is convenient to input the known data through the numeric keypad. It makes the input be set at only one step without the intermediate transition data. For the partial modification of the input data or at the situation of monitoring the variation process of the input data, the rotary knob is usually more useful. For a series of equal interval data input, the step input method is the most efficient. Users can use the different data input methods according to different situations.

3.2 Setup of Channel A

Press key [CHA/CHB] and select “CHA Alone” function. The upper-left area of LCD displays the waveform name of channel A.

3.2.1 Set the Frequency of Channel A

Press key [FREQ] to display the current frequency. Input a new frequency data here by numeric keypad or rotary dial. Press the key corresponding to the frequency units to confirm the new data input. The function generator outputs the specified frequency at CHA Output.

3.2.2 Set the Period of Channel A

The frequency of the channel A can also be set and displayed in the way of period. Press keys [Period] to display the current period. Input a new period data here by numeric keypad or rotary dial. Press the key corresponding to the period time units to confirm the new data input.

However, the instrument still uses the frequency synthesis internally and the input data is just converted to the correct value when it is input and displayed. Due to the limitation of the lower resolution at low frequency ($40\ \mu\text{Hz}$), when the period is too long, the function generator can only generate the frequency points with the longer period interval. Although the preset and displayed period is precise, the actual period of the output signal has the relatively big variation. Users shall pay attention to this point.

3.2.3 Set the Amplitude of Channel A

Press key [AMPL] and select amplitude of channel A. Input a new amplitude data here by numeric keypad or rotary dial. The function generator outputs the amplitude signal at the CHA Output.

3.2.4 Amplitude Format

The input and display of the Channel A amplitude value have two formats: Vpp and Vrms. Press keys [Shift] [Vpp] after numeric input to input and display amplitude peak-to-peak value. Press keys [Shift] [Vrms] after numeric input to input and display amplitude true RMS value. The displayed amplitude value varies with the

format conversion simultaneously.

Although the amplitude value has two formats, the instrument still uses the peak-to-peak format internally and makes the format conversion on the data input and the data display. Due to the limitation of the amplitude resolution, there is a difference between the format conversions. For example, if the V_{pp} of sine wave is $1V_{pp}$, the V_{rms} conversion value is $0.353V_{rms}$. If the V_{rms} of sine wave is $0.353V_{rms}$, the V_{pp} conversion value is $0.998V_{pp}$. In most of cases, this difference is within the error range. If the square waveform is selected, the conversion factor is 2. The V_{rms} format can only be used at the “CHA Alone” mode and the waveform selected as sine or square wave. For other operations and waveforms, only peak-to-peak format can be used.

3.2.5 Amplitude Attenuation

Press keys [**Shift**] [**ATT**] to select the attenuation of channel A. After instrument power on or reset, the attenuation is default in “AUTO” mode. In “AUTO” mode, the instrument automatically selects suitable attenuation ratio according to preset amplitude values. When the output amplitude is at 2V, 0.2V, or 0.02V, the instrument switches between attenuation ratios. In this situation, the instrument generates a waveform of high amplitude resolution, high signal & noise ratio, and low distortion, regardless of signal amplitude values. However, during attenuation ratio switch, there is instant hopping in the output signal, which is not allowed in some practices. That is why the instrument has preset with fixed attenuation mode.

Press keys [**Shift**] [**ATT**]. An attenuation data can be input here by numeric keypad or rotary dial. There are five ranges of attenuation: 0dB, 20dB, 40dB, 60dB and AUTO, which can be input by numeric key 1, 2, 3, 4 and 0 respectively plus the soft key corresponding to [**dB**]. The attenuation mode can also be selected by rotary dial. One step in rotary dial tuning goes to one range. If a fixed attenuation mode is selected, the attenuation is fixed and does not change according to amplitude value changes, which make continuous variation of the output signal in full amplitude range. But in range of 0dB, if the signal amplitude value is too small, there will be higher waveform distortion and the signal & noise ratio can not be so good.

3.2.6 Output Load

The default amplitude value is calibrated when the output is open circuit. The real voltage on the output load is the default amplitude multiplying the dividing ratio of the load impedance and the output impedance. The output impedance of the instrument is about 50Ω . When the load impedance is big enough and the voltage dividing ratio is close to 1, the loss on the output impedance can be ignored. The voltage on the load is close to default amplitude value. When the load impedance is too small, the loss on the output impedance is significant and can not be ignored. The voltage on the output load is not same as the default amplitude value. Please pay attention to this point.

The output of channel A has the over voltage and over current protections. The instrument can not be damaged if the output is short-circuit for a few minutes or the transient inverse voltage is less than 30V. However, this kind of operation should avoid in case of potential damage to the instrument.

3.2.7 Amplitude Flatness

If the output frequency is lower than 1MHz, the amplitude and frequency characteristics of the output signal are very flat. If the output frequency is over 10MHz, due to the characteristics of the output amplitude and load matching, the amplitude and frequency characteristics of the output signal will not be so good. The maximum

output amplitude is also affected. The higher frequency is, the higher amplitude and the more distortion will be in output waveform.

3.2.8 Set the Offset of Channel A

Press key **[Offset]** and select “CHA Offset”. The current offset value is shown on the LCD display. Input a new offset data here by numeric keypad or rotary dial. Press the key corresponding to the offset units to confirm the new data input. The function generator outputs the desired signal at the CHA output.

Please note that the sum of half of the signal output amplitude value and the offset value should be less than 10V, so as to make sure the offset signal peak value is less than $\pm 10V$. Otherwise, there will be amplitude distortion. Besides, when Channel A is at AUTO attenuation, the output offset attenuates as per amplitude attenuation. When amplitude V_{pp} value is above about 2V, the actual output offset is the preset offset value. When amplitude V_{pp} value is approximately between 0.2V~2V, the actual output offset is 10% of the preset offset value. When the amplitude V_{pp} value is approximately less than 0.2V, the actual output offset is 1% of the preset offset value.

When adjusting DC offset value of the signal, the rotary knob is more frequently used than numeric keypad. As a common rule, tune the rotary knob to the right to increase DC offset level, while to the left to decrease the DC offset value, regardless of the DC offset value as positive or negative. When the rotary knob tune across zero, the offset value changes automatically between positive and negative signs.

3.2.9 DC Voltage Output

When the attenuation of channel A is set at 0dB, the output offset is the preset offset value, regardless of amplitude values. If the amplitude value is set at 0V, the offset value can be set at any value between -10V and +10V. In this situation, the instrument becomes a DC power source, which can output preset DC voltage signal.

3.2.10 Select the Waveform of Channel A

The channel A can output three kinds of waveforms: sine wave, square wave, and pulse wave. Press shortcut function key on the front panel to select the corresponding waveform. The selected waveform will be output at CHA output.

Press keys **[Shift]** [\sim] to select sine wave.

Press keys **[Shift]** [\square] to select square wave. The duty cycle of square wave is default to 50%.

Press keys **[Shift]** **[Duty]** to select pulse wave.

