

Arbitrary/DDS Function Generator
AFG-1000 series
5MHz~20MHz
Operation Manual V1.0

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 replacement or repair of products which are approved defective. 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



CAUTION

- 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



WARNING

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



WARNING

- 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 user's guide 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 5MHz, 10MHz, 15MHz and 20MHz.

This series of arbitrary waveform 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 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
- 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 Waveform: 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 frequency
- Modulation Characteristics: output FM 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 (for a few minutes), reverse voltage protection
- Frequency testing: built-in frequency counter, capable of internal and external frequency signal testing
- Remote control: RS232 interface

Check list

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

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Chapter 1 Quick Starting

This chapter describes the front and rear panels of the arbitrary waveform 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 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, users can connect power cable and turn on the power switch.

Voltage: AC220V (1±10%)

AC110V (1±10%) (Pay attention to the position of voltage selection switch)

Frequency: 50Hz (1±5%)

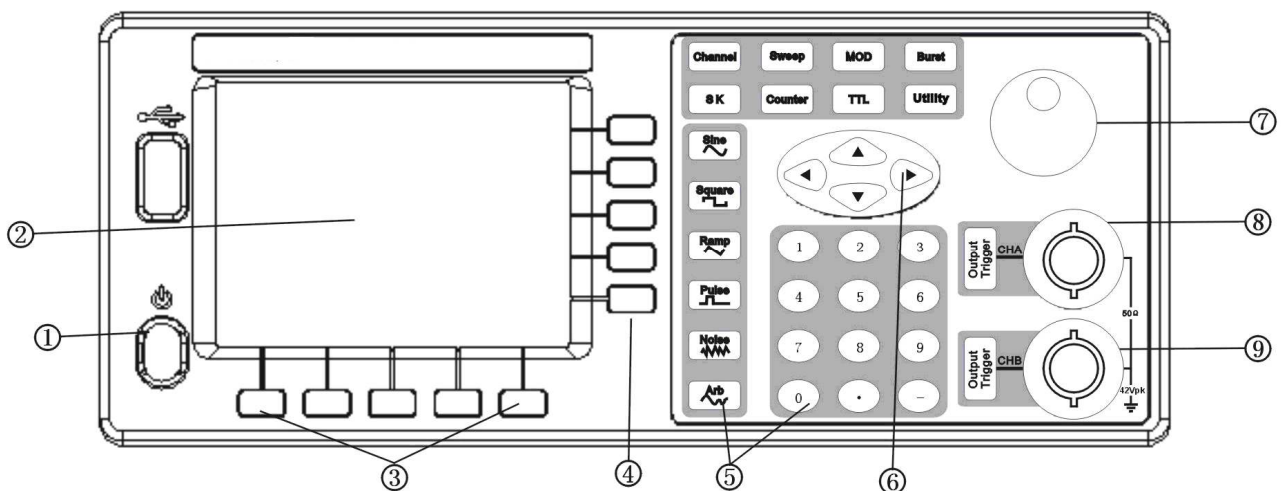
Watts: <45VA Temperature: 0~40℃ Humidity: <80%

Plug the power cord into an 110V or 220 V 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.

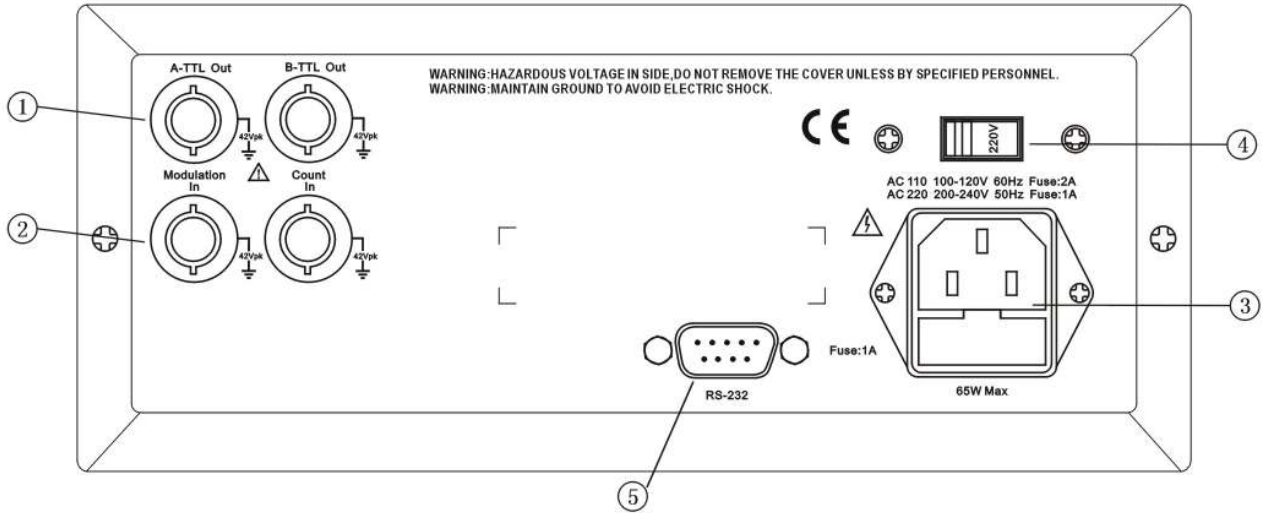
1.2 Front Panel and Rear Panel

Front Panel



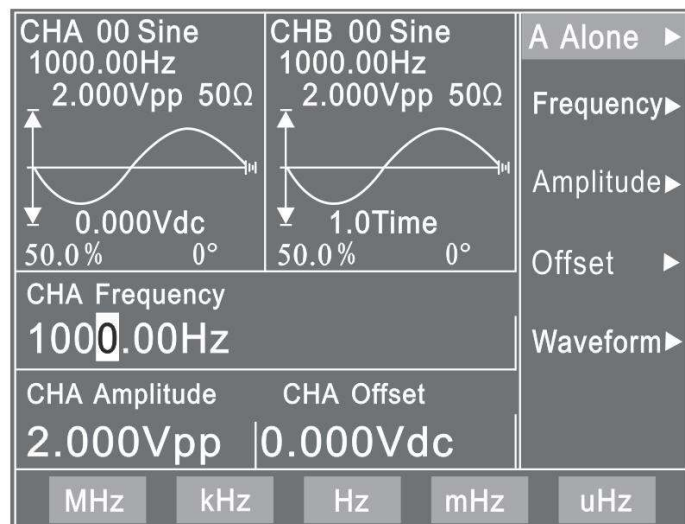
- 1. Power switch
- 2. LCD display
- 3. Unit soft key
- 4. Software option
- 5. Function key and Numeric keypad
- 6. Direction key
- 7. Rotary knob
- 8. Channel A trigger/output
- 9. Channel B trigger/output

Rear Panel



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

1.3 Description of LCD Display



Channel A waveform display: the waveform of channel A and preset parameter is displayed at the upper-left portion.

