User's Guide

SUIN 数英仪器
Digital Instruments

TFG2900A Series

Function/Arbitrary Waveform Generators

Introduction

With Direct Digital Synthesis technique (DDS), Field Programmable Gate Array (FPGA) and high sampling rate 1.2GSa/s, TFG2900A series are of the excellent technical performances and powerful function characteristics which are necessary for the fast measurement. 7 inches color LCD display can show the illustration of output waveform and parameters. The touch screen and easy - to - use keypads and knobs make the operation much easier.

1. Main Features

Output Channel: up to four independent output channels with complete equivalent function.

Frequency Characteristic: 1ppm Accuracy, 1μHz Resolution.

Amplitude Offset: 1% Accuracy, 1mVpp Resolution.

Built-in Waveform: 165 kinds of waveform, Sine, Square, Exponential, Log, etc.

Square, Ramp: Accurate Square's duty cycle and Ramp's symmetry could be set.

Pulse: Accurate pulse width and edge time could be set.

Double Pulse: Pulse width and time interval of the two Pulses could be set separately.

Phase Characteristic: The phase and polarity that output signal relative to synchronizing signal could be set.

Modulation Characteristic: Total 13 types of modulation such as FM, AM, PM, PWM, SUM, FSK, ASK, etc. could be supported.

Burst Output: period-settable signal and gated-controlled signal could be output.

Frequency Sweep: Support linear frequency sweep and exponential frequency sweep signal.

Frequency sequence: High speed hop-frequency frequency sequence can be output..

Synthesis of harmonic: The instrument can synthesize multiple harmonics, and every harmonic's amplitude and phase can be independently set.

Arbitrary waveform: Point by point output mode to prevent waveform's any detail from losing.

Waveform Editing: You can use keyboard editing function or computer's edit software to edit arbitrary wave

Waveform sequence: The instrument can output arbitrary wave sequence with different waveform length and cycle times.

Isolation characteristic: Output signals are isolated from case by grounding, they can be connected

to different reference level by floating way.

Channel Coupling: Each channel's frequency, amplitude and offset setting parameter can be intercoupling.

Storage characteristic: The instrument can store and recall several group working condition parameters and several users' arbitrary waveform.

Sync Output: The instrument can output corresponding signals synchronizing on different functions.

External Modulation: External modulation can be used when FM, AM, PM, PWM, SUM are modulating.

External Trigger: External Trigger can be used in key controlling, sweep, burst, double pulse, frequency and waveform sequence.

External Clock: It can automatically test and use external base clock. Internal reference clock can be output.

Counter: It can test external signals' frequency, cycle, pulse width, duty cycle, upper frequency limits up to 3GHz.

Touch Screen: Capacitive touch screen to make the operation more easily.

Calculation function: Values of frequency, period, amplitude peak to peak, RMS or dBm could be selected.

Communication interface: USB Host, USB device, LAN and WIFI interfaces are supported.

2. Model

This User's Guide is applied to TFG29xxA series function/arbitrary waveform generator.

The first x in TFG29xxA means the upper limit of Sine, and separately are 200MHz, 300MHz and 400MHz.

The second x in TFG29xxA means the output channel numbers, and separately are 2 channels or 4 channels.

3. Packing list

TFG29xxA function/arbitrary waveform generator	1
3-core power cord	1
BNC testing cable	1
WIFI Antenna	1
CD	1

Note: This document may include technical inaccuracy, and it is only a usage guide for the instrument. Suin Instruments Co., Ltd. will not make any promise to this document, including but not limit to the promise for some special sales and usage. It will not be notified if there were any modification in this documentation.

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 difficulties are met in operation, please read operating instruction in chapter 3.

1.1 Preparation for usage

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,

Voltage: AC 100~240V　　　　Frequency: 45~65Hz

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, enter into 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.

By the way, other equipment's ground wire connecting with the instrument must be firmly connected, otherwise the instrument will be damaged.

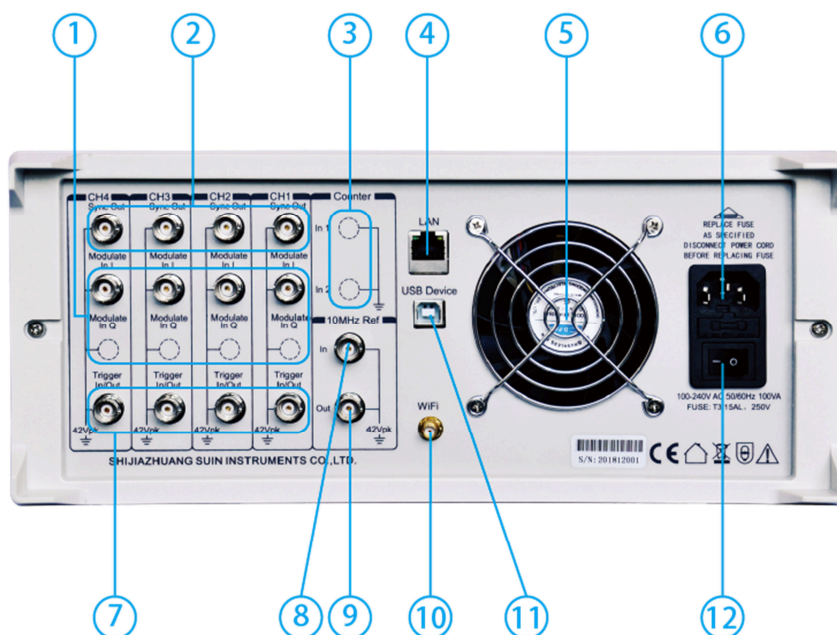## 1.2 Front and Rear Panel
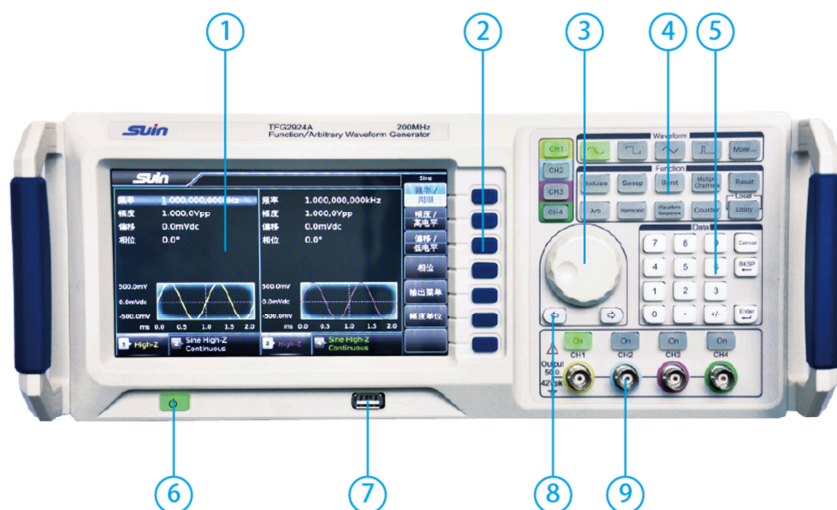
Front Panel

①Display ②Menu soft keys ③Knob ④Function keys ⑤Number keys

⑥On/Off Switch ⑦USB port ⑧Direction keys ⑨CH1/CH2/CH3/CH4 Output

①Modulate input of CH1/CH2/CH3/CH4 ②Sync output ③Counter input ④LAN interface

⑤Fan ⑥Power Socket ⑦Trigger In/Output of CH1/CH2/CH3/CH4 ⑧External Clock Input

⑨Internal clock output ⑩WiFi interface ⑪USB Device interface ⑫On/Off switch

1.3 Keyboard & Display

1.3.1 Keyboard description

There are 47 keys in 4 channel models and 43 keys in 2 channel models. The keys with certain definition embraced with 【】 are used to choose function, data input, move cursor and switch output, etc. There are also 7 blank keys in right side of display are soft keys, embraced with 〖〗 and used to different purpose with menu changing. The detail keyboard instruction is as follows:

【CH1】: Key to select CH1

【CH2】: Key to select CH2

【CH3】: Key to select CH3 and only available on 4 channel models

【CH4】: Key to select CH4 and only available on 4 channel models

【0】【1】【2】【3】【4】【5】【6】【7】【8】【9】【10】: Numerical keys

【.】: Key is used to enter decimal point

【+/-】: enter +/-

【<】: move cursor to left

【>】: move cursor to right

【Modulate】: select modulation mode

【Sweep】: select sweep mode

【Burst】: select burst mode

【Multiple Channel】: select multiple channel mode

【Counter】: select counter mode

【Arb】: select arbitrary wave function

【Harmonic】: select harmonic function

【Waveform Sequence】: choose waveform sequence function

【Utility】: system setting key

【Reset】: system reset key

【Local】: return to local when it is in remote control status. Used with 【Utility】.

【∿】: select Sine

【⎍】: select Square

【⎍】: select Pulse

【More...】: select other built-in waveforms except of listing

【On】: turn on or off output

〖〗:soft keys, to select the menu and unit

1.3.2 Display description: There are four areas in the display screen. Upside is company's logo and status information area, middle area is used to display parameters and waveform diagram, downside area is used to show channel's brief information, and the right side of display is menu area. Display interface is as follows:
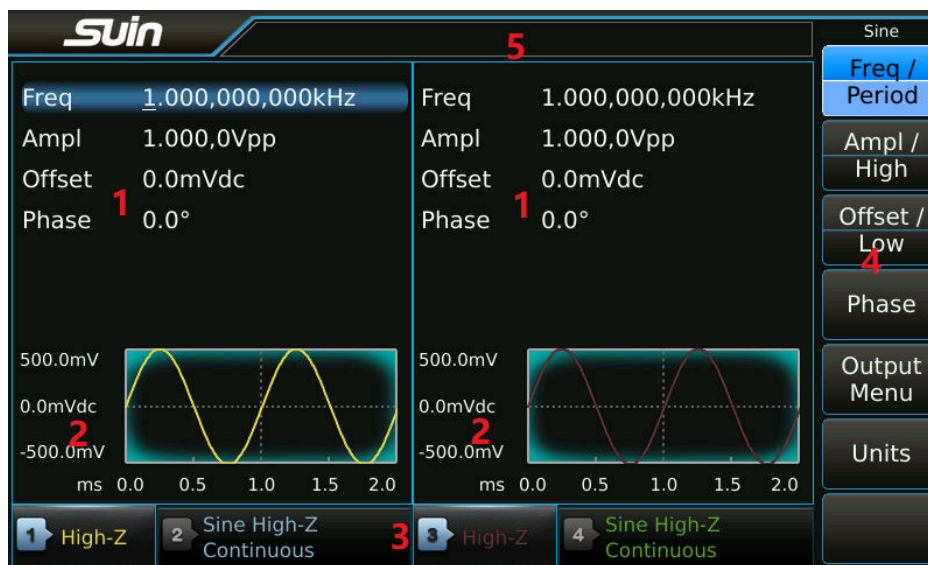

1. Working parameter 2. Voltage scale 3. Channel's brief information

4. Operation menu 5.Status information

1.4 Data Input

1.4.1 Menu operation: Screen's right side is operating menu, press the soft keys besides this menu and select one of them you want to set, while the background of chosen item will turn light and you can use the numerical keys or knob to set or modify the parameter, for balance items still remain grey and it's unavailable for user to set now.

Functions which can be chosen by the soft keys can also be selected by finger touch because of touch screen. For a brief description, the following contents about menu operation are all related to soft key operation but not touch screen.
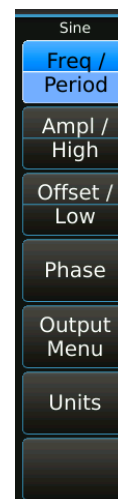
1.4.2 Keyboard input: If one parameter is chosen, the background of chosen item will turn light. Input date using the Number keys, point key and minus key. If there is mistakes, you can press 【BKSP】to delete one by one before select the unit, or【Cancel】key or 〖Cancel〗soft key to

cancel the operation. When the data is finished inputting, you should press the unit key or【Enter】 to make the data take effect as following picture shown. When pressing【Enter】, the unit will not change by default. For example, the unit for now is Vpp, when pressing【Enter】after inputting numbers, the unit will be Vpp and not change. The same with kHz.
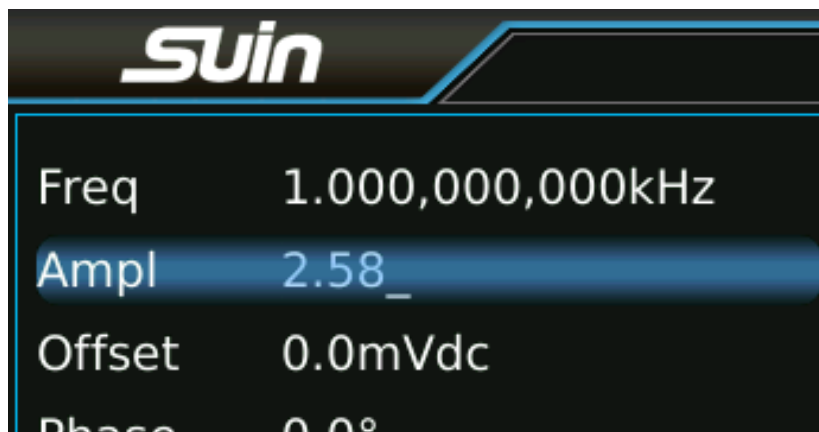
Numbers, point and minus can only be input by the keyboard, but not by finger touch in screen.

1.4.3 Knobs Adjustment: In the real usage, you may have to adjust the signals continuously, at this time, you can use knobs to adjust. When a parameter is chosen, there will be backlight in it, and also a white line called cursor position under a number. Press【<】or【>】, the cursor position will move to left or right. While adjust the knob to right, the number with the cursor position will add one continuously and can carry up. Adjust the knob to left, the number with the cursor position will decrease one continuously and borrow from the high position. Using the knob to input data, the number will take effect on that it changed, and there is no need to press unit. Move the cursor position to left, you can adjust the data roughly, while move it to right, you can adjust the parameter detailedly as following shown.
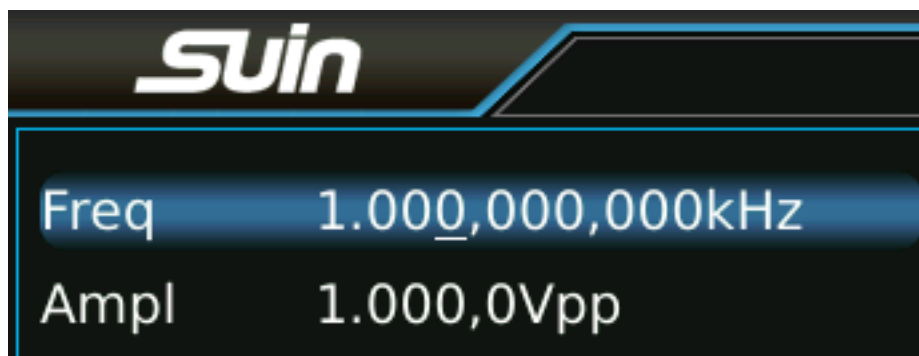
1.4.4 To Select input mode: For the known data, using number keys to input is more easily, and can input for one time without transitional data. For adjusting the input data or inputting

continuously changing data to observe, using knob is more easily. Users can choose flexibly according to different requirement.

1.5 Basic Operation

1.5.1 Channel Selection: Select channel by pressing 【CH1】【CH2】【CH3】or【CH4】to set. Press【On】repeatedly, you can turn on or off the output signals from output port in the front panel. The output turns on if the indicator under the key light on, while the output turns off if the indicator light off.

1.5.2 Waveform Selection: There are four waveforms which can be chosen by the keys directly, and they are Sine, Square, Ramp and Pulse. Other waveforms need to be selected by pressing 【More...】, and they are standard wave, mathematical wave, linear wave, combination wave, window function, special wave.

Press one of the soft keys, you can open the waveform list in this mode.

The selected wave in the waveform list is marked with a little yellow triangle in the left. Switch the knob to move the little triangle, other waveform will be selected. Press 〖OK〗, the selected wave will be displayed in the screen with its name and diagram, at the same time it will be displayed in the output port. Press〖Back〗two times, return to the function display. Waveform selection interface is as following shown:
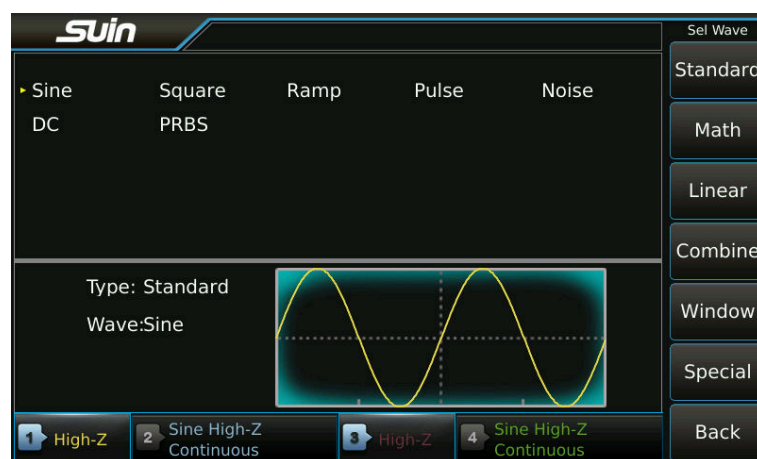
Using finger touch way in screen to select waveform directly is easier.

1.5.3 Duty cycle setting: If the square is selected, you should set the duty cycle to 20% according to the following steps:

Press 〖Duty cycle〗soft key, the backlight of it will turn on.
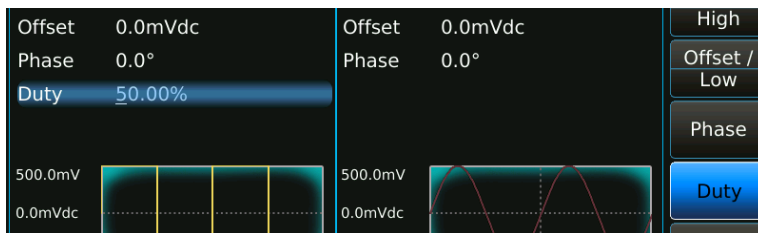
Press 【2】【0】 to input the parameter value, press〖%〗or【Enter】, duty cycle will be 20%, and the instrument will output the signals according to the new setting.
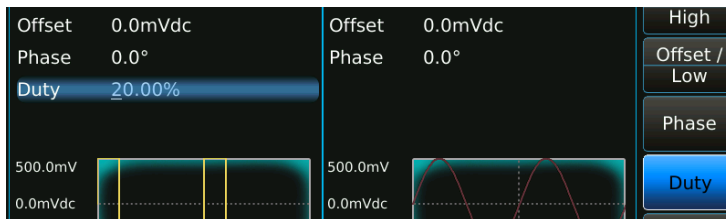
You can also perform duty cycle setting using knob and【<】【>】keys.

1.5.4 Frequency setting: If you want to change the frequency from 1kHz to 2.5kHz, you can operate as follows:

Press〖Freq/Period〗soft key, select 'Frequency', the matched backlight turns light.

Press 【2】【·】【5】keys to input the parameter value, then press〖kHz〗or 【Enter】, frequency parameter will be 2.500,000,000kHz. Instrument will output signals according to the setting parameter as below picture shown:
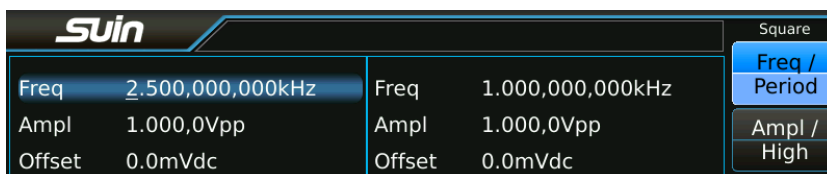
You can also perform the frequency setting using knob and【<】【>】keys.

1.5.5 Amplitude setting: If you want to set the amplitude to 1.5Vrms, please operate as follow steps:

Press 〖Ampl/High〗, select 'amplitude', its backlight will turn light.

Press 【1】【·】【5】keys to input parameter value, press 〖Vrms〗, and amplitude will be 1.500,0Vrms. Instrument will output signals according to the setting parameter like below shown:

You can also perform amplitude setting using knob and【＜】【＞】keys.

1.5.6 Offset setting: If you want to set the DC offset to -500mVdc, you can operate as following steps:

Press 〖Offset/Low〗, select 'offset', its backlight will turn light.

Press 【-】【5】【0】【0】to input parameter value, and then press 〖mVdc〗, then offset display -500,0mVdc. Instrument will output signals according to the setting as follows shown:
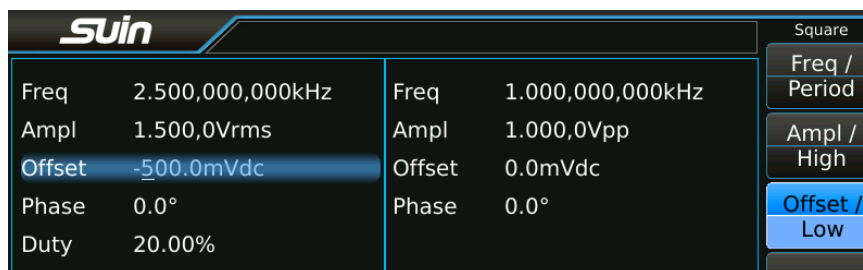
You can also use knob and【＜】【＞】to set the DC offset.

1.5.7 Amplitude modulation: If you want to output an amplitude modulation wave, with carrier wave Sine, 10kHz frequency, 1Vpp amplitude, 0Vdc offset, 80% modulation depth, 100Hz modulation frequency, modulation wave Ramp, you can operate as following steps:

Press【Modulate】, then press〖Type〗, modulation type menu will be displayed. Press 〖AM〗, wave diagram will be the modulation wave and modulation menu will be displayed too.

Press 【CH1】to enter carrier wave's parameter setting, then press〖Freq〗,set it to 10kHz. Press 〖Ampl〗, set the carrier wave's amplitude to 1Vpp. Press 〖Offset〗, set carrier wave's offset to 0Vdc as follows shown:
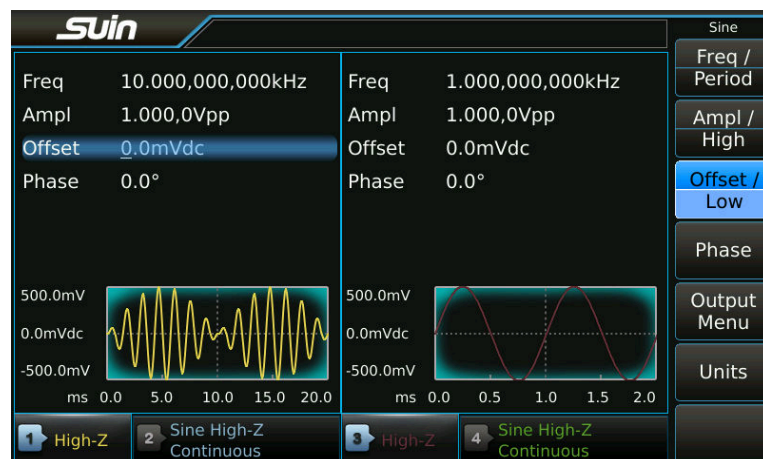
Press【Modulate】again, then press〖Depth〗to set modulation depth to 80%.