3.2.11 Set the Duty Cycle of Channel A

Press keys **[Shift]** **[Duty]** to select pulse wave. The pulse duty cycle is shown on the LCD display. A new duty cycle data can be input here by numeric keypad or rotary dial. The duty cycle value can be set at any value between 0.1%~99.9%. When the converted duty cycle value is less than 0.1%, the duty cycle value is displayed as 0.1%. When the converted duty cycle value is greater than 99.9%, the duty cycle value is displayed as 99.9%.

3.2.12 Frequency and Amplitude Step Input

In “CHA Alone” mode, it is very convenient to use the step input method to enter a set of frequency or amplitude value with same interval. For details, please refer to section 3.1.2. This step input method is only used on the frequency and amplitude of channel A.

3.2.13 Set the Phase of Channel A

Press keys [Shift] [Phase] to select “Phase” option. The phase value is shown on the LCD display. Input a new phase data here by numeric keypad or rotary dial. The phase can be adjusted at any value between 0~360 degree. The phase resolution is 11.25 degree.

3.2.14 Set the Output Impedance of Channel A

Press key [Menu] and select “Impedance” option. The impedance value is shown on the LCD display. The function generator is default as high impedance. The impedance value can be set by numeric keypad or rotary dial and the output impedance is 50Ω.

3.3 Setup of Channel B

Press key [CHA/CHB] and select “CHB Alone” function. The upper-left area of LCD displays the channel B waveform name or index number.

3.3.1 Select the Waveform of Channel B

There are 32 kinds of waveforms in channel B. Press keys [Shift] [B Wave] to select “CHB Wave”, the current waveform name and index number are shown on the bottom of the LCD display. Enter the index number by using the numeric keypad or rotary knob, press the soft key corresponding to [No.] to confirm the index number input. Users can use the shortcut function key on the front panel to select the 4 frequently-used waveforms.

Press keys [Shift] [~] to select sine wave.

Press keys [Shift] [□] to select square wave.

Press keys [Shift] [B- ~] to select triangle wave.

Press keys [Shift] [B- ✓] to select ramp wave.

The function generator outputs the selected waveform at the CHB Output. For 4 frequently-used waveforms, they are displayed as waveform name in the upper-left portion of the LCD. As to the other 28 waveforms which are not frequently used, they are displayed as “Arb” in the upper-left portion of the LCD. The index number and name of the 32-waveform are shown as the table below.

The Index Number and Waveform Name of Channel B

Index Number	Name	Index Number	Name
00	Sine	16	Exponent
01	Square	17	Logarithm
02	Triang	18	Half round
03	Up ramp	19	Tangent
04	Down ramp	20	Sin(x)/x
05	Pos-pulse	21	Noise
06	Neg-pulse	22	Duty 10%
07	Tri-pulse	23	Duty 90%
08	Up stair	24	Down stair
09	Pos-DC	25	Po-bipulse
10	Neg-DC	26	Ne-bipulse
11	All sine	27	Trapezia
12	Half sine	28	Coscine
13	Limit sine	29	Bidir-SCR

14	Gate sine	30	Cardiogram
15	Square-root	31	Earthquake

3.3.2 Set the frequency of Channel B

Press key **[FREQ]** and select “CHB Frequency”. Input a new frequency data here by numeric keypad or rotary dial. There will be corresponding frequency output in CHB output terminal. The displayed units can be MHz, kHz, Hz, mHz. The resolution is 40 mHz. Same as channel A frequency, channel B frequency can also be set and displayed in the way of period.

3.3.3 Set the Amplitude of Channel B

Press key **[AMPL]** and select “CHB Amplitude”. Input a new amplitude data here by numeric keypad or rotary dial. Press the soft key corresponding to the amplitude units to confirm the new data input. The function generator outputs the desired signal at CHB Output. The amplitude unit of Channel B can only use Vpp but not Vrms. The channel B does not have the amplitude attenuation or DC offset functions.

3.3.4 Set the Harmonic Wave

The frequency of channel B can be set and displayed as multiple times of channel A frequency. That is, channel B signal becomes the multiple N times harmonic of channel A signal.

Press keys **[Shift] [Harmonic]** to select “CHB Harmonic”. Input harmonic times via numeric keypad or rotary dial. Press the soft key corresponding to **[TIME]** to confirm the new data input. Channel B frequency becomes the set multiple times of channel A frequency. That means, channel B signal becomes the multiple N times harmonic of channel A signal. At this time, phase of channel A and B signals has stable synchronization. Press keys **[Shift] [Phase]** to select “CHB Phase”. Input phase value via numeric keypad or rotary dial. In this mode, the phase difference of the CHA and CHB signals can be set. If there is a difference between the output phase difference and the preset phase difference, please adjust the channel B phase. Connect the channel A and B signals to an oscilloscope to change the phase difference, so that all kinds of stable Lissajou’s figures are generated. If channel B is not selected, channel A and B will not have synchronization. Although channel B frequency is set at a multiple time of channel A frequency, channel A and channel B may not able to reach synchronization. Therefore, to make sure of stable phase synchronization of channel A and B, user must first set up channel A frequency, next select “B harmonic” and set harmonic time so that channel B frequency can change automatically.

3.3.5 Set the Phase of Channel B

Press keys **[Shift] [Phase]** to select “Phase” option. The phase value is shown on the LCD display. Input a new phase data here by numeric keypad or rotary dial. The phase can be adjusted at any value between 0~360 degree. The phase resolution is 1 degree.

3.3.6 Sum of Channel A and Channel B Signals

After power on the instrument, the signals of channel A and channel B are completely independent. Signals from the two channels can be summed together.

Press key **[Menu]** and select “A B ADD” mode. The add switch “On” or “Off” can be set by using the numeric keypad or rotary dial. The output signal on CHA output becomes the linear sum of channel A and channel B signal. In this situation, frequency and amplitude of channel A and channel B are still in independent mode and

can be set independently. This function is very useful in the applications of filter experiment and waveform analysis. To return to independent channels, press add switch “Off” by using the numeric keypad or rotary dial. The sum of signals of channel A and channel B can only apply in the mode of CHB Alone. In other working mode, channel A and channel B signals are completely independent.

3.4 Frequency Sweep

Press key [**Sweep**] and select “CHA Sw Fr” function. “CHA Sw Fr” is shown on the upper-left of LCD. The function generator outputs the frequency sweep signal at the CHA Output. The sweep mode of output frequency is step sweep. The output frequency automatically increases or decreases by a step value in a certain interval time. Start frequency, stop frequency, sweep time, sweep mode and trigger mode are free to be set by the users.

3.4.1 Set the Start and Stop Frequency

The frequency at sweep starting is called start frequency. The frequency at sweep ending is called stop frequency. Press key [**Menu**] and select “Start Freq” option. Input a new start frequency data here by numeric keypad or rotary dial. Press the soft key corresponding to the frequency units to confirm the new data input. To set the stop frequency, press key [**Menu**] and select “Stop Freq” option. Input a new stop frequency data here by numeric keypad or rotary dial.

Note: the stop frequency must be greater than the start frequency. Otherwise the sweep can not operate.

3.4.2 Set the Sweep Direction

The frequency sweep has three directions represented by three index numbers: 0, 1 and 2.

