

BENCHTOP INSTRUMENT

MYWAVE[®]

MFG-3000A Series
DDS Function Generator
Operation Manual

Part No. FGOM-060010E



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 $-10\sim 70^{\circ}\text{C}$. Note that the instrument operation may become unstable if it is operated in an ambient temperature exceeding the range of $0\sim 40^{\circ}\text{C}$

3. Power Supply



AC Input voltage: $110\text{V}\sim 120\text{V}/220\sim 240\text{V} \pm 10\%$, 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 three models to choose from this series, with max.frequency range of 10MHz, 20MHz, 40MHz.

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) TFT 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)
- High Amplitude Resolution: maximum resolution is 1 μ Vpp (high impedance), minimum output amplitude is 1mVpp (high impedance)
- Phase Adjustment: free to set the phase of the signal (sine) from two channels
- 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, and 8 user defined arbitrary 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 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: standard 200MHz frequency counter, capable of external frequency signal testing
- Remote Control: standard USB and RS232 interface

Check List

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

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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: AC200V~AC240V 50Hz

AC100V~AC127V 60Hz (Pay attention to the position of voltage selection switch)

Frequency: 50Hz (1±5%)

Watts: <45VA

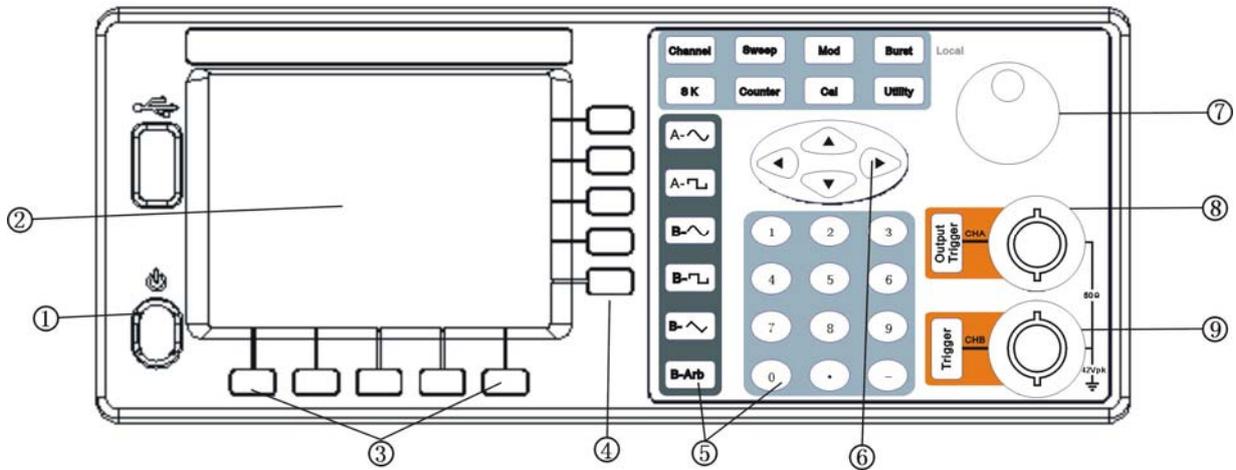
Temperature: 0~40°C Humidity: <80%

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.