Channel B waveform display: the waveform of channel B and preset parameters are displayed at the upper-middle portion.

Function menu: The first line on the right of the LCD displays the function menu

Option menu: The second to the sixth lines display the option menu.

Parameter menu: Three of the waveform parameters of channel A are displayed at the middle of the lower-left portion.

Unit menu: The bottom line displays the unit menu.

1.4 Key Description

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

1.4.1 Function Key

Key [Freq] [Sweep] [MOD] [BURST] [SK] [TTL]: selects the ten functions of the instrument.

Key [COUNT]: selects the function of frequency counter.

Key [Utility]: sets the system parameters and exits remote control.

Key [Sine 

Key [CHA Output Trigger] [CHB Output Trigger]: Turns on or off the signal output of channel A & channel B and the trigger output of channel A & channel B.

1.4.2 Soft Key

There are five soft keys at the right side of LCD display. They are used to select the various 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 LCD 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 at the end of data input.

1.4.5 Directional Key

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

Key [▲] and [▼]: used to increase or decrease the frequency or amplitude of channel A at the specified step.

1.5 Fundamental Operation

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

1.5.1 Function of Channel A

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

Set the frequency of channel A: set frequency at 3.5kHz

Select “Frequency” by the corresponding soft key, then press keys [3] [.] [5] and the soft key corresponding to [kHz].

Adjust the frequency of channel A: press [◀] or [▶] keys to move the triangle-shape cursor left or right, and rotate the knob left or right to decrease or increase the digits continuously for the coarse or fine adjustment of frequency. Apply the same for adjustments of other parameters.

Set period of channel A: set a period of 25ms.

Into the frequency menu, select “Period” by the corresponding soft key, then press keys [2] [5] and the soft key corresponding to [ms].

Set amplitude of channel A: set amplitude peak value at 3.2Vpp

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

Set amplitude of channel A: set amplitude value at 1.5Vrms

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

Set offset of channel A: set DC offset at -1Vdc

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

Select waveform of channel A: select arbitrary waveform

Press key [Arb]

Select waveform of channel A: select square waveform

Press key [Square □□]

Set duty ratio of channel A: set pulse duty ratio at 25%

Into the impedance menu, select “Duty” by the corresponding soft key, then press the soft key corresponding to “duty ratio”, next press keys [2] [5] and the soft key corresponding to [%]

Set step frequency of channel A: set step frequency at 12.5Hz

Into the frequency menu, select “Step Freq” by the corresponding soft key, then press key [1] [2] [.] [5] and the soft key corresponding to [Hz]. After this setup, every press on key [▲] increase the frequency of channel A increase by 12.5Hz; and very press on key [▼] decrease the frequency of channel A by 12.5Hz. Apply the same procedure in setup of CHA amplitude.

1.5.2 Function of Channel B

Press key [Channel] to select “CHB Alone”.

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

Select waveforms of channel B: select triangle wave

Press the soft key correspond to [Ramp ^∨].

Set harmonic wave of channel B: set frequency of channel B as a triple harmonic wave of channel A

Into the wave menu, select “Phase” by the corresponding soft key, press the soft key corresponding to “Harmonic”, then press keys [3] and the soft key corresponding to [Time].

Set phase difference of channel B: set phase difference of channel B at 90°

Into the wave menu, select “Phase” by the corresponding soft key, then press keys [9] [0] and the soft key corresponding to [°].

1.5.3 Frequency Sweep of Channel A

Select “A SweepF” by the corresponding soft key.

Set stop frequency: set stop frequency at 50kHz

Select “Stop Freq” by the corresponding soft key, then press keys [5] [0] [kHz].

Set start frequency: set start frequency at 10kHz

Select “Start Freq” by the corresponding soft key, then press key [1] [0] [kHz].

Set step frequency: set step frequency at 200Hz

Select “Step Freq” by the corresponding soft key, then press key [2] [0] [0] [Hz].

Set sweep mode: set sweep mode at down sweep

Select “Down Swe” by the corresponding soft key.

Set interval time: set interval time at 25ms

Select “Interval” by the corresponding soft key, then press key [2] [5] [ms].

Set manual sweep: set the sweep at manual mode

Select “Manual Sweep” by the corresponding soft key. This operation ceases the continuous sweep mode.

Press key [CHA Output/Trigger] for one time, the frequency of channel A will step up or down by one step.

1.5.4 Amplitude Sweep

Press key [Sweep] to select “S SweepA”. Apply the same setting procedure as described in section 1.5.3.

1.5.5 Frequency Modulation (FM)

Press key [MOD] to select “CHA FM”.

Set carrier frequency: set carrier frequency at 100kHz

Select “Carrier Freq” by the corresponding soft key, then press keys [1] [0] [0] and the key corresponding to [kHz].

Set carrier waveform amplitude: set carrier amplitude at 2Vpp

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

Set frequency modulation: set frequency modulation at 10kHz

Select “MOD Freq” by the corresponding soft key, then press key [1] [0] and the key corresponding to [kHz].

Set modulation deviation: set modulation deviation at 5.2%

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

Set modulation waveform: set modulation waveform (actually it is waveforms of channel B) as Triangle wave

Select “Mod Wav” by the corresponding soft key, then press key [2] and the key corresponding to [No.].

Set external modulation:

Select “Mod Wav” by the corresponding soft key, press the same key again to select “External”.

1.5.6 Burst Output of Channel A

Press key [Channel] to select “CHA Alone”. Next press key [Burst] to go to “CHA Burst”. Apply the same setting procedures as described in section 1.5.1. for frequency and amplitude setup.

Set burst count set burst count as 5 cycles

Select “N Cycles” by the corresponding soft key, then press keys [5] and the key corresponding to [Cycl].

Set burst frequency: set burst frequency at 50Hz

Select “Carrier Freq” by the corresponding soft key, then press keys [5] [0] and the key corresponding to [Hz].