Up Sweep (0 Up Sweep): the output signal sweeps from the start frequency to the stop frequency at the preset sweep rate.

Down Sweep (1 Down Swe): the output signal sweeps from the stop frequency to the start frequency at the preset sweep rate.

Up-Down Sweep (2 UpDownS): the output signal sweeps from the start frequency to the stop frequency at the preset sweep rate, then sweeps from the stop frequency to the start frequency at the same sweep rate.

Press key [**Menu**] and select “Sweep Direction” option. The instrument displays the index number and name of the sweep mode. User can input the index number or turn the knob to set the sweep mode.

3.4.3 Select the Sweep Mode

Press key [**Menu**] to select linear sweep or logarithmic sweep.

Linear sweep: the output signal changes linearly during the duration of sweep.

Logarithmic sweep: the output signal changes logarithmically during the duration of sweep.

3.4.4 Set the Sweep Time

After the start frequency and the stop frequency are set, the sweep time can be determined according to frequency step. The shorter sweep time is, the bigger frequency step will be. The longer sweep time is, the smaller frequency step will be. The minimum frequency update time is the software execution time.

Press key [**Menu**] and select “Sweep Time” option. Input a new sweep time here by numeric keypad or rotary dial. Press the soft key corresponding to the time units to confirm the new data input.

3.4.5 Single Sweep

After the “CHA Sw Fr” mode is selected, the frequency sweep starts. During the sweep, user can change the sweep parameter and sweep mode at any time. Press key **[Menu]** and select “Single Sweep” option, the sweep process stops at once. The output signal will keep at the stop state without any changes. The current frequency value is shown on the LCD display. After the sweep process stops, press key **[Trigger]** once, the sweep process goes on by one step. The frequency of Channel A will sweep according to the desired sweep mode.

3.4.6 AUTO Sweep

Press key **[Menu]** and select “CHA Frequency”. Frequency of channel A changes simultaneously according to the sweep process. Users can have dynamic monitor of the sweep process.

3.5 Amplitude Sweep

Press key **[Sweep]** and select “CHA Sw Ampl” function. “CHA Sw Ampl” is shown on the upper-left of LCD. The function generator outputs the amplitude sweep signal at the CHA Output. All operations of sweep parameter, sweep mode, single sweep, and sweep monitor apply the same operation procedures as explained in section Channel A frequency sweep.

3.6 Frequency Modulation (FM)

Press key **[MOD]** and select “CHA FM” option. “CHA FM” is shown on the upper-left of LCD. The function generator outputs the frequency modulation signal on the CHA Output.

3.6.1 Set the Carrier Frequency

Press key **[Menu]** and select “Carrier Freq” option. A new carrier frequency data can be input here by numeric keypad or rotary dial. Press the soft key corresponding to the frequency units to confirm the new data input. In the frequency modulation mode, the signal of Channel A is used as the carrier signal and the carrier frequency is the frequency of Channel A. In this mode, the clock signals of DDS synthesizer are switched from the fixed reference clock to the programmable reference clock, the accuracy and stability of the carrier frequency may decrease.

3.6.2 Set the Modulation Frequency

Press key **[Menu]** and select “Mod Freq” option. A new modulation frequency data can be input here by numeric keypad or rotary dial. Press the soft key corresponding to the frequency units to confirm the new data input. In the frequency modulation mode, the signal of Channel B is the modulation signal and the modulation frequency is the frequency of Channel B. Generally, the carrier frequency should be at least 10 times higher than the modulation frequency.

3.6.3 Set the Frequency Modulation Deviation

Press key **[Menu]** and select “FM Deviation” option. A new frequency modulation deviation data can be input here by numeric keypad or rotary dial. Press the soft key corresponding to **[%]** to confirm the new data input.

Deviation shows the variations of the carrier signal frequency during the frequency modulation. It is more intuitional to show the variation in the way of carrier waveform period variation. Variation in the frequency of

modulated waveform is shown as the equation below:

$$\text{DEVI}\% = 100 \times \text{SHIFT} / \text{PERD}$$

DEVI is the modulation frequency deviation;

SHIFT is the peak variation;

PERD is the period of the carrier signal at the zero frequency deviation.

In the modulation demonstration, to have clear observation of the frequency variation, a bigger frequency deviation should be set. In practices, to reduce the bandwidth of the carrier signal, the frequency deviation is usually less than 5%.

3.6.4 Set the Modulation Waveform

Since the signal of channel B as the modulation signal, the Channel B waveform is actually the modulated waveform. Press key [Menu] and select “Mod Wave” option. The index number and name of waveform are displayed on the LCD. Input the correct index number by numeric keypad or rotary dial to select corresponding waveform. Press the key corresponding to [No.] to confirm the index number input. The function generator outputs the desired modulated signal.

3.6.5 External Modulation Source

The frequency modulation can use the external modulation signal. There is a “Modulation In” connector on the rear panel to import external modulation signal. The external modulation signal frequency should be compatible to the frequency of carrier signal. The amplitude of external modulation signal should be adjusted according to the frequency deviation. The bigger the amplitude of external modulation signal is, the bigger the frequency deviation will be. In the external modulation mode, the frequency deviation should be set to 0 and turn off the internal modulation signal. Otherwise, it will affect the external modulation process. Similarly, in the internal mode, the frequency deviation should be set, and the external signal connection should be disconnected. Otherwise, the internal modulation will be affected.

3.7 Amplitude Modulation (AM)

Press key [MOD] and select “CHA AM” option. “CHA AM” is shown on the upper-left of LCD. The function generator outputs the amplitude modulation signal on the CHA Output. The operation of modulation parameter setup is same as the frequency modulation.

3.7.1 Set the Carrier Frequency

Press key [Menu] and select “Carrier Freq” option. Input a new carrier frequency data here by numeric keypad or rotary dial. Press the soft key corresponding to the frequency units to confirm the new data input. In the amplitude modulation mode, the signal of Channel A is the carrier signal and the carrier frequency is the frequency of Channel A.

3.7.2 Set the Modulation Frequency

Press key [Menu] and select “Mod Freq” option. Input a new modulation frequency data here by numeric keypad or rotary dial. Press the soft key corresponding to the frequency units to confirm the new data input. In the amplitude modulation mode, the signal of Channel B is the modulation signal and the modulation frequency is the frequency of Channel B. Generally, the carrier frequency is at least 10 times higher than the modulation frequency.

3.7.3 Set the Amplitude Modulation Depth

Press [Menu] and select “AM Depth” option. Input a new modulation depth data here by numeric keypad or rotary dial. Press the soft key corresponding to [%] to confirm the new data input. In the amplitude modulation mode, the amplitude of the carrier signal varies periodically with the modulation signal. The modulation depth represents the variation in the carrier signal.