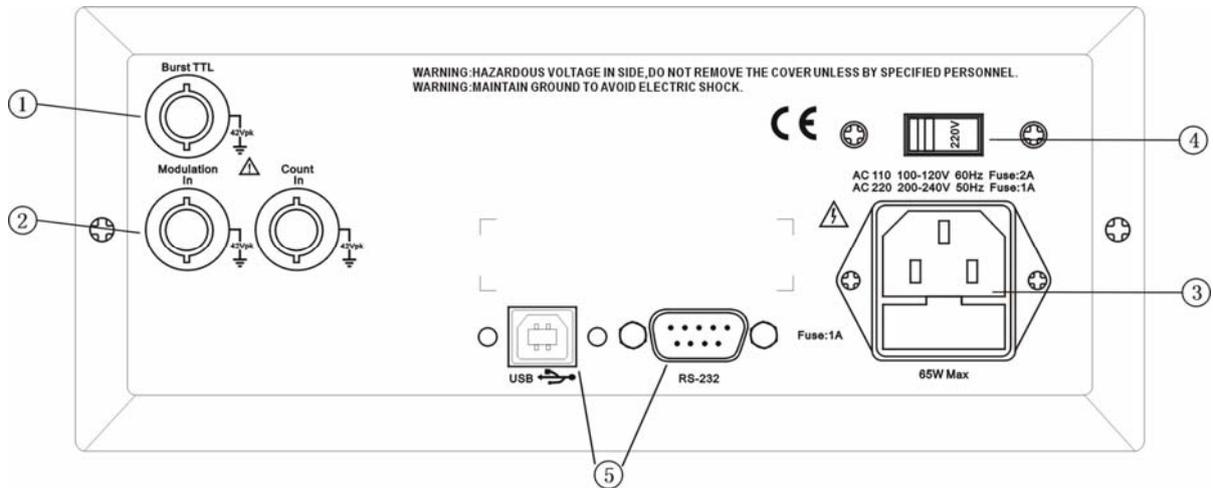
1.2 Front and Rear Panel

Front panel



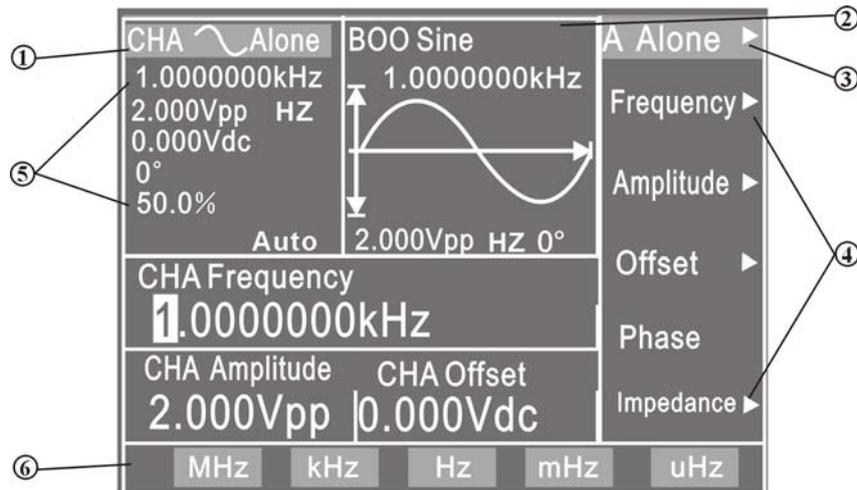
- | | | | |
|------------------------------------|----------------|----------------------|--------------------|
| 1. Power switch | 2. TFT display | 3. Unit soft key | 4. Software option |
| 5. Function key and Numeric keypad | | 6. Direction key | 7. Rotary knob |
| 8. Channel A output/trigger | | 9. Channel B trigger | |

Rear Panel



- | | |
|------------------------------|---|
| 1. Burst 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 TFT Display



1. **A Waveform Display:** at the upper-left display area, displays the waveform of channel A and preset parameter.
2. **B Waveform Display:** at the upper-central display area, displays the waveform of channel B under the variety functions.
3. **Function Menu:** at the right-side display area, displays the function menu on the first line.
4. **Option Menu:** at the right-side display area, displays the option menu from the second line to the sixth line.
5. **Parameter Menu:** at the lower-left display area, displays the waveform of channel A, frequency, amplitude, offset, phase and duty cycle.
6. **Unit Menu:** at the bottom of display area, displays unit menu on the bottom line of TFT display.

1.4 Key Description

On the front panel, there are 38 keys which are divided into five categories.

1.4.1 Function Key

Key **[Channel] [Sweep] [Mod] [Burst] [SK]**: select the ten functions of the instrument

Key **[Burst]**: the second function is to exit remote control.

Key **[Counter]**: select the function of frequency counter.

Key **[Utility]** and **[Cal]**: set the system parameter and calibration, also used to exit remote control.

Key **[A-~] [A-□]**: select the waveform of channel A.

Key **[B-~] [B-□] [B-~] [B-Arb]**: select the channel B waveform.

Key **[CHA Output/Trigger]**: turn on/off the output or the trigger signal of channel A.

Key **[CHB Trigger]**: trigger the signal of channel B.

1.4.2 Soft Key

There are five blank soft keys at the right side of TFT display. They are used to select the variety options under each function.

1.4.3 Numeric Keypad

Key **[0] [1] [2] [3] [4] [5] [6] [7] [8] [9]**: for numeric input.

Key **[.]**: decimal point.

Key **[-]**: negative sign (-).

1.4.4 Unit Soft key

There are five blank keys at the bottom side of the TFT display. The definitions of these soft keys change according to the characteristics of data. The input value has to be validated by pressing the unit soft key after data input.

1.4.5 Direction Key

Key [◀] and [▶]: cursor keys. Used to add or subtract the digit on the cursor when tuning the rotary knob.

Key [▲] and [▼]: Used to add or subtract the digit on the cursor.

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 [Channel] and select “CHA Alone” function by corresponding soft key on right side of the TFT.

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

Press key corresponding to “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 adjustments of other parameters.

Set the period of the channel A: set period at 25 ms.

Select “Period” by the corresponding soft key, 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.

Select “Amplitude” by the corresponding soft key, then press keys [3] [.] [2] and the soft key corresponding to [Vpp].

Set the amplitude of the channel A: set amplitude at 1.5 Vrms.

Select “Amplitude” by the corresponding soft key, then press keys [1] [.] [5] and the soft key corresponding to [Vrms].

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

Select “Offset” by the corresponding soft key, then press keys [-] [1] and the soft key corresponding to [Vdc].

Set the channel A attenuation: set attenuation as -4dB

Select “Attenuation” by the corresponding soft key, then press keys [2] [0] and the soft key corresponding to [dB].

Select the channel A waveform: select the square wave.

Press key [A-□].

Set channel A phase: set channel A phase at 90 degree

Press the soft key corresponding to [Phase], then press keys [9] [0] and the soft key corresponding to [°].

Set the channel A duty cycle: set the duty cycle at 25%.

Select “Duty” by the corresponding soft key, then press keys [2] [5] and the soft key corresponding to [%].

1.5.2 Function of Channel B

Press key [**Channel**] and select “CHB Alone” function by corresponding soft key on right side of the TFT.

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

Select the channel B waveform: select the triangle wave.

Press key [**B- \sim**].

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

Select “Phase” by the corresponding soft key, then select “Harmonic”;

Press key [**3**] and the soft key corresponding to [**Time**].

1.5.3 Frequency Sweep

Press key [**Sweep**] and select “CHA Sw Fr” function.

Set the start frequency: set the start frequency at 10 kHz.

Select “Start F” by the corresponding soft key

Press keys [**1**] [**0**] and the soft key corresponding to [**kHz**].

Set the stop frequency: set the stop frequency at 50 kHz.

Select “Stop F” by the corresponding soft key

Press keys [**5**] [**0**] and the soft key corresponding to [**kHz**].

Set the sweep time: set the interval time as 200 ms.

Select “Sweep Time” by the corresponding soft key

Press keys [**2**] [**0**] [**0**] and the soft key corresponding to [**ms**].