Press〖ModFreq〗, set it to 100Hz.

Press〖Shape〗,select〖Ramp〗, instrument will output the amplitude wave according to the setting parameter. Details are as follows:
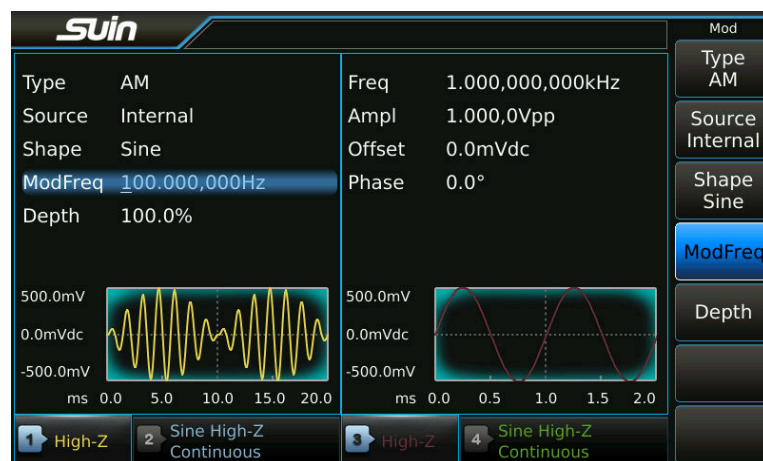
You can also use knob and【<】【>】keys to set above parameters continuously.

1.5.8 Sum modulation: If add a Ramp on the output waveform, sum amplitude 50%, please operate as following steps:

Press【Modulate】, then press〖Type〗, there will be modulation type menu displayed, press〖Sum〗to select modulation type to be Sum, then Sum waveform display in the diagram area, and the sum modulation menu will also be displayed.

Press〖Sum Ampl〗soft key to set sum amplitude to 50%.

Press〖Shape〗to enter wave selection menu. Press〖Ramp〗to set the modulation wave as Ramp. Then instrument will output a sum waveform as follows shown:
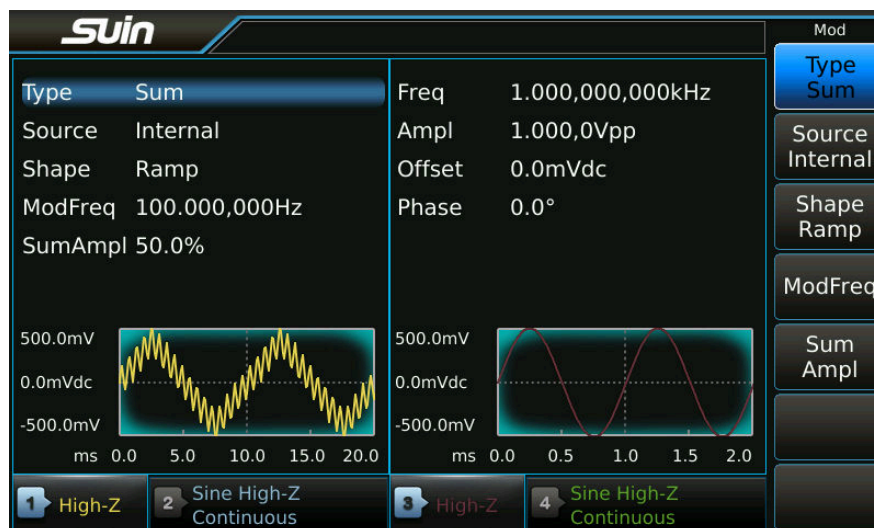
You can also use knob and 【<】【>】 to set above modulation setting.

1.5.9 Frequency-Shift Keying Modulation: If you want to output a frequency shift keying wave, with hop frequency 300Hz, frequency shift rate 50Hz , please operate as following steps:

Press 【Modulate】, then press 〖Type〗 to display modulation type menu, press〖FSK〗, to set modulation type to be FSK, then frequency shift keying wave will display in diagram area, and the frequency shift keying menu will be displayed too.

Press 〖Hop Freq〗 then set it to be 300Hz.

Press 〖FSK Rate〗, set hop frequency to 50Hz. Instrument will output a FSK wave according to the setting. Details are as followings:
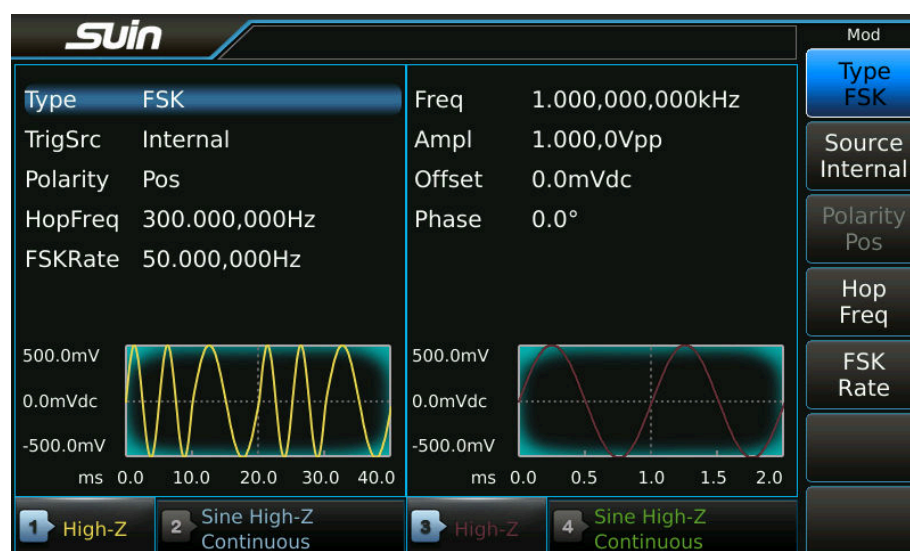
You can also use knob and 【<】【>】 keys to set hop frequency and frequency shift rate continuously.

1.5.10 Frequency sweep: If output a frequency sweep wave, of which sweep time 5s, logarithm sweep, please operate as following steps:

Press【Sweep】, mode 'Sweep', diagram of frequency sweep wave and menu will display.

Press〖Sweep Time〗, set the sweep time to 5s.

Press〖Type〗, set the sweep type to Log.

Instrument will output sweep wave according to the setting as follows shown:
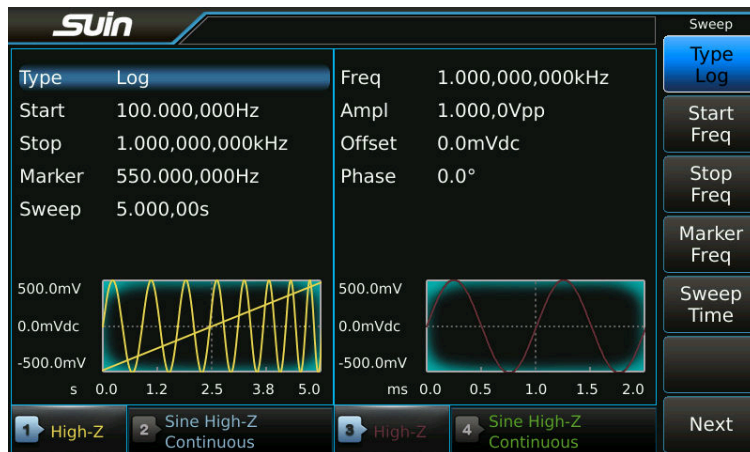
1.5.11 Burst output: If output a burst wave, of which burst period 10ms, 5 burst counting cycles, continuous or single manual trigger, please operate as following steps:

Press【Burst】, mode 'Burst', diagram of burst wave and menu will display.

Press〖Burst Period〗, set it to 10ms.

Press〖Cycle〗, set it to 5, while the diagram doesn't display the actual period.

Press〖Type〗, set it to trigger.

Press〖Source〗, set it to internal.

Instrument will output the burst wave according to the setting as follows shown:
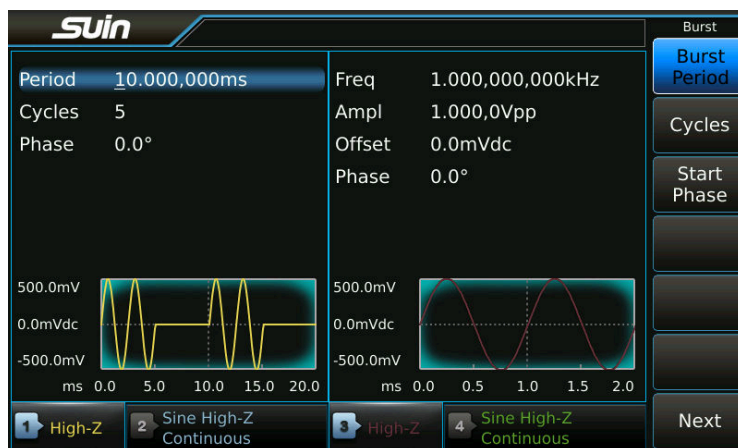
Press〖Source〗, set it to manual.

Press〖Manual Trig〗per time, instrument will output 5 period waves.

1.5.12 Frequency coupling: If couple the two channel's frequency, please operate as following steps:

Press【Multiple Channels】to enter the coupling mode and display the correspondent menu.

Press soft keys of〖Target Channel〗〖CH3〗, select the CH3 as the target channel. CH 1 is source channel, and CH3 is target channel.

Press〖FreqCpl〗, set it to 'On'.
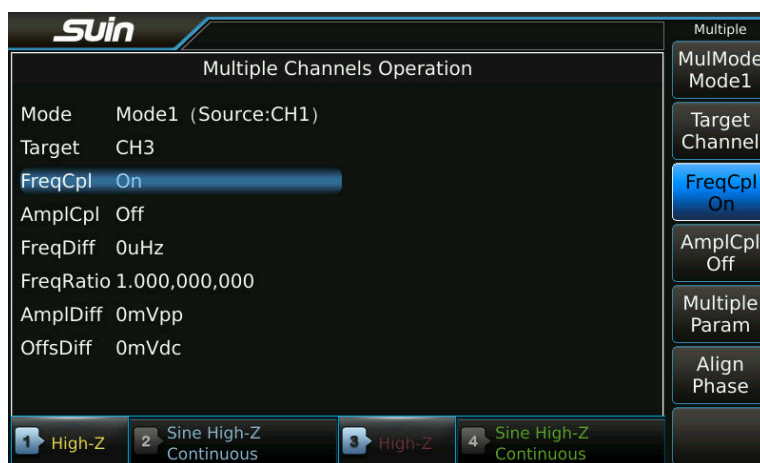
Press【CH1】to enter continuous work mode. Change CH1's frequency value, CH 3's frequency value will change accordingly. Channel 1 and channel 3's frequency are equal all the time. In this time you can't set CH3's frequency.

Press【Multiple Channels】, then press〖FreqCpl〗, set it to Off. In this time, the two channel's coupling is disconnected, and returns to mutual independence status.

Chapter 2 Principle Overview

Thought this chapter, you can get the knowledge of basic concept of signal forming and the instrument's internal operation, and then use it better.

2.1 Principle block diagram

After the digit analog converter, two same channels CHA and CHB are separated. Following block diagram is just one of them.
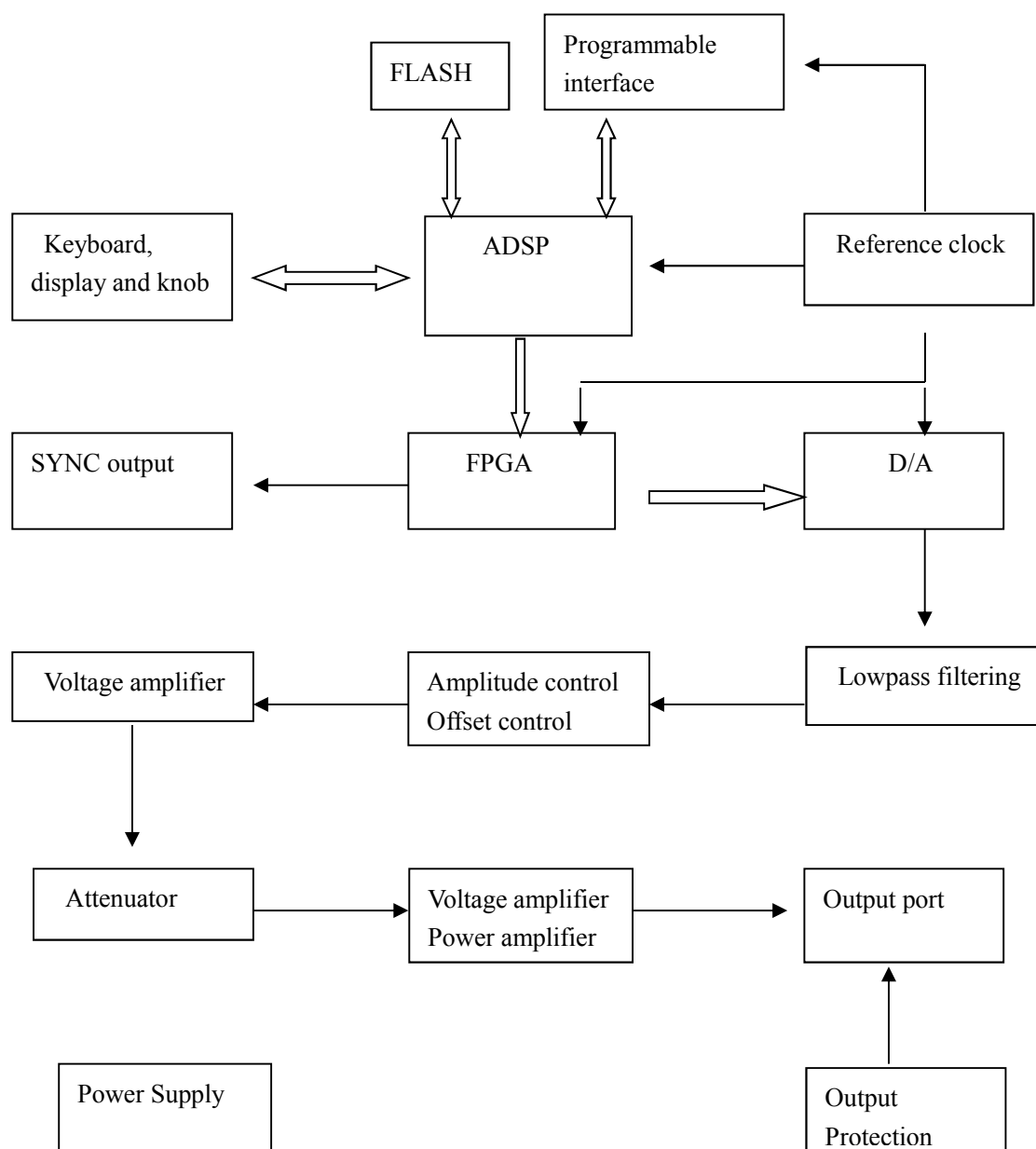
2.2 Working principle

2.2.1 Digital combination: To generate a voltage signal, traditional analog generator uses electron components to constitute oscillator. While its disadvantages are low frequency accuracy and stability, complex technology, low resolution, not convenient for setting the frequency and programming by the computer. DDS is a digital way of signal generating. It has no oscillator and uses digit combination to generator a serial of data flow, and then generates an analog signal through the D/A (digital analog converter).

For example, to generate a Sine, you should firstly make Y=SinX digital quantification, and then store X as address and Y as quantification data to waveform memory one by one. DDS uses phase accumulation technology to control the waveform memory's address. In each sampling clock period, it accumulates the phase increment to the real time value of the phase accumulator. Through changing phase increment to change DDS output frequency value. According to the address phase accumulator outputs, waveform memory gets out waveform's quantification data, and then converts to analog voltage through D/A and operational amplifier. Waveform data is discontinuous sampling data, what DDS generator outputs is a staircase sine waveform. Higher harmonic in the waveform has to be filtered by low pass filter (LPF), after that the outputs is continuous sine wave.

2.2.2 Working principle: There is a high resolution digital analog converter(D/A) inside device, which uses high accuracy reference voltage source to provide reference voltage which can be set for amplitude and offset control, thus we guarantee output amplitude's and DC offset's accuracy and stability.

After amplitude and offset controlling, the signals will go through attenuator, voltage amplifier and power amplifier, and then be output by output interface.

Microcontroller (ADSP) controls keyboard and displaying, when the keys are pressing, it will recognize the code and then execute it. The display circuit will display instrument's working status and various parameters.

The knob in the front panel is used for changing the number in cursor position. Every rotating to an angle there will be a trigger pulse generating. Controller can judge whether it is left or right rotating, if it is left rotating, the number in cursor position will be decreased one; if it is right rotating, the number will increase one, and carry or borrow a bit continuously.

Chapter 3 Operating Instruction

This chapter will introduce instrument's function characteristic and operation in detail. Before reading this chapter, if you haven't master instrument's basic operation, firstly please read chapter 1 Quick Start and make more practice. In this chapter, we will not repeat the basic operation and mainly take CH1 as example in the operation of this chapter because other channel's setting is totally same as CH1's.

3.1 Working Mode

Multi working modes are configured into instrument, each channel is independent, with same characteristic.

3.1.1 Continuous output: select continuous mode to output continuous signals.

3.1.2 Modulation output: it can output modulation signals, such as FM, AM, PM, PWM, SUM, FSK, PSK, ASK, OSK, etc.

3.1.3 Frequency sweep: Linear and Log sweep are supported.

3.1.4 Burst output: it can output burst signals with specified cycles.

3.1.5 Double Pulse: it can output double pulse signals.

3.1.6 Arbitrary waveform: it can output user defined arbitrary waveform.

3.1.7 Waveform's sequence: it can output wave sequence user defined.

3.1.8 Frequency sequence: it can output FH signal user defined .

3.1.9 Harmonic Synthesis: it can output multiple harmonic signal user defined.

3.1.10 Parameter coupling: To couple the parameter's setting between channels

3.2 Continuous Output

Continuous output means that output signals are stable and continuous. Signal's waveform, frequency and amplitude don't change with time, while signal's phase changes linearly with time.

3.2.1 Waveform selection: There are 165 kinds of built-in waveform as following:

No	Waveform	No	Waveform
Standard Waveform 7			
01	Sine	02	Square
03	Ramp	04	pulse
05	Noise	06	DC
07	PRBS		
Math Waveform 38			
08	Cosine	09	Tangent
10	CoTangent	11	ArgSine
12	ArcCos	13	ArcTan
14	ArcCoTan	15	SineH
16	CosinH	17	TangentH
18	CoTangentH	19	ArcSineH
20	ArcCosinH	21	ArcTangentH
22	Erf	23	Erfc
24	HaverSine	25	Sinc
26	ExpRise	27	ExpFall
28	LogRise	29	LogFall
30	PosSquare	31	NegSquare
32	PosCube	33	NegCube
34	SquareRoot	35	PosRecipro
36	NegRecipro	37	PNRecipro
38	BiRecipro	39	PosSemicirc
40	NegSemicirc	41	Gaussian
42	Maxwell	43	Lorentz
44	Laplace	45	Besell
Linear Waveform 36			
46	PosPulse	47	NegPulse
48	PN_Pulse	49	PosBiPulse
50	NegBiPulse	51	PNBiPulse
52	PMulPulse	53	NMulPulse
54	PNMulPulse	55	WidePulse
56	NarrowPulse	57	WiNaPulse
58	HiLoPulse	59	RisePulse
60	FallPulse	61	RiFaPulse
62	PosTriangl	63	NegTriangl
64	PNTriangl	65	HiLoTri

66	LoHiTri	67	PosRiseRamp
68	PosFallRamp	69	RiFaRamp
70	NegRiseRamp	71	NegFallRamp
72	FaRiRamp	73	Trapezia
74	RiseStair	75	FallStair
76	RiFaStair	77	RiStariRamp
78	FaStariRamp	79	Spiry
80	Swallow	81	Chair
Combine Waveform 40			
82	PAllSine	83	NAllSine
84	PHalfSine	85	NHalfSine
86	SiAmplCut	87	BiAmplCut
88	SiPhaseICut	89	BiPhaseICut
90	SinePulse	91	NoisePulse
92	BiHarmo	93	TriHarmo
94	FourthHarmo	95	FifthHarmo
96	SineFM	97	SineAM
98	SquareAM	99	NoiseAM
100	PulsePWM	101	SineFSK
102	SineFSK	103	SinePSK
104	SineSum	105	SineSweep
106	AmplInc	107	AmplDec
108	BurstNoise	109	BurstSine
110	LowPass	111	HighPass
112	BandPass	113	BandPit
114	PulseOSC	115	PulseOver
116	PNCircle	117	Tripagoda
118	Candela	119	ExpSquare
120	ExpSine	121	TanSquRoot
Window Function12			
122	Hanning	123	Barthanning
124	Parzen	125	Nuttal
126	Kaiser	127	Gaussian
128	FloatTop	129	Bohman
130	BlackManHarris	131	BlackMan
132	Bartlett	133	Trigangular

Special Waveform 32			
134	TanArcTan	135	ReciInvReci
136	HarmInvHarm	137	BiReciHarm
138	BiReciCircle	139	CubeGause
140	TanHarm	141	HalfBiReci
142	Charge	143	Stress
144	MulHarm	145	Syntony
146	Stereo	147	RainFall
148	Cardiac1	149	Cardiac2
150	NearQuake	151	FarQuake
152	Blast	153	Shake
154	LandScape	155	Cloud
156	Camel	157	User_Arb1
158	User_Arb2	159	User_Arb3
160	User_Arb4	161	User_Arb5
162	User_Arb6	163	User_Arb7
164	User_Arb8	165	User_Harm

01~07 are the common standard waveforms.

08~156 are fixed waveforms, which can be used in various occasion and also be materials for users to edit arbitrary waveform.

157~164 are eight user defined arbitrary waveforms, which are used to store user defined arbitrary waveforms.

