User's Guide

SUIN

TFG6900A Series

Function/Arbitrary Waveform Generators

Brief Introduction

With Direct Digital Synthesis technique (DDS)，large scale integrated circuits and soft-core embedded system (SOPC), TFG6900A series are of the excellent technical performances and powerful function characteristics which are necessary for the fast measurement. TFT-LCD interface can show the illustration of output waveform and parameters. Keypads and knob are convenient for operation. The introduction of main characteristics is following:

- Dual independent output channels: CHA and CHB, with the same characteristics.

- Dual channel operation: Couple frequency, amplitude and offset of two channels, also combine two outputs into CHB connector.

- Multi-waveform: 5 standard waveforms, 5 user-defined waveforms and 50 built-in arbitrary waveforms.

- Plentiful modulation: FM, AM, PM, PWM, FSK, BPSK and Sum.

- Built-in 350MHz frequency counter

- Five instrument state storage/recall with user-defined names.

- 4.3" TFT-LCD display provide numeric and graphical views.

- Communication port: RS-232, USB device and USB host.

- SCPI (Standard Commands for Programmable Instruments) compatibility.

Packing List

TFG69××A Function/Arbitrary waveform generator   1

3-core power cord   1

BNC testing cable   1

CD   1

   CD includes: USB Driver programmer

               Remote control demonstration software

               Waveform edition software

               User's Guide

               Programmers' Guide

               Waveform edition instruction

               Interface usage instruction

In This Book

This manual is available for five models under TFG6900A series –TFG6910A, TFG6920A, TFG6930A, TFG6940A and TFG6960A, of which the Sine frequency limits are 10MHz, 20MHz, 30MHz, 40MHz and 60MHz.

Quick Start Chapter 1 prepares the waveform generator for helps you get familiar with a few of its front-panel features and basic operations.

Front-Panel Menu Operation Chapter 2 introduces how to use the waveform generator.

Features and Functions Chapter 3 gives a detailed description of the waveform generator's capabilities and operation.

Service and Support Chapter 4 promise the warranty and technical support of the waveform generator.

Specifications Chapter 5 lists the waveform generator's specifications in detail.

Note: This document is just a guide of operation of this instrument, it is unavoidable for not-so-adequate description of technology and wrong printing, please excuse any modification of the contents without special notification.

Content

Chapter 1 Quick Start

If it's the first time for you to use the generator or you have no time to read the guide carefully, you can get the basic operation as soon as you finish browsing the chapter1. If more complicated functions are needed or meet difficulties in operation, please read Features and Functions in chapter 3.

1.1 Prepare the waveform generator for use

1.1.1 Check the list of supplied items

Verify that you have received the complete unit according to the packing list. If you find package damaged badly, leave it until the instrument passes performance test. If anything is missing, please contact sales office

1.1.2 Connect the power

Turn on the instrument only the following conditions are met,

Power: AC 100 ~ 240 V

Frequency: 45 ~ 65 Hz

Power consumption: $<$ 30VA

Temperature: 0 ~ 40℃   Humidity: <80％

Plug the power cord into an AC100 ~240V socket with ground wire and press On /Off switch below socket on rear panel. Then blinking power button on front panel indicating the generator well connected with power but still in off state. Only press power button, the generator initializes itself and obtains the default parameters, outputting continuous Sine under normal working state, with signal's parameters displayed.

Warning: In order to ensure the security of the operator, use triple - core power socket with ground wire.

1.2 Front/Rear panels at a Glance
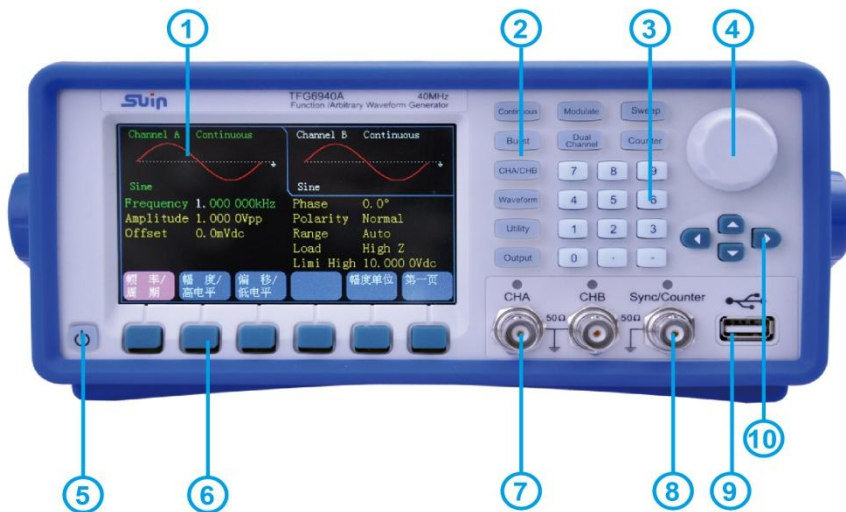
Front panel

1. Display   2. Function Keys   3. Numeric Keypad   4. Knob   5. On/Off Switch

6. Menu Operation Softkey   7. CHA/CHB Output   8. Sync/Counter Connector

9. USB Port   10. Arrow Keys
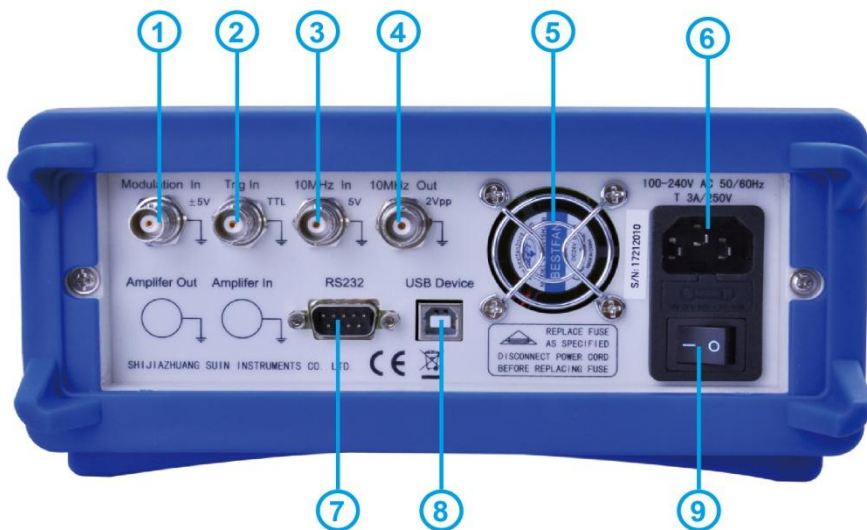
Rear panel

1. External Modulation Input   2. External Trig Input   3. External Clock Input

4. Internal Clock Input   5. Fan   6. AC Power

7. RS-232 Interface Connector   8. USB Interface Connector

9. On/Off Swtich

Chapter 2 Front-panel Menu Operation

2.1 Reference

2.1.1 Keypad description

There are totally 32 keys in the front panel, of which, 26 keys with certain definition embraced with 【 】 .

10 function keys:

【Continue】【Modulate】【Sweep】【Burst】【Dual Chan】【Counter】【CHA/CHB】

【Waveform】 【Utility】 【Output】 .

While, 【Utility】key is used to set common parameter and 【Output】key is used to enable or disenable output port.

12 keys in numeric keypad:

【0】【1】【2】【3】【4】【5】【6】【7】【8】【9】are used to enter numbers.

【.】is used to enter decimal point and 【-】is only available to enter allowed minus.

Four arrow keys:

【<】 【>】 were used to move the cursor left or right.

【∧】【∨】were used to increase and decrease the displayed number when setting frequency and amplitude.

The balance 6 keys under display are menu operation softkeys, embraced with 〖〗 and used to select menu or unit.

2.1.2 Display description

The display screen is divided into four sections:

Top left section: CHA information

Top right section: CHB information

Middle section: parameters display of Frequency or Amplitude or Offset etc.

Bottom section: display of menu or unit.

2.2 Number Entry

2.2.1 Use the keypad to enter numbers and softkey to select unit.

Please use 【<】 key to cancel mistake enter before select unit key. Don't forget to select unit key after finishing entering number. Only this, the enter data can come into effect. Press 〖Cancel〗 softkey in unit menu to cancel the enter data that has come into effect.

2.2.2 Use the knob and arrow keys to modify the displayed number.

Use the arrow keys 【<】【>】to move the cursor left or right. While, rotate the knob to change digits. (clockwise to increase and the inverse to decrease). It's not necessary for user to select unit if entering number by this way.

2.2.3 Use the arrow keys to set step value.

For one selected Frequency or Amplitude parameter, press the arrow keys 【∧】 or 【∨】 one time to increase or decrease a step value. It's not necessary for user to select unit if entering number by this way.

Users can enter numbers by one of three mentioned methods based on different applications.

2.3 Basic Operation

2.3.1 To select the output channel

Press 【CHA/CHB】 key to open desired channel configuration screen. Note that fonts of channel name, mode and waveform were indicated by green color. Use softkeys together with knob or numeric keypad to set the waveform and parameters of desired channel. Enable or disable the output signal of desired channel by pressing 【Output】 key.

2.3.2 To select a waveform

Press 【Waveform】 key to see the first page of the list, and then press 〖More〗 softkey to see the rest of the list. There are sixty waveforms type in total, and select

one desired in sixty to see the waveform diagram under Continuous mode.

2.3.3 To set duty cycle

For example, specify a duty cycle of Square to 20%.

Press 〖Duty Cycle〗 softkey and then set the duty cycle to 20% using the numeric keypad or the knob and arrow keys 【<】【>】. If you use the keypad, press 〖%〗 softkey to finish entering the value.

2.3.4 To set Frequency

For example, specify a frequency to 2.5kHz.

Press 〖Freq/period〗 softkey and then set the frequency to 2.5kHz using the numeric keypad or the knob and arrow keys 【<】【>】. If you use the keypad, press 〖kHz〗 softkey to finish entering the value.

2.3.5 To set Amplitude

For example, specify a amplitude to 1.6Vrms.

Press 〖Ampl/High〗 softkey and then set the amplitude to 1.6Vrms using the numeric keypad or the knob and arrow keys 【<】【>】. If you use the keypad, press 〖Vrms〗 softkey to finish entering the value.

2.3.6 To set offset

For example, specify an offset to -25mVdc.

Press 〖Offset〗 softkey and then set the offset to -25mVdc using the numeric keypad or the knob and arrow keys 【<】【>】. If you use the keypad, press 〖mVdc〗 softkey to finish entering the value.

2.3.7 To output an AM waveform

A modulated waveform consists of a carrier and a modulation waveform. In AM, for example, you want to output an AM waveform with 80% modulation depth, the carrier will be 10kHz and the modulation waveform will be a 10Hz Ramp wave.

1. Select AM

Press 【Modulate】key and then select 〖AM〗softkey by pressing the〖Mod Type〗 softkey.

2. To set Carrier frequency

Press 〖Freq〗softkey under AM Modulation, enter 10 kHz with the numeric keypad or the knob and arrow keys. Press 〖kHz〗 softkey to finish entering the number if you are using the numeric keypad.

3. To set the modulation depth

Press the 〖Depth〗softkey and then set the value to 80% using the numeric keypad or the knob and arrow keys. Press 〖%〗 softkey finish entering the number if you are using the numeric keypad.