Set the sweep direction: set the Down sweep mode.

select “Down Swe” by the corresponding soft key

Set the sweep mode: set the logarithmic sweep mode.

select “Logarithmic” by the corresponding soft key

Set the sweep mode: set the manual sweep mode.

Select “Manual Sw” by the corresponding soft key.

This operation ceases the continuous sweep mode. Press the key [**CHA Trigger/Output**], the frequency steps up/down once. If the manual sweep mode is not selected, the instrument returns to continuous sweep. The displayed frequency values change simultaneously according to changes of sweep process.

1.5.4 Amplitude Sweep

Press key [**Sweep**] and select “CHA Sw Am”. Apply the same operation procedure as explained in section 1.5.3.

1.5.5 Frequency Modulation (FM)

Press key [**Mod**] and select “CHA FM”.

Set the carrier frequency: set the carrier frequency at 100 kHz.

Select “Carrier Freq” by the corresponding soft key

Press keys [**1**] [**0**] [**0**] and the soft key corresponding to [**kHz**].

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

Select “Carrier Amp” by the corresponding soft key

Press key [**2**] and the soft key corresponding to [**Vpp**].

Set the modulation frequency: set the modulation frequency at 10 kHz.

Select “Mod Freq” by the corresponding soft key

Press keys [1] [0] and the soft key corresponding to [kHz].

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

Select “FM Deviation” by the corresponding soft key

Press keys [5] and the soft key corresponding to [%].

Set the modulation waveform: set the modulation waveform (actually as the waveform of channel B) as the triangle wave.

Select “Mod Wave” by the corresponding soft key

Press key [2] and the soft key corresponding to [No.].

Set the external modulation

Select “Mod Wave” by the corresponding soft key, next select “External” by the corresponding soft key.

1.5.6 Amplitude Modulation (AM)

Press key [Mod] and select “CHA AM”.

The setups of the carrier frequency, carrier amplitude, modulation frequency, and modulation waveform apply the same operation method as explained in section 1.5.5

Set the AM depth: set the AM depth at 85%

Select “AM Depth” by the corresponding soft key, next press keys [8] [5] and the soft key corresponding to [%].

1.5.7 Burst Output

Press key [Burst] and select “CHB Burst”. The setup of the frequency and amplitude of channel B is same as the “CHB Alone” function.

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

Select “Cycles” by the corresponding soft key, next press key [5] and the soft key corresponding to [CYCL].

Set the burst frequency: set the burst frequency as 50 Hz.

Select “Frequency” by the corresponding soft key

Press keys [5] [0] and the soft key corresponding to [Hz].

Set the single burst mode:

Select “Single” by the corresponding soft key

This operation stops the continuous burst mode. Press key [CHB Trigger] once, the burst operates once. If the single burst mode is not selected, pressing on key [CHB Trigger] starts a continuous burst.

Set the internal burst: set the internal single burst mode.

Select “Single” by the corresponding soft key, next select “Int Burst” by the corresponding soft key. The channel B signal is used as the continuous burst signal source. Channel B must be at output ON status.

External TTL burst: set the TTL burst

Select “Int Burst” by the corresponding soft key, next select “TTL Burst” by the corresponding soft key.

Import the signal from “Count In” terminal through rear panel.

1.5.8 FSK Modulation

Press key [SK] to select “CHA FSK”.

Set the carrier frequency: set the carrier frequency at 15 kHz.

Select “Carrier Freq” by the corresponding soft key

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

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

Select “Carrier Amp” by the corresponding soft key

Press key [2] and the soft key corresponding to [Vpp].

Set the hop frequency: set the hop frequency at 2 kHz.

Select “Hop Freq” by the corresponding soft key

Press key [2] and the soft key corresponding to [kHz].

Set the Interval Time: set the interval time at 20 ms.

Select “Interval” by the corresponding soft key

Press keys [2] [0] and the soft key corresponding to [ms].

1.5.9 PSK Modulation

Press key [SK] and select “CHA PSK”. The setups of carrier frequency, amplitude, and interval time apply the same operation method explained in section 1.5.8.

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

Select “Hop Phase” by the corresponding soft key

Press keys [1] [8] [0] and the soft key corresponding to [°].

1.5.10 System Initialization Status

At power on, the system initialization status of the instrument is as the followings:

Channel A:

Waveform: sine wave	Frequency: 1.0000000kHz	Amplitude: 2.000Vpp
Start frequency: 500.00000Hz	Offset: 0.000 Vdc	Duty cycle: 50.0%
Stop frequency: 50.000000kHz	Start amplitude: 10mVpp	Time interval: 10ms
FM Deviation: 10%	Stop amplitude: 2.000Vpp	Sweep direction: Up
AM depth: 100%	Carrier frequency: 50kHz	Sweep mode: linear
Hop phase: 180 degree	Hop frequency: 5.0000000kHz	Modulation frequency: 1.0000000kHz
Output: Off	Sweep time: 1.000s	Output impedance: high impedance