For example, the 100% modulation depth represents that the maximum amplitude of modulation signal is 100% of the set value, the minimum amplitude of modulation signal is 0% of the set value, i.e. $100\% - 0\% = 100\%$. The 0% modulation depth represents that both maximum and minimum amplitude of modulation signal are 50% of the set value, i.e. $50\% - 50\% = 0\%$. Similarly, the 120% depth is $110\% - (-10\%) = 120\%$. The modulation depth has another expression: If the maximum modulation peak-to-peak value is A, the minimum peak-to-peak value is B, then the modulation depth is expressed as:

$$\text{DEPTH}\% = 100 \times (A-B) / (A+B)$$

Actually these two kinds of expressions are the same. However, the second one is easier to understand.

In the amplitude modulation demonstration, in order to clearly observe the amplitude variation, the modulation depth is set to a relative big value even greater than 100%. But in the practices, in order to avoid the distortion of the modulation signal, the modulation depth is generally set to less than 50%. This kind of modulation carrier is called the double-side carrier. Most of the middle-wavelength radio stations use this modulation.

3.7.4 Set the Modulation Waveform

Since the signal of channel B as the modulation signal, the Channel B waveform is actually the modulated waveform. Press key [Menu] to select “Mod Wave” option. Enter the correct index number by numeric keypad or rotary dial to select a waveform. Press the key corresponding to [No.] to confirm the index number input. The function generator outputs the desired modulated signal.

3.7.5 External Modulation

The amplitude modulation can use the external modulation signal. There is a “Modulation In” connector on the rear panel to import external signal. The frequency of external modulation signal should be compatible to the carrier frequency. The amplitude of external modulation signal should be adjusted according to amplitude modulation depth. The bigger amplitude of external modulation signal is, the bigger amplitude modulation depth will be. In the external modulation mode, the amplitude modulation depth should be set to 0 and turn off the internal modulation signal. Otherwise, it will affect the external modulation process. Similarly, in the internal mode, the amplitude modulation depth should be set, and the external signal connection should be disconnected. Otherwise, the internal modulation will be affected.

3.8 Burst Output

Press key [Burst] and select “CHB Burst” option. “CHB Burst” is displayed in the upper-left portion of the LCD. The function generator outputs a waveform with a specified number of cycles at the burst frequency continuously at the CHB Output. Each set has a preset burst count and there is a time interval between each burst.

3.8.1 Set the Frequency of Channel B

Since channel B signal is the burst source for burst output, frequency and amplitude of channel B signal should firstly be set up. The settings of the frequency and amplitude are introduced in the section 3.3.

3.8.2 Set the Burst Count

Press **[Menu]** and select “Cycles” option. Input a new burst count number here by numeric keypad or rotary dial. Press the key corresponding to **[CYCL]** to confirm the new data input. If the burst frequency is fixed, the maximum value of the burst count is limited. The lower burst frequency is, or we say the longer burst period is, the bigger the burst count number can be set. Vice versa, the smaller burst count number is. If the burst frequency is not set, the burst count can be set firstly and then the burst frequency value is adjusted in order to keep an appropriate time interval between each burst.

3.8.3 Set the Burst Frequency

Press **[Menu]** and select “Burst Freq” option. Input a new burst frequency data here by numeric keypad or rotary dial. Press the soft key corresponding to the frequency units to confirm the new data input. The burst frequency is determined by the Channel B frequency value and the burst count number. The multiple of channel B signal period value and burst count number is the time needed for a set of burst. In order to keep an appropriate time interval between each burst, the burst period should be greater than the time of a burst. Otherwise all bursts are connected to each other and the waveform is not the burst signal anymore.

3.8.4 Burst Start Phase

The start phase of each set of burst waveforms is fixed to 0° .

3.8.5 Set the Single Burst Mode

Press **[Menu]** and select “Single Burst” option. The function generator turns off the continuous burst mode and signal output is 0. In the single burst mode, press key **[Trigger]** once, the burst process executes once and the function generator outputs one burst waveform according to the preset value of the burst count. If the burst count number is set to 1, the single burst can be operated manually. If the “Single Burst” option is not selected, the burst process is back to the continuous burst mode. Burst count can be used to test the dynamic characteristics of the audio equipment and calibrate the counter.

3.9 Frequency Shift Keying (FSK)

In the digital communication and remote measurement systems, the transmission of the digital signal uses the Frequency Shift Keying (FSK) or Phase Shift Keying (PSK) method to encode the frequency or phase of the carrier signal. At the receiving station, the received signal is decoded and recovered to the original digital signal.

Press key **[MOD]** and select “FSK” option. The upper-left portion of the LCD displays “A_FSK”. The function generator outputs the FSK signal on the CHA Output. The frequency of the output signal is the alternative variation of the carrier frequency and the hop frequency. The interval time of alternation is adjustable.

3.9.1 Set the Carrier Frequency

Press **[Menu]** and select “Carrier Freq” option. Input a new carrier frequency here by numeric keypad or rotary dial. Press the key corresponding to the frequency units to confirm the new data input. In the FSK mode, the signal of the channel A is the carrier signal. The carrier frequency is the first frequency value of channel A signal.

3.9.2 Set the Hop Frequency

Press **[Menu]** and select “Hop Freq” option. Input a new hop frequency here by numeric keypad or rotary dial. Press the key corresponding to the frequency units to confirm the new data input. The hop frequency is the second frequency value of channel A signal.

3.9.3 Set the Interval Time

Press **[Menu]** and select “Interval” option. Input a new interval time data here by numeric keypad or rotary dial. Press the key corresponding to the time units to confirm the new data input.

3.10 Amplitude Shift Keying (ASK)

Press key **[MOD]** and select “ASK” option. The upper-left portion of the LCD displays “A_ASK”. The function generator outputs the ASK signal on the CHA Output. The amplitude of output signal is the alternative variation of the carrier amplitude and the hop amplitude. The interval time of alternation is adjustable.

3.10.1 Set the Carrier Amplitude

Press **[Menu]** and select “Carrier Ampl” option. Input a new carrier amplitude data here by numeric keypad or rotary dial. Press the key corresponding to the amplitude units to confirm the new data input. In the ASK mode, the channel A signal is the carrier signal. The carrier amplitude is the first amplitude value of channel A signal.

3.10.2 Set the Hop Amplitude

Press **[Menu]** and select “Hop Ampl” option. Input a new hop amplitude data here by numeric keypad or rotary dial. Press the key corresponding to the amplitude units to confirm the new data input. The hop amplitude is the second amplitude value of channel A signal. There may be a big difference between carrier amplitude and hop amplitude. In the ASK process, the generator attenuates according to channel A fixed attenuation, so as to avoid frequent relay switch during auto attenuation.

3.10.3 Set the Interval Time

Press **[Menu]** and select “Interval” option. Input a new interval time data here by numeric keypad or rotary dial. Press the key corresponding to the time units to confirm the new data input.

3.11 Phase Shift Keying (PSK)

Press key **[MOD]** and select “PSK” function. The upper-left portion of the LCD displays “A_PSK”. The function generator outputs the PSK signal on the CHA Output. The phase of the output signal is the alternative variation of the reference phase and the hop phase. The interval time of alternation is adjustable.