165 is harmonic waveform which is used to store harmonic waveform user defined.

Press【More】to display the waveform selection menu and 6 types waveform are listing: Standard, Math, Linear, Combine, Window and Special. Select one by pressing the corresponding soft key, then it will show the waveform list under this type. Choose required waveform and press 〖OK〗, the selected waveform will output, and its diagram will also be displayed in waveform area.

Press〖Back〗to return to interface of waveform type selection, then you can reselect other built-in waveforms. Press 〖Back〗again, it will exit from the built-in waveform choosing menu.

Waveform's diagram is just a simple analog graph, of which resolution is low and distortion is big. The actual waveform output from instrument should be observed and tested by oscilloscope.

3.2.2 Square and Pulse: Their waveforms are same but there is a little difference in their

parameter setting. For Square, duty cycle can be set, while for Pulse, not only duty cycle, but also pulse width and edge time could be set.

Duty cycle: it means ratio of time that Square or Pulse's high level occupied to period. If you select Square or Pulse, you can set their duty cycle by pressing 〖Duty〗 in continuous mode menu. When their frequency is changing, their duty cycle remains unchanged. But when the frequency is high, duty cycle setting will be limited by smallest pulse width, which should conform to the following rules:

$$3.2ns \leq (duty\ cycle*period) \leq (period-3.2ns)$$

Pulse width: it means the hold time starting from the middle of rising edge to middle of the falling edge. If pulse is selected, you can set its pulse width by pressing 〖Width〗 in continuous mode. Pulse width setting is limited not only by pulse frequency, but also by smallest pulse width, which should conform to the following rules:

$$3.2ns \leq pulse\ width \leq (period-3.2ns)$$

When pulse wave's frequency is changing not exceeding the above rule, pulse width will remain unchanged. But if it exceeds, instrument will modify pulse width value automatically to make it suitable for pulse frequency.

Edge time: it means the hold time pulse wave's rising edge rises from 10% amplitude to 90%, or pulse wave's falling edge falls down from 90% to 10% amplitude. If Pulse is selected, you can set edge time of rising edge and falling edge by pressing 〖Rising〗 or 〖Falling〗 in continuous mode. Edge time will be limited by pulse width and duty cycle, which should conform to the following rule:

$$Rising\ edge\ time/0.8 + high\ level\ time \geq 5ns$$

$$Falling\ edge\ time/0.8 + low\ level\ time \geq 5ns$$

If pulse width and duty cycle don't exceed the above formula specified, the edge time will remain unchanged. If they exceed the rules above, instrument will modify edge time automatically to make it suitable for pulse width and duty cycle.

3.2.3 Ramp: Ramp can set symmetry. Ramp's symmetry means the ratio of rising time to period. When Ramp's frequency changing, its symmetry remains unchanged. When symmetry is 100%, it is Rising Ramp. When symmetry is 0%, it is Fall Ramp. When symmetry is 50%, it is Triangle.

3.2.4 Frequency setting: The upper frequency limit of Sine is related to instrument model, while other wave's frequency is also limited influenced by sampling rate and channel band width (details see Chapter5). When the waveform is changing, if the current frequency exceeds the specified upper frequency limits, instrument will modify it automatically to upper frequency limits. All waveforms' lowest frequency is 1μHz.

Except Sine, other waveform's highest frequency limitation is flexible. When the frequency is rising up, step waveform's overshoot will increase, arbitrary waveform's details will be lost, upper harmonic in Harmonic will attenuate. The higher the frequency is, the bigger the waveform's distortion is. For different waveforms, its distortion rate is different. Users should make some limitation to the highest frequency according to test needs.

In continuous mode menu, press〖Freq/Period〗. If Frequency is selected, you can set frequency value, the same to Period setting. Either frequency setting or period setting is allowed, but in actual frequency combination way is used into instrument, and converts it when data is inputting and displaying.

3.2.5 Amplitude setting: There are two modes of amplitude setting: 'Amplitude setting' and 'Level setting'. If use 'Amplitude setting', signal's high level and low level will change simultaneously, while its DC offset remains unchanged. If use 'Level setting', signal's high level and low level can be set independently, and its DC offset will change accordingly. The relation of amplitude Vpp, high level, low level and DC offset are as follows:

Amplitude Vpp=high level-low level

High level=DC offset+Amplitude Vpp/2

Low level= DC offset- Amplitude Vpp /2

In continuous mode, press〖Ampl/High〗, and select 'Ampl', you can set signal's amplitude; select 'High', you can set its high level. Press〖Offset/Low〗, select 'offset', you can set signal's DC offset; while select 'Low', you can choose its low level.

3.2.6 Amplitude Limit: Signal's output amplitude will be limited by these factors. If it surpasses the limitation, instrument will modify its setting value to limit it to the maximum value allowed. Limiting level's limit: press〖Output Menu〗, and then〖HighLimit〗, you can set the limit value of the output high level. Press〖LowLimit〗, you can set the limit value of the output low level.

Level limit setting is a safety method. Users can preset the high level's and low level's limit value. Even if there is misoperation in the actual use, the limit value won't be surpassed by the output voltage to protect the instrument from damage by overvoltage. High level limit's maximum setting value is +10Vdc, and low level limit's minimum value is -10Vdc.

DC offset limit: If DC offset setting is 0, amplitude setting will be only influenced by limit level, otherwise it will be limited by DC offset further. Amplitude setting should conform to the rules following:

$$\text{DC offset+amplitude Vpp/2} \leq \text{high level limit}$$

$$\text{DC offset- amplitude Vpp /2} \geq \text{low level limit}$$

Frequency limit: When frequency is higher, the maximum allowable amplitude value will be limited (see specification).

Affected by the channel's bandwidth, the output amplitude will decrease if frequency is higher. In continuous output mode, flatness output compensation is provided and the output amplitude will be accurate. But in other function, flatness output compensation is unavailable, output amplitude will fall down as the frequency's rising.

For arbitrary waveform, in its diagram, if its peak to peak value doesn't reach the vertical full amplitude, then the real output amplitude won't conform to the displaying value.

3.2.7 Amplitude format: There are three fomats to express amplitude value: peak to peak value Vpp, effective value Vrms, Power level value dBm. Vpp is available for all waveforms. Sine, Square, Ramp and Pulse can also use Vrms. If external load setting is not high resistance status, power level value dBm could also be used.

In continuous mode menu, press 〖Unit〗, if the wave and load condition is allowable, press different unit keys, amplitude value will be displayed in different formats.

For different waveforms, Amplitude Vpp and Vrms is also different as follows:

Waveform	Vpp	Vrms
Sine	2.828Vpp	1Vrms
Square, Pulse	2.000Vpp	1Vrms
Ramp	3.464Vpp	1Vrms

Crest factor of Square and Pulse is calculated by 50% of duty cycle.

Power level value and Amplitude Vrms have links with external loading, as following formula:

$$dBm＝10×\log_{10}(P/0.001) \qquad P＝(Vrms)^2/Load$$

When it is Sine, external load is 50Ω, Vpp,Vrms and dBm are as following:

Vpp	Vrms	dBm
10.000 Vpp	3.5355Vrms	23.979 dBm
6.3246 Vpp	2.2361Vrms	20.000 dBm
2.8284 Vpp	1.0000Vrms	13.010 dBm
2.0000 Vpp	707.1 mVrms	10.000 dBm
1.4142 Vpp	500.0 mVrms	6.9897 dBm
632.5 mVpp	223.6 mVrms	0.00 dBm
282.8 mVpp	100.0 mVrms	-6.9897 dBm
200.0 mVpp	70.7 mVrms	-10.000 dBm
10.0 mVpp	3.5 mVrms	-36.020 dBm

3.2.8 Offset setting: In continuous mode menu, press 〖Offset/Low〗, choose 'offset' to set DC offset value. It is limited by amplitude and limit level, which should conform to the following formula:

DC offset≥low level limit+amplitude Vpp value/2

DC offset≤high level limit-amplitude Vpp/2

If DC offset exceeds the formula stipulated, instrument will modify it to limit it to the allowable value.

While using knobs to adjust DC offset is easier than operation using number keypad. No matter DC offset is positive value or negative value, switch the knob to right, DC level will incerease, while it will decrease when switch it to left. When it goes through 0, offset value's symbol will change automatically.

3.2.9 Phase setting: In continuous mode menu, press 〖Phase〗to set output the phase. Output phase means the phase difference that output signal relative to sync signal.

3.2.10 Polarity setting: In continuous mode menu, press〖OutputMenu〗then press〖Polarity〗to set the output signal's polarity.

If you select 'Positive', output signal's polarity will be positive. Take Sine for example, positive polarity means waveform starts from 0 phase and voltage keeps rising status.

If you select 'Negative', output signal's polarity will be negative. Negative polarity takes 0V voltage as axis, reverse the waveform of positive polarity, which is vertical mirror to positive

polarity's waveform.

3.2.11 Sync output: Sync signal's frequency is equal to output signal's. But when the frequency exceeds 66.66667MHz, sync signal's frequency will be one sixth of output signal's.

3.2.12 External load: In continuous mode menu, press〖OutputMenu〗, and then press〖Load〗, external load menu will display and you can set it.

The fixed output impedance is 50Ω, and external load's actual voltage value is the partial voltage between load impedance and 50Ω. When external load is set to high impedance, the higher it is, the bigger the actual voltage in external load is, and the smaller the real voltage and the displaying value are. When external load is greater than 10kΩ, error will be lower than 0.5%. If external load is smaller, the actual voltage will not match with displaying value in load.

When external load is smaller, in order to make the actual voltage match with displaying value, the setting for external load is required.

Press〖50Ω〗, you can directly set the external load to 50Ω.

Press〖High-Z〗, you can directly set the external load to high impedance.

Press〖Res〗, you can set the actual value of external load.

The amplitude and offset's displaying value will change accordingly when setting for external load changing. But the actual output doesn't change. If you connect an external load whose actual value is equal to the setting value, then the actual voltage of load will match with the current displaying value.

The default status of external load is high impedance (High-Z) when power on the instrument. Please be noted, most of the external load are not pure resistive. Perceptual impedance and capacitive impedance will change with the frequency. This will not be ignored when frequency is higher. If the exact external load's impedance is not sure, you can make it to match with the real displaying value through changing the external load's setting value step by step. At this time, external load's setting value is equal to external load's actual impedance.

3.2.13 Output protection: Instrument's output impedance is 50Ω and it won't be damaged by short circuit in short time at output port. The instrument has over-voltage protection, when higher voltage is connected to the output port, protection circuit will disable the output immediately, and display the alarm information with sounds. Users should check load port. After confirming the

problem is solved, you can press【On】to enable output. Although some protection measures could be taken by device, the protection can't avoid all the damages. If the input voltage is too high, the instrument may be damaged before the circuit protection function takes effect. So long time short circuit at output port and connecting to high voltage must be forbidden.

3.2.14 Over-limit Data: Frequency and amplitude have their own allowable data range. When the setting data exceeds its range, instrument will remind the users as following:
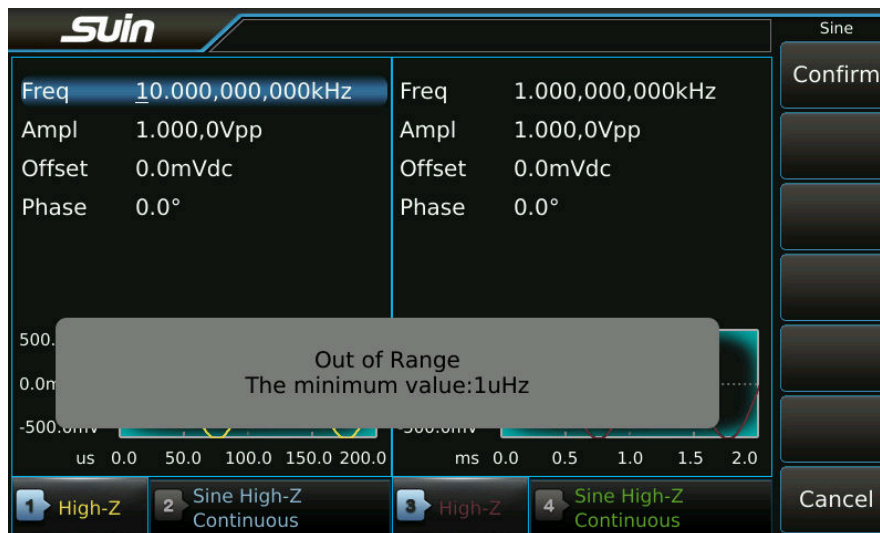
At this time if press〖Confirm〗, instrument will set parameters to allowable limit value and may modify the relevant parameters.

At this time if press〖Cancel〗or wait for a minute, instrument will cancel the current setting. Although the out of range won't damage the instrument, the output result may not accord with expected value. It will remind users to reset the parameters.

3.3 Frequency Modulation

In frequency modulation, carrier's frequency changes with the modulation signal's transient voltage.

3.3.1 Function selection: Press【Modulate】to enter modulation function, then press〖Modulation Type〗to display modulation menu. Press〖FM〗, modulation type will be FM, instrument will display its waveform's diagram and menu.

3.3.2 Carrier setting: Sine usually will be the carrier in FM modulation, other built-in waveforms also could be used but some may be not suitable. Press【CH1】to enter carrier parameter interface

to set its parameter, and press【Modulate】again to enter modulation parameter setting interface to set its parameter.

3.3.3 Frequency Deviation: Press〖FreqDev〗to set frequency deviation value. It means the carrier frequency's variation quantity when modulation signal reaches in full amplitude during the frequency modulation. In modulation signal's positive full value, output frequency is carrier frequency plus frequency deviation. While in its negative full value, output frequency is that carrier frequency decreases frequency deviation. Thus, frequency deviation should conform to the following two conditions:

(carrier frequency-frequency deviation)>0

(carrier frequency + frequency deviation)<frequency upper limitation

frequency deviation ≤ carrier frequency/2

3.3.4 Modulation frequency: Press〖ModFreq〗to set modulation signal's frequency value. In usual modulation frequency is lower than carrier frequency.

3.3.5 Modulation waveform: Most of the built-in waveforms could be used as modulation waveform, but some may be not suitable. Press〖Shape〗to choose modulation signal's waveform.

3.3.6 Modulation source: Press〖Source〗to choose the modulation source. If 'Internal' is chosen, instrument will use internal modulation source, at this time modulation frequency and modulation waveform's setting is effective. If 'External' is chosen, instrument will use external modulation source, at this time modulation frequency and modulation waveform's setting will be ignored. Input modulation signal from rear panel's 《Mod In I》 port in present channel. When external modulation signal's amplitude is 5Vpp, DC offset is 0Vdc, frequency deviation display will match with the actual frequency deviation.

3.3.7 Sync output: Sync signal's duty cycle is 50%, sync signal's frequency is equal to modulation frequency, sync signal's phase takes modulation signal's phase as reference.

3.4 Amplitude Modulation

In amplitude modulation, carrier's amplitude changes with the modulation signal's transient voltage.

3.4.1 Function selection: Press【Modulate】to enter modulation function, then press〖Modulation

Type〗to display modulation type menu, press〖AM〗, modulation type will be AM, and display the waveform's diagram of amplitude modulation and it's menu.

3.4.2 Carrier setting: Usually Sine will be used as carrier. Of course other built-in waveforms can also be used, but some are not suitable. Press【CH1】to enter carrier parameter interface to set carrier's parameter. Press【Modulate】again to enter modulation parameter setting interface to set its parameter.

3.4.3 Modulation depth: Press〖Depth〗to set modulation depth. It means the percent of carrier amplitude variation quantity to amplitude setting value when modulation signal reaches the full amplitude during AM process. After modulation, carrier envelope's maximum amplitude(Amax), minimum amplitude(Amin), amplitude setting (A), modulation depth(M), the four relationship is as following formula:

Amax=(1+M)*A/2.2   Amin=(1-M)*A/2.2

Modulation depth can be derived from the two formulas above.

M=(Amax-Amin)*1.1/A

If modulation depth is 120%, Amax=A, Amin=-0.09A.

If modulation depth is 100%, Amax=0.909A, Amin=0.

If modulation depth is 50%, Amax=0.682A, Amin=0.227A.

If modulation depth is 0%, Amax=0.4545A, Amin=0.4545A.

That's to say, when modulation depth is 0, carrier amplitude is almost half of amplitude setting value.

3.4.4 Modulation frequency: Press〖ModFreq〗to set modulation signal's frequency value. Modulation frequency is usually far lower than carrier frequency.

3.4.5 Modulation waveform: Most of built-in waveform could be used as modulation waveform, but some of them may be not suitable. Press〖Shape〗to choose modulation signal's wave. After selecting, press〖Back〗 to return to modulation menu.

3.4.6 Modulation source: Press〖Source〗to choose modulation source. If 'Internal' is chosen, instrument will use internal modulation source, modulation frequency and waveform setting is effective. If 'External' is chosen, instrument will use external modulation source, modulation frequency and waveform setting will be ignored. Input modulation signal from rear panel's present

channel's《Mod In I》port. When external modulation signal's amplitude is 5Vpp, DC offset is 0Vdc, displaying value of modulation depth will match with the actual modulation depth.

3.4.7 Sync output: Sync signal's duty cycle is 50%, sync signal's frequency is equal to modulation frequency, sync signal's phase takes modulation signal's phase as reference.

3.5 Phase Modulation

In phase modulation, carrier's phase changes with the modulation signal's transient voltage.

3.5.1 Function selection: Press【Modulate】to enter modulation function, and then press〖Type〗to display modulation type menu, press〖PM〗, modulation type will be PM, and display the phase modulation's waveform diagram and phase modulation menu.

3.5.2 Carrier setting: Usually Sine is used as carrier wave. Of course other built-in waveforms can also be used, but some are not suitable. Press【CH1】to enter carrier parameter interface to set carrier's parameter. Press【Modulate】again to enter modulation parameter setting interface to set its parameter.

3.5.3 Phase deviation: Press〖PhaseDev〗, you can set phase difference value. Phase deviation means carrier phase's variation quantity when modulation signal reaches full amplitude in the phase modulation. In modulation signal's positive full amplitude value, output signal's phase increases a phase difference. While in negative full amplitude value, the phase decreases a phase difference.

3.5.4 Modulation frequency: Press〖ModFreq〗to set modulation signal's frequency value. Modulation frequency is usually far lower than carrier frequency.

3.5.5 Modulation waveform: You can use most of built-in waveform as modulation waveform, but some of them may be not suitable. Press〖Shape〗to choose modulation waveform. After choosing it, press〖Back〗to return to modulation menu.

3.5.6 Modulation source: Press〖Source〗to choose modulation source. If 'Internal' is chosen, instrument will use internal modulation source, modulation frequency and waveform setting is effective. If 'External' is chosen, instrument will use external modulation source, modulation frequency and waveform setting will be ignored. Input modulation signal from rear panel's《Mod In I》port of current channel. When external modulation signal's amplitude is 5Vpp, DC offset is

0Vdc, phase difference's displaying value will match with the real phase difference.

3.5.7 Sync output: Sync signal's duty cycle is 50%, sync signal's frequency is equal to modulation's frequency, sync signal's phase takes modulation signal's phase as reference.

3.6 Pulse Width Modulation

In pulse width modulation, carrier's pulse width changes with the modulation signal's transient voltage.

3.6.1 Function selection: Press【Modulate】to enter modulation function, and then press〖Type〗to display modulation type menu, press〖PWM〗, modulation type will be PWM, and display the pulse width modulation's waveform diagram and pulse width modulation menu.

3.6.2 Carrier setting: In pulse width modulation, we can only use pulse wave. If present wave is not pulse wave, instrument will change it to pulse automatically. Press【CH1】to enter carrier parameter interface, you can set carrier wave's parameter. Press【Modulate】to enter modulation parameter setting interface to set its parameter.

3.6.3 Pulse width deviation: Press〖WidthDev〗, you can set pulse width deviation value. Pulse width deviation means in the pulse width modulation, the percent of carrier wave's pulse width variation quantity to pulse width setting value when modulation signal reaches full amplitude. In modulation signal's positive full amplitude value, output signal's pulse width is equal to pulse width setting value plus pulse width deviation. While in negative full amplitude value, output signal's pulse width is equal to pulse width setting value minus pulse width deviation.

3.6.4 Modulation frequency: Press〖ModFreq〗to set modulation signal's frequency value. Modulation frequency is usually far lower than carrier frequency.

3.6.5 Modulation waveform: You can use most of built-in waveform as modulation waveform, but some of them may be not suitable. Press〖Shape〗to choose modulation waveform. After choosing it, press〖Back〗, return to modulation menu.

3.6.6 Modulation source: Press〖Source〗to choose modulation source. If' Internal' is chosen, instrument will use internal modulation source, modulation frequency and waveform setting is effective. If 'External' is chosen, instrument will use external modulation source, modulation frequency and waveform setting will be ignored. Input modulation signal from rear panel's《Mod

In I》 port of current channel. When external modulation signal's amplitude is 5Vpp, DC offset is 0Vdc, pulse width difference's displaying value will match with the real pulse width difference.

3.6.7 Sync output: Sync signal's duty cycle is 50%, sync signal's frequency is equal to modulation frequency, sync signal's phase takes modulation signal's phase as reference.

3.7 Sum Modulation

In Sum modulation, output waveform's transient voltage is equal to the sum of carrier and modulation signal's transient voltage at the same moment.

3.7.1 Function selection: Press【Modulate】to enter modulation function, and then press〖Type〗 to display modulation type menu, press 〖Sum〗, modulation type will be Sum, and display the Sum modulation's waveform diagram and it's menu.

3.7.2 Carrier setting: Usually Sine is used as carrier. Of course other built-in waveforms can also be used, but some are not suitable. Press【CH1】to enter carrier parameter interface to set carrier wave's parameter. Press【Modulate】again to enter modulation parameter setting interface to set its parameter.

3.7.3 Sum amplitude: Press〖SumAmpl〗, you can set sum amplitude value. Superposition amplitude means in sum modulation, modulation signal's amplitude size overlapped in the carrier, which is shown by carrier amplitude setting value's percentage. When sum amplitude is set to 100%, modulation waveform's amplitude is equal to half of carrier amplitude's setting value. When sum amplitude is set to 0%, modulation waveform amplitude is 0, and carrier wave amplitude is equal to half of carrier wave amplitude's setting value at this time.

3.7.4 Modulation frequency: Press〖ModFreq〗to set modulation signal's frequency value. Different from other modulation type, this modulation frequency can be higher or lower than carrier's frequency value.

3.7.5 Modulation waveform: You can use all of the built-in waveforms as modulation waveform. Press〖Shape〗, you can choose modulation waveform. After it is selected, press〖Back〗, return to modulation menu.