4. To set modulating waveform frequency

Press 〖AM Freq〗 softkey and then set the value to 10 using the numeric keypad and finally press 〖Hz〗 softkey, or set by the knob and arrow keys.

5. To select the modulation waveform shape

Press the 〖Shape〗 softkey then press 【Waveform】key to select the shape of modulating waveform. For this example, select a 〖Ramp〗softkey. Finally, press 〖Return〗 softkey to back to AM menu.

2.3.8 To output an Sum waveform

If you want to output a Sum waveform with amplitude 10% and modulation waveform is Noise.

1. Select Sum

Press 【Modulate】key and then select 〖Sum〗softkey by pressing the〖Mod Type〗 softkey.

2. To set the Sum amplitude

Press the 〖Sum Ampl〗 softkey and then set the value to 10 using the numeric keypad and finally press 〖%〗 softkey, or set by the knob and arrow keys.

3. To select the modulation waveform shape

Press the 〖Shape〗softkey then press 【Waveform】key to select the shape of modulating waveform. For this example, select a 〖Noise〗softkey. Finally, press 〖Return〗softkey to come back to Sum menu.

2.3.9 To output a FSK waveform

If you want to output a FSK waveform with hop frequency to 100Hz, with an FSK rate of 10Hz,

1. Select FSK

Press 【Modulate】key and then select 〖FSK〗softkey by pressing the〖Mod Type〗softkey.

2. Set the hop frequency

Press the 〖Hop Freq〗softkey then set the value to 100Hz using the numeric keypad or the knob and arrow keys.

3. Set the FSK rate

Press the 〖FSK Rate〗softkey then set the value to 10Hz using the numeric keypad or the knob and arrow keys.

2.3.10 To output a Frequency Sweep

If you want to output an swept waveform with sweep time of 5 second, logarithmic sweep,

1. Select Frequency sweep

Press 【Sweep】key and then verify that the Frequency Sweep is selected in default.

2. Select sweep time

Press the 〖Sweep Time〗softkey then set the value to 5s using the numeric keypad or the knob and arrow keys.

3. Select sweep mode

Press the 〖Mode Line/Log〗softkey and then verify that the logarithmic sweep

mode is currently selected on the first softkey.

2.3.11 To output a Burst waveform

If you want to output a five-cycle wave with a 10ms burst period, continuous or manual signal trigger.

1. Press 【Burst】key then burst menu is shown in the screen of the current channel.

2. Press 【Burst Mode】and select the 'Triggered'.

3. Press 〖Burst Period〗softkey then set the value to 10ms using the numeric keypad or the knob and arrow keys.

4. Press 〖Cycle Count〗softkey then set the value to 5 using the numeric keypad or the knob. Press the 〖Ok〗 softkey to finish data entry if you are using the numeric keypad.

At this point, the waveform generator outputs a continuous five-cycle burst at 10 ms intervals.

You also can generate signal burst (still with 5 cycles) by pressing 〖Source Int/Ext〗softkey and select External to disable above setting output. Then each time you press 〖Manual Trig〗softkey, one five-cycle burst will be output. Press number depends on the desired burst number.

2.3.12 Frequency Coupling

If you want to couple frequencies between the two channels,

1. Press 【Dual Channel】key. The dual channel menu is shown in the current screen.

2. Press the 〖Freq Cpl〗softkey to turn frequency coupling on. Then press 〖More〗softkey to configure frequency coupling.

3. Press 【Continuous】key to configure CHA frequency, just because channel frequencies can be linked with a constant ratio or difference between them,

CHB frequency will be changing as CHA changes.

2.3.13 To Store/Recall the Instrument State

If you want to store the instrument state,

1.   Press 【Utility】key.

2.Press 〖Store State〗softkey then press 〖User 0〗softkey to store the current instrument state into appointed location and 'Stored' is shown at the same time.

3. Press 〖Recall State〗softkey then press 〖User 0〗softkey to recall the parameters in the location.

2.3.14 Frequency Counter

If you want to measure a frequency of external signal,

1.   Press 【Counter】key to enter into Counter mode.

2.   Input measured signal through 'SYC/Counter' connector in the front panel.

3.   Press 〖Freq〗softkey, the generator begin to measure then display the measured frequency value.

4.   Press 〖Duty cyc〗softkey. For this example, input a Square, then the value of duty cycle is displayed.

Chapter 3 Features and Functions

This chapter makes it easy to look up details about a particular feature of the waveform generator. It also covers the front-panel operations. You should read Chpter2 'Front-panel Menu Operation' first and master the basic operation so as to get a better understanding for this chapter.

3.1 Reference

3.1.1 Working mode

Key	Working Mode
【Continuous】	Continuous output
【Modulate】	Modulate output
【Sweep】	Sweep output
【Burst】	Burst output
【Dual Channel】	Dual channel operation
【Counter】	Frequency counter

There are six working modes for the waveform generator,

While,

CHA covers four modes: continuous output, modulate output, sweep output and burst output.

Notice that the modulate output covers seven types: FM, AM, PM, PWM, Sum, FSK and BPSK.

And sweep output covers two types: Frequency sweep and List sweep.

CHB covers two modes: continuous output and dual channel operation.

Dual channel operation includes frequency coupling, amplitude coupling and waveform combine.

Besides, the frequency counter is just an additional part which has no any relationship with CHA/CHB. In a word, one dual-purpose instrument- waveform generator and frequency counter.

3.1.2 Common mode

Press 【Utility】key and display four modes, system setting, calibration, waveform edit and color setting.

3.2 Output Configuration

3.2.1 Waveform Selection

The waveform generator can output 60 waveforms, see below table,

No.	Waveform	No.	Waveform
00	Sine	30	Pos Triangle
01	Square	31	Pos Rise Ramp
02	Ramp	32	Pos Fall Ramp
03	pulse	33	Trapezia
04	Noise	34	Rise Stair
05	User 0	35	Fall Stair
06	User 1	36	Spiry
07	User 2	37	All Sine
08	User 3	38	Half Sine
09	User 4	39	Ampl Cut
10	PRBS	40	Phase Cut
11	Exponent Rise	41	Add Pulse
12	Exponent Fall	42	Add Noise
13	Logarithm Rise	43	BiHarmonic
14	Tangent	44	TriHarmonic
15	Sin(x)/x	45	FM
16	Semicircle	46	AM

17	Gaussian	47	PWM
18	Cardiac	48	FSK
19	Quake	49	BPSK
20	Square	50	Ampl Increase
21	Cube	51	Ampl Decrease
22	Square Root	52	Burst
23	1/x	53	Low Pass
24	Cotangent	54	High Pass
25	x/(x2+1)	55	Band Pass
26	DC	56	Band Pit
27	Pos Pulse	57	Arb 1
28	Neg Pulse	58	Arb 2
29	Pos-Neg Pulse	59	Pos-Neg Circle

00~04 are standard common waveforms (Sine, Square, Ramp, Pulse and Noise), 05~09 are 5 user-defined arbitrary waveforms, allows to be saved by users after creating with software. 10~59 are 50 built-in arbitrary waveforms which are used in special occasion.

Press 【Waveform】key to see the first page of the list, and then continuously press 〖More〗softkey to see the rest of the list. Select one desired in sixty then waveform diagram is shown but which is just a sample one with lower resolution. Observe and test the output waveforms using oscilloscope.

3.2.2 Set duty cycle (Square)

The duty cycle represents the fraction of time per cycle that the square wave is at a high level. Press 【Waveform】key and choose Square, press 〖Duty Cycle〗softkey after selecting 【Continuous】key then set the desired value of duty cycle. Usually, the duty cycle value remains unchanged if the Square frequency is changing, but duty cycle is limited by the edge time if output frequency is too high, which should comply with the below formula:

$$50\text{ns}\leqslant(\text{Duty Cycle}\times\text{period})\leqslant(\text{period}-50\text{ns})$$

3.2.3 Set Symmetry (Ramp)

Apply to ramp waves only. Symmetry represents the fraction of time per cycle that the ramp wave is rising. After selecting the ramp, press 〖Ramp Symmetry〗then set the desired value of symmetry. The symmetry will remain unchanged if output frequency is changing. Rising Ramp will be shown when symmetry is 100%, falling ramp will be shown when symmetry is 0%, triangle wave display when symmetry is 50%.

3.2.4 Set Pulse Width

The pulse width represents the time from the 50% threshold of the rising edge of the pulse to the 50% threshold of the next falling edge. After selecting the pulse function, press the 〖Pulse Width〗softkey. Then use the knob or numeric keypad to enter the desired pulse width. The specified pulse width must also be less than the difference between the period and the minimum pulse width as shown below.

$$50\text{ns}\leqslant\text{Pulse Width}\leqslant\ \text{Period}-50\text{ns}$$

3.2.5 Set Frequency

The output frequency range depends on the function currently selected and the upper limit for sine depends on the model selected. The minimum frequency is 1μ Hz for all functions. For detail specification, please see chapter 5. If you change to a function whose maximum frequency is less than that of the current function, the frequency is adjusted to the maximum value for the new function. Except of sine, the distortion of other waves will go increasing as frequency rising. In practice, you can limits the maximum frequency based on the desired function distortion.

To set the output frequency, press the 【Continuous】key, then the 〖Freq/Period〗softkey for the selected function. Then use the knob or numeric keypad to enter the

desired frequency. Or press 〖Freq/Period〗 softkey again to set using Period. For internally applying to frequency synthesis, the display period value is the conversed one from enter value. As limited by resolution of frequency low end and only some interval frequency points will be output, so the output value may not be the entered one with some difference.

3.2.6 Set amplitude

You can set amplitude by 'amplitude' or 'level'. If amplitude set is selected, high level and low level of signal will change at the same time when changing amplitude but DC offset remain unchangeable. If level set is selected, no matter high level or low level changing, low or high level remain unchangeable but DC offset will change. The relationships between Vpp, High, Low and offset are shown below:

$$Vpp=High-Low \qquad High=Offset+Vpp/2 \qquad Low=Offset-Vpp/2$$

In continuous menu, press softkey 〖Ampl/High lev〗to set amplitude or high level. Press softkey 〖Offset/Low lev〗 to set low level.

Amplitude Limitation: Press 〖Limit/More〗softkey, then select 'Limit High' or 'Limit Low' to specify the limit value of high level or low level. Even if wrong operation that exceed the limit value, the generator won't be damage and perform within the limit value.

But if specify the high level value to be +10Vdc and low level to be -10Vdc, the limit function won't work anymore. Besides, the amplitude setting will be limit by DC offset, the amplitude value (V_{pp}) should be confined as below,

$$V_{pp}\leqslant2\times(Limi\ High-Offset) \qquad\qquad V_{pp}\leqslant2\times(Offset-Limit\ Low)$$

Not only this, the maximum amplitude will also be limited by frequency (see chapter 5). If V_{pp} exceed the limitation of above formula or frequency, waveform generator will modify the setting value to make it confined within the allowable maximum amplitude.

Influenced by channel bandwidth, the output amplitude will decrease if frequency is higher. So flatness compensation will be needed. To improve the sweep speed, it's not available for frequency sweep, and the amplitude will decrease if span higher frequency.

For the arbitrary waveform generator, if V_{pp} don't reach to full range, the display value is not agreed with the output value.

Output Units: You can set the output amplitude in Vpp, Vrms, or dBm. Vpp is available for all functions. For sine, square, ramp and pulse, Vrms can also be used. The output units for amplitude can also be set to dBm if the external load is currently set to 'non High Z'.