3.11.1 Set the Hop Phase

Press **[Menu]** and select “Hop Phase” option. Input a new hop phase data here by numeric keypad or rotary dial. Press the key that corresponds to [°] to confirm the new data input. The resolution of the hop phase is 11.25 degree. If users enter the phase value by using the numeric keypad, the instrument will round the input value to the number of times of 11.25 degree.

3.11.2 Set the Interval Time

Press **[Menu]** and select “Interval” option. The interval time value is shown on the LCD display. Input a new interval time here by numeric keypad or rotary dial. Press the key corresponding to the time units to confirm the new data input.

3.11.3 PSK Observation

Due to the phase variation caused by PSK signal, it is hard to have synchronization on the oscilloscope, and therefore cannot observe a stable waveform. If the frequency of the channel B is set at the same value of carrier frequency, and use channel B signals as synchronization burst signals, a stable PSK signal waveform can be observed.

3.12 Measure External Frequency

This function is available only when the user chooses to install the frequency counter. Press key **[Count]** to go to the external measurement mode. The LCD display shows the external measurement interface. In this mode, the instrument can be used as a frequency counter and measures the frequency value of the external signal.

3.12.1 Frequency and Count Measurement

Press **[Menu]** and select “Measure Freq” option. Connect the external signal to the “Count In” terminal on the rear panel. The instrument displays the frequency of measured external signal. The measured external signal can be periodical signal of the arbitrary waveform. The signal amplitude peak-to-peak value should be 100mVpp~20Vpp.

3.12.2 Set the Gate Time

Press **[Menu]** and select “Gate Time” option. Input a new gate time data here by numeric keypad or rotary dial. Press the key corresponding to the time units to confirm the new data input. During frequency measurement, the tested signal must be continuous. However, the measurement is intermittent. With the preset gate time as a cycle, the instrument makes sampling of the tested signal, analyzes the testing data and refreshes display. The instrument usually adopts average periodical measurement. The longer gate time is, the more cycle numbers to be collected from the testing signal, the more stable the average value will be, the more valid digits to get in testing results, but the slower tracking to the frequency variation will be, which is suitable to frequency testing requiring a long time of stability. The shorter gate time is, the less valid digits to get in testing results, the faster tracking to the frequency variation will be, which is suitable to frequency testing requiring a short time of stability.

3.12.3 Low-pass Filter

In the measurement of the external signal, if the signal frequency is relatively low and has high frequency noise, the measured data has bigger error and is not stable. Press **[Menu]** and select “LPF” option. Use the numeric keypad or rotary dial to change the display to “1 ON” and add a 100 kHz low-pass filter to the input signal. The low-pass filter filters out the high-frequency noise and makes the measured result much more accurate. If the frequency of the testing signal is relatively high, the low-pass filter may attenuate the signal, decrease the sensitivity of the measurement, and even result in the wrong testing data. In this situation, use the numeric keypad or rotary dial to change the display from “1 ON” to “0 OFF” and remove the 100 kHz low-pass filter. For the low frequency of square signal, because of steep edge of the signal, the trigger error is not significant. Therefore, the

low pass filter is not necessary here.

3.12.4 Self Check and Demonstration

The instrument is capable of using internal waveform to carry out self check and present demonstration. Use a test cable to connect the CHA terminal with the “Count In” terminal on the rear panel. Press **[Menu]** and select “Measure Freq”. The test result displayed is the current channel A frequency value. Since channel A frequency synthesizer uses the same clock with frequency tester, the test result does not have the affect of crystal error. Therefore the test result is highly accurate. However, in the situation of the external frequency measurement, due to the affect of crystal error, the accuracy and stability may not be as good as those in self checks.

3.13 Parameter Calibration

The parameter errors listed in the technical specification are the factory calibrated specifications. Long-time use or drastic changes in ambient temperature may enlarge the parameter errors. When the instrument is used as a precise testing instrument, a calibration should be carried out periodically. Press key **[CAL/SYS]** and select “User CAL” option. This function uses the calibration software to calibrate the three parameters through the keypad.

3.13.1 Calibration Code

Press key **[Menu]** and select “CAL Off” option. On the bottom-left of the LCD, “0 Off” is shown and indicates to input the calibration code, then enter a calibration code 666666 by numeric keypad and press the soft key corresponding to **[No.]**. The “0 Off” changes to “1 On”, which means the instrument is ready for parameter calibration following the ways below.

3.13.2 Calibrate the Frequency of Channel A

Press key **[Menu]** and select “CHA Freq” option. The calibration code of channel A frequency is displayed. At this time, the frequency of channel A is 2MHz. Use a frequency counter of at least 6 digits to test the frequency of channel A. In the mean time, rotate the knob to change the calibration code to change channel A frequency until channel A frequency has an accuracy of 10^{-6} . Since channel A frequency and Channel B frequency use the same fixed reference clock, after channel A frequency is calibrated, channel B applies the same accuracy.

3.13.3 Calibrate the Carrier Frequency

In the frequency modulation mode, the carrier frequency uses a programmable clock as its reference clock. Although the carrier frequency is the frequency of the channel A, it still needs to be calibrated. Press key **[Menu]** and select “Carrier Freq” option. The calibration code of carrier frequency is displayed. At this time, the frequency of channel A is 2MHz. Use a frequency counter to measure the frequency of channel A and adjust the calibration code by the rotary knob until channel A frequency has an accuracy of 10^{-3} .

3.13.4 Calibrate the Frequency Modulation Deviation

Press key **[Menu]** and select “FM Deviation” option. The calibration code of FM deviation value is displayed. At this time, the frequency of channel A is 2MHz. Use a modulation meter to measure the FM deviation of channel A and adjust the calibration code by the rotary knob until the accuracy is calibrated to 10^{-3} .

After calibration, press key **[Menu]** and select “CAL Over” option to exit the calibration mode. The calibration codes are stored into the nonvolatile memory of the instrument, and will not be lost after power off. The

calibration codes will be refreshed after a second calibration is carried out.

3.14 System Setup

3.14.1 Interface Setup

Press key **[SYS]** and select “Interface Type” option. The interface type is displayed. Users can select the USB/RS232 interface by numeric keypad or rotary dial.

3.14.2 Remote Address

Press keys **[SYS]** **[Menu]** to select “Remote Address” option. The remote address is displayed and can be modified by numeric keypad or rotary dial.

3.14.3 Language Setup

Press keys **[SYS]** **[Menu]** to select “Language Setup” option. The language is displayed. Users can select Chinese (simplified) /Chinese (traditional)/English by numeric keypad or rotary dial.

3.14.4 Beeper

Press keys **[SYS]** **[Menu]** to select “Beep Setup” option. The Beep On/Off is displayed. Users can select Beep On/Beep Off by numeric keypad or rotary dial.

3.14.5 Store and Recall Parameters

In some applications, it is required to frequently use a set of certain parameters, such as frequency, amplitude, offset, waveform, etc. It is very easy and convenient to store and recall these frequently used parameter settings. The instrument provides 40 index numbers (0-39) for the parameter memories, starting from index number 0 to 39. Memories of index number 1~39 are available for user defined setting storage, except memory of number 0. Memory index number 0 is for the storage of default parameters setup. Users also can input recall index number 0 to 39 to recall the stored settings in each memory. Input number 0 recalls the default parameter setting of the instrument. After the parameters are recalled, the instrument outputs the signal based on the recalled parameters.