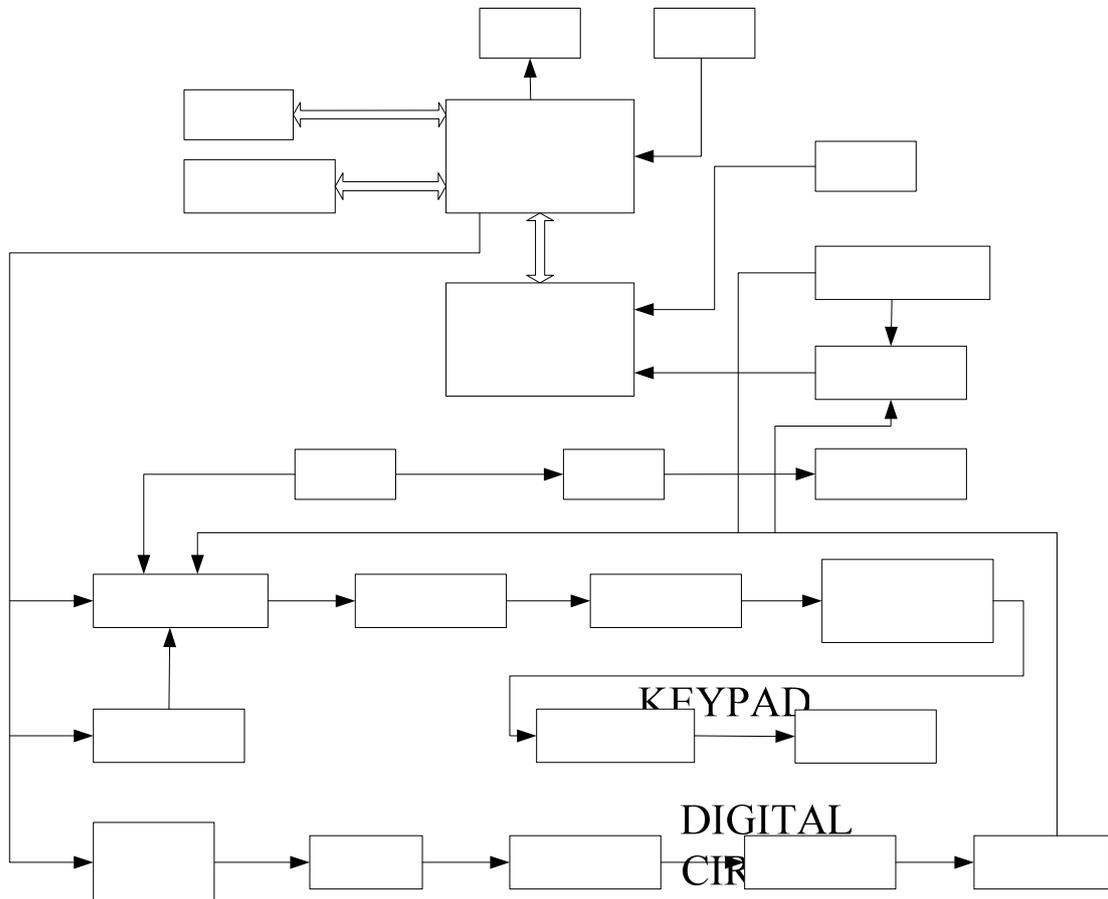
Channel B:

Waveform: sine wave	Frequency: 1.0000000kHz	Amplitude: 2.000Vpp
A harmonic: 1.0 Time	Phase: 0 degree	Mode: A B alone
Burst frequency: 100.0000000Hz	Burst count: 3 CYCL	

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 TFT 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 TFT 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 Menu Selection

If there is a triangle displayed on the right side of the menu, it means this menu has several options. Otherwise, this menu has only one option. Press one option key to select the corresponding option in this menu. The first line on the right side of TFT is function menu. This instrument has ten functions which are selected by the corresponding five function keys: [Channel], [Sweep], [Mod], [Burst], and [SK]. The second to the sixth lines are option menus which can be selected by pressing one of the five blank soft keys located on the right side of TFT. The selected menu will turn to green color.

3.1.2 Parameter Display

The area under the waveform display is for parameter display. The contents in this parameter area are divided into two parts. One is the name of parameter displayed in the 8×16 size text. The other is the parameter value displayed in various colors. These setups make the TFT display more beautiful and easier to recognize.

The parameter display is divided into the five areas below:

“Frequency” area: display the frequency or period value.

“Amplitude” area: display the output amplitude value. The frequency and amplitude parameters are displayed in a larger font size because of frequently use of these parameters.

“Offset and Other Parameters” area: display all other parameters except frequency and amplitude parameters. The bottom line in the TFT displays the units of parameters. The unit is selected by the corresponding blank keys under the TFT, and it changes according to variation of parameter values. The input data is validated only after selecting a correct unit.

“Parameter of Channel A” area: display the current waveform, function and the other parameters of the channel A.

“Parameter of Channel B” area: display the current waveform, function and the other parameters of the channel B.

3.1.3 Numeric Keypad Input

If a parameter is selected, the color of this parameter changes to yellow. It means this parameter can be modified. 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.

3.1.4 Knob Adjustment

In some applications, it requires to adjust the output signal continuously. Using the rotary knob can complete this task. When a parameter is selected, the color of this parameter changes to yellow. One digit in this parameter which is located by cursor changes to anti-color. 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.

3.1.5 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. Users can use the different data input methods according to different situations.

3.2 Setup of Channel A

Press key [Channel] and select “CHA Alone” function.

3.2.1 Set the Frequency of Channel A

Select “Frequency” option by the corresponding soft key. The current frequency value changes to yellow. 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. Select “Period” by the corresponding soft key. The current period value changes to yellow. 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, 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

Select “Vpp” or “Vrms” by the corresponding soft key. The current amplitude value changes to yellow. Input a new amplitude data here by numeric keypad or rotary dial. The function generator outputs the desired signal at the CHA Output.

The input and display of the Channel A amplitude value have two formats: Vpp and Vrms. Press key **[Vpp]** or **[mVpp]** after numeric input to input and display amplitude peak-to-peak value. Press key **[Vrms]** or **[mVrms]** after numeric input to input and display amplitude true RMS value.