Use the numeric keypad to enter the desired magnitude and then press the appropriate softkey to select the units.

The convert relationship between Vrms and Vpp is subject to waveform, see below table:

Waveform	Vpp	Vrms
Sine	2.828Vpp	1Vrms
Square, Pulse	2Vpp	1Vrms
Ramp	3.464Vpp	1Vrms

The relationship among dBm and Vrms and Vpp is subject to waveform and load,

dBm＝10×log10(P/0.001), while, P＝(Vrms)2/Load

If waveform is sine, set 50Ω load, the convert among three output units is shown below,

Vpp	Vrms	dBm
10.0000 Vpp	3.5356 Vrms	23.98 dBm
6.3246 Vpp	2.2361 Vrms	20.00 dBm
2.8284 Vpp	1.0000 Vrms	13.01 dBm
2.0000 Vpp	707.1 mVrms	10.00 dBm
1.4142 Vpp	500.0 mVrms	6.99 dBm
632.5 mVpp	223.6 mVrms	0.00 dBm
282.9 mVpp	100.0 mVrms	-6.99 dBm
200.0 mVpp	70.7 mVrms	-10.00 dBm
10.0 mVpp	3.5 mVrms	-36.02 dBm

3.2.7 Set DC offset

Press 〖Offset/Low lev〗softkey then set the desired offset value using the knob or numeric keypad. Here, enter by knob is strongly recommend because of more convenience feature. The DC offset setting will limit by amplitude and level, which should be agreed with below formula:

$$\text{Limit Low} + \text{Vpp}/2 \leq \text{Offset} \leq \text{Limi High} - \text{Vpp}/2$$

If the specified offset is not valid, the waveform generator will automatically adjust it to the maximum DC voltage allowed with the amplitude specified.

If set amplitude to 0V, high level limit to +10Vdc and low level limit to -10Vdc, then the offset can be set within ±10V range. The waveform generator become one set of DC power supply and can output DC voltage signal.

3.2.8 Set phase

Press 〖Phase/Align〗softkey to select 'Phase' then set the desired phase using the numeric keypad or knob.

Output phase means the phase difference between output signal and synchronous signal, and output signal advance to synchronous signal.

Press 〖Phase/Align〗softkey to select 'Align' to make the synchronous signal of CHA and CHB are with same phase. So it's easy to calculate the phase difference of two channels on basis of the phase setting for CHA and CHB.

3.2.9 Set polarity

Press 〖Polarity Nor/Inv〗softkey to toggle between the Normal and Inverted selections. To most of waveforms, Normal means output waveform start from zero phase and voltage goes rising. Inverted means output waveform start from zero phase and voltage goes dropping. For arbitrary waveform, Normal means output waveforms are same as selected waveform; Inverted means output waveforms are opposite to selected waveform. Take a positive pulse for example, if select the inverted, the negative pulse will be output.

Polarity setting has no any influence to DC offset volts and Sync signal.

3.2.10 Amplitude range

The generator has a 0 to 50 dB attenuator with 10 dB step. Press 〚Range Aut/Hold〛 softkey, the amplitude range will change between "Auto" and "Hold". According to the amplitude value setting, the generator will automatically select the most suitable amplitude range and attenuator state to get most accurate output amplitude and highest signal-noise ratio.   But when amplitude changes, the output waveform may be damaged and generate glitch instantaneously at some specifically voltage value due to the attenuator switch.

Press 〚Range Aut/Hold〛 softkey to select Hold, the generator could keep the attenuation setting value fixed at current status so it won't change along with the amplitude setting, this can prevent output waveform from being damaged and generating glitch. But when the amplitude setting value exceeds current range, the amplitude accuracy and signal distortion may be worse.

The amplitude range will also influence DC offset.

3.2.11 Output Termination/External Load

The waveform generator has a fixed output impedance of 50Ω, the actual volts value at the load is the standoff ration that load impedance to 50Ω. If change output termination setting to higher, the standoff ratio will more approximate to 1, the error between actual volts at the load and displayed amplitude or offset will become more less. If output termination is greater than $10k\Omega$, the error will be less than 0.5%. But if change output termination too lower, the actual volts will be not agreed with displayed value.

In order to make actual volts be agreed with display value, you should set output termination when it's too lower. Press 〚Load/High Z〛 softkey, if select High Z, output termination of waveform generator must be 'high impedance' ($>10k\Omega$), if select 'xxΩ',output termination can be set within range of 1Ω to $10k\Omega$.

When setting value of output termination is equal to actual value, the actual volts value at the load is in line with display value.

You must notice that most output termination are not resistive, because the inductive impedance and capacitive impedance vary with frequency, especially when frequency high, that the variation can't be ignored. If you don't know the actual impedance of output termination, you can change the setting of 'Load' and make the actual volts are in line with displayed value, then final setting value for 'Load' is the actual impedance.

3.2.12 Output Control

The waveform generator has a output impedance of 50Ω, and it won't be damage if instantaneous short-circuit. If an excessive external voltage is applied to a front-panel channel output connector by an external circuit, the instrument will disable the output and generate an error message with sound alarm. To re-enable the output, remove the overload from the connector and press 【Output】key to enable output. But this function is not absolutely safe, and long-time short circuit or too excessive external voltage is forbidden.

3.2.13 Data Out of Range

As mentioned above, the parameters of frequency and amplitude have the specified allowed range. Once exceed, the waveform generator will modify the setting value automatically, or modify the relative other parameters. Meantime, generate an error message with sound alarm. Data out of range, won't cause damage to instrument. But display value maybe not the expected one, the generator will alarm again to remind you set it again.

3.3 Frequency Modulation (FM)

A modulated waveform consists of a carrier waveform and a modulating waveform. In FM, the frequency of the carrier is varied by the instantaneous voltage of the modulating waveform. Press 【Modulate】key to select the mode, the default is FM.

3.3.1 Set Carrier

Firstly, set the shape, frequency, amplitude and offset of Carrier Waveform. You can select most waveforms from above table to be carrier, but some waveforms are not available.

3.3.2 Frequency Deviation

Press 〖Freq Dev〗softkey to set value of Freq Dev. The frequency deviation setting represents the peak variation in frequency of the modulated waveform from the carrier frequency. When the amplitude of the modulated waveform is at positive peak value, the output frequency is equal to the frequency of the carrier plus the frequency deviation, and when it is at the negative peak value, the output frequency is equal to the carrier frequency minus the frequency deviation. Therefore, the frequency deviation setting must conform to the following two conditions:

Carrier frequency – Frequency deviation > 0

Carrier frequency + Frequency deviation < upper limit frequency of waveform generator

3.3.3 Modulating Waveform Frequency

After selecting FM, press 〖FM Freq〗softkey then enter the desired value. Generally speaking, modulating waveform frequency is always less than the carrier frequency.

3.3.4 Modulating Waveform Shape

Press 〖Shape〗softkey then select 'Shape' to enter the desired value. Press 【Waveform】key, then select one of most waveforms in above table as modulating waveform. Finally, return to FM menu.

3.3.5 Modulating Source

The waveform generator will accept an internal or external modulation source for FM. Press 〖Source Int/Ext〗softkey. It's available to set modulating frequency and modulating waveform if 'Internal' source is selected. But if you select External source, the carrier waveform is modulated with an external waveform. The frequency deviation is controlled by the ±5 V signal level present on the rear-panel Modulation In connector.

3.4 Amplitude Modulation (AM)

A modulated waveform consists of a carrier waveform and a modulating waveform. In AM, the amplitude of the carrier is varied by the instantaneous level of the modulating waveform. The waveform generator will accept an internal or external modulation source.

You must select AM before setting up any of the other modulation parameters. Press 【Modulate】key then select the AM using the 〖Mod Type〗softkey. The AM waveform is output using the present settings for the carrier frequency, modulating frequency, output amplitude, and offset voltage.

3.4.1 Set Carrier

Firstly, set the shape, frequency, amplitude and offset of Carrier Waveform. You can select most waveforms from above table to be carrier, but some waveforms are not available.

3.4.2 Modulation Depth

Press 〖Depth〗softkey then set desired depth using knob or numeric keypad. The modulation depth is expressed as a percentage and represents the extent of the amplitude variation. If the maximum amplitude of modulating carrier is expressed as Amax, the minimum amplitude Amin, setting value of amplitude as A and modulation depth as M, the relationship among the four factors are expressed as following:

$$\text{Amax} = (1+M) \times A/2.2 \qquad \text{Amin} = (1-M) \times A/2.2$$

Therefore,

$$M = (\text{Amax} - \text{Amin}) \times 1.1/A$$

If modulation depth at 120%, then Amax=A and Amin= -0.09A. If modulation depth at 100%, then Amax=0.909A and Amin=0. If modulation depth at 50%, then Amax=0.682A and Amin=0.227A. If modulation depth at 0%, then Amax=0.455A and Amin=0.455A. This is to say, when the modulation depth is at 0, carrier amplitude is a half of amplitude setting.

3.4.3 Modulating Waveform Frequency

Press 〖AM Freq〗softkey to set the value of AM frequency. Generally speaking, the modulating frequency is always lower than carrier frequency.

3.4.4 Modulating Waveform Shape

Press 〖Shape〗softkey then select 'Shape' to enter the desired wave. Press 【Waveform】key, then select one of most waveforms in above as modulating waveform. Finally, return to FM menu.

3.4.5 Modulating Source

The waveform generator will accept an internal or external modulation source for AM. Press 〖Source Int/Ext〗softkey. It's available to set modulating frequency and modulating waveform if 'Internal' source is selected. But if you select External source, the carrier waveform is modulated with an external waveform. The frequency deviation is controlled by the ±5 V signal level present on the rear-panel Modulation In connector.

3.5 Phase Modulation (PM)

A modulated waveform consists of a carrier waveform and a modulating waveform. PM is very similar to FM, but in PM the phase of the modulated waveform is varied by the instantaneous voltage of the modulating waveform.

3.5.1 Set Carrier

Firstly, set the shape, frequency, amplitude and offset of Carrier Waveform. You can select most waveforms from above to be carrier, but some waveforms are not available.

3.5.2 Phase Deviation

Press 〖Phase Dev〗softkey then enter the desired value using knob or keypad. The phase deviation setting represents the peak variation in phase of the modulated waveform from the carrier waveform. If at positive peak value, the phase of output signal increases one phase deviation. If at negative peak value, the phase of the output signal will decrease one phase deviation.

3.5.3 Modulating Waveform Frequency

Press 〖PM Freq〗softkey then set the desired value using knob or keypad. Generally speaking, the modulating frequency is always lower than carrier frequency.

3.5.4 Modulating Waveform Shape

Press 〖Shape〗softkey then select 'Shape' to enter the desired wave. Press 【Waveform】key, then select most waveforms from above table as modulating waveform, but some waveforms are not available. Finally, return to PM menu.

3.5.5 Modulating Source

The waveform generator will accept an internal or external modulation source for PM. Press 〖Source Int/Ext〗softkey. It's available to set modulating frequency and modulating waveform if 'Internal' source is selected. But if you select External source, the carrier waveform is modulated with an external waveform. The frequency deviation is controlled by the ±5 V signal level present on the rear-panel Modulation In connector.

3.6 Pulse Width Modulation (PWM)

In Pulse Width Modulation (PWM), the width of a pulse waveform is varied by the instantaneous voltage of the modulating waveform. You must select PWM before setting up any of the other modulation parameters. Press 【Modulate】key then select the PWM using the 〖Mod Type〗softkey. The PWM waveform is output using the present settings for the carrier frequency, modulating frequency, output amplitude, and offset voltage.