After input a set of parameters, press key **[Store]** and select “Store” option, input the memory index number by numeric keypad, press the corresponding soft key of **[No.]** to store this set of parameter setting into the corresponding memory. Apply the same storage procedure to store up to 40 sets of parameter settings. The parameter memory uses a non-volatile memory, which can store the settings even the instrument is power off.

If you need to use the stored parameter later, press key **[Recall]** and select “Recall” option, input the recall index number and press the soft key corresponding to **[No.]**. The stored parameter setting is recalled. If press key **[Recall]** and select “Recall” option, then press key **[0]** and the soft key corresponding to **[No.]**, the default parameter settings is recalled. It can get the same result to press keys **[Shift]** **[Reset]**.

3.14.6 Software Version

Press keys **[SYS]** **[Menu]** to select “Software version” option. The software version is displayed.

Chapter 4 Programmable Interface

This chapter introduces the usage of the programmable interface. Through the study of this chapter, you will learn how to setup the testing system and use the testing software to program the instrument.

4.1 Interface Application

Nowadays, the application of computer is prevalent. The traditional test equipment is gradually replaced by the digital test devices. Most of the manual testing tasks have been replaced by the automatic testing systems based on the computer control technology, which is an inevitable trend in testing & measuring field. Today almost all high-end and middle-end test equipments have the communication interfaces. With the interfaces, the test equipments can be connected to the computer with the communication cables to make a testing system. During the test, all the devices or equipments in the system can communicate with each other through the interfaces and cables. Based on the preprogrammed test software, the remote computer can control various devices and make them work coordinately. For example, first, the remote computer sends a command to the function generator to request it to output an appropriate signal. Secondly, the computer sends commands to the frequency meter and voltage meter to measure the frequency and voltage. After collecting all measurement data, the computer processes and analysis the data, and finally prints out the test report. In this example, all complicated tasks are completed by the automatic testing system. What the testing engineer needs to do is to write a testing program. A good testing system can not only save a lot of labor and improve the efficiency, but also provide the reliable results and reduce the risk of the mistakes and faults caused by the testing engineer. In some situations, the automatic testing system can even complete the test tasks which cannot be done by the manual test ways.

4.2 Interface Selection

The instrument has two kinds of interfaces.

4.2.1 USB Interface

The USB interface has the advantages of the high transmission rate, high reliability, easy-to-use, and plug-in play. It is a commonplace on all current computers and devices.

4.2.2 RS232 Interface

The RS232 interface is the serial asynchronous communication interface. It has the characteristics of the long transmission distance and less number of transmission wire. Most of the current computer has the RS232 interface. Recently, RS232 interface is gradually being replaced by USB interface because of its low transmission rate and inconvenient connection.

4.3 USB Interface

The USB protocol used in this instrument meets the standard of USB V1.1.

4.3.1 Interface Pin Assignment

Power Line: +5V and GND;

Signal Line: D+ and D-, three-state bidirectional.

4.3.2 USB Interface Connection

Connect the USB connector on the front panel to the USB connector on the computer with a USB cable.

4.3.3 Operation Instruction

The detailed information is on the CD-ROM shipped with the box.

4.3.4 Environment

The USB adapts the short distance data transmission in the common lab and production environment.

4.4 RS232 Interface

The RS232 used in the instrument meets the standard of EIA-RS232.

4.4.1 Interface Voltage Level

Logic "0": +5 V to +15 V;

Logic "1": -5 V to -15 V.

4.4.2 Transmission Format

Each transmission frame consists of eleven bits: 1 start bit (logic "0"), 8 data bits (ASCII code), 1 index bit (address logic = "1", data logic = "0"), 1 stop bit (logic "1").

4.4.3 Transmission Rate

In this instrument, the transmission rate is set to 19200 bits/s and can be reset in the software.

4.4.4 RS232 Interface Connection

Connect the RS232 connector on the rear panel to the COM1 or COM2 connector on the computer with a RS232 cable.

4.4.5 System Construction

In one system, the maximum number of connected instruments is 99 and the total length of connection cable cannot exceed 100 meters.

4.4.6 Applications

The RS232 adapts the data transmission in the common lab and production environment without heavy electrical interference.

4.4.7 Address Information

In the programmable mode, the instrument starts to receive the message from computer, checks the index bit, and

determines the received message is either address message or data message. If it is an address message, check whether the received address matches its own address or not, if not, ignore all following messages and wait for the next address message. If the address matches, the instrument starts to receive the following data message until the whole message is received.

4.4.8 Data Information

After receiving the data message, the instrument verifies and stores the data into the memory. If the received character is the line feed Chr (10), it means that this is the end of the data message. The instrument starts to execute each operation in this remote command.

4.5 Remote Command

The remote command is a series of ASCII code strings sent by the host computer. The operation of the instrument is based on the remote command. Every instrument has its own defined command format. In order to control the instrument successfully, users have to follow the rules when writing the application program.

1 Remote command; <u>CHA:AFREQ:1.31:MHz</u> ↑ ↑ ↑ ↑↑ ↑ ↑ 1 5 2 53 5 4	2 Remote command (without digit and unit); <u>CHA:SQUAR</u> ↑ ↑ ↑ 1 5 2	3 Inquiry command <u>CHA:?AFREQ</u> ↑ ↑ ↑ 1 6 2
--	--	--

1: Function string 2: Option string 3: Data string 4: Unit string 5: Separate character 6: Question mark
The remote command consists of the function string, the option string, the data string, the unit string, the separate character, and the question mark. Some commands do not include the data string or the unit string. (Please refer to the software in the CD ROM attached to the function generator.)

4.5.1 Command String

The instrument remote commands consist of the function string, the option string, the data string, and the unit string shown in the tables below. Both function and option strings use the uppercase characters. Every definition is corresponding to the instrument functionality and option. The data string consists of 10 digits from 0 to 9, decimal point, and negative sign. The unit string consists of the defined uppercase and lowercase characters depending on the data characteristics. Except the characters in the table, the other characters can not be used. Otherwise, error occurs.