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 Vpp of sine wave is 1Vpp, the Vrms conversion value is 0.353 Vrms. If the Vrms of sine wave is 0.353Vrms, the Vpp conversion value is 0.998Vpp. In most of cases, this difference is within the error range. If the square waveform is selected, the conversion factor is 2. The Vrms 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.

3.2.4 Amplitude Attenuation

Select “Offset” by the corresponding soft key, next select “Attenuation” by the corresponding soft key. Input a new attenuation value here by numeric keypad or rotary dial. Press the soft key corresponding to **[dB]** to confirm the new data input.

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 and 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.

Select “Attenuation” by the corresponding soft key. An attenuation data can be input here by numeric keypad or rotary dial. There are some ranges of attenuation: AUTO, 0dB, -4dB, -12dB, -16dB and etc., which can be input by numeric key 0, 1, 2, 3, 4 and so on 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.

3.2.5 Output Load

The default amplitude value is calibrated when the output load is 50Ω. 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 load 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 load 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.

3.2.6 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.

3.2.7 Set the Offset of Channel A

Select “Offset” by the corresponding soft key. The current offset value shown on the TFT display changes to yellow. 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 pay attention to the following conditions. In AUTO attenuation mode, when the peak-to-peak value is not higher than 4, the offset range should satisfy the following equation: $(\text{offset} + 0.5 \times \text{peak-to-peak amplitude}) \leq 2V_{dc} \times \text{attenuation coefficient}$. However, when peak-to-peak amplitude is not lower than 4, it should satisfy the following equation: $(\text{offset} + 0.5 \times \text{peak-to-peak amplitude}) \leq 10V_{dc} \times \text{attenuation coefficient}$. Besides, When Channel A is at fixed attenuation and preset offset value is between $-2V_{dc} \sim 2V_{dc}$, the sum of half of the signal output amplitude value and the offset value should be less than 2V, so as to make sure the offset signal peak value is less than $\pm 2V$. Otherwise, there will be amplitude distortion. At this time, the output offset attenuates as per amplitude attenuation and the actual output offset is preset value divided by attenuation coefficient.

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.

3.2.8 Select the Waveform of Channel A

The channel A can output three kinds of waveforms: sine wave, square wave, and pulse wave. Press function key [A-~], [A-□] to select the corresponding waveform. The duty cycle of square is default to 50%. When the duty cycle is selected, the waveform is switched to pulse wave and the duty cycle is adjustable.

3.2.9 Set the Duty Cycle of Channel A

Press function key [A-□], select “Duty” by the corresponding soft key. The current duty cycle value changes to yellow. 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 1%~99%. When the converted duty cycle value is less than 1%, the duty cycle value is displayed as 1%. When the converted duty cycle value is greater than 99%, the duty cycle value is displayed as 99%.

3.2.10 Set the Phase of Channel A

Select “Phase” by the corresponding soft key. The phase value changes to yellow. 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.

3.2.11 Set the Output Impedance of Channel A

Select “Impedance” by the corresponding soft key. The output impedance value changes to yellow. Input a new output impedance value by numeric keypad or rotary dial. Number 0 represents high impedance, number 1 represents 50Ω.

3.2.12 Set the Small Signal Output of Channel A

In “AUTO” attenuation mode, the minimum output signal for amplitude is 1mVpp (high impedance). The instrument can output smaller signal than 1mVpp. For example: to set the output signal as 0.4mVpp, firstly set the attenuation as -80dB (attenuation coefficient 10000), then set the amplitude as 4.000Vpp, so the instrument will output the 0.4mVpp (high impedance) signal at CHA output. Another example: to set the output signal as 0.1mVpp, firstly set the attenuation as -92dB (attenuation coefficient 39810), then set the amplitude as 3.981Vpp, so the instrument will output the 0.1mVpp (high impedance) signal at CHA output. When use this method to output small signal, in order to make sure of good signal & noise ratio, the preset amplitude of channel A should be set between 2.000Vpp ~ 4.000Vpp.

3.3 Setup of Channel B

Press key [Channel] and select “CHB Alone” function.

3.3.1 Set the frequency of Channel B

Select “Frequency” by the corresponding soft key. The current frequency value changes to yellow. Input a new frequency data here by numeric keypad or rotary dial. There will be corresponding frequency output in CHB output terminal. Same as channel A frequency, channel B frequency can also be set and displayed in the way of period.

3.3.2 Set the Amplitude of Channel B

Select “Vpp” by the corresponding soft key. The current amplitude value changes to yellow. 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, DC offset or output off functions.

3.3.3 Select the Waveform of Channel B

The channel B can output 32 pre-stored waveforms and 8 user defined arbitrary waveforms, including: Sine, Square, Triangle, Arbitrary waveforms. These waveforms can be directly selected by waveform keys. After selecting a waveform, the CHB output will output the selected waveform and display the waveform in display area of parameters of channel B. When the square waveform is selected in channel B, the square duty ratio is default at 50%. The user defined arbitrary waveform is edited by the control program on the computer, and can be downloaded to the designated storage unit. To output those user defined arbitrary waveforms, recall the waveforms by the correct index number to the storage unit. The function generator will output the selected waveform and display it on the TFT. The following table lists the code and waveform names of the 32 waveforms:

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	Cosine
13	Limit sine	29	Bidir-SCR
14	Gate sine	30	Cardiogram
15	Square-root	31	Earthquake

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.

Select “Phase” by the corresponding soft key, next select “Harmonic” in the same way. 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. The frequency of channel B varies with the harmonic number simultaneously. Phase of channel A and B signals has stable synchronization.