3.6.1 Set Carrier

Firstly, set the frequency, amplitude and offset of Carrier Waveform. The waveform generator only allows PWM to be selected for a pulse waveform.

3.6.2 Pulse Width Deviation

The PWM deviation setting represents the peak variation in width of the modulated pulse waveform. Press 〖Width Dev〗softkey then enter the desired value using the knob or keypad. If at positive peak value, the pulse width of output signal equals to setting value of pulse width plus deviation. If at negative peak value, the pulse width of output signal equals to setting value of pulse width decrease a deviation.

3.6.3 Modulating Waveform Frequency

Press 〖PWM Freq〗softkey then set the desired value using knob or keypad. Generally speaking, the modulating frequency is always lower than carrier frequency.

3.6.4 Modulating Waveform Shape

Press 〖Shape〗softkey then select 'Shape' to enter the desired wave. Press 【Waveform】 key, then select one of most waveforms from above table as modulating waveform, but some waveforms are not available. Finally, return to PWM menu.

3.6.5 Modulating Source

The waveform generator will accept an internal or external modulation source for PWM. Press 〖Source Int/Ext〗softkey. It's available to set modulating frequency and modulating waveform if 'Internal' source is selected. But if you select External source, the carrier waveform is modulated with an external waveform. The frequency deviation is controlled by the ±5 V signal level present on the rear-panel Modulation In connector.

3.7 Sum Modulation

In Sum Modulation (Sum), the modulating signal is added to the carrier waveform. Press 【Modulate】key then select the SUM using the 〖Mod Type〗softkey. The Sum waveform is output using the present settings.

3.7.1 Set Carrier

Firstly, set the shape, frequency, amplitude and offset of Carrier Waveform. In Sum, the instantaneous voltage of output waveforms equals to sum voltage of carrier waveform and modulating waveform. You can select one of most waveforms from above table to be carrier, but some waveforms are not available.

3.7.2 Sum Amplitude

After selecting Sum, press the Sum Ampl softkey. Then use the knob or numeric keypad to enter the desired amplitude. The sum amplitude represents the amplitude of the signal added to the carrier (in percent of carrier amplitude). When sum amplitude at 100%, amplitude of modulating waveform is a half of amplitude of carrier waveform. When sum amplitude at 0%, amplitude of modulating waveform is 0, then amplitude if carrier waveform will be half of setting value for carrier waveform.

3.7.3 Modulating Waveform Frequency

Press 〖Sum Freq〗softkey then set the desired value using knob or keypad. Different from other modulating mode, the modulating frequency can be highly greater than carrier frequency.

3.7.4 Modulating Waveform Shape

Press 〖Shape〗softkey then select 'Shape' to enter the desired wave. Press 【Waveform】 key, then select most waveforms from above table as modulating waveform, but some waveforms are not available. Finally, return to Sum menu.

3.7.5 Modulating Source

The waveform generator will accept an internal or external modulation source for Sum. Press 〖Source Int/Ext〗softkey. It's available to set modulating frequency and modulating waveform if 'Internal' source is selected. But if you select External source, the carrier waveform is modulated with an external waveform. The frequency deviation is controlled by the ±5 V signal level present on the rear-panel Modulation In connector.

3.8 Frequency -Shift Keying Modulation (FSK)

The FSK rate is the rate at which the output frequency "shifts" between the carrier frequency and the hop frequency when you select the internal FSK source, and hop rate is depends on FSK rate. Press 【Modulate】key then select the FSK using the 〖Mod Type〗softkey. The FSK waveform is output using the present settings.

3.8.1 Set Carrier

Firstly, set the shape, frequency, amplitude and offset of Carrier Waveform. You can select most waveforms from above table to be carrier, but some waveforms are not available.

3.8.2 Hop Frequency

Press 〖Hop Freq〗softkey and then set the desired value of hop frequency. FSK modulation is similar to FM that modulating waveform is Square. And hop frequency is similar to frequency deviation. But the difference is that, frequency deviation is the frequency of

carrier wave plus or minus deviation value, whose setting range is relational with the frequency of carrier wave, while hop frequency has no relationship with it.

3.8.3 FSK rate

The FSK rate is the rate at which the output frequency "shifts" between the carrier frequency and the hop frequency when you select the internal FSK source.

To set the FSK rate, press the FSK Rate softkey. Then use the knob or numeric keypad to enter the desired rate.

3.8.4 Modulating Waveform Shape

In FSK，the internal modulating waveform is fixed to a square wave with a 50% duty cycle.

3.8.5 FSK Source

When the Internal source is selected, the rate at which the output frequency "shifts" between the carrier frequency and hop frequency is determined by the FSK rate specified.

When the External source is selected, the output frequency is determined by the signal level on the rear-panel Trig In connector. When a logic low level is present, the carrier frequency is output. When a logic high level is present, the hop frequency is output.

3.9 Bi – Phase Shift Keying Modulation (BPSK)

Press 【Modulate】key then select the BPSK using the 〖Mod Type〗softkey. The BPSKSK waveform is output using the present settings.

3.9.1 Set Carrier

Firstly, set the shape, frequency, amplitude and offset of Carrier Waveform. In BPSK, the phase of output signal alternately hop between carrier phase and hop phase, and hop rate depends on BPSK rate. You can select one of most waveforms from above table to be carrier, but some waveforms are not available.

3.9.2 Hop Phase

Press 〖Hop Phase〗 softkey then enter the desired value using the knob or keypad. The BPSK modulation is similar to PM with modulation waveform of Square. And hop phase is similar to phase deviation.

3.9.3 BPSK Rate

To set the BPSK rate, press the BPSK Rate softkey. Then use the knob or numeric keypad to enter the desired rate.

3.9.4 Modulating Waveform Shape

In BPSK，the internal modulating waveform is fixed to a square wave with a 50% duty cycle.

3.9.5 BPSK Source

When the Internal source is selected, the rate is determined by the BPSK rate specified.

When the External source is selected, the output frequency is determined by the signal level on the rear-panel Trig In connector. When a logic low level is present, the carrier frequency is output. When a logic high level is present, the hop frequency is output.

3.10 Frequency Sweep

You must enable sweep before setting up any of the other sweep parameters. Press 【Sweep】 key then output a sweep using the present settings for frequency, output amplitude, and offset.

3.10.1 Set Sweep Signal

Firstly, set up the waveform shape, amplitude and offset of sweep signal. In the frequency sweep mode, the waveform generator moves from the start frequency to the stop frequency at a sweep rate which you specify. It can span with the whole frequency range and the phase of output signal is continuous. The waveform generator can produce a frequency sweep for most waveforms mentioned above, but some waveforms are not available.

Frequency linear sweep is similar to frequency modulation with ramp, the difference is that frequency sweep don't use the modulating waveform, continuously output series of discrete frequency point based on the sweep time.

3.10.2 Start Frequency and Stop Frequency

After enabling sweeps, press the 〖Start Freq 〗or 〖Stop Freq〗 softkey. Then use the knob or numeric keypad to enter the desired frequency. To sweep up in frequency, set the start frequency less than the stop frequency. To sweep down in frequency, set the start frequency be greater than the stop frequency.

3.10.3 Marker Frequency

press 〖Marker Freq〗softkey, then use the knob or numeric keypad to enter the desired marker frequency. The marker frequency must be between the specified start frequency and stop frequency. If you attempt to set the marker frequency to a frequency not in this range, the waveform generator will automatically set the marker frequency in the middle point between the start frequency and stop frequency.

3.10.4 Sweep Mode

After enabling sweeps, press the 〖Mode Line/Log〗 softkey again to toggle between the linear or log mode.

Under linearity sweeping mode, the frequency step is fixed, but a fixed frequency step always does a bad effect when sweeping comparatively wide-range frequency. In that case, the resolution is high when sweeping high stop of frequency, the frequency changes slowly, and the sweeping is fine. But the resolution is low when sweeping the low end of frequency, the frequency changes very quickly, the sweeping is rough. So linearity sweeping is applicable only for sweeping with narrow frequency range.

Under logarithm sweeping mode, the frequency step value is not fixed but changes according to logarithm relation. When sweeping the high stop of frequency, the frequency step value is comparatively large; when sweeping the low end of

frequency, the frequency step value is comparatively small. The frequency change is comparatively average for sweeping with wide frequency range. So logarithm sweeping is applicable for sweeping with wide frequency range.

3.10.5 Sweep Time

After enabling sweeps, press 〖Sweep Time〗softkey. Then use the knob or numeric keypad to enter the desired sweep time.

Sweep time represents the time required to sweep from the start frequency to the stop frequency. The time interval to sweep from one frequency to next one is constant, so more sweep time results in more sweep frequency points and finer sweep step, vice visa.

3.10.6 Hold Time

After enabling sweeps, press 〖Hold Time〗 softkey. Then use the knob or numeric keypad to enter the desired sweep time. The hold time specifies the number of seconds to remain at the stop frequency. This allows the stop frequency to be sustained for a set time.

3.10.7 Return Time

After enabling sweeps, press〖Return Time〗softkey. Then use the knob or numeric keypad to enter the desired sweep time. The return time specifies the number of seconds to return from the stop frequency to the start frequency. No matter sweep mode is Linear or log, linear sweep will be the only mode on return sweep.

3.10.8 Sweep Trigger Source

Press 〖Trig Imm/Ext〗softkey. When the Immediate (Internal) source is selected, the waveform generator outputs a continuous sweep at a rate determined by the total of the hold time, sweep time and return time.

When the External source is selected, the waveform generator outputs one sweep each time you press〖Manual Trig〗softkey. Or the waveform generator initiates one sweep each time input TTL level trigger signal from Trig In connector on the rear panel. The trigger period must be greater than the total of the hold time, sweep time and return time.

3.11 List Sweep

You must enable list before setting up any of the other list parameters. Press 【Sweep】key, then 〖List Sweep〗soft key to begin setting up a list.

3.11.1 Set Sweep Signal

In the frequency list mode, the function generator "steps" through the frequencies contained in a list, dwelling on each frequency for a specified period. The waveform generator can produce a frequency list sweep for most waveforms mentioned above, but some waveforms are not available.

In some occasion, a frequency list with arbitrary regularity or without any regularity need to be output, and dwell time on each frequency point can be set, then frequency list sweep will be used.

3.11.2 Frequency List

The length of frequency list can store 600 frequency values with list number 00 to 599. Press 〖List Number〗softkey and set the desired list number. Then, 〖List Freq〗will be automatically selected and set the frequency value according to selected list number. Press 〖Next〗softkey can add 1 on list number and set the following frequency value. Using this method to create or modify a frequency list. The store and recall of the frequency list are processing with store and recall of instrument state at the same time, which will be introduced in detail in 'common operation'.

3.11.3 Start Number and Stop Number

Press 〖Start Number〗or〖Stop Number〗softkey to select the desired number. In the frequency list sweep mode, the waveform generator moves from the start number, output each frequency value contained in a list one by one, until to the stop number.

3.11.4 Dwell Time

After enabling sweeps, press 〖Dwell Time〗 softkey. Then use the knob or numeric keypad to enter the desired dwell time. The dwell time specifies the number of seconds to remain at each frequency point.