3.7.6 Modulation source: Press〖Modulation Source〗to choose modulation source. If 'Internal' is chosen, instrument will use internal modulation source, modulation frequency and waveform

setting is effective. If 'External' is chosen, instrument will use external modulation source,

modulation frequency and waveform setting will be ignored. Input modulation signal from rear

panel's《Mod In I》port of current channel. When external modulation signal's amplitude is 5Vpp,

DC offset is 0Vdc, sum amplitude's displaying value will match with the actual sum amplitude.

3.7.7 Sync output: Sync signal's duty cycle is 50%, sync signal's frequency is equal to

modulation frequency, sync signal's phase takes modulation signal's phase as reference.

3.8 Frequency-shift keying (FSK) Modulation

In FSK modulation, output signal's frequency will jump alternatively between 'Carrier frequency'

and 'Hop frequency'. Jumping speed depends on shift keying rate.

3.8.1 Function selection: Press【Modulate】to enter modulation function, and then press〖Type〗

to display modulation type menu, press〖FSK〗 〖4FSK〗 〖nFSK〗modulation type will be FSK,

4FSK, nFSK, and display the FSK waveform's diagram and menu.

3.8.2 Carrier setting: Usually sine is used as carrier wave. Of course other built-in waveforms

can also be used, but some are not suitable. Press【CH1】to enter carrier parameter interface to set

it's parameter. Press【Modulate】to enter modulation parameter setting interface to set its

parameter.

3.8.3 Hop frequency: FSK modulation is similar to square's FM modulation. Hop frequency is

similar to frequency deviation. The difference is FM modulation's frequency deviation is carrier

frequency plus an offset, whose setting range has relationship with carrier frequency; while hop

frequency can be set in the full frequency range randomly, without relationship with carrier

frequency. Press〖HopFreq〗, you can set its value.

You can set one hop frequency in FSK, and carrier frequency and hop frequency output

alternately.

You can set 3 hop frequencies in 4FSK, and carrier frequency and hop frequency 1, 2, 3 output in

order.

You can also set 3 hop frequencies in nFSK, carrier frequency and three hop frequency output

randomly.

3.8.4 FSK rate: Press〖FSK Rate〗〖4FSK Rate〗〖NFSK Rate〗, you can set frequency shift keying

rate value. FSK rate is usually lower than carrier frequency and hop frequency.

3.8.5 Trigger source: Press 〖Trigger Source〗to choose trigger source. If 'Internal' is chosen, instrument will use internal trigger source, FSK rate setting is effective. If 'External' is chosen, instrument will use external trigger source, FSK rate setting will be ignored. Input external trigger signal from rear panel's《Trig In/Out》port.

When it is inFSK, input external trigger signal from rear panel's《Trig In/Out》port.

When it is in 4FSK or nFSK, input two external trigger signal. As CH1 and CH2 share one external trigger signal, and CH3 and CH4 share another external trigger signal, then CH1 and CH2 can't be set as external trigger at the same time, nor can CH3 and CH4.   When CH1 is set to external trigger, input the lower trigger signal from rear panel's《Trig In/Out》port of CH1, and input the higher from《Trig In/Out》interface of CH2. When CH2 is set to external trigger, Input the lower trigger signal from rear panel's《Trig In/Out》port of CH2, and input the higher from《Trig In/Out》 interface of CH1. CH3 and CH4 are same as CH1 and CH2.

3.8.6 Trigger polarity: Press 〖Polarity〗to choose external trigger signal's polarity.   It is only effective for external trigger.

When it is positive:

FSK setting: when trigger signal is 0, it will output carrier frequency; and when trigger signal is 1, hop frequency will be output.

4FSK setting: when trigger signal is 00, it will output carrier frequency.

   when trigger signal is 01, it will output hop frequency 1.

   when trigger signal is 10, it will output hop frequency 2.

   when trigger signal is 11, it will output hop frequency 3.

When it is negative:

FSK setting: when trigger signal is 1, it will output carrier frequency; and when trigger signal is 0, hop frequency will be output.

4FSK setting: when trigger signal is 00, it will output carrier frequency.

   when trigger signal is 01, it will output hop frequency 1.

   when trigger signal is 10, it will output hop frequency 2.

when trigger signal is 11, it will output hop frequency 3.

nFSK setting: trigger signal just takes the triggering effect, and has no relationship with which frequency outputting.

3.8.7 Sync output: Sync signal's duty cycle is 50%, and sync signal's frequency is equal to frequency shift keying rate.

FSK setting: when carrier frequency is output, sync signal will be low level; when hop frequency is output, sync signal will be high level.

4FSK setting: when carrier frequency and hop frequency 2 are output, sync signal will be low level; when hop frequency 1 and 3 are output, sync signal will be high level.

nFSK setting: carrier frequency and the three hop frequencies are output randomly, which has no high level or low level relationship with sync signal.

If external trigger is used, sync signal will be decided by external trigger signal.

3.9 Phase shift keying (PSK) Modulation

In PSK, the phase of output signal hops between carrier phase and hop phase alternately, and hop rate depends on shift keying rate.

3.9.1 Function selection: Press【Modulate】to enter modulation function, and then press〖Type〗to display modulation type menu, press〖PSK〗 〖4PSK〗 〖nPSK〗modulation type will be PSK, 4PSK, nPSK, and display the PSK waveform's diagram and menu.

3.9.2 Carrier setting: We usually use sine wave as carrier wave. Of course other built-in waveforms can also be used, but some are not suitable. Press【CH1】to enter carrier parameter interface to set carrier's parameter. Press【Modulate】to enter modulation parameter setting interface to set its parameter.

3.9.3 Hop phase: PSK modulation is similar to square's PM modulation. Hop phase is similar to phase deviation. Press〖HopPhase〗to set its value.

You can set one hop phase in PSK, and carrier phase and hop phase output alternately.

You can set 3 hop phases in 4PSK, and carrier phase and hop phase 1, 2, 3 output in order.

You can also set 3 hop phases in nPSK, carrier phase and three hop phases output randomly.

3.9.4 PSK rate: Press〖PSK Rate〗〖4PSK Rate〗〖NPSK Rate〗to set phase shift keying rate value.

PSK rate is usually lower than carrier frequency.

3.9.5 Trigger source: Press 〖Source〗, you can choose trigger source. If 'Internal' is chosen, instrument will use internal trigger source, PSK rate setting is effective. If 'External' is chosen, instrument will use external trigger source, PSK rate setting will be ignored. Input external trigger signal from rear panel's 《Trig In/Out》port.

When it is PSK, you should input trigger signal from rear panel's 《Trig In/Out》port.
When it is 4PSK or nPSK, you should input two external trigger signals. As CH1 and CH2 share one external trigger signal, and CH3 and CH4 share another external trigger signal, then CH1 and CH2 can't be set as external trigger at the same time, nor can CH3 and CH4. When CH1 is set to external trigger, input the lower trigger signal from rear panel's 《Trig In/Out》port of CH1 and input the higher from 《Trig In/Out》port of CH2. When CH2 is set to external trigger, input the lower trigger signal from rear panel's 《Trig In/Out》port of CH2 and input the higher from 《Trig In/Out》port of CH1, same as for CH3 and CH4.

3.9.6 Trigger polarity: Press 〖Trigger Polarity〗to choose external trigger signal's polarity. It is only effective for external trigger.
When it is positive:
PSK setting: when trigger signal is 0, it will output carrier phase; and when trigger signal is 1, hop phase will be output.
4PSK setting: when trigger signal is 00, it will output carrier phase.

        when trigger signal is 01, it will output hop phase 1.

        when trigger signal is 10, it will output hop phase 2.

        when trigger signal is 11, it will output hop phase 3.

When it is negative:
PSK setting: when trigger signal is 1, it will output carrier phase; and when trigger signal is 0, hop phase will be output.
4PSK setting: when trigger signal is 00, it will output carrier phase.

        when trigger signal is 01, it will output hop phase 1.

        when trigger signal is 10, it will output hop phase 2.

when trigger signal is 11, it will output hop phase 3.

nPSK setting: trigger signal just takes the triggering effect, and has no relationship with which phase outputting.

3.9.7 Sync output: Sync signal's duty cycle is 50%, and sync signal's frequency is equal to phase shift keying rate.

PSK setting: when carrier phase is output, sync signal will be low level; when hop phase is output, sync signal will be high level.

4PSK setting: when carrier phase and hop phase 2 are output, sync signal will be low level; when hop phase 1 and 3 are output, sync signal will be high level.

nPSK setting: carrier phase and the three hop phases are output randomly, which has no high level or low level relationship with sync signal.

If external trigger is used, sync signal will be decided by external trigger signal.

3.10 Amplitude shift keying(ASK)

In ASK, the amplitude of output signal hops between carrier amplitude and hop amplitude alternately, and hop rate depends on shift keying rate.

3.10.1 Function selection: Press【Modulate】to enter modulation function, and then press 〖Type〗 to display modulation type menu, press〖ASK〗or〖OSK〗modulation type will be ASK or OSK, and display the amplitude-shift keying waveform's diagram and menu.

3.10.2 Carrier setting: We usually use sine as carrier wave. Of course other built-in waveforms can also be used, but some are not suitable. Press【CH1】to enter carrier wave parameter interface, to set carrier wave's parameter. Press【Modulate】to enter modulation parameter setting interface to set its parameter.

3.10.3 Hop Amplitude: In ASK, press 〖Hop Ampl〗soft key to set its value. Hop amplitude must be less than carrier amplitude. The default setting for OSK hop amplitude is 0, so there is no menu item for OSK.

3.10.4 Hop Time: In OSK, press〖Hop Time〗soft key to set its value. Hop Time represents the period of amplitude decreases from carrier amplitude to 0 or increases from 0 to carrier amplitude. In ASK, default hop time is 0 without menu option.

3.10.5 ASK Rate: Press 〖ASK Rate〗or〖OSK Rate〗soft key to set the value, ASK rate or OSK rate is usually lower than carrier frequency.

3.10.6 Trigger Source: Press〖Source〗to choose trigger source. If 'Internal' is chosen, instrument will use internal trigger source, ASK rate setting is effective. If 'External' is chosen, instrument will use external trigger source, ASK rate setting will be ignored. Input external trigger signal from rear panel's《Trig In/Out》port.

3.10.7 Trigger polarity: Press〖Polarity〗, you can choose external trigger signal's polarity.   It is only effective for external trigger.

When it is positive:

When trigger signal is 0, instrument will output carrier amplitude.

When trigger signal is 1, instrument will output hop amplitude.

When it is negative:

When trigger signal is 1, instrument will output carrier amplitude.

When trigger signal is 0, instrument will output hop amplitude.

3.10.8 Sync output: Sync signal's duty cycle is 50%, and sync signal's frequency is equal to ASK rate. When carrier amplitude is output, sync signal will be low level. When hop amplitude is output, sync signal will be high level.

If external trigger is used, sync signal will be decided by external trigger signal.

3.11 Burst Output

3.11.1 Function Selection: Press 【Burst】 key to enter the burst function. The burst waveform's diagram and burst menu will be both displayed.

3.11.2 Burst Signal: We usually use sine wave as burst signal. Of course other built-in waveforms can also be used, but some are not suitable. Press【CH1】to enter burst signal setting interface to set burst signal's parameter. Press 【Burst】again to enter burst parameter setting interface to set its parameter.

3.11.3 Burst mode: Press〖Type〗to choose burst mode. If you choose 'Trigger', burst signal will output setting numbers of cycle from the start phase and then stop at the level corresponding to start phase for each trigger and then wait for the next trigger. Trigger signal's period should

conform to the following formula:

Trigger signal period > (cycle numbers ╳ burst signal period + delay time)

If you choose 'Gate control', you can only use external trigger source. Gate control output is two cycles at least. If it is less than two cycles, burst signal won't output completely waveform. The period of gate control signal should conform to the following formula:

Gate control signal's period>(2╳burst signal period)

3.11.4 Delay Time: Press 〖DelayTime〗to set the delay time value. The delay time means output time from burst period begin to burst signal starts.

3.11.5 Burst period: Press 〖BurstPeriod〗soft key to set the burst period. The burst period defines lasting time from the start of one burst to the start of the next burst. The burst period must be long enough to accommodate the cycle counts of burst signal, see below formula:

Burst Period > (cycle numbers ╳ burst signal period)

If burst signal's frequency changing causes burst period can't contain the burst signal's cycle numbers, instrument will change delay time, cycle numbers and burst period value automatically to the allowable minimum value.

3.11.6 Cycle numbers: press〖Cycles〗to set burst signal's cycle numbers. Cycle numbers defines the burst signal numbers in a burst period. It must be small enough to be contained in burst period, as following formula:

Cycle numbers<(burst period*burst signal frequency)

If the setting cycle numbers is too big to exceed the range, instrument will remind the users. Press 〖Confirm〗to set it to allowable maximum value, in contrast, press〖Cancel〗to cancel this setting value.

3.11.7 Start Phase: Press〖Start Phase〗to set the start phase value. Burst signal's start time and end time are always in the same waveform's phase, which is called start phase. Start phase setting is unavailable for some waveforms, such as square wave.

3.11.8 Trigger Source: Press〖Source〗to choose trigger source. If internal is chosen, instrument will use internal trigger source and continuously output burst signals, at this time burst period setting is effective. If you choose 'manually', once you press〖ManualTrig〗, burst signal will output one time. If you choose external, instrument will use external trigger source, and burst

period setting will be ignored, you can input external signal from rear panel's 《Trig In/Out》port.

3.11.9 Trigger edge: Press〖Trigger Edge〗to choose trigger signal's effective edge. Trigger edge's setting is only available for external trigger.

When trigger edge is rising edge, burst signal will output setting cycle numbers from the start phase. Rising edge means trigger signal changes from 0 to 1.

When trigger edge is falling edge, burst signal will output setting cycle numbers from the start phase. Falling edge means trigger signal changes from 1 to 0.

3.11.10 Trigger polarity: Press〖Polarity〗to choose external trigger signal's polarity. Trigger polarity is only available for Gate control.

When it is positive:

When Gate control signal is 1, burst signal will output from start phase. When gate control is 0, burst signal will stop outputting to the level correspondent to start phase after the last cycle waveform is completed.

When it is negative:

When gate control signal is 0, burst signal will output from start phase. When gate control is 1, burst signal will stop outputting to the level correspondent to start phase after the last cycle waveform is completed.

3.11.11 Trigger output: Press〖TrigOut〗to choose trigger signal's output mode. If you choose 'off', no trigger signal will be output. If you choose 'Rising edge', when burst signal starts to output, trigger signal will change from 0 to 1 and remain in 1. When the output is done, it will change from 1 to 0. If you choose 'Falling edge', when burst signal starts to output, trigger signal will change from 1 to 0 and remain in 0. When the output is done, it will change from 0 to 1.

3.11.12 Sync output: Sync signal's period is equal to burst period, sync signal's rising edge is in burst signal's starting point, and sync signal's falling edge is in burst signal's ending point. In burst signal outputting period, sync signal will be high level, while in burst signal stopping period, sync signal will be low level.

If external trigger or manual trigger is used, sync signal will be decided by external trigger or manual trigger signal.

3.12 Double Pulse

There is one pulse in one pulse's period. But in some applications, such as consecutively trigger two relevant things according to certain intervals or test the time interval of two pulses, specialized pulse signal generator will be required to generate double pulse signal. Choose double pulse, you can work out this function.

3.12.1 Function Selection: Press【 ⎍ 】, then press〖PulseParam〗〖PulseModDouble〗to enter double pulse function and display double pulse's waveform diagram and its operation menu.
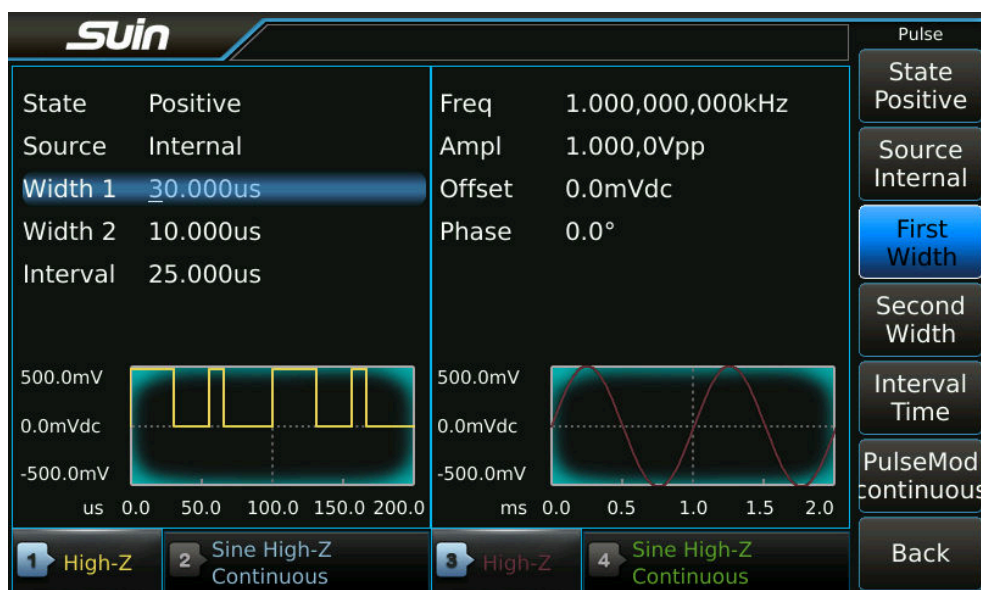
3.12.2 First pulse width: Press〖Frist Width〗to set first pulse width. Pulse width means the lasting time from rising edge's middle point of first pulse to falling edge's middle point.

3.12.3 Second pulse width: Press〖Second Width〗to set second pulse width. Pulse width means the lasting time from rising edge's middle point of second pulse to falling edge's middle point.

3.12.4 Interval Time: Press〖Interval Time〗to set two pulses' time interval. It means the lasting time from falling edge's middle point of first pulse to rising edge's middle point of second pulse.

Two pulse width and time interval's setting is limited not only by double pulse frequency, but also by minimum time, which should conform to the following rules:

5ns≤(first pulse width or time interval or second pulse width)

(first pulse width+ interval time +second pulse width) ≤(period-5ns)

When pulse's frequency or period changes according to above rules, the two pulse width and interval time remains unchanged. If it can't meet above rules, instrument will automatically

modify pulse's parameters with the sequence of second pulse width, interval time and first pulse width.

3.12.5 Pulse State: Press 〖State〗to choose 'Positive pulse' 'Negative pulse' and 'Plus-Negative pulse' alternatively. Positive pulse's pulse width is positive value, pulse interval is 0 value. Negative pulse's pulse width is negative value, pulse interval is 0 value. Plus-Negative pulse's pulse width is positive value, pulse interval is negative value. When positive pulse or negative pulse is output, output signal's amplitude is half of the setting value.

3.12.6 Trigger source: Press 〖Source〗to choose trigger source. If internal is chosen, instrument will use internal trigger source to continuously output double pulse signal. In this condition, double pulse frequency and period setting is effective. If external is chosen, instrument will use external trigger source and double pulse frequency and period setting will be ignored. Input external signal from rear panel's《Trig In/Out》port. But external trigger signal's period should conform to the following rules.

Trigger signal's period>(first pulse width+ interval time + second pulse width+5ns)

3.12.9 Sync output: Sync signal's period is equal to double pulse's period, sync signal's width is equal to first pulse's width. If external or manual trigger is selected, sync signal will be decided by external trigger or manual trigger signal.

3.13 Harmonic Synthesis

According to Fourier transform, any periodic function can decompose into several sine waves with different frequencies, amplitudes and phases. In contrast, we can also use several sine waves with different frequencies, amplitudes and phases to compose a predicted periodic arbitrary waveform. Using this method, we can accurately simulate all kinds of arbitrary waveforms in our real life, and supply perfect signal testing source to the testing instrument.

3.13.1 Function selection: Press【Harmonic】to enter harmonic synthesis function and display harmonics list and operation menu.

3.13.2 Harmonic order: Harmonic order defines that harmonic frequency is multiple of fundamental frequency. It must be positive integer. Harmonic order is set to 1, that's fundamental wave. Harmonic synthesis function actually is linear superposition of N-th Sine. You can set n-th harmonic randomly, even without fundamental wave. Please pay attention that harmonic frequency can't exceed the upper frequency limits of device.

3.13.3 Harmonic phase: Harmonic phase means harmonic's start phase. If harmonic phase is different, the synthesized arbitrary waveform will be different.

3.13.4 Harmonic amplitude: Harmonic amplitude means it's amplitude value. If harmonic amplitude is set to 0, this harmonic will not affect. The amplitude of each harmonic could be set randomly. If the amplitude value of final synthesized arbitrary waveform exceeds the amplitude limits of device, the complete waveform could be shown in the graphic interface but amplitude limiting will occur when output waveform.

3.13.5 Harmonic Sequence: In order to synthesize a harmonic, you should load a harmonic sequence list, each sine in this list could have different frequency, amplitude and phase. For example, we use fundamental wave and 2-harmonic to synthesize a harmonic, with the harmonic sequence list as follows:

Harmonic Order	Harmonic phase	Harmonic amplitude
1	0.0°	7.0Vpp
2	90.0°	3.0Vpp

Operation steps are as follows:

Press 〖Order〗, and set to 1, that's fundamental wave.

No.1 harmonic's default phase is 0, so there is no need to set it.

Press 〖Ampl〗, and set it to 7Vpp.

Press 〖Next〗, No. will become 2, then user can start to set second harmonic wave.

Press 〖Phase〗, and set it to 90°.

Press 〖Ampl〗, and set it to 3Vpp.

3.13.6 Harmonic synthesis: After harmonic sequence list is loading, press 〖Execute〗, instrument will synthesize each named harmonics to one harmonic. The longer the loaded harmonic sequence list is, the longer time to synthesize the harmonic will be needed. When amplitude value of final synthesized waveform exceeds the amplitude limits of device, prompt will pop up to reminder user to pay attention to it.

3.13.7 Harmonic preview: There are two kinds of displaying interface for synthesis harmonic, one is graphical interface to preview the harmonic visually, the other is editing interface, which can display all harmonic's setting. After the harmonic is synthesized, you can press〖Prev〗,display interface will be switched to graphical interface to show the synthesized harmonic as follows:

Press 〖Edit〗, the display interface will be switched to harmonic list as follows:

3.13.8 Store to built-in waveforms: Built-in waveforms are main output modes functions. In order to make the synthesis harmonic easily used as built-in waveforms, a storage location 'User _Harm' for user defined harmonic are put aside in built-in waveforms (the last position after special). After synthesis harmonic is loading to RAM storage, press〖Save as UserHar〗, the current synthesised harmonic will be stored as built-in waveform. It won't be lost even if power off and can be easily used as other built-in waveforms.