Set single burst mode:

Press the soft key corresponding to “TTL_A Trig”. Press this soft key twice to step down to “Single” to select the signal burst mode. Press key [CHA Output/Trigger] for one time will output burst for one time. If the signal burst mode is not selected, pressing on key [CHA Output/Trigger] starts a continuous burst..

Set internal burst:

Select “TTL_A Trig” by the corresponding soft key. The signal of TTL_A will be used as burst source for continuous burst.

Set external TTL burst:

Press the soft key corresponding to “TTL_A Trig”. Press this soft key once more to step down to “EXT Trigge” to select the external TTL burst. Input external signal from “Count In” terminal on the rear panel. The input external signal will be used as a burst source.

1.5.7 Burst Count of Channel B

Press key [Channel] to select “CHB Alone”. Next press key [Burst] to go to “CHB Burst”. Apply the same setting procedure as explained in section 1.5.6 for setting burst of channel A.

1.5.8 FSK Modulation (FSK)

Press key [SK] to select “CHA FSK”.

Set carrier frequency: set carrier frequency at 15kHz

Select “Carrier Freq” by the corresponding soft key, then press the key corresponding to [1] [5] [kHz].

Set carrier amplitude: set carrier amplitude at 2Vpp

Select “Carrier AMP” by the corresponding soft key, then press the key corresponding to [2] [Vpp].

Set hop frequency: set hop frequency at 2kHz

Select “Hop Freq” by the corresponding soft key, then press the key corresponding to [2] [kHz].

Set interval time: set interval time at 20ms

Select “Interval” by the corresponding soft key, then press the key corresponding to [2] [0] [ms].

1.5.9 Amplitude Shift Keying (ASK)

Press key [SK] to step down to “CHA ASK”. The setups of carrier frequency, carrier amplitude and interval time here apply the same setting procedure of explained in the above section 1.5.8.

Set hop frequency: set hop amplitude at 0.5Vpp

Select “Hop Amp” by the corresponding soft key, then press the key corresponding to [0] [.] [5] [Vpp].

1.5.10 Phase Shift Keying (PSK)

Press key [SK] to twice to step down to “CHA PSK” function. The setup of carrier frequency, carrier amplitude and interval time here apply the same setting procedure of explained in the above section 1.5.8.

Set hop phase: set hop phase at 180°.

Select “Hop Phase” by the corresponding soft key, then press the key corresponding to [1] [8] [0] [°].

1.5.11 System Initialization

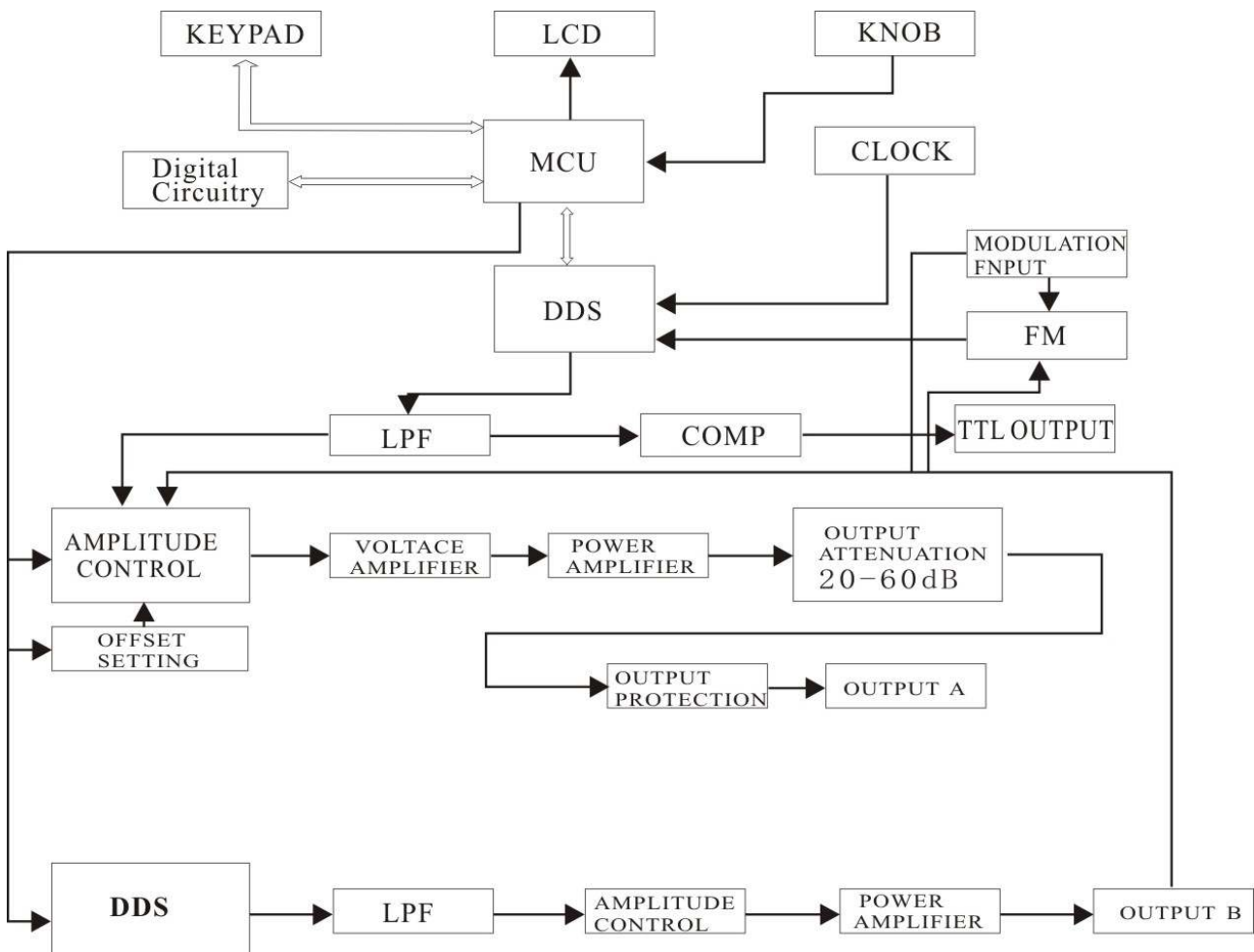
After power on, the system initialization of the instrument displays the following parameters:

CHA and CHB waveform: Sine	CHA and CHB frequency: 1kHz	CHA and CHB amplitude: 2Vpp
CHA and CHB duty cycle: 50%	CHA attenuation: AUTO	CHA offset: 0V
CHB harmonics: 1.0 Time	CHB phase offset: 0°	Step frequency: 10Hz
Gate time: 100ms	Start frequency: 500Hz	Stop frequency: 5kHz
Interval time: 10ms	Sweep mode: UP	Carrier frequency: 50kHz
Carrier amplitude: 2Vpp	Modulation frequency: 1kHz	Modulation waveform: Sine
Modulation deviation: 5%		

Chapter 2 Principle of the Function Generator

In order to help you to better understand the internal operation of the instrument, this chapter describes the basic signal-generation 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 (DAC) converter. 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 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 Instructions

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. This instrument has ten functions and the five function keys: [Channel],[Sweep], [MOD], [BURST], and [SK] are used to select these functions. The five lines on the right side of LCD are the option menus which can be selected by pressing one of the five option keys located on the right side of LCD. The selected option menu will change to green.

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 8x16 size text. The other is the parameter value displayed in a variety of colors. These setups make the LCD display more beautiful and easier to recognize. The parameter display is divided into the five areas below:

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

“Amplitude” area: display the output amplitude. Because of the frequently used of frequency and amplitude parameters, they are displayed in a larger font size to make them eye-catching.

“Offset and Other Parameters” area: display all parameters except the two important parameters.

The data units are shown on the bottom line of the LCD display. The units change according to the data characteristic. The input data have to be validated by pressing the corresponding one of the five blank soft keys.

“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, which 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 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. After input a value, press a unit key to validate the input data.

If the input data has error, there are two ways to correct it. If the destination side of output signal can receive the wrong signal, press any unit key to terminate the pervious operation. Input the correct data and press the unit key to validate the input. 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. In this case, 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 1500.00Hz.

3.1.4 Knob Adjustment

In some applications, it is required to adjust the output signal continuously. The rotary knob is in use here. When a parameter is selected, the color of this parameter changes to yellow, and the color of one digit in this parameter changes to yellow too. Actually, this digit is located on the cursor position. Press key [◀] or [▶] to move the cursor left or right. Rotate the knob to the right to continuously increase the digit on the cursor by one and make the carry to a higher unit position. Rotate the knob to the left to continuously decrease the digit on the cursor by one and make the carry to a lower unit position. When using the knob to modify a specified data, the modified data is valid instantaneously without pressing the unit key. Move the cursor left to make a coarse adjustment and move to the right to make a fine adjustment.

3.1.5 Frequency and Amplitude Step Input

In applications, it is very common to input a set of data or several sets of data with the same frequency or amplitude interval. It is complicated and time consuming to input this kind of data by repeatedly pressing the numeric keypad and unit key. However, it is very convenient to use the step input method. Set the frequency interval as the “step frequency” value, every press on key [▲] makes the frequency increase by one step value, every press on key [▼] makes the frequency decrease by one step value. The modified data is validated automatically without pressing the unit key.

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

Press the corresponding soft key to “Step Frequency”;

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

Into CHA menu, press the soft key corresponding to “Frequency”;

Press keys [▲] to increase the frequency by 12.5k Hz or press key [▼] to decrease the frequency by 12.5kHz. 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 can only be used on the frequency and amplitude of channel A.

3.1.6 Input Mode Selection

It is convenient to input the known data through the numeric keypad. It makes the input to 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 knob is usually more useful. For a series of equal interval data input, the step input method is the most efficient. You can use the different ways to meet your requirement.

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. Using the numeric keypad or rotary knob to input a new frequency value. The function generator outputs the specified frequency at CHA Output.

3.2.2 Set the Period of Channel A

The frequency of 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 value here by numeric keypad or rotary knob. The instrument still uses the frequency synthesis and the input data is just converted to the right value when it is input and displayed. Due to the limitation of the low resolution at low frequency, when the period is too big, the function generator can only generate the frequency points with the bigger period interval. Although the preset and displayed period is precise, the real period of the output signal has relatively big variation. Please pay attention to this point.

3.2.3 Set the Amplitude of Channel A

Select "Amplitude" 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 on 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. If press key [Vrms] and [mVrms] without amplitude data input, the current amplitude value unit can be switched between the two formats.

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 difference between the format conversions. For example, if the Vpp of sine wave is 1 V, the Vrms conversion value is 0.353 Vrms. If the Vrms of sine wave is 0.353 Vrms, the Vpp conversion value is 0.998 V. In most cases, this difference is within the error range. The RMS format can only be used at the channel A or channel B frequency mode and the waveform selected as sine. For other operations and waveforms, only peak-to-peak format can be used.

3.2.4 Amplitude Attenuation

Press the corresponding "Offset" soft key twice to step down to "Attenuator".

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.

Select "Attenuator" by the corresponding soft key. 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. 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 is open circuit. The real voltage on the output load is the

default amplitude multiplying the dividing ratio of the load and the output load. The output resistance of the instrument is about 50Ω. When the load resistance is big enough and the voltage dividing ratio is close to 1, the loss on the output load resistance can be ignored. The voltage on the load is close to default amplitude value. When the load resistance is too small, the loss on the output load is significant and can not be ignored. The voltage on the 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 only few minutes or the transient inverse voltage 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 phase characteristics of the output signal will not be so good. The maximum output amplitude is also affected. The higher frequency, the higher amplitude, and the more distortion in output waveform.

Output frequency 10MHz~15MHz: max. output amplitude 15Vpp

Output frequency 15MHz~20MHz: max. output amplitude 8Vpp

3.2.7 Set the Offset of Channel A

Select “Offset” by the corresponding soft key. The current offset value is shown on the LCD display. Enter a new offset data here by numeric keypad or rotary dial. 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 ±10V. Otherwise, there will be amplitude distortion. Besides, when Channel A is at AUTO mode in attenuation, the output offset attenuates as per amplitude attenuation. When amplitude Vpp value is above about 2V, the actual output offset is the preset offset value. When amplitude Vpp value is approximately between 0.2V~2V, the actual output offset is 10% of the preset offset value. When the amplitude Vpp 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 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 DC Voltage Output

If the amplitude attenuation is set at fixed 0dB, the output DC offset value is the preset offset value. Set the amplitude at 0V, the offset value can be set at any value within the range of ±10V. In this case, the function generator becomes a DC voltage source to output preset DC voltage signal.