3.11.5 Hold Time

After enabling sweeps, press 〖Hold Time〗 softkey. Then use the knob or numeric keypad to enter the desired hold time. The hold time specifies the number of seconds to remain at the stop number.

3.11.6 Sweep Trigger Source

Same as frequency sweep. See 3.10.8 sweep trigger source.

3.12 Burst Output

You must enable burst before setting up any of the other burst parameters. Press 【Burst】 key to output a burst using the present settings for frequency, output amplitude, and offset voltage.

3.12.1 Set burst signal

Firstly, set the shape, frequency, amplitude and offset of burst signal. The waveform generator can produce a burst using the above mentioned most waveforms except of some according to setting value of burst period, bust counting and start phase.

3.12.2 Burst Mode

You can use burst in one of two modes by pressing 〖Mode Trig/Gat〗 softkey to select. If 'Triggered' is selected, the waveform generator outputs a waveform with a specified number of cycles (burst count) each time a trigger is received. After the specified number of cycles have been output, the waveform generator stops and waits for the next trigger. You can configure the waveform generator to use an internal trigger to initiate the burst or you can provide an external trigger, applying a trigger signal to the rear-panel Trig In connector. If Gated is selected, the output waveform is either "on" or "off" based on the level of the external signal applied to the rear-panel Trig In connector. When the gate signal is true, the

waveform generator outputs a continuous waveform. When the gate signal goes false, the current waveform cycle is completed and then the waveform generator stops while remaining at the voltage level corresponding to the starting burst phase of the selected waveform.

3.12.3 Burst Period

The burst period defines time from the start of one burst to the start of the next burst. Used in the internal triggered burst mode only. To set the burst period, press 【Burst】 key and then the 〖Burst Period〗 softkey. Then use the knob or numeric keypad to enter the period. The burst period must be long enough to accommodate the setting counts, see below formula,

$$\text{Burst Period} > \text{Burst Count/Frequency of Burst Signal}$$

If the burst period is too short, the waveform generator will automatically adjust it to be allowed minimum value.

3.12.4 Burst Count

The burst count defines the number of cycles to be output per burst. Used in the triggered burst mode only (internal or external source). To set the burst count, press 【Burst】 key and then the 〖N Cycles〗 softkey. Then use the knob or numeric keypad to enter the period. See below formula to clarify the relationship between burst count and burst period.

$$\text{Burst Count} < \text{Burst Period} \times \text{frequency of burst signal}$$

If the burst count is too long, the waveform generator will automatically increase the burst period up to its maximum value to accommodate the specified burst count

3.12.5 Start Phase

The start phase defines the start phase of the burst. To set the burst phase, press 【Burst】 key and then the 〖Start Phase〗 softkey. Then use the knob or numeric keypad to enter the desired phase in degrees.

3.12.6 Burst Trigger Source

Burst trigger source: Internal (Immediate), External or Manual.

Press 〖Trig Imm/Ext〗softkey. If the Internal (immediate) source is selected, the rate at which the burst is generated is determined by the burst period. If external source is selected, the burst count and burst phase remain in effect but the burst period is ignored.

In the triggered burst mode, the waveform generator outputs a burst with the specified number of cycles (burst count) each time a trigger is received by pressing〖Manual Trig〗softkey or Trig In connector receives a TTL level signal. After the specified number of cycles have been output, the waveform generator stops and waits for the next trigger.

In the gated burst mode, burst count is ignored but the burst period at least will be two. Press 〖Manual Trig〗softkey to enable or disable output signal. When disable output manual by manual, input a TTL level trigger signal from Trig In connector in rear panel. If trigger signal is high level, the output signal is enable. But if trigger signal is low level, the waveform generator will stop the level point that corresponding to start phase until last bust is output. When the trigger signal becomes high level, then enable the output signal again.

3.13 Dual Channel Operations

You enter the dual channel configuration menu by pressing 【Dual Channel】key.

3.13.1 Operation Mode

There are two modes for dual channel operation: parameters coupling and waveform combine. While, parameters coupling includes frequency coupling and amplitude coupling. Using parameter coupling way can generate two synchronous changing signal, take difference signal or multiplier signal for example. Using the waveform combine way can add harmonic, noise or pulse on output waveforms to realize a analog signal.

If enable the parameters coupling or waveform combine, only CHB enter into dual channel operations. Otherwise, the two channels are still independent one.

3.13.2 Frequency Coupling

Frequency coupling allows you to couple frequencies between the two channels. Channel frequencies can be linked with a constant ratio or difference between them.

Press the 〖Freq Cpl On/Off〗 softkey to turn frequency coupling on or off. Once configure CHA frequency, the frequency value of CHB can be changed automatically. Well noted that the CHB can't be set.

Press 〖Freq Ratio〗and 〖Freq Diff〗softkey to specify the desired frequency ration and frequency difference. The frequency coupling relationships of two channels are as below,

CHB frequency = CHA frequency × frequency ratio + frequency difference

Press the 〖Freq Cpl On/Off〗 softkey then select Off, the frequency coupling end.

3.13.3 Amplitude Coupling

Amplitude coupling, which is enabled by the 〖Ampl Cpl On/Off〗 softkey, couples the amplitude and offset voltage between the channels. This means that changing the amplitude or offset on CHA will affect CHB. Well noted that the CHB can't be set.

Press 〖Ampl Diff〗and 〖Offs Diff〗softkey to configure the desired amplitude difference and offset difference. The amplitude coupling relationships of two channels are as below,

CHB amplitude = CHA amplitude + amplitude difference

CHB offset = CHA offset + offset difference

Press 〖Ampl Cpl On/Off〗 softkey then select Off, the amplitude coupling end.

3.13.4 Waveform Combine

The Combine feature allows you to combine two outputs into one connector (CHB).

In waveform combine, select most waveforms mentioned above table except of some. Waveform combine is similar to Sum modulation. The difference is that Sum modulation use modulating waveform but waveform combine allows to couple CHA waveform. But continuous wave, modulating wave, sweep wave or burst wave are all available for CHA setting. Therefore, more complicated wave can be generated for waveform combine.

Press 〖Combine On/Off〗softkey then select On to enable waveform combine feature. The waveform of CHA can be combined with CHB's, then output from CHB connector.

Press 〖Combine Ampl〗softkey then configure the parameter of combine amplitude.

Combined waveform = CHA wave × combine amplitude ration + CHB wave

Press 〖Combine On/Off〗softkey then select Off to disable waveform combine feature.

3.13.5 Bursts

Make use of waveform combine feature, the waveform generator can output some special waveforms. For example, couple two-cycle bursts with high frequency on CHB. You can operate as following steps:

(1) Enable CHA to be continuous, 10kHz Square with duty cycle 10%.

(2) Enable CHA to be burst again, burst period 1ms and burst count 2.

(3) Press 【Dual Channel】key and set the amplitude combine to be 50%.

(4) Press 〖Combine On/Off〗softkey then select On.

(5) Enable CHB to be continuous, 1kHz Sine.

(6) Then a Sine with two-cycle bursts output from CHB connector.

3.14 Arbitrary Waveform

Press 【Utility】key then 〖Arb Edit〗softkey, then edit window and menu appears.

3.14.1 Edit Window

You can edit some simple waveforms by keypad through this edit window. The horizontal axis stands for phase with range 0 to 4095 and output phase 0° to 360. And vertical axis presents for amplitude voltage with range 0 to 16383 and output voltage -10V to +10V. Press 【Waveform】key to select one of 60 waveforms (take a Sine for example) then return. The selected waveform will be displayed in the edit window for user to edit and modify.

3.14.2 Edit Cursor

There is one piece of vertical cursor line and one horizontal cursor line in edit window. Press

〖Hor_x Value〗softkey to select 'X Value', then set the desired value. And press 〖Ver_y Value〗softkey to select 'Y Value' and input the desired value. The intersection of the two cursor lines stands for the XY coordinate position of present point. If you change the horizontal coordinate value, the vertical coordinate value will be read out automatically and intersection will move along present waveform paths.

3.14.3 Horizontal Zoom and Shift

Limited by horizontal resolution, the edit window can't display the detail section of waveforms. Press 〖Hor_x Zoom〗softkey and select 'Hor Zoom' to set the desired pantographratio. The greater the horizontal pantographratio is, the higher the resolution of waveform is. Limited by window size, the full view of waveform can be display in edit window when pantographratio is set to 1. If beyond 1, only partial view of waveform can be displayed. Press 〖Hor_x Shift〗softkey to select 'Hor Shift' then set the desired value. The horizontal shift value equals to horizontal coordinate value in left part. You can zoom in or observe any part of waveform through set the value of zoom and shift, so as to edit or modify the detail section of waveform.

3.14.4 The start and end point

Here introduce the method of drawing vector lines to edit or modify the waveform. When XY coordinate of one point is positioned, press〖Vector Start〗softkey then the green cursor line turns to be white, where is defined as start point. Then, set the XY coordinate position of next point and define the cross point of green cursor line to be end point. Press〖Vector End〗softkey, the instrument will draw a piece of line between start and end points, then erase cursor line and vector line is ok.

3.14.5 Create Arbitrary Waveform

Press〖Create New〗softkey and delete the present waveform in edit window. Draw vector lines by above mentioned method and set the end of last vector line to be next vector line

start, make the vector lines connected end to end then an arbitrary waveform is formed. Take a triangle for example, you can operate as following steps,

(1) Set horizontal coordinate and vertical coordinate to be 0. Press 〖Vector Start〗 softkey.

(2) Set horizontal coordinate to be 2048 and vertical coordinate to be16383. Press 〖Vector End〗 softkey.

(3) Press 〖Vector Start〗 softkey.

(4) Press horizontal coordinate to be 4095 and vertical coordinate to be 0. Press 〖Vector End〗 softkey.

Until now, a triangle has been created. But user need to note that, the end point must be at right side of start point, that's to say, X coordinate value of end must be greater than start. Additionally, if you want to output a waveform with continuous period, the vertical coordinate value should be equal for two waveform points, that one horizontal coordinate is 0 and the other is 4095.

3.14.6 Modify Arbitrary Waveform

Here introduce how to modify waveform. For example, to add a narrow pulse on a Sine, the operating steps as below:

(1) Press 【Waveform】 key and select a Sine then return.

(2) Set horizontal coordinate to be 2048 and vertical coordinate be 15000. Press 〖Vector Start〗 softkey.

(3) Set horizontal coordinate to be 2050 and vertical coordinate be 15000. Press 〖Vector End〗 softkey.

(4) Press 〖Hor_x Zoom〗 softkey and set the pantographratio to be 18.5. Press 〖Hor_x Shift〗

softkey and set the horizontal shift value be 2000. Then you can watch detail of added pulse.

3.14.7 Download Waveform

It is available to edit a simple user-defined waveform by keypad, and easy to be modified. But for complicated waveforms, it will take too much time. Here introduce how to edit on computer by waveform-editor software and download the waveform to the generator. Follow below steps:

(1) Install the waveform edition software written in the CD to the PC, connect the generator to PC with an USB cable (enclosed with manual of waveform edit).

(2) Run the waveform edition software to edit a user-defined waveform.

(3) Download the user-defined waveform to the generator, which will enter into working mode of waveform edit. The download user-defined waveform will show at edit window.

3.14.8 Store Waveforms

No matter how you create or edit, the final displayed waveform is only stored temporarily in volatile memory, which will vanish once power off. If you want to preserve the waveform for a long time, please store the waveform.