The Table of the Function Command

Option	String	Option	String
Frequency of channel A	CHA	Amplitude modulation of channel A	AM
Frequency of channel B	CHB	Burst of channel B	BURST
Frequency sweep of channel A	FSWP	FSK of channel A	FSK
Amplitude sweep of channel A	ASWP	ASK of channel A	ASK
Frequency modulation of channel A	FM	PSK of channel A	PSK
External frequency measurement	COUNT	System	SYS
Return to local	LOCAL	RS232 control	RS232
USB control	USB		

The Table of the Option Command

Option	String	Option	String	Option	String
CHA frequency	AFREQ	Interval time	INTVL	Hop phase	HOPP
CHA period	APERD	Start amplitude	STARA	Single trigger	TRIGG
CHA amplitude	AAMPL	Stop amplitude	STOPA	Sine waveform	SINE
CHA offset	AOFFS	Burst count	NCYCL	Square waveform	SQUAR
CHA attenuation	AATTE	Burst frequency	BURSF	CHB triangle waveform	BTRIG
CHA duty cycle	ADUTY	Single burst	ONCES	CHB ramp waveform	BRAMP
CHB frequency	BFREQ	Carrier frequency	CARRF	Store parameter	STORE
CHB amplitude	BAMPL	Carrier amplitude	CARRA	Recall parameter	RECAL
CHB waveform	BWAVE	FM deviation	DEVIA	System reset	RESET
CHB harmonic wave	BHARM	AM depth	DEPTH	Phase	PHASE
Peak-to-peak value	VPP	Modulation frequency	MODUF	Signal source	SOURCE
Root mean squared value	VRMS	Modulation waveform	MWAVE	Beeper	BEEP
Start frequency	STARF	Hop frequency	HOPF	CHB period	BPERD
Stop frequency	STOPF	Hop amplitude	HOPA	Gate time	STROBE
Sweep type	MODEL	Low pass filter	LPF	Measurement frequency	MEASF
Sweep mode	TYPE	Language setup	LANG	Interface address	ADDR
Output switch	SWITCH	Software version	VER		

The Table of the Data Command

Data	String	Data	String
Digit	0 1 2 3 4 5 6 7 8 9	Decimal Point	•
Negative Sign	-		

The Table of the Unit Command

Unit	String	Unit	String
Frequency	MHz, kHz, Hz, mHz	Phase	DEG
Peak-to-peak Value	Vpp, mVpp	Attenuation	dB
Time	s, ms	Index	No.
Harmonic wave	TIME	Percentage	%
Burst count	CYCL	DC offset	Vdc, mVdc
RMS	Vrms, mVrms		

4.5.2 Character Return

The length of a remote command cannot exceed 60 characters. Every string is ended with a Chr (10), meaning an end to a data string.

4.5.3 Separate Character

The separate character has to be placed between the function and option strings, between the option and data strings, between the data and unit strings, and between the function string and question mark.

4.5.4 Question Mark

Adding the question mark (?) before the option string will be return to the corresponding value and unit, if no unit, the instrument will only return to the value.

4.5.5 Data String

The maximum length of the data string is 10 characters.

4.5.6 Control Capability

The remote commands can control all instrument functionalities.

4.5.7 Serial Port Control

In the serial port control mode, users should firstly send the instrument's address and select the corresponding instrument, next send the remote commands. If the USB interface is used, no need to send the address message. Select the corresponding device on the computer directly.

4.5.8 Online Operation

First, send the interface select command. For example, send “address + RS232” command to select the RS232 interface. The instrument will switch to the RS232 remote mode. If the address of the instrument is 88, send “88RS232”. To exit this remote control mode, send “88LOCAL” or press key **[Shift]** to make the instrument back to the normal key operation mode. Otherwise, neither the key operation nor the other remote controls can be used.

4.6 Application Software

In the automatic testing system, the application software is a control program which is written by the testing engineers for the accurate control on the variety of instruments and devices. Users have to read the details of this guide before starting to write the application program. It is quite easy to program as long as you are familiar with the manual operations and transfer each manual operation to the program of each remote command gradually. The application program can be written by a variety of computer languages.

4.6.1 Enter the Program Mode

After power on, the instrument is in the manual operation mode. When the remote command is received, the instrument enters the remote operation mode. At this time, all the key functions are not available. The instrument can only be operated by the remote command. To return to the manual operation mode, send the “Address + LOCAL” (for example “88LOCAL”) command from the computer to tell the instrument back to the manual operation mode. Or, press key **[Shift]** to return to manual operation.

4.6.2 Tips for Programming

Users have to pay attention to the program main points below when use the remote command to program.

- 1: Strictly follow the remote command format, including the uppercase and lowercase characters in the command code. Otherwise, the instrument will consider the command as a wrong message and ignore the operation.
- 2: Users should be familiar with the manual operation firstly and make sure the remote command sequence exactly same as the manual operation. The right sequence of the command should be the function string, the

option string, the data string, and finally the unit string. If the program sequence is not correct or the string does not match the corresponding functionality, although the instrument executes the code and does not give any error notice, the result may be wrong. For example, set the frequency of the channel A at 100 kHz, remote command: 100:AFREQ:kHz:100. This is a string in wrong sequence. Another example, select the No.3 waveform of channel B, remote command: CHA:BWAVE:3No., the command and function are not matching.

4.6.3 Application Example

The application examples of the variety type of the remote command are shown as followings. (No blanks in the command)

Example 1: Channel A, single output, frequency at 1MHz

RS232 mode: 88CHA:AFREQ:1:MHz

USB mode: CHA:AFREQ:1:MHz

Example 2: Channel B, single output, frequency at 1 kHz

RS232 mode: 88CHB:BFREQ:1:kHz

USB mode: CHB:BFREQ:1:kHz

Example 3: Channel A, single output, pulse wave, duty cycle at 25%.

RS232 mode: 88CHA:ADUTY:25%

USB mode: CHA:ADUTY:25%

Example 4: Frequency sweep output, start frequency at 1 kHz.

RS232 mode: 88FSWP:STARF:1:kHz

USB mode: FSWP:STARF:1:kHz

Chapter 5 Optional Parts

This chapter introduces the optional parts of the function generator which are not included as standard.

5.1 Programmable Interface

If users choose to purchase the USB or RS232 interface, the corresponding parts will be installed in the instrument. The detailed instruction has been described in Chapter 4.

5.2 Frequency Counter

If users choose to purchase the frequency counter, the frequency count board will be installed in the instrument. The input connector is the “Count In” connector on the rear panel. The detailed instruction has been described in section 3.12.

5.3 Power Amplifier

If users choose to purchase the power amplifier, the power amplifier board will be installed in the instrument. This is an independent part of the instrument, with input terminal “power amplifier input” and output terminal “2 time power amplifier output” located on the rear panel of the instrument. When using the power amplifier, use a connecting cable to input the signal to the input terminal “power amplifier input”. There will be a 2-time-amplified signal in the output terminal “2 time power amplifier output”. The input signal can be the channel A signal, or channel B signal, or external signal.

5.3.1 Input Voltage

The power amplifier can amplify the input voltage by 2 times. The maximum output amplitude is 22Vpp. Therefore, the maximum input amplitude should not exceed 11Vpp. Input amplitude exceeds this limit will cause distortion.

5.3.2 Frequency Range

The frequency range of power amplifier is 10Hz~150kHz. Amplitude flatness within this frequency range is better than 3%, and sine distortion is better than 1%. The maximum testing frequency is up to 200kHz.

5.3.3 Output Power

The equation for output power of power amplifier is:

$$P=V^2/R$$

P is the output power, with the unit of W

V is the output amplitude RMS value, with the unit of Vrms

R is the load resistance, with the unit of Ω

The maximum output amplitude is up to 22Vpp (7.8Vrms). The minimum load resistance is 2 Ω . As the ambient temperature increases, the output signal frequency increases too. The lower output signal distortion is required, the smaller the max.output power is. Generally, the maximum output power can be up to 7W (8 Ω) or 1W (50 Ω).