3.2.9 Select the Waveform of Channel A

The channel A can output 32 waveforms, including: Sine, Square, Triangle, Pulse, Noise, Arbitrary waveforms. These waveforms can be directly selected by waveform keys. After selecting a waveform, the CHA output will output the selected waveform and display the waveform in display area of parameters of channel A. When the

square waveform is selected in channel A, the Square duty ratio is default at 50%. As to the other 27 waveforms which are not frequently used, they are displayed as “Arb” in the upper portion of the LCD and can be selected with corresponding button. Regarding the user defined arbitrary waveform, it is edited by the control program on the computer, and can be downloaded to the designated storage unit. To output 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 LCD. The following table lists the code and waveform names of the 32 waveforms:

Code and name for 32 waveforms

Code	Waveform name	Code	Waveform name	Code	Waveform name	Code	Waveform name
00	Sine	08	Up stair	16	Exponent	24	Down stair
01	Square	09	Pos-DC	17	Logarithm	25	Po-bipulse
02	Triangle	10	Neg-DC	18	Half round	26	Ne-bipulse
03	Up ramp	11	All sine	19	Tangent	27	Trapezia
04	Down ramp	12	Half sine	20	Sin (x)/x	28	Cosine
05	Pos-pulse	13	Limit sine	21	Noise	29	Bidir-SCR
06	Neg-pulse	14	Gate sine	22	Duty 10%	30	Cardiogram
07	Tri-pulse	15	Squar-root	23	Duty 90%	31	Earthquake

3.2.10 Set the Duty Cycle of Channel A

For the convenience of application, the duty cycle value can be input via numeric keypad or rotary dial. When the current duty cycle value is changed to yellow, the output duty cycle is the square wave of the preset duty cycle. The pulse duty cycle can be set at any value between 1%~99%. The duty cycle can be displayed only when the pulse wave is selected.

3.2.11 Set the Phase of Channel A

Press the corresponding soft key to step down to “Phase”. The phase value can be set at any value between 0~360° via numeric keypad or rotary dial. When the frequency is at low value, the phase has a high resolution. For example, the frequency is below 1MHz, the phase resolutions 3.6°.

3.3 Setup of Channel B

Press key [Channel] to select “CHB Alone”. Setup for frequency, period, amplitude, waveform selection, duty ratio, phase apply the same procedures as explained in the setup of channel A. The difference is that there is no amplitude attenuation and DC offset in channel B.

3.3.1 Set the Frequency of Channel B

Select “Frequency” by the corresponding soft key. The current frequency value changes to yellow, which means the frequency value can be modified and input via numeric keypad or rotary dial. The function generator outputs the desired frequency signal on CHB output. In channel B, frequency period can also be set and displayed.

3.3.2 Set the Amplitude of Channel B

Select “Amplitude” by the corresponding soft key. The current amplitude value changes to yellow, which means the amplitude value can be modified and input via numeric keypad or rotary dial. 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.

3.3.3 Select the Waveform of Channel B

The waveform of channel B is represented by the index number. Select “Waveform” by the corresponding soft key, apply the same operation as explained in section 3.2.9.

3.3.4 Set the Harmonics of Channel B

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 signal of channel A signal. Select “B harmonics” by the corresponding soft key. Input harmonic times via numeric keypad or rotary dial. Channel B frequency becomes the set multiple times of channel A frequency. That means, channel B signal becomes the multiple N times harmonic signal of channel A signal. At this time, phase of channel A and B signals has stable synchronization. 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 harmonics” and set harmonic multiple time so that channel B frequency can change automatically.

3.4 Frequency Sweep

Press key [Sweep] and select “A SweepF” option. 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, step frequency and interval time are free to be set by the users.

3.4.1 Set the Start and Stop Frequency

The start point of frequency sweep is start frequency, and the stop point is stop frequency. To set the start frequency, press key “Start F” by the corresponding soft key and display the start frequency. Input a new start frequency value via numeric keypad or rotary dial. To set the stop frequency, select “Stop F” by the corresponding soft key and display stop frequency. Input a new stop frequency value via 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 Step Frequency

After the start frequency and the stop frequency are set, the sweep rate can be determined according to the required accuracy. In a sweep process, the bigger the step frequency, the less numbers of frequency points and lower accuracy, the shorter time taken in a sweep process. The smaller step frequency, the more numbers of frequency points and higher accuracy, the longer time taken in a sweep process.

Select “Step F” by the corresponding soft key, the current step frequency changes to yellow. Input a new step frequency data here by numeric keypad or rotary dial.

3.4.3 Select Sweep Mode

Select one of the three sweep modes by the corresponding soft key: Up Sweep Mode, Down Sweep Mode, Up-Down Sweep Mode.

Up Sweep Mode: the output signal sweeps repetitively from the start frequency to the stop frequency at the sweep rate.

Down Sweep Mode: the output signal sweeps repetitively from the stop frequency to the start frequency at the sweep rate.

Up-Down Sweep Mode: the output signal sweeps from the start frequency to the stop frequency at the sweep rate, then sweeps from the stop frequency to the start frequency at the same sweep rate.

3.4.4 Set Step Time

After the start frequency, the stop frequency, and the sweep rate are set, the interval time can be determined according to sweep speed. The shorter interval time, the faster sweep speed. The longer interval time, the slower sweep speed. However, practically, the real interval time is the sum of the preset interval time and the software execution time. When the interval time is very short, the software execution time can not be ignored. The actual interval time may have a big difference with the preset interval time.

Select “Interval” by the corresponding soft key, the step time changes to yellow. Input a new interval time here by numeric keypad or rotary dial.

3.4.5 Manual and Auto Sweep

After the “A SweepF” mode is selected, the sweep mode is default as manual mode. Select “Manual Sweep” by the corresponding soft key, the sweep process stops at once. The output signal will keep at the stop stage without any changes. The current frequency value is shown on the LCD display. After the sweep process stops, press key [CHA output/Trigger] once, the sweep process goes on by one step. According to the desired sweep mode, the frequency of Channel A increases or decreases by one sweep step value. In this way, users can observe the detailed variations in the frequency sweep.

If “Auto Sweep” is selected in this menu, 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 sweep process stops when setting of other sweep parameters is in operation.