Press〚Arb Store〛softkey then 'Arb Store' to store the present arbitrary waveform to non-volatile memory, and won't be lost even turn off power.

But stored new arbitrary waveform will cover the original waveform in same location. In order to protect the original waveform, the waveform generator will pop a prompt 'Will cover original data, Store?' before storing. Only press〚Yes〛softkey to enable the store. Otherwise, to press〚Cancel〛softkey.

Press 〚Arb Store〛softkey to display 5 memory location from 〚User 0〛to〚User 4〛, select one to store. 'Stored' will display after finishing.

3.14.9 Recall Waveform

Same as other waveforms, press 【Waveform】key and select the waveform name User 0 to User 4 to recall the selected user-defined waveform.

3.14.10 Memory

If U-disk is not applied to, 'Memory' will display 'Internal', which is available for store or recall operation. While, insert U-disk to USB connector at the front panel, 'Memory' will display 'External', indicating that the waveform generator will applied to U-disk to perform store. A file of 'USER_X.CSV' (x＝0~4)will be created automatically in U-disk during store process, and the user-defined waveforms will be stored in this file and 5 at most. But in recall operating, the user-defined waveforms in the 'USER_X.CSV' (x＝0~4)file will be recalled to generator.

Use U-disk to store and recall arbitrary waveform, the file format is CSV, which is plain text, easy for device to transfer the data with Excel and database. For example, you can download the arbitrary waveform data to Excel for editing or modification, also can create any waveform in Excel and download to device for outputting the waveform signal.

3.15 Common Operation

Press 【Utility】key, the operating window and menu are appears.

3.15.1 Status store

The setting for the instrument, such as waveform, frequency and amplitude, are commonly named as instrument state parameters. The internal of instrument are divided into 5 non-volatile areas and can store 5 group state parameters.

Press〚Status Store〛softkey then select 'Store' to save current state to specified non-volatile locations, which won't be lost even turn off the power.

But store a new group of state parameters will cover the previous state setting. In order to protect the previous state, the waveform generator will pop up a prompt 'Will cover original data, Store?' Only press 〚Yes〛softkey to enable the store. Otherwise, to press 〚Cancel〛softkey.

Press 〚Status Store〛softkey and display 5 memory location, 〚Default State〛, 〚Power On State〛,〚 User 0 State〛, 〚 User 1 State〛and〚User 2 State〛. Press any one of five to store present state to appointed location. The 'Store' will show after finishing store.

〖Default State〗location store the factory default state, to prevent it from damage, state storage can't be allowed in 〖Default State〗.

〖Power On State〗location store the state when instrument power on. User can store the common states to this location, which will be recalled automatically when power on the generator.

The memory location of 〖 User 0 State〗, 〖 User 1 State〗and 〖User 2 State〗can be used to store three group customization states for special use.

3.15.2 Recall State

Press 〖Status Recall〗softkey and select 'Recall' to recall the state parameters from appointed non-volatile area. Press 〖Status Recall〗softkey then display 5 memory locations just same as store state. Press any one of five to recall the relative state. After finishing recall, the display interface converts to continuous mode and the instrument work under new mode.

3.15.3 Memory

If U-disk is not applied to, 'Memory' will display 'Internal', which is available for store or recall operation. While, insert U-disk to USB connector at the front panel, 'Memory' will display 'External', indicating that the waveform generator will applied to U-disk to perform store. A file of 'STATEX.BIN' (x＝1 to 4) will be created automatically in U-disk during store process, and the instrument state will be stored in this file. For recall operation, if the ''STATEX.BIN' file (x＝1 to 4) in U-disk, that the data of file will be recalled to generator. With using of U-disk, the operator can save or use the desired working status parameters and both of storage and recall operation by format BIN.

3.15.4 Language Setting

Press 〖Language〗softkey to choose Chinese language or English language. The selection is only available for operate menu and prompt information. The rest sections are always displayed using English language. If select one language, the generator will always use it and won't change even if system reset and power off, unless select language again.

3.16 System Configuration

Press 【Utility】key then to 〖System Configur〗softkey.

3.16.1 Display Mode

Press 〖Display Mode〗softkey. If 'Single CH' is selected, only one channel's information are shown in display area and 10 parameters at most. Press 【CHA/CHB】to see the other channel's information.

If 'Dual CH' is selected, the display area is divided into two parts and can display the two channels at the same time. But only 5 parameters of each channel can be shown. Press 〖More〗softkey to see the rest parameters.

3.16.2 Cursor Mode

Press 〖Cursor Mode〗softkey then select 'Auto' to configure the auto mode. When the cursor are located in leftmost of parameter, rotate the adjusting knob right to add the digit on the cursor position by 1, it can do a carry to the former; rotate the adjusting knob left to subtract the digit on the cursor position by 1, it can borrow digit from the former. It's more convenient to adjust parameter within wide range using cursor auto mode. But make sure that the cursor must be located in leftmost of parameter. Otherwise, it's same as manual mode.

If 'Manual' is selected, the cursor shift by use of manual mode no matter where the cursor in. And it will be more convenient if parameters allow to be used positive and negative value.

3.16.3 Power-on State

You can store the regular parameters of power-on state to 1# location, then press 〖Power on State〗softkey to select 'User Def'. Once power on, the waveform generator will automatically recall the power-on state in 1# memory location. Every time you power on the generator, the power-on state will be the same.

If select 'Last', the waveform generator will store the present state to 1# location, which will be recalled automatically next time you power on the generator, namely, the state of last operation. Therefore, every time you power on the generator, the power-on state will be different.

3.16.4 Screen protect

Press 〖Screen Protect〗softkey to select 'Scrn pro' to set the time of screen protection. If no panel operation lasts a certain time as set, the screen will light off automatically to save source and screen aging, and longer generator's working life. Press any key to resume screen display.

3.16.5 Beeper

When you press a front-panel key or turn the knob, the waveform generator will emit a short tone. If you want to disable the beeper for certain applications, press 〖Beeper On/Off〗 softkey then to select 'Off' to turn off the beeper. A long beeper tone will be emit when an error is generated from front-panel operation.

3.16.6 Baud Rate

Press〖Baud Rate〗 softkey then select 'Baud Rate' to configure the baud rate of RS-232. There are six configurations for selecting: 2400, 4800, 7200, 9600, 14400 and 19200. Make sure that the baud rate of device connected with the generator should be same as setting of waveform generator to realize the normal communication.

3.17 Color Configuration

Press 【Utility】key then to 〖Color Config〗 softkey to configure the color of the system.

3.17.1 Set color of CHA font

Press 〖Chanl A Font〗softkey then select 'CHA Font' to choose the desired color for CHA font.

3.17.2 Set color of CHB font

Press 〖Chanl B Font〗softkey then select 'CHB Font' to choose the desired color for CHB font.

3.17.3 Menu background color

Press 〖Menu Color〗softkey then select 'Menu' to configure the desired menu color.

3.17.4 Background color of selected option

Press 〖Selected Color〗then select 'Selected' to set the desired background color for selected option.

3.17.5 Border background color

Press 〖Border Color〗softkey then select 'Border' to configure the desired color of border. Configure the desired color in palette, which includes 255 kinds of color type. User can select any color he like for border with this function.

3.18 Frequency Counter

Press 【Counter】key to enter into counter menu.

Connect the external measured signal to 'Sync/Counter' connector in front panel, then to measure the frequency, period, pulse width and duty cycle of measured signal.

3.18.1 Continuous Signal

The waveform generator can measure the frequency, period, pulse width and duty cycle of measured continuous signal. Use multi-cycle measurement when high frequency to get a accurate result.

Press 〖Freq〗softkey then select 'Frequency' to measure frequency of measured signal.

Press 〖Period〗softkey then select 'Period' to measure period of measured signal.

Press 〖Width〗softkey then select 'Width' to measure pulse width of measured signal.

Press 〖Duty Cyc〗softkey then select 'Duty Cyc' to measure duty cycle of measured signal.

3.18.2 Non-continuous Signal

Non-continuous signal, take a burst signal for example, is not available for the measurement of frequency, period, pulse width and duty cycle but only for measurement of cycle number.

Press 〖Count On/Off〗softkey then select 'On' to enable the counter. Firstly clear the count value then totalize count begins. Select 'Off' to disable the counter. To get a accurate measurement, turn counter off when disable the input signal.

Once turn on counter, the setting of gate time is ignored.

3.18.3 Gate Time

Press 〖Gate Time〗softkey then select 'Gate Time' to configure the desired gate time. The gate time indicates the sampling interval time of tested signal, the longer the gate time is, the more the sampling data, so the users may get more stable measurement result and higher measurement resolution. And the shorter the gate time is, the better the tested signal is tracked, but short gate time will result in low measurement resolution. Generally, gate time should be longer than the period of tested signal.

3.18.4 Trigger Level

Press 〖Trig level〗 softkey then select 'Trig levl' to configure the desired trigger level value. Set the trigger level to be 0 if using AC coupling and adjust the trigger level if using DC coupling. The influence for trigger level adjustment is small if the amplitude of tested signal is higher. But if the amplitude of measured signal is lower or frequency is higher, you need adjust the trigger level carefully to get a better result.

3.18.5 Sensitivity

Press 〖Sensitiv〗softkey then select 'Sensitive' to configure the desired sensitivity value. The bigger the value is, the higher the sensitivity is. The influence for sensitivity adjustment is small if the amplitude of tested signal is higher. But if the amplitude of measured signal is lower and noise contained in signal, you need adjust the sensitivity to get a better result.

Generally speaking, improve sensitivity if test value of frequency is less than standard frequency of measured signal, or lower sensitivity if test value of frequency is greater than standard frequency of measured signal.

3.18.6 Coupling Mode

Press 〖Coupled AC/DC〗softkey to choose between AC or DC. If frequency of measured signal is higher with DC offset, select AC mode and set the trigger level to be 0. If frequency of measured signal is lower than 1Hz or amplitude lower than 100mVpp, select DC mode and adjust trigger level properly to get a better result.

3.18.7 Low-pass Filter

Press 〖Filter On/Off〗softkey to turn on or off the low-pass filter. When frequency of measured signal is lower with high-frequency noise, frequency testing value will be greater than standard frequency value of test signal, low-pass filter should be turned on to filter the high-frequency noise, then get an accurate result. But when frequency of measured signal is higher with lower amplitude, the low-pass filter will attenuate the high-frequency signal and frequency testing value will be less than standard frequency value of test signal even can't get a result, low-pass filter should be turned off. The upper limit frequency of low-pass filter will be around 50kHz.

3.19 Output Port

There are four output ports on the front-rear panel: CHA, CHB, Sync and 10MHz output. Forbid to input signal from output port, or the waveform generator will be damage.

3.19.1 CHA output port

Locate in front panel and the signal of CHA output from this port. Press【Output】 key circularly to enable or disable the signal from CHA port. The indicator on the top of CHA port light on or off to tell you whether the port is enable or disable.

3.19.2 CHB output port

Same as CHA port and won't introduce in detail.

3.19.3 Synchronous output port

Locate in front panel and a dual-purpose port. Press 【Utility】key then to 〖Sync On/Off〗softkey to enable or disable the sync output. When the indicator at top of port lights on to be green if enable the sync port.

The synchronous output signal is a pulse signal with TTL level, and high level is greater than 3V and low level is lower than 0.3V. The characteristic will be different under working mode changing, introduce as below,

(1) If select CHA under continuous mode, frequency of sync signal is same as signal from CHA port, but phase lag to CHA's. The phase difference can be set on phase setting of CHA.