3.13.9 To recall the built-in waveforms: If you've stored a built-in waveform into 'User_Harm', you can recall one harmonic sequence from 'User_Harm' directly by pressing 〖Recall UserHar〗 to edit or output. Edited harmonic sequence doesn't influence the parameters of harmonic before editing in 'User_Harm'.

3.13.10 Harmonic storage: If you store the synthesis harmonic to RAM storage, it will be lost once you quit the synthesis harmonic function. So store the harmonic sequence is required when you want to store the current synthesized harmonic. Press〖Save to this file〗, create a document named ***Harm_seq1. Har*** (there is no need to input expanded name when you create a file, instrument will add it automatically.), and then store the harmonic sequence to it. It is a binary system document, so you can store many such documents and recall it any time.

3.13.11 Harmonic recall: After entering harmonic synthesis interface, if you've stored the harmonic sequence document, you can find it ***Harm_seq1. Har*** by pressing〖Recall File〗, and then press〖Options〗〖HarmoRecall〗, you can load this harmonic sequence document to resynthesize the needed harmonic and display the graphic waveform in screen.

3.14 Frequency Sweep

3.14.1 Function Selection: Press 【Sweep】to enter the frequency sweep function, at the same time waveform diagram of frequency sweep and it's menu are display.

3.14.2 To set Sweep signal: Most built - in waveforms could be used as frequency sweep, but some are not suitable. Press 【CH1】 to enter sweep signal's parameter interface to set it's parameter. Please note that frequency and period cannot be set. During frequency sweep process, the output frequency varies from the start frequency to the end frequency, the phase of output signal is continuous, the sweep could be carried out during whole frequency range.

3.14.3 Sweep Mode: Press 〖Type〗to select Linear or Log for sweeping.

In Linear mode, frequency step is fixed. For wide sweep range, fixed step has negative influence, which leads to high sweep resolution, slow sweep speed and precise sweeping at high frequency, but low sweep resolution, fast sweep speed and coarse sweeping at low frequency. Therefore, linear is much applicable for narrow sweep range.

Linear sweep is similar as FM with modulating waveform ramp, the difference between which is that no modulating wave needed for sweep, just output discrete points in interval continuously.

In Log mode, frequency step is not fixed but changes with log relationship. At high frequency, the step is large and at low frequency step is less. For wide sweep range, the variation is relative well-proportioned, so log sweep is applicable for wide sweep range.

3.14.4 Start Frequency and Stop Frequency: Press the 〖Start Freq 〗or 〖Stop Freq〗 soft key. 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.

3.14.5 Marker frequency: Press 〖Marker Freq〗soft key, then use the knob or numeric keypad to enter the desired marker frequency. When sweeping cross the marker frequency point, the sync output hop at the same time. The marker frequency must be set between the specified start frequency and stop frequency.

3.14.6 Sweep Time: Press 〖Sweep Time〗soft key and 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.

3.14.7 Hold Time: Press 〖Hold Time〗 soft key and use the knob or numeric keypad to enter the desired hold time. The hold time specifies the length of time to remain at the stop frequency.

3.14.8 Return Time: Press 〖Return Time〗 soft key and use the knob or numeric keypad to enter the desired return time. The return time specifies the length of time to return from the stop frequency to the start frequency.

3.14.9 Interval Time: Press 〖Interval Time〗soft key and use the knob or numeric keypad to enter the desired interval time. The interval time specifies the time from one sweep to next sweep.

3.14.10 Trigger Source: Press 〖Source〗 soft key. If internal mode is selected, the waveform generator takes internal source and trigger sweep repeat running. When manual mode selected, the waveform generator outputs one sweep each time you press 〖Manual Trig〗 soft key. When External selected, generator takes external source, input external trigger signal from 'Trig In/Out' port in rear panel. Each effective trigger clock edge will trigger once sweep, the period of trigger signal should greater than the total time of one sweep, as below formula shown:

Trigger signal's cycle> Sweep time +Hold time+ Return time+ Interval time

3.14.11 Trigger Edge: Press 〖Slope〗soft key to select the efficient edge of external trigger signal. The setting for it is only valid when external trigger.

When the rising edge is selected, the sweep will start when trigger signal changes from 0 to 1.

When the falling edge is selected, the sweep will start when trigger signal changes from 1 to 0.

3.14.12 Trigger Output: Press 〖Trig Out〗soft key to select output mode of the trigger signal. If Off is selected, there is no trigger signal at output port. If rising edge is selected, the trigger signal changes from 0 to 1 when sweep starts. When sweep to marker frequency, the trigger signal will change from 1 to 0. If falling edge is selected, the trigger signal changes from 1 to 0 when sweep starts. When sweep to marker frequency, the trigger signal from 0 to 1.

3.14.13 Sync Output: The cycle of sync signal equals to the total time of sweep process. The rising edge and falling edge of sync signal separately corresponds to the start frequency point and marker frequency point.

3.15 Frequency List

Actually frequency list is an advanced mode of frequency sweep. In common linear or logarithmic sweep mode, the change of frequency can only be gradually increased or decreased and sweep speed is slower. While for frequency list mode, user can define the frequency list randomly and sweep speed is faster. In modern communication, the frequency value of communicating carrier can hop quickly according to the certain frequency list defined both by sender and receiver, which also be called frequency-hopping communication. The frequency list could be changed at any time, even the random variable frequency list could be used. Multi waveforms could be used as carrier in frequency list mode while usually Sine is used.

3.15.1 Function Select: Press 【Sweep】key then soft key 〖Type〗, and select 'List' to enter it's interface.

3.15.2 Sample Rate: Press the soft key〖Sample〗to set the sampling rate of the frequency list. Then loop specified frequency value of frequency list will be output according to setting sample rate.

The sampling rate means the time used to output a frequency point during sample. The output frequency and sampling rate of the frequency list can be expressed as follows:

$$\text{List Frequency} = \text{Sample Rate} \div \text{List length}$$

3.15.3 Frequency Data: A set of frequency data is initialized when power on instrument, from No.1 to No. 1024, each No. are assigned a frequency data from 1kHz to 1024kHz like below shown.

NO.1	NO.2	NO.3	NO.4	············	NO.1024
1kHz	2kHz	3kHz	4kHz	············	1024kHz

Below table are a frequency list is composed by 10 frequency data from 100kHz to 10kHz with step 10kHz. The following steps show you how to create this frequency list.

NO.1	NO.2	NO.3	NO.4	············	NO.10
100kHz	90kHz	80kHz	70kHz	············	10kHz

Press〖List Len〗soft key and set it to 10.

Press 〖List No.〗soft key and set it to 1.

Press 〖FreqVal〗soft key and set it to 100kHz.

Press 〖NextListNo〗soft key and No. will change to 2 automatically and input frequency value to 90kHz.

Then repeat the above steps until last No. 10 and input frequency value 10kHz.

3.15.4 List Mode : Press 〖ListMode〗soft key and two modes 'Customs' and ' Random' could be selected. In customized mode, a series of frequency value from user's customized frequency list will be output in sequence. In pseudorandom mode, a series of random variable frequency value according to pseudo-random code will be output, the list length is specified value like below shown:

$$\text{List Length}=2^n (5{\leq}n{\leq}10)$$

3.15.5 Trigger Source: Press 〖Source〗soft key, If Internal selected, the waveform generator takes internal source and frequency list repeat running. If manual mode selected, the waveform generator outputs one sweep each time you press 〖Manual Trig〗 soft key. If External selected, generator takes external source, input external trigger source from 'Trig In / Out' port in rear panel. Each effective trigger edge will trigger once frequency list output. The cycle of trigger signal should greater than cycle of frequency list and like below formula shown:

Trigger signal's cycle> List length/ sample rate

3.15.6 Trigger Edge: Press 〖Slope〗 soft key to select the effective edge of external signal and make sure set it under external trigger mode to ensure it is effective.

When the rising edge is selected, the frequency list sweep will start when trigger signal changes from 0 to 1.

When the falling edge is selected, the frequency list sweep will start when trigger signal changes from 1 to 0.

3.15.7 Trigger Output: Press 〖Trig Out〗 soft key to select output mode of the trigger signal. The setting of trigger output will be available when in Internal and Manual trigger mode. If Off is selected, there is no trigger signal at output port. If rising edge is selected, the trigger signal changes from 0 to 1 when frequency list sweep starts. When frequency list output finish, the

trigger signal will change from 1 to 0. If falling edge is selected, the trigger signal changes from 1 to 0 when frequency list output starts. When frequency list output finish,, the trigger signal from 0 to 1.

3.15.8 Sync Output: The cycle of sync signal equals to the time of one frequency list sweep process (List rate/list length). The rising edge of sync signal corresponds to the start frequency point of frequency list, pulse width of sync signal equals to half of frequency list process. If external or manual trigger is selected, the sync signal will be determined external trigger or manual trigger signal.

3.15.9 List storage: If you store the frequency lists to RAM storage, it will be lost once power off. If you want to save current frequency list, make sure save it to FLASH storage.

Press〖List Store〗, create a document named ***Freq_data1.freq*** (there is no need to input expanded name because instrument will add it automatically.), and press 〖Save to this file〗to save it. It is a binary system document, so you can store many such documents and recall it any time.

**3.15.10 List recall**: After entering frequency list interface, if you've stored it earlier, you can find it ***Freq_data1.freq*** by pressing〖List Recall〗, and then press〖Option〗〖RecallFreqList〗, you can recall the stored list file.

3.16 Arbitrary Waveform

When Direct Digital Synthesis (DDS) technique is used to output the built-in waveform, the sampling rate can reach to1200MSa/s, but it's also not a perfect way. Since DDS use interval sample way, the higher the output frequency is, the fewer sampling points within a waveform cycle will be. Also the details of the waveform will be lost largely and the distortion of the output waveform will be very badly, which is not allowed in severe test. To reproduce the real electrical signals at work site truly, now most of waveform generators use point by point way to generate arbitrary waveform to ensure the complete details of waveform.

3.16.1 Function Selection:

Press 【Arb】key to enter the editing interface. A linear waveform is preset by instrument with waveform length 20 points, and the voltage value of each waveform point is 0.000V. The waveform editing interface is shown as follows:
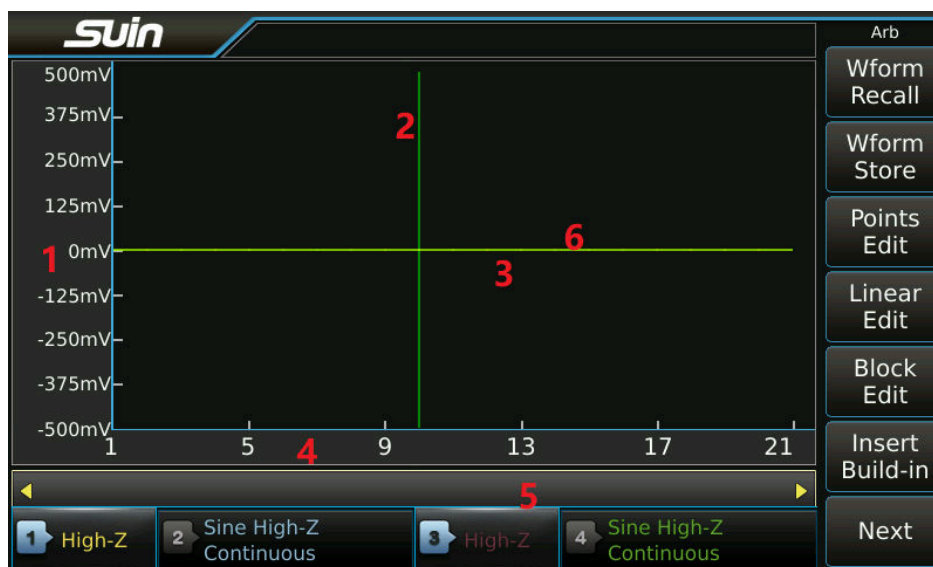
1. Voltage scale   2.X-cursor   3.Y-cursor (green line)   4. Point scale

5. Edit Parameters   6. Current waveform (yellow line and overlap 3)

3.16.2 Insert built-in waveform

If user wants to create a simple waveform, such as a Pulse or Ramp, methods 'points edi

t' and 'linear edit' could be used to edit out it point by point. But the two methods are inconvenient to create the complicated waveform such as Sine, also it's hard to make each point of waveform very precisely.

Fortunately the build-in waveform of instrument help user to provide the available waveform materials. Insert one of them to waveform editing area and use method of local modification or clipping or pasting to create a complicated waveform quickly without edit it point by point.

Press 〖Insert Build-in〗 soft key to enter the waveform selection interface and choose the waveform you want to insert and press the soft key 〖OK〗.

Press 〖Build Params〗 soft key and display a setting box. User can set parameters for the waveform that will be inserted, as below picture shown.

Amplitude: Amplitude peak-to-peak value of the inserted waveform.

Offset: DC offset voltage of the inserted waveform.

Phase: Starting phase of the inserted waveform, taking the waveform itself as a reference

InsertPos: Inserts the waveform to any position that currently edited arbitrary waveform in (X coordinate value).

Points: Total point numbers of inserted waveform, that's the length of the inserted waveform.

Modify the required parameters, use the original value if there is no modify options.

After finishing setting to inserted waveform, press 〖Back〗 continuously, to return to editing interface of arbitrary waveform, then the selected waveform is inserted to the specified position. If fail to return to the editing interface of arbitrary waveform, then the edited arbitrary waveform will be lost.
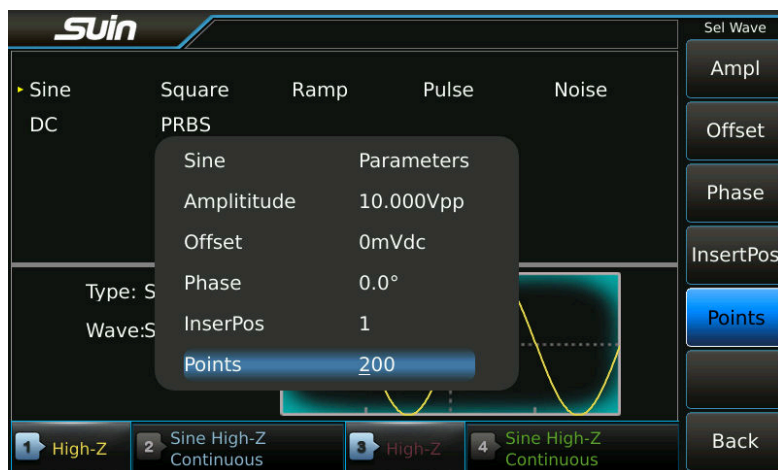
For example, insert a Sine with 200 points.

Press 〖Insert Build-in〗 soft key to enter waveform edition interface, press 〖Standard〗soft key and select Sine and press 〖OK〗 soft key.

Press 〖Build Params〗soft key and display a setting box. Set total point number to be 200 and no set for other options.

Press 〖Back〗soft key continuously to return to the arbitrary wave editing interface, a Sine with 200 points is inserted on basis of previous linear waveform with 20 points, like below shown.
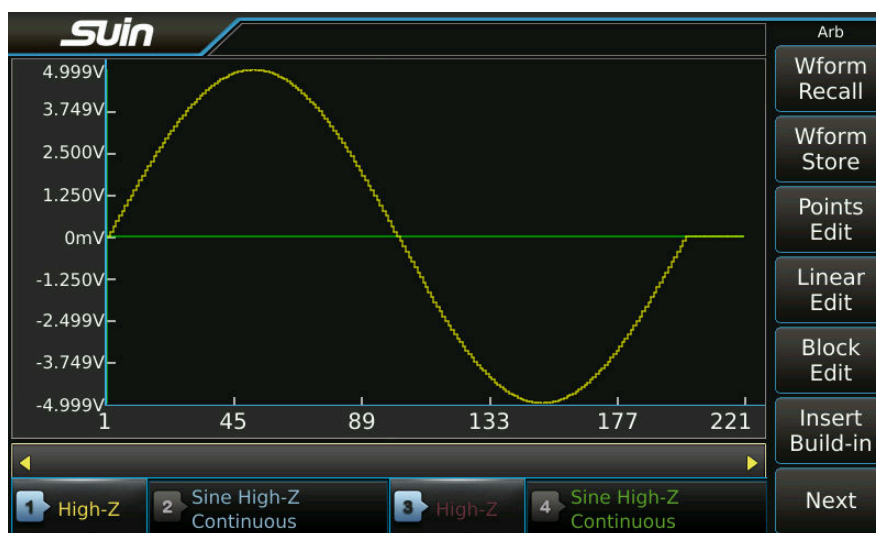
In arbitrary waveform edition interface, Y-axis in left of waveform and Y-axis under waveform will be adjusted automatically as changing of coordinates.

3.16.3 Cursor Selection

In arbitrary waveform edition interface, use cursor can fix position of a point in one wav

eform quickly and precisely and display the X and Y coordinate values of this point.

Press 〖Cursor XY〗 soft key to select one cursor mode in four.

The cursor display will be closed if the 'no cursor' is chosen.

A piece of vertical cursor is displayed if 'cursor X' is chosen.

A piece of horizontal cursor is displayed if 'cursor Y' is chosen.

Two cursors are displayed horizontally and vertically if 'cursor XY' is chosen.

The cursor could be active when X or Y coordinate parameter is chosen.

3.16.4 Points Edition

The points edition allow user to operate the voltage setting for some point of one waveform, or insert a point in specified position of a waveform, or delete a point. The function applies to a local modification for exited waveform or to create a simple waveform with fewer points.

For example, make local modifications for a Sine with 100 points, insert and delete waveform points.

Firstly insert a Sine with 100 points and amplitude 1Vpp.

Press 〖Points Edit〗 soft key to enter it's interface.

Press 〖Point〗 soft key and set to 10, that is to edit the x-coordinate of the wave point.

Press 〖Voltage〗 soft key and set to 1V, that is to edit the x-coordinate of the wave point.

The coordinate value of crossing point of green cursor are the setting values in above two steps if cursor in X and Y direction is open. The information of this waveform point is displayed in the upper right corner: D1 (10,1.000V)

Press 〖Point〗 soft key, adjust the knob to change the selection point, and the crossing point of the two cursors will move along the trajectory line of the Sine and show the X and Y coordinates of each waveform point. When the cursor moves to the X-coordinate of 50, the Y-coordinate is 31mV, as below picture shown.

Press 〖Point Insert〗 soft key 5 times continuously, 5 waveform points with voltage 0.000V are added behind of waveform point 50.
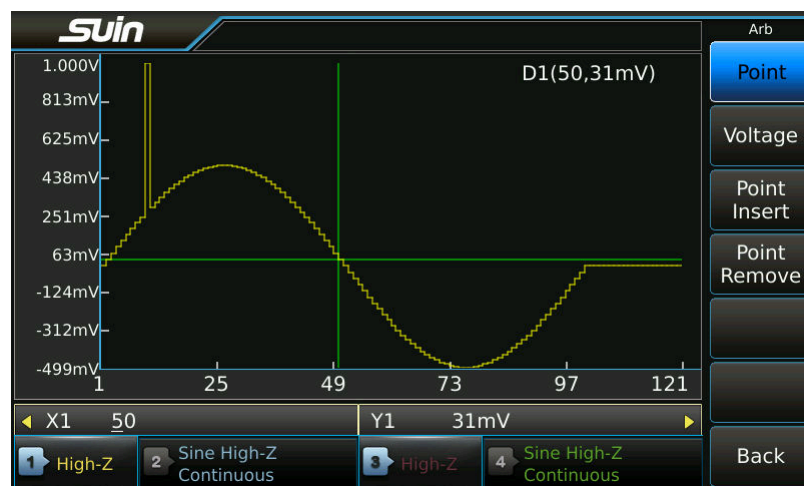
Move the X coordinate of the cursor to 26, press〖Point Remove〗soft key 10 times conti nuously, the 10 points from 26 to 36 will be deleted as below picture shown.
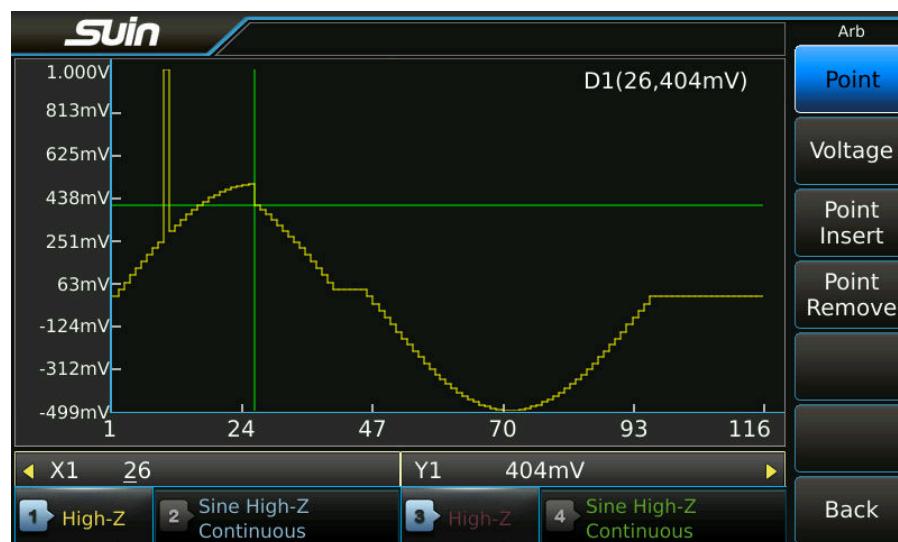
3.16.5 Line Edition

Use 'point edit' to set voltage for each point in one waveform. But it will be inconvenien t when there are lots of wave points need to be set. Then line edition can solve the prob lem. Under this function, user only needs to set two points, then all points between the t wo points will be automatically set by instrument according to linear relationship. It is mo re convenient than point edition function and is applied to make linear modification for ex isting waveform, or create a waveform consisting of broken lines.

For example, make a linear modification for a Sine with 100 points.

Firstly insert a Sine with 100 points and amplitude 1Vpp.