3.5 Amplitude Sweep

Press key [Sweep] to select “A SweepA”. Settings of different sweep parameters, sweep mode, single sweep, and sweep monitor apply the same procedures as explained in section Channel A set up. 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 sweep.

3.6 Frequency Modulation (FM)

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

3.6.1 Set the Carrier Frequency

Select “Carrier Freq” by the corresponding soft key. The carrier frequency value changes to yellow. Input a new carrier frequency value here via numeric keypad or rotary dial. In the frequency modulation mode, the signal of Channel A is the carrier signal and the carrier frequency actually is the frequency of Channel A. In the frequency sweep mode, the clock signals of DDS synthesizer are switched to 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” by the corresponding soft key. The modulation frequency value changes to yellow. Input a new modulation frequency value via numeric keypad or rotary dial. In the frequency modulation mode, the signal of Channel B is the modulation signal. So the modulation frequency actually is the frequency of Channel B. Generally speaking, the carrier frequency should be at least 10 times higher than the modulation frequency.

3.6.3 Set the Frequency Deviation

Select “FM Deviation” by the corresponding soft key. The frequency deviation value changes to yellow. Input a new deviation value here via numerical keypad or rotary dial. Deviation depth 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:

$$\text{DEVI}\% = 100 * \text{SHFT} / \text{PERD}$$

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 Wav” by the corresponding soft key. The index number changes to yellow. Input the correct index number by numeric keypad or rotary dial so as to select corresponding waveform. 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 external signal, the bigger the frequency deviation. In the external modulation mode, the frequency depth 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 depth deviation should be set, and the external signal connection should be disconnected. Otherwise, the internal modulation will be affected.

3.7 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] and select “CHA FSK” option. The function generator outputs the FSK signal on the CHA Output.

The upper-left portion of the LCD 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.

3.7.1 Set the Carrier Frequency

Select “Carrier Freq” by the corresponding soft key. The carrier frequency value changes to yellow. Input a new carrier frequency value here via numeric keypad or rotary dial. In the FSK mode, the signal of the channel A is the carrier signal. The first frequency value is the carrier frequency.

3.7.2 Set the Hop Frequency

Select “Hop Freq” by the corresponding soft key. The hop frequency value changes to yellow. Input a new hop frequency value via numeric keypad or rotary dial. The hop frequency is the second frequency of the channel A.

3.7.4 Set the Interval Time

Select “Interval” by the corresponding soft key. The interval time value changes to yellow. Input a new interval time via numeric keypad or rotary dial.

3.8 Amplitude Shift Keying (ASK)

Press key [SK] again to step down to “CHA ASK” option. The function generator outputs the ASK signal on the CHA Output. The upper-left portion of the LCD displays the ASK waveform. The amplitude of output signal is the alternative variation of the carrier amplitude and the hop amplitude. The interval time of alternation is adjustable.

3.8.1 Set the Carrier Amplitude

Select “Carrier AMP” by the corresponding soft key. The carrier amplitude value changes to yellow. Input a new amplitude value via numeric keypad or rotary dial. In the ASK mode, the channel A signal is the carrier signal. The first amplitude of channel A signal is the carrier amplitude.

3.8.2 Set the Hop Amplitude

Select “Hop Amp” by the corresponding soft key. The hop amplitude value changes to yellow. Input a new hop amplitude here via numeric keypad or rotary dial. The hop amplitude is the second amplitude of the channel A.

3.8.3 Set the Interval Time

Select “Interval” by the corresponding soft key. The interval time value changes to yellow. Input a new interval time value here via numeric keypad or rotary dial.

3.9 Phase Shift Keying (PSK)

Press key [SK] to step down to “CHA PSK”. The function generator outputs the PSK signal on the CHA Output. The phase of output signal is the alternative variation of the reference phase and the hop phase. The alternative time of these two phases can be set at the desired value.

3.9.1 Set the Hop Phase

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

value here via numeric keypad or rotary dial. The hop phase here is the second hop phase value of channel A signal. The basic phase value is the phase value set in channel A setup.

3.9.2 Set the Interval Time

Select “Interval” by the corresponding soft key. The interval time value changes to yellow. Input a new interval time value here via numeric keypad or rotary dial.

3.9.3 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 signal as synchronization burst signal, a stable PSK signal waveform can be observed.

However, the PSK waveform displayed on the LCD 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.

3.10 Burst Output of Channel A

Press key [Channel] to select “CHA alone”, and then press key “Burst” to go to channel A burst mode. The LCD will display “CHA Burst” in the upper portion. The function generator outputs a waveform with a specified number of cycles at the burst frequency continuously at CHA output. Every set has a preset burst count, and there is an interval time between very set of burst.

3.10.1 Set the Carrier Frequency

Signal of channel A is used as the output burst signal. Therefore, channel A signal frequency and amplitude should be firstly set up. Select “Carrier Freq” by the corresponding soft key. The carrier frequency value becomes yellow. Input a new carrier frequency value here via numeric keypad or rotary dial.

3.10.2 Set the Carrier Amplitude

Select “Carrier AMP” by the corresponding soft key. The carrier amplitude value becomes yellow. Input a new carrier amplitude value here via numeric keypad or rotary dial.

3.10.3 Set the Burst Count

Select “N Cycles” by the corresponding soft key. The burst count value becomes yellow. Input a new burst count number here via numeric keypad or rotary dial. If the burst frequency is fixed, the maximum value of the burst count is limited. The lower burst frequency, the longer burst period and the bigger the burst count number to 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.

3.10.4 Set the Burst Frequency

Select “Burst Freq” by the corresponding soft key. The burst frequency changes to yellow. Input a new burst frequency here via numeric keypad or rotary dial. When burst is in operation in channel A, TTL_A signal is used as the trigger signal. The burst frequency actually is the TTL_A frequency. The burst frequency is determined by the values of the Channel A frequency and the burst count. The multiple of channel A signal period value and burst count number is the time needed for a set of burst. Burst period value should be bigger than the interval time so as to make sure of a suitable interval time between each set of burst. Otherwise, all sets of burst will be output continuously and cannot be a burst signal.

3.10.5 Set the Single Burst Mode

Press the soft key corresponding to “TTL_A Trig” twice to step down to “Single” to enter single burst mode. The function generator turns off the continuous burst mode and signal output. In the single burst mode, press key [CHA Output/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 is set to 1, users can output the single burst manually.