    CHB under continuous mode is same as CHA.

(2) Under FM, AM, PM, PWM and Sum mode, the duty cycle of sync signal is 50%, the frequency of sync signal is same as frequency of modulating waveform and the phase of sync signal are relative with phase of modulating waveform.

(3) Under FSK mode, the duty cycle of sync signal is 50%, frequency of sync signal equals to hop rate. The sync signal is low level when outputting carrier frequency and high level when outputting hop frequency.

(4) Under BPSK mode, the duty cycle of sync signal is 50%, frequency of sync signal equals to hop rate. The sync signal is low level when outputting carrier phase and high level when outputting hop phase.

(5) Under frequency sweep mode, the period of sync signal equals to total time of sweep process. The rise edge corresponding to start frequency point and falling edge corresponding to marker frequency point.

(6) Under list sweep mode, the duty cycle of sync signal is 50%, period of sync signal equals to total sweep time and rise edge of sync signal corresponding to

start number.

(7) Under burst mode, period of sync signal equals to burst period, the rise edge corresponding to start point of burst signal and fall edge corresponding to stop point of burst signal. Sync signal is high level if enable burst signal but low level if disable burst signal.

(8) Under FSK, BPSK, frequency sweep, list sweep and burst output mode, the frequency of sync signal will determined by trigger signal if external or manual trigger is selected.

3.19.4 Clock Output Port '10MHz Out'

Locate in rear panel and output 10MHz clock signal, which can be used external clock for other device.

3.20 Input Port

The waveform generator has four input port, 'Modulation In', 'Trig In', 'Counter' and '10MHz In', which are used for inputting external signal.

3.20.1 Modulation In Port

Locate in rear panel and input external modulating signal under FM, AM, PM, PWM and Sum mode.

3.20.2 Trig In Port

Locate in rear panel and input external trigger signal under FSK, BPSK, frequency sweep, list sweep and burst mode.

3.20.3 Counter Input Port 'Sync/Counter'

Locate in front panel and it's a dual-purpose port. Press 【Utility】 key then to 〖Sync On/Off〗 softkey to disable or enable the counter input port. When the indicator at top of port light on to be yellow, the counter input port is enable.

3.20.4 Clock input port '10MHz In'

Locate in rear panel and input external clock signal with 10 MHz frequency with higher accuracy.

3.21 Communication Port

3.21.1 USB Device

The USB Device connector is provided on rear panel, which be connected with PC using USB cable to remote control for the instrument, or download the user-defined waveform with waveform edit software, or update the instrument using firmware updating software. For detail instruction, please refer to CD.

3.21.2 RS-232 port

The RS-232 connector is provided on rear panel, which be connected with PC using RS-232 cable to remote control for the instrument. For detail instruction, please refer to CD.

3.21.3 USB Host

This connector is provided on front panel, which is used to insert U-disk to store or recall the user-defined waveforms or instrument state.

3.22 Calibration Overview

The waveform generator is secured when shipped from factory. After a long time operating, some parameters will out of range. To guarantee the accuracy, periodical calibration is needed. It's no necessary to open case for calibration but just using keypad.

When power off, the generator will automatically recall the calibration code stored on last time. Turning off the calibration is used to prevent the calibration code to be modified.

3.22.1 Enable Calibration

Press 【Utility】key then to 〖Calibrat〗softkey.

If calibration is disabled, 'Closed' is displayed and generator is in safe state. Analog calibration demonstration can be processed but the calibration value can't be modified.

Press 〖Password〗softkey then select 'Calibrate' to enter calibration code 6900. 'Opened' is displayed, now calibration on and ready to process.

3.22.2 Channel Selection

Press 〖Cal Channel〗softkey to cycle through calibration channel. If 'Channel A' is displayed, user can calibrate for CHA. If 'Channel B' is displayed, user can calibrate for CHB.

3.22.3 Trigger Level Calibration

Press 〖Cal Number〗 softkey. Configure the value to 0# to perform a trigger level

calibration

of counter. Use the DC voltmeter to test the TP12 and TP19 on main board, and adjust the calibration code to make the testing voltage of TP12 equals to TP19.

(Note: you need to open the case if you want to perform such calibration. If no necessary, this calibration can be neglected)

3.22.4 DC Offset Calibration

Press 〖Next〗softkey. Configure the calibration code to 1# to perform a DC offset calibration. Calibration conditions 'Amplitude=0Vpp, Offset=0Vdc' displays in windows, and select 'Cal Value'. Use DC voltmeters to test the actual output DC offset and use keypad or knob to adjust the calibration code, make the output DC offset equal to offset nominal value.

Press 〖Next〗softkey and the calibration number plus one automatically and display net offset nominal value. Adjust the calibration code to make the output DC offset equal to nominal value. Make sure perform the DC offset calibration from 1# to 4#.

3.22.5 Amplitude Calibration

Press〖Next〗softkey and the calibration number turns to 5#, then amplitude calibration begins. Calibration conditions 'Frequency=1kHz' and 'Amplitude=7Vrms' displays, then select 'Cal Value'. Use RMS voltmeters to test the actual output amplitude and adjust using keypad or knob, to make the actual output amplitude equal to amplitude nominal value.

Press〖Next〗softkey again the calibration number will plus one automatically and new amplitude nominal value displays. Adjust the calibration number to make the actual output amplitude equal to amplitude nominal value. Make sure that perform the amplitude calibration from 5# to 7#.

3.22.6 Flatness Calibration

The amplitude of output signal will decrease as the frequency increasing if frequency is greater than 1MHz. Therefore, you need to calibrate for different frequency point. Amplitude flatness uses the relative comparison method and makes the amplitude with 100kHz frequency as comparison standard. The nominal amplitude is 14dBm and 0dBm.

(1) Press〖Next〗softkey until the calibration number becomes to 20#, then perform the calibration for the first section amplitude. Calibration condition is Frequency=100kHz and Amplitude=14dBm. Use spectrum analyzer to test the actual output amplitude as standard value of first section.

Press 〖Next〗 softkey again, the calibration number will plus one automatically. The calibration condition is Frequency=01MHz but amplitude nominal value remain unchanged. Adjust the calibration value to make the output amplitude equal to standard value of first section amplitude. Make sure that perform the calibration of first section amplitude from 20# to 60#.

(2) Press 〖Next〗 softkey until calibration number turns to 70# to perform the flatness calibration for second section. The condition is Frequency=100kHz and Amplitude=0dBm. Use the spectrum analyzer to test the actual output amplitude and make this value as standard value.

Press 〖Next〗 softkey again, the calibration number plus one automatically. The condition is Frequency=01MHz and amplitude remain unchanged. Adjust the calibration value to make the actual output amplitude equal to standard value of second section. Make sure that perform the calibration for second amplitude flatness from 70# to 110#.

3.22.7 Calibration Value Storage

Make sure to store the calibration value after finishing calibration in case that the value is lost once power off. Press 〖Cal Store〗 softkey then select 'Cal Store' to store present calibration value in non-volatile memory and does not change when power has been off. Store the new calibration value will cover the previous value in memory location. To protect the previous calibration value, an enquiry 'Will cover original data, Store?' will pop up before storage. Only press 〖Yes〗 softkey to enable the storage. Otherwise, press 〖Cancel〗 softkey.

Press 〖Cal Store〗 softkey then two storage locations displays in operation menu, 〖Default Value〗 and 〖User Value〗. Press 〖User Value〗 softkey to store the present calibration value to appointed storage location. 'Store' will be displayed after finishing storage.

〖Default Value〗 location stores the factory default calibration value, to prevent it from damage, which is not allowed for store operation.

If calibration disabled, the generator is in safe state and can't allow store operation.

3.22.8 Calibration Value Recall

Press 〖Cal Recall〗 softkey then select 'Cal Recall' to recall the calibration value from non-volatile memory. Press 〖Cal Recall〗 softkey then two storage locations displays in operation menu, 〖Default Value〗 and 〖User Value〗. The location of 〖Default Value〗 stores the factory default calibration value.

If user stores a wrong value by wrong operation, the waveform generator will be out of work. In this case, you must recall default calibration value from 〖Default Value〗 location then store to〖User Value〗 memory. The waveform generator will recall automatically the value from 〖User Value〗 memory and applied to it.

3.22.9 Disable Calibration

There are two ways to disable calibration as below, which will make 'Closed' displayed and the waveform generator operate in security conditions.

1. Store the calibration value, the calibration state will turn off automatically after finishing storage.

2. If you don't want to store, press 〖Password〗 softkey then select 'Calibrate', input wrong password (except of 6900) to disable calibration.

3.22.10 Exit Calibration

If you select the other mode during the calibration process, the instrument will remain the state of last calibration. If the state is not you want, press 〖Exit〗 softkey, the waveform generator will resume the state of power on.

3.23 System Reset

Press 【Utility】 key then to 〖Reset〗 softkey to recall the default setting value.

3.24 Firmware Version Code

Firmware code of will display in the interface once power on. It will be available once maintain, which can be set and modified. Press 【Utility】 key and then〖System〗softkey to check the firmware number and factory series number.

3.25 Default Setting

3.25.1 Continuous Output

Waveform	Sine	Duty Cycle of Square	50％
Frequency	1kHz	Symmetry of Ramp	50％
Amplitude	1Vpp	Pulse Width	200μs
DC Offset	0Vdc	High Level Limitation	10Vdc
Output Phase	0 °	Low Level Limitation	-10Vdc
Output Polarity	Normal	Frequency Step	25Hz
Amplitude Range	Auto	Amplitude Step	25mVpp
External Load	High Z	Output Port	Off

3.25.2 Modulation Output (FM, AM, PM, PWM and Sum)

Frequency Difference	100Hz	Sum Frequency	20kHz
AM Depth	100％	Modulating Frequency	10Hz
Phase Difference	90 °	Modulating Waveform	Sine
Pulse Width Difference	50％	Modulating Source	Internal
Sum Amplitude	20％	Modulating State	Off

3.25.3 Modulating Output (FSK and BPSK)

Hop Frequency	100Hz	Modulating Source	Internal
Hop Phase	180 °	Modulating State	Off
Hop Rate	10Hz		

3.25.4 Frequency Sweep

Start Frequency	100Hz	Sweep Time	3s
Stop Frequency	1kHz	Remain time	0s
Marker Frequency	450Hz	Return Time	0s
Sweep Mode	Linear	Trigger Source	Immediate
		Sweep State	Off

3.25.5 List Sweep

List Length	600	Remain Time	200ms
Start Number	0#	Trigger Source	Immediate
Stop Number	20#	Sweep State	Off

3.25.6 Burst Output

Burst Mode	Triggered	Trigger Source	Immediate
Burst Period	10ms	Burst State	Off
Burst Count	3cyc	Gated State	Off
Start Phase	0 °		

3.25.7 Dual Channel Operation

Frequency Coupling	Off	Frequency Ration	1
Amplitude Coupling	Off	Frequency Difference	0Hz
Waveform Combine	Off	Amplitude Difference	0Vpp
Combine Depth	50％	Offset Difference	0Vdc

3.25.8 System Configuration

Language	Chinese	Power-on State	Default
Beeper	On	Screen saver	3600s
Cursor Mode	Manual	Calibration State	Closed
Display Mode	Single CH	Error Queue	Clear

3.26 Power Amplifier (Option)

If user selects power amplifier, a power amplifier board will be supplied in the package. It is an independent component of the generator, 'Amplifer In' in rear panel is input connector of power amplifier and 'Amlifer Out' is output connector of power amplifier.