3.3.5 Set the Phase of Channel B

Select “Phase” by the corresponding soft key. The phase value changes to yellow. 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. Phase of channel A and B signals has stable synchronization. Set the phase by the corresponding soft key, at this time the phase difference of the CHA and CHB signals can be set. The phase difference is valid when the channel A frequency is between 10Hz~1MHz. 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.

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.

Select “A B ADD” mode by the corresponding soft key. 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, select “A B Alone” mode by the corresponding soft key. 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**] to select “CHA Sw Fr” function by the corresponding soft key. 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

Select “Start Freq” option by the corresponding soft key. 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 the same soft key to 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 Select the Sweep Direction

Press the corresponding key to select one of the three sweep directions below:

Up Sweep (key [**Up Sweep**]): the output signal sweeps from the start frequency to the stop frequency at the preset sweep rate.

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

Up-Down Sweep (key [**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.

3.4.3 Select the Sweep Mode

Press the corresponding key 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.

Select “Sweep Time” option by the corresponding soft key, the sweep time changes to yellow. 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 Manual Sweep

After the “CHA Sw Fr” mode is selected, the sweep mode is default as auto mode. In auto sweep mode, the sweep

parameters and sweep mode can be modified at any time. Select “Manual Sw” option by the corresponding soft key, 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 TFT display. After the sweep process stops, press key [**CHA Output/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

Select “Auto Sweep” option by the corresponding soft key. This operation ceases the manual sweep and starts auto sweep. Users can have dynamic monitor of the sweep process. Frequency of channel A changes simultaneously according to the sweep process. The refreshed frequency values are displays on the TFT. In auto sweep mode, setting up other parameters will stop the current sweep process.

3.5 Amplitude Sweep

Press key [**Sweep**] to select “CHA Sw A” option. The function generator outputs the sweep signal on 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. To have continuous amplitude variations, user shall firstly set attenuation of channel A. In the sweep process, the generator attenuates according to channel A fixed attenuation, so as to avoid frequent relay switch during auto attenuation.

3.6 Frequency Modulation (FM)

Press key [**MOD**] to select “CHA FM” option. The function generator outputs the frequency modulation signal on the CHA Output.

3.6.1 Set the Carrier Frequency

Select “Carrier Freq” option by the corresponding soft key. The carrier frequency changes to yellow. 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

Select “Mod Freq” option by the corresponding soft key. The modulation frequency value changes to yellow. 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

Select “FM Deviation” option by the corresponding soft key. The frequency modulation deviation value changes to yellow. 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. Select “Mod Wave” option by the corresponding soft key. The index number changes to yellow. 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. The function generator outputs the modulated signal on the CHA Output.

3.7.1 Set the Carrier Frequency

Select “Carrier Freq” option by the corresponding soft key. The carrier frequency value changes to yellow. 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

Select “Mod Freq” option by the corresponding soft key. The modulation frequency value changes to yellow. 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

Select “AM Depth” option by the corresponding soft key. The amplitude modulation depth value changes to yellow. 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. Select “Mod Wave” option by the corresponding soft key. The index number changes to yellow. 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 and frequency modulation can use the external modulation signal. There is a “Modulation In” connector on the rear panel to import external signal. Select “Mod Wave” option by the corresponding soft key, press the same key again to select “External”. The internal modulation is automatically shut off. The frequency of external modulation signal should be compatible to the carrier frequency. The amplitude of external modulation signal should be adjusted according to frequency modulation deviation or amplitude modulation depth. The bigger amplitude of external modulation signal is, the bigger frequency modulation deviation or the bigger amplitude modulation depth will be. In external modulation mode, the keypad operation is not valid for frequency modulation deviation or amplitude modulation depth. In this mode, if “FM Deviation” or “AM Depth” is selected by the corresponding soft key, the instrument turns to internal modulation. “Modulation In” connector on the rear panel should be disconnected, otherwise there will be significant effect on the internal modulation.

3.8 Burst Output

Press key [Burst] to select “CHB Burst” option. “CHB Burst” is displayed in the upper-left portion of the TFT.

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 Burst Count

Select “Cycles” option by the corresponding soft key. The burst count changes to yellow. 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

Select “Burst Freq” option by the corresponding soft key. The burst frequency changes to yellow. 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 multiply 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. The internal trigger signal will output from “Burst TTL” output (BNC) on the rear panel.

3.8.4 Burst Start Phase

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

3.8.5 Set the Single Burst Mode

Select “Single” option by the corresponding soft key. The function generator turns off the continuous burst mode and signal output is 0. In the single burst mode, press key [CHB Output] 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 “Int Burst” option is selected, the burst process is back to the continuous burst mode. If the “TTL Burst” option is selected, use “Count In” connector to import the burst signal. In this case, a frequency counter input function should be equipped with the instrument. 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 [SK] to select “CHA FSK” option. The function generator outputs the FSK signal on the CHA Output.

The upper-left portion of the TFT displays the FSK waveform. 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

Select “Carrier Freq” option by the corresponding soft key. The carrier frequency value changes to yellow. 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.

3.9.2 Set the Hop Frequency

Select “Hop Freq” option by the corresponding soft key. The hop frequency value changes to yellow. 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 the channel A.

3.9.3 Set the Interval Time

Select “Interval” option by the corresponding soft key. The interval time value changes to yellow. 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 Phase Shift Keying (PSK)

Press key [SK] to select “CHA PSK” function by the corresponding soft key. The function generator outputs the PSK signal on the CHA Output. The upper-left portion of the TFT displays a PSK waveform. 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.

3.10.1 Set the Hop Phase

Select “Hop Phase” option by the corresponding soft key. The hop phase value changes to yellow. 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.

3.10.2 Set the Interval Time

Select “Interval Time” option by the corresponding soft key. The interval time value is shown by yellow on the TFT 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.