3.10.6 Set TTL_A Burst

Select “TTL_A Burst” by the corresponding soft key. At the rise edge of every TTL_A signal, the burst process executes once according to the preset burst count number, and outputs a set of preset numbers of burst waveform. The burst process is operating continuously.

3.10.7 Set External Burst

Press the soft key corresponding to “TTL_A Burst” to step down to “EXT Burst” to enter external burst mode.. Input external burst signal from the “Count In” terminal on the rear panel. To validate “Count In” function, the generator must have frequency counter input.

Burst count function can be used to test the dynamic features of audio equipments as well as to calibrate a counter.

3.11 Burst Output of Channel B

Press key [Channel] to select “CHB Alone”. Next press key [Burst] to enter “CHB Burst” mode. The function generator outputs a waveform with a specified number of cycles at the burst frequency continuously at the CHB Output. There is a time interval between each burst. Parameter settings of channel B burst is the same as setting procedure of channel A burst parameter setting.

Set the Burst Frequency

Select “Burst Freq” by the corresponding soft key. The burst frequency changes to yellow. Input a new burst frequency here via numeric keypad or rotary dial. In channel B burst operation, TTL_B signal is used as the burst signal. The burst frequency actually is the TTL_B frequency. The burst frequency is determined by the values of the Channel B frequency and the burst count. The multiple of channel B signal period value and burst count number is the time needed for a set of burst. Burst period value should be bigger than the interval time so as to make sure of a suitable interval time between each set of burst. Otherwise, all sets of burst will be output continuously and cannot be a burst signal.

3.12 TTL Output

Press key [TTL] to enable the TTL function. The upper-left portion of the LCD displays TTL, and there is TTL signal output at the TTL_A and TTL_B terminals on the rear panel.

3.12.1 Set the TTL_A Frequency

Select “TTL_A Freq” by the corresponding soft key. The LCD displays TTL_A frequency value. A new TTL_A frequency value can be set here via numeric keypad or rotary dial.

3.12.2 Set the TTL_A Duty Cycle

Press soft key corresponding to “TTL_A Duty”. The LCD displays TTL_A duty ratio value. A new duty ratio value can be set here via numeric keypad or rotary dial.

3.12.3 Set the TTL_B Frequency

Select “TTL_B Freq” by the corresponding soft key. The LCD displays TTL_B frequency value. A new TTL_B frequency value can be set here via numeric keypad or rotary dial.

3.12.4 Set the TTL_B Duty Cycle

Select “TTL_B Duty” by the corresponding soft key. The LCD displays TTL_B duty ratio. A new TTL_B duty ratio value can be set here via numeric keypad or rotary dial.

3.13 Measure External Frequency

Press key [COUNT] to select “EXT Freq” option by the corresponding soft key. The LCD display shows the external measurement interface. In this mode, the instrument is a frequency meter and measures the frequency value of the external signal.

3.13.1 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. Select “External Freq” by the corresponding soft key. 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.

3.13.2 Measure External Frequency

Select “EXT Freq” by the corresponding soft key. Input the external frequency from the “Count In” terminal on the rear panel. The LCD displays the testing external frequency value. The testing external signal can be period signal of the arbitrary waveform. The signal amplitude peak-to-peak value should be 100mVpp~20Vpp. Due to the affect of crystal error and trigger error, the accuracy and stability may not be as good as those in self check.

3.13.3 Set the Gate Time

Select “Strobe Time” by the corresponding soft key. The gate time changes to yellow. Input a new gate time data here by numeric keypad or rotary dial. 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 refresh display. The instrument usually adopts average periodical

measurement. The longer gate time, the more cycle numbers to be collected from the testing signal, the more stable the average value, the more valid digits to have in testing results, but the slower tracking to the frequency variation. This is applicable to test the long-term frequency stability. The shorter gate time, the less valid digits to have in testing results, the faster tracking to the frequency variation, which is suitable to frequency testing requiring a short time of stability.

3.14 System Setup

Press key [**Utility**] to enter system setup mode. The system interface is displayed. Users can store or recall system setup parameters and carry out the programmable interface operation.

3.14.1 Store Parameters

Press the soft key corresponding to “Recall” to step down to “Store” to enter the parameter storage mode. All preset parameters can be stored into the memory of the instrument. The instrument provides 39 index numbers for the parameter memories, starting from index NO.1 to index NO.39. Memories of index No.1~39 are available for user defined setting storage, except memory of index NO.0. Memory index NO.0 is for the storage of default parameters setup.

3.14.2 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 [**SYS**], 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 39 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. If select “Recall”, then press key [**0**] and the soft key corresponding to [**No.**] to recall the default parameter setting.

3.14.3 Remote Address

Select “Address” 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.

3.14.4 Beeper

Select “Beep On” 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 by the corresponding soft key to “Beep Off”.

3.14.5 Choose A Language

Select a language by the corresponding soft key. There are only two languages available in the system: English, Chinese (simplified), Chinese (Traditional).

Chapter 4 Programmable Interface

This chapter introduces the usage of the program 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 equipment has 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 RS232 Interface

The instrument has the option to install the RS232 interface, which is compliant to EIA-RS232 standards. 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.

4.2.1 Interface Voltage Level

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

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

4.2.2 Transmission Format

Each transmission frame consists of 11 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").

4.2.3 Transmission Rate

In this instrument, the transmission rate is default 19200bits/s and can be reset by software.

4.2.4 Interface Connection

Use a RS232 cable to connect the RS232 connector on the rear panel to the COM1 or COM2 connector on the computer.

4.2.5 System Construction

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

4.2.6 Environment

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

4.2.7 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 if 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 received.

4.2.8 Data Information

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

4.3 Remote Command

The remote command is the ASCII code delivered from the computer to the controlled equipment. The controlled equipment works according to given command. Each equipment has its own command in a specified format and definition. In writing a new remote command, user must strictly follow the format and definition of the equipment's command, so as to give correct command for the controlled equipment to complete the work.

Remote command 1	Remote command 2 (without digit and unit)	Inquiry command
<u>CHA:AFREQ:1.31:MHZ</u>	<u>CHA:SQUAR</u>	<u>CHA:?AFREQ</u>
↑ ↑ ↑ ↑↑ ↑ ↑	↑ ↑ ↑	↑ ↑ ↑
1 5 2 53 5 4	1 5 2	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 and the unit string.

4.3.1 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, whose definition is corresponding to the instrument functionality and option. The data string consists of 10 digits of numbers 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, the error occurs.