Press 〖LinearEdit〗 soft key to enter it's interface, as below picture shown.
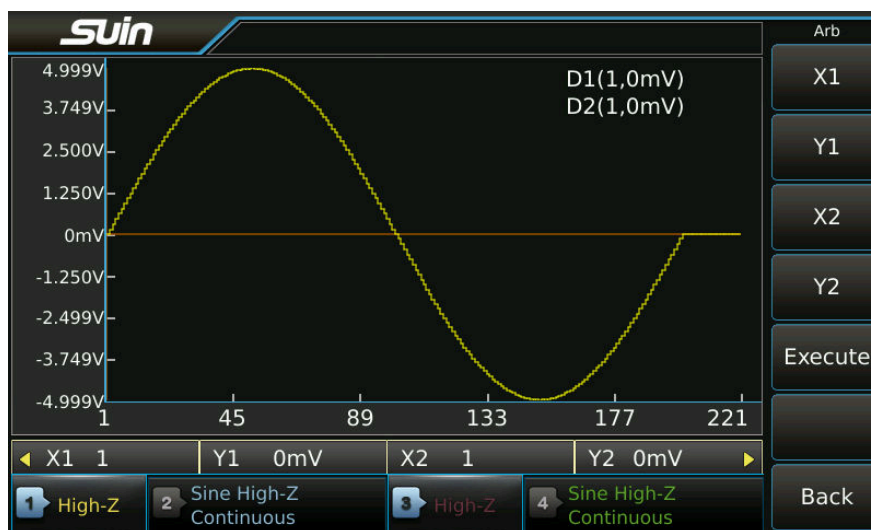
Press 〖X1〗 soft key to set coordinate value of the starting point X1 to 50. Press 〖Y1〗 soft key set coordinate value of the starting point Y1 to be 0.5V, and the crossing point of the green cursor is the starting point of the line segment.

Press 〖X2〗 soft key to set the coordinate value of the stop point X2 to 55. Press 〖Y2〗 soft key to set the coordinate value of the termination point Y2 to 0.6V, and the crossing point of the red cursor is the stop point of the line segment.

Press 〖Execute〗 soft key, the start and stop points will be connected by a straight line automatically. A pulse is added on a Sine and the top of which is a slash as shown below picture shown.
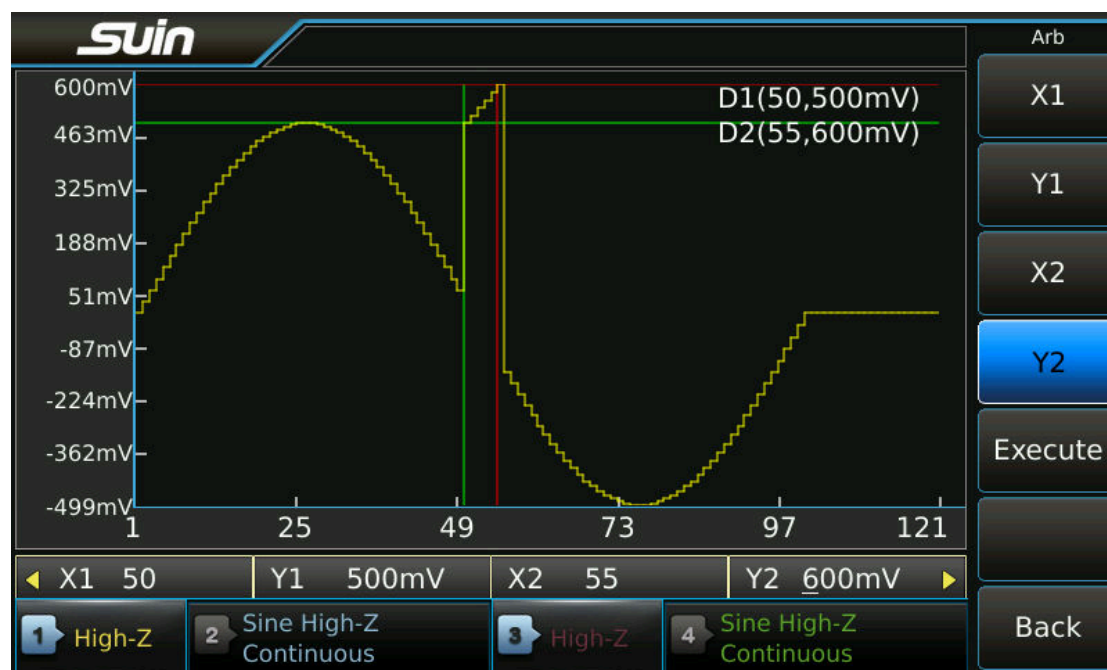
3.16.6 Block Edition

Compared with line edition, block edition is more abundant and which provide block insert, block replication and block deletion for existing waveforms so as to create a more complicated arbitrary waveform.

For example, block edits to arbitrary waveforms composed of three built - in waveforms.

Inset below three waveforms with different setting, user will find the influence that differed settings for waveform caused to inserted waveform from display windows.

Sinc, amplitude is 1.000Vpp, offset is 310mVdc, phase is 0.0°, total points are 150.

Sine, amplitude is 500mVpp, offset is 0mVdc, phase is 180°, total points are 200.

Tangent, amplitude is 1.000Vpp, offset is 0mVdc, phase is 0.0°, total points are 300.

Press〖Block Edit〗 soft key to enter it's interface. Block edits includes 'Insert', 'Copy' and 'Delete' as below picture shown.
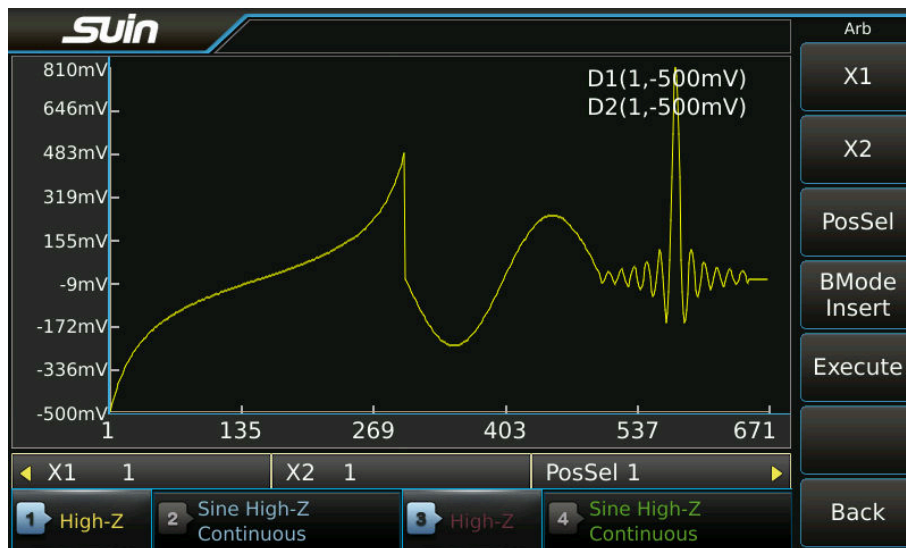
Block insert: Press 〖BMode〗soft key and select 'BMode Insert' mode

Press 〖X1〗soft key and set the starting point coordinates of the block to 150, and the crossing point of the green cursor is the starting point of the waveform block.

Press 〖X2〗soft key and set the end point coordinates of waveform block to 300, and the crossing point of red cursor is the end point of waveform block. The waveform block is selected as the second half of the tangent waveform.

Press〖PosSel〗soft key and set the coordinates of the inserted point to 500, and the crossing point of the white cursor is the position to be inserted, behind the Sine as below picture shown.
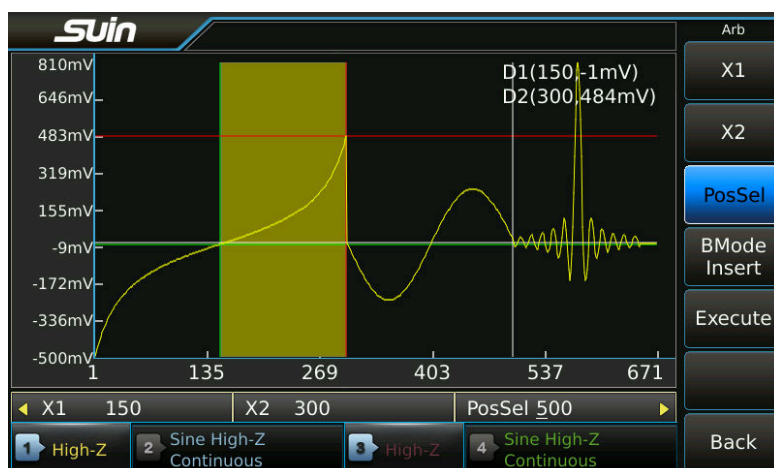
Press〖Execute〗soft key and the selected waveform will be inserted to specified position. Meantime, the original Sinc behind of inserted point will move to right with shape unchanging. Block insert operation is to add the selected waveform block to the specified positi

on as below shown.
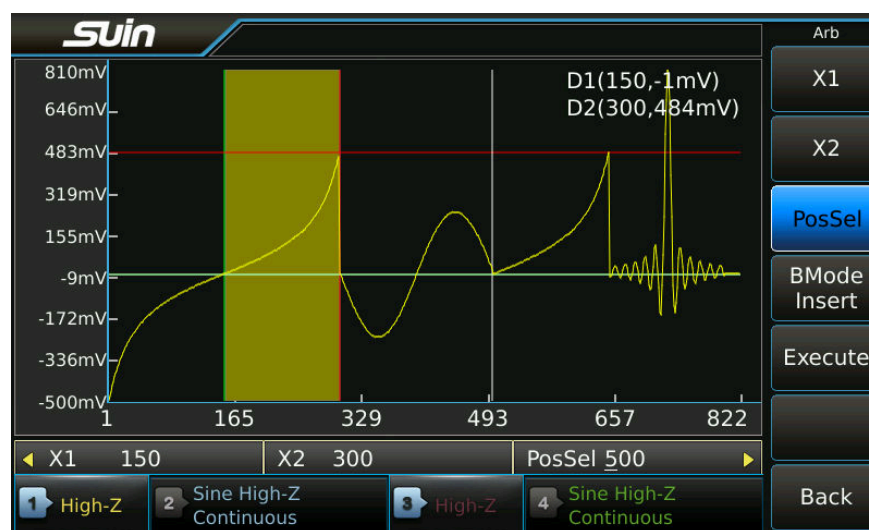
Block Copy: Press 〖BMode〗 soft key and select 'BMode Copy'.

Still use the currently selected waveform block

Press〖PosSel〗soft key, set the coordinates of the copy point to 650, and the crossing poi nt of the white cursor is the position to be copied and ahead of the Sinc.

Press〖Execute〗soft key. The selected waveform block will be copied to the specified loc ation and covers the original Sinc behind of copy point. The block copy operation is to c over the selected waveform block to the specified location as below shown.
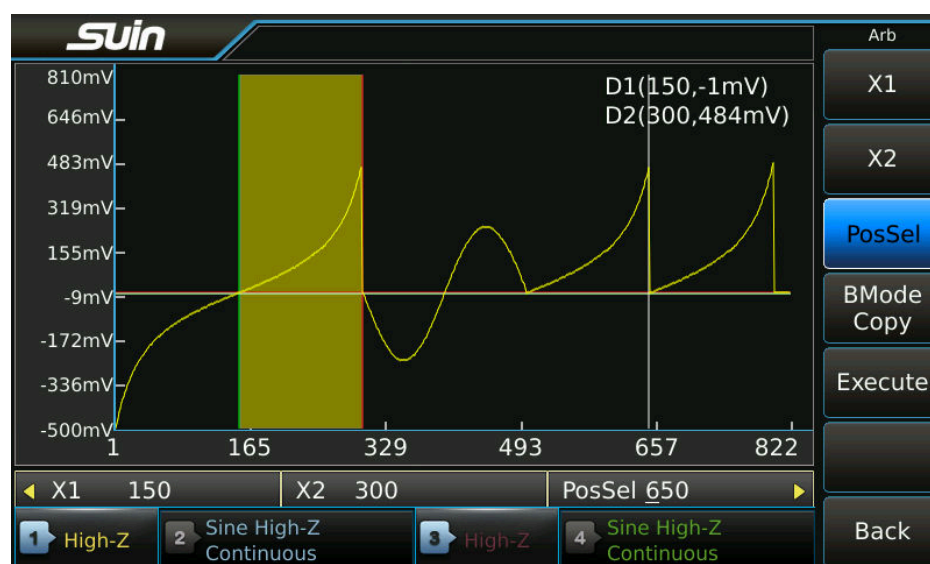
Mirroring: The operating sequence of the waveform block is always from X1 to X2 in th e 'block insert' and 'block copy' operations. The waveform blocks are inserted or copied from left to right if X2 is greater than X1. The waveform block is inserted or copied fro

m right to left if X2 is less than X1, that's to say insert or copy the reversal mirror of waveform block.

Switch the coordinates of X1 and X2 to each other to make X2 is less than X1.

Press 〖X1〗 soft key to set the starting point of the waveform block to 300, and the crossing point of the green cursor is the starting point of the waveform block.

Press 〖X2〗 soft key to set the stop point of the waveform block to 150, and the crossing point of the red cursor is the end point of the waveform block.

Press〖Execute〗soft key and the reversal mirror of waveform block will copied to specified position as below picture shown:
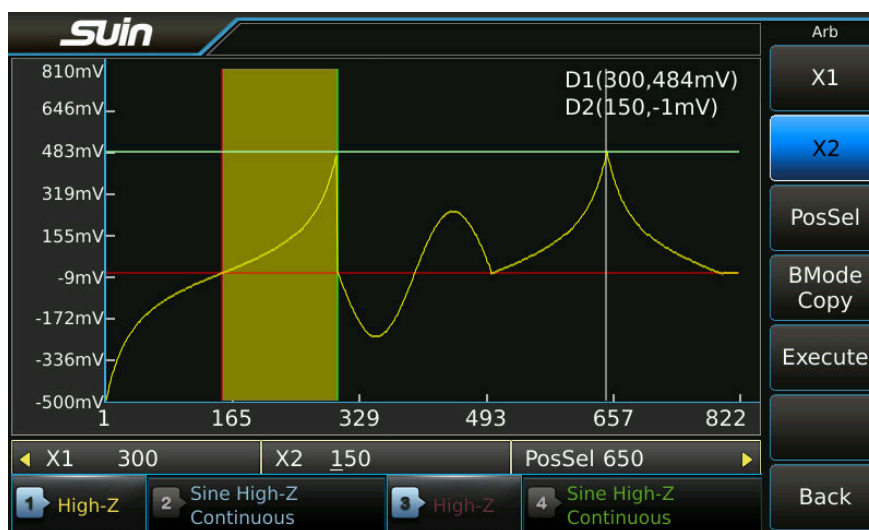
Block Remove: Press〖BMode〗soft key and select 'BMode Remove' mode.

Still use the currently selected waveform block and now there is no soft key 〖PosSel〗.

Press 〖Execute〗soft key and the selected waveform block will be removed. The original Sine behind the waveform block moves to the left and keeps the shape unchanged as below picture shown.
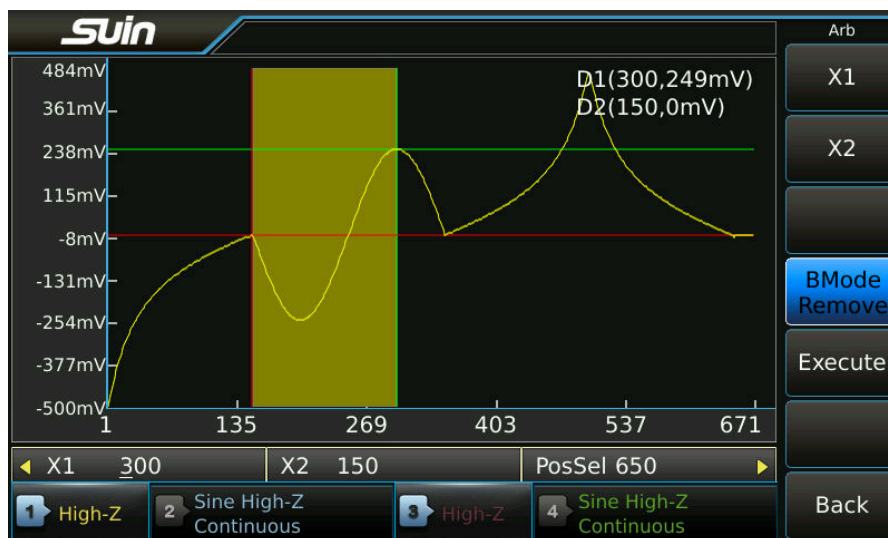
3.16.7 Zoom

For complicated waveforms with more waveform points, it's difficult to show the fine parts of the waveform in a limited display window. Therefore, the functions of zoom and shift are required to locally according to the zoom ratios so as to clearly display the fine parts of the waveform.

For example, zoom and shift the Sine with 1000 points.

Firstly insert a Sine with 1000 points and amplitude 1Vpp.

Use point edition function to modify X-coordinate to 402 points and the Y-coordinate to 4 V. Modify X-coordinate to 251 points and the Y-coordinate to 550mV. The two waveform points that's just modified cannot be seen in the display window because the resolution of the display window is lower.

Horizontal zoom: Exit point edit function，press 〖Zoom〗soft key to enter zoom and shift function as below picture shown.

Press 〖Point〗soft key to set the horizontal coordinates of the mark point to 402. Then instrument will zoom in taking horizontal axis as direction and mark point as center. Press 〖X Zoom〗 soft key and set the zoom ratio to 200%, waveform point (402,4.000V) will be displayed as below picture shown.
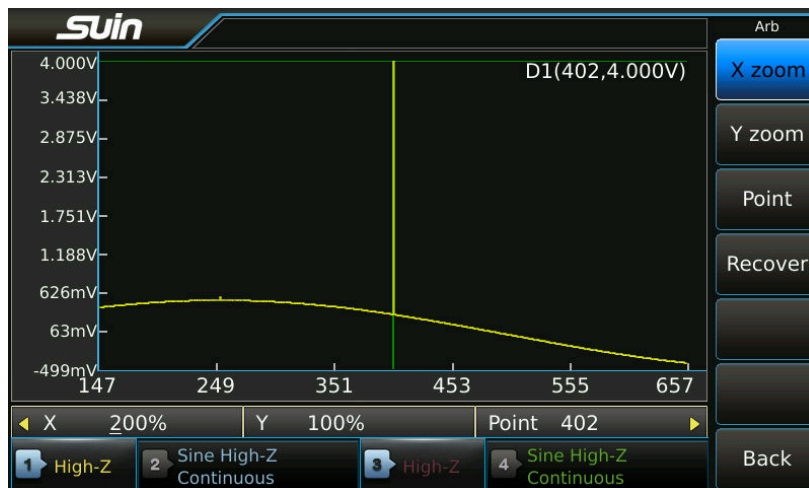
Continue to increase the zoom ratio to 500%, and waveform point (400,4.000V) will display more clearly and reset the zoom ration to 200%.

Vertical Zoom: Press 〖Point〗 soft key and set the horizontal coordinate of mark point to 260. Then observe another waveform point (251,550mV) just modified. The Sine is compressed vertically because of larger amplitude of waveform point (400,4.000V), which leads to the waveform point (251,550mV) is barely visible, so vertical zoom function is required in this situation.

Press 〖Y Zoom〗 soft key and select 'vertical', the instrument will zoom in taking vertical axis as direction and mark point as center. Set the zoom ratio to 500% as below picture shown.
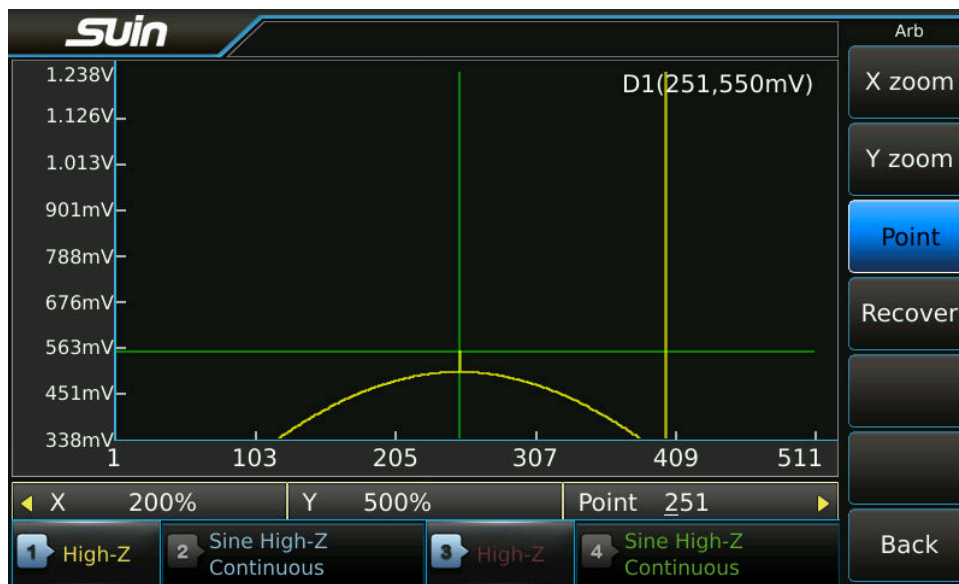
At this moment, points from 512 to 1021 are not shown in the screen.

In conclusion, to observe the local details of a waveform, use 'horizontal zoom' to expand waveform horizontally and use 'vertical zoom' to expand the waveform vertically, and move the waveform left and right through adjust mark point. The zoom operation only changes the display of the waveform but have no effect on the output of the waveform.

After zoom and shift, only the local detail of the waveform is shown in the display window. Press 〖Recover〗 soft key to resume the three parameters to the initial value, then the original appearance of waveform will be displayed again.

3.16.8 Waveform Length

After editing to arbitrary waveform, then load it's data into RAM memory, and the instrument can output arbitrary waveform edited by the user. Press 〖Wave Length〗soft key to set the waveform length, that's the number of samples for arbitrary in a period. The length's setting could less than actual length of the loaded waveform, then parts of the loading waveform could be output, but if the length's setting is greater than the actual length of the loaded waveform, the output of the waveform for excess part is uncertain so this setting not allowed. The default setting of length is the actual length of loaded waveform if there is no set to length.

The maximum editable waveform length of the instrument is 16384 points. If exceeds the 16384 points, please use the arbitrary waveform editing software to download the waveform data from the computer to the instrument.

3.16.9 Sample Rate

The waveform output way is point by point, and you can set the sample rate by press soft key 〖Sample Rate〗, that's the number of sample in one second for arbitrary waveform, the relationship as follows:

Output frequency = sampling rate / waveform length

3.16.10 Sync Output:

The frequency and phase of sync signal is the same as ones of output arbitrary waveform, so phase deviation is not allowed.