3.10.3 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.

However, the PSK waveform displayed on the TFT is just an extreme special case for the purpose of direct and easy explanation of PSK process. There are conditions for operating the special case: the carrier signal period should be exactly same as the interval time of two alternative phase signals, hop phase at 180° and hop at the phase value of 0° . In practices, it is very difficult to meet the conditions required. If we set the carrier frequency at 1Hz, interval time as 1s, hop phase at 180° , we can observe a similar waveform on the oscilloscope. But the waveform can only stay for a very short time, because the actual interval time is not exactly same as carrier frequency period. Adjust the interval time to make it as close as possible to the carrier frequency period, so as to have a longer display of the waveform.

3.11 Measure External Frequency

Press key [**Counter**] to go to the external measurement mode. The TFT 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.

3.11.1 Frequency and Count Measurement

Select “Measure Freq” option by the corresponding soft key. The instrument can measure the frequency of external signal. The measured result is displayed in the purple text on the upper-left of the TFT display. During the measurement, the measured signal must be continuous. But the measurement process is intermittent. It samples the signal using the preset gate time as period, calculates the measurement result, and updates the display.

3.11.2 Set the Gate Time

Select “Gate Time” option. The gate time changes to yellow. 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. 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. 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.

3.11.3 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. The low-pass filter is default as OFF. Select “LPF On” option by the corresponding soft key. This adds 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, Press the key corresponding to “LPF On” once more to select the “LPF Off” function to 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 System Setup

Press key [**Utility**] and select “System” option. The system interface is displayed. Users can select operations of store and recall system setup parameters, set up remote control interfaces. This operation is valid only on software

operation via PC, but not valid for rotary dial operations.

3.12.1 Store Parameters

Select “Store” option by the corresponding soft key to store preset parameters into memory of the instrument. 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.

3.12.2 Recall Parameters

Select “Recall” by the corresponding soft key. 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. 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.

After input a set of parameters, press soft key **[Utility]** to select “Store”, 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, select “Recall” by the corresponding soft key, input the recall index number and press the soft key corresponding to **[No.]**. The stored parameter setting is recalled. Select “Recall”, then press key **[0]** and the soft key corresponding to **[No.]** to recall the default parameter settings.

3.12.3 Remote Address

Select “Address” option by the corresponding soft key. The remote address changes to yellow. The remote address can be entered by numeric keypad or rotary dial. After power on, the instrument remote address is default as 88. If the instrument is connected to other equipments with RS232 interface to make an auto testing system, each equipment in the system should have a different remote address for PC recognition. If the instrument is connected to other equipments with USB interface, the PC has a way to recognize it and the remote address is invalid here.

3.12.4 Beeper

Select “Beep On” option by the corresponding soft key. The beeper can be turned on or off here. After power on the instrument, the beeper is default as ON, the key sound is on. Every press on a key, there is a sound going with. To turn off the beeper, press the soft key “Beep Off”.

3.12.5 Select a Language

Select a language. There are three languages available in the system: English, Chinese (simplified), Chinese (traditional).

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] to select “User CAL” option. This function uses the calibration software to calibrate the three parameters through the keypad.

3.13.1 Calibration Code

Select “CAL Code” option by the corresponding soft key. The calibration code value changes to yellow. Input a calibration code 666666 and press the soft key corresponding to [No.]. The “CAL Code” changes to “CAL On”, which means the instrument is ready for parameter calibration.

3.13.2 Calibrate the Frequency of Channel A

Select “CHA Freq” option by the corresponding soft key. The frequency value of channel A changes to yellow. The instrument outputs a sine wave at fixed 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. Select “Carrier Freq” option by the corresponding soft key. The carrier frequency value of channel A changes to yellow. The instrument outputs a sine wave at fixed 2MHz. Use a frequency counter to measure the frequency of channel A and adjust the calibration code by the rotary knob until the accuracy of channel A frequency is calibrated to 10^{-4} .

3.13.4 Calibrate the Frequency Modulation Deviation

Select “FM Deviation” option by the corresponding soft key. The FM deviation value changes to yellow. The instrument outputs a carrier frequency at fixed 2MHz. The signal of the frequency modulation deviation is 1%. 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} .

Select “CAL Over” option by the corresponding soft key. The characters change to yellow and 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.

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
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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
AB alone/add	ABADD	Beeper	BEEP	External burst	TTL
Phase	PHASE	Reset	RESET	Measurement frequency	MEASF
Waveform	WAVE	Interval time	INTVL	Harmonic waveform	HARM
Store parameter	STORE	Ramp waveform	RAMP	Signal source	SOURCE
Recall parameter	RECALL	Switch	SWITCH	Root mean squared value	VRMS
Software version	VER	Offset	OFFS	Language setup	LANG
Burst count	NCYCL	Frequency	FREQ	Carrier amplitude	CARRA
Burst frequency	BURSF	Triangle waveform	TRIG	Carrier frequency	CARRF
Single trigger	TRIGG	Sweep direction	MODEL	Noise	NOISE
Single burst	ONCES	Sweep mode	TYPE	Gate time	STROBE
Low pass filter	LPF	Sweep time	TIME	Duty cycle	DUTY
AM depth	DEPTH	Start amplitude	STARA	Sine waveform	SINE
FM deviation	DEVIA	Start frequency	STARF	Stop amplitude	STOPA
Modulation frequency	MODUF	Attenuation	ATTE	Stop frequency	STOPF
Square waveform	SQUAR	Hop frequency	HOPF	Period	PERD
Peak-to-peak value	VPP	Hop phase	HOPP	Auto	AUTO

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 [**Utility**] 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 [**Utility**] 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)