5.3.4 Output Protections

The power amplifier has short circuit protection and over heat protection. It may not be burnt out in common operation. However, to prevent damage to power amplifier's performance, long time short circuit output should be avoided. Please also avoid to frequently using the maximum value of the frequency, amplitude and load.

Chapter 6 Technical Specifications

6.1 Output Characteristics of Channel A

6.1.1 Waveform Characteristics

Waveform Type: sine, square, pulse, DC

Wave Length: 4 ~ 16000 points

Waveform Amplitude Resolution: 10 bits

Sample Rate: 180MSa/s

Sinusoidal Harmonic Rejection: $\geq 50\text{dBc}$ ($\leq 1\text{MHz}$), $\geq 40\text{dBc}$ ($1\text{MHz} \sim 20\text{MHz}$), $\geq 30\text{dBc}$ ($20\text{MHz} \sim 40\text{MHz}$)

Sine Wave Total Distortion: $\leq 0.5\%$ ($20\text{Hz} \sim 200\text{kHz}$)

Pulse Wave and Square Wave: rise or fall time: $\leq 20\text{ns}$, overshoot: $\leq 5\%$

Square Wave Duty Cycle: 50%

6.1.2 Frequency Characteristics

Frequency Range of Sine Wave: 2kHz ~ the maximum frequency, resolution: 40 mHz

40 μHz ~ 2kHz, resolution: 40 μHz

Frequency Range of Square Wave: 40 μHz ~20MHz

Frequency Range of Pulse Wave: 40 μHz ~10MHz

Frequency Accuracy: $\pm(5 \times 10^{-5} + 40\text{mHz})$

Frequency Stability: $\pm 5 \times 10^{-6}$ / 3 hours

6.1.3 Pulse Characteristics

Duty Cycle: 0.1%~ 99.9%

6.1.4 Amplitude Characteristics

Amplitude Range: 2mVpp ~ 20Vpp (high impedance)

Resolution: 20mVpp (amplitude > 2V), 2mVpp (amplitude < 2V)

Amplitude Accuracy: $\pm(1\%+2\text{ mVrms})$ (high impedance, RMS, frequency 1 kHz)

Amplitude Stability: $\pm 0.5\%$ / 3 hours

Amplitude Flatness: $\pm 5\%$ (frequency < 1MHz), $\pm 10\%$ (frequency between 1MHz~10MHz)

$\pm 20\%$ (frequency between 10MHz~60MHz)

Output Impedance: 50 Ω

Sine Wave Amplitude Setting Range (50 Ω)

1mVpp ~ 10Vpp, when output frequency $\leq 10\text{MHz}$

1mVpp ~ 5Vpp, when output frequency $\leq 40\text{MHz}$

1mVpp ~ 2Vpp, when output frequency $\geq 40\text{MHz}$

Amplitude Setting Range (high impedance)

2mVpp ~ 20Vpp, when output frequency $\leq 10\text{MHz}$

2mVpp ~ 10Vpp, when output frequency $\leq 40\text{MHz}$

2mVpp ~ 4Vpp, when output frequency $\geq 40\text{MHz}$

6.1.5 Offset Characteristics

Offset Range: ± 10 V (high impedance)

Resolution: 20mV

Offset Accuracy: $\pm(1\% + 20\text{mV})$

6.1.6 Sweep Characteristics

Sweep Type: frequency sweep, amplitude sweep

Sweep Range: free to set the start and stop points

Sweep Time: 100ms ~ 600s

Sweep Direction: Up, Down, Up-down

Sweep Mode: linear, logarithmic

Control Mode: auto sweep or manual sweep

6.1.7 Frequency Modulation Characteristics

Modulation signal: Internal or external waveforms

FM Deviation: 0%~20%

6.1.8 Amplitude Modulation Characteristics

Modulation signal: Internal or external waveforms

AM Depth: 0%~120%

6.1.9 Shift Keying Characteristics

FSK: Free to set the hop frequency and the carrier frequency

ASK: Free to set the hop amplitude and the carrier amplitude

PSK: hop phase: 0 ~ 360 degree, Resolution: 11.25 degree

Alternate Rate: 10ms ~ 60s

6.2 Output Characteristics of Channel B

6.2.1 Waveform Characteristics

Wave Type: 32 kinds of waveforms, like sine, square, triangle, sawtooth, ladder etc.

Wave Length: 1024 points

Waveform Amplitude Resolution: 8 bits

Sample Rate: 12.5MSa/s

6.2.2 Frequency Characteristics

Frequency Range: Sine: 10mHz ~ 1MHz, other waveforms: 10mHz ~ 100kHz

Resolution: 10 mHz

Frequency Accuracy: $\pm(1 \times 10^{-5} + 10 \text{ mHz})$

6.2.3 Amplitude Characteristics

Amplitude Range: 50mVpp ~ 20Vpp (high impedance)

Resolution: 20mVpp

Output Impedance: 50Ω

6.2.4 Harmonic Characteristics

Channel B frequency is the harmonic wave of channel A.

Harmonic Time: 0.1 ~ 250.0 times, Harmonic Frequency <1MHz

Phase Adjustment: coarse adjustment: 11.25 degree/step, fine adjustment: 2 degree/step

6.2.5 Burst Characteristics

Channel B signal is used as burst signal

Frequency of Channel B: 40mHz ~ 1MHz

Burst Frequency: 10mHz ~ 50kHz

Burst Count: 1 ~ 65000 cycles

Burst Mode: continuous burst and single burst

6.3 TTL Output Characteristics

Waveform Characteristics: square wave, rise or fall time ≤20ns

Frequency Features: same as sine wave of channel A

Amplitude Characteristics: TTL, CMOS compatible, low level <0.3V, high level >4V

6.4 Common Characteristics

6.4.1 Power Requirement

Power Requirements: AC220V ±10%

AC110V ±10% (Pay attention to the position of voltage selection switch)

Frequency: 50Hz ±5%

Power Consumption: <45VA

6.4.2 Environmental Condition

Temperature: 0 ~ 40°C

Humidity: <80%

6.4.3 Operation Characteristics

Key operation for all functions, menu display, rotary dial adjustment

6.4.4 Display Characteristics

Display: LCD, English, Chinese (simplified), Chinese (traditional)

6.4.5 Dimension and Weight

Machine dimensions: 385(D)×260(W)×110(H)mm

Chassis dimensions: 415(D)×295(W)×195(H)mm

Weight: 3.5 kg

6.4.6 Manufacturing

Manufacturing Process: Surface mount technology (SMT), large-scale integrated circuits, high reliability and long service life.

6.5 Optional Parts Characteristics

6.5.1 Remote Interface

USB Universal Serial Bus Interface

RS232 serial interface

6.5.2 Frequency Counter

Frequency Range: 1Hz ~ 200MHz

Input Signal Amplitude: 100mVpp ~ 20Vpp

6.5.3 Power Amplifier

Max.output Power: 7W (8Ω), 1W (50Ω)

Max.output Voltage: 22Vpp

Frequency Bandwidth: 1Hz~200kHz