3.16.11 Store to built-in waveform

There are 8 waveform memory locations from 'User_arb1' to 'User_arb8' in instrument to store the user defined arbitrary waveforms and recall them at any time like other built-in waveforms. After finishing edition to waveform, press 〖Save As Build-in〗soft key to display menu of memory location and select one of them 〖User_arbX〗, then the current waveform is stored as built-in waveform and won't lost even power off.

Please note that the fixed length of the built - in waveform is 16384 points. If the user defined waveform length is less than 16384 points, it will be scaled up to 16384 points before storage. For example, the length of one user defined waveform is 512 points, then magnified factor is 64 (16384/512), thus each waveform point in memory area will be magnified to 64 points and the data for those 64 points will be exactly the same.

3.16.12 Store to file

Arbitrary waveforms can be stored as file, which can be assigned directly to other machines via USB flash disk.

Press soft keys 〖Wform Store〗and〖Save As File〗 to enter the interface of' file management', press the soft keys〖Open Dir〗and〖Options〗,you can select it if there is file in that folder. Press 〖Save to this file〗soft key to store the arbitrary waveform to this file. (Note: if the file previously stored an arbitrary, this new save will overwrite the original data. Or create a new file to store this waveform.

3.16.13 Recall from the file

Press soft key〖Wform Recall〗to enter the interface of' file management', press soft keys〖Open Dir〗 and〖Options〗, select a file and press soft key 〖Arb Recall〗to recall and display it.

3.16.14 Computer edit

Using the keyboard to edit an arbitrary waveform, which can be modified randomly, is only applied to a simple waveform edition. For complicated waveform edition, computer edit than rather than keyboard edit will be recommended. For details, please refer to how to use arbitrary waveform edition software.

3.17 Waveform Sequence

As the test tasks become more complicated, the requirements for waveform generator are higher than ever. Except of output a single waveform, it also require multi waveforms are lined up as sequence according to requirement, and each waveform could be set length and times to repeat, thus to generate a more longer and complicated waveform.

The waveforms in sequence are all built-in waveforms.

3.17.1 Function Selection

Press 【Waveform Sequence】key and enter waveform sequence function to display wavefo rm sequence list and menu.

3.17.2 Sequence settings

Waveforms sequence has 1024 units, each unit can load a waveform parameter, including waveform's No., length and times to repeat, each unit has a number and be called it seria l number.

Take below table as an example, to customize a sequence consisting of three units, that's to say, a sequence is composed of three waveforms, see below:

	Serial number	Waveform	Times to repeat	Length
Unit1	1	Sine	2	128
Unit2	2	Ramp	4	96
Unit3	3	Third harmonic	1	4096

The operating steps are as follows:

Set the first waveform as below:

Press 〖No.〗 soft key and set to 1.

Press 〖Wave〗 soft key and set to 1,Sine.

Press 〖Wave Length〗 soft key and set to 128.

Press 〖Repeat〗 soft key and set to 2.

Set the second waveform as below:

Press 〖No.〗 soft key and set to 2.

Press 〖Wave〗 and set to 3, Ramp.

Press 〖Wave Length〗 soft key and set to 96.

Press 〖Repeat〗 soft key and set to 4.

Set the third waveform as below:

Press 〖No.〗 soft key and set to 3.

Press 〖Wave〗 soft key and set to 89, Third- harmonic.

Press 〖Wave Length〗 and set to 4096.

Press 〖Repeat〗 soft key and set to 1.

Press 〖Execute〗 soft key, the setting waveform sequence is output.

3.17.3Sample rate

Press 〖Sample Rate〗 soft key to set sampling rate of the waveform sequence. That is to say, the sampling point number in one second of waveform sequence, and the waveform sequence is output point by point. A period of waveform sequence is expressed as follows.

Sequence period=Sum of N (waveform length÷sample rate × times to repeat)

3.17.4 Trigger source

Press〖Source〗 soft key to select the trigger source, if select the internal, the instrument will use the internal trigger source and the waveform sequence output process is continuously repeated. If select manual, every time press 〖Manual Trig〗soft key, the output of waveform sequence will be triggered once. If selected External, the instrument will use external trigger source, and each effective trigger edge will triggers a waveform sequence outp

ut. In modes of manual trigger and external trigger, the output of the waveform sequence is controlled by trigger mode. Input the external trigger signal from the 《Trig In》 port i n the rear panel of the instrument.

3.17.5 Trigger mode

Press 〖Trig Mode〗 soft key to select trigger mode, of which setting is valid in external and manual triggers.

When trigger mode is selected to 'sequence', a group of waveform signals will be output for each effective trigger. Follow the Settings in the above example. The first trigger ca n output 2 Sine signals with repeated cycles, the second trigger can output 4 Ramp sign als with repeated cycles, and the third trigger output one third harmonic with repeat cycl e. It takes three effective triggers to finish the output of a complete waveform sequence when the trigger mode is set to 'sequence'.

The waveform sequence will output one cycle of waveform signals for each valid trigger when the trigger mode 'waveform' is selected. Follow the setting in the above example, o ne sinc signal will be output separately after the first and second triggers, and one Ramp will be output separately after the third, fourth, fifth and sixth triggers, and one third har monic will be output after seventh trigger. That's to say, it takes seven effective triggers t o finish a complete waveforms sequence output when the trigger mode is set to 'wavefor m'.

3.17.6 Trigger Edge

Trigger edge could be set when external trigger. Press 〖Slope〗soft key to select the edge of trigger signal.

If select the 'rising edge', and the trigger signal changes from '0' to'1', the waveform seq uence output starts.

If elect the 'falling edge', and the trigger signal changes from '1' to'0',the waveform sequ ence output starts.

3.17.7 Sync Mode

Press 〖Sync Mode〗 soft key to select output mode of the synchronization signal.

The period of synchronous signal is related to the number of waveforms in the waveform sequence when 'sequence' is selected. According to the setting in the above example, the number of waveforms in the sequence is 3, and the sum of times to repeat is 7. When the waveform sequence is output, three synchronous signals will be output as below picture shown:
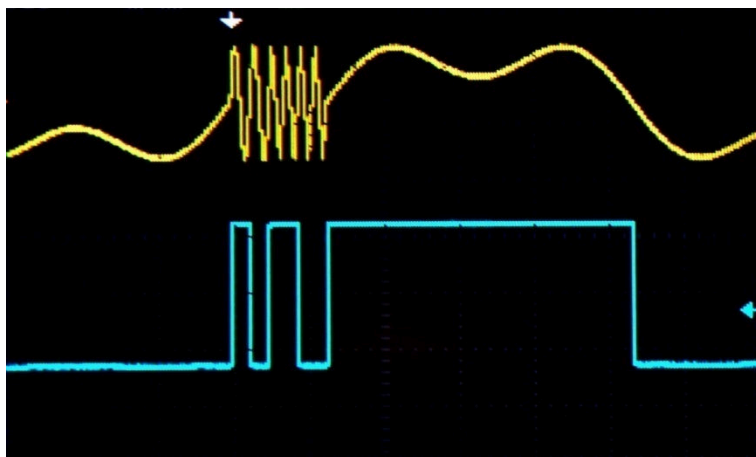
The period of synchronous signal is related to the waveform numbers and times to repeat In the waveform sequence when the 'waveform' is selected. Follow the Settings in the above example, the number of waveforms in the sequence is 3, and the sum of repetitions is 7. When the waveform sequence is output, 7 synchronous signals will be output as the following picture shown.
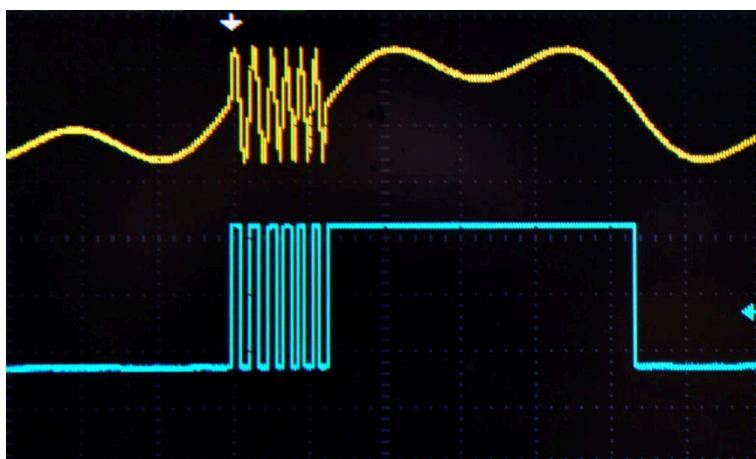
3.17.8 Sync output

The rising edge of the synchronization signal corresponds to the switching point of each arbitrary waveform in the sequence, and the pulse width of the synchronous signal is equal to half of the number of repetitions of this arbitrary waveform.

The synchronization signal is determined by the external trigger or manual trigger if an external trigger or manual trigger is used

3.17.9 Sequence storage

The data of arbitrary sequence is stored in RAM memory and which will be lost once power off. For long time storage, user needs to save the arbitrary wave sequence data to FLASH memory. Press soft keys 〖Store Recall〗and〖Save As File〗to enter the file management interface, press 〖Open Dir〗soft key and then 〖Options〗 and〖New File〗 to create a file named Arb_seq1.wseq (you do not need to enter an extension, and the instrument automatically adds an extension when creating a file,). Save arbitrary sequence data to a file, which is a binary-type file and multiple such files could be saved and could be recall at any time for use.

3.17.10 Sequence Recall

After entering the operation interface of arbitrary wave sequence, press soft keys 〖Store Recall〗and〖Recall File〗 to enter the file management interfaces if arbitrary sequence file has been stored previously, press〖Open Dir〗and find the sequence file Arb_seq1.wseq, press the soft key〖Options〗and〖WaveSeqRecall〗 to load this sequence.

3.18 Channel Coupling

The channels of the instrument have identical characteristic, using channel coupling function can easily change the parameter values of multiple channels. Channel coupling contains frequency coupling and amplitude coupling. There are some differences in setting for the 4-channel model and the 2-channel model.

3.18.1 Function selection

Press 【Multiple Channels】 key to enter channel coupling function.

3.18.2 Source channel and Target channel

For 4-channel model, only 2 channels that's CH1 and CH3 can be used as source channel When CH1 is source channel, it can be coupled to the other three or two or one channels. When CH3 is the source channel, it can only be coupled to CH4. CH2 and CH4 cann

ot be used as source channels. For 2-channel model, both CH1 and CH2 could be used as source channel or target channel, press 〖Direction〗soft key to switch.

3.18.3 Coupling Mode

Press 〖Mode〗soft key to enter the coupling mode selection menu, You can select four c oupling modes, which could be valid at the same time. This setting is not available to 2-channel model.

3.18.4 Target Channel

Press 〖TargetChannel〗 soft key to enter the channel selection menu and select the targ et channel of the current mode. For example, if current model is 'mode 1', press the soft keys 〖CH2〗and 〖CH3〗and they are highlighted to mean they are chosen. Press the s oft key 〖CH2〗again and it's highlight disappear to mean CH2 is removed, and the chos en target channel is shown in the display area. Because CH3 has been selected as the tar get channel in 'mode 1', it cannot be selected as the target channel again in other modes. The setting is not available for 2-channel model.

3.18.5 Frequency Coupling

With frequency coupling function, generator can make frequency output of channels relates and generates multiplied frequency or differenced frequency signal. Press 〖FreqCpl〗 soft key to set the frequency coupling to 'On', and the frequency value between channels shall comply with the following formula.

Target channel's frequency= Source channel's frequency×frequency ratio+ frequency difference

When using the frequency coupling function, if the frequency of the target channel exceeds the frequency upper or lower limit, the instrument will set the frequency to the limit value and the above formula is no longer applied to.

3.18.6 Amplitude Coupling

Amplitude coupling enables the output amplitude between channels related and output differential signal. Press 〖AmplCpl〗 soft key and set the amplitude coupling to 'On', and the amplitude or offset value of the two channels shall comply with the following formula:

Target channel amplitude= Source channel amplitude+ amplitude difference

Target channel offset= Source channel offset+ offset deviation

When using the amplitude coupling function, the instrument will set the amplitude or offset to the limit value if the amplitude or offset of the target channel exceeds the upper limit or lower limit, and the above formula is no longer applied to.

3.18.7 Coupling parameter

Press 〖MultipleParam〗 soft key to enter the coupling parameter setting menu. Four parameters can be set: frequency ratio, frequency difference, amplitude difference and amplitude ratio.

3.18.8 Phase alignment

Press〖AlignPhase〗soft key and select the channel to be alignment, and press〖ConfirmAlign〗soft key, the synchronization signal of the selected channel can be aligned with the CH1 phase. At this moment, the phase difference between each channel could be calculated according to phase setting for each channel.

3.19 File Manager

File managers are used in the operations of harmonic synthesis, frequency sequences, arbitrary waveforms, arbitrary wave sequences, instrument state, system update and USB disk operation. File manager allows user to handle file save and recall conveniently in the above function.

3.19.1 Layout

The layout of the file manager is as below picture shown:

1. Current directory area: to display current opened directory (folder), that is the upper directory of sub-directory display area.

2. Subdirectory area: to display the sub-directory of current directory and the file comply with the type.

3. Type of operated file: it contains below types:

File of harmonic series: Harm_seq*.har

Frequency data file: Freq_data*.freq

Arbitrary wave data file: Arb_data*.arb

Arbitrary wave sequence file: Arb_seq*.wseq

Operating state file: State*.sta

FPGA Update file: Update_FPGA.bin

4. Current operation: to indicate the use of current opened file manager such as harmonic synthesis, frequency sequences, arbitrary wave sequences, operating state, system update

5. Current file path: to indicate current operation directory of selected file.

3.19.2 Locate File

The files can be located by the following steps:

(1) Open directory (folder): press right key to move the cursor to sub-directory area, then use up/down key to select the file you want to open. Press〖Open Dir〗to show the next directories and files whose type meets with the operation requirement. The files can be transferred to the Current Directory Area on the left, while the files or document list included in the files are displayed in the right Sub-directory Area. If the documents are failed to be found, generator will continue select the file in the right sub-directory area until locating them.

(2) Fold directory: press 〖Fold Dir〗 soft key to fold current directory and current directory area to display top level directory.

(3) Directory Branches: There might be various files when using USB device. Then both of the directory open and fold directory will be used to search branches of files one by one to find the required document. But the document is easy to be found in internal memory named Local when the quantity files is not big.

3.19.3 Create Files

Create a file with the required type, avoiding replacing the existing file in the saving process.

Press〖NewFile〗soft key, pop up Key Board, enter the file name by finger touch edition or number

keys and no extension name is needed.
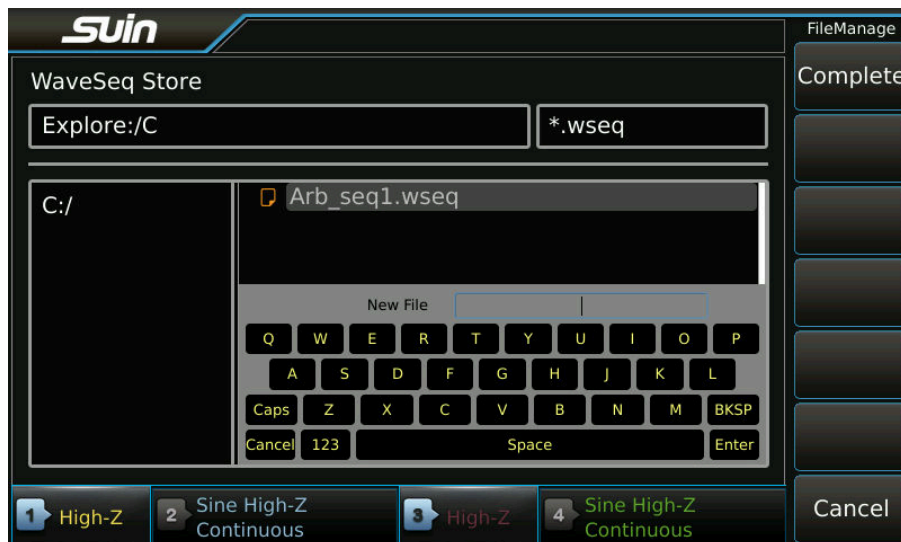
When finish file name, press〖Complete〗to save the file. Generator will add the right suffix behind

the file name. The new file can be shown in the Sub-directory Area.
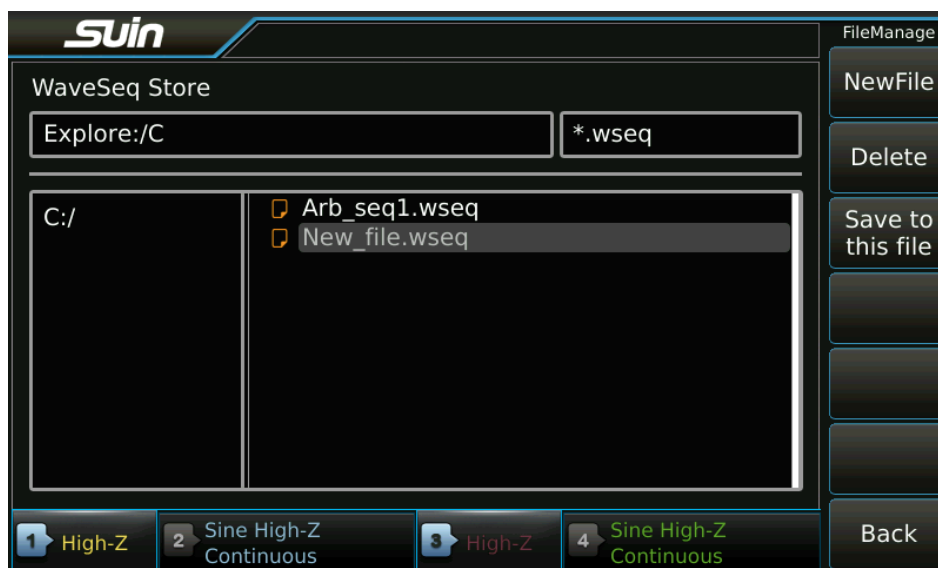
3.19.4 Delete file

Choose the required file in the Sub-directory Area, Press 〖DelFile〗 key to delete stored file.

3.20 System Setup

3.20.1 Function Selection

Press 【Utility】key to enter auxiliary function and set the items like interface display, operating

state, language, Interface and so on.

3.20.2 Language selection

Press 〖Language〗soft key to choose Chinese language or English language. The selection is available for operate menu and prompt information. The rest part is shown in English. Once you set the language, it will be shown in this language all the time even system reset and power off.

3.20.3 Power-on State

A set of default state is load into instrument before factory shipment. If power-on state is set to 'Last', the current setting for state will be stored automatically.

Press 〖Power on〗soft key and select 'Default' or 'Last' as Power-on State recurrently.

Once select 'Default', the generator will recall the default state at power-on. The default state is recommended when generator is used by many people or operation changes a lot.

If select 'Last', the generator will automatically recall the last setting that before power off the generator. For continuous work, user can set the power-on state as Last to reduce the repeated operation every time they turn on the generator. .

3.20.4 Display/Sound

Press〖Display Sound〗soft key to enter into the setting menu.

(1) Press〖ScrnSvr〗key to set the screensaver on or off.

If set on, the generator will enter into the screen protection if no operation is conducted within 2 minutes. A moving logo is shown on screen. Pressing any button or using knob can active the instrument.

If set off, the screen can be in work state all the time.

(2) Press〖Light〗key to adjust the backlight of screen.

(3) Press 〖Beep〗 key to enable or disable the beep for key pressing.

If the beep is set on, any operation such as pressing the button or using knob can make the generator one short beep to show the action work.

If the beep is set off, the generation is in mute state to avoid disturbing any other people.

But once the setting is out of range, generator also gives a warning with long blew. The alarm is not controlled by the switch of Beep.

3.20.5 State storage and recall

The instrument can set various functions in use, such as continuous, modulation, etc. Various parameters can be set in each function, such as waveform, frequency, amplitude modulation depth, etc., which are called operating state of the instrument. Each user can store the state they preferred into device and which can be quickly recall when use next time.

Press 〖StateStore〗soft key to store the current state into state file and recall it by pressing 〖StateRecall〗 soft key.

3.20.6 Network setting

Press〖Net Set〗enables users to set parameters involving network access.

Press〖DHCP〗key to set DHCP on or off. If DHCP is on, user can not set the IP, Subnet Mask and Default Gateway.

Press〖IP Addr〗key to set IP address by numeric keys.

Press〖Submask〗key to set subnet mask by numeric keys.

Press〖GateWay〗key to set Default Gateway by numeric keys.

3.20.7 System information

Pressing 〖System Info〗is to check the information about system information. These information is not identical for each device
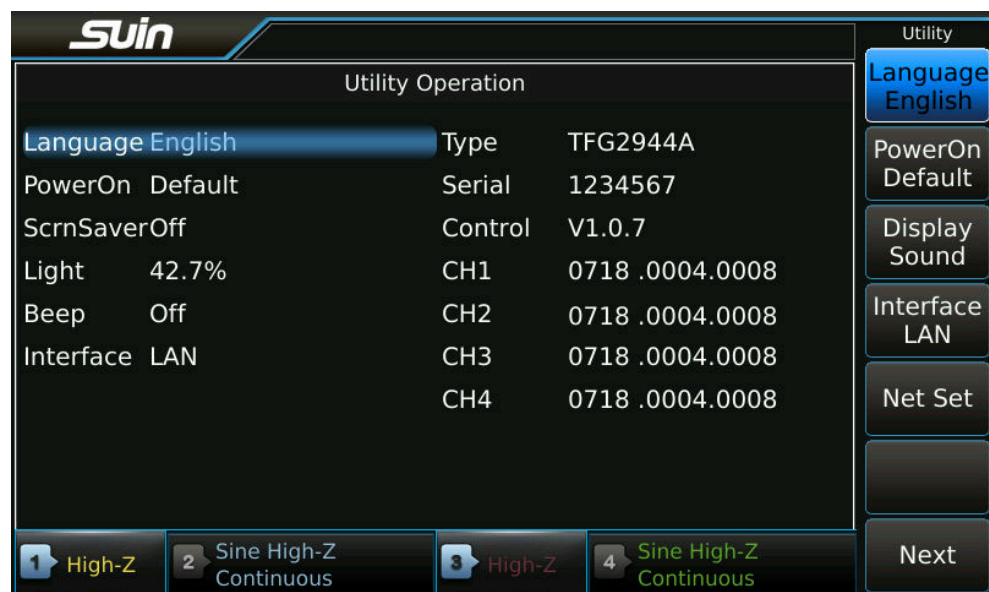
Type: the model of generator. It is fixed after leaving factory

Serial: It is fixed and unique.

Control: the version of controlling program. It mainly affects the operation of the generator, and can be renewed after update of system.