Example1: 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 Technical Specifications

5.1 Output Characteristics of Channel A

5.1.1 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: $\geq 50\text{dBc}$ ($\leq 5\text{MHz}$), $\geq 45\text{dBc}$ ($\leq 10\text{MHz}$), $\geq 40\text{dBc}$ ($\leq 20\text{MHz}$), $\geq 35\text{dBc}$ ($\leq 40\text{MHz}$)

Sine Wave Total Distortion: $\leq 0.1\%$ (20Hz ~ 200kHz)

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

Square Wave Duty Cycle: 50.0%

5.1.2 Frequency Characteristics

Frequency Range (Sine): 2kHz ~ the maximum frequency, resolution: 40 mHz

40 μHz ~ 2kHz, resolution: 40 μHz

Frequency Range (Square): 40 μHz ~10MHz ($< 20\text{MHz}$); 40 μHz ~20MHz ($\geq 20\text{MHz}$)

Frequency Range (Pulse): 40 μHz ~10MHz

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

Frequency Stability: $\pm 1 \times 10^{-6} / 3$ hours (small TCXO)

5.1.3 Pulse Characteristics

Duty Cycle: 1%~ 99% ($\leq 1\text{MHz}$)

5.1.4 Amplitude Characteristics

Amplitude Range: 1mVpp ~ 20Vpp (high impedance)

Maximum Resolution: 1 μVpp (high impedance)

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

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

Amplitude Flatness: $\pm 5\%$ (frequency $< 5\text{MHz}$), $\pm 10\%$ (frequency $< 10\text{MHz}$)
 $\pm 20\%$ (frequency $> 10\text{MHz}$)

Output Impedance: 50 Ω

Sine Wave Amplitude Setting Range (50 Ω)

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

1mVpp ~ 7Vpp, when output frequency $\leq 40\text{MHz}$

Amplitude Setting Range (high impedance)

1mVpp ~ 20Vpp, when output frequency $\leq 10\text{MHz}$

1mVpp ~ 14Vpp, when output frequency $\leq 40\text{MHz}$

5.1.5 Offset Characteristics

Offset Range:

$(\text{offset} + 0.5 \times \text{peak-to-peak amplitude}) \leq 2V_{dc} \times \text{attenuation coefficient}$, when peak-to-peak amplitude ≤ 4 , auto attenuation

$(\text{offset} + 0.5 \times \text{peak-to-peak amplitude}) \leq 10V_{dc} \times \text{attenuation coefficient}$, when peak-to-peak amplitude ≥ 4 , auto attenuation

Maximum Resolution: 20mV (high impedance)

Offset Accuracy: $\pm (1\% + 20\text{mV})$ (amplitude $< 4V_{pp}$)

5.1.6 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

5.1.7 Frequency Modulation Characteristics

Carrier Signal: sine or square wave, frequency range same as main waveforms

Modulation Mode: Internal or external

Modulation Signal: channel B signals or external signals

Modulation Frequency: same as channel B signals

FM Deviation: 0% ~ 20%

External Input Signal Amplitude: 20V_{pp} (-10V ~ +10V)

External FM: carrier frequency accuracy $\leq 10^{-3}$, modulation error $\leq \pm 20\%$

5.1.8 Amplitude Modulation Characteristics

Carrier Signal: sine or square wave, frequency range same as main waveforms

Modulation Mode: Internal or external

Modulation Signal: channel B signals or external signals

Modulation Frequency: same as channel B signals

Distortion: $\leq 2\%$

AM Depth: 0% ~ 120%

Relative Modulation Error: $\leq \pm 5\%$

External Input Signal Amplitude: 20V_{pp} (-10V ~ +10V)

5.1.9 Shift Keying Characteristics

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

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

Control Mode: internal

Alternate Rate: 10ms ~ 60s

5.2 Output Characteristics of Channel B

5.2.1 Waveform Characteristics

Wave Type: 32 kinds of pre-stored waveforms, like sine, square, triangle, sawtooth, ladder etc. and 8 kinds of user defined arbitrary waveforms.

Wave Length: 1024 points

Waveform Amplitude Resolution: 8 bits

Sample Rate: 100MSa/s

5.2.2 Frequency Characteristics

Frequency Range: Sine: 10mHz ~ 1MHz, other waveforms: 10mHz ~ 50kHz

Resolution: 40 mHz

Frequency Accuracy: $\pm(1 \times 10^{-5} + 40 \text{ mHz})$

5.2.3 Amplitude Characteristics

Amplitude Range: 100mVpp ~ 20Vpp (high impedance)

Maximum Resolution: 2mVpp

Output Impedance: 50 Ω

5.2.4 Harmonic Characteristics

Channel B frequency is the harmonic wave of channel A.

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

Phase Adjustment: 1 degree/step

5.2.5 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

Trigger Mode: internal trigger, single trigger, TTL trigger

5.3 Frequency Counter

Frequency Range: 1Hz ~ 200MHz

Input Signal Amplitude: 100mVpp ~ 20Vpp

Low Pass Filter: cut off frequency 100kHz

Gate Time: 10ms ~ 60.0s

5.4 Common Characteristics

5.4.1 Power Requirement

Power Requirements: AC200V~AC240V 50Hz

AC100V~AC127V 60Hz (Pay attention to the position of voltage selection switch)

Power Consumption: <45VA

5.4.2 Environmental Condition

Temperature: 0 ~ 40°C Humidity: <80%

5.4.3 Operation Characteristics

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

5.4.4 Display Characteristics

Display: TFT display, English, Chinese (simplified), Chinese (traditional)

5.4.5 Dimension and Weight

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

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

Weight: 4 kg

5.4.6 Manufacturing

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