Connect the input signal to 'Amplifer In' connector, then amplified signal can be obtained at the connector of 'Amlifer Out'. The input signal can be the output signal of this instrument or other device's.

3.26.1 Input Waveform

Sine. For other waveforms, the distortion will be greater.

3.26.2 Input voltage

The multiple of the power amplifier is double and the maximum output amplitude is 10Vrms. So the maximum input amplitude should be limited within 5Vrms. The output signal will be distorted beyond the limitation.

3.26.3 Frequency range

The frequency range of the power amplifier is 1Hz to 150kHz. Within the range, the distortion of Sine is better than 1％ and the maximum frequency can reach to 200kHz.

3.26.4 Output power

The expression of power for the power amplifier is

$$P = V^2 / R$$

Where, P is the output power(the unit is W), V is the output virtual amplitude value (the unit is Vrms), R is the load resistance （the unit is Ω）.

The maximum output amplitude can reach 10Vrms and the minimum load resistance can be 2Ω. Besides, the higher the temperature of the working environment, the larger is the frequency of the output signal and the greater the distortion of the output signal. Usually, the maximum output power can reach 8W(8Ω) or 2W(50Ω).

3.26.5 Output protection

The power amplifier is of short circuit protection function and over heat protection. Usually it is unable to be destroyed but long time output short circuit should be avoided. The frequency, amplitude and loading should be best within the limitation, two of which, especially, cannot get the limitation at the same time in case that the power amplifier is damaged.

Chapter 4 Service and support

4.1 Warranty

Shijiazhuang Suin Instruments Co., Ltd. will give one year's warranty to maintaining or replacing since consignment for the verified quality problem of the product.

Except for this explanation and the description in the warranty card, the company has no other warranty, in proclamation or in implication. Under no circumstances, the company will responsible for the direct, indirect or other secondary loss.

4.2 Contact us

If you have any questions or inconvenience during the use of our products please do not hesitate to contact us.

   Monday to Friday   8: 00-17: 00

  Telephone: 86-311-86086971(after service)   Fax: 86-311-86018511

              86-311-86014314(technical support)

  E-mail address: export@suintest.com

  Website: http://www.suintest.com

Chapter 5 Specifications

5.1 Continuous Output (CHA&CHB)

5.1.1 Waveform

Standard Waveforms: Sine, Square, Ramp, Pulse, Noise

Built-in Arbitrary: 50 waveforms including PRBS (Pseudorandom Binary Sequence),

Exponential Fall, Exponential Rise, Logarithm, Sinc, Gaussian, Cardiac, Tangent,

Semi-Circle, Quake, etc.

User-defined Arbitrary: 5

5.1.2 Spectral Purity of Sine

Harmonic distortion (0dBm): ≤-60dBc   Frequency<5MHz

≤-50dBc   Frequency$\geq$5MHz

≤-50dBc   Frequency<20MHz (only for TFG6960A)

≤-45dBc   Frequency$\geq$20MHz (only for TFG6960A)

Total Distortion (20Hz to 20kHz, 20Vpp): $\leq0.1\%$

5.1.3 Square, Pulse and Ramp

Edge time of Square and Pulse (1Vpp): $\leq$20ns

Overshoot (Typical Value): $\leq$ 10％

Duty Cycle of Square: 0.1% to 99.9% (minimum Pos width and Neg width of Square is 50ns)

Pulse Width: 50ns to 2000s

Symmetry of Ramp: 0.0% to 100.0%

5.1.4 Arbitrary Waveform

Waveform Length: 4096 points

Sample Rate: 120 MSa/s

Amplitude Resolution: 14bits (CHA)

10bits (CHB)

Filter Bandwidth: 50MHz

Non-Volatile Memory: 5 waveforms

5.1.5 Frequency

Frequency Range: Sine: 1μHz to 60MHz (see note2)

Square and Pulse: 1μHz to 10MHz

Other waveforms: 1μHz to 5MHz

Frequency Resolution: 1μ Hz

Frequency Accuracy: ±（50ppm+1μ Hz）

5.1.6 Amplitude (auto range, offset 0Vdc)

Amplitude Range:

0.1mVpp to 10Vpp (50Ω load)　　0.2mVpp to 20Vpp (open circuit)　　Frequency≤20MHz

0.1mVpp to 7.5Vpp (50Ω load)　　0.2mVpp to 15Vpp (open circuit)　　Frequency>20MHz

Amplitude Resolution:

1mVpp (Amplitude≥1Vpp, 50Ω load)　　0.1mVpp(Amplitude<1Vpp, 50Ω load)

2mVpp (Amplitude≥2Vpp, open circuit)　　0.2mVpp(Amplitude<2Vpp, open circuit)

Amplitude Accuracy (1kHz Sine, 0V offset, auto range): ±(setting value×1％＋1mVpp)

Amplitude Flatness (compared to 100kHz Sine):

±0.2dBm　frequency<5MHz

±0.3dBm　frequency<20MHz

±0.5dBm　frequency≥20MHz

Amplitude Unit (Sine): Vpp, Vrms and dBm

5.1.7 Offset (amplitude 0.2mVpp)

Offset range: ±5Vdc (50Ω load)　　±10Vdc (open-circuit)

Offset resolution:

1mVdc (offset≥0.5Vdc, 50Ω load)

0.1mVdc (offset<0.5Vdc, 50Ω load)

2mVdc (offset≥1Vdc, open circuit)   0.2mVdc(offset<1Vdc, open circuit)

Offset accuracy: ±(setting value×1％＋1mVdc)

5.1.8 Polarity and Phase

Output Polarity: positive or negative (compared to the displaying waveform)

Output Phase: (compared to sync) 0° to 360°

5.1.9 State Storage

Non-volatile Memory: 5 groups

5.1.10 Output Connector

Output Impedance: 50Ω (typical)

Protection: short-circuit protected, overload relay automatically disables main output

5.2 Modulation Characteristics (CHA)

5.2.1 FM, AM, PM, PWM and Sum Modulation

Carrier Waveforms:	Sine, Square, Ramp (only pulse for PWM), etc.
Modulation Waveforms:	Sine, Square, Ramp, etc.
Modulating Frequency:	1 μHz to 100 kHz
Frequency Difference:	1 μHz to 30MHz (see Note3)
AM Modulating Depth:	0% to 120%
Phase Deviation:	0 ° to 360 °
Pulse Width Deviation:	0% to 99%
Sum amplitude:	0% to 100%
Sum frequency:	1μ Hz to 1MHz
Modulating Source:	Internal and External

5.2.2 FSK and BPSK

Carrier Waveforms:	Sine, Square, Ramp and so on
FSK Frequency:	1μ Hz to 60 MHz (see note2)
Hop Phase:	0 ° to 360 °

Hop Rate: 1μ Hz to 100kHz

Modulating Source: Internal/External

5.3 Sweep Characteristics (CHA)

5.3.1 Frequency Sweep

Sweep time: 5ms to 500s

Remain time: 0s to 500s

Return time: 0s to 500s

Sweep mode: linear, logarithmic

5.3.2 List Sweep

List Length: 600 pcs

Stop time: 5ms to 500s

Hold Time: 0s to 500s

5.3.3 Sweep Waveform: Sine, Square, Ramp and etc.

5.3.4 Sweep Range: within the frequency's range

5.3.5 Trigger Source: internal, external and manual

5.4 Burst Output (CHA)

Waveform: Sine, Square, Ramp and etc.

Output mode: Counted, Gated

Period: 1μs to 500s

Burst count: 1 to 1000000 cycles

Gated output: produces complete cycles

Start/Stop Phase: 0 ° to 360 °

Trigger Source: internal, external or manual

5.5 Two-Channels Characteristics (CHB)

5.5.1 Frequency Coupling: frequency ratio, frequency difference

5.5.2 Amplitude & DC offset Coupling: amplitude difference, offset difference

5.5.3 Combine Output: combine amplitude: 0％ to 100％

5.6 SYNC Output

.6.1 Waveform characteristics: Square, edge time≤10ns

5.6.2 Frequency and pulse width: changes as working mode

5.6.3 Output level: 5V (open circuit)   2.5V(50Ω load)

5.6.4 Output Impedance: 50Ω typical value

5.7 Modulation and Trigger Input

5.7.1 Modulation Input Voltage: ±5Vpp (full scale)

  Input Impedance: 10kΩ

5.7.2 Trigger Input Level: TTL

   Input Impedance: 10kΩ

5.8 Frequency Counter

5.8.1 Frequency Range: 10mHz to 350MHz   **Resolution:** 6 digits/s

5.8.2 Sensitivity:

    20mVrms to 5Vrms   10mHz to 100MHz
    40mVrms to 5Vrms   100MHz to 200MHz
    50mVrms to 5Vrms   200MHz to 350MHz

5.8.3 Measurement of Period and Pulse-width: 100ns to 20s

5.8.4 Duty Cycle Measurement: 1％ to 99％

5.8.5 Gate Time: 1ms~500s

5.8.6 Couple Mode: AC, DC

5.8.7 Trigger Level: -3V to 3V

5.8.8 Low-pass Filter: enable or disable

5.9 Communication Connector

USB Host, USB Device and RS-232

5.10 Clock

5.10.1 External Clock Input

Clock frequency: 10 MHz $\pm$ 100 kHz

Clock amplitude: 1 Vpp to 5 Vpp

Input impedance: 5 kΩ, AC coupling

5.10.2 Internal Clock Output

Clock frequency: 10 MHz

Clock amplitude: >1 Vpp

Output impedance: 50Ω, AC coupling

5.11 General Characteristics

5.11.1 Power: AC 100 ~ 240V, 45~65Hz, <30 VA

5.11.2 Environment Condition: Temperature: 0 ~ 40℃   Humidity: <80%

5.11.3 Display: 4.3″ colorful TFT-LCD, 480×272 pixel，Chinese/English menu

5.11.4 Dimensions & Weight: 334×256×106 mm, Approx.3 kg

5.12 Power Amplifier (Option)

5.12.1 Input signal:

Voltage: 0Vrms to 5Vrms

Frequency: 1Hz to 200kHz

5.12.2 Voltage Amplifier: double

5.12.3 Output Power: 8W (load 8Ω)   2W(load 50Ω)   Frequency≤100kHz

3W(load 8Ω)   1W(load 50Ω)   Frequency≤200kHz

5.13 TCXO (Optional)

Frequency Stability: $\pm$2ppm (0℃ ~ 40℃)

Note 1: The test of the specifications should be operated under temperature of 18℃ to 28℃, 30

minutes after power-on.

Note 2: Sinewave frequency range of TFG6910A: 1μHz~10MHz

Sinewave frequency range of TFG6920A: 1μHz~20MHz

Sinewave frequency range of TFG6930A: 1μHz~30MHz

Sinewave frequency range of TFG6940A: 1μHz~40MHz

Sinewave frequency range of TFG6960A: 1μHz~60MHz

Note3:　Frequency difference range of TFG6910A: 1μHz~5MHz

Frequency difference range of TFG6920A: 1μHz~10MHz

Frequency difference range of TFG6930A: 1μHz~15MHz

Frequency difference range of TFG6940A: 1μHz~20MHz

Frequency difference range of TFG6960A: 1μHz~30MHz