FPGA: version of firmware. It mainly impact on function of the instrument, and can be renewed after update of system.

3.21 System Update

For found Bug or some improvements to instrument, system update function is required to update the bottom firmware and control program of instrument. If the update is failing, it will cause the abnormal work of device and users have to return factory to repair. Therefore, please take care to use this function and it's better to contact us before update.

3.21.1 Control software update

The suffix of update package is 'sys'. Rename it as 'SysUpdate.sys' and copy to a USB flash disk with FAT32 format, then insert the USB to the USB Host interface in the front panel.

Power on the instrument, then press and hold【Reset】key at once until a message pops up on the screen. Then release【Reset】key, and the message of completing updates will be displayed on the screen several minutes later. Then the generator will reboot automatically to complete the update.

3.21.2 Firmware update

Generator has 2 or 4 channels and every channel's firmware is independent, so updates should be done to every channel. Channel No. is shown as * in below instruction. There will be a message of completing updates for every channel when it completes updates. You can reboot the generator now, or continue to update other channels and reboot the generator after all channels completed updates.

The suffix of firmware update package is 'bin'. Copy it to USB flash disk with FAT32 format and then insert it to the USB Host interface in the front panel. Generator can recognize it and has an usb icon in the screen.

Press【Utility】→〚Next〛→〚Upgrade〛, system updates interface will be shown. Rotate the knob and select 'UDisk' directory, press 〚OpenDir〛to open 'UDisk' directory, the files and file folders under this directory will be shown, and then rotate the knob to choose the updated file suffix as 'bin'.

Press 〚Options〛→〚SeleChannel〛→〚CH*〛, and message 'CH*：system will be upgraded, Do you want to continue?' will be shown on the screen, then press 〚Confirm〛and generator will start to update firmware. During this updating process, there will be messages 'Checking the upgrade package' 'Please do not operate then instrument as it is being updated'. And after updates completed, it will show 'Channel*The update is complete, please restart'. If update fails, it will show 'Upgrate failed'. Press 〚Cancel〛to exit the updating.

3.22 Clock Calibration

TCXO is used on this waveform generator, after a long time operating, the oscillator will age and which will lead to the drift of frequency. Therefore, clock calibration is required to solve this problem.

Frequency counter will be used during clock calibration, connect the 10MHZ Ref Out port in the rear panel of device into frequency counter, then press 【Utility】and enter auxiliary function interface, press soft keys 〚Cal Info〛 and 〚Clock Cal〛to enter clock calibration function. Please operate as per of promotes from instrument one by one. Finally input the measured frequency value to complete the clock calibration.

3.23 Signal Port

There are four signal output ports in front panel of instrument and twenty four signal ports in rear panel (only 12 signal ports available on 2-channel model).

The ground of 'Counter In 1' and 'Counter In 2' ports is directly connected to the ground of the case; The ground of the '10MHz In' port is independent, absolutely isolating from ground of the case and other signal ports. In addition to the above three signal terminals, other signal ports share a signal ground, which is insulated isolated from the ground of the case. Therefore, the signal port can be connected with the circuit of different reference potentials floatingly, but the voltage between the signal ground and the case ground must not exceed 42Vpk, otherwise the instrument may be damaged.

The output port of the instrument is strictly prohibited to be used as signal input port, otherwise, it may cause damage to the instrument.

(1) Signal output port CH1, CH2, CH3 and CH4 (only CH1 and CH2 are available for 2-channel models): All are located in front panel and out signal from corresponding channel.

(2) Signal output port 《Sync》: It's located in the rear panel (the 2-channel instrument is located in the front panel) and output the sync signal.

Synchronous output signal is a pulse compatible TTL with rich higher harmonics. The sync out may interfere in the main signal and please turn off it when unneeded. The default state of Sync output is Off when power on instrument.

(3) Modulation port 《Mod in I》, 《Mod in Q》: They are located in the rear panel and served as input port, external modulation signal is input from this port.

(4) Trigger port 《Trig In /Out》 : It's located in the rear panel and is an inout port. It served as input port to input the external trigger signal when the trigger source is selected to 'External'.

Press 〖Polarity〗 soft key, if select positive polarity, the logic high level of the trigger signal is taken as the number '1' and the logic low level as the number '0'. If select negative polarity, the logic high level of the trigger signal is taken as the number '0' and the logic low level as the number '1'.

Press 〖Slope〗soft key, The jump of the trigger signal from low to high is considered as the effective triggering edge if the 'rising edge' is selected, The jump of the trigger signal from high to low is considered as the effective triggering edge if the 'falling edge' is selected.

When the trigger source is selected as 'internal', the trigger port 《Trig In /Out》 is served as the output port to output the internal trigger signal to trigger other devices.

Press 〖TrigOut〗 soft key. If 'rising edge' is selected, the signal of the trigger port is logic high level when the output number '1' is triggered. If selected as a 'falling edge', the signal of the trigger port is at a logical low level when the output number '1' is triggered. If you select close, the trigger port has no signal output.

If the current function is Burst output, the triggered port will output the number '1' during the output of the burst signal, and the triggered port will output the number '0' during the burst signal is closed.

If the current function is frequency sweep and the trigger source is selected as 'internal', the trigger port will output the number '1' when the sweep starts, and the pulse width of the number '1' is half of the total sweep time.

If the current function is a frequency sequence and the trigger source is selected as 'internal', the trigger port will output the number '1' when the sweep starts, and the pulse width of the number '1' is equal to a duration time.

(5) Counter input port《Counter In 1》,《Counter In 2》: They are located in rear panel. 《Counter In 1》 is the input port of counter 1, 《Counter In 2》 is the input port of counter 2.

(6) Clock input port 《10MHz Ref In》 : It's located in the rear panel and used to input external clock signal.

(7) Clock output port《10MHz Ref Out》: It's located in the rear panel and used to output internal clock signal.

3.24 Communication port

The communication port of the instrument is connected to the ground of the case.

3.24.1 USB Host: This connector is provided on front panel, which is used to insert U-disk to store and recall the user-defined waveforms or instrument state, or used for system update.

3.24.2 USB Device: The USB Device connector is provided on rear panel, which be connected with PC using USB cable to remote control 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.

3.24.3 LAN Port: The LAN Port is provided on rear panel, which be connected with PC through LAN cable to remote control for the instrument. For detail instruction, please refer to CD.

3.24.4WIFI Port: The WIFI Port is provided on rear panel, which is connected with PC through wireless connection. For detail instruction, please refer to CD.

3.25 Frequency Reference

3.25.1 Frequency reference input port《10MHz Ref In》: The port is provided on rear panel, the external clock signal can be input to synchronize this instrument with other devices, or the external clock with higher precision can be used to further improve the accuracy of output frequency. The clock input port adopts ac coupling mode of transformer, and there is no common ground terminal with other ports of the instrument.

When there is an external clock access, and the clock frequency is within the range that can be locked, the prompt message of 'external clock access' is displayed, and 'Ext Ref On' is displayed in the state information display area. The instrument automatically switches to the external clock.

The prompt message 'the external clock is invalid, please move the excluded clock' displayed if the external clock frequency is beyond the range that can be locked. At the same time, 'Ext Ref In' is displayed in the status information display area, and the device will automatically switch to the internal clock. If the external clock is not removed, the instrument will frequently detect whether the external clock can be locked, which will make the frequency of output signal unstable, so the external clock needs to be removed.

If the external clock is disconnected, prompt 'external clock removal' is displayed. The state information display area no longer displays information related to the external clock, and the instrument will automatically switch to the internal clock.

3.25.2 Frequency reference output port《10MHz Ref Out》: The port is provided on rear panel to output 10MHz clock signal and which can be used as the clock of other devices to synchronize other devices with this instrument.

3.26 Default Setting

3.26.1 Continuous output (default continuous output after startup)

Waveform	Sine	Duty Cycle of Square	50%
Frequency	1kHz	Symmetry of Ramp	50%
Amplitude	1Vpp	Pulse Width	500μs
DC Offset	0Vdc	High Level Limitation	10Vdc
Output Phase	0°	Low Level Limitation	-10Vdc
Output Polarity	Positive	Output Port	Off
External Load	High Z		

3.26.2 Modulated output (FM,AM,PM,PWM,Sum)

Frequency Difference	500Hz	Phase Deviation	90°
AM Depth	100%	Modulating Frequency	100Hz
Pulse Width Difference	50%	Modulating Waveform	Sine
Sum Amplitude	100%	Modulating Source	Internal

3.26.3 Modulating Output(FSK,4FSK,nFSK,PSK,4PSK,nPSK,ASK,OSK)

Hop Frequency 0	1Hz	Hop Phase 0	0°
Hop Frequency 1	200Hz	Hop Phase 1	180°
Hop Frequency 2	5.0KHz	Hop Phase 2	45°
Hop Frequency 3	400Hz	Hop Phase 3	90°
Hop Amplitude	0.5Vpp	Hop Rate	100Hz
Hop Time	3ms	Trigger Source	Internal
		Trigger Polarity	Positive

3.26.4 Burst output

Burst Period	10ms	Burst Mode	Triggered
Burst Count	3cyc	Trigger Source	Internal
Start Phase	0°	Trigger Output	Off

3.26.5 Double Pulse

Double pulse frequency	1kHz	Double pulse status	positive pulse

First pulse width	200 μ s	Trigger source	internal
interval time	100 μ s	Trigger out	close
Second pulse width	50 μ s		

3.26.6 Frequency Sweep

Starting Frequency	100Hz	Return Time	1ms
Stop Frequency	1kHz	Interval Time	0s
Mark Frequency	550Hz	Sweep Mode	linear
Sweep Time	5s	Trigger Source	internal
Remain Time	0s	Trigger Output	close

3.26.7 Frequency Sequence

Sample Rate	1Hz	Trigger Source	Internal
Sequence Length	20	Trigger Output	closed
Sequence Mode	Customized sequence		

Frequency Data

NO.1	NO.2	NO.3	NO.4	············	NO.20
1kHz	2kHz	3kHz	4kHz	············	20kHz

3.26.8 Arbitrary Waveform Sequence

Sample Rate	1MSa/s	Trigger source	Internal
Sequence Length	3		

Arbitrary Waveform Sequence

	Arbitrary 1	Arbitrary 2	Arbitrary 3
Waveform	Sine	Ramp	third harmonic
Initial Address	2000	4000	6000
Waveform Length	128	96	4096
Repeated Period	2	4	1

3.26.9 Channel Coupling

Frequency Ratio	1	Coupling mode	Mode 1
Frequency Difference	0Hz	Coupling direction	CHA → CHB
Amplitude Difference	0Vpp	Frequency coupling	closed
		Amplitude coupling	closed

3.26.10 System Settings

Language	Chinese	Screen Lightness	50%
Power on status	Default	Key Sound	Close
Screen Saver	Close	Remote interface	USB

3.27 Frequency Counter (option)

The frequency counter has four functions to measure the frequency period, pulse width and duty cycle of input signal. The default setting is frequency measurement like below picture shown, of which 'Frequency', 'Period', 'PulseWidth' and 'Duty' in screen shown could be switch by press touch screen.

Counter 1 could set gate time, trigger level, couple, impedance, bandwidth limit and attenuator, counter 2 could set gate time.

3.27.1 Gate Time: Press softkey〖GateTime〗to set it, default setting is 1s.

3.27.2 Trigger Level: Press softkey 〖TrigLevel〗to set it, default setting is 0mV.

3.27.3 Couple Mode: Press softkey 〖Couple〗 to set couple mode of counter between DC and AC, default setting is AC.

3.27.4 Input Impedance: Press softkey 〖Imped〗to set input impedance of counter and default setting is MΩ.

3.27.5 Bandwidth Limit: Press softkey 〖BW Limit〗to set bandwidth of frequency counter, of which is used to limit the signal beyond 100kHz to input counter, the default setting is off.

3.27.6 Attenuator: Press softkey〖Attenuate〗to set the attenuating status of counter, the default setting is off.

Chapter 4 Service and Support

4.1 Warranty

For the technical and material's defects of the products that Suin Instruments Co., Ltd produced and sold, we promise one year warranty since the shipment day. During the warranty, as to the defective products which are proved, we will regroup or replace these defective ones based on the detailed provisions of the warranty.

Except guarantees of this outline and warranty, we factory make no any other forms of expressed or implied guarantees at all. In any case, we factory bear no responsibility with those direct, indirect or any other consequential loss.

4.2 Contact

If you have any inconvenience during the use of this product, please contact us directly.

Working time: 8:30am~17:15pm Monday to Friday, Beijing Time

Sales: 0086-0311-83897147

Fax: 0086-0311-83897040

Email: export@suintest.com

Website: www.suindigital.com

Chapter 5 Specifications

The test for specifications should be carried out under the ambient temperature 18℃~28℃, warm up at least 30 minutes after power on, make instrument placed separately and no stacked, good ventilation cooling and keep at least 150mm airspace on both sides and rear side.

5.1 Continuous Output

5.1.1 Built-in Waveform:

165 kind of waveforms including Sine, Square, Ramp, Pulse, Noise, DC, PRBS (Pseudorandom Binary Sequence), User-defined Arbitrary, User-defined Harmonic and so on.

Sample rate: 1.2GSa/s

Amplitude resolution: 14 bits

5.1.2 Sine

Harmonic Distortion (0dBm):	≤－65dBc	frequency<40MHz
	≤－60dBc	frequency<80MHz
	≤－55dBc	frequency<120MHz
	≤－50dBc	frequency<150MHz
	≤－45dBc	frequency<200MHz
	≤－40dBc	frequency<250MHz
	≤－45dBc	frequency<300MHz
	≤－50dBc	frequency≥300MHz

Total Distortion: ≤0.2%(20Hz~20kHz，20Vpp)

Phase Noise: ≤-140dBc/Hz(0dBm，10kHz offset, 10MHz)

5.1.3 Square

Duty Cycle: 0.01%~99.99%(limited by frequency setting)

Overshoot: ≤ 5%(typical value)

Edge time: ≤2.5ns(1Vpp)

5.1.4 Pulse

Duty Cycle: 0.01%~99.99%(limited by settings of frequency and edge time)

Overshoot: ≤ 5%(typical value)

Edge time: 2.5ns~1.2s(1Vpp)The rising edge and the falling edge are separately adjustable

Pulse width: 4ns~ (Period - 4ns)

5.1.5 Double Pulse:

Overshoot: ≤ 5%(typical value)

Edge time: ≤2.5ns(1Vpp)

First pulse width: 5ns~20s

Second pulse width: 5ns~20s

Time Interval: 5ns~20s

Pulse width and interval time resolution: 5ns

Pulse Status: positive pulse, negative pulse, positive and negative pulse

Trigger source: Internal, external

5.1.6 Ramp

Symmetry: 0.0%~100.0%

5.1.7 Arbitrary Waveform

Sample Mode: Point by point

Sample rate: 1μSa/s~200MSa/s

Waveform Length: 2~16K points   step: 1point

                16K~32M points   step: 4 point

Amplitude Resolution: 14bits

5.1.8 Harmonics Synthesis

Harmonic Order: 1~50

Harmonic Phase: 0°~360°

5.1.9 Frequency

Range: Sine: 1μHz~400MHz(note)

Square: 1μHz~120MHz

Pulse: 1μHz~80MHz

Ramp: 1μHz~6MHz

Other waveforms: 1 μ Hz~50MHz

Resolution: 1　μ Hz or 12 digits

Accuracy: ±1ppm±1μHz　　0℃~40℃

Aging rate: ±1ppm/year

5.1.10   Amplitude(50Ω load, offset 0Vdc)

Range: 1mVpp~10Vpp　　frequency≤40MHz

　　　1mVpp~5Vpp　　　frequency≤100MHz

　　　1mVpp~2Vpp　　　frequency≤200MHz

　　　1mVpp~1.5Vpp　frequency≤300MHz

　　　1mVpp~1Vpp　　　frequency>300MHz

Resolution: 1mVpp or 3digits

Accuracy: (Sine 1kHz, ≥10mVpp, high impedance):±(of settings value×1%＋1mV)

Flatness: (Sine 0dBm，relative to 10MHz):

　　　　±0.2dBm　　frequency<100MHz

　　　　±0.3dBm　　frequency<200MHz

　　　　±0.4dBm　　frequency<300MHz

　　　　±0.5dBm　　frequency≥300MHz

Unit (Sine) : Vpp, Vrms, dBm

5.1.11 DC offset (50 Ω load) :

Range: ±5Vpk(ac＋dc)

Resolution: 1mVdc

Accuracy(High-Z): ±(|setting value|×1%＋2mV＋amplitude value ×0.5%)

5.1.12Polarity and Phase

Output Polarity: positive or negative

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

5.1.13 Signal Output

Output impedance: 50Ω (typical value)

Output protection: overload automatically disables main output

Port grounding: The signal is isolated from the case

5.2 Modulation Output

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:	1mHz to 100kHz
Frequency Difference:	0 Hz to upper frequency limits/2
AM Modulating Depth:	0% to 120%
Phase Deviation:	0° to 360°
Pulse Width Deviation:	0% to 99.9%
Sum amplitude:	0% to 100%
Modulating Source:	Internal and External

5.2.2 FSK, 4FSK, NFSK, PSK, 4PSK, NPSK, ASK and OSK

Carrier Waveforms:	Sine, Square, Ramp and so on
FSK Frequency:	1μHz to upper frequency limits
Hop Phase:	0° to 360°
Hop Amplitude:	1mVpp to amplitude of carrier
Hop Time:	5ns to 500s
Hop Rate:	1μHz to 1MHz
Modulating Source:	Internal/External

5.3 Burst Output

5.3.1 Burst Waveform:	Sine, Square, Ramp and etc.
5.3.2 Burst Mode:	Triggered, Gated
5.3.3 Burst Period:	1μs to 600s
5.3.4 Burst Signal Frequency:	2mHz~ upper frequency limit (see note 2)
5.3.5 Burst Count:	1 to 100000000 cycles
5.3.6 Gated Output:	More than two complete cycles
5.3.7 Start/Stop Phase:	0°to 360°

5.3.8 Trigger Source: internal, external or manual

5.4 Frequency Sweep

5.4.1 Sweep Waveform: Sine, Square, Ramp, etc.

5.4.2 Sweep Range: 1 μ Hz ~ upper frequency limit

5.4.3 Sweep Mode: Linear, logarithmic

5.4.3 Sweep Time: 1ms to 500s

    Hold Time: 0s to 500s

    Return Time: 0s to 500s

    Interval Time: 0s to 500s

5.4.5 Trigger source: Internal, external, manual

5.5 Frequency Sequence

5.5.1 Sequence waveform: Sine, Square, Ramp etc.

5.5.2 Frequency Range: 1μHz~upper frequency limit

5.5.3 Sequence Mode: Customized sequences, pseudo-random sequences

5.5.4 Sequence Length: 2~1024

5.5.5 Sample Rate: 1mSa/s~50MSa/s

5.5.6 Trigger Source: Internal, external, manual

5.6 Waveform Sequence

5.6.1 Sample rate: 1μSa/s~200MSa/s

5.6.2 Waveform length: 12~16K points   step:4 points

5.6.3 Times of repetition: 1~1024

5.6.4 Sequence length: 2~1024

5.6.5 Trigger source: Internal, external, manual

5.7 Channel Coupling

5.7.1 Coupling direction: CHA→CHB, CHC, CHD, CHC→CHD

5.7.2 Frequency Coupling: Frequency ratio, frequency difference

5.7.3 Amplitude and offset coupling: Amplitude difference, Offset difference

5.7.4 Phase alignment: phase difference between channels ≤5ns (typical value)

5.8 Sync Output

5.8.1 Waveform characteristic: Square, edge time≤20nS

5.8.2 Frequency and pulse width: Changes with working mode

5.8.3 Output level: TTL compatible

5.8.4 Output impedance: 50Ω (typical value)

5.8.5 Port grounding: The signal is isolated from the case

5.9Modulation/Trigger Input

5.9.1 Modulation Input: ±2.5Vpp (full value)

5.9.2 Trigger Input: TTL level

5.9.3 Input Resistance: 10kΩ (typical value)

5.10 Communication Port

5.10.1 Interface types: USB Host, USB Device, LAN port, WIFI

5.10.2Port grounding: Connected with case grounded

5.11 Frequency Reference

5.11.1 Frequency reference input:

Frequency: 10MHz±50Hz

        10MHz±0.5Hz (when OCXO option is selected)

Amplitude: 100mVpp~5Vpp

Input resistance: 1kΩ，AC coupling

5.11.2 Frequency reference output:

Frequency: 10MHz

Amplitude: 0dBm

Output impedance: 50Ω, AC coupling

5.12 General Characteristics

5.12.1 Power: Voltage: AC 100~240V

Frequency: 45~65Hz

Power Consumption: <70VA   (TFG29X2A)

<80VA   (TFG29X4A)

5.12.2 Environmental Conditions: Working Temperature: 0~40℃, Humidness: <80%, Storage

Temperature: -30~60℃

5.12.3 Operating characteristics: All key operation, knob continuous adjustment, English and

Chinese menu

5.12.4 Display: 7″colorful TFT-LCD Touch screen, pixel: 800×480

5.12.5 Dimensions & Weight:

363mm×154mm×327mm, Approx. 7.0kg (TFG29X2A)

363mm×154mm×467mm, Approx. 10.0kg (TFG29X4A)

5.13 Frequency Counter (option)

5.13.1 Counter 1

Frequency range: DC coupling 1Hz~100MHz

AC coupling 1MHz~100MHz (50Ω open)

AC coupling 30Hz~200 MHz (1MΩ open)

Dynamic range: 50mVrms~1.0Vrms Sine

150mVP-P~4.5VP-P Pulse

Input Impedance: 1MΩ//35pF or 50Ω

Coupling mode: AC or DC

Attenuator: off or ×10

Filter: ending frequency is around 100kHz

Trigger level: -5.000V~+5.000V, step value 3mV

5.13.2 Counter 2

Frequency range: 100MHz~3GHz

Dynamic range: -15dBm~+13dBm Sine (Frequency: 100MHz~2.0GHz)

        -10dBm~+13dBm Sine (Frequency: 2.0GHz~3GHz)

Input Impedance: 50Ω

Coupling mode: AC

5.14 OCXO (option)

5.14.1 Accuracy: ±0.01ppm±1μHz   0℃~40℃

5.14.2 Aging Rate: ±0.03ppm/year

Note 1: Frequency range of sine: 1μHz~200MHz(TFG292XA)

                                1μHz~300MHz(TFG293XA)

                                1μHz~400MHz(TFG294XA)

Note 2: The burst signal may become distortion at a higher frequency.