The Table of Function Command

Option	String	Option	String
Frequency of Channel A	CHA	Burst of Channel A	ABURST
Frequency of Channel B	CHB	Burst of Channel B	BBURST
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	TTL	TTL
Return to Local	LOCAL	RS232 control	RS232
System	SYS		

The Table of the Option Command

Option	String	Option	String	Option	String
CHA waveform	AWAVE	Recall Parameter	RECAL	Hop Amplitude	HOPA
CHA offset	AOFFS	Measuring Frequency	MEASF	Hop Frequency	HOPF
CHA frequency	AFREQ	Software Version	VER	Hop Phase	HOPP
CHA attenuation	AATTE	Burst Count	NCYCL	External Trigger	EXTTR
CHA period	APERD	Burst Frequency	BURSF	External Modulation	EXT
CHA duty cycle	ADUTY	Single Trigger	TRIGG	System Reset	RESET
CHB frequency	BFREQ	Single Burst	ONCES	Phase	PHASE
CHB harmonic Wave	BHARM	FM Deviation Depth	DEVIA	True RMS	VRMS
CHB period	BPERD	Modulation Waveform	MWAVE	Language Setup	LANG
CHB duty cycle	BDUTY	Modulation Frequency	MODUF	Carrier Amplitude	CARRA
TTL_A Frequency	TTLAF	Peak-to-peak value	VPP	Carrier Frequency	CARRF
TTL_A Duty Cycle	TTLAD	Beep Sound	BEEP	Gate time	STROBE
TTL_B Frequency	TTLBF	Interval Time	INTVL	Stop Amplitude	STOPA
TTL_B Duty Cycle	TTLBD	Interface Address	ADDR	Stop Frequency	STOPF
TTL_A Trigger	TTLTR	Sweep Mode	MODEL	Auto Sweep	AUTO
Step Amplitude	STEPS	Start Amplitude	STARA	Store Parameter	STORE
Step Frequency	STEPF	Start Frequency	STARF	Output Switch	SWITCH
CHB waveform	BWAVE	Arbitrary waveform	ARB		

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		

4.3.2 Character Return

The length of a remote command cannot exceed 60 characters. Every string is ended with a Chr (10).

4.3.3 Separate Character

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

4.3.4 Question Mark

To add the question mark (?) before the option string will be back the corresponding value and unit. If no unit, only back to the value.

4.3.5 Data String

The maximum length of the data string is 10 characters.

4.3.6 Control Capability

The remote commands can control all instrument functionalities.

4.3.7 Serial Port Control

In the serial port control mode, first user must send the instrument's address and then select the corresponding instrument, next send the remote commands.

4.3.8 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” to make the instrument back to the normal key operation mode. Otherwise, neither the key operation nor the other remote controls can be used.

4.4 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.

4.4.1 Enter the Programmable 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 [SYS] to return to manual operation.

4.4.2 Tips for Writing a Program

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.

4.4.3 Application Example

The application examples of the various types of the remote command are shown as below:

Example1: Channel A, Single output, Sine wave, Frequency 1MHz

```
RS232 mode: 88CHA:AWAVE:0:No.  
            88CHA:AFREQ:1:MHz
```

Example 2: Channel B, Single output, Triangle wave, Frequency 1kHz

```
RS232 mode: 88CHB:BWAVE:2:No.  
            88CHB:BTRIG:1:kHz
```

Example 3: Channel A, Single Output, Pulse wave, Duty cycles 25%

```
RS232 mode:88CHA:ADUTY:25:%
```

Example 4: Frequency Sweep output, Start frequency 1kHz

```
RS232 mode: 88FSWP:STARF:1:kHz
```

Example 5: FSK output, Carrier frequency 25kHz

```
RS232 mode: 88FSK:CARRF:25:kHz
```

Example 6: Query channel A frequency operation mode

```
RS232 mode: 88CHA:?AFREQ
```

Example 7: Return to the control mode and recover keypad operation

```
RS232 mode: 88LOCAL
```

Chapter 5 Frequency Counter & RS232

This chapter introduces the function generator accessories which are not included in the standard.

5.1 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 detail instruction is in the section 3.13.

5.2 RS232

If users choose to purchase RS232 interface, user can remote control the instrument from a computer.

6.1.7 Shift Keying Characteristics

FSK: free to set carrier frequency and hop frequency

ASK: free to set carrier amplitude and hop amplitude

PSK: hop phase 0~360°, Max. resolution 1°

Alternative rate: 10ms~60s

6.1.8 Burst Characteristics

Carrier signal: channel A signal

Trigger signal: TTL_A signal

Burst count: 1~65000 cycles

Burst mode: Internal TTL, External, Single

6.2 Output Characteristics of Channel B

6.2.1 Waveform Characteristics

Waveform type: 32 waveforms including: Sine, Square, Triangle, Pulse etc. and 8 user defined arbitrary waveforms

Waveform length: 1024 points Sampling range: 12.5MSa/S

Waveform amplitude resolution: 8bits

Square duty cycle: 1%~99%

6.2.2 Frequency Characteristics

Frequency range: Sine: 10mHz~1MHz Other waveforms: 10mHz~100kHz

Resolution: 10mHz

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 Burst Characteristics

Trigger signal: TTL_B signal

Burst count: 1~65000 cycles

Burst mode: Internal TTL, External, Single

6.3 TTL Output Characteristics

6.3.1 Waveform Characteristics: Square, rise/fall time \leq 20ns

6.3.2 Frequency Characteristics: 40mHz~1MHz

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

6.4 Common Characteristics

6.4.1 Power Source

Voltage: AC220V (1±10%)

AC110V (1±10%) (Pay attention to the voltage selection on rear panel)

Frequency: 50Hz (1±5%)

Power: <45VA

6.4.2 Environment

Temperature: 0~40℃

Humidity: 80%

6.4.3 Operation Characteristics

Keypad operation and rotary knob operation

6.4.4 Display

TFT LCD display, 320*240, English, Chinese (simplified), Chinese (traditional)

6.4.5 Dimension and Weight

415mmx295mmx195mm

Weight: 3.5kg

6.4.6 Manufacturing Technology

Surface Mount Technology, Integrated Circuit. High reliability and stability.

6.5 Frequency Counter Characteristics

6.5.1 Frequency Counter

Testing frequency range: 1Hz~100MHz, or 1Hz~150MHz

Input signal amplitude: 100mVpp~20Vpp